NCHRP Project 20-07/Task 355

GUIDELINES FOR RELIABLE FIT-UP OF STEEL I-GIRDER BRIDGES

FINAL REPORT

Prepared for
The AASHTO Subcommittee on Bridges and Structures,
T-14 Structural Steel

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ABSTRACT

This report presents the results of research supporting the development of improved design, detailing and erection guidelines to ensure reliable fit-up of skewed and/or curved steel I-girder bridges. Twenty-one bridges, including multiple framing arrangements on a number of the bridges, are analyzed to provide quantitative support for, and refinements to guidelines produced by an affiliated National Steel Bridge Alliance (NSBA) Steel Bridge Collaboration Task Group. The quantitative data of this research support recommended cross-frame detailing methods, as a function of the bridge geometry, provided in the guidelines document. Forces required to assemble the steel during erection are evaluated and difficult cases are highlighted. Suggested erection considerations are provided to facilitate fit-up. In addition, the report investigates and specifies beneficial staggered cross-frame arrangements for straight skewed bridges, as well as framing arrangements around bearing lines at interior piers in continuous-span bridges. The report places a major emphasis on identifying the impacts of cross-frame detailing methods on girder elevations, girder layovers, cross-frame forces, girder stresses, and vertical reactions in completed bridge systems. Simplified methods of accounting for SDLF and TDLF detailing effects are provided. In addition, procedures are developed and explained for direct calculation of the locked-in forces due to Steel Dead Load Fit (SDLF) and Total Dead Load Fit (TDLF) detailing in cases where a more precise calculation of these effects may be beneficial. Lastly, inspection best practices are recommended to ensure that the erected geometry sufficiently meets the specified fit conditions, and design specification provisions are developed that synthesize the key guidelines.

EXECUTIVE SUMMARY

Steel I-girder bridges have performed well in the majority of cases that involve horizontal curvature and skew. However, in situations where problems have occurred, these problems often have been related to difficulty of fit-up (i.e., assembly) of the steel components and/or control of the constructed geometry. In addition, questions are sometimes raised regarding the impact of forces that may be locked into the structural system during the erection. The mitigation of these three issues is referred to generally in this research as "reliable fit-up." Three key considerations pertaining to reliable fit-up of steel I-girder bridges include:

- Understanding the implications of different types of cross-frame detailing methods,
- Determining the impact of various cross-frame framing arrangements (variations in cross-frame location and/or spacing, staggered versus contiguous cross-frames, etc.), and
- Identifying the benefits and limitations of specific erection procedures and practices

with regard to facilitating the assembly of the steel during the steel erection, enhancing the achievement of the targeted constructed geometry, assuring the generation of beneficial locked-in forces in the structural system, and limiting the development of non-beneficial locked-in forces in the structure. Bridges with significant span lengths, curvature and/or skew generally have a greater potential to experience difficulties relating to reliable fit-up.

This research has analyzed 21 bridges with a range of different curved and/or skewed geometries, as well as multiple framing arrangements on a number of these bridges. The bridges are analyzed at various stages during their steel erection and in their completed condition. Cross-frame fit-up forces are evaluated and discussed for each of the bridge cases. Bridges with difficult fit-up are highlighted. In a number of cases that involve the installation of drop-in girder segments, girder splice fit-up forces are evaluated and discussed. The quantitative data of this research support the recommended fit conditions (i.e., recommended cross-frame detailing methods) as a function of the bridge geometry, provided in a referenced National Steel Bridge Alliance (NSBA) guidelines document. The fit condition recommendations address two main bridge categories: straight skewed I-girder bridges and curved I-girder bridges with or without skewed supports. The research also investigates the influence of erection schemes and provides recommendations for erection procedures (such as lifting, holding, and shoring requirements and target holding and temporary support elevations for erection) that facilitate fit-up. In addition, the research recommends beneficial staggered cross-frame arrangements in straight skewed bridges, as well as specific framing arrangements around bearing lines at interior piers in continuous-span bridges. A major emphasis is placed on identifying the impacts of cross-frame detailing methods on various responses in the completed bridge systems. Simplified methods of accounting for SDLF and TDLF detailing effects are provided. In addition, methods of rigorously including the effects of Steel Dead Load Fit (SDLF) and Total Dead Load Fit (TDLF) directly in the structural analysis are developed and explained. Lastly, the research develops recommended inspection best practices to ensure that the erected geometry sufficiently meets the specified fit conditions and design specification provisions that synthesize the key guidelines.

1. BACKGROUND

1.1 Problem Statement

Tighter constraints on right-of-way, particularly in urban environments, have led to a significantly increased utilization of skewed and/or curved alignments in highway bridge construction. Due to the relative ease of configuring the structure to the roadway geometry, steel I-girder bridges are often a preferred option for these cases. However, challenging attributes of the framing arrangements combined with current practices for detailing the cross-frames and erecting these bridges can result in problems during and after construction. Some of the problems encountered have included:

- Girders and cross-frames that are difficult to fit-up (i.e., assemble into the structure) during erection, requiring unplanned contractor operations such as substantial force fitting of connections, field drilling and field welding,
- Erected girders with webs that are significantly out of plumb, although out-of-plumbness of girder webs is not necessarily indicative of a structural problem, as discussed in NSBA (2015) and NCHRP Report 725,
- Locked-in stresses in the cross-frames and girders that are not appropriately accounted for in design,
- Bearings rotated beyond tolerable design limits, and
- Deck joints and barrier rails that are significantly out-of-alignment between the approach and the end of the bridge.

In certain instances, these problems have resulted in construction delays, rework, cost overruns, disputes and litigation. These problems can be avoided by developing a better understanding of the ways in which framing arrangements, cross-frame detailing practices and erection procedures affect the overall constructed bridge geometry and internal forces in completed structural systems, as well as the fit-up during the erection of the steel.

1.2 Current Knowledge

Substantial progress has been made in answering many of the questions associated with this research via the completion of NCHRP Report 725 as well as subsequent efforts by an ad hoc Task Group of the National Steel Bridge Alliance (NSBA) Steel Bridge Collaboration on Skewed and/or

Curved Steel I-Girder Bridge Fit. NCHRP Report 725 provided a substantive literature review of this area and conducted numerous targeted studies related to "reliable fit-up," a phrase which is intended to encompass ease of assembly of the structural steel during erection, control of the constructed geometry, assurance of the generation of beneficial locked-in forces in the structural system, and limitation of the development of non-beneficial locked-in forces within the structure. However, the NCHRP Report 725 project focused predominantly on the sufficiency of different methods of analysis and did not provide a comprehensive evaluation of the questions related to NCHRP 20-07 Task 355. The subsequent NSBA Steel Bridge Collaboration Task Group effort provided an intensive focus on the various attributes and practices associated with reliable fit-up, and produced a white paper on this topic. However, the focus of this effort was predominantly on broad recommendations and a synthesis of the best information on the various behavioral phenomena, and how that behavior might influence the decision to specify a particular fit condition for a skewed and/or curved I-girder bridge. Quantitative research was needed to corroborate and refine these recommendations.

1.3 Objectives and Scope of this Research

The objective of NCHRP 20-07 Task 355 is to propose improved design, detailing and erection guidelines to ensure reliable fit-up of skewed and/or curved steel I-girder bridges. These guidelines will provide a clear understanding of the implications of various

- Framing arrangements,
- Cross-frame detailing methods, and
- Erection procedures

on the

- Ease of fit-up during the steel erection,
- Achievement of the targeted constructed geometry, and
- Generation of locked-in stresses in the cross-frames and girders.

1.4 Organization of this Report

Chapter 2 of this report provides a brief overview of the research approach used in NCHRP 20-07 Task 355. This is followed by Chapter 3, which highlights the major findings from this research and their applications.

Section 3.1 discusses the characteristic behavior of each of the three bridge types considered in this work - curved radially-supported, straight skewed, and curved and skewed steel I-girder bridges. Sections 3.2 and 3.3 discuss detailed results from cross-frame fit-up and girder splice fit-up investigations, respectively. Section 3.4 provides a substantive discussion of the influence of detailing methods on the completed bridge responses. Sections 3.5 and 3.6 then summarize the influence of framing arrangements and erection schemes, respectively. This is followed by Section 3.7, which provides a detailed evaluation of the responses associated with the use of Line Girder Analysis (LGA) versus 3D FEA based cambers in straight skewed bridges. Section 3.8 then discusses the influence of variations in camber, deck thickness, and cross-frame stiffness on the responses in completed structures. Chapter 3 concludes with Section 3.9, which provides concepts and procedures for direct calculation, in the bridge structural analysis, of the locked-in forces due to cross-frame detailing methods.

Chapter 4 emphasizes the most important findings of the NCHRP 20-07 Task 355 research, provides specific recommendations for application and implementation of the findings, and describes areas where further research would be valuable. Simplified methods of accounting for SDLF and TDLF detailing effects are suggested, and straightforward methods of rigorously including these effects within a bridge structural analysis are explained. This chapter also presents recommended inspection best practices and design specification provisions

Appendices A to U provide detailed information and analytical results for the bridges analyzed in the main portion of this research. Appendix V provides detailed information and analytical results for a benchmark example straight skewed bridge discussed in Sections 3.9.3.1 and 3.9.4.1. Appendix W provides a synthesis of current industry practice gained from a survey conducted at the beginning of the project. Appendix X provides the guidelines document produced by the affiliated NSBA Steel Bridge Collaboration Task Group.

2. RESEARCH APPROACH

The following sections provide a brief summary of the approach used in addressing the objectives of the NCHRP 20-07 Task 355 research. The primary project tasks were:

Task 1. Survey and synthesize current industry practice,

Task 2. Select base steel I-girder bridge designs

Task 3. Vary the framing arrangements,

Task 4. Vary the cross-frame detailing methods,

Task 5. Select erection schemes,

Task 6. Perform analytical parametric studies,

Task 7. Refine existing guidelines and propose new guidelines, and

Task 8. Identify best inspection practices.

The following descriptions are organized and arranged in the order of these tasks.

2.1 Survey and Synthesize Current Industry Practice

The first task of the NCHRP 20-07 Task 355 research focused on conducting a survey of current industry practice with regard to cross-frame framing arrangements, cross-frame detailing methods, and erection procedures, with an aim of:

1) Easing the fit-up of the structural steel,
2) Ensuring achievement of the targeted constructed geometry, and
3) Assuring the generation of beneficial locked-in stresses and limiting the generation of adverse locked-in stresses in the cross-frames and the girders.

The survey also requested input on current practices related to construction inspection to ensure that the erected geometry meets the specified fit conditions. The questionnaires regarding design and construction inspection were sent to all state departments of transportation within the United States (state DOTs) as well as several fabricators, detailers, erectors, and consultant bridge designers. It was anticipated that this survey would aid the project team in understanding various current practices within the industry, as well as possible misconceptions and common problems being experienced. These inputs were expected to be valuable particularly in the subsequent Tasks 6 through 8. This first task was conducted in parallel with Tasks 2 through 5.

A summary of responses to the survey is provided in Appendix W. Thirty-five responses were received. Of those, 28 were from state DOTs, and the rest were from consulting bridge design engineers, steel detailers, fabricators, and erectors. The survey results showed a general lack of consistency in terminology, choice of, and understanding of cross-frame detailing methods.

Over a third of the respondents currently did not address the topic of cross-frame detailing. Of those who did address this issue, the preference appeared to be for either Steel Dead Load Fit (SDLF) or Total Dead Load Fit (TDLF) detailing for straight skewed bridges. Four states prohibited the use of No-Load Fit (NLF) for all skewed bridges. For curved radially-supported bridges and curved and skewed bridges, there was no clear preference among the three detailing methods, but SDLF detailing was the most prevalent choice by a small margin.

In addition, the survey suggested a wide range of cross-frame detailing policies and a wide range of understanding of the issues. For example, some respondents indicated a preference for TDLF detailing, based on their understanding that this results in theoretically zero dead load cross-frame forces and flange lateral bending stresses in straight skewed bridges at the completion of the construction. The responses also suggested a wide range of experiences relative to these considerations. Some respondents indicated that they had experienced no problems with fit-up for steel girder bridges, while others had experienced problems of a variety of types and severity. These anecdotal accounts support the hypothesis that in a large number of situations, there are few reported problems associated with fit-up of steel girder bridges, while in certain cases, the problems can be significant. The problematic cases appear to be associated with more severe geometry (tighter curvature, sharper skew, longer spans, poor span balance, or other complicating geometric factors).

The responses were wide ranging with regard to the strategies used to determine cross-frame framing arrangements. Some states have clear rules and guidelines, while others have less specific requirements. Suggestions included eliminating cross-frames in troublesome “nuisance stiffness” locations (i.e., locations where undesired transverse stiffness associated with the skew and the bridge framing arrangement leads to large internal cross-frame forces), using lean-on bracing

(Helwig and Yura 2012), and offsetting intermediate cross-frames from the bearing line cross-frames.

Few respondents addressed the calculation of fit-up forces and locked-in forces in any quantitative manner. Qualitative means of addressing any concerns about locked-in forces and excessively high fit-up forces varied greatly.

With regard to methods for calculating bearing rotations, most respondents had no specific policies or simply used the results of the design analysis without consideration of the specified cross-frame detailing method. Few respondents presented girder layover information on the bridge plans. Those who indicated that they have presented this information on the bridge plans also indicated that they seldom did so. The respondents reported a variety of bearing rotation problems, but there did not appear to be a trend associating bearing rotation problems with a specific bridge geometry or a specific detailing method.

Among the state DOTs, very few reported regularly specifying an erection sequence on their plans, reflecting a policy that the determination of the erection sequence is instead the responsibility of the contractor and is considered “means and methods”; these owners typically explained that they tried to avoid specifying “means and methods” partly to allow contractors the flexibility to bid projects as competitively as possible, and partly to leave the responsibility for successful erection of the bridge clearly with the contractor.

2.2 Select Base Steel I-Girder Bridge Designs

The second project task identified a suite of 21 base steel I-girder bridge designs targeted to address the key research questions. NHCRP Report 725 compiled and developed a suite of existing and parametric study bridge designs encompassing a spectrum of span arrangements, span lengths, curvature, bridge widths and skew angles encountered in practice. The NCHRP 20-07 Task 355 research team leveraged the NCHRP Report 725 research to maximize the number of cases that could be studied feasibly in the current research. In selecting a set of 21 base I-girder bridge designs, emphasis was placed (in the order listed below) on cases where:

1) Fit-up problems might exist,
2) The bridge may be useful in identifying the boundaries where fit-up problems start to occur and how key response parameters vary as a function of the bridge geometry,

3) Quality field response measurements and observations from existing bridges were available, particularly measurements and observations during intermediate construction stages,
4) Detailed erection plans were available (for existing bridges).

The 21 steel I-girder bridges studied in this project are designated by the letters A to U. In addition, the bridges are named as follows using the naming convention from NCHRP Report 725 research (e.g., EISCR1):

- The first letter in the bridge name indicates whether the structure is an Existing bridge (E) or a New design (N) conducted by HDR, Inc., as part of the NCHRP Report 725 research, based on targeted overall geometry parameters.
- The second letter in the bridge name indicates that the bridge is an I-girder bridge type (NCHRP Report 725 also studied tub-girder bridges; however, these bridge types are not within the scope of the NCHRP 20-07 Task 355 project).
- The third letter indicates whether the bridge is a Simple span (S) or a Continuous span (C).
- The fourth letter indicates whether the bridge is Curved (C) or Straight (S).
- The fifth letter in the bridge name indicates whether the bridge has "Radial" (R) or "Skewed" (S) supports.
- Finally, the number at the end of the bridge name is simply a unique designator assigned to the bridge as part of a given category based on the above parameters.

The base plan geometries for the bridges selected using the above criteria are shown and the key characteristics of these bridges are summarized in the following sub-sections. The rectangles shown on the bridge plans indicate the bearing support lines. In addition, a scale is shown for each of the bridge plans to quickly convey the overall dimensions. The curved radially-supported bridges are discussed first, followed by straight skewed cases, and finally, the bridges that are both curved and skewed. Detailed information is provided in Appendices A to U for all the bridge cases.

2.2.1 Curved Radially-Supported Bridges

The following seven curved radially-supported bridges were evaluated in this research. The curved radially-supported bridges are designated from (A) through (G) in the overall list of bridges. These bridges are listed in the order of:

1) Simple-span bridges,
2) Continuous-span bridges, and
3) Increasing maximum span length of the curved spans (within each of the simple-span and continuous-span bridge sub-groups).

The key geometry parameters shown for each of these bridges are:

L_s = span lengths along the curve between the bearing lines at the centerline of the bridge;

w_g = out-to-out width between the fascia girders in the radial direction orthogonal to the girder tangents;

R = radius of curvature to the centerline of the bridge;

n_g = number of girders in the bridge cross-section;

L_s/D = bridge span to girder depth ratios.

Descriptions of Bridges (A) through (G) follow:

(A) EISCR1 (L_s = 90 ft; w_g = 17.5 ft; R = 200 ft; n_g = 3; L_s/R = 0.45; L_s/w_g = 5.1; L_s/D = 23.5)

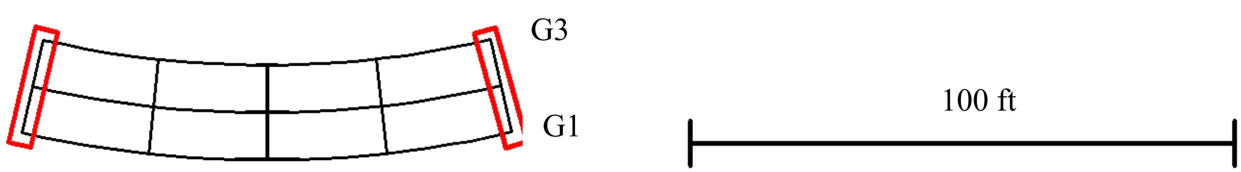


Figure 1. Bridge (A) EISCR1.

This is a very basic simple-span curved radially-supported bridge that was tested at the FHWA Turner Fairbank Research Center in 2005-2006 (Jung and White 2008). This bridge was designed to a number of extreme limits of the AASHTO LRFD Specifications (AASHTO 2015) and is useful as a benchmark and demonstration case for horizontally curved radially-supported bridge responses.

(B) NISCR2 (L_s = 150 ft; w_g= 24 ft; R = 438 ft; n_g = 4; L_s/R = 0.34; L_s/w_g = 6.2; L_s/D = 22.1)

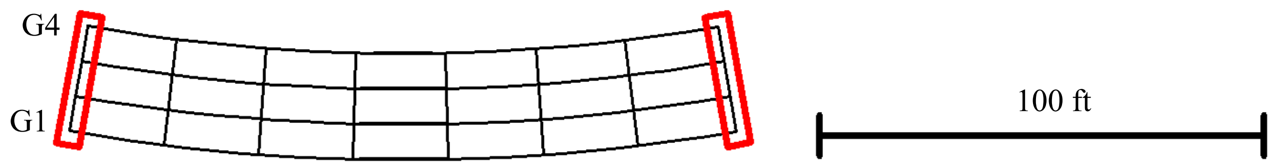


Figure 2. Bridge (B) EISCR2.

This bridge was used in NCHRP Report 725 to provide a substantive illustration of the behavior of curved radially-supported I-girder bridges, including the influence of NLF, SDLF and TLDF detailing. As shown in Figures 3-72 through 3-77 of the NCHRP 725 report, relative to the NLF steel dead load forces, SDLF increases the cross-frame diagonal forces in this bridge by 2x, and relative to the NLF total dead load forces, and TDLF increases the cross-frame diagonal forces in this bridge also by 2x. DLF detailing has little influence on the cross-frame chord forces in this bridge. These results are consistent with the findings of this research.

(C) NISCR7 (L_s = 150 ft; w_g = 74 ft; R = 280 ft; n_g = 9; L_s/R = 0.54; L_s/w_g = 2.0; L_s/D = 24.3)

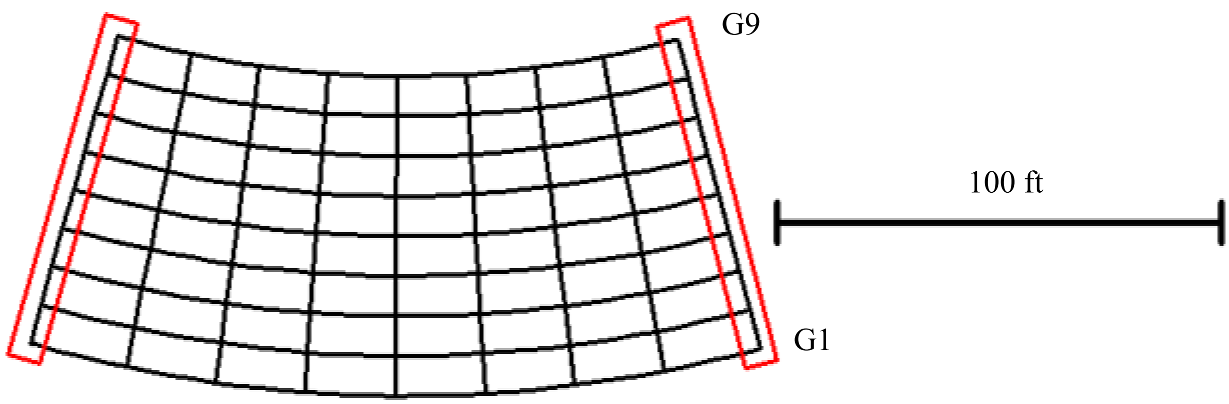


Figure 3. Bridge (C) NISCR7.

This bridge has greater interaction between the girders and cross-frames compared to Bridge (B) NISCR2 since it is a wider and more sharply curved radially-supported I-girder bridge. In this research, it is observed that the cross-frame members with the largest forces are not in the exterior bay of this bridge (the bay between the outside girder and the adjacent interior girder).

(D) NISCR10 (L_s = 225 ft; w_g = 74 ft; R = 705 ft; n_g = 9; L_s/R = 0.32; L_s/w_g = 3.0; L_s/D = 23.7)

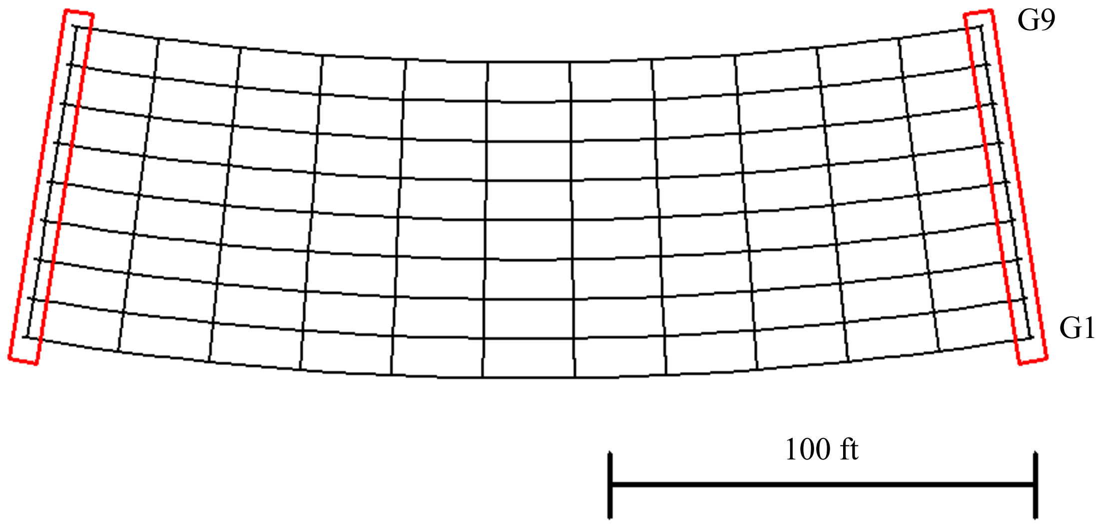


Figure 4. Bridge (D) NISCR10.

This is an intermediate-span wide bridge with a more moderate horizontal curvature compared to Bridge (C) NISCR7. The cross-frame members with the largest forces are not in the bay between the outside girder and the adjacent interior girder in this bridge as well.

(E) EICCR11, Ford City Bridge, Ford City, PA (L_s = 322, 417 and 322 ft; w_g = 40.4 ft; $R = \infty,\infty,411$ ft, i.e., the bridge is straight in spans 1 and 2, and 411 ft in span 3; n_g = 4; L_s/R = 0, 0, and 0.80; L_s/w_g = 8.0, 10.3, and 8.1; L_s/D = 23.0, 29.8, 23.5)

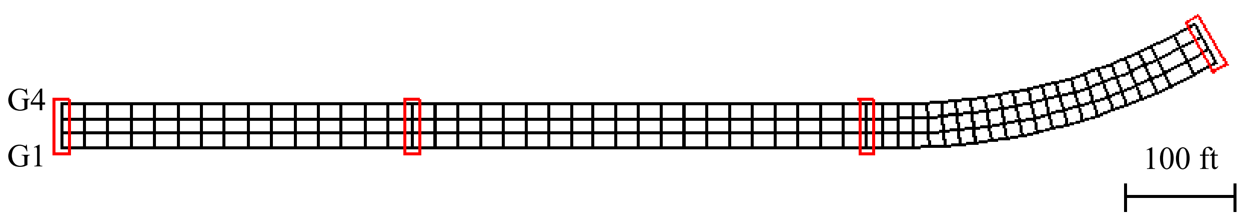


Figure 5. Bridge (E) EICCR11.

As discussed in NCHRP Report 725, this bridge represents an extreme geometry that exhibited relatively large fit-up forces in the field. The erection of the curved span involved drop-in segments. The cross-frames in this bridge were mistakenly detailed for SDLF based on Concrete Dead Load (CDL) deflections. Fortunately, this was essentially SDLF detailing since the steel and concrete dead load deflections are approximately equal for this structure. This bridge has been studied extensively in prior research by Chavel and Earls (2006a & b).

(F) NICCR12 (L_s = 350, 350 and 280 ft; w_g = 74 ft; R = 909 ft; n_g = 9; L_s/R = 0.39, 0.39, and 0.31; L_s/w_g = 4.7, 4.7 and 3.8; L_s/D = 25, 25, 20)

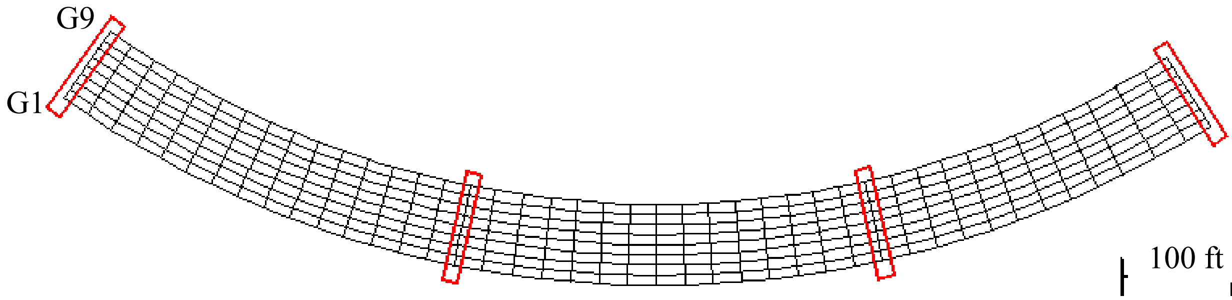


Figure 6. Bridge (F) NICCR12.

This case represents an extremely long-span, relatively wide bridge with significant horizontal curvature and radial supports. Shoring towers were used to install the long field segments.

(G) EICCR4 (L_s = 219, 260, 211 ft, 162 ft, 256 ft, and 190 ft; w_g = 36.7 ft; R = 968, 3 @ 1108 ft, 968 ft, and ∞, n_g = 4; L_s/R = 0.198, 0.235, 0.190, 0.146, 0.264, 0; L_s/w_g = 6.0, 7.1, 5.7, 4.4, 7.0, and 5.2; L_s/D = 26.5, 31.5, 25.6, 19.6, 31.0 ,23.0)

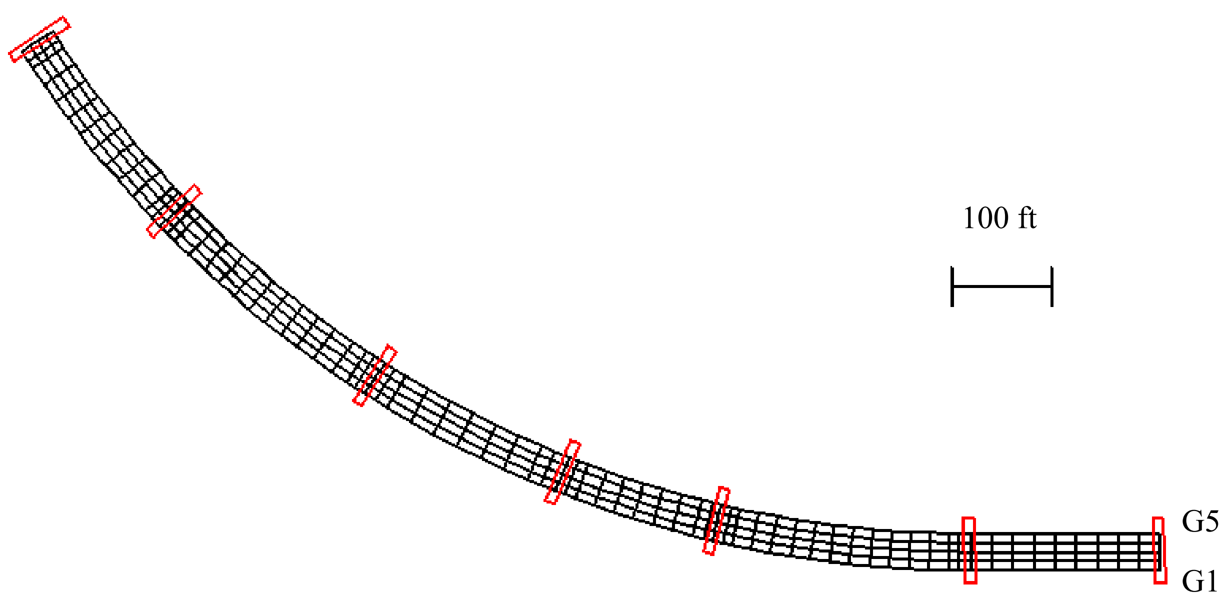


Figure 7. Bridge (G) EICCR4.

This is the existing Ramp GG of the John F. Kennedy Memorial Highway, I-95 Express Toll Lanes and I-695 Interchange, Baltimore Co., MD. It has relatively long spans as well as a relatively narrow bridge cross-section. It represents a successful implementation of SDLF detailing.

2.2.2 Straight-Skewed Bridges

The following six straight skewed bridges were evaluated in this research. Similar to the presentation of the curved radially-supported bridges, simple-span bridges are shown first followed by continuous-span bridges. Within each of these sub-groups, the bridges are listed in the order of increasing maximum span length. The key geometry parameters shown for each bridge, not already defined in Section 2.2.1 for the curved radially-supported bridges, are:

L_{max} = maximum fascia girder length, reported for the bridges with non-parallel skew;

L_{min} = minimum fascia girder length, reported for the bridges with non-parallel skew;

θ = bearing line skew angle, defined as zero for a bearing line having zero skew (one value shown for all the bearing lines for bridges with parallel skew);

L_s = span length between the bearing lines along the centerline of the bridge;

$$I_s = \frac{w_g \times \tan\theta}{L_s} \qquad \text{Eq. (1)}$$

= Maximum value of the skew index for each span (NCHRP Report 725 identified this parameter, as well as the skew angle itself, as useful indicators of the potential impact of skew on the bridge responses.)

The straight skewed bridges are designated from (H) through (M) in the overall list of bridges. Multiple framing arrangements are considered for all of these bridges except for Bridge (L) NISCS16. Overview plan sketches are shown here for only the original or base framing arrangements. The alternative framing arrangements for the straight skewed bridges are discussed and shown in Section 2.3.1. The designations within the parentheses with a number included after the letter indicate that different framing arrangements are considered subsequently for the given bridge geometry.

Descriptions of Bridges (H) through (M) follow:

(H1) EISSS57 (L_s = 137 ft; L_{max} = 211 ft; L_{min} = 63 ft; w_g = 61.0 ft; θ = 69.5° and -4.4°, non-parallel skew; n_g = 7; I_s = 1.19; L_{max}/w_g = 3.5; L_{min}/w_g = 1.0; L_s/D = 18.3)

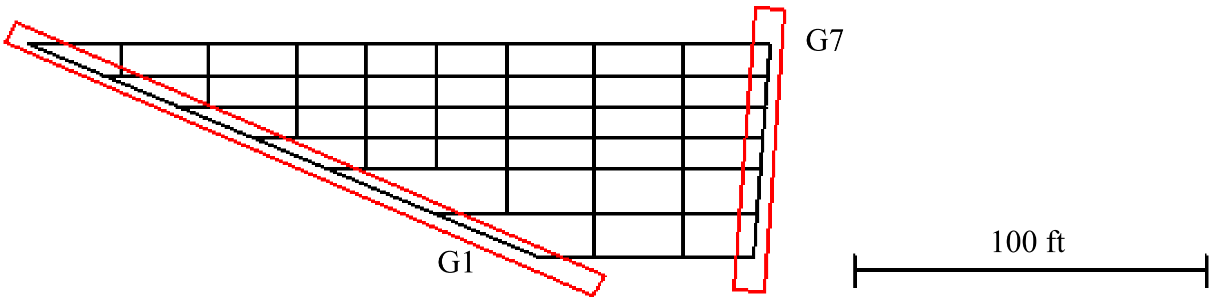


Figure 8. Bridge (H1) EISSS57.

This is an existing bridge with an extreme non-parallel skew, erected over a rail yard in Fort Worth, TX. The characteristics of this bridge have been discussed as an example of those that may cause potential fit-up issues in various workshop and seminar venues. This bridge's geometry is slightly simplified from the existing bridge in Fort Worth: (1) the girder spacing is assumed constant along the length of the girders, whereas some of the girders were slightly splayed in the existing bridge; (2) the bridge deck is assumed to be straight, whereas the bridge deck in the existing bridge was slightly curved, causing variable width overhangs.

(I1) NISSS14 (L_s = 150 ft; w_g = 74 ft; θ = 70°, parallel skew; n_g = 9; I_s = 1.36; L_s/w_g = 2.0; L_s/D = 25)

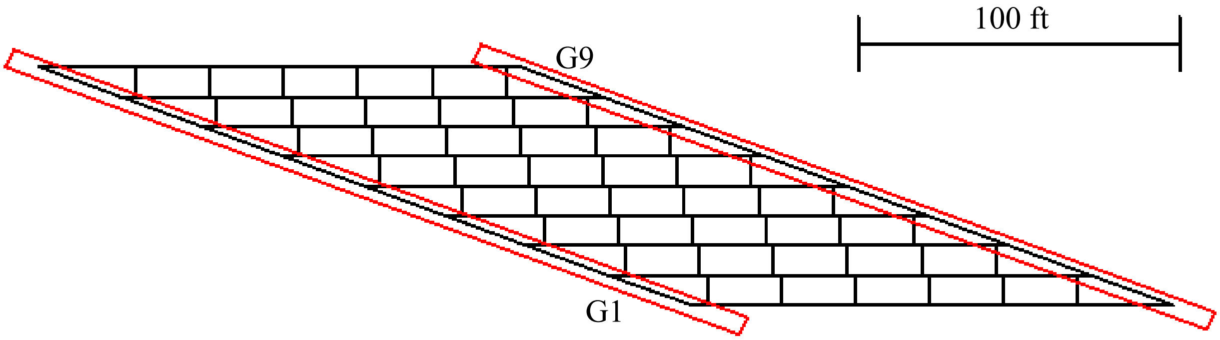


Figure 9. Bridge (I1) NISSS14.

This is a relatively short bridge that had the largest skew index of all the simple-span bridges studied in the NCHRP Report 725 research. This framing arrangement has relatively high nuisance transverse stiffness due to small offsets from the first intermediate cross-frames to the skewed bearing lines, small stagger distances between the cross-frames, and a large number of cross-frames.

(J1) NISSS54 (L_s = 300 ft; w_g = 74 ft; θ = 70°, parallel skew; n_g = 9; I_s = 0.68; L_s/w_g = 4.1; L_s/D = 25)

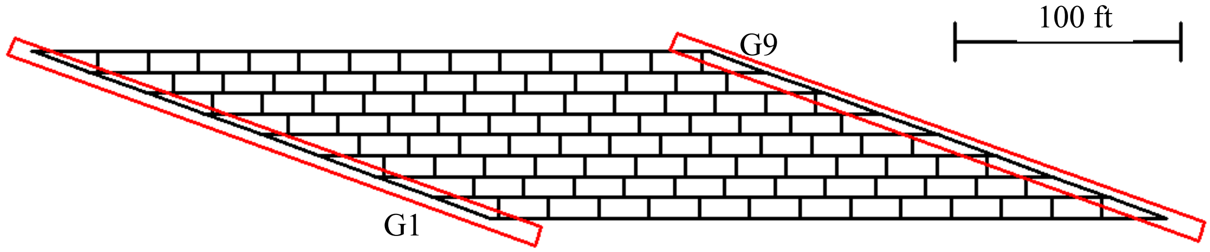


Figure 10. Bridge (J1) NISSS54.

This bridge has a long span and a high skew index, making it particularly sensitive to any variation in attributes that affect erection fit-up. In addition, this bridge has been used extensively as an example case in NCHRP Report 725.

(K1) EICSS12, US 82 Mainline Underpass at 19th Street WB, Lubbock, TX (L_s = 150 and 139 ft; w_g = 41.0 ft; θ = 59.6°, parallel skew; n_g = 6; I_s = 0.47 and 0.50; L_s/w_g = 3.7 and 3.4; L_s/D = 33.3, 30.8)

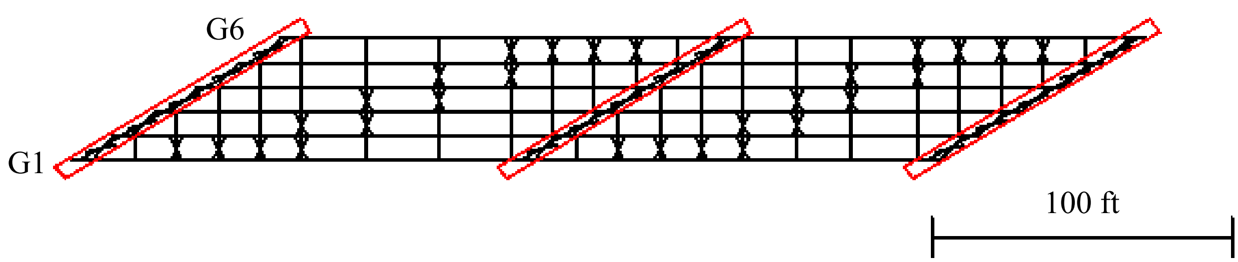


Figure 11. Bridge (K1) EICSS12.

This two-span continuous bridge, constructed in Lubbock, TX, was studied extensively by Romage (2008) and others. This bridge served as an evaluation and demonstration case for the use of lean-on bracing systems in straight skewed I-girder bridges (Helwig and Yura 2012). The cross-frames with diagonals are marked by an 'X' on the above plan. The rest of the cross-frames have only top and bottom chords.

(L) NICSS16 (L_s = 120, 150 and 150 ft; w_g = 74 ft; θ = 70°, parallel skew; n_g = 9; I_s = 1.69, 1.36, and 1.36; L_s/w_g = 1.6, 2.0, and 2.0; L_s/D = 20, 25, 25)

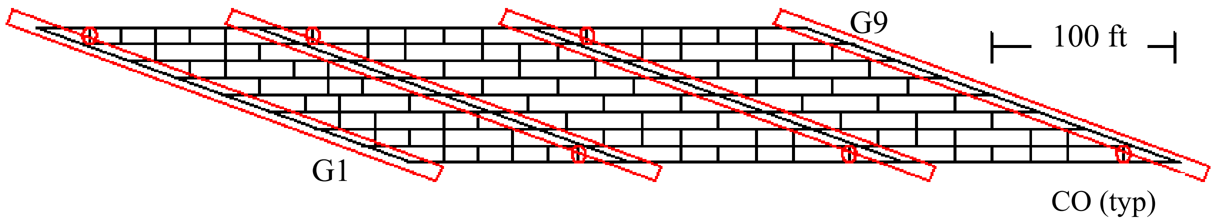


Figure 12. Bridge (L) NICSS16.

This three-span continuous bridge had the largest skew index of all the bridges studied in the NCHRP Report 725 research. The framing plan shown is a modification of the Bridge (L) NISCS16 original framing plan, which is not studied in this research. The original plan had undesirable features such as very close offsets between the intermediate cross-frames and the bearing lines, and very small stagger spacing between cross-frames. The issues associated with these features are addressed by the studies of Bridge (I1) NISSS14.

The framing plan shown here provides larger offsets of the first intermediate cross-frames from the bearing lines except on the first interior girder at the acute corners. At these locations, providing an offset that satisfies the $1.5D$ and $0.4L_b$ rules discussed in Section 3.5.1 would make the unbraced lengths on the fascia girders at the acute corners quite large. Instead, small offset distances are used at these locations and the diagonals are removed in these first intermediate cross-frames to alleviate the nuisance transverse stiffness effects. The cross-frames highlighted by an oval and labeled on the plan view as "CO" (for "chords only") do not contain any diagonals. Furthermore, the intermediate cross-frames are all equally-spaced except for the offsets adjacent to the skewed bearing lines. Every other cross-frame is intentionally omitted within the interior of the bridge plan. In addition to reducing the cross-frame forces caused by nuisance transverse stiffness effects, this results in a significant reduction in the overall number of cross-frames employed in the bridge.

(M1) EICSS2, I-235 EB over E. University Ave., Polk Co., IA (L_s = 239, 257, and 220 ft; L_{max} = 259, 255, and 220 ft; L_{min} = 241,183, and 220 ft; w_g = 66.6 ft; θ = 58°, 61.8°, 38°, and 38°; n_g = 8; I_s = 0.52, 0.48, and 0.24; L_{max}/w_g = 3.9, 3.8, and 3.3; L_{min}/w_g = 3.6, 2.7, and 3.3; L_s/D = 26, 28, 23.8)

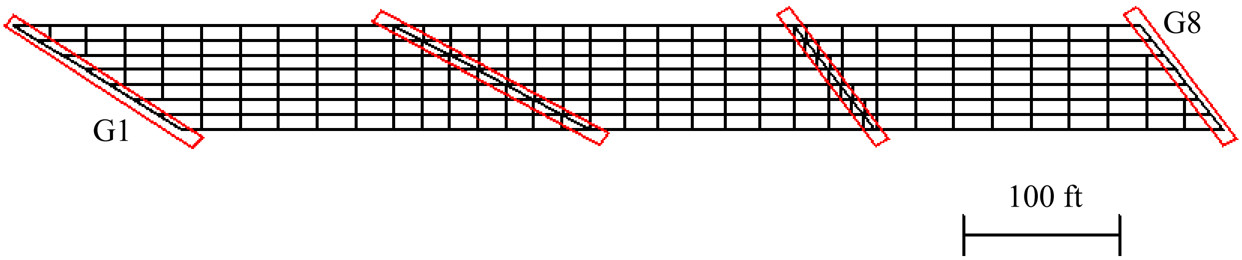


Figure 13. Bridge (M1) EICSS2.

This three-span continuous bridge, constructed in Polk Co., IA, had substantial difficulty with the installation of its cross-frames during the steel erection. This bridge was built using phased construction. The bridge was built in two phases. In the first phase, the first four girder lines and the cross-frames between these girder lines were installed, and then the concrete deck was placed on the girders associated with this phase. In the second phase, the other four girder lines and the cross-frames between these girder lines were installed and then the concrete deck was placed on the girders associated with the second phase. The phased construction made the installation of the cross-frames in-between the phases difficult. The intermediate cross-frames framing directly into the bearing locations at the interior piers create a large transverse (nuisance) stiffness, and are subject to high differential deflections.

2.2.3 Curved and Skewed Bridges

Seven bridges having combined horizontal curvature and skew were evaluated in the NCHRP 20-07 Task 355 research. Similar to the curved radially-supported and straight skewed bridge presentations, the simple-span bridges are shown first followed by continuous-span bridges. The bridges are presented in the order of increasing maximum span length within each of these sub-groups. The curved and skewed bridges are designated from (N) through (U).

Multiple framing arrangements are considered for five of these bridges. Overview plan sketches are shown here for the original framing arrangements. The alternative framing arrangements for the curved and skewed bridges are discussed and shown in Section 2.3.2. The designations in the parentheses that have numbers included after the letter indicate that different framing arrangements are considered subsequently for the given bridge geometry.

Descriptions of Bridges (N) through (U) follow:

(N) NISCS14 (L_s = 150 ft; L_{max} = 192 ft; L_{min} = 126 ft; w_g = 74 ft; R = 280 ft; θ = 53.7° and 0°; n_g = 9; L_s/R = 0.54; L_s/w_g = 2.0; $(L_{min} - L_{max})/(L_{min} + L_{max})$ = -0.21; L_s/D = 25)

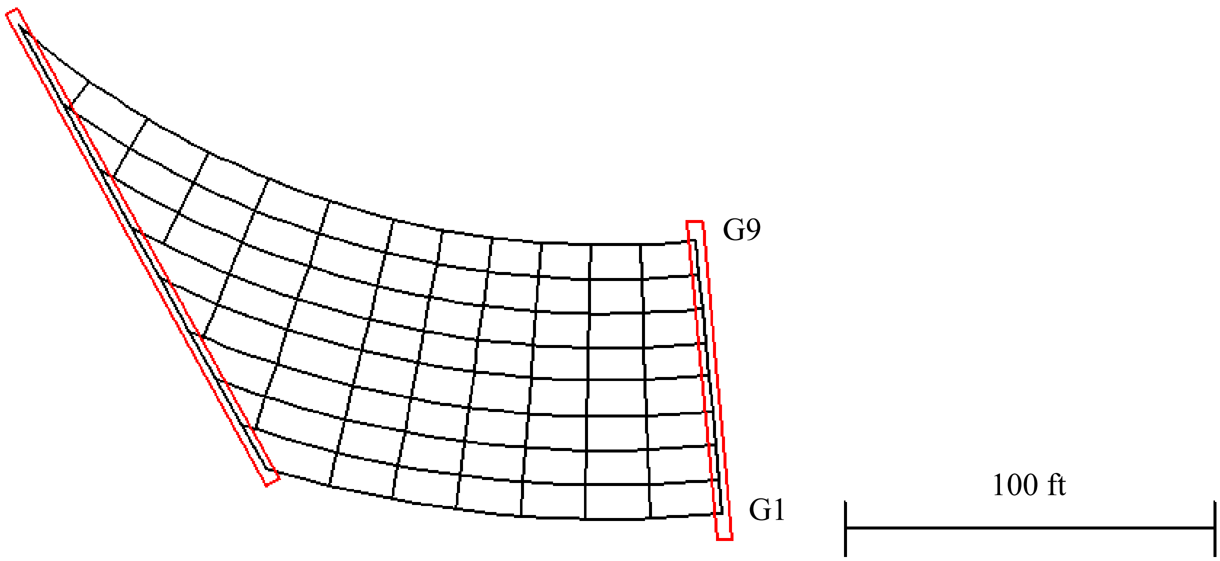


Figure 14. Bridge (N) NISCS14.

This bridge is similar to (C) NISCR7 in terms of span length, bridge width, and radius of curvature. The orientation of the skew at the left end of this bridge makes the inside girder (i.e., the girder on the inside of the curve) longer than the outside girder. The orientation of the skew at the left end tends to counteract the bridge horizontal curvature effects to some extent.

(O1) NISCS15 (L_s = 150 ft; L_{max} = 195 ft; L_{min} = 103 ft; w_g = 74 ft; R = 280 ft; θ = -35° and 0°; n_g = 9; L_s/R = 0.54; L_s/w_g = 2.0; $(L_{max} - L_{min})/(L_{max} + L_{min})$ = 0.31; L_s/D = 20)

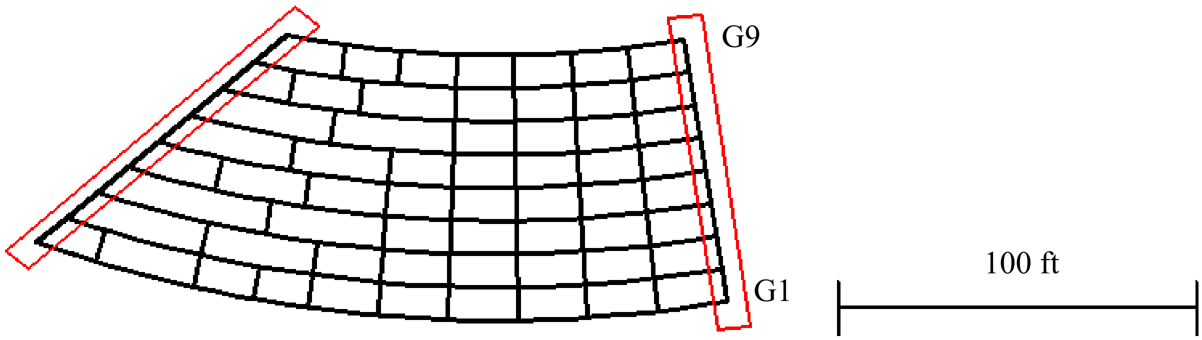


Figure 15. Bridge (O1) NISCS15.

This bridge is similar to (C) NISCR7 and (N) NISCS14 in terms of span length, bridge width, and radius of curvature. However, the orientation of the skew at the left end makes the girders on the inside of the curve significantly shorter than the outside girders. The effects of the skew at the left-hand end tend to be additive with the horizontal curvature effects.

(P) EISCS3, SR 8002 Ramp A-1, King of Prussia, PA (L_s = 153 ft; L_{max} = 164 ft; L_{min} = 140 ft; w_g = 30.6 ft; R = 279 ft; θ = 52.4° and 0°; n_g = 6; L_s/R = 0.55; L_s/w_g = 5.0; $(L_{min} - L_{max})/(L_{min} + L_{max})$ = -0.08; L_s/D = 27)

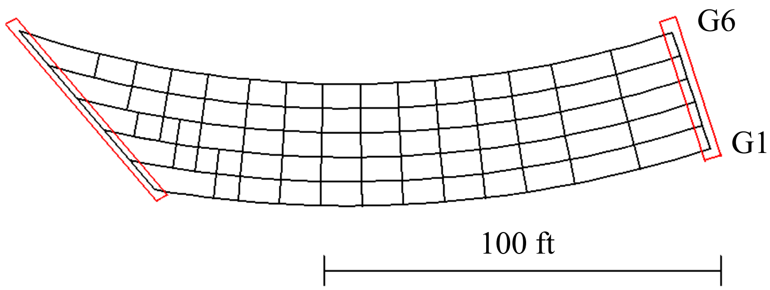


Figure 16. Bridge (P) EISCS3.

This is an existing bridge that required a holding crane until four girders were erected. This bridge has been studied extensively in prior research by Chavel and Earls (2003) and Chavel (2008). The orientation of the skew at the left end of this bridge tends to counteract the bridge horizontal curvature effects to some extent.

(Q1) NISCS38 (L_s = 300 ft; L_{max} = 366 ft; L_{min} = 249 ft; w_g = 74 ft; R = 730 ft; θ = 62.6° and 0°; n_g = 9; L_s/R = 0.41; L_s/w_g = 4.1; $(L_{min} - L_{max})/(L_{min} + L_{max})$ = -0.19; L_s/D = 23)

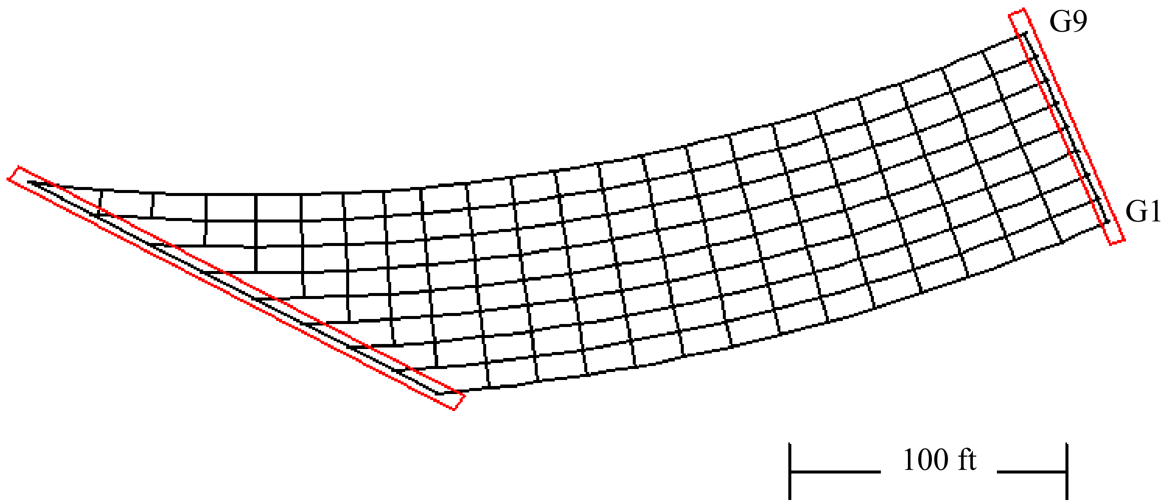


Figure 17. Bridge (Q1) NISCS38.

This is a longer-span curved and skewed bridge similar to (N) NISCS14. Phased construction is studied on this bridge for the framing plan shown above. The second phase, which includes the four inside girders, has a span length of 330 ft with a width of 27.75 ft. This is the critical phase of the construction. The deflections of this phase are large and the system is near the point of instability during its deck placement.

(R1) NISCS39 (L_s = 300 ft; L_{max} = 340 ft; L_{min} = 258 ft; w_g = 74 ft; R = 730 ft; θ = -35° and 0°; n_g = 9; L_s/R = 0.41; L_s/w_g = 4.1; $(L_{max} - L_{min})/(L_{max} + L_{min})$ = 0.14 ; L_s/D =23)

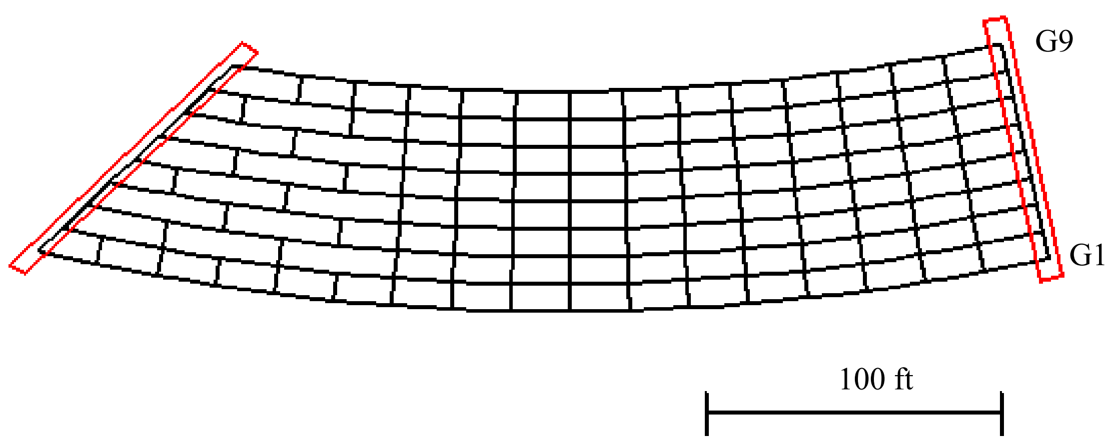


Figure 18. Bridge (R1) NISCS39.

This is a longer-span curved and skewed bridge similar to (O1) NISCS15. The skew orientation makes the outside girder (i.e., the girder on the outside of the curve) significantly longer than the inside girder.

(S) XICCS7 (L_s = 160, 210 and 160 ft; L_{max} = 185, 214 and 191 ft; L_{min} = 136, 205 and 126 ft; w_g = 33.0 ft; R =700 ft; θ = 0, -60, -60 and 0°; n_g = 4; L_s/R = 0.26, 0.31 and 0.27; L_s/w_g = 4.8, 6.4 and 4.8; $(L_{min} - L_{max})/(L_{min} + L_{max})$ = -0.15, $(L_{max} - L_{min})/(L_{max} + L_{min})$ = 0.02 and 0.21; L_s/D = 20.8, 27.4, 20.8)

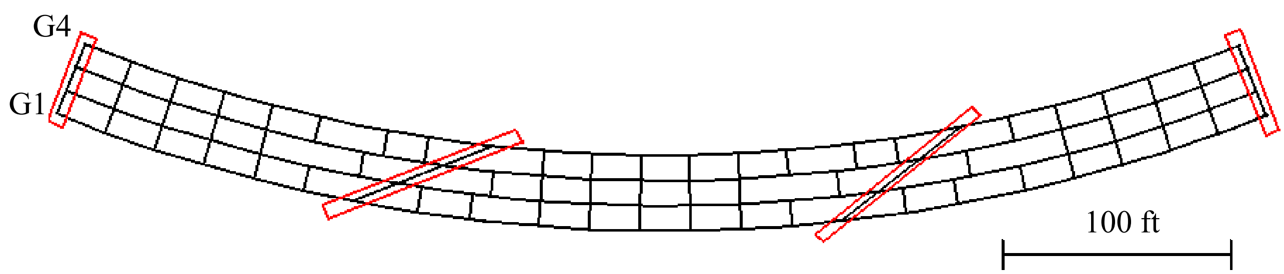


Figure 19. Bridge (X) XICCS7.

This is a significantly curved and skewed I-girder bridge. This bridge is presented as a design example in the NHI Course "Analysis and Design of Skewed and Curved Steel Bridges with LRFD" (NHI 2011).

(T1) EICCS27, SR 386 over SR6 and Ramp F, Sumner Co., TN (L_s = 279 ft, 224 ft, and 236 ft; L_{max} = 279, 239 and 231 ft; L_{min} = 268, 214 and 217 ft; w_g = 79.9 ft; R = 2546 ft; θ= -53.1, -59.4, -64.4 and -69.7°; n_g = 8; L_s/R = 0.11, 0.09 and 0.09; L_s/w_g = 3.5, 2.8 and 3.0; $(L_{min} - L_{max})/(L_{min} + L_{max})$ = -0.02, -0.03 and -0.01; L_s/D = 37.2, 29.8, 31.5)

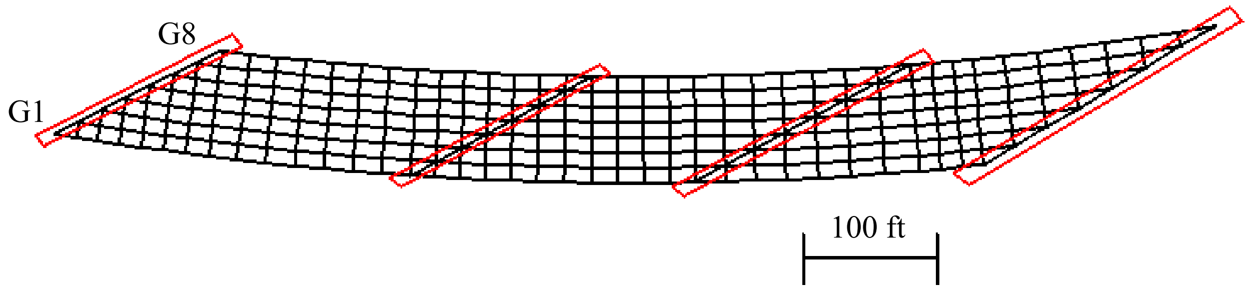


Figure 20. Bridge (T1) EICCS27.

This is an existing bridge in which a number of bolts connecting the cross-frames to the connection plates sheared off after the erection of the steel and before the completion of the structure. The intermediate cross-frames frame directly into the bearing locations at the interior piers, creating a large (nuisance) transverse stiffness. These cross-frames are subject to high differential deflections.

(U1) EICCS28, Corridor X and I-65 Interchange Ramp NW65X, Jefferson County, AL (L_s = 326, 160 and 235 ft; L_{max} = 369, 165 and 258 ft; w_g = 52.0 ft; R = 1255 ft; θ= 0, 47, 54.5 and 0°; n_g = 7; L_s/R = 0.26, 0.13 and 0.19; L_s/w_g = 6.3, 3.1 and 4.5; L_s/D = 32.6, 16, 23.5)

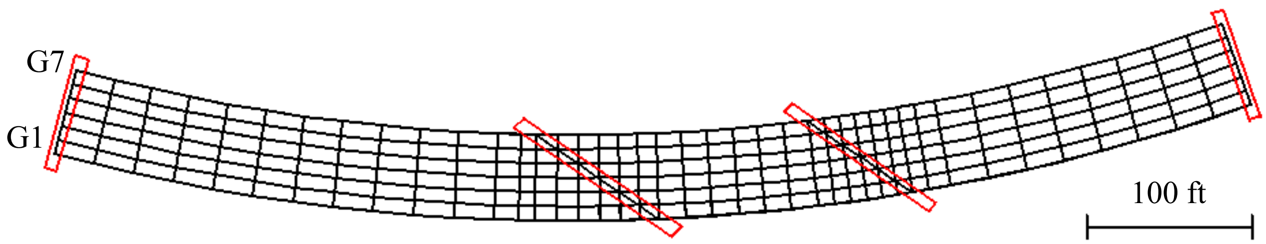


Figure 21. Bridge (U1) EICCS28.

This is an existing bridge which suffered substantial delays during construction due to erection difficulty resulting from a combination of high span length to girder depth ratios, poor span balance, long spans, a tight horizontal curve, sharp skew of the interior bearing lines, substantial transverse (nuisance) stiffness paths and detailing of the cross-frames for TDLF. For the above framing arrangement, the bearing at the first pier from the left on the inside fascia girder experiences significant uplift at the end of the erection and after the deck is placed (in the structural analysis conducted in this research). For this and other reasons, this framing arrangement is considered infeasible to build.

2.2.4 Summary

To succinctly convey the main geometry parameters of the above selected bridges, Table 1 summarizes the:

- Span length L_s,
- Width w_g,
- Radius of curvature R,

- Skew angle θ,
- Subtended angle between the bearing lines L_s/R,
- Length-to-width ratio L_s/w_g or maximum L_{max}/w_g, where L_{max} is the maximum girder length,
- Skew index I_s, and
- Span length-to-depth ratio L_s/D for all of the bridges.

These parameters do not capture all of the parametric influences on the bridge responses, but they are certainly some of the most important parameters. The bridges are grouped by the three main bridge classifications considered in this work:

1) Curved radially-supported: (A) through (G)
2) Straight skewed: (H) through (M)
3) Curved and skewed: (N) through (U)

Within each of the bridge classifications, the simple-span bridges are shown first followed by the continuous-span bridges. The bridges are presented in the order of increasing maximum span length within each of these sub-groups.

It should be noted that the maximum span-to-depth ratio may have a significant impact in some bridges, since if this ratio is large, the bridge may exhibit relatively large displacements during the different stages of construction and in the completed bridge. In straight skewed bridges, the displacements are significantly influenced by the span length and skew index. In curved bridges, the span length and subtended angle between the bearing lines have significant impact on the displacements. In addition, in curved bridges with large length-to-width ratios (i.e., relatively narrow curved bridges), the lateral and vertical displacements can be amplified by measurable second-order (stability) effects.

Table 1. Summary of the selected 21 I-girder bridges studied in the NCHRP 20-07 Task 355 research.

Bridge Type	**Bridge Letter**	**Bridge Name**	L_s **(ft)**	w_g **(ft)**	R **(ft)**	**θ (deg.)**	L_s/R	L_s/w_g *or* L_{max}/w_g^*	I_s	L_s/D
Curved Radially-Supported	A	EISCR1	90	17.5	200	0,0	0.45	5.1	0	23.5
	B	NISCR2	150	24	438	0,0	0.34	6.2	0	22.1
	C	NISCR7	150	74	280	0,0	0.54	2.0	0	24.3
	D	NISCR10	225	74	705	0,0	0.32	3.0	0	23.7
	E	EICCR11	310,417, 322	40.3	∞, ∞, 411	0,0, 0,0	0.78	8.0,10.3, 8.1	0	23,29.8, 23.5
	F	NICCR12	350,350, 280	74	909	0,0, 0,0	0.31,0.39	4.7,4.7, 3.8	0	25,25, 20
	G	EICCR4	219,260, 211,162, 256,190	36.7	968, 3@1108, 968,∞	0,0, 0,0, 0,0	0.20,0.24, 0.19,0.15, 0.27,0	6.0,7.1, 5.7,4.4, 7.0,5.2	0	26.5,31.5, 25.6,19.6, 31.0,23.0
Straight-Skewed	H	EISSS57	137	61	N/A	69,-4	N/A	3.5	1.19	18.3
	I	NISSS14	150	74	N/A	70,70	N/A	2.0	1.36	25
	J	NISSS54	300	74	N/A	70,70	N/A	4.1	0.68	25
	K	EICSS12	150,139	41	N/A	59.6,59.6, 59.6	N/A	3.7,3.4	0.47,0.50	33.3,30.8
	L	NICSS16	120,150, 150	74	N/A	70,70, 70,70	N/A	1.6,2.0, 2.0	1.69,1.36, 1.36	20,25, 25
	M	EICSS2	239,257, 220	66.6	N/A	58,62, 38,38	N/A	0.48,0.49, 0.23	0.52,0.48, 0.24	26,28, 23.8

Table 1 (Continued). Summary of the selected 21 I-girder bridges studied in the NCHRP 20-07 Task 355 research.

Bridge Type	**Bridge Letter**	**Bridge Name**	**L_s (ft)**	**w_g (ft)**	**R (ft)**	**θ (deg.)**	**L_s/R**	**L_s/w_g or L_{max}/w_g***	**I_s**	**L_s/D**
Curved and Skewed	N	NISCS14	150	74	280	53.7,0	0.54	2.0	0.53	25
	O	NISCS15	150	74	280	-35,0	0.54	2.0	0.27	20
	P	EISCS3	153	74	279	52.4,0	0.55	5.0	0.24	27
	Q	NISCS38	300	74	730	62.6,0	0.41	4.1	0.39	23
	R	NISCS39	300	74	730	-35,0	0.41	4.1	0.15	23
	S	XICCS7	160,210, 160	33	700	0,60, 60,0	0.23,0.30, 0.23	4.8,6.4, 4.8	0.31,0.27, 0.30	20.8,27.4, 20.8
	T	EICCS27	279,224, 236	79.9	2546	-53.1,-59.4, -64.4,-69.7	0.11,0.09, 0.09	3.5,2.8, 3.0	0.48,0.70, 0.94	37.2,29.8, 31.5
	U	EICCS28	326,160, 235	52	1255	0,54.5, 47,0	0.26,0.13, 0.19	6.3,3.1, 4.5	0.28,0.44, 0.15	32.6,16, 23.5

* For the straight skewed and curved and skewed bridges, this table reports the maximum fascia girder length (along its arc for curved girders), divided by the width between the fascia girders perpendicular to the girders.

2.3 Vary the Framing Arrangements

In this research, the original framing arrangements were studied for all 21 of the base bridge designs discussed in Section 2.2. In a number of these bridges, it was apparent that specific improvements in the cross-frame framing arrangements were possible based on the NCHRP Report 725 research and other more recent developments and findings. These improvements relate particularly to the alleviation of significant nuisance transverse stiffness (undesirable large transverse stiffness associated with the combination of the skew and the cross-frame framing arrangement, leading to large cross-frame forces) via the application of the following guidelines:

1) Provide generous offsets between intermediate cross-frames and skewed supports and avoid large discrepancies in girder unbraced lengths to the extent practicable at skewed bearing lines.
2) Provide cross-frames along skewed bearing lines and avoid framing of intermediate cross-frames directly into bearing locations at interior piers.
3) In straight skewed bridges, stagger the intermediate cross-frames to both dramatically reduce the number of cross-frames required within the bridge as well as to reduce the overall transverse stiffness effects.
4) Keep the intermediate cross-frames contiguous within the main portion of the span in curved bridges.

These and other recommendations for improved cross-frame framing arrangements are discussed in Section 3.5.

In the NCHRP 20-07 Task 355 studies, the bridge girders and cross-frames were not redesigned given the changes in the framing layouts. The modified base bridges, with the varied framing arrangements, are expected to provide a reasonable first-level estimate of the effect of changes in the framing on the primary factors to be investigated in this research: ease of fit-up during erection of the steel, achievement of the targeted constructed geometry, and generation of locked-in stresses in the cross-frames and girders. It is emphasized that the base designs are actual bridges in service, or bridges that have been designed specifically to satisfy the criteria of the AASHTO LRFD Specifications.

2.3.1 Alternative Framing Arrangements for the Straight-Skewed Bridges

Alternative framing arrangements for the straight skewed bridges studied in the NCHRP 20-07 Task 355 research are shown below. The simple-span bridges are shown first followed by the continuous-span bridges. In addition, the bridges are listed in the order of increasing maximum span length within each sub-group.

(H2) EISSS57 (L_s = 137 ft; L_{max} = 211 ft; L_{min} = 63 ft; w_g = 61.0 ft; θ = 69.5° and -4.4°, non-parallel skew; n_g = 7; I_s = 1.19; L_{max}/w_g = 3.5; L_{min}/w_g = 1.0; L_s/D = 18.3)

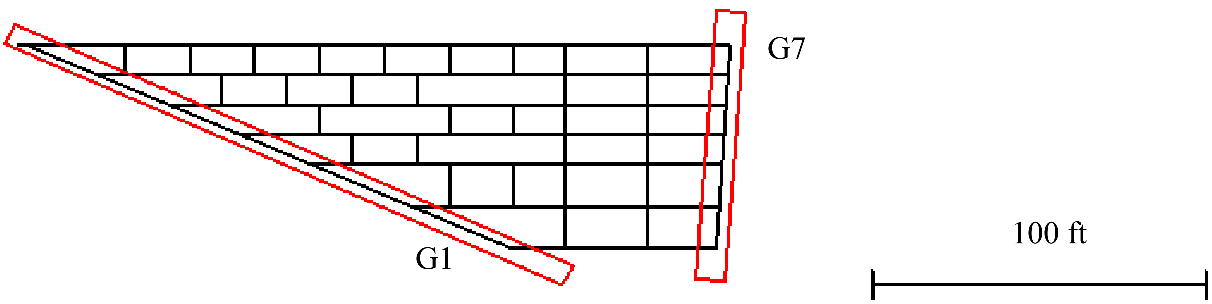


Figure 22. Bridge (H2) EISSS57.

Compared to Bridge (H1) (Figure 8), the framing arrangement of Bridge (H2) employs slightly larger offsets from the left highly-skewed bearing line, as well as staggered cross-frames near this bearing line. The cross-frames are kept contiguous near the right bearing line.

(I2) NISSS14 (L_s = 300 ft; w_g = 74 ft; θ = 70°, parallel skew; n_g = 9; I_s = 1.36; L_s/w_g = 4.1; L_s/D = 25)

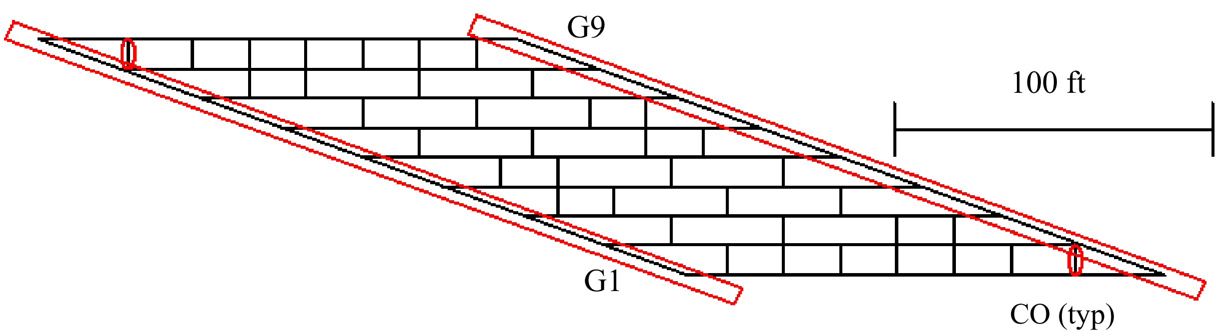


Figure 23. Bridge (I2) NISSS14.

The cross-frames are all equally-spaced in this framing arrangement except for the offsets adjacent to the skewed bearing lines. Seven intermediate cross-frames are attached between the fascia girder and the first interior girder on each side of the bridge. However, compared to Bridge (I1) (Figure 9), almost every other cross-frame is intentionally omitted within the interior of the bridge plan. This results in a significant reduction in the overall number of cross-frames being employed in the bridge. The cross-frames that are not omitted are kept in the bridge plan so that the unbraced lengths on the interior girders are equally-spaced except for the unbraced lengths adjacent to the skewed bearing lines.

The diagonal members of the first intermediate cross-frames adjacent to the skewed bearing lines at the acute corner in the exterior bays are removed to alleviate a nuisance stiffness problem (i.e., the unwanted transverse stiffness caused by the position of these cross-frames and the sharp skew of the bearing lines). The cross-frames highlighted by an oval and labeled on this plan view as "CO" (for "chords only") do not contain any diagonals. This is to allow for a small offset of these cross-frames relative to the skewed bearing lines (i.e., the highlighted cross-frames do not intersect exactly at the skewed bearing lines) to provide sufficient lateral bracing to the fascia girders at the acute corners of the span without inducing large cross-frame forces from nuisance transverse stiffness effects.

(J2) NISSS54 (L_s = 300 ft; w_g = 74 ft; θ = 70º, parallel skew; n_g = 9; I_s = 0.68; L_s/w_g = 4.1; L_s/D = 25)

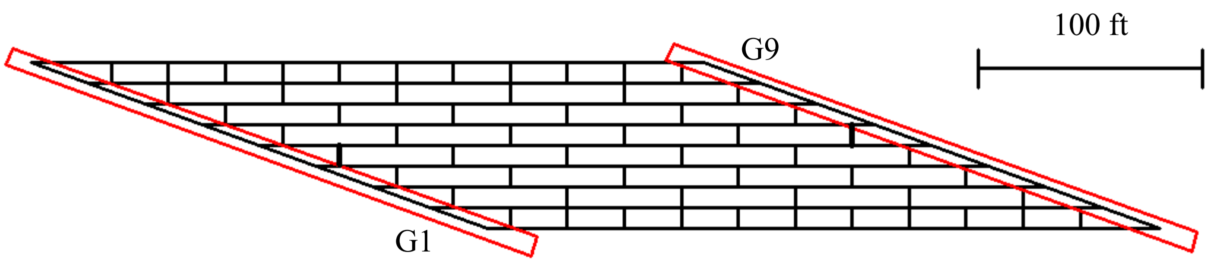


Figure 24. Bridge (J2) NISSS54.

The considerations in selecting the framing arrangement for Bridge (J2) NISSS54 are similar to those for Bridge (I2) NISSS14 (Figure 23). However, all the cross-frames have diagonal members in this alternative framing plan. Compared to Bridge (J1) (Figure 10), the framing arrangement of Bridge (J2) results in a significantly reduced number of cross-frames in the bridge system. Not only does this provide cost savings by reducing the large cross-frame forces caused by nuisance transverse stiffness effects; significant savings are achieved by the sheer reduction in the number of cross-frames in the bridge.

(K2 and K3) EICSS12, US 82 Mainline Underpass at 19th Street WB, Lubbock, TX (L_s = 150 and 139 ft; w_g = 41.0 ft; θ = 59.6°, parallel skew; n_g = 6; I_s = 0.47 and 0.50; L_s/w_g = 3.7 and 3.4; L_s/D = 33.3, 30.8)

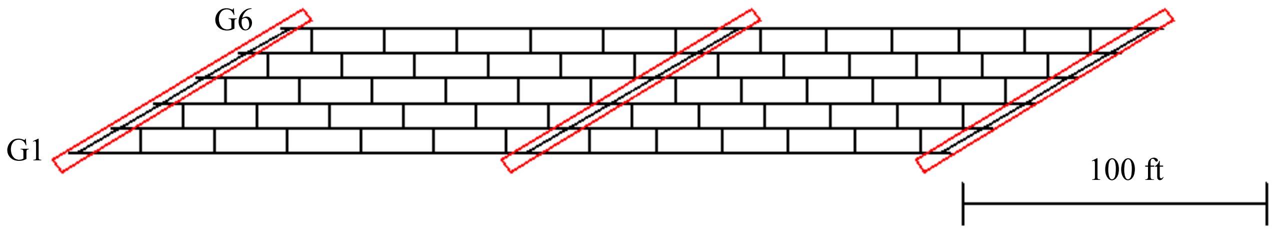


Figure 25. Bridge (K2) EICSS12.

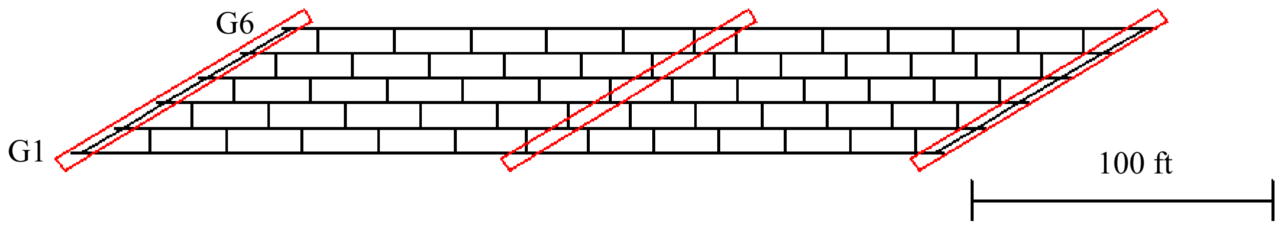


Figure 26. Bridge (K3) EICSS12.

The framing arrangements of bridge cases (K1), and (K2) and (K3) EICSS12 are studied to understand the effectiveness of staggered cross-frames versus lean-on cross-frames with respect to reliable fit-up. Compared to Bridge (K1) (Figure 11), Bridge (K2) provides a larger offset of the intermediate cross-frames adjacent to the skewed bearing lines at the interior pier and at the abutments. Skewed bearing line cross-frames are used at the interior pier for Bridge (K2). In addition, this bridge employs a staggered cross-frame arrangement within the span. In Bridge (K2), the cross-frames adjacent to the bearing lines are all placed at the same offset distance relative to the skewed bearing lines, satisfying the NCHRP Report 725 recommendations. The other intermediate cross-frames are placed at a constant spacing along the span length in all the bays between the girders. The flange resistance requirements given in the AASHTO LRFD Specifications are satisfied by framing one cross-frame into each girder location where a brace point is desired. Given the particular skew angle in this bridge, the stagger distances between the intermediate cross-frame locations within the spans are larger than a minimum limit discussed further in Section 3.5 of this report. The lines through the work points at the mid-length of the cross-frames are all parallel to the bearing lines in this bridge.

The considerations for Bridge (K3) are similar to Bridge (K2). Bridge (K3) does not use any skewed bearing line cross-frames at the interior pier, but provides an intermediate cross-frame normal to the girder on one or both of its sides close to each of the bearings at the interior pier.

(M2) EICSS2, I-235 EB over E. University Ave., Polk Co., IA (L_s = 239, 257 and 220 ft; L_{max} = 259, 255 and 220 ft; L_{min} = 241,183 and 220 ft; w_g = 66.6 ft; θ = 58°, 61.8°, 38° and 38°; n_g = 8; I_s = 0.52, 0.48, and 0.24; L_{max}/w_g = 3.9, 3.8 and 3.3; L_{min}/w_g = 3.6, 2.7 and 3.3; L_s/D = 26, 28, 23.8)

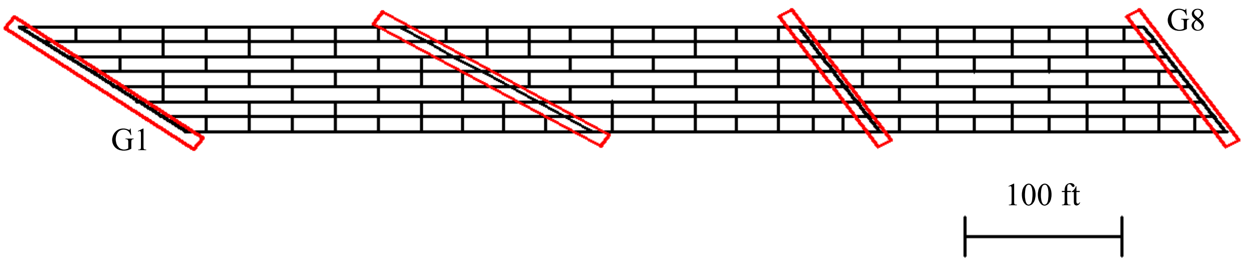


Figure 27. Bridge (M2) EICSS2.

The considerations for Bridge (M2) EICSS2 are similar to the considerations for bridge cases (I2) NISSS14 (Figure 23) and (J2) NISSS54 (Figure 24). Because the center span has a non-parallel skew, a number of cross-frames are taken out to ensure that the offsets from the bearing lines are greater than the recommended minimums. In addition, cross-frames are provided along the skewed bearing lines at the interior piers, and the intermediate cross-frames are offset from the skewed bearing lines at the interior piers and at the abutments.

2.3.2 Alternative Framing Arrangements for the Curved and Skewed Bridges

Alternative framing arrangements for the curved and skewed bridges studied in the NCHRP 20-07 Task 355 research are shown below. The simple-span bridges are shown first followed by the continuous-span bridges. In addition, the bridges are listed in the order of increasing maximum span length within each sub-group.

(O2) NISCS15 (L_s = 150 ft; L_{max} = 195 ft; L_{min} = 103 ft; w_g = 74 ft; R = 280 ft; θ = -35° and 0°; n_g = 9; L_s/R = 0.54; L_s/w_g = 2.0; $(L_{max} - L_{min})/(L_{max} + L_{min})$ = 0.31; L_s/D = 20)

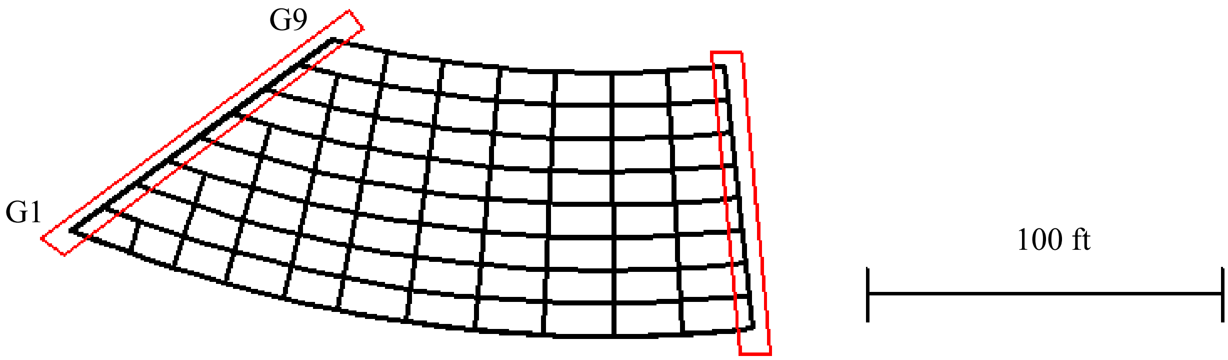


Figure 28. Bridge (O2) NISCS15.

The framing arrangement of Bridge (O2) NISCS 15 has contiguous instead of staggered cross-frames near the skewed bearing line as in Bridge (O1) (Figure 15). The first intermediate cross-frames exceed the recommended minimum offset distance from the left skewed bearing line (see Section 3.5.1). By using a contiguous cross-frame arrangement, the overall rotations and deflections of Bridge (O2) are reduced because of the increased engagement of the girders in developing the overall width of the structural system. However, at the skewed bearing line, uplift occurs at the support for the girder on the inside of the curve as well as for the adjacent interior girder. Uplift is encountered both at the end of the steel erection and in the completed structure. The uplift is resisted by using a tie-down device.

(Q2) NISCS38 (L_s = 300 ft; L_{max} = 366 ft; L_{min} = 249 ft; w_g = 74 ft; R = 730 ft; θ = 62.6° and 0°; n_g = 9; L_s/R = 0.41; L_s/w_g = 4.1; $(L_{min} - L_{max})/(L_{min} + L_{max})$ = -0.19; L_s/D = 23)

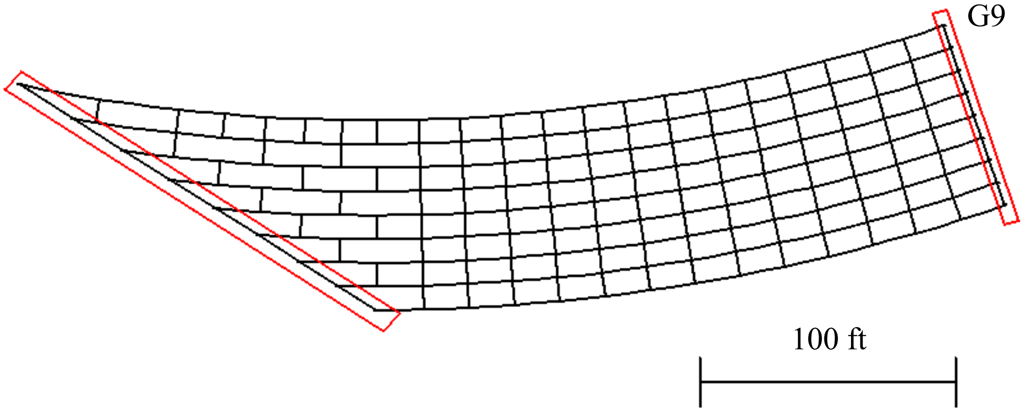


Figure 29. Bridge (Q2) NISCS38.

The framing arrangement of Bridge (Q2) NISCS38 has staggered cross-frames near the left-hand skewed bearing line. The first intermediate cross-frames are offset at a minimum distance from the skewed bearing line. Studying bridge cases (Q1) (Figure 17) and (Q2) provides a better understanding of the influence of contiguous versus staggered cross-frame arrangements in curved and skewed bridges where the skew orientation makes the inside girder (i.e., the girder on the inside of the curve) longer.

(R2) NISCS39 (L_s = 300 ft; L_{max} = 340 ft; L_{min} = 258 ft; w_g = 74 ft; R = 730 ft; θ = -35° and 0°; n_g = 9; L_s/R = 0.41; L_s/w_g = 4.1; $(L_{max} - L_{min})/(L_{max} + L_{min})$ = 0.14; L_s/D = 23)

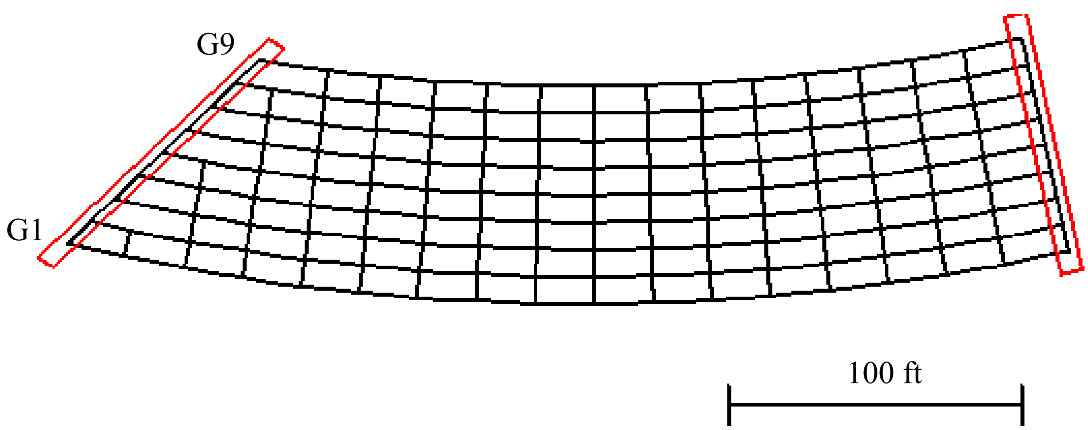


Figure 30. Bridge (R2) NISCS39.

Bridge cases (R1) (Figure 18), (R2) NISCS39, (O1) (Figure 15) and (O2) NISCS15 (Figure 28) have a skew orientation that makes the outside girder significantly longer. Bridge (R2) uses a contiguous cross-frame arrangement adjacent to the skewed bearing line. Due to increased development of the girders by the contiguous cross-frames, Bridge (R2) experiences significant uplift at the girder on the inside of the curve as well as at the adjacent interior girder at the skewed bearing line. The magnitude of the uplift force, 457 kip, is too large to be offset by a typical tie-down device or a counter-weight. This framing arrangement is considered infeasible to build.

(T2) EICCS27, SR 386 over SR6 and Ramp F, Sumner Co., TN (L_s = 279 ft, 224 ft, and 236 ft; L_{max} = 279, 239 and 231 ft; L_{min} = 268, 214 and 217 ft; w_g = 79.9 ft; R = 2546 ft; θ= -53.1, -59.4, -64.4 and -69.7°; n_g = 8; L_s/R = 0.11, 0.09 and 0.09; L_s/w_g = 3.5, 2.8 and 3.0; $(L_{min} - L_{max})/(L_{min} + L_{max})$ = -0.02, -0.03 and -0.01; L_s/D = 37.2, 29.8, 31.5)

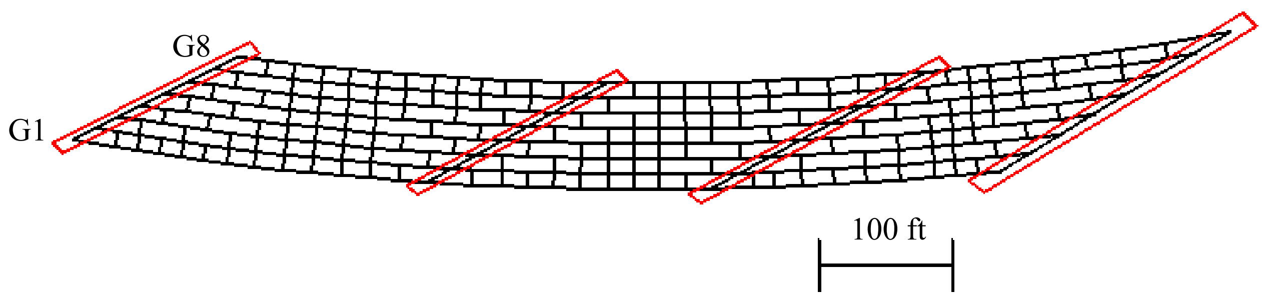


Figure 31. Bridge (T2) EICCS27.

Bridge (T2) has staggered cross-frames near the skewed bearing lines while using cross-frames along the skewed bearing lines both at the interior piers and at the abutments. In addition, intermediate cross-frames are offset by more than the recommended minimum distance from the skewed bearing lines, discussed further in Section 3.5.1. Contiguous cross-frame lines are employed within the middle of its left-hand end span and its center span, to assist in developing the width of the bridge cross-section for resistance of the horizontal curvature effects.

(U2) EICCS28, Corridor X and I-65 Interchange Ramp NW65X, Jefferson County, AL *(*L_s = 326, 160 and 235 ft; L_{max} = 369, 165 and 258 ft; w_g = 52.0 ft; R = 1255 ft; θ= 0, 47, 54.5 and 0°; n_g = 7; L_s/R = 0.26, 0.13 and 0.19; L_s/w_g = 6.3, 3.1 and 4.5; L_s/D = 32.6, 16, 23.5)

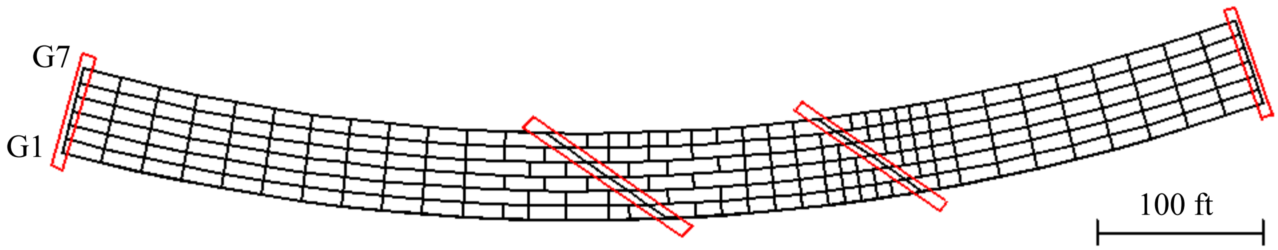


Figure 32. Bridge (U2) EICCS28.

Significant uplift (at the inside girder at the first interior pier from the left-hand abutment) and high cross-frame forces were experienced in Bridge (U1) EICCS28 (Figure 21). Bridge (U2) alleviates the uplift at this support as well as the large forces in the adjacent cross-frame members by staggering the cross-frames near the first interior pier from the left abutment. The cross-frames are offset by the recommended minimum distance discussed in Section 3.5, and bearing line cross-frames are used along the skew at the interior piers. The cross-frames near the second interior pier from the left-hand abutment have relatively low forces whether these cross-frames are staggered or contiguous.

2.4 Vary the Cross-Frame Detailing Methods

The "fit" or "fit condition" of a skewed and/or curved I-girder bridge refers to the geometry in which the cross-frames are detailed to attach to the girders. A fit condition is selected to offset, or compensate for (to different extents), the tendency of the I-girders to twist in these bridge types. The selected fit condition corresponds to a specific targeted outcome of when the girder webs will be approximately plumb in the field. "Fit-up" refers to the assembly of the structural steel during the bridge erection. It is desirable that the "fit-up" of the structural steel should be manageable, without the need for excessive jacking or pulling forces from the erector. The "fit condition" and the "fit-up" of the structural steel are interrelated, but these terms refer to different attributes of the construction. (It should be noted in this report, the term cross-frame is considered to be synonymous with the term diaphragm. AASHTO LRFD defines a diaphragm as a vertically-oriented solid transverse member and a cross-frame as a transverse truss framework. The primary emphasis in the studies conducted in this report is on transverse truss frameworks. However, the majority of the discussions and concepts also apply to solid transverse members.)

Table 2 summarizes the three most common fit conditions considered in skewed and/or curved I-girder bridges. Alternate names for each potential fit condition, which are generally more familiar to Fabricators/Detailers, are also provided in the table; the names are used interchangeably in practice.

Table 2. Common Fit Conditions.

Condition	Alternate Name	Description
No-Load Fit (NLF)	Fully-Cambered Fit	The cross-frames are detailed to fit to the girders in the fabricated fully-cambered and plumb position of the girders under zero load.
Steel Dead Load Fit (SDLF)	Erected Fit	The cross-frames are detailed to fit to the girders in an ideal plumb position where the girders are assumed deflected under the self-weight of the structural steel at the completion of the steel erection.
Total Dead Load Fit (TDLF)	Final Fit	The cross-frames are detailed to fit to the girders in an ideal plumb position where the girders are assumed deflected under the total as-constructed dead loads.

Steel Dead Load Fit (SDLF) gives approximately plumb girder webs once the erection of the steel is completed. This is the most customary form of detailing for skewed and/or curved I-girder bridges. Total Dead Load Fit (TDLF) gives approximately plumb girder webs once the bridge is subjected to its Total Dead Load (TDL). The term “Total Dead Load,” typically is assumed to include either all dead loads that are present when the bridge is opened to traffic, or the as-constructed dead loads, taken as the weight of the structural steel plus the weight of the concrete deck, but not including the weight of barrier rails, sidewalks, etc. The later of these definitions is the preferred definition for most bridges (NSBA 2015). This definition is employed in this research. Future wearing surface loads and their effects generally are not considered as a part of the TDL. No-Load Fit (NLF) corresponds to detailing of the cross-frames so that they fit-up with the girders in their No-Load (NL) undeflected geometry. In this case, the girder webs will not be plumb once the bridge is subjected to its dead loads, except at non-skewed bearing lines.

There are two key sets of values used by detailers in calculating the geometry of the cross-frames for SDLF or TDLF detailing:

(1) The vertical Total Dead Load (TDL) and/or Steel Dead Load (SDL) deflections provided on the design plans (Both TDL and SDL deflections are required for SDLF detailing while only the TDL deflections are required for TDLF detailing), and
(2) The associated major-axis bending rotations at the girder connection plates under the targeted load condition.

The girder camber profiles provided on the engineering plans are commonly set as the negative of the TDL vertical deflections. These camber values are referred to herein as the TDL camber. Although not actually applied to the girders, the corresponding negative of the SDL vertical deflections is referred to in this work as the girder SDL camber. These values are used along with the TDL camber in setting the geometry of the cross-frames for SDLF detailing.

In the fourth task of NCHRP 20-07 Task 355, the three main types of cross-frame detailing, No-Load Fit (NLF), Steel Dead Load Fit (SDLF) and Total Dead Load Fit (TDLF), are varied and applied to the 21 base designs and their framing variations.

It is necessary to study NLF detailing for all the cases since this is the base case from which the SDLF and TDLF effects are measured. It should be noted that SDLF and TDLF detailing of the cross-frames produces an intentional lack-of-fit between the cross-frames and the girders in their undeformed No-Load condition, and generally results in significant changes to the dead load cross-frame internal forces as well as the dead load flange lateral bending stresses in the girders. The project team did not conduct any full redesign of the base bridges and their framing variations to account for the modified internal forces from the detailing of the cross-frames. In all cases, it is emphasized that the base bridges were analyzed for design, and for setting the girder cambers, using the current customary practice within the bridge design industry, which is to analyze the bridge structural system dead load effects by simply "turning gravity on," without considering the locked-in force effects associated with the cross-frame detailing (i.e., assuming NLF detailing). The simulation studies conducted in this research include the initial lack-of-fit effects associated with SDLF and TDLF detailing directly and rigorously in the corresponding structural analysis.

It is important to note that for the straight skewed bridges studied in this research, the cambers used for SDLF or TDLF detailing are calculated both from a line girder analysis (LGA) as well as from 3D FEA. However, for the curved bridges with and without skew, 3D FEA is used for calculation of the cambers in all cases. In straight skewed bridges, the use of cambers from LGA gives the closest match to the ideal zero girder layovers and internal stresses under the targeted dead load conditions. The use of cambers from an accurate 2D Grid or 3D FEA gives non-zero girder layovers and flange lateral bending stresses. However, these layovers and stresses are small compared to the overall dead load responses under the targeted conditions. The ultimate recommendation from the NCHRP 20-07 Task 355 research is that the engineer should not mix the methods of analysis being applied for a given bridge. That is, if a refined analysis is employed for the overall bridge design (i.e., grid analysis or 3D FEA), the cambers also should be calculated based on the refined analysis. The influence of camber calculations (accurate refined analysis versus LGA) in straight skewed bridges is discussed in Sections 3.4 and 3.7.

The specific procedures used for LGA and 3D FEA, including the incorporation of the effects of the detailing methods considered in this research in the structural analysis simulations, are discussed in Section 2.6.

2.5 Select Erection Schemes

In Task 5 of the research, erection schemes were selected for the 21 bridges listed in Section 2.2. Appendices A to U show the details of the erection stages for the selected erection schemes. The research analyzed the erection stages for both the base design and alternate framing arrangements. For the existing bridges, the erection schemes followed the as-built scheme, if available. This allowed for an evaluation of the as-built scheme fit-up difficulty and comparison with available field observations for bridge cases such as (E) EICCR11, (M1) EICSS2, and (U1) EICCS28. For existing bridges whose erection schemes were unavailable and for the parametric bridges, the erection schemes were devised so that the fit-up forces were manageable. These erection schemes are not necessarily the “optimum” schemes, but they provide for a feasible and practical erection of the bridge.

Detailed erection plans with numerous stages were developed for all 21 bridges. These plans are provided in Part 1 of the appendix corresponding to each bridge. When developing the erection plans, the locations of the field splices, the segment lengths that can be lifted in the field, and girder stability during erection (particularly important for curved girders) were considered. The research team then selected what were expected to be the most critical erection stages, i.e., stages that were expected to experience potential fit-up difficulty, for detailed simulation.

For straight skewed bridges, when erecting girder by girder, the later stages have a higher skew index. As a result, the collateral effects due to the skew are more substantial during the later stages. For curved bridges, substantial vertical support from shoring towers and/or cranes is often necessary in the early stages. The later stages often involve less vertical support from shoring towers and/or cranes, and thus have higher fit-up forces. Due to these characteristics, the critical erection stages are often the last few stages for both straight and curved bridges.

For continuous-span bridges, or simple-span bridges with long span lengths, a sufficient number of stages were selected to illustrate the bridge behavior as the erection progresses. For a number of curved bridges, two erection methods were selected to investigate the effects of erecting from the inside to the outside of the curve and vice versa.

Support uplift often is more apt to occur during erection. In all cases, the analyses conducted allowed the girders to uplift at any support locations that did not have a tie-down.

Unless noted otherwise, the shoring and crane elevations are modeled at the no-load elevations for all the curved radially-supported and curved and skewed bridges studied in this research. This idealization of the shoring and crane elevations is applied regardless of the cross-frame detailing method. For straight skewed bridges, the shoring and crane elevations are modeled at the steel dead load elevations (i.e., the steel dead load elevations in the completed bridge system) in all cases, unless noted otherwise. The rationale for these assumptions is as follows:

- The girder fabricated geometries are of course the no-load geometry.
- In addition, the girder splices are commonly detailed for the no-load geometry.
- In cases where the girders can be installed sequentially along the length of the bridge, without the need for any drop-in segments, the field section that is being installed can be knifed-in to the splice with the previous field section, as long as attention is paid to the

orientation of the splice and vertical clearances between the field section that is being installed and permanent support locations. However, for cases involving drop-in segments, the completion of the second girder splice of the drop-in segment can be greatly facilitated by having the steel on both sides of the splice in the approximate no-load geometry.

- The cross-frame fit-up forces in horizontally curved bridge units tend to be minimized, as an approximate target, by hold points and temporary supports that are located at the no-load elevations.
- For straight skewed bridges, the fit-up of the cross-frames often can be achieved most easily by allowing the girders to deflect under their self-weight. Particularly when Steel Dead Load Fit (SDLF) detailing is employed, the resulting girder elevations will be very close to their Steel Dead Load (SDL) elevations in the completed bridge. This condition is of course achieved approximately by locating the girder hold and temporary support points at the final SDL elevations of the completed bridge.

Erection simulations for straight skewed bridges with NLF detailing were not considered in this research. This is because the sharp skews associated with the bridges considered in this work would cause high girder layovers and large rotation demands on the bearings if NLF detailing was used.

2.6 Perform Analytical Parametric Studies

In its sixth task, the project team performed structural analyses of the steel and total dead load configurations as well as the erection sequences. This task involved detailed 3D FEA test simulation studies of all 21 bridge cases and their framing variations. Data from these studies were collected, synthesized, and analyzed to quantify the influence of the various parameters on the three primary factors investigated in this research:

- Ease of fit-up during erection of the steel,
- Achievement of the targeted constructed geometry, and
- Generation of locked-in stresses in the cross-frames and girders.

The results from these studies are compiled and presented in various ways to facilitate the interpretation and understanding of the data by bridge professionals. This includes the development of force summary tables for each analysis case, and tabulation and plotting of the summary results for:

- Cross-frame fit-up forces,
- Girder splice fit-up forces,
- Girder vertical displacements,
- Girder elevation profiles,
- Girder layovers,
- Cross-frame forces.
- Girder major-axis bending stresses,
- Girder flange lateral bending stresses, and
- Bearing reactions.

Various graphs and plots of the data are provided to allow effective visualization of the responses. The tables, graphs and plots were generated automatically to the maximum extent possible via advanced programming tools utilized within the NCHRP Report 725 research plus some additional refinements to these tools developed in the current research.

At the present time (2015), simulation of many types of physical responses can be readily performed using 3D Finite Element Analysis (FEA). The availability of these tools provides substantial promise for detailed analytical studies to address the outstanding questions in this research. However, the accuracy of results from 3D FEA simulations depends on the accuracy of the capture of the following attributes:

- Geometry details,
- Boundary conditions – loads and displacements,
- Assumed initial conditions, e.g., any lack-of-fit between components in the No-Load (NL) condition,
- The interconnection between various components (e.g., dimensional tolerances in girder splice and cross-frame to girder connections, and the composite interaction between the steel girders and the concrete slab).

In this research, 3D FEA is used to calculate all the bridge responses. All of the 3D FEA studies are conducted using the ABAQUS 6.12 platform (Dassault Systemes 2014). The research utilizes an input file generator that allows accelerated generation of the 3D FEA models. The following are modeling specifics selected in ABAQUS for this research:

- The girder webs are modeled using the S4R shell elements throughout the depths between the mid-thicknesses of the girder flanges. The S4R element is a 4-node quadrilateral displacement-based shell element with reduced integration and a large-strain formulation. This research utilizes the FEA mesh density recommended by the NCHRP Report 725 research, which demonstrated that 12 S4R shell elements through the web depth is sufficient for the types of studies conducted in this research. The number of the S4R elements is selected along the girder lengths such that an element aspect ratio close to 1.0 is achieved.
- A 2-node shear-deformable beam element, B31, which is compatible with the S4R shell element, is used to model the flanges, stiffeners, and chords of V or inverted-V cross-frames to which the diagonals are connected. The cross-frame chords in this case are modeled as being moment connected to the girder connection plates. All of the flange plates, etc. are modeled at their correct depths in the physical structure.
- A truss element, T3D2, is used to model the cross-frame members except in the case of the chords mentioned above. The cross-frame elements are connected to their exact physical work points on the girder webs. The connections of the cross-frames at the girder webs are modeled using multi-point constraints. This eliminates the need to adjust the FEA discretization through the depth of the girder webs to place the nodes at the work points.
- The axial stiffness of single-angle and flange-connected tee cross-frame members is taken as 0.65 of the nominal EA/L of these members. This modeling practice accounts for the additional flexibility associated with the eccentric one-sided connections to gusset plates or girder connection plates at the member ends, as specified in Article 4.6.3.3.4 of the 7th Edition AASHTO LRFD Specifications. This modeling of the reduced stiffness of single-angle and flange-connected tee cross-frame members was not employed in the NCHRP Report 725 research.
- Separate line girder analyses (LGA) are conducted in this research to obtain LGA cambers for straight skewed bridges. These analyses are conducted by running the corresponding 3D FEA model with the cross-frame elements removed and the girder lateral displacements

restrained. The LGA cambers also can be obtained by analyzing the girders using ordinary beam elements. The LGA cambers obtained from the above 3D FEA model and from a beam element model are the same for all practical purposes. The use of the 3D FEA model to conduct the LGA solutions is simply a matter of convenience in this research, since the same girder models employed in the 3D FEA system simulations could be easily re-used to obtain the LGA solutions.

- Grid-analysis is conducted in this research to illustrate the incorporation of cross-frame detailing method effects via initial fixed-end forces, as discussed in Section 3.9. For this portion of the research, the girders are modeled using a separate grid analysis capability developed in this research. The girder section properties are specified including the use of the equivalent St. Venant torsion constant for the I-girders from the NCHRP Report 725 research, which accounts approximately for the contribution of warping to the torsional stiffness. An Euler-Bernoulli frame element is used in this software to model the girders. The cross-frames are modeled using equivalent beam elements based on two methods: Euler-Bernoulli beam elements with the cross-section properties determined by the flexural analogy, as discussed in Section3.2.3 of the NCHRP Report 725, and the Timoshenko beam approach recommended by NCHRP Report 725. The equivalent beam cross-frame properties are calculated for each of these two beam elements using the methods recommended in NCHRP Report 725. The Timoshenko beam element formulation is explained in (McGuire, et. al. 2000). It is found that for the bridge cases studied in Section 3.9, the responses are essentially the same with the cross-frames modeled based on Euler-Bernoulli beam with the flexural analogy and Timoshenko beam. This is largely because the cross-frames are effectively rigid relative to the stiffness of the girders in the example bridges studied in this section.
- In this research, the lack-of-fit due to SDLF and TDLF detailing is accounted for directly in the 3D FEA simulations via cross-frame initial strains. These initial strains are calculated in ABAQUS by imposing the vertical deflections associated with the girder dead load cambers (i.e., the corresponding vertical lack-of-fit of the cross-frames in the bridge reference no-load geometry is equal to the TDL camber for TDLF and it is equal to the SDL camber for SDLF; the cross-frames are detailed to fit to the girder elevations after the SDL displacements have occurred, for SDLF, and after the TDL displacements have

occurred, for TDLF). As noted in Section 2.4, the TDL camber is taken simply as the negative of the TDL girder vertical deflections; similarly, the term "SDL camber" is used in this research to refer to the negative of the SDL deflections used in the calculation of the cross-frame initial strains for SDLF detailing. Special-purpose tools were developed and used to facilitate the calculation of initial strains in the 3D FEA software and for including these initial strains in the bridge 3D FEA simulations.

- As noted previously, the cambers used for SDLF or TDLF detailing are calculated both from a LGA and from 3D FEA for the straight skewed bridges. For the curved and curved and skewed bridges, the girder cambers are calculated in all cases using the 3D FEA models. When TDLF detailing is used on a straight skewed bridge, the TDL cambers used for fabrication of the girders are calculated, neglecting any contribution of the bridge deck to the resistance of vertical displacements. When SDLF detailing is employed based on LGA cambers, the correct total cambers to be fabricated into the girders are calculated as the SDL camber from an LGA for SDL plus the Concrete Dead Load (CDL) camber, taken as the negative of the CDL girder displacements in the bridge system as calculated from 3D FEA (neglecting the contribution of the bridge deck to the resistance). For the unusual case of NLF detailing on a sharply skewed straight I-girder bridge, the TDL girder cambers used for fabricating the girders are determined directly from 3D FEA.
- In all cases, the girder cambers are calculated by the common practice of building a model of the structure (or girder) and then simply "turning gravity on." The influence of the SDLF or TDLF detailing effects on the girder vertical displacements is not considered in calculating the girder cambers.
- The girder cambers are accounted for explicitly in the structural analysis simulations by modeling the no-load geometry of the steel girders using their cambered no-load profiles. Given the specified cambers, from whatever the source and method that they may be determined, the 3D FEA procedures provide a unified rigorous approach for determining the locked-in force effects associated with the SDLF or TDLF detailing.
- Superelevation, cross-slope, grade and vertical curve are neglected in this research. The effects of these attributes on the gravity load responses is usually assumed negligible in bridge design practice, based on the assumption that the angles with the horizontal associated with these attributes of the geometry are small.

- The weight of steel is modeled using a weight density of 490 pcf applied to the flange, web, connection plate, transverse stiffener and cross-frame member areas and lengths between work points, etc. specified in the 3D FEA model. No additional allowance for miscellaneous steel is included. This means that the weights of the cross-frames in the 3D FEA model are somewhat underestimated relative to the corresponding physical cross-frames. This under-estimate is of a minor consequence at most for the purposes of this study. In the above LGA calculations, the weight of the cross-frames (based on the cross-frame member areas times their lengths between the connection work points) is included by adding vertical concentrated loads at the connection work points on the girder webs.
- The concrete deck weight is modeled on the noncomposite I-girders as distributed line loads applied at the centerlines of the top flanges. This weight is calculated based on the tributary widths between the girders and from the deck overhangs. In addition, the weight of the concrete in the girder haunches is included. The eccentricity of the deck overhang weights with respect to the fascia girders is modeled as equal and opposite uniformly distributed lateral loads at the level of the fascia girder flanges, representing the effect of overhang bracket loadings on the girders.
- Construction equipment loads are not considered in the direct calculations considered in this research.
- The influence of staged concrete deck placement is neglected in this research. Where TDL responses are evaluated, the calculations are performed using the idealization that the entire concrete deck is placed prior to any participation of the deck in resisting load. This results in an upper-bound estimate of the TDL deflections and the corresponding fit-condition and fit-up effects.
- The bridges are assumed to float on the bearings to minimize the impact of bearing restraints on the system responses in all cases. This is a common recommended approach for highly skewed and/or curved I-girder bridges (NHI 2011). The bridge is restrained laterally only by small stiffnesses from the bridge bearings, thus avoiding undesirable restraint in the in-plan directions. The physical bearing details are designed to restrain large movements during potential extreme events.

- The bridges are analyzed using a geometrically nonlinear elastic analysis in all cases. This allows for the capture of second-order amplification of the physical response in any situations where these effects may be important.
- All of the test simulation models are based on the assumption of linear elastic material behavior in this research.

2.7 Refine Existing Guidelines and Propose New Guidelines

Task 7 of the NCHRP 20-07 Task 355 research involved performing a final assessment of the results from Tasks 1 and 6 and recommending modifications to a guidelines document developed by an affiliated NSBA Steel Bridge Collaboration Task Group on Skewed and/or Curved Steel I-Girder Bridge Fit (2015). These guidelines address the three primary factors investigated in this research: ease of fit-up during erection of the steel, achievement of the targeted constructed geometry, and generation of locked-in stresses in the cross-frames and girders. The effects of variations in geometric parameters (span length, degree of curvature, severity of skew, etc.) are considered in these recommendations. The recommendations address the implications of different framing arrangements, cross-frame detailing methods, and erection procedures.

2.8 Identify Best Inspection Practices

In some instances, steel I-girder bridges have deviated measurably from the targeted geometry at the completion of the steel erection or at completion of the concrete deck placement. When this occurs, the engineer is faced with a very difficult inverse problem in that there are a plethora of different factors that may have contributed to the bridge geometry being out-of-tolerance. The studies in Task 6 provide an improved understanding of the sensitivity of the final constructed geometry of the bridge to these factors.

Task 8 of the NCHRP 20-07 Task 355 research focuses on the identification of best practices for construction inspection of the erected geometry of skewed and/or curved I-girder bridges to ensure that the erected geometry sufficiently meets the specified fit conditions. The recommendations developed from this task were informed by the experiences of erectors and bridge construction inspection engineers, as well as the implications from the various results developed in Task 6 of the project. One important focus of Task 8 is a clear identification of the potential consequences of different magnitudes of web out-of-plumbness at supports as well as within the span of I-girder bridges.

3. FINDINGS AND APPLICATIONS

3.1 Behavior of Curved and/or Skewed I-Girder Bridges

An understanding the basic behavior of straight skewed, curved, and curved and skewed I-girder bridges is important to understanding the implications of various framing arrangements, cross-frame detailing methods, and erection procedures on the ease of fit-up, achievement of the targeted constructed geometry, and generation of locked-in stresses in the cross-frame and girders of these structures. The key pertinent behavior of each of these bridge types is summarized in the following sections.

3.1.1 Behavior of Straight Skewed I-Girder Bridges

In straight skewed bridges, the girders deflect only vertically under their self-weight, as long as the cross-frames are not connected to the girders in a manner such that they are engaged and can transfer internal shears and moments. This is illustrated by Figure 33, but with the cross-frames not shown. If all the girders are theoretically placed on their vertical supports, just the top chords of all the cross-frames are attached to the girders (such that there is no shear and moment transfer via the cross-frames), and the girders are allowed to deflect under the full steel self-weight, the resulting girder vertical deflections are exactly equal to the Steel Dead Load (SDL) deflections obtained from a Line Girder Analysis (LGA).

If the SDL cambers are set based on the above deflections, and then the cross-frames are detailed for Steel Dead Load Fit (SDLF) using these cambers, the cross-frames will theoretically fit exactly to the girders in the above SDL geometry without any forcing. That is, the SDLF detailing creates locked-in internal forces that cancel out the dead load cross-frame forces that would exist if the cross-frames were detailed for No-Load Fit (NLF). These statements apply to all straight I-girder bridges with either parallel skew or non-parallel skew. However, they do not apply to curved I-girder bridges, as explained in Section 3.1.2. Section 3.7 provides a detailed explanation of this behavior in straight skewed bridges.

After the cross-frames are connected to the girders, the interconnected girders deflect as a 3D system under all subsequent loads. The cross-frames brace the girders, but they also serve as an additional transverse load path in the system. As a result, the girders deflect vertically and simultaneously twist under the dead loads. This is illustrated using a simple two-girder system in Figure 34.

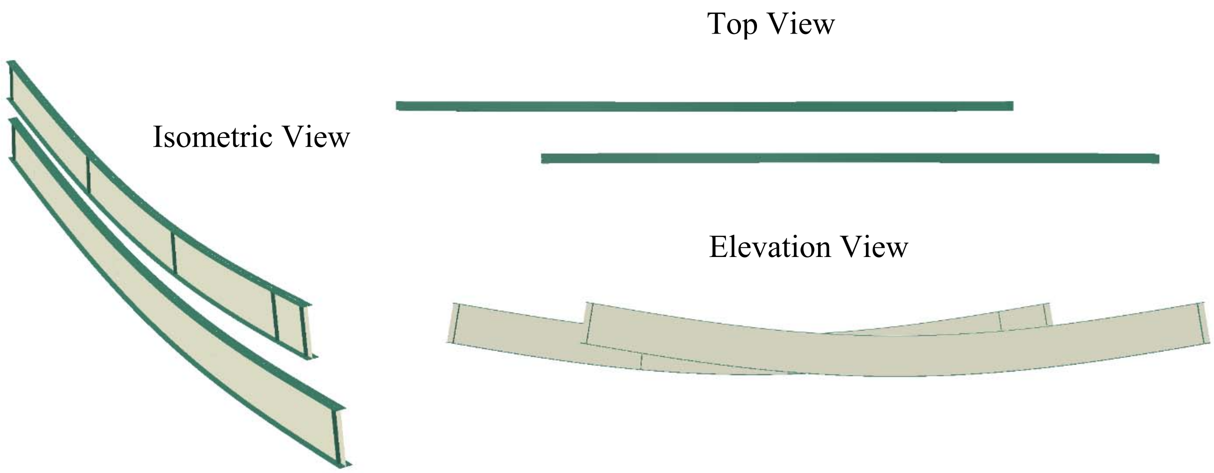


Figure 33. Magnified girder deflections for two straight I-girders, simply-supported at their ends on skewed bearing lines, and subjected to the self-weight of the structural steel prior to interconnecting the girders by the cross-frames (cross-frames not shown).

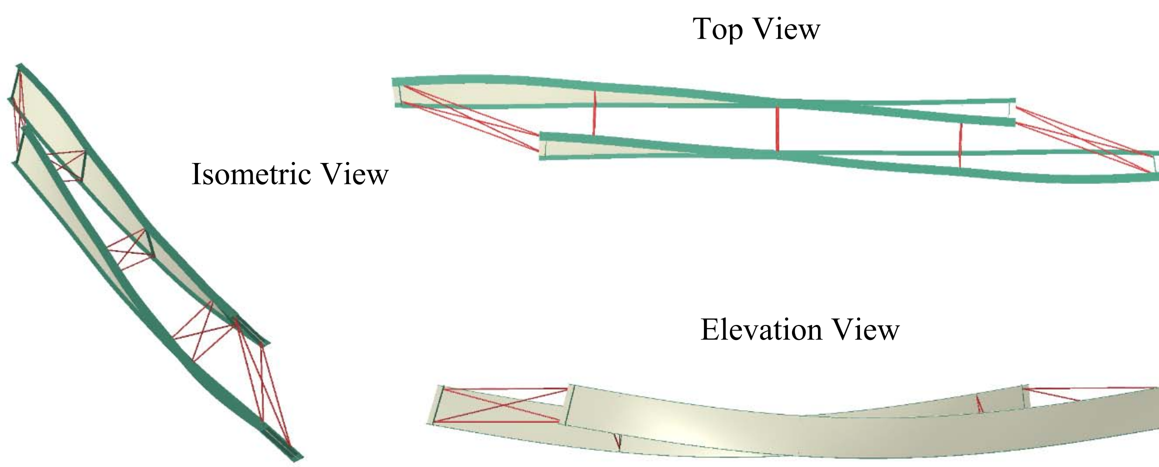


Figure 34. Magnified girder deflections for two straight I-girders, simply-supported on skewed bearing lines at their ends, and subjected to vertical load after interconnecting the girders by cross-frames.

This behavior is different from the behavior of a straight non-skewed bridge. In a straight non-skewed bridge, the girders deflect predominantly in a vertical fashion. This is because there are no significant differential vertical deflections between the girders and there is no significant interaction between the girders and the cross-frames (aside from aspects such as eccentric overhang bracket loads during the concrete deck placement). However, in a straight skewed bridge, there are significant differential vertical deflections between the girders at each of the intermediate cross-frames, since these cross-frames connect to different positions within the span of each of the girders. In addition, to maintain compatibility between the cross-frames and the girders at sharply-skewed abutment bearing lines, the girders have to twist substantially at the skewed abutments.

3.1.2 Behavior of Curved Radially-Supported Bridges

The fundamental behavior of horizontally curved radially-supported I-girder bridges is substantially different from that of straight skewed I-girder bridges. Figure 35 shows the magnified deflections under vertical load in a simply-supported bridge of this type after all of the steelwork has been completed. By comparing to Figure 34, one can immediately observe that the deflections are entirely different in a curved radially-supported bridge. Essential behavior differences compared to straight skewed bridges are discussed below.

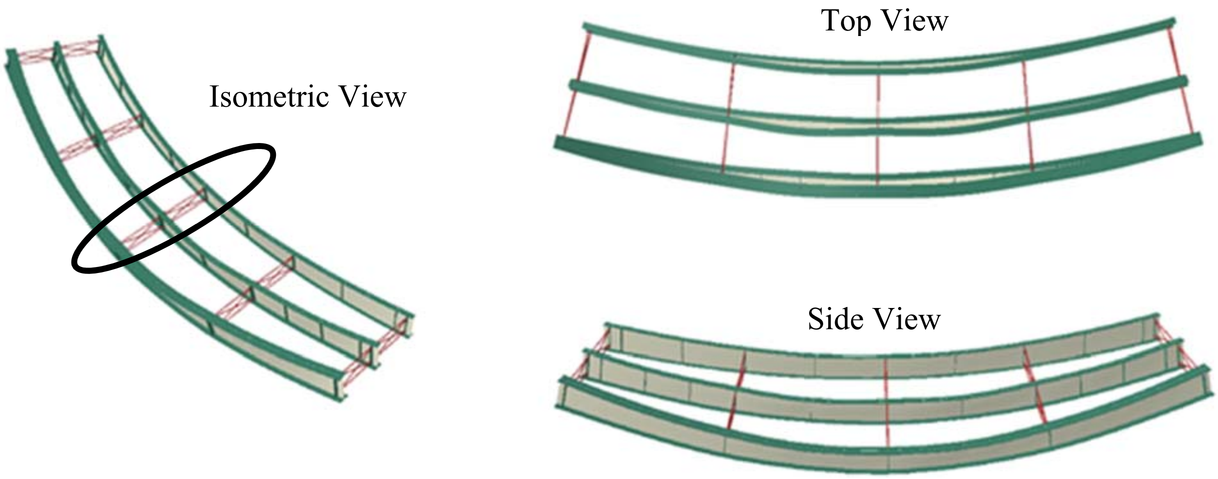


Figure 35. Magnified girder deflections in a representative horizontally curved I-girder bridge, simply-supported on radial bearing lines at its ends, and subjected to vertical load after interconnecting all the girders by cross-frames.

The bridge cross-section in horizontally curved bridges is subjected to substantial internal torsional moments due to the fact that the resultant of the bridge vertical loads within the spans has an eccentricity relative to a straight chord between the supports. In a straight bridge, the total internal torsion tends to be relatively small and the twisting of the girders is induced predominantly by the compatibility of deformations between the girders and the cross-frames. That is, if the girders are not interconnected by the cross-frames, there is no tendency for them to twist under the primary vertical loads. In a curved bridge, the total internal torsion is due to the eccentricity of the resultant of the vertical loads. This torsion is independent of the interconnection of the girders by the cross-frames.

The predominant resistance to the above internal torsion in horizontally curved I-girder bridges is developed by interconnecting the girders by the cross-frames across the entire bridge width. If the girders in Figure 35 were connected together *only* by the cross-frames at the *ends of the span*, the individual girder twist rotations and the coupled vertical displacements would be excessive. Curved I-girders, and curved I-girder bridge units, generally cannot be erected without providing some type of intermediate vertical support within the spans, typically via holding cranes or temporary shoring at critical stages of the erection. The individual girders as well as the partially completed bridge cross-sections tend to "torsionally over-rotate" during the steel erection compared to their behavior within the completed steel superstructure.

In a straight skewed bridge detailed for SDLF (using Line Girder Analysis cambers), the girders inherently do not transfer load to the cross-frames under the SDL condition since the cross-frames are not needed to restrain the girders from twisting. Horizontally curved bridges are different. Regardless of the detailing method used (NLF, SDLF, TDLF, etc.), vertical forces ("V-loads") are applied to the girders by the cross-frames, producing a shift in the internal vertical loads toward the girders on the outside of the horizontal curve. Associated radial forces are applied to the girders from the cross-frames that restrain the tendency of the girders to twist excessively on their own. The cross-frames provide these restoring forces to the individual girders via the system behavior of the bridge, thus preventing excessive individual girder out-of-plane rotations.

Due to the above behavioral effects, the locked-in internal forces due to SDLF and TDLF detailing of the cross-frames tend to be additive with the other internal dead load force effects. This behavior can be explained conceptually by considering the actions at a contiguous cross-frame line near mid-span in the representative curved radially-supported bridge shown in Figure 35. Figure 36 illustrates the behavior at the highlighted cross-frame line in the curved bridge from Figure 35. If the cross-frames in this bridge are detailed for NLF, then the girders are plumb and the cross-frames fit between the girders without any forcing in the fully-cambered no-load geometry. Therefore, once the TDL is applied to this bridge, the overall bridge cross-section twists and the girders will be "laid over" within the bridge span. These layovers are not a structural concern, generally, as long as overall global stability of the bridge system is ensured, since they are within the span and do not have any significant influence on the bearings or the overall roadway alignment. For simplicity, the sketch in Figure 36 shows the girders in a configuration without any superelevation or cross-slope at the completion of the bridge and under the TDL, assuming NLF detailing of the cross-frames (see the middle sketch in Figure 36). The girder at the left of Figure 36 is on the outside of the curve and is subjected to larger dead load deflection because of the behavior resulting for horizontal curvature. Therefore it has larger vertical camber than the adjacent interior girder and is at a higher elevation in the no-load condition.

If TDLF detailing of the cross-frames is used on a curved radially-supported bridge such as in the above example, the cross-frames are built in a geometry such that they twist the girders substantially in the direction opposite from the direction which they want to roll under dead loads. This is illustrated by the sketch at the bottom of Figure 36. In this case, this additional "pulling" (or "twisting") of the girders in the direction opposite from that which they want to roll tends to increase the internal forces in the cross-frames.

TDLF detailing also twists the girders substantially in the direction opposite from that which they roll under dead loads in a straight skewed bridge. However, in this case, the detailing relieves the TDL effects in the cross-frames. This is because the TDL twist rotations in a straight skewed bridge are imposed on the girders via the compatibility of deformations with the cross-frames. Conversely, in a curved radially-supported bridge, the intermediate cross-frames restrain or resist the tendency of the curved girders to twist and deflect excessively, which would occur if they were restrained from twisting only at the bearing lines. The intermediate cross-frames tie the girders into the overall structural system, and force the girders to work together to resist torsion via differential major-axis bending of the girders across the bridge cross-section. Therefore, the additional pulling or twisting of the girders in the opposite direction from that which they want to roll adds to the other dead load cross-frame forces in a curved radially-supported bridge, since the other dead load forces *and* the additional forces associated with the TDLF detailing are both restraining or resisting the tendency of the individual girders to twist and deflect excessively.

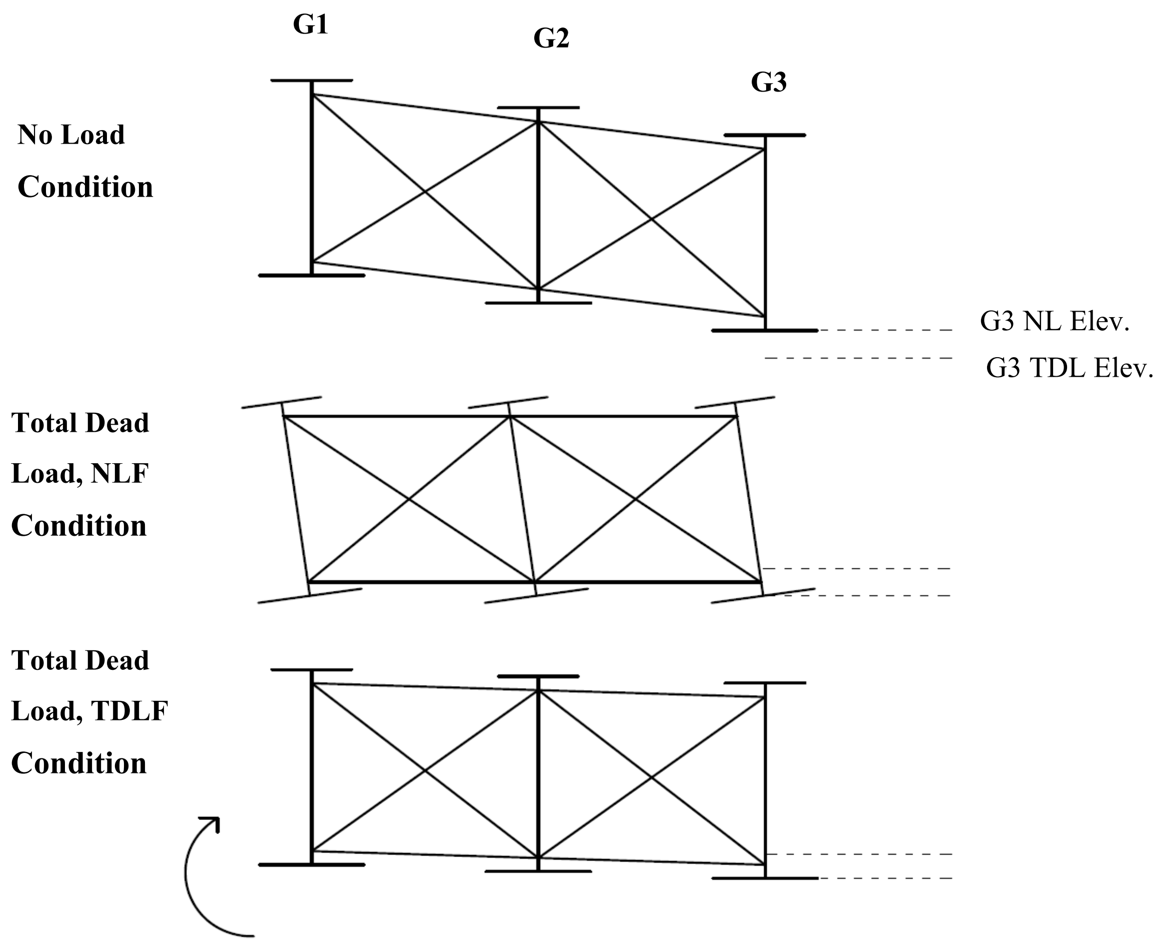


Figure 36. The behavior at the highlighted cross-frame line in the curved radially-supported bridge from Figure 35.

It should be noted that Figure 35 does not show the initial vertical camber that is fabricated into the girders. If the initial vertical camber were included in this figure, the bridge would essentially be in a flat geometry under the TDL when NLF detailing is used, as shown in the center sketch of Figure 36. Figure 35 shows the magnified displacements on the bridge geometry, neglecting the influence of the vertical camber.

When TDLF detailing is used, the girders are twisted in the direction opposite from the direction they tend to roll under dead loads. Because twist rotations and vertical deflections are coupled in curved bridges, the final girder elevations are somewhat higher when TDLF detailing is used.

3.1.3 Behavior of Curved and Skewed Bridges

Horizontally curved I-girder bridges with skewed supports generally include a combination of all of the effects discussed in the above sections. The curvature and the skew can induce responses that are either additive or subtractive with one another, depending on the overall bridge geometry. A skewed abutment, combined with the framing arrangement of the cross-frames, can cause girder twist rotations that are in the same direction as the twist due to the horizontal curvature. However, a similar skewed abutment with a skew angle that is the negative of the above case, in combination with the framing of the cross-frames, can induce girder twist rotations that are in the opposite direction from those due to the horizontal curvature. Therefore, it is imperative that curved and skewed bridges be considered on a case-by-case basis.

3.2 Cross-Frame Fit-Up

Cross-frame fit-up forces are the forces required to physically bring a cross-frame and a girder that the cross-frame is being connected to together and complete the connection during the erection of the steel. These forces are influenced by the bridge type (straight skewed, curved radially-supported, or curved and skewed), bridge parameters such as span length and radius of curvature, detailing methods, framing arrangements, and erection procedures.

A major focus of the NCHRP 20-07 Task 355 research is on the ease of fit-up of the cross-frames during erection. In this work, cross-frame fit-up is estimated by calculating the forces induced at the cross-frame top and bottom connections, for the second girder that the cross-frame is connected to, as the cross-frame is installed. The first and second connections made to a given girder are denoted as connections A and B. In cases involving V or inverted-V type cross-frames, the first connection is assumed to be made to the joint where the diagonal attaches to the girder. In cases involving X-type cross-frames, it is assumed that the first connection is made at the top chord in these studies. The connection forces are zero prior to making a given connection, and they assume a non-zero value as a function of the geometry and boundary conditions at a given stage once the connection is completed. This non-zero force attained when the connection is completed is taken as the fit-up force. In this research, extensive parametric analyses are conducted to evaluate the cross-frame fit-up forces by sequentially installing cross-frames at selected critical stages.

The fit-up force calculations performed in this research are accurate to the extent that the nominal assumptions generally employed in bridge design are satisfied. That is, the simulations to determine fit-up forces are based on the following assumptions:

(1) No yielding of the steel occurs during erection,

(2) No incidental restraint from friction, etc. at temporary or permanent supports,

(3) The girder geometries, support elevations, etc. are as specified in the bridge plans, and

(4) Negligible play in the connections between the various bridge components.

There are various factors that can influence the actual bridge erection but cannot be accounted for in any detailed way within a practical engineering erection analysis, such as:

- Tolerances and the associated "play" at bolted connections,
- Adjustments of the crane and support elevations by the erector,
- Tolerances on support elevations, and
- Changes in the geometry of the steel due to thermal movements, etc.

These factors can cause differences between the actual fit-up forces encountered in the field compared to the erection analysis estimates. Connection tolerances and adjustment of crane and temporary support elevations can indeed make the fit-up forces somewhat smaller than the calculated estimates, as discussed subsequently in Section 3.6.2.1. However, the calculated fit-up forces determined in this research are believed to be reasonable engineering estimates associated with the nominal design representation of the structures.

As noted in Section 2.5, for the curved radially-supported and curved and skewed bridges studied in this research, the shoring and crane holding elevations are modeled at the no-load elevations. Conversely, for the straight skewed bridges, the final steel dead load elevations are used for the shoring and crane holding elevations. These elevations have been observed to be good targets that tend to facilitate the fit-up of the cross-frames.

This research focuses primarily on determining the maximum of the cross-frame fit-up forces to make the connections at selected critical stages. Discussions of how the critical stages were selected in this research are provided in Section 3.6. All the cross-frame connections within the selected critical stages are parametrically evaluated to determine the maximum fit-up forces. The sub-sections below provide some discussion of whether the fit-up forces are large for a significant number of cross-frames or only for a small number of cross-frames. However, the key fit-up force estimate is assumed to be the maximum one. The distribution of the final steel and total dead load cross-frame forces in the completed bridges is discussed in Section 3.4. The cross-frame fit-up forces are of course indirectly related to the final cross-frame dead load forces.

3.2.1 Cross-Frame Fit-Up in Curved Radially-Supported Bridges

For the evaluation of the fit-up forces, all three detailing methods – No-Load Fit (NLF), Steel Dead Load Fit (SDLF) and Total Dead Load Fit (TDLF) – are considered for the curved radially-supported bridges. NLF detailing tends to provide the lowest fit-up forces for these bridge types. This is because, as explained in Section 3.1.2, SDLF and TDLF detailing effects tend to be additive with the internal force effects in these bridge types. Evaluating the SDLF and TDLF fit-up forces (i.e., the required fit-up forces when the cross-frames are detailed for SDLF and TDLF) for the study bridges provides insight into when SDLF and TDLF fit-up may become prohibitive.

The following are trends in the values of the cross-frame fit-up forces in the curved radially-supported bridge cases studied in this research:

- The cross-frame fit-up forces for NLF detailing are generally very low for radial bearing-line cross-frames. This is because the girder deflections, girder differential deflections, and girder layovers are all practically zero at these locations. However, SDLF and TDLF detailing tend to give a minor increase in the fit-up forces for these radial bearing-line cross-frames. This is due to the deformation in the system caused by force-fitting the cross-frames at the other locations and due to the lack-of-fit from the differential major-axis rotations of the girders (note that the differential vertical deflections are still zero).
- For all the detailing methods, the cross-frame fit-up forces are generally largest near mid-span where the differential deflections and the differences in the girder layovers are also largest. The specific cross-frame connections with the largest fit-up forces are not necessarily the same for each of the detailing methods.
- The latter stages where the holding cranes often have been released often have larger cross-frame fit-up forces due to the bridge cross-section rotations and deflections and the increasing stiffness of the partially completed bridge system as more girders are installed.

Table 3 provides a synthesis of the maximum fit-up forces during the steel erection, calculated for all the curved radially-supported bridges studied in this research. In parallel to the presentation of the bridges in Chapter 2, the simple-span bridges are shown first followed by continuous-span bridges. They are presented in the order of increasing maximum span length within each of these sub-groups. One can observe several basic trends in this data. However, some of the values require detailed inspection of the bridge geometry, framing arrangement, and erection procedure to fully understand their origins. The base overall bridge geometry parameters shown in Table 1 are also listed in Table 3 to assist the reader in inspecting the results.

Erectors commonly use come-alongs and other local equipment, as necessary, to make the connections between the cross-frames and the girders. A typical come-along capacity is taken as 20 kip (some erectors indicate that 12 kip is more typical). A calculated fit-up force significantly more than 40 kip is considered difficult and is highlighted by dark shading in Table 3. The selection of this value is based on the judgment of the project team, considering the fact that various factors in the field, including connection tolerances as well as manipulation of crane, temporary tower, or support elevations, can typically result in some reduction in these forces. Maximum fit-up forces between 30 and 40 kip are shown by light shading in Table 3.

The most significant trends shown in Table 3 are as follows (exceptions are discussed further below):

(1) In most cases, the fit-up forces for NLF detailing are small and manageable.

(2) In general, because of the additive SDLF and TDLF detailing effects on the internal dead load forces in curved radially-supported bridges, SDLF and TDLF detailing tend to increase the maximum fit-up forces in these bridges. However, the fit-up force increase caused by SDLF detailing typically is not prohibitive.

(3) In most cases, the fit-up forces for TDLF detailing are significantly larger. This supports the recommendation from NSBA (2014) that TDLF should be avoided on curved radially-supported bridges. This recommendation is discussed further in Section 4.1.

(4) For the curved radially-supported bridges, the largest of the maximum fit-up forces correspond to cases with a combination of longer spans with a narrow bridge cross-section (large L_s/w_g) and a tight curve (large L_s/R).

Table 3. Maximum cross-frame fit-up forces of the curved radially-supported bridges studied in this research (Fit-up forces below 30 kip are unshaded, between 30 and 40 kip are shown by light shading, and above 40 kip are highlighted by dark shading).

Bridge	Framing Plan	Shoring Towers	L_s (ft)	w_g (ft)	R (ft)	n_g	L_s/R	L_s/w_g	Differential Deflections (in.)		Cross-Frame Fit-Up Force (in.)		
									SDL	**TDL**	**NLF**	**SDLF**	**TDLF**
(A) EISCR1	Figure 1	0	90	17.5	200	3	0.45	5.1	**0.42**	**1.67**	**3.3**	**7.4**	**22.3**
(B) NISCR2, Scheme 1	Figure 2	0	150	24.0	438	4	0.34	6.2	**0.68**	**1.83**	**16.6**	**28.7**	**54.0**
(B) NISCR2, Scheme 2A	"	"	"	"	"	"	"	"	"	"	**84.4**	**82.5**	**80.2**
(B) NISCR2, Scheme 2B	"	"	"	"	"	"	"	"	"	"	**40.4**	**19.4**	**50.5**
(C) NISCR7	Figure 3	0	150	74.0	280	9	0.54	2.0	**0.42**	**1.19**	**21.3**	**35.9**	**75.3**
(D) NISCR10	Figure 4	1	225	74.0	705	9	0.32	3.0	**0.47**	**0.78**	**18.6**	**20.4**	**21.8**
(E) EICCR11	Figure 5	3 (in curved span)	322,417, 322	40.4	∞, ∞, 411	4	0, 0, 0.80	8.0, 10.3, 8.1	**3.10**	**5.41**	**37.5**	**86.3**	**130.0**
(F) NICCR12	Figure 6	3	350,350, 280	74.0	909	9	0.39, 0.39, 0.31	4.7, 4.7, 3.8	**0.96**	**1.72**	**28.4**	**38.6**	**57.4**
(G) EICCR4	Figure 7	2	219,260, 211,162, 256,190	36.7	968,3@1108, 968,∞	4	0.20,0.24, 0.19,0.15, 0.26,0	6.0,7.1, 5.7,4.4, 7.0,5.2	**0.35**	**1.09**	**12.3**	**12.6**	**16.0**

Notes:

(1) Bridge (B) NISCR2 Schemes 2A and 2B involved erection from the inside to the outside of the curve.
(2) Bridge cases (E) EICCR11 and (G) EICCR4 involved drop-in segments.

(5) Higher differential deflections tend to lead to higher fit-up forces. The fit-up forces are significantly reduced when temporary supports such as shoring towers or holding cranes are used. (Note that the differential deflections reported in the table are the maximum values between the individual cross-frame ends in the completed bridge system, obtained from 3D FEA assuming No-Load Fit (NLF) detailing of the cross-frames.)

A few of the bridge cases do not follow the above trends. The critical erection stages for TDLF detailing are shown for each of the bridge cases in the subsequent figures in this section. In many cases, the critical stages are the same stages for NLF, SDLF, and TDLF detailing. As shown in Figure 37, Bridge (D) NISCR10 uses a shoring tower during its construction to allow the girder splices to be made in the air, resulting in a significant reduction in the displacements during the erection. Correspondingly, the fit-up forces are reduced for this bridge. Bridge (B) NISCR2, with Erection Scheme 2A (shown in Figure 38), has high maximum fit-up forces regardless of the method of cross-frame detailing. This is due to the specific erection procedure used for this bridge – erection of the girders from the inside to the outside of the curve – and the fact that this bridge has a relatively large L_s/w_g of 6.2 and a tight horizontal curve ($L_s/R = 0.34$). The large fit-up forces for this bridge occur in spite of its relatively short span length ($L_s = 150$ ft). The large forces shown for Scheme 2A indicate that this is not a feasible erection scheme. It is necessary to add additional vertical support on the outside girder of the partially completed bridge cross-section, to reduce its vertical deflections. Erection Scheme 2B (Figure 38) does this by placing an additional holding crane on the outside girder of the partially completed bridge cross-section. The NLF and TDLF fit-up forces for NISCR2 Scheme 2B are reduced to 40.4 kip and 50.5 kip, respectively, which are close to the 40 kip threshold where fit-up is considered to become difficult.

The SDLF fit-up forces for all the curved radially-supported bridges except for Bridge (E) EICCR11 (Figure 39), which is the most extreme case considered in this research, involving a highly curved large span and a relatively narrow bridge cross-section, and Bridge (B) NISCR2 Scheme 2A (Figure 38) are below 40 kip and thus are considered manageable. Bridge (E) EICCR11 is discussed further in Section 3.3.

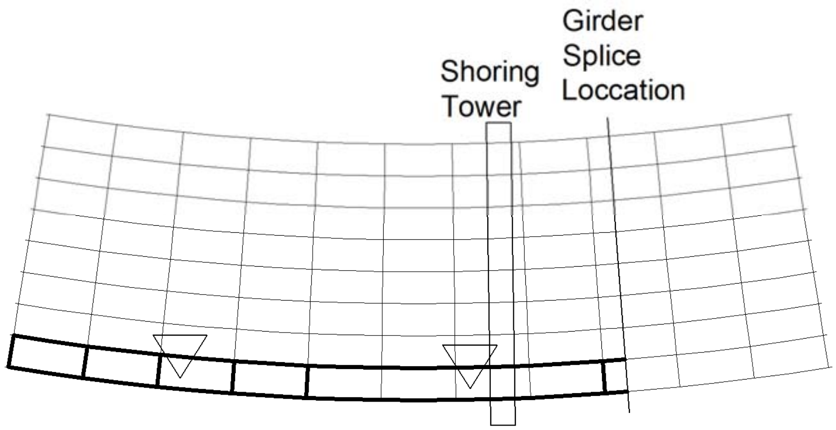


Figure 37. Critical erection stage of Bridge (D) NISCR10 for TDLF detailing. The darker lines show portions of the bridge that are already completed. The two triangles are the pick points of the lifting crane.

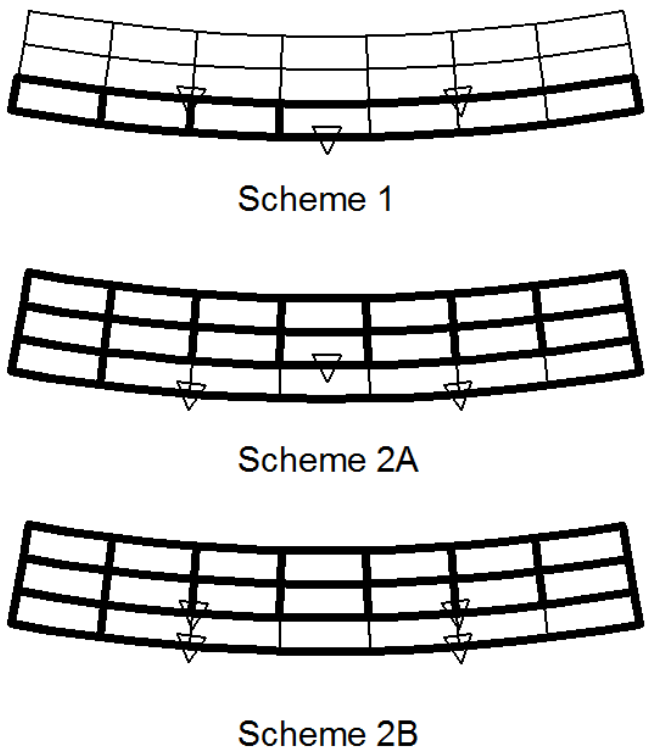


Figure 38. Critical erection stages of Erection Schemes 1 (outside to inside, one holding crane), 2A (inside to outside, one holding crane) and 2B (inside to outside, two holding cranes) of Bridge (B) NISCR2 for TDLF detailing. The darker lines show portions of the bridge that are already completed. The triangles denote the pick points of the lifting crane and of the holding crane.

In all the cases in Table 3, except for Bridge (B) NISCR2 with Erection Schemes 2A and 2B and Bridge (E) EICCR11, the fit-up forces for the NLF cases are small and manageable. The maximum TDLF fit-up forces for bridges (A) EISCR1, (D) NISCR10, and (G) EICCR4 (i.e., the maximum calculated fit-up forces when TDLF detailing is used) are below 40 kip. These results are discussed further below:

- Bridge (A) EISCR1 (Figure 40) is a short span and its maximum girder differential deflection under SDL is low (0.42 inches).
- Bridge (D) NISCR10 (Figure 37) has a longer span of 225 ft, but its span to radius ratio L_s/R is smaller (0.32). Furthermore, the erection of Bridge (D) NISCR10 involved the use of a shoring tower within the span.
- The Bridge (G) EICCR4 (Figure 41) maximum span length is 350 ft, but its maximum L_s/R is relatively low (0.26). In addition, the erection of Bridge (G) EICCR4 used shoring towers, which helped reduce the fit-up forces.

The maximum TDLF fit-up forces for bridges (B) NISCR2 Schemes 1, 2A, and 2B, (C) NISCR7 (Figure 42), (E) EICCR11, and (F) NICCR12 (Figure 43) are significantly larger than 40 kip. Specific explanations of the TDLF fit-up forces for these bridges are as follows:

- For Bridge (B) NISCR2, its L_s/R is reasonably high (0.34).
- For Bridge (C) NISCR7, its L_s/R (0.54) is even larger than Bridge (B) NISCR2, leading to larger TDLF fit-up forces than Bridge (B) NISCR2 Schemes 1 and 2B.
- Both Bridge (B) NISCR2 Scheme 1 and Bridge (C) NISCR7 did not use shoring towers.
- Bridge (E) EICCR11 is a large bridge with long spans, a narrow bridge cross-section, and the highest L_s/R (0.78) of all bridge cases studied. The site conditions limited the locations of the shoring towers in this bridge. In addition the use of drop-in segments was required on this bridge. For Bridge (E) EICCR11, not only is the TDLF fit-up unmanageable, but SDLF fit-up also is prohibitive.
- Bridge (F) NICCR12 has the longest span of all bridge cases considered (350 ft). However, a single shoring tower is provided at the mid-spans of this bridge, which leads to some reduction in the calculated maximum fit-up forces. In addition, the maximum L_s/R is relatively high (0.39) for this structure.

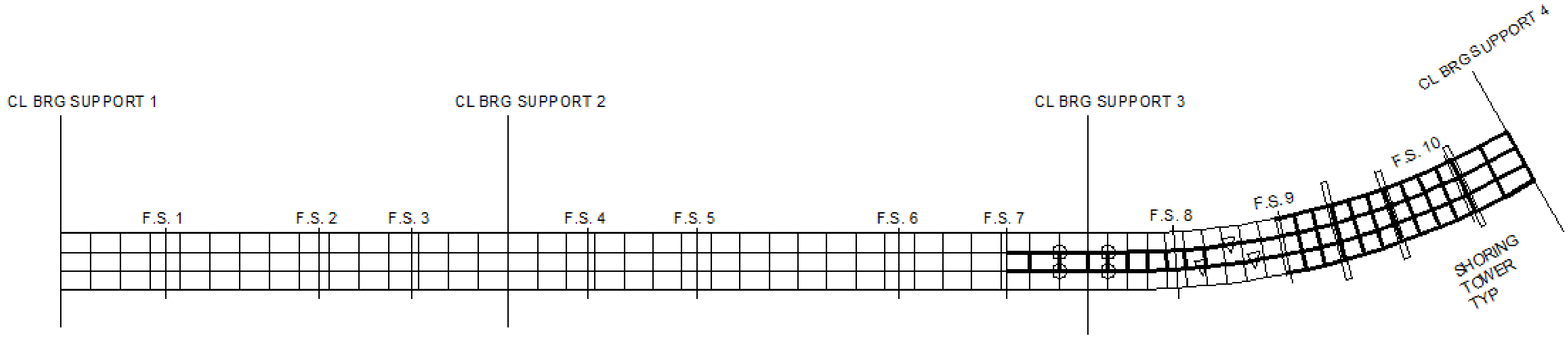


Figure 39. Critical erection stage of Bridge (E) EICCR11 for TDLF detailing. The darker lines show portions of the bridge that are already completed. The triangles denote the pick points of the lifting crane and of the holding crane. The four circles are the pier brackets.

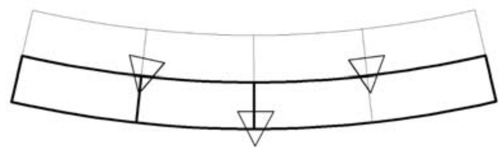


Figure 40. Critical erection stage of Bridge (A) EISCR1 for TDLF detailing. The darker lines show portions of the bridge that are already completed. The triangles denote the pick points of the lifting crane and of the holding crane.

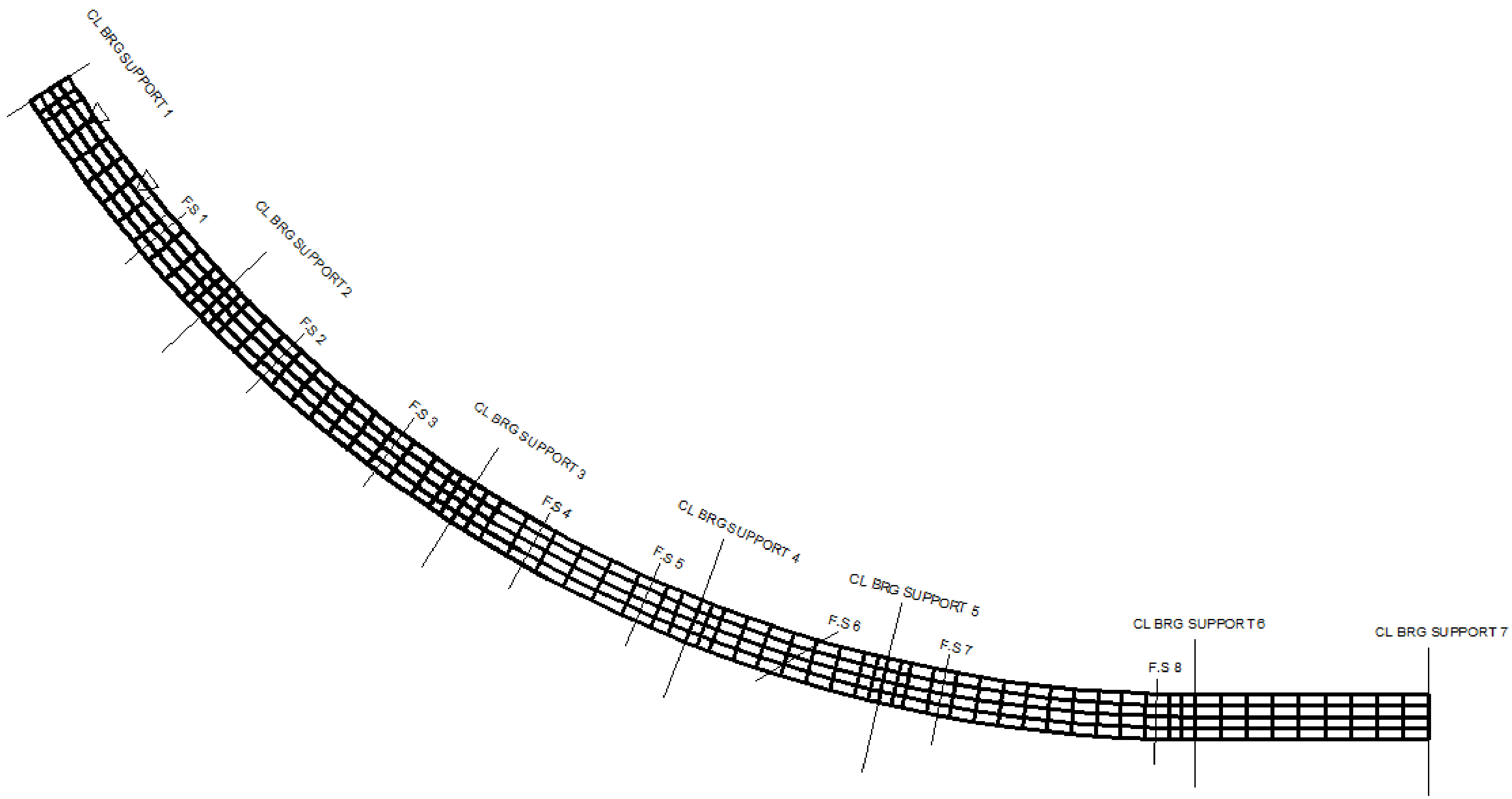


Figure 41. Critical erection stage of Bridge (G) EICCR4 for TDLF detailing (see Span 1 between bearing lines 1 and 2). The two triangles denote the pick points of the lifting crane. All the girders have been placed at this stage, a cross-frame is being inserted next to the second pick point, and two additional cross-frames have not yet been inserted between the second pick point and Field Splice 1 (F.S. 1).

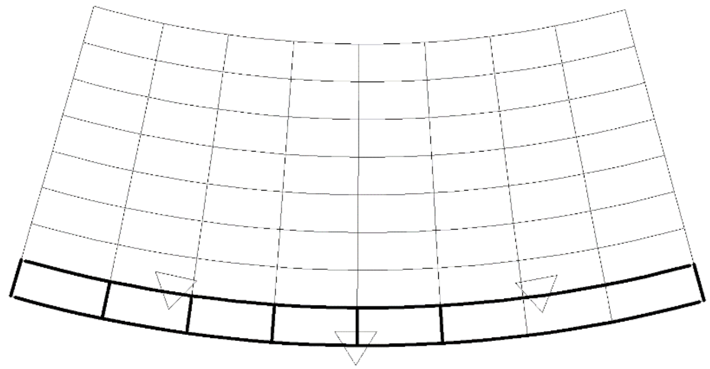


Figure 42. Critical erection stage of Bridge (C) NISCR7 for TDLF detailing. The darker lines show portions of the bridge that are already completed. The triangles denote the pick points of the lifting crane and of the holding crane.

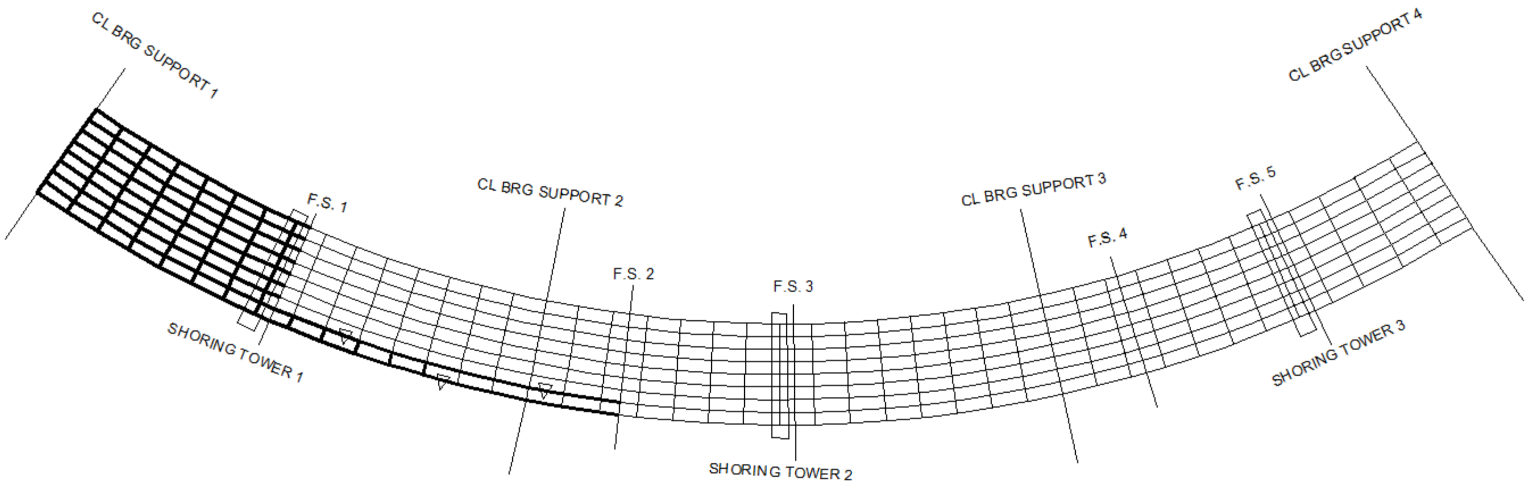


Figure 43. Critical erection stage of Bridge (F) NICCR12 for TDLF detailing. The darker lines show portions of the bridge that are already completed. The triangles denote the pick points of the lifting crane and of the holding crane.

3.2.2 Cross-Frame Fit-Up in Straight Skewed Bridges

For straight skewed bridges, only cases with SDLF and TDLF detailing were considered for the evaluation of the fit-up forces. This is for the following reasons:

- SDLF detailing provides the lowest fit-up forces for straight skewed bridges
- Studying the fit-up forces with TDLF detailing provides insights into when TDLF detailing could become prohibitive.
- The cases with NLF detailing were not studied for the evaluation of fit-up forces in straight skewed bridges because NLF fit-up can be more difficult than SDLF in straight skewed bridges.
- Furthermore, more importantly, the bearing rotation demands and girder layovers under TDL can be excessive if a straight skewed bridge with sharp skew is detailed using a NLF. (The studies on curved radially-supported bridges and bridges having both skew and horizontal curvature consider NLF detailing in addition to SDLF and TDLF detailing.)

In contrast, the results of all three detailing methods are provided for all the bridge cases in the evaluation of the bridge responses in the final SDL and TDL conditions. This is because the current common practice in design is to analyze the bridge neglecting any internal forces induced by the detailing method, i.e., bridges are commonly analyzed assuming NLF detailing is used.

The following are trends in the values of cross-frame fit-up forces in the straight skewed bridge cases studied in this research (these trends are distinctly different from the trends in curved radially-supported bridges):

- The cross-frame fit-up forces for all the detailing methods are generally largest near the skewed bearing line and along the transverse load path between the obtuse corners in bridges with parallel skew. For non-parallel skew bridges, the cross-frame fit-up forces tend to be largest near the skewed bearing line and between the interior girders. These observations show some correlation with the distribution of the cross-frame forces in the completed structure in straight skewed bridges discussed in Section 3.4.

- For erection stages where the splice connection has not been made (i.e., the steel is not yet at the SDL elevation profile), the cross-frame fit-up forces for SDLF and TDLF detailing are generally larger at the crane and shoring tower locations which can have temporary lateral bracing. In these cases, the cross-frame fit-up forces for TDLF detailing tend to be larger than those for SDLF detailing since the crane and shoring tower elevations are set at the SDL elevations for the straight skewed bridges in this research. The partially-erected bridge system is deflecting under its self-weight, but the total dead loads are of course not yet in place.

- The specific cross-frame connections with the largest fit-up forces are not necessarily the same for SDLF and TDLF detailing.
- In straight skewed bridges, holding cranes do not have as significant of an effect on the bridge deflection as in curved bridges. Holding cranes are often only needed for stability during the installation of the first few girders. In parallel skew bridges, each of their girders and cross-frames are installed in the same sequence for most of the bridge cases. As such, the latter erection stages where the holding cranes often have been released generally have the same range of cross-frame fit-up forces as in the other erection stages. In non-parallel straight skewed bridges, the erection stages with the longer girders often have higher cross-frame fit-up forces due to higher differential deflections at these stages.

Table 4 provides a synthesis of the maximum fit-up forces during the steel erection, calculated for all the straight skewed bridges studied by the project. As indicated in Chapter 2, the simple-span bridges are shown first followed by continuous-span bridges. The bridges are presented in the order of increasing maximum span length within each of these sub-groups. Some of the values require detailed inspection of the bridge geometry, framing arrangement, and erection scheme to fully understand their origins and significance. The base overall bridge geometry parameters shown in Table 1 are also listed in Table 4 to assist the reader in inspecting the results. A calculated fit-up force significantly more than 40 kip is considered difficult and is highlighted by dark shading in Table 4. Maximum fit-up forces between 30 and 40 kip are shown by light shading.

Table 4. Maximum cross-frame fit-up forces of the straight skewed bridges studied in this research (Fit-up forces below 30 kip are unshaded, between 30 and 40 kip are shown by light shading, and above 40 kip are highlighted by dark shading).

Bridge	Framing Plan	Shoring Towers	L_{max} (ft)	L_{min} (ft)	w_g (ft)	θ (deg.)	n_g	I_s	L_{max}/w_g	L_{min}/w_g	Differential Deflections (in.)		Max fit-up forces (kip)	
											SDL	TDL	SDLF	TDLF
(H1) EISSS57	Figure 8	0	211	63	61	69.5, -4.4	7	0.77	3.5	1.0	**1.00**	**2.95**	**5.0**	**15.0**
(H2) EISSS57	Figure 22	"	"	"	"	"	"	"	"	"	**1.09**	**3.19**	**5.0**	**14.2**
(I1) NISSS14	Figure 9	0	150	150	74	70	9	1.36	2.0	2.0	**0.97**	**4.33**	**3.6**	**15.3**
(I2) NISSS14	Figure 23	"	"	"	"	"	"	"	"	"	**0.98**	**4.37**	**2.5**	**7.5**
(J1) NISSS54	Figure 10	1	300	300	74	70	9	0.68	4.1	4.1	**2.07**	**4.56**	**9.2**	**73.5**
(J2) NISSS54	Figure 24	"	"	"	"	"	"	"	"	"	**1.98**	**4.49**	**8.4**	**47.9**
(K1) EICSS12	Figure 11	0	150, 139	150, 139	41	59.6	6	0.47, 0.50	3.7, 3.4	3.7, 3.4	**0.38**	**1.67**	**0.6**	**6.3**
(K2) EICSS12	Figure 25	"	"	"	"	"	"	"	"	"	**0.36**	**1.62**	**0.4**	**7.7**
(K3) EICSS12	Figure 26	"	"	"	"	"	"	"	"	"	**0.36**	**1.60**	**1.2**	**17.0**
(L) NICSS16	Figure 12	0	120, 150, 150	120, 150, 150	74	70	9	1.69, 1.36, 1.36	1.6, 2.0, 2.0	1.6, 2.0, 2.0	**0.53**	**2.81**	**0.8**	**36.9**
(M1) EICSS2	Figure 13	0	259, 255, 220	241, 183 ,220	66.6	58, 61.8, 38,38	8	0.48, 0.49, 0.23	3.9, 3.8, 3.3	3.6, 2.7, 3.3	**0.77**	**2.39**	**4.9**	**46.9**
(M2) EICSS2	Figure 27	"	"	"	"	"	"	"	"	"	**0.74**	**2.49**	**0.8**	**2.8**

Notes:

(1) Bridge cases (M1) and (M2) EICSS2 involved phased construction.

The most significant trends shown in Table 4 are as follows:

(1) The maximum fit-up forces are generally low when SDLF detailing is used. These forces are only a fraction of the forces encountered when TDLF detailing is used. However, TDLF detailing is never prohibitive on the straight skewed bridges considered in the NCHRP 20-07 Task 355 research until the spans become relatively long (larger than about 200 ft).
(2) The maximum fit-up forces tend to be larger for longer span bridges with sharper skew of the bearing lines.
(3) Higher differential deflections tend to lead to higher fit-up forces. For the same order of differential deflections, the fit-up forces tend to be higher for curved radially-supported bridges than for straight skewed bridges (see Table 3). (Note that the differential deflections reported in the table are the maximum values obtained between the individual cross-frame ends in the completed bridge system, obtained from 3D FEA assuming No-Load Fit (NLF) detailing of the cross-frames.)

As noted above, for the straight skewed bridges in Table 3, the SDLF fit-up forces are low and are only a fraction of the TDLF fit-up forces. This is because the cross-frame internal forces are minimal under SDL for SDLF detailing. The locked-in forces due to SDLF detailing approximately cancel with the SDL internal force effects determined via 3D FEA. Stated alternately, the SDLF cross-frame geometries are such that the cross-frames fit up with the girders, with negligible to small forcing, in the deflected (stressed) condition of the girders under the self-weight of the partially and fully erected steel.

The fit-up forces are evaluated for both the base and alternate framing arrangements of the straight skewed bridges. The alternate framing plans stagger the cross-frames in a way that tends to alleviate the nuisance transverse stiffness effects. The erection schemes (installation order of girders and cross-frame and support requirements) are the same for the base and the alternate framing arrangements for each of the bridge cases. The figures shown below illustrate the erection schemes using the base framing arrangement. The following are further details regarding the behavior of the fit-up forces in for the straight skewed bridges from Table 4 (The critical erection stages for TDLF detailing are shown for each of the bridge cases in the subsequent figures in this section. In many cases, the critical stages are the same stages for SDLF and TDLF detailing):

- For Bridge (H1) EISSS57 (Figure 44), a non-parallel straight skewed simple-span bridge, the alternate framing arrangement (H2) only slightly decreases the TDLF fit-up forces.
- For bridges (I1) NISSS14 (Figure 45) and (J1) NISSS54 (Figure 46), which are parallel skew simple-span bridges, the alternate framing arrangements (I2) and (J2) significantly decrease the TDLF fit-up forces. However, for Bridge (J2) NISSS54, the TDLF fit-up force remains high due to its 300 ft span and high skew index.

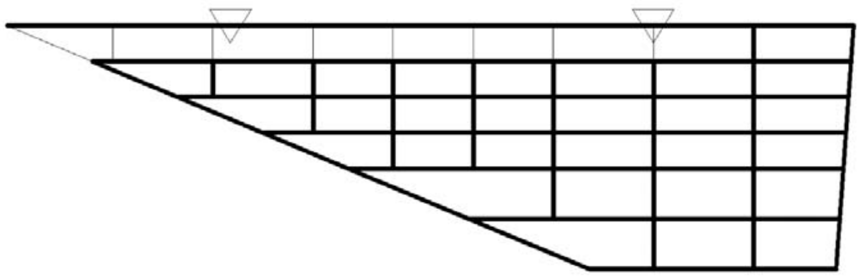


Figure 44. Critical erection stage of Bridge (H1) EISSS57 for TDLF detailing. The darker lines show portions of the bridge that are already completed. The two triangles denote the pick points of the lifting crane.

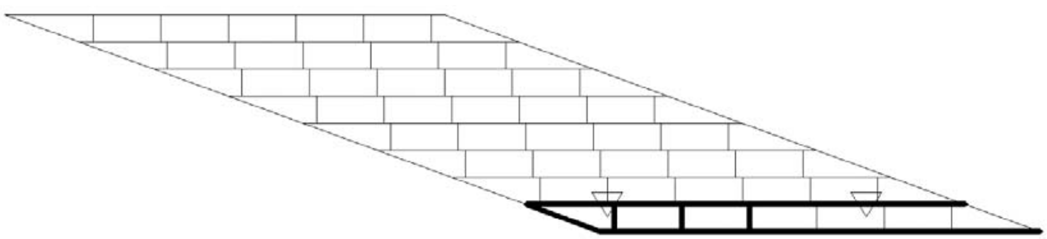


Figure 45. Critical erection stage of Bridge (I1) NISSS14 for TDLF detailing. The darker lines show portions of the bridge that are already completed. The two triangles denote the pick points of the lifting crane.

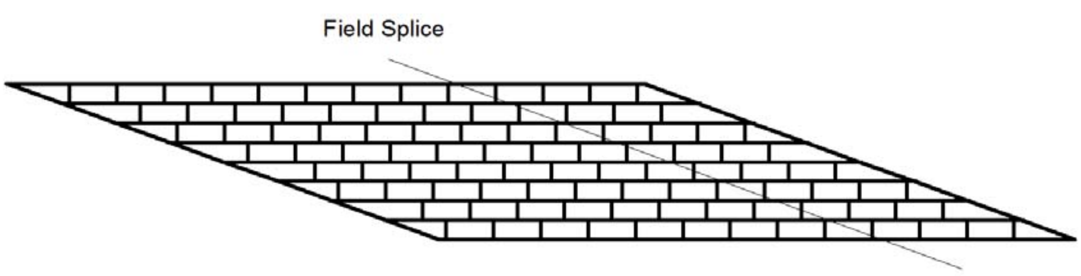


Figure 46. Critical erection stage of Bridge (J1) NISSS54 for TDLF detailing (the cross-frame connection with the largest fit-up force is the last connection installed in this bridge).

- Bridge (K1) EICSS12 (Figure 47) employs a lean-on system (Helwig and Yura 2012). The alternate framing arrangement (K2) employs a staggered cross-frame system plus larger offsets of the intermediate cross-frames from the bearing lines. The arrangement (K3) employs a staggered cross-frame system with no bearing line cross-frames at the interior pier location and cross-frames connected directly into the bearing positions. Bridge (K1) with the lean-on framing arrangement has the smallest TDLF fit-up forces compared to bridge cases (K2) and (K3).However, it is important to note that the difference in TDLF fit-up forces between Bridge case (K1) (6.3 kip) and (K2) (7.7 kip) is small. Bridge (K3), with cross-frames connected directly into the bearing locations (and no cross-frames along the bearing line), has the highest TDLF fit-up forces. Framing cross-frames directly into the bearing locations results in an increased displacement incompatibility between the adjacent girders at the interior bearing line. For these cross-frames, the girder vertical displacement is zero on the side connected to the bearing and non-zero on the other side. Section 3.5.4 provides additional discussion of the effects of lean-on versus staggered cross-frame framing arrangements on the completed bridge responses.
- Bridge cases (M1) and (M2) EICSS2 (Figure 48) involved phased construction. With the exception of the cross-frames within the closure region between the phases, the SDLF fit-up forces are low.
- The TDLF fit-up forces are high for Bridge (M1) EICSS2, due to the high transverse stiffness caused by the contiguous cross-frame arrangement and the framing of the cross-frames into the girders close into the bearing locations (i.e., small offsets). The closure cross-frames are installed after the decks of the two phases are placed. This means the closure cross-frames are installed under TDL conditions. As a result, the closure fit-up forces are significant if these cross-frames are detailed for SDLF. Conversely, the TDLF closure fit-up forces are relatively low. An alternate fit-up option for this bridge would be to detail the main bridge cross-frames for SDLF, and detail the closure region cross-frames to fit to the geometry under TDL. However, the girders are not plumb under TDL for SDLF detailing of the main bridge cross-frames. Detailing the closure region cross-frames to fit to this TDL geometry would involve additional detailed calculations that are different than the routine calculations commonly conducted for TDLF. A suggested option for the cross-frames in the closure region, to facilitate ease of fit-up, is to use chords without diagonals

between the phases during the deck placement, where needed, and to then field weld or field drill bolt holes to fit the cross-frame diagonals to the completed geometry.

- The fit-up forces on Bridge (M2) EICSS2 are reduced substantially due to the modifications in the framing arrangement. In general, the fit-up forces in the closure region for these bridges can be high, depending on the attributes of the framing plans. These forces are not shown in Table 4.

3.2.3 Cross-Frame Fit-Up in Curved and Skewed Bridges

For the evaluation of the fit-up forces, all three main detailing methods were considered for the curved and skewed bridges examined in this research. For curved radially-supported bridges, NLF detailing generally provides the lowest fit-up forces. This is because SDLF and TDLF detailing effects tend to be additive with the internal force effects in these bridge types. For straight skewed bridges, SDLF detailing provides the lowest fit-up forces, while TDLF detailing makes the fit-up during steel erection difficult in some longer-span cases with a high skew index. For curved and skewed bridges, there is a complex combination of effects from the skew and curvature.

The following are trends in the values of cross-frame fit-up forces in the curved and skewed bridge cases studied in this research (these trends are of course related to the trends observed for the curved radially-supported bridges and straight skewed bridges):

- The cross-frame fit-up forces for NLF detailing are generally very low for radial bearing-line cross-frames. This is because the girder deflections, girder differential deflections, and girder layovers are practically zero at these locations. However, SDLF and TDLF detailing tend to give a minor increase in the fit-up forces for these radial bearing-line cross-frames. This is due to the deformation in the system caused by force-fitting the cross-frames at the other locations and due to the lack-of-fit from the differential major-axis rotations of the girders (note that the differential deflections are still zero).

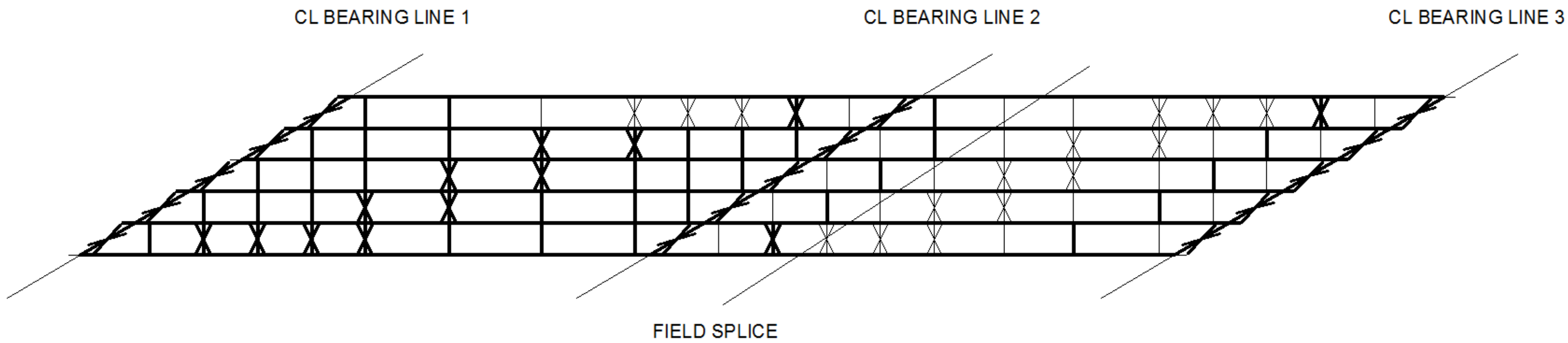


Figure 47. Critical erection stage of Bridge (K1) EICSS12 for TDLF detailing. The darker lines show portions of the bridge that are already completed.

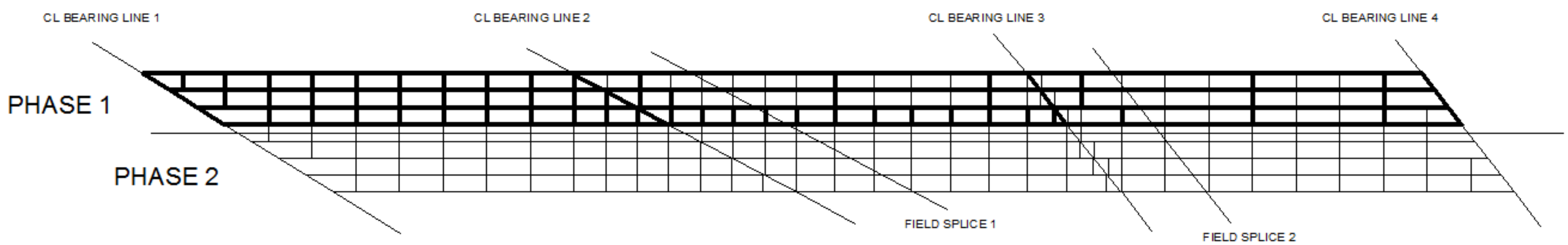


Figure 48. Critical erection stage of Bridge (M1) EICSS2 for TDLF detailing. The darker lines show portions of the bridge that are already completed.

- The cross-frame fit-up forces are generally slightly higher at the skewed bearing lines than at the radial bearing lines. However, the cross-frame fit-up forces for all the detailing methods tend to be largest near mid-span where the differential deflections and the difference in girder layovers are also largest.
- The latter stages where the holding cranes often have been released often have larger cross-frame fit-up forces due to larger bridge cross-section rotations and deflections.
- The orientation of the skew can make one fascia girder substantially longer than the other fascia girder. In these cases, the cross-frame fit-up forces tend to be substantially larger for the erection stages involving the longer girders in the bridge.

Table 5 provides a synthesis of the maximum fit-up forces during the steel erection, calculated for all the curved and skewed bridges studied in this project. As indicated in Chapter 2, the simple-span bridges are shown first followed by continuous-span bridges. They are presented in the order of increasing maximum span length within each of these sub-groups. Some of the values require detailed inspection of the bridge geometry, framing arrangement, and erection scheme to fully understand their origins and significance. The base overall bridge geometry parameters shown in Table 1 are also listed in Table 5 to assist the reader in inspecting the results. A calculated fit-up force significantly more than 40 kip is considered difficult and is highlighted by dark shading in the table. Maximum fit-up forces between 30 and 40 kip are shown by light shading.

It can be observed from Table 5 that there is no simple general trend for curved and skewed bridges. The tendencies related to the skew and the horizontal curvature combine and/or offset each other in complex ways in these types of structures. Other than this fact, the most important points shown in Table 5 are as follows:

(1) The fit-up forces are highly dependent on the erection method. In tightly curved and sharply skewed bridges, the use of shoring towers is advisable to reduce the deflections and help reduce the fit-up forces due to the extreme geometries.

Table 5. Maximum cross-frame fit-up forces of the curved and skewed bridges studied in this research (Fit-up forces below 30 kip are unshaded, between 30 and 40 kip are shown by light shading, and above 40 kip are highlighted by dark shading).

Bridge	Framing Plan	Shoring Towers	L_s (ft)	w_g (ft)	R (ft)	θ (deg.)	L_s/R	L_s/w_g	I_s	Differential Deflections (in.)		Maximum fit-up forces (kip)		
										SDL	TDL	NLF	SDLF	TDLF
(N) NISCS14	Figure 14	0	150	74	280	53.7,0	0.54	2.0	0.53	**0.49**	**1.52**	**35.3**	**34.9**	**34.8**
(O1) NISCS15 Scheme 1	Figure 15	0	150	74	280	-35,0	0.54	2.0	0.27	**1.04**	**2.23**	**79.3**	**81.0**	**81.8**
(O1) NISCS15 Scheme 2A	"	"	"	"	"	"	"	"	"	**"**	**"**	**40.8**	**39.2**	**64.5**
(O1) NISCS15 Scheme 3	"	"	"	"	"	"	"	"	"	**"**	**"**	**82.0**	**32.6**	**93.8**
(O1) NISCS15 Scheme 4	"	"	"	"	"	"	"	"	"	**"**	**"**	**9.9**	**38.5**	**71.2**
(O2) NISCS15 Scheme 2A	Figure 28	0	"	"	"	"	"	"	"	**0.66**	**1.40**	**141.0**	**147.1**	**155.8**
(O2) NISCS15 Scheme 2B	"	"	"	"	"	"	"	"	"	**"**	**"**	**88.1**	**58.7**	**50.1**
(O2) NISCS15 Scheme 2C	"	"	"	"	"	"	"	"	"	**"**	**"**	**61.1**	**51.0**	**78.4**
(O2) NISCS15 Scheme 4	"	1	"	"	"	"	"	"	"	**"**	**"**	**6.5**	**40.0**	**50.3**

Notes:

(1) For bridge cases (O1) and (O2) NISCS15, Scheme 1 uses one holding crane until 3 outside girders are installed. Scheme 2A uses two holding cranes until 4 outside girders are installed. Scheme 2B is similar to Scheme 2A, but the holding cranes are retained until all girders are installed. Scheme 2C is similar to Scheme 2B, but the cross-frames are installed sequentially in the opposite direction along the span. The erection is from the inside to the outside of the curve for Scheme 3. Two holding cranes are used for Scheme 3. Scheme 4 uses one shoring tower.

Table 5 (Continued). Maximum cross-frame fit-up forces of the curved and skewed bridges studied in this research. (Fit-up forces below 30 kip are unshaded, between 30 and 40 kip are shown by light shading, and above 40 kip are highlighted by dark shading).

Bridge	Framing Plan	Shoring Towers	L_s (ft)	w_g (ft)	R (ft)	θ (deg.)	L_s/R	L_s/w_g	I_s	Differential Deflections (in.)		Maximum fit-up forces (kip)		
										SDL	TDL	NLF	SDLF	TDLF
(P) EISCS3 Scheme 1	Figure 16	0	153	31	279	52.4,0	0.55	5.0	0.24	**0.40**	**0.83**	**23.4**	**14.9**	**16.8**
(P) EISCS3 Scheme 2	"	0	"	"	"	"	"	"	"	"	"	**45.7**	**33.0**	**20.5**
(Q1) NISCS38	Figure 17	2	300	74	730	62.6,0	0.41	4.1	0.39	**1.06**	**2.26**	**22.4**	**21.6**	**26.2**
(Q2) NISCS38	Figure 29	2	"	"	"	"	"	"	"	**1.00**	**2.15**	**20.1**	**18.5**	**15.7**
(R1) NISCS39	Figure 18	2	300	74	730	-35,0	0.41	4.1	0.15	**1.84**	**3.25**	**16.9**	**61.2**	**103.9**
(R2) NISCS39	Figure 30	NA	"	"	"	"	"	"	"	**1.67**	**2.85**	**NA**	**NA**	**NA**
(S) XICCS7	Figure 19	1	160, 210, 160	33	700	0,60, 60,0	0.23, 0.30, 0.23	4.8, 6.4, 4.8	0.31, 0.27, 0.30	**0.39**	**1.60**	**5.7**	**5.0**	**5.5**
(T1) EICCS27	Figure 20	4	279, 224, 236	79.9	2546	-53.1,-59.4, -64.4,-69.7	0.11, 0.09, 0.09	3.5, 2.8, 3.0	0.48, 0.70, 0.94	**1.67**	**5.90**	**15.2**	**14.2**	**46.2**
(T2) EICCS27	Figure 31	4	"	"	"	"	"	"	"	**1.65**	**5.85**	**9.0**	**9.6**	**28.8**
(U1) EICCS28	Figure 21	NA	326, 160, 235	52	1255	0, 54.5, 47,0	0.26, 0.13, 0.19	6.3, 3.1, 4.5	0.28, 0.44, 0.15	**1.82**	**3.25**	**NA**	**NA**	**NA**
(U2) EICCS28	Figure 32	5	"	"	"	"	"	"	"	**2.09**	**3.75**	**6.1**	**19.6**	**33.0**

Notes:

(2) Bridge (P) EISCS3 erection is from the inside to the outside of the curve.

(3) Bridge cases (R2) NISCS39 and (U1) EICCS28 are not feasible for construction.

(2) For bridges that are highly curved but not sharply skewed, the fit-up forces tend to follow the trend for curved radially-supported bridges. For bridges that are sharply skewed but not tightly curved, the fit-up forces tend to follow the trend for straight skewed bridges.

(3) The skew orientation has a significant influence on the fit-up forces in the highly curved bridges. When the skew orientation makes the girder on the inside of the curve longer, the effects of the skew tend to relieve the effects of the curvature. The fit-up forces for all three detailing methods are lower in these cases. When the skew orientation makes the girder on the outside of the curve longer, the effects of the skew tend to be additive with the effects of the curvature. The fit-up forces for all three detailing methods are higher in these cases.

(4) The maximum fit-up forces tend to be larger for cases involving a combination of longer maximum fascia girder span length with a tighter curve (larger L_s/R).

(5) Higher differential deflections tend to lead to higher fit-up forces. The fit-up forces are significantly decreased when shoring towers are used. (Note that the differential deflections reported in the table are the maximum values obtained between the individual cross-frame ends in the completed bridge system, obtained from 3D FEA assuming No-Load Fit (NLF) detailing of the cross-frames.)

The fit-up forces were evaluated for both the base and alternate framing arrangements of the curved and skewed bridges, except for Bridge (R2) NISCS39 which experiences significant uplift at the girder on the inside of the curve at the skewed bearing line, and Bridge (T1) EICCS28 which experienced high cross-frame forces and significant uplift at one of its interior skewed bearing lines. The alternate framing plans typically stagger the cross-frames near skewed bearing lines for the base contiguous framing arrangements and make these cross-frame lines contiguous for cases where the base bridge designs used staggered framing arrangements in these regions. The goal was to study the effects of different framing arrangements on bridges with different combinations of skew and curvature. The erection schemes (installation order of the girders and cross-frame and support requirements) are the same for the base and the alternate framing arrangements for each of the bridge cases, except Bridge (R2) and Bridge (T1). The following are further details of the fit-up forces reported in Table 5 (The critical erection stages for TDLF detailing are shown for each of the bridge cases in the subsequent figures in this section. In many cases, the critical stages are the same stages for NLF, SDLF, and TDLF detailing):

- Bridge (N) NISCS14 (Figure 49) has a span length of 150 ft. The skew effects relieve the curvature effects in this bridge; the maximum fit-up forces for this bridge are slightly below the 40 kip threshold.
- Bridge cases (O1) and (O2) NISCS15 (Figures 50 and 51) also have a span length of 150 ft, but the skew effects are additive with the curvature effects. It can be seen from Table 4 that for all the cases except Erection Scheme 4 for bridge cases (O1) and (O2), the fit-up forces varied from relatively large to very large. For this bridge, Erection Scheme 1 involves erection from the outside to the inside of the curve with one holding crane on the outside girder until the next two adjacent girders of the bridge cross-section are installed. Erection Scheme 2A is similar to Erection Scheme 1 but has two holding cranes on the outside girder until the next three adjacent girders of the bridge cross-section are installed. Erection Scheme 2B is similar to Scheme 2A but holding cranes are retained until all girders of the bridge cross-section are installed. For Erection Schemes 1, 2A, and 2B, the cross-frames are installed sequentially from the skewed bearing line to the radial bearing line. Erection Scheme 2C is similar to Erection Scheme 2B but the cross-frames are installed sequentially from the radial bearing line to the skewed bearing line.
- As shown by Table 5, for the same framing arrangement, generally the maximum fit-up forces are reduced the most by the scheme that has more vertical support (i.e., the scheme that has more holding cranes and in which the holding cranes are left in place until a larger number of girders and cross-frames are installed). For Bridge (O1) NISCS15, Erection Scheme 3 - erecting from the inside to the outside of the curve - significantly increases the maximum fit-up forces. For bridge cases (O1) and (O2) NISCS15, Erection Scheme 4 uses a shoring tower across the full width of the bridge cross-section until all the girders are erected. As a result, the maximum fit-up forces for bridge cases (O1) and (O2) NISCS15 Erection Scheme 4 are significantly smaller than for the other erection schemes.
- For Bridge (P) EISCS3 (Figure 52), the skew effects relieve the curvature effects. For Erection Scheme 1 on this bridge, where the girders are erected from the outside to the inside, the maximum fit-up forces are relatively low. Bridge (P) EISCS3 and Bridge (N) NISCS14 (Figure 49) have a skew index of 0.24 and 0.53, respectively. The maximum fit-up forces are lower for Bridge (P) than for Bridge (N). For Erection Scheme 2 on Bridge

(P), where the girders are erected from the inside to the outside, the maximum NLF fit-up force is slightly above the 40-kip threshold.

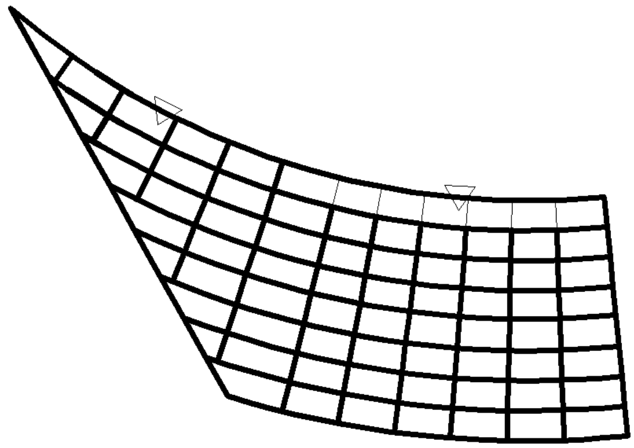
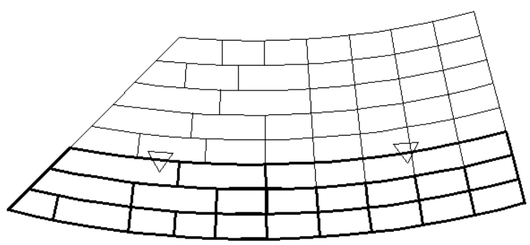
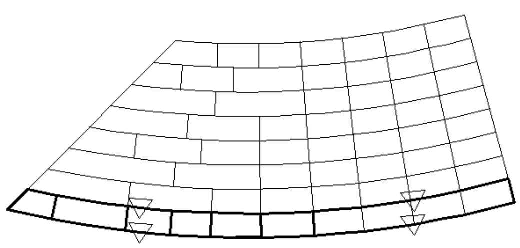


Figure 49. Critical erection stage of Bridge (N) NISCS14. The darker lines show portions of the bridge that are already completed. The triangles denote the pick points of the lifting.



SCHEME 1

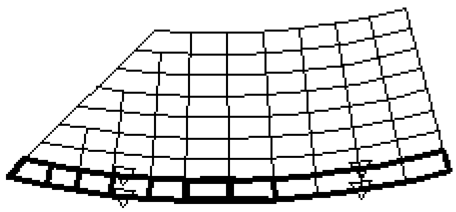
The holding crane is maintained on the outside girder until three outside girders and CFs are installed. One holding crane.



SCHEME 2A

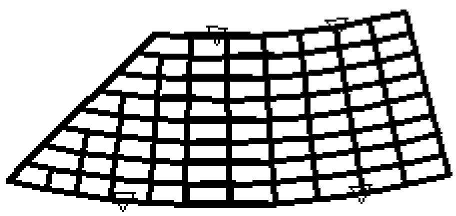
The holding crane is maintained on the outside girder until four outside girders and CFs are installed. Two holding cranes.

Figure 50. Critical erection stages of erection schemes 1 and 2A of bridge cases (O1) and (O2) NISCS15 for TDLF detailing. The darker lines show portions of the bridge that are already completed. The triangles denote the pick points of the lifting and holding cranes.



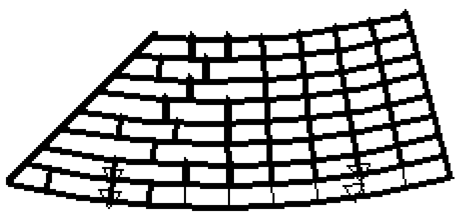
SCHEME 2B

The two holding cranes are maintained on the outside girder until all girders and CFs are installed.



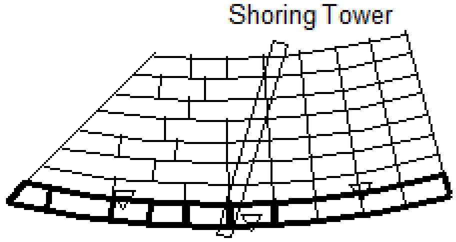
SCHEME 2C

Similar to Scheme 2B but the CFs are installed in the opposite direction, from the right to left bearings.



SCHEME 3

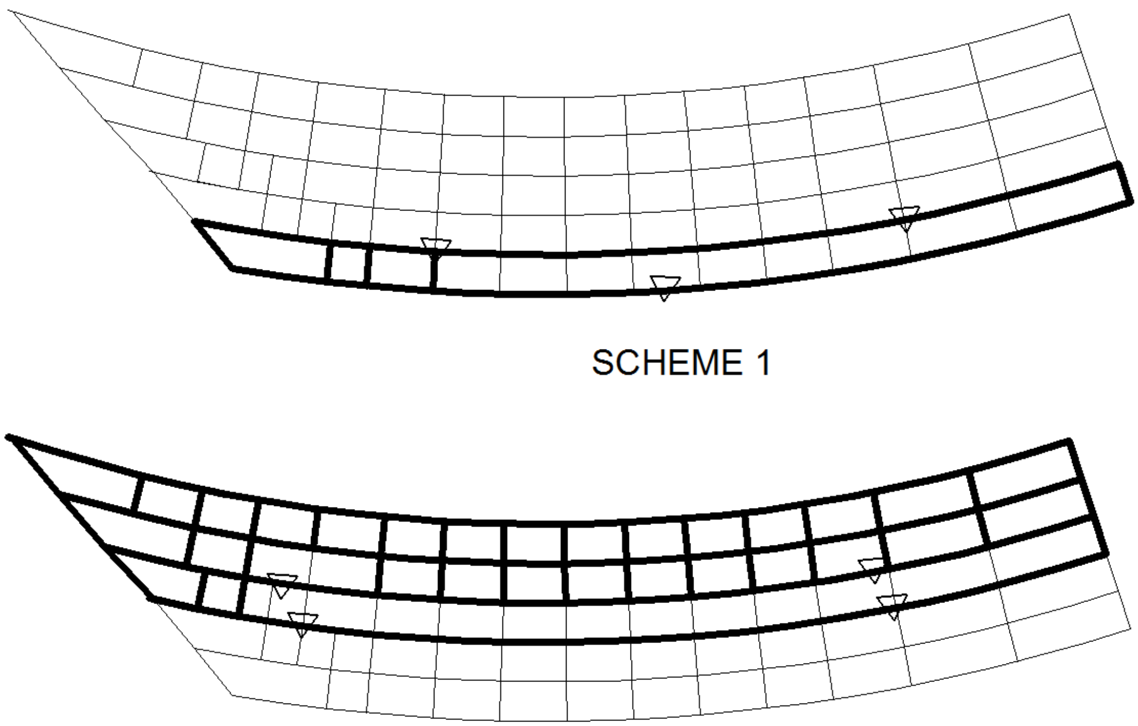
Inside to outside erection. The two holding cranes are on the inside girder adjacent to the girder being installed.



SCHEME 4

The shoring tower is retained until all girders and CFs are installed.

Figure 51. Critical erection stages of erection schemes 2B, 2C, 3 and 4 of bridge cases (O1) and (O2) NISCS15 for TDLF detailing. The darker lines show portions of the bridge that are already completed. The triangles denote the pick points of the lifting and holding cranes.



SCHEME 1

SCHEME 2

Figure 52. Critical erection stages of erection schemes 1 and 2 of Bridge (P) EISCS3 for TDLF detailing. The darker lines show portions of the bridge that are already completed. The two triangles denote the pick points of the lifting and holding cranes.

- For bridge cases (Q1) and (Q2) NISCS38 (Figure 53), the skew effects again relieve the curvature effects. However, the span length is 300 ft at the centerline of this bridge, and the maximum fascia girder span length is 365 ft. Two shoring towers are used to erect this bridge. By using this approach, the maximum fit-up forces are manageable. Phased construction was initially considered for the bridge case (Q1). However, the studies showed that phased construction was not feasible for this case. Phased construction was not considered for bridge case (Q2).

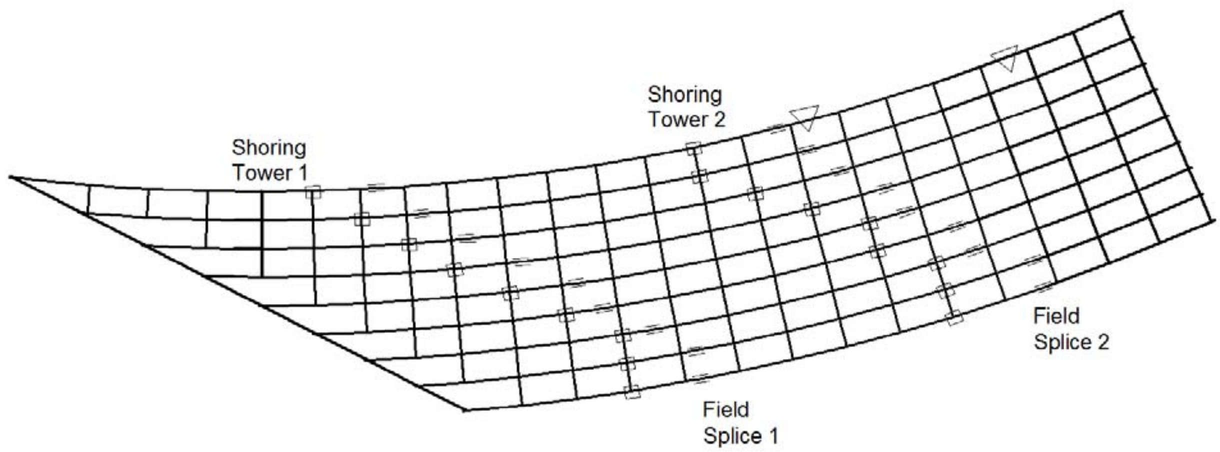


Figure 53. Critical erection stage of Bridge (Q1) NISCS38. The two triangles are the pick points of the lifting crane.

- Bridge (R1) NISCS39 (Figure 54) also has a span length of 300 ft but its skew effects are additive to its curvature effects. Two shoring towers are used to erect this bridge.

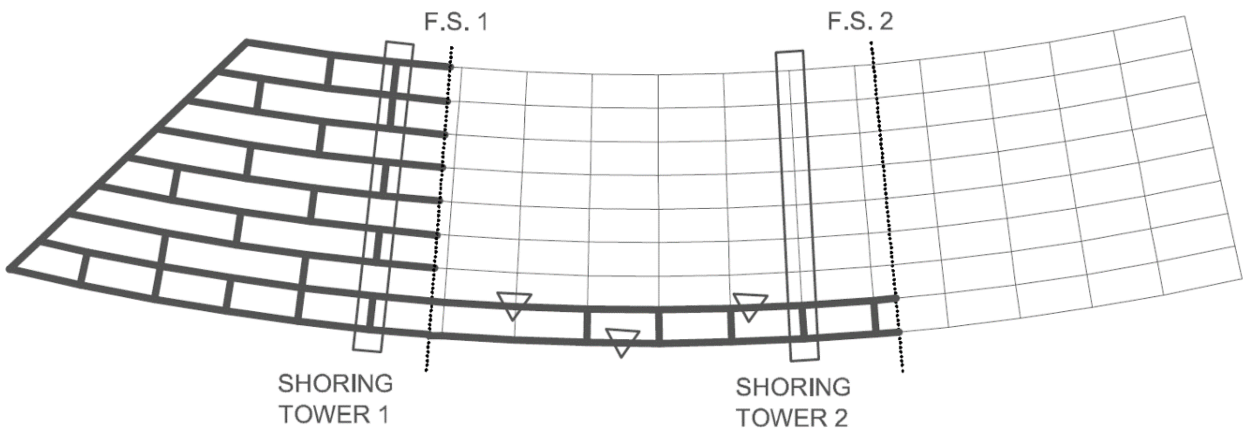


Figure 54. Critical erection stage of Bridge (R1) NISCS39 for TDLF detailing. The darker lines show portions of the bridge that are already completed. The two triangles denote the pick points of the lifting and holding cranes.

- Bridge (R2) NISCS39 uses a contiguous framing arrangement. This bridge experiences significant uplift at the obtuse corner associated with its skewed bearing line. The required capacity of tie-downs and the magnitude of counter-weights to resist the uplift are impractical. As such, the results for this framing arrangement are studied only for the final constructed geometry. This bridge is effectively unbuildable, unless it is substantially shored during the construction, and even then, the uplift at the obtuse corner is impractical in the bridge's final constructed condition. Erection studies are not conducted and the fit-up forces are not provided for this bridge case.

- Bridge (S) XICCS7 (Figure 55) has a relatively low L_s/R ratio. The use of a shoring tower and skewed bearing line cross-frames at the interior piers, combined with offsetting the intermediate cross-frames from the bearing lines, help to make the fit-up forces for this bridge the lowest of all the curved and skewed bridge cases studied.

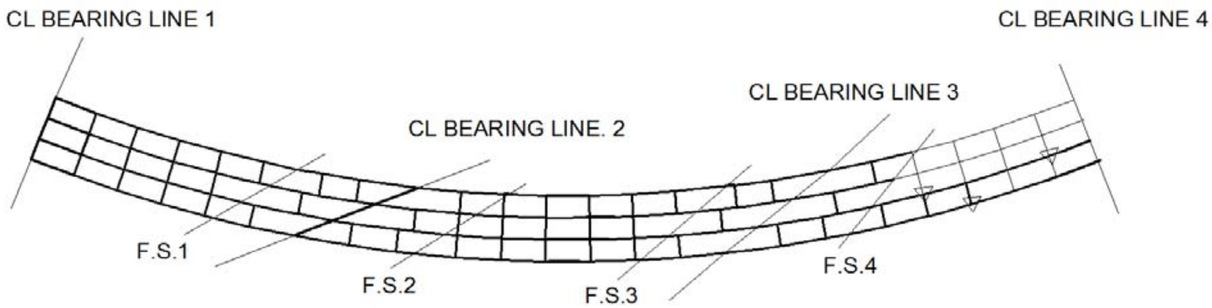


Figure 55. Critical erection stage of Bridge (S) XICCS7. The darker lines show portions of the bridge that are already completed. The two triangles denote the pick points of the lifting and holding cranes.

- Bridge cases (T1) and (T2) EICCS27 (Figure 56) have the lowest L_s/R ratio of the curved and skewed bridges studied in this research. This bridge behaves much like a straight skewed bridge. The SDLF fit-up force is the lowest for bridge case (T1) and is only slightly larger than the NLF fit-up force for bridge case (T2). The TDLF fit-up forces for bridge case (T1) are relatively large because of the contiguous cross-frames and intermediate cross-frames framing into the bearing locations. The maximum fit-up forces for bridge case (T2) are significantly reduced because the cross-frames are staggered throughout the spans and the intermediate cross-frames framing into the bearing locations are eliminated. Four shoring towers are used for the erection of cases (T1) and (T2), all positioned at the no-load elevations. The spans in this bridge have multiple field splices. Span 1 has three field sections and two shoring towers are selected for that span. Span 3 has two field sections, and one shoring tower is selected for that span. Span 2 involves the use of a drop-in segment and needs one shoring tower to limit its deflections. After making the field splices within the spans of this bridge, the shoring towers in the corresponding spans could be moved toward the middle of the span to reduce the number of shoring towers. However, it is felt that it is more efficient to maintain the towers at their original locations throughout the erection. Two lifting cranes with a spreader beam and holding cranes are used for this bridge.

- Bridge case (U1) EICCS28 experiences high cross-frame forces and significant uplift at an interior bearing location due to the use of contiguous cross-frame framing arrangement in all spans with intermediate cross-frames framing into the interior bearing locations, poor span balance, long spans, tight curvature and sharp skew. As such, the results for this framing arrangement are studied only for the final constructed geometry. Erection studies are not conducted and the fit-up forces are not provided for this case.
- For bridge case (U2) EICCS28 (Figure 57), the cross-frames are staggered near the skewed bearing lines and skewed bearing line cross-frames are used along with offsetting of the intermediate cross-frames from the bearing lines. Due to the large span lengths and large number of field sections, five shoring towers are selected to facilitate the installation of the girders and cross-frames. Using this approach, the maximum fit-up forces for this case are relatively low.

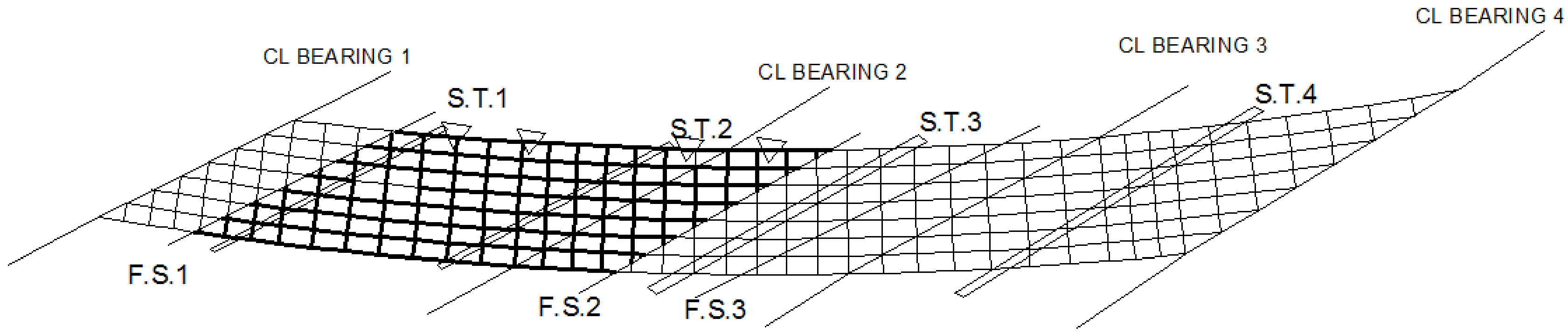


Figure 56. Critical erection stage of Bridge (T1) EICCS27for TDLF detailing. The darker lines show portions of the bridge that is already completed. The triangles denote the pick points of the lifting crane.

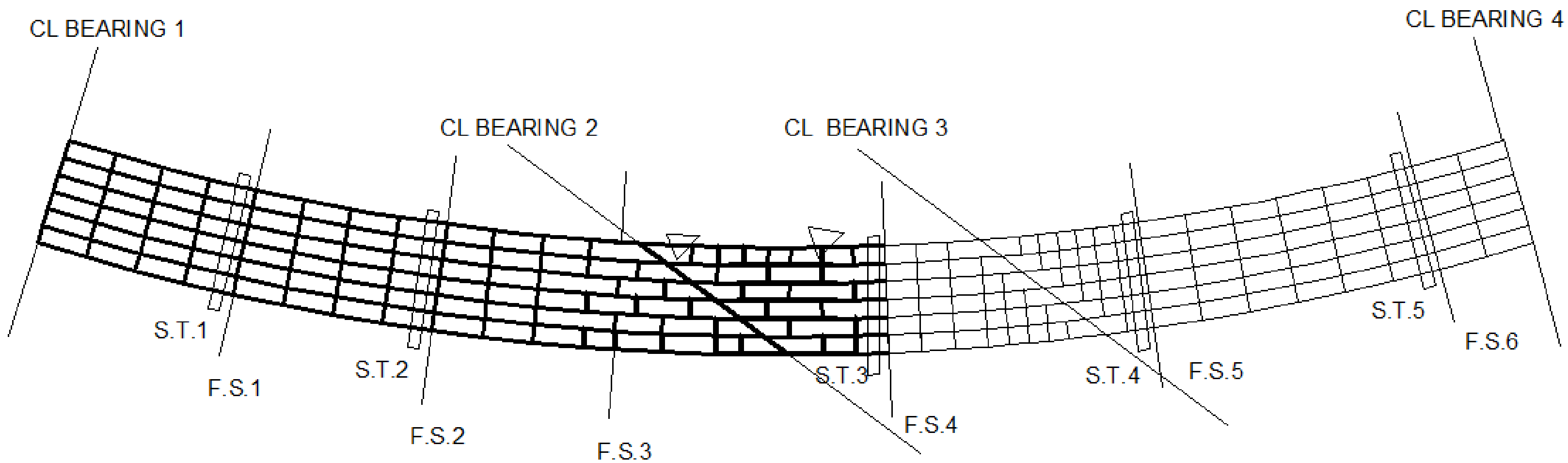


Figure 57. Critical erection stage of Bridge (U2) EICCS28 for TDLF detailing. The darker lines show portions of the bridge that is already completed. The two triangles denote the pick points of the lifting crane.

3.3 Girder Splice Fit-Up

Girder splice fit-up forces are the forces required to physically bring two adjacent field sections together and complete the splice connection during the erection of the steel. In the NCHRP 20-07 Task 355 research, girder splice fit-up is examined by calculating the following quantities (induced at the splice connections as the girder field sections are installed):

- The major axis bending moments,
- The equivalent flange forces from the major-axis bending moments, and
- The flange lateral bending moments.

The following are important considerations regarding fit-up and girder splices:

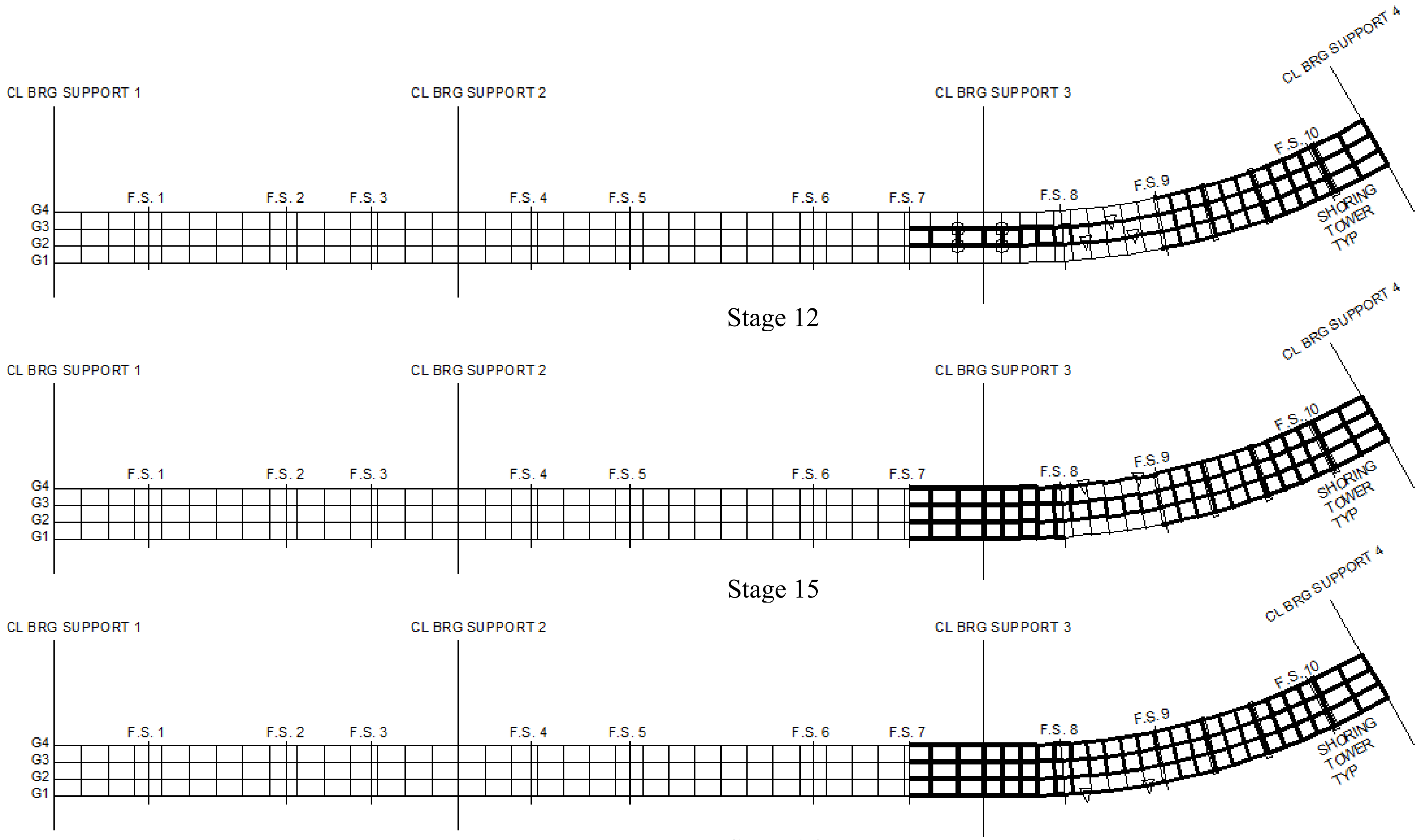
- For the cases where the girder field sections are installed sequentially from one end of the bridge to the other, typically the erector can simply knife the field sections in at the splice to the portion of the structure that is already erected. That is, the erector typically can adjust the position and orientation of the field section being erected, so that it will fit properly with the previously erected field section to which the new section is being spliced.
- The erector needs to ensure that the girder end at the splice, in the portion of the structure that is already erected, is at an orientation and/or elevation such that there is no interference of the field section being knifed in with the abutments or piers.
- When interference of the field section and the abutments or piers occurs, the erector can increase the elevations at shoring towers and/or cranes, remove a bearing, etc., to resolve the interference.
- In addition, the erector can avoid the interference by adjusting the locations and/or heights of the shoring towers (either in the back spans or in the cantilever spans) such that the cantilever tips deflect to higher elevations and/or the slope at the tips are positive to the horizontal line.
- Curved girders are also likely to be twisted at the cantilevered end due to the effects of the horizontal curvature. Lifting to adjust the orientation of the web is more problematic for curved bridges since the girders typically are interconnected by cross-frames and are working together as a structural system; therefore, relatively large forces may be required to increase the bridge elevations.

Erecting the girders in the above fashion is not always feasible due to reasons such as site constraints. An example case of this is Bridge (E) EICCR11, where the erection site constraint was a waterway. The following describes the erection stages for the actual field section installation in this bridge:

- Girder field sections were installed from the right abutment (Support 4 in Figure 58) and the second pier (Support 3 in Figure 58).
- The field section between Field Splices F.S.8 and F.S.9 was then dropped in. The first splice connection at F.S.8 could be knifed in with relative ease. However, the second splice connection at F.S.9 was difficult.

Table 6 shows the predicted major-axis bending moments, flange lateral bending moments, and equivalent flange forces developed at the second splice at the time that this connection is made (for girders 2, 4, and 1). Stages 12, 15, and 16 involved the installation of the drop-in field sections between F.S.8 and F.S.9 for girders 2, 4, and 1, respectively. The following are observations from Table 6:

- Stage 12 (shown only the curved span in Figure 59) is the critical stage for Bridge (E) EICCR11.
- The cross-frames of this bridge were designed and fabricated approximately for SDLF. This led to delays and fit-up difficulty as observed in the field. It is evident from Table 5 that NLF detailing would have substantially alleviated the problems that occurred in erecting this bridge.
- The SDLF and TDLF detailing effects tend to increase the predicted major-axis bending moments, flange lateral bending moments, and equivalent flange forces developed at the second splice connection. This is consistent with the field observations that the field splice fit-up was very difficult for the approximation of the SDLF detailing condition used in this bridge.
- It should be reiterated that Bridge (E) EICCR11 is an extreme case involving longer-spans and significantly larger L_s/R and L_s/w_g than the other bridges studied in this research.
- The major-axis and flange lateral bending moments and the equivalent flange forces for NLF detailing are relatively low, but they are not ideally zero. This is due to the deflections of the bridge system in spite of the shoring towers, cranes, and pier brackets which were all set at the no-load elevations.



Stage 12

Stage 15

Stage 16

Figure 58. Erection stages involving field splice connections of drop-in segments in Bridge (E) EICCR11.

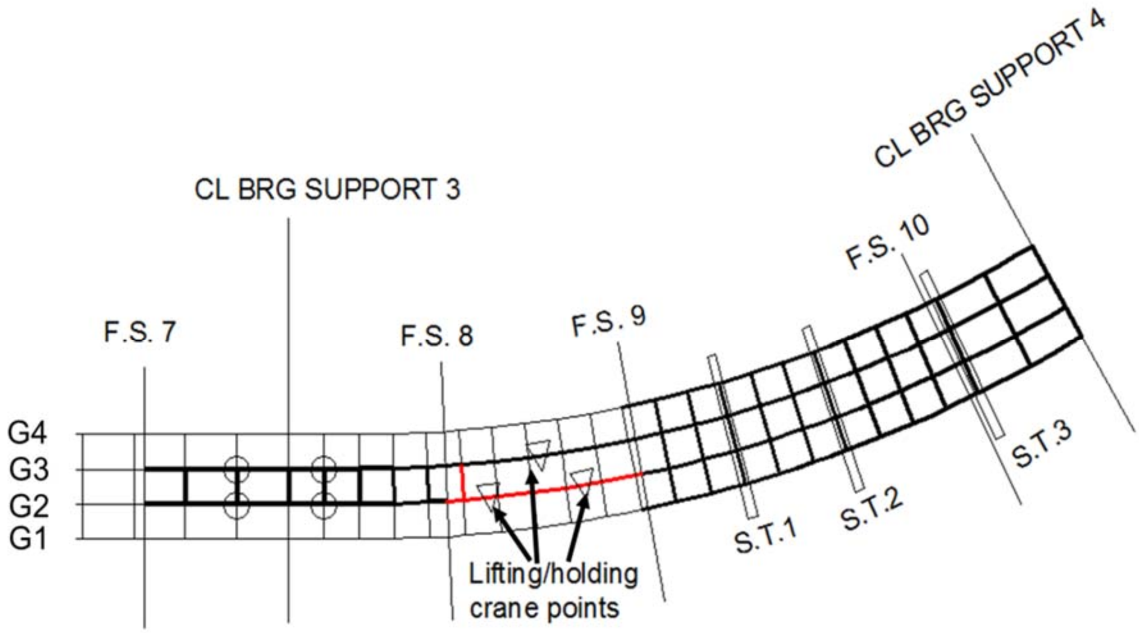


Figure 59. Critical stage of Bridge (E) EICCR11, involving field splice connection of drop-in segments of girder line 2 (showing only the curved span).

Table 6. Predicted major-axis bending moments, equivalent flange forces, and flange lateral bending moments and at the second field splice connections at F.S.9 for G2, G4, and G1 for Bridge (E) EICCR11.

Stage	Detailing Method	M (kip*ft)	Equivalent Flange Force (kip)	Top Flange M_ℓ (kip*ft)	Bottom Flange M_ℓ (kip*ft)
12	NLF	315	23	4.8	4.8
	SDLF	7566	540	43.5	9.5
	TDLF	11267	805	103.1	17.2
15	NLF	212	15	5.3	5.4
	SDLF	2694	192	34.3	2.8
	TDLF	1454	104	32.4	13.0
16	NLF	639	46	0.2	1.8
	SDLF	8986	642	103.9	12.3
	TDLF	12443	889	161.0	15.7

The curved and skewed bridge cases (T1) and (T2) EICCS27 (shown in Figure 60 for Bridge (T1)) also involved the use of drop-in segments. From Table 7, one can observe that values of the predicted major-axis bending moments, flange lateral bending moments, and equivalent flange forces at the second field splice connection of the inside girder are much lower for both bridge cases (T1) and (T2) than bridge case (E). This is because bridge cases (T1) and (T2) have the smallest L_s/R ratio of the bridges studied and four shoring towers are used for the erection of cases (T1) and (T2), all positioned at the no-load elevations. The values for bridge case (T2) are significantly reduced because the cross-frames are staggered throughout the spans and the intermediate cross-frames framing into the bearing locations are eliminated. The SDLF and TDLF detailing effects tend to increase the predicted major-axis bending moments, flange lateral bending moments, and equivalent flange forces developed at the second splice connection for bridge cases (T1) and (T2).

Shoring towers and holding and lifting cranes should be set at the no-load elevations to facilitate girder splice fit-up of drop-in segments. This is because the girders, and the girder splices, are detailed for NLF by customary practice. For straight skewed bridges, shoring towers and holding and lifting cranes should be set at the SDL elevations to facilitate cross-frame fit-up. For straight skewed bridge cases that involve drop-in segments, the elevations can be adjusted temporarily to higher elevations to facilitate the girder splice fit-up.

Table 7. Predicted major-axis bending moments, equivalent flange forces, and flange lateral bending moments and at the second field splice connection of the inside girder for bridge cases (T1) and (T2) EICCS27.

Bridge Case	Detailing Method	M (kip*ft)	Equivalent Flange Force (kip)	Top Flange M_ℓ (kip*ft)	Bottom Flange M_ℓ (kip*ft)
(T1) EICCS27	NLF	31	0.3	0.1	0.2
	SDLF	113	1.2	1.1	1.2
	TDLF	508	5.6	4.8	4.2
(T2) EICCS27	NLF	6	0.1	0.4	0.3
	SDLF	20	0.2	1.1	0.8
	TDLF	61	0.7	3.5	2.5

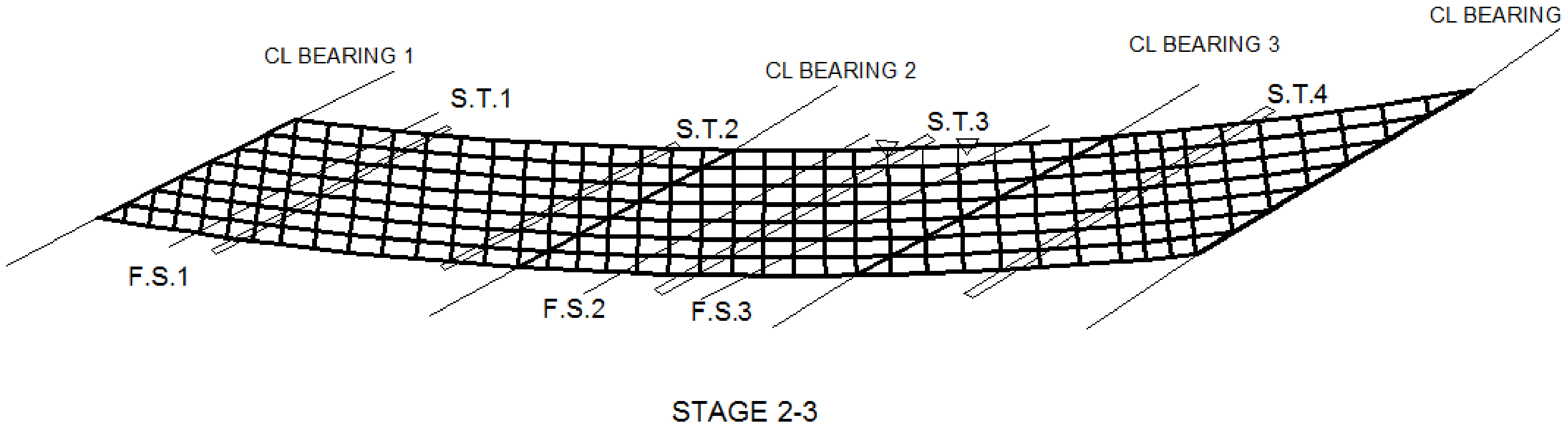


Figure 60. Erection stage involving field splice connections of drop-in segments in Bridge (T1) EICCS27.

3.4 Influence of Detailing Methods on Completed Bridge Responses

Cross-frame detailing methods can have a significant influence on the responses in completed bridge systems. This section provides a major synthesis of the broad effects of different types of detailing on the responses for the three major bridge types considered in this research – curved radially-supported, straight skewed and curved and skewed. Data from the parametric studies conducted in this research is summarized and analyzed to explain the trends, and recommendations for simplified handling of the effects of the different cross-frame detailing methods are provided.

It can be argued that, ultimately, the simplest way of handling the effects of SDLF or TDLF cross-frame detailing on bridge responses is to directly model the corresponding fabricated lack-of-fit between the cross-frames and the girders. This approach gives the most accurate calculation of the reductions in cross-frame forces and girder flange lateral bending stresses in cases where the detailing results in a reduction of these forces and stresses, and it gives the most accurate calculation of increases in these responses in cases where increases occur. The basic structural analysis methods for handling lack-of-fit are fundamental, and are taught in common undergraduate Strength of Materials and Structural Analysis courses. The handling of lack-of-fit is very similar to the handling of the effects of temperature change within the structural system.

Nevertheless, within a design production environment, it is essential that the lack-of-fit calculations be handled in an automated or semi-automated fashion to avoid undue manual and potentially error prone calculation burdens on the design engineer. Although the direct lack-of-fit calculations are relatively basic and straightforward, they require a detailed understanding and, manually, they can become somewhat tedious. Section 3.9 aims to provide the necessary details of the processes for handling the lack-of-fit due to SDLF and TDLF detailing of the cross-frames. It is hoped that bridge engineers and software providers will recognize the value of these calculations, and that handling of lack-of-fit from the detailing of the cross-frames in curved and/or skewed I-girder bridges will eventually become as common place as other important considerations such as handling of temperature effects and staged deck placement or general staged construction effects. Until this milestone is reached, and even then, for certain design situations, simplified methods are needed to account for these effects in design, where they are important. In addition, the influences of SDLF and TDLF detailing generally need to be better understood by bridge professionals. This section aims to address these needs in a thorough fashion.

Abbreviations and definitions of terms central to discussion of the influence of detailing methods on completed bridge responses are summarized in Section 3.4.1. Section 3.4.2 provides a synthesis of the wide range of facts and attributes pertaining to curved and/or skewed I-girder bridge fit. It is important to understand these facts and attributes to facilitate a complete understanding of the considerations and the data summarized from related analytical studies. Recommended procedures for including the results from a dead load fit refined analysis (DLF RA) in LRFD load combinations (i.e., the locked-in stresses and forces obtained from a refined analysis that includes the lack-of-fit associated with SDLF or TDLF detailing of the cross-frames) are discussed in Section 3.4.3. This is followed by Section 3.4.4 which summarizes key questions pertaining to the influence of the fit decision on completed bridge responses. These questions are addressed in Sections 3.4.5 to 3.4.10. The specific influences of SDLF and TDLF detailing on the bridge responses is summarized in these sections. In addition, these sections provide recommendations for handling DLF detailing effects using simple approximate scale factors on the dead load results from a No-Load Fit Refined Analysis (NLF RA), i.e., a refined analysis that does not include the lack-of-fit effects from DLF detailing of the cross-frames. These sections address the following six specific combinations of bridge types and methods of setting the cambers and detailing of the cross-frames:

- Curved radially-supported bridges with cambers set based on NLF RA,
- Straight bridges with parallel skew and cambers set based on Line Girder Analysis (LGA),
- Straight bridges with parallel skew and cambers set based on NLF RA,
- Straight bridges with non-parallel skew and cambers set based on LGA,
- Straight bridges with non-parallel skew and cambers set based on NLF RA, and
- Curved and skewed bridges with cambers set based on NLF RA.

In each of these sections, key results and data from the studies conducted in this research are presented first, followed by a summary of the influences of SDLF and TDLF on the different bridge responses and recommendations for the use and simplified handling of the SDLF and TDLF detailing effects.

3.4.1 Abbreviations and Definitions

The area of skewed and curved I-girder bridge fit is littered with numerous subtle and ambiguous definitions and terms. Therefore, it is essential to provide clear definitions of all the terms to be able engage in any rigorous evaluation and discussion of the procedures.

3.4.1.1 Abbreviations

The following abbreviations are used in the discussions below to help make the discussions as concise as possible:

CDL	=	Concrete Dead Load
CF	=	Cross-Frame
DL	=	Dead Load
LGA	=	Line Girder Analysis
NL	=	No Load, i.e., zero load
NLF	=	No-Load Fit
RA	=	Refined Analysis
SDL	=	Steel Dead Load, i.e., self-weight of all the structural steel including the girders and the CFs
SDLF	=	Steel Dead Load Fit
TDL	=	Total Dead Load, taken as the weight of the structural steel plus the weight of the concrete bridge deck, but not including any additional DC2 and DW loads
TDLF	=	Total Dead Load Fit

3.4.1.2 Definitions

The following terms are used in the discussions below:

CF detailing = Determination of the cross-frame (CF) fabricated geometry such that the CF connection work points match with corresponding work points on the girders in a particular assumed undeflected or deflected geometry, with the girders assumed to be plumb and without any forcing or deformation of the CFs. Also referred to as fit.

CF drop = The difference in the vertical elevation between the top of the girder webs on each side of a CF, considered under NL or under a targeted DL condition. For SDLF and TDLF detailing, the detailer calculates the drops by subtracting the vertical DL deflections (i.e., the girder SDL or TDL cambers) provided on the design plans from the girder fully-cambered NL geometry. Alternatively, some detailers start from the targeted TDL elevations and add the appropriate deflections (the TDL minus the SDL deflections for SDLF, or the TDL deflections for NLF) to determine the geometry in the targeted fit condition. The goal is for the CF connection work points to match with the corresponding work points on the girders in the targeted fit condition. It is important to note that, generally, there are two major contributors to the detailing of the CFs. The CF drops are one contributor. The other contributor, particularly at skewed CF lines, is the corresponding girder connection plate rotated positions in the targeted DL geometry.

CF initial lack-of-fit forces = The CF member forces required to theoretically resolve the lack-of-fit in the undeformed NL geometry due to SDLF or SDLF detailing, if the girders were held artificially in their fully-cambered NL geometry and the CFs were then deformed (subjected to their initial strains) such that their connection work points are matched with the corresponding work points on the girders. The actual CF locked-in forces due to the lack-of-fit are generally much smaller than the CF initial lack-of-fit forces, since deformations are induced in the girders and the rest of the structure when the CF lack-of-fit is resolved by enforcing compatibility at the CF-to-girder connections. As such, although the locked-in forces due to SDLF or TDLF detailing are directly related to the CF lack-of-fit, the CF lack-of-fit on its own is not sufficient to estimate the locked-in forces. The locked-in forces also depend on the compliance of the structure in resisting the removal of the lack-of-fit displacements by enforcing compatibility at the CF-to-girder connections.

CF initial strains = The strains induced in the CF members by theoretically resolving the lack-of-fit in the undeformed NL geometry due to SDLF or TDLF detailing, if the girders were held artificially in their fully-cambered NL geometry and the CFs were then deformed such that the CF connection work points are matched with the corresponding work points on the girders.

CF initial fixed-end forces = The forces induced in an equivalent beam representation of the CFs by theoretically resolving the lack-of-fit in the undeformed NL geometry due to SDLF or TDLF detailing, if the girders were held artificially in their fully-cambered NL geometry and the CFs were then deformed such that the CF connection work points are matched with the corresponding work points on the girders.

CF lack-of-fit = The difference in the position between the work points of the CF connections and the corresponding work points on the girders in the undeformed geometry of the structure under zero load, typically measured/calculated as the displacement incompatibility between the CF and the girder on one side of the CFs with the CF connection work points attached to the girder work points on other side of the CFs. This is also referred to as the "CF initial lack-of-fit." It should be noted that for CFs that are not normal (perpendicular) to the girders, there are generally two contributions to the initial lack-of-fit: (1) the difference in the vertical elevation between the work points on the connected girders, typically referred to as the CF drop, and (2) the major-axis bending rotational orientation of the connection plates at the girder work points (see Section 3.9.1). The NL geometry defines the reference state of the corresponding conservative elastic system at which the strain energy is equal to zero. Hence, the NL configuration serves as the most appropriate basis for calculation of the lack-of-fit and its effects on the structure.

Dead Load Fit (DLF) = Dead Load Fit (DLF) detailing.

DL condition = The fit condition under a given DL, typically either the SDL condition or the TDL condition.

DLF detailing = A method of detailing in which the CF fabricated geometry is set such that the CF connection work points match with corresponding work points on the girders in a particular dead load (DL) deflected position, with the girders assumed to be plumb and without any forcing or deformation of the CFs.

DLF Refined Analysis (RA) = A refined analysis (RA) that includes initial strains in the CF members (for 3D FEA) or initial fixed-end forces in the CF elements (using accurate grid analysis methods) to account for any fabricated lack-of-fit between the CFs and the girders in the undeformed geometry of the structure.

DLF RA Cambers = Girder cambers calculated using a DLF Refined Analysis (RA). This calculation of the girder cambers would generally require an iterative solution, since DLF detailing generally has some influence on the girder vertical displacements, and in turn, the girder displacements influence the DLF RA cambers and the DLF RA cambers influence the girder vertical displacements. This process is neither recommended nor required for sufficiency of DLF detailing.

Fit = In curved and/or skewed I-girder bridges, the process of determining the geometry in which the CFs are detailed to attach to the girders.

Fit-up	=	The process of assembling the structural steel during the bridge erection. It is desirable that the fit-up of the structural steel should be manageable, without the need for excessive jacking or pulling forces from the erector.
Fit-up forces	=	The forces required to physically bring the components together and complete a connection during the erection of the steel. These forces are influenced by initial lack-of-fit effects from SDLF or TDLF detailing of the CFs, but generally, they are distinctly different from the forces associated with the initial lack-of-fit between the girders and the CFs in the initial fabricated NL geometry.
Fit condition	=	The undeflected or deflected geometry of the girders that the CFs are detailed to attach to without any forcing or deformation of the CFs. The fit condition is selected to offset, or compensate for (to different extents), the tendency of the I-girders to twist in curved and/or skewed bridges (with due consideration of the impact on the bridge constructability and the impact on the internal forces in the structure). The selected fit condition corresponds to a specific targeted outcome of when the girder webs will be approximately plumb in the field.
Fit choice	=	Fit decision.
Fit decision	=	The selection of a fit condition; also referred to as the fit choice.
Lack-of-fit	=	CF lack-of-fit.
Lack-of-fit analysis	=	A structural analysis in which locked-in forces are determined based on the initial lack-of-fit between the connection points within the structure. The designer can conduct a lack-of-fit analysis without any applied DL on the structure to calculate the specific locked-in forces in the structure, or the SDL or TDL may be included in the analysis to determine the total force effects in the structure for the selected SDL or TDL condition.
Layover	=	The lateral deflection of the girder top flange relative to its bottom flange associated with twisting.

LGA cambers = Camber profiles determined based on a Line Girder Analysis (LGA). LGA cambers are applicable only for straight skewed bridges. Furthermore, it is explained in this research that Refined Analysis (RA) cambers are the preferred cambers for use in design.

Locked-in forces = The internal forces induced into the structural system by the CF lack-of-fit. These internal forces would remain if the structure's DL were theoretically removed. In straight skewed bridges, the locked-in forces in the CFs due to SDLF or TLDF detailing are predominantly opposite in sign to the corresponding DL effects. In curved radially-supported bridges, the locked-in forces in the CFs due to SDLF or TDLF detailing are predominantly additive with the corresponding DL effects. The locked-in forces are never "removed" by the corresponding SDL or TDL forces; however, when they are opposite in sign to these forces, they reduce these forces. In addition, it should be noted that the locked-in forces in the CFs generally are substantially smaller than the corresponding CF initial lack-of-fit forces. This is due to the overall compliance of the structural system that is invoked when resolving the lack-of-fit (i.e., when the CFs are forced to connect to the girders at the connection work points, the structure deforms under the associated loads). Therefore, just the lack-of-fit itself is not a good indicator of the magnitude of the locked-in forces in a bridge structure.

NL condition = The undeformed plumb geometry of the girders under No Load; also referred to as the fully-cambered condition.

No-Load Fit (NLF) = The process of conducting NLF detailing; also referred to as "fully-cambered fit."

NLF detailing = A method of detailing in which the CF fabricated geometry is set such that the CF connection work points match with corresponding work points on the girders, without any forcing or deformation of the CFs and with the girders assumed erected in their undeformed fully-cambered (plumb) geometry under zero load (i.e., under NL); also referred to as "fully-cambered fit."

NLF Refined Analysis (RA) = A refined analysis that does not include any accounting for DLF.

NLF RA Cambers = Girder cambers calculated using a NLF Refined Analysis (RA). NLF RA cambers are the recommended standard camber calculation.

Nuisance transverse stiffness = Undesired transverse stiffness associated with a combination of the bridge skew and CF framing arrangement that can result in excessively large CF forces, and potentially difficult CF installation, particularly near skewed support lines. Nuisance transverse stiffness effects can be reduced, when CFs are provided along a skewed support line, by offsetting the first intermediate CF placed perpendicular to the girders adjacent to that support, where practicable, by a distance greater than or equal to the minimum indicated in AASHTO LRFD Article C6.7.4.2, and by providing discontinuous (staggered) CF lines in the vicinity of the skewed supports.

Refined Analysis (RA) = A structural analysis in which the 3D actions of the interconnected bridge system are accounted for. In all the discussions provided in this study, it is assumed that the RA is an *accurate* RA. That is, it is assumed that the analysis provides an accurate calculation of the true 3D bridge system responses. NCHRP Report 725 provides guidelines for when simplified methods of analysis, such as grid methods, may be considered to be sufficiently accurate. In this research, refined 3D FEA models, as described in Section 2.6, are employed to represent the "gold standard" RA.

Refined Analysis (RA) cambers = Girder cambers (SDL or TDL) determined using an accurate refined analysis of the interconnected 3D bridge system in which the bridge model is fully assembled and then the gravity loads are simply "turned on."

SDL camber = The negative of the girder SDL deflections.

SDL condition = The hypothetical geometry in which the girders are assumed to be plumb but subjected to the Steel Dead Load (SDL) vertical deflections; also referred to as the "erected condition."

Steel Dead Load Fit (SDLF) = The process of conducting SDLF detailing; also referred to as "erected fit."

SDLF detailing = A method of detailing in which the CF fabricated geometry is set such that the CF connection work points match with corresponding work points on the girders, without any forcing or deformation of the CFs and with the girders deformed into the plumb hypothetical position obtained by subtracting the SDL vertical deflections calculated at the completion of the steel erection, and the associated girder major-axis rotations, from the fully-cambered geometry of the girders; also referred to as "erected fit." Detailers work with the girder SDL cambers or SDL deflections specified on the engineering drawings to set the CF drops associated with this method of detailing. They also consider the relative major-axis bending rotational orientation of the girder connection plates associated with the CF drops. The girders are assumed to be displaced from their initially fabricated fully-cambered and plumb position to the targeted *plumb* SDL position. Any twisting of the girders associated with their 3D interactions with the CFs and the overall structural system are not considered in these calculations.

Targeted DL condition = The DL condition for which the CFs are detailed and in which it is desired for the girders to be approximately plumb, selected considering the impact on constructability and on the internal forces generated in the structure, i.e., the SDL condition for SDLF and the TDL condition for TDLF; also referred to as the targeted fit condition and the targeted DL geometry.

Targeted DL geometry = Targeted DL condition.

Targeted fit condition = Targeted DL condition.

Targeted elevation = The desired final elevation of the girders under the TDL, taken as a flat horizontal plane in the absence of considering the superelevation, cross-slope, vertical curve and grade; also referred to as the targeted TDL elevation.

Targeted TDL elevation = Targeted elevation.

TDL camber = The negative of the girder TDL deflections; also referred to as the total camber. This is the nominal camber used for fabrication of the girders. The actual fabricated girder camber is typically larger than the nominal camber since the AWS D1.5 Specification (AWS 2010) has a zero tolerance for under-camber.

TDL condition = The hypothetical geometry in which the girders are assumed to be plumb but subjected to the total deal load (TDL) vertical deflections; also referred to as the "final condition."

Total camber = TDL camber.

Total Dead Load Fit (TDLF) = The process of conducting TDLF detailing; also referred to as "final fit."

TDLF detailing = A method of detailing in which the CF fabricated geometry is set such that the CF connection work points match with the corresponding work points on the girders, without any forcing or deformation of the CFs and with the girders deformed into the plumb hypothetical position obtained by subtracting the TDL vertical deflections calculated at the completion of the concrete deck placement, and the associated major-axis rotations, from the fully-cambered geometry of the girders (or put alternately, with the girders deflected into their final targeted elevations); also referred to as "final fit." Detailers work solely with the girder total cambers or the TDL deflections specified on the engineering drawings to set the CF drops associated with this method of detailing. They also consider the relative major-axis bending rotational orientation of the girder connection plates associated with the CF drops. The girders are assumed to be displaced from their initially fabricated (cambered and plumb) position to the targeted *plumb* TDL position. Any twisting of the girders associated with their 3D interactions with the CFs, slab, and overall structural system are not considered in these calculations.

3.4.2 Facts and Attributes of Curved and/or Skewed I-Girder Bridge Fit

There are numerous facts and attributes associated with skewed and/or curved I-girder bridge fit. It is important to clearly understand these facts and attributes as a starting point for any rigorous assessment of the procedures.

3.4.2.1 General

The following are general facts and attributes about curved and/or skewed I-girder bridge fit:

- SDLF and TDLF detailing give approximately plumb webs in the targeted DL condition.
- Except in unusual cases involving substantial global displacement amplification of a slender I-girder bridge unit in its noncomposite condition during the deck placement, due to stability effects as discussed in AASHTO LRFD Article 6.10.3.4.2, deviation from the ideal plumb condition due to the deflection of the structure is typically taken to have a negligible influence on the structural resistance.
- Twisting of the girders and of the structural system in skewed and/or curved I-girder bridges is not necessarily indicative of a structural problem or deficiency; it is a natural, predictable, and controllable response to gravity loading in these types of structures. If this were not the case, essentially all of these bridges would be deficient under the design live loads (since they twist under live load).
- Since the structural displacements in skewed and/or curved bridges involve twisting of the girders and of the bridge system, the girders can be plumb only under one loading condition. In fact, generally speaking, due to the elastic deformation of the CFs and the elastic torsional deformation of the girders, all the girders being perfectly plumb at all locations is physically impossible except in certain very specific cases.
- The magnitude of the TDLF detailing effects on the responses is generally larger than the magnitude of the SDLF detailing effects. For SDLF or TDLF detailing, the pattern of the effects on the responses typically is similar under the respective targeted SDL and TDL

conditions. There are slight differences in some cases due to geometric nonlinearity of the bridge system.

- The locked-in forces in the bridge structural system due to SDLF or TDLF depend generally on both the lack-of-fit in the NL fully-cambered geometry associated with the DLF detailing as well as the overall compliance of the structural system in resisting the removal of the lack-of-fit displacements, when compatibility is enforced at the CF-to-girder connections.

3.4.2.2 Straight skewed bridges with the CFs detailed based on Line Girder Analysis (LGA) cambers

The following are specific facts and attributes about straight skewed bridge fit where the CFs are detailed based on LGA:

- In straight skewed bridges, SDLF using LGA cambers results theoretically in zero CF forces, zero flange lateral bending stresses, and perfectly plumb girders in the SDL condition. This is accomplished by detailing the CFs to fit between the girders in their theoretical deflected position under the self-weight of the structural steel, but with the CFs conceptually disengaged such that they do not transfer any internal forces. If the girders are allowed to deflect conceptually under the SDL with the CFs disengaged, the girder vertical deflections, major-axis bending stresses, and reactions are theoretically identical to the values determined from LGA for the SDL. In turn, for SDLF, the CF connection work points match with the corresponding work points on the SDL deflected geometry of the girders.
- The above result, i.e., girder responses identical to the values determined from LGA for the SDL, is accomplished in the 3D bridge system via the lack-of-fit introduced between the CFs and the girders in their undeformed (NL) geometry by the SDLF detailing of the CFs.
- Based on the assumptions that:
    1) All the bridge components stay elastic,
    2) Any play in the CF-to-girder and girder splice connections has a negligible influence on the bridge response, and
    3) There is no incidental restraint (friction forces, etc.) at the bridge supports,

  the bridge is a conservative elastic structural system. As such, the bridge responses in the completed condition and at any stage of erection are unique and independent of the prior sequence of the erection. These are the assumptions commonly made by the design engineer when analyzing a bridge. This fact explains why the above two different conceptual models for SDLF (i.e., disengaging the CFs from the girders and then connecting them once the girders are deflected to their SDL profiles, versus forcing the girders and CFs to fit together under zero load, then applying the SDL) produce the same end result. This does not mean that the erector can neglect the influence of play in the structural connections on the bridge geometry.

- In straight skewed bridges, TDLF using LGA cambers results in theoretically zero CF forces, zero flange lateral bending stresses, and perfectly plumb girders in the TDL condition, based on the idealization that the deck forms and the bridge deck in its early condition during concrete placement do not provide any interconnection between the girders in resisting the TDL.
- Similar to the above behavior for SDLF detailing, TDLF detailing of the CFs based on LGA cambers theoretically produces zero CF forces, and girder responses identical to the values determined from LGA, for the TDL condition in straight skewed bridges.
- The above behavior for SDLF and TDLF is the same regardless of whether the bridge has parallel or non-parallel skew of its bearing lines. SDLF and TDLF detailing of the CFs causes the complete behavior of the individual girders to be theoretically exactly equal to the behavior from the LGA under the targeted DL condition. Of course, the behavior of the interconnected 3D bridge system clearly can be very different for parallel skew versus non-parallel skew.
- Generally, the physical straight skewed bridge responses do not match up exactly with the above theoretical results for various reasons including:
  1) For TDLF, the additional torsional loading on the fascia girders from eccentric overhang bracket loads. These torsional loads may be calculated separately from the other TDL effects; however, they are included in the DLF RA results presented in this research.
  2) For SDLF and TDLF, minute lack-of-symmetry of the girders associated with one-sided web stiffeners and connection plates, etc., such that the girders exhibit some minor lateral deflections when they are conceptually disengaged from the CFs and subjected to the DL.
  3) For SDLF and TDLF, secondary bending of the CF members due to any rotational continuity between the CF members and the girders, as well as secondary bending of the CF members due to connection eccentricities for single angle and flange-connected tees.
  4) As discussed in Section 2.6, in the DLF RA (3D FEA simulation) studies conducted in this research, the CF chord to which the diagonals are connected in V and inverted-V CFs is modeled as being moment connected to the girder connection plates. Although one would

expect that this assumption results in some secondary bending within the 3D FEA bridge models, it is apparent from the research results that this assumption also has a measurable effect on the axial forces in the CF members in cases where the CF member axial forces are relatively small due to improved CF framing arrangements.

5) As discussed in Section 2.6, the influence of secondary bending within single angle and flange-connected tee-section members on the member axial stiffnesses is included in the 3D FEA analyses conducted in this research by reducing the member axial stiffnesses by 0.65 as specified in Article 4.6.3.3.4 of the 7th Edition AASHTO LRFD Specifications.
6) For SDLF and TDLF, specific lateral constraint conditions at guided and fixed bearings. As discussed at length in NHI (2011), it is common to obtain large lateral forces at bearing locations in 3D FEA models, particularly when rigid constraints are assumed in the directions of bearing fixity. As discussed in Section 2.6, the bridges in this research are assumed to be "floated" on the bearings in the lateral directions to eliminate these potentially large lateral forces. As such, the lateral forces at the bearings are negligible in the 3D FEA studies conducted in this research.
7) Various attributes of the physical bridge behavior, including incidental contributions from deck forms and early concrete deck stiffness (for TLDF), incidental lateral or rotational restraint at bearings, play in the CF and girder splice connections within connection tolerances, over-camber of the girders within camber tolerances, variations in the concrete deck thickness within construction tolerances, factors that affect the specific geometry of the steel, such as field temperature, deviations from ideal support elevations within construction tolerances, etc. For engineering design, bridges are commonly analyzed without directly accounting for these factors.

- It is desirable to understand the potential impact of the above effects on the deviation from the ideal theoretical results.
- It is important to note that the LGA calculations give a theoretically "exact" determination of the girder responses ONLY in straight skewed bridges and ONLY in the targeted DL condition. It is desirable to understand the magnitude of the errors produced by using LGA calculations for other DL conditions.

- In straight skewed bridges detailed for SDLF based on LGA cambers, the TDL responses are theoretically equal to the LGA responses under the SDL plus the CDL responses obtained from a NLF RA. Alternatively, the TDL responses may be calculated directly from a DLF RA.
- In straight skewed bridges detailed for TDLF based on LGA cambers, the SDL responses are theoretically equal to the LGA responses under the TDL minus the CDL responses obtained from a NLF RA. Alternatively, the SDL responses may be calculated directly from a DLF RA.
- Based on the above, for straight skewed bridges, theoretically the most accurate girder TDL cambers that should be fabricated into the girders to achieve the targeted elevations under the TDL (when the CFs are detailed based on the LGA cambers) are:
  1) For TDLF, the negative of the girder TDL vertical deflections obtained from the LGA.
  2) For SDLF, the negative of the girder SDL vertical deflections obtained from the LGA plus the negative of the CDL vertical deflections obtained from a NLF RA.
- Although TDLF and SDLF detailing based on the above LGA deflections (or the corresponding girder cambers) is theoretically the most accurate approach, this is not recommended for reasons discussed in the next section, which addresses the use of RA cambers in straight skewed bridges.
- It is important to note that since the girder LGA vertical displacements generally differ substantially from the girder NLF RA displacements, the bridge responses from a NLF RA generally will differ substantially from the theoretical (and actual) bridge responses associated with SDLF or TDLF detailing based on the LGA cambers. Detailing for SDLF or TLDF based on LGA cambers results in the girder responses in the targeted DL condition theoretically being exactly the responses from the corresponding LGA (LGA girder vertical deflections, zero flange lateral bending, LGA major-axis bending stresses and LGA girder vertical reactions). Detailing based on a different set of displacements from RA cannot possibly produce the same ideal (theoretical) results.
- It is desirable to understand the errors associated with applying a NLF RA to predict the responses in straight skewed bridges detailed for SDLF or TDLF using LGA cambers. These errors are due to neglecting the lack-of-fit associated with the DLF detailing in the structural analysis, and are expected to vary as a function of the "nuisance transverse stiffness" effects in a given bridge. That is, a bridge that has substantial transverse stiffness, compared to the vertical stiffnesses of the girders in their longitudinal direction, will tend to have larger

deviation of the NLF RA responses from the correct theoretical (and actual) results that include the influence of the SDLF or TDLF detailing. These errors are different from the errors associated with attempts to apply LGA to predict bridge responses in DL conditions other than the targeted condition; however, they can be of comparable significance.

- It should be noted that, given the specified girder SDL or TDL cambers arrived at by any method, including fabrication over-camber, etc., DLF RA produces the correct responses by properly accounting for the lack-of-fit in the initial undeformed (NL) geometry associated with the SDLF or TLDF detailing.

3.4.2.3 Straight skewed bridges with the CFs detailed based on Refined Analysis (RA) cambers

The following are specific facts and attributes about straight skewed bridge fit where the CFs are detailed based on Refined Analysis (RA):

- In straight skewed bridges, if SDLF and TDLF detailing are conducted using RA cambers, which can be dramatically different from the LGA cambers because of the 3D action of the interconnected bridge system, the CF lack-of-fit can be dramatically different from that associated with the LGA cambers.
- In straight skewed bridges, SDLF and TDLF detailing based on RA cambers still gives approximately plumb webs, small flange lateral bending stresses, and small CF forces in the targeted DL condition; however, these responses are no longer theoretically zero. This is due to the overall elastic deformations of the CFs and the elastic torsional deformations of the girders in the structural system. There is only one set of cambers and corresponding CF drops that gives theoretically exactly plumb webs, zero flange lateral bending stresses and zero CF forces in the targeted DL condition for straight skewed bridges – the LGA cambers. If the CF members truly have zero force and the girder flanges truly have zero lateral bending, then the girders can only respond in the manner assumed in the LGA.
- In straight skewed bridges, SDLF and TDLF detailing based on RA cambers tends to have only a small impact on the girder vertical displacements, as opposed to SDLF and TDLF detailing based on LGA cambers, in which the girder vertical displacements are actually modified from the values obtained from a NLF RA to those associated with LGA (via the initial lack-of-fit and the resulting locked-in forces). Since DLF detailing based on RA cambers has

a small effect on the girder vertical displacements, the change in the girder major-axis bending stresses and reactions from the values obtained from a NLF RA tends to be relatively small.

- The relatively small changes in the vertical displacements in straight skewed bridges, when DLF detailing based on RA cambers is employed, is because the resulting targeted DL elevations are essentially the "natural" deflected elevations of the girders under the targeted DL in the 3D structural system. As such, the girders are subjected predominantly just to twist rotations to move them from their deflected out-of-plumb geometry in the 3D system to their approximately plumb targeted DL geometry, via the DLF detailing effects. The girder twisting is accomplished with relative ease when the straight girders are in this "natural" deflected geometry.
- It is desirable to understand the potential impact of SDLF and TDLF detailing based on RA cambers on the magnitude of the small girder layovers, CF forces, and girder flange lateral bending stresses in straight skewed bridges. Stated alternately, what are the consequences of using a NLF RA (which neglects the lack-of-fit associated with the CF detailing) to calculate the girder layovers, CF forces and girder flange lateral bending stresses, when the CFs are detailed for SDLF or TDLF based on RA cambers?
- It is desirable to understand the potential impact of SDLF and TDLF detailing based on RA cambers on the SDL and TDL girder major-axis bending stresses and vertical reactions, which are generally more substantial non-zero values.
- It is important to note that the girder layovers, the CF forces and the girder flange lateral bending stresses associated with SDLF or TLDF detailing based on the RA cambers are substantially reduced relative to the values obtained from a NLF RA. For instance, in certain cases with severe nuisance transverse stiffness effects, some of the CF forces can be tremendous in a NLF RA. In addition, in a bridge with sharply skewed abutments, the twist rotations of the girders at the abutment bearings can be several times larger than the corresponding girder major-axis bending rotations. The SDLF or TDLF detailing effects can reduce these forces and rotations to only a small fraction of their NLF based values.
- In parallel with the above facts, it should be emphasized that a NLF RA will tend to significantly over-predict the CF forces, girder flange lateral bending stresses, and girder twist rotations in a straight skewed bridge.

- It is desirable to understand the reductions in the girder layovers, CF forces and girder flange lateral bending stresses due to SDLF and TDLF detailing based on RA cambers.
- The overall behavior of straight bridges with non-parallel skew can be significantly different from that of straight bridges with parallel skew. Although the overall aspects of the behavior for SDLF and TDLF detailing using LGA cambers are the same regardless of the parallel or non-parallel nature of the skews, additional elastic system deformations come into play when a straight bridge with non-parallel skew is detailed using RA cambers.
- It is desirable to understand the behavior for SDLF and TDLF using RA cambers in straight bridges with non-parallel skew.
- An important question that may be asked is the following: Is it better to perform SDLF or TDLF detailing of straight skewed bridges using LGA cambers, or is it better to use RA cambers? Some of the considerations in answering this question are as follows:
  1) LGA cambers give the theoretical result of zero girder layover, zero CF forces, and zero girder flange lateral bending stress in the targeted DL condition.
  2) RA cambers result generally in larger DL displacements on some of the girders in the bridge cross-section (typically the fascia girders in straight bridges with parallel skew or the longer fascia girder in bridges with non-parallel skew, due to additional vertical loads distributed to those girders), and smaller displacements on other girders (e.g., the innermost girders in bridges with parallel skew, due to the transverse stiffness developed by the CFs in the short direction between the obtuse corners of the bridge plan); however, these displacements are offset by the calculated RA girder cambers, and therefore the final targeted elevations can be achieved with good accuracy.
  3) Similarly, if LGA cambers are employed, the vertical displacements are offset by the calculated cambers, and therefore the final targeted elevations can be achieved with good accuracy with that approach as well (theoretically, this approach gives the best accuracy); however, a “mixture” of SDL LGA deflections and RA CDL deflections must be considered in this case to achieve the best results, as discussed in Section 3.4.2.2.
  4) The RA cambers tend to be smaller in many of the girders in a multi-girder bridge, since they are associated with the smaller girder vertical displacements of the interconnected 3D structural system. In some bridges with extreme nuisance transverse stiffness effects, the differential RA cambers between the interior and the fascia girders can be large.

5) The RA cambers match with the displacements obtained from ordinary NLF RA models in which a model of the bridge is built, gravity is simply "turned on," and the lack-of-fit associated with SDLF or TDLF detailing is neglected.
6) SDLF or TDLF detailing with RA cambers does not require any "mixing and matching" of separate solutions from LGA and RA to achieve the best accuracy; however, a DLF RA gives a correct rigorous solution for the effect of the lack-of-fit associated with the detailing of the CFs, regardless of what this lack-of-fit is and regardless of what method or assumptions are used to detail the CFs.
7) RA better accommodates the consideration of staged concrete deck placement, its influence on the CDL deflections and the resulting appropriate cambers, in cases where the consideration of staged concrete deck placement may be important.
8) In the limit that TDLF based on LGA cambers is applied to bridges where the skew is close to zero, the application of the dead load to each girder based on the tributary deck widths (which is the recommended practice for sharply skewed bridges (NHI 2011)), combined with TDLF detailing, results in each of the individual girders behaving essentially as assumed in the LGA within the targeted TDL condition. Therefore, for instance, if a fascia girder is subjected to unusually heavy loads that are included in the TDL (due to a large overhang, a heavy wall placed at or near the fascia girder, etc.), the fascia girder will be designed to support this load entirely on its own without any help from the remainder of the girders in the bridge cross-section. Furthermore, the cross-frames between this girder and the remainder of the bridge cross-section will be detailed with an initial lack-of-fit such that they do not transfer any of these large dead loads to the rest of the bridge, aside from the restraint of any eccentric torsion applied to the fascia girder. (The loads from eccentric torsion on the fascia girder are calculated separately from the basic LGA solution.) The vertical deflection of this fascia girder will tend to be substantially larger than the other bridge girders; however, this girder's camber will also be substantially larger, such that theoretically, the girder elevations will be as targeted. Although it can be argued that this is correct and acceptable design behavior (assuming that the concrete deck does not provide a significant path for the heavy load to be transferred to the rest of the bridge system), the response of the bridge designed in this way is not as efficient as it would be if TDLF RA cambers are used, in which case the entire bridge structural system is engaged in resisting

the heavy load on the fascia girder. Also, one can question whether this degree of differential vertical deflection between the fascia girder and the interior girders is desirable.

9) RA is generally required for tightly curved bridge geometries; therefore, the use of RA cambers for straight skewed bridges results in calculations that are consistent and more uniform across all types of I-girder bridges.

- The use of LGA for setting the girder cambers in sharply skewed straight bridges is generally discouraged based on the above considerations.
- It is desirable to understand the consequences of using LGA versus RA cambers more quantitatively.
- It should be noted that large DC2 loads, such as heavy walls, planters, etc. are not commonly included in the TDL considered for TDLF detailing.

3.4.2.4 Curved bridge geometries, with and without skew

The following are specific facts and attributes about horizontally curved bridge fit, for bridges with and without skew:

- For all curved and curved and skewed bridge geometries, generally the CF forces and the girder flange lateral bending stresses are significant due to the horizontal curvature. They never approach theoretical zero values as a function of the DLF detailing, as in straight skewed bridges, except in the limit that the radius of curvature becomes infinite and when LGA cambers are employed. In curved and skewed bridges, the magnitudes of these bridge responses can be increased or decreased compared to a similar curved radially-supported bridge depending on the skew orientation.
- For bridges having significant horizontal curvature, with or without skew, the design analysis typically should be an accurate RA. NCHRP Report 725 provides guidance regarding various simplifications, such as the use of grid analysis methods, and when these simplifications are sufficient. An accurate RA should always be used to calculate the girder cambers on a highly curved bridge.
- For curved geometries, with and without skew, SDLF and TDLF detailing result in approximately plumb webs in the targeted DL condition. However, the webs will never be perfectly plumb. This is due to the overall elastic deformations of the CFs and the elastic torsional deformations of the girders in the structural system.

- It is desirable to understand the magnitude of the girder layovers in typical curved I-girder bridge systems resulting from the above elastic deformations.

3.4.2.5 Curved radially-supported bridges

The following are specific facts and attributes about curved radially-supported bridges and fit:

- For curved radially-supported geometries, both SDLF and TDLF detailing tend to increase the CF forces and the girder flange lateral bending stresses. This is due to the fact that horizontally curved girders tend to twist and deflect excessively if they are restrained only at their ends (whereas straight girders conceptually do not twist at all if they are not engaged with the CFs).
- Due to the above fact, a NLF RA generally tends to under-predict the CF forces and girder flange lateral bending stresses in curved radially-supported bridges.
- It is desirable to understand the typical increases in the CF forces and the girder flange lateral bending stresses from the values obtained from a NLF RA due to SDLF and TDLF detailing effects. Stated alternately, it desirable to determine if any simple scale factors should be (or can be) applied to the results of a NLF RA to account in a simple way for SDLF and TDLF detailing effects on the CF forces and the girder flange lateral bending stresses in curved radially-supported bridges.
- The girder displacements are generally reduced and the resulting elevations of the girders are increased in curved radially-supported bridges due to SDLF and TDLF detailing effects. This behavior is due to the coupling between the twisting and the vertical deflections in curved girders and bridge units. For example, a curved I-girder cannot be twisted about a chord through its ends without also changing its vertical displacements and vertical elevations within the span.
- It is desirable to understand the impact of the above elevation changes due to SDLF and TDLF detailing in horizontally curved bridges. Stated alternately, it is desirable to determine if any simple scale factors should be (or can be) applied to the results of NLF RA to account in a simple way for SDLF and TDLF detailing effects on the girder vertical displacements.
- In curved radially-supported bridges, the impact of SDLF and TDLF detailing on the girder major-axis bending stresses and the support vertical reactions tends to be relatively small. However, there is some minor effect. The girder major-axis bending stresses and vertical reactions on the girder at the outside of the curve generally tend to be increased by the DLF

detailing, since the major-axis bending of the girders is in effect used as a reaction to twist the girders back in the direction opposite to the one that that they want to roll.

- It is desirable to understand the impact of SDLF and TDLF detailing on the girder major-axis bending stresses and support vertical reactions in curved radially-supported bridges. Stated alternately, it is desirable to determine if simple scale factors can be applied to the results of NLF RA to account in a simple way for SDLF and TDLF detailing effects on the girder major-axis bending stresses and support vertical reactions.

3.4.2.6 Curved and skewed bridges

The following are specific facts and attributes about fit in curved and skewed bridges:

- In curved and skewed bridges, the separate effects of DLF detailing on the bridge responses discussed above (the DLF effects associated with skew and the DLF effects associated with horizontal curvature) are observed, generally, in the limit that the horizontal curvature or the skew become small respectively.
- In curved and skewed bridges where both the curvature and the skew are significant, the separate DLF detailing effects associated with the skew and the curvature interact in complex ways:
  1) In simply-supported spans where the skew tends to make the girder on the outside of the curve longer, a number of the DLF detailing effects associated with the horizontal curvature tend to be amplified by the effects associated with the skew.
  2) In simply-supported spans where the skew tends to make the girder on the inside of the curve longer, a number of the DLF detailing effects associated with the horizontal curvature tend to be offset by the effects associated with the skew.
- The above results parallel the dramatically different overall behavior of straight skewed versus curved radially-supported bridges, and the combinations of these dramatically different behavior attributes when the bridge is curved and skewed.
- It is desirable to determine when a NLF RA gives sufficient predictions of the responses in curved and skewed I-girder bridges, and whether simple scale factors can be applied to the responses in cases where NLF RA may under-predict the magnitude of the responses.

3.4.3 Recommended Application of DLF RA to Curved and/or Skewed I-Girder Bridges

In bridges with large skew and tight curvature, where the effects of SDLF and TDLF are significant and cannot be captured accurately by a simplified methods, it is recommended that a DLF RA be performed to determine the bridge responses. In these cases, recommendations for the application of DLF RA are provided in the bold italicized text below (the recommendations in the subsequent sections are also highlighted in bold italics):

- ***When a DLF RA is employed for curved and/or skewed I-girder bridges with the CFs detailed for SDLF based on NLF RA cambers, it is recommended that the locked-in force effects from the lack-of-fit be determined by a separate structural analysis and that the EL (miscellaneous locked-in force) load factor of 1.0 be applied to these effects for combination with other loadings. Per AASHTO LRFD recommendations, the resulting net factored DL to be considered for construction is 1.4 DC + 1.0 EL and the resulting net factored DL for STRENGH I is 1.25 DC + 1.0 EL.***
- ***When a DLF RA is employed for curved and/or skewed I-girder bridges with the CFs detailed for TDLF based on NLF RA cambers, it is recommended that the locked-in force effects from the lack-of-fit be determined by a separate structural analysis. When the locked-in force effects are additive to the effects of the DC loads, it is recommended that the EL (miscellaneous locked-in force) load factor of 1.0 be applied to these effects for combination with other loadings. When the locked-in force effects are of opposite sign to the DC loads, it is recommended that the EL (miscellaneous locked-in force) load factor of 0.85 be applied to these effects for combination with other loadings. Per AASHTO LRFD recommendations, the resulting net factored DL is 1.4 DC + 1.0 EL for construction load combinations and 1.25 DC + 1.0 EL for STRENGH I when the locked-in force effects are additive with the effects of the DC loads, and the resulting net factored DL is 1.4 DC + 0.85 EL for construction load combinations and 1.25 DC + 0.85 EL when the locked-in force effects are of opposite sign to the effects of the DC loads.***
- The EL load factor of 1.0 is considered justified when a DLF RA is employed for SDLF and for TLDF where the effects are additive to the DC load effects because the lack-of-fit of the CFs in the NL geometry of the bridge is directly accounted for in the structural analysis.

- The EL load factor of 0.85 is intended to account for additional uncertainties and variabilities associated with TDLF, such as incidental participation of deck forms and early concrete stiffness in the structural resistance, and larger potential play in the CF connections due to the larger CF forces associated with TDLF. It is suggested that a value between 0.85 and 1.0 may be used if considered justified based on the judgment of the engineer of record.
- Although the girder deflections are changed slightly from the NLF RA values when a DLF RA is conducted in some cases, it is sufficient to use the vertical deflections from the NLF RA for setting the girder cambers (and the CF drops) in curved and/or skewed I-girder bridges. Use of the DLF RA deflections for setting the girder cambers would require an iterative approach, for instance, starting with a NLF RA, then modifying the girder cambers based on the results from the subsequent DLF RA, then feeding these results back into another DLF RA, etc. Although this type of iterative process results in girder layovers that are closer to zero (Ozgur 2011), any improvements achieved by this process are unjustified. The sufficiency of this approach is discussed in the following summaries of the *Elevation* results for the different bridge geometries.

3.4.4 Summary of Questions Pertaining to the Influence of the Fit Decision on Dead Load Responses in Completed Curved and/or Skewed I-Girder Bridge Systems

In lieu of accounting for the SDLF and TDLF detailing effects directly within a structural analysis, one can use the results from a NLF RA with simple approximate adjustment factors in certain curved and/or skewed bridges. As mentioned in the above discussions, for the development of these adjustment factors, the following questions need to be answered:

1) What is the influence of various incidental effects on the deviation of the responses from the ideal theoretical results in straight skewed bridges detailed for SDLF or TLDF using LGA cambers?
2) What magnitude of errors are produced by applying LGA for the calculation of all the responses in straight skewed bridges detailed for SDLF or TDLF using LGA cambers?
3) What magnitude of errors are produced by applying a NLF RA to predict the responses in straight skewed bridges detailed for SLDF or TDLF using LGA cambers?

4) What is the impact of SDLF and TDLF detailing based on RA cambers on the magnitude of the supposedly small girder layovers, CF forces and girder flange lateral bending stresses in straight skewed bridges?
5) What is the impact of SDLF and TDLF detailing based on RA cambers on the major-axis bending stresses and vertical reactions in straight skewed bridges?
6) Given that the reductions are not generally to zero values, to what extent are the girder layovers, CF forces and girder flange lateral bending stresses in straight skewed bridges reduced due to SDLF and TDLF detailing based on RA cambers?
7) What effects do the RA cambers have in straight bridges with non-parallel skew? Are there any significant differences in the effects compared to those in straight bridges with parallel skew? How do the RA camber effects compare to the LGA camber effects in straight bridges with non-parallel skew?
8) What are the quantitative consequences of SDLF or TDLF detailing based on LGA cambers versus RA cambers in straight skewed bridges?
9) Given that the reductions are not generally to zero values, to what extent are the girder layovers reduced in curved radially-supported bridges by SLDF and TDLF detailing?
10) By what extent are the worst-case CF forces, girder flange lateral bending stresses, girder elevations, major-axis bending stresses, and support vertical reactions increased in curved radially-supported bridges by the effects of SDLF and TDLF detailing?
11) Given that the reductions are not generally to zero values, to what extent are the girder layovers reduced in curved and skewed bridges by SLDF and TDLF detailing?
12) What is the largest magnitude of the deviations from the targeted elevations due to SDLF and TDLF detailing in curved and skewed I-girder bridges?
13) By what extent are the worst-case CF forces, girder flange lateral bending stresses, girder elevations, major-axis bending stresses, and support vertical reactions increased in curved and skewed bridges by the effects of SDLF and TDLF detailing?

The following sections provide various answers to these questions.

3.4.5 Curved Radially-Supported Bridges with Cambers Set Based on NLF RA

Section 3.4.5.1 provides quantitative results on the influence of SDLF and TDLF detailing on bridge responses in curved radially-supported bridges with cambers set based on NLF RA. The influence of SDLF and TDLF is discussed on the responses in the following order: girder vertical displacements, girder elevations, girder layovers, CF forces, girder stresses, and vertical reactions. Section 3.4.5.2 then summarizes the influences on the key bridge responses and provides recommendations for handling of these effects. The recommendations are highlighted in bold italicized text.

3.4.5.1 Quantitative Results

3.4.5.1.1 Girder Vertical Displacements

For curved radially-supported bridges, SDLF and TDLF detailing tend to reduce the vertical displacements of all the girders, thus resulting in an overall tendency for higher final elevations of the steel within the spans. The twisting of the girders induced by SDLF and TDLF detailing, combined with the overall three-dimensional action of the curved spans, causes an upward movement of all of the girders. This effect is illustrated in Figure 61 which shows the vertical displacements of the girder on the outside of the curve for Bridge (C) NISCR7 under TDL. The horizontal axis of this plot is the normalized position along the girder length, x_g/L_g, where x_g is the position along the curved axis of the girder and L_g is the total distance from bearing-to-bearing along the length of the girder.

Table 8 shows the maximum vertical displacements and the changes in the vertical displacements relative to those associated with NLF detailing for the curved radially-supported bridges studied in this research. One should note that Table 8 reports the absolute maximum downward displacement in the bridges. As such, the data in this table is useful for understanding the overall trends in the behavior of the bridges, but not necessarily the specific changes that occur at different positions in the individual girders. In some of the cases for the bridges considered in this research, the location of the maximum displacement can change as a function of the CF detailing method.

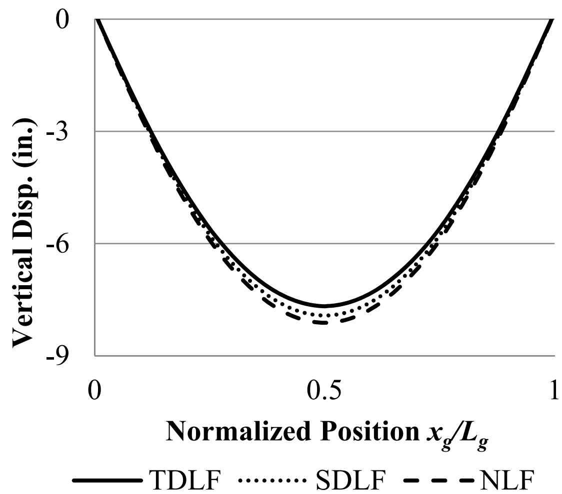


Figure 61. Bridge (C) NISCR7 vertical displacements under TDL for the girder on the outside of the curve.

Table 8. Maximum vertical displacement under TDL with NLF, SDLF and TDLF detailing, and corresponding change in the maximum vertical displacement relative to the results from NLF RA, for the curved radially-supported bridges studied in this research (excluding Bridge (E), the largest changes due to SDLF and TDLF are highlighted by dark shading).

Bridge	NLF	SDLF		TDLF	
	Disp. (in.)	Disp. (in.)	Change (in.)	Disp. (in.)	Change (in.)
(A) EISCR1	-4.7	-4.5	0.2	-3.9	0.8
(B) NISCR2	-7.1	-6.6	0.5	-5.9	1.2
(C) NISCR7	-8.1	-7.9	0.2	-7.7	0.4
(D) NISCR10	-11.7	-11.4	0.3	-11.3	0.4
(E) EICCR11	-19.4	-16.8	2.6	-15.5	3.9
(F) NICCR12	-18.0	-16.8	**1.2**	-16.0	**2.0**
(G) EICCR4	-9.6	-9.5	0.1	-9.3	0.3

From Table 8, it can be observed that SDLF and TDLF detailing reduce the maximum vertical displacements in all of the cases. The largest decreases in the maximum TDL vertical displacement are 2.6 inches for SDLF detailing and 3.9 inches for TDLF detailing. These decreases occur in Bridge (E) EICCR11, which is significantly more extreme than the other bridges considered. In all other cases, the largest decreases in the maximum TDL vertical displacement are 1.2 inches for SDLF detailing and 2.0 inches for TDLF detailing.

3.4.5.1.2 Girder Elevations

The girder cambers for the curved radially-supported bridges are based on NLF RA in this research. The total girder cambers are taken as the negative of the vertical deflections obtained from the NLF RA for the corresponding TDL, using the common engineering practice of building a model of the bridge and "turning gravity on." That is, any changes in the deflections due to SDLF or TDLF detailing effects are not included in the calculation of the cambers. The vertical elevations under TDL for NLF detailing are zero (assuming no superelevation, etc., as a simplification).

As discussed in Sections 2.4, 2.6 and 3.4.2, the negative of the SDL deflections is used in a similar fashion to the TDL cambers in setting the drops between each side of the CFs when SDLF detailing is employed. As such, the phrase "SDL camber" is used in this research to refer to the negative of the SDL deflections. These deflections, in addition to the TDL cambers, affect the final girder elevations when SDLF detailing is employed. Similar to the calculation of the TDL cambers, for the curved radially-supported bridges, the SDL cambers are calculated without considering the influence of the SDLF detailing effects on the girder vertical displacements.

Since the SDLF and TDLF detailing effects tend to reduce the vertical displacements as discussed above, the vertical elevations of the girders are somewhat higher than the targeted elevations (i.e., the "zero" elevation level) when SDLF or TDLF detailing is employed. The deviation from the targeted vertical elevations, when the bridge is detailed for SDLF or TDLF detailing, is equal to the displacement caused by the SDLF and TDLF detailing effects alone. Figure 62 shows the vertical elevations of the girder on the outside of the curve for Bridge (C) NISCR7 under TDL. The maximum vertical elevation for this bridge, under TDL for TDLF detailing, is 0.44 inches.

Considering the complete set of curved radially-supported bridges studied in this research, the largest deviation from the targeted elevation under TDL for TDLF detailing, is 6.7 inches for Bridge (E) EICCR11 and the smallest is 0.4 inches for Bridge (G) EICCR4 (see Table 9). It is apparent that the geometry parameters for Bridge (E) are so different from the other bridges (L_s = 329 ft, L_s/R = 0.80 and L_s/w_g = 8.1 on its curved span) that this bridge should be considered as an outlier. Bridge (F) NICCR12 has the second largest deviation, 2.1 inches, from the targeted elevation under TDL for TDLF. This bridge has the longest curved spans considered (350 ft) of all the bridges studied. It is apparent that for tightly curved bridges with L_s values larger than about 250 ft, and if TDLF detailing were to be used (which is not recommended), consideration should be given to these deviations from the targeted elevations. For extreme cases where SDLF is employed, consideration should be given to specifying a somewhat thicker concrete haunch than might normally be specified to compensate for these increases in the overall girder elevations.

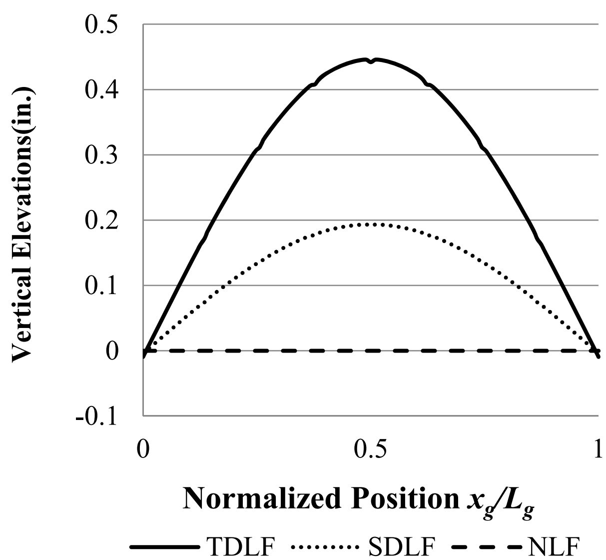


Figure 62. Bridge (C) NISCR7 TDL vertical elevation of the girder on the outside of the curve

Table 9. Maximum final elevation deviation from the targeted elevation line, for the curved radially-supported bridges studied in this research (excluding Bridge (E), the largest final girder elevations with SDLF and TDLF detailing under TDL are highlighted by dark shading).

Bridge	NLF (in.)	SDLF (in.)	TDLF (in.)
(A) EISCR1	0.0	0.2	0.8
(B) NISCR2	0.0	0.5	1.2
(C) NISCR7	0.0	0.2	0.4
(D) NISCR10	0.0	0.3	0.4
(E) EICCR11	0.0	4.0	6.7
(F) NICCR12	0.0	**1.4**	**2.1**
(G) EICCR4	0.0	0.1	0.4

It is important to note the final elevation deviation values in Table 9 do not exactly match values of the maximum displacement change due to detailing methods in Table 8. This is because the cambers are based on NLF RA for all three detailing methods. Therefore, the maximum camber location and the maximum displacement location are generally different when SDLF or TDLF detailing is used. This results in the location and value of the maximum deviation from the target elevation being different from the location and value of the maximum displacement.

3.4.5.1.3 Girder Layovers

For curved radially-supported bridges, the girders and the bridge cross-section both tend to roll towards the outside of the curve under the action of the DL. The SDLF and TDLF detailing effects twist the girders in the opposite direction from these DL rotations. As shown in Figure 63 for Bridge (C) NISCR7, the maximum layover (i.e., the difference between the radial deflections of the top and bottom flanges) of the girder on the inside of the curve is 0.02 inches for TDLF, and 0.53 inches for NLF. TDLF detailing is effective in making the inside girder nearly plumb under TDL. The girder layovers at the CF locations on the inside girder are essentially zero for TDLF. The girder layovers of the inside girder in-between the CF locations are slightly non-zero.

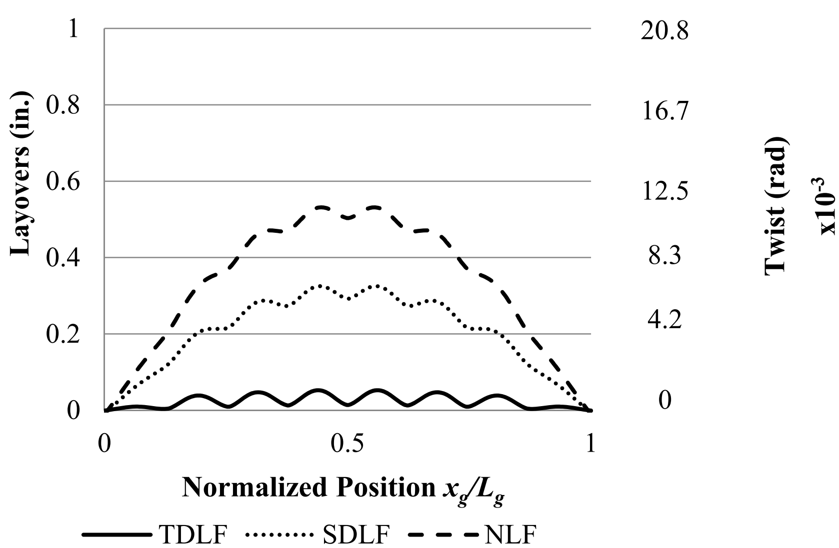


Figure 63. TDL layover and twist of the girder on the inside of the curve in Bridge (C) NISCR7.

As shown in Figure 64, for Bridge (C) NISCR7, the maximum layover of the girder on the outside of the curve is 0.42 inches for TDLF, and 0.87 inches for NLF. The girders are 74 inches deep in NISCR7. Therefore, it can be stated that TDLF detailing also is reasonably effective in making the outside girder nearly plumb under TDL. The girders that are located further toward the outside of the curve are less plumb than the inside girders due to the elastic deformation of the CFs.

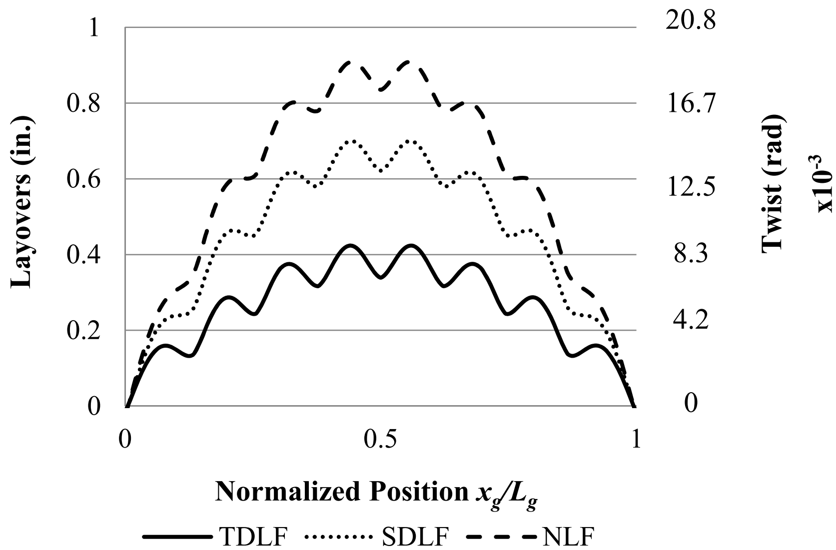


Figure 64. TDL layover and twist of the girder on the outside of the curve in Bridge (C) NISCR7.

Considering the complete set of curved radially-supported bridges studied in the NCHRP 20-07 Task 355 research, the largest girder layovers are 0.9 inches under SDL for SDLF detailing (see Table 10) and 1.2 inches under TDL for TDLF detailing (see Table 11). These layovers occur on the outside girder of Bridge (E) EICCR11 which is an outlier with D = 168 inches, L_s = 322 ft, L_s/R = 0.80 and L_s/w_g = 8.1 on its curved span. Other than Bridge (E) and Bridge (A) which has a limited number of CFs and CF spacing at the maximum limits permitted by the AASHTO LRFD Specifications, the largest girder layovers are 0.3 inches under SDL for SDLF detailing and 0.4 inches under TDL for TDLF detailing, corresponding to Bridge (F) NICCR12. The largest girder twist rotations are 0.0024 rad. under SDL for SDLF and 0.0048 rad. under TDL for TDLF, corresponding to Bridge (C) NICCR7.

Table 10. Maximum magnitudes of girder layovers and twists under SDL in the curved radially-supported bridges studied in this research (LO1 and LO2 are the maximum girder layovers with NLF and SDLF, respectively. $\phi 1$ and $\phi 2$ are the maximum girder twists with SDLF and SDLF detailing, respectively. Excluding the results for Bridge (E), the largest girder layover and twists with SDLF are highlighted by dark shading).

Bridge	**Girder Depth (in.)**	**NLF**		**SDLF**	
		LO1 (in.)	**ϕ1 (rad) x10^{-3}**	**LO2 (in.)**	**ϕ2 (rad) x10^{-3}**
(A) EISCR1	48	0.3	6.3	0.1	2.1
(B) NISCR2	84	0.7	8.3	0.1	1.2
(C) NISCR7	84	0.4	4.8	0.2	**2.4**
(D) NISCR10	120	0.6	5.0	0.2	1.7
(E) EICCR11	168	3.4	20.2	0.9	5.4
(F) NICCR12	168	1.5	8.9	**0.3**	1.8
(G) EICCR4	99	0.3	3.0	0.1	1.0

Table 11. Maximum magnitudes of girder layovers and twists under TDL in the curved radially-supported bridges studied in this research (LO1 and LO3 are the maximum girder layovers with NLF and TDLF, respectively. $\phi 1$ and $\phi 3$ are the maximum girder twists with NLF and TDLF detailing, respectively. Excluding the results for bridges (A) and (E), the largest girder layover and twists with TDLF are highlighted by dark shading).

Bridge	**Girder Depth (in.)**	**NLF**		**TDLF**	
		LO1 (in.)	**ϕ1 (rad) x10^{-3}**	**LO3 (in.)**	**ϕ3 (rad) x10^{-3}**
(A) EISCR1	48	1.1	22.9	0.4	8.3
(B) NISCR2	84	1.9	22.6	0.3	3.6
(C) NISCR7	84	0.9	10.7	**0.4**	**4.8**
(D) NISCR10	120	1	8.3	0.3	2.5
(E) EICCR11	168	6	35.7	1.2	7.1
(F) NICCR12	168	2.8	16.7	**0.4**	2.4
(G) EICCR4	99	1.1	11.1	0.1	1.0

3.4.5.1.4 Cross-Frame Forces

For curved radially-supported bridges, the effects of SDLF and TDLF detailing often do not have much influence on the CF chord forces. However, the influence on the CF diagonal forces is substantial. Table 12 summarizes the average and maximum magnitudes of the CF chord forces in the curved radially-supported bridges studied in this research, and Table 13 gives these values for the CF diagonals. The cells for Bridge (A) EISCR1 are shaded grey in the tables to highlight the fact that this FHWA test bridge had only three intermediate CF lines and subtended angles between the CFs, L_b/R, slightly larger than the permitted AASHTO LRFD maximum. Also, the cells for Bridge (E) EICCR11 are shaded grey, highlighting the aspect that this bridge is largely an outlier as discussed in the previous sections. The largest F2/F1 and F3/F1 ratios in the tables are highlighted by dark shading. These ratios compare the responses under SDL for SDLF to the corresponding responses under SDL for NLF, and the responses under TDL for TDLF to the corresponding responses under TDL for NLF.

Clearly, the differences between the DLF and NLF values are relatively small for the chords, as shown in Table 12, excluding Bridges (A) and (E). The largest ratio of 1.29 between the SDL/SDLF maximums corresponds to Bridge (G) EICCR4, where the chord forces themselves are relatively small. However, Table 13 shows that both the average and the maximum ratios of the diagonal forces are substantially increased for all the bridges with the exception of Bridge (F) NICCR12 (the different ratios for Bridge (F) appear to be related to the complex interaction between the behavior of its three continuous spans). The increases in both the average and the maximum values are close to a multiple of 2.0 in the majority of the bridges. There is no clear correlation between the specific maximum and average values as a function of the different bridge geometry parameters (e.g., L_s, L_s/R, L_s/w_g, L_s/D, simple- or continuous-span, etc.)

Table 12. Average and maximum magnitudes of the CF chord forces in each of the curved radially-supported bridges studied in this research (F1, F2, and F3 are the CF forces with NLF, SDLF, and TDLF detailing, respectively. Excluding bridges (A) and (E), the largest F2/F1, F2-F1, F3/F1, and F3-F1 for the average and maximum forces are highlighted by dark shading).

	Bridge	SDL				TDL			
		NLF	SDLF			NLF	TDLF		
		F1 (kip)	**F2 (kip)**	**F2/F1**	**F2 – F1 (kip)**	**F1 (kip)**	**F3 (kip)**	**F3/F1**	**F3 – F1 (kip)**
Average	(A) EISCR1	4.5	5.1	1.13	0.6	26.4	29.4	1.11	3.0
	(B) NISCR2	6.5	6.4	**0.98**	-0.1	19.6	18.6	0.95	-1.0
	(C) NISCR7	18.1	16.4	0.91	-1.7	41.9	38.5	0.92	-3.4
	(D) NISCR10	11	10.2	0.93	-0.8	23.1	21.2	0.92	-1.9
	(E) EICCR11	9.1	11.6	1.27	2.5	18.2	20.2	1.11	2.0
	(F) NICCR12	10.9	10.4	0.95	-0.5	20.6	18.7	0.91	-1.9
	(G) EICCR4	1.1	1.04	0.92	-0.1	4.2	4.11	**0.98**	-0.1
Maximum	(A) EISCR1	18.9	23.9	1.26	5.0	96.0	113.9	1.19	17.9
	(B) NISCR2	19.0	17.5	0.92	-1.5	49.1	47.8	0.97	-1.3
	(C) NISCR7	59.0	55.1	0.93	-3.9	151.5	142.1	0.94	-9.4
	(D) NISCR10	41.8	40.9	0.98	-0.9	95.3	92.5	0.97	-2.8
	(E) EICCR11	45.8	76.2	1.66	30.4	91.0	100.8	1.11	9.8
	(F) NICCR12	56.8	58.4	1.03	1.6	108.4	102.7	0.95	-5.7
	(G) EICCR4	4.1	5.3	**1.29**	1.2	18.3	22.2	**1.21**	3.9

Table 13. Average and maximum magnitudes of the CF diagonal forces in each of the curved radially-supported bridges studied in this research (F1, F2, and F3 are the CF forces with NLF, SDLF, and TDLF detailing, respectively. Excluding bridges (A) and (E), the largest F2/F1, F2-F1, F3/F1, and F3-F1 for the average and maximum forces are highlighted by dark shading).

	Bridge	SDL				TDL			
		NLF	SDLF			NLF	TDLF		
		F1 (kip)	F2 (kip)	F2/F1	F2 – F1 (kip)	F1 (kip)	F3 (kip)	F3/F1	F3 – F1 (kip)
Average	(A) EISCR1	4.0	6.5	1.63	2.5	21.5	31.2	1.45	9.7
	(B) NISCR2	5.6	12.1	2.16	6.5	17.1	33.8	1.98	16.7
	(C) NISCR7	6.3	15.7	**2.49**	9.4	20.2	42.0	**2.08**	21.8
	(D) NISCR10	7.5	11.2	1.49	3.7	19.4	24.9	1.28	5.5
	(E) EICCR11	5.7	13.2	2.32	7.5	13.5	25.0	1.85	11.5
	(F) NICCR12	10.2	12.5	1.23	2.3	21.2	25.0	1.18	3.8
	(G) EICCR4	1.7	3.1	1.82	1.4	5.5	10.4	1.89	4.9
Maximum	(A) EISCR1	8.4	14.3	1.70	5.9	46.9	69.3	1.48	22.4
	(B) NISCR2	11.6	26.6	**2.29**	15.0	36.1	67.0	**1.86**	30.9
	(C) NISCR7	16	34	2.13	18.0	55.7	98.2	1.76	42.5
	(D) NISCR10	21.9	29.5	1.35	7.6	62.4	73.6	1.18	11.2
	(E) EICCR11	22.9	75.9	3.31	53.0	53.9	92.9	1.72	39.0
	(F) NICCR12	50.3	54.0	1.07	3.7	98.1	86.6	0.88	-11.5
	(G) EICCR4	7.3	10.9	1.49	3.6	22.1	35.3	1.60	13.2

The reasons for the behavior shown in Tables 12 and 13 are as follows:

- When SDLF or TDLF detailing is used, the CF geometry pulls the girders back further in the direction opposite from which they want to roll such that the girders are approximately plumb under SDL or TDL, respectively (this behavior is explained in detail previously in Section 3.1.2).
- Because TDLF detailing pulls the girders back further than SDLF detailing, TDLF detailing increases the CF member forces more than SDLF detailing. However, it appears from Tables 12 and 13 that the ratios for SDL/SDLF are about the same as the ratios for TDL/TDLF. That is, the increase in magnitude of the TDLF effects relative to the SDLF effects is roughly the same as the ratio of the TDL to the SDL.

- The majority of the critical intermediate CFs in the bridges summarized in Tables 12 and 13 are X-type. The primary nature of the SDLF and TDLF effects on the cross-frames is a shear-racking action as shown in Figure 65. The girders tend to stay relatively parallel to each other, as they are twisted in the opposite direction from the one they want to roll by the DLF actions. Therefore, the CF actions associated with the DLF effects are similar to those of a simply-supported beam subjected to equal end rotations and equal end moments. Figure 65a shows the statical relationships for an X-type CF of equal width/depth associated with this behavior. The CF is subjected to a shear force V and the corresponding couple forces at the cross-frame connections are $V/2$ on each side of the CF. The corresponding forces in the CF diagonals are shown by the dashed arrows. One can observe that the above external actions on the X-type CF are resisted without inducing any force in the CF top and bottom chords. Figure 65b shows the same behavior for an X-type CF that has a width/depth of two. It should be noted that this result does not extend to V or inverted-V type CFs. For these CF types, the chords also must resist forces due to the above actions. The CFs in Bridge (A) EISCR1 are V-type. From Tables 12 and 13, one can observe that the F2 – F1 for the chords is comparable to the F2 – F1 for the diagonals, corresponding to the SDLF actions. In addition, the F3 – F1 for the chords is comparable to the F3 – F1 for the diagonals, corresponding to the TDLF actions. However, the total chord forces are larger than the diagonal forces. Therefore, the DLF effects get washed out to some extent in the F2/F1 and F3/F1 ratios for the chords in Bridge (A) EISCR1.

In addition to the effect on the average and maximum CF member forces, it is useful to understand the frequency distribution of the changes in the CF member forces due to SDLF and TDLF detailing. Also, rather than consider the change normalized by the NLF member force, it is informative to evaluate the change normalized by the member yield load, which is an upper-bound estimate of the member load capacity. Figure 66 shows this frequency distribution for all the CF chords and Figure 67 shows this distribution for all the CF diagonals in Bridge (C) NISCR7. The horizontal axes in these plots correspond to sub-ranges of -12 to -10 %, -10 to -8 %, etc. The axis labels show the values at the middle of each sub-range. The change in the CF chord forces relative to the results from NLF RA, normalized by the member yield loads, is less than 0.6 % in all cases for TDLF and SDLF detailing. However, the increase in the CF diagonal forces is as large as 12.3 % for TDLF detailing and as large as 6.2 % for SDLF detailing.

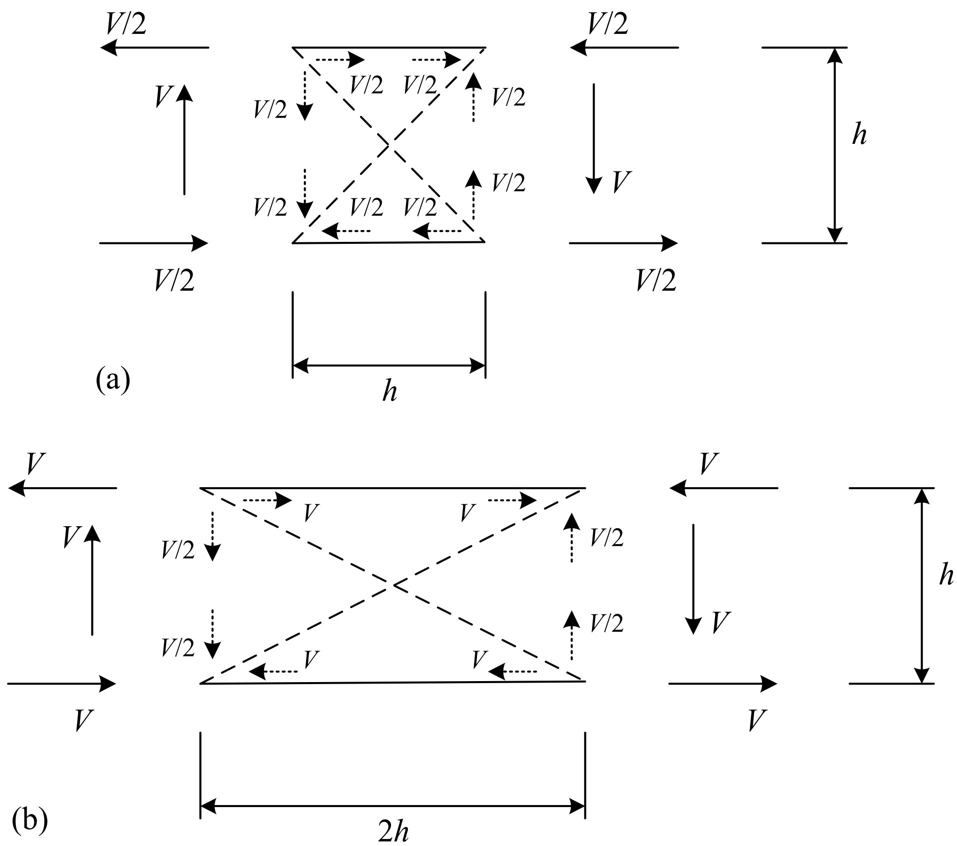


Figure 65. Statical behavior of X-type CFs associated with the DLF effects in horizontally-curved bridges.

Figure 68 shows the frequency distribution for all the CF chords and Figure 69 shows this distribution for all the CF diagonals in all the curved-radially supported bridges studied in this research. Table 14 shows a summary of the statistics for the percent change in the CF forces, normalized by the member yield load, due to SDLF or TDLF detailing in all the curved radially-supported bridges. From Tables 12 and 13, Figures 66 through 69, and similar figures of the frequency distribution of the CF forces for the other curved radially-supported bridges studied in this research (included in Appendices A to G), the following can be observed:

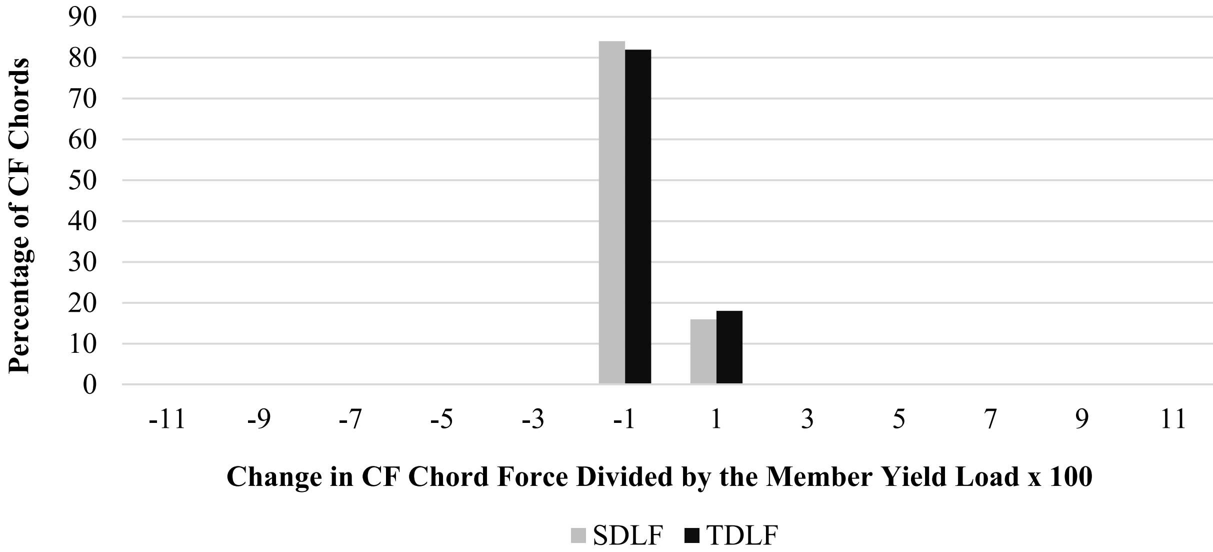


Figure 66. Frequency distribution for the change in the magnitude of the CF chord forces, normalized by the member yield load, due to SDLF or TDLF detailing in Bridge (C) NISCR7.

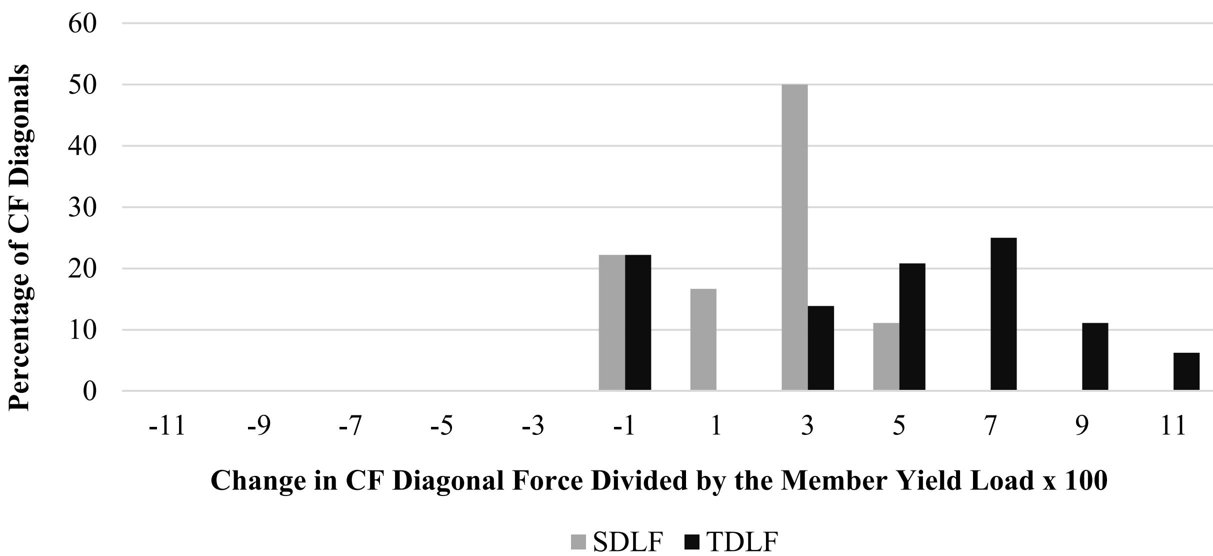


Figure 67. Frequency distribution for the change in the magnitude of the CF diagonal forces, normalized by the member yield load, due to SDLF or TDLF detailing in Bridge (C) NISCR7.

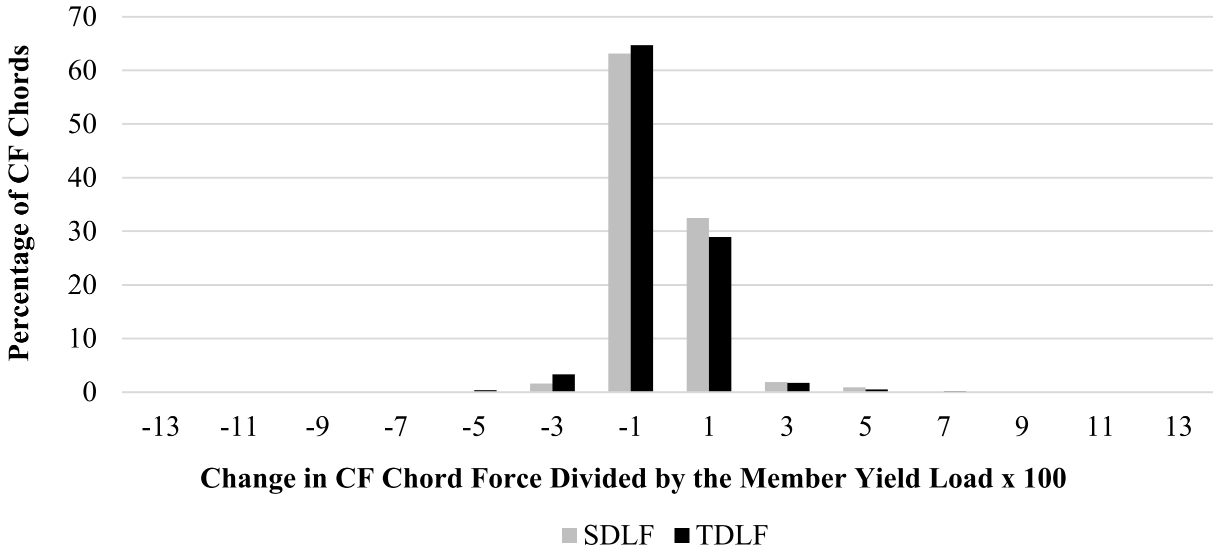


Figure 68. Frequency distribution for the change in the magnitude of the CF chord forces, relative to the member yield load, due to SDLF and TDLF detailing in all the curved-radially supported bridges studied in this research.

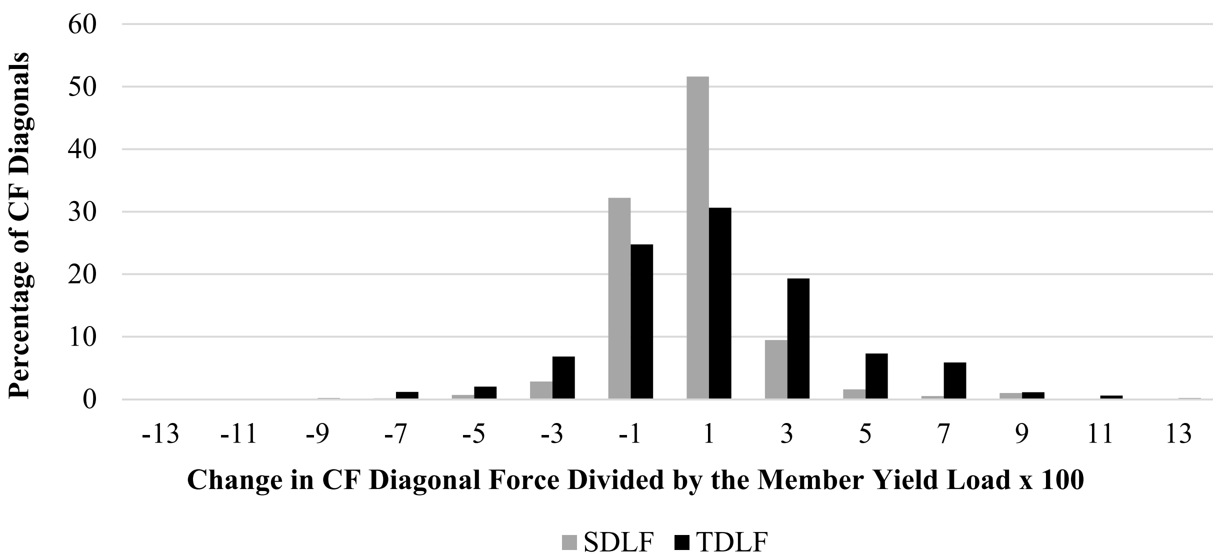


Figure 69. Frequency distribution for the change in the magnitude of the CF diagonal forces, relative to the member yield load, due to SDLF or TDLF detailing in all the curved-radially supported bridges.

- SDLF and TDLF detailing have a wide range of effects on the individual CF member forces. However, the force effects from SDLF and TDLF detailing are relatively small compared to the member yield loads in the all the curved radially-supported bridges studied.
- SDLF and TDLF detailing tend to increase the CF member forces in general, especially the diagonal forces.
- The largest percentage increase in any individual CF member force, normalized by the member yield load, is 9.5 and 12.9 % for SDLF and TDLF detailing, respectively (these results are 5.1 and 12.3 % excluding Bridge (E) EICCR11).

Table 14. Summary statistics for the percent change in the magnitude of the CF forces divided by the member yield load (i.e., change in member force divided by the member yield load x 100), due to SDLF or TDLF detailing, summed over all the curved-radially supported bridges.

	Chords		*Diagonals*	
	SDLF	*TDLF*	*SDLF*	*TDLF*
Average	*-0.09*	*-0.22*	*0.54*	*1.16*
Median	*-0.06*	*-0.17*	*0.35*	*0.95*
Max	*5.15*	*10.2*	*9.52*	*12.9*
Min	*-4.10*	*-11.1*	*-7.02*	*-12.9*
COV	*-1.97*	*-2.97*	*4.22*	*9.14*

The following should be noted regarding the tables and figures presented above as well as in subsequent sections presenting CF forces for other groups of completed bridges:

- The results are presented as the magnitude (absolute value) of the CF forces.
- The average CF member forces and the maximum CF member force in each bridge are useful to understand the broad trends in the behavior; however, these results do not capture the detailed variations in the CF forces throughout the bridge system due to DLF detailing.
- In many of the cases for the bridges considered in this research, the location of the maximum CF force can change substantially as a function of the DLF detailing.
- The frequency distribution plots provide specific insight into the number of individual CF chords and diagonals that are significantly affected by the DLF detailing.

- The changes in the CF chord and diagonal member forces are normalized by the member yield load for the frequency distribution plots since:
  - If the changes are normalized relative to the NLF force, the percentage changes can be very large in situations where the NLF CF member force is small.
  - If the changes are not normalized at all and are presented as absolute forces in kip, the results are skewed by the size of the bridge.
  - By normalizing by the member yield load, the results are skewed by any conservatism in the design of the CF members; however, the bridge designs utilized in this research are based on representative current design practices.

Based on the above, results, it would appear that a potential coarse approximation of the SDLF and TDLF effects on the CF members in curved radially-supported bridges is to scale the CF SDL forces by a factor of 2.0 to account for SDLF effects and to scale the CF TDL forces also by a factor of 2.0 to account for TDLF effects, with the exception that the chord forces do not need to be scaled for X-type CFs. For Bridge (B) NISCR2, Figures 3-72 through 3-77 of the NCHRP 725 report show that relative to the NLF SDLF, SDLF increases the diagonal forces by 2x, and relative to the NLF TDL forces, TDLF increase the diagonal forces by 2x. These figures of the NCHRP 725 report show that DLF detailing has little influence on the chord forces in this bridge. Therefore, the above findings are consistent with the targeted studies on Bridge (B) NISCR2 presented in the NCHRP 725 report.

In addition to the above results, it is useful to gain a more detailed perspective of how the specific CF forces are impacted by the SDLF and TDLF detailing effects. Figures 70 through 75 are intended to provide this perspective by plotting all the CF forces in Bridge (C) NISCR7, which is the most critical case identified in Table 13, in a highly synthesized manner. The basic plan for this bridge is shown in Figure 3 of Section 2.2.1. It should be noted that the CFs are all X-type in this bridge. Figures 70 and 71 show the gold standard DLF RA calculation of the CF forces in this bridge under the SDL and TDL. These calculations include the locked-in forces from SDLF and TDLF, respectively. The vertical axis of these plots is the axial force magnitude in kip. The horizontal axis corresponds to the CF number or identifier. The CF identifiers are not shown on the horizontal axis since generally, the number of CFs is too large to do so. The CFs are numbered starting with the bearing line CF in the bay between Girders G1 and G2 at bottom left corner of the bridge plan (Figure 3) and progressing along the length of the bridge to the CF on the opposite bearing line. The numbering then continues from left to right in the second bay between girders G2 and G3, then the third bay, on so on.

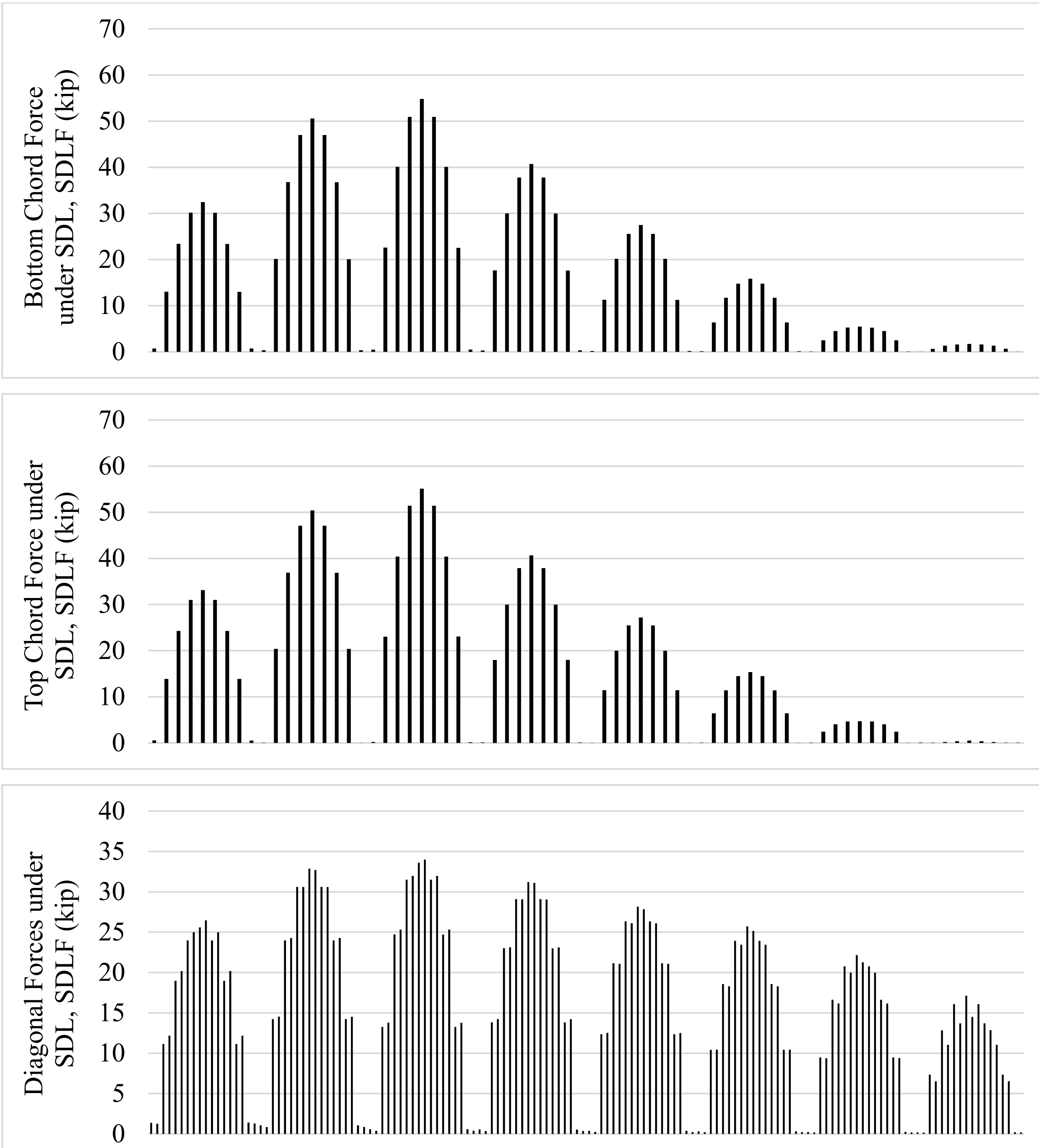


Figure 70. Magnitude of CF member forces from DLF RA, Bridge (C) NISCR7 under SDL, SDLF detailing.

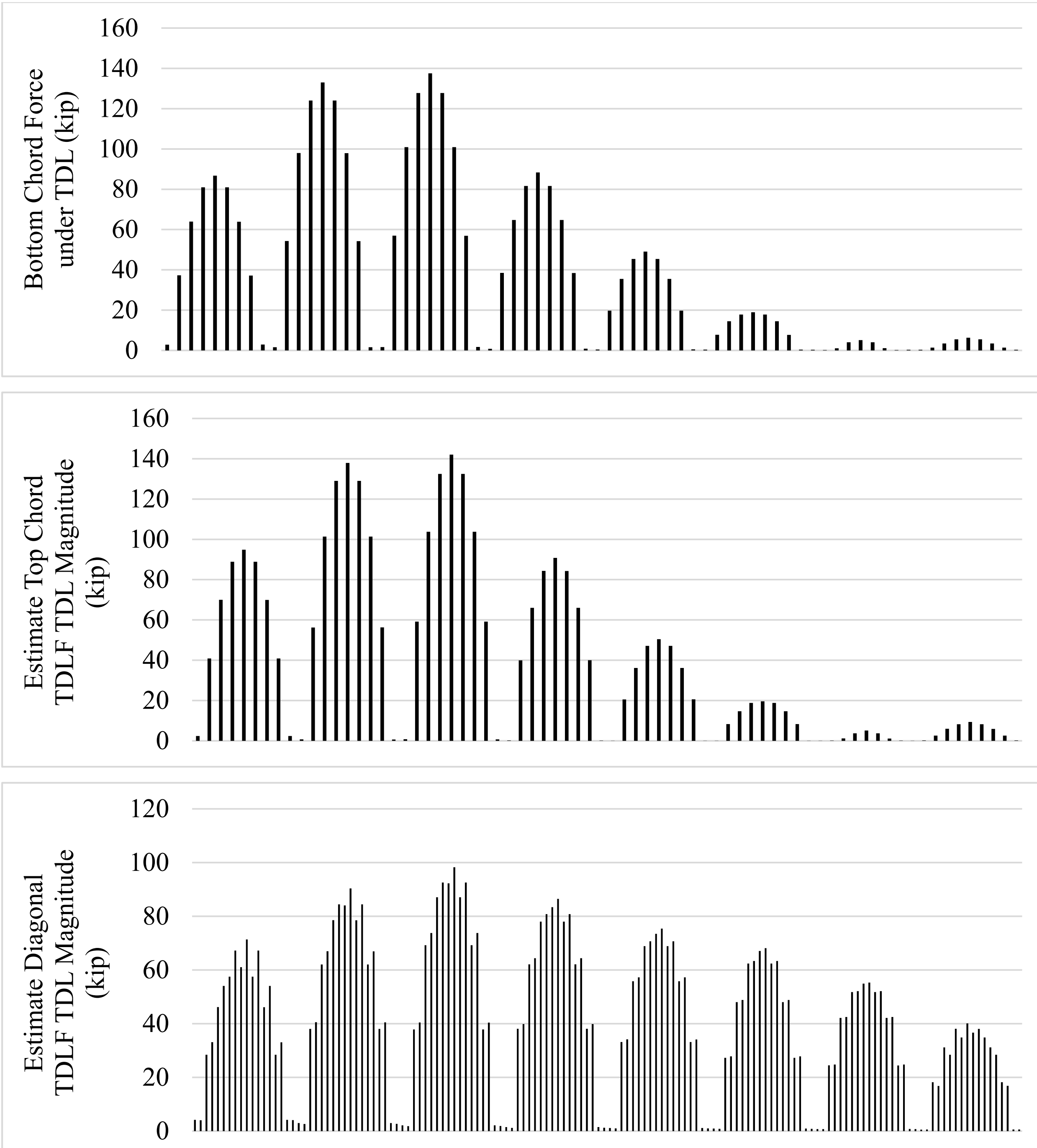


Figure 71. Magnitude of CF member forces from DLF RA, Bridge (C) NISCR7 under TDL, TDLF detailing.

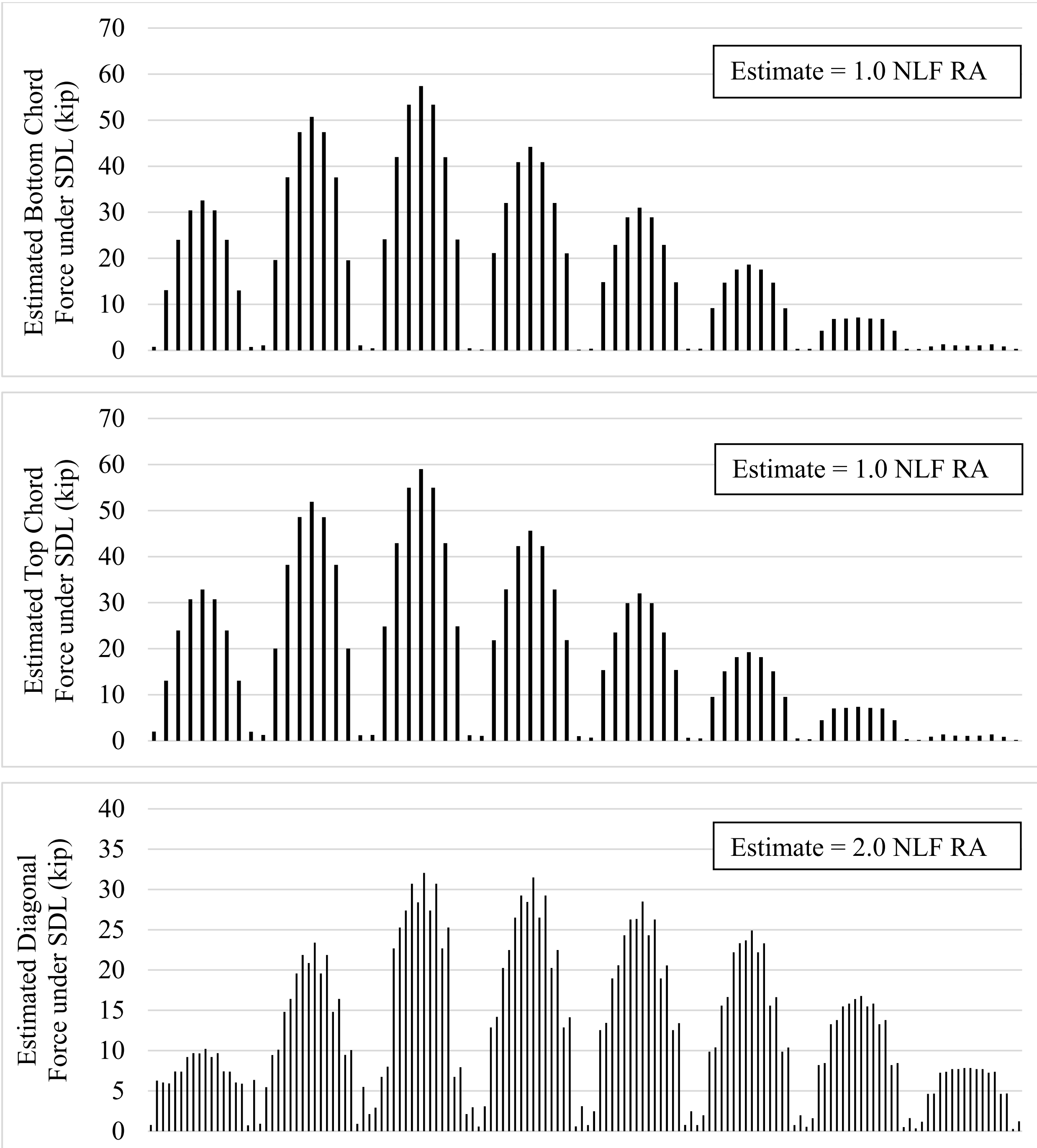


Figure 72. Estimated magnitude of CF member forces based on scaling of NLF RA results, assuming SDLF detailing, Bridge (C) NISCR7 under SDL.

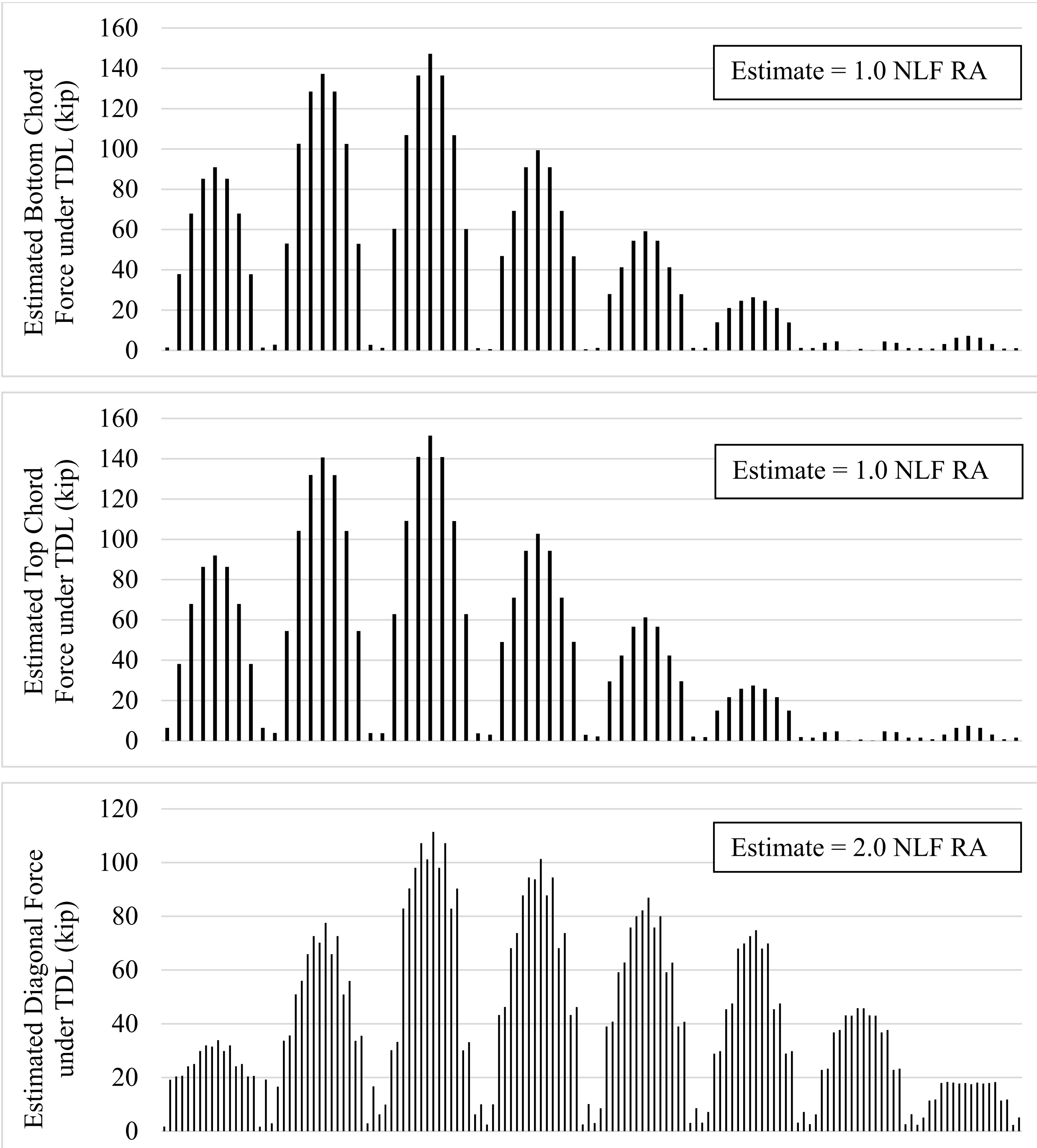


Figure 73. Estimated magnitude of CF member forces based on scaling of NLF RA results, assuming TDLF detailing, Bridge (C) NISCR7 under TDL.

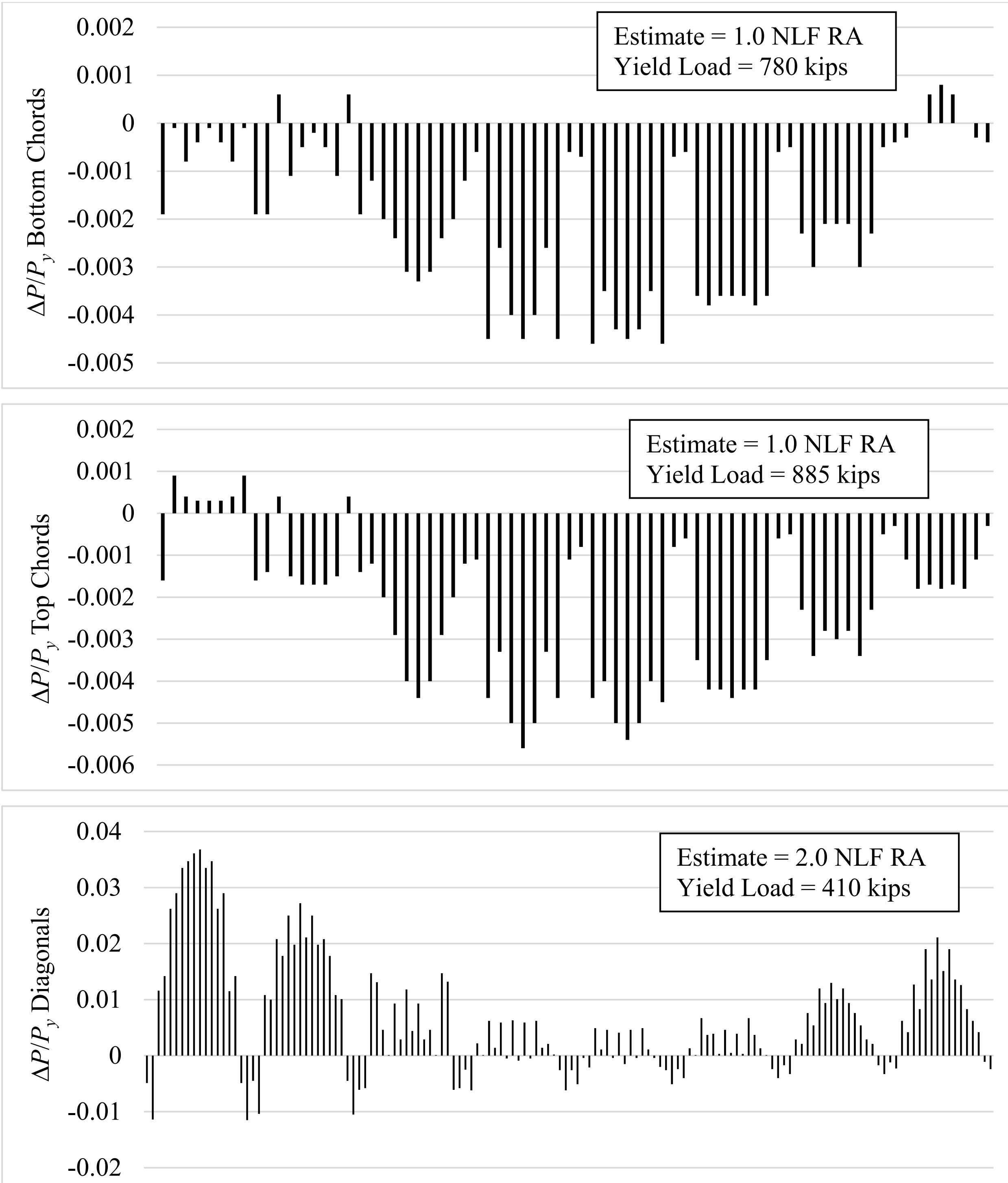


Figure 74. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (C) NISCR7 under SDL, SDLF detailing.

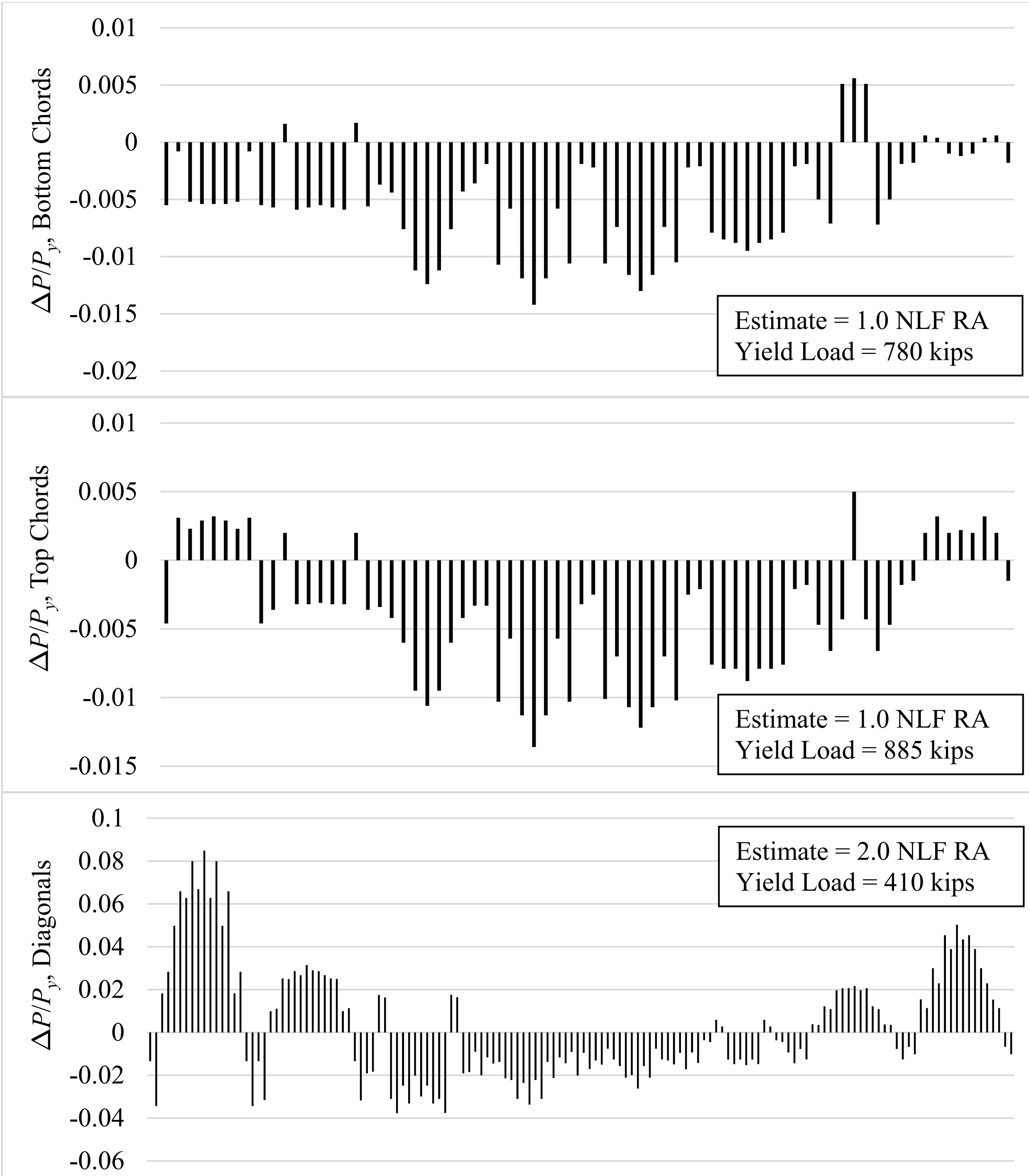


Figure 75. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_Y$), Bridge (C) NISCR7 under TDL, TDLF detailing.

Given the above ordering of the CFs, one can observe that the vertical bars in Figure 70 are arranged in eight groups. Each group corresponds to a different bay between the girders. The first group corresponds to the CFs in the bay between Girders G1 and G2 on the outside of the curve, the second group corresponds to the second bay between Girders G2 and G3, etc. The TDL/TDLF results in Figure 71 have a very similar pattern to the SDL/SDLF results in Figure 70; however, the TDL/TDLF forces in Figure 71 are generally larger.

One can observe from Figures 70 and 71 that the largest CF forces in this relatively wide curved radially-supported bridge are at the middle of the span and in bay 3 between Girders G3 and G4. The maximum chord forces are 55.1 kip for SDL/SDLF in Figure 70 and 151.5 kip for TDL/TDLF in Figure 71. These values are also reported in Table 12 for Bridge (C) NISCR7. The maximum diagonal forces are 34.0 and 98.2 kip for SDL/SDLF and TDL/TDLF in these figures, which are reported in Table 13 for Bridge (C). The fact that the cross-frame forces are not maximum in the bay on the outside of the curve is consistent with estimates that can be generated using the V-load Method (Richardson, Gordon and Associates 1963). However, the detailed variation of the CF forces across the width of the bridge depends on the elasticity of the bridge system.

Figures 72 and 73 show the approximation of the SDL/SDLF and TDL/TDLF CF forces suggested at the conclusion of the above discussion of Table 14. By comparing the top two plots of these figures to the corresponding plots in Figures 70 and 71, one can observe that taking the unscaled results from a NLF RA, which does not include the lack-of-fit associated with the DLF detailing, gives a reasonable approximation of the chord forces from the DLF RA. Furthermore, by comparing the bottom plots in Figures 72 and 73 to the corresponding plots in Figures 70 and 71, on can observe that the maximum diagonal forces are predicted reasonably well by scaling the NLF RA forces by a factor of 2.0. The maximum diagonal force estimate for SDL/SDLF in Figure 72 is 32.0 kip versus a force of 34.0 kip from the DLF RA in Figure 70 and the maximum diagonal force estimate for TDL/TDLF in Figure 73 is 111.4 kip versus 98.2 kip from the DLF RA in Figure 71. However, the actual maximum forces particularly in bay 1 and in bay 8 are somewhat underestimated. For instance, in bay 1, the maximum force estimate for SDL/SDLF is 10 kip in Figure 72 whereas the corresponding maximum force from the DLF RA is 26 kip in Figure 70. This under-estimate of the diagonal forces in bay 1 is not a problem if a single section is selected for all of the different CF diagonals, which is often the case in design. That is, a significant amount of repetition in CF member sizes would be expected throughout the bridge.

Figures 74 and 75 show the differences between the CF forces from DLF RA and the above coarse estimates obtained by scaling the diagonal forces from NLF RA by the factor 2.0, ΔP, divided by the yield load for all the members, P_y. The yield load for each of the chords and for the diagonals is reported in these figures. One can observe that the largest under-prediction of the DLF RA results for the chords is approximately $0.001P_y$ for SDL/SDLF and $0.005P_y$ for TDL/TDLF, whereas the largest over-prediction is approximately $-0.0055P_y$ for SDL/SDLF and $-0.014P_y$ for TDL/TDLF. For the diagonals, the results are less conservative, with the largest under-prediction of the DLF/RA results being $0.036P_y$ for SDL/SDLF and $0.081P_y$ for TDL/TDLF and the largest over-prediction being $-0.011P_y$ for SDL/SDLF and $-0.039P_y$ for TDL/TLDF.

Figures 76 and 77 show the $\Delta P/P_y$ results for the above NLF RA estimate of the DLF RA results for SDL/SDLF and TDL/TLDF in Bridge (B) NISCR2, Figures 78 and 79 show the corresponding results for Bridge (F) NICCR12, and Figures 80 and 81 show the corresponding results for Bridge (G) EICCR4. The largest under-predictions for Bridge (F) are $0.023P_y$ for the chords and SDL/SDLF and $0.029P_y$ for the diagonals, although this bridge has the smallest F2/F1 values of the bridges presented in Table 13.

In summary, it is found that the suggested estimate of 2x the CF forces from NLF RA, with the exception that the chord forces in X-type CFs do not need to be scaled, limits the under-prediction to close to $0.05P_y$ for SDL/SDLF and less than $0.10P_y$ in all the bridges studied for TDL/TDLF.

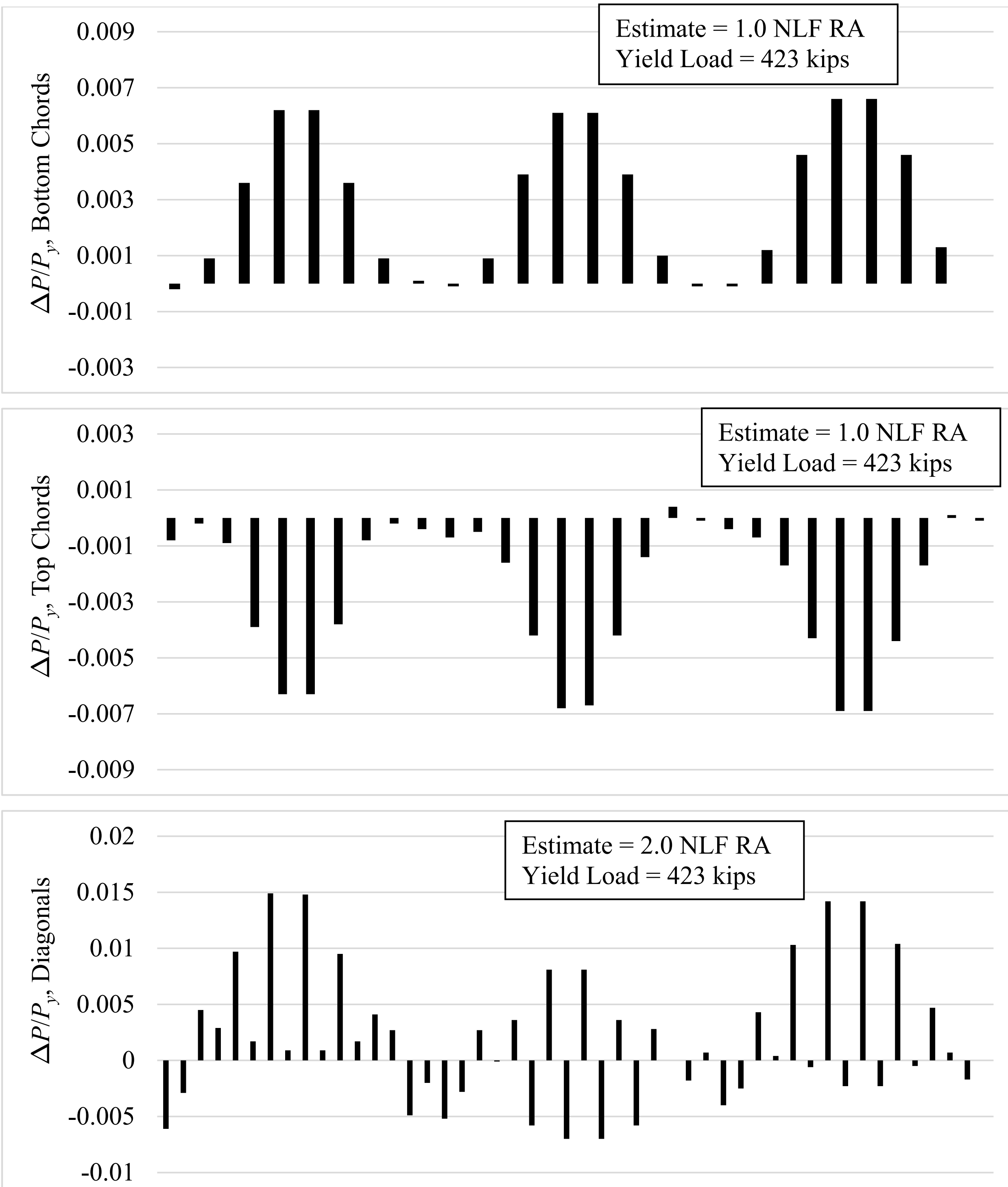


Figure 76. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (B) NISCR2 under SDL, SDLF detailing.

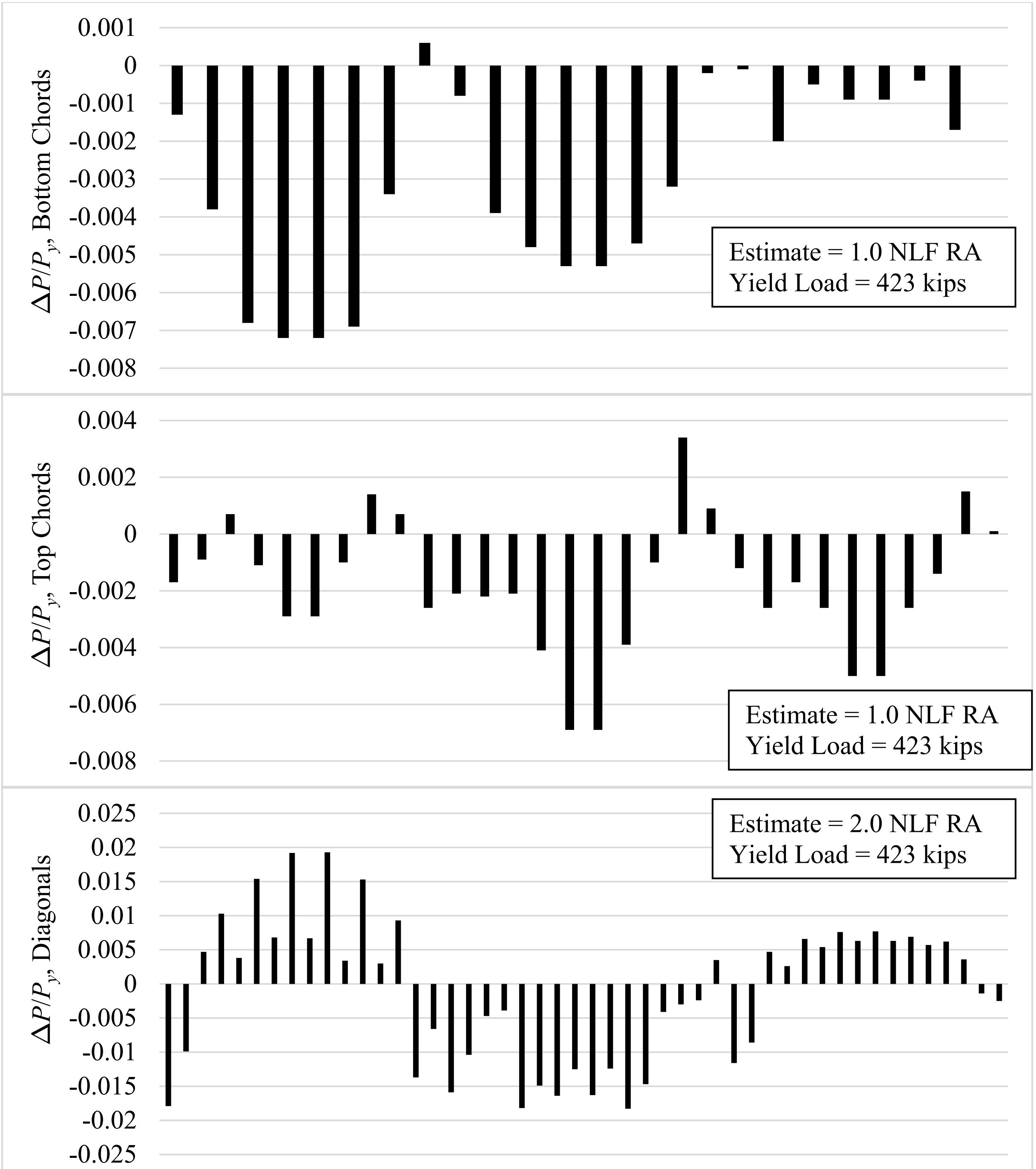


Figure 77. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_Y$), Bridge (B) NISCR2 under TDL, TDLF detailing.

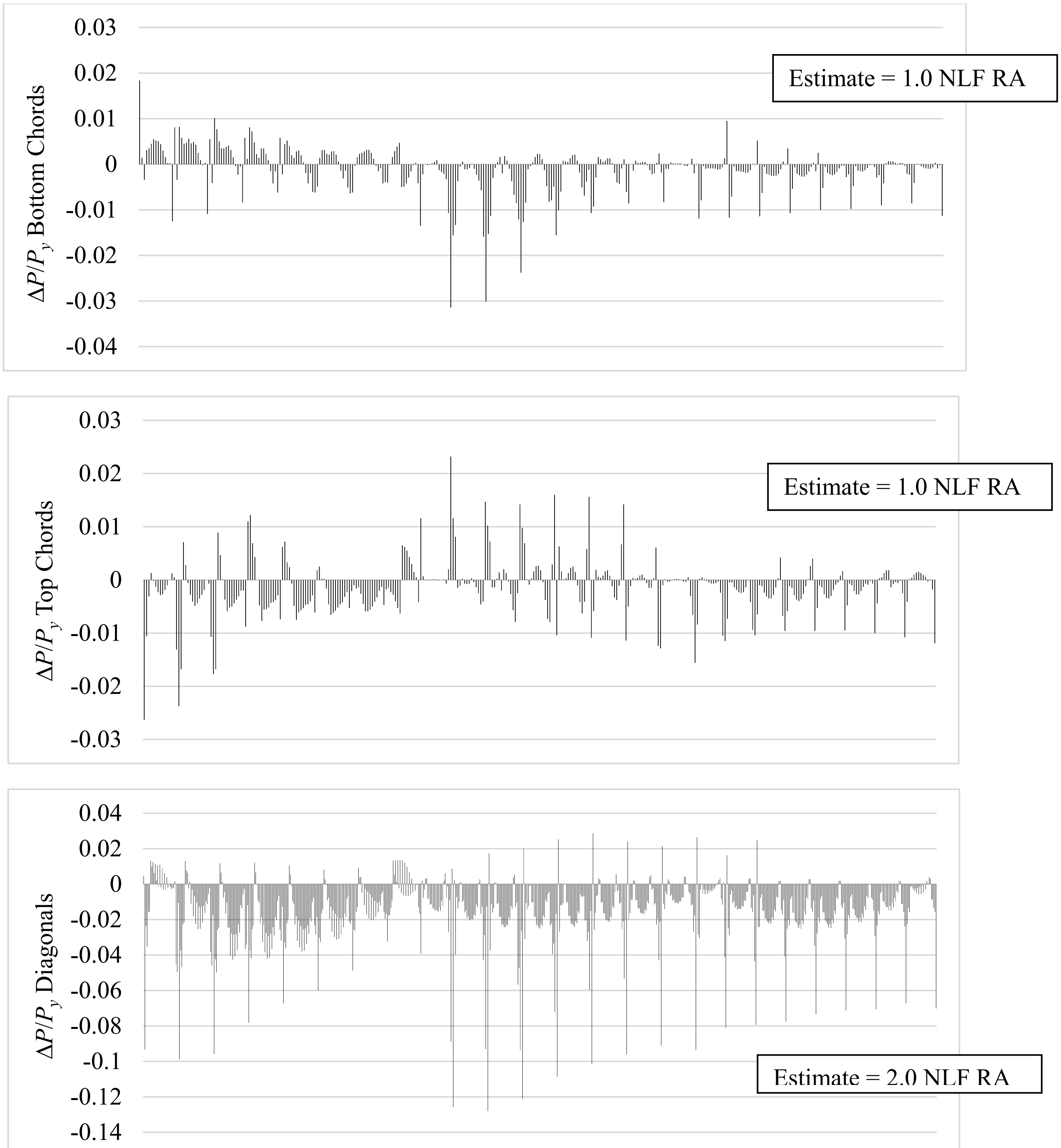


Figure 78. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (F) EICCR4 under SDL, SDLF detailing.

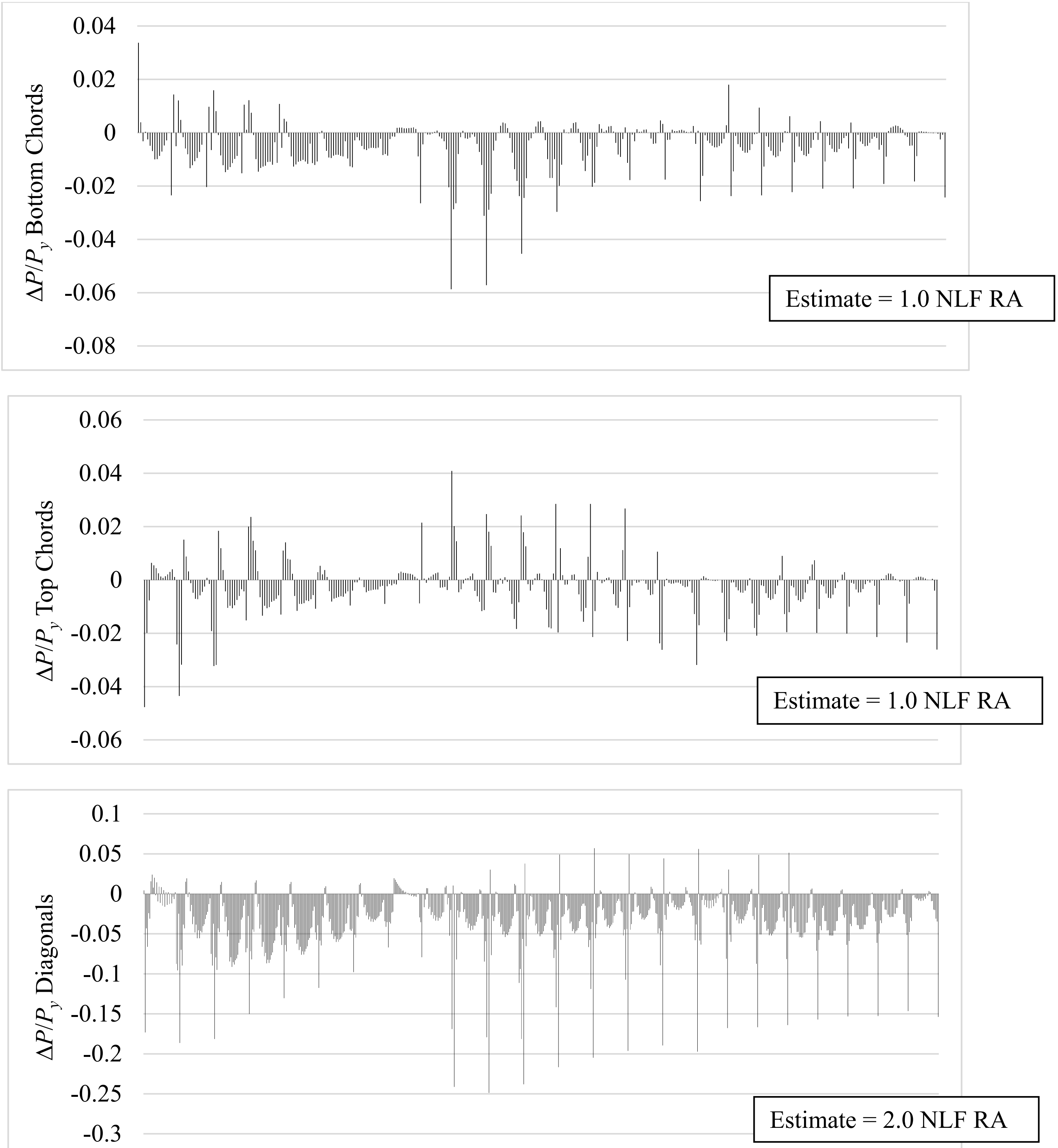


Figure 79. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (F) EICCR4 under TDL, TDLF detailing.

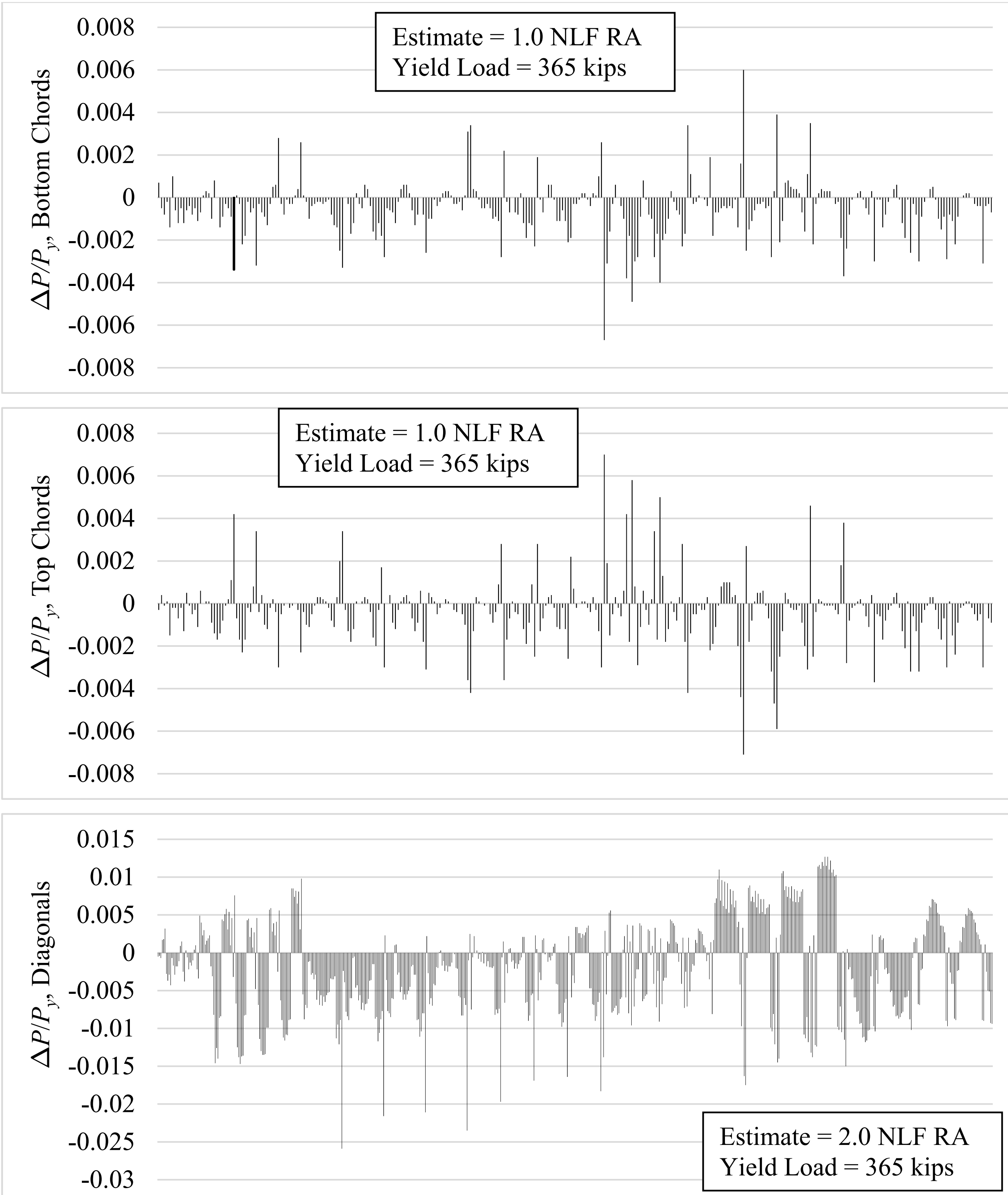


Figure 80. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (G) EICCR4 under SDL, SDLF detailing.

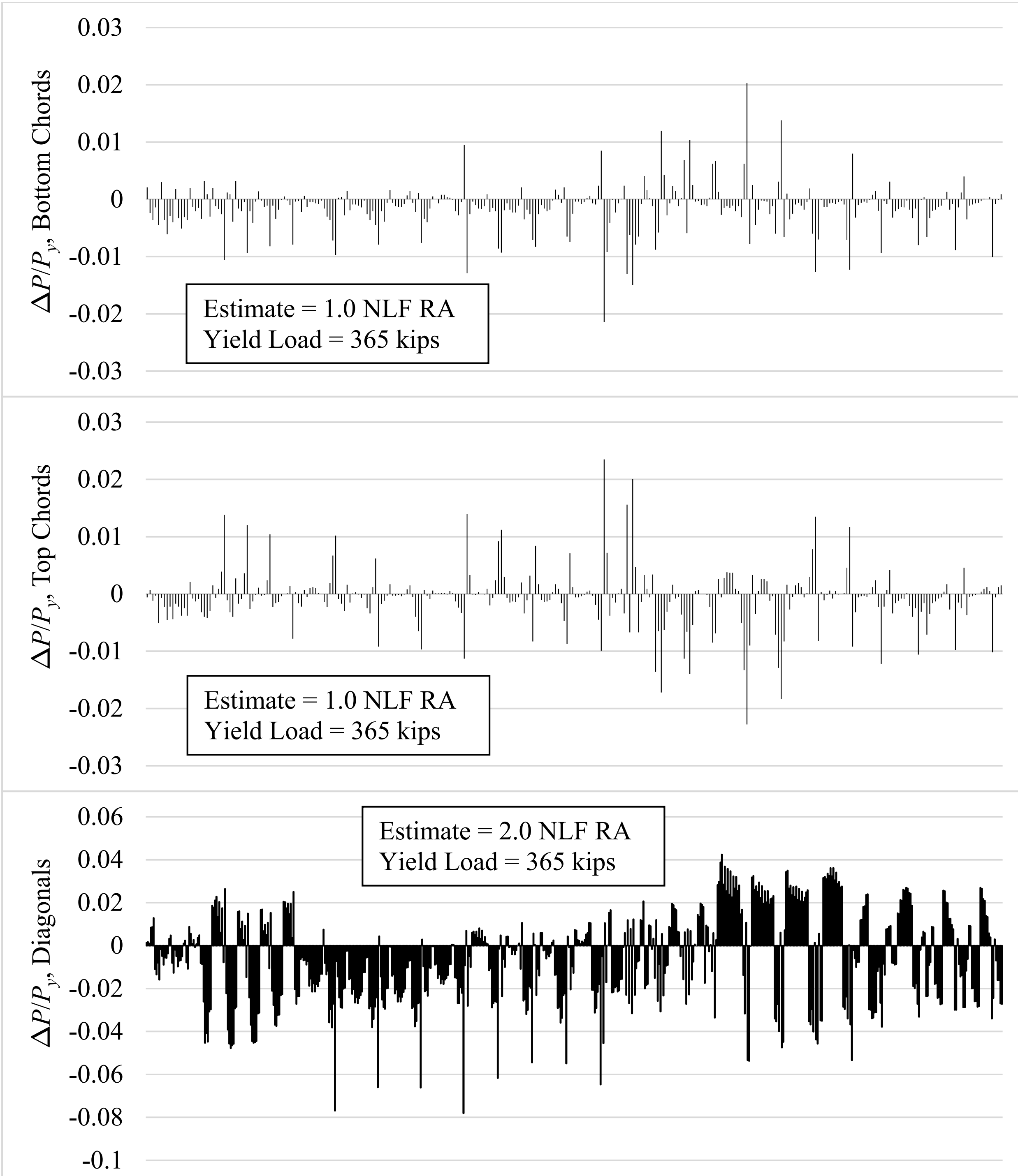


Figure 81. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (G) EICCR4 under TDL, TDLF detailing.

3.4.5.1.5 Girder Stresses

The SDLF and TDLF detailing effects tend to increase the maximum girder major-axis bending and flange lateral bending stresses in curved radially-supported bridges. However, the increase in the major-axis bending stress tends to be insignificant, and the increase in the flange lateral bending stress is relatively small. Figures 82 and 83 show a typical result, taken from Bridge (C) NISCR7, and Table 15 gives a summary of the results for the curved radially-supported bridge cases studied in this research. From Table 15, the largest increase in the maximum girder major-axis bending stresses 31 % under the SDL for SDLF detailing and 10 % under the TDL for TDLF detailing. The governing case for SDL/SDLF is the fascia girder on the inside of the curve in Bridge (C) NISCR7 and the governing case for TDL/TDLF is the fascia girder on the inside of the curve in Bridge (B) NISCR2 (it should be noted that the plots in Figure 82 correspond to the girder on the outside of the curve in Bridge (C)). It can be observed that the increase for TDL/TDLF on Bridge (C), for the girder on the inside of the curve, is only 1.08. The corresponding increase under the TDL for SDLF (not shown in the table) is 1.05. The largest increase in f_b in the girder on the outside of the curve is only 1.02 under the TDL for SDLF. The above 31 % increase for SDL/SDLF is largely due to the fact that the value of the maximum f_b for the girder on the inside of the curve is very small, only 1.3 ksi, for Bridge (C) NISCR7. Therefore, it can be argued that, based on the minor increase in the major-axis bending stresses under the TDL for SDLF, the influence of SDLF on the major-axis bending stresses may be neglected.

The maximum increases in the TDL maximum flange lateral bending stresses relative to NLF detailing are 25 % under the SDL for SDLF detailing and 22 % under the TDL for TDLF detailing. Furthermore, the increase in the flange lateral bending stress is close to 20 % both for SDL/SDLF and TDL/TDLF for a large number of the bridges and on the fascia girders both on the inside and the outside of the curve. These flange lateral bending stresses tend to come from the significant overall bridge cross-section twist rotations in these types of bridges. The behavior is analogous to support settlement on a continuous-span beam subjected to transverse load. If one considers the girder flanges as effective continuous-span beams in their lateral bending direction, spanning across the CF locations, these effective beams in essence experience some “support settlement” at the CF locations due to the overall twisting of the structure in relatively narrow, tightly curved bridges.

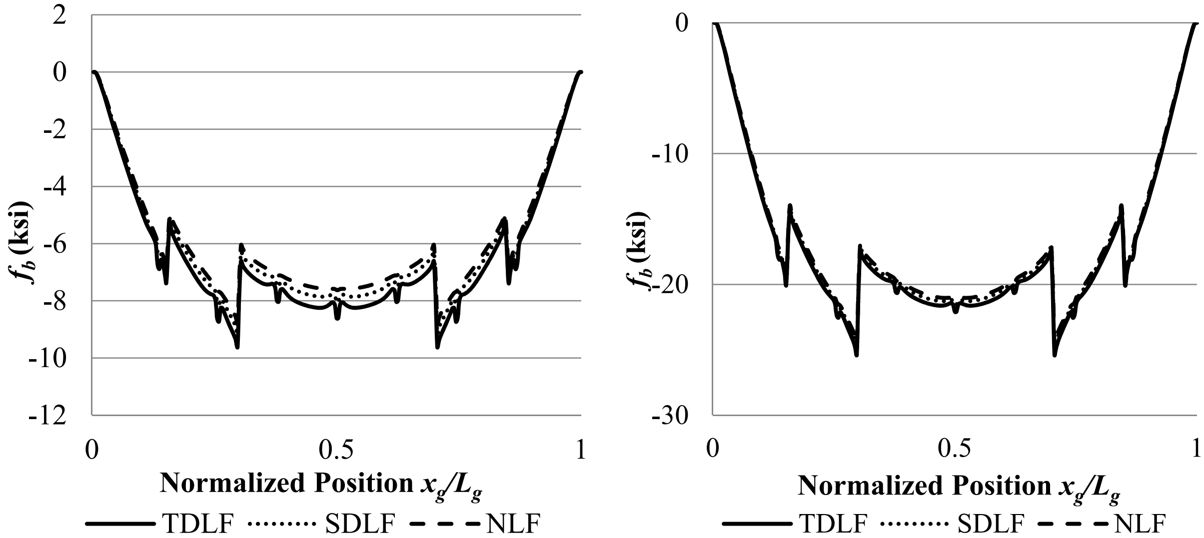


Figure 82. SDL (left) and TDL (right) top flange major-axis bending stresses in the girder on the outside for Bridge (C) NISCR7.

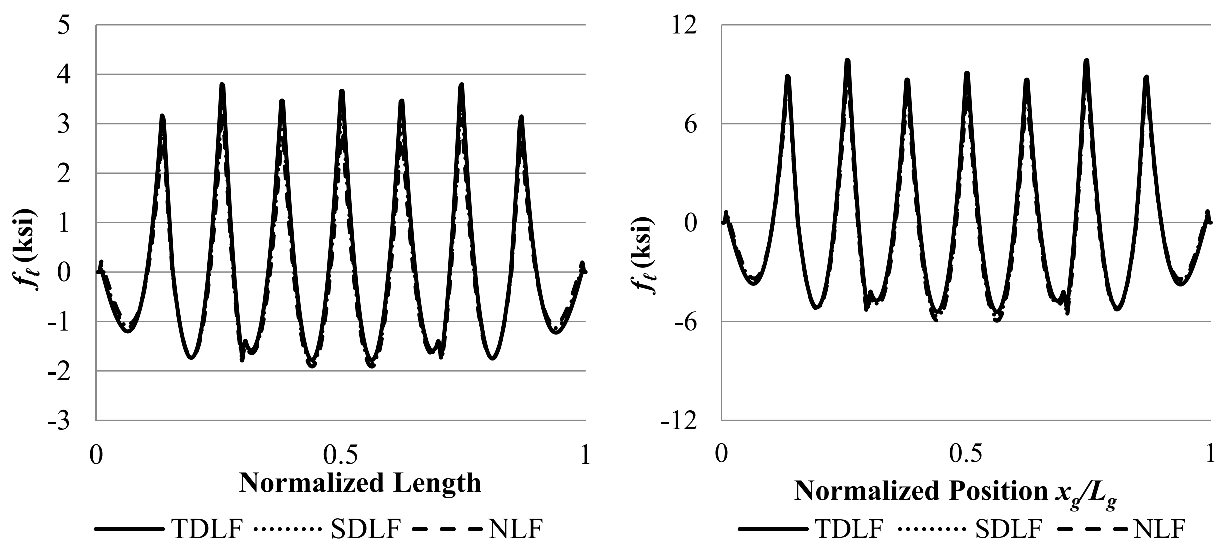


Figure 83. SDL (left and) TDL (right) top flange lateral bending stresses in the girder on the outside for Bridge (C) NISCR7.

Table 15. Maximum magnitudes of major-axis bending stresses and top flange lateral bending stresses in the girder on the outside and inside of the curve in the curved radially-supported bridges studied in this research (f_{b1}, f_{b2} and f_{b3} are the maximum major-axis bending stresses, and $f_{\ell 1}$, $f_{\ell 2}$ and $f_{\ell 3}$ are the maximum girder flange lateral bending stresses for NLF, SDLF, and TDLF detailing, respectively; the largest f_{b2}/f_{b1}, $f_{\ell 2}/f_{\ell 1}$ under SDL for SDLF and f_{b3}/f_{b1} and $f_{\ell 3}/f_{\ell 1}$ under TDL for TDLF are highlighted by dark shading).

		SDL						**TDL**					
		NLF		**SDLF**				**NLF**		**TDLF**			
Girder	**Bridge**	f_{b1} **(ksi)**	$f_{\ell 1}$ **(ksi)**	f_{b2} **(ksi)**	$\frac{f_{b2}}{f_{b1}}$	$f_{\ell 2}$ **(ksi)**	$\frac{f_{\ell 2}}{f_{\ell 1}}$	f_{b1} **(ksi)**	$f_{\ell 1}$ **(ksi)**	f_{b3} **(ksi)**	$\frac{f_{b3}}{f_{b1}}$	$f_{\ell 3}$ **(ksi)**	$\frac{f_{\ell 3}}{f_{\ell 1}}$
Outside Girder	(A) EISCR1	4.4	2.7	4.5	1.02	3.1	1.15	21.2	12.8	21.2	1.00	15.4	1.20
	(B) NISCR2	8.3	2.2	8.3	1.00	2.7	1.23	23.4	7.7	23.2	0.99	7.9	1.03
	(C) NISCR7	8.8	3.1	9.1	1.03	3.4	1.10	24.6	8.9	25.4	1.03	9.9	1.11
	(D) NISCR10	11.2	2.0	11.2	1.00	2.0	1.00	26.1	4.9	26.1	1.00	4.9	1.00
	(E) EICCR11	13.6	2.7	15.1	1.11	2.5	0.93	28.8	6.2	29.3	1.02	5.3	0.85
	(F) NICCR12	12.0	1.9	12.5	1.04	1.6	0.84	23.1	4.8	23.8	1.03	3.3	0.69
	(G) EICCR4	6.7	1.2	6.8	1.01	1.3	1.08	21.6	5.0	21.9	1.01	5.1	1.02
Inside Girder	(A) EISCR1	0.3	0.4	0.3	1.00	0.5	**1.25**	5.3	4.7	5.6	1.06	5.7	1.21
	(B) NISCR2	0.5	0.6	0.5	1.00	0.2	0.33	2.9	3.0	3.2	**1.10**	0.7	0.23
	(C) NISCR7	1.3	0.6	1.7	**1.31**	0.7	1.17	8.7	3.4	9.4	1.08	4.1	1.21
	(D) NISCR10	4.9	1.2	4.9	1.00	1.4	1.17	17.1	4.3	17.2	1.01	4.9	1.14
	(E) EICCR11	9.2	1.9	10.0	1.09	1.0	0.53	26.3	5.3	27.7	1.05	1.9	0.36
	(F) NICCR12	7.4	1.1	7.0	0.95	0.8	0.73	16.1	3.4	15.2	0.94	1.5	0.44
	(G) EICCR4	4.9	0.8	4.8	0.98	0.9	1.13	16.9	1.8	16.6	0.98	2.2	**1.22**

3.4.5.1.6 Vertical Reactions

In simply-supported curved radially-supported bridges, the loads tend to shift from the inside to the outside of the curve in the bridge cross-section due to the curvature effects, resulting in higher vertical reactions in the outside girders and lower vertical reactions in the inside girders (see Table 16 for example results from Bridge (C) NISCR7). This is not always the case in continuous-span curved radially-supported bridges, particularly for the interior pier reactions on the girders toward the inside of the curve.

For Bridge (C) NISCR7, the vertical reactions are approximately the same at each bearing for each of the girders due to the bridge symmetry about the CF line at the mid-span. With NLF detailing, the vertical reactions under TDL are 227 kip for Girder 1, the outside girder, and 60 kip for Girder 9, the inside girder. With the exception of one case at the completion of the steel erection and the removal of temporary in Bridge (E) EICCR11, uplift was not encountered for any of the curved radially-supported studied in this research. Although the bridges studied in this research have relatively extreme geometries, their proper design for combined dead and live load is such that uplift is not encountered under the dead load conditions. Avoiding uplift at the bearings tends to be more of a problem for sharply skewed bridges and in certain cases where sharp skew is combined with a tight horizontal curve. These types of cases are discussed subsequently.

SDLF and TDLF detailing effects twist the girders in the direction opposite to the direction the girders tend to roll under the DL. These effects tend to increase the reactions on both the inside and outside fascia girders of Bridge (C) NISCR7. This is due to the complex elastic interactions of the structural system with the lack-of-fit displacements in resolving the initial lack-of-fit (i.e., the resistance of the bridge to the enforcement of compatibility between the CFs and the girders). For Bridge (C), the reactions on Girder 1, on the outside of the curve, are increased by 3 kip under the SDL for SDLF and 5 kip under the TDL for TDLF. The reactions for Girder 9, on the inside of the curve, are increased by 2 kip under the SDL for SDLF and by 4 kip under the TDL due to TDLF detailing. However, the reactions on Girder 4, an interior girder, are decreased by 3 kip under the SDL for SDLF and 7 kip under the TDL due to TDLF detailing. The total net change in vertical reactions at all bearings is zero when SDLF or TDLF detailing is employed, since DLF detailing does not add or subtract any vertical load from the bridge.

Table 16. Bridge (C) NISCR7 vertical reactions (kip) (G1 and G9 are the outside girder and the inside girder of the curve, respectively).

Girder	Detailing Method	SDL Support 1	SDL Support 2	TDL Support 1	TDL Support 2
G1	NLF	79	79	227	227
	SDLF	82	82	229	229
	TDLF	85	85	232	232
G2	NLF	72	73	212	212
	SDLF	73	73	212	212
	TDLF	73	73	212	212
G3	NLF	65	65	198	198
	SDLF	65	65	197	197
	TDLF	65	65	197	197
G4	NLF	38	38	120	120
	SDLF	35	35	117	117
	TDLF	31	31	113	113
G5	NLF	32	32	109	109
	SDLF	31	31	107	107
	TDLF	29	29	106	106
G6	NLF	29	29	102	101
	SDLF	28	28	101	101
	TDLF	27	27	100	100
G7	NLF	23	23	85	85
	SDLF	22	22	85	85
	TDLF	22	22	85	85
G8	NLF	18	18	76	76
	SDLF	19	19	76	76
	TDLF	20	20	77	77
G9	NLF	11	11	60	60
	SDLF	13	13	62	62
	TDLF	15	15	64	64

Considering the entire suite of curved radially-supported bridges studied in this research, the results presented in the Appendices show that SDLF and TDLF detailing generally tend to increase the smaller DL reactions on the girders toward the inside of the curve. This is related to the overall nature of the DLF effects in that they tend to twist the girders in the opposite direction from the one they want to roll. Therefore, as an approximate estimate for simply-supported bridges, if uplift is not encountered at any of the bearings in a NLF RA, it should be sufficient to assume that uplift will not be a problem in the bridge if it is detailed for SDLF or TDLF. For the continuous-span cases, the influence of the geometry and the overall compliance of the structure on the NLF reactions as well as the influence of SDLF or TDLF on these reactions is more complex. In these cases, if uplift at any of the bearings is a concern, it may be useful to conduct a DLF RA. Nevertheless, as discussed below, even for the relatively extreme bridge geometries studied in this research, the influence of SDLF and TDLF on the reactions is relatively small.

From Table 17, it can be observed that the largest increase in any of the reactions is 17 % for SDL/SDLF and 9 % for TDL/TDLF detailing for the curved radially-supported bridges studied in this research. However, the 17 % increase is actually only 2 kip, at one of the bearings on Bridge (C) NISCR7 where the DL reaction is relatively small. The next largest increase in any of the reactions under SDL due to SDLF is 6 %.

Table 17. Summary of maximum percentage increase in the vertical reaction at each of the girder bearings due to SDLF and TDLF detailing in the curved radially-supported bridges (The largest percentage increases by SDLF and TDLF detailing are highlighted by dark shading).

Bridge	**SDLF under SDL**	**TDLF under TDL**
(A) EISCR1	5	4
(B) NISCR2	5	8
(C) NISCR7	**17 (2 kip)**	7
(D) NISCR10	6	5
(E) EICCR11	6	**9 (70 kip)**
(F) NICCR12	4	7
(G) EICCR4	1	2

3.4.5.2 Summary and Recommendations – Curved Radially-Supported Bridges with Cambers Set Based on NLF RA

The influence of SDLF and TDLF detailing on the responses in completed curved radially-supported bridge systems may be summarized as follows. Recommendations pertaining to these quantitative results are highlighted in bold italicized text.

Girder Elevations

- With the exception of the Ford City bridge (Bridge (E) EICCR11), which is significantly more extreme than the other bridges considered, the deviations from the targeted elevations are small (less than or equal to 2.1 inches for TLDF detailing) for all the curved radially-supported bridges studied in this research, based on the use of NLF RA.
- The above maximum deviation from the targeted girder elevations is due to the lack of consideration of the lack-of-fit from the DLF detailing in a NLF RA.
- ***It is recommended that NLF RA is sufficient for calculation of the cambers in curved radially-supported bridges. There is no need to consider any change in the girder vertical displacements and elevations due to the change in the internal forces, and the change in the vertical deflections in the structural system, associated with the DLF detailing.***

Girder Layovers

- With the exception of the Ford City Bridge (EICCR11), and not considering the FHWA test bridge (Bridge (A) EISCR1), which has a limited number of CFs and CF spacing at the maximum limits permitted by the AASHTO LRFD Specifications, the largest layovers are 0.3 inches (0.0024 rad) under SDL for SLDF detailing and 0.4 inches (0.0048 rad) under TDL for TDLF detailing in the bridges studied.
- The match with the calculated/expected non-zero layovers under TDL for SDLF, and under SDL for TDLF, is similar.
- ***It is recommended that the girder layovers may be assumed to be negligible in the targeted DL condition in curved radially-supported bridges. There is no need to consider any change in the girder layovers due to the change in the internal forces, and the change in the elastic deformations in the system, associated with the DLF detailing. The fascia girders should be checked separately for twist rotation between the CF locations due to eccentric overhang bracket loads.***

- ***For curved radially-supported bridges detailed for SDLF, the girder layovers under the TDL may be estimated as the CDL layovers obtained from a NLF RA.***
- ***For curved radially-supported bridges detailed for TDLF, the girder layovers under the SDL may be estimated as the negative of the CDL layovers obtained from a NLF RA.***

Cross-Frame Forces

- The effect of SDLF and TDLF detailing on the chord forces in X-type CFs is negligible in curved radially-supported bridges.
- The effect of SDLF detailing on other CF forces can be estimated accurately to conservatively by multiplying the CF forces obtained from a NLF RA by a factor of 2.0.
- The overall statistics for the percent change in the individual CF member forces relative the member yield load, due to SDLF and TDLF detailing, indicate a wide range (dispersion) of the individual CF member force effects. However, the force effects from SDLF and TDLF detailing are relatively small compared to the member yield loads in all the bridges studied. The mean, median, maximum and minimum change in the individual CF member forces are all somewhat larger in magnitude for TDLF detailing compared to SDLF detailing. For SDLF and TDLF detailing, the largest percentage increase in any individual CF member force, normalized by the member yield load, is 5.1 and 12.3 % respectively in the bridges studied, when Bridge (E) EICCR11 is excluded. These maximums occur for different bridge cases.
- ***In lieu of a DLF RA, it is recommended that the influence of SDLF detailing on the CF SDL forces in curved radially-supported bridges may be addressed by scaling the factored CF SDL forces from a NLF RA by the multiplier 2.0, with the exception that the chord member forces in X-type CFs need not be scaled.***
- ***In lieu of a DLF RA, it is recommended that the influence of TDLF detailing on the CF TDL forces in curved radially-supported bridges may be addressed by scaling the factored CF TDL forces from a NLF RA by the multiplier 2.0, with the exception that the chord member forces in X-type CFs need not be scaled. Since the TDL forces tend to be significantly larger, this recommendation amplifies the recommendation that, due to potential fit-up difficulty during the steel erection, TDLF detailing should not be employed for curved I-girder bridges.***

- With the use of the above scale factors, the maximum difference between the magnitudes of the individual DLF RA CF member forces versus the scaled NLF RA results, normalized by the member yield load, is reduced to 3.7 and 8.5 %, and the corresponding average difference is reduced to -0.5 and -1.2 % for SDLF under SDL and TDLF under TDL, respectively, for the curved radially-supported bridges studied in this research, excluding bridge (E) EICCR11.

Girder Stresses

- In curved radially-supported bridges, both the maximum girder major-axis bending (f_b) and flange lateral bending (f_ℓ) stresses generally are increased due to the DLF detailing effects.
- Under TDL, the largest percentage increase in the maximum f_b for the fascia girder on the outside of the curve is 2 % for SDLF detailing and 3 % for TDLF detailing for the bridges studied. The corresponding largest increases for the fascia girder on the inside of the curve are 5 % and 10 % for SDLF and TDLF detailing, respectively.
- The largest percentage increase in the maximum f_ℓ for the fascia girders on the outside of the curve is 23 % under SDL for SDLF detailing and 20 % for under TDL for TDLF detailing. The corresponding values for the fascia girders on the inside of the curve are 25 % and 22 % for SDLF and TDLF detailing, respectively.
- ***It is recommended that the influence of SDLF detailing on the girder f_b stresses may be neglected in curved radially-supported bridges.***
- ***In lieu of a DLF RA, it is recommended that the influence of SDLF detailing on the girder f_ℓ stresses in curved radially-supported bridges may be addressed by scaling the*** **factored SDL** ***f_ℓ values obtained from a NLF RA by the multiplier 1.2.***
- ***In lieu of a DLF RA, it is recommended that the influence of TDLF detailing on the girder f_b and f_ℓ stresses in curved radially-supported bridges may be addressed by scaling the*** **factored TDL** ***f_b and f_ℓ values from a NLF RA by the multipliers 1.1 and 1.2, respectively.***

Vertical Reactions

- With the exception of one case at the completion of the steel erection and the removal of temporary supports in the Ford City Bridge (EICCR11), uplift was not encountered for any of the curved radially-supported bridges studied in this research.

- DLF detailing increases the reactions on some of the girders and decreases them on others. The net total change in the vertical reactions is zero.
- In single-span horizontally curved radially-supported bridges with simple supports, DLF detailing tends to increase the smaller reactions at the bearings toward the inside of the curve.
- The largest increase in the reactions is 6 % under SDL due to SDLF detailing and 9 % under TDL due to TDLF detailing for the curved radially-supported bridges studied.
- ***It is recommended that the influence of SDLF detailing on any potential increases in the girder vertical reactions may be neglected in curved radially-supported bridges.***
- ***In lieu of a DLF RA, it is recommended that the influence of TDLF detailing on the girder reactions may be addressed by scaling the reactions from a NLF RA by the multiplier 1.1.***
- ***For simply-supported horizontally-curved bridges on radial supports, DLF tends to have a relieving influence on potential uplift at bearings having the smaller reactions, and therefore the influence of DLF detailing on any uplift at the bearings may be neglected.***
- ***For continuous-span horizontally-curved bridges, a DLF RA should be considered in cases where there are any particular concerns about potential uplift at lightly-loaded bearings.***

The above recommendations are considered applicable for curved radially-supported bridges with L_s/R up to 0.5 and L_s up to 300 ft. These limits are different from those listed in the tables for recommended fit conditions discussed subsequently in Section 4.1. The limits here are aimed at ensuring sufficient accuracy of the structural analysis whereas the limits discussed in Section 4.1 address broader questions of ensuring reliable fit-up of the structural steel. For bridges that exceed these limits, it is recommended that DLF RA be considered. Section 3.9 explains the details of several procedures for conducting a DLF RA.

3.4.6 Straight Bridges with Parallel Skew and Cambers Set Based on LGA

Straight bridges with a difference in the skew angles at the ends of all the spans less than or equal to $\Delta\theta = 20^o$ may be considered as parallel skew bridges. The use of LGA for setting the girder cambers in sharply skewed straight bridges is generally discouraged based on the considerations discussed in Section 3.4.2.3.

Section 3.4.6.1 provides quantitative results on the influence of SDLF and TDLF detailing on the responses in straight bridges with parallel skew and cambers set based on LGA. The influence of SDLF and TDLF is discussed on the responses in the following order: girder vertical displacements, girder elevations, girder layovers, CF forces, girder stresses, and vertical reactions. Section 3.4.6.2 then summarizes the influences on the key bridge responses, and provides recommendations for handling of these effects. The recommendations are highlighted in bold italicized text.

3.4.6.1 Quantitative Results

3.4.6.1.1 Girder Vertical Displacements

For straight skewed bridges with a parallel skew arrangement of the bearing lines, SDLF and TDLF detailing with cambers set based on LGA tend to reduce the vertical displacement of the fascia girders and increase the vertical displacement of the interior girders relative to the results from a NLF RA. The increase or decrease in the vertical displacements can be significant for bridges with long span and high skew index, such as Bridge (J1) NISSS54 (see Figure 84). (It should be noted that the analyses conducted here are 3D FEA for all the bridge cases. The only usage of LGA is for the determination of the girder cambers.) The maximum TDL displacement difference between the TDLF and NLF detailing is 3.7 inches on the innermost girder and 3.5 inches on the fascia girder. This occurs due to the fact that, when the CFs are detailed for TDLF, the effect of the TDLF detailing is to force the girders to deflect in the manner calculated by LGA under the TDL condition. However this effect is accomplished only under the targeted TDL condition. It should be noted that, as explained previously in Section 2.6, it is assumed that the concrete deck does not participate in resisting any of the DL in the studies conducted in this research. Similarly, when the CFs are detailed for SDLF, the effect of the SDLF detailing is to force the girders to deflect in the manner calculated by LGA under the SDL condition (but only under this condition).

It should be noted that the inspection of these vertical displacements alone can be somewhat disconcerting and misleading. The important result is the final girder elevations. The girder elevations are discussed subsequently.

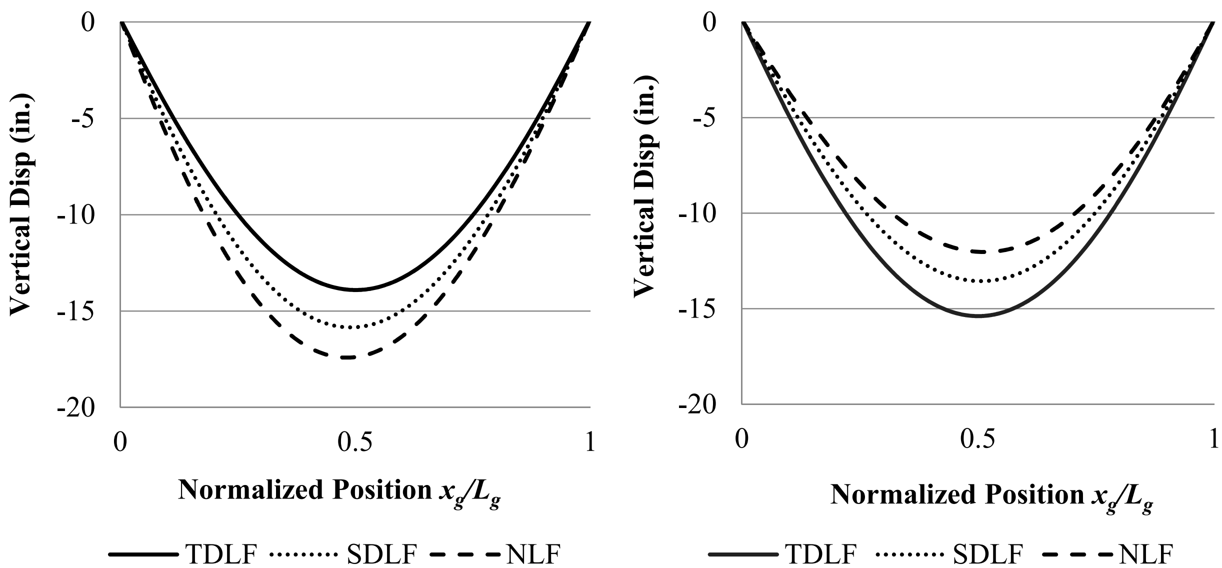


Figure 84. Bridge (J1) NISSS54 fascia girder (left) and innermost girder (right) vertical displacements under TDL from 3D FEA with the CFs detailed based on LGA cambers.

Tables 18 and 19 show the maximum TDL vertical displacements and the changes in the TDL vertical displacements relative to NLF detailing of the fascia girders and the innermost girders, respectively for the straight bridges with parallel skew studied in this research, based on the use of LGA cambers. From Table 18, it can be observed that SDLF and TDLF detailing reduce the maximum vertical displacements of the fascia girder in all the straight parallel skew bridge cases except Bridge (M1) EICCS2. The largest decrease in the maximum TDL vertical displacement of the fascia girders is 1.6 inches for SDLF detailing and 3.5 inches for TDLF detailing (taking the downward direction as positive; the downward deflections are shown as negative values in the tables). From Table 19, it can be observed that SDLF and TDLF detailing increase the maximum vertical displacements of the innermost girder in all the straight parallel skew bridge cases except Bridge (M2) EICCS2. The largest increase in the maximum TDL vertical displacement of the innermost girders is 1.7 inches for SDLF detailing and 3.7 inches for TDLF detailing.

One should note that Tables 18 and 19 report the absolute maximum downward displacements for the fascia girder and the innermost girder, respectively, in the bridge. In some of the cases for the bridges considered in this research, the location of the maximum displacement can change along the girder substantially as a function of the CF detailing method.

In bridges where the framing arrangement is improved to reduce the nuisance transverse stiffness effects, the girders in the bridge 3D system deflect in a fashion closer to that of the LGA model, and the changes in the vertical displacements due to the DLF detailing are smaller. For example, Bridge (J2) greatly reduces the nuisance transverse stiffness effects. For the maximum TDL vertical displacement, the largest decrease in the fascia girder displacement in this bridge is 2.6 inches and the largest increase in the innermost girder displacement is 0.8 inches due to TDLF detailing based on LGA cambers (again taking the downward direction as positive, which is the opposite of the sign convention used in the tables).

Table 18. Maximum vertical displacements under TDL of fascia girders and changes in maximum vertical displacements relative to NLF detailing for the straight skewed bridges studied in this research based on the use of LGA cambers (The largest changes by SDLF and TDLF under TDL are highlighted by dark shading).

Bridge	**NLF**	**SDLF**		**TDLF**	
	Disp. (in.)	Disp. (in.)	Change (in.)	Disp. (in.)	Change (in.)
(I1) NISSS14	-8.4	-8.2	0.2	-7.1	1.3
(I2) NISSS14	-8.4	-8.1	0.3	-7.2	1.2
(J1) NISSS54	-17.4	-15.8	**1.6**	-13.9	**3.5**
(J2) NISSS54	-16.5	-15.5	1.0	-13.9	2.6
(K1) EICSS12	-4.5	-4.4	0.1	-3.8	0.7
(K2) EICSS12	-4.5	-4.4	0.1	-3.9	0.6
(K3) EICSS12	-4.5	-4.4	0.1	-3.9	0.6
(L) NICSS16	-4.9	-4.8	0.1	-4.2	0.7
(M1) EICSS2	-12.2	-12.4	-0.2	-12.8	-0.6
(M2) EICSS2	-13.1	-12.9	0.2	-12.0	1.1

Table 19. Maximum vertical displacements under TDL of innermost girders and changes in maximum vertical displacements relative to NLF detailing for the straight skewed bridges studied in this research based on the use of LGA cambers (The largest changes by SDLF and TDLF under TDL are highlighted by dark shading).

Bridge	**NLF**	**SDLF**		**TDLF**	
	Disp. (in.)	Disp. (in.)	Change (in.)	Disp. (in.)	Change (in.)
(I1) NISSS14	-4.4	-5.2	-0.8	-7.9	-3.5
(I2) NISSS14	-6.9	-7.1	-0.2	-7.8	-0.9
(J1) NISSS54	-11.7	-13.4	**-1.7**	-15.4	**-3.7**
(J2) NISSS54	-14.1	-14.4	-0.3	-14.9	-0.8
(K1) EICSS12	-3.8	-3.9	-0.1	-4.0	-0.2
(K2) EICSS12	-3.8	-3.9	-0.1	-4.0	-0.2
(K3) EICSS12	-3.8	-3.8	-0	-4.0	-0.2
(L) NICSS16	-4.7	-4.7	-0	-4.6	-0.1
(M1) EICSS2	-9.4	-9.7	-0.3	-10.3	-0.9
(M2) EICSS2	-10.3	-10.1	0.2	-9.5	0.8

3.4.6.1.2 Girder Elevations

When a straight skewed bridge is designed using LGA, it is common that the CFs are detailed based on LGA cambers. The TDL LGA girder cambers are taken as the negative of the TDL girder vertical deflections calculated from a LGA. With TDLF detailing, the corresponding TDL girder elevations are theoretically zero (neglecting superelevation, etc.). Similarly, the SDL LGA cambers are taken as the negative of the SDL girder displacements calculated from a LGA. As noted previously, in this work the term “SDL camber” is simply a phrase used to indicate the negative of the calculated SDL displacements used for setting the drops between the girders for SDLF detailing of the CFs. The bridge girders are always fabricated based on the TDL cambers.

The actual responses corresponding to the above are always slightly different from the above theoretical ideals due to various factors that are not accounted for in the CF detailing, as discussed in Section 3.4.2.2. However, the use of LGA cambers gives the closest capture of these ideals. In addition, it is essential to recognize that the above findings apply ONLY to the targeted DL conditions. For example, one cannot use solely a LGA to determine the TDL girder deflections for a bridge that has been detailed for SDLF without encountering some deviation from the targeted final girder elevations. The correct calculation of the girder TDL deflections in this case, if the SDLF detailing is based on LGA cambers, is to sum the girder SDL deflections obtained from a LGA with the Concrete Dead Load (CDL) deflections obtained from a 3D FEA. (It should be noted that if the corresponding CF initial lack-of-fit effects are included in an accurate 2D Grid analysis or 3D FEA, the influence of the girder cambers and CF drops, whatever they are, are directly and integrally incorporated within the RA without any mixing and matching of analysis methods.)

Figure 85 shows the TDL results, with SDLF detailing, for the final girder elevations, on the fascia girder and on the middle girder on Bridge (J1) NISSS54. It is important to note that for SDLF detailing, the total girder cambers are set by summing the girder SDL deflections from LGA with the CDL deflections from 3D FEA. The CFs are detailed to fit to the ideal girder SDL elevations based on the application of the SDL deflections obtained from the LGA to the above initial fully-cambered girder profiles. In this case, the largest deviation from the targeted elevations under TDL is 0.4 inches for Bridge (J1). Figure 86 shows similar results to Figure 85 but for Bridge (I1) NISSS14. One can observe that that the corresponding largest deviation from the targeted elevations under TDL is 0.1 inches for Bridge (I1).

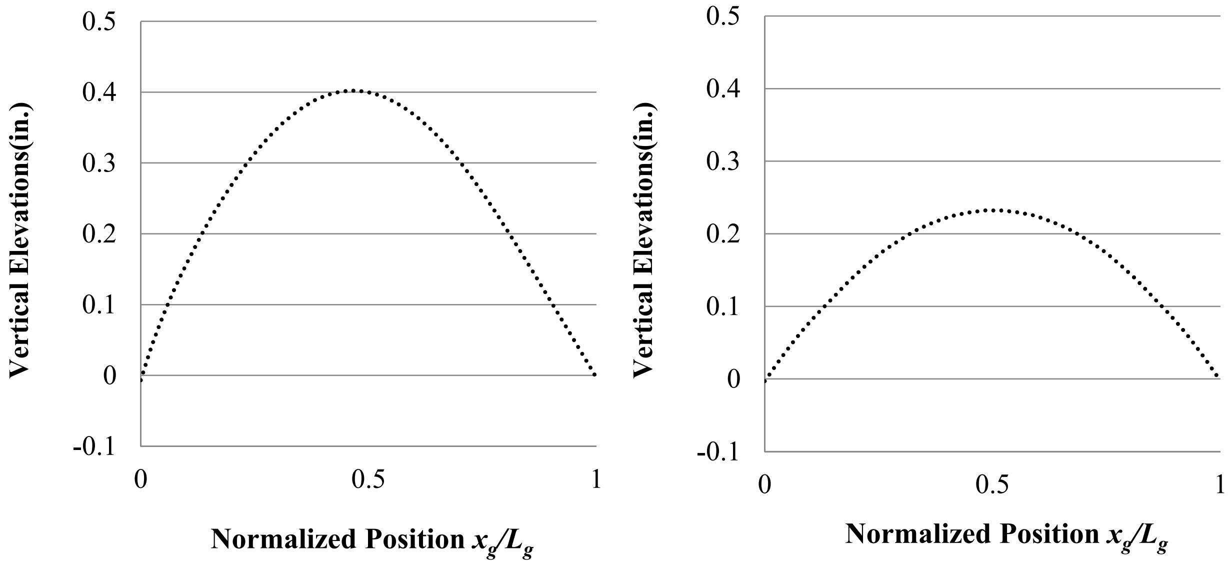


Figure 85. Bridge (J1) NISSS54 fascia girder (left) and middle girder (right) vertical elevations under TDL with SDLF based on LGA. The TDL girder cambers set based on the LGA SDL girder cambers plus the negative of the 3D FEA CDL girder displacements for SDLF detailing.

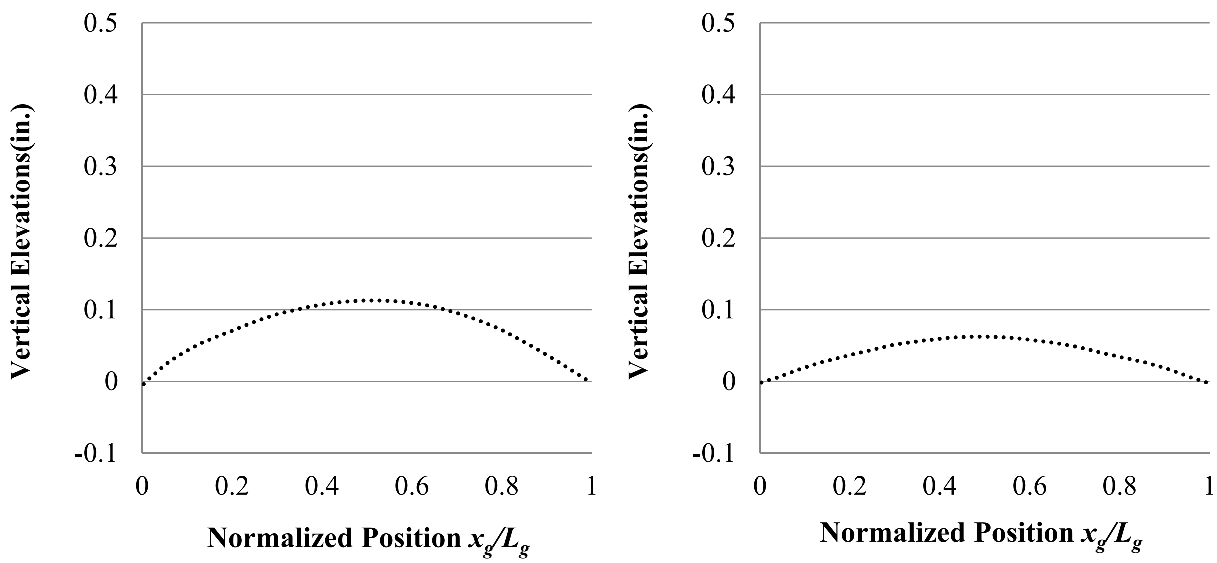


Figure 86. Bridge (I1) NISSS54 fascia girder (left) and middle girder (right) vertical elevations under TDL with SDLF based on LGA. The TDL girder cambers set based on the LGA SDL girder cambers plus the negative of the 3D FEA CDL girder displacements for SDLF detailing.

Figure 87 shows the vertical elevations for the fascia and middle girders of Bridge (J1) NISSS54, under TDL, if the CFs were detailed based on LGA and the girder TDL cambers are set *entirely* based on LGA. One can observe that the elevations match accurately with the targeted zero final elevations for TDLF in this situation. However, these good results apply *ONLY* to the use of TDLF and for the TDL condition.

If NLF detailing is used, and if the girder cambers are set based on the LGA results for the TDL, the girder final elevations are substantially in error from the targeted elevations. These errors are equal to the differences between the LGA girder deflections and the 3D FEA girder deflections. If SDLF detailing is used, and if the girder cambers are set based on the LGA results for the TDL, the elevation errors are smaller. However, these errors are still substantial, equal to the differences between the LGA girder deflections and the 3D FEA girder deflections under the CDL. Bridge cases (J1) and (J2) NISSS54 and (M1) EICSS2 show substantial final elevation errors for SDLF and NLF detailing if the cambers are based entirely on LGA and the CFs are detailed using the LGA cambers (see Table 20). These are cases with long span lengths and a high skew index. For the other straight skewed bridge cases studied in this research, the associated largest final elevation errors are 1.3 inches for NLF detailing and 0.8 inches for SDLF detailing.

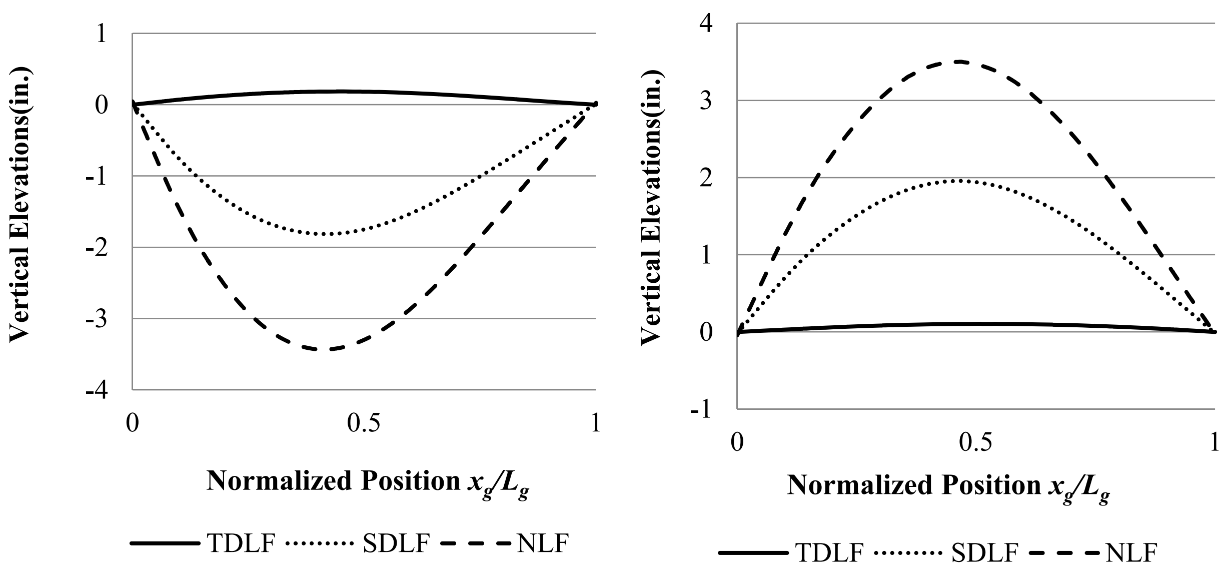


Figure 87. Bridge (J1) NISSS54 fascia girder (left) and middle girder (right) vertical elevations under TDL with the CFs detailed based on LGA and the TDL girder cambers set entirely based on LGA (not recommended), showing substantial elevation errors for SDLF and NLF detailing cases

Table 20. Maximum elevation deviations under TDL from the targeted elevation line with the CFs detailed based on LGA and the TDL girder cambers set entirely based on LGA (not recommended), for the straight bridges with parallel skew studied in this research (The largest final girder elevations with NLF, SDLF and TDLF detailing under TDL are highlighted by dark shading).

Bridge	NLF	SDLF	TDLF
(I1) NISSS14	**3.5**	**2.7**	0.1
(I2) NISSS14	1.2	1.0	0.1
(J1) NISSS54	**3.5**	2.0	0.2
(J2) NISSS54	2.5	1.5	**0.3**
(K1) EICSS12	0.8	0.6	0.1
(K2) EICSS12	0.6	0.5	0.1
(K3) EICSS12	0.7	0.6	0.1
(L) NICSS16	1.0	0.8	0.1
(M1) EICSS2	3.0	2.0	0.1
(M2) EICSS2	0.9	0.6	0.3

It is apparent from the above results that it is possible to "mix and match" the TDL cambers from LGA and RA results to obtain the desired targeted girder elevations while also achieving the close capture of the ideal responses (approximately zero CF forces, approximately zero girder flange lateral bending and approximately plumb girders under the targeted condition). However, this mixing and matching of analysis results can be awkward for the design engineer, and furthermore, it can be highly prone to errors.

3.4.6.1.3 Girder Layovers

For straight bridges with parallel skew, the CFs theoretically fit to the girders under TDL with zero force, when the CFs are detailed for TDLF using LGA. In this case, the girders are nearly ideally plumb under TDL with TDLF detailing based on LGA for Bridge (J1) NISSS54 (see Figure 88).

Considering the complete set of straight skewed bridges studied in the NCHRP 20-07 Task 355 research, the largest corresponding girder layovers are 0.1 inches under SDL for SDLF detailing and 0.6 inches under TDL for TDLF detailing (see Table 21). The largest girder layovers are not ideally zero under the targeted condition due to a number a reasons, as discussed in Section 3.4.2.2. By comparison to the results in Section 3.4.5.1.3, it can be observed that SDLF and TDLF detailing are more effective in making the girders nearly plumb for straight skewed bridges than curved radially-supported bridges. This is due to the tendency for larger forces, and larger elastic deformations in the CFs of the curved bridges studied in this research.

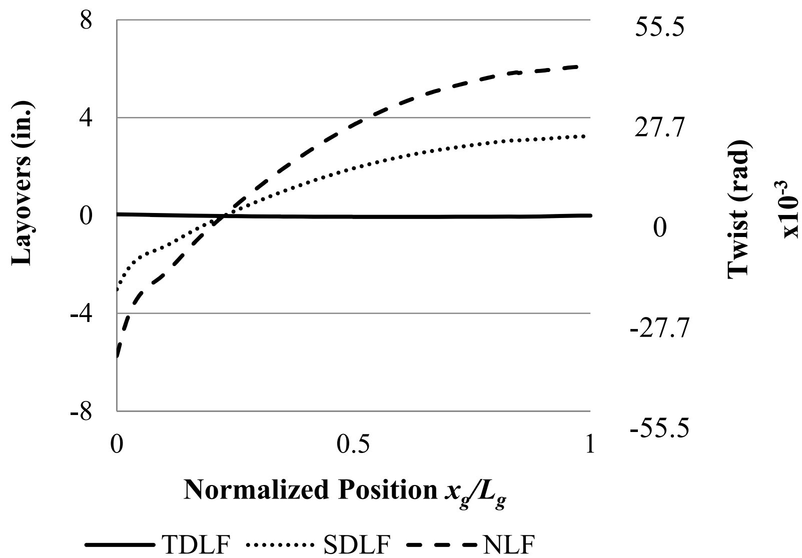


Figure 88. TDL fascia girder layovers Bridge (J1) NISSS54 for detailing based on LGA.

From Table 21 and Figures 89 and 90, one can observe that, for straight skewed bridges, the layovers under SDL with TDLF detailing are approximately equal in magnitude but opposite in sign to the layovers under TDL with SDLF detailing. The variable x_{ac} in the plots is the position along the length of the bridge relative to the bearing at the acute corner at the starting end of the bridge. With SDLF detailing, the layovers are theoretically zero under SDL (when LGA cambers are employed). The layovers with SDLF detailing under TDL are therefore theoretically equal to the layovers due to the CDL determined from a NLF RA. With TDLF detailing, the layovers are ideally zero under TDL. The layovers with TDLF detailing under SDL are thus theoretically equal in magnitude but opposite in sign to the layovers due to the CDL determined from a NLF RA. It should be emphasized that LGA can be a very erroneous predictor of the CDL displacements. This is because the girders are interconnected by their CFs and are thus behaving as a three-dimensional structural system under the action of the CDL.

Table 21. Maximum magnitudes of girder layovers and twists in the straight bridges with parallel skew studied in this research with CFs detailed entirely based on LGA cambers. (LO1, LO2, and LO3 are maximum girder layovers with NLF, SDLF, and TDLF detailing, respectively. $\phi 1$, $\phi 2$, and $\phi 3$ are the maximum girder twists with NLF, SDLF, and TDLF detailing, respectively. The largest girder layovers and twists with SDLF under SDL and TDLF under TDL are highlighted by dark shading).

Load Cond.	Bridge	Girder Depth (in.)	NLF		SDLF		TDLF	
			LO1 (in.)	ϕ1 (rad) x10^{-3}	LO2 (in.)	ϕ2 (rad) x10^{-3}	LO3 (in.)	ϕ3 (rad) x10^{-3}
SDL	(I1) NISSS14	72	0.7	9.7	0.0	0.0	2.6	36.1
	(I2) NISSS14	"	0.7	9.7	**0.1**	**1.4**	2.3	31.9
	(J1) NISSS54	144	2.8	19.4	**0.1**	0.7	3.3	22.9
	(J2) NISSS54	"	2.7	18.8	**0.1**	0.7	3.3	22.9
	(K1) EICSS12	54	0.2	3.7	0.0	0.0	0.7	13.0
	(K2) EICSS12	"	0.2	3.7	0.0	0.0	0.7	13.0
	(K3) EICSS12	"	0.2	3.7	0.0	0.0	0.7	13.0
	(L) NICSS16	72	0.4	5.6	0.0	0.0	1.6	22.2
	(M1) EICSS2	98.4	0.8	8.1	0.0	0.0	1.6	16.3
	(M2) EICSS2	"	0.8	8.1	0.0	0.0	1.6	16.3
TDL	(I1) NISSS14	72	3.3	45.8	2.6	36.1	0.3	4.2
	(I2) NISSS14	"	3.2	44.4	2.5	34.7	**0.6**	**8.3**
	(J1) NISSS54	144	6.1	42.4	3.3	22.9	0.1	0.7
	(J2) NISSS54	"	6.3	43.8	3.4	23.6	0.1	0.7
	(K1) EICSS12	54	1.0	18.5	0.8	14.8	0.1	1.9
	(K2) EICSS12	"	1.0	18.5	0.8	14.8	0.1	1.9
	(K3) EICSS12	"	1.0	18.5	0.8	14.8	0.1	1.9
	(L) NICSS16	72	2.3	31.9	1.9	26.4	0.4	5.6
	(M1) EICSS2	98.4	2.5	25.4	1.7	17.3	0.1	1.0
	(M2) EICSS2	"	2.5	25.4	1.7	17.3	0.3	3.0

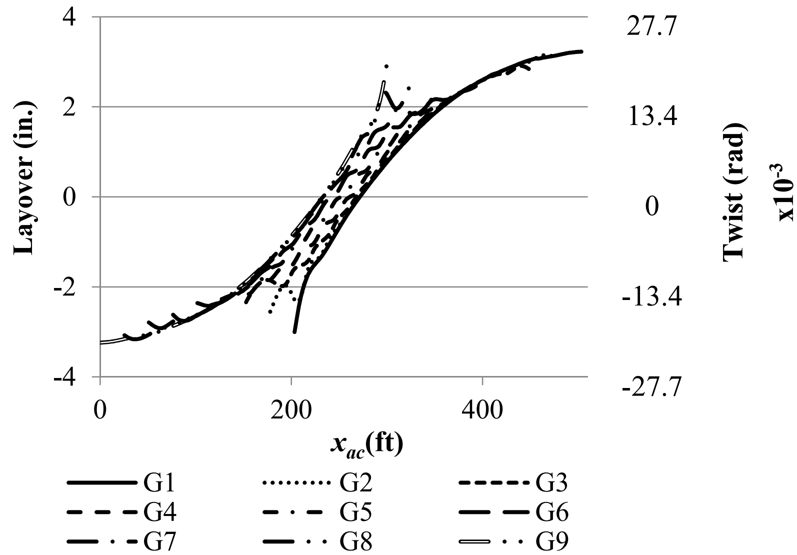


Figure 89. TDL girder layovers and twists of Bridge (J1) NISSS54 with SDLF detailing based on LGA cambers.

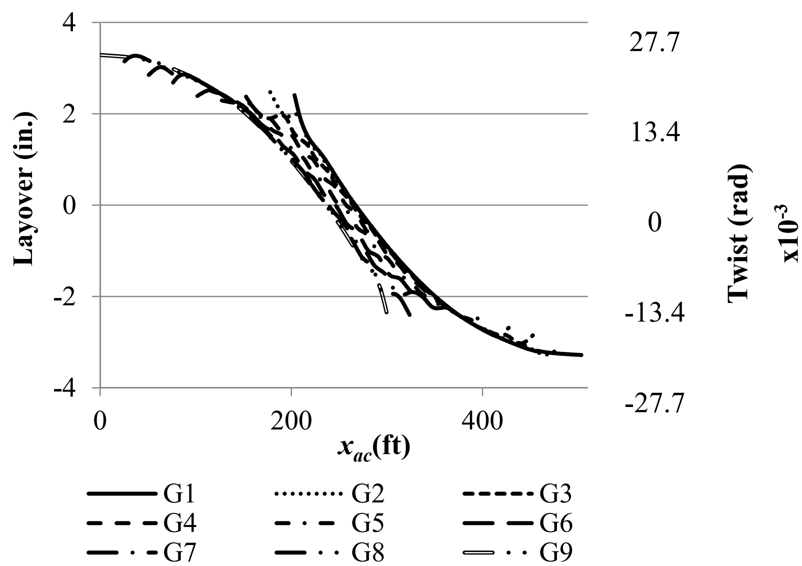


Figure 90. SDL girder layovers and twists of Bridge (J1) NISSS54 with TDLF detailing based on LGA cambers.

3.4.6.1.4 Cross-Frame Forces

For straight bridges with parallel skew, both the average and the maximum CF forces in the completed bridge are small under SDL for SDLF detailing, and they are small under TDL for TDLF detailing. The effects of SDLF and TDLF detailing approximately cancel the CF DL effects, when the SDLF and TDLF detailing is based on cambers obtained from LGA girder deflections (see Section 3.7 for detailed discussion of this behavior). If the bridge design is based on LGA, it is common that the CFs are detailed based on LGA cambers. It is emphasized that the recommendation of the NCHRP 20-07 Task 355 research is that the engineer should not mix the methods of analysis being applied to a given bridge. That is, if a RA is employed for the overall bridge design (i.e., grid analysis or 3D FEA), the cambers should be calculated based on the RA. This recommendation is due to the high chance of significant errors entering into the solutions when the results from LGA and from RA are mixed (e.g., improperly using the LGA result for the total girder cambers when the bridge is detailed for SDLF, which will result in substantial girder elevation errors), as well as other reasons discussed in Section 3.4.2.3.

From Tables 22 and 23, it can be observed that the average and maximum CF forces are relatively small under the targeted conditions. However, the actual CF forces generally are not zero under the targeted condition for reasons discussed in Section 3.4.2.2. The following can be observed from the above tables:

- Under SDL/SDLF, the largest F2/F1 ratio of the average of the CF member forces (in each bridge) is 0.48. This ratio corresponds to the bridge with the next to the largest skew index of all the bridges studied, (I2) NISSS14. The CF forces are substantially reduced by the improved framing arrangement in this particular bridge. The above ratio is close to zero for nearly all of the other bridges studied. The next largest value is 0.25.
- Under SDL/SDLF, the largest F2/F1 ratio of the maximum CF member force (in each bridge) is 0.31. This ratio corresponds to Bridge (J2) NISSS54.
- Under TDL/TDLF, the largest F3/F1 ratio of the average of the CF member forces (in each bridge) is 0.48. These values are greater than or equal to 0.12 for all but one of the other bridges studied. The larger ratios correspond to cases with smaller NLF CF forces.
- Under TDL, the largest F3/F1 ratio of the maximum CF member force (in each bridge) is again 0.31. Many of the other bridges have similar maximum values.

Table 22. Average magnitude of the CF member forces in each of the straight bridges with parallel skew studied in this research (F1, F2, and F3 are the CF forces with NLF, SDLF, and TDLF detailing based on LGA cambers, respectively. The largest F2/F1 and F2-F1 under SDL and F3/F1 and F3-F1 under TDL are highlighted by dark shading).

Load Cond.	**Bridge**	**NLF**	**SDLF**			**TDLF**		
		F1 (kip)	**F2 (kip)**	**F2/F1**	**F2 – F1 (kip)**	**F3 (kip)**	**F3/F1**	**F3 – F1 (kip)**
SDL	(I1) NISSS14	8.8	1.7	0.19	-7.1	26.2	2.98	17.4
	(I2) NISSS14	3.3	1.6	**0.48**	-1.7	15.4	4.67	12.1
	(J1) NISSS54	19.5	1.0	0.05	**-18.5**	20.3	1.04	0.8
	(J2) NISSS54	5.7	1.4	0.25	-4.3	9.2	1.61	3.5
	(K1) EICSS12	1.4	0.0	0.00	-1.4	4.6	3.29	3.2
	(K2) EICSS12	0.9	0.0	0.00	-0.9	2.8	3.11	1.9
	(K3) EICSS12	1.0	0.0	0.00	-1.0	3.2	3.20	2.2
	(L) NICSS16	1.4	0.1	0.07	-1.3	6.0	4.29	4.6
	(M1) EICSS2	4.4	0.0	0.00	-4.4	8.7	1.98	4.3
	(M2) EICSS2	2.0	0.0	0.00	-2.0	4.2	2.10	2.2
TDL	(I1) NISSS14	37.8	28.4	0.75	-9.4	6.5	0.17	-31.3
	(I2) NISSS14	13.9	11.1	0.80	-2.8	6.7	**0.48**	-7.2
	(J1) NISSS54	42.9	22.5	0.52	-20.4	2.0	0.05	**-40.9**
	(J2) NISSS54	13.5	7.7	0.57	-5.8	3.4	0.25	-10.1
	(K1) EICSS12	6.0	4.6	0.77	-1.4	1.5	0.25	-4.5
	(K2) EICSS12	3.5	2.7	0.77	-0.8	1.1	0.31	-2.4
	(K3) EICSS12	4.2	3.2	0.76	-1.0	1.1	0.26	-3.1
	(L) NICSS16	7.5	6.0	0.80	-1.5	1.0	0.13	-6.5
	(M1) EICSS2	13.1	8.8	0.67	-4.3	1.6	0.12	-11.5
	(M2) EICSS2	7.0	5.2	0.74	-1.8	2.2	0.31	-4.8

Table 23. Maximum magnitude of the CF member forces in each of the straight bridges with parallel skew studied in this research (F1, F2, and F3 are the CF forces with NLF, SDLF, and TDLF detailing based on LGA cambers, respectively. The largest F2/F1 and F2-F1 under SDL and F3/F1 and F3-F1 under TDL are highlighted by dark shading).

Load Cond.	Bridge	NLF	SDLF			TDLF		
		F1 (kip)	F2 (kip)	F2/F1	F2 – F1 (kip)	F3 (kip)	F3/F1	F3 – F1 (kip)
SDL	(I1) NISSS14	33.5	5.6	0.17	-27.9	93.1	2.78	59.6
	(I2) NISSS14	29.7	6.5	0.22	-23.2	103.9	3.50	74.2
	(J1) NISSS54	162.4	6.4	0.04	**-156.0**	145.5	0.90	-16.9
	(J2) NISSS54	25.4	8.0	**0.31**	-17.4	35.2	1.39	9.8
	(K1) EICSS12	4.2	0.2	0.05	-4.0	13.8	3.29	9.6
	(K2) EICSS12	3.2	0.0	0.00	-3.2	10.0	3.13	6.8
	(K3) EICSS12	5.0	0.1	0.02	-4.9	15.2	3.04	10.2
	(L) NICSS16	12.0	0.7	0.06	-11.3	51.4	4.28	39.4
	(M1) EICSS2	42.1	0.6	0.01	-41.5	80.0	1.90	37.9
	(M2) EICSS2	20.6	0.6	0.03	-20.0	43.5	2.11	22.9
TDL	(I1) NISSS14	144.4	109.4	0.76	-35.0	22.9	0.16	-121.5
	(I2) NISSS14	130.7	101.8	0.79	-28.9	30.1	0.23	-100.6
	(J1) NISSS54	354.0	181.9	0.51	-172.1	8.8	0.02	**-345.2**
	(J2) NISSS54	58.5	31.2	0.53	-27.3	18.1	**0.31**	-40.4
	(K1) EICSS12	17.7	13.6	0.77	-4.1	4.1	0.23	-13.6
	(K2) EICSS12	13.7	10.6	0.77	-3.1	3.4	0.25	-10.3
	(K3) EICSS12	20.5	15.4	0.75	-5.1	3.5	0.17	-17.0
	(L) NICSS16	63.5	51.0	0.80	-12.5	7.1	0.11	-56.4
	(M1) EICSS2	122.7	80.5	0.66	-42.2	5.4	0.04	-117.3
	(M2) EICSS2	69.8	49.3	0.71	-20.5	11.7	0.17	-58.1

The SDLF maximum fit-up forces for the straight skewed bridges shown in Table 4 (Section 3.2.2) are slightly larger than their maximum forces in the completed bridge under SDL shown in Table 23. This is because the critical CFs are installed at intermediate erection stages for which the bridge configuration and boundary conditions were not the same as the final bridge configuration that the CFs were detailed for. For instance, in the case of bridge cases (J1) and (J2) NISSS54, field splices and shoring towers are required due to the span length. A minimum number of CFs were installed before making the splice connection to keep the girders stable.

Figure 91 shows the frequency distribution of the changes in the CF chord forces due to SDLF and TDLF detailing for Bridge (J1) NISSS54. Figure 92 shows this frequency distribution for the CF diagonal forces in this bridge. From these figures, it can be observed that nearly all of the CF members (both chords and diagonals) have internal forces that are decreased due to SDLF and TDLF detailing. The maximum negative percent change in the CF forces, normalized by the member yield load, are 21.6 % for SDLF detailing and 37.9 % for TDLF detailing. Figure 93 shows the frequency distribution for the CF chords and Figure 94 shows this frequency distribution for the CF diagonal forces in all the straight bridges with parallel skew considered in this research. Table 24 shows a summary of the percent change in the CF forces, normalized by the member yield load, due to SDLF or TDLF detailing in all the straight bridges with parallel skew. From Tables 22 through 24, Figures 91 through 94, and other similar figures of the frequency distribution of CF forces in the straight bridges with parallel skew studied in this research (included in Appendices I to M), it can be observed that SDLF and TDLF detailing have substantial beneficial (subtractive) effects on the CF DL forces. The CF forces are close to but not ideally zero under the targeted conditions for various reasons explained above. In addition, the influence of the DLF detailing on the chord forces is somewhat larger than on the diagonal forces for straight skewed bridges. This is the opposite of the trend in the DLF effects on the CF member forces for curved-radially supported bridges. Furthermore, in the case of straight skewed bridges, these influences tend to involve a significant reduction in the CF forces rather than the increases observed for curved radially-supported bridges.

The statistics for the percent change in the individual CF member forces relative the member yield load, due to SDLF and TDLF detailing, indicate a wide range (dispersion) of individual CF member force effects. However, the predominant tendency is a reduction of the CF member forces in parallel-skew straight bridges due to SDLF and TDLF detailing.

Figure 95 shows the actual distribution of the CF forces under the SDL in Bridge (I2), including the locked-in force effects from SDLF detailing with LGA cambers. The presentation of the CF forces in these plots, as well as the plots in the subsequent figures is similar to that for Figures 70 through 81 in Section 3.4.5.1.4. The reader is referred to this previous section for an explanation of these details. One can observe that the largest of the CF member forces in Figure 95 is only 6.5 kip.

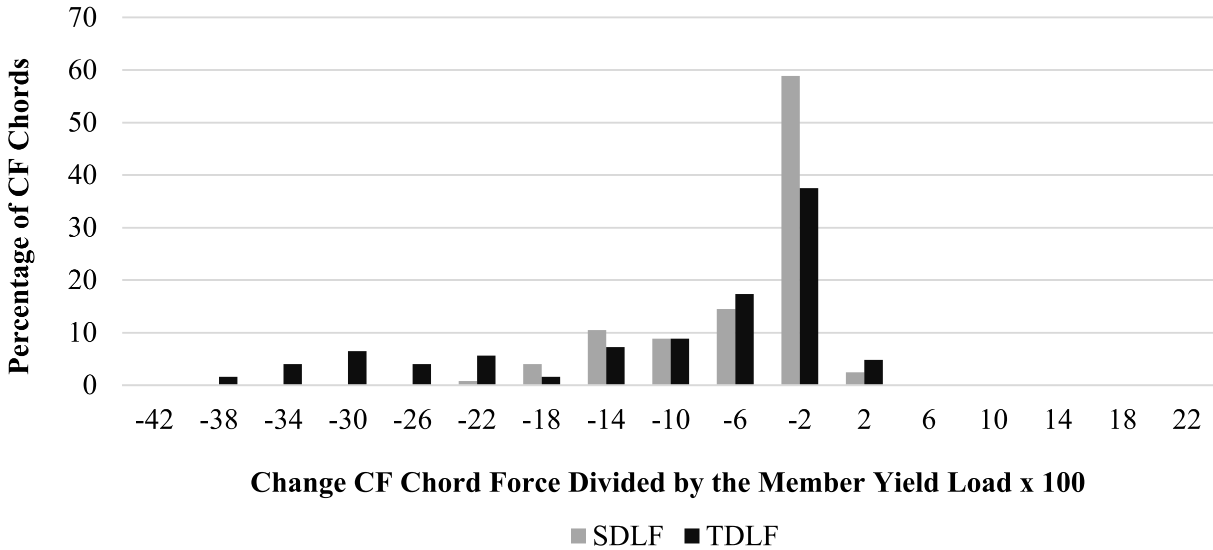


Figure 91. Frequency distribution for the change in the magnitude of the CF chord forces, normalized by the member yield load, due to SDLF and TDLF detailing using LGA cambers, Bridge (J1) NISSS54.

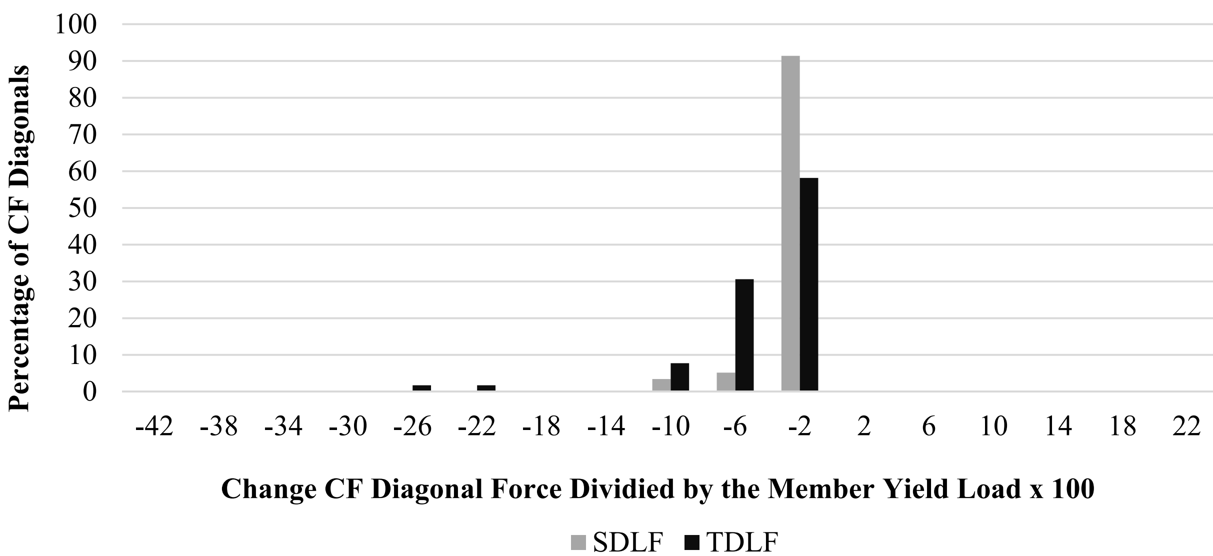


Figure 92. Frequency distribution for the change in the magnitude of the CF diagonal forces, normalized by the member yield load, due to SDLF and TDLF detailing using LGA cambers, Bridge (J1) NISSS54.

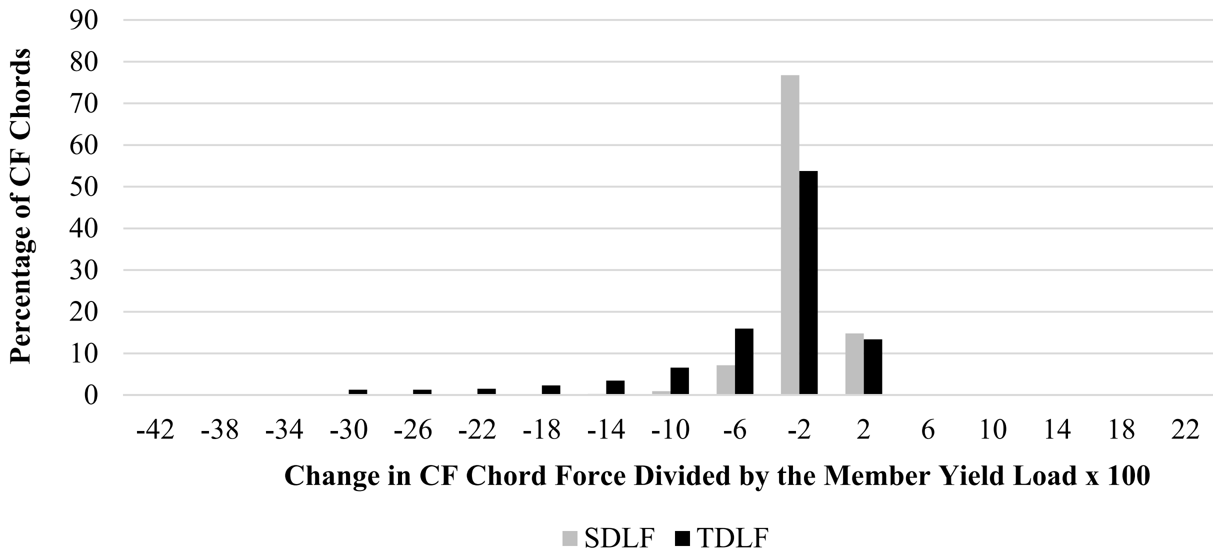


Figure 93. Frequency distribution for the change in the magnitude of the CF chord forces, normalized by the member yield load, due to SDLF and TDLF detailing using LGA cambers, all the straight bridges with parallel skew studied in this research.

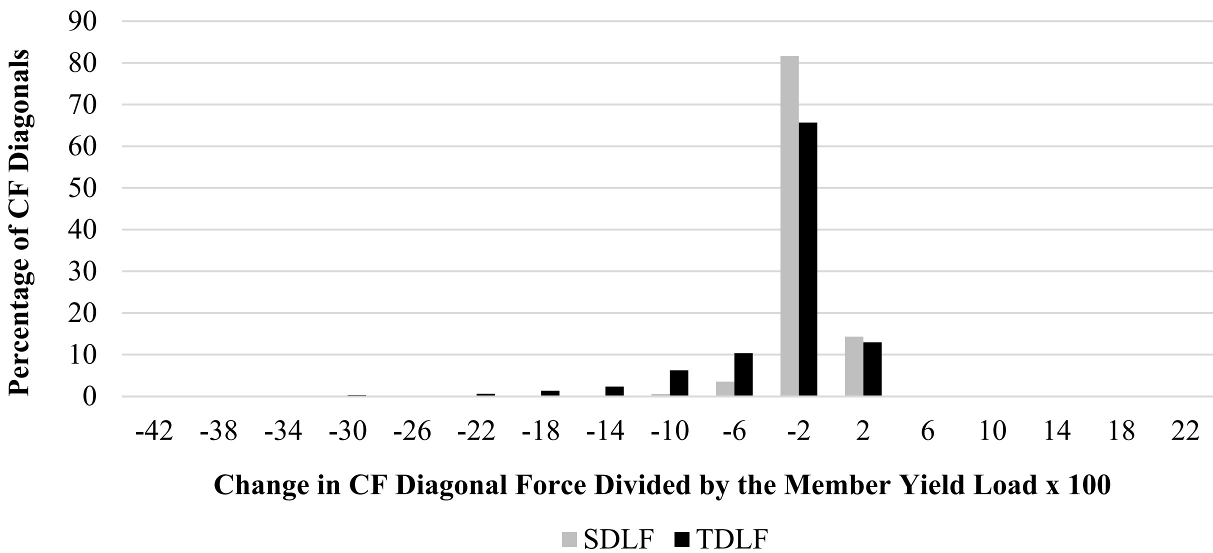


Figure 94. Frequency distribution for the change in the magnitude of the CF diagonal forces, normalized by the member yield load, due to SDLF and TDLF detailing using LGA cambers, all the straight bridges with parallel skew studied in this research.

Table 24. Summary statistics for the percent change in the magnitude of the CF forces divided by the member yield load (i.e., change in member force divided by the member yield load x 100), due to SDLF or TDLF detailing using LGA cambers, all the straight bridges with parallel skew studied in this research.

	Chords		*Diagonals*	
	SDLF	*TDLF*	*SDLF*	*TDLF*
Average	*-1.63*	*-4.85*	*-0.97*	*-2.88*
Median	*-0.65*	*-2.34*	*-0.47*	*-1.47*
Max	*0.78*	*3.33*	*0.99*	*4.36*
Min	*-21.6*	*-37.9*	*-11.7*	*-28.9*
COV	*51.2*	*34.2*	*52.4*	*42.9*

Figure 96 shows an estimate of the CF member forces under the SDL, assuming SDLF detailing, obtained by scaling the NLF RA forces for all the cross-frame members by 0.35. This scale factor is approximately equal to the maximum F2/F1 for SDL/SDLF in Table 23. One can observe that the absolute maximum CF force values from Figure 95 are estimated conservatively. However, the actual distribution of the CF forces from Figure 95 is predicted poorly. The poor prediction of the CF force distribution is not of any significant consequence though since all the CF forces are relatively small. Since Figure 96 simply shows all the NLF RA CF forces scaled by 0.35, it can be concluded that the distribution of the non-zero CF forces under SDL associated with NLF detailing is very different from the distribution of the reduced (smaller) CF forces under SDL associated with SDLF detailing.

Figure 97 shows the difference between the magnitude of the DLF RA forces and the CF forces under SDL, assuming SDLF detailing, estimated by scaling the NLF RA forces, divided by the CF member yield loads. The plots in this figure are similar those for the curved radially-supported bridges shown previously in Figures 74 through 81. One can observe that the largest under-prediction of the DLF RA results is $0.01P_y$ for several of the top chord members, while the largest over-prediction is $-0.025P_y$ using the recommended estimate on Bridge (I2) NISSS14. Figure 98 shows the same results as Figure 97, but under TDL and assuming TDLF detailing. The maximum under-prediction is $0.05P_y$ and the largest over-prediction is $-0.115P_y$ for this case.

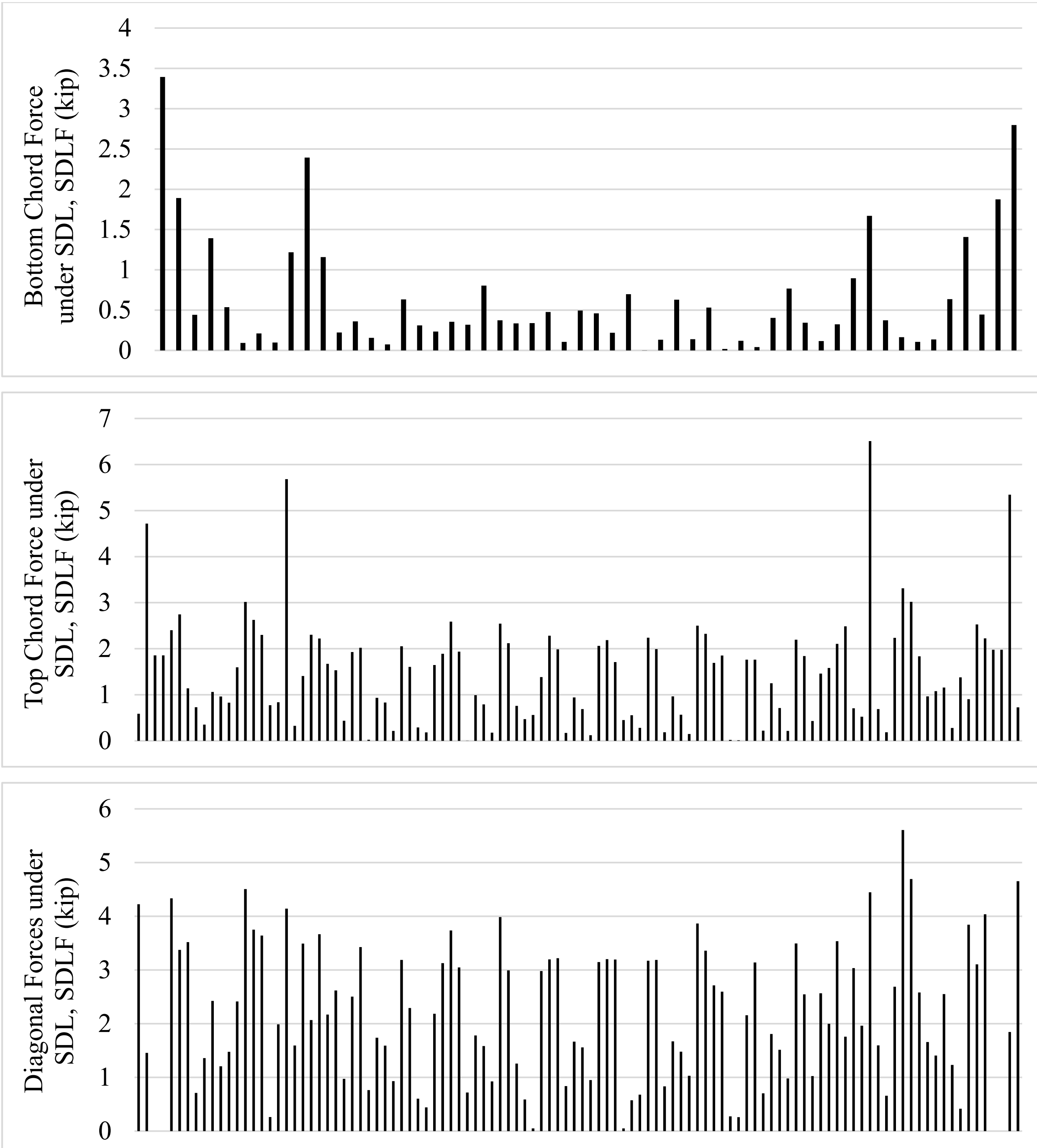


Figure 95. Magnitude of CF member forces from DLF RA, Bridge (I2) NISSS14 under SDL, SDLF detailing based on LGA cambers.

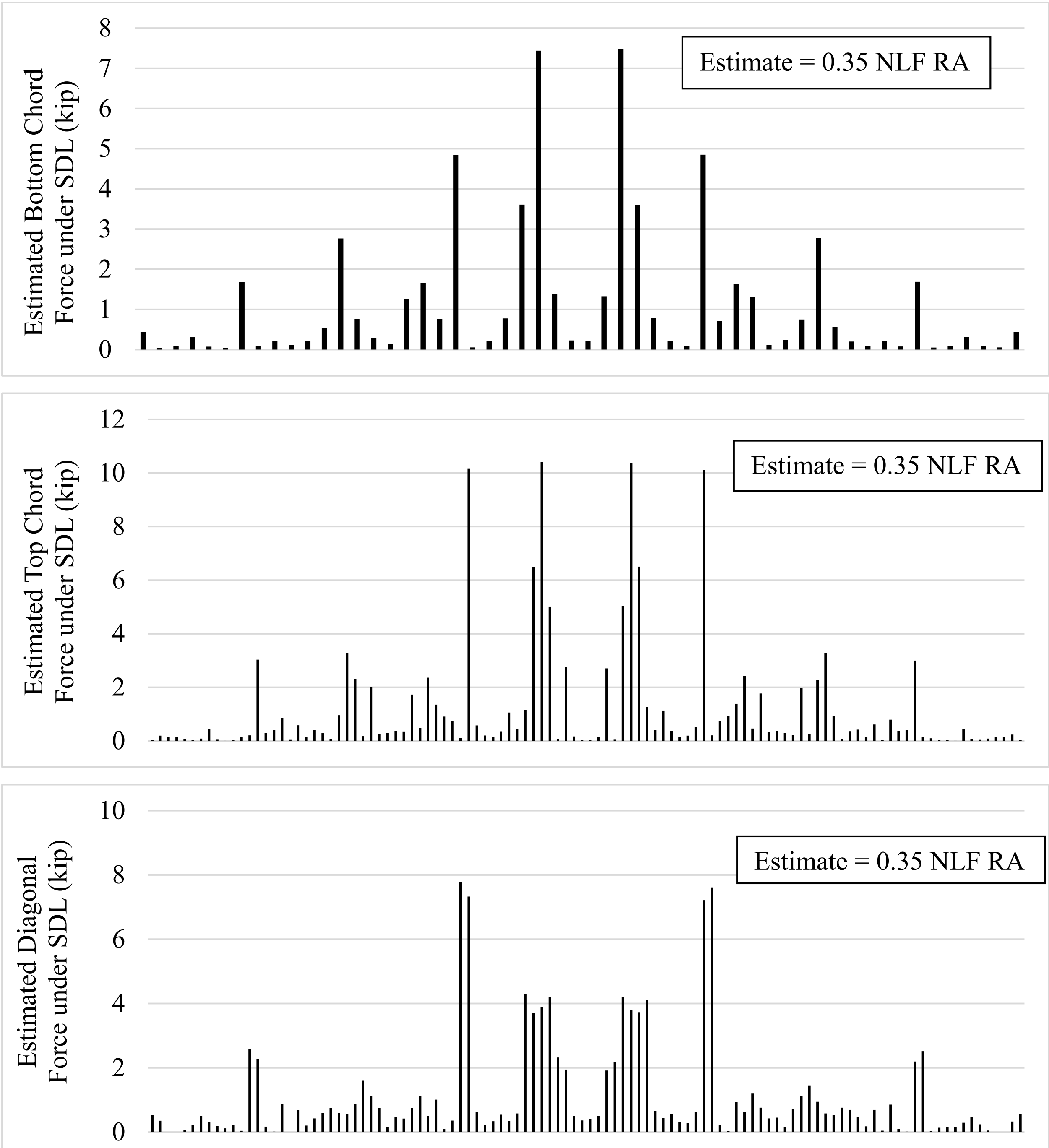


Figure 96. Estimated magnitude of CF member forces based on scaling of NLF RA results, assuming SDLF detailing, Bridge (I2) NISSS14 under SDL.

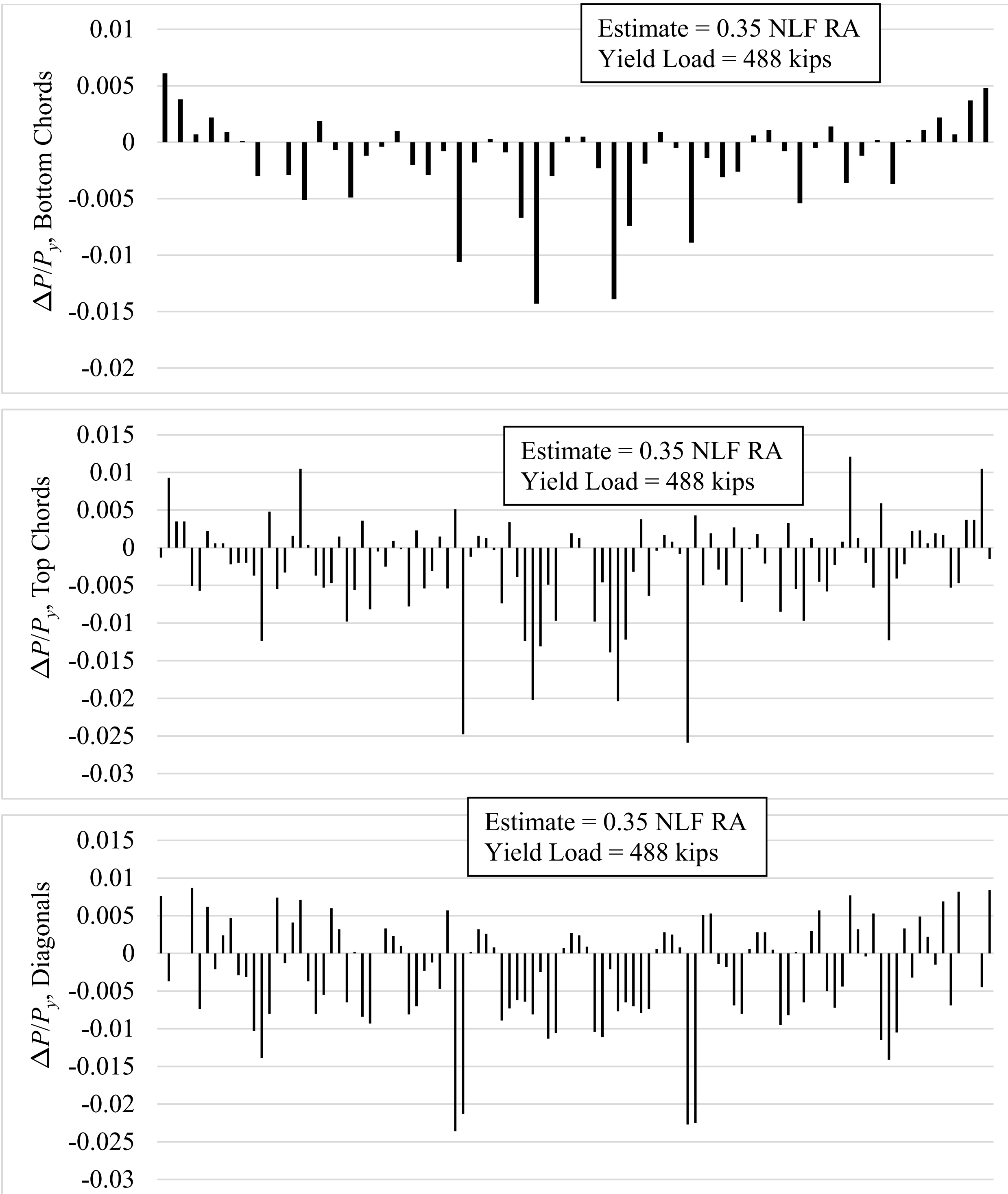


Figure 97. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (I2) NISSS14 under SDL, SDLF detailing based on LGA cambers.

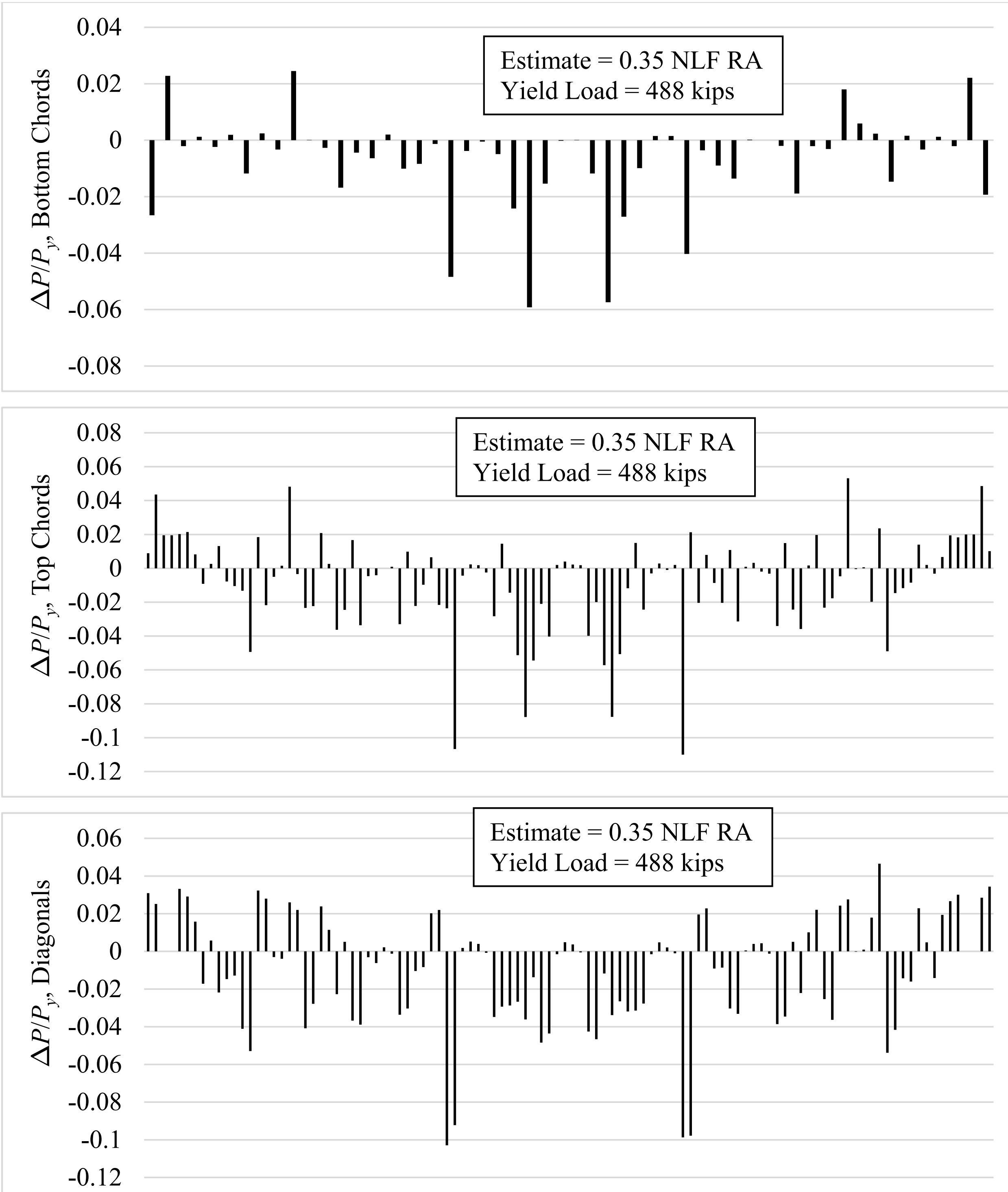


Figure 98. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (I2) NISSS14 under TDL, TDLF detailing based on LGA cambers.

Figures 99 and 100 show comparable plots to Figures 97 and 98 for Bridge (J1) NISSS54. Figures 101 and 102 do the same for Bridge (J2) NISSS54. For Bridge (J1), the largest under-prediction is $0.002P_y$ for SDL/SDLF and $0.001P_y$ for TDL/TDLF, whereas the largest over-prediction is $-0.08P_y$ for SDL/SDLF and $-0.17P_y$ for TDL/TLDF. For Bridge (J2), the largest under-prediction is $0.008P_y$ for SDL/SDLF and $0.017P_y$ for TDL/TDLF, while the largest over-prediction is $-0.019P_y$ for SDL/SDLF and $0.042P_y$ for TDL/TDLF.

Similar to the estimate recommended for curved radially-supported bridges in Section 3.4.5.1.4, the largest under-prediction is less than $0.05P_y$ for all the cases considered, given the CF member sizes selected in the original bridge designs.

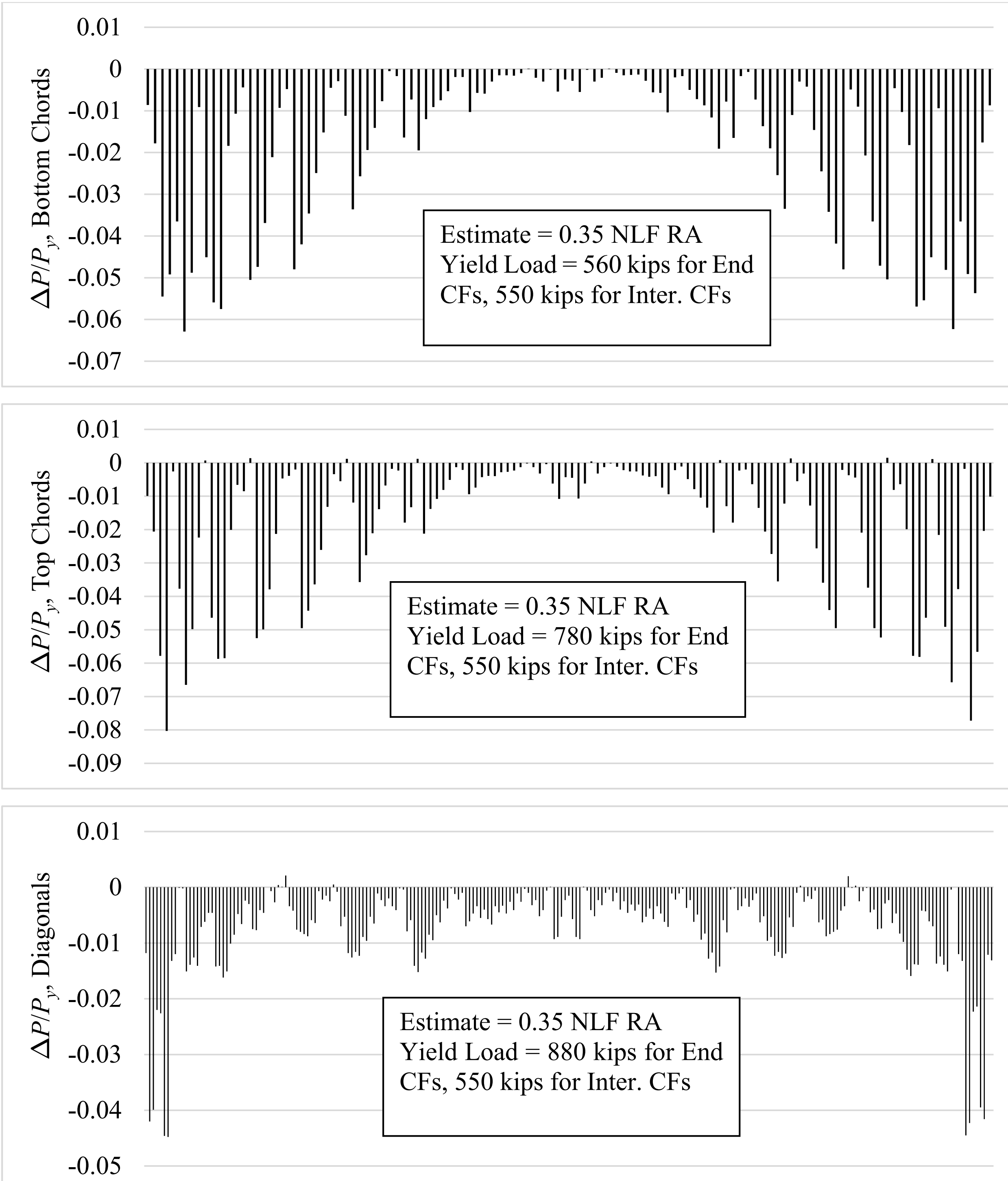


Figure 99. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (J1) NISSS54 under SDL, SDLF detailing based on LGA cambers.

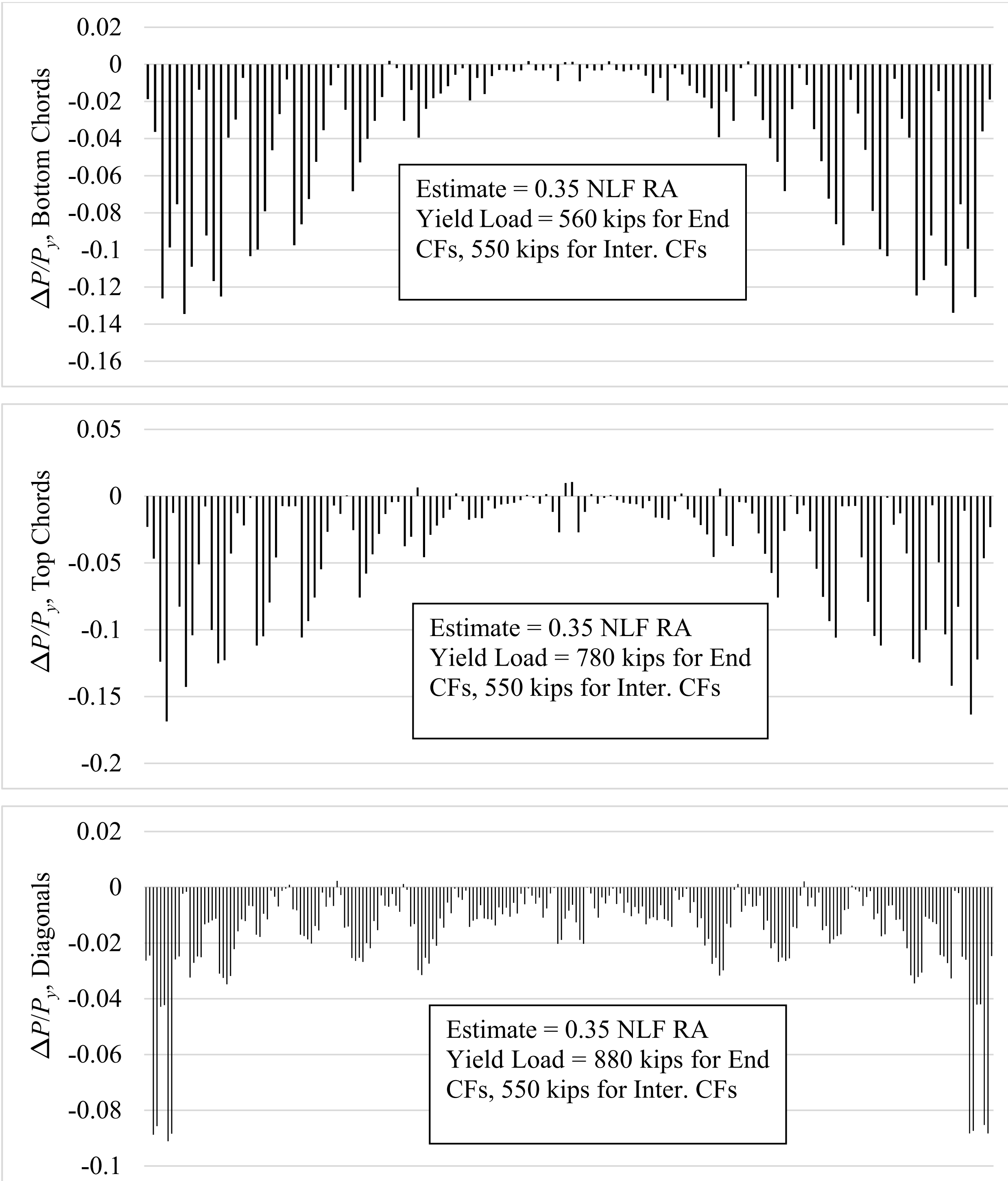


Figure 100. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (J1) NISSS54 under TDL, TDLF detailing based on LGA cambers.

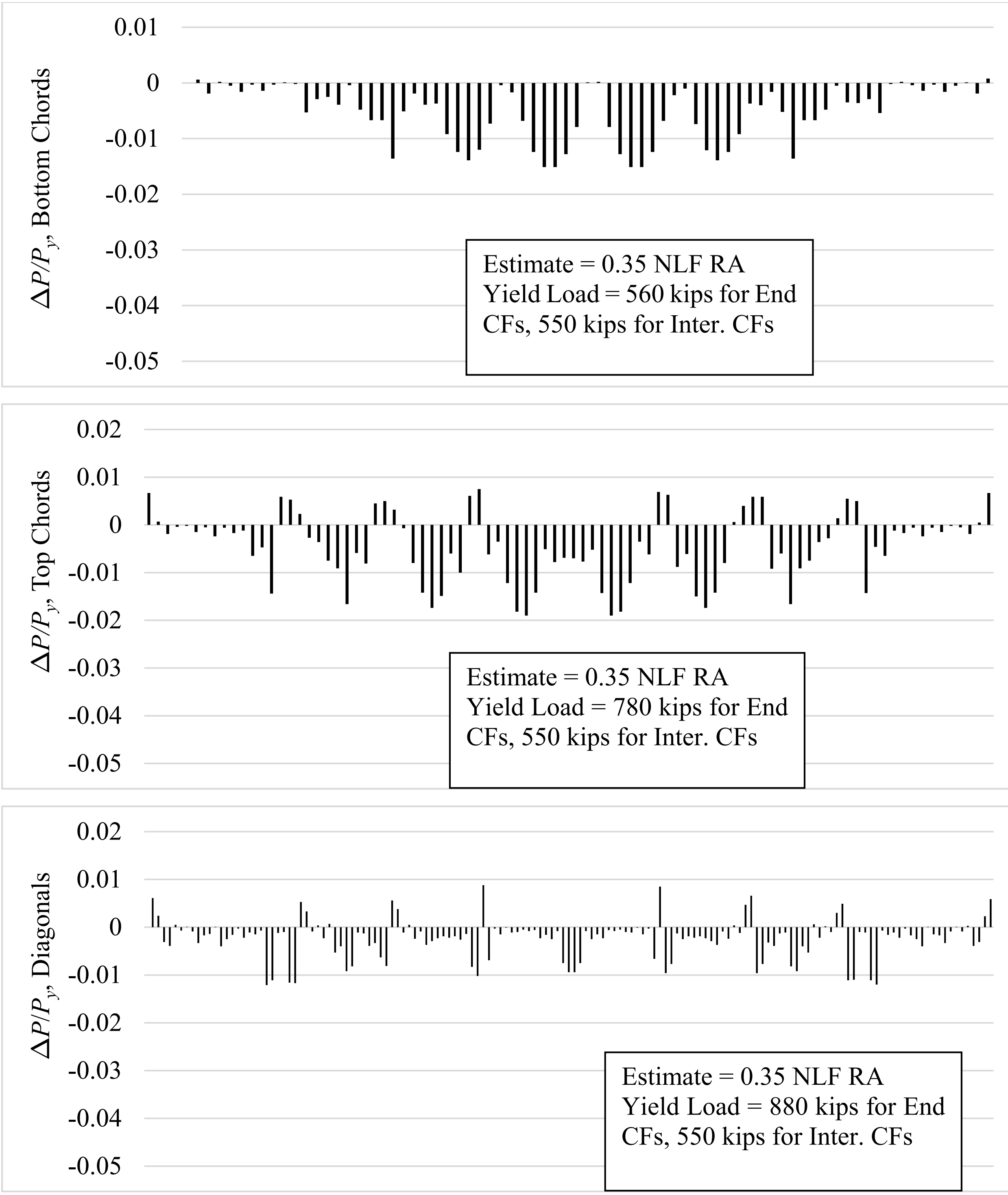


Figure 101. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (J2) NISSS54 under SDL, SDLF detailing based on LGA cambers.

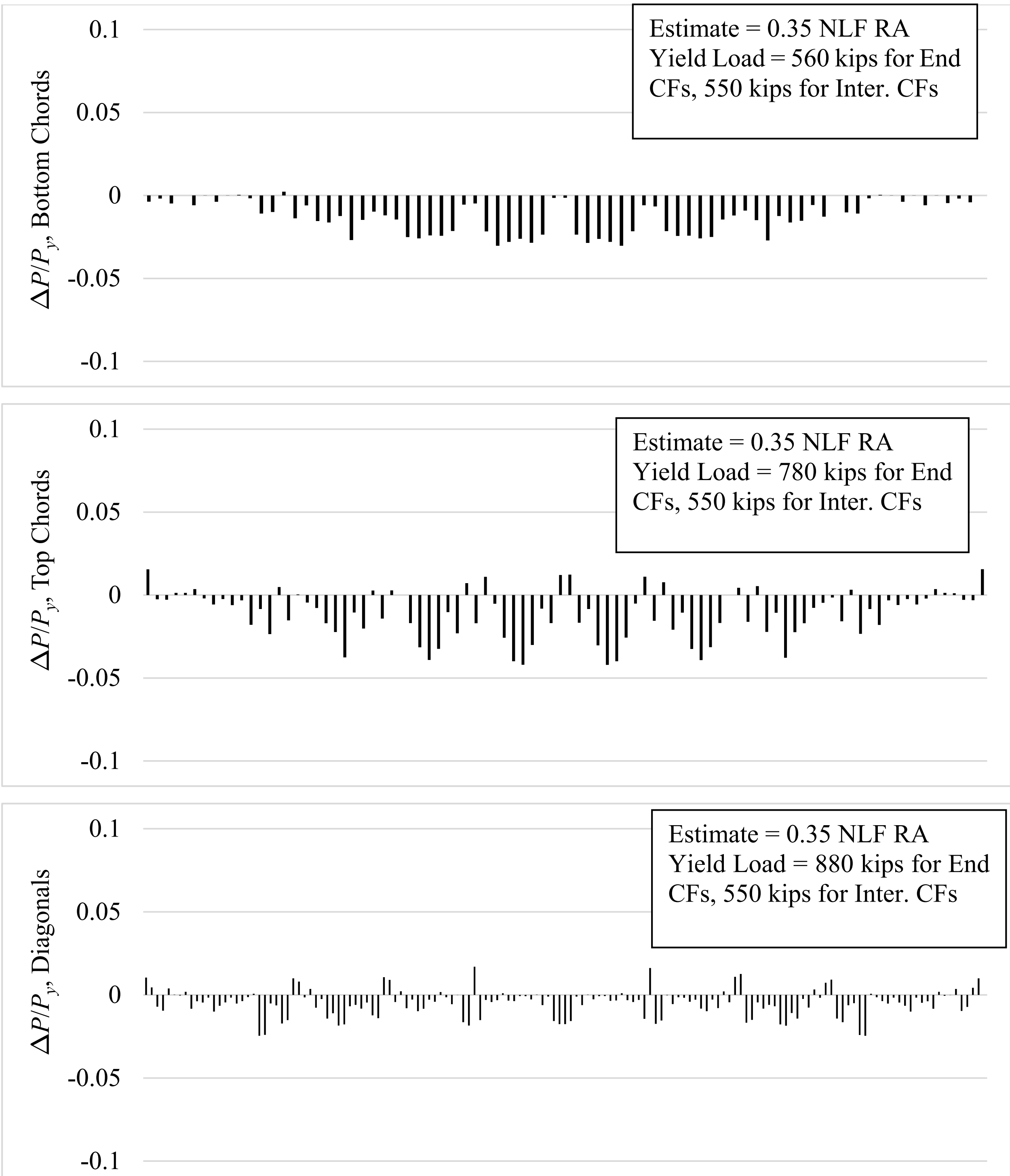


Figure 102. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (J2) NISSS54 under TDL, TDLF detailing based on LGA cambers.

3.4.6.1.5 Girder Stresses

For straight bridges with parallel skew, the SDLF and TDLF detailing effects based on LGA cambers tend to increase the major-axis bending stresses in the interior girders and decrease these stresses in the fascia girders. This behavior is shown in Figures 103 through 106 for bridges (J1) NISSS54 and (I1) NISSS14, respectively. This increase or decrease is significant in these bridge cases, which have substantial nuisance transverse stiffness and uplift at some of the bearings.

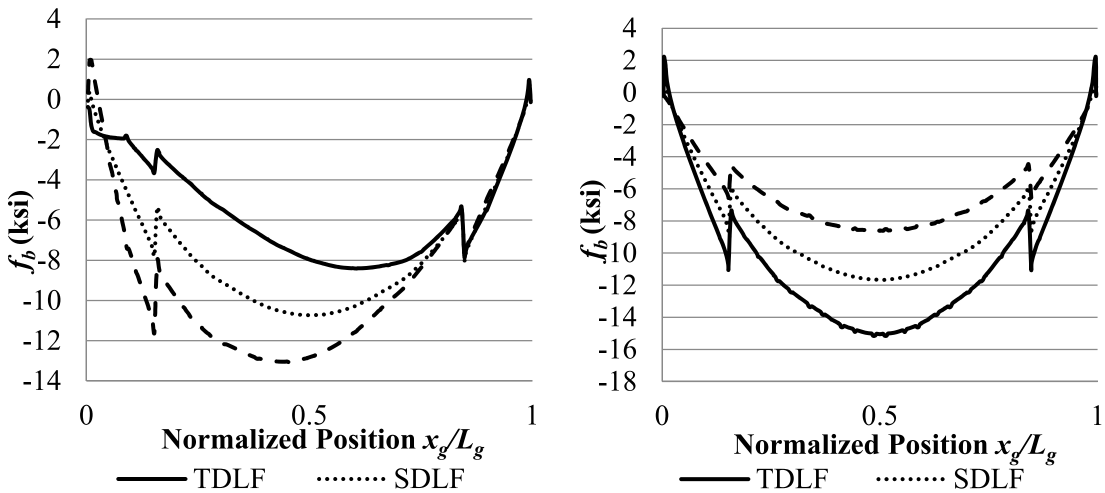


Figure 103. Top flange major-axis bending stresses in Bridge (J1) NISSS54 fascia girder (left) and innermost girder (right) under SDL with detailing based on LGA cambers.

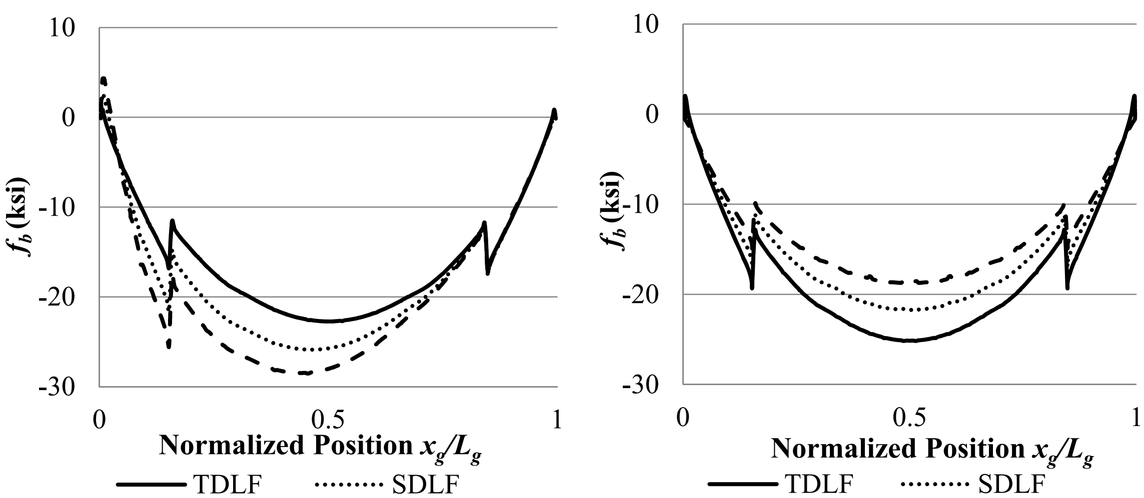


Figure 104. Top flange major-axis bending stresses in Bridge (J1) NISSS54 fascia girder (left) and innermost girder (right) under TDL with detailing based on LGA cambers.

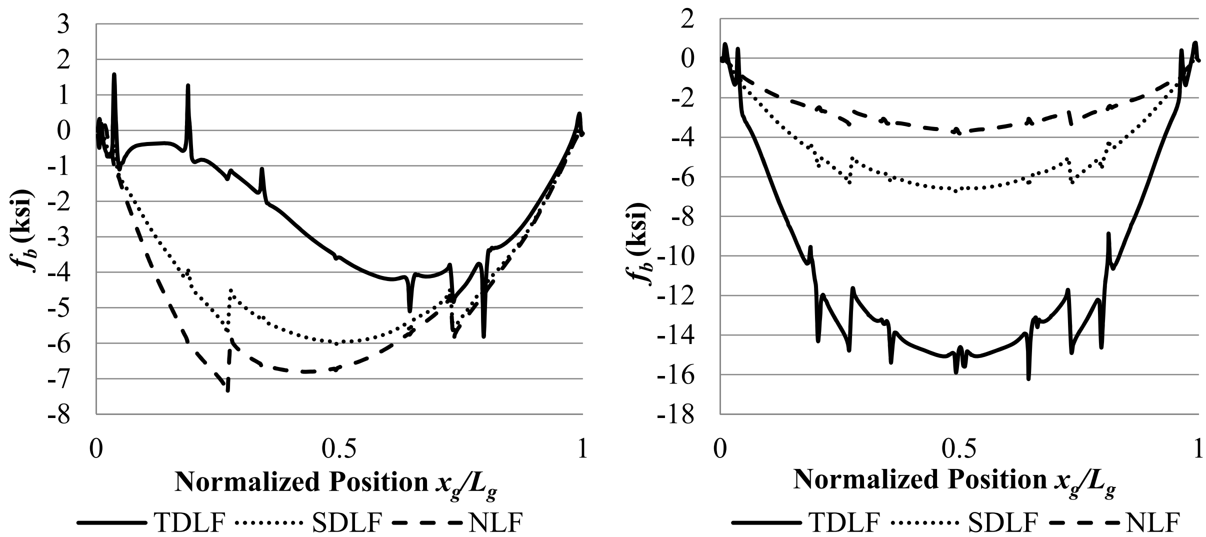


Figure 105. Top flange major-axis bending stresses in Bridge (I1) NISSS14 fascia girder (left) and innermost girder (right) under SDL with detailing based on LGA cambers.

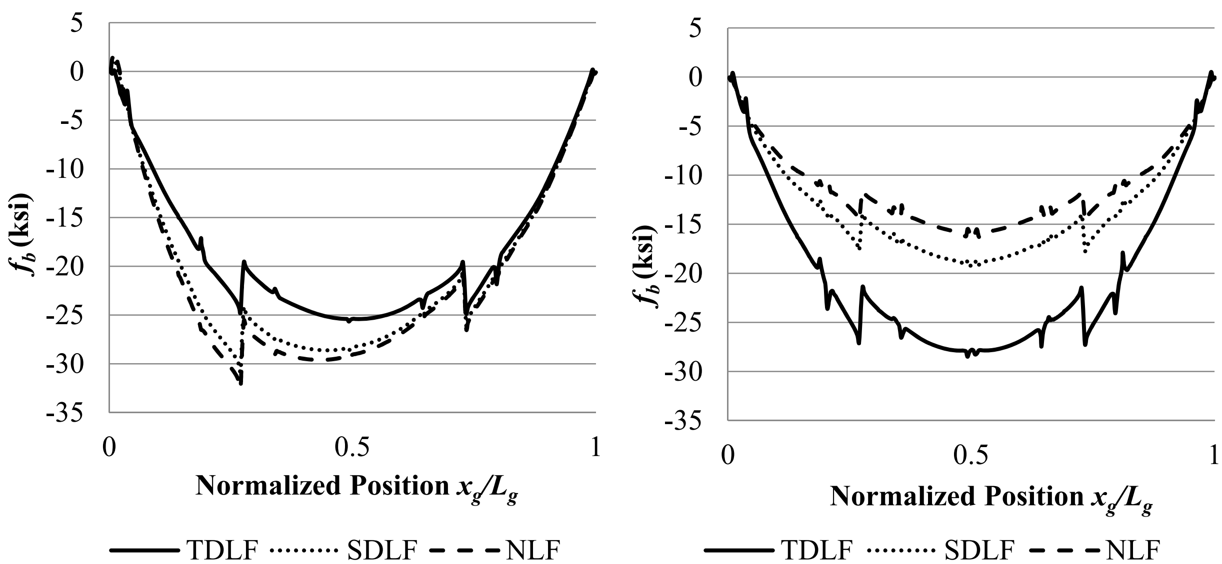


Figure 106. Top flange major-axis bending stresses in Bridge (I1) NISSS14 fascia girder (left) and innermost girder (right) under TDL with detailing based on LGA cambers.

The girder flange lateral bending stresses are theoretically zero under SDL for SDLF detailing and under TDL for TDLF detailing based on LGA cambers, and they are generally significant under TDL if NLF detailing is used (shown in Figures 107 through 110 for bridge cases (I1) and (J1), respectively). However, the stresses are actually non-zero under SDL for SDLF detailing and under TDL for TDLF detailing due to a number of factors, as discussed in Section 3.4.2.2.

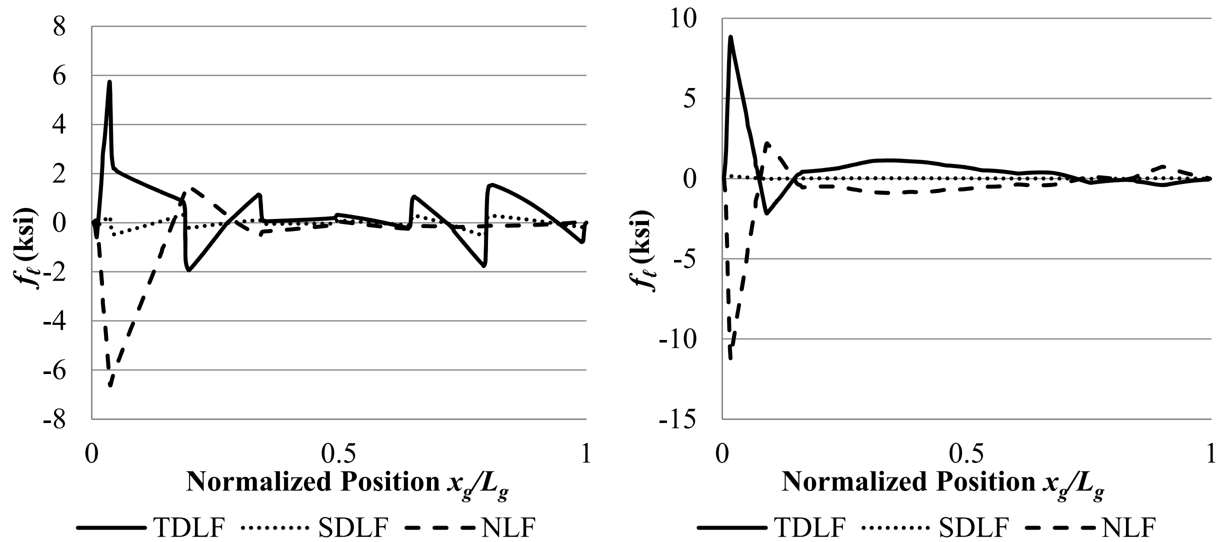


Figure 107. Top flange lateral bending stresses in fascia girder under SDL with detailing based on LGA cambers, in Bridge (I1) NISSS14 (left) and in bridge in Bridge (J1) NISSS54 (right).

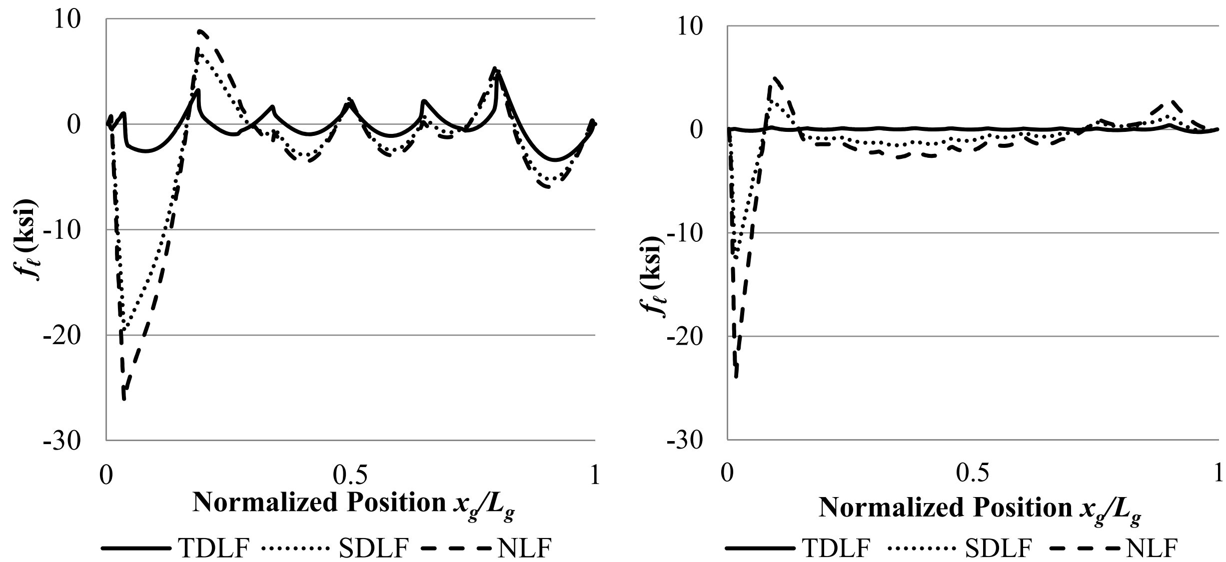


Figure 108. Top flange lateral bending stresses in fascia girder under TDL with detailing based on LGA cambers, in Bridge (I1) NISSS14 (left) and in bridge in Bridge (J1) NISSS54 (right).

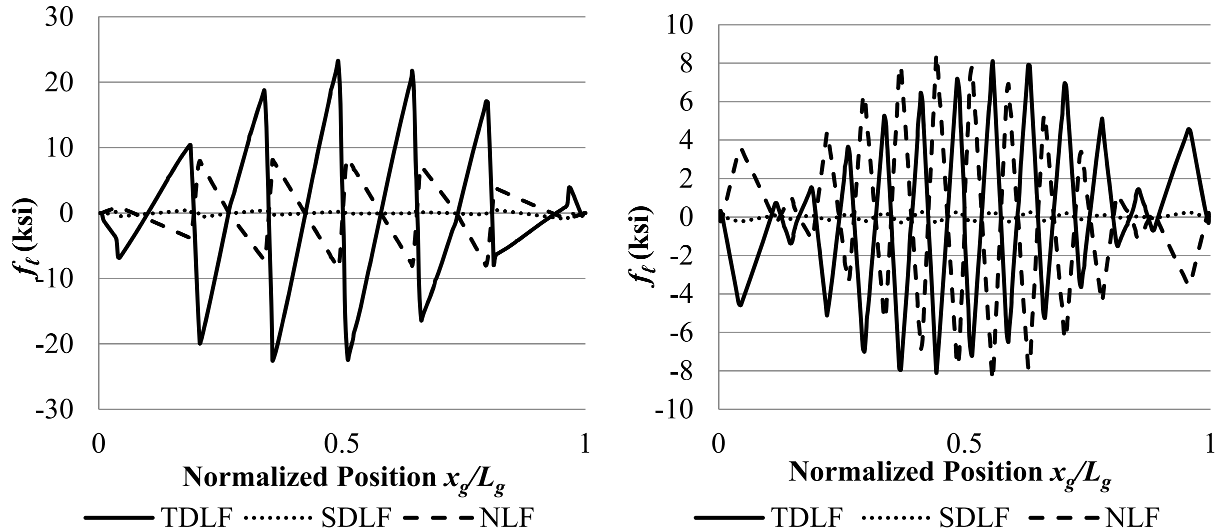


Figure 109. Top flange lateral bending stresses innermost girder under SDL with detailing based on LGA cambers in Bridge (I1) NISSS14 (left) and in bridge in Bridge (J1) NISSS54 (right).

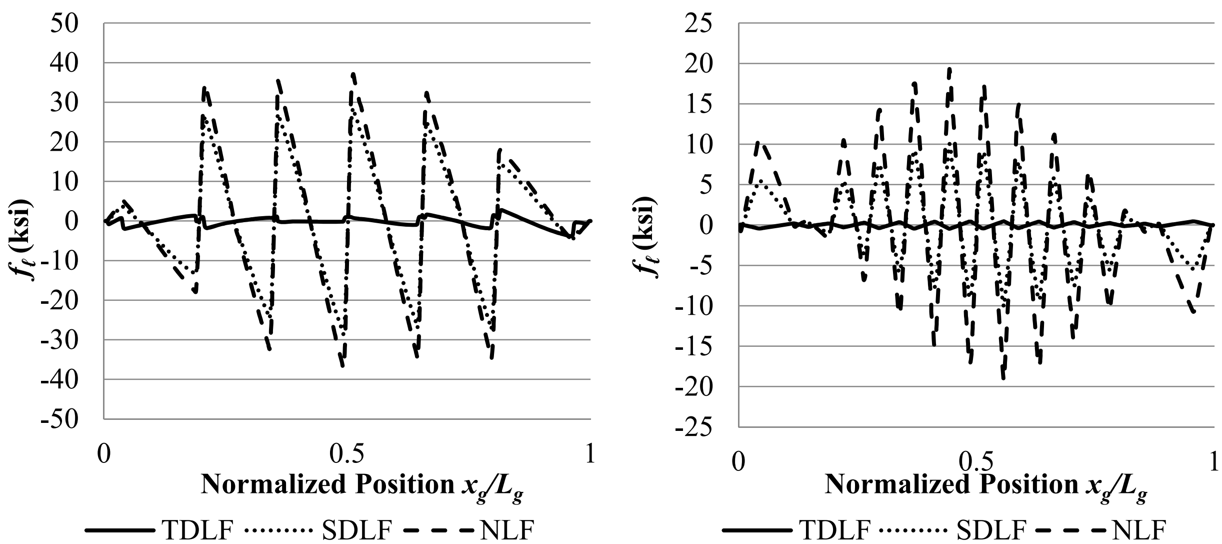


Figure 110. Top flange lateral bending stresses innermost girder under TDL with detailing based on LGA cambers in Bridge (I1) NISSS14 (left) and in bridge in Bridge (J1) NISSS54 (right).

From Figure 111, one can observe that, for straight bridges with parallel skew, the girder flange lateral bending stresses under SDL with TDLF detailing are approximately equal in magnitude but opposite in sign to the flange lateral bending stresses under TDL with SDLF detailing. With SDLF detailing, the flange lateral bending stresses are theoretically zero under SDL. The flange lateral bending stresses with SDLF detailing under TDL are theoretically equal to the flange lateral bending stresses due to the CDL from 3D FEA. With TDLF detailing based on LGA cambers, the flange lateral bending stresses are theoretically zero under TDL. The flange lateral bending stresses with TDLF detailing under SDL are theoretically equal to the negative of the flange lateral bending stresses due to the CDL from 3D FEA.

Tables 25 and 26 show the maximum magnitude of the girder stresses for NLF, SDLF and TDLF detailing based on LGA cambers for the critical fascia girder and the innermost girder, respectively, in the straight bridges with parallel skew studied in this research. The following can be observed:

- SDLF and TDLF detailing with LGA cambers imposes the LGA responses on the girders in the targeted DL condition.
- In bridges where the framing arrangement is improved to reduce the "nuisance" transverse stiffness effects, the girders in the bridge 3D system deflect in a fashion closer to that of the LGA model, and the changes in the major-axis bending stresses due to the DLF detailing are smaller.

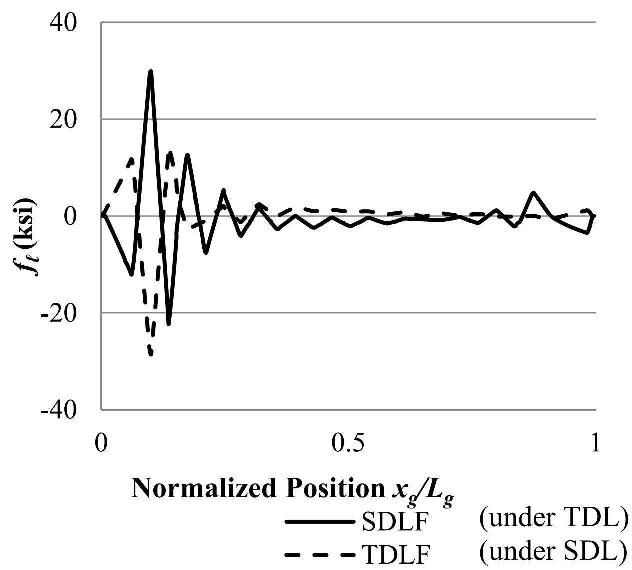


Figure 111. Top flange lateral bending stresses in Bridge (J1) NISSS54 interior girder adjacent to a fascia girder under TDL with SDLF detailing and under SDL with TDLF detailing (SDLF and TDLF detailing based on LGA cambers).

Table 25. Maximum magnitudes of major-axis bending stresses and top flange lateral bending stresses for the critical fascia girder in the straight skewed bridges studied in this research with the CFs detailed based on LGA cambers (f_{b1}, f_{b2} and f_{b3} are the maximum major-axis bending stresses, and $f_{\ell 1}$, $f_{\ell 2}$ and $f_{\ell 3}$ are the maximum girder flange lateral bending stresses for NLF, SDLF, and TDLF detailing, respectively; the largest f_{b2}/f_{b1} and $f_{\ell 2}/f_{\ell 1}$ under SDL for SDLF and f_{b3}/f_{b1} and $f_{\ell 3}/f_{\ell 1}$ under TDL for TDLF are highlighted by dark shading).

Load Cond.	Bridge	NLF		SDLF				TDLF			
		f_{b1} (ksi)	$f_{\ell 1}$ (ksi)	f_{b2} (ksi)	$\frac{f_{b2}}{f_{b1}}$	$f_{\ell 2}$ (ksi)	$\frac{f_{\ell 2}}{f_{\ell 1}}$	f_{b3} (ksi)	$\frac{f_{b3}}{f_{b1}}$	$f_{\ell 3}$ (ksi)	$\frac{f_{\ell 3}}{f_{\ell 1}}$
SDL	(I1) NISSS14	7.4	6.6	6.0	0.81	0.5	0.08	5.8	0.78	5.7	0.86
	(I2) NISSS14	6.8	2.5	6.2	0.91	1.2	**0.48**	4.5	0.66	7.3	2.92
	(J1) NISSS54	13.1	11.2	10.7	0.82	0.2	0.02	8.1	0.62	8.8	0.79
	(J2) NISSS54	12.0	4.1	10.7	0.89	0.3	0.07	8.5	0.71	3.2	0.78
	(K1) EICSS12	4.1	1.2	3.6	0.88	0.0	0.00	3.3	0.80	4.0	3.33
	(K2) EICSS12	3.9	0.8	3.6	0.92	0.0	0.00	3.4	0.87	2.9	3.63
	(K3) EICSS12	3.9	0.2	3.5	0.90	0.0	0.00	3.2	0.82	0.6	3.00
	(L) NICSS16	3.7	0.7	3.4	0.92	0.0	0.00	2.5	0.68	2.2	3.14
	(M1) EICSS2	7.7	0.9	7.4	0.96	0.0	0.00	7.6	0.99	1.9	2.11
	(M2) EICSS2	7.4	0.5	7.3	0.99	0.0	0.00	7.0	0.95	0.9	1.80

Table 25 (Continued). Maximum magnitudes of major-axis bending stresses and top flange lateral bending stresses for the critical fascia girder in the straight bridges with parallel skew studied in this research with the CFs detailed based on LGA cambers (f_{b1}, f_{b2} and f_{b3} are the maximum major-axis bending stresses, and $f_{\ell 1}$, $f_{\ell 2}$ and $f_{\ell 3}$ are the maximum girder flange lateral bending stresses, with NLF, SDLF, and TDLF detailing, respectively; the largest f_{b2}/f_{b1} and $f_{\ell 2}/f_{\ell 1}$ under SDL for SDLF and f_{b3}/f_{b1} and $f_{\ell 3}/f_{\ell 1}$ under TDL for TDLF are highlighted by dark shading).

Load Cond.	**Bridge**	**NLF**		**SDLF**				**TDLF**			
		f_{b1} **(ksi)**	$f_{\ell 1}$ **(ksi)**	f_{b2} **(ksi)**	$\frac{f_{b2}}{f_{b1}}$	$f_{\ell 2}$ **(ksi)**	$\frac{f_{\ell 2}}{f_{\ell 1}}$	f_{b3} **(ksi)**	$\frac{f_{b3}}{f_{b1}}$	$f_{\ell 3}$ **(ksi)**	$\frac{f_{\ell 3}}{f_{\ell 1}}$
TDL	(I1) NISSS14	32.5	26.2	30.8	0.95	19.5	0.74	25.7	0.79	4.7	0.18
	(I2) NISSS14	29.6	7.5	28.8	0.97	5.9	0.79	26.1	0.88	4.4	0.59
	(J1) NISSS54	28.5	24	25.9	0.91	12.7	0.53	22.7	0.80	0.4	0.02
	(J2) NISSS54	26.9	6.5	25.3	0.94	3.3	0.51	22.8	0.85	0.7	0.11
	(K1) EICSS12	17.6	5.1	17.1	0.97	3.9	0.76	15.2	0.86	1.1	0.22
	(K2) EICSS12	17.1	3.2	16.7	0.98	2.5	0.78	15.2	0.89	1.0	0.31
	(K3) EICSS12	17.1	1.6	16.7	0.98	1.4	0.88	15.3	0.89	1.7	**1.06**
	(L) NICSS16	19.2	4.0	18.8	0.98	3.8	0.95	16.8	0.88	2.7	0.68
	(M1) EICSS2	23.7	2.6	23.3	0.98	1.7	0.65	22.9	**0.97**	1.0	0.38
	(M2) EICSS2	24.1	4.2	23.8	**0.99**	3.0	0.71	23.2	0.96	1.1	0.26

Table 26. Maximum magnitudes of major-axis bending stresses and top flange lateral bending stresses for the innermost girder in the straight bridges with parallel skew studied in this research with CFs detailed based on LGA cambers (f_{b1}, f_{b2} and f_{b3} are the maximum major-axis bending stresses, and $f_{\ell 1}$, $f_{\ell 2}$ and $f_{\ell 3}$ are the maximum girder flange lateral bending stresses for NLF, SDLF, and TDLF detailing, respectively; the largest f_{b2}/f_{b1} and $f_{\ell 2}/f_{\ell 1}$ under SDL for SDLF and f_{b3}/f_{b1} and $f_{\ell 3}/f_{\ell 1}$ under TDL for TDLF are highlighted by dark shading).

Load Cond.	Bridge	NLF		SDLF				TDLF			
		f_{b1} (ksi)	$f_{\ell 1}$ (ksi)	f_{b2} (ksi)	$\frac{f_{b2}}{f_{b1}}$	$f_{\ell 2}$ (ksi)	$\frac{f_{\ell 2}}{f_{\ell 1}}$	f_{b3} (ksi)	$\frac{f_{b3}}{f_{b1}}$	$f_{\ell 3}$ (ksi)	$\frac{f_{\ell 3}}{f_{\ell 1}}$
SDL	(I1) NISSS14	3.8	8.5	6.7	**1.76**	0.9	0.11	16.2	**4.26**	23.2	2.73
	(I2) NISSS14	5.5	12.5	6.3	1.15	0.6	0.05	10.4	1.89	41.1	3.29
	(J1) NISSS54	8.6	8.5	11.7	1.36	0.3	0.04	15.2	1.77	8.1	0.95
	(J2) NISSS54	10.1	7.5	10.9	1.08	0.5	0.07	11.8	1.17	10.5	1.40
	(K1) EICSS12	3.6	0.6	3.7	1.03	0.1	0.17	5.0	1.39	1.9	3.17
	(K2) EICSS12	3.7	0.5	3.7	1.00	0.1	**0.20**	3.8	1.03	1.6	3.20
	(K3) EICSS12	3.6	1.5	3.8	1.06	0.0	0.00	4.4	1.22	0.5	0.33
	(L) NICSS16	3.6	5.5	3.4	0.94	0.3	0.05	3.2	0.89	24.0	**4.36**
	(M1) EICSS2	6.1	0.6	7.1	1.16	0.0	0.00	9.1	1.49	1.1	1.83
	(M2) EICSS2	6.9	2.0	7.0	1.01	0.0	0.00	7.2	1.04	4.3	2.15

Table 26 (Continued). Maximum magnitudes of major-axis bending stresses and top flange lateral bending stresses for the innermost girder in the straight bridges with parallel skew studied in this research with CFs detailed based on LGA cambers (f_{b1}, f_{b2} and f_{b3} are the maximum major-axis bending stresses, and $f_{\ell 1}$, $f_{\ell 2}$ and $f_{\ell 3}$ are the maximum girder flange lateral bending stresses, with NLF, SDLF, and TDLF detailing, respectively; the largest f_{b2}/f_{b1} and $f_{\ell 2}/f_{\ell 1}$ under SDL for SDLF and f_{b3}/f_{b1} and $f_{\ell 3}/f_{\ell 1}$ under TDL for TDLF are highlighted by dark shading).

Load Cond.	**Bridge**	**NLF**		**SDLF**				**TDLF**			
		f_{b1} **(ksi)**	$f_{\ell 1}$ **(ksi)**	f_{b2} **(ksi)**	$\frac{f_{b2}}{f_{b1}}$	$f_{\ell 2}$ **(ksi)**	$\frac{f_{\ell 2}}{f_{\ell 1}}$	f_{b3} **(ksi)**	$\frac{f_{b3}}{f_{b1}}$	$f_{\ell 3}$ **(ksi)**	$\frac{f_{\ell 3}}{f_{\ell 1}}$
TDL	(I1) NISSS14	16.5	37.2	19.3	**1.17**	28.4	0.76	28.5	**1.73**	3.8	0.10
	(I2) NISSS14	24.8	61.6	25.5	1.03	48.0	0.78	27.7	1.12	2.5	0.04
	(J1) NISSS54	18.8	19.3	21.7	1.15	10.1	0.52	25.2	1.34	0.5	0.03
	(J2) NISSS54	22.8	19.8	23.5	1.03	10.6	0.54	24.3	1.07	0.8	0.04
	(K1) EICSS12	14.5	2.5	14.8	1.02	2.0	0.80	15.8	1.09	0.8	0.32
	(K2) EICSS12	16.0	2.5	16.0	1.00	1.9	0.76	15.9	0.99	0.9	**0.36**
	(K3) EICSS12	15.1	6.3	15.2	1.01	4.7	0.75	15.8	1.05	0.7	0.11
	(L) NICSS16	18.5	30.9	18.4	0.99	24.7	0.80	18.1	0.98	0.3	0.01
	(M1) EICSS2	19.4	1.7	20.3	1.05	1.1	0.65	22.3	1.15	0.1	0.06
	(M2) EICSS2	21.7	7.2	21.7	1.00	5.2	0.72	21.8	1.00	1.8	0.25

- If DLF detailing is conducted using LGA cambers on a straight skewed bridge, it is not acceptable in general to simply build a 3D model of the bridge and turn gravity on.
- A 3D FEA or accurate RA that correctly incorporates the initial lack-of-fit effects from the DLF detailing will produce accurate results.
- It is possible for the engineer to combine results from LGA of the targeted DL condition with accurate RA solutions for all the other responses, but the chances for costly errors are high.
- Regardless of the method of detailing, straight skewed bridges respond as 3D systems once the girders are interconnected.

3.4.6.1.6 Vertical Reactions

In straight bridges with parallel skew, the skew effects tend to twist the girders such that they layover in the direction towards the acute corner of the bearing lines. With NLF detailing, the vertical reactions tend to be larger on the girders near the obtuse corner and smaller on the girders near the acute corner along each of the skewed bearing lines, except that the reaction for the fascia girders can be opposite to this trend. Table 27 shows the corresponding results for Bridge (J1) NISSS54. In this bridge case, because of the severe nuisance transverse stiffness along the short direction between the obtuse corners of the span, the fascia girder reactions at the obtuse corners are substantially larger than the other reactions if NLF detailing is used. SDLF and TDLF detailing based on LGA cambers substantially reduce these large reactions.

With SDLF and TDLF detailing based on LGA cambers, the girders in straight skewed bridges behave as line girders under the targeted load condition. The vertical reactions can be calculated accurately with LGA for each of the girders in this condition – SDL for SLDF and TDL for TDLF, but they cannot be calculated accurately with LGA in any other condition. This statement of course applies to all the other bridge DL responses as well. The reactions for SDLF under TDL can be calculated as the sum of the LGA SDL reactions and NLF RA CDL reactions. The reactions for TDLF under SDL can be calculated as the sum of the LGA TDL reactions and the negative of the NLF RA CDL reactions.

Table 27. Bridge (J1) NISSS54 vertical reactions (kip) (G1 and G9 are fascia girders, bearing locations experiencing uplift are highlighted by dark shading), detailing based on LGA cambers.

Girder	Detailing Method	SDL Support 1	SDL Support 2	TDL Support 1	TDL Support 2
G1	NLF	387	145	833	329
	SDLF	138	145	588	323
	TDLF	**Uplift**	140	304	314
G2	NLF	61	171	133	367
	SDLF	160	157	231	353
	TDLF	100	145	345	341
G3	NLF	121	174	267	375
	SDLF	157	157	302	359
	TDLF	233	139	343	343
G4	NLF	94	127	202	279
	SDLF	159	158	270	309
	TDLF	232	192	345	344
G5	NLF	109	109	238	238
	SDLF	158	158	288	288
	TDLF	209	209	344	344
G6	NLF	127	94	279	201
	SDLF	158	159	309	269
	TDLF	192	233	344	345
G7	NLF	174	121	375	267
	SDLF	157	158	360	302
	TDLF	139	233	343	343
G8	NLF	170	63	366	139
	SDLF	157	160	353	234
	TDLF	145	98	342	347
G9	NLF	146	384	330	828
	SDLF	144	137	323	584
	TDLF	139	**Uplift**	313	302

From Table 28, it can be observed that the largest maximum absolute and percentage increases in the TDL reactions are 98 kip and 74 % respectively, due to SDLF detailing based on LGA cambers, for the straight bridges with parallel skew considered in this research. This occurs in Bridge (J1) which has substantial nuisance transverse stiffness. The maximum absolute and percentage increases in the TDL reactions are 212 kip and 159 % respectively, also in this bridge, due to TDLF detailing based on LGA cambers.

From Table 28, it can also be observed that the largest maximum absolute and percentage decreases in the TDL reactions are 245 kip and 29 % respectively, due to SDLF detailing based on LGA cambers, for the straight bridges with parallel skew considered in this research. This occurs in Bridge (J1) which has substantial nuisance transverse stiffness. The maximum absolute and percentage decreases in the TDL reactions are 529 kip and 64 % respectively, also in this bridge, due to TDLF detailing based on LGA cambers. It is evident from Tables 27 and 28 that with TDLF detailing based on LGA cambers, uplift may occur at the obtuse corner on the fascia girder bearings, particularly during the erection of the steel. This uplift force is exacerbated with longer spans and sharper skews. In addition, uplift at the supports is more likely to occur with contiguous framing arrangements and staggered framing arrangements with small stagger distances and small offsets from the skewed bearing lines (i.e., when the bridge has highly stiff transverse load paths). These issues are relieved by the recommended CF framing arrangements discussed in Section 3.5. Bridge (J2) illustrates these framing arrangement recommendations. This bridge substantially reduces the maximum absolute and percentage decreases in the TDL reactions to 75 kip and 19 %, respectively due to TDLF. For SDLF, the maximum absolute and percentage decreases in the TDL reactions are only 33 kip and 8 %.

Table 28. Summary of maximum absolute and percentage increases and decreases in the TDL vertical reactions at the girder bearings, due to SDLF and TDLF detailing based on LGA cambers, in the straight skewed bridges (the largest of these maximum absolute and percentage increases decreases are highlighted by dark shading).

Bridge	SDLF				TDLF			
	Max Decrease (kip)	Max % Decrease	Max Increase (kip)	Max % Increase	Max Decrease (kip)	Max % Decrease	Max Increase (kip)	Max % Increase
(I1) NISSS14	-27	-12	12	16	-182	-50	48	65
(I2) NISSS14	-11	-7	9	11	-50	-29	41	51
(J1) NISSS54	**-245**	**-29**	**98**	**74**	**-529**	**-64**	**212**	**159**
(J2) NISSS54	-33	-8	16	5	-75	-19	35	12
(K1) EICSS12	-1	-2	1	1	-6	-9	4	6
(K2) EICSS12	-1	-2	1	1	-6	-7	3	5
(K3) EICSS12	-1	-2	1	1	-4	-7	3	5
(L) NICSS16	-5	-5	3	5	-25	-27	16	29
(M1) EICSS2	-45	-8	67	28	-139	-23	205	85
(M2) EICSS2	-28	-5	22	6	-88	-16	67	18

3.4.6.2 Summary and Recommendations – Straight Bridges with Parallel Skew and Cambers Set Based on LGA

The influence of SDLF and TDLF detailing on the responses in completed straight bridge systems with parallel skew and girder cambers calculated based on LGA may be summarized as follows. Recommendations pertaining to these quantitative results are highlighted in bold italicized text.

General

- Straight bridges with a difference in the skew angles at the ends of all the spans less than or equal to $\Delta\theta = 20^{o}$ may be considered as parallel skew bridges.
- The use of LGA for setting the girder cambers in sharply skewed straight bridges is generally discouraged based on the considerations discussed in Section 3.4.2.3.

Girder Elevations

- The use of LGA to calculate the vertical displacements associated with the CDL, for SDLF, or associated with the TDL, for NLF, results in measurable elevation errors. For the most extreme bridge case considered in this research, (I1) NISSS14, the largest deviation from the targeted elevations under TDL is 2.7 inches for SDLF detailing and 3.5 inches for NLF detailing when LGA is used for all of the vertical deflection calculations. Bridge (J1) NISSS54 has corresponding deviations from the targeted elevations under TDL of 2.0 inches for SDLF and 3.5 inches for NLF.
- The largest deviation from the targeted elevations under TDL is 0.3 inches, corresponding to Bridge (J2) NISSS54, when TDLF detailing based on LGA cambers is employed. These deviations from the targeted elevations are due to the incidental effects discussed earlier in Section 3.4.2.2.
- ***Based on these findings, it is recommended that LGA alone should not be utilized for calculation of the girder total cambers in straight bridges with parallel skew, unless TDLF detailing is employed.***
- If the girder total camber for SDLF is calculated based on the SDL camber from LGA plus the negative of the CDL deflections from RA, then the largest deviation from the targeted elevations under TDL is reduced to 0.4 inches for the most extreme case considered in this research, Bridge (J1) NISSS54.
- ***Based on these findings, it is recommended that, if LGA is used for calculating the girder cambers in straight bridges with parallel skew, the girder TDL cambers should be calculated as follows:***
    - ***For TDLF, the negative of the girder TDL vertical deflections obtained from the LGA.***
    - ***For SDLF, the negative of the girder SDL vertical deflections obtained from the LGA plus the negative of the CDL vertical deflections obtained from a NLF RA.***

Girder Layovers

- All the straight bridges with parallel skew considered in this research exhibit practically zero layover under TDL, for TDLF, when the TDL camber is based on LGA.
- All the straight bridges with parallel skew considered in this research exhibit practically zero layover under SDL, for SDLF, when the SDL camber is based on LGA.

- The calculated girder non-zero layovers under the SDL for TDLF, and under the TDL for SDLF, are very close to the theoretical values.
- ***It is recommended that the girder layovers may be assumed to be negligible in the targeted DL condition in straight bridges with parallel skew when the CFs are detailed using the above recommended procedures with LGA. The fascia girders should be checked separately for twist rotation between the CF locations due to eccentric overhang bracket loads.***
- ***For straight bridges with parallel skew, detailed for SDLF using the above recommended procedures with LGA, the girder layovers under the TDL may be estimated as the CDL layovers obtained from a NLF RA.***
- ***For straight bridges with parallel skew, detailed for TDLF using the above recommended procedures with LGA, the girder layovers under the SDL may be estimated as the negative of the CDL layovers obtained from a NLF RA.***

Cross-Frame Forces

- Under SDL, the largest ratio of the average of the CF member forces for SDLF detailing (in each bridge) to the corresponding forces for NLF detailing is 0.48 (in straight bridges with parallel skew, when the CFs are detailed using the above recommended procedures with LGA). This ratio corresponds to the bridge with the next to the largest skew index of all the bridges studied, (I2) NISSS14. The CF forces are substantially reduced by an improved framing arrangement (and are thus relatively small) in this particular bridge. The above ratio is close to zero for nearly all of the other bridges studied. The next largest value is 0.25.
- Under SDL, the largest ratio of the maximum CF member force (in each bridge) for SDLF detailing to the corresponding force for NLF detailing is 0.31. That is, the beneficial locked-in force is 1.0 – 0.31 = 0.69 of the CF force corresponding to NLF detailing for this member.
- Under TDL, the largest ratio of the average of the CF member forces for TDLF detailing (in each bridge) to the corresponding forces for NLF detailing is 0.48. These values are greater than or equal to 0.12 for all but one of the other bridges studied. The larger ratios correspond to cases with smaller NLF CF forces.
- Under TDL, the largest ratio of the maximum CF member force for TDLF detailing to that for NLF detailing, is again 0.31. Many of the other bridges have similar maximum values. That is,

the beneficial locked-in force is 1.0 – 0.31 = 0.69 of the CF force corresponding to NLF detailing for this member.

- The statistics for the percent change in the individual CF member forces relative the member yield load due to SDLF and TDLF detailing indicate a wide range (dispersion) of individual CF member force effects, but a predominant tendency for reduction of the CF member forces in parallel-skew straight bridges due to SDLF and TDLF detailing.
- There is a substantial reduction in the maximum CF member forces, particularly for bridges with a nuisance transverse stiffness problem, by the use of SDLF and TDLF detailing. The reduction due to TDLF is as large as 345 kip under the TDL in the most extreme case, Bridge (J1) NISSS54. Using the recommended improved framing arrangements, as shown for Bridge (J2) NISSS54, results in a further significant reduction in the overall magnitude of the CF forces.
- ***In lieu of a DLF RA, it is recommended that a net load factor of (γ_p – 0.65) be used for determination of the factored SDL CF forces in straight I-girder bridges with parallel skew, when the CFs are detailed for SDLF using the above recommended procedures with LGA. This net load factor is to be applied to the results from a NLF RA for the SDL. It should be noted that these SDL CF forces must be added to the factored CDL CF forces from a NLF RA to obtain the total factored DL CF forces.*** The factor of 0.65 is a slightly conservative estimate of the above SLDF locked-in force ratio of 1.0 – 0.31 = 0.69.
- ***In lieu of a DLF RA, it is recommended that a net load factor of (γ_p – 0.65) be used for determination of the factored TDL CF forces in straight I-girder bridges with parallel skew, when the CFs are detailed for TDLF using the above recommended procedures with LGA. This net load factor is to be applied to the results from a NLF RA for the TDL. The factored CF forces under the SDL may be estimated by subtracting the factored CDL CF forces obtained by a NLF RA from the above factored TDLF forces.*** The factor of 0.65 is a conservative estimate of the above TDLF locked-in force ratio of 1.0 – 0.31 = 0.69. In cases where additional uncertainties and variabilities associated with TDLF are anticipated, such as incidental participation of deck forms and early concrete stiffness in the structural resistance, and/or larger potential play in the CF connections due to the larger CF forces associated with TDLF, it is suggested that a value between 0.65 and 0.50 may be used for the above locked-in force estimate based on the judgment of the engineer of record. This suggested reduction is

based on the judgement of the research team. The current research did not perform any specific investigations of the above effects.

- The maximum difference in the magnitude of the individual CF member forces from a DLF RA and (1 – 0.65 = 0.35) of the estimated values from a NLF RA, normalized by the member yield load, is 1.1 and 4.8 %, and the average difference is -0.5 and -1.4 % for SDLF under SDL and TDLF under TDL, respectively, for the straight parallel skew bridges studied in this research and girder cambers based on LGA.

Girder Stresses

- For SDLF detailing, the largest girder flange lateral bending stress (f_ℓ) under SDL is 1.2 ksi for all the straight parallel-skew bridges studied when the CFs are detailed based on LGA using the above recommended procedures. This stress is theoretically equal to zero. The above stress occurs in the fascia girders of Bridge (I2) NISSS14 and is 48 % of the corresponding f_ℓ for NLF detailing. The next largest f_ℓ in the straight parallel-skew bridges studied, under SDL for SDLF, is 0.9 ksi (11 % of the corresponding f_ℓ for NLF detailing) and occurs in an interior girder of Bridge (I1) NSSS14. All the other bridge maximum girder f_ℓ values, under SDL for SLDF, are 0.6 ksi or smaller.
- For TDLF detailing, the largest girder f_ℓ under the TDL is 4.7 ksi for all the straight parallel-skew bridges studied when the CFs are detailed based on LGA using the above recommended procedures. This stress is theoretically equal to zero if the overhang eccentric bracket loads are not included in the structural analysis; however these loads are included in the TDLF-TDL values presented in this research. The above stress occurs in the fascia girders of (I1) NISSS14 and is 18 % of the corresponding f_ℓ for NLF detailing. The next largest girder f_ℓ values in the straight parallel-skew bridges studied, under TDL for TDLF, are 4.4 ksi in the fascia girders of (I2) NISSS14 (59 % of the corresponding f_ℓ for NLF detailing), 2.7 ksi in the fascia girders of Bridge (L) NICSS16 (68 % of the corresponding f_ℓ for NLF detailing), 3.8 ksi in an interior girder of (I1) NISSS14 (10 % of the corresponding f_ℓ for NLF detailing), and 2.5 ksi in an interior girder of (I2) NISSS14 (4 % of the corresponding f_ℓ for NLF detailing). All of the other maximum girder f_ℓ values are less than 2 ksi in all the straight parallel-skew bridges studied in this work.

- For all the bridges studied in this research, the use of an assumed locked-in f_ℓ of 0.65 of the f_ℓ from a NLF RA gives an accurate to conservative estimate of the f_ℓ values determined from a DLF RA.
- ***In lieu of a DLF RA, for straight bridges with parallel skew and with the CFs detailed for SDLF using the above recommended procedures with LGA, it is recommended that the above procedures for calculation of the CF forces also be used for determining the girder f_ℓ values.***
- For both SDLF and TDLF, the changes in the girder major-axis bending stresses (f_b) due to the effects of the CF detailing using the LGA cambers are substantial. The recommended framing arrangements that relieve nuisance transverse stiffness effects dramatically reduce the magnitude of these changes. In these cases, the deflections of the 3D bridge system obtained from NLF RA are much closer to the deflections obtained from LGA.
- The above substantive change in the girder major-axis bending stresses is because, for the targeted SDL or TDL condition, the lack-of-fit due to the DLF detailing with LGA cambers actually modifies the vertical displacements of the girders in the 3D system to the displacements associated with the LGA. This behavior is captured by a DLF RA, but is neglected by a NLF RA.
- The solution for f_b from a NLF RA can be substantially in error in sharply skewed bridges when the DLF detailing is based on LGA cambers.
- LGA gives accurate f_b values for the targeted DL condition – SDL for SDLF and TDL for TDLF.
- ***In lieu of a DLF RA, for straight bridges with parallel skew and with the CFs detailed using the above recommended procedures with LGA, it is recommended that the girder f_b values in the targeted DL condition be taken as the values from the LGA.***
- ***In lieu of a DLF RA, for straight bridges with parallel skew and with the CFs detailed for SDLF using the above procedures with LGA, the girder f_b values under the TDL may be estimated by adding the CDL f_b values obtained from a NLF RA to the SDL f_b values obtained from LGA.***
- ***In lieu of a DLF RA, for straight bridges with parallel skew and with the CFs detailed for TDLF using the above recommended procedures with LGA, the girder f_b values under SDL***

may be estimated by subtracting the CDL f_b values obtained from a NLF RA from the TDL f_b values obtained from LGA.

- The above procedures for calculating the girder f_b values differ from the recommended procedures for calculating the CF forces and the girder f_ℓ values. The CF force and f_ℓ procedures are more conservative based on the recognition that although the theoretical CF forces and girder flange lateral bending stresses are zero in the targeted DL condition, various incidental effects can result in measurable non-zero values for these forces and stresses.

Vertical Reactions

- The results for the girder reactions largely parallel the above results for the girder major-axis bending stresses.
- ***In lieu of a DLF RA, for straight bridges with parallel skew and with the CFs detailed using the above recommended procedures with LGA, it is recommended that the girder reactions in the targeted DL condition be taken as the values from the LGA.***
- ***In lieu of a DLF RA, for straight bridges with parallel skew and with the CFs detailed for SDLF using the above recommended procedures with LGA, the girder reactions under the TDL may be estimated by adding the CDL reactions obtained from a NLF RA to the SDL reactions obtained from LGA.***
- ***In lieu of a DLF RA, for straight bridges with parallel skew and with the CFs detailed for TDLF using the above recommended procedures with LGA, the girder reactions under SDL may be estimated by subtracting the CDL reactions obtained from a NLF RA from the TDL reactions obtained from LGA.***

The above recommendations are considered applicable for straight bridges with parallel skew up to 70^o and spans up to 300 ft. These limits are different from those listed in the tables for recommended fit conditions discussed in Section 4.1. The limits here are aimed at ensuring sufficient accuracy of the structural analysis whereas the limits discussed in Section 4.1 address broader questions of ensuring reliable fit-up of the structural steel.

For bridges that exceed these limits, it is recommended that DLF RA be considered. Section 3.9 explains the details of several procedures for conducting a DLF RA.

3.4.7 Straight Bridges with Parallel Skew and Cambers Set Based on NLF RA

Straight bridges with a difference in the skew angles at the ends of all the spans less than or equal to $\Delta\theta = 20^{o}$ may be considered as parallel skew bridges. This section studies a limited number straight bridges with parallel skew and cambers set based on NLF RA. These bridge cases are (I1) and (I2) NISSS14 and (J1) and (J2) NISSS54. These are the critical cases of all the straight parallel-skew bridges studied in this research.

Section 3.4.7.1 provides quantitative results on the influence of SDLF and TDLF detailing on bridge responses in these bridges with cambers set based on NLF RA. The influence of SDLF and TDLF is discussed on the responses in the following order: girder vertical displacements, girder elevations, girder layovers, CF forces, girder stresses, and vertical reactions. Section 3.4.7.2 then summarizes the influences on the key bridge responses, and provides recommendations for handling these effects. The recommendations are highlighted in bold italicized text.

3.4.7.1 Quantitative Results

3.4.7.1.1 Girder Vertical Displacements

For straight bridges with parallel skew and cambers set based on NLF RA, SDLF and TDLF detailing tend to reduce the vertical displacement of the fascia girders and increase the vertical displacement of the interior girders. The increase or decrease in the vertical displacements when the cambers are based on NLF RA is not as significant as when the cambers are based on LGA. This is because when the cambers are set based on NLF RA, the resulting targeted DL elevations are essentially the "natural" deflected elevations of the girders under the targeted DL in the 3D structural system. As such, the girders are subjected predominantly just to twist rotations to move them from their deflected out-of-plumb geometry in the 3D system to their approximately plumb targeted DL geometry, via the DLF detailing effects. The girder twisting is accomplished with relative ease when the straight girders are in this "natural" deflected geometry.

Figure 112 shows the fascia and middle girder TDL vertical displacements in Bridge (J1) NISSS54 if the CFs are detailed for TDLF based on the cambers calculated from NLF RA (calculated using the common practice of constructing a model of the full bridge system and "turning gravity on.") In this case, the fascia girder displacements are practically unaffected by the CF detailing, while the displacements on the middle girder are only slightly affected. The maximum displacement difference between TDLF and NLF is 0.83 inches on the middle girder.

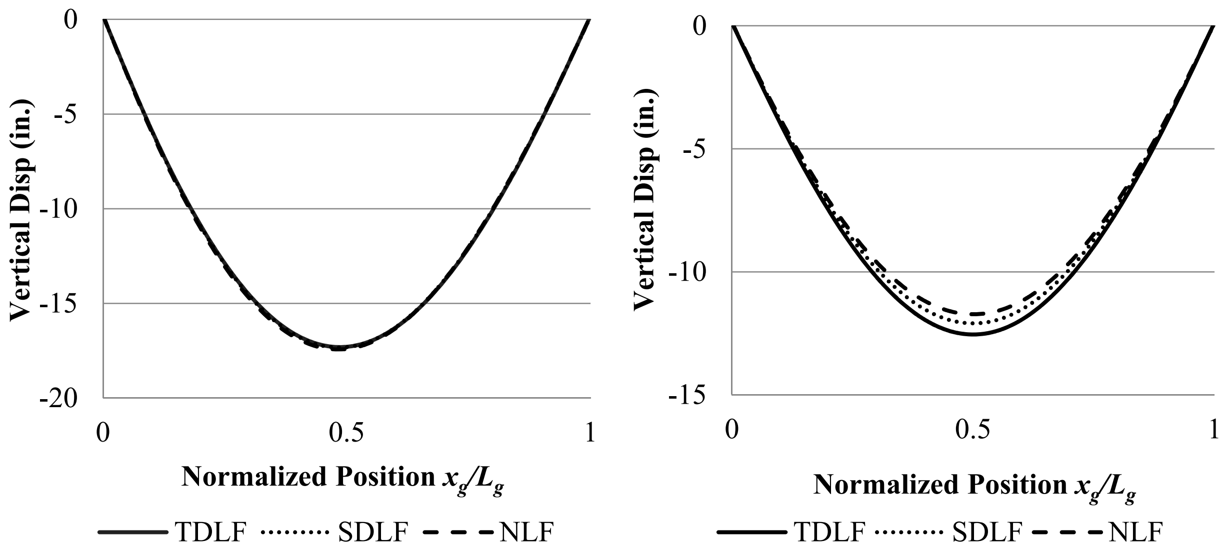


Figure 112. Bridge (J1) NISSS54 fascia girder (left) and middle girder (right) vertical displacements under TDL with the CFs detailed based on NLF RA cambers.

3.4.7.1.2 Girder Vertical Elevations

The girder cambers for the straight parallel-skew bridges in this section are based on NLF RA. The vertical elevations under TDL for NLF detailing are zero (assuming no superelevation, etc., as a simplification). Figures 113 and 114 show the results for the girder TDL elevations in Bridge (I1) NISSS14 and (J1) NISSS54, respectively, with all of the calculations conducted by NLF RA. The deviations from the targeted deviations in bridge cases (I1) and (J1) are larger than bridge cases (I2) and (J2) since (I1) and (J1) have substantially larger nuisance transverse stiffness. As one might expect, the elevations are the exact “zero” values for NLF detailing, since the bridge responds in this case as if the gravity loads were simply “turned on.” The vertical elevations deviate slightly from the targeted zero values for SDLF detailing, and the deviations are somewhat larger for the case of TDLF detailing. Bridge (J1) exhibits a maximum deviation of 0.8 inches from the targeted DL elevations for TDLF. Bridge (I1) exhibits a maximum deviation of 1.4 inches from the targeted DL elevations for TDLF.

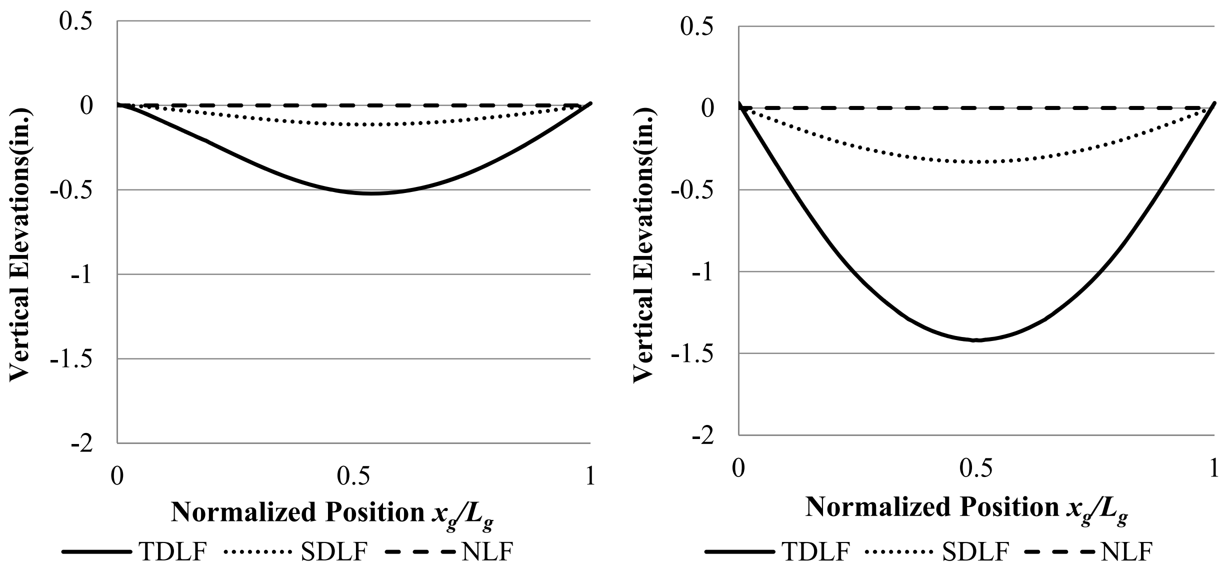


Figure 113. Bridge (I1) NISSS14 fascia girder (left) and middle girder (right) vertical elevations under TDL with the CF detailed based on 3D FEA and the girder TDL cambers based entirely on 3D FEA

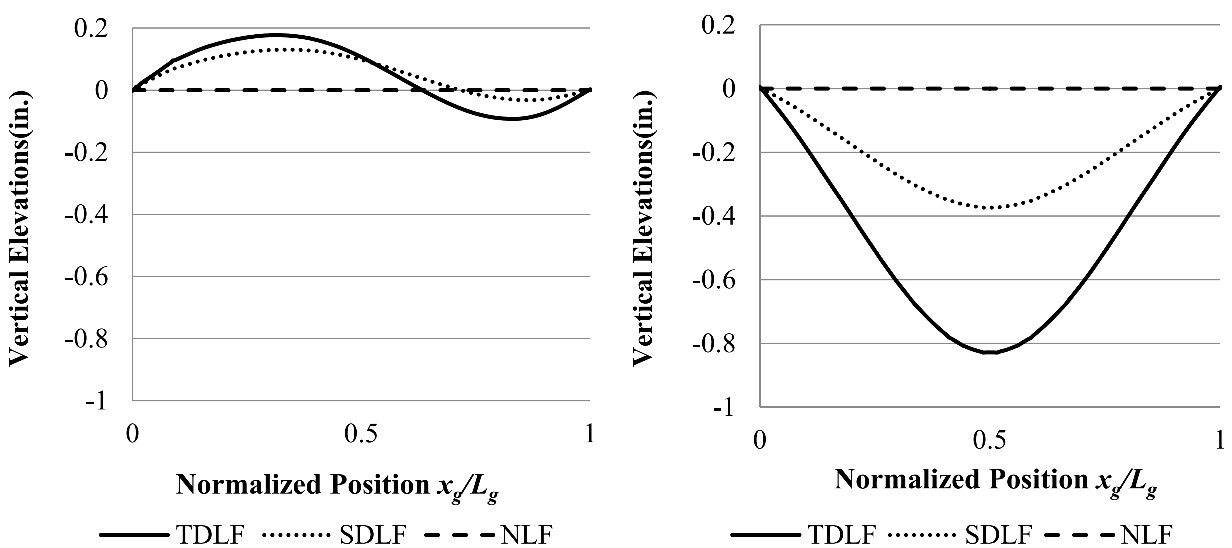


Figure 114. Bridge (J1) NISSS54 fascia girder (left) and middle girder (right) vertical elevations under TDL with the CF detailed based on 3D FEA and the girder TDL cambers based entirely on 3D FEA

3.4.7.1.3 Girder Layovers

In straight skewed bridges, SDLF and TDLF detailing based on RA cambers still gives approximately plumb webs under the targeted condition. However, the layovers are no longer theoretically zero under the targeted condition. This is due to the overall elastic deformations of the CFs and the elastic torsional deformations of the girders in the structural system. There is only one set of cambers and corresponding CF drops that gives theoretically exactly plumb webs for straight skewed bridges – the LGA cambers.

Figure 115 shows the fascia girder layovers under TDL for Bridge (J1) NISSS54 based on NLF RA. Table 29 shows the maximum girder layovers and twists in the critical straight parallel-skewed Bridge (I2) NISSS14. This bridge has the largest layovers in the straight parallel-skewed bridge cases based on NLF RA cambers studied in this section.

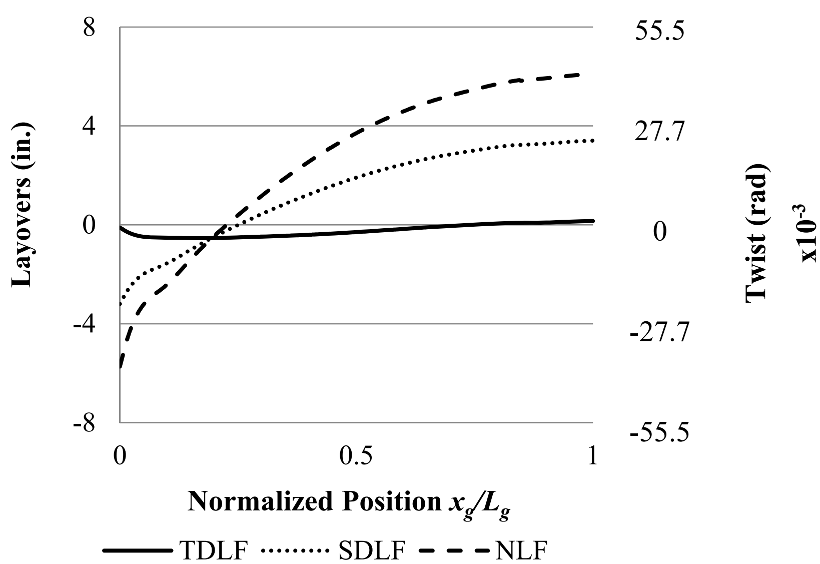


Figure 115. TDL fascia girder layovers Bridge (J1) NISSS54 for detailing based on NLF RA.

Table 29. Maximum magnitudes of girder layovers and twists in the critical straight parallel-skewed Bridge (I2) NISSS14 with CFs detailed entirely based on NLF RA cambers. (LO1, LO2, and LO3 are maximum girder layovers with NLF, SDLF, and TDLF detailing, respectively. $\phi 1$, $\phi 2$, and $\phi 3$ are maximum girder twists with NLF, SDLF, and TDLF detailing, respectively).

Load Cond.	Girder Depth (in.)	NLF		SDLF		TDLF	
		LO1 (in.)	ϕ1 (rad) x10^{-3}	LO2 (in.)	ϕ2 (rad) x10^{-3}	LO3 (in.)	ϕ3 (rad) x10^{-3}
SDL	72	0.7	9.7	0.1	1.4	2.6	36.1
TDL	"	3.2	44.4	2.6	36.1	0.6	8.3

3.4.7.1.4 Cross-Frame Forces

In straight skewed bridges, SDLF and TDLF detailing based on RA cambers gives small CF forces under the targeted condition. However, the CF forces are no longer theoretically zero under the targeted condition due to the overall elastic deformations of the CFs and the elastic torsional deformations of the girders in the structural system. Table 30 shows the average and maximum magnitude of the CF forces for the critical bridge cases (J1) and (J2) NISSS54. There is clearly a substantial reduction in the average of the CF member forces as well as in the maximum CF member force due to SDLF and TDLF with RA cambers for the straight parallel skew bridges considered in this research, in cases where the CF member forces are relatively large due to nuisance transverse stiffness effects. However, for the alternate framing plans where the CF forces are significantly reduced, the effect of SLDF or TDLF detailing with RA cambers on the CF forces is relatively erratic.

It is apparent that given the reductions in the cross-frame forces due to the improved framing arrangement in Bridge (J2), the incidental effects discussed in Section 3.4.2.2 combined with the influence of the elastic deformations of the CFs and elastic torsional deformations of the girders within the 3D bridge system has a substantial influence on these smaller CF forces for SDLF. As a result, under SDL, the largest ratio of the average of the CF member forces for SDLF detailing with RA cambers to the corresponding average force for NLF detailing is 1.28 in Table 30. As such, the estimation of the CF forces from DLF RA as simply 1.0 of the NLF RA results is considered below for SDL/SDLF. Under TDL, the largest ratio of the maximum CF member force for TDLF detailing with RA cambers to the corresponding force for NLF detailing is 0.55 in Table

30, corresponding to Bridge (J2). Therefore, the estimation of the CF forces from DLF RA as 0.6 of the NLF RA results is considered below for TDL/TLDF.

Figure 116 shows the actual distribution of the CF forces under the SDL in Bridge (J2) NISSS54, including the locked-in force effects from SDLF detailing with NLF RA cambers. The presentation of the CF forces in these plots, as well as the plots in the subsequent figures is similar to that for Figures 70 through 81 in Section 3.4.5.1.4. The reader is referred to this previous section for an explanation of these details. One can observe that the largest of the CF member forces in Figure 116 is approximately 31 kip.

Table 30. Average and maximum magnitude of the CF member forces in the critical bridge cases (J1) and (J2) NISSS54 (F1, F2, and F3 are the average and maximum CF forces with NLF, SDLF, and TDLF detailing based on NLF RA cambers, respectively). The largest F2/F1 ratio under SDL for SDLF and F3/F1 ratio under TDL for TDLF are highlighted by dark shading.

	Load Cond.	Bridge	NLF	SDLF		TDLF	
			F1 (kip)	F2 (kip)	F2/F1	F3 (kip)	F3/F1
Average	SDL	(I2) NISSS14	3.3	2.3	0.70	10.8	3.27
		(J1) NISSS54	19.4	7.4	0.38	13.9	0.72
		(J2) NISSS54	5.7	7.3	**1.28**	8.9	1.56
	TDL	(I2) NISSS14	13.9	12.5	0.90	9.5	**0.68**
		(J1) NISSS54	42.9	29.2	0.68	16.3	0.38
		(J2) NISSS54	13.5	13.4	0.99	6.4	0.47
Maximum	SDL	(I2) NISSS14	29.8	15.1	0.51	45.2	
		(J1) NISSS54	162.4	31.8	0.20	252.6	1.56
		(J2) NISSS54	25.4	30.9	**1.22**	20.8	0.82
	TDL	(I2) NISSS14	130.8	116.0	0.89	63.6	
		(J1) NISSS54	354	155.8	0.44	73.6	0.21
		(J2) NISSS54	58.5	38.9	0.66	32.3	**0.55**

Figure 117 shows an estimate of the CF member forces under SDL, assuming SDLF detailing, estimated as 1.0 of the NLF RA member forces. One can observe that the maximum chord forces are slightly over-estimated – the maximum DLF RA chord force is 19.5 kip whereas the prediction from the NLF RA is 25.4 kip. However, maximum diagonal forces are somewhat under-estimated – the maximum DLF RA diagonal force is 30.9 kip while the prediction from the NLF RA is 18.9 kip. However, this difference is judged to be acceptable given the small magnitude of the forces, and given the further considerations discussed below. Similar to the results discussed for straight skewed bridges and LGA cambers in Section 3.4.6.1.4, the pattern of the NLF RA CF forces is very different from that of the DLF RA forces though.

Figure 118 shows the difference between the magnitude of the DLF RA forces and the CF forces under SDL, assuming SDLF detailing, estimated by 1.0 of the NLF RA forces, divided by the CF member yield loads. The plots in this figure are similar to those discussed previously in Sections 3.4.5.1.4 and 3.4.6.1.4. One can observe that the largest under-prediction of the DLF RA results is $0.045P_y$ for several of the diagonals, while the largest over-prediction is $-0.062P_y$ on several diagonals using the suggested estimate on Bridge (J2) NISSS54. Figure 119 shows the same results as Figure 118, but under TDL and assuming TDLF detailing. The maximum under-prediction is $0.0016P_y$ and the largest over-prediction is $-0.059P_y$ for this case.

Figures 120 and 121 show comparable results to Figures 118 and 119 for the other critical Bridge (I2) NISSS14. For this bridge, the largest under-prediction is $0.011P_y$ for SDL/SDLF and $0.051P_y$ for TDL/TDLF, whereas the largest over-prediction is $-0.032P_y$ for SDL/SDLF and $-0.052P_y$ for TDL/TLDF.

Similar to the previous estimates, the largest under-prediction approximately $0.05P_y$ for all the cases considered, given the CF member sizes selected in the original bridge designs.

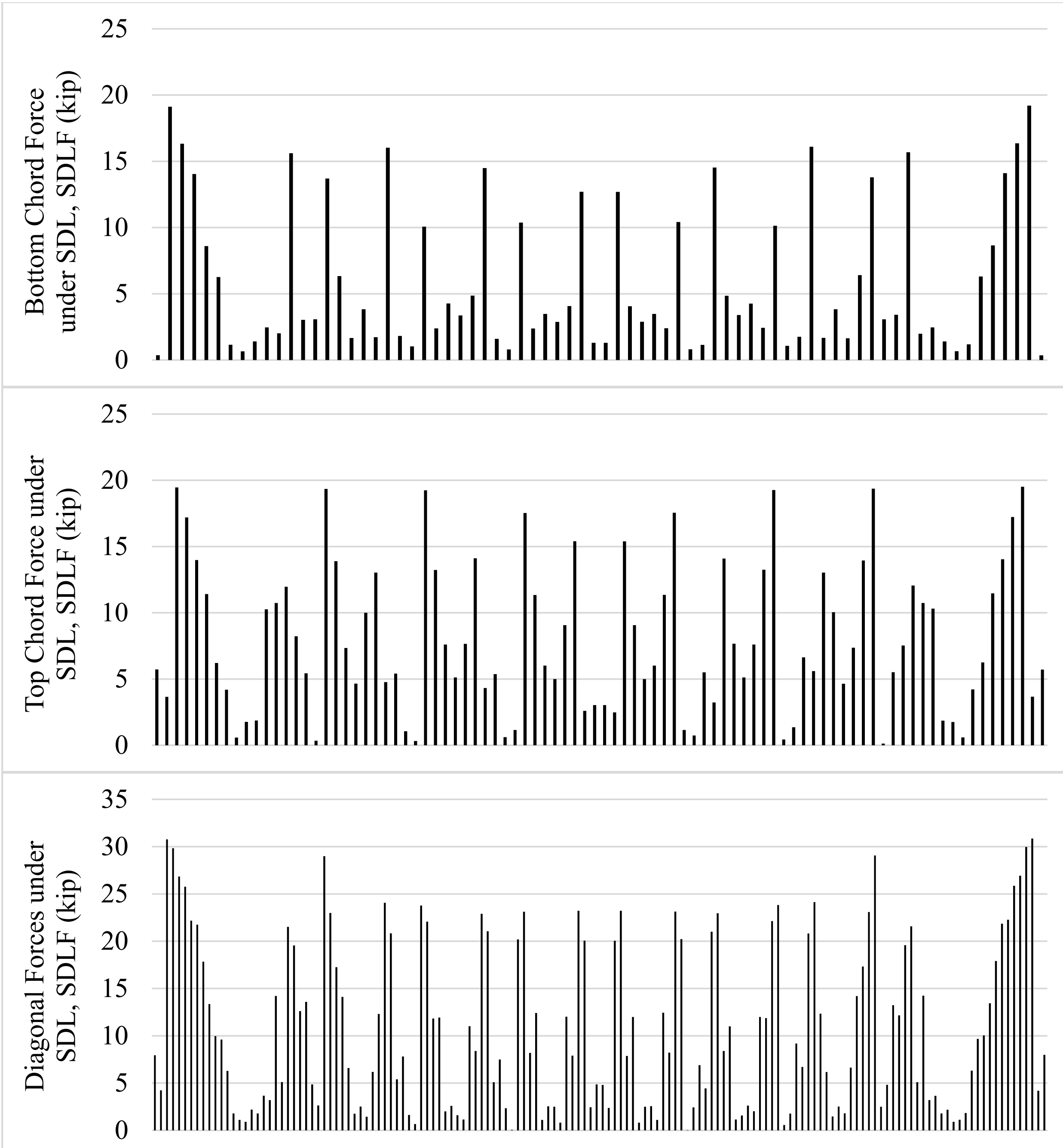


Figure 116. Magnitude of CF member forces from DLF RA, Bridge (J2) NISSS54 under SDL, SDLF detailing based on NLF RA cambers.

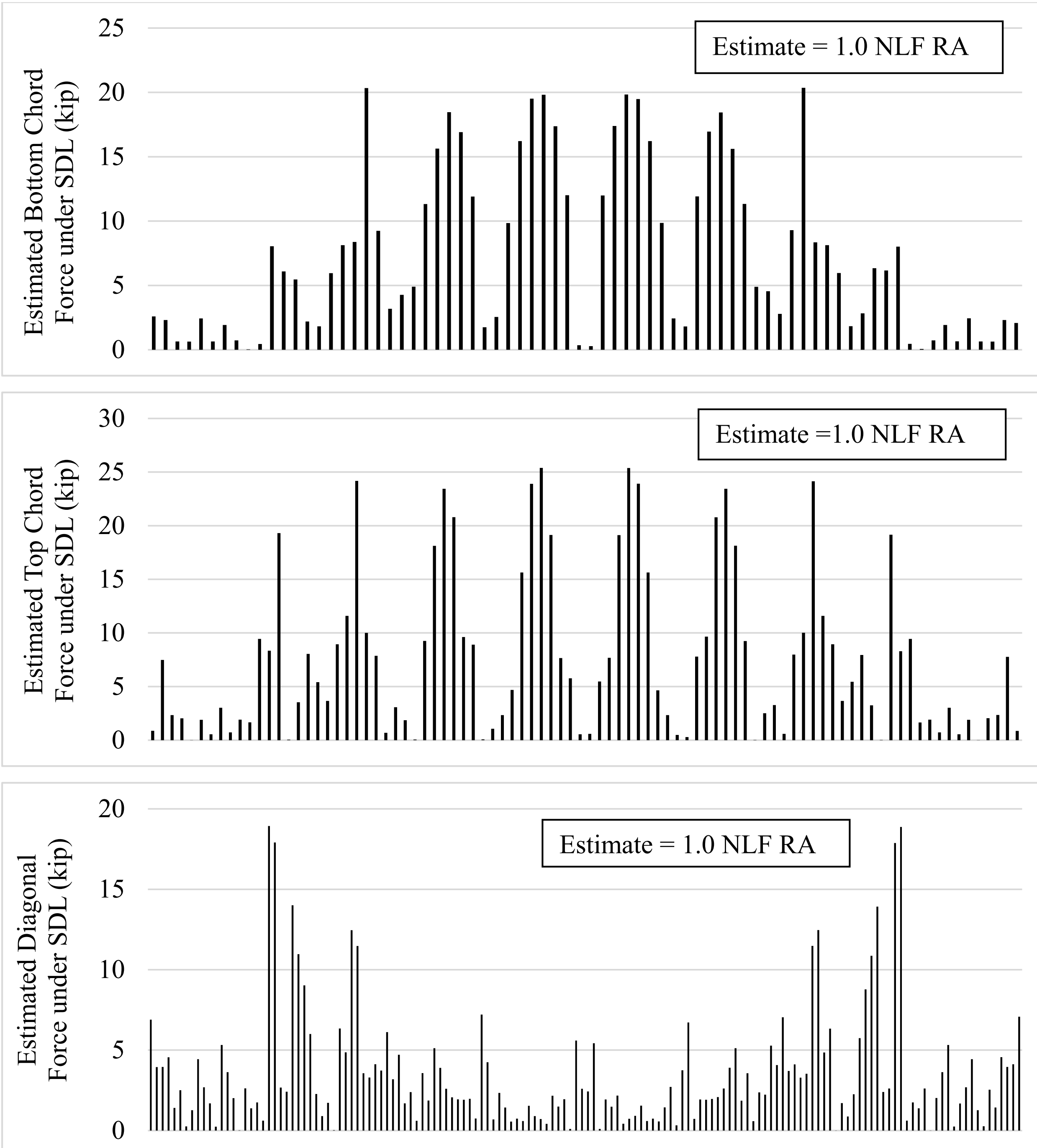


Figure 117. Estimated magnitude of CF member forces based on scaling of NLF RA results, assuming SDLF detailing, Bridge (J2) NISSS54 under SDL.

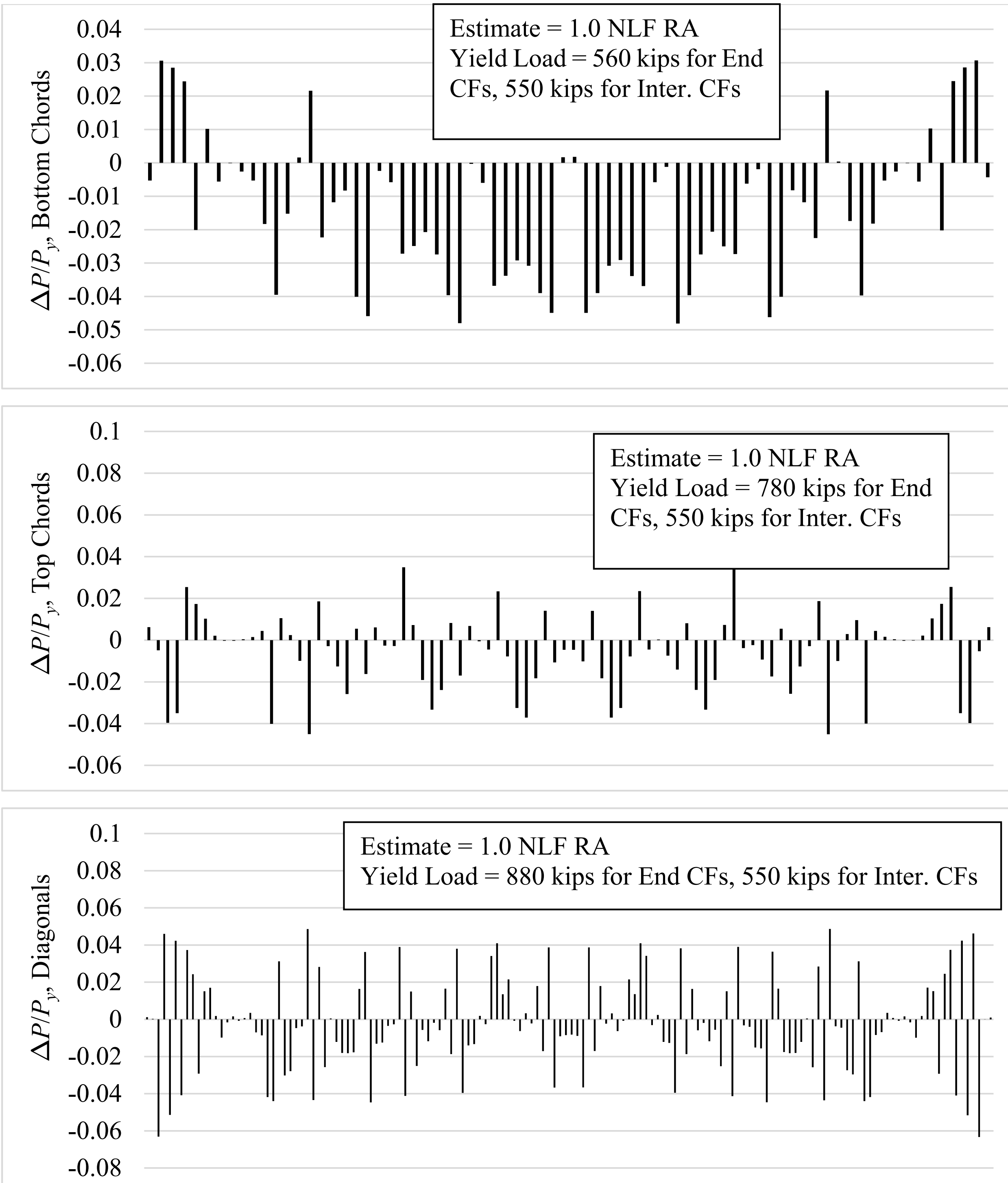


Figure 118. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (J2) NISSS54 under SDL with SDLF detailing based on NLF RA cambers.

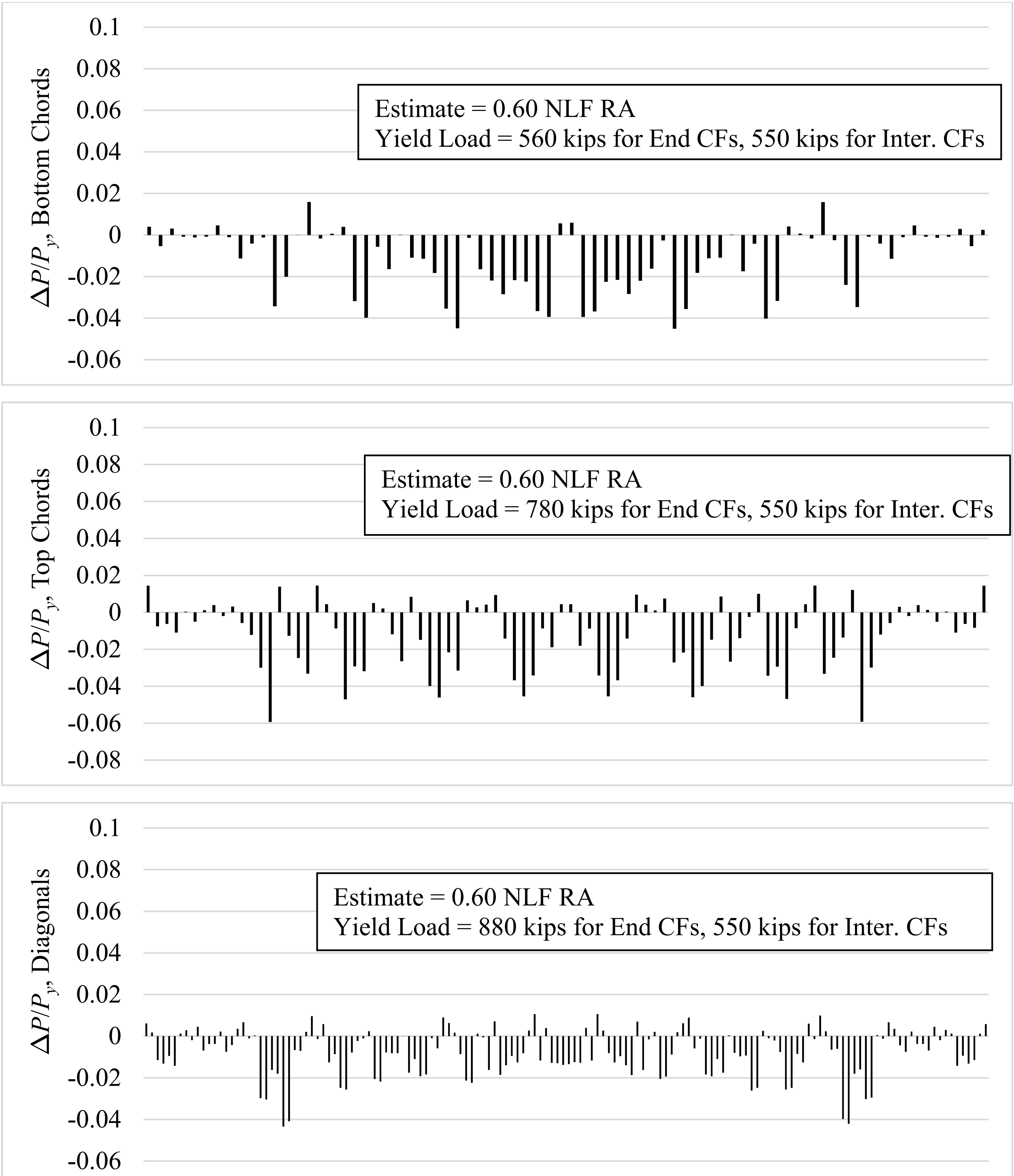


Figure 119. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (J2) NISSS54 under TDL with TDLF detailing based on NLF RA cambers.

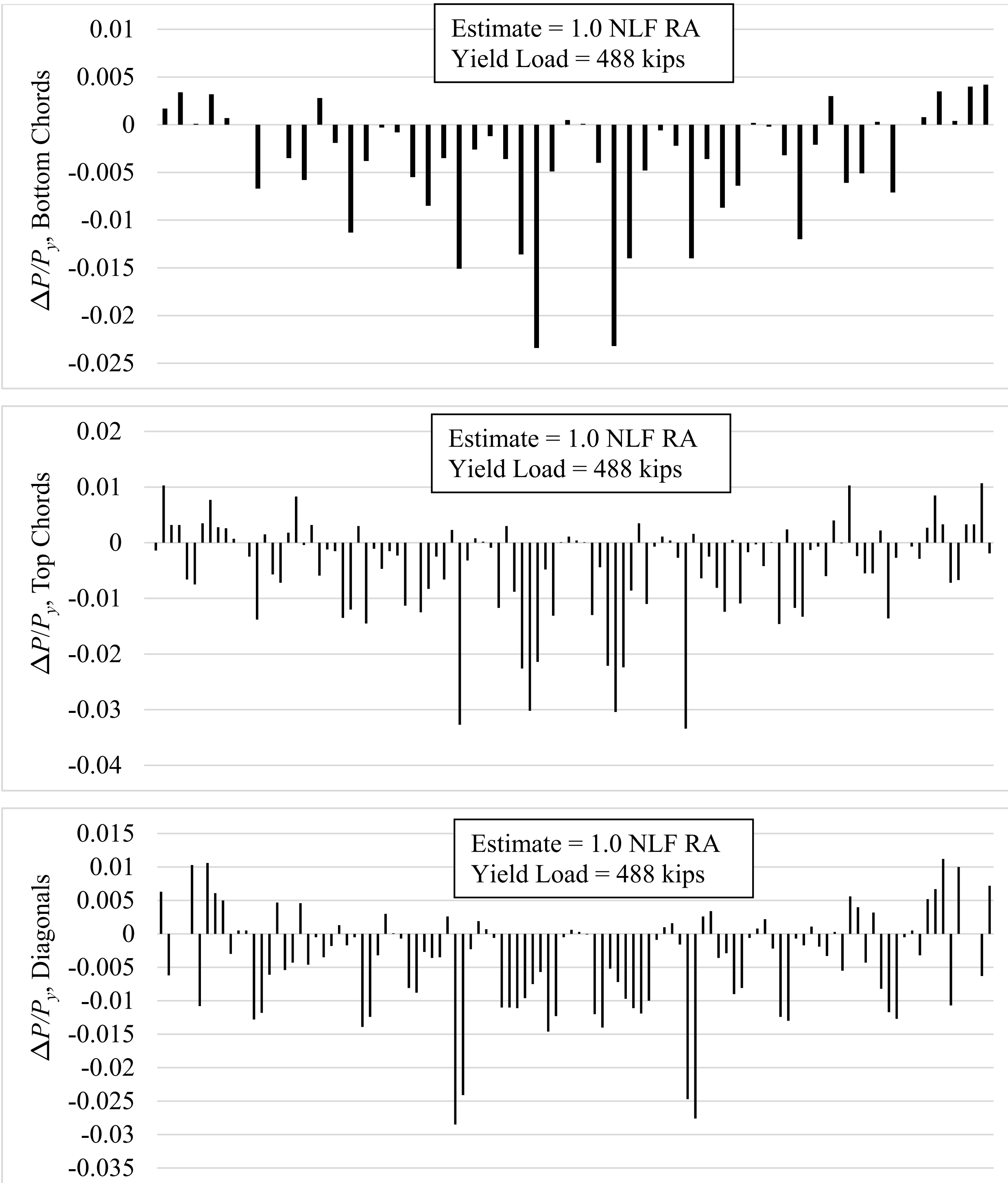


Figure 120. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (I2) NISSS14 under SDL with SDLF detailing based on NLF RA cambers.

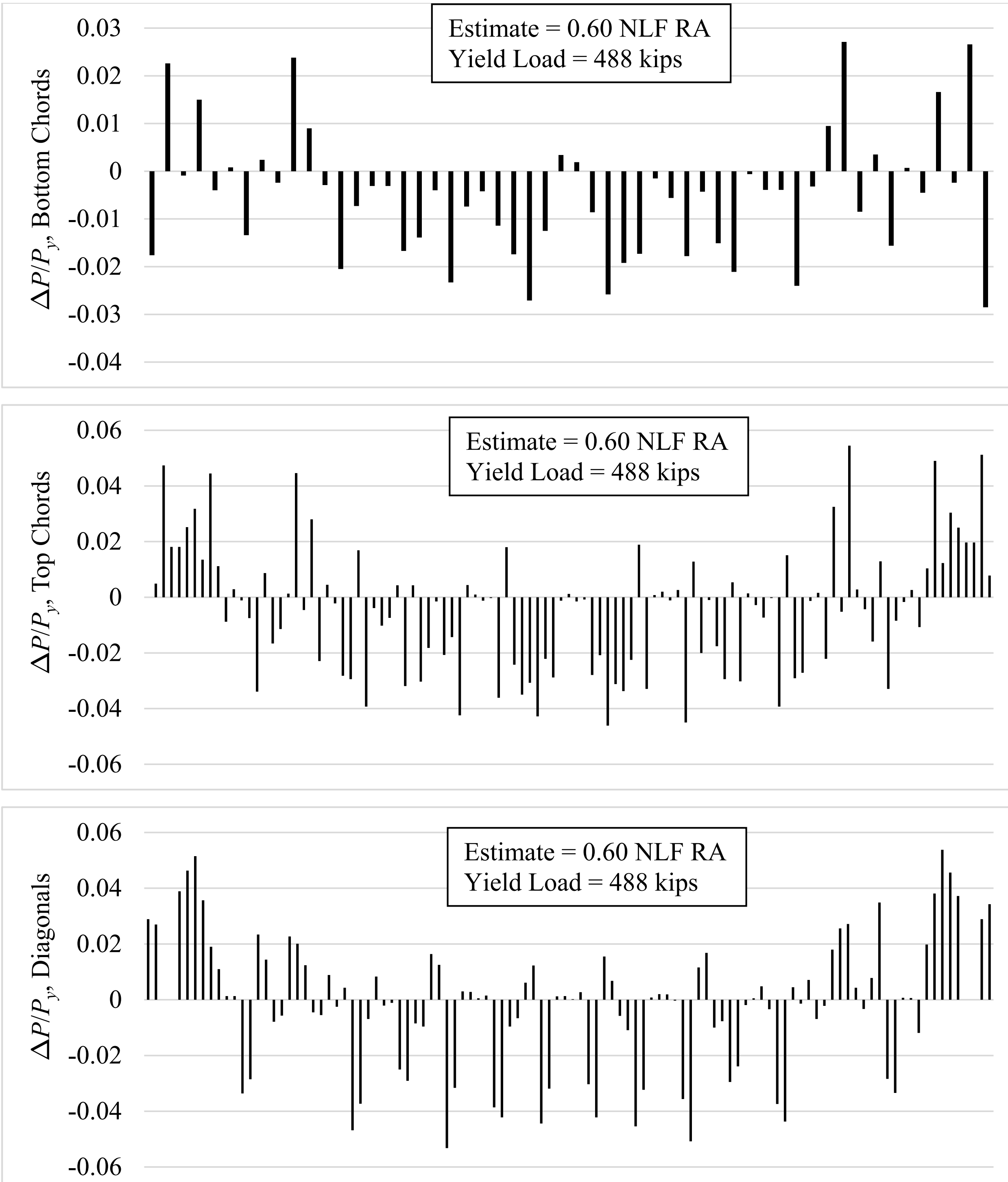


Figure 121. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (I2) NISSS14 under TDL with TDLF detailing based on NLF RA cambers.

3.4.7.1.5 Girder Stresses

In straight bridges with parallel skew, SDLF and TDLF detailing based on RA cambers gives small girder flange lateral bending stresses under the targeted condition. However, the girder flange lateral bending stresses are no longer theoretically zero under the targeted condition due to the overall elastic deformations of the CFs and the elastic torsional deformations of the girders in the structural system. From Table 31 and Figures 122 through 125, it can be seen that SDLF and TDLF based on NLF RA cambers give some reduction in the flange lateral bending stresses under the targeted condition relative to the NLF values. The largest ratio of the flange lateral bending stress under SDL with SDLF detailing is 49 % (4.2 ksi), corresponding to Bridge (I1). The largest corresponding value under TDL with TDLF detailing is 73 % (5.5 ksi), corresponding to Bridge (I2). However, the largest absolute flange lateral bending stresses are 4.9 ksi (39 % of the corresponding NLF RA stress, $f_{\ell 1}$) for SDL/SDLF and 22.7 ksi (37 % of $f_{\ell 1}$) for TDL/TDLF.

Table 31. Maximum magnitudes of top flange lateral bending stresses of the critical fascia girder and innermost girder in the straight bridges with parallel skew studied in this research with the CFs detailed based on NLF RA cambers ($f_{\ell 1}$ is the maximum girder flange lateral bending stresses with NLF. f_{ℓ} is the maximum girder flange lateral bending stresses with SDLF under SDL and TDLF under TDL. The largest $\frac{f_{\ell}}{f_{\ell 1}}$ under SDL and TDL are highlighted by dark shading).

Load	**Bridge**	**Fascia Girder**			**Innermost Girder**		
		$f_{\ell 1}$ **(ksi)**	f_{ℓ} **(ksi)**	$\frac{f_{\ell}}{f_{\ell 1}}$	$f_{\ell 1}$ **(ksi)**	f_{ℓ} **(ksi)**	$\frac{f_{\ell}}{f_{\ell 1}}$
SDL	(I1) NISSS14	6.4	1.1	0.17	8.5	4.2	**0.49**
	(I2) NISSS14	2.4	1.0	**0.45**	12.5	4.9	0.39
	(J1) NISSS54	10.5	2.0	0.20	8.5	3.5	0.42
	(J2) NISSS54	3.9	1.3	0.33	7.5	1.2	0.16
TDL	(I1) NISSS14	25.5	7.1	0.27	37.6	18.4	**0.49**
	(I2) NISSS14	7.3	5.5	**0.73**	61.3	22.7	0.37
	(J1) NISSS54	22.6	4.6	0.20	19.3	8.0	0.41
	(J2) NISSS54	6.2	1.7	0.27	19.7	3.5	0.18

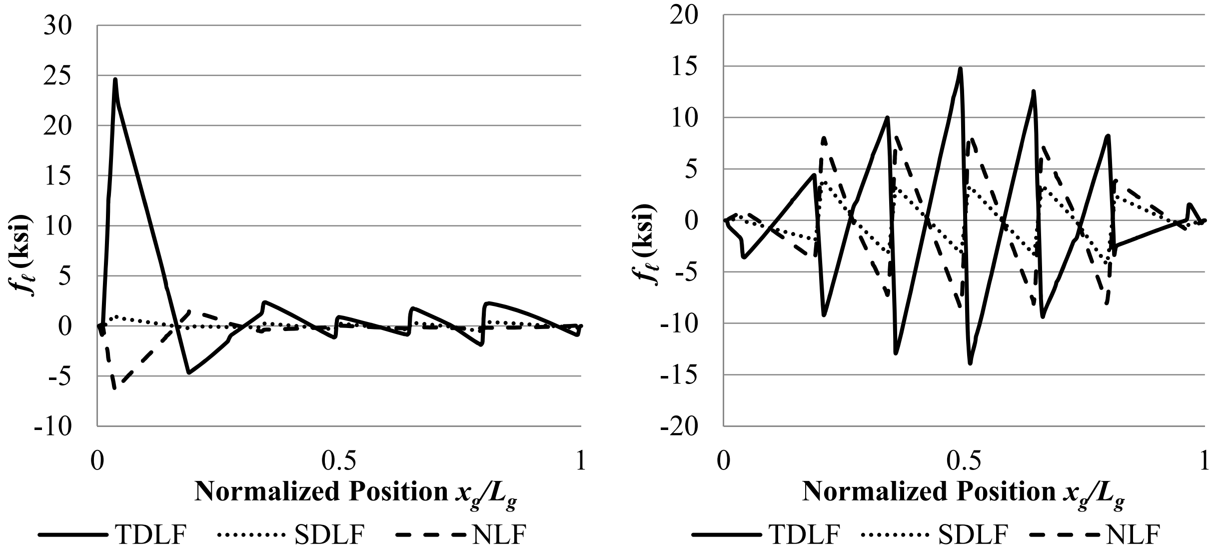


Figure 122. Top flange lateral bending stresses in Bridge (I1) NISSS14 fascia girder (left) and interior girder (right) under SDL with detailing based on NLF RA cambers.

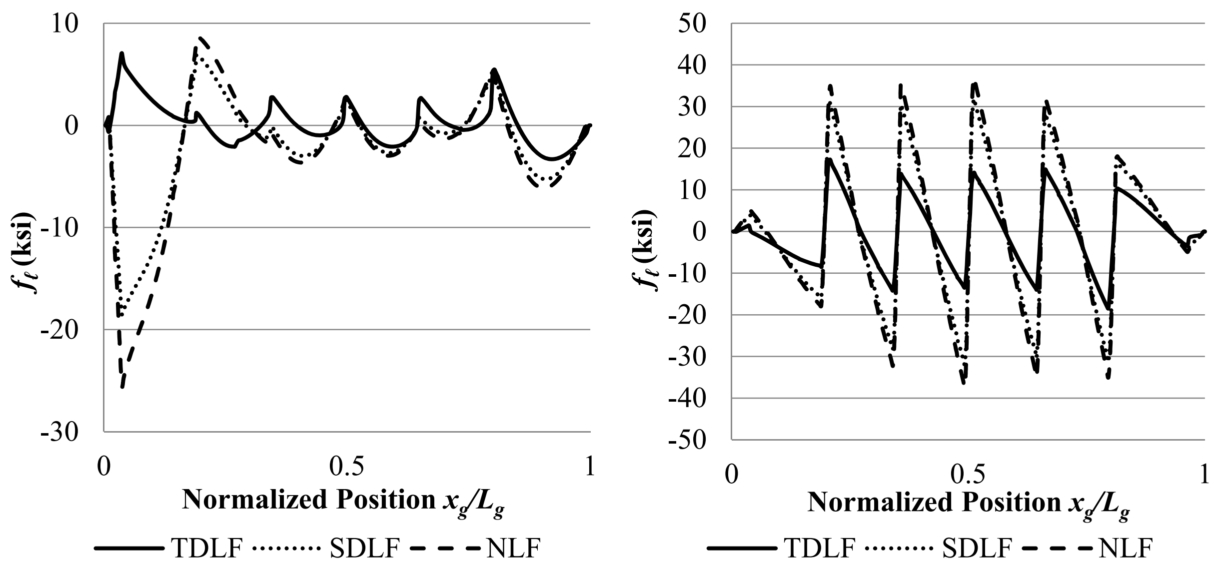


Figure 123. Top flange lateral bending stresses in Bridge (I1) NISSS14 fascia girder (left) and interior girder (right) under TDL with detailing based on NLF RA cambers.

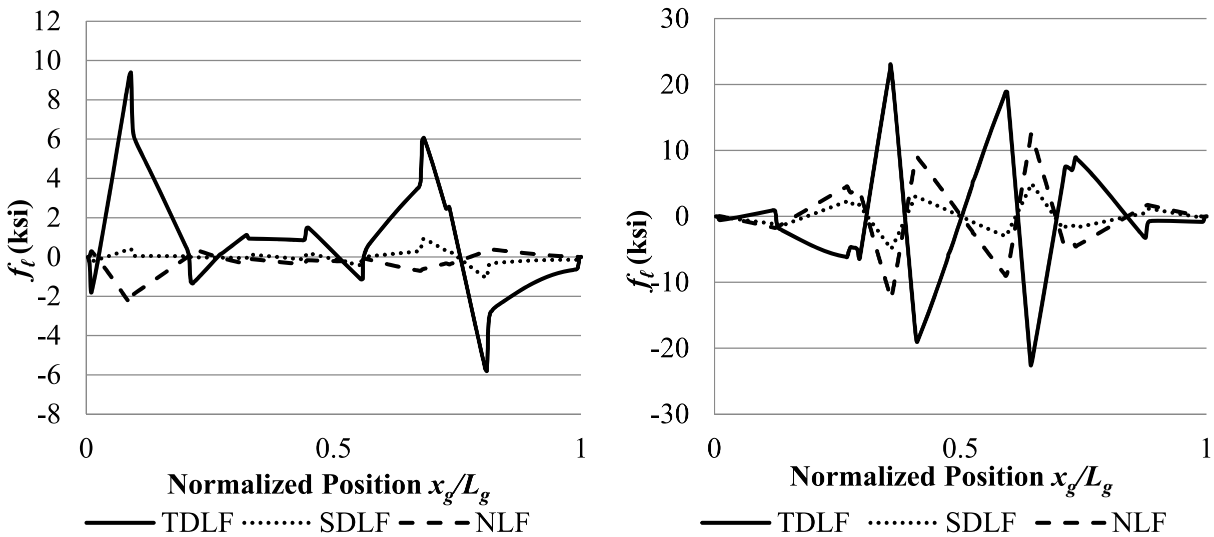


Figure 124. Top flange lateral bending stresses in Bridge (I2) NISSS14 fascia girder (left) and interior girder (right) under SDL with detailing based on NLF RA cambers.

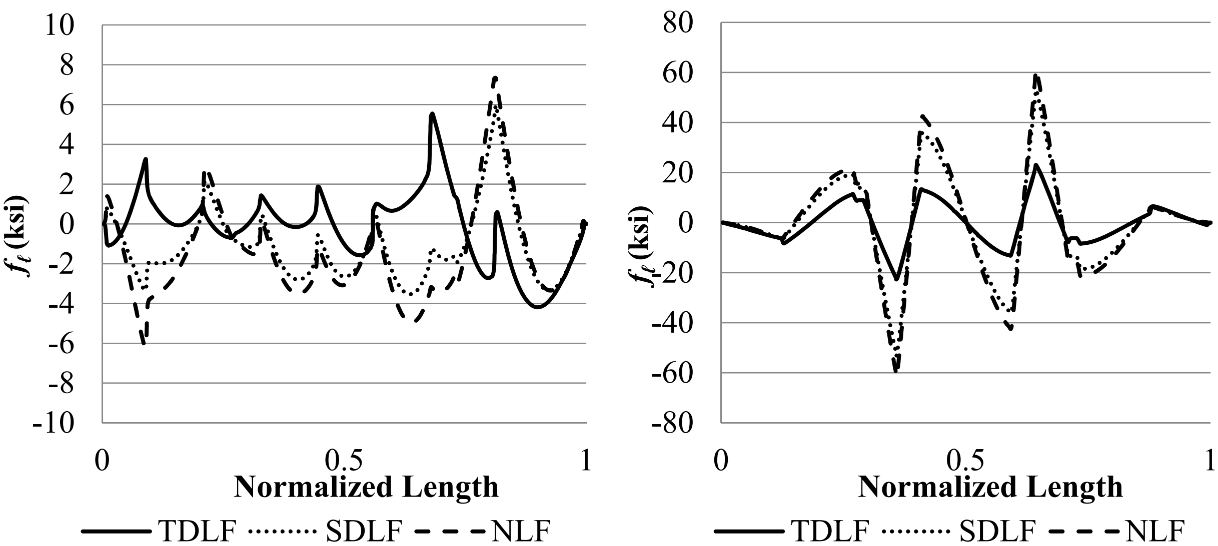


Figure 125. Top flange lateral bending stresses in Bridge (I2) NISSS14 fascia girder (left) and interior girder (right) under TDL with detailing based on NLF RA cambers.

Figures 126 through 129 show the variation in the fascia girder and innermost girder major-axis bending stresses for the different detailing methods for the most critical bridges with respect to this consideration, Bridges (I1) and (J1). For the straight parallel-skew bridges studied in this research, the largest percentage increase in any of the girder major-axis bending stresses under the TDL, due to the effect of SDLF and TDLF detailing based on NLF RA cambers, is 7 % (1.2 ksi)) and 28 % (4.7 ksi), respectively (see Figure 127). Both of these changes in stress occur on the innermost girder on Bridge (I1) NISSS14. These changes in stress are a larger fraction of the total stress under the SDL condition, as shown in Figure 126.

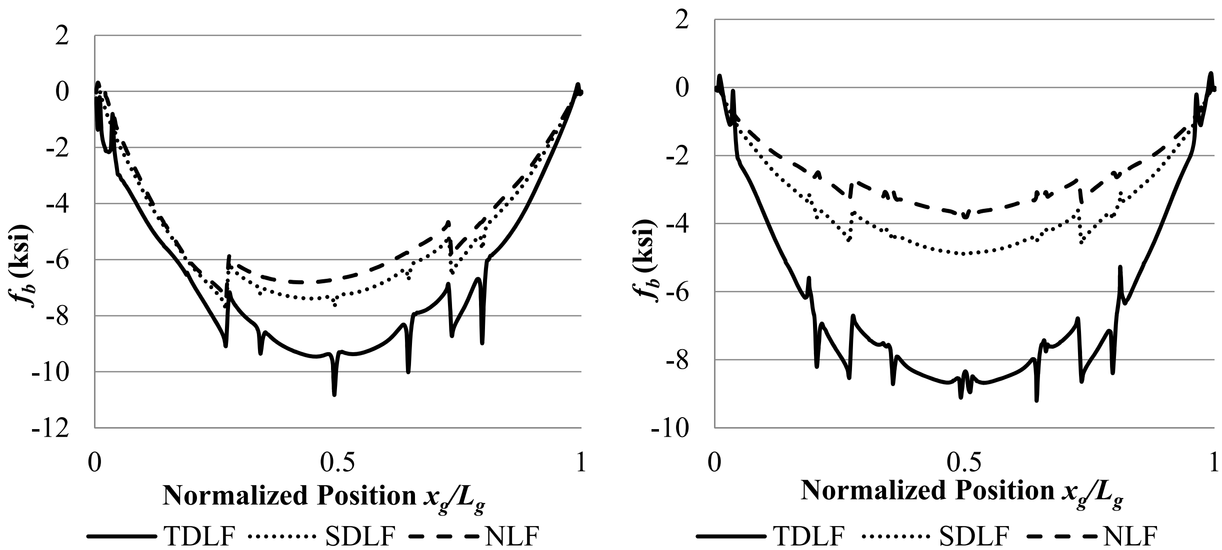


Figure 126. Top flange major-axis bending stresses in Bridge (I1) NISSS14 fascia girder (left) and innermost girder (right) under SDL with detailing based on NLF RA cambers.

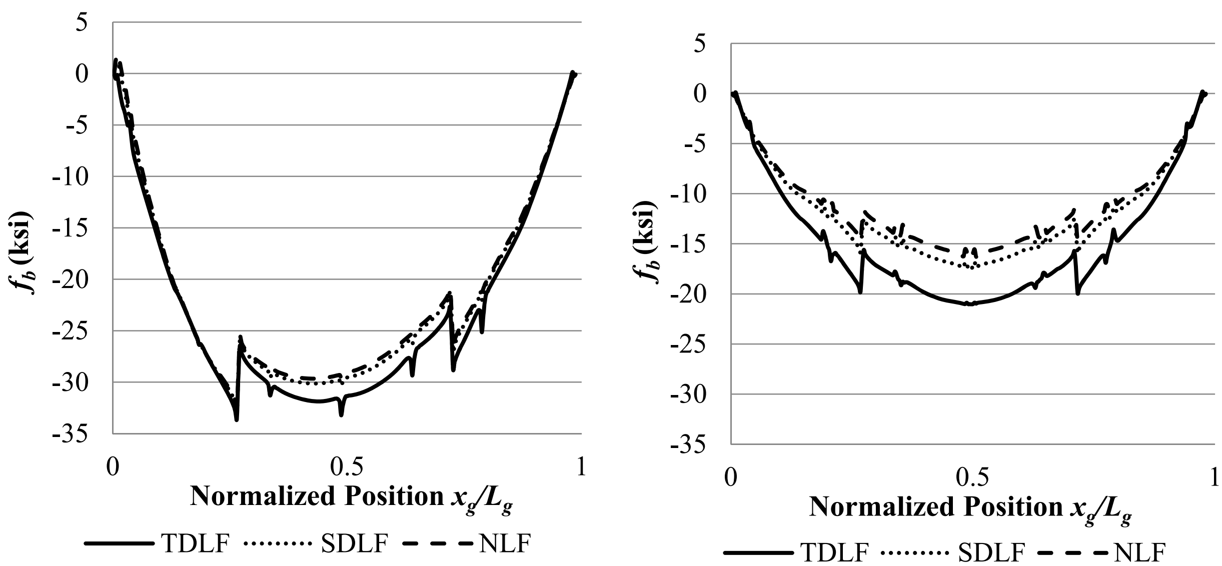


Figure 127. Top flange major-axis bending stresses in Bridge (I1) NISSS14 fascia girder (left) and innermost girder (right) under TDL with detailing based on NLF RA cambers.

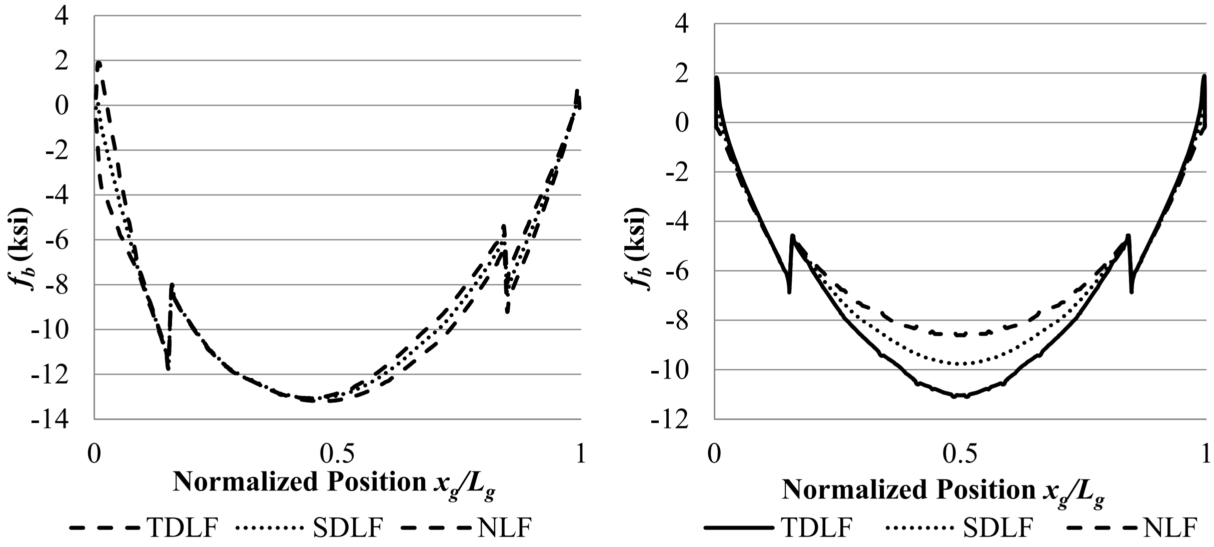


Figure 128. Top flange major-axis bending stresses in Bridge (J1) NISSS54 fascia girder (left) and innermost girder (right) under SDL with detailing based on NLF RA cambers.

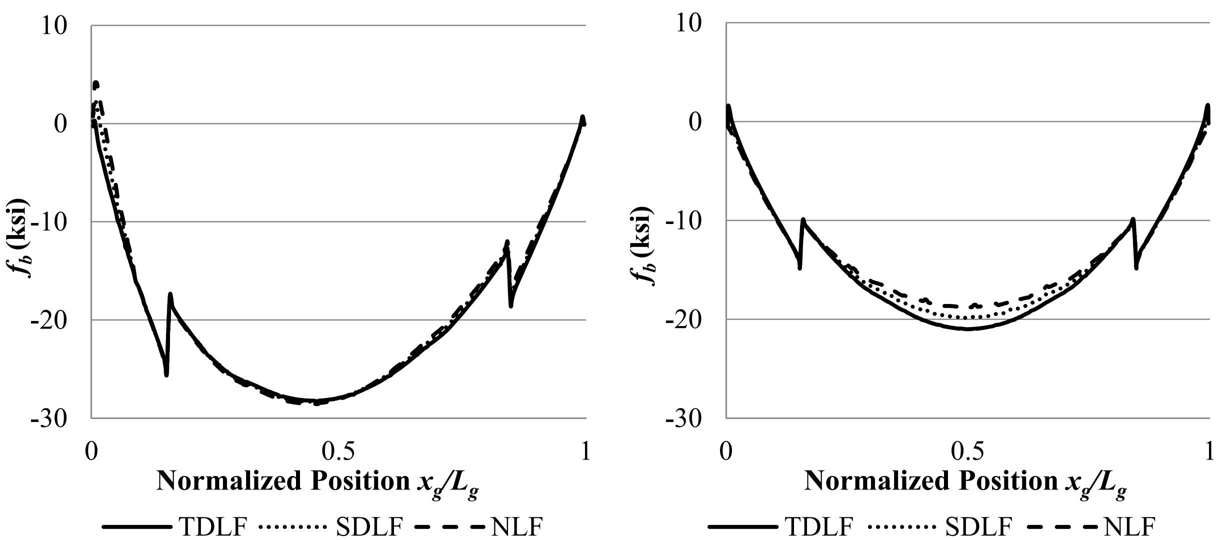


Figure 129. Top flange major-axis bending stresses in Bridge (J1) NISSS54 fascia girder (left) and innermost girder (right) under TDL with detailing based on NLF RA cambers.

3.4.7.1.6 Vertical Reactions

In straight parallel-skew bridges, the use of NLF RA cambers for DLF detailing tends to give smaller differences between the fascia girder and interior girder reactions along each of the skewed bearing lines compared to the use of DLF detailing with LGA cambers. This reduces the tendency for uplift at the obtuse corners of the bridge plan. This behavior is related to the fact that the girder vertical displacements are changed substantially by the DLF detailing when LGA cambers are used, whereas there is little change in the girder vertical displacements due to DLF detailing with RA cambers. Table 32 shows the SDL and TDL vertical reactions for Bridge (J1) with cambers set based on NLF RA. The reactions for this bridge with the cambers set based on LGA are reported in Table 27 of Section 3.4.6.1.6. Under SDL with TDLF detailing based on the RA cambers, the smallest reaction is 14 kip at the obtuse corners of the bridge plan whereas uplift is encountered for this scenario in Table 27. Application of the rules for CF framing arrangements recommended in this research also tends to alleviate uplift at the obtuse corners. Bridge (J2) NISSS54 and Bridge (I2) NISSS14 follow these recommendations.

From Tables 32 and 33, it can be observed that Bridge (J1) NISSS54 has a severe nuisance stiffness problem. With the use of RA cambers, the largest increase in the TDL reactions is 71 % (92 kip) due to SDLF detailing and 163 % (212 kip) due to TDLF detailing for this bridge. These increases occur at the bearing on girder G2 near the corresponding obtuse corner of the span. The largest decrease in the TDL reactions is 20 % (165 kip) due to SDLF detailing and 44 % (370 kip) due to TDLF detailing. These decreases occur at the bearing on G1 at the corresponding obtuse corner of the span. The reactions at the opposite obtuse corner are essentially the same. It can be observed that for this severe case, a DLF RA is required to accurately predict the reactions. In lieu of a DLF RA, the LGA SDL reactions plus the NLF RA CDL reactions can be used to give a conservative estimate TDL reactions detailed for SDLF. In lieu of a DLF RA, the LGA TDL reactions can be used to give a conservative estimate TDL reactions.

Table 33 shows that the largest changes in the reactions due to SDLF detailing are relatively minor for the bridges where the CF framing arrangements follow the recommended rules to avoid nuisance stiffness effects. However, the changes associated with TDLF detailing are somewhat larger.

Table 32. Bridge (J1) NISSS54 vertical reactions (kip) (G1 and G9 are fascia girders), detailing based on NLF RA cambers.

Girder	Detailing Method	SDL Support 1	SDL Support 2	TDL Support 1	TDL Support 2
G1	NLF	384	146	828	332
	SDLF	219	154	666	334
	TDLF	14	161	463	337
G2	NLF	63	170	138	367
	SDLF	155	168	227	363
	TDLF	276	168	350	363
G3	NLF	122	173	270	372
	SDLF	161	157	308	358
	TDLF	206	137	350	340
G4	NLF	94	127	200	279
	SDLF	121	128	231	279
	TDLF	153	127	267	275
G5	NLF	109	109	238	238
	SDLF	127	127	257	256
	TDLF	147	147	277	277
G6	NLF	127	94	279	199
	SDLF	128	121	279	231
	TDLF	127	154	275	268
G7	NLF	173	122	372	271
	SDLF	157	161	358	308
	TDLF	138	209	341	353
G8	NLF	170	64	367	141
	SDLF	168	156	363	231
	TDLF	169	272	363	348
G9	NLF	146	382	332	825
	SDLF	153	217	334	662
	TDLF	161	14	337	462

Table 33. Summary of maximum absolute and percentage increases and decreases in the TDL vertical reactions at the girder bearings, due to SDLF and TDLF detailing based on RA cambers, in the straight parallel-skew bridges (the largest of these maximum absolute and percentage increases are highlighted by dark shading).

Bridge	SDLF				TDLF			
	Max Decrease (kip)	Max % Decrease	Max Increase (kip)	Max % Increase	Max Decrease (kip)	Max % Decrease	Max Increase (kip)	Max % Increase
(I1) NISSS14	-16	-7	7	10	-66	-29	31	42
(I2) NISSS14	-5	-3	4	5	-23	-13	19	24
(J1) NISSS54	**-168**	**-20**	**94**	**71**	**-370**	**-44**	**216**	**163**
(J2) NISSS54	-23	-6	12	4	-54	-14	29	9

3.4.7.2 Summary and Recommendations – Straight Bridges with Parallel Skew and Cambers Set Based on NLF RA

The influence of SDLF and TDLF detailing on the responses in completed straight bridge systems with parallel skew and girder cambers calculated based on NLF RA may be summarized as follows. Recommendations pertaining to these quantitative results are highlighted in bold italicized text.

General

- Straight bridges with a difference in the skew angles at the ends of all the spans less than or equal to $\Delta\theta = 20^o$ may be considered as parallel skew bridges.

Girder Elevations

- In straight bridges with parallel skew, where the CFs are detailed for SDLF based on NLF RA cambers, the most extreme case considered in this research, (J1) NISSS54, exhibits a maximum deviation of 0.4 inches from the targeted DL elevations.
- In straight bridges with parallel skew, where the CFs are detailed for TDLF based on NLF RA cambers, the most extreme case considered in this research, (I1) NISSS14, exhibits a maximum deviation of 1.4 inches from the targeted DL elevations.
- ***It is recommended that NLF RA is sufficient for calculation of the girder cambers in straight bridges with parallel skew. There is no need to consider any change in the girder vertical***

displacements and elevations due to the change in the internal forces, and the change in the vertical deflections in the structural system, associated with the DLF detailing.

Girder Layovers

- All the straight bridges with parallel skew considered in this research exhibit very small layovers under the TDL, for TDLF, when the TDL camber is based on a NLF RA.
- All the straight bridges with parallel skew considered in this research exhibit very small layovers under the SDL, for SDLF, when the SDL camber is based on a NLF RA.
- The match with the calculated/expected non-zero layovers under TDL for SDLF, and under SDL for TDLF, is similar.
- NLF RA predicts substantial girder layovers at sharply skewed abutment bearing lines. These layovers are false when the CFs are detailed for SDLF or TDLF based on NLF RA cambers.
- ***It is recommended that the girder layovers may be assumed to be negligible in the targeted DL condition in straight bridges with parallel skew in which the cambers are set based on a NLF RA. There is no need to consider any change in the girder layovers due to the change in the internal forces, and the change in the elastic deformations in the system, associated with the DLF detailing.***
- ***For straight parallel-skew bridges detailed for SDLF, the girder layovers under the TDL may be estimated as the CDL layovers obtained from a NLF RA.***
- ***For straight parallel-skew bridges detailed for TDLF, the girder layovers under the SDL may be estimated as the negative of the CDL layovers obtained from a NLF RA.***

Cross-Frame Forces

- There is clearly a substantial reduction in the average of the CF member forces as well as in the maximum CF member force due to SDLF and TDLF with RA cambers for the straight parallel skew bridges considered in this research, in cases where the CF member forces are relatively large due to nuisance transverse stiffness effects. However, for the alternate framing plans where the CF forces are significantly reduced, the effect of SLDF or TDLF detailing with RA cambers on the CF forces is relatively erratic. It appears that in these cases, the incidental effects discussed in Section 3.4.2.2 combined with the influence of the elastic deformations of the CFs and elastic torsional deformations of the girders within the 3D bridge system has a substantial influence on these smaller CF forces for SDLF. The reduction in the

CF force values relative to the values obtained assuming NLF detailing generally tends to not be as substantial as the reductions obtained when the CF detailing is based on LGA cambers.

- Under SDL, the largest ratio of the average of the CF member forces for SDLF detailing with RA cambers to the corresponding average force for NLF detailing is 1.28, that is, a 28 % increase in the average CF member force. This result corresponds to Bridge (J2) NISSS54.
- Under TDL, the largest ratio of the average of the CF member forces for TDLF detailing with RA cambers to the corresponding average force for NLF detailing is 0.68, corresponding to Bridge (I2) NISSS14.
- Under SDL, the largest ratio of the maximum CF member force for SDLF detailing with RA cambers to the corresponding force for NLF detailing is 1.22, that is, a 22 % increase in the maximum CF member force, corresponding to the Bridge (J2) NISSS54.
- Under TDL, the largest ratio of the maximum CF member force for TDLF detailing with RA cambers to the corresponding force for NLF detailing is 0.55, corresponding to Bridge (J2) NISSS54.
- ***Based on the above results, in lieu of a DLF RA, it is recommended that the locked-in forces due to SDLF detailing with RA cambers should be neglected and the NLF RA results should be used directly estimate the CF forces in straight bridges with parallel skew detailed for SDLF based on RA cambers.***
- ***In lieu of a DLF RA, it is recommended that a net load factor of (γ_p – 0.4) be used for determination of the factored TDL CF forces in straight I-girder bridges with parallel skew, when the CFs are detailed for TDLF using a NLF RA. This net load factor is to be applied to the results from a NLF RA for the TDL. The factored CF forces under the SDL may be estimated by subtracting the factored CDL CF forces obtained via a NLF RA from the above factored TDL forces.*** The factor of 0.4 is a conservative estimate of the TDLF locked-in force of 1.0 – 0.55 = 0.45. In cases where additional uncertainties and variabilities associated with TDLF are anticipated, such as incidental participation of deck forms and early concrete stiffness in the structural resistance, and/or larger potential play in the CF connections due to the larger CF forces associated with TDLF, it is suggested that a value between 0.4 and 0.3 may be used for the above locked-in force estimate based on the judgment of the engineer of record. This suggested reduction is based on the judgement of the research team. The current research did not perform any specific investigations of the above effects.

- For SDLF under SDL, the maximum difference in the magnitude of the individual CF member forces from a DLF RA and the estimated values from a NLF RA, normalized by the member yield load, is 4.9 %, and the average difference is –1.2 %, for the straight bridges studied in this research with parallel skew and girder cambers based on RA.
- For TDLF under TDL, the maximum difference in the magnitude of the individual CF member forces from a DLF RA and (1 – 0.4 = 0.6) of the estimated values from a NLF RA, normalized by the member yield load, is 5.4 %, and the average difference is -1.4 %, for the straight parallel skew bridges studied in this research and girder cambers based on RA.

Girder Stresses

- For SDLF detailing, the largest flange lateral bending stress under SDL is 4.2 ksi (49 % of the corresponding f_ℓ for NLF detailing).
- ***In lieu of a DLF RA, it is recommended that a net load factor of (γ_p – 0.5) be used for determination of the factored SDL f_ℓ in straight I-girder bridges with parallel skew, when the CFs are detailed for SDLF using a NLF RA. This net load factor is to be applied to the results from a NLF RA for the SDL. The factored f_ℓ under the TDL may be estimated by adding the factored CDL f_ℓ obtained via a NLF RA from the above factored SDL forces.*** The factor of 0.50 is an estimate of the SDLF locked-in force of 1.0 – 0.49 = 0.51.
- For TDLF detailing, the largest girder f_ℓ under the TDL is 22.7 ksi for all the straight parallel-skew bridges studied with the CFs detailed based on RA cambers. This compares to a largest girder f_ℓ of only 4.7 ksi when the CF detailing is based on LGA girder cambers. The above stress occurs in an interior girder of Bridge (I2) NISSS14 and is 37 % of the corresponding f_ℓ for NLF detailing. The next largest girder f_ℓ values in the straight parallel-skew bridges studied, under TDL for TDLF, are 18.4 ksi in an interior girder of (I1) NISSS14 (49 % of the corresponding f_ℓ for NLF detailing), 8.0 ksi in an interior girder of (J1) NISSS54 (41 % of the corresponding f_ℓ for NLF detailing), 7.1 ksi in the fascia girders of (I1) NISSS14 (27 % of the corresponding f_ℓ for NLF detailing) and 5.5 ksi in the fascia girders of (I2) NISSS14 (73 % of the corresponding f_ℓ for NLF detailing). All of the other maximum girder f_ℓ values are less than 5 ksi in all the straight parallel-skew bridges studied in this work.

- For all the straight parallel-skew bridges studied in this research, an assumed locked-in f_ℓ of 0.4 of the f_ℓ from a NLF RA gives a reasonable estimate of the TDL f_ℓ values determined from a DLF RA. This value parallels the above recommended assumed locked-in force effect for calculation of the reduced CF forces. The largest under-prediction for the above cases is only 1.1 ksi for the fascia girders, corresponding to Bridge (I2) NISSS54.
- ***In lieu of a DLF RA, it is recommended that a net load factor of (γ_p – 0.4) be used for determination of the factored TDL f_ℓ in straight I-girder bridges with parallel skew, when the CFs are detailed for SDLF using a NLF RA. This net load factor is to be applied to the results from a NLF RA for the SDL. The factored f_ℓ under the SDL may be estimated by subtracting the factored CDL f_ℓ obtained via a NLF RA from the above factored TDL forces.***
- For the straight parallel-skew bridges studied in this research, the largest percentage increase in any of the girder major-axis bending stresses under the TDL, due to the effect of SDLF detailing based on NLF RA cambers, is 7 % (1.2 ksi). This increase is observed for the innermost girder in Bridge (I1) NISSS14, which has a skew index of I_s = 1.36 and severe nuisance transverse stiffness effects. Bridge (J1) NISSS54 had a comparable slightly smaller increase of 5 % (1.0 ksi).
- For the straight parallel-skew bridges studied in this research, the largest percentage increase in any of the girder major-axis bending stresses under the TDL, due to the effect of TDLF detailing based on NLF RA cambers, is 28 % (4.7 ksi). This increase is observed for the innermost girder in Bridge (I1) NISSS14. Bridge (J1) NISSS54 had a comparable smaller increase of 12 % (2.2 ksi).
- The above largest increases in the girder f_b values are dramatically reduced by the use of the recommended improved CF framing arrangements. However, with the use TDLF detailing based on NLF RA cambers, the largest increase in the girder f_b values in Bridge (I2) NISSS14, under the TDL, is still 12 %.
- ***Based on the above results, it is recommended that for straight bridges with parallel skew and with the girder cambers set based on a NLF RA, the DLF effects on the girder f_b values may be neglected for SDLF detailing as long as the recommendations for the CF framing arrangements specified in this research are followed.***

- ***Unfortunately, additional requirements are necessary for TDLF based on NLF RA cambers. It is recommended that for straight bridges with parallel skew and with the girder cambers set based on a NLF RA, the DLF effects on the girder f_b values may be neglected for TDLF detailing as long as:***

  1) The recommendations for the CF framing arrangements specified in this research are followed, and

  2) The skew index is less than or equal to approximately 1.0.

  That is, in cases that satisfy the above requirements, the girder f_b values may be obtained from a NLF RA (which does not consider of the lack-of-fit from the detailing of the CFs).

- The above limit of 1.0 on the skew index is based largely on the judgment of the research team, considering the results from this research as well as the results from the NCHRP 725 report for bridges with a wide range of skew indices.
- ***For straight bridges with parallel skew that do not satisfy the above requirements, it is recommended that the girder major-axis bending stresses be determined from a DLF RA.***
- The above procedures for calculating the girder f_b values differ from the recommended procedures for calculating the CF forces and the girder f_ℓ values. The CF force and f_ℓ procedures are more conservative based on the recognition that although the theoretical CF forces and girder flange lateral bending stresses small in the targeted DL condition, various incidental effects can result in measurable non-zero values for these forces and stresses.

Vertical Reactions

- In straight parallel-skew bridges, the use of NLF RA cambers for DLF detailing tends to give smaller differences between the fascia girder and interior girder reactions along each of the skewed bearing lines compared to the use of DLF detailing with LGA cambers. This reduces the tendency for uplift at the obtuse corners of the bridge plan. This is behavior is related to the fact that the girder vertical displacements are changed substantially by the DLF detailing when LGA cambers are used, whereas there is little change in the girder vertical displacements due to DLF detailing with RA cambers. Application of the rules for CF framing arrangements recommended in this research also tends to alleviate uplift at the obtuse corners.
- The results for the girder reactions largely parallel the above results for the girder major-axis bending stresses.

- The largest increase in the TDL reactions is 5 % due to SDLF detailing and 24 % due to TDLF detailing for the critical Bridge (I2) NISSS14, when NLF RA cambers are employed for the detailing of the CFs and the recommended rules for improving the CF framing arrangement are employed. These values are 4 % for SDLF detailing and 9 % for TDLF detailing for the critical Bridge (J2) NISSS54 with improved framing of the CFs. The maximum changes in the reactions are substantially larger for bridges (I1) and (J1), which have extreme nuisance transverse stiffness issues.
- The largest decrease in the TDL reactions is -6 % due to SDLF detailing and -14 % due to TDLF detailing for the critical Bridge (J2) NISSS54, when NLF RA cambers are employed for the detailing of the Cs and the recommended rules for improving the CF framing arrangement are employed. These values are -3 % and -13 %, respectively, for the critical Bridge (I2) NISSS14.
- ***Based on the above results, it is recommended that for straight bridges with parallel skew and with the girder cambers set based on a NLF RA, the DLF effects on the girder reactions may be neglected for SDLF detailing as long as the recommendations for the CF framing arrangements specified in this research are followed.***
- ***Unfortunately, additional requirements are necessary for TDLF based on NLF RA cambers. It is recommended that for straight bridges with parallel skew and with girder cambers set based on a NLF RA, the DLF effects on the girder reactions may be neglected for TDLF detailing as long as:***
  1) ***The recommendations for the CF framing arrangements specified in this research are followed, and***
  2) ***The skew index is less than or equal to approximately 1.0.***

  That is, in cases that satisfy the above requirements, the girder reactions may be obtained from a NLF RA (which does not consider of the lack-of-fit from the detailing of the CFs).
- The above limit of 1.0 on the skew index is based largely on the judgment of the research team, considering the results from this research as well as the results from the NCHRP 725 report for bridges with a wide range of skew indices.
- ***For straight bridges with parallel skew that do not satisfy the above requirements, it is recommended that the girder reactions be determined from a DLF RA.***

The above recommendations are considered applicable for straight bridges with parallel skew up to 70^o and spans up to 300 ft. For bridges that exceed these limits, it is recommended that DLF RA be considered. Section 3.9 explains the details of several procedures for conducting a DLF RA.

3.4.8 Straight Bridges with Non-Parallel Skew and Cambers Set Based on LGA

Straight bridges with a difference in the skew angles at the ends of all the spans less than $\Delta\theta$ = 20^o may be considered as parallel skew bridges, and are addressed in Sections 3.4.6 and 3.4.7. With LGA cambers, the responses of straight non-parallel skew bridges are close to the ideal theoretical values (i.e., in the targeted DL conditions, zero layover, CF forces, and girder flange lateral bending stresses, and girder major-axis bending stresses and vertical reactions equal to the values from LGA). The following discussions focus predominantly on the TDL results with TDLF detailing based on LGA cambers, using the Bridge (H1) EISSS57 as an extreme example.

Section 3.4.8.1 provides quantitative results on the influence of SDLF and TDLF detailing with cambers set based on LGA. The influence of SDLF and TDLF is discussed on the responses in the following order: girder vertical displacements, girder elevations, girder layovers, CF forces, girder stresses, and vertical reactions. Section 3.4.8.2 then summarizes the influences on the key bridge responses, and provides recommendations for handling these effects. The recommendations are highlighted in bold italicized text.

3.4.8.1 Quantitative Results

3.4.8.1.1 Girder Vertical Displacements

For straight non-parallel skew bridges, SDLF and TDLF detailing tend to increase the vertical displacement of the longer fascia girder and reduce the vertical displacement of the other girders. The increase or decrease in the vertical displacements, for bridges with a high skew index, is significant when the detailing is based on Line Girder Analysis (LGA) cambers as shown in Figure 130 for Bridge (H1) EISSS57. The maximum TDL displacement difference between the result for TDLF and NLF detailing is 0.82 inches on the innermost girder and 1.26 inches on the fascia girder in (H1) EISSS57. This occurs due to the fact that when the CFs are detailed for TDLF, the effect of the TDLF detailing is to force the girders to deflect in the manner calculated by LGA under the TDL condition. However this effect is accomplished only under this targeted TDL condition. Similarly, when the CFs are detailed for SDLF, the effect of the SDLF detailing is to force the girders to deflect in the manner calculated by LGA under the SDL condition (but only under this condition).

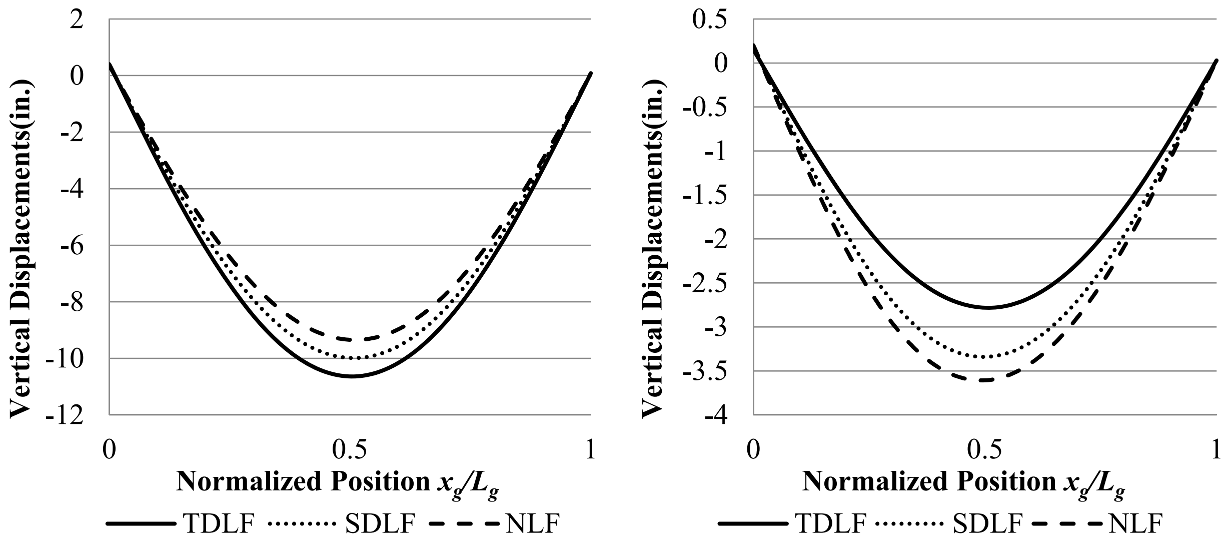


Figure 130. Bridge (H1) EISSS57 critical fascia girder (left) and middle girder (right) vertical displacements under TDL with the CFs detailed based on LGA cambers.

3.4.8.1.2 Girder Elevations

As noted previously, when straight skewed bridges are designed using LGA, the CFs are commonly detailed based on LGA cambers. The TDL LGA girder cambers are taken as the negative of the TDL girder vertical deflections calculated from a LGA. With TDLF detailing, the corresponding TDL girder elevations are theoretically zero (neglecting superelevation, etc.). Similarly, the SDL LGA cambers are taken as the negative of the SDL girder displacements calculated from a LGA. The actual responses corresponding to the above are always slightly different from the above theoretical ideals due to various factors that are not accounted for in the CF detailing, as discussed in Section 3.4.2.2. However, the use of LGA cambers gives the closest capture of these ideals.

In addition, it is essential to recognize that the above findings apply ONLY to the targeted DL conditions. For example, if one uses solely a LGA to determine the TDL girder deflections for a bridge that has been detailed for SDLF, the calculated elevations can be significantly in error. The correct calculation of the girder deflections in this case, if the SDLF detailing is based on LGA cambers, is to sum the girder SDL deflections obtained from a LGA with the CDL deflections obtained from a RA.

Figure 131 shows the vertical elevations for the critical fascia girder of Bridge (H1) EISSS57, under TDL, if the CFs are detailed based on LGA and the girder TDL cambers are set *entirely* based on LGA. One can observe that the elevations match accurately with the targeted zero final elevations for TDLF in this situation. However, these good results apply *ONLY* to the use of TDLF for this TDL condition. If NLF detailing is used, and if the girder cambers are set based on the LGA results for the TDL, the girder final elevations can be substantially in error from the targeted elevations. These errors are equal to the differences between the LGA girder deflections and the 3D FEA girder deflections. If SDLF detailing is used, and if the girder cambers are set based on the LGA results for the TDL, the elevation errors will be smaller. However, these errors can still be substantial, equal to the differences between the LGA girder deflections and the 3D FEA girder deflections under the CDL.

Nevertheless, for the extreme Bridge (H1) EISSS57, the largest error in the girder vertical elevations caused by using LGA results for all the girder deflections is only 1.3 inches, which is considered to be small enough to be addressed within the selection of the girder concrete haunch depths. The above deviation from the ideal elevation by 1.3 inches corresponds to NLF detailing and the use of the LGA total cambers.

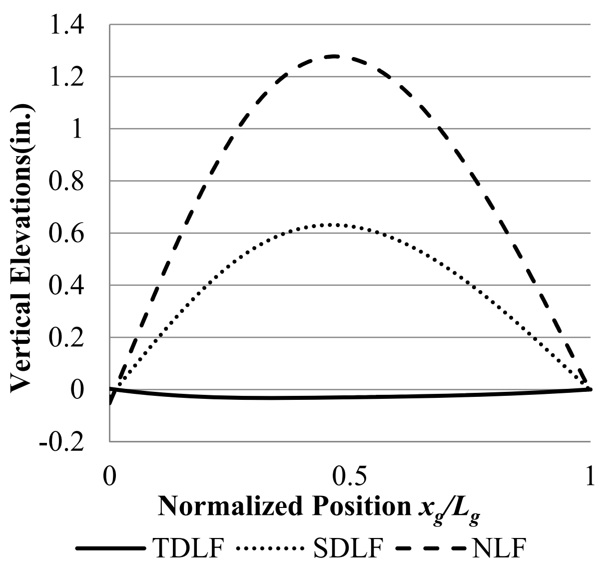


Figure 131. Bridge (H1) EISSS57 critical fascia girder vertical elevations under TDL with the CF detailed based on LGA cambers.

3.4.8.1.3 Girder Layovers

For straight bridges with non-parallel skew, the CFs theoretically fit to the girders under SDL with zero force, when the CFs are detailed for SDLF using LGA. In this case, the girders are nearly ideally plumb under SDL with SDLF detailing based on LGA for Bridge (H1) EISSS57 (see Figure 132). Similarly, the girders are nearly ideally plumb under TDL with TDLF detailing based on LGA.

From Figure 132 one can observe that, for this straight non-parallel skew bridge, the layovers under SDL with TDLF detailing are approximately equal in magnitude but opposite in sign to the layovers under TDL with SDLF detailing. With SDLF detailing, the layovers are theoretically zero under SDL (when LGA cambers are employed). The layovers with SDLF detailing under TDL are approximately equal to the layovers due to the CDL determined from a NLF RA. With TDLF detailing, the layovers are theoretically zero under TDL. The layovers with TDLF detailing under SDL are thus theoretically equal in magnitude but opposite in sign to the layovers due to the CDL determined from a NLF RA.

It should be emphasized that LGA can be a very erroneous predictor of the CDL displacements. This is because the girders are interconnected by their CFs and are thus behaving as a three-dimensional structural system under the action of the CDLs.

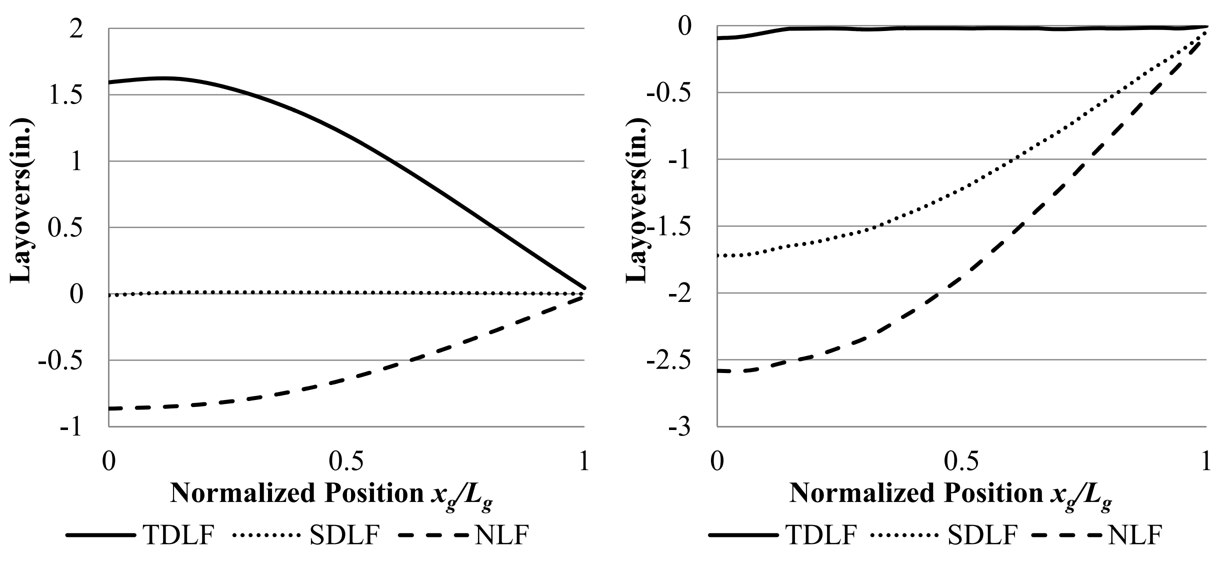


Figure 132. Fascia girder layovers of Bridge (H1) EISSS57 under SDL (left) and under TDL (right) with cambers based on LGA.

3.4.8.1.4 Cross-Frame Forces

For straight bridges with non-parallel skew and girder cambers based on LGA, both the average and the maximum CF forces in the completed bridge are small under SDL for SDLF detailing, and they are small under TDL for TDLF detailing. The effects of SDLF and TDLF detailing approximately cancel the CF DL effects, when the SDLF and TDLF detailing is based on cambers obtained from LGA girder deflections (see Section 3.7 for further detailed discussion). When a straight skewed bridge is designed using LGA, the CFs are detailed commonly based on LGA cambers. It is emphasized that the recommendation of the NCHRP 20-07 Task 355 research is that the engineer should not mix the methods of analysis being applied to a given bridge. That is, if a RA is employed for the overall bridge design (i.e., grid analysis or 3D FEA), the cambers should be calculated based on the RA. This recommendation is due to the high chance of significant errors entering into the solutions when the results from LGA and from RA are mixed (e.g., improperly using the LGA result for the total girder cambers when the bridge is detailed for SDLF, which can result in substantial girder elevation errors) as well as other reasons discussed in Section 3.4.2.3.

Considering Tables 34 and 35, the CF forces are theoretically zero under the targeted DL condition. However, the actual CF forces generally are not zero under the targeted condition for reasons discussed in Section 3.4.2.2. The following can be observed from Tables 34 and 35:

- Under SDL, the largest F2/F1 ratio of the average of the CF member forces is 0.07.
- Under SDL, the largest F2/F1 ratio of the maximum CF member force is 0.26.
- Under TDL, the largest F3/F1 ratio of the average of the CF member forces is 0.14.
- Under TDL, the largest F3/F1 ratio of the maximum CF member force) is 0.37.

Table 34. Average magnitude of the CF member forces in straight non-parallel skew Bridge (H1) EISSS57 (F1, F2, and F3 are the CF forces with NLF, SDLF, and TDLF detailing based on LGA cambers, respectively).

Load Cond.	NLF	SDLF			TDLF		
	F1 (kip)	F2 (kip)	F2/F1	F2 – F1 (kip)	F3 (kip)	F3/F1	F3 – F1 (kip)
SDL	4.6	0.3	0.07	-4.3	6.2	1.35	1.6
TDL	12.1	7.7	0.64	-4.4	1.7	0.14	-10.4

Table 35. Maximum magnitude of the CF member forces in straight non-parallel skew Bridge (H1) EISSS57 (F1, F2, and F3 are the CF forces with NLF, SDLF, and TDLF detailing based on LGA cambers, respectively).

Load Cond.	NLF	SDLF			TDLF		
	F1 (kip)	F2 (kip)	F2/F1	F2 – F1 (kip)	F3 (kip)	F3/F1	F3 – F1 (kip)
SDL	19.2	5.0	0.26	-14.2	27.3	1.42	8.1
TDL	48.9	30.5	0.62	-18.4	18.1	0.37	-30.8

The SDLF maximum fit-up forces for the straight skewed bridges shown in Table 4 (Section 3.2.2) are slightly larger than their maximum forces in the completed bridge under SDL shown in Table 35. This is because the critical CFs are installed at intermediate erection stages for which the bridge configuration and boundary conditions are not the same as the final bridge configuration that the CFs were detailed for.

Figure 133 shows the actual distribution of the CF forces under the SDL in Bridge (H1) EISSS57, including the locked-in force effects from SDLF detailing with LGA cambers. The presentation of the CF forces in these plots, as well as the plots in the subsequent figures is similar to that for Figures 70 through 81 in Section 3.4.5.1.4. The reader is referred to this previous section for an explanation of these details. One can observe that the largest of the CF member forces in Figure 133 is only 5.0 kip.

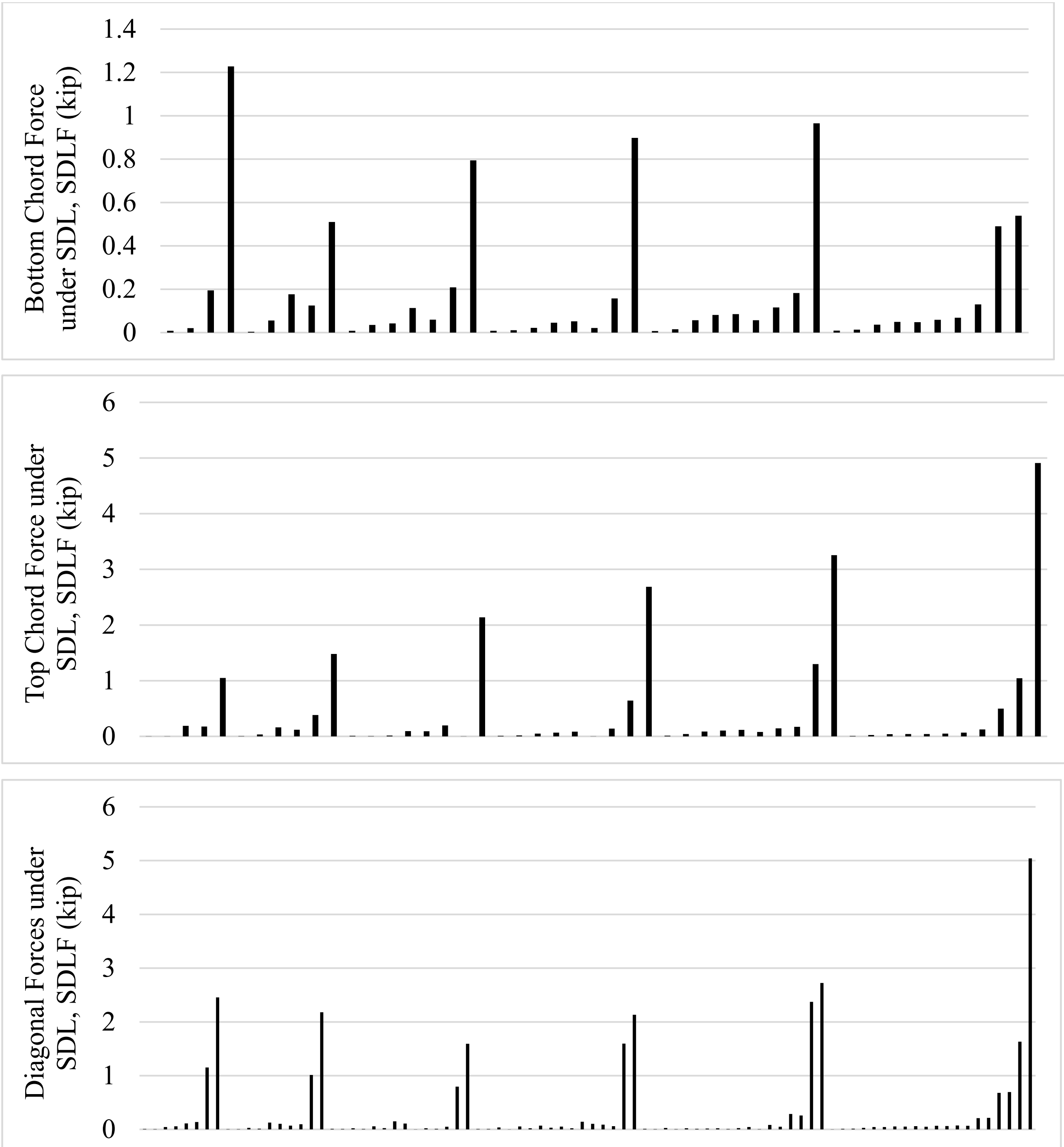


Figure 133. Magnitude of CF member forces from DLF RA, Bridge (H1) EISSS57 under SDL, SDLF detailing based on LGA cambers.

Figure 134 shows an estimate of the CF forces under the SDL, assuming SDLF detailing, obtained by scaling the NLF RA forces for all the cross-frame members by 0.35. This is the scale factor recommended in Section 3.4.6.2 for both SDL/SDLF and TDL/TDLF estimates in straight parallel skew bridges. One can observe that the absolute maximum CF force values from Figure 133 are estimated accurately to conservatively. However, the actual distribution of the CF forces from Figure 133 is predicted poorly. The poor prediction of the CF force distribution is not of any significant consequence though since all the CF forces are relatively small. Since Figure 134 simply shows all the NLF RA CF forces scaled by 0.35, it can be concluded that the distribution of the non-zero CF forces under SDL associated with NLF detailing is very different from the distribution of the reduced (smaller) CF forces under SDL associated with SDLF detailing.

Figure 135 shows the difference between the magnitude of the DLF RA forces and the CF forces under SDL, assuming SDLF detailing, estimated by scaling the NLF RA forces, divided by the CF member yield loads. The plots in this figure are similar those for the curved radially-supported bridges shown previously in Figures 74 through 81. One can observe that the largest under-prediction of the DLF RA results is $0.009P_y$ for one of the chords of the cross-frame connected to the longer fascia girder at the upper-right non-skewed corner of the bridge plan. The largest over-prediction is $-0.028P_y$ using the recommended estimate. Figure 136 shows the same results as Figure 135, but under TDL and assuming TDLF detailing. The maximum under-prediction is $0.027P_y$ and the largest over-prediction is $-0.065P_y$ for this case.

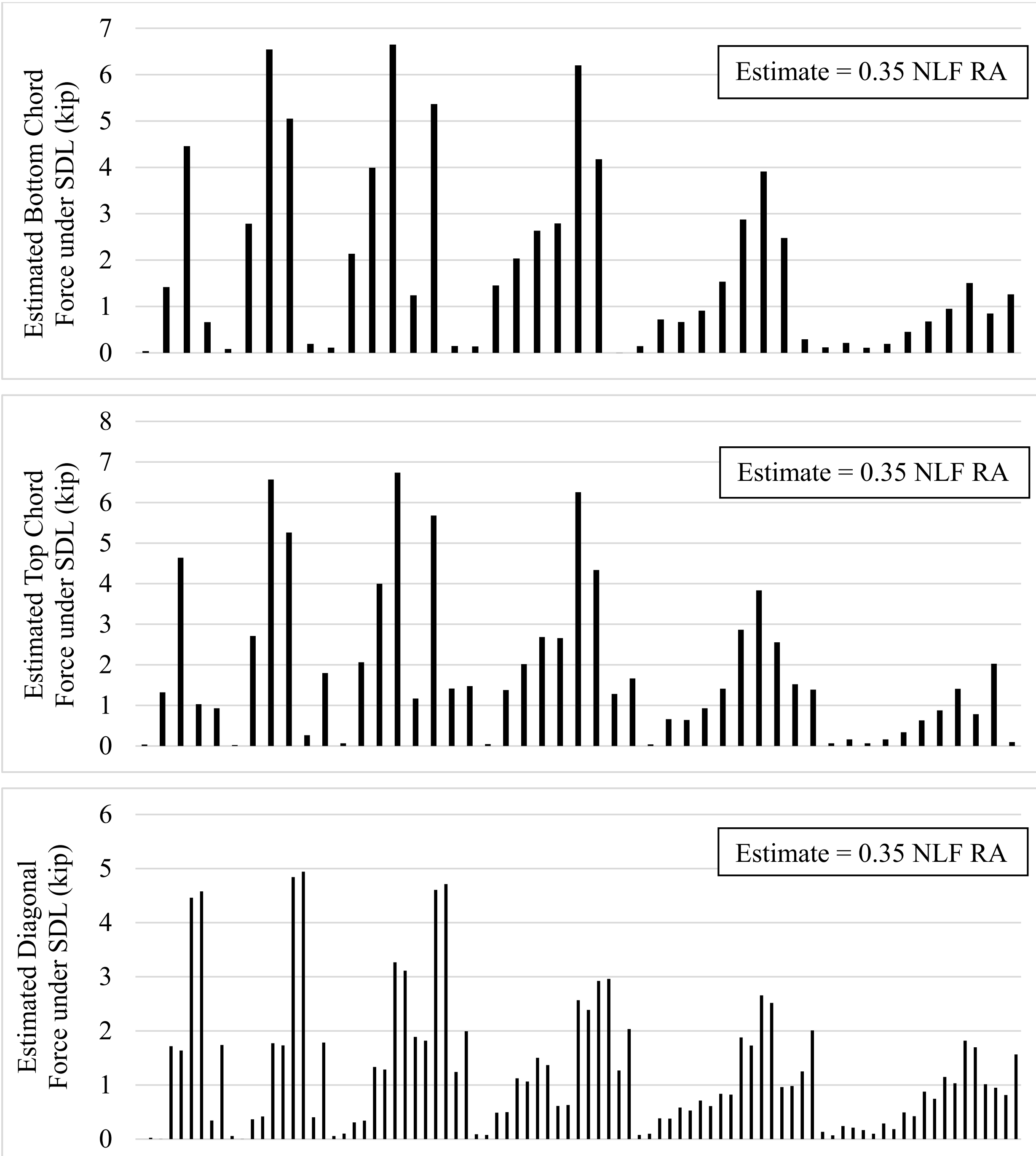


Figure 134. Estimated magnitude of CF member forces based on scaling of NLF RA results, assuming SDLF detailing, Bridge (H1) EISSS57 under SDL.

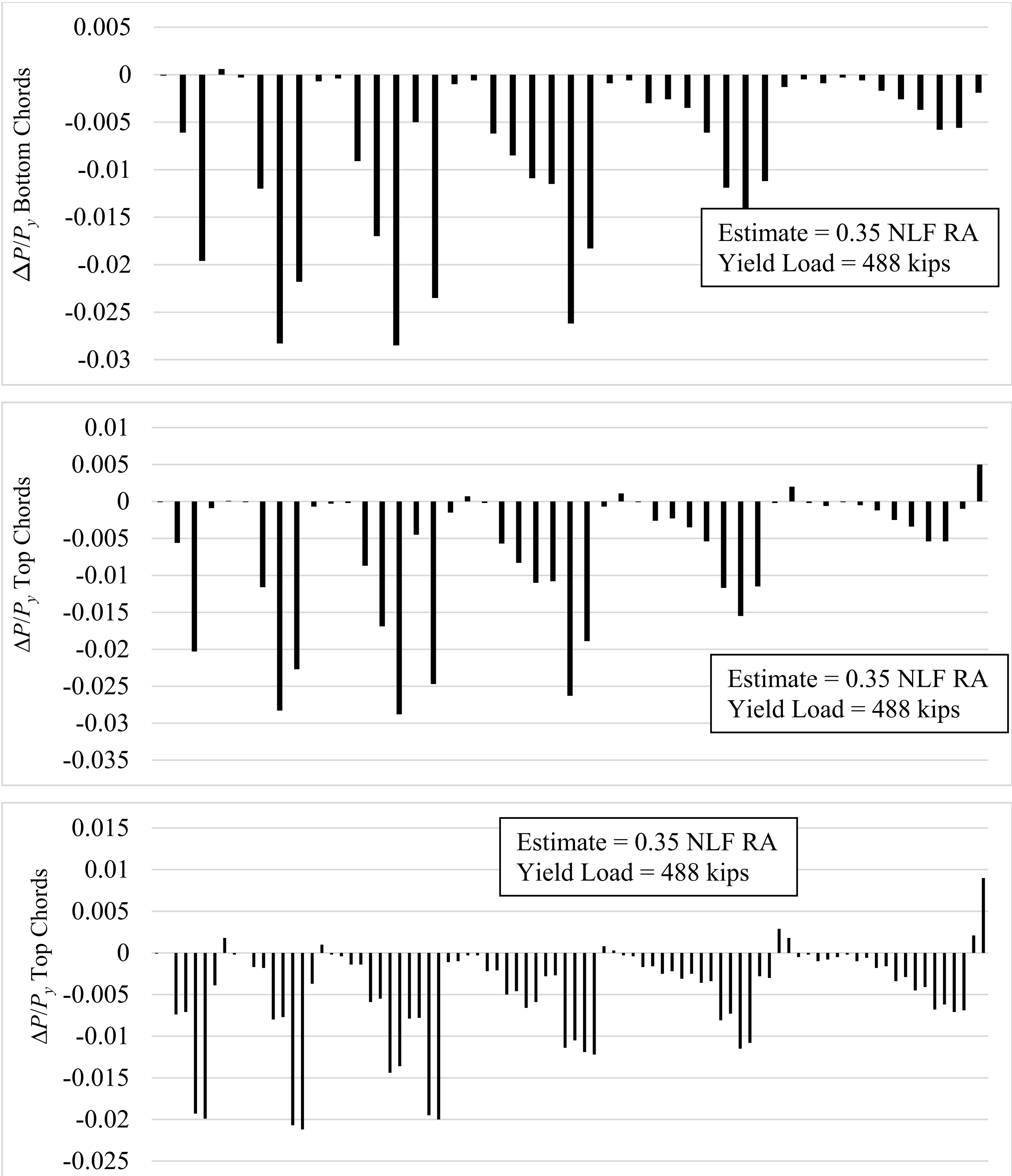


Figure 135. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (H1) EISSS57 under SDL, SDLF detailing based on LGA cambers.

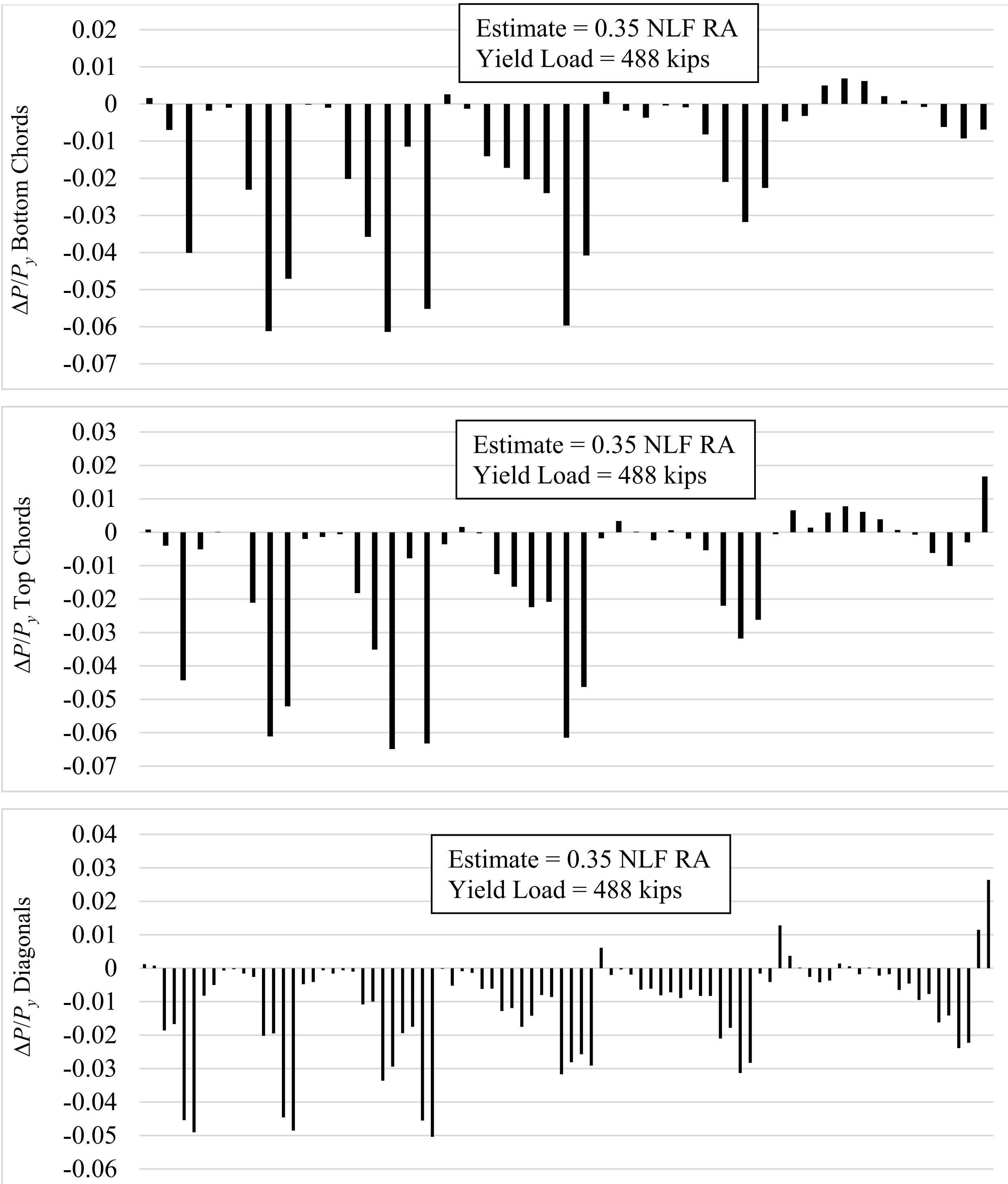


Figure 136. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (H1) EISSS57 under TDL, TDLF detailing based on LGA cambers.

3.4.8.1.5 Girder Stresses

For straight bridges with non-parallel skew, the SDLF and TDLF detailing effects based on LGA cambers tend to increase the major-axis bending stresses on the longer fascia girders and decrease these stresses in the other girders. This behavior is shown in Figures 137 and 138 for Bridge (H1) EISSS57.

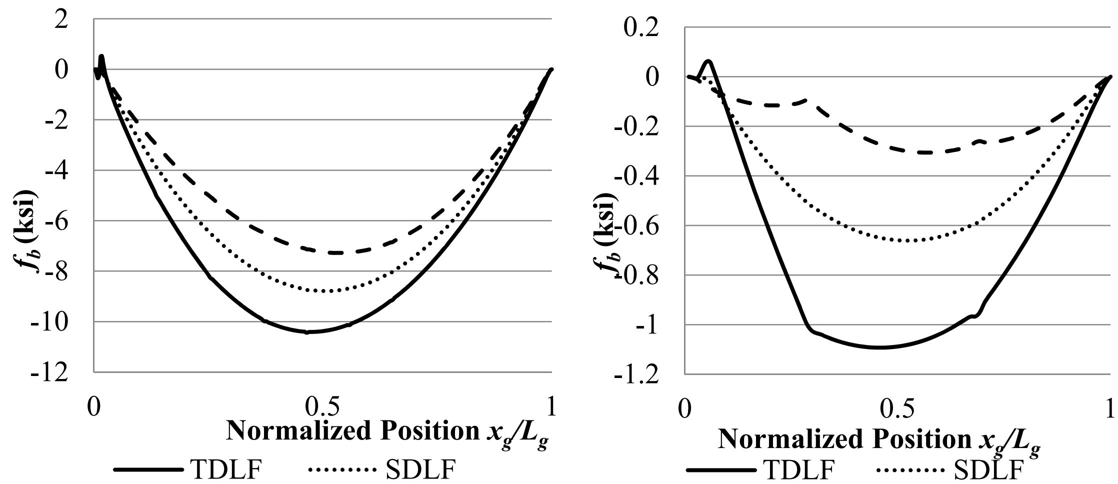


Figure 137. Top flange f_b in Bridge (H1) EISSS57 longer fascia girder (left) and short fascia girder (right) under SDL with detailing based on LGA cambers.

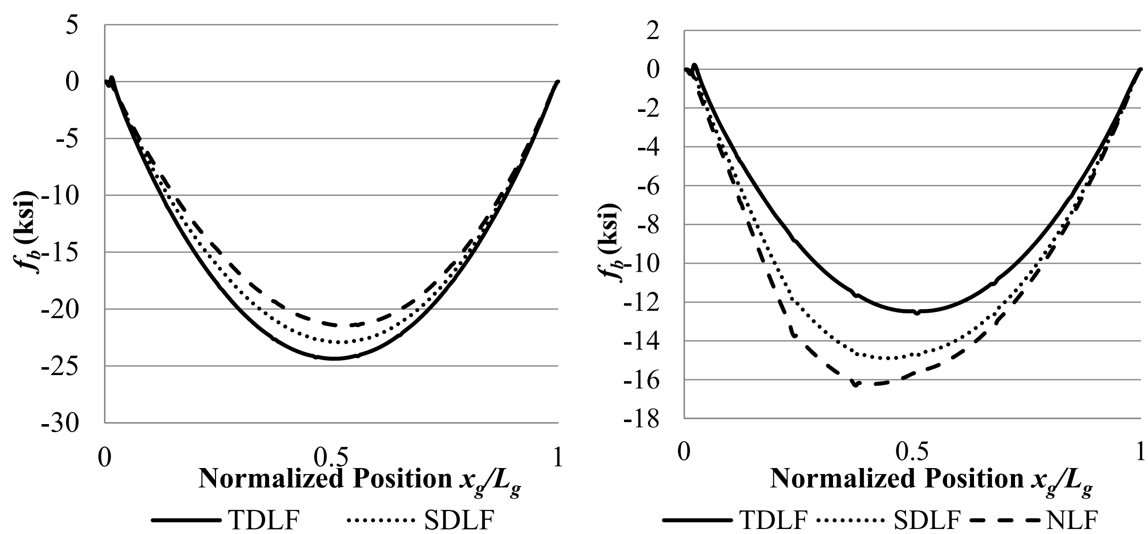


Figure 138. Top flange f_b in Bridge (H1) EISSS57 longer fascia girder (left) and short fascia girder (right) under TDL with detailing based on LGA cambers.

The girder flange lateral bending stresses are theoretically zero under SDL for SDLF detailing and under TDL for TDLF detailing based on LGA cambers, and they are generally significant under TDL if NLF detailing is used (shown in Figures 139 and 140 for Bridge (H1) EISSS57). However, the stresses are actually non-zero under SDL for SDLF detailing and under TDL for TDLF detailing due to a number of factors discussed in Section 3.4.2.2.

From Figure 140, one can observe that, for straight bridges with non-parallel skew, the girder flange lateral bending stresses under SDL with TDLF detailing are approximately equal in magnitude but opposite in sign to the flange lateral bending stresses under TDL with SDLF detailing. With SDLF detailing, the flange lateral bending stresses are theoretically zero under SDL. The flange lateral bending stresses with SDLF detailing under TDL are theoretically equal to the flange lateral bending stresses due to the CDL from 3D FEA. With TDLF detailing, the flange lateral bending stresses are theoretically zero under TDL. The flange lateral bending stresses with TDLF detailing under SDL are theoretically equal to the negative of the flange lateral bending stresses due to the CDL from 3D FEA.

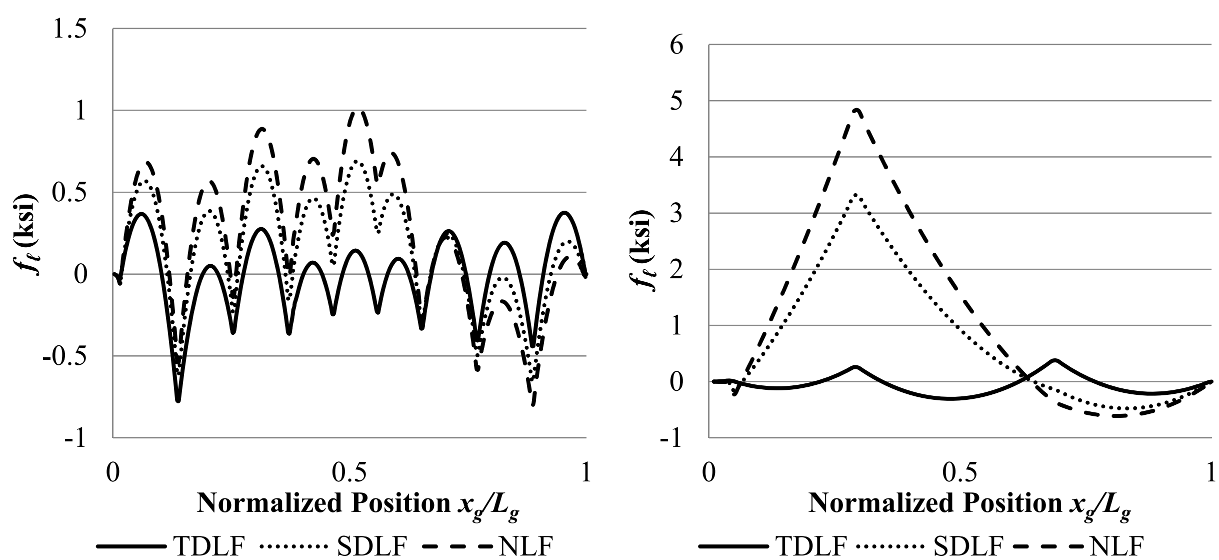


Figure 139. Top flange f_ℓ in Bridge (H1) EISSS57 longer fascia girder (left) and shorter fascia girder (right) under TDL with detailing based on LGA cambers.

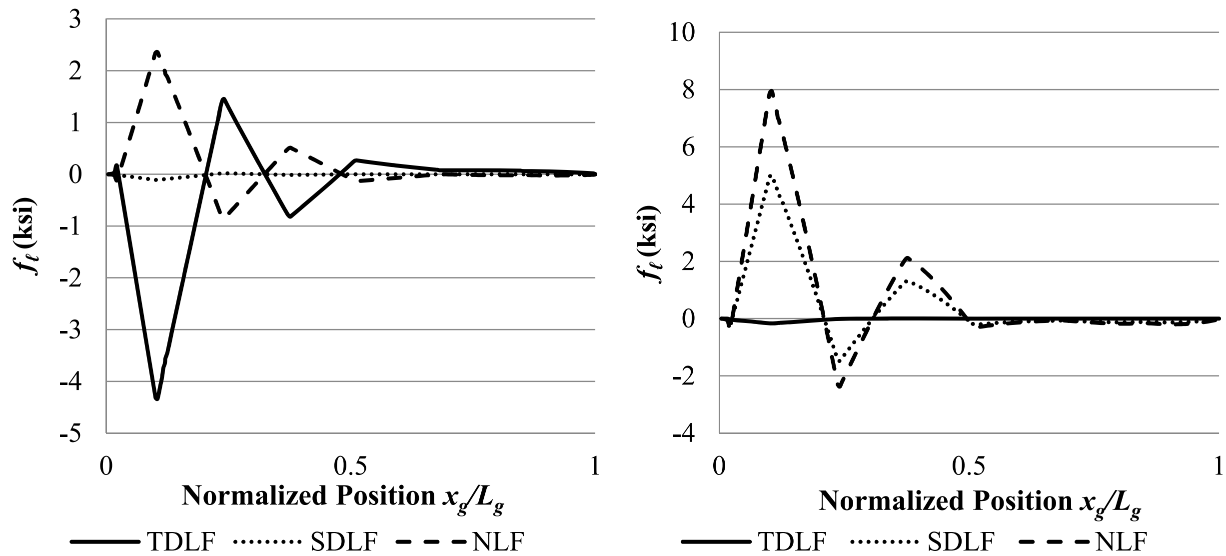


Figure 140. Top flange f_ℓ in Bridge (H1) EISSS57 middle girder under SDL (left) and under TDL (right) with detailing based on LGA cambers.

3.4.8.1.6 Vertical Reactions

With SDLF and TDLF detailing based on LGA cambers, the girders in straight skewed bridges behave as line girders under the targeted load condition. The vertical reactions can be calculated accurately with LGA for each of the girders in this condition – SDL for SLDF and TDL for TDLF, but cannot be calculated accurately with LGA in any other condition. This statement of course applies to all the other bridge DL responses as well.

From Table 36, the largest increase in the TDL vertical reactions due to SDLF detailing based on LGA cambers is 11 kip (34 % relative to the TDL reaction for NLF) in Bridge (H1). This increase occurs at the shorter fascia Girder G1 bearing on the skewed bearing line. The largest increase in the TDL vertical reactions due to TDLF detailing based on LGA cambers is 27 kip (84 %). This increase occurs at the same bearing. The largest decrease in the TDL vertical reactions due to SDLF detailing based on LGA cambers is 10 kip (6 %) at the G4 bearing on the skewed bearing line. The largest decrease in the TDL vertical reactions due to TDLF detailing based on LGA cambers is 31 kip (20 %) at the same bearing. The changes in the vertical reactions in bridge (H2) are not as large as in bridge (H1).

With SDLF and TDLF detailing based on LGA cambers, the girders in straight skewed bridges behave as line girders under the targeted load condition. The vertical reactions can be calculated accurately with LGA for each of the girders in this condition – SDL for SLDF and TDL for TDLF, but they cannot be calculated accurately with LGA in any other condition. This statement of course applies to all the other bridge DL responses as well. The reactions for SDLF under TDL can be calculated as the sum of the LGA SDL reactions and NLF RA CDL reactions. The reactions for TDLF under SDL can be calculated as the sum of the LGA TDL reactions and the negative of the NLF RA CDL reactions.

Table 36. Bridge (H1) EISSS57 vertical reactions (kip) (G1 and G7 are fascia girders), detailing based on LGA cambers.

Girder	**Detailing Method**	**SDL Support 1**	**SDL Support 2**	**TDL Support 1**	**TDL Support 2**
G1	NLF	8	10	32	42
	SDLF	19	15	43	47
	TDLF	33	22	59	53
G2	NLF	28	33	99	113
	SDLF	29	24	100	104
	TDLF	30	12	101	93
G3	NLF	30	38	95	124
	SDLF	36	32	102	117
	TDLF	51	26	118	112
G4	NLF	55	44	156	136
	SDLF	44	40	146	132
	TDLF	22	27	125	119
G5	NLF	58	46	163	139
	SDLF	50	46	155	138
	TDLF	37	45	143	137
G6	NLF	59	48	164	140
	SDLF	56	52	161	143
	TDLF	56	64	161	155
G7	NLF	52	53	151	154
	SDLF	62	60	159	160
	TDLF	73	65	169	165

Table 37 compares the maximum increases and decreases in the vertical reactions due to SDLF and TDLF detailing in Bridges (H1) and (H2) EISSS57. It can be observed that the improved framing arrangement in Bridge (H2) leads to a significant reduction in the magnitude of the changes due to the DLF detailing.

Table 37. Summary of maximum absolute and percentage increases and decreases in the TDL vertical reactions at the girder bearings, due to SDLF and TDLF detailing based on LGA cambers, in the straight bridges with non-parallel skew (the largest of these maximum absolute and percentage increases are highlighted by dark shading).

Bridge	SDLF				TDLF			
	Max Decrease (kip)	Max % Decrease	Max Increase (kip)	Max % Increase	Max Decrease (kip)	Max % Decrease	Max Increase (kip)	Max % Increase
(H1) EISSS57	**-9**	**-8**	**11**	**34**	**-31**	**-20**	**27**	**81**
(H2) EISSS57	-5	-5	9	24	-21	-15	21	56

3.4.8.2 Summary and Recommendations – Straight Bridges with Non-Parallel Skew and Cambers Set Based on LGA

The influence of SDLF and TDLF detailing on the responses in completed straight bridge systems with non-parallel skew and girder cambers calculated based on LGA may be summarized as follows. Recommendations pertaining to these quantitative results are highlighted in bold italicized text.

General

- The use of LGA for setting the girder cambers in sharply skewed straight bridges is generally discouraged based on the considerations discussed in Section 3.4.2.3.
- Straight bridges with a difference in the skew angles at the ends of all the spans less than or equal to $\Delta\theta = 20^o$ may be considered as parallel skew bridges. Section 3.4.6 applies in these cases.
- With LGA cambers, the responses of straight non-parallel skew bridges are close to the ideal theoretical values (i.e., in the targeted DL conditions, zero layover, CF forces, and girder flange lateral bending stresses, and girder major-axis bending stresses and vertical reactions equal to the values from LGA).

The following discussions focus predominantly on the TDL results with TDLF detailing based on LGA cambers, using the Bridge (H1) EISSS57 as an extreme example.

Girder Elevations

- For Bridge (H1) EISSS57, the maximum deviation from the targeted elevations is 0.03 inches under the TDL with TDLF based on the LGA cambers.
- For this bridge, the maximum deviation from the targeted elevations is 0.63 inches if the LGA results are used for all the camber calculations and the bridge is detailed for SDLF.
- ***It is recommended that LGA alone should not be utilized for calculation of the girder total cambers in straight bridges with parallel or non-parallel skew, unless TDLF detailing is employed.***
- ***It is recommended that, if LGA is used for calculating the girder cambers in straight bridges with parallel or non-parallel skew, the girder TDL cambers should be calculated as follows:***
    - ***For TDLF, the negative of the girder TDL vertical deflections obtained from the LGA.***
    - ***For SDLF, the negative of the girder SDL vertical deflections obtained from the LGA plus the negative of the CDL vertical deflections obtained from a NLF RA.***
- Although the above error in the targeted elevations is tolerable for Bridge (H1), the recommendations developed for parallel skew are extended to the non-parallel skew cases to maintain simplicity and consistency.

Girder Layovers

- For Bridge (H1) EISSS57, the maximum girder layover under the TDL, with TDLF detailing based on LGA cambers, is 0.1 inches (0.001 rad).
- ***It is recommended that the girder layovers may be assumed to be negligible in the targeted DL condition in straight bridges with parallel or non-parallel skew when the CFs are detailed using the above recommended procedures with LGA. The fascia girders should be checked separately for twist rotation between the CF locations due to eccentric overhang bracket loads.***
- ***For straight bridges with parallel or non-parallel skew, detailed for SDLF using the above recommended procedures with LGA, the girder layovers under the TDL may be estimated as the CDL layovers obtained from a NLF RA.***

- ***For straight bridges with parallel or non-parallel skew, detailed for TDLF using the above recommended procedures with LGA, the girder layovers under the SDL may be estimated as the negative of the CDL layovers obtained from a NLF RA.***

Cross-Frame Forces

- Under SDL in Bridge (H1) EISSS57, the largest ratio of the average of the CF member forces for SDLF detailing to the corresponding forces for NLF detailing is 0.07 for SDLF based on LGA cambers.
- Under SDL in Bridge (H1) EISSS57, the largest ratio of the maximum CF member force for SDLF detailing to the corresponding force for NLF detailing is 0.26 for SDLF based on LGA cambers. That is, the beneficial locked-in force is 1.0 – 0.26 = 0.74 of the CF force corresponding to NLF detailing for this member.
- Under TDL in this bridge, the largest ratio of the average of the CF member forces for TDLF detailing to the corresponding forces for NLF detailing is 0.14 for TDLF based on LGA cambers.
- Under TDL in this bridge, the largest ratio of the maximum CF member force for TDLF detailing to the corresponding force for NLF detailing is 0.37 for TDLF based on LGA cambers. That is, the beneficial locked-in force is 1.0 – 0.37 = 0.63 of the CF force corresponding to NLF detailing for this member.
- ***In lieu of a DLF RA, it is recommended that a net load factor of (γ_p – 0.65) be used for determination of the factored SDL CF forces in straight I-girder bridges with parallel or non-parallel skew, when the CFs are detailed for SDLF using the recommended procedures with LGA. This net load factor is to be applied to the results from a NLF RA for the SDL. It should be noted that these SDL CF forces must be added to the factored CDL CF forces from a NLF RA to obtain the total factored DL CF forces.*** The factor of 0.65 is a slightly conservative estimate of the maximum SLDF locked-in force ratio of 1.0 – 0.26 = 0.74, selected to be consistent with the recommendations for straight parallel-skew bridges.
- ***In lieu of a DLF RA, it is recommended that a net load factor of (γ_p – 0.65) be used for determination of the factored TDL CF forces in straight I-girder bridges with parallel or non-parallel skew, when the CFs are detailed for TDLF using the recommended procedures with LGA. This net load factor is to be applied to the results from a NLF RA for the TDL.***

The factored CF forces under the SDL may be estimated by subtracting the factored CDL CF forces obtained by a NLF RA from the above factored TDLF forces. The factor of 0.65 is an estimate of the TDLF locked-in force of 1.0 – 0.37 = 0.63, selected to be consistent with the recommendations for straight parallel-skew bridges. In cases where additional uncertainties and variabilities associated with TDLF are anticipated, due to incidental participation of deck forms, early concrete stiffness gain, and/or larger potential play in the CF connections due to the larger CF forces associated with TDLF, it is suggested that a value between 0.65 and 0.50 may be used for the above locked-in force estimate based on the judgment of the engineer of record. This suggested reduction is based on the judgement of the research team. The current research did not perform any specific investigations of the above effects.

- The maximum difference in the magnitude of the individual CF member forces from a DLF RA and (1 – 0.65 = 0.35) of the estimated values from a NLF RA, normalized by the member yield load, is 1.1 and 4.8 %, and the average difference is -0.5 and -1.4 % for SDLF under SDL and TDLF under TDL, respectively, for the straight bridges with non-parallel skew studied in this research and girder cambers based on LGA.
- The maximum difference in the magnitude of the individual CF member forces from a DLF RA and (1 – 0.65 = 0.35) of the estimated values from a NLF RA, normalized by the member yield load, is 1.1 and 3.1 %, and the average difference is -0.5 and -1.0 % for SDLF under SDL and TDLF under TDL, respectively, for the straight bridges studied in this research with non-parallel skew and girder cambers based on LGA.

Girder Stresses

- For Bridge (H1) EISSS57, the largest maximum girder flange lateral bending stress (f_ℓ), under the TDL for TDLF based on LGA cambers, is 0.8 ksi, 80 % of the corresponding maximum girder NLF value. This f_ℓ occurs on the longest fascia girder in the bridge. The next largest maximum girder f_ℓ is 0.4 ksi, on the shortest fascia girder under the TDL for TLDF based on LGA cambers, and is 8 % of the corresponding maximum girder NLF value. The largest maximum girder f_ℓ based on the assumption of NLF detailing is 8.4 ksi, and occurs on the interior Girder 3 in this bridge. The maximum f_ℓ on Girder 3 is reduced to 0.1 ksi (1 % of the above NLF value) by the use of TDLF detailing based on the LGA cambers.

- For all the bridges studied in this research, the use of an assumed locked-in f_ℓ of 0.65 of the f_ℓ from a NLF RA gives an accurate to conservative estimate of the f_ℓ values determined from a DLF RA.
- ***In lieu of a DLF RA, for straight bridges with non-parallel skew and with the CFs detailed for SDLF using the recommended procedures with LGA, it is recommended that the corresponding procedures for calculation of the CF forces proposed for parallel-skew bridges also be used for determining the girder f_ℓ values.***
- In (H1) EISSS57, the largest increase in the girder major-axis bending stresses under the TDL, due to the effect of SDLF detailing based on LGA cambers, is 1.5 ksi (6 %). The largest increase in any of the girder major-axis bending stresses under the TDL, due to the effect of TDLF detailing based on LGA cambers, is 2.9 ksi (13 %). The largest increase occurs in the long fascia Girder G7, but a slightly smaller increase appears in the short fascia Girder G1.
- The LGA solution gives accurate f_b values for the targeted DL condition – SDL for SDLF and TDL for TDLF.
- ***In lieu of a DLF RA, for straight bridges with non-parallel skew and with the CFs detailed using the above recommended procedures with LGA, it is recommended that the girder f_b values in the targeted DL condition be taken as the values from the LGA.***
- ***In lieu of a DLF RA, for straight bridges with non-parallel skew and with the CFs detailed for SDLF using the recommended procedures with LGA, the girder f_b values under the TDL may be estimated by adding the CDL f_b values obtained from a NLF RA to the SDL f_b values obtained from LGA.***
- ***In lieu of a DLF RA, for straight bridges with non-parallel skew and with the CFs detailed for TDLF using the recommended procedures with LGA, the girder f_b values under SDL may be estimated by subtracting the CDL f_b values obtained from a NLF RA from the TDL f_b values obtained from LGA.***

Vertical Reactions

- When LGA cambers are used with (H1) EISSS57, the results for the girder reactions parallel the above results for the girder major-axis bending stresses, except that the changes in the reactions are affected more significantly.

- The recommendations for improved CF framing arrangements from this research have a measurable effect in reducing the changes in the bearing reactions due to DLF.
- ***In lieu of a DLF RA, for straight bridges with non-parallel skew and with the CFs detailed using the recommended procedures with LGA, it is recommended that the girder reactions in the targeted DL condition be taken as the values from the LGA.***
- ***In lieu of a DLF RA, for straight bridges with non-parallel skew and with the CFs detailed for SDLF using the recommended procedures with LGA, the girder reactions under the TDL may be estimated by adding the CDL reactions obtained from a NLF RA to the SDL reactions obtained from LGA.***
- ***In lieu of a DLF RA, for straight bridges with non-parallel skew and with the CFs detailed for TDLF using the recommended procedures with LGA, the girder reactions under SDL may be estimated by subtracting the CDL reactions obtained from a NLF RA from the TDL reactions obtained from LGA.***

The above recommendations are considered applicable for straight bridges with non-parallel skew, skew angles up to 70^o, and spans up to 300 ft.

For bridges that exceed these limits, it is recommended that DLF RA be considered. Section 3.9 explains the details of several procedures for conducting a DLF RA.

3.4.9 Straight Bridges with Non-Parallel Skew and Cambers Set Based on NLF RA

Straight bridges with a difference in the skew angles at the ends of all the spans less than equal to $\Delta\theta = 20^o$ may be considered as parallel skew bridges, and are addressed in Sections 3.4.6 and 3.4.7. The following discussions focus predominantly on the TDL results with TDLF detailing based on NLF RA cambers, using the Bridge (H1) EISSS57 as an extreme example. In (H1) EISSS57, the pattern of the RA cambers is very similar to the pattern of the LGA cambers, but the RA cambers are smaller in magnitude than the LGA cambers.

Section 3.4.9.1 provides quantitative results on the influence of SDLF and TDLF detailing with cambers set based on NLF RA. The influence of SDLF and TDLF is discussed on the responses in the following order: girder vertical displacements, girder elevations, girder layovers, CF forces, girder stresses, and vertical reactions. Section 3.4.9.2 then summarizes the influences on the key bridge responses, and provides recommendations for handling these effects. The recommendations are highlighted in bold italicized text.

3.4.9.1 Quantitative Results

3.4.9.1.1 Girder Vertical Displacements

For straight bridges with non-parallel skew based on NLF RA, SDLF and TDLF detailing tend to increase the vertical displacement of the longer fascia girder and reduce the vertical displacements of the other girders. The increase or decrease in the vertical displacements when the cambers are based on NLF RA is not as significant as when the cambers are based on LGA. This is because when the cambers are set based on NLF RA, the resulting targeted DL elevations are essentially the "natural" deflected elevations of the girders under the targeted DL in the 3D structural system. As such, the girders are subjected predominantly just to twist rotations to move them from their deflected out-of-plumb geometry in the 3D system to their approximately plumb targeted DL geometry, via the DLF detailing effects. The girder twisting is accomplished with relative ease when the straight girders are in this "natural" deflected geometry.

Figure 141 shows the fascia and middle interior girder TDL vertical displacements in Bridge (H1) EISSS57 if the CFs are detailed for TDLF based on the cambers calculated from NLF RA (calculated using the common practice of constructing a model of the full bridge system and "turning gravity on"). In this case, both the fascia and interior girder displacements are practically unaffected by the CF detailing. The maximum displacement difference between TDLF and NLF is 0.39 inches on the longer fascia girder.

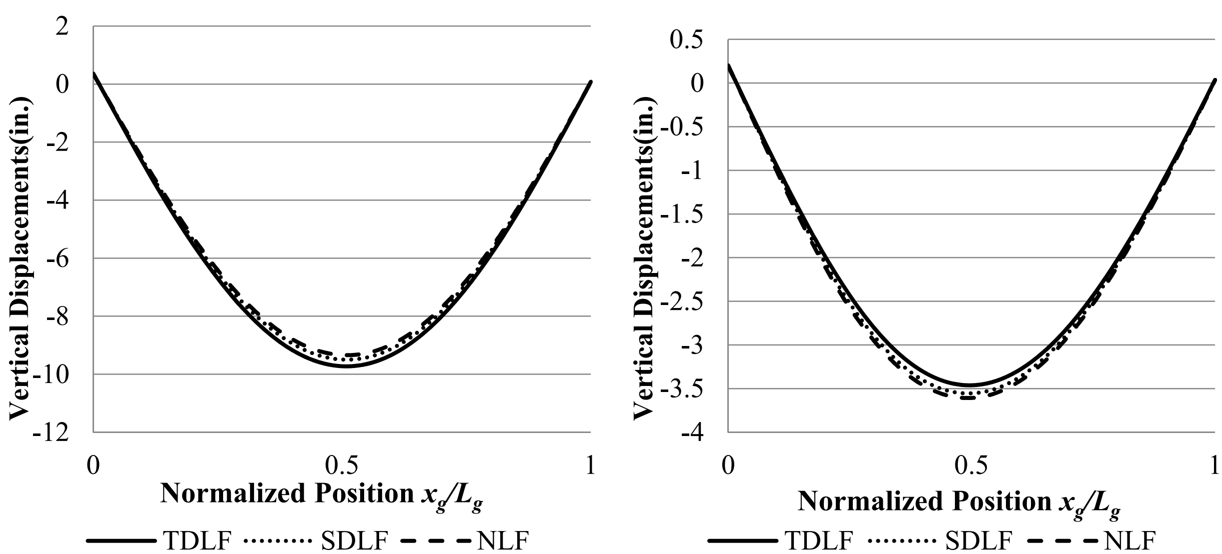


Figure 141. Bridge (H1) EISSS57 critical fascia girder (left) and middle girder (right) vertical displacements under TDL with the CFs detailed based on NLF RA cambers.

3.4.9.1.2 Girder Elevations

The girder cambers are based on NLF RA in this section. The vertical elevations under TDL for NLF detailing are theoretically zero (assuming no superelevation, etc., as a simplification). Figure 142 shows the results for the girder TDL elevations in Bridge (H1) EISSS57, with all of the calculations conducted by NLF RA. One can observe that, as one might expect, the elevations are the exact "zero" values for NLF detailing, since the bridge responds in this case as if the gravity loads were simply "turned on." The vertical elevations deviate slightly from the targeted zero values for SDLF detailing, and the deviations are somewhat larger for the case of TDLF detailing. Bridge (H1) exhibits a maximum deviation of 0.4 inches from the targeted DL elevations with TDLF detailing.

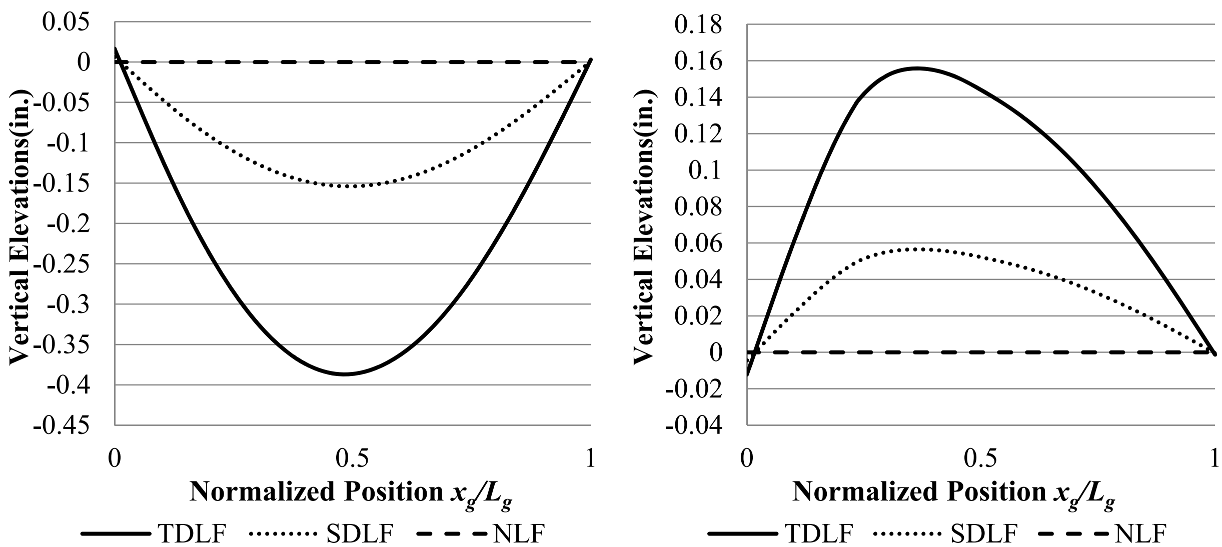


Figure 142. Bridge (H1) EISSS57 longer fascia girder (left) and middle girder (right) vertical elevations under TDL with the CF detailed based on NLF RA and the girder TDL cambers based entirely on NLF RA

3.4.9.1.3 Girder Layovers

In straight skewed bridges, SDLF and TDLF detailing based on RA cambers still gives approximately plumb webs under the targeted condition. However, the layovers are no longer theoretically zero under the targeted condition. This is due to the overall elastic deformations of the CFs and the elastic torsional deformations of the girders in the structural system. There is only one set of cambers and corresponding CF drops that gives theoretically exactly plumb webs for straight skewed bridges – the LGA cambers.

Figure 143 shows the longer fascia girder layover under TDL for Bridge (H1) EISSS57 based on NLF RA. One can observe that the layovers with TDLF detailing based on NLF RA are approximately zero under TDL.

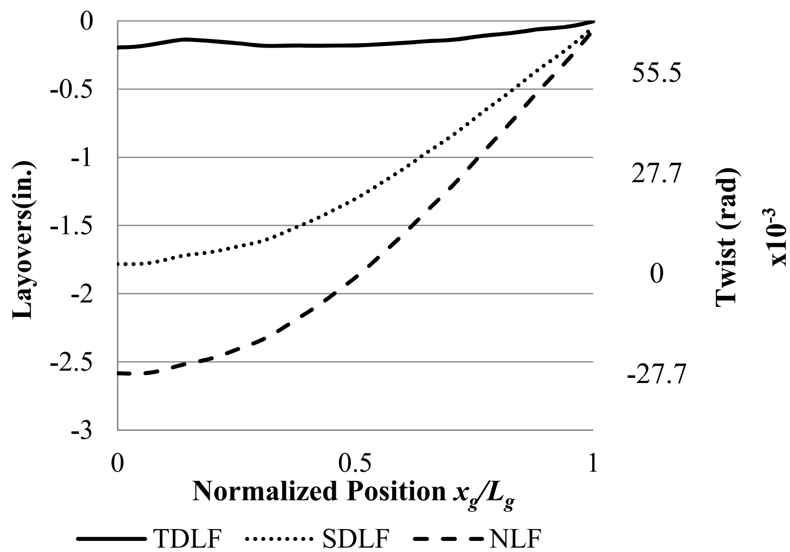


Figure 143. Longer fascia girder layover under the TDL for Bridge (H1) EISSS57 with detailing based on NLF RA.

3.4.9.1.4 Cross-Frame Forces

In straight non-parallel skew bridges, SDLF and TDLF detailing based on RA cambers gives small CF forces under the targeted condition. However, the CF forces are not theoretically zero under the targeted condition due to the overall elastic deformations of the CFs and the elastic torsional deformations of the girders in the structural system, for reasons discussed in Section 3.4.2.2.

Tables 38 and 39 report the average magnitude of the CF member forces and the maximum magnitude of these forces in Bridge (H1) EISSS57. The following can be observed from these tables:

- Under SDL, the largest F2/F1 ratio of the average of the CF member forces is 0.61.
- Under SDL, the largest F2/F1 ratio of the maximum CF member force is 0.62.
- Under TDL, the largest F3/F1 ratio of the average of the CF member forces is 0.62.
- Under TDL, the largest F3/F1 ratio of the maximum CF member force is 0.65.

Table 38. Average magnitude of the CF member forces in straight non-parallel skew bridge EISSS57 (F1, F2, and F3 are the CF forces with NLF, SDLF, and TDLF detailing based on NLF RA cambers, respectively).

Load Cond.	NLF	SDLF			TDLF		
	F1 (kip)	F2 (kip)	F2/F1	F2 – F1 (kip)	F3 (kip)	F3/F1	F3 – F1 (kip)
SDL	4.6	2.8	0.61	-1.8	2.6	0.57	-2.0
TDL	12.1	10.2	0.83	-1.9	7.5	0.62	-4.6

Table 39. Maximum magnitude of the CF member forces in straight non-parallel skew bridge EISSS57 (F1, F2, and F3 are the CF forces with NLF, SDLF, and TDLF detailing based on NLF RA cambers, respectively).

Load Cond.	NLF	SDLF			TDLF		
	F1 (kip)	F2 (kip)	F2/F1	F2 – F1 (kip)	F3 (kip)	F3/F1	F3 – F1 (kip)
SDL	19.2	12.0	0.62	-7.2	12.1	0.63	-7.1
TDL	48.8	42.5	0.87	-6.3	31.7	0.65	-17.1

Figure 144 shows the actual distribution of the CF forces under the SDL in Bridge (H1) EISSS57, including the locked-in force effects from SDLF detailing with NLF RA cambers. The presentation of the CF forces in these plots, as well as the plots in the subsequent figures is similar to that for Figures 70 through 81 in Section 3.4.5.1.4. The reader is referred to this previous section for an explanation of these details. One can observe that the largest of the CF member forces in Figure 144 is only 12.0 kip.

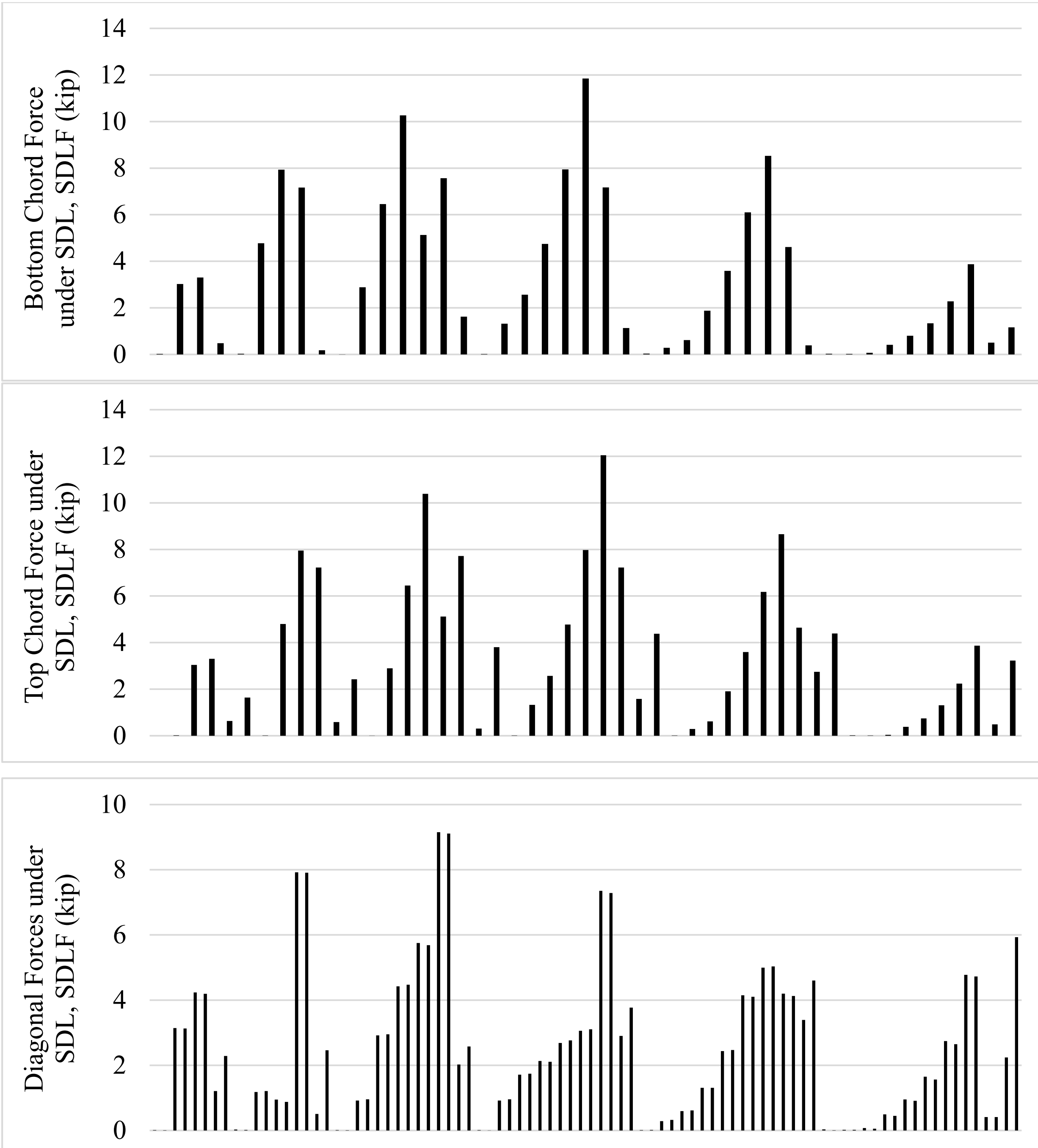


Figure 144. Magnitude of CF member forces from DLF RA, Bridge (H1) EISSS57 under SDL, SDLF detailing based on NLF RA cambers.

Figure 145 shows an estimate of the CF forces under the SDL, assuming SDLF detailing, obtained by scaling the NLF RA forces for all the cross-frame members by 1.0. This is the scale factor recommended in Section 3.4.7.2 for the SDL/SDLF estimates in straight parallel skew bridges. One can observe that almost all of the CF force values from Figure 144 are estimated accurately to conservatively. However, the actual distribution of the CF forces from Figure 144 is predicted poorly. The poor prediction of the CF force distribution is not of any significant consequence though since all the CF forces are relatively small. Since Figure 145 simply shows all the NLF RA CF forces scaled by 1.0, it can be concluded that the distribution of the non-zero CF forces under SDL associated with NLF detailing is very different from the distribution of the reduced (smaller) CF forces under SDL associated with SDLF detailing. Figure 146 shows the difference between the magnitude of the DLF RA forces and the CF forces under SDL, assuming SDLF detailing, estimated by scaling the NLF RA forces, divided by the CF member yield loads. The plots in this figure are similar those for the curved radially-supported bridges shown previously in Figures 74 through 81. One can observe that the largest under-prediction of the DLF RA results is $0.007P_y$ for one of the chords of the cross-frame. The largest over-prediction is -$0.045P_y$ using the recommended estimate.

Figure 147 shows the same results as Figure 146, but under TDL and assuming TDLF detailing. In this case, the estimate of 0.6 of the NLF RA forces is used. The maximum under-prediction is $0.041P_y$ and the largest over-prediction is -$0.051P_y$ for this case.

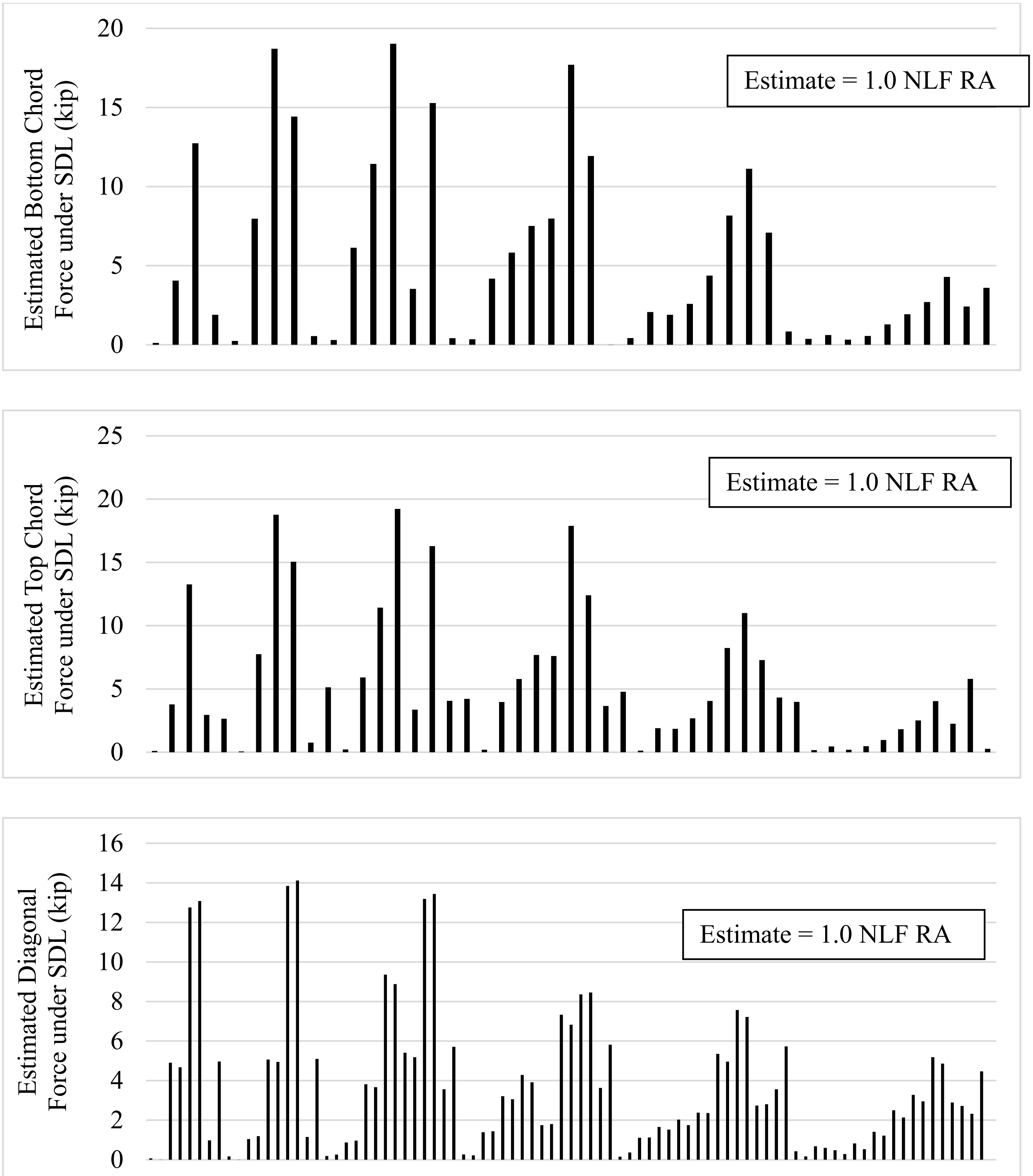


Figure 145. Estimated magnitude of CF member forces based on scaling of NLF RA results, assuming SDLF detailing, Bridge (H1) EISSS57 under SDL.

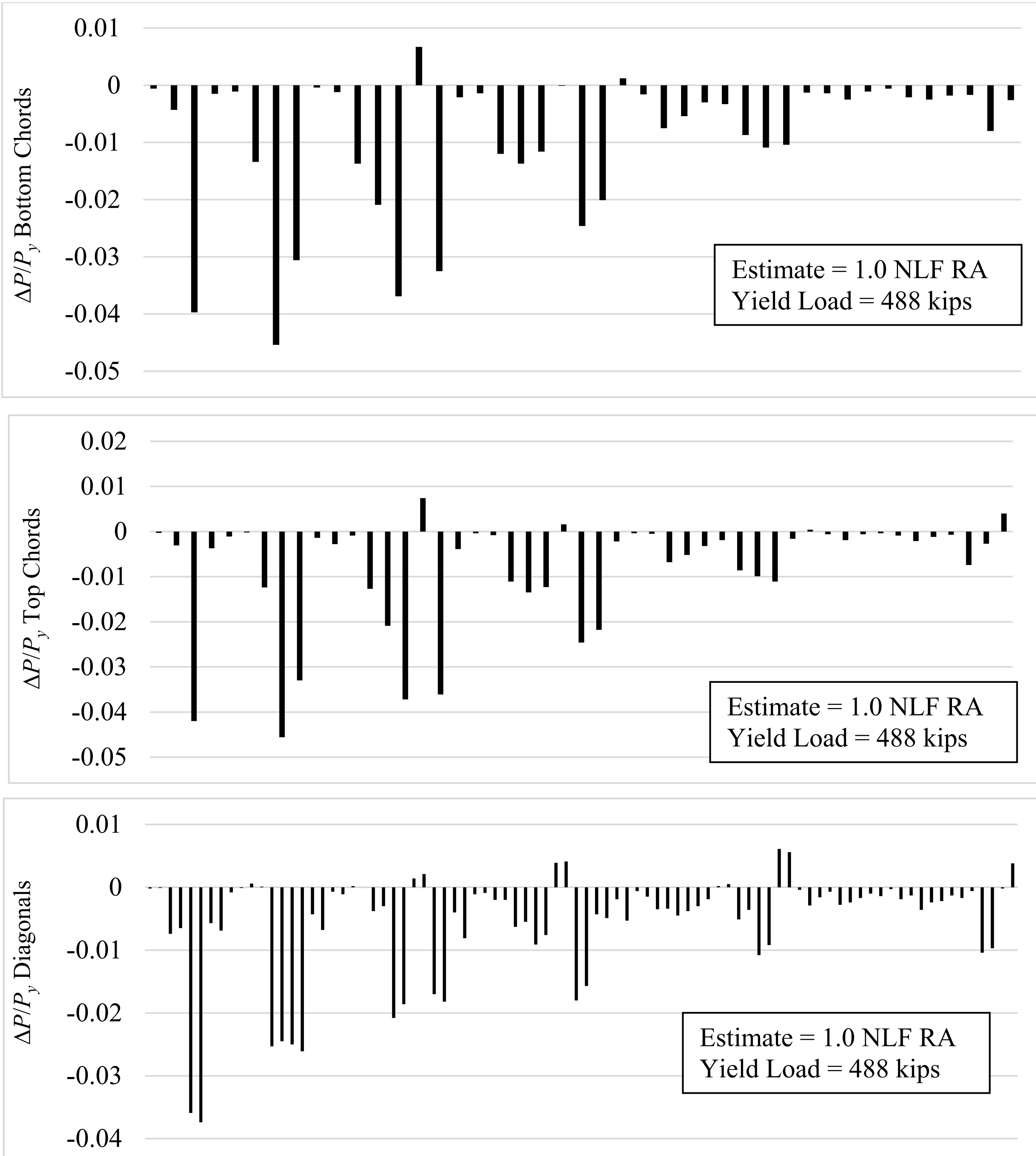


Figure 146. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load (ΔP/Py), Bridge (H1) EISSS57 under SDL, SDLF detailing based on NLF RA cambers.

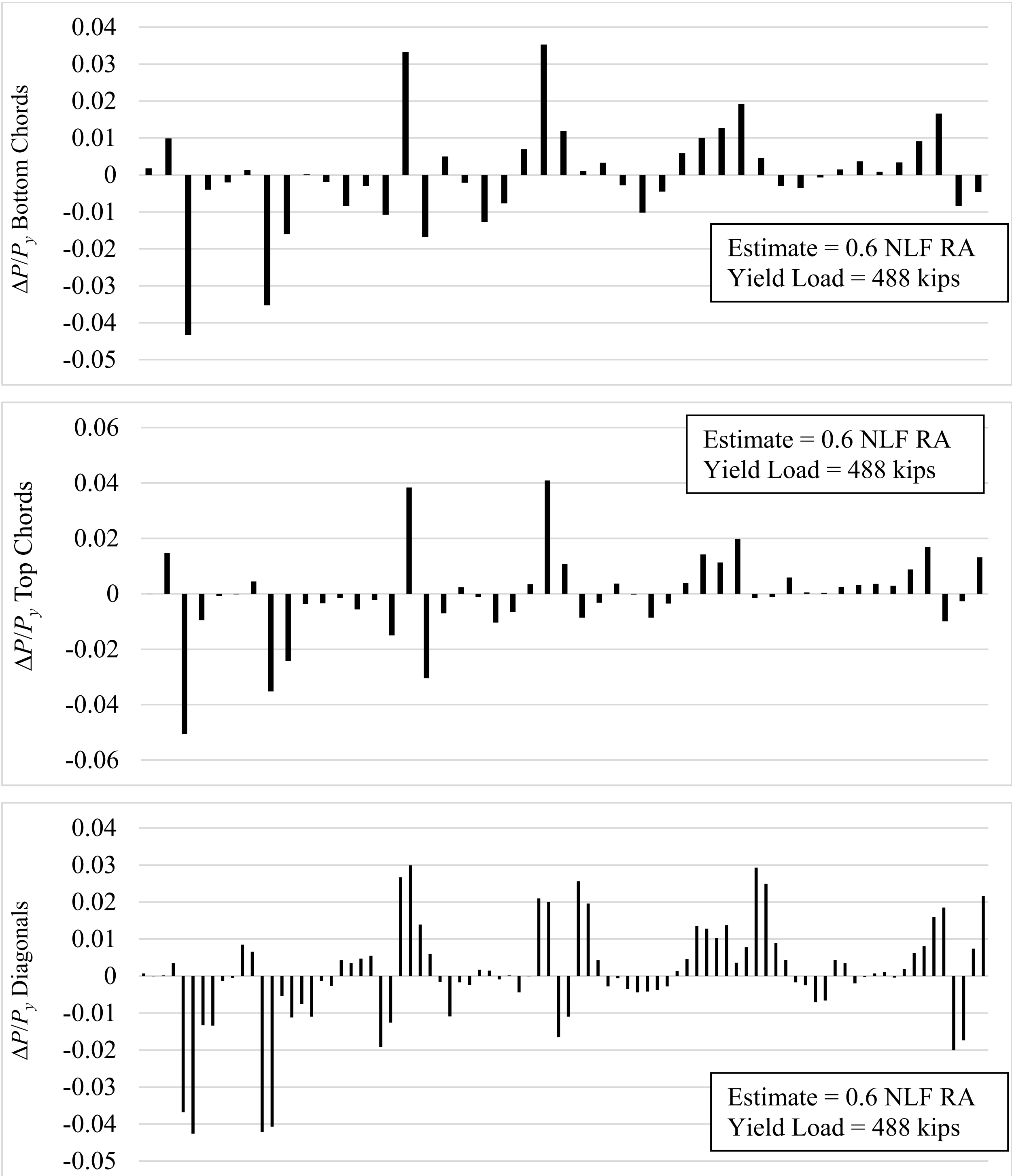


Figure 147. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load (ΔP/Py), Bridge (H1) EISSS57 under TDL, TDLF detailing based on NLF RA cambers.

3.4.9.1.5 Girder Stresses

For straight bridges with non-parallel skew, the SDLF and TDLF detailing effects based on NLF RA cambers tend to increase the major-axis bending stresses in the longer fascia girder and decrease these stresses in the other girders. This behavior is shown in Figure 149 for Bridge (H1) EISSS57. These changes in the major-axis bending stresses are negligible for Bridge (H1).

The girder flange lateral bending stresses are small under SDL for SDLF detailing and under TDL for TDLF detailing based on RA cambers, and they are generally significant under TDL if NLF detailing is used. This behavior is shown in Figure 151 for Bridge (H1) under the TDL.

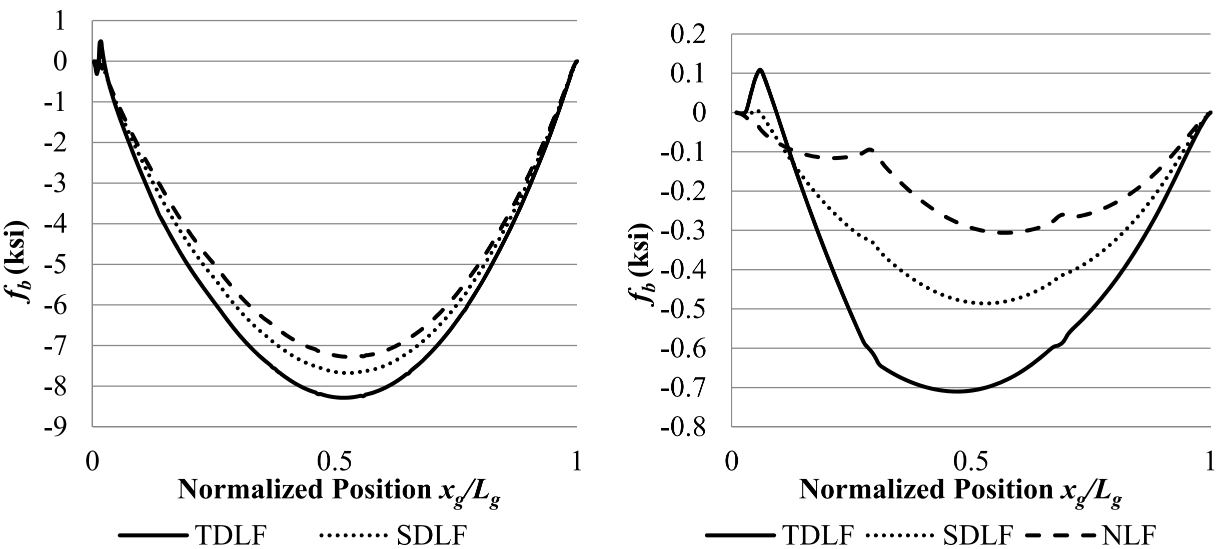


Figure 148. Top flange f_b in Bridge (H1) EISSS57 longer fascia girder (left) and short fascia girder (right) under SDL with detailing based on NLF RA cambers.

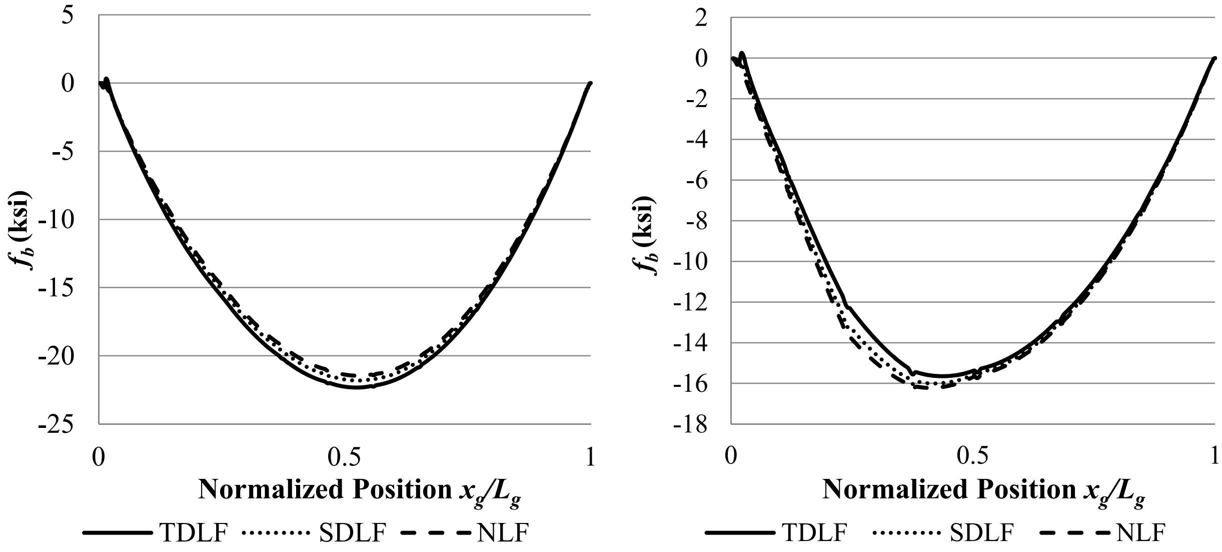


Figure 149. Top flange f_b in Bridge (H1) EISSS57 longer fascia girder (left) and short fascia girder (right) under TDL with detailing based on NLF RA cambers.

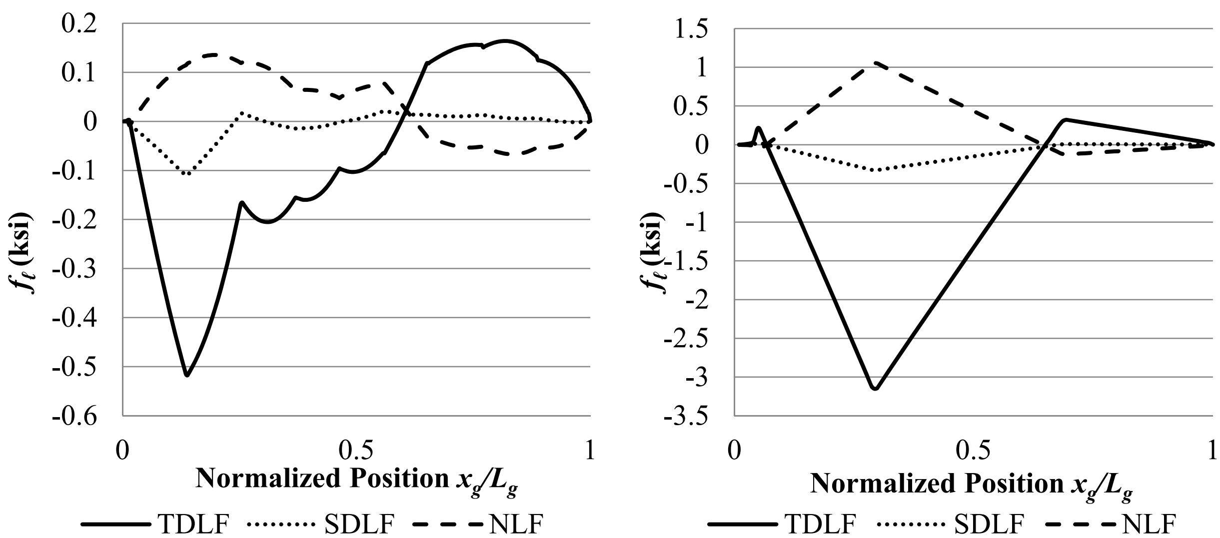


Figure 150. Top flange f_ℓ in Bridge (H1) EISSS57 longer fascia girder (left) and short fascia girder (right) under SDL with detailing based on NLF RA cambers.

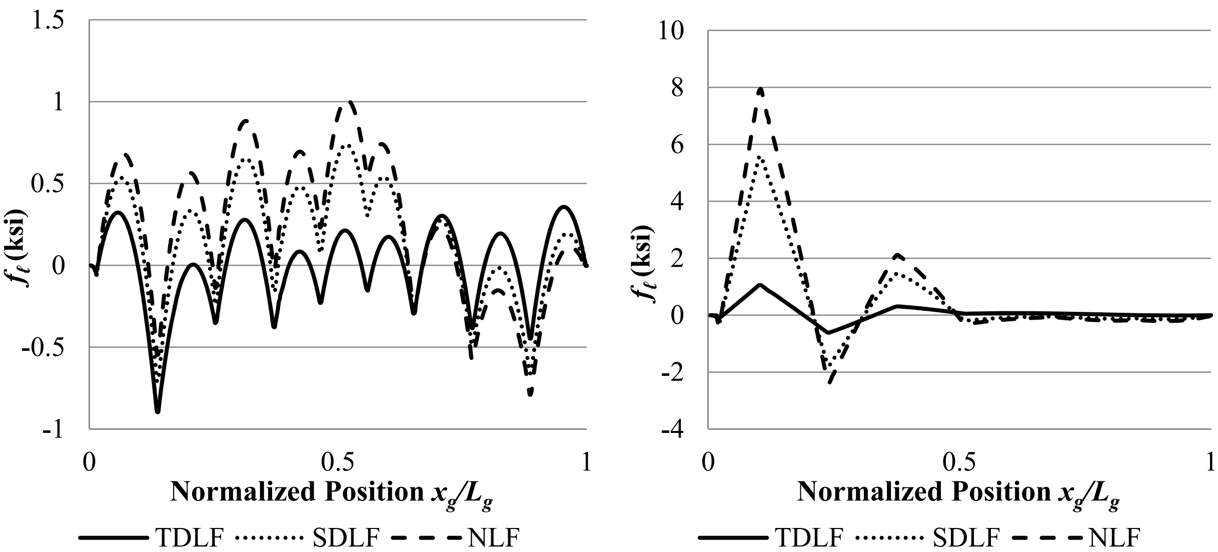


Figure 151. Top flange f_ℓ in Bridge (H1) EISSS57 longer fascia girder (left) and short fascia girder (right) under TDL with detailing based on NLF RA cambers.

3.4.9.1.6 Vertical Reactions

Table 40 shows the vertical reactions for Bridge (H1) with cambers set based on NLF RA. Table 41 summarizes the maximum changes in the TDL reactions of Bridges (H1) and (H2) due to SDLF and TDLF detailing. From these tables, the largest increase in the reactions under TDL is 5 kip (23 %) due to SDLF detailing and 19 kip (58 %) due to TDLF detailing for Bridge (H1). This maximum occurs at the shorter fascia Girder G1 bearing on the skewed bearing line. The reactions on the shorter fascia Girder G1 are somewhat smaller for this case, where the girder cambers are based on NLF RA, compared to the results in Table 36, where the girder cambers are based on LGA. This behavior is related to the fact that the girder vertical displacements are changed substantially by the DLF detailing when LGA cambers are used, whereas there is little change in the girder vertical displacements due to DLF detailing with RA cambers. The largest decrease in the reactions under TDL is 6 kip (5 %) due to SDLF detailing and 15 kip (12 %) due to TDLF detailing for Bridge (H1).

It can be observed that for this severe case, a DLF RA is required to accurately predict the reactions. The LGA SDL reactions plus NLF RA CDL can be used to give a conservative estimate of the TDL reactions for SDLF. The use of LGA TDL reactions can be used to give a conservative estimate of the TDL reactions for TDLF.

For bridge (H2), which follows the framing recommendations in this research, the change in the reactions is relatively small for SDLF. However, the changes associated with TDLF detailing are somewhat larger.

Table 40. Bridge (H1) EISSS7 vertical reactions (kip) (G1 and G7 are fascia girders), detailing based on NLF RA cambers.

Girder	Detailing Method	SDL Support 1	SDL Support 2	TDL Support 1	TDL Support 2
G1	NLF	8	10	32	42
	SDLF	15	13	40	44
	TDLF	26	15	51	47
G2	NLF	28	33	99	113
	SDLF	26	27	97	107
	TDLF	23	19	94	99
G3	NLF	30	38	95	124
	SDLF	30	36	96	122
	TDLF	33	34	99	119
G4	NLF	55	45	156	136
	SDLF	51	44	153	136
	TDLF	45	42	147	133
G5	NLF	58	46	163	139
	SDLF	56	47	161	139
	TDLF	53	47	158	139
G6	NLF	59	48	164	140
	SDLF	59	49	164	141
	TDLF	60	52	164	143
G7	NLF	52	54	151	154
	SDLF	54	56	152	156
	TDLF	58	59	154	159

Table 41. Summary of maximum absolute and percentage increases and decreases in the TDL vertical reactions at the girder bearings, due to SDLF and TDLF detailing based on NLF RA cambers, in the straight bridges with non-parallel skew (the largest of these maximum absolute and percentage increases are highlighted by dark shading).

Bridge	SDLF				TDLF			
	Max Decrease (kip)	Max % Decrease	Max Increase (kip)	Max % Increase	Max Decrease (kip)	Max % Decrease	Max Increase (kip)	Max % Increase
(H1) EISSS57	**-6**	**-5**	**5**	**23**	**-15**	**-13**	**19**	**58**
(H2) EISSS57	-3	-4	5	7	-7	-11	4	12

3.4.9.2 Summary and Recommendations – Straight Bridges with Non-Parallel Skew and Cambers Set Based on NLF RA

The influence of SDLF and TDLF detailing on the responses in completed straight bridge systems with non-parallel skew and girder cambers calculated based on NLF RA may be summarized as follows. Recommendations pertaining to these quantitative results are highlighted in bold italicized text.

General

- Straight bridges with a difference in the skew angles at the ends of all the spans less than or equal to $\Delta\theta = 20^o$ may be considered as parallel skew bridges. Section 3.4.7 applies in these cases.
- The following discussions focus predominantly on the TDL results with TDLF detailing based on NLF RA cambers, using the Bridge (H1) EISSS57 as an extreme example.
- In (H1) EISSS57, the pattern of the RA cambers is very similar to the pattern of the LGA cambers, but the RA cambers are smaller in magnitude than the LGA cambers.

Girder Elevations

- The maximum deviation from the targeted elevations is 0.4 inches under the TDL with TDLF based on NLF RA cambers.
- ***It is recommended that NLF RA is sufficient for calculation of the girder cambers in straight bridges with non-parallel skew. There is no need to consider any change in the girder***

vertical displacements and elevations due to the change in the internal forces, and the change in the vertical deflections in the structural system, associated with the DLF detailing.

Girder Layovers

- The maximum girder layover under the TDL with TDLF detailing based on NLF RA cambers is 0.2 inches (0.002 rad).
- ***It is recommended that the girder layovers may be assumed to be negligible in the targeted DL condition in straight bridges with non-parallel skew in which the cambers are set based on NLF RA. There is no need to consider any change in the girder layovers due to the change in the internal forces, and the change in the elastic deformations in the system, associated with the DLF detailing. The fascia girders should be checked separately for twist rotation between the CF locations due to eccentric overhang bracket loads.***
- ***For straight parallel-skew bridges detailed for SDLF, the girder layovers under the TDL may be estimated as the CDL layovers obtained from a NLF RA.***
- ***For straight parallel-skew bridges detailed for TDLF, the girder layovers under the SDL may be estimated as the negative of the CDL layovers obtained from a NLF RA.***

Cross-Frame Forces

- Under SDL in Bridge (H1) EISSS57, the largest ratio of the average of the CF member forces for SDLF detailing to the corresponding forces for NLF detailing is 0.61 for SDLF based on NLF RA cambers.
- Under SDL in Bridge (H1) EISSS57, the largest ratio of the maximum CF member force for SDLF detailing to the corresponding force for NLF detailing is 0.62 for SLDF based on NLF RA cambers. That is, the beneficial locked-in force is 1.0 – 0.62 = 0.38 of the CF force corresponding to NLF detailing for this member.
- Under TDL in this bridge, the largest ratio of the average of the CF member forces for TDLF detailing to the corresponding forces for NLF detailing is 0.62 for TDLF based on NLF RA cambers.
- Under TDL in this bridge, the largest ratio of the maximum CF member force for TDLF detailing to the corresponding force for NLF detailing is 0.65 for TLDF based on NLF RA cambers. That is, the beneficial locked-in force is 1.0 – 0.65 = 0.35 of the CF force corresponding to NLF detailing for this member.

- ***Based on the above results, in lieu of a DLF RA, it is recommended that the locked-in forces due to SDLF detailing with RA cambers should be neglected and the NLF RA results should be used directly estimate the CF forces in straight bridges with parallel or non-parallel skew detailed for SDLF based on RA cambers.*** This recommendation is generally conservative, but is selected to be consistent with the recommendations for straight parallel-skew bridges.
- ***In lieu of a DLF RA, it is recommended that a net load factor of (γ_p – 0.4) be used for determination of the factored TDL CF forces in straight I-girder bridges with parallel skew, when the CFs are detailed for TDLF using a NLF RA. This net load factor is to be applied to the results from a NLF RA for the TDL. The factored CF forces under the SDL may be estimated by subtracting the factored CDL CF forces obtained via a NLF RA from the above factored TDL forces.*** The factor of 0.4 is an estimate of the TDLF locked-in force of 1.0 – 0.65 = 0.35, selected to be consistent with the recommendations for straight parallel-skew bridges, and intended to account for additional uncertainties and variabilities associated with TDLF. In cases where additional uncertainties and variabilities associated with TDLF are anticipated, such as incidental participation of deck forms and early concrete stiffness in the structural resistance, and/or larger potential play in the CF connections due to the larger CF forces associated with TDLF, it is suggested that a value between 0.4 and 0.3 may be used for the above locked-in force estimate based on the judgment of the engineer of record.
- For SDLF under SDL, the maximum difference in the magnitude of the individual CF member forces from a DLF RA and the estimated values from a NLF RA, normalized by the member yield load, is 0.74 %, and the average difference is –0.71 %, for the straight bridges studied in this research with parallel skew and girder cambers based on RA.
- For TDLF under TDL, the maximum difference in the magnitude of the individual CF member forces from a DLF RA and (1 – 0.4 = 0.6) of the estimated values from a NLF RA, normalized by the member yield load, is 4.1 %, and the average difference is 0.0 %, for the straight bridges studied in this research with parallel skew and girder cambers based on RA.

Girder Stresses

- The largest maximum girder flange lateral bending stress (f_ℓ) in (H1) EISSS57, under the TDL for TDLF based on LGA cambers, is 0.9 ksi, 90 % of the corresponding maximum girder NLF value. This f_ℓ occurs on the longest fascia girder in the bridge. The next largest maximum girder f_ℓ is 0.4 ksi, on the shortest fascia girder under the TDL for TLDF based on LGA cambers, and is 8 % of the corresponding maximum girder NLF value. The largest maximum girder f_ℓ based on the assumption of NLF detailing is 8.4 ksi, and occurs on the interior Girder 3 in this bridge. The maximum f_ℓ on Girder 3 is reduced to 0.4 ksi (5 % of the above NLF value) by the use of TDLF detailing based on the LGA cambers.

- For all the straight non-parallel skew bridges studied in this research, the use of an assumed locked-in f_ℓ of 0.35 of the f_ℓ from a NLF RA gives an accurate to conservative estimate of the f_ℓ values determined from a DLF RA.
- ***In lieu of a DLF RA, for straight bridges with parallel or non-parallel skew and with the CFs detailed for SDLF or TDLF using a NLF RA, it is recommended that the above procedures for calculation of the CF forces also be used for determining the girder f_ℓ values.***
- In (H1) EISSS57, the largest increase in any of the girder major-axis bending stresses under the TDL, due to the effect of SDLF detailing based on NLF RA cambers, is 0.5 ksi (2 %). The largest increase in any of the girder major-axis bending stresses under the TDL, due to the effect of TDLF detailing based on NLF RA cambers, is 0.9 ksi (4 %). The largest increase occurs in the long fascia Girder G7, but a slightly smaller increase occurs in the short fascia Girder G1.
- ***Based on the above results, it is recommended that for straight bridges with non-parallel skew and with the girder cambers set based on a NLF RA, the DLF effects on the girder f_b values may be neglected for SDLF detailing as long as the recommendations for the CF framing arrangements specified in this research are followed.***
- ***It is recommended that for straight bridges with non-parallel skew and with the girder cambers set based on a NLF RA, the DLF effects on the girder f_b values may be neglected for TDLF detailing as long as:***
  1) ***The recommendations for the CF framing arrangements specified in this research are followed, and***
  2) ***The skew index is less than or equal to approximately 1.0.***

That is, in cases that satisfy the above requirements, the girder f_b values may be obtained from a NLF RA (which does not consider of the lack-of-fit from the detailing of the CFs).

- ***For straight bridges with non-parallel skew that do not satisfy the above requirements, and when the CFs are detailed based on a NLF RA, it is recommended that the girder major-axis bending stresses be determined from a DLF RA.***
- The above requirements are conservative compared to the results for (H1) EISSS57. They are specified to be the same as the corresponding requirements for straight bridges with parallel skew, to simplify the rules and to avoid potential unconservative errors for bridges that fall near the boundaries between parallel and non-parallel skew.

Vertical Reactions

- The results for the girder reactions largely parallel the above results for the girder major-axis bending stresses.
- For (H2) EISSS57, which follows the recommended practices to avoid nuisance transverse stiffness effects, when the cambers are determined from NLF RA, the largest increase in the reactions under the TDL is 7 % due to SDLF detailing and 12 % due to TDLF detailing, relative to the NLF RA solution. For these cases, the maximum increase in the reaction is only 5 kip.
- For (H2), EISSS57, when the cambers are determined from NLF RA, the largest decrease in the reactions under TDL is -4 % due to SDLF detailing and -11 % due to TDLF detailing, relative to the NLF RA solution. For these cases, the maximum decrease in the reaction is only 7 kip.
- ***Based on the above results, it is recommended that for straight bridges with parallel and non-parallel skew and with the girder cambers set based on a NLF RA, the DLF effects on the girder reactions may be neglected for SDLF detailing as long as the recommendations for the CF framing arrangements specified in this research are followed.***
- ***Additional requirements are recommended for TDLF based on NLF RA cambers. It is recommended that for straight bridges with parallel and non-parallel skew and with girder cambers set based on a NLF RA, the DLF effects on the girder reactions may be neglected for TDLF detailing as long as:***
    1) ***The recommendations for the CF framing arrangements specified in this research are followed, and***
    2) ***The skew index is less than or equal to approximately 1.0.***

That is, in cases that satisfy the above requirements, the girder reactions may be obtained from a NLF RA (which does not consider of the lack-of-fit from the detailing of the CFs).

- The above requirements are conservative for Bridge (H2), but are specified to be consistent with the recommendations for parallel skew bridges and to cover cases that may be on the boundary in the definitions of when a bridge may be considered as parallel versus non-parallel skew. .
- ***For straight bridges with parallel and non-parallel skew that do not satisfy the above requirements, it is recommended that the girder reactions be determined from a DLF RA.***

The above recommendations are considered applicable for straight bridges with non-parallel skew, skew angles up to 70^{o}, and spans up to 300 ft. For bridges that exceed these limits, it is recommended that DLF RA be considered. Section 3.9 explains the details of several procedures for conducting a DLF RA.

3.4.10 Curved and Skewed Bridges with Cambers Set Based on NLF RA

In the limit that the skew becomes small, taken as $\theta \leq 20^{o}$, the curved radially-supported bridge recommendations are considered to apply. Therefore, Section 3.4.5 should be consulted for these cases. In the limit that the horizontal curvature becomes small, taken as $L_s/R \leq 0.03$, the straight bridge recommendations are considered to apply. Sections 3.4.6 through 3.4.9 address these cases. Section 3.4.10.1 provides quantitative results on the influence of SDLF and TDLF detailing on bridge responses in curved and skewed bridges with cambers set based on NLF RA. The influence of SDLF and TDLF is discussed on the responses in the following order: girder vertical displacements, girder elevations, girder layovers, CF forces, girder stresses, and vertical reactions. Section 3.4.10.2 then summarizes the influences on the key bridge responses, and provides recommendations for handling these effects. The recommendations are highlighted in bold italicized text.

3.4.10.1 Quantitative Results

3.4.10.1.1 Girder Vertical Displacements

For curved and skewed bridges, SDLF and TDLF detailing tend to increase the vertical displacements of all the girders when the skew orientation makes the girder on the inside of the curve longer, as in Bridge (N) NISCS14 as shown in Figure 152 and Table 42. When the skew orientation makes the outside girder longer, as in Bridge (O1) NISCS15, SDLF and TDLF detailing tend to reduce the vertical displacements of all the girders. SDLF and TDLF detailing effects also reduce the vertical displacements in continuous-span curved and skewed bridges as shown in Table 42 for bridge cases (S), (T1), (T2), (U1), and (U2). From this table, the largest change in the maximum TDL vertical displacement is 4.4 inches for SDLF detailing and 7.4 inches for TDLF detailing. These maximums occur in Bridge (R1) NISCS39 which has L_s = 300 ft and the skew makes the outside girder longer. Bridge cases (R1) and (R2) are very extreme, and (R2) is essentially unbuildable. With the exception of (R1) and (R2), the largest change in the maximum TDL vertical displacement is 0.9 inches for SDLF detailing and 2.1 inches for TDLF detailing.

One should note that Table 42 reports the absolute maximum downward displacement in the bridge. As such, the data in this table is useful for understanding the overall trends in the behavior of the bridges, but not necessarily the changes that occur in individual girders. In some of the cases for the bridges considered in this research, the location of the maximum displacement can change substantially as a function of the CF detailing method.

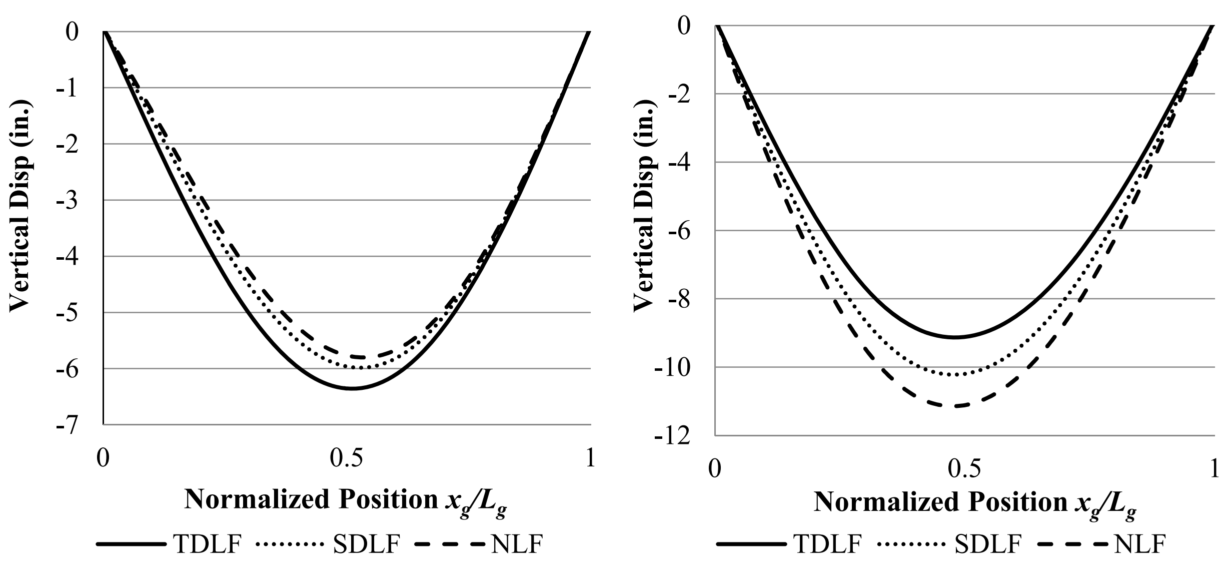


Figure 152. TDL vertical displacements in Bridge (N) NISCS14 longer fascia girder (left), where the skew makes the girder on the inside of the curve longer, and Bridge (O1) NISCS15 longer fascia girder (right), where the skew makes increases the length of the girder on the outside of the curve.

Table 42. Maximum TDL vertical displacements and changes in maximum TDL vertical displacements relative to NLF detailing for the curved and skewed bridges studied in this research. (Excluding bridges (R1) and (R2), the largest changes by SDLF and TDLF under TDL are highlighted by dark shading).

Bridge	NLF	SDLF		TDLF	
	Disp. (in.)	Disp. (in.)	Change (in.)	Disp. (in.)	Change (in.)
(N) NISCS14*	-5.8	-6	-0.2	-6.4	-0.6
(O1) NISCS15†	-11.1	-10.2	0.9	-9.1	2
(O2) NISCS15†	-9.4	-8.8	0.6	-8.2	1.2
(P) EISCS3*	-6.6	-6.3	0.3	-6	0.6
(Q1) NISCS38*	-13	-13.6	-0.6	-14.3	-1.3
(Q2) NISCS38*	-12.8	-13.3	-0.5	-13.9	-1.1
(R1) NISCS39†	-26.2	-21.8	4.4	-18.8	7.4
(R2) NISCS39†	-24.3	-20.9	3.4	-18.7	5.6
(S) XICCS7	-4.9	-4.8	0.1	-4.5	0.4
(T1) EICCS27	-28.6	-28	0.6	-26.9	1.7
(T2) EICCS27	-27.3	-26.6	**0.7**	-25.2	**2.1**
(U1) EICCS28	-23.9	-23.5	0.4	-23.2	0.7
(U2) EICCS28	-25.8	-24.9	0.9	-24.3	1.5

* Fascia girder on the inside of the curve is made longer by the skew.
†Fascia girder on the outside of the curve is made longer by the skew.

3.4.10.1.2 Girder Elevations

As noted previously, for curved and skewed bridges, all of the camber calculations are conducted using NLF RA in this research. For curved and skewed bridges, the girder cambers with the CFs detailed for NLF are exactly the same magnitude but opposite in sign to the RA girder vertical deflections. The corresponding vertical elevations under TDL for NLF detailing are zero (assuming no superelevation, etc., as a simplification). The SDLF and TDLF detailing effects reduce or increase the vertical displacements depending on the skew orientation as discussed above. As a result, the vertical elevations with SDLF and TDLF detailing under TDL are below the targeted elevations for bridges with a longer inside girder, such as Bridge (N) NISCS14 (Figure 153). The vertical elevations with SDLF and TDLF detailing under TDL are above the targeted elevations for bridges with a longer outside fascia girder, such as Bridge (O1) NISCS15.

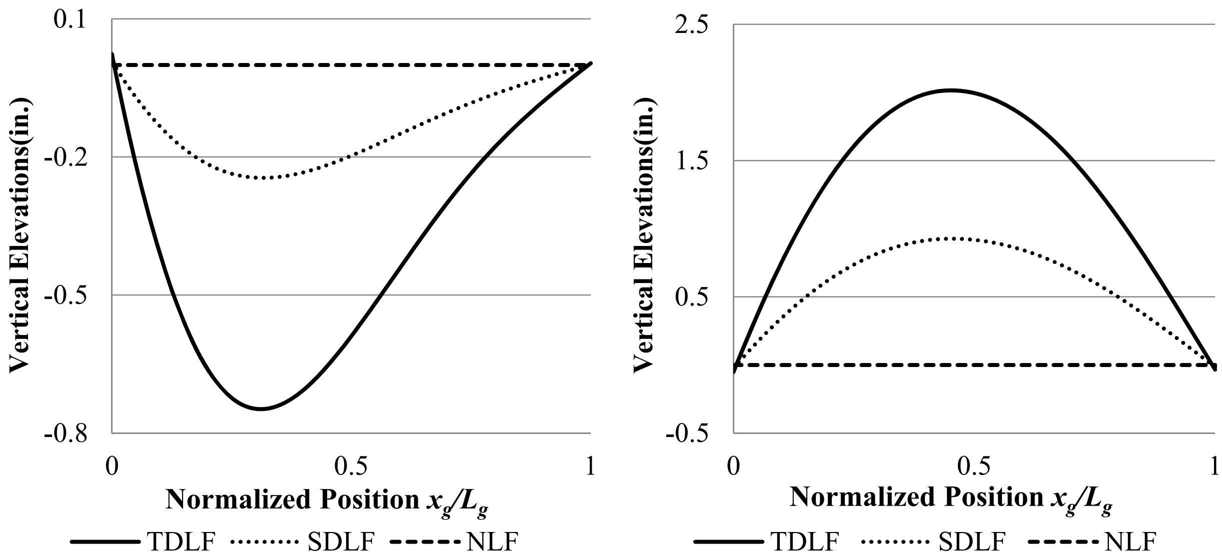


Figure 153. Bridge (N) NISCS14 longer fascia girder (left), where the skew makes the girder on the inside of the curve longer, and Bridge (O1) NISCS15 longer fascia girder (right), where the skew makes the girder on the outside of the curve longer, final elevations under TDL.

The deviation from the targeted vertical elevations, when the bridge is detailed for SDLF or TDLF detailing, is equal to the displacement caused by the SDLF and TDLF detailing effects alone. Considering the complete set of curved and skewed bridges studied in this research, from Table 43, the largest deviations from the targeted elevation under TDL are 7.4 inches for TDLF detailing and 4.4 inches for SDLF detailing (Bridge (R1) NISCS39 which has a span length of 300ft and outside girder length of 341 ft). The use of SDLF detailing or TDLF detailing is not recommended for such a case. With the exception of (R1) and (R2) NISCS39, the largest deviations from the targeted/expected elevations are 1.2 inches for SDLF and 2.1 inches for TDLF.

Table 43. Maximum final elevation deviations under from the zero elevation line, for the curved and skewed bridges studied in this research (Excluding bridges (R1) and (R2), the largest final girder elevations with SDLF and TDLF detailing under TDL are highlighted by dark shading).

Bridge	NLF (in.)	SDLF (in.)	TDLF (in.)
(N) NISCS14*	0.0	0.2	0.6
(O1) NISCS15†	0.0	0.9	2.0
(O2) NISCS15†	0.0	0.6	1.2
(P) EISCS3*	0.0	0.3	0.6
(Q1) NISCS38*	0.0	0.6	1.3
(Q2) NISCS38*	0.0	0.5	1.1
(R1) NISCS39†	0.0	4.4	7.4
(R2) NISCS39†	0.0	3.4	5.6
(S) XICCS7	0.0	0.1	0.4
(T1) EICCS27	0.0	0.6	1.7
(T2) EICCS27	0.0	**0.7**	**2.1**
(U1) EICCS28	0.0	1.2	2.1
(U2) EICCS28	0.0	0.9	1.5

* Fascia girder on the inside of the curve is made longer by the skew.
†Fascia girder on the outside of the curve is made longer by the skew.

3.4.10.1.3 Girder Layovers

For curved and skewed bridges, when the skew is substantial and makes the inside girder longer as in the case of Bridge (N) NISCS14, the girders and the bridge cross-section both tend to roll largely towards the inside of the curve under the action of the DL (see the layovers and twists with NLF detailing in Figures 154 and 155). The portion of the bridge near the right radial bearing line rolls towards the outside of the curve due to the horizontal curvature effects. However, the skew effects cause the girders to twist towards the inside of the curve, which is opposite from the direction that the girders in a similar curved radially-supported bridge would tend to roll under DL. As a result, the layovers are reduced near mid-span. The layovers are largest at the left-hand skewed bearing line. The girder on the inside of the curve in Bridge (N), which is longer than the girder on the outside of the curve in this bridge, has the largest layover of all the girders, -1.03 inches. The SDLF and TDLF detailing effects largely twist the girders towards the outside of the curve, which is the direction opposite to the predominant direction of the bridge twist rotations. With TDLF detailing, the largest layover is -0.3 inches, which occurs on the inside girder.

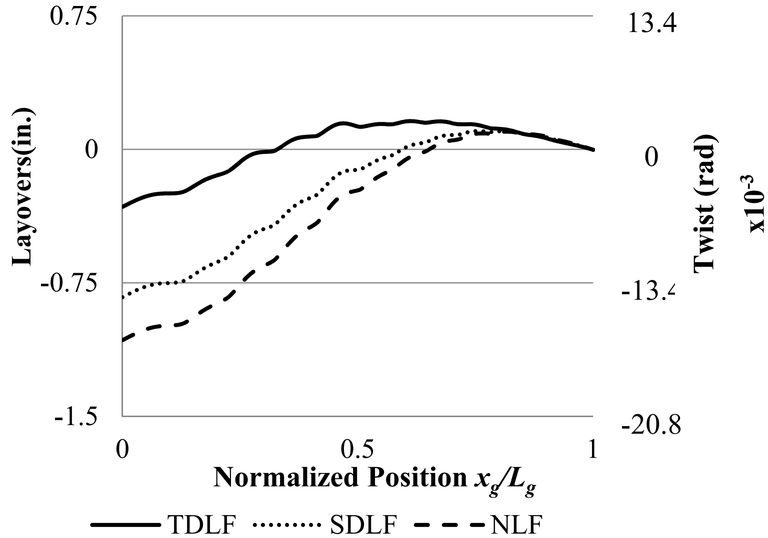


Figure 154. TDL layovers and twists of the girder on the inside of the curve in Bridge (N) NISCS14, where the skew makes the girder on the inside of the curve longer (Positive layovers indicate rolling towards the outside of the curve).

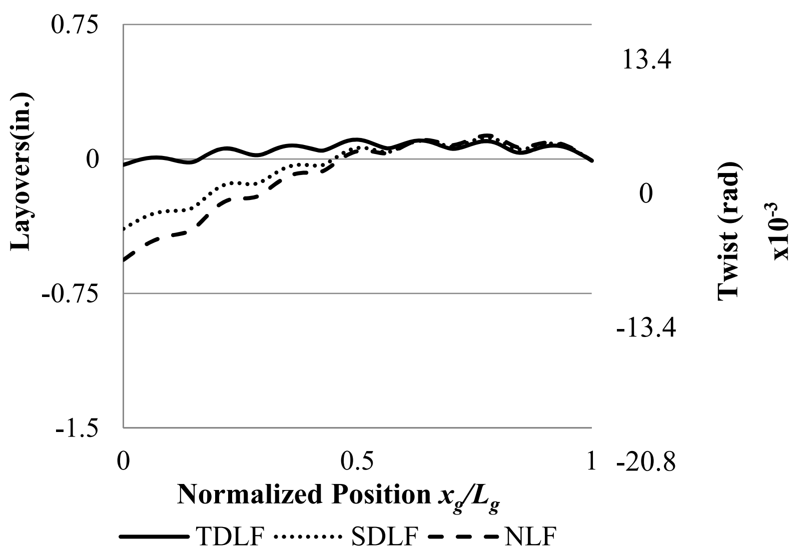


Figure 155. TDL layovers and twists of the girder on the outside of the curve in Bridge (N) NISCS14, where the skew makes the girder on the inside of the curve longer (Positive layovers indicate rolling towards the outside of the curve).

When the skew makes the outside girder longer as in the case of Bridge (O1) NISCS15, the girders and the bridge cross-section both tend to roll substantially towards the outside of the curve under the action of the DL, which is the same direction that a similar curved radially-supported bridge cross-section tends to roll under DL (see the layovers and twists with NLF detailing in Figures 156 and 157). As a result, the girder layovers are amplified. The outside girder of Bridge (O1), which is the longer fascia girder, has the largest layovers of all the girders, 2.0 inches for NLF. The largest layovers occur near mid-span. The girder on the outside of the curve has a layover of 0.9 inches at the left-hand skewed bearing line. The SDLF and TDLF detailing effects twist the girders towards the inside of the curve, which is the direction opposite to the predominant direction of the bridge twist rotations. With TDLF detailing, the largest layover is -0.4 inches, which occurs on the inside girder.

Considering the complete set of curved and skewed bridges studied in the NCHRP 20-07 Task 355 research, the largest girder layovers are 0.5 inches (0.056 rad) under SDL for SDLF detailing and 1.7 inches (0.0189 rad) under TDL for TDLF detailing (see Table 44). The large 1.7 inches layover occurs at the skewed bearing line at one of the interior piers in Bridge (T2) EICCS27, which has a maximum span of 279 ft and a maximum skew angle of 70 degrees. The framing arrangement of Bridge (T2) uses skewed bearing line CFs at the interior pier and intermediate CFs that are offset from the skewed bearing line. This framing arrangement alleviates the nuisance transverse stiffness issues that cause large forces in the CF members. However, due to this flexibility, there is some layover of the girders, especially at the skewed bearing lines.

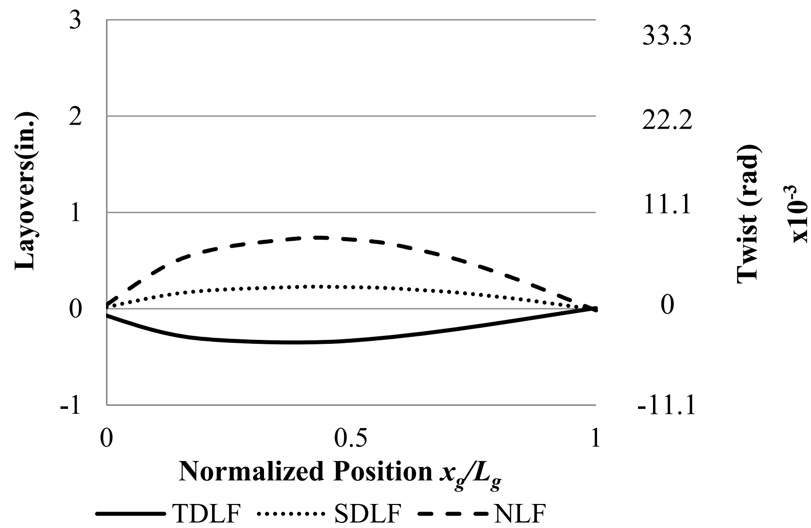


Figure 156. TDL layovers and twists of the girder on the inside of the curve in Bridge (O1) NISCS15, where the skew makes the girder on the outside of the curve longer (Positive layovers indicate rolling towards the outside of the curve).

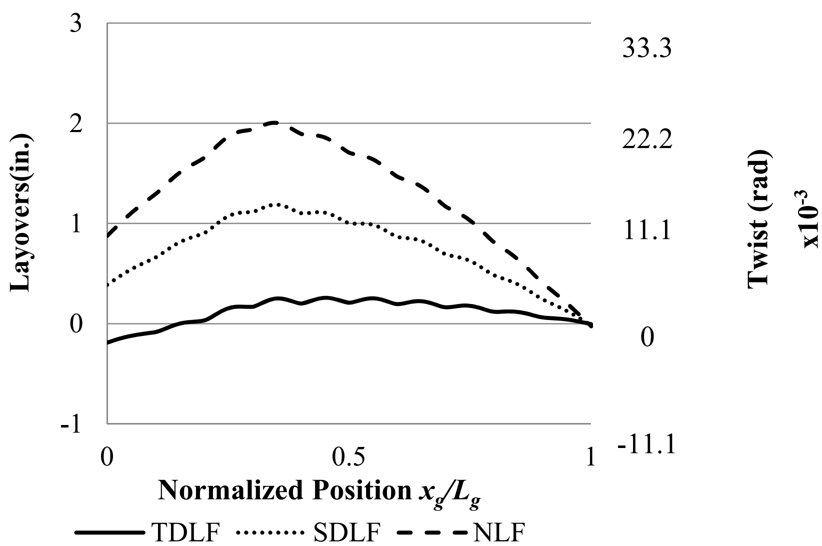


Figure 157. TDL layovers and twists of the girder on the outside of the curve in Bridge (O1) NISCS15, where the skew makes the girder on the outside of the curve longer (Positive layovers indicate rolling towards the outside of the curve).

Table 44. Maximum magnitudes of girder layovers and twists in the curved and skewed bridges studied in this research (LO1, LO2, and LO3 are the maximum girder layovers with NLF, SDLF, and TDLF detailing, respectively. $\phi1$, $\phi2$, and $\phi3$ are the maximum girder twists with NLF, SDLF, and TDLF detailing, respectively. The largest girder layovers and twists with SDLF under SDL and TDLF under TDL are highlighted by dark shading).

Load Cond.	Bridge	Girder Depth (in.)	NLF		SDLF		TDLF	
			LO1 (in.)	ϕ1 (rad) $x10^{-3}$	LO2 (in.)	ϕ2 (rad) $x10^{-3}$	LO3 (in.)	ϕ3 (rad) $x10^{-3}$
SDL	(N) NISCS14*	72	0.3	4.2	0.1	1.4	0.4	5.6
	(O1) NISCS15†	90	0.9	10.0	0.2	2.2	0.9	10.0
	(O2) NISCS15†	"	0.6	6.7	0.1	1.1	0.7	7.8
	(P) EISCS3*	68	0.4	5.9	0.1	1.5	0.6	8.8
	(Q1) NISCS38*	156	1.5	9.6	0.4	2.6	1.1	7.1
	(Q2) NISCS38*	"	1.5	9.6	0.3	1.9	1.2	7.7
	(R1) NISCS39†	180	3.2	17.8	0.5	2.8	2.8	15.6
	(R2) NISCS39†	"	3	16.7	0.4	2.2	2.2	12.2
	(S) XICCS7	92	0.3	3.3	0.1	1.1	0.8	8.7
	(T1) EICCS27	90	1.1	12.2	0.1	1.1	2.9	32.2
	(T2) EICCS27	"	1.2	13.3	**0.5**	**5.6**	3	33.3
	(U1) EICCS28	120	2.2	18.3	0.4	3.3	1.3	10.8
	(U2) EICCS28	"	2.5	20.8	0.4	3.3	1.7	14.2
TDL	(N) NISCS14*	72	1.1	15.3	0.8	11.1	0.3	4.2
	(O1) NISCS15†	90	2.0	22.2	1.2	13.3	0.4	4.4
	(O2) NISCS15†	"	1.3	14.4	0.8	8.9	0.3	3.3
	(P) EISCS3*	68	1.0	14.7	0.6	8.8	0.2	2.9
	(Q1) NISCS38*	156	3.3	21.2	2.1	13.5	0.8	5.1
	(Q2) NISCS38*	"	3.2	20.5	2	12.8	0.7	4.5
	(R1) NISCS39†	180	5.6	31.1	2.3	12.8	1.2	6.7
	(R2) NISCS39†	"	5.1	28.3	2.1	11.7	0.9	5.0
	(S) XICCS7	92	1.2	13.0	0.9	9.8	0.7	7.6
	(T1) EICCS27	90	4.4	48.9	3.4	37.8	0.6	6.7
	(T2) EICCS27	"	4.4	48.9	3.2	35.6	**1.7**	**18.9**
	(U1) EICCS28	120	4.0	33.3	2.1	17.5	0.6	5.0
	(U2) EICCS28	"	4.5	37.5	2.3	19.2	0.5	4.2

* Fascia girder on the inside of the curve is made longer by the skew.

†Fascia girder on the outside of the curve is made longer by the skew.

3.4.10.1.4 Cross-Frame Forces

The effects of the detailing methods on the DL CF forces in the completed bridge system are influenced in complex ways by the different combinations of skew and curvature. SDLF and TDLF detailing methods can either increase or decrease the CF forces depending on the combination of the skew index, I_s, and the tightness of the curvature L_s/R. In Tables 45 and 46, F1, F2, and F3 are CF forces for NLF, SDLF and TDLF detailing respectively. These tables report the average and maximum CF chord and diagonal forces, respectively, for the curved and skewed I-girder bridges studied in this research. The most important points from these tables are:

- The F2/F1 and F3/F1 ratios for both the average and the maximum CF member forces are often slightly smaller than 1.0.
- The orientation of the skew has a significant influence on the CF forces in completed curved and skewed bridges. When the skew orientation makes the inside girder longer, the skew causes girder twist rotations that are in the opposite direction from those due to the horizontal curvature. As a result, the average and maximum CF forces are significantly reduced as illustrated in the case of bridges (N) NISCS14, (P) EISCS3, and (Q1) and (Q2) NISCS38.
- When the skew orientation makes the outside girder longer, the skew causes girder twist rotations that are in the same direction as those due to the horizontal curvature, resulting in a significant increase in the average and maximum CF forces as illustrated in the case of bridges (O) NISCS15 and (R1) and (R2) NISCS39.
- For curved and skewed continuous-span bridges, the skew can make the outside fascia girder longer in one span and shorter in another span. The middle spans of bridge cases (S) XICCS7, (T1) and (T2) EICCS27 and (U1) and (U2) EICCS28 all have a parallel skew in their middle spans. The effects of the skew orientation in continuous-span bridges tend to cause the average and maximum CFs forces to be greater in the span where the skew orientation makes the outside fascia girder longer than in the span where the skew orientation makes the outside fascia girder shorter.

Table 45. Average and maximum magnitudes of the CF chord forces in each of the curved and skewed bridges studied in this research (F1, F2, and F3 are the average or maximum CF forces with NLF, SDLF, and TDLF detailing, respectively; the largest F2/F1 ratio under SDL and F3/F1 ratio under TDL are highlighted).

	Bridge	SDL			TDL		
		NLF	SDLF		NLF	TDLF	
		F1 (kip)	F2 (kip)	F2/F1	F1 (kip)	F3 (kip)	F3/F1
Average	(N) NISCS14*	7.7	6.6	0.86	24.1	20.7	0.86
	(O1) NISCS15†	48.7	44.5	0.91	99.6	90.2	0.91
	(O2) NISCS15†	47.4	42.8	0.90	95.9	86.0	0.90
	(P) EISCS3*	10.1	8.3	0.82	22.2	18.2	0.82
	(Q1) NISCS38*	14.6	11.5	0.79	28.6	22.9	0.80
	(Q2) NISCS38*	15.1	11.8	0.78	29.6	24.0	0.81
	(R1) NISCS39†	72.0	65.4	0.91	129.2	103.4	0.80
	(R2) NISCS39†	80.0	69.4	0.87	138.6	109.9	0.79
	(S) XICCS7	1.9	1.8	0.95	8.1	7.5	0.93
	(T1) EICCS27	13.4	5.9	0.44	48.6	22.2	0.46
	(T2) EICCS27	3.1	3.3	**1.06**	12.1	11.7	**0.97**
	(U1) EICCS28	22.4	15.4	0.69	41.9	26.5	0.63
	(U2) EICCS28	16.1	12.3	0.76	30.2	21.0	0.70
Maximum	(N) NISCS14*	24.3	17.9	0.74	77.0	70.5	0.92
	(O1) NISCS15†	222.7	195.0	0.88	471.8	405.3	0.86
	(O2) NISCS15†	159.7	103.9	0.65	317.9	215.1	0.68
	(P) EISCS3*	34.8	36.5	1.05	80.2	81.9	**1.02**
	(Q1) NISCS38*	45.6	38.5	0.84	89.9	75.5	0.84
	(Q2) NISCS38*	66.5	39.0	0.59	137.8	106.4	0.77
	(R1) NISCS39†	391.7	276.1	0.70	678.0	525.7	0.78
	(R2) NISCS39†	450.2	185.6	0.41	769.5	287.7	0.37
	(S) XICCS7	9.9	7.4	0.75	43.8	30.5	0.70
	(T1) EICCS27	52.7	22.3	0.42	203.1	84.7	0.42
	(T2) EICCS27	16.8	19.7	**1.17**	74.2	67.5	0.91
	(U1) EICCS28	152.1	69.8	0.46	271.7	122.7	0.45
	(U2) EICCS28	99.6	80.4	0.81	176.1	134.9	0.77

* Fascia girder on the inside of the curve is made longer by the skew.
†Fascia girder on the outside of the curve is made longer by the skew.

Table 46. Average and maximum magnitudes of the CF diagonal forces in each of the curved and skewed bridges studied in this research (F1, F2, and F3 are the average or maximum CF forces with NLF, SDLF, and TDLF detailing, respectively; the largest F2/F1 ratio under SDL and F3/F1 ratio under TDL are highlighted).

	Bridge	SDL			TDL		
		NLF	SDLF		NLF	TDLF	
		F1 (kip)	F2 (kip)	F2/F1	F1 (kip)	F3 (kip)	F3/F1
Average	(N) NISCS14*	7.1	7.1	1.00	21.7	21.7	1.00
	(O1) NISCS15†	15.8	15.0	0.95	35.7	34.0	0.95
	(O2) NISCS15†	13.7	12.4	0.91	30.5	28.1	0.92
	(P) EISCS3*	5.7	5.1	0.89	13.8	12.3	0.89
	(Q1) NISCS38*	13.3	13.0	0.98	28.0	27.3	0.98
	(Q2) NISCS38*	15.4	14.9	0.97	32.6	31.4	0.96
	(R1) NISCS39†	33.6	30.7	0.91	60.8	52.0	0.86
	(R2) NISCS39†	34.1	27.4	0.80	61.2	47.0	0.77
	(S) XICCS7	2.6	2.2	0.85	11.0	9.7	0.88
	(T1) EICCS27	9.5	4.7	0.49	35.9	17.9	0.50
	(T2) EICCS27	5.3	6.7	**1.26**	20.8	23.4	**1.13**
	(U1) EICCS28	12.8	9.5	0.74	24.8	17.9	0.72
	(U2) EICCS28	10.2	8.8	0.86	20.3	17.3	0.85
Maximum	(N) NISCS14*	17.0	15.6	0.92	54.4	49.6	0.91
	(O1) NISCS15†	74.6	74.2	0.99	158.7	165.6	1.04
	(O2) NISCS15†	73.0	46.2	0.63	145.8	92.4	0.63
	(P) EISCS3*	25.5	13.0	0.51	55.0	27.9	0.51
	(Q1) NISCS38*	34.9	29.0	0.83	57.9	60.9	1.05
	(Q2) NISCS38*	34.6	34.9	1.01	73.2	74.1	1.01
	(R1) NISCS39†	132.2	123.7	0.94	224.3	211.7	0.94
	(R2) NISCS39†	235.2	89.5	0.38	392.7	141.3	0.36
	(S) XICCS7	13.0	12.8	0.98	52.2	50.2	0.96
	(T1) EICCS27	51.5	18.4	0.36	189.7	73.2	0.39
	(T2) EICCS27	18.6	29.1	**1.56**	77.7	97.7	**1.26**
	(U1) EICCS28	79.7	43.0	0.54	144.4	65.5	0.45
	(U2) EICCS28	51.2	38.6	0.75	93.5	67.0	0.72

* Fascia girder on the inside of the curve is made longer by the skew.
†Fascia girder on the outside of the curve is made longer by the skew.

Figures 158 through 161 show the frequency distribution for the change in the CF chord and diagonal forces due to SDLF and TDLF detailing for Bridges (N) NISCR14 and (O) NISCR15. Figures 162 and 163 show the frequency distribution for the change in the CF chord and diagonal forces for all the curved and skewed I-girder bridges studied in this research. Table 47 provides a summary of the statistics for the percent change in the magnitude of the CF forces for these bridges. From Tables 45 through 47, Figures 158 to 163, and other similar figures of the frequency distribution of CF forces in the curved and skewed bridges studied in this research (included in Appendices N to U), the following can be observed:

- SDLF and TDLF detailing increase the forces for about half of the CFs and decrease CF forces for about the other half by about the same percentage, normalized by the member yield load. Thus, SDLF and TDLF detailing do not significantly change the average CF forces.
- Changes in the CF forces due to SDLF detailing tend to be small in curved bridges that do not have sharp skew, tight curvature, and long spans, and
- Changes in the CF member forces due to TDLF detailing can be significant in cases with tight curvature, sharp skew, and long spans.

Table 47. Summary statistics of the percent change in the magnitude of the CF forces relative to the member yield load (i.e., change in member force divided by the member yield load x 100), due to SDLF or TDLF detailing in all the curved and skewed bridges.

	Chords		*Diagonals*	
	SDLF	*TDLF*	*SDLF*	*TDLF*
Average	*-1.14*	*-2.78*	*-0.43*	*-0.87*
Median	*-0.37*	*-0.85*	*-0.15*	*-0.34*
Max	*4.68*	*15.5*	*6.53*	*22.0*
Min	*-25.3*	*-42.2*	*-13.9*	*-39.1*
COV	*-12.5*	*-20.2*	*-7.81*	*-10.7*

Figure 164 shows the actual distribution of the CF forces under the SDL in Bridge (Q1) EISSS57, including the locked-in force effects from SDLF detailing with NLF RA cambers. The presentation of the CF forces in these plots, as well as the plots in the subsequent figures is similar to that for Figures 70 through 81 in Section 3.4.5.1.4. The reader is referred to this previous section for an explanation of presentation in these plots. One can observe that the largest of the CF member forces in Figure 164 is 38.5 kip.

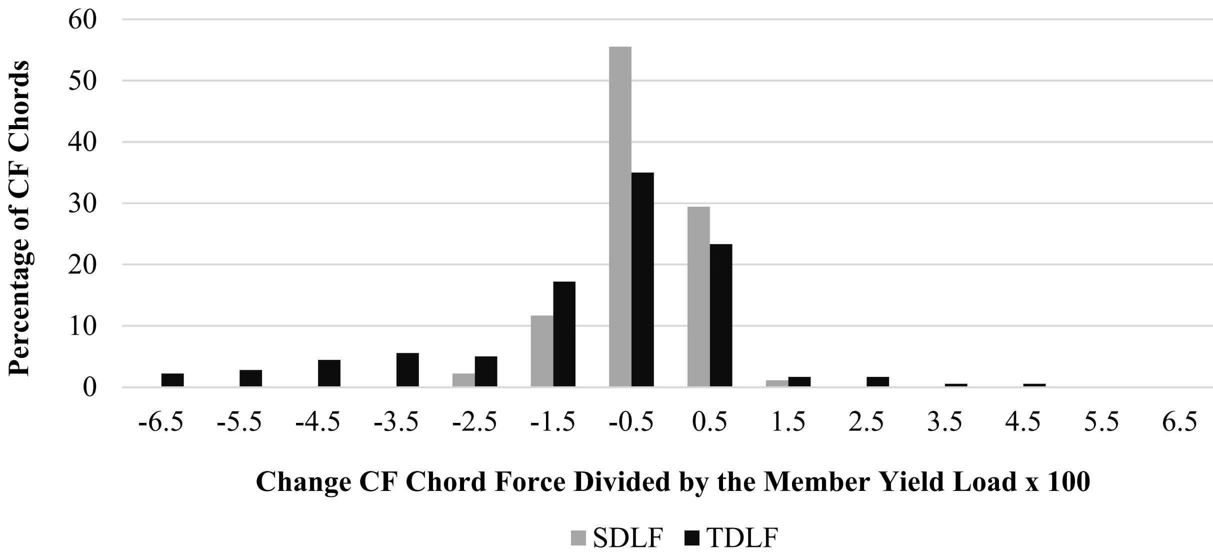


Figure 158. Frequency distribution for the change in the magnitude of the CF chord forces, normalized by the member yield load, due to SDLF and TDLF detailing in Bridge (N) NISCS14, where the girder on the inside of the curve is made longer by the skew.

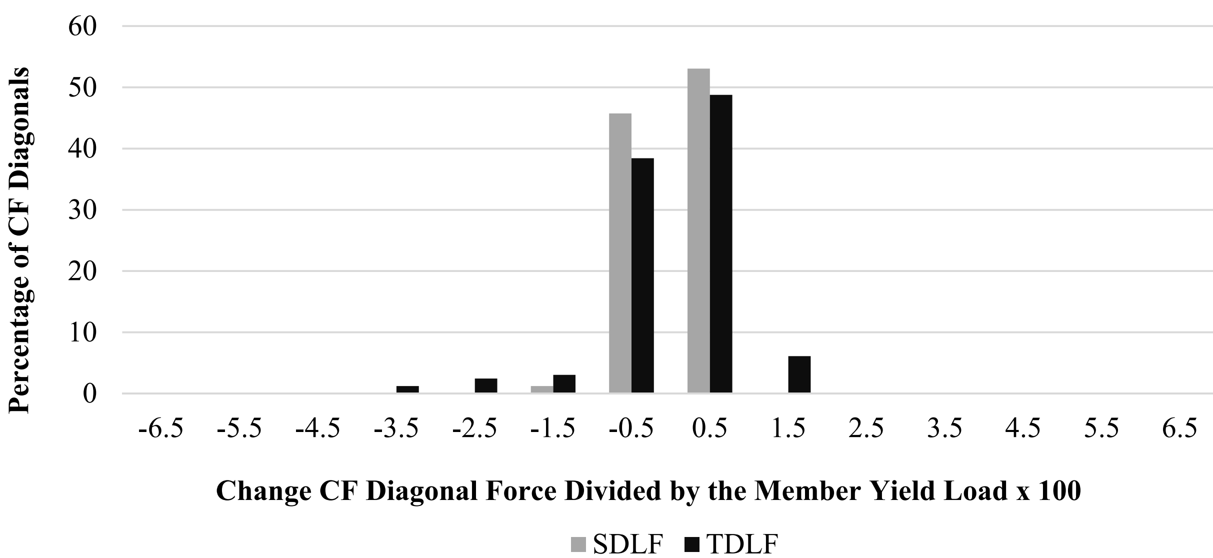


Figure 159. Frequency distribution for the change in the magnitude of the CF diagonal forces, normalized by the member yield load, due to SDLF and TDLF detailing in Bridge (N) NISCS14, where the girder on the inside of the curve is made longer by the skew.

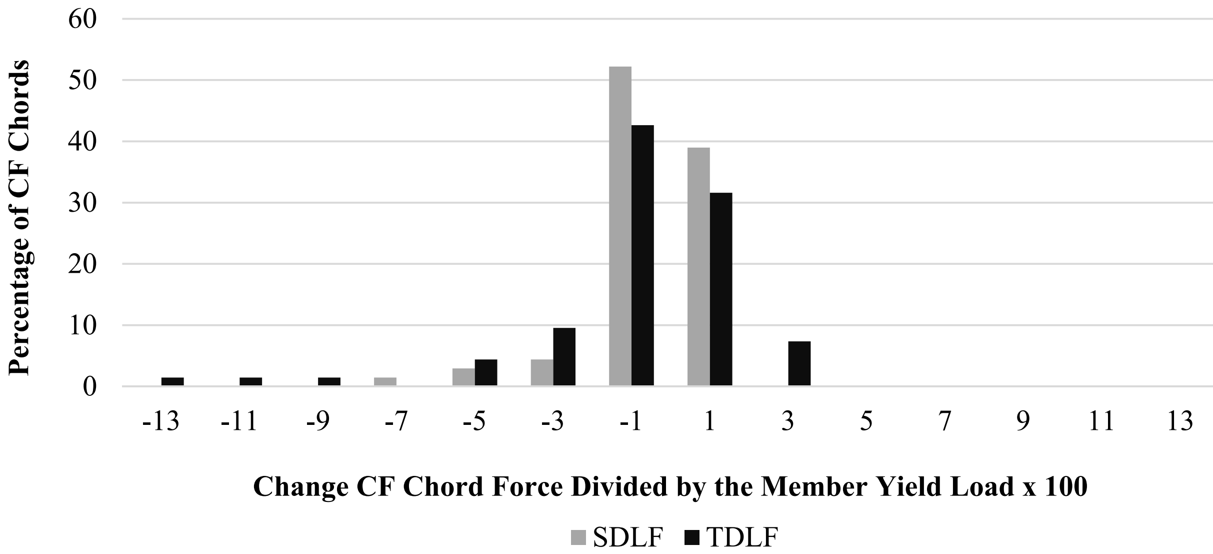


Figure 160. Frequency distribution for the change in the magnitude of the CF chord forces, normalized by the member yield load, due to SDLF and TDLF detailing in Bridge (O) NISCS15, where the girder on the outside of the curve is made longer by the skew.

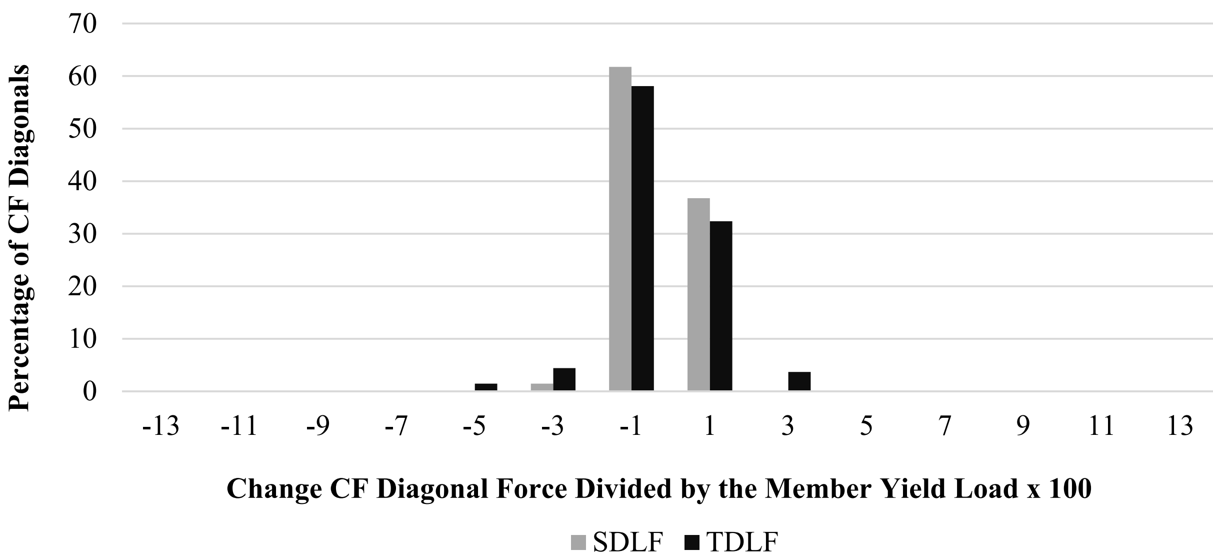


Figure 161. Frequency distribution for the change in the magnitude of the CF diagonal forces, normalized by the member yield load, due to SDLF and TDLF detailing in Bridge (O) NISCS15, where the girder on the outside of the curve is made longer by the skew.

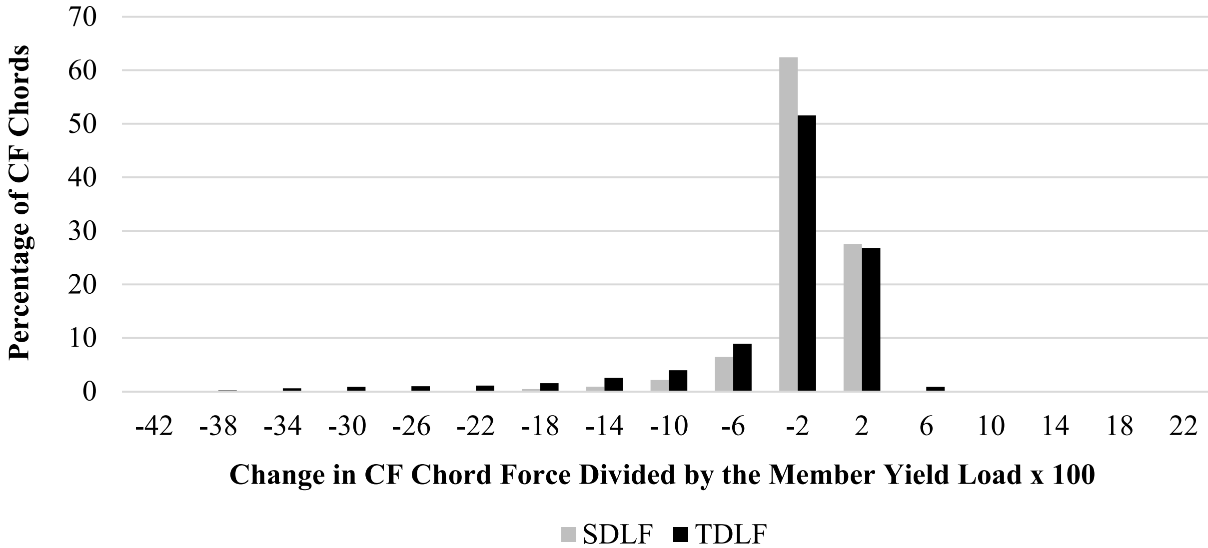


Figure 162. Frequency distribution for the change in the magnitude of the CF chord forces, normalized by the member yield load, due to SDLF and TDLF detailing in the all curved and skewed bridges.

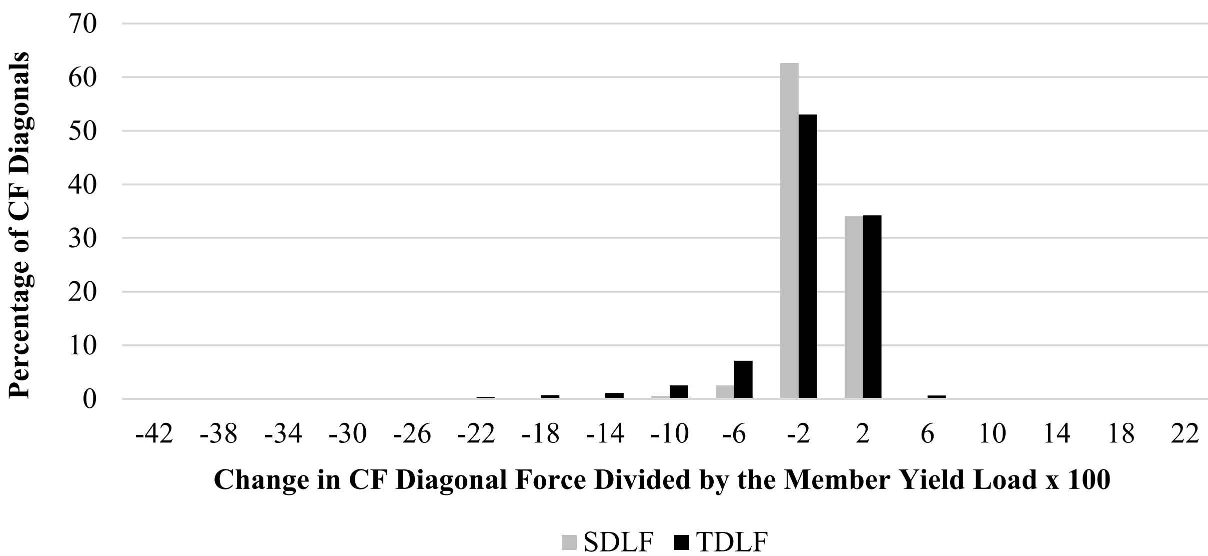


Figure 163. Frequency distribution for the change in the magnitude of the CF diagonal forces, normalized by the member yield load, due to SDLF and TDLF detailing in the all curved and skewed bridges.

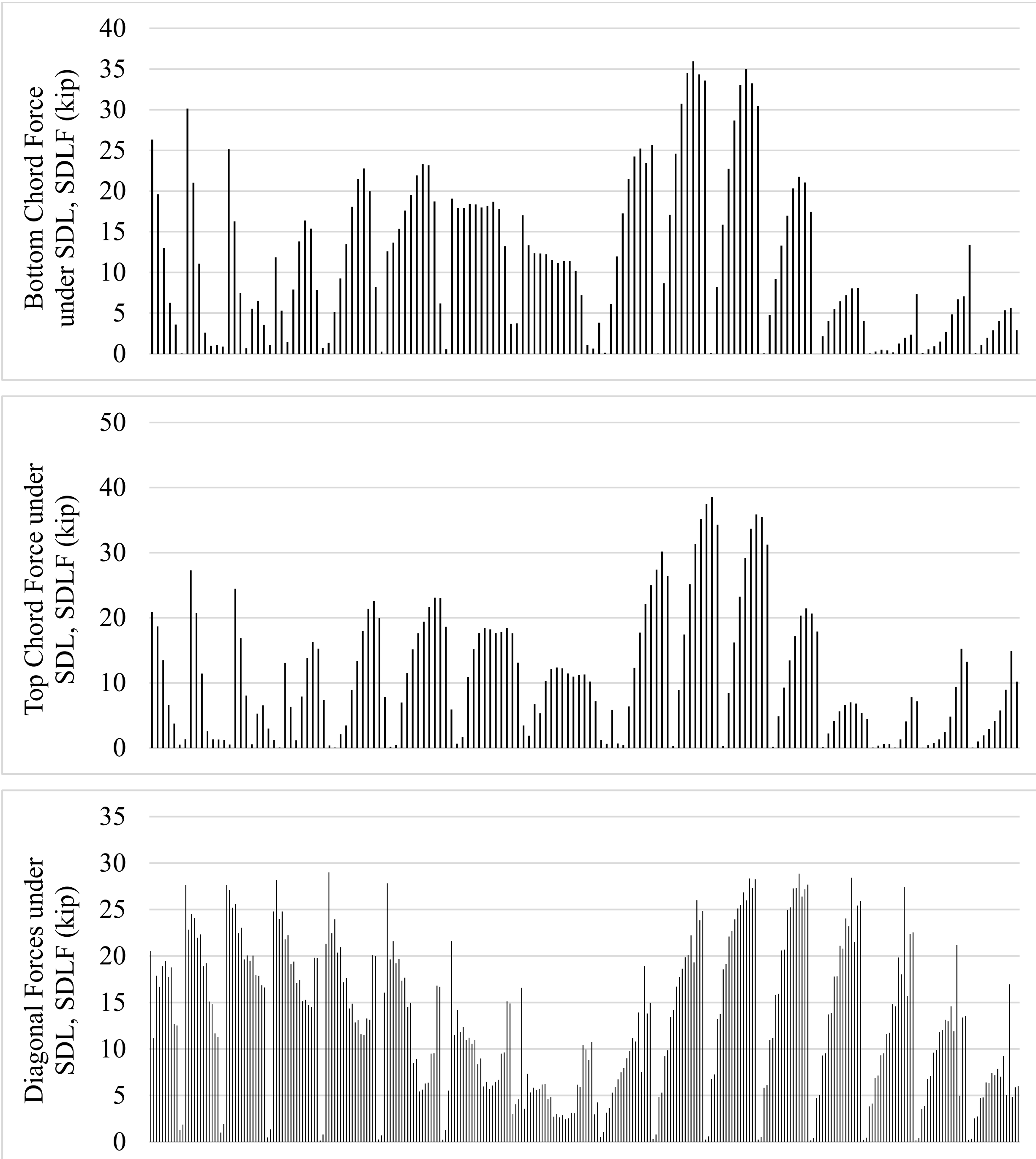


Figure 164. Magnitude of CF member forces from DLF RA, Bridge (Q1) NISCS38 (girder on the inside of the curve made longer by the skew), under SDL, SDLF detailing.

Figure 165 shows an estimate of the CF forces under the SDL, assuming SDLF detailing, obtained by scaling the NLF RA forces by 1.0 for the cross-frame chords and by 2.0 for the cross-frame diagonals. This is the scale factor recommended in Section 3.4.5.2 for both SDL/SDLF and TDL/TDLF estimates in curved radially-supported bridges. One can observe that almost all of the CF force values from Figure 165 are estimated accurately to conservatively. However, the actual distribution of the CF forces from Figure 164 is predicted poorly. The poor prediction of the CF force distribution is not of any significant consequence though since all the CF forces are relatively small. Since Figure 165 simply shows all the NLF RA CF forces scaled by 1.0 for the chords and by 2.0 for the diagonals, it can be concluded that the distribution of the non-zero CF forces under SDL associated with NLF detailing is very different from the distribution of the reduced (smaller) CF forces under SDL associated with SDLF detailing.

Figure 166 shows the difference between the magnitude of the DLF RA forces and the CF forces under SDL, assuming SDLF detailing, estimated by scaling the NLF RA forces, divided by the CF member yield loads for Bridge (Q1). The plots in this figure are similar those for the curved radially-supported bridges shown previously in Figures 74 through 81. One can observe that the largest under-prediction of the DLF RA results is $0.019P_y$ for one of the chords of the cross-frame. The largest over-prediction is -0.07 using the recommended estimate. Figure 167 shows the same results as Figure 166 for Bridge (Q1), but under TDL and assuming TDLF detailing. The maximum under-prediction is $0.039P_y$ and the largest over-prediction is $-0.22P_y$ for this case.

Figures 168 and 169 show the same results as Figures 166 and 167 but for Bridge (Q2). The maximum under-prediction is $0.02P_y$ and the largest over-prediction is $-0.13P_y$ for SDLF under SDL. The maximum under-prediction is $0.044P_y$ and the largest over-prediction is $-0.22P_y$ for TDLF under TDL.

Figures 170 and 171 show the same results as Figures 166 and 167 but for Bridge (P). The maximum under-prediction is $0.0034P_y$ and the largest over-prediction is $-0.10P_y$ for SDLF under SDL. The maximum under-prediction is $0.0085P_y$ and the largest over-prediction is $-0.21\ P_y$ for TDLF under TDL.

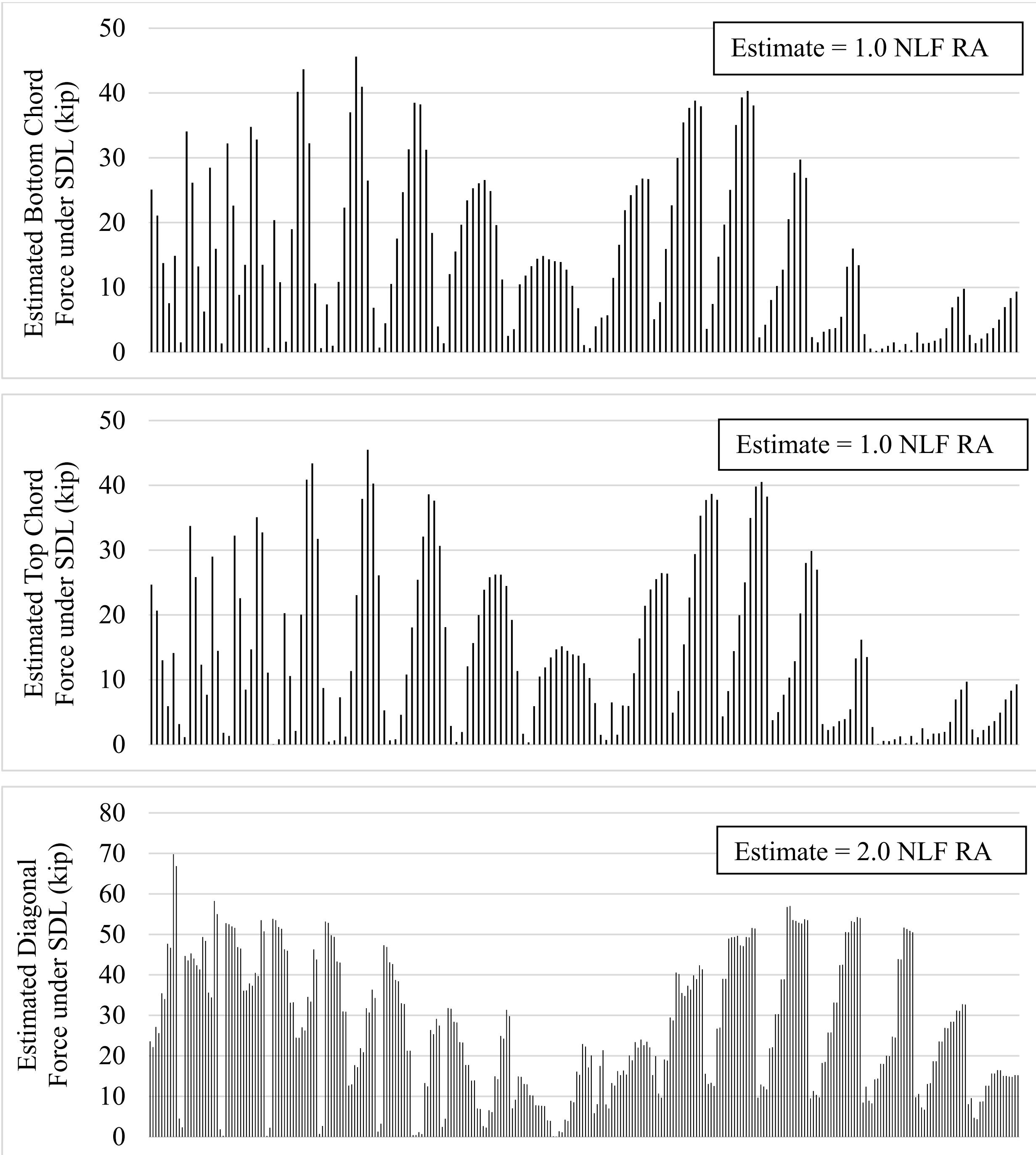


Figure 165. Estimated magnitude of CF member forces based on scaling of NLF RA results, assuming SDLF detailing, Bridge (Q1) NISCS38 under SDL (girder on the inside of the curve made longer by the skew).

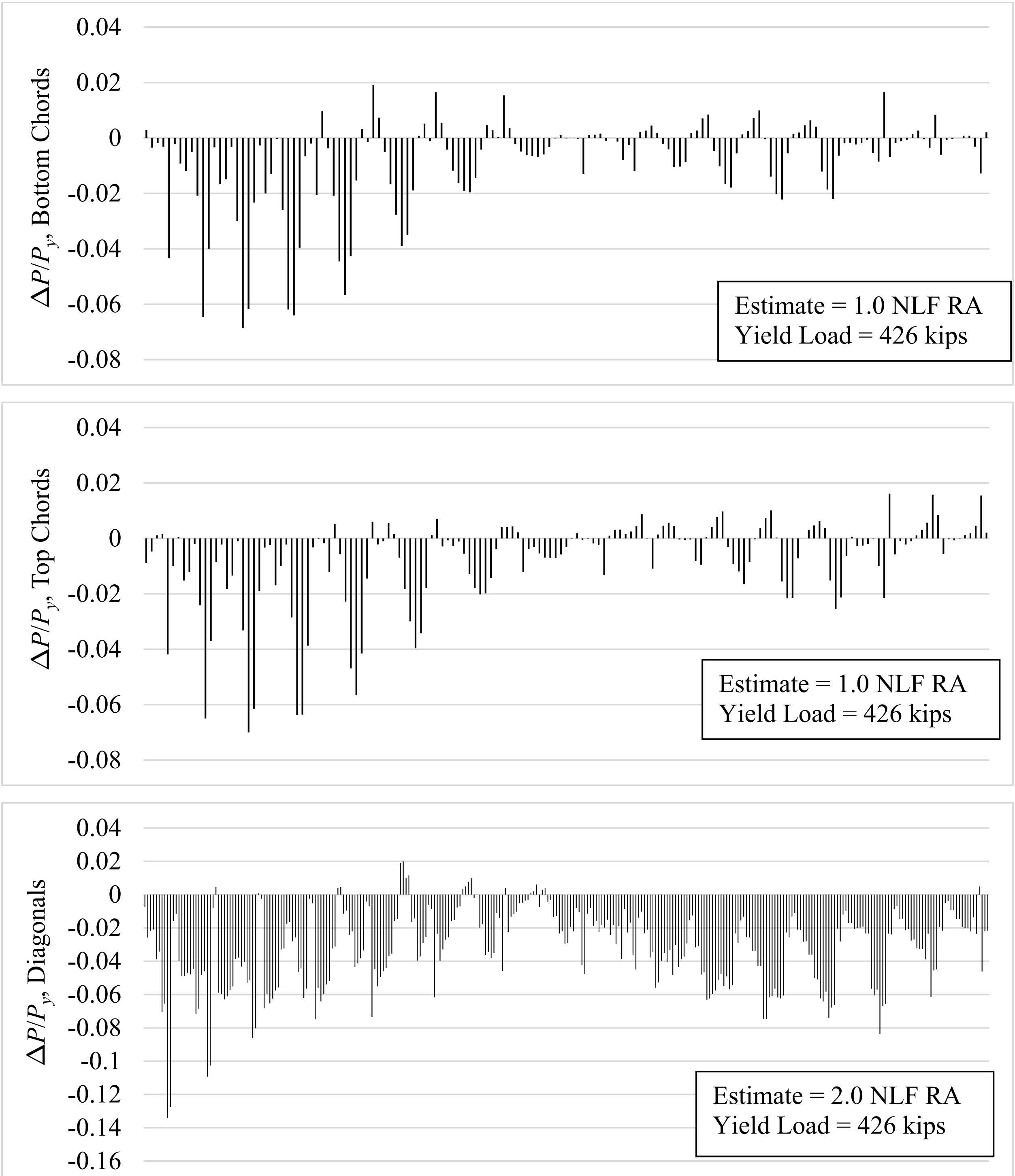


Figure 166. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (Q1) NISCS38 under SDL with SDLF detailing based on NLF RA cambers (girder on the inside of the curve made longer by the skew).

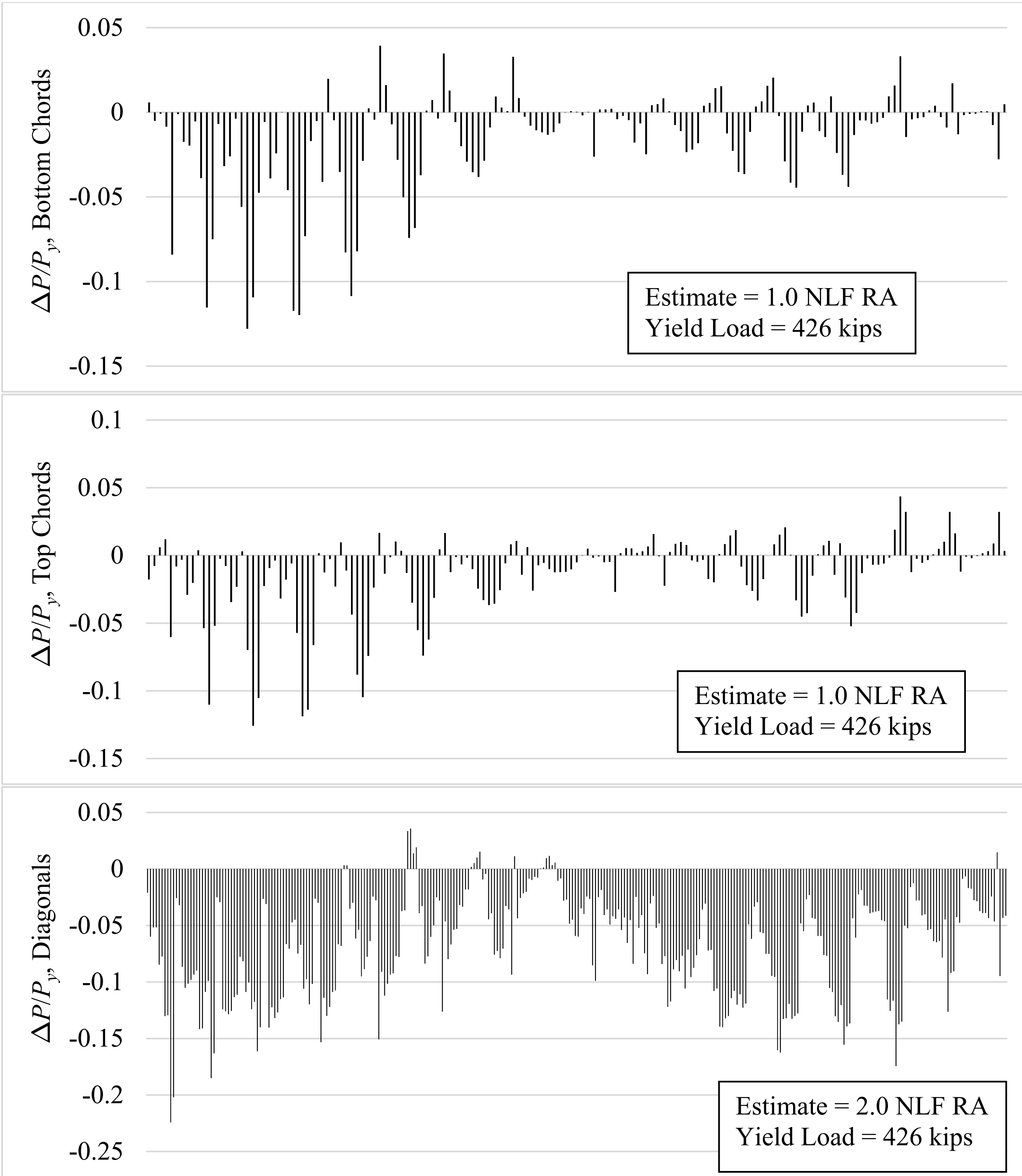


Figure 167. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (Q1) NISCS38 under TDL with TDLF detailing based on NLF RA cambers (girder on the inside of the curve made longer by the skew).

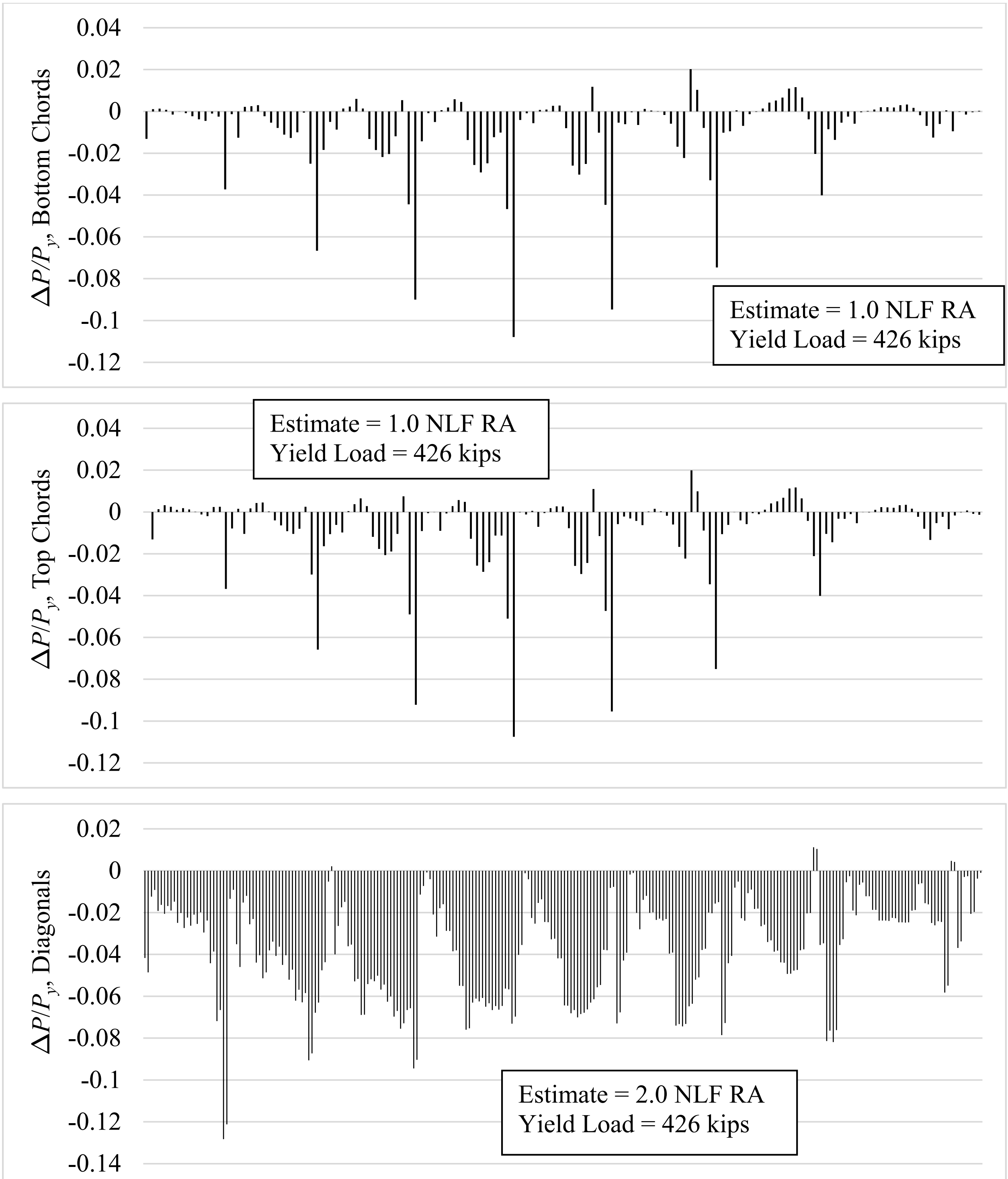


Figure 168. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (Q2) NISCS38 under SDL with SDLF detailing based on NLF RA cambers (girder on the inside of the curve made longer by the skew).

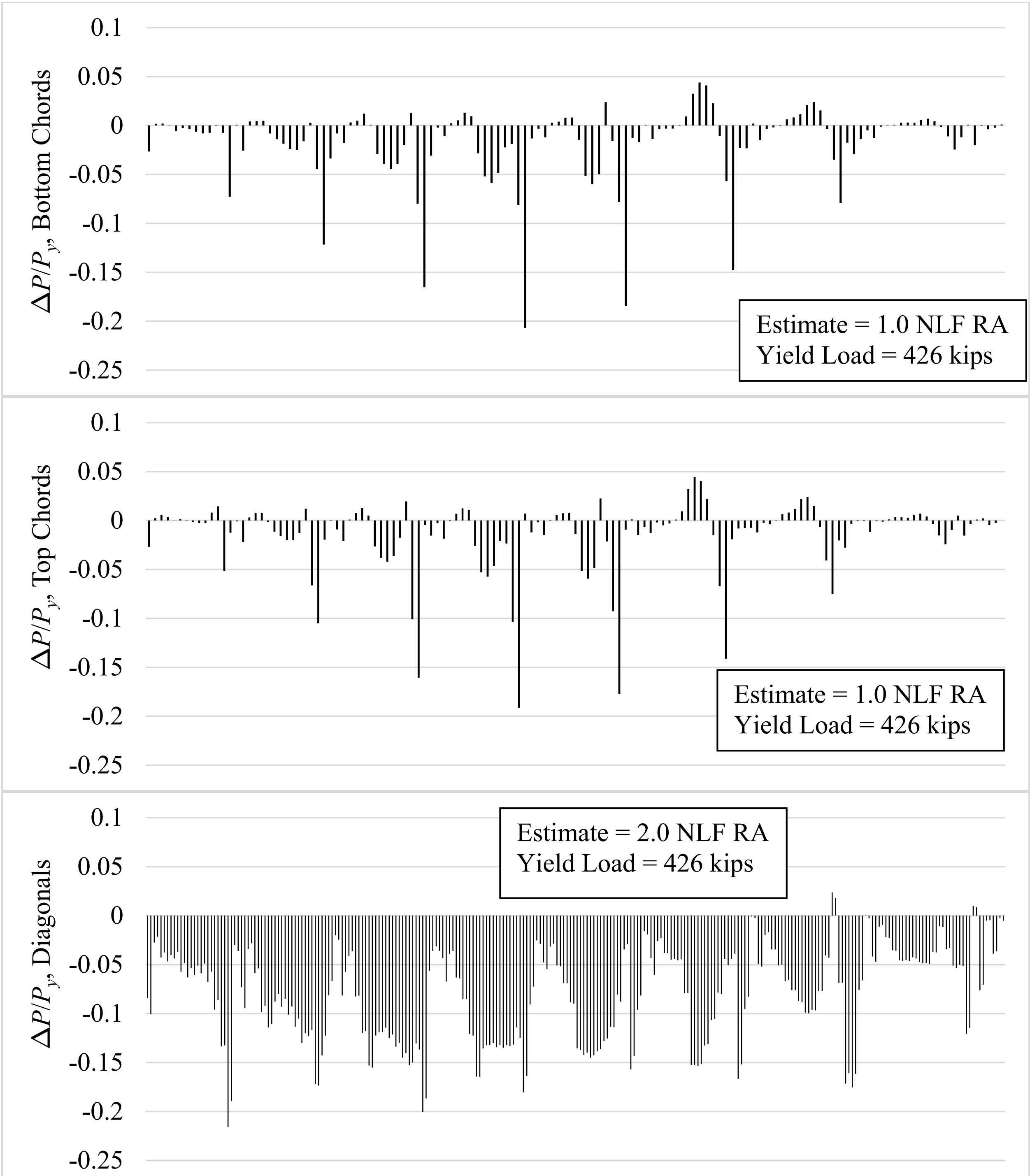


Figure 169. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (Q2) NISCS38 under TDL with TDLF detailing based on NLF RA cambers (girder on the inside of the curve made longer by the skew).

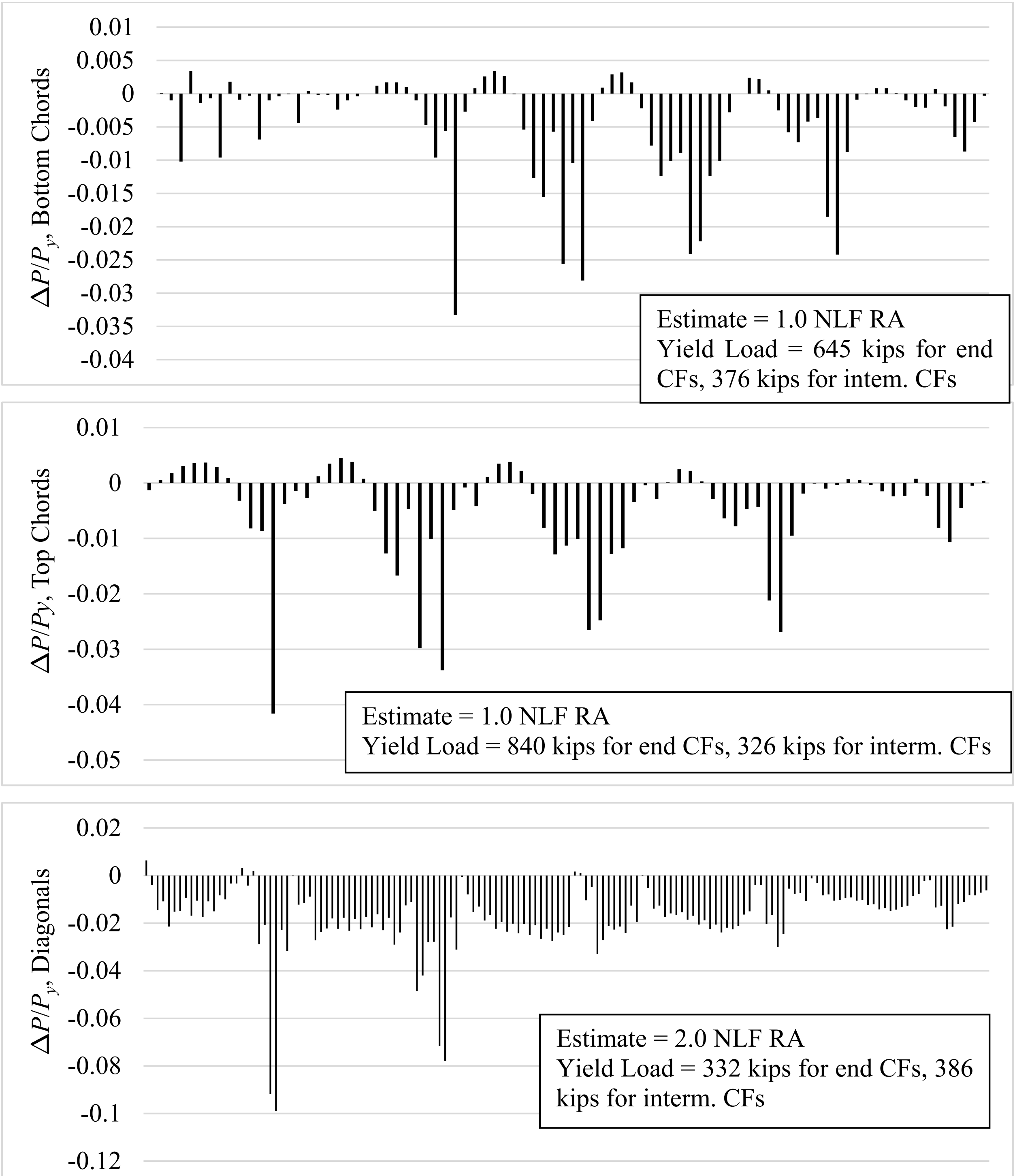


Figure 170. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (P) EISCS3 under SDL with SDLF detailing based on NLF RA cambers (girder on the inside of the curve made longer by the skew).

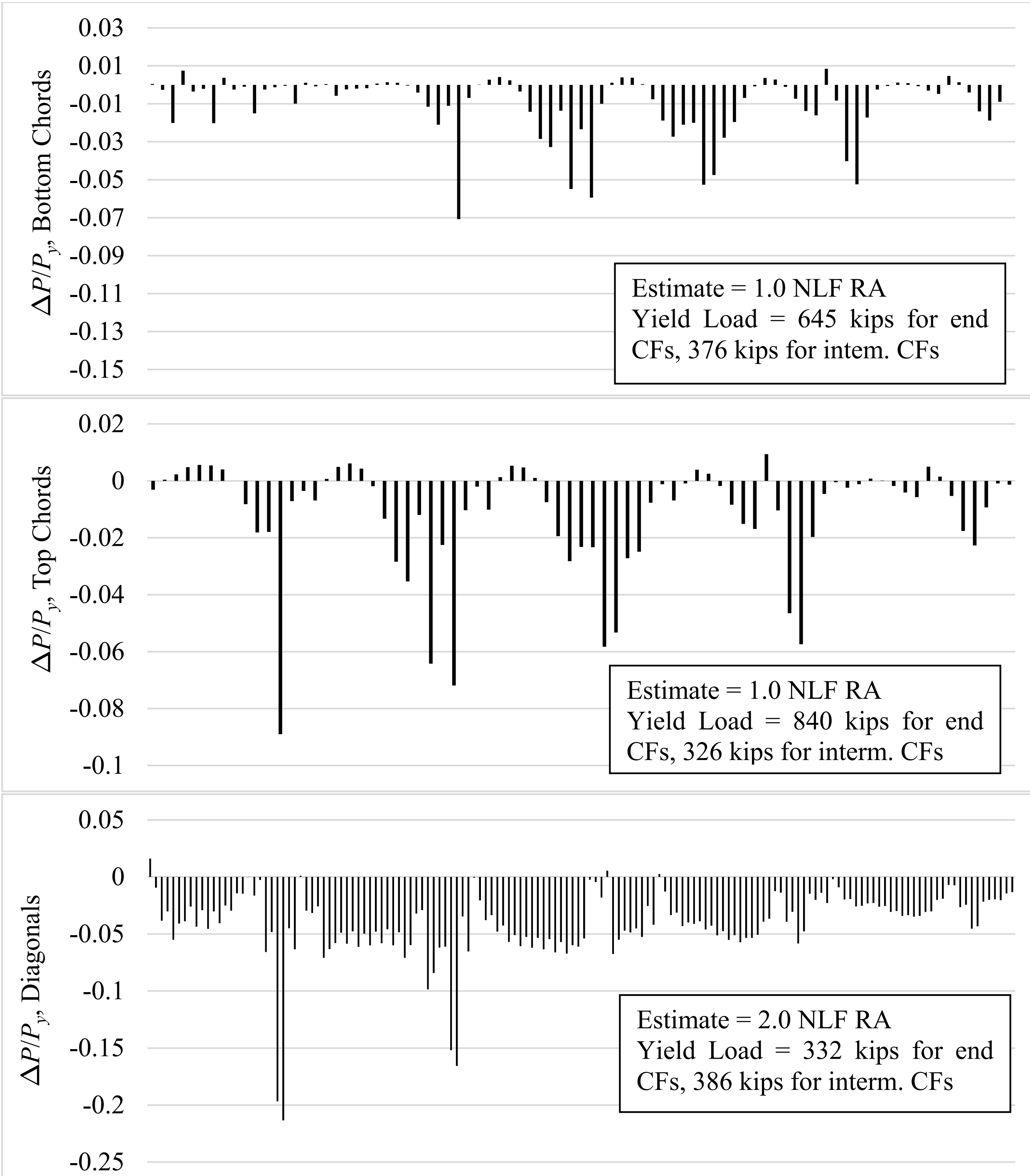


Figure 171. Difference between the magnitude of the DLF RA forces and the values estimated by scaling the NLF RA results, divided by the member yield load ($\Delta P/P_y$), Bridge (P) EISCS3 under TDL with TDLF detailing based on NLF RA cambers (girder on the inside of the curve made longer by the skew).

3.4.10.1.5 Girder Stresses

For curved bridges with or without skew, the girder on the outside of the curve typically tends to have the largest girder major-axis bending stresses and flange lateral bending stresses. The skew orientation of Bridge (N) NISCS14 decreases the maximum vertical displacement and maximum layover of the outside girder of Bridge (N) NISCS14. The skew orientation of Bridge (O1) NISCS15 increases the maximum vertical displacement and maximum layover of the outside girder of Bridge (O1) NISCS15. However, from Figures 170 through 173, the skew orientations of bridge cases (N) and (O1) have negligible influence on the maximum major-axis bending stresses and flange lateral bending stresses on the outside girder.

Considering all the curved and skewed bridge cases studied in this research, from Tables 48 and 49, the largest increases in the major-axis bending stresses under TDL are nine and 16 % for SDLF and TDLF, respectively. The largest increases in the flange lateral bending stresses under TDL are 14 and 31 % for SDLF and TDLF, respectively.

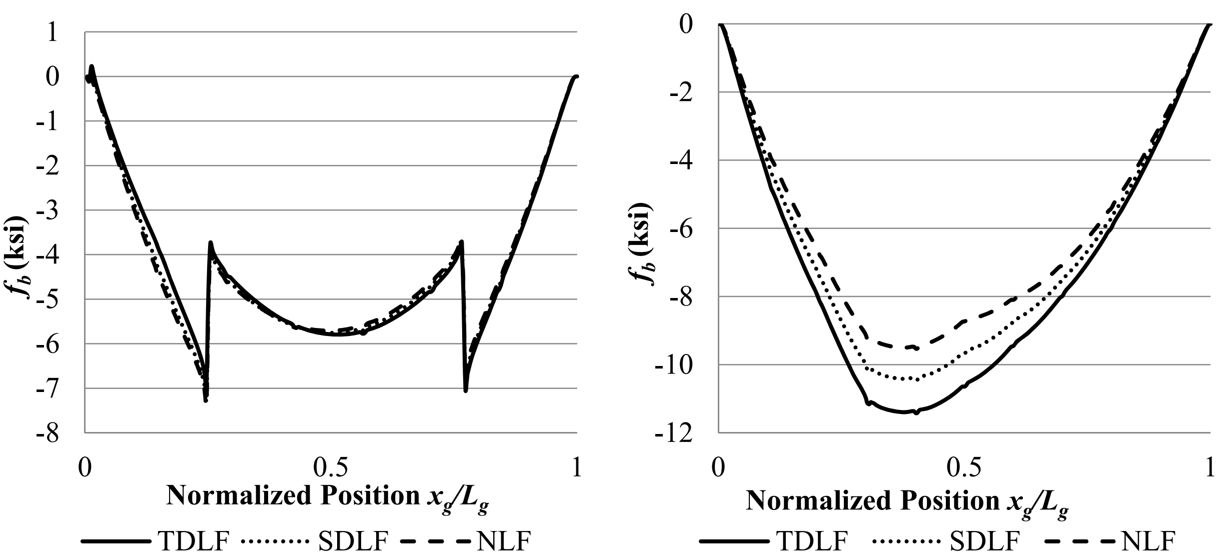


Figure 172. SDL top flange major-axis bending stresses of the outside girder for Bridge (N) NISCS14 (left), where the girder on the outside of the curve is made longer by the skew, and Bridge (O1) NISCS15 (right), where the girder on the outside of the curve is made longer by the skew.

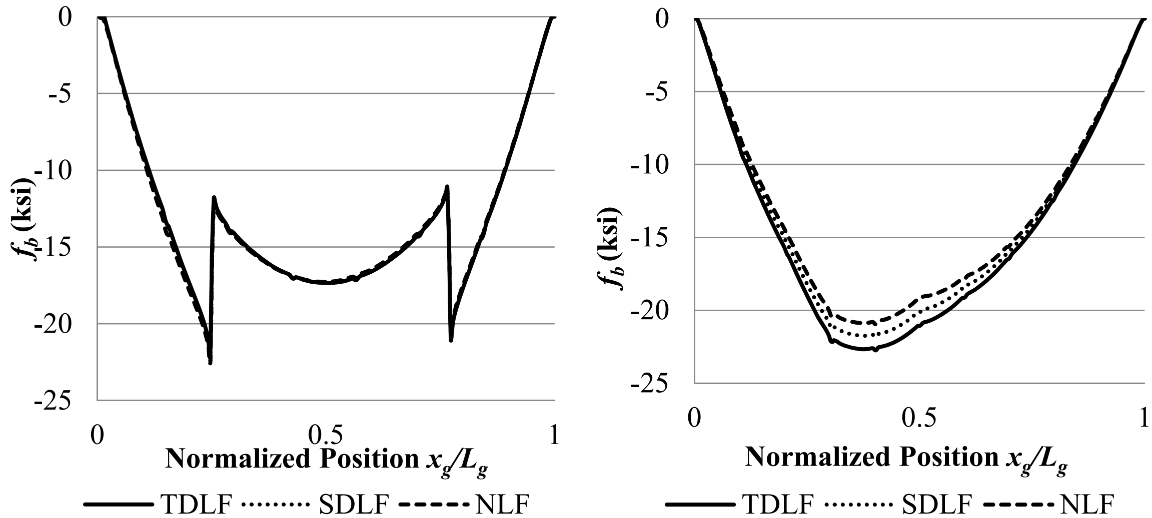


Figure 173. TDL top flange major-axis bending stresses of the outside girder for Bridge (N) NISCS14 (left), where the girder on the inside of the curve is made longer by the skew, and Bridge (O1) NISCS15 (right), where the girder on the outside of the curve is made longer by the skew.

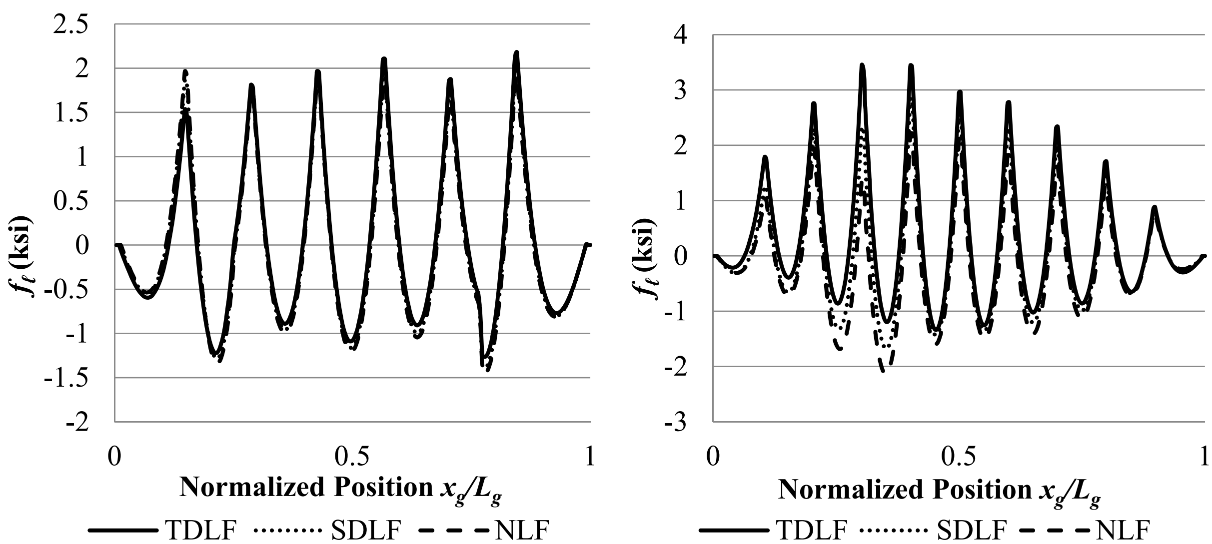


Figure 174. SDL top flange lateral bending stresses of the outside girder for Bridge (N) NISCS14 (left), where the girder on the inside of the curve is made longer by the skew, and Bridge (O1) NISCS15 (right), where the girder on the outside of the curve is made longer by the skew.

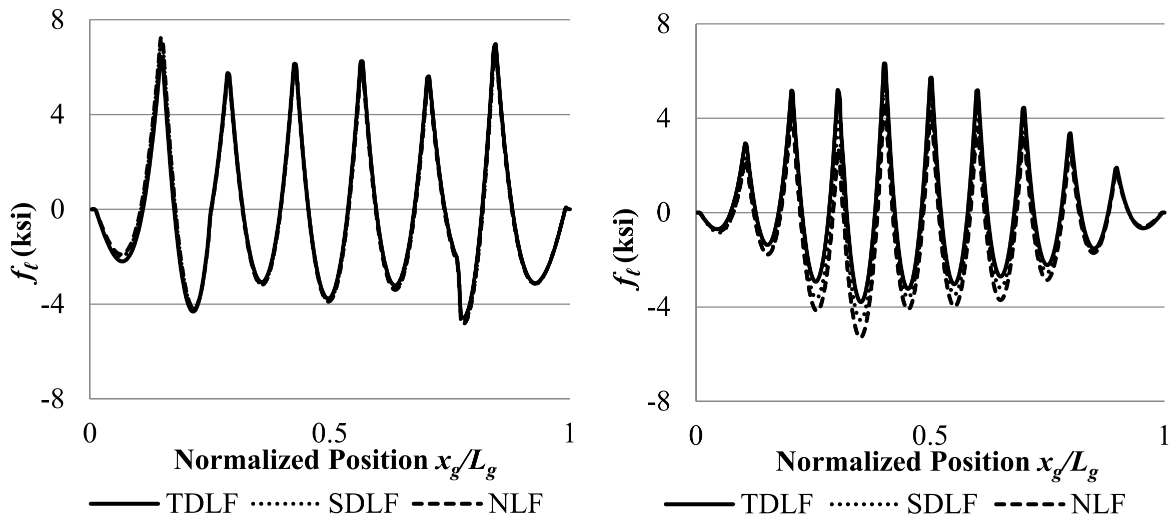


Figure 175. TDL top flange lateral bending stresses of the outside girder for Bridge (N) NISCS14 (left), where the girder on the inside of the curve is made longer by the skew, and Bridge (O1) NISCS15 (right), where the girder on the outside of the curve is made longer by the skew.

Table 48. Maximum magnitudes of major-axis bending stresses and top flange lateral bending stresses under TDL in the girder on the outside of the curve in the curved and skewed bridges studied in this research (f_{b1}, f_{b2} and f_{b3} are the maximum major-axis bending stresses, and $f_{\ell 1}$, $f_{\ell 2}$ and $f_{\ell 3}$ are the maximum girder flange lateral bending stresses for NLF, SDLF, and TDLF detailing, respectively; the largest f_{b2}/f_{b1} and $f_{\ell 2}/f_{\ell 1}$ under SDL for SDLF and f_{b3}/f_{b1} and $f_{\ell 3}/f_{\ell 1}$ under TDL for TDLF are highlighted by dark shading).

	SDL							TDL					
	NLF		SDLF				NLF		TDLF			
Bridge	f_{b1} **(ksi)**	$f_{\ell 1}$ **(ksi)**	f_{b2} **(ksi)**	$\frac{f_{b2}}{f_{b1}}$	$f_{\ell 2}$ **(ksi)**	$\frac{f_{\ell 2}}{f_{\ell 1}}$	f_{b1} **(ksi)**	$f_{\ell 1}$ **(ksi)**	f_{b3} **(ksi)**	$\frac{f_{b3}}{f_{b1}}$	$f_{\ell 3}$ **(ksi)**	$\frac{f_{\ell 3}}{f_{\ell 1}}$
(N) NISCS14*	7.4	2.0	7.3	0.99	2.0	1.00	22.5	7.2	22.1	0.98	7	0.97
(O1) NISCS15†	9.5	2.2	10.4	1.09	2.8	1.27	21.0	5.3	22.7	1.08	6.3	1.19
(O2) NISCS15†	8.6	2.0	9.3	1.08	2.5	1.25	18.7	4.2	20.1	1.07	5.5	**1.31**
(P) EISCS3*	8.9	1.7	9.2	1.03	1.5	0.88	21.0	4.1	21.6	1.03	3.8	0.93
(Q1) NISCS38*	12.0	1.0	12.5	1.04	0.9	0.90	24.4	2.8	25.2	1.03	1.9	0.68
(Q2) NISCS38*	12.2	1.2	12.7	1.04	1.1	0.92	24.8	3.2	25.6	1.03	2.3	0.72
(R1) NISCS39†	16.9	4.1	17.7	1.05	1.8	0.44	29.4	10.8	29.8	1.01	3.7	0.34
(R2) NISCS39†	17.3	3.8	17.3	1.00	1.4	0.37	29.7	9.5	28.8	0.97	2.8	0.29
(S) XICCS7	3.9	0.9	4.1	1.05	1.1	1.22	16.9	5.1	17.5	1.04	5.4	1.06
(T1) EICCS27	12.4	1.1	12.7	1.02	1.3	1.18	43.2	7.9	43.6	1.01	7.2	0.91
(T2) EICCS27	12.5	1.1	12.4	0.99	3.7	**3.36**	44.3	8.5	42.7	0.96	9.6	1.13
(U1) EICCS28	12.2	2.0	14.3	**1.17**	1.8	0.90	22.2	5.2	25.8	**1.16**	3.5	0.67
(U2) EICCS28	13.8	2.1	14.5	1.05	1.2	0.57	24.6	5.7	26.2	1.07	3.2	0.56

* Fascia girder on the inside of the curve is made longer by the skew.
†Fascia girder on the outside of the curve is made longer by the skew.

Table 49. Maximum magnitudes of major-axis bending stresses and top flange lateral bending stresses under TDL in the girder on the inside of the curve in the curved and skewed bridges studied in this research (f_{b1}, f_{b2} and f_{b3} are the maximum major-axis bending stresses, and $f_{\ell 1}$, $f_{\ell 2}$ and $f_{\ell 3}$ are the maximum girder flange lateral bending stresses for NLF, SDLF, and TDLF detailing, respectively; the largest f_{b2}/f_{b1} and $f_{\ell 2}/f_{\ell 1}$ under SDL for SDLF and f_{b3}/f_{b1} and $f_{\ell 3}/f_{\ell 1}$ under TDL for TDLF are highlighted by dark shading).

	SDL						TDL					
Bridge	NLF		SDLF				NLF		TDLF			
	f_{b1} (ksi)	$f_{\ell 1}$ (ksi)	f_{b2} (ksi)	$\frac{f_{b2}}{f_{b1}}$	$f_{\ell 2}$ (ksi)	$\frac{f_{\ell 2}}{f_{\ell 1}}$	f_{b1} (ksi)	$f_{\ell 1}$ (ksi)	f_{b3} (ksi)	$\frac{f_{b3}}{f_{b1}}$	$f_{\ell 3}$ (ksi)	$\frac{f_{\ell 3}}{f_{\ell 1}}$
(N) NISCS14*	4.5	1.4	4.1	0.91	1.2	0.86	13.8	4.3	12.5	0.91	3.7	0.86
(O1) NISCS15†	2.2	2.0	1.1	0.50	0.4	0.20	2.6	5.9	1	0.38	1	0.17
(O2) NISCS15†	2.3	3.1	1.6	0.70	0.5	0.16	3.7	7.3	1.5	0.41	0.8	0.11
(P) EISCS3*	3.6	1.0	2.9	0.81	0.5	0.50	9.5	2.7	8	0.84	1.1	0.41
(Q1) NISCS38*	8.3	1.1	7.6	0.92	0.7	0.64	17.8	2.9	16.5	0.93	1.5	0.52
(Q2) NISCS38*	8.1	1.5	7.6	0.94	1.1	0.73	17.7	3.7	16.6	0.94	2.3	0.62
(R1) NISCS39†	2.4	7.9	2.0	0.83	0.5	0.06	5.0	20.0	2.3	0.46	2.2	0.11
(R2) NISCS39†	4.8	10.2	3.7	0.77	0.6	0.06	7.7	22.1	4.7	0.61	0.9	0.04
(S) XICCS7	4.5	1.9	4.7	**1.04**	1.4	0.74	20.0	8.3	20.8	**1.04**	6.4	0.77
(T1) EICCS27	11.7	1.3	11.3	0.97	1.3	1.00	40.8	5.9	39	0.96	4.1	0.69
(T2) EICCS27	10.2	1.6	9.8	0.96	2.2	**1.38**	35.0	7.5	32.9	0.94	8.1	**1.08**
(U1) EICCS28	5.3	1.9	4.9	0.92	1.3	0.68	13.2	5.5	12.5	0.95	2.9	0.53
(U2) EICCS28	5.1	4.7	4.8	0.94	0.9	0.19	12.9	11.1	12	0.93	2.2	0.20

* Fascia girder on the inside of the curve is made longer by the skew.
†Fascia girder on the outside of the curve is made longer by the skew.

3.4.10.1.6 Vertical Reactions

In curved and skewed bridges, when the skew makes the inside girder longer as in Bridge (N) NISCS14, the skew effects tend to counteract the curvature effects. In addition, larger DL is applied to the inside girder, which is the longer girder. As a result, the overall DL tends to distribute more equally to each of the girders (shown in Table 50 for Bridge (N)). SDLF and TDLF detailing tend to have a small influence on the vertical reactions in this case.

In curved and skewed bridges, when the skew makes the outside girder longer as in Bridge (O1) NISCS15, the skew effects tend to be additive with the curvature effects. In addition, larger DL is applied to the girder on the outside of the curve, which is the longer girder. The loads tend to shift from the inside to the outside of the bridge cross-section, resulting in higher vertical reactions in the outside girder of the curve and lower vertical reactions in the inside girder. This behavior is exhibited by Bridge (O1) in Table 51. The inside girder in Bridge (O1), Girder 9, experiences uplift at the skewed bearing line (highlighted as "Uplift" in the table). SDLF and TDLF detailing effects twist the girders in the direction opposite to that which the girders tend to roll under the DL. The detailing effects increase the reactions in both the inside and outside girders due to the interaction of the DLF effects with the overall compliance of the bridge system. For Bridge (O1) NISCS15, the reactions at the skewed bearing line on Girder 1 under TDL are increased by 12 kip by SDLF detailing and 26 kip by TDLF detailing. The support at the skewed bearing line on Girder 9 experiences uplift with NLF detailing. The reactions at the skewed bearing line on Girder 9 under TDL are 18 kip with SDLF detailing and 39 kip with TDLF detailing. However, the reactions on Girder 4 under TDL, an interior girder, are decreased by 5 kip with SDLF detailing and 7 kip with TDLF detailing. The total net change in vertical reactions at all bearings is zero when SDLF or TDLF detailing is employed.

Table 50. Bridge (N) NISCS14 vertical reactions (kip), where the skew increases the length of the girder on the inside of the curve (G1 and G9 are the girders on the outside and the inside of the curve, respectively).

Girder	Detailing Method	SDL Support 1	SDL Support 2	TDL Support 1	TDL Support 2
G1	NLF	56	53	172	164
	SDLF	53	53	170	165
	TDLF	49	54	165	165
G2	NLF	53	49	165	153
	SDLF	51	49	163	152
	TDLF	46	49	158	152
G3	NLF	50	45	157	142
	SDLF	52	45	159	142
	TDLF	57	46	164	143
G4	NLF	51	40	162	125
	SDLF	51	39	162	124
	TDLF	50	37	161	123
G5	NLF	44	37	140	116
	SDLF	46	37	142	116
	TDLF	51	39	147	118
G6	NLF	46	35	144	109
	SDLF	48	36	146	111
	TDLF	52	38	151	113
G7	NLF	51	44	154	133
	SDLF	52	44	154	133
	TDLF	53	45	156	134
G8	NLF	45	40	134	120
	SDLF	44	39	132	120
	TDLF	40	38	128	119
G9	NLF	31	34	95	103
	SDLF	30	33	94	102
	TDLF	29	30	93	98

Table 51. Bridge (O1) NISCS15 vertical reactions (kip), where the skew increases the length of the girder on the outside of the curve (G1 and G9 are the girders on the outside and inside of the curve, respectively. The bearing locations experiencing uplift are highlighted by dark shading).

Girder	Detailing Method	SDL Support 1	SDL Support 2	TDL Support 1	TDL Support 2
G1	NLF	170	133	369	287
	SDLF	183	138	381	292
	TDLF	199	143	395	297
G2	NLF	131	124	280	271
	SDLF	132	126	280	274
	TDLF	128	130	281	275
G3	NLF	71	120	162	265
	SDLF	62	120	153	263
	TDLF	55	115	140	264
G4	NLF	64	77	150	177
	SDLF	59	73	145	174
	TDLF	53	72	143	169
G5	NLF	51	73	126	168
	SDLF	45	69	120	164
	TDLF	38	65	112	161
G6	NLF	39	64	104	150
	SDLF	35	60	100	147
	TDLF	33	56	96	145
G7	NLF	39	38	86	92
	SDLF	26	36	80	91
	TDLF	21	34	78	88
G8	NLF	7	5	74	57
	SDLF	23	10	75	57
	TDLF	19	14	70	58
G9	NLF	**Uplift**	**Uplift**	**Uplift**	11
	SDLF	9	**Uplift**	18	14
	TDLF	29	**Uplift**	39	17

Of the other curved and skewed bridge cases studied in this research, bridge cases (O2) NISCS15, (R1) and (R2) NISCS39, and (U1) EICCS28 experienced uplift at the bearing on the inside girder at the obtuse corner of the bridge plan (Bridge (U1) exhibits this behavior with respect to its longer end span). The skew orientation of these bridge cases makes the outside girder longer (the outside girder is longer in the left-hand end span in continuous-span Bridge (U1)). It is important to note that uplift is exacerbated by longer spans, sharper skews, tighter curvature, and contiguous framing arrangements.

From Table 52, for the curved and skewed bridges considered in this research, the largest increases in the vertical reactions are 155 kip (154 %), under the SDL due to SDLF. The largest increases are 298 kip (132 %) and 130 kip (983 %) respectively under the TDL due to TDLF detailing. These maximums occur in bridge cases (U1) and (U2), which correspond to an extreme continuous-span geometry. The reaction values in Table 52 are reported under SDL for SDLF and under TDL for TDLF, to support the use of a simple scale factor on the NLF RA results for estimation of the maximum reactions. This is discussed further in Section 3.4.10.2.

It can be stated that generally, for simply-supported bridges that have both a tight horizontal curvature and sharp skew, DLF detailing tends to relieve potential uplift conditions at lightly loaded bearings that are most vulnerable to uplift. This behavior is similar to the behavior observed for the horizontally curved radially-supported bridges with simple supports in Section 3.4.5.1.6. Therefore, as an approximate estimate for simply-supported bridges, if uplift is not encountered at any of the bearings in a NLF RA, it should be sufficient to assume that uplift will not be a problem in the bridge if it is detailed for SDLF or TDLF.

Table 52. Summary of maximum percentage increase in the vertical reaction at each of the girder bearings due to SDLF and TDLF detailing in the curved and skewed bridges (Largest increases highlighted by dark shading).

Bridge	SDLF under SDL		TDLF under TDL	
	Change (kip)	Percentage Increase	Change (kip)	Percentage Increase
(N) NISCS14*	5	2	7	5
(O1) NISCS15†	246	16	6	55
(O2) NISCS15†	62	15	38	61
(P) EISCS3*	35	6	13	26
(Q1) NISCS38*	8	12	23	7
(Q2) NISCS38*	8	16	28	7
(R1) NISCS39†	39	54	137	159
(R2) NISCS39†	24	6	24	33
(S) XICCS7	4	3	18	4
(T1) EICCS27	191	48	165	143
(T2) EICCS27	6	9	14	7
(U1) EICCS28	**155**	**154**	**298**	132
(U2) EICCS28	45	92	130	**983**

* Fascia girder on the inside of the curve is made longer by the skew.
†Fascia girder on the outside of the curve is made longer by the skew.

3.4.10.2 Summary and Recommendations – Curved and Skewed Bridges with Cambers Set Based on NLF RA

The influence of SDLF and TDLF detailing on the responses in the completed curved and skewed bridge systems studied in this research may be summarized as follows. Recommendations pertaining to these quantitative results are highlighted in bold italicized text.

General

- In the limit that the skew becomes small, taken as $\theta \leq 20^{o}$, the curved radially-supported bridge recommendations are considered to apply. Therefore, Section 3.4.5 should be consulted for these cases.
- In the limit that the horizontal curvature becomes small, taken as $L_s/R \leq 0.03$, the straight bridge recommendations are considered to apply. Sections 3.4.6 through 3.4.9 address these cases.

Girder Elevations

- The elevations are slightly low for the most extreme curved and skewed bridges considered when the skew makes the inside girder shorter.
- The elevations are slightly high for the most extreme curved and skewed bridges considered when the skew makes the outside girder longer.
- With the exception of (R1) and (R2) NISCS39, which are so extreme that (R2) is essentially unbuildable, the largest deviations from the targeted/expected elevations (calculated without considering the DLF effects) are 1.2 inches for SDLF and 2.1 inches for TDLF.
- ***It is recommended that NLF RA is sufficient for calculation of the cambers in curved radially-supported bridges. This recommendation is identical to the recommendations for general curved radially-supported and straight skewed bridges.***

Girder Layovers

- The maximum layover under SDL for SDLF is 0.5 inches (0.0056 rad) for the bridges studied.
- The maximum layover under TDL for TDLF is 1.7 inches (0.0189 rad) for the bridges studied.
- These nonzero layovers are largely due to elastic deformations of the CFs and the elastic torsional deformations of the girders in the three-dimensional bridge systems.

- ***It is recommended that the girder layovers may be assumed to be negligible in the targeted DL condition in curved and skewed bridges. There is no need to consider any change in the girder layovers due to the change in the internal forces, and the change in the elastic deformations in the system, associated with the DLF detailing. The fascia girders should be checked separately for twist rotation between the CF locations due to eccentric overhang bracket loads.***
- ***For curved and skewed bridges detailed for SDLF, the girder layovers under the TDL may be estimated as the CDL layovers obtained from a NLF RA.***
- ***For curved and skewed bridges detailed for TDLF, the girder layovers under the SDL may be estimated as the negative of the CDL layovers obtained from a NLF RA.***
- ***This recommendations are identical to the recommendations for general curved radially-supported and for general straight skewed bridges.***

Cross-Frame Forces

- Not considering bridge (T2) EICCS27, the average of the CF chord forces under SDL decreases for SDLF detailing in the bridges studied. In addition, the average of the CF chord forces under TDL decreases for TDLF detailing in the bridges studied. Bridge (T2) has an extremely large skew index and an improved arrangement of the CFs that greatly reduces its CF forces. The improvement (reduction) in the overall CF force magnitudes coincides with larger elastic girder torsional deformations, which results in changes in the force distributions in the structural system, including the distributions associated with the TDLF detailing effects.
- Not considering bridge (T2) EICCS27, the largest increase in the maximum of the CF chord forces under SDL is 5 % (1.7 kip) for SDLF detailing in the bridges studied. The largest increase in the maximum of the CF member forces under TDL is 2 % (1.7 kip) for TDLF detailing. Both of these increases occur in bridge (P) EISCS3.
- Not considering bridge (T2) EICCS27, the average of the CF diagonal forces under SDL either remains unchanged (bridge (N) NISCS14) or decreases for SDLF detailing in the bridges studied. In addition, the average of the CF diagonal forces under TDL either remains unchanged (bridge (N) NISCS14) or decreases for TDLF detailing in the bridges studied.

- Not considering bridge (T2) EICCS27, the largest increase in the maximum of the CF diagonal forces under SDL is 1 % (0.3 kip) for SDLF detailing in the bridges studied. This increase occurs in bridge (Q1) NISCS38.The largest increase in the maximum of the CF member forces under TDL is 5 % (kip) for TDLF detailing. This increase occurs in bridge (Q2) NISCS38.
- For the bridges studied, the overall statistics for the percent change in the individual CF member forces relative the member yield load due to SDLF and TDLF detailing indicate a wide range (dispersion) of individual CF member force effects, but a predominant tendency for reduction of the CF member forces (relative to the values associated with the assumption of NLF detailing) due to SDLF and TDLF detailing. The reductions in the CF member forces tend to not be as large as in the straight skewed bridges. This is due to the overall influence of the effects associated with horizontal curvature, which are opposite to the effects associated with support skew.
- It is observed that the combination of the skew effects and the horizontal curvature effects tends to reduce the influence of DLF detailing on the CF forces from the values associated with the recommendations for curved radially-supported bridges in all cases.
- ***Based on the above observations, it is recommended that, in lieu of a DLF RA, the CF member forces in curved and skewed I-girder bridges may be calculated conservatively by using the recommendations for curved radially-supported bridges.***
- With the use of the above scale factors, the maximum difference between the magnitudes of the individual DLF RA CF member forces versus the scaled NLF RA results, normalized by the member yield load, is reduced to 4.4 and 9.0 %, and the corresponding average difference is reduced to -1.9 and -4.3 % for SDLF under SDL and TDLF under TDL, respectively, for the curved radially-supported bridges studied in this research, excluding bridge (T2)

Girder Stresses

- For the curved and skewed bridges studied in this research:
    - The largest increase in the maximum major-axis bending stress on any of the girders, under TDL for SDLF (relative to the response from NLF RA), is 9 % (2.0 ksi).
    - The largest increase in the maximum major-axis bending stress on any of the girders, under TDL for TDLF (relative to the response from NLF RA), is 16 % (3.6 ksi).

- The largest increase in the maximum flange lateral bending stress on any of the girders, under TDL for SDLF (relative to the response from NLF RA), is 14 % (0.6 ksi).
- The largest increase in the flange lateral bending stress on any of the girders, under TDL for TDLF (relative to the response from NLF RA), is 31 % (1.3 ksi).

- ***It is recommended that, in lieu of a DLF RA, the girder f_b and f_ℓ values in curved and skewed I-girder bridges may be calculated conservatively by using the recommendations for curved radially-supported bridges.***

Vertical Reactions

- Horizontally curved and skewed bridges where the outside girder is made longer by the skew of the bearing lines are apt to see uplift at an obtuse corner of the bridge plan.
- For simply-supported bridges that have both a tight horizontal curvature and sharp skew, DLF detailing tends to relieve potential uplift conditions at lightly loaded bearings that are most vulnerable to uplift. Therefore, as an approximate estimate for simply-supported bridges, if uplift is not encountered at any of the bearings in a NLF RA, it should be sufficient to assume that uplift will not be a problem in the bridge if it is detailed for SDLF or TDLF.
- DLF detailing increases the reactions on some of the girders and decreases them on others. The net total change in the vertical reactions is zero.
- In the simple-span curved and skewed bridges studied where the length of the girder on the outside of the curve is increased by the skew (Bridges (O1) and (O2) NISCS15 and (R1) and (R2) NISCS39), the reactions tend to be very small or negative at the girder on the inside of the curve (negative reactions mean uplift, based on the assumption that a tie-down device is employed). In these cases, both SDLF and TDLF reduce the uplift and redistribute the reactions substantially.
- In the simple-span curved and skewed bridges considered in this research, where the length of the girder on the inside of the curve is increased by the skew (Bridges (N) NISCS14, (P) EISCS3, and (Q1) and (Q2) NISCS38), the largest increase in the reactions is 16 % (8 kip) under SDL for SDLF and 26 % (13 kip) under TDL for TDLF.
- In the extreme simple-span curved and skewed Bridge (O1) NISCS15, where the length of the girder on the outside of the curve is increased substantially by the skew, the largest increase in

the reactions is 16 % (8 kip) and 54 % (39 kip) for SDLF under SDL and TDLF under TDL, respectively.

- In the continuous-span curved and skewed bridges, the influence of DLF detailing on the reactions can be substantial in certain cases, as much as 155 kip (154 %) under SDL for SLDF and 298 kip (132 %) under TDL for TDLF (neglecting the very large percentage change for bridge (U2) EICCS28, due to the fact that some of the reactions from the NLF RA are relatively small.
- ***In lieu of a DLF RA, it is recommended that the influence of SDLF detailing on the girder reactions in curved and skewed simply-supported bridges, where the length of the girder on the inside of the curve is increased by the skew, may be addressed by scaling the SDL reactions from a NLF RA by the multiplier 1.20.***
- ***In lieu of a DLF RA, it is recommended that the influence of SDLF detailing on the SDL girder reactions in curved and skewed simply-supported bridges, where the length of the girder on the outside of the curve is increased by the skew, may be addressed by scaling the SDL reactions from a NLF RA by the multiplier 1.60.***
- ***For all other cases, it is recommended that a DLF RA should be conducted to determine the girder reactions in curved and skewed I-girder bridges.***
- ***For SDLF detailing, the TDL reactions can be computed as the sum of the above SDL reactions and CDL reactions.***
- ***In simple spans, if uplift is not experienced for NLF, it is likely that uplift would not occur for SDLF and TDLF. This is because SDLF and TDLF tend to increase the vertical reactions bearing that are most vulnerable to uplift.***

The above recommendations are considered applicable for curved and skewed bridges with L_s/R up to 0.5, skews up to 70°, and spans up to 300 ft. These limits are different from those listed in the tables for recommended fit conditions discussed in Section 4.1. The limits here are aimed at ensuring sufficient accuracy of the structural analysis whereas the limits discussed in Section 4.1 address broader questions of ensuring reliable fit-up of the structural steel. For bridges that exceed these limits, it is recommended that DLF RA be considered. Section 3.9 explains the details of several procedures for conducting a DLF RA.

3.5 Influence of Framing Arrangements

The cross-frame framing arrangement can have a significant effect on the overall bridge behavior as well as the fit-up forces during the steel erection. In a number of the bridges studied in this research, specific improvements in the cross-frame framing arrangements were possible based on the NCHRP Report 725 research and other recent developments and findings. These improvements relate particularly to the alleviation of significant nuisance transverse stiffness paths associated with skew. These recommended improvements are expanded upon in the discussions below.

3.5.1 Offsets between Intermediate Cross-Frames and Skewed Supports

NCHRP Report 725 recommends the use of an offset of the intermediate cross-frames from the skewed bearing line cross-frames that is the larger of $1.5D$ or $0.4L_b$ wherever practicable, where D is the girder web depth and L_b is the next or adjacent interior unbraced length. The provision of this offset locates cross-frames where girder differential displacements between the cross-frame ends are significantly reduced, leading to lower cross-frame forces. This offset has been incorporated in AASHTO LRFD Article C6.7.4.2.

Upon applying these rules to the suite of bridges selected for NCHRP 20-07/Task 355, it became apparent that the above $1.5D$ rule was overly punitive and difficult to implement in longer-span highly-skewed bridges. This is because $1.5D$ is commonly a larger fraction of the other unbraced lengths for longer-span bridges, where the typical unbraced lengths of 30 ft or less are a smaller fraction of the overall span length. As such, the unbraced length on the fascia girders at the acute corners of the spans tended to be too long. However, the other characteristic of the longer-span straight skewed bridges is that their flanges tend to be a smaller fraction of the overall girder depths. This is a "natural" occurrence in the designs, since the unbraced lengths, L_b, are also a smaller fraction of the span lengths. The flange width is the predominant dimension that influences the girder warping and lateral bending stiffnesses, and therefore influences the tendency to develop large transverse nuisance stiffness due to small offsets (and stagger distances). The research team found that a length of $4b_f$, where b_f is the largest girder flange width within the unbraced lengths on either side of the first cross-frame, serves as a better minimum limit that should always be met to ensure that offsets (and stagger distances) actually serve their intended purpose.

For bridges with sharply skewed bearing lines, the max($4b_f$, $0.4L_b$) offset rule still result in a large L_b on the fascia girder near the acute corners of sharply skewed spans. The AASHTO Standard Specifications formerly recommended a maximum unbraced length of 25 ft. This has been replaced in the AASHTO LRFD Specifications by the requirement for a rational analysis to assess the cross-frame spacing. However, cross-frame spacings larger than 30 ft are relatively rare in straight I-girder bridges, and are not permitted for curved I-girder bridges. If the overhang loads do not cause excessive twisting of the fascia girder, then unbraced lengths slightly larger than 30 ft can be accommodated easily in many cases at the simply-supported ends of a straight-girder bridge. However, the negative moments at in interior pier can require increases in the size of the fascia girder at an acute corner to handle the lateral torsional buckling limit state. To solve the above issues of either the torsional rotations due to overhang loads or the lateral torsional buckling resistance, the first intermediate cross-frames from the bearing lines may be skewed to reduce the unbraced length on the fascia girder at this location. A skew angle of approximately one-half the skew angle of the bearing line is suggested. Figure 176 demonstrates this application skewed intermediate cross-frames by showing a portion of the framing arrangement of a continuous-span bridge

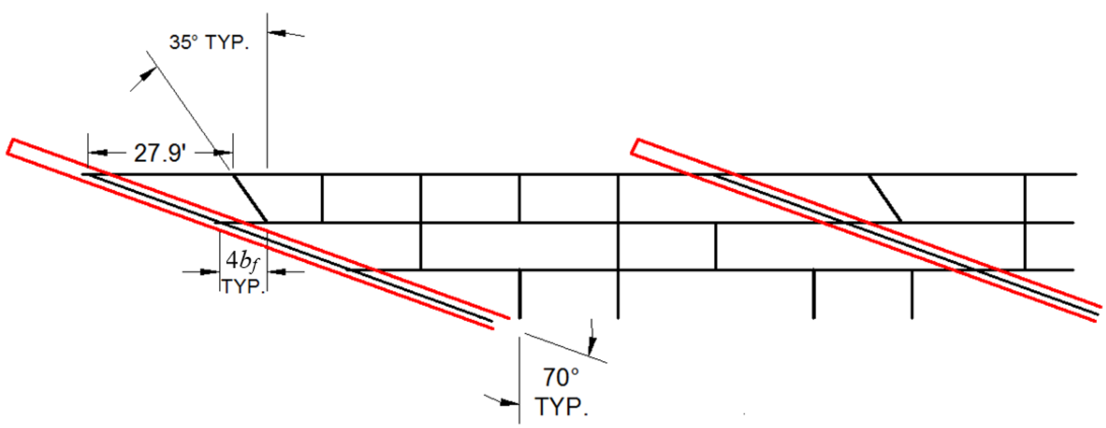


Figure 176. Use of skewed intermediate cross-frames adjacent the skewed bearing lines (not recommended).

The most important points of the framing arrangement shown in Figure 176 are:

- It maintains the minimum offset of the larger of $4b_f$ and $0.4L_b$ while also providing an acceptable unbraced length on the fascia girders, where b_f is the largest girder flange width within the unbraced lengths on either side of the first cross-frame and L_b is the next or adjacent interior unbraced length. This research recommends that the traditional recommendation of an offset of $1.5D$ in the AASHTO LRFD Article C6.7.4.2 be modified to $4b_f$. An engineer who understands approximately what b_f/D values will be needed for a given type of bridge structure can still convert the $4b_f$ requirement into a related fraction of the girder web depth, if desired.

- The skewed intermediate cross-frame also experiences smaller differential vertical deflections at its ends than if it were framed normal to the girders. This reduction in vertical differential deflections leads to a substantial reduction in nuisance transverse stiffness.

- Although the intermediate cross-frame skew results in some coupling between the girder major-axis bending and twisting rotations, this effect is not as severe as in the bearing line cross-frames since the skew angle is only about half that of the bearing line.

- Skewing the above intermediate cross-frame actually provides an additional "degree of freedom" (dof) of low stiffness that may facilitate the installation of the skewed cross-frame – the rotation of the cross-frame about its axis and the rotation of the girder about its longitudinal axis both have relatively low stiffness compared to the other deformations in the region of the acute corner. By skewing the intermediate cross-frame, these two flexible rotational dofs have components that are additive to one another, rather than these rotations being orthogonal to one another.

It should be noted that the use of skewed intermediate cross-frames may result in a potential increase in the fabrication costs for the skewed connection plate detail. Therefore, the scheme shown in Figure 176 is not generally recommended. To avoid using skewed intermediate cross-frames at the acute corners of the spans in such cases, it is instead recommended that the first cross-frame in the exterior bays adjacent to the skewed bearing lines be framed perpendicular to the girders with a small offset from the bearing on the interior girder as shown in Figure 177, and that the diagonal members of this cross-frame be removed to reduce the resulting nuisance transverse stiffness. The cross-frames highlighted by an oval and labeled on this plan view as “CO” (for “chords only”) do not contain any diagonals. This allows for a small offset of these cross-frames relative to the skewed bearing lines without inducing large cross-frame forces from nuisance transverse stiffness effects, while reducing the large unbraced length on the adjacent girder at the acute corner of the bridge plan. This scheme may be considered as a variant of the lean-on bracing concept, discussed further in Section 3.5.4.

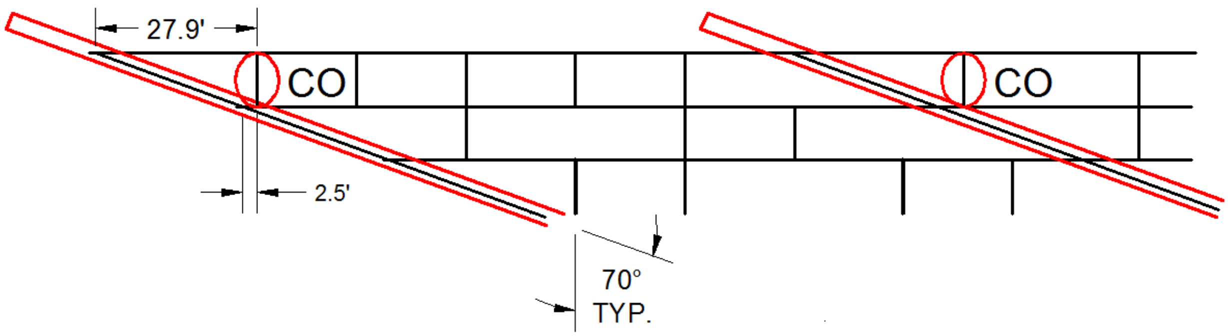


Figure 177. Demonstration of the use of intermediate cross-frames with chord only adjacent to the skewed bearing lines (recommended).

3.5.2 Cross-Frames at and Near Interior Piers in Continuous-Span Bridges

Figure 13 (Section 2.2.2) shows the Bridge (M1) EICSS2 framing arrangement with intermediate cross-frames connected directly into the bearings at the interior piers where bearing-line cross-frames are also provided. This framing arrangement causes substantial nuisance transverse stiffness. The enforcement of compatible deformations is difficult for this type of framing arrangement, leading potentially to large required external fit-up forces during erection and large internal forces in the cross-frames in the vicinity of the piers.

One option to avoid this problem on continuous-span bridges is to offset the intermediate cross-frames relative to the skewed bearing line at the interior piers, as discussed above in Section 3.5.1. Alternately, this problem can be avoided by not using any skewed bearing line cross-frames at the pier, but instead providing an intermediate cross-frame normal to the girder on one or both sides of each bearing. These two alternative framing arrangements are shown for bridge cases (K2) and (K3) EICSS12 in Figures 25 and 26 of Section 2.3.1, respectively. It is important to note that at least one cross-frame must be connected to the girder at or near each bearing. This is necessary to transfer lateral loads to the bearing, if the bearing is laterally restrained, as well as to provide bracing to the girder at this location.

Nevertheless, for cross-frames framing directly into the bearing locations at an interior pier in a continuous-span bridge, the girder vertical displacement is zero on the side connected at the bearing location and non-zero on the other side. As such, framing any intermediate cross-frame directly into a bearing tends to cause substantial nuisance transverse stiffness.

When the span ratio is balanced, the major-axis bending rotations at the interior piers are minimal. The pier cross-sections act approximately as if they were fixed points. NCHRP Report 725 shows that at a skewed bearing line $\phi_z = \phi_x \tan\theta$ where ϕ_x is the major-axis bending rotation, ϕ_z is the twist rotation, and θ is the skew angle (zero for zero skew). Since ϕ_x is minimal at the interior piers in balanced spans, the twist rotations ϕ_z are also minimal. The use of skewed bearing line cross-frames to transfer lateral loads to the restrained bearings and provide bracing to the girder at the interior pier, along with a liberal offset of the first intermediate cross-frames on each side of the interior pier, generally results in a greater reduction of overall nuisance transverse stiffness and lower forces in the interior skewed bearing line cross-frames.

Table 53 compares the average and maximum cross-frame forces under SDL and TDL for bridge cases (K2) and (K3) EICCS12. The framing arrangement of bridge case (K2) gives smaller average and maximum cross-frame forces under both SDL and TDL, for all three detailing methods, compared to the framing arrangement of bridge case (K3). In continuous-span cases, the use of skewed bearing line cross-frames at the interior piers, with ample offsetting of the intermediate cross-frames from the bearing line, generally gives much lower cross-frames forces than the use of intermediate cross-frames framing into the bearing locations, as discussed previously. The use of skewed bearing lines cross-frames at the interior piers along with liberal offsetting of the intermediate cross-frames, as in bridge case (K2), is recommended.

If L_s/R is small and the skew is sharp in a continuous-span curved and skewed bridge, the structure tends to behave more like a straight skewed bridge. In this case, it can be beneficial to stagger the cross-frames near a skewed interior bearing line. It is recommended that cross-frames should always be used between the girders along the skewed bearing lines. Bridge cases (S) XICCS7 and T2 (EICCS27) are examples of this type of case.

Table 53. Average and maximum cross-frame forces under SDL and TDL for bridge cases (K2) and (K3) EICCS12. The (K2) and (K3) columns show the values for bridge cases (K2) and (K3), respectively.

Summary	**Load Condition**	**NLF (kip)**		**SDLF (kip)**		**TDLF (kip)**	
		(K2)	**(K3)**	**(K2)**	**(K3)**	**(K2)**	**(K3)**
Average	SDL	0.9	1.0	0.0	0.0	2.8	3.2
	TDL	3.5	4.2	2.7	3.2	1.1	1.1
Maximum	SDL	3.2	5.0	0.0	0.1	10.0	15.2
	TDL	13.7	20.5	10.6	15.4	3.4	3.5

3.5.3 Overall Cross-Frame Framing Arrangement for Straight Skewed Bridges

It is common practice to allow skewed intermediate cross-frames where the support lines are skewed by less than or equal to 20 degrees from normal. However, where the support lines are skewed more than 20 degrees from normal, AASHTO requires that the cross-frames be framed orthogonal to the girders. In this case, it may be advantageous to place the intermediate cross-frames oriented normal to the girders in discontinuous lines, to selectively remove certain cross-frames, and/or to stagger the cross-frames in adjacent bays between the girders, in such a manner that the transverse stiffness of the bridge is reduced. This is particularly important in the vicinity of skewed supports. Removal of highly stressed cross-frames, particularly in the vicinity of the obtuse corners of a span, interrupts and reduces the stiffness of the corresponding transverse load path by forcing load transfer via girder flange lateral bending. This practice is usually beneficial as long as the unbraced lengths between the cross-frame locations satisfy the flange resistance requirements of the design specifications.

The above practices tend to decrease the cross-frame forces and increase the girder flange lateral bending. However, in certain cases involving excessively stiff transverse load paths, the cross-frame forces may be decreased to the extent that the associated flange lateral bending stresses are also reduced. Where the flange sizes are increased due to the additional flange lateral bending, this increase often is not significant. In fact, the increased cost resulting from the increased flange sizes is often much less than the increased cost of providing a larger number of cross-frames as well as larger cross-frames and larger connections.

This research recommends framing of the cross-frames within straight skewed spans using arrangements such as those shown in Figure 24 (Bridge (J2)), Figure 25 (Bridge (K2), Figure 178 (a variation of Bridge (H2)), and Figure 179 (a variation of Bridge (M2)) to both dramatically reduce the number of cross-frames required within the bridge as well as to reduce the overall transverse stiffness effects.

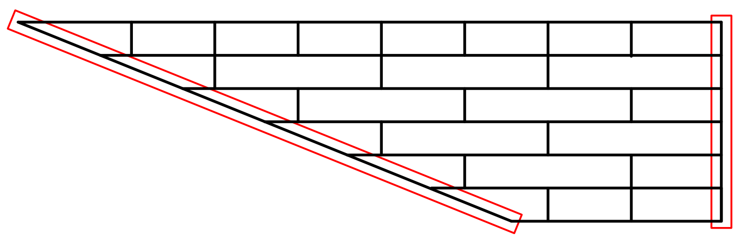


Figure 178. Beneficial Staggered Cross-Frame Framing Arrangement for a Straight Bridge with Non-Parallel Skew

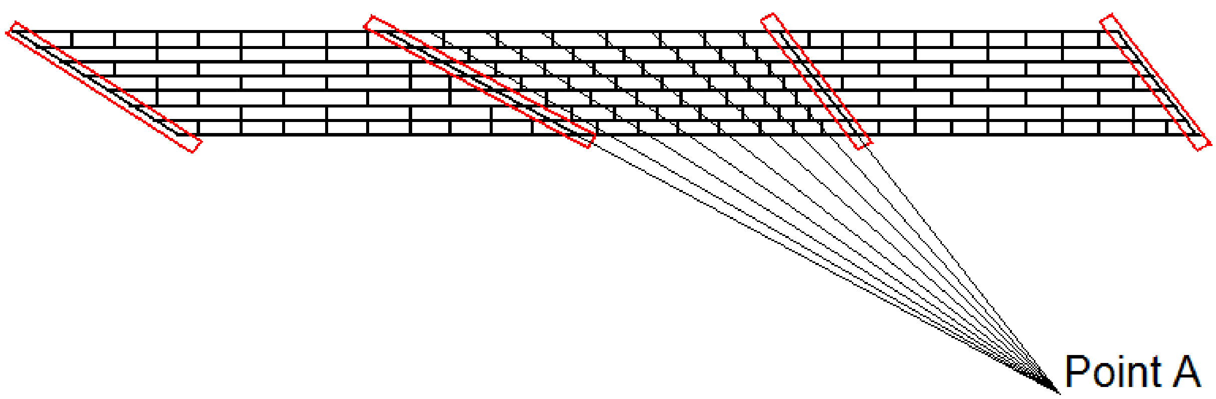


Figure 179. Additional alternative framing arrangement for bridge EISSS2.

The recommended practices, and their influence on the bridge responses, can be illustrated using Bridges (J1) (Figure 10 of Section 2.2.2) and Bridge (J2) (Figure 24 of Section 2.3.1). Bridge (J1) has a 300 ft span length, a 74 ft width between its fascia girders, and a 70° skew of its abutment bearing lines. Due to its long span and high skew index, this bridge is particularly sensitive to any variation in attributes that affect erection fit-up. In addition, Bridge (J1) NISSS54 has small stagger distances between its cross-frames and small offsets of the intermediate cross-frames from the skewed bearing lines, resulting in large nuisance transverse stiffness.

Sanchez (2011) showed that the cross-frame forces in straight skewed bridges can be reduced substantially by framing the intermediate cross-frames parallel to the skew, in parallel skew bridges, and by “fanning” the cross-frames between the skew angles of the bearing lines in non-parallel skew bridges. However, the extensive use of skewed intermediate cross-frames leads to various other problems, particularly when the skew angles are large. One simple variation on the scheme suggested by Sanchez is to place the cross-frames perpendicular to the girders in a staggered arrangement, but position a common “work point” on the different cross-frames parallel to the skew or fanned approximately between the skew angles at the ends of the span. Figure 24 of Section 2.3.1 provides a basic example of this approach using Bridge (J2) NISSS54. The particulars of this framing arrangement are as follows:

- The cross-frames adjacent to the skewed bearing lines are placed at the same offset distance relative to these lines, satisfying the offset recommendations in Section 3.5.1.
- The other intermediate cross-frames are placed at a constant spacing along the span length to satisfy the flange resistance requirements of the design specifications.
- In addition, every other cross-frame is intentionally omitted within the bays between the interior girders of the bridge plan. This relaxes the large transverse stiffness that would otherwise be developed in the short diagonal direction between the obtuse corners of the span.
- Furthermore, the smallest unbraced lengths or stagger distances between intermediate cross-frame locations within the bridge spans are larger than $4b_f$ and $0.4L_b$. The use of stagger distances smaller than $4b_f$ tends to result in the associated cross-frames working more like a contiguous cross-frame line rather than a discontinuous one.

Eleven intermediate cross-frames are attached between the fascia girders and the first interior girder on each side of the bridge. However, every other cross-frame is omitted within the interior of the bridge plan. This results in 30 fewer intermediate cross-frames than if all of the cross-frame lines were framed contiguously. However, since the cross-frames are staggered, there is no reduction in the unbraced length of the girders. The reduction of cross-frames is even greater, (a reduction of 42 cross-frames), compared to the staggered arrangement of Bridge (J1). The cross-frame framing arrangement of Bridge (J2) results in a substantial reduction in the large cross-frame forces as shown in Table 54.

Table 54. Average and maximum cross-frame forces under SDL and TDL for bridge cases (J1) and (J2) NISSS54. The (J1) and (J2) columns show the values for bridge cases (J1) and (J2), respectively.

Summary	**Load Condition**	**NLF (kip)**		**SDLF (kip)**		**TDLF (kip)**	
		(J1)	**(J2)**	**(J1)**	**(J2)**	**(J1)**	**(J2)**
Average	SDL	19.5	5.7	1.0	1.4	20.3	9.2
	TDL	42.9	13.5	22.5	7.7	2.0	3.4
Maximum	SDL	162.4	25.4	6.4	8.0	145.5	35.2
	TDL	354.0	58.5	181.9	31.2	8.8	18.1

Figure 178 shows a similar concept on a straight bridge with an extreme non-parallel skew. The original framing arrangement, Bridge (H1), is shown in Figure 8 of Section 2.2.2. The essential consideration, when intentionally omitting cross-frames between the interior girders, is that a cross-frame must be provided on at least one side of a girder at each location where a brace point is desired. In some situations, additional cross-frames may be retained to provide additional lateral stiffness for bracing or for other purposes; however, the alternating removal of the internal cross-frames is sufficient and is the preferred option in most cases. The framing arrangement in Figure 178 results in lower average cross-frame forces and maximum cross-frame forces compared to the framing arrangement of Bridge (H1).

Figure 25 of Section 2.3.1 shows an alternative beneficial framing concept on a straight bridge with a parallel skew. In Figure 25, the cross-frames adjacent to the bearing lines are all placed at the same offset distance relative to the skewed bearing lines, satisfying the above offset recommendations. The other intermediate cross-frames are placed at a constant spacing along the span length to satisfy the flange resistance requirements of the design specifications. In addition, the stagger distances between intermediate cross-frame locations within the bridge spans is set at a value greater than $4b_f$ and $0.4L_b$, This arrangement relaxes the large transverse stiffness that would otherwise be developed in the short diagonal direction between the obtuse corners of the spans. Additional discussion of this framing arrangement is provided in Section 3.5.4.

Figure 179 shows a continuous-span straight skewed I-girder bridge with different skew angles at the bearing lines. Within the end spans of this bridge, the normal cross-frames adjacent to the bearing lines are all placed at the same offset distance relative to the skewed bearing lines, satisfying the above offset recommendations, except that a number of these cross-frames are intentionally omitted. This is necessary to satisfy the offset recommendations in the right-hand end span, which has smaller parallel skew. In a few locations, two adjacent cross-frames are intentionally omitted, progressing along the length of the span within a given bay between the interior girders. A cross-frame is framed into every girder on at least one side at each location where a braced point is desired. Within the center span, where the bearing lines are non-parallel but both have significant skew, the cross-frames are arranged in a "fanned" pattern from one bearing line to the next. The lighter-weight lines, which pass through work points at the mid-length of the cross-frames in the center span, all intersect at Point A. This arrangement can be shown to be one of the best options to mitigate the transverse stiffness load paths in this type of span.

3.5.4 Comparison of Recommended Staggered Cross-Frame Arrangement to Lean-On Arrangement of Cross-Frames in Straight Skewed Bridges

The lean-on cross-frame system has been studied extensively in research on straight parallel skew bridges (Romage 2008; Zhou 2006). In this structural system, the diagonals are left out of a large number of the cross-frames. Only the top and bottom chords are installed, providing a load path to resist the torsional rotation of all the girders connected along contiguous cross-frame lines by one or only a few cross-frames on each line (Helwig and Yura 2012). This basically provides a "shear release," removing the restraint of the differential displacements between the girders throughout much of the bridge plan.

The NCHRP 20-07 Task 355 research studied Bridge (K1) EICSS12 (shown in Figure 11 of Section 2.2.2), which has a lean-on cross-frame system and has been studied extensively by Romage (2008). The cross-frames shown with an X on the plan have diagonals, whereas all the other intermediate cross-frames have only top and bottom chords. The following discussion summarizes a few key considerations in developing a lean-on cross-frame arrangement.

Along skewed bearing lines, cross-frames with diagonals are needed to transfer the lateral loads to the laterally restrained bearings. The cross-frame diagonals are removed at intermediate cross-frame locations having large differential vertical deflections. The remaining top and bottom chords do not develop any significant forces from girder relative vertical deflections. Cross-frames that contain diagonals are placed as far from the support as possible. It is critical that each cross-frame line has at least one cross-frame with diagonals to provide restraint of the girder torsional rotations along that line. There are no diagonals in the first cross-frame line connected to the fascia girders at the acute corners. Only top and bottom chords are needed at these locations since the short girder segments between the bearing line and these cross-frames are adequate to effectively brace the girders.

Along each girder pair, at least one cross-frame is needed for stability during the steel erection. To facilitate erection and increase stability, at least two cross-frames with diagonals are provided between each girder pair. It is best that each cross-frame line has a pair of cross-frames with diagonals (Zhou 2006). Zhou also recommends keeping the cross-frame lines contiguous and spreading the cross-frames with diagonals across the width of the bridge for both stability and constructability purposes. Some additional cross-frames with diagonals are provided to limit the differential vertical displacements between the girders.

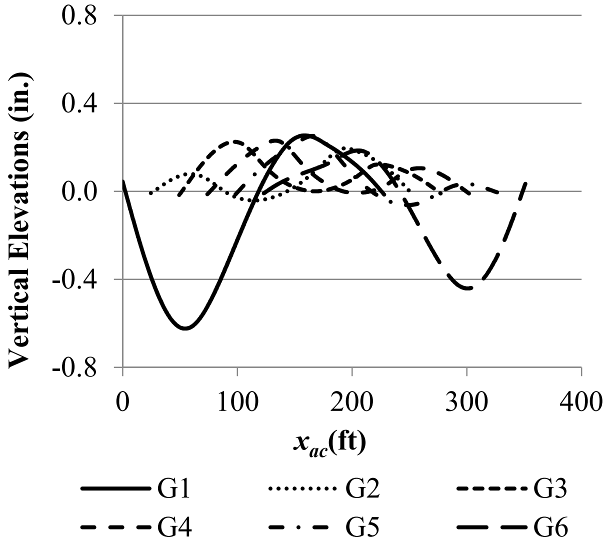
One attribute of the lean-on cross-frame system that may limit its usefulness in general is the fact that the bearing line cross-frames at skewed abutments impose a significant twist on the girders at their ends, due to the compatibility of the girder and cross-frame rotations at these locations. If contiguous cross-frame lines are framed into the girders close to these bearing locations, the cross-frame containing the diagonals still may provide substantial restraint of this twisting of the ends of the girders. The staggered cross-frame systems discussed in Section 3.5.3 soften the system "flexurally" by relying on the lateral bending stiffness of the girders between the cross-frame locations. The NCHRP 20-07 Task 355 research studied the efficacy of the "shear release" provided by the lean-on framing systems, as in Bridge (K1), versus the "flexural softening" of the system in the transverse direction via the staggered arrangement of the cross-frames, as in Bridge

(K2) (see Table 55). The staggered cross-frame arrangement in Bridge (K2) gives lower average and maximum cross-frame forces for all the three detailing methods than the framing arrangement of Bridge (K1). It is important to note that from Section 3.2.2, Bridge (K1) gives smaller erection fit-up forces than Bridge (K2). However, the difference in the fit-up forces is small.

Table 55. Average and maximum cross-frame forces under SDL and TDL for bridge cases (K1) and (K2) EICCS12.

Summary	**Load Condition**	**NLF (kip)**		**SDLF (kip)**		**TDLF (kip)**	
		(K1)	**(K2)**	**(K1)**	**(K2)**	**(K1)**	**(K2)**
Average	SDL	1.4	0.9	0.0	0.0	4.6	2.8
	TDL	6.0	3.5	4.6	2.7	1.5	1.1
Maximum	SDL	4.2	3.2	0.2	0.0	13.8	10.0
	TDL	17.7	13.7	13.6	10.6	4.1	3.4

A designer might be concerned that the shear release provided by the lean-on framing arrangement could allow excessive differential vertical deflections between the girders, resulting in large deviations in the final elevations. In fact, this is one of the design considerations discussed by Zhou (2006). From Figure 180, with SDLF detailing, the maximum deviations in the final elevations are 0.61 inches and 0.54 inches for bridge cases (K1) and (K2), respectively. (The variable x_{ac} in the plots is the position along the length of the bridge relative to the bearing at the acute corner at the starting end of the bridge.) The differences in the deviations of the final elevations are negligible between bridge cases (K1) and (K2). The girder elevations of straight skewed bridges are discussed in detail in Sections 3.4.6 through 3.4.9. It can be concluded that the lean-on and the recommended staggered cross-frame framing systems are comparable in terms of achieving the desired results of mitigating nuisance transverse stiffness effects while providing lateral bracing and some degree of interconnection to the girders.



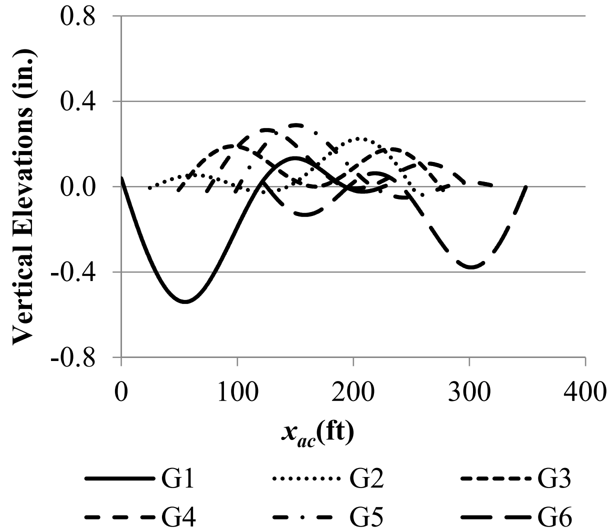


Figure 180. Final vertical elevations with SDLF detailing, based on LGA cambers, of bridge cases (K1) (left) and (K2) (right) EICSS12.

3.5.5 Contiguous Cross-Frames within the Main Portion of the Span in Curved and Skewed Bridges

For curved and skewed spans, omitting cross-frames in the vicinity of skewed bearing lines, can help to alleviate uplift at critical bearing locations; however, this is typically at the expense of larger cross-frame forces and larger bridge deflections compared to the use of contiguous intermediate cross-frame lines with the recommended offset provided at the skewed bearing lines. Contiguous cross-frame lines are necessary within the span of curved I-girder bridges to develop the width of the bridge structural system for resistance of the overall torsional effects. As such, the use of discontinuous cross-frame lines near a skewed bearing line in these bridge types involves competing considerations. Cross-frames can be omitted to alleviate uplift considerations at certain bearings, and potentially to relieve excessive cross-frame forces due to transverse stiffness effects in certain cases; for instance, if the horizontal curvature is relatively small and the skew is significant. However, removal of too many cross-frames may result in a larger than desired increase in the cross-frame forces and bridge system deflections due to the horizontal curvature effects when the bridge is significantly curved.

_Table 56 illustrates the above competing considerations by showing various responses for bridge cases (O1) NISCS15 (staggered framing arrangement) and (O2) NISCS15 (contiguous framing arrangement).

Table 56. Comparisons of various bridge responses under SDL and TDL conditions with NLF detailing for bridge cases (O1) (staggered framing arrangement) and (O2) NISCS15 (contiguous framing arrangement).

Summary	Load Condition	Bridge (O1) NISCS15 (Staggered CFs)	Bridge (O2) NISCS15 (Contiguous CFs)
Maximum Layovers (in.)	SDL	0.9	0.6
	TDL	2.0	1.3
Maximum Vertical Disp. (in.)	SDL	-5.1	-4.3
	TDL	-11.1	-9.4
Average CF Forces (kip)	SDL	32.3	30.6
	TDL	67.6	63.3
Tie-Down Forces (kip)	SDL	11	3
	TDL	52	77
f_ℓ **(ksi)**	SDL	9.5	8.6
	TDL	12.8	7.3

3.6 Influence of Erection Schemes

As the spans become larger, the curvature becomes tighter, and/or the skews become sharper, determining an effective erection scheme is critical to ensure that a curved and/or skewed bridge is constructible and the maximum fit-up forces are maintained in a reasonable range. In some cases, site constraints such as a waterway (Bridge (E) EICCR11), and availability, capacity, and allowed erection duration and location of cranes and shoring towers, can dictate the erection schemes.

3.6.1 Miscellaneous Erection Considerations

Girder field sections can be lifted during the erection of the steel using various schemes including:

(1) Lifting solely at the center of gravity of the field section,

(2) Lifting the field section at two locations, but with crane cables attached directly, and

(3) Lifting the field section at two locations separated by a spreader beam.

These schemes are illustrated in Figure 181, adapted from Davidson (1996), and are discussed further below:

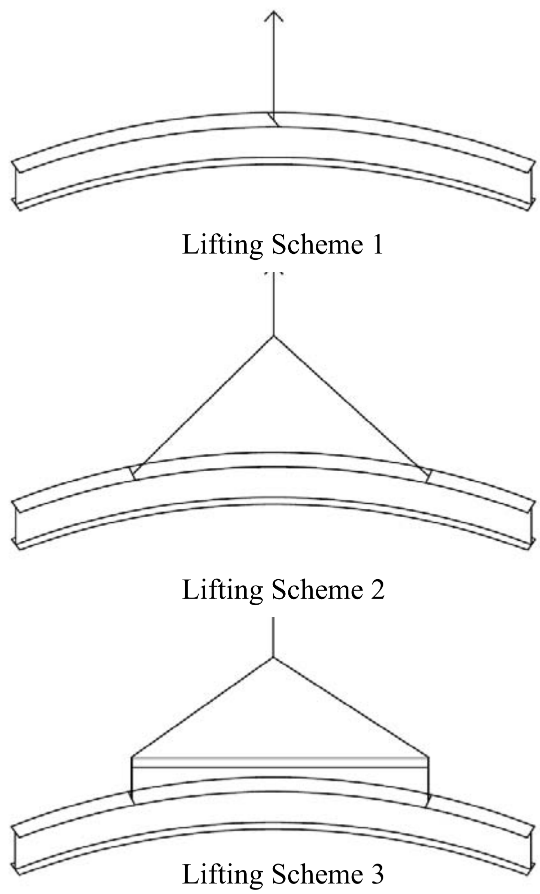


Figure 181. Various lifting schemes of girder field sections, adapted from Davidson (1996).

- Lifting Scheme 1 tends to allow curved girder field sections to roll excessively.
- Lifting Scheme 2 induces axial forces in the girder due to the inclined cables. In addition, with Scheme 2, additional minor- and major-axis bending is induced in the curved girder field section.

- Lifting Scheme 3 is used as the main method of lifting girder field sections in the NCHRP 20-07 Task 355 research. The lifting locations should be located at approximately 0.25 of the field section length from the ends of the field section for straight girders. For curved girders, the lifting points are determined using the UT-Lift software (Ferguson Laboratory 2014) to ensure stability and minimize the girder torsional rotations. For most of the curved bridge cases analyzed in this research, the lifting points are between 0.20L and 0.25L. For a number of cases, the girder field sections are too long and heavy for a single lifting crane. In these cases, two lifting cranes with cables attached directly to the lifting points are used for moderately long field sections, and two lifting cranes with spreader beams are used for significantly long field sections.

It is important to recognize the following mechanics of the lifting crane and spreader beam behavior:

- The girder pick points are "hung" from the ends of the spreader beam.
- The assembly involving the spreader beam and the diagonal cables works essentially as a rigid pin-connected truss as long as the cables are in tension. If the cables go into compression, they go slack and the assembly does not provide any restraint to the bridge.
- The triangular cable and spreader beam assembly is restrained vertically at its top, but is free to move laterally in any direction at all of its joints.
- The vertical forces transmitted to the field section at the ends of the spreader beam must be equal. This is because equilibrium must be maintained between the vertical loads transmitted to the triangular assembly at the ends of the spreader beam and the single total vertical crane reaction applied at the top of the triangular assembly. The pick points on the field section are free to move vertically relative to one another to obtain this balance of the forces.
- The average elevation of the hold points at the ends of the spreader beams is controlled by the specified elevation at the top of the triangular assembly. Although it is possible that the physical crane may pull laterally on this assembly by a minor amount, these actions are assumed to be negligible in the NCHRP 20-07 Task 355 research.

Often, a holding crane is needed during the early stages of steel erection to reduce deflections, ensure stability, and facilitate the fit-up of girders and cross-frames, especially in curved bridges. The following are considerations regarding holding cranes:

- The holding crane is typically attached near the middle of the span.
- For curved bridges, the holding crane should be placed on the girder at the outside of the curve of the partial or full bridge cross-section.
- In bridges with tight curvature, the holding crane may need to be retained on the outside girder until multiple girders of the bridge cross-section have been installed.
- When the erection is from the inside to the outside of the curve, the holding crane should be placed on the outer-most girder adjacent to the girder that is being installed.

Shoring towers are often needed in the construction of long-span bridges and curved bridges. Multiple field splices may be required within longer spans. Shoring towers help limit deflections and facilitate the installation of field splices and cross-frames. The shoring towers should be used across the full width of the bridge cross-section where practicable to best facilitate the erection. The number of shoring towers and cranes is selected generally to provide for a feasible, safe, and economical erection. Furthermore, tie-downs typically are provided for the girders at the shoring tower locations and/or the permanent supports to ensure girder stability before and after the splices are made within the spans.

The elevations of holding cranes, lifting cranes, and shoring towers need to be specified for the evaluation of an erection scheme. When the pick points on the girders displace upward, the cables can go slack and therefore not provide any restraint to the bridge. In addition, one should note that the lifting and holding cranes do not provide lateral restraint to the girders. When the contact points at temporary or permanent supports displace upwards, the shoring towers and/or permanent supports do not provide any support to the girder unless tie-downs are provided.

The critical stages for fit-up often are stages that have the highest differential deflections between the girders. This is largely because high differential deflections are indicative of the potential for development of large internal forces between the girders, either in the final constructed geometry or during the erection of the steel. Fit-up potentially can be the most difficult for the last girders installed in the bridge cross-section, and for drop-in segments installed in continuous spans.

3.6.2 Influence of Erection Schemes in Curved Radially-Supported Bridges

For curved bridges, cranes and/or temporary supports are critical for stabilizing the partially completed systems, as well as for erecting the girders and cross-frames. Individual curved girders and narrow partially-erected curved bridge units have little stability on their own. The bridge cross-section generally over-rotates until all of its girders are installed.

For most of the curved radially-supported bridges studied in this research, the bridges are erected from the outside to the inside of the curve. This is for the following reasons:

- The girder on the inside of the curve on the portion of the bridge cross-section that has been completed deflects less than the outside girder.
- The girder that is being installed is supported by a lifting crane, and thus its deflections are typically small.
- Erecting from the outside to the inside of the curve requires smaller fit-up forces due to the smaller differential displacements between the inside girder and the girder being installed.
- Erecting from the outside to the inside of the curve, if possible, avoids the need to lift the outside girder on the partially completed bridge cross-section to achieve fit-up with the next girder being installed on the outside of the curve, which is typically the case when the bridge is erected from the inside to the outside of the curve.
- For highly curved bridges such as most of the curved bridges considered in this study, the crane and temporary support requirements for erection from the inside to the outside of the curve can be significantly greater than for erection from the outside to the inside of the curve.

In many cases, when a bridge is highly curved, a holding crane will be required on the girder on the outside of the curve until a number of the girders in the bridge cross-section have been installed. The erection schemes employed in this research install the bearing line cross-frames immediately after the girder is placed on its supports, to help provide torsional stability to the girder. Then the remaining intermediate cross-frames are sequentially installed.

Figure 182 shows a representative erection scheme for Bridge (A) EISCR1, proceeding from the outside to the inside of the curve. The bold lines indicate the girders and cross-frames that are already installed at a given stage. The triangles show the locations of the crane holding or lifting points. Where one symbol is shown on a girder, that point is a pick point for the holding crane. Where two symbols are shown on a girder, these points are the pick points for the lifting crane. These points are attached to the ends of a spreader beam in the erection schemes employed in this research. The stages and sub-stages are designated by the stage number followed by a dash and the sub-stage number. The stage number corresponds to the installation of a field section and cross-frames that connect the field section to the adjacent portion of the bridge that is already erected. The sub-stage number indicates the order of the cross-frame that is being installed within a stage. For example, Stage 2-3 indicates Sub-stage 3 of stage 2. Stage 2-3 involves the installation of the third cross-frame from the left bearing line between Girder 1 (G1) and Girder 2 (G2).

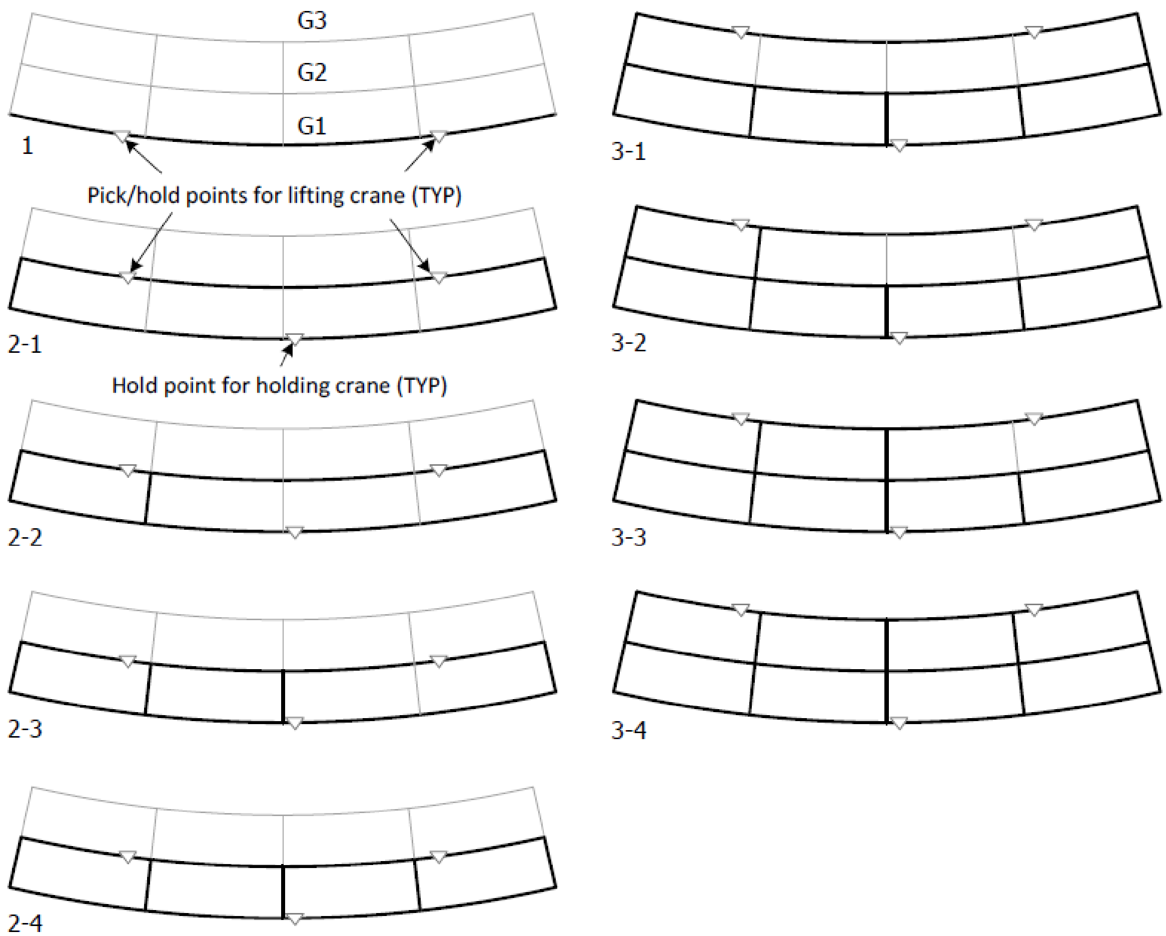


Figure 182. Bridge (A) EISCR1 erection scheme, from the outside to the inside

3.6.2.1 Influence of Manipulation of Temporary Support Elevations by the Erector

This section discusses the influence of the manipulation of temporary support elevations in curved radially-supported bridges by presenting the calculated results for the critical (maximum) external fit-up forces for Bridge (A) EISCR1. As discussed in Section 3.2, the cross-frame fit-up forces are defined as the local forces that need to be developed at the top and bottom chord cross-frame connections to the latest girder that is being installed into the bridge. From Figure 182, this is Girder G2 for Stage 2 and this is Girder G3 for Stage 3 on Bridge (A) EISCR1. It is assumed that the cross-frames are first attached to the adjacent girder in the partially-completed bridge, and then the cross-frame connections are made successively to the "latest" girder. Since V-type cross-frames are used in Bridge (A) EISCR1, it is assumed that the top-chord connection corresponding to the cross-frame diagonal is made first, and that this is followed by the connection to the bottom chord.

The fit-up forces can be sensitive to the holding elevations of the holding and lifting cranes, particularly in curved bridges. In addition, there are various nonlinear effects that impact the fit-up forces, i.e., boundary or contact/noncontact nonlinearities, crane cables going slack, etc. It is recommended that the crane holding elevations can be varied relative to the base NL girder elevations as a starting point, to minimize the fit-up forces. In the study below, it is desired to calculate the minimum fit-up force as a function of the crane holding elevations corresponding to the installation of each of the cross-frames, and then to determine the maximum value of these minimum cross-frame fit-up forces throughout the overall erection sequence.

Table 57 lists the various elevations considered for the holding and lifting cranes for the erection of Bridge (A) EISCR1, as well as the critical sub-stage in each of the main stages 2 and 3 of its erection sequence. Actually, a number of additional crane holding elevations were studied; however, only the ones shown in Table 57 are presented to simplify the discussions.

Table 57. Bridge (A) EISCR1 erection critical sub-stages

Crane Elevation Designation	**Holding Elevations**	**Stage**	
		2	**3**
A	Holding Crane: NL; Lifting Crane: NL	2-3	3-3
B	Holding Crane: SDL; Lifting Crane: SDL	2-3	3-3
C	Holding Crane: NL; Lifting Crane: NL + 40 % *	2-3	3-3
D	Holding Crane: NL; Lifting Crane: NL + 80 %	2-3	3-3
E	Holding Crane: NL; Lifting Crane: NL – 40 %	2-3	3-3
F	Holding Crane: NL; Lifting Crane: NL + 160 %	2-3	3-3

* The % values indicate the percentage of the SDL camber displacement at the hold points.

Sub-stage 3 is the critical stage, requiring the largest fit-up forces for both of the main stages and for all of the crane holding elevations in Bridge (A) EISCR1, regardless of the detailing method. One can observe that this sub-stage corresponds to the installation of the cross-frame at the mid-span of the bridge. This finding is certainly logical, since the largest differential displacements between the girders tend to occur at the mid-span in Bridge (A) EISCR1.

Table 58 shows the vertical and horizontal components of the calculated fit-up forces for the critical Sub-stage 3 for each of the cross-frame detailing methods and for each of the most important combinations of holding and lifting crane holding elevations considered in this work. The most important points from Table 58 are as follows:

- The sub-stages are further designated as 2-3A, 2-3B, 3-3A and 3-3B to distinguish between the forces for each of the sub-stages of the connection of the critical cross-frame to the girders.
- Sub-stages A and B are the first and second connections between the cross-frames and the girders. The forces labeled as V1 and H1 in the table are the forces in the first connection between the cross-frame and the "latest" girder at the top chord of the critical cross-frame. The forces labeled as V2 and H2 are the forces in the second connection between the cross-frame and the "latest" girder at the bottom chord of the critical cross-frame.
- It should be noted that the cells marked as "NA" in the table for the Sub-stages 2-3A and 3-3A correspond to the state where the second connection has not yet been made. Therefore, the forces V2 and H2 are in fact zero at this state or sub-stage.
- Furthermore, it should be noted that the forces V1 and H1 for Sub-stages 2-3B and 3-3B are strictly *not* actual external fit-up forces. For these sub-stages, V1 and H1 are simply the internal connection forces developed at the top chord of the cross-frame when the bottom chord connection is made.
- The forces shown in Table 58 are the forces applied from the cross-frame to the girder that is being installed. Therefore, if the vertical force is positive, the cross-frame is having to push up on the girder to make the connection. Hence, if the lifting crane elevation is raised in this case, the vertical connection force will tend to be reduced. Conversely, if the vertical force is negative, the cross-frame is having to push down on the girder to make the connection. Hence, if the lifting crane elevation is lowered, the vertical connection force will tend to be reduced in this case.

Table 59 parallels Table 58, but shows just the single vector force resultants of V1 and H1, and V2 and H2, at the cross-frame connections to the girder that is being installed into the bridge. These resultants are designated as F1 and F2. For each row in Table 59, corresponding to a given cross-frame detailing method and a particular critical sub-stage, it is assumed that the crane operator(s) would vary the crane holding elevations to minimize the vertical component of the fit-up force (shown as V1 and V2 in Table 58). This would be achieved in the field during the erection essentially by the crane operator following the directions of the iron workers to raise or lower the holding points to aid them in aligning the holes for the connection of the cross-frame to the "latest" girder that is being installed.

The resulting minimum fit-up force resultants F1 and F2 for each row of Table 59 are listed in Table 60. For instance, corresponding to Sub-stage 2-3A and NLF detailing, the minimum fit-up force is obtained by positioning the holding and lifting crane elevations both at the NL elevation of the girders. This results in a minimum fit-up force F1 of 0.4 kip. However, for Sub-stage 2-3A and SDLF detailing, the minimum fit-up force F1 (equal to 1.1 kip) is obtained by positioning the holding crane at the NL elevation, but raising the lifting crane hold location by 160 % of the SDL camber. As indicated by the comments in the right-most column of Table 60, Girder G2 is lifted off of both its supports at this sub-stage. In addition, one can observe from Table 58 that V1 has become slightly negative and the fit-up force is dominated by the horizontal components H1 when the lifting crane is raised to this elevation. Therefore, F1 = 1.1 kip is a reasonable estimate of the minimum possible fit-up force for SDLF detailing at this critical sub-stage.

It should be noted that the elevations of the holding points of the lifting crane are varied in the above by varying the elevation at the top of the lifting crane triangular assembly of the crane cables and the spreader beam. This in effect varies the average elevation of the hold points at the ends of the spreader beam. The actual elevations of these hold points are not equal to one another; these elevations "adjust" to the deflections of the bridge system such that the forces in the two inclined cables remain the same.

Table 58. Bridge (A) EISCR1 critical fit-up forces applied to the girder being installed (kip).

Sub-Stage	Detailing Method	Holding Elevations											
		Crane Elevation A				Crane Elevation B				Crane Elevation C			
		V1	H1	V2	H2	V1	H1	V2	H2	V1	H1	V2	H2
2-3A	NLF	-0.2	0.4	--	--	6.5	0.3	--	--	-0.7	0.5	--	--
	SDLF	2.3	0.9	--	--	8.5	0.7	--	--	1.7	0.9	--	--
	TDLF	9.8	2.7	--	--	14.5	1.9	--	--	9.1	2.4	--	--
2-3B	NLF	0.4	1.7	-0.0	-1.8	6.8	1.6	-0.1	-1.7	-0.2	2	-0.0	-2
	SDLF	5.2	7.2	1.2	-7.3	10.5	5.3	1.1	-5.4	4.1	5.9	1.2	-6
	TDLF	18.5	21.8	5.0	-21.7	21.8	16.7	5.0	-16.6	18.5	21.8	5	-21.7
3-3A	NLF	-2.8	0.3	--	--	4.9	-0.1	--	--	-3.3	0.3	--	--
	SDLF	0.3	0.6	--	--	6.6	0.4	--	--	-0.2	0.6	--	--
	TDLF	9.9	1.5	--	--	10.3	1.4	--	--	9.2	1.5	--	--
3-3B	NLF	-2.4	2.3	-0.0	-2.3	4.7	-0.2	-0.1	0.2	-3	1.9	-0.0	-1.9
	SDLF	2.3	6.6	1.0	-6.6	8.2	4.7	1.0	-4.8	1.6	6.0	1.1	-6.0
	TDLF	15	18.7	4.2	-18.6	15.9	17.3	4.2	-17.2	15	18.7	4.2	-18.6

Notes:

(1) Sub-stage "A" = first connection of cross-frame and girder
(2) Sub-stage "B" = second connection of cross-frame and girder
(3) For crane elevation definition, see Table 57
(4) V1, H1 = vertical and horizontal components of the forces in the first connection, or internal connection forces developed at the location of the first connection when the second connection is made.
(5) V2, H2 = vertical and horizontal components of the forces in the second connection
(6) Cells marked with "--" correspond to the state where the second connection has not yet been made

Table 58 (Continued). Bridge (A) EISCR1 critical fit-up forces applied to the girder being installed (kip).

Sub-Stage	**Detailing Method**	**Holding Elevations**											
		Crane Elevation D				**Crane Elevation E**				**Crane Elevation F**			
		V1	**H1**	**V2**	**H2**	**V1**	**H1**	**V2**	**H2**	**V1**	**H1**	**V2**	**H2**
2-3A	NLF	-1.3	0.5	--	--	0.6	0.7	--	--	-2.5	0.6	--	--
	SDLF	1.1	1.0	--	--	3.1	1.3	--	--	-0.1	1.1	--	--
	TDLF	8.5	2.4	--	--	10.2	2.9	--	--	7.3	2.5	--	--
2-3B	NLF	-0.7	2.3	-0.0	-2.3	1.9	4.2	-0.1	-4.3	-1.7	2.8	0.0	-2.8
	SDLF	3.6	6.2	1.2	-6.2	6.8	9.8	1.1	-9.9	2.6	6.7	1.2	-6.8
	TDLF	17.0	19.2	5.0	-19.1	18.5	21.8	5.0	-21.7	15.7	19.0	5.1	-18.9
3-3A	NLF	-3.5	0.3	--	--	-2.3	0.4	--	--	-3.7	0.3	--	--
	SDLF	-0.8	0.5	--	--	0.9	0.7	--	--	-1.2	0.5	--	--
	TDLF	8.6	1.4	--	--	9.9	1.5	--	--	7.4	1.3	--	--
3-3B	NLF	-3.3	1.8	0.1	-1.7	-1.8	2.7	0.0	-2.7	-3.5	1.9	0.1	-1.9
	SDLF	0.9	5.6	1.1	-5.6	3.0	7.1	1.1	-7.1	0.1	5.2	1.1	-5.1
	TDLF	15	18.7	4.2	-18.6	15.0	18.7	4.2	-18.6	13.8	17.8	4.2	-17.7

Table 59. Bridge (A) EISCR1 critical fit-up force resultants applied to the girder being installed (kip).

Stage	Detailing Method	Holding Elevations											
		Crane Elevation A		Crane Elevation B		Crane Elevation C		Crane Elevation D		Crane Elevation E		Crane Elevation F	
		F1	**F2**	**F1**	**F2**	**F1**	**F2**	**F1**	**F2**	**F1**	**F2**	**F1**	**F2**
2-3A	NLF	0.4	--	6.5	--	0.9	--	1.4	--	0.9	--	2.6	--
	SDLF	2.5	--	8.5	--	1.9	--	1.5	--	3.4	--	1.1	--
	TDLF	10.2	--	14.6	--	9.4	--	8.8	--	10.6	--	7.7	--
2-3B	NLF	1.7	1.8	7.0	1.7	2.0	2.0	2.4	2.3	4.6	4.3	3.3	2.8
	SDLF	8.9	7.4	11.8	5.5	7.2	6.1	7.2	6.3	11.9	10.0	7.2	6.9
	TDLF	28.6	22.3	27.5	17.3	28.6	22.3	25.6	19.7	28.6	22.3	24.6	19.6
3-3A	NLF	2.8	--	4.9	--	3.3	--	3.5	--	2.3	--	3.7	--
	SDLF	0.7	--	6.6	--	0.6	--	0.9	--	1.1	--	1.3	--
	TDLF	10.0	--	10.4	--	9.3	--	8.7	--	10.0	--	7.5	--
3-3B	NLF	3.3	2.3	4.7	0.2	3.6	1.9	3.8	1.7	3.2	2.7	4.0	1.9
	SDLF	7.0	6.7	9.5	4.9	6.2	6.1	5.7	5.7	7.7	7.2	5.2	5.2
	TDLF	24.0	19.1	23.5	17.7	24.0	19.1	24.0	19.1	24.0	19.1	22.5	18.2

Table 60. Bridge (A) EISCR1 critical fit-up force resultants applied to the girder being installed (kip).

Stage	Detailing Method	Minimum Fit-Up Forces as a Function of the Crane Elevations		Comments on Configuration Pertaining to the Minimum Fit-Up Force
		F1	F2	
2-3A	NLF	0.4	--	Lift-off at G2 supports
	SDLF	1.1	--	Lift-off at G2 supports
	TDLF	7.7	--	Lift-off at G2 supports
2-3B	NLF	--	1.7	Slack cables on lifting crane (G2)
	SDLF	--	5.5	Slack cables on lifting crane (G2)
	TDLF	--	17.3	Slack cables on lifting crane (G2)
3-3A	NLF	2.3	--	Lift-off at G3 supports
	SDLF	0.6	--	Lift-off at G3 supports
	TDLF	7.5	--	Slack cables on lifting crane (G3)
3-3B	NLF	--	0.2	No slack cables or lift-off
	SDLF	--	4.9	Slack cables on lifting crane (G3) and on holding crane (G1)
	TDLF	--	17.7	

For Sub-stage 2-3A and TDLF detailing, the minimum fit-up force resultant shown in Table 60 is again obtained when the holding crane hold point is located at the NL girder elevation on G1 and the average lifting crane hold elevations are located at 160 % of the SDL Camber above the NL girder elevation on G3. Actually, for this case, it is possible that the fit-up force resultant can be reduced further by increasing the average elevation of the lifting crane hold points by an additional amount. By inspecting Table 58, one can ascertain that the force V1 is still positive, equal to 7.3 kip, and that this force still dominates the connection force resultant at Sub-stage 2-3A, for TDLF detailing. However, Girder G2 is already lifted substantially off of its supports by this operation, and the subsequent evaluations of F2 indicate significantly larger fit-up forces for TDLF detailing than the resultant for F1 = 7.7 kip shown in Table 60 for Sub-stage 2-3A and TDLF detailing.

The largest of the minimum fit-up forces F2, for SDLF detailing, is obtained as 5.5 kip in Sub-Stage 2-3B. For TDLF detailing, the largest of the minimum fit-up forces F2 is obtained as 17.7 kip in Sub-Stage 3-3B. In both cases, these minimum forces are obtained by lowering both the holding crane as well as the lifting crane to the girder SDL elevations. The corresponding required fit-up forces at the other critical Sub-stages 3-3B and 2-3B for these cases are only slightly smaller. Also, these force resultants are dominated by the horizontal components H2, and therefore, the overall fit-up force resultant is effectively minimized in terms of the holding crane elevations in these cases.

The largest overall of the above minimum fit-up force resultants, as a function of the crane holding elevations are summarized in Table 61. One can observe that the NLF, SDLF, and TDLF maximum fit-up forces are 3.3, 7.4, and 22.3 kip, respectively, for the case of the NL holding elevations. By iteratively considering the holding and lifting cranes at various positions, the maximum fit-up forces are reduced to 2.3, 5.5, and 17.7 kip for NLF, SDLF, and TDLF detailing, respectively. One can observe that these changes are reasonably small in magnitude, for this bridge; however, they are certainly measurable and a potentially significant percentage of the fit-up forces.

Table 61. Bridge (A) EISCR1 largest overall of the minimum fit-up force resultants F_{max} as a function of the crane position (kip) and maximum fit-up force resultants $F_{no\text{-}load}$ with the crane at NL elevations (kip).

Detailing Method	**F1**	**F2**	F_{max}	$F_{no\text{-}load}$
NLF	2.3	1.7	2.3	3.3
SDLF	1.1	5.5	5.5	7.4
TDLF	7.7	17.7	17.7	22.3

Although the erector will often make minor elevation adjustments in the field to facilitate fit-up, iteratively adjusting the crane and shoring elevations to minimize the calculated fit-up forces was not feasible within the scope of this research. This sort of practice certainly would not be feasible as part of any ordinary erection engineering calculations either.

The fit-up forces on the other curved radially-supported bridge cases investigated in this research are conducted with the crane and shoring tower supports all placed at the NL elevations. The NL elevations always serve as a useful starting point for the selection of crane or shoring tower support elevations for curved radially-supported bridges (straight skewed bridges are different, as discussed subsequently). The fit-up forces in curved radially-supported bridges generally can be reduced somewhat by manipulating the elevations upward and/or downward from these positions; however, performing any sort of engineering calculations to estimate the impact of "jimmying" the various support elevations around generally would be cost prohibitive.

3.6.2.2 Influence of Erection from the Inside to the Outside of the Curve

Depending on a number of factors such as site constraints, erectors may decide to erect from the inside to the outside of the curve. Bridge (B) NISCR2 Erection Scheme 2A (see Figure 38 in Section 3.2.1) is an example of this type of erection. The fit-up forces for all three detailing methods are prohibitive as explained below:

- The partially-completed bridge cross-section over-rotates.
- As the next girder is installed on the outside of the curve, it is held by the lifting crane basically at its NL elevation. The girder being installed is adjacent to the outside girder on the partially-completed bridge cross-section. The vertical deflections in the girder on the outside of the curve in the partially-completed bridge cross-section are relatively large, causing high differential vertical displacements between this girder and the girder that is being installed. These large displacements lead to high cross-frame fit-up forces.

The large cross-frame fit-up forces shown for Erection Scheme 2A in Table 3 of Section 3.2.1 (84.4 kip for NLF, 82.5 kip for SDLF, and 80.2 kip for TDLF) indicate that this is not a feasible erection scheme. It is necessary to add additional vertical support on the outside girder of the partially completed bridge cross-section, to reduce its vertical deflections. One cannot resolve the vertical displacement incompatibility by effectively lifting the partially-completed bridge via the local equipment that is intended only to install the cross-frames. Erection Scheme 2B satisfies this requirement by placing an additional holding crane on the outside girder of the partially completed bridge cross-section.

The additional holding crane for Erection Scheme 2B adds cost to the erection but reduces the fit-up forces for all the detailing methods. The NLF and TDLF fit-up forces for Erection Scheme 2B are reduced to 40.4 kip and 50.5 kip, respectively, which are close to the 40 kip threshold where fit-up is considered to be difficult.

Interestingly, the SDLF fit-up force for Erection Scheme 2B is only 19.4 kip, which is below the 40 kip threshold. This is the only case of the curved radially-supported bridges studied, other than Erection Scheme 2A of this bridge, in which the maximum fit-up forces are smaller for SDLF than for NLF. The reason for this behavior is that the displacement incompatibility between the cross-frames and their connection points on the girder being installed happens to be smaller for SDLF detailing, given the configuration of the geometry and the support points at the critical stage.

3.6.3 Influence of Erection Schemes in Straight Skewed Bridges

The potential fit-up considerations for straight skewed bridges are somewhat different than those discussed above for curved radially-supported bridges. A number of considerations for straight skewed simply-supported spans are as follows:

- For short straight skewed simply-supported spans that do not require a field splice within the span, and therefore would rarely require shoring towers, the cross-frames can be installed sequentially from one abutment to the other after each girder is lifted onto its vertical supports.
- Tie downs can be provided at the supports as necessary to maintain lateral-torsional stability of the girders.
- For longer spans that require a field splice within the span (because the field sections otherwise become too heavy), and often may require shoring towers, it is best to install only a few cross-frames or struts before the field splice is made, and to install the remaining cross-frames after the field splice is completed. The intent is to install the majority of the cross-frames after all the girders have been erected, so that the girders are deflected close to their SDL elevation profiles. For SDLF detailing, the cross-frames are detailed to fit ideally to the final girder SDL profiles, and therefore, allowing the girders to deflect to a position close to this profile should clearly facilitate fit-up.
- If any temporary supports are still being employed when the cross-frames are being installed, positioning the temporary supports at the final girder SDL elevations is often a good starting point to alleviate potential large fit-up forces.
- Typically, cranes are only used to lift the girders into place and are not critical to the erection of straight skewed bridges constructed in the above ways. This is in contrast to the curved bridge cases discussed in Section 3.6.2.

- When the cross-frames are detailed for SDLF, their installation using the above type of erection scheme tends to result in the lowest level of fit-up forces.

For continuous-span straight skewed bridges, the erection schemes with the greatest ease of fit-up are typically similar to those for the simply-supported bridges described above. However, it is impractical for the erector to install each girder in all the spans, one at a time throughout the bridge length, to achieve the girder SDL elevation profiles. The erector would have to move back and forth along the entire bridge length to do this. Instead, all the girders are typically erected in each span before moving to the next span. In these bridge types, a good option is to:

- Install only a minimal number of cross-frames to keep the bridge stable until all the girders are erected.
- Once all the girders in all spans have been erected, install the remaining cross-frames span-by-span.

This scheme limits the crane movement along the length of the bridge while keeping the bridge stable and the SDLF fit-up forces relatively small. In addition, this procedure also appears to provide the best option to mitigate large fit-up forces in straight skewed bridges detailed for TDLF detailing. However, for longer spans with sharp skew, the largest fit-up forces associated with TDLF can be problematic in some cases.

Figure 183 shows a representative erection scheme for the straight skewed Bridge (J1) NISSS54 at its Stage 3. The stage designation follows the scheme discussed in Section 3.6.2. Due to the bridge's 300 ft. span, a shoring tower is needed to facilitate the splice connection from Stage 3-1 to Stage 3-4. The shoring tower support is only on the girder that is being installed, and is shown by the square symbol within the span in the plan view. Only the end cross-frames and a few top and bottom flange struts are installed between the girders during these stages. After Stage 3-3, the shoring tower is removed and the remaining cross-frames are installed sequentially.

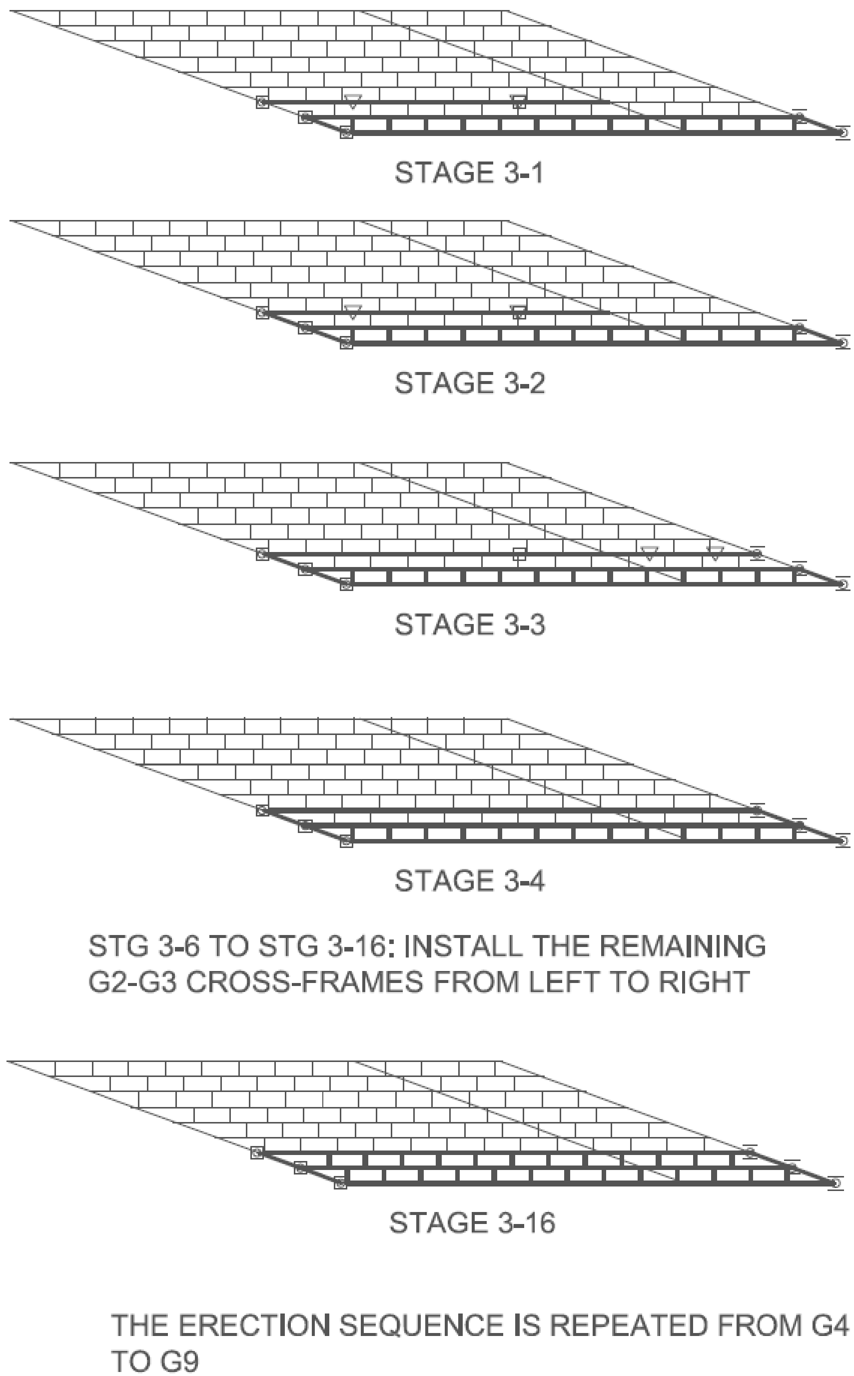


Figure 183. Bridge (J1) NISSS54 erection scheme of stage 3.

3.6.4 Influence of Erection Schemes in Curved and Skewed Bridges

For the curved and skewed bridges studied in this research, the holding crane, lifting crane and shoring tower elevations are located at the no-load elevations. As discussed in Section 3.6.2.1, the fit-up forces in curved bridges can be reduced by varying the crane and shoring tower elevations from the no-load elevations. However, it is shown that the reduction in fit-up forces is relatively small. Also, iteratively adjusting the crane and shoring tower elevations to minimize the fit-up forces is not practical in general erection engineering practice. In addition, it was concluded that this was not feasible within the scope of this research. With that said, in some cases, it can be very beneficial for the steel erection personnel to install cross-frames at positions where the deflected geometries are reasonably compatible, and for the crane operator to incrementally raise or lower a girder that is being installed after successive insertions of cross-frames, to in effect "button up" the cross-frames between the girder that is being installed and the structural steel that is already in place.

From the studies of multiple erection schemes on Bridge (O1) and (O2) NISCS15 (see Figures 50 and 51 of Section 3.2.3) with the maximum fit-up forces as shown in Table 5 of Section 3.2.3, as well as the studies of the erection schemes of the other curved and skewed bridge cases, one can conclude the following:

- When shoring towers are employed, generally it is preferable that they span across the full bridge cross-section to limit the overall deflections in extreme curved and skewed cases.
- Among many other factors, the number of shoring towers required to facilitate fit-up in highly curved and skewed bridges is a function of the span length and the number of field sections and number of spans.
- For continuous-span cases, when erecting the subsequent spans, leaving the shoring towers in place through the erection of subsequent spans helps to reduce the overall deflections, which can facilitate fit-up.
- Similar to the recommended practice for curved radially-supported bridges, the erection scheme for curved and skewed bridges should also be from the outside to inside on tightly curved bridges, whenever practicable, to reduce the maximum fit-up forces.
- The cross-frames ideally should be installed sequentially from the radial bearing line (if there is a radial bearing line) to the skewed bearing line. Installing the cross-frames in this

way reduces the deflection incompatibilities when installing the cross-frames near the skewed end of the span.

3.7 Detailed Evaluation of Straight Skewed Bridge Responses Associated with the Use of LGA versus 3D FEA Camber

It is common for girder camber profiles to be calculated from a 1D Line Girder Analysis (LGA) for some bridges, 2D Grid analysis for others, and in some cases from a 3D Finite Element Analysis (FEA). For a highly skewed I-girder bridge, the differences in the cambers obtained from LGA versus the other two methods can be substantial. An engineer may rightfully question whether these camber differences can have a significant influence on the intended fit behavior. This section addresses the influence of these differences and explains the mechanics behind the findings.

Bridge (J2) NISSS54 is used to demonstrate the influence of camber calculations in straight skewed bridges. This bridge has a 300 ft simple span, nine girders spaced at 9.25 ft, and an 80 ft wide deck. Both bearing lines are skewed at 70 degrees. Due to its severe skew, relatively wide deck, and long span length, this bridge is one of several straight skewed bridges with the greatest potential for fit-up difficulty considered in this research. The fascia and interior girders are identical. All the girder webs are 12 ft deep and 1 inches thick. The girder flange thicknesses are stepped at four locations.

To simplify the discussion, only cambers based on LGA and 3D FEA are discussed in this section. The cambers calculated from a 2D Grid analysis are practically the same as those calculated from 3D FEA if the 2D Grid analysis employs the improvements recommended by NCHRP Report 725 for I-girder bridges. The detailed procedures for the 3D FEA and LGA calculations conducted in this section are outlined in Section 2.6. It is important to note that the concrete deck weight is modeled on the noncomposite I-girders as distributed line loads applied at the centerlines of the top flanges. This weight is calculated based on the tributary widths between the girders and from the deck overhangs.

Table 62 shows the girder plate lengths and the girder flange dimensions for Bridge (J2) NISSS54. The intermediate cross-frames are X-type, framed perpendicular to the girders and with L6x6x1 sections used for all their members. The end cross-frames at the abutments are inverted V-type and utilize WT6x53 sections for their chords and WT9x38 sections for their diagonals. The intermediate cross-frames are placed in a staggered pattern with work points positioned along the same angle as the bearing lines. The framing arrangement of Bridge (J2) NISSS54, as discussed in Section 3.5.3, mitigates the effects of nuisance transverse stiffness associated with the bridge's severe skew.

Table 62. Bridge (J2) NISSS54 girder plate lengths and girder flange dimensions.

Length (ft)	**Top flange**		**Bottom flange**	
	Width (in.)	**Thickness (in.)**	**Width (in.)**	**Thickness (in.)**
45	28	1.25	30	1.25
45	28	2	30	2.25
120	28	2	30	2.75
45	28	2	30	2.25
45	28	1.25	30	1.25

3.7.1 SDLF Behavior using Line Girder Analysis Cambers

The practice of SDLF detailing using the cambers obtained from a Line Girder Analysis (LGA) theoretically gives exactly plumb girder webs, zero cross-frame forces, and zero flange lateral bending stresses under the targeted DL, in this case SDL. This fact is explained below by two hypothetical erection sequences.

3.7.1.1 Hypothetical Erection Sequence 1

In straight skewed bridges, the girders deflect only vertically under their self-weight and the self-weight of the cross-frames, as long as the cross-frames are not connected to the girders in a manner such that they are engaged and can transfer internal shears and moments. Therefore, if all the girders are theoretically placed on their vertical supports, just the top chords of all the cross-frames are attached to the girders (such that there is no shear and moment transfer via the cross-frames), and the girders are allowed to deflect under the full steel self-weight, the resulting girder vertical deflections are exactly equal to the SDL deflections obtained from a LGA.

If the SDL cambers are set based on the above deflections, and the cross-frames are then detailed for SDLF using these cambers, then the cross-frames will fit exactly to the girders in the above SDL geometry. In other words, for the structure in the above hypothetical deflected geometry under the steel self-weight, the cross-frame connections match up perfectly with the corresponding positions on the girders. Therefore, the connections to the girders can be completed without any forcing. These statements apply to all straight I-girder bridges with either parallel skew or non-parallel skew. However, they do not apply to curved I-girder bridges.

All the cross-frames are assumed inactive and the girders deflect only in the plane of their webs in a LGA. The girders deflect independently of each other under the dead loads in this analysis. Figure 184 shows the girder vertical deflections due to SDL in the Bridge (J2) NISSS54 bridge, calculated by LGA. The variable x_{ac} in the plots is the position along the length of the bridge relative to the bearing at the acute corner at the starting end of the bridge. The SDL and TDL camber profiles on the engineering drawings are taken simply as the inverse of the vertical deflections under SDL or TDL, respectively.

One can observe that all the girder vertical deflections are nearly identical in Figure 184. This is because the girders are all of the same size and length, such that the SDL is the same for all the interior girders. The SDL applied to the fascia girders is only slightly less since the cross-frames connect to only one side of the fascia girders. The cross-frame weights, applied as concentrated nodal loads to the fascia girders, are one-half of those applied to the interior girders.

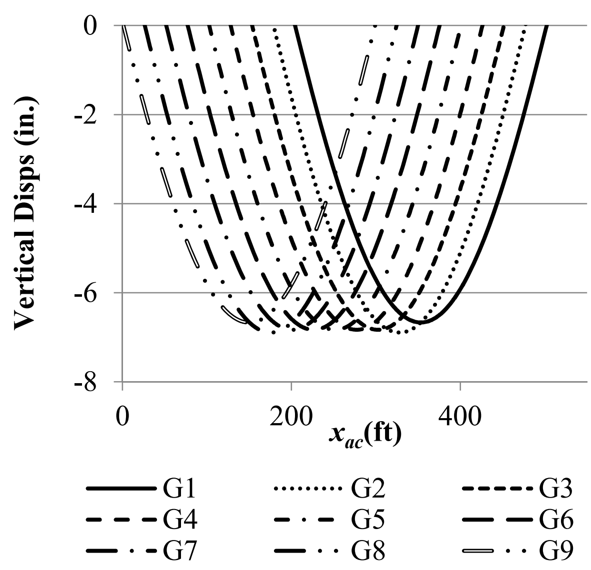


Figure 184. Bridge (J2) NISSS54 girder vertical displacements due to SDL calculated by LGA.

Table 63 shows the maximum girder layovers, the maximum cross-frame stresses, and the maximum flange lateral bending stresses for NISSS54 under SDL, including SDLF effects based on the LGA cambers. The girder layovers and internal stresses closely match the theoretical ideal zero values. The reason for the minor deviation from zero is because the secondary bending actions induced by the connections of inverted-V cross-frames at the skewed bearing lines are not accounted for in the process of detailing the cross-frames. Another reason is the intermediate connection plates. They are not placed symmetrically along the web of each girder due to the staggered cross-frame pattern. Because of the weight and stiffness of the connection plates, the girder lateral deflections under self-weight, before the cross-frames are connected to the girders, are very slightly non-zero.

Table 63. Bridge (J2) NISSS54 maximum responses (girder layovers and twists, cross-frame (CF) stresses, and flange lateral bending stresses (f_ℓ)) under SDL, including SDLF effects based on LGA cambers

Layover (in.)	**Twist (rad)x10^{-3}**	**CF stress (ksi)**	**f_ℓ (ksi)**
0.077	0.53	0.46	0.46

Due to stability considerations, Bridge (J2) NISSS54 would not be erected in the hypothetical fashion explained above, where all the girders are allowed to deflect under the full steel self-weight without any cross-frame connections. It would be erected in stages (such as the stages shown in Figure 183) in which individual girders or girder pairs would be placed and the cross-frames would be connected to the erected girders successively after each of the girder lines or girder pairs are placed. However, based on common engineering analysis assumptions discussed below, the final bridge responses in the completed bridge system under the SDL are independent of the specific erection sequence.

Once the cross-frames are connected to the girders, the interconnected girders deflect as a three-dimensional system under subsequent dead loads. The cross-frames brace the girders, but they also serve as an additional transverse load path in the system. As a result, the girders deflect vertically and simultaneously twist under the subsequent dead loads. This behavior of straight skewed bridges is different from the behavior of a straight bridge with zero skew. In a straight bridge with zero skew, the girders deflect predominantly only in a vertical fashion. This is because there are no significant differential deflections between the girders and there is no interaction between the girders and the displacements of the bearing line cross-frames. However, in a straight skewed bridge, such as (J2) NISSS54, there are substantial non-zero differential deflections between the girders at each of the cross-frames, since the cross-frames connect to different positions within the span of each of the girders. In addition, to maintain compatibility between the cross-frames and the girders along the skewed abutment bearing lines, the girders have to twist substantially at the skewed abutments.

3.7.1.2 Behavior Independent of Erection Sequence

Regardless of the sequence in which the bridge is erected, if the SDL cambers are calculated from LGA, and the cross-frames are detailed for SDLF using these cambers, the girder layovers and internal stresses in the completed bridge system under the SDL are theoretically equal to the above ideal values. This is because, as long as:

(1) All the bridge components are kept elastic,

(2) The influence of the girder splice and cross-frame-to-girder connection tolerances is assumed to be negligible, and

(3) There are no effects such as friction providing unintended restraint at the supports,

the bridge is what is referred to in structural mechanics as a conservative elastic structural system. Within these limits, the response of the structure for any given erection stage is independent of the erection sequence up to that point. In mechanics terms, the behavior at any hypothetical erection stage is unique and path independent.

3.7.1.3 Hypothetical Erection Sequence 2

To further understand the fit behavior based on the use of girder LGA cambers, the Bridge (J2) NISSS54 responses can be examined assuming that all the cross-frames are connected to the girders first, before the dead loads are applied to the bridge, and then the SDL is “turned on.” For SDLF detailing, the cross-frames are fabricated to fit to the girder connection work points in a conceptual geometry in which the girders are plumb when the girders are subjected to their SDL deflections. As such, the cross-frames do not fit up with the girders in the reference no-load geometry. This initial lack-of-fit between the cross-frames and the girders in the reference no-load geometry induces girder layovers (i.e., relative lateral displacements of the top and bottom flanges) in the opposite direction from the layovers due to the SDL when the girders and the cross-frames are hypothetically connected together under zero load. These SDLF detailing effects on the girder layovers are shown in Figure 185. Similarly, the SDLF detailing effects cause girder flange lateral bending stresses as shown in Figure 186.

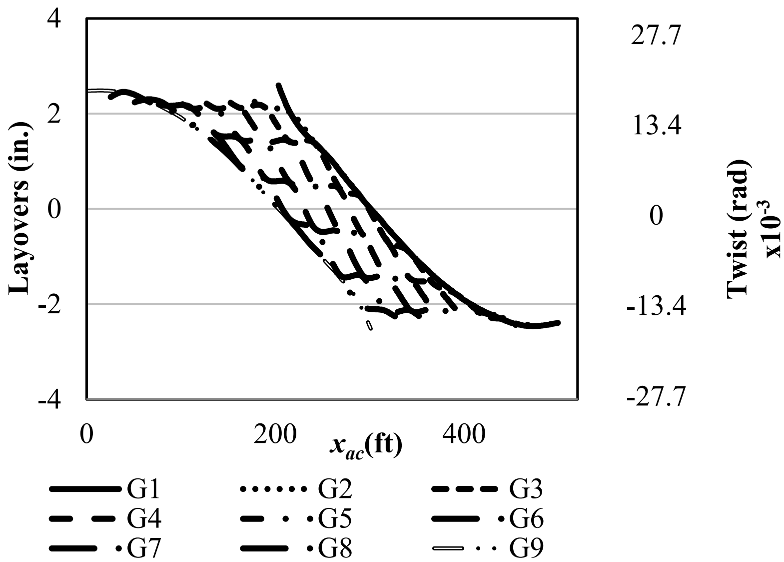


Figure 185. Bridge (J2) NISSS54 girder layovers and twists due to SDLF detailing effects based on LGA cambers.

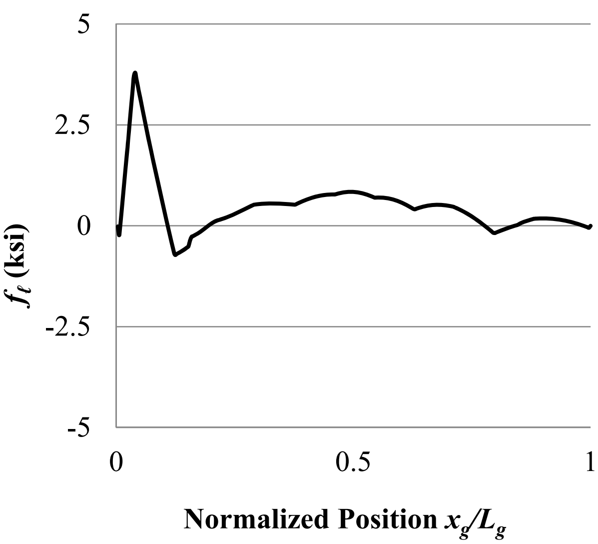


Figure 186. Bridge (J2) G1 top flange lateral bending stresses due to SDLF detailing effects based on LGA cambers.

When the SDL is subsequently applied to the bridge in the above conceptual scenario, the girders deflect vertically and twist under the application of the SDL to the three-dimensional structural system, as discussed above. Figures 187 and 188 show the girder layovers and flange lateral bending stresses, respectively, due to the SDL. The girder layovers and flange lateral stresses due to the SDL (not including the SDLF detailing effects) are substantial. This is due to the compatibility between the girders and the heavily skewed bearing line cross-frames as well as the differential deflections between the girders within the span.

One can observe that the layovers in Figure 185 due to the SDLF locked-in forces based on the LGA cambers, are approximately equal in magnitude and opposite in direction to the layovers in Figure 187 due to the SDL. That is, these two sets of layovers effectively cancel one another. As such, the girder flanges are essentially straight in the final SDL condition as shown in Figure 189 (the layover shown in this figure is the summation of those from Figures 185 and 187). Since the girder flanges are essentially straight, their lateral bending is approximately zero in the final SDL condition as shown in Figure 190 (which is the summation of Figures 186 and 188). Furthermore, since the girder flange lateral bending is effectively zero, the cross-frame forces are all essentially zero under the SDL condition as well.

In addition, the SDLF detailing effects based on LGA cambers cause significant girder vertical displacements as shown in Figure 191. Figure 192 shows the NISSS54 girder vertical deflections due to SDL when the bridge deflects as a system. The vertical deflections are much smaller near the center of the bridge width in the three-dimensional structural system. This is due to the substantial transverse load path between the obtuse corners of the bridge, developed via the cross-frames. Figure 193 shows the SDL girder elevations under the SDL. These elevations are equal to the summation of:

- The negative of the LGA vertical displacements (Figure 184),
- The vertical displacements due to SDLF detailing effects based on LGA cambers (Figure 191), and
- The vertical displacements due to SDL when the bridge deflects as a system (Figure 192).

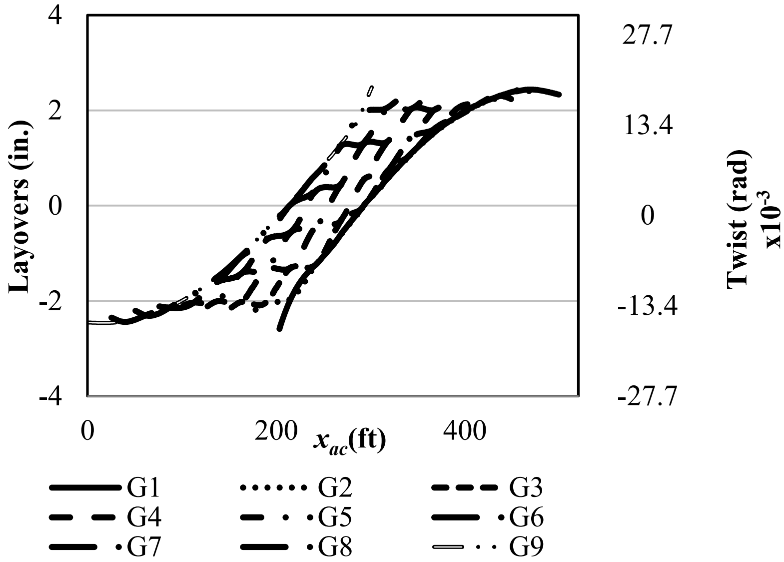


Figure 187. Bridge (J2) NISSS54 girder layovers and twists within the three-dimensional structural system due to SDL (i.e., due to "turning the SDL on" in the 3D model of the bridge).

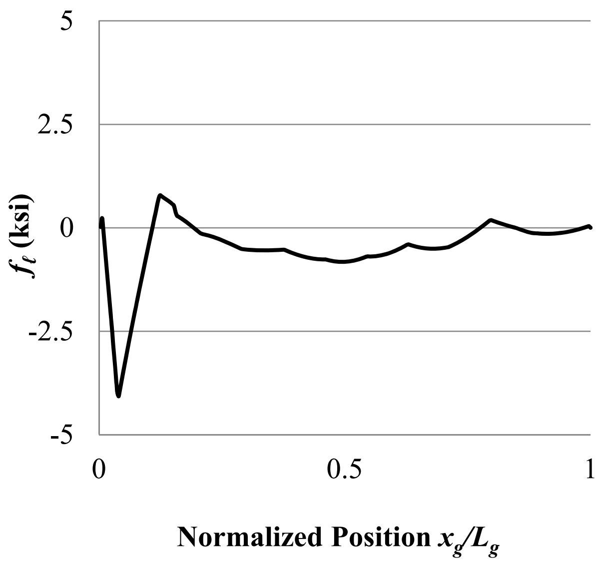


Figure 188. Bridge (J2) G1 top flange lateral bending stresses within the three-dimensional system due to SDL (i.e., due to "turning the SDL on" in the 3D model of the bridge).

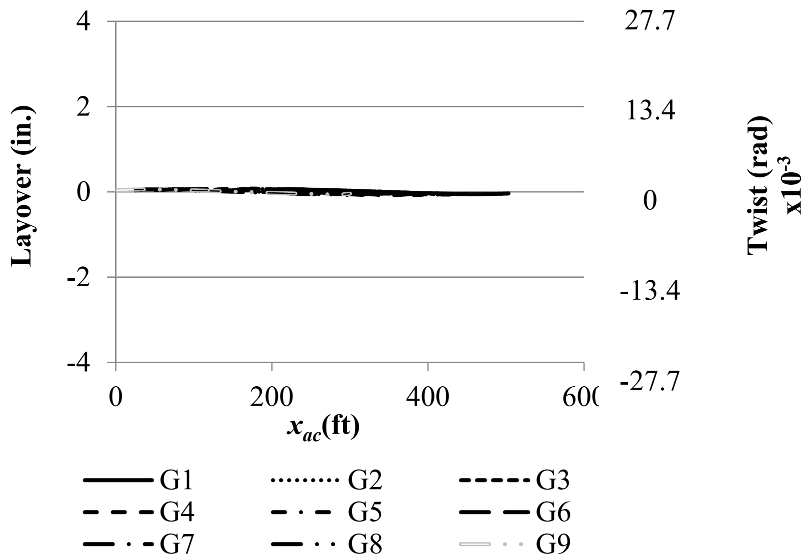


Figure 189. Bridge (J2) NISSS54 girder layovers and twists under SDL including SDLF detailing effects based on LGA cambers.

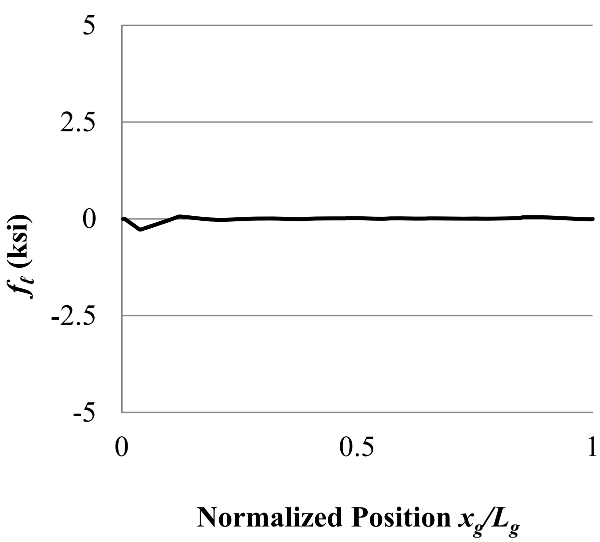


Figure 190. Bridge (J2) G1 top flange lateral bending stresses due to SDL including SDLF effects based on LGA cambers.

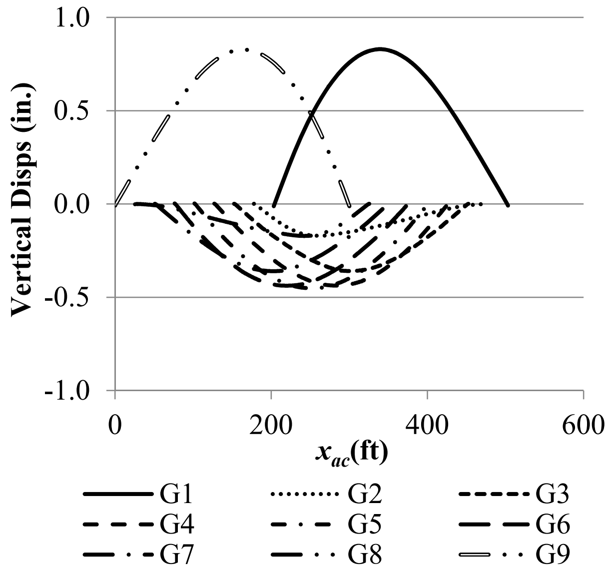


Figure 191. Bridge (J2) girder displacements due to the SDLF detailing effects based on the LGA cambers.

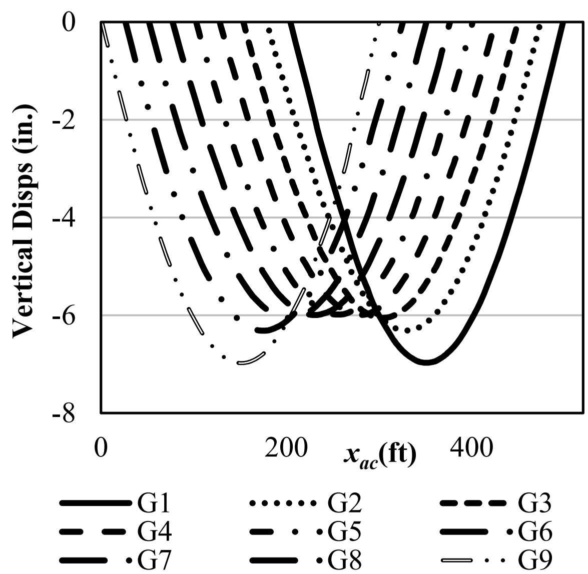


Figure 192. Bridge (J2) NISSS54 girder vertical displacements due to SDL when the bridge deflects as a three-dimensional system.

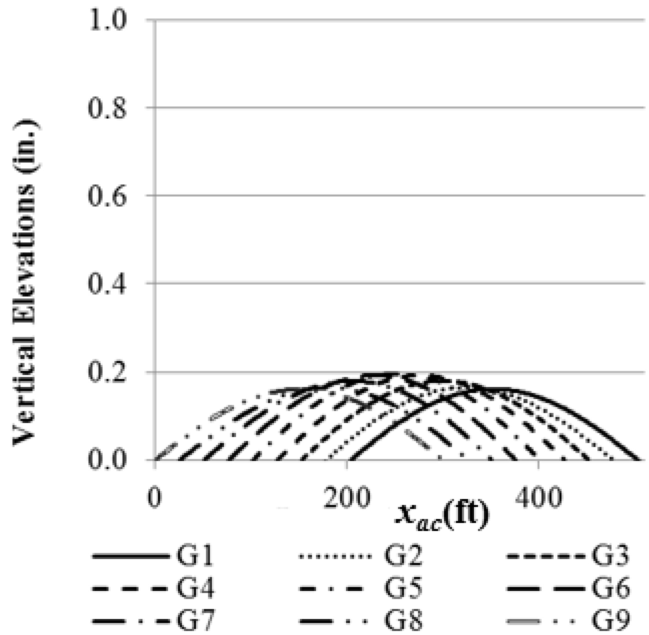


Figure 193. Bridge (J2) girder elevations under SDL for SDLF detailing based on the LGA cambers.

As explained in Section 3.7.1.1, when the detailing is SDLF based on LGA cambers, the girder elevations, girder layovers, and flange lateral bending stresses are theoretically zero under SDL condition. However, the solutions shown in Figures 189, 190 and 193 are slightly non-zero. This is due to the incidental effects discussed in Section 3.7.1.1. It should also be noted that due to the additional vertical displacements due to SDLF detailing effects, the girder elevations are approximately zero despite the large differences between the SDL LGA cambers and the vertical displacements due to SDL. With the exception of the above small incidental effects, the SDLF detailing based on the LGA cambers actually imposes the LGA vertical displacements on the girders in the targeted SDL condition.

Figures 194 and 195 show the major-axis bending stresses due to SDLF detailing effects based on LGA cambers and due to SDL acting on the three-dimensional bridge system, respectively. Since the vertical displacements caused by SDLF detailing effects are substantial (Figure 191), the corresponding impact on the major-axis bending stresses is also significant. Figure 196 (which is the summation of Figures 194 and 195) shows major-axis bending stresses under SDL including the SDLF detailing effects. The SDLF detailing based on the LGA cambers actually imposes the LGA major-axis bending stresses on the girders in the targeted SDL condition.

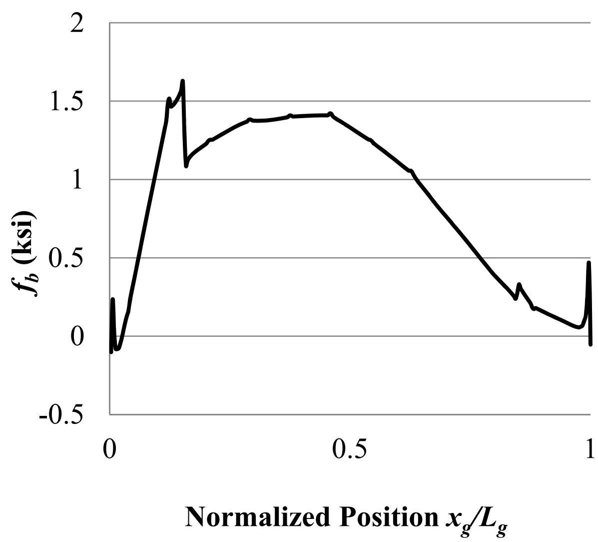


Figure 194. Bridge (J2) G1 top flange major-axis bending stresses due to SDLF detailing effects based on LGA cambers.

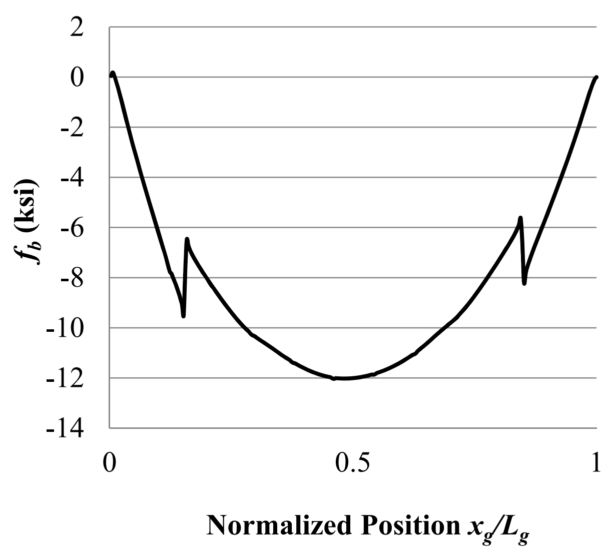


Figure 195. Bridge (J2) G1 top flange major-axis bending stresses due to SDL when the bridge deflects as a three-dimensional system.

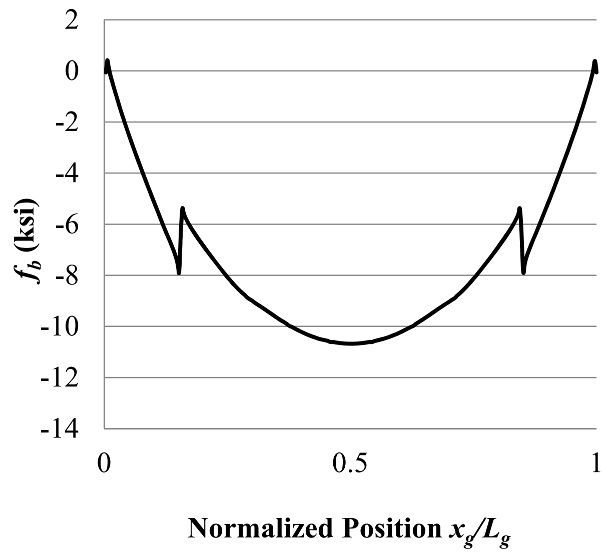


Figure 196. Bridge (J2) G1 top flange major-axis bending stresses under the SDL including the SDLF effects based on LGA cambers (effectively equal to the girder LGA major-axis bending stresses).

3.7.1.4 Summary

One can view the above behavior as a beneficial effect of lack-of-fit between the cross-frames and the girders in the reference no-load bridge geometry. The lack-of-fit effects cancel the SDL effects, theoretically resulting in plumb girders, zero lateral bending, zero girder deviations from target elevations, and zero cross-frame forces in the SDL condition. That is, the lack-of-fit effects impose the LGA responses on the girders within the targeted SDL condition demonstrated here. Alternatively, one can consider the simpler hypothetical Erection Sequence 1, in which the cross-frames fit to the girders in their ideal SDL deflected geometry without any forcing, if the girders and cross-frames are all placed first without engaging the cross-frames in resisting any internal forces. Both idealized sequences, or any other erection sequence, produce the same result, since under the previously stated assumptions, the bridge is a conservative elastic structural system.

3.7.2 SDLF Behavior using 3D FEA Cambers

The common current structural practice, when using 2D Grid or 3D FEA, is to build a model of the structure and then simply "turn the gravity load on." This practice captures the behavior of the bridge if the cross-frames could be fully connected to all the girders, in a no-load (e.g., a shored) condition, without any forcing (i.e., cross-frames detailed for NLF), followed by removal of the shoring. This practice does not account for the actual behavior of the bridge if the girders and cross-frames could be placed first and allowed to deflect under the steel self-weight, followed by connection of the cross-frames fabricated for SDLF to the girders in their SDL condition without any forcing. Furthermore, it does not account for any other erection scenario with detailing of the cross-frames for anything other than NLF. In fact, one should recall that given the previously stated assumptions, the bridge is a conservative elastic structural system; hence, the erection sequence does not influence the completed state of the bridge. However, the fit method, for instance SDLF versus NLF, certainly does influence the response. Also, the SDL deflections assumed in setting the cambers definitely influence the completed state of the bridge.

For the parallel skew Bridge (J2) NISSS54, the differences in the cambers obtained from LGA (negative of the vertical displacements Figure 184) versus 3D FEA (negative of vertical displacements in Figure 192) are substantial. When the cross-frames are detailed for SDLF based on 3D FEA cambers, due to beneficial lack-of-fit effects generated by the cross-frame detailing, the girders tend to be close to plumb, and the cross-frame forces and girder flange lateral bending stresses will be relatively small. However, these quantities generally differ from the targeted ideal zero values. This fact is explained further in the following discussions.

In the context of a conceptual model in which the cross-frames are connected to the girders first, including the SDLF detailing effects, and then the SDL is subsequently applied (recall that the sequencing of these steps has no influence on the final result since the response is path independent within the limits of the previously stated assumptions), SDLF detailing based on the 3D FEA cambers induces the layovers in the girders shown in Figure 197. These layovers are in the opposite direction from those due to the SDL, which are shown in Figure 187. However, these layovers are not exactly equal to the negative of the layovers caused by the SDL.

Figure 198 demonstrates this point by showing the final layover of the girders under the SDL, when SDLF based on the 3D FEA cambers is used. The maximum girder layover in this case is 0.26 inches. These results show that, for practical engineering purposes, these 12 ft. deep girder webs can be considered plumb. However, strictly speaking, they are not exactly plumb.

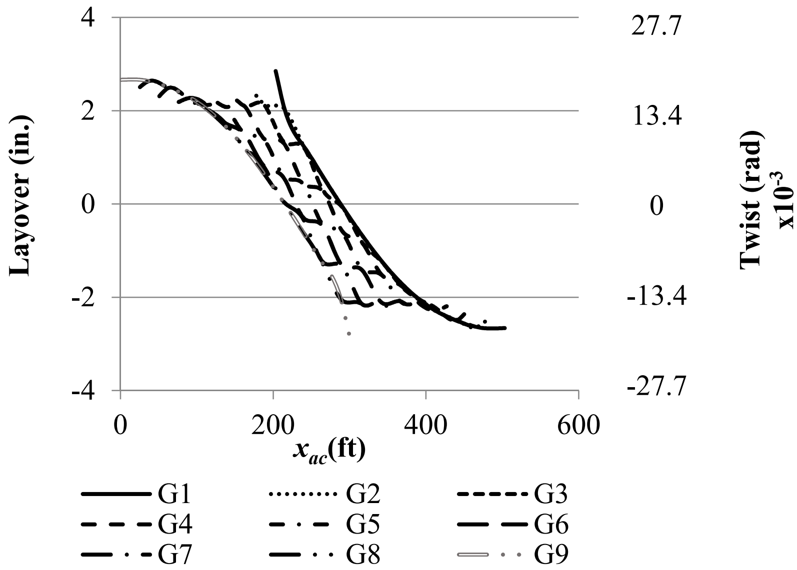


Figure 197. Bridge (J2) NISSS54 girder layovers and twists due to SDLF detailing effects based on 3D FEA cambers.

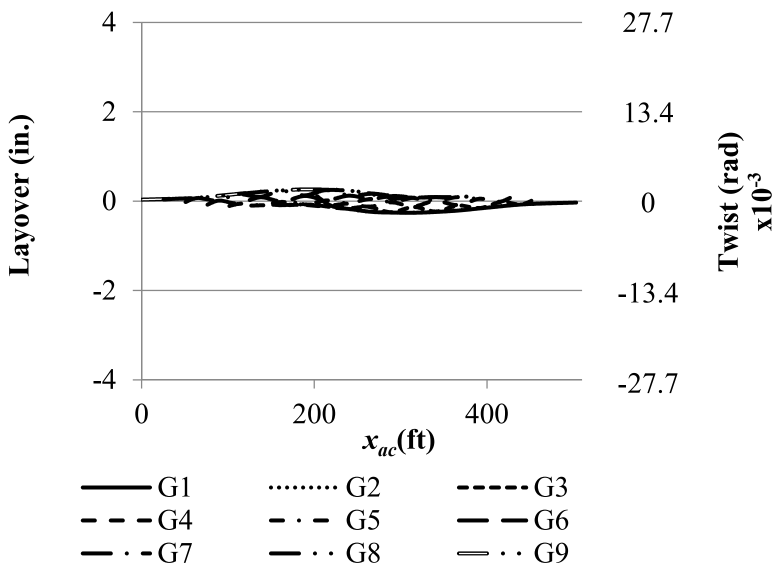


Figure 198. Bridge (J2) NISSS54 girder layovers and twists under SDL including the effects of SDLF detailing based on the 3D FEA cambers.

Since the girders are not exactly plumb under SDL, for SDLF based on the 3D FEA cambers, the associated cross-frame axial forces and girder flange lateral bending stresses are not exactly zero either. However, these stresses are relatively small (e.g., the maximum cross-frame axial stress magnitude is 2.81 ksi). Figure 199 shows the flange lateral bending stresses due to SDLF detailing effects based on 3D FEA cambers. Theses stresses are slightly larger than those induced by SDLF detailing effects based on LGA cambers (Figure 186). Figure 200 shows the flange lateral bending stresses under SDL including SDLF detailing effects based on 3D FEA cambers. These stresses are the sum of the stresses in Figures 188 and 199. It can be seen that theses stresses are close to zero, but they are slightly larger those under SDL including SDLF detailing effects based on LGA cambers (Figure 190).

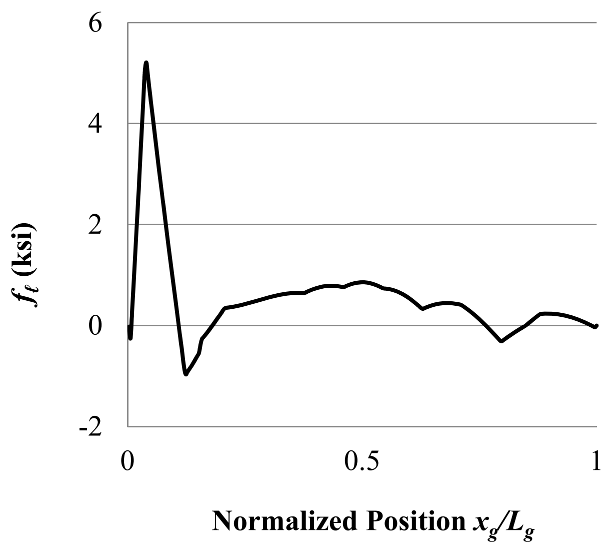


Figure 199. Bridge (J2) G1 top flange lateral bending stress due to SDLF detailing effects based on 3D FEA cambers.

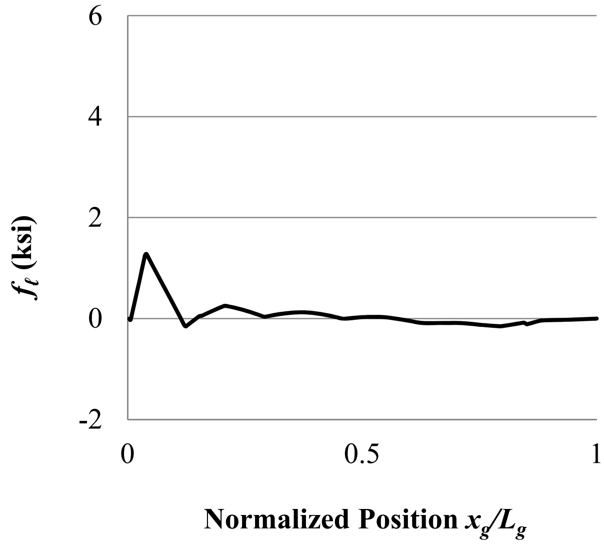


Figure 200. Bridge (J2) G1 top flange lateral bending stress under SDL including the effects of SDLF based on the 3D FEA cambers.

Although it can be seen from Figures 184 and 192 that the SDL cambers calculated from LGA and 3D FEA are substantially different, the final bridge geometries and internal stresses are very similar under the targeted dead load condition.

As noted previously, the SDL girder elevations due to SDLF detailing based on the LGA cambers closely match with the ideal targeted elevations. This is because, if the girders are allowed to deflect under SDL before all the cross-frames are connected to the girders, the resulting girder vertical deflections are exactly equal to the SDL deflections obtained from a LGA.

The SDL girder elevation due to SDLF based on the 3D FEA cambers deviate slightly from the ideal targeted elevations under the SDL. The girder deviations from target elevations under the SDL condition, due to SDLF based on 3D FEA cambers, can be considered as the summation of three independent components:

- The 3D FEA cambers (negative the SDL vertical displacements in Figure 192),
- The change in elevations due to SDLF effects from the 3D FEA cambers (Figure 201), and
- The system vertical deflections due to the SDL effects alone (Figure 192).

As such, the girder deviations from target elevations in this scenario (Figure 202) are exactly equal the change in elevations due to the SDLF effects from 3D FEA cambers (Figure 201). It can be observed that maximum deviations from the ideal zero elevation change line are +0.53 and -0.11 inches.

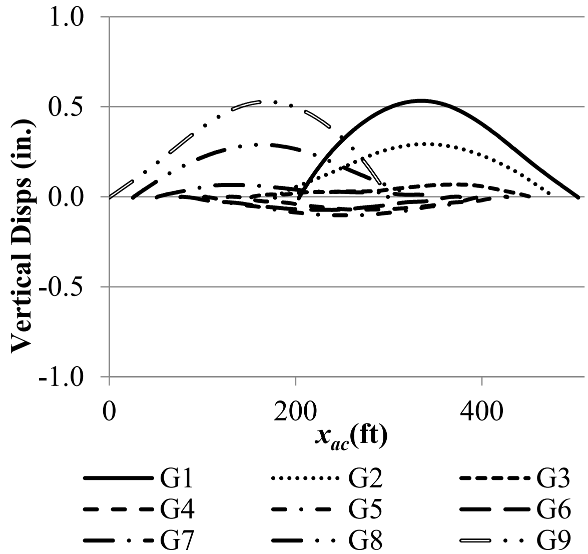


Figure 201. Bridge (J2) girder vertical displacements due to SDLF detailing effects based on the 3D FEA cambers.

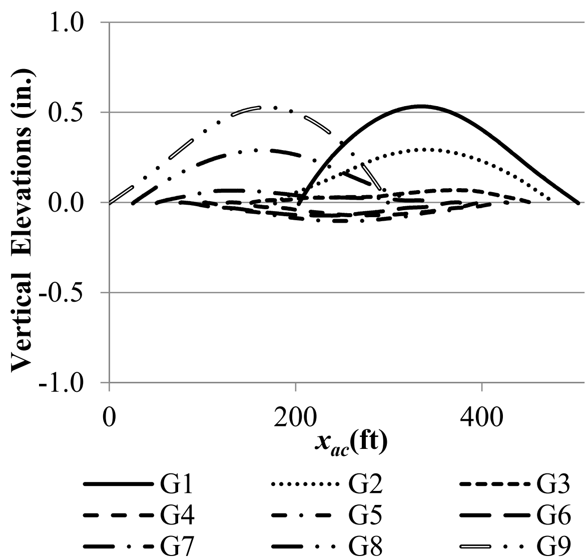


Figure 202. Bridge (J2) girder deviations from target elevations under SDL including SDLF detailing effects based on the 3D FEA cambers.

Figure 203 shows the major-axis bending stresses due to SDLF detailing effects based on 3D FEA cambers. One can see that these major-axis bending stresses are smaller than those when the SDLF detailing is based on LGA cambers (Figure 194). Figure 204 (which is the summation of Figures 195 and 203) shows the major-axis bending stresses under SDL including the SDLF detailing effects based on 3D FEA cambers.

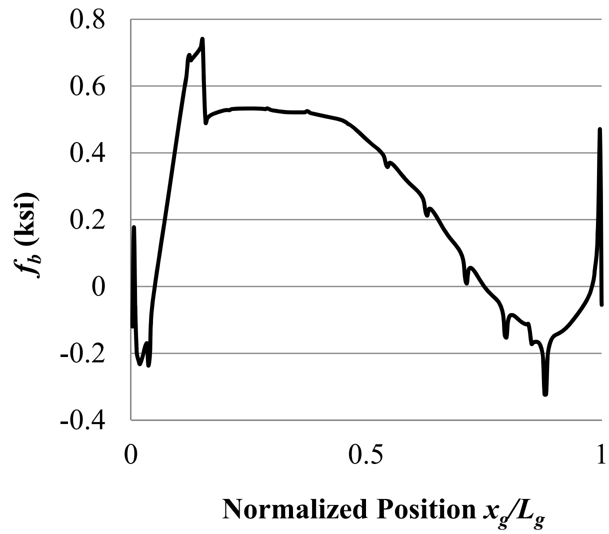


Figure 203. Bridge (J2) G1 top flange major-axis bending stress due to SDLF detailing effects based on the 3D FEA cambers.

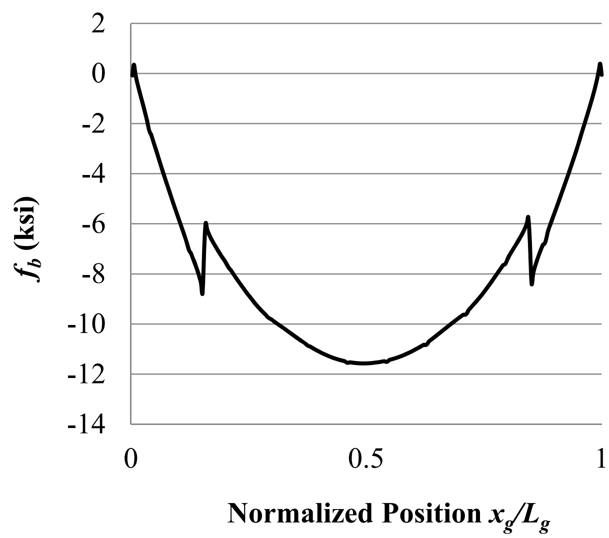
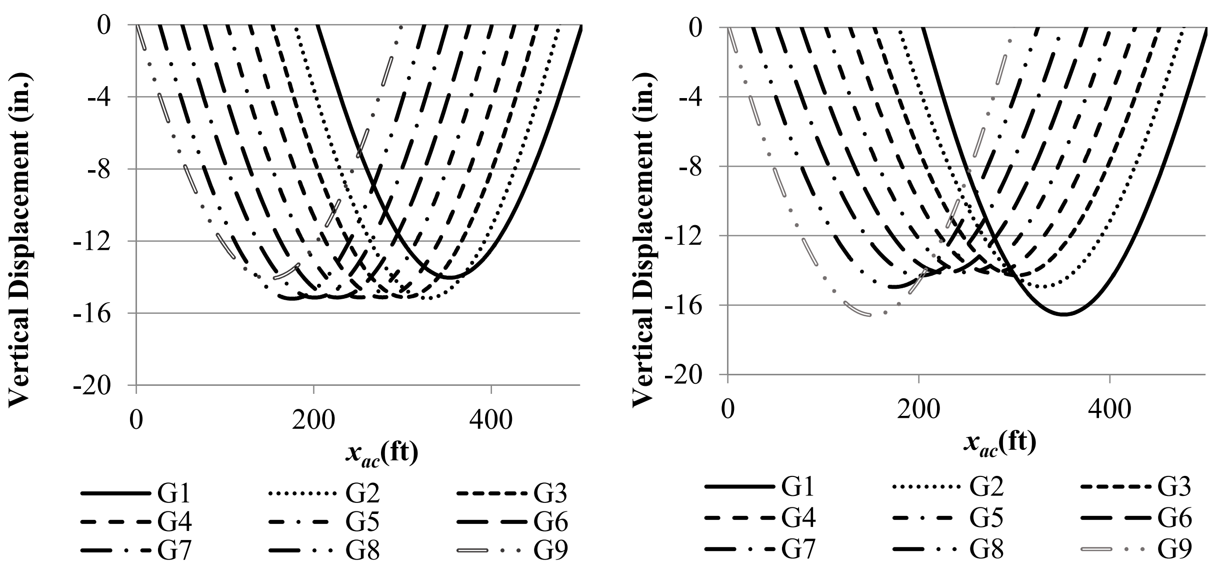


Figure 204. Bridge (J2) G1 top flange major-axis bending stress under SDL including the effects of SDLF based on the 3D FEA cambers.

3.7.3 TDLF Behavior

Similar conclusions to the above can be drawn for TDLF detailing. The final bridge geometries and internal stresses are very similar for TDLF regardless of whether the cambers are calculated by LGA, 2D-gird analysis, or 3D FEA. This is because the behavior of a skewed I-girder bridge is very similar under both SDL and TDL within the context of the assumption that the volume of the deck concrete is small enough such that the deck can be placed entirely in one stage and the concrete dead weight must be resisted entirely by the noncomposite steel structural system (or alternately, if the influence of staged deck placement is assumed to be negligible). The concrete weight is calculated based on the tributary deck widths and is applied as vertical line loads at the tops of the girders.

Figure 205 shows the girder TDL vertical displacements calculated by LGA and 3D FEA for Bridge (J2) NISSS54. One can observe that:



(a) (b)

Figure 205. Bridge (J2) girder vertical displacements due to TDL calculated by (a) LGA and (b) 3D FEA.

- All the girder vertical displacements calculated by LGA are nearly identical. This is because the girders are all of the same size and length, the TDL is the same for all the interior girders. The TDL applied to the fascia girders is only slightly less since the cross-frames connect to only one side of the fascia girders and the deck overhangs are not large.

- The TDL vertical displacements calculated by 3D FEA are much smaller near the center of the bridge width in the three-dimensional structural system. This is due to the substantial transverse load path between the obtuse corners of the bridge, developed via the cross-frames.

The TDLF detailing effects based on the LGA and 3D FEA cambers cause the girder vertical displacements shown in Figure 206. Figure 207 shows the final TDL girder elevations. When the cambers are from LGA, the final elevations are equal to the summation of:

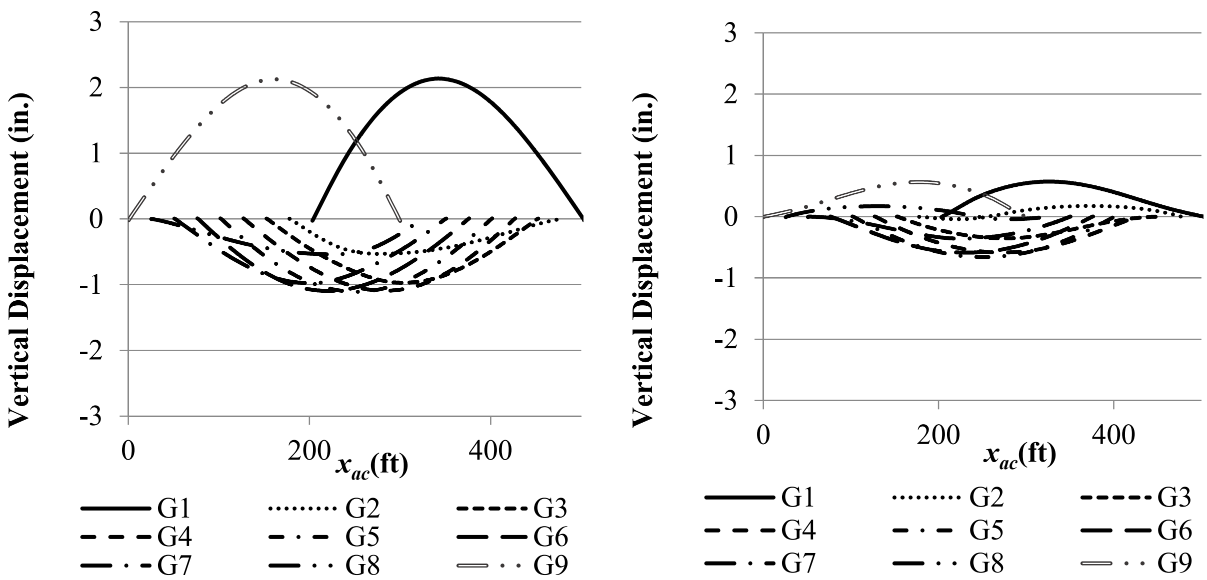
1) The LGA TDL cambers (the negative of the TDL vertical displacements calculated by LGA, shown in Figure 205a),
2) The vertical displacements due to TDLF detailing effects based on LGA cambers (shown in Figure 206a), and
3) The vertical displacements of the three-dimensional bridge system due to the TDL (Figure 205b).

Theoretically, when LGA cambers are used, the final girder elevations are zero under TDL condition. However, the solutions shown in Figure 207a are slightly non-zero. This is due to the incidental effects discussed in Section 3.7.1.1 as well as the fact that eccentric overhang bracket loads are included in the TDL solution of Figure 205b. It should also be noted that due to the additional significant vertical displacements due to the TDLF detailing effects based on the LGA cambers (Figure 206a), these final elevations are approximately zero despite the large differences between the TDL LGA cambers (which are the negative of the LGA vertical displacements as shown in Figure 205a) and the vertical displacements due to the TDL (Figure 205b).

When the cambers are based on 3D FEA, the final elevations are equal to the summation of:

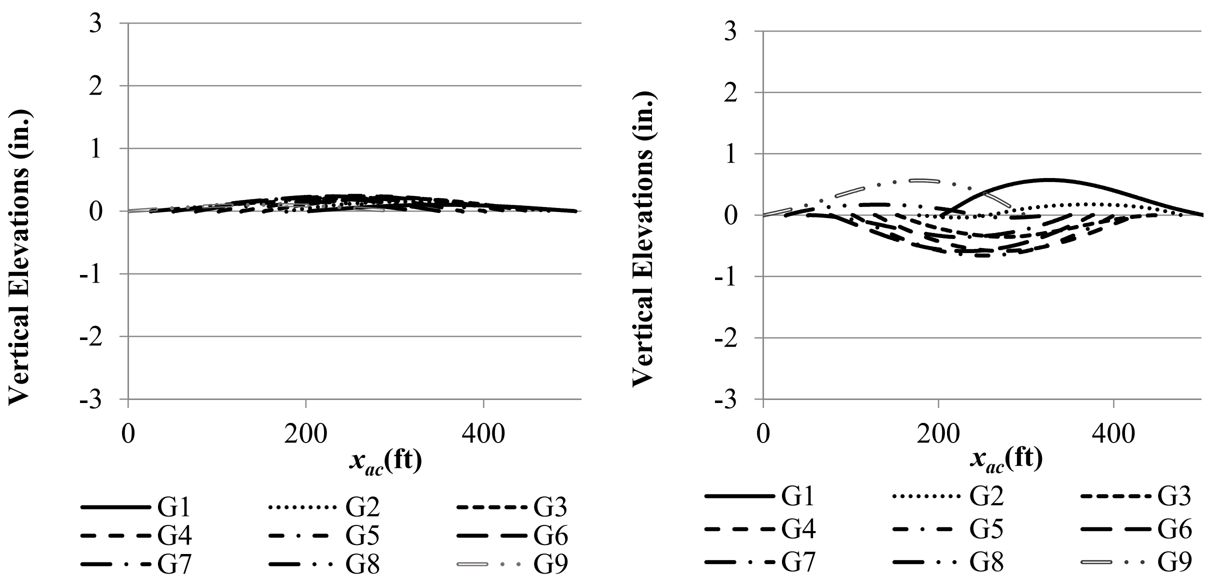
1) The 3D FEA cambers (the negative the TDL vertical displacements calculated by 3D FEA, shown in Figure 205b),
2) The change in elevations due to TDLF detailing effects from the 3D FEA cambers (shown in Figure 206b), and
3) The system vertical deflections due to the TDL effects alone (Figure 205b).

Therefore, the final girder elevations (Figure 207b) are exactly equal the change in elevations due to the TDLF detailing effects from 3D FEA cambers shown in Figure 206b.



(a) (b)

Figure 206. Bridge (J2) girder vertical displacements due to TDLF detailing effects based on the (a) LGA cambers and (b) 3D FEA cambers.



(a) (b)

Figure 207. Bridge (J2) final girder elevations under TDL including TDLF detailing effects based on the (a) LGA cambers and (b) 3D FEA cambers.

One can observe that the layovers in Figure 208a due to the TDLF locked-in forces based on the LGA cambers, are effectively equal in magnitude and opposite in direction to the layovers in Figure 209 due to the TDL. That is, these two sets of layovers approximately cancel one another. As such, the girder flanges are completely straight in the final TDL condition, as shown in Figure 210a (the layovers shown in this figure are the summation of the layovers from Figures 208a and 209).

The TDLF detailing effects based on the 3D FEA based cambers induce the girder layovers (Figure 208b) that are in the opposite direction from those due to the TDL (Figure 209). However, these layovers are not exactly equal the layovers caused by the TDL. This is because the LGA based camber is the only vertical camber that produces the targeted ideal results in a straight skewed I-girder bridge. Figure 210b demonstrates this point by showing the final layover under the TDL, when TDLF based on the 3D FEA cambers is used. The maximum girder layover in this case is 0.71 inches. These results show that, for practical engineering purposes, these 12 ft. deep girder webs can be considered plumb. However, strictly speaking, they are not exactly plumb.

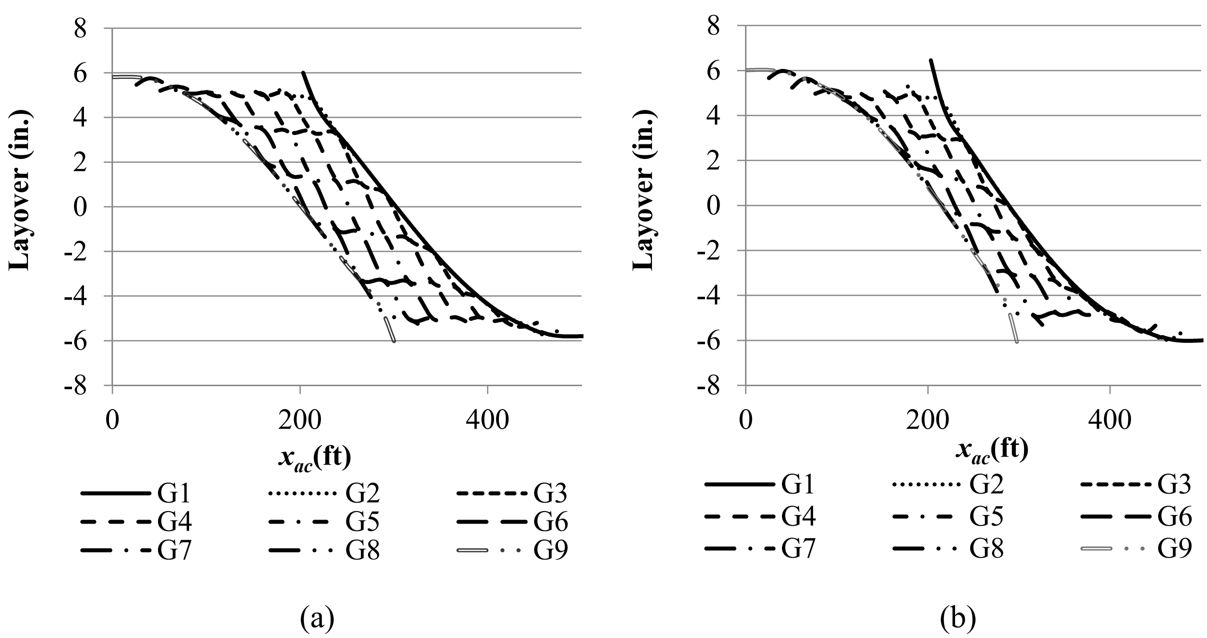


Figure 208. Bridge (J2) girder layovers due to TDLF detailing effects based on the (a) LGA cambers and (b) 3D FEA cambers.

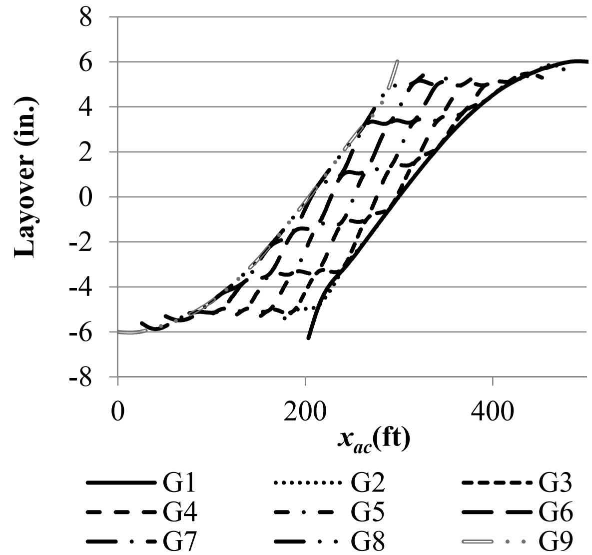


Figure 209. Bridge (J2) girder layovers due to TDL calculated by NLF 3D FEA.

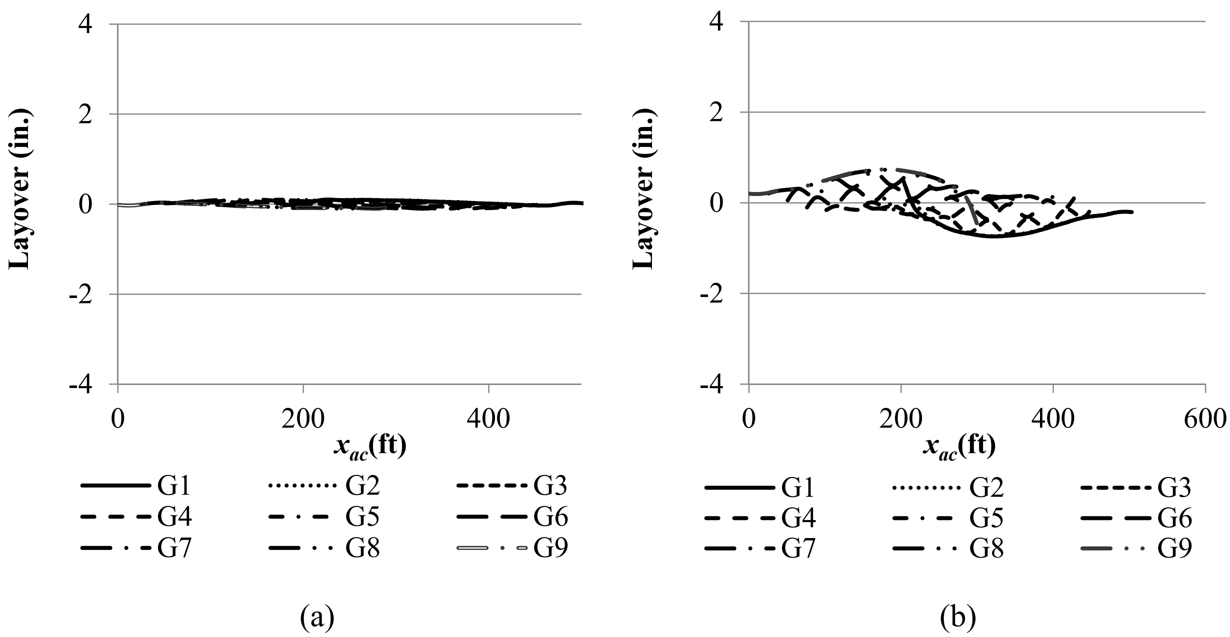


Figure 210. Bridge (J2) girder layovers under TDL including TDLF detailing effects based on the (a) LGA cambers and (b) 3D FEA cambers.

Since the girder flanges are effectively straight in the targeted DL condition, when LGA cambers are employed, the flange lateral bending stresses are effectively zero in the final TDL condition as shown in Figure 213a, which are the summation of the flange lateral bending stresses shown in Figures 211a and 212. When the cambers are based on 3D FEA, the TDL girder layovers are small, but non-zero. Again, the LGA based camber is the only vertical camber that produces the targeted ideal in a straight skewed I-girder bridge. The final TDL flange lateral bending stresses, based on 3D FEA girder cambers, are shown in Figure 213b. These are the summation of the stresses from Figures 211b and 212).

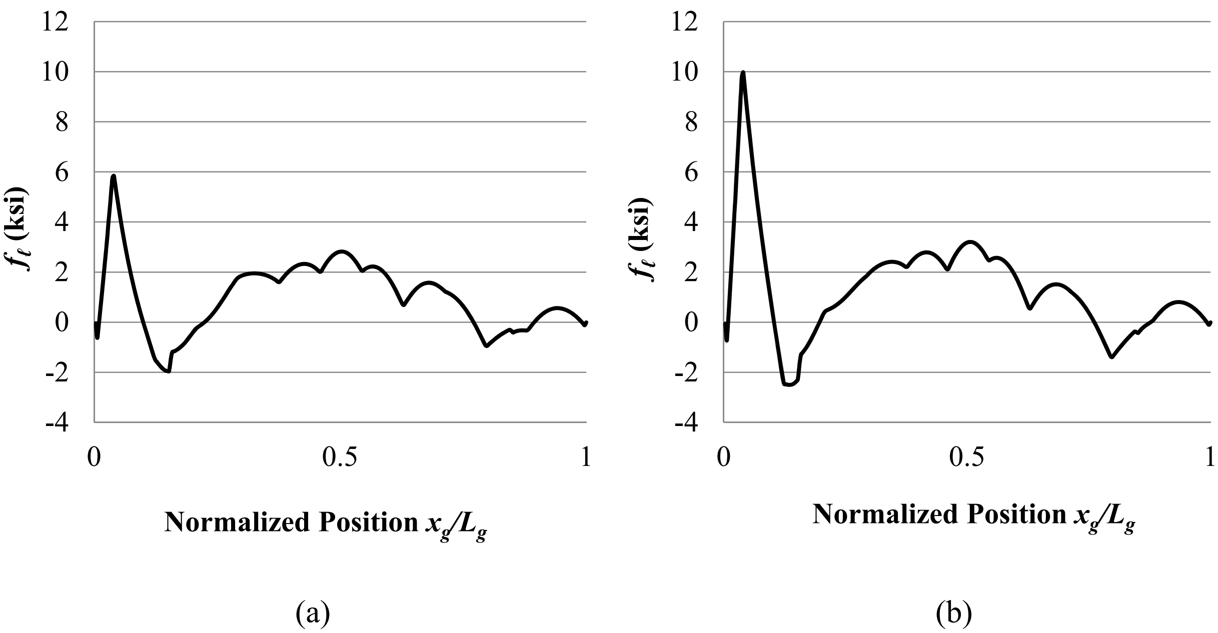


Figure 211. Bridge (J2) G1 top flange lateral bending due to TDLF detailing effects based on the (a) LGA cambers and (b) 3D FEA cambers.

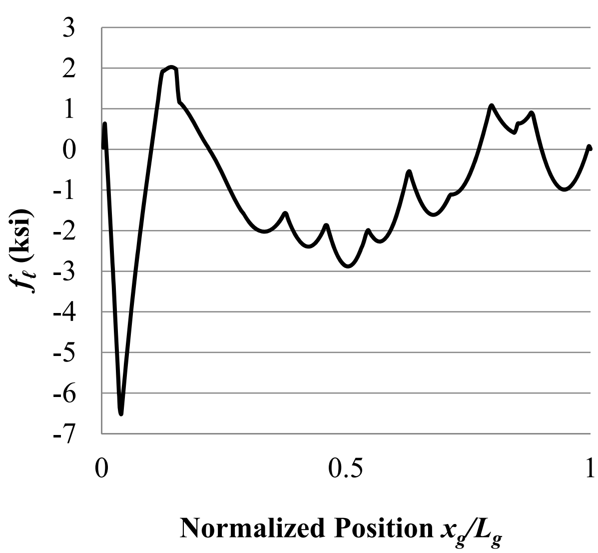


Figure 212. Bridge (J2) G1 top flange lateral bending stresses due to TDL calculated by 3D FEA.

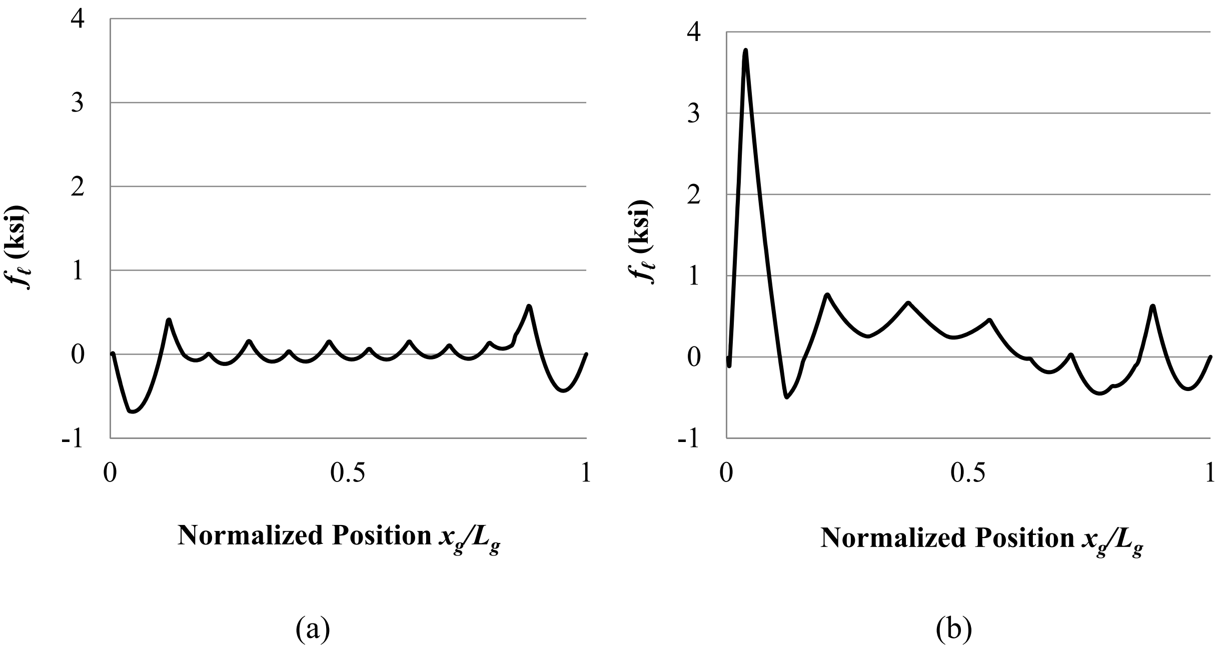


Figure 213. Bridge (J2) G1 top flange lateral bending stresses under TDL including TDLF detailing effects based on the (a) LGA cambers and (b) 3D FEA cambers.

Figure 214 shows the girder major-axis bending stresses due to TDLF detailing effects based on LGA cambers and 3D FEA cambers. Since the vertical displacements caused by the TDLF detailing effects are larger when the cambers are from LGA than when the cambers are from 3D FEA, the corresponding major-axis bending stresses are also larger. Figure 215 shows the major-axis bending stresses under the TDL in the three-dimensional bridge system, calculated by creating the bridge model and then "turning gravity on." Figure 216 shows major-axis bending stresses under TDL including the TDLF detailing effects based on LGA cambers and 3D FEA cambers. The LGA based results shown in Figure 216a are a close match to the girder major-axis bending stresses from the LGA. The TDLF detailing effects shown in Figure 214a modify the stresses from Figure 215, producing these LGA major-axis bending stresses. The girder major-axis bending stresses shown in Figure 216b, obtained with TDLF detailing based on the 3D FEA cambers, are slightly different.

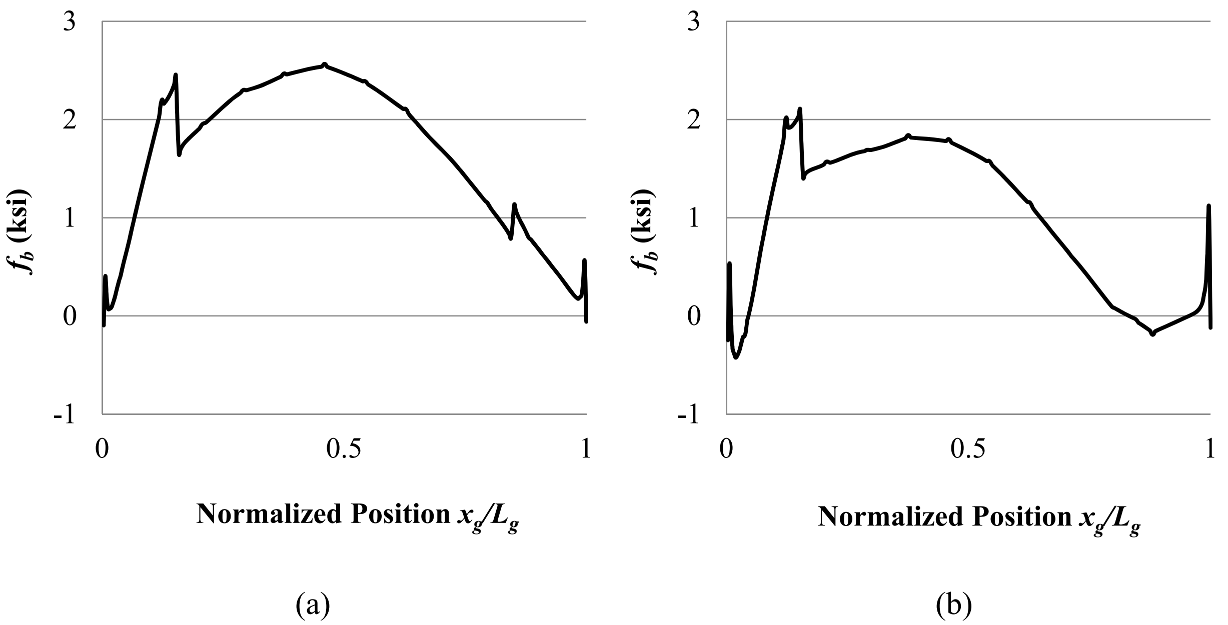


Figure 214. Bridge (J2) G1 top flange major-axis bending stresses due to TDLF detailing effects based on the (a) LGA cambers and (b) 3D FEA cambers.

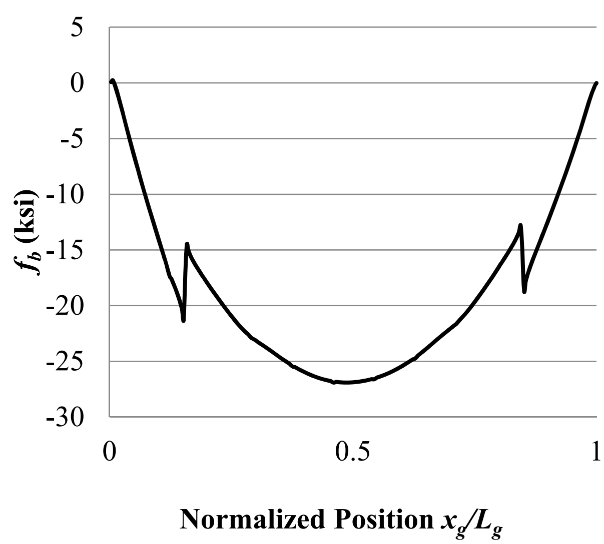


Figure 215. Bridge (J2) G1 top flange major-axis bending stresses due to TDL calculated by 3D FEA.

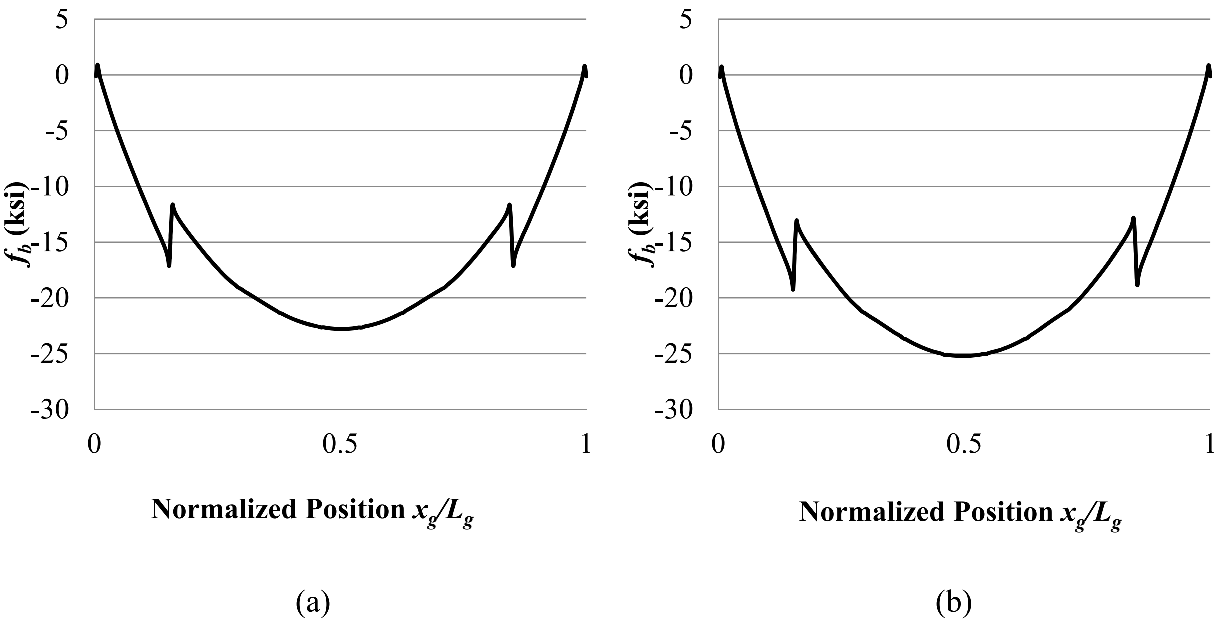


Figure 216. Bridge (J2) G1 top flange major-axis bending stresses under TDL including TDLF detailing effects based on the (a) LGA cambers and (b) 3D FEA cambers.

3.7.4 Summary

The camber profiles calculated from LGA and 3D FEA for a straight sharply-skewed bridge can be substantially different. However, the final bridge geometries and responses obtained with either SDLF or TDLF detailing are very similar. The use of cambers from LGA gives the closest match to the ideal zero girder layovers and flange lateral bending stresses under the targeted dead load conditions while the use of 3D FEA cambers gives girder layovers and internal stresses that are small, but non-zero, compared to the overall dead load responses under the targeted conditions. The final girder elevations due to TDLF detailing based on the LGA cambers closely match with the ideal targeted girder elevations under TDL. However, the final girder elevations due to TDLF based on the 3D FEA cambers deviate only slightly from the ideal targeted elevations under TDL. Based on the studies synthesized in Section 3.4, it can be concluded that the 3D FEA results are close enough to matching the ideal values such that it is sufficient to use 3D FEA (or other accurate RA) cambers for detailing of straight skewed bridges.

3.8 Sensitivities of Completed Bridge Responses to Various Factors

This section discusses the sensitivities of the completed bridge responses to girder over-camber, variations in the deck thickness, and variations in the cross-frame stiffness in bridges detailed for a SDLF or a TDLF. The straight skewed Bridge (J2) NISSS54 is used as a representative extreme case to investigate these sensitivities.

The cross-frame drops for SDLF or TDLF detailing are set by subtracting the corresponding SDL or TDL camber profiles from the fully-cambered girder elevations, or in other words, by applying the SDL or TDL deflections to the fully-cambered girder elevations. As a result, the girder layovers and the internal stresses potentially can be affected significantly by any tolerances associated with the physical cambering of the girders.

SDLF and TDLF detailing rely on the dead load cambers provided on the engineering drawings. For dead load fit detailing, the girders are theoretically plumb under the targeted dead load condition, in a straight skewed I-girder bridge, if the girders are cambered exactly according to the specified LGA cambers. Any deviations from the specified cambers make the ideal girder layovers and internal stresses nonzero. The larger the deviations of the actual from the specified cambers, the more the girder layover and internal stresses are affected.

Fabricators generally impose positive tolerances on the girder camber profiles. The negative camber tolerance specified in the AASHTO/AWS D1.5 Bridge Welding Code (AWS 2010) is zero. Fabricated girders that are under-cambered may be rejected. The positive camber tolerance at the mid-span is +1.5 inches for spans that are greater than 100 ft. (AWS 2010). For other positions along the span, the positive camber tolerance varies parabolically between 1.5 inches at mid-span and 0 inches at the supports (although the Bridge Welding Code indicates a separate tolerance on the camber at interior supports of $\pm$ 1/8 inches).

It is expected that for a bridge such as (J2) NISSS54, the fabricator would typically use a positive over-camber within the middle of the above range. The impact of this practice is investigated below by assuming LGA cambers and scaling the Bridge (J2) NISSS54 camber profiles by the factors ($1 + T / C$), where T is the maximum over-camber at the girder mid-span and C is the specified girder camber at its mid-span. For example, for the fascia Girder G1, the specified TDL camber at mid-span is C = 14.08 inches. Therefore, the G1 camber is scaled by the factor ($1 + T/14.08$). The maximum over-camber at the girder mid-span T is taken as 0.5., 1.0., and

1.5 inches. The parameter *T* is assumed to be the same for all the girders in this base study (the effect of deviations in the over-camber between girders is discussed below). Figure 217 shows the corresponding maximum layovers, cross-frame member axial stresses and girder flange lateral bending stresses under TDL in Bridge (J2) NISSS54 for TDLF detailing. As discussed previously, all of these quantities are theoretically equal to zero for this case, with the exception of effects due to factors such as eccentric overhang bracket loads, etc. (discussed in Section 3.4.4.2). Figure 218 shows a comparable result for this bridge corresponding to the SDL condition and SDLF detailing. Although the above AWS camber tolerances strictly apply only to the full or TDL camber of the girders, Figure 218 shows the results if there are deviations of 0.5, 1.0 and 1.5 inches in the SDL camber. These deviations can occur simply due to over-camber of the girders relative to their proper full (total) cambers, i.e., the negative of the SDL deflection from the LGA plus the negative of the girder deflections due to the concrete dead load (CDL), determined from an accurate refined analysis.

Interestingly, the maximum responses increase in a nearly linear fashion with increases in the camber tolerance in Figures 217 and 218. This is because the material is assumed to be linear elastic and the geometric nonlinearity in the bridge structural system is very minor under the targeted dead load conditions.

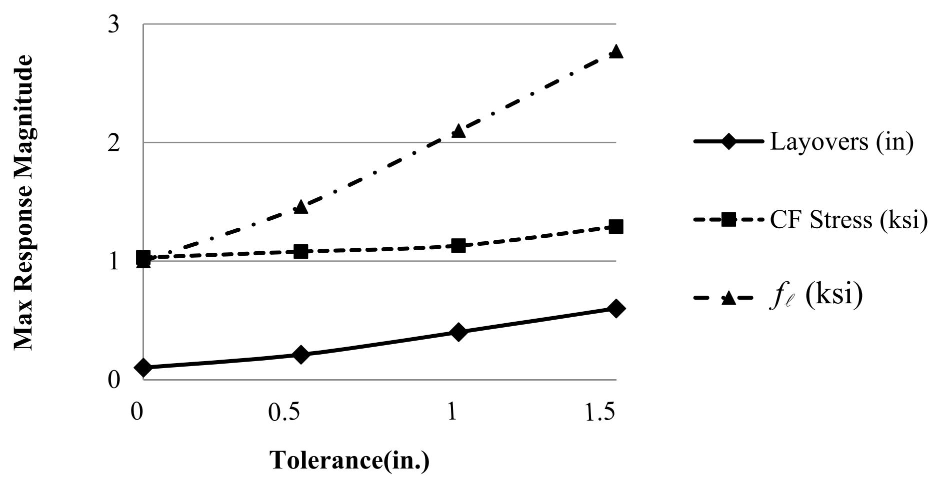


Figure 217. Bridge (J2) NISSS54 maximum responses under TDL, for TDLF detailing based on LGA cambers, versus the camber tolerance.

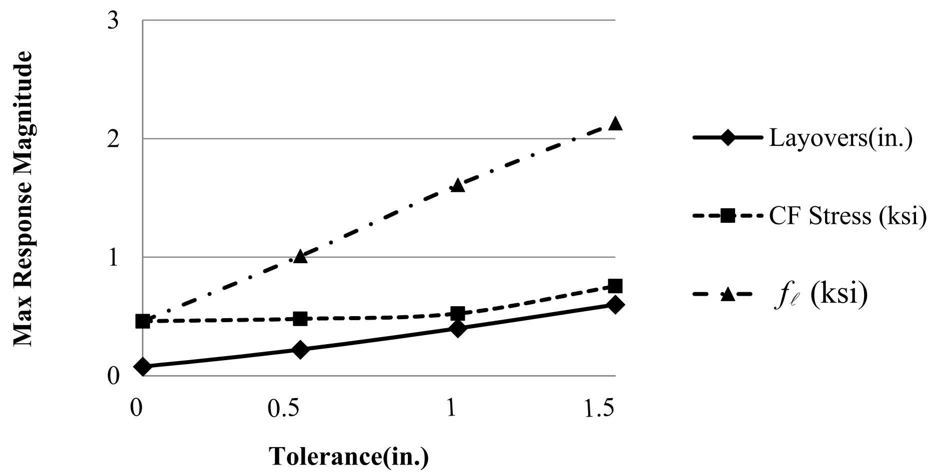


Figure 218. Bridge (J2) NISSS54 maximum responses under SDL, for SDLF detailing based on LGA cambers, versus the camber tolerance.

The camber tolerances have similar effects on the responses for TDLF or SDLF detailing based on the 3D FEA cambers. Any deviations from the specified cambers change the final girder layovers and internal stresses. These increases are nearly a linear function of the camber tolerance values since the nonlinearity in the structural system is minor.

Another factor that can have an important influence on the response is the concrete deck thickness tolerance. For TDLF detailing, the cross-frames are detailed such that, ideally, the girders are plumb under TDL. Changes in the deck thickness cause a change in the concrete weight. An increase in the concrete weight leads to a nearly linear increase in the bridge responses. Figure 219 shows the maximum responses under TDL, for TDLF detailing based on LGA cambers, versus a hypothetical uniform increase in the deck thickness. The corresponding responses for TDLF based on 3D FEA cambers are similar and are not shown for the sake of brevity.

It is important to note that while the above potential increases in the above cambers and deck thicknesses lead to measurable changes in the bridge responses, these changes are relatively small compared to the overall bridge responses.

One other sensitivity that can have an important influence on the response is the assumed axial stiffness of cross-frame members in the bridge model. In the main studies of this research, the axial stiffness of the single-angle and flange-connected tee-section cross-frame members is taken as 0.65 of the nominal *EA*/*L* to account for the additional flexibility associated with the eccentric one-sided connections at the member ends, as specified in (AASHTO 2015). The influence of variations of the axial stiffness of the cross-frame members on the bridge responses is investigated below by varying the elastic modulus of the cross-frames for Bridge (J2) NISSS54. The intermediate cross-frames are single-angle members and the bearing line cross-frames are flange-connected tee-section members in this bridge.

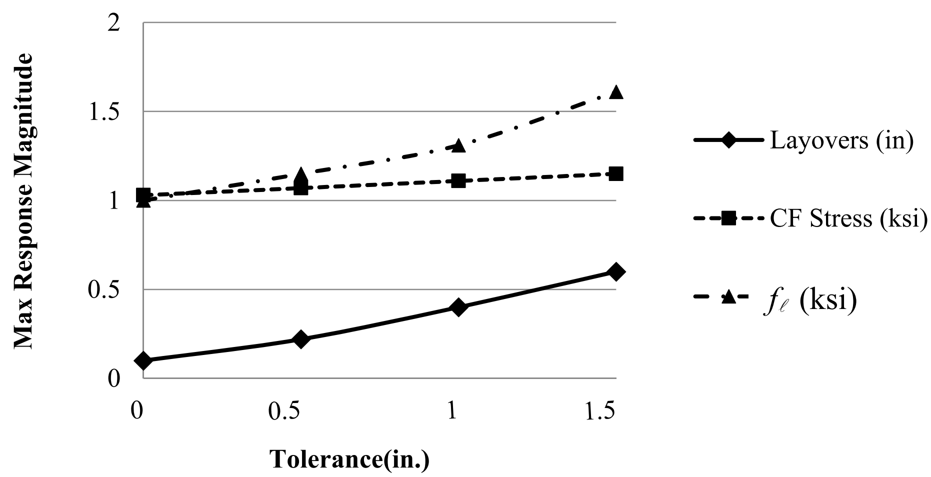


Figure 219. Bridge (J2) NISSS54 maximum responses under TDL, for TDLF detailing based on LGA cambers, versus the deck thickness tolerance.

Figures 220 through 222 show the maximum layovers, cross-frame stresses, and girder flange lateral bending stresses, respectively, under TDL, for TDLF detailing based on LGA cambers, versus the cross-frame elastic modulus. One can observe that the maximum layovers, cross-frame stresses, and flange lateral bending stresses are practically unchanged for TDLF detailing. This is because the cross-frame forces, and therefore the cross-frame deformations, are close to zero under TDL for TDLF detailing. As long as the cross-frame members have sufficient strength, they respond in essentially the same manner, for this scenario, regardless of their stiffness.

In addition, it is observed that even for the case of NLF detailing, which is not recommended for bridges with highly-skewed abutment bearing lines due to the resulting substantial girder layovers at the abutments, the influence of the effective cross-frame member stiffnesses varying from 0.5 to 1.0 of their nominal *EA*/*L* values is very small. This is due to the fact that the cross-frames are responding essentially as rigid components, compared to the girders, in this bridge. The reduced cross-frame forces, due to the improved cross-frame framing arrangement in this bridge, has an impact on this behavior. Straight skewed bridges with high nuisance transverse stiffness potentially can be more sensitive to the modeling of the cross-frames.

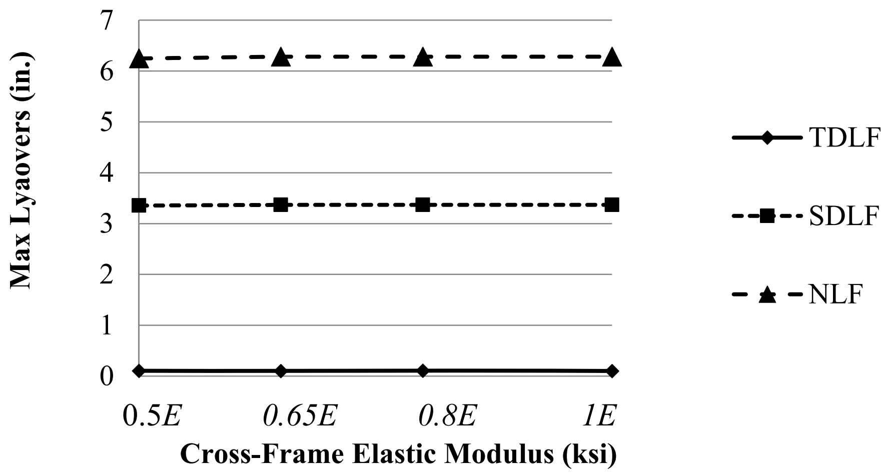


Figure 220. Bridge (J2) NISSS54 maximum layovers under TDL, for TDLF detailing based on LGA cambers, versus the cross-frame elastic modulus.

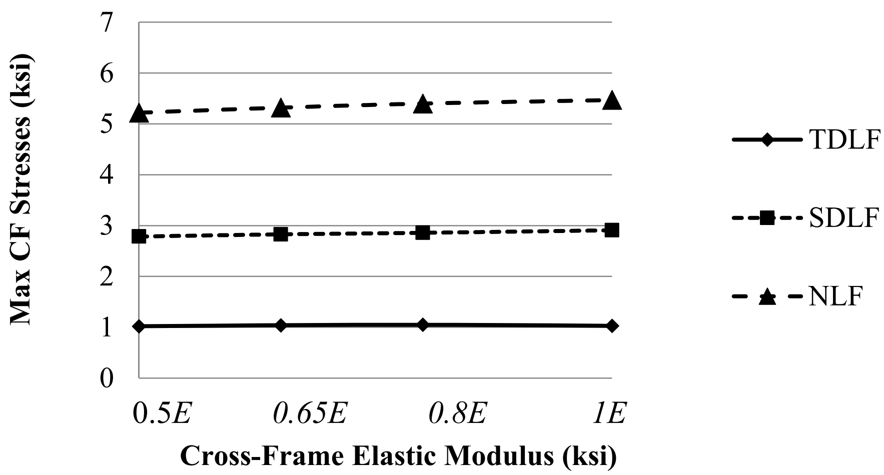


Figure 221. Bridge (J2) NISSS54 maximum cross-frame stresses under TDL, for TDLF detailing based on LGA cambers, versus the cross-frame elastic modulus.

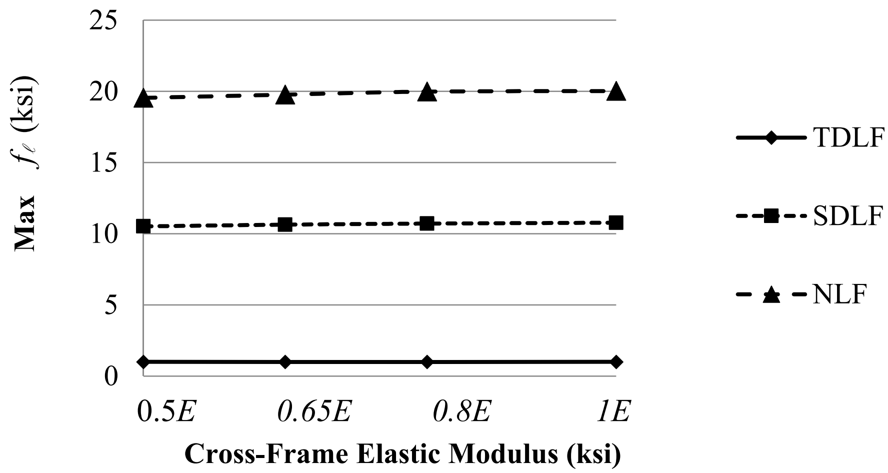


Figure 222. Bridge (J2) NISSS54 maximum flange lateral bending stresses under TDL, for TDLF detailing based on LGA cambers, versus the cross-frame elastic modulus.

3.9 Concepts and Procedures for Including Cross-Frame Detailing Effects Directly in the Structural Analysis

Cross-frame detailing methods can have a significant influence on the bridge responses in the completed bridge as well as during construction. In straight skewed bridges, SDLF and TDLF detailing effects generally are very beneficial, i.e., they tend to be subtractive relative to the dead load effects on the cross-frame forces and girder flange lateral bending stresses. However, in curved radially-supported bridges, SDLF and TDLF detailing effects tend to be additive with the dead load effects on the cross-frame forces and flange lateral bending stresses. In addition, in curved and skewed bridges, SDLF and TDLF detailing effects can either increase or decrease the cross-frame forces and flange lateral bending stresses depending on many complex factors. This section presents general procedures for including cross-frame detailing effects directly in the structural analysis. Simplified methods of considering these effects are discussed in Section 3.4.

Section 3.9.1 discusses the initial lack-of-fit associated with the cross-frame detailing methods in curved and/or skewed I-girder bridges. Section 3.9.2 then addresses the calculation of initial strains and initial fixed-end forces via the software GT-LOFT, a "Lack Of Fit analysis Tool" developed as part of this research. Examples are provided illustrating the inclusion of the detailing effects via initial strains in 3D FEA (Section 3.9.3) and via initial fixed-end forces in a grid analysis (Section 3.9.4). The examples consider both a representative straight skewed bridge and a representative curved radially-supported bridge.

3.9.1 Calculation of the Initial Lack-of-Fit due to SDLF or TDLF Detailing

When the cross-frames are detailed for either SDLF or TDLF, they do not fit up with the girders in their cambered, plumb, no-load (NL) geometry. This initial lack-of-fit between the cross-frames and the girders consists of two components: the lack-of-fit due to the girder vertical displacements and the lack-of-fit due to the girder major-axis bending rotations. These components are referred to as the vertical and the rotational lack-of-fit displacements in the following discussions.

3.9.1.1 Initial Vertical Lack-of-Fit Displacements

Figure 223 illustrates a cross-frame, detailed for SDLF or TDLF within the span of a curved and/or skewed I-girder bridge. The girders are assumed to be in their idealized cambered, plumb, NL geometry in this sketch. As a simplification, the geometric factors involving superelevation, cross-slope, grade and vertical curve are not shown. Therefore, the targeted final girder elevations under the TDL, measured for instance as the elevations at the top of the girder webs, fall within a single horizontal plane. The cross-frame in Figure 223 is assumed to be attached to the connection plate on the left-hand girder. However, it does not fit up with the work points at the connection plate on the right-hand girder. This is because the cross-frame is detailed to fit to the girders in an idealized plumb SDL or TDL condition. The cross-frame initial vertical lack-of-fit displacement may be calculated as follows:

- For SDLF detailing, the initial vertical lack-of-fit displacement is equal to the difference between the negative of the girder SDL vertical deflections on each side of the cross-frame, referred to as the differences in the girder SDL cambers in this research.
- For TDLF detailing, the initial vertical lack-of-fit displacement is equal the difference in the negative of the girder TDL deflections on each side of the cross-frame. That is, the initial vertical lack of fit is equal to the difference in the girder TDL cambers.

The initial vertical lack-of-fit displacement characterizes the shear racking deformation that the cross-frame must be subjected to if vertical displacement compatibility is maintained with the girders in their fully-cambered NL geometry.

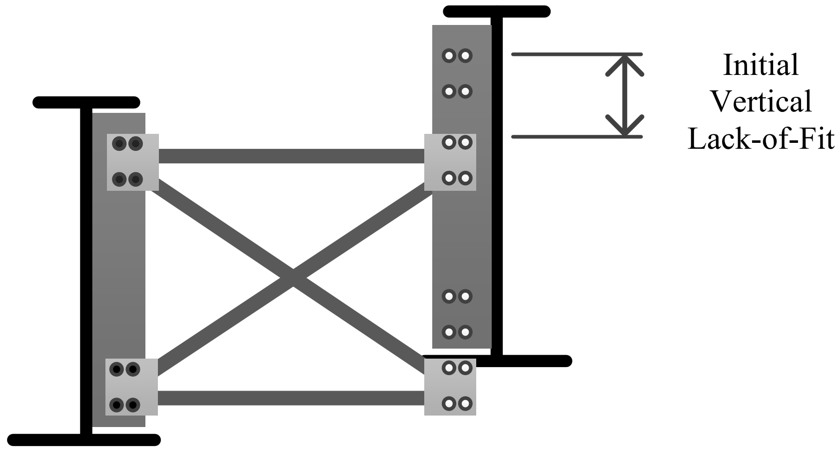


Figure 223: Illustration of the initial vertical lack-of-fit. The girders are in their idealized fully-cambered, plumb, NL geometry and the cross-frame is in its unstressed geometry detailed for SDLF or TDLF. The cross-frame is connected only to the left-hand girder.

3.9.1.2 Initial Rotational Lack-of-Fit Displacements

Figure 224 shows a representative elevation view of a girder in a simply-supported curved and/or skewed bridge. The girder height is exaggerated for purposes of illustration. The dashed lines show the girder in its final, ideal (flat) TDL geometry with a plumb girder web. The solid lines show the girder in its idealized fully-cambered, plumb, NL geometry. The connection plates and cross-frames are not shown for clarity. It is assumed that the girder is attached to skewed bearing-line cross-frames at its ends. In the following, the skewed end cross-frames are used to explain the mechanics of the initial rotational lack-of-fit for the case of TDLF detailing. The behavior for SDLF detailing is similar.

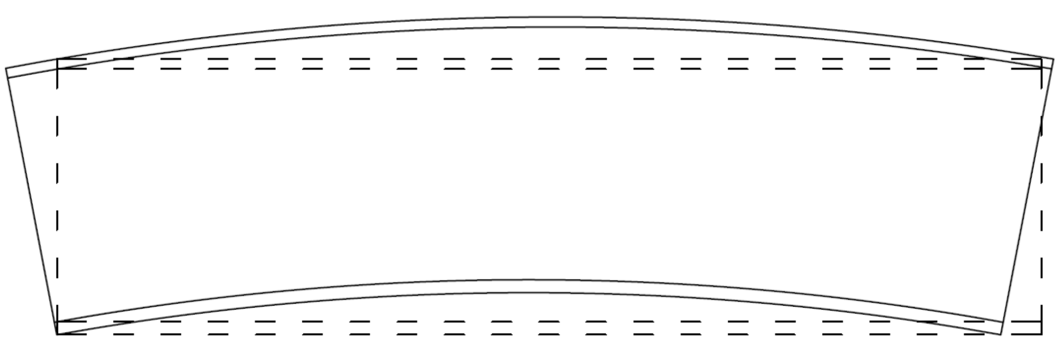


Figure 224. Illustration of the major-axis bending rotation due TDL cambers. The dashed lines show the girder in its final, ideally TDL elevations with plumb girder web. The solid lines show the girder in its idealized fully-cambered, plumb, NL geometry. The girder is assumed fixed in the longitudinal direction at the bottom flange on the left-hand end.

With TDLF detailing, the end cross-frames fit to the vertically-oriented connection plates on the targeted TDL geometry of the girders, shown by the dashed lines. When the bridge is in the NL geometry, the girders are cambered upwards and the end connection plates are no longer vertical. The girder end major-axis bending rotations in the NL geometry can be calculated from the TDL cambers by assuming that the girder cross-sections (and the end connection plates) are perpendicular to the flanges. The girder TDL cambers, as well as the girder TDL major-axis bending camber rotations, are often different for different bridge girders.

As stated above, the end cross-frames are detailed such that they fit exactly to the girders in their final deflected (flat) TDL positions without any forcing. However, the end cross-frames have to deform to maintain compatibility with the work points at the girder connection plates in the fully-cambered NL geometry. The change in the vertical displacements at the girder ends is zero in going from the final TDL configuration to the fully-cambered NL configuration. However, the girder ends experience a major-axis bending rotation in going from the flat TDL geometry to the fully-cambered NL geometry. The corresponding displacements imposed on the end cross-frames at their connections to the girders are the rotational lack-of-fit displacements. Note that if the end cross-frames are perpendicular to the girders, and if the girder camber rotations on each side of the cross-frames are the same, the rotational lack-of-fit at the end cross-frames is zero. In this case, the cross-frames are subjected simply to rigid-body rotation due to the major-axis bending camber rotations at the girder ends. However, if the end cross-frames or skewed and/or the end girders have different major-axis bending camber rotations, the cross-frames are subjected to non-zero rotational lack-of-fit displacements to maintain compatibility with the girder work points.

The initial rotational lack-of-fit displacements characterize the deformations that the cross-frames must be subjected to if rotational compatibility is maintained with the girders in their fully-cambered NL geometry.

In general, both the girder TDL cambers and the girder TDL major-axis bending camber rotations are different on each side of an intermediate cross-frame. The difference in the girder cambers between the sides of a cross-frame is the vertical lack-of-fit. In addition, intermediate cross-frames also generally have a rotational lack-of-fit whenever they have non-zero TDL camber rotations and a non-zero skew relative to the girders, and/or when the girders have a different major-axis bending camber rotations at opposite sides of a cross-frame.

The cross-frame vertical and rotational lack-of-fit displacements are calculated generally by performing a position vector analysis on the work points at the cross-frame to girder connections. For this purpose, the girders are assumed fixed in the longitudinal direction at the bottom flange at their left-hand ends in their elevation views in this work. Because the total length along the girder centroid is unchanged (assuming zero axial load within the girders), the distance from the fixed point on the bottom flange to the bottom flange at the opposite end of the girder is shorter in the no-load condition compared to the targeted TDL condition (see Figure 224). The girders generally shift longitudinally as the girder TDL vertical deflections and major-axis rotations occur. These longitudinal displacements are included in a position vector analysis to determine the total displacements of the work points on the girders at the cross-frame connections. Given typical girder length-to-depth ratios, the above longitudinal movements are commonly an order of magnitude smaller than the corresponding girder maximum vertical deflections. Therefore, although there is some lack-of-fit of the cross-frames associated with these movements, the predominant lack-of-fit effects are the vertical and rotational lack-of-fit discussed above.

The total initial lack-of-fit is the summation of the initial vertical lack-of-fit and initial rotational lack-of-fit. For cross-frames at different locations in a bridge, the contribution of each of the components to the total initial lack-of-fit varies as follows:

- At skewed bearing line cross-frames, where the vertical deflections are zero, the initial rotational lack-of-fit is the only lack-of-fit component.
- For intermediate cross-frames that frame normal to the girder tangents, the initial vertical lack-of-fit is the dominant component.
- For skewed intermediate cross-frames, the initial vertical and rotational lack-of-fit are both significant components.

3.9.2 Calculation of Initial Strains and Initial Fixed End Forces due to the Lack-of-Fit from SDLF or TDLF Detailing

Various methods are possible to account for the influence of cross-frame detailing methods. However, many of these methods are approximate and may not always properly capture the effects. The most accurate and direct approach is to either include the initial strains or stresses due to the above vertical and rotational initial lack-of-fit displacements in a 3D FEA model, or the corresponding fixed-end forces due to these displacements in a grid analysis model. Any 3D FEA software that is already capable of modeling thermal loading has the capability to include the initial strains due to the initial lack-of-fit. In addition, the corresponding fixed-end forces can be calculated for the beam elements representing the cross-frames in any grid analysis software. The negative of these forces can be applied to the nodes at the ends of the cross-frames in a grid analysis to model the initial lack-of-fit effects.

3.9.2.1 Calculation of the Initial Strains in 3D FEA Software

Generally speaking, any matrix analysis software where the structure is modeled in three dimensions may be referred to as a three-dimensional finite element analysis (3D FEA). The NCHRP Report 725 research and this research adopt the more restrictive definition of 3D FEA stated by AASHTO/NSBA G13.1 (2011). According to G13.1, an analysis method is classified as 3D FEA if:

1) The superstructure is modeled fully in three dimensions,
2) The individual girder flanges are modeled using beam, shell, or solid type elements,
3) The girder webs are modeled using shell or solid type elements,
4) The cross-frames or diaphragms are modeled using truss, beam, shell, or solid type elements as appropriate, and
5) The concrete deck is modeled using shell or solid elements (when considering the response of the composite structure).

The cross-frame initial strains can be obtained directly from 3D FEA software, by imposing the vertical deflections associated with the girder dead load cambers. This procedure is as follows:

- A specified displacement analysis is run in which the girders are displaced from the configuration where the they are in their desired, plumb targeted dead load configuration to the configuration where the girders are "locked" in their no-load, plumb, and fully-cambered geometry. In this work, the nodal vertical displacements (from the corresponding camber profiles) are applied to the bottom flange nodes of the girders throughout the girder lengths as the specified displacements.
- The cross-frames are subjected to the initial strains associated with the corresponding initial lack-of-fit by maintaining compatibility with the girder displaced configurations at the cross-frame connection points in the above specified displacement analysis.

- For SDLF detailing, the above nodal displacements are the negative of the SDL displacements, which are referred to as the SDL cambers in this work.
- For TDLF detailing, the above nodal displacements are obtained from the girder TDL camber profiles. That is, for TDLF detailing, the nodal displacements are the TDL cambers (i.e., the negative of the girder TDL vertical displacements).
- By definition, the girders are restrained from any lateral displacements in the above 3D FEA solution. Only the girder vertical displacement effects, and the corresponding girder major-axis bending rotations, are considered.

It should be noted that the above cross-frame initial strains are simply a computational device to account for the initial lack-of-fit. Therefore, even if the corresponding initial stress is larger than the material yield strength, the material behavior should be assumed to be linear elastic.

One should note that in the above specified displacement analysis, the elastic modulus for the cross-frame members should be set to a value significantly smaller than the physical elastic modulus (1000 times smaller is used in this research). This avoids local deformations in the girders and the girder connection plates due to potentially large force components introduced to the girders from cross-frame members in the above specified displacement analysis. Any local deformations in the girders and the connection plates in effect produces initial strains in these members. The recommended calculation procedures are based on generating initial strains, due to the lack-of-fit, only in the cross-frame members.

The initial strains for SDLF and TDLF detailing of the bridge cases studied in this research are calculated using the 3D FEA ABAQUS software. Special-purpose tools were developed and used to facilitate the calculation of the initial strains in the 3D FEA software and for including these initial strains in the simulations of the bridge cases.

3.9.2.2 Calculation of the Initial Strains for 3D FEA using GT-LOFT

Running the above displacement analysis in a 3D FEA software system to obtain the initial strains due to the cross-frame detailing methods can be time consuming, and not all bridge programs are capable of easily running such an analysis. Therefore, the GT-LOFT software tool was developed as part of this research to facilitate the calculation of cross-frame initial strains, which can then be specified in the cross-frame elements of the bridge analysis software (assuming the software has capabilities for directly modeling initial strains, such as for modeling thermal deformations). The tool utilizes an Excel spreadsheet to specify the bridge inputs and MATLAB to calculate the initial strains. Based on the bridge inputs, the tool determines the spatial position of the work points on the girders in the final plumb targeted dead load geometry and in the plumb fully-cambered geometry. The tool assumes that the connection plates are effectively rigid and are normal to the girder flanges. The influence of connection plates that are not normal to the flanges, typically plates that are desired to be vertical in the final girder geometry (including any effects of grade and/or vertical curve), is assumed to be small. Also, any superelevation or cross-slope is assumed to have a negligible effect on the bridge structural actions.

The calculation of the initial strains depends on the cross-frame type and the element formulation. The discussions below give the initial engineering strain calculations, suitable for use in a geometrically linear (i.e., first-order) elastic analysis, as well as rotated engineering strains and log strains, suitable for use in a geometrically nonlinear analysis in which the cross-frame element formulation is based on either of these strain measures. The geometrically nonlinear versions of the B31 (beam) and T3D2 (truss) elements utilized in ABAQUS are based on log strain. The tool uses a right-handed Cartesian coordinate system for straight skewed bridges and a cylindrical coordinate system for horizontally curved bridges. For straight bridges, the girders span in the positive direction of the X-axis and the non-skewed cross-frames are considered to frame between the girders in the positive direction of the Y-axis. The coordinate origin is at the start of Girder 1 which is the bottom girder on the plan view for straight bridges. For curved bridges, $\theta = 0$ in the cylindrical coordinate system is taken at the intersection of a ray from the center of curvature with the centerline of the bridge cross-section.

The initial strain calculation varies depending on whether the analysis being conducted is geometrically linear (first-order) or geometrically nonlinear (second-order), and if the analysis is second-order, the strain measure upon which the elements used to model the cross-frame members are based. Geometrically linearly (first-order) elements are based on engineering strain, whereas common geometrically nonlinear element formulations are often based on rotated engineering strain or log strain. For X-type cross-frames, the cross-frame initial strains are calculated for these different cases as follows:

(1) Initial engineering strain:

$$\varepsilon = \frac{L' - L_o}{L_o} \quad \text{Eq. (2a)}$$

where:

$$L' = \frac{L_x L_{xo} + L_y L_{yo} + L_z L_{zo}}{L_o} \quad \text{Eq. (2b)}$$

= Projection of the cross-frame member length corresponding to the girder fully-cambered geometries onto the targeted dead load orientation of the member; the member length being projected here is the length that the cross-frame members must be stretched or compressed to in order to connect to the girders in their fully-cambered geometries.

L_o = Cross-frame member length in the targeted dead load condition.

L_x, L_y, L_z = Cross-frame member length components in the fully-cambered geometry of the bridge system, corresponding to the global X, Y, and Z directions, respectively; for curved bridges, the lengths in the R, θ, Z coordinates are transformed to a global X, Y, Z system for this calculation.

L_{xo}, L_{yo}, L_{zo} = Cross-frame member length components in the targeted dead load geometry of the bridge system, corresponding to the X, Y, and Z global directions, respectively.

(2) Initial rotated engineering strain:

$$\varepsilon = \frac{L - L_o}{L_o} \quad \text{Eq. (3)}$$

where

L = Cross-frame member length in the fully-cambered geometry of the bridge system

(3) Initial log strain:

$$\varepsilon = \ln \frac{L}{L_o} \quad \text{Eq. (4)}$$

For V or inverted-V cross-frames, when the girders are in their plumb fully-cambered position, the positions of the chord middle node where the diagonals frame in cannot be found by kinematics alone. GT-LOFT has a built-in matrix analysis that solves for the engineering initial strains based on the displacements calculated at each of the cross-frame work points on the girders. For the rotated engineering or log initial strains, the tool calculates the location of the chord middle node in the geometry corresponding to the fully-cambered girder profiles from a geometric linear structural analysis and then solves for the rotated engineering and log initial strains via Eqs. (3) and (4). Benchmark studies show that there is negligible error associated with the determination of the middle node displacements by this simpler geometrically linear analysis, followed by calculation of the rotated engineering or log initial strains.

The Excel spreadsheet has three input worksheets: General, Cross-Frames, and Section Changes. In the General sheet, the user specifies the negative of the girder SDL vertical displacements (defined as the "SDL cambers") for SDLF detailing and the negative of the girder TDL vertical displacements (the TDL cambers) for TDLF detailing. In addition, the user specifies the girder depths, the girder lengths, the girder spacing, the distance from each girder bearing radial line (i.e., the line perpendicular to the girder tangent at each bearing) to the coordinate origin (or simply the distance along the X axis to each bearing for straight skewed bridges), the number of girders, and the elastic modulus.

GT-LOFT presently addresses only circular horizontal curves. The user specifies the location of the bearing at the start of each girder as a distance along the girder arc from the radial line corresponding to $\theta = 0$. The cross-frame connection work point positions are then specified as a distance along the girder arc from bearing at the start of the girder. The elastic modulus and the coefficient of thermal expansion are used by the tool to convert the calculated initial strains into initial stresses and equivalent temperature changes respectively, to facilitate input into programs that may support only a thermal strain analysis.

In the Cross-Frames sheet, the user provides the positions of cross-frames along the girders, the cross-frame types (X, V, and Inverted-V), the offsets of the chords from the top and bottom of the web, and the cross-frame member cross-section properties. The cross-frame properties are used for the matrix analysis to determine the V or Inverted-V type cross-frame initial strains.

GT-LOFT uses the cambers specified at the bottom of the girder webs to perform its calculations. The vertical displacements due to the camber are essentially the same at the top of the girder webs; however, the bottom of the webs is a more convenient reference for ultimately determining the position of the cross-frame to girder connection work points, for reasons explained in the discussions below. The camber profile curve may be defined using 11 to 21 camber points for the span under consideration. GT-LOFT fits a piecewise cubic hermite interpolating polynomial function to these points to represent the camber profiles and the associated major-axis bending rotations at the cross-frame locations. This function generates a smooth curve with continuous first derivatives for the camber profiles. The camber profiles pass through the specified camber points and the girder simply-supported ends, where the second derivative of the interpolated vertical displacements is zero. For continuous spans, the cambers for each span should be specified into the adjacent span up to the approximate inflection point location, typically taken as 0.20*L* or 0.25*L* in the adjacent span, where *L* is the adjacent span length. This practice allows the interpolating functions to be ended where the second derivative of the vertical displacements is approximately zero.

In addition to the above camber profile curve, GT-LOFT calculates the longitudinal position of the points along the bottom flange at the cross-frame connection locations as explained below. The lengths along the girder bottom flange projected onto the girder longitudinal axis change due to the major-axis bending rotations associated with the cambers, as shown in Figure 224 for TDLF. To account for this change, GT-LOFT provides the sheet Section Changes, for input of girder dimensions. The tool assumes that the total length along the girder centroidal axis is unchanged and that the connection plates are perpendicular to the flanges. All the girders are assumed as fixed longitudinally at the bottom flange at the girder left-hand ends in the elevation views of the members. As such, the longitudinal positions of the bottom flange at the cross-frame locations are calculated in the fully-cambered geometry as follows:

$$\bar{X} = X - d_0\,\phi_0 + d_{CF}\,\phi_{CF} - \sum_{i=1}^{n}(d_i - d_{i-1})\,\phi_i \qquad \text{Eq. (5)}$$

where:

$\bar{X}$ = Longitudinal position of the bottom flange at a cross-frame location, in the plumb fully-cambered geometry.

X = Longitudinal position of the bottom flange at the cross-frame location, in the plumb targeted dead load condition.

d_i = Distance from the girder centroid to the bottom flange at the ith section change location, where location 0 corresponds to the starting end of the girder.

d_{CF} = Distance from the centroid to the bottom flange at the cross-frame location under consideration.

n = The number of section changes between the girder start and the cross-frame location. The girders are assumed to be prismatic between the locations where there is a section change.

ϕ_i = Major-axis bending rotation due to the camber, in the fully-cambered geometry, at the ith section change location, positive counter-clockwise.

ϕ_{CF} = Major-axis bending rotation due to the camber, in the fully-cambered geometry, at the cross-frame location under consideration, positive counter-clockwise.

The term $d_0\phi_0$ in Eq. (5) gives the shift in the girder centroid at the starting end of the girder, along the girder axis, due to the major-axis bending rotation at that point, ϕ_0. The term $d_{CF}\phi_{CF}$ gives the shift in the position along the bottom of the web relative to the girder centroid due to the major-axis bending rotation ϕ_{CF} at that location. The term $\sum_{i=1}^{n}(d_i - d_{i-1})\,\phi_i$ gives the shift in the longitudinal coordinate of the girder centroid from all the section change locations between the starting end of the girder and the cross-frame that is being considered.

Given the above equation, the longitudinal and vertical coordinates can be determined at the bottom of the web for each of the cross-frame connection locations in the targeted SDL or TDL geometry, as well as in the fully-cambered geometry. In addition, the girder camber rotations can be determined at each of the connection locations. Given this information, the longitudinal and vertical positions of all the cross-frame connection work points can be calculated. Given these work point positions in the targeted geometry and in the fully-cambered geometry, the desired strains can be determined from Eqs. (2) through (4) and the work point vertical and longitudinal camber displacements can be computed.

For curved bridges, the above calculations are applied along the arc of the girder and the cross-frame work point coordinates are maintained along the girder arc, both in the plumb targeted dead load condition and in the plumb fully-cambered positions of the girders. That is, the *R* coordinates of the cross-frame connection work points are not allowed to change.

3.9.2.3 Calculation of Initial Fixed-End Forces for 2D Grid Analysis using GT-LOFT

In a 2D Grid analysis, the cross-frames are represented by equivalent beam elements. In addition, in this type of analysis, the depth of the superstructure is not considered. The girders, cross-frames and bearings are all modeled at a common elevation. There are various forms of 2D Grid analysis, some of which use a reduced degree of freedom set (the vertical displacement and rotations about two axes within the plane of the bridge model). In the work presented here, it is assumed that three translational and three rotational degrees of freedom (dofs) are tracked at each node of the grid model. The discussions below focus on the calculation of the fixed-end forces in the cross-frame equivalent beam elements associated with the lack-of-fit from SDLF or TDLF detailing. It is assumed that the 2D Grid analysis is a geometrically linear (i.e., first-order) elastic analysis. To calculate the equivalent beam element fixed-end forces, GT-LOFT resolves the displacements at the cross-frame work points, calculated as discussed in Section 3.9.2.2, into beam element end displacements and rotations using the assumption that the nodes of the 2D Grid model are at the mid-height of the cross-frame at each of the cross-frame ends.

One should note that the equivalent beam element end rotations associated with the lack-of-fit calculation are nonzero only within the plane of the girder web. This is because the girder webs are taken as plumb in both the NL and the targeted SDL or TDL geometry. Figure 225 shows an elevation view of a representative cross-frame and its equivalent beam element. Specifically, the equivalent beam element end displacements and rotations are calculated by GT-LOFT as follows:

$$u_{Ii} = \frac{u_{Ai} + u_{Bi}}{2} \qquad \text{Eq. (6)}$$

$$u_{IIi} = \frac{u_{Ci} + u_{Di}}{2} \qquad \text{Eq. (7)}$$

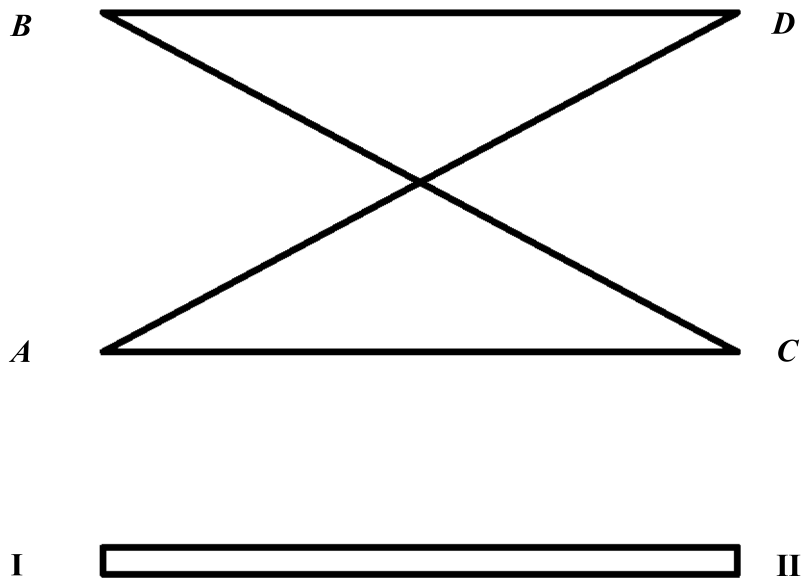


Figure 225. Illustration of a representative cross-frame (top) and its equivalent beam element (bottom). The cross-frame work points are labeled A through D. The ends of the equivalent beam element are labeled I and II.

$$\phi_I = \frac{u_B - u_A}{h} \quad \text{Eq. (8)}$$

$$\phi_{II} = \frac{u_D - u_C}{h} \quad \text{Eq. (9)}$$

where:

u_{Ii} = Displacement in the *i*th direction at the equivalent beam element end I.

u_{IIi} = Displacement in the *i*th direction at the equivalent beam element end II.

u_{Ai} = Displacement in the *i*th direction at the cross-frame work point *A*, similar for work points *B*, *C* and *D*

u_A = Displacement tangent to the girder longitudinal axis at cross-frame work point *A*, similar for work points *B, C* and *D*

ϕ_I = Rotation of the equivalent beam element about the axis normal the girder web ϕ at the element end I.

ϕ_{II} = Rotation of the equivalent beam element about the axis normal the girder web at the element end II.

i = X, Y, and Z directions in the right-handed Cartesian coordinate system for straight bridges. R, θ, and Z directions in the cylindrical coordinate system for curved bridges.

h = Depth of the cross-frame, taken as the distance between the cross-frame top and bottom chords.

The element end displacements and rotations are calculated in the global coordinate system, which is an XYZ Cartesian system for straight skewed bridges and an RθZ cylindrical coordinate system for horizontally curved bridges with or without skew. In straight skewed bridges, the cross-frame end vertical displacements and the rotations about the Y-axis (the axis normal to the girder webs) have the greatest impact on the cross-frame equivalent beam fixed-end forces. In curved bridges, the cross-frame end vertical displacements and the rotations about the R-axis (the axis normal to the girder webs) have the greatest impact on the cross-frame equivalent beam fixed-end forces.

The above element end displacements and rotations are used to calculate the initial fixed-end forces as follows:

$$f_{initial} = k_{equivalent} d_{LOF} \qquad \text{Eq. (10)}$$

where:

$k_{equivalent}$ = Stiffness of the equivalent beam element in the bridge global coordinates (12x12 matrix).

d_{LOF} = Lack-of-fit end displacements and rotations of the equivalent beam element in the bridge global coordinates, calculated based on the displacements of the cross-frame work points from the targeted SDL or TDL geometry to the fully-cambered geometry, using the above assumption that girder webs are plumb under the no-load and the targeted SDL or TDL geometries (12x1 vector).

$f_{initial}$ = Initial fixed-end forces of the equivalent beam element, calculated in the bridge global coordinates (12x1 vector).

The above calculation applies to all cross-frame types (X, V, and inverted V) and to geometrically linear (first-order) analysis. Depending on the element formulation, the above element stiffness $k_{equivalent}$ varies. GT-LOFT provides the calculations of initial fixed-end forces for the following equivalent beam element formulations:

- The Euler-Bernoulli beam element based on the traditional flexural analogy or shear analogy approximations,
- The Timoshenko beam element, which is recommended in NCHRP Report 725, and
- An "exact" equivalent beam element (Sanchez 2011).

GT-LOFT calculates the moment of inertia for bending within the plane of the cross-frame for the equivalent Euler-Bernoulli beam element based either on the flexural analogy or shear analogy as explained in Sections 3.2.3.1 and 3.2.3.2 of NCHRP Report 725. GT-LOFT calculates the moment of inertia and the shear area for bending within the plane of the cross-frame for the equivalent Timoshenko beam element via the calculations presented in Section 3.2.3.3 of the NCHRP Report 725. For both the equivalent Euler-Bernoulli and Timoshenko beam elements, the area *A*, the torsional constant *J*, and the moment of inertia for out-of-plane bending of the cross-frame are taken as the sum of the corresponding values of the cross-frame top and bottom chords.

The cross-frame initial fixed-end forces calculated above appear in the global matrix equations for a 2D Grid analysis as follows:

$$F = F_{initial} + K D \qquad \text{Eq. (11)}$$

where:

K = Global stiffness matrix of the bridge system.

D = Vector of the global nodal displacements in the bridge system.

$F_{initial}$ = Global vector of equivalent beam element nodal initial fixed-end forces, assembled from the individual element $f_{initial}$ vectors.

F = Global nodal forces applied to the 2D Grid model of the bridge system.

One can subtract $F_{initial}$ from both sides of Eq. (11) to observe that the overall global effect of the lack-of-fit induced by the SDLF or TDLF detailing is generated by applying the negative of $F_{initial}$ at the nodal degrees of freedom in the global 2D Grid analysis model. The force vector $-F_{initial}$ causes global nodal displacements D, which offset the dead load torsional rotations of the girders. It should be emphasized that the actual cross-frame "locked-in" forces are then calculated as

$$f_{locked\text{-}in} = f_{initial} + k_{equivalent}\, d \qquad \text{Eq. (12)}$$

where $f_{initial}$ is the element fixed-end force vector calculated in Eq. (10), $k_{equivalent}$ is the equivalent beam element stiffness matrix, and d is the element displacements associated with the global nodal displacements D caused by $-F_{initial}$. The total cross-frame dead load force is equal to the above force plus the cross-frame forces caused by the global dead load nodal forces F.

3.9.3 Examples Showing Inclusion of the Detailing Effects via Initial Strains in 3D FEA

This section illustrates the inclusion of the initial strains due to the detailing effects, calculated by GT-LOFT, in the 3D FEA of a straight skewed bridge NISSS4, not studied in the previously considered bridge cases, and a curved radially-supported Bridge (B) NISCR2. These two bridges were selected because they are relatively small simple-span bridges. In addition, the number of cross-frames are relatively low, thus facilitating the illustration of the initial strain calculations. Complete sets of results showing the responses of bridge NISSS4 and Bridge (B) NISCR2 are provided in Appendices V-1 and B-4, respectively. The SDLF and TDLF detailing effects are included in these studies via the initial strains calculated by GT-LOFT. The geometric nonlinearity in bridge NISSS4 and Bridge (B) NISCR2 is essentially negligible. Therefore, Appendices V-1 and B-4 effectively show the same results as obtained from a geometrically linear (first-order) elastic analysis and using the initial engineering strains from GT-LOFT.

The initial strains for SDLF and TDLF detailing calculated by GT-LOFT are identical for all practical purposes to the initial strains for SDLF and TDLF detailing calculated by 3D FEA using the procedure discussed in Section 3.9.2.1. Correspondingly, the bridge responses are identical for all practical purposes using the initial strains from GT-LOFT and the initial strains from the procedure described in Section 3.9.2.1.

3.9.3.1 Straight Skewed Bridge Example, NISSS4

Figure 226 shows the framing plan for straight skewed bridge NISSS4. This bridge has a span length of 150 ft and a severe parallel skew of 70 degrees. All the girders have the same prismatic section (1.125 inch x 16 inch top flanges and 2 inch x 18 inch bottom flanges) throughout the bridge length. The intermediate cross-frames are X type, and the end cross-frames are inverted-V type. All cross-frame members are L6x6x1. The girders are 72 inches deep and are designated G1 to G4, starting at the bottom and proceeding to the top of the plan view as shown in Figure 226.

Figure 227 shows the SDL and TDL LGA cambers, determined as explained in Section 2.6. Tables 64 and 65 show the initial engineering strains and the initial log strains calculated by GT-LOFT for SDLF detailing. The initial rotated engineering strains are not shown since they are essentially equal to the initial log strains. Tables 66 and 67 show the initial engineering strains and the initial log strains calculated by GT-LOFT for TDLF detailing. In these tables, the columns indicate the bays between the designated girders, i.e., column G1-G2 indicates the bay between G1 and G2. The rows indicate the cross-frames in the order from left to right in the plan view within each bay, i.e., row 1 corresponds to the cross-frames on the left-hand skewed bearing line, row 2 corresponds to the left-most intermediate cross-frame within the span in a given bay, etc. "Diagonal 1" is the diagonal framing from the lower-left to the upper-right in the X-type cross-frames in an elevation view looking from the starting end of the bridge, "Diagonal 1" is the left-hand diagonal in this elevation view for the inverted-V cross-frames.

One can observe from these tables that the initial strains are much higher for the diagonals than for the chords. This is because the diagonals have higher initial vertical and rotational lack-of-fit. The bottom chords have very low initial strains. In addition, the initial strains for TDLF detailing are higher than the initial strains for SDLF detailing. This is because the TDL cambers are larger than the SDL cambers (see Figure 227). The intermediate cross-frame top chords and bottom chords have zero initial engineering strains. These members are perpendicular to the girder webs and the offsets from the bottom flanges to the bottom chords are all the same. The chord lengths projected onto the member orientation in the targeted DL condition are the same as the chords lengths in the targeted DL condition.

Figures 228 and 229 show the girder layovers and twists from a geometrically linear analysis using the initial engineering strains versus from a geometrically nonlinear analysis using the initial log strains under SDL and TDL. One can see that, with the calculated initial strains included in the structural analysis, the girder webs are essentially plumb under SDL for SDLF detailing and under TDL for TDLF detailing. The difference in layovers between the geometrically linear analysis with initial engineering strains and the geometrically nonlinear analysis with initial log strains are negligible for bridge NISSS4. Appendix V provides detailed results and a brief discussion of other responses for this bridge.

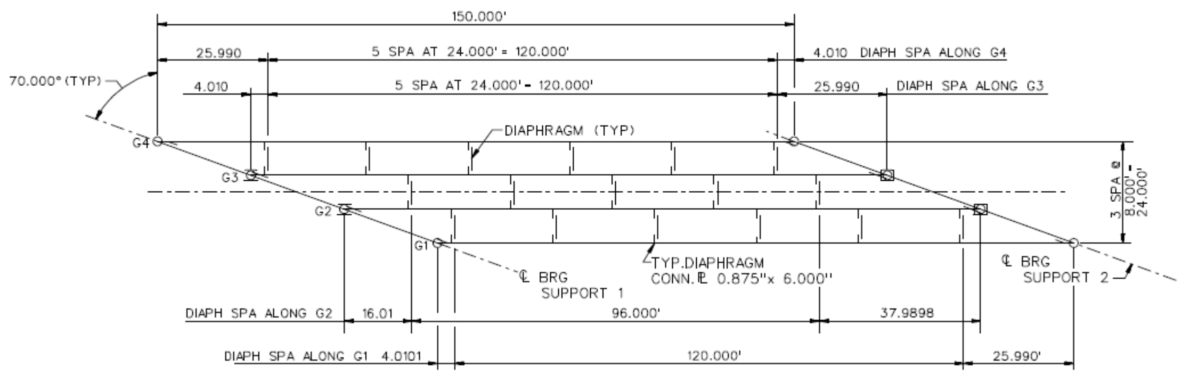


Figure 226. Bridge NISSS4 framing plan.

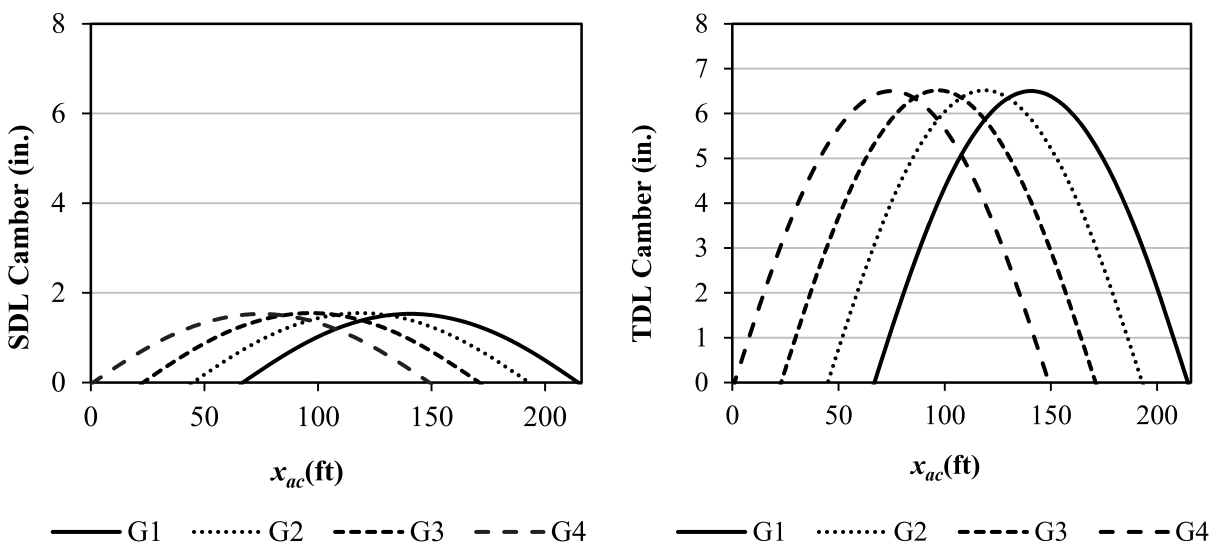


Figure 227. Bridge NISSS4 SDL cambers (left) and TDL cambers (right) from LGA.

Table 64. Bridge NISSS4 SDLF initial engineering strains based on LGA cambers and obtained from GT-LOFT (x10[6], '--' indicates that the value is not available because there is no cross-frame member that location).

CF #	Bottom Chords			Top Chords 1			Top Chords 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	0.21	-1.54	0.25	-525.38	-539.60	-512.99	530.26	503.92	518.76
2	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--
3	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--
4	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--
5	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--
6	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--
7	0.00	-1.54	0.00	0.00	503.92	0.00	--	-539.60	--
8	1.14	--	-6.54	515.62	--	533.77	-513.70	--	-506.34

Table 64 (Continued). Bridge NISSS4 SDLF initial engineering strains based on LGA cambers and obtained from GT-LOFT (x10[6] , '--' indicates that the value is not available because there is no cross-frame member that location).

CF #	Diagonals 1			Diagonals 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	579.28	572.62	566.17	-579.28	-572.64	-566.17
2	3246.63	2753.10	3195.80	-3248.61	-2754.60	-3197.73
3	2220.20	1514.25	2250.37	-2221.19	-1514.80	-2251.37
4	760.12	-0.06	823.97	-760.32	-0.06	-824.18
5	-822.04	-1514.80	-787.19	821.82	1514.25	786.98
6	-2236.28	-2754.60	-2271.19	2235.28	2753.10	2270.19
7	-3189.21	-572.64	-3266.02	3187.28	572.62	3264.09
8	-564.84	--	-570.80	564.85	--	570.72

Table 65. Bridge NISSS4 SDLF initial log strains based on LGA cambers and obtained from GT-LOFT (x10^6, '--' indicates that the value is not available because there is no cross-frame member that location).

CF #	Bottom Chords			Top Chords 1			Top Chords 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	0.21	-1.54	0.25	-525.52	-539.75	-513.12	530.12	503.79	518.62
2	24.89	17.91	24.12	24.91	17.95	24.13	--	--	--
3	11.66	5.44	11.98	11.71	5.51	12.02	--	--	--
4	1.40	0.04	1.64	1.46	0.13	1.70	--	--	--
5	1.63	5.44	1.50	1.69	5.51	1.56	--	--	--
6	11.82	17.91	12.19	11.86	17.95	12.24	--	--	--
7	23.99	-1.54	25.16	24.01	503.79	25.17	--	-539.75	--
8	1.14	--	-6.54	515.48	--	533.63	-513.84	--	-506.47

Table 65 (Continued). Bridge NISSS4 SDLF initial log strains based on LGA cambers and obtained from GT-LOFT (x10^6, '--' indicates that the value is not available because there is no cross-frame member that location).

CF #	Diagonals 1			Diagonals 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	579.23	572.57	566.12	-579.34	-572.69	-566.22
2	3254.25	2758.56	3203.19	-3240.75	-2748.88	-3190.12
3	2223.74	1515.89	2254.01	-2217.49	-1513.03	-2247.58
4	760.52	-0.05	824.44	-759.87	-0.05	-823.66
5	-821.51	-1513.03	-786.71	822.29	1515.89	787.41
6	-2232.53	-2748.88	-2267.34	2238.87	2758.56	2273.88
7	-3181.63	-572.69	-3258.12	3194.64	572.57	3271.76
8	-564.89	--	-570.85	564.80	--	570.67

Table 66. Bridge NISSS4 TDLF initial engineering strains based on LGA cambers and obtained from GT-LOFT (x10⁶, '--' indicates that the value is not available because there is no cross-frame member that location)

CF #	Bottom Chords			Top Chords 1			Top Chords 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	0.83	-6.11	0.99	-2085.5	-2142.0	-2036.3	2104.9	2000.3	2059.2
2	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--
3	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--
4	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--
5	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--
6	0.00	0.00	0.00	0.00	0.00	0.00	--	--	--
7	0.00	-6.11	0.00	0.00	2000.3	0.00	--	-2142.0	--
8	4.52	--	-25.96	2046.8	--	2118.86	-2039.2	--	-2009.9

Table 66 (Continued). Bridge NISSS4 TDLF initial engineering strains based on LGA cambers and obtained from GT-LOFT (x10⁶, '--' indicates that the value is not available because there is no cross-frame member that location).

CF #	Diagonals 1			Diagonals 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	2299.51	2273.08	2247.46	-2427.01	-242.75	-2458.12
2	12880.04	10924.60	12678.23	-12911.38	-10948.19	-12708.70
3	8812.08	6011.36	8931.71	-8827.78	-6019.90	-8947.47
4	3018.05	-0.87	3271.57	-3021.24	-0.87	-3274.93
5	-3266.40	-6019.90	-3128.03	3263.03	6011.36	3124.70
6	-8887.55	-10948.19	-9026.30	8871.79	10924.60	9010.56
7	-12674.86	-2273.22	-12979.75	12644.48	2273.08	12949.29
8	-2242.22	--	-2265.89	2242.20	--	2265.52

Table 67. Bridge NISSS4 TDLF initial log strains based on LGA cambers and obtained from GT-LOFT (x10^6, '--' indicates that the value is not available because there is no cross-frame member that location).

CF #	Bottom Chords			Top Chords 1			Top Chords 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	0.83	-6.11	0.99	-2087.75	-2144.32	-2038.45	2102.71	1998.38	2057.16
2	392.22	282.17	380.02	392.81	283.19	380.51	--	--	--
3	183.83	85.73	188.80	184.80	86.98	189.70	--	--	--
4	22.11	0.63	25.90	23.05	2.08	26.86	--	--	--
5	25.75	85.73	23.69	26.72	86.98	24.66	--	--	--
6	186.28	282.17	192.18	187.19	283.19	193.17	--	--	--
7	378.00	-6.11	396.41	378.50	1998.38	396.90	--	-2144.32	--
8	4.52	--	-25.96	2044.72	--	2116.62	-2041.29	--	-2012.00

Table 67 (Continued). Bridge NISSS4 TDLF initial log strains based on LGA cambers and obtained from GT-LOFT (x10^6, '--' indicates that the value is not available because there is no cross-frame member that location).

CF #	Diagonals 1			Diagonals 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	2298.70	2272.27	2246.69	-2300.37	-2273.98	-2248.28
2	12996.65	11008.54	12791.44	-12783.75	-10855.77	-12585.12
3	8866.89	6036.85	8987.94	-8768.16	-5991.59	-8886.40
4	3024.40	-0.80	3278.98	-3014.06	-0.80	-3266.63
5	-3258.12	-5991.59	-3120.37	3270.41	6036.85	3131.49
6	-8827.18	-10855.77	-8964.30	8927.36	11008.54	9067.56
7	-12551.89	-2273.98	-12851.45	12757.10	2272.27	13066.69
8	-2242.99	--	-2266.59	2241.45	--	2264.67

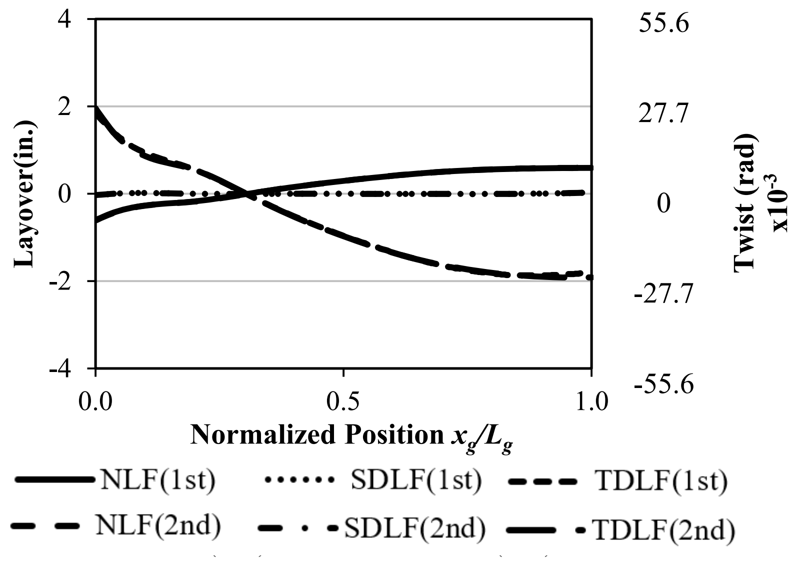


Figure 228. Layovers of fascia girder G1 of bridge NISSS4 under SDL. The (1st-order) layovers are from a geometrically linear 3D FEA using the initial engineering strains. The (2nd-order) layovers are from a geometrically nonlinear 3D FEA using the initial log strains.

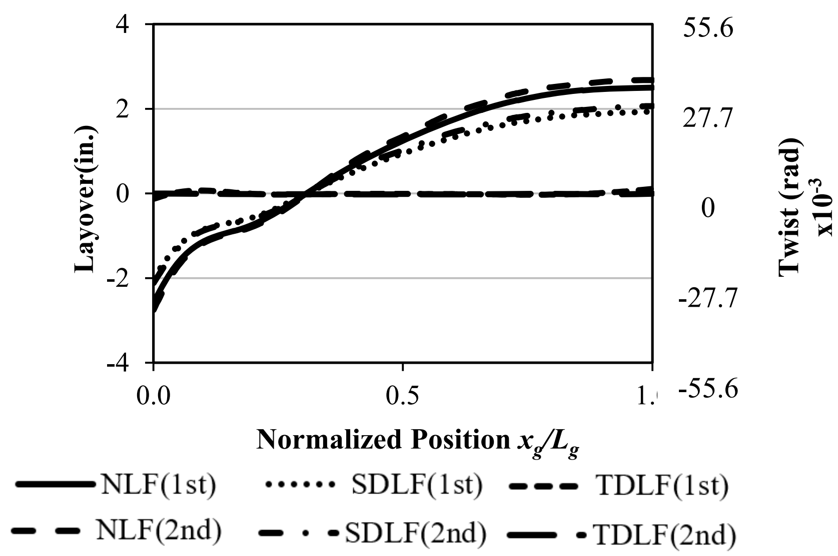


Figure 229. Layovers of fascia girder G1 of bridge NISSS4 under TDL. The (1st-order) layovers are from a geometrically linear 3D FEA using the initial engineering strains. The (2nd-order) layovers are from a geometrically nonlinear 3D FEA using the initial log strains.

3.9.3.2 Curved Radially-Supported Bridge Example, NISCR2

Figure 230 shows the framing plan for the curved radially-supported Bridge (B) NISCR2. This bridge has a span length of 150 ft and centerline radius of curvature of 438 ft. All of the girders have four section changes along the span. The intermediate cross-frames are X type, and the end cross-frame are inverted-V type. All the cross-frame members are L6x6x3/4. A detailed description of this bridge is provided in Appendix B1. The girders are 84 inches deep and are designated G1 to G4, where G1 and G4 are the girders on the outside and the inside of the curve as shown in Figure 230.

Figure 231 shows the SDL and TDL 3D FEA cambers for Bridge (B) NISCR2. These cambers have a significant influence on the calculation of the initial strains. Tables 68 and 69 show the initial engineering and log strains calculated by GT-LOFT for SDLF detailing. The initial rotated engineering strains are not shown since they essentially equal to the initial log strains. Tables 70 and 71 show the initial engineering and log strains calculated by GT-LOFT for TDLF detailing. In these tables, the columns indicate the bays between the designated girders, i.e., column G1-G2 indicates the bay between G1 and G2. The rows indicate the cross-frames in the order from left to right in each bay, i.e., row 1 indicates cross-frames on the left-hand bearing line. "Diagonal 1" is the diagonal framing from the lower-left to the upper-right in the X-type cross-frames in an elevation view looking from the starting end of the bridge, "Diagonal 1" is the left-hand diagonal in this elevation view for the inverted-V cross-frames.

One can observe from these tables that the initial strains are much larger for the diagonals than the chords. The top and bottom chords have relatively low initial strains with respect to the diagonals. This is because the diagonals have larger initial vertical and rotational lack-of-fit. In addition, the initial strains for TDLF detailing are larger than the initial strains for SDLF detailing. This is because the TDL cambers are larger than the SDL cambers (see Figure 231). The intermediate cross-frame top and bottom chords have close to zero initial engineering strains. The slightly non-zero values for these strains are due to the fact that the girders toward the outside of the curve have larger deflections and rotations than the girders toward the inside of the curve. The cross-frame connection work point camber displacements are forced to maintain constant R when the cambers are imposed.

Figures 232 and 233 show the girder layovers and twists from a geometrically linear analysis using the initial engineering strains versus a geometrically nonlinear analysis using the log strains. These figures correspond to SDL and TDL respectively. One can see that, with the initial strains calculated by GT-LOFT included in the analysis, the girder webs are approximately plumb under SDL for SDLF detailing and under TDL for TDLF detailing. The difference in layovers between the geometrically linear analysis with initial engineering strains and the geometrically nonlinear analysis with initial log strains are very small for Bridge (B) NISCR2. Appendix B-4 provides detailed results and a brief discussion for other responses for this bridge.

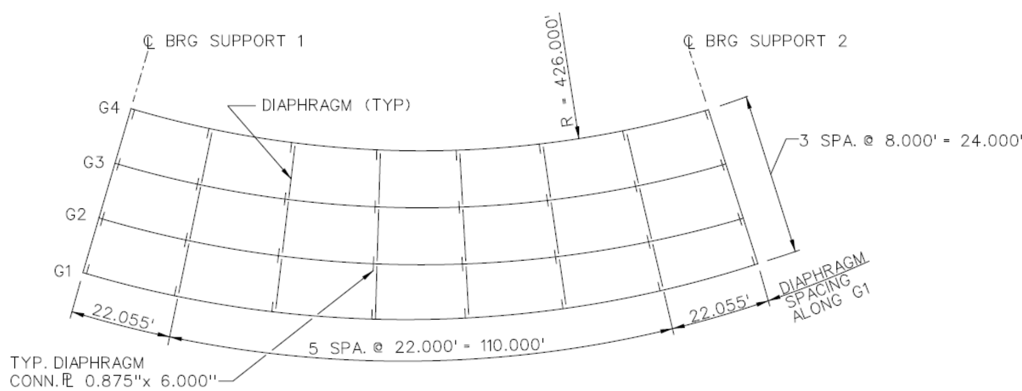


Figure 230. Bridge (C) NISCR2 framing plan

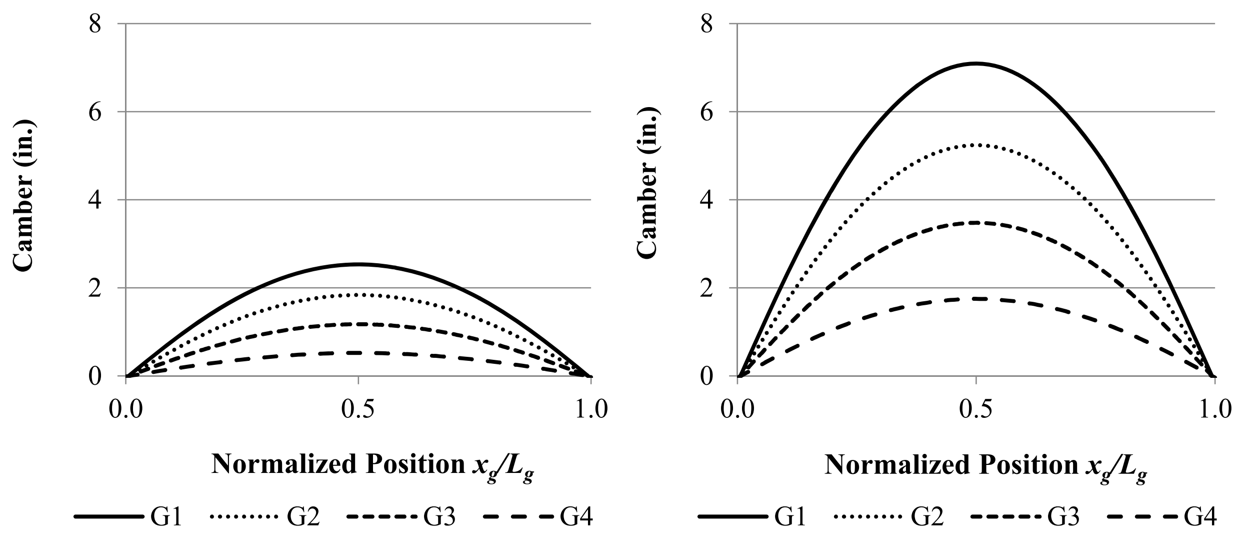


Figure 231. Bridge (C) NISCR2 SDL cambers (left) and TDL 3D FEA cambers (right) based on 3D FEA.

Table 68. Bridge (C) NISCR2 SDLF initial engineering strains based on 3D FEA cambers and obtained from GT-LOFT (x10^6, '--' indicates that the value is not available because there is no cross-frame member that location).

CF #	Bottom Chords			Top Chords 1			Top Chords 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	0.000	0.000	0.000	0.250	0.417	0.226	-0.250	-0.366	-0.226
2	-0.001	-0.001	-0.001	-0.047	-0.034	-0.020	--	--	--
3	-0.004	-0.003	-0.002	-0.032	-0.023	-0.014	--	--	--
4	-0.009	-0.006	-0.004	-0.019	-0.013	-0.009	--	--	--
5	-0.018	-0.012	-0.008	-0.008	-0.006	-0.004	--	--	--
6	-0.028	-0.019	-0.013	-0.002	-0.001	-0.001	--	--	--
7	-0.037	-0.026	-0.017	0.000	0.000	0.000	--	--	--
8	-0.072	-0.058	0.039	0.269	0.421	0.248	-0.269	-0.366	-0.248

Table 68 (Continued). Bridge (C) NISCR2 SDLF initial engineering strains based on 3D FEA cambers and obtained from GT-LOFT (x10^6)

CF #	Diagonals 1			Diagonals 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	18.59	12.03	6.03	19.52	13.38	6.86
2	-1555	-1517	-1493	1555	1514	1493
3	-2707	-2631	-2597	2707	2631	2597
4	-3314	-3221	-3179	3314	3221	3179
5	-3310	-3217	-3179	3310	3217	3179
6	-2703	-2628	-2597	2703	2628	2597
7	-1555	-1514	-1493	1555	1514	1493
8	19.24	12.38	6.03	20.21	13.76	6.93

Table 69. Bridge (C) NISCR2 SDLF initial log strains based on 3D FEA cambers and obtained from GT-LOFT (x10[6], '--' indicates that the value is not available because there is no cross-frame member that location).

CF #	Bottom Chords			Top Chords 1			Top Chords 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	0.002	0.002	0.002	0.250	0.417	0.226	-0.250	-0.366	-0.226
2	5.241	4.966	4.828	5.586	5.310	5.241	--	--	--
3	15.9	15.0	14.7	16.1	15.2	14.9	--	--	--
4	23.9	22.6	22.0	23.9	22.6	22.1	--	--	--
5	23.9	22.6	22.1	23.8	22.5	22.0	--	--	--
6	16.0	15.2	14.9	15.9	15.0	14.6	--	--	--
7	5.517	5.207	5.138	5.207	4.966	4.793	--	--	--
8	0.306	0.284	0.466	0.269	0.421	0.248	-0.269	-0.366	-0.248

Table 69 (Continued). Bridge (C) NISCR2 SDLF initial log strains based on 3D FEA cambers and obtained from GT-LOFT (x10[6]).

CF #	Diagonals 1			Diagonals 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	18.59	12.03	6.03	19.52	13.38	6.86
2	-1555	-1514	-1493	1555	1514	1493
3	-2703	-2628	-2593	2707	2631	2600
4	-3307	-3214	-3172	3314	3221	3183
5	-3307	-3214	-3172	3314	3221	3179
6	-2697	-2624	-2590	2703	2631	2597
7	-1548	-1510	-1490	1552	1510	1490
8	19.24	12.38	6.03	20.21	13.76	6.93

Table 70. Bridge (C) NISCR2 TDLF initial engineering strains based on 3D FEA cambers and obtained from GT-LOFT (x10^6, '--' indicates that the value is not available because there is no cross-frame member that location).

CF #	Bottom Chords			Top Chords 1			Top Chords 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	-0.002	-0.002	-0.001	0.001	0.001	0.001	-0.001	-0.001	-0.001
2	-0.011	-0.008	-0.006	-0.345	-0.254	-0.171	--	--	--
3	-0.032	-0.021	-0.017	-0.241	-0.173	-0.122	--	--	--
4	-0.071	-0.049	-0.038	-0.144	-0.102	-0.074	--	--	--
5	-0.135	-0.094	-0.070	-0.064	-0.043	-0.034	--	--	--
6	-0.208	-0.146	-0.108	-0.021	-0.012	-0.012	--	--	--
7	-0.279	-0.194	-0.146	-0.002	0.000	-0.002	--	--	--
8	-0.417	-0.306	-0.022	0.001	0.001	0.001	-0.001	-0.001	-0.001

Table 70 (Continued). Bridge (C) NISCR2 TDLF initial engineering strains based on 3D FEA cambers and obtained from GT-LOFT (x10^6).

CF #	Diagonals 1			Diagonals 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	0.05	0.04	0.02	0.06	0.04	0.02
2	-4000	-3862	-3793	4000	3862	3793
3	-6931	-6724	-6621	6931	6724	6621
4	-8483	-8207	-8103	8483	8207	8103
5	-8483	-8207	-8103	8483	8207	8103
6	-6931	-6690	-6621	6931	6690	6621
7	-3966	-3862	-3793	3966	3862	3793
8	0.06	0.04	0.02	0.06	0.04	0.02

Table 71. Bridge (C) NISCR2 TDLF initial log strains based on 3D FEA cambers and obtained from GT-LOFT ($x10^6$, '--' indicates that the value is not available because there is no cross-frame member that location).

CF #	Bottom Chords			Top Chords 1			Top Chords 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	0.020	0.017	0.023	0.001	0.001	0.001	-0.001	-0.001	-0.001
2	34.8	32.6	31.7	36.9	34.8	34.3	--	--	--
3	104.8	98.3	95.9	106.2	99.7	97.6	--	--	--
4	157.2	147.2	144.1	157.9	147.9	144.5	--	--	--
5	157.6	147.6	144.5	157.2	147.2	143.8	--	--	--
6	105.9	99.3	97.2	104.5	97.9	95.5	--	--	--
7	36.2	34.1	33.9	34.4	32.3	31.5	--	--	--
8	2.307	1.952	3.072	0.001	0.001	0.001	-0.001	-0.001	-0.001

Table 71 (Continued). Bridge (C) NISCR2 TDLF initial log strains based on 3D FEA cambers and obtained from GT-LOFT ($x10^6$).

CF #	Diagonals 1			Diagonals 2		
	G1-G2	G2-G3	G3-G4	G1-G2	G2-G3	G3-G4
1	0.05	0.04	0.02	0.06	0.04	0.02
2	-3966	-3862	-3793	4000	3862	3793
3	-6931	-6690	-6621	6966	6724	6655
4	-8448	-8207	-8103	8517	8241	8138
5	-8448	-8172	-8103	8517	8241	8138
6	-6897	-6690	-6586	6931	6724	6621
7	-3966	-3828	-3793	3966	3862	3793
8	0.06	0.04	0.02	0.06	0.04	0.02

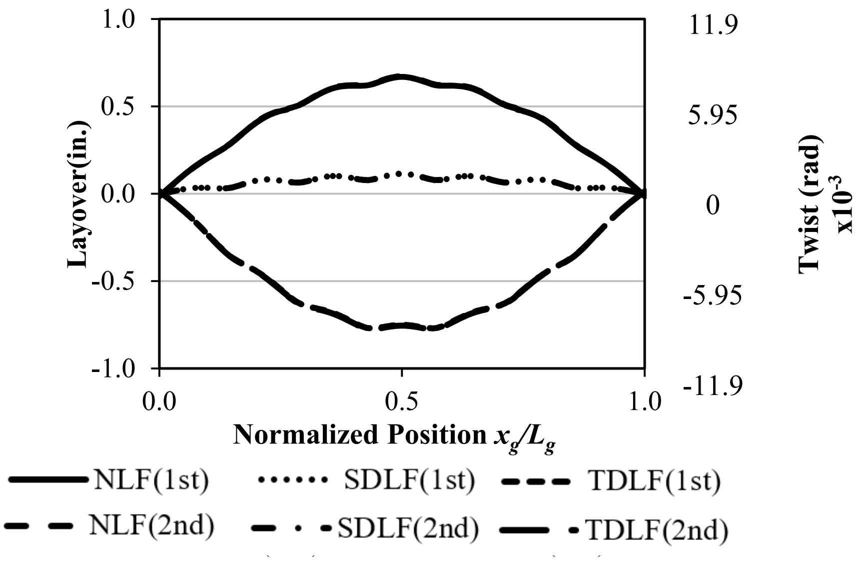


Figure 232. Layovers of the outside girder of Bridge (C) NISCR2 under SDL. The (1st-order) layovers are from a geometrically linear 3D FEA using the initial engineering strains. The (2nd-order) layovers are from a geometrically nonlinear 3D FEA using the initial log strains.

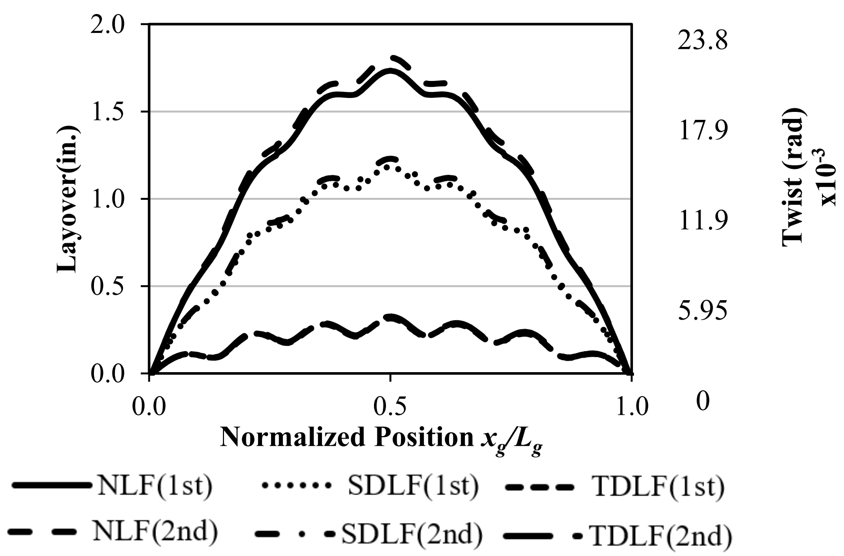


Figure 233. Layovers of the outside girder of Bridge (C) NISCR2 under TDL. The (1st-order) layovers are from a geometrically linear 3D FEA using the initial engineering strains. The (2nd-order) layovers are from a geometrically nonlinear 3D FEA using the initial log strains.

3.9.4 Examples Showing Inclusion of the Detailing Effects via Fixed-End Forces in 2D Grid Analysis

This section illustrates the inclusion of the fixed-end forces due to the detailing effects, calculated by GT-LOFT, in a 2D Grid analysis of the straight skewed bridge NISSS4 and the curved radially-supported Bridge (B) NISCR2. These two bridges were selected for this section for the same reasons explained in Section 3.9.3. The 2D Grid analysis results are compared to the 3D FEA results from Section 3.9.3. Complete sets of results showing the responses for bridge NISSS4 and Bridge (B) NISCR2 are shown in Appendices V-2 and B-6 respectively.

A 2D Grid analysis was developed in MATLAB to illustrate the incorporation of cross-frame detailing effects via initial fixed-end forces. The important aspects of the grid analysis conducted in section are as follows:

- The girders are modeled using Euler-Bernoulli beam elements.
- Equivalent St. Venant torsion constants, J_{eq}, are used for the I-girders as specified in the NCHRP 725 report. These constants account approximately for the contribution of warping to the girder torsional stiffness. A different value is calculated for each unbraced length. It is assumed that the warping is fixed at both ends in intermediate girder unbraced lengths and that the warping is free at the free end and fixed at the other end for end unbraced lengths.
- Each girder unbraced length is modeled by a single element for straight bridge NISSS4 and by two elements for the curved bridge NISCR2.
- The cross-frames are modeled using two approaches: an equivalent Euler-Bernoulli beam element with properties determined by the flexural analogy and equivalent Timoshenko beam element with properties determined as recommended in NCHRP Report 725. It is found that the responses for the example bridges used in this section are approximately the same for the two approaches. The results in this section are provided with the cross-frames modeled using the Timoshenko beam element.

3.9.4.1 Straight Skewed Bridge NISSS4 Example

The framing plan of bridge NISSS4 is shown in Section 3.9.3.1, Figure 226. The primary bridge characteristics are discussed in that section. The SDL and TDL cambers used below are LGA cambers determined using the grid model by removing the equivalent cross-frame elements and analyzing the girders as individual line elements. These LGA cambers are effectively the same as the LGA cambers determined from 3D FEA (shown in Figure 227).

Tables 72 and 73 show the initial fixed-end forces calculated by GT-LOFT for SDLF and TDLF detailing. In these tables, the columns indicate the initial fixed-end forces (dofs 1 to 3) and moments (dofs 4 to 6). These initial fixed-end forces and moments are shown in two groups corresponding to the beam element ends I and II. These forces and moments correspond to the global right-handed Cartesian coordinate system used for straight skewed bridges in GT-LOFT. The rows indicate the cross-frames in the order from left to right, i.e., row 1 indicates the cross-frames on the left-hand skewed bearing line, row 2 corresponds to the left-most intermediate cross-frame within the pan in a given bay, etc.

It is important to note that the initial fixed-end forces and moments in any equivalent beam element are (and must be) in static equilibrium, as shown in Figure 234 for the second equivalent beam element from the left skewed bearing line between girders 1 and 2.

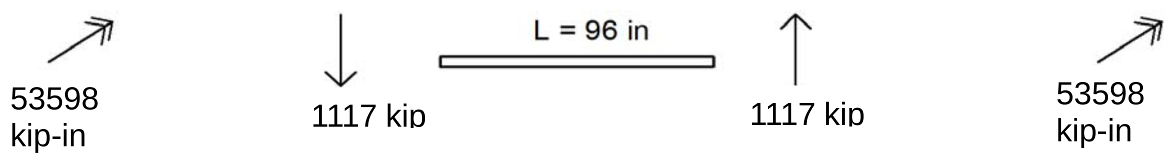


Figure 234. Illustration of static equilibrium of SDLF initial fixed-end forces and moments in the second equivalent beam element from the left skewed bearing line between Girders 1 and 2 of Bridge NISSS4.

The following are important observations from Tables 72 and 73:

- The largest fixed-end force values are in the columns corresponding to dof 3 (the vertical fixed-end forces) and dof 4 (the fixed-end moments about the X-axis). This is because, in determining the fixed-end forces, the equivalent beam element is subjected to vertical lack-of-fit displacements while the end rotations about the X-axis are restrained to enforce plumb girder webs in both the final targeted dead load position and in the initially-plumb cambered positions of the girders.
- The initial fixed-end forces in the X and Y axis directions, shown in the columns corresponding to dofs 1 and 2 in Tables 72 and 73, are zero or quite small compared to the values discussed above.

Table 72. Bridge NISSS4 SDLF initial fixed end forces based on LGA cambers and obtained from GT-LOFT.

Between	CF #	Equivalent Element End I Global DOF						Equivalent Element End II Global DOF					
		1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)	1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)
G1-G2	**1**	0	0	-73	-3498	-9619	0	0	0	73	-3498	-9619	0
	2	0	0	-1117	-53598	0	5	0	0	1117	-53598	0	5
	3	0	0	-766	-36769	-1	8	0	0	766	-36769	1	8
	4	0	0	-262	-12595	-1	10	0	0	262	-12595	1	10
	5	0	0	262	12595	-1	10	0	0	-262	12595	1	10
	6	0	0	766	36769	-1	8	0	0	-766	36769	1	8
	7	0	0	1117	53598	0	5	0	0	-1117	53598	0	5
	8	0	0	73	3498	9619	0	0	0	-73	3498	9619	0
G2-G3	**1**	0	0	-73	-3498	-9619	0	0	0	73	-3498	-9619	0
	2	0	0	-967	-46396	-1	7	0	0	967	-46396	1	7
	3	0	0	-527	-25287	-1	10	0	0	527	-25287	1	10
	4	0	0	0	0	-1	11	0	0	0	0	1	11
	5	0	0	527	25287	-1	10	0	0	-527	25287	1	10
	6	0	0	967	46396	-1	7	0	0	-967	46396	1	7
	7	0	0	73	3498	9619	0	0	0	-73	3498	9619	0

Table 72 (Continued). Bridge NISSS4 SDLF initial fixed end forces based on LGA cambers and obtained from GT-LOFT.

Between	**CF #**	**Equivalent Element End I Global DOF**						**Equivalent Element End II Global DOF**					
		1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)	1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)
G3-G4	**1**	0	0	-73	-3498	-9619	0	0	0	73	-3498	-9619	0
	2	0	0	-1117	-53598	0	5	0	0	1117	-53598	0	5
	3	0	0	-766	-36769	-1	8	0	0	766	-36769	1	8
	4	0	0	-262	-12595	-1	10	0	0	262	-12595	1	10
	5	0	0	262	12595	-1	10	0	0	-262	12595	1	10
	6	0	0	766	36769	-1	8	0	0	-766	36769	1	8
	7	0	0	1117	53598	0	5	0	0	-1117	53598	0	5
	8	0	0	73	3498	9619	0	0	0	-73	3498	9619	0

Table 73. Bridge NISSS4 TDLF initial fixed end forces based on LGA cambers and obtained from GT-LOFT.

Between	CF #	Equivalent Element End I Global DOF						Equivalent Element End II Global DOF					
		1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)	1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)
G1-G2	**1**	0	0	-289	-13885	-38185	0	0	0	289	-13885	-38185	0
	2	0	0	-4434	-212827	-2	19	0	0	4434	-212827	2	19
	3	0	-1	-3042	-146036	-3	34	0	1	3042	-146036	3	34
	4	0	-1	-1042	-50028	-4	39	0	1	1042	-50028	4	39
	5	0	-1	1042	50028	-4	39	0	1	-1042	50028	4	39
	6	0	-1	3042	146036	-3	34	0	1	-3042	146036	3	34
	7	0	0	4434	212827	-2	19	0	0	-4434	212827	2	19
	8	0	0	289	13885	38185	0	0	0	-289	13885	38185	0
G2-G3	**1**	0	0	-289	-13885	-38185	0	0	0	289	-13885	-38185	0
	2	0	-1	-3839	-184254	-3	27	0	1	3839	-184254	3	27
	3	0	-1	-2093	-100441	-4	38	0	1	2093	-100441	4	38
	4	0	-1	0	0	-4	43	0	1	0	0	4	43
	5	0	-1	2093	100441	-4	38	0	1	-2093	100441	4	38
	6	0	-1	3839	184254	-3	27	0	1	-3839	184254	3	27
	7	0	0	-289	-13885	-38185	0	0	0	289	-13885	-38185	0

Table 73 (Continued). Bridge NISSS4 TDLF initial fixed end forces based on LGA cambers and obtained from GT-LOFT.

Between	**CF #**	**Equivalent Element End I Global DOF**						**Equivalent Element End II Global DOF**					
		1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)	1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)
G3-G4	**1**	0	0	-289	-13885	-38185	0	0	0	289	-13885	-38185	0
	2	0	0	-4434	-212827	-2	19	0	0	4434	-212827	2	19
	3	0	-1	-3042	-146036	-3	34	0	1	3042	-146036	3	34
	4	0	-1	-1042	-50028	-4	39	0	1	1042	-50028	4	39
	5	0	-1	1042	50028	-4	39	0	1	-1042	50028	4	39
	6	0	-1	3042	146036	-3	34	0	1	-3042	146036	3	34
	7	0	0	4434	212827	-2	19	0	0	-4434	212827	2	19
	8	0	0	289	13885	38185	0	0	0	-289	13885	38185	0

- For the skewed cross-frames, to maintain compatibility between the cross-frames and the girders, the columns corresponding to dof 5 (the initial fixed-end moments about the Y-axis) are comparable to the moments about the X-axis.
- The initial fixed-end forces are larger for TDLF detailing than SDLF detailing. Obviously, this is because the displacements and rotations applied to the equivalent beam elements are larger for TDLF.

Figures 235 and 236 show the girder layovers and twists from a geometrically linear 2D Grid analysis using the initial fixed-end forces, calculated by GT-LOFT. These figures correspond to SDL and TDL respectively. The symbols on the curves correspond to the cross-frame locations. One can observe that, with the calculated initial fixed-end forces included in the grid analysis, the girder webs are essentially plumb under SDL for SDLF detailing and under TDL for TDLF detailing. It can been seen that the girder layovers and twists from Figures 235 and 236 closely match with those from Figures 228 and 229.

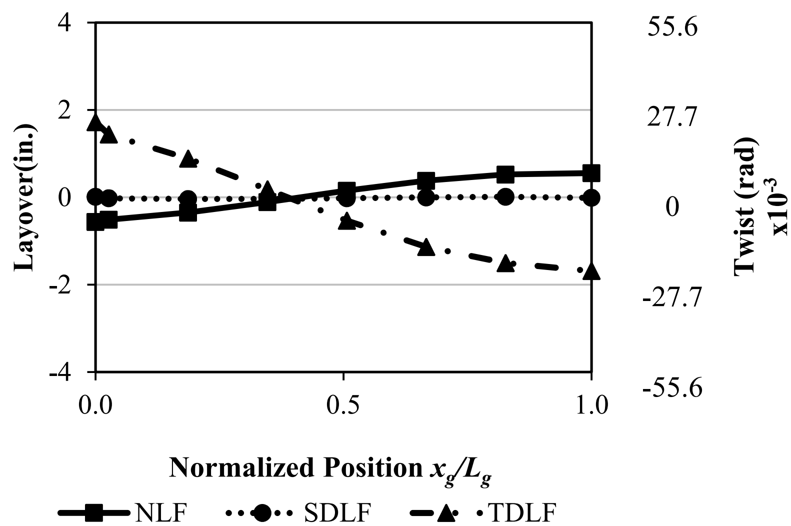


Figure 235. Layovers of fascia girder G1 of bridge NISSS4 under SDL. These are layovers are from a geometrically linear grid analysis using the initial engineering strains.

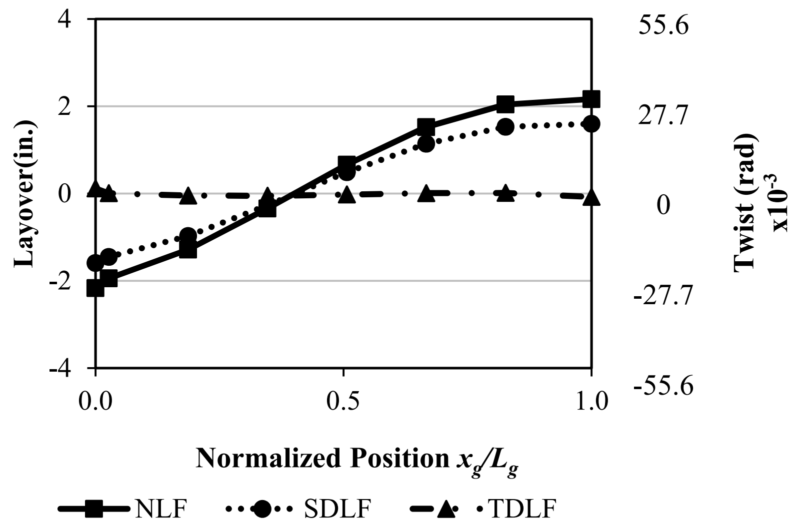


Figure 236. Layovers of fascia girder G1 of bridge NISSS4 under TDL. These are layovers are from a geometrically linear grid analysis using the initial engineering strains.

3.9.4.2 Curved Radially-Supported Bridge NISCR2 Example

The framing plan of Bridge (B) NISCR2 is shown in Section 3.9.3.2, Figure 230. The primary bridge characteristics are discussed in that section. The SDL and TDL cambers used below are obtained from a 2D Grid analysis. The cambers from the grid model are approximately the same as the 3D FEA cambers shown in Figure 231.

Tables 74 and 75 show the initial fixed-end forces calculated by GT-LOFT for SDLF and TDLF detailing respectively. In these tables, the columns indicate the initial fixed-end forces, as dofs 1 to 3, and moments, as dofs 4 to 6. These initial fixed-end forces and moments are shown in two groups corresponding to ends I and II of the cross-frames. These forces and moments are calculated in the tool's cylindrical coordinate system. The rows indicate the cross-frames in the order from left to right, i.e., row 1 indicates cross-frames on the left-hand bearing line.

The following are important observations from Tables 74 and 75:

- The largest values are in the columns corresponding to dof 3 (the vertical fixed-end forces) and dof 5 (the fixed-end moments about the θ axis). This is because, in determining the fixed-end forces, the equivalent beam element is subjected to vertical displacement while the end rotations about the θ axis are restrained to enforce plumb girder webs in both the final targeted dead load position and in the plumb fully-cambered positions of the girders.

- The initial fixed-end forces in the R and θ axis directions, indicated in the columns corresponding to dofs 1 and 2 in Tables 74 and 75, are zero.
- The initial fixed-end forces are larger for TDLF detailing than SDLF detailing since the displacements and rotations subjected to the equivalent beam element are larger for TDLF.

Figures 237 and 238 show the girder layovers and twists from a geometrically linear 2D Grid analysis using the initial fixed end forces, calculated by GT-LOFT. These figures correspond to the SDL and TDL conditions respectively. The symbols on the curves correspond to the cross-frame nodes. One can see that, with the calculated initial fixed-end forces included in the grid analysis, the girder webs are essentially plumb under SDL for SDLF detailing and under TDL for TDLF detailing. It can been seen that the girder layovers and twists from Figures 237 and 238 closely match with those from Figures 232 and 233. The plots in Figures 237 and 238 are obviously more discretized due to connecting the values at the nodal points in the grid analysis model by straight lines.

Table 74. Bridge NISCR2 SDLF initial fixed end forces based on 3D FEA cambers and obtained from GT-LOFT.

Between	CF #	Equivalent Element End I Global DOF						Equivalent Element End II Global DOF					
		1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)	1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)
G1-G2	**1**	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	508	0	24367	0	0	0	-508	0	24367	0
	3	0	0	883	0	42376	0	0	0	-883	0	42376	0
	4	0	0	1081	0	51878	0	0	0	-1081	0	51878	0
	5	0	0	1081	0	51878	0	0	0	-1081	0	51878	0
	6	0	0	883	0	42375	0	0	0	-883	0	42375	0
	7	0	0	508	0	24367	0	0	0	-508	0	24367	0
	8	0	0	0	0	0	0	0	0	0	0	0	0
G2-G3	**1**	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	453	0	21749	0	0	0	-453	0	21749	0
	3	0	0	787	0	37771	0	0	0	-787	0	37771	0
	4	0	0	963	0	46226	0	0	0	-963	0	46226	0
	5	0	0	963	0	46226	0	0	0	-963	0	46226	0
	6	0	0	787	0	37772	0	0	0	-787	0	37772	0
	7	0	0	453	0	21749	0	0	0	-453	0	21749	0
	8	0	0	0	0	0	0	0	0	0	0	0	0

Table 74 (Continued). Bridge NISCR2 SDLF initial fixed end forces based on 3D FEA cambers and obtained from GT-LOFT.

Between	**CF #**	**Equivalent Element End I Global DOF**						**Equivalent Element End II Global DOF**					
		1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)	1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)
G3-G4	**1**	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	411	0	19718	0	0	0	-411	0	19718	0
	3	0	0	714	0	34290	0	0	0	-714	0	34290	0
	4	0	0	874	0	41969	0	0	0	-874	0	41969	0
	5	0	0	874	0	41969	0	0	0	-874	0	41969	0
	6	0	0	714	0	34290	0	0	0	-714	0	34290	0
	7	0	0	411	0	19718	0	0	0	-411	0	19718	0
	8	0	0	0	0	0	0	0	0	0	0	0	0

Table 75. Bridge NISCR2 TDLF initial fixed end forces based on 3D FEA cambers and obtained from GT-LOFT.

Between	CF #	Equivalent Element End I Global DOF						Equivalent Element End II Global DOF					
		1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)	1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)
G1-G2	**1**	0	0	-8	-1	-375	0	0	0	8	1	-375	0
	2	0	0	1256	-1	60296	0	0	0	-1256	1	60296	0
	3	0	0	2182	-1	104755	0	0	0	-2182	1	104755	0
	4	0	0	2671	0	128186	0	0	0	-2671	0	128186	0
	5	0	0	2671	0	128186	0	0	0	-2671	0	128186	0
	6	0	0	2182	1	104755	0	0	0	-2182	-1	104755	0
	7	0	0	1256	1	60296	0	0	0	-1256	-1	60296	0
	8	0	0	-8	1	-395	0	0	0	8	-1	-395	0
G2-G3	**1**	0	0	-5	-1	-222	0	0	0	5	1	-222	0
	2	0	0	1154	-1	55410	0	0	0	-1154	1	55410	0
	3	0	0	2005	-1	96242	0	0	0	-2005	1	96242	0
	4	0	0	2454	0	117801	0	0	0	-2454	0	117801	0
	5	0	0	2454	0	117801	0	0	0	-2454	0	117801	0
	6	0	0	2005	1	96242	0	0	0	-2005	-1	96242	0
	7	0	0	1154	1	55410	0	0	0	-1154	-1	55410	0
	8	0	0	-4	1	-203	0	0	0	4	-1	-203	0

Table 75 (Continued). Bridge NISCR2 TDLF initial fixed end forces based on 3D FEA cambers and obtained from GT-LOFT.

Between	**CF #**	**Equivalent Element End I Global DOF**						**Equivalent Element End II Global DOF**					
		1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)	1 (kip)	2 (kip)	3 (kip)	4 (kip*in)	5 (kip*in)	6 (kip*in)
G3-G4	**1**	0	0	-8	-1	-396	0	0	0	8	1	-396	0
	2	0	0	1089	-1	52289	0	0	0	-1089	1	52289	0
	3	0	0	1895	-1	90963	0	0	0	-1895	1	90963	0
	4	0	0	2320	0	111355	0	0	0	-2320	0	111355	0
	5	0	0	2320	0	111355	0	0	0	-2320	0	111355	0
	6	0	0	1895	1	90963	0	0	0	-1895	-1	90963	0
	7	0	0	1089	1	52289	0	0	0	-1089	-1	52289	0
	8	0	0	-9	1	-409	0	0	0	9	-1	-409	0

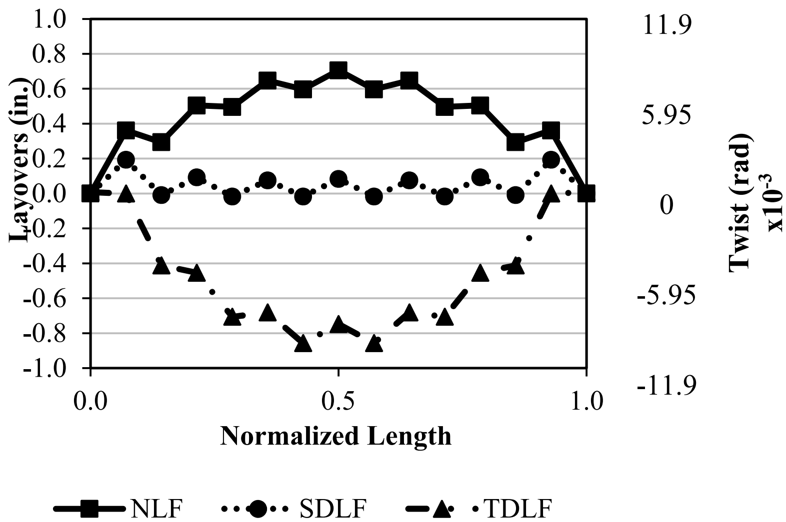


Figure 237. Layovers of fascia girder G1 of bridge NISCR2 under SDL. These are layovers are from a geometrically linear grid analysis using the initial engineering strains.

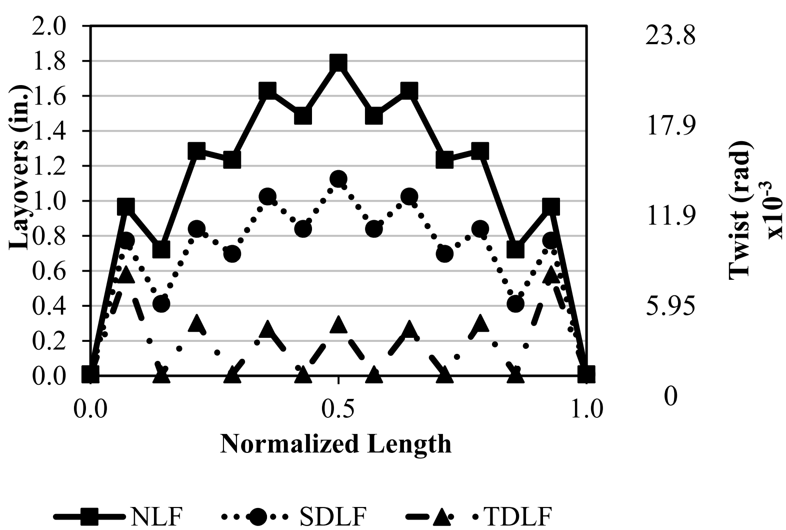


Figure 238. Layovers of fascia girder G1 of bridge NISCR2 under TDL. These are layovers are from a geometrically linear grid analysis using the initial engineering strains.

4. CONCLUSIONS AND RECOMMENDATIONS

The objective of NCHRP 20-07 Task 355 is to propose improved design, detailing and erection guidelines to ensure reliable fit-up of skewed and/or curved steel I-girder bridges. The term "reliable fit-up" is intended to encompass the considerations involving ease of assembly during the steel erection, control of the constructed geometry, assurance of the generation of beneficial locked-in forces in the structural system, and limitation of the development of non-beneficial locked-in forces within the structure. Substantial progress has been made in answering many of the questions associated with this research via the completion of NCHRP Report 725 as well as subsequent efforts by an ad hoc Task Group of the National Steel Bridge Alliance (NSBA) Steel Bridge Collaboration on Skewed and/or Curved Steel I-Girder Bridge Fit. The subsequent NSBA Steel Bridge Collaboration Task Group effort has produced a guidelines document on this topic (NSBA 2015) as well as a stand-alone summary of this guidelines document (NSBA 2014). The focus of this effort was predominantly on broad recommendations and synthesis of the best information on the various behavioral phenomena, and how that behavior might influence the decision to specify a particular fit condition for a skewed and/or curved I-girder bridge.

The focus of this research is on quantitative studies needed to corroborate and refine the above NSBA guidelines. The following Sections 4.1 and 4.2 summarize specific findings from this research. These findings corroborate and provide data for refinement of the recommendations in the NSBA documents. Section 4.3 provides additional recommendations that may be considered for inclusion in other AASHTO and AASHTO/NSBA publications. Section 4.4 provides recommendations regarding best inspection practices to ensure that the erected geometry sufficiently meets the specified fit conditions. Section 4.5 provides recommended updates to the AASHTO LRFD Specifications based on the above developments. Lastly, Section 4.6 suggests further research needs.

4.1 Review of Key Recommendations of the NSBA Guidelines Document (NSBA 2015)

The quantitative data from this research supports the broad fit condition recommendations (i.e., the recommended cross-frame detailing practices) of the NSBA guidelines documents (NSBA 2014) and (NSBA 2015). These recommendations are summarized in Tables 76 and 77 below. These tables subdivide I-girder bridges into several groups based on simple measures of their horizontal curvature and/or skew. It is suggested that bridges with L/R less than or equal to 0.03 in all of their spans may be considered effectively as straight bridges when making decisions about the fit condition. In addition, it is suggested that bridges that have a maximum skew angle less than or equal to 20° (with an angle of zero indicating zero skew) may be considered effectively as non-skewed with regard to the fit decision. These limits, and the additional limits discussed below, are shown with the qualification "+/ – " to emphasize that there is no dramatic shift in the responses when the limits are crossed. Rather, they are approximate values where a shift in the fit decision should be considered.

Table 76. Recommended fit conditions for straight bridges (including horizontally curved bridges with L/R in all spans ≤ 0.03 +/-), from NSBA (2014) and (2015).

Square Bridges and Skewed Bridges up to 20 deg. +/- Skew			
	Recommended	***Acceptable***	***Avoid***
Any span length	Any		None
Skewed Bridges with Skew > 20 deg. +/- and $I_s \leq 0.30$ +/-			
	Recommended	***Acceptable***	***Avoid***
Any span length	TDLF or SDLF		NLF
Skewed Bridges with Skew > 20 deg. +/- and $I_s > 0.30$ +/-			
	Recommended	***Acceptable***	***Avoid***
Span lengths up to 200 ft +/-	SDLF	TDLF	NLF
Span lengths greater than 200 ft +/-	SDLF		TDLF & NLF

Table 77. Recommended fit conditions for horizontally curved bridges ($(L/R)_{max}$ > 0.03 +/-), from NSBA (2014) and (2015).

Radial or Skewed Supports			
	Recommended	***Acceptable***	***Avoid***
Span lengths greater than 250 ft +/- and L/R > 0.1 +/-	NLF	SDLF	TDLF
All other cases	SDLF	NLF	TDLF

The top rows of Table 76 indicate that any fit condition is acceptable for bridges that satisfy both of the above limits on the horizontal curvature and skew. The remainder of Table 76 addresses the recommended fit condition for bridges that have significant skew but are effectively straight when it comes to the fit decision. The middle recommendation this table pertains to bridges in which the skew index I_s (Eq. (1) in Section 2.2.2) is less than or equal to 0.30. In these cases, the influence of the skew is generally such that either TDLF or SDLF detailing should perform well. However, NLF is not recommended for straight skewed bridges where any of the skew angles θ are larger than 20 degrees. This is because larger skew angles of the bearing lines generally result in substantial twisting of the girders and girder layover at abutments, and unnecessarily large cross-frame forces at the abutments or at interior pier locations. These issues can be alleviated with relative ease, in straight skewed bridges, by SLDF or TDLF detailing of the cross-frames.

The last two rows of Table 76 pertain to straight I-girder bridges with $I_s > 0.30$. For these types of bridges, SDLF is recommended in all cases, and TDLF is considered acceptable up to approximately 200 ft span lengths. For straight I-girder bridges with span lengths larger than 200 ft, skew greater than 20° and $I_s > 0.30$, it is considered wise to avoid TDLF. This is largely due to the potential for the assembly of the steel during erection to be challenging when TDLF is used with these geometries. The 200 ft span length, as a limit for this change in the fit decision, is supported by the data from the cross-frame fit-up studies of Section 3.2 of this report.

When SDLF and TDLF detailing are used for straight skewed bridges, it is recommended that the engineer should account for the beneficial reduction of the cross-frame forces and flange lateral bending stresses due to the locked-in force effects introduced into the structure during the erection. This recommendation is discussed further in Section 4.2.

Table 77 addresses the recommended fit condition for horizontally curved I-girder bridges with or without skew. This table suggests that if the bridge has any span lengths greater than 250 ft +/- in combination with $L/R > 0.1$ +/-, NLF should be considered. Otherwise, SDLF is recommended. These recommendations apply irrespective of any skew of the bearing lines. Lastly, Table 77 recommends that TDLF should be avoided in all cases for bridges that are classified as horizontally curved with respect to the consideration of the fit condition. These recommendations are supported by the quantitative results from this research, which clearly show greater potential difficulty of the assembly of the steel as well as larger locked-in force effects that are additive with the other dead load effects in the case of horizontally curved bridges with and without skew detailed for TDLF. Recommendations are provided in this research for simple estimation of the smaller additive effects from the locked-in forces associated with SDLF detailing in horizontally curved bridges. These recommendations are discussed further in Section 4.2.

4.2 Recommended Updates to the NSBA Guidelines Document (NSBA 2015)

The following updates are recommended by the NCHRP 20-07 Task 355 research for incorporation into the NSBA guidelines documents. These improvements impact the larger guidelines document (NSBA 2015) to the greatest extent. As such, the following discussions focus on improvements to that document. Some of these recommendations also may be worthwhile for consideration as potential updates to the stand-alone summary document (NSBA 2014). The research team is cognizant of the importance of maintaining the brevity of the NSBA Guidelines Documents. As such, some of the following recommendations may be considered for other AASHTO and AASHTO/NSBA guidelines, or simply addressed by reference to this NCHRP Report.

(1) Section 2 Behavior of Straight Skewed I-Girder Bridges

- Provide the following summary of impacts on girder stresses from SDLF & TDLF detailing:

  "In straight skewed bridges, the influence on the girder major-axis bending stresses due to SDLF and TDLF detailing based on refined analysis cambers is small and can be neglected, as long as the cross-frame framing arrangement satisfies the recommendations discussed further in Section 4.4."

  Background: Sharply skewed I-girder bridges that have framing arrangements causing transverse load paths having large "nuisance" stiffness can see significant changes in the girder major-axis bending stresses due to SDLF or TDLF detailing. It is recommended that the specific handling of this issue be addressed in Section 5.3 of the paper; however, it is believed that a brief reference to this issue should be provided in this section to tie in with the subsequent discussion.

- Modify the second sentence of the last paragraph of Section 2, after the sentence "NLF detailing is not typically used and should be avoided for straight skewed bridges," to the following:

  "This is because this type of detailing results in larger cross-frame forces and greater potential fit-up difficulty in these types of bridges."

Background: The current statement at this location in the paper is that NLF detailing generally requires the use of temporary shoring and/or a significant number of holding cranes during the erection in order to avoid excessive forced fit-up of the cross-frames to the girders that are deflected under their self-weight. NLF detailing does not always necessitate substantial shoring and holding. The proposed modification appropriately softens the language to allow for greater leeway in interpretation of the recommendations. The next sentence in the NSBA (2015) manuscript addresses the important fact that NLF detailing does not provide any compensation for the significant girder twist rotations that occur at the skewed abutments.

- Section 2 currently contains several statements that may be read to imply that the ideal result of zero cross-frame forces and zero flange lateral bending stresses is always achieved in the targeted DL condition for SDLF and TDLF. These statements need to be "softened" to recognize the quantitative results presented in this research, which indicate that the compliance of the three-dimensional structural system as well as various incidental effects generally result in the ideal of perfectly zero cross-frame forces and zero flange lateral bending stresses not being achieved.

(2) Section 3 Behavior of Horizontally Curved I-Girder Bridges

- At the end of the fourth paragraph of this section, add the following:

  "TDLF detailing also twists the girders substantially in the direction opposite from that which they roll under the DL in a straight skewed bridge. However, in this case, the detailing relieves the TDL effects in the cross-frames. This is because the TDL twist rotations in a straight skewed bridge are imposed on the girders via the compatibility of deformations with the cross-frames. Conversely, in a curved radially-supported bridge, the intermediate cross-frames restrain or resist the tendency of the curved girders to twist and deflect excessively, which would occur if they were restrained from twisting only at the bearing lines. The intermediate cross-frames tie the girders into the overall structural system, and force the girders to work together to resist torsion via differential major-axis bending of the girders across the bridge cross-section. Therefore, the additional pulling or twisting of the girders in the opposite direction from that which they want to roll adds to the other DL cross-frame forces in a curved radially-supported bridge, since the other DL forces *and* the additional forces associated with the TDLF detailing are both restraining or resisting the tendency of the individual girders to twist and deflect excessively.”

Background: The current discussion in this section of NSBA (2015) does not clearly explain why the twisting of the girders in the opposite direction from the one which they want to roll tends to increase the internal cross-frame forces and girder flange lateral bending stresses in curved bridges, while it tends to relieve these forces and stresses in straight skewed bridges. This additional paragraph is intended to clarify these attributes of the behavior.

- Remove the following statement:

  “Studies are underway at the time of this writing to better define ‘small span length’ and ‘minor horizontal curvature’ for these types of bridges.”

  Background: This research supports the guidelines definitions of small span length (less than or equal to about 200 ft) and minor horizontal curvature (a subtended angle L_s/R in all spans less than or equal to about 0.03).

- Add the following sentence to the end of the next to the last paragraph of Section 3:

  “SDLF detailing assists with reducing these rotations.”

  Background: This paragraph of NSBA (2015) discusses the girder twist rotations at the supports in curved and skewed bridges, and the need to address these rotations in the design of the bearings and in deck joint alignment. It is useful to remind the reader that SLDF detailing helps to reduce these rotations.

- Modify the statement

  “It should be noted that for straight skewed bridges, SDLF and TDLF detailing do not have a significant effect on the girder elevations in the completed structure. However, for curved bridges, SDLF and TDLF generally tend to increase the elevations of all the girders within the bridge spans (NCHRP 2012). These effects are smaller for SDLF and are commonly neglected in design practice.”

  to the following:

"It should be noted that for straight skewed bridges, SDLF and TDLF detailing based on refined analysis girder deflections do not have a significant effect on the girder elevations in the completed structure. For curved bridges, SDLF and TDLF generally tend to increase the elevations of all the girders within the bridge spans. However, these effects have been shown to be small enough to be accommodated within typical practices for selecting girder haunch depths and setting of formwork elevations for placement of the deck concrete, with the exception of an extreme notable case where the critical span length was larger than 250 ft, L_s/R was greater than 0.5, and L_s/w_g was relatively small (White et al. 2015)."

Background: The studies from this research have confirmed that the influence of these elevation changes are negligible in straight skewed bridges and in curved bridges with or without skew.

(3) Section 4.4 Stiffness and Geometry Effects

Replace the discussion after the first paragraph of this section with the following recommendations regarding beneficial cross-frame framing arrangements:

"Nuisance stiffness can produce dramatically increased cross-frame forces and can result in potential fit-up difficulties during the steel erection. In bridges where the bearing lines are skewed more than 20^{o}, it is often advantageous to place the intermediate cross-frames oriented in discontinuous lines perpendicular to the girders, to selectively remove certain cross-frames and/or to stagger the cross-frames in adjacent bays between the girders, in such a manner that the transverse stiffness of the bridge is reduced, particularly in the vicinity of the supports. Removal of highly stressed cross-frames, particularly in the vicinity of the obtuse corners of a span, interrupts and reduces the stiffness of the corresponding transverse load path by forcing load transfer via girder flange lateral bending. The above practices are often beneficial as long as the unbraced lengths between the cross-frame locations satisfy the flange resistance requirements of the design specifications. These practices tend to decrease the cross-frame forces and increase the girder flange lateral bending. However, in certain cases involving excessively stiff transverse load paths, the cross-frame forces may be decreased to the extent that the associated flange lateral bending stresses are also reduced. Where the flange sizes are increased due to the additional flange lateral bending, this increase often is not significant.

In fact, the increased cost resulting from the larger flange sizes is typically offset by the reduced cost of providing fewer cross-frames and smaller cross-frame connections.

Where cross-frames are provided along bearing lines that are skewed more than 20°, the first intermediate cross-frames placed normal to the girders adjacent to the skewed support ideally should be offset by a minimum of the larger of $4b_f$ and $0.4L_{b.adj}$, where b_f is the largest girder flange width within the unbraced lengths on either side of the intermediate cross-frame, and $L_{b.adj}$ is the adjacent unbraced length to the offset under consideration. This practice helps to alleviate the introduction of a stiff load path that will attract and transfer large transverse forces to the skewed supports, particularly at the obtuse corners of a skewed span. In some cases, the limit of $0.4L_b$ may be difficult to achieve, in which case the offset should be made as large as practicable but not less than $4b_f$. At the acute corners of severely skewed bridge spans, the above requirements may result in an excessive unbraced length on the fascia girder. In this case, a cross-frame with top and bottom chords but without diagonal members can be framed from the first interior girder to the fascia girder at a small offset from the support, perpendicular to the girders, to avoid introducing a large transverse stiffness while also providing adequate lateral support to the fascia girder.

Where practicable, the smallest unbraced lengths, offsets, or stagger distances between the cross-frame locations within the skewed bridge spans should be greater than or equal to the larger of $4b_f$ or $0.4L_{b.adj}$, where b_f and $L_{b.adj}$ are as defined above but corresponding to the intermediate cross-frames and unbraced lengths, offsets or stagger distances within the span. The use of unbraced lengths smaller than $4b_f$ tends to result in the associated cross-frames working more like a contiguous cross-frame line rather than a discontinuous one.

White et al. (2015) [this report] recommend framing of the cross-frames within straight skewed spans using arrangements such as those shown in Figures 239 through 241 [these figure numbers correspond to the figures provided below in this document] to both reduce the number of cross-frames required within the bridge as well as to reduce the overall transverse stiffness effects. In Figure 239, the cross-frames adjacent to the bearing lines are all placed at the same offset distance relative to the skewed bearing lines, satisfying the above offset recommendations. The other intermediate cross-frames are placed at a constant spacing along the span length to satisfy the flange resistance requirements of the design specification. In addition, every other cross-frame is intentionally omitted within the bays between the interior girders of the bridge plan. This relaxes the large transverse stiffness that would otherwise be developed in the short diagonal direction between the obtuse corners of the span.

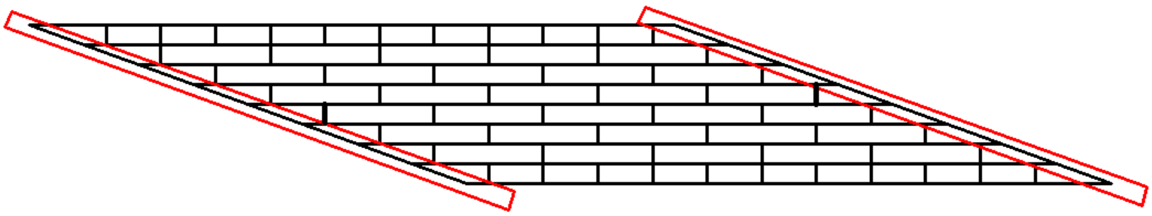


Figure 239. Recommended staggered framing arrangements for straight parallel-skewed bridges.

Figure 240 shows a similar concept on a straight bridge with an extreme non-parallel skew. The essential consideration, when intentionally omitting cross-frames between the interior girders, is that a cross-frame must be provided on at least one side of a girder at each location where a braced point is desired. In some situations, additional cross-frames may be retained to provide additional lateral stiffness for bracing or other purposes; however, the alternating removal of the internal cross-frames is sufficient and is the preferred option in most cases.

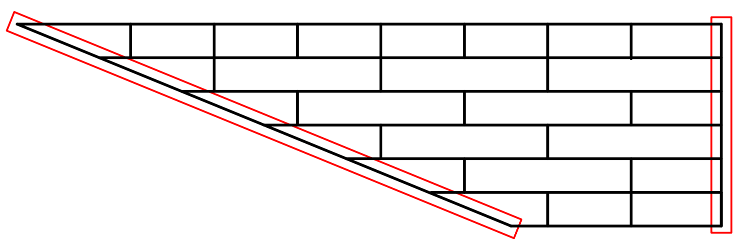


Figure 240. Recommended staggered framing arrangements for straight skewed bridges with only one bearing line having a substantial skew angle.

Figure 241 shows a continuous-span straight skewed I-girder bridge with different skew angles at the bearing lines. Within the end spans of this bridge, the intermediate cross-frames adjacent to the bearing lines are all placed at the same offset distance relative to the skewed bearing lines, satisfying the above offset recommendations, except that a number of these cross-frames are intentionally omitted. This is necessary to satisfy the offset recommendations, given the geometry of this bridge. Note that similar to the above examples, additional cross-frames are intentionally omitted in the end spans, progressing along the length of the span within the bays between the interior girders. Each girder still has at least one side braced by a cross-frame at each braced point. Furthermore, intermediate cross-frames still remain within each cross-frame line across the width of the bridge to interconnect the girders and help control the differential deflections between the girders.

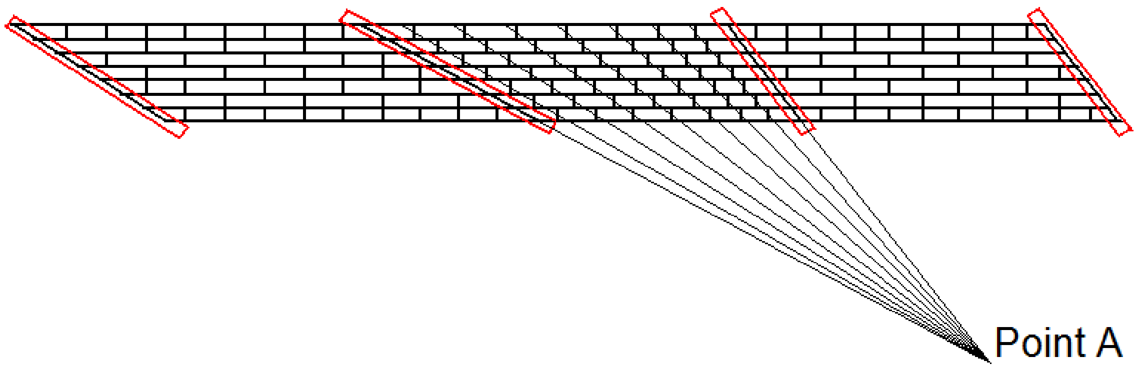


Figure 241. Recommended staggered framing arrangements for straight skewed bridges with different skew angles of the bearing lines.

Within the center span of this bridge, where the bearing lines are non-parallel but both have significant skew, the cross-frames are arranged in a "fanned" pattern from one bearing line to the next. The lighter weight lines in this sketch, which pass through work points at the mid-length of the cross-frames in the center span, all intersect at Point A. This arrangement can be shown to be one of the best options to mitigate the transverse stiffness load paths in this type of span.

Figure 242 shows a simple variation on the concept used in the center span of Figure 241, applied to a straight bridge with parallel skew. In this figure, the cross-frames adjacent to the bearing lines are all placed at the same offset distance from the skewed bearing lines, satisfying the above offset recommendations. The other intermediate cross-frames are placed at a constant spacing along the span length in all the bays between the girders. The flange resistance requirements of the design specifications are satisfy by framing one cross-frame into each girder location where a braced point is desired. Given the particular skew angle in this bridge, the stagger distances between the intermediate cross-frame locations within the span are larger than both $4b_f$ and $0.4L_{b.adj}$. The lines through the work points at the mid-length of the cross-frames are all parallel to the bearing lines in this bridge.

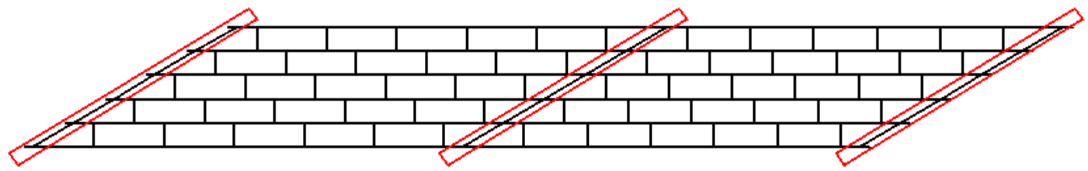


Figure 242. Recommended staggered framing arrangements for straight skewed bridges with different skew angles of the bearing lines.

Another framing option that alleviates transverse stiffness effects, and significantly reduces the number of cross-frames containing diagonal members, is the use of lean-on bracing (Helwig and Yura 2012; Herman, et al. 2015). White et al. (2015) studied both lean-on bracing and the framing arrangements discussed above and found that both types of framing arrangements provided comparable performance. The above recommended use of cross-frames without diagonals at the acute corners of sharply skewed spans is a basic variation on the lean-on bracing concept.

At skewed interior piers in continuous-span bridges, NHI (2011) and White et al. (2015) found that transverse stiffness effects are alleviated most effectively by placing cross-frames along the skewed bearing line and locating intermediate cross-frames normal to the girders at greater than or equal to the minimum offset from the bearing lines discussed above. The bearing line cross-frames in Figures 241 and 242 are framed in this manner. Framing of an intermediate cross-frame perpendicular to the girders and into or near a bearing location along a skewed support line is strongly discouraged unless the cross-frame diagonals are omitted as discussed previously. White et al. (2015) found that alternate framing schemes in which the skewed bearing line cross-frames are omitted and intermediate cross-frames are framed perpendicular to the girders and into or near the bearing locations typically results in unnecessary transverse restraint and correspondingly large cross-frame forces.

For curved and skewed spans, omitting cross-frames in the vicinity of skewed bearing lines, as shown in Figure 243, can help to alleviate uplift at critical bearing locations at and near an obtuse corner of a span; however, this is typically at the expense of larger cross-frame forces and larger bridge deflections compared to the use of contiguous intermediate cross-frame lines with the recommended offset provided at the skewed bearing lines. Contiguous cross-frame lines are necessary within the span of curved I-girder bridges to develop the width of the bridge structural system for resistance of the overall torsional effects. As such, the use of discontinuous cross-frame lines near a skewed bearing line in these bridge types involves competing considerations. Cross-frames can be omitted to alleviate uplift considerations at certain bearings, and potentially to relieve excessive cross-frame forces due to transverse stiffness effects in certain cases – for instance, if the horizontal curvature is relatively small and the skew is significant. However, removal of too many cross-frames may result in a larger than desired increase in the cross-frame forces and bridge system deflections due to the horizontal curvature effects when the bridge is significantly curved.

In horizontally curved I-girder bridges, it is important to select a spacing of the cross-frames within the curved spans that limits the magnitude of the flange lateral bending stresses due to the horizontal curvature of the girders between the cross-frame locations. This also limits the magnitude of the cross-frame forces that need to be developed to stabilize the curved unbraced lengths of the girders. AASHTO LRFD Equation C6.7.4.2-1 is a useful simple calculation that achieves this goal."

Background: The NCHRP 20-07 Task 355 studies, as well as other studies such as the design example calculations provided in NHI (2011), have identified a number of useful practices pertaining to softening of the transverse stiffness in highly skewed bridge spans. These practices can result in substantially reduced cross-frame forces and girder flange lateral bending stresses, in addition to reducing the number of cross-frames in skewed I-girder bridges and providing for greater ease of assembly of the structural steel. Selection of a cross-frame framing arrangement that alleviates high "nuisance" transverse stiffness load paths associated with the skew of the bearing lines, while also developing the width of the bridge cross-section as a structural system and providing adequate support to curved girders, is one of the most important decisions that can facilitate the economical and safe design and construction of curved and/or skewed steel I-girder bridges.

(4) Section 5.1 Design and Analysis Considerations, Straight Skewed Bridges

- In the first and next to last paragraph of this section, soften the language to refer to the locked-in internal forces due to SDLF and TDLF in straight skewed bridges as "opposite in sign to and a significant fraction of" the dead load cross-frame forces, rather than "approximately equal and opposite" to these forces, and to refer to the cross-frame forces in straight skewed bridges detailed for SDLF or TDLF as being "relatively small" in the targeted DL condition, recognizing the fact that due to the compliance of the 3D bridge system and due to various incidental effects, the cross-frame forces and flange lateral bending stresses are reduced in the targeted DL condition; however, generally the cross-frame forces and flange lateral bending stresses are not necessarily reduced to close to zero.
- Modify the second paragraph of this section to read as follows:

  "It is conservative to design the cross-frames in a straight skewed bridge using the results from an accurate grid or 3D FEA model and neglecting the SDLF or TDLF effects. This is the current common practice when the engineer chooses to utilize more than a line girder analysis for the design. In I-girder bridges having a particularly large skew index I_s (see Table 2 in Section 7 and Equation 2 below [Table 2, Section 7 and Equation 2 of NSBA (2015)]), the cross-frame forces estimated in this way can be very conservative. In some cases, this can lead to excessively large cross-frames. In lieu of requiring a refined analysis that includes the lack-of-fit due to the DLF detailing, White et al. (2015) [this report] provide a range of simple reduction factors that may be applied to the cross-frame forces and the flange lateral bending stresses from a refined analysis that does not otherwise account for these effects. These reduction factors are discussed in Section 5.3.

  It is emphasized that the reductions in the internal cross-frame forces and girder flange lateral bending stresses in straight skewed bridges due to SDLF or TDLF are substantial. Designing the cross-frames and girders using the results from an analysis that completely neglects the beneficial offsetting of the DL forces and stresses by the corresponding locked-in forces can lead to excessive conservatism in some cases."

Background: The above recommended changes remove some more general wording about a “large fraction of the SDL” and “large fraction of the “TDL” forces being removed by SDLF and TDLF detailing and replace this by a reference to the specific discussions recommended for Section 5.3.

(5) Section 5.2 Horizontally Curved Bridges

- Modify the last sentence in the first paragraph of this section to read:

  “The girders in curved bridges require radial forces to be introduced by the cross-frames to satisfy equilibrium with their major-axis bending moments, and to restrain their tendency to twist. SDLF and TDLF detailing tends to increase these internal cross-frame forces, since the cross-frames are used to twist the girders back the direction opposite to the direction that they naturally roll under the dead loads; this action effectively increases the restraint provided to the girders from the cross-frames.”

  Background: The suggested modification emphasizes why there is an increase in the cross-frame forces for SDLF and TDLF detailing in curved bridges.

- Change the last paragraph of this section to read as follows:

  “Curved I-girder bridges have been detailed successfully for SDLF in common practice. As discussed above, this results in some additional internal forces due to the SDLF effects; however, the additional internal forces due to the SDLF effects are relatively small in bridges for which SDLF is recommended in Table 3 of Section 7 [Table 3 and Section 7 of NSBA (2015)]. Section 5.3 provides guidance for when the force effects from SDLF detailing may be neglected, and provides simple scale factors that can be applied to the refined analysis results to approximate these effects where they should be considered. As indicated in Table 3 of Section 7, for bridges with longer spans and significant horizontal curvature, NLF is recommended to limit the magnitude of these effects. These types of bridges are more likely to require significant shoring and support during the erection as a matter of course – as such, the bridge can be erected in a ‘quasi’ no-load condition as the general practice and the cross-frames can be easily installed in this shored condition.”

  Background: This paragraph is revised to tie in with the recommendations proposed for Section 5.3 of the NSBA paper. The NSBA (2015) manuscript indicated that the increases in the cross-frame forces due to the SDLF effects could be neglected for curved bridges that satisfy the requirements in Table 3 of Section 7 of the paper. The NCHRP 20-07 / Task 355 research indicates that the additive locked-in forces from SDLF detailing are indeed relatively small; however, the research indicates that these forces are generally too large to neglect. Simple modifiers are recommended in the new Section 5.3 to estimate these effects.

- Add the following paragraph to the end of Section 5.2:

  "The research by White et al. (2015) indicates that the girder deflections calculated from an accurate refined analysis, without the consideration of the SDLF or TDLF effects, is sufficient in all cases for the straight and curved bridge characteristics where these detailing methods are recommended or allowed in Tables 2 and 3 of Section 7 [Tables 2 and 3 of Section 7 of (NSBA 2015)]. The engineer need not consider the influence of the DLF detailing on the girder vertical deflections when setting the girder cambers and/or determining the cross-frame drops and the associated girder connection plate rotational orientations. In addition, White et al. (2015) find that the deviation from the targeted girder elevations and the girder plumb condition is small enough to be neglected in all cases that satisfy the recommendations in Tables 2 and 3 when the girder deflections are calculated using an accurate refined analysis. Furthermore, the girder layovers in the TDL condition can be estimated as the concrete dead load layovers from a refined analysis, for bridges detailed for SDLF, and the girder layovers in the SDL condition can be estimated as the negative of the concrete dead load layovers from a refined analysis, for bridges detailed for TDLF."

  Background: The current Sections 5.1 and 5.2 of NSBA (2015) do not address potential questions about the ability of the analysis calculations to predict the targeted geometry in the intermediate and final constructed conditions of a curved and/or skewed I-girder bridge structure. The above paragraph addresses these potential questions.

(6) Section 5.3 Design and Analysis Considerations, Calculation of Internal Forces due to SDLF and TDLF Detailing

Replace the paragraph in this section by the following:

“Although the use of refined analysis methods is not required for curved and/or skewed I-girder bridges, these methods, when utilized, do allow for direct consideration of DL cross-frame forces and girder flange lateral bending stresses. In straight skewed I-girder bridges, these DL force effects are partially offset by the corresponding locked-in force effects at the completion of the steel erection (White et al. 2012 [the NCHRP 725 report]; White et al. 2015 [this report]). It is important to recognize that the DL force effects, when determined from a refined analysis model, typically do not include the locked-in force effects from SDLF or TDLF detailing of the cross-frames. That is, the analysis model corresponds to the assumption of NLF.

It is possible to directly calculate the internal “locked-in forces” associated with SDLF or TDLF detailing directly within either a 2D grid or 3D Finite Element Analysis. The calculations simply involve the consideration of the initial lack-of-fit displacements between the cross-frame connection work points and the corresponding work points on the girders in the undeformed No-Load geometry of the structure. These lack-of-fit displacements are then used to calculate initial strains in the cross-frame members, or initial fixed-end forces in an overall beam element representation of the cross-frames. These initial strains or initial fixed-end forces induce nodal loads in the structural analysis model that account for the influence of the initial lack-of-fit. The response of the structure to these nodal loads is added to the above “initial effects” in the undeformed configuration of the structure to determine the corresponding internal forces and stresses that are “locked-in” to the structure due to the DLF detailing.

Section 3.9 and associated appendices of White et al. (2015) [this report] provides a detailed explanation of the above procedures, complete with benchmark example 2D-grid and 3D FEA calculations for a basic straight skewed as well as a horizontally curved radially-supported bridge. Section 3.4.3 of White et al. (2015) explains how the results for the locked-in forces determined from this type of analysis may be included within design load combinations to properly satisfy AASHTO LRFD requirements.

From a technical viewpoint, there is no reason why lack-of-fit effects should not and cannot be included in any refined analysis of a bridge structural system. The handling of these effects is very similar to the calculation of the effects of temperature change. The associated concepts are very straightforward and simple at the fundamental level associated with their implementation within a structural analysis. These concepts are taught in nearly every undergraduate strength of materials and introductory structural analysis class. The corresponding detailed effects of the basic lack-of-fit on the internal forces and stresses in I-girder bridge structures is relatively complex. This complexity is best addressed by including the lack-of-fit effects in the structural analysis. Nevertheless, at the present time (2015), inclusion of the lack-of-fit effects from SDLF or TDLF detailing is not well supported in professional analysis and design software. An engineer who wishes to include these effects typically must to a significant amount of calculations external to the software, then input information such as, for example, pseudo temperature increases or decreases in the cross-frame members that produce the same initial strains as the initial lack-of-fit displacements. Until this situation is improved, and for simple sanity checking of the results from these types of analysis calculations when they are performed, the basic estimates recommended in Table 78 [this table number corresponds to the table provided below in this document] may be employed to estimate the locked-in force effects associated with SDLF and TDLF detailing. This table is based on the extensive studies conducted by White et al. (2015).

The first column of Table 78 lists the primary responses that need to be calculated for the design of the structural components in a curved and/or skewed I-girder bridge. The second through fourth columns list recommended calculations of the factored DL responses including the consideration of the SDLF and/or TDLF detailing effects as appropriate for curved radially-supported, straight skewed, and curved and skewed I-girder bridges.

In curved I-girder bridges, the locked-in force effects from SDLF and TDLF detailing tend to be additive with the corresponding DL effects. As discussed in Section 3 [Section 3 of NSBA (2015)], the additional forces associated with TDLF detailing tend to be prohibitive for highly-curved I-girder bridges, and thus TDLF detailing of these types of structures is strongly discouraged. Therefore, Table 78 does not address estimates for curved bridges detailed for TDLF. The following procedures do not address the effects due to the bracket loads supporting the eccentric deck overhangs during deck construction. These effects may be estimated separately as described in AASHTO LRFD Article C6.10.3.4 and combined as appropriate with the other dead load effects discussed below.

Table 78. Recommended estimates of factored dead load bridge responses for curved and/or skewed bridges in their final constructed condition, in lieu of including lack-of-fit directly within the structural analysis.

Responses	(1) Curved Radially-Supported	(2) Straight Skewed	(3) Curved and Skewed
CF Forces	γ_p (2.0 SDL + ADL*) for SDLF†, except γ_p (SDL + ADL) for chords of X-Type CFs	γ_p TDL for SDLF, (γ_p – 0.4) TDL for TDLF	Same as (1)
Flange lateral bending	γ_p (1.2 SDL + ADL*) for SDLF†	(γ_p – 0.5) SDL + γ_p ADL* for SDLF (γ_p – 0.4) TDL for TDLF	Same as (1)
Major-axis bending	γ_p TDL for SDLF†	γ_p TDL for SDLF‡ γ_p TDL for TDLF§	Same as (1)
Vertical Reactions	γ_p TDL for SDLF† For simply supported bridges, DLF tends to increase the smallest reactions at the girders on the inside of the curve¶	γ_p TDL for SDLF‡\\ γ_p TDL for TDLF§\\ For simply-supported bridges the tendency for uplift on the girder bearings at the obtuse corners of the bridge plan is lessened by the use of DLF detailing based on RA cambers (compared to the use of LGA cambers)	For simply-supported bridges¶**: Worst-case maximum reactions††: • γ_p (1.2 SDL + ADL) for SDLF†, when the length of girder on the inside of the curve is increased by the skew • γ_p (1.6 SDL + ADL) for SDLF†, when the length of girder on the outside of the curve is increased by the skew

* ADL = Additional Dead Load

†TDLF detailing is strongly discouraged for curved bridges with $L_s/R > 0.03 \pm$, where L_s is the span length along the centerline of the bridge.

‡ Contingent on the use of discontinuous CF lines with $L_b \geq \max(4b_f, 0.4L_{b.adj})$ for all unbraced lengths within the span, where b_f is the largest girder flange width within on either side of a given CF, and $L_{b.adj}$ is the smallest adjacent unbraced length.

§ Contingent on $I_s \leq 1.0 \pm$ and $L_b \geq \max(4b_f, 0.4L_{b.adj})$.

¶ The influence of DLF detailing on the reactions for curved continuous-span bridges is relatively complex; If potential uplift and/or increases in the reactions are a concern, a Dead Load Fit Refined Analysis (DLF RA) is recommended.

\\ If potential uplift at obtuse corners of the bridge plan is a concern, the uplift condition can be estimated conservatively by using LGA for the targeted DL condition and NLF RA for additional dead and/or live loads.

** In curved and skewed I-girder bridges, the CF lines need to be contiguous out within the spans to develop the width of the structural system; in some cases, this requirement can exacerbate potential uplift conditions at obtuse corners of the bridge plan that are on the inside of the curve.

†† If potential uplift at obtuse corners of the bridge plan is a concern, a DLF RA should be considered.

For curved I-girder bridges, with or without skew and with a maximum L_s/R greater than 0.03 $\pm$, the additional locked-in force effects may be accounted for approximately by multiplying the unfactored SDL cross-frame forces by the factor 2.0 and the unfactored SDL flange lateral bending stresses by the factor 1.2 prior to applying the AASHTO LRFD DL factor γ_p. For X-type cross-frames, SDLF detailing has a substantial effect only on the cross-frame diagonal forces; therefore, the above factor of 2.0 need only be applied to the diagonal forces for these types of cross-frames. White et al. (2015) show that these factors provide a reasonable coarse approximation of the SDLF detailing effects for a range of curved bridges with L_s/R ranging from 0.2 to 0.5. The smaller increase in the flange lateral bending stresses is due to the attribute that the ratio of the locked-in effects from SDLF detailing to the effects from the horizontal curvature generally tend to be smaller for the flange lateral bending stresses than for the cross-frame forces. For a bridge where the factored SDL cross-frame forces are one-half of the factored TDL forces, and the factored TDL forces are one-half of the total factored forces for design, the total factored cross-frame forces are increased by a factor of 1.25. For bridges with smaller L_s/R, the horizontal curvature effects are smaller, and hence the scaled SDL cross-frame forces and girder flange lateral bending stresses are smaller.

Table 78 shows that the girder major-axis bending stresses and vertical reactions in curved radially-supported I-girder bridges may be estimated sufficiently from a refined analysis that does not include the consideration of the initial lack-of-fit from the SDLF detailing of the cross-frames. One caveat associated with this recommendation, shown as a footnote to the table, is that the influence of DLF detailing on the reactions for curved continuous-span bridges is relatively complex. In cases where potential uplift and/or increase in the reactions are a concern in these types of bridges, it is recommended that a refined analysis that includes the consideration of the initial lack-of-fit displacements should be considered. This type of analysis is referred to as a Dead Load Fit Refined Analysis (DLF RA) in the table.

The third column of Table 78 lists recommended calculations of the factored DL responses for straight skewed I-girder bridges, including the consideration of the SDLF and/or TDLF detailing effects as appropriate. For straight skewed I-girder bridges detailed for SDLF, and where the recommendations of Section 4.4 to lessen the nuisance transvers stiffness effects are not applied, direct calculation of the influence of DLF detailing on the girder vertical reactions and major-axis bending stresses should be considered. For straight skewed I-girder bridges detailed for TDLF, the recommendations of Section 4.4 should be applied *and* the skew index, I_s, should be less than 1.0 $\pm$ in order to avoid potential significant impacts from nuisance transverse stiffness on the girder reactions and major-axis bending stresses.

For straight skewed I-girder bridges that are detailed for TDLF, the TDL cross-frame forces and flange lateral bending stresses, when determined from a refined analysis not including the influence of DLF detailing, may be reduced to account for the corresponding locked-in forces introduced into the structural system during the steel erection. In this case, a net reduced load factor of (γ_p – 0.4) may be applied to the unfactored TDL cross-frame forces and flange lateral bending stresses, where γ_p is the required AASHTO LRFD factor on DL and 0.4 is an estimated lower-bound estimate of the internal locked-in force effect (AASHTO LRFD multiplies the locked-in force effects by a load factor of 1.0). It should be noted that larger beneficial locked-in force effects can be calculated in many situations by performing a direct DLF RA. In straight skewed bridges detailed for a TDLF, the engineer should also check the cross-frame forces and the flange lateral bending stresses for the fit-up force effects during the steel erection. These effects may be estimated as the negative of the corresponding unfactored concrete dead load force effects, which should then be multiplied by γ_p (White et al. 2015).

White et al. (2015) recommend that the AASHTO LRFD load factor, γ_p, should be applied directly to the DC cross-frame forces for straight skewed bridges detailed for SDLF. Significant cross-frame force reductions are achievable in straight skewed bridges detailed for SDLF; however, in the most extreme cases studied by White et al. (2015), incidental and elastic deformation effects in the structural system lead to negligible corresponding locked-in force effects in the cross-frames for SDLF. White et al. (2015) found that the SDLF locked-in force effects on the girder flange lateral bending stresses may be estimated conservatively as 0.5 of the f_ℓ values determined from a refined analysis not considering the initial lack-of-fit (i.e., a NLF RA). Therefore, Table 78 recommends a net reduced load factor of (γ_p – 0.5) on the SDL for these bridges. The overall influence of this beneficial effect is relatively small, since the SDL stresses are often a fraction of the overall required design stresses, plus these stresses are multiplied by 1/3 in the application of the AASHTO LRFD one-third rule for the strength design. Therefore, a simpler conservative approximation would be to use the same approach as recommended for the cross-frames for SDLF of straight skewed bridges, i.e., simply factor the SDL f_ℓ values obtained from a NLF RA by γ_p, neglecting the beneficial locked-in force effects from the SDLF detailing. It should be emphasized that the best estimate of the internal force reductions, when either SDLF or TDLF is employed, is obtained by calculation of the locked-in force effects directly within the structural analysis.

The fourth column of Table 78 lists recommended calculations of the factored DL responses for curved and skewed I-girder bridges. White et al. (2015) found that the cross-frame forces and the girder flange lateral bending and major-axis bending stresses can be estimated conservatively for curved and skewed bridges by applying the same recommendations discussed above for curved radially-supported bridges. Unfortunately, the accurate estimation the girder reactions is rather difficult in curved and skewed I-girder bridges. Therefore, if potential uplift and/or increases in the reactions are a concern in these types of bridges, it is recommended that a DLF RA be considered.

All of the above recommendations are based on the use of the girder deflections determined from an accurate refined analysis for setting the girder cambers, and the associated cross-frame drops and corresponding connection plate rotational orientations for SDLF or TLDF detailing. For straight skewed I-girder bridges designed using Line Girder Analysis (LGA), the LGA cambers may be used for detailing of the cross-frames. However, various limitations associated with doing so should be recognized. Section 3.4.2.3 of White et al. (2015) details these considerations. In short, the use of LGA girder deflections for SDLF or TDLF detailing of the cross-frames in straight skewed bridges theoretically imposes (or allows) the girders to respond under the targeted DL condition (SDL for SDLF or TDL for TDLF) precisely in the manner assumed within the LGA. This means that, theoretically, the girders all deflect independently of one another, only in the vertical direction, and the cross-frame forces and girder flange lateral bending stresses are effectively zero. As discussed in detail in Section 3.4.2.2 of White et al. (2015), various incidental effects can result in these theoretical or ideal conditions not being exactly achieved. Nevertheless, the cross-frame force and flange lateral bending stress reductions associated with the use of LGA cambers tend to be substantial. White et al. (2015) provide a lower-bound estimate of the beneficial locked-in force effects as 0.65 of the corresponding responses obtained from a NLF RA. That is, one can expect these forces and stresses to be reduced to values less than or equal to 35 % of the calculated NLF RA responses.

Of course, if LGA is used for the design of a straight skewed I-girder bridge, the structural analysis does not provide any information regarding the corresponding cross-frame forces and girder flange lateral bending stresses. Fortunately, if the recommended practices discussed in Section 4.4 are employed, the cross-frame forces and flange lateral bending stresses tend to be relatively small. In cases where these practices are not used, the cross-frame forces and flange lateral bending stresses in a sharply skewed bridge can be relatively large.

It is important to note that the above theoretical results associated with SDLF or TDLF based on LGA girder deflections occur ONLY in the targeted DL condition. The DL results for any other loading, aside from the approximations associated with live load distribution factors, completely miss the fact that the girders, the cross-frames and the composite bridge deck respond as a three-dimensional system."

Background: Guidance is needed for where it is necessary for engineers to make adjustments to commonly used methods of structural analysis, or to perform a more rigorous analysis, to account for the beneficial (subtractive) or non-beneficial (additive) effects of SDLF and TDLF detailing on the internal forces and stresses in curved and skewed I-girder bridges. Practical calculation options need to be recommended for cases where adjustments are necessary or beneficial. Specific recommendations to software providers for enhancement of their capabilities to facilitate the direct consideration of the lack-of-fit from SDLF or TDLF detailing are needed. These recommended updates to Section 5.3 of NSBA (2015) are intended to accomplish these objectives.

(7) Section 6 Summary Advantages and Disadvantages of Various Fit Conditions

- Remove the first two sentences under "The disadvantages of NLF detailing …", which read:

  "The girders must be adequately supported in the field such that the girder self-weight stresses are reasonably small and the girder webs are plumb. Under this scenario, the cross-frames can be installed without any significant force fitting."

Background: This statement implies that NLF detailing generally requires the use of temporary shoring and/or a significant number of holding cranes during the erection. The remainder of the discussion after this sentence makes the appropriate qualification that "Bridges erected without temporary shoring can be detailed for NLF and successfully erected if the fit-up forces are manageable."

- Modify the fifth bullet item under "The advantages of SDLF detailing …" to:

  "In straight skewed bridges, the SDL cross-frame forces determined from a structural analysis (and the corresponding girder flange lateral bending stresses) are often reduced substantially due to the SDLF detailing effects (see Section 5.3 for discussion of procedures to calculate the reduced forces and stresses).

  Background: The current statement in this bullet item might be interpreted as saying that the cross-frame forces and flange lateral bending stresses may be essentially set to zero due to the SDLF detailing effects. The proposed wording change softens this wording to acknowledge the fact that the SDL cross-frame forces and flange lateral bending stresses generally are not fully canceled out by the SLDF detailing effects under the targeted SDL condition.

- In the third bullet item under "The advantages of TLDF detailing...," change "essentially offset" to "largely offset" to also soften the wording regarding the fact that the cross-frame forces and girder flange lateral bending stresses are not fully canceled out by the TDLF detailing effects under the targeted TDL condition. Section 5.3 should be referenced for guidance regarding the calculation of these responses.

- In the first bullet under "The disadvantages of TDLF detailing," which addresses the fact that the girders will be out-of-plumb when the Erector leaves the site and provides an equation for estimating these layovers at the supports, provide the following discussion regarding construction tolerances and inspection of the bridge geometry:

  "This equation may be used as an estimate for inspection of the geometry at the end of the steel erection. The reader is referred to the NCHRP 20-07 Task 355 final report (White et al. 2015) [this report] for recommended inspection practices to ensure to ensure that the erected geometry sufficiently meets the specified fit conditions. The best time to assess the position of the web is at the completion of the steel erection, prior to deck placement, when the steel erector still has a chance to make adjustments to achieve the targeted geometries."

Background: The (NSBA 2015) paper does not discuss the appropriate use of the equation provided for estimating the girder layover at the supports.

- Modify the fourth bullet item under "The disadvantages of TDLF detailing…" to the following:

  "In horizontally curved bridges, the additive locked-in force effects are likely to be significant in the majority of cases. Practically speaking, these larger effects are not readily calculable for consideration in design at the present time, although White et al. (2015) [this report] provide specific guidelines and software tools for calculating these effects."

  Background: Technically, there is no reason why these effects cannot be calculated; however, these calculations are not well facilitated in current professional design software packages. It is hoped that the materials provided in this report will be of assistance to software providers in implementing these capabilities.

- Remove following fifth bullet item under "The disadvantages of TDLF detailing…," which reads:

  "TDLF detailing tends to amplify uplift in horizontally curved bridges at supports where uplift is detected due to design loads, due to combined curvature and skew effects, poor span balance, etc. TDLF also tends to increase the elevations of all the girders within the bridge spans in horizontally curved bridges, which may make it more difficult to achieve the desired bridge profile."

  Background: In certain cases, TDLF detailing can actually help relieve uplift. It is not possible to provide a simple statement that explains the impact of the detailing on uplift one way or the other. In general, the sum of all the changes in the reactions induced by the detailing method has to be zero. In addition, the studies conducted in this research indicate that with the exception of one notable case where the critical span length was larger than 250 ft, L_s/R was greater than 0.5, and L_s/w_g was relatively small, the influence of TDLF on the girder elevations is negligible.

(8) Section 7 Recommended Fit

Remove the phrase ", and as such, these forces can be neglected in most cases," from the third from the last paragraph of this section.

Background: The NCHRP 20-07/Task 355 research shows that the SDLF effects on the cross-frame forces generally are not negligible in curved I-girder bridges.

(9) Section 8.1 Bearing Rotations at Skewed Supports

- It should be possible to simplify the discussion of the impacts of the fit condition on bearing rotations and bearing design. One of the essential points of this section is that SDLF and TLDF reduce the bearing rotations associated with twisting of the girders in the completed bridge. In addition, the girder cambers offset the major-axis rotation of the girders at the bearings. Based on anecdotal inquiries to various design consultants, it appears that the impact of the girder cambers on the major-axis rotation demands at the bearings is often ignored.

(10) Provide a new Section 8.2 on Erection Considerations

- Provide the following discussion reading erection from the outside of the curve to the inside of the curve for curved spans:

"For curved bridges, the erection should be from the outside to the inside of the curve where practicable. Under these circumstances, the girder on the outside of the curve is erected first, and held in place with either a hold crane or temporary support structure, until the adjacent girder towards the inside of the curve is erected. Once these girders are connected via cross-frames, the hold crane or temporary support potentially may be released, at which point the girders will displace vertically and rotate. The vertical displacement on the girder at the inside of the curve in this temporary condition is often less than the final displacement of the girder. Additionally, the out-of-plane rotation that occurs will often be in a manner in which the top flange moves away from the center of the curve more than the bottom flange, thus allowing easier fit up of the next girder and the cross-frames that are being attached.

In addition, in curved and skewed bridges with at least one radially oriented bearing line, it is typically easier to erect first from a radial support, proceeding toward a skewed support, i.e., erecting the framing where the geometry conditions are simpler first."

Background: These statements provide a few useful recommendations that can be applied to facilitate fit-up of the structural steel during erection.

4.3 Additional Guideline Recommendations

This section provides additional guideline recommendations that fall somewhat outside the direct scope of the NSBA guidelines document, but are useful within a broader context.

(1) Complexities of Combined Horizontal Curvature and Skew on the Cross-Frame Forces in Completed Bridge Systems

The orientation of the skew has a significant influence on the cross-frame forces in completed curved and skewed bridges. When the skew orientation makes the inside girder longer, the average and maximum cross-frame forces tend to be significantly reduced. When the skew orientation makes the outside girder longer, the average and maximum cross-frame forces tend to be significantly increased (this is an effect of the overall geometry of the bridge, and should not be considered as an effect pertaining to the SDLF or TDLF detailing). In addition, SDLF and TDLF detailing effects tend to be additive with the internal forces in curved radially-supported bridges while they tend to be subtractive with the internal forces in straight skewed bridges. Therefore, for curved and skewed bridges, the effects of the detailing methods on the dead load cross-frame forces in the completed bridge system are influenced in complex ways by the different combinations of skew and curvature. To correctly capture the effects of the detailing methods, the corresponding initial strains or fixed-end forces should be calculated as discussed in Section 3.9 of this report and included in an accurate refined analysis of the bridge.

(2) Calculation of Locked-in Force Effects due to SDLF and TDLF Detailing

For curved and skewed bridges, there can be major advantages in terms of reduction of the cross-frame forces and girder flange lateral bending stresses from the SDLF or TDLF detailing and the behavior emanating from the skew effects. However, the procedure recommended for the NSBA guidelines document does not recognize the potential reduction in the cross-frame forces due to DLF detailing and the skew effects in bridges that are curved and skewed. This is because the locked-in forces emanating from the horizontal curvature and SDLF or TDLF detailing effects tend to be additive with the internal dead load forces. When designing these types of bridges, it is possible to account for beneficial reductions in the cross-frame forces and girder flange lateral bending stresses by directly calculating the locked-in force effects due to SDLF and TDLF detailing - including the initial strains or fixed-end forces due to the initial lack-of-fit directly in the structural analysis. Any software that is capable of modeling thermal loading has the capability to include the initial strains due to the initial lack-of-fit. In addition, although TDLF detailing is strongly discouraged for horizontally curved I-girder bridges, it is important to have a method to assess the additive TDLF effects in curved bridges that are detailed in this way.

The initial strains can be obtained in 3D FEA software by imposing the vertical deflections associated with the girder dead load cambers. Conducting a specified displacement analysis in 3D FEA software to obtain the initial strains due to the cross-frame detailing can be time consuming and not all bridge software is capable of running such an analysis. A tool, GT-LOFT, is developed as part of this research to facilitate the calculation of the cross-frame initial strains associated with their detailing. A thorough discussion of the calculation of the initial strains via GT-LOFT, with examples, is provided in Section 3.9 of this report.

(3) Lifting, Holding, and Shoring Requirements for Erection

Generally, it is most effective to lift a field section at two locations separated by a spreader beam. As the field section length becomes longer, it may be necessary to use two cranes along with two spreader beams. The pick points for a single crane lift should be determined to ensure stability and to minimize the girder torsional rotations (typically 0.25*L* for straight field sections and between 0.2*L* and 0.25*L* for curved field sections are good initial targets for lifting points, where *L* is the length of the field section). The UT-Lift software (Ferguson Laboratory 2014) is a computational tool that greatly facilitates the accurate positioning of these pick points.

Often, a holding crane is needed during the early stages of steel erection to reduce deflections, ensure stability, and facilitate the fit-up of girders and cross-frames, especially in curved bridges. The hold point is typically near the middle of the span. For curved bridges, the holding crane should be placed on the girder at the outside of the curve for the unit that is presently in place. In bridges with tight curvature, the holding crane typically will need to be retained until multiple girders of the bridge cross-section have been installed. When the erection is from the inside to the outside, the holding crane should be placed on the girder on the outside of the curve at each stage, adjacent to the girder being installed. One should note that the lifting and holding cranes do not provide lateral restraint to the girders.

Shoring towers are often needed in the construction of long-span bridges, including curved bridges with or without sharp skew. Field splices are usually required for these types of bridges. Shoring towers help limit deflections and facilitate the completion of the field splices and the installation of the cross-frames. The use of shoring towers across the full width of the bridge cross-section can greatly facilitate the erection in these situations.

(4) Target Holding or Temporary Support Elevations for Erection

To facilitate fit-up of cross-frames and girders, the holding or temporary support elevations should be set at the no-load elevations for curved radially-supported bridges and at steel dead load elevations for straight skewed bridges for all detailing methods as an initial target for the erection. In curved radially-supported bridges, the detailing effects are additive with the dead load effects. The deflection of the girders under their steel self-weight increases the cross-frame forces. Thus, setting the holding or temporary supports at elevations lower than the NL elevations typically results in higher fit-up forces. Even with SDLF detailing, the elevations should still be set at NL for curved radially-supported bridges. In sharply-skewed straight bridges, NLF detailing is not recommended, since the girder layovers at the abutment lines will be significant. For SDLF detailing, the SDL elevations give the lowest fit-up forces because the girders are tending to deflect into relative positions that are closer to those assumed in the final erected configuration, which the cross-frames are detailed for. For the same reasons, SDL elevations give lower fit-up forces than NL elevations when TDLF detailing is used.

For curved and skewed bridges, the initial targets for the holding or temporary support elevations should be set at the no-load elevations. In curved and skewed bridges, the detailing effects can be either additive or subtractive with the dead load effects. However, the change in cross-frame forces due to SDLF detailing tends to be insignificant. To best facilitate fit-up, the initial target elevations should be at NL.

The erector can manipulate the holding or temporary support elevations relative to the above base target elevations to minimize fit-up forces. When interference of the field section and the abutments or piers occurs, the erector can adjust the elevations of shoring towers and/or cranes pick or hold points to higher elevations, remove a bearing, etc., to resolve the interference. In addition, the erector can avoid the interference by adjusting the locations and/or heights of the shoring towers (either in the back spans or in the cantilever spans) such that the cantilever tips deflect to higher elevations and/or the slopes at the tips are "upward."

4.4 Recommendation of Best Practices for Construction Inspection

As can be seen from the discussions in this research, the behavior of curved and/or skewed steel I-girder bridges can be quite complex, and the constructed geometry can change significantly through the various stages of construction. However, this research has also shown that this behavior is also predictable within reasonable accuracy, and that properly designed, detailed, and fabricated bridges, when properly assembled, can achieve their constructed geometry at all significant milestones in the construction sequence.

Due to the complex nature of the behavior of these types of structures, it is advisable that construction inspectors have some knowledge of that behavior, and some understanding of the significance of the various notes and information presented on the plans. Inspectors should have a clear understanding of the meaning of, and differences between, NLF, SDLF, and TDLF detailing. They should also understand the various synonymous terms such as Fully Cambered Fit, Erected Fit, and Final Fit. They should know how to evaluate the constructed geometry

It is critical that inspectors be able to properly assess the constructed geometry of a bridge at two key stages of construction: at the completion of steel erection, and at the completion of deck placement. Properly assessing the constructed geometry at these key stages, and taking proper action (or properly taking no action) will help ensure successful construction and minimize problems, delays, and unnecessary costs. With a small amount of instruction, inspectors can achieve this goal.

4.4.1 Common Items/Issues

The following are a few items/issues which are common to any curved and/or skewed steel I-girder bridge, regardless of geometric configuration or specified detailing method:

(1) Web Plumbness /Girder Layover Tolerance

Tolerances for girder layover are specified in the AASHTO/NSBA Guide Specification S10.1-2014, *Steel Bridge Erection Guide Specification*.

(2) Effect of Girder Layover on Girder Stresses and Strength

Multiple studies have shown that the effects of girder layover on girder stresses and girder strength are small up to certain practical limits (Domalik et al. 2005a and b; Chavel and Earls 2005; Howell and Earls 2007; Linzell et al. 2010). For curved girder bridges (with either radial or skewed supports), inspectors should not be overly concerned about the strength of or internal stresses in girders which are out of plumb less than two degrees (7/16" of layover per foot of girder height) in positive moment regions in the span. For straight skewed bridges, inspectors should also not be overly concerned about the strength of or internal stresses in girders which are out of plumb near end supports, regardless of the degree of out of plumbness.

However, at skewed end supports of straight or curved girder bridges, out-of-plumbness which deviates from predicted values by more than 0.6 degrees (1/8 inch of layover per foot of girder height) may lead to problems with bearing performance, and more significant deviations from predicted layover may lead to problems with alignment of joints, barriers, etc. Furthermore, at radial supports of straight or curved girder bridges, out-of-plumbness of more than 0.6 deg. (1/8 inch of layover per foot of girder height) is an indication of incorrect detailing, fabrication, or construction; girders should be plumb at radial supports under all loading conditions. The value 0.6 deg. (1/8 inch of layover per foot of girder height) is the tolerance listed in S10.1, which was developed as an industry-consensus document. While there is typically a 0.005 radian (approximately 0.3 deg.) construction tolerance value included in most elastomeric bearing designs, elastomeric bearings are typically fairly forgiving and should be able to tolerate higher rotations if necessary.

Girders in straight skewed bridges which exhibit their expected layover at end supports should be expected to be reasonably plumb at continuous supports and at maximum positive moment locations.

If a given bridge exhibits layovers which exceed the above limits, it is recommended that the inspector contact the engineer for a closer evaluation of the situation.

(3) Girder Camber at End of Steel Erection

Most owners require that the tops of girders be surveyed in the as-erected position, prior to installing deck formwork, and the contractor use this survey information to determine the correct position of the deck forms.

The surveyed profiles of the girder top flanges are compared to the camber profiles on the plans to check for general conformance. The surveyed profile information is also used to determine the appropriate position of the deck formwork relative to the girder top flanges; the anticipated dead load deflection is subtracted from the surveyed elevation of the top of the girder and then compared to the desired final roadway profile and deck thickness to determine the correct position of the deck formwork relative to the top flange.

Generally, if the top flange is a little higher or a little lower than anticipated, the contractor can compensate by setting the deck formwork a little lower or a little higher, respectively. If the needed adjustments appear to be excessive, i.e., if the haunch will be too deep or too shallow, other actions may be required, such as providing haunch reinforcing (for an excessively deep haunch), adjusting the final roadway profile (for an excessively over-cambered girder with a “negative” haunch, i.e., girder flange would be embedded in the deck), or other actions.

Owners should clearly specify the required field survey and calculation procedures, and should identify minimum and maximum haunch values so that inspectors can easily review this information and make appropriate decisions on whether to allow construction to continue, to require adjustments to deck forms, or to contact the engineer to discuss more significant remedial actions.

(4) Uplift at Bearings

Uplift at bearings may or may not represent a problem; inspectors should be provided with sufficient information in the plans to assess the nature of any observed uplift, and should be sufficiently informed about this issue so as to know if and when to involve the engineer in discussions about possible remedial actions.

Generally, uplift is considered undesirable by most owners, under any conditions. However, it may be appropriate and acceptable to allow some degree of temporary uplift during construction, provided that in the final condition there is no uplift.

If temporary uplift is anticipated at an intermediate stage of erection or deck placement, this should be indicated in the plans or specifications, or communicated at a preconstruction meeting or by other means. The locations where uplift is anticipated, and the specific conditions under which uplift is anticipated, should be presented. If feasible and appropriate, the predicted amount of anticipated uplift might be presented. This information will allow the inspector to compare the as-built condition of the bridge under those same stages of erection or construction to the anticipated conditions. If the observed behavior of the structure is significantly different from the anticipated behavior, the engineer should be contacted and an investigation undertaken to determine the causes and possible consequences of this behavior, and to determine what, if any, remedial actions may be necessary.

Inspectors should understand that anticipated uplift during intermediate stages of construction is not necessarily a sign of a problem. The inspector should not unilaterally undertake remedial action to “correct” what may be perceived to be a “problem” with uplift. For example, if uplift is anticipated at some intermediate stage of construction and if the designer evaluated this condition and found no long term problems associated with it, the inspector should not attempt to remediate the uplift by means of shims, counterweights, etc., as these actions would interfere with the subsequent behavior of the structure and may cause long term problems.

(5) Effects of Deviations from Anticipated Web Position or other Anticipated Constructed Geometry Measurements

Layover and web position for various bridge geometries and detailing methods is discussed in detail later in this section. The possible consequences of unintended layover or deviations from anticipated web position are discussed here in general terms. Inspectors should be familiar with these possible consequences so that they can have informed discussions with the contractor and the engineer as appropriate. The possible consequences of unintended layover or deviations from anticipated web position, and some possible remedial actions, are listed below. The list of possible remedial actions is not meant to be comprehensive; other actions may be warranted or necessary in specific situations.

- **Increased Rotational Demand on Bearings:** In some cases this may be a minor effect, especially if it is determined that the effects are temporary (occurring only during an intermediate stage of construction). For cases of temporary increased rotational demand on bearings, one possible solution is to temporarily support the girders on blocking (removing all load from the bearings), or otherwise provide additional support to reduce demand on the bearings in the intermediate condition.

- **Girder/Cross-Frame Fit-Up Problems:** Unintended layover or other deviations from the anticipated constructed geometry (such as excessive deflection, particularly of excessive differential deflection between adjacent girders) at intermediate stages of steel erection may be a sign that the contractor is losing control of the constructed geometry. This problem is sometimes difficult to recognize since specific constructed geometry information at each and every stage of erection typically is not calculated or provided. However, if such information is available, the inspector should evaluate the constructed geometry at intermediate stages of erection. If significant deviations from the targeted geometry are observed, the inspector and the contractor should discuss the matter and verify that the problems can be corrected in the next stage of erection. If the structure continues to deviate further from its anticipated constructed position in the next stage of erection that could be a sign that eventually the contractor will be unable to fit-up the remainder of the structural steel. Inspectors should evaluate compliance with the anticipated constructed geometry throughout the erection of the structural steel. The sooner issues are identified and diagnosed, the better the chances are that simpler, easier actions will be able to correct the problem.
- **Misaligned Joints and Barriers:** Unintended layover or deviations from anticipated web position at skewed supports under total dead load (TDL) conditions can result in misaligned joints or barriers. The best time to assess the position of the web is at the end of steel erection, prior to deck placement, since there is still a reasonable opportunity to take remedial actions at that time. If problems with web position are not identified until after deck placement, the range of possible remedial actions is very limited and generally very costly. Inspectors should carefully evaluate the position of the webs at supports at the end of steel erection, prior to deck placement.

4.4.2 Issues/Items Related to Straight Skewed Bridges

Straight, skewed steel I-girder bridges will exhibit noticeable changes in their web position (i.e., noticeable layover) throughout construction. The girder webs will be plumb under only one loading condition. Girder webs that are plumb at the end of erection (prior to deck placement) will not be plumb after deck placement, and vice versa. It is important that inspectors evaluate girder layover at supports both at the end of steel erection (prior to deck placement) and also after deck placement.

Most straight, skewed steel I-girder bridges are detailed for one of two possible types of fit:

- **Steel Dead Load Fit (SDLF, also known as Erected Fit):** For bridges which are detailed for SDLF the girder webs should be plumb (within reasonable construction tolerances) at the end of steel erection, prior to deck placement. If they are not plumb at the end of steel erection (prior to deck placement), the engineer should be consulted and remedial action should be considered. Later, when the deck is placed, the webs will lay over and be out of plumb. This sequence of webs being plumb prior to deck placement and out of plumb after deck placement is normal and generally does not represent a problem.
- **Total Dead Load Fit (TDLF, also known as Final Fit):** For bridges which are detailed for TDLF the girder webs should be plumb (within reasonable construction tolerances) at the end of deck placement. The webs will be out of plumb at the end of steel erection, prior to deck placement. If the webs are plumb at the end of steel erection (prior to deck placement), or are out of plumb in the wrong direction or beyond reasonable construction tolerances, remedial action should be considered. If the webs are in their correct, anticipated out of plumb position prior to deck placement, then when the deck is placed the webs will rotate (twist) to a plumb position, at least at the supports. This sequence of webs being out of plumb prior to deck placement and plumb after deck placement is normal and generally does not represent a problem.

Some owners/designers may present web orientation information on the plans; if so, the inspector can use this data to evaluate the positions of the webs at the end of steel erection (prior to deck placement). If this information is not on the plans, the web orientation (out of plumbness) at the end of steel erection (prior to deck placement) can be estimated using a simple geometric formula commonly used by steel detailers (NSBA 2015). Depending on the owner’s specification requirements, the inspector may be able to request this information from the contractor, or may only be able to encourage the contractor to perform their own evaluation at the end of steel erection. In either case, both the magnitude and direction of out-of-plumbness of the webs at the end of steel erection should be considered.

4.4.3 Issues/Items Related to Curved Radially-Supported Bridges

Curved, radially supported steel I-girder bridges will exhibit noticeable changes in their web position (i.e., noticeable layover) throughout construction, but only within the span. At the supports the girders will be plumb both at the end of steel erection (prior to deck placement) and after deck placement. Out in the span, the girder webs will be plumb under only one loading condition. Girder webs may be plumb when shored, or they may be plumb at the end of erection (after shoring is removed but prior to deck placement). It is highly unlikely that the webs will be plumb after deck placement. It is important that inspectors evaluate web plumbness at supports at all stages of the construction process, including under shored conditions (if shoring is used), at the end of steel erection (prior to deck placement), and after deck placement.

Most curved, radially supported steel I-girder bridges will be detailed for one of two possible types of fit:

- **No-Load Fit (NLF, also known as Fully Cambered Fit):** For bridges which are detailed for NLF, the girder webs should be plumb under shored conditions throughout the length of the bridge. Later, when the shoring is removed at the end of steel erection (prior to deck placement) the webs should still be plumb at the supports, but will be out of plumb in the span. Generally the girders should be expected to twist so that the top flange is deflected toward the outside of the curve. Later, when the deck is placed, the webs should still be plumb at the supports, but will be further out of plumb in the span. Again, in most cases, the girders should be expected to twist so that the top flange is deflected toward the outside of the curve. If the girder webs are out of plumb at the supports at any stage of construction the engineer should be consulted and remedial action should be considered. Girder layover in the span at the end of construction is normal in a curved, radially supported bridge and generally does not represent a problem.
- **Steel Dead Load Fit (SDLF, also known as Erected Fit):** For bridges which are detailed for SDLF the girder webs should be plumb (within reasonable construction tolerance) at the end of steel erection, prior to deck placement, throughout the length of the bridge. If they are not plumb at the end of steel erection (prior to deck placement), the engineer should be consulted and remedial action should be considered. Later, when the deck is placed, the webs should still be plumb at the supports, but will be further out of plumb in the span. In most cases, the

girders should be expected to twist so that the top flange is deflected toward the outside of the curve. Girder layover in the span at the end of construction is normal in a curved, radially supported bridge and generally does not represent a problem.

The use of Total Dead Load Fit (TDLF) detailing (also known as Final Fit detailing) is strongly discouraged for curved, radially supported steel I-girder bridges.

4.4.4 Issues/Items Related to Curved and Skewed Bridges

Curved and skewed steel I-girder bridges are very complicated structures. They will exhibit noticeable changes in their web position (i.e., noticeable layover) throughout construction. Girder webs may be plumb when shored, or they may be plumb at the end of erection (after shoring is removed but prior to deck placement). It is highly unlikely that the webs will be plumb after deck placement. It is important that inspectors evaluate web plumbness at supports at all stages of the construction process, including under shored conditions (if shoring is used), at the end of steel erection (prior to deck placement), and after deck placement.

Most curved and skewed steel I-girder bridges will be detailed for one of two possible types of fit:

- **No-Load Fit (NLF, also known as Fully Cambered Fit):** For bridges which are detailed for NLF, the girder webs should be plumb under shored conditions throughout the length of the bridge. Later, when the shoring is removed at the end of steel erection (prior to deck placement) the webs will be out of plumb in the span, and possibly also at the supports, particularly at any and all skewed supports. Generally the girders should be expected to twist so that the top flange is deflected toward the outside of the curve, but this may not be true if the geometry is particularly complicated. Later, when the deck is placed, the webs which were plumb at radial supports prior to deck placement will likely still be plumb after deck placement, but will be further out of plumb within the span. Again, in most cases, the girders should be expected to twist so that the top flange is deflected toward the outside of the curve, but this may not be true if the geometry is particularly complicated. Girder layover at the end of construction is normal and generally does not represent a problem.
- **Steel Dead Load Fit (SDLF, also known as Erected Fit):** For bridges which are detailed for SDLF the girder webs should be plumb (within reasonable construction tolerance) at the end

of steel erection, prior to deck placement, throughout the length of the bridge. If they are not plumb at the end of steel erection (prior to deck placement), the engineer should be consulted and remedial action should be considered. Later, when the deck is placed, the webs should still be plumb at radial supports, but will be further out of plumb in the span. In most cases, the girders should be expected to twist so that the top flange is deflected toward the outside of the curve. Girder layover in the span at the end of construction is normal in a curved, radially supported bridge and generally does not represent a problem.

Total Dead Load Fit (TDLF, also known as Final Fit is not generally used for curved and skewed steel I-girder bridges.

4.5 Recommendations for Modifications to the AASHTO LRFD Design Specification Provisions

One of the products of this research is recommendations for appropriate modifications to the AASHTO standards. The following modifications to Articles 6.2, 6.7.2 , C6.7.2, 6.7.4.1 and C6.7.4.1 are recommended:

2016 AASHTO BRIDGE COMMITTEE AGENDA ITEM:

SUBJECT: LRFD Bridge Design Specifications: Section 6, Articles 6.2, 6.7.2 and C6.7.2

TECHNICAL COMMITTEE: T-14 Steel

☒ **REVISION**	☒ **ADDITION**	☐ **NEW DOCUMENT**
☒ **DESIGN SPEC**	☐ **CONSTRUCTION SPEC**	☐ **MOVABLE SPEC**
☐ **MANUAL FOR BRIDGE EVALUATION**	☐ **SEISMIC GUIDE SPEC**	☐ **COASTAL GUIDE SPEC**
	☐ **OTHER**	

DATE PREPARED: 10/25/15
DATE REVISED:

AGENDA ITEM:

Item #1

Add the following definitions to Article 6.2:

Contiguous Cross-Frames/Diaphragms—Intermediate cross-frames or diaphragms arranged in a continuous line across an entire I-girder bridge cross-section.

Discontinuous Cross-Frames/Diaphragms—Intermediate cross-frames or diaphragms arranged in a discontinuous line across an I-girder bridge cross-section.

Fit Condition—The deflected girder geometry associated with a specific dead load condition in which the cross-frames or diaphragms in certain skewed and horizontally curved I-girder bridges are detailed to connect to the girders.

Locked-in Forces—The internal forces induced into a structural I-girder system when SDLF or TDLF detailing is employed. These internal forces are caused by the lack-of-fit detailed between the cross-frames and the girders in the base fully-cambered No-Load (NL) geometry. These internal forces would remain if the structure's dead loads were theoretically removed.

No-Load Fit (NLF) Detailing—A method of detailing in which the cross-frames or diaphragms are detailed such that the cross-frame or diaphragm connection work points fit with the corresponding work points on the girders without any force-fitting, with the girders assumed erected in their fully-cambered (plumb) geometry under zero load. NLF detailing is also synonymously referred to as fully-cambered fit detailing.

Phased Construction—Construction in which a bridge is built in separate units with a longitudinal construction joint between them.

Staged Deck Placement—Placement of a concrete bridge deck in successive stages with a longitudinal and/or transverse construction joint between them.

Steel Dead Load Fit (SDLF) Detailing—A method of detailing in which the cross-frames or diaphragms are detailed such that the cross-frame or diaphragm connection work points fit with the corresponding work points on the girders with the steel dead load vertical deflections and the associated girder major-axis rotations at the connection plates (where applicable) subtracted from the fully-cambered geometry of the girders, and with the girder webs assumed in an ideal plumb position under the Steel Dead Load (SDL) condition at the completion of the steel erection. SDLF detailing is also synonymously referred to as erected-fit detailing.

Total Dead Load Fit (TDLF) Detailing—A method of detailing in which the cross-frames or diaphragms are detailed such that the cross-frame or diaphragm connection work points fit with the corresponding work points on the girders with the total dead load vertical deflections and the associated girder major-axis rotations at the connection plates (where applicable) subtracted from the fully-cambered geometry of the girders, and with the girder webs assumed in an ideal plumb position under the Total Dead Load (TDL) condition. TDLF detailing is also synonymously referred to as final-fit detailing.

Item #2

Revise the 4th paragraph of Article 6.7.2 as follows:

When staged deck placement or phased construction is specified, the sequence of load application and the change in the composite stiffness during the different stages of the deck placement should be considered when ~~determining the~~ establishing cambers and setting screed requirements.

Item #3

Revise the last paragraph of Article 6.7.2 as follows:

For straight or horizontally curved ~~skewed~~ I-girder bridges where one or more support lines are skewed more than 20 degrees from normal, and for horizontally curved radially supported I-girder bridges ~~with or without skewed supports~~ with a maximum L/R greater than 0.03, where L is the actual span length bearing to bearing along the centerline of the girder and R is the girder radius at the bridge centerline, the contract documents should ~~clearly~~ state ~~an intended erected position of the girders and the condition under which that position is to be theoretically achieved~~ the fit condition for which the cross-frames or diaphragms are to be detailed. The provisions of Article 2.5.2.6.1 related to bearing rotations also should ~~also apply~~ be considered.

Item #4

Revise Article C6.7.2 as follows:

Generally, the effects of staged deck placement as well as the impact of phased construction should be considered when establishing cambers and setting screed requirements. AASHTO/NSBA (2014a) and NHI (2015) provide further guidance on these considerations.

Skewed and curved I-girder bridges generally exhibit torsional displacements, or twisting, of the individual girders and of the overall bridge cross-section under load, including the loads during construction. As a result, the girder webs can only be plumb in one load condition. Also, the ends of the cross-frames or diaphragms in these bridges can experience significantly different vertical dead load deflections, which can affect the detailing of these members. The fit condition of an I-girder bridge refers to the deflected girder geometry associated with a targeted dead load condition for which the cross-frames or diaphragms are detailed to connect to the girders. The girder geometry used by the Fabricator/Detailer to detail the cross-frames or diaphragms is based on the deflections provided in the contract documents that are associated with the targeted dead load condition.

The fit condition is selected to determine the approximate vertical orientation of the girders under various stages of dead load. The choice of fit condition can also influence the constructibility and long-term performance of the bridge because it can affect the magnitude of the locked-in force effects in the cross-frames or diaphragms and the girders, and it can influence the forces required to assemble the steel together during the erection. I-girder bridges with smaller skew, larger radii and/or shorter spans are insensitive to the choice of the fit condition. For a given skew and/or horizontal curvature, bridges with longer spans potentially can experience more difficulties with respect to key responses during and at the completion of the construction, such as: fit-up (i.e., assembly) of the steel during the erection, achievement of the targeted constructed geometry under dead load, and development of significant changes in the internal force states in the structure under dead load due to detailing and erection procedures.

The framing arrangement of the cross-frames or diaphragms within skewed and curved I-girder bridges also can be an important factor. Arrangements of cross-frames or diaphragms that inadvertently create stiff transverse load paths in certain portions of the structure, combined with other attributes of the bridge geometry such as high span length-to-girder depth ratios, simply-supported spans, or poor span balance in continuous spans, can lead to dramatically increased cross-frame or diaphragm forces and potential fit-up difficulties during the steel erection. Basically, substantial differences in stiffness of different portions of a large bridge structure can be problematic. Utilization of discontinuous cross-frame or diaphragm lines adjacent to skewed supports, as discussed further in Articles 6.7.4.2 and C6.7.4.2, is one practice that can mitigate the stiff transverse load paths and their effects in these regions.

A fit decision must always be made for the bridge types specified in Article 6.7.2 so that the Fabricator/Detailer can complete the shop drawings and fabricate the bridge components in a way that allows the Erector/Contractor to assemble the steel and achieve a desired geometry in the field. The fit decision also influences the rotation demands on the bearings (NSBA 2015), as well as the internal forces for which the cross-frames or diaphragms and girders must be designed. Since the fit decision directly influences the cross-frame fabricated geometry, as well as the bridge constructibility and subsequent internal forces, the fit condition should ideally be selected by the Engineer, who best knows the loads and capacities of the structural members, with proper consideration of the bridge erection. The fit condition must be selected to effectively manage the structure's constructed geometry and internal forces, and to facilitate the construction of the bridge. Skewed and curved I-girder bridges have been successfully fabricated and erected for many years and have performed well in service. However, in some cases, failure to engineer the erection to achieve a targeted final position of the girders, or to properly investigate potential outcomes when detailing to achieve a targeted final position of the girders, has resulted in construction delays and claims.

The three most common fit conditions are:

- No-Load Fit (NLF),
- Steel Dead Load Fit (SDLF), or
- Total Dead Load Fit (TDLF).

For the bridge types specified in Article 6.7.2, the contract documents should indicate one of these fit conditions for which the cross-frames or diaphragms are to be detailed. More detailed guidance on the selection of an appropriate fit condition is provided in NSBA (2014) and NSBA (2015).

NLF refers to the condition where the cross-frames or diaphragms are detailed to fit to the girders in their fabricated, plumb, fully cambered position under zero load. In this case, the girder webs will be out-of-plumb after any dead load is applied, except at non-skewed bearing lines. At skewed bearing lines, this out-of-plumbness should be considered in the detailing of the deck, deck joint, barrier joint, and bearings, as applicable. Girder dead load layovers at highly skewed abutments can be substantial when NLF detailing is employed. The specification of NLF detailing is recommended only for longer-span horizontally curved I-girder bridges, with or without skewed supports and with a maximum L/R greater than 0.03 (NSBA 2014; NSBA 2015).

SDLF refers to the condition where the cross-frames or diaphragms are detailed to fit to the girders in their ideally plumb as-deflected positions under the self-weight of the steel at the completion of the erection. SDLF is common and effective for straight I-girder bridges and for most horizontally curved I-girder bridges (NSBA 2014; NSBA 2015). SDLF is favored for ease of construction of these types of bridges since the steel dead load corresponds to the condition where all the girders are erected and all the cross-frames or diaphragms are connected. Bridges detailed for this condition generally require less forced fit-up of the cross-frames or diaphragms; particularly if the girders are allowed to deflect under their self-weight before installing the cross-frames or diaphragms. Where a SDLF is employed, dead loads applied after the completion of the steel erection will introduce a final and permanent twist into the girders.

TDLF refers to the condition where the cross-frames or diaphragms are detailed to fit to the girders in their ideally plumb as-deflected positions under the total dead load. The total dead load generally includes the weight of the concrete deck. In phased construction or where superimposed dead loads cause significant girder deflection, it may also be desirable to consider the effect of the superimposed dead loads. In the case of TDLF detailing, the Erector will leave the site with the girders out-of-plumb since the total dead load will not yet have been applied. However, a TDLF gives approximately plumb girder webs once the bridge is subjected to its total dead load. For straight skewed I-girder bridges, or for horizontally curved skewed I-girder bridges with L/R in all spans less than or equal to 0.03, a TDLF can be effective for span lengths up to approximately 200 feet (NSBA 2014; NSBA 2015). Practice has demonstrated that the use of a TDLF for longer-span straight skewed bridges, and for horizontally curved bridges with or without skew and with a maximum L/R greater than 0.03, can potentially render the bridge unconstructable because the girders cannot be twisted as readily in these bridges to facilitate erection (NSBA 2014; NSBA 2015). Curved I-girders, in particular, resist the twisting required to fit the steel together via their coupled resistance to major-axis bending and twisting. This behavior tends to increase the difficulty of fitting the steel together during the steel erection.

When either a SDLF or a TDLF is specified, the girders are fabricated plumb and are twisted out-of-plumb during steel erection in the opposite direction that they tend to twist under the application of the corresponding targeted dead load to connect them with the cross-frames or diaphragms. This compensating twist in the girders is achieved by introducing locked-in internal forces in the system during the erection.

Although the use of refined analysis methods is not required for these bridges, these methods, when utilized, do allow for consideration of dead load cross-frame or diaphragm forces and flange lateral bending stresses. In straight skewed I-girder bridges, these dead load force effects are partially offset by the corresponding locked-in force effects at the completion of the steel erection (White et al. 2012; White et al. 2015). It is important to recognize that the dead load force effects, when determined from a refined analysis model, typically do not include the locked-in force effects due to SDLF or TDLF detailing of the cross-frames or diaphragms. That is, the analysis model corresponds to the assumption of a NLF.

White et al. (2015) describe a procedure for directly determining the locked-in force effects from SDLF or TDLF detailing as part of a refined analysis. Otherwise, in lieu of considering the locked-in force effects directly within the structural analysis, the approximations discussed in subsequent paragraphs may be employed. For straight skewed I-girder bridges detailed for a TDLF where the skew index, I_s, defined in Article 4.6.3.3.2 is greater than 1.0, and/or the recommendations provided in Article C6.7.4.2 to lessen nuisance transverse stiffness effects are not applied, direct calculation of the influence of the dead-load fit detailing on the girder vertical reactions and girder major-axis bending stresses via a refined analysis should be considered. In addition, for curved and skewed I-girder bridges with a maximum L/R greater than 0.03, direct calculation of the influence of the dead load fit detailing on the girder vertical reactions via a refined analysis should be considered (White et al. 2015). The following procedures do not address the effects due to the bracket loads supporting the eccentric deck overhangs during deck construction. These effects may be estimated separately as described in Article C6.10.3.4 and combined as appropriate with the other dead load effects discussed below.

For straight skewed I-girder bridges that are detailed for a TDLF, the total dead load cross-frame or diaphragm forces and flange lateral bending stresses, when determined from a refined analysis not including the influence of dead load fit detailing, may be reduced to account for the corresponding locked-in force effects introduced into the structural system during the steel erection. In this case, a net reduced load factor, $(\gamma_p)_{red}$, to be applied to the unfactored total dead load cross-frame or diaphragm forces and flange lateral bending stresses may be conservatively taken equal to:

$$(\gamma_p)_{red} = (\gamma_p - 0.4) \qquad \text{(C6.7.2-1)}$$

where:

γ_p = the maximum load factor for *DC* specified in Table 3.4.1-2, or the maximum load factor specified in Article 3.4.2.1 for *DC* and any construction loads that are applied to the fully erected steelwork, as applicable.

The above recommended net reduced load factor, applied to the unfactored total dead load cross-frame or diaphragm forces and flange lateral bending stresses, is based on an approximate lower-bound estimate of the corresponding beneficial locked-in force effects from TDLF detailing (White et al. 2015). Smaller net reduced load factors may be applied to the unfactored cross-frame or diaphragm forces and flange lateral bending stresses at the discretion of the Owner. In straight skewed bridges detailed for a TDLF, the Engineer should also check the cross-frame or diaphragm forces and the flange lateral bending stresses for the fit-up force effects during the steel erection. These effects may be estimated as the negative of the corresponding unfactored concrete dead load force effects, which should then be multiplied by γ_p (White et al., 2015).

White et al. (2015) recommend that the specified load factor, γ_p, should be applied directly to the *DC* cross-frame or diaphragm forces and flange lateral bending stresses for straight skewed bridges detailed for a SDLF. Significant cross-frame or diaphragm force and flange lateral bending stress reductions are achievable in straight skewed bridges detailed for a SDLF; however, in the most extreme cases studied by White et al. (2015), incidental and elastic deformation effects in the structural system lead to negligible corresponding locked-in force effects for SLDF. It should be emphasized that the best estimate of the internal force reductions, when either a SDLF or TDLF is employed, is obtained by calculation of the locked-in force effects directly within the structural analysis.

In curved I-girder bridges, the locked-in force effects tend to be additive with the corresponding dead load effects. For curved I-girder bridges, with or without skew and with a maximum *L*/*R* greater than 0.03, for which detailing using a SDLF is acceptable and recommended (NSBA 2014; NSBA 2015), the additional locked-in force effects may be accounted for approximately by multiplying the unfactored steel dead load cross-frame or diaphragm forces by the factor 2.0 and the unfactored steel dead load flange lateral bending stresses by the factor 1.20 prior to applying γ_p (White et al. 2015). For X-type cross-frames, SDLF detailing has a substantial effect only on the cross-frame diagonal forces; therefore, the above factor of 2.0 need only be applied to the diagonal forces for these types of cross-frames. White et al. (2015) show that these factors provide a reasonable coarse approximation of the SDLF detailing effects for a range of curved bridges with *L*/*R* ranging from 0.2 to 0.5. The smaller increase in the flange lateral bending stresses is due to the attribute that the ratio of the locked-in effects from SDLF detailing to the effects from horizontal curvature generally tend to be smaller for the flange lateral bending stresses than for the cross-frame forces (White et al. 2015). For a bridge where the factored steel dead load cross-frame forces are roughly one-half of the factored total dead load forces, and the factored total dead load cross-frame forces are one-half of the total factored forces for design, the total factored cross-frame forces are increased by a factor of 1.25. For bridges with smaller *L*/*R*, the horizontal curvature effects are smaller, and hence the scaled steel dead load cross-frame forces and flange lateral bending stresses are smaller.

The additional locked-in force effects are more significant for TDLF detailing; however, TDLF detailing is to be avoided for horizontally curved bridges with or without skew and with a maximum *L*/*R* greater than 0.03 (NSBA 2014; NSBA 2015). Since the locked-in force effects from SDLF and TDLF detailing associated with horizontal curvature tend to be additive with the corresponding dead load force effects, the optional reduction of the total dead load cross-frame or diaphragm forces and flange lateral bending stresses discussed previously is not applicable to horizontally curved or curved and skewed bridges.

Various factors can cause the girders to deviate from an ideal plumb geometry under the targeted dead load condition, particularly when TDLF detailing is specified. These factors include connection tolerances, fabrication tolerances, accuracy of the structural analysis models, accuracy of the dead load deflection estimates, stiffness of the deck forming (which is typically neglected in analysis calculations), and sequential casting and early stiffness gains of the deck concrete. Except in unusual cases involving substantial global displacement amplification of a slender I-girder bridge unit in its noncomposite condition during the deck placement due to stability effects, such as discussed in Article 6.10.3.4.2, deviation from the ideal plumb condition due to the deflection of the structure generally has a negligible influence on the structural resistance (White et al. 2012). However, substantial deviation from the targeted geometry is an indication that the dead load internal forces and internal stresses in the structure may differ significantly from their calculated values. AASHTO/NSBA (2014b) suggests a tolerance on the deviation from the theoretical erected web position.

Shop assembly of the entire bridge or any significant portion of the bridge is not customary and is typically not needed, except possibly for highly complex framing detailed for a NLF. Such a requirement adds unnecessary cost to projects that utilize less complex and more conventional framing. Full shop assembly cannot be done if the bridge has been detailed for a TDLF.

Tub girders with properly designed top flange lateral bracing effectively behave as closed sections, and as such, they are torsionally quite stiff. Straight or slightly curved tub girders with top flange lateral bracing, but without external intermediate cross-frames or diaphragms, generally exhibit little twist under non-composite loading. Tub girders with longer spans and more significant curvature are potentially subject to more significant twisting of the individual girders, but this is often controlled and minimized by providing external intermediate cross-frames or diaphragms. Tub girders are typically designed and detailed to be oriented normal to the cross-slope of the roadway and their webs are detailed to be of equal depth (AASHTO/NSBA 2006). Thus, the concepts of NLF, SDLF, and TDLF do not directly apply. Also, since tub girders are inherently torsionally stiff, it is difficult to twist them in the field to achieve fit-up of external cross-frames or diaphragms. As a result, tub girder external cross-frames or diaphragms are typically detailed and fabricated to fit under no-load or a specific intermediate steel dead load condition depending on the intended erection sequence. In addition, depending on the magnitude of their twist deformations under loading, tub girders may need to be detailed and fabricated with a built-in reverse twist so that when they twist under dead load, they deflect to a position normal to the roadway cross-slope. The camber of the two webs in skewed and/or curved tub-girder bridges can be significantly different.

As specified herein, staged construction refers to the situation in which superstructures are built in separate longitudinal units with a longitudinal joint, i.e., it does not refer to the deck pouring sequence.

The erection and cambering of straight skewed bridges and horizontally curved bridges with or without skewed supports is a more complex problem than generally considered. As of this writing (2005), there has been a trend toward more complex geometries and more flexible bridges combined with the use of higher strength steels. In some cases, failure to engineer the erection to achieve the intended final position of the girders, or to properly investigate potential outcomes when detailing to achieve an intended final position of the girders, has resulted in construction delays and claims. It is important that Engineers and Owners recognize the need for an engineered construction plan and the implied level of checking of shop drawings of girders and cross-frames or diaphragms, processing of RFIs or Requests for Information, and field inspection.

Intended erected positions of I-girders in straight skewed and horizontally curved bridges are defined herein as either:

- girder webs theoretically vertical or plumb, or
- girder webs out-of-plumb.

Three common conditions under which these intended erected positions can be theoretically achieved are defined herein as:

- the no-load condition,
- the steel dead load condition, or
- the full dead load condition.

The no-load condition refers to the condition where the girders are erected under a theoretically zero-stress condition, i.e., neglecting any stress due to the steel dead load acting between points of temporary support. The steel dead load condition refers to the condition after the erection of the steel is completed. The full dead load condition refers to the condition after the full noncomposite dead load, including the concrete deck, is applied.

In order for the girder webs of straight skewed I-girder bridges to end up theoretically plumb at the bearings under either the steel or full dead load condition, the cross-frames or diaphragms must be detailed for that condition in order to introduce the necessary twist into the girders during the erection. Although the cross-frames or diaphragms may have to be forced into position in this case, this can usually be accomplished in these types of bridges without inducing significant additional locked-in stresses in the girder flanges or the cross-frames or diaphragms. Alternatively, the girders may be erected plumb in the no-load condition if the resulting out-of-plumbness at the bearings and any potential errors in the horizontal roadway alignment under the full dead load condition are considered. In this case, the cross frames or diaphragms are detailed to fit theoretically stress free in the no-load condition. In either case, the rotation capacity of the bearings must either be able to accommodate the twist or the bearings must be installed in a manner to ensure that their rotation capacities are not exceeded.

~~For horizontally curved I-girder bridges with or without skewed supports, where the girders are erected plumb in the no-load condition, with the cross-frames or diaphragms detailed to fit in the no-load condition, the girder webs will not be plumb in the full dead load condition, except at supports that do not deflect vertically in bridges for which all supports are radial. This out-of-plumbness should be considered in the detailing of the deck and bearings, as applicable.~~

~~In order for the girder webs of horizontally curved I-girder bridges with or without skewed supports to end up theoretically plumb under either the steel or full dead load condition, the cross-frames or diaphragms must again be detailed for that condition in order to introduce the necessary twist into the girders. In this case, however, as the cross frames are forced into place and the girders are twisted out of plumb during the erection, the curved-girder flanges act to resist the induced change to their radii. Therefore, the Engineer may need to consider the potential for any problematic locked-in stresses in the girder flanges or the cross-frames or diaphragms when this method of detailing is specified for these types of bridges. The decision as to when these stresses should be evaluated is currently a matter of engineering judgment. It is anticipated that these stresses will be of little consequence in the vast majority of cases and that the resulting twist of the girders will be small enough that the cross-frames or diaphragms will easily pull the girders into their intended position and reverse any locked-in stresses as the dead load is applied.~~

~~For curved I-girder webs to end up theoretically plumb in the desired final condition without also theoretically inducing any additional locked-in stresses, the girders would have to be fabricated for the no-load position with a twist about the tangential axis of the girder for that particular condition. In such a case, the girder flanges would be welded square with respect to the webs and the cross-frames or diaphragms would be detailed for the desired final condition to correspond with the twist. Such a practice is generally more costly and has found very limited use as of this writing (2005).~~

~~It should be noted that detailing of the cross-frames or diaphragms for this case where the girder webs are plumb in the no-load condition can result in the potential for many different connection-plate configurations. In this case, the drop of the cross-frames or diaphragms or difference in elevation of the girders at the level of the cross-frames or diaphragms typically varies causing the bolt holes in the connection plates to be different distances from the flanges.~~

~~Tub girders should be detailed to be normal to the crown of the roadway. Although the twist in I-girders is often greater than in tub girders, twist in tub girders may also be significant. Almost all horizontally curved tub girders are fabricated with a twist and are not erected with the girders plumb in the no-load condition. This is done because the inherent torsional stiffness of tub sections makes field adjustments difficult. Particular care must be taken in analyzing and detailing tub girders; in particular, tub girders in bridges with skewed supports.~~

~~For cases that begin to push the current limits of the specification or conventional practice, for example, cases with unusually long spans, tight radii, sharp skews, stiff and/or slender flanges in the lateral direction, special attention may be required by the Engineer. In cases where twist is introduced into the girders during the erection, slender flanges may be subject to local buckling and unusually stiff flanges may be difficult to push or pull into position in a practical manner.~~

Item #5

Add the following references to the reference list in Article 6.17:

AASHTO/NSBA Steel Bridge Collaboration. 2006, *Guidelines for Design Details, G1.4*, 1st Edition, NSBAGDD-1-OL, American Association of State Highway and Transportation Officials, Washington, DC.

AASHTO/NSBA Steel Bridge Collaboration. 2014a. *Guidelines for Steel Girder Bridge Analysis*, *G13.1*, 2nd Edition, NSBASGBA-2-OL, American Association of State Highway and Transportation Officials, Washington, DC.

AASHTO/NSBA Steel Bridge Collaboration. 2014b. Steel *Bridge Erection Guide Specification, S10.1*, 2nd Edition, NSBASBEGS-2-OL, American Association of State Highway and Transportation Officials, Washington, DC.

NHI. 2015. "Load and Resistance Factor Design (LRFD) for Highway Bridge Superstructures," Course No. 130081, Publication No. FHWA-NHI-15-047. National Highway Institute, Federal Highway Administration, U.S. Department of Transportation, Washington, DC, April 2007, Revised July 2015.

NSBA. 2014. "Skewed and Curved Steel I-Girder Bridge Fit," NSBA Technical Subcommittee Fit Task Force, Stand-Alone Summary, National Steel Bridge Alliance, Chicago, IL, August, 2014.

NSBA. 2015. "Skewed and Curved Steel I-Girder Bridge Fit," NSBA Technical Subcommittee Fit Task Force, Guide Document, National Steel Bridge Alliance, Chicago, IL, October, 2015.

White, D.W., Nguyen, T.V., Coletti, D.A., Chavel, B.W., Grubb, M.A., and Boring, C.G. 2015. "Guidelines for Reliable Fit-Up of Steel I-Girder Bridges," NCHRP 20-07/Task 355, Transportation Research Board, National Research Council, Washington, DC.

OTHER AFFECTED ARTICLES:

Revise the 4th sentence of the 4th paragraph of Article C6.10.3.4.1 as follows:

If the differences are deemed significant, this should be considered when establishing camber and screed requirements, as specified in Article 6.7.2.

BACKGROUND:

The proposed revisions to Articles 6.7.2 and C6.7.2 incorporate and reflect various findings gained from recent research studies on curved and/or skewed steel I-girder bridges, specifically NCHRP Project 12-79 and NCHRP 20-07/Task 355, and other related studies. The proposed revisions to Article 6.7.2 state more explicitly the issues to be considered in the analysis for phased construction and/or staged deck placement when establishing the girder cambers. In addition, the proposed revisions to Article 6.7.2 revise the language to indicate that for certain specified bridge types, the contact documents should state the fit condition for which the cross-frames or diaphragms are to be detailed. This change in language recognizes that the detailing of the cross-frames or diaphragms in curved and/or skewed I-girder bridges involves various approximations and idealizations, and aims to clarify cross-frame or diaphragm detailing recommendations based on the corresponding idealized fit conditions, as described in more detail in the proposed commentary language. Also, when straight skewed I-girder bridges are detailed for a Steel Total Dead Load Fit, Article C6.7.2 permits the Engineer to optionally reduce the total dead load cross-frame or diaphragm forces and flange lateral bending stresses, when determined from a refined analysis, by accounting for the corresponding locked-in force effects introduced into the system during the erection; for horizontally curved bridges with or without skew, an increase in the cross-frame or diaphragm forces and the flange lateral bending stresses is recommended to account for the fact that the Dead Load Fit effects tend to be additive with these responses in curved bridges. These recommended increases are applied to the steel dead load responses obtained from a refined analysis. As such, their influence on the overall proportioning of the cross-frames and girder flanges is relatively minor. The revisions to Article C6.7.2 emphasize the idealizations associated with different methods of detailing of the cross-frames or diaphragms. Discussion of web plumbness under steel dead load or total dead load is de-emphasized, since it is well established that web out-of-plumbness due to the deflection under the steel dead load or total dead load has a negligible impact on the strength of the structure, except in cases such as narrow units composed of only a few girders, and where the structure is experiencing substantial second-order displacement amplification due to stability effects in its noncomposite condition during the deck placement.

The proposed revisions aim to clarify the important technical considerations associated with the selection of a method of cross-frame or diaphragm detailing, and to establish and help ensure the use of a more consistent terminology to enhance communication related to cross-frame or diaphragm detailing considerations.

ANTICIPATED EFFECT ON BRIDGES:

The proposed revisions to Articles 6.7.2 and C6.7.2 should help provide a stronger understanding of the implications of dead load camber and cross-frame or diaphragm detailing methods for curved and/or skewed steel I-girder bridges among the various stakeholders. This should lead to safer and more consistent practices, and should help to reduce the possibility of construction delays and claims. Permitting the use of optional lower-bound reduced total dead load cross-frame forces and flange lateral bending stresses by accounting for the corresponding locked-in force effects induced during the erection in straight skewed I-girder bridges detailed for a Total Dead Load Fit should lead to economies in the design of the flanges, cross-frame members, and cross-frame connections in these bridges when these bridges are analyzed and designed using refined analysis methods and a Total Dead Load Fit is employed. Recommendation of an increase in the cross-frame or diaphragm forces and flange lateral bending stresses for horizontally curved bridges detailed for a SDLF better recognizes the physical behavior of these bridges, and alludes to the importance of discouraging the use of TDLF for these types of structures. These increases are applied to the steel dead load responses obtained from a refined analysis. As such, their influence on the overall proportioning of the cross-frames and girder flanges is relatively minor.

REFERENCES:

NSBA. 2014. "Skewed and Curved Steel I-Girder Bridge Fit," NSBA Technical Subcommittee Fit Task Force, Stand-Alone Summary, National Steel Bridge Alliance, Chicago, IL, August 20, 2014.

NSBA. 2015. "Skewed and Curved Steel I-Girder Bridge Fit," NSBA Technical Subcommittee Fit Task Force, Guide Document, National Steel Bridge Alliance, Chicago, IL, November 2015.

White, D.W., Coletti, D., Chavel, B.W., Sanchez, A., Ozgur, C., Jimenez Chong, J.M., Leon, R.T., Medlock, R.D., Cisneros, R.A., Galambos, T.V., Yadlosky, J.M., Gatti, W.J., and Kowatch, G.T. 2012. "Guidelines for Analytical Methods and Construction Engineering of Curved and Skewed Steel Girder Bridges," NCHRP Report 725, Transportation Research Board, National Research Council, Washington, D.C.

White, D.W., Nguyen, T.V., Coletti, D.A., Chavel, B.W., Grubb, M.A., and Boring, C.G. 2015. "Guidelines for Reliable Fit-Up of Steel I-Girder Bridges," NCHRP 20-07/Task 355, Transportation Research Board, National Research Council, Washington, D.C.

2016 AASHTO BRIDGE COMMITTEE AGENDA ITEM:

SUBJECT: LRFD Bridge Design Specifications: Section 6, Articles 6.7.4.1 and C6.7.4.2

TECHNICAL COMMITTEE: T-14 Steel

☒ **REVISION**	☒ **ADDITION**	☐ **NEW DOCUMENT**
☒ **DESIGN SPEC**	☐ **CONSTRUCTION SPEC**	☐ **MOVABLE SPEC**
☐ **MANUAL FOR BRIDGE EVALUATION**	☐ **SEISMIC GUIDE SPEC**	☐ **COASTAL GUIDE SPEC**
	☐ **OTHER**	

DATE PREPARED: 10/25/15
DATE REVISED:

AGENDA ITEM:

Item #1

Add the following just after the first bullet item in Article 6.7.4.1:

- Provision of lateral support to the fascia girders between cross-frame or diaphragm locations to control torsional stresses and rotations due to loads applied to the overhangs particularly during concrete deck placement.

Item #2

Revise the 4th through the 6th paragraphs of Article C6.7.4.2 as follows:

Allowance of skewed intermediate diaphragms or cross-frames where support lines are not skewed more than 20 degrees from normal is consistent with past practice. Where support lines are skewed more than 20 degrees from normal, it may be advantageous to place the intermediate diaphragms or cross-frames oriented normal to the girders in discontinuous lines, to selectively remove certain diaphragms or cross-frames, and/or to stagger the diaphragms or cross-frames in adjacent bays between the girders, in such a manner that the transverse stiffness of the bridge is reduced, particularly in the vicinity of the supports. Removal of highly stressed diaphragms or cross-frames, particularly in the vicinity of the obtuse corners of a span, interrupts and reduces the stiffness of the corresponding transverse load path by forcing load transfer via girder flange lateral bending, and is often beneficial as long as the unbraced lengths between the diaphragm or cross-frame locations satisfy the flange resistance requirements given in these specifications. The above practices ~~Placing the cross-frames in discontinuous lines~~ tend to~~has the effect of decreasing~~ decrease the diaphragm or cross-frame forces and ~~increasing~~ increase the girder flange lateral bending. In certain cases involving excessively stiff transverse load paths, the diaphragm or cross-frame forces may be decreased to the extent that the associated flange lateral bending stresses are also reduced. The resulting ~~actual~~ flange lateral bending moments ~~with discontinuous cross-frame lines~~ may differ from those estimated using Eq. C4.6.1.2.4b-1, or equivalent; therefore, ~~so~~ a special investigation of flange lateral bending moments and diaphragm or cross-frame forces is recommended ~~advisable~~. Where the flange sizes are increased due to the additional flange lateral bending, this increase often is not significant. In fact, the increased cost resulting from the larger flange sizes is often offset by the reduced cost of providing fewer and smaller diaphragms or cross-frames and smaller diaphragm or cross-frame connections. ~~Removal of highly stressed diaphragms or cross-frames, particularly near obtuse corners, releases the girders torsionally and is often beneficial as long as girder rotation is not excessive.~~

Where support lines are skewed more than 20 degrees from normal and cross-frames or diaphragms are provided along the skewed support line, the first intermediate cross-frames or diaphragms placed normal to the girders adjacent to the skewed support ideally should be offset by a minimum of the larger of $4b_f$ ~~$1.5D$~~ or $0.4L_b$ from the supports, where b_f ~~D~~ is the largest girder flange width within the unbraced lengths on either side of the first cross-frame or diaphragm, ~~web depth~~ and L_b is the unbraced length between the first and the second intermediate cross-frame or diaphragm from the support along the girder under consideration (~~White et al., 2012~~ White et al. 2015). This practice helps to alleviate the introduction of a stiff load path that will attract and transfer large transverse forces to the skewed supports, particularly at the obtuse corners of a skewed span. In some cases, the limit of $0.4L_b$ may be difficult to achieve, in which case the offset should be made as large as practicable but not less than $4b_f$ ~~$1.5D$~~. At the acute corners of severely skewed bridge spans, the above requirements may result in an excessive unbraced length on the fascia girder. In this case, a cross-frame with top and bottom chords but without diagonal members can be framed from the first interior girder to the fascia girder at a small offset from the support, perpendicular to the girders, to avoid inducing a large transverse stiffness while also providing adequate lateral support to the fascia girder.

Where practicable, the smallest unbraced lengths, offsets, or stagger distances between intermediate diaphragm or cross-frame locations within the bridge spans should not be less than $4b_f$ or $0.4L_b$, where b_f is defined in the above paragraph and L_b is the smallest unbraced length adjacent to the unbraced length, offset, or stagger distance under consideration. The use of unbraced lengths smaller than $4b_f$ tends to result in the associated cross-frames working more like a contiguous cross-frame line rather than a discontinuous one.

White et al. (2015) recommend framing of the diaphragms or cross-frames within straight skewed spans using arrangements such as those shown in Figures C6.7.4.2-1 through C6.7.4.2-4 to both reduce the number of cross-frames required within the bridge as well as to reduce the overall transverse stiffness effects. In Figure C6.7.4.2-1, the cross-frames adjacent to the bearing lines are all placed at the same offset distance relative to the skewed bearing lines, satisfying the above offset recommendations. The other intermediate diaphragms or cross-frames are placed at a constant spacing along the span length to satisfy the flange resistance requirements given in these specifications. In addition, every other diaphragm or cross-frame is intentionally omitted within the bays between the interior girders of the bridge plan. This relaxes the large transverse stiffness that would otherwise be developed in the short diagonal direction between the obtuse corners of the span.

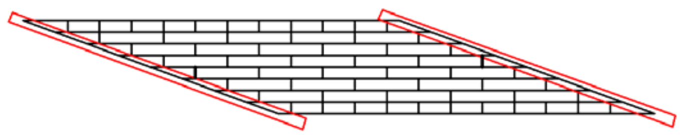


Figure C6.7.4.2-1 – Beneficial Staggered Diaphragm or Cross-Frame Framing Arrangement for a Straight Bridge with Parallel Skew

Figure C6.7.4.2-2 shows a similar concept on a straight bridge with an extreme non-parallel skew. The essential consideration, when intentionally omitting diaphragms or cross-frames between the interior girders, is that a diaphragm or cross-frame must be provided on at least one side of a girder at each location where a braced point is desired. In some situations, additional diaphragms or cross-frames may be retained to provide additional lateral stiffness for bracing or for other purposes; however, the alternating removal of the internal diaphragms or cross-frames is sufficient and is the preferred option in most cases.

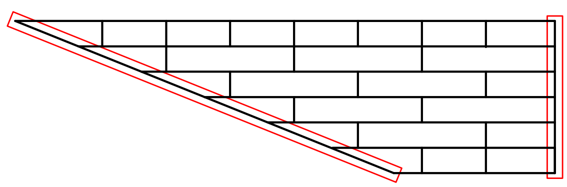


Figure C6.7.4.2-2 -- Beneficial Staggered Diaphragm or Cross-Frame Framing Arrangement for a Straight Bridge with Non-Parallel Skew

Figure C6.7.4.2-3 shows a continuous-span straight skewed I-girder bridge with different skew angles at the bearing lines. Within the end spans of this bridge, the normal diaphragms or cross-frames adjacent to the bearing lines are all placed at the same offset distance relative to the skewed bearing lines, satisfying the above offset recommendations, except that a number of these diaphragms or cross-frames are intentionally omitted. This is necessary to satisfy both the bracing requirements and the offset recommendations, given the geometry of this bridge. Note that similar to the above examples, additional diaphragms or cross-frames in the end spans are intentionally omitted progressing along the length of the span within the bays between the interior girders. Each girder still has at least one side braced by a diaphragm or cross-frame at each braced point. Intermediate diaphragms or cross-frames still remain within each diaphragm or cross-frame line across the width of the bridge to interconnect the girders and help control the differential deflections between the girders. Within the center span, where the bearing lines are non-parallel but both have significant skew, the diaphragms or cross-frames are arranged in a "fanned" pattern from one bearing line to the next. The lighter-weight lines in this figure, which pass through work points at the mid-length of the diaphragms or cross-frames in the center span, all intersect at Point A. This arrangement can be shown to be one of the best options to mitigate the transverse stiffness load paths in this type of span.

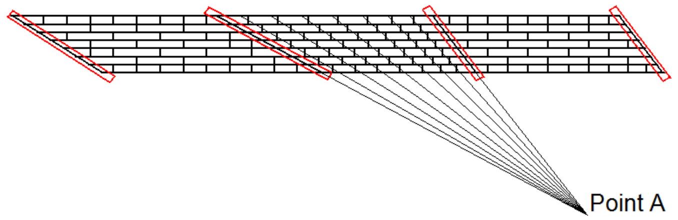


Figure C6.7.4.2-3 -- Beneficial Staggered Diaphragm or Cross-Frame Framing Arrangement for a Straight Bridge illustrating a "Fanning" of the Diaphragm or Cross-Frame Work Points within the Center Span

Figure C6.7.4.2-4 shows a simple variation on the concept used in the center span of Figure C6.7.4.2-3, applied to a straight bridge with parallel skew. In this figure, the diaphragms or cross-frames adjacent to the bearing lines are all placed at the same offset distance relative to the skewed bearing lines, satisfying the above offset recommendations. The other intermediate diaphragms or cross-frames are placed at a constant spacing along the span length in all the bays between the girders. The flange resistance requirements given in these specifications are satisfied by framing one diaphragm or cross-frame into each girder location where a braced point is desired. Given the particular skew angle in this bridge, the stagger distances between the intermediate diaphragm or cross-frame locations within the spans are larger than both $4b_f$ and $0.4L_b$, where b_f is defined in the above discussions and L_b is the smaller of the unbraced lengths adjacent to the unbraced length, offset, or stagger distance under consideration. The lines through the work points at the mid-length of the diaphragms or cross-frames are all parallel to the bearing lines in this bridge.

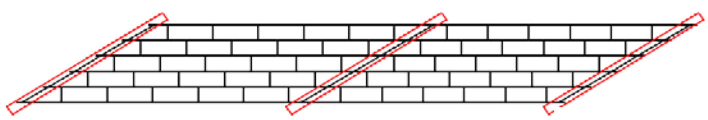


Figure C6.7.4.2-4 – Alternative Beneficial Staggered Diaphragm or Cross-Frame Framing Arrangement for a Straight Bridge with Parallel Skew

Another framing option that alleviates transverse stiffness effects, and significantly reduces the number of cross-frames containing diagonal members, is the use of lean-on bracing (Helwig and Yura 2012; Herman et al. 2005). White et al. (2015) studied both lean-on bracing and the framing arrangements discussed above, and found that both types of framing arrangements provided comparable performance. The above recommended use of cross-frames without diagonals at the acute corners of sharply skewed bridge spans is a basic variation on the lean-on bracing concept.

At skewed interior piers in continuous-span bridges, NHI (2011) and White et al. (2015) found that transverse stiffness effects are alleviated most effectively by placing diaphragms or cross-frames along the skewed bearing line, and locating normal intermediate diaphragms or cross-frames at greater than or equal to the minimum offset from the bearing lines discussed above. The bearing line cross-frames in Figures C6.7.4.2-3 and C6.7.4.2-4 are framed in this manner. Framing of a normal intermediate cross-frame into or near a bearing location along a skewed support line is strongly discouraged unless the cross-frame diagonals are omitted as discussed previously. White et al. (2015) found that alternate framing schemes in which the skewed bearing line cross-frames are omitted and normal intermediate cross-frames are framed into or near the bearing locations typically result in unnecessary transverse restraint and correspondingly large cross-frame forces.

For curved and skewed spans, omitting diaphragms or cross-frames in the vicinity of skewed bearing lines, as shown in Figure C6.7.4.2-5, can help to alleviate uplift at critical bearing locations; however, this is typically at the expense of larger diaphragm or cross-frame forces and larger bridge deflections compared to the use of contiguous intermediate diaphragm or cross-frame lines with the recommended offset provided at the skewed bearing lines. Contiguous diaphragm or cross-frame lines are necessary within the span of curved I-girder bridges to develop the width of the bridge structural system for resistance of the overall torsional effects. As such, the use of discontinuous diaphragm or cross-frame lines near a skewed bearing line in these bridge types involves competing considerations. Diaphragms or cross-frames can be omitted to alleviate uplift considerations at certain bearings, and potentially to relieve excessive diaphragm or cross-frame forces due to transverse stiffness effects in certain cases – for instance, if the horizontal curvature is relatively small and the skew is significant. However, removal of too many diaphragms or cross-frames may result in a larger than desired increase in the diaphragm or cross-frame forces and bridge system deflections due to the horizontal curvature effects when the bridge is significantly curved.

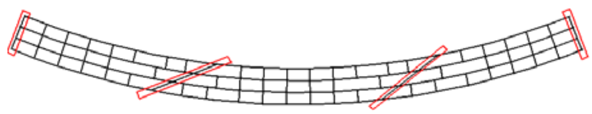


Figure C6.7.4.2-5 – Curved and Skewed Bridge Framing Plan showing the use of Staggered or Discontinuous Intermediate Diaphragm or Cross-Frame Lines in the vicinity of the Skewed Bearing Lines

~~At severely skewed support lines at interior piers, detailing of the intersections of diaphragms or cross-frames along the skewed support line with intermediate diaphragms or cross-frames oriented normal to the girders is complex and, in many cases, the normal diaphragms or cross-frames alone should be sufficient to resist any lateral components of force that develop at the bearings. Where discontinuous intermediate diaphragm or cross-frame lines are employed normal to the girders in the vicinity of interior supports, care should be taken to match a diaphragm or cross-frame with each bearing that resists lateral force. Otherwise, the effect of the lateral moment induced in the bottom flange due the eccentricity between the intermediate diaphragm or cross-frame and the bearing should be considered. Also, whenever any bearing along that support line is not matched with a diaphragm or cross-frame, care should be taken to ensure that the bottom flange of the girder is adequately braced. For such cases, the provision of diaphragms or cross-frames along the skewed support line may be necessary. Refined analysis is recommended to allow for a more detailed examination of cross-frame forces, lateral bearing reactions, and lateral flange bending whenever removal of diaphragms or cross-frames along and/or in the vicinity of severely skewed interior support lines is considered. For skews not exceeding 20 degrees from normal, diaphragms or cross-frames along the skewed support line alone may be sufficient. In this case, intermediate diaphragms or cross-frames placed normal to the girders would likely be too close together, introducing significant lateral bending into the girder flanges.~~ For skewed diaphragms or cross-frames, connection plates should be oriented in the plane of the transverse bracing. The connection plate must be able to transfer force between the girder and the bracing without undue distortion. Welding of skewed connection plates to the girder may be problematic where the plate forms an acute angle with the girder.

Item #3:

Add the following references to the reference list in Article 6.17:

Helwig, T.A. and Yura, J.A. (2012). Steel Bridge Design Handbook: Bracing System Design, Federal Highway Administration, Washington, D.C.

Herman, R., T. Helwig, J. Holt, R. Medlock, M. Romage, and C. Zhou. 2005. "Lean-On Cross-Frame Bracing for Steel Girders with Skewed Supports." *Proceedings of the 2005 World Steel Bridge Symposium*, Orlando, FL, available from the National Steel Bridge Alliance, Chicago, IL.

White, D.W., Nguyen, T.V., Coletti, D.A., Chavel, B.W., Grubb, M.A., and Boring, C.G. 2015. "Guidelines for Reliable Fit-Up of Steel I-Girder Bridges," NCHRP 20-07/Task 355, Transportation Research Board, National Research Council, Washington, D.C.

OTHER AFFECTED ARTICLES:

None

BACKGROUND:

The proposed revisions to Articles 6.7.4.1 and C6.7.4.2 incorporate and reflect various findings gained from recent research studies on curved and/or skewed steel I-girder bridges, specifically NCHRP Project 12-79 and NCHRP 20-07/Task 355, and other related studies. The additional bullet item recommended for Article 6.7.4.1 is an important consideration for fascia girders in I-girder bridges to control the torsional stresses and rotations due to the eccentric deck overhang loads during the concrete deck placement. The proposed revisions to Article 6.7.4.2 reflect the results from research and practice, where it has been clearly shown that the use of discontinuous cross-frame lines, selective removal of certain intermediate diaphragms or cross-frames, and/or staggering of intermediate diaphragms or cross-frames not only reduces the number of costly cross-frames and diaphragms in the bridge, but these practices also substantially reduce the diaphragm or cross-frame forces in bridges having substantial skew. These benefits are achieved by interrupting the load path and forcing load transfer primarily via girder flange lateral bending. Where the flange sizes are increased due to the additional flange lateral bending, this increase often is not significant. In fact, the increased flange cost is often offset by the reduced cost of providing fewer and/or smaller diaphragms or cross-frames and smaller diaphragm or cross-frame members and connections. Specific figures are included to illustrate the recommended concepts. It is submitted that these figures are very important to clearly convey these approaches, which can have substantial benefit in terms of the design economy and design efficiency, to bridge engineering professionals. A reference is provided for further discussion of lean-on bracing concepts, which provide comparable benefits to the specifically recommended framing methods.

The traditional recommendation of an offset of 1.5D in the 5th paragraph of Article C6.7.4.2 is modified to $4b_f$, where b_f is the largest girder flange width within the unbraced lengths on either side of the first cross-frame or diaphragm placed adjacent to a skewed bearing line. The associated transverse stiffness is much more directly tied to the girder flange widths than the girder web depths. In long-span skewed bridges, where the girder b_f/D and necessary L_b / D ratios can become relatively small, an offset of 1.5D can be rather large and can result in difficulty in satisfying unbraced length requirements at acute corners of a sharply skewed bridge span, etc. Furthermore, offsets this large are not necessary when the girder b_f/D is relatively small. An Engineer who understands approximately what b_f/D values will be needed for a given type of bridge structure can still convert the $4b_f$ requirement into a related fraction of the girder web depth, if desired.

A new 6th paragraph is added that extends the above rules of thumb to the smallest unbraced lengths, offsets, or stagger distances between intermediate diaphragm or cross-frame locations within the span. This avoids the potential use of excessively small diaphragm or cross-frame offsets within the bridge spans, which can be a source of unnecessary large transverse stiffness as well as girder flange lateral bending.

The existing 6th paragraph of Article 6.7.4 is substantially shortened to include just its last three sentences, which address important considerations for skewed diaphragm or cross-frame connection plates. The earlier portions of this paragraph are replaced by a recommendation that diaphragms or cross-frames should always be included along skewed interior-support bearing lines, with the recommended offsets of the first normal intermediate cross-frames provided. The research by White et al. (2015) as well as investigations presented in NHI (2011) have clearly shown that framing of a normal intermediate diaphragm or cross-frame into or near a bearing location along a skewed support line results in the introduction of unnecessary deleterious transverse stiffness effects and large cross-frame forces, unless the diagonals are omitted from the normal cross-frame, i.e., a variation of lean-on bracing.

The competing considerations between the omission of selected diaphragms or cross-frames near skewed bearing lines, and the need to develop the width of the bridge system via contiguous diaphragm or cross-frame lines to resist horizontal curvature effects, are discussed and an example framing plan is shown that illustrates the handling of these considerations.

ANTICIPATED EFFECT ON BRIDGES:

The proposed revisions to Articles 6.7.4.1 and C6.7.4.2 should help to provide a stronger understanding of the implications of different types of diaphragm or cross-frame framing arrangements for curved and/or skewed steel I-girder bridges among the various stakeholders. In particular, the revised Article C6.7.4.2 better emphasizes the importance of framing the diaphragms or cross-frames in a manner to avoid deleterious transverse stiffness effects in sharply skewed bridge spans and provides specific recommended ways to accomplish this goal. The resulting design economies achieved by reducing the number of cross-frames and avoiding large transverse stiffness load paths, resulting in significantly smaller cross-frame forces and flange lateral bending stresses, can be substantial for bridges that have sharp skew.

REFERENCES:

NHI (2011). "Analysis and Design of Skewed and Curved Steel Bridges with LRFD, Reference Manual", NHI Course No. 130095, Publication No. FHWA-NHI-10-087, National Highway Institute, Federal Highway Administration, 1476 pp.

White, D.W., Nguyen, T.V., Coletti, D.A., Chavel, B.W., Grubb, M.A., and Boring, C.G. 2015. "Guidelines for Reliable Fit-Up of Steel I-Girder Bridges," NCHRP 20-07/Task 355, Transportation Research Board, National Research Council, Washington, D.C.

4.6 Further Research Needs

The NCHRP 20-07 Task 355 research has proposed improved design, detailing and erection guidelines to ensure reliable fit-up of skewed and/or curved steel I-girder bridges. These guidelines provide a clear understanding of the implications of various framing arrangements, cross-frame detailing methods, and erection procedures on the ease of fit-up during the steel erection, achievement of the targeted constructed geometry, and generation of locked-in stresses in the cross-frames and girders. Nevertheless, the following areas merit further study:

- **Early Concrete Deck Stiffness and Strength**

Cross-frame detailing methods can have a significant influence on the bridge responses in the completed bridge as well as during construction. The detailing methods are significantly influenced by the camber calculations as the cross-frame detailing is set based on the camber profiles. In continuous-span bridges, the construction often involves staged deck placement. The portion of the deck that has already been placed contributes to the stiffness of the bridge. In the current research, this stiffness contribution from the concrete deck was neglected. In some cases, this leads to a conservative estimate of TDL cambers. More extensive coupled field and analytical evaluation of the effects of early concrete deck stiffness and strength gains, including the influence of staged concrete deck placement, would be valuable to better quantify the effects of TDLF detailing on the completed bridge as well as during construction. Prior research addressing this consideration has been limited to only a few bridges and a few parameters of the concrete mix design and methods of construction. A more comprehensive understanding of the actual early-age behavior during and after placement of concrete decks is needed.

- **Further Cross-Frame Analysis and Design Improvements**

With the increasing utilization of skew and curvature in steel I-girder bridges, requirements for cross-frames to be designed as primary members in horizontally curved bridges, and the improvements in refined analysis methods, the need for more detailed analysis and improved design of diaphragms and cross-frames arises. Areas that need to be researched to achieve improvements in cross-frame analysis and design include, but are not limited to: (1) Improved fatigue design of cross-frames using accurate refined analysis, (2) Improved consideration of girder stability bracing requirements, (3) Improved accounting for the true stiffness of cross-frames in refined analysis methods, and (4) Simplified design of tee (WT) section struts. These topics are discussed in more detail below:

(1) Improved fatigue design of cross-frames using accurate refined analysis.

The AASHTO *LRFD Bridge Design Specifications*, C6.6.1.2.1, include guidance suggesting the application of a 0.75 factor on the stress range in cross-frame members determined, from refined analysis, by the passage of two vehicles traversing the bridge in two separate transverse positions with one vehicle leading the other (so as to cause one full cycle of stress reversal in the cross-frame members). This guidance is described as "recommended," "in lieu of more specific owner supplied guidance." It appears that this guidance is based primarily on engineering judgment; however there is no available information for the engineer or owner to judge the design loading. Associated problems include:

(a) The current AASHTO LRFD provisions for fatigue loading are based upon longitudinal member behavior. Transverse members such as cross frames are not specifically considered in the fatigue loading provisions. The longitudinal member stress ranges are calculated from the fatigue loading placed in a design lane. It is unclear if such an approach is applicable to transverse members.

(b) The proper configuration of the fatigue truck loading for transverse member is not known. The fatigue design load in AASHTO is based upon an effective fatigue truck loading based on truck weight surveys and does not consider wheel weights. It would seem that axle or even wheel load may be a better means of estimating fatigue stresses in cross frames.

(2) Improved consideration of girder stability bracing requirements.

Provisions for girder stability bracing strength and stiffness are available in the AISC (2010) Specifications and from other sources such as Helwig and Yura (2012) and Yura (2001). These provisions are straightforward and are useful in many cases for the design of cross-frames for steel I-girder bridges. However, these provisions have a number of limits of applicability for common structural conditions in I-girder bridges. Specifically, improvements and extensions are needed in following areas:

a) The current stability bracing provisions and research studies to date have not fully addressed the stability bracing requirements within the negative moment regions of composite continuous-span I-girders, particularly regarding the beneficial effects from the concrete deck stiffness in combination with the torsional and/or lateral bracing from cross-frames and other bridge components.

b) The current stability bracing provisions focus largely on the stiffness and strength demands placed on bracing components in situations where the I-girders being braced are nominally straight, but with unavoidable geometric imperfections, and where the I-girders are acting as isolated members in supporting the loads rather than as part of a complex three-dimensional structural system. The calculated bracing demands are essentially due to second-order effects associated with the member internal forces and the initial member imperfections out of the plane of the web in this idealized isolated configuration. The true cross-frame forces in curved and/or skewed I-girder bridges actually may be impacted by only a small extent due to stability bracing effects in many situations. Research is needed to determine when second-order effects such as those addressed by the current stability bracing provisions are important and how to best incorporate the consideration of these effects in appropriate simplified design criteria for all types of I-girder bridge geometries.

(3) Improved accounting for the true stiffness of cross-frames in refined analysis methods.

Single angle and flange-connected tee section struts in cross-frame members are typically subjected to eccentric axial loading, due to their connection to gusset plates and/or girder connection plates as discussed in Section 2.6 of this report. As discussed in this section, the NCHRP 20-07/Task 355 research has followed the recommendation from AASHTO LRFD Article 5.6.3.3.4 in reducing the axial stiffness of these types of members by the scale factor 0.65. Section 3.8 of this report provides analysis results for a straight severely skewed bridge which indicate that the cross-frame stresses and the bridge deflections are insensitive to the specific values of this cross-frame stiffness. In addition, the authors observe that the bridge responses are relatively insensitive to the cross-frame properties in the benchmark examples discussed in Section 3.9. However, the studies in these sections involve only two bridges. In some straight skewed bridges having extreme nuisance stiffness effects, and in some horizontally curved bridge geometries (possibly wide horizontally curved bridges where the cross-frames framing in the radial direction do not act essentially as rigid components compared to the I-girders) the bridge responses may sensitive to the specific cross-frame stiffness values.

Recent research by Battistini et al. (2014) has provided equations for a variable stiffness reduction factor, for different types of cross-frames composed of single angle members, that can be applied in lieu of the simpler 0.65 factor recommended by AASHTO. Bridge system sensitivity analyses should be conducted to gage the importance of using these more accurate stiffness reduction factors. In addition, additional appropriate factors should be evaluated and studied for specific cases involving flange-connected tee (WT) section cross-frame members.

(4) Simplified design of tee (WT) section struts.

Streamlined procedures are currently available in AISC (2010) and in the AASHTO LRFD Specifications for the design of single angle cross-frame members subjected to eccentric axial loading via their connections to gussets or girder connection plates. These procedures are based on the use of a modified effective length factor that accounts for the angle geometric properties, the eccentric axial loading, and the common nature of the restraints provided by the end connections (White 2012). Similar procedures are not available at present for tee sections; instead, designers must check WT cross-frame members as general eccentrically-loaded singly-symmetric beam-columns, including the corresponding relatively complex evaluation of the strength of these member types under pure axial compression and under pure flexure about an axis parallel to the flange. It would be desirable to have a streamlined design procedure for these types of members similar to that for single angles. The challenges involved include the fact that tee section members loaded as cross-frame members commonly have enhanced beam-column resistances. This is due to the nature of their single symmetry as well as the nature of the eccentric loading. This enhanced resistance is not commonly recognized with the current AISC (2010) and AASHTO LRFD beam-column strength equations. The challenge will be largely whether these enhanced resistances can be recognized within new simplified calculation procedures.

- **Implementation and Validation of Analysis Methods for Handling of Lack-of-Fit in Professional Bridge Design Software**

As discussed at the beginning of Section 3.4 and in Item (6) of Section 4.2 of this report, it is possible to directly calculate the internal "locked-in forces" associated with SDLF or TDLF detailing directly within either a 2D grid or 3D Finite Element Analysis. Resulting "Dead Load Fit Refined Analysis" (DLF RA) procedures provide a much more accurate characterization of the beneficial (subtractive) and non-beneficial (additive) locked-in internal forces and stresses due to these cross-frame detailing methods. Their implementation and adoption in steel I-girder bridge design practice can lead to significant economies. The handling of these effects is very similar to the calculation of the effects of temperature change. The associated concepts are very straightforward and simple at the fundamental level associated with their implementation within a structural analysis. These concepts are taught in nearly every undergraduate strength of materials and introductory structural analysis class. The corresponding detailed effects of the basic lack-of-fit on the internal forces and stresses in I-girder bridge structures is relatively complex. This complexity is best addressed by including the lack-of-fit effects in the structural analysis.

Nevertheless, at the present time (2015), inclusion of the lack-of-fit effects from SDLF or TDLF detailing is not well supported in professional analysis and design software. An engineer who wishes to include these effects typically must to a significant amount of calculations external to the software, then input information such as, for example, pseudo temperature increases or decreases in the cross-frame members that produce the same initial strains as the initial lack-of-fit displacements.

Software providers should implement the types of procedures discussed in Section 3.9 of this report. These procedures should then be thoroughly tested and their benefits demonstrated in practical curved and skewed I-girder bridge design.

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Appendix A-1. EISCR1 Bridge Description

EISCR1 is a relatively basic simple-span curved radially-supported bridge that was tested at the FHWA Turner Fairbank Research Center in 2005-2006 (Jung and White 2008). This bridge was designed to a number of extreme limits of the AASHTO LRFD Specifications and is useful as a benchmark and demonstration case for horizontally-curved radially-supported bridge responses. It is used in this research predominantly as a simple benchmark to understand the various issues, considerations and methods associated with the NCHRP 20-07/Task 355 project. Obviously, regarding any of the specific bridge issues and considerations, the emphasis here is on curved radially-supported bridges.

The key characteristics of EISCR1 are as follows:

- Span length along the centerline of the bridge, L_s = 90 ft.
- Width between the fascia girders, w_g = 17.5 ft.
- Radius of curvature to the centerline of the bridge, R = 200 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 5.1
- Subtended angle between the supports, L_s/R = 0.45.
- Number of girders in the completed bridge cross-section, n_g = 3.

Figure A-1-1 shows the framing plan for EISCR1 and Fig. A-1-2 provides a view of the bridge cross-section. Figures A-1-3 and A-1-4 provide detailed information about the girder cross-section and cross-frame dimensions.

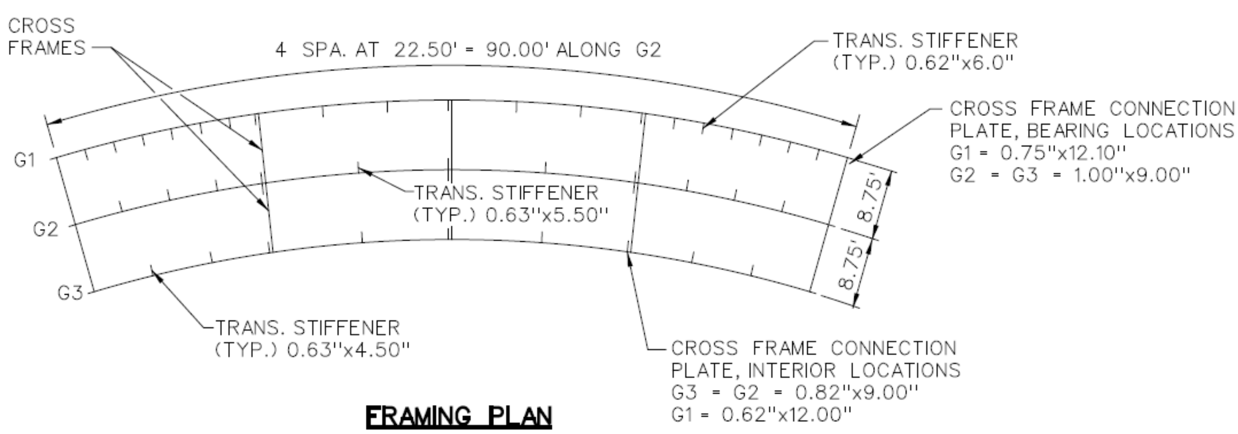


Figure A-1-1. EISCR1 framing plan.

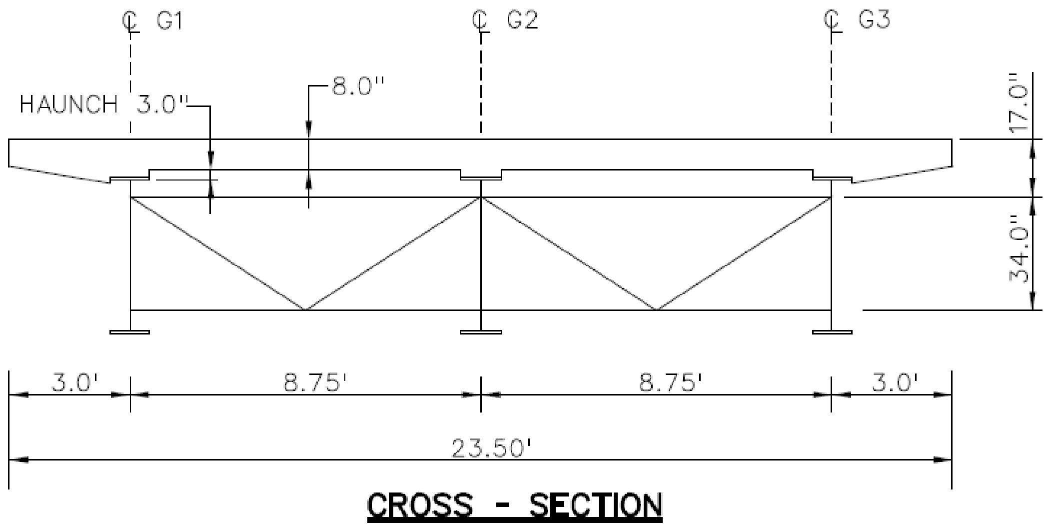
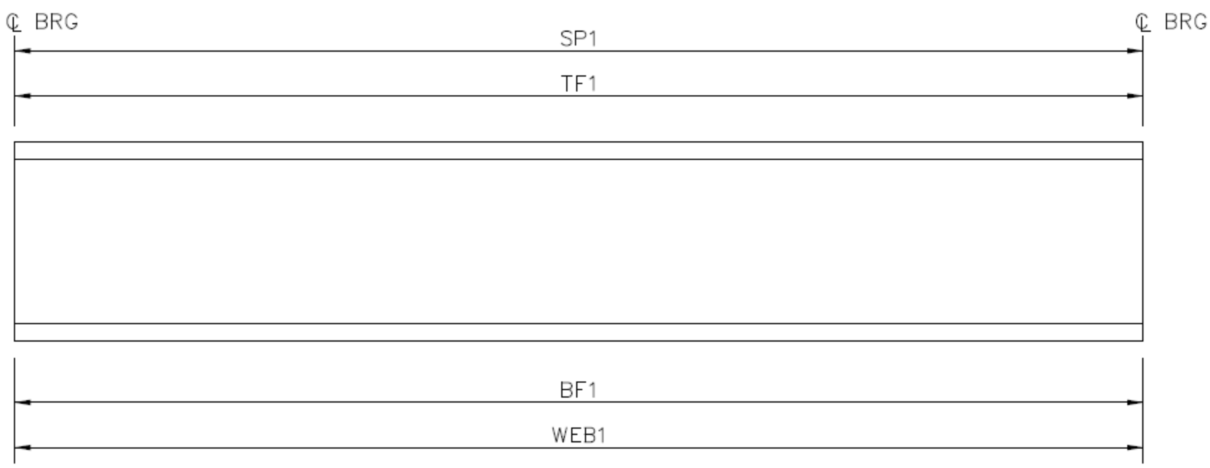


Figure A-1-2. EISCR1 bridge cross-section.



GIRDER	SP1	TF1	BF1	WEB1
G1	86.0625'	0.833" x 12.2"	0.886" x 17.3"	0.331" x 48.0"
G2	90.0000'	0.877" x 14.2"	1.000" x 22.2"	0.323" x 48.0"
G3	93.9375'	1.000" x 24.2"	1.389" x 24.2"	0.362" x 48.0"

Figure A-1-3. EISCR1 girder elevations and cross-section dimensions.

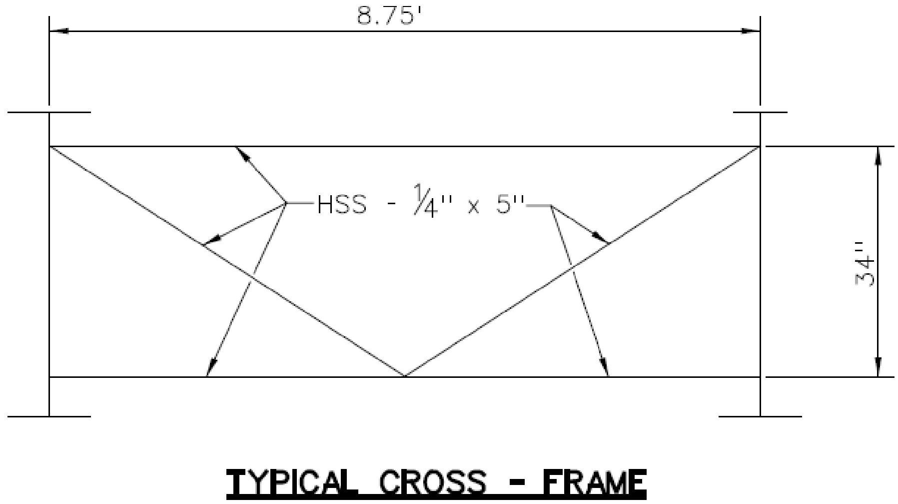


Figure A-1-4. EISCR1 cross-frame details.

Only one framing plan, the one shown in Fig. A-1-1, is considered for EISCR1. Furthermore, only one erection scheme is considered for this bridge. This scheme is illustrated in Fig. A-1-5 and Table A-1-1 and may be summarized as follows:

- The girders are each lifted one-by-one as single field sections corresponding to the entire bridge span and placed on their end supports. The erection starts with girder G1 on the outside of the curve and proceeds to girder G3 on the inside of the curve.
- Starting with girder G2, the bearing line cross-frames are flown and placed between the latest girder being installed and the rest of the bridge before any of the intermediate cross-frames are installed. Then the intermediate cross-frames are placed one-by-one from one end of the bridge to the other.
- A holding crane is placed on the exterior girder G1 near its mid-span until all the steel is erected. This is essential to prevent potential overturning of the partially completed bridge during erection, due to the tight horizontal curve of this bridge. The attachment of the holding crane to the girder is at 8.4 inches away from the mid-span location due to the presence of a cross-frame connection plate at the mid-span.
- Starting with girder G2, the lifting crane is maintained on the latest inside girder being installed while the cross-frames are flown in and connected between this girder and rest of the bridge cross-section.

The erection scheme is subdivided into three main stages, corresponding to placement of each of the girders and the installation of the cross-frames between the subject girder and the rest of the bridge

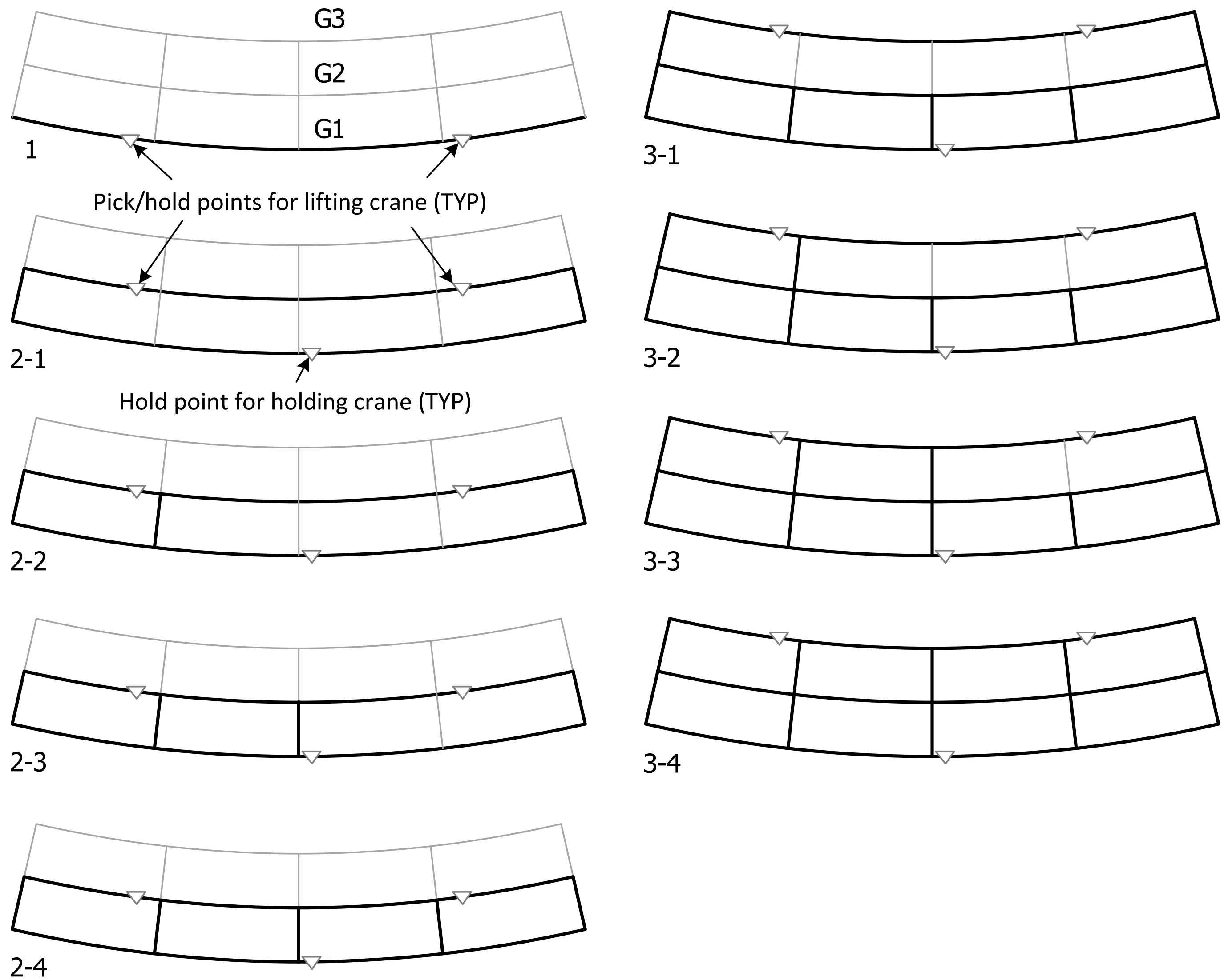


Figure A-1-5. EISCR1 erection scheme.

Table A-1-1. Three-dimensional view of EISCR1 erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

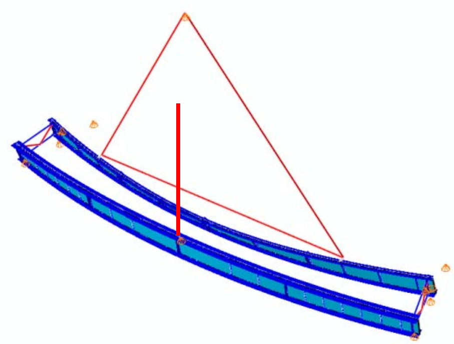
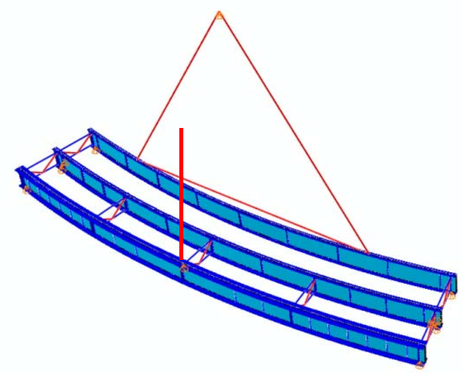
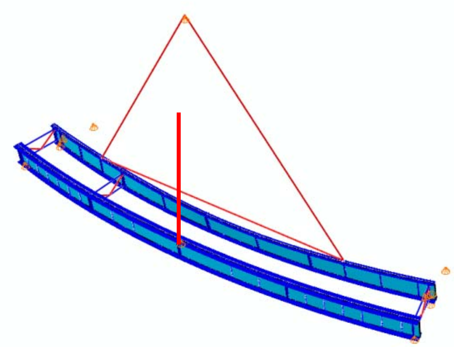
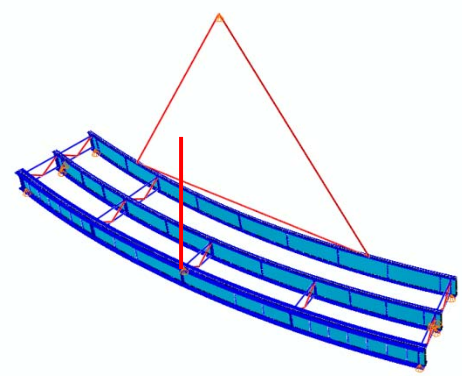
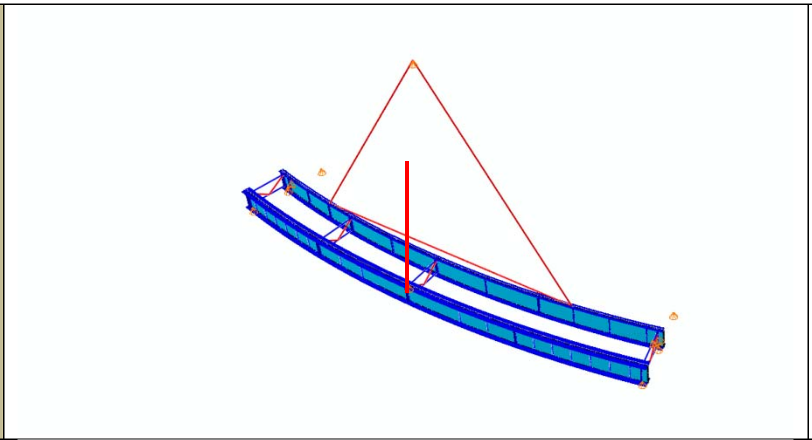
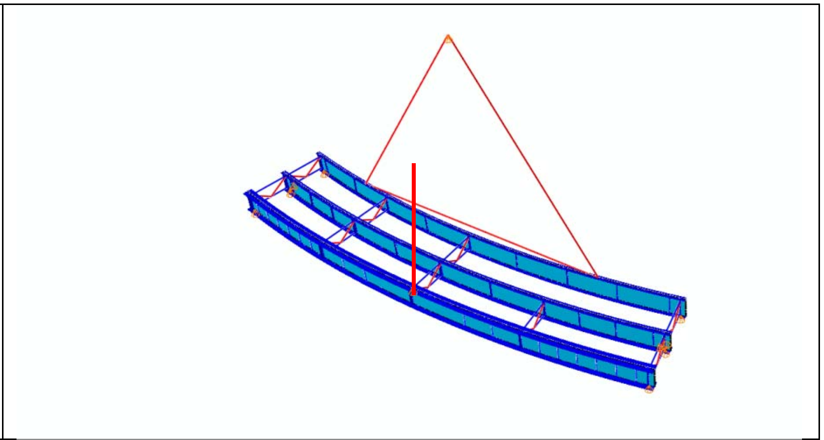
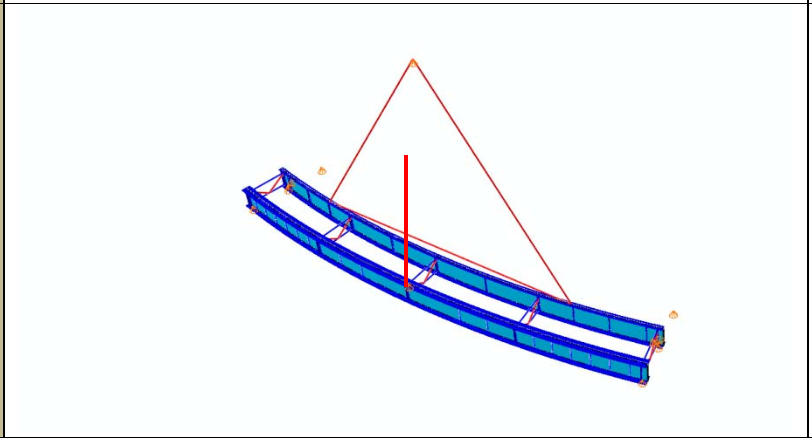
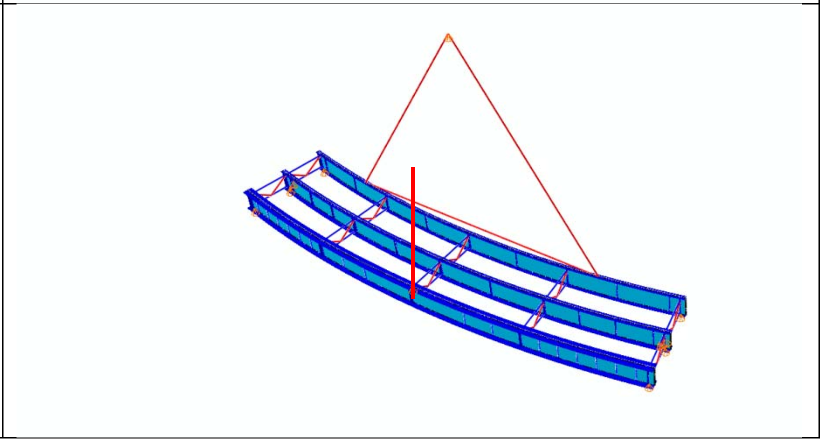
Sub-Stage	Stage	
	2	3
1		
2		

Table A-1-1 (continued). Three-dimensional view of EISCR1 erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

<table>
<tr><td>3</td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td></tr>
</table>

- Each main stage is subdivided into four sub-stages, corresponding to the installation of the end cross-frames followed by the installation of each of the three intermediate cross-frames.
- Using UT-Lift (Ferguson Laboratory 2014), it is determined that a 50 foot long spreader beam limits the total torsional rotation of the outside girder G1 to 0.046 degrees when this girder is lifted. The spreader beams used on G2 and G3 have lengths of 47.9 and 45.8 ft. such that they connect to the same normalized locations along their lengths as the spreader beam connected to G1. This results in a similar behavior for G2 and G3. Because of the tight horizontal curve, the torsional rotations of the girders during lifting become relatively large with only small deviations from these values.

Table A-1-1 provides a three-dimensional pictorial representation of the above erection process. This table indicates the holding crane on the outside girder G1 by the bold vertical line connected to this girder, and it indicates the lifting crane by a horizontal line, representing the spreader beam, and two inclined lines, representing cables going up to an attachment to the vertical cable of the lifting crane (not shown in the table). The permanent supports at the ends of the girders also are not shown in Table A-1-1.

The crane loads and the required externally-applied fit-up forces at the cross-frame locations are relatively sensitive to the holding elevations at the attachments of the holding and lifting cranes to the girders in this bridge. In straight-skewed bridges detailed for Steel Dead Load Fit (SDLF), the optimum location of the crane holding elevations is always approximately the final Steel Dead Load (SDL) elevations of the girders. This is because, prior to their attachment to the cross-frames, if the girders could simply be placed on the bridge bearings and allowed to deflect under their self-weight, their individual girder elevations would be approximately equal to the final SDL elevations. It is essential for engineers to understand that curved bridges do not work this way. If an individual curved I-girder is placed on its supports, the twisting of the girder is restrained there, and then the girder is released from the crane, the girder will tend to deflect excessively under its self-weight within the span. Additional support is necessary along the girder's length to limit its deflections. An individual straight I-girder will tend to deflect a lesser amount and only in a vertical plane without twisting under its self-weight. However, a curved girder exhibits both major-axis bending and twisting when it deflects under its self-weight. The major-axis bending and the twisting of the girder are significantly coupled. In addition, any partially or fully-erected curved bridge unit composed of multiple girders also exhibits overall coupled major-axis bending and twisting. At any intermediate stage where a girder is being installed into the bridge by connecting it to an adjacent girder via cross-frames, the bending and twisting of both the girder and the bridge unit it is being installed into change as the girder and the cross-frames are fit together.

With an erection scheme such as the one shown in Fig. A-1-5 and Table A-1-1, it is common that the crane operator(s) will raise and lower the hold points on the lifting crane and/or the holding crane to facilitate the connection of the cross-frames to the girders. In addition come-alongs and/or other rigging are used locally at a cross-frame that is being inserted into the bridge to fit-up the connection points. The interaction of the partially assembled curved bridge with the raising and lowering of the hold points is relatively complex – second-order effects as well as nonlinearity associated with lift-off at the permanent supports or with the crane cables going slack can have a significant influence on the fit-up forces required to make the connection at a cross-frame that is being installed.

In this research, for the analyses to determine the local external fit-up forces and the crane reactions required to install the cross-frames, the NL and SDL elevations are used as a base, then the hold point elevations on the cranes are varied to minimize the fit-up force resultants at the connection of the cross-frames to the girder being installed. This process is described in detail in Appendix A3.

It is important to recognize the mechanics of the lifting crane and spreader beam behavior represented by the analyses illustrated in Table A-1-1. The girder pick points are “hung” from the ends of the spreader beam. In addition, the assembly involving the spreader beam and the diagonal cables works essentially as a rigid pin-connected truss as long as the cables are in tension. (If the cables go into compression, they go slack and the assembly does not provide any restraint to the bridge.) The triangular assembly is restrained vertically at its top, but is free to move laterally in any direction at all of its joints. The elevations at the ends of the spreader beam, and at the hold points on the girder hung below these points, can move upward or downward relative to one another; however, equilibrium is maintained between the vertical loads transmitted to the triangular assembly at the ends of the spreader beam and the single total vertical crane reaction applied at the top of the triangular assembly. The average elevation of the hold points at the ends of the spreader beams is controlled by the specified elevation at the top of the triangular assembly. Although it is possible that the physical crane may pull laterally on this assembly by a minor amount, these actions are assumed to be negligible in the NCHRP 20-07/Task 355 studies.

The influence of each of the three primary cross-frame detailing methods, NLF, SDLF and TDLF, is addressed for all of the bridges studied by the NCHRP 20-07/Task 355 project. The influence of the cross-frame detailing on the various dead load responses for the completed EISCR1 bridge is addressed in Appendix A2. Appendix A3 addresses the influence of the cross-frame detailing, the erection scheme, etc. on the critical fit-up forces during the erection of this structure.

It is important to understand that the SDLF and TDLF effects on the cross-frame forces tend to be additive with the dead load effects in curved radially-supported bridges. As illustrated by Fig. A-1-6, if TDLF detailing is used on such a bridge, the cross-frames are fabricated in a geometry that induces a twist in the girders that counteracts or offsets the layover of the girders at the cross-frame locations under the TDL. This is achieved in effect, by the cross-frames twisting the girders opposite to the direction of the torsional rotation of the bridge cross-section, if the bridge were theoretically constructed under no-load. In curved radially-supported bridges, the corresponding forces that are locked-in to the cross-frames tend to be additive with the cross-frame dead load forces.

The influence of SDLF detailing in curved radially-supported bridges is similar. However, the lack-of-fit of the cross-frames with the girders in their initial no-load plumb condition, and the corresponding locked-in forces, are smaller for SDLF detailing.

The exact opposite effect happens in straight-skewed bridges. The locked-in cross-frames forces due to SDLF or TDLF detailing in straight-skewed bridges tend to subtract from the dead load cross-frame forces. Curved radially supported bridges behave in a fundamentally different way than straight-skewed bridges. This aspect is explained further in Appendix A2.

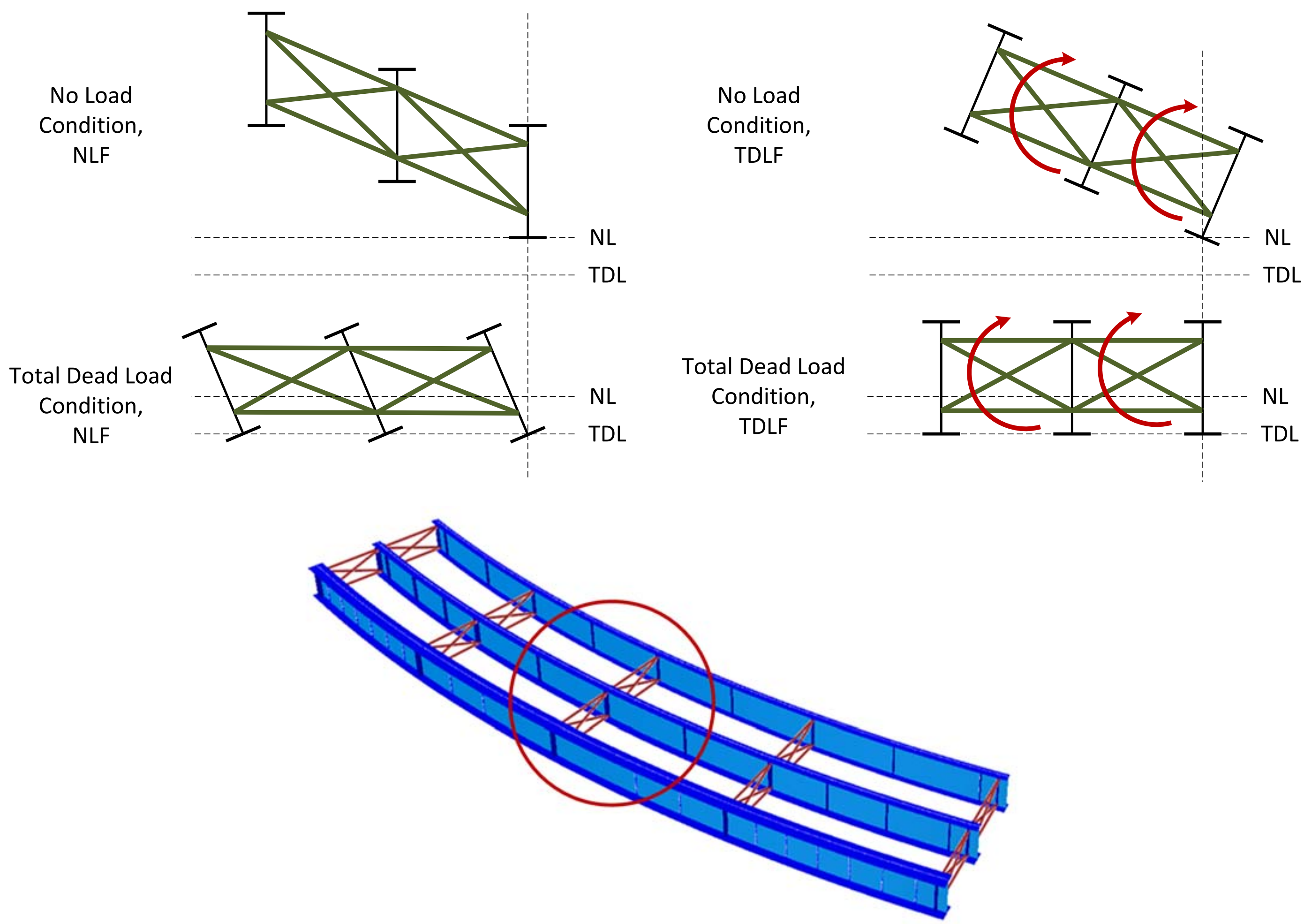


Figure A-1-6. Influence of TDLF detailing on curved radially-supported bridges.

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Appendix A-2. EISCR1 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EISCR1 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table A-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.0	4.7
	SDLF	0.8	4.5
	TDLF	0.3	3.9
G2	NLF	0.6	3.0
	SDLF	0.4	2.8
	TDLF	0.2	2.2
G3	NLF	0.2	1.5
	SDLF	0.1	1.4
	TDLF	0.4	0.9
All Girders	NLF	1.0	4.7
	SDLF	0.8	4.5
	TDLF	0.4	3.9

Table A-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.3	1.1
	SDLF	0.1	1.0
	TDLF	0.5	0.4
G2	NLF	0.2	1.0
	SDLF	0.1	0.9
	TDLF	0.5	0.3
G3	NLF	0.2	0.8
	SDLF	0.0	0.6
	TDLF	0.5	0.1
All Girders	NLF	0.3	1.1
	SDLF	0.1	1.0
	TDLF	0.5	0.4

Table A-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	3.4	16.4	4.4	21.2	2.1	12.3	2.7	12.8
	SDLF	3.5	16.4	4.5	21.2	2.3	12.1	3.1	13.4
	TDLF	3.6	16.4	4.6	21.2	2.7	11.5	4.4	15.4
G2	NLF	1.6	9.0	2.5	13.7	1.1	7.8	3.0	17.6
	SDLF	1.6	9.0	2.4	13.6	1.1	7.5	3.1	17.7
	TDLF	1.4	8.8	2.0	13.3	1.4	6.8	3.4	18.2
G3	NLF	0.3	4.2	0.3	5.3	0.2	3.8	0.4	4.7
	SDLF	0.3	4.3	0.3	5.4	0.3	3.7	0.5	4.4
	TDLF	0.3	4.4	0.4	5.6	0.7	3.4	1.2	5.7
All Girders	NLF	3.4	16.4	4.4	21.2	2.1	12.3	3.0	17.6
	SDLF	3.5	16.4	4.5	21.2	2.3	12.1	3.1	17.7
	TDLF	3.6	16.4	4.6	21.2	2.7	11.5	4.4	18.2

Table A-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	8.4	41.4	65.8	65.8
	SDLF	14.3	41.7	83.4	83.4
	TDLF	31.4	42.9	135.3	135.3
TDL	NLF	46.9	198.5	335.1	335.1
	SDLF	52.4	197.8	350.9	350.9
	TDLF	69.3	195.8	397.5	397.5

Table A-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	4.0	14.9	15.7	10.9
	SDLF	6.5	14.7	19.1	13.2
	TDLF	14.0	14.5	41.0	24.9
TDL	NLF	21.5	71.6	77.4	53.9
	SDLF	23.9	71.1	80.5	56.0
	TDLF	31.2	69.7	91.6	63.1

Table A-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	All Girders
NLF	0.42	0.37	0.42
SDLF	0.43	0.34	0.43
TDLF	0.48	0.25	0.48

Table A-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	All Girders
NLF	1.67	1.47	1.67
SDLF	1.68	1.44	1.68
TDLF	1.71	1.32	1.71

Table A-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	All Girders
NLF	0.14	0.12	0.14
SDLF	0.14	0.11	0.14
TDLF	0.16	0.08	0.16

Table A-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	All Girders
NLF	0.54	0.48	0.54
SDLF	0.54	0.46	0.54
TDLF	0.55	0.43	0.55

Table A-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	60.8	315.2
SDLF	60.8	315.2
TDLF	60.8	315.2

Table A-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	20.4	94.6	0.0	0.0	0.0	0.0
SDLF	20.5	94.6	0.0	0.0	0.0	0.0
TDLF	20.9	94.4	0.0	0.0	0.0	0.0

Table A-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.09	0.12	0.00	0.00
SDLF	0.08	0.12	0.00	0.00
TDLF	0.04	0.12	0.00	0.00

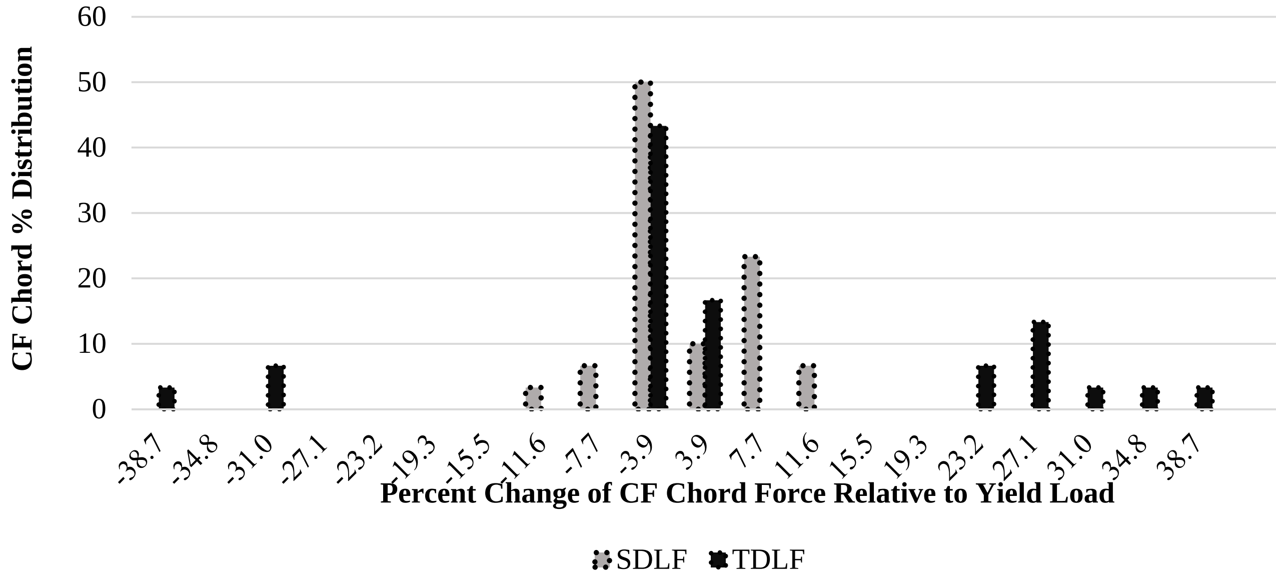


Figure A-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

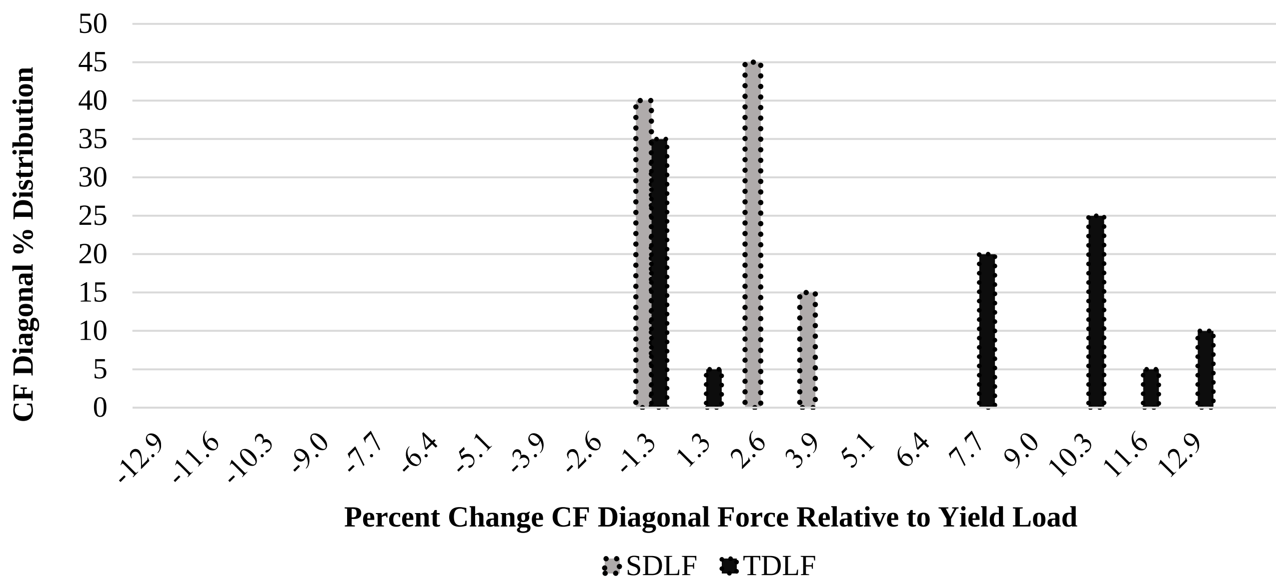


Figure A-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

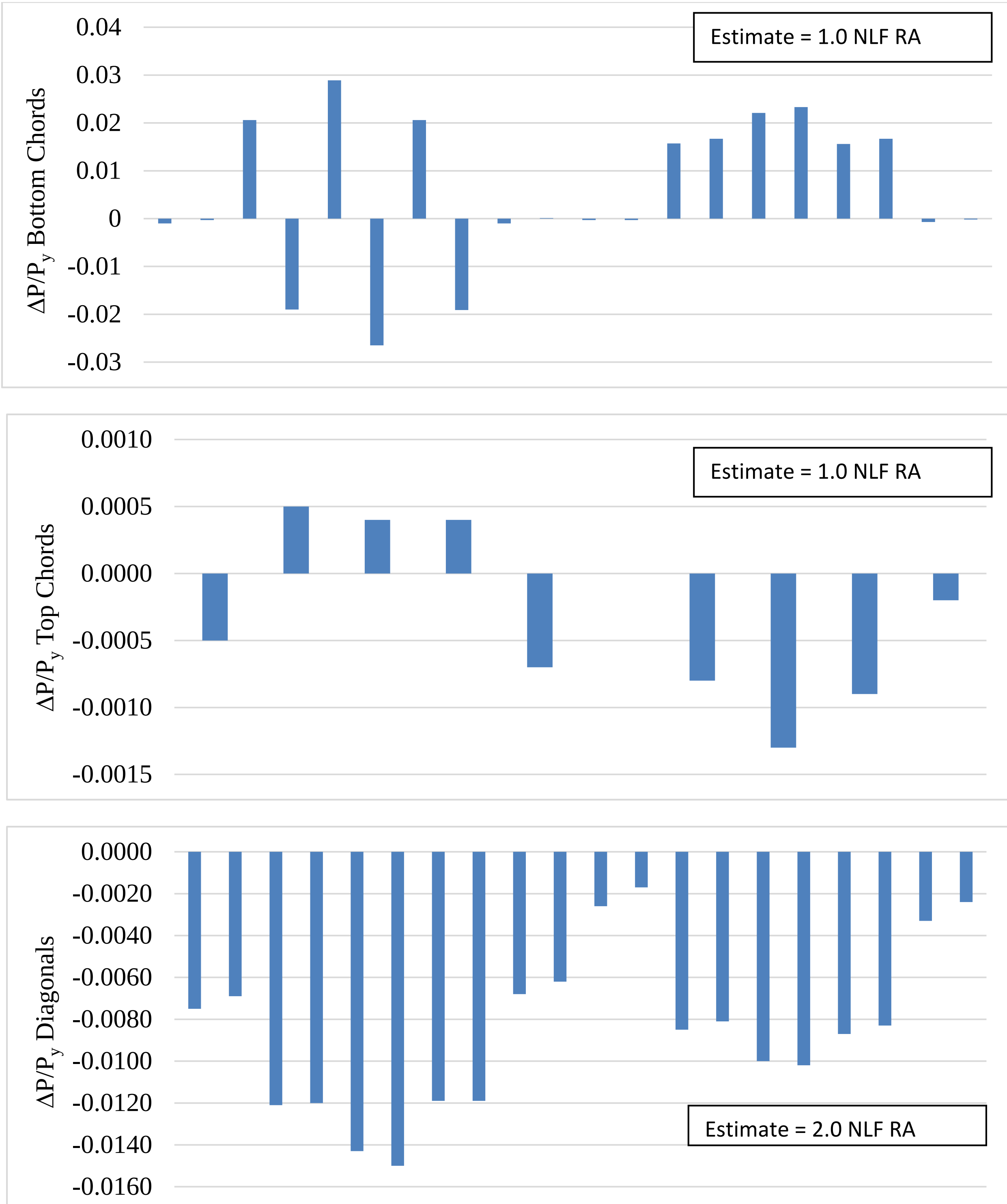


Figure A-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

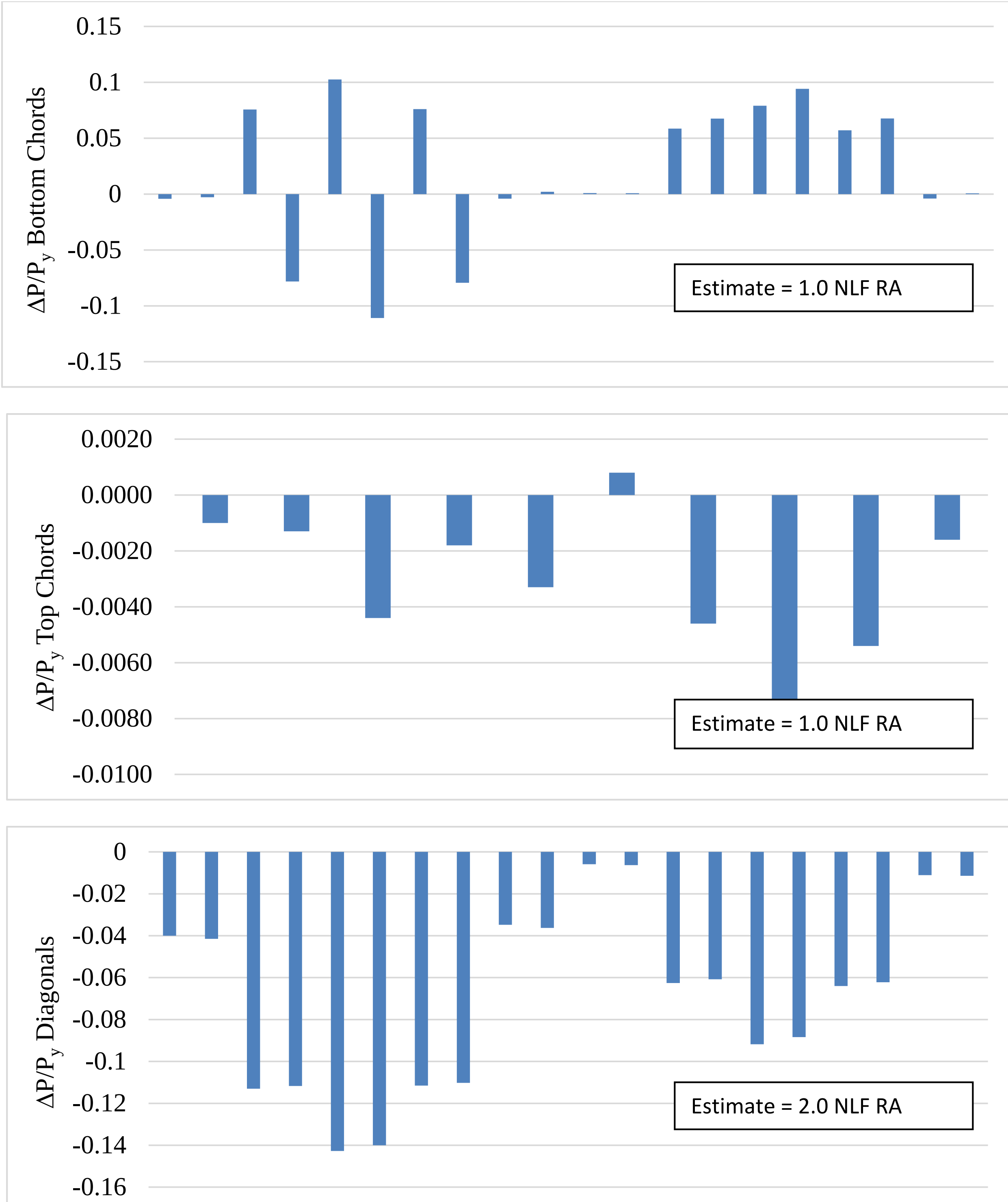


Figure A-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix A-3. EISCR1 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EISCR1 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table A-3-7. Maximums of the minimum fit-up force resultants (kips) as a function of the crane position

Detailing Method	F1	F2	F_{max}
NLF	2.3	1.7	2.3
SDLF	1.1	5.5	5.5
TDLF	7.7	17.7	17.7

Table A-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	21.1	1.8
	SDLF	21.2	3.9
	TDLF	22.4	10.3
G2	NLF	7.6	0
	SDLF	8.1	0
	TDLF	8.1	0
G3	NLF	1.9	0
	SDLF	3.1	0
	TDLF	3.7	0
All Girders	NLF	21.1	0
	SDLF	21.2	0
	TDLF	22.4	0

Table A-3-3. Summary of crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	22.8	0	22.5	0.2
SDLF	21.2	0	18.7	0
TDLF	12.4	0	12.2	0

Table A-3-4. Total Vertical Reactions (kips)

Stage	Detailing	Sub-Stage			
		1	2	3	4
2	NLF	44.7	45.0	45.4	45.7
	SDLF	44.7	45.0	45.4	45.7
	TDLF	44.7	45.0	45.4	45.7
3	NLF	59.8	60.1	60.5	60.8
	SDLF	59.8	60.1	60.5	60.8
	TDLF	59.8	60.1	60.5	60.8

Appendix A-4. EISCR1 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge EISCR1 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

The legends of the plots showing the overall bridge responses accommodate bridges with up to nine girders in the bridge cross-section. EISCR1 only has three girders, and therefore only three curves are shown in these plots.

From Fig. A-4-1, one can observe the maximum SDL camber in this bridge, on G1, is only 1.0 in, whereas the maximum TDL camber is approximately 4.7 in. Due to the relatively short span of this bridge, the dead load deflections due to the concrete slab are significantly larger than the SDL deflections. Therefore, the SDLF effects are relatively small in this bridge. Bridges with longer spans, in which the steel self-weight is a larger fraction of the TDL, will tend to have larger SDLF effects.

The SDL and TDL cambers shown in Fig. A-4-1 are based on a structural analysis that assumes NLF, which is the predominant approach used in current practice. Figures A-4-6 and A-4-9 show that the lack-of-fit effects from SDLF and TDLF detailing generally cause an upward vertical deflection in all of the girders of roughly the same magnitude on all the girders. This attribute of the behavior of curved radially-supported bridges has been discussed previously in the NCHRP 12-79 research (White et al. 2012). The maximum girder upward deflection due to the SDLF effects is approximately 0.20 in, on G2, and the maximum upward deflection due to the TDLF effects is 0.77 in, also on G2.

The girder vertical deflections as well as the corresponding girder vertical elevations are shown in Figs. A-4-1 through A-4-9. The vertical elevations plot in Fig. A-4-3 shows that, for the case of NLF detailing, the vertical elevation is equal to zero throughout the length of all the girders under the TDL. All the girders in EISCR1 are fabricated such that the bridge geometry is "flat" with no vertical curve and no superelevation when the bridge is subjected to the TDL. For SDLF and TDLF detailing, the girder vertical elevations under the TDL match with the influence of the lack-of-fit from the SDLF and TDLF detailing effects (see Figs. A-4-5 and A-4-8 and compare these responses with Figs. A-4-6 and A-4-9).

The layovers plot in Fig. A-4-4 illustrates that SDLF detailing is successful at enforcing approximately zero layover at the cross-frame locations under SDL. The maximum layover at the cross-frame locations is slightly less than 0.06 inches, on G1. Similarly, Fig. A-4-8 shows that TDLF detailing limits the layovers to relatively small vales at the cross-frame locations. The maximum layover at the cross-frame locations is approximately 0.25 inches, on G1, when this detailing method is used. Maximum layovers of approximately 0.45 inches are observed between the cross-frames. For NLF detailing, the maximum layover under the TDL is approximately 1.0 in (see Fig. A-4-3). The final layovers for TDLF detailing are not exactly zero because TDLF detailing neglects various response attributes, such as the in-plane deformability of the cross-frames.

Figures A-4-10 through A-4-17 compare the individual girder displacements and elevations for each of the cross-frame detailing methods.

Figures A-4-18 and A-4-20 compare the individual girder major-axis bending stresses under SDL and TDL for EISCR1. It can be observed that the influence of SDLF and TDLF detailing on the girder major-axis bending stresses is very small. This behavior has been discussed previously in the NCHRP 12-79 research (White et al. 2012). Figures A-4-19 and A-4-21 show that SDLF and TDLF detailing result in some increase in the "negative" flange lateral bending stresses at the cross-frame locations. This is associated with the girder flanges working like continuous-span beams in the lateral direction in resisting torsion, and the fact that SDLF and TDLF detailing offsets the torsional rotations of the girders under the dead loads. That is, using the continuous-span beam analogy, the SDLF and TDLF detailing effects are akin to jacking of the interior supports of a continuous-span beam in the direction opposite to a support settlement.

Figures A-4-22 through A-4-27 provide an overall perspective of the distribution and magnitude of the cross-frame forces in the bridge for the different cross-frame detailing methods. Tables A-4-1 through A-4-3 provide specific numerical values for the cross-frame member axial forces. The bearing line cross-frames are numbered 1 and 5, and the cross-frame at the mid-span of the bridge is labeled as number 3. One can observe from Table A-4-1 that the maximum cross-frame 3 diagonal forces, under the TDL, are increased from 46.8 kips when NLF detailing is used to 68.7 kips for TDLF detailing, a 47 % increase in the TDL axial force. Tables A-4-2 and A-4-3 show that the cross-frame chord forces are not as significantly affected. This behavior has been discussed previously in the NCHRP 12-79 research (White et al. 2012). In curved radially-supported bridges, the shear raking of the cross-frames associated with SDLF and TDLF detailing generally adds to the dead load cross-frame forces, particularly to the cross-frame diagonal forces. One can observe from Table A-4-1 that SDLF detailing only increases the maximum cross-frame diagonal forces by 12 % in EISCR1. It is anticipated that the NCHRP 20-07/Task 355 project may be able to provide a simple estimate of the increase in the cross-frame forces by SDLF or TDLF effects as a function of the bridge geometry and/or other calculated responses.

Table A-4-4 shows the SDL and TDL differential vertical displacements between the girders in EISCR1. One can observe that the cross-frame detailing methods have little influence on the girder differential displacements. This is consistent with the previously discussed girder displacement plots. The maximum differential vertical displacement shown in the table is only about 1.7 in under the TDL, and it is less than ½ inch under the SDL. The differential vertical displacements are, of course, a key attribute used in the SDLF and TDLF detailing of the cross-frames (NSBA 2014).

Table A-4-5 shows the corresponding "horizontal differential displacements," calculated by taking the differential vertical displacements and multiplying by the height/width ratio of the cross-frames. This calculation neglects the influence of any cross-frame deformations, i.e., it assumes that the cross-frames respond essentially as rigid components, which is an adequate approximation in various contexts.

It is important to note that the horizontal differential displacements are not the same as the girder layovers. In addition to the fact that the above displacement estimate does not account for any deformation of the cross-frames, it also does not account for the "counter twisting" of the girders, in the opposite direction from that of their torsional rotations under the dead loads, associated with the SDLF and TDLF detailing effects. Furthermore, the above horizontal differential displacements are between the top and bottom chords of the cross-frames, whereas the previously reported girder layovers are between the top and bottom girder flanges.

The maximum horizontal differential displacements under the TDL in EISCR1 are slightly larger than ½ inch. This exceeds the limit, indicated by Respondent F2 to the NCHRP 20-07/Task 355 survey, at which they would send an RFI to the engineer requesting input regarding the cross-frame detailing preference.

Some discussion of the influence of attributes such as camber tolerances, play within bolted connections, and other attributes that can affect the constructed geometry such as deviations of support locations from their nominal or ideal positions, the influence of temperature changes on the precise geometry of the steel, the influence of early setup of the concrete during the deck placement, etc. relative to the above vertical and horizontal differential displacements is in order. When the girder differential displacements are relatively small, these displacements can potentially be overwhelmed by any of the above values. Nevertheless, it is submitted that the SDLF and TDLF cross-frame geometries are appropriately calculated based on the vertical differential displacements. Furthermore, assuming that the above effects do not overwhelm the girder differential displacements, the results presented in this appendix show that SDLF and TLDF detailing do a good job of offsetting the tendency of the I-girders to twist under the SDL and the TDL.

Table A-4-6 shows the sum of the total vertical SDL and TDL reactions in EISCR1, which is one important check in confirming that the analyses are correct. One can observe from this table that the total weight of the structural steel is 60.8 kips in this bridge. Table A-4-7 shows the distribution of the reactions at the bearing lines. The bearings on the outside girder, G1, accept the majority of the dead loads on this bridge. Also, it can be observed from Table A-4-7 that the cross-frame detailing methods have little influence on the bearing reactions in EISCR1. The SDLF and TDLF detailing effects are primarily internal to the structure.

Table A-4-8 shows the longitudinal displacements at EISCR1's supports. Support 1 is at the "start" of the bridge, where EISCR1 has a fixed bearing on G2. The other bearings in EISCR1 are guided longitudinally. The radial and longitudinal forces in the directions of the bearing constraints are all zero to within one decimal point (100 lb) in this bridge.

References

NSBA (2014). *Skewed and Curved Steel I-Girder Bridge Fit*, National Steel Bridge Alliance, August, Chicago, IL, 6 pp.

White, D.W., Coletti, D., Chavel, B.D., Sanchez, A., Ozgur, C., Jimenez Chong, J.M., Leon, R.T., Medlock, R.D., Cisneros, R.A., Galambos, T.V., Yadlosky, J.M., Gatti, W.J., and Kowatch, G.T. (2012). "Guidelines for Analytical Methods and Construction Engineering of Curved and Skewed Steel Girder Bridges," NCHRP Report 725, Final Report, Project No. NCHRP 12-79, February, 209 pp.

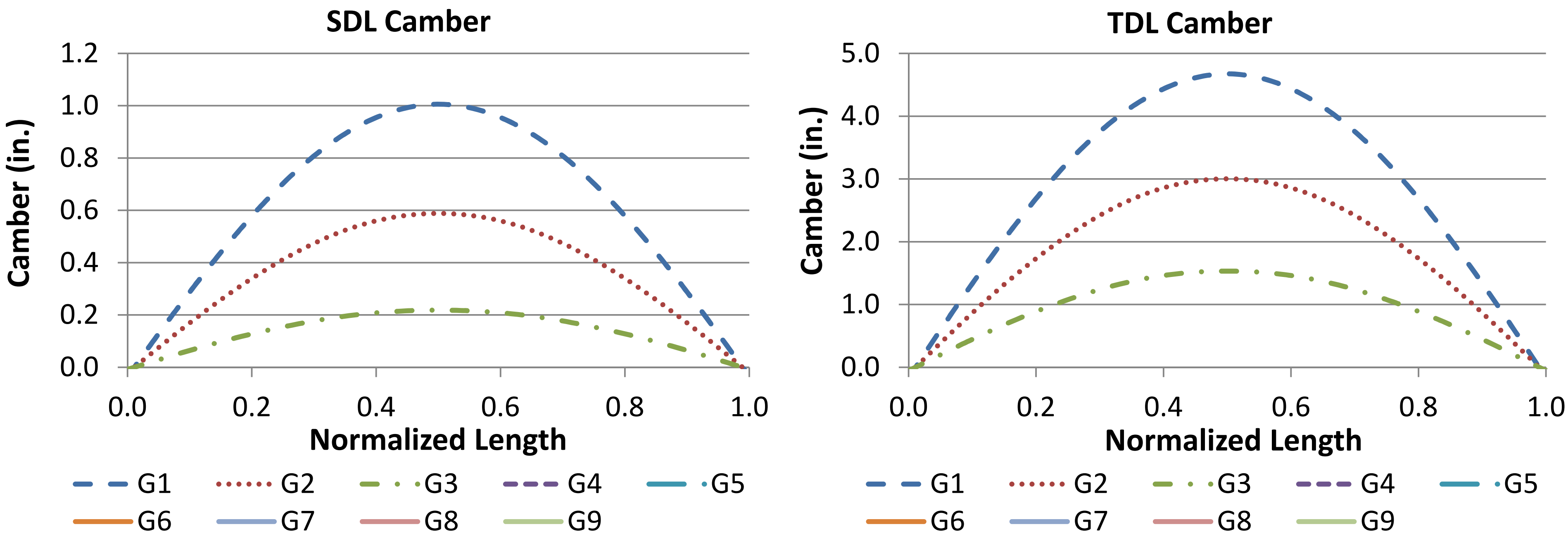
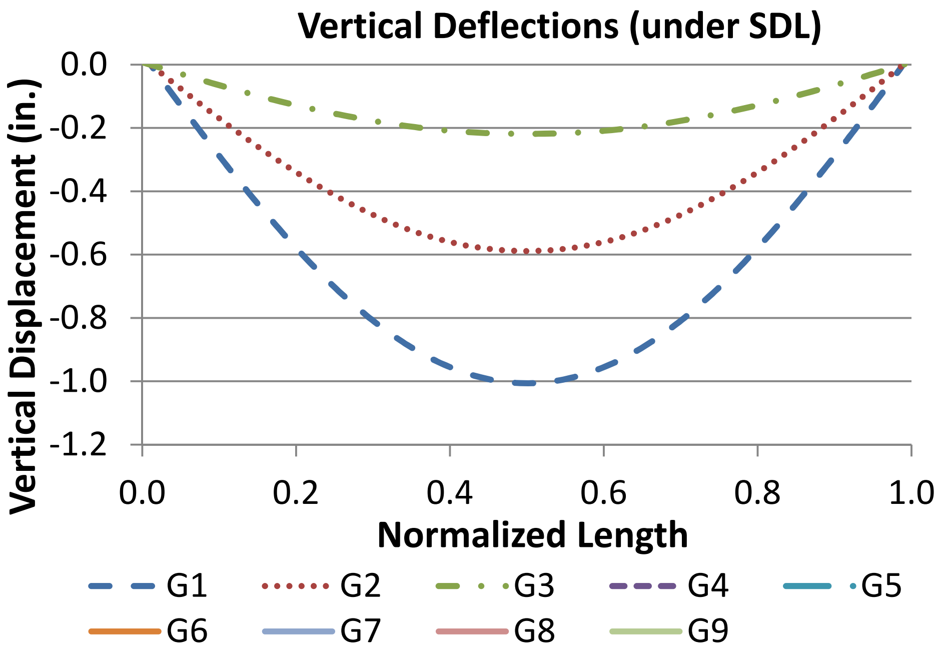
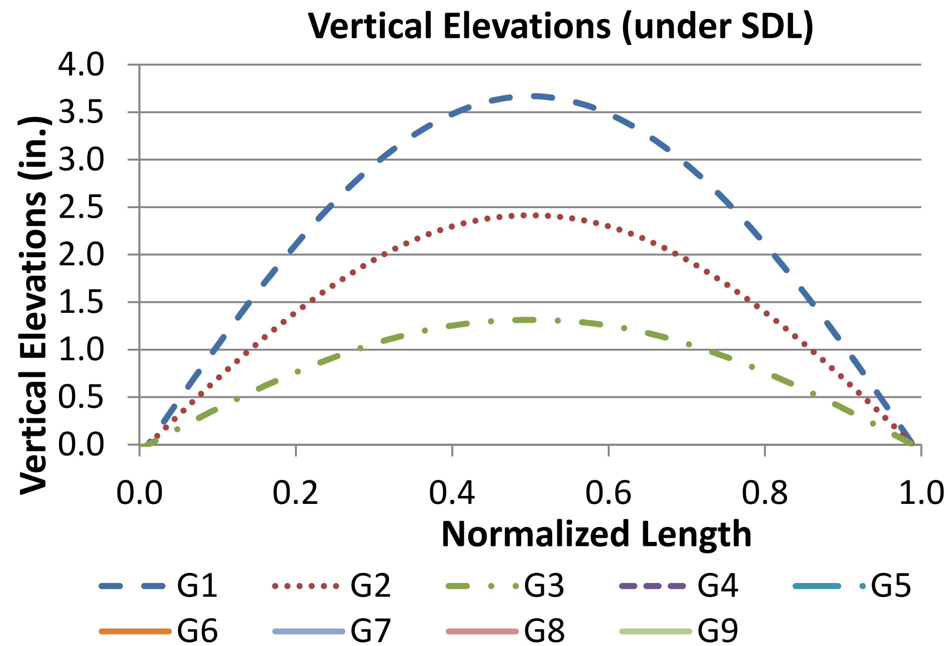


Figure A-4-1. SDL and TDL cambers.





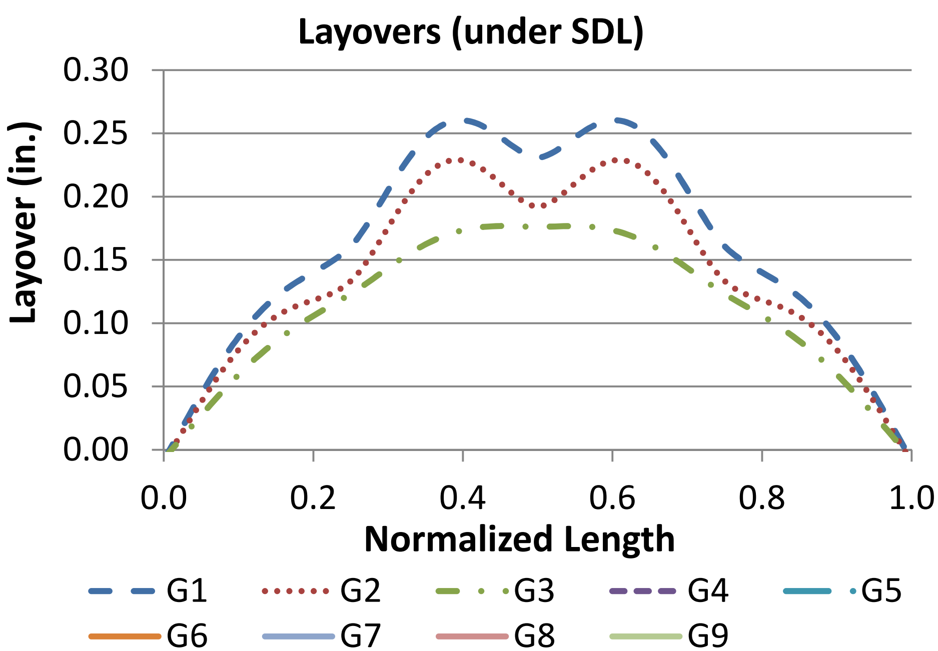


Figure A-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

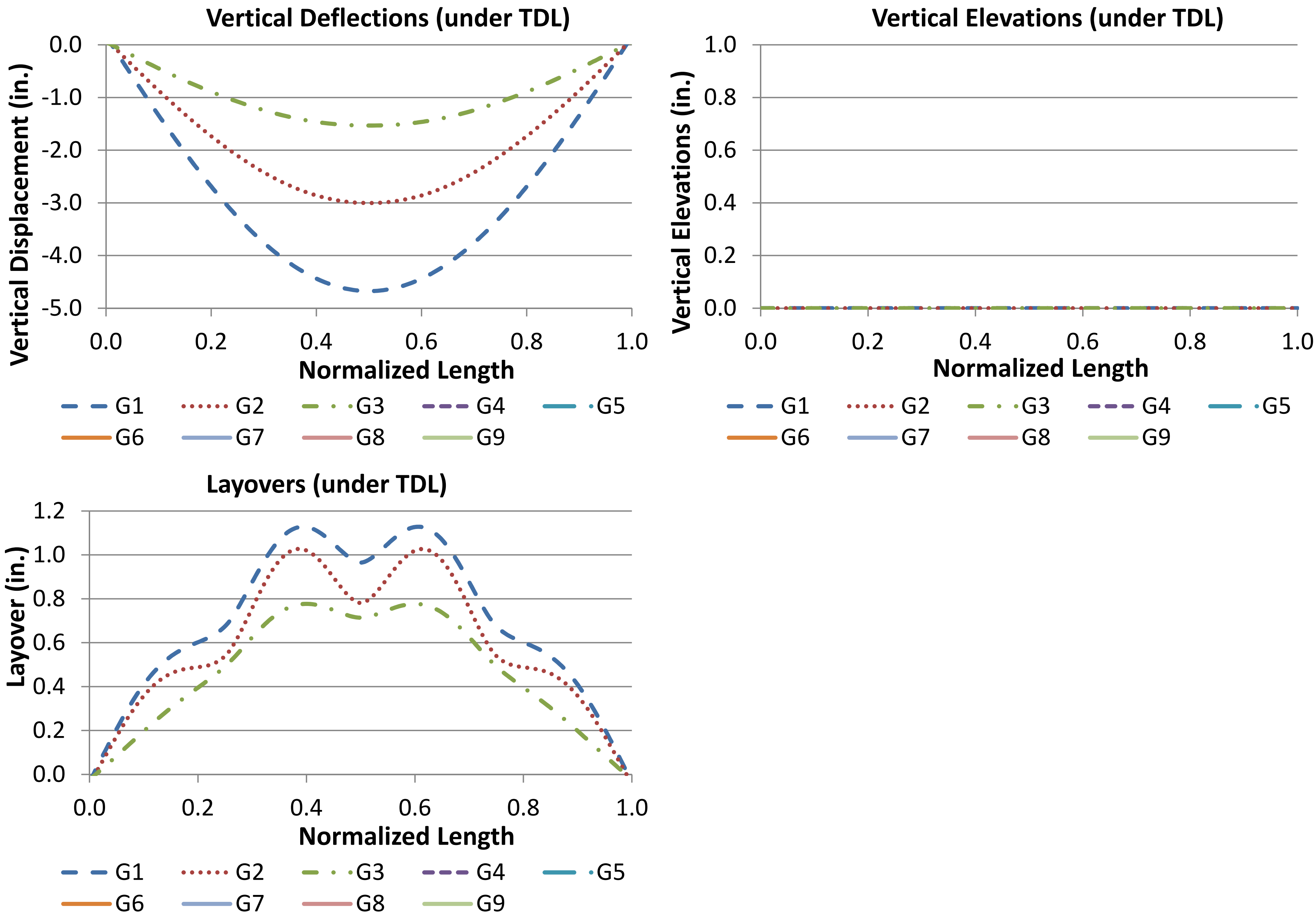


Figure A-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

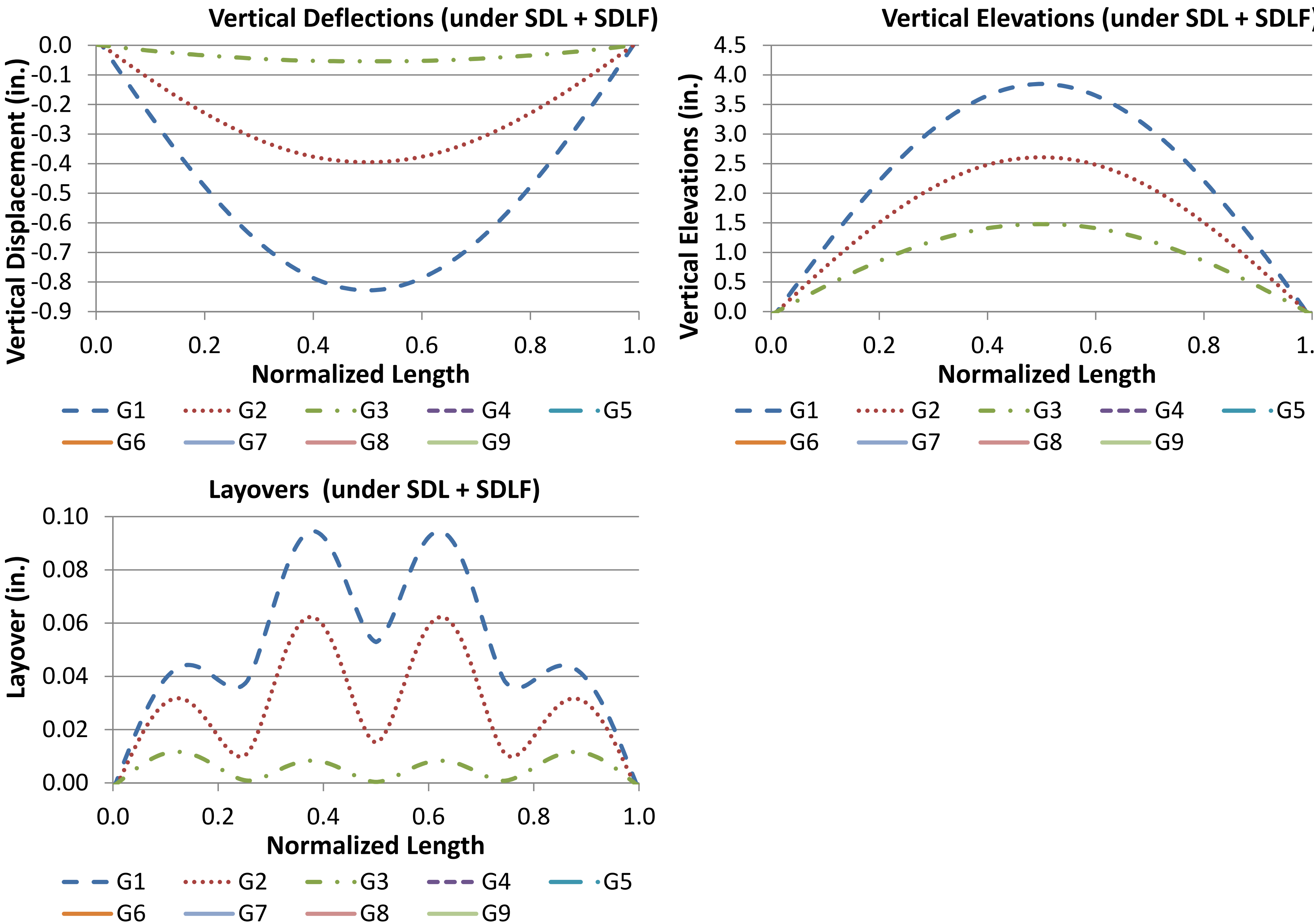


Figure A-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

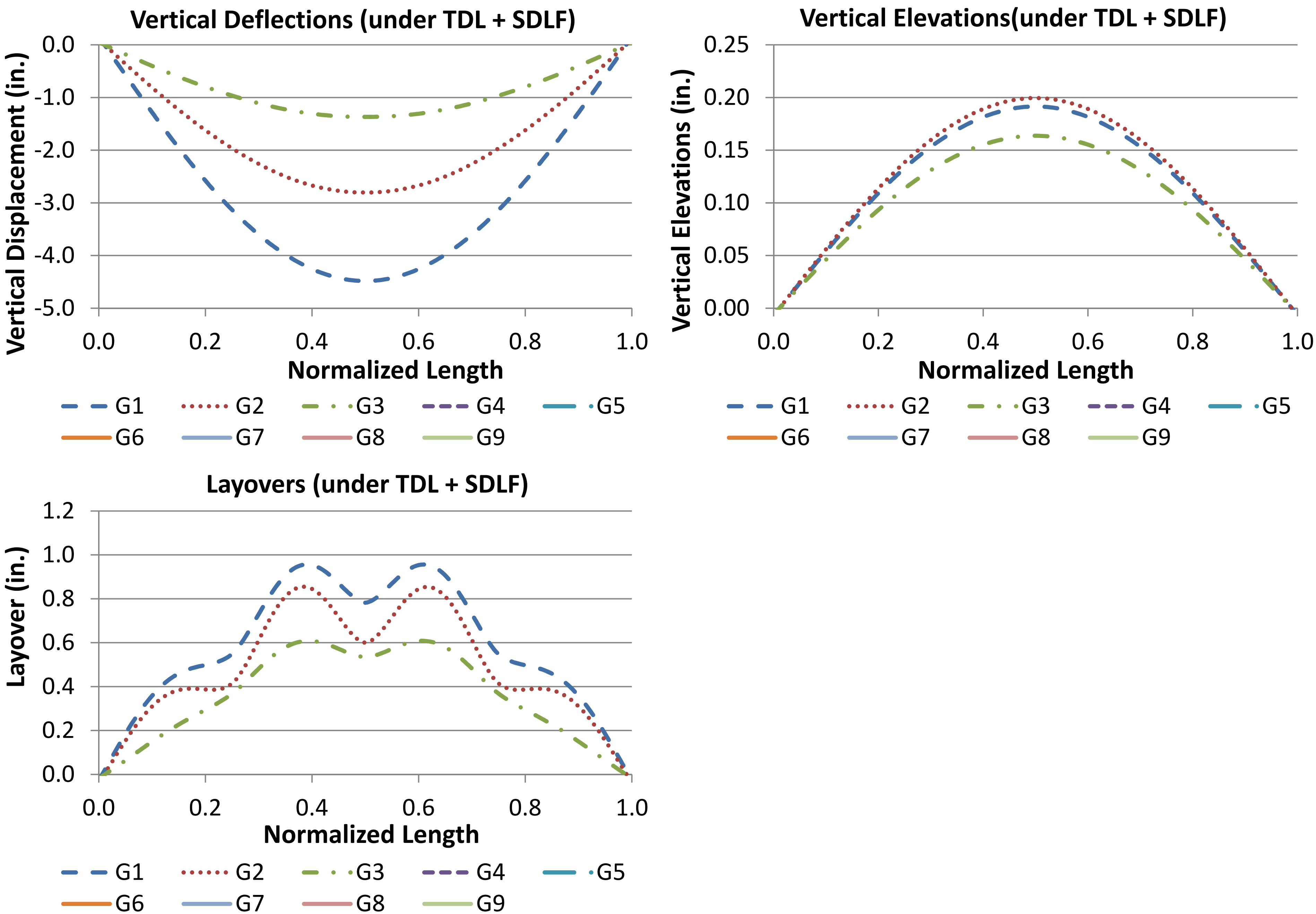


Figure A-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

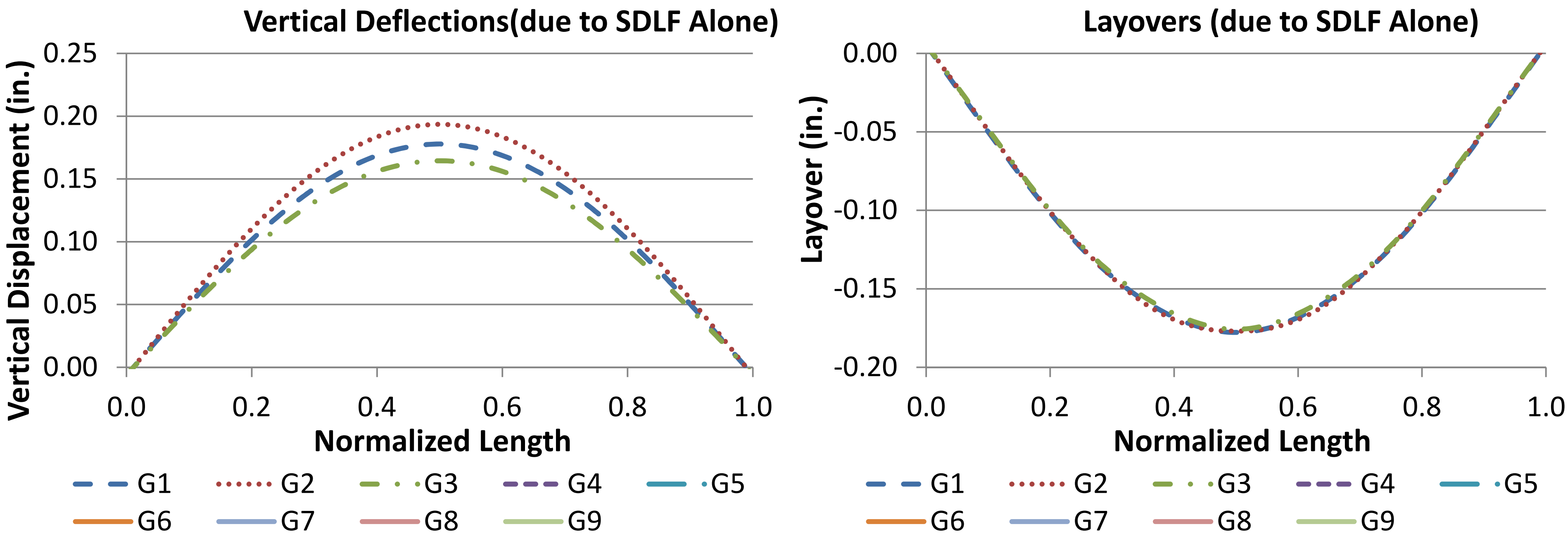


Figure A-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

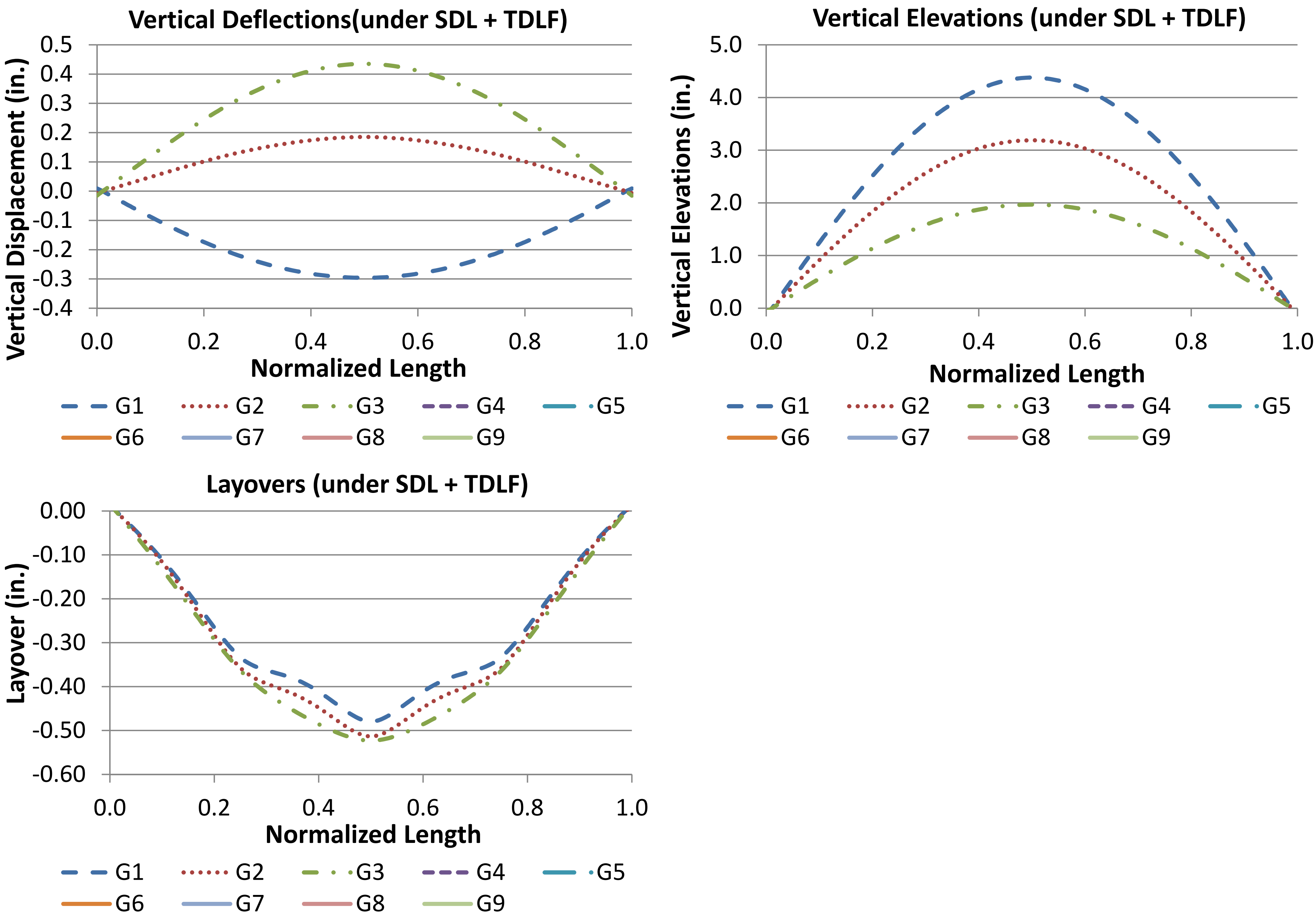


Figure A-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

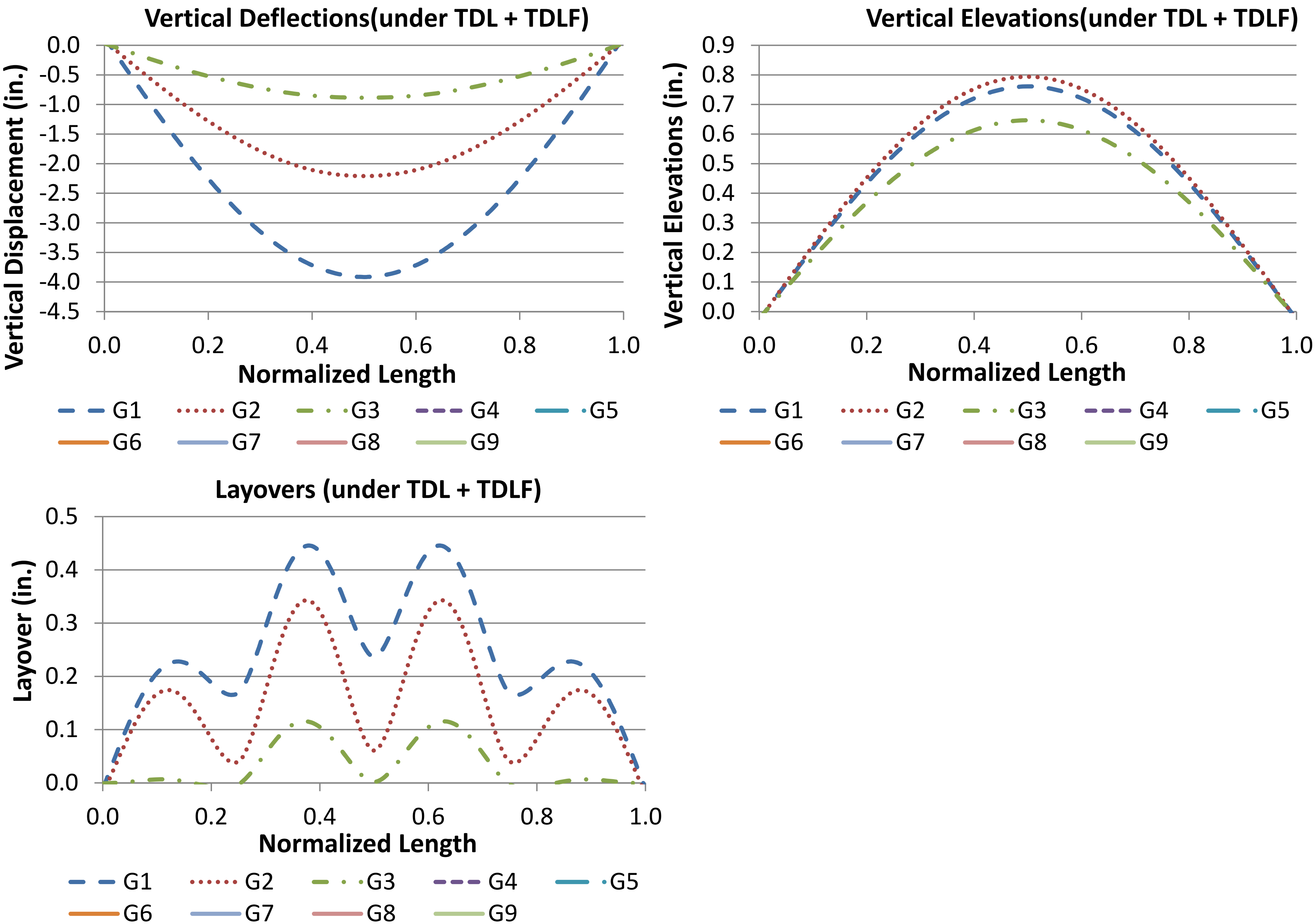


Figure A-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

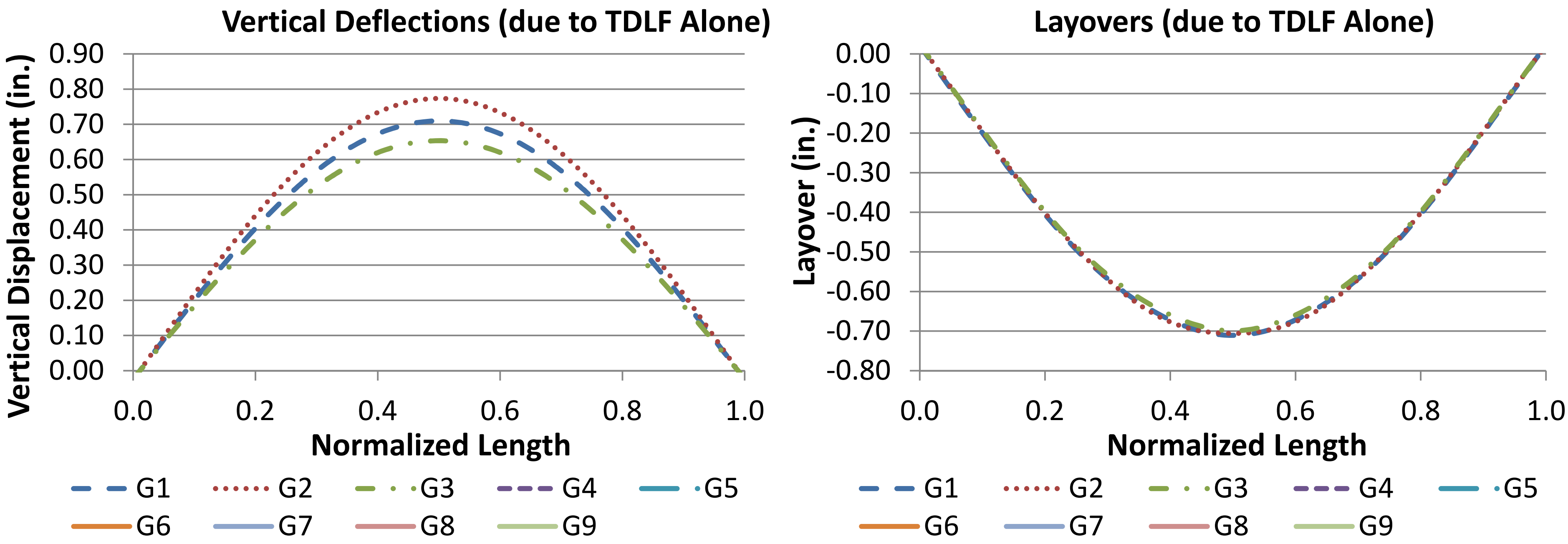


Figure A-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

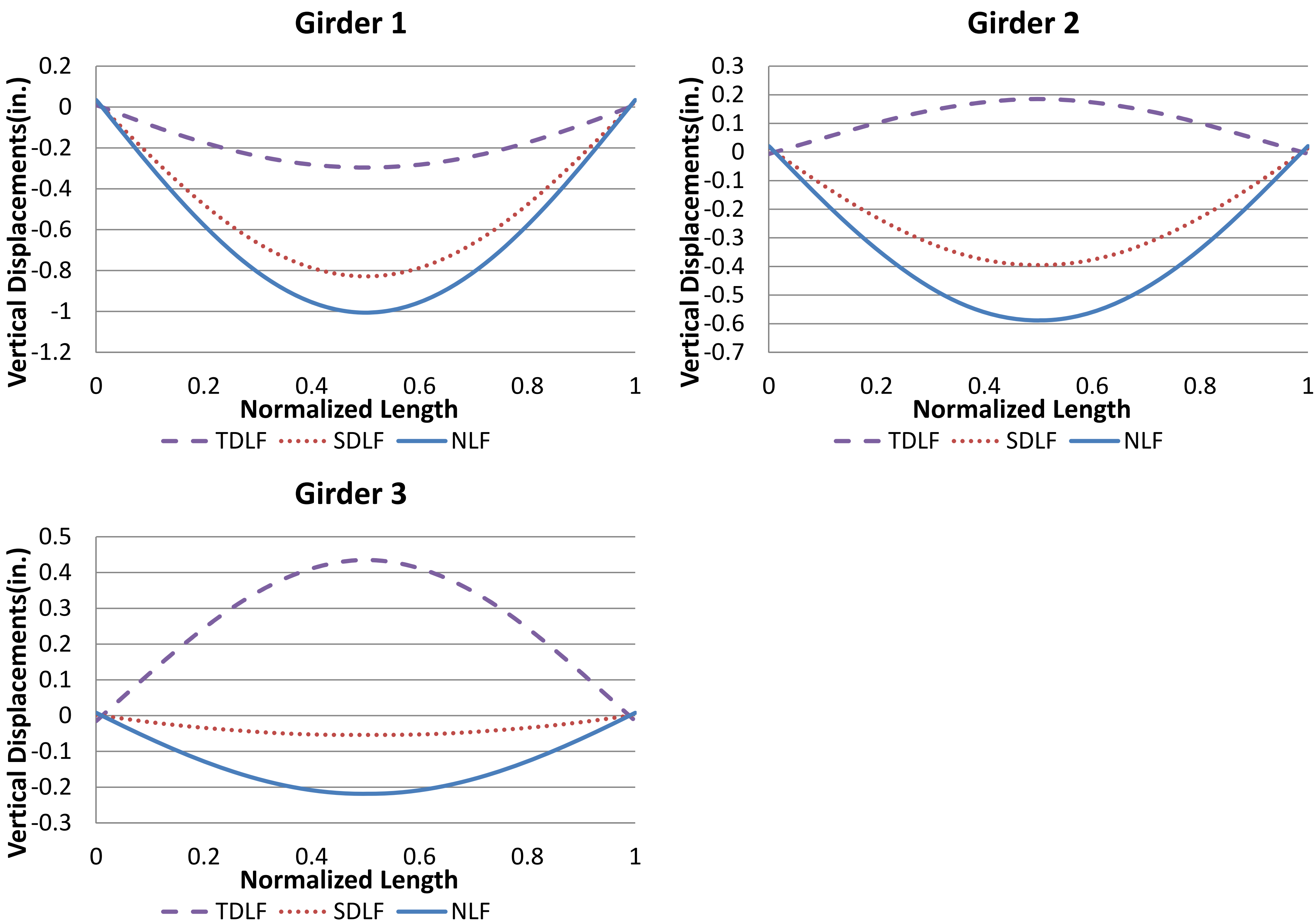


Figure A-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

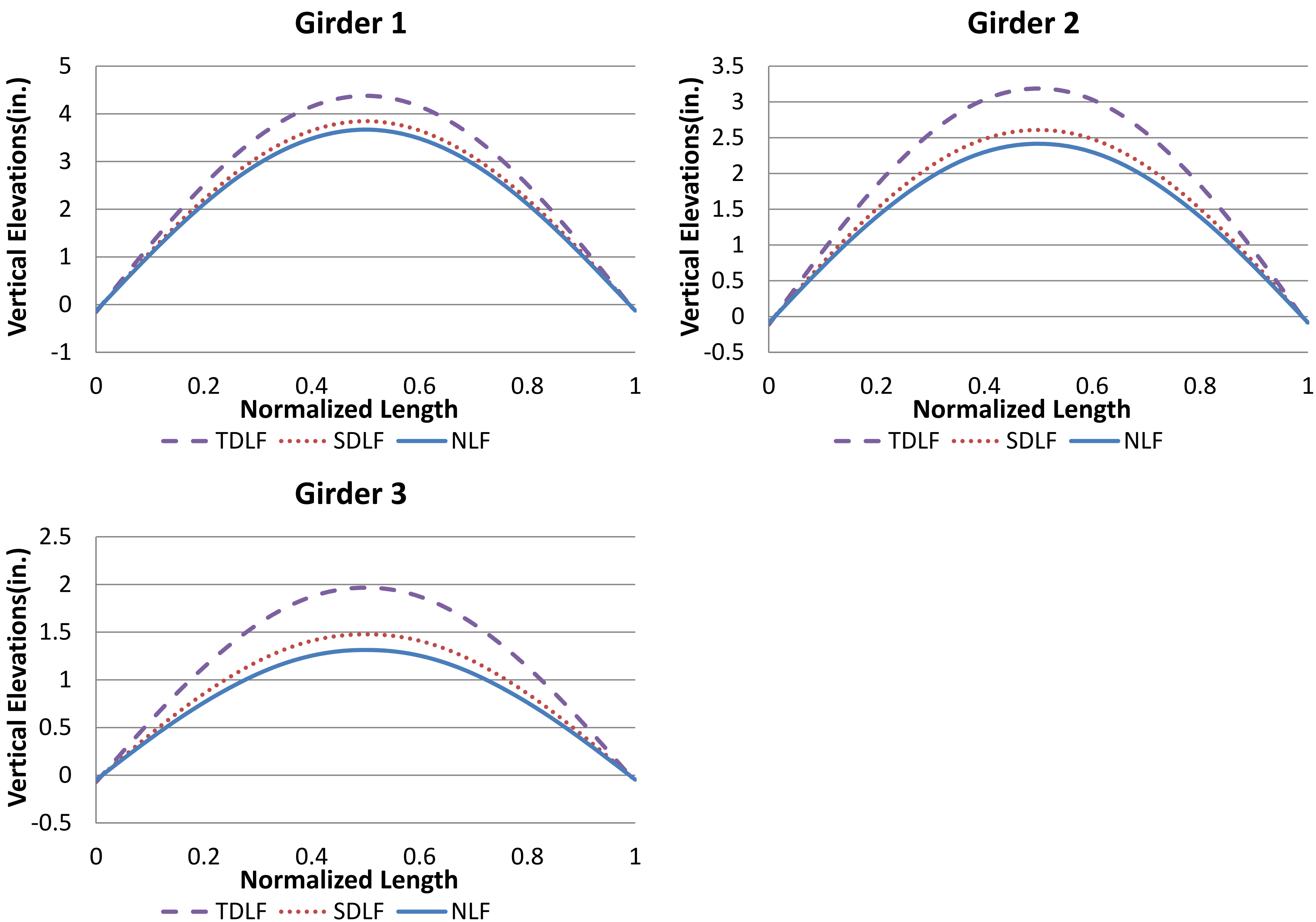
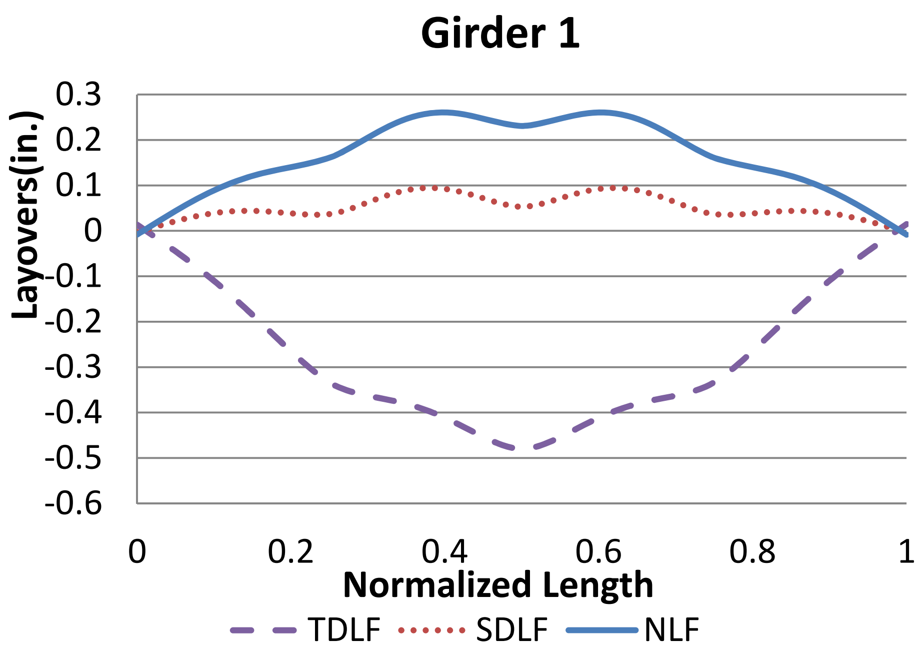
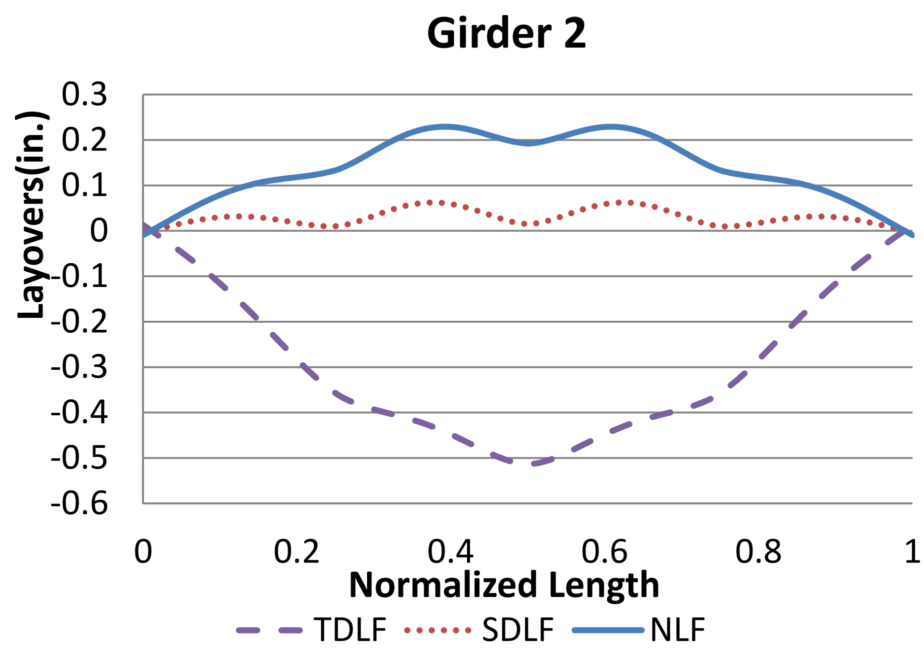


Figure A-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.





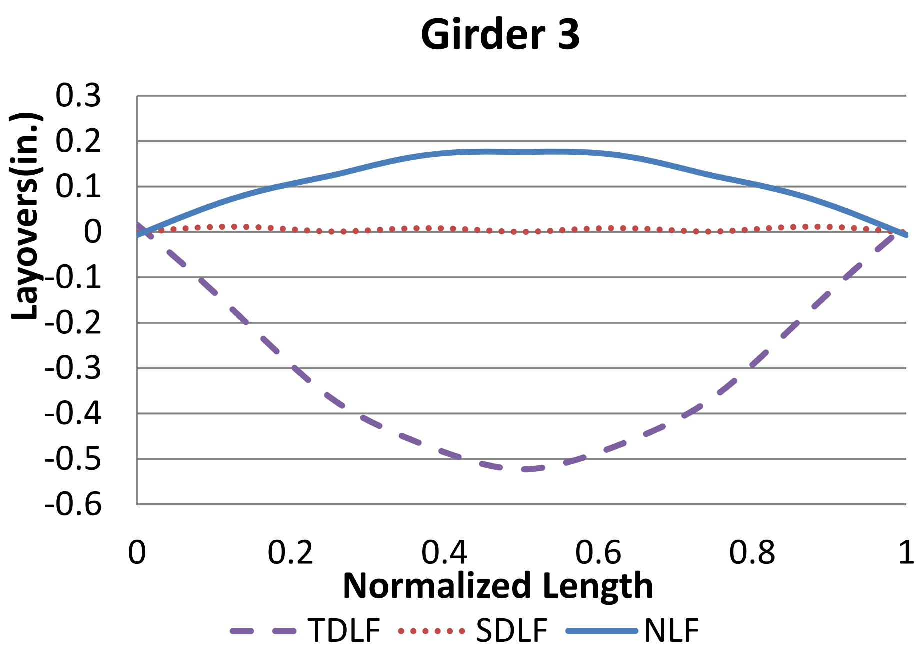


Figure A-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

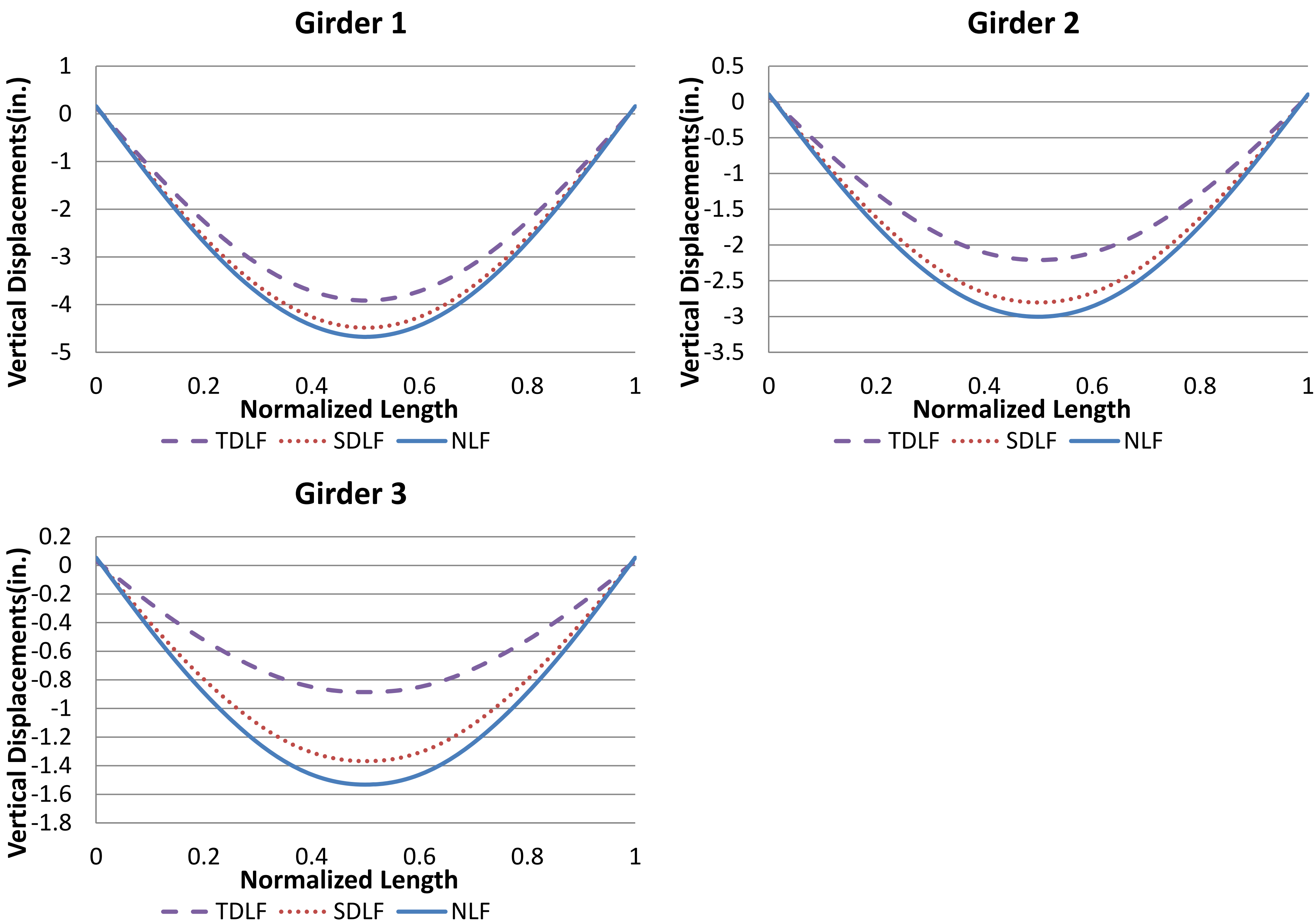


Figure A-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

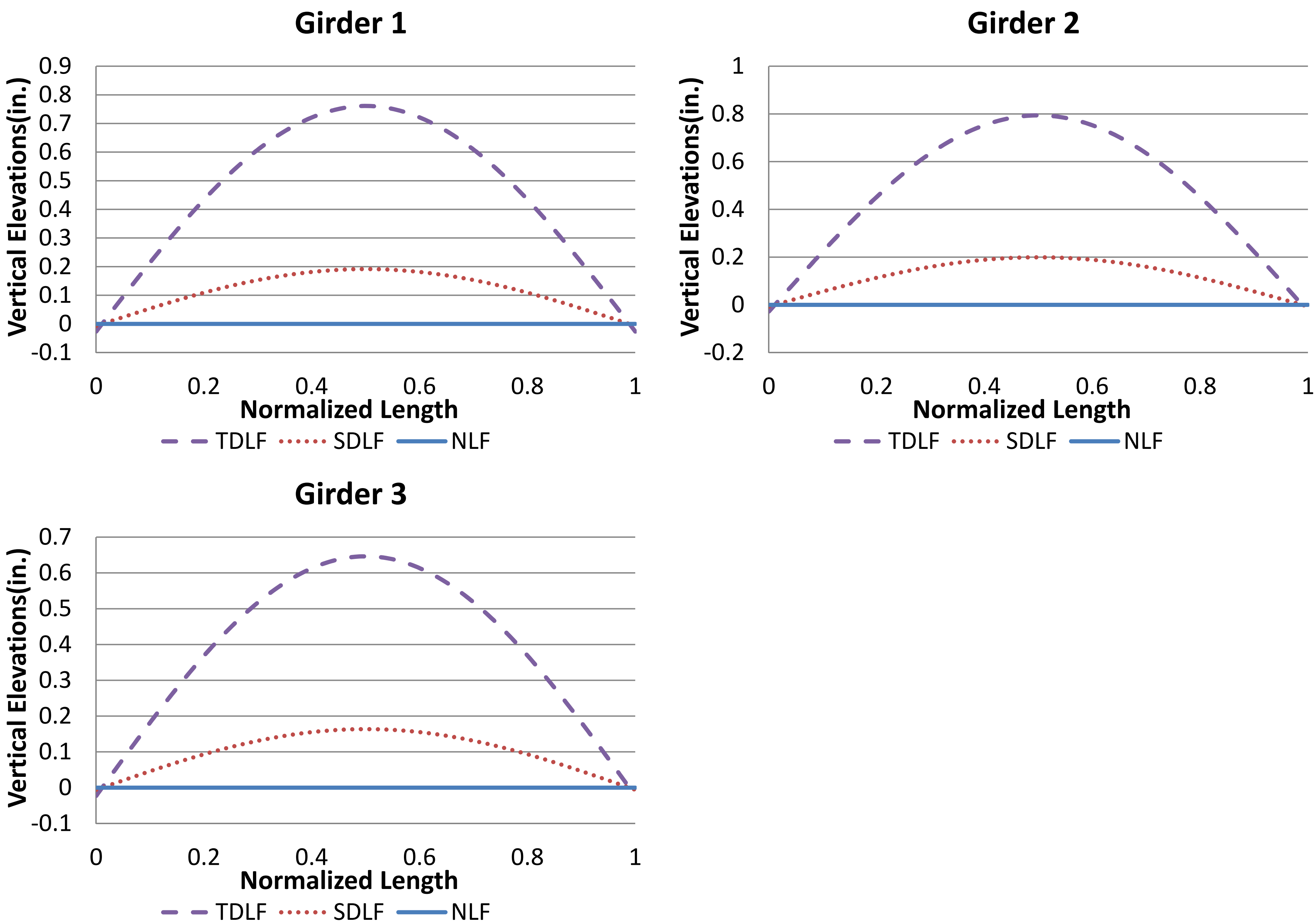


Figure A-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

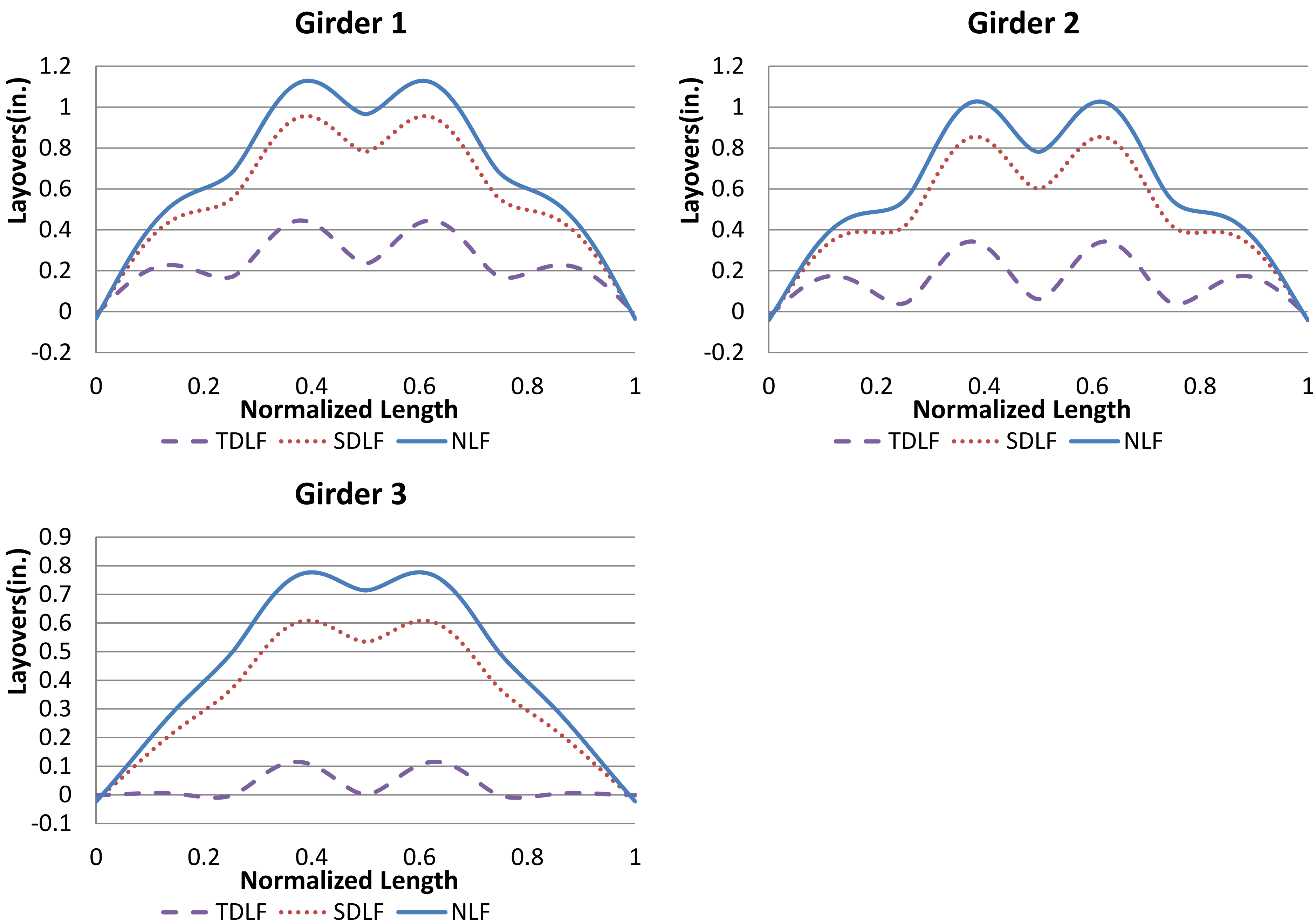


Figure A-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

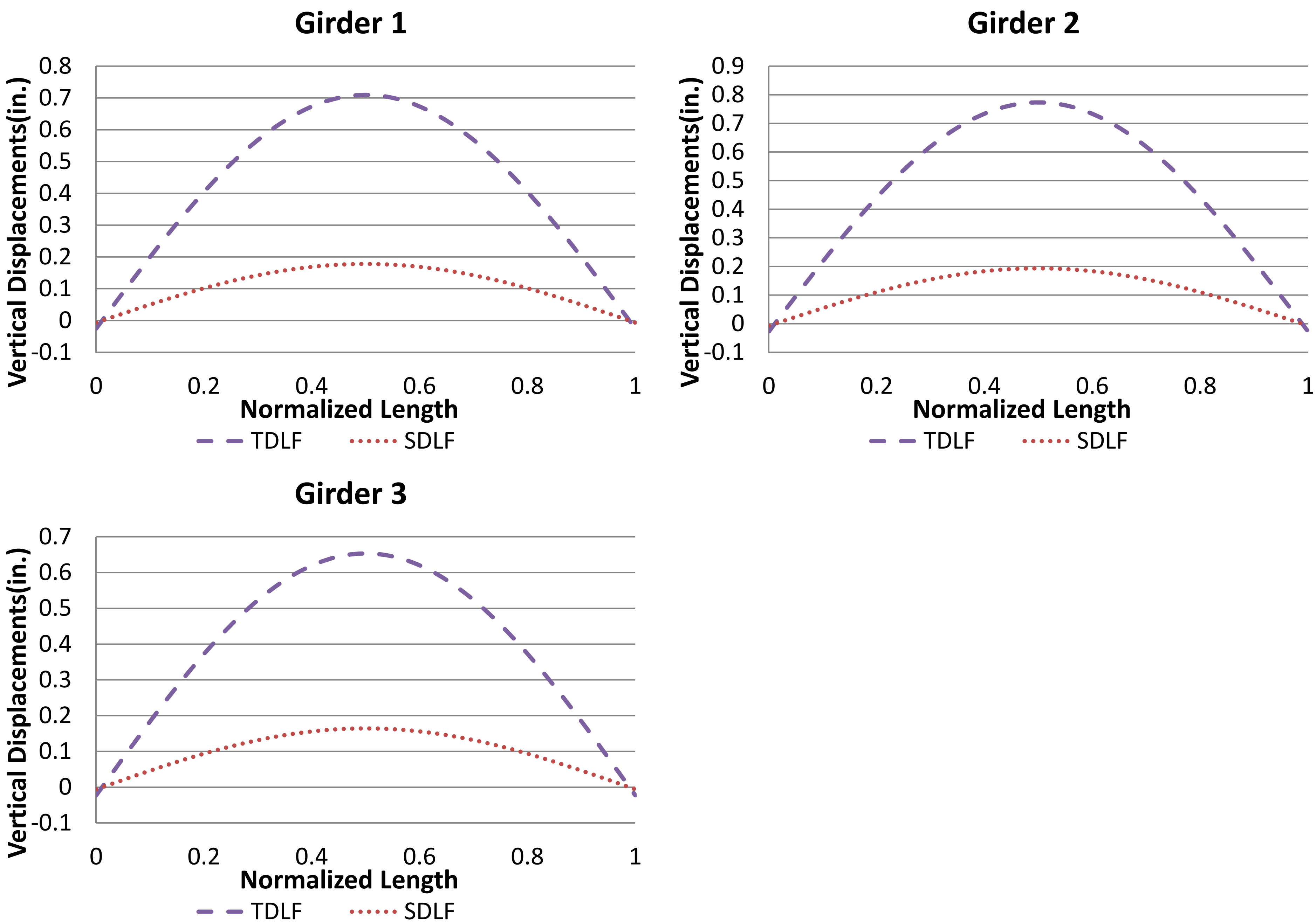


Figure A-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

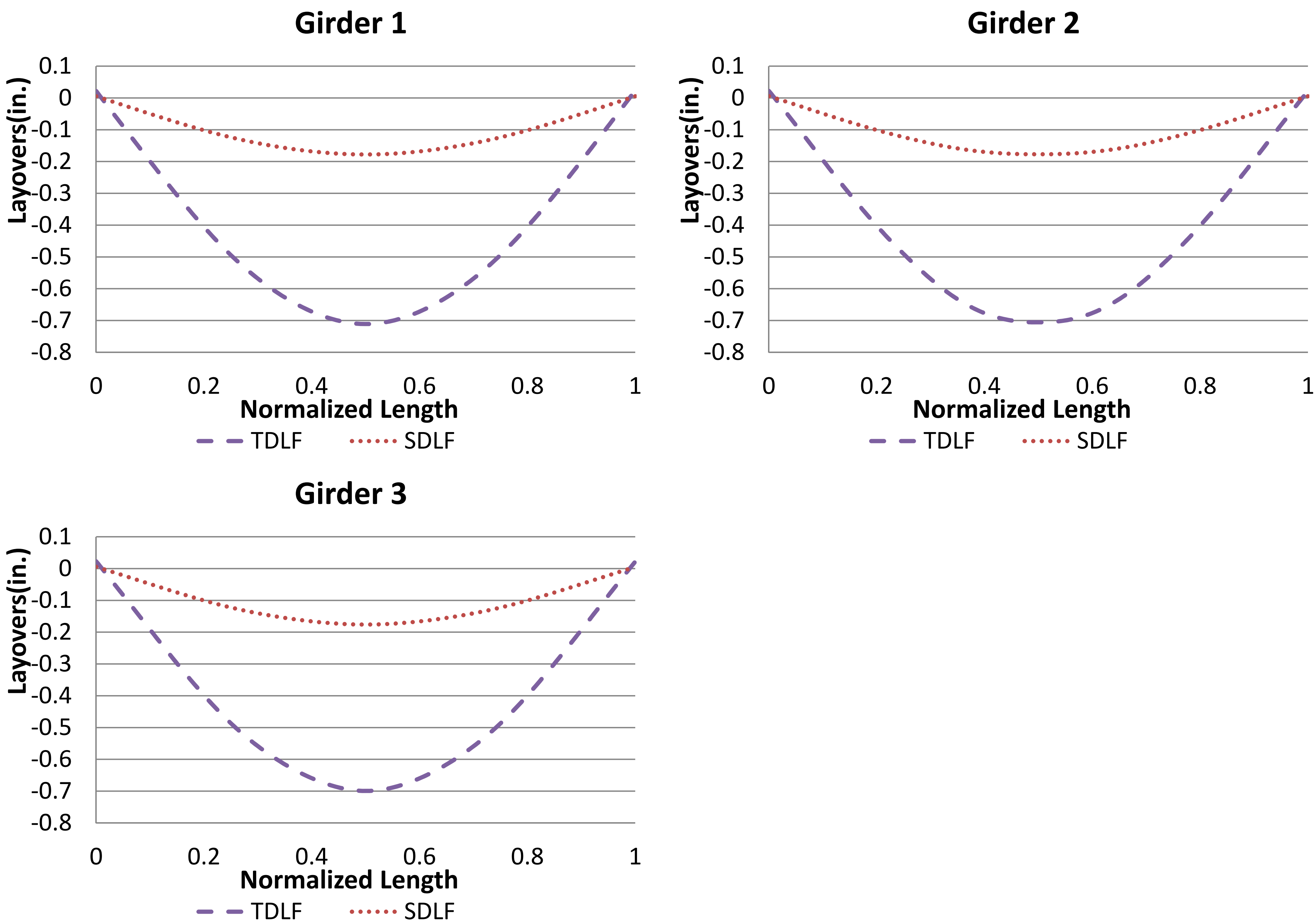


Figure A-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

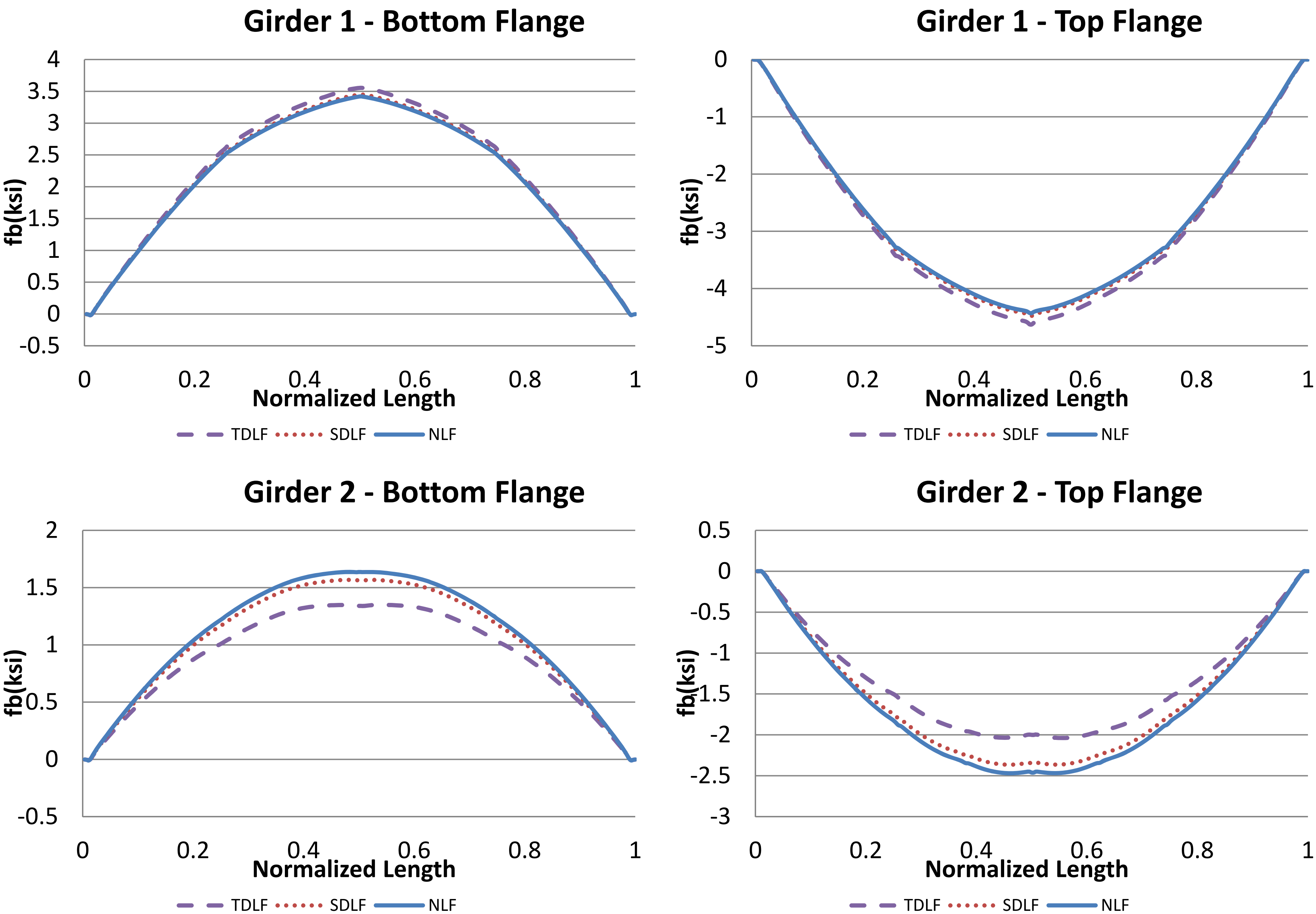


Figure A-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

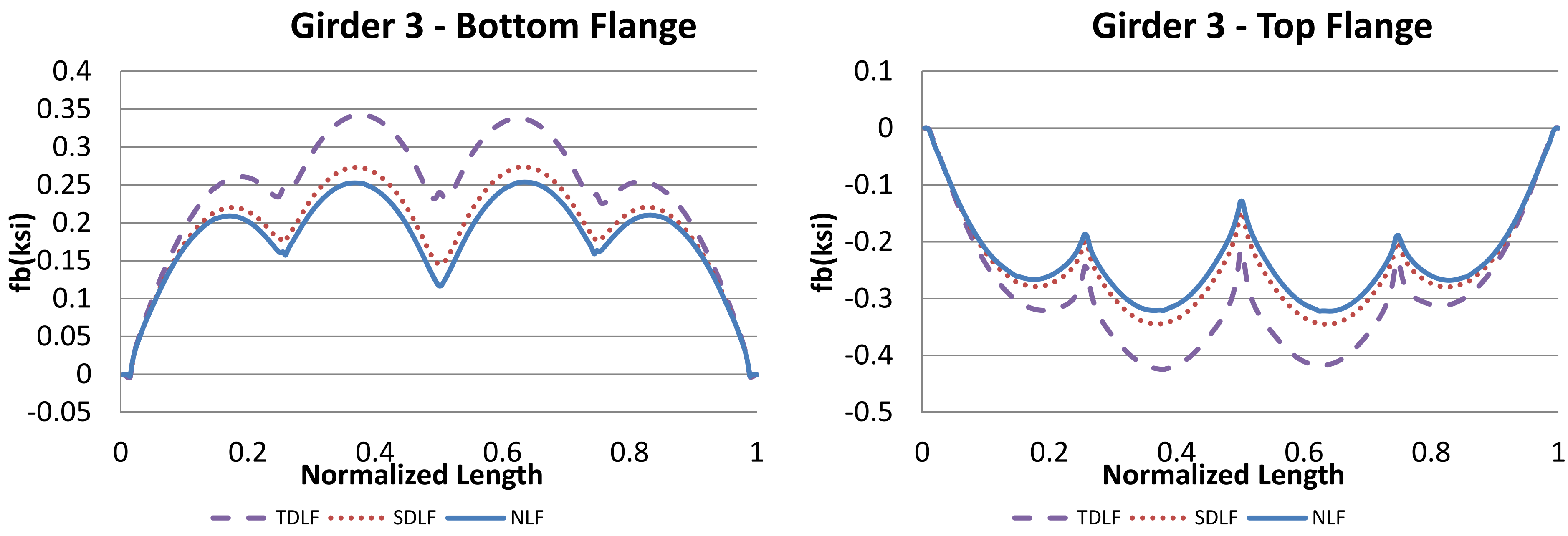


Figure A-4-18 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

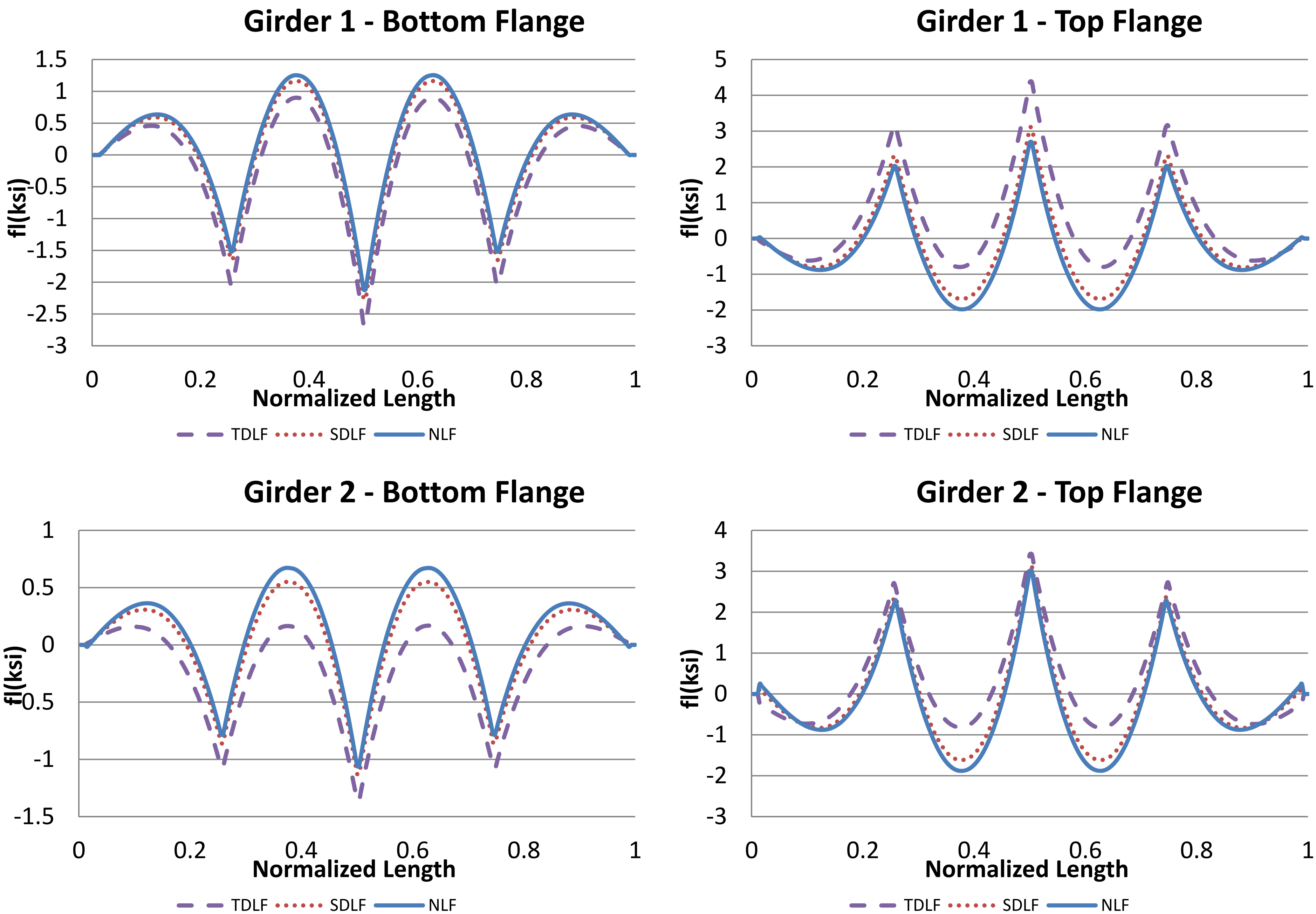
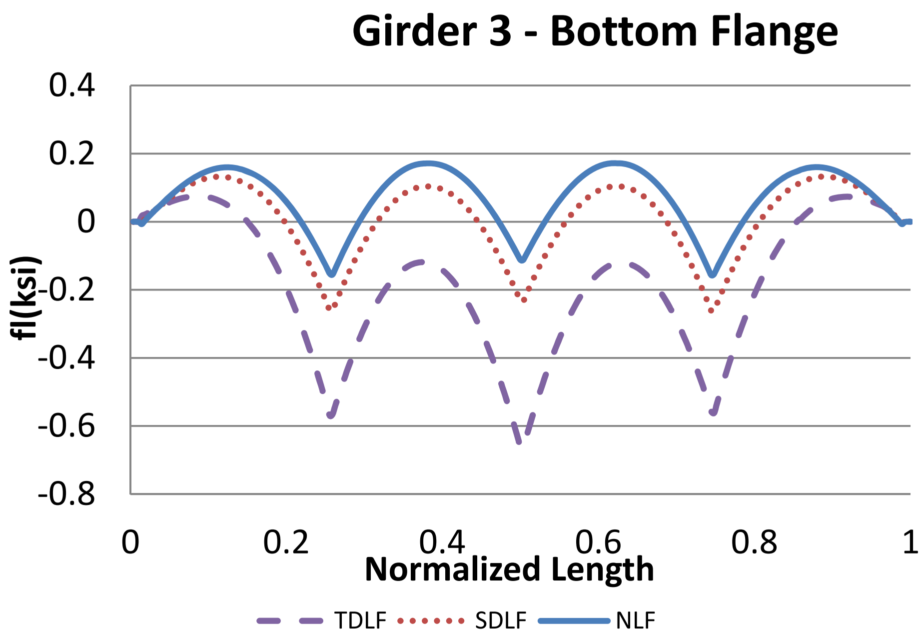


Figure A-4-19. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**



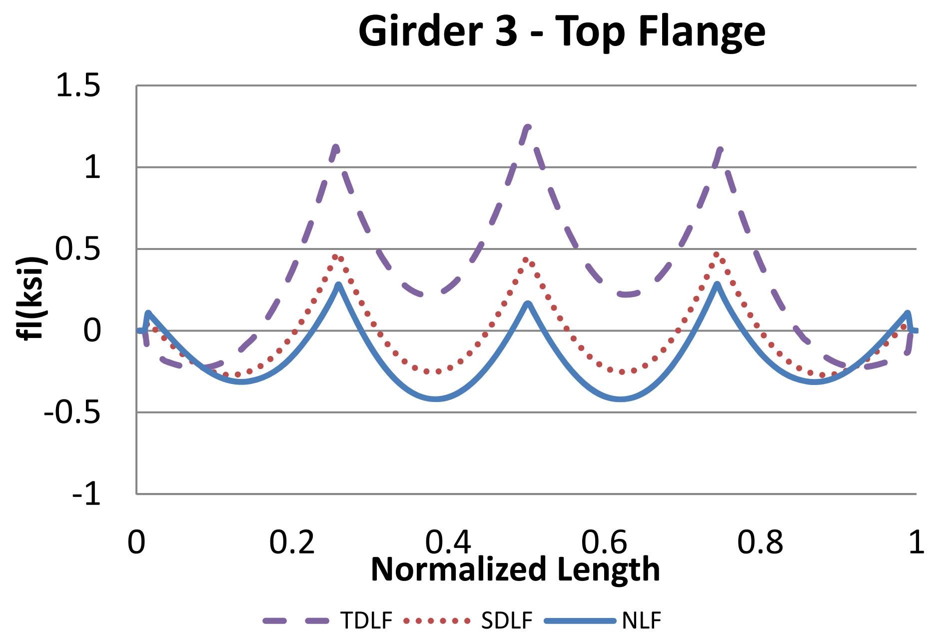


Figure A-4-19 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

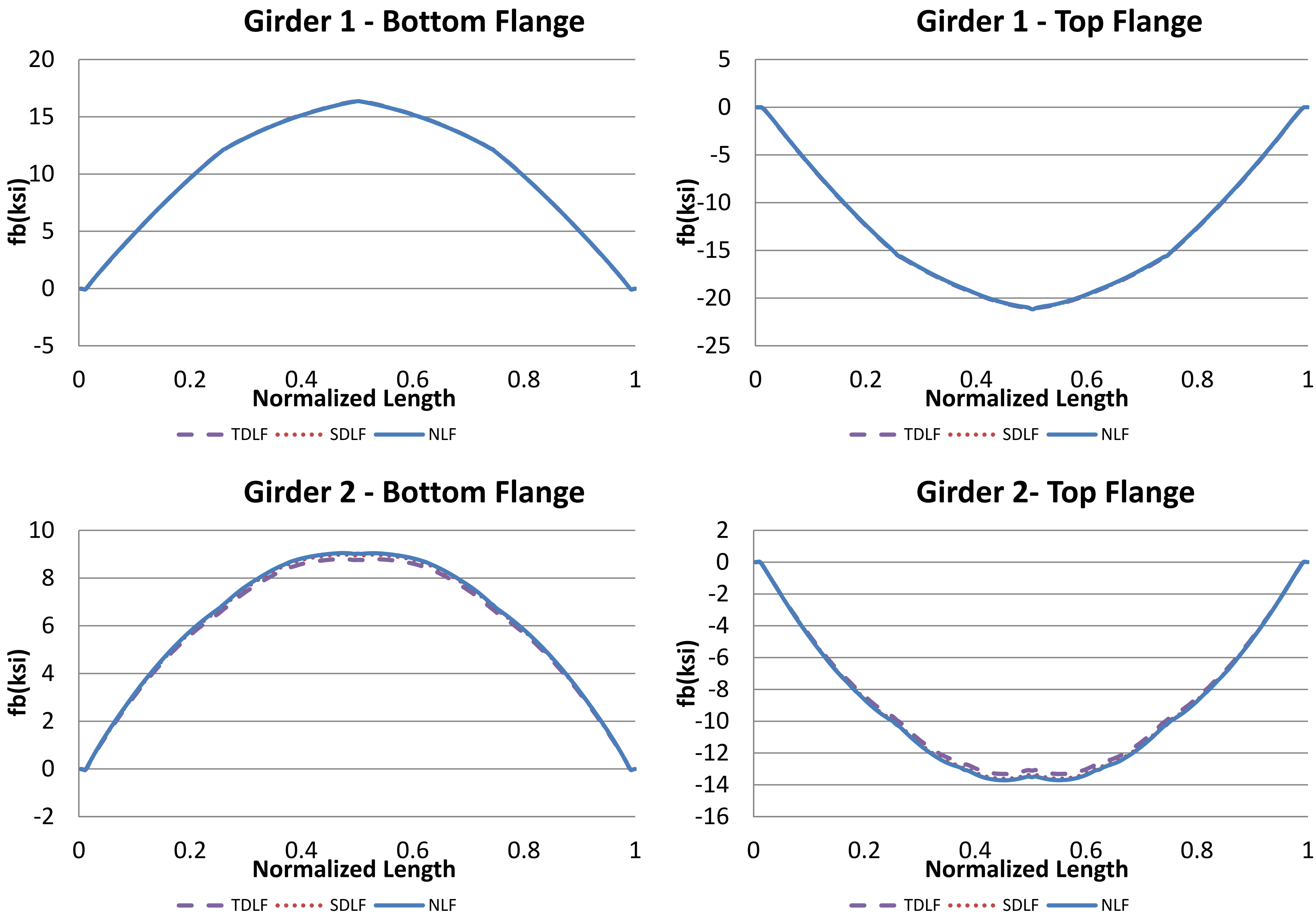


Figure A-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

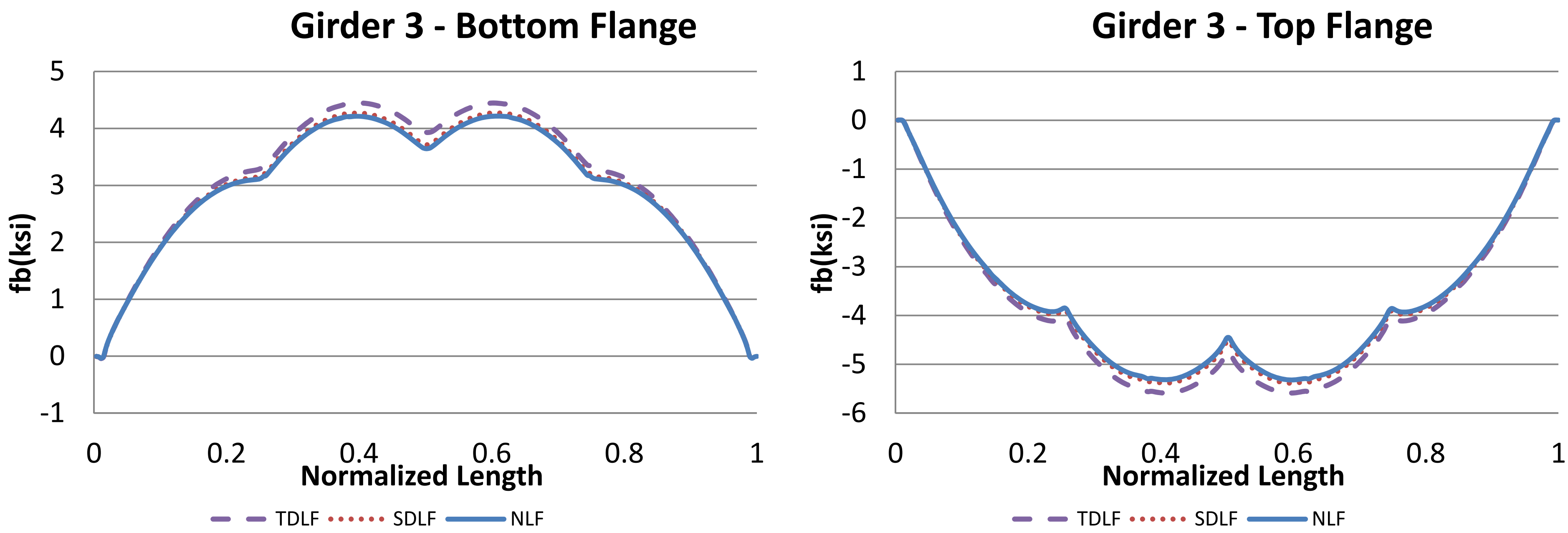


Figure A-4-20 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

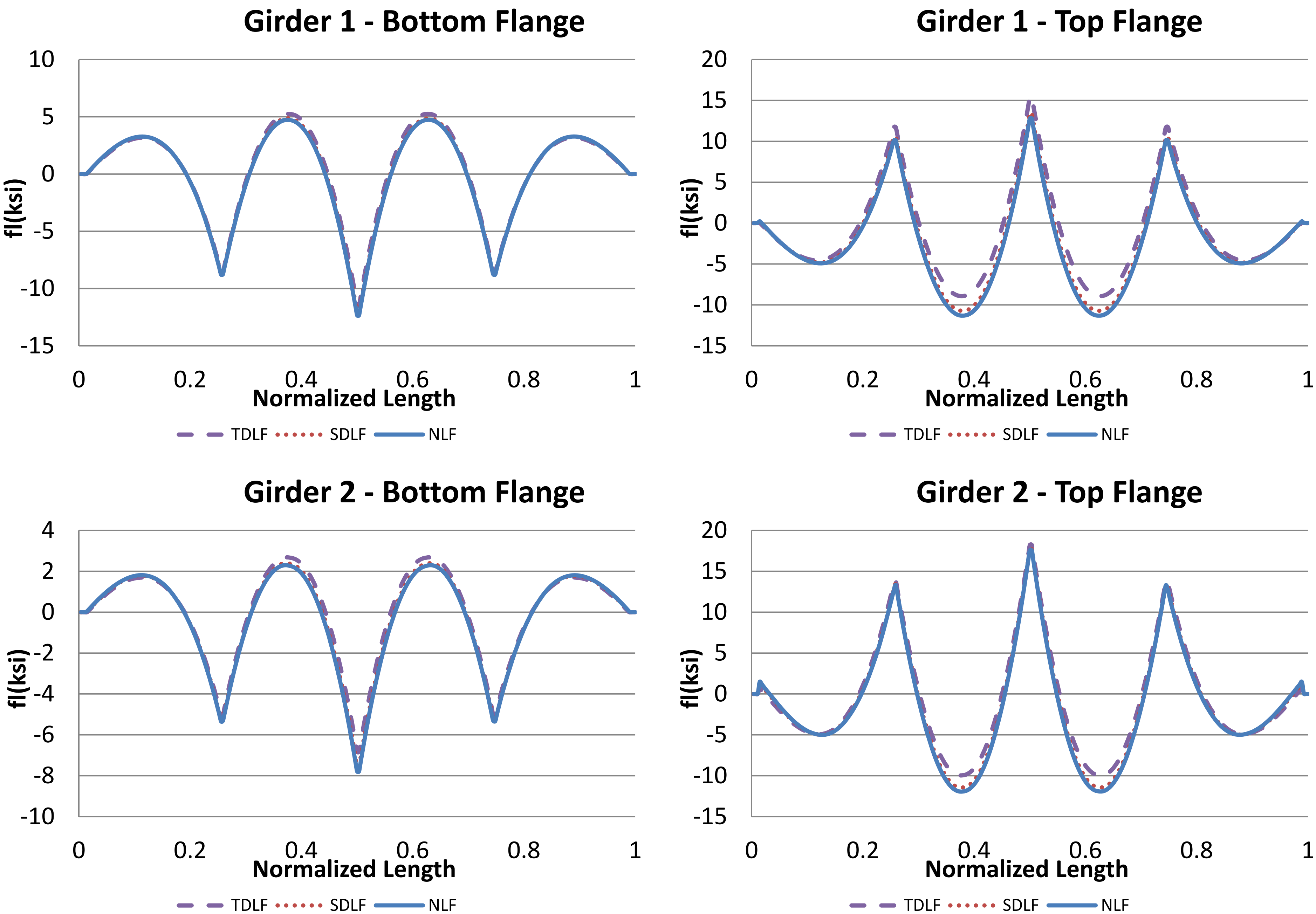
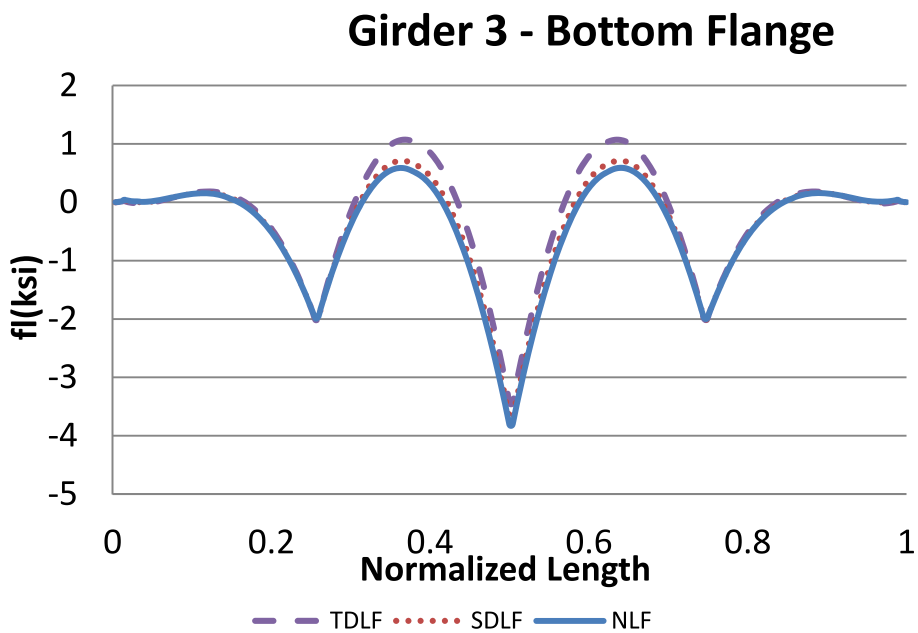


Figure A-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**



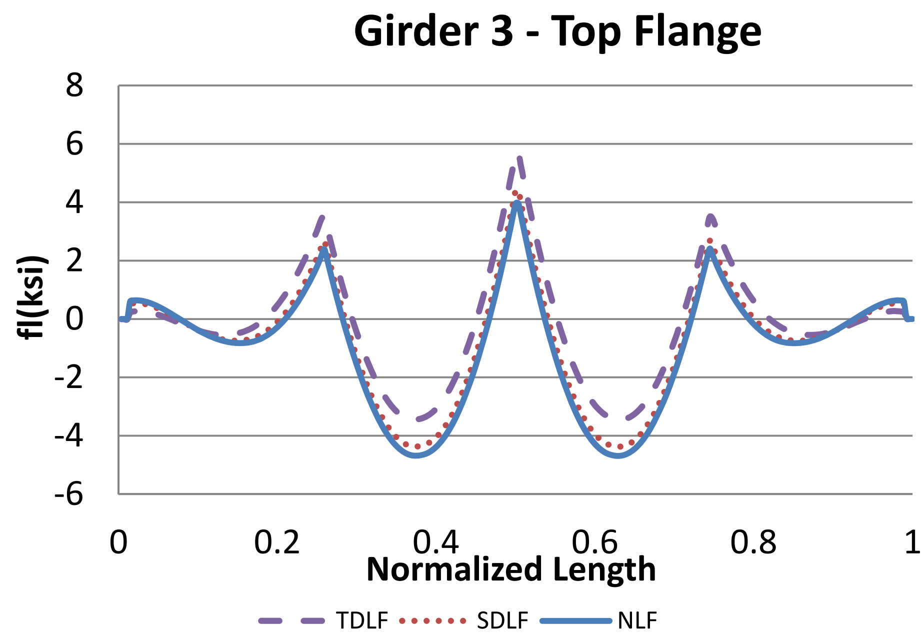


Figure A-4-21 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

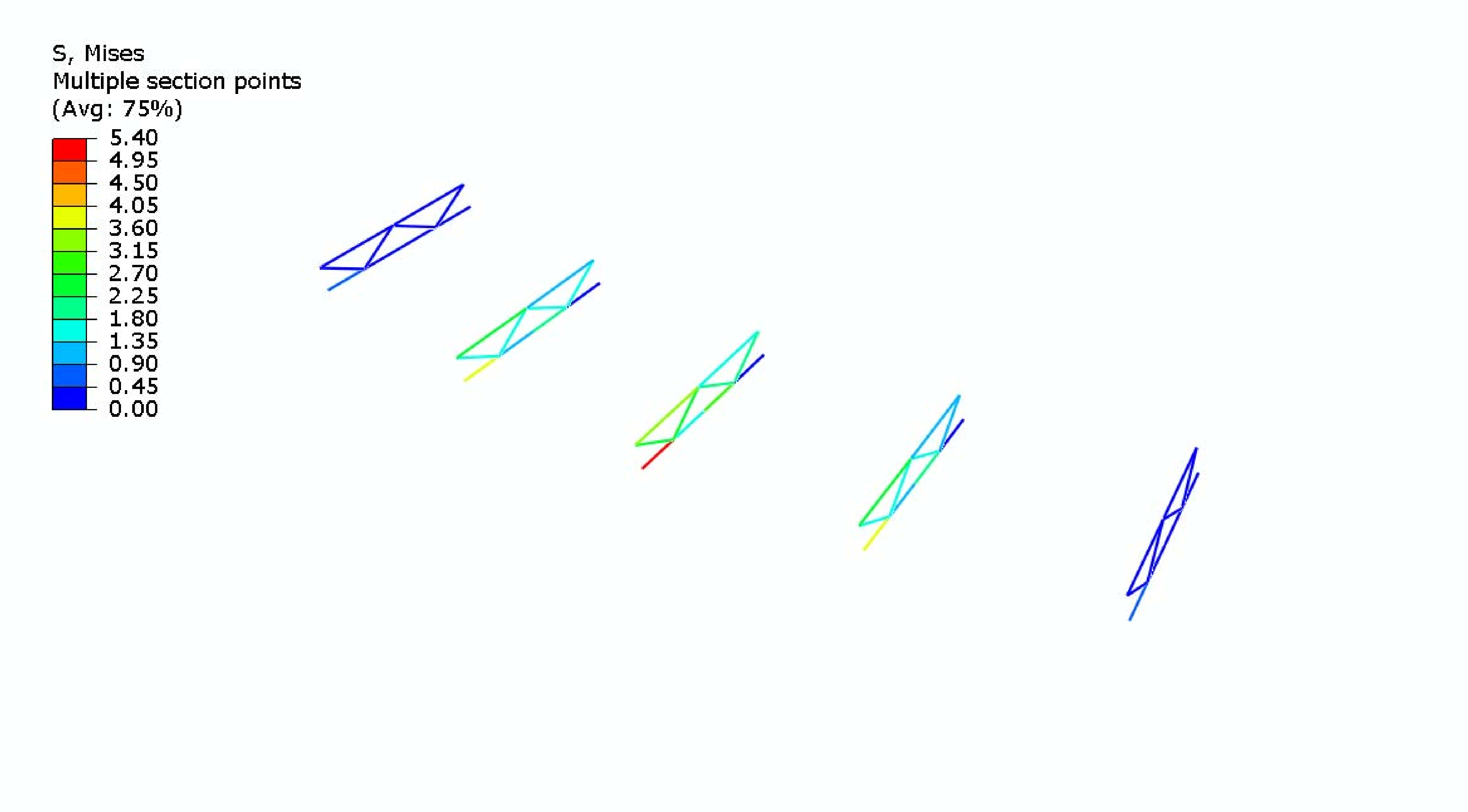


Figure A-4-22. **Cross-frame stress contours (ksi) under SDL, NLF detailing (cross-frame member areas = 3.49 in^2).**

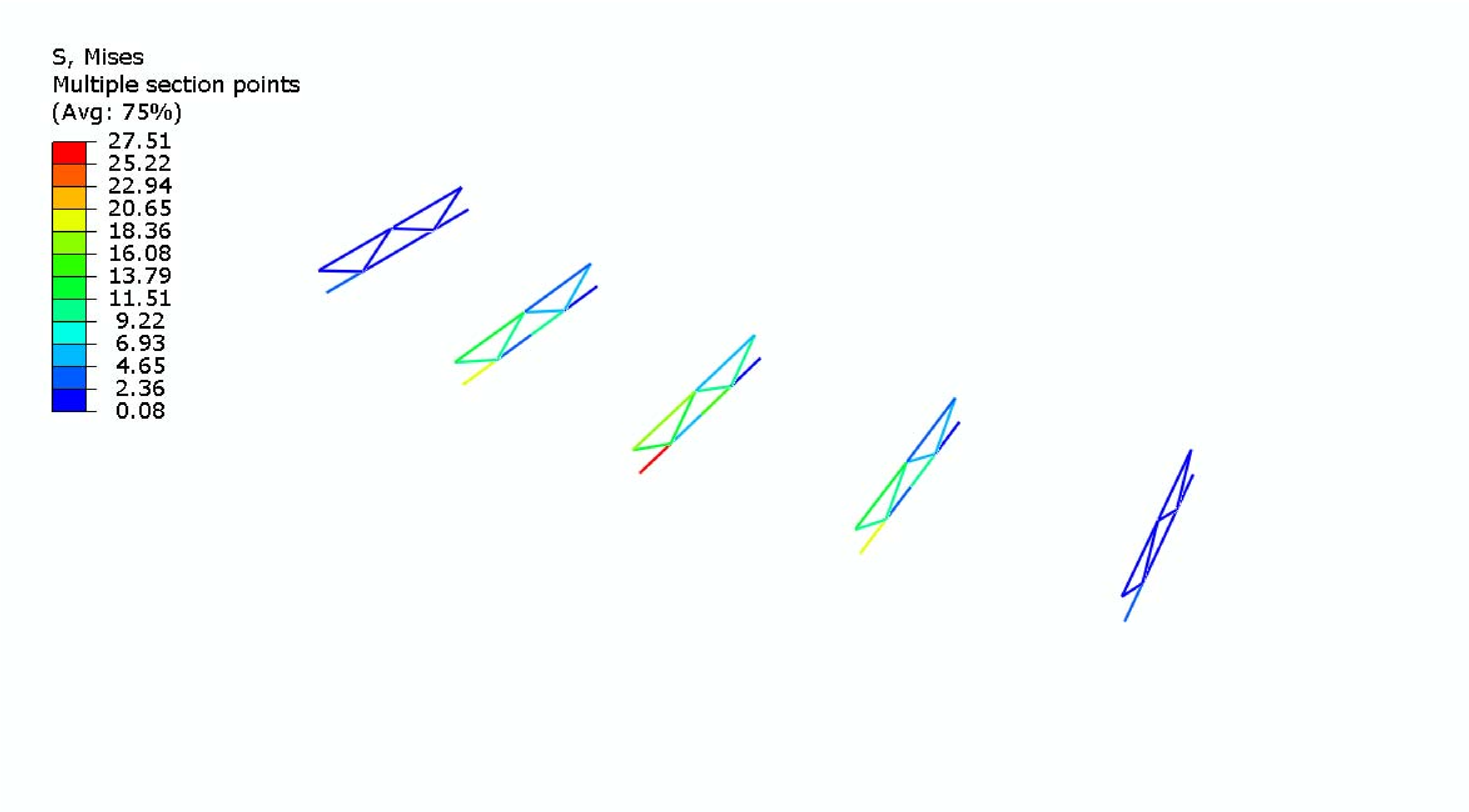


Figure A-4-23. Cross-frame stress contours under TDL, NLF detailing (cross-frame member areas = 3.49 in^2).

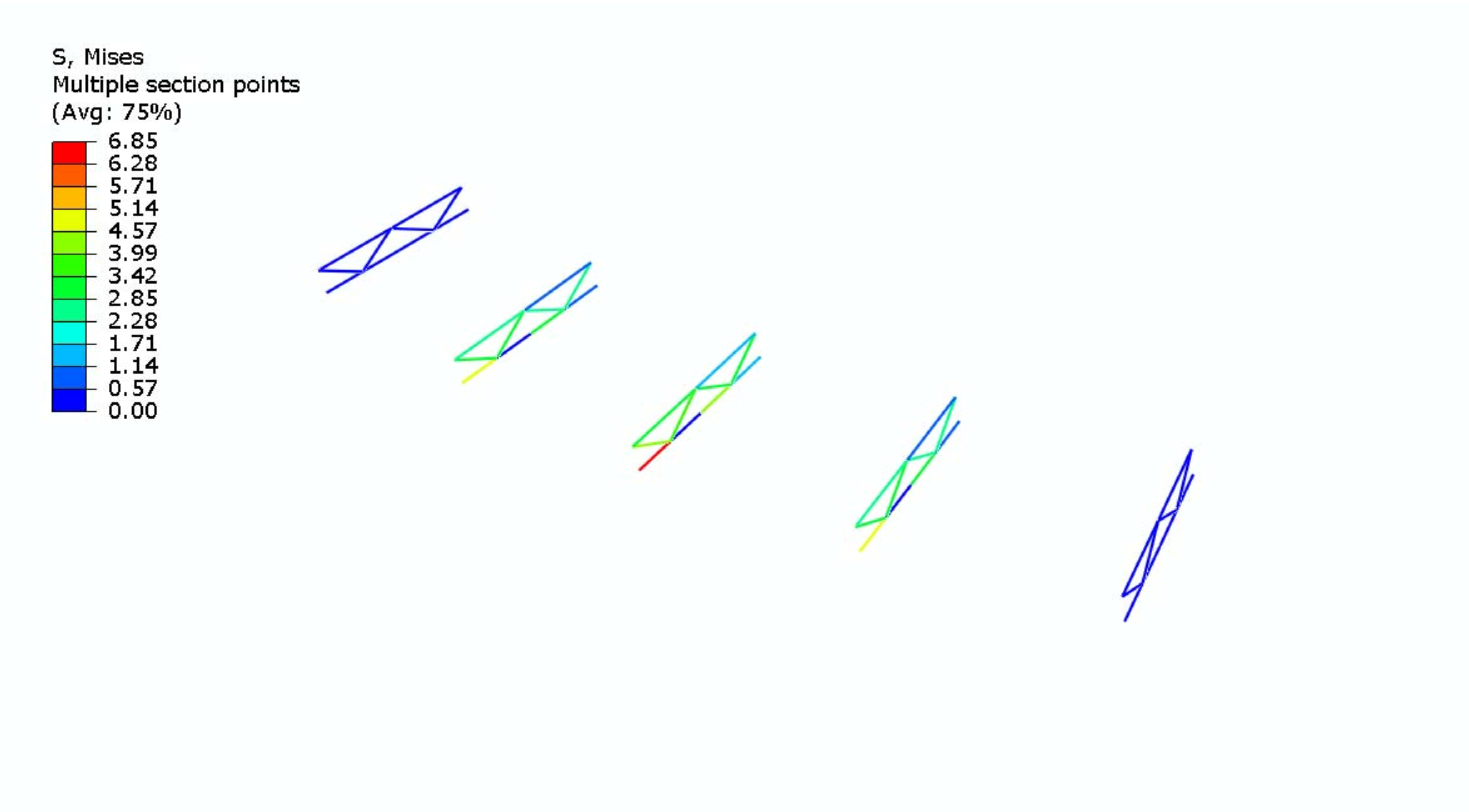


Figure A-4-24. **Cross-frame stress contours under SDL, SDLF detailing (cross-frame member areas = 3.49 in^2).**

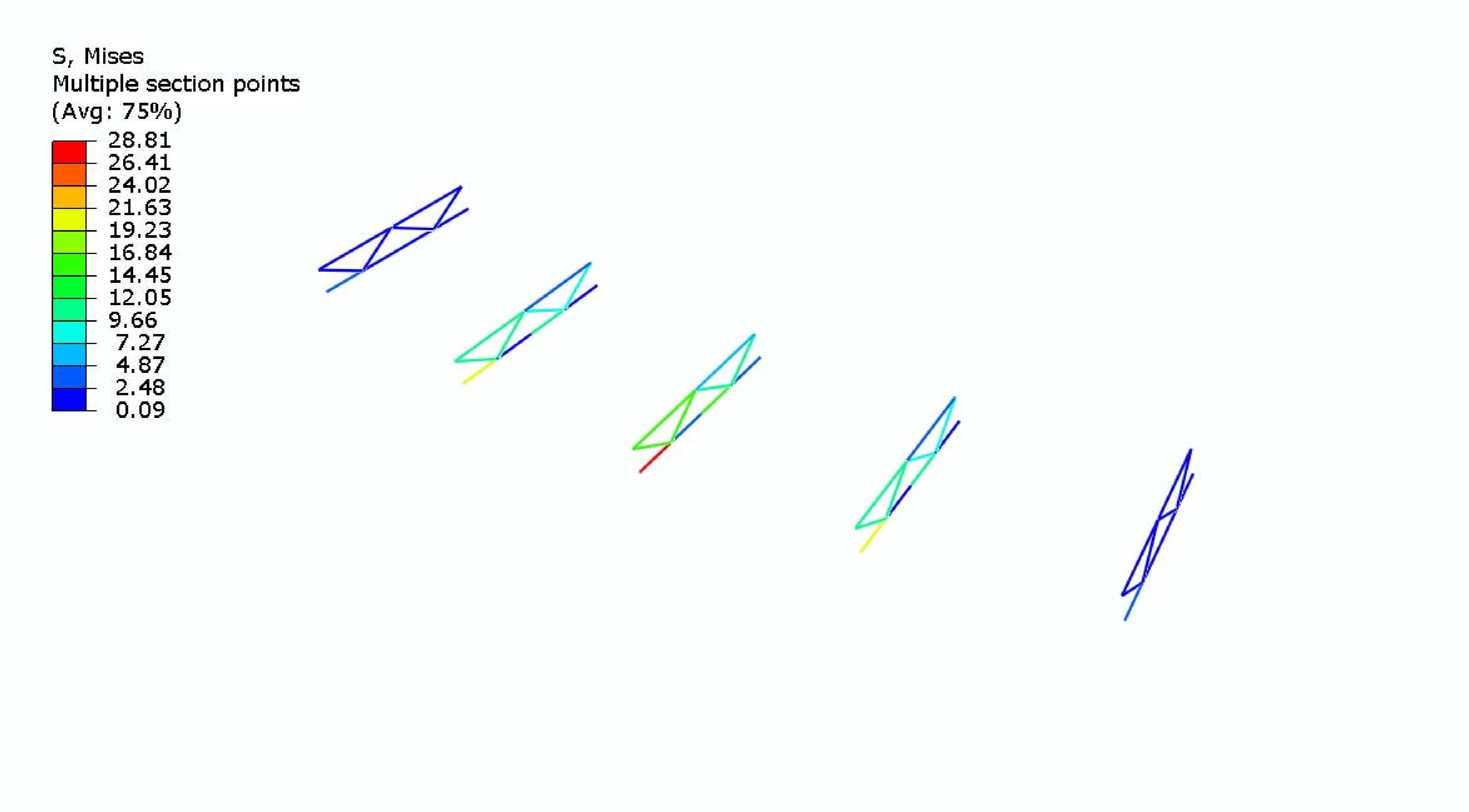


Figure A-4-25. Cross-frame stress contours under TDL, SDLF detailing (cross-frame member areas = 3.49 in^2).

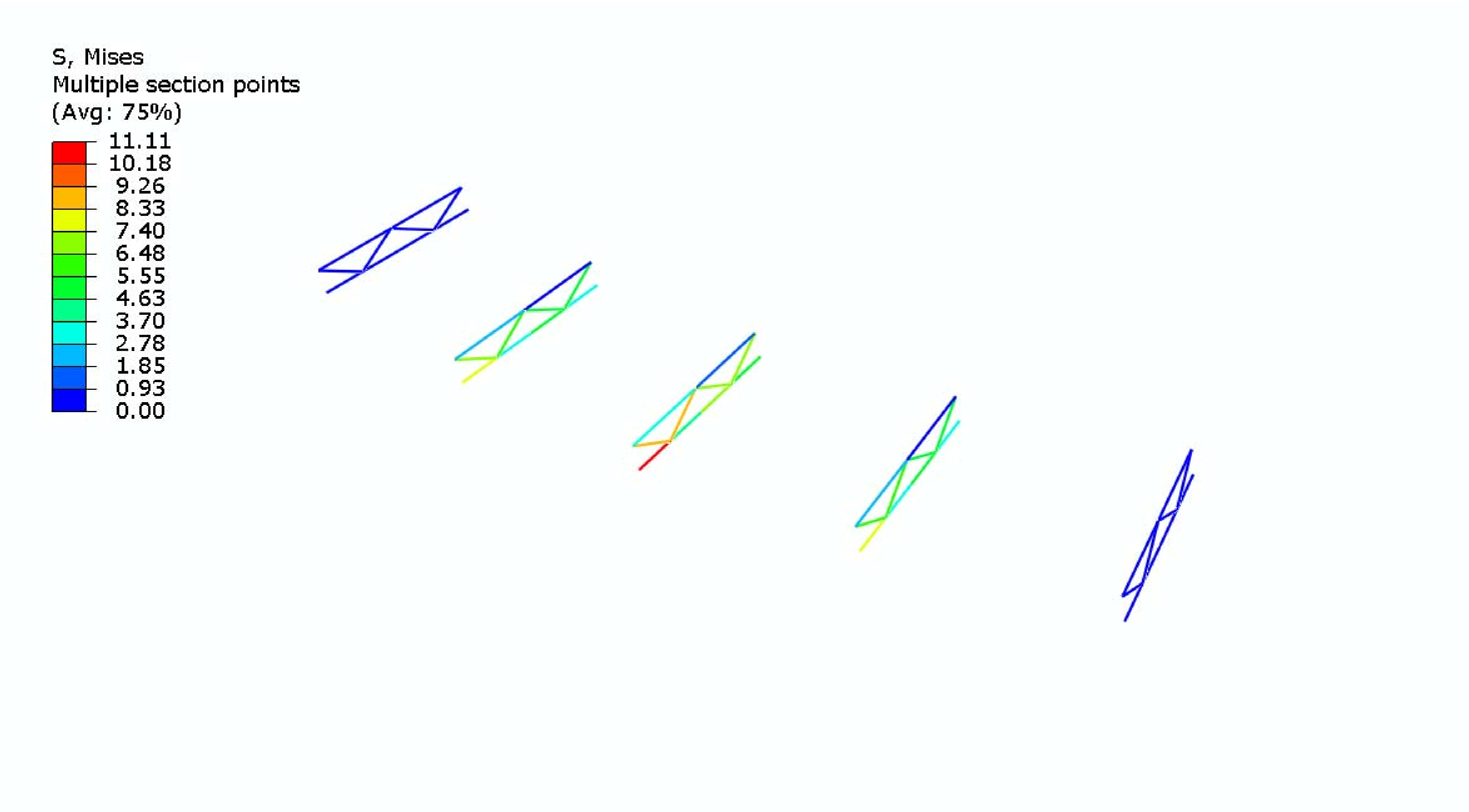


Figure A-4-26. **Cross-frame stress contours under SDL, TDLF detailing (cross-frame member areas = 3.49 in^2).**

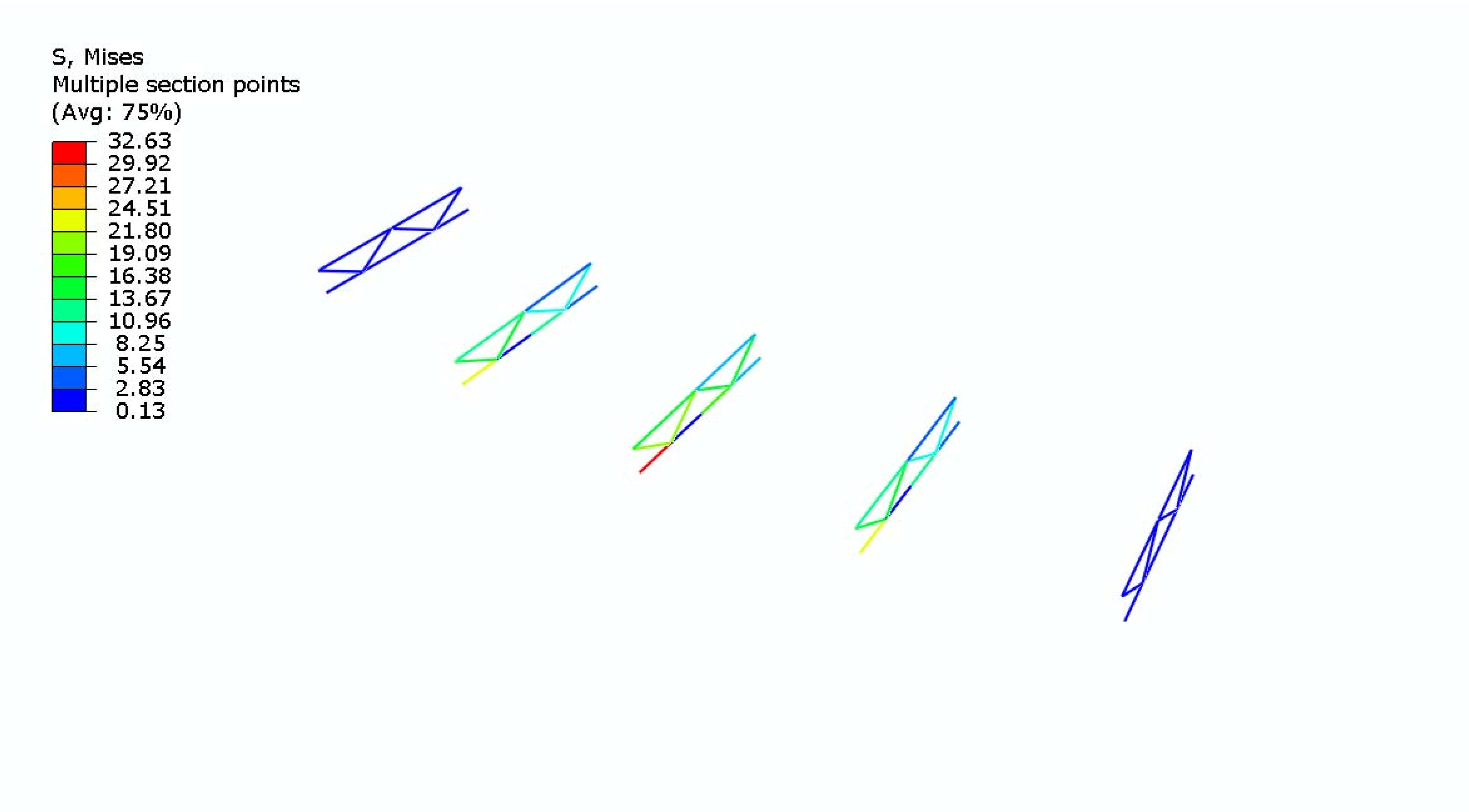


Figure A-4-27. **Cross-frame stress contours under TDL, TDLF detailing (cross-frame member areas = 3.49 in^2).**

Table A-4-1. Axial forces (kips) in cross-frame diagonals under SDL and TDL for different detailing methods.

		Load Type & CF Location			
CF	Detailing Method	SDL G1-G2	SDL G2-G3	TDL G1-G2	TDL G2-G3
1	NLF	1.1	0.5	6.0	1.5
	SDLF	1.1	0.4	5.9	1.4
	TDLF	1.0	0.3	5.9	1.1
2	NLF	6.3	4.9	35.5	24.1
	SDLF	10.5	8.3	39.6	27.4
	TDLF	22.7	18.2	51.8	37.1
3	NLF	8.4	6.6	46.9	33.9
	SDLF	14.3	11.4	52.4	38.6
	TDLF	31.4	25.3	69.3	51.8
4	NLF	6.3	4.9	35.6	24.0
	SDLF	10.5	8.3	39.7	27.3
	TDLF	22.6	18.4	51.8	37.1
5	NLF	1.2	0.4	6.4	1.1
	SDLF	1.1	0.4	6.3	1.1
	TDLF	0.6	0.4	5.8	1.2

Table A-4-2. Maximum axial forces (kips) in cross-frame bottom chord under SDL and TDL for different detailing methods.

		Load Type & CF Location			
CF	Detailing Method	SDL G1-G2	SDL G2-G3	TDL G1-G2	TDL G2-G3
1	NLF	1.7	0.5	9.8	2.9
	SDLF	1.5	0.4	9.6	2.7
	TDLF	1.0	0.2	9.1	2.2
2	NLF	13.8	7.7	71.5	36.2
	SDLF	17.4	10.4	74.9	38.7
	TDLF	28.1	18.3	84.8	46.2
3	NLF	18.9	10.6	96.0	50.0
	SDLF	23.9	14.4	100.5	53.6
	TDLF	38.8	25.5	113.9	63.8
4	NLF	13.8	7.6	71.6	36.0
	SDLF	17.4	10.4	74.9	38.6
	TDLF	28.0	18.6	84.8	46.2
5	NLF	1.7	0.4	9.8	2.2
	SDLF	1.5	0.3	9.6	2.1
	TDLF	1.0	0.5	9.1	2.3

Table A-4-3. Axial forces (kips) in cross-frame top chord under SDL and TDL for different detailing methods.

		Load Type & CF Location			
CF	**Detailing Method**	**SDL G1-G2**	**SDL G2-G3**	**TDL G1-G2**	**TDL G2-G3**
1	NLF	0.7	0.1	4.6	1.5
	SDLF	0.6	0.0	4.4	1.4
	TDLF	0.1	0.2	4.0	1.2
2	NLF	8.6	3.6	41.8	15.9
	SDLF	8.7	3.4	41.7	15.7
	TDLF	8.9	3.0	41.5	15.0
3	NLF	11.9	5.1	56.9	21.7
	SDLF	11.9	4.9	56.7	21.3
	TDLF	12.3	4.2	56.1	20.2
4	NLF	8.6	3.5	41.7	15.8
	SDLF	8.7	3.4	41.6	15.6
	TDLF	9.0	3.1	41.5	15.0
5	NLF	0.7	0.0	4.2	1.1
	SDLF	0.6	0.0	4.1	1.1
	TDLF	0.5	0.1	4.1	1.3

Table A-4-4. Vertical differential displacements (in) at cross-frames under SDL and TDL for different detailing methods.

		Loading Type & CF Location			
CF	Detailing Method	SDL G1-G2	SDL G2-G3	TDL G1-G2	TDL G2-G3
1	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
2	NLF	0.30	0.26	1.19	1.04
	SDLF	0.31	0.24	1.19	1.02
	TDLF	0.34	0.18	1.21	0.94
4	NLF	0.42	0.37	1.68	1.47
	SDLF	0.43	0.34	1.68	1.44
	TDLF	0.48	0.25	1.71	1.33
5	NLF	0.30	0.26	1.19	1.04
	SDLF	0.31	0.24	1.19	1.02
	TDLF	0.34	0.18	1.21	0.94
6	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00

Table A-4-5. Approximate horizontal differential displacements (in) at cross-frames under SDL and TDL for different detailing methods, assuming negligible cross-frame deformations.

		Load Type & CF Location			
CF	Detailing Method	SDL G1-G2	SDL G2-G3	TDL G1-G2	TDL G2-G3
1	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
2	NLF	0.10	0.08	0.39	0.34
	SDLF	0.10	0.08	0.39	0.33
	TDLF	0.11	0.06	0.39	0.30
3	NLF	0.14	0.12	0.54	0.48
	SDLF	0.14	0.11	0.54	0.47
	TDLF	0.16	0.08	0.55	0.43
4	NLF	0.10	0.08	0.39	0.34
	SDLF	0.10	0.08	0.39	0.33
	TDLF	0.11	0.06	0.39	0.30
5	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00

Table A-4-6. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	60.8	315.2
SDLF	60.8	315.2
TDLF	60.8	315.2

Table A-4-7. Individual support vertical reactions under SDL and TDL (kips).

		Load Type & Support Number			
Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	20.4	20.4	94.6	94.3
	SDLF	20.5	20.5	94.6	94.3
	TDLF	20.6	20.9	94.4	94.4
G2	NLF	7.7	7.8	41.0	41.5
	SDLF	7.5	7.5	40.8	41.3
	TDLF	7.2	6.7	40.6	40.5
G3	NLF	2.3	2.3	22.0	21.8
	SDLF	2.4	2.4	22.2	22.0
	TDLF	2.6	2.8	22.6	22.7

Table A-4-8. Individual support longitudinal reactions under SDL and TDL (kips).

		Load Type & Support Number			
Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.0	NA	0.0	NA
	SDLF	0.0	NA	0.0	NA
	TDLF	0.0	NA	0.0	NA
G2	NLF	0.0	NA	0.0	NA
	SDLF	0.0	NA	0.0	NA
	TDLF	0.0	NA	0.0	NA
G3	NLF	0.0	NA	0.0	NA
	SDLF	0.0	NA	0.0	NA
	TDLF	0.0	NA	0.0	NA

Table A-4-9. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number: SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G2	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G3	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0

Table A-4-10. Longitudinal displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number: SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.03	-0.09	0.12	-0.29
	SDLF	0.03	-0.08	0.12	-0.30
	TDLF	0.04	-0.04	0.12	-0.34
G2	NLF	0.00	-0.06	0.00	-0.17
	SDLF	0.00	-0.05	0.00	-0.18
	TDLF	0.00	0.00	0.00	-0.21
G3	NLF	-0.02	-0.04	-0.07	-0.09
	SDLF	-0.02	-0.02	-0.07	-0.10
	TDLF	-0.02	0.02	-0.07	-0.13

Table A-4-11. Transverse displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G2	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G3	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0

Appendix A-5. EISCR1 Detailed Results, Erection Fit-Up

This appendix presents the calculated results for the critical (maximum) external fit-up forces and the corresponding crane and permanent support reactions for the bridge EISCR1. The external fit-up forces are defined as the local forces that need to be developed at the top and bottom chord cross-frame connections to the latest girder that is being installed into the bridge. As discussed in Appendix A1, this is girder G2 for Stage 2 and this is girder G3 for Stage 3 on EISCR1. It is assumed that the cross-frames are first attached to the adjacent girder in the partially-completed bridge, and then the cross-frame connections are made successively to the "latest" girder. Since V-type cross-frames are used in EISCR1, it is assumed that the top-chord connection corresponding to the cross-frame diagonal is made first, and that this is followed by the connection to the bottom diagonal. The overall erection sequence is illustrated in Fig. A1-5 and Table A1-1 of Appendix A1.

The fit-up forces are calculated by analyzing the partially completed bridge structure with all of the components up to the sub-stage at which the connection under consideration is being made connected together and included in the model. Just before the subject connection is made, the force transferred by the connection is zero. Therefore, the calculated force that is transferred by the connection just after it is made is representative of the external loads that need to be applied to make the connection.

As noted in Appendix A1, the above fit-up forces are sensitive to the holding elevations of the holding and lifting cranes in curved radially-supported bridges. In addition, there are various nonlinear effects that impact the fit-up forces. Therefore, the crane holding elevations generally need to be varied relative to the base NL girder elevations to minimize the fit-up forces. It is desired to calculate the minimum fit-up force as a function of the crane holding elevations corresponding to the installation of each of the cross-frames, and then to determine the maximum value of the minimum cross-frame fit-up forces throughout the overall erection sequence.

Table A-5-1 lists the various holding elevations considered for the holding and lifting cranes for the erection of EISCR1, as well as the critical sub-stage in each of the main stages 2 and 3 of its erection sequence. Actually, a number of additional crane holding elevations were studied; however, only the ones shown in Table A-5-1 are presented to simplify the discussions. The reader may find it helpful to view Fig. A1-5 and Table A1-1 of Appendix A1 along with the presentations in this appendix in understanding the nature and calculation of the cross-frame fit-up forces for this bridge.

Sub-stage 3 is the critical one, requiring the largest fit-up forces for both of the main stages and for all of the crane holding elevations in EISCR1. One can observe from Fig. A1-5 and Table A1-1 of Appendix A1 that this sub-stage corresponds to the installation of the cross-frame at the mid-span of the bridge. This finding is certainly logical, since the largest differential displacements between the girders tend to occur at the mid-span in bridge EISCR1.

Generally, a separate version of Table A-5-1 could be shown for each of the cross-frame detailing methods. However, for EISCR1, the same sub-stage (either 2-3 or 3-3) is the critical one regardless of the cross-frame detailing method.

Table A-5-1. EISCR1 Erection Critical Sub-Stages

Holding Elevations	Stage	
	2	**3**
Holding Crane: NL Lifting Crane: NL	**2-3**	**3-3**
Holding Crane: SDL Lifting Crane: SDL	**2-3**	**3-3**
Holding Crane: NL Lifting Crane: NL + 40 % SDL Camber (upward)	**2-3**	**3-3**
Holding Crane: NL Lifting Crane: NL + 80 % SDL Camber (upward)	**2-3**	**3-3**
Holding Crane: NL Lifting Crane: NL – 40 % SDL Camber (downward)	**2-3**	**3-3**
Holding Crane: NL Lifting Crane: NL + 160 % SDL Camber (upward)	**2-3**	**3-3**

Generally, the critical sub-stage pertaining to the cross-frame fit-up forces can be identified visually by analyzing all of the sub-stages as shown in Fig. A1-5 and Table A1-1, which is handled automatically via a parametric analysis, and then viewing the cross-frame stress contours from each of the sub-stages. The critical sub-stage tends to be the one that exhibits the maximum cross-frame stress contours. Tables A-5-2 through A-5-4 show example contours of the cross-frame member stresses for Stage 2 of EISCR1 for NLF, SDLF and TDLF detailing respectively, once both the top and bottom chord connections are made for the cross-frame that is being installed at each sub-stage. The Mises stress contours are shown in these tables. Since all the cross-frame members except the bottom chord (where the "V" connection is made) are modeled by truss elements, the Mises stresses are the same as the absolute magnitude of the axial stresses in the truss elements. For the bottom chord, which is modeled by beam elements, the reported Mises stresses still correspond solely the axial stress P/A.

Tables A-5-2 through A-5-4 do not show the bridge girders to simplify the presentation. The cross-frames in these tables are being inserted between girders G1 and G2. The critical sub-stage is also generally identified by using the method of joints to resolve the member forces within the plane of the cross-frame into the connection forces transferred between the girder and the cross-frame at the cross-frame connection to the girder that is being installed. The out-of-plane forces developed at the cross-frames (i.e., the forces orthogonal to the plane of the cross-frames) are generally small and are neglected in determining the fit-up forces.

Table A-5-2. Cross-frame stress contours at Stage 2 with the cross-frames detailed NLF, with the hold elevations on the holding crane and the lifting crane set at the NL elevations, and with both the top and bottom chord cross-frame connections completed at the cross-frame that is being installed at each sub-stage.

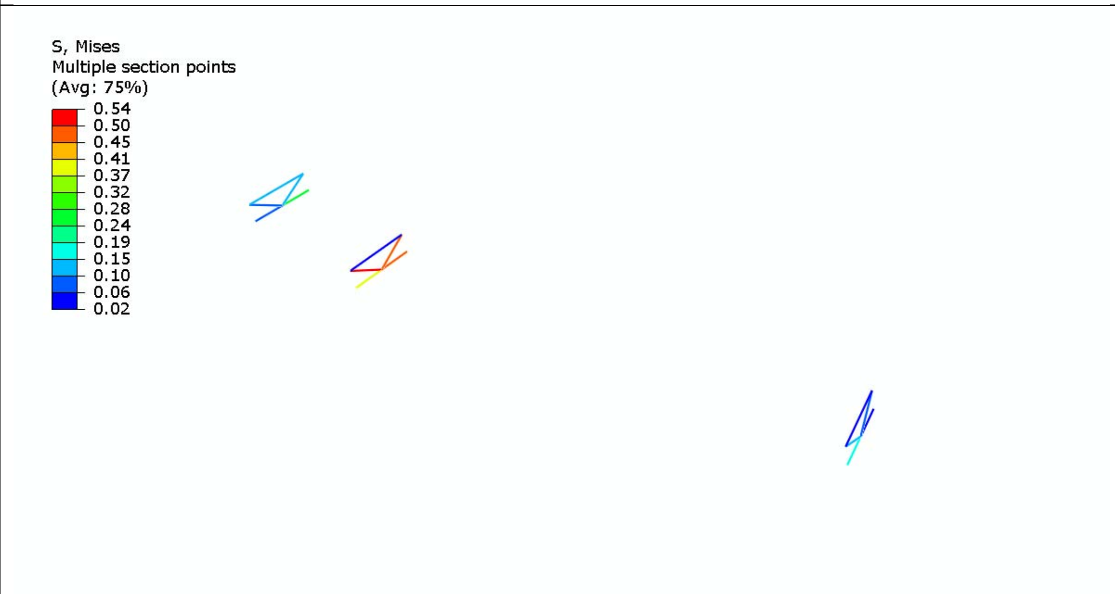
Sub-Stage	Cross-frame Mises stress contours (ksi)
1	
2	

Table A-5-2 (continued). Cross-frame stress contours at Stage 2 with the cross-frames detailed NLF, with the hold elevations on the holding crane and the lifting crane set at the NL elevations, and with both the top and bottom chord cross-frame connections completed at the cross-frame that is being installed at each sub-stage.

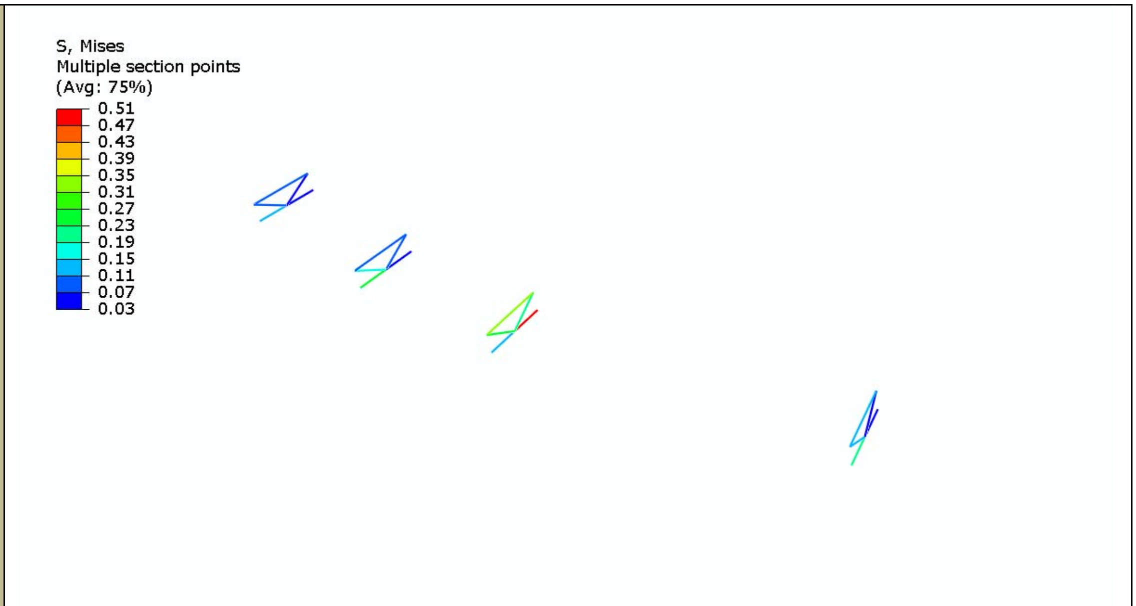
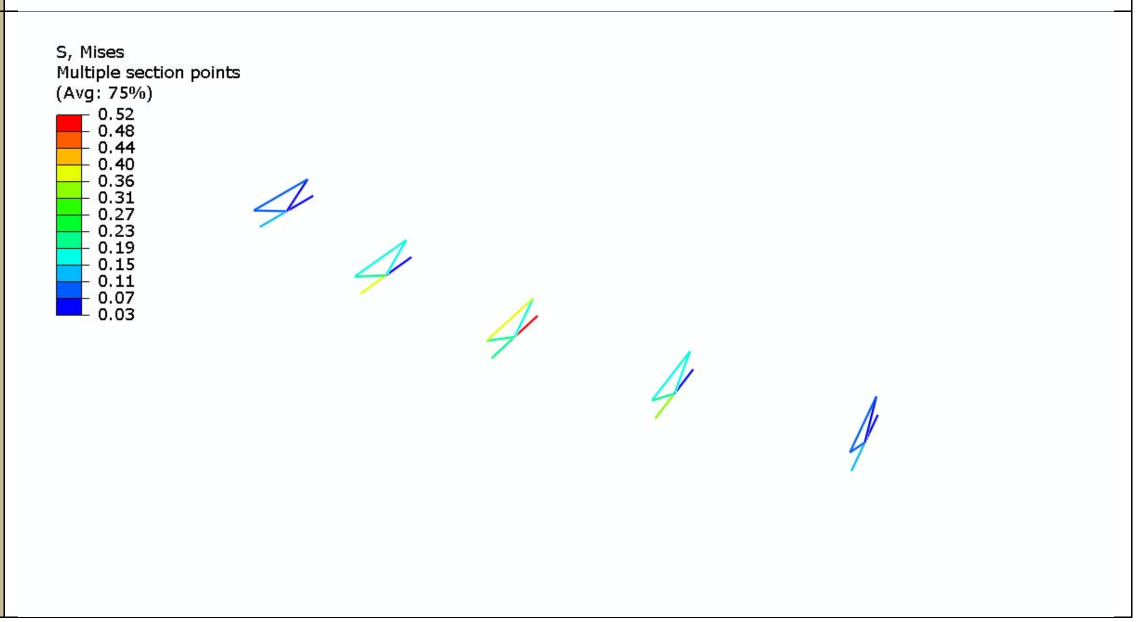
3	
4	

Table A-5-3. Cross-frame stress contours at Stage 2 with the cross-frames detailed SDLF, with the hold elevations on the holding crane and the lifting crane set at the NL elevations, and with both the top and bottom chord cross-frame connections completed at the cross-frame that is being installed at each sub-stage.

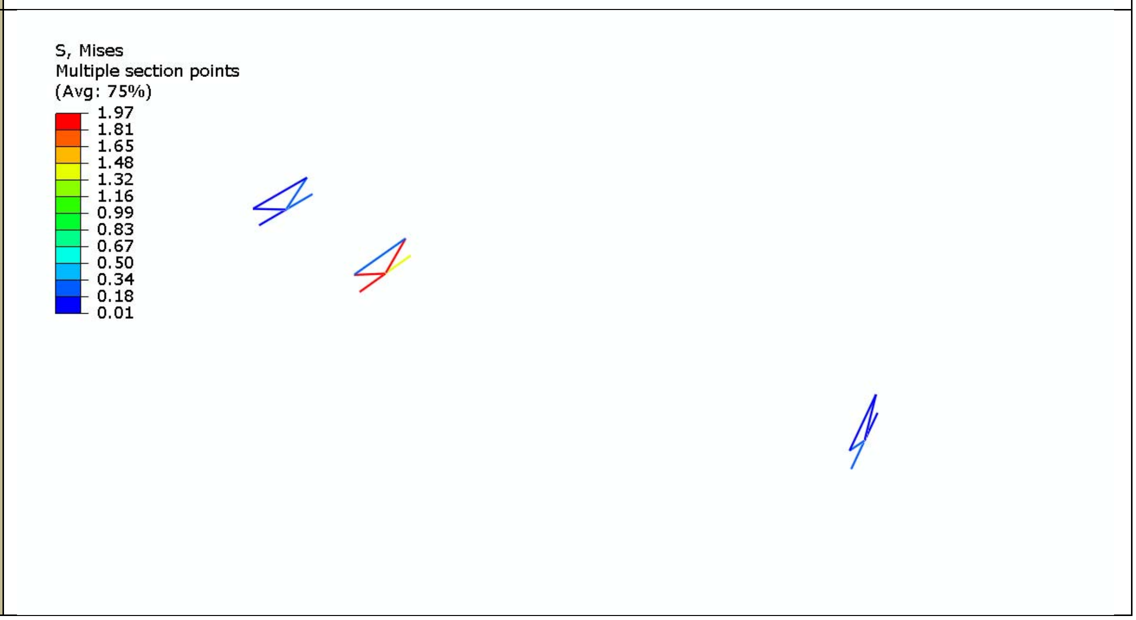
Sub-Stage	Cross-frame Mises stress contours (ksi)
1	
2	

Table A-5-3 (continued). Cross-frame stress contours at Stage 2 with the cross-frames detailed SDLF, with the hold elevations on the holding crane and the lifting crane set at the NL elevations, and with both the top and bottom chord cross-frame connections completed at the cross-frame that is being installed at each sub-stage.

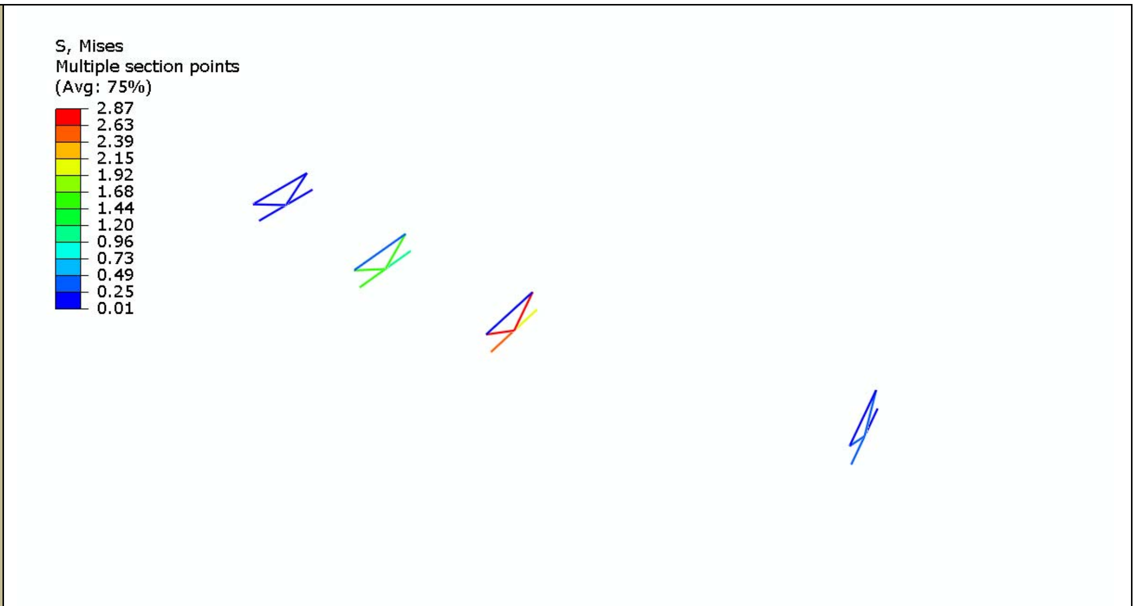
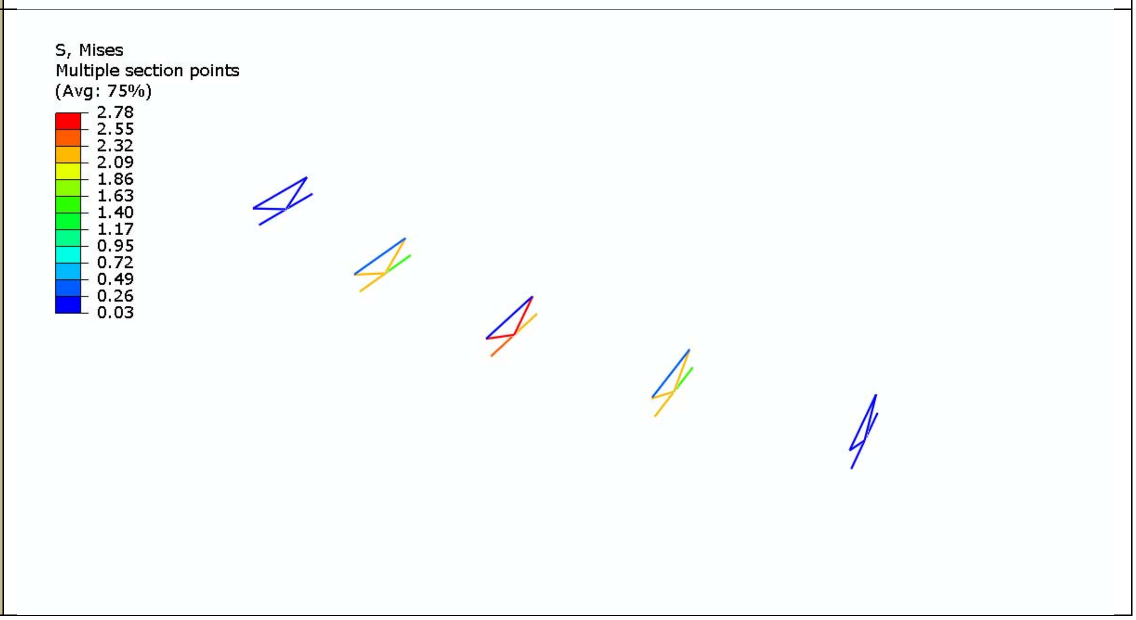
3	
4	

Table A-5-4. Cross-frame stress contours at Stage 2 with the cross-frames detailed TDLF, with the hold elevations on the holding crane and the lifting crane set at the NL elevations, and with both the top and bottom chord cross-frame connections completed at the cross-frame that is being installed at each sub-stage.

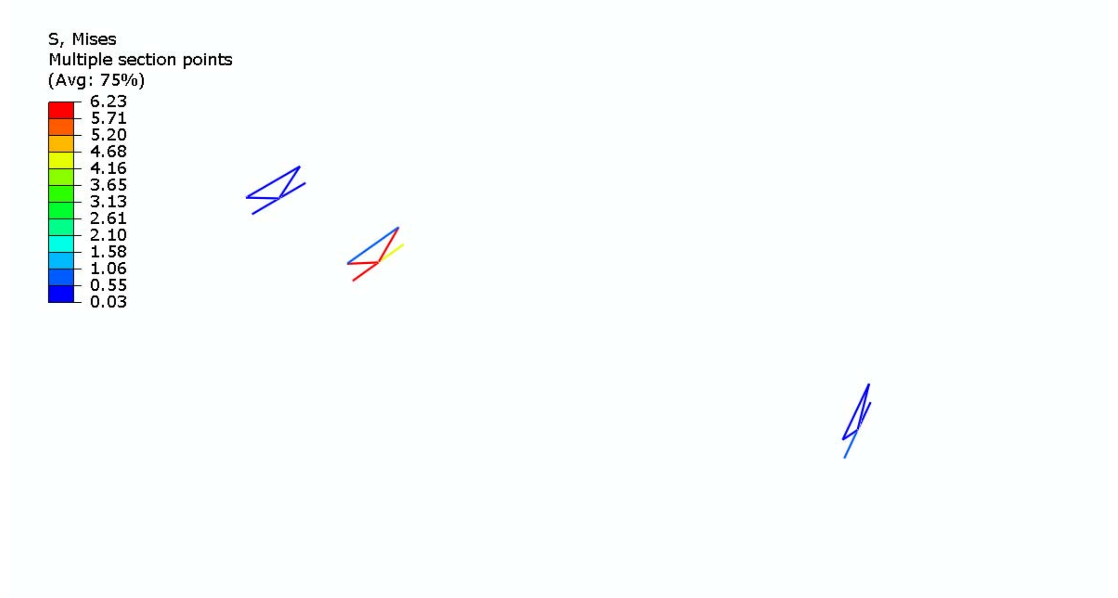
Sub-Stage	TDLF
1	
2	

Table A-5-4 (continued). Cross-frame stress contours at Stage 2 with the cross-frames detailed TDLF, with the hold elevations on the holding crane and the lifting crane set at the NL elevations, and with both the top and bottom chord cross-frame connections completed at the cross-frame that is being installed at each sub-stage.

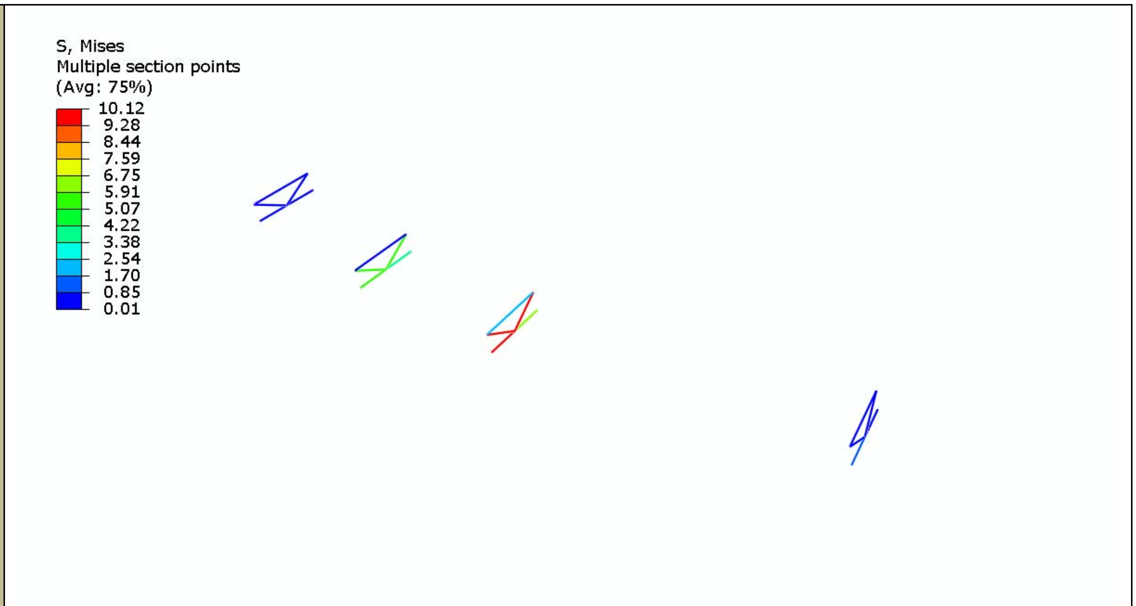
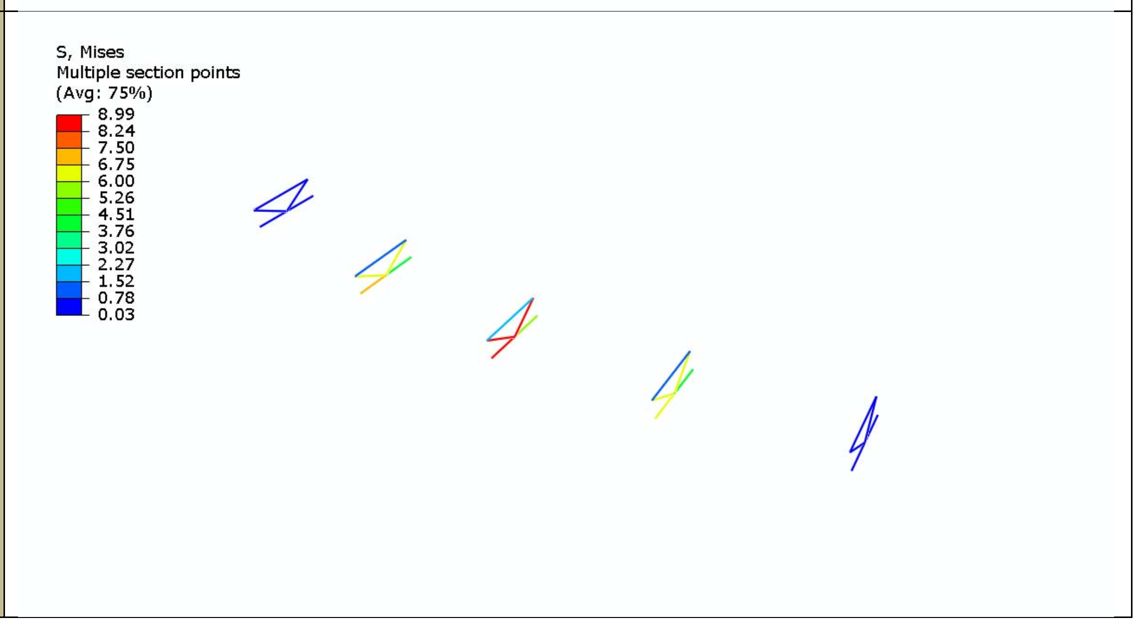
3	
4	

Table A-5-5 shows the vertical and horizontal components of the calculated fit-up forces for the critical sub-stage 3 for each of the cross-frame detailing methods and each of the most important combinations of holding and lifting crane holding elevations considered in this work. Two separate analyses are conducted for each of the sub-stages, detailing methods and combinations of holding elevations:

A. The cross-frame under consideration is connected at its bottom and top the “previous” girder that has been installed into the bridge, but it is connected just at the top chord at the “latest” girder that is being installed into the bridge. This allows for the calculation of the external fit-up force at the top chord connection of the cross-frame.

B. The cross-frame under consideration is connected to the adjacent girders at all four of its corners. This allows for the calculation of the external fit-up force at the bottom chord connection of the cross-frame, which is assumed as the second connection that is made to the “latest” girder being installed for EISCR1.

The sub-stages are further designated as 2-3A, 2-3B, 3-3A and 3-3B in Table A-5-5 to distinguish between the forces for each of the sub-stages of the connection of the critical cross-frame to the girders. The forces labeled as V1 and H1 in the table are the forces in the first connection between the cross-frame and the “latest” girder at the top chord of the critical cross-frame. The forces labeled as V2 and H2 are the forces in the second connection between the cross-frame and the “latest” girder at the bottom chord of the critical cross-frame. It should be noted that the cells marked as “NA” in the table for the sub-stages 2-3A and 3-3A correspond to the state where the second connection has not yet been made. Therefore, the forces V2 and H2 are in fact zero at this state or sub-stage. Furthermore, it should be noted that the forces V1 and H1 for sub-stages 2-3B and 3-3B are strictly *not* actual external fit-up forces. For these sub-stages, V1 and H1 are simply the internal connection forces developed at the top chord of the cross-frame when the bottom chord connection is made.

The forces shown in Table A-5-5 are the forces applied from the cross-frame to the girder that is being installed. Therefore, if the vertical force is positive, the cross-frame has to push up on the girder to make the connection. Hence, if the lifting crane elevation is raised in this case, the vertical connection force will tend to be reduced. Conversely, if the vertical force is negative, the cross-frame has to push down on the girder to make the connection. Hence, if the lifting crane elevation is lowered, the vertical connection force will tend to be reduced in this case.

Table A-5-6 parallels Table A-5-5, but shows just the single vector force resultants of V1 and H1, and V2 and H2, at the cross-frame connections to the girder that is being installed into the bridge. These resultants are designated as F1 and F2. For each row in Table A-5-6, corresponding to a given cross-frame detailing method and a particular critical sub-stage, it is assumed that the crane operator(s) would vary the crane holding elevations to minimize the vertical component of the fit-up force (shown as V1 and V2 in Table A-5-5). This would be achieved in the field during the erection essentially by the crane operator following the directions of the iron workers to raise or lower the holding points to aid them in aligning the holes for the connection of the cross-frame to the “latest” girder that is being installed. The resulting minimum fit-up force resultants F1 and F2 for each row of Table A-5-6 are listed toward the right-hand side of the table. For instance, in the first row, corresponding to Sub-stage 2-3A and NLF detailing, the minimum fit-up force is obtained by positioning the holding and lifting crane elevations both at the NL elevation of the girders. This results in a minimum fit-up force F1 of 0.4 kips. However, for Sub-stage 2-3A and SDLF detailing, the minimum fit-up force F1 (equal to 1.1 kips) is obtained by positioning the holding crane at the NL elevation, but raising the lifting crane hold location by 160 % of the SDL camber. As indicated by the comments in the right-most column of Table A-5-6, girder G2 is lifted off of both its supports at this sub-stage. In addition, one can observe from Table A-5-5 that V1 has become slightly negative and the fit-up force is dominated by the horizontal components H1 when the lifting crane is raised to this elevation. Therefore, F1 = 1.1 kips is a reasonable estimate of the minimum possible fit-up force for SDLF detailing at this critical sub-stage.

It should be noted that the elevation of the holding points of the lifting crane are varied in the above by varying the elevation at the top of the lifting crane – spreader beam assembly shown in Table A1-1. This in effect varies the average elevation of the hold points at the ends of the spreader beam. The actual elevations of these hold points are not equal to one another; as discussed in Appendix A1, these elevations "adjust" to the deflections of the bridge system such that equilibrium is maintained on the lifting crane – spreader beam assembly.

For Sub-stage 2-3A and TDLF detailing, the minimum fit-up force resultant shown in Table A-5-6 is again obtained when the holding crane hold point is located at the NL girder elevation on G1 and the average lifting crane hold elevations are located at 160 % of the SDL Camber above the NL girder elevation on G3. Actually, for this case, it is possible that the fit-up force resultant can be reduced further by increasing the average elevation of the lifting crane hold points by an additional amount. By inspecting Table A-5-5, one can ascertain that the force V1 is still positive, equal to 7.3 kips, and that this force still dominates the connection force resultant at Sub-stage 2-3A, for TDLF detailing. However, Girder G2 is already lifted substantially off of its supports by this operation, and the subsequent evaluations of F2 indicate significantly larger fit-up forces for TDLF detailing than the resultant for F1 = 7.7 kips shown in Table A-5-6 for Sub-stage 2-3A and TDLF detailing.

The largest of the minimum fit-up forces F2, for SDLF detailing, is obtained as 5.5 kips in Sub-Stage 2-3B. For TDLF detailing, the largest of the minimum fit-up forces F2 is obtained as 17.7 kips in Sub-Stage 3-3B. In both cases, these minimum forces are obtained by lowering both the holding crane as well as the lifting crane to the girder SDL elevations. The corresponding required fit-up forces at the other critical sub-stages 3-3B and 2-3B for these cases are only slightly smaller. Also, these force resultants are dominated by the horizontal components H2, and therefore, the overall fit-up force resultant is effectively minimized in terms of the holding crane elevations in these cases.

Table A-5-5. EISCR1 critical fit-up forces (kips) applied to the girder being installed

Sub-Stage	Detailing Method	Holding Elevations															
		Holding Crane: NL Lifting Crane: NL				Holding Crane: SDL Lifting Crane: SDL				Holding Crane: NL Lifting Crane: NL + 40 % SDL Camber (upward)				Holding Crane: NL Lifting Crane: NL + 80 % SDL Camber (upward)			
		V1	H1	V2	H2	V1	H1	V2	H2	V1	H1	V2	H2	V1	H1	V2	H2
2-3A	NLF	-0.2	0.4	NA	NA	6.5	0.3	NA	NA	-0.7	0.5	NA	NA	-1.3	0.5	NA	NA
	SDLF	2.3	0.9	NA	NA	8.5	0.7	NA	NA	1.7	0.9	NA	NA	1.1	1.0	NA	NA
	TDLF	9.8	2.7	NA	NA	14.5	1.9	NA	NA	9.1	2.4	NA	NA	8.5	2.4	NA	NA
2-3B	NLF	0.4	1.7	-0.0	-1.8	6.8	1.6	-0.1	-1.7	-0.2	2	-0.0	-2	-0.7	2.3	-0.0	-2.3
	SDLF	5.2	7.2	1.2	-7.3	10.5	5.3	1.1	-5.4	4.1	5.9	1.2	-6	3.6	6.2	1.2	-6.2
	TDLF	18.5	21.8	5.0	-21.7	21.8	16.7	5.0	-16.6	18.5	21.8	5	-21.7	17.0	19.2	5.0	-19.1
3-3A	NLF	-2.8	0.3	NA	NA	4.9	-0.1	NA	NA	-3.3	0.3	NA	NA	-3.5	0.3	NA	NA
	SDLF	0.3	0.6	NA	NA	6.6	0.4	NA	NA	-0.2	0.6	NA	NA	-0.8	0.5	NA	NA
	TDLF	9.9	1.5	NA	NA	10.3	1.4	NA	NA	9.2	1.5	NA	NA	8.6	1.4	NA	NA
3-3B	NLF	-2.4	2.3	-0.0	-2.3	4.7	-0.2	-0.1	0.2	-3	1.9	-0.0	-1.9	-3.3	1.8	0.1	-1.7
	SDLF	2.3	6.6	1.0	-6.6	8.2	4.7	1.0	-4.8	1.6	6.0	1.1	-6.0	0.9	5.6	1.1	-5.6
	TDLF	15	18.7	4.2	-18.6	15.9	17.3	4.2	-17.2	15	18.7	4.2	-18.6	15	18.7	4.2	-18.6

Table A-5-5 (Continued). EISCR1 critical fit-up forces (kips) applied to the girder being installed

Sub-Stage	Detailing Method	Holding Elevations							
		Holding Crane: NL Lifting Crane: NL - 40 % SDL Camber (downward)				Holding Crane: NL Lifting Crane: NL + 160 % SDL Camber (upward)			
		V1	H1	V2	H2	V1	H1	V2	H2
2-3A	NLF	0.6	0.7	NA	NA	-2.5	0.6	NA	NA
	SDLF	3.1	1.3	NA	NA	-0.1	1.1	NA	NA
	TDLF	10.2	2.9	NA	NA	7.3	2.5	NA	NA
2-3B	NLF	1.9	4.2	-0.1	-4.3	-1.7	2.8	0.0	-2.8
	SDLF	6.8	9.8	1.1	-9.9	2.6	6.7	1.2	-6.8
	TDLF	18.5	21.8	5.0	-21.7	15.7	19.0	5.1	-18.9
3-3A	NLF	-2.3	0.4	NA	NA	-3.7	0.3	NA	NA
	SDLF	0.9	0.7	NA	NA	-1.2	0.5	NA	NA
	TDLF	9.9	1.5	NA	NA	7.4	1.3	NA	NA
3-3B	NLF	-1.8	2.7	0.0	-2.7	-3.5	1.9	0.1	-1.9
	SDLF	3.0	7.1	1.1	-7.1	0.1	5.2	1.1	-5.1
	TDLF	15.0	18.7	4.2	-18.6	13.8	17.8	4.2	-17.7

Table A-5-6. EISCR1 critical fit-up force resultants on the girder being installed

Stage	Detailing Method	Holding Elevations: Holding Crane: NL Lifting Crane: NL		Holding Crane: SDL Lifting Crane: SDL		Holding Crane: NL Lifting Crane: NL + 40 % SDL Camber (upward)		Holding Crane: NL Lifting Crane: NL + 80 % SDL Camber (upward)		Holding Crane: NL Lifting Crane: NL - 40 % SDL Camber (downward)		Holding Crane: NL Lifting Crane: NL + 160 % SDL Camber (upward)		Minimum Fit-Up Forces as a Function of the Crane Holding Elevations		Comments on Configuration Pertaining to the Minimum Fit-Up Force
		F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	
2-3A	NLF	0.4	NA	6.5	NA	0.9	NA	1.4	NA	0.9	NA	2.6	NA	0.4	NA	Lift-off at G2 supports
	SDLF	2.5	NA	8.5	NA	1.9	NA	1.5	NA	3.4	NA	1.1	NA	1.1	NA	Lift-off at G2 supports
	TDLF	10.2	NA	14.6	NA	9.4	NA	8.8	NA	10.6	NA	7.7	NA	7.7	NA	Lift-off at G2 supports
2-3B	NLF	1.7	1.8	7.0	1.7	2.0	2.0	2.4	2.3	4.6	4.3	3.3	2.8	NA	1.7	Slack cables on lifting crane (G2)
	SDLF	8.9	7.4	11.8	5.5	7.2	6.1	7.2	6.3	11.9	10.0	7.2	6.9	NA	5.5	Slack cables on lifting crane (G2)
	TDLF	28.6	22.3	27.5	17.3	28.6	22.3	25.6	19.7	28.6	22.3	24.6	19.6	NA	17.3	Slack cables on lifting crane (G2)
3-3A	NLF	2.8	NA	4.9	NA	3.3	NA	3.5	NA	2.3	NA	3.7	NA	2.3	NA	Lift-off at G3 supports
	SDLF	0.7	NA	6.6	NA	0.6	NA	0.9	NA	1.1	NA	1.3	NA	0.6	NA	Lift-off at G3 supports
	TDLF	10.0	NA	10.4	NA	9.3	NA	8.7	NA	10.0	NA	7.5	NA	7.5	NA	Slack cables on lifting crane (G3)
3-3B	NLF	3.3	2.3	4.7	0.2	3.6	1.9	3.8	1.7	3.2	2.7	4.0	1.9	NA	0.2	No slack cables or lift-off
	SDLF	7.0	6.7	9.5	4.9	6.2	6.1	5.7	5.7	7.7	7.2	5.2	5.2	NA	4.9	Slack cables on lifting crane (G3) and on holding crane (G1)
	TDLF	24.0	19.1	23.5	17.7	24.0	19.1	24.0	19.1	24.0	19.1	22.5	18.2	NA	17.7	

The total overall maximums of the above minimum fit-up force resultants, as a function of the crane holding elevations are summarized in Table A-5-7. One can observe that the largest of these fit-up forces is 2.3 kips for NLF detailing, but is roughly doubled to 5.5 kips for SDLF detailing and is increased by nearly 8x to 17.7 kips for TDLF detailing.

Table A-5-7. EISCR1 maximums of the minimum fit-up force resultants (kips) as a function of the crane position

Detailing Method	F1	F2	F_{max}
NLF	2.3	1.7	2.3
SDLF	1.1	5.5	5.5
TDLF	7.7	17.7	17.7

Tables A-5-8 and A-5-9 show the vertical reactions at the permanent supports as well as at the lifting and holding cranes in the above solutions. The different supports are numbered 1 through 5 along each of the girders as applicable. For Girder G1, there are only three supports. For this girder, the end bearing supports are numbered 1 and 3 and the holding crane support is numbered 2. In addition, the holding crane reaction is highlighted in red. For Girder G2 at Sub-stage 2-3B (see Table A-5-8), the end bearing supports are numbered 1 and 5 and each of the individual lifting crane supports are numbered 2 and 4. In addition, the total lifting crane reaction is numbered 3 and is highlighted in yellow. The reactions 2 and 4 sum to give the total lifting crane reaction 3.

For Sub-stages 3-3A and 3-3B (Table A-5-9), the supports are the same as in Sub-stages 2-3A and 2-3B for Girder G1. However, the lifting crane is on Girder G3 during these sub-stages, and hence five reactions are shown on G3 as described above. Furthermore, for these sub-stages, Girder G2 is supported only by its end bearings. Therefore, only two reactions are shown in Girder G2 for these sub-stages.

Tables A-5-8 and A-5-9 provide the specific data indicating when uplift has occurred at any of the permanent supports or the cables have gone slack on either the lifting crane or the holding crane, as documented in the right-most comments column of Table A-5-6. It should be noted that since EISCR1 is a relatively small bridge, none of the total crane reactions are excessive in Tables A-5-8 and A-5-9. For some of the larger bridges to be studied in the NCHRP 20-07/Task 355 research, this may not always be the case.

Table A-5-10 shows the total vertical reactions for each sub-stage of the EISCR1 construction. As noted previously in Appendix A2, these reactions are one useful check of the correctness of the various calculations.

Table A-5-8. EISCR1 Stage 2 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Girder	Detailing Method	Holding Elevations																				
			Holding Crane: NL Lifting Crane: NL					Holding Crane: SDL Lifting Crane: SDL					Holding Crane: NL Lifting Crane: NL + 40 % SDL Camber (upward)					Holding Crane: NL Lifting Crane: NL + 80 % SDL Camber (upward)				
			Support Number					Support Number					Support Number					Support Number				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2-3A	G1	NLF	5.7	16.9	6.0			16.1	7.7	16.2			4.8	17.8	5.1			3.9	18.7	4.2		
		SDLF	8.0	14.5	8.3			17.7	5.6	17.9			7.1	15.4	7.4			6.2	16.3	6.5		
		TDLF	15.4	7.8	15.6			22.3	0.0	22.4			14.1	8.3	14.3			13.2	9.2	13.4		
	G2	NLF	0.0	8.4	16.7	8.4	0.0	2.6	0.0	0.0	0.0	2.7	0.0	8.8	17.6	8.8	0.0	0.0	9.3	18.5	9.3	0.0
		SDLF	0.0	7.2	14.4	7.2	0.0	2.0	0.0	0.0	0.0	2.1	0.0	7.7	15.4	7.7	0.0	0.0	8.1	16.2	8.1	0.0
		TDLF	1.6	1.6	3.1	1.6	1.7	0.2	0.0	0.0	0.0	0.4	0.0	4.3	8.5	4.3	0.1	0.0	4.7	9.5	4.7	0.0
2-3B	G1	NLF	5.5	17.1	5.8			15.7	8.1	15.9			4.6	18.0	4.9			3.7	19.0	4.0		
		SDLF	7.9	15.5	8.1			17.1	6.5	17.2			6.7	15.9	7.0			5.8	16.8	6.1		
		TDLF	13.5	10.9	13.7			21.1	1.5	21.2			13.5	10.9	13.7			12.2	10.6	12.4		
	G2	NLF	0.0	8.5	16.9	8.5	0.0	2.8	0.0	0.0	0.0	2.8	0.0	8.9	17.9	8.9	0.0	0.0	9.4	18.8	9.4	0.0
		SDLF	1.6	5.4	10.7	5.3	1.6	2.3	0.0	0.0	0.0	2.3	0.0	7.9	15.8	7.9	0.0	0.0	8.4	16.7	8.4	0.0
		TDLF	3.6	0.0	0.0	0.0	3.7	0.7	0.0	0.0	0.0	0.8	3.6	0.0	0.0	0.0	3.7	0.7	4.3	8.5	4.3	0.8

Table A-5-8 (Continued). EISCR1 Stage 2 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Girder	Detailing Method	Holding Elevations									
			Holding Crane: NL Lifting Crane: NL - 40 % SDL Camber (downward)					Holding Crane: NL Lifting Crane: NL + 160 % SDL Camber (upward)				
			Support Number					Support Number				
			1	2	3	4	5	1	2	3	4	5
2-3A	G1	NLF	7.0	16.4	7.2			2.1	20.5	2.4		
		SDLF	9.4	14.2	9.7			4.4	18.1	4.7		
		TDLF	16.1	7.7	16.2			11.4	11.0	11.7		
	G2	NLF	1.5	5.8	11.7	5.8	1.6	0.0	10.1	20.3	10.1	0.0
		SDLF	2.1	3.9	7.8	3.9	2.1	0.0	9.0	18.0	9.0	0.0
		TDLF	2.6	0.0	0.0	0.0	2.7	0.0	5.6	11.2	5.6	0.0
2-3B	G1	NLF	6.8	17.2	7.1			1.8	20.9	2.1		
		SDLF	9.2	15.8	9.4			3.9	18.7	4.2		
		TDLF	13.5	10.9	13.7			10.3	12.2	10.5		
	G2	NLF	2.8	4.3	8.6	4.3	2.8	0.0	10.3	20.6	10.3	0.0
		SDLF	4.4	1.1	2.1	1.1	4.5	0.0	9.3	18.5	9.3	0.0
		TDLF	3.6	0.0	0.0	0.0	3.7	0.0	6.2	12.4	6.2	0.0

Table A-5-9. EISCR1 Stage 2 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Girder	Detailing Method	Holding Elevations																			
			Holding Crane: NL Lifting Crane: NL					Holding Crane: SDL Lifting Crane: SDL					Holding Crane: NL Lifting Crane: NL + 40 % SDL Camber (upward)					Holding Crane: NL Lifting Crane: NL + 80 % SDL Camber (upward)				
			Support Number					Support Number					Support Number					Support Number				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
3-3A	G1	NLF	8.0	20.7	8.1			21.1	0.2	20.0			8.3	21.2	8.4			8.1	21.5	8.3		
		SDLF	10.1	16.1	10.2			21.0	0.0	20.0			10.5	16.6	10.6			10.8	17.0	10.9		
		TDLF	18.9	2.2	18.7			20.4	0.0	20.1			18.6	2.6	18.5			18.3	3.2	18.2		
	G2	NLF	1.8	2.0				5.3	7.6				0.1	0.3				0.0	0.2			
		SDLF	4.3	4.5				6.1	8.1				2.6	2.8				0.9	1.1			
		TDLF	7.6	8.0				7.3	8.1				7.1	7.5				6.7	7.0			
	G3	NLF	0.0	10.0	19.9	10.0	0.0	1.9	1.8	3.6	1.8	0.9	0.0	11.0	22.1	11.1	0.0	0.0	11.2	22.4	11.2	0.0
		SDLF	0.0	7.6	15.2	7.6	0.0	2.6	0.4	0.9	0.4	1.7	0.0	8.7	17.4	8.7	0.0	0.0	9.8	19.6	9.8	0.0
		TDLF	2.5	0.0	0.0	0.0	2.4	2.4	0.0	0.0	0.0	2.1	1.8	1.3	2.5	1.3	1.7	1.0	2.5	5.1	2.5	1.0
3-3B	G1	NLF	7.4	21.1	7.5			21.1	0.2	20.0			7.9	21.5	8.0			7.9	21.8	8.0		
		SDLF	9.5	16.8	9.9			21.2	0.0	20.2			9.4	17.2	9.7			9.9	17.6	10.0		
		TDLF	17.7	5.0	17.5			21.3	0.0	20.6			17.7	5.1	17.5			17.7	5.1	17.5		
	G2	NLF	2.6	2.8				5.3	7.6				0.7	0.9				0.0	0.2			
		SDLF	5.1	4.5				5.8	8.0				4.2	4.0				2.3	2.5			
		TDLF	6.1	6.8				5.7	7.1				6.1	6.8				6.1	6.7			
	G3	NLF	0.0	9.6	19.1	9.6	0.0	1.9	1.8	3.7	1.8	0.8	0.0	10.7	21.5	10.7	0.0	0.0	11.2	22.5	11.3	0.0
		SDLF	0.7	6.5	13	6.5	1	3.1	0.0	0.0	0.0	2.1	0.0	7.9	15.8	7.9	0.2	0.0	9.1	18.2	9.1	0.0
		TDLF	3.7	0.0	0.0	0.0	3.5	3.2	0.0	0.0	0.0	2.6	3.7	0.0	0.0	0.0	3.5	3.7	0.0	0.0	0.0	3.5

Table A-5-9 (Continued). EISCR1 Stage 2 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Girder	Detailing Method	Holding Elevations									
			Holding Crane: NL Lifting Crane: NL - 40 % SDL Camber (downward)					Holding Crane: NL Lifting Crane: NL + 160 % SDL Camber (upward)				
			Support Number					Support Number				
			1	2	3	4	5	1	2	3	4	5
3-3A	1	NLF	7.6	20.2	7.7			7.6	22.2	7.8		
		SDLF	10.0	15.6	10.4			10.7	17.8	10.8		
		TDLF	18.9	2.2	18.7			18.1	4.1	18.1		
	2	NLF	3.5	3.7				0.0	0.1			
		SDLF	5.7	5.1				0.0	0.2			
		TDLF	7.6	8.0				5.0	5.2			
	3	NLF	0.0	8.9	17.7	8.9	0.0	0.0	11.3	22.6	11.3	0.0
		SDLF	0.2	6.4	12.8	6.4	0.6	0.0	10.5	21.0	10.5	0.0
		TDLF	2.5	0.0	0.0	0.0	2.4	0.0	5.0	10.0	5.0	0.0
3-3B	1	NLF	6.9	20.6	7.5			7.4	22.5	7.6		
		SDLF	9.7	16.4	10.2			10.3	18.4	10.4		
		TDLF	17.7	5.0	17.5			17.3	5.8	17.1		
	2	NLF	4.5	3.8				0.0	0.1			
		SDLF	5.5	5.0				0.0	0.2			
		TDLF	6.1	6.8				5.3	5.9			
		NLF	0.0	8.3	16.7	8.3	0.4	0.0	11.4	22.8	11.4	0.0
		SDLF	1.6	5.1	10.1	5.1	1.9	0.0	10.6	21.2	10.6	0.0
		TDLF	3.7	0.0	0.0	0.0	3.5	2.2	2.4	4.9	2.4	2.1

Table A-5-10. EISCR1 Total Vertical Reactions (kips)

Stage	Detailing	Sub-Stage			
		1	2	3	4
2	NLF	44.7	45.0	45.4	45.7
	SDLF	44.7	45.0	45.4	45.7
	TDLF	44.7	45.0	45.4	45.7
3	NLF	59.8	60.1	60.5	60.8
	SDLF	59.8	60.1	60.5	60.8
	TDLF	59.8	60.1	60.5	60.8

Appendix B-1. NISCR2 Bridge Description

The key characteristics of NISCR2 are as follows:

- Span length along the centerline of the bridge, L_s = 150 ft.
- Width between the fascia girders, w_g = 24 ft.
- Radius of curvature to the centerline of the bridge, R =438 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 6.2
- Subtended angle between the supports, L_s/R = 0.34.
- Number of girders in the completed bridge cross-section, n_g =4.

This appendix presents the bridge description of the bridge NISCR2 in its final condition as well as during erection. The following figures and tables are provided:

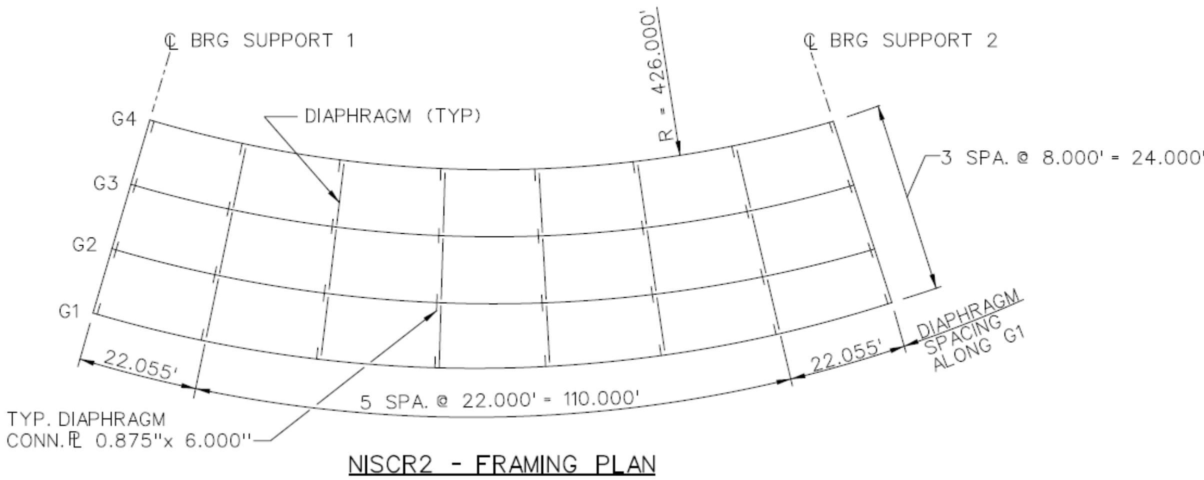


Figure B-1-1. Framing plan.

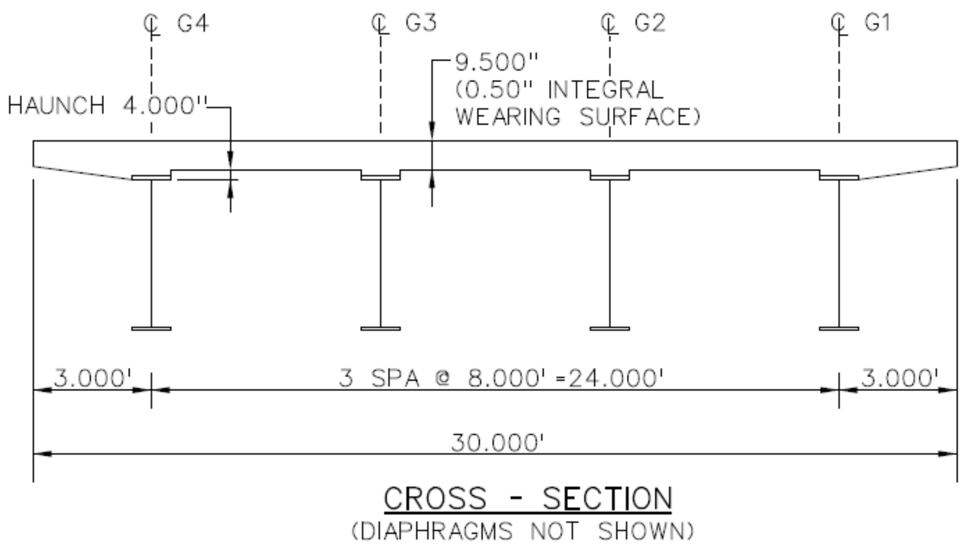


Figure B-1-2. Bridge cross-section.

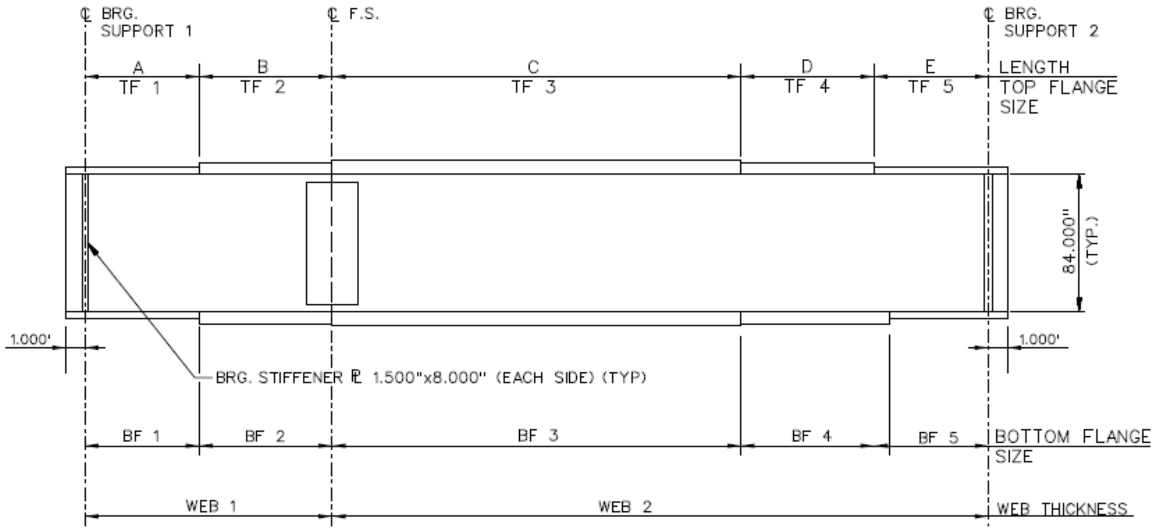


Figure B-1-3. NISCR2 girder elevations

	GIRDER PLATE LENGTHS ⁎			
LENGTH	G1	G2	G3	G4
A	20.000	19.644	19.289	18.933
B	20.000	19.644	19.289	18.933
C	74.110	72.793	71.475	70.158
D	20.000	19.644	19.289	18.933
E	20.000	19.644	19.289	18.933

⁎ ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS ⁎⁎							
TOP FLANGE	G1		G2		G3		G4	
	BF	TF	BF	TF	BF	TF	BF	TF
TF1	22.000	1.000	22.000	1.000	20.000	1.000	20.000	1.000
TF2	22.000	1.250	22.000	1.250	20.000	1.000	20.000	1.000
TF3	22.000	2.000	22.000	2.000	20.000	1.500	20.000	1.500
TF4	22.000	1.250	22.000	1.250	20.000	1.000	20.000	1.000
TF5	22.000	1.000	22.000	1.000	20.000	1.000	20.000	1.000

⁎⁎ ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS ⁎⁎							
BOTTOM FLANGE	G1		G2		G3		G4	
	BF	TF	BF	TF	BF	TF	BF	TF
BF1	26.000	1.250	26.000	1.250	24.000	1.000	24.000	1.000
BF2	26.000	2.000	26.000	2.000	24.000	1.250	24.000	1.250
BF3	26.000	2.750	26.000	2.750	24.000	2.000	24.000	2.000
BF4	26.000	2.000	26.000	2.000	24.000	1.250	24.000	1.250
BF5	26.000	1.250	26.000	1.250	24.000	1.000	24.000	1.000

⁎⁎ ALL DIMENSIONS ARE IN INCHES.

Figure B-1-4. Cross-section dimensions.

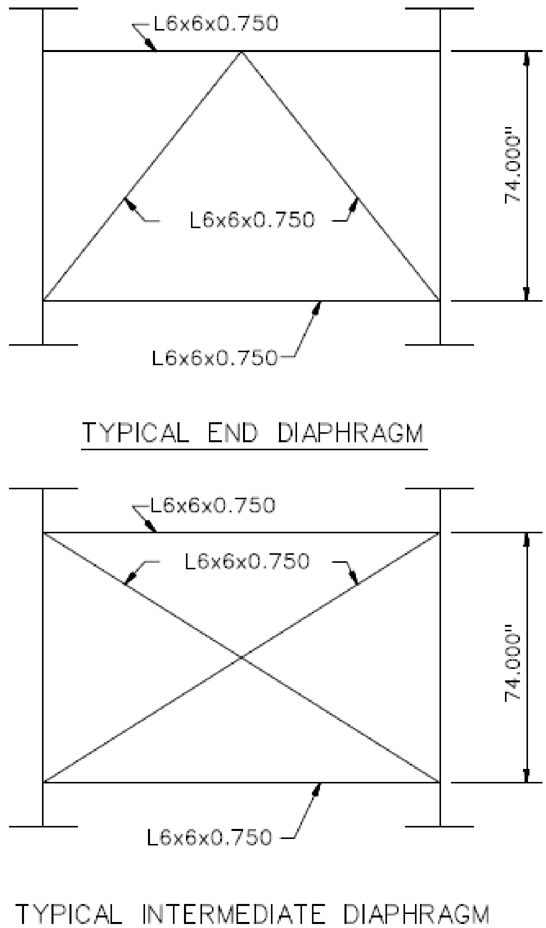


Figure B-1-5. Cross-frame details.

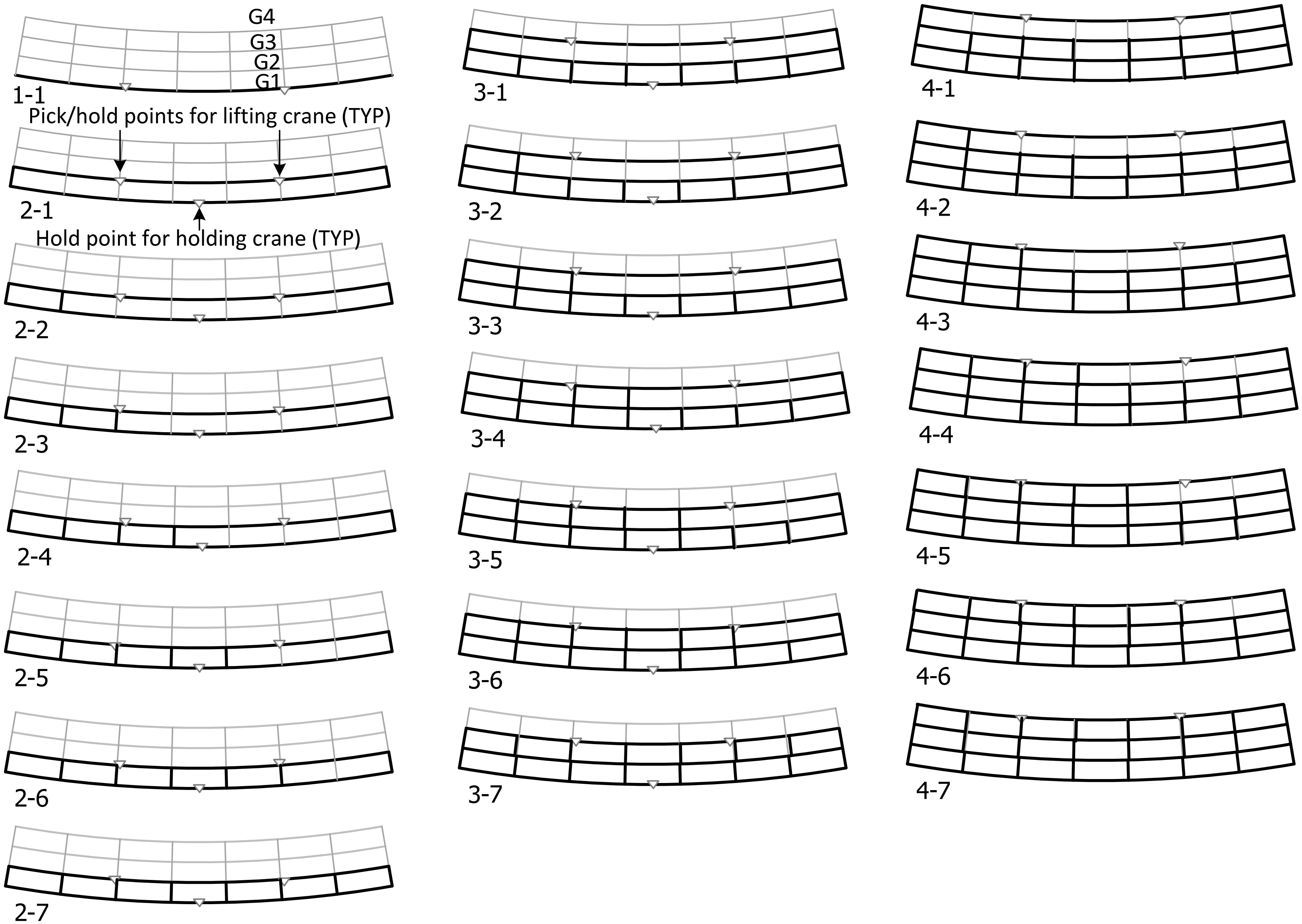


Figure B-1-6. Erection method 1 scheme.

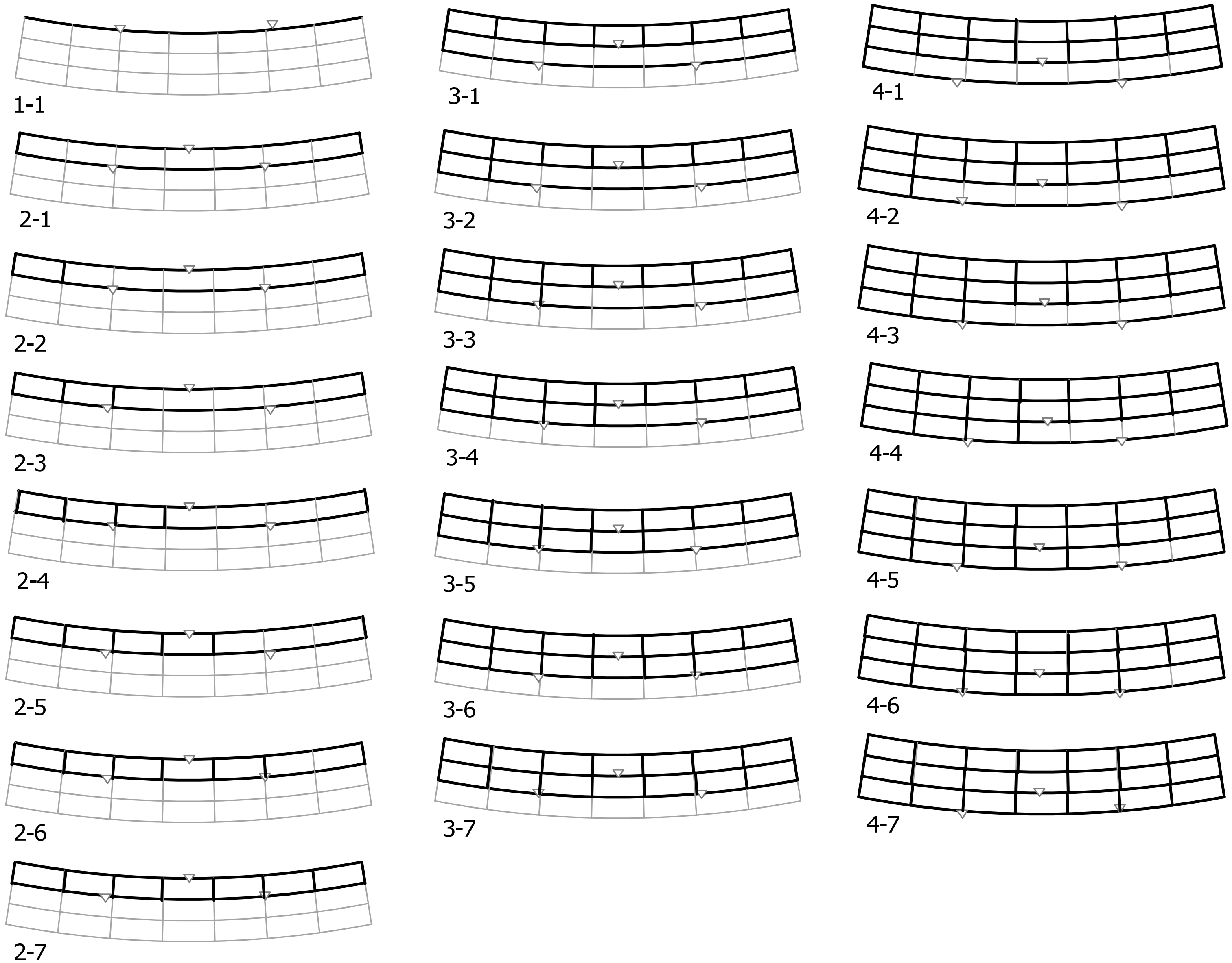


Figure B-1-7. NISCR2 erection method 2A scheme.

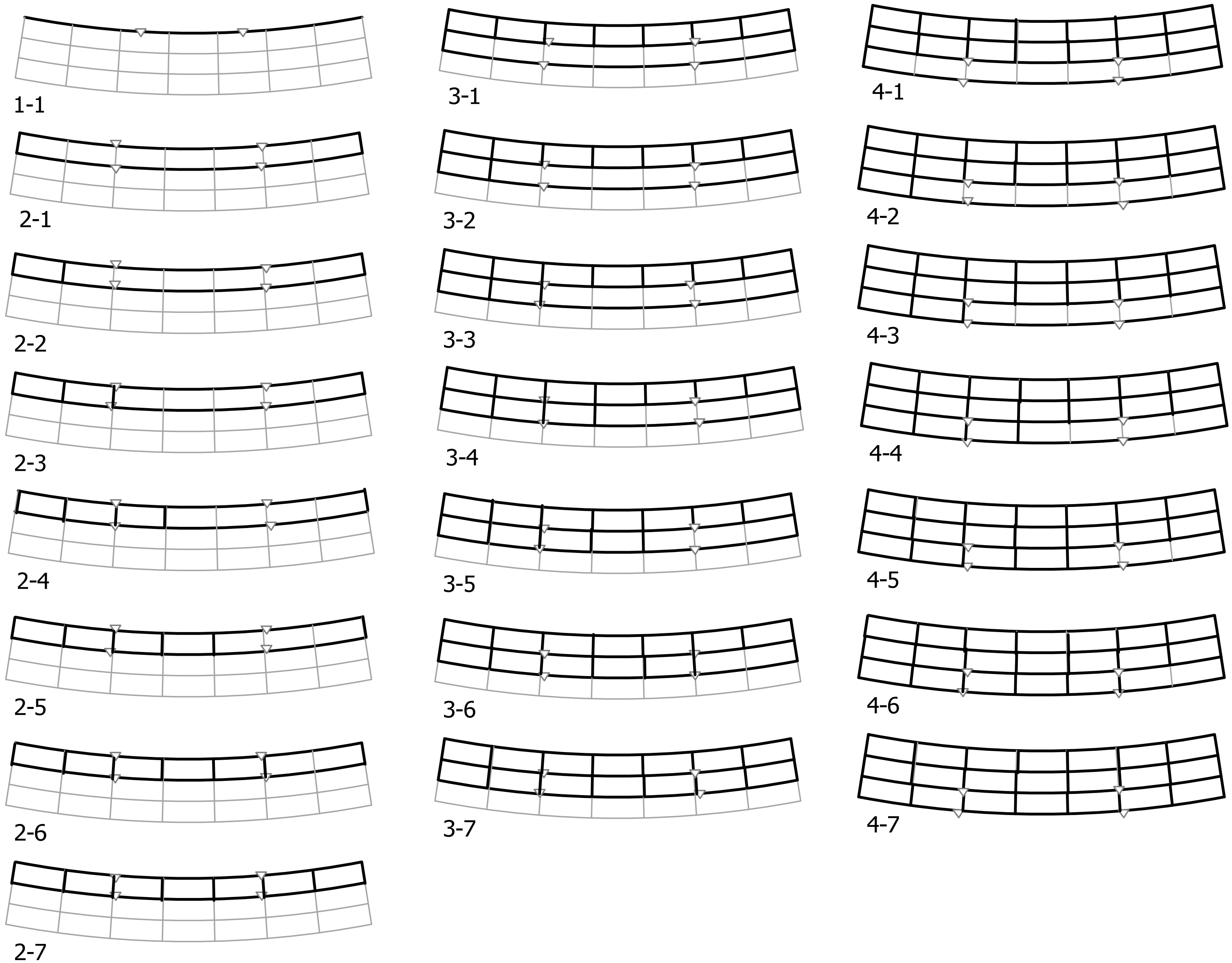


Figure B-1-8. NISCR2 erection method 2B scheme.

Table B-1-1. Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

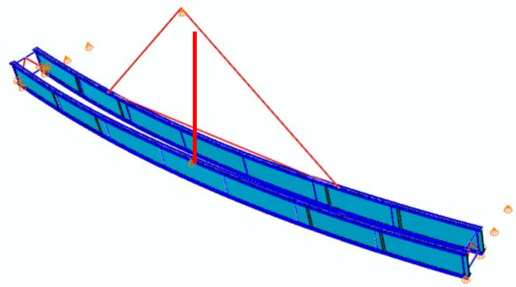
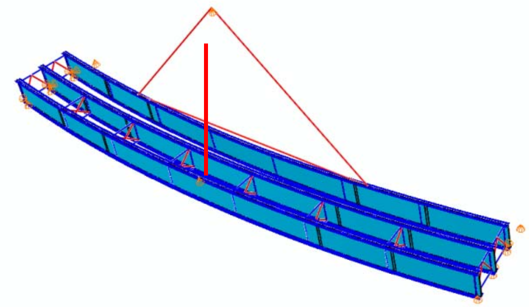
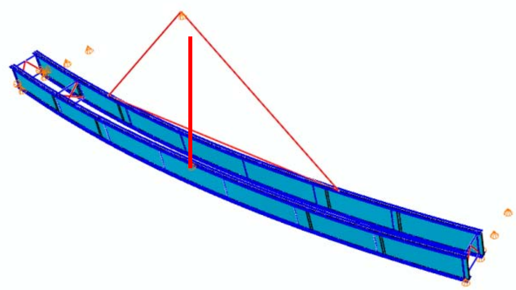
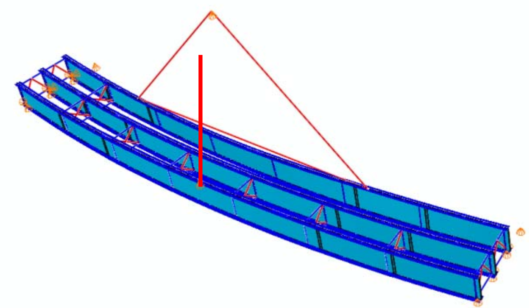
Sub-Stage	Stage	
	2	3
1		
2		

Table B-1-1 (continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

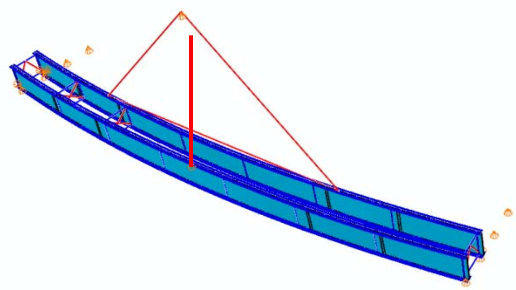
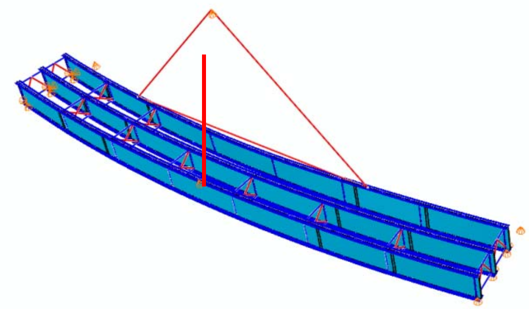
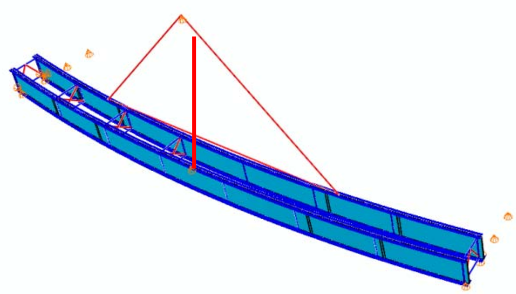
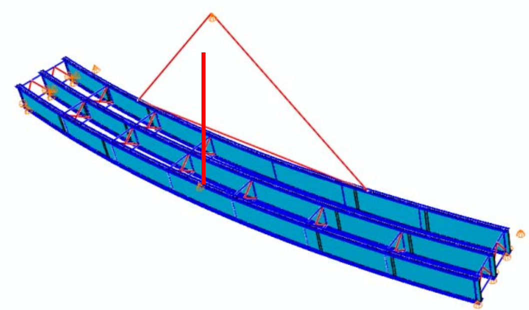
3		
4		

Table B-1-1 (continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

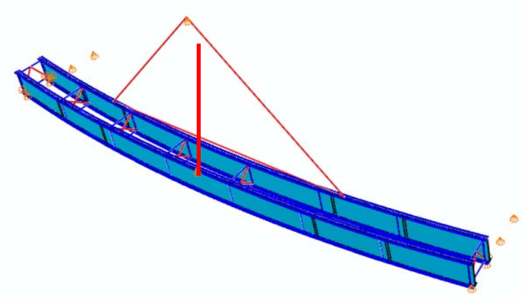
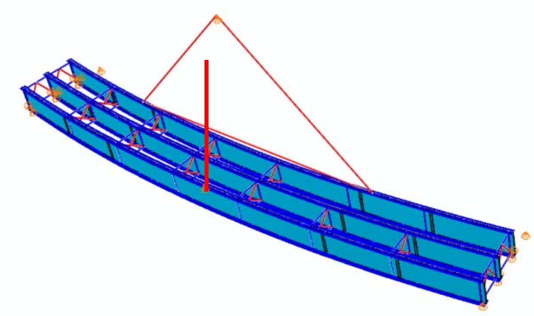
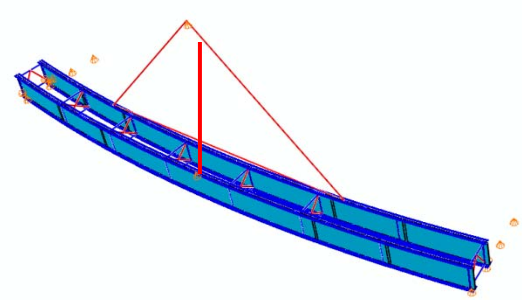
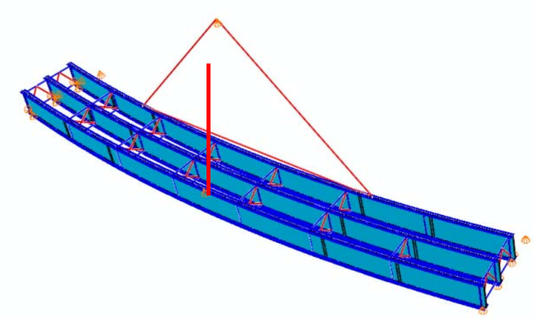
5		
6		

Table B-1-1 (continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

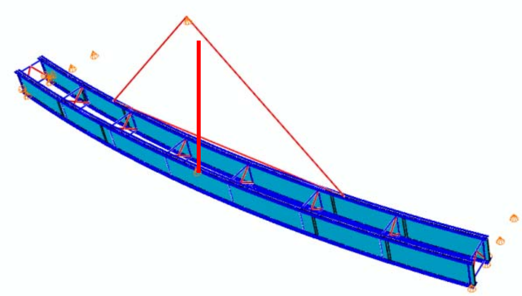
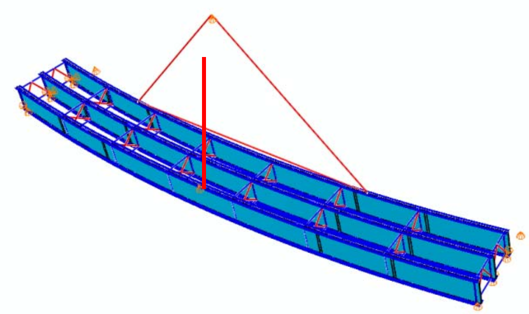
7		

Table B-1-1(continued. Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

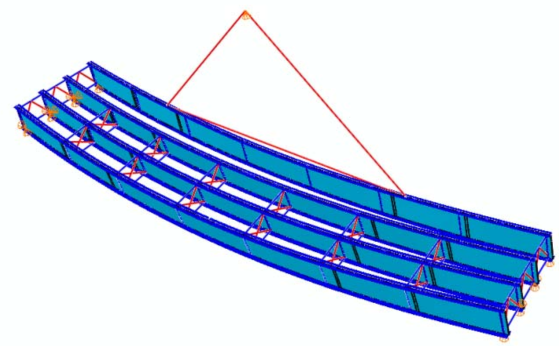
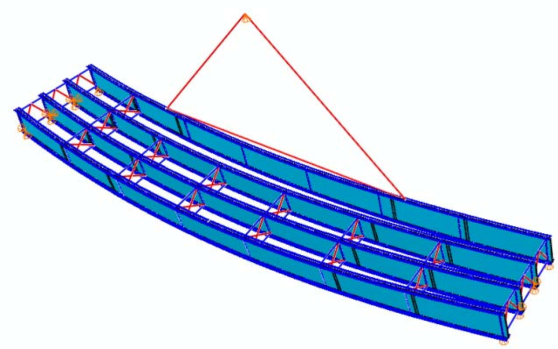
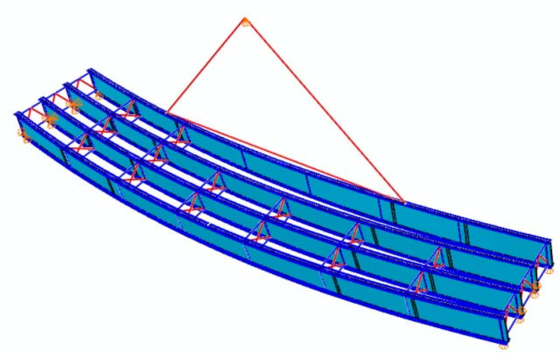
Sub-Stage	Stage 4
1	
2	
3	

Table B-1-1(continued. Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

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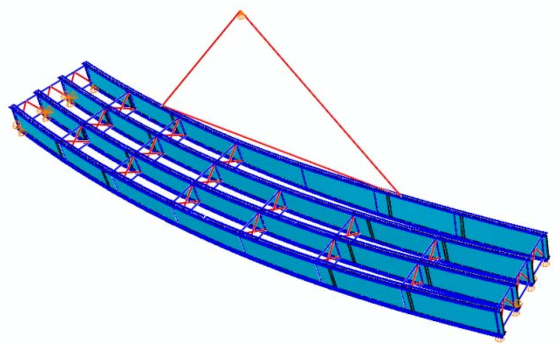
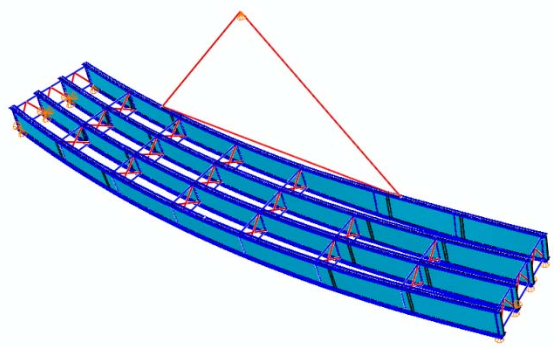
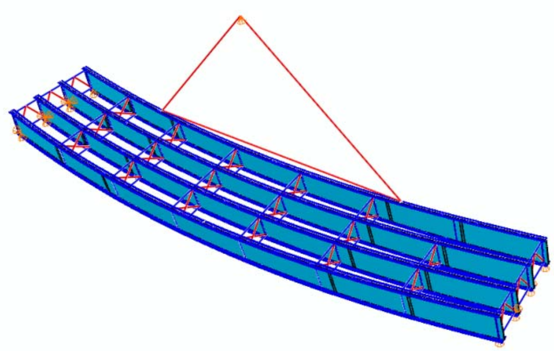
<tr><th>4</th></tr>
<tr><td>4</td><td></td></tr>
<tr><td>5</td><td></td></tr>
<tr><td>6</td><td></td></tr>
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Table B-1-1(continued. Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

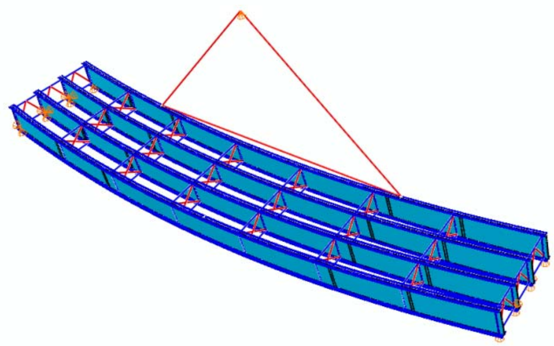
Sub-Stage	Stage
	4
7	

Table B-1-2. Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

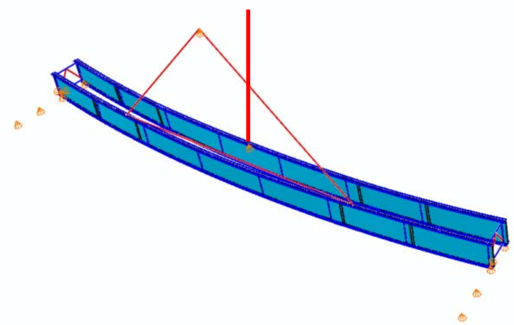
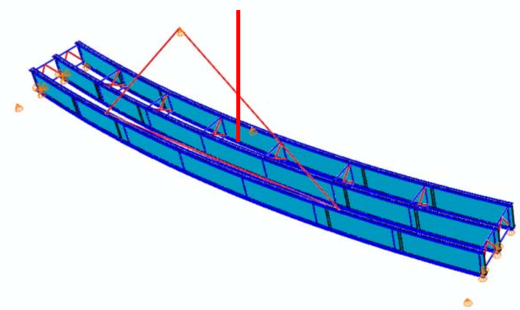
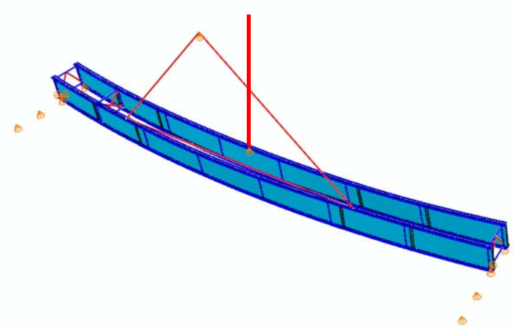
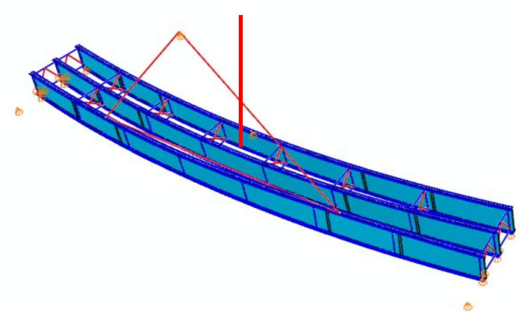
Sub-Stage	Stage	
	2	3
1		
2		

Table B-1-2 (continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

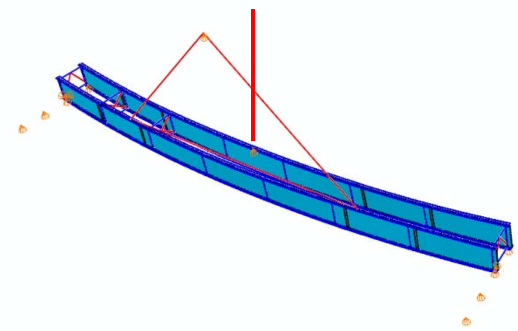
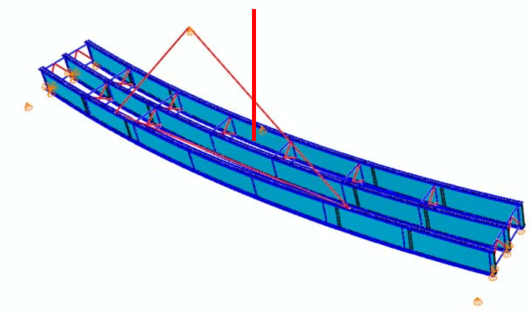
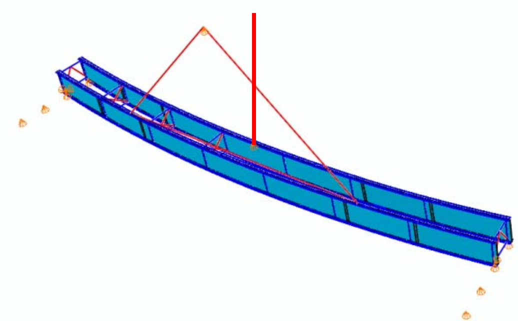
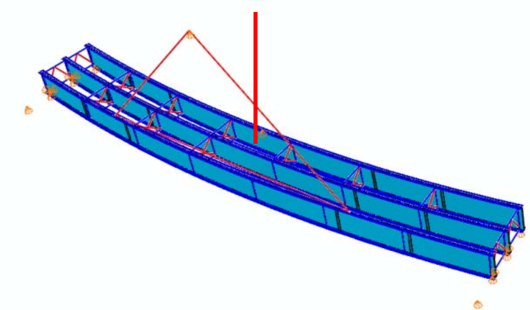
3		
4		

Table B-1-2 (continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

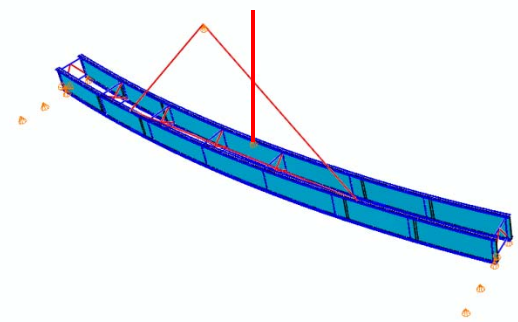
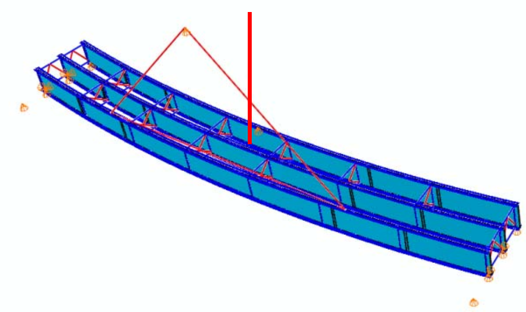
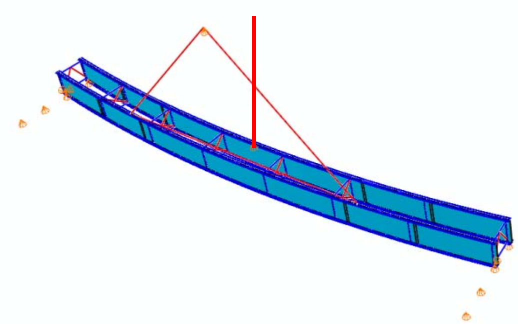
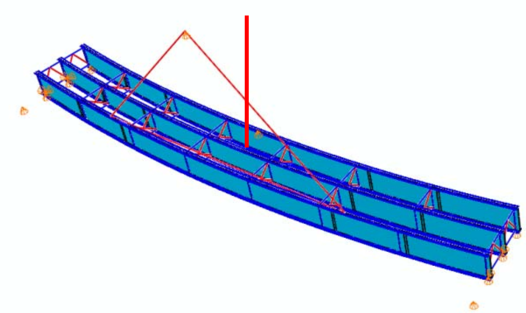
5		
6		

Table B-1-2 (continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

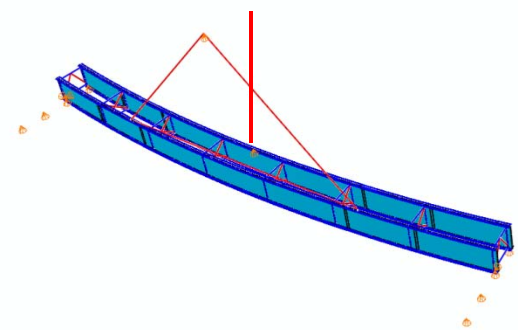
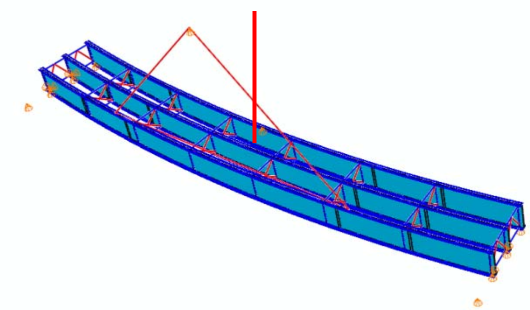
7		

Table B-1-2(continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

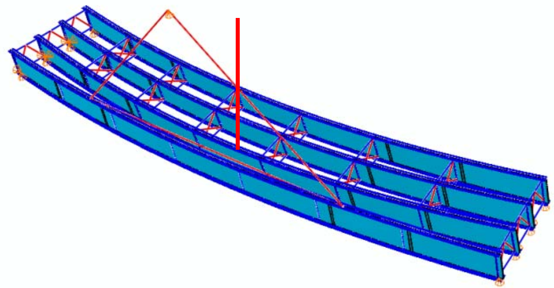
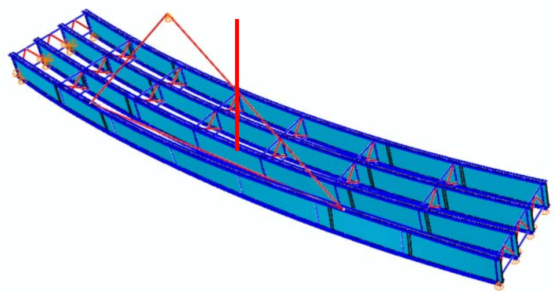
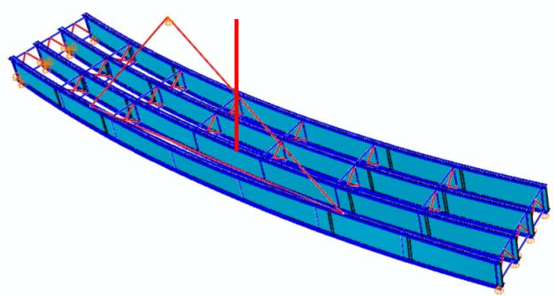
Sub-Stage	Stage 4
1	
2	
3	

Table B-1-2(continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

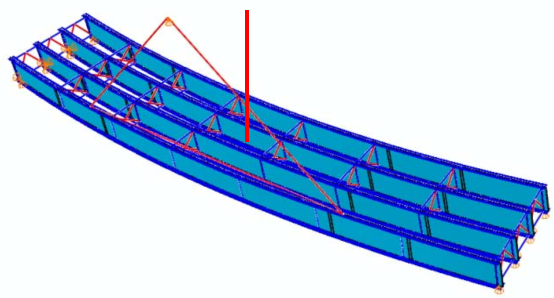
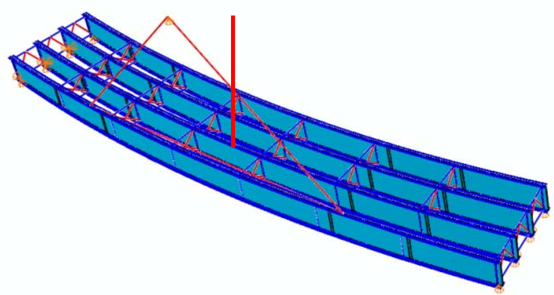
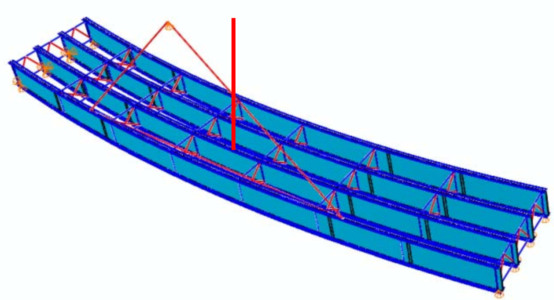
Sub-Stage	Stage 4
4	
5	
6	

Table B-1-2(continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

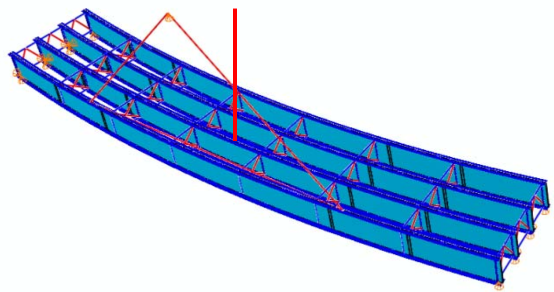
Sub-Stage	Stage
	4
7	

Table B-1-3. Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

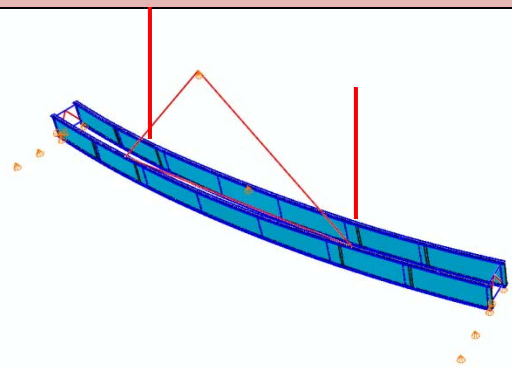
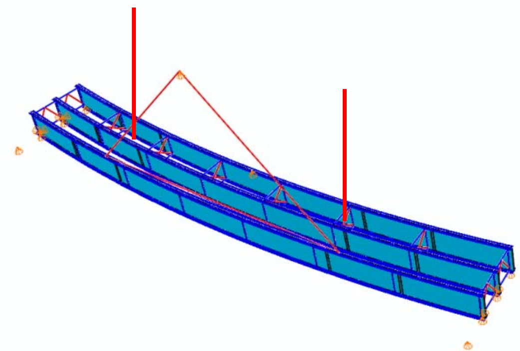
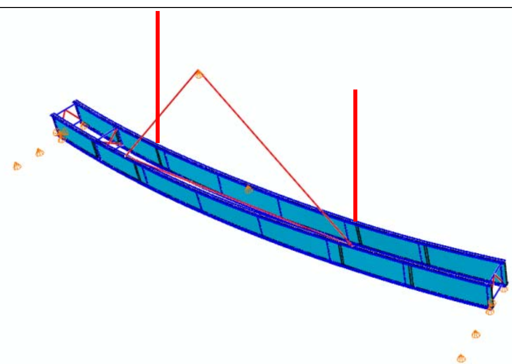
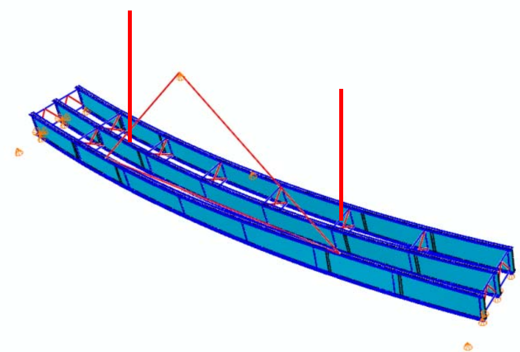
Sub-Stage	Stage	
	2	3
1		
2		

Table B-1-3 (continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

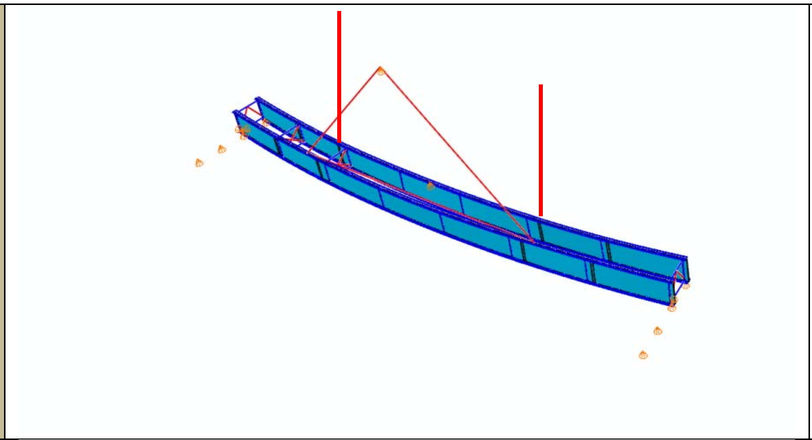
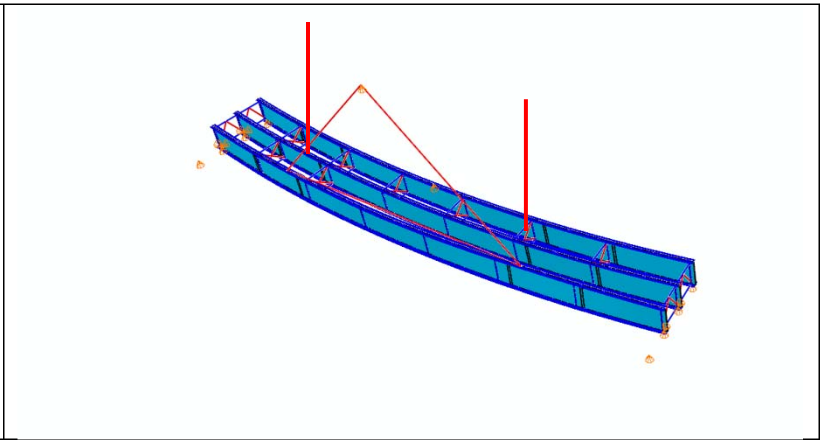
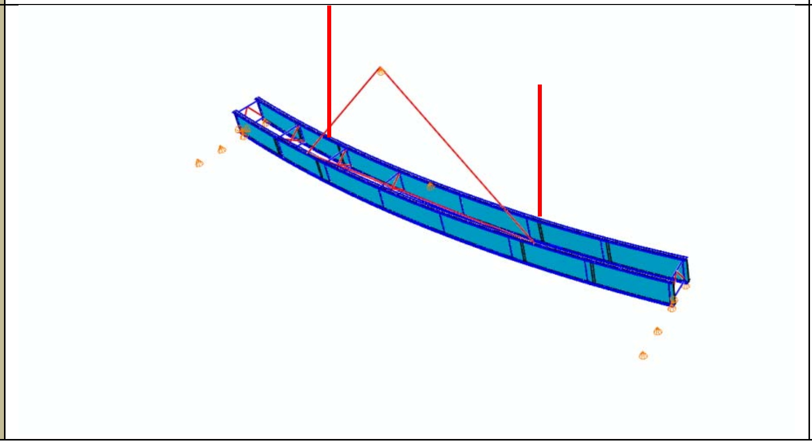
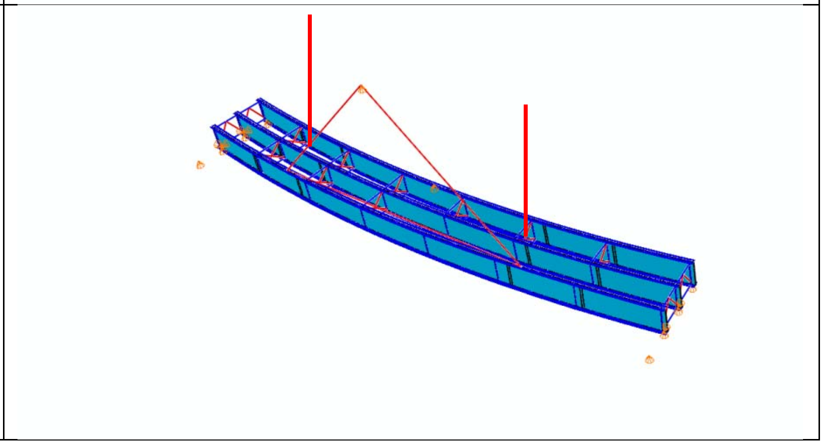
3		
4		

Table B-1-3 (continued). Three-dimensional view of erection method2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

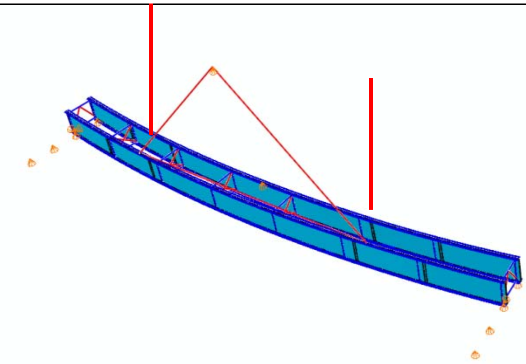
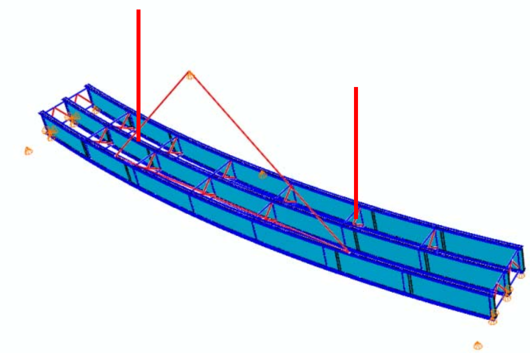
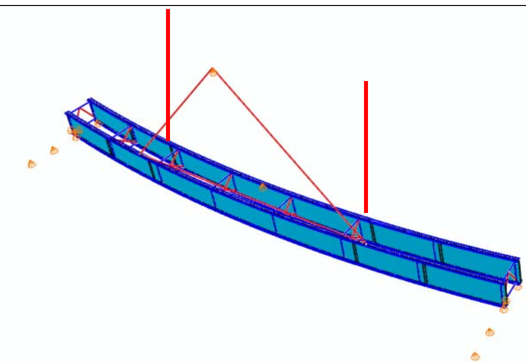
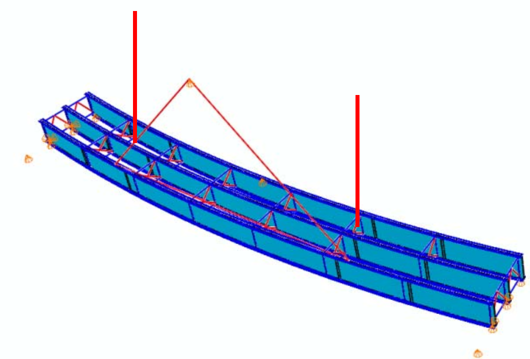
5		
6		

Table B-1-3 (continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

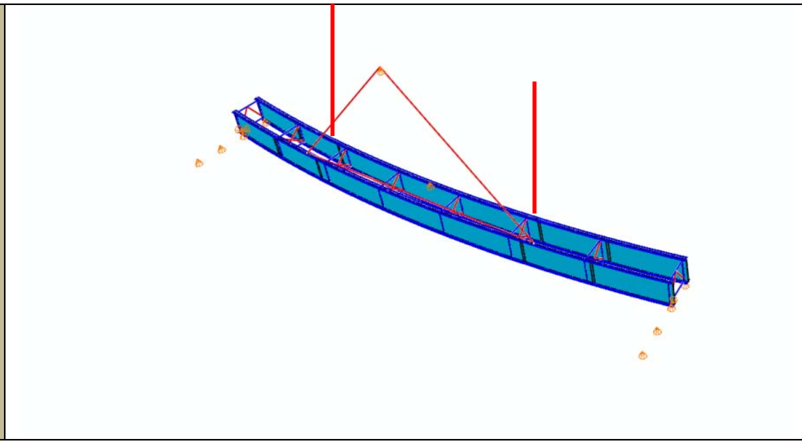
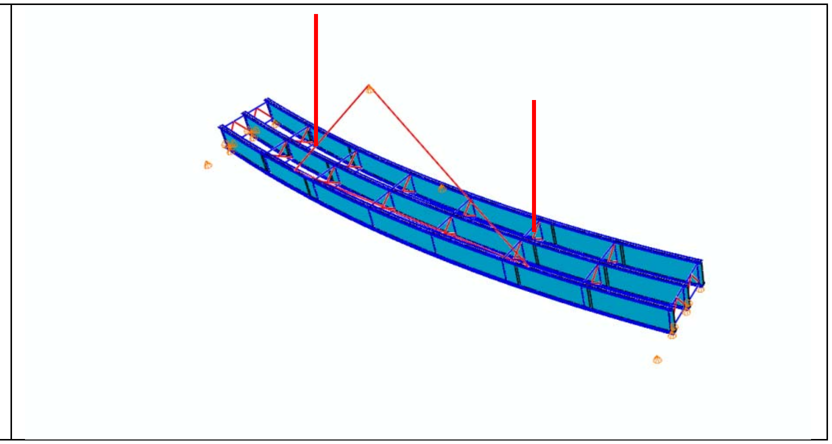
7		

Table B-1-3(continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

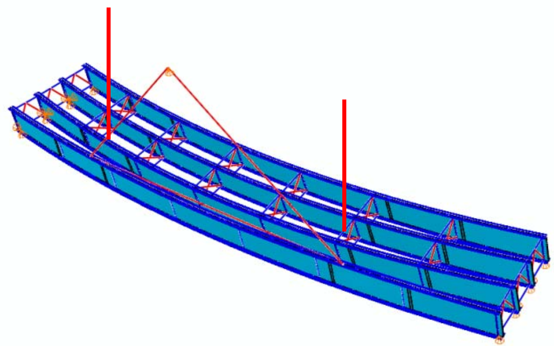
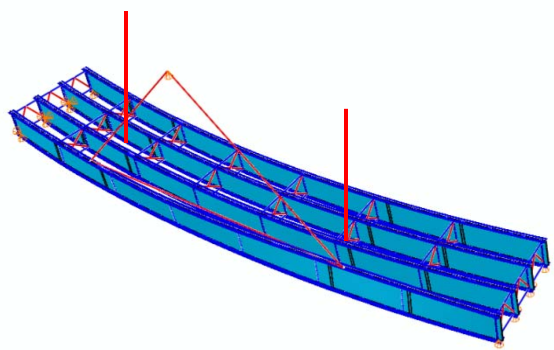
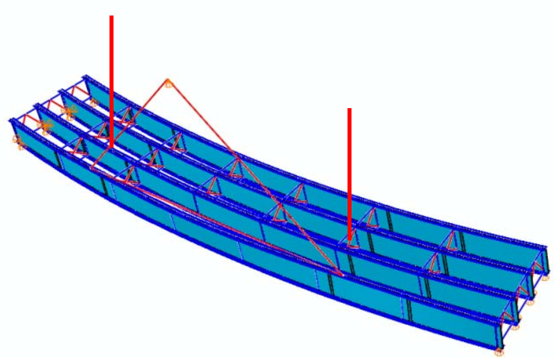
Sub-Stage	Stage 4
1	
2	
3	

Table B-1-3(continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

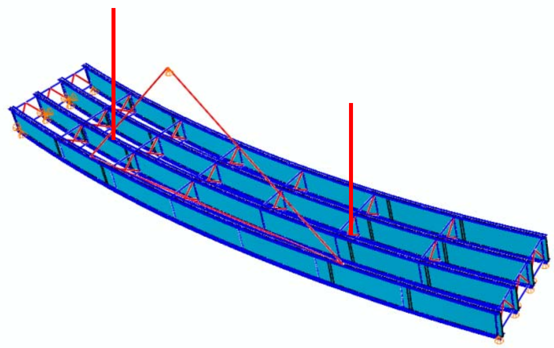
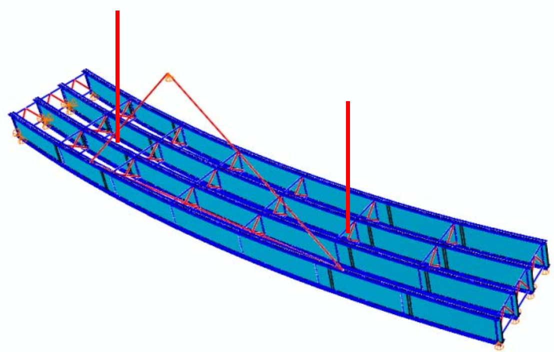
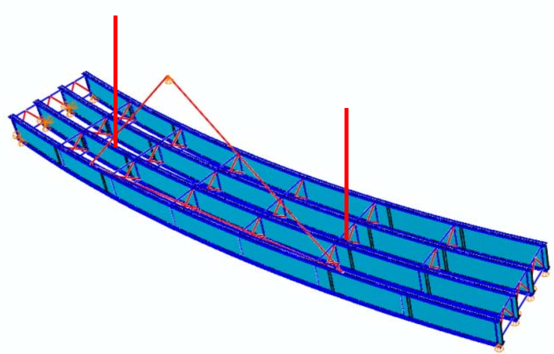
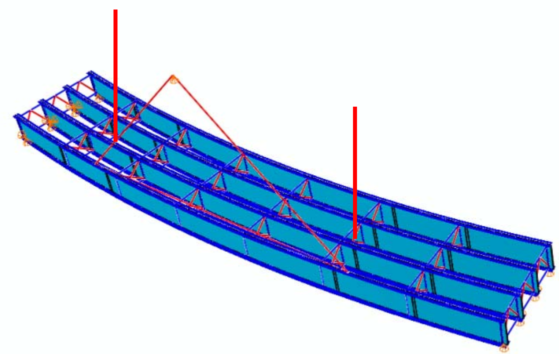
Sub-Stage	Stage 4
4	
5	
6	

Table B-1-3(continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

Sub-Stage	Stage 4
7	

Appendix B-2. NISCR2 Summary, Completed Bridge Responses

This appendix presents the summary of SDL and TDL responses of the bridge NISCR2 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table B-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	2.5	7.1
	SDLF	2.1	6.6
	TDLF	1.4	5.9
G2	NLF	1.8	5.2
	SDLF	1.4	4.8
	TDLF	0.7	4.0
G3	NLF	1.2	3.5
	SDLF	0.8	3.0
	TDLF	0.1	2.3
G4	NLF	0.5	1.8
	SDLF	0.1	1.4
	TDLF	0.5	0.7
All Girders	NLF	2.5	7.1
	SDLF	2.1	6.6
	TDLF	1.4	5.9

Table B-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.7	1.9
	SDLF	0.1	1.3
	TDLF	0.8	0.3
G2	NLF	0.6	1.7
	SDLF	0.1	1.2
	TDLF	0.9	0.2
G3	NLF	0.6	1.6
	SDLF	0.0	1.0
	TDLF	0.9	0.1
G4	NLF	0.6	1.6
	SDLF	0.0	1.0
	TDLF	0.9	0.0
All Girders	NLF	0.7	1.9
	SDLF	0.1	1.3
	TDLF	0.9	0.3

Table B-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	5.5	15.7	8.3	23.4	1.4	5.5	2.2	7.7
	SDLF	5.5	15.6	8.3	23.3	1.4	5.0	2.7	6.7
	TDLF	5.6	15.4	8.4	23.2	1.4	4.1	3.7	7.9
G2	NLF	3.9	11.3	5.8	16.9	1.0	4.3	1.6	6.1
	SDLF	3.9	11.2	5.8	16.8	1.0	3.8	1.8	5.1
	TDLF	3.8	11.1	5.7	16.6	1.0	2.9	2.7	5.2
G3	NLF	2.5	7.8	3.0	9.5	0.6	3.3	1.2	4.7
	SDLF	2.5	7.8	3.0	9.6	0.6	2.9	1.1	3.8
	TDLF	2.4	7.8	3.0	9.6	0.7	2.1	2.0	3.4
G4	NLF	0.4	2.2	0.5	2.9	0.2	1.8	0.6	3.0
	SDLF	0.4	2.4	0.5	3.0	0.2	1.4	0.2	2.1
	TDLF	0.5	2.6	0.6	3.2	0.4	0.6	1.1	0.7
All Girders	NLF	5.5	15.7	8.3	23.4	1.4	5.5	2.2	7.7
	SDLF	5.5	15.6	8.3	23.3	1.4	5.0	2.7	6.7
	TDLF	5.6	15.4	8.4	23.2	1.4	4.1	3.7	7.9

Table B-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	11.6	16.2	16.4	16.4
	SDLF	26.6	13.6	19.0	26.6
	TDLF	43.7	17.5	15.2	43.7
TDL	NLF	36.1	49.0	49.1	49.1
	SDLF	50.7	45.4	51.0	51.0
	TDLF	67.0	47.8	46.1	67.0

Table B-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	5.6	5.9	7.2	6.1
	SDLF	12.1	4.9	8.4	9.1
	TDLF	22.8	6.0	6.8	14.1
TDL	NLF	17.1	17.8	21.8	18.4
	SDLF	23.4	16.5	22.7	21.2
	TDLF	33.8	17.1	20.6	25.8

Table B-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	All Girders
NLF	0.68	0.65	0.64	0.68
SDLF	0.70	0.64	0.62	0.70
TDLF	0.74	0.62	0.58	0.74

Table B-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	All Girders
NLF	1.81	1.72	1.69	1.81
SDLF	1.81	1.69	1.65	1.81
TDLF	1.81	1.64	1.58	1.81

Table B-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	All Girders
NLF	0.52	0.50	0.49	0.52
SDLF	0.54	0.49	0.47	0.54
TDLF	0.57	0.48	0.44	0.57

Table B-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	All Girders
NLF	1.40	1.33	1.30	1.40
SDLF	1.39	1.30	1.27	1.39
TDLF	1.40	1.26	1.22	1.40

Table B-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	312	946
SDLF	312	946
TDLF	312	946

Table B-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	72	208	0	0	0	2
SDLF	72	207	0	0	0	2
TDLF	73	205	0	0	1	2

Table B-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.30	0.58	0.00	0.00
SDLF	0.30	0.65	0.00	0.00
TDLF	0.29	0.78	0.00	0.00

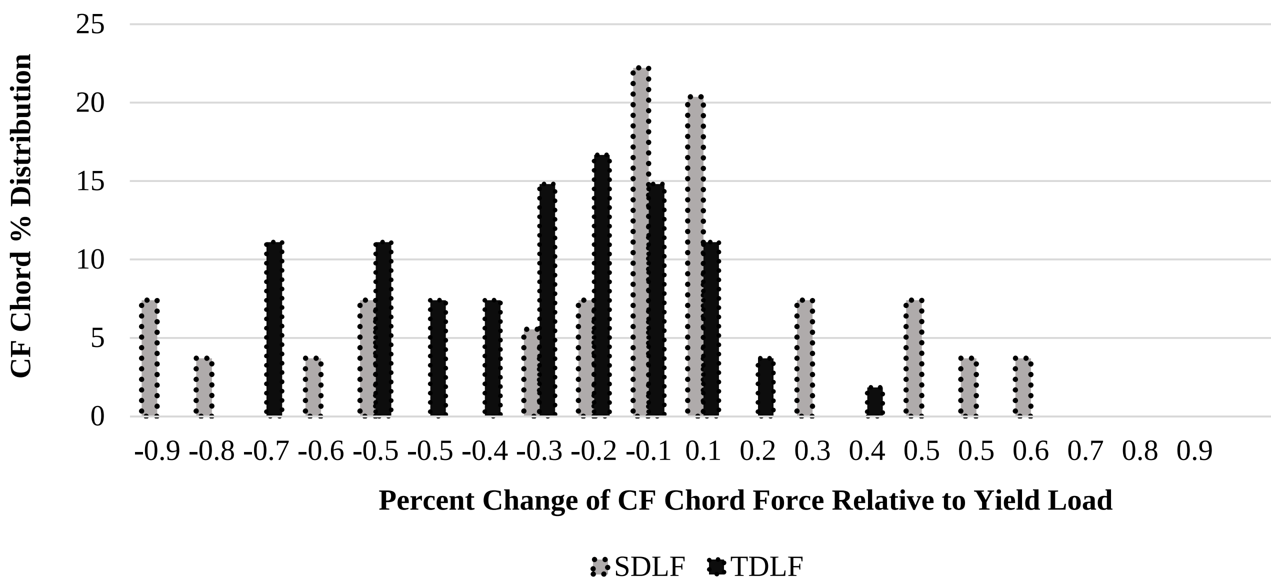


Figure B-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

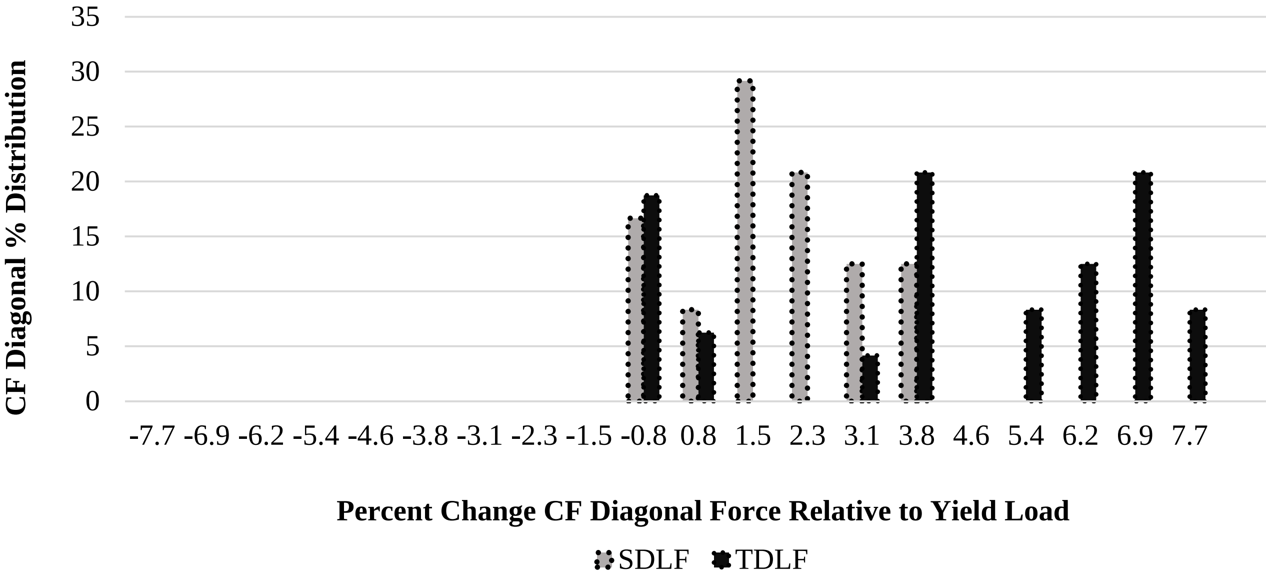


Figure B-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

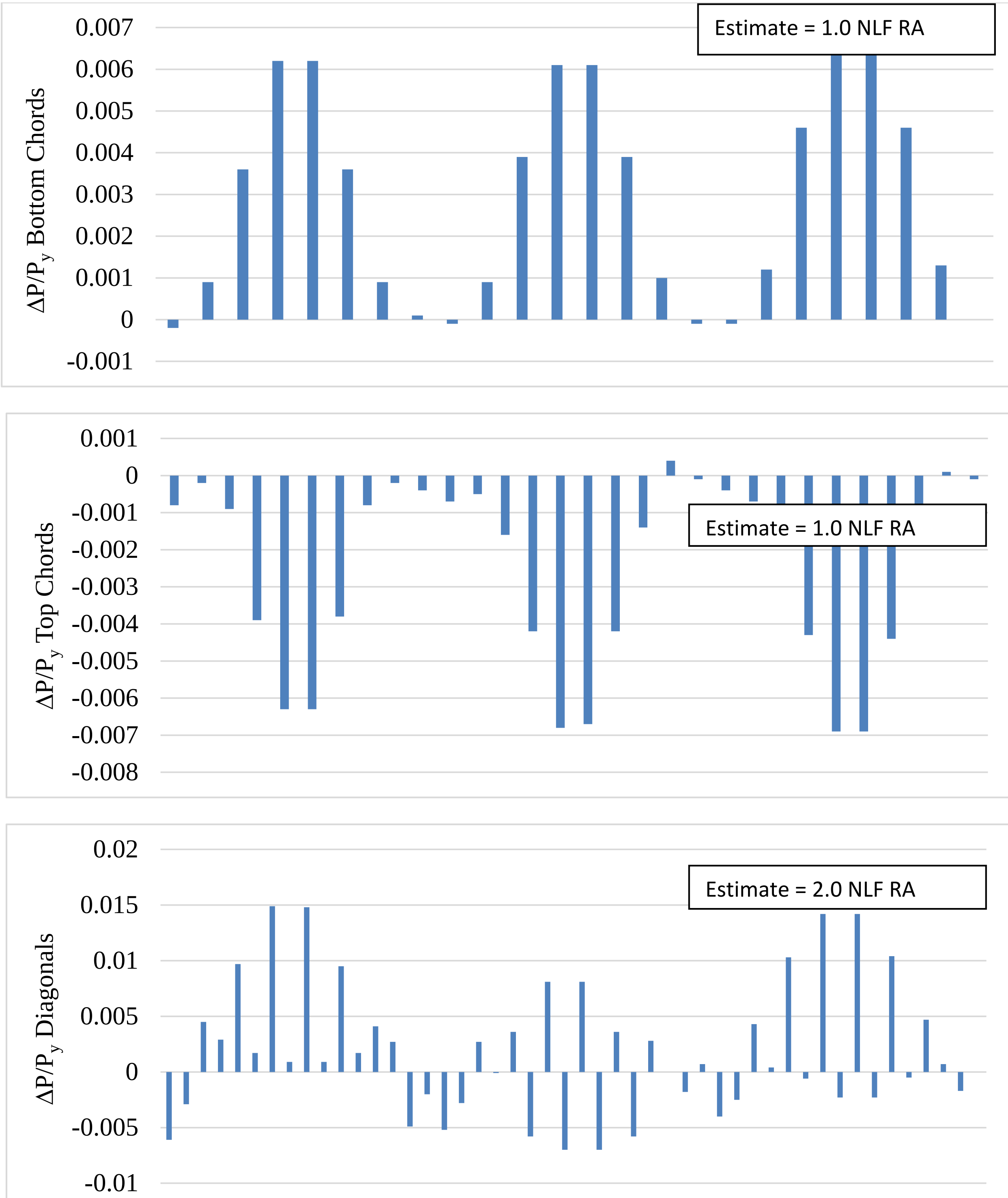


Figure B-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

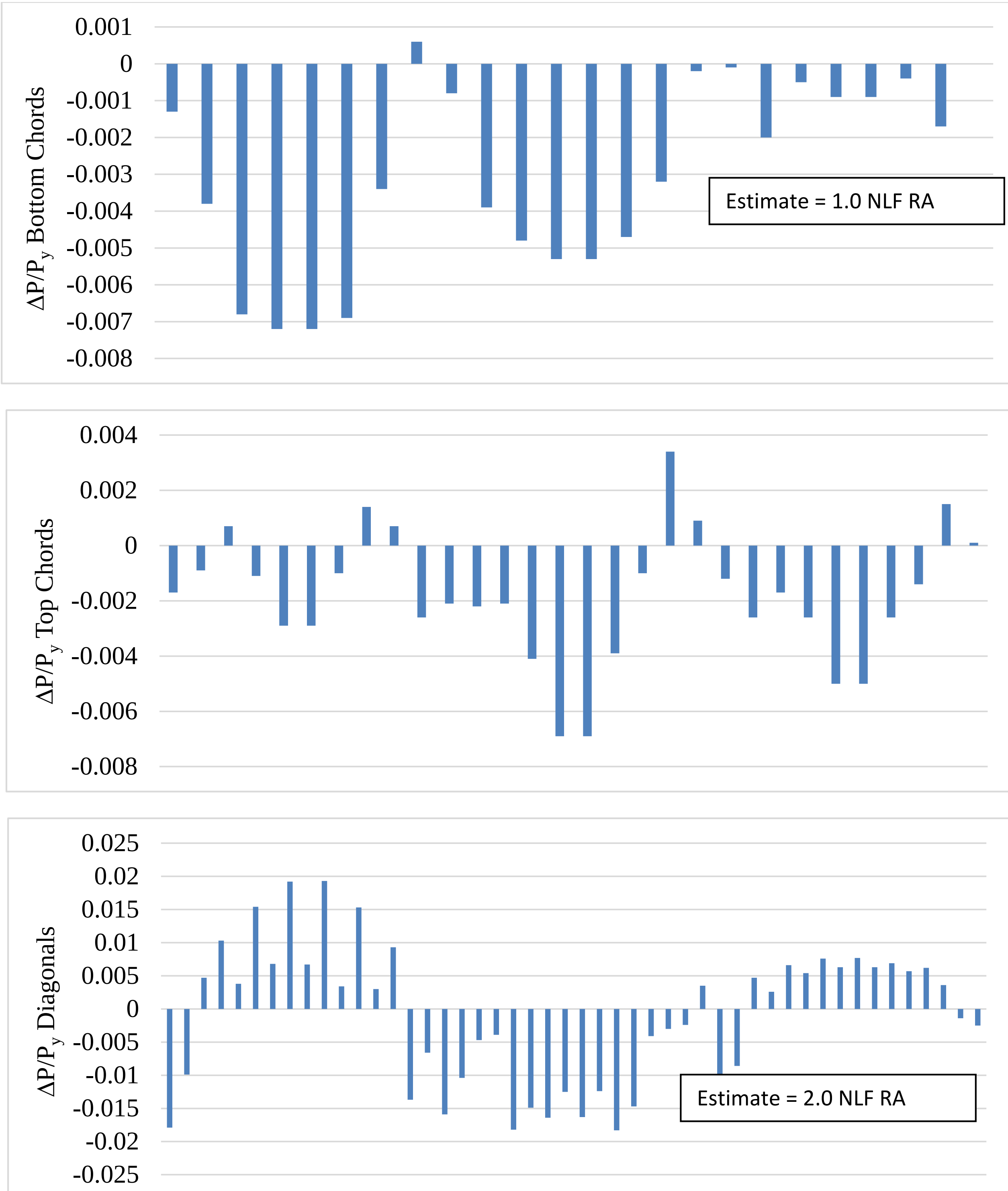


Figure B-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix B-3. NISCR2 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISCR2 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table B-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	Erection Method 1			Erection Method 2			Erection Method 3		
	F1	F2	F_{max}	F1	F2	F_{max}	F1	F2	F_{max}
NLF	16.6	10.2	16.6	2.8	84.4	84.4	2.2	40.4	40.4
SDLF	28.7	21.3	28.7	7.7	82.5	82.5	11.7	19.4	19.4
TDLF	46.5	54.0	54.0	16.7	80.2	80.2	24.8	50.5	50.5

Table B-3-2. Erection method 1 summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	79.6	13.9
	SDLF	78.3	17.8
	TDLF	76.5	25.7
G2	NLF	47.8	1.1
	SDLF	52.4	6.6
	TDLF	54.8	4.3
G3	NLF	5.6	0
	SDLF	13.8	0
	TDLF	24.5	6.7
G4	NLF	2.9	0
	SDLF	5.6	0
	TDLF	12.8	4.8
All Girders	NLF	79.6	0
	SDLF	78.3	0
	TDLF	76.5	4.3

Table B-3-3. Erection method 2 summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	34.1	0
	SDLF	34.6	0
	TDLF	32.1	0
G2	NLF	73.2	0
	SDLF	73.7	0
	TDLF	74.2	0
G3	NLF	31.9	0
	SDLF	32.2	0
	TDLF	48.4	0
G4	NLF	41.9	0
	SDLF	38.4	0
	TDLF	34.7	0
All Girders	NLF	73.2	0
	SDLF	73.7	0
	TDLF	74.2	0

Table B-3-4. Erection method 1 summary of crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Reaction	Min Reaction	Max Reaction	Min Reaction
NLF	82.9	49.8	86.2	58.1
SDLF	87.6	33.7	88.1	57.9
TDLF	55	0	63	46.7

Table B-3-5. Erection method 2 summary of crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Reaction	Min Reaction	Max Reaction	Min Reaction
NLF	120.7	58.8	96.7	39.4
SDLF	117.2	32.1	69	16.2
TDLF	111.3	53.3	30.3	0

Table B-3-6. Erection method 1 total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage						
		1	2	3	4	5	6	7
2	NLF	169	170	171	172	173	174	175
	SDLF	169	170	171	172	173	174	175
	TDLF	169	170	171	172	173	174	175
3	NLF	238	239	240	241	242	243	244
	SDLF	238	239	240	241	242	243	244
	TDLF	238	239	240	241	242	243	244
4	NLF	306	307	308	309	310	311	312
	SDLF	306	307	308	309	310	311	312
	TDLF	306	307	308	309	310	311	312

Table B-3-7. Erection methods 2 and 3 total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage						
		1	2	3	4	5	6	7
2	NLF	123	124	125	126	127	128	129
	SDLF	123	124	125	126	127	128	129
	TDLF	123	124	125	126	127	128	129
3	NLF	214	215	216	217	218	219	220
	SDLF	214	215	216	217	218	219	220
	TDLF	214	215	216	217	218	219	220
4	NLF	306	307	308	309	310	311	312
	SDLF	306	307	308	309	310	311	312
	TDLF	306	307	308	309	310	311	312

Appendix B-4. NISCR2 Detailed Results, Completed Bridge Responses

This appendix provides detailed analytical results for curved radially-supported bridge NISCR2 used an example of using GT-LOFT to determine the initial strains associated with No Load Fit (NLF), Steel Dead Load Fit (SDLF) and Total Dead Load Fit (TDLF) detailing methods. This bridge has a span length of 150 ft and centerline radius of curvature of 438 ft. All of the girders have four section changes. The intermediate cross-frames are X type, and the end cross-frame are K type. All cross-frame members are L6x6x3/4

These results are with SDLF and TDLF detailing effects included via the initial strains calculated by GT-LOFT. Since the nonlinearity effects in bridge NSICR2 are insignificant, the responses are approximately the same with engineering and log strains. Thus, this appendix shows only the responses with the initial engineering strains.

The initial strains for SDLF and TDLF detailing calculated by GT-LOFT are comparable to the initial strains for SDLF and TDLF detailing calculated by an accurate refined analysis. There are small but negligible difference in the initial strains calculated by GT-LOFT and an accurate refined analysis. The responses of bridge NISCR2 are comparable using the initial strains from GT-LOFT and the initial strains from an accurate refined analysis.

The important point from these results is that SDLF and TDLF effects, included in the structural analysis via initial engineering strains calculated by GT-LOFT, are additive to the dead load cross-frame forces. The girders are approximately plumb under the targeted conditions. The figures and tables are grouped into major units as follows:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

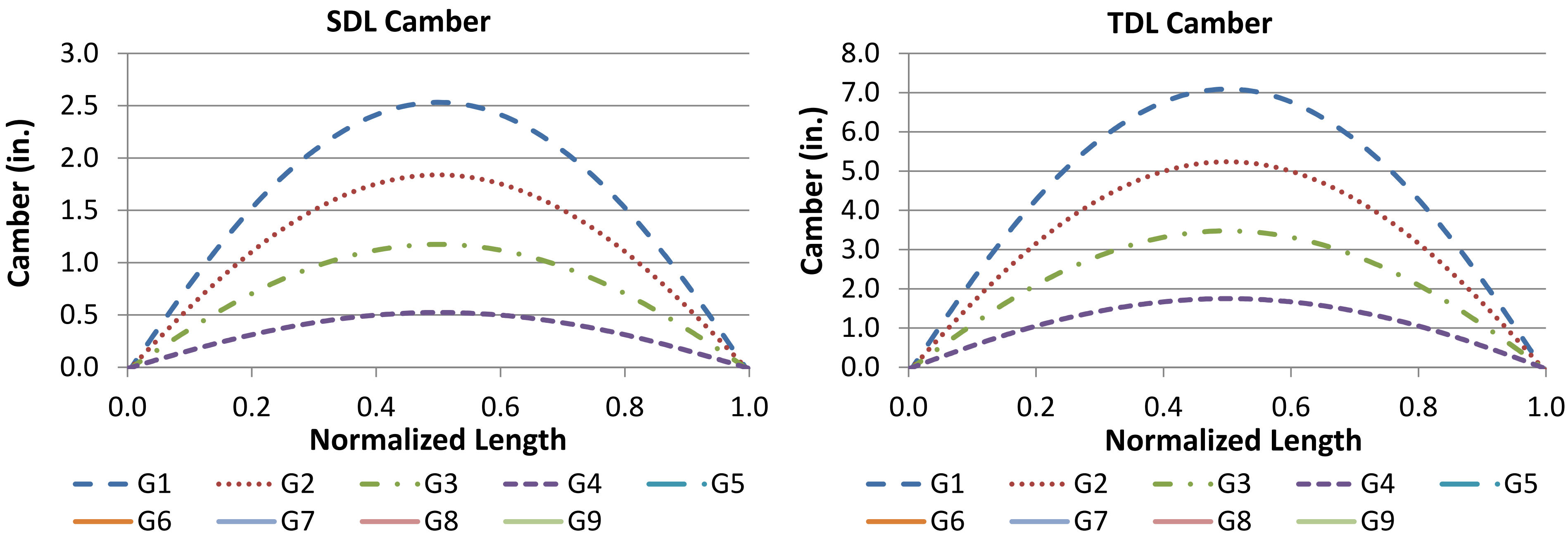


Figure B-4-1. SDL and TDL 3D FEA cambers.

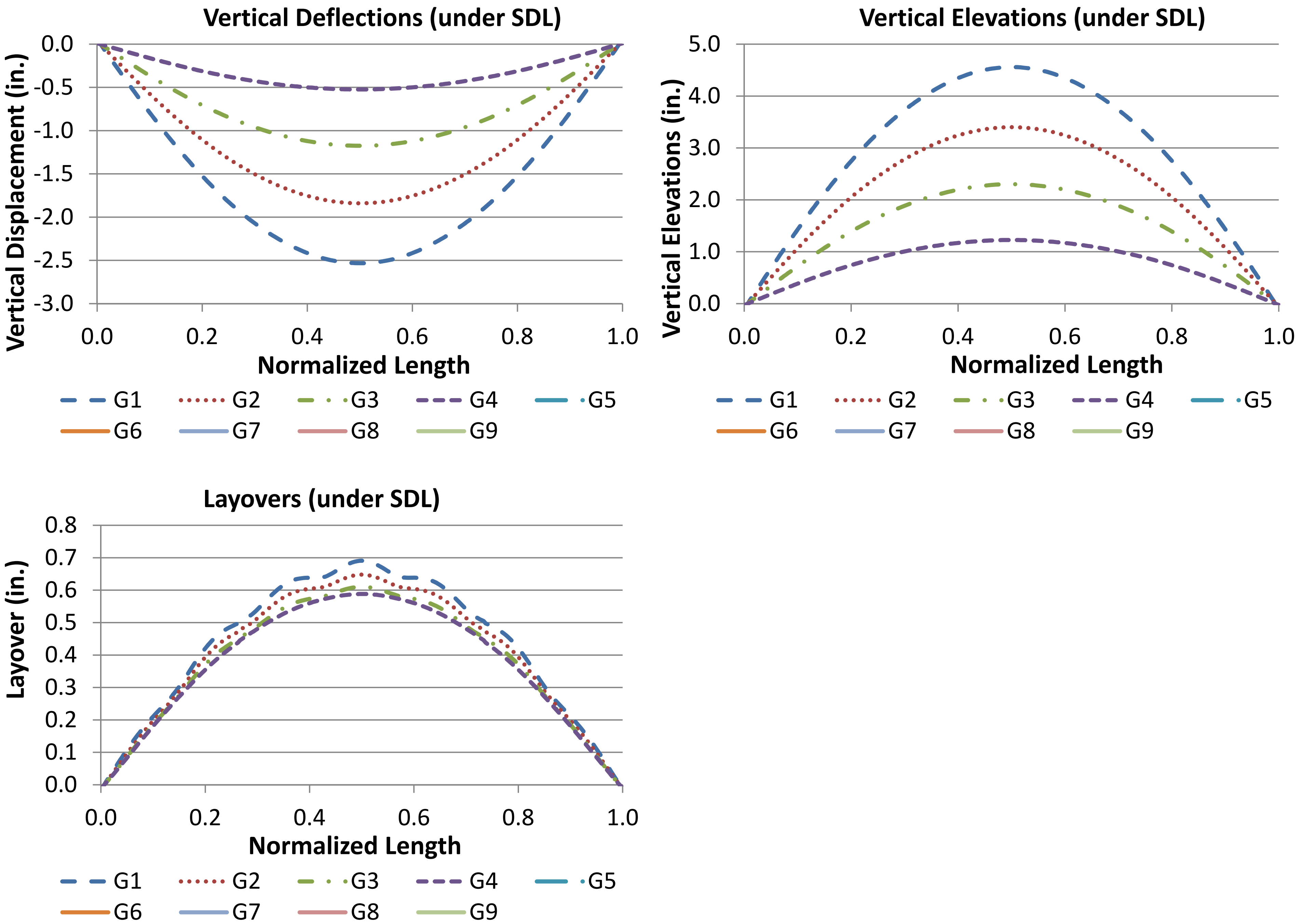


Figure B-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

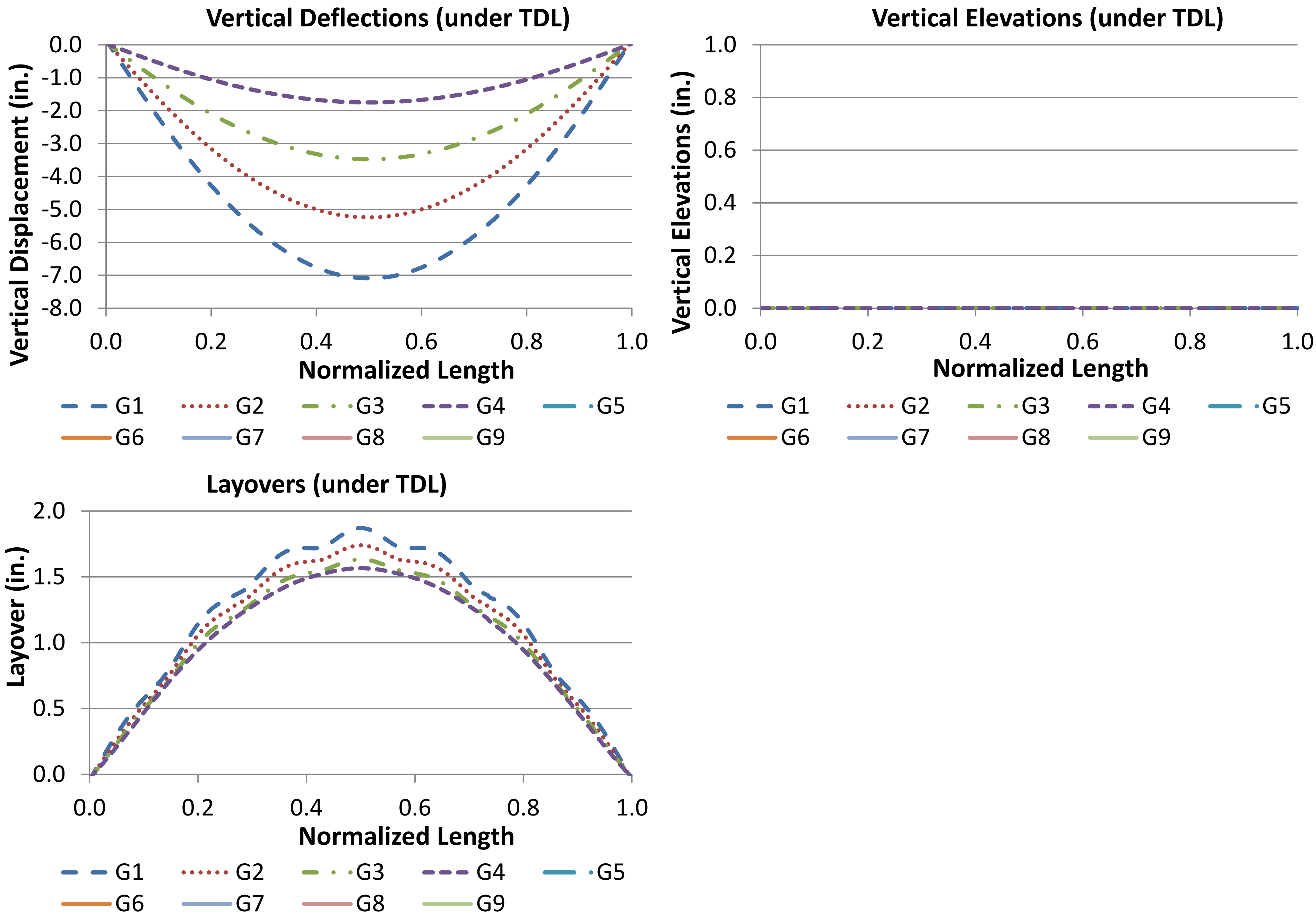


Figure B-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

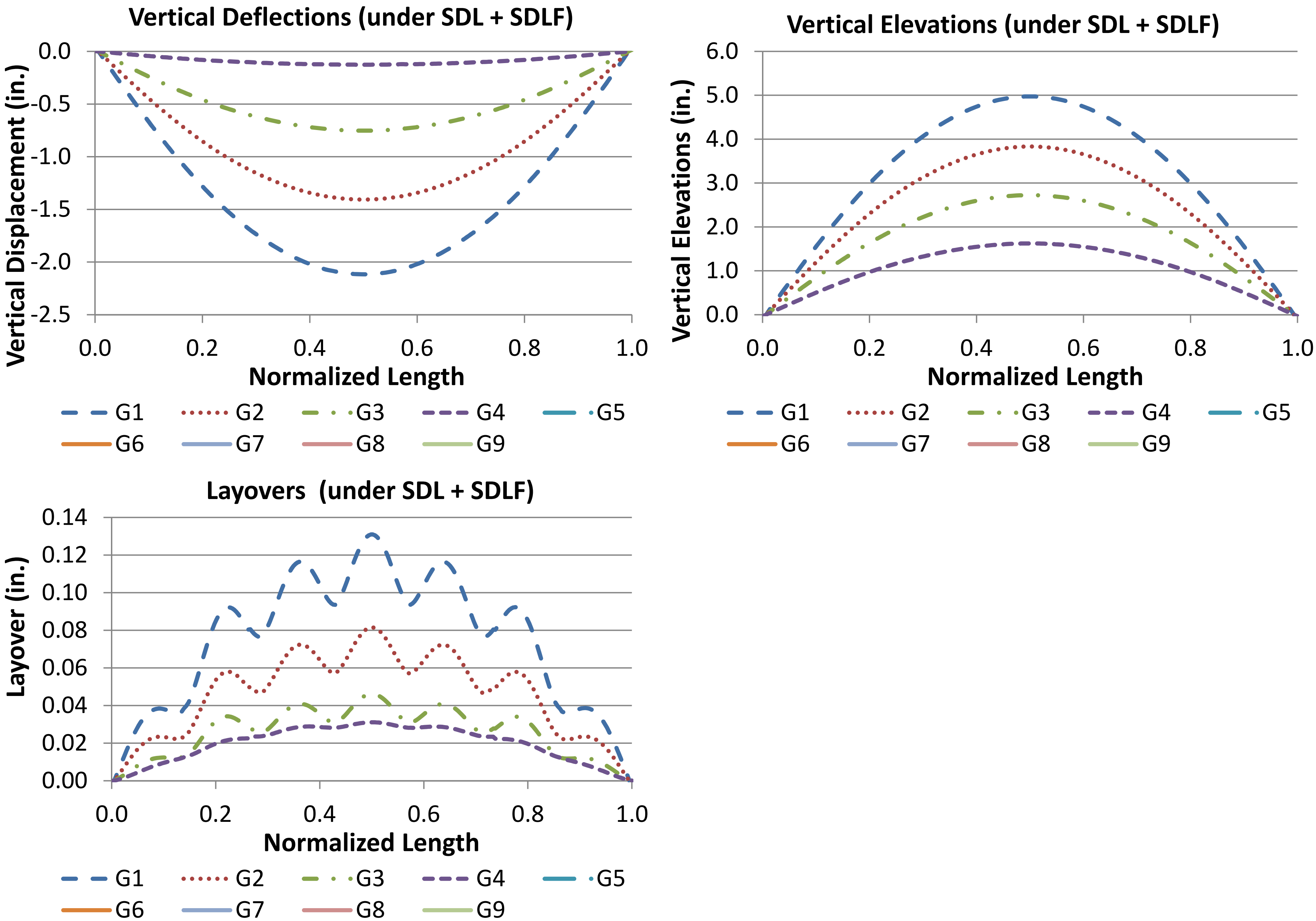


Figure B-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

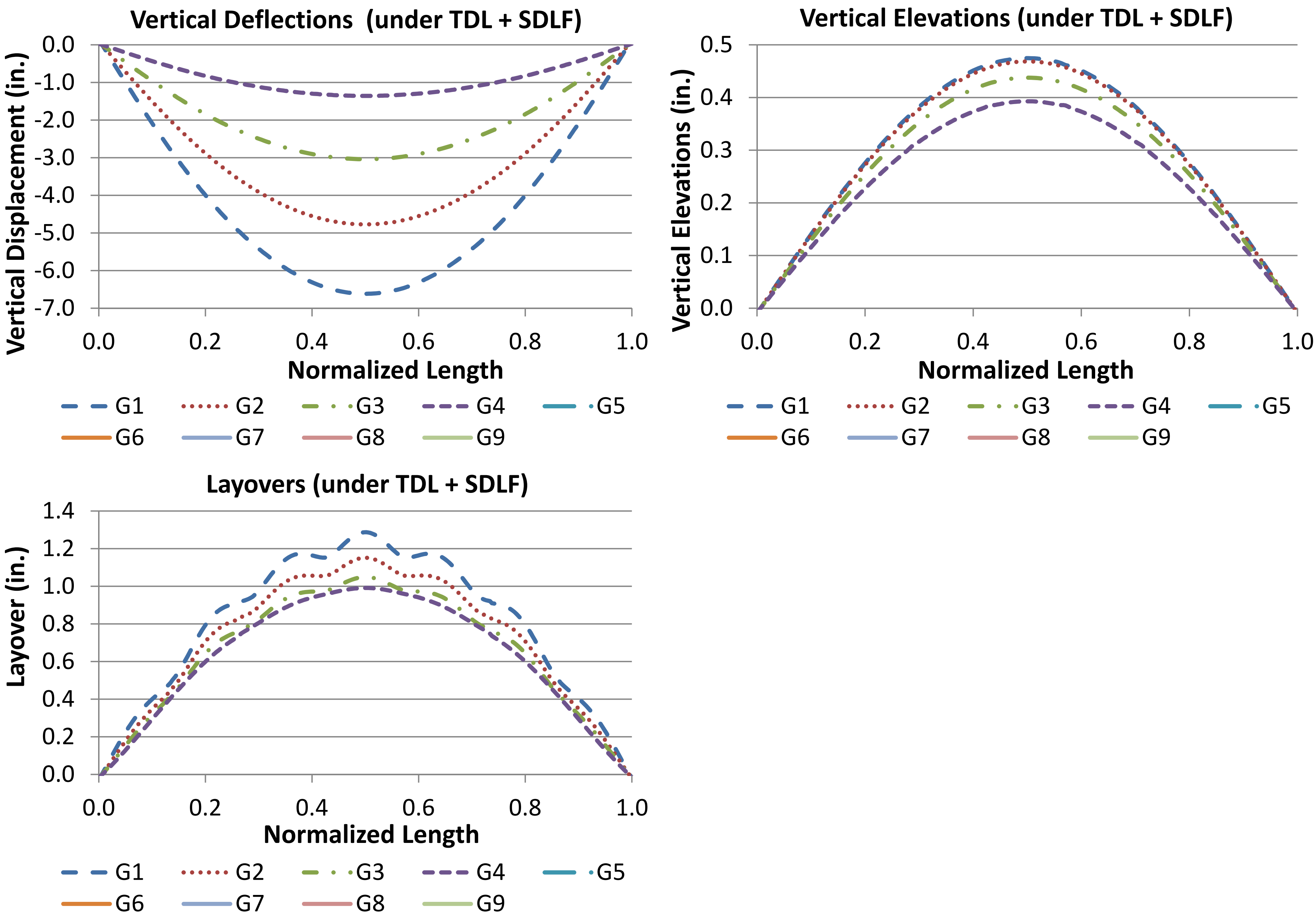


Figure B-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

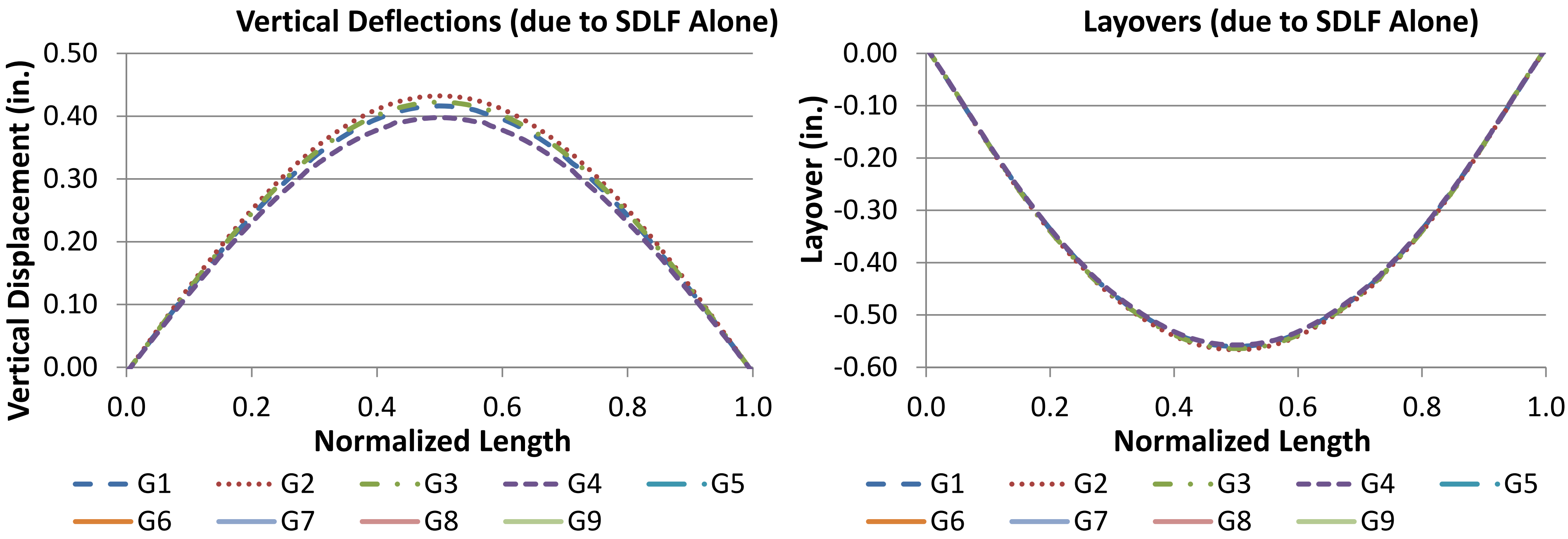


Figure B-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

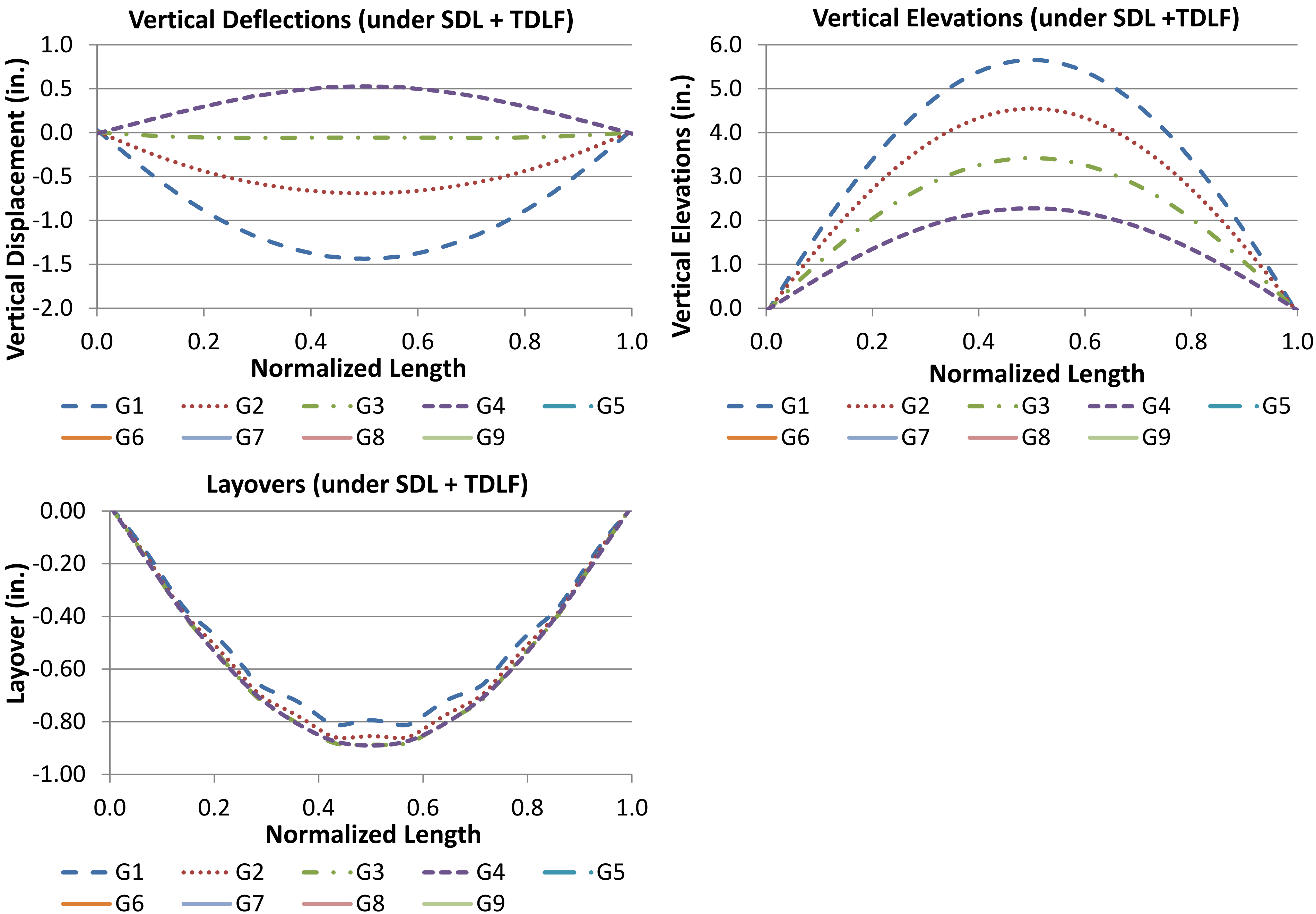


Figure B-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

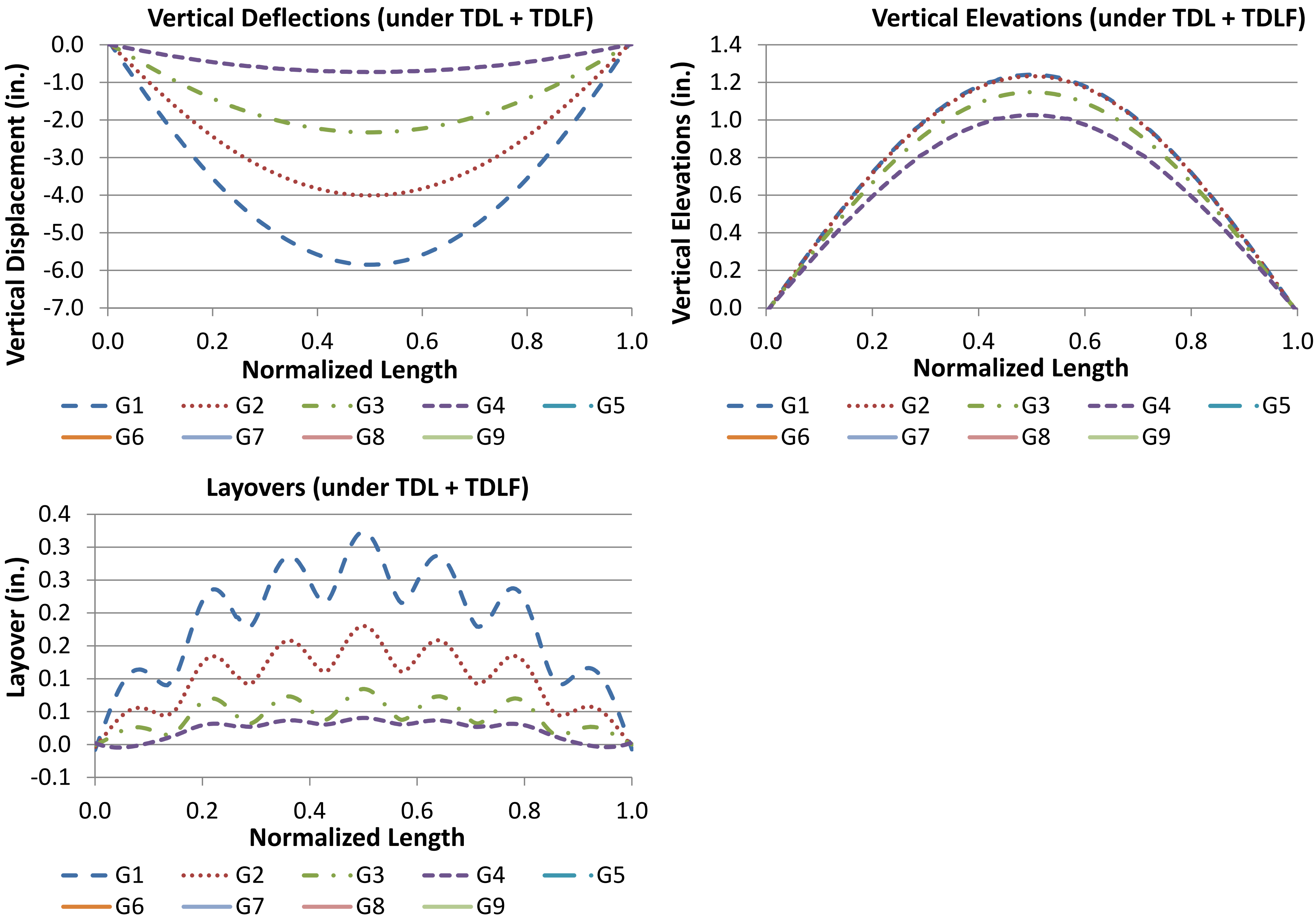


Figure B-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

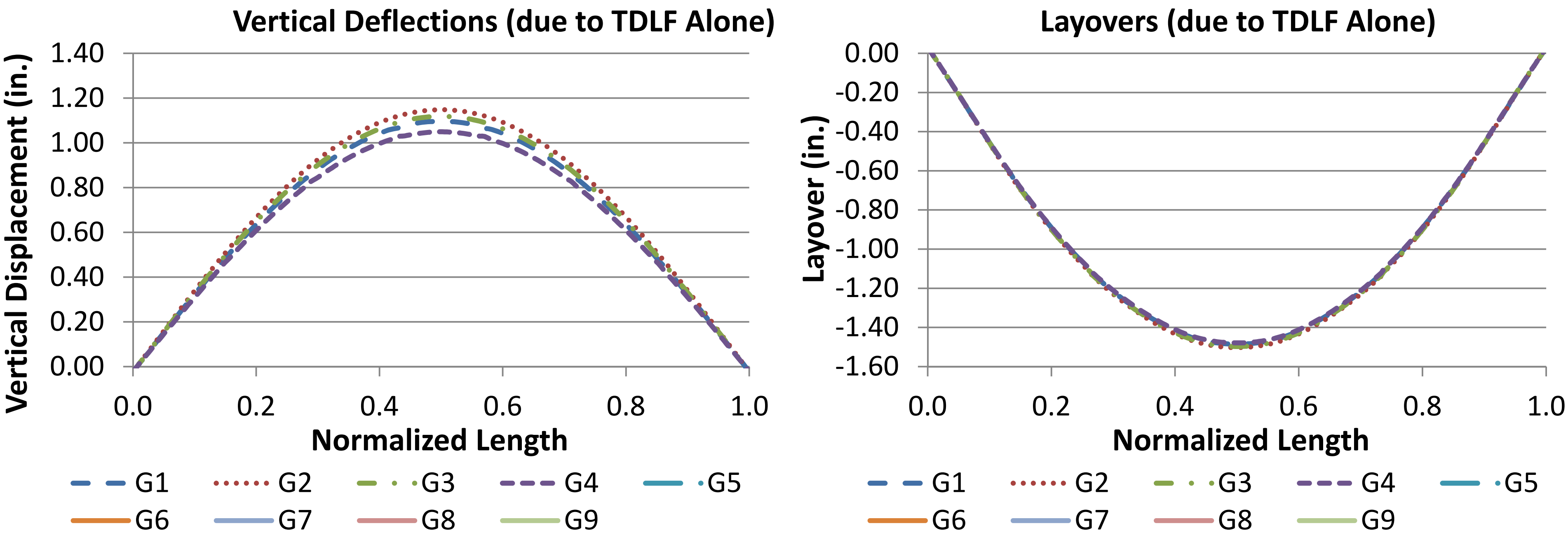


Figure B-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

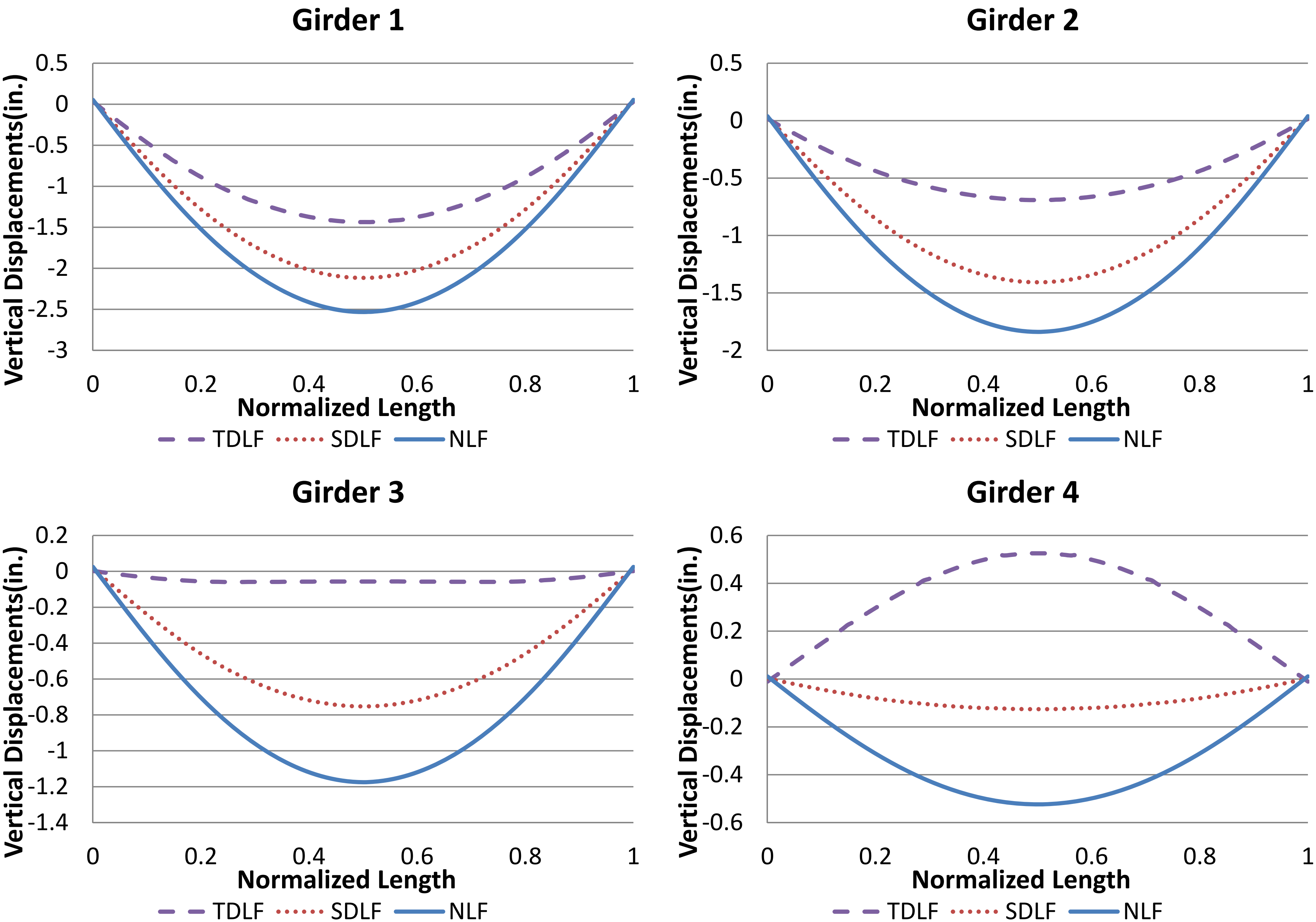


Figure B-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

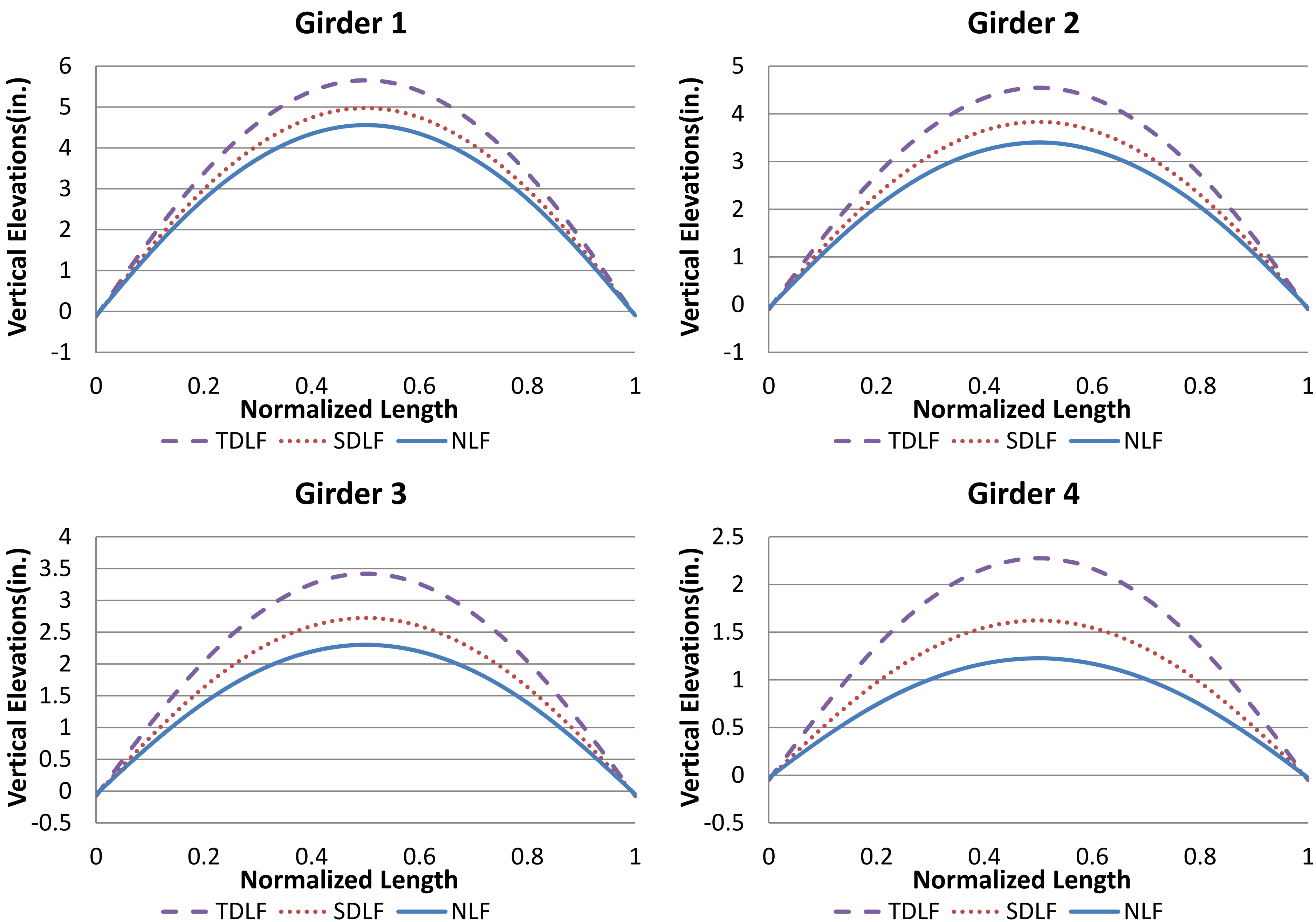


Figure B-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

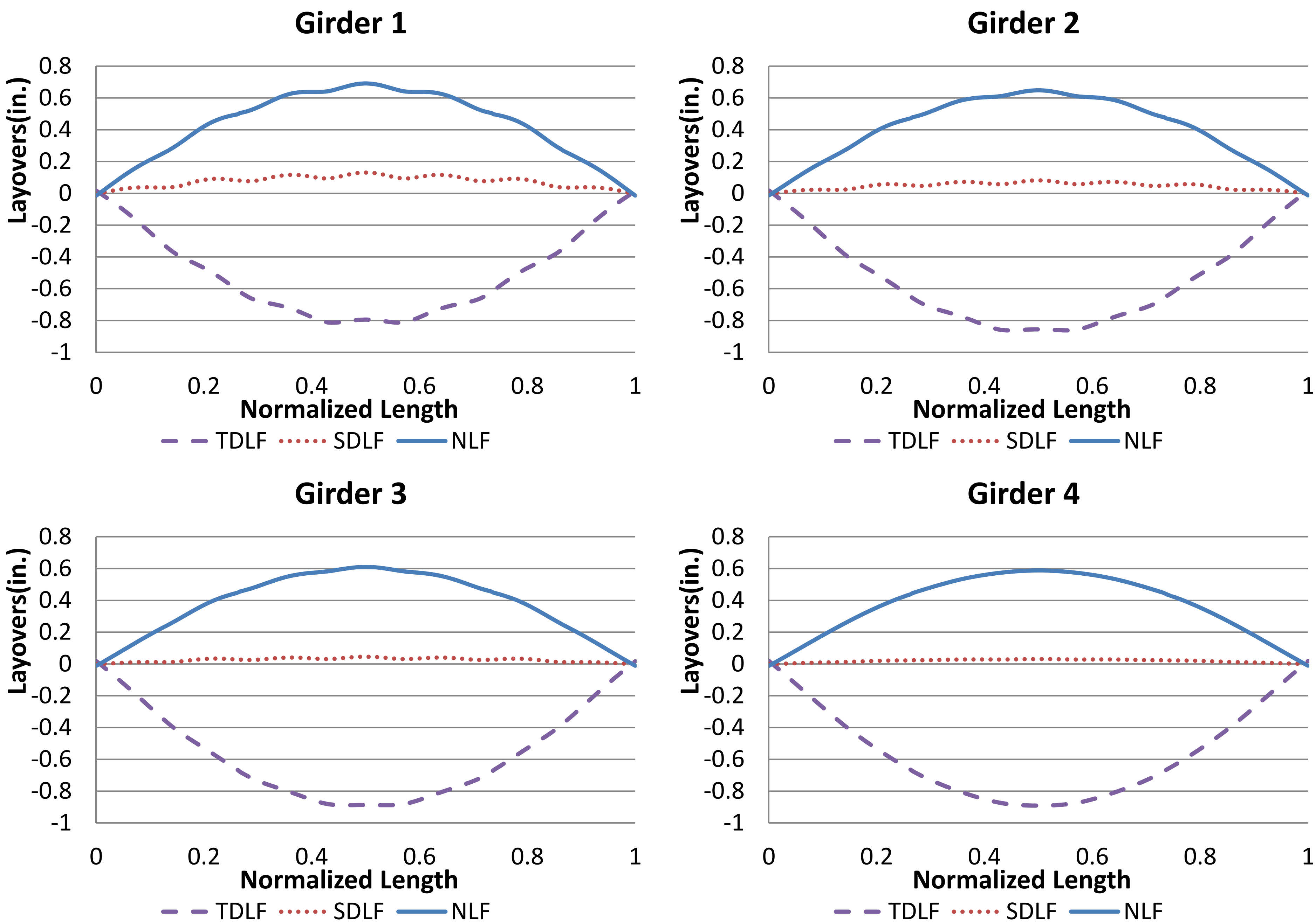


Figure B-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

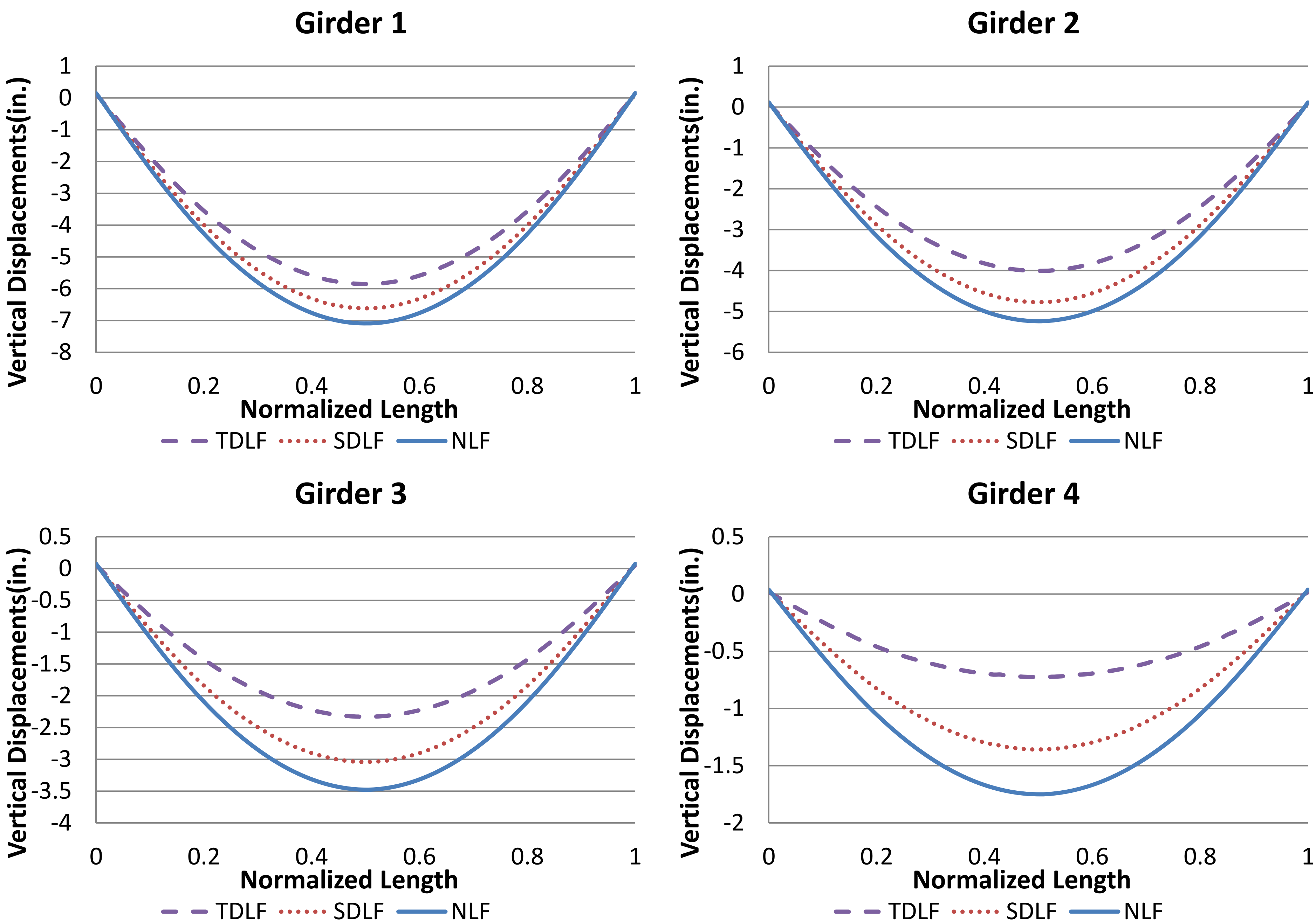


Figure B-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

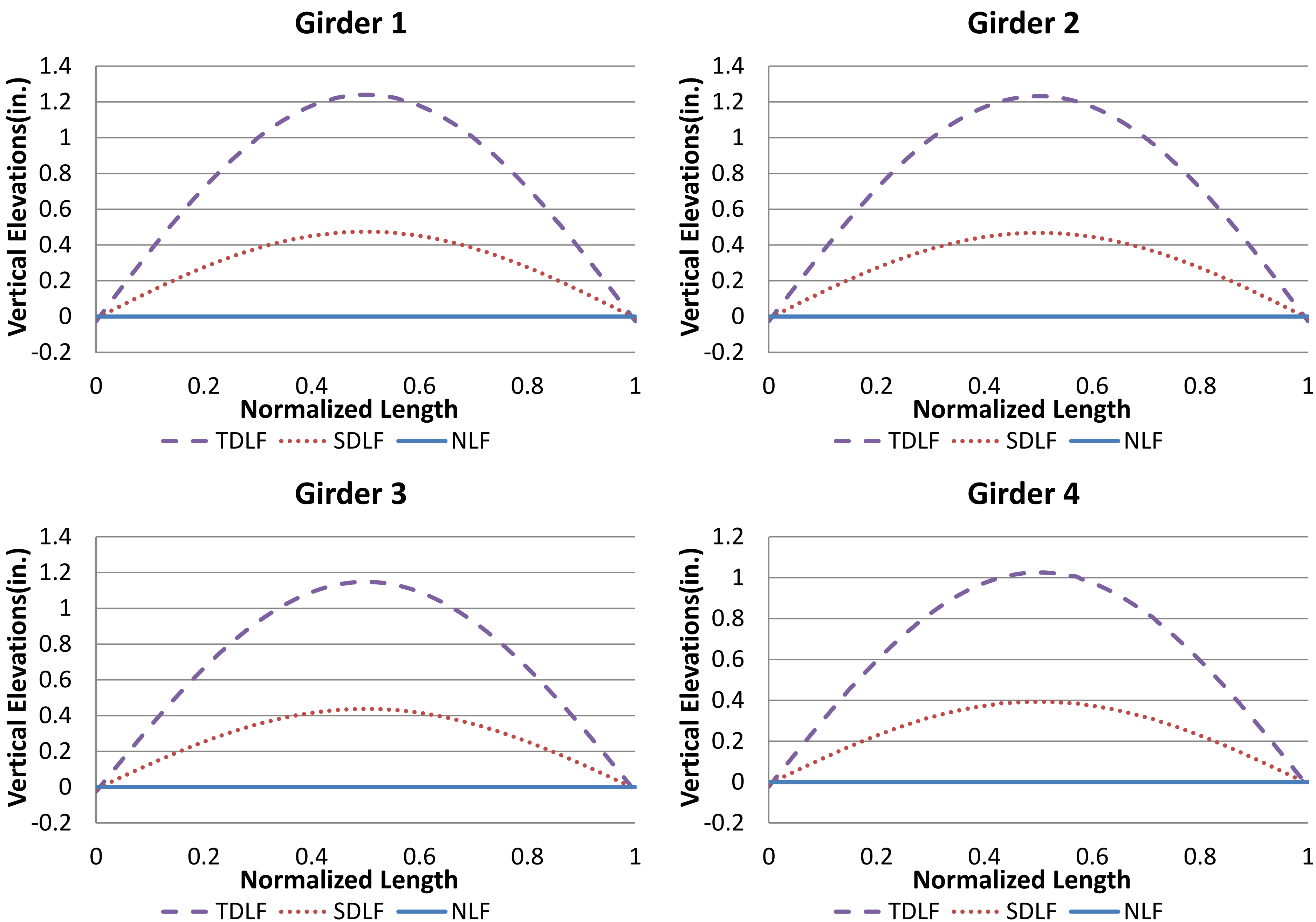


Figure B-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

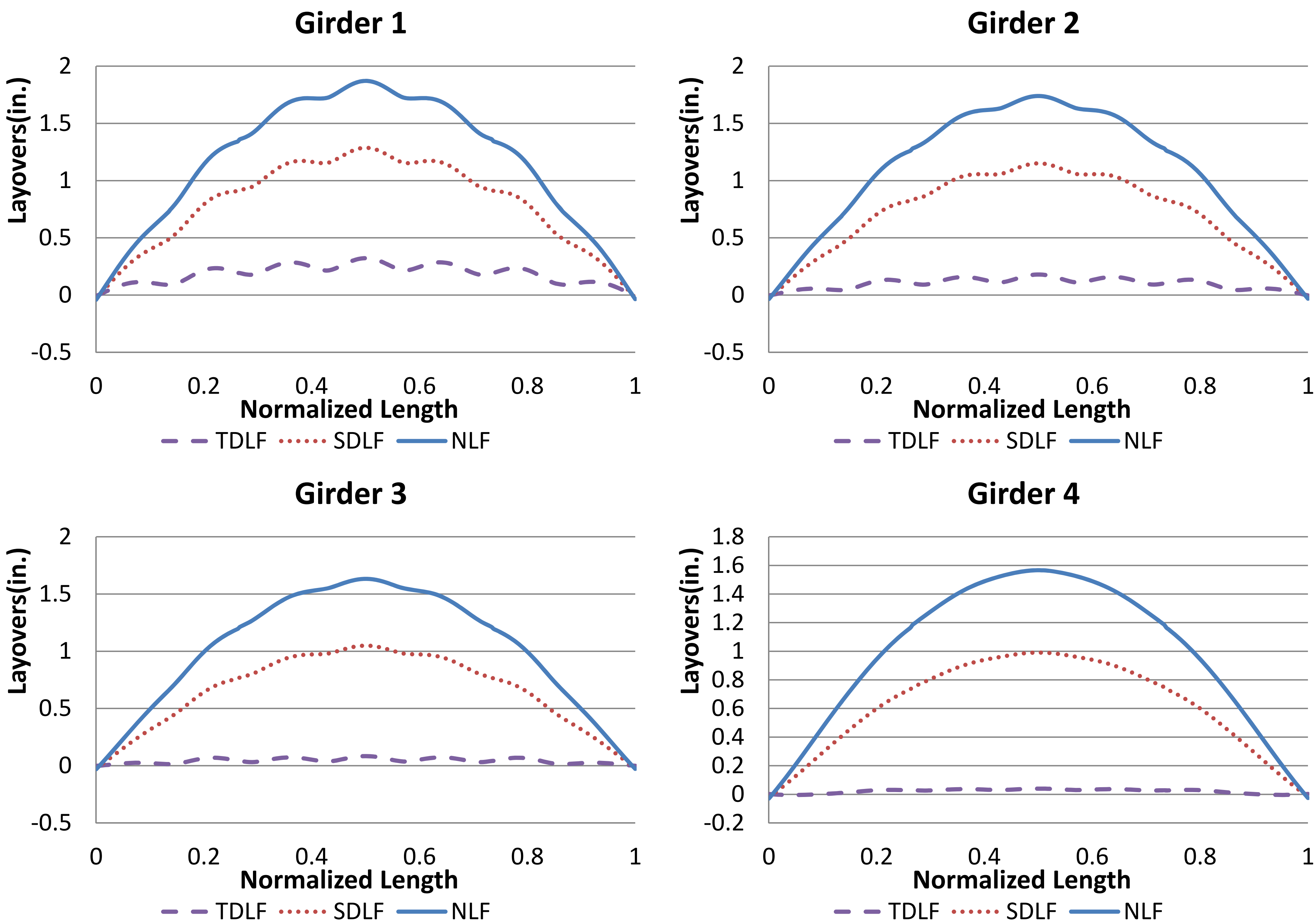


Figure B-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

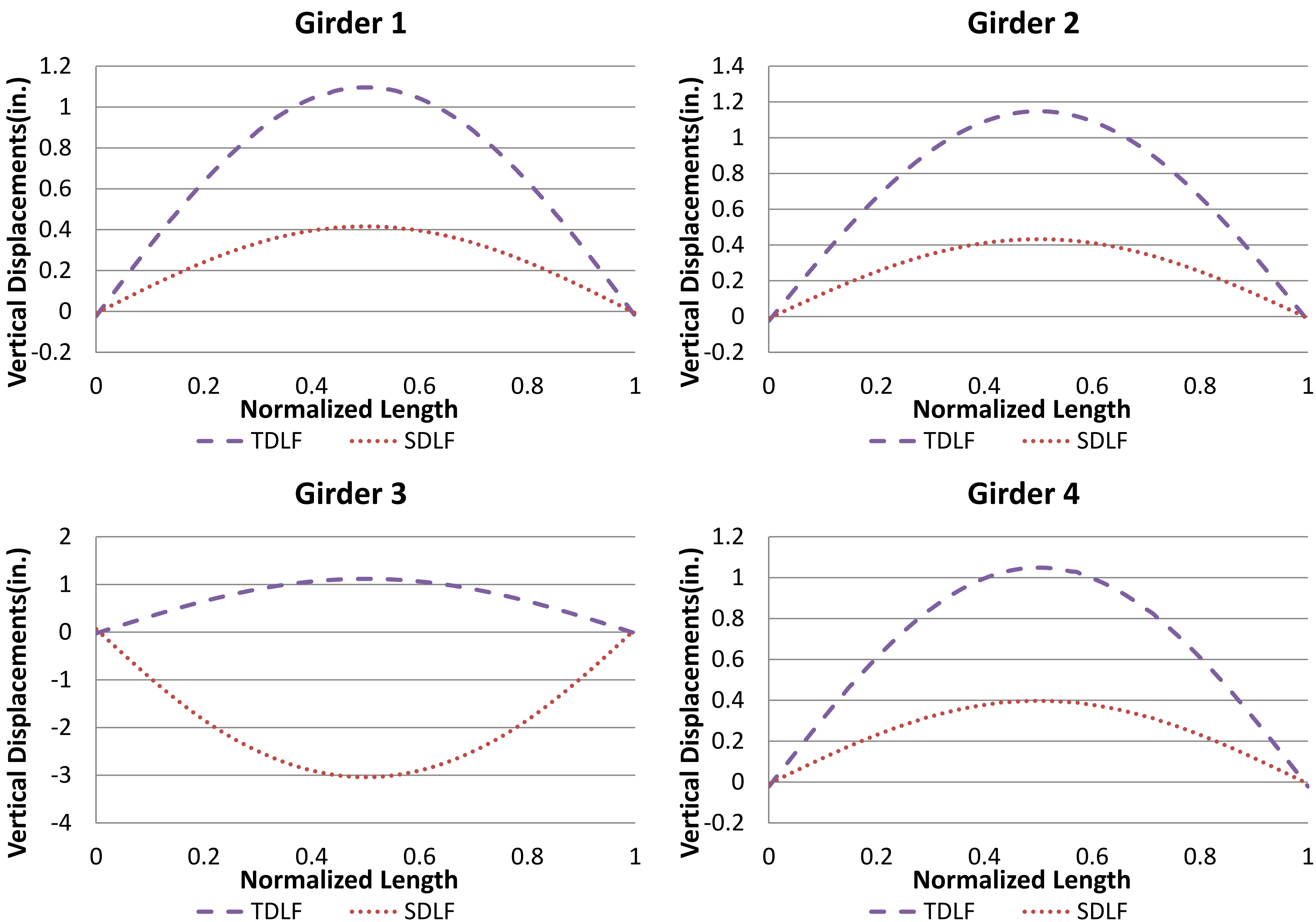


Figure B-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

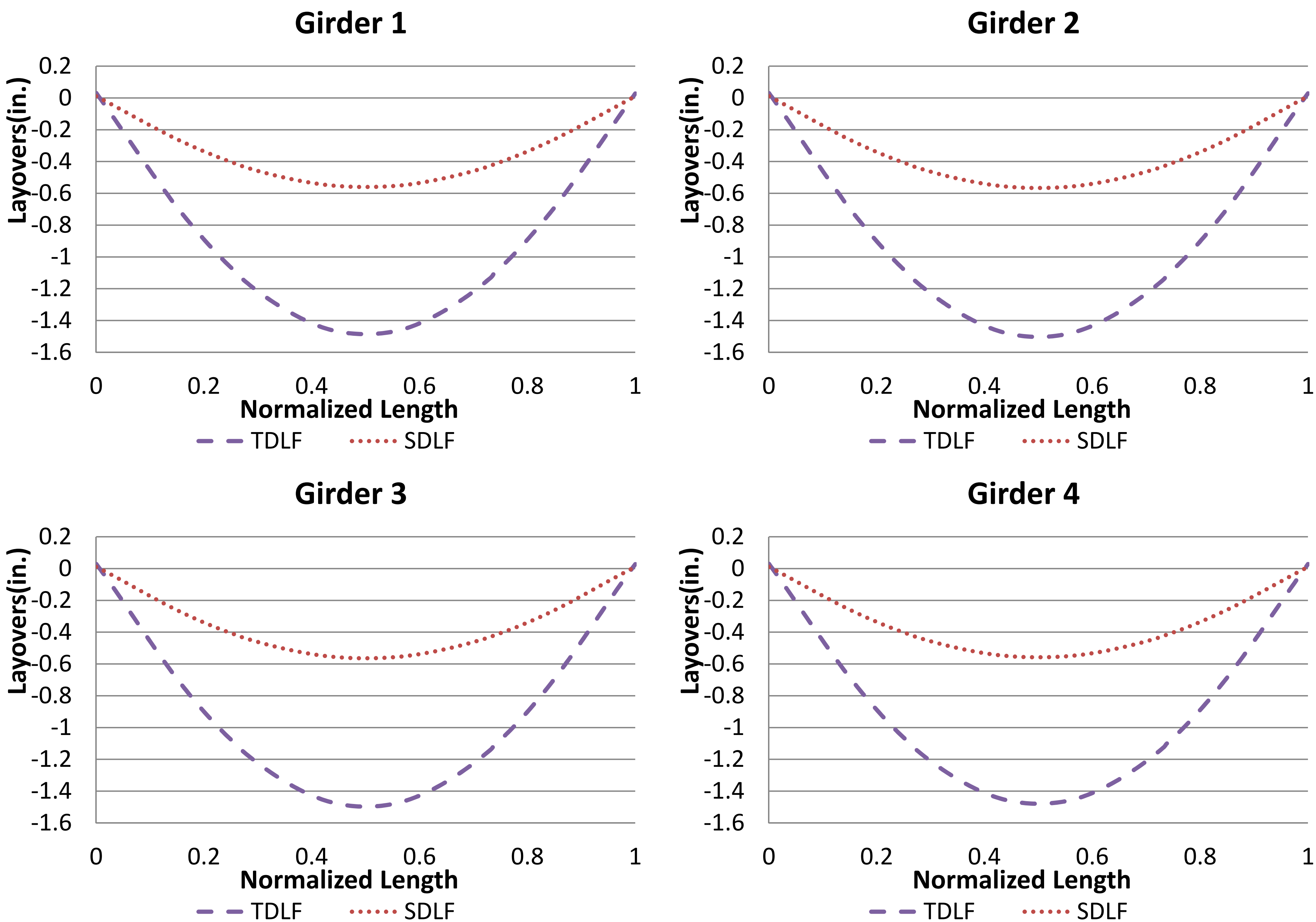


Figure B-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

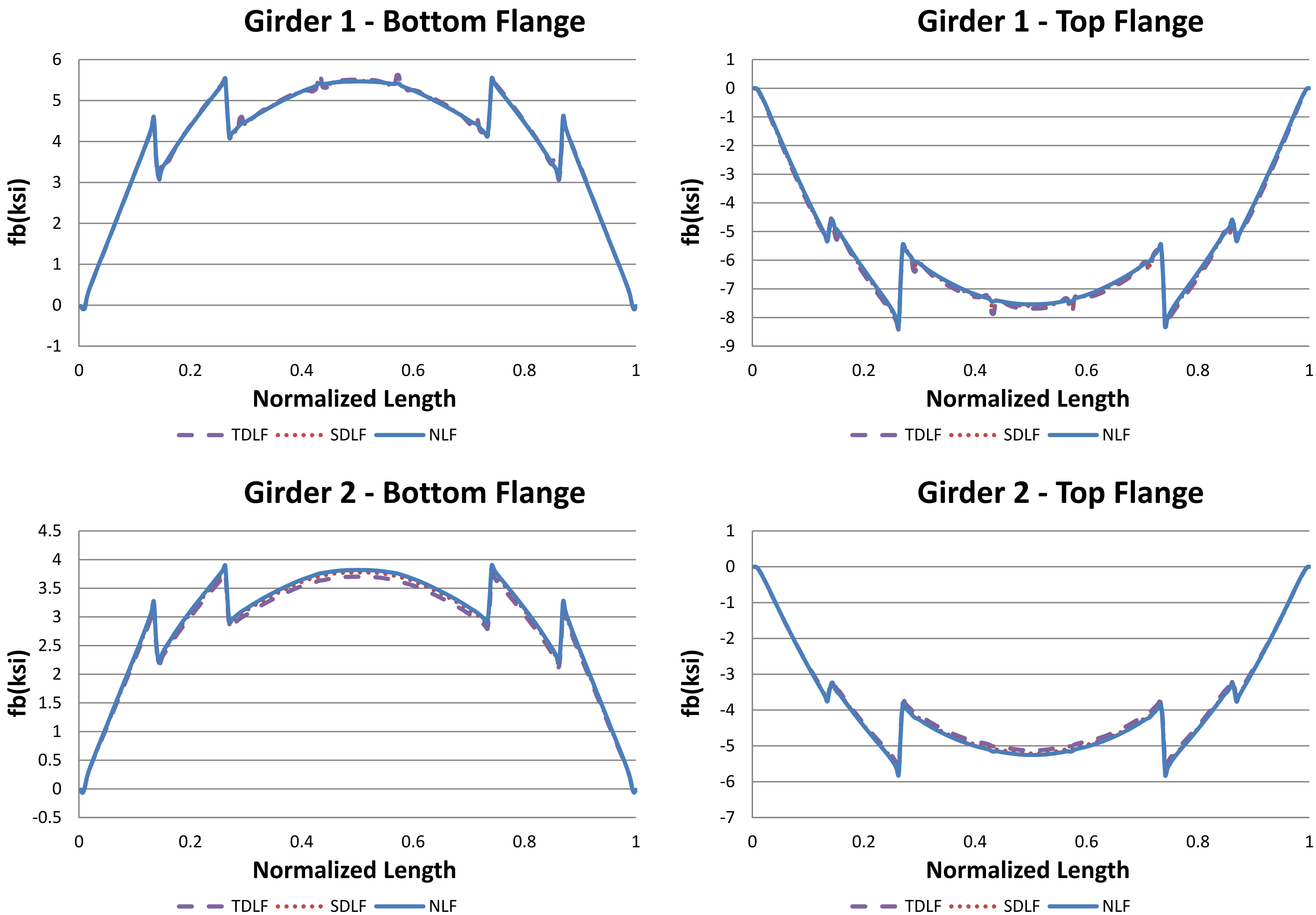


Figure B-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

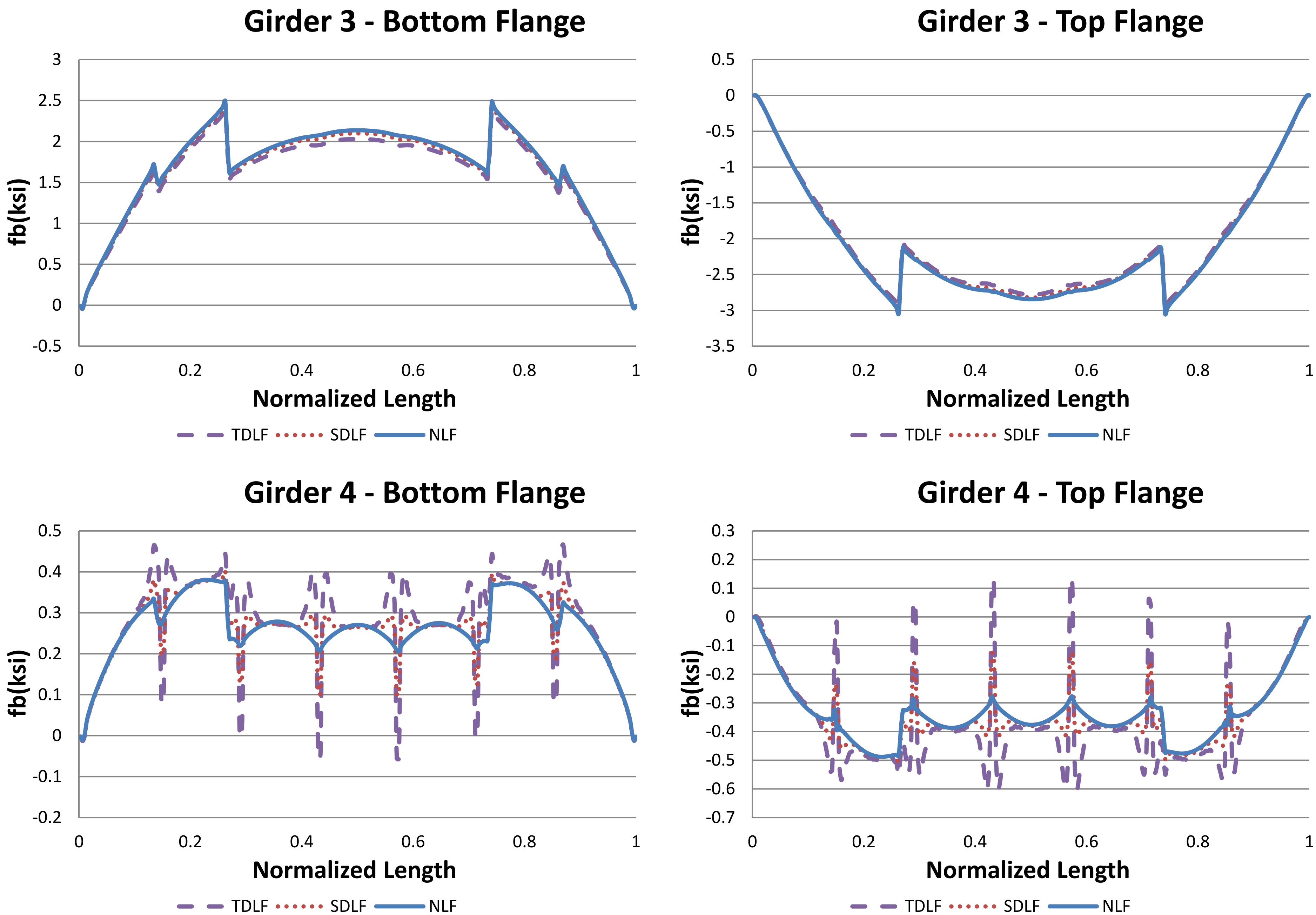


Figure B-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

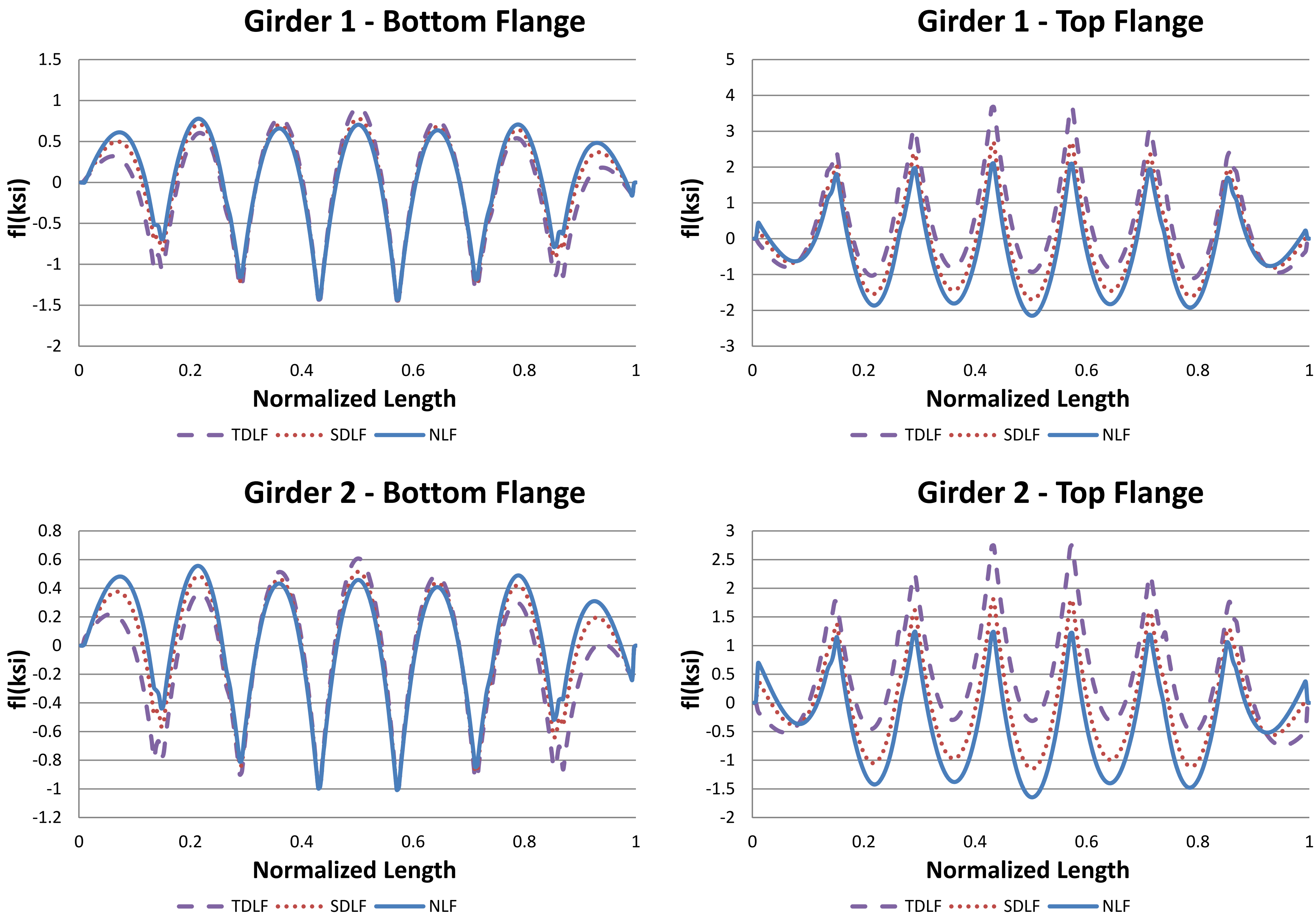


Figure B-4-19. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

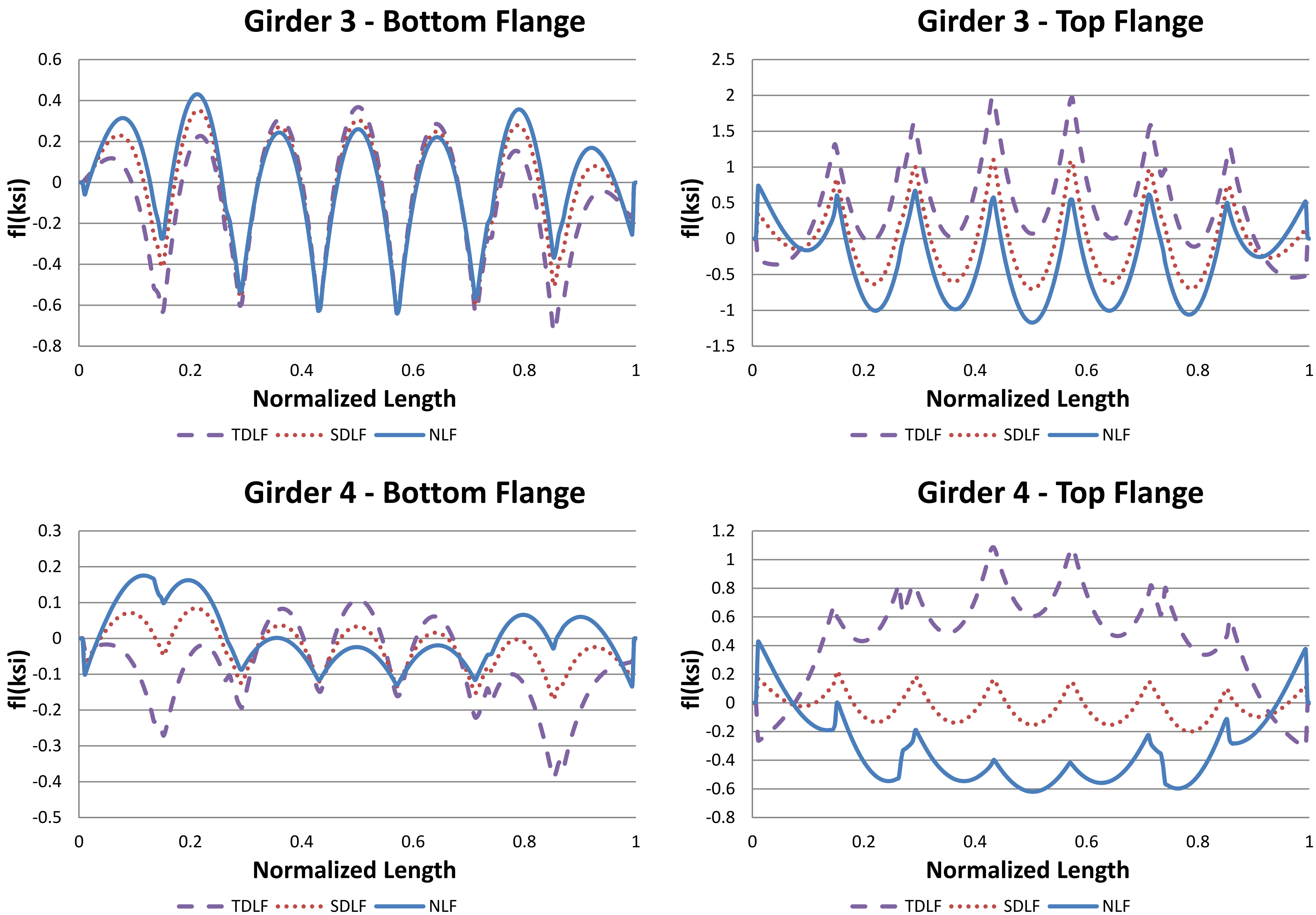


Figure B-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

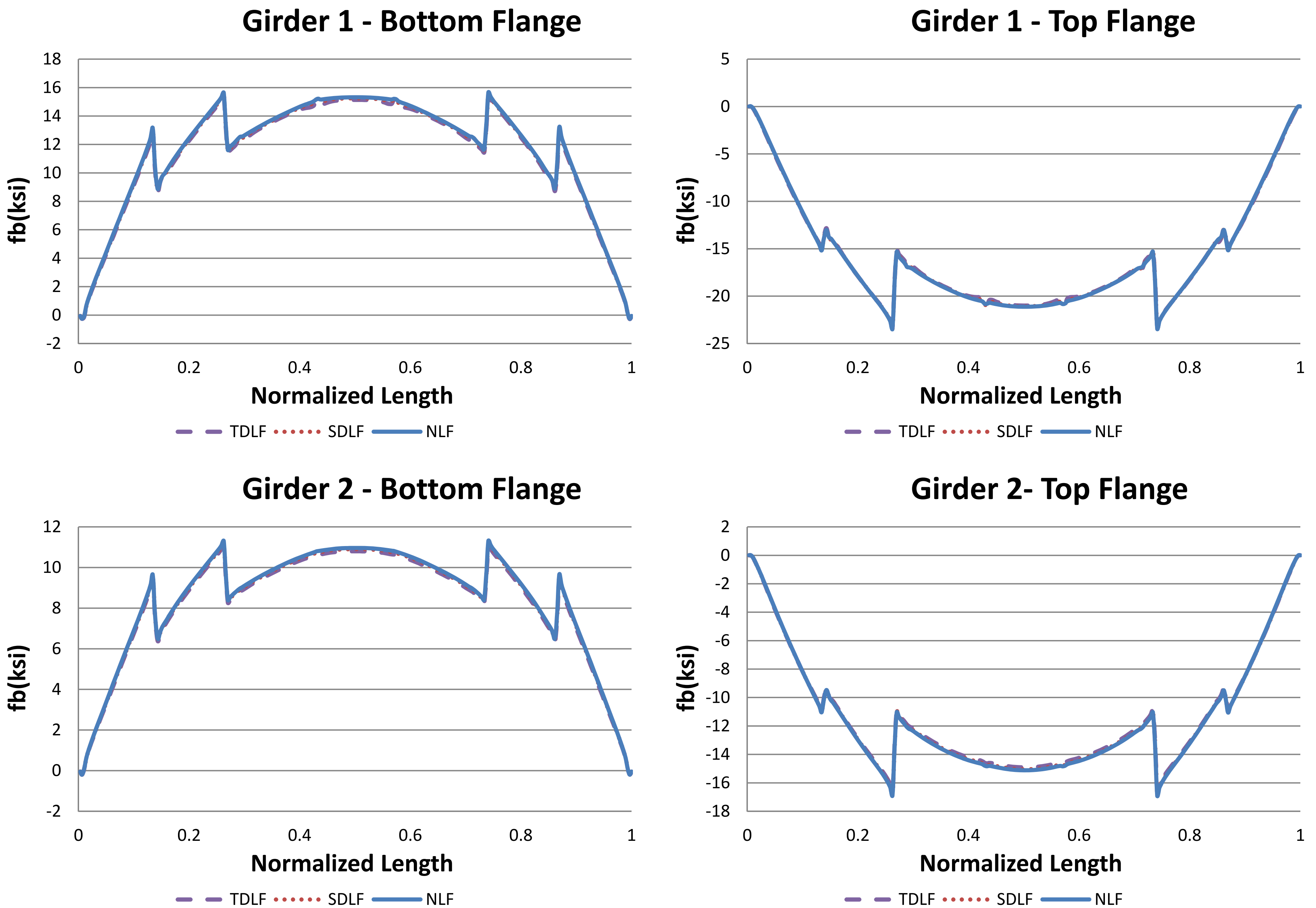


Figure B-4-20. Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

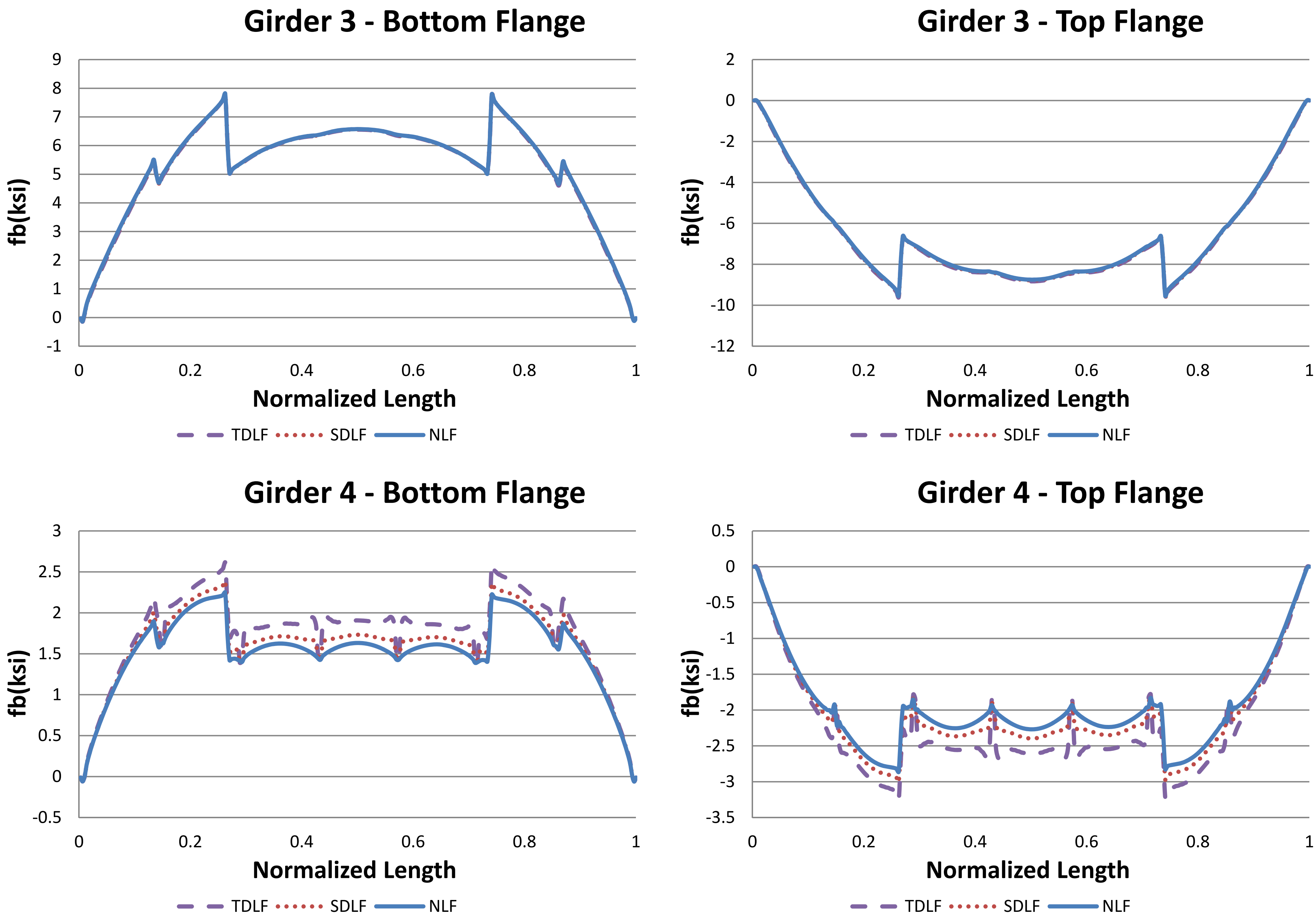


Figure B-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

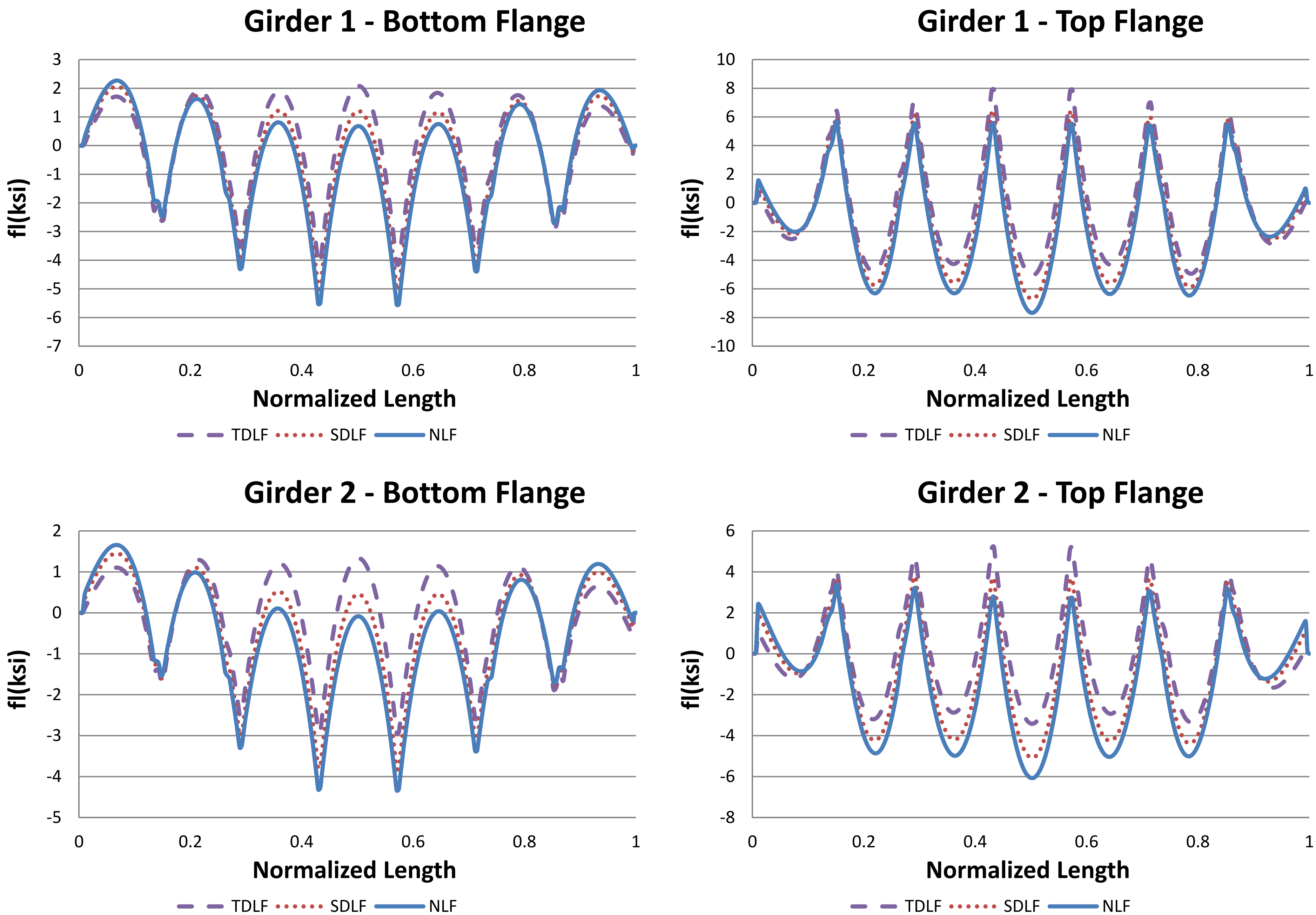


Figure B-4-21. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

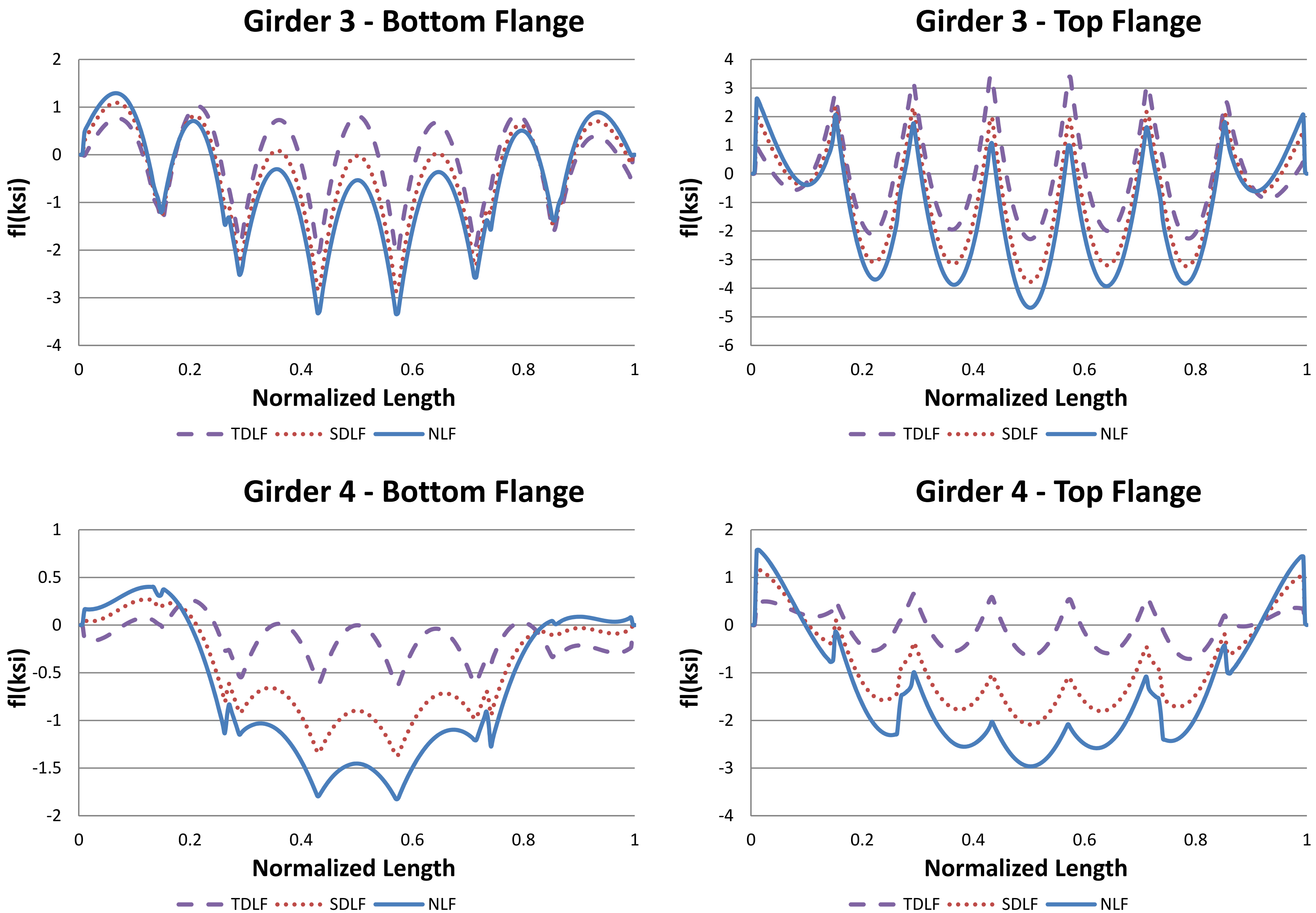


Figure B-4-21(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

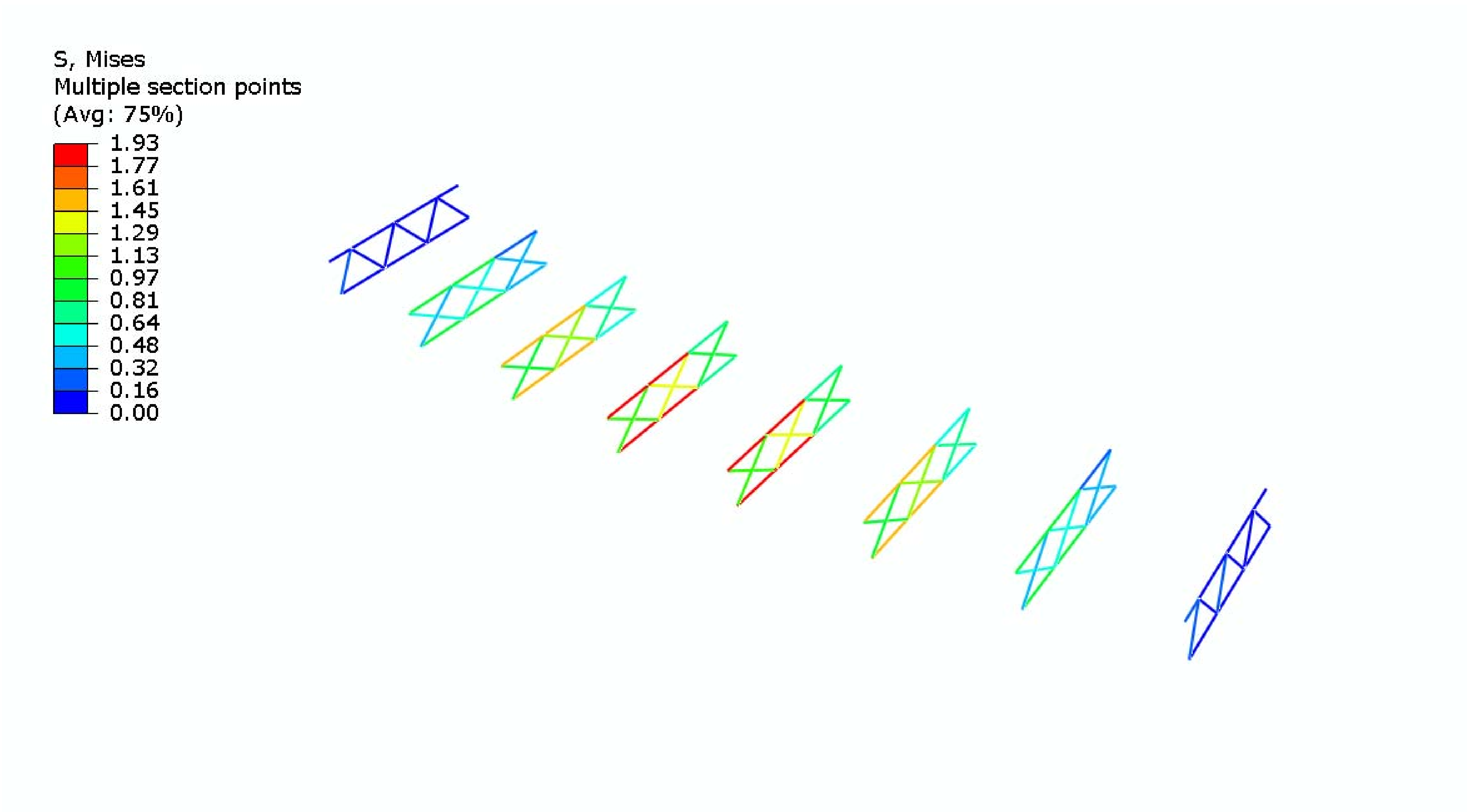


Figure B-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing (cross-frame member areas = 8.46 in^2).

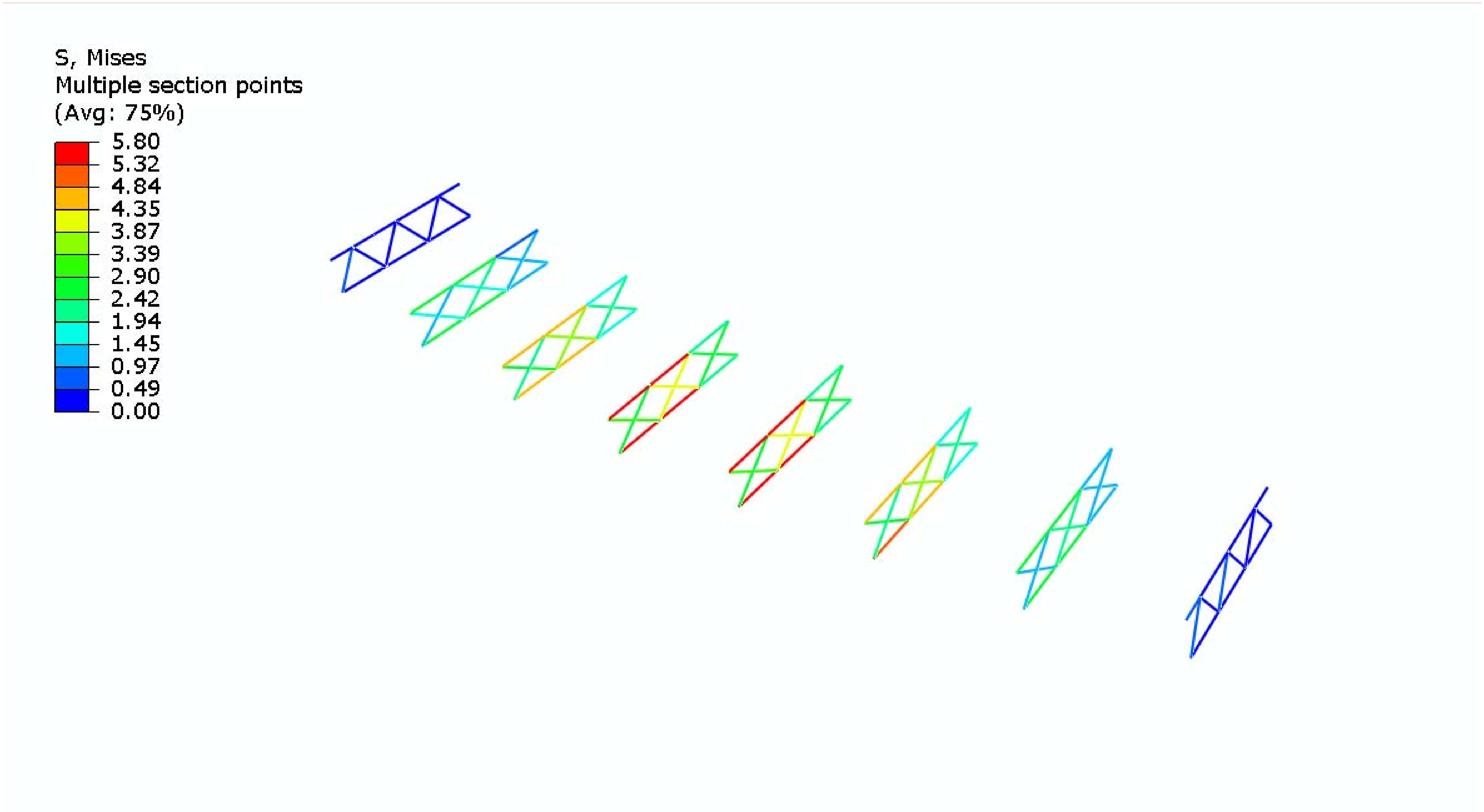


Figure B-4-23. Cross-frame stress contours under TDL, NLF detailing (cross-frame member areas = 8.46 in^2).

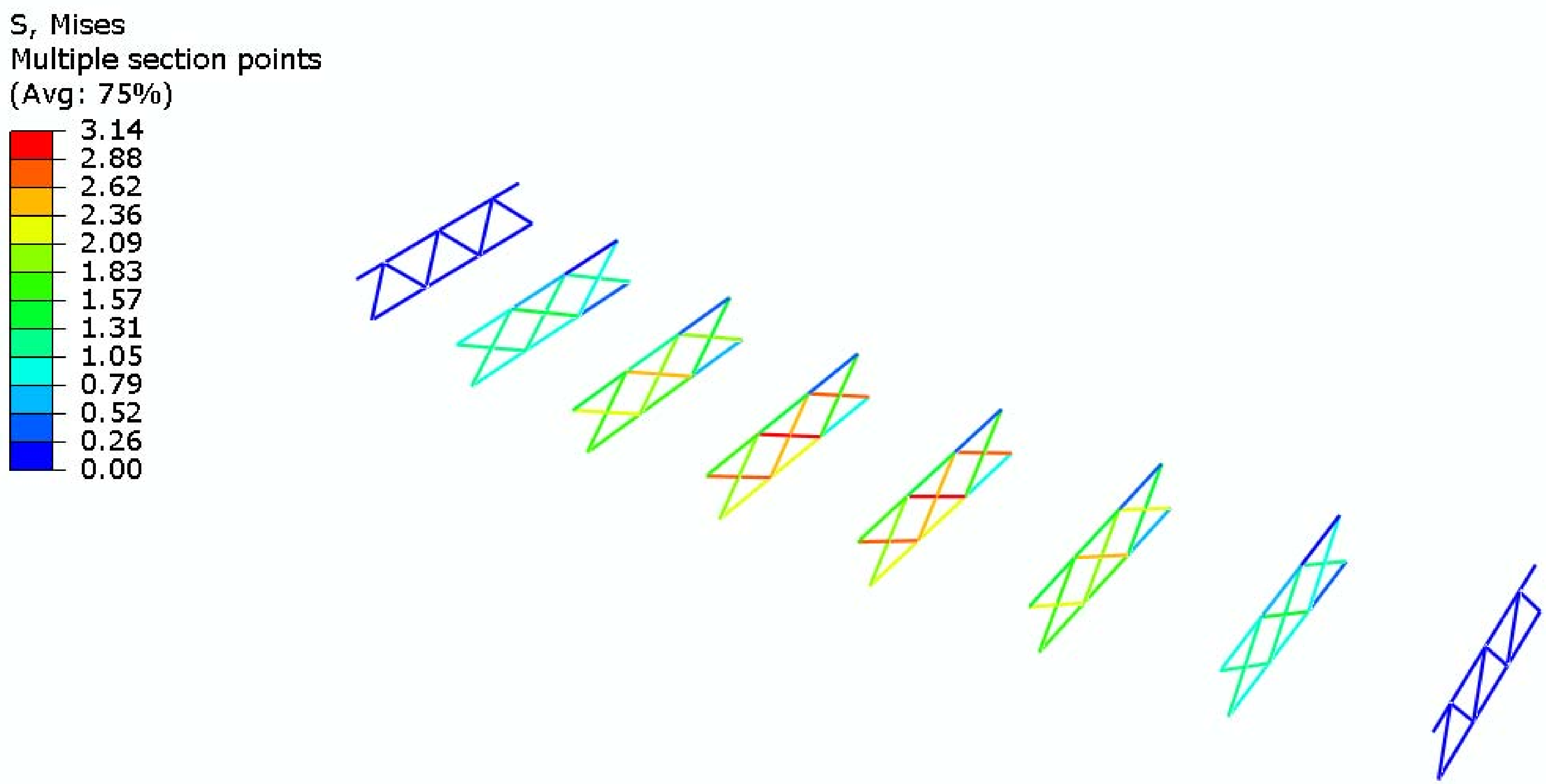


Figure B-4-24. Cross-frame stress contours under SDL, SDLF detailing (cross-frame member areas = 8.46 in^2).

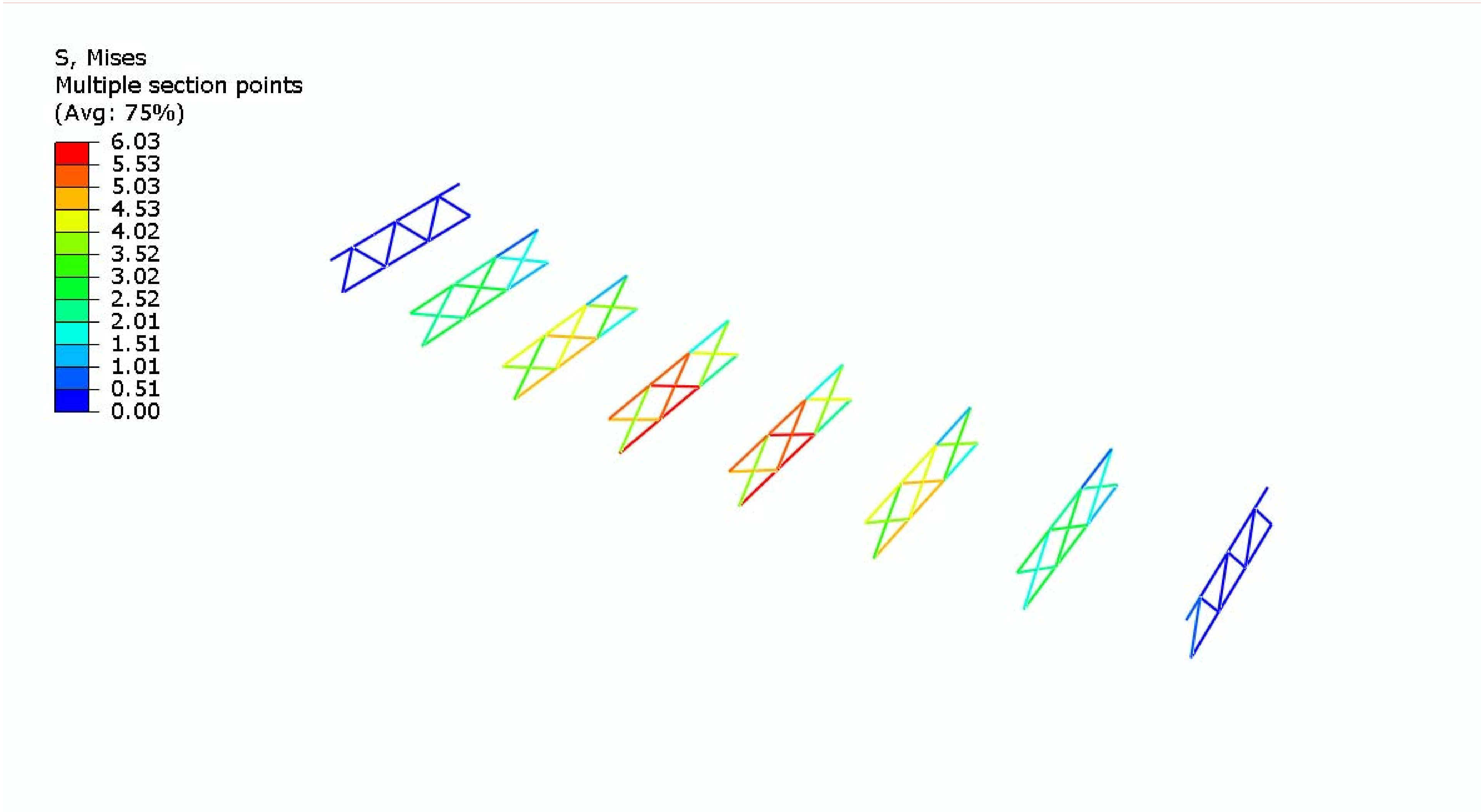


Figure B-4-25. Cross-frame stress contours under TDL, SDLF detailing (cross-frame member areas = 8.46 in^2).

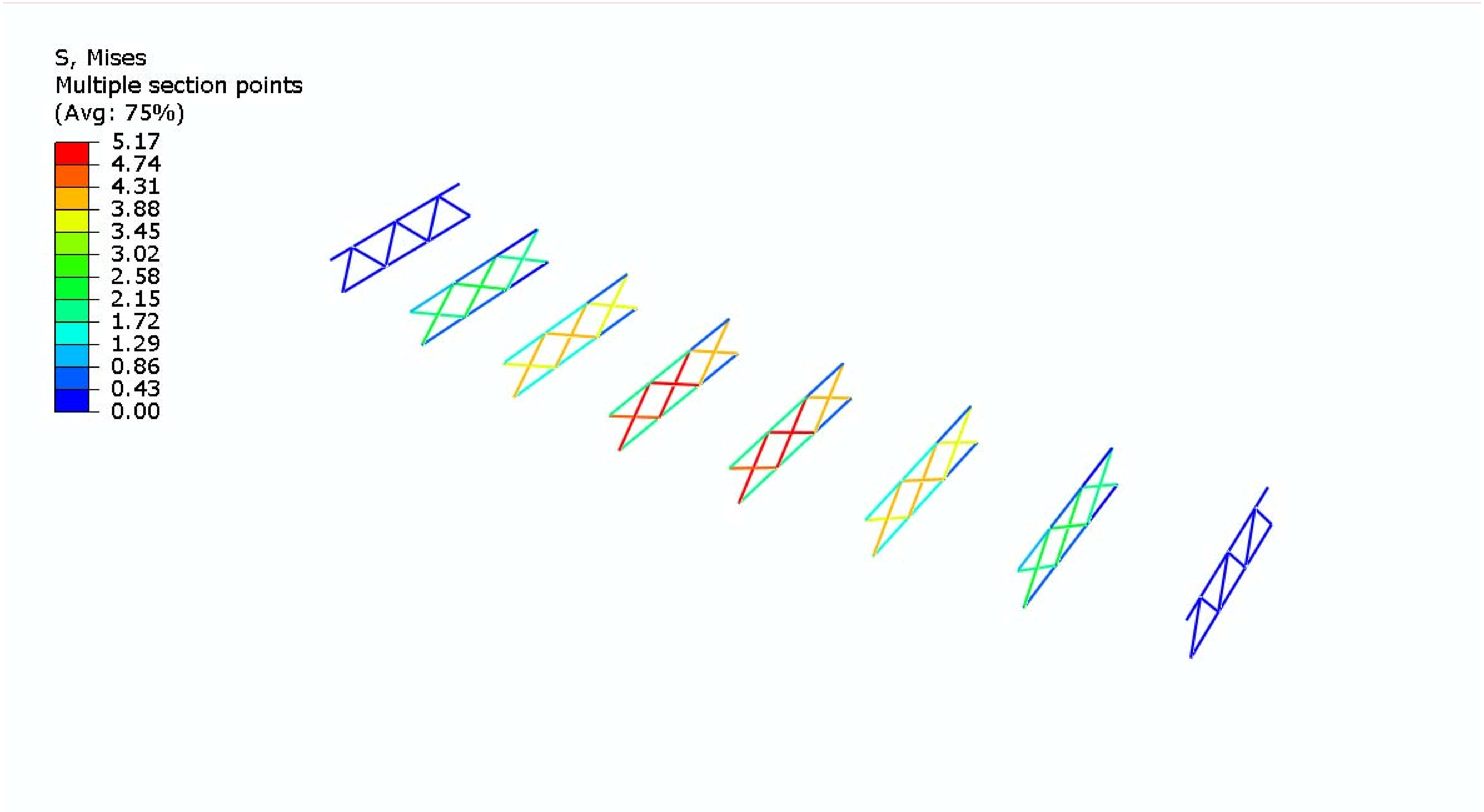


Figure B-4-26. Cross-frame stress contours under SDL, TDLF detailing (cross-frame member areas = 8.46 in^2).

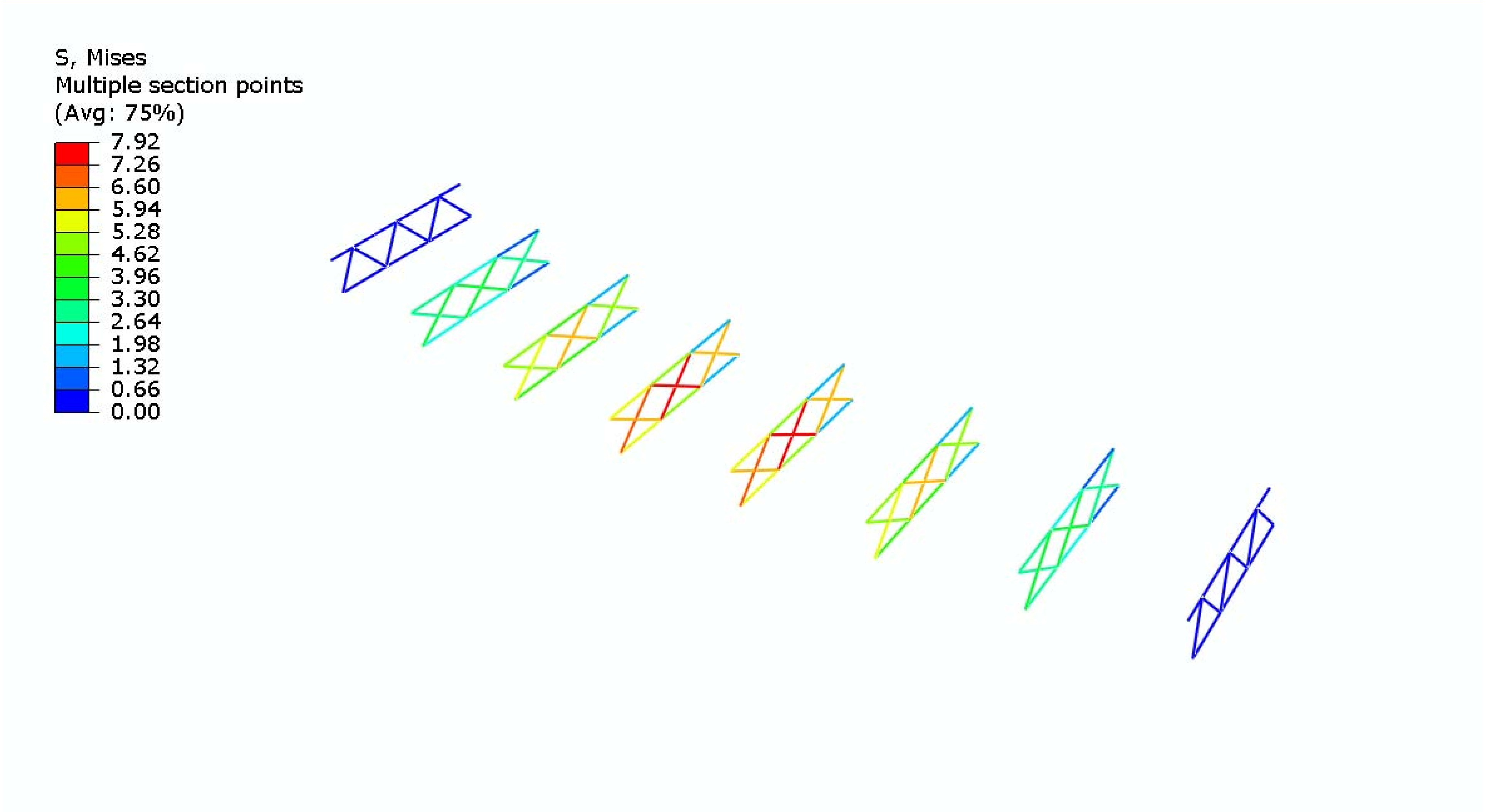


Figure B-4-27. Cross-frame stress contours under TDL, TDLF detailing (cross-frame member areas = 8.46 in^2).

Table B-4-1. Axial forces (kips) in cross-frame diagonals under SDL and TDL for different detailing methods.

		Load Type & CF Location					
CF	Detailing Method	SDL G1-G2	SDL G2-G3	SDL G3-G4	TDL G1-G2	TDL G2-G3	TDL G3-G4
1	NLF	1.1	0.9	0.7	4.0	3.2	2.4
	SDLF	1.0	0.6	0.3	3.8	2.9	1.9
	TDLF	1.0	0.0	-0.2	3.8	2.1	1.2
2	NLF	4.2	5.2	4.0	12.1	16.6	11.3
	SDLF	10.3	11.6	9.8	18.3	23.0	17.1
	TDLF	18.1	19.8	17.2	26.3	31.2	24.5
3	NLF	7.4	9.9	6.7	21.4	31.0	19.9
	SDLF	18.9	21.4	17.8	32.8	42.3	30.7
	TDLF	30.9	33.9	29.9	44.5	54.3	42.5
4	NLF	8.6	11.6	8.1	25.4	36.1	24.2
	SDLF	23.6	26.6	22.2	40.0	50.7	37.9
	TDLF	37.7	41.8	36.3	53.6	65.3	51.5
5	NLF	8.6	11.6	8.1	25.4	36.1	24.1
	SDLF	23.6	26.6	22.2	40.0	50.7	37.9
	TDLF	37.7	41.8	36.3	53.6	65.3	51.5
6	NLF	7.4	9.9	6.7	21.5	31.0	19.8
	SDLF	18.9	21.4	17.7	32.8	42.3	30.6
	TDLF	30.9	33.8	29.8	44.5	54.3	42.4
7	NLF	4.3	5.2	3.9	12.5	16.4	10.8
	SDLF	10.3	11.5	9.7	18.6	22.7	16.7
	TDLF	17.9	19.8	17.3	26.3	31.0	24.3
8	NLF	0.8	0.0	0.1	2.8	0.1	-0.2
	SDLF	0.9	0.3	0.2	3.0	0.5	0.0
	TDLF	0.4	1.2	0.5	2.7	1.7	0.7

Table B-4-2. Axial forces (kips) in cross-frame bottom chord under SDL and TDL for different detailing methods.

		Load Type & CF Location					
CF	Detailing Method	SDL G1-G2	SDL G2-G3	SDL G3-G4	TDL G1-G2	TDL G2-G3	TDL G3-G4
1	NLF	-0.6	-0.2	0.1	-3.0	-0.4	-1.0
	SDLF	-0.5	-0.1	0.0	-2.8	-0.4	-0.9
	TDLF	-0.2	0.1	0.0	-2.4	-0.1	-0.9
2	NLF	-7.6	-7.4	-2.8	-24.3	-22.4	-9.0
	SDLF	-8.0	-7.7	-3.3	-24.5	-22.5	-9.3
	TDLF	-6.7	-6.5	-2.5	-22.7	-20.8	-8.2
3	NLF	-13.5	-12.8	-4.6	-41.0	-37.7	-13.3
	SDLF	-15.1	-14.4	-6.6	-42.0	-38.9	-15.0
	TDLF	-12.0	-12.2	-5.1	-38.1	-35.7	-13.1
4	NLF	-16.4	-15.7	-5.9	-49.1	-46.0	-16.7
	SDLF	-19.0	-18.3	-8.7	-51.0	-47.9	-19.2
	TDLF	-15.2	-15.2	-6.2	-46.1	-43.7	-16.3
5	NLF	-16.3	-15.7	-5.9	-49.0	-45.9	-16.7
	SDLF	-19.0	-18.3	-8.7	-51.0	-47.8	-19.2
	TDLF	-15.1	-15.2	-6.2	-46.0	-43.7	-16.3
6	NLF	-13.5	-12.7	-4.6	-40.8	-37.4	-13.2
	SDLF	-15.0	-14.3	-6.5	-41.8	-38.6	-14.9
	TDLF	-12.0	-12.1	-5.0	-37.9	-35.4	-13.0
7	NLF	-7.4	-7.2	-2.8	-23.7	-21.8	-8.9
	SDLF	-7.8	-7.6	-3.3	-23.9	-21.9	-9.3
	TDLF	-6.6	-6.6	-2.6	-22.3	-20.4	-8.2
8	NLF	-0.2	0.1	0.0	-1.8	0.0	-0.9
	SDLF	-0.3	0.0	0.0	-1.8	0.0	-0.9
	TDLF	-0.7	0.0	-0.2	-2.1	0.0	-0.9

Table B-4-3. Maximum axial forces (kips) in cross-frame top chord under SDL and TDL for different detailing methods.

		Load Type & CF Location					
CF	**Detailing Method**	**SDL G1-G2**	**SDL G2-G3**	**SDL G3-G4**	**TDL G1-G2**	**TDL G2-G3**	**TDL G3-G4**
1	NLF	1.4	0.9	0.4	5.0	3.2	2.1
	SDLF	1.1	0.6	0.3	4.7	3.0	1.9
	TDLF	0.6	-0.1	0.0	4.3	2.3	1.6
2	NLF	7.3	7.3	2.7	23.3	21.9	8.4
	SDLF	6.9	6.6	2.0	22.7	21.0	7.6
	TDLF	8.1	7.0	2.3	23.6	21.0	7.7
3	NLF	13.3	12.9	4.7	40.4	38.1	13.5
	SDLF	11.6	11.1	2.8	38.1	35.6	11.3
	TDLF	14.5	12.9	4.5	39.9	36.3	12.4
4	NLF	16.2	15.9	6.0	49.0	46.9	17.3
	SDLF	13.6	13.1	3.1	45.4	43.1	13.9
	TDLF	17.5	15.7	5.2	47.8	44.0	15.2
5	NLF	16.2	15.9	6.0	49.0	46.9	17.3
	SDLF	13.6	13.1	3.1	45.4	43.0	13.8
	TDLF	17.5	15.7	5.2	47.8	44.0	15.2
6	NLF	13.3	12.8	4.7	40.2	37.9	13.4
	SDLF	11.6	11.0	2.8	38.0	35.4	11.3
	TDLF	14.4	12.9	4.5	39.8	36.2	12.4
7	NLF	7.2	7.1	2.6	22.8	21.1	8.1
	SDLF	6.8	6.5	1.9	22.3	20.4	7.3
	TDLF	8.2	7.1	2.3	23.4	20.7	7.6
8	NLF	1.0	0.3	0.2	3.4	1.0	0.9
	SDLF	0.9	0.5	0.3	3.5	1.3	1.0
	TDLF	0.8	1.3	0.5	3.7	2.4	1.5

Table B-4-4. Vertical differential displacements (in) at cross-frames under SDL and TDL for different detailing methods.

		Load Type & CF Location					
CF	Detailing Method	SDL G1-G2	SDL G2-G3	SDL G3-G4	TDL G1-G2	TDL G2-G3	TDL G3-G4
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.32	0.31	0.30	0.85	0.81	0.79
	SDLF	0.33	0.30	0.29	0.85	0.80	0.77
	TDLF	0.35	0.29	0.27	0.85	0.77	0.74
3	NLF	0.55	0.53	0.52	1.48	1.41	1.38
	SDLF	0.57	0.52	0.50	1.48	1.38	1.35
	TDLF	0.60	0.51	0.47	1.48	1.34	1.29
4	NLF	0.68	0.65	0.64	1.81	1.72	1.69
	SDLF	0.70	0.64	0.62	1.81	1.69	1.65
	TDLF	0.74	0.62	0.58	1.81	1.64	1.58
5	NLF	0.68	0.65	0.64	1.81	1.72	1.69
	SDLF	0.70	0.64	0.62	1.81	1.69	1.65
	TDLF	0.73	0.62	0.58	1.81	1.64	1.58
6	NLF	0.55	0.53	0.52	1.48	1.41	1.38
	SDLF	0.57	0.52	0.50	1.48	1.38	1.35
	TDLF	0.60	0.51	0.47	1.48	1.34	1.29
7	NLF	0.32	0.31	0.30	0.85	0.81	0.79
	SDLF	0.33	0.30	0.29	0.85	0.80	0.77
	TDLF	0.34	0.29	0.27	0.85	0.77	0.74
8	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00

Table B-4-5. Approximate horizontal differential displacements (in) at cross-frames under SDL and TDL for different detailing methods, assuming negligible cross-frame deformations.

		Load Type & CF Location					
CF	Detailing Method	SDL G1-G2	SDL G2-G3	SDL G3-G4	TDL G1-G2	TDL G2-G3	TDL G3-G4
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.25	0.24	0.23	0.66	0.62	0.61
	SDLF	0.25	0.23	0.22	0.66	0.62	0.59
	TDLF	0.27	0.22	0.21	0.66	0.59	0.57
3	NLF	0.42	0.41	0.40	1.14	1.09	1.06
	SDLF	0.44	0.40	0.39	1.14	1.06	1.04
	TDLF	0.46	0.39	0.36	1.14	1.03	0.99
4	NLF	0.52	0.50	0.49	1.40	1.33	1.30
	SDLF	0.54	0.49	0.48	1.40	1.30	1.27
	TDLF	0.57	0.48	0.45	1.40	1.26	1.22
5	NLF	0.52	0.50	0.49	1.40	1.33	1.30
	SDLF	0.54	0.49	0.48	1.40	1.30	1.27
	TDLF	0.56	0.48	0.45	1.40	1.26	1.22
6	NLF	0.42	0.41	0.40	1.14	1.09	1.06
	SDLF	0.44	0.40	0.39	1.14	1.06	1.04
	TDLF	0.46	0.39	0.36	1.14	1.03	0.99
7	NLF	0.25	0.24	0.23	0.66	0.62	0.61
	SDLF	0.25	0.23	0.22	0.66	0.62	0.59
	TDLF	0.26	0.22	0.21	0.66	0.59	0.57
8	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00

Table B-4-6. Individual support vertical reactions under SDL and TDL (kips).

		Load Type & Support Number			
Girder	**Detailing Method**	**SDL 1**	**SDL 2**	**TDL 1**	**TDL 2**
G1	**NLF**	72	72	206	208
	SDLF	72	72	205	207
	TDLF	73	72	205	205
G2	**NLF**	52	52	154	152
	SDLF	52	52	154	151
	TDLF	51	52	152	152
G3	**NLF**	24	24	78	78
	SDLF	24	24	78	78
	TDLF	24	23	78	78
G4	**NLF**	8	8	35	36
	SDLF	8	8	36	37
	TDLF	9	8	38	38

Appendix B-5. NISCR2 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISCR2 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table B-5-1. Erection method 1 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-1	NLF	0.1	0.6	0.6	0.0	-0.6	0.6
		SDLF	0.3	0.5	0.6	0.0	-0.5	0.5
		TDLF	0.7	0.4	0.8	0.0	-0.4	0.4
	2-2	NLF	0.2	1.0	1.0	0.2	-1.0	1.0
		SDLF	5.2	-4.9	7.2	4.6	5.0	6.8
		TDLF	12.0	-14.8	19.0	13.5	15.0	20.2
	2-3	NLF	0.5	-1.6	1.7	0.5	1.6	1.7
		SDLF	10.3	-12.6	16.3	8.0	12.7	15.1
		TDLF	22.2	-30.6	37.9	24.9	31.2	39.9
	2-4	NLF	0.6	-3.9	4.0	0.6	3.9	4.0
		SDLF	14.2	-18.4	23.3	10.4	18.5	21.2
		TDLF	30.3	-42.0	51.8	33.0	42.7	54.0
	2-5	NLF	0.3	-1.1	1.1	0.3	1.0	1.1
		SDLF	15.5	-17.9	23.7	11.6	17.9	21.3
		TDLF	30.7	-38.9	49.5	33.3	39.5	51.7
	2-6	NLF	0.2	1.8	1.8	0.1	-1.8	1.8
		SDLF	12.4	-13.2	18.1	10.0	13.2	16.6
		TDLF	22.6	-26.9	35.1	25.0	27.4	37.1
	2-7	NLF	0.2	0.8	0.9	0.2	-0.8	0.9
		SDLF	6.1	-6.7	9.1	5.5	6.8	8.7
		TDLF	12.0	-14.7	18.9	13.2	14.8	19.9

Table B-5-1(Continued). Erection method 1 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
3	3-1	NLF	-0.3	0.2	0.3	0.0	-0.4	0.4
		SDLF	0.0	0.0	0.0	0.0	-0.3	0.3
		TDLF	1.0	-0.5	1.1	0.0	-0.1	0.1
	3-2	NLF	-7.2	-1.6	7.4	-7.3	1.7	7.5
		SDLF	3.1	-5.4	6.2	2.3	5.4	5.9
		TDLF	18.2	-11.6	21.6	18.9	12.0	22.4
	3-3	NLF	-7.9	-3.8	8.8	-8.1	4.1	9.0
		SDLF	7.2	-11.8	13.8	4.7	12.0	12.9
		TDLF	28.1	-24.4	37.3	29.3	25.1	38.6
	3-4	NLF	-8.1	-5.2	9.6	-8.3	5.5	9.9
		SDLF	9.9	-16.5	19.3	5.9	16.7	17.7
		TDLF	33.5	-34.7	48.2	34.7	35.6	49.7
	3-5	NLF	-6.8	-1.8	7.0	-7.0	2.0	7.3
		SDLF	10.5	-16.2	19.3	6.5	16.4	17.7
		TDLF	29.4	-36.0	46.5	30.6	36.9	47.9
	3-6	NLF	-4.3	1.7	4.6	-4.4	-1.6	4.6
		SDLF	8.8	-11.7	14.6	6.2	11.9	13.4
		TDLF	21.4	-27.2	34.6	22.4	27.9	35.8
	3-7	NLF	-1.6	1.0	1.9	-1.6	-1.0	1.9
		SDLF	4.8	-6.0	7.7	4.0	6.1	7.3
		TDLF	11.8	-14.8	18.9	12.3	15.0	19.4

Table B-5-1(Continued). Erection method 1 fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
4	4-1	NLF	-0.4	0.6	0.7	0.0	-0.5	0.5
		SDLF	-0.2	0.5	0.5	0.0	-0.4	0.4
		TDLF	0.2	0.3	0.3	0.0	-0.3	0.3
	4-2	NLF	9.0	4.4	10.1	9.0	-4.8	10.2
		SDLF	16.3	0.6	16.3	15.4	-0.7	15.4
		TDLF	26.9	-5.7	27.5	26.8	6.1	27.5
	4-3	NLF	8.7	4.5	9.8	8.7	-5.1	10.1
		SDLF	19.9	-3.3	20.2	17.2	3.1	17.4
		TDLF	34.5	-16.1	38.0	34.5	16.6	38.3
	4-4	NLF	6.3	4.8	7.9	6.3	-5.0	8.1
		SDLF	19.9	-6.7	21.0	15.8	6.6	17.1
		TDLF	35.3	-24.3	42.8	35.2	25.0	43.2
	4-5	NLF	2.5	6.7	7.2	2.5	-6.7	7.2
		SDLF	16.4	-7.5	18.0	12.2	7.4	14.3
		TDLF	28.0	-24.4	37.2	27.8	24.9	37.4
	4-6	NLF	-0.2	6.1	6.1	-0.2	-6.0	6.0
		SDLF	10.9	-6.1	12.5	8.0	6.1	10.1
		TDLF	19.8	-19.5	27.7	19.6	19.7	27.8
	4-7	NLF	-0.9	2.4	2.6	-0.9	-2.3	2.5
		SDLF	5.3	-3.6	6.5	4.3	3.6	5.6
		TDLF	10.5	-11.1	15.3	10.3	11.1	15.1

Table B-5-2. Erection method 2 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-1	NLF	0.1	-0.7	0.7	0.0	0.7	0.7
		SDLF	0.1	-0.7	0.7	0.0	0.7	0.7
		TDLF	0.3	-0.8	0.8	0.0	0.8	0.8
	2-2	NLF	0.2	-1.0	1.1	0.2	1.0	1.0
		SDLF	4.7	-5.8	7.5	3.7	5.8	6.9
		TDLF	10.8	-13.6	17.4	10.6	13.7	17.4
	2-3	NLF	0.1	0.8	0.8	0.0	-0.8	0.8
		SDLF	8.8	-8.0	11.9	5.9	8.1	10.0
		TDLF	19.3	-22.3	29.5	19.3	22.8	29.9
	2-4	NLF	-0.2	2.6	2.6	-0.2	-2.6	2.6
		SDLF	12.3	-10.4	16.1	8.1	10.6	13.3
		TDLF	27.1	-31.4	41.5	27.0	32.3	42.1
	2-5	NLF	0.2	0.2	0.3	0.2	-0.3	0.4
		SDLF	13.9	-14.6	20.2	9.7	14.7	17.6
		TDLF	27.1	-31.6	41.6	26.9	32.2	42.0
	2-6	NLF	0.4	-1.8	1.9	0.4	1.8	1.8
		SDLF	10.1	-11.9	15.7	7.3	11.9	14.0
		TDLF	19.8	-23.2	30.5	19.6	23.5	30.6
	2-7	NLF	0.2	-1.0	1.0	0.2	1.0	1.0
		SDLF	4.9	-6.1	7.8	3.9	6.1	7.2
		TDLF	10.6	-12.7	16.5	10.4	12.8	16.5

Table B-5-2(Continued). Erection method 2 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
3	3-1	NLF	12.5	-8.4	15.0	0.0	16.5	16.5
		SDLF	10.2	-6.8	12.3	0.0	13.4	13.4
		TDLF	6.5	-4.1	7.7	0.0	8.3	8.3
	3-2	NLF	16.1	-38.9	42.1	16.3	38.6	41.9
		SDLF	22.9	-48.4	53.6	22.4	48.3	53.2
		TDLF	31.5	-61.0	68.6	32.2	61.0	69.0
	3-3	NLF	13.0	-29.2	32.0	13.3	28.9	31.8
		SDLF	22.6	-37.8	44.0	20.2	37.6	42.7
		TDLF	32.5	-48.6	58.5	33.6	48.6	59.1
	3-4	NLF	10.0	-20.8	23.1	10.2	20.5	22.9
		SDLF	21.2	-27.8	35.0	17.4	27.8	32.8
		TDLF	32.3	-37.3	49.3	33.4	37.8	50.4
	3-5	NLF	6.7	-15.6	17.0	6.8	15.5	16.9
		SDLF	18.1	-22.0	28.5	14.2	21.9	26.2
		TDLF	29.5	-30.5	42.4	30.6	31.0	43.5
	3-6	NLF	3.6	-11.1	11.6	3.7	11.0	11.6
		SDLF	13.0	-17.5	21.8	10.4	17.5	20.4
		TDLF	22.9	-25.7	34.4	23.9	26.2	35.5
	3-7	NLF	1.6	-5.3	5.6	1.6	5.3	5.6
		SDLF	6.5	-9.7	11.7	5.8	9.8	11.4
		TDLF	12.5	-15.7	20.1	13.1	16.0	20.6

Table B-5-2(Continued). Erection method 2 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
4	4-1	NLF	0.4	-0.6	0.8	0.0	0.9	0.9
		SDLF	0.5	-0.6	0.8	0.0	0.9	0.9
		TDLF	0.7	-0.6	0.9	0.0	0.8	0.8
	4-2	NLF	32.9	-78.0	84.6	33.2	77.6	84.4
		SDLF	34.2	-75.6	83.0	33.8	75.3	82.5
		TDLF	34.9	-71.7	79.8	36.3	71.5	80.2
	4-3	NLF	24.0	-52.5	57.7	24.2	51.8	57.2
		SDLF	28.9	-52.6	60.0	26.7	51.9	58.4
		TDLF	32.9	-53.2	62.6	35.2	52.7	63.4
	4-4	NLF	17.5	-35.2	39.3	17.7	34.7	38.9
		SDLF	24.7	-35.9	43.6	20.9	35.5	41.2
		TDLF	30.3	-37.3	48.0	32.8	37.3	49.6
	4-5	NLF	13.0	-28.5	31.3	13.2	28.2	31.1
		SDLF	20.9	-29.2	35.9	17.0	29.0	33.6
		TDLF	27.5	-30.5	41.1	30.0	30.7	42.9
	4-6	NLF	9.3	-24.0	25.8	9.4	23.9	25.7
		SDLF	15.8	-25.5	29.9	13.4	25.4	28.7
		TDLF	22.2	-28.2	35.9	24.6	28.5	37.6
	4-7	NLF	4.8	-13.0	13.9	4.9	13.0	13.9
		SDLF	8.2	-14.5	16.7	7.5	14.7	16.5
		TDLF	12.4	-17.5	21.5	13.6	17.9	22.4

Table B-5-3. Erection method 3 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-1	NLF	0.0	-0.4	0.4	-0.7	0.4	0.8
		SDLF	0.0	-0.3	0.3	-0.6	0.3	0.7
		TDLF	0.0	-0.3	0.3	-0.5	0.3	0.6
	2-2	NLF	-0.8	-1.2	1.5	-0.8	1.2	1.5
		SDLF	3.2	4.8	5.8	4.2	-4.8	6.4
		TDLF	11.1	14.7	18.5	11.2	-14.6	18.4
	2-3	NLF	0.4	0.2	0.5	0.4	-0.2	0.4
		SDLF	7.6	11.8	14.0	10.4	-11.7	15.7
		TDLF	21.3	27.6	34.9	21.4	-27.1	34.6
	2-4	NLF	1.6	1.5	2.2	1.6	-1.6	2.2
		SDLF	9.4	13.8	16.8	13.7	-13.7	19.4
		TDLF	26.2	31.4	40.9	26.4	-30.6	40.4
	2-5	NLF	0.7	0.8	1.0	0.7	-0.8	1.0
		SDLF	8.8	13.0	15.7	13.1	-12.9	18.4
		TDLF	26.9	32.2	42.0	27.1	-31.6	41.6
	2-6	NLF	-0.6	-0.6	0.9	-0.7	0.6	0.9
		SDLF	6.8	10.9	12.8	9.7	-10.9	14.5
		TDLF	19.6	23.5	30.6	19.8	-23.2	30.5
	2-7	NLF	-0.4	-0.4	0.5	-0.4	0.4	0.5
		SDLF	3.8	5.8	6.9	4.8	-5.8	7.5
		TDLF	10.4	12.8	16.5	10.6	-12.7	16.5

Table B-5-3(Continued). Erection method 3 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
3	3-1	NLF	0.0	0.2	0.2	-0.4	0.2	0.4
		SDLF	0.0	0.3	0.3	-0.2	0.1	0.2
		TDLF	0.0	0.5	0.5	0.1	-0.1	0.2
	3-2	NLF	-7.0	-16.1	17.5	-7.0	16.2	17.6
		SDLF	3.2	3.7	4.9	4.0	-3.6	5.4
		TDLF	22.5	38.7	44.8	21.9	-38.7	44.5
	3-3	NLF	-6.4	-17.0	18.2	-6.3	17.1	18.2
		SDLF	7.5	8.4	11.2	10.0	-8.5	13.1
		TDLF	28.9	38.1	47.8	27.9	-38.0	47.2
	3-4	NLF	-2.1	-9.2	9.4	-2.0	9.2	9.4
		SDLF	9.6	9.3	13.4	13.5	-9.3	16.4
		TDLF	32.7	36.3	48.8	31.6	-35.7	47.7
	3-5	NLF	-3.5	-11.9	12.4	-3.4	11.9	12.4
		SDLF	8.3	6.8	10.7	12.3	-6.8	14.0
		TDLF	30.6	31.0	43.5	29.5	-30.5	42.4
	3-6	NLF	-8.2	-20.8	22.4	-8.1	21.0	22.5
		SDLF	5.2	3.7	6.4	7.8	-3.6	8.6
		TDLF	23.9	26.2	35.5	22.9	-25.7	34.4
	3-7	NLF	-4.8	-11.9	12.8	-4.8	12.0	12.9
		SDLF	3.1	2.8	4.2	3.9	-2.7	4.7
		TDLF	13.1	16.0	20.6	12.5	-15.7	20.1

Table B-5-3(Continued). Erection method 3 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
4	4-1	NLF	0.0	0.2	0.2	-0.4	-0.2	0.5
		SDLF	0.0	0.2	0.2	-0.3	-0.2	0.3
		TDLF	0.0	-0.1	0.1	-0.2	0.2	0.2
	4-2	NLF	-9.1	-21.0	22.9	-9.1	21.1	23.0
		SDLF	1.9	0.8	2.1	2.5	-0.9	2.6
		TDLF	23.9	42.6	48.8	22.6	-42.7	48.3
	4-3	NLF	-11.9	-29.1	31.4	-11.7	29.3	31.5
		SDLF	4.7	2.8	5.5	7.1	-3.0	7.8
		TDLF	30.3	41.5	51.4	28.0	-42.0	50.5
	4-4	NLF	-6.6	-19.3	20.3	-6.4	19.3	20.4
		SDLF	7.0	4.3	8.2	10.9	-4.4	11.8
		TDLF	32.0	35.6	47.9	29.6	-35.5	46.2
	4-5	NLF	-8.0	-23.7	25.0	-7.8	23.7	25.0
		SDLF	5.4	0.7	5.4	9.4	-0.7	9.4
		TDLF	30.0	30.7	42.9	27.5	-30.5	41.1
	4-6	NLF	-14.3	-37.7	40.3	-14.1	37.9	40.4
		SDLF	1.8	-4.7	5.1	4.2	4.8	6.4
		TDLF	24.6	28.5	37.6	22.2	-28.2	35.9
	4-7	NLF	-8.4	-21.4	23.0	-8.3	21.5	23.1
		SDLF	1.0	-2.4	2.6	1.7	2.6	3.1
		TDLF	13.6	17.9	22.4	12.4	-17.5	21.5

Table B-5-4: Erection Methods 1, 2 and 3 Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage		
		Erection Method 1	Erection Method 2	Erection Method 3
2	NLF	2-4	2-4	2-4
	SDLF	2-5	2-5	2-4
	TDLF	2-4	2-4	2-5
3	NLF	3-4	3-2	3-6
	SDLF	3-5	3-2	3-4
	TDLF	3-4	3-2	3-4
4	NLF	4-2	4-2	4-6
	SDLF	4-3	4-2	4-4
	TDLF	4-4	4-2	4-3

Table B-5-5. Erection method 1 critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	-1.8	-0.5	1.9	NA	NA	NA
		SDLF	9.5	-2.2	9.8	NA	NA	NA
		TDLF	20.3	-4.3	20.7	NA	NA	NA
	B	NLF	0.6	-3.9	4.0	0.6	3.9	4.0
		SDLF	15.5	-17.9	23.7	11.6	17.9	21.3
		TDLF	30.3	-42.0	51.8	33.0	42.7	54.0
3	A	NLF	-16.0	-0.6	16.0	NA	NA	NA
		SDLF	5.6	-2.0	6.0	NA	NA	NA
		TDLF	36.5	-3.6	36.7	NA	NA	NA
	B	NLF	-8.1	-5.2	9.6	-8.3	5.5	9.9
		SDLF	10.5	-16.2	19.3	6.5	16.4	17.7
		TDLF	33.5	-34.7	48.2	34.7	35.6	49.7
4	A	NLF	16.6	0.1	16.6	NA	NA	NA
		SDLF	28.7	-0.1	28.7	NA	NA	NA
		TDLF	46.4	-2.6	46.5	NA	NA	NA
	B	NLF	9.0	4.4	10.1	9.0	-4.8	10.2
		SDLF	19.9	-3.3	20.2	17.2	3.1	17.4
		TDLF	35.3	-24.3	42.8	35.2	25.0	43.2

Table B-5-6. Erection method 2 critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	1.9	0.3	1.9	NA	NA	NA
		SDLF	7.6	-1.5	7.7	NA	NA	NA
		TDLF	16.6	-2.1	16.7	NA	NA	NA
	B	NLF	-0.2	2.6	2.6	-0.2	-2.6	2.6
		SDLF	13.9	-14.6	20.2	9.7	14.7	17.6
		TDLF	27.1	-31.4	41.5	27.0	32.3	42.1
3	A	NLF	0.5	-1.3	1.4	NA	NA	NA
		SDLF	3.4	-1.3	3.7	NA	NA	NA
		TDLF	8.3	-1.5	8.4	NA	NA	NA
	B	NLF	16.1	-38.9	42.1	16.3	38.6	41.9
		SDLF	22.9	-48.4	53.6	22.4	48.3	53.2
		TDLF	31.5	-61.0	68.6	32.2	61.0	69.0
4	A	NLF	2.6	-1.1	2.8	NA	NA	NA
		SDLF	4.7	-1.2	4.9	NA	NA	NA
		TDLF	8.2	-1.3	8.3	NA	NA	NA
	B	NLF	32.9	-78.0	84.6	33.2	77.6	84.4
		SDLF	34.2	-75.6	83.0	33.8	75.3	82.5
		TDLF	34.9	-71.7	79.8	36.3	71.5	80.2

Table B-5-7. Erection method 3 critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	1.9	-0.3	1.9	NA	NA	NA
		SDLF	7.8	-1.2	7.9	NA	NA	NA
		TDLF	17.2	-2.9	17.4	NA	NA	NA
	B	NLF	1.6	1.5	2.2	1.6	-1.6	2.2
		SDLF	9.4	13.8	16.8	13.7	-13.7	19.4
		TDLF	26.9	32.2	42.0	27.1	-31.6	41.6
3	A	NLF	0.6	0.7	1.0	NA	NA	NA
		SDLF	11.7	-0.4	11.7	NA	NA	NA
		TDLF	24.8	-1.2	24.8	NA	NA	NA
	B	NLF	-8.2	-20.8	22.4	-8.1	21.0	22.5
		SDLF	9.6	9.3	13.4	13.5	-9.3	16.4
		TDLF	32.7	36.3	48.8	31.6	-35.7	47.7
4	A	NLF	1.8	1.2	2.2	NA	NA	NA
		SDLF	11.0	-0.4	11.0	NA	NA	NA
		TDLF	6.8	-0.4	6.8	NA	NA	NA
	B	NLF	-14.3	-37.7	40.3	-14.1	37.9	40.4
		SDLF	7.0	4.3	8.2	10.9	-4.4	11.8
		TDLF	30.3	41.5	51.4	28.0	-42.0	50.5

Table B-5-8. Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	15.1	58.1	13.9		
			SDLF	24.4	57.9	23.1		
			TDLF	27.8	53.4	26.0		
		G2	NLF	1.4	40.9	81.7	40.8	1.1
			SDLF	6.8	26.7	53.3	26.6	6.6
			TDLF	4.3	27.5	55.0	27.5	4.7
	B	G1	NLF	13.9	59.8	15.1		
			SDLF	23.2	64.0	24.5		
			TDLF	25.7	63.0	27.4		
		G2	NLF	2.5	38.8	77.6	38.8	2.9
			SDLF	12.7	17.7	35.4	17.7	12.9
			TDLF	14.3	13.6	27.2	13.6	14.1
3	A	G1	NLF	22.9	84.5	19.8		
			SDLF	31.8	72.6	29.2		
			TDLF	48.5	46.7	49.7		
		G2	NLF	11.3	16.1			
			SDLF	19.3	22.8			
			TDLF	30.9	27.0			
		G3	NLF	3.3	41.5	82.9	41.4	0.0
			SDLF	6.8	27.6	55.1	27.5	4.2
			TDLF	6.7	11.6	23.2	11.6	8.0
	B	G1	NLF	18.0	86.2	21.8		
			SDLF	17.8	88.1	20.3		
			TDLF	49.2	51.2	46.7		
		G2	NLF	17.9	11.9			
			SDLF	21.3	21.1			
			TDLF	25.3	31.8			
		G3	NLF	0.0	40.8	81.5	40.7	3.9
			SDLF	0.0	43.9	87.6	43.7	2.7
			TDLF	13.7	6.1	12.1	6.1	11.3

Table B-5-8(Continued). Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
4	A	G1	NLF	76.8	79.6			
			SDLF	71.7	78.3			
			TDLF	69.2	75.3			
		G2	NLF	45.9	42.6			
			SDLF	52.1	44.5			
			TDLF	54.8	48.1			
		G3	NLF	5.6	2.7			
			SDLF	13.3	7.7			
			TDLF	24.5	18.3			
		G4	NLF	0.0	25.2	50.4	25.1	2.9
			SDLF	0.0	17.2	34.3	17.1	5.6
			TDLF	4.8	1.6	3.2	1.6	10.3
	B	G1	NLF	79.4	75.6			
			SDLF	78.1	71.5			
			TDLF	76.5	70.2			
		G2	NLF	42.8	47.8			
			SDLF	44.7	52.4			
			TDLF	47.7	54.1			
		G3	NLF	3.3	5.5			
			SDLF	8.1	13.8			
			TDLF	16.9	24.1			
		G4	NLF	2.6	24.9	49.8	24.8	0.0
			SDLF	5.6	16.9	33.7	16.8	0.0
			TDLF	12.8	0.0	0.0	0.0	6.8

Table B-5-9. Erection method 2 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G3	NLF	2.4	29.9	59.8	29.8	3.3
			SDLF	9.8	28.4	56.8	28.3	10.7
			TDLF	11.0	26.7	53.3	26.6	12.1
		G4	NLF	10.1	39.4	10.6		
			SDLF	10.2	28.5	10.7		
			TDLF	9.3	30.3	9.6		
	B	G3	NLF	2.5	29.4	58.8	29.3	3.5
			SDLF	32.2	64.3	32.1	9.9	32.2
			TDLF	10.1	31.4	62.6	31.2	11.3
		G4	NLF	9.5	42.0	10.0		
			SDLF	13.6	16.2	14.1		
			TDLF	13.5	14.9	13.8		
3	A	G2	NLF	11.2	42.5	85.0	42.5	11.3
			SDLF	9.2	42.0	84.0	42.0	9.5
			TDLF	5.8	41.2	82.4	41.1	7.5
		G3	NLF	4.9	5.6			
			SDLF	21.3	21.6			
			TDLF	48.4	46.1			
		G4	NLF	0.0	96.7	0.0		
			SDLF	0.0	69.0	0.0		
			TDLF	0.0	23.3	1.1		
	B	G2	NLF	0.0	50.7	101.3	50.6	8.5
			SDLF	0.0	51.6	103.2	51.6	13.7
			TDLF	0.0	52.5	104.9	52.4	20.8
		G3	NLF	16.0	0.0			
			SDLF	26.3	0.0			
			TDLF	40.4	0.0			
		G4	NLF	3.7	73.5	12.2		
			SDLF	8.5	41.5	22.0		
			TDLF	14.3	0.0	34.7		

Table B-5-9(Continued). Erection method 2 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
4	A	G1	NLF	1.4	42.8	85.6	42.8	7.2
			SDLF	1.9	42.2	84.3	42.1	6.4
			TDLF	2.7	41.1	82.1	41.0	4.7
		G2	NLF	73.2	66.2			
			SDLF	73.7	68.6			
			TDLF	74.2	73.3			
		G3	NLF	30.3	28.6			
			SDLF	30.2	28.4			
			TDLF	30.1	27.9			
		G4	NLF	5.3	8.6			
			SDLF	5.1	7.9			
			TDLF	4.9	6.5			
	B	G1	NLF	0.0	60.3	120.7	60.4	34.1
			SDLF	0.0	58.6	117.2	58.6	34.6
			TDLF	0.0	55.6	111.3	55.7	32.1
		G2	NLF	43.2	0.0			
			SDLF	46.5	0.0			
			TDLF	51.9	7.2			
		G3	NLF	31.9	17.5			
			SDLF	31.5	22.3			
			TDLF	31.0	25.9			
		G4	NLF	17.6	41.9			
			SDLF	16.5	38.4			
			TDLF	14.5	33.0			

Appendix B-6. NISCR2 Results with GT-LOFT Initial Fixed-End Forces

This appendix provides detailed analytical results for curved radially-supported bridge NISCR2 used an example of using GT-LOFT to determine the initial fixed-end forces associated with No Load Fit (NLF), Steel Dead Load Fit (SDLF) and Total Dead Load Fit (TDLF) detailing methods. This bridge has a span length of 150 ft and centerline radius of curvature of 438 ft. All of the girders have four section changes. The intermediate cross-frames are X type, and the end cross-frame are K type. All cross-frame members are L6x6x3/4

These results are with SDLF and TDLF detailing effects included via the initial fixed-end forces calculated by GT-LOFT.

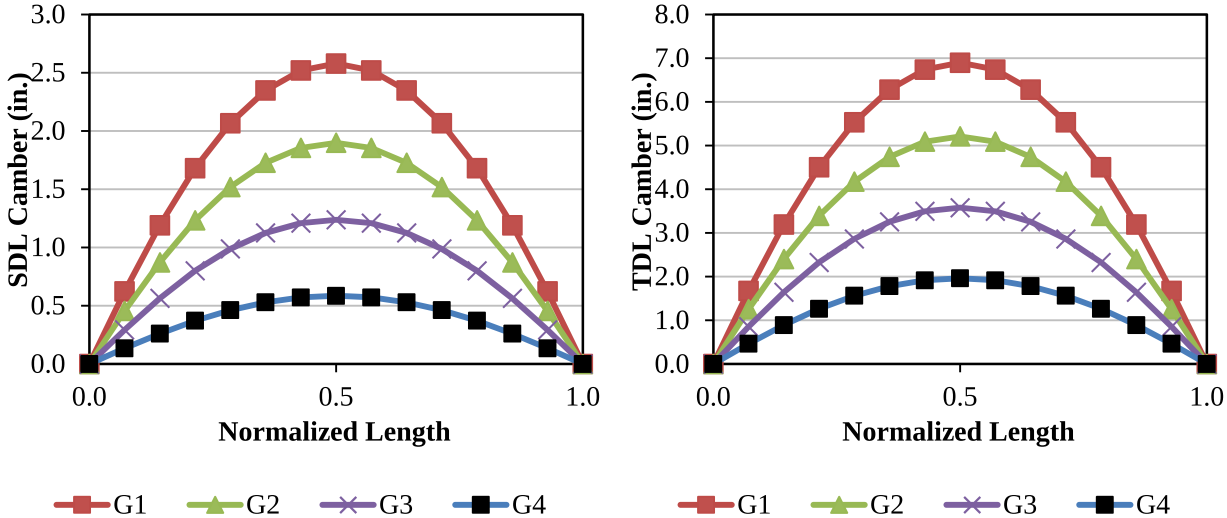


Figure B-6-1. SDL and TDL 2-D Grid Analysis Cambers.

Table B-6-1. Girder Properties

Girder	Length (ft)	Area (in^2)	I_y (in^4)	I_z (in^4)	J (in^4)	J_{new} (in^4)
G1	154	118,142, 179@3, 142,118	2721,4041, 5805@3, 4041,2721	134110,175235, 244786@3, 175235,134110	36,95, 250@3, 95,36	515,2657, 4193@3, 2657,515
G2	151	118,142, 179@3, 142,118	2721,4041, 5805@3, 4041,2721	134110,175235, 244786@3, 175235,134110	36,95, 250@3, 95,36	515,2657, 4193@3, 2657,515
G3	149	97,103, 130@3, 103,97	1820,2108, 3305@3, 2108,1820	110049,119713, 169730@3, 119713,110049	21,29, 93@3, 29,21	386,1590, 2492@3, 1590,386
G4	146	97,103, 130@3, 103,97	1820,2108, 3305@3, 2108,1820	110049,119713, 169730@3, 119713,110049	21,29, 93@3, 29,21	386,1590, 2492@3, 1590,386

Table B-6-2. Cross-Frame Properties (Timoshenko Approach)

Girder	Length (in)	Area (Chords Only) (in^2)	Shear Area (in^2)	I_y (Chords Only) (in^4)	$I_{z\_equiv.}$ (in^4)	J (Chords Only) (in^4)
End CFs	96	17	7.99	56.2	21928	3.2
Interm. CFs	96	17	15.28	56.2	21928	3.2

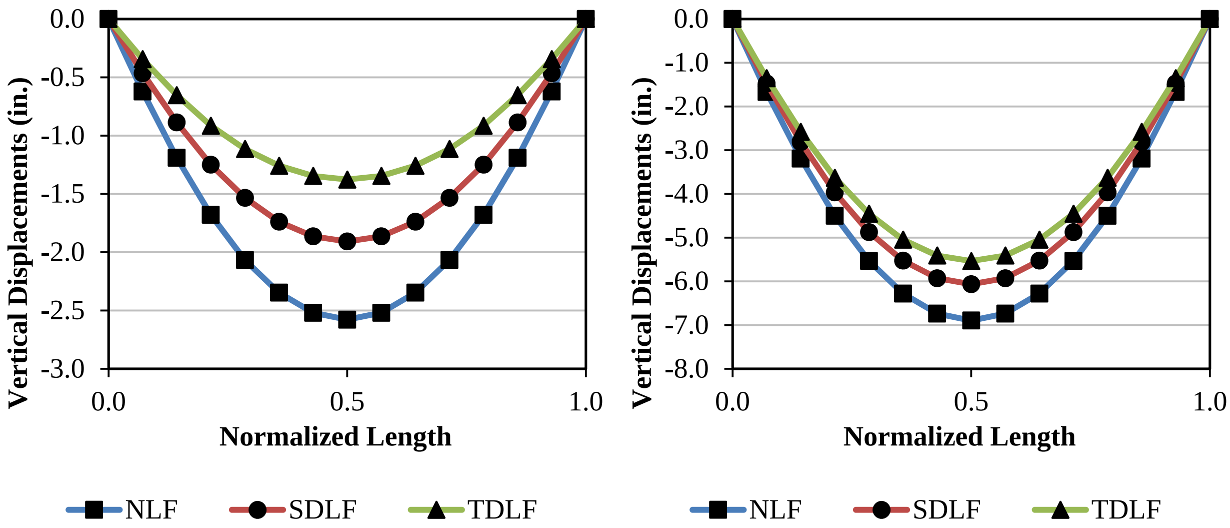


Figure B-6-2. G1 Vertical Displacements under SDL (left) and TDL (right).

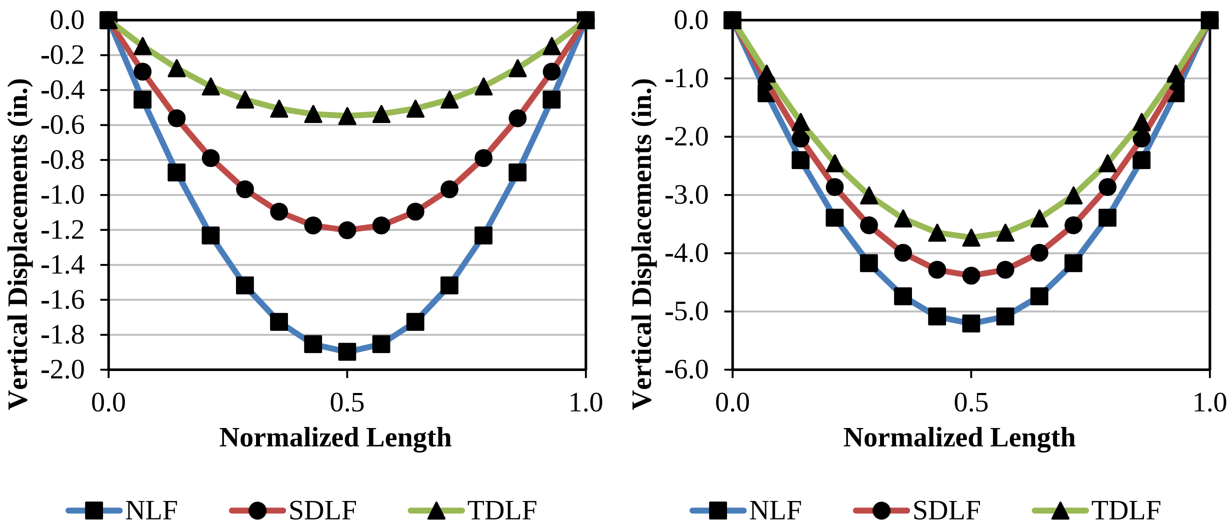


Figure B-6-3. G2 Vertical Displacements under SDL (left) and TDL (right).

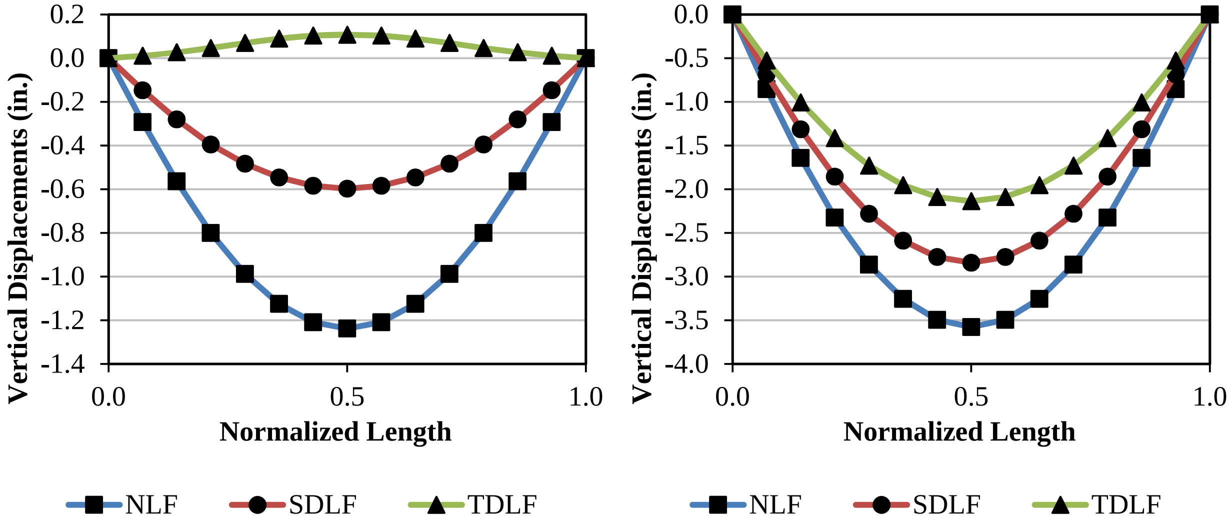


Figure B-6-4. G3 Vertical Displacements under SDL (left) and TDL (right).

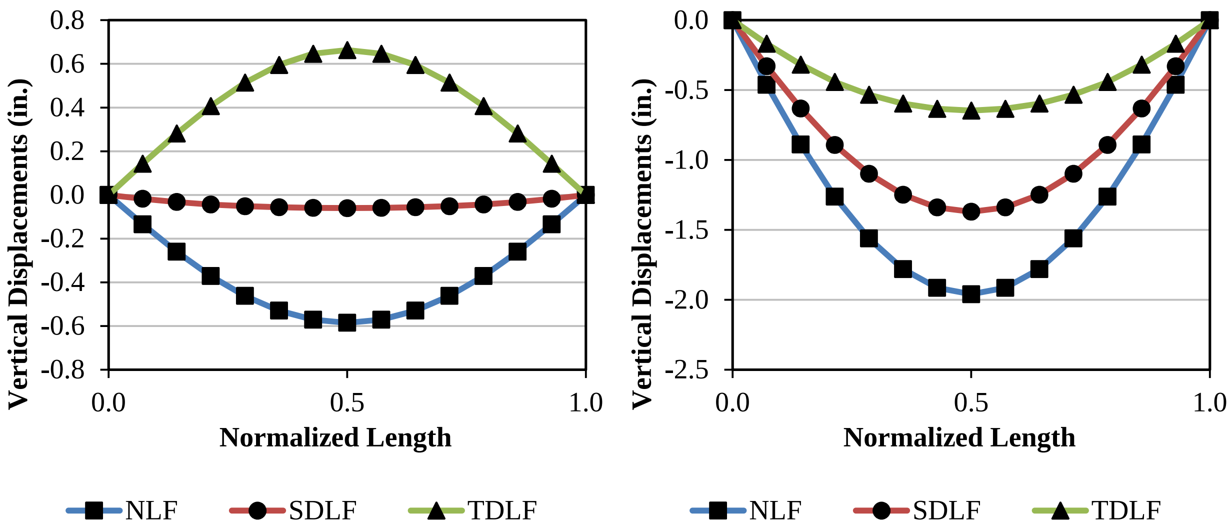


Figure B-6-5. G4 Vertical Displacements under SDL (left) and TDL (right).

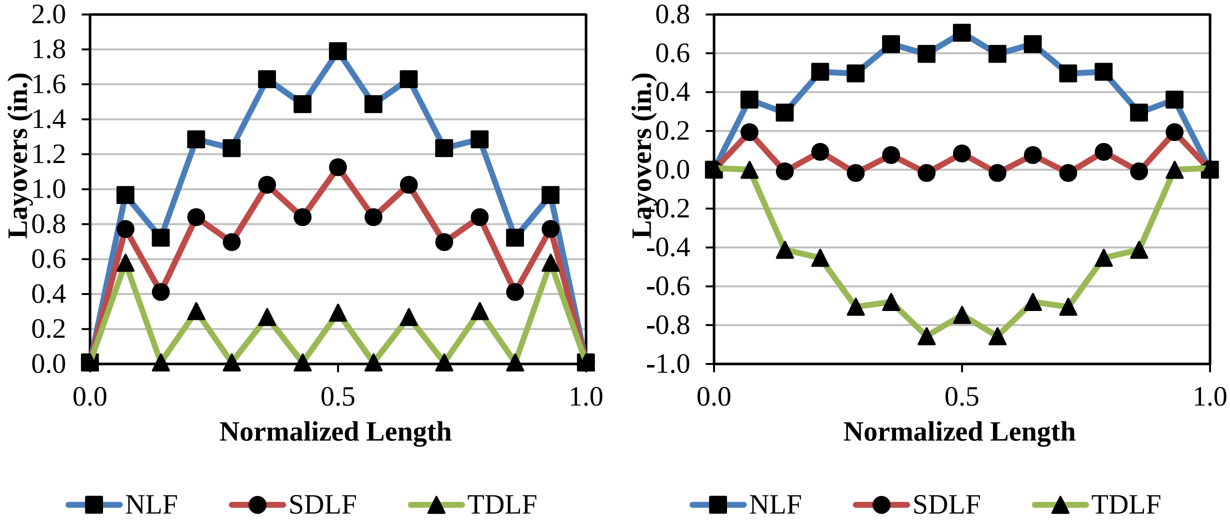


Figure B-6-6. G1 Layovers under SDL (left) and TDL (right).

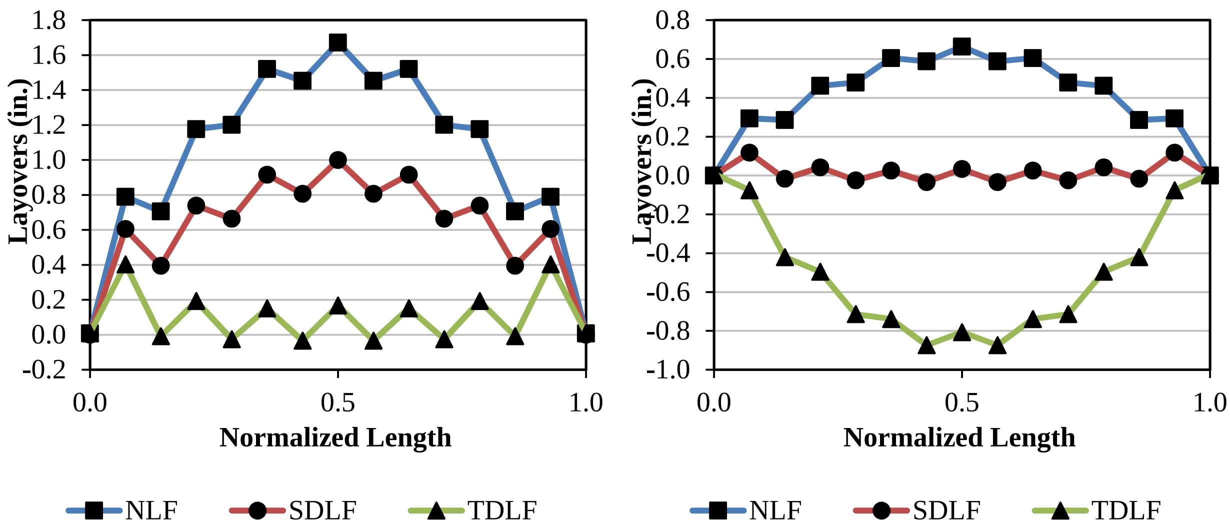


Figure B-6-7. G2 Layovers under SDL (left) and TDL (right).

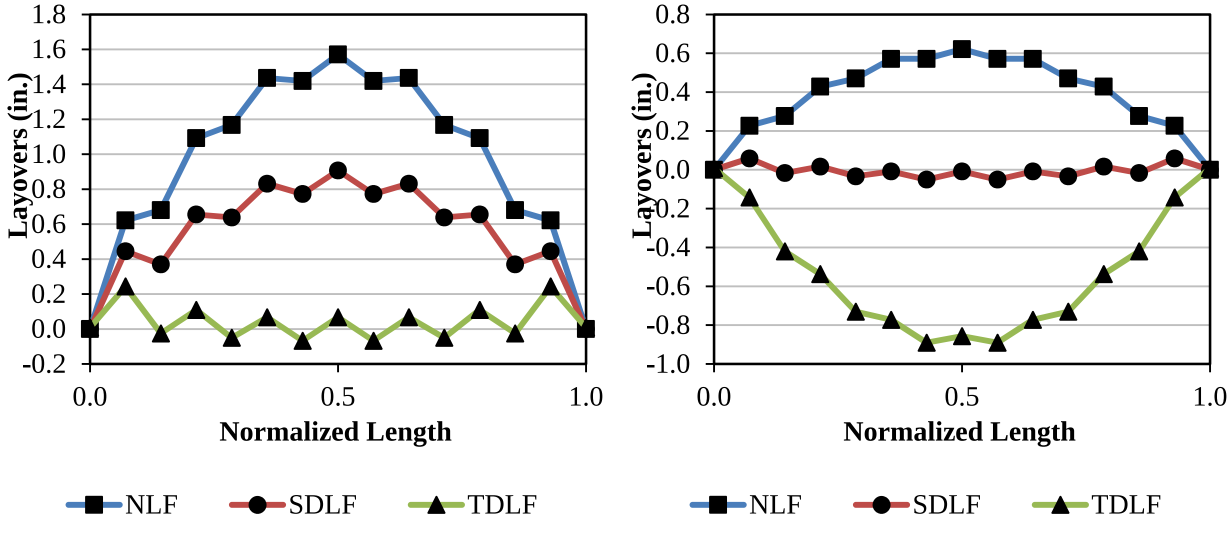


Figure B-6-8. G3 Layovers under SDL (left) and TDL (right).

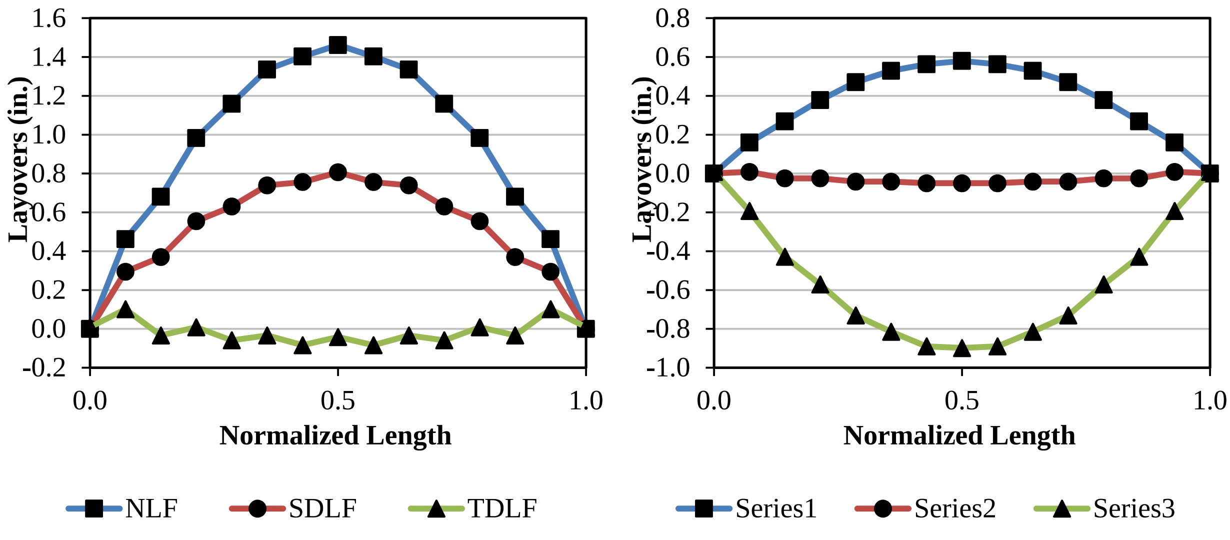


Figure B-6-9. G4 Layovers under SDL (left) and TDL (right).

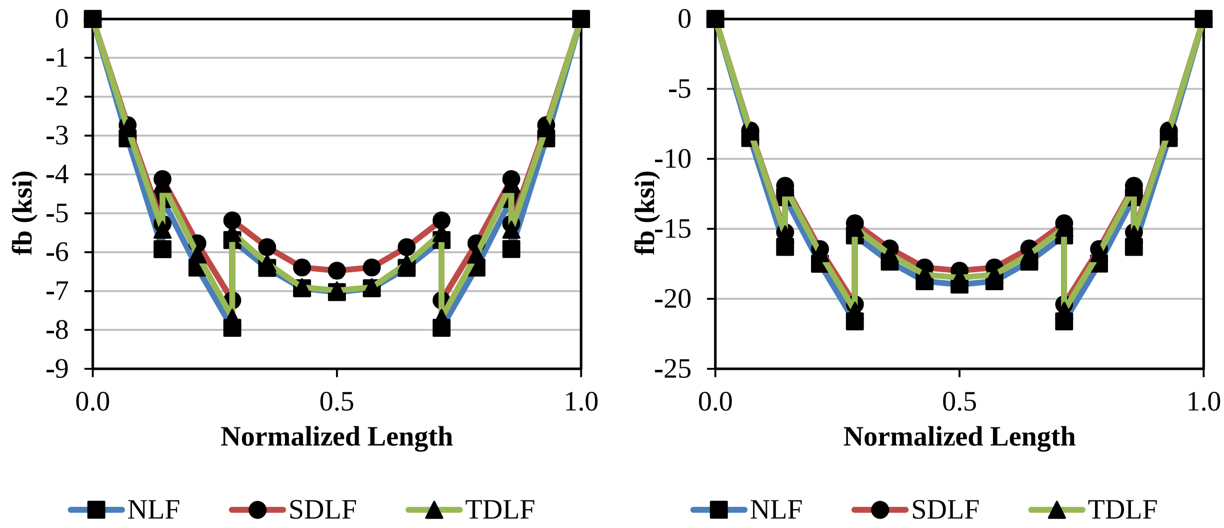


Figure B-6-10. G1 Major-Axis Bending Stresses under SDL (left) and TDL (right).

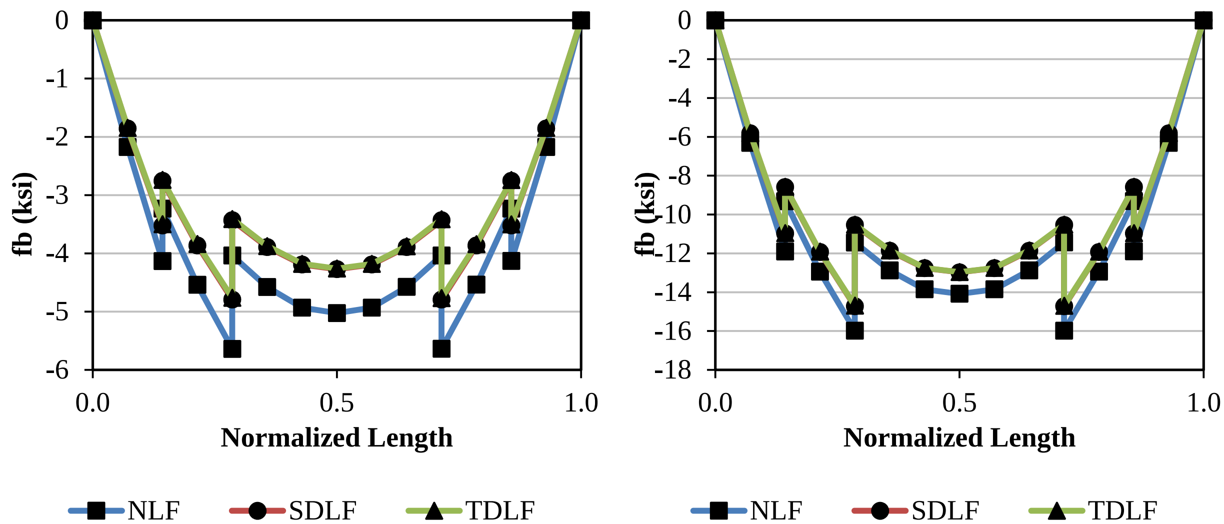


Figure B-6-11. G2 Major-Axis Bending Stresses under SDL (left) and TDL (right).

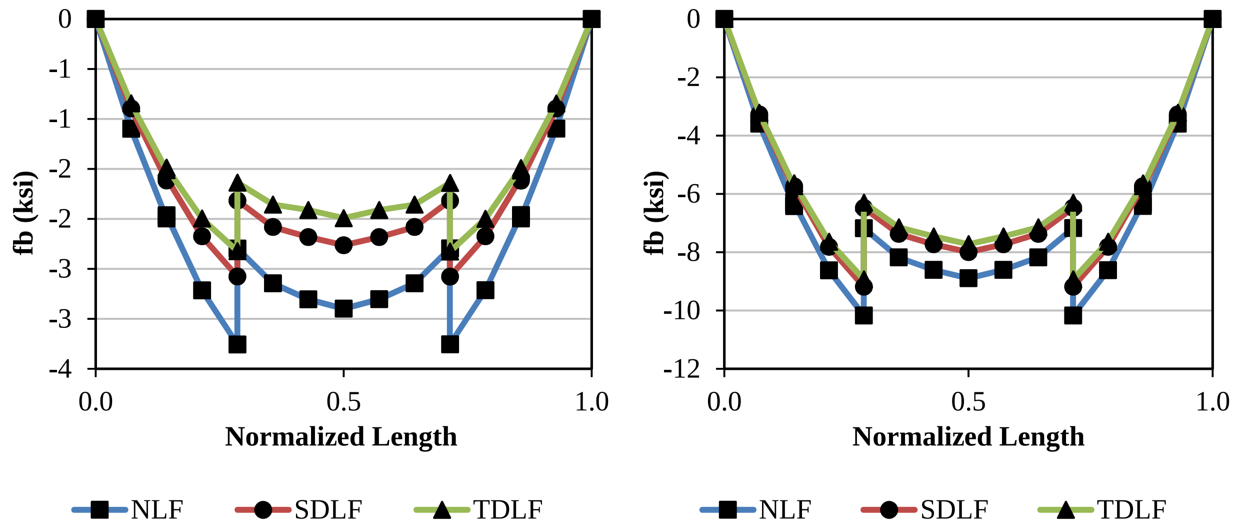


Figure B-6-12. G3 Major-Axis Bending Stresses under SDL (left) and TDL (right).

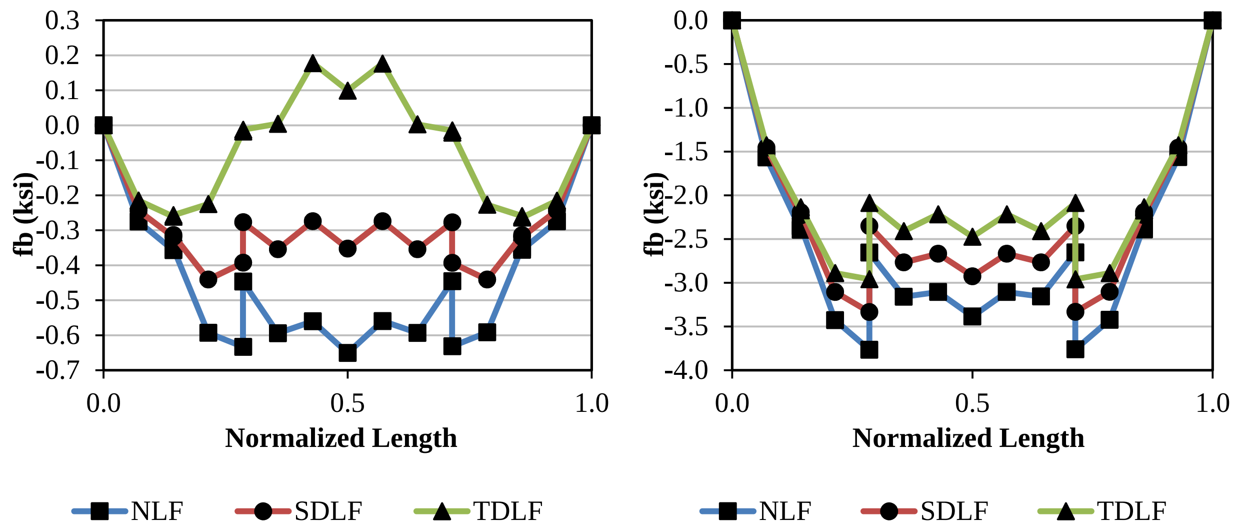


Figure B-6-14. G4 Major-Axis Bending Stresses under SDL (left) and TDL (right).

Table B-6-3. Cross-Frame Equivalent Element Forces and Moments under SDL

CF	Detailing Method	G1-G2			G2-G3			G3-G4		
		V (kip)	M1 (kip*in)	M2 (kip*in)	V (kip)	M1 (kip*in)	M2 (kip*in)	V (kip)	M1 (kip*in)	M2 (kip*in)
1	NLF	-2.2	-181	-33	-1.5	-116	-29	-1.3	-58	-62
	SDLF	-1.0	-93	-4	-0.6	-57	4	-0.3	-26	-2
	TDLF	1.8	-34	208	0.7	-190	259	-1.8	-210	39
2	NLF	-7.8	-1027	274	-8.8	-1054	212	-7.5	-561	-156
	SDLF	-4.7	-734	283	-5.6	-767	234	-4.7	-421	-30
	TDLF	-3.8	-652	286	-4.4	-527	111	-0.7	-46	-21
3	NLF	-8.8	-1405	557	-12.4	-1543	357	-8.2	-737	-53
	SDLF	-8.5	-1326	510	-11.1	-1391	323	-7.3	-650	-55
	TDLF	-11.4	-1576	479	-11.7	-1302	176	-5.3	-268	-246
4	NLF	-9.5	-1573	660	-12.6	-1720	515	-9.1	-894	21
	SDLF	-10.3	-1683	578	-13.4	-1678	439	-9.3	-822	-73
	TDLF	-16.8	-2147	537	-13.3	-1930	-149	-6.4	-217	-366
5	NLF	-9.5	-1574	660	-12.6	-1720	515	-9.1	-894	21
	SDLF	-11.1	-1661	600	-13.5	-1704	413	-9.3	-822	-74
	TDLF	-16.8	-2147	538	-17.5	-1731	50	-6.7	-247	-394
6	NLF	-8.8	-1405	557	-12.4	-1543	357	-8.2	-737	-53
	SDLF	-8.5	-1326	510	-11.1	-1391	324	-7.3	-650	-55
	TDLF	-11.4	-1576	480	-11.7	-1303	176	-5.3	-268	-246
7	NLF	-7.8	-1027	274	-8.8	-1054	212	-7.5	-561	-156
	SDLF	-4.7	-734	283	-5.6	-767	234	-4.7	-421	-30
	TDLF	-3.8	-652	287	-4.3	-528	111	-0.7	-46	-21
8	NLF	-2.2	-181	-33	-1.5	-116	-29	-1.3	-58	-62
	SDLF	-1.0	-93	-3	-0.6	-57	4	-0.3	-27	-2
	TDLF	2.1	-34	236	0.4	-218	252	-1.7	-203	39

Table B-6-4. Cross-Frame Equivalent Element Forces and Moments under TDL

CF	Detailing Method	G1-G2			G2-G3			G3-G4		
		V (kip)	M1 (kip*in)	M2 (kip*in)	V (kip)	M1 (kip*in)	M2 (kip*in)	V (kip)	M1 (kip*in)	M2 (kip*in)
1	NLF	-6.0	-481	-92	-4.1	-309	-86	-3.5	-156	-182
	SDLF	-4.6	-382	-61	-3.1	-243	-51	-2.5	-120	-117
	TDLF	-1.8	-323	150	-1.8	-376	204	-4.0	-304	-75
2	NLF	-21.5	-2770	703	-26.1	-2866	364	-20.6	-1408	-570
	SDLF	-17.9	-2413	697	-22.1	-2511	388	-17.3	-1239	-423
	TDLF	-17.0	-2330	700	-20.9	-2271	265	-13.3	-865	-414
3	NLF	-24.9	-3833	1440	-37.7	-4250	630	-23.4	-1841	-410
	SDLF	-24.0	-3662	1361	-35.4	-3994	598	-21.9	-1718	-389
	TDLF	-26.9	-3912	1331	-36.0	-3905	451	-20.0	-1335	-580
4	NLF	-27.3	-4303	1679	-38.6	-4727	1022	-26.3	-2261	-261
	SDLF	-27.4	-4308	1563	-38.3	-4569	940	-25.8	-2144	-333
	TDLF	-33.9	-4773	1522	-38.2	-4821	352	-22.9	-1539	-625
5	NLF	-27.3	-4303	1679	-38.6	-4727	1022	-26.3	-2261	-261
	SDLF	-28.1	-4287	1585	-38.4	-4596	914	-25.8	-2144	-333
	TDLF	-33.9	-4773	1522	-42.4	-4623	551	-23.1	-1568	-654
6	NLF	-24.9	-3833	1440	-37.7	-4250	630	-23.4	-1841	-410
	SDLF	-24.0	-3662	1362	-35.4	-3994	599	-21.9	-1718	-389
	TDLF	-26.9	-3913	1332	-36.0	-3906	451	-20.0	-1336	-580
7	NLF	-21.5	-2770	702	-26.1	-2866	364	-20.6	-1408	-570
	SDLF	-17.9	-2412	697	-22.1	-2511	388	-17.3	-1239	-423
	TDLF	-17.0	-2330	700	-20.9	-2272	265	-13.3	-865	-414
8	NLF	-6.0	-481	-92	-4.1	-309	-86	-3.5	-156	-182
	SDLF	-4.6	-382	-61	-3.1	-243	-50	-2.5	-121	-117
	TDLF	-1.5	-323	178	-2.2	-404	198	-3.9	-297	-75

Table B-6-5. Individual support vertical reactions under SDL and TDL (kips).

		Load Type & Support Number			
Girder	**Detailing Method**	**SDL 1**	**SDL 2**	**TDL 1**	**TDL 2**
G1	**NLF**	72	72	200	200
	SDLF	72	72	199	199
	TDLF	73	72	198	198
G2	**NLF**	52	52	152	152
	SDLF	52	52	152	152
	TDLF	51	52	153	153
G3	**NLF**	23	23	80	80
	SDLF	23	23	81	81
	TDLF	23	22	82	82
G4	**NLF**	7	7	39	39
	SDLF	7	7	39	39
	TDLF	8	7	39	39

Appendix C-1. NISCR7 Bridge Description

The key characteristics of NISCR7 are as follows:

- Span length along the centerline of the bridge, L_s = 150 ft.
- Width between the fascia girders, w_g = 74 ft.
- Radius of curvature to the centerline of the bridge, R =280 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 2.0
- Subtended angle between the supports, L_s/R = 0.54
- Number of girders in the completed bridge cross-section, n_g =9.

This appendix presents the bridge description of the bridge NISCR7 in its final condition as well as during erection. The following figures and tables are provided:

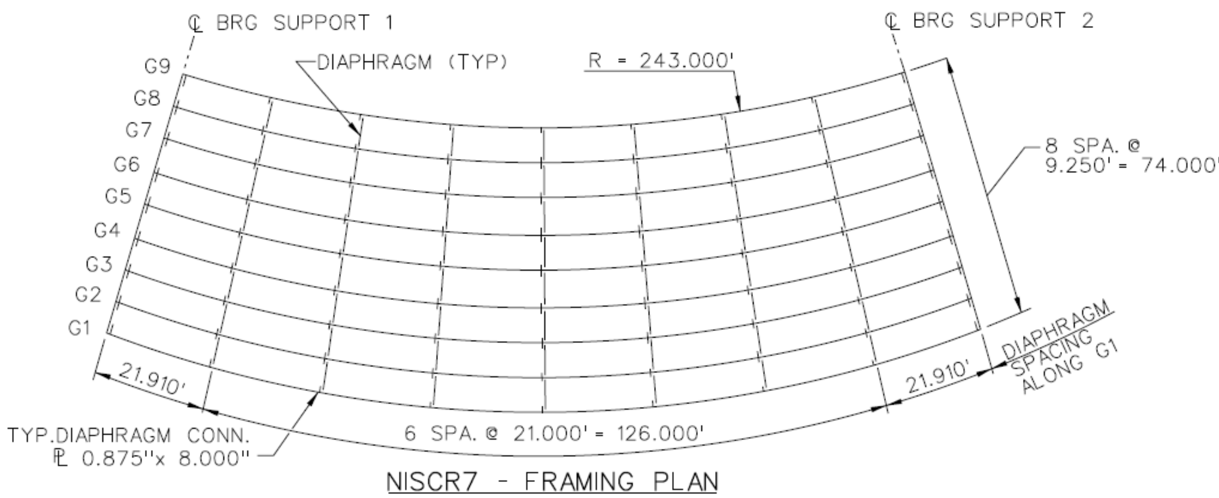


Figure C-1-1. Framing plan.

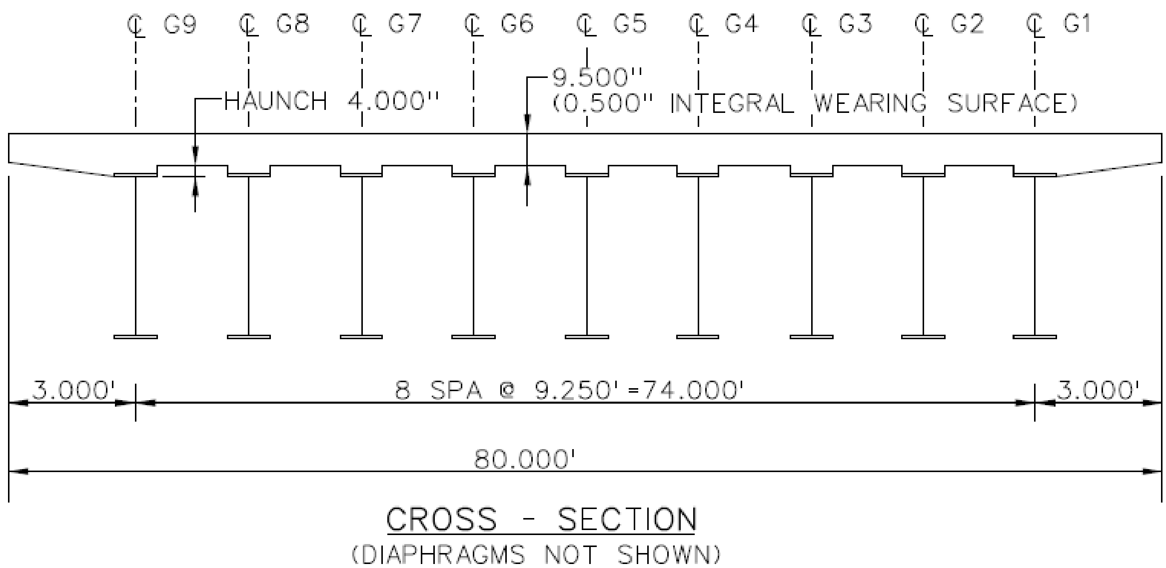


Figure C-1-2. Bridge cross-section.

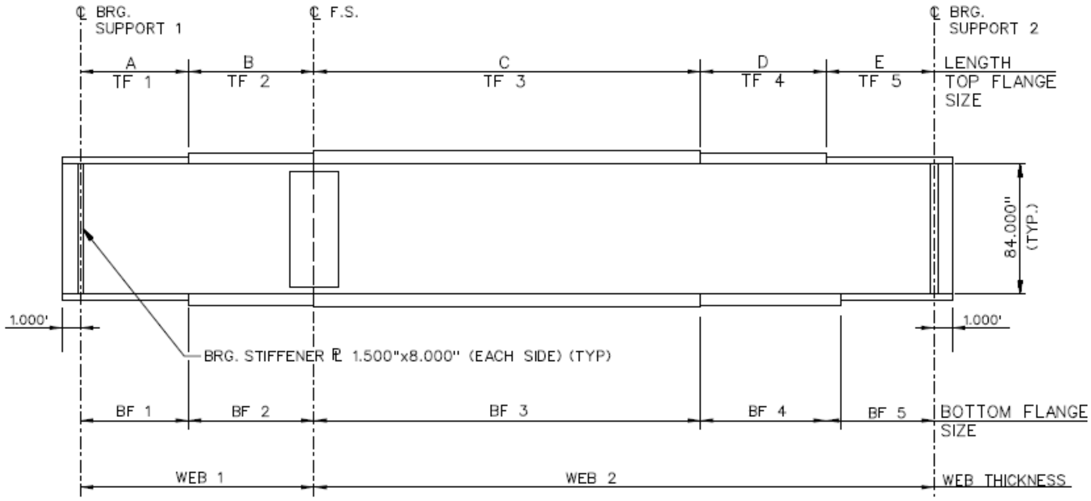


Figure C-1-3. Girder elevations

	GIRDER PLATE LENGTHS ⚹								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	25.000	24.271	23.541	22.812	22.082	21.353	20.623	19.894	19.164
B	25.000	24.271	23.541	22.812	22.082	21.353	20.623	19.894	19.164
C	69.821	67.784	65.747	63.709	61.672	59.635	57.597	55.560	53.522
D	25.000	24.271	23.541	22.812	22.082	21.353	20.623	19.894	19.164
E	25.000	24.271	23.541	22.812	22.082	21.353	20.623	19.894	19.164

⚹ ALL DIMENSIONS ARE IN FEET.

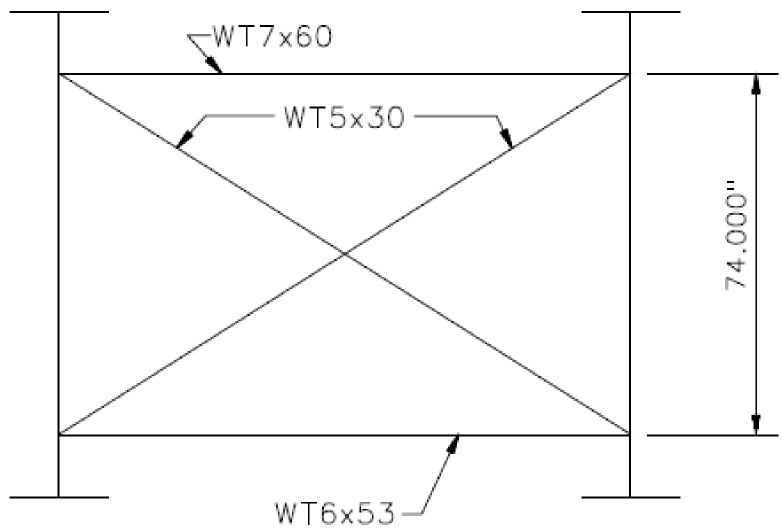
	GIRDER FLANGE DIMENSIONS ⚹⚹					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	24.000	1.000	20.000	1.000	18.000	1.000
TF2	24.000	1.500	20.000	1.000	18.000	1.000
TF3	24.000	2.250	20.000	1.500	18.000	1.000
TF4	24.000	1.500	20.000	1.000	18.000	1.000
TF5	24.000	1.000	20.000	1.000	18.000	1.000

⚹⚹ ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS ⚹⚹					
BOTTOM FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
BF1	30.000	1.250	22.000	1.000	18.000	1.000
BF2	30.000	2.250	22.000	1.000	18.000	1.000
BF3	30.000	3.000	22.000	1.500	18.000	1.500
BF4	30.000	2.250	22.000	1.000	18.000	1.000
BF5	30.000	1.250	22.000	1.000	18.000	1.000

⚹⚹ ALL DIMENSIONS ARE IN INCHES.

Figure C-1-4. Cross-section dimensions.



TYPICAL END AND INTERMEDIATE DIAPHRAGM

Figure C-1-4. Cross-frame details

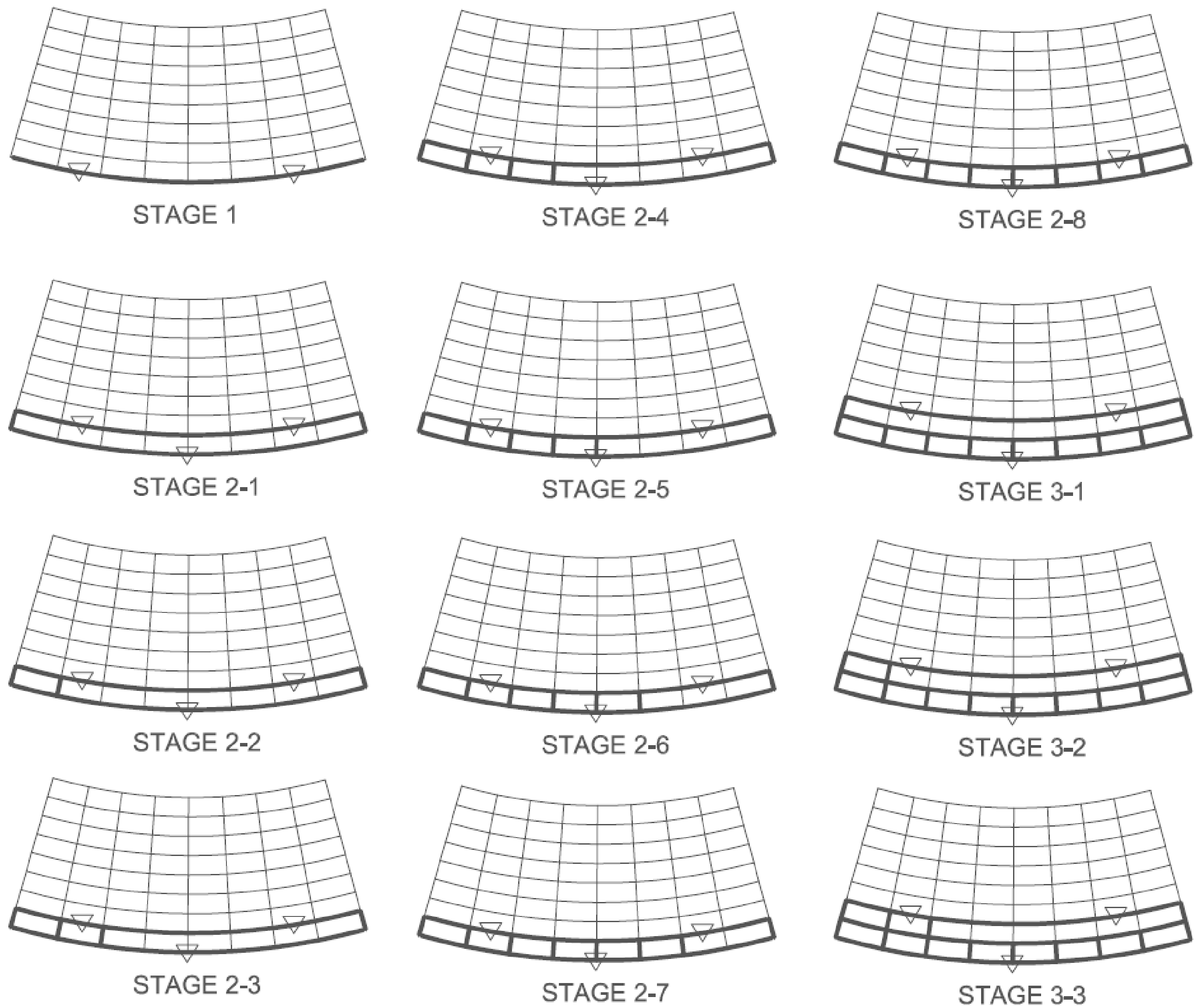


Figure C-1-6. Erection scheme.

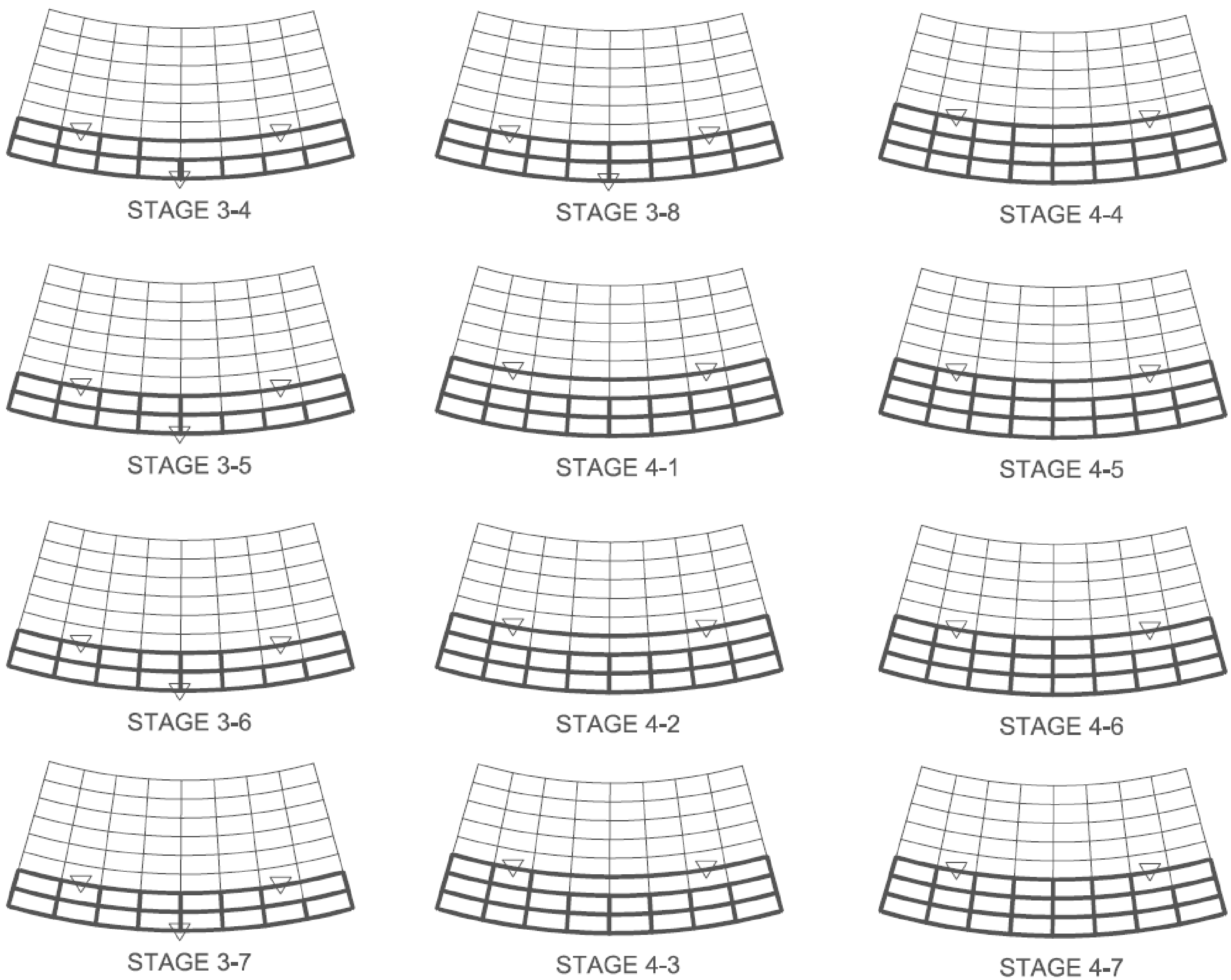
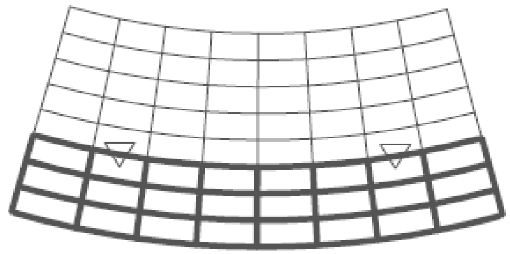


Figure C-1-6(Continued). Erection scheme.



THE SEQUENCE OF STAGE 4 IS REPEATED FOR GIRDERS 4 TO 9

Figure C-1-6(Continued). Erection scheme.

Table C-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

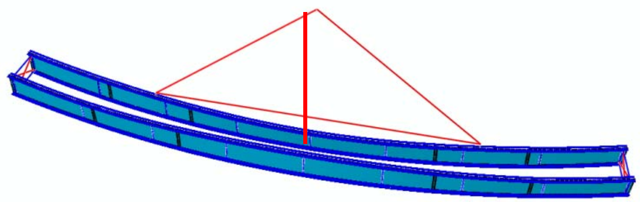
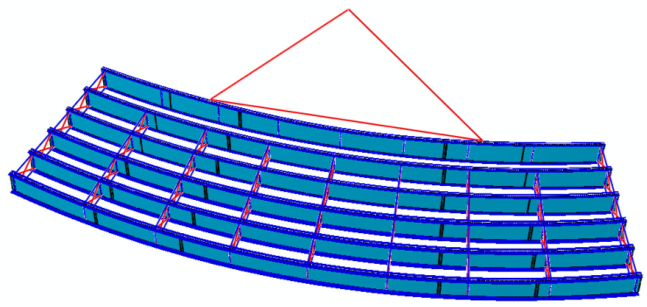
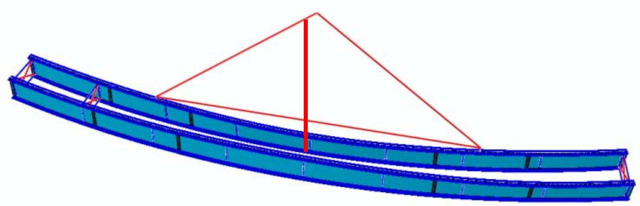
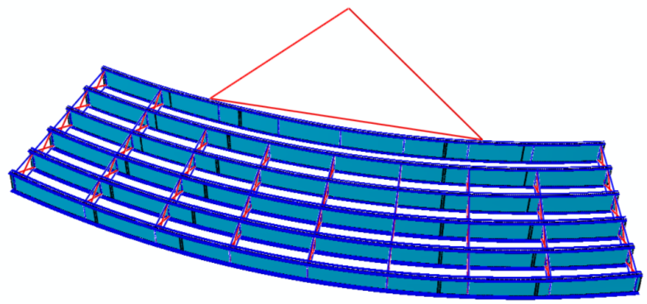
Sub-Stage	Stage	
	2	6
1		
2		

Table C-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

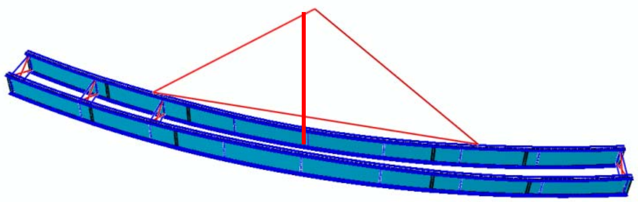
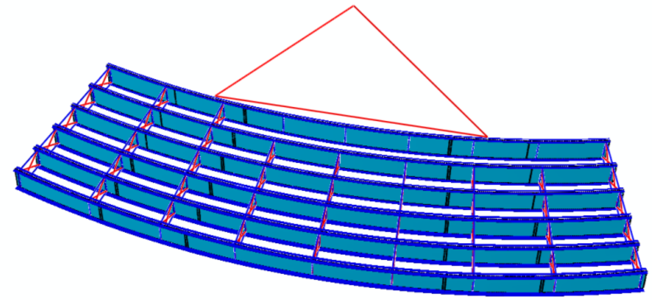
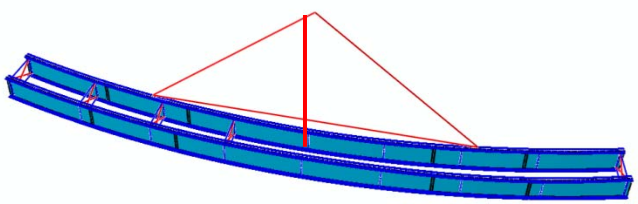
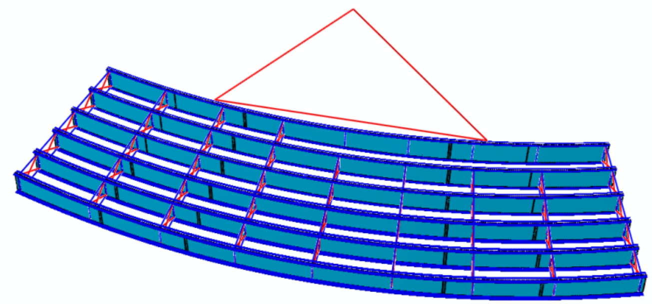
3		
4		

Table C-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

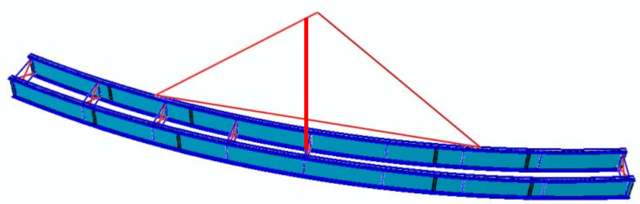
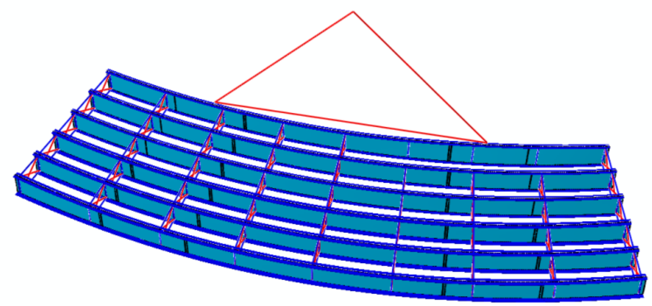
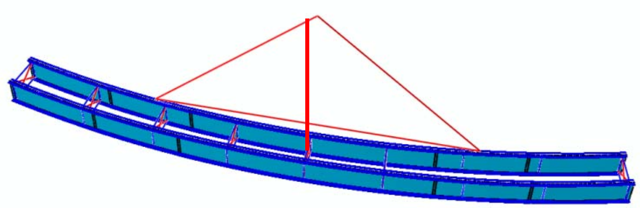
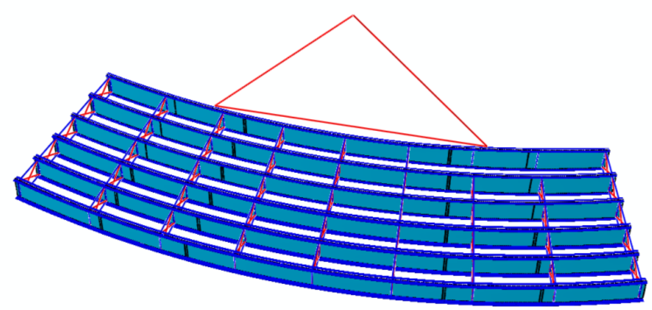
5		
6		

Table C-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

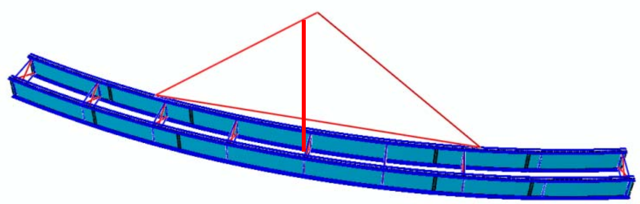
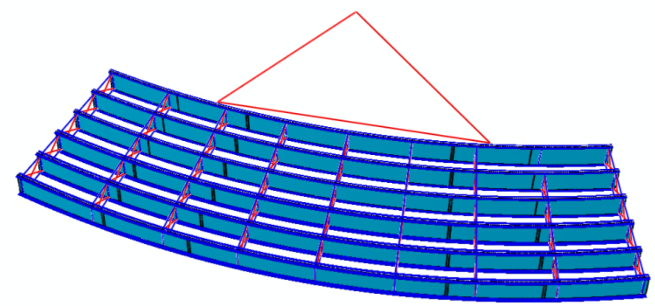
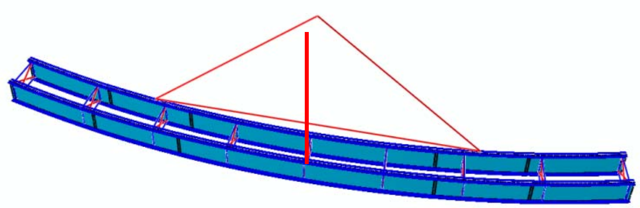
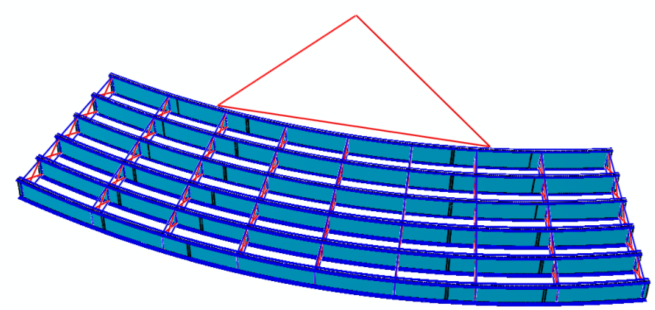
7		
8		

Table C-1-1(continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

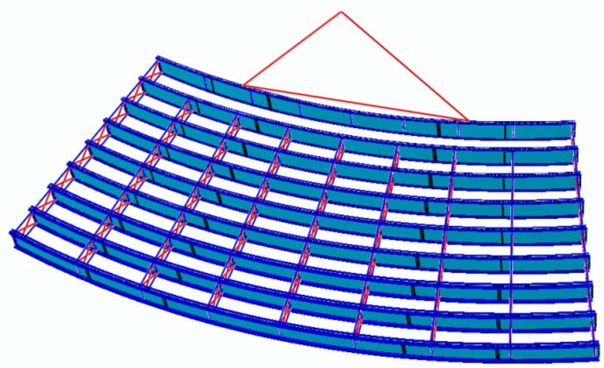
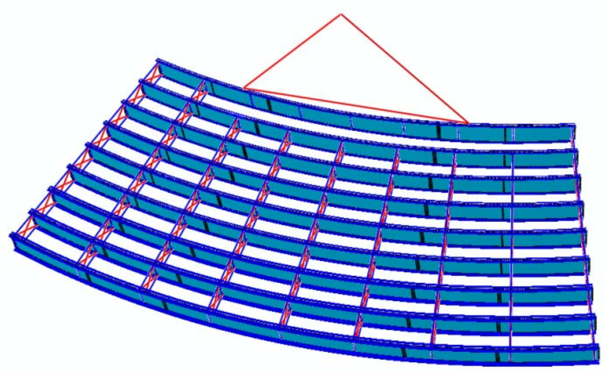
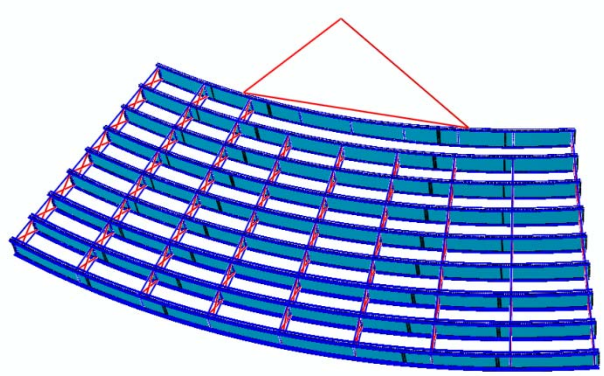
Sub-Stage	Stage 9
1	
2	
3	

Table C-1-1(continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

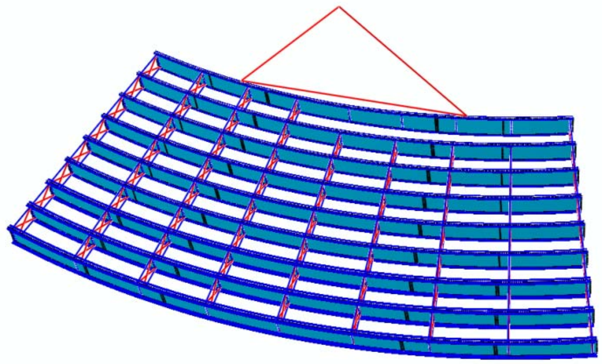
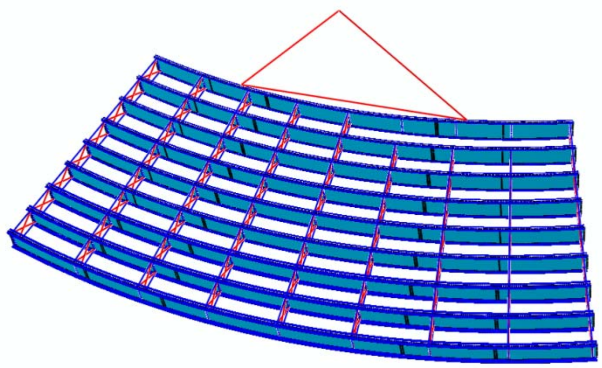
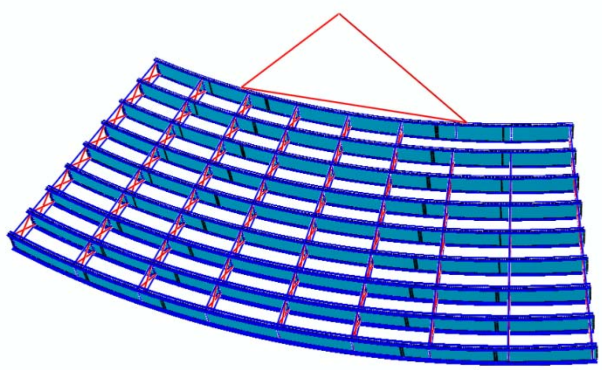
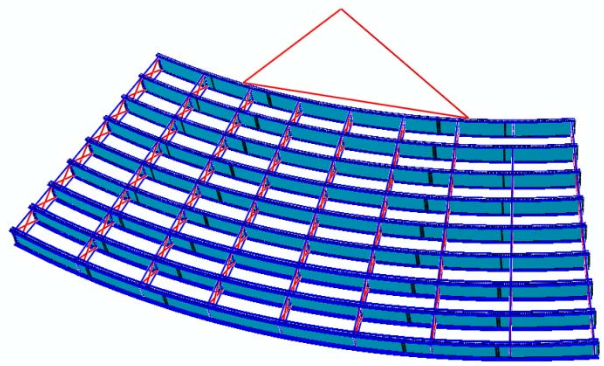
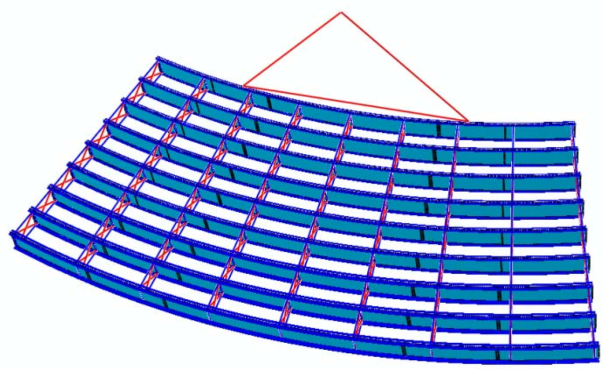
Sub-Stage	Stage 9
4	
5	
6	

Table C-1-1(continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

Sub-Stage	Stage 9
7	
8	

Appendix C-2. NISCR7 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISCR7 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided:

Summary

Table C-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	3.0	8.1
	SDLF	2.8	7.9
	TDLF	2.6	7.7
G2	NLF	2.5	7.1
	SDLF	2.3	6.9
	TDLF	1.9	6.5
G3	NLF	2.2	6.2
	SDLF	1.8	5.9
	TDLF	1.4	5.5
G4	NLF	1.8	5.5
	SDLF	1.5	5.1
	TDLF	1.0	4.7
G5	NLF	1.5	4.8
	SDLF	1.2	4.4
	TDLF	0.8	4.0
G6	NLF	1.2	4.1
	SDLF	0.9	3.8
	TDLF	0.6	3.5
G7	NLF	1.0	3.5
	SDLF	0.7	3.3
	TDLF	0.4	3.0
G8	NLF	0.7	2.9
	SDLF	0.5	2.7
	TDLF	0.3	2.4
G9	NLF	0.5	2.2
	SDLF	0.3	2.1
	TDLF	0.1	1.9
All Girders	NLF	3.0	8.1
	SDLF	2.8	7.9
	TDLF	2.6	7.7

Table C-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.4	0.9
	SDLF	0.2	0.7
	TDLF	0.1	0.4
G2	NLF	0.3	0.8
	SDLF	0.1	0.6
	TDLF	0.2	0.3
G3	NLF	0.3	0.7
	SDLF	0.1	0.5
	TDLF	0.2	0.2
G4	NLF	0.3	0.7
	SDLF	0.1	0.5
	TDLF	0.2	0.2
G5	NLF	0.3	0.6
	SDLF	0.0	0.4
	TDLF	0.3	0.1
G6	NLF	0.2	0.6
	SDLF	0.0	0.3
	TDLF	0.3	0.1
G7	NLF	0.2	0.6
	SDLF	0.0	0.3
	TDLF	0.3	0.1
G8	NLF	0.2	0.5
	SDLF	0.0	0.3
	TDLF	0.3	0.1
G9	NLF	0.2	0.5
	SDLF	0.0	0.3
	TDLF	0.3	0.1
All Girders	NLF	0.4	0.9
	SDLF	0.2	0.7
	TDLF	0.3	0.4

Table C-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	5.7	15.9	8.8	24.6	1.5	4.9	3.1	8.9
	SDLF	5.9	16.1	9.1	24.9	1.6	4.7	3.4	9.3
	TDLF	6.2	16.3	9.6	25.4	1.7	4.5	3.8	9.9
G2	NLF	5.1	14.7	7.9	22.8	1.3	4.4	2.7	7.7
	SDLF	5.1	14.7	8.0	22.9	1.3	4.2	2.9	8.0
	TDLF	5.1	14.7	7.9	22.8	1.4	3.9	3.1	8.3
G3	NLF	4.6	13.7	7.1	21.3	1.2	4.2	2.3	6.9
	SDLF	4.5	13.6	6.9	21.0	1.1	3.9	2.4	7.1
	TDLF	4.2	13.4	6.5	20.7	1.2	3.5	2.5	7.3
G4	NLF	5.2	16.4	5.6	17.5	1.9	6.5	2.3	7.2
	SDLF	5.0	16.2	5.3	17.2	1.9	6.3	2.3	7.3
	TDLF	4.7	15.9	5.0	16.9	1.8	6.0	2.3	7.4
G5	NLF	4.6	15.4	4.9	16.3	1.7	5.9	1.9	6.3
	SDLF	4.4	15.1	4.6	16.0	1.6	5.7	1.9	6.4
	TDLF	4.1	14.9	4.3	15.7	1.6	5.4	2.0	6.5
G6	NLF	3.9	14.0	4.2	14.9	1.4	5.3	1.5	5.4
	SDLF	3.8	13.8	4.0	14.7	1.3	5.1	1.6	5.5
	TDLF	3.6	13.7	3.8	14.5	1.4	4.9	1.7	5.8
G7	NLF	3.0	11.9	3.2	12.5	1.3	5.5	1.5	5.9
	SDLF	3.0	11.9	3.1	12.5	1.3	5.4	1.7	6.2
	TDLF	3.0	11.9	3.2	12.6	1.4	5.3	2.0	6.8
G8	NLF	2.2	10.1	2.3	10.8	0.9	4.6	0.9	4.6
	SDLF	2.3	10.3	2.5	11.0	1.0	4.6	1.2	5.1
	TDLF	2.5	10.5	2.7	11.3	1.1	4.5	1.6	5.8
G9	NLF	1.2	7.9	1.3	8.7	0.5	3.5	0.6	3.4
	SDLF	1.5	8.3	1.7	9.1	0.6	3.4	0.7	3.4
	TDLF	1.8	8.6	2.1	9.4	0.8	3.3	1.2	4.1
All Girders	NLF	5.7	16.4	8.8	24.6	1.9	6.5	3.1	8.9
	SDLF	5.9	16.2	9.1	24.9	1.9	6.3	3.4	9.3
	TDLF	6.2	16.3	9.6	25.4	1.8	6.0	3.8	9.9

Table C-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	16.0	59.0	57.4	59.0
	SDLF	34.0	55.1	54.8	55.1
	TDLF	63.8	51.2	48.9	63.8
TDL	NLF	55.7	151.5	147.2	151.5
	SDLF	73.4	146.9	144.1	146.9
	TDLF	98.2	142.1	137.5	142.1

Table C-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	6.3	18.3	17.8	12.2
	SDLF	15.7	16.4	16.4	16.1
	TDLF	28.9	15.6	14.6	22.0
TDL	NLF	20.2	42.7	41.2	31.1
	SDLF	29.4	41.0	39.7	34.9
	TDLF	42.0	39.4	37.7	40.3

Table C-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.42	0.38	0.34	0.31	0.28	0.26	0.26	0.26	0.42
SDLF	0.51	0.44	0.36	0.29	0.25	0.22	0.21	0.21	0.51
TDLF	0.64	0.51	0.36	0.26	0.19	0.16	0.16	0.18	0.64

Table C-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.19	1.04	0.72	0.65	0.60	0.58	0.58	0.60	1.19
SDLF	1.19	1.02	0.74	0.63	0.57	0.54	0.54	0.55	1.19
TDLF	1.21	0.95	0.74	0.60	0.52	0.48	0.49	0.52	1.21

Table C-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.31	0.29	0.25	0.23	0.21	0.20	0.19	0.19	0.31
SDLF	0.38	0.33	0.27	0.22	0.18	0.16	0.16	0.16	0.38
TDLF	0.48	0.38	0.27	0.19	0.15	0.12	0.12	0.13	0.48

Table C-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.69	0.62	0.54	0.49	0.45	0.43	0.44	0.45	0.69
SDLF	0.75	0.66	0.55	0.47	0.43	0.40	0.40	0.41	0.75
TDLF	0.84	0.71	0.55	0.45	0.39	0.36	0.37	0.39	0.84

Table C-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	734.7	2376.0
SDLF	734.7	2376.0
TDLF	734.7	2376.0

Table C-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	79	227	0	0	0	0
SDLF	82	229	0	0	0	0
TDLF	85	232	0	0	0	0

Table C-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.3	0.7	0.0	0.0
SDLF	0.3	0.8	0.0	0.0
TDLF	0.3	0.8	0.0	0.0

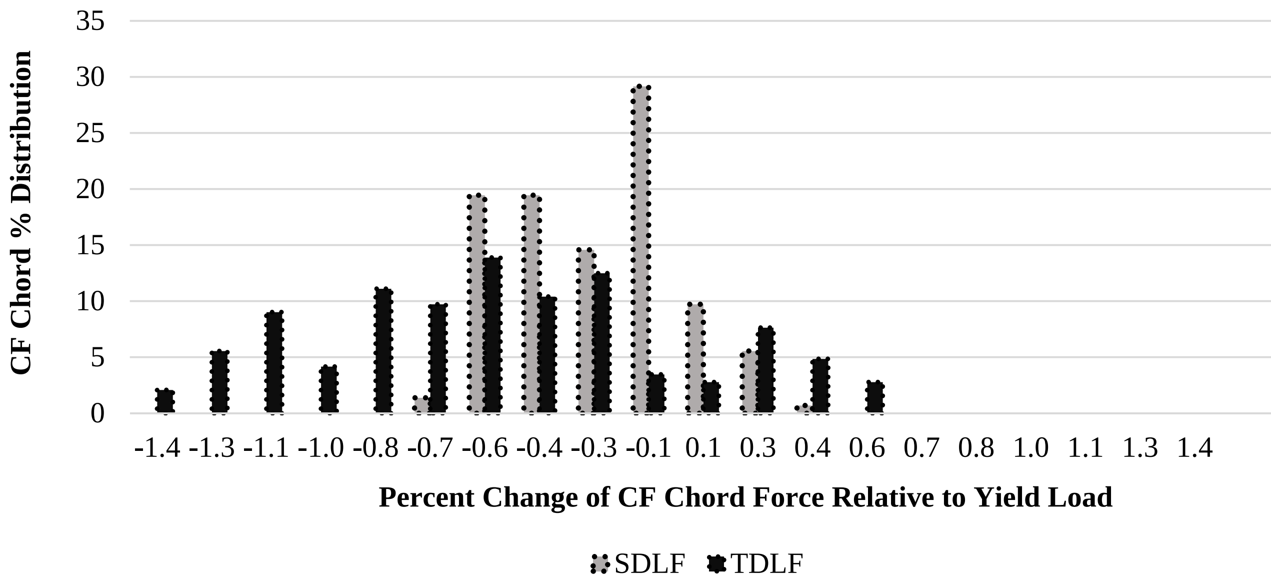


Figure C-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

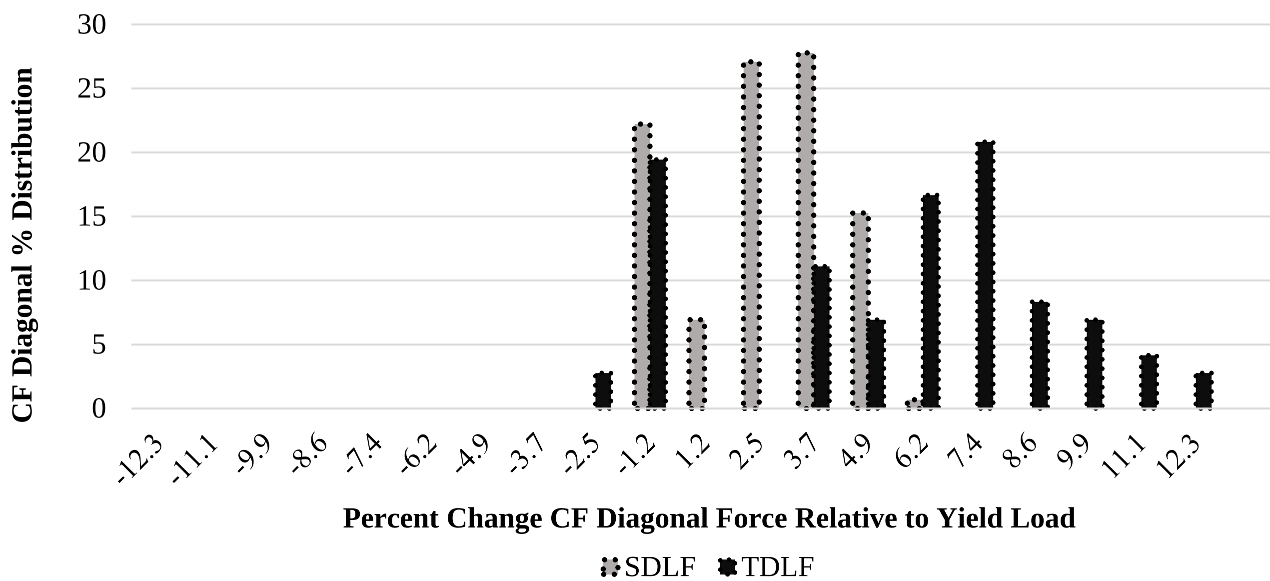


Figure C-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

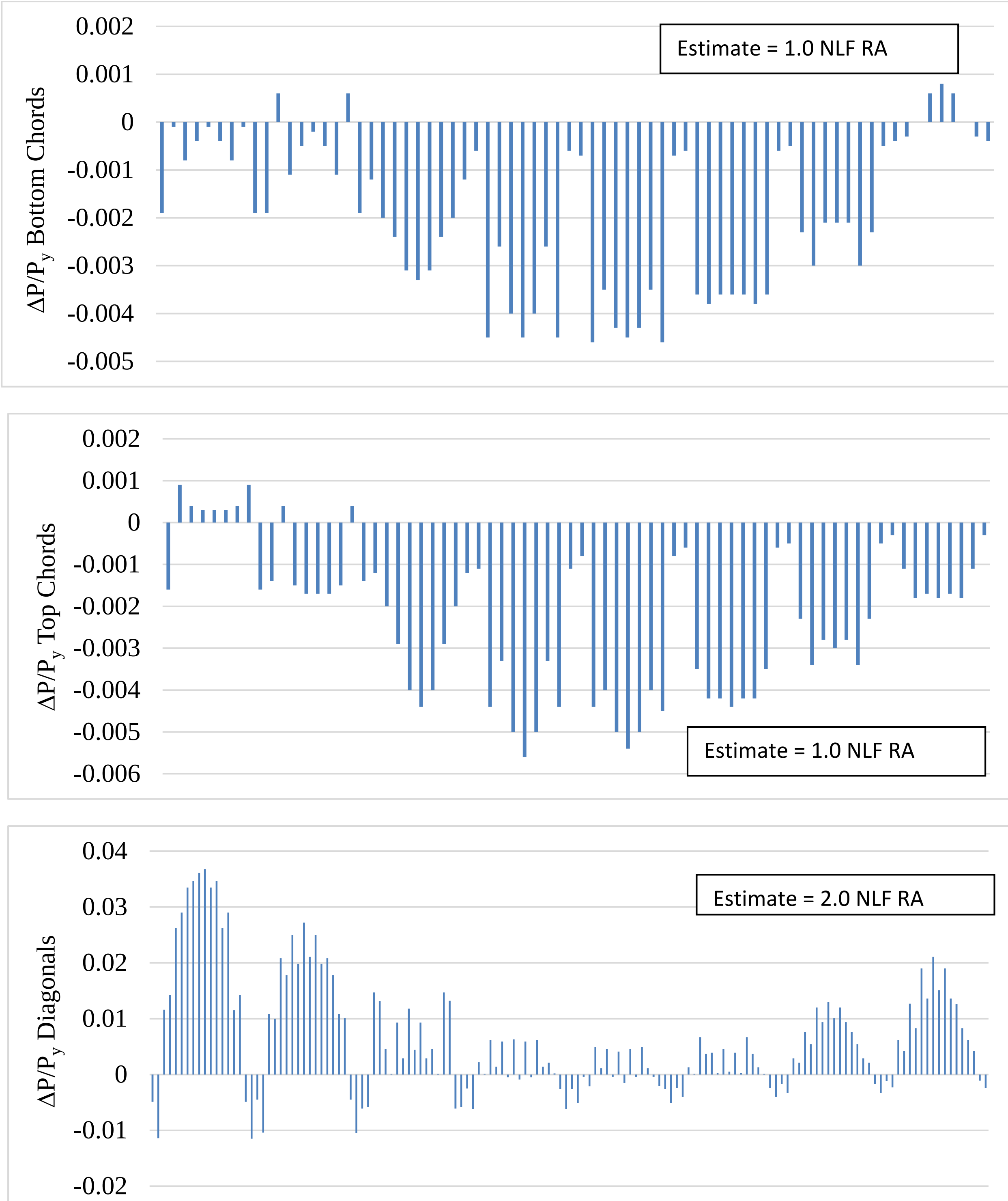


Figure C-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

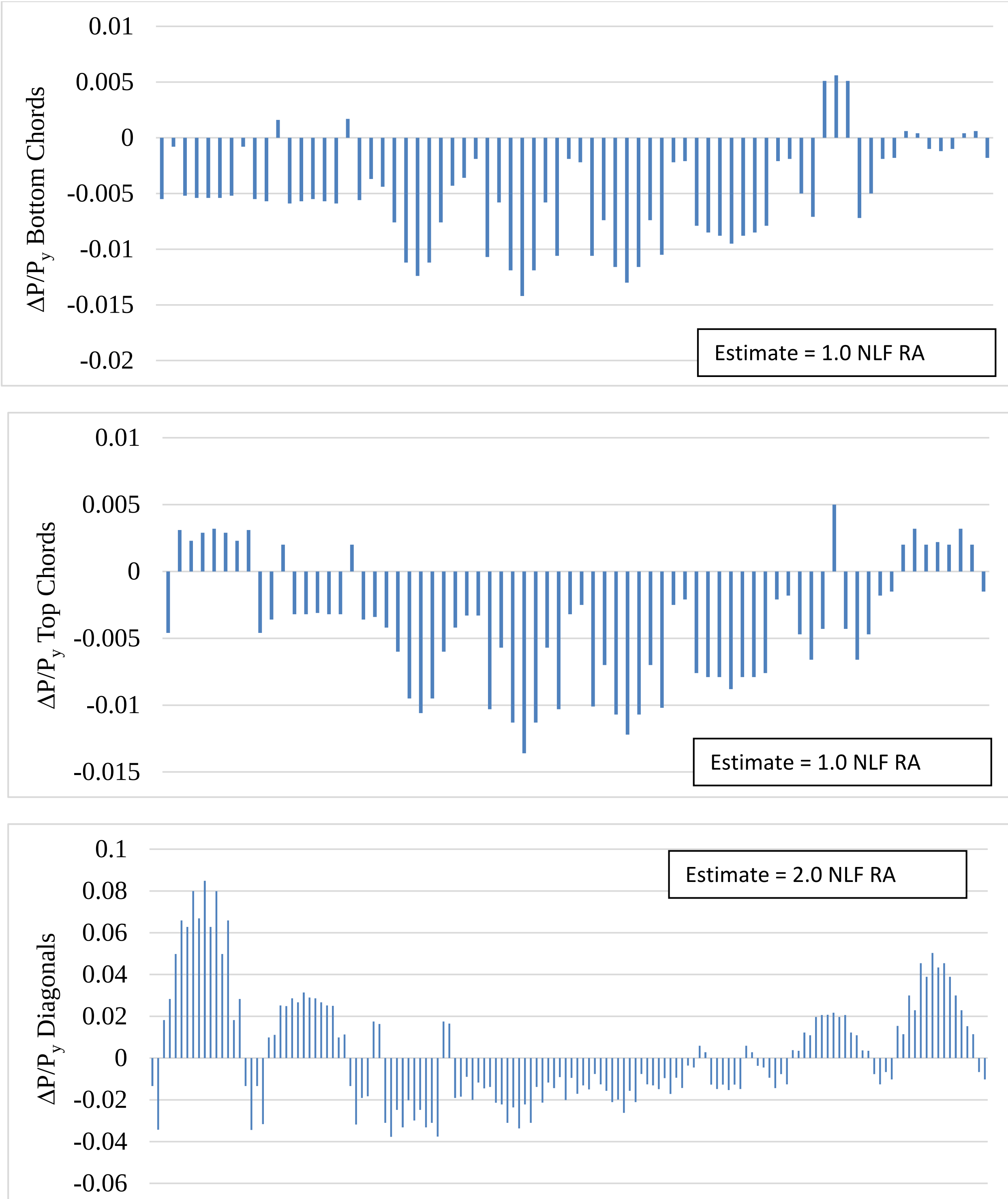


Figure C-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix C-3. NISCR7 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISCR7 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table C-3-1. NISCR7 maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	21.3	12.6	21.3
SDLF	28.3	35.9	35.9
TDLF	37.5	75.3	75.3

Table C-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	97	16.9
	SDLF	96.2	18.9
	TDLF	95.1	23.5
G2	NLF	76.1	0
	SDLF	75.9	2.9
	TDLF	75.5	4.3
G3	NLF	65	53.4
	SDLF	64.5	55.2
	TDLF	64.8	58.5
G4	NLF	36.4	19.2
	SDLF	34.3	19.9
	TDLF	31	20.1
G5	NLF	29.9	0
	SDLF	29.3	4.5
	TDLF	28.7	10
G6	NLF	24.6	0
	SDLF	25.1	0
	TDLF	25.8	4.1
G7	NLF	17.4	16.5
	SDLF	18.4	17.8
	TDLF	20	19.5
G8	NLF	3.6	0
	SDLF	12.5	12.3
	TDLF	16	14.7
G9	NLF	0	0
	SDLF	4.4	2.5
	TDLF	8.5	4.3
All Girders	NLF	97	0
	SDLF	96.2	0
	TDLF	95.1	4.1

Table C-3-3. Summary of crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	100.6	35.4	74.3	73.0
SDLF	87.9	23.1	81.0	76.9
TDLF	74.3	5.4	84.6	77.7

Table C-3-4. NISCR7 erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage							
		1	2	3	4	5	6	7	8
2	NLF	207	208	210	212	214	215	217	219
	SDLF	207	208	210	212	214	215	217	219
	TDLF	207	208	210	212	214	215	217	219
6	NLF	538	539	541	543	544	546	548	550
	SDLF	538	539	541	543	544	546	548	550
	TDLF	538	539	541	543	544	546	548	550
9	NLF	723	724	726	728	730	731	733	735
	SDLF	723	724	726	728	730	731	733	735
	TDLF	723	724	726	728	730	731	733	735

Appendix C-4. NISCR7 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge NISCR7 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

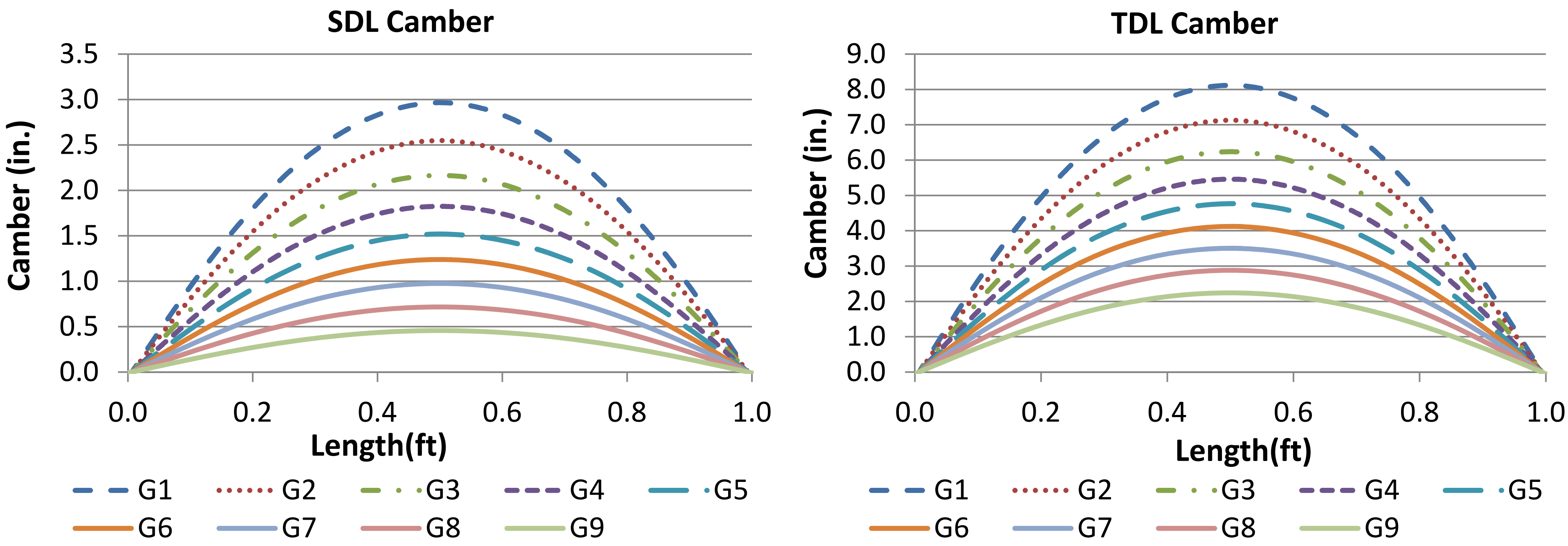
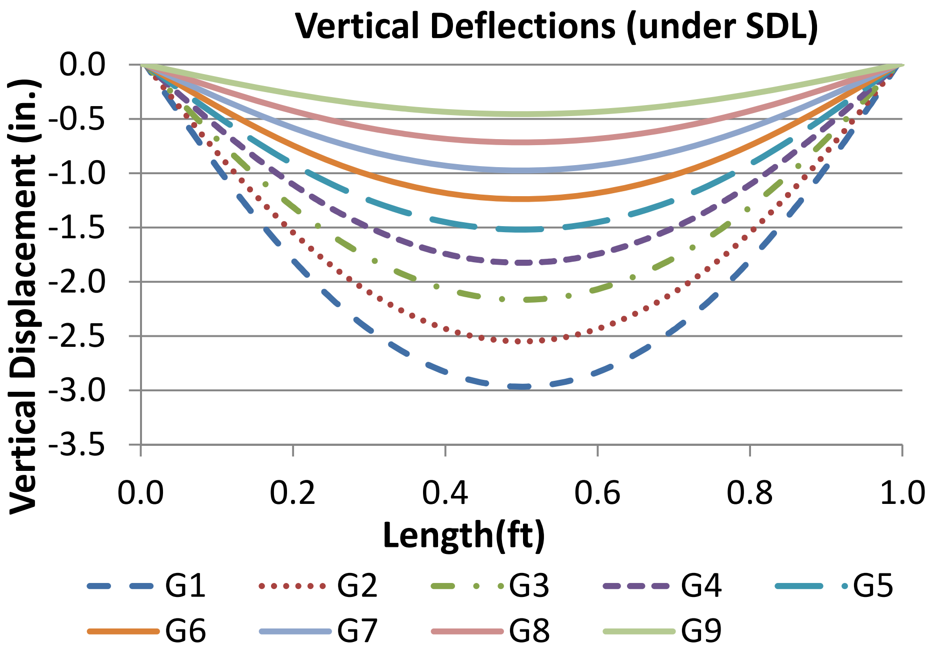
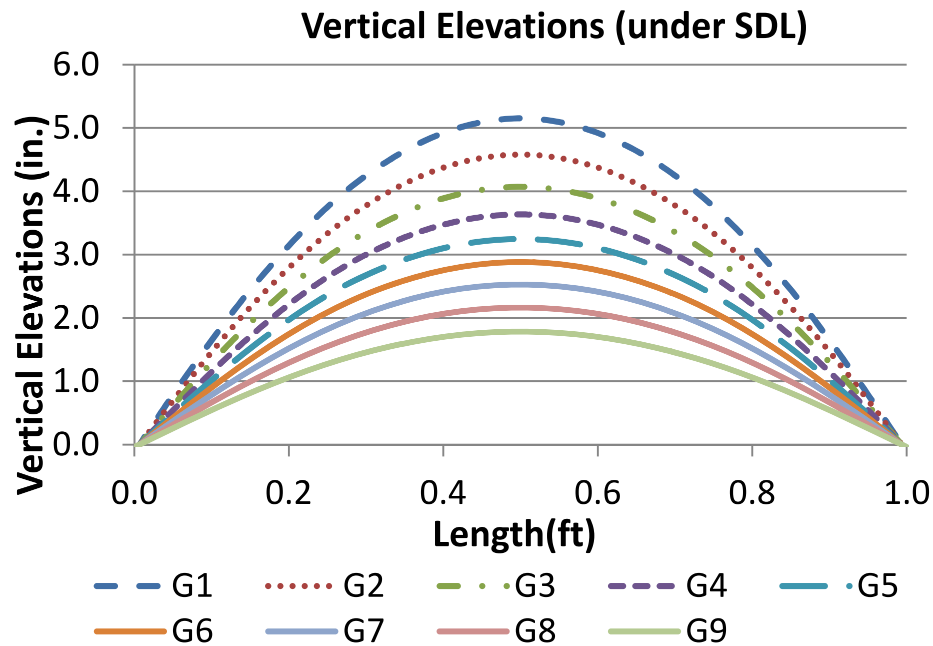


Figure C-4-1. SDL and TDL 3D FEA cambers.





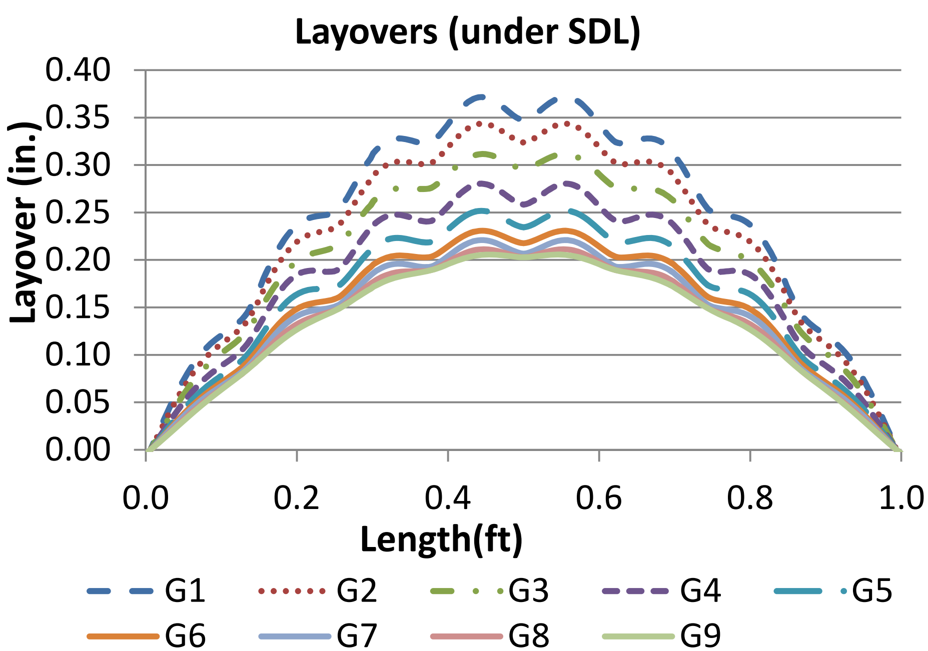


Figure C-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

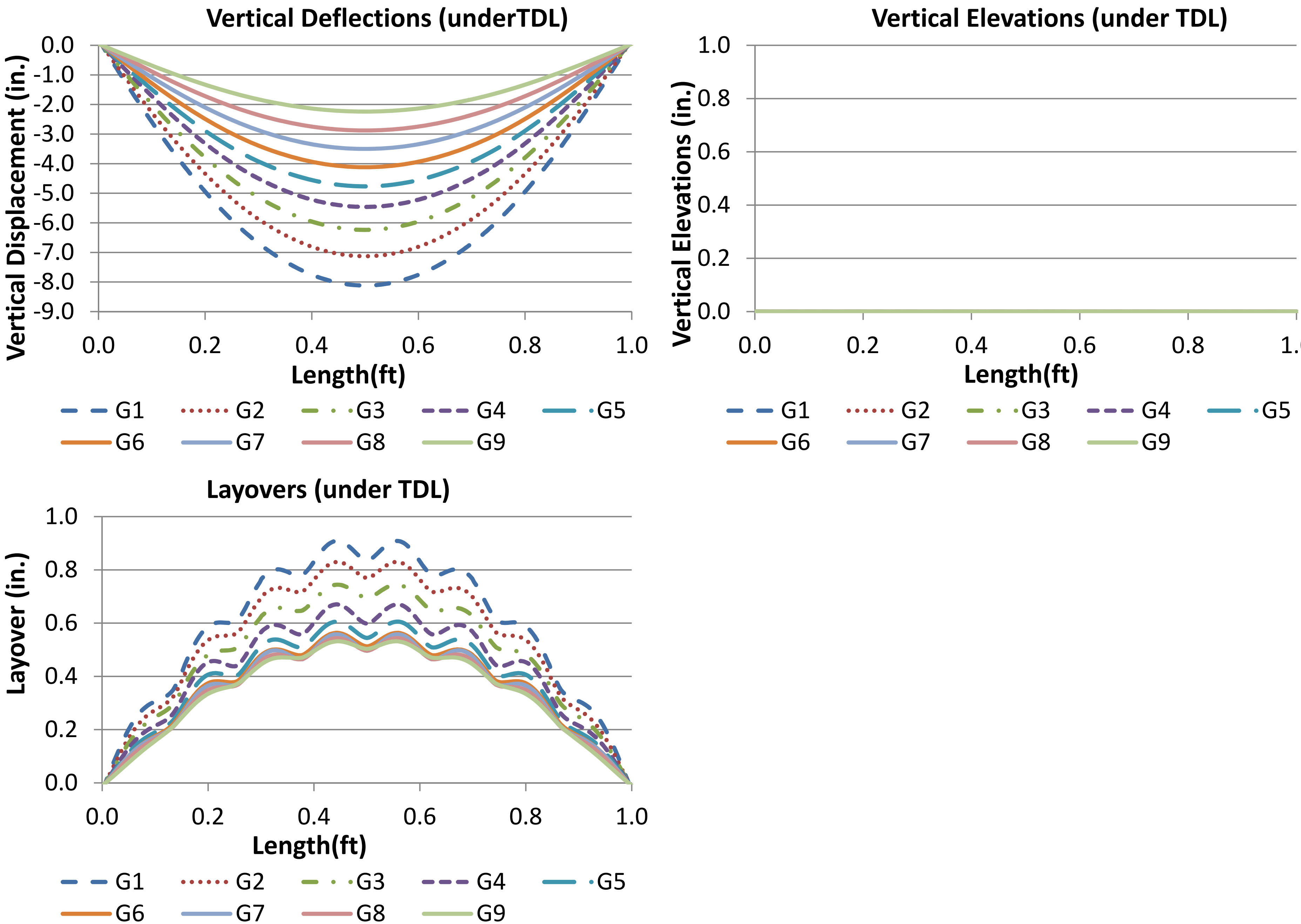


Figure C-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

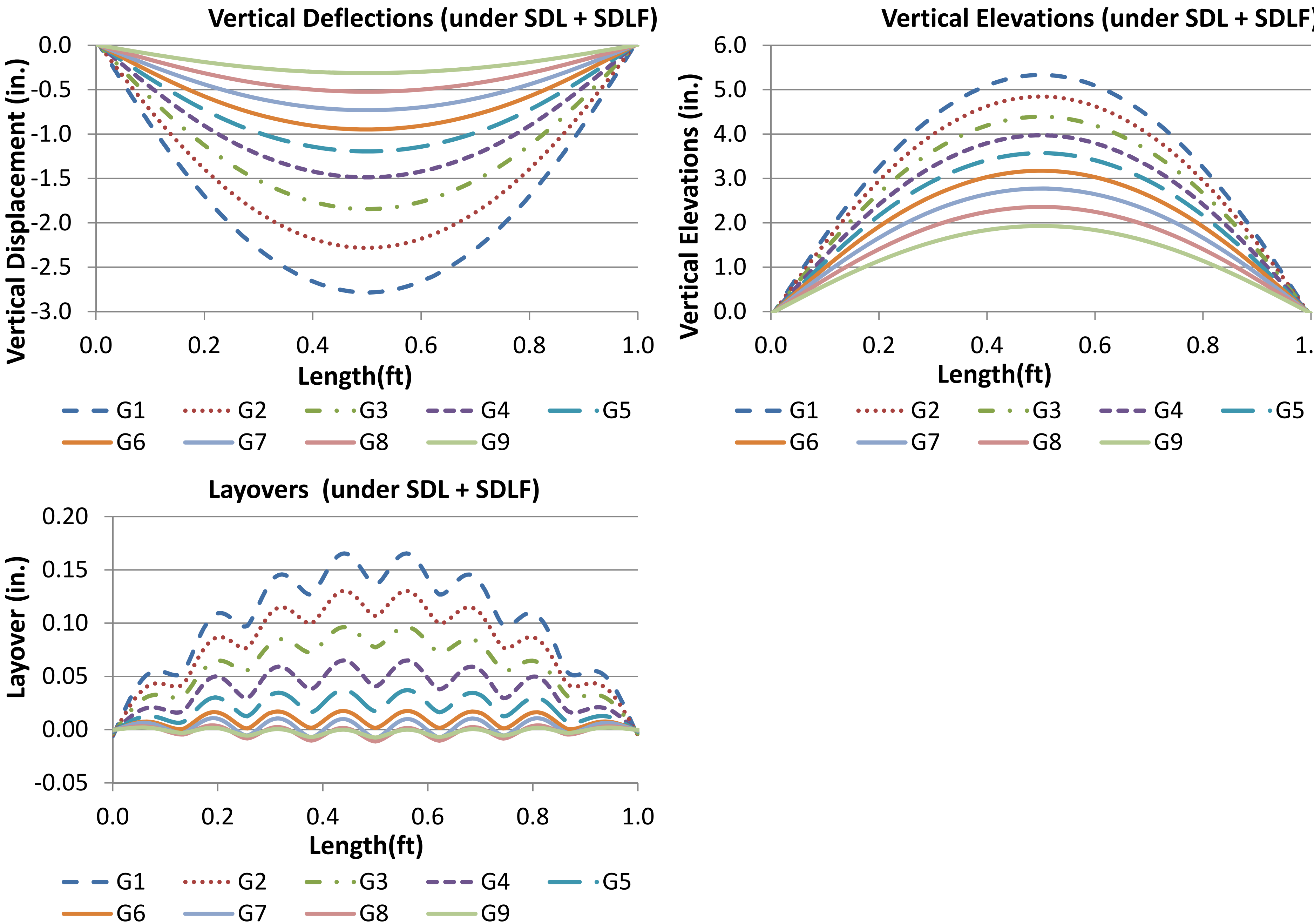


Figure C-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

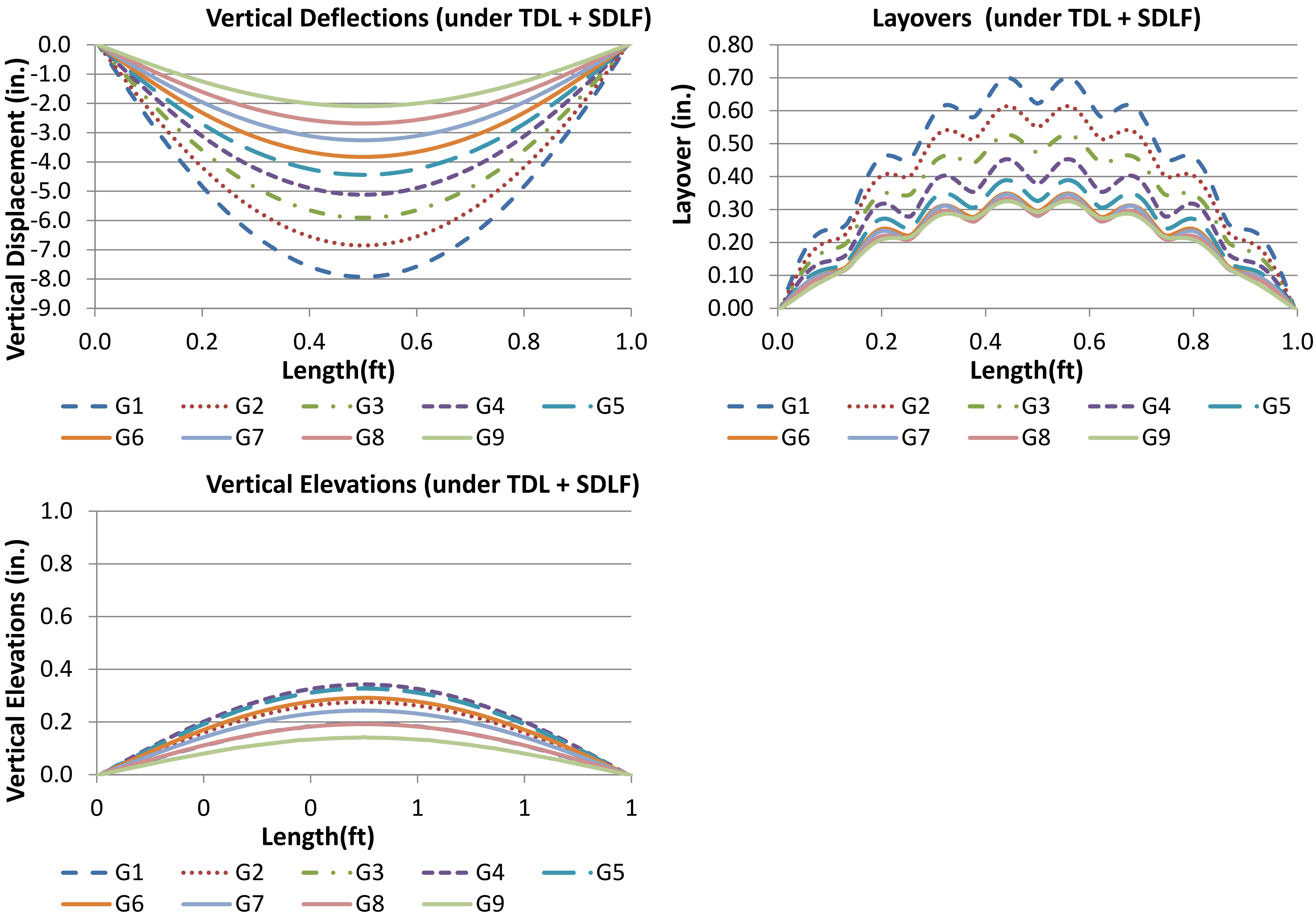


Figure C-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

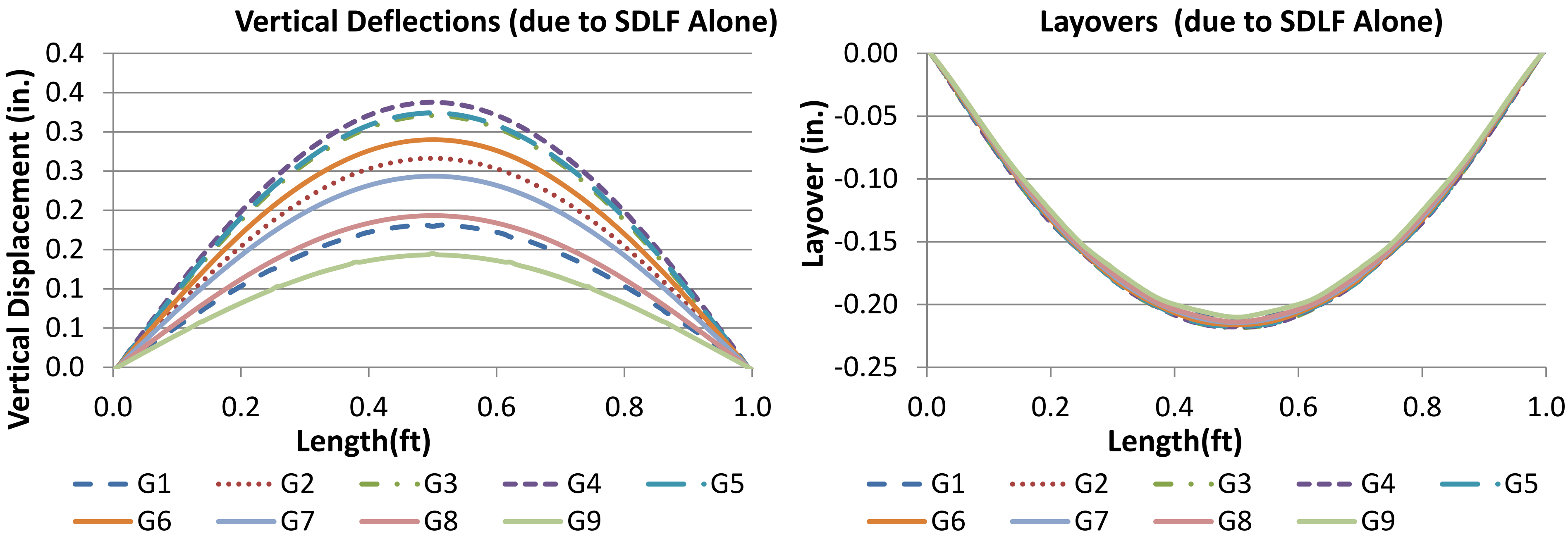


Figure C-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

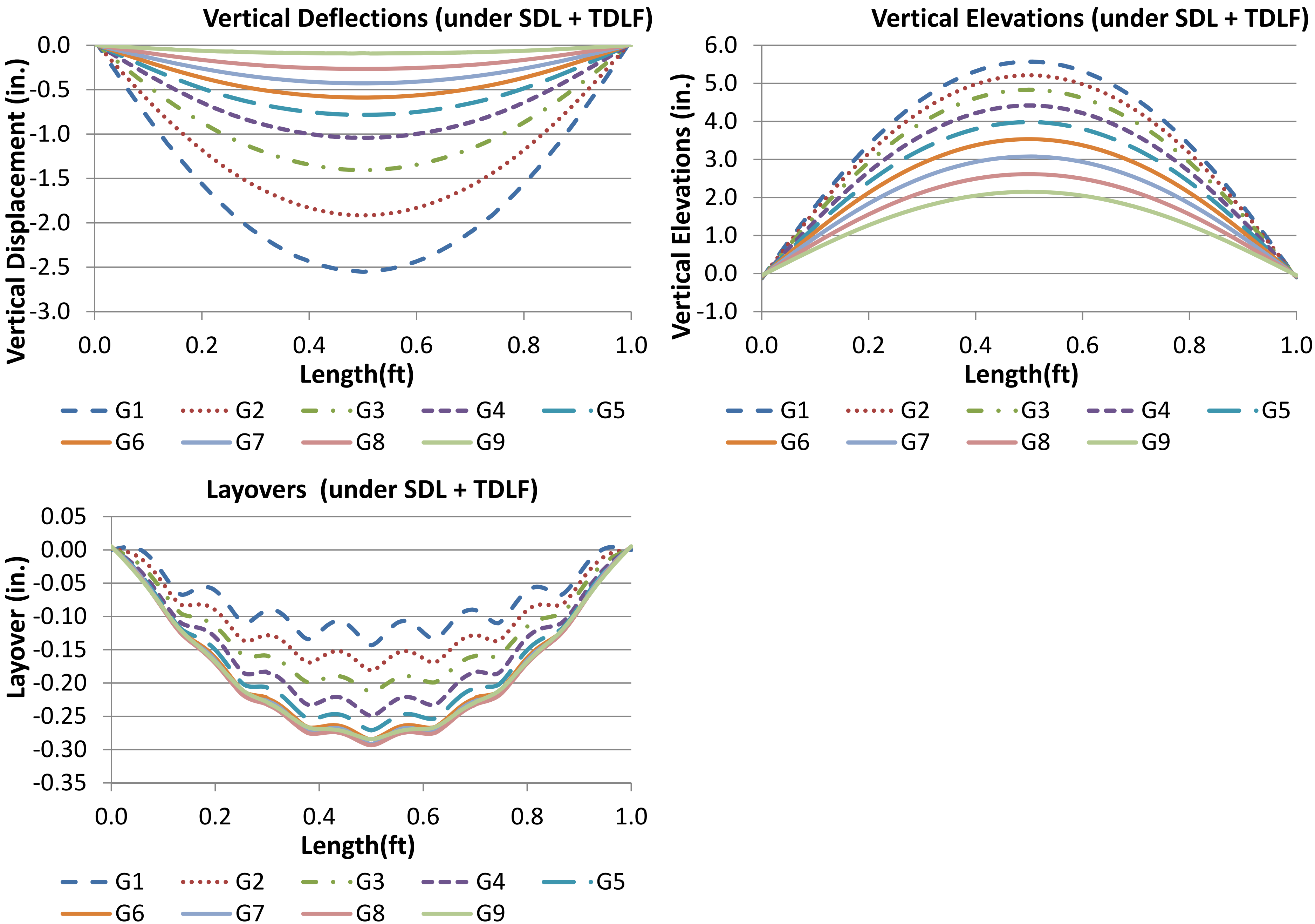


Figure C-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

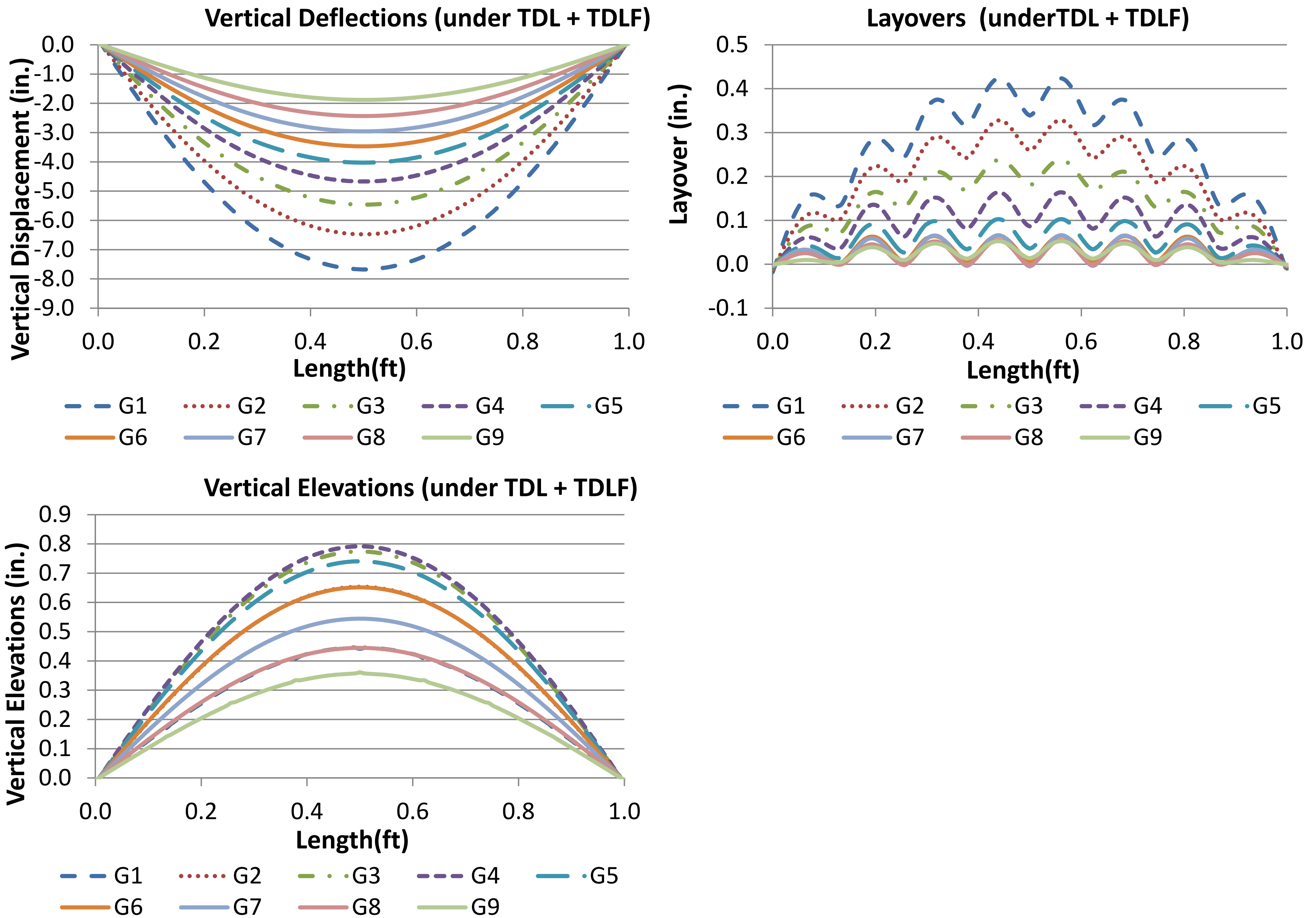


Figure C-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

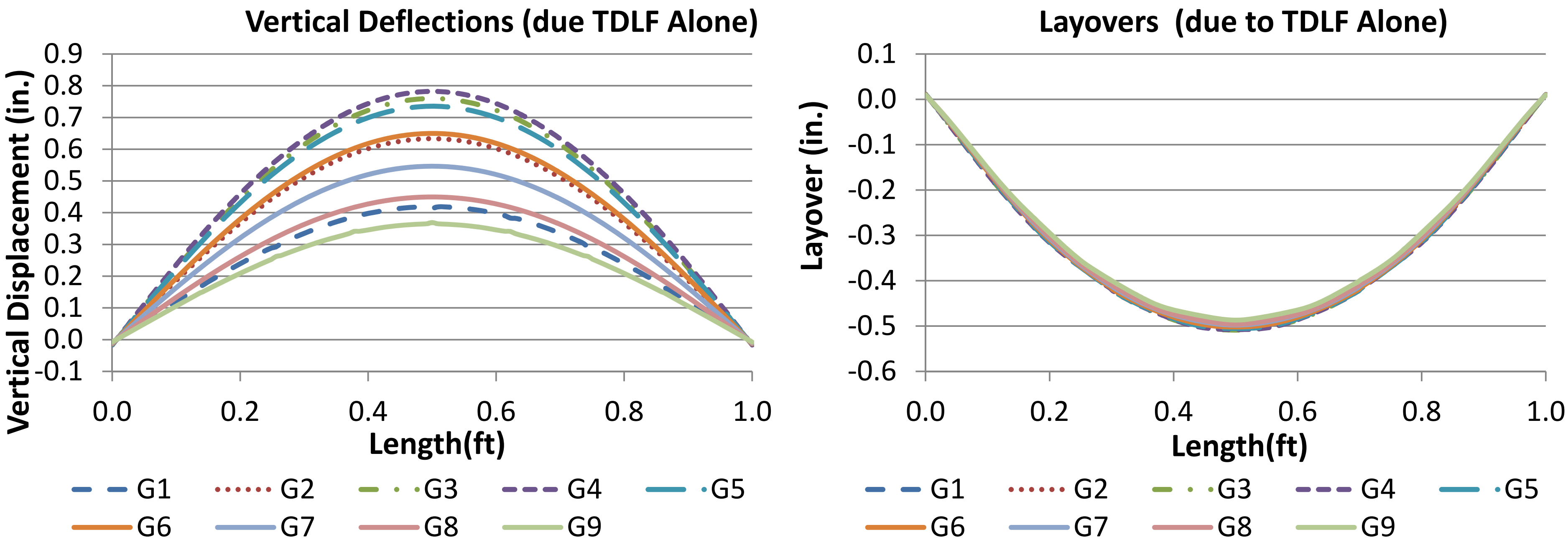


Figure C-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

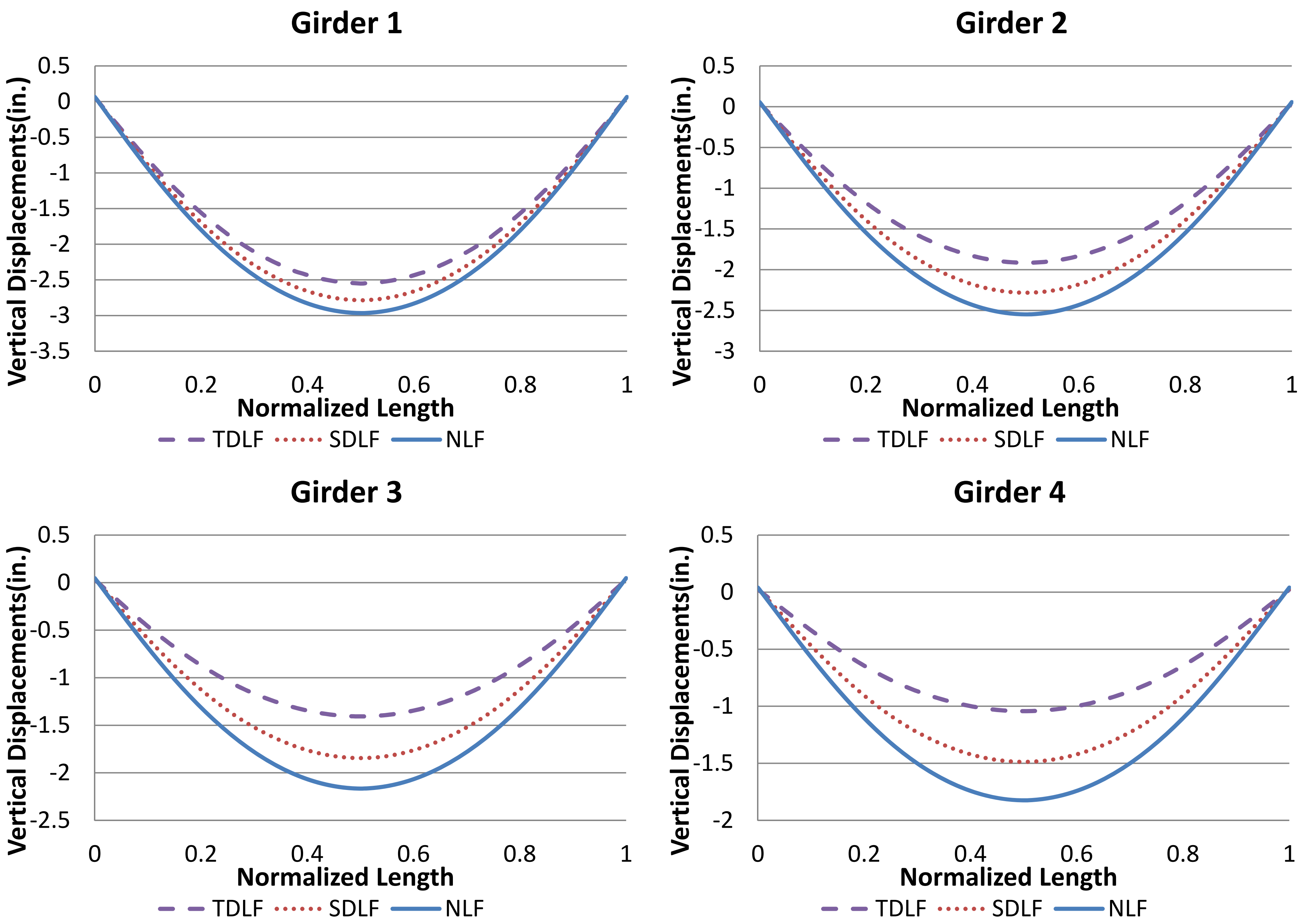


Figure C-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

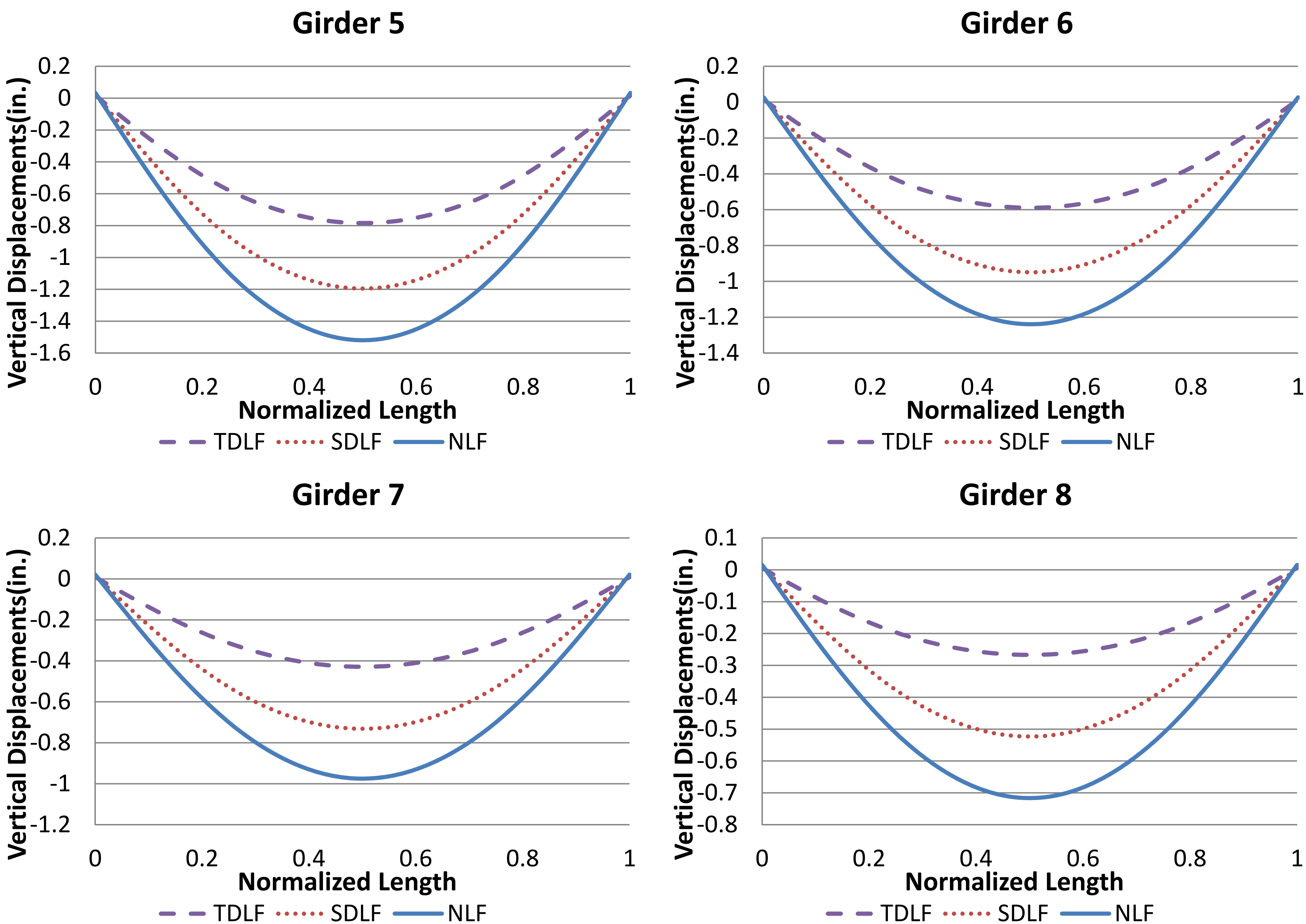


Figure C-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

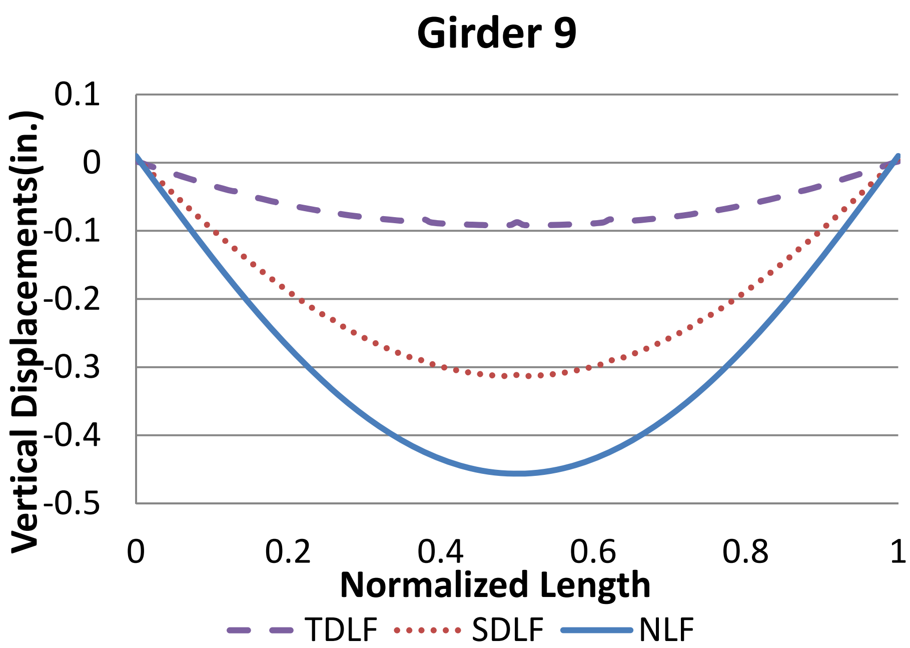


Figure C-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

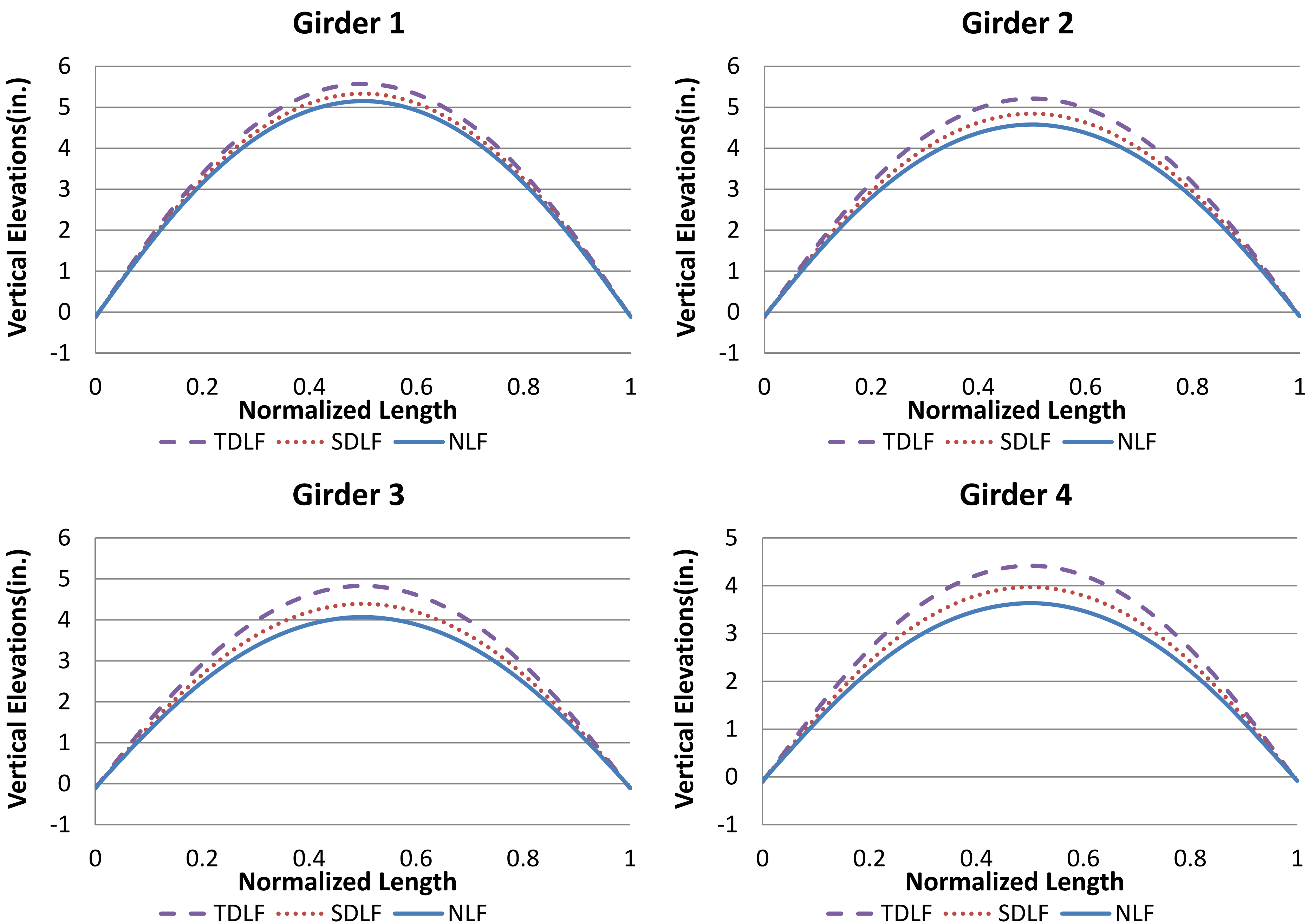


Figure C-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

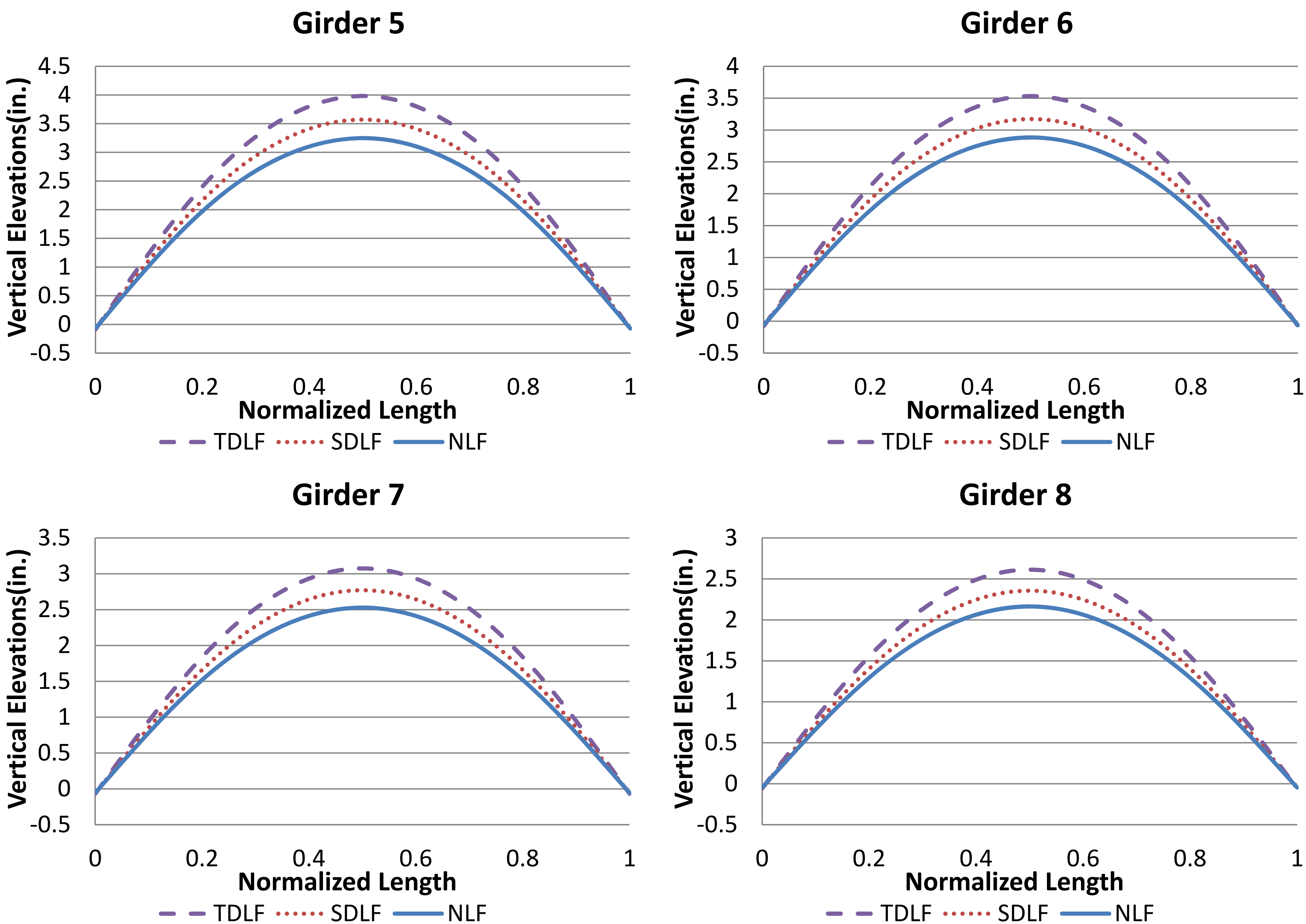


Figure C-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

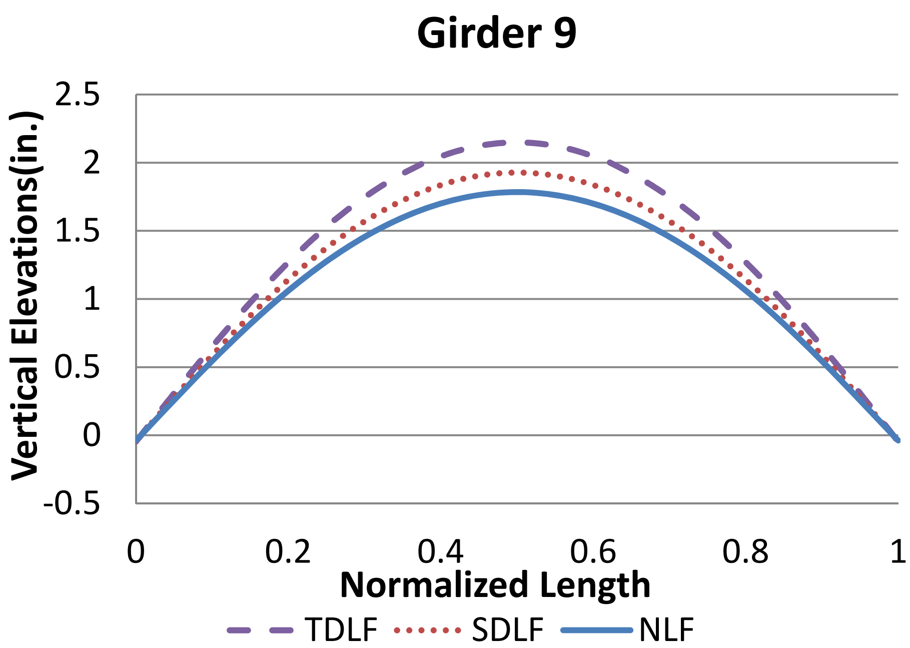


Figure C-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

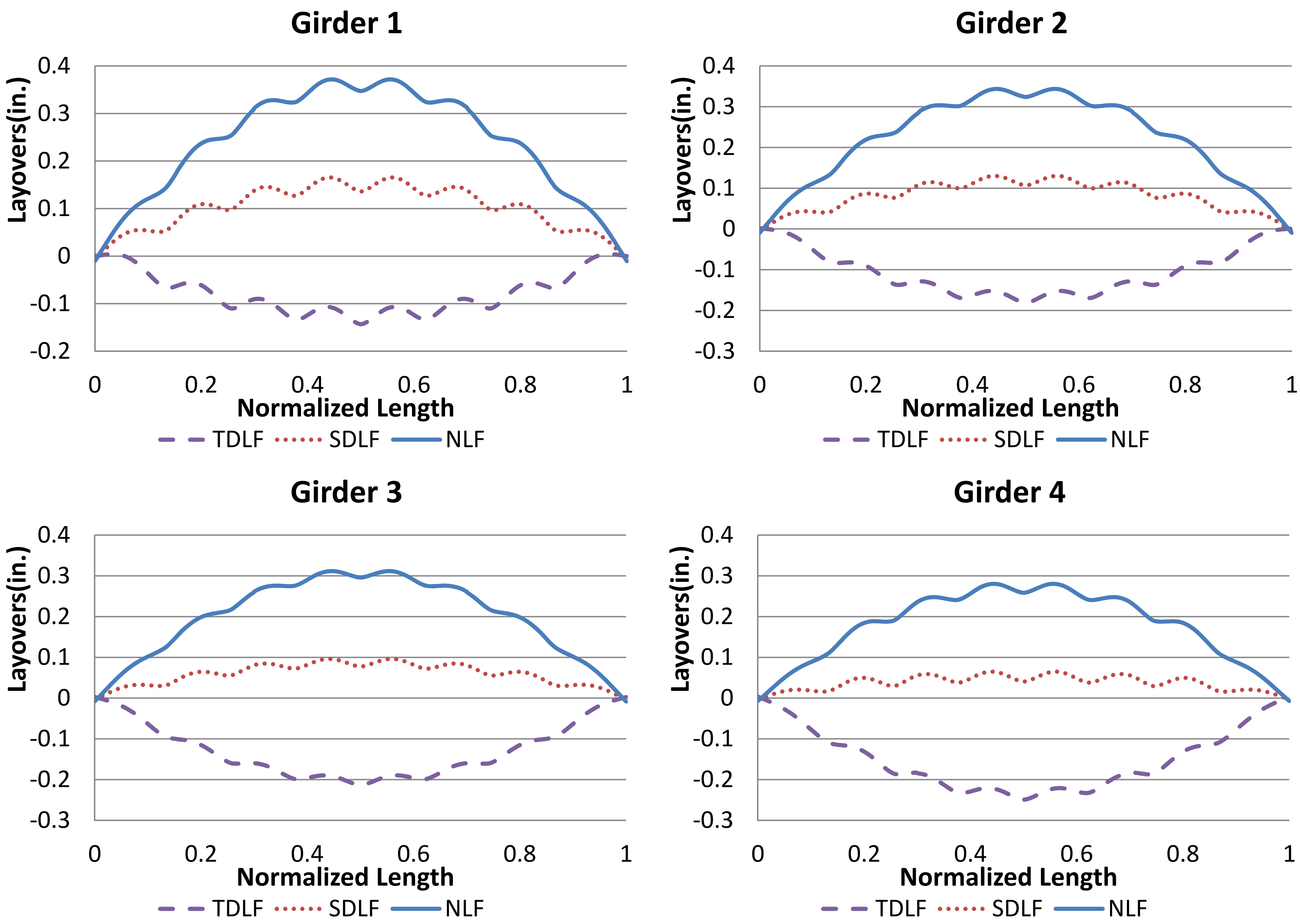


Figure C-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

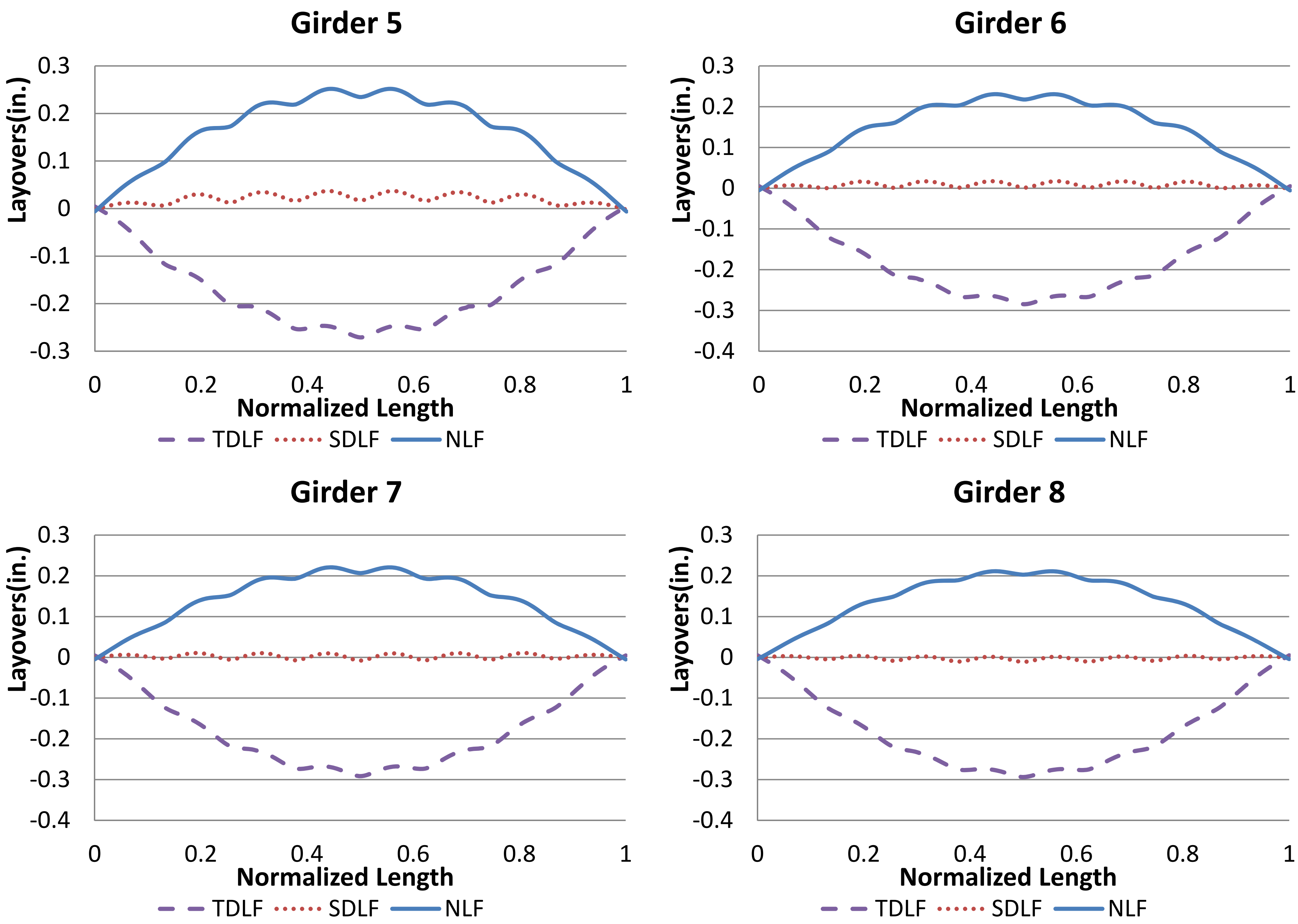


Figure C-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

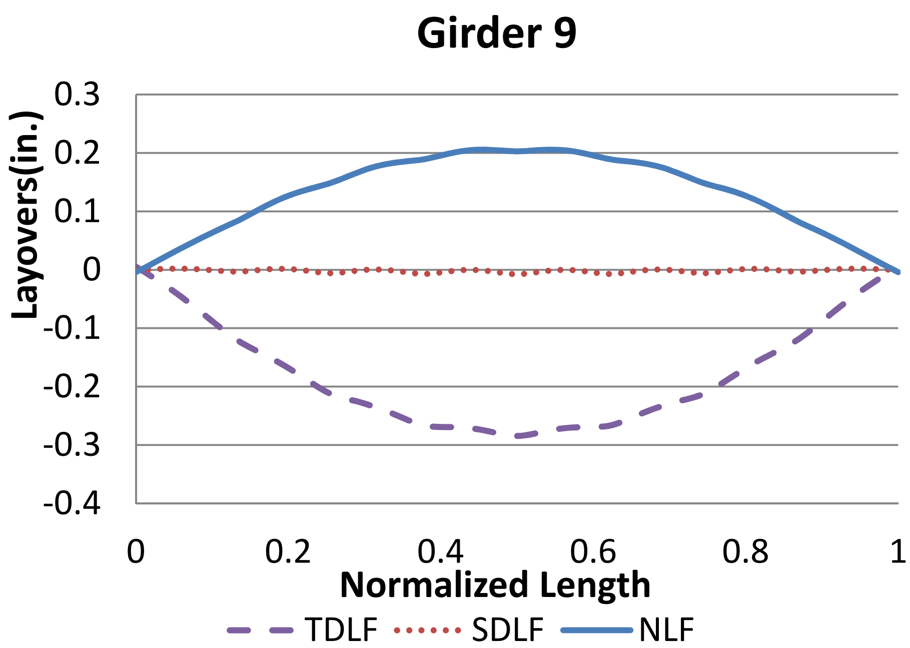


Figure C-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

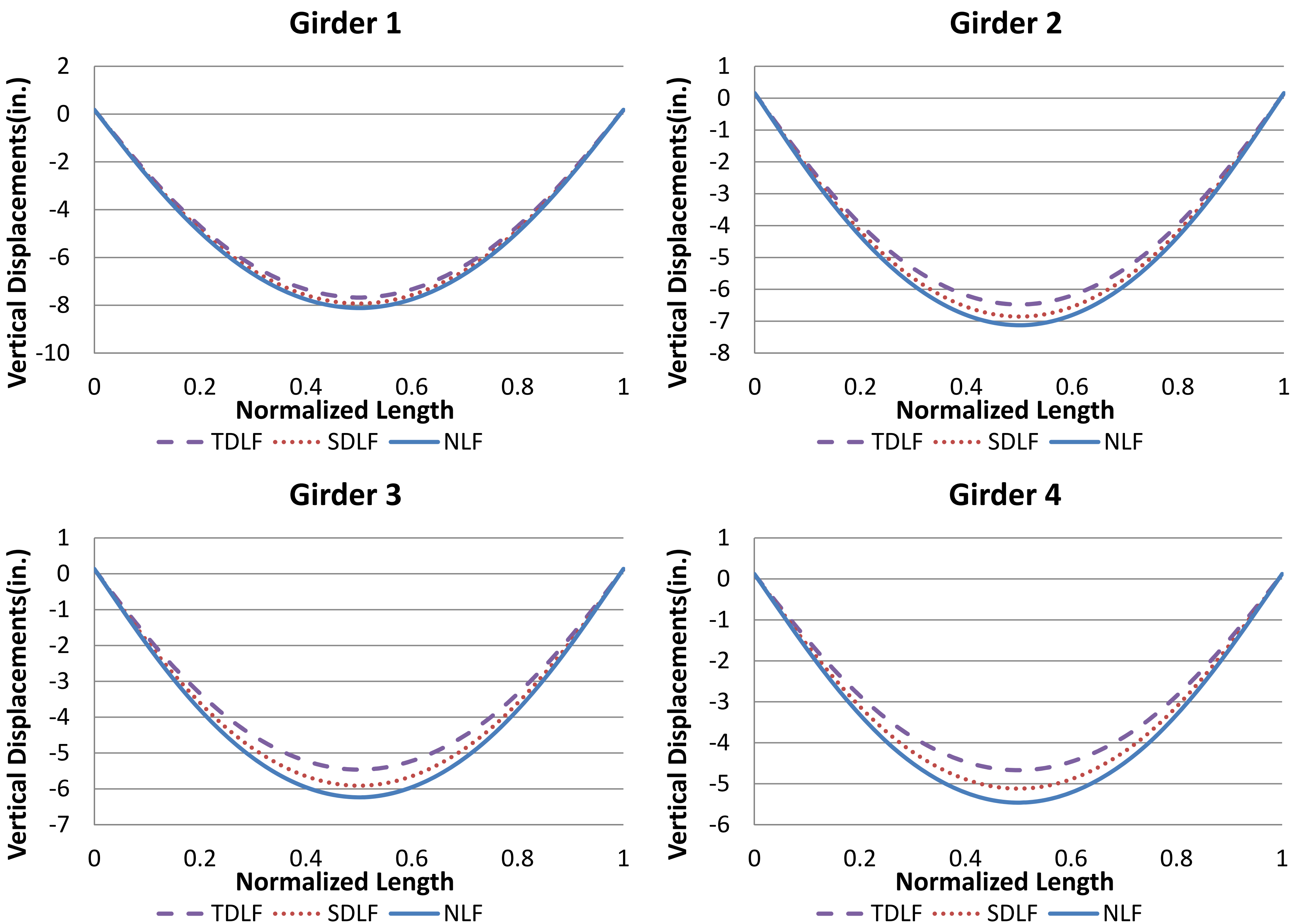


Figure C-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

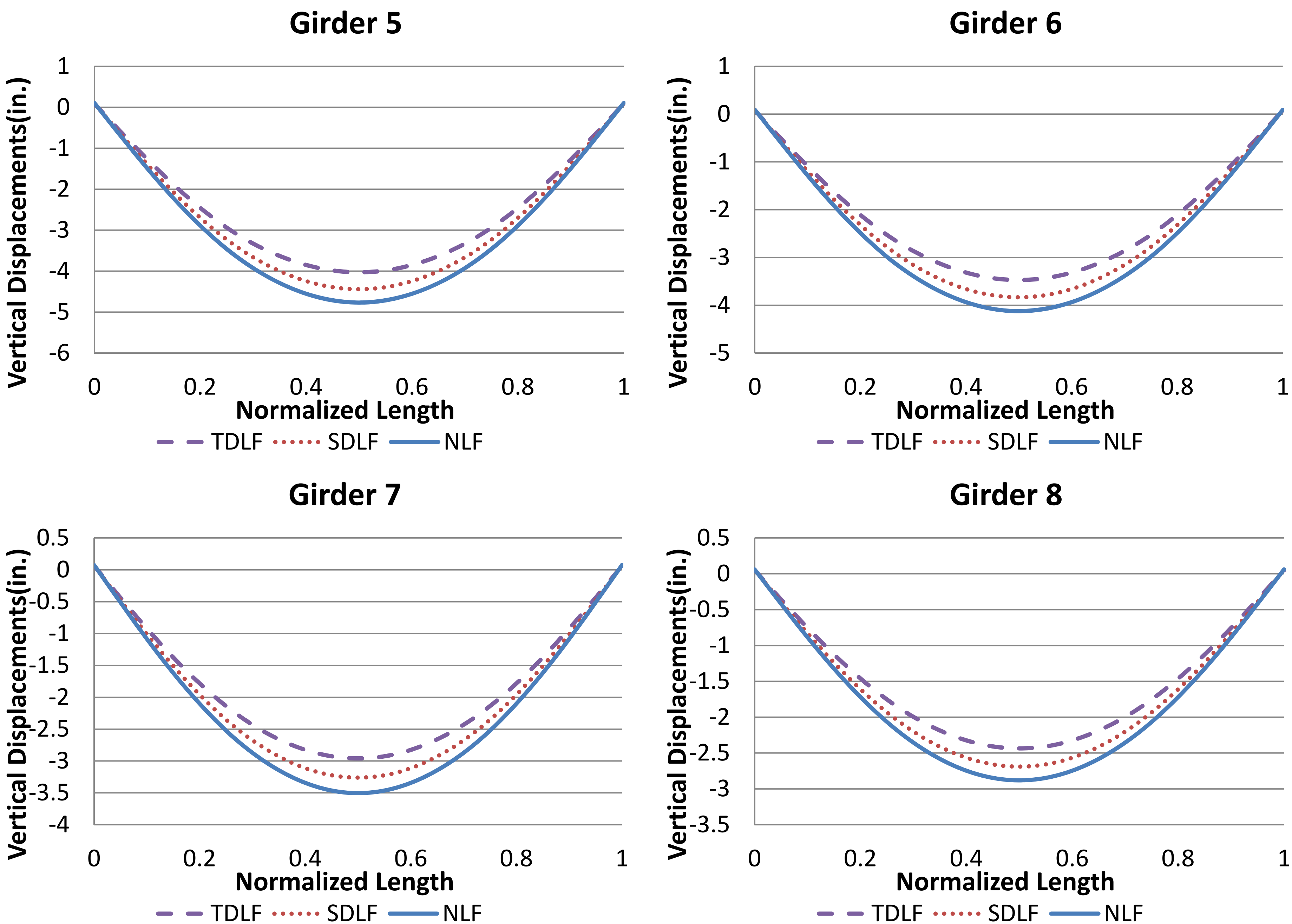


Figure C-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

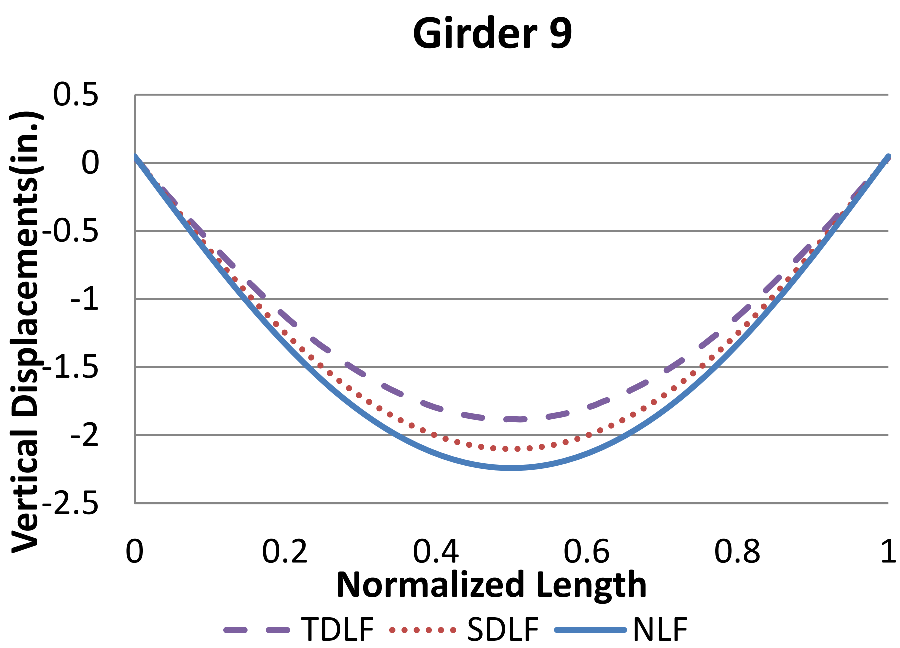


Figure C-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

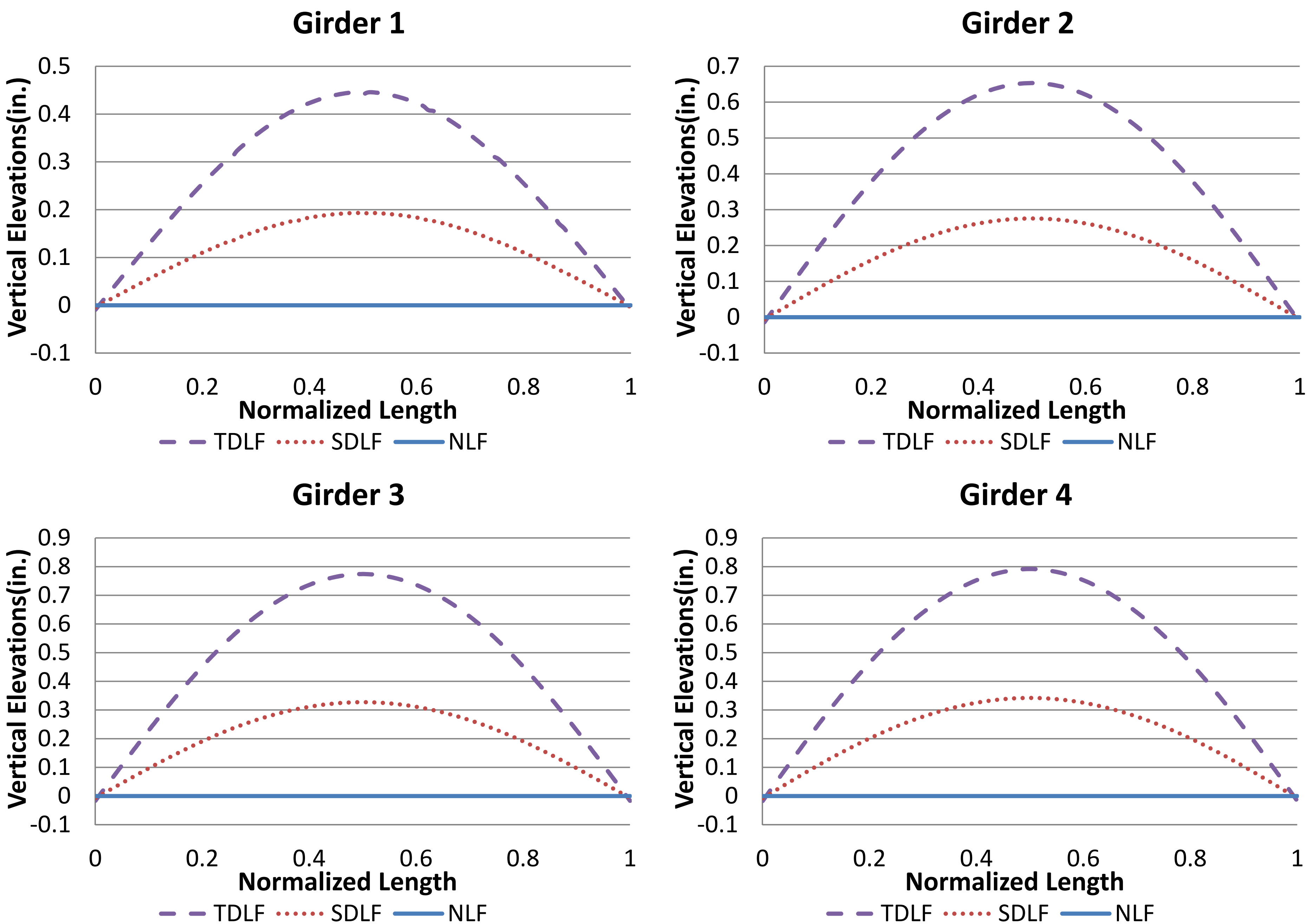


Figure C-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

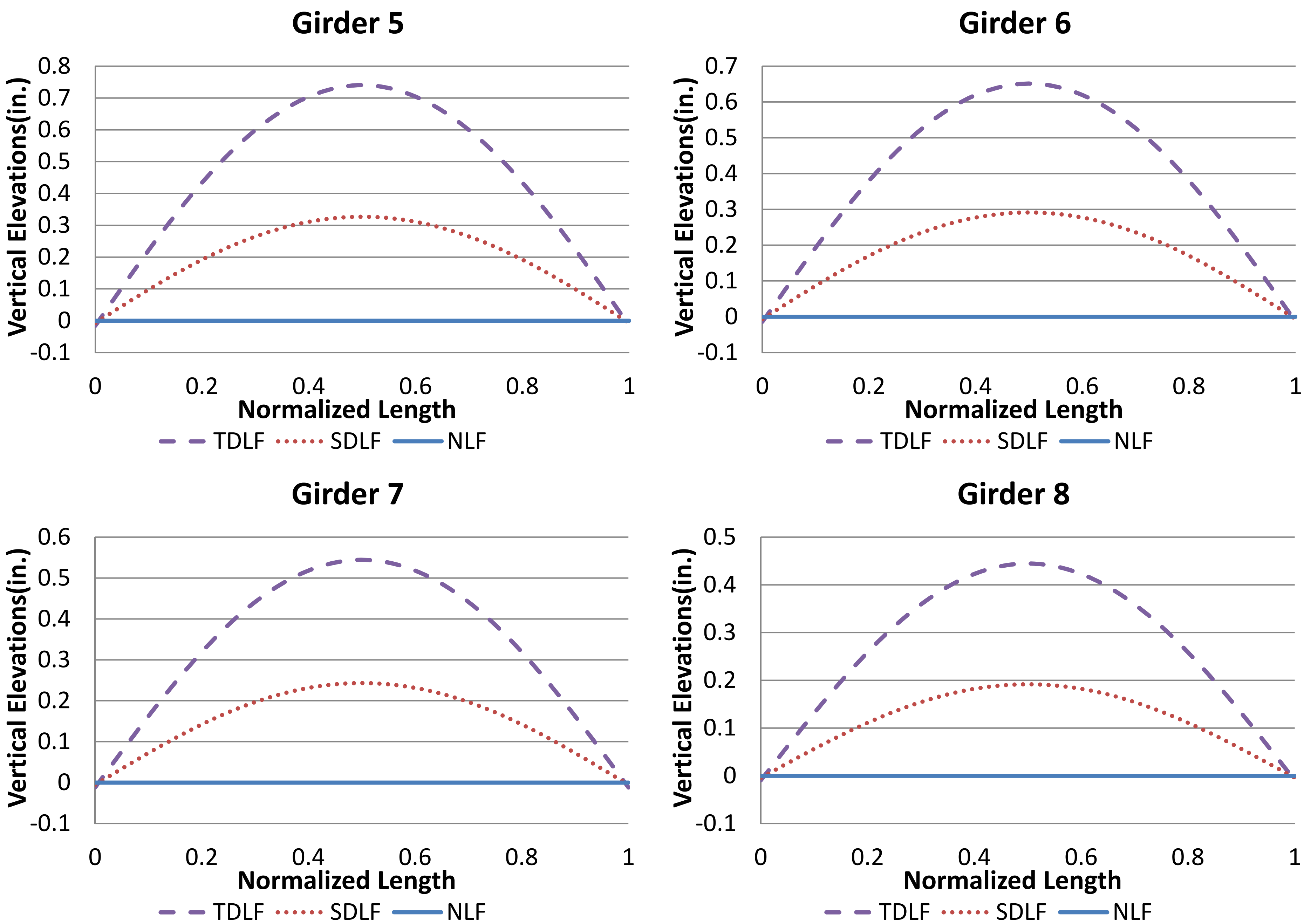


Figure C-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

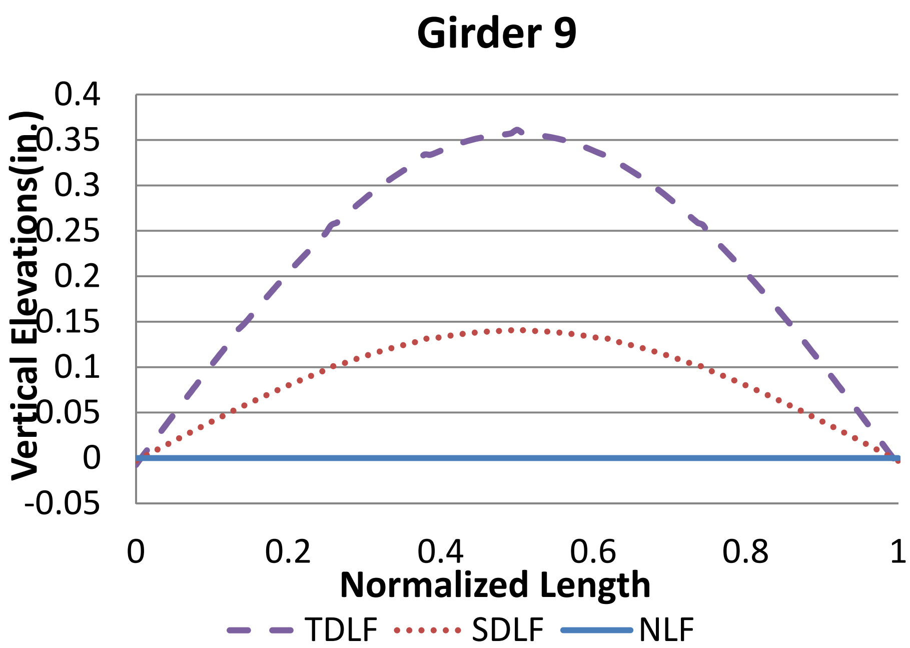


Figure C-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

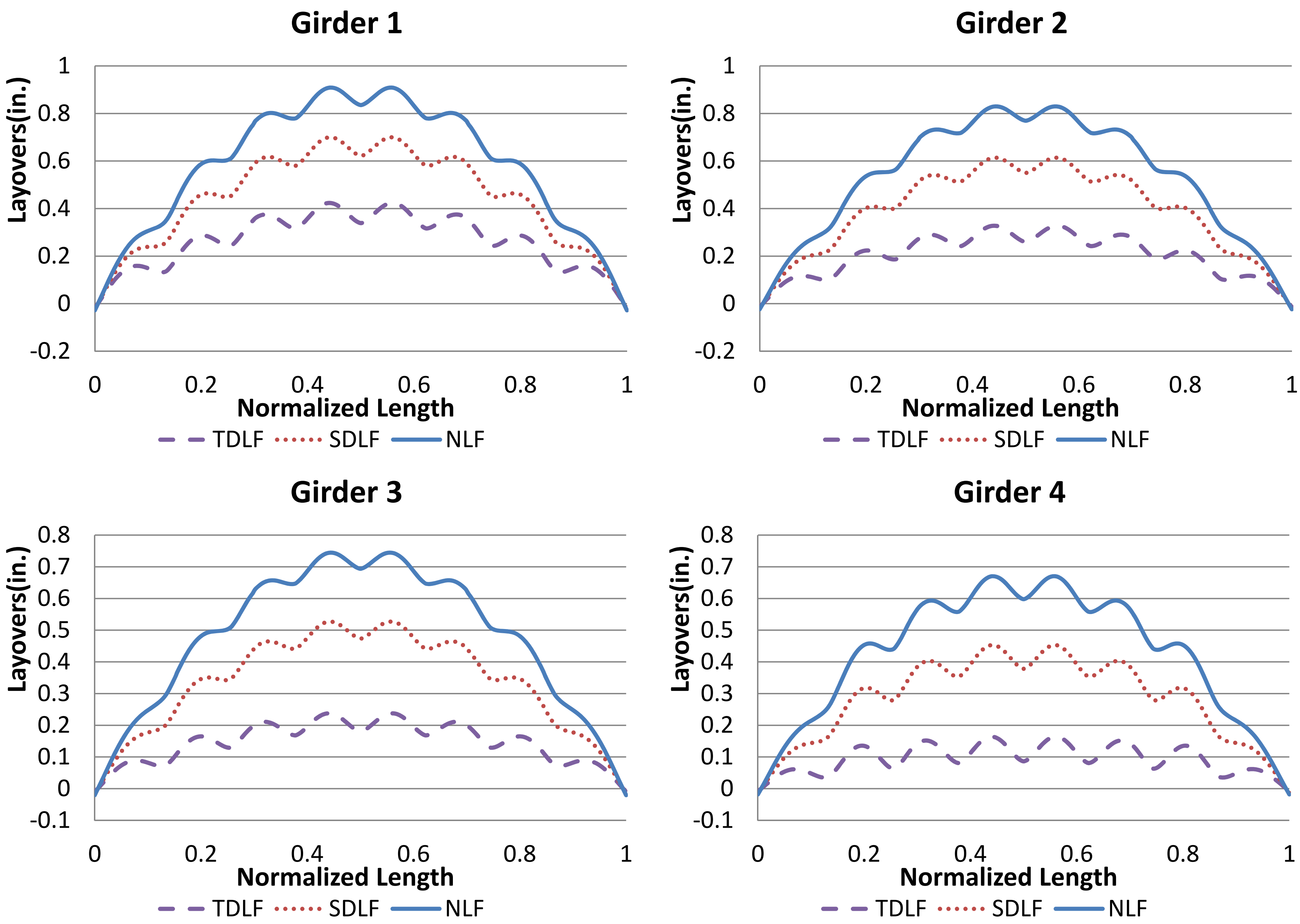


Figure C-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

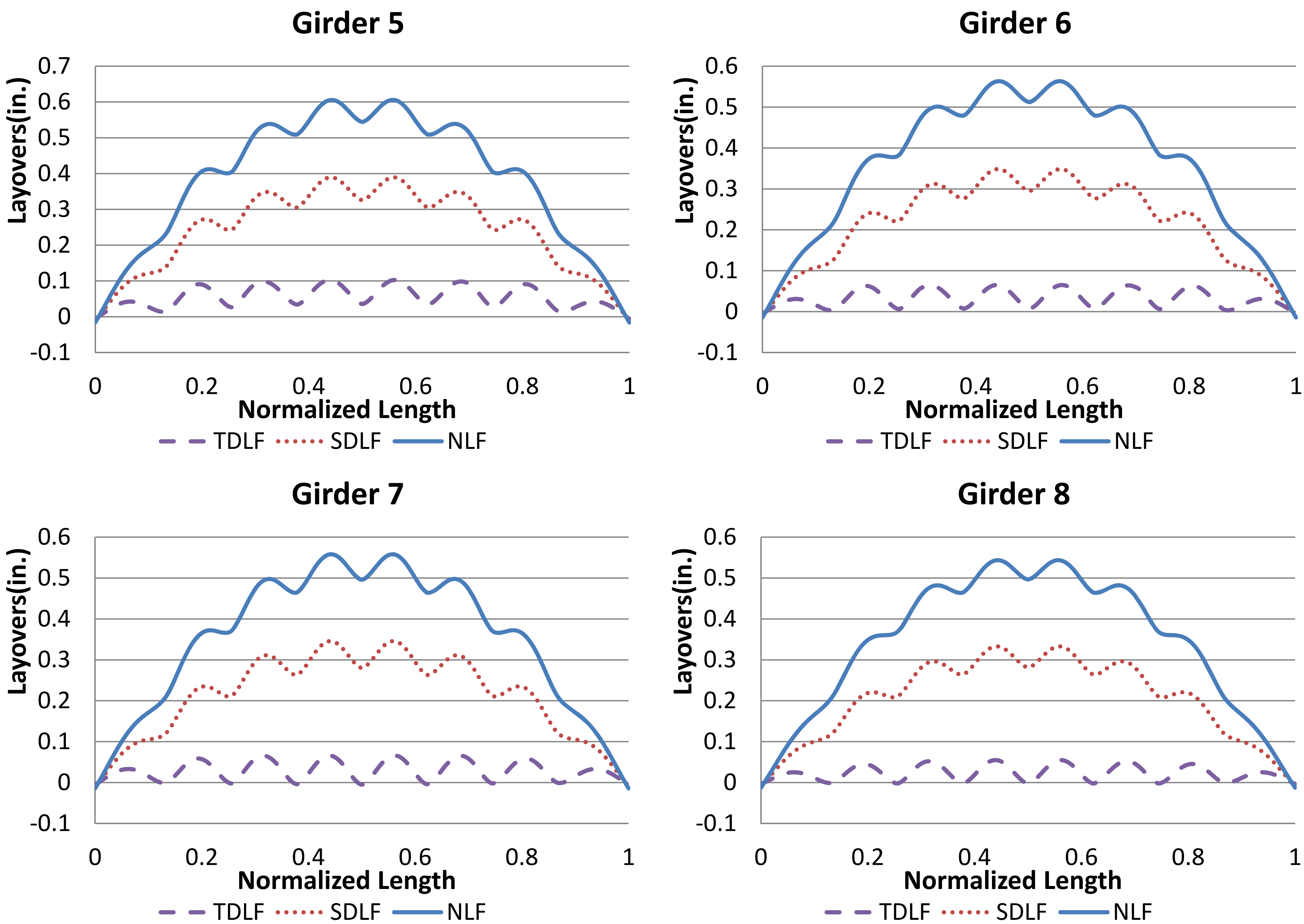


Figure C-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

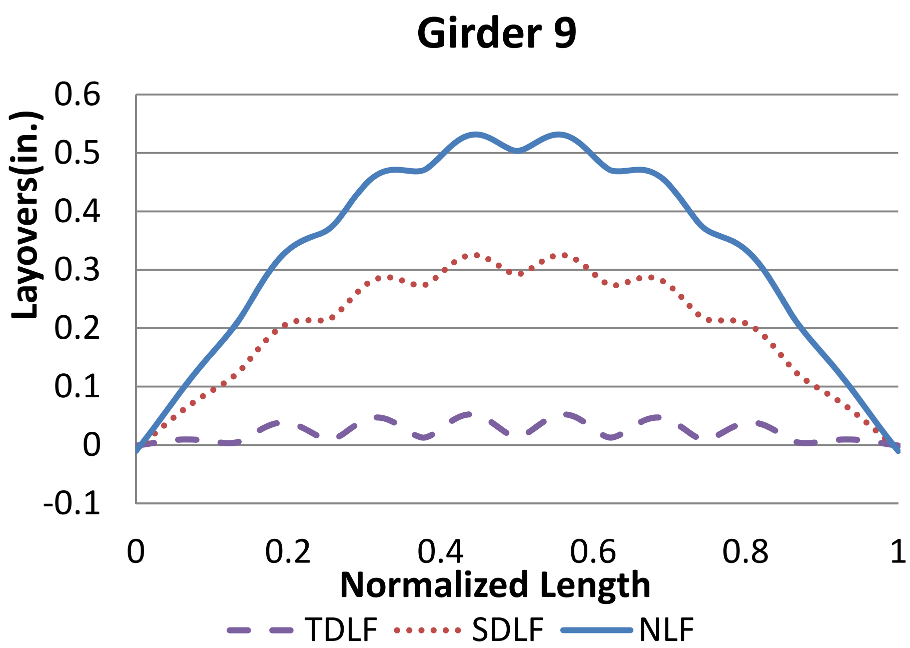


Figure C-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

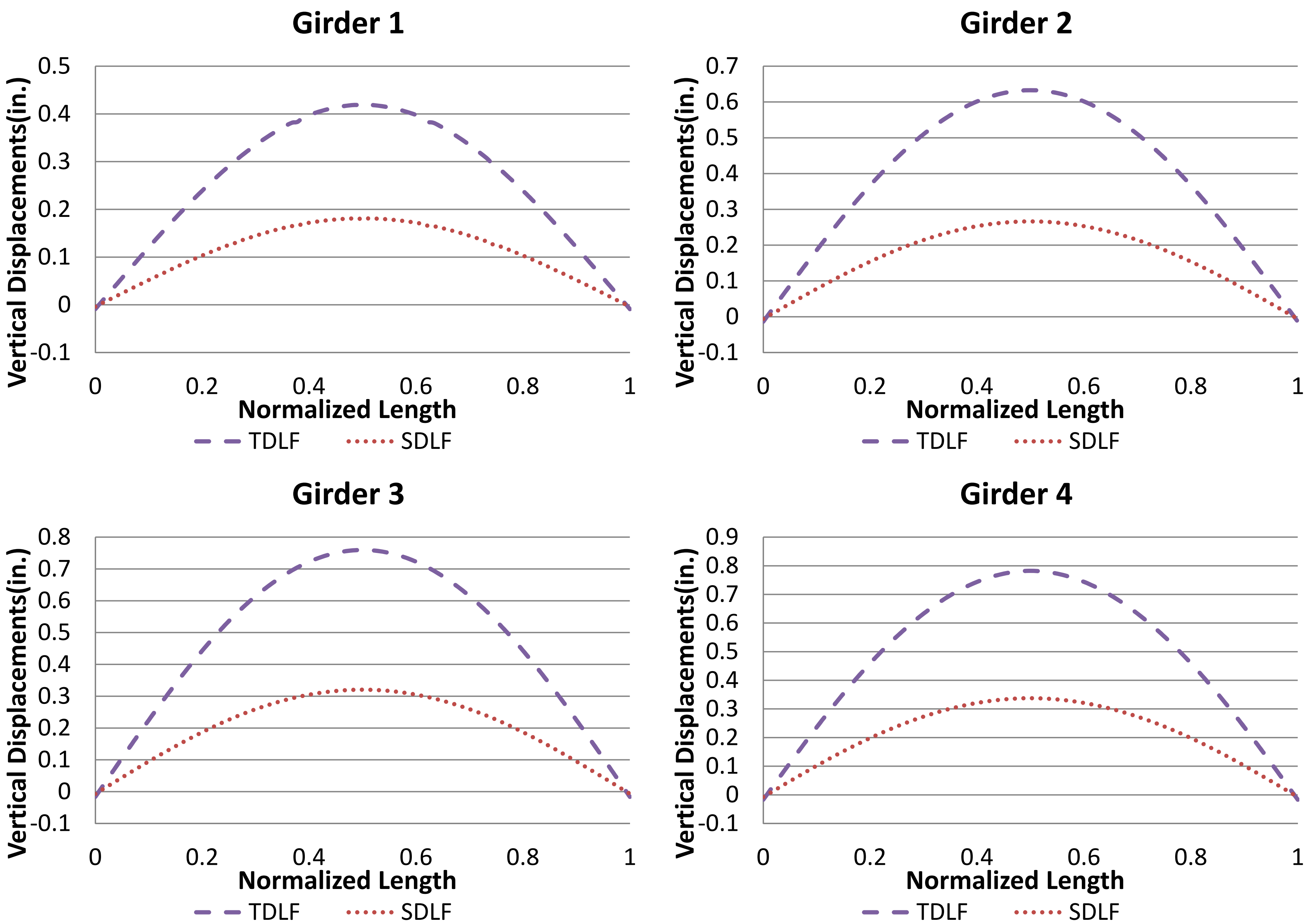


Figure C-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

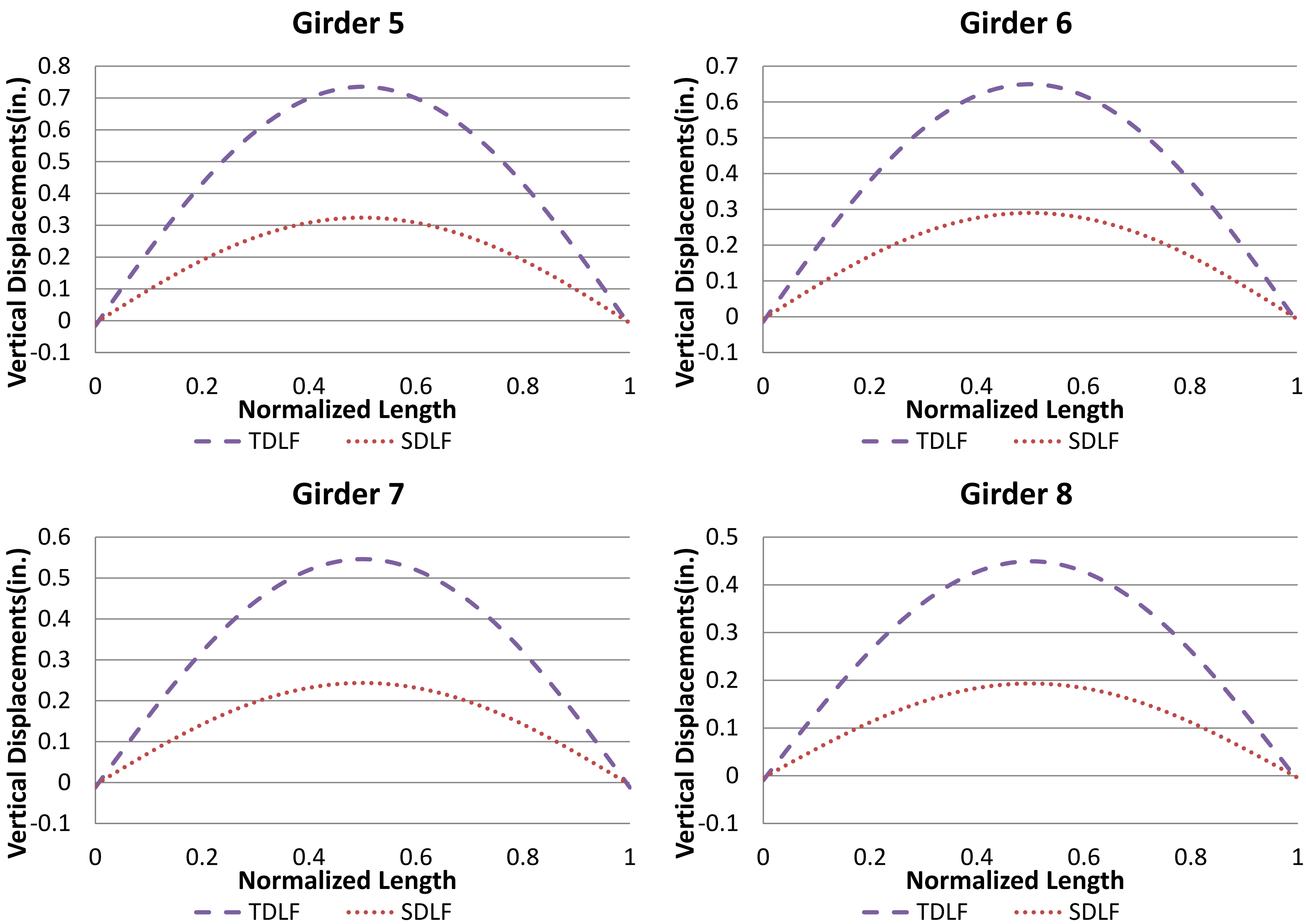


Figure C-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

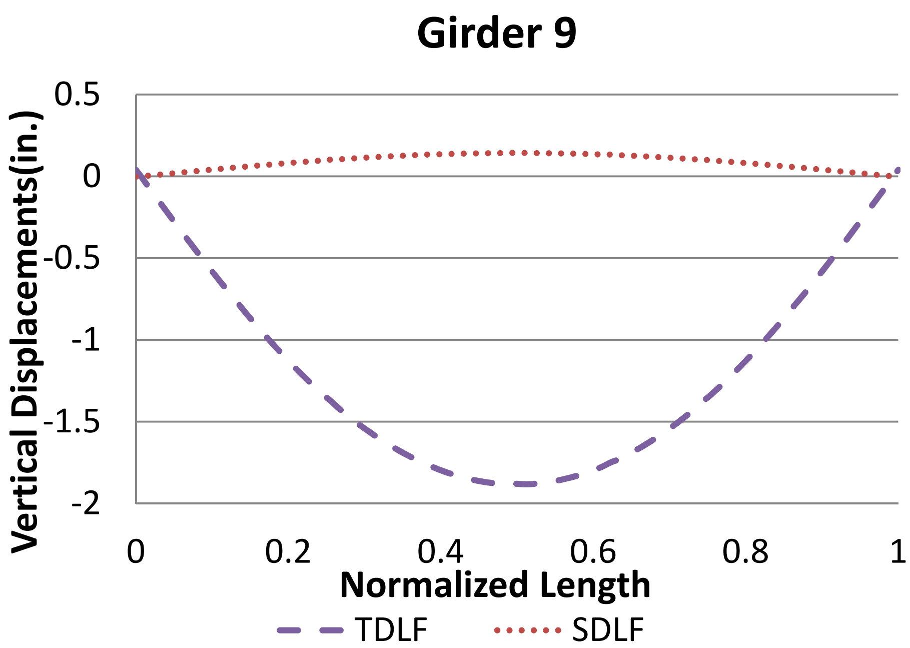


Figure C-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

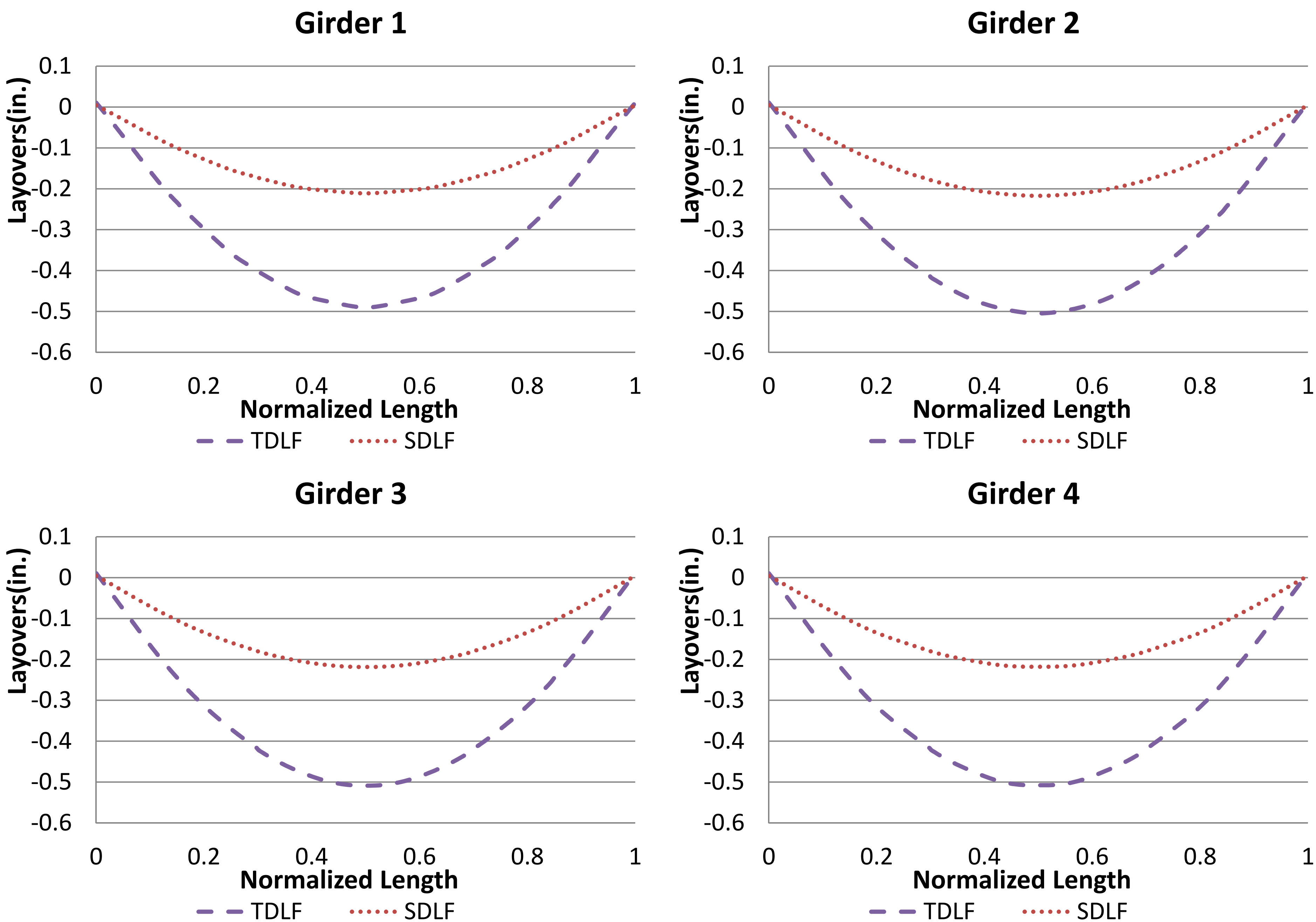
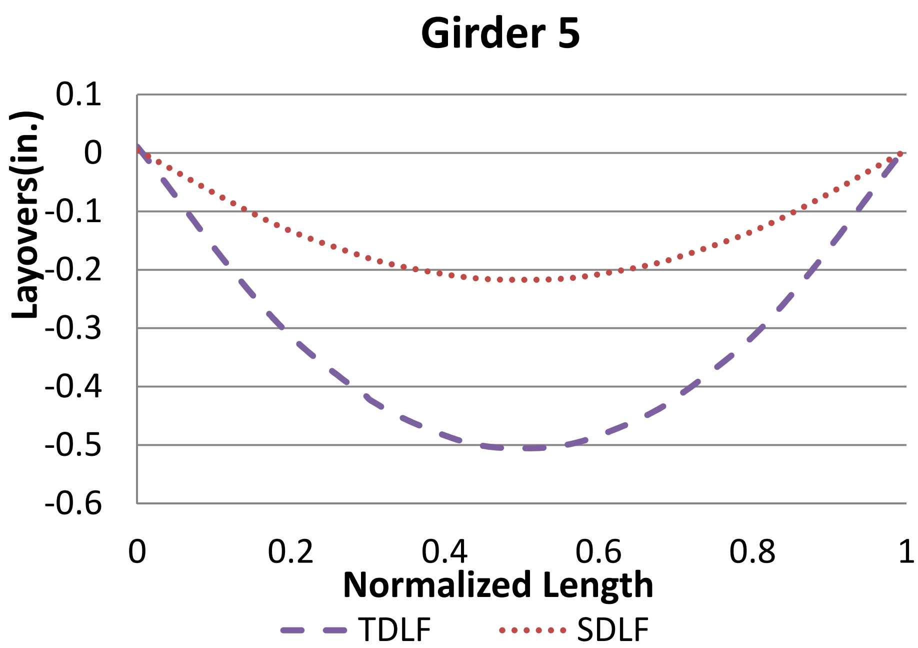
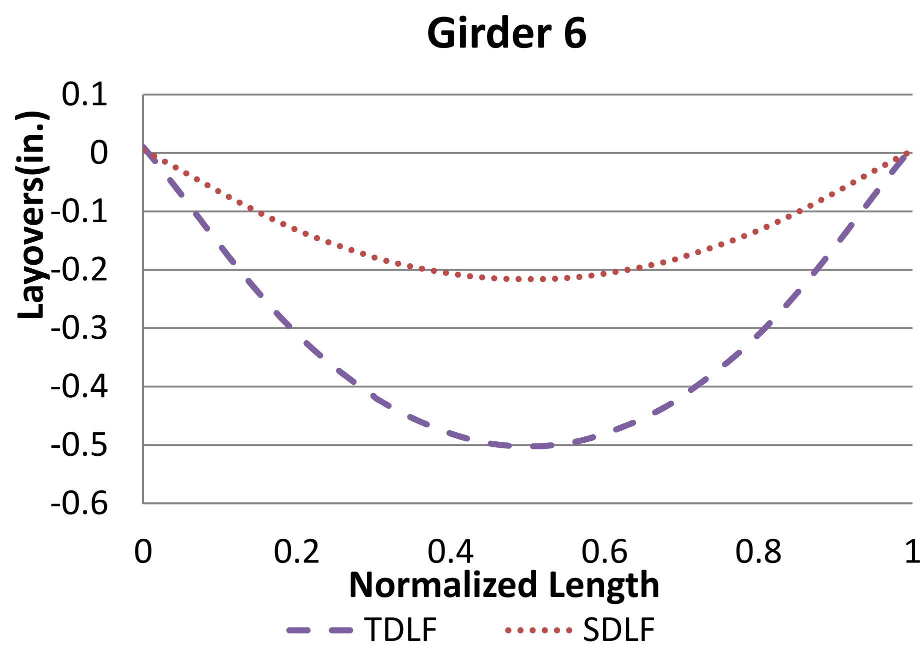
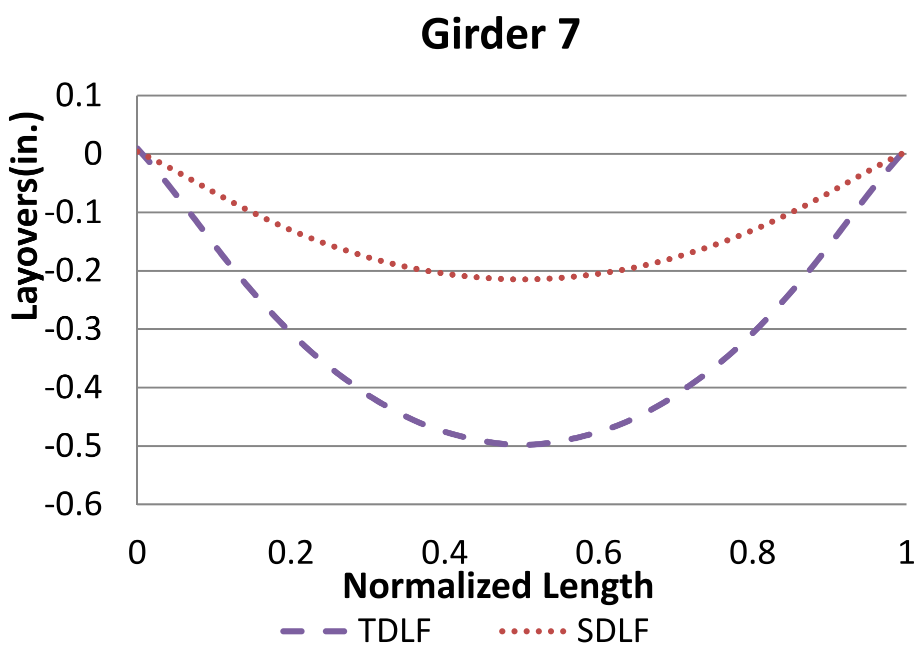


Figure C-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.







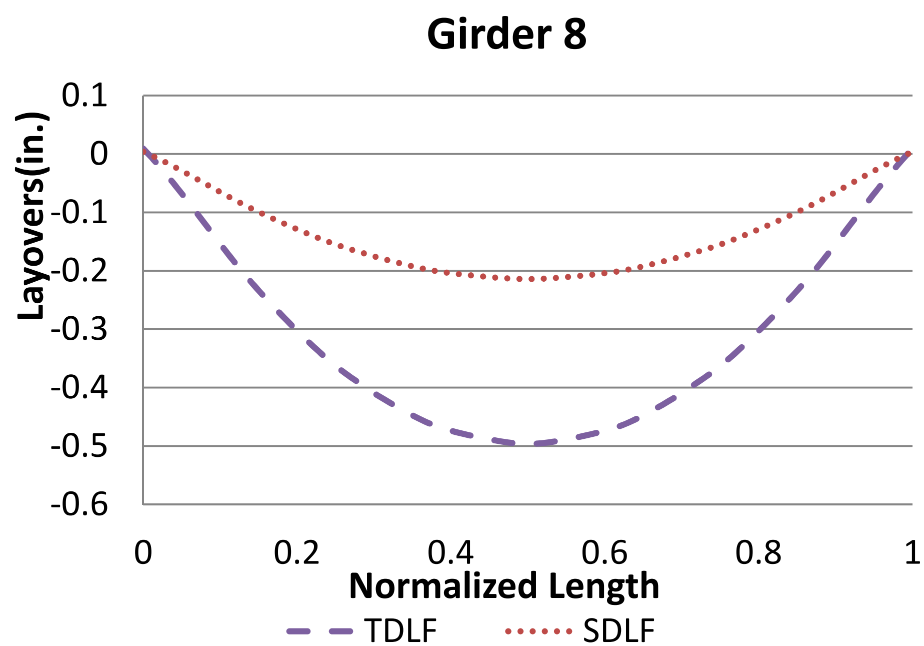


Figure C-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

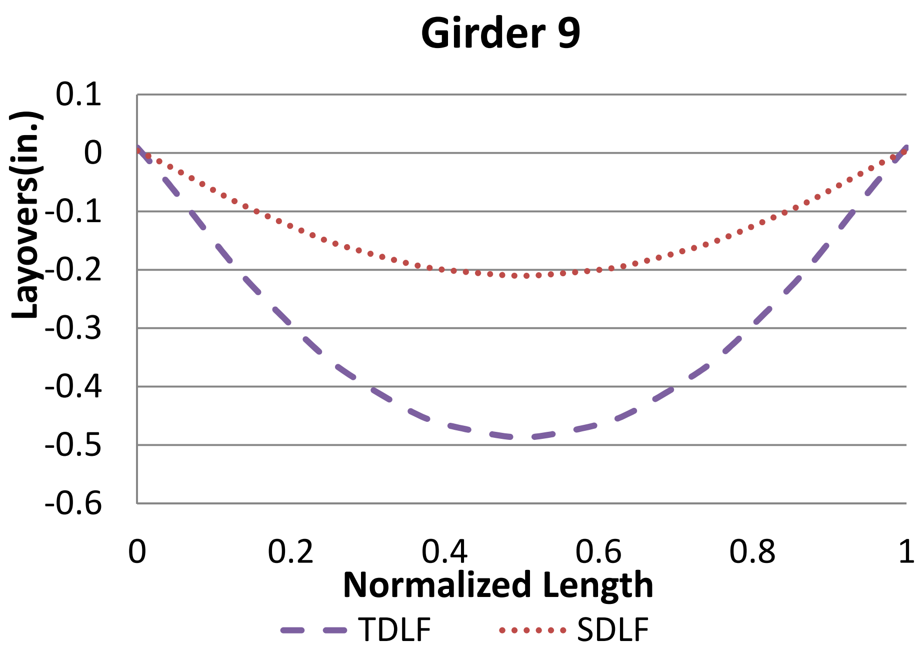


Figure C-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

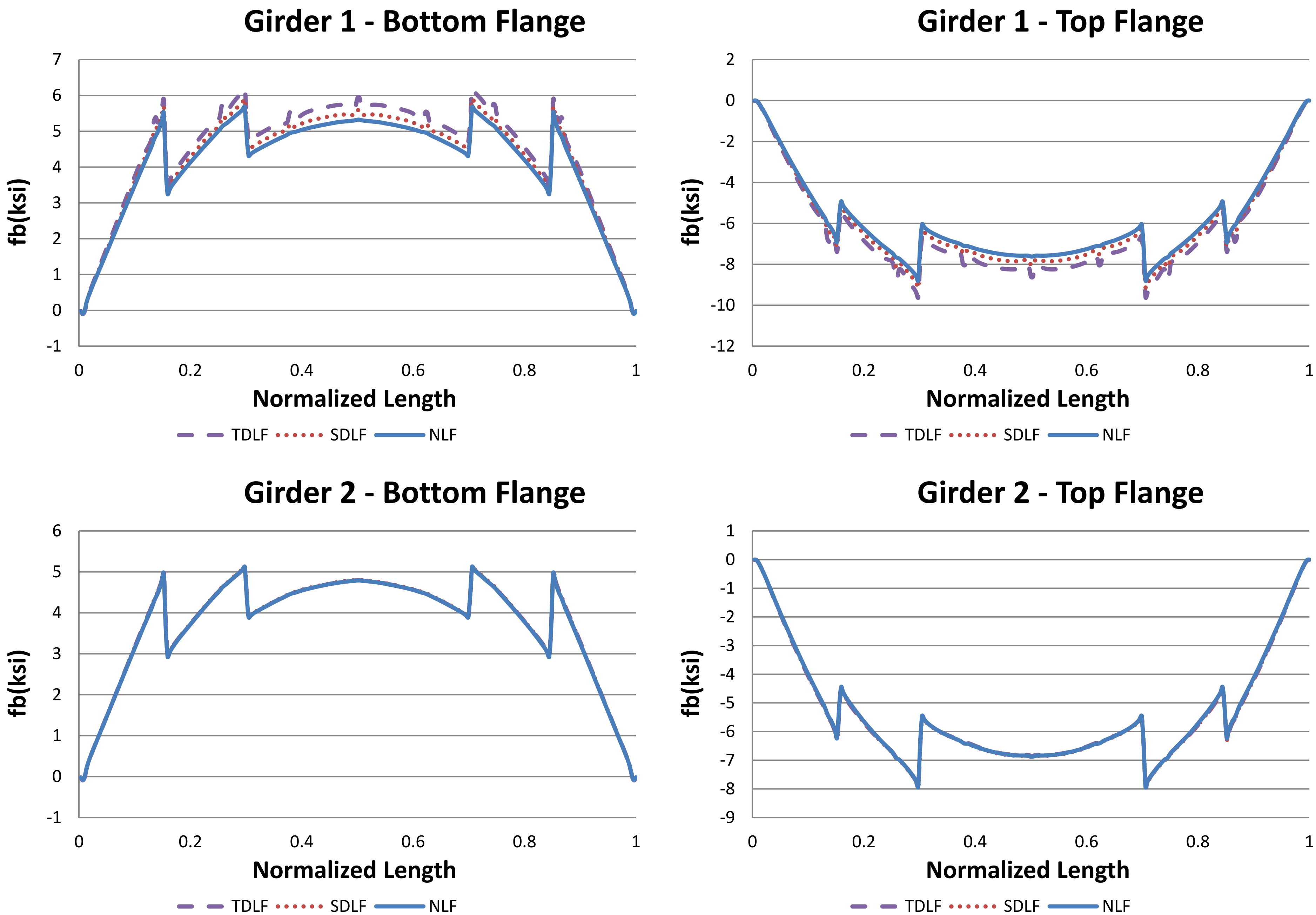


Figure C-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

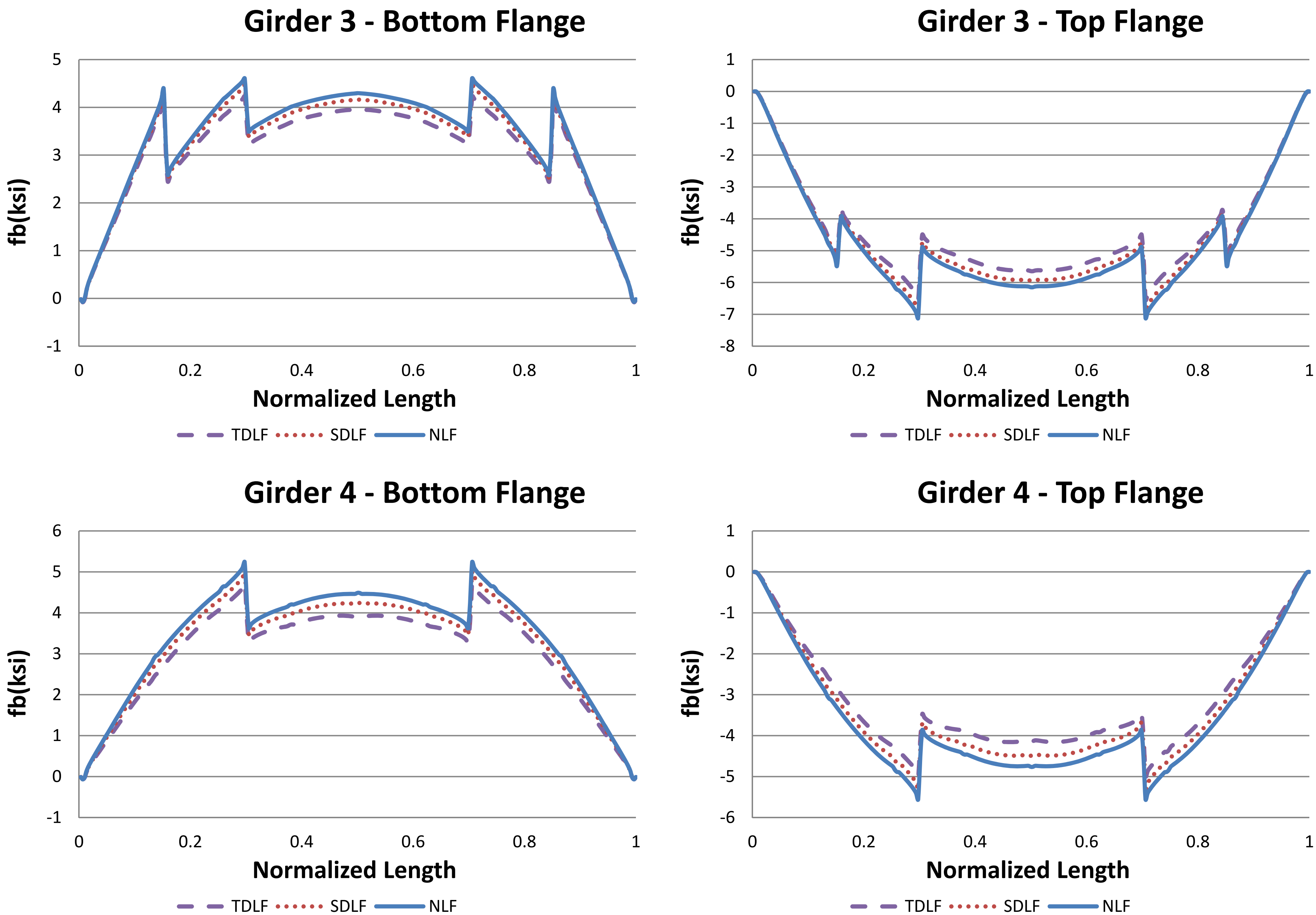
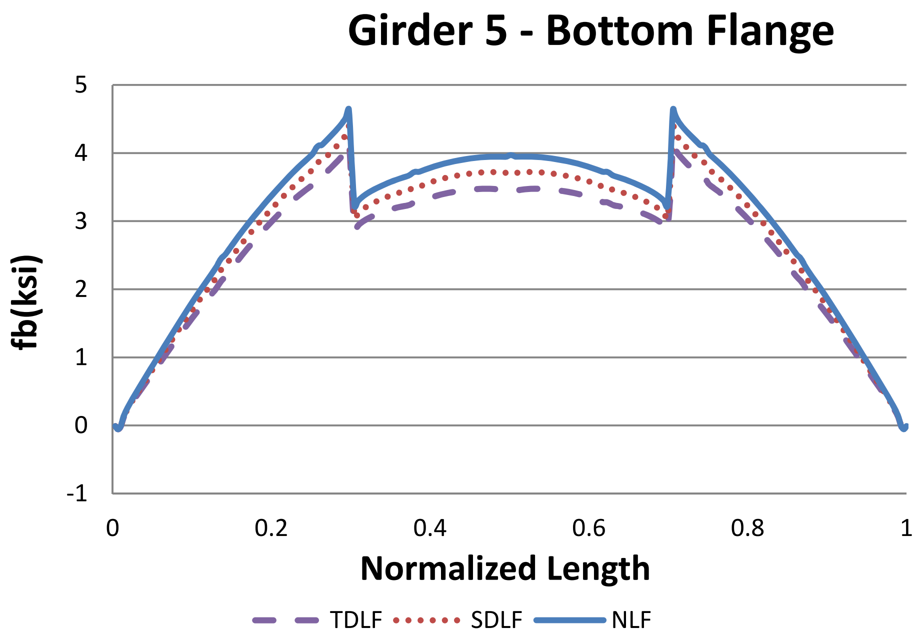
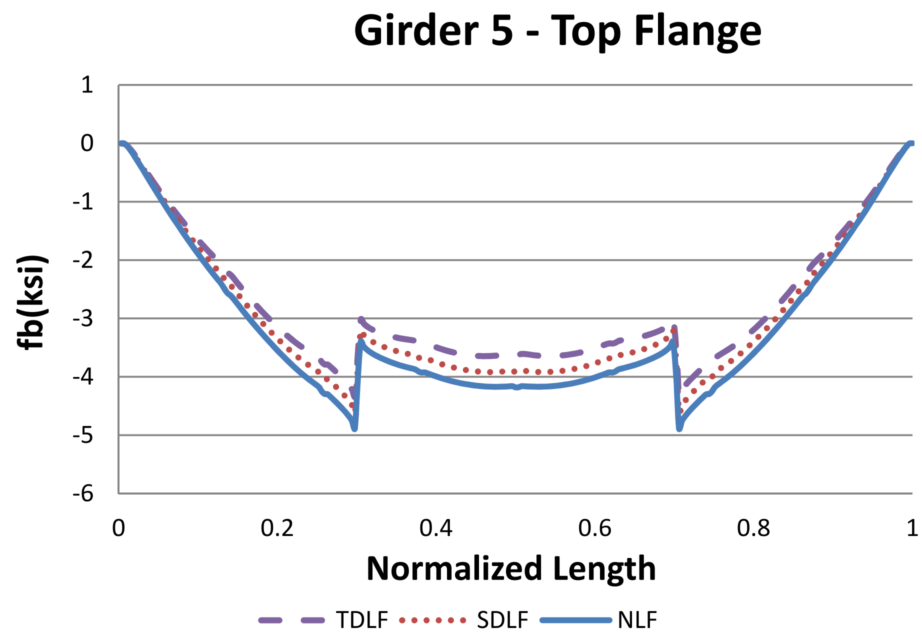
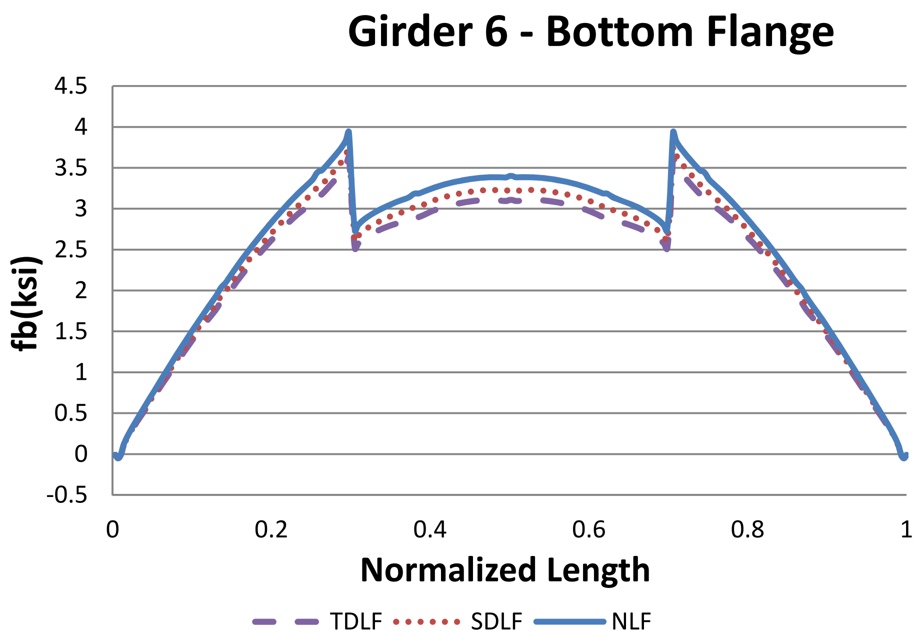


Figure C-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.







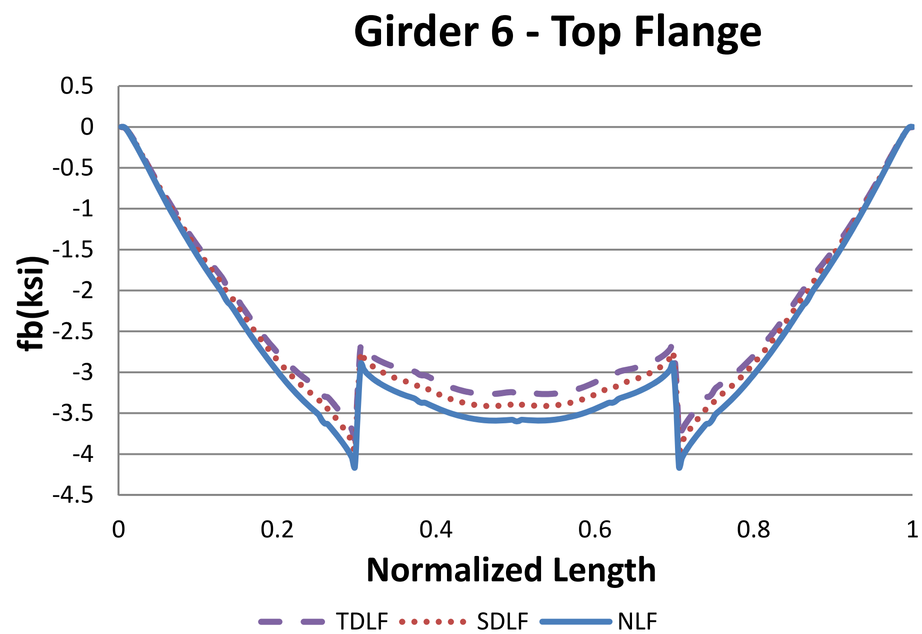


Figure C-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

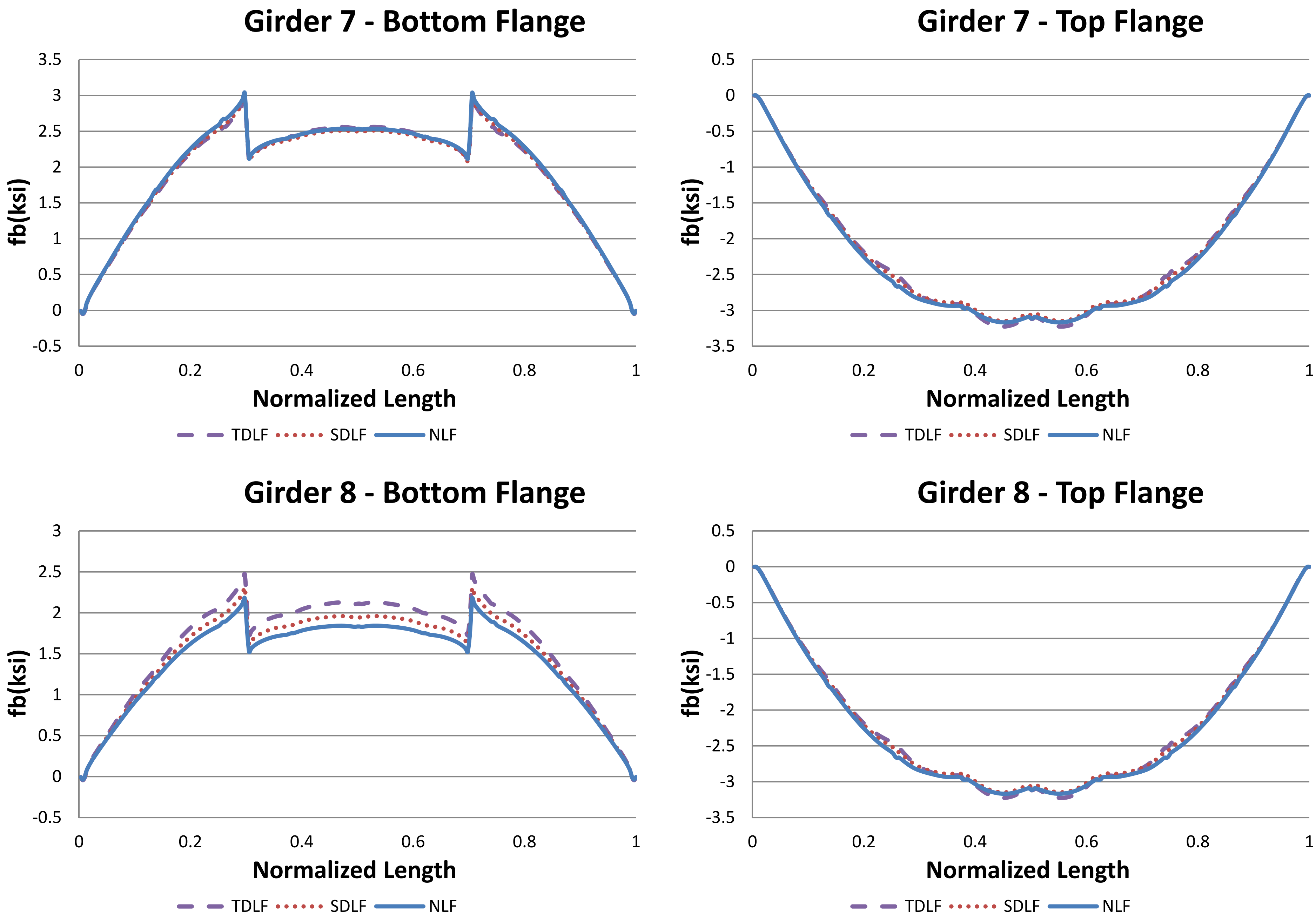
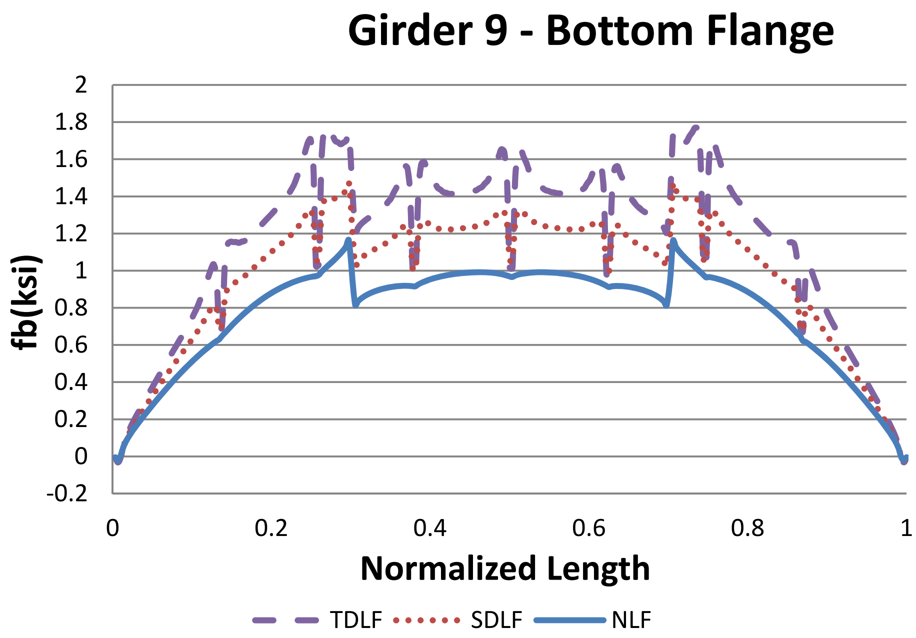


Figure C-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.



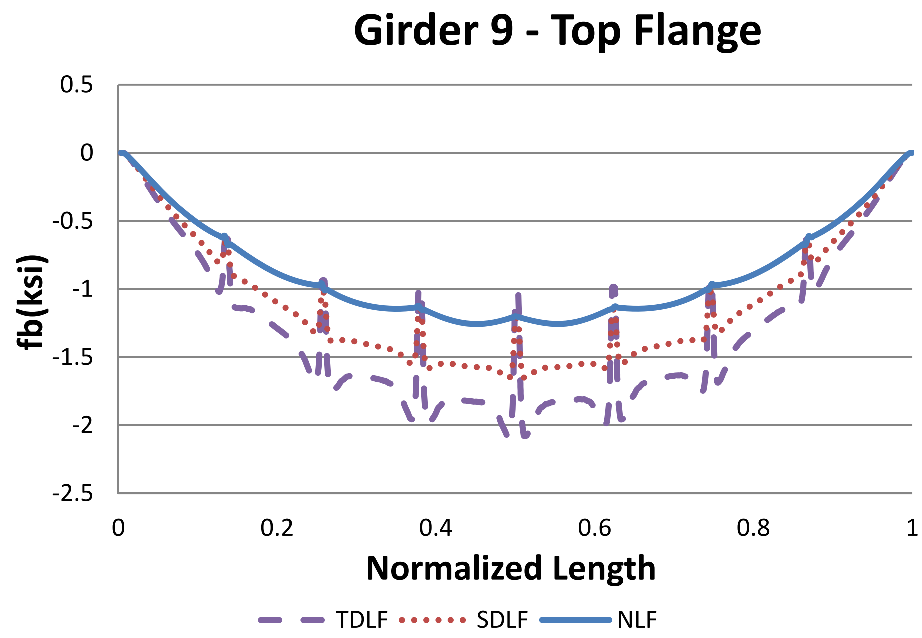


Figure C-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

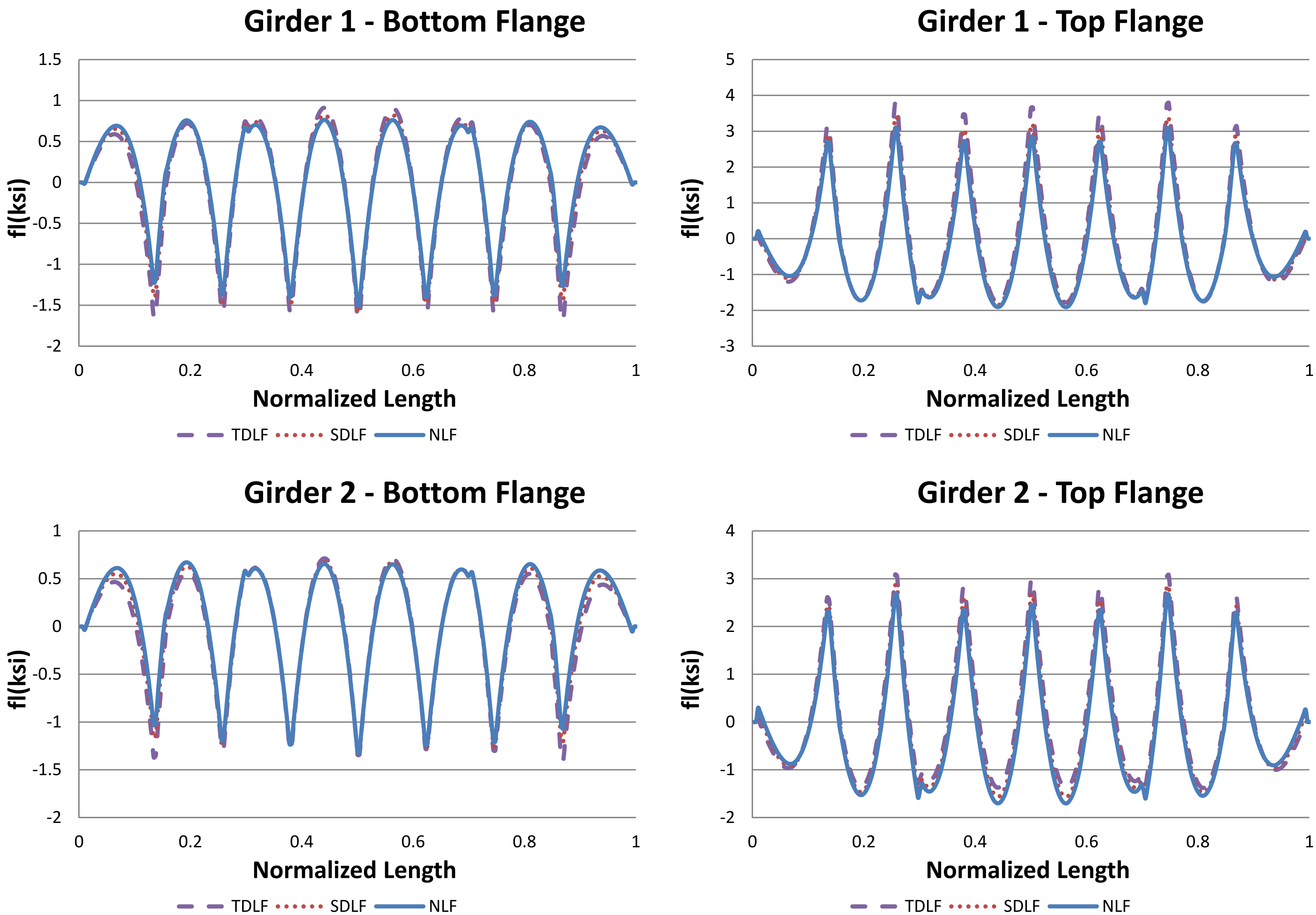
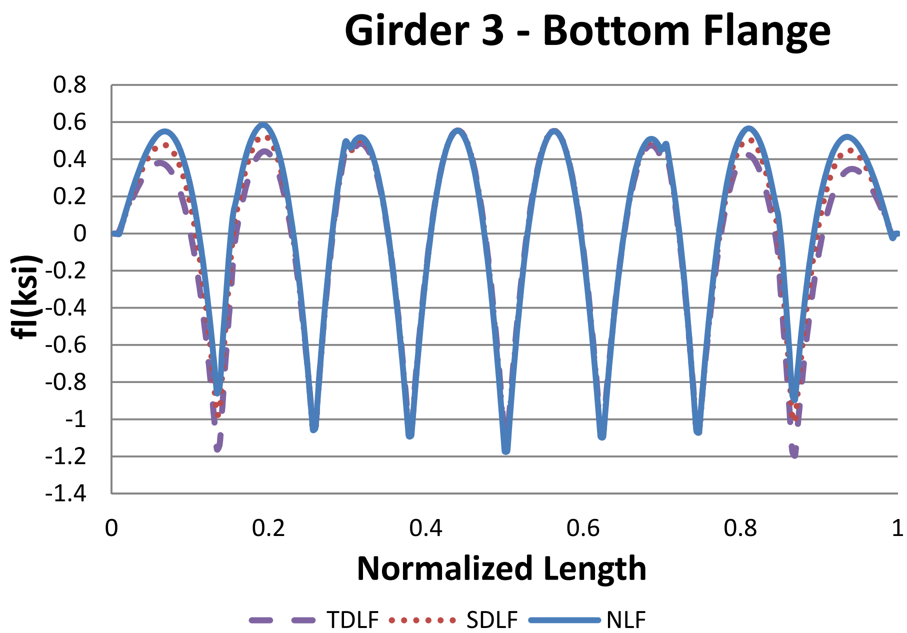
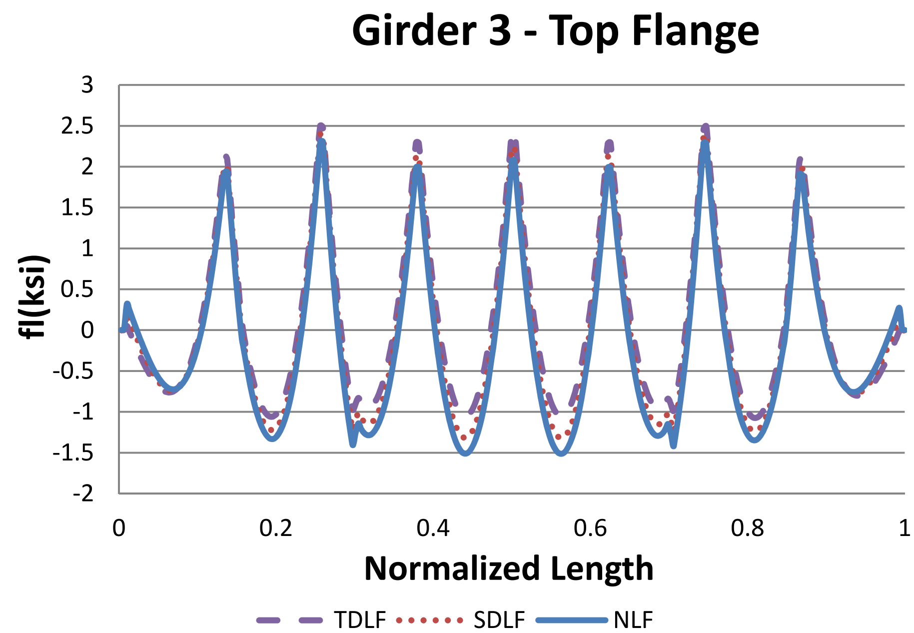
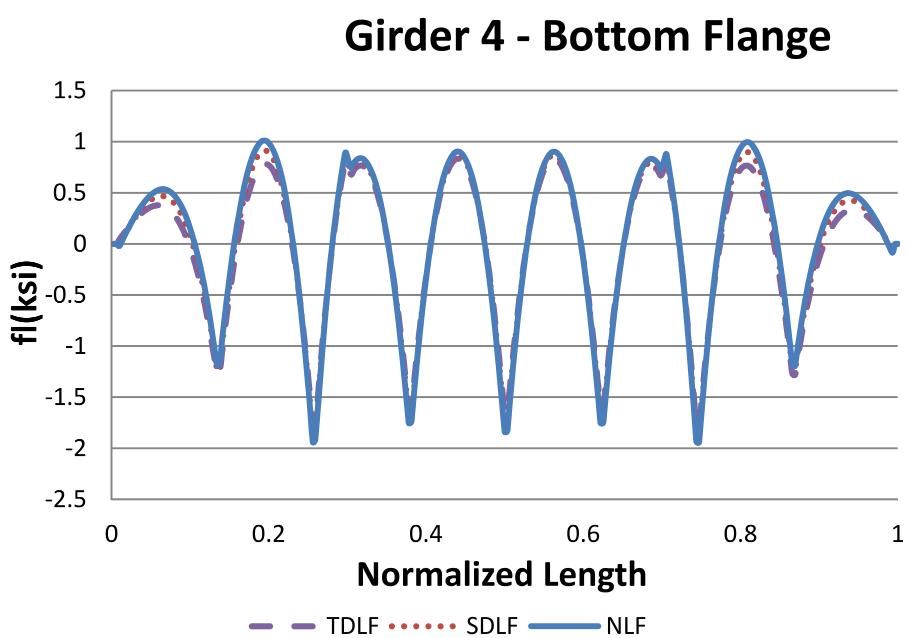


Figure C-4-19. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.







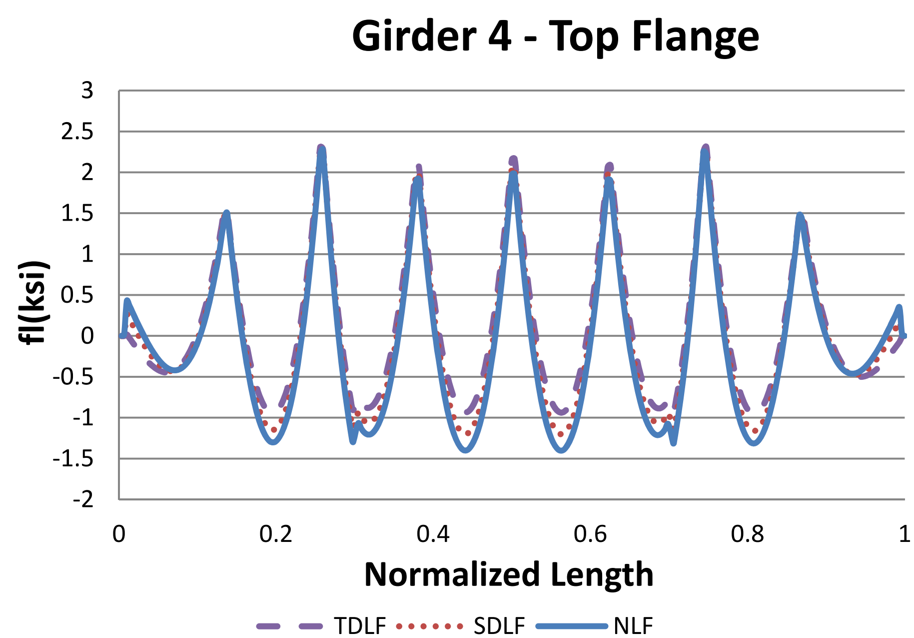
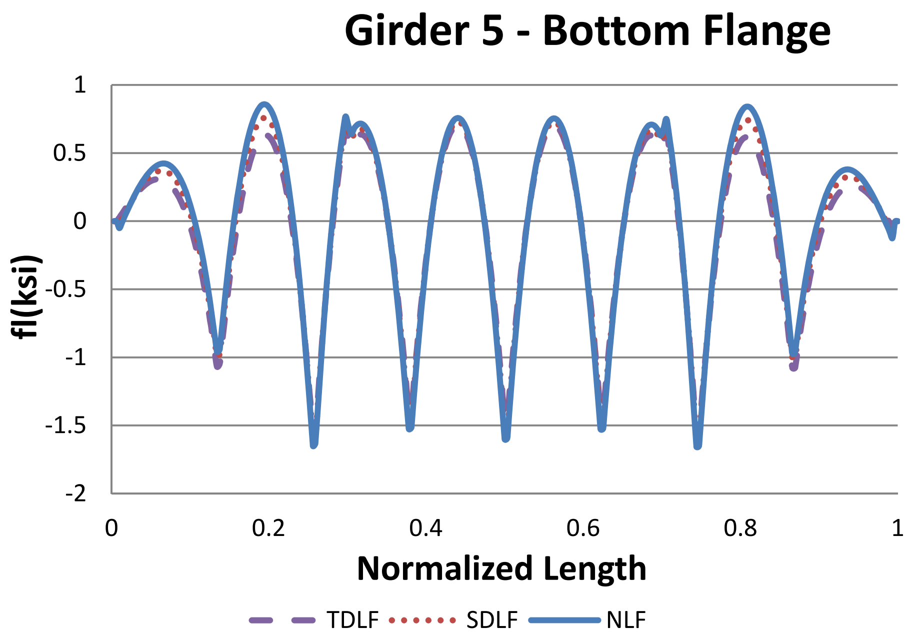
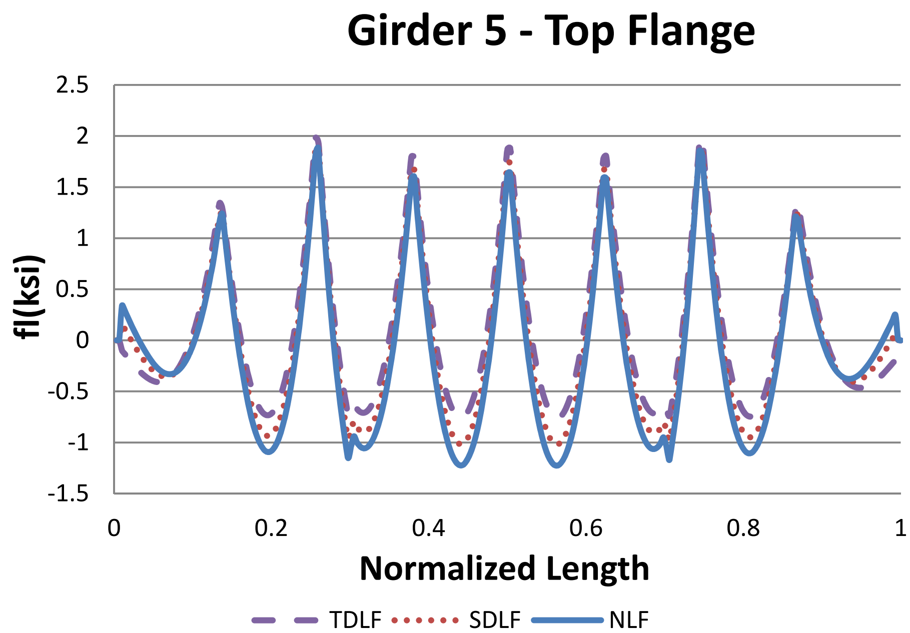
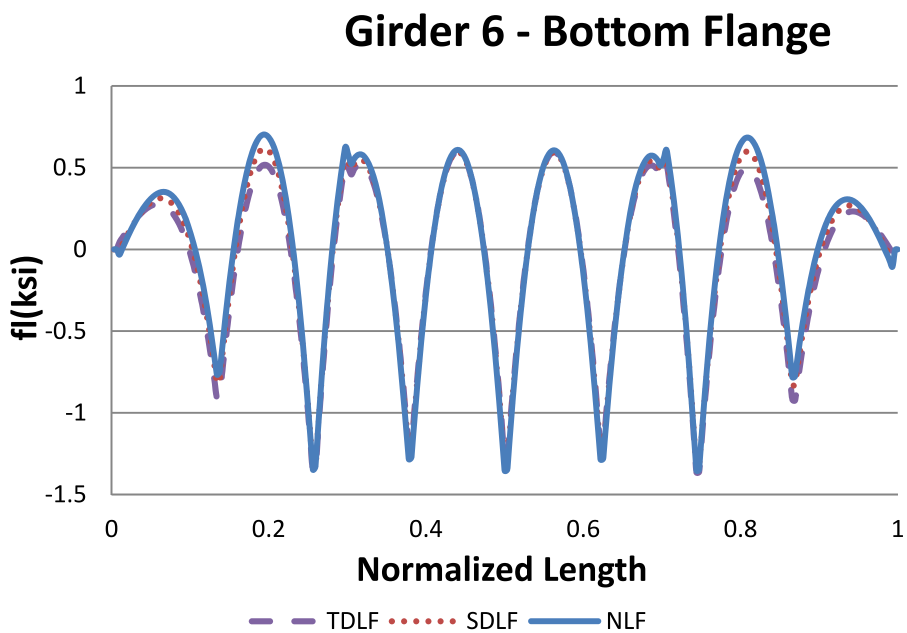


Figure C-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**







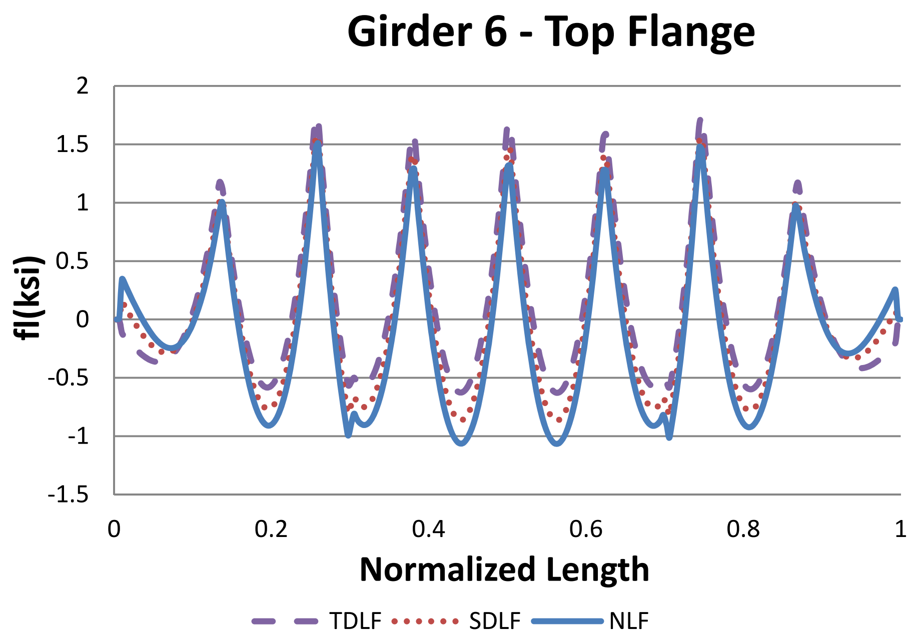
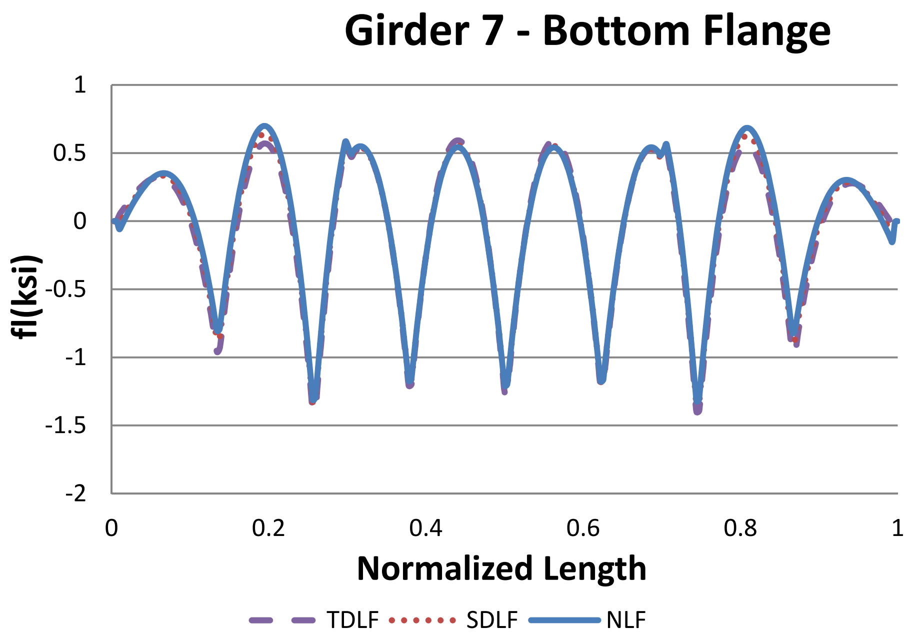
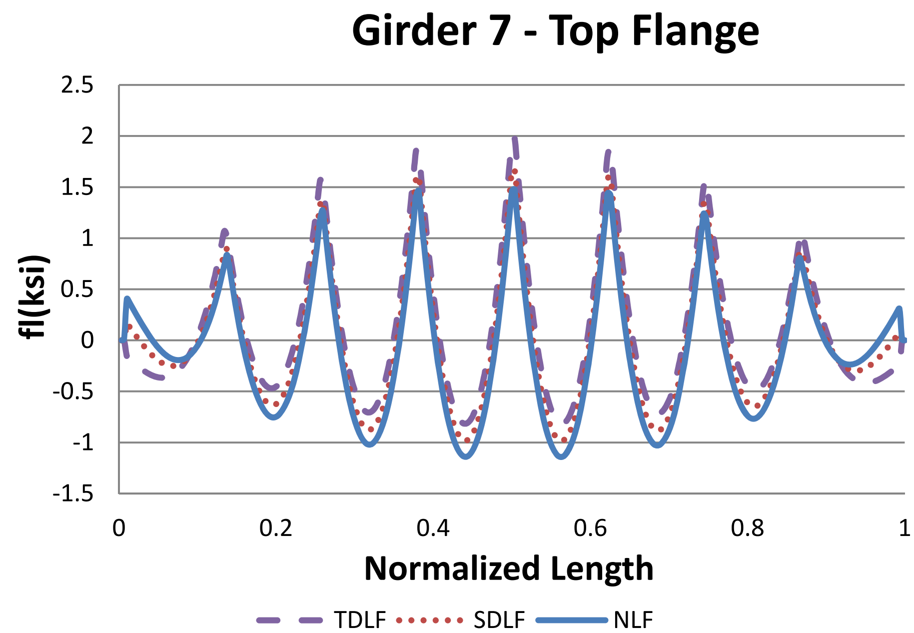
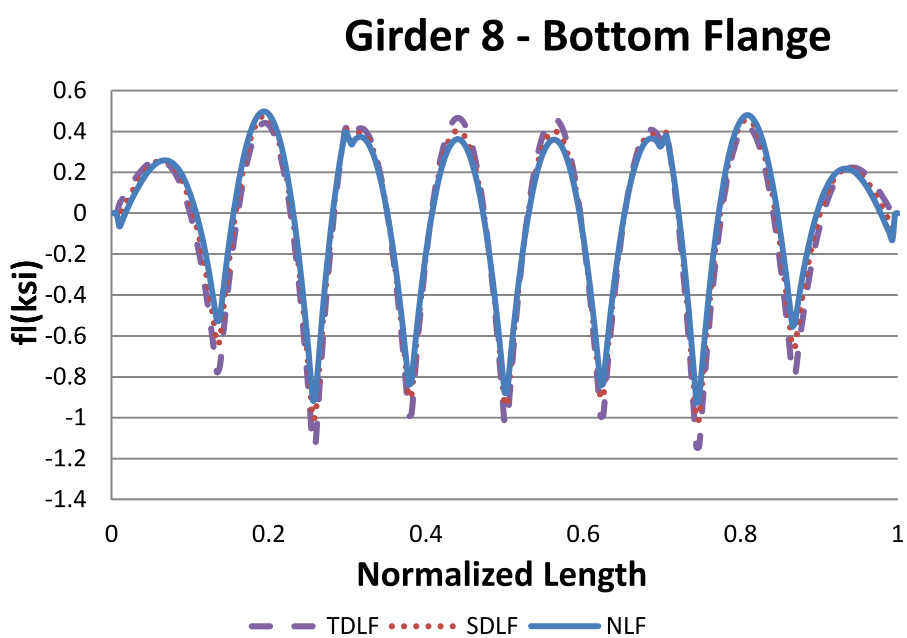


Figure C-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**







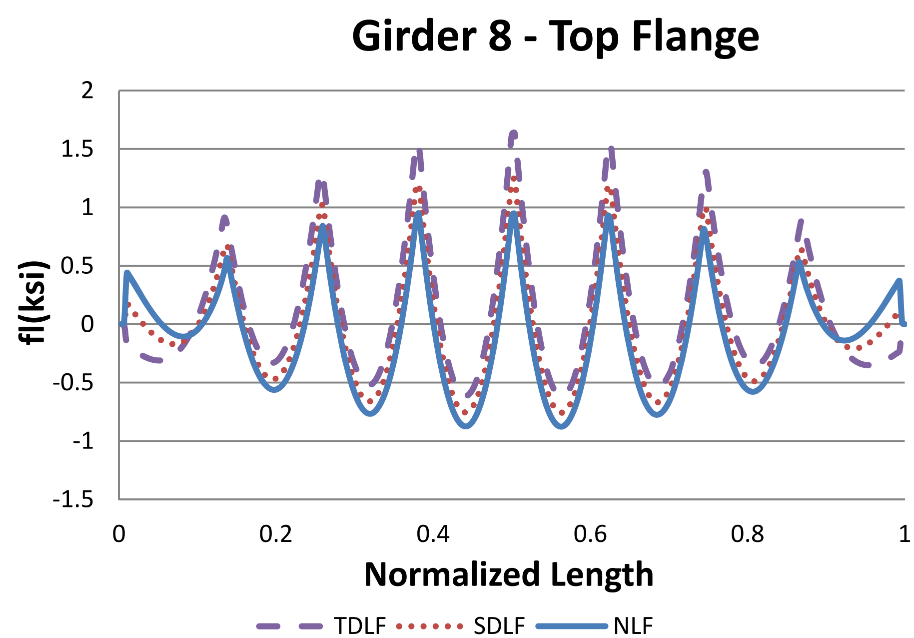
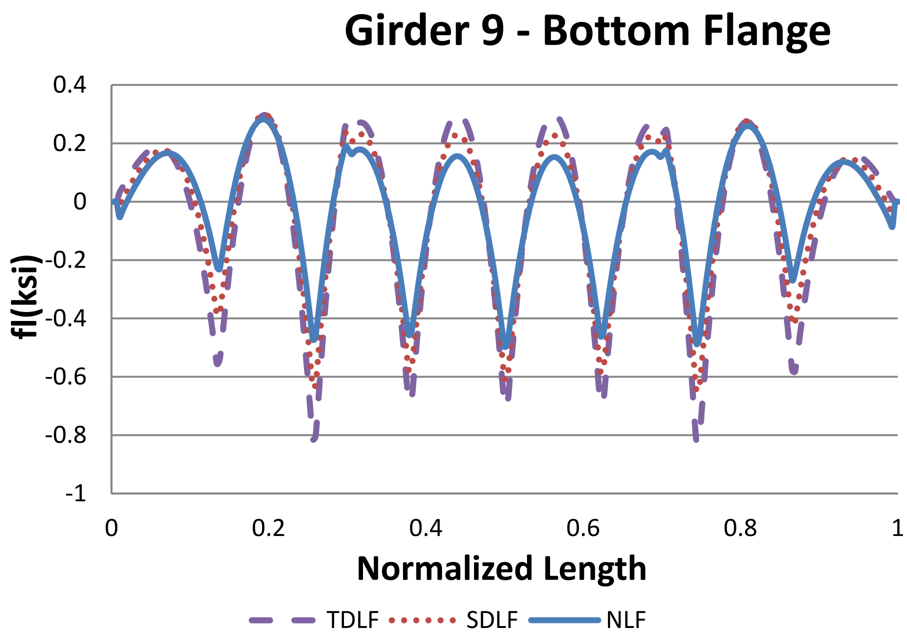


Figure C-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**



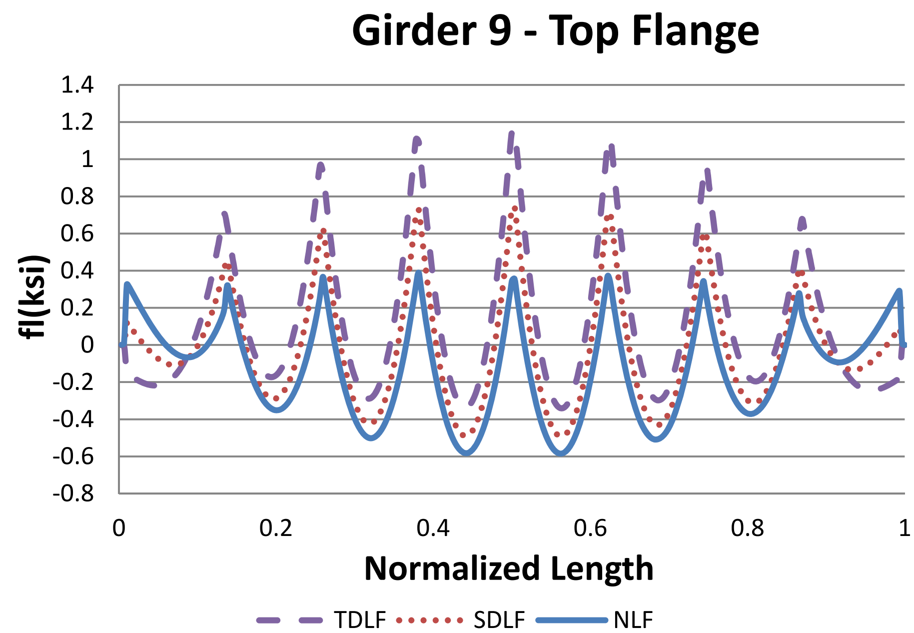


Figure C-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

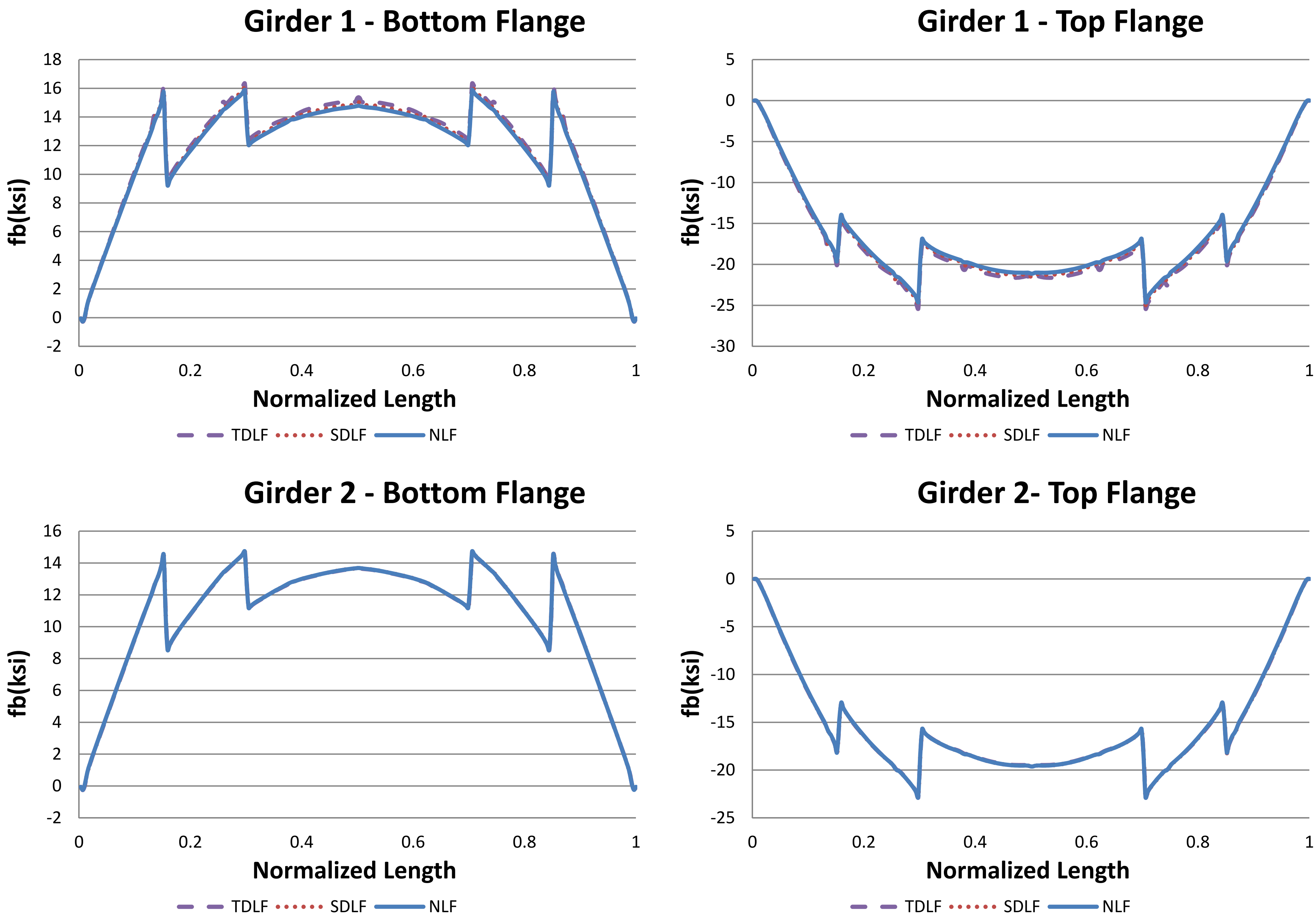


Figure C-4-20. Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

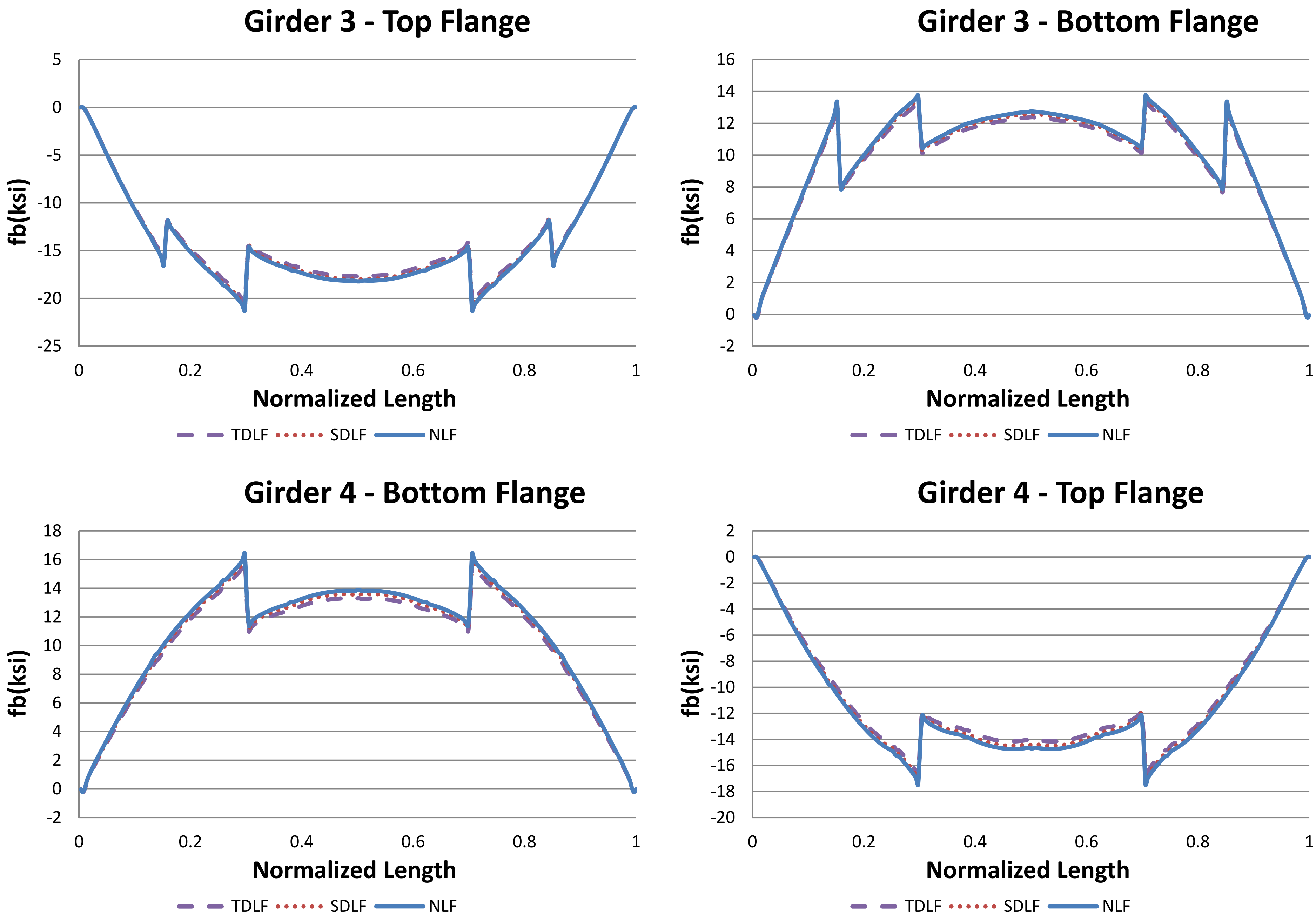


Figure C-4-20(Continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

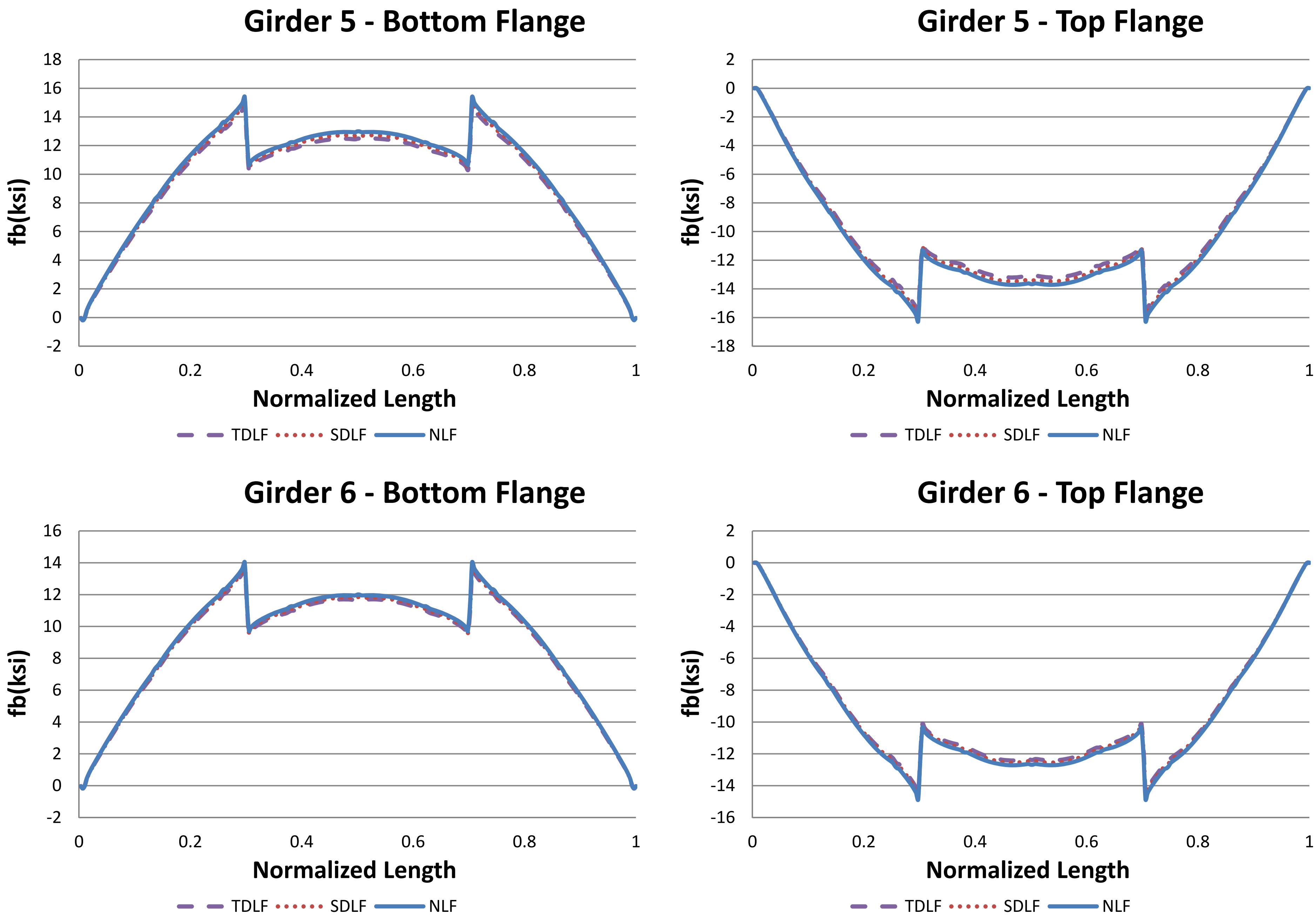


Figure C-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

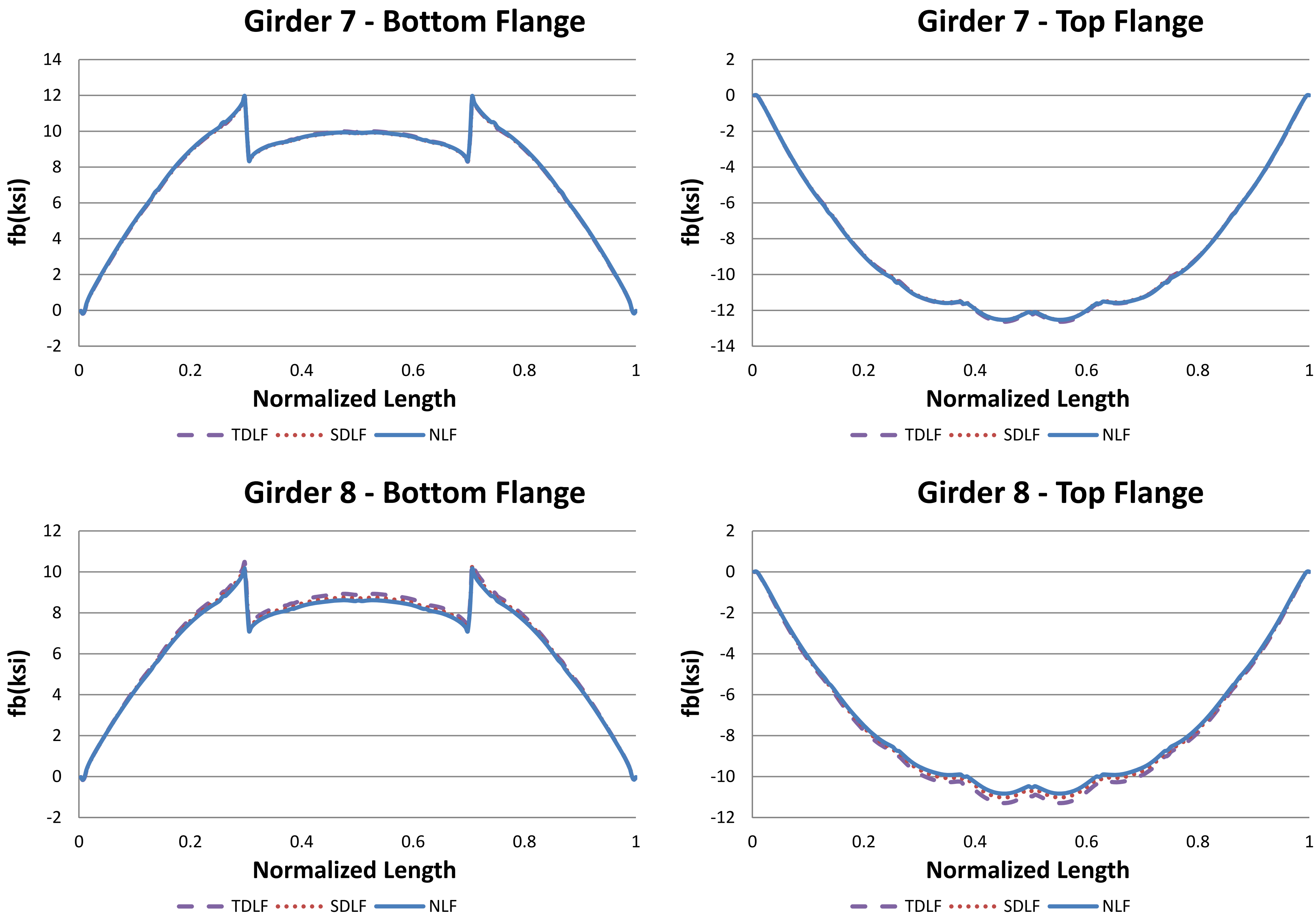
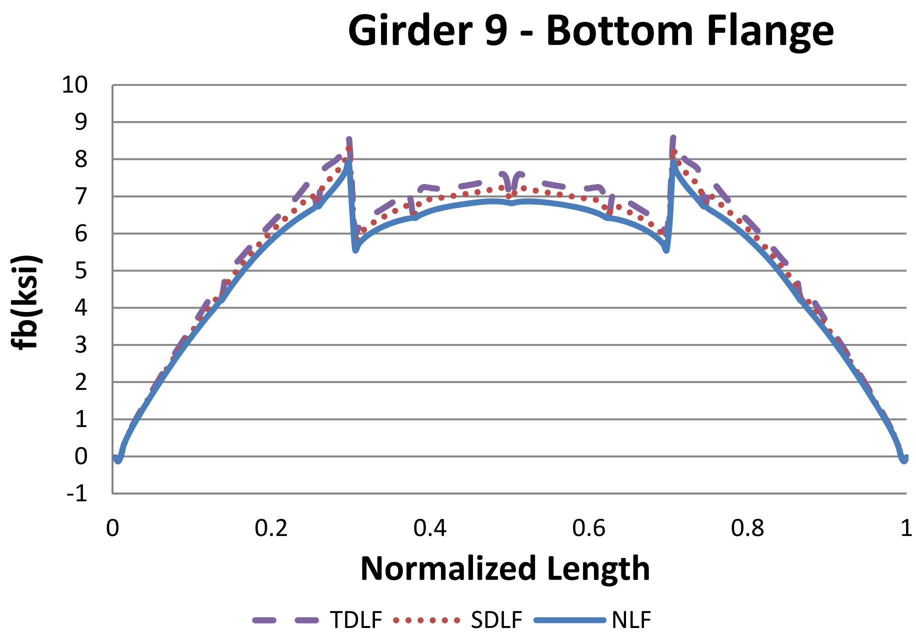


Figure C-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



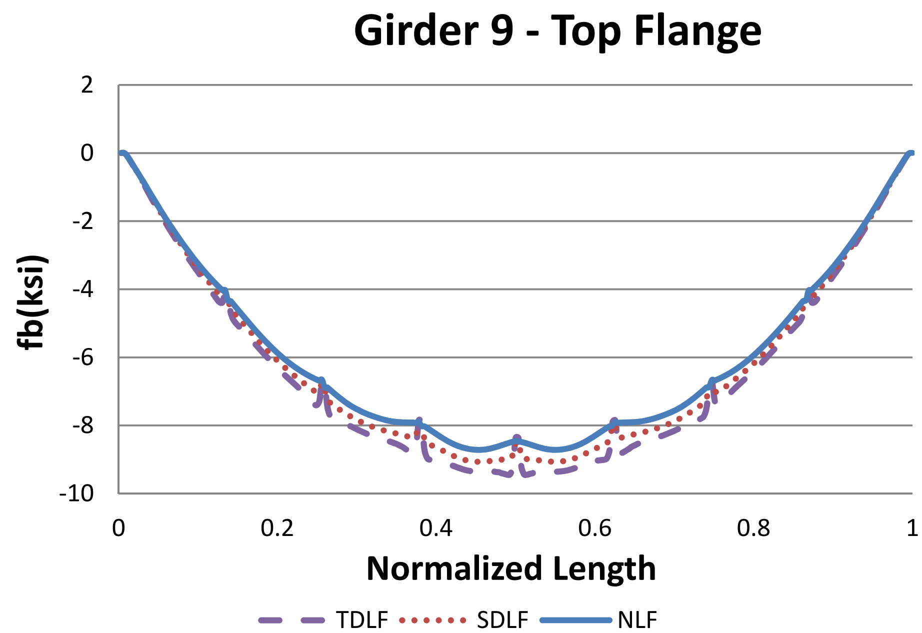


Figure C-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

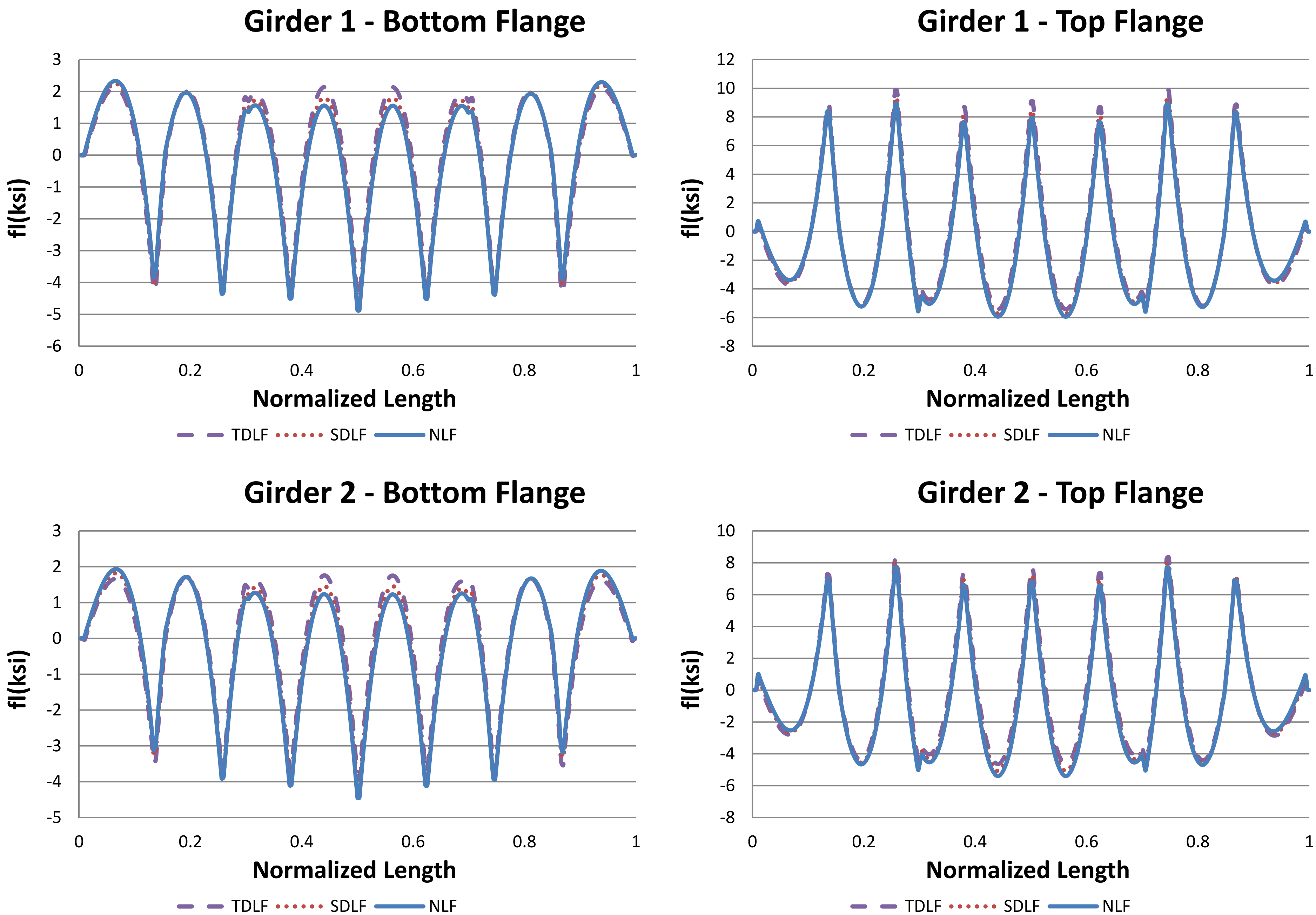


Figure C-4-21. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

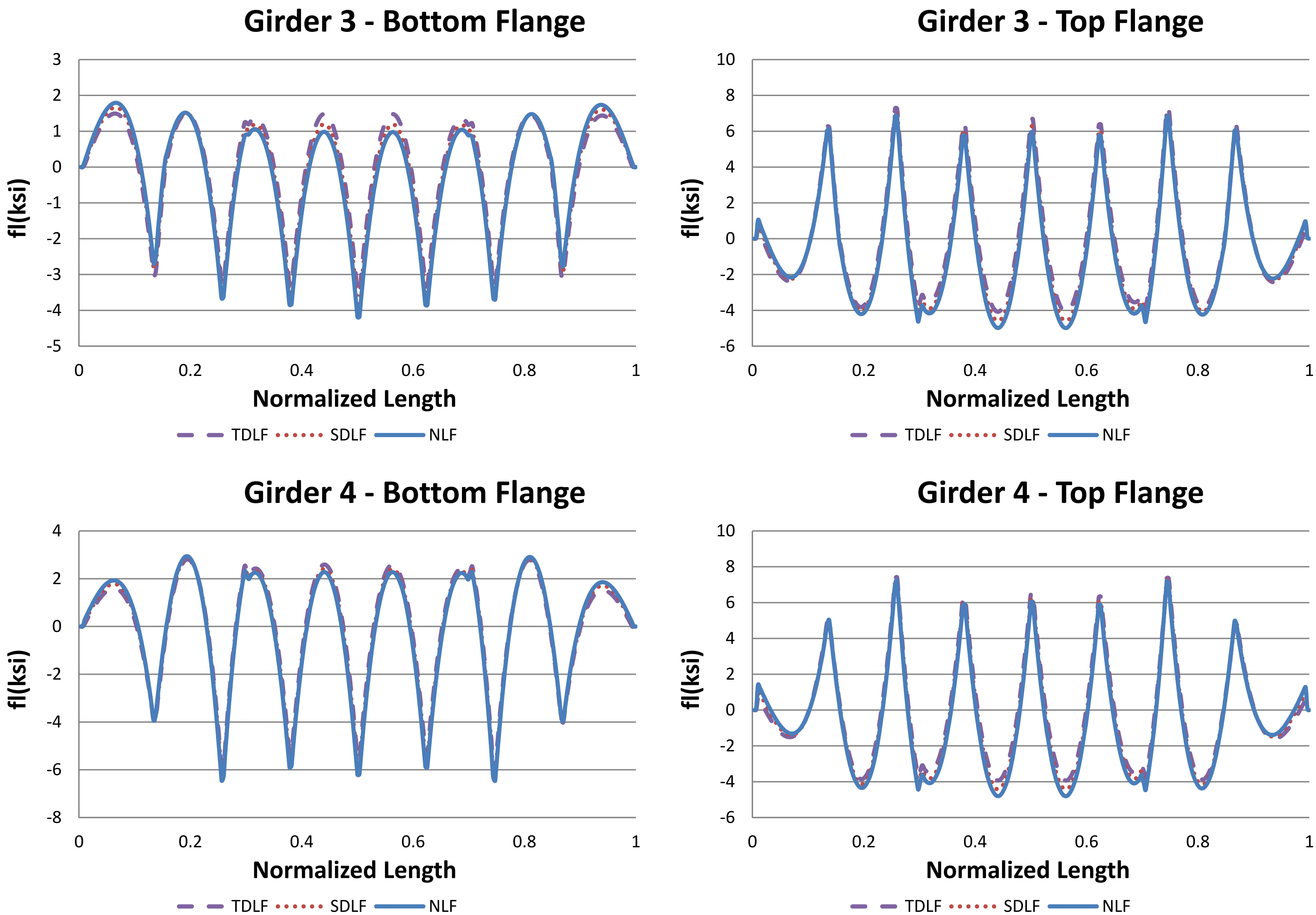


Figure C-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

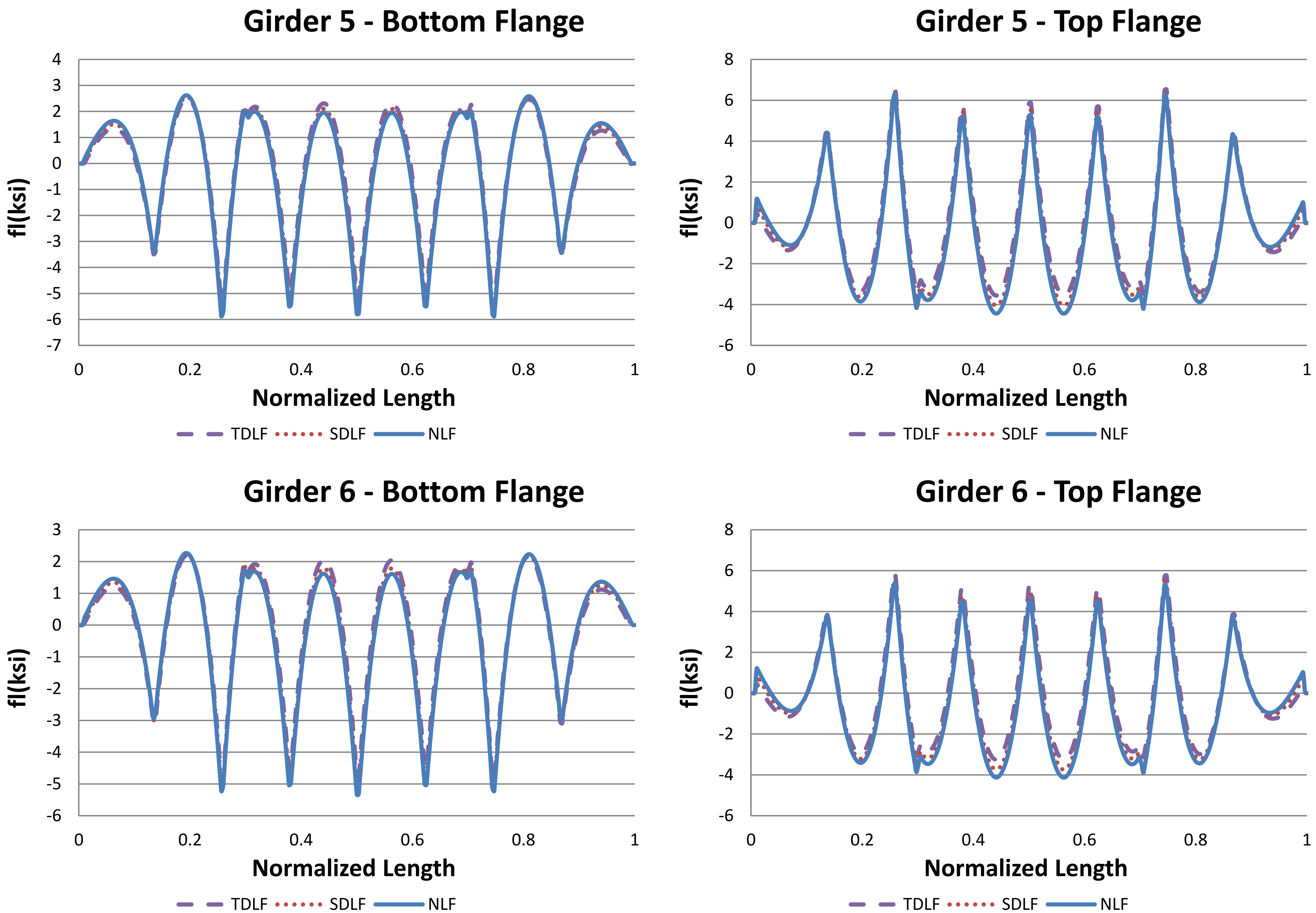
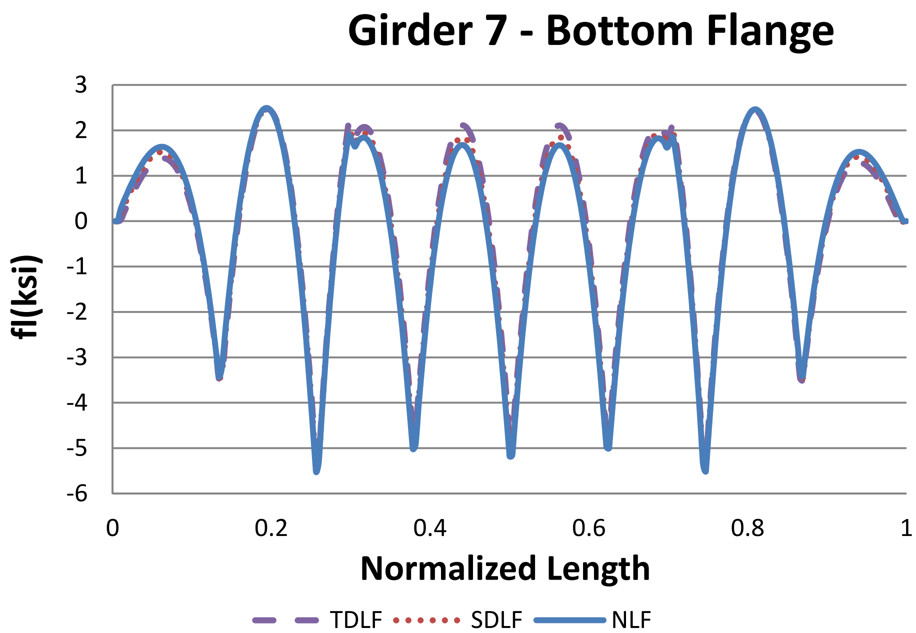
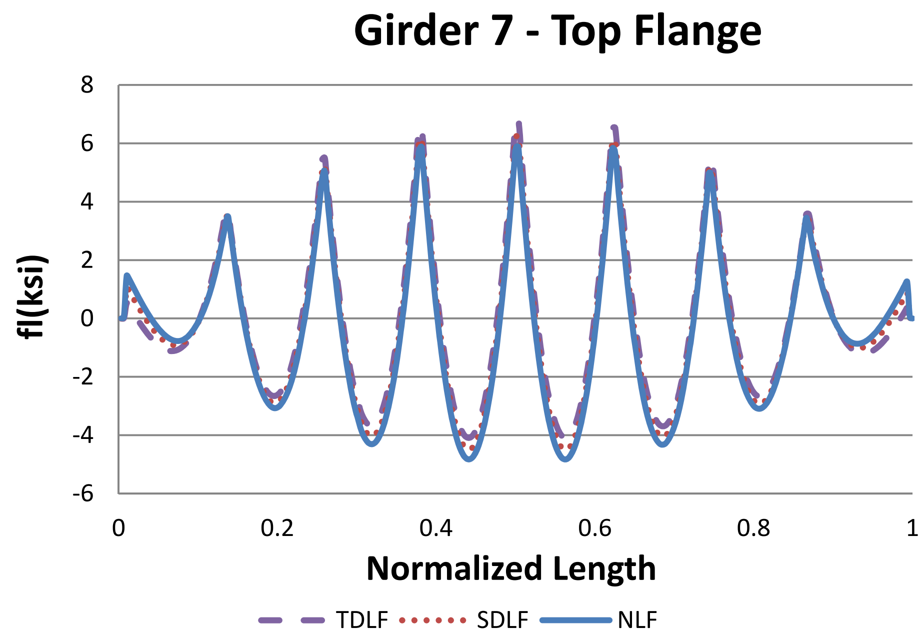
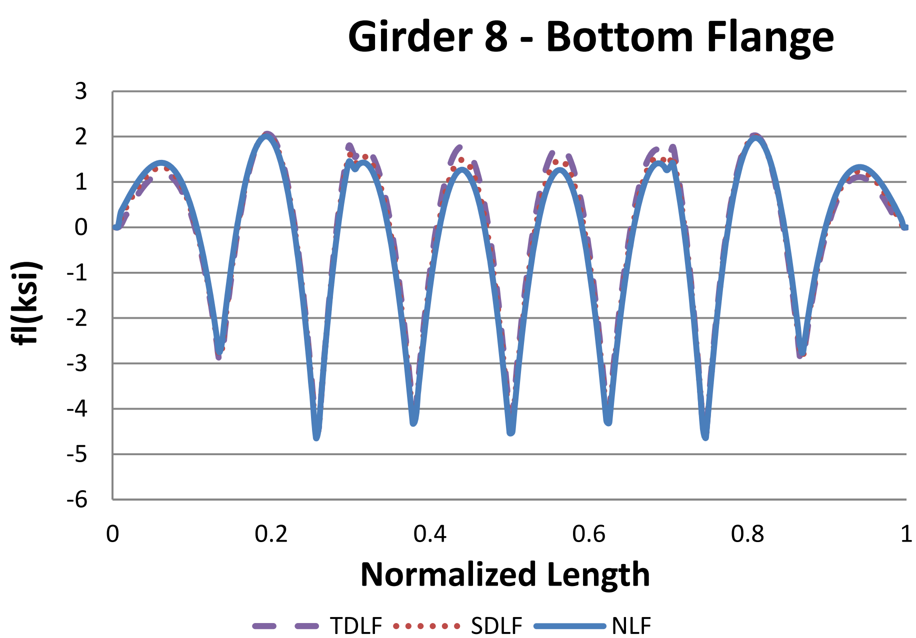


Figure C-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.







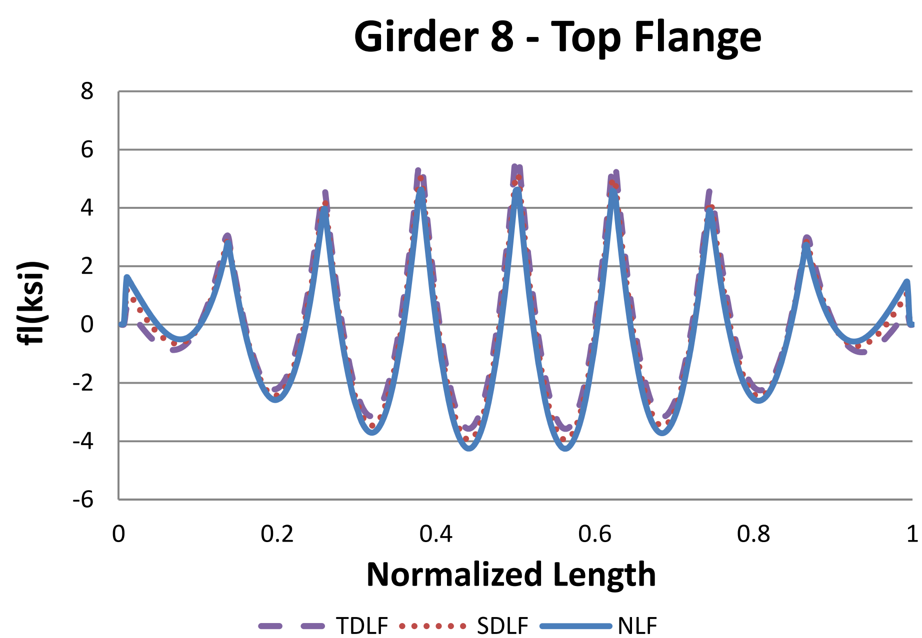
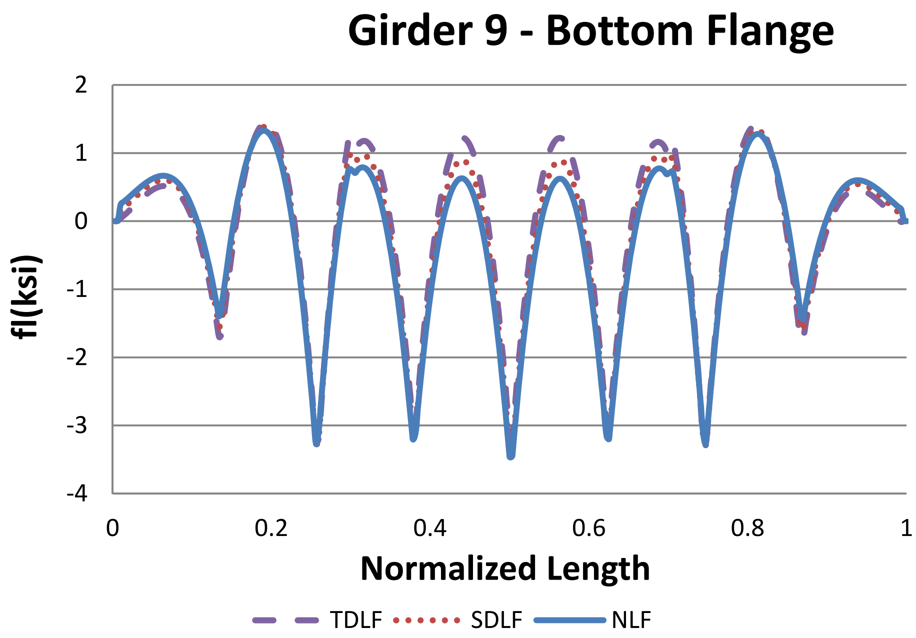


Figure C-4-21(Continued). **Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.**



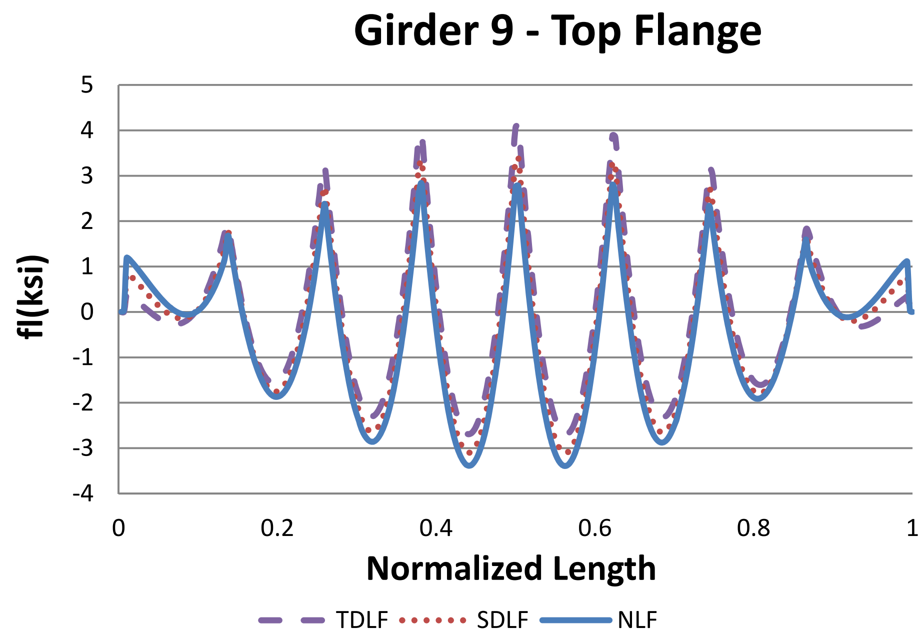


Figure C-4-21(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

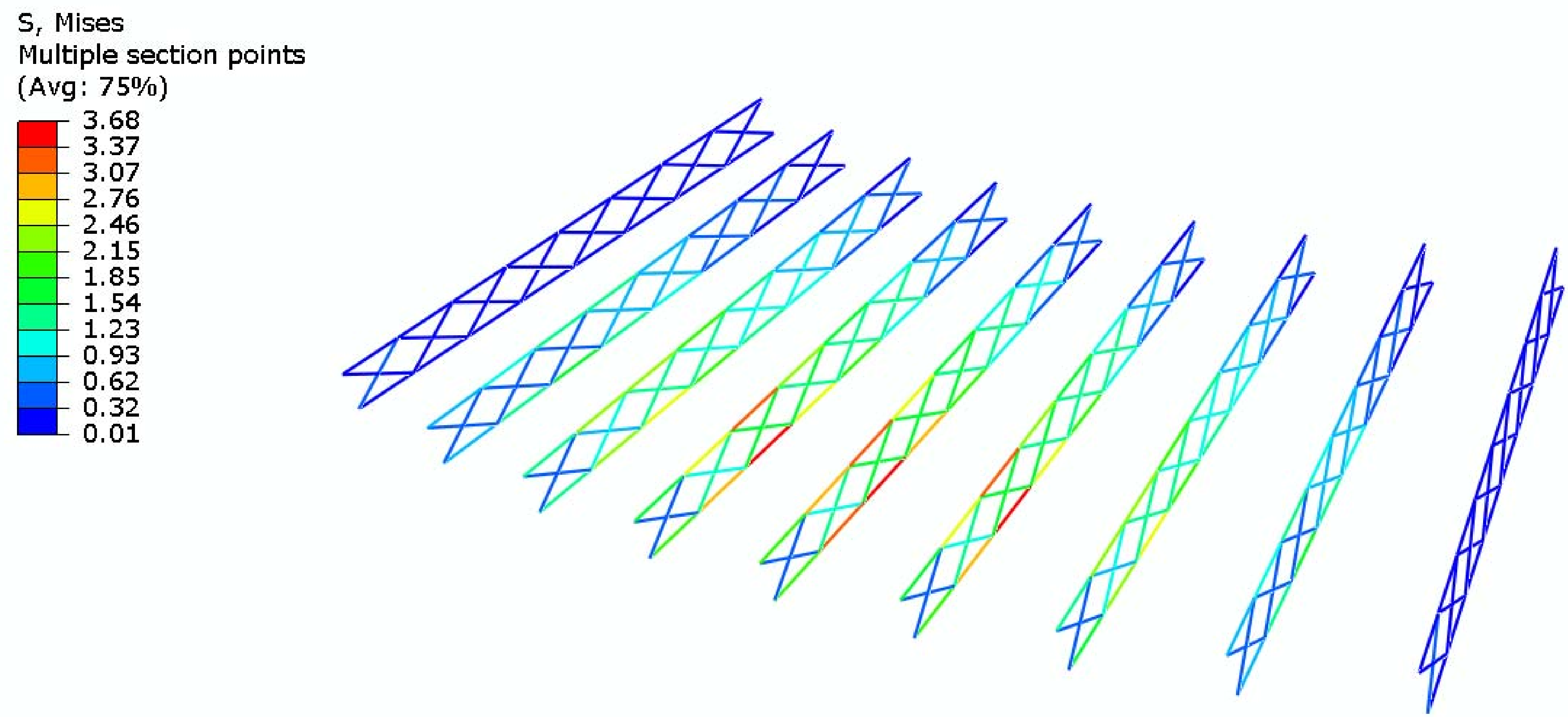


Figure C-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing (bottom chord areas = 15.6 in^2, top chord areas = 17.7 in^2, diagonal areas = 8.82 in^2).

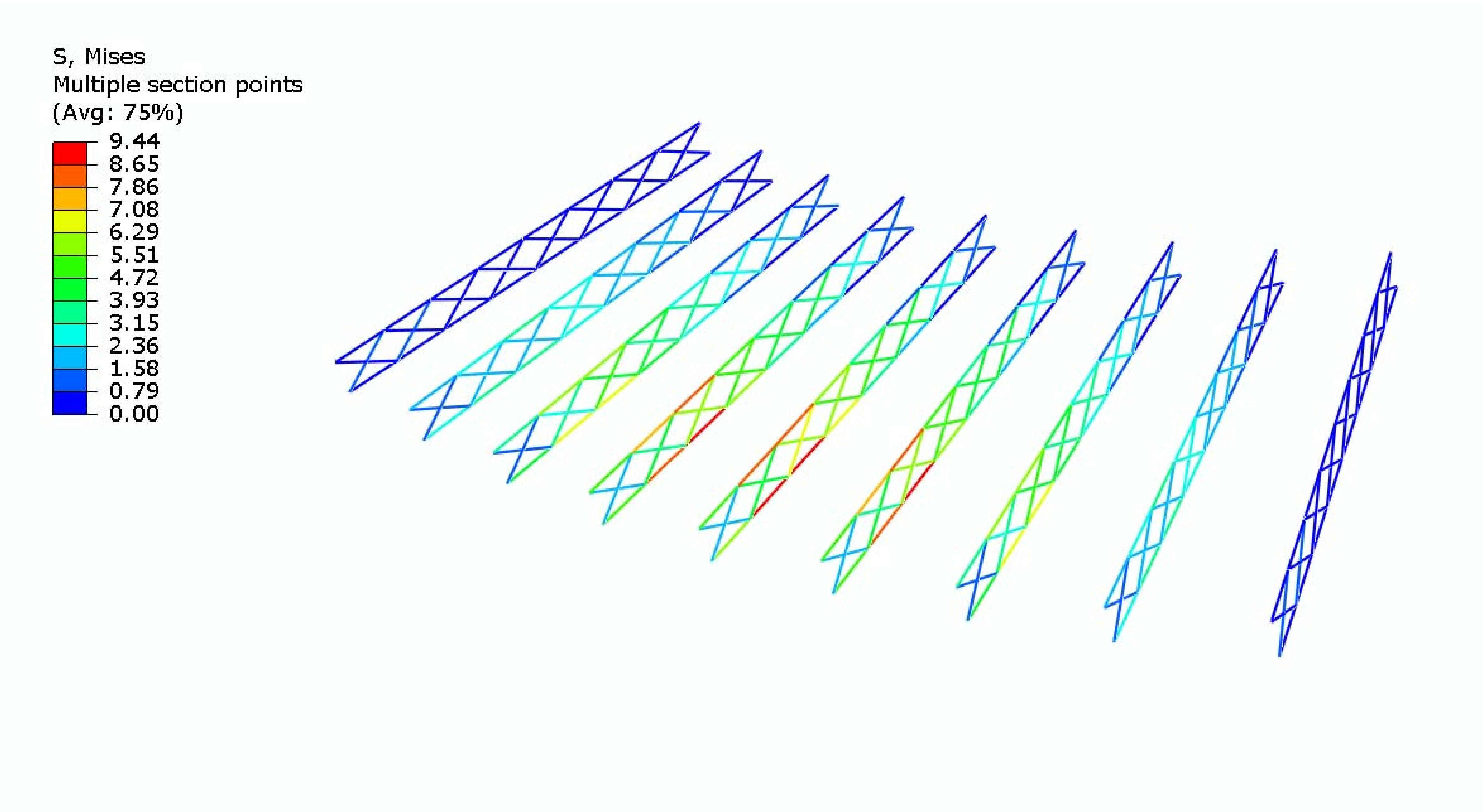


Figure C-4-23. Cross-frame stress contours under TDL, NLF detailing (bottom chord areas = 15.6 in^2, top chord areas = 17.7 in^2, diagonal areas = 8.82 in^2).

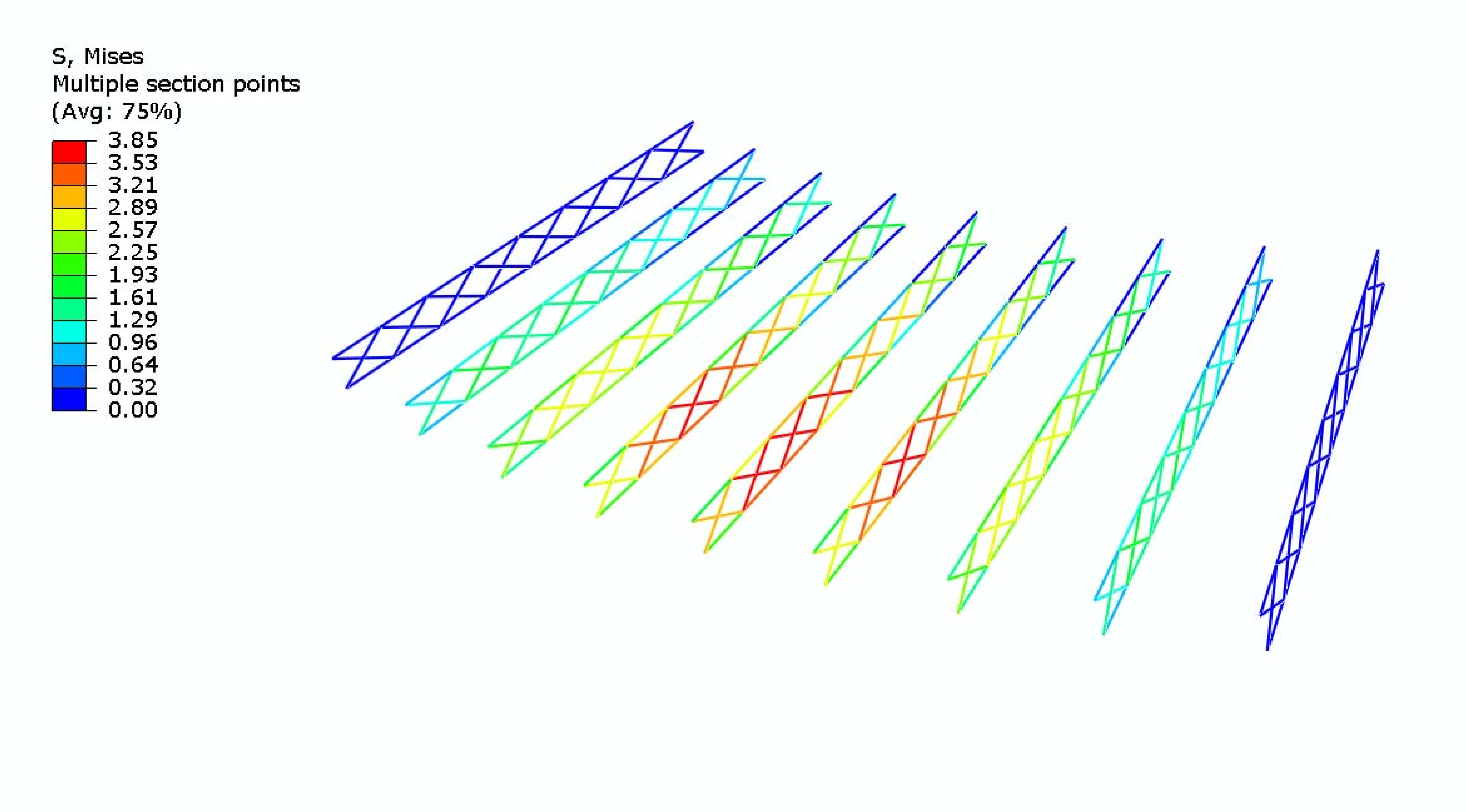


Figure C-4-24. Cross-frame stress contours under SDL, SDLF detailing (bottom chord areas = 15.6 in^2, top chord areas = 17.7 in^2, diagonal areas = 8.82 in^2).

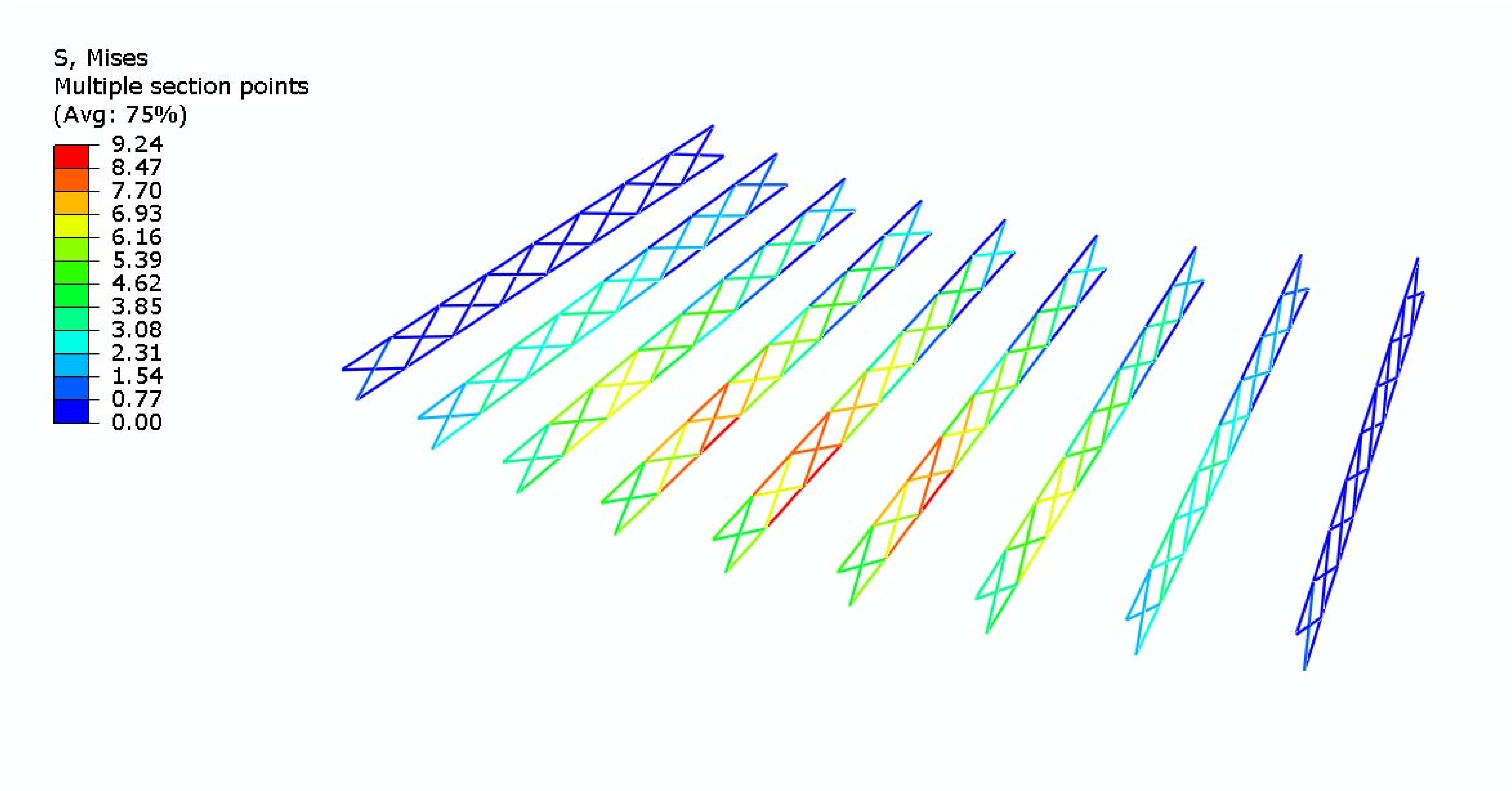


Figure C-4-25. Cross-frame stress contours under TDL, SDLF detailing (bottom chord areas = 15.6 in^2, top chord areas = 17.7 in^2, diagonal areas = 8.82 in^2).

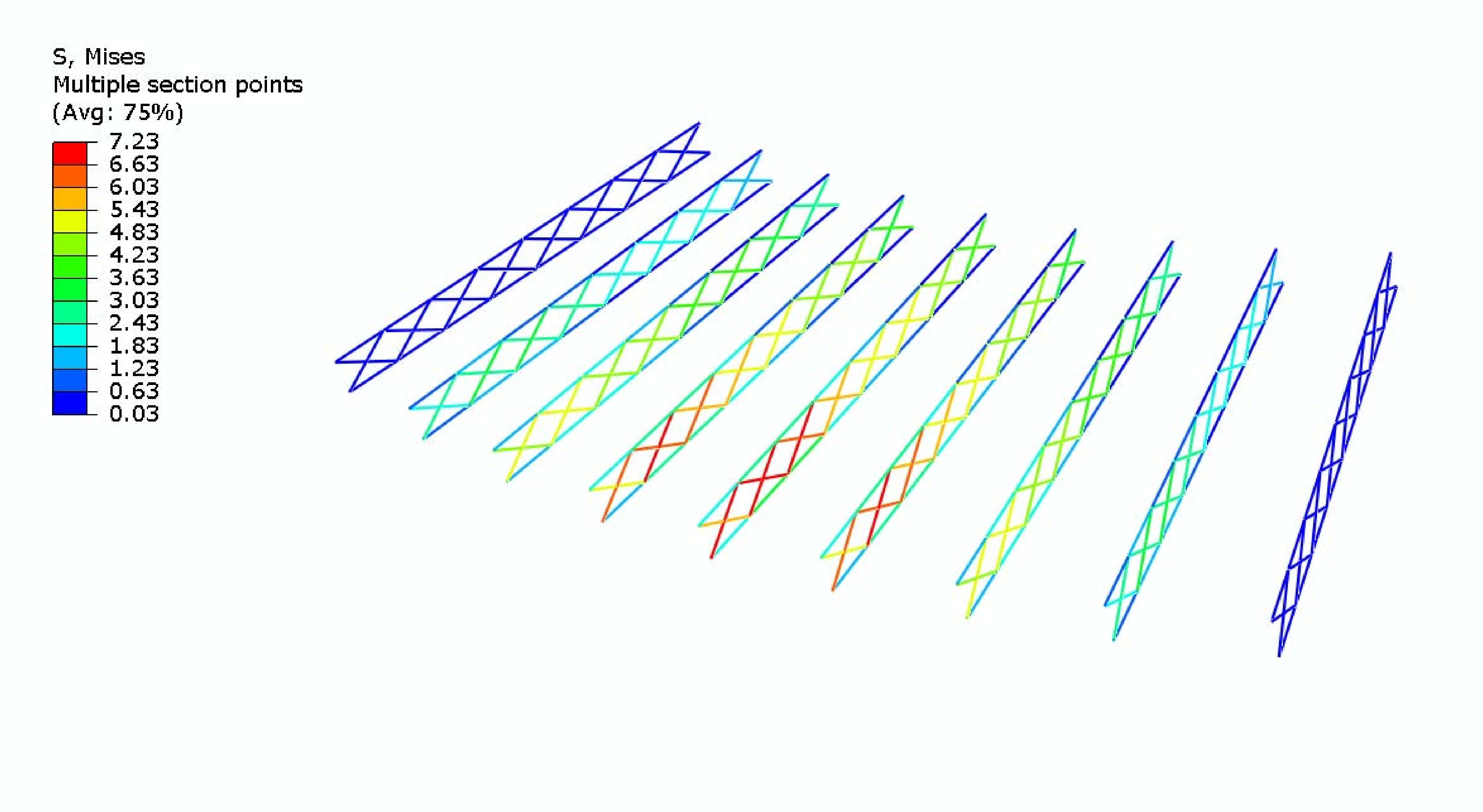


Figure C-4-26. Cross-frame stress contours under SDL, TDLF detailing (bottom chord areas = 15.6 in^2, top chord areas = 17.7 in^2, diagonal areas = 8.82 in^2).

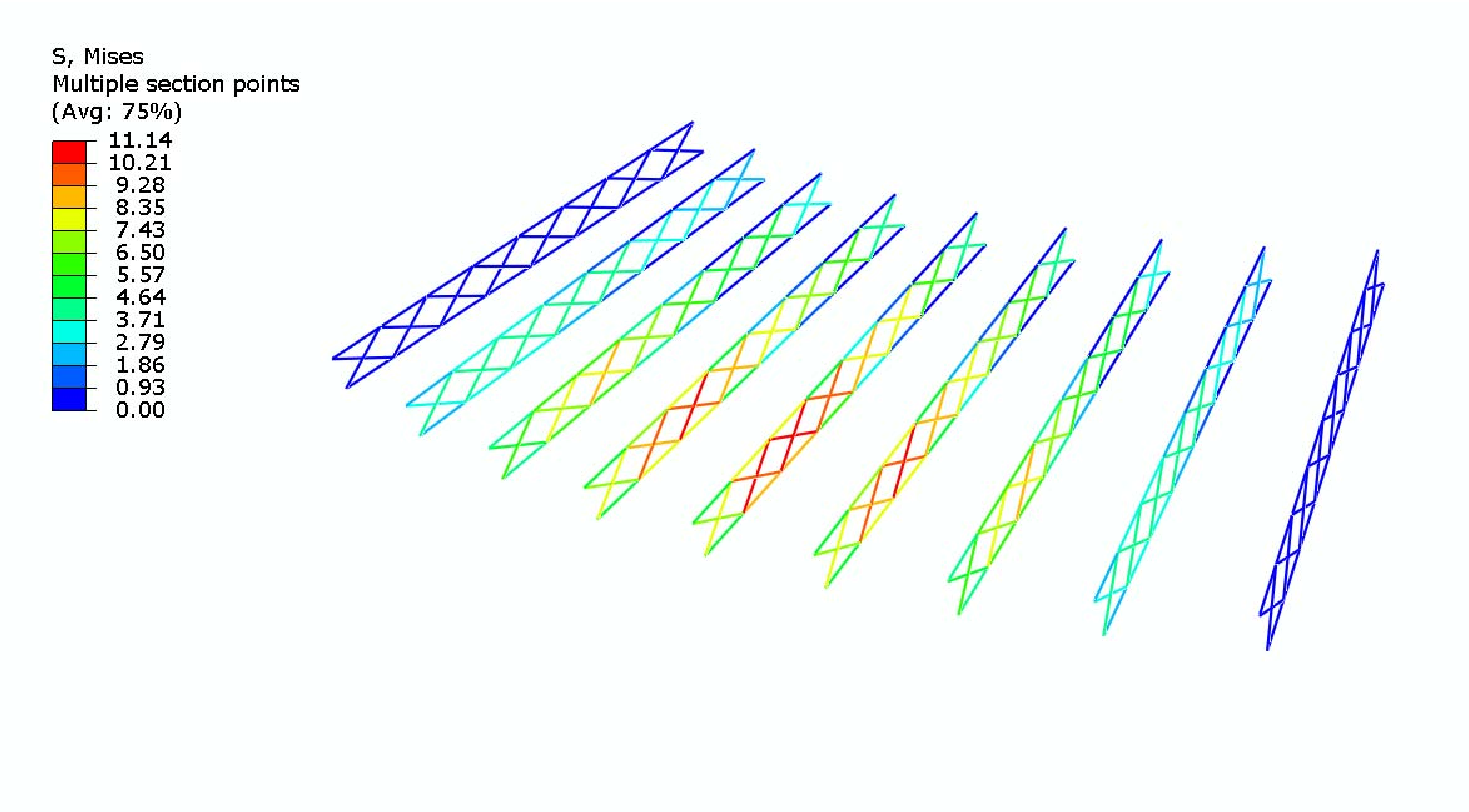


Figure C-4-27. Cross-frame stress contours under TDL, TDLF detailing (bottom chord areas = 15.6 in^2, top chord areas = 17.7 in^2, diagonal areas = 8.82 in^2).

Table C-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
1	NLF	3.2	2.8	1.5	1.6	1.2	1.0	0.8	0.6
	SDLF	1.4	1.1	0.6	0.5	0.4	0.3	0.2	0.2
	TDLF	4.7	3.9	4.2	2.4	2.2	2.1	1.8	1.6
2	NLF	3.0	5.0	4.0	7.1	6.7	5.2	4.2	2.3
	SDLF	12.2	14.5	13.8	14.2	12.5	10.4	9.5	7.4
	TDLF	25.6	27.6	27.7	23.8	20.5	18.2	17.4	14.8
3	NLF	3.7	8.2	12.6	11.2	10.3	8.3	6.9	3.7
	SDLF	20.2	24.3	25.3	23.1	21.1	18.6	16.6	12.8
	TDLF	45.4	47.4	41.5	39.0	36.4	33.6	30.7	25.9
4	NLF	4.8	10.9	15.4	14.6	13.1	11.7	7.9	3.9
	SDLF	25.0	30.6	32.0	29.1	26.3	23.9	20.8	16.1
	TDLF	56.3	59.4	54.8	48.6	44.2	40.4	38.8	33.0
5	NLF	5.1	11.7	16.0	15.7	14.3	12.5	8.4	3.9
	SDLF	26.5	32.9	34.0	31.2	28.2	25.7	22.2	17.1
	TDLF	59.8	63.8	59.2	52.1	46.6	43.5	41.1	35.2
6	NLF	4.8	10.9	15.4	14.6	13.1	11.7	7.9	3.9
	SDLF	25.0	30.6	32.0	29.1	26.3	23.9	20.8	16.1
	TDLF	56.3	59.5	54.8	48.6	44.2	40.4	38.8	33.0
7	NLF	3.7	8.2	12.6	11.2	10.3	8.3	6.9	3.7
	SDLF	20.2	24.3	25.3	23.1	21.1	18.6	16.6	12.8
	TDLF	45.4	47.5	41.5	39.0	36.4	33.6	30.7	25.9
8	NLF	3.0	5.1	4.0	7.1	6.7	5.2	4.2	2.3
	SDLF	12.2	14.5	13.8	14.2	12.5	10.4	9.5	7.4
	TDLF	25.6	27.6	27.7	23.8	20.5	18.2	17.4	14.8
9	NLF	3.1	2.7	1.5	1.5	1.2	1.0	0.8	0.6
	SDLF	1.4	1.1	0.6	0.5	0.4	0.3	0.2	0.2
	TDLF	4.6	3.9	4.2	2.4	2.2	2.1	1.8	1.6

Table C-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	9.6	8.3	5.0	5.1	4.3	3.6	3.2	2.6
	SDLF	7.7	6.5	3.9	3.8	3.3	2.8	2.5	2.1
	TDLF	4.2	3.0	2.2	1.5	1.2	1.0	0.8	0.6
2	NLF	10.3	17.8	16.6	23.1	20.4	14.9	11.6	5.9
	SDLF	19.6	27.3	26.4	30.3	26.2	20.1	16.8	10.7
	TDLF	33.1	40.5	40.4	39.8	34.1	27.8	24.8	18.2
3	NLF	12.5	28.0	45.2	36.9	31.4	23.8	18.9	9.2
	SDLF	28.9	43.9	57.7	48.6	42.1	33.7	28.4	18.2
	TDLF	54.1	67.0	73.7	64.4	57.2	48.8	42.5	31.2
4	NLF	16.0	36.3	53.6	47.2	40.0	34.9	21.6	9.0
	SDLF	36.0	55.8	70.0	61.5	52.8	46.8	34.5	21.2
	TDLF	67.2	84.4	92.6	80.8	70.7	63.4	52.1	38.1
5	NLF	17.0	38.8	55.7	50.7	43.5	37.4	22.9	9.0
	SDLF	38.2	59.6	73.4	65.8	56.9	50.1	36.8	22.1
	TDLF	71.4	90.4	98.2	86.5	75.4	68.1	55.3	40.1
6	NLF	16.0	36.3	53.6	47.2	40.0	34.9	21.6	9.0
	SDLF	36.0	55.8	70.0	61.5	52.8	46.8	34.5	21.2
	TDLF	67.2	84.4	92.6	80.8	70.7	63.4	52.1	38.1
7	NLF	12.5	28.0	45.2	36.9	31.4	23.8	18.9	9.2
	SDLF	28.9	43.9	57.7	48.7	42.1	33.7	28.4	18.2
	TDLF	54.1	67.0	73.8	64.4	57.2	48.8	42.5	31.2
8	NLF	10.3	17.8	16.6	23.1	20.4	14.9	11.6	5.9
	SDLF	19.6	27.4	26.5	30.3	26.2	20.1	16.8	10.7
	TDLF	33.1	40.5	40.5	39.9	34.1	27.8	24.8	18.2
9	NLF	9.6	8.3	5.0	5.0	4.3	3.6	3.1	2.5
	SDLF	7.7	6.4	3.8	3.8	3.3	2.8	2.5	2.1
	TDLF	4.2	3.0	2.1	1.5	1.2	0.9	0.8	0.6

Table C-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.8	1.1	0.5	0.2	0.4	0.4	0.3	0.3
	SDLF	0.7	0.3	0.5	0.3	0.2	0.1	0.1	0.0
	TDLF	3.6	3.4	2.5	1.4	1.5	1.5	1.3	1.2
2	NLF	13.0	19.6	24.1	21.1	14.8	9.2	4.3	0.9
	SDLF	13.0	20.1	22.5	17.6	11.3	6.4	2.5	0.7
	TDLF	12.4	20.9	20.7	12.9	6.7	3.1	0.4	0.5
3	NLF	24.0	37.6	42.0	32.0	22.9	14.7	6.8	1.3
	SDLF	23.4	36.8	40.1	30.0	20.2	11.7	4.5	1.3
	TDLF	20.4	33.7	36.8	28.1	17.6	8.4	1.4	1.1
4	NLF	30.4	47.4	53.4	40.9	28.9	17.6	6.9	1.1
	SDLF	30.1	47.0	50.9	37.8	25.5	14.8	5.2	1.6
	TDLF	26.8	43.9	45.7	32.5	20.5	11.1	3.1	2.0
5	NLF	32.6	50.7	57.4	44.2	31.0	18.6	7.1	1.0
	SDLF	32.5	50.6	54.8	40.7	27.5	15.8	5.5	1.7
	TDLF	29.1	47.5	48.9	34.1	21.5	11.6	3.0	2.1
6	NLF	30.4	47.4	53.4	40.9	28.9	17.6	6.9	1.1
	SDLF	30.1	47.0	50.9	37.8	25.6	14.8	5.2	1.6
	TDLF	26.8	43.9	45.7	32.5	20.5	11.1	3.1	2.0
7	NLF	24.0	37.6	42.0	32.0	22.9	14.7	6.8	1.3
	SDLF	23.4	36.8	40.1	30.0	20.2	11.7	4.5	1.3
	TDLF	20.5	33.7	36.8	28.1	17.6	8.4	1.4	1.1
8	NLF	13.1	19.6	24.1	21.1	14.8	9.2	4.3	0.9
	SDLF	13.0	20.1	22.6	17.6	11.3	6.4	2.5	0.6
	TDLF	12.5	21.0	20.7	12.9	6.7	3.1	0.4	0.5
9	NLF	0.8	1.1	0.5	0.2	0.4	0.4	0.4	0.3
	SDLF	0.7	0.3	0.5	0.3	0.2	0.1	0.0	0.0
	TDLF	3.6	3.4	2.5	1.4	1.5	1.4	1.3	1.2

Table C-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
1	NLF	1.4	2.8	1.1	0.6	1.2	1.2	1.2	1.1
	SDLF	0.1	1.4	0.3	0.2	0.8	0.8	0.9	0.8
	TDLF	2.9	1.6	1.7	0.9	0.5	0.4	0.3	0.3
2	NLF	37.8	52.9	60.3	46.7	27.9	13.9	3.8	0.9
	SDLF	37.8	53.4	58.7	43.2	24.3	11.1	1.9	1.2
	TDLF	37.2	54.2	56.9	38.4	19.7	7.7	0.2	1.4
3	NLF	67.9	102.5	106.8	69.3	41.3	21.1	4.5	3.2
	SDLF	67.1	101.4	104.6	67.0	38.3	18.0	2.1	3.2
	TDLF	63.9	97.9	100.9	64.7	35.5	14.5	1.1	3.5
4	NLF	85.2	128.5	136.5	90.9	54.4	24.7	0.0	6.3
	SDLF	84.6	127.7	133.6	87.4	50.8	21.7	1.8	5.8
	TDLF	81.0	124.0	127.8	81.6	45.4	17.8	4.0	5.5
5	NLF	91.0	137.3	147.2	99.4	59.2	26.4	0.8	7.3
	SDLF	90.5	136.6	144.1	95.5	55.4	23.4	2.5	6.6
	TDLF	86.7	133.0	137.5	88.3	49.1	19.0	5.1	6.3
6	NLF	85.2	128.5	136.5	90.9	54.4	24.7	0.0	6.3
	SDLF	84.7	127.7	133.6	87.5	50.8	21.7	1.8	5.8
	TDLF	81.0	124.1	127.8	81.7	45.4	17.8	4.0	5.5
7	NLF	68.0	102.5	106.9	69.3	41.3	21.1	4.5	3.2
	SDLF	67.1	101.4	104.6	67.0	38.3	18.0	2.1	3.2
	TDLF	63.9	98.0	100.9	64.7	35.5	14.5	1.1	3.4
8	NLF	37.9	53.0	60.4	46.8	28.0	13.9	3.8	0.9
	SDLF	37.8	53.5	58.9	43.3	24.4	11.1	1.9	1.2
	TDLF	37.3	54.3	57.0	38.5	19.8	7.7	0.2	1.4
9	NLF	1.5	2.9	1.2	0.7	1.3	1.2	1.2	1.1
	SDLF	0.0	1.4	0.3	0.2	0.8	0.8	0.9	0.8
	TDLF	2.8	1.6	1.6	0.8	0.5	0.4	0.3	0.3

Table C-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.0	1.2	1.2	1.0	0.7	0.5	0.4	0.2
	SDLF	0.5	0.0	0.2	0.1	0.0	0.0	0.0	0.1
	TDLF	2.2	2.2	2.0	2.1	1.7	1.5	1.3	1.2
2	NLF	13.1	20.0	24.9	21.9	15.4	9.5	4.5	0.9
	SDLF	13.9	20.4	23.1	18.0	11.4	6.4	2.4	0.0
	TDLF	16.0	22.2	21.7	13.3	6.8	3.1	0.4	0.9
3	NLF	24.0	38.2	42.9	32.9	23.5	15.1	7.0	1.4
	SDLF	24.3	36.9	40.4	30.0	20.0	11.4	4.1	0.2
	TDLF	26.5	36.2	38.5	28.6	17.9	8.6	1.4	1.4
4	NLF	30.7	48.6	55.0	42.3	29.9	18.2	7.2	1.1
	SDLF	31.0	47.1	51.4	37.9	25.5	14.5	4.6	0.4
	TDLF	34.0	46.9	48.0	33.3	21.2	11.7	3.6	0.6
5	NLF	32.8	51.9	59.0	45.6	32.0	19.2	7.4	1.1
	SDLF	33.1	50.4	55.1	40.7	27.2	15.3	4.7	0.5
	TDLF	36.6	50.6	51.2	34.8	22.0	12.0	3.3	0.7
6	NLF	30.7	48.6	55.0	42.3	29.9	18.2	7.2	1.1
	SDLF	31.0	47.1	51.4	37.9	25.5	14.5	4.6	0.4
	TDLF	34.0	46.9	48.0	33.3	21.2	11.7	3.6	0.6
7	NLF	24.0	38.2	42.9	32.9	23.5	15.1	7.0	1.4
	SDLF	24.3	36.9	40.4	30.0	20.0	11.4	4.0	0.2
	TDLF	26.5	36.2	38.5	28.6	17.9	8.5	1.4	1.4
8	NLF	13.1	20.0	24.8	21.8	15.3	9.5	4.5	0.9
	SDLF	13.9	20.4	23.0	18.0	11.4	6.4	2.4	0.0
	TDLF	15.9	22.2	21.6	13.3	6.8	3.1	0.4	0.9
9	NLF	2.0	1.3	1.3	1.1	0.7	0.5	0.3	0.2
	SDLF	0.6	0.1	0.2	0.1	0.0	0.0	0.1	0.1
	TDLF	2.2	2.1	2.0	2.1	1.8	1.5	1.4	1.2

Table C-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
		CF Location							
1	NLF	6.4	3.9	3.7	3.0	2.1	1.8	1.6	1.6
	SDLF	5.0	2.8	2.8	2.2	1.5	1.4	1.3	1.3
	TDLF	2.4	0.7	0.8	0.1	0.1	0.0	0.0	0.2
2	NLF	38.1	54.5	62.9	49.1	29.6	15.0	4.3	0.8
	SDLF	38.9	54.7	60.9	45.0	25.4	11.8	2.2	1.7
	TDLF	40.9	56.3	59.2	40.0	20.6	8.3	0.1	2.6
3	NLF	67.9	104.2	109.1	71.1	42.3	21.7	4.7	3.1
	SDLF	68.1	102.5	106.2	67.8	38.5	17.8	1.6	4.7
	TDLF	69.9	101.4	103.8	66.0	36.2	14.7	1.1	5.9
4	NLF	86.3	131.9	140.9	94.3	56.7	25.8	0.1	6.5
	SDLF	86.3	129.9	136.7	89.5	51.9	21.9	2.5	8.0
	TDLF	88.9	129.0	132.5	84.3	47.2	18.8	3.7	8.3
5	NLF	92.0	140.7	151.5	102.8	61.3	27.4	0.7	7.4
	SDLF	91.9	138.5	146.9	97.3	56.1	23.3	3.5	9.1
	TDLF	94.9	137.9	142.1	90.8	50.5	19.6	5.1	9.4
6	NLF	86.3	131.9	140.9	94.4	56.7	25.8	0.1	6.5
	SDLF	86.3	129.9	136.8	89.5	51.9	21.9	2.5	8.0
	TDLF	88.9	129.1	132.5	84.3	47.1	18.8	3.7	8.3
7	NLF	68.0	104.2	109.1	71.1	42.3	21.7	4.7	3.1
	SDLF	68.1	102.5	106.2	67.9	38.5	17.8	1.6	4.7
	TDLF	70.0	101.4	103.8	66.0	36.1	14.7	1.2	5.9
8	NLF	38.1	54.5	62.9	49.0	29.5	15.0	4.3	0.8
	SDLF	38.9	54.7	60.8	45.0	25.4	11.8	2.2	1.7
	TDLF	40.9	56.3	59.1	39.9	20.5	8.3	0.1	2.6
9	NLF	6.4	3.9	3.8	3.1	2.2	1.9	1.6	1.6
	SDLF	5.0	2.8	2.8	2.2	1.6	1.4	1.3	1.3
	TDLF	2.4	0.7	0.8	0.2	0.1	0.0	0.0	0.2

Table C-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	NLF	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
	SDLF	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
	TDLF	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1
3	NLF	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
	SDLF	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2
	TDLF	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1
4	NLF	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2
	SDLF	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2
	TDLF	0.6	0.5	0.3	0.2	0.2	0.2	0.2	0.2
5	NLF	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
	SDLF	0.5	0.4	0.4	0.3	0.2	0.2	0.2	0.2
	TDLF	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.2
6	NLF	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2
	SDLF	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2
	TDLF	0.6	0.5	0.3	0.2	0.2	0.2	0.2	0.2
7	NLF	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
	SDLF	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2
	TDLF	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1
8	NLF	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
	SDLF	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
	TDLF	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1
9	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Table C-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	NLF	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
	SDLF	0.5	0.4	0.4	0.3	0.3	0.2	0.2	0.2
	TDLF	0.5	0.4	0.4	0.3	0.2	0.2	0.2	0.2
3	NLF	0.7	0.7	0.6	0.5	0.5	0.5	0.5	0.5
	SDLF	0.8	0.7	0.6	0.5	0.5	0.4	0.4	0.4
	TDLF	0.9	0.8	0.6	0.5	0.4	0.4	0.4	0.4
4	NLF	0.9	0.8	0.7	0.6	0.6	0.6	0.6	0.6
	SDLF	1.0	0.9	0.7	0.6	0.6	0.5	0.5	0.6
	TDLF	1.1	0.9	0.7	0.6	0.5	0.5	0.5	0.5
5	NLF	1.0	0.9	0.8	0.7	0.6	0.6	0.6	0.6
	SDLF	1.1	0.9	0.8	0.7	0.6	0.6	0.6	0.6
	TDLF	1.2	1.0	0.8	0.6	0.6	0.5	0.5	0.6
6	NLF	0.9	0.8	0.7	0.6	0.6	0.6	0.6	0.6
	SDLF	1.0	0.9	0.7	0.6	0.6	0.5	0.5	0.6
	TDLF	1.1	0.9	0.7	0.6	0.5	0.5	0.5	0.5
7	NLF	0.7	0.7	0.6	0.5	0.5	0.5	0.5	0.5
	SDLF	0.8	0.7	0.6	0.5	0.5	0.4	0.4	0.4
	TDLF	0.9	0.8	0.6	0.5	0.4	0.4	0.4	0.4
8	NLF	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3
	SDLF	0.5	0.4	0.4	0.3	0.3	0.2	0.2	0.2
	TDLF	0.5	0.4	0.4	0.3	0.2	0.2	0.2	0.2
9	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table C-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
1	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	NLF	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	SDLF	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	TDLF	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0
3	NLF	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
	SDLF	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
	TDLF	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1
4	NLF	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	SDLF	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1
	TDLF	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1
5	NLF	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
	SDLF	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1
	TDLF	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1
6	NLF	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	SDLF	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1
	TDLF	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1
7	NLF	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
	SDLF	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
	TDLF	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1
8	NLF	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	SDLF	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	TDLF	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0
9	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table C-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	NLF	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
	SDLF	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
	TDLF	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.2
3	NLF	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3
	SDLF	0.5	0.5	0.4	0.3	0.3	0.3	0.3	0.3
	TDLF	0.6	0.5	0.4	0.3	0.3	0.3	0.3	0.3
4	NLF	0.6	0.6	0.5	0.4	0.4	0.4	0.4	0.4
	SDLF	0.7	0.6	0.5	0.4	0.4	0.4	0.4	0.4
	TDLF	0.8	0.6	0.5	0.4	0.3	0.3	0.3	0.3
5	NLF	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4
	SDLF	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4
	TDLF	0.8	0.7	0.5	0.4	0.4	0.3	0.3	0.4
6	NLF	0.6	0.6	0.5	0.4	0.4	0.4	0.4	0.4
	SDLF	0.7	0.6	0.5	0.4	0.4	0.4	0.4	0.4
	TDLF	0.8	0.6	0.5	0.4	0.3	0.3	0.3	0.3
7	NLF	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3
	SDLF	0.5	0.5	0.4	0.3	0.3	0.3	0.3	0.3
	TDLF	0.6	0.5	0.4	0.3	0.3	0.3	0.3	0.3
8	NLF	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
	SDLF	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
	TDLF	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.2
9	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table C-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	79	79	227	227
	SDLF	82	82	229	229
	TDLF	85	85	232	232
G2	NLF	72	73	212	212
	SDLF	73	73	212	212
	TDLF	73	73	212	212
G3	NLF	65	65	198	198
	SDLF	65	65	197	197
	TDLF	65	65	197	197
G4	NLF	38	38	120	120
	SDLF	35	35	117	117
	TDLF	31	31	113	113
G5	NLF	32	32	109	109
	SDLF	31	31	107	107
	TDLF	29	29	106	106
G6	NLF	29	29	102	101
	SDLF	28	28	101	101
	TDLF	27	27	100	100
G7	NLF	23	23	85	85
	SDLF	22	22	85	85
	TDLF	22	22	85	85
G8	NLF	18	18	76	76
	SDLF	19	19	76	76
	TDLF	20	20	77	77
G9	NLF	11	11	60	60
	SDLF	13	13	62	62
	TDLF	15	15	64	64

Table C-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	-0.2	NA	-0.3	NA
	SDLF	-0.2	NA	-0.3	NA
	TDLF	-0.2	NA	-0.4	NA
G2	NLF	-0.1	NA	-0.1	NA
	SDLF	-0.1	NA	-0.1	NA
	TDLF	-0.1	NA	-0.1	NA
G3	NLF	0.0	NA	0.0	NA
	SDLF	0.0	NA	0.0	NA
	TDLF	0.0	NA	0.1	NA
G4	NLF	0.0	NA	-0.1	NA
	SDLF	0.0	NA	-0.1	NA
	TDLF	0.0	NA	-0.1	NA
G5	NLF	0.0	NA	-0.1	NA
	SDLF	0.0	NA	0.0	NA
	TDLF	0.0	NA	0.0	NA
G6	NLF	0.0	NA	0.0	NA
	SDLF	0.0	NA	0.0	NA
	TDLF	0.0	NA	0.0	NA
G7	NLF	0.1	NA	0.1	NA
	SDLF	0.1	NA	0.1	NA
	TDLF	0.1	NA	0.1	NA
G8	NLF	0.1	NA	0.2	NA
	SDLF	0.1	NA	0.2	NA
	TDLF	0.1	NA	0.2	NA
G9	NLF	0.2	NA	0.4	NA
	SDLF	0.1	NA	0.3	NA
	TDLF	0.1	NA	0.3	NA

Table C-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G2	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G3	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G4	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G5	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G6	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G7	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G8	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G9	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0

Table C-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.0	0.3	-0.1	0.7
	SDLF	0.0	0.3	-0.1	0.8
	TDLF	0.0	0.3	-0.1	0.8
G2	NLF	0.0	0.3	0.0	0.6
	SDLF	0.0	0.3	0.0	0.7
	TDLF	0.0	0.3	0.0	0.7
G3	NLF	0.0	0.3	0.0	0.6
	SDLF	0.0	0.2	0.0	0.6
	TDLF	0.0	0.2	0.0	0.7
G4	NLF	0.0	0.2	0.0	0.5
	SDLF	0.0	0.2	0.0	0.6
	TDLF	0.0	0.2	0.0	0.6
G5	NLF	0.0	0.2	0.0	0.5
	SDLF	0.0	0.2	0.0	0.5
	TDLF	0.0	0.2	0.0	0.6
G6	NLF	0.0	0.2	0.0	0.4
	SDLF	0.0	0.2	0.0	0.4
	TDLF	0.0	0.1	0.0	0.5
G7	NLF	0.0	0.1	0.0	0.3
	SDLF	0.0	0.1	0.0	0.4
	TDLF	0.0	0.1	0.0	0.4
G8	NLF	0.0	0.1	0.0	0.2
	SDLF	0.0	0.1	0.0	0.3
	TDLF	0.0	0.1	0.0	0.4
G9	NLF	0.0	0.1	0.1	0.2
	SDLF	0.0	0.1	0.1	0.2
	TDLF	0.0	0.1	0.1	0.3

Table C-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G2	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G3	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G4	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G5	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G6	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G7	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G8	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G9	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0

Appendix C-5. NISCR7 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISCR7 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table C-5-1. NISCR7 erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-1	NLF	0.4	-1.3	1.3	0.1	1.2	1.2
		SDLF	-0.7	-1.3	1.4	1.1	1.2	1.6
		TDLF	-2.6	-1.3	2.9	3.0	1.2	3.3
	2-2	NLF	1.3	-0.3	1.4	1.3	0.2	1.3
		SDLF	7.7	9.2	12.0	6.8	-9.3	11.5
		TDLF	16.7	22.3	27.9	14.2	-22.3	26.4
	2-3	NLF	1.6	4.0	4.3	1.7	-4.0	4.3
		SDLF	12.7	20.2	23.9	11.2	-20.1	23.0
		TDLF	28.4	43.0	51.5	24.1	-42.5	48.9
	2-4	NLF	1.1	8.2	8.2	1.1	-8.0	8.1
		SDLF	15.9	30.3	34.3	14.2	-30.1	33.3
		TDLF	36.6	60.9	71.0	31.7	-60.3	68.1
	2-5	NLF	-0.1	7.3	7.3	1.1	-7.2	7.3
		SDLF	16.8	32.3	36.4	16.1	-32.1	35.9
		TDLF	40.2	66.6	77.8	36.3	-66.0	75.3
	2-6	NLF	0.2	-0.6	0.6	0.1	0.6	0.7
		SDLF	17.6	25.7	31.1	15.7	-25.5	30.0
		TDLF	41.8	61.9	74.7	36.9	-61.2	71.5
	2-7	NLF	0.0	-4.2	4.2	0.0	4.2	4.2
		SDLF	14.6	18.5	23.6	13.0	-18.4	22.6
		TDLF	33.0	45.9	56.5	28.7	-45.6	53.9
	2-8	NLF	0.3	-1.6	1.6	0.3	1.6	1.6
		SDLF	8.0	10.3	13.0	7.1	-10.3	12.5
		TDLF	17.8	24.9	30.6	15.4	-24.8	29.2

Table C-5-1(Continued). NISCR7 erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-1	NLF	0.6	-0.7	0.9	0.5	0.8	1.0
		SDLF	-0.2	-0.7	0.7	0.7	0.7	1.0
		TDLF	-1.7	-0.7	1.8	1.4	0.7	1.6
	6-2	NLF	10.6	-7.6	13.0	10.2	7.4	12.6
		SDLF	16.1	-1.3	16.1	15.7	1.1	15.7
		TDLF	23.4	7.3	24.5	22.8	-7.3	23.9
	6-3	NLF	10.5	-7.8	13.1	10.1	7.5	12.6
		SDLF	19.6	3.5	19.9	19.6	-3.7	19.9
		TDLF	32.1	18.7	37.2	31.6	-18.7	36.7
	6-4	NLF	9.1	-6.5	11.2	8.7	6.3	10.7
		SDLF	20.5	8.3	22.2	20.7	-8.4	22.3
		TDLF	36.0	27.8	45.5	35.3	-27.7	44.9
	6-5	NLF	5.2	-6.2	8.1	5.0	6.2	7.9
		SDLF	17.9	10.9	21.0	18.3	-10.8	21.2
		TDLF	35.2	33.2	48.4	34.7	-33.0	47.8
	6-6	NLF	1.4	-8.1	8.2	1.2	8.2	8.3
		SDLF	13.8	10.1	17.1	14.2	-10.0	17.3
		TDLF	30.0	33.3	44.8	29.6	-33.0	44.3
	6-7	NLF	-0.2	-6.9	6.9	-0.3	7.1	7.1
		SDLF	9.6	8.0	12.5	9.9	-7.9	12.7
		TDLF	21.9	27.1	34.9	21.8	-26.9	34.6
	6-8	NLF	-0.1	-2.7	2.7	-0.1	2.8	2.8
		SDLF	5.3	5.2	7.5	5.4	-5.1	7.4
		TDLF	11.4	15.8	19.5	11.3	-15.7	19.3

Table C-5-1(Continued). NISCR7 erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-1	NLF	0.0	-0.4	0.4	-0.1	0.4	0.5
		SDLF	-0.2	-0.4	0.5	0.1	0.4	0.4
		TDLF	-1.1	-0.5	1.2	0.8	0.4	0.9
	9-2	NLF	0.1	-1.0	1.0	0.1	0.9	0.9
		SDLF	3.5	2.8	4.5	3.8	-2.8	4.7
		TDLF	9.5	8.1	12.4	9.7	-8.0	12.6
	9-3	NLF	0.2	0.0	0.2	0.2	0.0	0.2
		SDLF	5.8	7.2	9.2	6.8	-7.1	9.9
		TDLF	15.3	17.3	23.1	16.8	-17.2	24.0
	9-4	NLF	-0.5	1.4	1.5	-0.4	-1.4	1.5
		SDLF	7.1	10.7	12.8	8.4	-10.7	13.6
		TDLF	19.7	23.8	30.9	21.2	-23.7	31.8
	9-5	NLF	-2.4	0.7	2.5	-2.3	-0.6	2.4
		SDLF	6.1	11.3	12.8	7.5	-11.2	13.5
		TDLF	19.9	26.4	33.1	21.6	-26.3	34.0
	9-6	NLF	-4.1	-2.3	4.7	-4.0	2.6	4.8
		SDLF	4.1	9.1	10.0	5.5	-8.9	10.5
		TDLF	17.5	25.4	30.8	19.1	-25.3	31.7
	9-7	NLF	-3.7	-3.7	5.3	-3.6	3.8	5.3
		SDLF	2.5	6.0	6.5	3.6	-5.9	6.9
		TDLF	12.3	20.3	23.8	13.9	-20.2	24.5
	9-8	NLF	-1.7	-1.4	2.2	-1.7	1.4	2.2
		SDLF	1.7	3.7	4.1	2.2	-3.6	4.3
		TDLF	6.8	11.3	13.2	7.6	-11.3	13.6

Table C-5-2: NISCR7 erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
2	NLF	2-4
	SDLF	2-5
	TDLF	2-5
6	NLF	6-3
	SDLF	6-4
	TDLF	6-5
9	NLF	9-7
	SDLF	9-4
	TDLF	9-5

Table C-5-3. NISCR7 erection critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	-2.4	2.2	3.2	NA	NA	NA
		SDLF	8.1	5.5	9.8	NA	NA	NA
		TDLF	23.3	10.6	25.6	NA	NA	NA
	B	NLF	1.1	8.2	8.2	1.1	-8	8.1
		SDLF	16.8	32.3	36.4	16.1	-32.1	35.9
		TDLF	40.2	66.6	77.8	36.3	-66	75.3
6	A	NLF	21.3	-1.4	21.3	NA	NA	NA
		SDLF	28.3	-0.1	28.3	NA	NA	NA
		TDLF	37.4	2.5	37.5	NA	NA	NA
	B	NLF	10.5	-7.8	13.1	10.1	7.5	12.6
		SDLF	20.5	8.3	22.2	20.7	-8.4	22.3
		TDLF	35.2	33.2	48.4	34.7	-33	47.8
9	A	NLF	-6.2	-1.2	6.3	NA	NA	NA
		SDLF	6.8	1.0	6.9	NA	NA	NA
		TDLF	18.7	2.7	18.9	NA	NA	NA
	B	NLF	-3.7	-3.7	5.3	-3.6	3.8	5.3
		SDLF	7.1	10.7	12.8	8.4	-10.7	13.6
		TDLF	19.9	26.4	33.1	21.6	-26.3	34

Table C-5-4. NISCR7 erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	19.4	73.0	17.0		
			SDLF	22.2	76.9	19.2		
			TDLF	27.5	77.7	24.3		
		G2	NLF	1.1	50.3	100.6	50.3	0.0
			SDLF	3.6	44.0	87.9	43.9	2.9
			TDLF	4.8	37.1	74.3	37.1	4.3
	B	G1	NLF	19.6	74.3	16.9		
			SDLF	21.8	81.0	18.9		
			TDLF	26.7	84.6	23.5		
		G2	NLF	1.7	49.4	98.7	49.3	0.7
			SDLF	6.4	40.0	79.9	39.9	5.6
			TDLF	9.8	29.8	59.6	29.8	9.4

Table C-5-4(Continued). NISCR7 erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	A	G1	NLF	92.4	97.0			
			SDLF	91.4	96.2			
			TDLF	92.4	94.7			
		G2	NLF	74.9	76.0			
			SDLF	74.9	75.9			
			TDLF	74.9	75.4			
		G3	NLF	58.0	53.4			
			SDLF	59.3	55.2			
			TDLF	60.5	58.7			
		G4	NLF	27.4	19.2			
			SDLF	27.3	19.9			
			TDLF	23.3	20.3			
		G5	NLF	0.0	0.6			
			SDLF	7.5	4.5			
			TDLF	14.3	10.0			
		G6	NLF	0.0	18.4	36.8	18.4	4.4
			SDLF	0.0	11.8	23.6	11.8	6.2
			TDLF	4.1	3.6	7.1	3.6	7.8

Table C-5-4(Continued). NISCR7 erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	B	G1	NLF	91.7	96.9			
			SDLF	91.4	96.1			
			TDLF	92.6	95.1			
		G2	NLF	74.8	76.1			
			SDLF	75.0	75.9			
			TDLF	74.9	75.5			
		G3	NLF	58.6	53.7			
			SDLF	59.3	55.3			
			TDLF	60.4	58.5			
		G4	NLF	28.8	19.5			
			SDLF	26.9	20.1			
			TDLF	23.3	20.1			
		G5	NLF	0.0	0.8			
			SDLF	8.5	4.7			
			TDLF	14.8	10.2			
		G6	NLF	0.0	17.7	35.4	17.7	4.6
			SDLF	0.0	11.6	23.1	11.6	6.2
			TDLF	4.8	2.7	5.4	2.7	8.9

Table C-5-4(Continued). NISCR7 erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	A	G1	NLF	82.1	82.2			
			SDLF	83.4	83.5			
			TDLF	85.5	85.5			
		G2	NLF	73.7	73.9			
			SDLF	73.6	73.7			
			TDLF	73.3	73.2			
		G3	NLF	64.9	65.0			
			SDLF	64.4	64.5			
			TDLF	64.8	64.7			
		G4	NLF	36.3	36.4			
			SDLF	34.3	34.3			
			TDLF	31.0	30.8			
		G5	NLF	29.9	29.8			
			SDLF	29.3	29.1			
			TDLF	28.7	28.5			
		G6	NLF	24.6	24.2			
			SDLF	25.1	24.7			
			TDLF	25.8	25.8			
		G7	NLF	17.1	16.5			
			SDLF	18.4	18.0			
			TDLF	19.5	20.0			
		G8	NLF	3.6	2.1			
			SDLF	12.5	12.3			
			TDLF	14.7	15.9			
		G9	NLF	0.0	34.8	69.6	34.8	0.0
			SDLF	4.1	19.7	39.4	19.7	2.5
			TDLF	8.0	14.3	28.7	14.4	4.3

Table C-5-4(Continued). NISCR7 erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	B	G1	NLF	82.2	82.2			
			SDLF	83.6	83.6			
			TDLF	85.8	85.7			
		G2	NLF	73.8	73.9			
			SDLF	73.7	73.8			
			TDLF	73.4	73.4			
		G3	NLF	64.9	65.0			
			SDLF	64.5	64.5			
			TDLF	64.8	64.7			
		G4	NLF	36.3	36.3			
			SDLF	34.3	34.2			
			TDLF	30.9	30.7			
		G5	NLF	29.9	29.9			
			SDLF	29.1	28.9			
			TDLF	28.5	28.3			
		G6	NLF	24.6	24.5			
			SDLF	24.9	24.5			
			TDLF	25.6	25.4			
		G7	NLF	17.1	17.4			
			SDLF	18.1	17.8			
			TDLF	19.5	19.6			
		G8	NLF	2.1	0.0			
			SDLF	12.5	12.3			
			TDLF	15.1	16.0			
		G9	NLF	0.0	36.5	73.0	36.5	0.0
			SDLF	4.4	20.3	40.6	20.3	2.6
			TDLF	8.5	14.1	28.2	14.1	5.5

Appendix D-1. NISCR10 Bridge Description

The key characteristics of NISCR10 are as follows:

- Span length along the centerline of the bridge, L_s = 225 ft.
- Width between the fascia girders, w_g = 74 ft.
- Radius of curvature to the centerline of the bridge, R =705 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 3.0
- Subtended angle between the supports, L_s/R = 0.32
- Number of girders in the completed bridge cross-section, n_g =9.

This appendix presents the bridge description of the bridge NISCR10 in its final condition as well as during erection. The following figures and tables are provided:

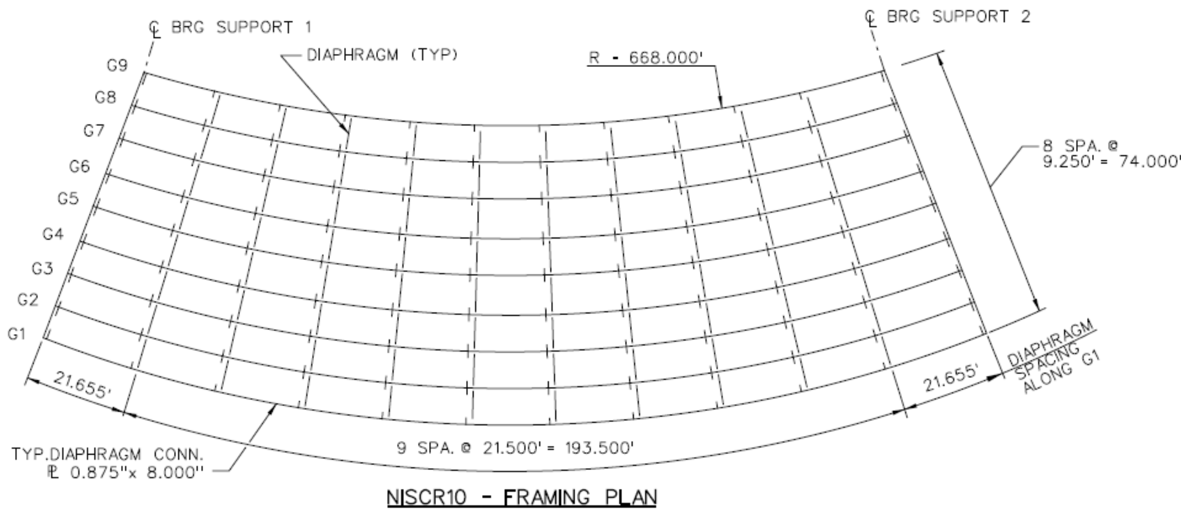


Figure D-1-1. Framing plan.

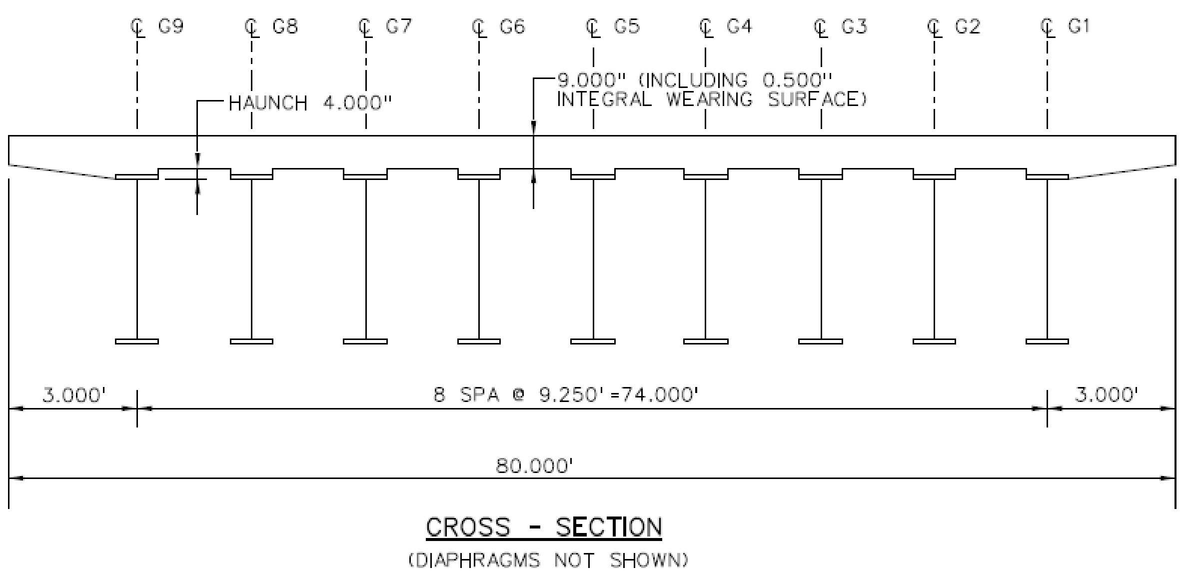


Figure D-1-2. Bridge cross-section.

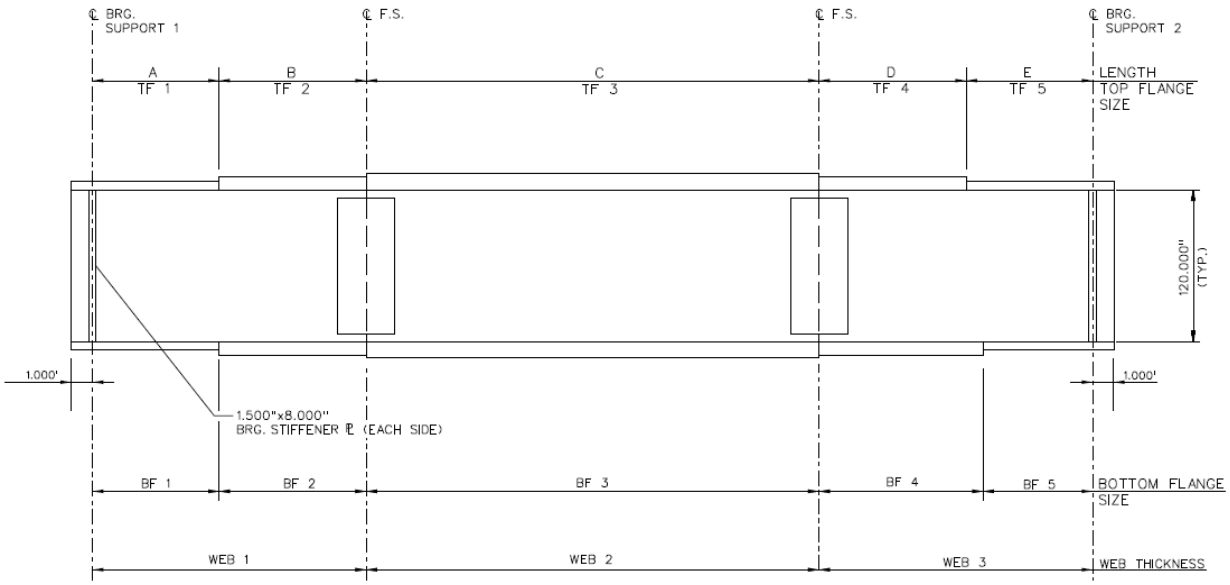


Figure D-1-3. Girder elevations

	GIRDER PLATE LENGTHS ⁎								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	28.405	27.739	27.073	26.408	25.742	25.076	24.410	23.745	23.079
B	25.000	25.000	25.000	25.000	25.000	25.000	25.000	25.000	25.000
C	130.000	128.379	126.759	125.138	123.518	121.897	120.276	118.656	117.035
D	25.000	25.000	25.000	25.000	25.000	25.000	25.000	25.000	25.000
E	28.405	27.739	27.073	26.408	25.742	25.076	24.410	23.745	23.079

⁎ ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS ⁎⁎					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	24.000	1.000	20.000	1.000	20.000	1.000
TF2	24.000	1.750	20.000	1.000	20.000	1.000
TF3	24.000	3.000	20.000	1.000	20.000	1.000
TF4	24.000	1.750	20.000	1.000	20.000	1.000
TF5	24.000	1.000	20.000	1.000	20.000	1.000

⁎⁎ ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS ⁎⁎					
BOTTOM FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
BF1	30.000	1.250	20.000	1.000	20.000	1.000
BF2	30.000	2.250	20.000	1.000	20.000	1.000
BF3	30.000	3.250	20.000	1.500	20.000	1.500
BF4	30.000	2.250	20.000	1.000	20.000	1.000
BF5	30.000	1.250	20.000	1.000	20.000	1.000

⁎⁎ ALL DIMENSIONS ARE IN INCHES.

Figure D-1-4. Cross-section dimensions.

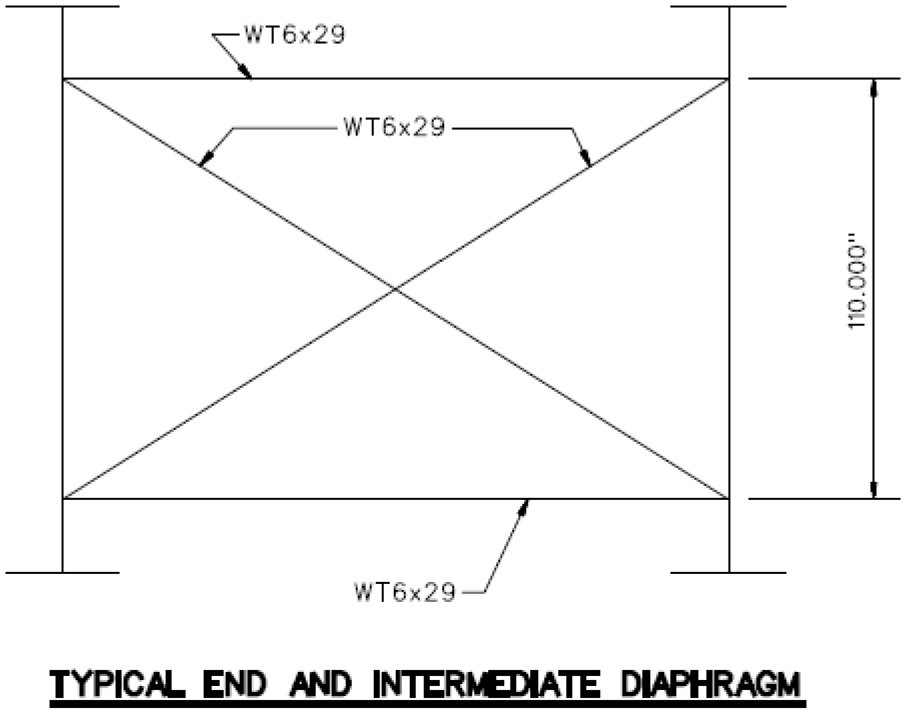


Figure D-1-4. Cross-frame details

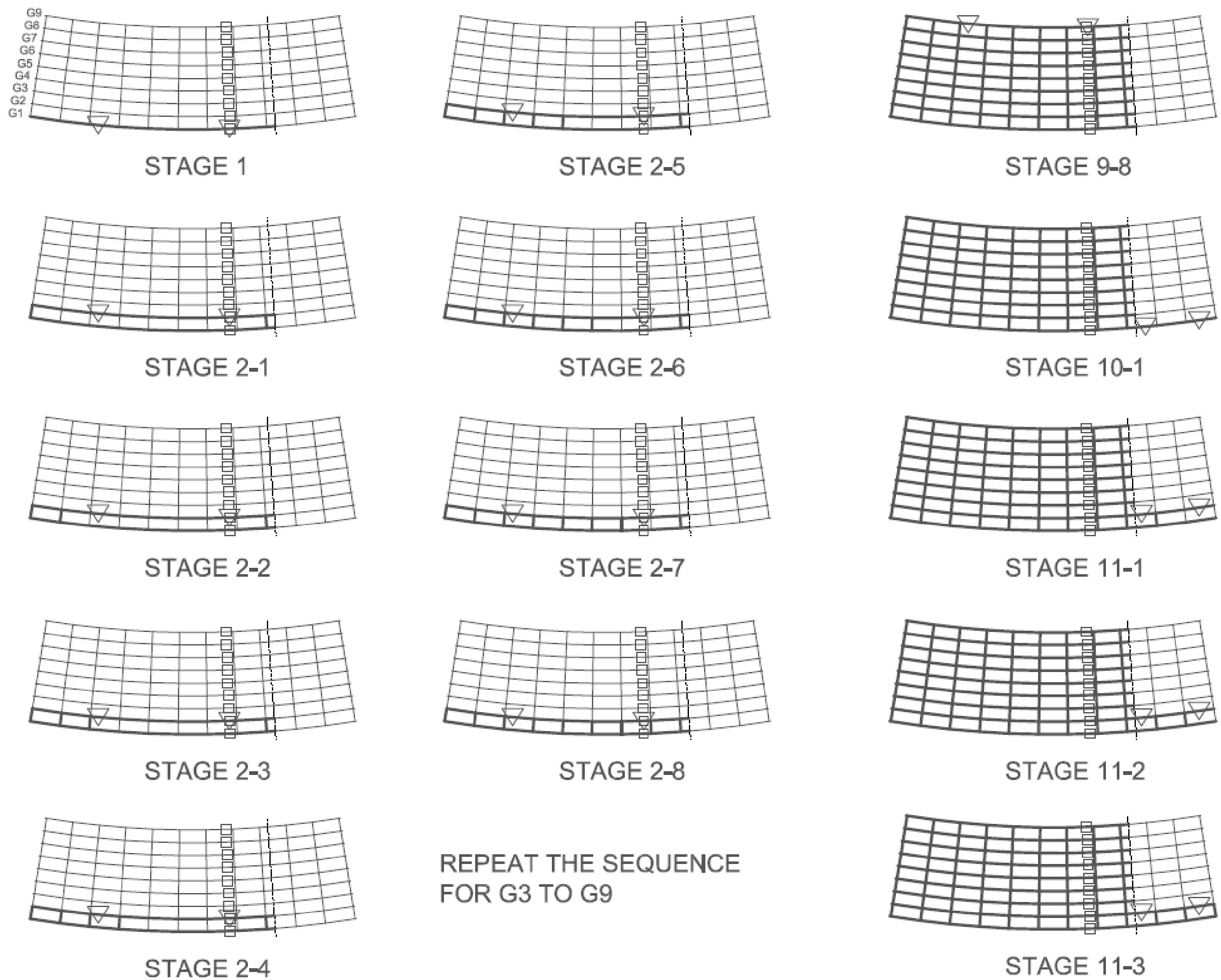


Figure D-1-6. Erection scheme.

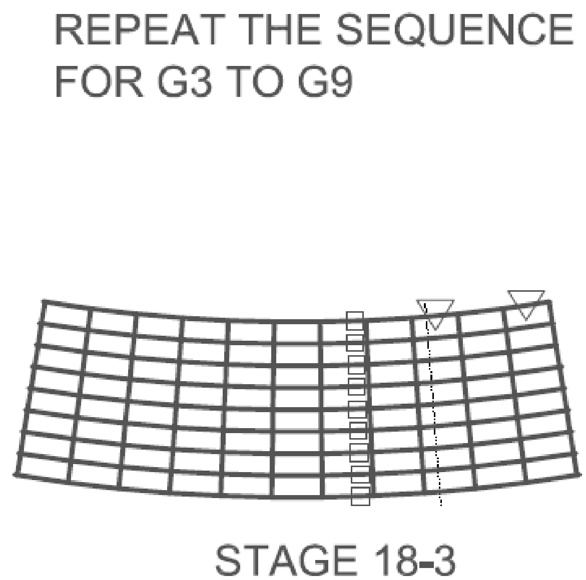


Figure D-1-6(Continued). Erection scheme.

Table D-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

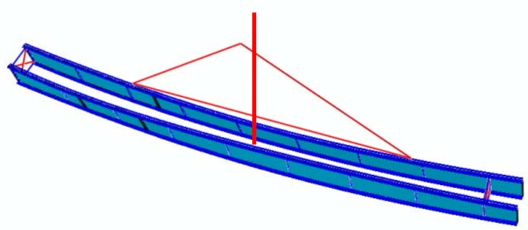
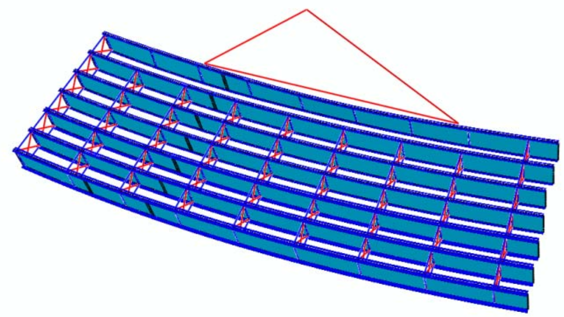
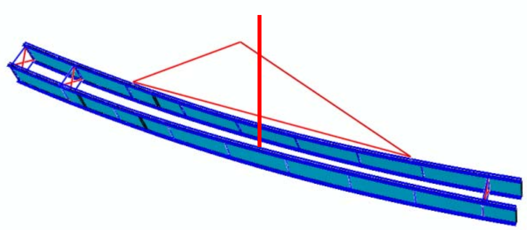
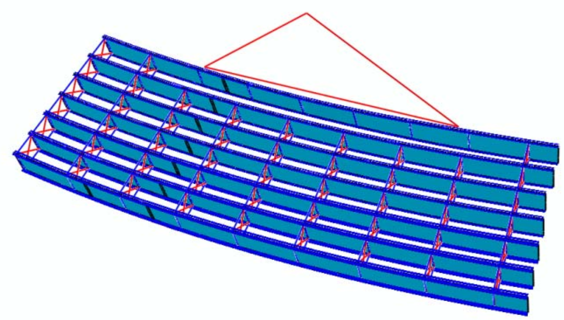
Sub-Stage	Stage	
	2	7
1		
2		

Table D-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

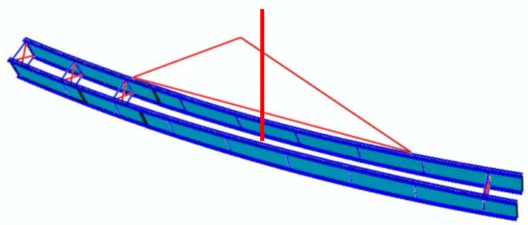
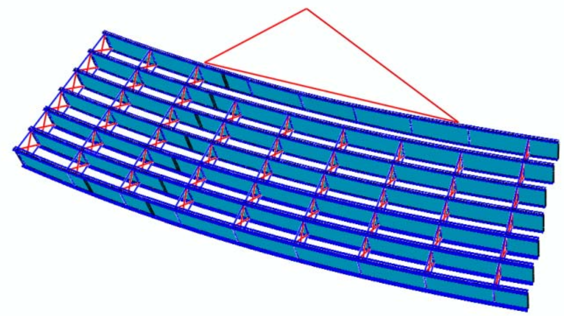
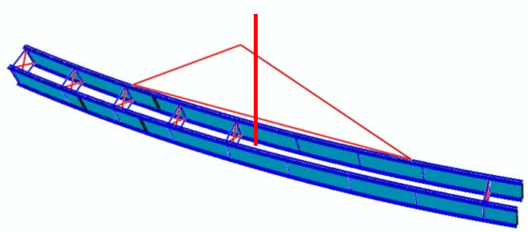
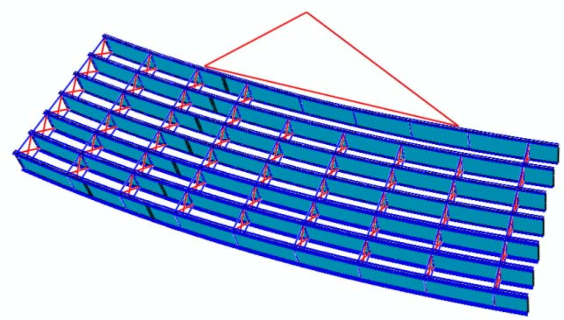
3		
4		

Table D-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

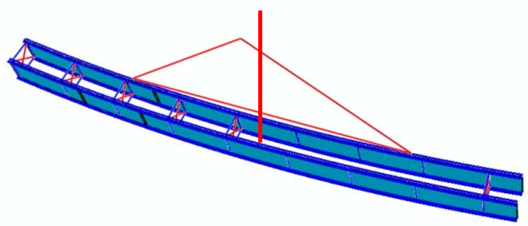
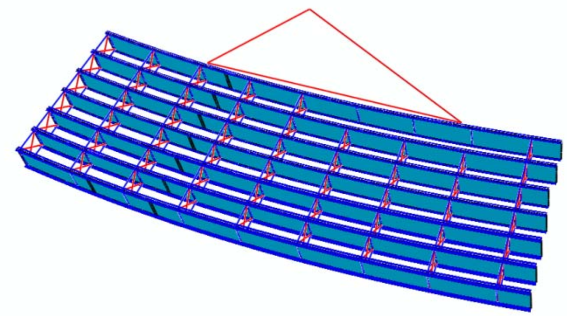
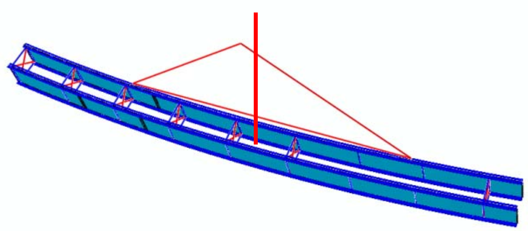
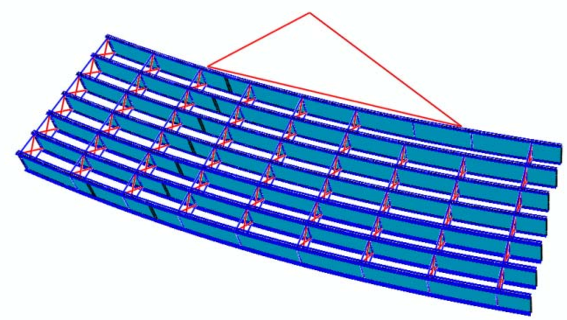
5		
6		

Table D-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

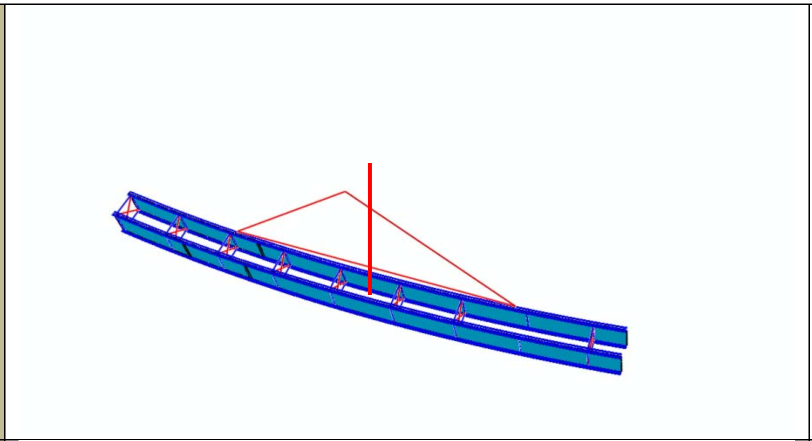
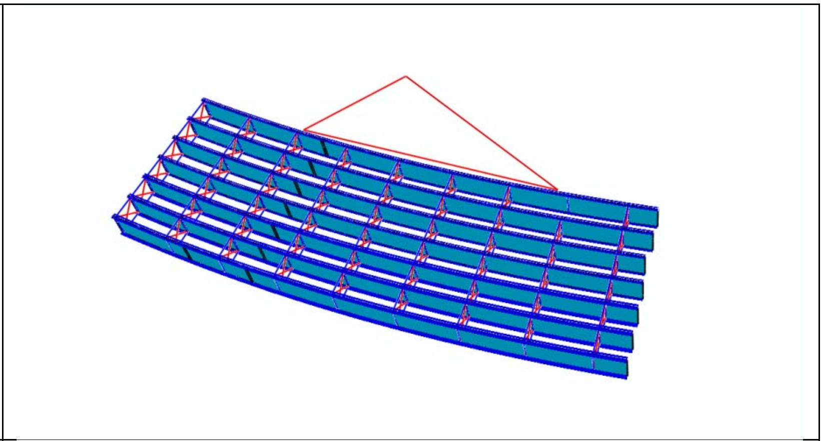
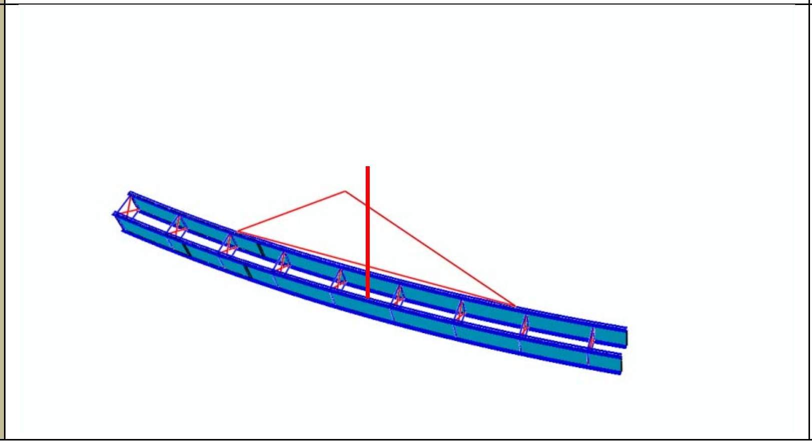
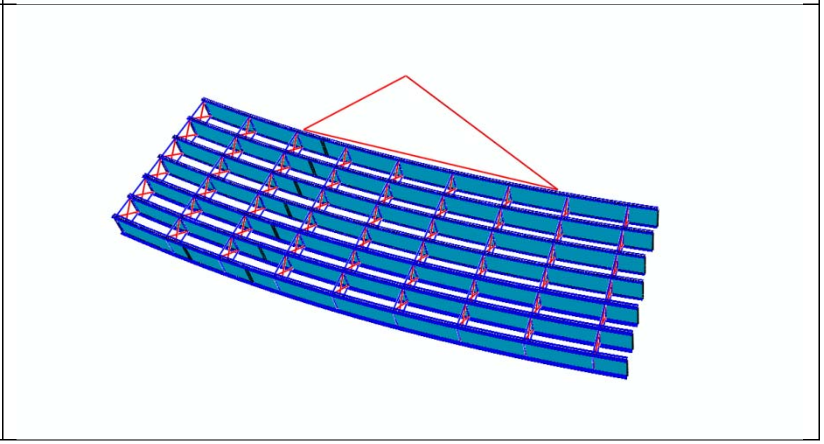
7		
8		

Table D-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

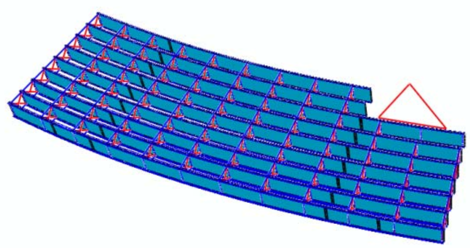
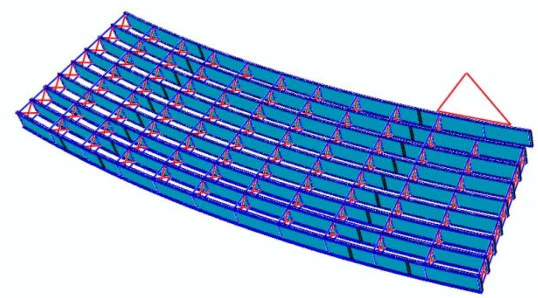
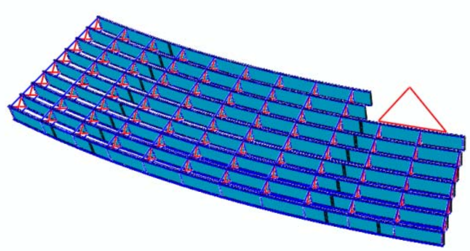
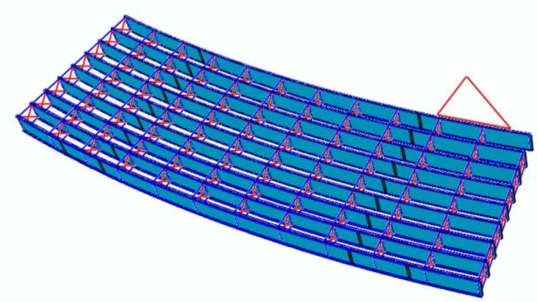
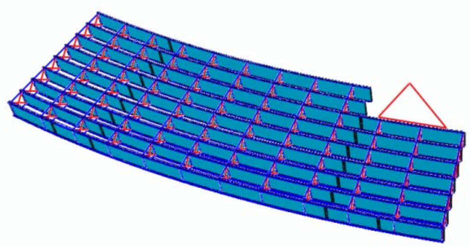
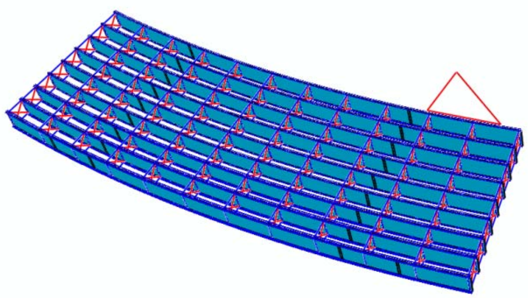
Sub-Stage	Stage	
	16	18
1		
2		

Table D-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

3		

Appendix D-2. NISCR10 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISCR10 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table D-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	5.2	11.7
	SDLF	4.9	11.4
	TDLF	4.8	11.3
G2	NLF	4.7	10.9
	SDLF	4.4	10.6
	TDLF	4.2	10.3
G3	NLF	4.2	10.3
	SDLF	3.9	9.9
	TDLF	3.6	9.6
G4	NLF	3.9	9.7
	SDLF	3.5	9.3
	TDLF	3.3	9.1
G5	NLF	3.5	9.1
	SDLF	3.2	8.8
	TDLF	3.0	8.6
G6	NLF	3.2	8.6
	SDLF	2.8	8.3
	TDLF	2.7	8.1
G7	NLF	2.8	8.0
	SDLF	2.5	7.8
	TDLF	2.4	7.6
G8	NLF	2.4	7.4
	SDLF	2.2	7.2
	TDLF	2.0	7.0
G9	NLF	2.1	6.8
	SDLF	1.9	6.6
	TDLF	1.7	6.4
All Girders	NLF	5.2	11.7
	SDLF	4.9	11.4
	TDLF	4.8	11.3

Table D-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.57	0.98
	SDLF	0.17	0.56
	TDLF	0.09	0.32
G2	NLF	0.54	0.91
	SDLF	0.13	0.48
	TDLF	0.13	0.24
G3	NLF	0.49	0.81
	SDLF	0.08	0.38
	TDLF	0.17	0.14
G4	NLF	0.46	0.75
	SDLF	0.06	0.34
	TDLF	0.21	0.10
G5	NLF	0.43	0.72
	SDLF	0.03	0.30
	TDLF	0.23	0.07
G6	NLF	0.42	0.72
	SDLF	0.02	0.30
	TDLF	0.24	0.07
G7	NLF	0.42	0.73
	SDLF	0.02	0.32
	TDLF	0.24	0.08
G8	NLF	0.42	0.75
	SDLF	0.02	0.34
	TDLF	0.24	0.10
G9	NLF	0.42	0.77
	SDLF	0.02	0.35
	TDLF	0.23	0.11
All Girders	NLF	0.57	0.98
	SDLF	0.17	0.56
	TDLF	0.24	0.32

Table D-2-3. Summary of girder maximum stresses (ksi).

Girder	Detailing Method	fb Bottom Flange SDL	fb Bottom Flange TDL	fb Top Flange SDL	fb Top Flange TDL	fl Bottom Flange SDL	fl Bottom Flange TDL	fl Top Flange SDL	fl Top Flange TDL
G1	NLF	8.3	19.5	11.2	26.1	1.3	3.7	2.0	4.9
	SDLF	8.4	19.5	11.2	26.2	1.1	3.0	2.0	4.9
	TDLF	8.6	19.4	11.2	26.1	1.2	2.7	2.0	4.9
G2	NLF	10.9	26.2	13.8	33.3	1.3	3.6	2.5	6.4
	SDLF	11.0	26.3	13.9	33.3	1.3	3.3	2.5	6.5
	TDLF	11.1	26.3	14.0	33.4	1.3	3.1	2.5	6.5
G3	NLF	10.1	25.2	12.8	32.0	1.2	3.5	2.1	5.6
	SDLF	10.1	25.2	12.8	31.9	1.1	2.8	2.2	5.7
	TDLF	10.2	25.2	12.8	31.9	1.3	2.8	2.4	5.9
G4	NLF	7.2	18.7	7.9	20.5	1.8	5.1	2.2	6.1
	SDLF	7.1	18.6	7.7	20.3	1.7	4.5	2.4	6.6
	TDLF	7.0	18.4	7.6	20.2	1.8	4.3	2.5	6.8
G5	NLF	6.5	17.5	7.4	20.2	1.7	5.0	2.0	5.9
	SDLF	6.4	17.3	7.4	20.2	1.6	4.4	2.3	6.5
	TDLF	6.5	17.3	7.5	20.3	1.5	4.2	2.5	6.7
G6	NLF	6.0	16.9	7.0	19.8	1.6	4.9	1.8	5.6
	SDLF	6.1	17.0	7.0	20.0	1.5	4.3	2.1	6.2
	TDLF	6.2	17.2	7.3	20.2	1.4	4.1	2.3	6.6
G7	NLF	5.5	16.3	6.4	19.2	1.5	4.8	1.6	5.2
	SDLF	5.6	16.5	6.5	19.3	1.3	4.2	1.9	5.9
	TDLF	5.7	16.6	6.6	19.6	1.3	3.9	2.1	6.2
G8	NLF	4.9	15.6	5.7	18.2	1.3	4.6	1.3	4.8
	SDLF	5.0	15.7	5.8	18.4	1.2	4.0	1.7	5.4
	TDLF	5.0	15.8	5.8	18.5	1.1	3.7	1.8	5.7
G9	NLF	4.2	14.5	4.9	17.1	1.2	4.1	1.2	4.3
	SDLF	4.3	14.7	4.9	17.3	1.0	3.5	1.4	4.6
	TDLF	4.2	14.7	4.8	17.2	0.9	3.2	1.5	4.9
All Girders	NLF	10.9	26.2	13.8	33.3	1.8	5.1	2.5	6.4
	SDLF	11.0	26.3	13.9	33.3	1.7	4.5	2.5	6.6
	TDLF	11.1	26.3	14.0	33.4	1.8	4.3	2.5	6.8

Table D-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	21.9	41.4	41.8	41.8
	SDLF	29.5	40.9	40.3	40.9
	TDLF	34.3	40.4	38.0	40.4
TDL	NLF	62.4	94.4	95.3	95.3
	SDLF	69.1	92.5	92.4	92.5
	TDLF	73.6	91.3	89.4	91.3

Table D-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	7.5	11.0	11.0	9.2
	SDLF	11.2	10.2	10.1	10.7
	TDLF	14.7	10.9	10.3	12.6
TDL	NLF	19.4	23.2	23.1	21.3
	SDLF	22.7	22.2	21.9	22.4
	TDLF	24.9	21.4	21.0	23.1

Table D-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.47	0.43	0.38	0.36	0.35	0.35	0.35	0.36	0.47
SDLF	0.55	0.47	0.39	0.34	0.32	0.32	0.33	0.34	0.55
TDLF	0.64	0.50	0.36	0.30	0.29	0.31	0.34	0.37	0.64

Table D-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.78	0.69	0.58	0.54	0.54	0.56	0.59	0.62	0.78
SDLF	0.85	0.72	0.57	0.51	0.50	0.52	0.56	0.59	0.85
TDLF	0.93	0.74	0.54	0.46	0.47	0.51	0.57	0.62	0.93

Table D-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.46	0.42	0.38	0.35	0.35	0.35	0.35	0.36	0.46
SDLF	0.55	0.47	0.38	0.33	0.32	0.31	0.32	0.34	0.55
TDLF	0.63	0.50	0.35	0.30	0.29	0.31	0.34	0.37	0.63

Table D-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.78	0.68	0.58	0.54	0.54	0.56	0.59	0.62	0.78
SDLF	0.84	0.71	0.57	0.50	0.50	0.52	0.55	0.58	0.84
TDLF	0.92	0.73	0.53	0.46	0.46	0.51	0.56	0.61	0.92

Table D-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	1417	3755
SDLF	1417	3754
TDLF	1417	3755

Table D-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	156	372	0.3	0.5	0.0	0.1
SDLF	157	372	0.3	0.4	0.0	0.0
TDLF	156	371	0.3	0.4	0.0	0.0

Table D-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.61	1.19	0.01	0.01
SDLF	0.60	1.26	0.00	0.01
TDLF	0.66	1.46	0.01	0.01

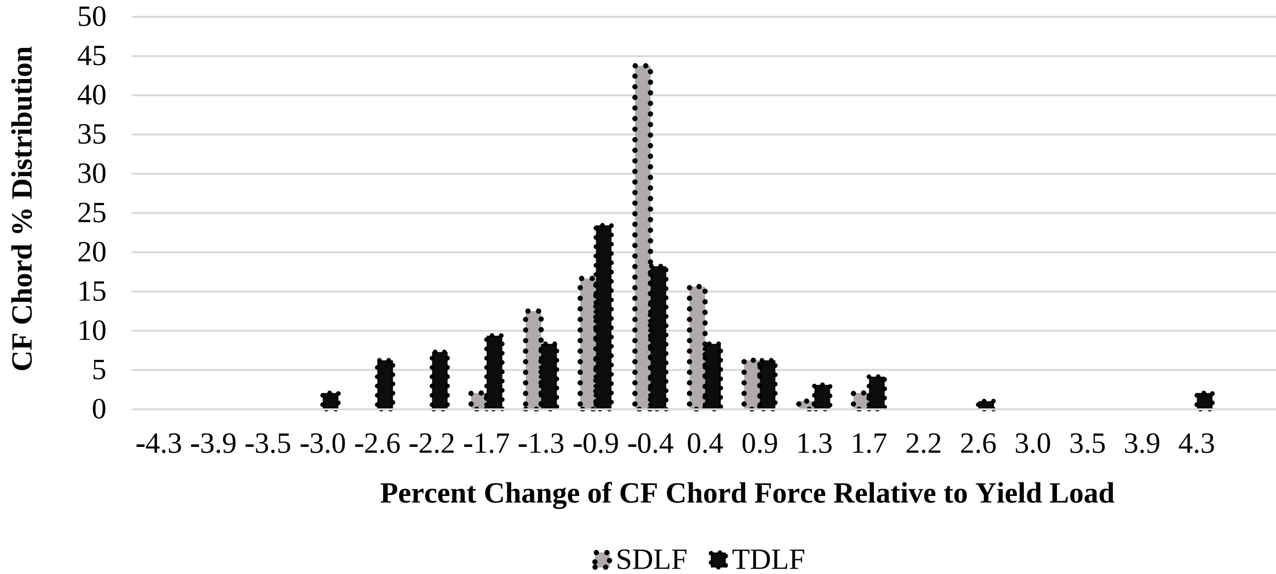


Figure D-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

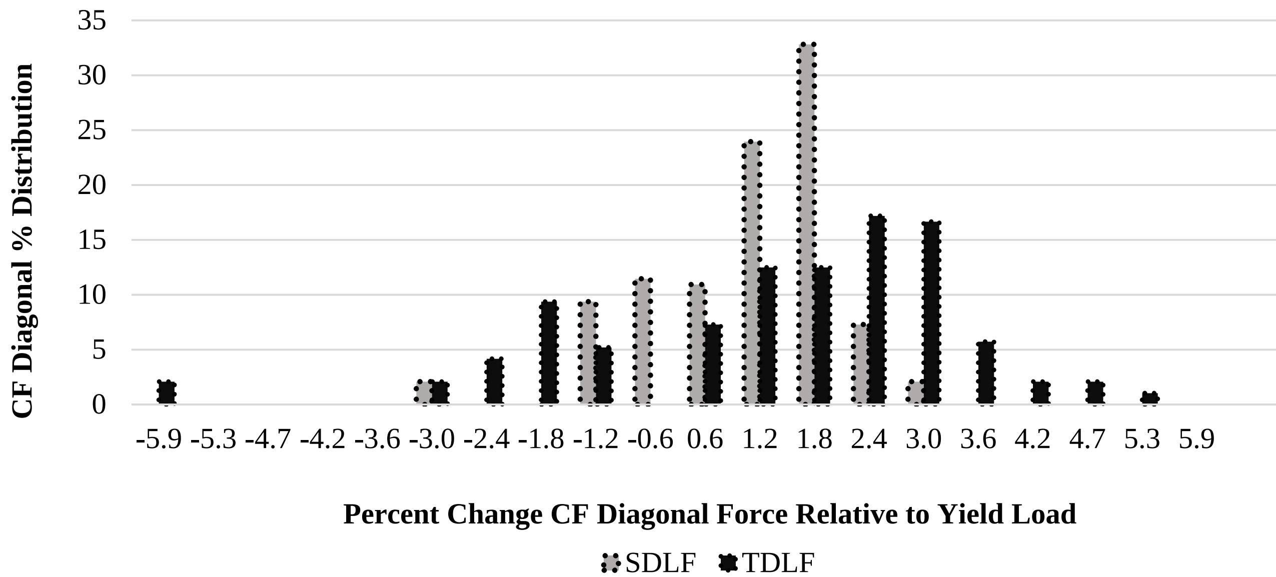


Figure D-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

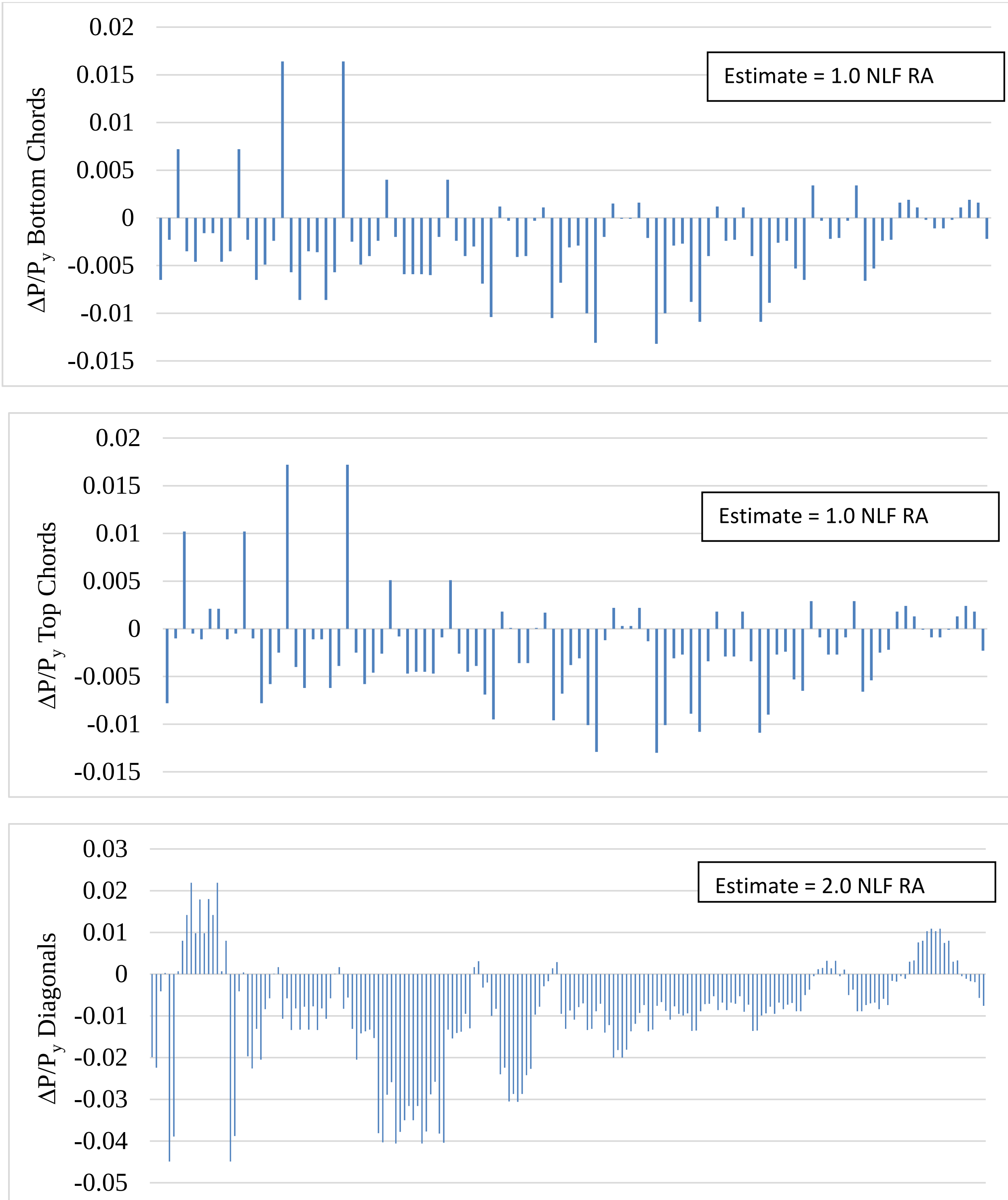


Figure D-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

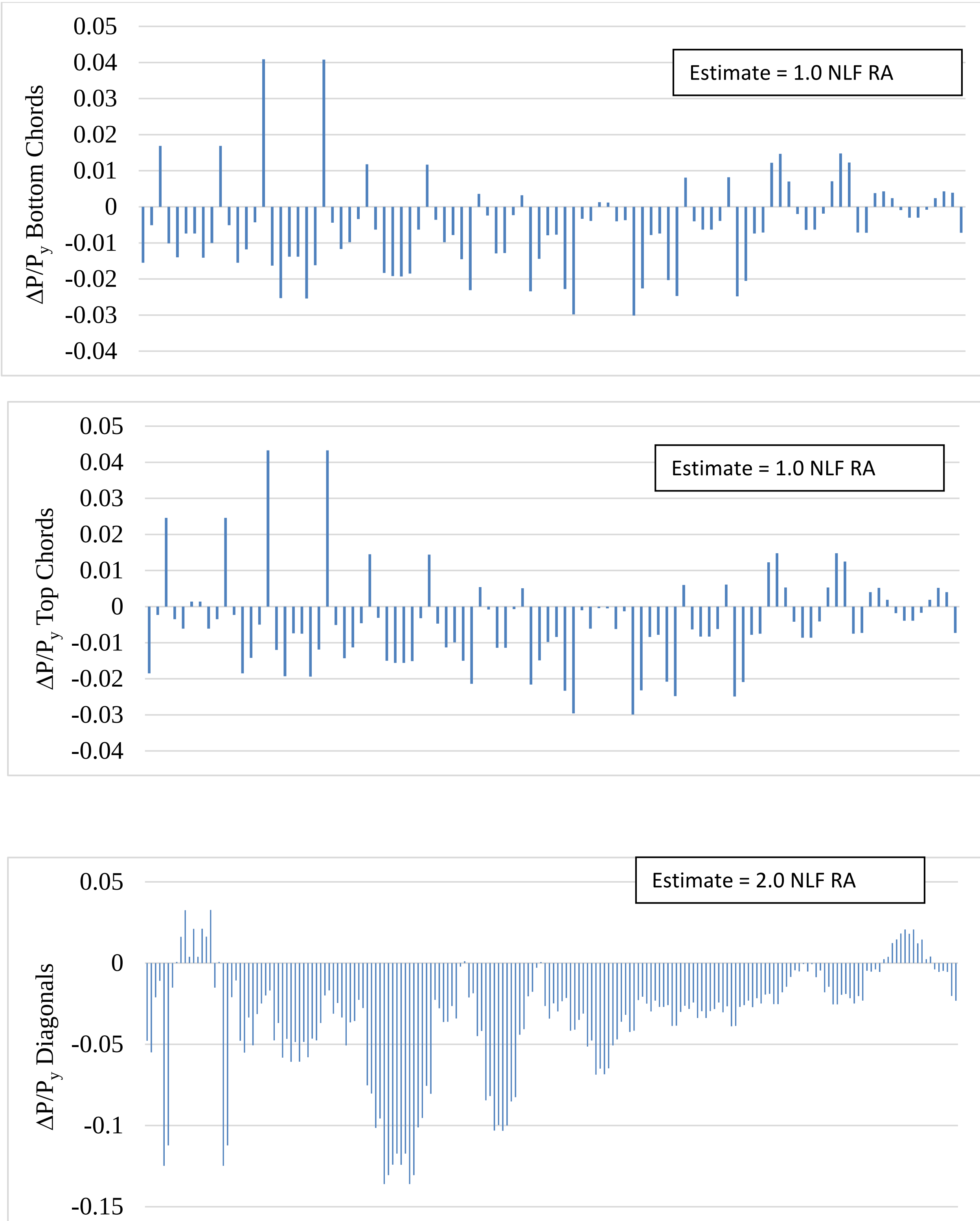


Figure D-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix D-3. NISCR10 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISCR10 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table D-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	18.6	10.7	18.6
SDLF	20.4	14.9	20.4
TDLF	21.8	21.8	21.8

Table D-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	139.6	9.2
	SDLF	207.6	22.7
	TDLF	290.5	30.8
G2	NLF	152.8	3.8
	SDLF	107.4	12.7
	TDLF	66.3	13.1
G3	NLF	154.1	13
	SDLF	81.4	20.9
	TDLF	60.9	0
G4	NLF	89.3	12.2
	SDLF	65.8	13.8
	TDLF	51.8	12.8
G5	NLF	88	12.1
	SDLF	78	14
	TDLF	89.7	13.5
G6	NLF	86.1	11.5
	SDLF	85.5	11.6
	TDLF	108.4	10.8
G7	NLF	84.7	0
	SDLF	89.5	0
	TDLF	113.5	0
G8	NLF	83.1	12.6
	SDLF	85.9	18.8
	TDLF	95.7	23.4
G9	NLF	83.1	8.6
	SDLF	71.4	6.6
	TDLF	37.9	6.6
All Girders	NLF	154.1	0
	SDLF	207.6	0
	TDLF	290.5	0

Table D-3-3. Summary of crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	131.2	0	79	77.4
SDLF	108.4	5.5	69	66.1
TDLF	109.8	9.8	62.2	58.4

Table D-3-4. Erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage							
		1	2	3	4	5	6	7	8
2	NLF	317	319	320	323	323	324	325	326
	SDLF	317	319	320	323	323	324	325	326
	TDLF	317	319	320	323	323	324	325	326
7	NLF	908	909	910	911	913	914	915	917
	SDLF	908	909	910	911	913	914	915	917
	TDLF	908	909	910	911	913	914	915	917
16	NLF	1153	1155	1157					
	SDLF	1153	1155	1157					
	TDLF	1153	1155	1157					
18	NLF	1414	1416	1417					
	SDLF	1414	1416	1417					
	TDLF	1414	1416	1417					

Appendix D-4. NISCR10 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge NISCR10 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

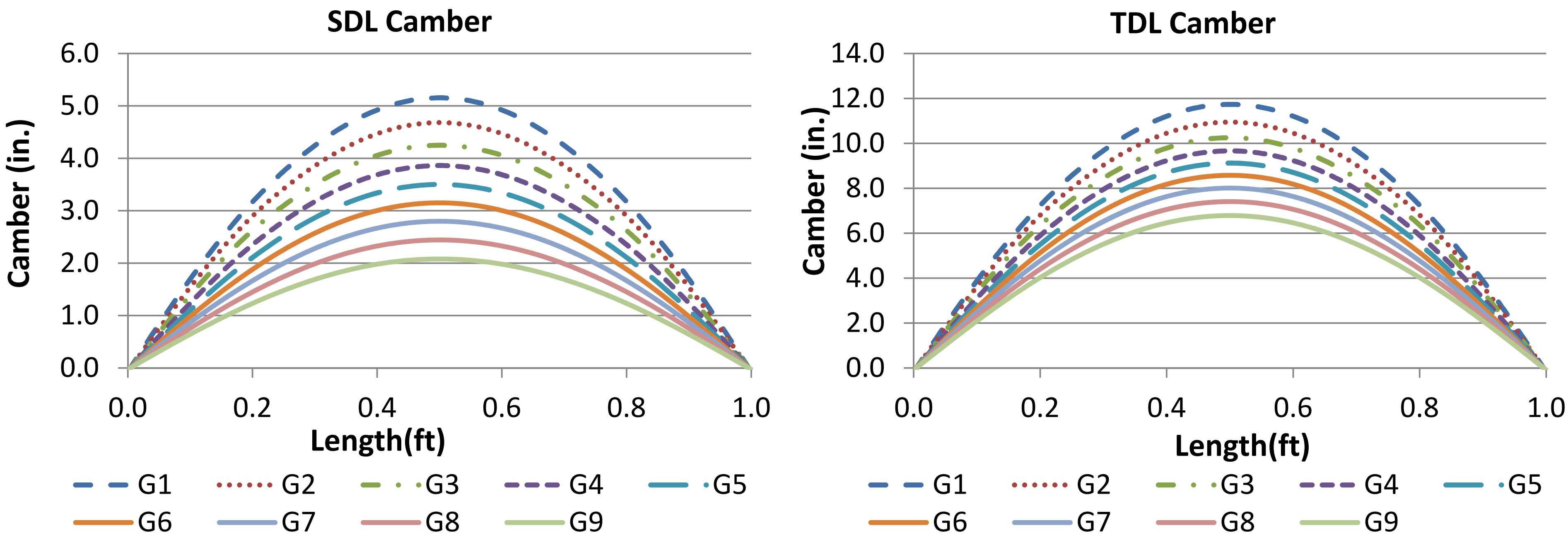


Figure D-4-1. SDL and TDL 3D FEA cambers.

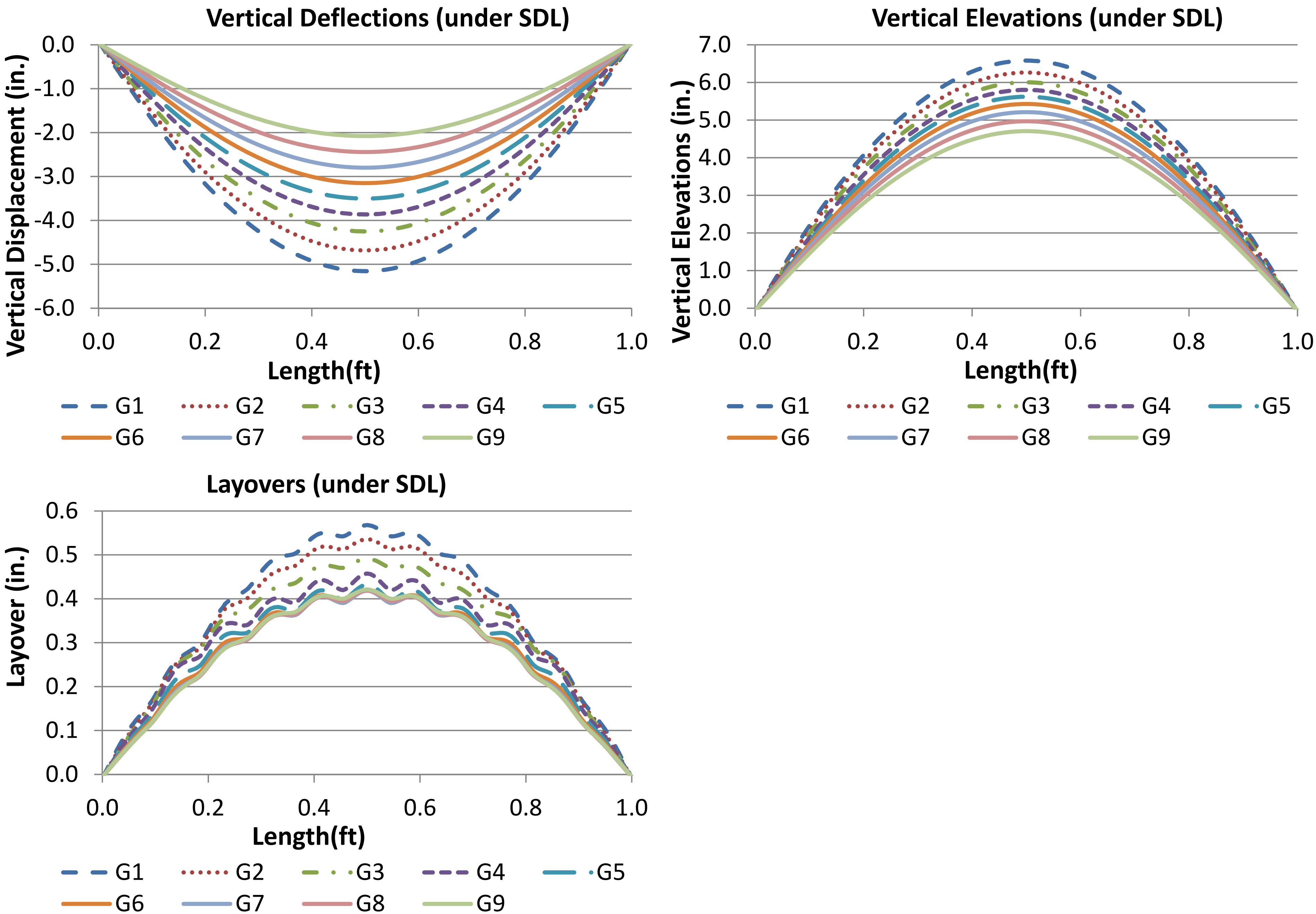
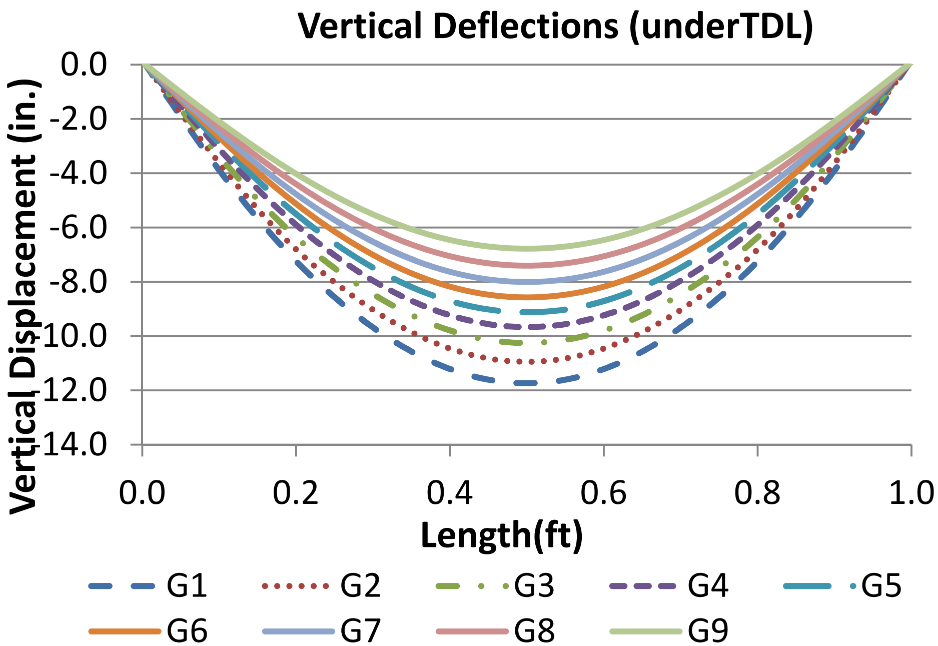
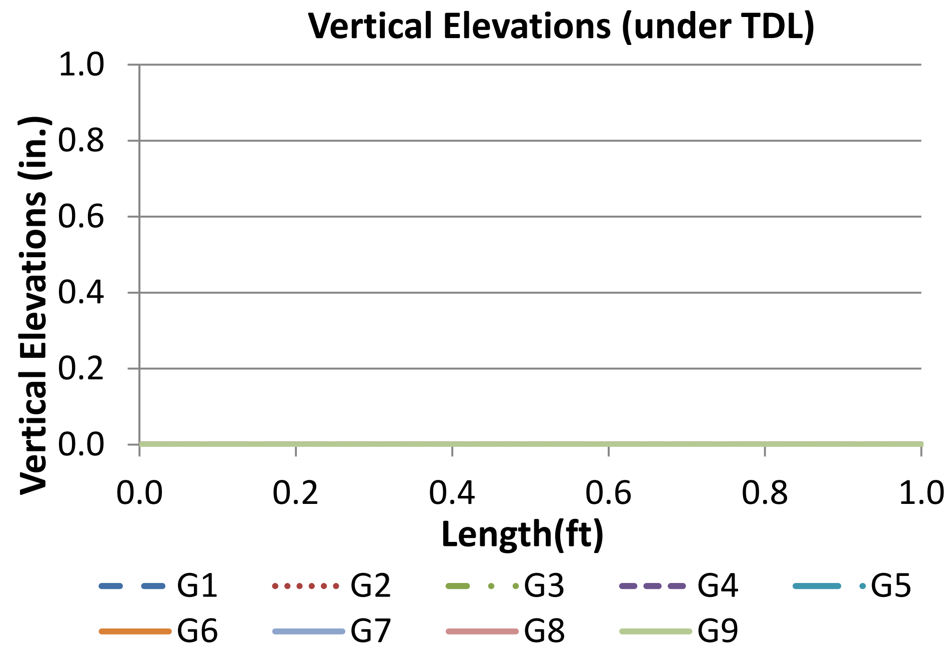


Figure D-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.





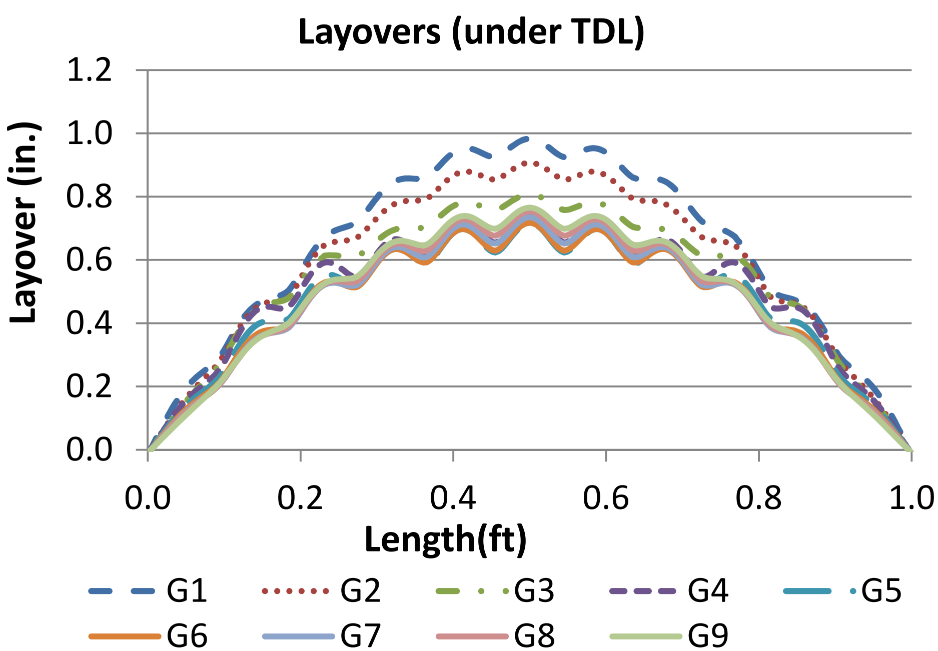


Figure D-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

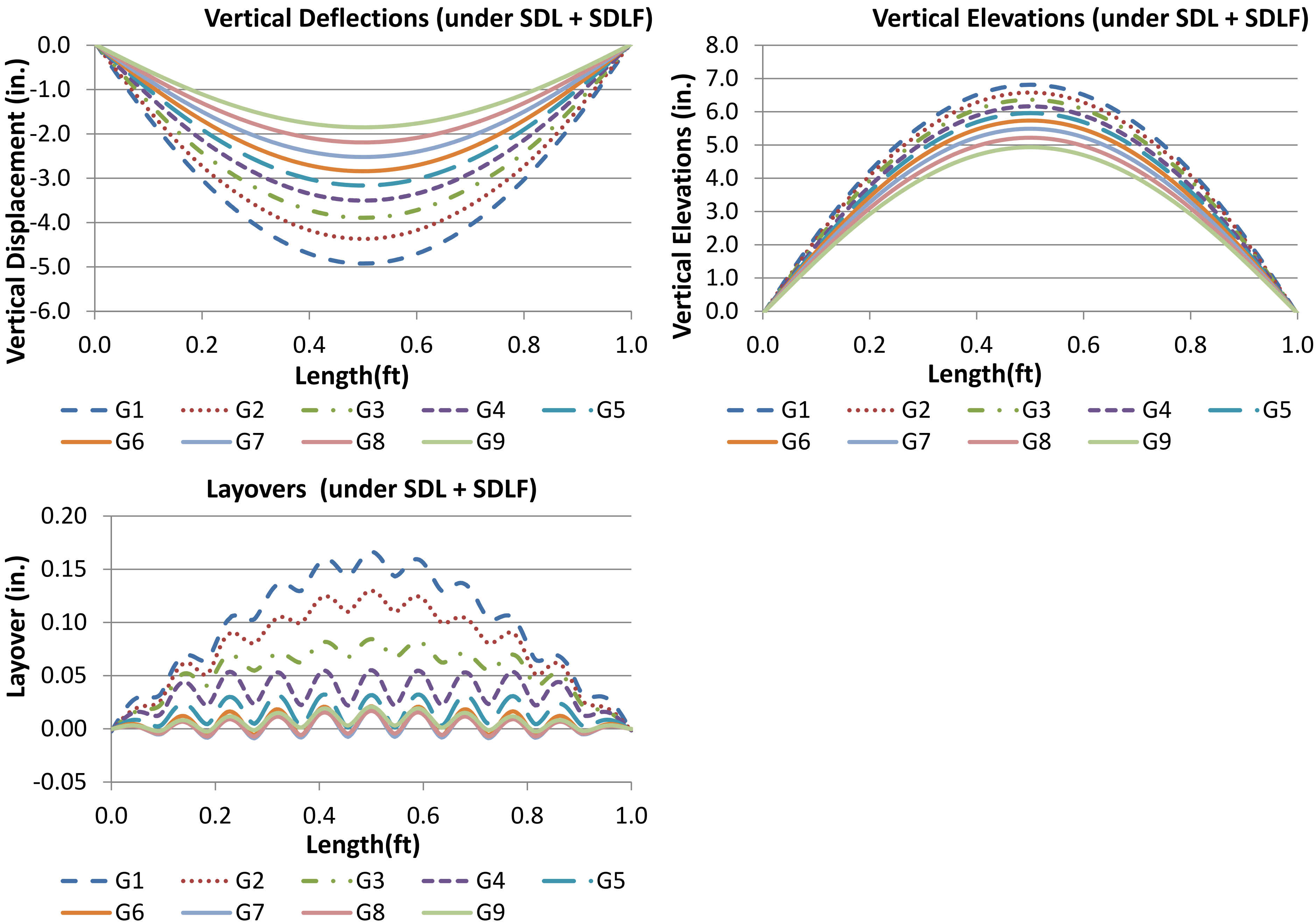


Figure D-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

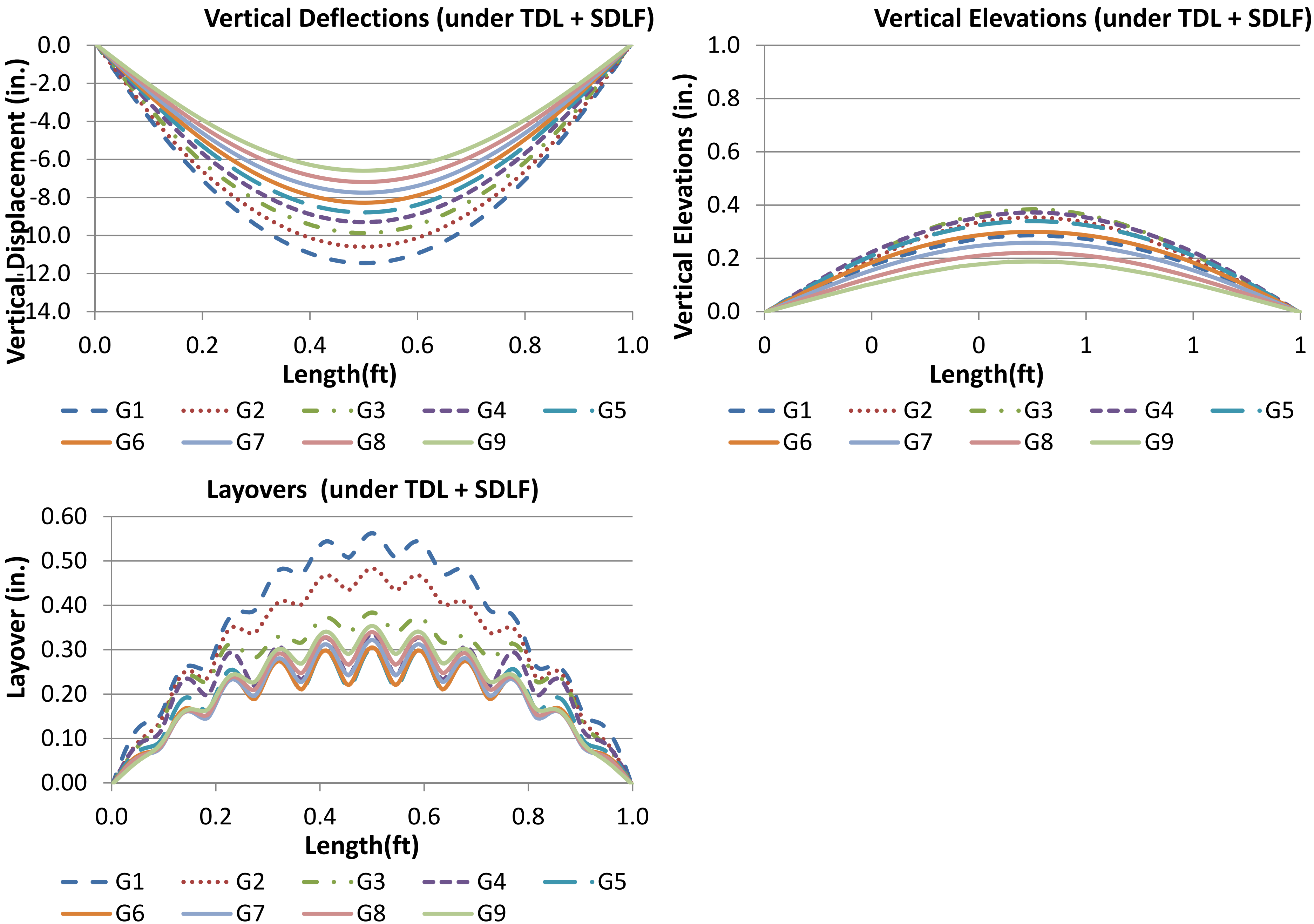


Figure D-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

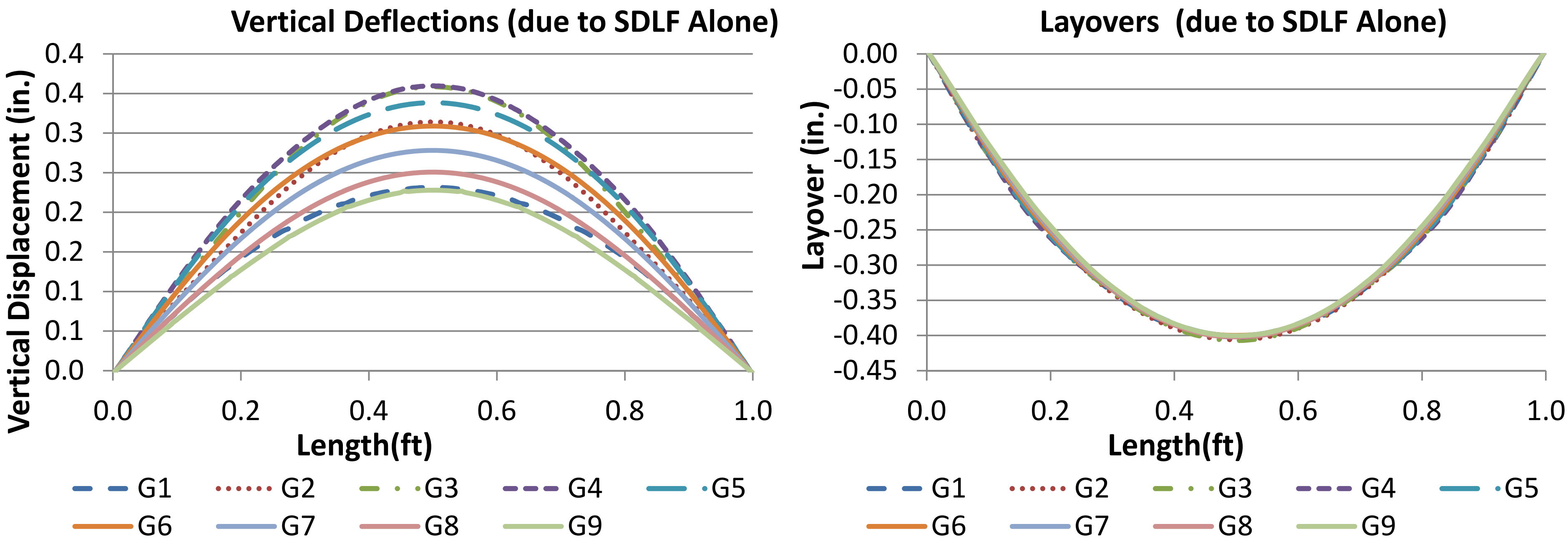


Figure D-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

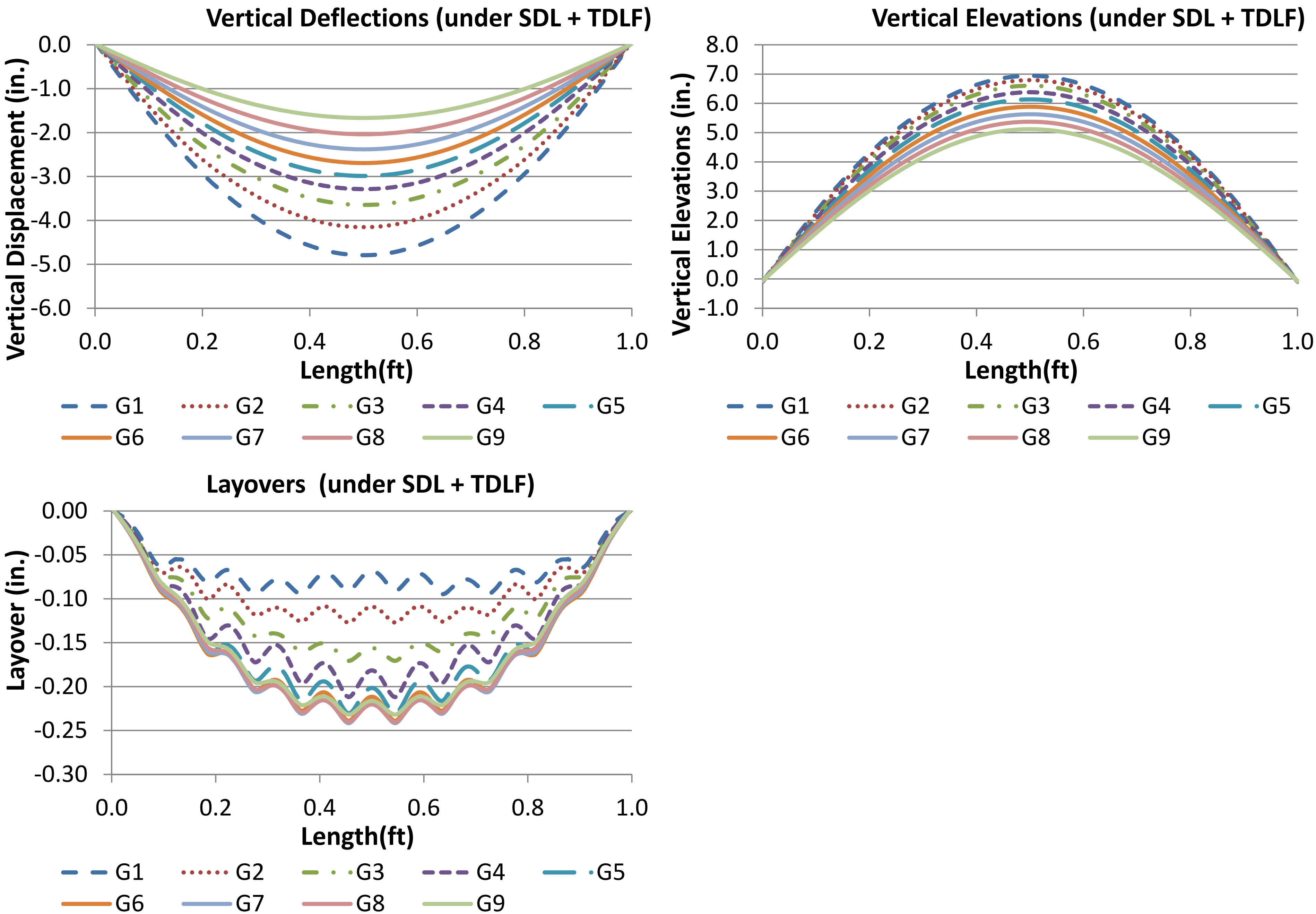


Figure D-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

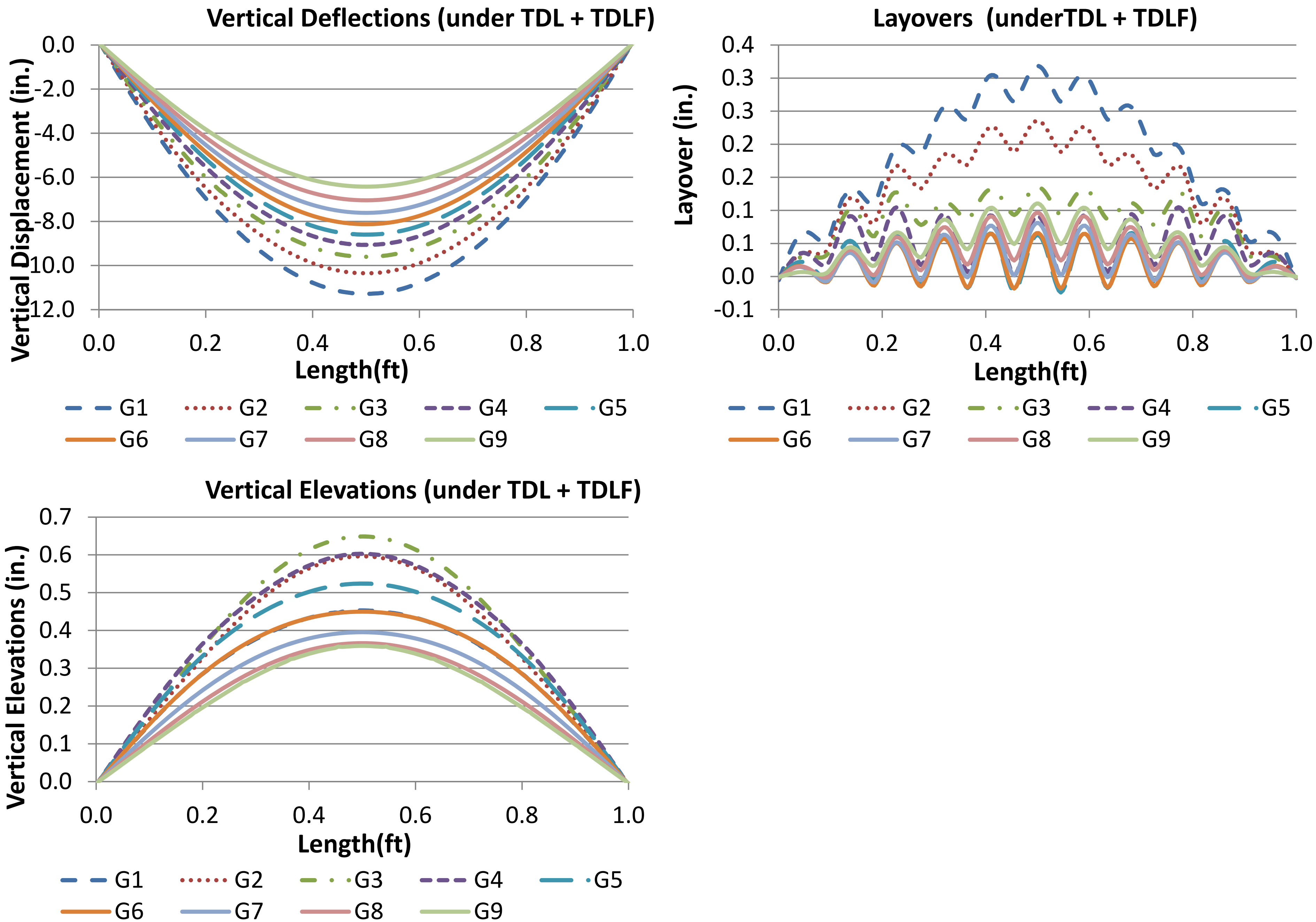


Figure D-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

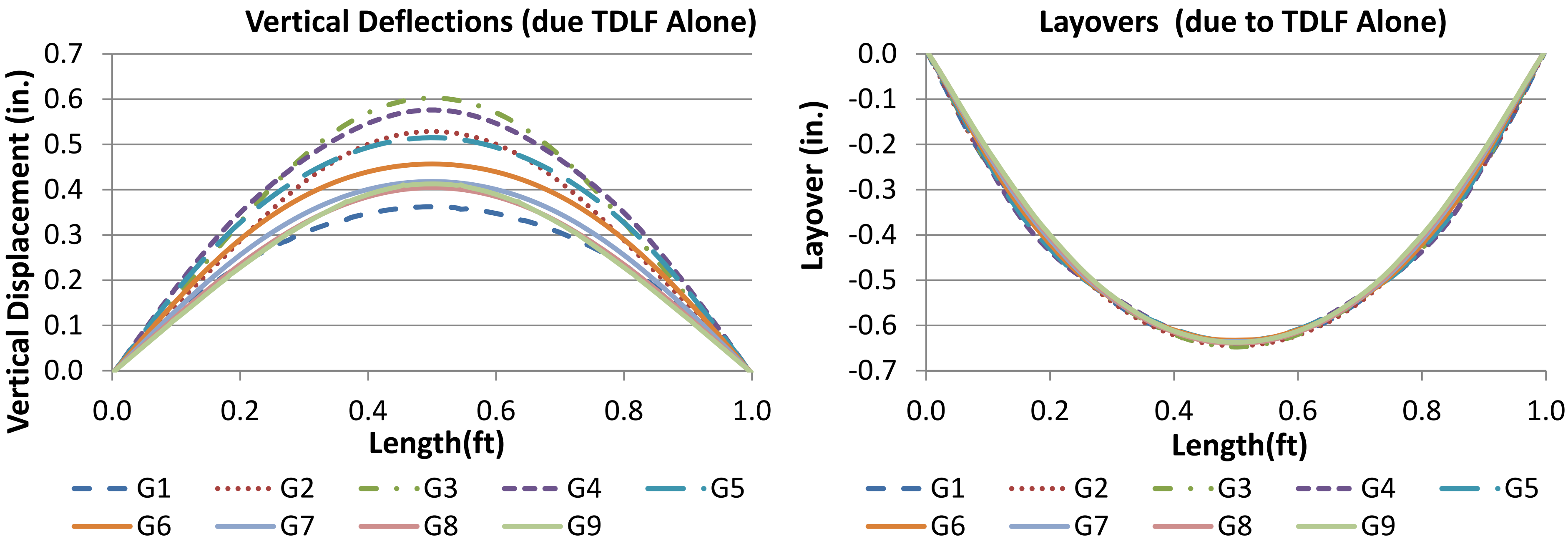


Figure D-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

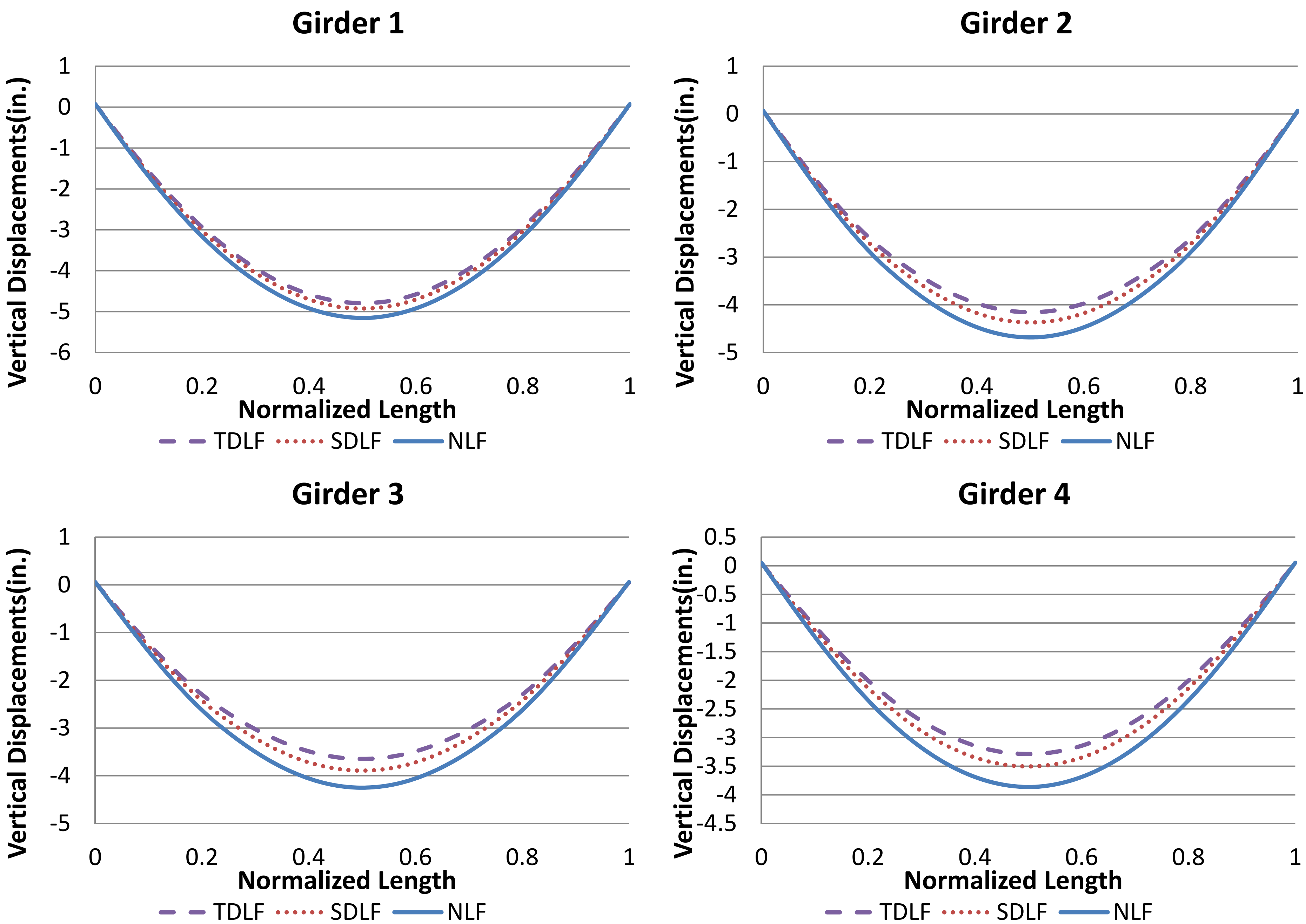


Figure D-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

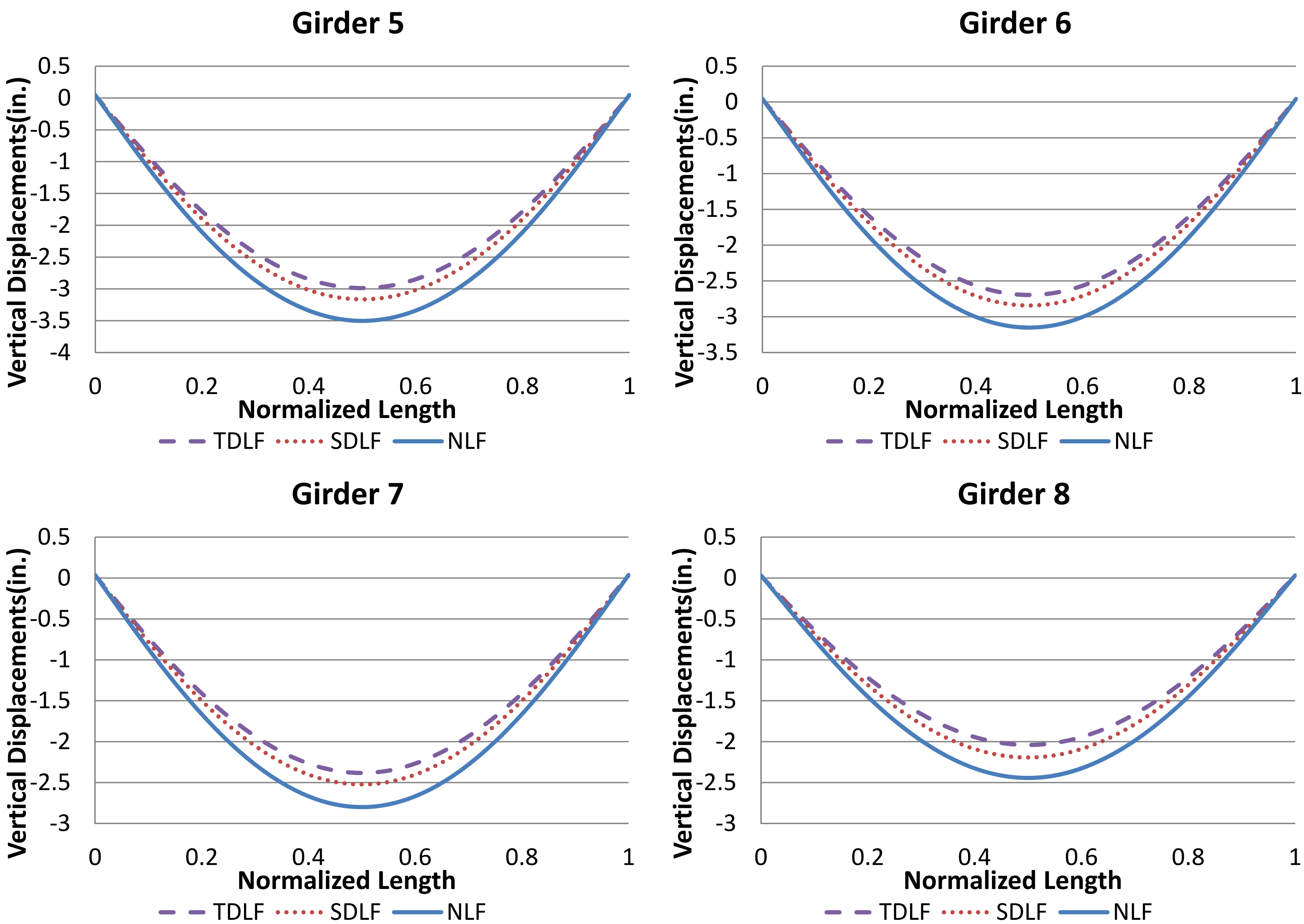


Figure D-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

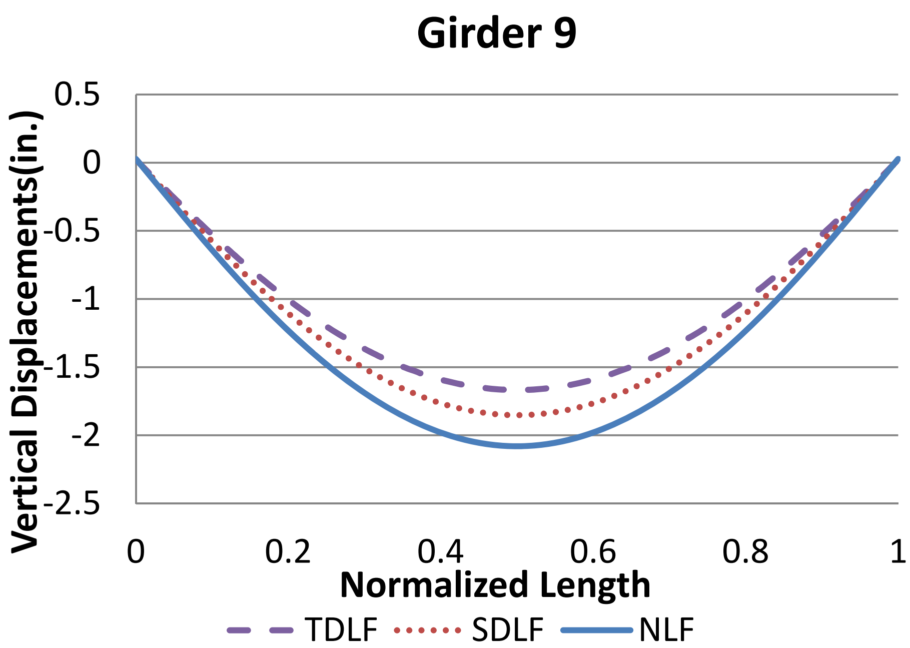


Figure D-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

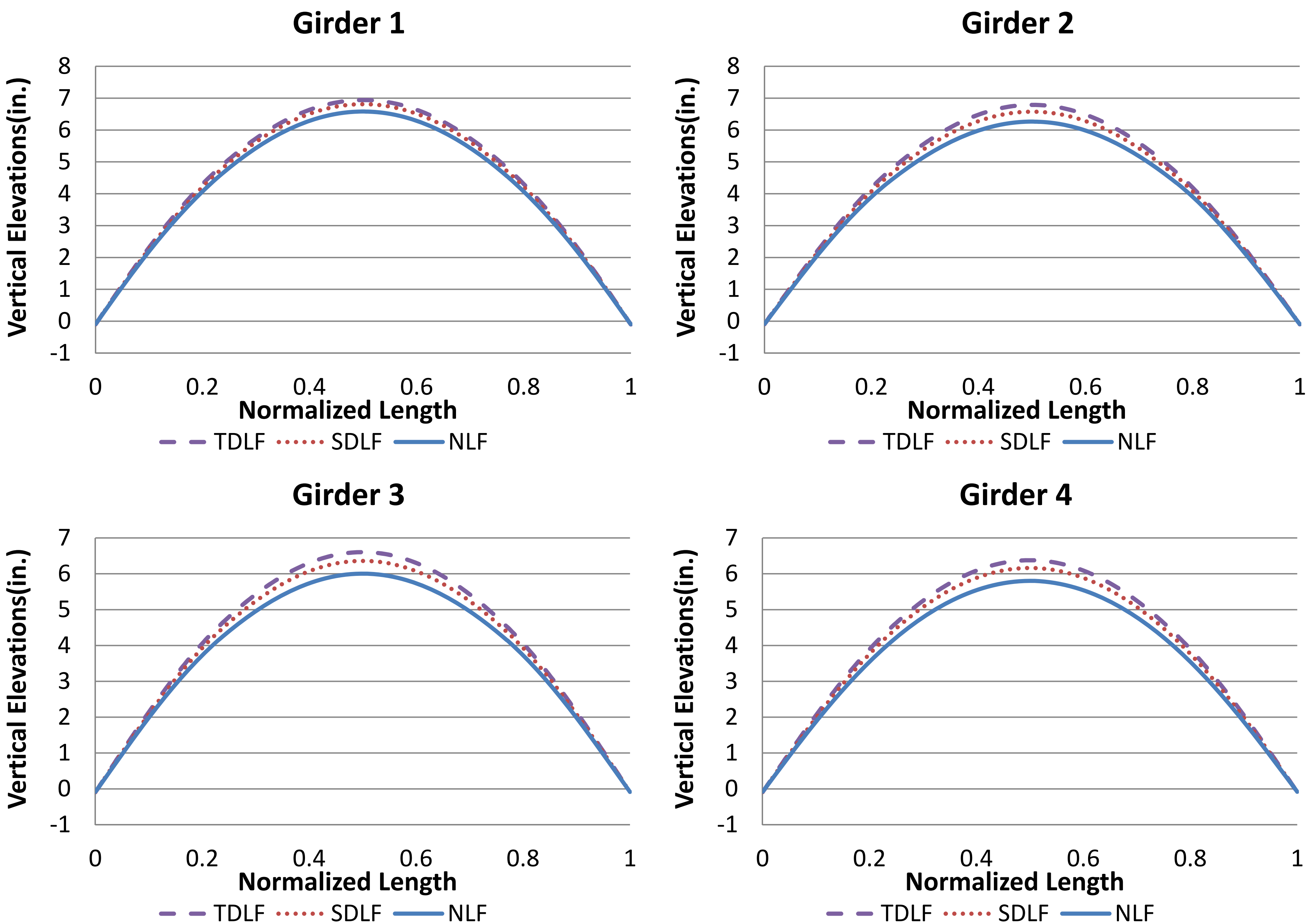


Figure D-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

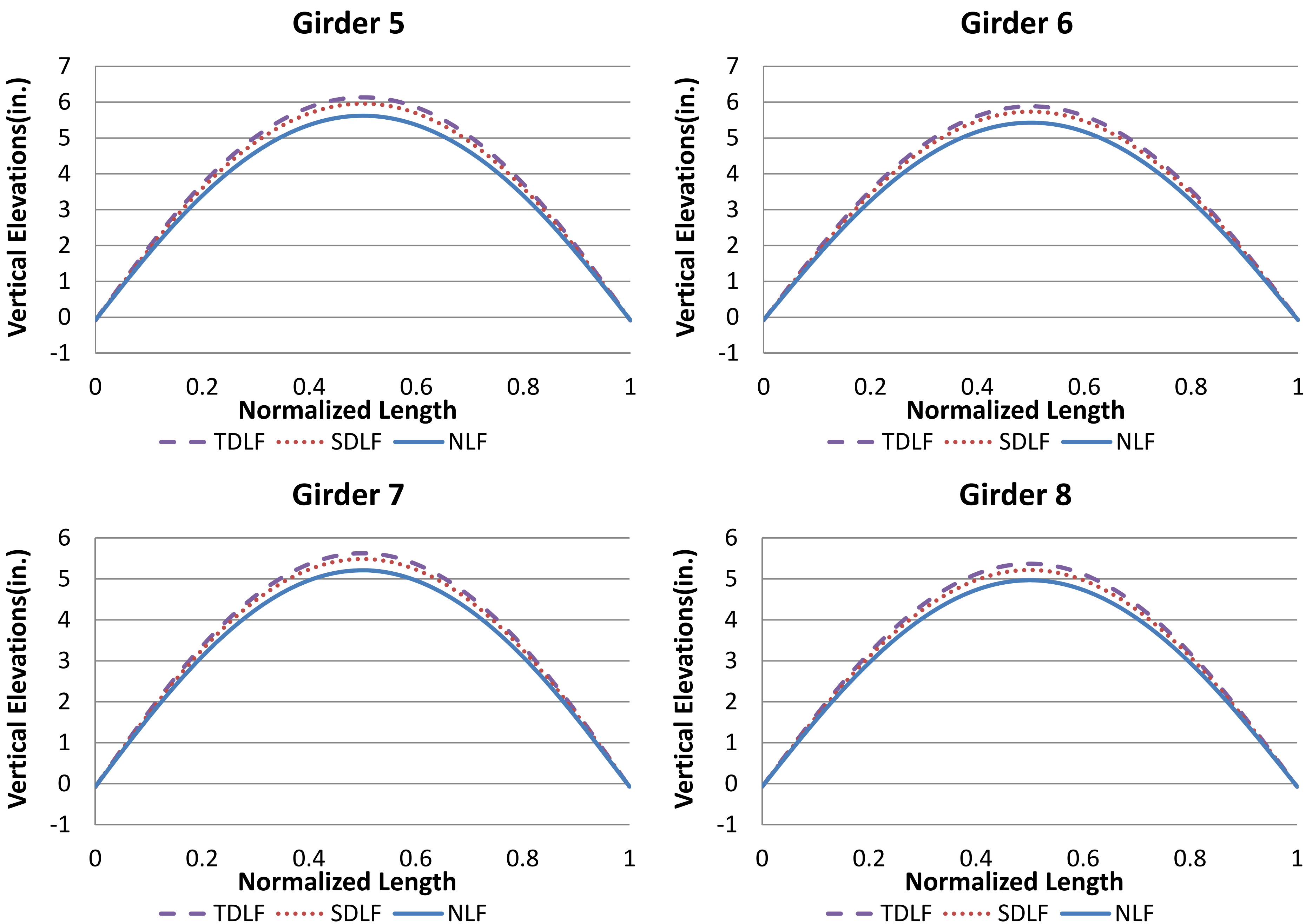


Figure D-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

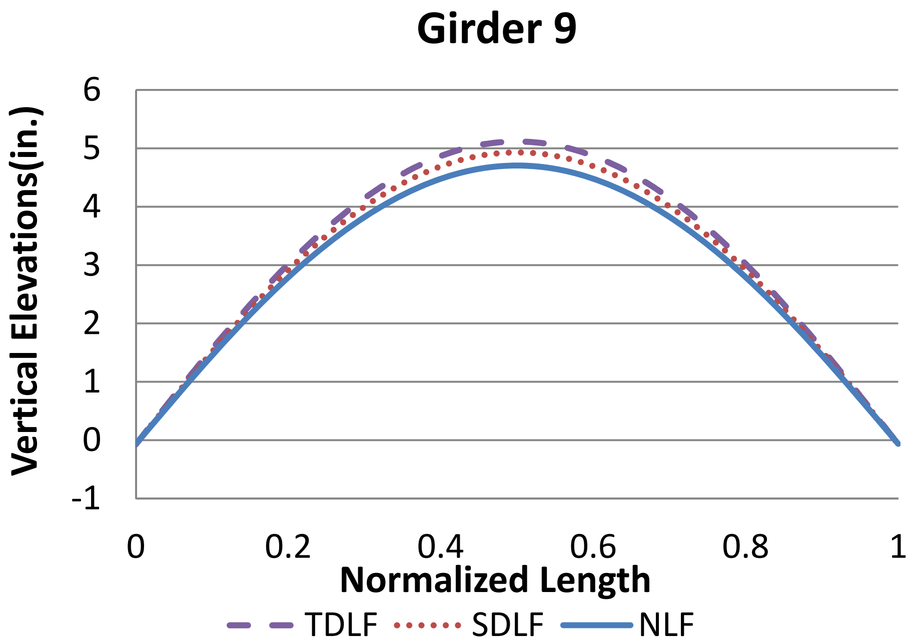


Figure D-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

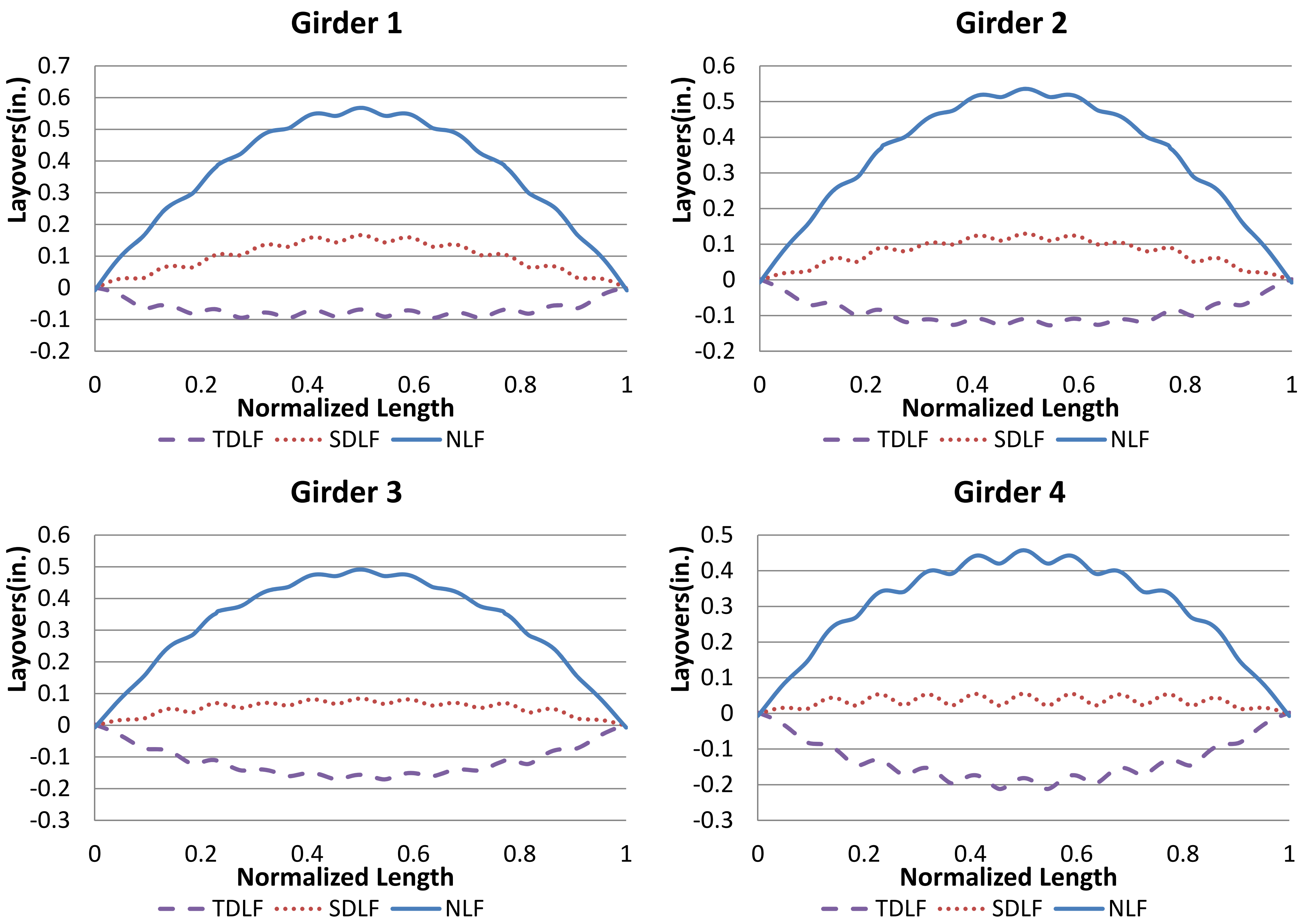


Figure D-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

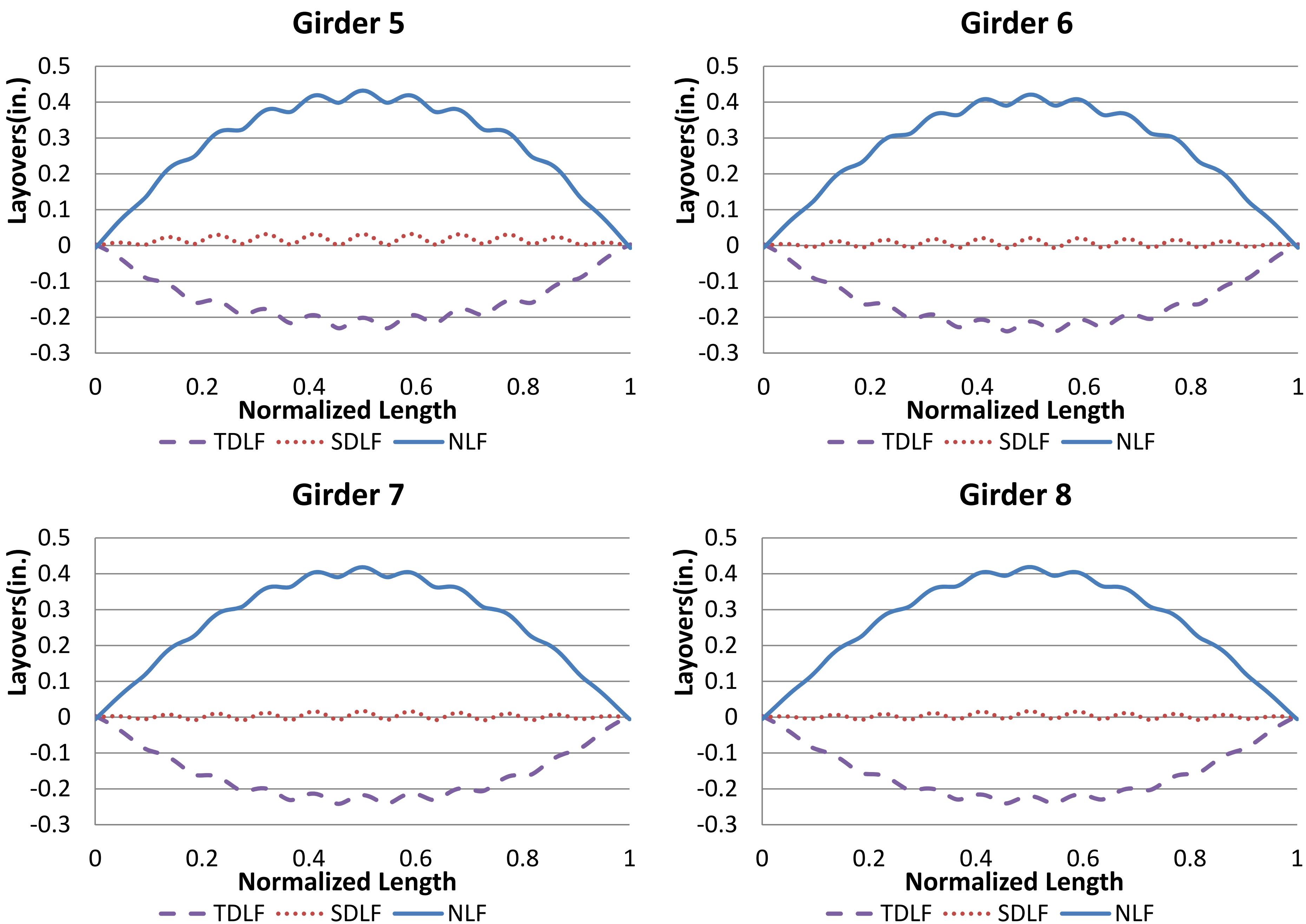


Figure D-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

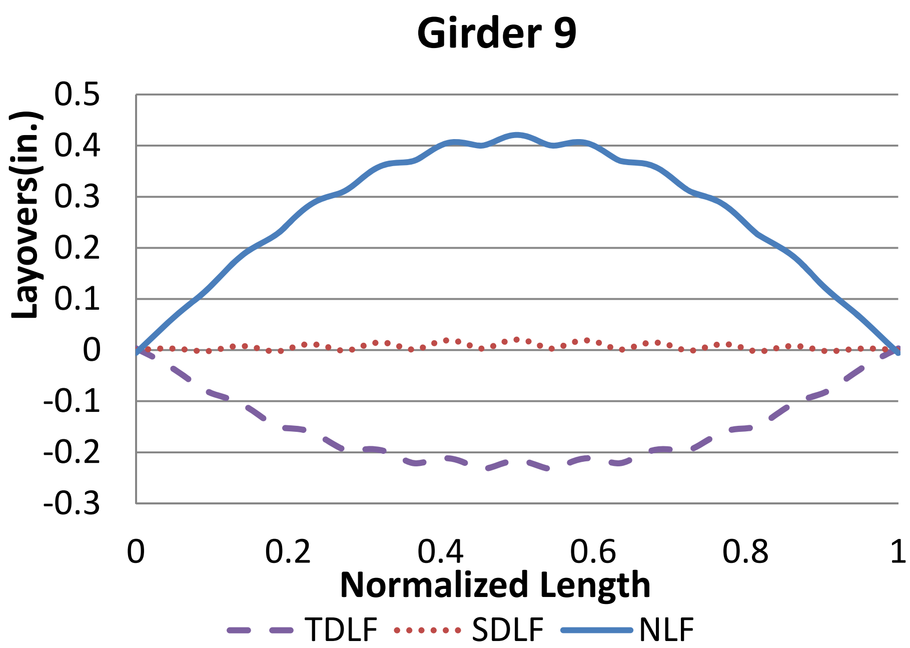


Figure D-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

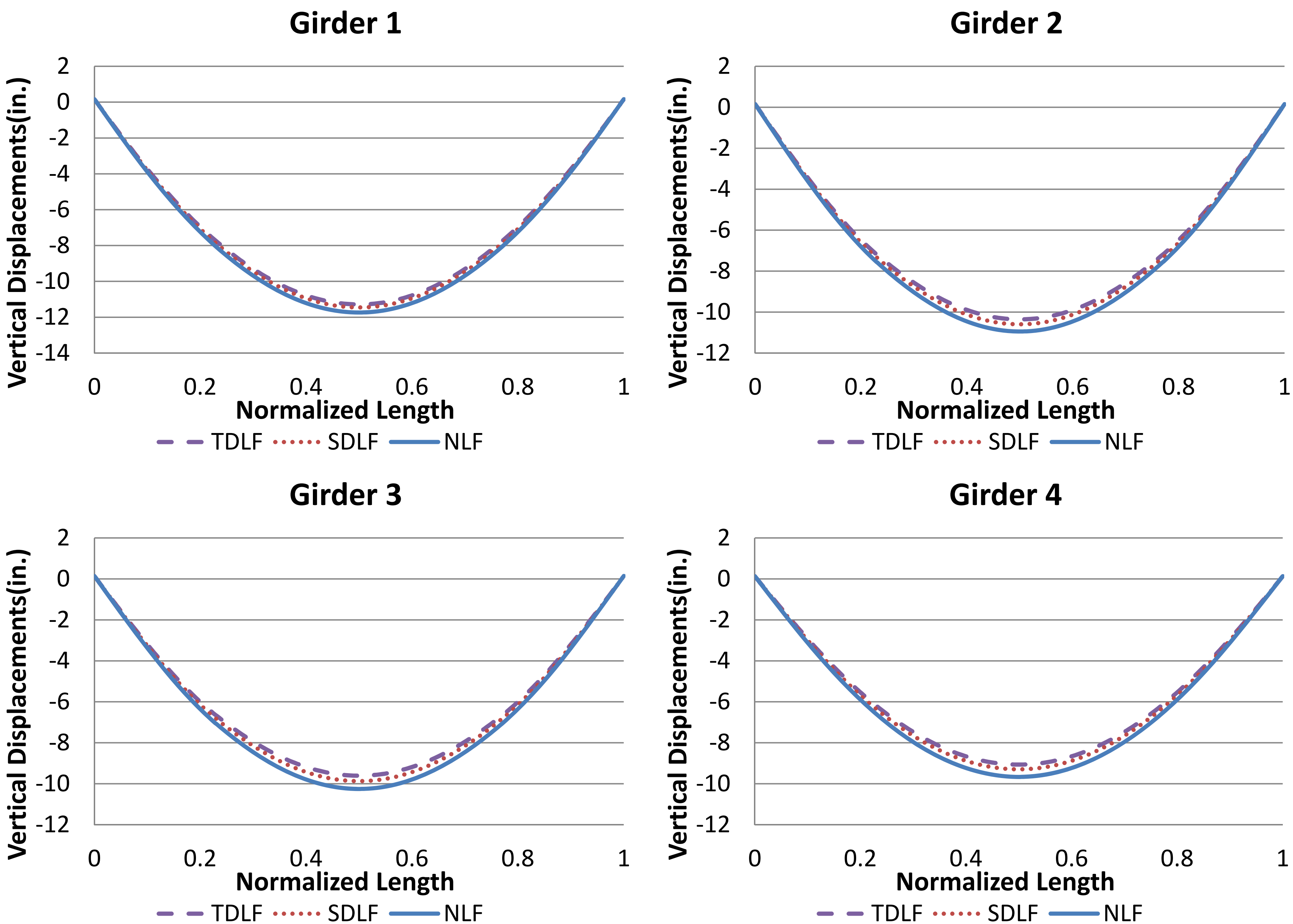


Figure D-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

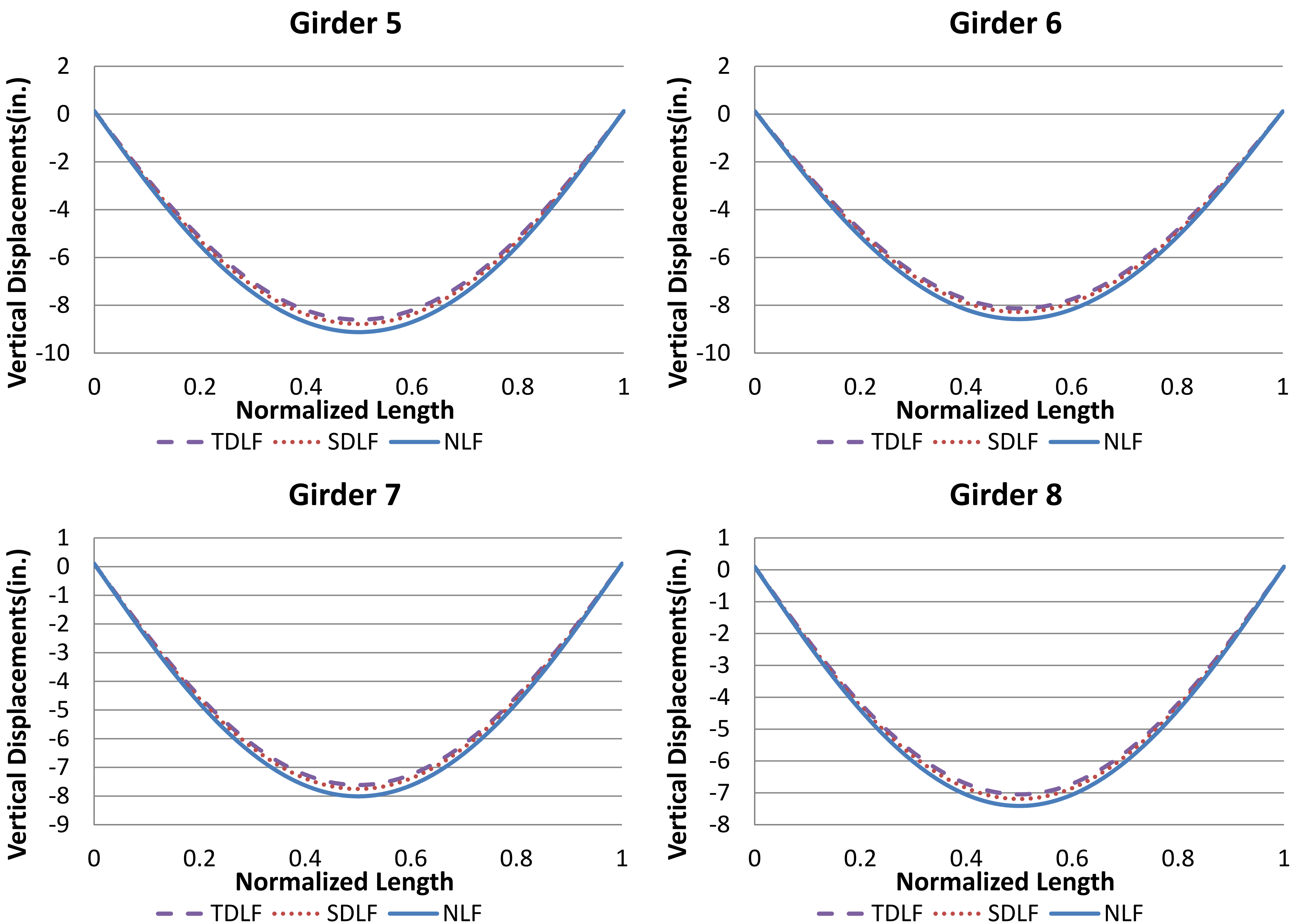


Figure D-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

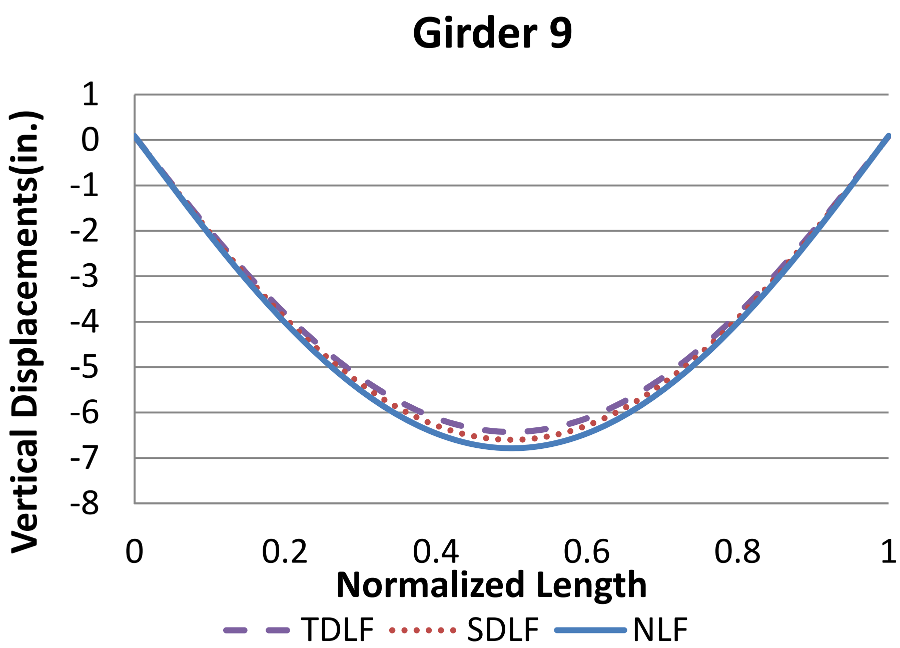


Figure D-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

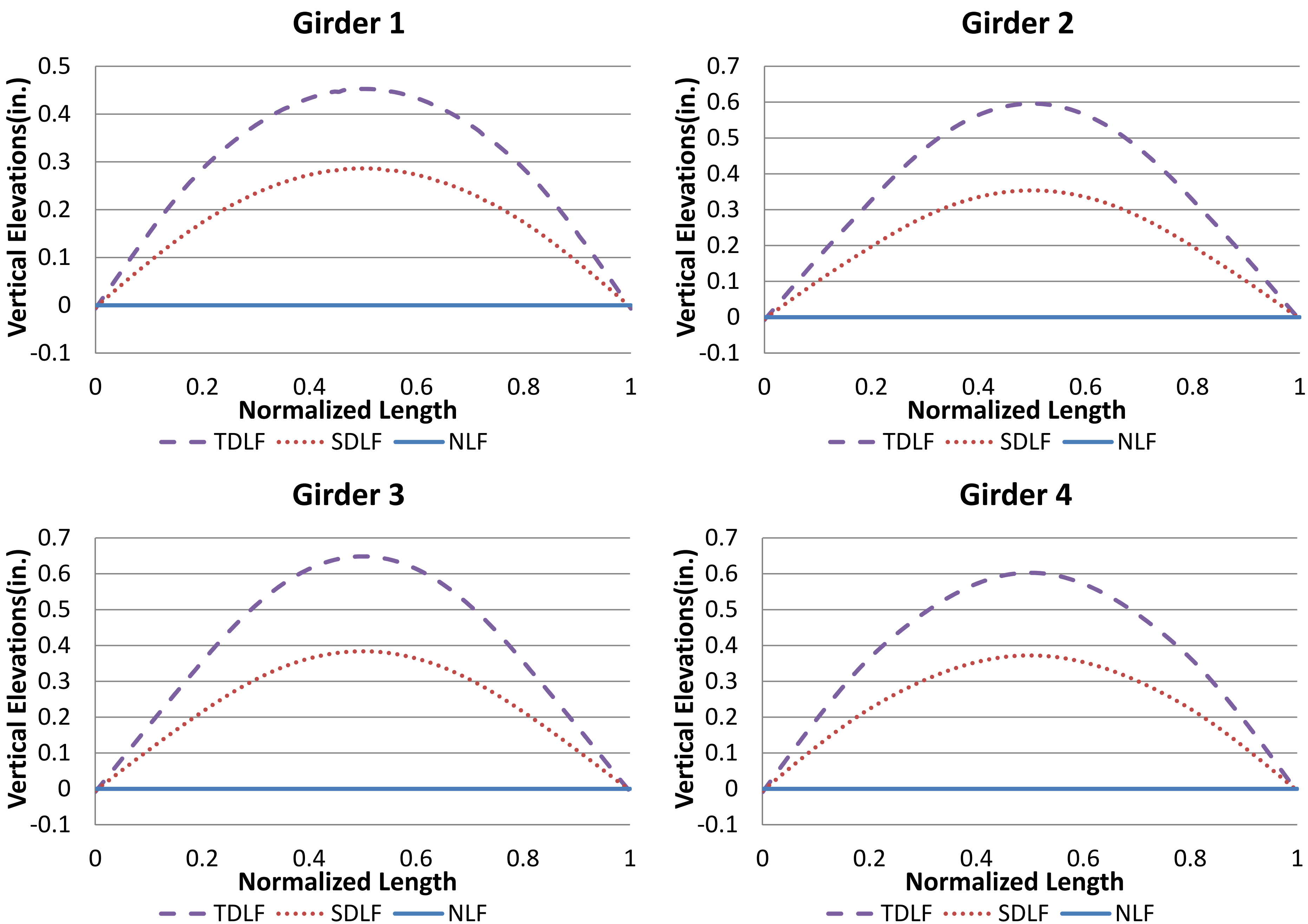


Figure D-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

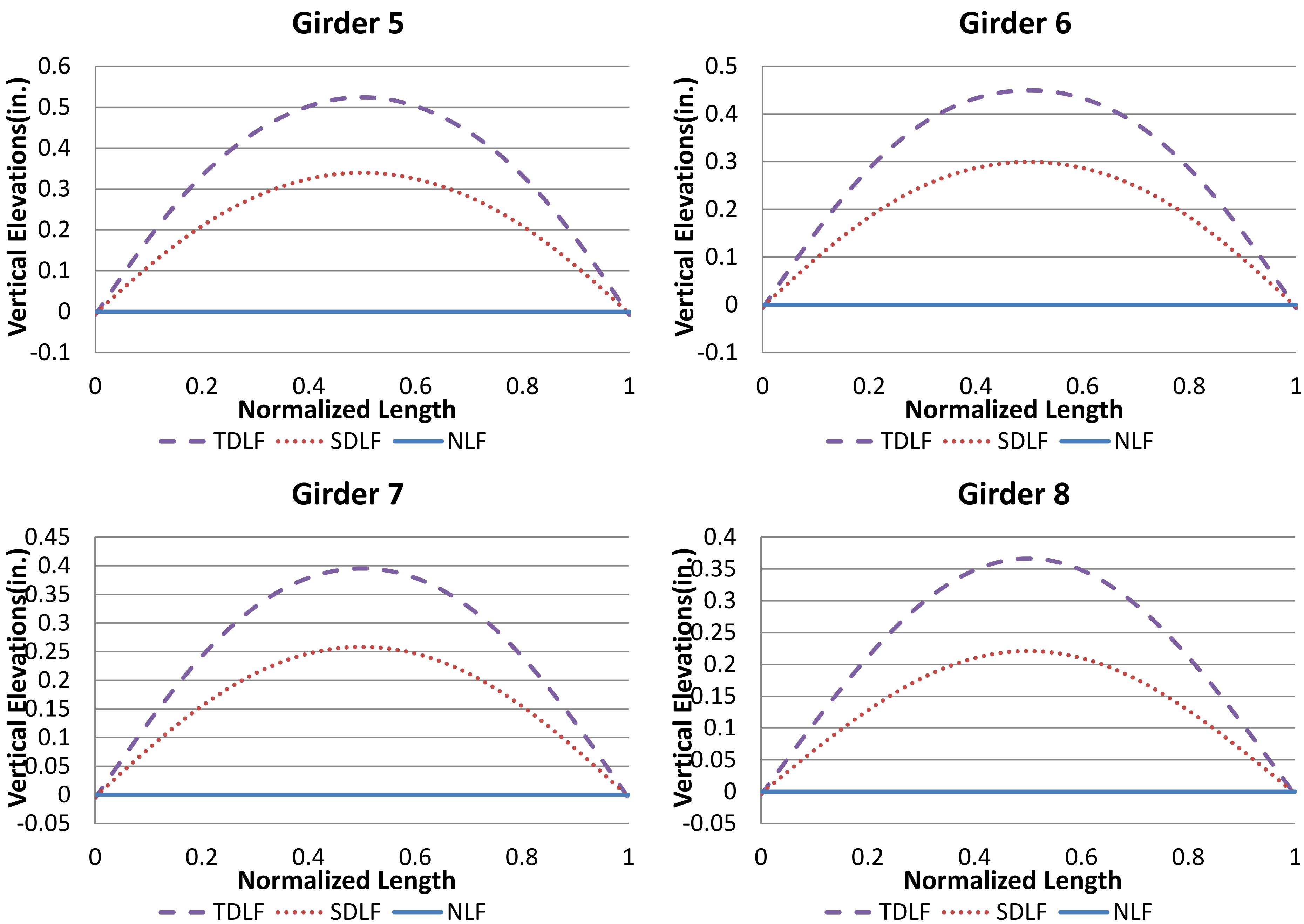


Figure D-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

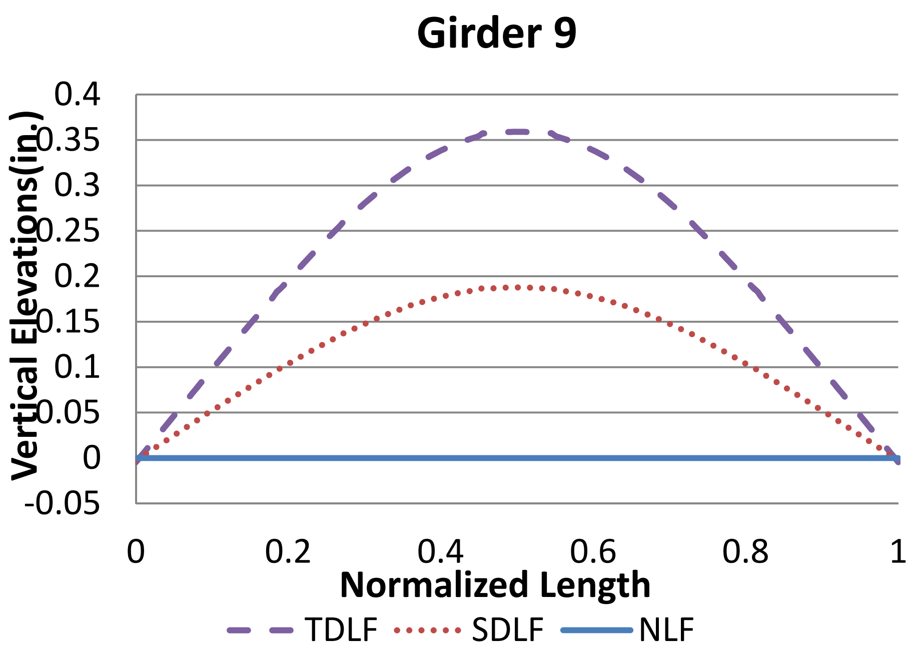


Figure D-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

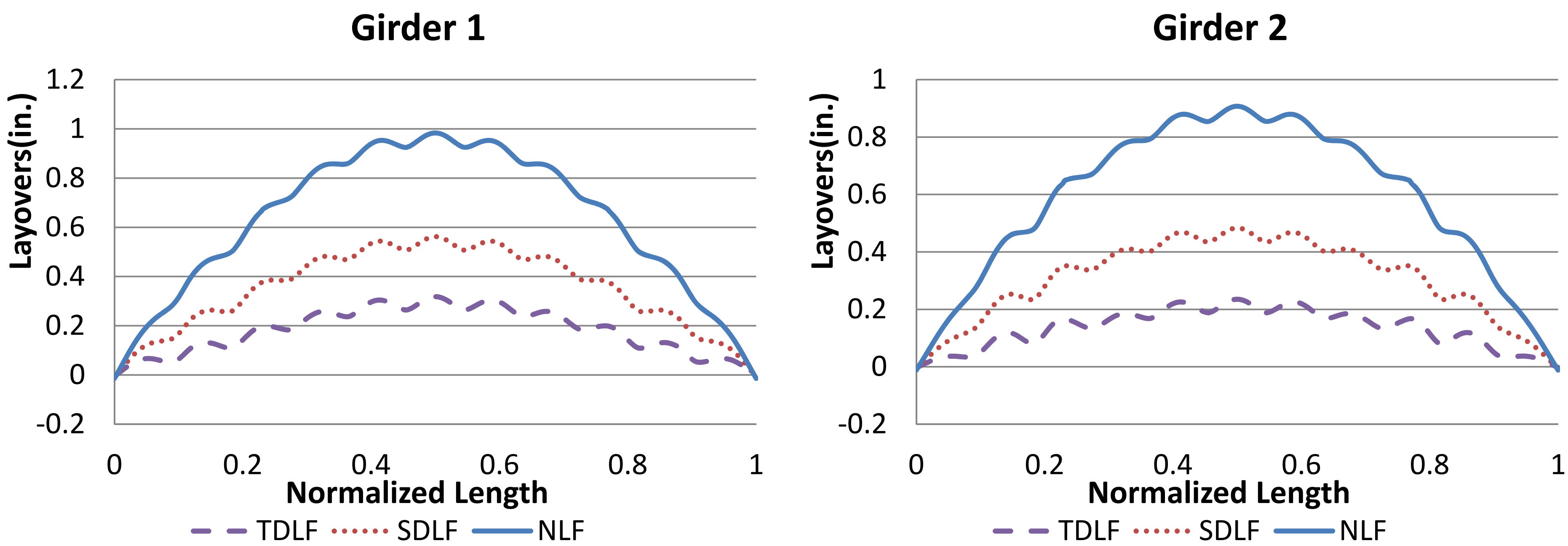


Figure D-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

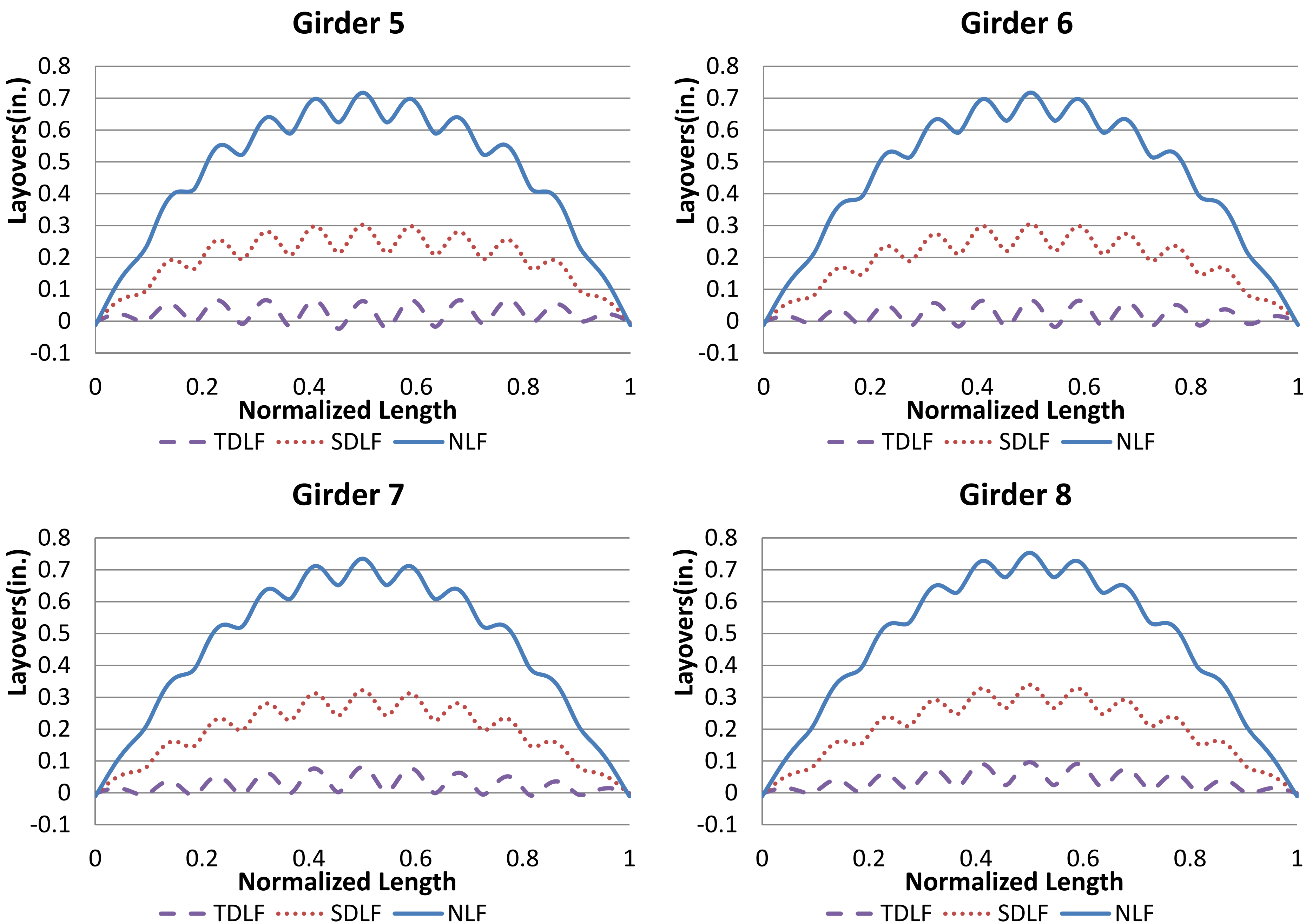


Figure D-4-15(Continued). **Comparison of individual girder layovers (in) under TDL for different detailing methods.**

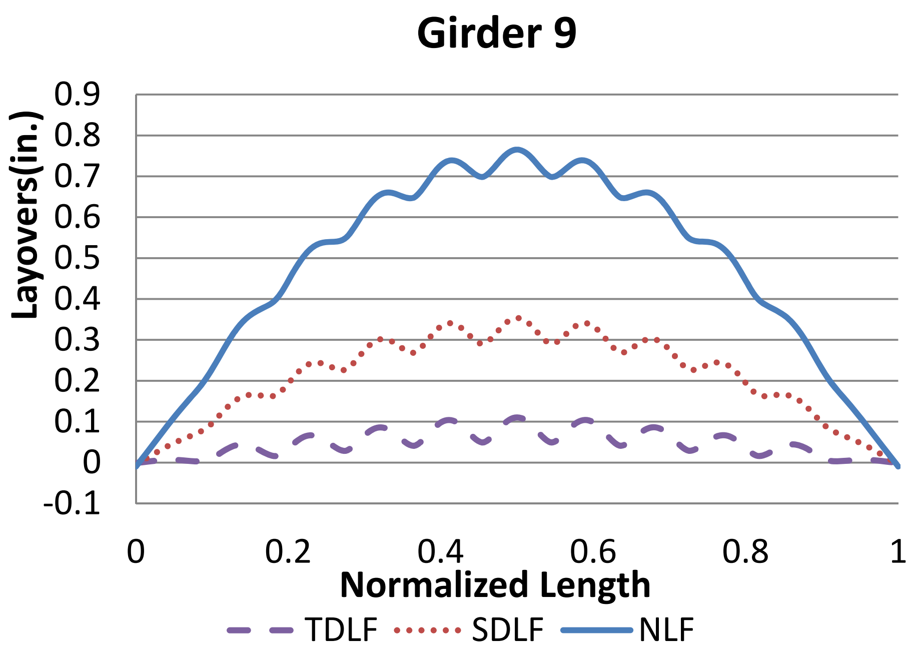


Figure D-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

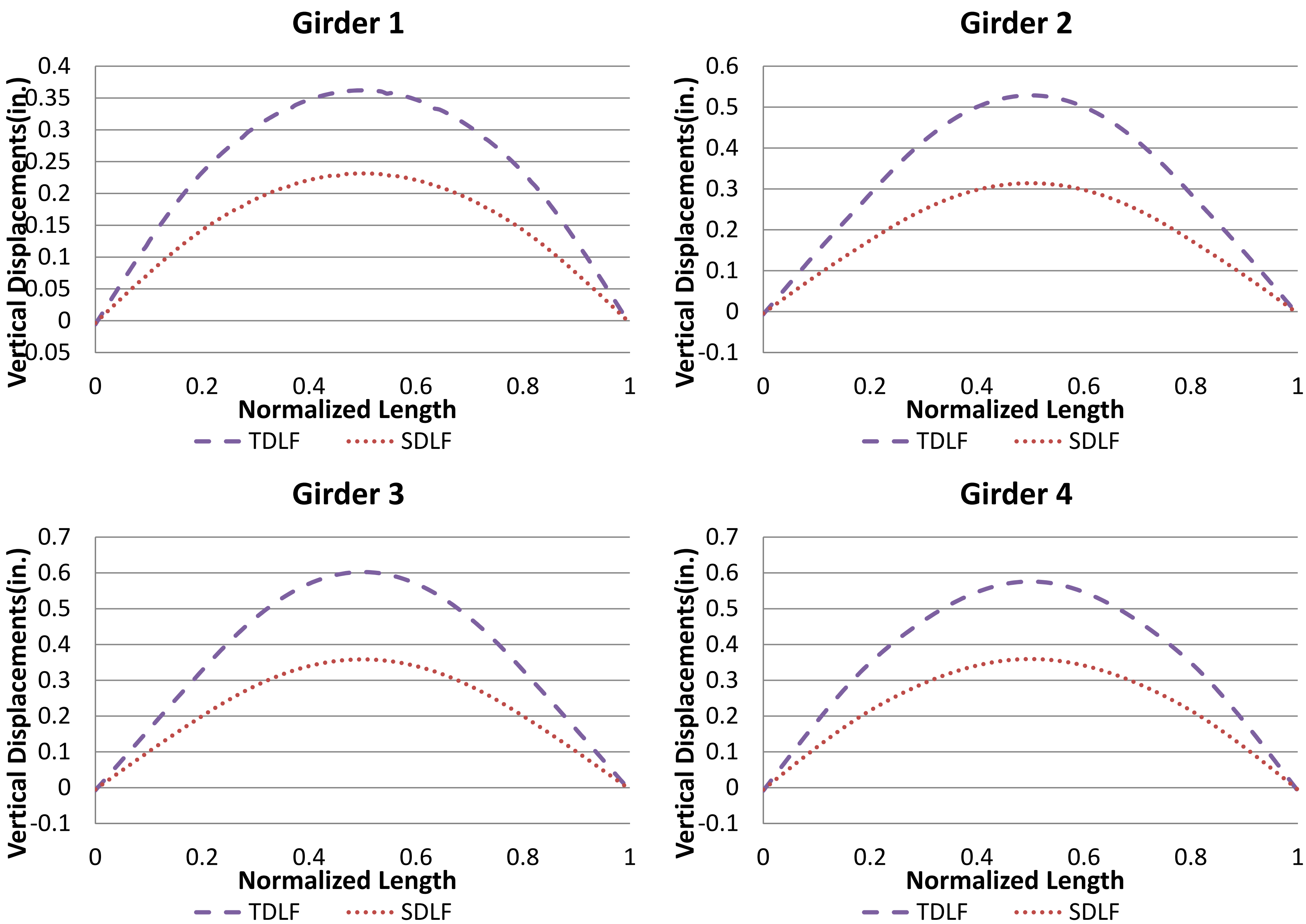


Figure D-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

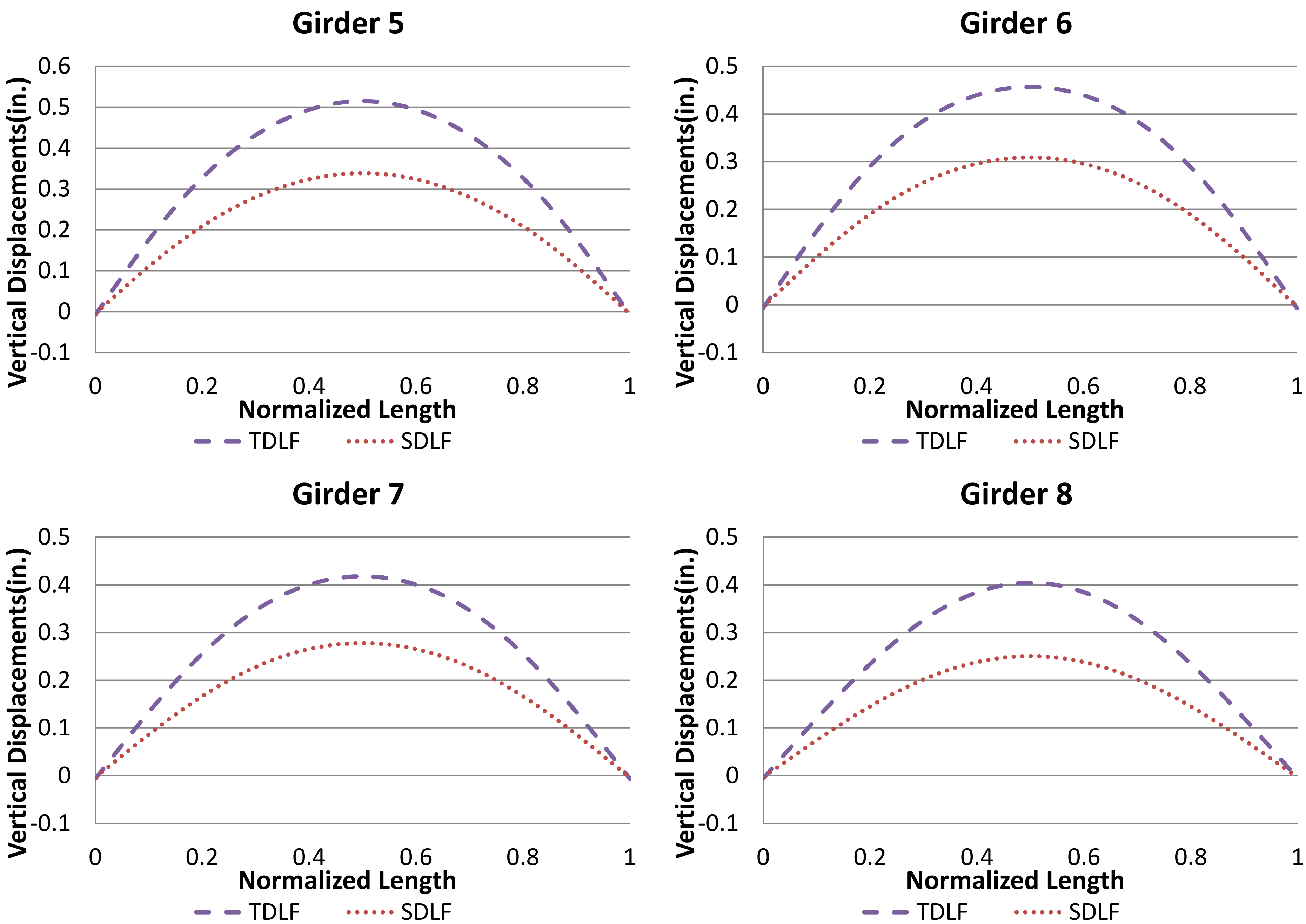


Figure D-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

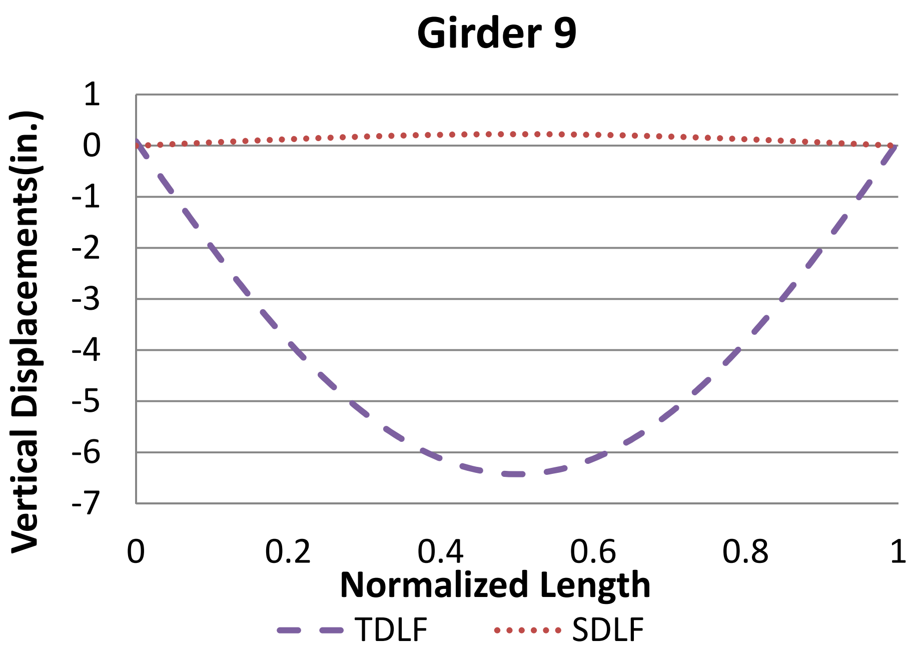


Figure D-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

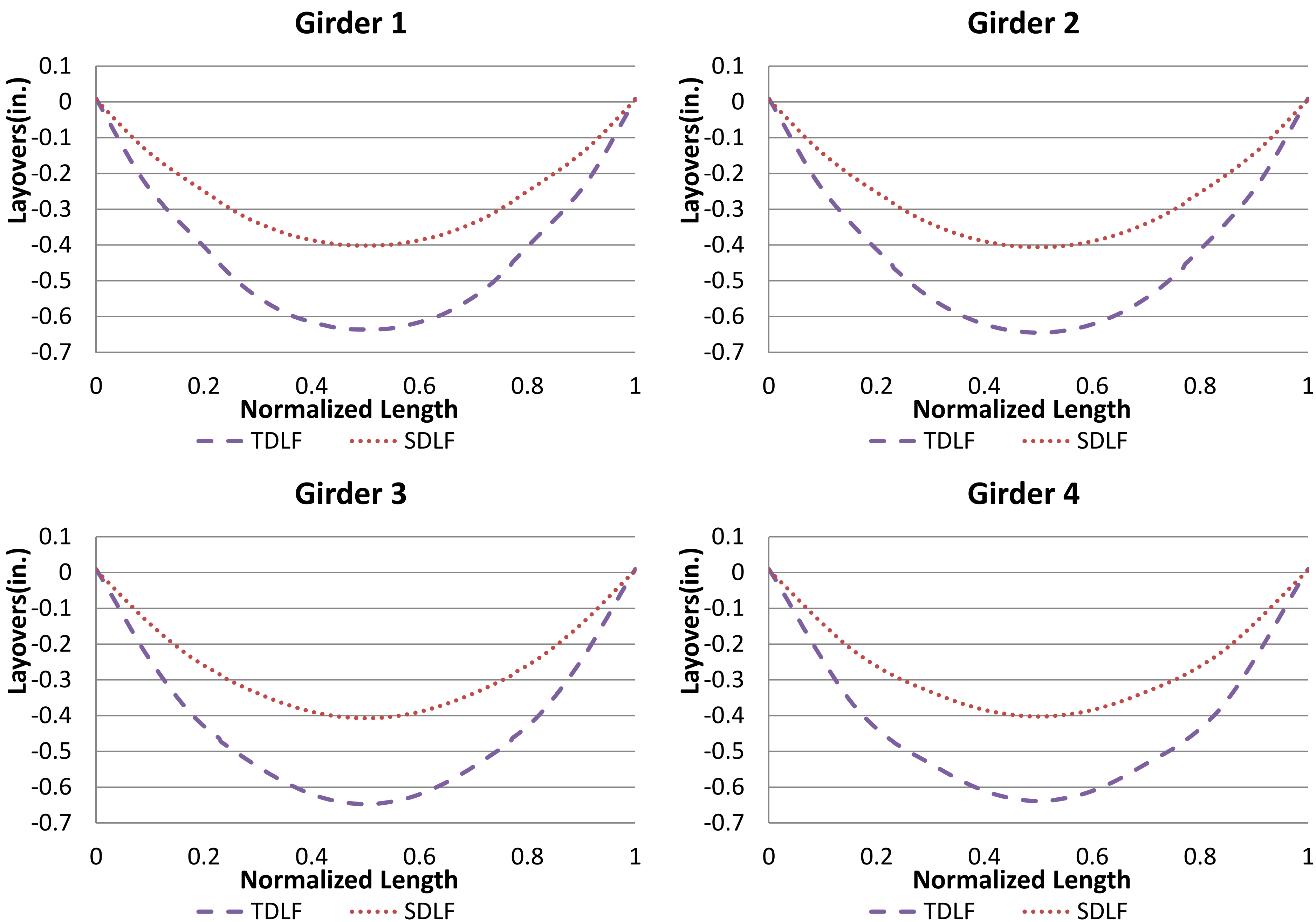


Figure D-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

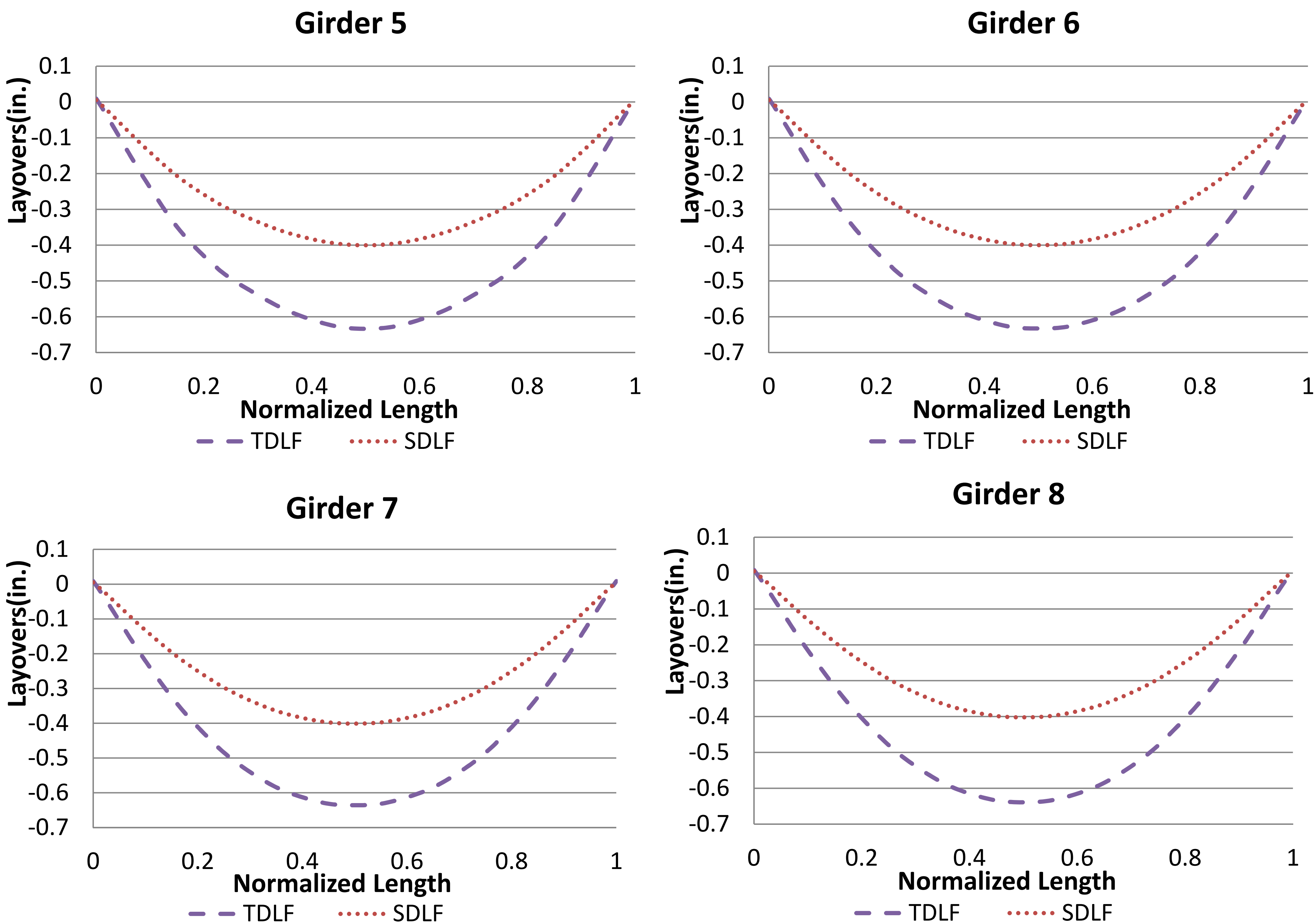


Figure D-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

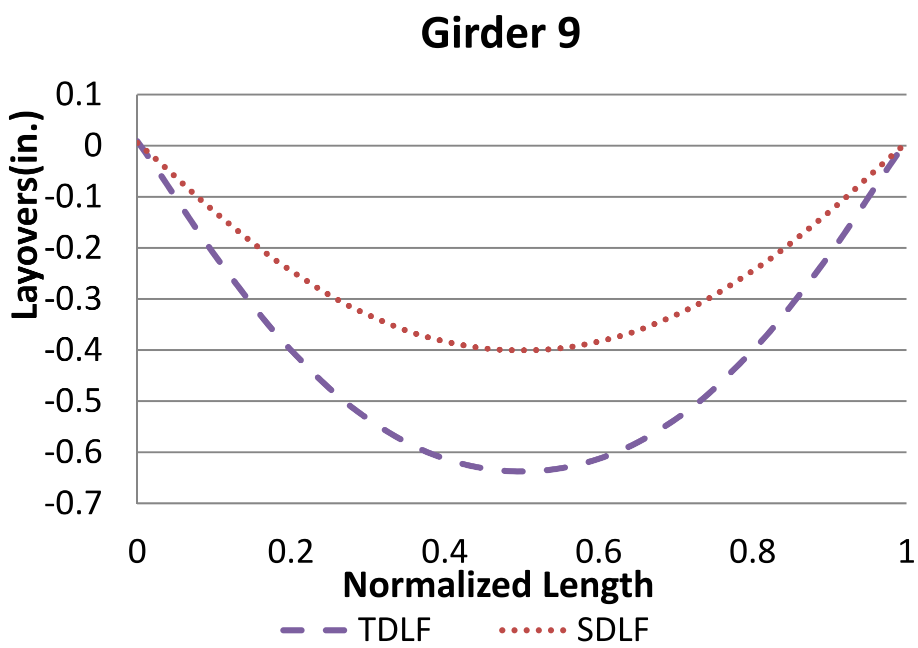


Figure D-4-17(Continued). **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.**

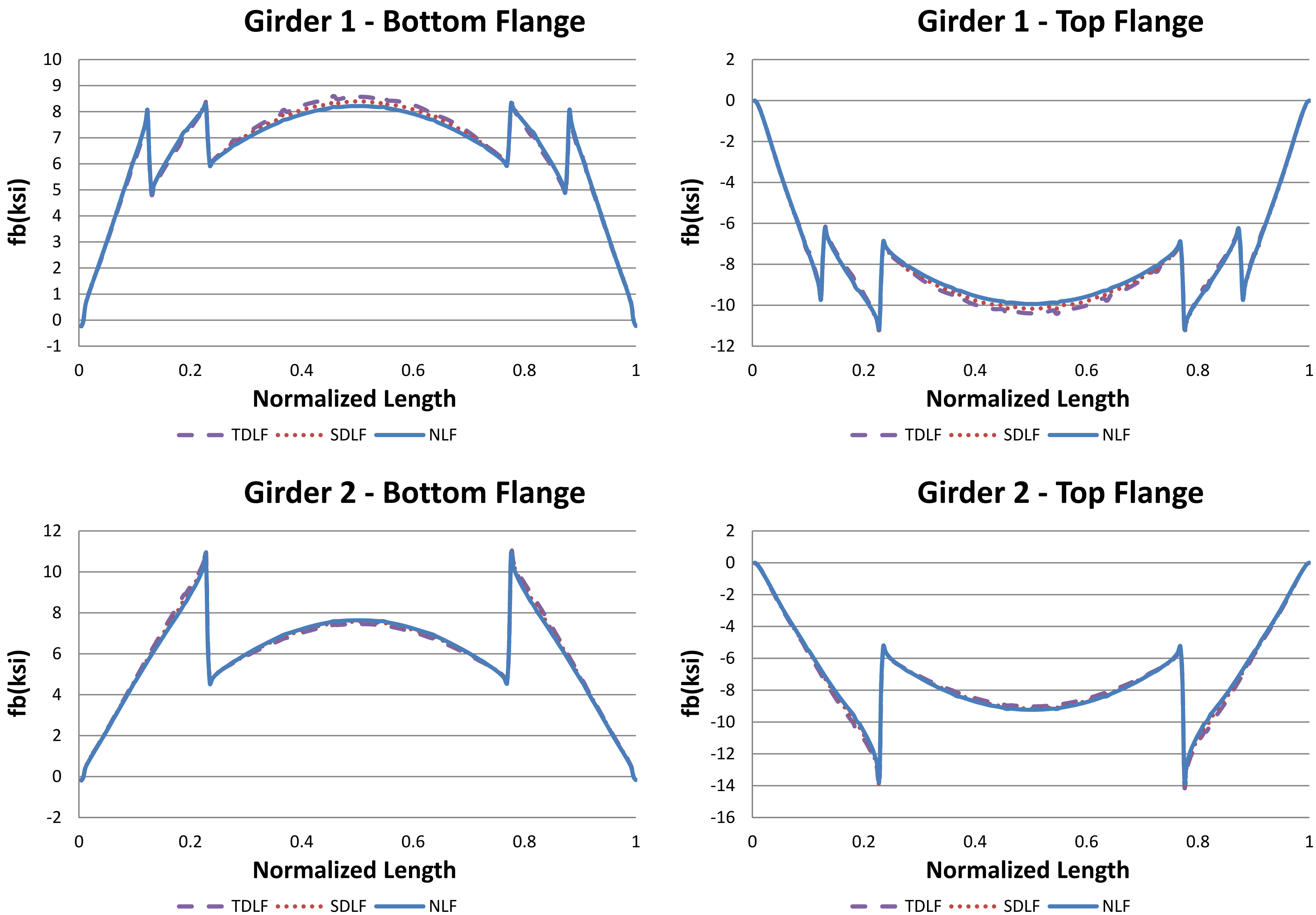


Figure D-4-18. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

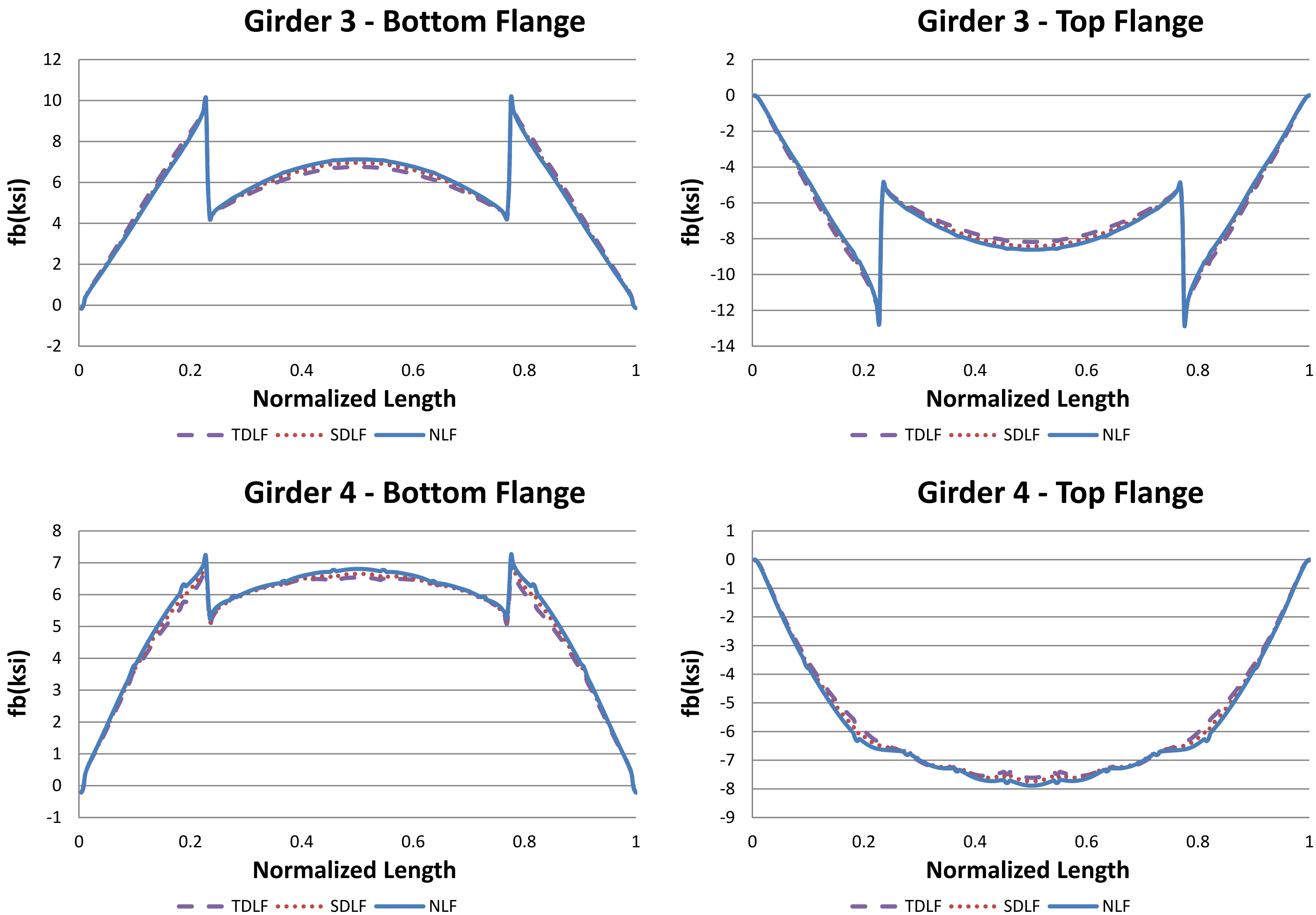


Figure D-4-18(Continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

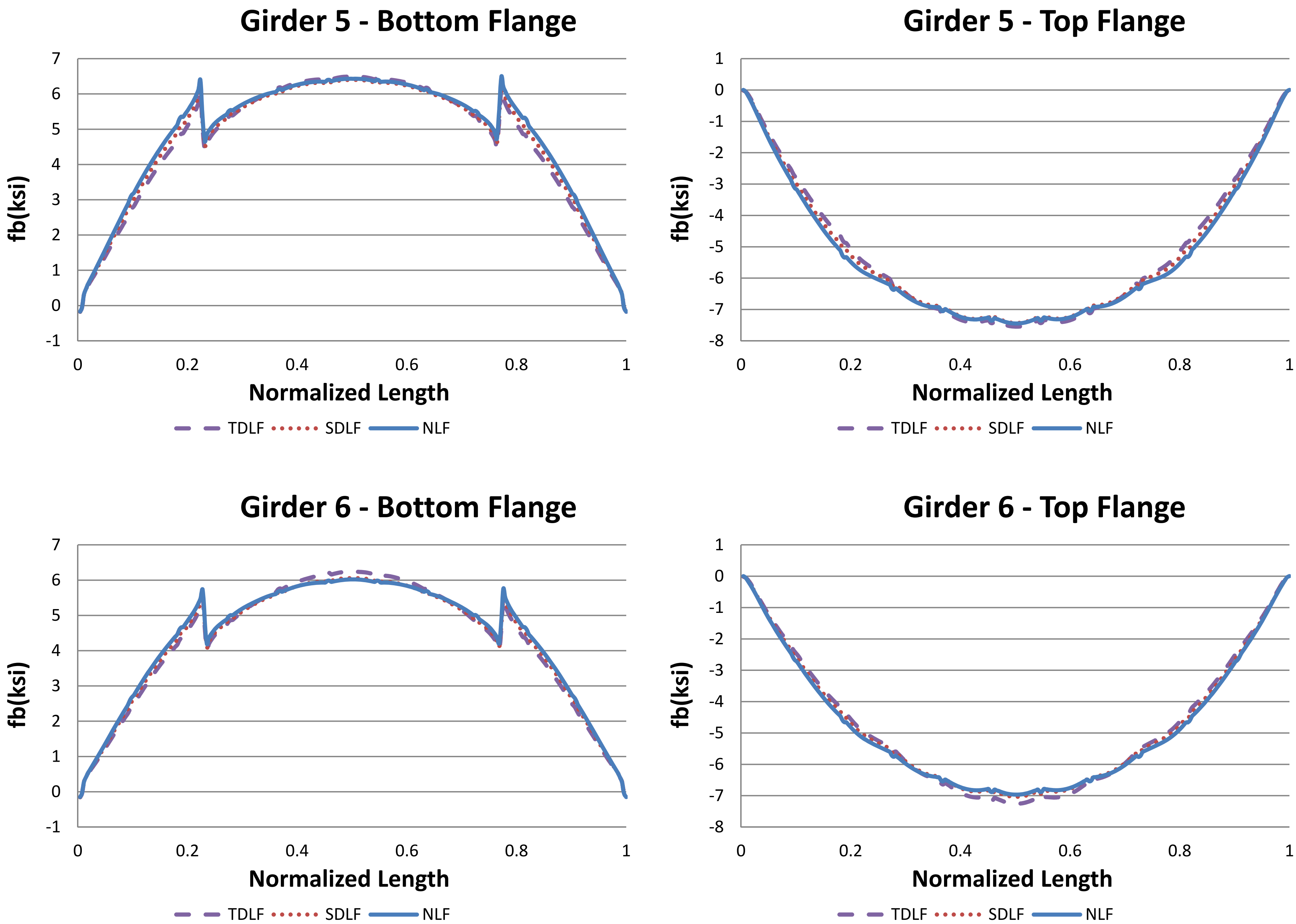


Figure D-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

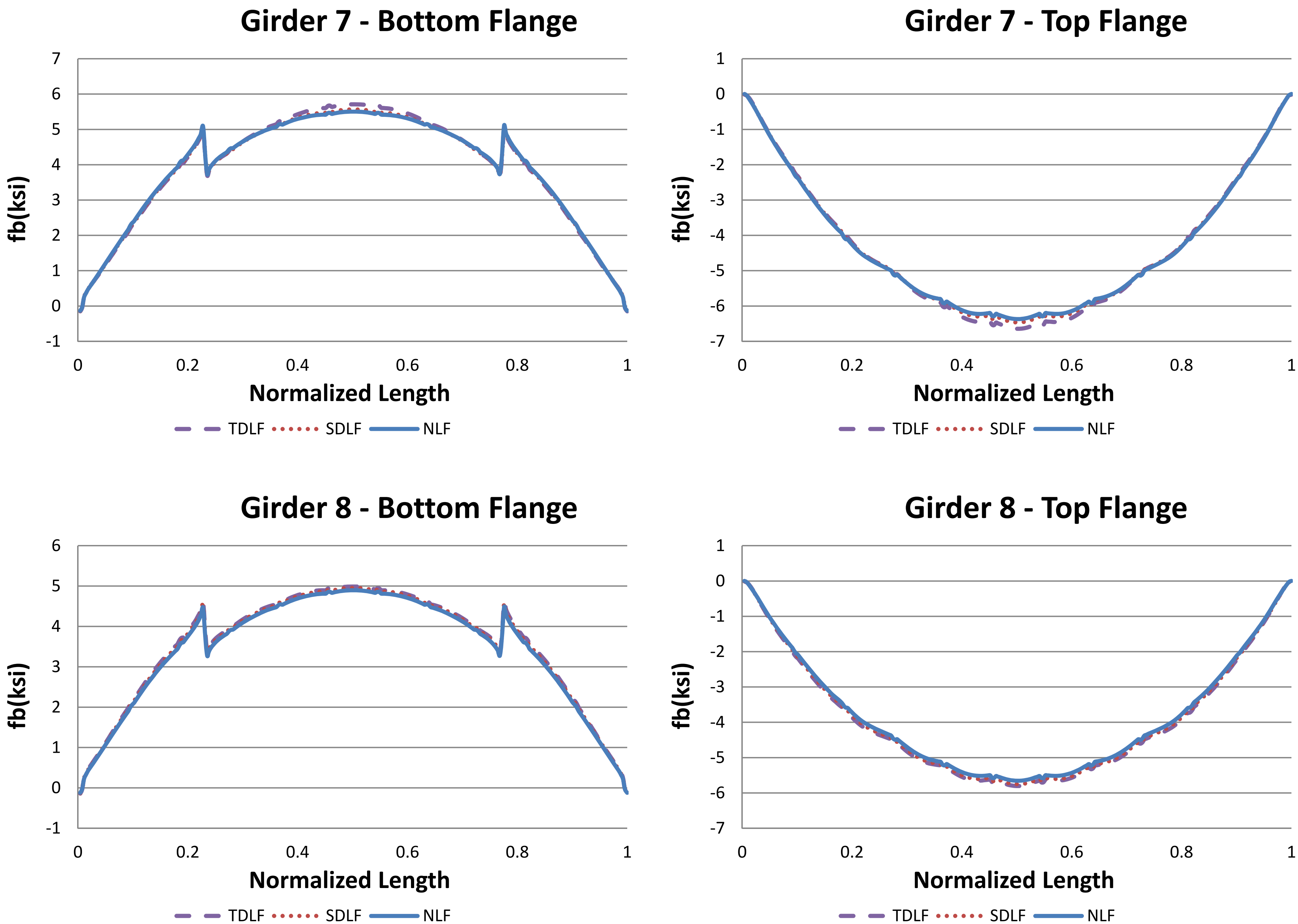
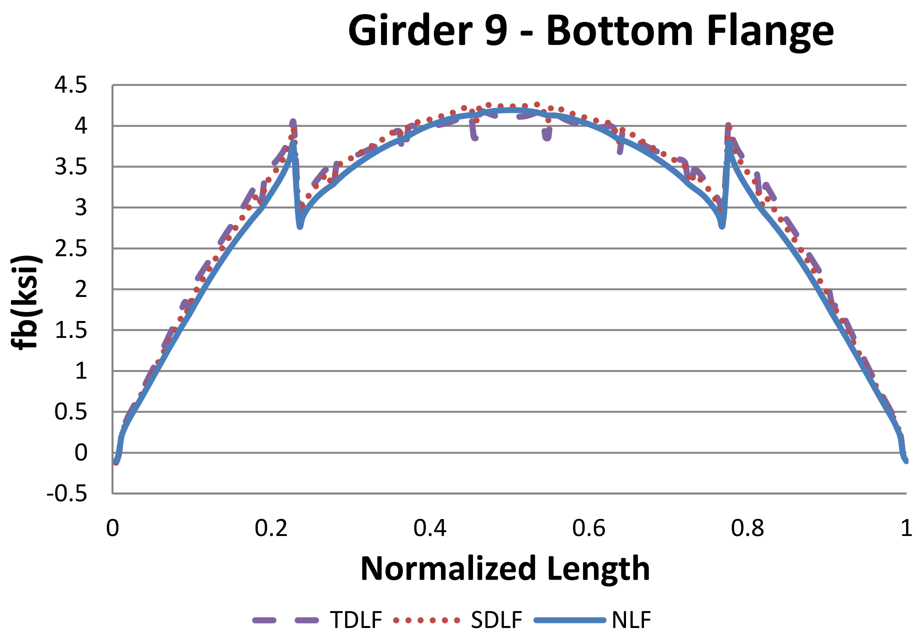


Figure D-4-18(Continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**



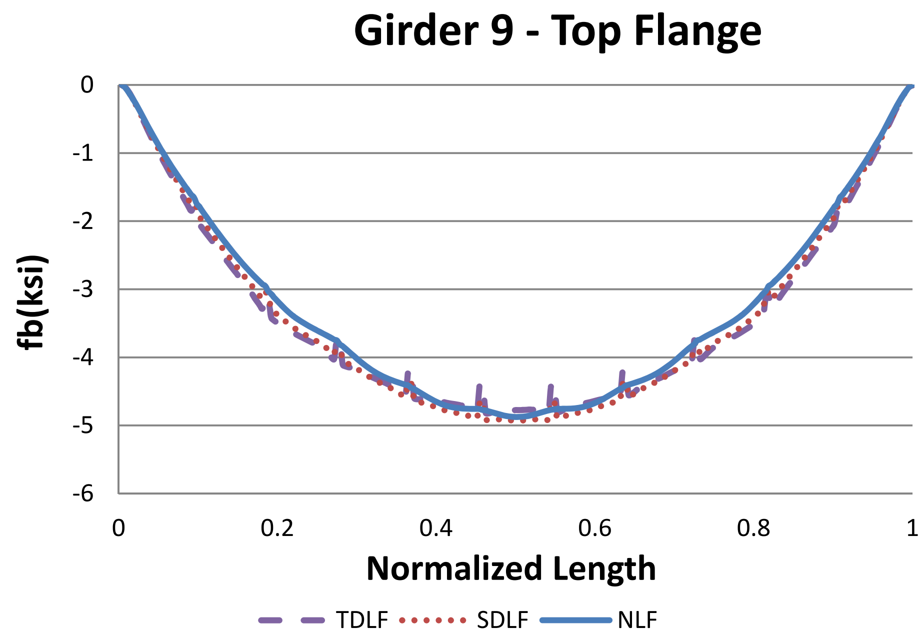


Figure D-4-18(Continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

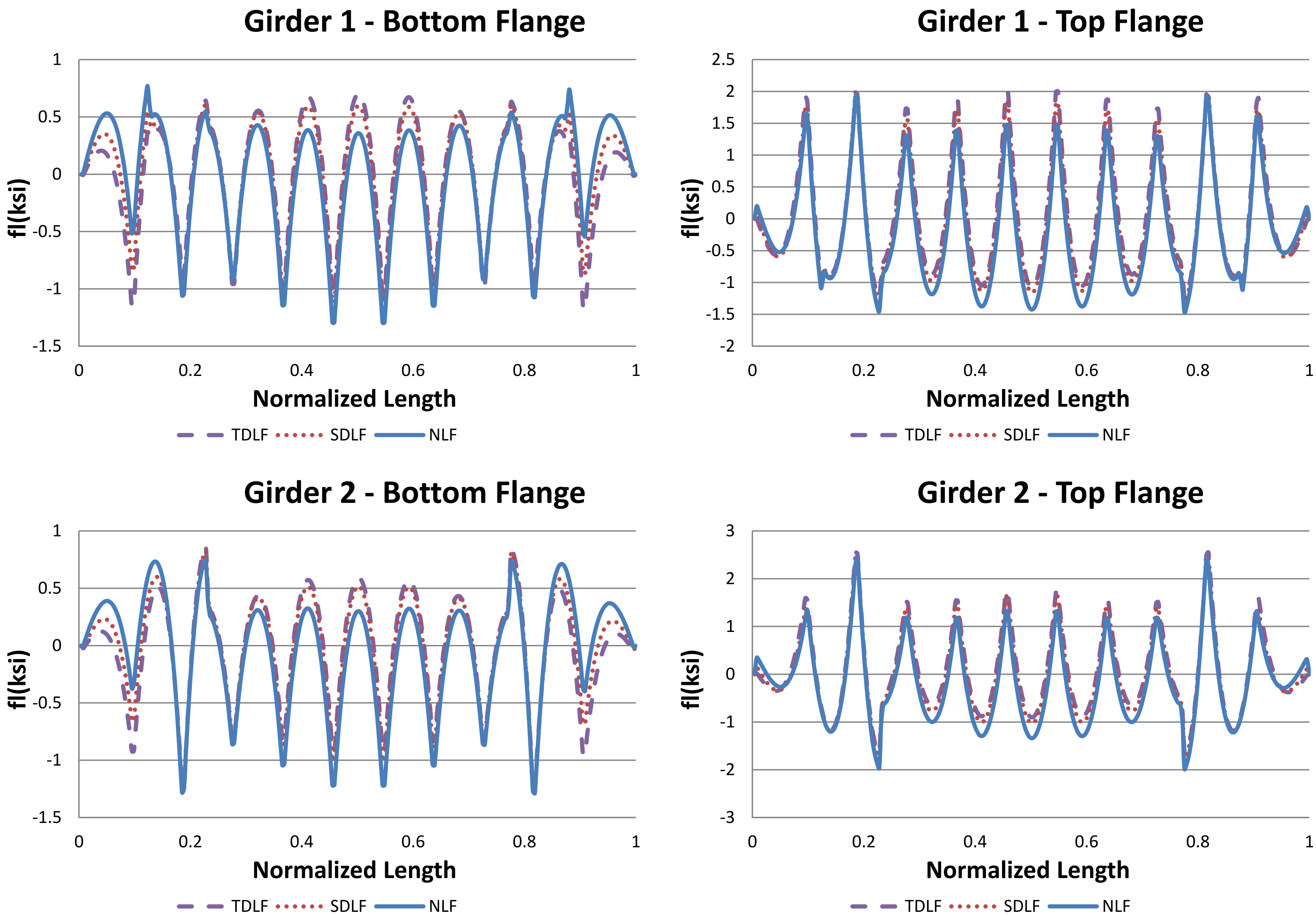


Figure D-4-19. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

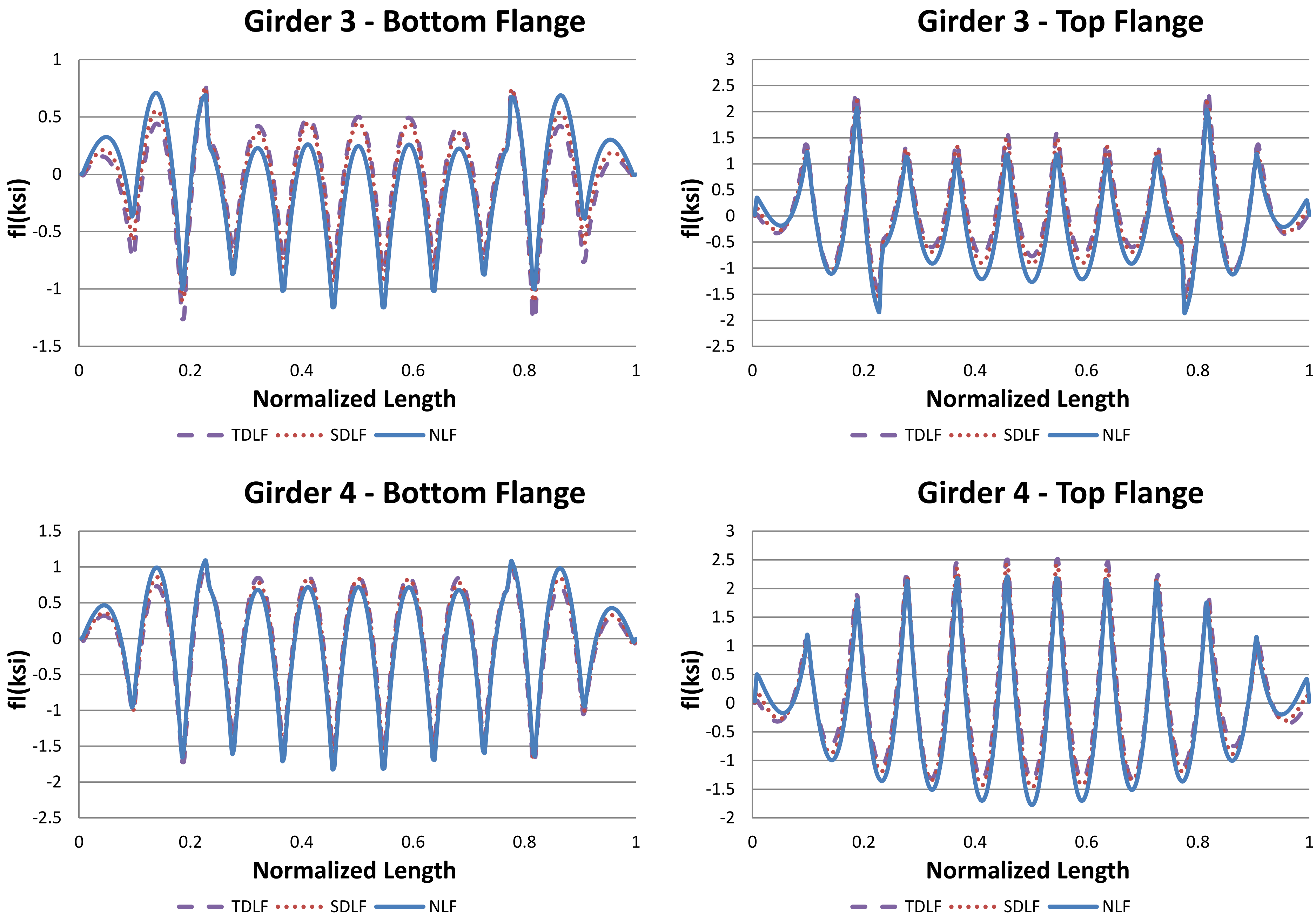


Figure D-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

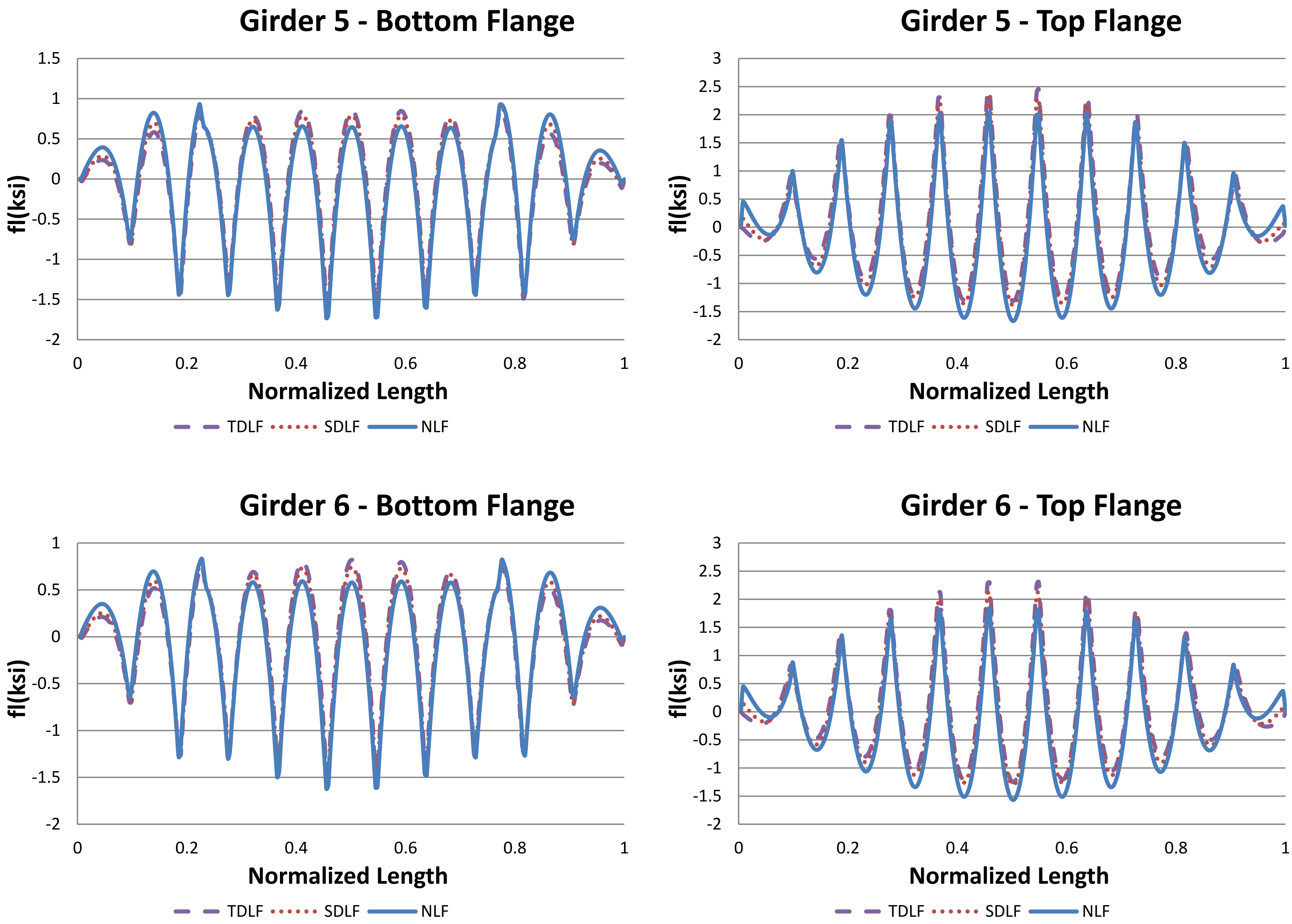


Figure D-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

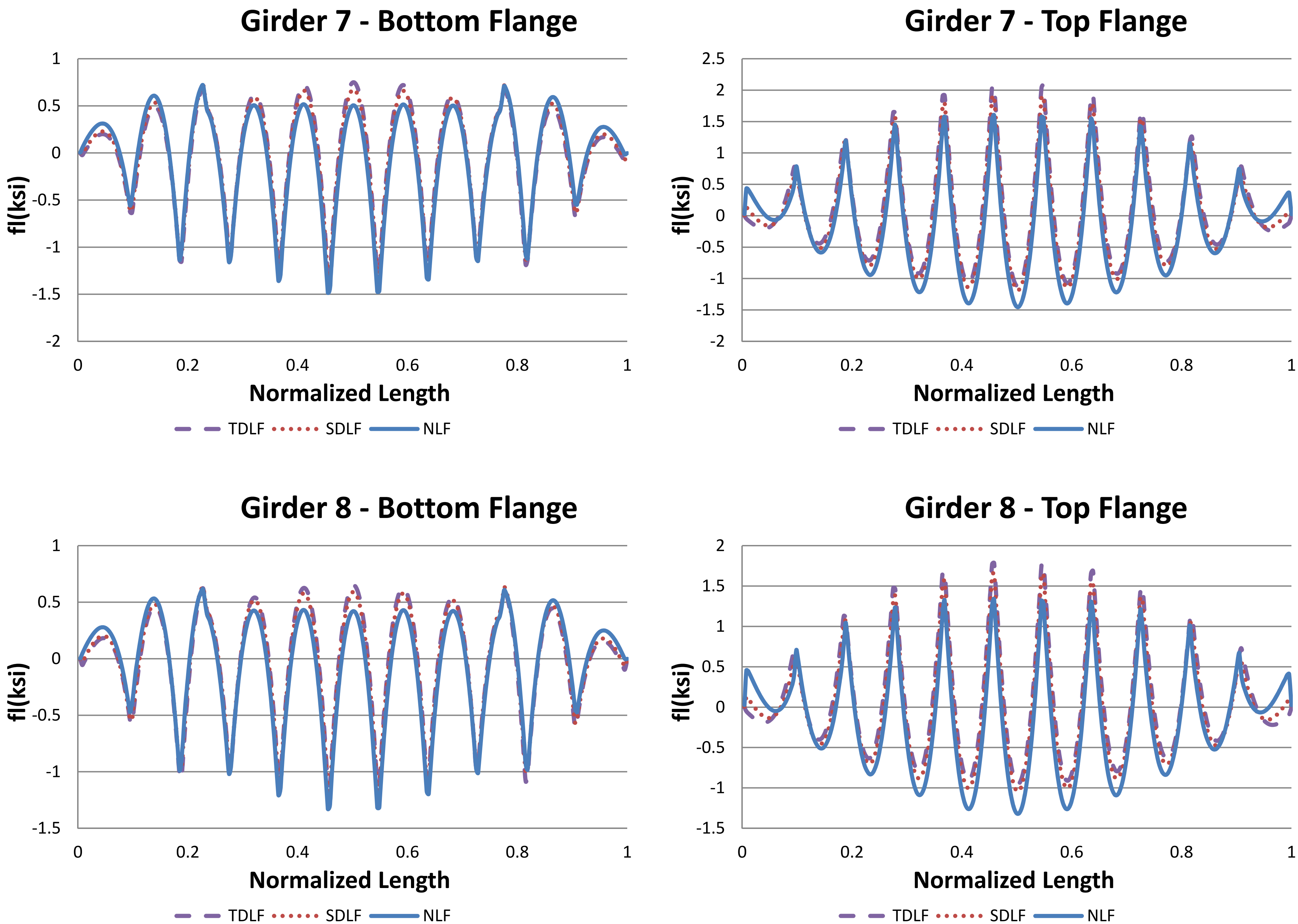
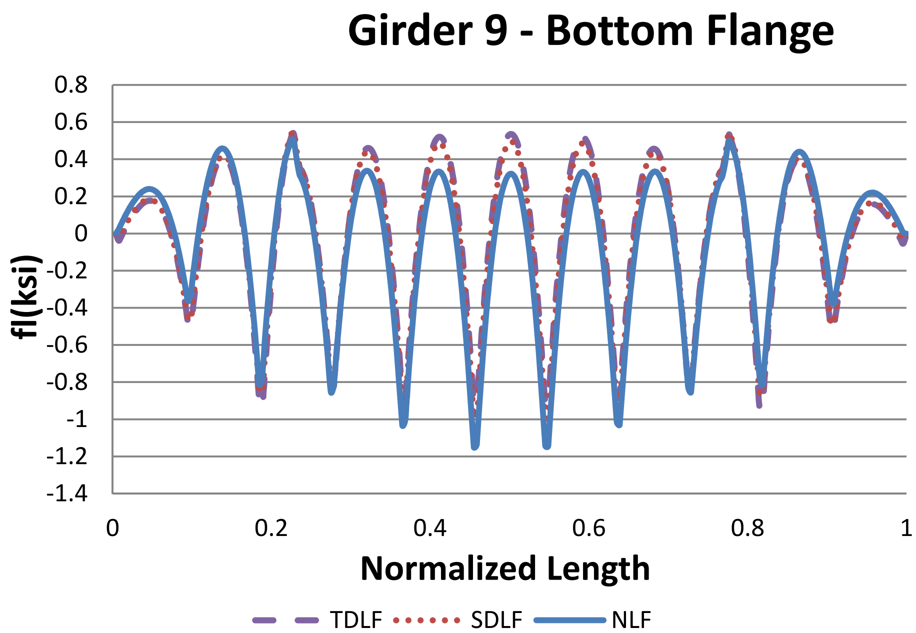


Figure D-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**



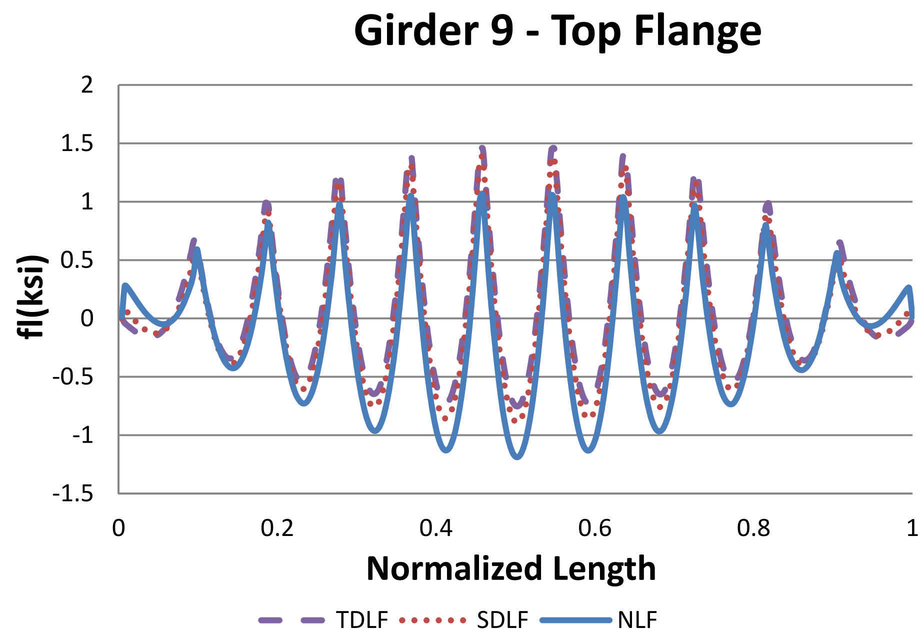


Figure D-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

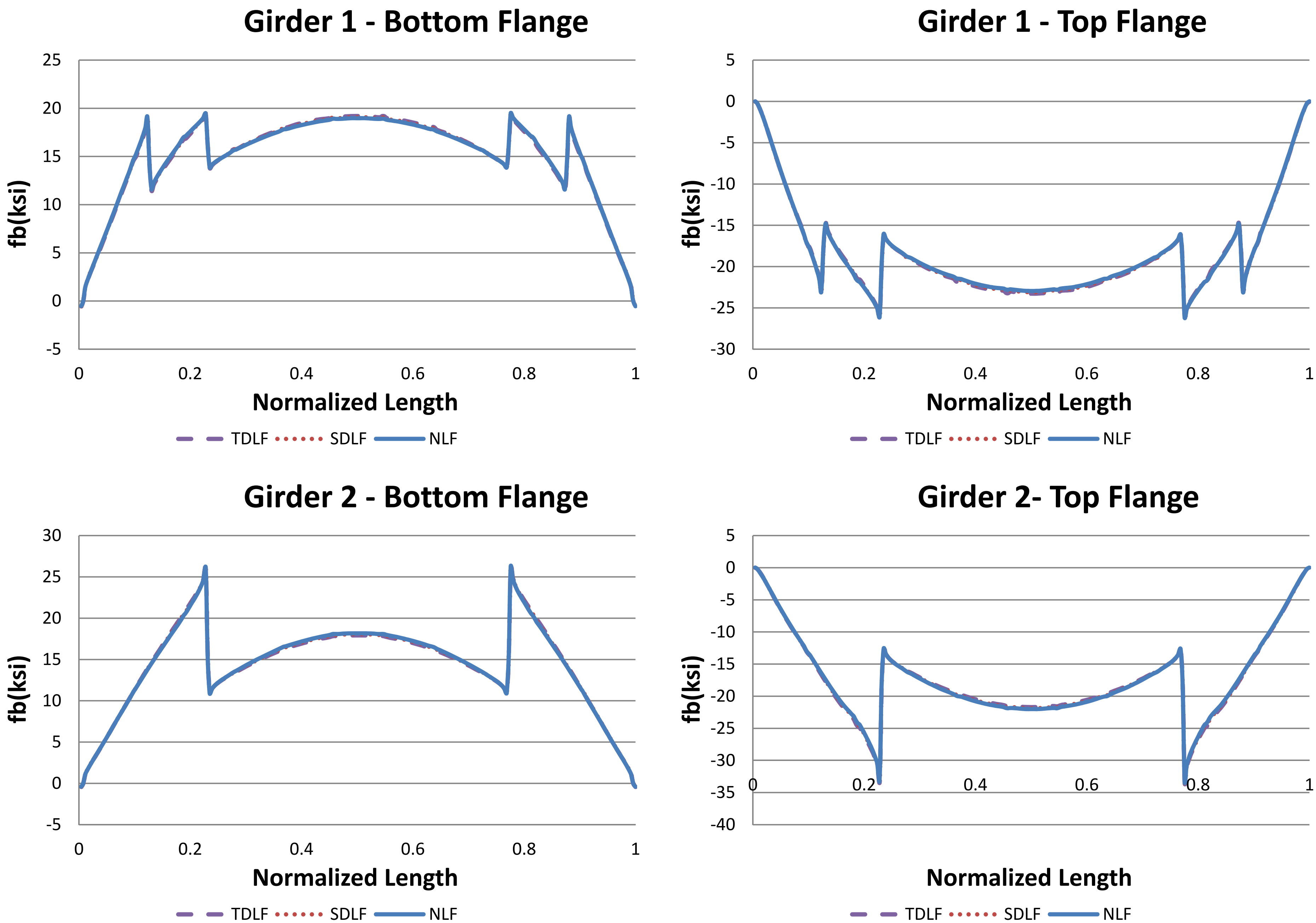


Figure D-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

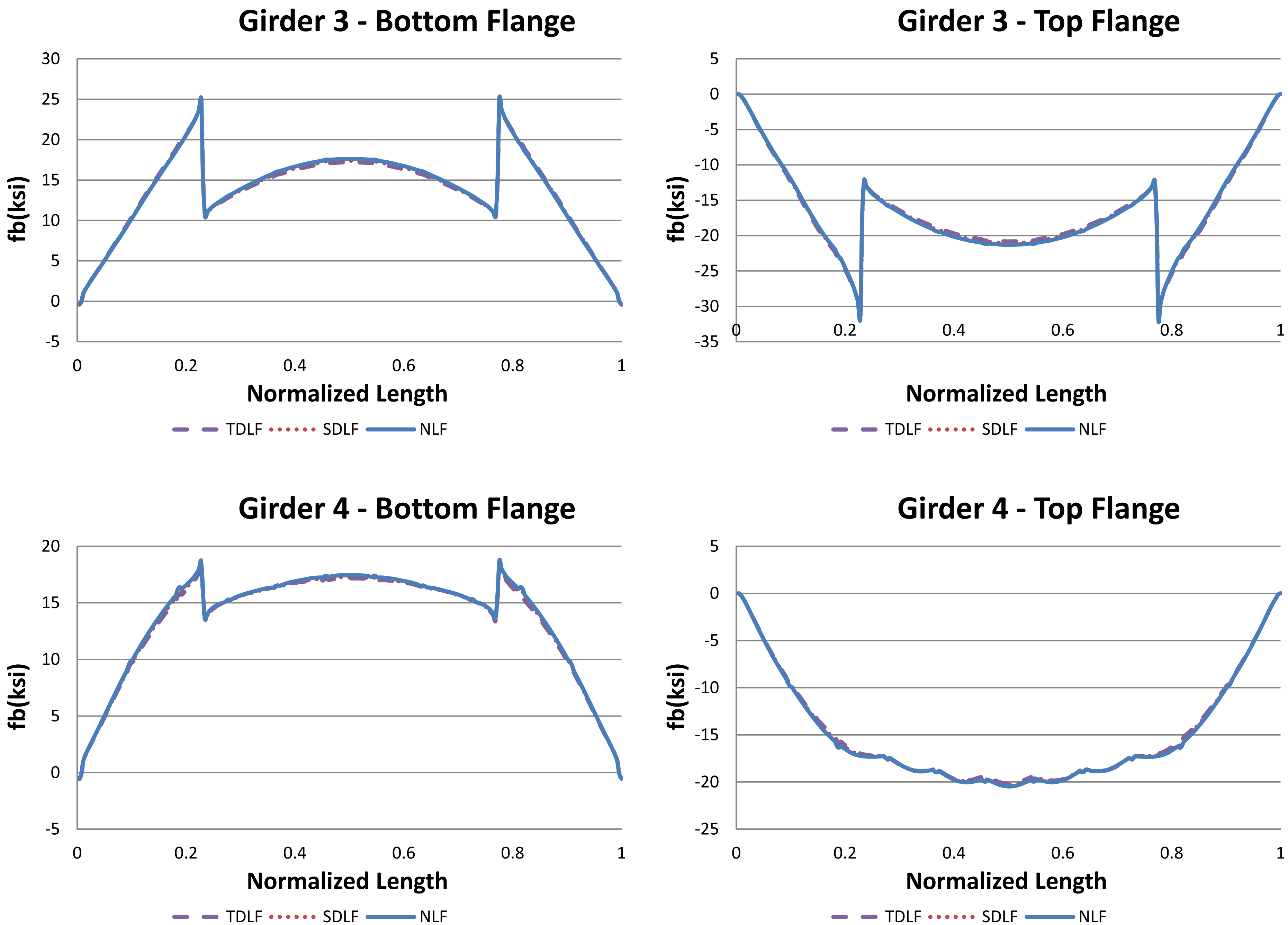
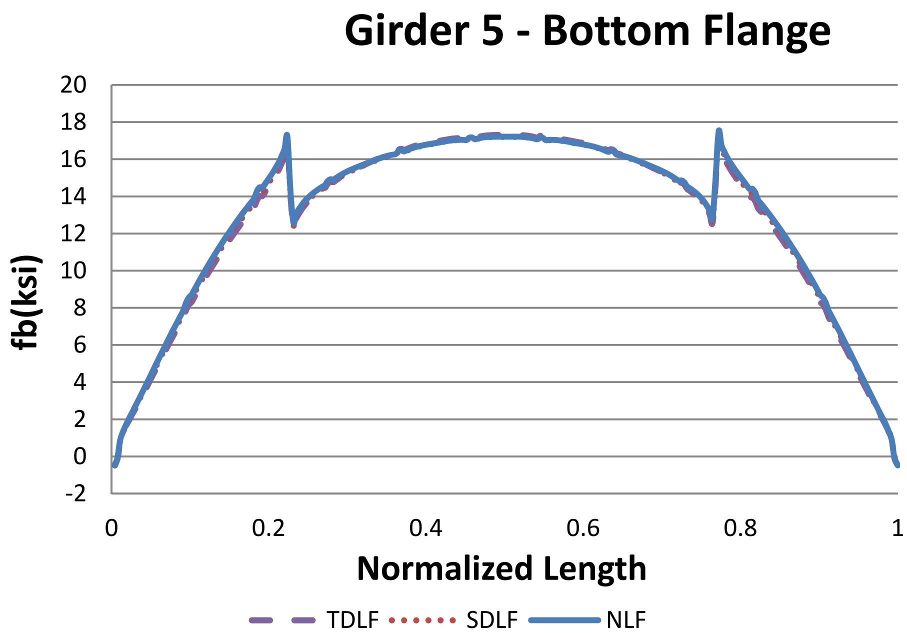
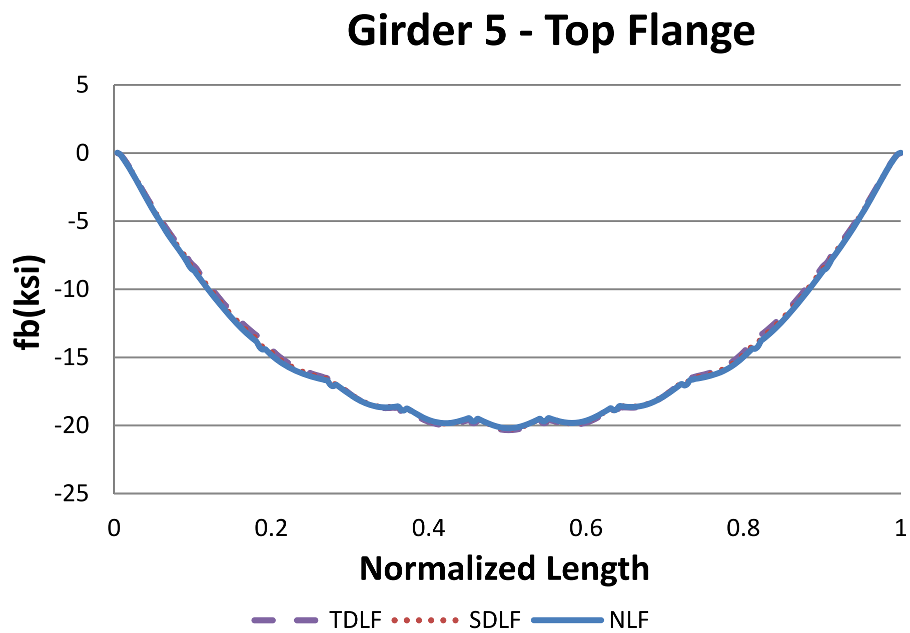
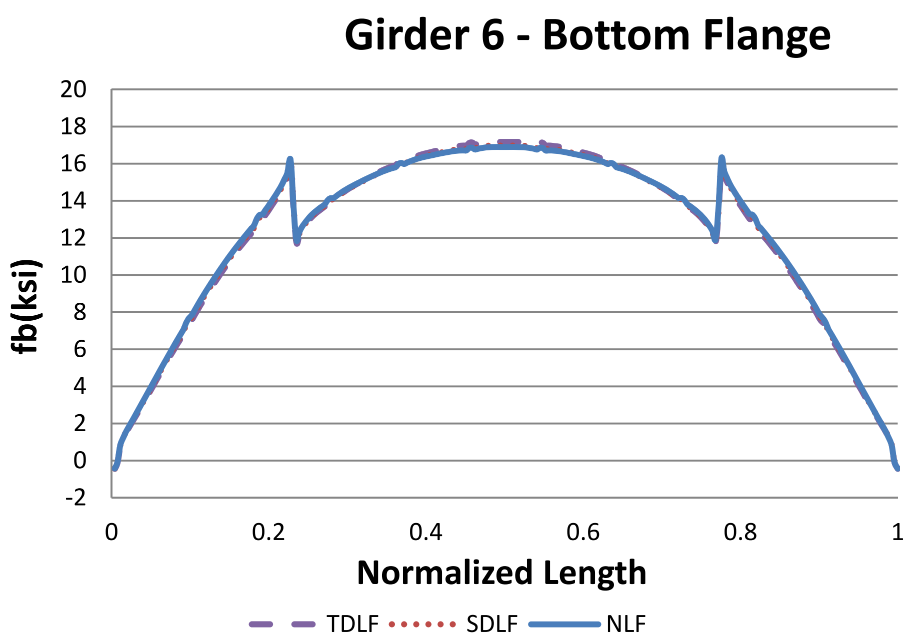


Figure D-4-20(Continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**







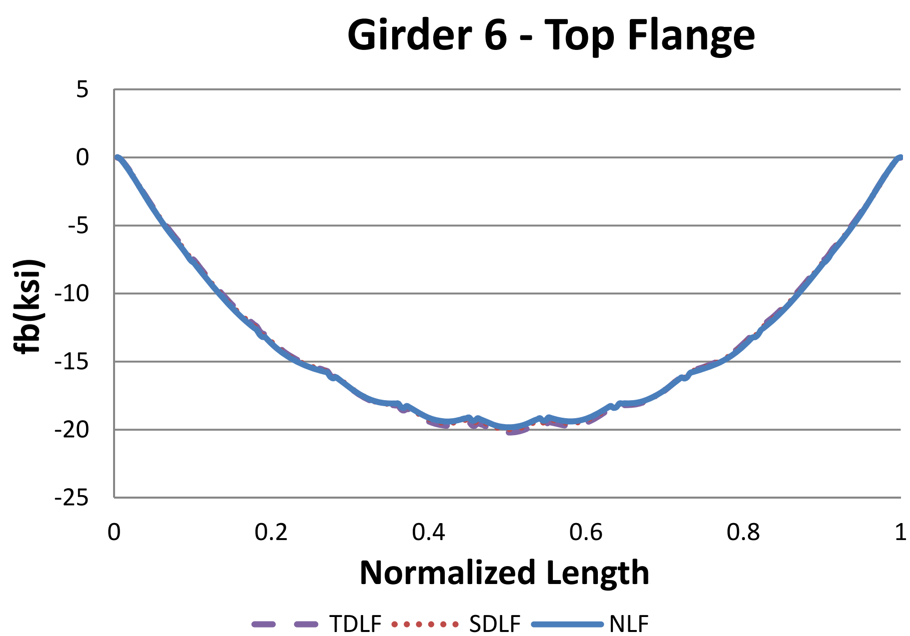
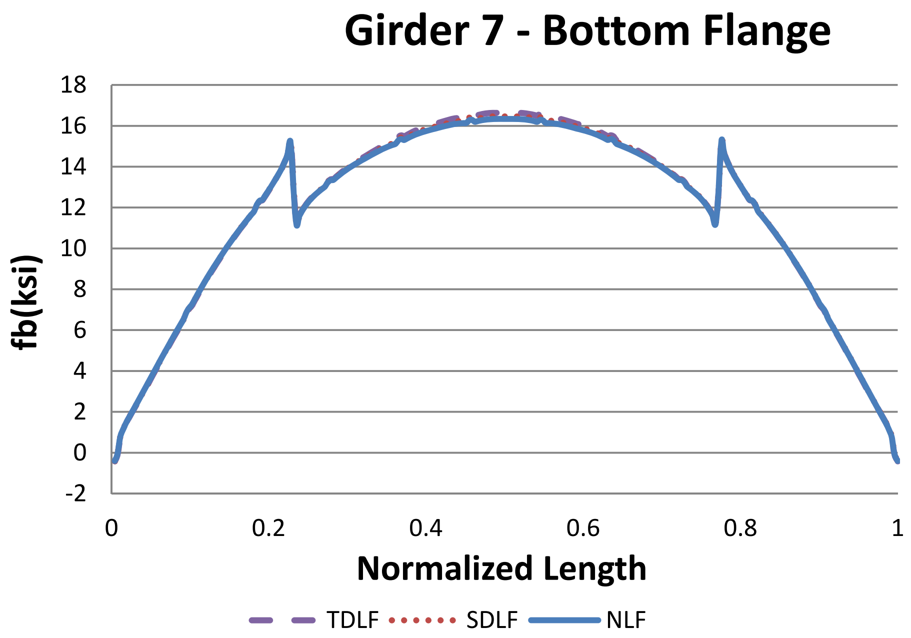
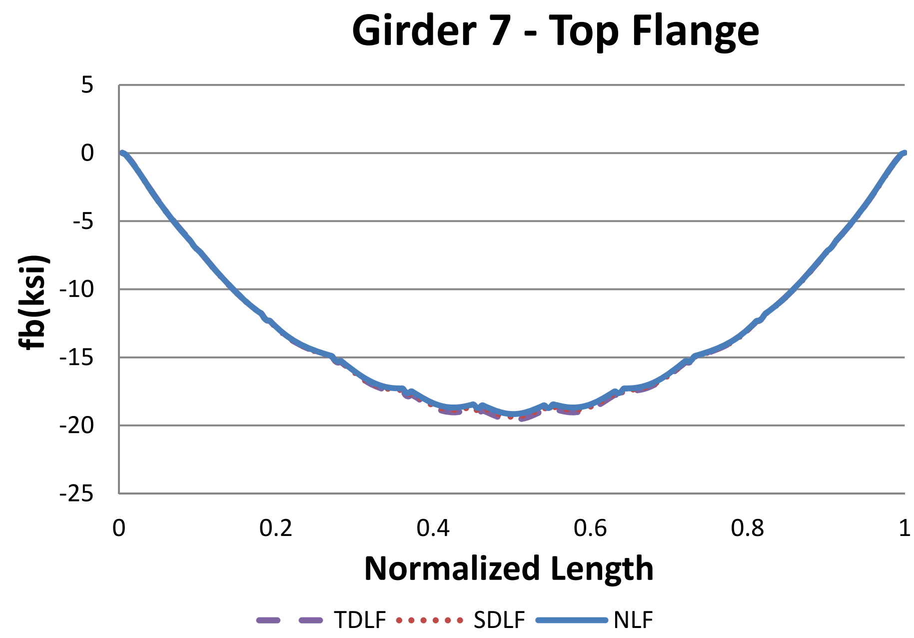
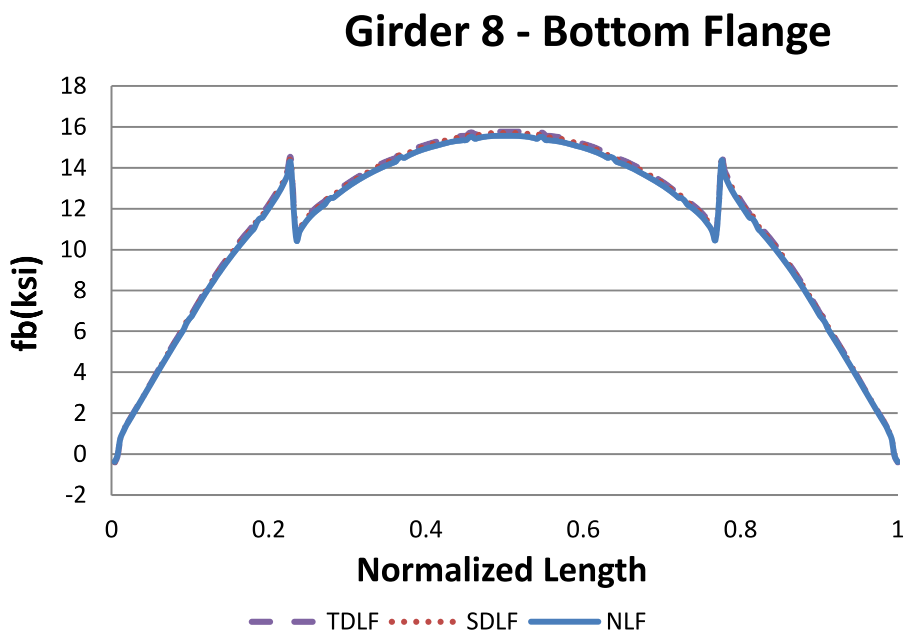


Figure D-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.







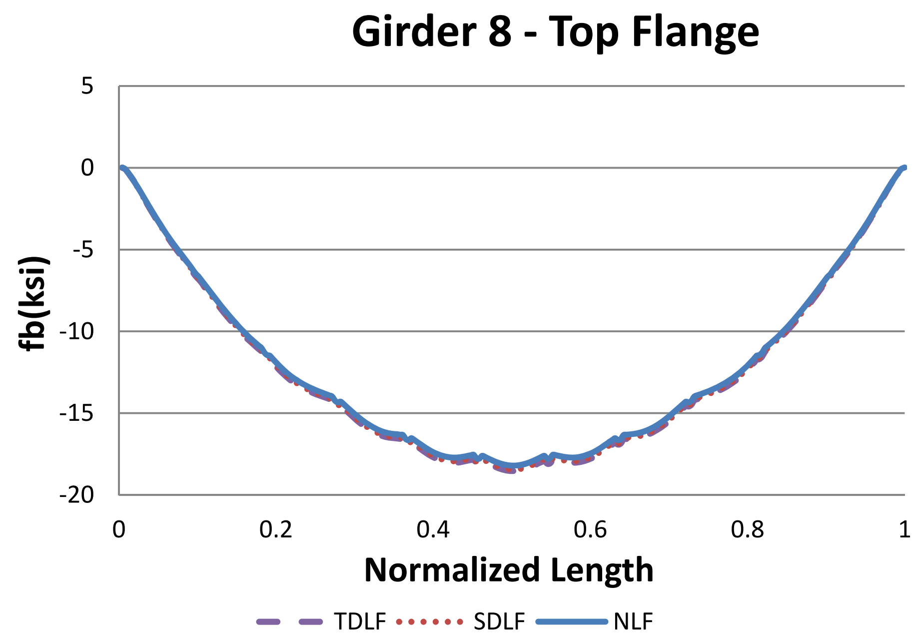
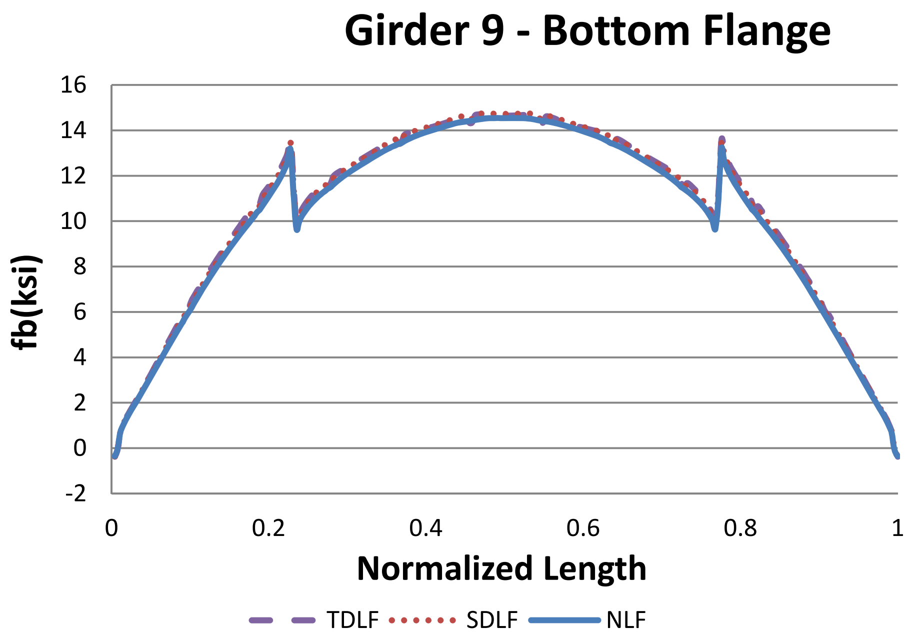


Figure D-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



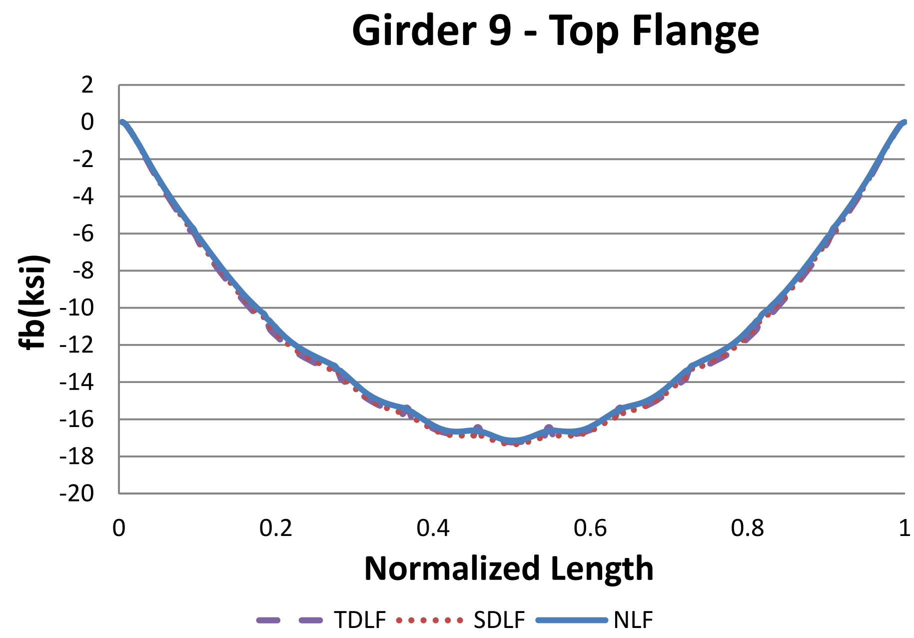


Figure D-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

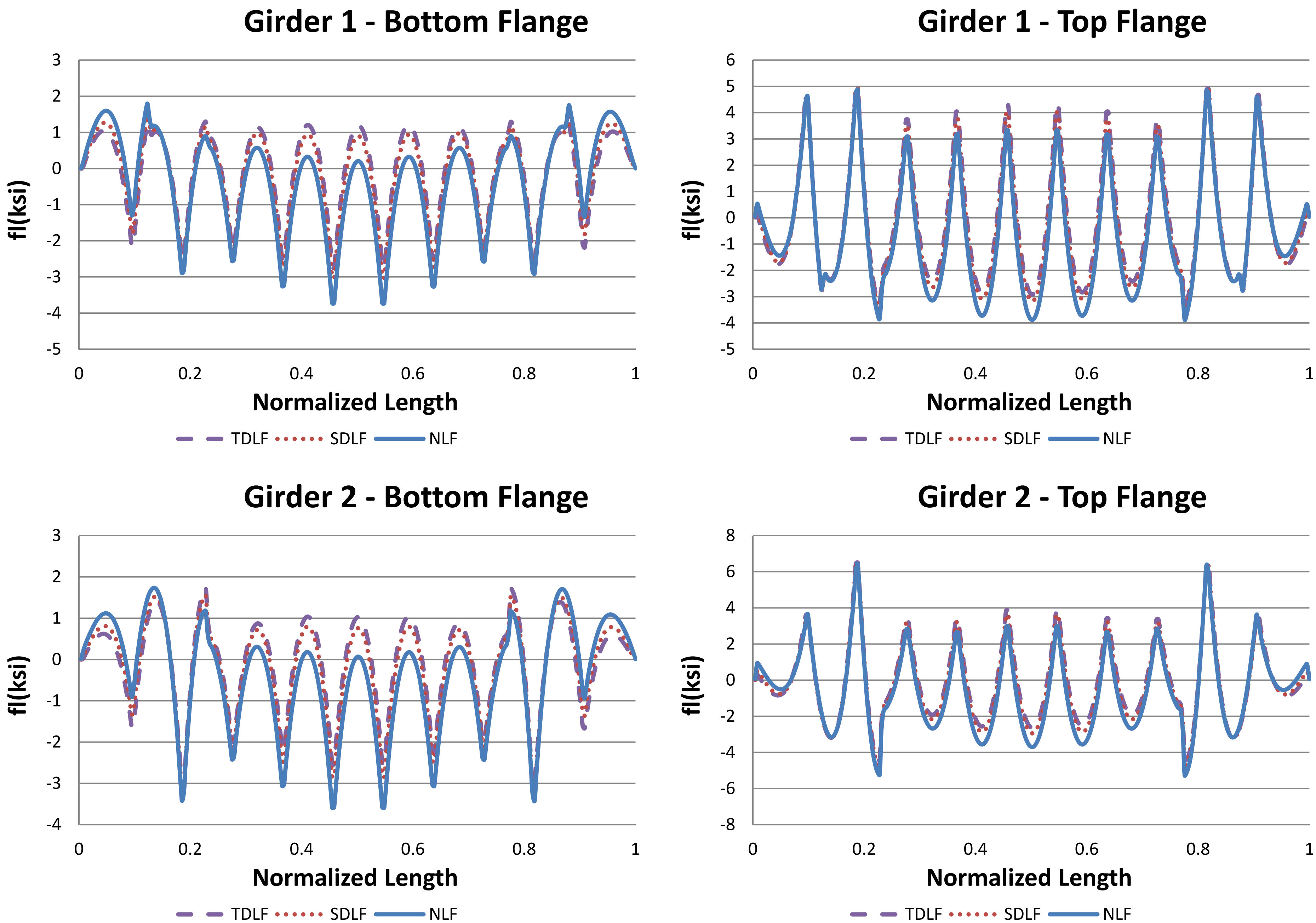


Figure D-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

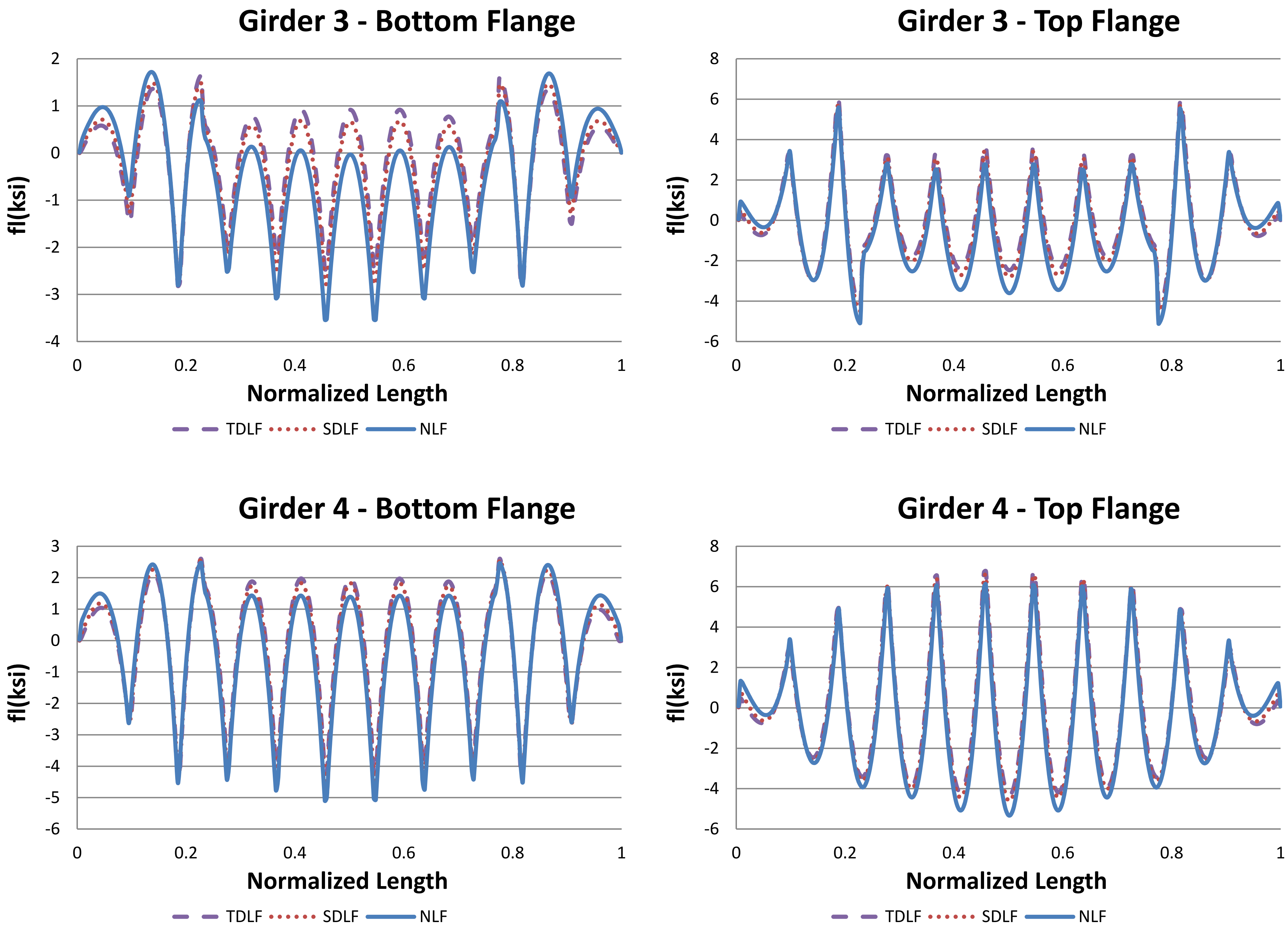


Figure D-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

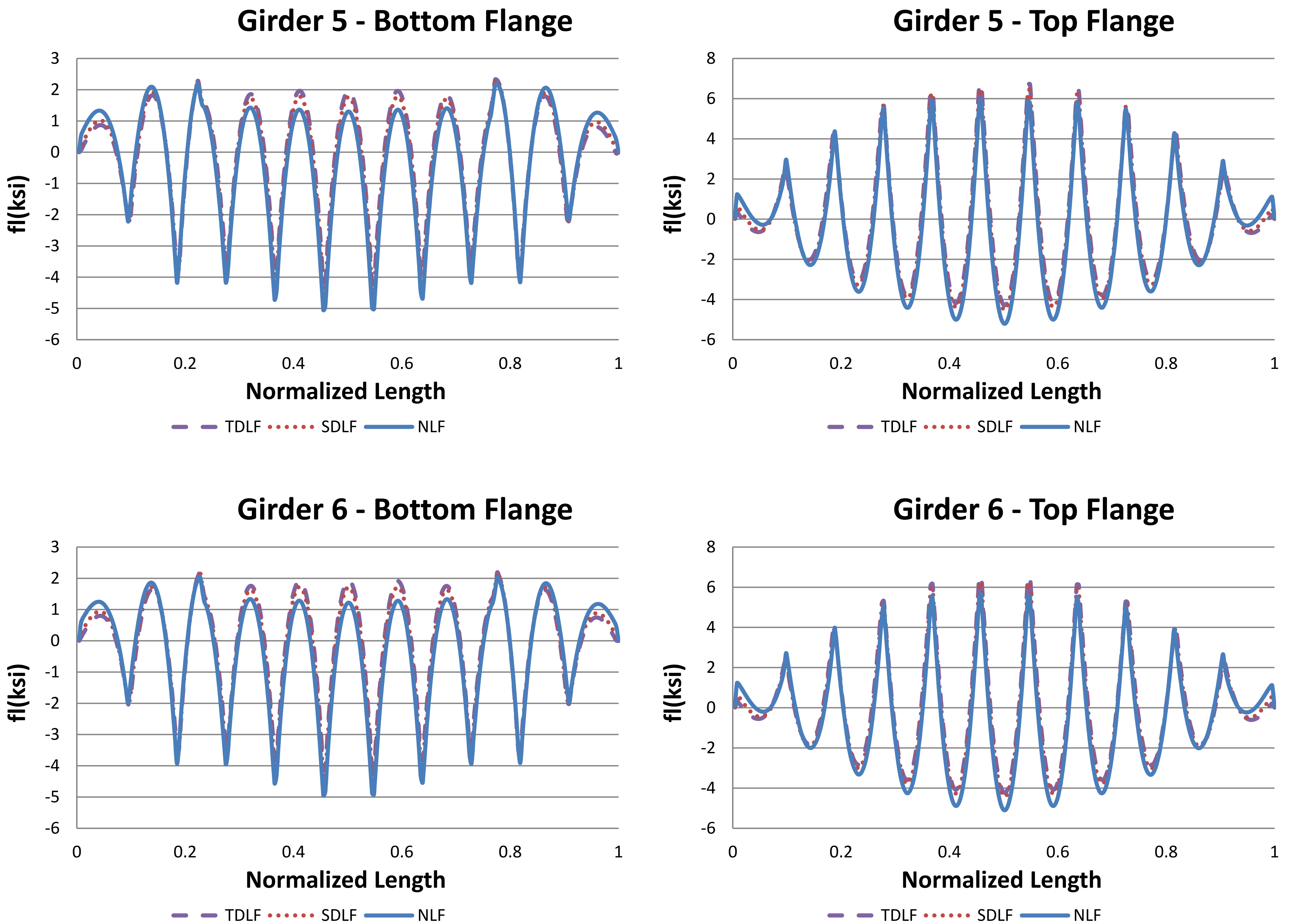


Figure D-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

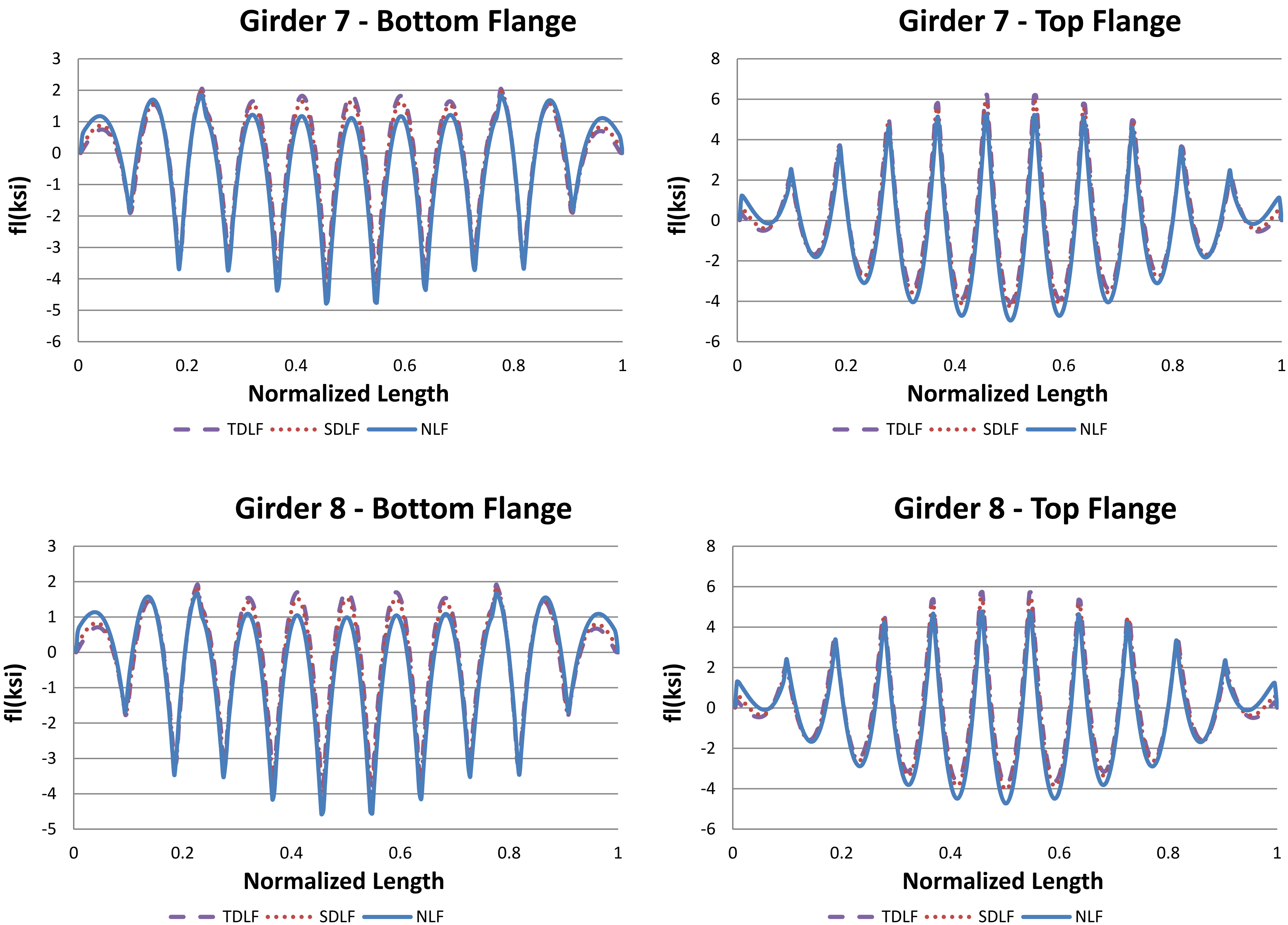
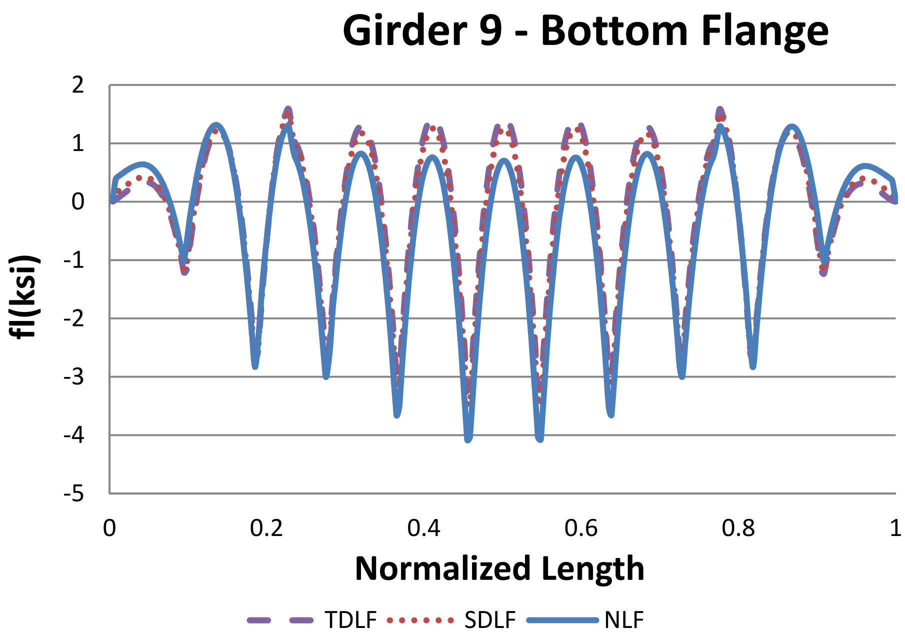


Figure D-4-21(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**



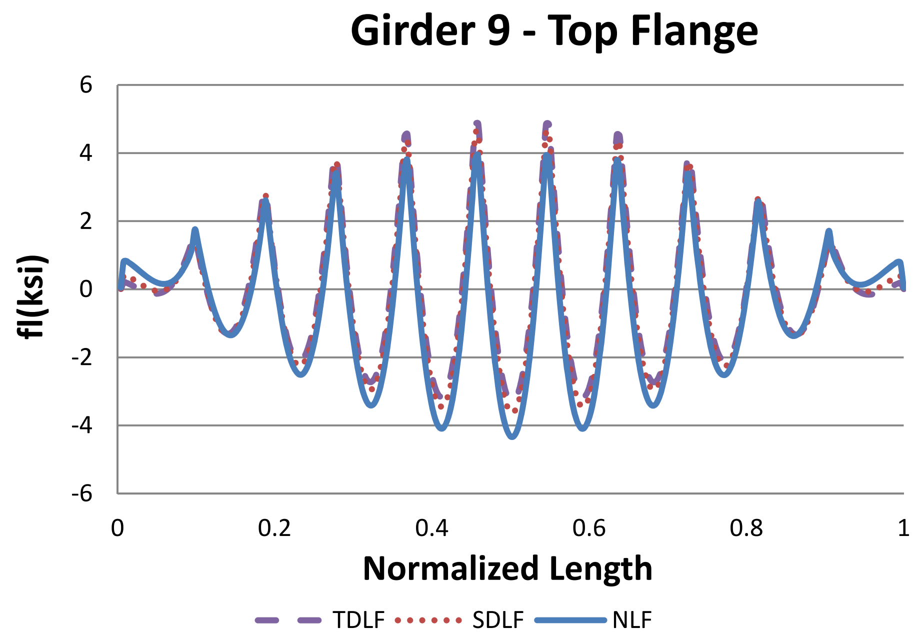


Figure D-4-21(Continued). **Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.**

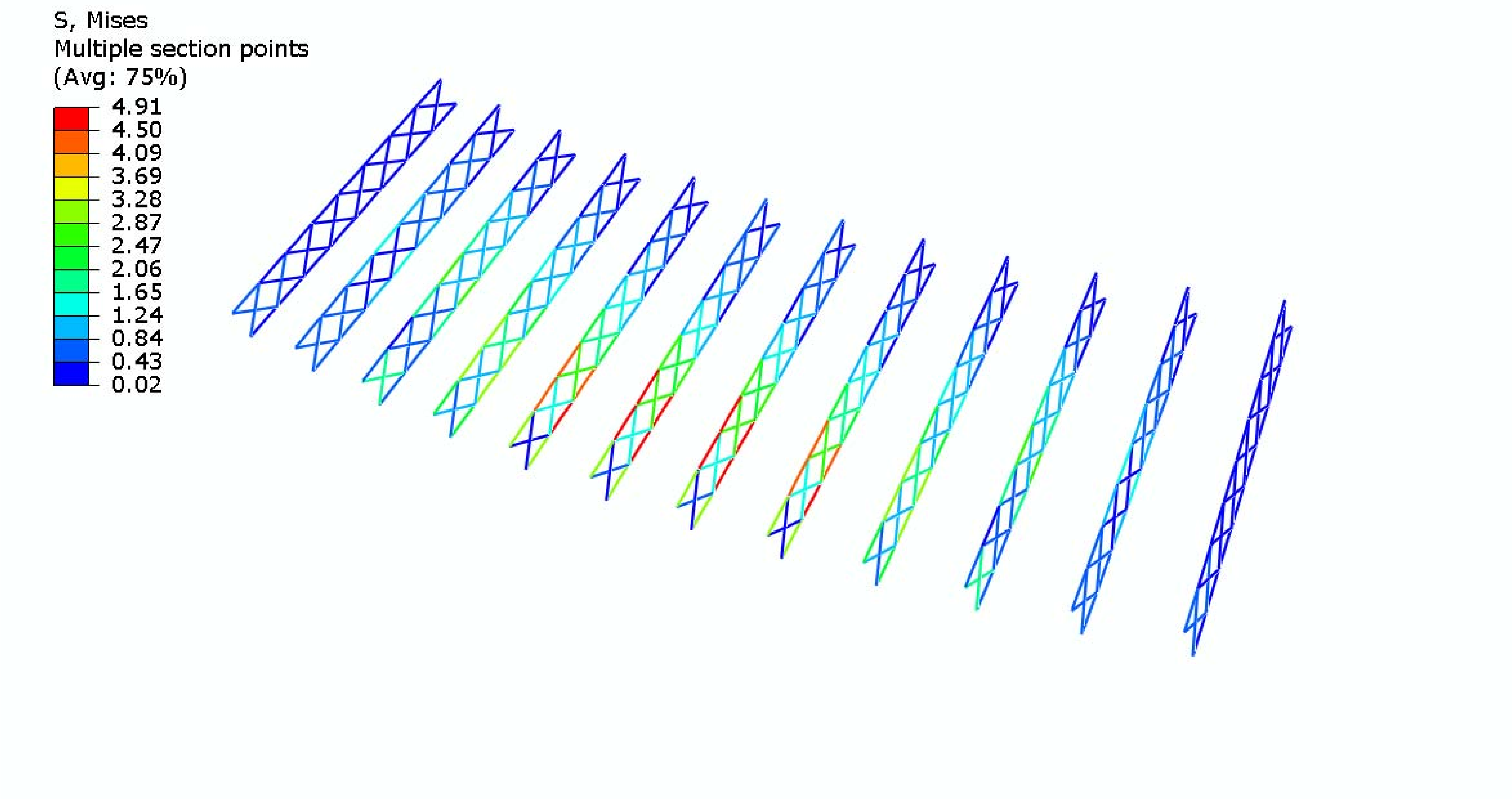


Figure D-4-22. **Cross-frame stress contours (ksi) under SDL, NLF detailing (all cross-frame member areas = 8.52 in²).**

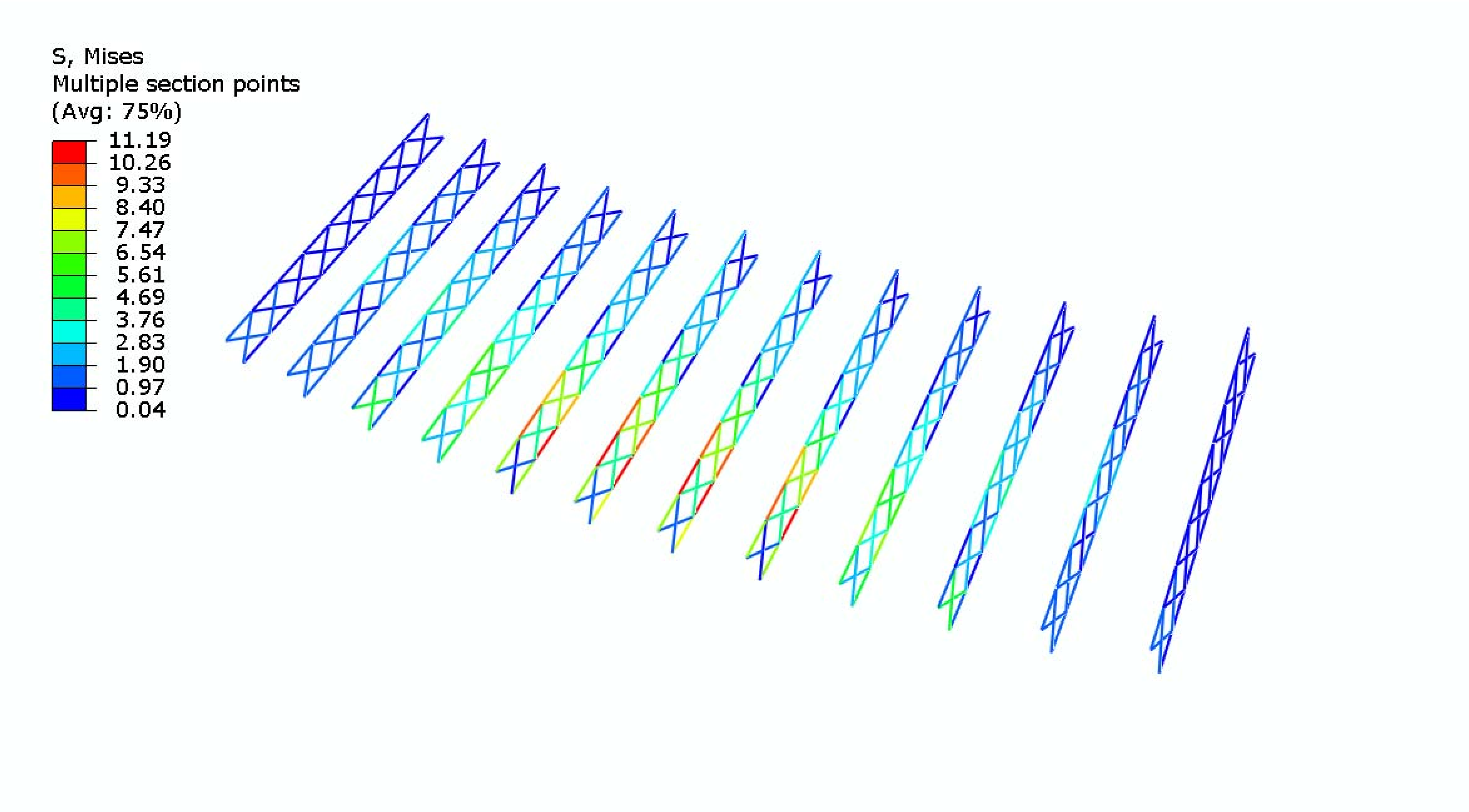


Figure D-4-23. Cross-frame stress contours under TDL, NLF detailing (all cross-frame member areas = 8.52 in^2).

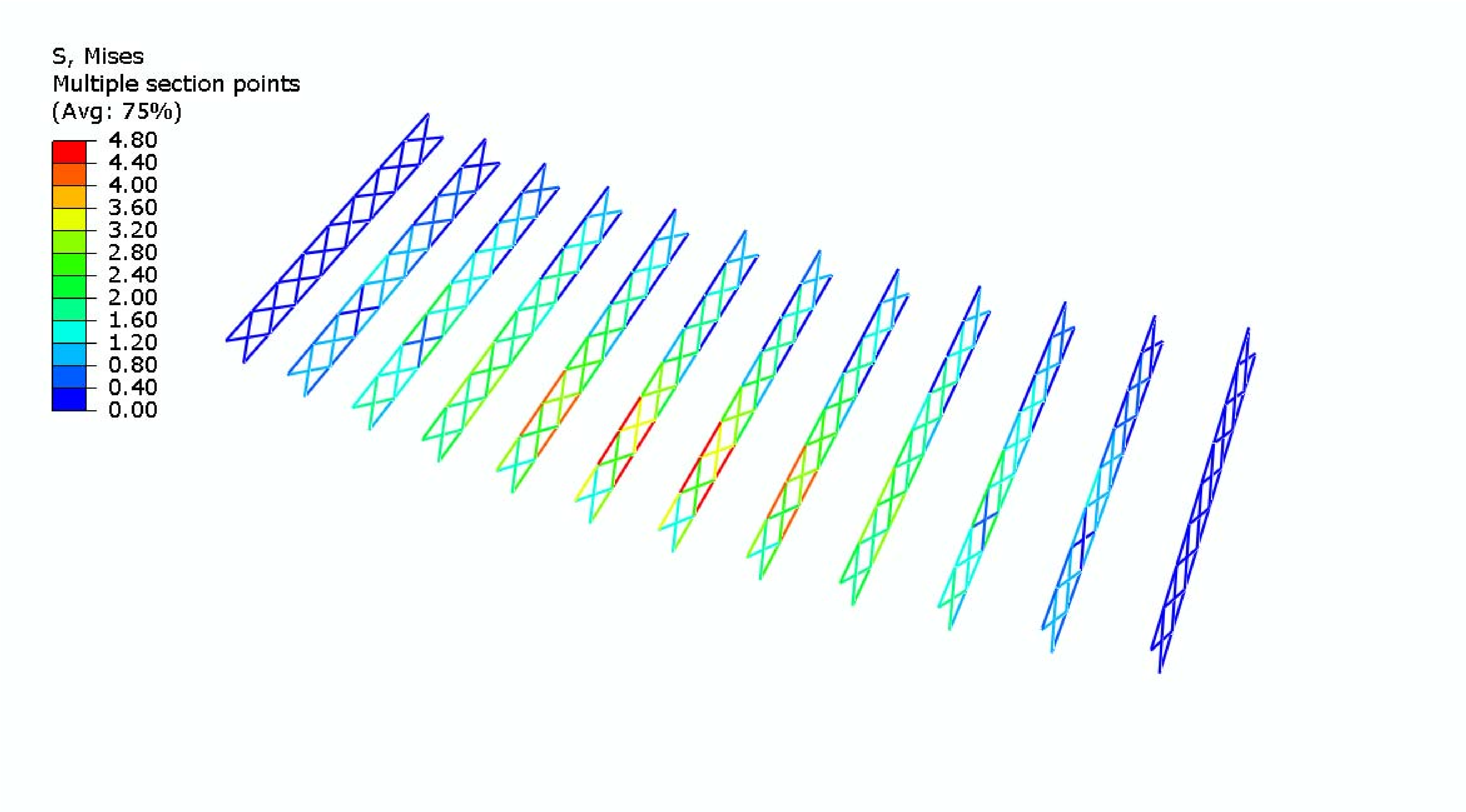


Figure D-4-24. Cross-frame stress contours under SDL, SDLF detailing (all cross-frame member areas = 8.52 in^2).

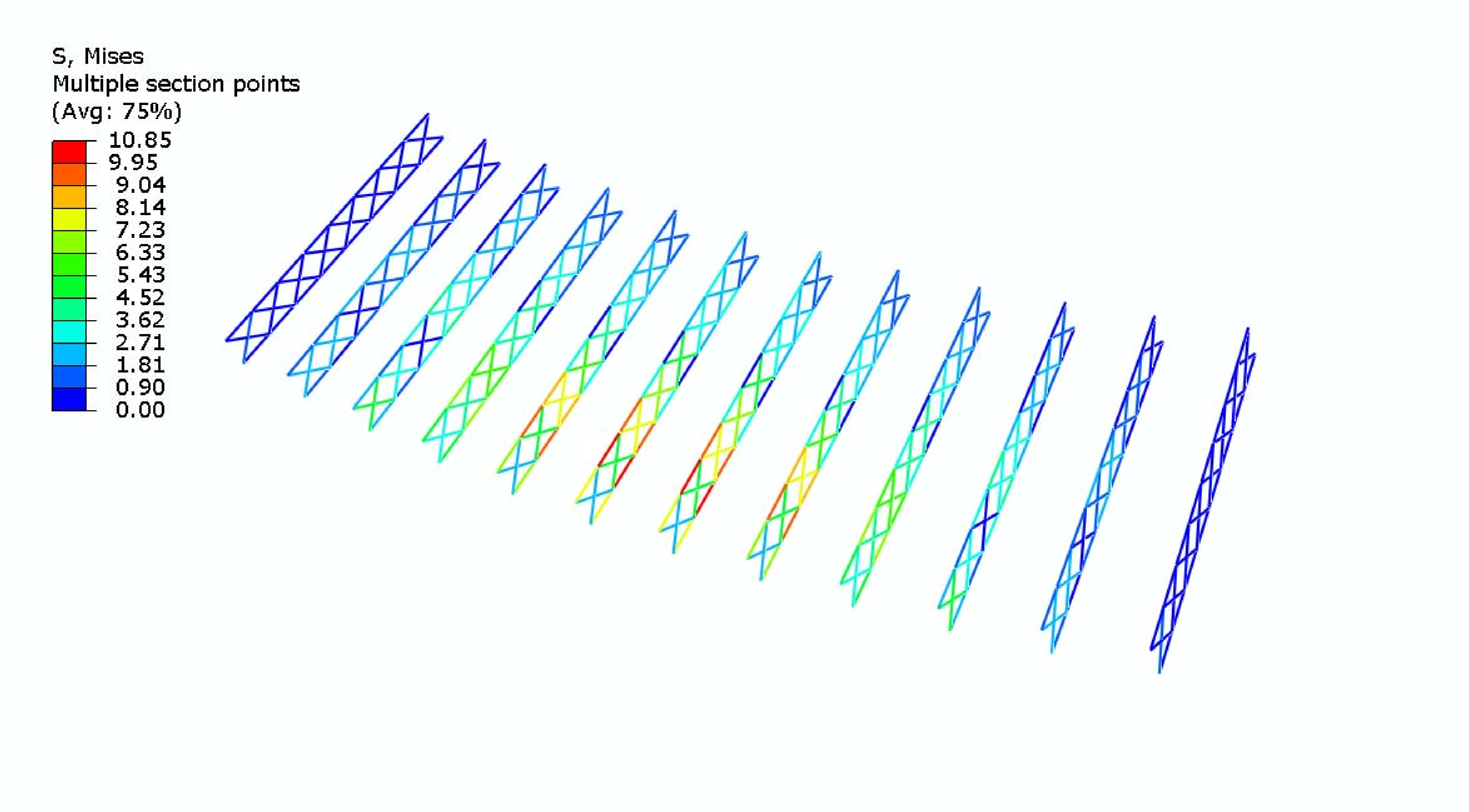


Figure D-4-25. Cross-frame stress contours under TDL, SDLF detailing (all cross-frame member areas = 8.52 in^2).

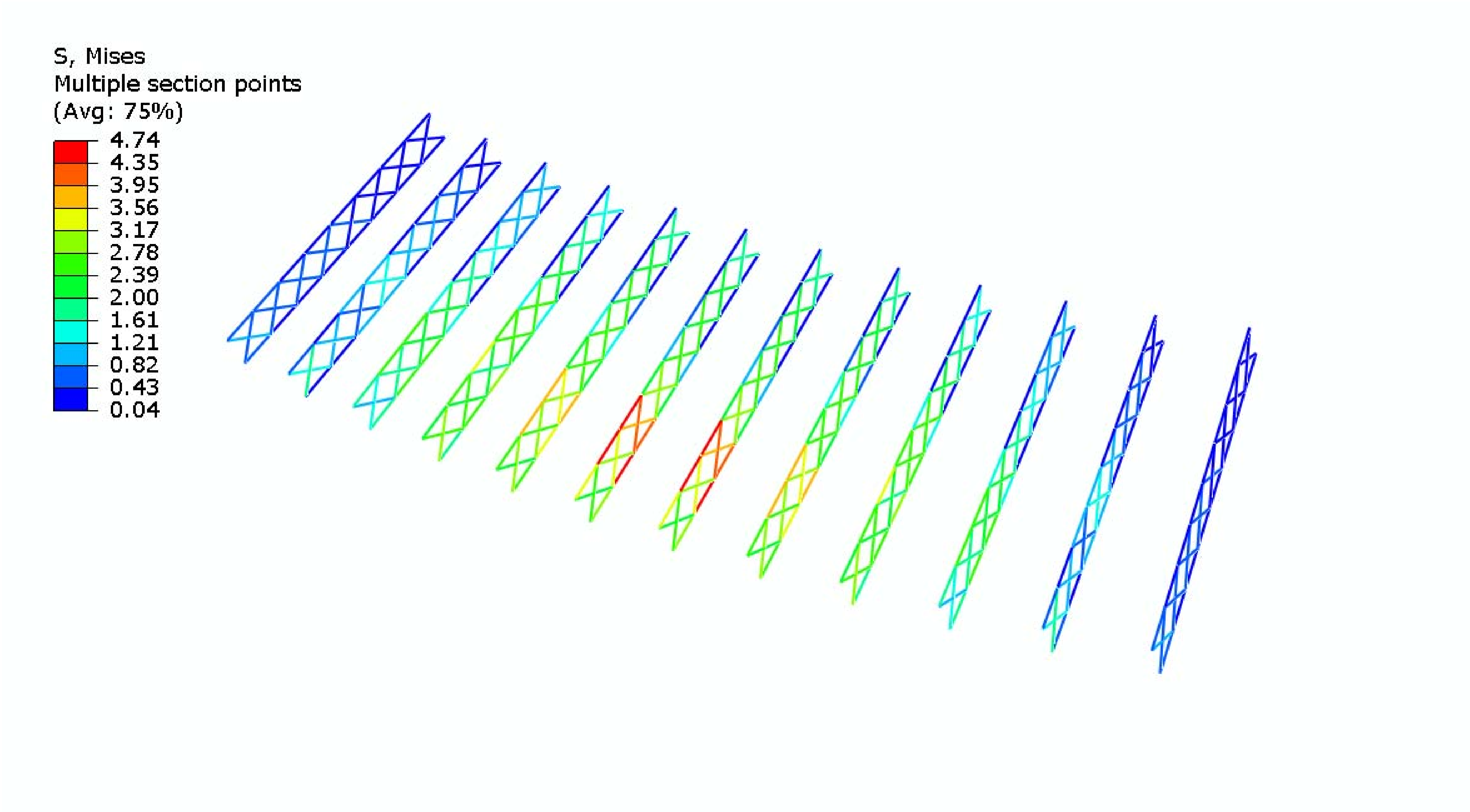


Figure D-4-26. Cross-frame stress contours under SDL, TDLF detailing (all cross-frame member areas = 8.52 in^2).

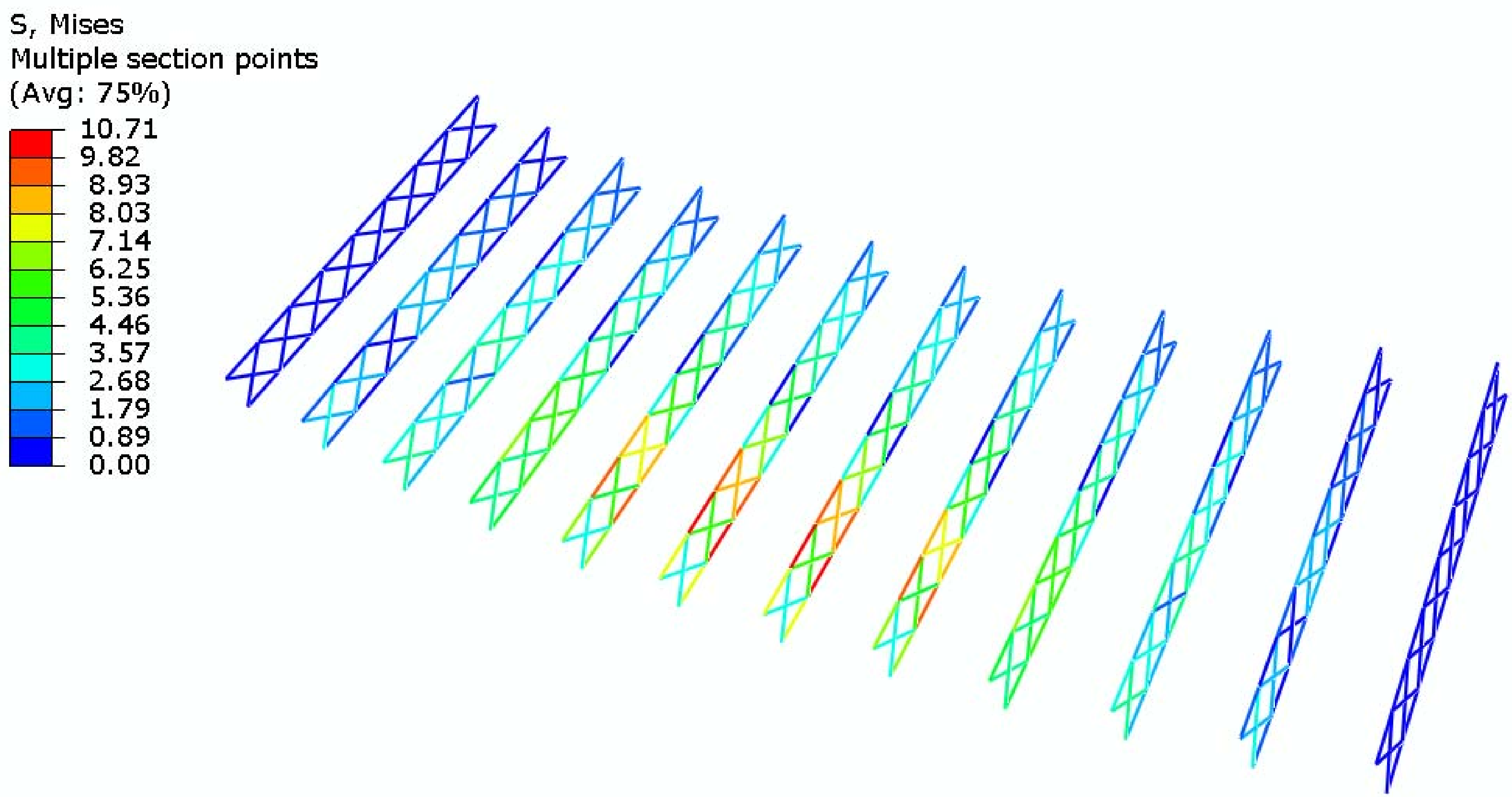


Figure D-4-27. Cross-frame stress contours under TDL, TDLF detailing (all cross-frame member areas = 8.52 in^2).

Table D-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	5.2	4.7	3.1	2.9	2.4	2.1	1.9	1.8
	SDLF	0.9	0.7	0.4	0.4	0.4	0.3	0.2	0.3
	TDLF	7.5	5.2	5.1	4.0	3.9	3.6	3.4	3.3
2	NLF	5.4	5.6	2.6	3.2	5.5	5.3	4.0	2.0
	SDLF	9.6	7.7	1.3	7.3	8.0	6.6	4.9	3.2
	TDLF	13.9	9.0	4.7	11.7	10.2	7.0	5.0	3.6
3	NLF	17.4	5.9	5.3	7.3	9.6	8.5	6.3	3.1
	SDLF	16.3	11.9	6.6	13.9	13.4	11.3	8.8	6.0
	TDLF	11.7	15.6	20.0	19.9	16.0	12.6	9.9	7.7
4	NLF	7.4	10.5	15.3	10.3	10.1	9.1	6.9	3.5
	SDLF	16.0	17.0	18.7	16.6	16.3	14.4	11.7	8.2
	TDLF	24.2	21.8	18.4	21.1	21.5	18.8	15.5	11.4
5	NLF	3.3	12.7	21.7	15.5	11.9	9.4	6.6	3.2
	SDLF	13.8	20.7	26.5	20.6	18.0	15.8	13.2	9.6
	TDLF	24.0	26.5	27.5	22.4	22.0	20.9	18.7	14.5
6	NLF	4.0	13.8	21.9	18.5	13.9	9.9	6.5	2.9
	SDLF	13.3	22.8	29.5	24.0	19.3	16.2	13.7	10.2
	TDLF	21.5	29.9	34.3	26.0	21.7	20.6	19.8	16.1
7	NLF	4.0	13.8	21.9	18.5	13.9	9.9	6.5	2.9
	SDLF	13.3	22.9	29.5	24.0	19.3	16.2	13.7	10.2
	TDLF	21.5	29.9	34.3	26.0	21.7	20.6	19.8	16.1
8	NLF	3.3	12.8	21.7	15.4	11.9	9.3	6.6	3.2
	SDLF	13.8	20.7	26.6	20.6	18.0	15.8	13.2	9.6
	TDLF	24.0	26.5	27.5	22.4	21.9	20.8	18.7	14.5
9	NLF	7.4	10.5	15.3	10.4	10.0	9.0	6.9	3.5
	SDLF	16.0	17.0	18.7	16.6	16.3	14.4	11.7	8.2
	TDLF	24.2	21.8	18.4	21.0	21.5	18.8	15.5	11.4
10	NLF	17.4	5.9	5.3	7.4	9.5	8.5	6.3	3.1
	SDLF	16.3	11.9	6.6	13.9	13.4	11.3	8.8	6.0
	TDLF	11.6	15.6	20.0	19.9	16.0	12.6	9.9	7.7

Table D-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	5.4	5.6	2.6	3.1	5.6	5.3	4.0	2.0
	SDLF	9.6	7.7	1.3	7.3	8.0	6.5	4.9	3.2
	TDLF	13.9	9.0	4.8	11.8	10.1	7.0	5.0	3.6
12	NLF	5.2	4.7	3.1	2.9	2.4	2.1	1.9	1.7
	SDLF	0.9	0.6	0.3	0.4	0.3	0.3	0.2	0.3
	TDLF	7.4	5.1	5.1	4.0	3.8	3.6	3.4	3.2

Table D-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	13.0	11.7	8.2	7.7	6.7	6.1	5.7	5.3
	SDLF	8.6	7.6	5.5	4.9	4.5	4.2	4.0	3.8
	TDLF	2.6	1.9	1.1	0.8	0.7	0.7	0.8	0.6
2	NLF	15.5	15.9	4.3	8.6	13.6	12.8	9.1	3.9
	SDLF	19.3	18.1	0.1	12.8	16.1	14.0	10.1	5.1
	TDLF	23.5	18.9	3.3	17.2	18.3	14.5	10.1	5.5
3	NLF	44.4	18.1	9.0	20.0	24.0	20.4	14.3	6.3
	SDLF	42.8	24.1	2.9	26.5	27.8	23.1	16.8	9.0
	TDLF	38.0	27.7	16.2	32.5	30.3	24.3	17.8	10.6
4	NLF	19.6	28.8	44.4	28.5	25.4	21.4	15.2	6.7
	SDLF	27.2	34.6	47.3	34.5	31.3	26.4	19.7	11.4
	TDLF	35.3	39.1	46.8	38.6	36.2	30.5	23.3	14.5
5	NLF	9.6	34.7	61.3	42.0	30.2	22.0	14.3	5.7
	SDLF	18.8	41.7	65.7	46.8	35.9	28.0	20.5	11.9
	TDLF	28.9	47.4	66.4	48.2	39.5	32.8	25.8	16.6
6	NLF	11.2	37.9	62.4	50.0	35.4	23.5	13.9	4.9
	SDLF	19.2	45.7	69.1	55.0	40.4	29.3	20.7	12.0
	TDLF	27.1	52.4	73.5	56.5	42.2	33.2	26.4	17.5
7	NLF	11.2	37.9	62.4	49.9	35.5	23.5	13.9	4.9
	SDLF	19.2	45.7	69.1	55.0	40.4	29.3	20.7	12.0
	TDLF	27.1	52.4	73.6	56.4	42.3	33.2	26.4	17.5
8	NLF	9.6	34.8	61.4	41.9	30.3	22.0	14.3	5.7
	SDLF	18.8	41.8	65.7	46.7	36.0	28.0	20.5	11.9
	TDLF	28.9	47.4	66.4	48.1	39.6	32.8	25.8	16.6
9	NLF	19.6	28.8	44.5	28.8	25.1	21.3	15.2	6.7
	SDLF	27.2	34.6	47.3	34.7	31.0	26.4	19.7	11.4
	TDLF	35.3	39.1	46.8	38.7	36.0	30.5	23.3	14.5
10	NLF	44.4	18.1	9.0	20.3	23.8	20.4	14.3	6.3
	SDLF	42.8	24.1	2.9	26.7	27.6	23.1	16.8	9.0
	TDLF	38.0	27.8	16.3	32.6	30.1	24.3	17.8	10.7

Table D-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	15.5	16.0	4.2	8.5	13.8	12.7	9.1	3.9
	SDLF	19.3	18.2	0.1	12.7	16.3	14.0	10.1	5.1
	TDLF	23.5	18.9	3.3	17.2	18.4	14.4	10.1	5.5
12	NLF	13.0	11.7	8.1	7.7	6.7	6.1	5.7	5.2
	SDLF	8.6	7.6	5.5	4.9	4.5	4.2	4.0	3.9
	TDLF	2.5	1.9	1.1	0.8	0.7	0.7	0.8	0.6

Table D-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.3	2.0	1.6	1.1	1.1	1.1	1.0	1.1
	SDLF	0.4	0.1	0.1	0.2	0.2	0.1	0.0	0.1
	TDLF	4.4	3.2	2.9	2.5	2.4	2.3	2.1	2.1
2	NLF	5.9	5.2	9.3	13.0	10.3	5.6	1.5	0.5
	SDLF	4.9	4.1	8.3	10.1	6.0	1.8	0.8	1.2
	TDLF	3.6	3.4	7.9	7.1	0.9	3.0	3.6	2.0
3	NLF	7.0	4.2	15.9	21.3	15.2	7.5	1.5	1.2
	SDLF	10.0	11.2	17.6	16.8	9.6	2.8	1.3	2.0
	TDLF	14.6	22.3	21.7	11.9	2.8	2.8	4.6	3.0
4	NLF	19.0	26.6	27.5	17.8	11.1	4.6	0.3	2.1
	SDLF	17.5	24.2	26.6	18.2	10.3	2.9	1.8	2.6
	TDLF	15.4	21.0	26.3	20.3	10.5	1.7	3.1	3.1
5	NLF	25.7	38.8	36.9	19.4	8.6	1.5	2.5	3.1
	SDLF	23.8	35.1	34.3	19.2	9.2	2.0	2.4	3.0
	TDLF	20.9	29.7	31.0	19.9	11.3	3.7	1.5	2.7
6	NLF	27.3	41.8	41.5	22.2	8.2	0.2	4.0	3.7
	SDLF	26.6	40.3	39.0	20.4	8.1	0.8	3.1	3.2
	TDLF	25.6	38.0	35.6	18.4	8.8	3.1	1.1	2.4
7	NLF	27.3	41.8	41.5	22.2	8.2	0.2	4.0	3.7
	SDLF	26.6	40.3	39.0	20.4	8.1	0.8	3.1	3.2
	TDLF	25.6	38.0	35.6	18.3	8.7	3.1	1.1	2.4
8	NLF	25.7	38.8	36.8	19.4	8.6	1.5	2.6	3.1
	SDLF	23.8	35.1	34.3	19.2	9.2	2.0	2.4	3.0
	TDLF	20.9	29.7	31.0	19.9	11.3	3.8	1.5	2.7
9	NLF	19.0	26.7	27.5	17.7	11.0	4.6	0.3	2.1
	SDLF	17.5	24.2	26.7	18.2	10.2	2.9	1.8	2.6
	TDLF	15.4	21.0	26.3	20.4	10.5	1.7	3.1	3.1
10	NLF	7.0	4.2	15.9	21.2	15.1	7.5	1.5	1.2
	SDLF	10.0	11.2	17.7	16.8	9.5	2.8	1.3	2.0
	TDLF	14.6	22.3	21.8	12.0	2.9	2.8	4.6	2.9

Table D-4-3(Continued). **Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.**

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	5.9	5.2	9.3	13.0	10.3	5.5	1.5	0.5
	SDLF	4.9	4.2	8.3	10.1	6.0	1.8	0.8	1.2
	TDLF	3.7	3.4	8.0	7.1	0.9	2.9	3.6	2.0
12	NLF	2.3	2.0	1.6	1.1	1.1	1.1	1.1	1.1
	SDLF	0.4	0.1	0.1	0.2	0.1	0.1	0.0	0.1
	TDLF	4.4	3.2	2.9	2.4	2.4	2.2	2.1	2.1

Table D-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	5.1	4.7	3.9	2.9	3.0	3.1	3.1	3.1
	SDLF	2.4	2.6	2.3	1.8	1.9	2.1	2.2	2.2
	TDLF	1.5	0.3	0.3	0.4	0.3	0.1	0.1	0.0
2	NLF	13.4	8.4	15.9	23.5	17.2	7.0	0.7	2.5
	SDLF	12.4	7.4	14.8	20.4	12.8	3.0	3.1	3.3
	TDLF	11.2	6.5	14.4	17.4	7.6	1.8	5.9	4.2
3	NLF	15.2	3.7	27.4	37.4	22.3	5.7	4.8	6.4
	SDLF	18.1	10.3	28.6	32.5	16.4	0.9	7.7	7.2
	TDLF	22.4	21.1	32.4	27.4	9.5	4.8	11.1	8.2
4	NLF	44.1	58.6	54.3	24.4	7.3	5.7	12.5	10.2
	SDLF	42.1	55.4	52.5	24.0	5.9	7.8	14.2	10.7
	TDLF	39.8	51.7	51.6	25.7	5.8	9.2	15.6	11.2
5	NLF	60.5	88.1	76.4	25.8	2.2	16.5	20.3	13.6
	SDLF	57.8	83.3	72.5	24.7	2.3	16.4	20.3	13.6
	TDLF	54.5	77.3	68.5	24.8	0.5	14.9	19.5	13.3
6	NLF	64.3	95.3	87.1	31.5	4.7	22.3	25.0	15.8
	SDLF	62.6	92.4	83.1	28.6	5.5	21.7	24.3	15.4
	TDLF	61.1	89.4	78.9	26.0	5.3	19.6	22.3	14.6
7	NLF	64.3	95.3	87.1	31.5	4.7	22.3	25.1	15.8
	SDLF	62.6	92.4	83.0	28.7	5.5	21.7	24.3	15.4
	TDLF	61.1	89.4	78.9	26.0	5.3	19.6	22.4	14.6
8	NLF	60.5	88.1	76.3	25.8	2.3	16.6	20.3	13.7
	SDLF	57.8	83.3	72.5	24.7	2.3	16.5	20.4	13.6
	TDLF	54.5	77.3	68.5	24.8	0.6	14.9	19.5	13.3
9	NLF	44.1	58.7	54.3	24.1	7.0	5.8	12.5	10.2
	SDLF	42.2	55.4	52.5	23.8	5.6	7.8	14.2	10.7
	TDLF	39.9	51.8	51.6	25.6	5.6	9.2	15.5	11.2
10	NLF	15.3	3.7	27.4	37.1	22.0	5.7	4.8	6.4
	SDLF	18.1	10.3	28.6	32.3	16.1	0.8	7.7	7.2
	TDLF	22.5	21.1	32.4	27.3	9.3	4.8	11.1	8.2

Table D-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	13.4	8.4	15.8	23.6	17.2	6.9	0.7	2.5
	SDLF	12.5	7.4	14.8	20.5	12.8	3.0	3.1	3.3
	TDLF	11.2	6.6	14.4	17.4	7.5	1.8	5.9	4.2
12	NLF	5.2	4.7	3.9	2.9	3.0	3.1	3.1	3.1
	SDLF	2.5	2.7	2.4	1.9	1.9	2.0	2.1	2.1
	TDLF	1.4	0.3	0.3	0.4	0.3	0.1	0.1	0.0

Table D-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	3.7	2.6	2.0	1.7	1.3	1.2	1.1	0.9
	SDLF	0.4	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	TDLF	4.4	3.7	3.1	2.8	2.5	2.3	2.2	2.3
2	NLF	5.7	5.2	9.5	13.2	10.5	5.7	1.6	0.5
	SDLF	5.2	4.2	8.4	10.3	6.2	1.8	0.7	1.3
	TDLF	4.8	3.5	8.0	7.4	1.0	3.0	3.6	2.2
3	NLF	5.9	3.4	15.5	21.2	15.1	7.5	1.5	1.2
	SDLF	10.3	10.7	17.6	17.1	9.6	2.8	1.3	2.2
	TDLF	16.9	22.5	22.6	13.0	3.2	2.6	4.5	3.3
4	NLF	18.5	26.5	27.4	17.7	11.1	4.5	0.4	2.3
	SDLF	18.2	24.8	27.1	18.4	10.5	3.1	1.7	2.8
	TDLF	17.8	22.7	27.5	21.0	11.3	2.5	2.5	3.1
5	NLF	25.0	38.3	36.6	19.1	8.3	1.3	2.8	3.3
	SDLF	24.5	35.6	34.5	19.1	9.3	2.0	2.4	3.3
	TDLF	23.6	31.9	32.2	20.3	12.0	4.5	0.8	2.6
6	NLF	26.5	41.4	41.3	22.0	8.0	0.4	4.2	3.9
	SDLF	27.4	40.9	39.4	20.5	8.2	0.9	3.0	3.6
	TDLF	28.5	40.3	37.1	18.9	9.4	3.8	0.4	2.4
7	NLF	26.5	41.4	41.3	22.0	8.0	0.4	4.2	3.9
	SDLF	27.4	40.9	39.4	20.5	8.2	0.8	3.0	3.6
	TDLF	28.5	40.4	37.1	18.9	9.3	3.8	0.3	2.3
8	NLF	25.0	38.3	36.5	19.1	8.3	1.2	2.8	3.3
	SDLF	24.5	35.6	34.5	19.1	9.2	2.0	2.4	3.3
	TDLF	23.6	31.9	32.2	20.2	11.9	4.5	0.8	2.6
9	NLF	18.5	26.5	27.4	17.6	10.9	4.5	0.4	2.3
	SDLF	18.2	24.8	27.1	18.4	10.4	3.1	1.7	2.8
	TDLF	17.8	22.7	27.5	21.0	11.4	2.5	2.5	3.1
10	NLF	6.0	3.4	15.5	21.1	15.0	7.4	1.5	1.2
	SDLF	10.3	10.7	17.6	17.1	9.5	2.8	1.3	2.2
	TDLF	16.9	22.6	22.6	13.0	3.2	2.6	4.5	3.3

Table D-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	5.7	5.2	9.4	13.2	10.5	5.6	1.5	0.5
	SDLF	5.2	4.2	8.3	10.3	6.1	1.8	0.7	1.3
	TDLF	4.8	3.5	8.0	7.3	0.9	3.0	3.6	2.2
12	NLF	3.7	2.6	2.0	1.7	1.3	1.1	1.0	0.9
	SDLF	0.4	0.1	0.1	0.1	0.0	0.0	0.0	0.0
	TDLF	4.3	3.7	3.1	2.8	2.5	2.4	2.3	2.3

Table D-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	9.2	6.4	5.0	4.3	3.6	3.4	3.3	3.4
	SDLF	6.1	4.2	3.3	2.8	2.5	2.3	2.3	2.5
	TDLF	1.4	0.3	0.2	0.1	0.0	0.0	0.1	0.3
2	NLF	13.4	9.1	16.8	24.5	18.0	7.5	0.3	2.4
	SDLF	12.9	7.8	15.4	21.3	13.4	3.5	2.7	3.2
	TDLF	12.4	6.9	14.8	18.2	8.1	1.4	5.7	4.1
3	NLF	12.9	2.0	26.8	37.7	22.7	6.1	4.5	6.2
	SDLF	16.9	8.8	28.4	33.0	16.7	1.1	7.5	7.3
	TDLF	23.4	20.4	33.0	28.5	10.0	4.5	10.8	8.4
4	NLF	43.2	58.4	54.2	24.2	7.2	5.9	12.8	10.6
	SDLF	42.5	55.8	52.8	24.1	6.0	7.7	14.2	11.1
	TDLF	41.8	53.3	52.9	26.4	6.6	8.5	15.0	11.4
5	NLF	59.1	87.2	75.7	25.1	3.0	17.2	20.9	14.3
	SDLF	57.8	83.3	72.2	24.1	2.7	16.8	20.6	14.2
	TDLF	56.5	78.9	69.2	24.7	0.3	14.5	19.1	13.6
6	NLF	62.6	94.4	86.8	31.2	5.1	22.7	25.5	16.5
	SDLF	62.6	92.5	83.2	28.4	5.8	21.9	24.5	16.0
	TDLF	63.2	91.3	80.2	26.4	4.9	19.2	21.9	14.8
7	NLF	62.6	94.4	86.8	31.2	5.1	22.8	25.6	16.5
	SDLF	62.6	92.4	83.1	28.4	5.8	22.0	24.5	16.0
	TDLF	63.2	91.3	80.2	26.4	4.9	19.2	21.9	14.8
8	NLF	59.1	87.1	75.6	25.1	3.0	17.3	20.9	14.3
	SDLF	57.8	83.2	72.1	24.0	2.8	16.9	20.7	14.3
	TDLF	56.5	78.9	69.2	24.7	0.4	14.6	19.1	13.6
9	NLF	43.3	58.4	54.2	24.0	6.9	6.0	12.8	10.6
	SDLF	42.5	55.8	52.8	23.9	5.7	7.8	14.2	11.1
	TDLF	41.8	53.3	52.9	26.3	6.4	8.5	15.0	11.4
10	NLF	12.9	2.0	26.8	37.5	22.5	6.1	4.5	6.2
	SDLF	16.9	8.8	28.4	32.8	16.4	1.0	7.6	7.3
	TDLF	23.4	20.4	33.0	28.4	9.8	4.5	10.8	8.4

Table D-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	13.4	9.0	16.7	24.5	18.0	7.4	0.4	2.4
	SDLF	12.9	7.7	15.3	21.2	13.4	3.4	2.8	3.2
	TDLF	12.4	6.9	14.8	18.1	8.0	1.5	5.7	4.1
12	NLF	9.2	6.4	5.1	4.3	3.6	3.4	3.3	3.4
	SDLF	6.1	4.2	3.3	2.8	2.5	2.3	2.3	2.5
	TDLF	1.4	0.4	0.2	0.1	0.0	0.0	0.1	0.3

Table D-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.15	0.14	0.14	0.13	0.12	0.11	0.11	0.11
	SDLF	0.16	0.15	0.16	0.13	0.11	0.10	0.09	0.10
	TDLF	0.17	0.16	0.16	0.12	0.10	0.09	0.09	0.10
3	NLF	0.25	0.26	0.26	0.23	0.21	0.20	0.20	0.20
	SDLF	0.28	0.28	0.28	0.22	0.19	0.18	0.18	0.19
	TDLF	0.30	0.30	0.28	0.21	0.18	0.17	0.18	0.20
4	NLF	0.36	0.34	0.31	0.29	0.28	0.28	0.28	0.28
	SDLF	0.42	0.37	0.32	0.28	0.26	0.25	0.25	0.26
	TDLF	0.46	0.39	0.31	0.26	0.24	0.24	0.25	0.28
5	NLF	0.44	0.40	0.36	0.34	0.33	0.32	0.33	0.33
	SDLF	0.51	0.44	0.36	0.32	0.30	0.29	0.30	0.31
	TDLF	0.58	0.46	0.34	0.29	0.28	0.29	0.31	0.34
6	NLF	0.47	0.43	0.38	0.36	0.35	0.35	0.35	0.36
	SDLF	0.55	0.47	0.39	0.34	0.32	0.32	0.33	0.34
	TDLF	0.64	0.50	0.36	0.30	0.29	0.31	0.34	0.37
7	NLF	0.47	0.43	0.38	0.36	0.35	0.35	0.35	0.36
	SDLF	0.55	0.47	0.39	0.34	0.32	0.32	0.33	0.34
	TDLF	0.64	0.50	0.36	0.30	0.29	0.31	0.34	0.37
8	NLF	0.44	0.40	0.36	0.34	0.33	0.32	0.33	0.33
	SDLF	0.51	0.44	0.36	0.32	0.30	0.29	0.30	0.31
	TDLF	0.58	0.46	0.34	0.29	0.28	0.29	0.31	0.34
9	NLF	0.36	0.34	0.31	0.29	0.28	0.28	0.28	0.28
	SDLF	0.42	0.37	0.32	0.28	0.26	0.25	0.25	0.26
	TDLF	0.46	0.39	0.31	0.26	0.24	0.24	0.25	0.28
10	NLF	0.25	0.26	0.26	0.23	0.21	0.20	0.20	0.20
	SDLF	0.28	0.28	0.28	0.22	0.19	0.18	0.18	0.19
	TDLF	0.30	0.30	0.28	0.21	0.18	0.17	0.18	0.20

Table D-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.15	0.14	0.14	0.13	0.12	0.11	0.11	0.11
	SDLF	0.16	0.15	0.16	0.13	0.11	0.10	0.10	0.10
	TDLF	0.17	0.16	0.16	0.12	0.10	0.09	0.09	0.10
12	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Table D-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.25	0.24	0.25	0.22	0.19	0.18	0.18	0.19
	SDLF	0.26	0.25	0.26	0.21	0.18	0.17	0.17	0.18
	TDLF	0.27	0.25	0.26	0.20	0.17	0.16	0.17	0.18
3	NLF	0.41	0.42	0.43	0.38	0.35	0.34	0.34	0.36
	SDLF	0.43	0.44	0.44	0.37	0.32	0.31	0.32	0.33
	TDLF	0.44	0.45	0.45	0.35	0.30	0.30	0.32	0.34
4	NLF	0.61	0.55	0.48	0.46	0.45	0.45	0.47	0.49
	SDLF	0.65	0.57	0.48	0.44	0.42	0.42	0.44	0.46
	TDLF	0.69	0.59	0.47	0.42	0.40	0.40	0.44	0.47
5	NLF	0.73	0.64	0.54	0.51	0.51	0.53	0.55	0.58
	SDLF	0.79	0.67	0.53	0.49	0.48	0.49	0.52	0.55
	TDLF	0.85	0.69	0.50	0.45	0.45	0.48	0.52	0.57
6	NLF	0.78	0.69	0.58	0.54	0.54	0.56	0.59	0.62
	SDLF	0.85	0.72	0.57	0.51	0.50	0.52	0.56	0.59
	TDLF	0.93	0.74	0.54	0.46	0.47	0.51	0.57	0.62
7	NLF	0.78	0.69	0.58	0.54	0.54	0.56	0.59	0.62
	SDLF	0.85	0.72	0.57	0.51	0.50	0.52	0.56	0.59
	TDLF	0.93	0.74	0.54	0.46	0.47	0.51	0.57	0.62
8	NLF	0.73	0.64	0.54	0.51	0.51	0.53	0.55	0.58
	SDLF	0.79	0.67	0.53	0.49	0.48	0.49	0.52	0.55
	TDLF	0.85	0.69	0.50	0.45	0.45	0.48	0.52	0.57
9	NLF	0.61	0.55	0.48	0.46	0.45	0.46	0.47	0.49
	SDLF	0.65	0.57	0.48	0.44	0.42	0.42	0.44	0.46
	TDLF	0.69	0.59	0.47	0.42	0.40	0.41	0.44	0.47
10	NLF	0.41	0.42	0.43	0.38	0.35	0.34	0.34	0.36
	SDLF	0.43	0.44	0.44	0.37	0.33	0.31	0.32	0.33
	TDLF	0.44	0.45	0.45	0.35	0.30	0.30	0.32	0.34

Table D-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	0.25	0.24	0.25	0.22	0.19	0.18	0.18	0.19
	SDLF	0.26	0.25	0.25	0.21	0.18	0.17	0.17	0.18
	TDLF	0.27	0.25	0.26	0.20	0.17	0.16	0.17	0.18
12	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table D-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.15	0.14	0.14	0.13	0.11	0.11	0.11	0.11
	SDLF	0.16	0.15	0.15	0.13	0.10	0.10	0.09	0.10
	TDLF	0.17	0.16	0.16	0.12	0.09	0.09	0.09	0.10
3	NLF	0.25	0.26	0.26	0.23	0.21	0.20	0.20	0.20
	SDLF	0.28	0.28	0.27	0.22	0.19	0.18	0.18	0.19
	TDLF	0.30	0.29	0.28	0.21	0.18	0.17	0.18	0.20
4	NLF	0.36	0.34	0.31	0.29	0.28	0.27	0.27	0.28
	SDLF	0.41	0.37	0.32	0.28	0.26	0.25	0.25	0.26
	TDLF	0.46	0.39	0.31	0.26	0.24	0.24	0.25	0.28
5	NLF	0.43	0.39	0.35	0.33	0.32	0.32	0.32	0.33
	SDLF	0.50	0.43	0.36	0.32	0.30	0.29	0.30	0.31
	TDLF	0.57	0.46	0.33	0.29	0.27	0.28	0.31	0.33
6	NLF	0.46	0.42	0.38	0.35	0.35	0.35	0.35	0.36
	SDLF	0.55	0.47	0.38	0.33	0.32	0.31	0.32	0.34
	TDLF	0.63	0.50	0.35	0.30	0.29	0.31	0.34	0.37
7	NLF	0.46	0.42	0.38	0.35	0.35	0.35	0.35	0.36
	SDLF	0.55	0.47	0.38	0.33	0.32	0.31	0.32	0.34
	TDLF	0.63	0.50	0.35	0.30	0.29	0.31	0.34	0.37
8	NLF	0.43	0.39	0.35	0.33	0.32	0.32	0.32	0.33
	SDLF	0.50	0.43	0.36	0.32	0.30	0.29	0.30	0.31
	TDLF	0.57	0.46	0.33	0.29	0.27	0.28	0.31	0.33
9	NLF	0.36	0.34	0.31	0.29	0.28	0.27	0.27	0.28
	SDLF	0.41	0.37	0.32	0.28	0.26	0.25	0.25	0.26
	TDLF	0.46	0.39	0.31	0.26	0.24	0.24	0.25	0.28
10	NLF	0.25	0.26	0.26	0.23	0.21	0.20	0.20	0.20
	SDLF	0.28	0.28	0.27	0.22	0.19	0.18	0.18	0.19
	TDLF	0.30	0.29	0.28	0.21	0.18	0.17	0.18	0.20

Table D-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.15	0.14	0.14	0.13	0.11	0.11	0.11	0.11
	SDLF	0.16	0.15	0.15	0.13	0.10	0.10	0.09	0.10
	TDLF	0.17	0.16	0.16	0.12	0.09	0.09	0.09	0.10
12	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table D-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.17	0.16	0.16	0.14	0.13	0.12	0.12	0.13
	SDLF	0.17	0.17	0.17	0.14	0.12	0.11	0.11	0.12
	TDLF	0.18	0.17	0.17	0.14	0.11	0.11	0.11	0.12
3	NLF	0.27	0.28	0.29	0.25	0.23	0.23	0.23	0.24
	SDLF	0.29	0.29	0.30	0.24	0.22	0.21	0.21	0.22
	TDLF	0.30	0.30	0.30	0.23	0.20	0.20	0.21	0.23
4	NLF	0.40	0.37	0.32	0.31	0.30	0.30	0.31	0.32
	SDLF	0.43	0.38	0.32	0.30	0.28	0.28	0.29	0.31
	TDLF	0.46	0.39	0.31	0.28	0.26	0.27	0.29	0.32
5	NLF	0.49	0.43	0.36	0.34	0.34	0.35	0.37	0.38
	SDLF	0.53	0.44	0.35	0.32	0.32	0.33	0.34	0.36
	TDLF	0.57	0.46	0.34	0.30	0.30	0.32	0.35	0.38
6	NLF	0.52	0.46	0.39	0.36	0.36	0.38	0.40	0.41
	SDLF	0.57	0.48	0.38	0.34	0.33	0.35	0.37	0.39
	TDLF	0.62	0.49	0.36	0.31	0.31	0.34	0.38	0.41
7	NLF	0.52	0.46	0.39	0.36	0.36	0.38	0.40	0.41
	SDLF	0.57	0.48	0.38	0.34	0.33	0.35	0.37	0.39
	TDLF	0.62	0.49	0.36	0.31	0.31	0.34	0.38	0.41
8	NLF	0.49	0.43	0.36	0.34	0.34	0.35	0.37	0.38
	SDLF	0.53	0.44	0.35	0.32	0.32	0.33	0.34	0.36
	TDLF	0.57	0.46	0.34	0.30	0.30	0.32	0.35	0.38
9	NLF	0.40	0.37	0.32	0.31	0.30	0.30	0.31	0.32
	SDLF	0.43	0.38	0.32	0.30	0.28	0.28	0.29	0.31
	TDLF	0.46	0.39	0.31	0.28	0.26	0.27	0.29	0.32
10	NLF	0.27	0.28	0.29	0.25	0.23	0.23	0.23	0.24
	SDLF	0.29	0.29	0.30	0.24	0.22	0.21	0.21	0.22
	TDLF	0.30	0.30	0.30	0.23	0.20	0.20	0.21	0.23

Table D-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.17	0.16	0.16	0.14	0.13	0.12	0.12	0.13
	SDLF	0.17	0.17	0.17	0.14	0.12	0.11	0.11	0.12
	TDLF	0.18	0.17	0.17	0.14	0.11	0.11	0.11	0.12
12	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table D-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	156	156	372	372
	SDLF	157	157	372	372
	TDLF	156	156	371	371
G2	NLF	119	119	291	291
	SDLF	119	119	291	291
	TDLF	120	120	291	291
G3	NLF	104	104	263	263
	SDLF	107	107	266	266
	TDLF	113	113	271	271
G4	NLF	75	75	196	196
	SDLF	72	72	193	193
	TDLF	70	70	191	191
G5	NLF	63	63	173	173
	SDLF	61	60	170	170
	TDLF	57	57	167	167
G6	NLF	56	56	159	159
	SDLF	54	54	157	157
	TDLF	52	52	155	155
G7	NLF	51	51	150	150
	SDLF	50	50	150	150
	TDLF	50	50	150	150
G8	NLF	46	46	142	142
	SDLF	47	47	144	144
	TDLF	48	48	145	145
G9	NLF	39	39	131	131
	SDLF	41	41	134	134
	TDLF	43	43	136	137

Table D-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	-0.3	NA	-0.4	NA
	SDLF	-0.3	NA	-0.4	NA
	TDLF	-0.3	NA	-0.4	NA
G2	NLF	-0.2	NA	-0.3	NA
	SDLF	-0.2	NA	-0.2	NA
	TDLF	-0.2	NA	-0.3	NA
G3	NLF	-0.1	NA	-0.1	NA
	SDLF	-0.1	NA	-0.1	NA
	TDLF	-0.1	NA	-0.1	NA
G4	NLF	-0.1	NA	-0.1	NA
	SDLF	0.0	NA	-0.1	NA
	TDLF	0.0	NA	-0.1	NA
G5	NLF	0.0	NA	0.0	NA
	SDLF	0.0	NA	0.0	NA
	TDLF	0.0	NA	0.0	NA
G6	NLF	0.1	NA	0.1	NA
	SDLF	0.1	NA	0.1	NA
	TDLF	0.1	NA	0.1	NA
G7	NLF	0.1	NA	0.2	NA
	SDLF	0.1	NA	0.2	NA
	TDLF	0.1	NA	0.2	NA
G8	NLF	0.2	NA	0.3	NA
	SDLF	0.2	NA	0.2	NA
	TDLF	0.2	NA	0.3	NA
G9	NLF	0.3	NA	0.5	NA
	SDLF	0.3	NA	0.4	NA
	TDLF	0.3	NA	0.4	NA

Table D-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.0	0.0	0.1	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G2	NLF	0.0	0.0	0.1	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G3	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G4	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G5	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G6	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G7	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G8	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0
G9	NLF	0.0	0.0	0.0	-0.1
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0

Table D-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.06	0.61	-0.09	1.19
	SDLF	-0.06	0.60	-0.07	1.26
	TDLF	-0.07	0.66	-0.08	1.46
G2	NLF	-0.04	0.57	-0.05	1.13
	SDLF	-0.04	0.56	-0.05	1.21
	TDLF	-0.04	0.62	-0.05	1.39
G3	NLF	-0.02	0.52	-0.02	1.06
	SDLF	-0.02	0.52	-0.02	1.14
	TDLF	-0.02	0.57	-0.02	1.32
G4	NLF	-0.01	0.49	-0.03	1.02
	SDLF	-0.01	0.49	-0.02	1.10
	TDLF	-0.01	0.53	-0.02	1.27
G5	NLF	0.00	0.44	0.00	0.95
	SDLF	0.01	0.44	0.00	1.04
	TDLF	0.01	0.48	0.01	1.20
G6	NLF	0.01	0.40	0.02	0.88
	SDLF	0.01	0.41	0.02	0.98
	TDLF	0.02	0.44	0.02	1.14
G7	NLF	0.03	0.36	0.04	0.82
	SDLF	0.02	0.37	0.03	0.93
	TDLF	0.02	0.41	0.03	1.08
G8	NLF	0.04	0.32	0.06	0.76
	SDLF	0.04	0.34	0.05	0.88
	TDLF	0.04	0.38	0.05	1.03
G9	NLF	0.06	0.28	0.09	0.70
	SDLF	0.05	0.31	0.07	0.83
	TDLF	0.06	0.34	0.08	0.97

Table D-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	0.01	0.00	0.01	0.00
	SDLF	0.00	0.00	0.01	0.00
	TDLF	0.00	-0.01	0.00	-0.01
G2	NLF	0.01	0.00	0.01	0.00
	SDLF	0.00	0.00	0.01	0.00
	TDLF	0.00	-0.01	0.00	-0.01
G3	NLF	0.00	0.00	0.01	0.00
	SDLF	0.00	0.00	0.01	0.00
	TDLF	0.00	-0.01	0.00	-0.01
G4	NLF	0.00	0.00	0.01	0.00
	SDLF	0.00	0.00	0.01	0.00
	TDLF	0.00	0.00	0.00	0.00
G5	NLF	0.00	0.00	0.00	-0.01
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.01	0.00
G6	NLF	0.00	0.00	0.00	-0.01
	SDLF	0.00	0.00	0.00	-0.01
	TDLF	0.01	0.00	0.01	0.00
G7	NLF	0.00	-0.01	0.00	-0.01
	SDLF	0.00	0.00	0.00	-0.01
	TDLF	0.01	0.00	0.01	0.00
G8	NLF	0.00	-0.01	0.00	-0.01
	SDLF	0.00	0.00	0.00	-0.01
	TDLF	0.01	0.00	0.01	0.00
G9	NLF	0.00	-0.01	0.00	-0.01
	SDLF	0.00	0.00	0.00	-0.01
	TDLF	0.01	0.00	0.01	0.00

Appendix D-5. NISCR10 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISCR10 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table D-5-1. Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-1	NLF	0.9	-0.6	1.1	0.3	0.6	0.6
		SDLF	-2.2	-0.5	2.3	3.5	0.5	3.6
		TDLF	-6.7	-0.5	6.7	8.1	0.5	8.1
	2-2	NLF	1.7	-0.7	1.9	1.8	0.6	1.9
		SDLF	4.9	1.7	5.2	4.1	-1.8	4.5
		TDLF	7.3	3.5	8.1	5.5	-3.5	6.5
	2-3	NLF	2.2	1.1	2.5	2.4	-1.1	2.7
		SDLF	7.8	5.5	9.5	6.8	-5.5	8.8
		TDLF	12.2	9.0	15.2	9.4	-9.0	13.0
	2-4	NLF	1.3	-0.7	1.5	1.3	0.7	1.5
		SDLF	7.9	5.8	9.8	6.5	-5.7	8.6
		TDLF	13.0	10.3	16.6	9.7	-10.1	14.0
	2-5	NLF	0.4	4.3	4.3	0.4	-4.2	4.2
		SDLF	10.3	11.9	15.8	8.8	-12.0	14.9
		TDLF	17.3	16.9	24.2	13.8	-16.9	21.8
	2-6	NLF	-1.2	1.3	1.8	-1.2	-1.3	1.8
		SDLF	8.2	9.0	12.1	6.5	-8.9	11.0
		TDLF	14.8	13.9	20.4	11.0	-13.8	17.7
	2-7	NLF	-1.8	-1.0	2.1	-1.8	1.1	2.1
		SDLF	6.7	6.5	9.3	5.0	-6.4	8.1
		TDLF	12.8	11.5	17.2	9.0	-11.3	14.4
	2-8	NLF	-1.4	-1.4	2.0	-1.5	1.4	2.1
		SDLF	6.2	5.6	8.3	4.3	-5.5	7.0
		TDLF	11.8	10.3	15.6	7.7	-10.1	12.7

Table D-5-1(Continued). Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
7	7-1	NLF	0.3	-0.4	0.5	-0.5	0.4	0.7
		SDLF	-1.1	-0.4	1.2	0.5	0.4	0.6
		TDLF	-3.5	-0.3	3.5	2.9	0.3	2.9
	7-2	NLF	-10.7	0.5	10.7	-10.7	-0.4	10.7
		SDLF	-11.0	2.7	11.4	-11.2	-2.6	11.4
		TDLF	-11.3	4.3	12.1	-11.6	-4.1	12.3
	7-3	NLF	-9.7	1.5	9.8	-9.5	-1.3	9.6
		SDLF	-7.9	5.2	9.5	-7.8	-5.0	9.3
		TDLF	-6.3	7.8	10.0	-6.4	-7.5	9.9
	7-4	NLF	-6.3	3.1	7.0	-6.2	-3.0	6.9
		SDLF	-1.9	7.8	8.1	-2.2	-7.7	8.0
		TDLF	2.4	11.0	11.2	1.4	-10.7	10.8
	7-5	NLF	-4.7	2.8	5.5	-4.6	-2.8	5.4
		SDLF	0.8	8.2	8.3	0.5	-8.2	8.2
		TDLF	5.7	11.7	13.0	4.7	-11.5	12.1
	7-6	NLF	-5.2	0.9	5.3	-5.1	-0.9	5.2
		SDLF	1.1	6.6	6.7	0.8	-6.5	6.5
		TDLF	6.3	10.2	12.0	5.3	-10.0	11.3
	7-7	NLF	-6.5	-0.6	6.5	-6.5	0.7	6.5
		SDLF	1.2	4.9	5.1	0.9	-4.7	4.8
		TDLF	7.6	8.4	11.3	6.5	-8.1	10.4
	7-8	NLF	-7.0	-0.9	7.0	-6.7	0.9	6.8
		SDLF	1.0	4.2	4.3	0.7	-4.0	4.1
		TDLF	8.4	7.5	11.3	7.2	-7.2	10.2

Table D-5-1(Continued). Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
16	16-1	NLF	-2.7	0.1	2.7	-2.7	0.1	2.8
		SDLF	-1.7	4.8	5.1	-1.8	-4.3	4.7
		TDLF	-1.5	7.2	7.4	-1.7	-6.8	7.0
	16-2	NLF	-0.9	0.3	0.9	-0.9	-0.2	0.9
		SDLF	-0.5	2.6	2.6	-0.6	-2.5	2.5
		TDLF	-1.2	3.8	4.0	-1.5	-3.7	4.0
	16-3	NLF	0.3	0.1	0.3	-0.2	-0.1	0.2
		SDLF	-0.8	0.0	0.8	0.8	-0.1	0.8
		TDLF	-3.4	-0.1	3.4	3.1	0.0	3.1
18	18-1	NLF	0.0	0.5	0.5	0.0	-0.5	0.5
		SDLF	1.2	3.9	4.1	1.4	-3.5	3.8
		TDLF	3.9	6.4	7.5	4.1	-5.8	7.2
	18-2	NLF	0.1	0.4	0.4	0.1	-0.4	0.4
		SDLF	0.5	2.1	2.1	0.6	-2.0	2.1
		TDLF	1.4	3.3	3.6	1.4	-3.2	3.5
	18-3	NLF	0.3	0.1	0.3	-0.3	-0.1	0.3
		SDLF	-0.6	0.0	0.6	0.6	0.0	0.6
		TDLF	-2.8	-0.1	2.8	2.7	-0.1	2.7

Table D-5-2: Erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
2	NLF	2-5
	SDLF	2-5
	TDLF	2-5
7	NLF	7-2
	SDLF	7-2
	TDLF	7-2
16	NLF	16-1
	SDLF	16-1
	TDLF	16-1
18	NLF	18-1
	SDLF	18-1
	TDLF	18-1

Table D-5-3. Erection critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	-1.7	2.2	2.8	NA	NA	NA
		SDLF	7.4	4.4	8.6	NA	NA	NA
		TDLF	13.5	5.8	14.7	NA	NA	NA
	B	NLF	0.4	4.3	4.3	0.4	-4.2	4.2
		SDLF	10.3	11.9	15.8	8.8	-12.0	14.9
		TDLF	17.3	16.9	24.2	13.8	-16.9	21.8
7	A	NLF	-18.6	0.1	18.6	NA	NA	NA
		SDLF	-20.4	0.3	20.4	NA	NA	NA
		TDLF	-21.8	0.4	21.8	NA	NA	NA
	B	NLF	-10.7	0.5	10.7	-10.7	-0.4	10.7
		SDLF	-11.0	2.7	11.4	-11.2	-2.6	11.4
		TDLF	-11.3	4.3	12.1	-11.6	-4.1	12.3
16	A	NLF	-4.6	0.1	4.6	NA	NA	NA
		SDLF	-5.9	1.5	6.1	NA	NA	NA
		TDLF	-7.7	2.0	8.0	NA	NA	NA
	B	NLF	-2.7	0.1	2.7	-2.7	0.1	2.8
		SDLF	-1.7	4.8	5.1	-1.8	-4.3	4.7
		TDLF	-1.5	7.2	7.4	-1.7	-6.8	7.0
18	A	NLF	0.0	0.4	0.4	NA	NA	NA
		SDLF	-0.5	1.2	1.3	NA	NA	NA
		TDLF	1.8	1.9	2.6	NA	NA	NA
	B	NLF	0.0	0.5	0.5	0.0	-0.5	0.5
		SDLF	1.2	3.9	4.1	1.4	-3.5	3.8
		TDLF	3.9	6.4	7.5	4.1	-5.8	7.2

Table D-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	34.1	77.4	54.4		
			SDLF	43.8	66.1	67.4		
			TDLF	50.2	58.4	76.0		
		G2	NLF	3.8	65.6	131.2	65.7	21.0
			SDLF	12.7	43.9	87.9	44.0	44.0
			TDLF	18.5	29.9	59.9	30.0	58.9
	B	G1	NLF	33.9	79.0	53.7		
			SDLF	43.4	69.0	65.9		
			TDLF	49.6	62.2	73.9		
		G2	NLF	5.2	63.3	126.7	63.4	24.0
			SDLF	15.4	39.5	79.1	39.6	49.8
			TDLF	22.0	24.3	48.6	24.3	66.3

Table D-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
7	A	G1	NLF	74.1	121.3			
			SDLF	74.7	187.8			
			TDLF	74.0	272.2			
		G2	NLF	59.2	117.0			
			SDLF	58.9	81.6			
			TDLF	58.6	13.1			
		G3	NLF	53.4	110.9			
			SDLF	55.8	54.8			
			TDLF	60.6	0.0			
		G4	NLF	39.8	61.2			
			SDLF	37.3	48.1			
			TDLF	34.3	42.5			
		G5	NLF	31.8	56.0			
			SDLF	29.7	60.4			
			TDLF	27.0	88.1			
		G6	NLF	15.9	48.5			
			SDLF	15.8	81.2			
			TDLF	16.1	97.4			
		G7	NLF	14.6	52.1	104.3	52.2	0.0
			SDLF	16.0	52.9	106.0	53.1	0.0
			TDLF	17.2	53.5	107.1	53.6	0.0

Table D-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
7	B	G1	NLF	74.5	121.6			
			SDLF	75.2	188.2			
			TDLF	74.7	272.7			
		G2	NLF	59.4	117.2			
			SDLF	59.2	81.8			
			TDLF	59.1	13.2			
		G3	NLF	53.6	110.9			
			SDLF	56.0	54.7			
			TDLF	60.9	0.0			
		G4	NLF	39.8	61.1			
			SDLF	37.3	48.0			
			TDLF	34.4	42.2			
		G5	NLF	31.3	55.6			
			SDLF	28.8	59.9			
			TDLF	25.9	87.5			
		G6	NLF	13.4	47.5			
			SDLF	11.6	80.0			
			TDLF	10.8	96.0			
		G7	NLF	16.7	53.0	106.2	53.2	0.0
			SDLF	19.7	54.1	108.4	54.3	0.0
			TDLF	21.8	54.8	109.8	55.0	0.0

Table D-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
16	A	G1	NLF	56.0	138.3	10.2			
			SDLF	66.5	206.8	22.9			
			TDLF	71.1	290.2	30.8			
		G2	NLF	47.7	152.3	12.2			
			SDLF	53.8	106.7	19.2			
			TDLF	57.6	35.8	22.8			
		G3	NLF	45.5	154.1	13.2			
			SDLF	52.5	81.2	20.9			
			TDLF	60.6	0.0	27.9			
		G4	NLF	36.4	89.3	12.2			
			SDLF	36.2	65.8	13.8			
			TDLF	35.3	51.7	12.8			
		G5	NLF	34.9	88.0	12.2			
			SDLF	33.2	78.0	14.3			
			TDLF	31.1	89.7	14.0			
		G6	NLF	34.4	85.9	11.6			
			SDLF	33.3	85.5	18.9			
			TDLF	32.2	106.5	23.2			
		G7	NLF	34.0	75.8	0.0	0.0	0.0	7.9
			SDLF	34.7	83.4	4.7	9.4	4.7	8.9
			TDLF	35.4	107.5	13.9	28.0	14.1	3.1

Table D-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
16	B	G1	NLF	56.0	138.4	10.2			
			SDLF	66.5	206.9	23.0			
			TDLF	71.1	290.4	30.9			
		G2	NLF	47.7	152.4	12.3			
			SDLF	53.8	106.9	19.3			
			TDLF	57.6	36.2	22.9			
		G3	NLF	45.5	154.1	13.3			
			SDLF	52.5	81.3	21.0			
			TDLF	60.6	0.0	28.1			
		G4	NLF	36.4	89.3	12.2			
			SDLF	36.2	65.7	13.8			
			TDLF	35.3	51.7	12.8			
		G5	NLF	34.9	88.0	12.1			
			SDLF	33.2	77.6	14.0			
			TDLF	31.1	89.1	13.5			
		G6	NLF	34.4	86.1	11.5			
			SDLF	33.3	85.4	18.3			
			TDLF	32.2	106.4	22.4			
		G7	NLF	34.0	75.8	0.0	0.0	0.0	8.1
			SDLF	34.7	84.4	2.7	5.5	2.8	12.6
			TDLF	35.4	109.0	10.6	21.3	10.7	8.9

Table D-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
18	A	G1	NLF	57.1	139.6	9.2			
			SDLF	66.9	207.6	22.7			
			TDLF	71.2	290.5	30.8			
		G2	NLF	48.0	152.8	11.6			
			SDLF	54.0	107.4	19.3			
			TDLF	57.6	36.5	23.2			
		G3	NLF	45.3	153.1	13.0			
			SDLF	52.4	81.4	21.5			
			TDLF	60.5	0.0	28.9			
		G4	NLF	35.9	87.5	12.7			
			SDLF	35.9	65.0	14.8			
			TDLF	35.1	51.8	14.3			
		G5	NLF	34.0	85.2	13.6			
			SDLF	32.7	76.2	15.2			
			TDLF	30.9	89.4	15.1			
		G6	NLF	33.1	85.3	14.0			
			SDLF	32.7	84.9	16.8			
			TDLF	31.9	108.4	18.9			
		G7	NLF	32.5	84.6	13.9			
			SDLF	34.0	89.5	18.2			
			TDLF	35.1	113.5	22.0			
		G8	NLF	31.7	83.0	12.6			
			SDLF	35.1	85.7	19.0			
			TDLF	37.4	95.4	23.6			
		G9	NLF	29.4	82.8	1.7	3.5	1.8	8.6
			SDLF	34.7	70.1	6.7	13.5	6.8	6.6
			TDLF	37.9	30.3	8.3	16.7	8.4	6.6

Table D-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
18	B	G1	NLF	57.1	139.6	9.2			
			SDLF	66.9	207.6	22.7			
			TDLF	71.2	290.5	30.8			
		G2	NLF	48.0	152.8	11.6			
			SDLF	54.0	107.4	19.4			
			TDLF	57.6	36.5	23.2			
		G3	NLF	45.3	153.1	13.0			
			SDLF	52.4	81.4	21.5			
			TDLF	60.5	0.0	28.9			
		G4	NLF	35.9	87.5	12.7			
			SDLF	35.9	65.1	14.8			
			TDLF	35.1	51.8	14.3			
		G5	NLF	34.0	85.2	13.6			
			SDLF	32.7	76.2	15.2			
			TDLF	30.9	89.5	15.2			
		G6	NLF	33.1	85.3	14.0			
			SDLF	32.7	84.8	16.8			
			TDLF	31.9	108.4	19.0			
		G7	NLF	32.5	84.7	13.9			
			SDLF	34.0	89.3	18.1			
			TDLF	35.1	113.3	21.9			
		G8	NLF	31.7	83.1	12.7			
			SDLF	35.1	85.9	18.8			
			TDLF	37.4	95.7	23.4			
		G9	NLF	29.4	83.1	1.7	3.5	1.7	8.9
			SDLF	34.7	71.4	4.8	9.7	4.9	9.8
			TDLF	37.9	32.5	4.9	9.8	4.9	11.8

Appendix E-1. EICCR11 Bridge Description

The key characteristics of EICCR11 are as follows:

- Span length along the centerline of the bridge, L_s = 310, 417, 332 ft.
- Width between the fascia girders, w_g = 40.3 ft.
- Radius of curvature to the centerline of the bridge, R =infinite, infinite, 411 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 8.0, 10.3, 8.1
- Subtended angle between the supports, L_s/R = 0.78
- Number of girders in the completed bridge cross-section, n_g =4.

This appendix presents the bridge description of the bridge EICCR11 in its final condition as well as during erection. The following figures and tables are provided:

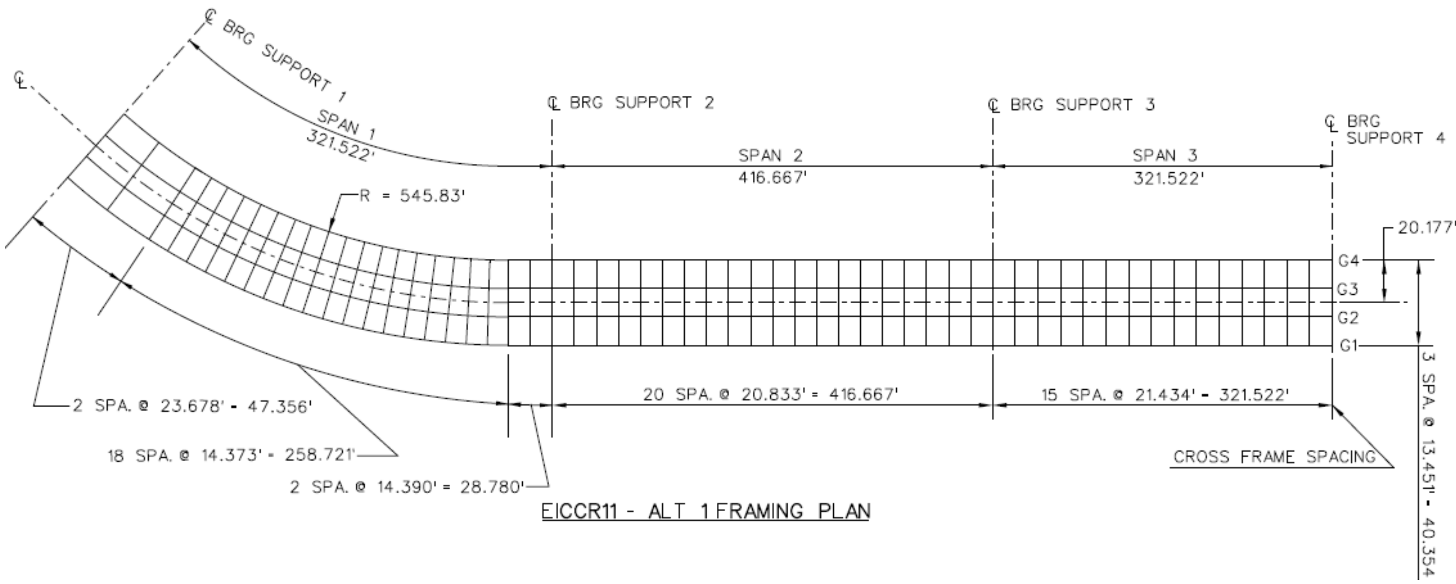


Figure E-1-1. Framing plan.

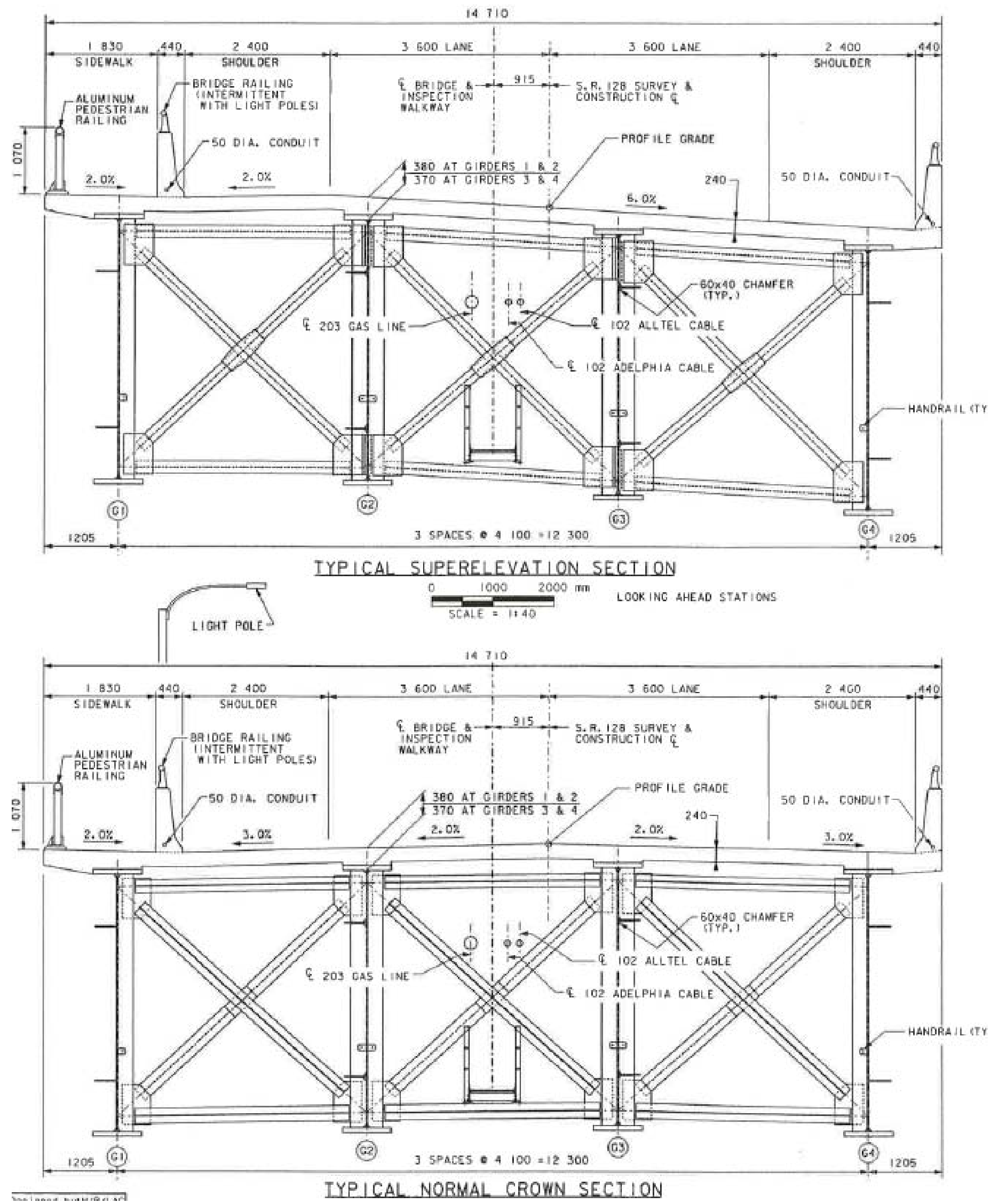


Figure E-1-2. Bridge cross-section.

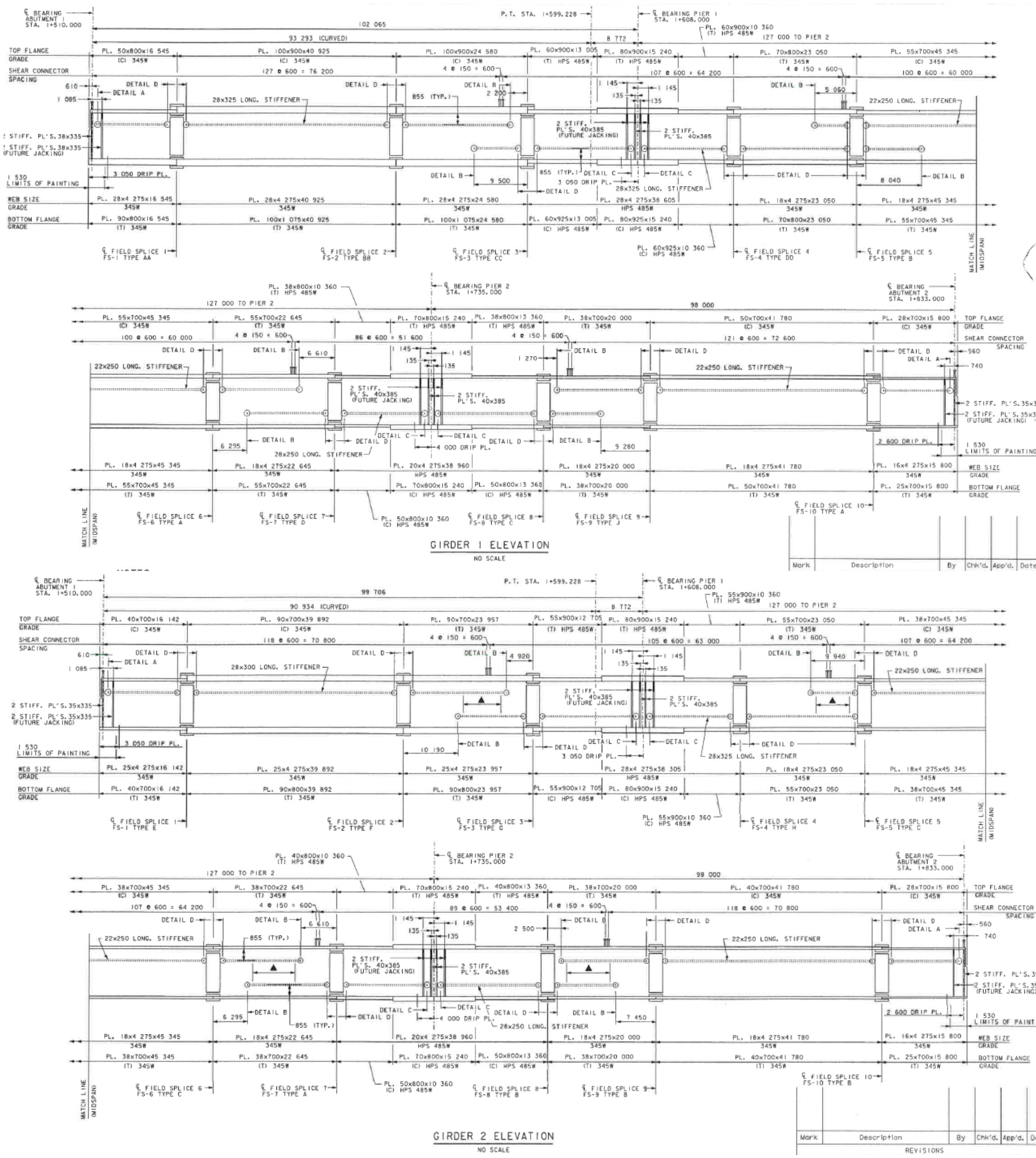


Figure E-1-3. Girder elevations

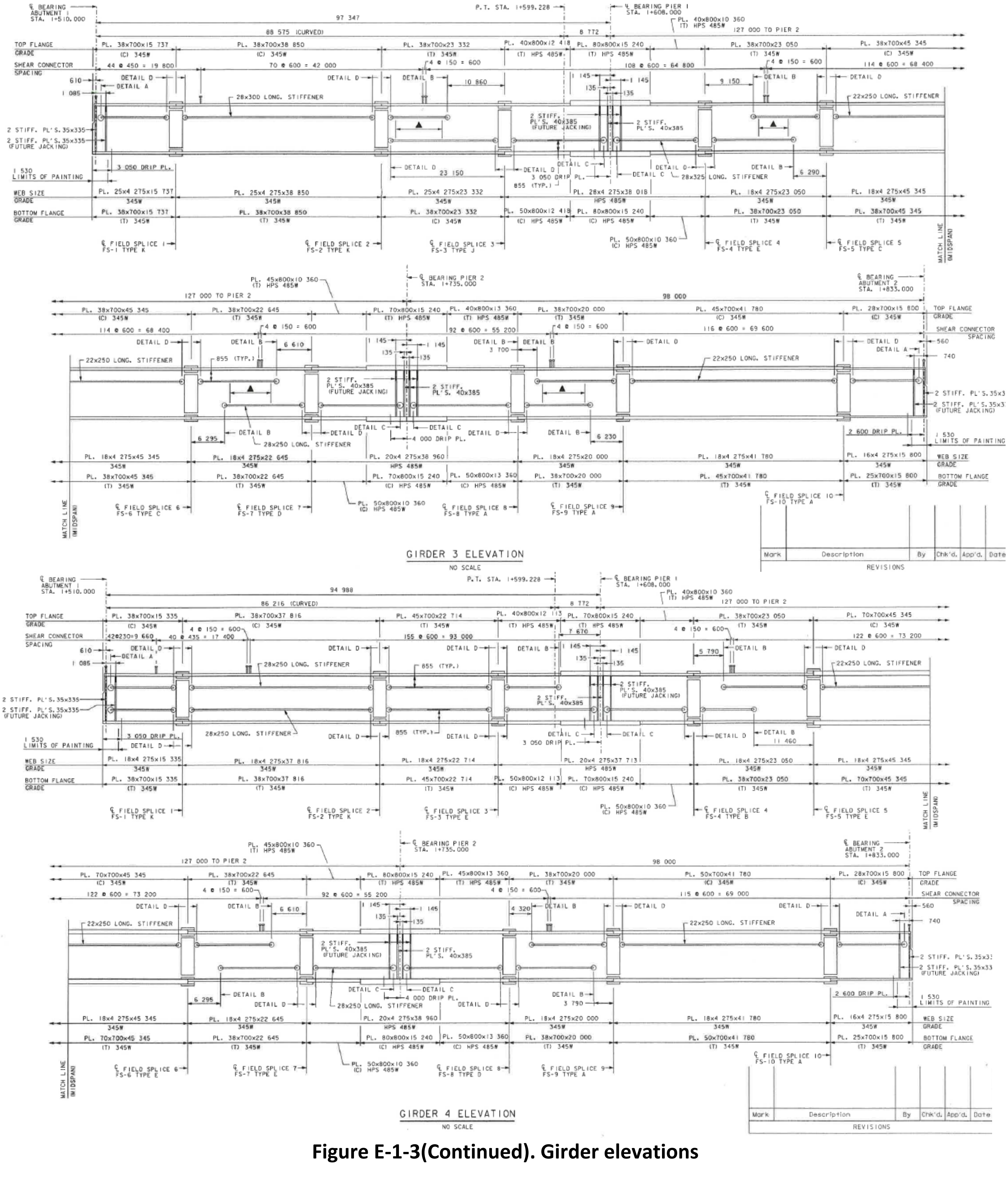


Figure E-1-3(Continued). Girder elevations

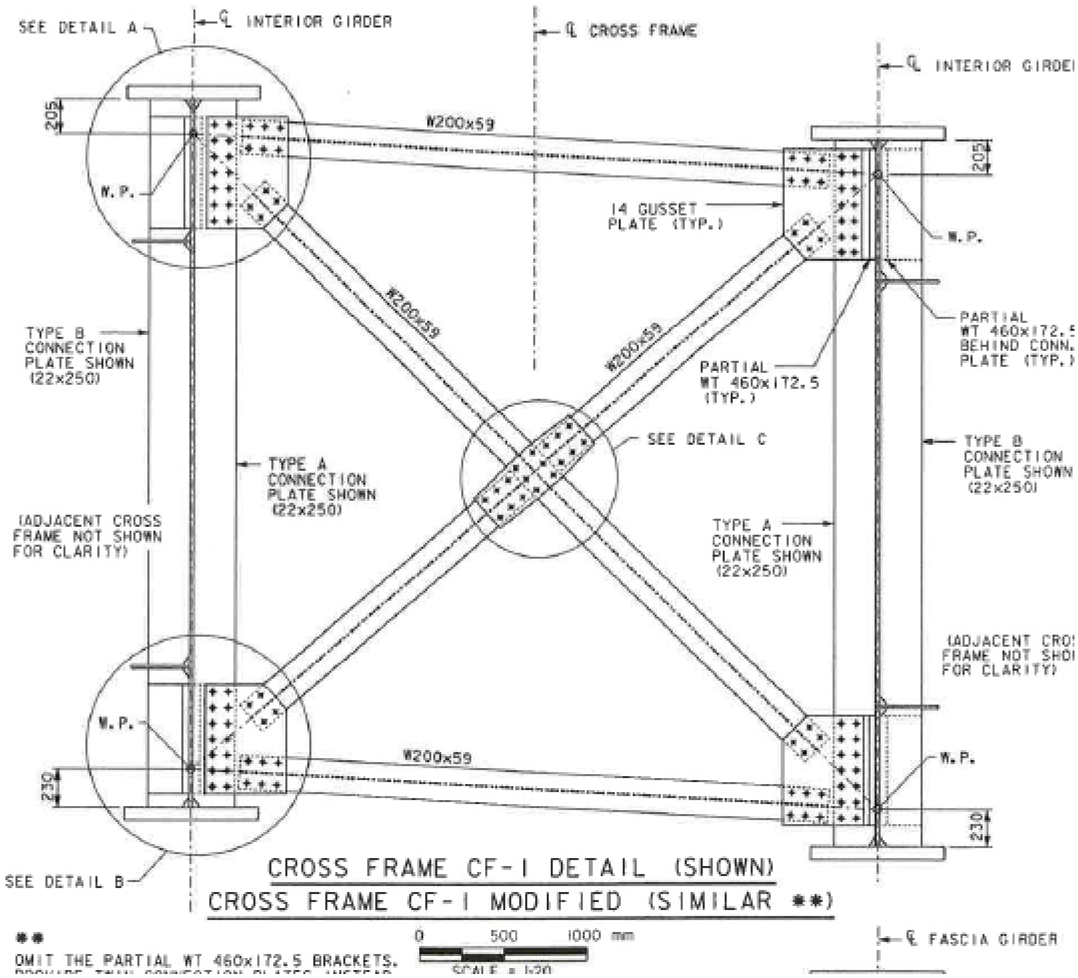
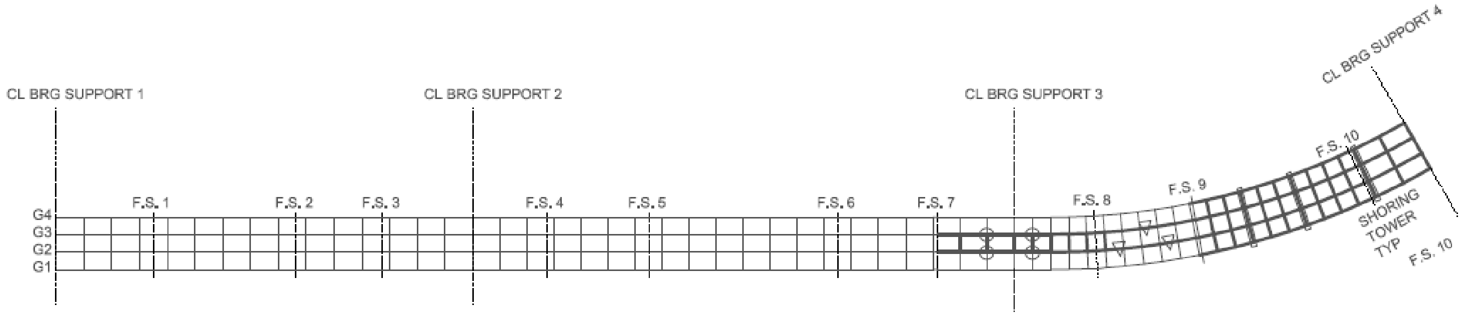
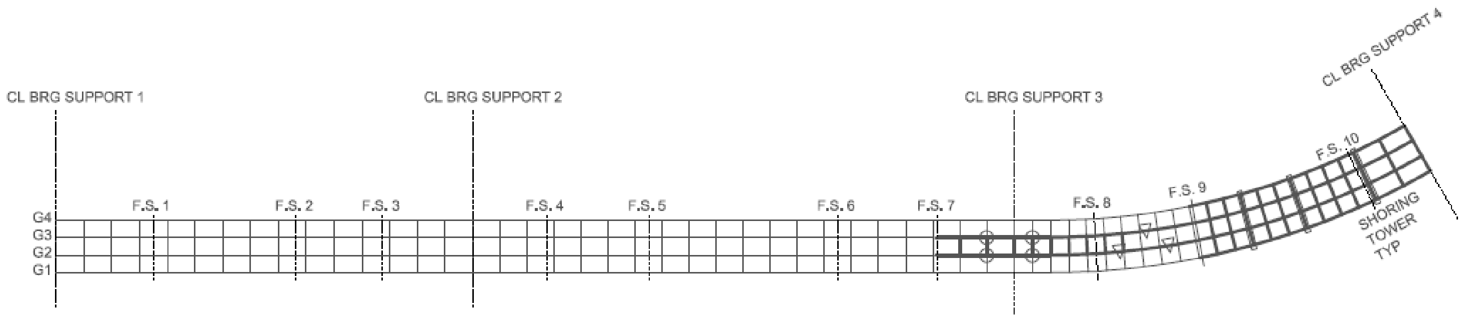


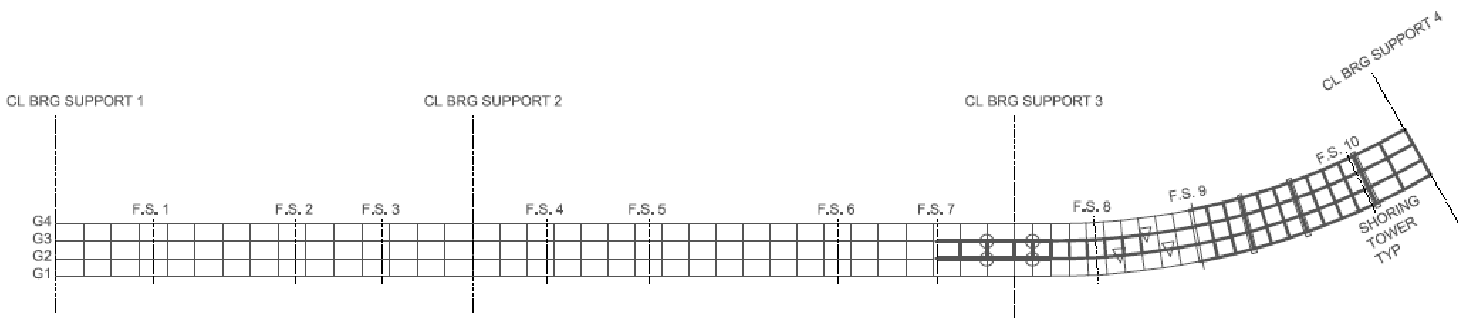
Figure E-1-4. Cross-frame details



STAGE 12-1

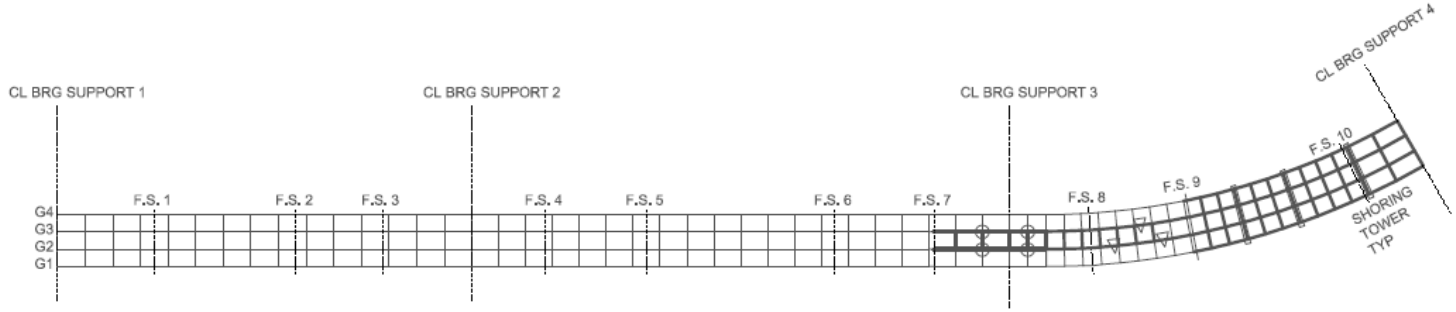


STAGE 12-2

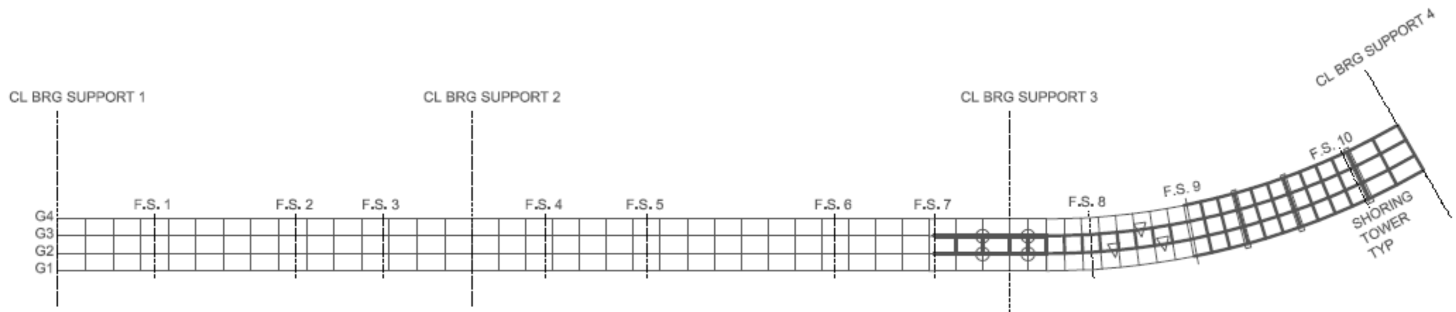


STAGE 12-3

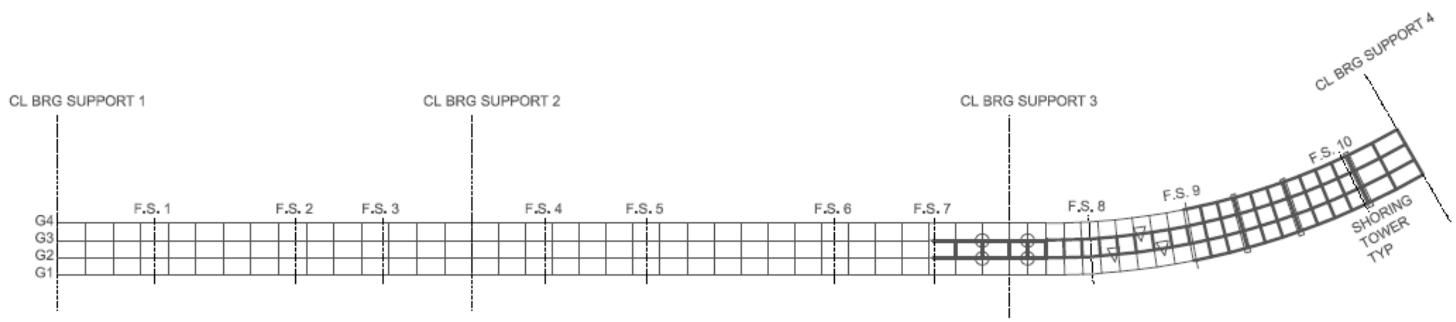
Figure E-1-5. Erection scheme.



STAGE 12-4

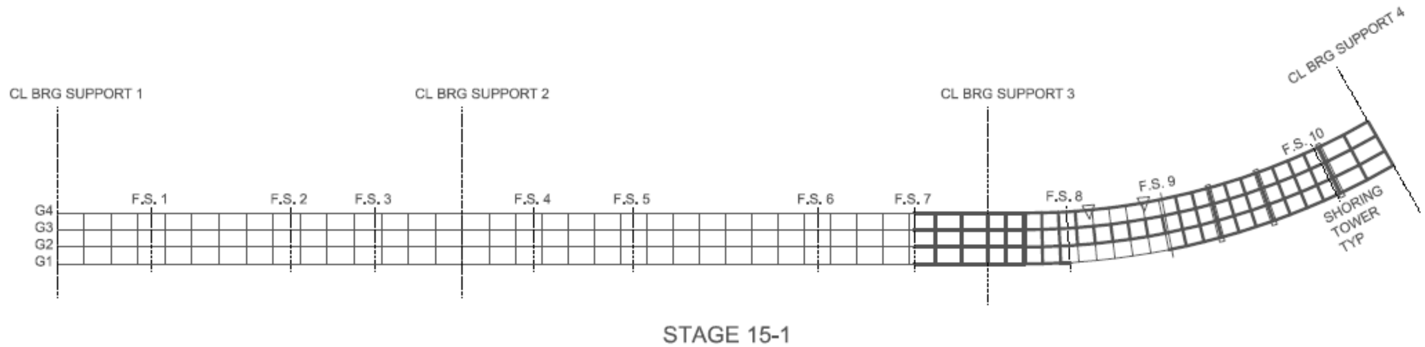


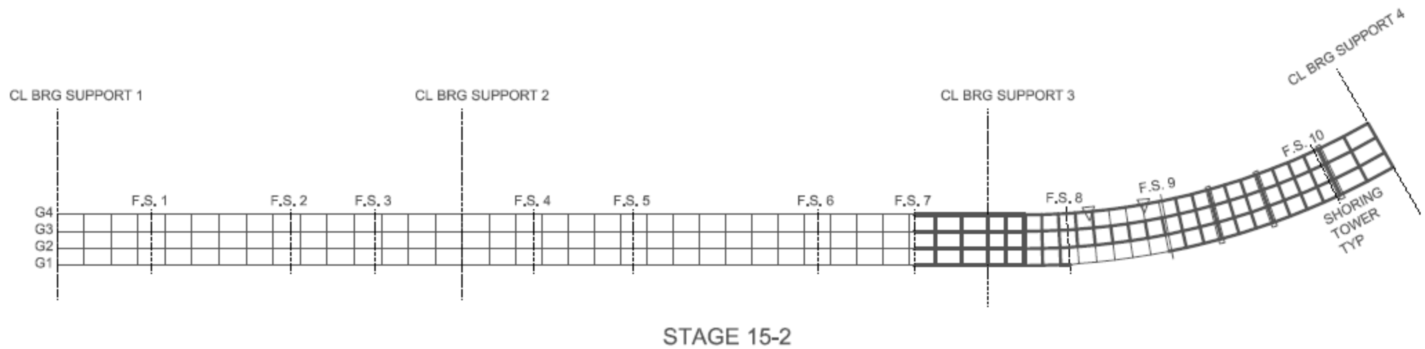
STAGE 12-5



STAGE 12-6

Figure E-1-5(Continued). Erection scheme.





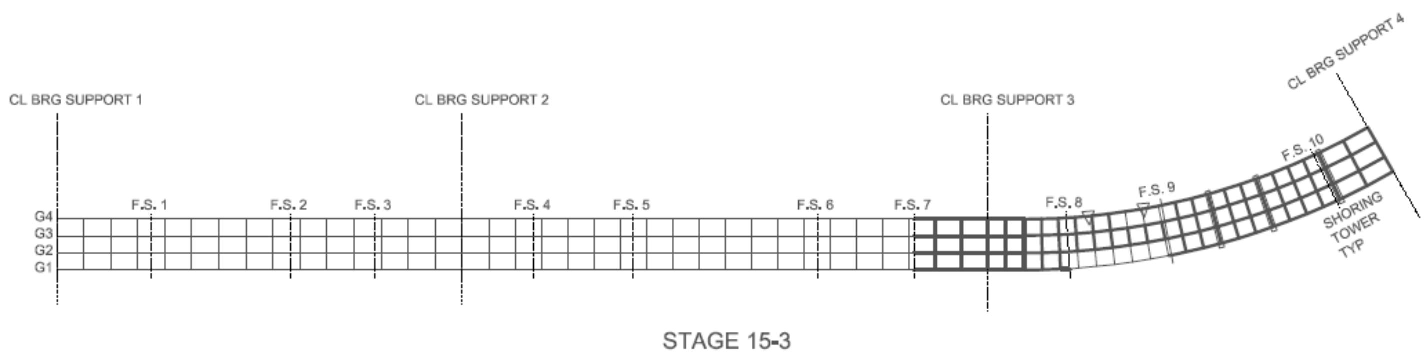
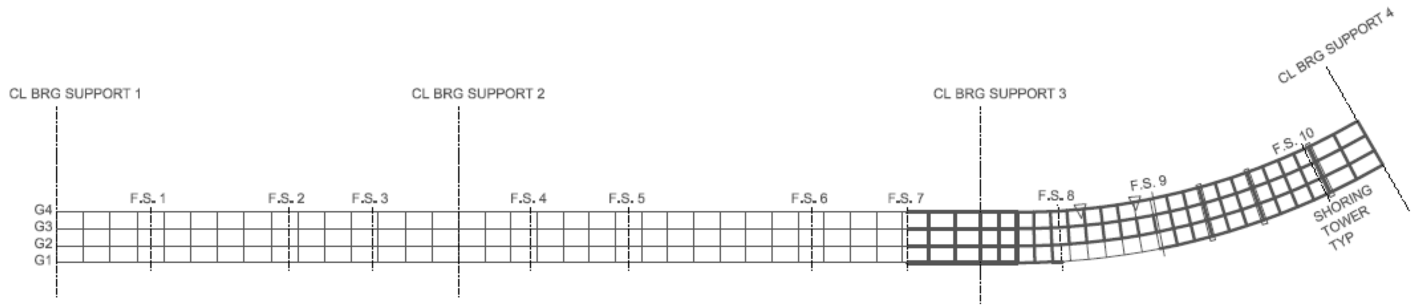
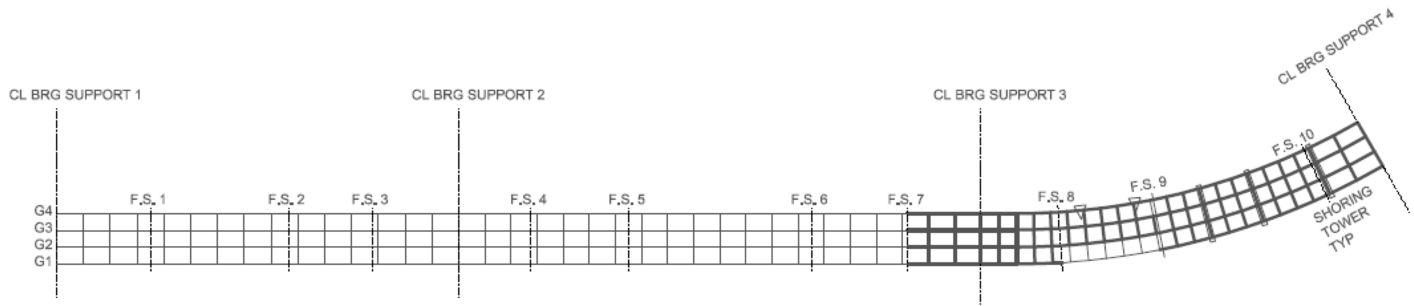


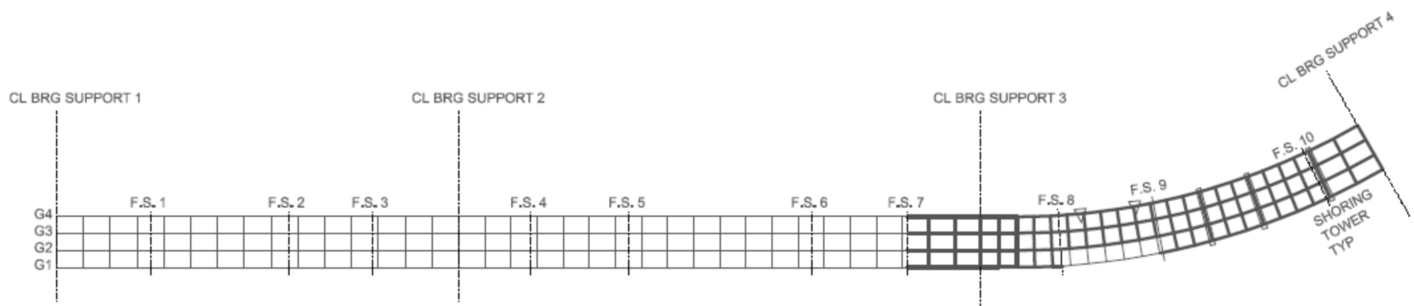
Figure E-1-5(Continued). Erection scheme.



STAGE 15-4

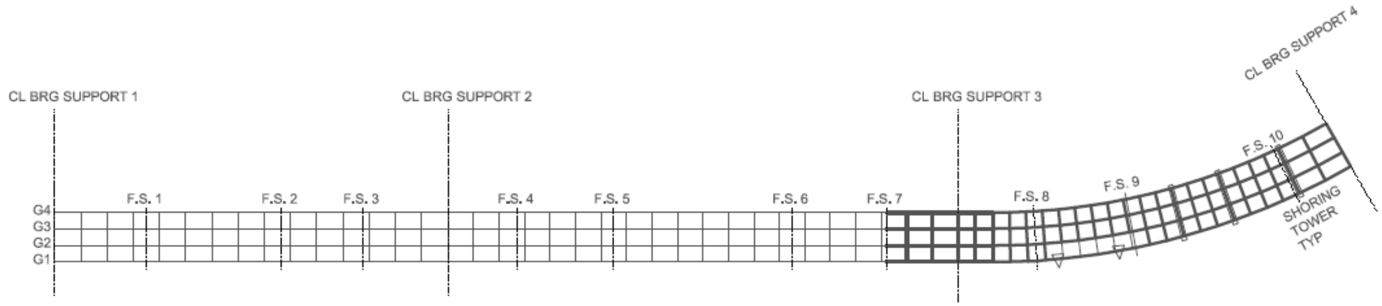


STAGE 15-5

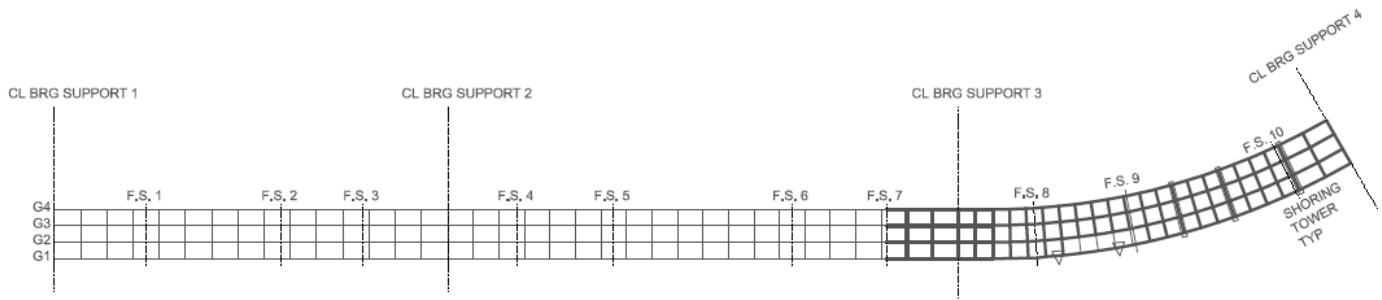


STAGE 15-6

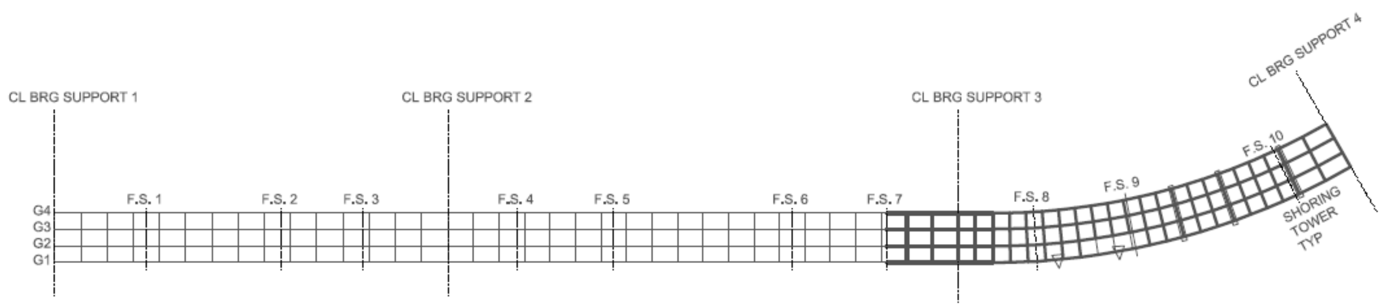
Figure E-1-5(Continued). Erection scheme.



STAGE 16-1

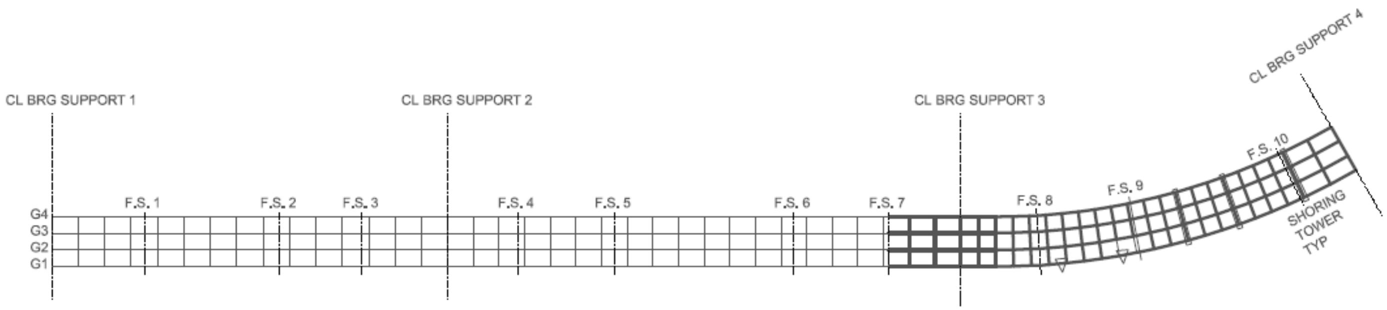


STAGE 16-2

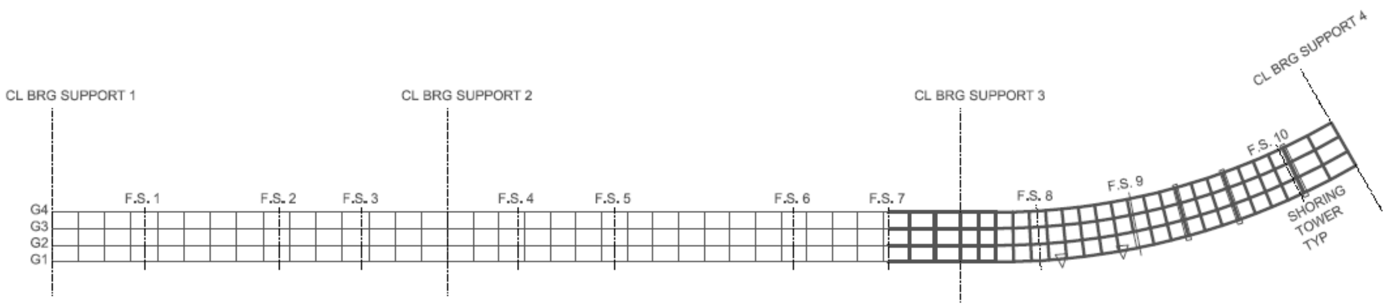


STAGE 16-3

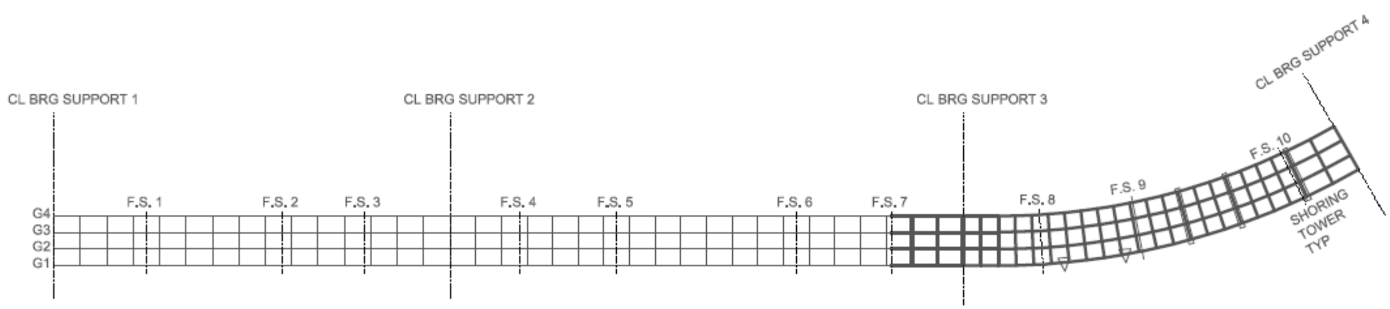
Figure E-1-5(Continued). Erection scheme.



STAGE 16-4



STAGE 16-5



STAGE 16-6

Figure E-1-5(Continued). Erection scheme.

Table E-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

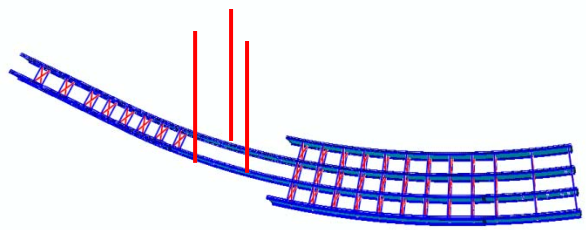
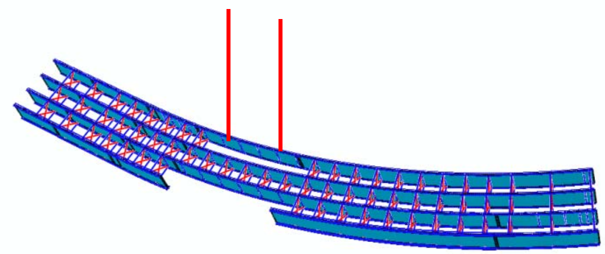
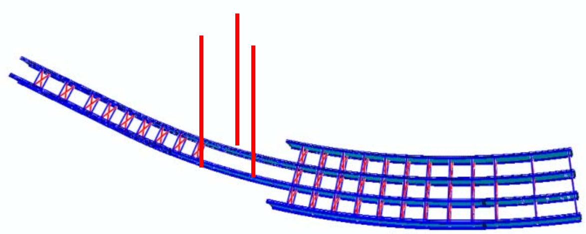
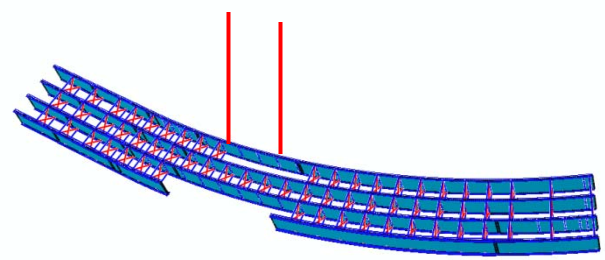
Sub-Stage	Stage	
	12	15
1		
2		

Table E-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

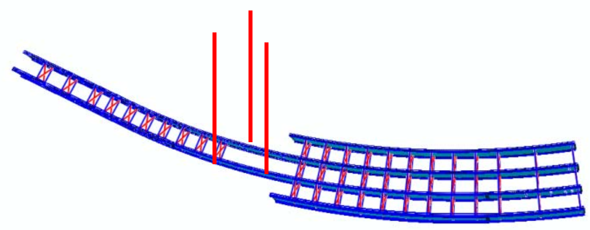
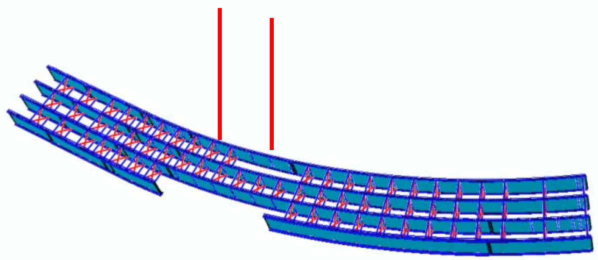
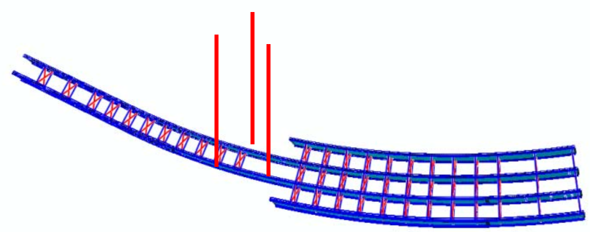
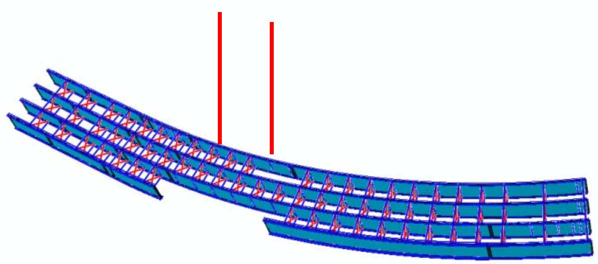
3		
4		

Table E-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

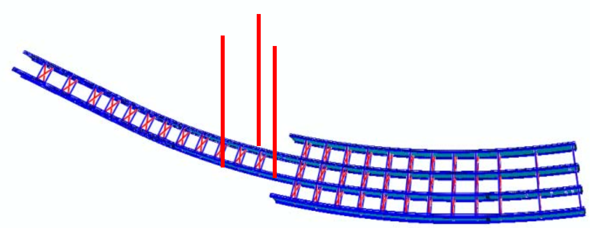
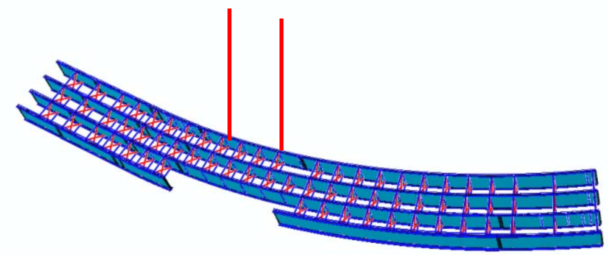
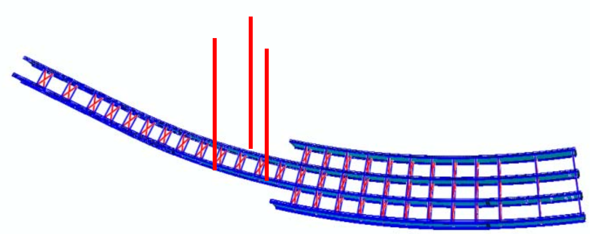
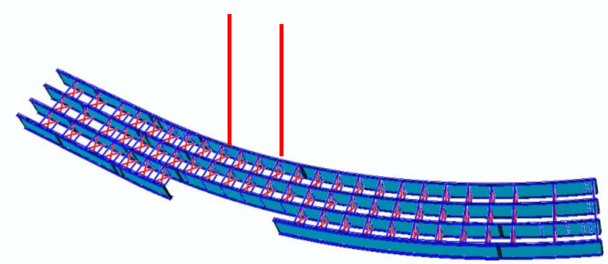
5		
6		

Table E-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

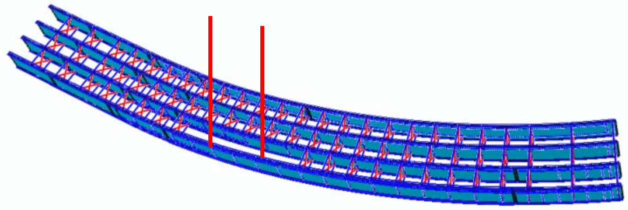
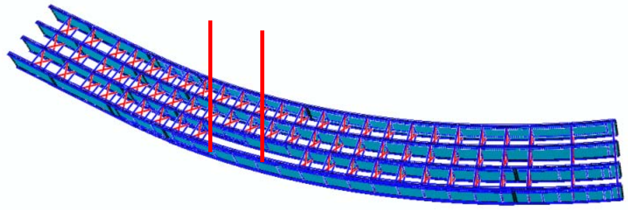
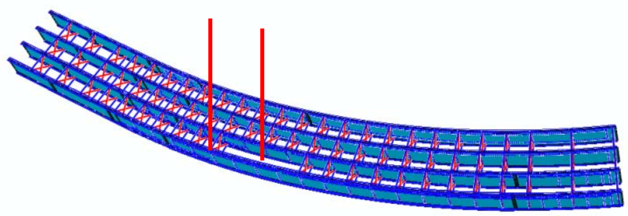
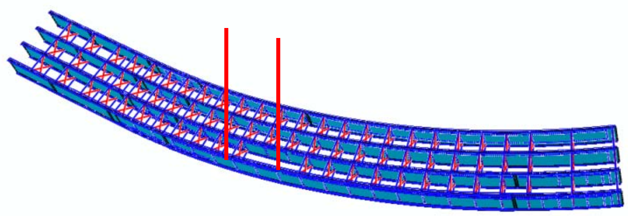
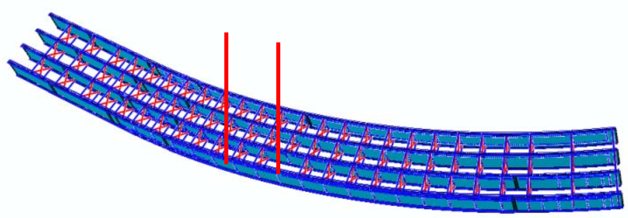
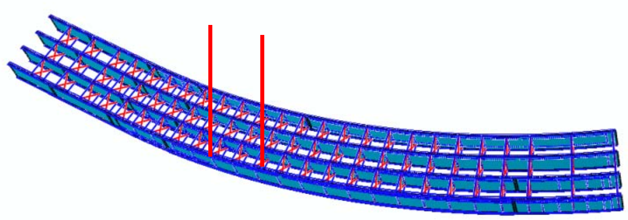
Sub-Stage	Stage 16
1	
2	
3	

Table E-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

Sub-Stage	Stage 16
4	
5	
6	

Appendix E-2. EICCR11 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EICCR11 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table E-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	10.6	19.4
	SDLF	8.5	16.8
	TDLF	7.0	14.7
G2	NLF	7.5	14.0
	SDLF	4.8	10.9
	TDLF	3.5	9.5
G3	NLF	4.5	10.0
	SDLF	4.3	11.4
	TDLF	5.5	12.5
G4	NLF	4.2	13.2
	SDLF	6.1	14.7
	TDLF	7.6	15.5
All Girders	NLF	10.6	19.4
	SDLF	8.5	16.8
	TDLF	7.6	15.5

Table E-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	3.37	5.92
	SDLF	0.89	3.24
	TDLF	1.23	1.18
G2	NLF	3.30	5.77
	SDLF	0.80	3.09
	TDLF	1.25	1.02
G3	NLF	3.21	5.61
	SDLF	0.73	2.94
	TDLF	1.26	0.89
G4	NLF	3.19	5.57
	SDLF	0.72	2.91
	TDLF	1.27	0.87
All Girders	NLF	3.37	5.92
	SDLF	0.89	3.24
	TDLF	1.27	1.18

Table E-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	13.6	28.8	13.6	28.8	1.8	5.9	2.7	6.2
	SDLF	12.6	27.9	15.1	28.2	1.4	3.6	2.5	5.7
	TDLF	13.3	27.4	16.4	29.3	1.7	2.9	2.8	5.3
G2	NLF	11.9	27.1	11.7	26.7	1.6	5.2	1.8	5.0
	SDLF	10.3	25.4	10.0	24.9	1.7	3.9	1.5	3.9
	TDLF	9.4	24.1	8.7	24.4	1.8	3.6	1.6	3.4
G3	NLF	10.0	25.1	11.6	29.4	1.4	5.6	1.7	5.0
	SDLF	8.7	24.5	9.0	26.0	1.0	3.2	0.7	3.2
	TDLF	9.2	25.0	9.7	26.2	1.3	2.0	0.7	2.0
G4	NLF	8.2	23.9	9.2	26.3	1.5	5.3	1.9	5.3
	SDLF	9.3	24.5	10.0	27.2	1.1	3.0	1.0	3.3
	TDLF	11.7	24.9	11.8	27.7	1.1	2.2	0.9	1.9
All Girders	NLF	13.6	28.8	13.6	29.4	1.8	5.9	2.7	6.2
	SDLF	12.6	27.9	15.1	28.2	1.7	3.9	2.5	5.7
	TDLF	13.3	27.4	16.4	29.3	1.8	3.6	2.8	5.3

Table E-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	22.9	45.8	45.6	45.8
	SDLF	75.9	33.8	76.2	76.2
	TDLF	67.1	61.3	59.4	67.1
TDL	NLF	53.9	91.0	90.8	91.0
	SDLF	101.2	76.0	118.5	118.5
	TDLF	92.9	100.8	99.6	100.8

Table E-2-5A. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	5.7	9.1	9.2	7.4
	SDLF	13.2	7.5	15.7	12.4
	TDLF	21.9	13.0	12.7	17.4
TDL	NLF	13.5	18.2	18.3	15.8
	SDLF	19.0	15.3	23.6	19.2
	TDLF	25.0	20.1	20.4	22.6

Table E-2-5B. Summary of average cross-frame forces in the curved span (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	11.8	20.0	20.1	15.9
	SDLF	25.9	14.9	35.5	25.5
	TDLF	39.3	30.3	29.0	34.5
TDL	NLF	25.8	37.8	37.4	31.7
	SDLF	37.2	30.2	51.5	39.0
	TDLF	47.7	43.9	44.0	45.8

Table E-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	All Girders
NLF	3.10	3.05	3.03	3.10
SDLF	3.75	3.65	3.61	3.75
TDLF	4.24	4.10	4.04	4.24

Table E-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	All Girders
NLF	5.41	5.33	5.29	5.41
SDLF	5.89	5.75	5.70	5.89
TDLF	6.19	6.00	5.93	6.19

Table E-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	All Girders
NLF	2.84	2.80	2.78	2.84
SDLF	3.44	3.35	3.31	3.44
TDLF	3.89	3.76	3.71	3.89

Table E-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	All Girders
NLF	4.96	4.88	4.85	4.96
SDLF	5.40	5.28	5.22	5.40
TDLF	5.67	5.51	5.44	5.67

Table E-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	4747.7	11983.0
SDLF	4747.7	11982.9
TDLF	4747.7	11982.7

Table E-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	678.5	1387.6	1.1	2.1	0.4	2.1
SDLF	722.1	1437.2	1.4	2.4	0.4	2.4
TDLF	757.7	1484.8	1.6	2.4	0.4	2.4

Table E-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.3	1.7	0.2	1.7
SDLF	0.4	1.3	0.4	1.3
TDLF	0.7	1.1	0.6	1.1

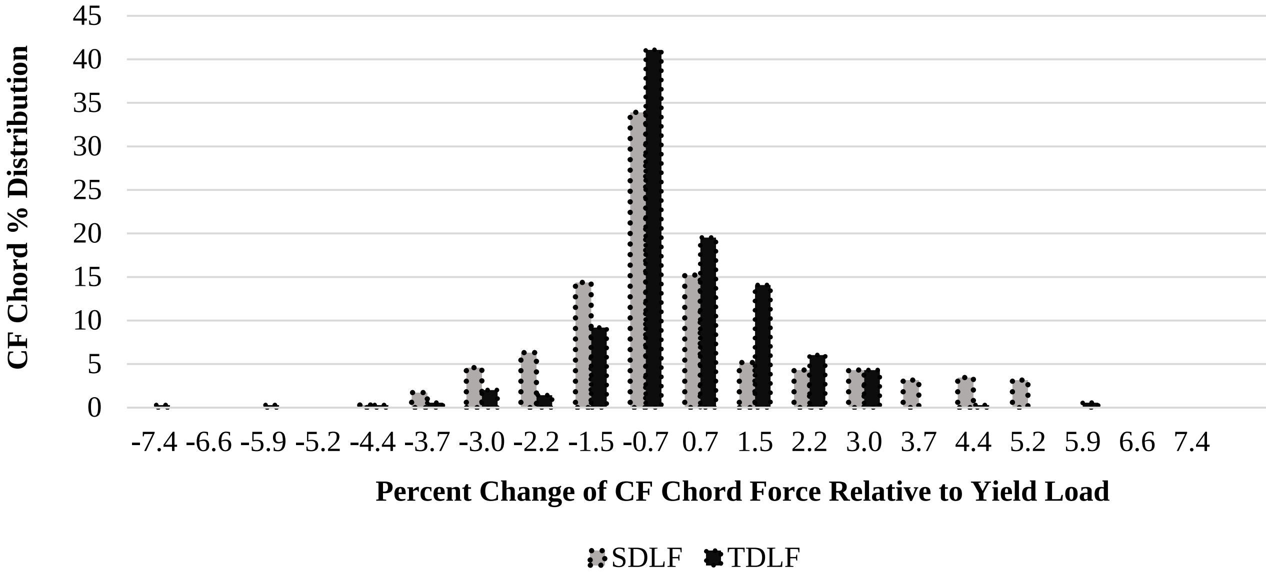


Figure E-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

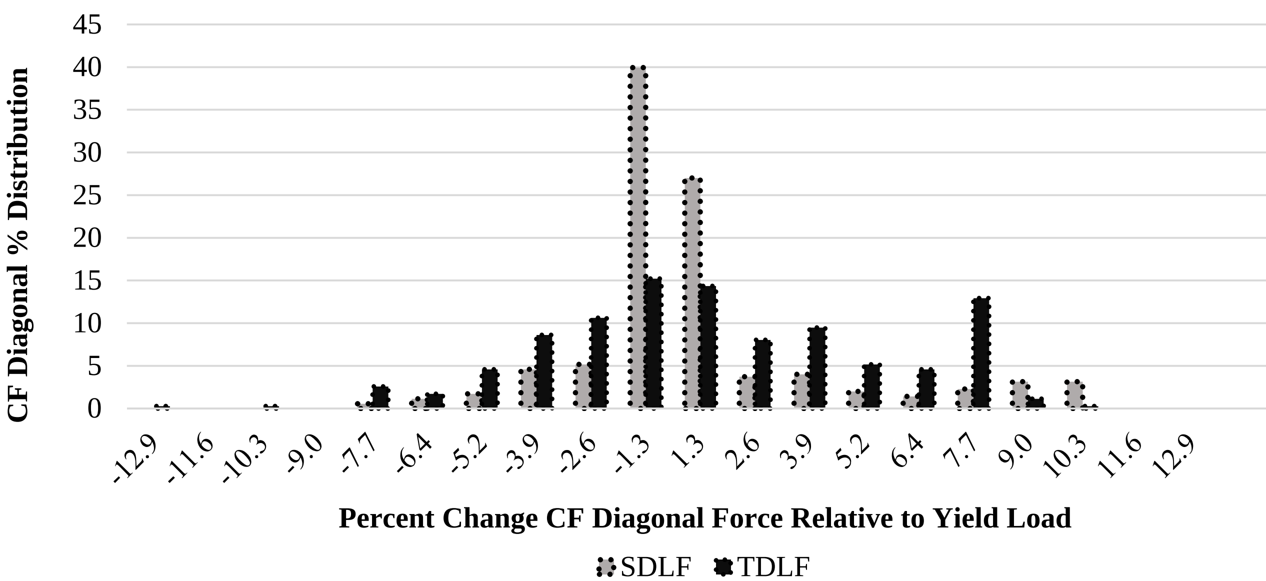


Figure E-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

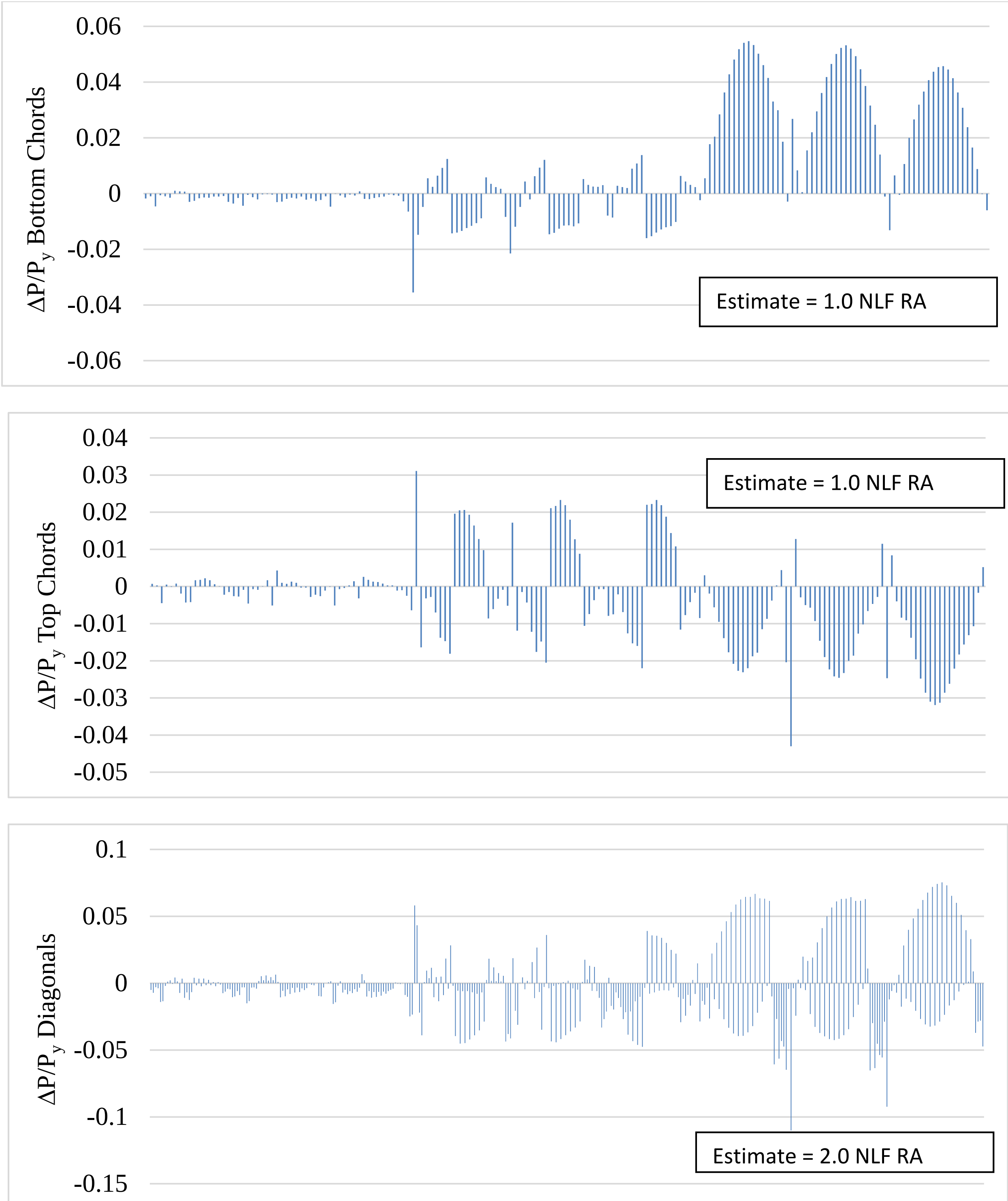


Figure E-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

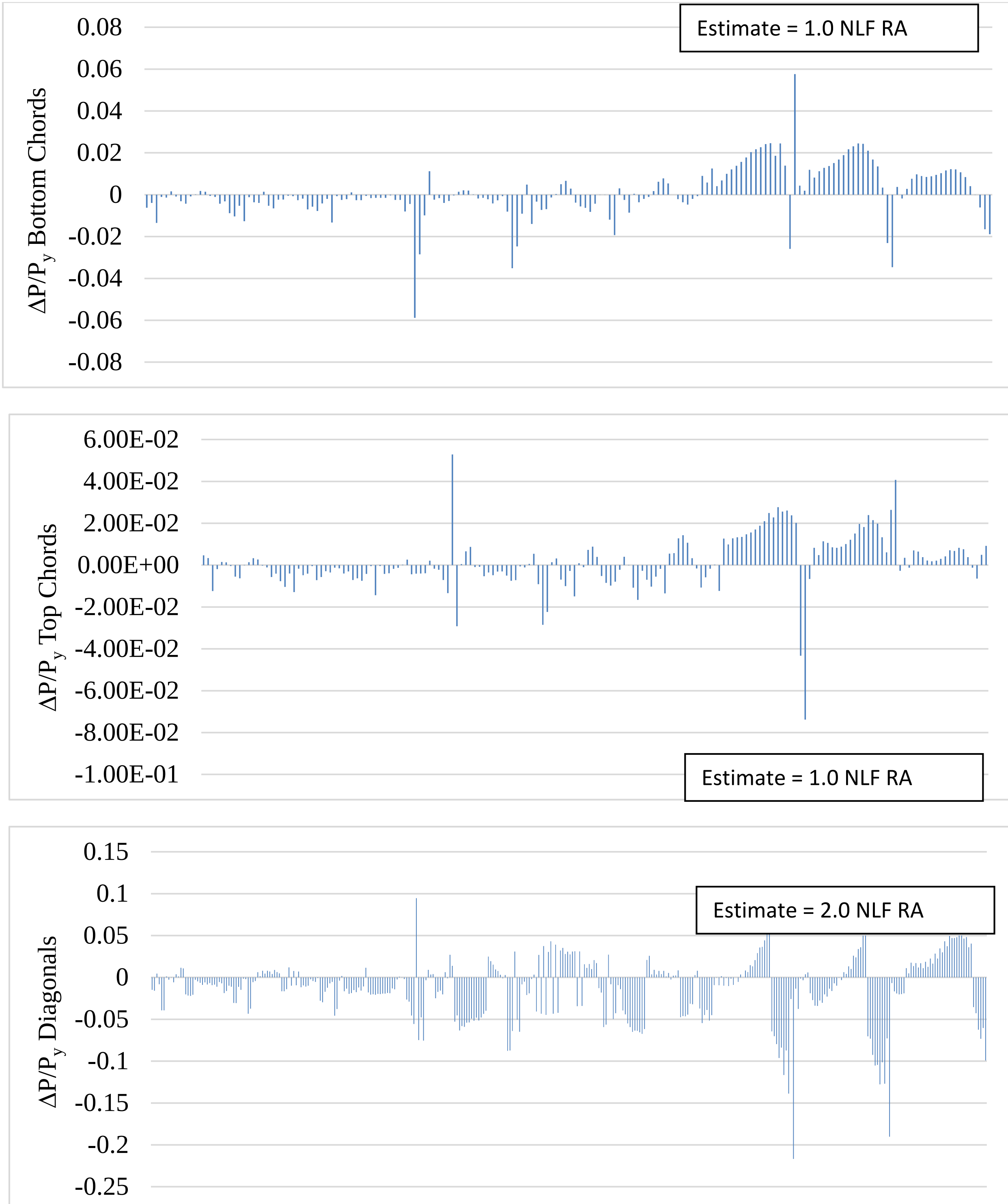


Figure E-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix E-3. EICCR11 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EICCR11 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Splice Fit-up

Table E-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	11.3	37.5	37.5
SDLF	86.3	81.6	86.3
TDLF	130	98.5	130

Table E-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	212.5	21.6
	SDLF	492	0
	TDLF	470.7	0
G2	NLF	218.7	0
	SDLF	303.2	0
	TDLF	325.8	0
G3	NLF	182.7	0
	SDLF	240	0
	TDLF	222.2	0
G4	NLF	160.4	0
	SDLF	155.8	0
	TDLF	141.4	0
All Girders	NLF	218.7	0
	SDLF	492	0
	TDLF	470.7	0

Table E-3-3. Summary of crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min load
NLF	122.4	42.3	82.1	80.4
SDLF	215	0	0	0
TDLF	257.9	0	0	0

Table E-3-4. Erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage					
		1	2	3	4	5	6
12	NLF	1404	1406	1409	1411	1414	1416
	SDLF	1404	1406	1409	1411	1414	1416
	TDLF	1404	1406	1409	1411	1414	1416
15	NLF	1801	1804	1806	1809	1811	1814
	SDLF	1801	1804	1806	1809	1811	1814
	TDLF	1801	1804	1806	1809	1811	1814
16	NLF	2026	2029	2031	2034	2036	2039
	SDLF	2026	2029	2031	2034	2036	2039
	TDLF	2026	2029	2031	2034	2036	2039

Table E-3-5: Splice fit-up moments (kip*ft.)

Stage	Detailing Method	M_b	Top Flange M_l	Bottom Flange M_l
12	NLF	315	4.8	4.8
	SDLF	7566	43.5	9.5
	TDLF	11267	103.1	17.2
15	NLF	212	5.3	5.4
	SDLF	2694	34.3	2.8
	TDLF	1454	32.4	13.0
16	NLF	639	0.2	1.8
	SDLF	8986	103.9	12.3
	TDLF	12443	161.0	15.7

Appendix E-4. EICCR11 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge EICCR11 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

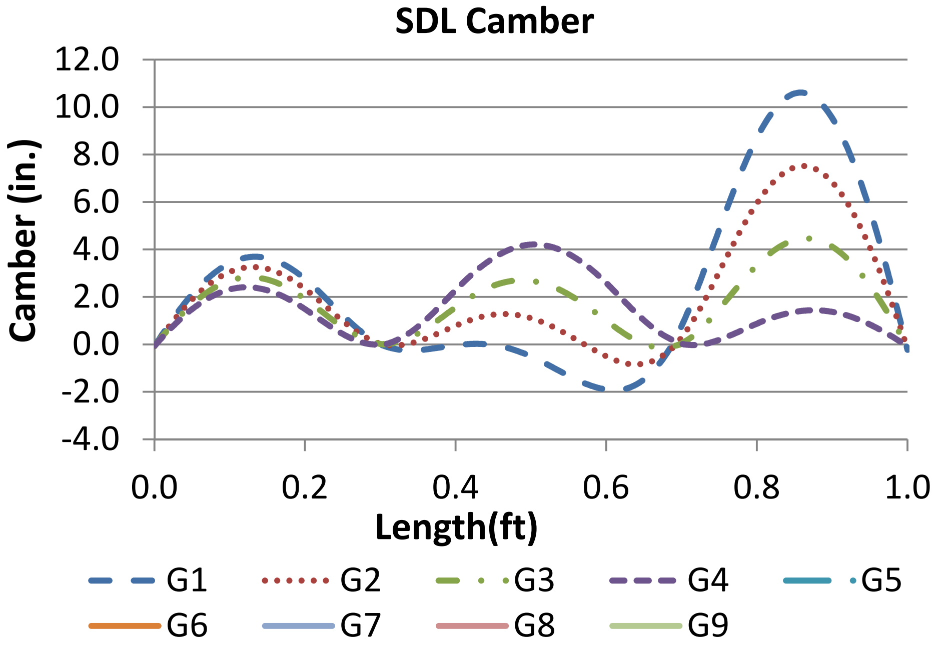
Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements



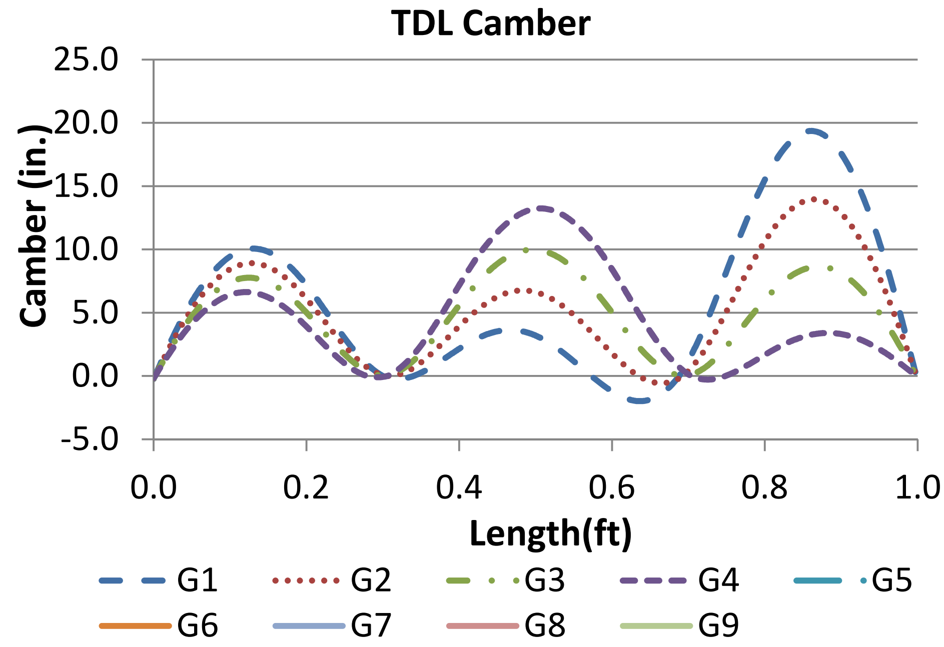


Figure E-4-1. SDL and TDL 3D FEA cambers.

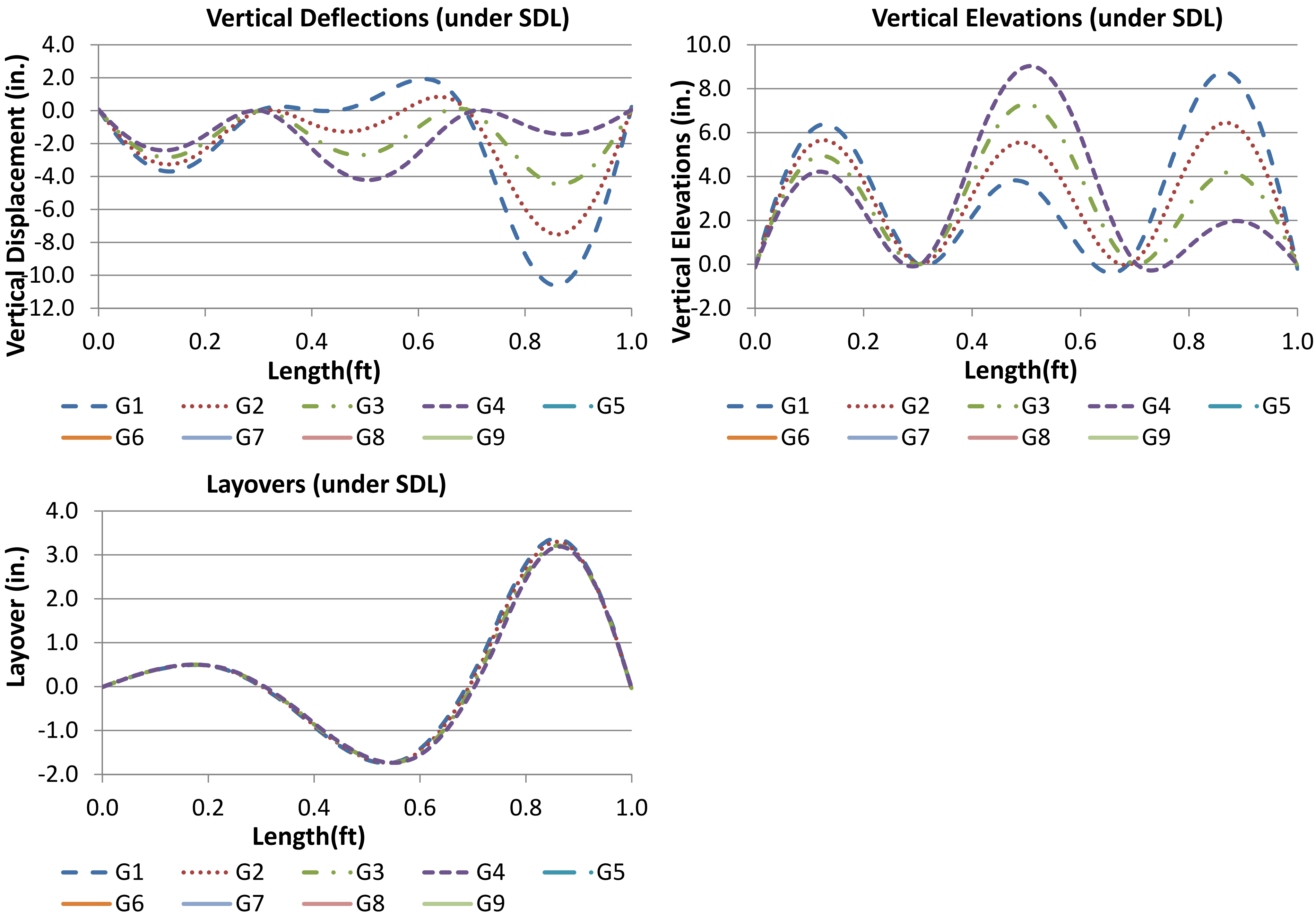


Figure E-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

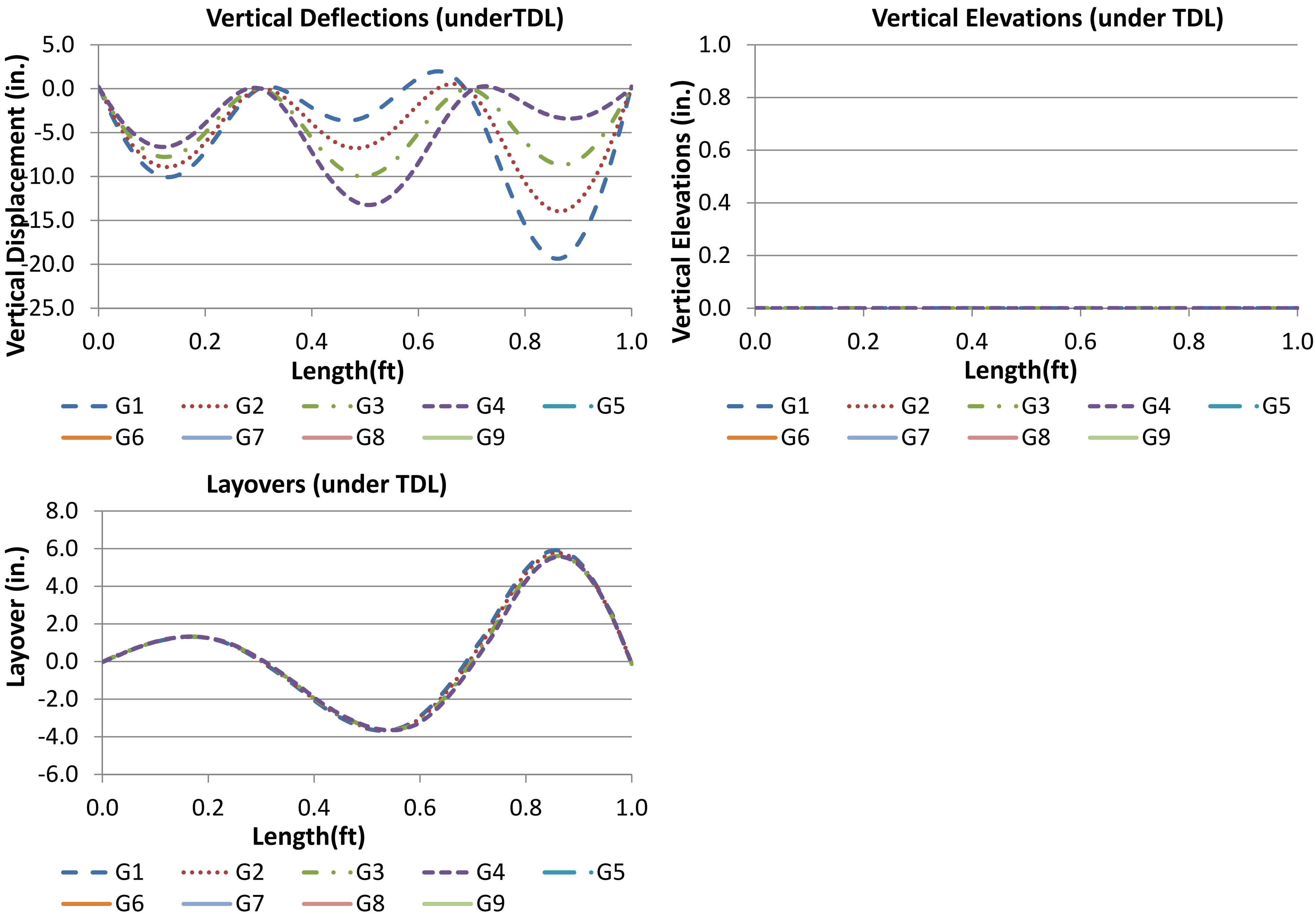


Figure E-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

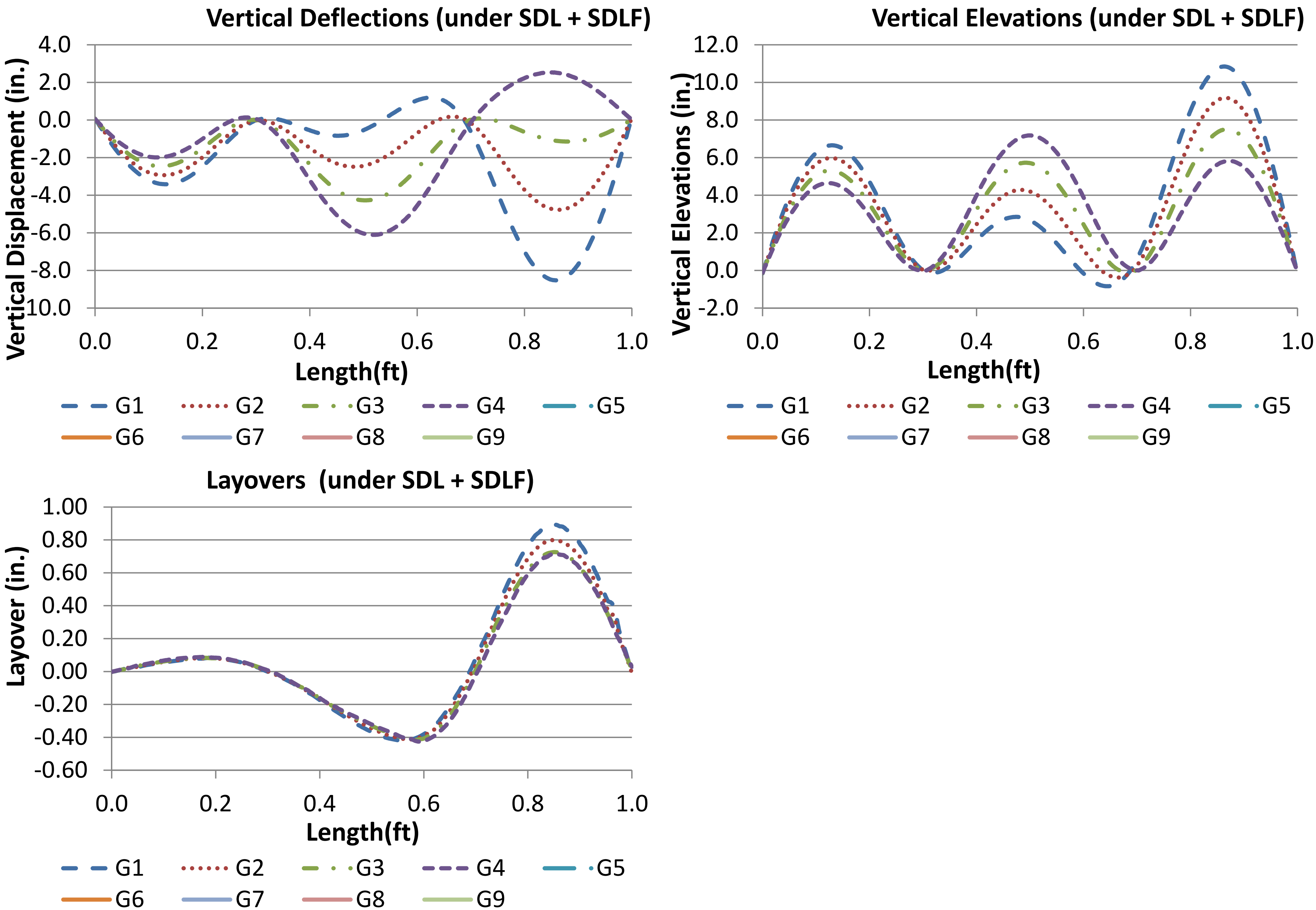


Figure E-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

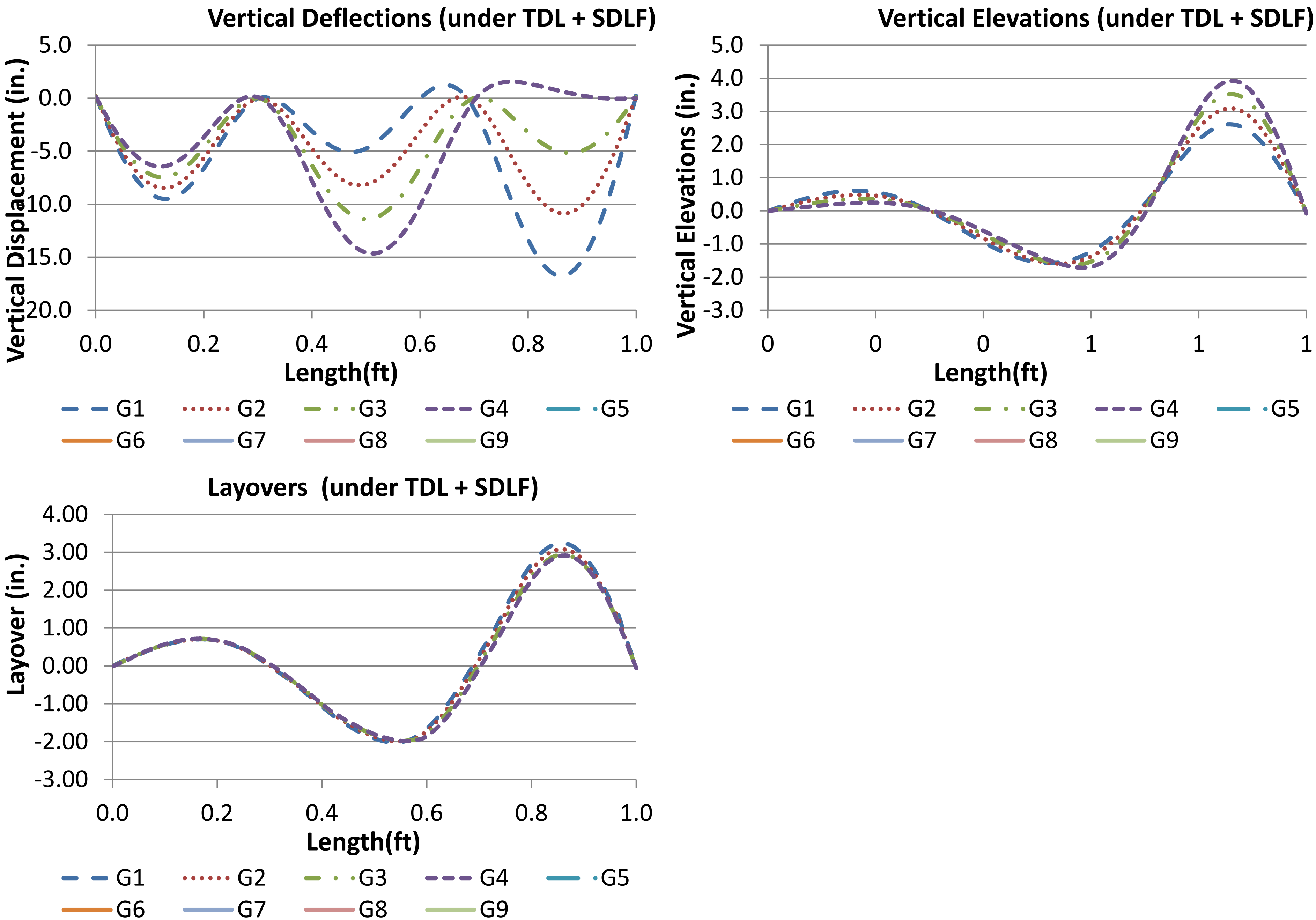
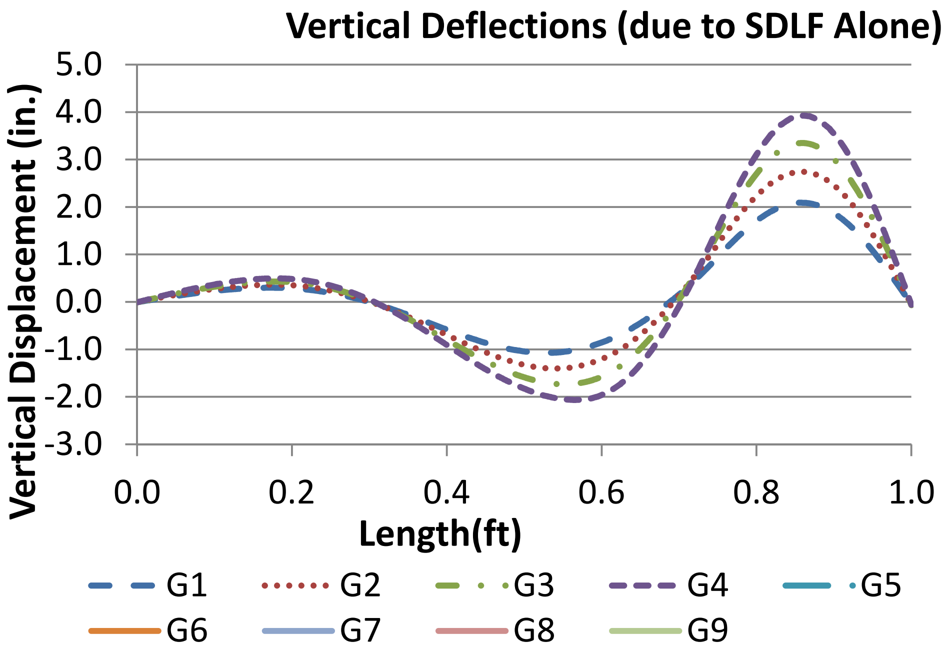


Figure E-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.



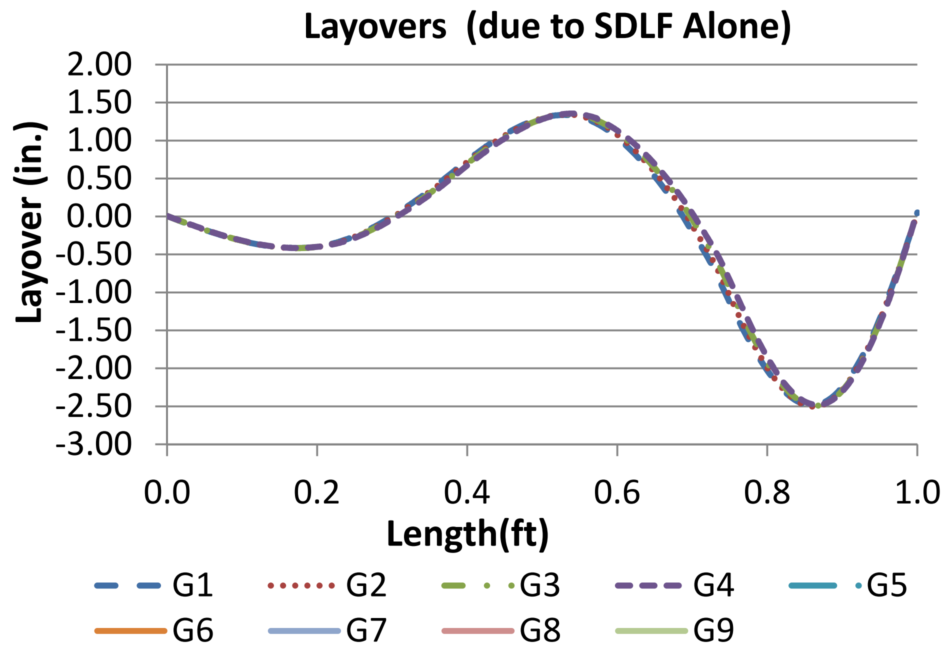


Figure E-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

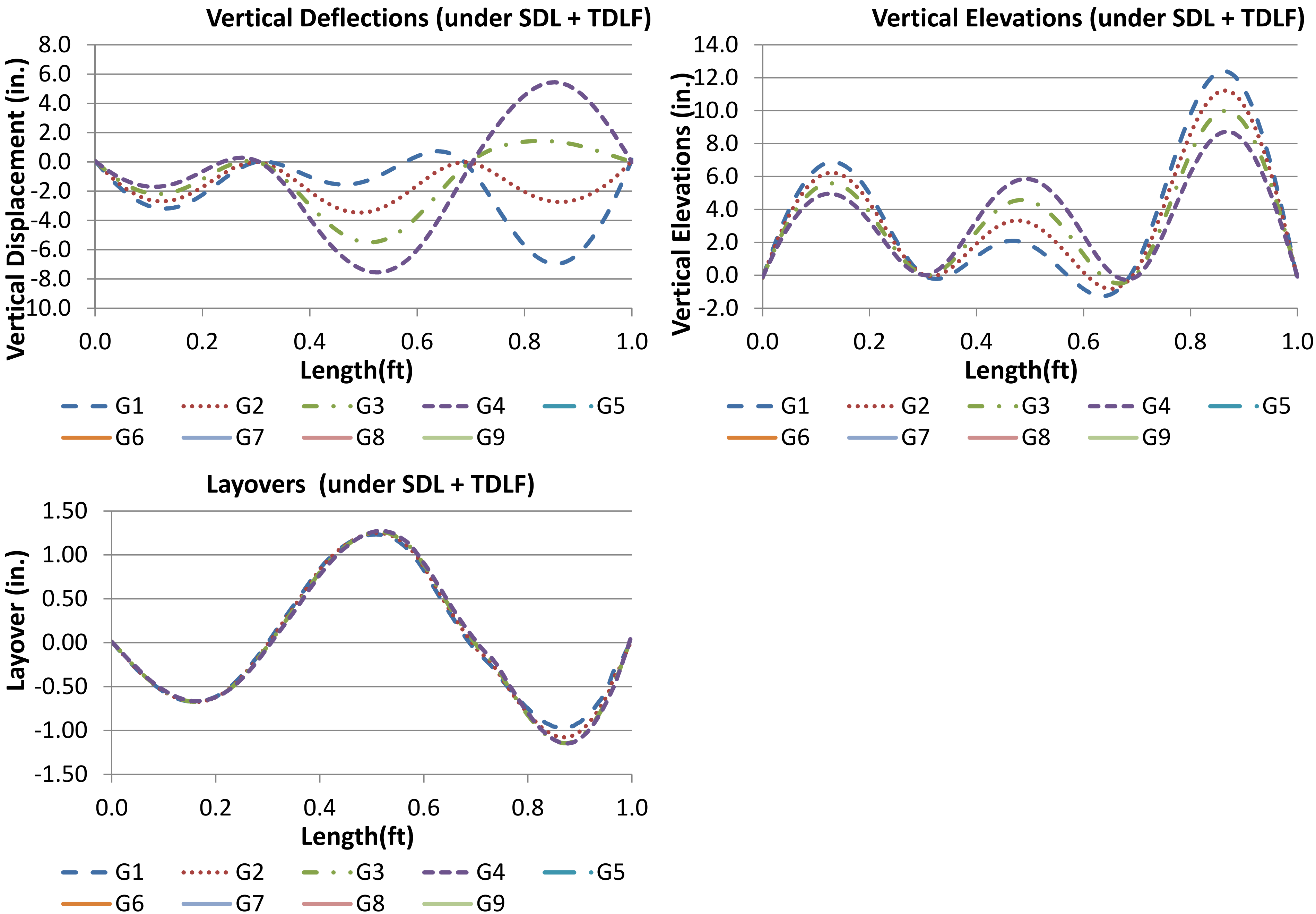


Figure E-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

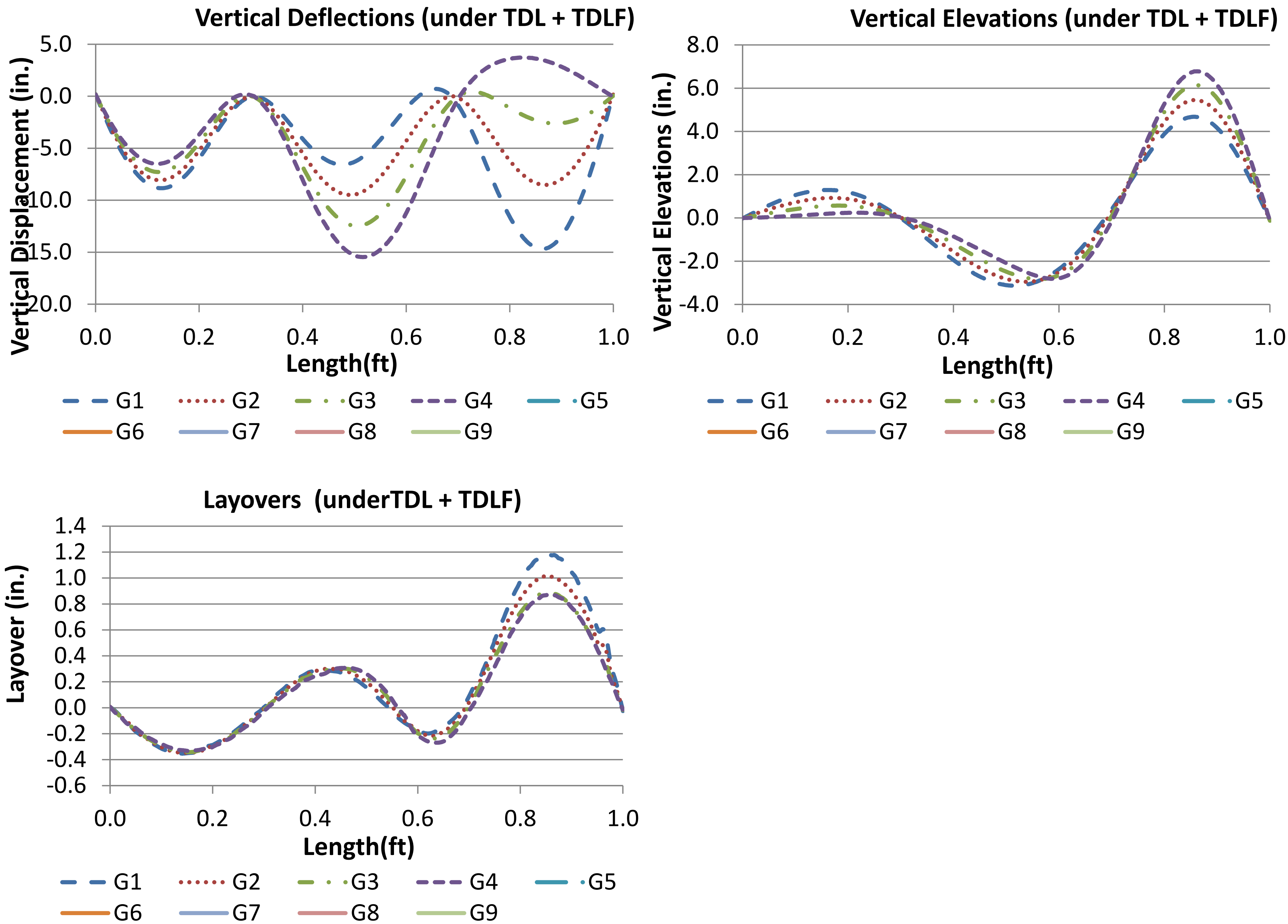


Figure E-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

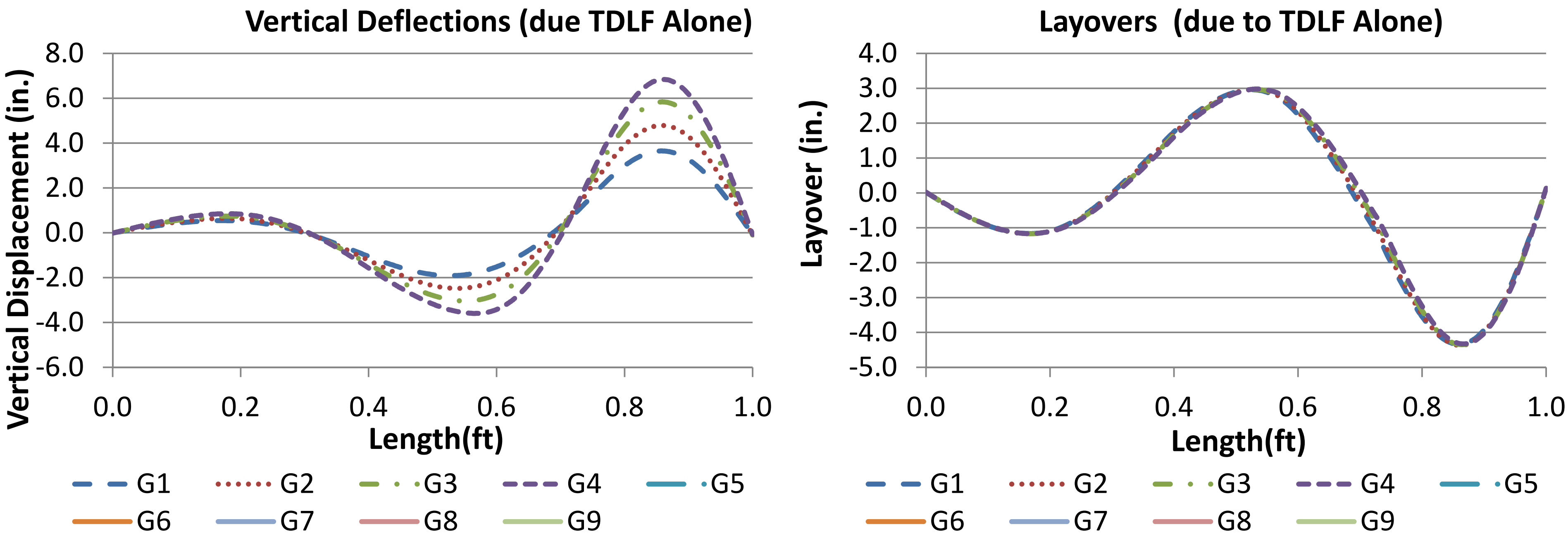


Figure E-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

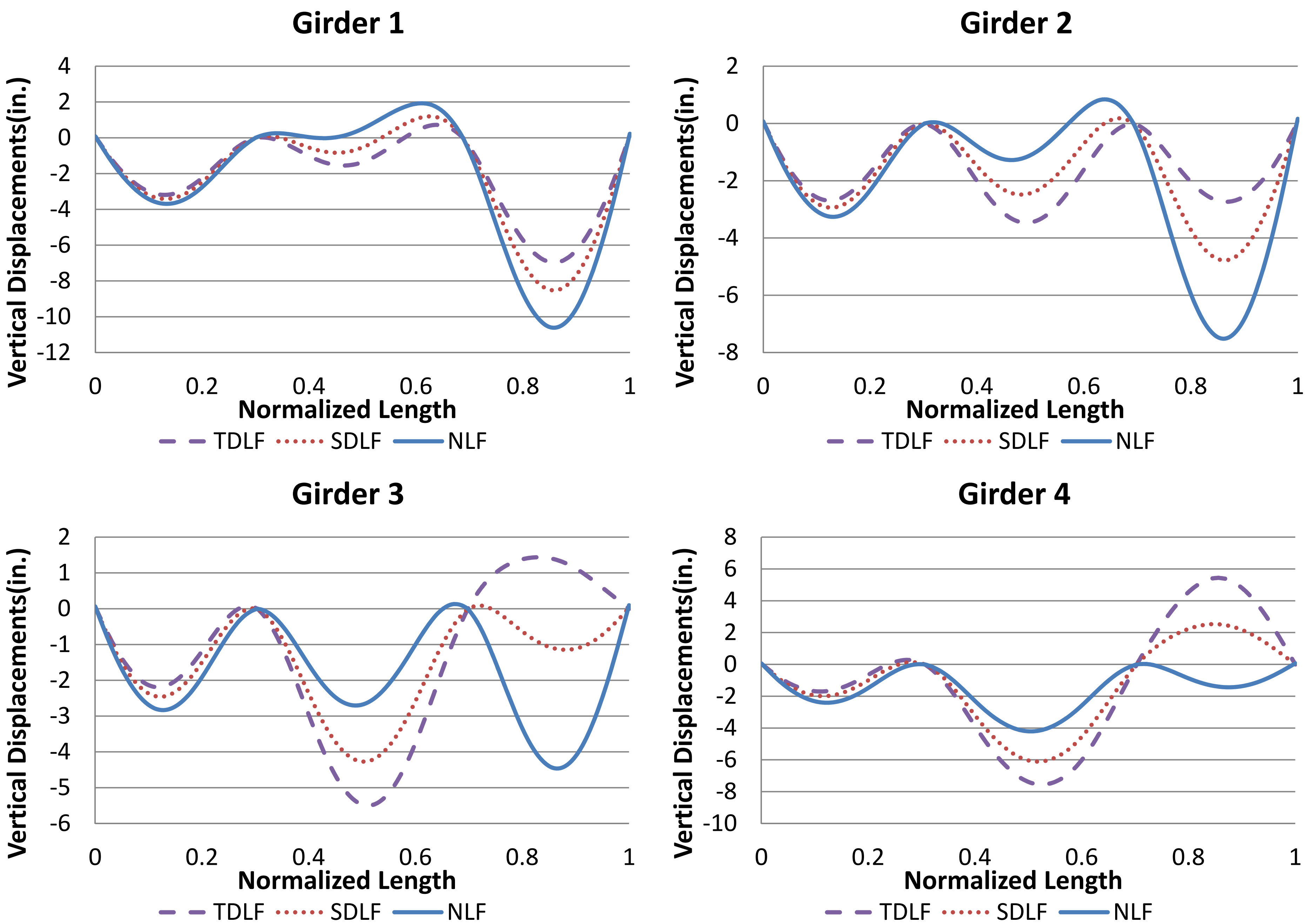


Figure E-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

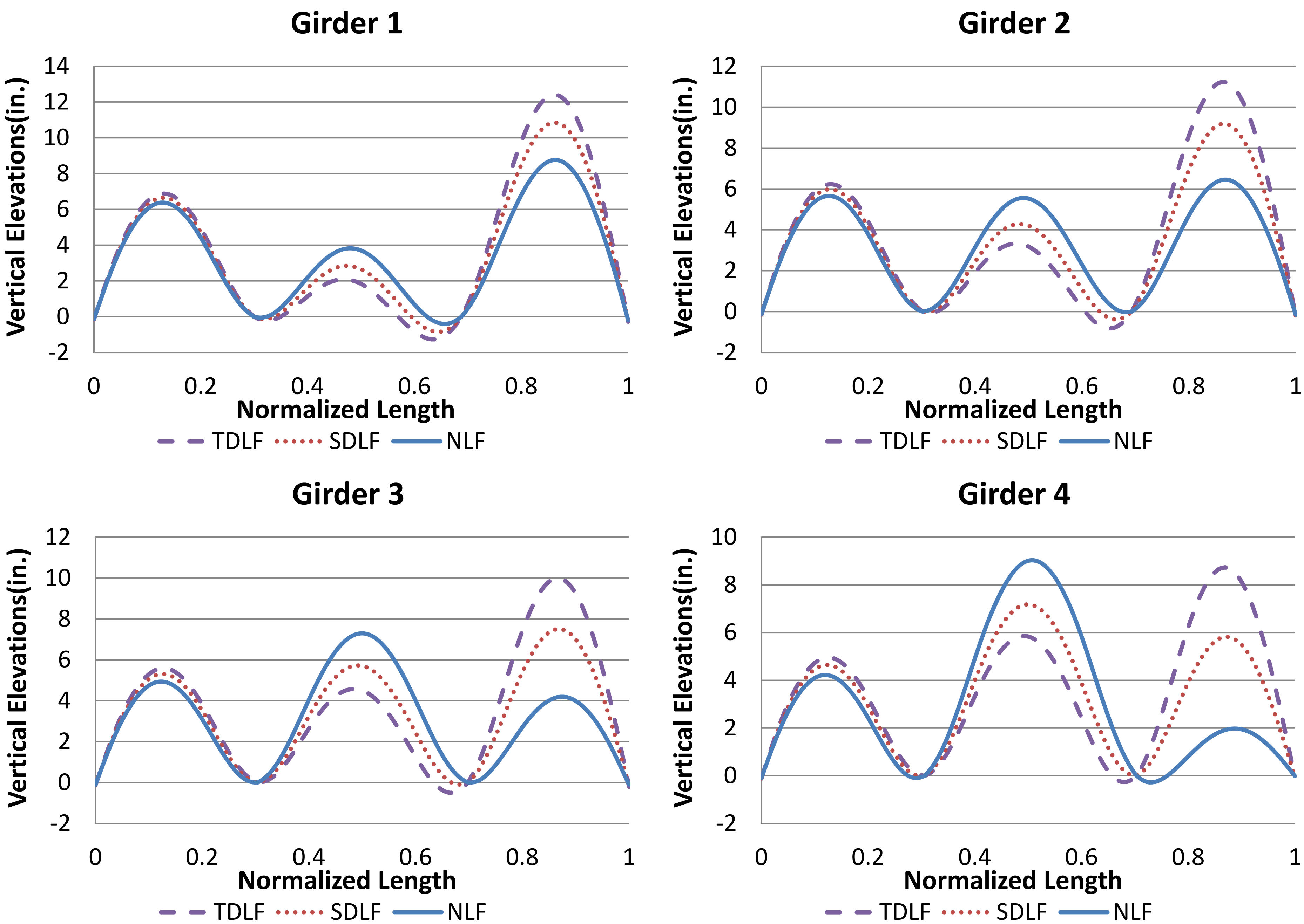


Figure E-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

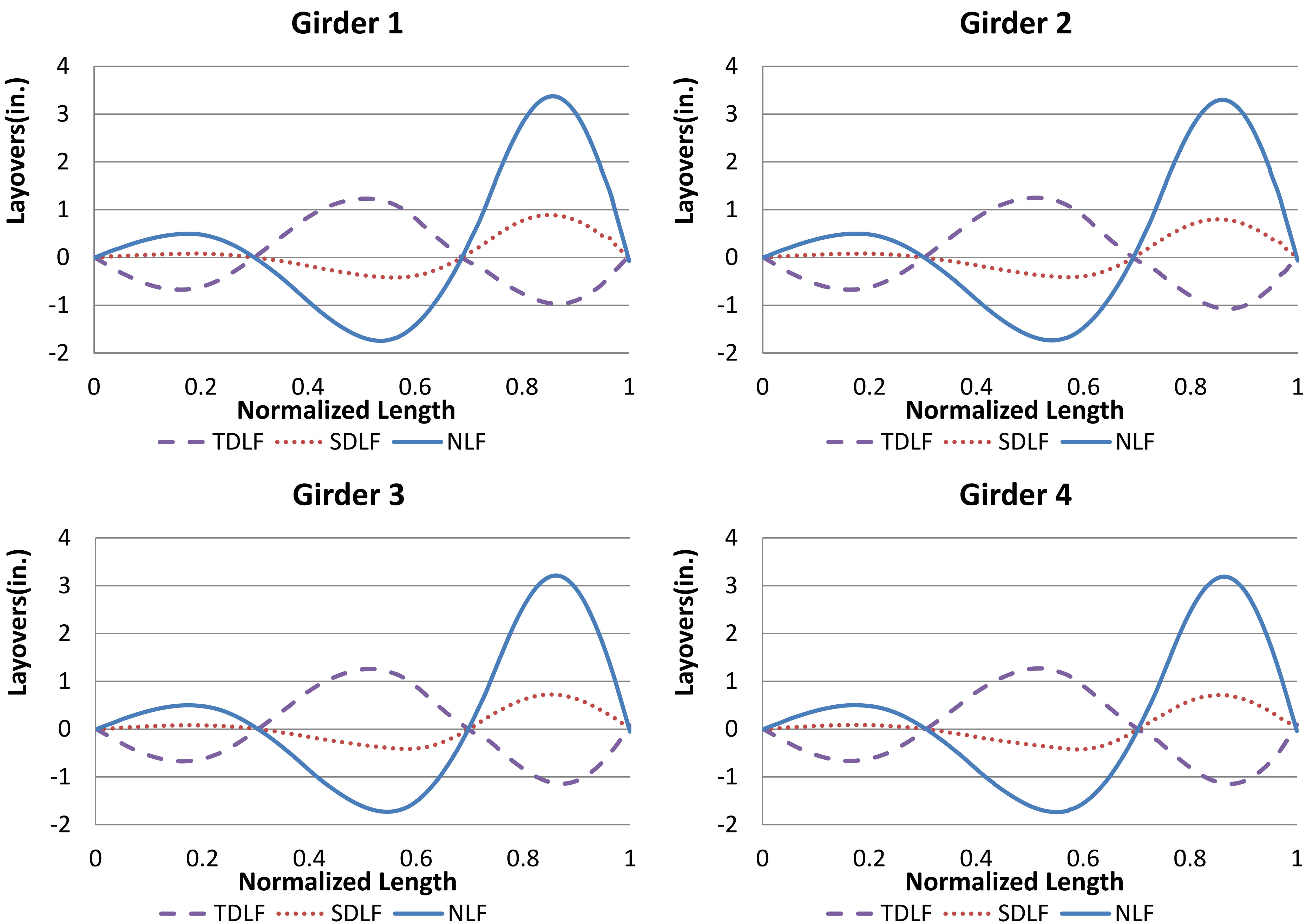


Figure E-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

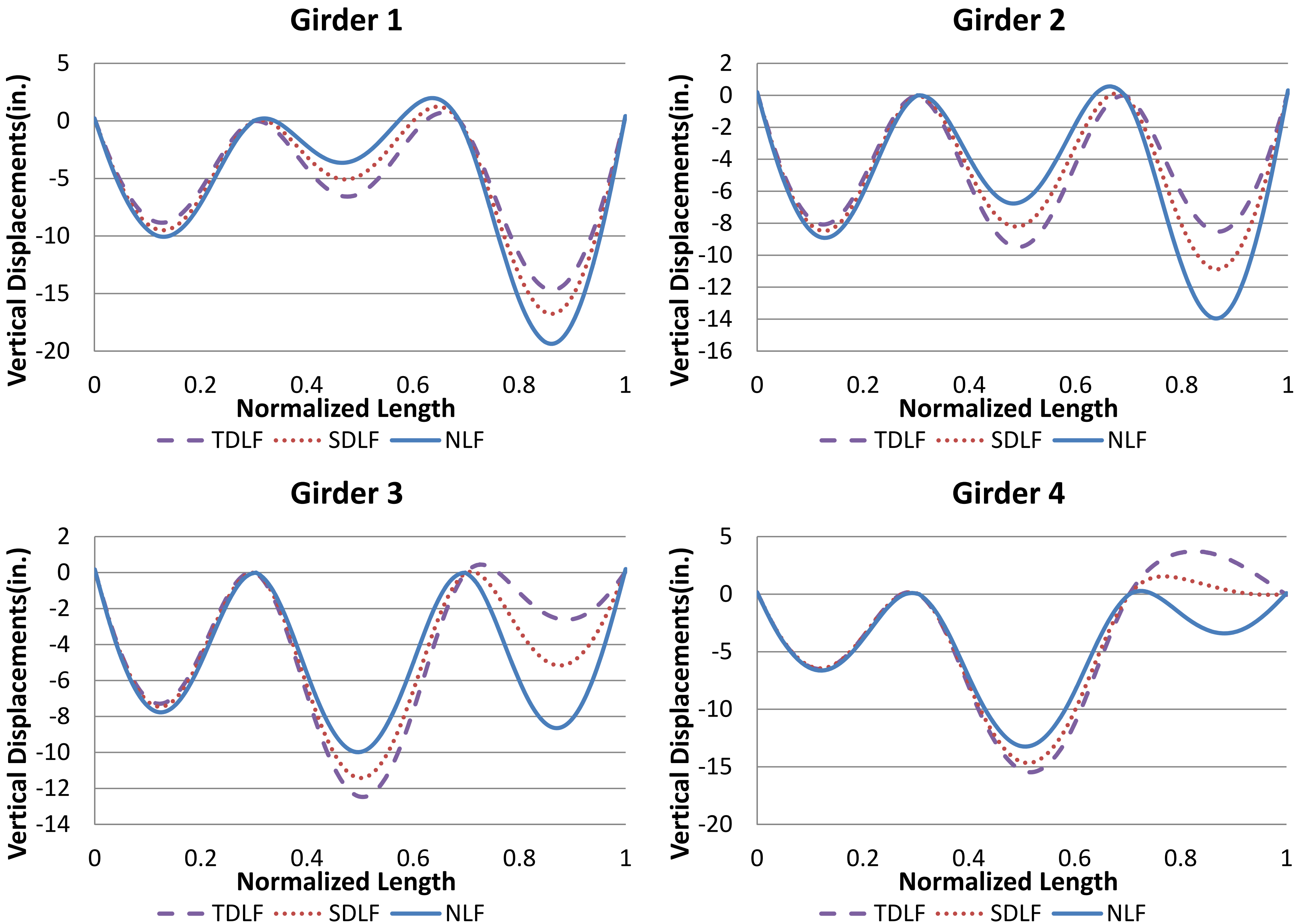


Figure E-4-13. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

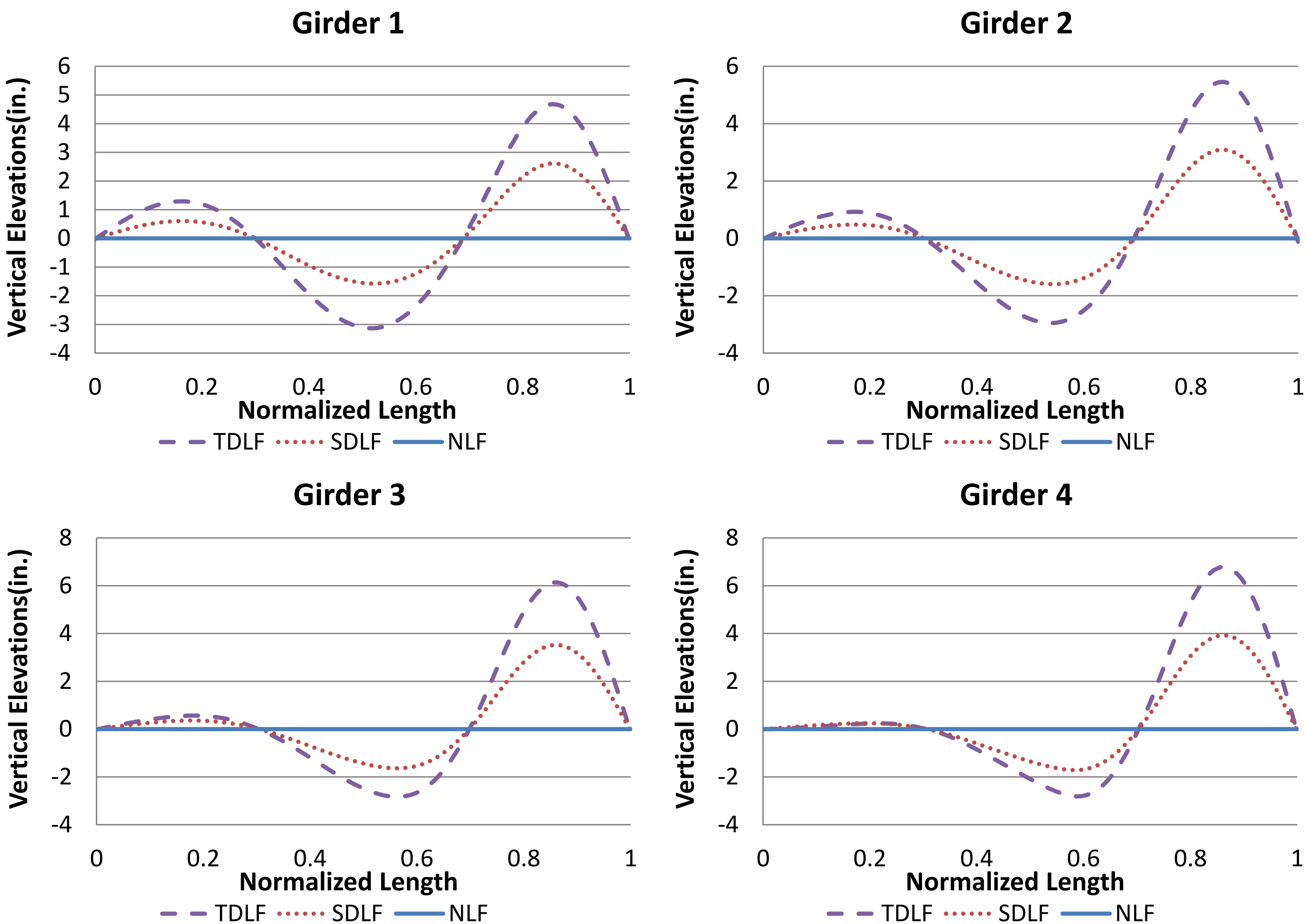


Figure E-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

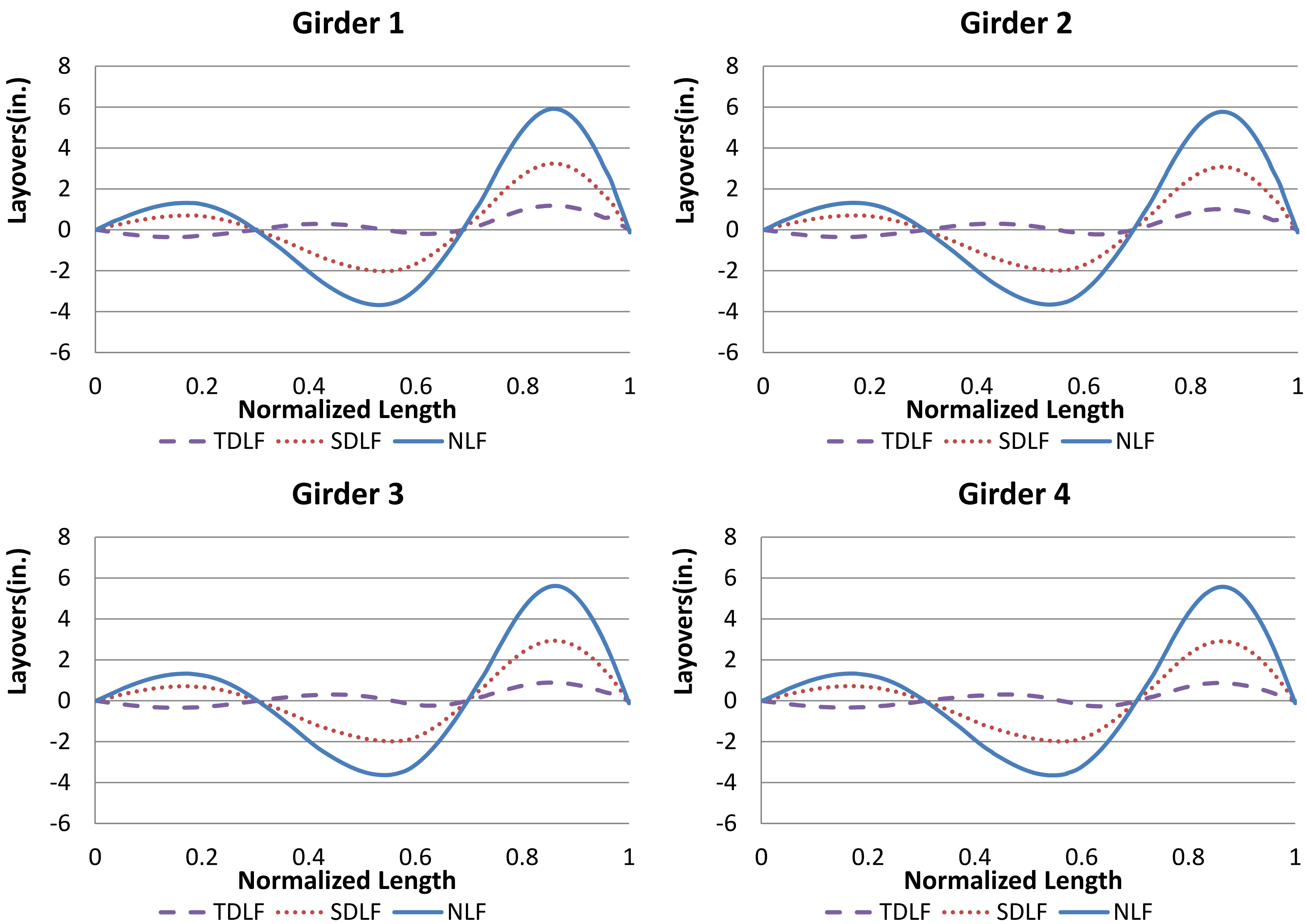


Figure E-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

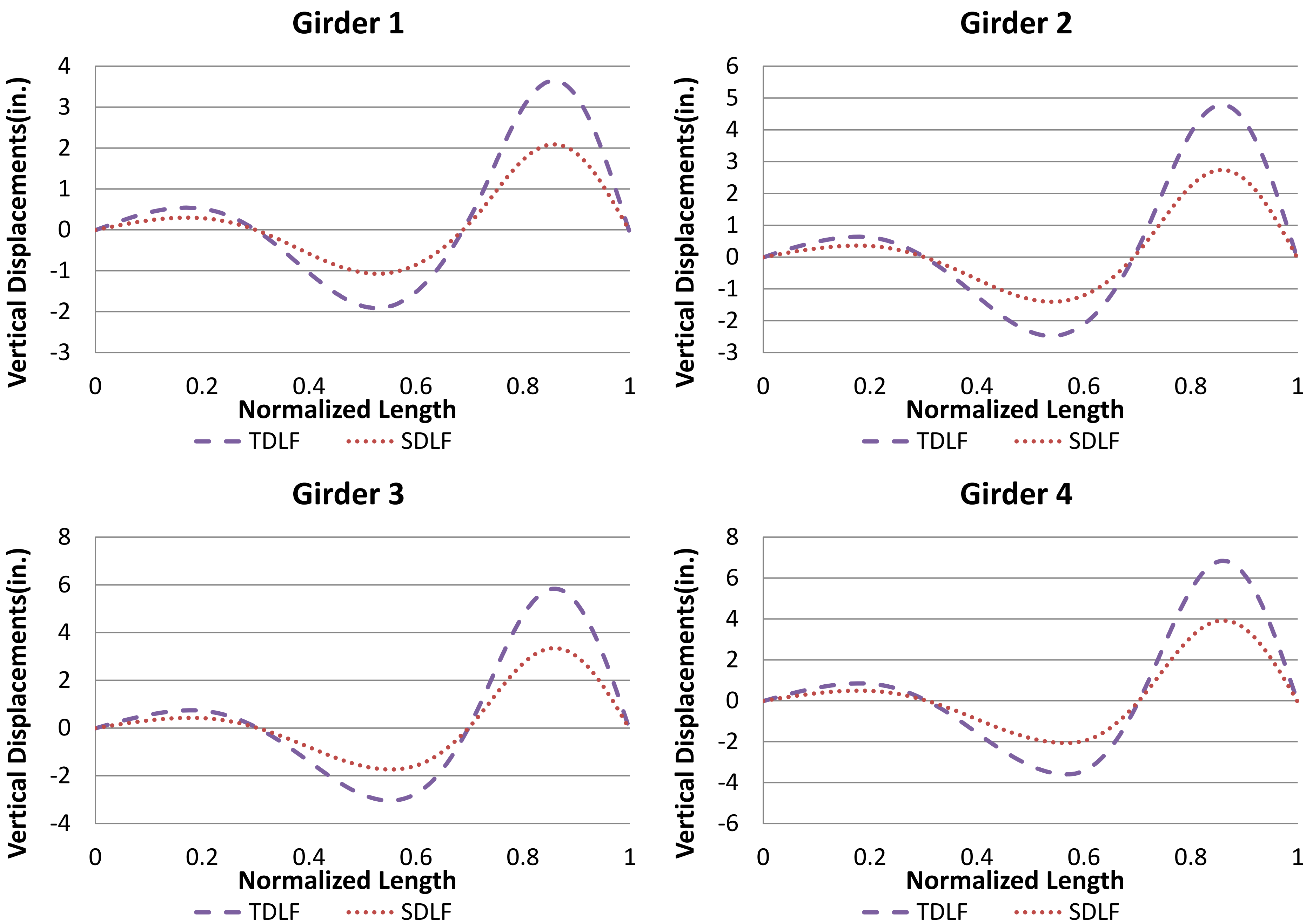


Figure E-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

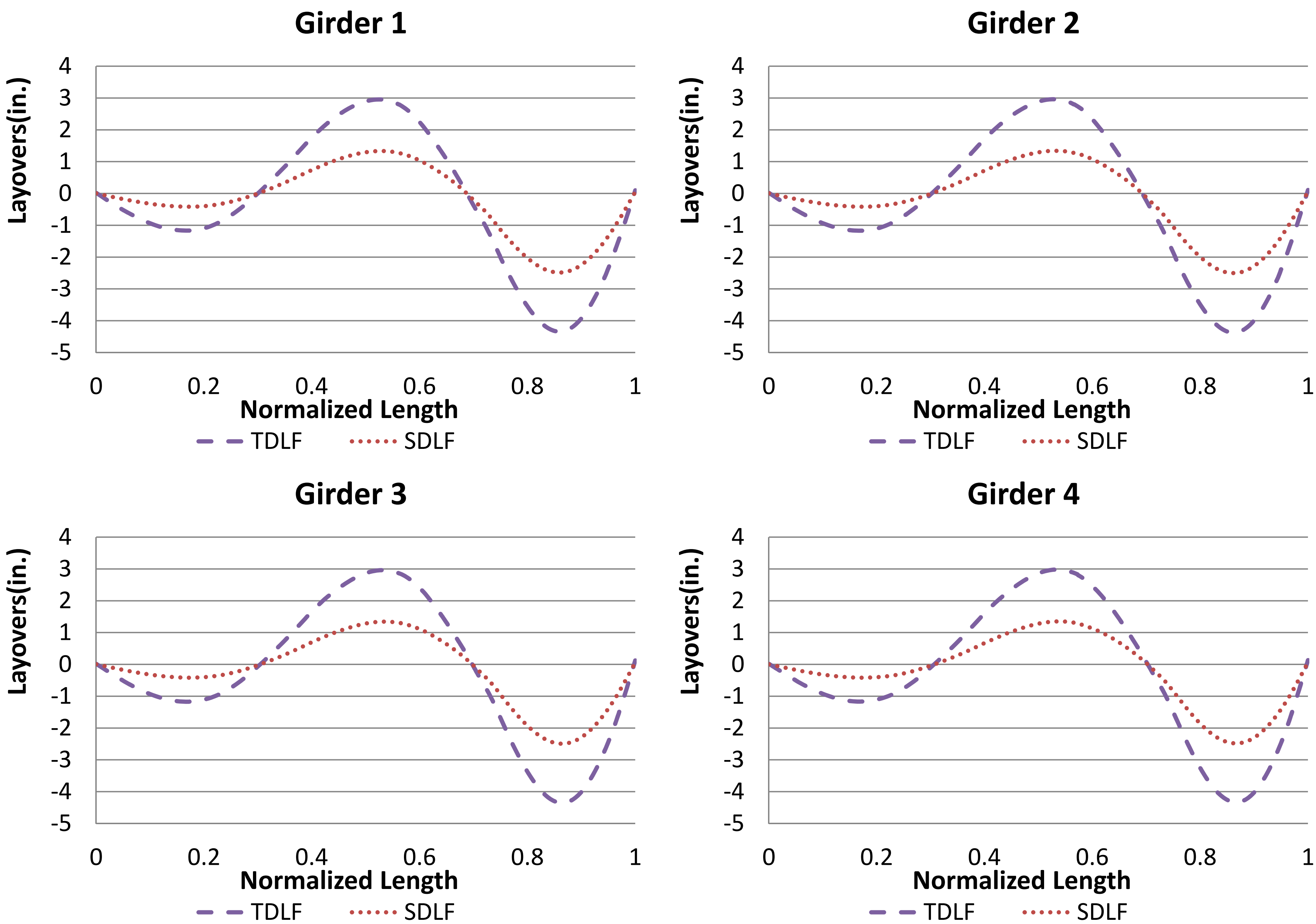


Figure E-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

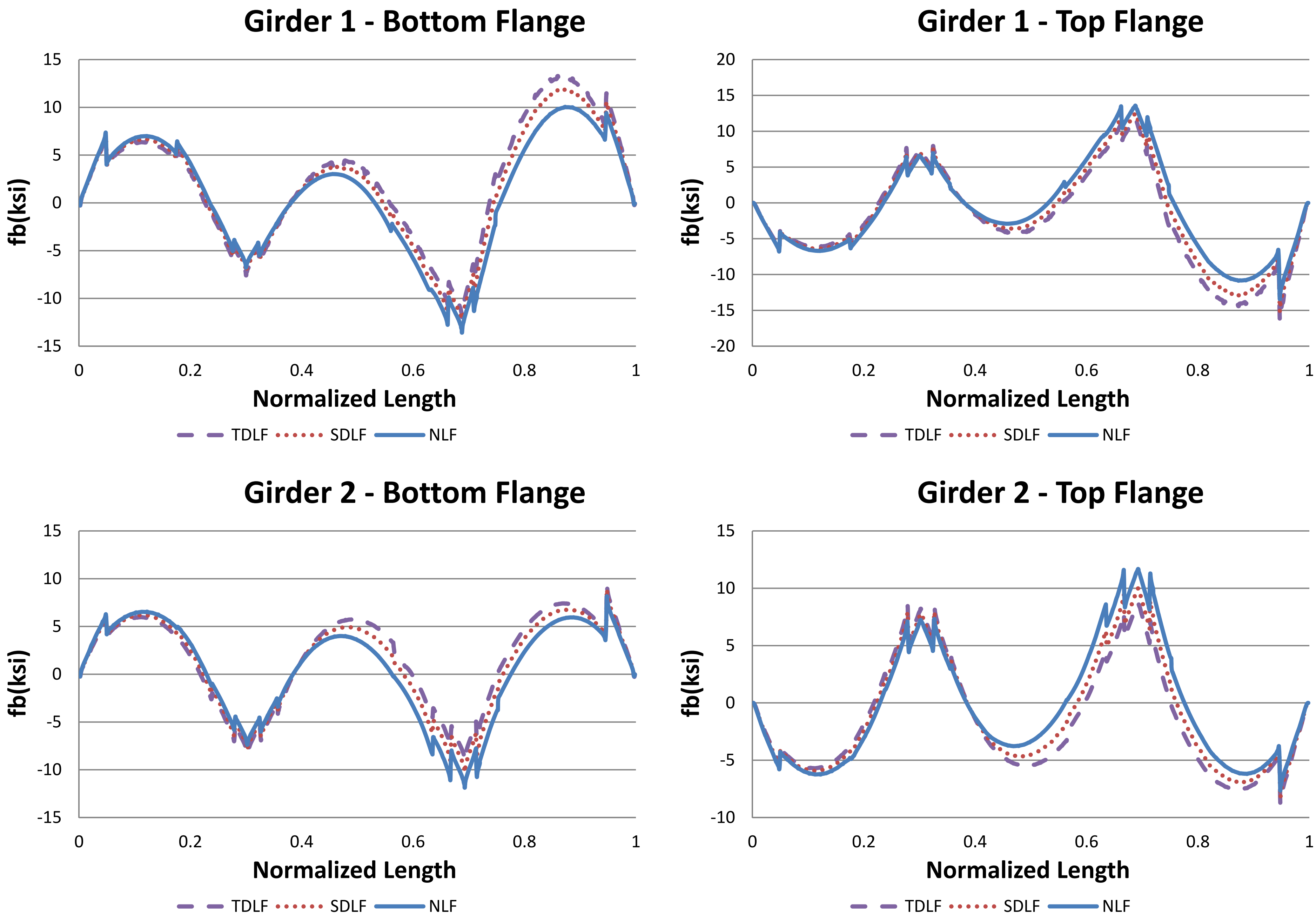
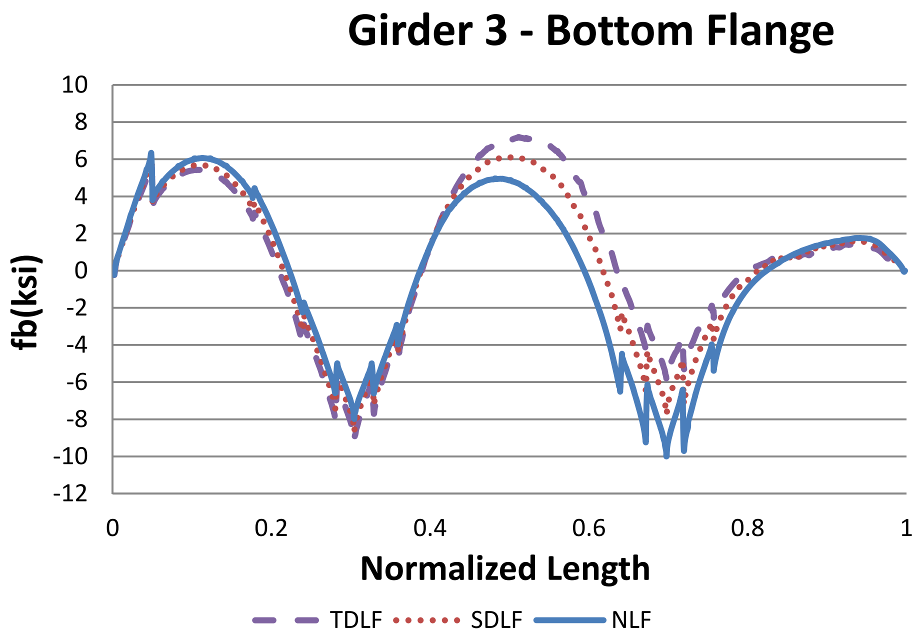
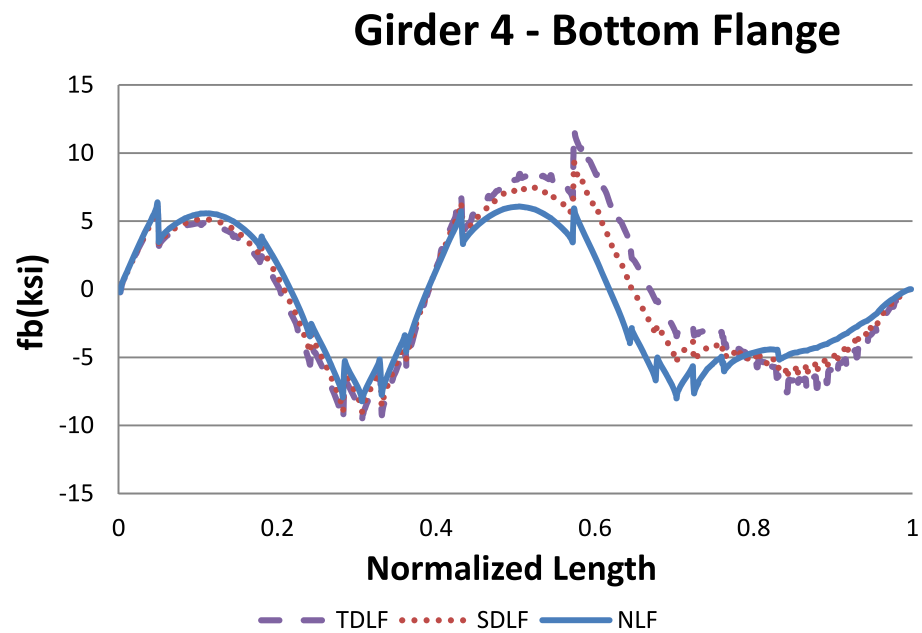
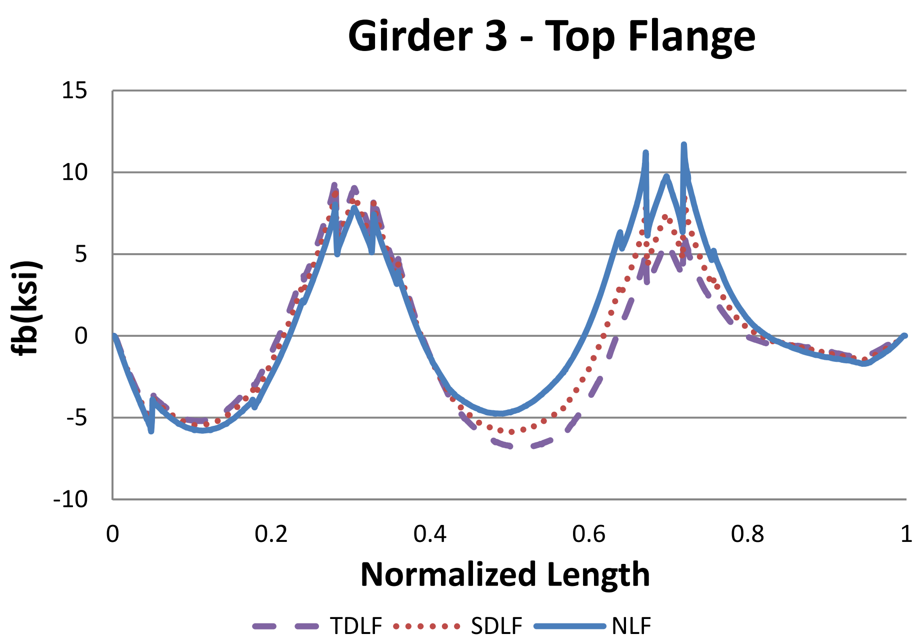


Figure E-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.







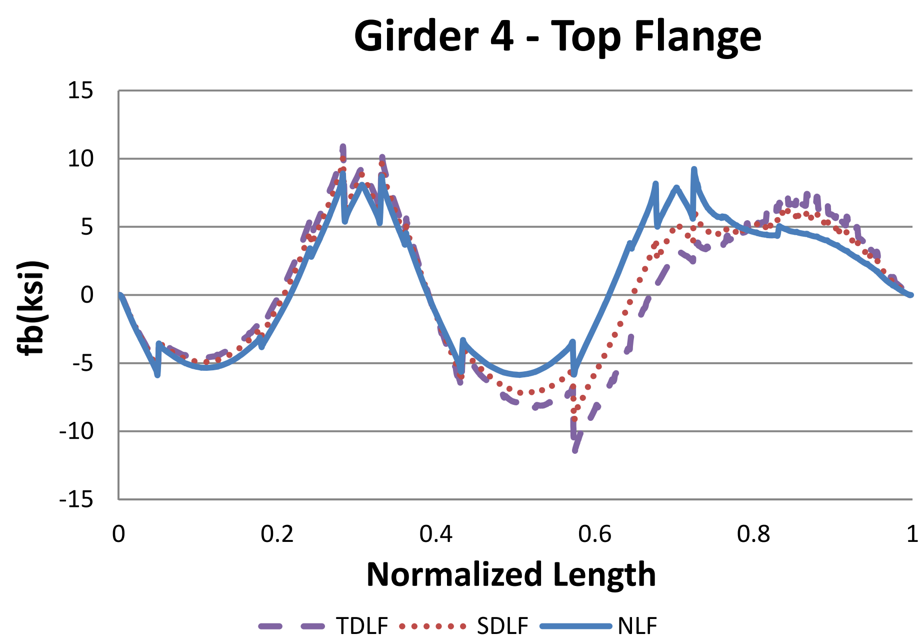


Figure E-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

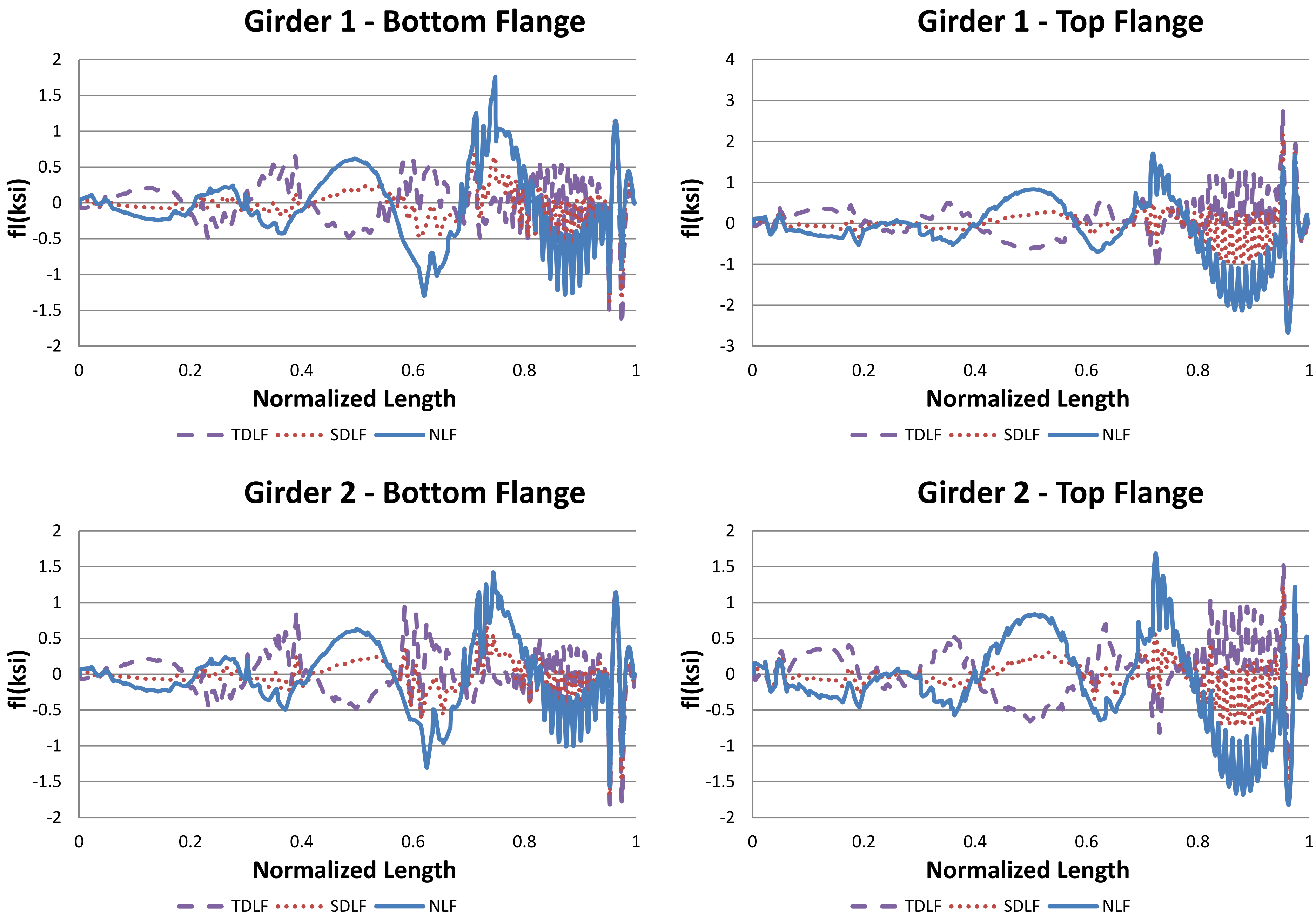


Figure E-4-19. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

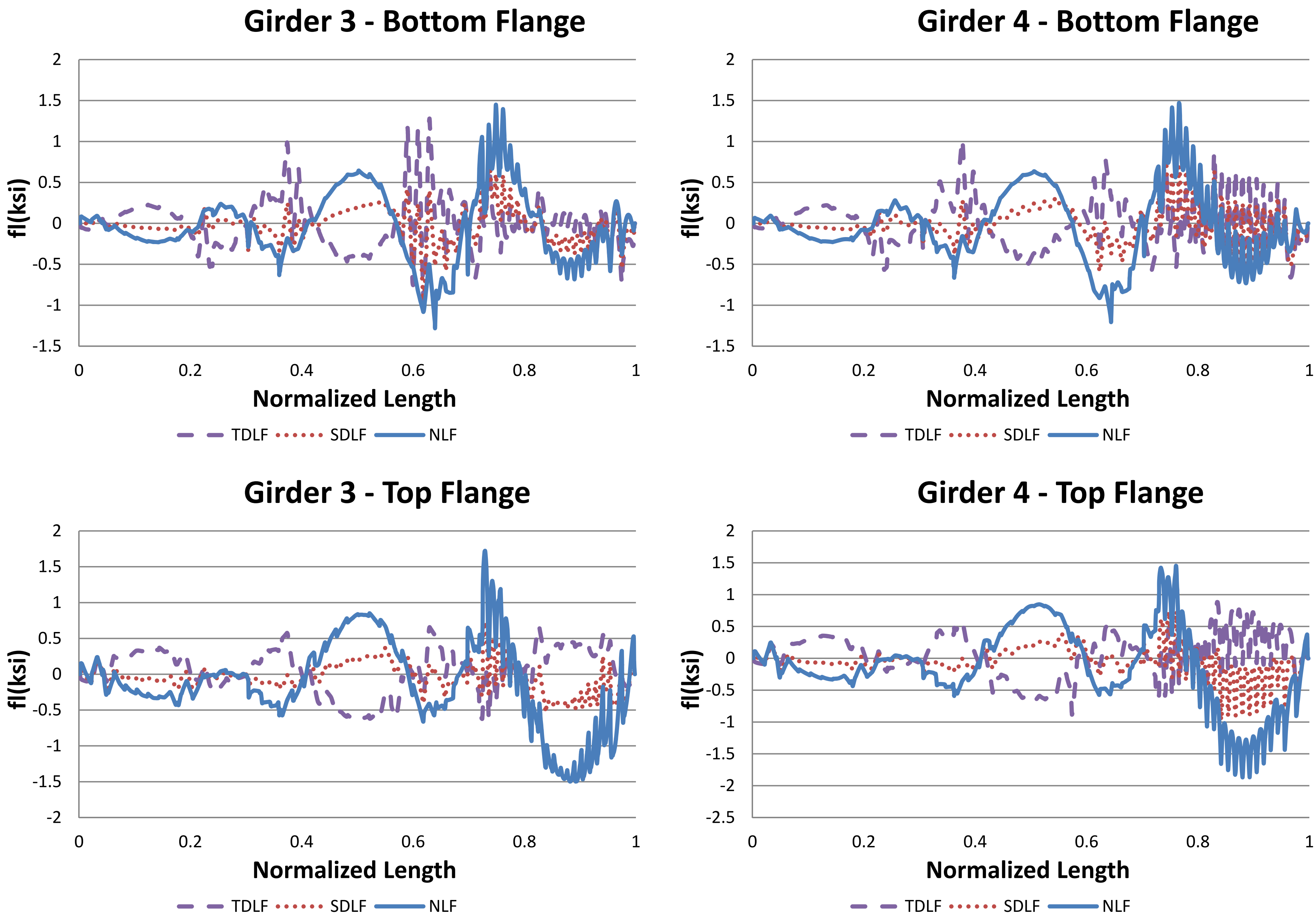


Figure E-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under SDL for different detailing methods.**

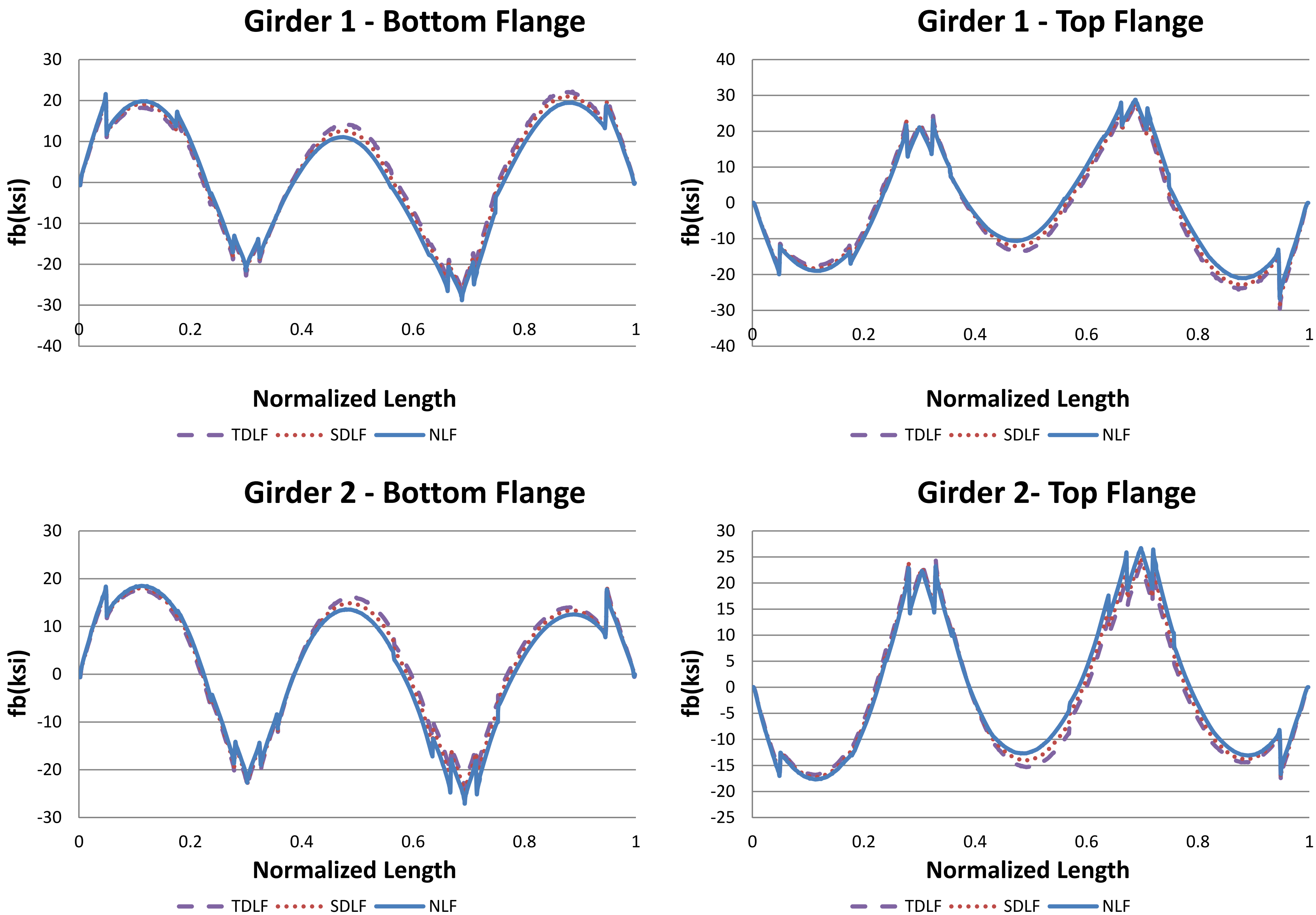


Figure E-4-20. Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

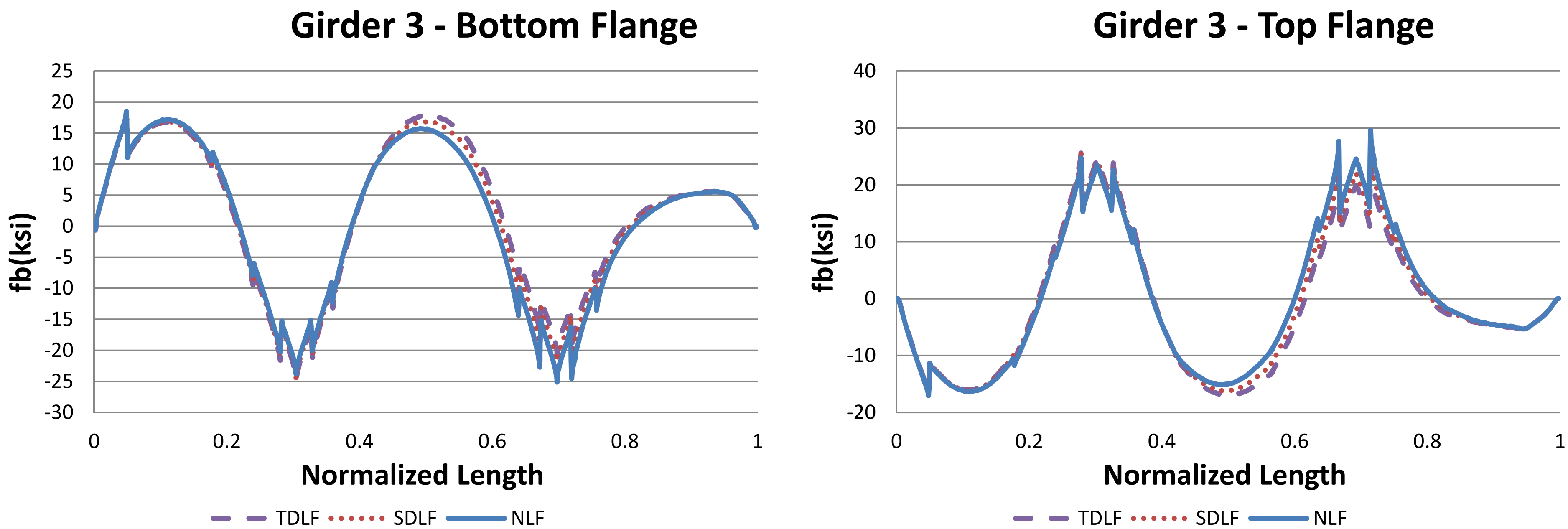


Figure E-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

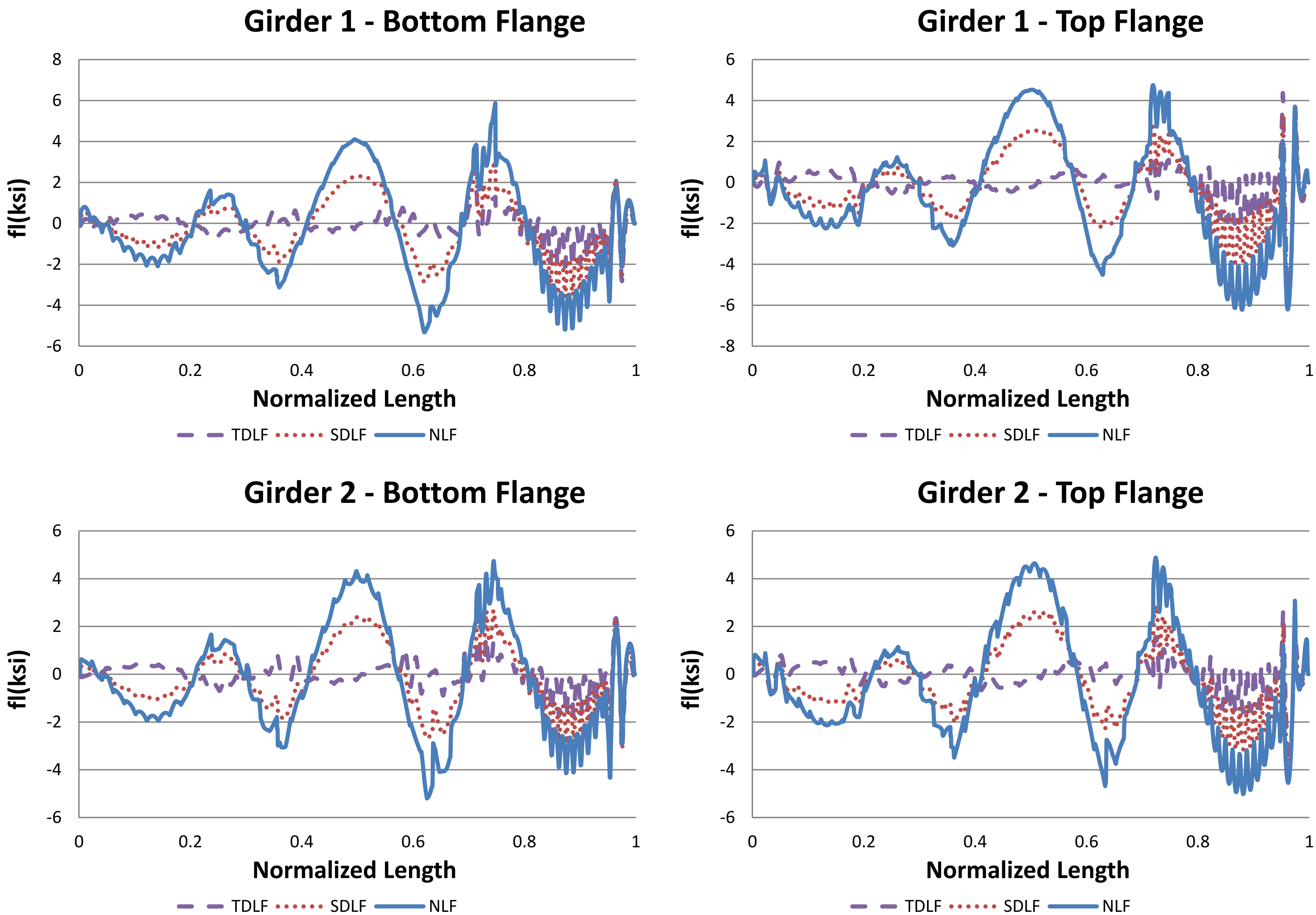


Figure E-4-21. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

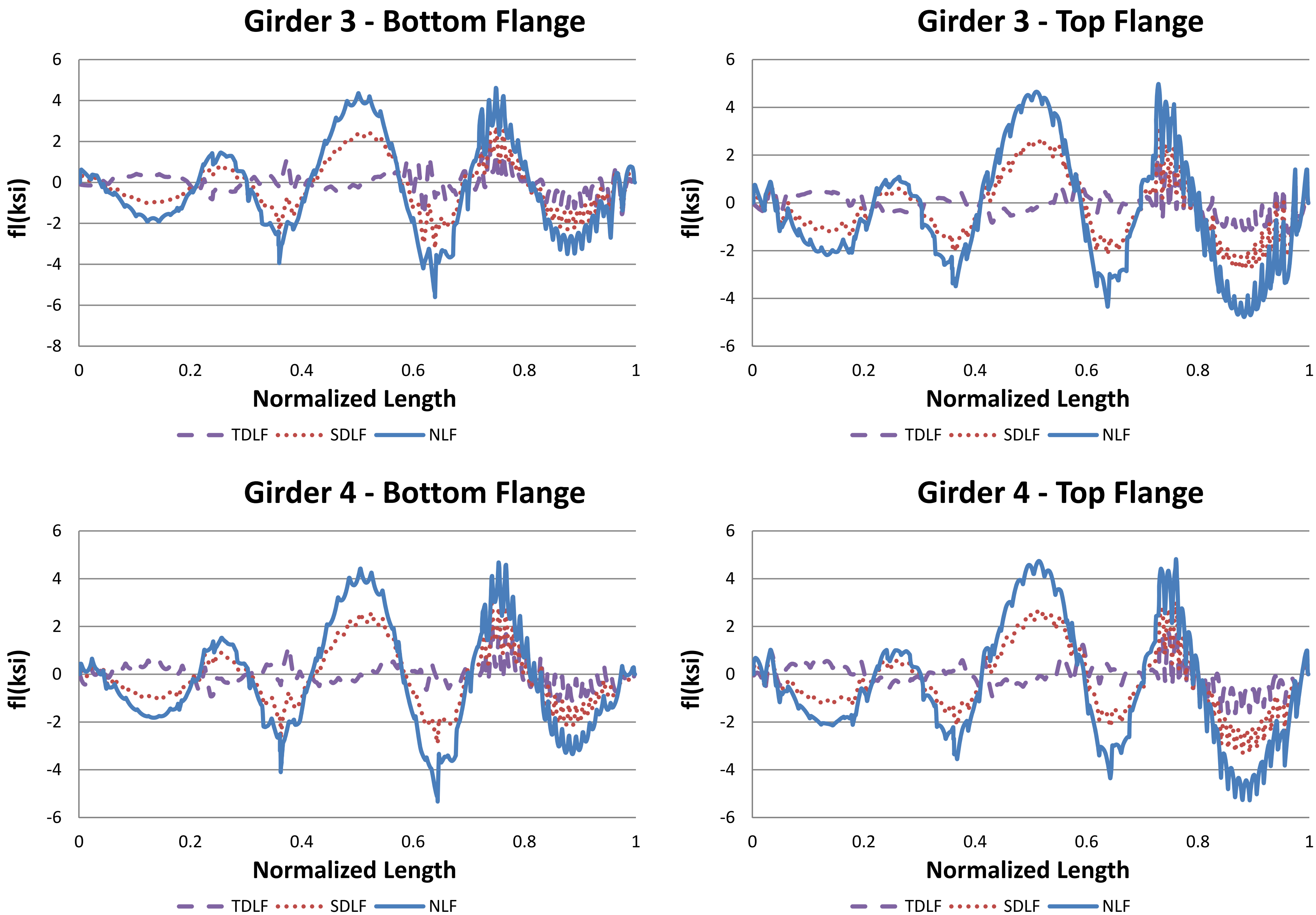


Figure E-4-21(Continued). **Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.**

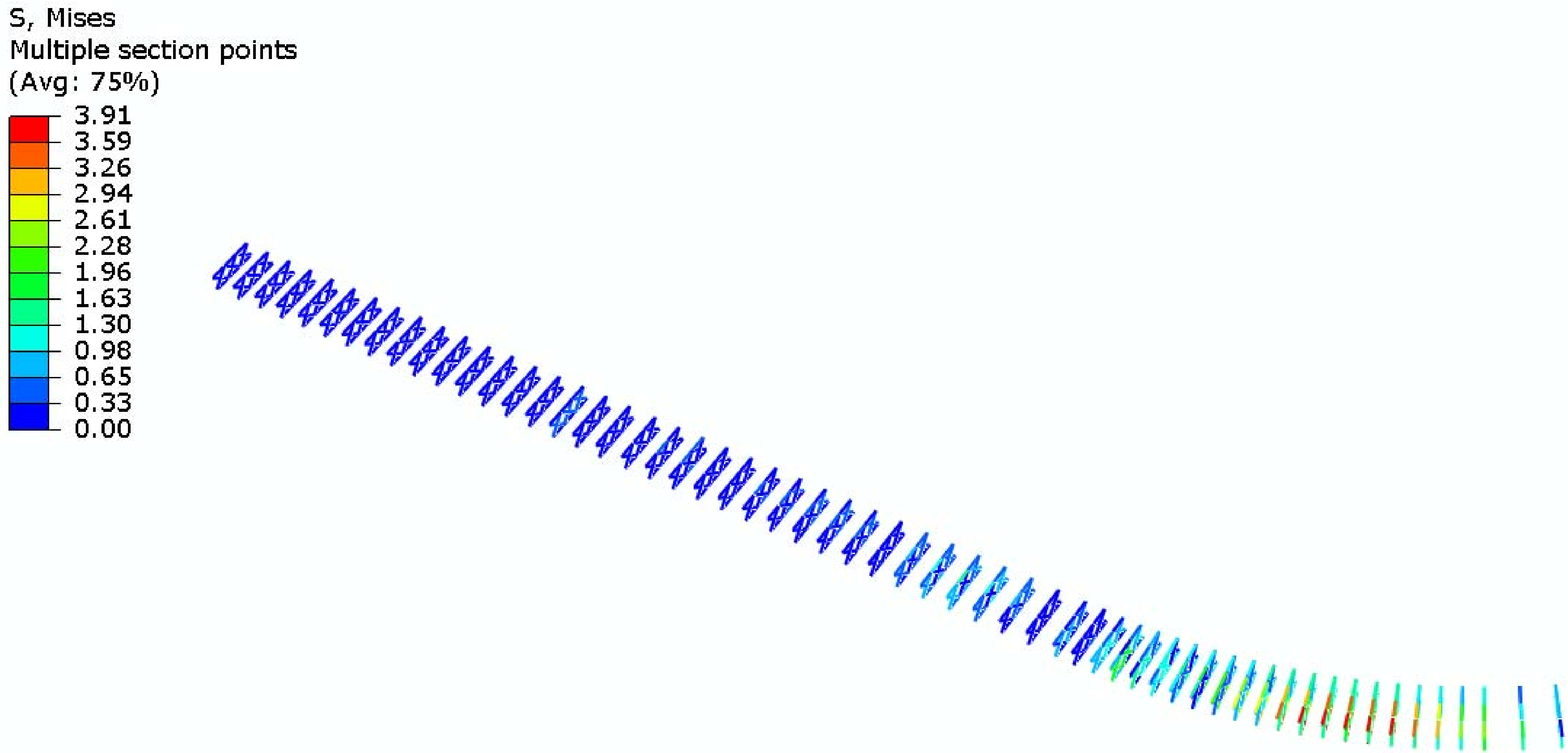


Figure E-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing (all cross-frame member areas = 8.52 in^2).

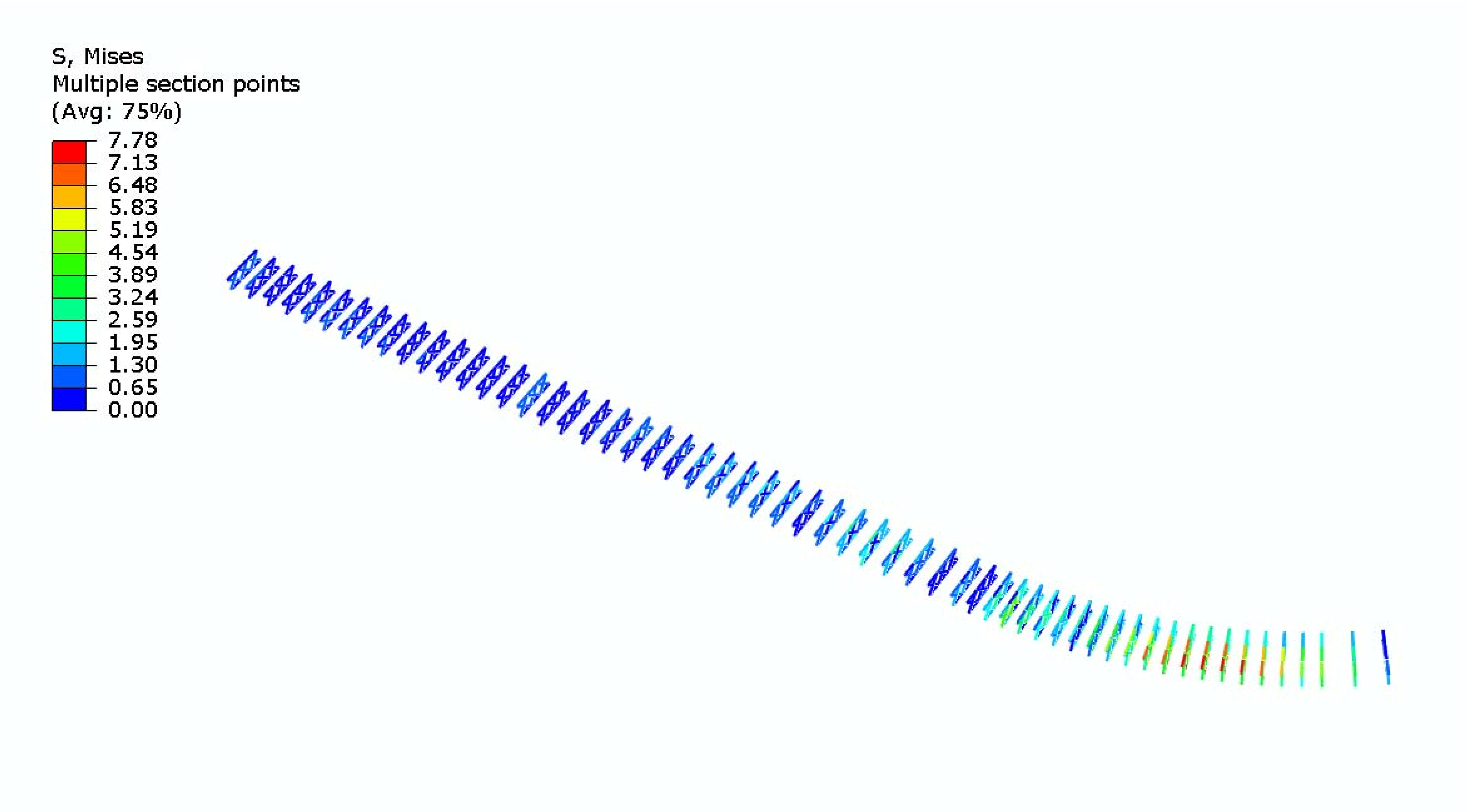


Figure E-4-23. Cross-frame stress contours under TDL, NLF detailing (all cross-frame member areas = 8.52 in^2).

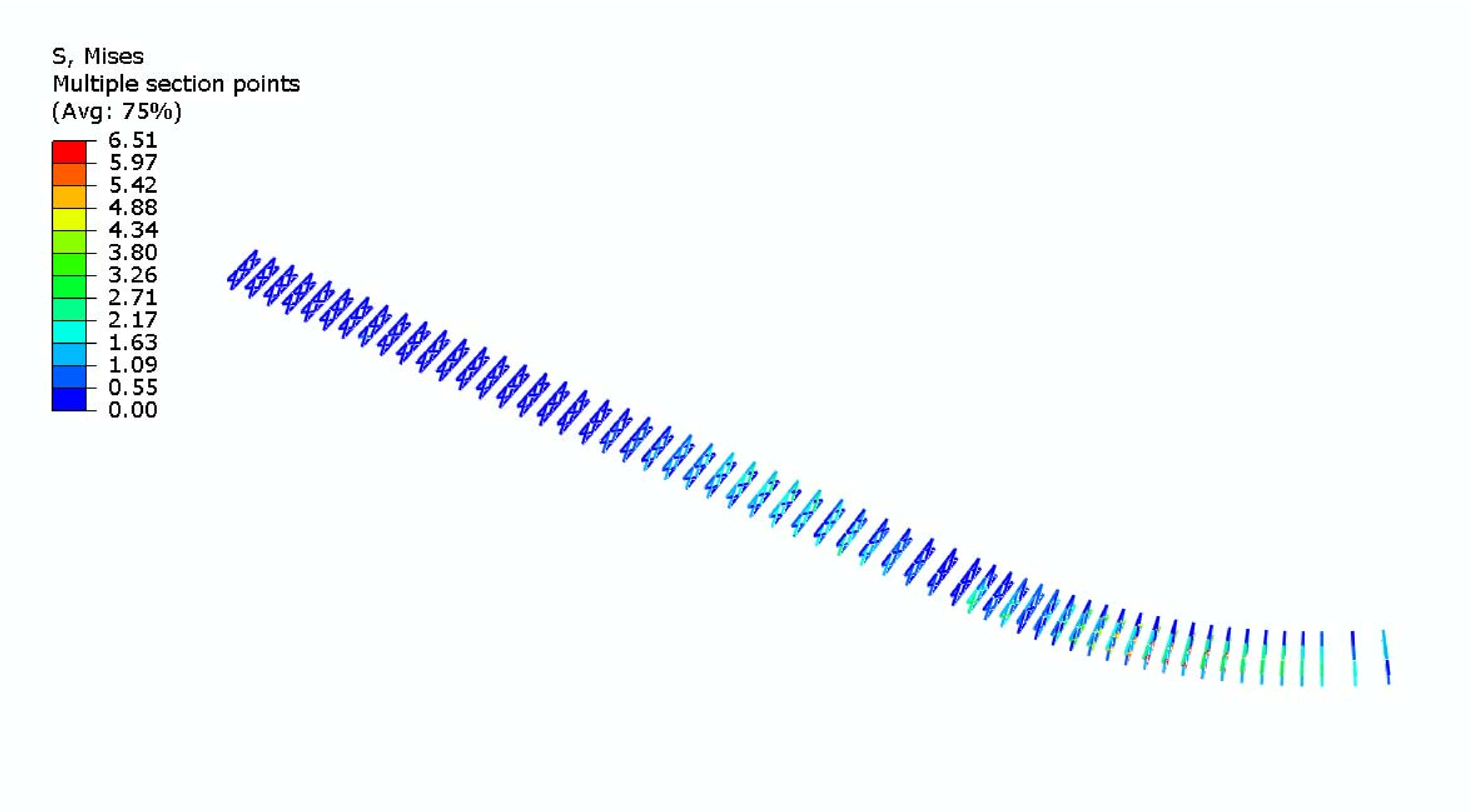


Figure E-4-24. Cross-frame stress contours under SDL, SDLF detailing (all cross-frame member areas = 8.52 in^2).

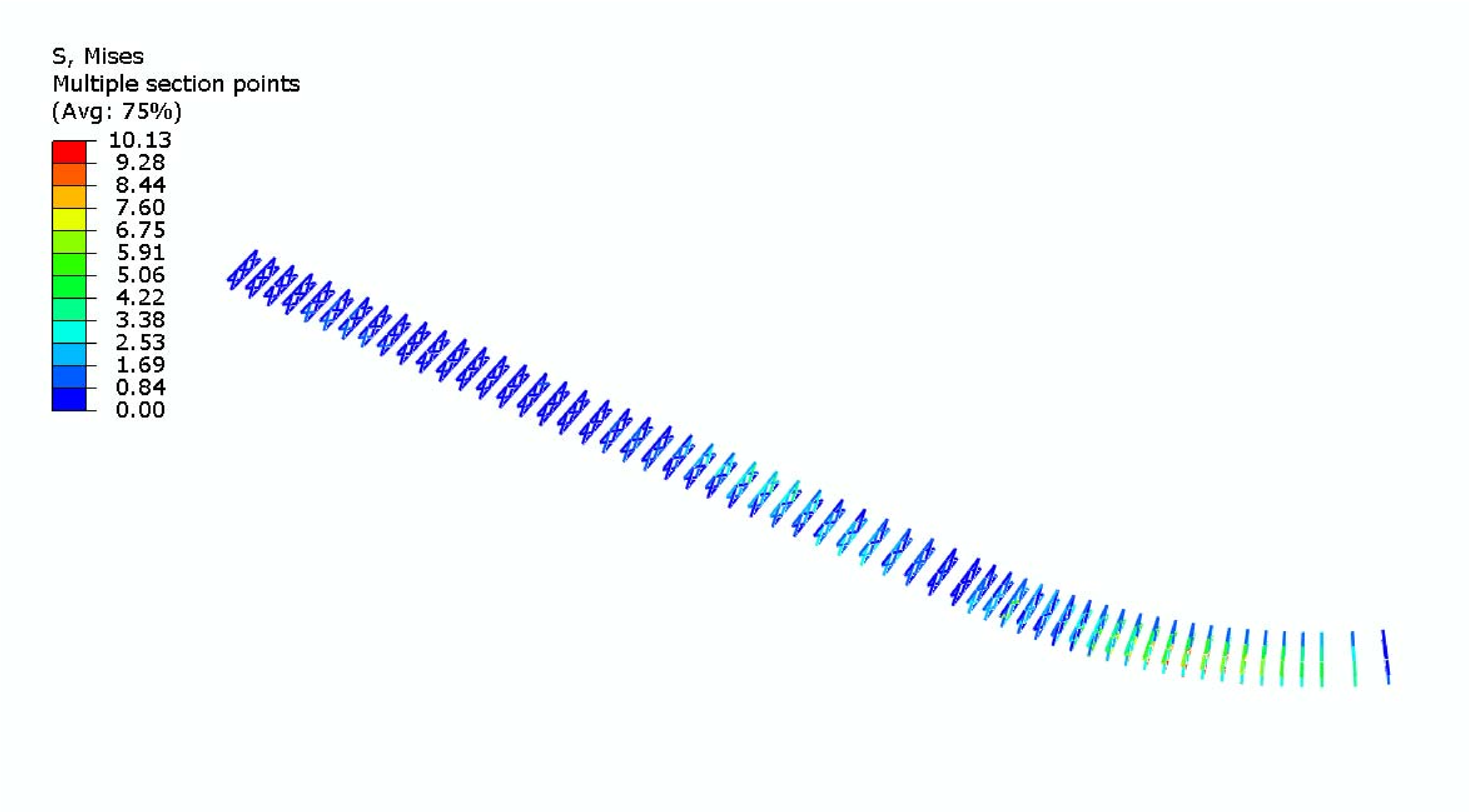


Figure E-4-25. Cross-frame stress contours under TDL, SDLF detailing (all cross-frame member areas = 8.52 in^2).

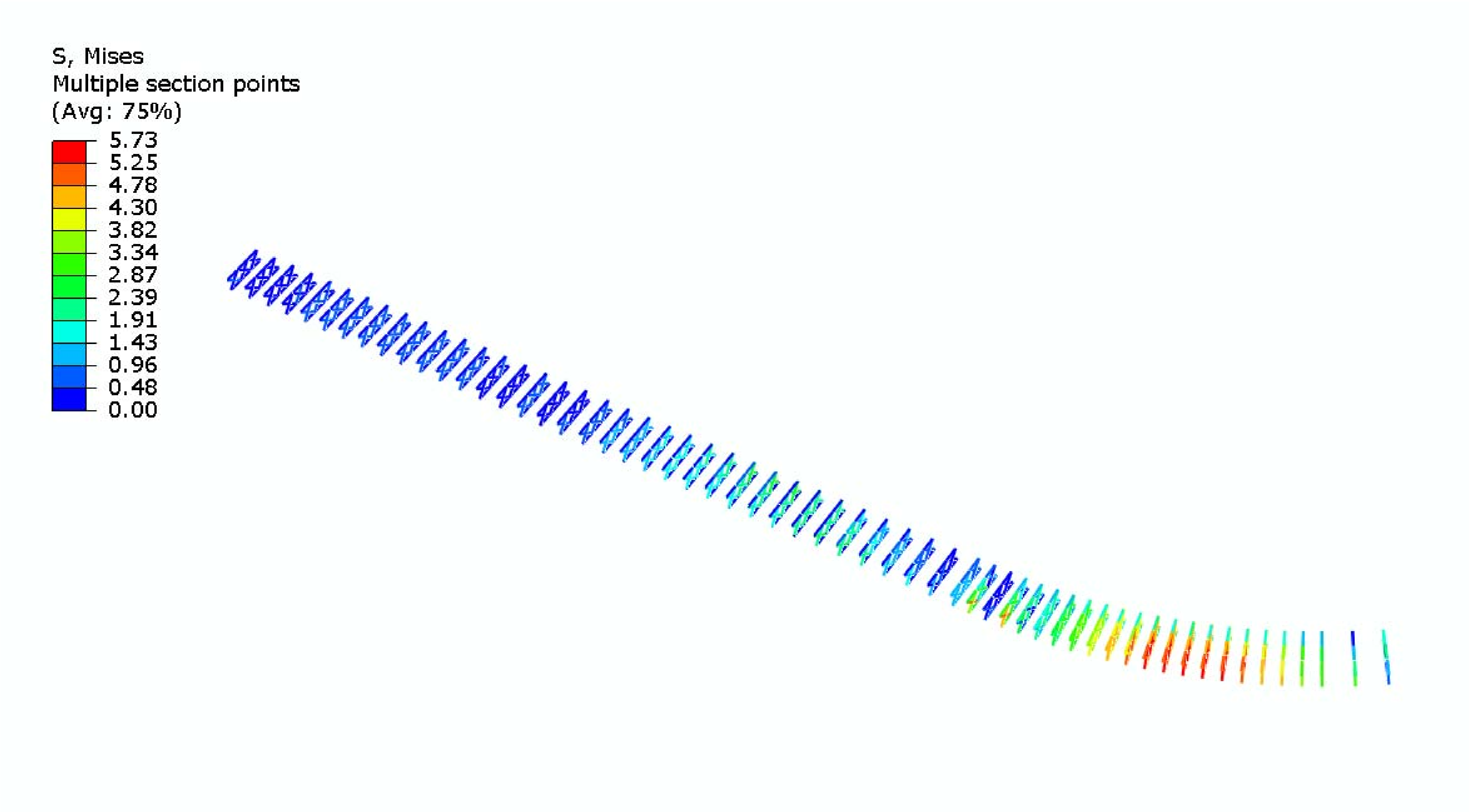


Figure E-4-26. Cross-frame stress contours under SDL, TDLF detailing (all cross-frame member areas = 8.52 in^2).

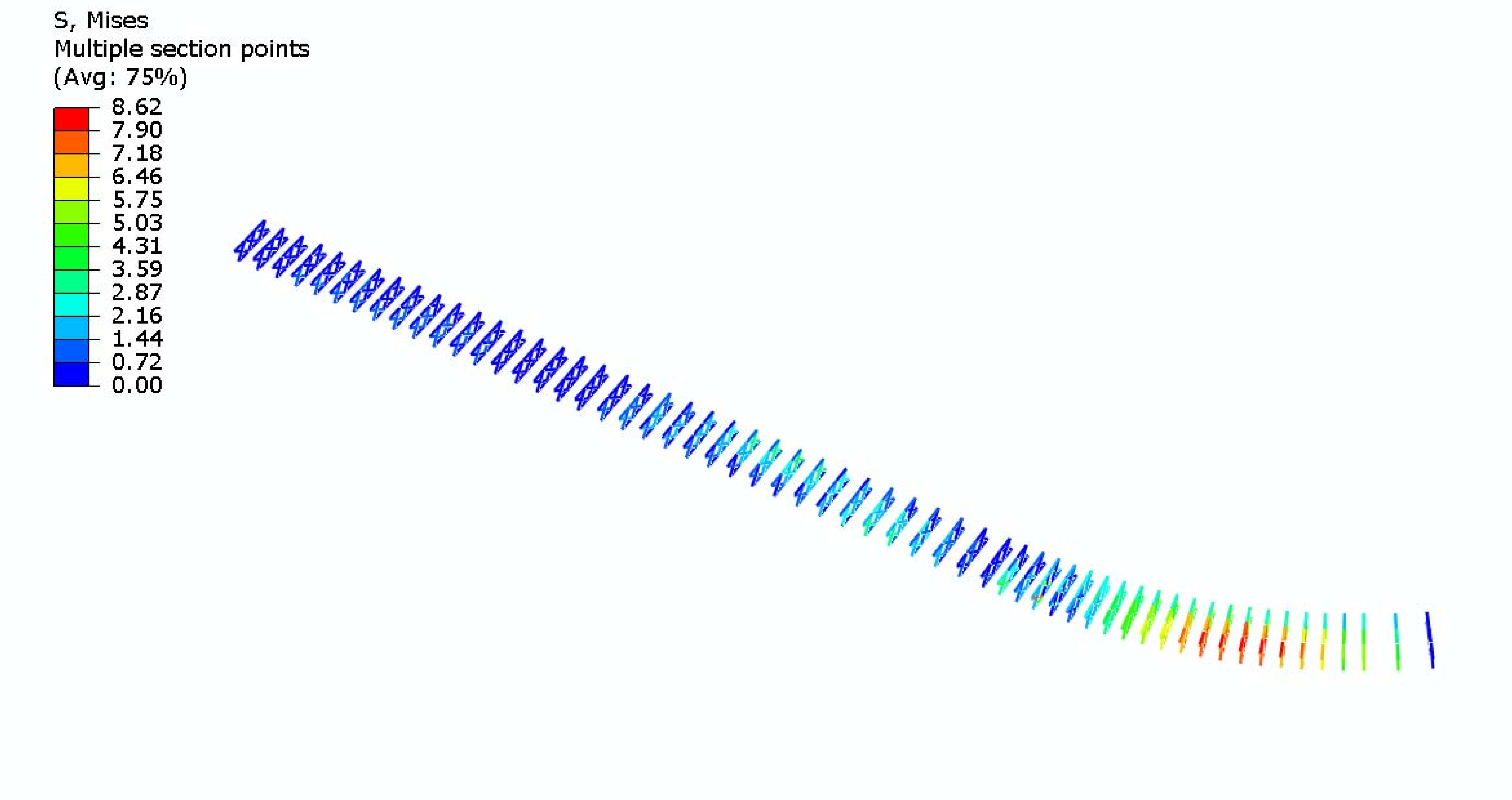


Figure E-4-27. Cross-frame stress contours under TDL, TDLF detailing (all cross-frame member areas = 8.52 in²).

Table E-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
1	NLF	2.7	2.6	2.6
	SDLF	0.2	0.2	0.1
	TDLF	4.8	4.4	4.5
2	NLF	1.1	1.0	0.3
	SDLF	0.3	1.3	0.3
	TDLF	2.5	1.9	0.5
3	NLF	1.5	1.2	0.6
	SDLF	0.7	1.8	1.0
	TDLF	4.3	3.4	2.1
4	NLF	1.2	0.4	0.7
	SDLF	2.5	1.7	1.1
	TDLF	3.9	5.1	4.3
5	NLF	2.0	0.6	1.3
	SDLF	3.9	2.0	1.3
	TDLF	5.9	5.5	5.5
6	NLF	2.0	0.5	1.5
	SDLF	4.8	2.5	1.7
	TDLF	7.8	6.1	6.1
7	NLF	2.1	0.5	1.5
	SDLF	5.4	3.0	2.2
	TDLF	8.7	6.9	6.9
8	NLF	2.1	0.8	1.3
	SDLF	5.5	3.4	2.9
	TDLF	8.4	7.8	7.9
9	NLF	1.6	0.6	0.8
	SDLF	5.2	4.1	3.4
	TDLF	7.9	8.8	8.2
10	NLF	1.1	1.1	0.3
	SDLF	4.0	4.4	3.6
	TDLF	9.1	8.6	7.5

Table E-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	1.0	1.3	0.2
	SDLF	4.1	4.9	3.0
	TDLF	8.6	8.5	6.6
12	NLF	0.1	1.0	0.4
	SDLF	3.5	4.2	2.8
	TDLF	6.9	8.3	7.1
13	NLF	0.7	0.6	1.4
	SDLF	2.9	2.8	1.4
	TDLF	5.3	6.2	5.8
14	NLF	1.0	0.4	1.1
	SDLF	2.3	2.1	1.4
	TDLF	3.9	4.4	4.9
15	NLF	0.2	0.5	0.1
	SDLF	0.9	0.7	1.0
	TDLF	2.1	2.3	2.3
16	NLF	5.2	5.8	6.1
	SDLF	0.4	0.6	0.9
	TDLF	9.0	8.9	9.6
17	NLF	0.4	0.7	0.3
	SDLF	1.3	0.5	0.9
	TDLF	3.8	1.6	1.5
18	NLF	0.3	1.5	1.7
	SDLF	3.0	1.3	2.7
	TDLF	7.6	4.5	2.6
19	NLF	1.6	1.2	0.2
	SDLF	5.2	3.1	3.7
	TDLF	8.6	7.0	6.2
20	NLF	2.1	0.2	2.2
	SDLF	8.0	6.5	4.5
	TDLF	11.9	10.8	8.5

Table E-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	1.9	1.7	3.2
	SDLF	9.7	10.0	6.7
	TDLF	13.5	13.6	12.0
22	NLF	1.1	1.7	3.0
	SDLF	11.3	12.2	9.2
	TDLF	15.8	15.7	14.6
23	NLF	1.0	0.4	1.8
	SDLF	12.3	13.5	14.1
	TDLF	18.1	18.1	15.1
24	NLF	2.2	0.7	3.1
	SDLF	13.3	15.1	18.2
	TDLF	18.9	18.9	19.6
25	NLF	2.7	0.6	3.4
	SDLF	14.2	16.9	21.1
	TDLF	18.5	20.1	23.4
26	NLF	3.0	0.5	3.6
	SDLF	15.0	18.5	23.5
	TDLF	18.6	21.3	25.9
27	NLF	3.2	0.7	4.0
	SDLF	15.9	19.4	24.9
	TDLF	19.7	22.0	26.3
28	NLF	2.7	1.1	4.1
	SDLF	17.2	19.8	25.3
	TDLF	21.8	22.1	25.5
29	NLF	0.4	1.2	1.5
	SDLF	19.0	19.4	21.8
	TDLF	23.8	21.9	21.7
30	NLF	3.8	0.5	4.3
	SDLF	21.7	19.0	16.7
	TDLF	24.3	21.6	20.1

Table E-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
31	NLF	6.5	1.0	5.8
	SDLF	22.3	17.3	12.8
	TDLF	24.4	20.1	16.1
32	NLF	8.7	1.8	7.1
	SDLF	19.8	14.1	9.0
	TDLF	22.2	18.3	12.4
33	NLF	6.3	1.4	6.9
	SDLF	13.4	9.9	5.6
	TDLF	15.4	11.7	10.7
34	NLF	2.5	3.9	5.2
	SDLF	10.8	8.7	3.5
	TDLF	15.3	9.0	8.5
35	NLF	0.9	1.6	2.4
	SDLF	6.4	5.2	1.3
	TDLF	10.5	7.3	3.5
36	NLF	12.2	9.8	6.0
	SDLF	7.4	3.4	2.5
	TDLF	19.3	16.4	12.5
37	NLF	0.4	2.7	1.0
	SDLF	34.2	21.1	10.5
	TDLF	57.4	35.0	16.2
38	NLF	11.2	15.1	9.5
	SDLF	7.9	7.4	3.2
	TDLF	8.8	2.0	4.3
39	NLF	22.9	21.9	12.0
	SDLF	43.4	27.0	7.7
	TDLF	60.1	37.6	18.9
40	NLF	17.8	16.3	5.3
	SDLF	7.9	2.5	11.0
	TDLF	29.8	24.4	23.5

Table E-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
41	NLF	12.2	12.4	0.8
	SDLF	11.4	14.1	20.9
	TDLF	26.0	27.9	23.7
42	NLF	5.7	6.5	3.8
	SDLF	25.7	27.2	30.7
	TDLF	33.2	34.3	31.2
43	NLF	0.6	0.6	4.4
	SDLF	37.1	38.0	38.6
	TDLF	38.5	40.6	38.0
44	NLF	4.9	6.3	5.5
	SDLF	46.7	48.1	46.1
	TDLF	46.6	47.0	43.4
45	NLF	10.5	11.2	7.5
	SDLF	58.2	58.4	53.2
	TDLF	53.7	53.5	47.8
46	NLF	11.4	14.1	7.5
	SDLF	60.5	63.5	56.8
	TDLF	56.6	58.9	49.6
47	NLF	16.6	17.6	9.3
	SDLF	71.0	71.8	62.1
	TDLF	63.2	63.1	52.2
48	NLF	17.8	19.4	10.9
	SDLF	73.2	74.8	64.7
	TDLF	65.6	66.0	53.1
49	NLF	18.8	20.7	12.0
	SDLF	74.3	75.9	65.3
	TDLF	66.5	67.1	53.2
50	NLF	19.4	21.6	12.8
	SDLF	73.2	75.2	64.4
	TDLF	65.9	66.9	52.8

Table E-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
51	NLF	19.3	22.2	12.9
	SDLF	69.7	72.5	61.4
	TDLF	63.7	65.4	51.2
52	NLF	18.5	22.3	12.4
	SDLF	64.1	67.8	56.8
	TDLF	60.1	62.2	48.8
53	NLF	17.0	21.9	11.4
	SDLF	56.8	60.9	50.9
	TDLF	55.5	56.8	45.9
54	NLF	15.7	20.4	10.6
	SDLF	49.1	52.1	44.7
	TDLF	50.4	48.4	43.2
55	NLF	12.3	15.8	10.5
	SDLF	37.5	38.9	37.1
	TDLF	42.1	39.3	37.8
56	NLF	21.1	10.8	13.1
	SDLF	40.2	33.2	30.0
	TDLF	39.6	38.6	29.8
57	NLF	18.2	9.4	5.5
	SDLF	28.7	20.3	10.1
	TDLF	35.0	23.9	9.8
58	NLF	10.6	12.1	11.7
	SDLF	8.5	16.3	20.6
	TDLF	21.6	17.2	27.9

Table E-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	8.0	7.8	7.5
	SDLF	5.5	5.3	5.0
	TDLF	0.6	0.7	0.9
2	NLF	1.9	3.0	0.6
	SDLF	0.7	3.2	0.5
	TDLF	1.8	3.3	0.7
3	NLF	3.7	4.0	1.1
	SDLF	1.5	4.4	1.4
	TDLF	3.1	5.8	2.5
4	NLF	5.6	1.2	3.1
	SDLF	6.3	1.0	1.5
	TDLF	7.7	4.3	1.7
5	NLF	8.4	1.4	4.6
	SDLF	9.2	0.9	2.4
	TDLF	11.2	4.5	1.8
6	NLF	8.8	0.9	4.8
	SDLF	10.3	1.7	2.5
	TDLF	13.1	5.4	2.1
7	NLF	9.0	1.2	4.5
	SDLF	10.9	2.3	2.2
	TDLF	13.8	6.1	2.9
8	NLF	8.9	1.0	3.9
	SDLF	10.8	2.5	1.5
	TDLF	13.3	6.8	4.3
9	NLF	6.9	0.7	2.6
	SDLF	9.5	3.4	1.1
	TDLF	11.5	7.8	5.5
10	NLF	1.7	4.0	0.7
	SDLF	3.2	5.6	2.9
	TDLF	8.6	10.4	7.1

Table E-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location		
		G1-G2	G2-G3	G3-G4
11	NLF	1.5	3.8	1.2
	SDLF	3.8	7.1	1.9
	TDLF	8.2	9.9	5.5
12	NLF	1.1	3.2	2.0
	SDLF	3.9	5.4	1.1
	TDLF	7.5	10.0	5.7
13	NLF	3.6	2.6	4.8
	SDLF	4.9	4.1	2.2
	TDLF	7.9	7.6	3.1
14	NLF	4.6	1.9	3.6
	SDLF	5.2	2.8	1.5
	TDLF	6.4	4.5	2.6
15	NLF	2.5	0.8	0.9
	SDLF	2.9	0.5	0.9
	TDLF	3.5	1.7	1.7
16	NLF	15.6	16.6	18.3
	SDLF	11.2	11.3	12.9
	TDLF	2.5	1.6	3.3
17	NLF	1.1	0.2	3.5
	SDLF	1.5	0.3	3.5
	TDLF	3.2	0.6	3.4
18	NLF	1.2	3.1	7.5
	SDLF	2.1	0.9	7.1
	TDLF	6.9	1.5	6.4
19	NLF	5.7	2.7	2.9
	SDLF	7.3	1.1	4.5
	TDLF	10.9	5.3	7.2
20	NLF	5.8	0.7	5.4
	SDLF	11.5	6.8	3.1
	TDLF	15.0	10.4	5.3

Table E-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	4.2	5.2	7.8
	SDLF	11.7	13.2	5.0
	TDLF	15.0	15.7	8.2
22	NLF	1.8	5.5	6.6
	SDLF	11.4	15.3	5.7
	TDLF	16.0	18.7	10.9
23	NLF	4.9	1.1	9.5
	SDLF	7.9	12.8	20.1
	TDLF	13.6	17.7	20.3
24	NLF	7.9	1.2	14.5
	SDLF	6.8	14.2	27.5
	TDLF	12.1	18.1	27.6
25	NLF	8.8	3.1	15.9
	SDLF	7.5	16.7	31.2
	TDLF	11.1	19.9	32.4
26	NLF	9.5	3.8	16.8
	SDLF	8.9	18.9	34.2
	TDLF	10.6	21.5	35.5
27	NLF	10.4	3.1	17.4
	SDLF	9.8	19.4	36.0
	TDLF	11.5	22.3	36.6
28	NLF	9.9	1.2	16.7
	SDLF	9.6	19.5	36.2
	TDLF	14.0	21.9	35.3
29	NLF	3.9	1.6	8.6
	SDLF	15.1	18.4	27.1
	TDLF	20.2	22.0	27.6
30	NLF	8.7	2.1	9.3
	SDLF	26.3	20.0	13.2
	TDLF	27.9	20.8	16.7

Table E-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
31	NLF	15.1	1.6	12.3
	SDLF	30.3	17.4	11.3
	TDLF	31.3	19.6	10.7
32	NLF	19.9	2.0	14.4
	SDLF	30.1	14.7	11.4
	TDLF	31.3	17.2	4.8
33	NLF	17.5	7.4	14.0
	SDLF	21.0	13.1	11.0
	TDLF	22.5	13.8	1.5
34	NLF	8.1	11.8	10.3
	SDLF	15.0	15.1	7.2
	TDLF	18.2	14.1	1.5
35	NLF	3.4	5.9	3.4
	SDLF	8.1	8.5	3.0
	TDLF	11.3	9.4	1.4
36	NLF	25.4	21.6	17.5
	SDLF	9.2	8.7	10.2
	TDLF	13.3	5.0	4.1
37	NLF	1.2	4.2	0.9
	SDLF	34.8	19.7	10.9
	TDLF	57.8	33.2	16.3
38	NLF	25.8	36.0	21.4
	SDLF	23.4	28.0	14.6
	TDLF	24.9	20.6	8.4
39	NLF	53.0	53.9	31.2
	SDLF	74.0	59.5	27.1
	TDLF	90.9	65.1	26.9
40	NLF	41.6	41.8	16.6
	SDLF	31.9	27.1	3.6
	TDLF	32.3	24.5	13.3

Table E-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
41	NLF	28.6	32.9	2.0
	SDLF	14.8	18.3	17.6
	TDLF	11.0	8.9	20.9
42	NLF	16.1	19.3	4.6
	SDLF	16.3	15.6	31.2
	TDLF	24.2	22.9	32.3
43	NLF	2.1	2.9	5.8
	SDLF	34.7	34.8	39.8
	TDLF	36.8	38.8	39.9
44	NLF	8.5	11.6	8.8
	SDLF	49.8	52.5	48.9
	TDLF	50.6	52.6	46.9
45	NLF	19.9	22.1	12.5
	SDLF	67.9	69.5	58.1
	TDLF	63.2	64.7	53.0
46	NLF	24.0	30.5	14.8
	SDLF	71.7	78.0	63.0
	TDLF	68.9	75.0	57.0
47	NLF	34.5	38.6	19.4
	SDLF	88.8	91.6	71.2
	TDLF	80.6	83.1	61.3
48	NLF	38.3	43.0	23.2
	SDLF	93.2	97.1	75.9
	TDLF	85.3	88.5	64.2
49	NLF	41.5	46.8	26.3
	SDLF	96.1	100.3	78.1
	TDLF	87.9	91.7	65.8
50	NLF	43.2	49.4	28.2
	SDLF	96.1	101.2	78.2
	TDLF	88.3	92.9	66.3

Table E-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
51	NLF	43.2	51.0	28.6
	SDLF	92.8	99.5	75.4
	TDLF	86.3	92.5	64.8
52	NLF	41.5	51.7	27.4
	SDLF	86.5	95.4	70.1
	TDLF	82.1	90.0	61.6
53	NLF	38.3	51.3	24.9
	SDLF	77.6	88.4	62.8
	TDLF	76.2	84.8	57.4
54	NLF	35.2	47.2	22.1
	SDLF	68.5	78.5	54.8
	TDLF	69.3	74.4	52.9
55	NLF	29.4	38.0	22.6
	SDLF	53.4	57.7	47.2
	TDLF	58.7	60.2	48.1
56	NLF	47.4	24.3	28.7
	SDLF	65.8	46.1	45.6
	TDLF	64.5	50.8	45.7
57	NLF	38.0	15.2	20.6
	SDLF	47.7	24.2	26.9
	TDLF	51.5	28.5	29.4
58	NLF	15.4	9.8	3.6
	SDLF	9.6	5.4	1.4
	TDLF	5.5	2.9	2.6

Table E-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	1.7	1.5	1.6
	SDLF	0.1	0.1	0.0
	TDLF	3.5	3.1	3.2
2	NLF	0.7	1.0	0.2
	SDLF	0.3	0.1	0.2
	TDLF	0.8	1.8	1.1
3	NLF	1.1	1.5	0.4
	SDLF	0.6	0.4	0.1
	TDLF	0.9	1.9	0.9
4	NLF	0.8	1.3	0.5
	SDLF	0.2	0.7	0.3
	TDLF	0.2	0.3	0.6
5	NLF	1.3	2.3	0.9
	SDLF	0.6	1.4	0.4
	TDLF	0.4	0.9	0.6
6	NLF	1.3	2.4	1.1
	SDLF	0.6	1.7	0.4
	TDLF	1.1	2.0	1.0
7	NLF	1.4	2.5	1.1
	SDLF	0.5	1.5	0.3
	TDLF	1.1	2.0	1.0
8	NLF	1.4	2.4	0.9
	SDLF	0.1	0.9	0.1
	TDLF	0.4	1.0	0.7
9	NLF	1.1	1.8	0.6
	SDLF	0.4	0.2	0.3
	TDLF	0.2	0.4	0.8
10	NLF	0.8	1.0	0.2
	SDLF	1.2	0.8	0.6
	TDLF	0.8	2.1	1.3

Table E-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	0.6	0.5	0.1
	SDLF	1.0	0.4	0.3
	TDLF	0.7	2.1	1.5
12	NLF	0.4	0.1	0.5
	SDLF	0.9	0.1	0.2
	TDLF	0.1	1.0	1.4
13	NLF	0.4	0.9	0.5
	SDLF	0.3	0.2	0.2
	TDLF	0.4	0.9	0.2
14	NLF	0.8	1.8	1.1
	SDLF	0.4	1.1	0.8
	TDLF	0.1	0.1	0.5
15	NLF	1.0	1.2	0.7
	SDLF	0.7	1.0	0.6
	TDLF	0.2	0.6	0.6
16	NLF	3.4	3.1	3.4
	SDLF	0.1	0.1	0.1
	TDLF	6.2	6.1	6.4
17	NLF	0.8	1.6	1.3
	SDLF	0.3	0.8	0.8
	TDLF	0.7	1.0	0.2
18	NLF	0.4	1.7	1.4
	SDLF	0.5	0.1	0.3
	TDLF	1.7	3.2	1.2
19	NLF	1.3	1.8	0.5
	SDLF	2.1	3.0	1.7
	TDLF	1.1	2.4	1.1
20	NLF	1.5	2.9	1.4
	SDLF	2.6	4.1	3.0
	TDLF	0.1	1.3	1.0

Table E-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	1.5	4.1	2.7
	SDLF	3.3	5.7	4.8
	TDLF	0.4	0.8	1.0
22	NLF	0.8	2.8	2.0
	SDLF	3.7	5.4	5.1
	TDLF	0.6	0.1	0.5
23	NLF	0.7	1.8	0.9
	SDLF	3.7	3.6	4.2
	TDLF	0.4	1.5	1.5
24	NLF	1.7	3.8	2.1
	SDLF	3.6	2.1	3.8
	TDLF	1.5	1.5	0.3
25	NLF	2.0	4.3	2.2
	SDLF	3.8	1.4	3.8
	TDLF	3.0	5.1	2.4
26	NLF	2.2	4.7	2.4
	SDLF	4.0	1.1	4.1
	TDLF	4.1	7.1	3.5
27	NLF	2.4	5.1	2.7
	SDLF	4.3	1.1	4.3
	TDLF	3.9	6.7	3.3
28	NLF	2.0	4.8	2.7
	SDLF	5.0	2.2	4.9
	TDLF	2.7	4.0	1.8
29	NLF	0.3	1.3	1.0
	SDLF	6.9	6.0	7.0
	TDLF	0.4	0.1	0.5
30	NLF	3.0	6.0	2.9
	SDLF	9.2	12.1	9.8
	TDLF	0.9	2.4	1.9

Table E-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
31	NLF	4.5	9.5	4.5
	SDLF	9.1	14.1	9.8
	TDLF	1.8	6.0	3.1
32	NLF	4.9	9.5	5.0
	SDLF	8.0	12.6	9.5
	TDLF	2.9	7.2	5.4
33	NLF	5.9	12.5	6.0
	SDLF	7.0	11.4	7.0
	TDLF	3.1	5.1	2.4
34	NLF	0.3	4.0	3.4
	SDLF	3.1	6.1	4.6
	TDLF	3.3	5.3	2.5
35	NLF	1.2	0.5	0.3
	SDLF	1.2	1.9	1.7
	TDLF	2.7	3.5	2.2
36	NLF	2.6	2.3	3.5
	SDLF	8.3	6.4	2.8
	TDLF	18.1	15.7	10.5
37	NLF	3.6	4.1	0.9
	SDLF	17.1	8.5	3.7
	TDLF	31.1	16.3	5.6
38	NLF	10.2	6.5	0.3
	SDLF	6.4	1.5	2.1
	TDLF	6.8	1.2	0.5
39	NLF	8.0	0.2	7.2
	SDLF	23.7	7.5	3.7
	TDLF	37.9	16.3	1.5
40	NLF	1.5	10.4	10.4
	SDLF	0.2	9.7	10.3
	TDLF	7.7	2.8	3.9

Table E-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
41	NLF	4.5	13.8	12.8
	SDLF	15.3	22.0	18.0
	TDLF	12.5	16.7	10.6
42	NLF	11.7	16.4	13.1
	SDLF	29.1	30.9	22.8
	TDLF	26.4	26.1	14.5
43	NLF	17.9	21.4	13.8
	SDLF	37.2	39.9	27.7
	TDLF	30.8	33.8	18.3
44	NLF	25.0	24.9	14.3
	SDLF	49.3	47.5	32.3
	TDLF	41.5	39.8	21.3
45	NLF	30.0	27.8	13.9
	SDLF	57.0	54.0	35.1
	TDLF	46.4	44.4	22.0
46	NLF	35.0	32.0	16.3
	SDLF	64.4	60.8	40.5
	TDLF	51.3	49.2	25.6
47	NLF	39.0	34.0	15.8
	SDLF	70.2	64.5	41.8
	TDLF	55.2	50.9	25.2
48	NLF	42.4	36.8	16.3
	SDLF	74.4	67.9	43.1
	TDLF	58.2	52.9	25.3
49	NLF	44.5	38.9	17.4
	SDLF	76.2	69.5	44.0
	TDLF	59.3	53.9	25.9
50	NLF	45.6	39.8	17.5
	SDLF	75.9	69.1	43.0
	TDLF	59.4	53.8	25.5

Table E-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
51	NLF	45.5	39.5	17.1
	SDLF	73.6	66.8	40.9
	TDLF	58.2	52.6	24.6
52	NLF	44.2	38.1	16.1
	SDLF	69.2	62.6	37.5
	TDLF	55.6	50.2	23.4
53	NLF	41.7	35.7	14.8
	SDLF	62.9	56.8	33.4
	TDLF	51.5	46.8	22.2
54	NLF	37.4	31.6	12.8
	SDLF	54.0	48.9	28.3
	TDLF	44.7	41.5	20.3
55	NLF	32.7	28.5	12.7
	SDLF	44.6	41.4	24.4
	TDLF	38.0	36.6	19.0
56	NLF	30.2	25.8	13.7
	SDLF	40.6	34.9	19.9
	TDLF	39.1	32.8	15.0
57	NLF	20.4	13.4	6.7
	SDLF	23.6	13.7	6.4
	TDLF	22.5	10.4	3.3
58	NLF	3.0	11.1	8.5
	SDLF	1.6	15.9	12.3
	TDLF	3.6	22.6	14.1

Table E-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location		
		G1-G2	G2-G3	G3-G4
1	NLF	4.2	3.9	4.0
	SDLF	2.5	2.4	2.4
	TDLF	0.9	0.7	0.6
2	NLF	3.5	3.3	1.8
	SDLF	3.0	2.4	1.4
	TDLF	1.9	0.5	0.6
3	NLF	4.3	4.6	2.1
	SDLF	3.7	3.5	1.8
	TDLF	2.2	1.0	0.9
4	NLF	1.1	4.0	0.7
	SDLF	0.7	3.5	0.4
	TDLF	0.6	3.1	0.5
5	NLF	2.6	6.9	2.1
	SDLF	2.2	6.1	1.4
	TDLF	2.3	5.6	1.4
6	NLF	2.4	7.3	2.7
	SDLF	2.1	6.6	1.8
	TDLF	3.2	7.0	2.0
7	NLF	2.2	7.2	2.7
	SDLF	1.8	6.3	1.6
	TDLF	3.1	6.9	1.9
8	NLF	2.2	6.6	2.1
	SDLF	1.3	5.3	0.9
	TDLF	2.2	5.5	1.3
9	NLF	1.1	4.5	1.0
	SDLF	0.0	3.1	0.1
	TDLF	0.7	3.3	0.7
10	NLF	3.8	3.3	1.5
	SDLF	4.0	3.0	2.0
	TDLF	1.7	0.0	0.3

Table E-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	3.4	2.4	1.1
	SDLF	3.7	2.3	1.5
	TDLF	1.8	0.2	0.2
12	NLF	2.2	0.1	0.4
	SDLF	2.6	0.1	0.0
	TDLF	1.8	0.8	0.9
13	NLF	0.4	1.7	0.3
	SDLF	1.1	0.6	0.5
	TDLF	1.2	0.2	0.7
14	NLF	1.4	5.2	2.7
	SDLF	1.0	4.5	2.1
	TDLF	0.7	3.4	1.5
15	NLF	1.6	3.2	1.1
	SDLF	1.4	3.0	1.0
	TDLF	1.1	2.6	0.8
16	NLF	8.2	7.8	7.6
	SDLF	4.8	4.5	4.2
	TDLF	1.6	1.5	2.1
17	NLF	2.0	4.6	2.2
	SDLF	1.4	3.7	1.8
	TDLF	0.0	1.9	1.2
18	NLF	1.0	4.9	2.4
	SDLF	0.3	2.9	1.5
	TDLF	2.1	0.3	0.3
19	NLF	5.4	7.1	3.8
	SDLF	6.2	8.1	4.6
	TDLF	5.1	7.0	3.5
20	NLF	5.5	9.2	5.7
	SDLF	6.6	10.3	7.1
	TDLF	4.1	7.1	4.7

Table E-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
21	NLF	5.4	12.4	9.1
	SDLF	7.1	13.7	11.0
	TDLF	3.3	8.3	6.8
22	NLF	2.3	6.8	6.0
	SDLF	5.3	9.3	9.0
	TDLF	1.2	3.6	4.2
23	NLF	2.5	6.8	1.6
	SDLF	2.0	1.7	2.9
	TDLF	1.7	4.0	0.6
24	NLF	5.7	13.3	4.9
	SDLF	0.2	7.6	0.2
	TDLF	4.8	11.3	4.9
25	NLF	7.0	14.5	4.6
	SDLF	0.9	9.2	0.4
	TDLF	7.0	15.9	7.3
26	NLF	7.6	15.4	4.6
	SDLF	1.1	10.1	0.6
	TDLF	8.6	18.7	8.5
27	NLF	7.7	16.5	5.5
	SDLF	1.0	10.6	0.5
	TDLF	8.8	19.0	8.6
28	NLF	6.7	15.7	6.0
	SDLF	0.2	9.1	1.0
	TDLF	7.4	15.8	6.9
29	NLF	1.2	5.6	1.3
	SDLF	6.1	1.6	6.5
	TDLF	1.0	4.9	0.7
30	NLF	7.1	13.6	7.0
	SDLF	13.6	19.8	14.0
	TDLF	5.6	10.2	6.0

Table E-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
31	NLF	11.5	23.0	11.7
	SDLF	16.6	27.6	16.9
	TDLF	9.6	19.3	9.9
32	NLF	11.7	22.1	13.2
	SDLF	15.5	25.4	17.4
	TDLF	10.9	20.4	13.4
33	NLF	12.9	28.9	15.9
	SDLF	14.9	28.0	16.5
	TDLF	11.7	21.9	11.6
34	NLF	0.4	10.5	10.4
	SDLF	4.5	13.1	11.2
	TDLF	6.0	12.9	9.1
35	NLF	2.1	0.2	2.7
	SDLF	0.8	2.4	3.8
	TDLF	2.9	4.4	4.2
36	NLF	4.7	4.8	7.8
	SDLF	6.1	3.9	1.5
	TDLF	16.1	13.3	6.3
37	NLF	6.5	8.1	1.6
	SDLF	14.0	4.5	3.3
	TDLF	27.8	12.4	5.3
38	NLF	19.6	9.5	5.3
	SDLF	16.1	4.6	7.1
	TDLF	17.0	4.7	5.2
39	NLF	17.2	2.0	19.9
	SDLF	34.8	7.4	15.4
	TDLF	50.9	18.2	8.9
40	NLF	1.8	22.1	24.7
	SDLF	3.1	18.4	23.1
	TDLF	13.4	8.6	15.1

Table E-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
41	NLF	2.1	23.6	26.8
	SDLF	13.2	31.6	31.5
	TDLF	10.2	25.5	23.2
42	NLF	15.3	26.9	25.6
	SDLF	32.7	40.7	34.7
	TDLF	29.6	34.8	25.5
43	NLF	30.0	37.1	25.8
	SDLF	48.4	54.5	38.8
	TDLF	40.9	46.9	28.2
44	NLF	43.6	43.2	25.4
	SDLF	66.9	64.6	42.4
	TDLF	58.0	55.5	30.3
45	NLF	54.2	48.6	23.8
	SDLF	80.2	73.7	44.2
	TDLF	68.4	62.8	30.0
46	NLF	65.1	57.3	27.9
	SDLF	93.1	84.9	51.1
	TDLF	78.4	71.6	35.0
47	NLF	74.6	62.9	27.4
	SDLF	104.1	91.8	52.3
	TDLF	87.3	76.4	34.5
48	NLF	82.1	68.9	28.6
	SDLF	112.3	98.3	54.3
	TDLF	94.0	81.6	35.4
49	NLF	87.6	73.9	30.7
	SDLF	117.1	102.6	56.1
	TDLF	98.0	85.0	36.7
50	NLF	90.5	76.2	30.9
	SDLF	118.5	103.5	55.3
	TDLF	99.6	86.1	36.4

Table E-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location		
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**
51	NLF	90.8	76.1	30.1
	SDLF	116.6	101.2	52.7
	TDLF	98.9	84.9	35.2
52	NLF	88.5	73.2	28.1
	SDLF	111.3	95.7	48.3
	TDLF	95.5	81.3	33.0
53	NLF	83.5	68.1	25.2
	SDLF	102.8	87.4	42.7
	TDLF	89.4	75.6	30.4
54	NLF	74.7	59.7	21.5
	SDLF	89.7	75.3	36.1
	TDLF	78.7	66.3	27.2
55	NLF	65.4	54.4	22.1
	SDLF	75.9	65.5	32.7
	TDLF	67.9	59.2	26.5
56	NLF	58.5	46.8	24.5
	SDLF	68.0	55.8	30.8
	TDLF	65.8	53.8	26.1
57	NLF	42.7	32.9	19.5
	SDLF	46.0	34.6	20.4
	TDLF	46.0	34.0	18.4
58	NLF	0.0	1.0	1.0
	SDLF	2.5	1.9	1.8
	TDLF	5.3	3.5	3.2

Table E-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	1.7	1.5	1.6
	SDLF	0.2	0.5	0.2
	TDLF	3.9	4.1	3.7
2	NLF	1.2	1.8	0.7
	SDLF	0.7	1.0	0.3
	TDLF	0.2	0.5	0.2
3	NLF	0.7	0.7	0.0
	SDLF	0.1	0.4	0.4
	TDLF	1.2	1.9	0.7
4	NLF	0.6	0.9	0.3
	SDLF	0.6	0.8	0.4
	TDLF	0.2	0.3	0.2
5	NLF	1.1	1.8	0.7
	SDLF	1.3	1.8	0.8
	TDLF	0.4	0.3	0.3
6	NLF	1.1	2.1	0.9
	SDLF	1.7	2.5	1.2
	TDLF	1.2	1.4	0.1
7	NLF	1.1	2.1	0.9
	SDLF	1.9	2.6	1.4
	TDLF	1.3	1.5	0.0
8	NLF	1.1	2.0	0.8
	SDLF	1.8	2.3	1.2
	TDLF	0.7	0.5	0.3
9	NLF	0.7	1.1	0.3
	SDLF	1.3	1.4	1.0
	TDLF	0.0	0.2	0.3
10	NLF	0.3	0.1	0.3
	SDLF	1.3	1.6	1.2
	TDLF	1.4	2.0	0.4

Table E-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4
11	NLF	1.1	1.4	0.3
	SDLF	0.4	0.5	0.9
	TDLF	0.6	1.2	0.4
12	NLF	0.0	0.6	0.6
	SDLF	0.7	1.2	1.1
	TDLF	0.0	0.4	0.1
13	NLF	0.5	1.3	0.7
	SDLF	0.8	1.3	0.8
	TDLF	0.0	0.0	0.3
14	NLF	0.4	1.1	0.5
	SDLF	0.4	0.8	0.3
	TDLF	0.3	0.5	0.6
15	NLF	0.1	0.0	0.2
	SDLF	0.3	0.2	0.1
	TDLF	0.5	0.7	0.4
16	NLF	3.5	3.4	4.1
	SDLF	0.2	0.1	0.4
	TDLF	5.9	6.1	6.2
17	NLF	0.1	0.2	0.3
	SDLF	0.2	0.1	0.3
	TDLF	0.7	1.1	0.1
18	NLF	0.2	1.0	0.9
	SDLF	0.4	0.0	0.5
	TDLF	1.9	3.1	1.3
19	NLF	0.7	0.8	0.0
	SDLF	0.3	0.5	0.6
	TDLF	1.5	1.8	0.5
20	NLF	1.2	2.5	1.2
	SDLF	0.0	1.1	0.4
	TDLF	1.3	1.9	0.8

Table E-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	1.4	3.9	2.4
	SDLF	0.8	1.2	0.4
	TDLF	1.1	1.6	0.7
22	NLF	0.6	2.2	1.7
	SDLF	2.6	1.7	2.5
	TDLF	0.6	0.2	0.9
23	NLF	0.7	1.6	0.9
	SDLF	4.3	4.8	4.8
	TDLF	1.3	1.6	0.4
24	NLF	1.5	3.2	1.7
	SDLF	6.1	7.9	7.0
	TDLF	0.4	1.1	1.2
25	NLF	1.9	3.9	1.9
	SDLF	7.8	10.5	8.8
	TDLF	1.0	4.7	3.4
26	NLF	2.1	4.2	2.0
	SDLF	9.1	12.2	10.0
	TDLF	1.9	6.5	4.5
27	NLF	2.2	4.6	2.3
	SDLF	9.7	13.1	10.8
	TDLF	1.7	6.3	4.4
28	NLF	1.8	4.2	2.2
	SDLF	9.3	12.1	10.3
	TDLF	0.4	3.2	2.6
29	NLF	0.4	1.4	1.1
	SDLF	7.5	9.1	9.2
	TDLF	1.3	0.6	1.7
30	NLF	3.1	5.6	2.9
	SDLF	3.6	1.9	5.1
	TDLF	2.1	1.8	0.6

Table E-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
31	NLF	4.5	8.3	4.0
	SDLF	0.9	2.9	1.9
	TDLF	3.9	7.3	3.2
32	NLF	5.4	10.3	4.7
	SDLF	0.3	3.9	0.9
	TDLF	3.2	6.0	2.5
33	NLF	3.6	8.6	4.7
	SDLF	1.0	4.1	0.2
	TDLF	3.4	4.6	1.1
34	NLF	1.6	5.0	3.8
	SDLF	0.6	3.4	1.2
	TDLF	2.4	4.4	1.3
35	NLF	0.3	1.8	1.4
	SDLF	0.9	1.3	0.6
	TDLF	0.9	1.6	0.6
36	NLF	6.0	3.3	2.8
	SDLF	6.0	5.4	2.6
	TDLF	15.8	13.3	9.2
37	NLF	1.6	1.1	0.3
	SDLF	19.8	11.2	4.3
	TDLF	32.2	17.6	6.2
38	NLF	9.3	5.4	1.5
	SDLF	5.5	2.4	1.1
	TDLF	0.2	1.3	2.1
39	NLF	8.7	0.1	5.5
	SDLF	16.4	14.4	8.6
	TDLF	36.9	26.1	12.0
40	NLF	2.4	6.3	8.9
	SDLF	9.6	13.1	7.9
	TDLF	24.1	23.4	12.8

Table E-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location		
		G1-G2	G2-G3	G3-G4
41	NLF	5.5	14.0	13.1
	SDLF	8.1	12.3	6.9
	TDLF	20.9	21.2	11.9
42	NLF	12.0	17.2	12.9
	SDLF	12.2	14.5	5.2
	TDLF	28.0	27.6	14.4
43	NLF	17.8	20.7	13.5
	SDLF	15.6	16.8	4.4
	TDLF	34.5	34.2	17.7
44	NLF	23.9	24.3	14.0
	SDLF	18.8	18.3	3.3
	TDLF	40.8	39.2	20.5
45	NLF	31.6	29.6	14.7
	SDLF	24.8	22.2	1.8
	TDLF	50.4	46.5	21.7
46	NLF	32.4	30.3	15.6
	SDLF	22.1	19.4	0.3
	TDLF	49.0	44.6	22.0
47	NLF	40.2	35.6	16.3
	SDLF	29.2	23.9	0.5
	TDLF	58.7	51.0	22.8
48	NLF	42.6	38.0	17.1
	SDLF	29.7	24.4	1.3
	TDLF	59.6	51.6	22.3
49	NLF	44.7	40.0	17.9
	SDLF	31.2	25.5	0.7
	TDLF	61.0	52.3	22.7
50	NLF	45.8	40.9	18.0
	SDLF	32.5	26.7	0.1
	TDLF	61.3	52.4	22.4

Table E-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
51	NLF	45.6	40.6	17.6
	SDLF	33.4	27.5	0.8
	TDLF	60.2	51.3	21.6
52	NLF	44.1	39.0	16.4
	SDLF	33.8	27.9	1.9
	TDLF	57.8	49.1	20.6
53	NLF	41.3	36.1	14.9
	SDLF	33.2	27.5	3.4
	TDLF	53.7	45.8	19.6
54	NLF	37.8	33.1	13.0
	SDLF	32.3	27.7	4.9
	TDLF	48.9	43.0	18.7
55	NLF	29.3	25.8	11.3
	SDLF	26.0	22.5	6.0
	TDLF	38.9	34.5	16.4
56	NLF	30.1	26.3	13.7
	SDLF	29.0	23.4	8.8
	TDLF	39.0	31.3	14.1
57	NLF	19.3	12.7	5.6
	SDLF	21.0	11.1	3.3
	TDLF	24.8	12.0	4.3
58	NLF	2.0	11.5	10.2
	SDLF	4.3	20.9	16.4
	TDLF	14.4	32.9	21.4

Table E-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	5.9	4.8	5.6
	SDLF	4.0	2.9	3.8
	TDLF	0.3	0.7	0.4
2	NLF	5.4	6.3	3.6
	SDLF	4.8	5.5	3.3
	TDLF	3.9	4.0	2.8
3	NLF	3.3	2.1	1.2
	SDLF	2.4	1.0	0.8
	TDLF	1.2	0.5	0.5
4	NLF	0.2	2.3	0.2
	SDLF	0.4	2.2	0.2
	TDLF	0.2	1.2	1.0
5	NLF	1.7	5.3	1.3
	SDLF	2.1	5.3	1.2
	TDLF	1.6	3.9	0.2
6	NLF	1.6	6.0	1.9
	SDLF	2.6	6.4	2.0
	TDLF	2.6	5.5	0.5
7	NLF	1.4	5.8	1.9
	SDLF	2.6	6.4	2.1
	TDLF	2.6	5.4	0.4
8	NLF	1.3	5.2	1.3
	SDLF	2.4	5.6	1.6
	TDLF	1.8	3.9	0.3
9	NLF	0.1	2.3	0.2
	SDLF	1.0	2.8	0.4
	TDLF	0.0	1.2	1.2
10	NLF	2.7	0.7	0.5
	SDLF	0.8	0.9	0.4
	TDLF	0.4	1.4	0.6

Table E-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	4.8	4.7	2.1
	SDLF	3.1	2.7	1.0
	TDLF	2.8	2.0	1.6
12	NLF	1.6	0.9	0.2
	SDLF	0.8	1.5	0.6
	TDLF	1.4	0.7	0.5
13	NLF	0.1	2.9	0.9
	SDLF	0.2	2.9	0.9
	TDLF	0.6	1.5	0.5
14	NLF	0.6	2.4	0.3
	SDLF	0.6	2.0	0.0
	TDLF	1.1	0.6	1.3
15	NLF	1.4	0.8	1.5
	SDLF	1.2	0.5	1.4
	TDLF	0.8	0.2	1.3
16	NLF	11.3	10.3	13.0
	SDLF	8.2	7.0	9.3
	TDLF	2.3	0.9	2.6
17	NLF	1.0	0.2	1.0
	SDLF	1.4	0.2	0.8
	TDLF	2.3	1.3	0.8
18	NLF	2.0	2.0	0.5
	SDLF	2.2	1.1	0.4
	TDLF	3.7	1.8	1.0
19	NLF	3.0	3.5	2.3
	SDLF	3.2	3.4	1.6
	TDLF	5.0	4.9	2.4
20	NLF	5.1	8.4	5.2
	SDLF	4.0	7.0	3.6
	TDLF	5.4	7.6	4.6

Table E-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location		
		G1-G2	G2-G3	G3-G4
21	NLF	5.4	12.0	8.6
	SDLF	3.1	9.1	5.7
	TDLF	5.0	9.1	6.5
22	NLF	2.3	6.0	6.4
	SDLF	1.0	1.6	1.6
	TDLF	2.1	2.4	2.4
23	NLF	2.0	6.0	1.6
	SDLF	5.4	9.2	5.8
	TDLF	0.6	2.8	1.0
24	NLF	4.7	10.9	3.5
	SDLF	9.1	15.8	9.5
	TDLF	1.9	9.0	4.7
25	NLF	6.0	12.8	3.6
	SDLF	11.7	19.7	11.5
	TDLF	4.2	14.2	7.5
26	NLF	6.6	13.3	3.5
	SDLF	13.3	21.7	12.6
	TDLF	5.5	16.5	8.7
27	NLF	6.7	14.5	4.3
	SDLF	14.1	23.5	13.9
	TDLF	5.6	17.1	9.0
28	NLF	5.5	12.9	4.2
	SDLF	12.9	21.1	13.0
	TDLF	3.7	12.5	6.3
29	NLF	1.2	5.6	1.7
	SDLF	8.6	13.8	10.2
	TDLF	0.1	5.9	3.7
30	NLF	9.1	14.9	9.2
	SDLF	2.1	6.8	0.7
	TDLF	7.2	9.5	4.3

Table E-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
31	NLF	11.9	20.6	11.1
	SDLF	6.8	15.2	5.3
	TDLF	11.6	19.6	10.4
32	NLF	11.8	23.4	12.1
	SDLF	7.7	17.3	6.6
	TDLF	11.4	19.7	10.1
33	NLF	6.9	20.1	13.2
	SDLF	5.9	16.3	8.4
	TDLF	10.0	17.6	9.4
34	NLF	3.9	11.8	11.1
	SDLF	3.7	11.1	8.5
	TDLF	6.3	13.0	8.6
35	NLF	1.1	5.3	5.5
	SDLF	0.6	5.1	4.5
	TDLF	1.3	5.8	4.5
36	NLF	13.8	8.9	10.0
	SDLF	2.0	0.3	4.6
	TDLF	7.5	7.5	2.1
37	NLF	1.3	0.1	2.3
	SDLF	19.7	10.0	2.2
	TDLF	32.3	16.6	4.1
38	NLF	16.5	6.1	8.9
	SDLF	13.7	3.8	8.2
	TDLF	8.7	0.7	8.8
39	NLF	18.3	2.1	16.2
	SDLF	5.7	15.6	18.9
	TDLF	24.8	25.9	21.5
40	NLF	9.2	10.8	21.1
	SDLF	2.4	17.0	19.8
	TDLF	16.1	26.3	23.9

Table E-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
41	NLF	8.2	26.9	29.1
	SDLF	8.9	23.4	21.7
	TDLF	20.0	30.4	25.4
42	NLF	18.6	30.5	26.3
	SDLF	17.8	26.6	17.6
	TDLF	32.5	38.3	25.6
43	NLF	29.3	35.3	25.5
	SDLF	26.4	30.6	15.5
	TDLF	44.6	46.9	27.7
44	NLF	41.5	41.6	25.0
	SDLF	35.6	34.6	13.4
	TDLF	56.5	54.2	29.4
45	NLF	57.2	52.5	25.8
	SDLF	49.3	43.8	11.9
	TDLF	73.4	66.5	30.7
46	NLF	60.3	54.1	26.8
	SDLF	48.4	41.4	10.3
	TDLF	73.6	64.7	30.8
47	NLF	76.3	65.6	28.3
	SDLF	63.4	51.9	10.4
	TDLF	90.9	77.1	32.5
48	NLF	82.7	71.7	30.3
	SDLF	67.4	55.7	10.6
	TDLF	94.9	80.5	32.7
49	NLF	87.9	76.2	32.0
	SDLF	71.8	59.1	11.8
	TDLF	98.9	83.3	33.7
50	NLF	90.9	78.7	32.3
	SDLF	74.8	61.7	12.6
	TDLF	100.8	84.6	33.5

Table E-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
51	NLF	91.0	78.4	31.3
	SDLF	76.0	62.5	13.1
	TDLF	100.2	83.5	32.4
52	NLF	88.4	75.3	29.0
	SDLF	75.4	61.5	13.0
	TDLF	97.0	80.1	30.3
53	NLF	82.9	69.1	25.7
	SDLF	72.5	58.1	13.0
	TDLF	90.8	74.1	28.0
54	NLF	75.6	63.2	22.2
	SDLF	68.4	55.9	13.1
	TDLF	83.4	69.4	26.0
55	NLF	57.8	46.8	18.7
	SDLF	53.4	42.5	12.8
	TDLF	65.3	53.5	22.8
56	NLF	60.0	50.4	26.5
	SDLF	57.2	46.2	20.9
	TDLF	65.8	53.3	25.8
57	NLF	40.5	31.1	16.9
	SDLF	42.7	31.7	16.4
	TDLF	47.9	35.9	19.0
58	NLF	10.1	3.3	1.0
	SDLF	5.5	0.9	0.3
	TDLF	1.1	1.5	1.0

Table E-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location		
		G1-G2	G2-G3	G3-G4
1	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0
2	NLF	0.1	0.1	0.1
	SDLF	0.1	0.1	0.1
	TDLF	0.1	0.1	0.1
3	NLF	0.2	0.2	0.2
	SDLF	0.2	0.2	0.2
	TDLF	0.2	0.2	0.2
4	NLF	0.2	0.2	0.2
	SDLF	0.3	0.3	0.3
	TDLF	0.3	0.3	0.3
5	NLF	0.3	0.3	0.3
	SDLF	0.3	0.3	0.4
	TDLF	0.4	0.4	0.4
6	NLF	0.4	0.4	0.4
	SDLF	0.4	0.4	0.4
	TDLF	0.4	0.4	0.5
7	NLF	0.4	0.4	0.4
	SDLF	0.5	0.5	0.5
	TDLF	0.5	0.5	0.5
8	NLF	0.4	0.5	0.5
	SDLF	0.5	0.5	0.5
	TDLF	0.5	0.5	0.6
9	NLF	0.5	0.5	0.5
	SDLF	0.5	0.5	0.5
	TDLF	0.6	0.6	0.6
10	NLF	0.5	0.5	0.5
	SDLF	0.5	0.5	0.5
	TDLF	0.6	0.6	0.6

Table E-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	0.5	0.5	0.5
	SDLF	0.5	0.5	0.5
	TDLF	0.6	0.6	0.6
12	NLF	0.4	0.4	0.4
	SDLF	0.5	0.5	0.5
	TDLF	0.5	0.5	0.5
13	NLF	0.3	0.3	0.3
	SDLF	0.4	0.4	0.4
	TDLF	0.4	0.4	0.4
14	NLF	0.2	0.2	0.3
	SDLF	0.3	0.3	0.3
	TDLF	0.3	0.3	0.3
15	NLF	0.1	0.1	0.1
	SDLF	0.2	0.2	0.2
	TDLF	0.2	0.2	0.2
16	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0
17	NLF	0.1	0.1	0.1
	SDLF	0.2	0.2	0.2
	TDLF	0.2	0.2	0.2
18	NLF	0.3	0.3	0.3
	SDLF	0.3	0.4	0.3
	TDLF	0.4	0.4	0.4
19	NLF	0.5	0.5	0.5
	SDLF	0.6	0.6	0.6
	TDLF	0.6	0.6	0.6
20	NLF	0.7	0.7	0.7
	SDLF	0.8	0.8	0.8
	TDLF	0.8	0.8	0.9

Table E-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
21	NLF	0.8	0.9	0.9
	SDLF	1.0	1.0	1.0
	TDLF	1.1	1.1	1.1
22	NLF	1.0	1.0	1.0
	SDLF	1.2	1.2	1.2
	TDLF	1.3	1.3	1.3
23	NLF	1.2	1.2	1.2
	SDLF	1.4	1.4	1.4
	TDLF	1.5	1.5	1.5
24	NLF	1.3	1.3	1.3
	SDLF	1.6	1.6	1.5
	TDLF	1.7	1.7	1.7
25	NLF	1.5	1.5	1.4
	SDLF	1.7	1.7	1.7
	TDLF	1.9	1.9	1.8
26	NLF	1.6	1.5	1.5
	SDLF	1.8	1.8	1.8
	TDLF	2.1	2.0	2.0
27	NLF	1.6	1.6	1.6
	SDLF	1.9	1.9	1.9
	TDLF	2.2	2.1	2.1
28	NLF	1.7	1.6	1.6
	SDLF	2.0	2.0	1.9
	TDLF	2.2	2.2	2.2
29	NLF	1.6	1.6	1.6
	SDLF	2.0	2.0	2.0
	TDLF	2.2	2.2	2.2
30	NLF	1.6	1.6	1.6
	SDLF	1.9	1.9	1.9
	TDLF	2.1	2.2	2.2

Table E-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
31	NLF	1.4	1.4	1.4
	SDLF	1.7	1.8	1.8
	TDLF	2.0	2.0	2.1
32	NLF	1.2	1.2	1.3
	SDLF	1.5	1.6	1.6
	TDLF	1.7	1.8	1.8
33	NLF	1.0	1.0	1.0
	SDLF	1.2	1.3	1.3
	TDLF	1.4	1.5	1.5
34	NLF	0.7	0.7	0.7
	SDLF	0.9	0.9	0.9
	TDLF	1.0	1.0	1.1
35	NLF	0.4	0.4	0.4
	SDLF	0.5	0.5	0.5
	TDLF	0.6	0.6	0.6
36	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0
37	NLF	0.3	0.3	0.3
	SDLF	0.4	0.4	0.4
	TDLF	0.4	0.4	0.4
38	NLF	0.6	0.6	0.6
	SDLF	0.8	0.8	0.8
	TDLF	0.9	0.9	0.9
39	NLF	0.9	0.9	0.9
	SDLF	1.2	1.2	1.2
	TDLF	1.4	1.4	1.3
40	NLF	1.3	1.3	1.3
	SDLF	1.6	1.6	1.6
	TDLF	1.9	1.8	1.8

Table E-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
41	NLF	1.6	1.6	1.6
	SDLF	2.0	2.0	1.9
	TDLF	2.3	2.3	2.2
42	NLF	1.9	1.9	1.9
	SDLF	2.4	2.4	2.3
	TDLF	2.7	2.7	2.6
43	NLF	2.2	2.2	2.2
	SDLF	2.8	2.7	2.7
	TDLF	3.1	3.1	3.0
44	NLF	2.5	2.5	2.4
	SDLF	3.1	3.0	3.0
	TDLF	3.5	3.4	3.3
45	NLF	2.7	2.7	2.7
	SDLF	3.3	3.3	3.2
	TDLF	3.8	3.7	3.6
46	NLF	2.9	2.9	2.8
	SDLF	3.5	3.4	3.4
	TDLF	4.0	3.9	3.8
47	NLF	3.0	3.0	3.0
	SDLF	3.7	3.6	3.5
	TDLF	4.2	4.0	4.0
48	NLF	3.1	3.0	3.0
	SDLF	3.7	3.7	3.6
	TDLF	4.2	4.1	4.0
49	NLF	3.1	3.1	3.0
	SDLF	3.7	3.7	3.6
	TDLF	4.2	4.1	4.0
50	NLF	3.0	3.0	3.0
	SDLF	3.7	3.6	3.5
	TDLF	4.2	4.0	3.9

Table E-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location		
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**
51	NLF	2.9	2.9	2.9
	SDLF	3.5	3.4	3.4
	TDLF	4.0	3.8	3.8
52	NLF	2.8	2.7	2.7
	SDLF	3.3	3.2	3.2
	TDLF	3.7	3.6	3.5
53	NLF	2.5	2.5	2.5
	SDLF	3.0	2.9	2.9
	TDLF	3.4	3.3	3.2
54	NLF	2.2	2.2	2.2
	SDLF	2.7	2.6	2.6
	TDLF	3.0	2.9	2.9
55	NLF	1.9	1.9	1.9
	SDLF	2.3	2.2	2.2
	TDLF	2.6	2.5	2.4
56	NLF	1.5	1.5	1.5
	SDLF	1.8	1.8	1.7
	TDLF	2.0	2.0	1.9
57	NLF	0.8	0.8	0.8
	SDLF	1.0	0.9	0.9
	TDLF	1.1	1.1	1.0
58	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.1
	TDLF	0.0	0.0	0.1

Table E-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
1	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0
2	NLF	0.2	0.2	0.2
	SDLF	0.2	0.2	0.2
	TDLF	0.2	0.2	0.1
3	NLF	0.5	0.5	0.5
	SDLF	0.4	0.4	0.4
	TDLF	0.3	0.3	0.3
4	NLF	0.7	0.7	0.7
	SDLF	0.6	0.6	0.6
	TDLF	0.4	0.4	0.5
5	NLF	0.8	0.9	0.9
	SDLF	0.7	0.8	0.8
	TDLF	0.6	0.6	0.6
6	NLF	1.0	1.0	1.0
	SDLF	0.9	0.9	0.9
	TDLF	0.7	0.7	0.7
7	NLF	1.1	1.1	1.1
	SDLF	1.0	1.0	1.0
	TDLF	0.8	0.8	0.8
8	NLF	1.2	1.2	1.2
	SDLF	1.1	1.1	1.1
	TDLF	0.8	0.9	0.9
9	NLF	1.2	1.3	1.3
	SDLF	1.1	1.1	1.1
	TDLF	0.9	0.9	0.9
10	NLF	1.2	1.2	1.2
	SDLF	1.1	1.1	1.1
	TDLF	0.9	0.9	0.9

Table E-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	1.2	1.2	1.2
	SDLF	1.1	1.1	1.1
	TDLF	0.9	0.9	0.9
12	NLF	1.1	1.1	1.1
	SDLF	1.0	1.0	1.0
	TDLF	0.8	0.8	0.8
13	NLF	0.9	0.9	0.9
	SDLF	0.8	0.8	0.8
	TDLF	0.6	0.6	0.7
14	NLF	0.6	0.6	0.6
	SDLF	0.6	0.6	0.6
	TDLF	0.5	0.5	0.5
15	NLF	0.3	0.3	0.3
	SDLF	0.3	0.3	0.3
	TDLF	0.2	0.3	0.3
16	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0
17	NLF	0.3	0.3	0.3
	SDLF	0.3	0.3	0.3
	TDLF	0.3	0.3	0.3
18	NLF	0.7	0.7	0.7
	SDLF	0.7	0.7	0.7
	TDLF	0.6	0.6	0.6
19	NLF	1.1	1.1	1.1
	SDLF	1.1	1.1	1.1
	TDLF	0.9	0.9	0.9
20	NLF	1.5	1.5	1.5
	SDLF	1.4	1.5	1.5
	TDLF	1.2	1.3	1.3

Table E-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
21	NLF	1.9	1.9	2.0
	SDLF	1.8	1.8	1.9
	TDLF	1.6	1.6	1.6
22	NLF	2.3	2.3	2.3
	SDLF	2.2	2.2	2.2
	TDLF	1.9	1.9	2.0
23	NLF	2.6	2.6	2.6
	SDLF	2.5	2.5	2.5
	TDLF	2.3	2.2	2.2
24	NLF	2.9	2.9	2.9
	SDLF	2.8	2.8	2.8
	TDLF	2.6	2.5	2.5
25	NLF	3.2	3.1	3.1
	SDLF	3.1	3.1	3.0
	TDLF	2.8	2.8	2.7
26	NLF	3.3	3.3	3.3
	SDLF	3.3	3.3	3.2
	TDLF	3.1	3.0	2.9
27	NLF	3.5	3.4	3.4
	SDLF	3.4	3.4	3.4
	TDLF	3.2	3.2	3.1
28	NLF	3.5	3.5	3.4
	SDLF	3.5	3.5	3.4
	TDLF	3.3	3.3	3.2
29	NLF	3.4	3.4	3.4
	SDLF	3.5	3.5	3.5
	TDLF	3.4	3.3	3.3
30	NLF	3.2	3.3	3.3
	SDLF	3.3	3.4	3.4
	TDLF	3.2	3.3	3.3

Table E-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
31	NLF	2.9	3.0	3.0
	SDLF	3.0	3.1	3.1
	TDLF	3.0	3.1	3.1
32	NLF	2.5	2.5	2.6
	SDLF	2.6	2.7	2.7
	TDLF	2.6	2.7	2.8
33	NLF	2.0	2.0	2.1
	SDLF	2.1	2.1	2.2
	TDLF	2.1	2.2	2.3
34	NLF	1.4	1.4	1.4
	SDLF	1.5	1.5	1.6
	TDLF	1.5	1.5	1.6
35	NLF	0.7	0.7	0.7
	SDLF	0.8	0.8	0.8
	TDLF	0.8	0.8	0.8
36	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0
37	NLF	0.5	0.5	0.5
	SDLF	0.6	0.6	0.6
	TDLF	0.6	0.6	0.6
38	NLF	1.1	1.1	1.1
	SDLF	1.2	1.2	1.2
	TDLF	1.3	1.3	1.3
39	NLF	1.7	1.7	1.6
	SDLF	1.8	1.8	1.8
	TDLF	1.9	1.9	1.9
40	NLF	2.3	2.3	2.2
	SDLF	2.5	2.5	2.4
	TDLF	2.6	2.6	2.5

Table E-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
41	NLF	2.9	2.8	2.8
	SDLF	3.1	3.1	3.0
	TDLF	3.3	3.3	3.2
42	NLF	3.4	3.4	3.3
	SDLF	3.7	3.7	3.6
	TDLF	3.9	3.9	3.8
43	NLF	3.9	3.9	3.8
	SDLF	4.3	4.2	4.2
	TDLF	4.5	4.4	4.3
44	NLF	4.4	4.3	4.3
	SDLF	4.8	4.7	4.6
	TDLF	5.0	4.9	4.8
45	NLF	4.7	4.7	4.7
	SDLF	5.2	5.1	5.0
	TDLF	5.4	5.3	5.3
46	NLF	5.0	5.0	5.0
	SDLF	5.5	5.4	5.4
	TDLF	5.8	5.7	5.6
47	NLF	5.3	5.2	5.2
	SDLF	5.7	5.6	5.6
	TDLF	6.0	5.9	5.8
48	NLF	5.4	5.3	5.3
	SDLF	5.9	5.7	5.7
	TDLF	6.2	6.0	5.9
49	NLF	5.4	5.3	5.3
	SDLF	5.9	5.8	5.7
	TDLF	6.2	6.0	5.9
50	NLF	5.3	5.2	5.2
	SDLF	5.8	5.6	5.6
	TDLF	6.1	5.9	5.8

Table E-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
51	NLF	5.1	5.0	5.0
	SDLF	5.6	5.4	5.4
	TDLF	5.8	5.7	5.6
52	NLF	4.8	4.7	4.7
	SDLF	5.2	5.1	5.0
	TDLF	5.5	5.3	5.3
53	NLF	4.4	4.3	4.3
	SDLF	4.8	4.7	4.6
	TDLF	5.0	4.8	4.8
54	NLF	3.9	3.8	3.8
	SDLF	4.2	4.1	4.1
	TDLF	4.5	4.3	4.2
55	NLF	3.3	3.3	3.2
	SDLF	3.6	3.5	3.5
	TDLF	3.8	3.7	3.6
56	NLF	2.7	2.6	2.6
	SDLF	2.9	2.8	2.8
	TDLF	3.0	2.9	2.9
57	NLF	1.4	1.4	1.4
	SDLF	1.5	1.5	1.4
	TDLF	1.6	1.6	1.5
58	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0

Table E-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0
2	NLF	0.1	0.1	0.1
	SDLF	0.1	0.1	0.1
	TDLF	0.1	0.1	0.1
3	NLF	0.2	0.2	0.2
	SDLF	0.2	0.2	0.2
	TDLF	0.2	0.2	0.2
4	NLF	0.2	0.2	0.2
	SDLF	0.2	0.3	0.3
	TDLF	0.3	0.3	0.3
5	NLF	0.3	0.3	0.3
	SDLF	0.3	0.3	0.3
	TDLF	0.3	0.3	0.4
6	NLF	0.3	0.3	0.3
	SDLF	0.4	0.4	0.4
	TDLF	0.4	0.4	0.4
7	NLF	0.4	0.4	0.4
	SDLF	0.4	0.4	0.4
	TDLF	0.5	0.5	0.5
8	NLF	0.4	0.4	0.4
	SDLF	0.5	0.5	0.5
	TDLF	0.5	0.5	0.5
9	NLF	0.4	0.4	0.4
	SDLF	0.5	0.5	0.5
	TDLF	0.5	0.5	0.5
10	NLF	0.4	0.4	0.4
	SDLF	0.5	0.5	0.5
	TDLF	0.5	0.5	0.5

Table E-4-9 (Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location		
		G1-G2	G2-G3	G3-G4
11	NLF	0.4	0.4	0.4
	SDLF	0.5	0.5	0.5
	TDLF	0.5	0.5	0.5
12	NLF	0.4	0.4	0.4
	SDLF	0.4	0.4	0.4
	TDLF	0.5	0.5	0.5
13	NLF	0.3	0.3	0.3
	SDLF	0.4	0.4	0.4
	TDLF	0.4	0.4	0.4
14	NLF	0.2	0.2	0.2
	SDLF	0.3	0.3	0.3
	TDLF	0.3	0.3	0.3
15	NLF	0.1	0.1	0.1
	SDLF	0.1	0.1	0.1
	TDLF	0.2	0.2	0.2
16	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0
17	NLF	0.1	0.1	0.1
	SDLF	0.2	0.2	0.2
	TDLF	0.2	0.2	0.2
18	NLF	0.3	0.3	0.3
	SDLF	0.3	0.3	0.3
	TDLF	0.3	0.4	0.3
19	NLF	0.5	0.5	0.5
	SDLF	0.5	0.5	0.5
	TDLF	0.6	0.6	0.6
20	NLF	0.6	0.6	0.6
	SDLF	0.7	0.7	0.7
	TDLF	0.8	0.8	0.8

Table E-4-9 (Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**
21	NLF	0.8	0.8	0.8
	SDLF	0.9	0.9	0.9
	TDLF	1.0	1.0	1.0
22	NLF	1.0	1.0	1.0
	SDLF	1.1	1.1	1.1
	TDLF	1.2	1.2	1.2
23	NLF	1.1	1.1	1.1
	SDLF	1.3	1.3	1.3
	TDLF	1.4	1.4	1.4
24	NLF	1.2	1.2	1.2
	SDLF	1.5	1.4	1.4
	TDLF	1.6	1.6	1.6
25	NLF	1.4	1.4	1.3
	SDLF	1.6	1.6	1.6
	TDLF	1.8	1.7	1.7
26	NLF	1.4	1.4	1.4
	SDLF	1.7	1.7	1.7
	TDLF	1.9	1.9	1.8
27	NLF	1.5	1.5	1.5
	SDLF	1.8	1.8	1.8
	TDLF	2.0	2.0	1.9
28	NLF	1.5	1.5	1.5
	SDLF	1.9	1.8	1.8
	TDLF	2.1	2.0	2.0
29	NLF	1.5	1.5	1.5
	SDLF	1.8	1.8	1.8
	TDLF	2.1	2.1	2.0
30	NLF	1.4	1.5	1.5
	SDLF	1.8	1.8	1.8
	TDLF	2.0	2.0	2.0

Table E-4-9 (Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
31	NLF	1.3	1.3	1.4
	SDLF	1.6	1.7	1.7
	TDLF	1.8	1.9	1.9
32	NLF	1.1	1.2	1.2
	SDLF	1.4	1.5	1.5
	TDLF	1.6	1.7	1.7
33	NLF	0.9	0.9	1.0
	SDLF	1.2	1.2	1.2
	TDLF	1.3	1.4	1.4
34	NLF	0.7	0.7	0.7
	SDLF	0.8	0.8	0.9
	TDLF	1.0	1.0	1.0
35	NLF	0.4	0.4	0.4
	SDLF	0.4	0.5	0.5
	TDLF	0.5	0.5	0.5
36	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0
37	NLF	0.3	0.3	0.3
	SDLF	0.4	0.4	0.4
	TDLF	0.4	0.4	0.4
38	NLF	0.6	0.6	0.6
	SDLF	0.7	0.7	0.7
	TDLF	0.8	0.9	0.8
39	NLF	0.9	0.9	0.9
	SDLF	1.1	1.1	1.1
	TDLF	1.3	1.3	1.2
40	NLF	1.2	1.2	1.2
	SDLF	1.5	1.5	1.5
	TDLF	1.7	1.7	1.7

Table E-4-9 (Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
41	NLF	1.5	1.5	1.5
	SDLF	1.9	1.9	1.8
	TDLF	2.2	2.1	2.1
42	NLF	1.8	1.8	1.8
	SDLF	2.2	2.2	2.2
	TDLF	2.6	2.5	2.4
43	NLF	2.1	2.1	2.0
	SDLF	2.6	2.5	2.5
	TDLF	2.9	2.9	2.8
44	NLF	2.3	2.3	2.3
	SDLF	2.9	2.8	2.8
	TDLF	3.2	3.2	3.1
45	NLF	2.5	2.5	2.5
	SDLF	3.1	3.0	3.0
	TDLF	3.5	3.4	3.4
46	NLF	2.7	2.7	2.6
	SDLF	3.3	3.2	3.2
	TDLF	3.7	3.6	3.6
47	NLF	2.8	2.8	2.8
	SDLF	3.4	3.3	3.3
	TDLF	3.9	3.8	3.7
48	NLF	2.9	2.8	2.8
	SDLF	3.5	3.4	3.4
	TDLF	3.9	3.8	3.8
49	NLF	2.9	2.8	2.8
	SDLF	3.5	3.4	3.4
	TDLF	3.9	3.8	3.8
50	NLF	2.8	2.8	2.8
	SDLF	3.4	3.3	3.3
	TDLF	3.9	3.7	3.7

Table E-4-9 (Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
51	NLF	2.7	2.7	2.7
	SDLF	3.3	3.2	3.2
	TDLF	3.7	3.6	3.5
52	NLF	2.6	2.5	2.5
	SDLF	3.1	3.0	3.0
	TDLF	3.5	3.3	3.3
53	NLF	2.4	2.3	2.3
	SDLF	2.8	2.7	2.7
	TDLF	3.2	3.1	3.0
54	NLF	2.1	2.0	2.0
	SDLF	2.5	2.4	2.4
	TDLF	2.8	2.7	2.7
55	NLF	1.8	1.7	1.7
	SDLF	2.1	2.1	2.0
	TDLF	2.4	2.3	2.3
56	NLF	1.4	1.4	1.4
	SDLF	1.7	1.7	1.6
	TDLF	1.9	1.9	1.8
57	NLF	0.7	0.7	0.7
	SDLF	0.9	0.9	0.9
	TDLF	1.0	1.0	1.0
58	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.1
	TDLF	0.0	0.0	0.1

Table E-4-10. Approximate horizontal differential displacements (in) at cross-frames under RDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0
2	NLF	0.2	0.2	0.2
	SDLF	0.2	0.2	0.2
	TDLF	0.2	0.1	0.1
3	NLF	0.4	0.4	0.4
	SDLF	0.4	0.4	0.4
	TDLF	0.3	0.3	0.3
4	NLF	0.6	0.6	0.6
	SDLF	0.5	0.6	0.6
	TDLF	0.4	0.4	0.4
5	NLF	0.8	0.8	0.8
	SDLF	0.7	0.7	0.7
	TDLF	0.5	0.5	0.6
6	NLF	0.9	0.9	0.9
	SDLF	0.8	0.8	0.8
	TDLF	0.6	0.6	0.7
7	NLF	1.0	1.1	1.1
	SDLF	0.9	0.9	1.0
	TDLF	0.7	0.7	0.7
8	NLF	1.1	1.1	1.1
	SDLF	1.0	1.0	1.0
	TDLF	0.8	0.8	0.8
9	NLF	1.2	1.2	1.2
	SDLF	1.0	1.1	1.1
	TDLF	0.8	0.8	0.8
10	NLF	1.2	1.2	1.2
	SDLF	1.1	1.0	1.0
	TDLF	0.8	0.8	0.8

Table E-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under RDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	1.1	1.1	1.1
	SDLF	1.0	1.0	1.0
	TDLF	0.8	0.8	0.8
12	NLF	1.0	1.0	1.0
	SDLF	0.9	0.9	0.9
	TDLF	0.7	0.7	0.7
13	NLF	0.8	0.8	0.8
	SDLF	0.7	0.7	0.7
	TDLF	0.6	0.6	0.6
14	NLF	0.6	0.6	0.6
	SDLF	0.5	0.5	0.5
	TDLF	0.4	0.4	0.5
15	NLF	0.3	0.3	0.3
	SDLF	0.3	0.3	0.3
	TDLF	0.2	0.2	0.2
16	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0
17	NLF	0.3	0.3	0.3
	SDLF	0.3	0.3	0.3
	TDLF	0.3	0.3	0.2
18	NLF	0.7	0.7	0.7
	SDLF	0.6	0.6	0.6
	TDLF	0.5	0.5	0.5
19	NLF	1.0	1.1	1.1
	SDLF	1.0	1.0	1.0
	TDLF	0.8	0.9	0.9
20	NLF	1.4	1.4	1.4
	SDLF	1.3	1.4	1.4
	TDLF	1.1	1.2	1.2

Table E-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under RDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	1.8	1.8	1.8
	SDLF	1.7	1.7	1.7
	TDLF	1.5	1.5	1.5
22	NLF	2.1	2.1	2.2
	SDLF	2.0	2.0	2.1
	TDLF	1.8	1.8	1.8
23	NLF	2.4	2.4	2.4
	SDLF	2.4	2.3	2.3
	TDLF	2.1	2.1	2.1
24	NLF	2.7	2.7	2.7
	SDLF	2.6	2.6	2.6
	TDLF	2.4	2.4	2.3
25	NLF	2.9	2.9	2.9
	SDLF	2.9	2.8	2.8
	TDLF	2.6	2.6	2.5
26	NLF	3.1	3.1	3.1
	SDLF	3.1	3.0	3.0
	TDLF	2.9	2.8	2.7
27	NLF	3.2	3.2	3.2
	SDLF	3.2	3.2	3.1
	TDLF	3.0	3.0	2.9
28	NLF	3.2	3.2	3.2
	SDLF	3.3	3.2	3.2
	TDLF	3.1	3.1	3.0
29	NLF	3.2	3.2	3.2
	SDLF	3.2	3.2	3.2
	TDLF	3.1	3.1	3.1
30	NLF	3.0	3.0	3.1
	SDLF	3.1	3.1	3.2
	TDLF	3.0	3.0	3.1

Table E-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under RDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location		
		G1-G2	G2-G3	G3-G4
31	NLF	2.7	2.8	2.8
	SDLF	2.8	2.9	2.9
	TDLF	2.8	2.8	2.9
32	NLF	2.3	2.4	2.4
	SDLF	2.4	2.5	2.5
	TDLF	2.4	2.5	2.6
33	NLF	1.8	1.9	1.9
	SDLF	2.0	2.0	2.1
	TDLF	2.0	2.0	2.1
34	NLF	1.3	1.3	1.3
	SDLF	1.4	1.4	1.4
	TDLF	1.4	1.4	1.5
35	NLF	0.7	0.7	0.7
	SDLF	0.7	0.7	0.8
	TDLF	0.7	0.8	0.8
36	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0
37	NLF	0.5	0.5	0.5
	SDLF	0.5	0.6	0.6
	TDLF	0.6	0.6	0.6
38	NLF	1.0	1.0	1.0
	SDLF	1.1	1.1	1.1
	TDLF	1.2	1.2	1.2
39	NLF	1.6	1.6	1.5
	SDLF	1.7	1.7	1.7
	TDLF	1.8	1.8	1.8
40	NLF	2.1	2.1	2.1
	SDLF	2.3	2.3	2.3
	TDLF	2.4	2.4	2.4

Table E-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under RDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
41	NLF	2.7	2.6	2.6
	SDLF	2.9	2.9	2.8
	TDLF	3.1	3.0	2.9
42	NLF	3.2	3.1	3.1
	SDLF	3.5	3.4	3.4
	TDLF	3.6	3.6	3.5
43	NLF	3.6	3.6	3.6
	SDLF	4.0	3.9	3.9
	TDLF	4.2	4.1	4.0
44	NLF	4.1	4.0	4.0
	SDLF	4.4	4.4	4.3
	TDLF	4.7	4.6	4.5
45	NLF	4.4	4.4	4.3
	SDLF	4.8	4.7	4.7
	TDLF	5.1	5.0	4.9
46	NLF	4.7	4.6	4.6
	SDLF	5.1	5.0	5.0
	TDLF	5.4	5.3	5.2
47	NLF	4.9	4.8	4.8
	SDLF	5.4	5.2	5.2
	TDLF	5.6	5.5	5.4
48	NLF	5.0	4.9	4.9
	SDLF	5.5	5.3	5.3
	TDLF	5.7	5.6	5.5
49	NLF	5.0	5.0	4.9
	SDLF	5.5	5.4	5.3
	TDLF	5.8	5.6	5.5
50	NLF	5.0	4.9	4.8
	SDLF	5.4	5.3	5.2
	TDLF	5.7	5.5	5.4

Table E-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under RDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
51	NLF	4.8	4.7	4.7
	SDLF	5.2	5.1	5.0
	TDLF	5.4	5.3	5.2
52	NLF	4.5	4.4	4.4
	SDLF	4.9	4.7	4.7
	TDLF	5.1	4.9	4.9
53	NLF	4.1	4.0	4.0
	SDLF	4.5	4.3	4.3
	TDLF	4.7	4.5	4.5
54	NLF	3.6	3.6	3.6
	SDLF	4.0	3.8	3.8
	TDLF	4.1	4.0	4.0
55	NLF	3.1	3.0	3.0
	SDLF	3.4	3.3	3.2
	TDLF	3.5	3.4	3.4
56	NLF	2.5	2.4	2.4
	SDLF	2.7	2.6	2.6
	TDLF	2.8	2.7	2.7
57	NLF	1.3	1.3	1.3
	SDLF	1.4	1.4	1.3
	TDLF	1.5	1.4	1.4
58	NLF	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0

Table E-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	110.0	362.6	678.5	400.5	323.5	1027.0	1387.6	794.8
	SDLF	108.6	371.8	722.1	450.6	318.4	1041.9	1437.2	836.2
	TDLF	108.4	377.5	757.7	495.8	312.5	1054.7	1484.8	864.2
G2	NLF	104.0	379.6	619.5	172.4	304.5	1064.3	1383.1	365.5
	SDLF	99.9	393.2	616.6	188.6	299.1	1079.9	1380.7	378.4
	TDLF	95.2	405.2	614.7	183.8	292.5	1094.3	1380.6	390.4
G3	NLF	101.5	386.0	534.4	31.8	296.1	1070.1	1325.1	186.2
	SDLF	97.7	401.6	469.8	8.4	293.5	1085.1	1255.4	184.6
	TDLF	94.2	415.1	413.6	0.0	291.8	1097.7	1191.5	183.9
G4	NLF	98.6	425.2	342.9	0.0	288.3	1168.3	980.4	18.2
	SDLF	95.5	442.0	281.3	0.0	288.7	1181.1	910.8	11.9
	TDLF	94.3	452.4	239.7	0.0	293.0	1186.4	856.4	8.1

Table E-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	NA	NA	-1.0	NA	NA	NA	-2.0	NA
	SDLF	NA	NA	-1.3	NA	NA	NA	-2.2	NA
	TDLF	NA	NA	-1.5	NA	NA	NA	-2.3	NA
G2	NLF	NA	NA	-0.3	NA	NA	NA	-0.6	NA
	SDLF	NA	NA	-0.4	NA	NA	NA	-0.7	NA
	TDLF	NA	NA	-0.5	NA	NA	NA	-0.7	NA
G3	NLF	NA	NA	0.4	NA	NA	NA	0.7	NA
	SDLF	NA	NA	0.5	NA	NA	NA	0.8	NA
	TDLF	NA	NA	0.6	NA	NA	NA	0.8	NA
G4	NLF	NA	NA	1.1	NA	NA	NA	2.1	NA
	SDLF	NA	NA	1.4	NA	NA	NA	2.4	NA
	TDLF	NA	NA	1.6	NA	NA	NA	2.4	NA

Table E-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	0.2	-0.4	0.2	-0.1	0.6	-0.9	0.4	-0.2
	SDLF	0.2	-0.4	0.1	0.0	0.6	-0.7	0.3	-0.1
	TDLF	0.2	-0.4	0.1	0.0	0.4	-0.6	0.3	-0.2
G2	NLF	0.1	-0.3	0.2	-0.1	0.3	-0.6	0.3	-0.2
	SDLF	0.1	-0.2	0.1	0.0	0.3	-0.4	0.2	-0.1
	TDLF	0.0	-0.2	0.1	0.0	0.2	-0.4	0.3	-0.1
G3	NLF	0.0	-0.1	0.2	-0.1	0.1	-0.2	0.2	-0.2
	SDLF	0.0	0.0	0.1	-0.1	0.1	-0.1	0.2	-0.1
	TDLF	0.0	0.1	0.1	-0.1	0.0	-0.1	0.2	-0.1
G4	NLF	-0.1	0.1	0.1	-0.1	-0.2	0.2	0.1	-0.2
	SDLF	-0.1	0.2	0.0	-0.1	-0.2	0.3	0.1	-0.1
	TDLF	0.0	0.3	0.0	-0.1	-0.1	0.3	0.1	-0.1

Table E-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	-0.22	0.24	-0.21	0.34	-0.81	0.34	-0.40	-0.62
	SDLF	-0.36	0.05	-0.27	0.42	-0.98	0.08	-0.45	-0.13
	TDLF	-0.44	-0.07	-0.31	0.65	-1.07	-0.11	-0.46	0.48
G2	NLF	-0.19	0.19	-0.07	0.13	-0.71	0.23	-0.13	-0.95
	SDLF	-0.31	0.00	-0.09	0.17	-0.89	-0.01	-0.14	-0.49
	TDLF	-0.40	-0.13	-0.10	0.36	-1.00	-0.19	-0.15	0.09
G3	NLF	-0.17	0.13	0.07	-0.09	-0.64	0.10	0.13	-1.30
	SDLF	-0.29	-0.06	0.10	-0.10	-0.82	-0.12	0.15	-0.87
	TDLF	-0.38	-0.20	0.11	0.05	-0.94	-0.28	0.16	-0.33
G4	NLF	-0.15	0.07	0.22	-0.30	-0.56	-0.02	0.42	-1.66
	SDLF	-0.26	-0.13	0.28	-0.34	-0.73	-0.23	0.47	-1.26
	TDLF	-0.36	-0.28	0.32	-0.24	-0.88	-0.37	0.48	-0.76

Table E-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	-0.25	0.10	0.04	-0.24	-0.94	0.05	0.06	0.36
	SDLF	-0.44	-0.05	0.02	-0.28	-1.22	-0.13	0.04	0.05
	TDLF	-0.58	-0.17	0.00	-0.43	-1.42	-0.26	0.04	-0.35
G2	NLF	-0.25	0.09	0.04	-0.10	-0.95	0.05	0.06	0.58
	SDLF	-0.44	-0.05	0.02	-0.12	-1.22	-0.13	0.04	0.29
	TDLF	-0.58	-0.17	0.01	-0.24	-1.42	-0.26	0.04	-0.09
G3	NLF	-0.25	0.09	0.03	0.03	-0.95	0.04	0.05	0.81
	SDLF	-0.44	-0.06	0.02	0.04	-1.23	-0.13	0.04	0.54
	TDLF	-0.58	-0.16	0.02	-0.05	-1.42	-0.26	0.04	0.18
G4	NLF	-0.25	0.09	0.03	0.16	-0.95	0.04	0.05	1.04
	SDLF	-0.44	-0.06	0.02	0.19	-1.23	-0.13	0.04	0.79
	TDLF	-0.58	-0.16	0.02	0.13	-1.42	-0.26	0.05	0.46

Appendix E-5. EICCR11 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge EICCR11 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table E-5-1. Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
12	12-1	NLF	-0.4	0.0	0.4	-0.4	0.0	0.4
		SDLF	51.0	45.4	68.3	59.5	-46.3	75.4
		TDLF	84.0	54.8	100.	78.8	-55.9	96.7
	12-2	NLF	-1.3	-1.0	1.7	-0.8	1.1	1.3
		SDLF	50.9	44.5	67.6	67.5	-45.8	81.6
		TDLF	85.6	49.3	98.8	84.6	-50.4	98.5
	12-3	NLF	-1.3	-1.1	1.7	-0.8	1.1	1.3
		SDLF	46.6	40.4	61.7	67.7	-41.2	79.3
		TDLF	80.1	46.0	92.3	78.5	-45.5	90.7
	12-4	NLF	0.3	0.4	0.5	0.2	-0.4	0.5
		SDLF	37.9	35.9	52.2	64.6	-36.1	74.0
		TDLF	69.2	44.1	82.0	67.8	-42.2	79.9
	12-5	NLF	0.6	0.9	1.1	0.9	-0.9	1.3
		SDLF	26.0	30.6	40.2	57.8	-30.2	65.2
		TDLF	57.6	41.8	71.1	56.2	-39.0	68.4
	12-6	NLF	0.9	0.5	1.0	0.9	-0.5	1.0
		SDLF	15.2	24.0	28.4	51.3	-23.0	56.2
		TDLF	47.1	36.8	59.8	45.6	-33.8	56.7

Table E-5-1(Continued). Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
15	15-1	NLF	-2.0	-4.1	4.6	-1.9	4.0	4.4
		SDLF	37.4	29.4	47.5	46.8	-28.5	54.8
		TDLF	46.4	20.9	50.9	44.3	-19.8	48.5
	15-2	NLF	-4.3	-4.1	5.9	-3.7	4.0	5.5
		SDLF	29.4	31.8	43.3	44.4	-30.7	54.0
		TDLF	43.8	25.1	50.5	42.4	-23.5	48.5
	15-3	NLF	-4.1	-3.1	5.1	-4.0	3.2	5.1
		SDLF	23.0	31.7	39.1	43.5	-30.6	53.1
		TDLF	42.8	28.2	51.2	41.7	-26.1	49.2
	15-4	NLF	-4.7	-2.4	5.2	-4.5	2.4	5.1
		SDLF	16.2	29.7	33.9	42.1	-28.6	50.9
		TDLF	40.6	30.2	50.5	39.7	-27.6	48.4
	15-5	NLF	-5.2	-1.3	5.3	-4.4	1.3	4.6
		SDLF	9.5	26.8	28.4	40.4	-25.7	47.8
		TDLF	37.6	31.2	48.9	36.8	-28.2	46.4
	15-6	NLF	-4.4	0.0	4.4	-4.3	0.1	4.3
		SDLF	3.4	23.4	23.7	38.7	-22.4	44.8
		TDLF	35.3	31.2	47.1	34.9	-28.2	44.9

Table E-5-1(Continued). Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
16	16-1	NLF	17.5	33.2	37.5	17.1	-33.4	37.5
		SDLF	50.0	31.3	59.0	57.1	-35.3	67.2
		TDLF	68.4	15.4	70.1	61.2	-21.5	64.8
	16-2	NLF	15.6	30.0	33.8	16.1	-30.2	34.2
		SDLF	45.9	24.6	52.1	62.4	-29.4	69.0
		TDLF	67.6	9.3	68.3	66.7	-16.3	68.7
	16-3	NLF	12.4	23.2	26.3	12.1	-23.3	26.2
		SDLF	38.2	17.9	42.2	59.7	-22.8	63.9
		TDLF	62.9	5.2	63.1	61.9	-12.0	63.0
	16-4	NLF	10.0	18.3	20.8	9.7	-18.5	20.8
		SDLF	30.4	16.0	34.4	57.0	-18.3	59.8
		TDLF	57.7	6.9	58.1	55.9	-9.3	56.6
	16-5	NLF	7.2	13.5	15.3	7.6	-14.0	15.9
		SDLF	21.0	16.2	26.6	53.4	-18.4	56.4
		TDLF	50.2	11.4	51.4	48.6	-12.9	50.3
	16-6	NLF	3.8	6.8	7.8	3.6	-6.6	7.5
		SDLF	10.8	17.7	20.8	45.5	-15.0	48.0
		TDLF	41.6	19.6	46.0	36.8	-14.1	39.4

Table E-5-2: Erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
12	NLF	12-2
	SDLF	12-2
	TDLF	12-2
15	NLF	15-2
	SDLF	15-1
	TDLF	15-3
16	NLF	16-1
	SDLF	16-2
	TDLF	16-2

Table E-5-3. Erection critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
12	A	NLF	-1.4	-0.5	1.5	NA	NA	NA
		SDLF	83.1	23.5	86.3	NA	NA	NA
		TDLF	127.	24.2	130	NA	NA	NA
	B	NLF	-1.3	-1.0	1.7	-0.8	1.1	1.3
		SDLF	50.9	44.5	67.6	67.5	-45.8	81.6
		TDLF	85.6	49.3	98.8	84.6	-50.4	98.5
15	A	NLF	-5.3	-2.4	5.8	NA	NA	NA
		SDLF	56.6	16.4	58.9	NA	NA	NA
		TDLF	51.6	11.1	52.8	NA	NA	NA
	B	NLF	-4.3	-4.1	5.9	-3.7	4.0	5.5
		SDLF	37.4	29.4	47.5	46.8	-28.5	54.8
		TDLF	42.8	28.2	51.2	41.7	-26.1	49.2
16	A	NLF	9.1	6.7	11.3	NA	NA	NA
		SDLF	73.5	-0.7	73.5	NA	NA	NA
		TDLF	105.	-6.6	106	NA	NA	NA
	B	NLF	17.5	33.2	37.5	17.1	-33.4	37.5
		SDLF	45.9	24.6	52.1	62.4	-29.4	69.0
		TDLF	67.6	9.3	68.3	66.7	-16.3	68.7

Table E-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number								
				1	2	3	4	5	6	7	8	9
12	A	G1	NLF	111.8	72.2	82.1	26.6					
			SDLF	295.0	0.0	25.1	181.5					
			TDLF	382.0	0.0	0.0	190.2					
		G2	NLF	81.6	19.0	50.0	73.5	76.5	95.2	71.8	68.7	24.7
			SDLF	88.2	46.6	100.5	129.5	150.5	0.0	0.0	0.0	117.8
			TDLF	67.1	49.9	183.0	139.4	0.0	0.0	0.0	0.0	127.3
		G3	NLF	67.1	16.6	56.8	80.4	70.2	52.2	61.8	24.1	
			SDLF	128.6	2.7	0.0	0.0	0.0	0.0	0.0	88.9	
			TDLF	123.4	0.0	0.0	0.0	0.0	0.0	0.0	91.5	
		G4	NLF	42.4	28.5	37.2	13.8					
			SDLF	0.0	0.0	0.0	50.1					
			TDLF	0.0	0.0	0.0	51.1					
12	B	G1	NLF	111.8	72.2	82.1	26.6					
			SDLF	308.5	0.0	20.0	182.2					
			TDLF	388.1	0.0	0.0	187.9					
		G2	NLF	81.6	19.0	50.0	74.0	76.4	95.1	71.9	68.7	24.7
			SDLF	87.4	45.1	99.5	145.0	125.9	0.0	0.0	0.0	118.5
			TDLF	63.2	48.0	192.2	130.4	0.0	0.0	0.0	0.0	126.8
		G3	NLF	67.1	16.6	56.4	82.1	69.9	52.3	61.8	24.1	
			SDLF	133.7	0.0	0.0	0.0	0.0	0.0	0.0	89.6	
			TDLF	125.5	0.0	0.0	0.0	0.0	0.0	0.0	91.9	
		G4	NLF	42.3	28.6	37.2	13.8					
			SDLF	0.0	0.0	0.0	50.8					
			TDLF	0.0	0.0	0.0	52.2					

Table E-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
15	A	G1	NLF	174.1	212.3	21.7	79.4	27.6		
			SDLF	189.9	490.3	0.0	0.0	170.0		
			TDLF	197.7	469.5	0.0	0.0	185.0		
		G2	NLF	206.9	218.7	0.0	68.2	25.4		
			SDLF	303.1	0.0	0.0	0.0	121.0		
			TDLF	325.8	0.0	0.0	0.0	129.6		
		G3	NLF	173.4	145.0	9.9	61.1	23.0		
			SDLF	240.0	0.0	0.0	0.0	94.3		
			TDLF	222.2	0.0	0.0	0.0	89.8		
		G4	NLF	110.2	42.3	49.7	64.6	30.8	40.0	17.9
			SDLF	112.8	0.0	0.0	0.0	0.0	0.0	78.2
			TDLF	113.1	0.0	0.0	0.0	0.0	0.0	71.9
	B	G1	NLF	174.1	212.5	21.6	79.4	27.6		
			SDLF	190.3	492.0	0.0	0.0	168.8		
			TDLF	197.8	470.7	0.0	0.0	184.4		
		G2	NLF	206.9	218.4	0.0	68.3	25.4		
			SDLF	303.2	0.0	0.0	0.0	120.7		
			TDLF	325.6	0.0	0.0	0.0	129.5		
		G3	NLF	173.1	144.3	10.1	61.1	23.0		
			SDLF	236.6	0.0	0.0	0.0	94.6		
			TDLF	221.8	0.0	0.0	0.0	90.1		
		G4	NLF	109.3	44.8	51.6	63.0	31.0	40.0	17.9
			SDLF	116.1	0.0	0.0	0.0	0.0	0.0	78.6
			TDLF	114.2	0.0	0.0	0.0	0.0	0.0	72.2

Table E-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
16	A	G1	NLF	186.5	115.0	97.7	114.5	90.5	88.0	32.2
			SDLF	264.0	160.4	215.0	85.9	79.2	189.7	169.3
			TDLF	299.0	153.9	257.9	14.9	35.0	200.0	232.0
		G2	NLF	180.4	177.7	29.3	70.7	25.2		
			SDLF	235.7	0.0	0.0	0.0	109.2		
			TDLF	252.5	0.0	0.0	0.0	127.4		
		G3	NLF	182.7	179.4	0.0	62.5	24.3		
			SDLF	200.5	0.0	0.0	0.0	90.3		
			TDLF	185.0	0.0	0.0	0.0	80.8		
		G4	NLF	148.4	159.3	0.0	40.3	20.2		
			SDLF	155.8	0.0	0.0	0.0	72.3		
			TDLF	141.4	0.0	0.0	0.0	47.4		
	B	G1	NLF	182.8	122.4	97.9	110.3	91.4	88.2	32.2
			SDLF	262.6	162.8	214.9	83.8	80.5	190.1	169.2
			TDLF	299.2	155.3	255.8	15.8	35.4	200.1	232.0
		G2	NLF	181.6	174.2	33.1	70.7	25.2		
			SDLF	237.3	0.0	0.0	0.0	109.0		
			TDLF	253.3	0.0	0.0	0.0	127.3		
		G3	NLF	182.2	177.3	0.0	62.4	24.3		
			SDLF	200.5	0.0	0.0	0.0	90.2		
			TDLF	184.9	0.0	0.0	0.0	80.8		
		G4	NLF	149.0	160.4	0.0	40.2	20.2		
			SDLF	155.3	0.0	0.0	0.0	72.4		
			TDLF	141.1	0.0	0.0	0.0	47.4		

Appendix F-1. NICCR12 Bridge Description

The key characteristics of NICCR12 are as follows:

- Span length along the centerline of the bridge, L_s = 350,350,280 ft.
- Width between the fascia girders, w_g = 74 ft.
- Radius of curvature to the centerline of the bridge, R =909 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 4.7,4.7,3.8
- Subtended angle between the supports, L_s/R = 0.31,0.39
- Number of girders in the completed bridge cross-section, n_g =9

This appendix presents the bridge description of the bridge NICCR12 in its final condition as well as during erection. The following figures and tables are provided:

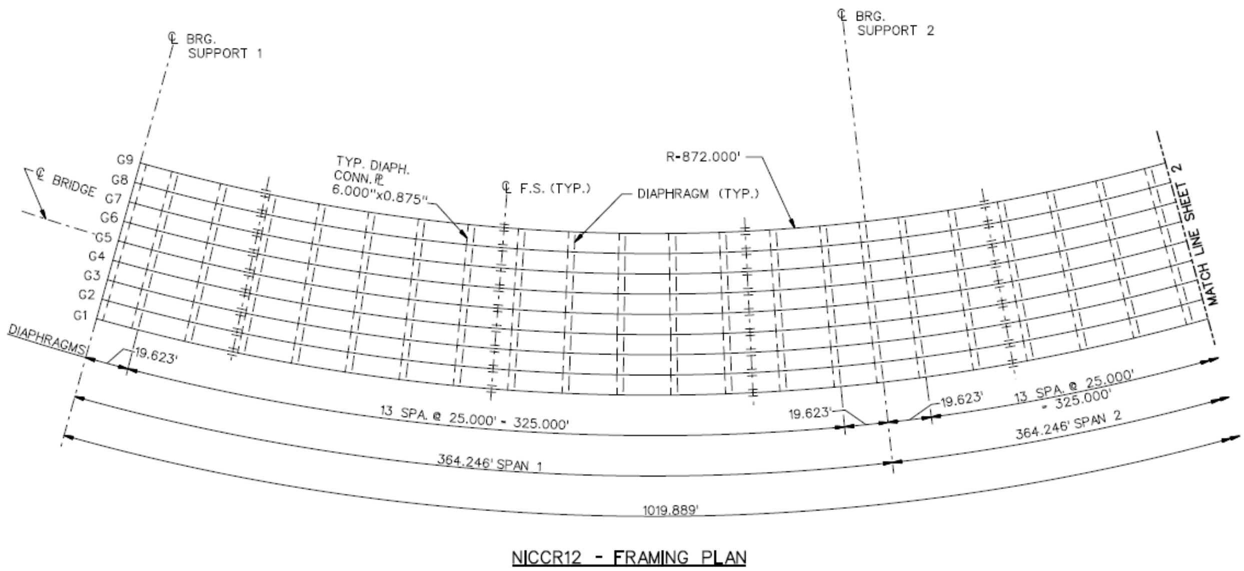


Figure F-1-1. Framing plan.

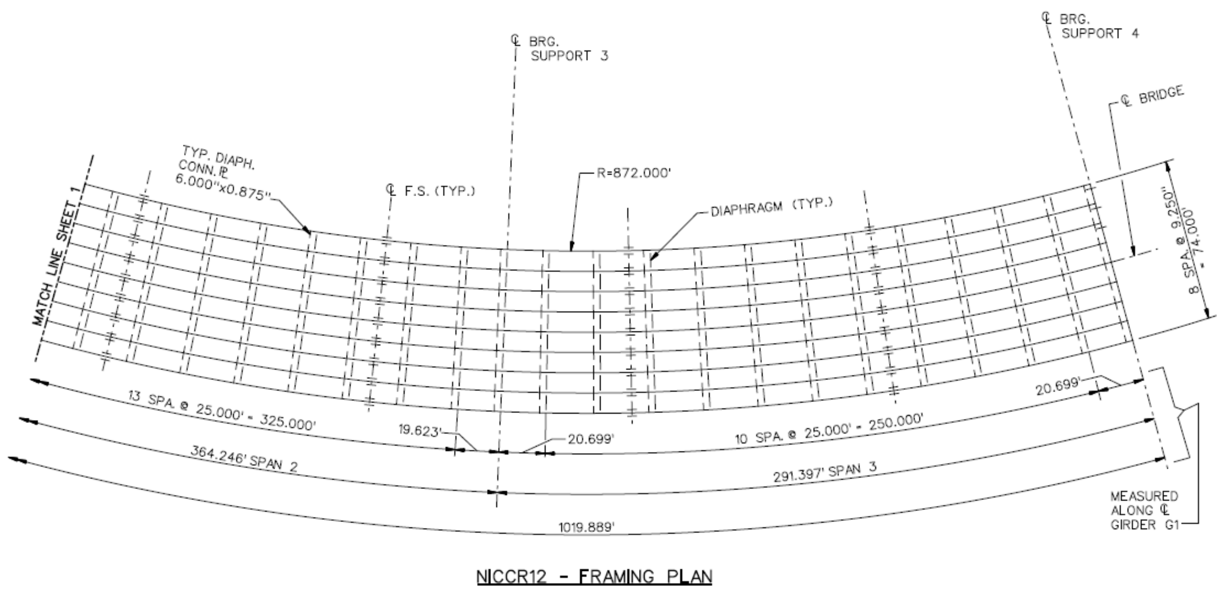


Figure F-1-1(Continued). Framing plan.

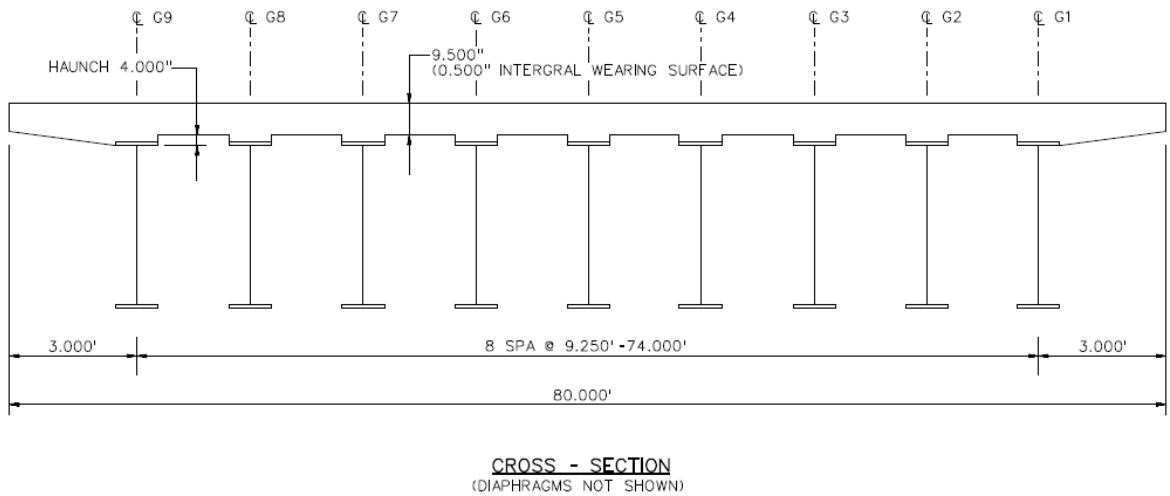


Figure F-1-2. Bridge cross-section.

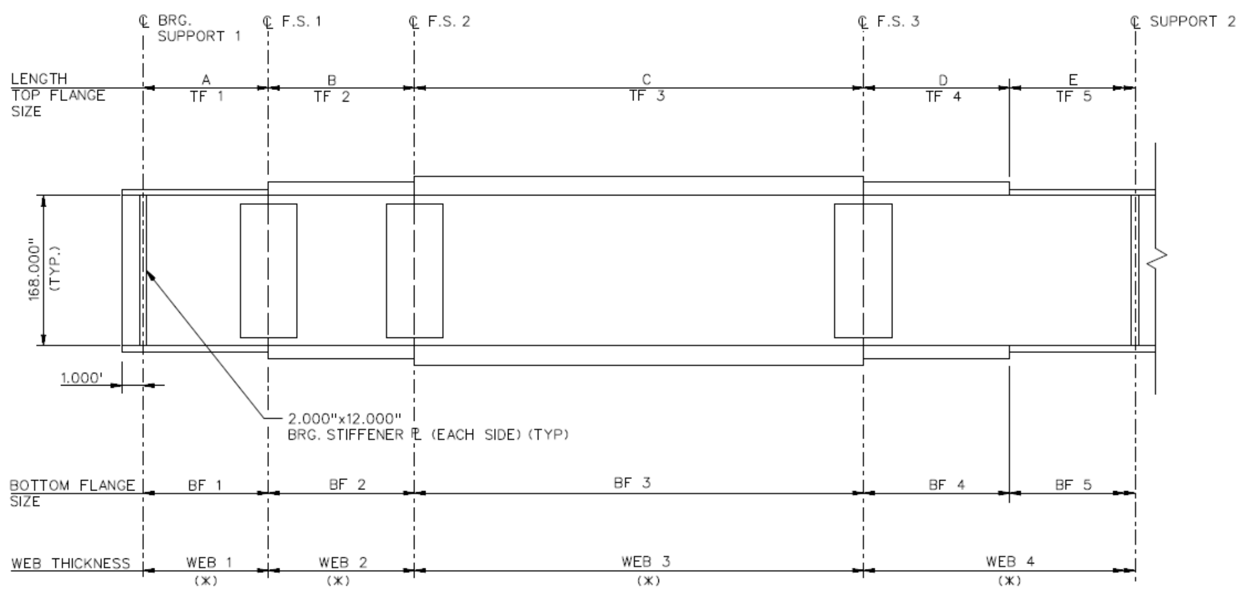


Figure F-1-3. Girder elevations

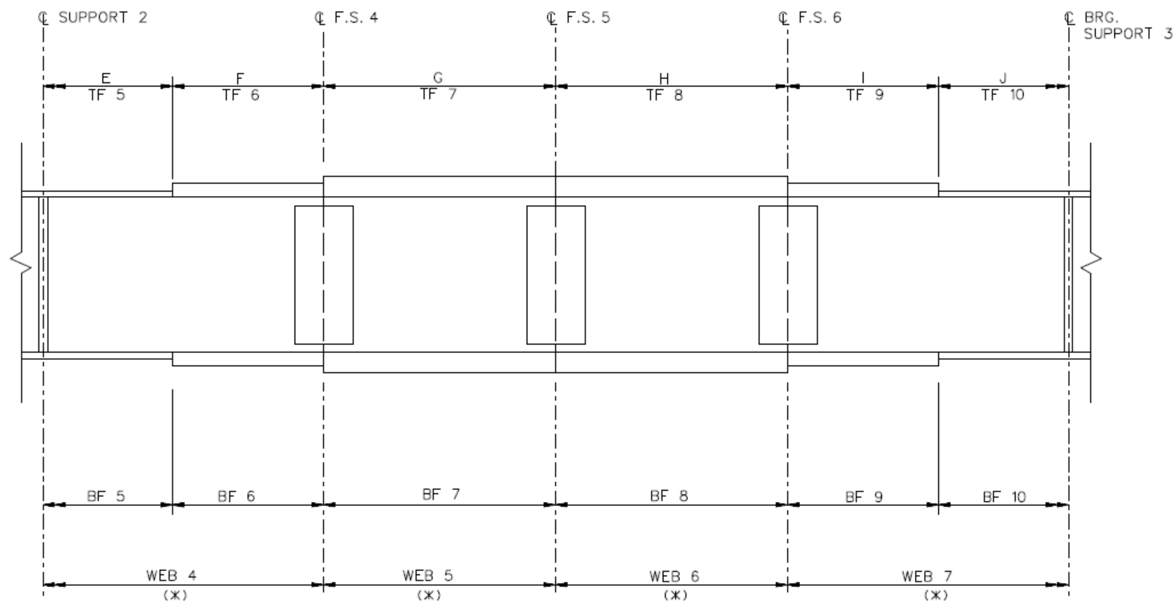


Figure F-1-3(Continued). Girder elevations

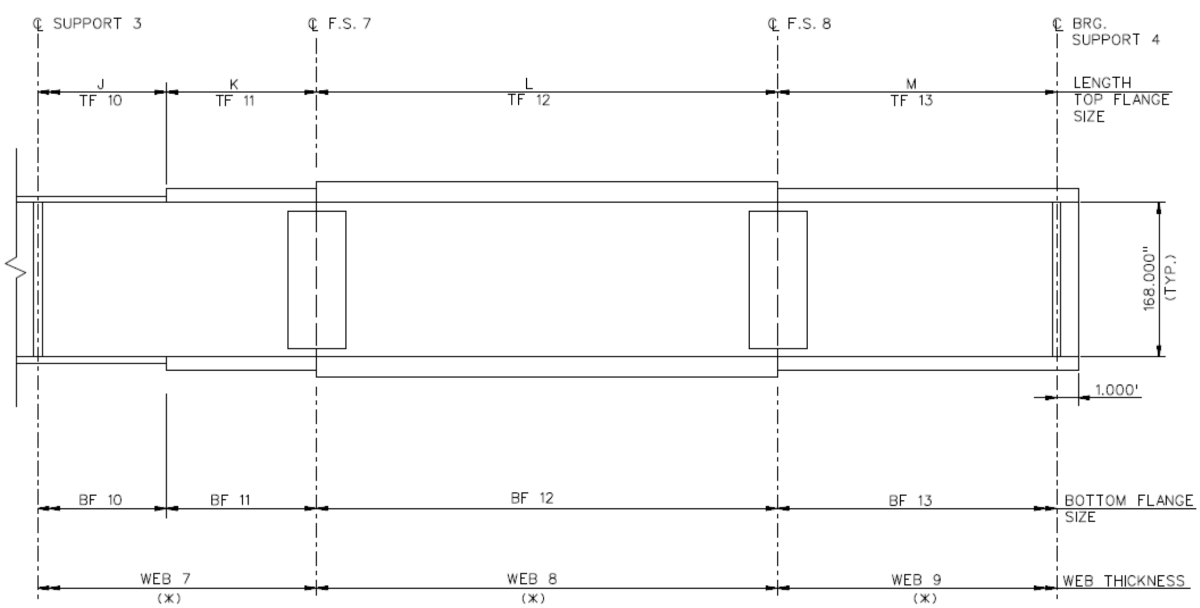


Figure F-1-3(Continued). Girder elevations

LENGTH	GIRDER PLATE LENGTHS *								
	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	64.246	63.618	62.990	62.362	61.734	61.105	60.477	59.849	59.221
B	120.000	118.827	117.653	116.480	115.307	114.133	112.960	111.786	110.613
C	120.000	118.827	117.653	116.480	115.307	114.133	112.960	111.786	110.613
D	30.000	29.707	29.413	29.120	28.827	28.533	28.240	27.947	27.653
E	60.000	59.413	58.827	58.240	57.653	57.067	56.480	55.893	55.307

* ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS **					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	36.000	2.250	32.000	1.750	30.000	1.500
TF2	36.000	2.500	32.000	1.750	30.000	1.500
TF3	36.000	2.250	32.000	1.750	30.000	1.500
TF4	42.000	2.250	38.000	1.750	36.000	1.500
TF5	42.000	2.750	38.000	2.250	36.000	2.000

** ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS **					
BOTTOM FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
BF1	36.000	2.500	32.000	2.000	30.000	1.750
BF2	36.000	2.750	32.000	2.000	30.000	1.750
BF3	36.000	2.500	32.000	2.000	30.000	1.750
BF4	42.000	2.500	38.000	2.000	36.000	1.750
BF5	42.000	3.000	38.000	2.500	36.000	2.250

Figure F-1-4. Cross-section dimensions.

	GIRDER PLATE LENGTHS ⚹								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
F	30.000	29.707	29.413	29.120	28.827	28.533	28.240	27.947	27.653
G	122.123	120.929	119.735	118.541	117.347	116.153	114.958	113.764	112.570
H	122.123	120.929	119.735	118.541	117.347	116.153	114.958	113.764	112.570
I	30.000	29.707	29.413	29.120	28.827	28.533	28.240	27.947	27.653
J	60.000	59.413	58.827	58.240	57.653	57.067	56.480	55.893	55.307

⚹ ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS ⚹⚹					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF6	42.000	2.250	38.000	1.750	36.000	1.500
TF7	36.000	1.500	32.000	1.500	30.000	1.500
TF8	36.000	1.500	32.000	1.500	30.000	1.500
TF9	36.000	1.500	32.000	1.500	30.000	1.500
TF10	36.000	2.250	32.000	2.000	30.000	1.750

⚹⚹ ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS ⚹⚹					
BOTTOM FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
BF6	42.000	2.500	38.000	2.000	36.000	1.750
BF7	36.000	1.750	32.000	1.500	30.000	1.500
BF8	36.000	1.750	32.000	1.500	30.000	1.500
BF9	36.000	1.750	32.000	1.500	30.000	1.500
BF10	36.000	2.500	32.000	2.250	30.000	2.000

Figure F-1-4(Continued). Cross-section dimensions.

	GIRDER PLATE LENGTHS *								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
K	30.000	29.707	29.413	29.120	28.827	28.533	28.240	27.947	27.653
L	120.000	118.827	117.653	116.480	115.307	114.133	112.960	111.786	110.613
M	111.397	110.308	109.219	108.129	107.040	105.951	104.862	103.772	102.683

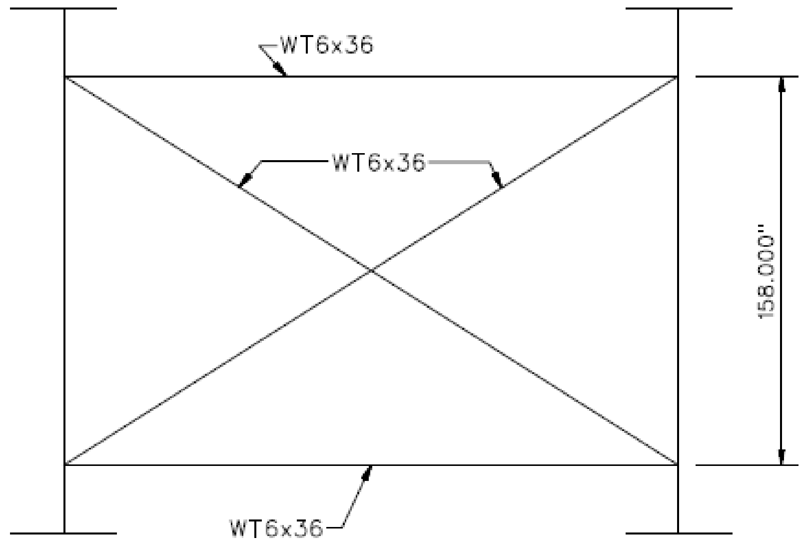
* ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS **					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF11	36.000	1.500	32.000	1.500	30.000	1.500
TF12	36.000	1.500	32.000	1.500	30.000	1.500
TF13	30.000	1.500	32.000	1.500	30.000	1.500

** ALL DIMENSIONS ARE IN INCHES.

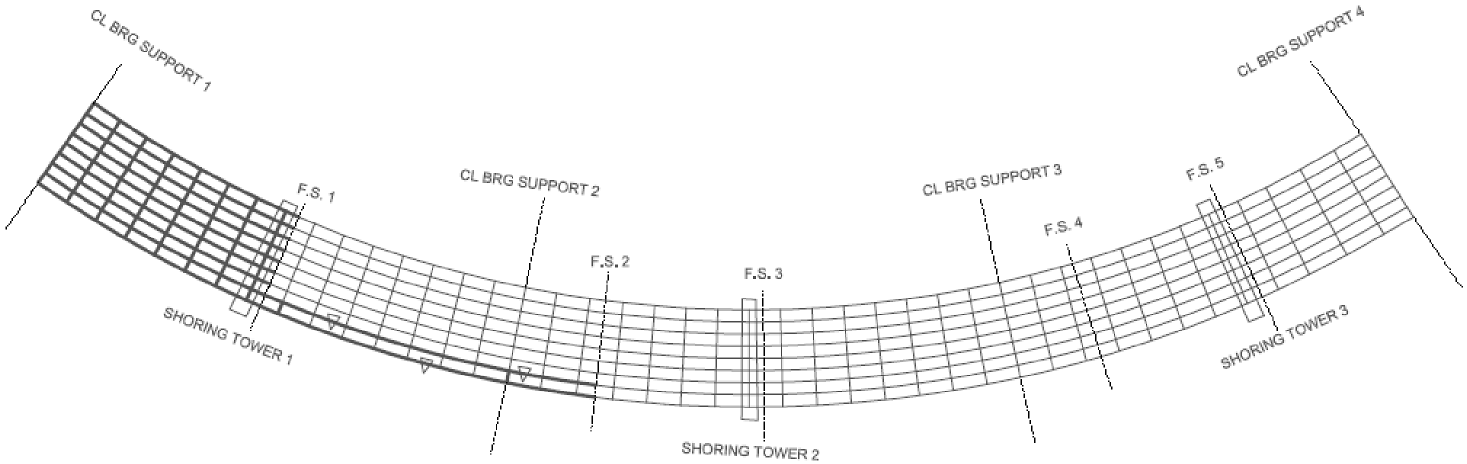
	GIRDER FLANGE DIMENSIONS **					
BOTTOM FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
BF11	36.000	1.750	32.000	1.500	30.000	1.500
BF12	36.000	1.750	32.000	1.500	30.000	1.500
BF13	36.000	1.750	32.000	1.500	30.000	1.500

Figure F-1-4(Continued). Cross-section dimensions.

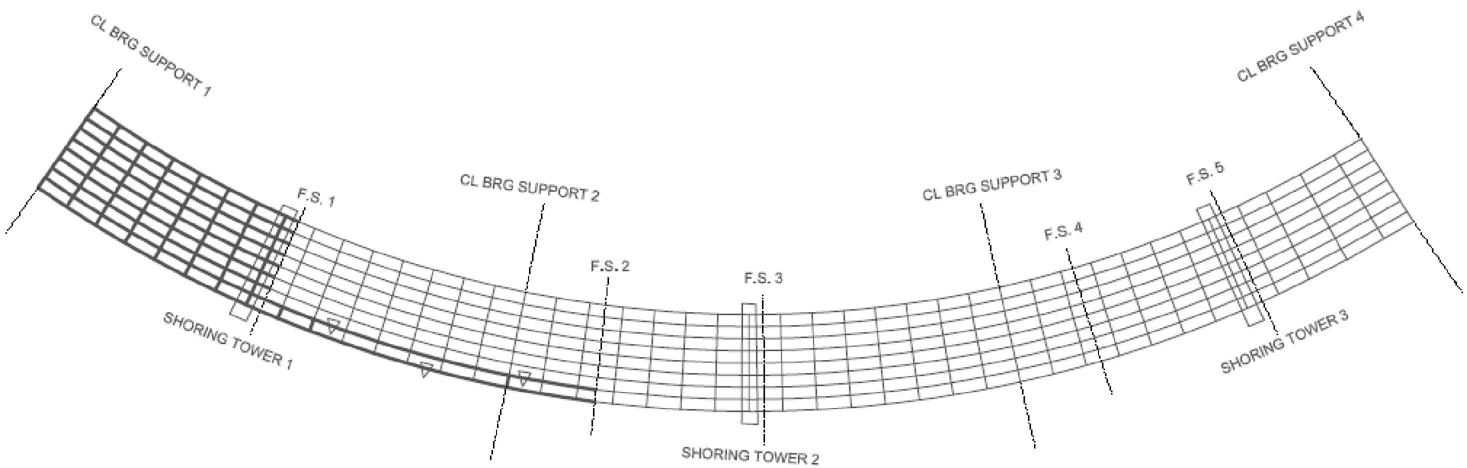


TYPICAL SUPPORT DIAPHRAGMS AND INTERMEDIATE DIAPHRAGMS

Figure F-1-4. Cross-frame details



STAGE 11-1



STAGE 11-2

Figure F-1-6. Erection scheme.

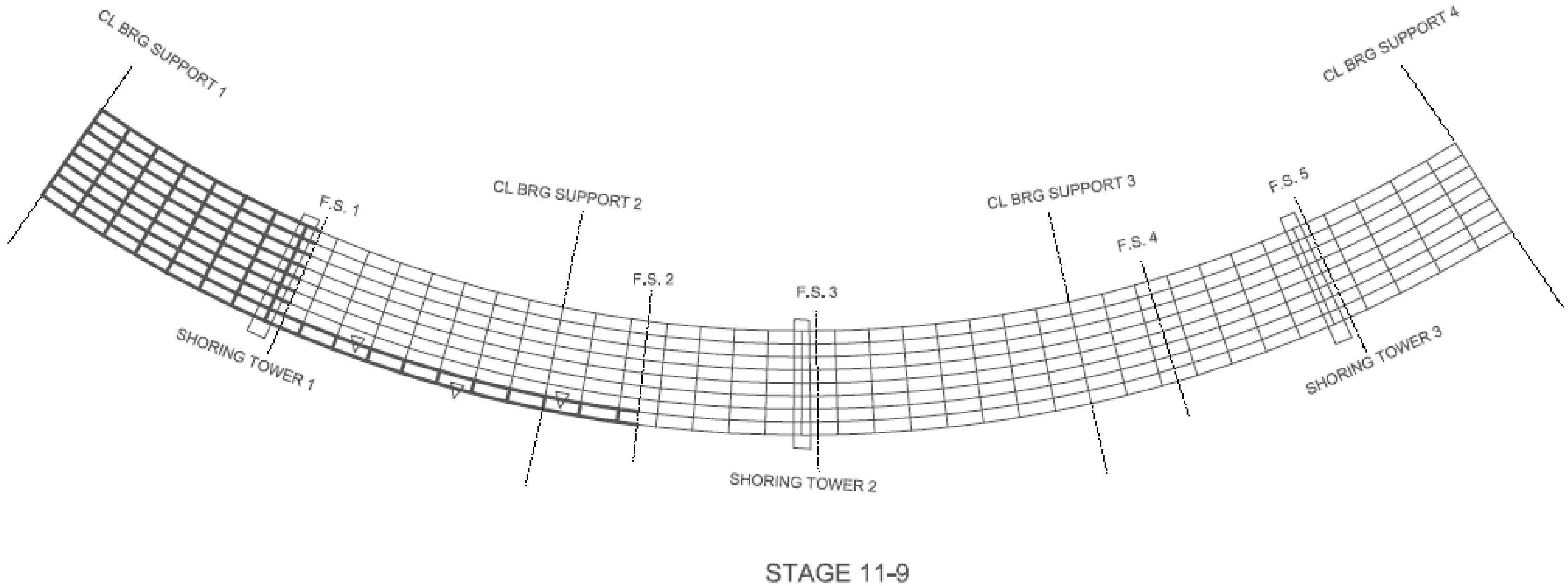
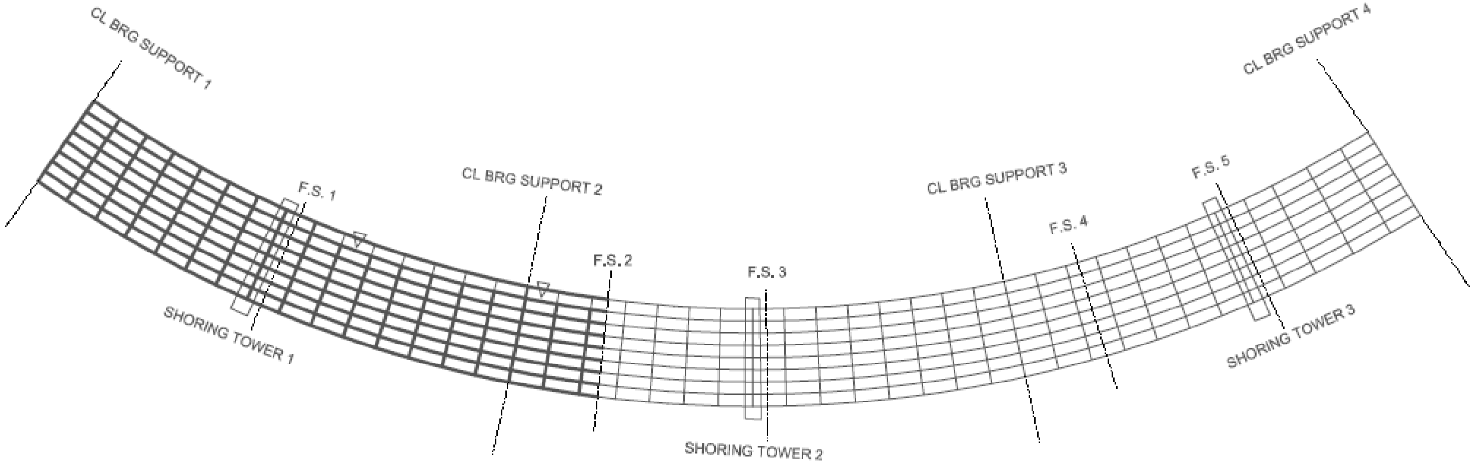
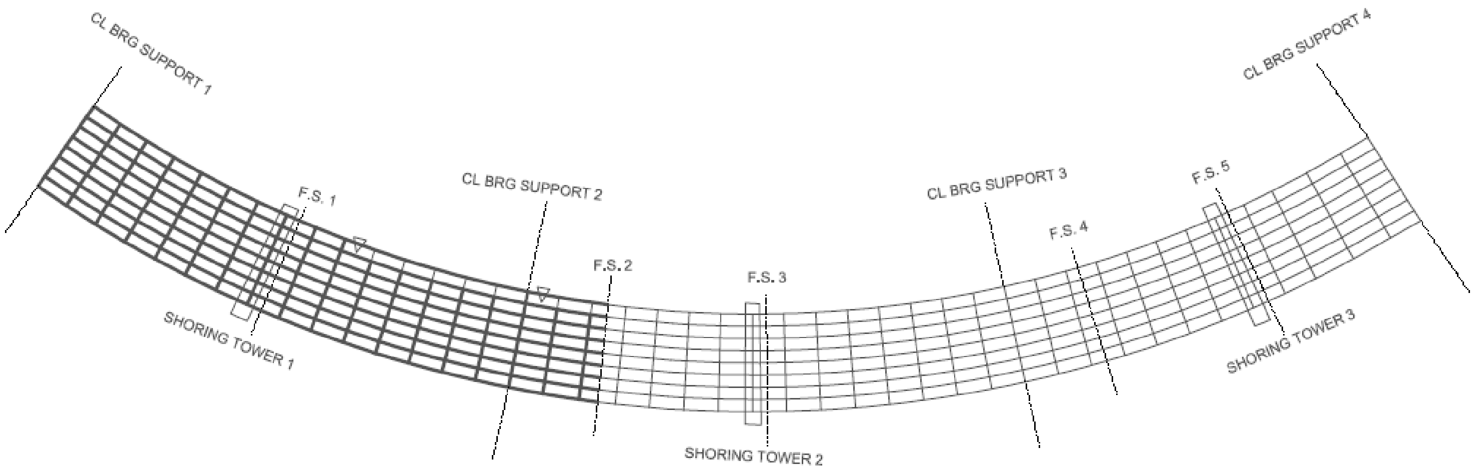


Figure F-1-6(Continued). Erection scheme.



STAGE 18-1



STAGE 18-2

Figure F-1-6(Continued). Erection scheme.

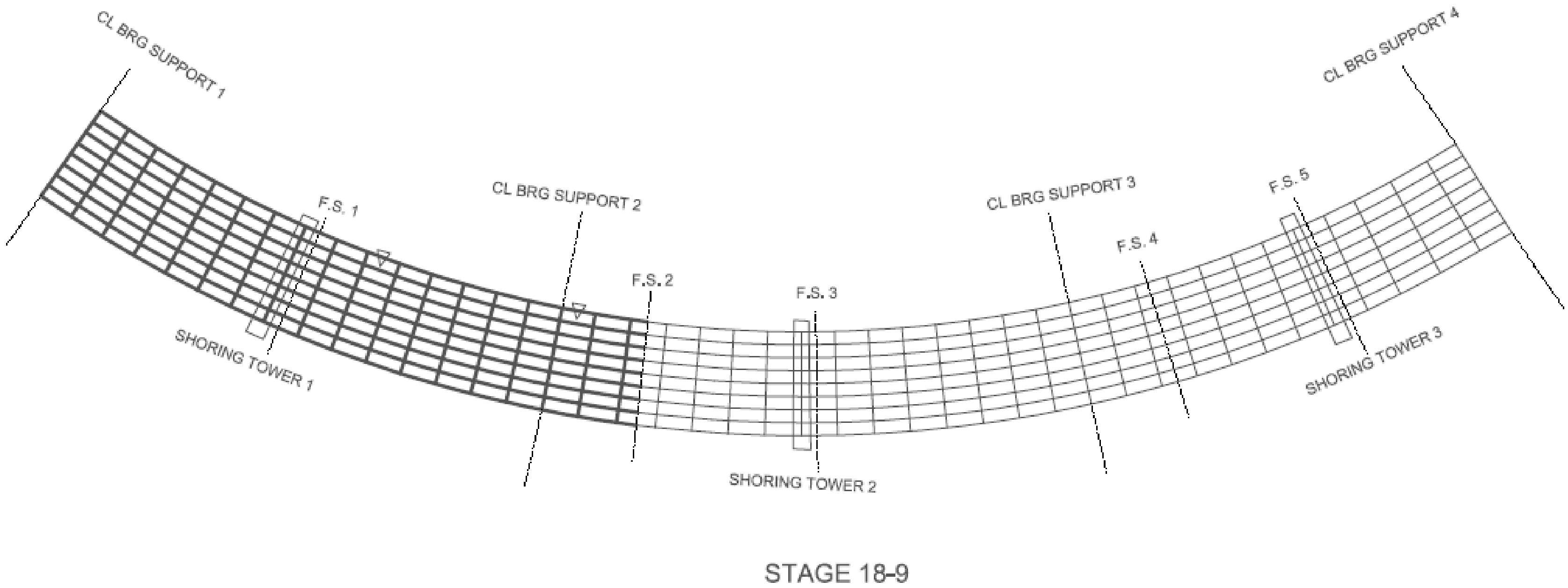


Figure F-1-6(Continued). Erection scheme.

Table F-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

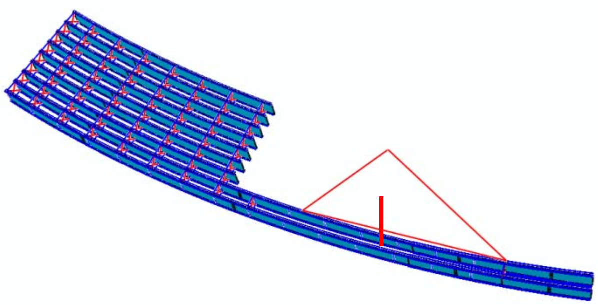
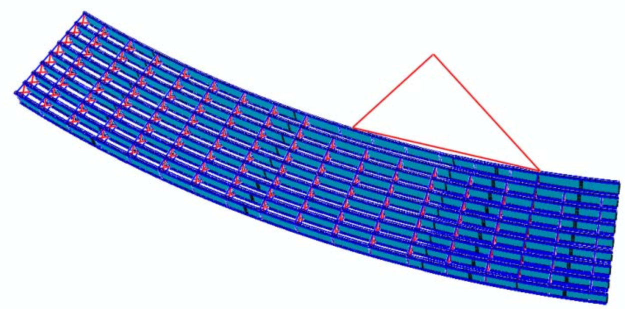
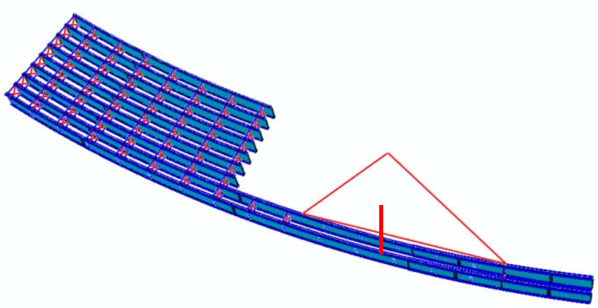
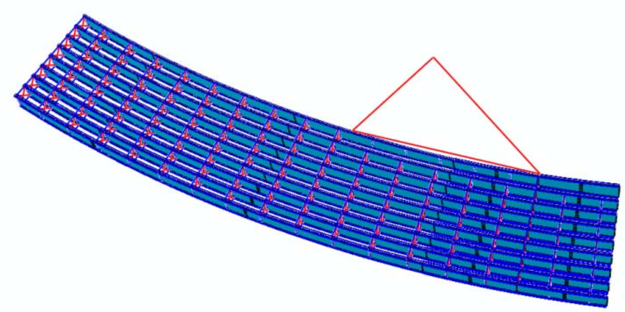
Sub-Stage	Stage	
	11	18
1		
2		

Table F-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

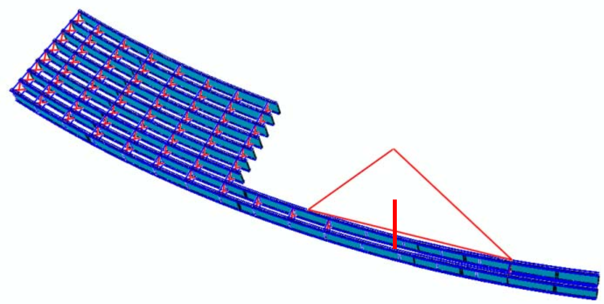
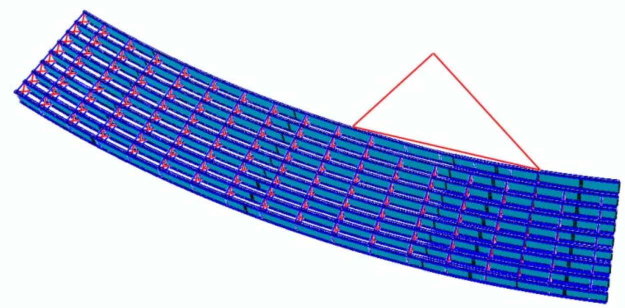
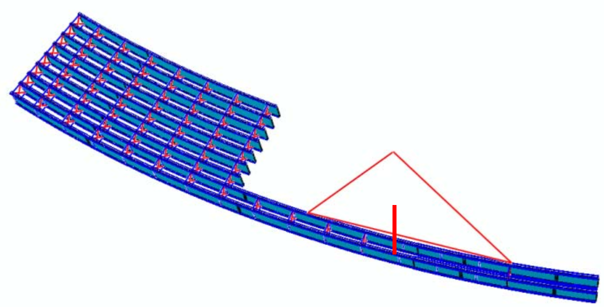
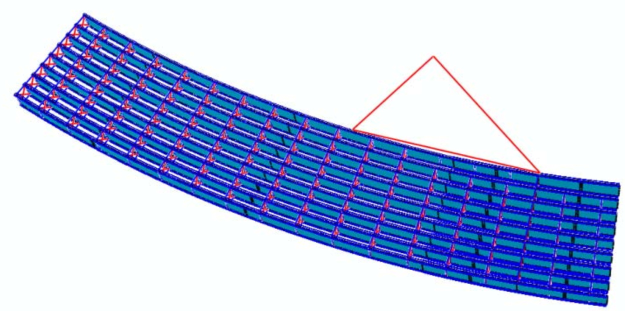
3		
4		

Table F-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

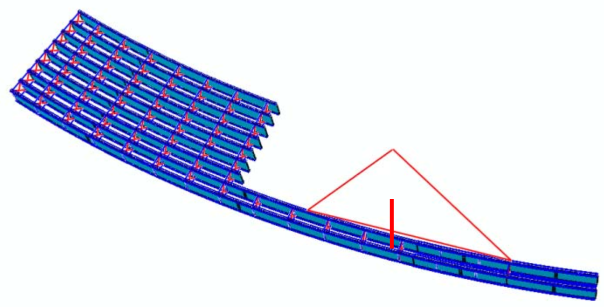
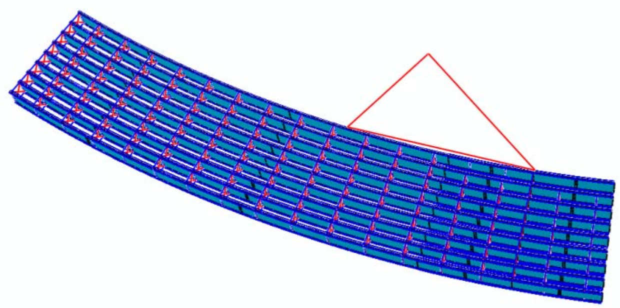
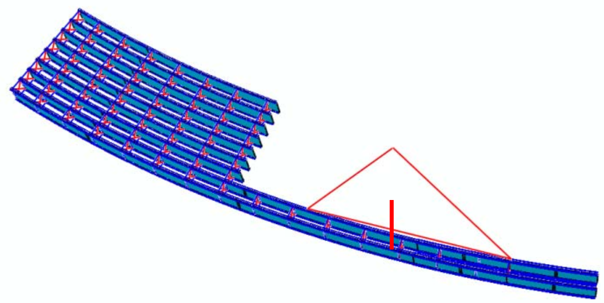
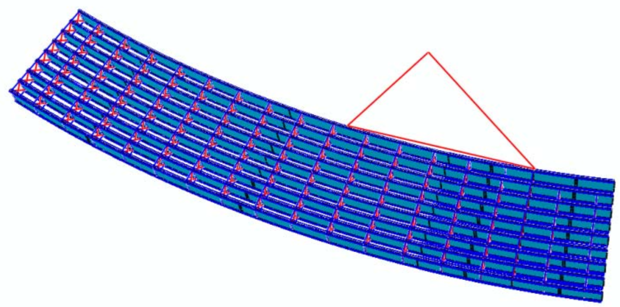
5		
6		

Table F-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

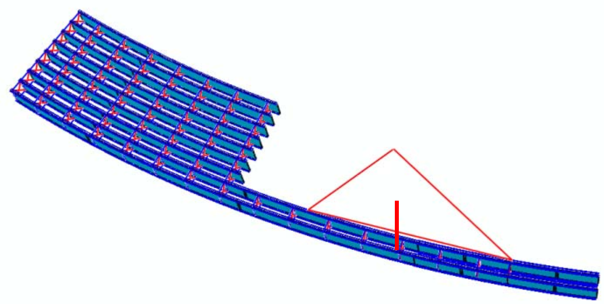
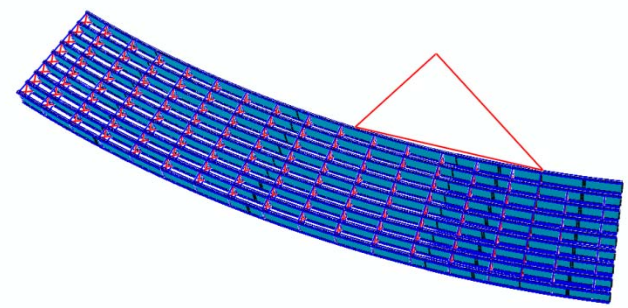
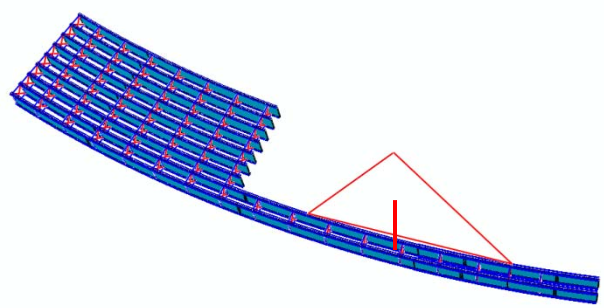
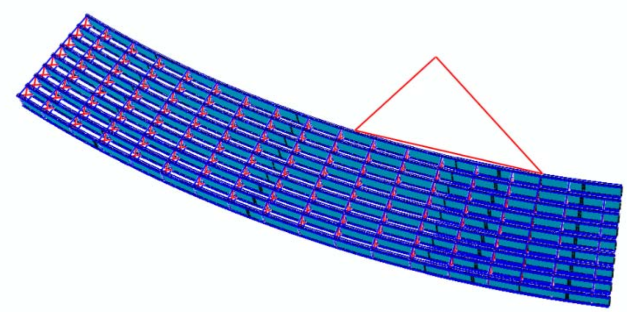
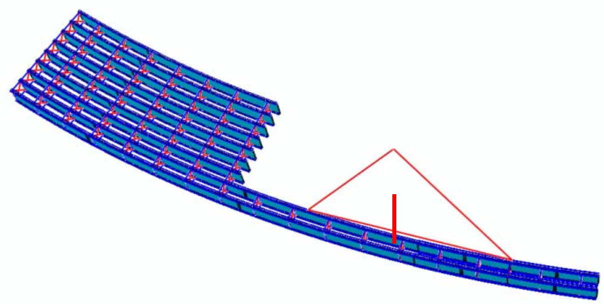
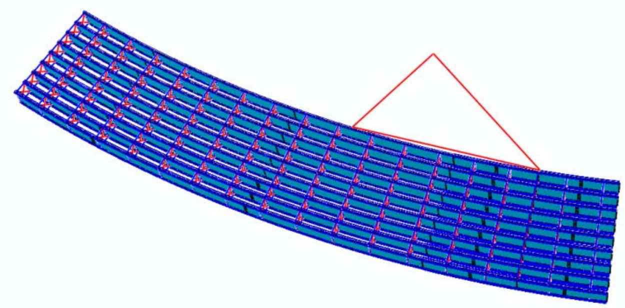
7		
8		

Table F-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

9		

Appendix F-2. NICCR12 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NICCR12 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table F-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	9.5	18.0
	SDLF	8.5	16.8
	TDLF	7.8	16.0
G2	NLF	8.5	16.3
	SDLF	7.5	15.1
	TDLF	6.7	14.2
G3	NLF	7.6	14.6
	SDLF	6.5	13.4
	TDLF	5.7	12.5
G4	NLF	6.7	13.0
	SDLF	5.6	11.8
	TDLF	4.8	10.9
G5	NLF	5.8	11.5
	SDLF	4.7	10.3
	TDLF	3.9	9.4
G6	NLF	5.0	9.9
	SDLF	3.9	8.8
	TDLF	3.1	8.0
G7	NLF	4.1	8.4
	SDLF	3.1	7.4
	TDLF	2.3	6.6
G8	NLF	3.3	6.9
	SDLF	2.3	6.0
	TDLF	2.3	5.2
G9	NLF	2.5	5.4
	SDLF	2.1	4.5
	TDLF	2.5	4.2
All Girders	NLF	9.5	18.0
	SDLF	8.5	16.8
	TDLF	7.8	16.0

Table F-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.52	2.75
	SDLF	0.27	1.44
	TDLF	0.74	0.41
G2	NLF	1.49	2.68
	SDLF	0.24	1.38
	TDLF	0.77	0.35
G3	NLF	1.44	2.60
	SDLF	0.19	1.29
	TDLF	0.82	0.26
G4	NLF	1.40	2.51
	SDLF	0.14	1.21
	TDLF	0.87	0.18
G5	NLF	1.36	2.44
	SDLF	0.11	1.14
	TDLF	0.90	0.11
G6	NLF	1.33	2.39
	SDLF	0.08	1.09
	TDLF	0.93	0.09
G7	NLF	1.32	2.37
	SDLF	0.06	1.07
	TDLF	0.94	0.12
G8	NLF	1.31	2.36
	SDLF	0.06	1.06
	TDLF	0.94	0.14
G9	NLF	1.31	2.36
	SDLF	0.05	1.06
	TDLF	0.94	0.15
All Girders	NLF	1.52	2.75
	SDLF	0.27	1.44
	TDLF	0.94	0.41

Table F-2-3. Summary of girder maximum stresses (ksi).

Girder	Detailing Method	fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
		SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	11.5	22.1	12.0	23.1	1.9	5.0	1.9	4.8
	SDLF	11.8	22.3	12.5	23.5	1.6	3.9	1.6	3.5
	TDLF	12.1	22.4	12.9	23.8	1.3	3.0	2.4	3.3
G2	NLF	10.4	20.1	10.9	21.2	1.8	4.7	1.8	4.6
	SDLF	10.5	20.1	11.1	21.3	1.4	3.6	1.4	3.2
	TDLF	10.6	20.1	11.3	21.4	1.1	2.7	2.2	2.9
G3	NLF	9.9	19.8	9.9	19.7	1.7	4.5	1.7	4.5
	SDLF	9.8	19.6	9.9	19.4	1.3	3.4	1.3	3.0
	TDLF	9.7	19.5	10.0	19.3	1.0	2.5	2.0	2.6
G4	NLF	9.8	19.8	9.7	19.5	1.8	4.6	1.7	4.5
	SDLF	9.6	19.5	9.3	19.1	1.4	3.5	1.5	3.2
	TDLF	9.4	19.3	9.1	18.9	1.1	2.7	2.1	3.1
G5	NLF	9.3	19.0	9.2	18.7	1.6	4.3	1.6	4.3
	SDLF	9.0	18.6	8.8	18.3	1.2	3.3	1.3	3.0
	TDLF	8.8	18.4	8.5	18.0	1.1	2.4	1.9	2.7
G6	NLF	8.8	18.2	8.7	18.0	1.4	4.1	1.5	4.1
	SDLF	8.4	17.8	8.2	17.5	1.1	3.0	1.1	2.8
	TDLF	8.2	17.5	7.9	17.1	1.0	2.2	1.7	2.3
G7	NLF	8.4	17.6	8.3	17.4	1.3	3.9	1.4	3.9
	SDLF	7.9	17.1	7.8	16.8	1.0	2.9	1.0	2.7
	TDLF	7.6	16.8	7.3	16.5	0.8	2.0	1.6	2.3
G8	NLF	8.0	16.9	7.8	16.7	1.1	3.5	1.3	3.7
	SDLF	7.4	16.4	7.2	16.1	0.8	2.5	0.7	2.4
	TDLF	7.4	16.1	7.0	15.7	0.8	1.7	1.4	1.8
G9	NLF	7.7	16.6	7.4	16.1	0.9	3.1	1.1	3.4
	SDLF	7.5	16.2	7.0	15.5	0.7	2.1	0.8	2.1
	TDLF	7.7	16.1	7.2	15.2	0.8	1.5	1.1	1.5
All Girders	NLF	11.5	22.1	12.0	23.1	1.9	5.0	1.9	4.8
	SDLF	11.8	22.3	12.5	23.5	1.6	3.9	1.6	3.5
	TDLF	12.1	22.4	12.9	23.8	1.3	3.0	2.4	3.3

Table F-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	50.3	56.8	56.2	56.8
	SDLF	45.9	54.2	58.4	58.4
	TDLF	54.0	57.0	54.0	57.0
TDL	NLF	98.1	108.4	106.9	108.4
	SDLF	81.6	102.5	106.2	106.2
	TDLF	86.6	102.7	99.5	102.7

Table F-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	10.2	10.8	11.0	10.6
	SDLF	12.5	10.3	10.5	11.5
	TDLF	15.9	11.5	10.1	13.3
TDL	NLF	21.2	20.4	20.8	20.9
	SDLF	23.2	19.3	19.8	21.4
	TDLF	25.0	19.3	18.2	21.9

Table F-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.96	0.93	0.89	0.87	0.85	0.84	0.84	0.85	0.96
SDLF	1.04	0.98	0.92	0.87	0.83	0.81	0.81	0.82	1.04
TDLF	1.10	1.02	0.93	0.86	0.81	0.79	0.79	0.81	1.10

Table F-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.72	1.66	1.59	1.55	1.52	1.51	1.51	1.52	1.72
SDLF	1.76	1.68	1.58	1.52	1.47	1.45	1.45	1.47	1.76
TDLF	1.80	1.69	1.57	1.49	1.43	1.40	1.41	1.43	1.80

Table F-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.36	1.32	1.27	1.24	1.21	1.20	1.20	1.20	1.36
SDLF	1.47	1.40	1.30	1.23	1.19	1.16	1.16	1.17	1.47
TDLF	1.57	1.45	1.32	1.22	1.16	1.13	1.13	1.15	1.57

Table F-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	2.44	2.36	2.27	2.21	2.16	2.14	2.14	2.16	2.44
SDLF	2.51	2.39	2.25	2.16	2.10	2.06	2.06	2.09	2.51
TDLF	2.57	2.41	2.23	2.11	2.03	2.00	2.00	2.04	2.57

Table F-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	10273	20990
SDLF	10273	20990
TDLF	10273	20990

Table F-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	616.1	1200.1	0.7	1.1	0.2	1.1
SDLF	634.7	1217.2	0.7	1.1	0.1	1.1
TDLF	652.4	1233.7	0.7	1.1	0.1	1.1

Table F-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.65	0.70	0.04	0.70
SDLF	0.77	1.08	0.02	1.08
TDLF	0.88	1.39	0.01	1.39

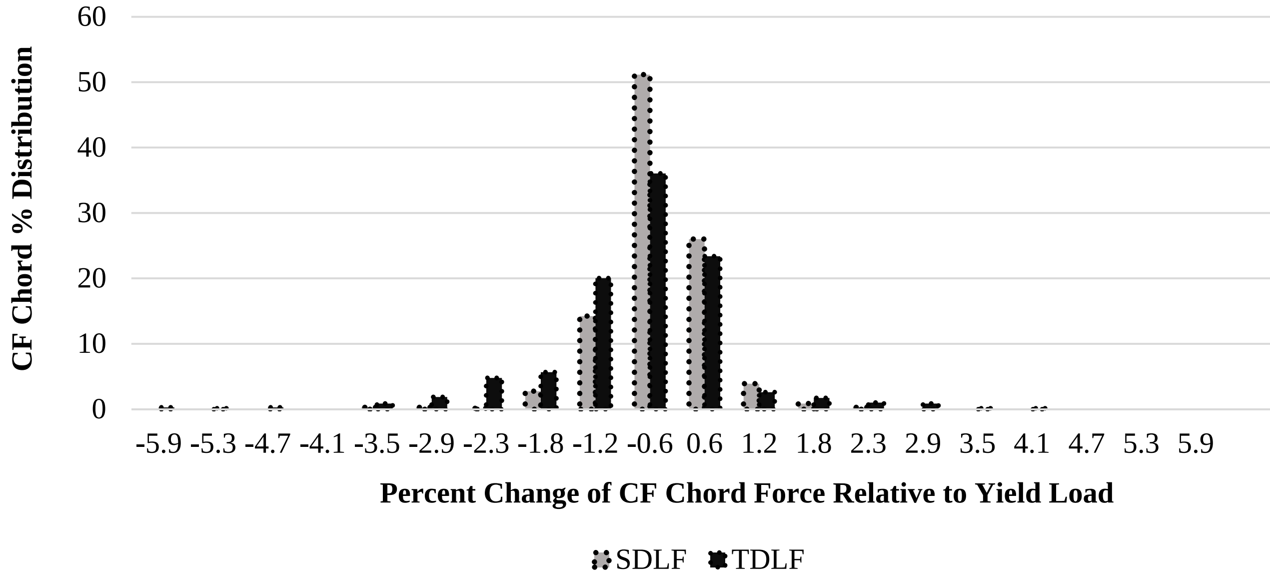


Figure F-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

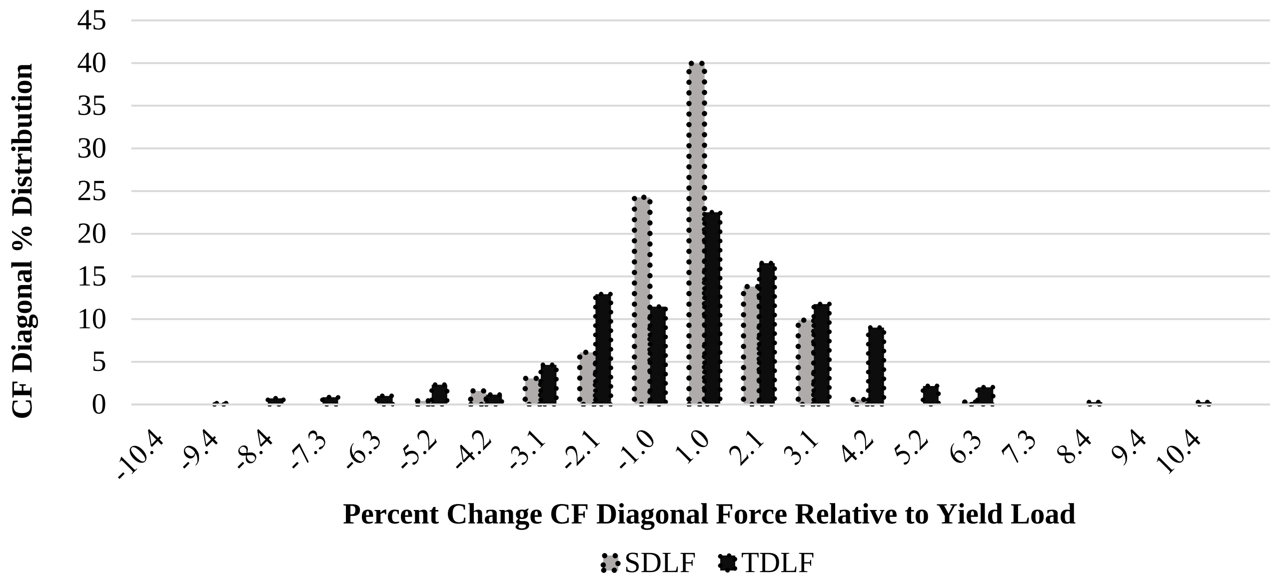


Figure F-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

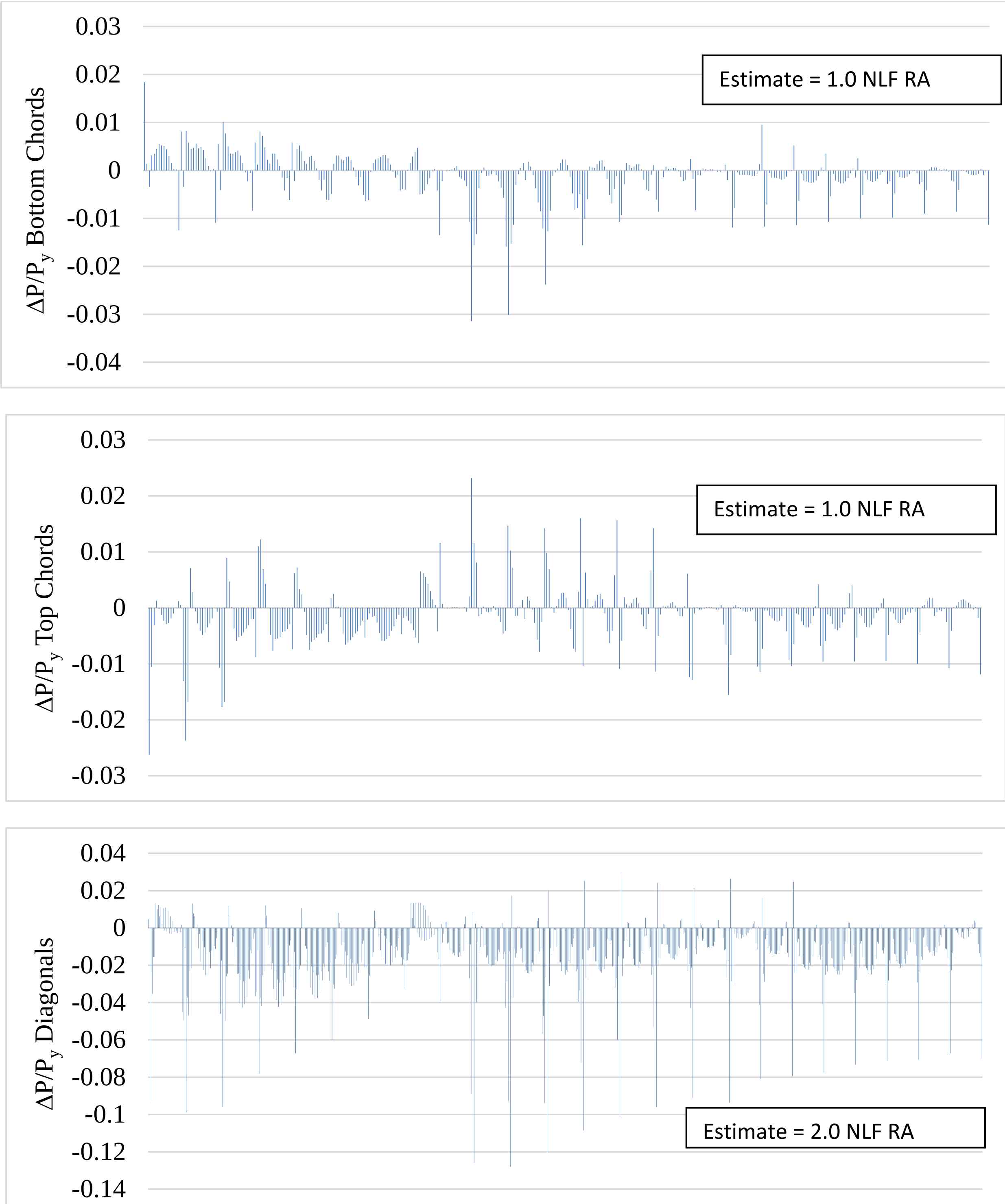


Figure F-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

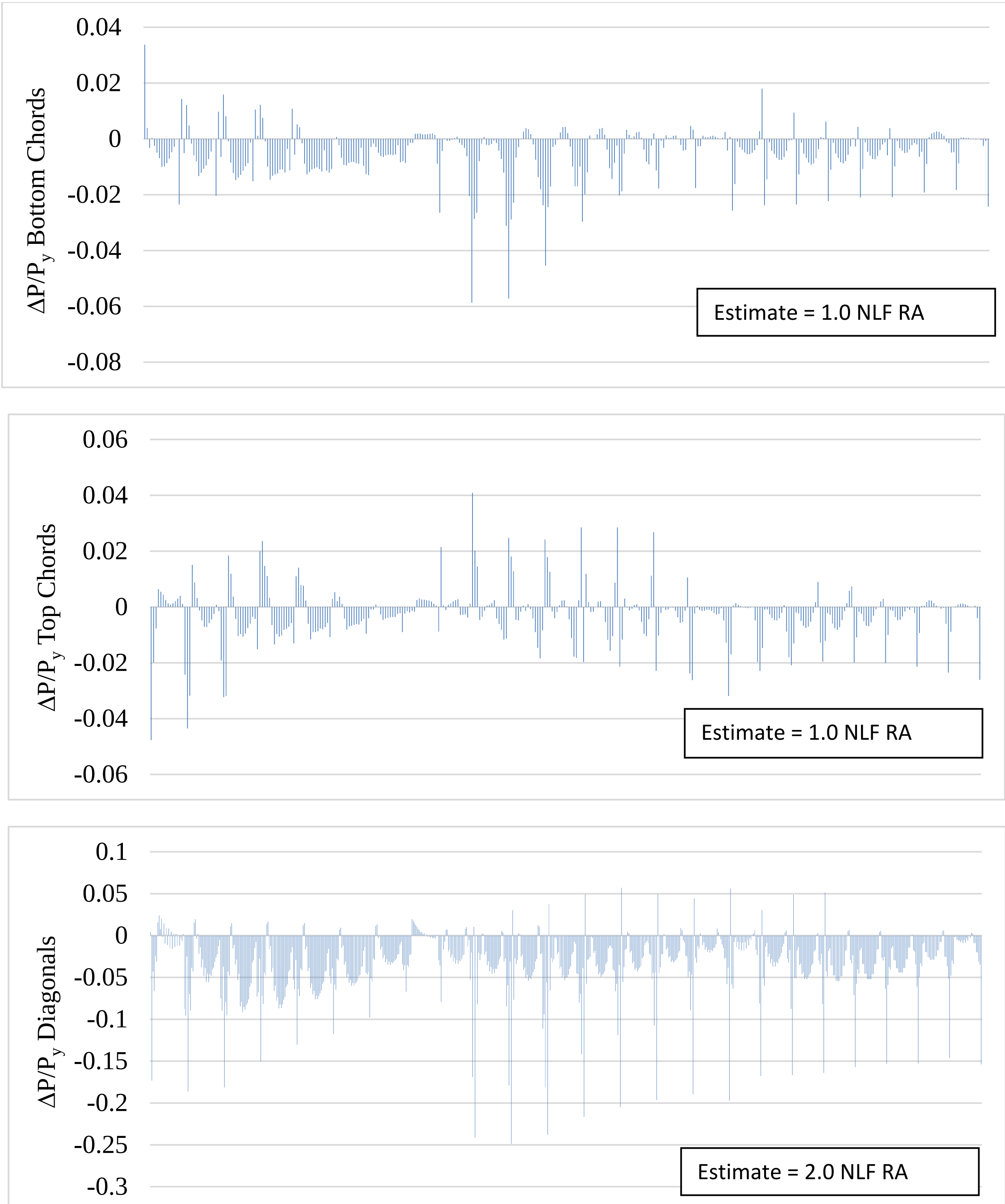


Figure F-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix F-3. NICCR12 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NICCR12 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table F-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	28.4	18.2	28.4
SDLF	30.7	38.6	38.6
TDLF	49.3	57.4	57.4

Table F-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	274.9	90.6
	SDLF	408.5	121.8
	TDLF	527.2	146
G2	NLF	311.9	89.9
	SDLF	255	103.7
	TDLF	283.2	11
G3	NLF	301.4	88
	SDLF	244.7	91
	TDLF	273.5	67.4
G4	NLF	246	73.2
	SDLF	191.7	75.1
	TDLF	202.3	64.9
G5	NLF	237.9	72.9
	SDLF	184	83.7
	TDLF	190.9	81.8
G6	NLF	230	73
	SDLF	186.7	85.8
	TDLF	190.7	87.4
G7	NLF	199.8	66.1
	SDLF	179.3	77.7
	TDLF	179.8	76.6
G8	NLF	177.9	64.8
	SDLF	169.4	78.3
	TDLF	166	77.2
G9	NLF	147.9	12.2
	SDLF	115.1	25.3
	TDLF	91.6	0
All Girders	NLF	311.9	12.2
	SDLF	408.5	25.3
	TDLF	527.2	0

Table F-3-3. Summary of crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	242.6	157.3	70.6	69.2
SDLF	244.1	127.9	109.5	99.8
TDLF	302.2	124.4	138.8	124.2

Table F-3-4. Erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage								
		1	2	3	4	5	6	7	8	9
11	NLF	2490	2492	2494	2496	2497	2499	2501	2503	2505
	SDLF	2490	2492	2494	2496	2497	2499	2501	2503	2505
	TDLF	2490	2492	2494	2496	2497	2499	2501	2503	2505
18	NLF	4507	4509	4511	4513	4514	4516	4518	4520	4522
	SDLF	4507	4509	4511	4513	4514	4516	4518	4520	4522
	TDLF	4507	4509	4511	4513	4514	4516	4518	4520	4522

Appendix F-4. NICCR12 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge NICCR12 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

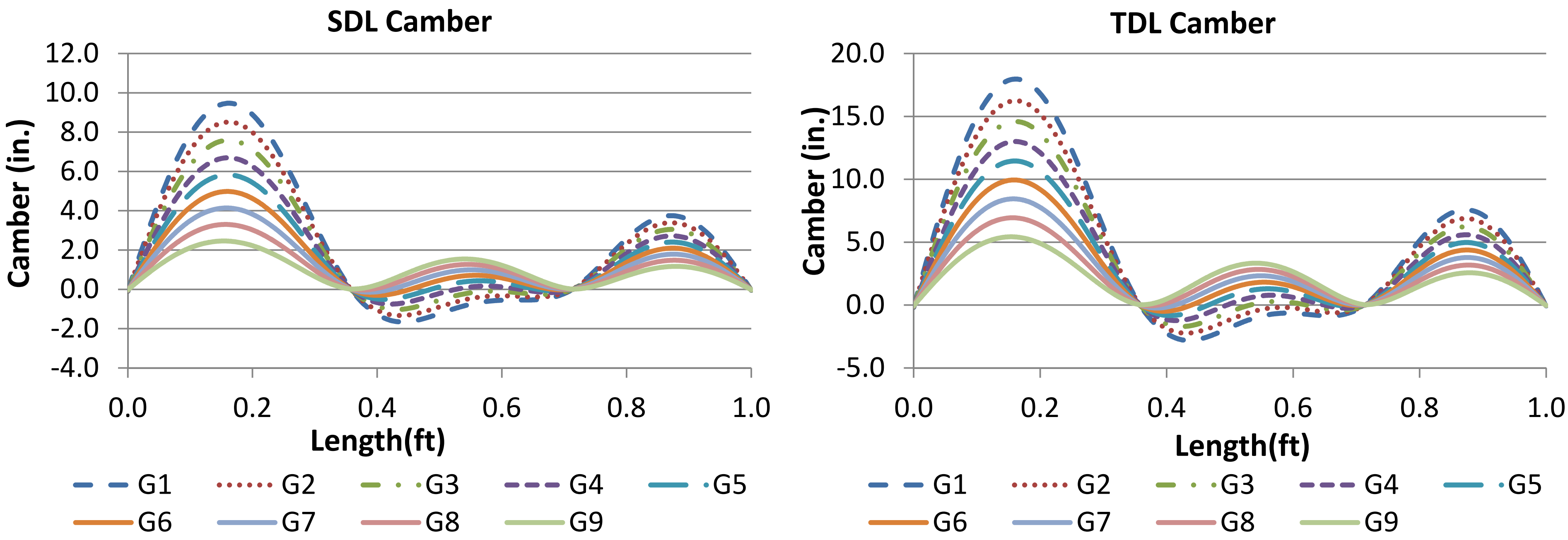


Figure F-4-1. SDL and TDL 3D FEA cambers.

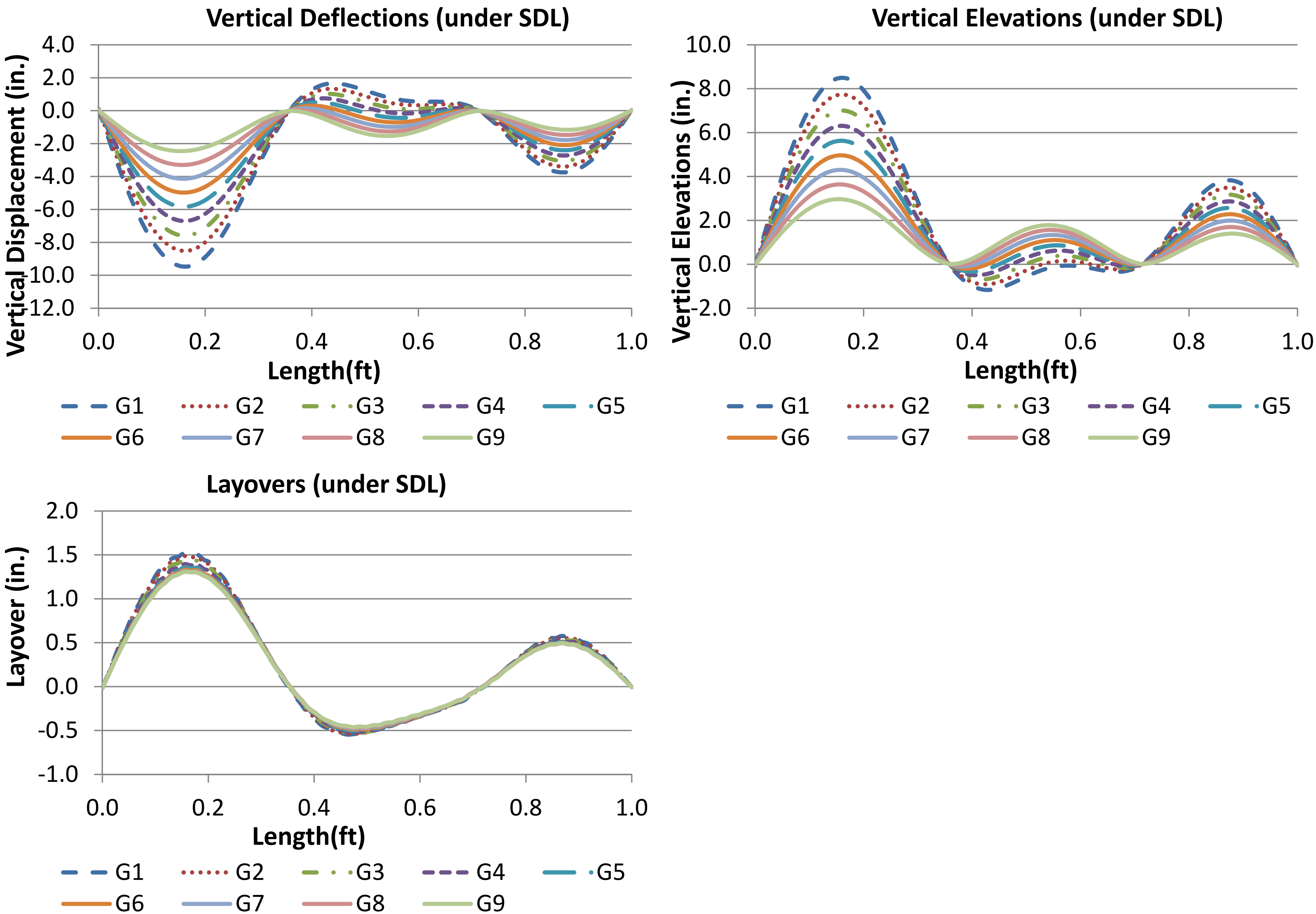


Figure F-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

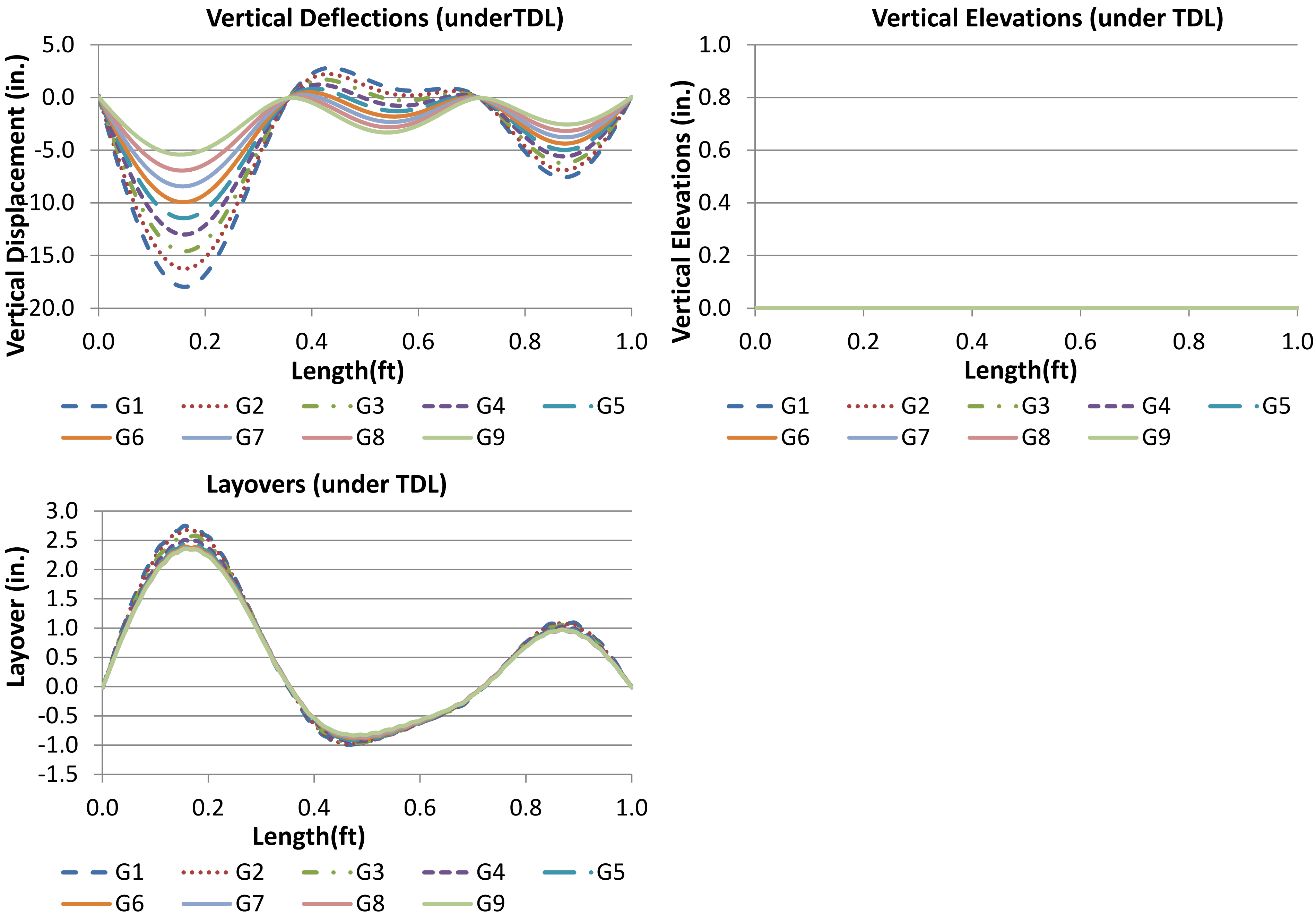


Figure F-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

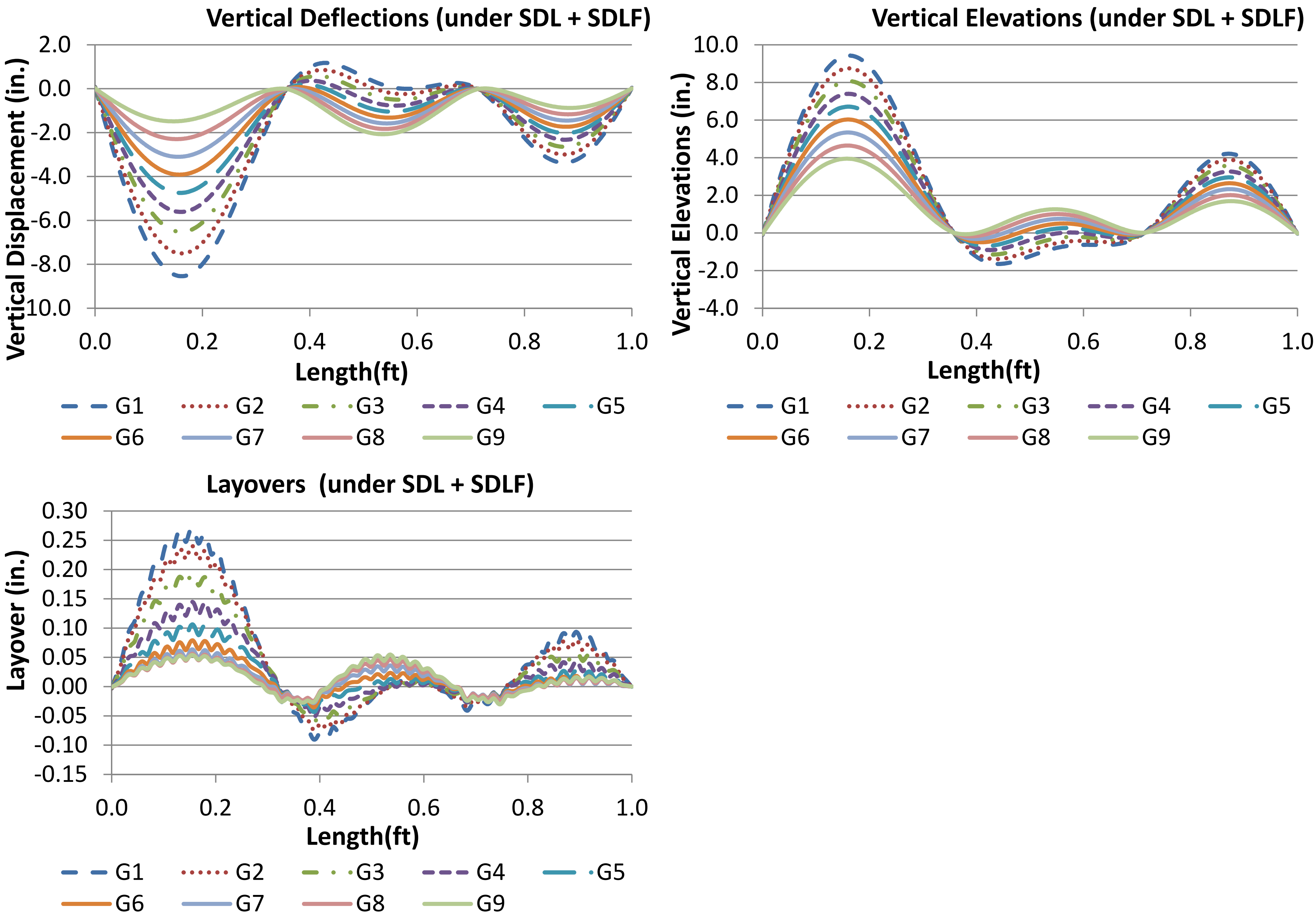


Figure F-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

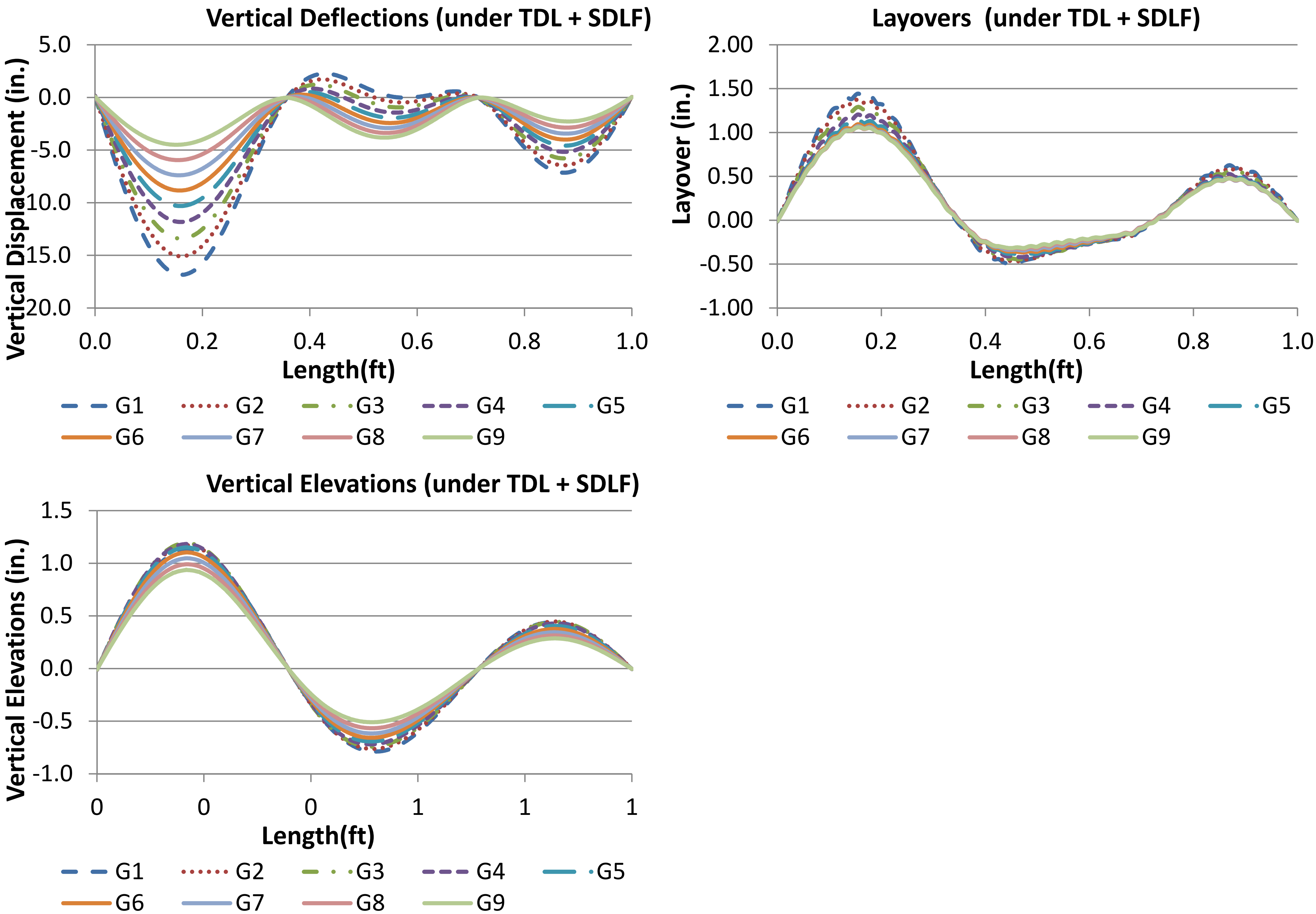


Figure F-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

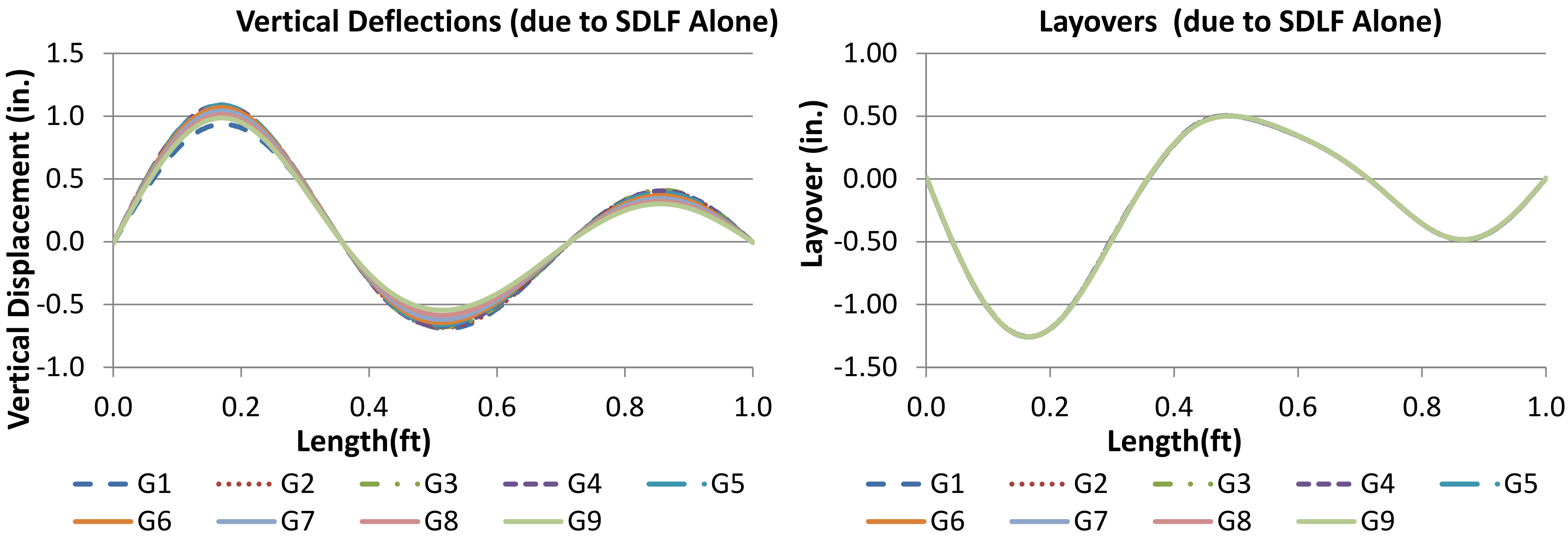


Figure F-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

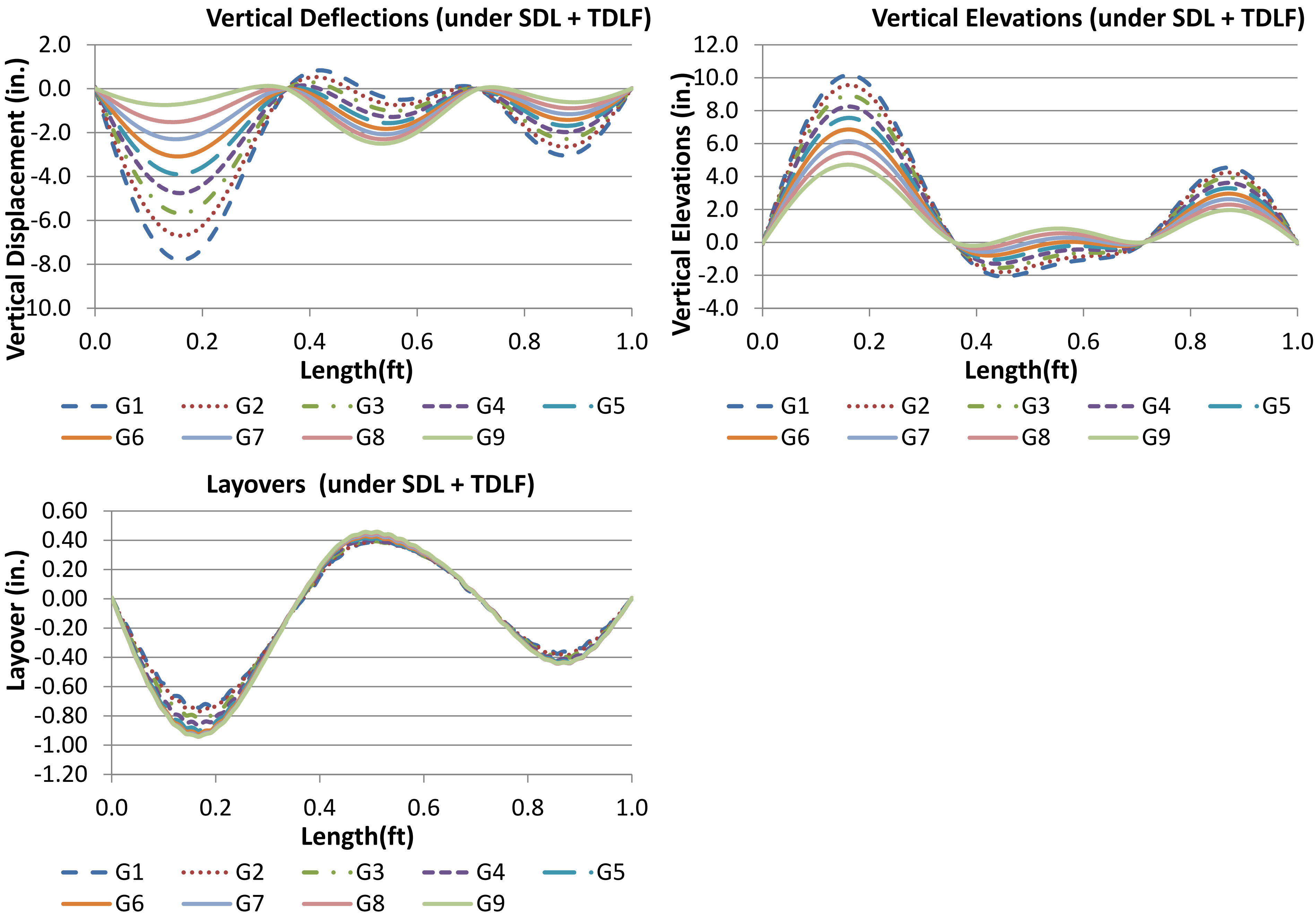


Figure F-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

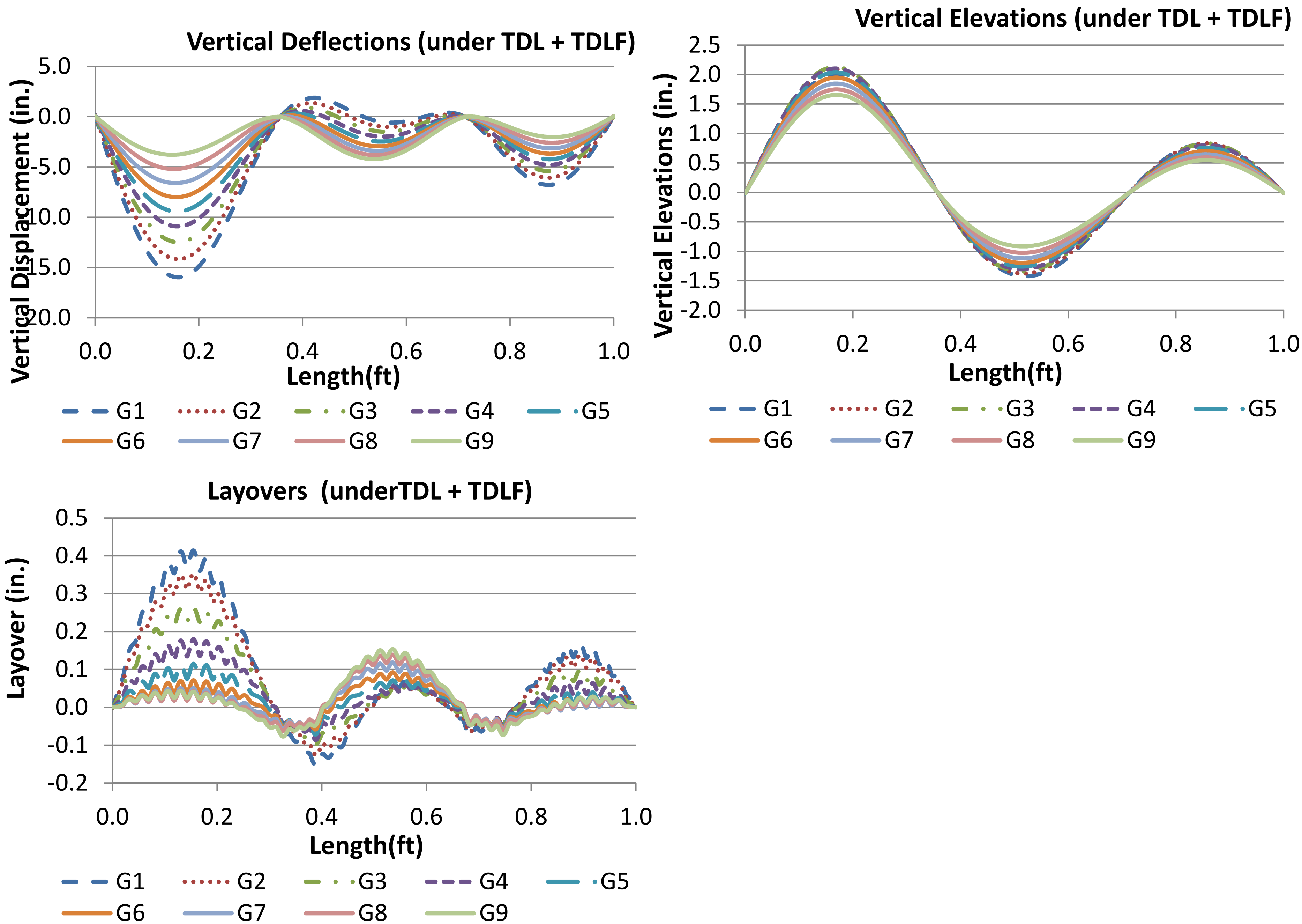


Figure F-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

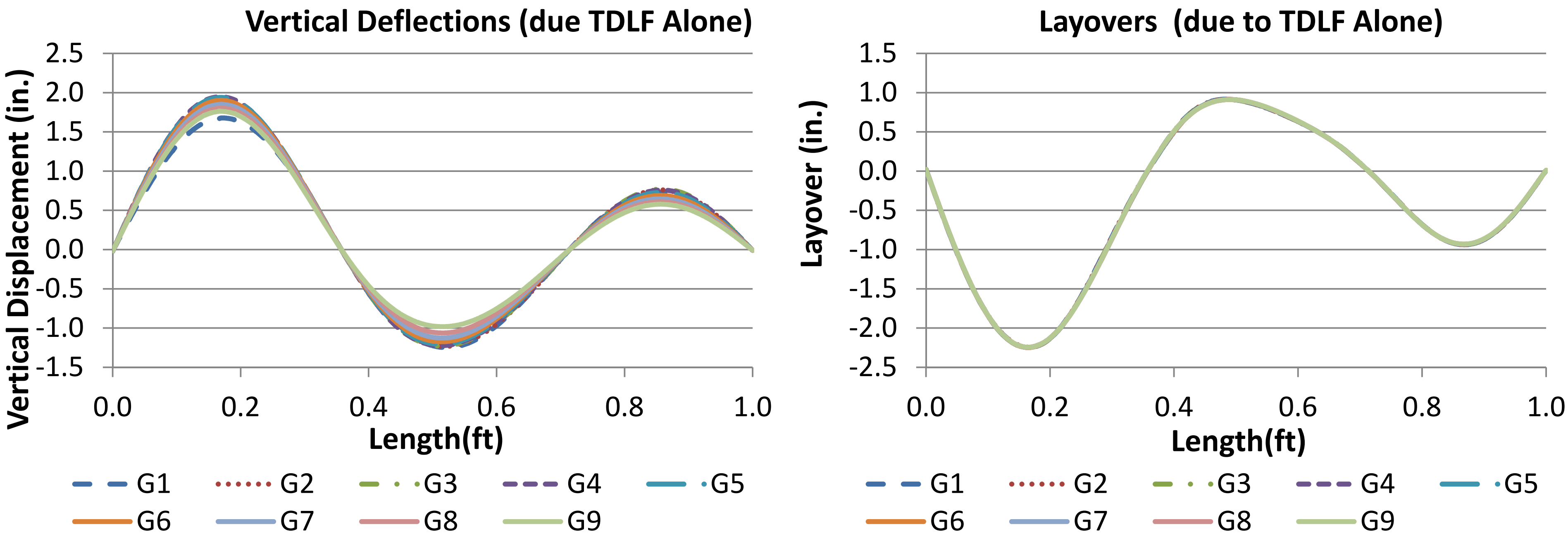


Figure F-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

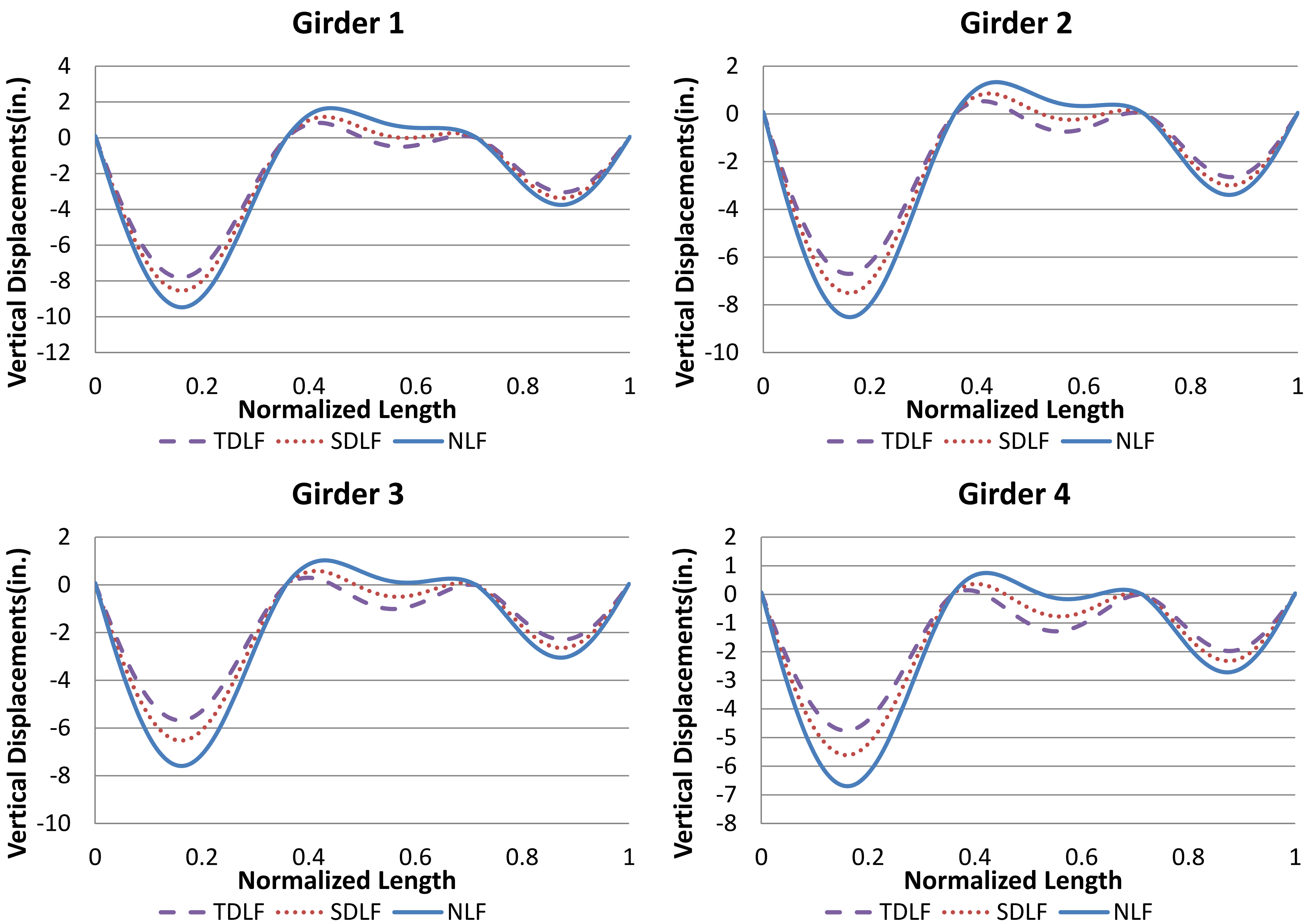


Figure F-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

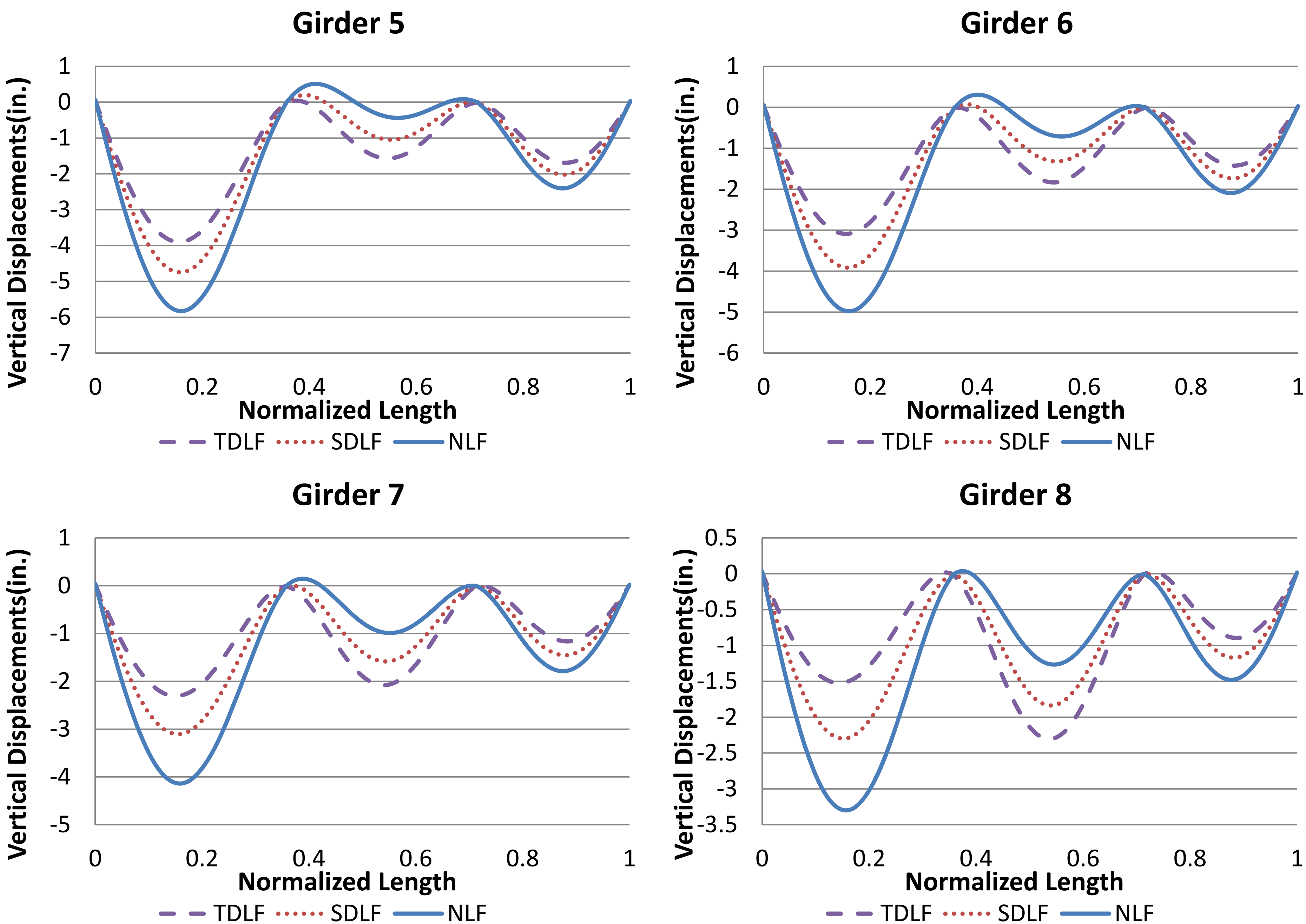


Figure F-4-10(Continued). **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

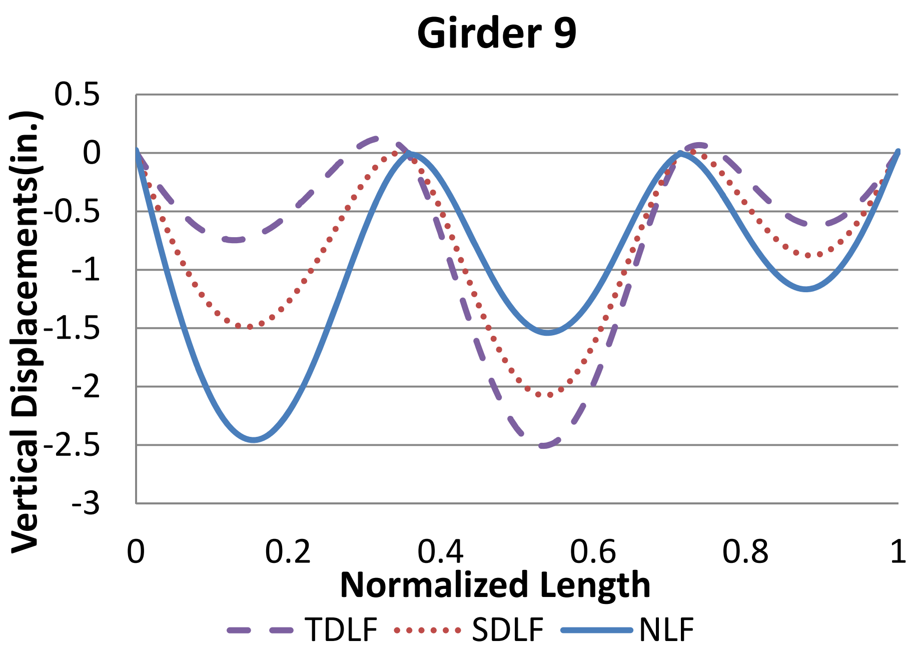


Figure F-4-10(Continued). **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

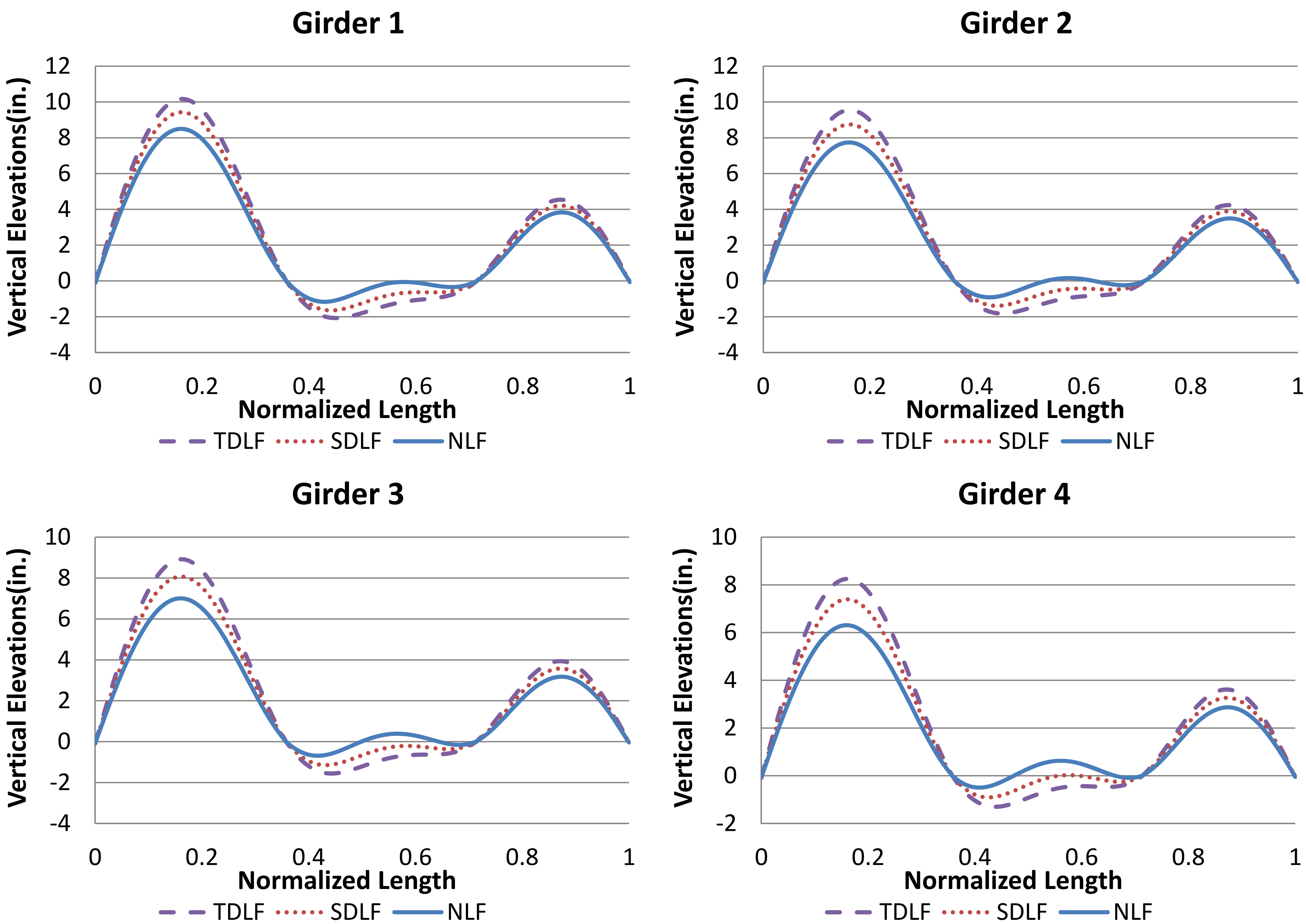


Figure F-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

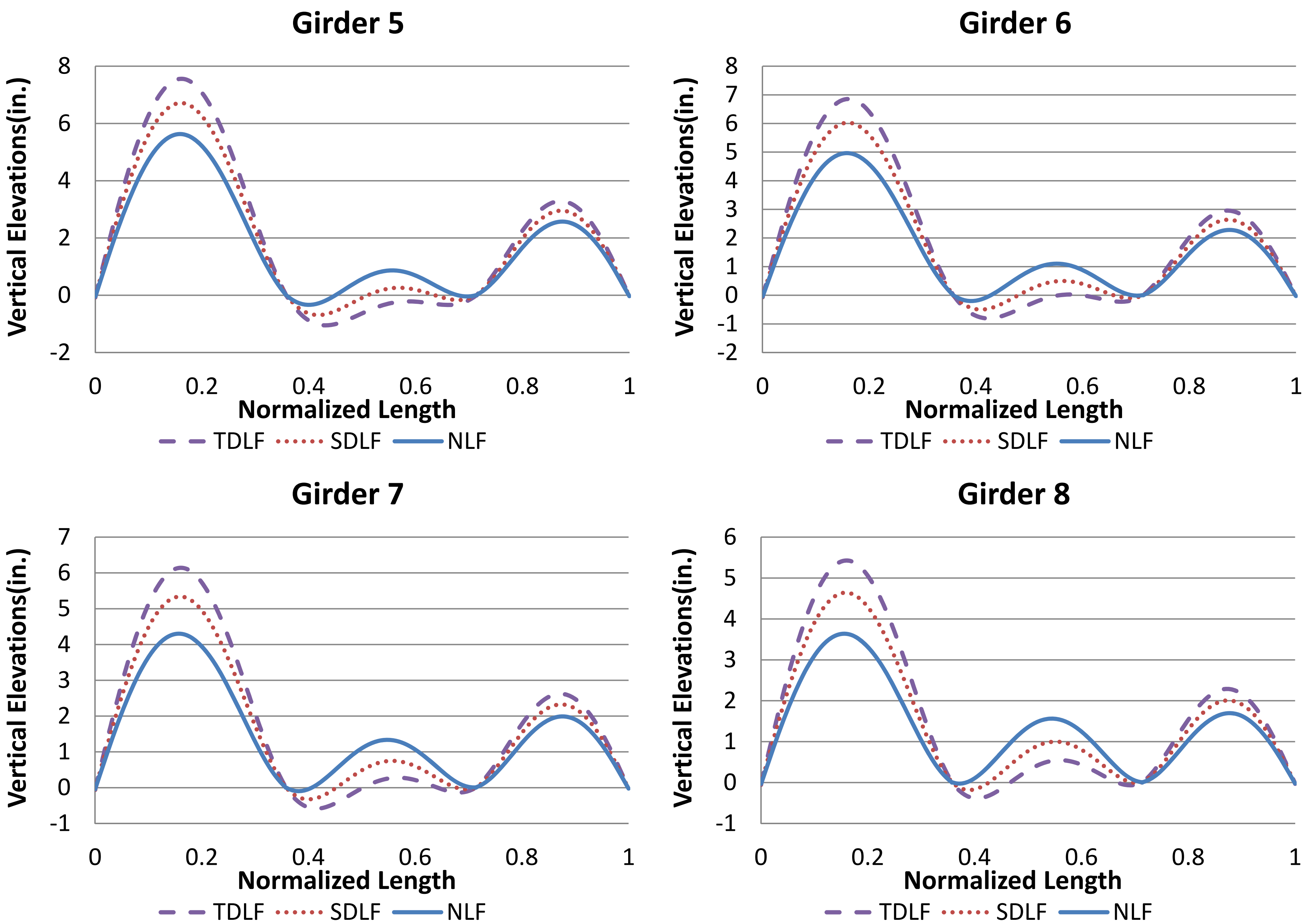


Figure F-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

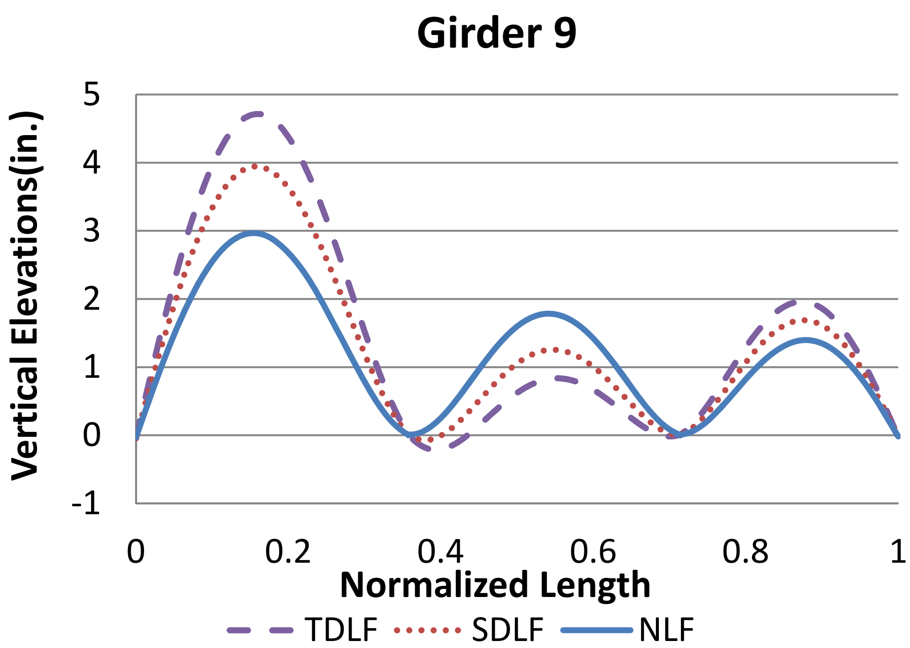


Figure F-4-11(Continued). **Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.**

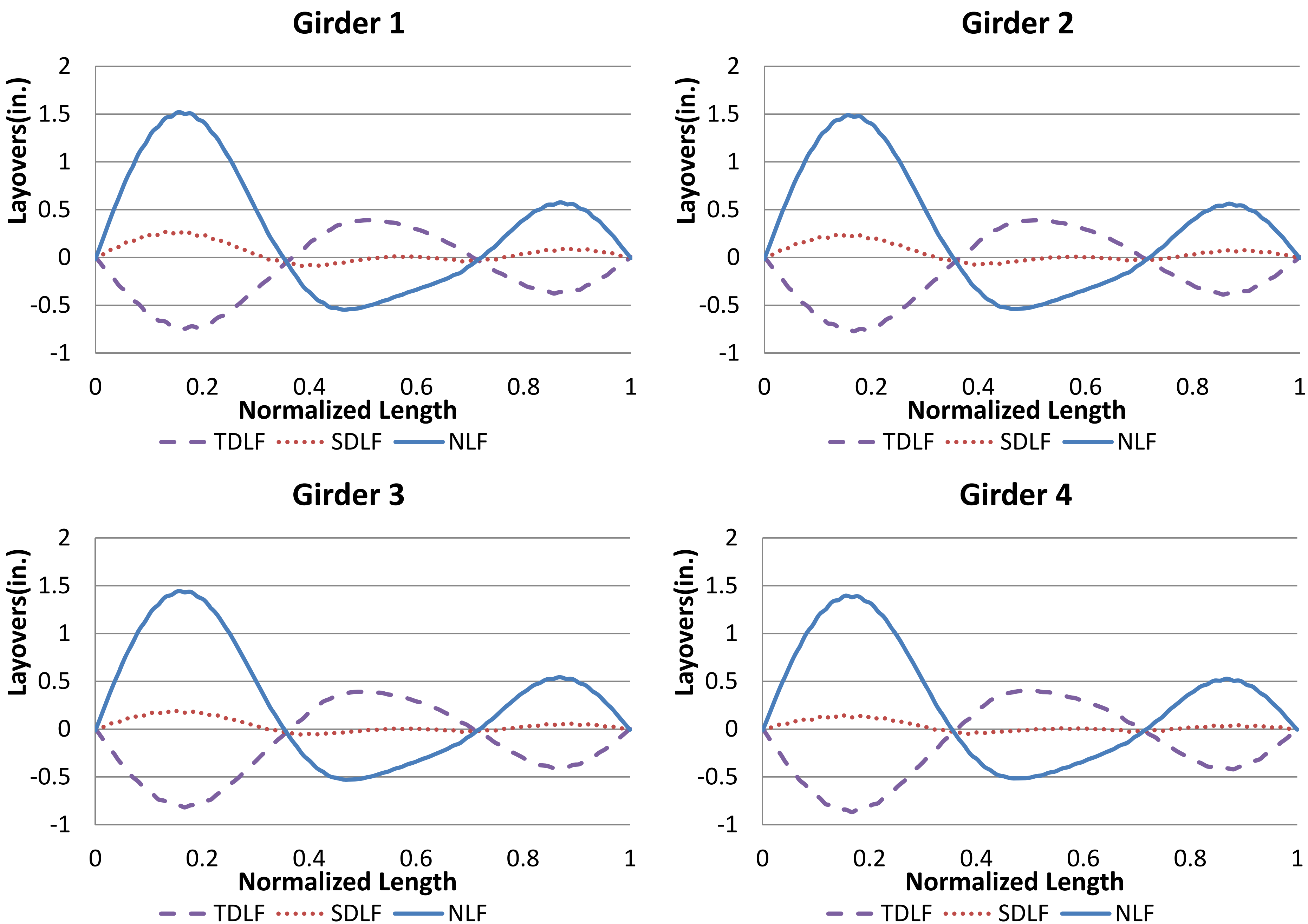


Figure F-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

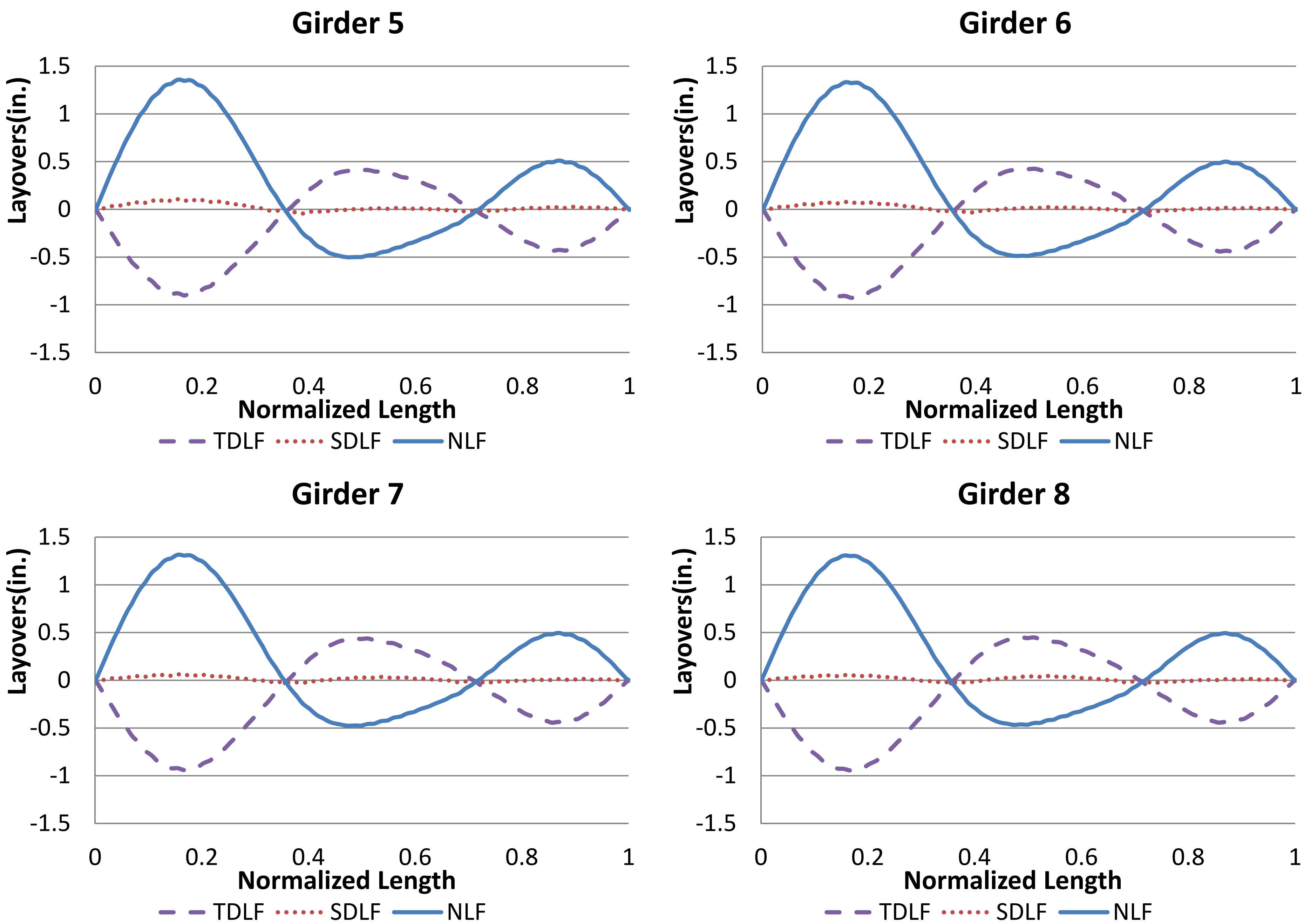


Figure F-4-12(Continued). **Comparison of individual girder layovers (in) under SDL for different detailing methods.**

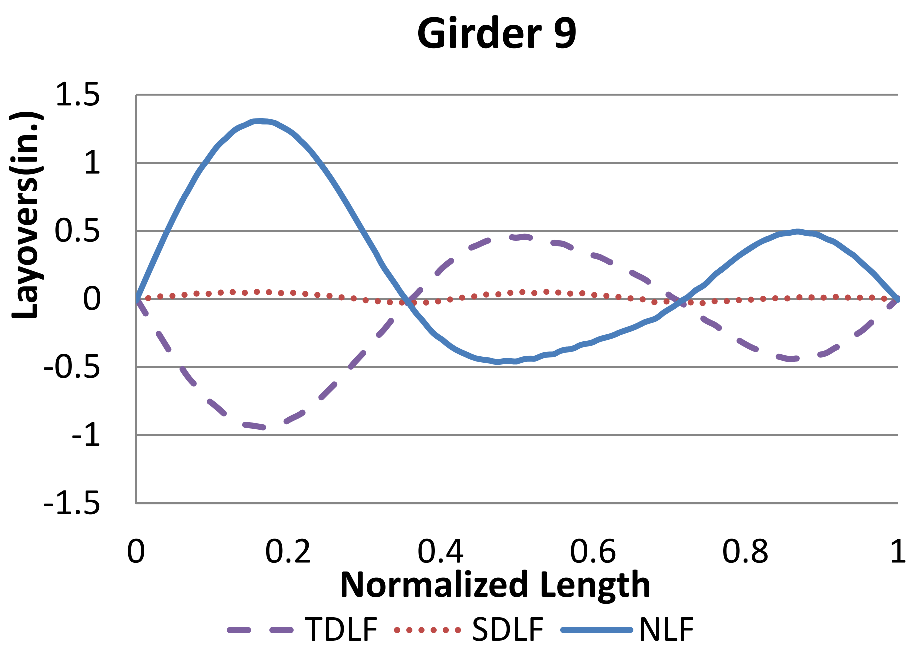


Figure F-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

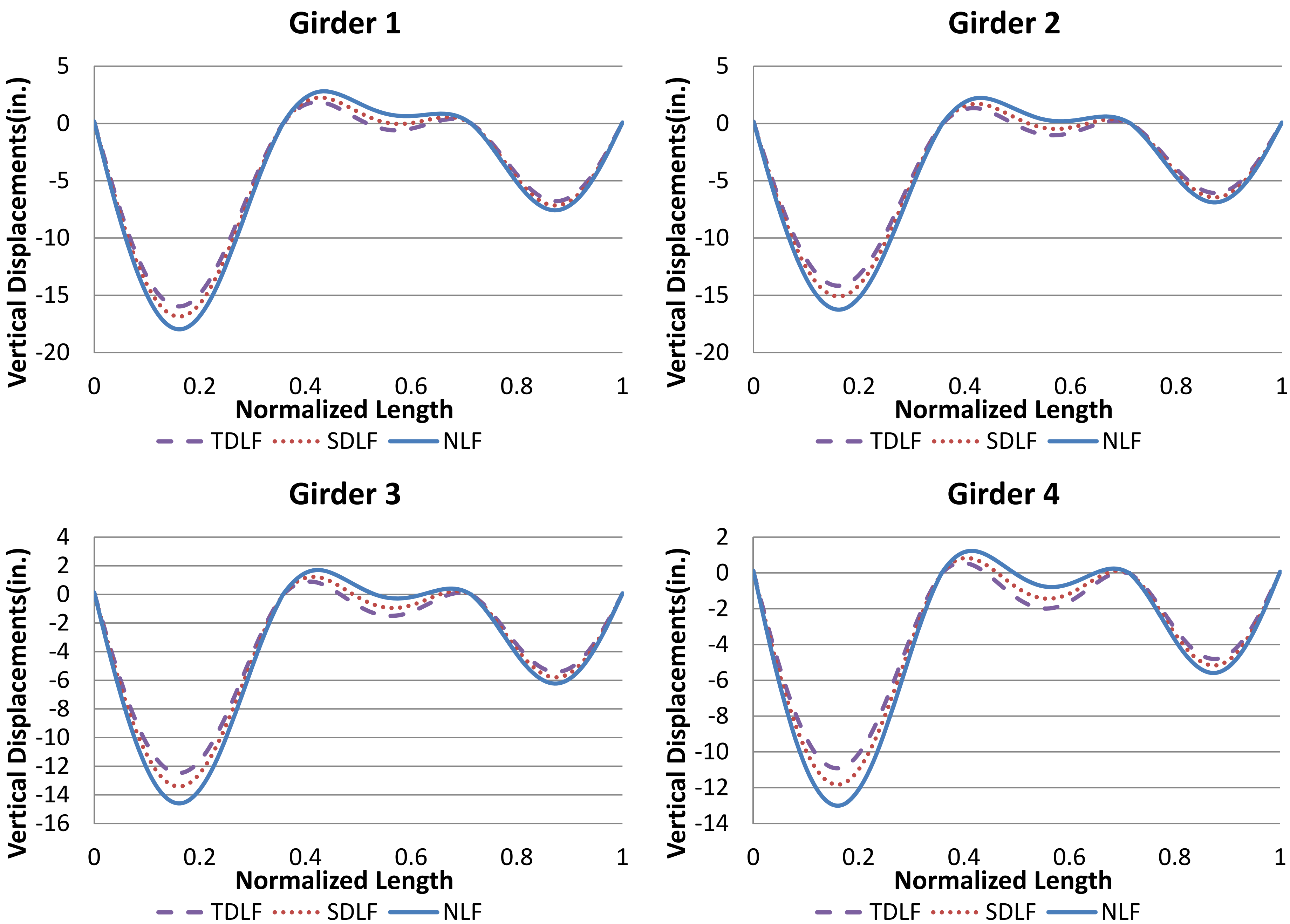


Figure F-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

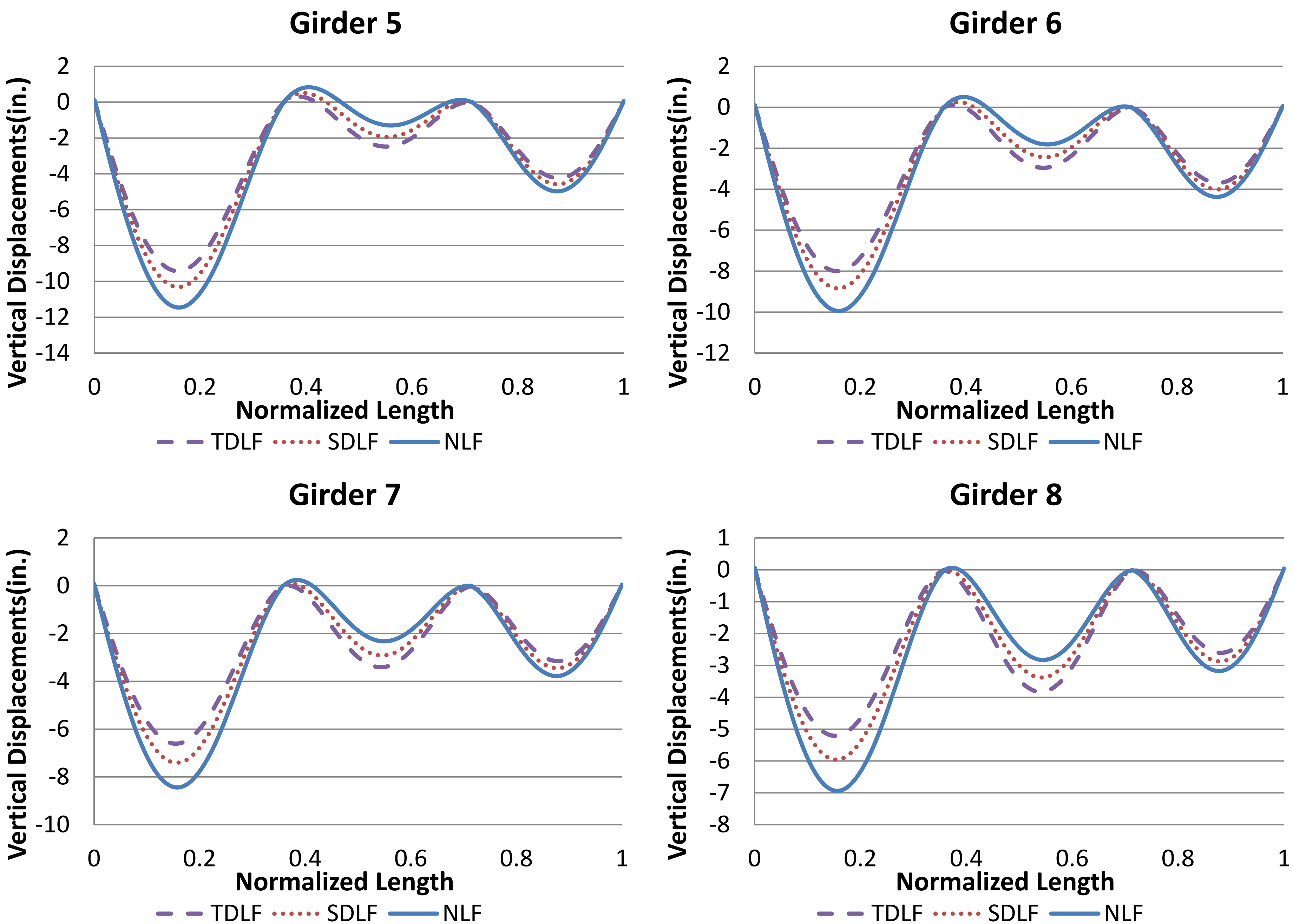


Figure F-4-13(Continued). **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

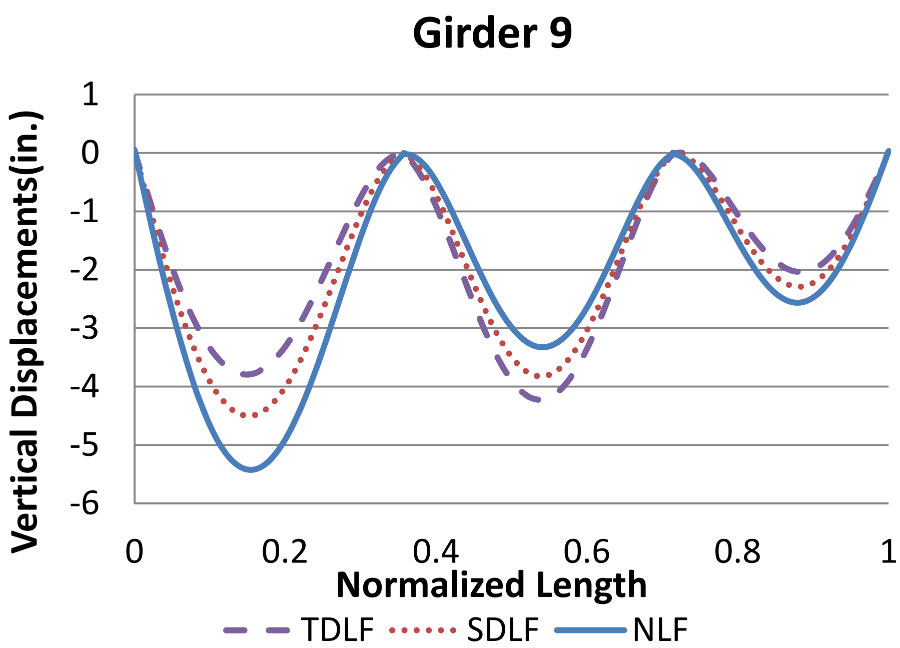


Figure F-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

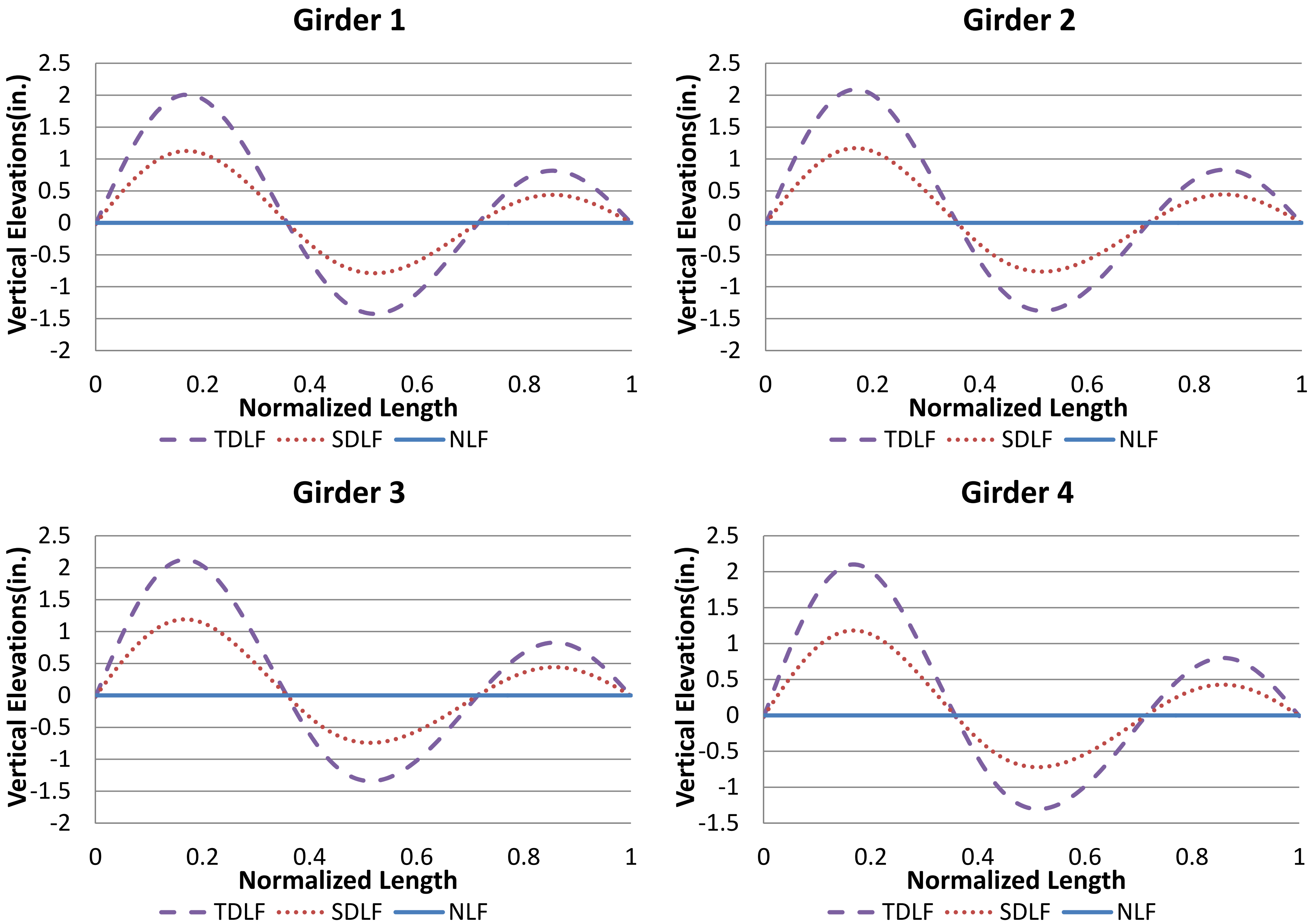


Figure F-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

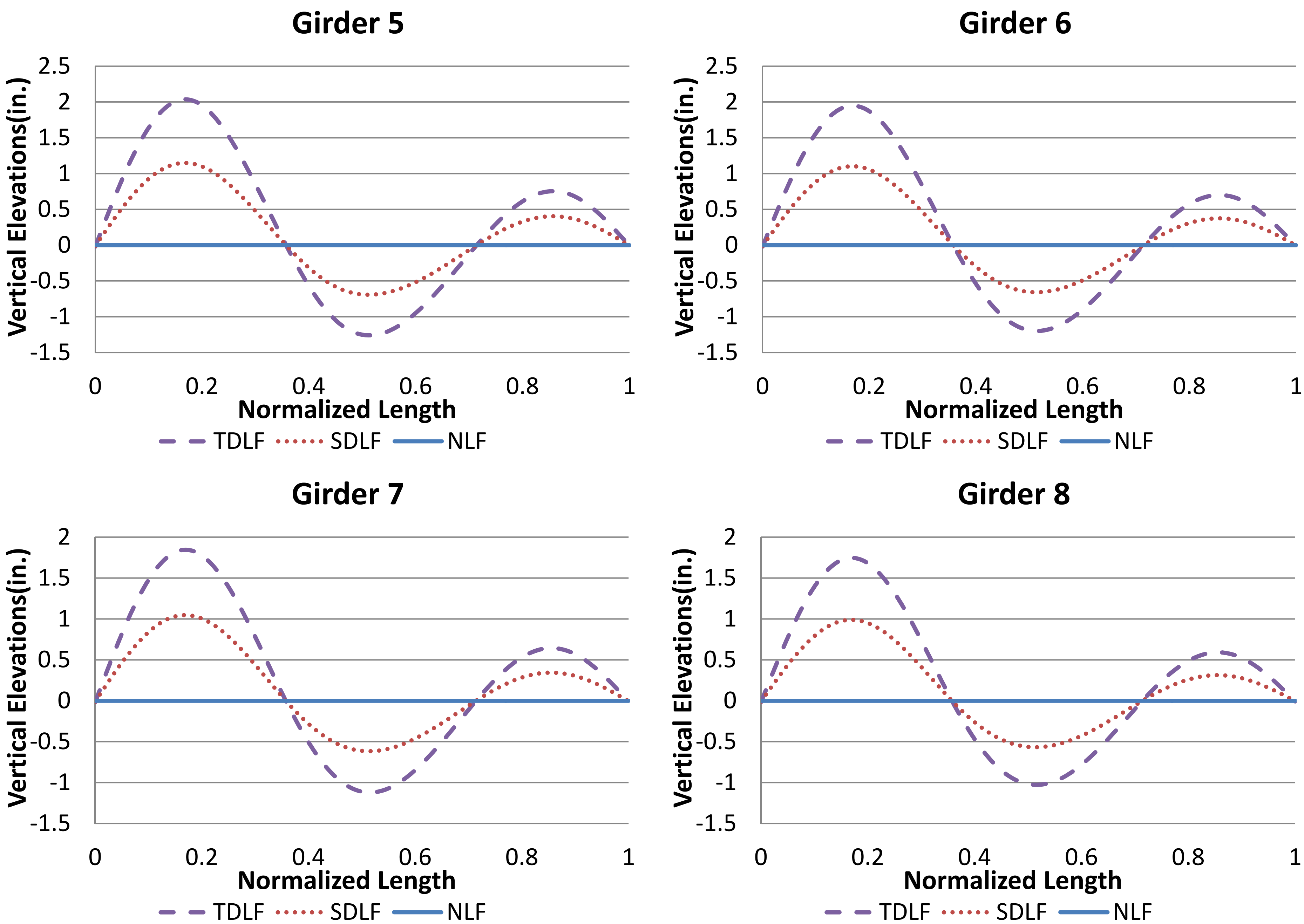


Figure F-4-14(Continued). **Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.**

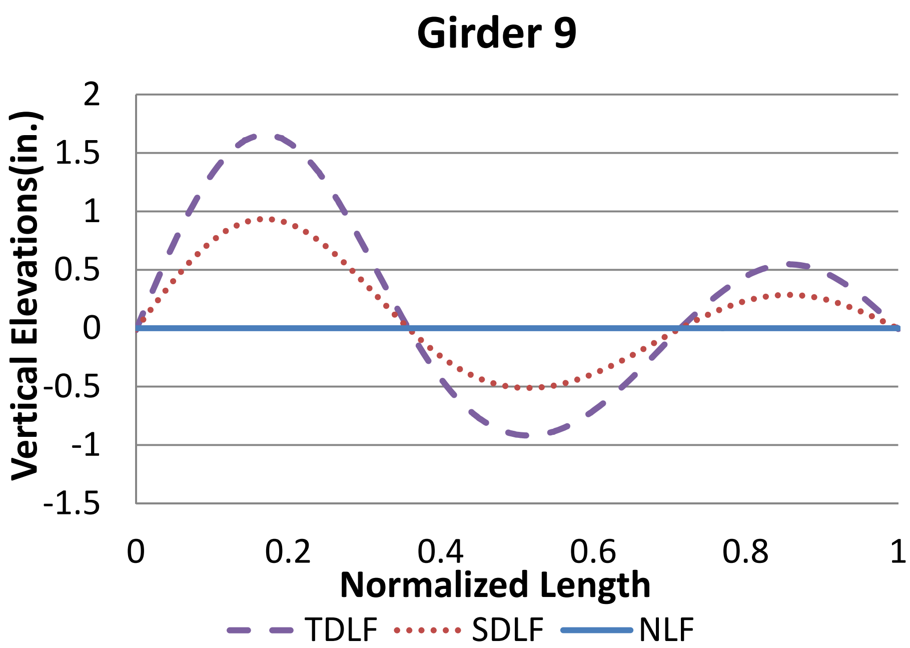


Figure F-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

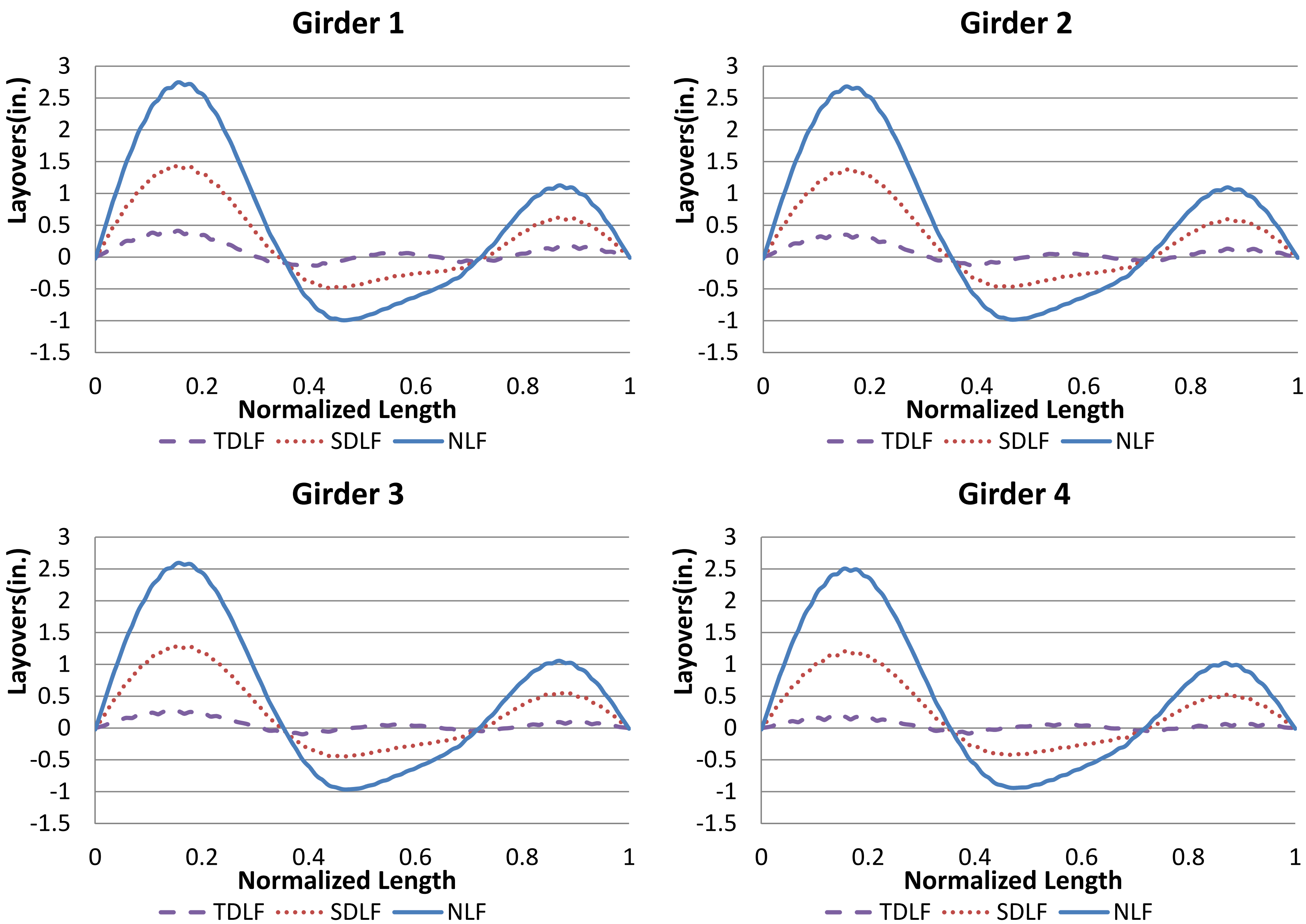


Figure F-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

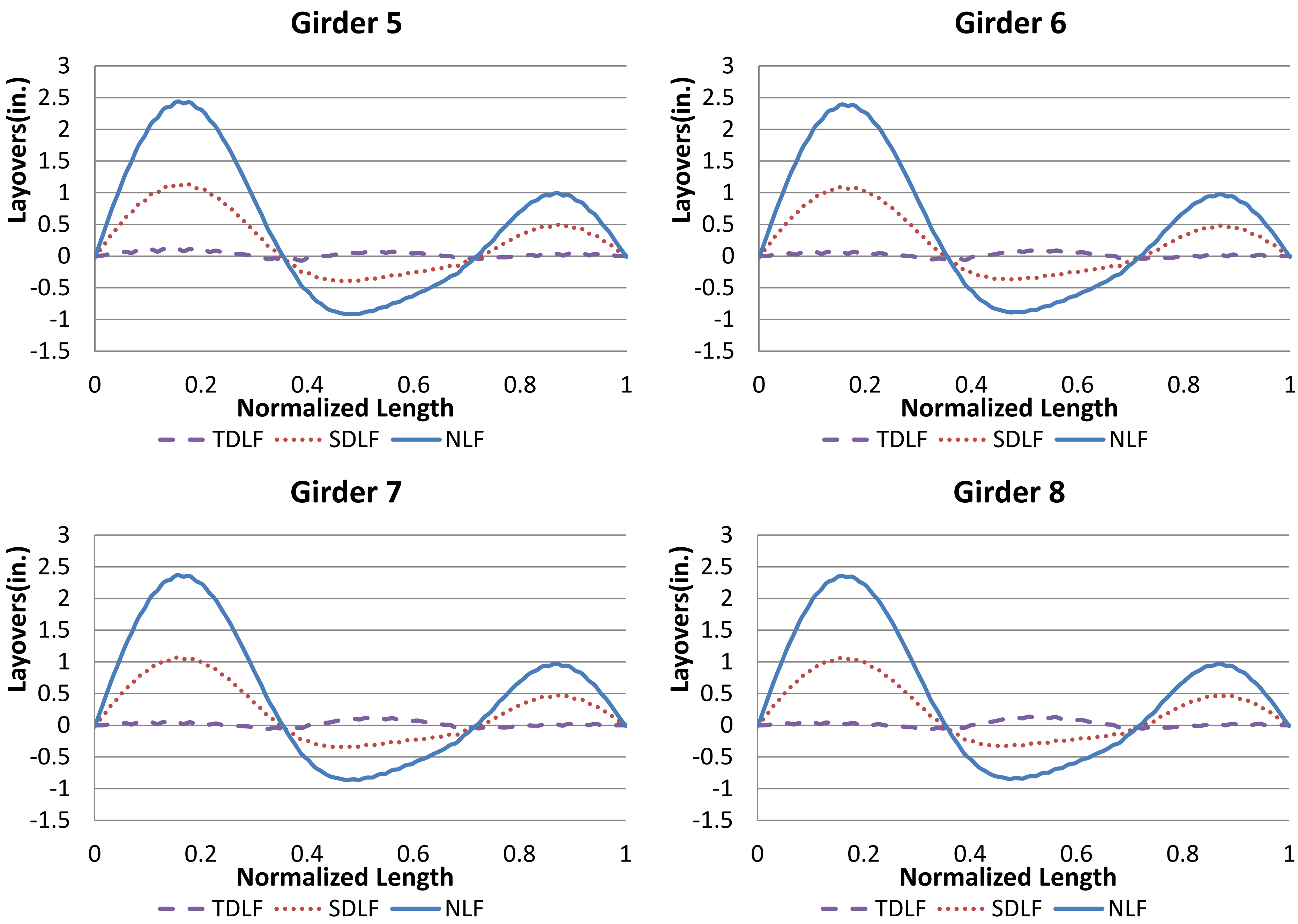


Figure F-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

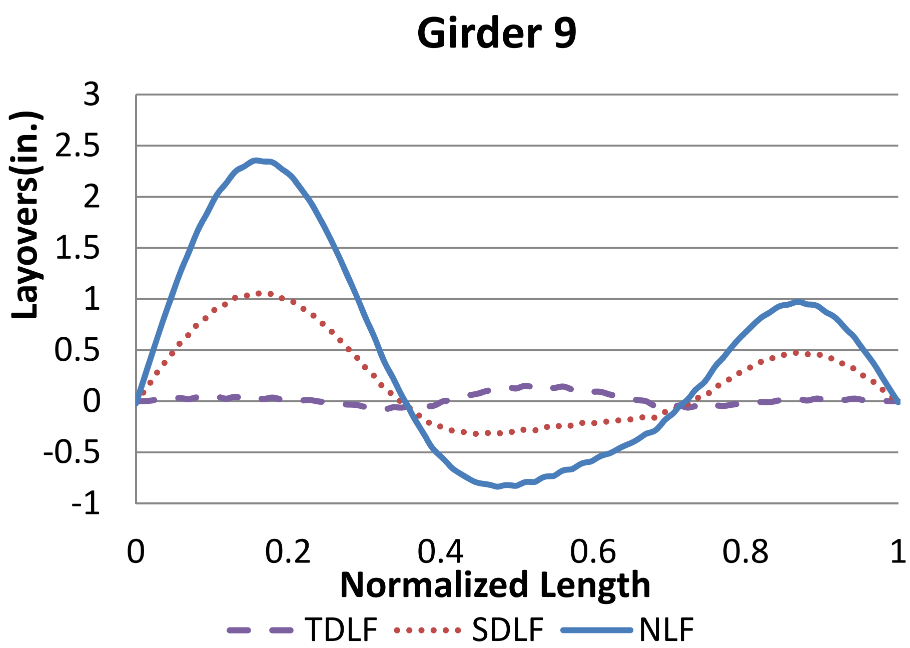


Figure F-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

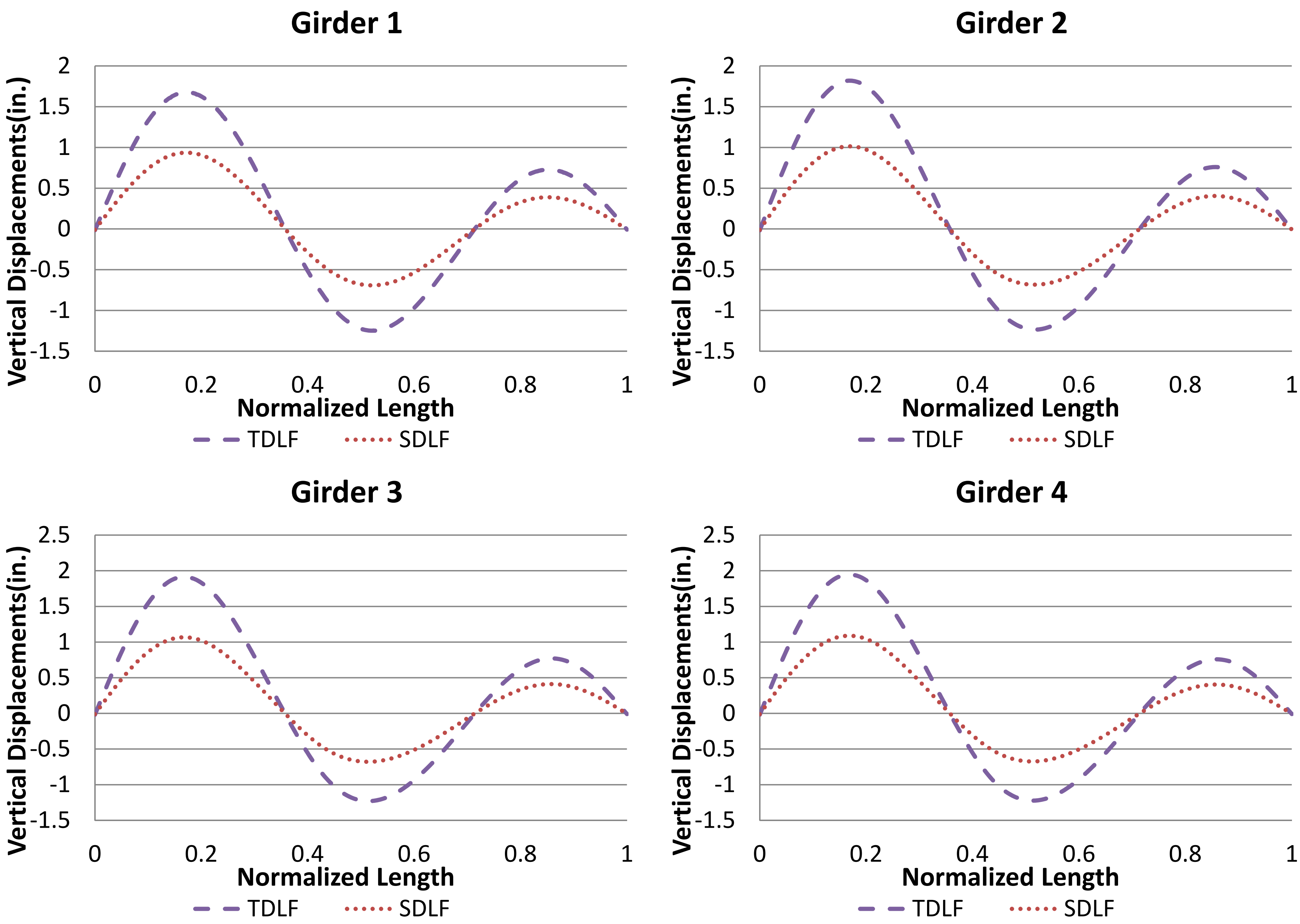


Figure F-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

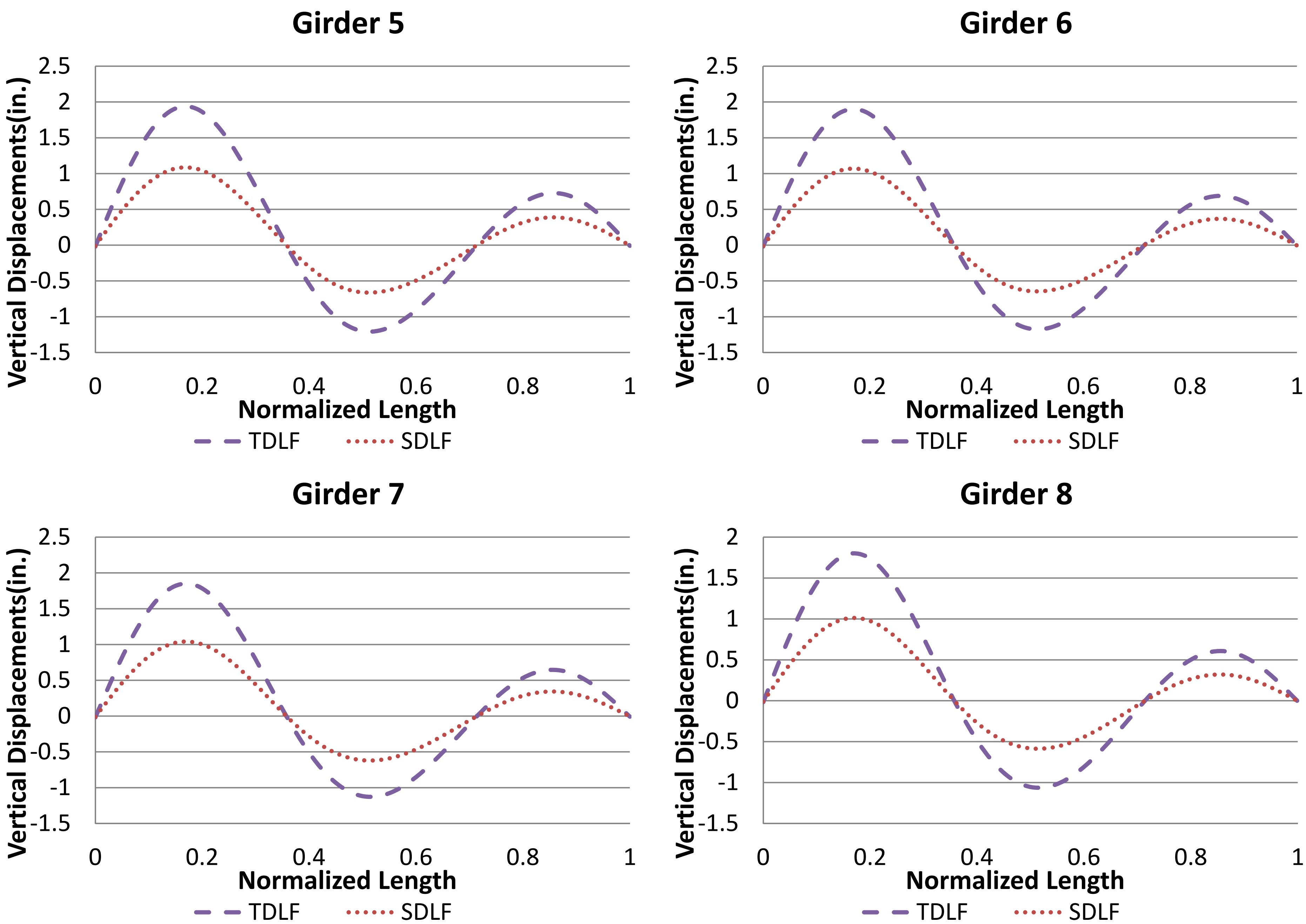


Figure F-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

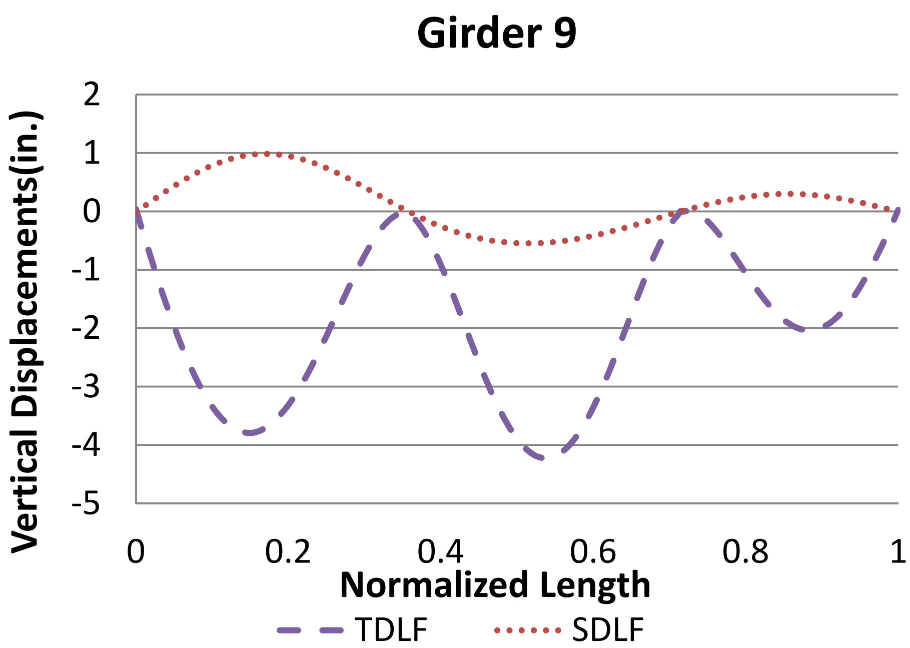


Figure F-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

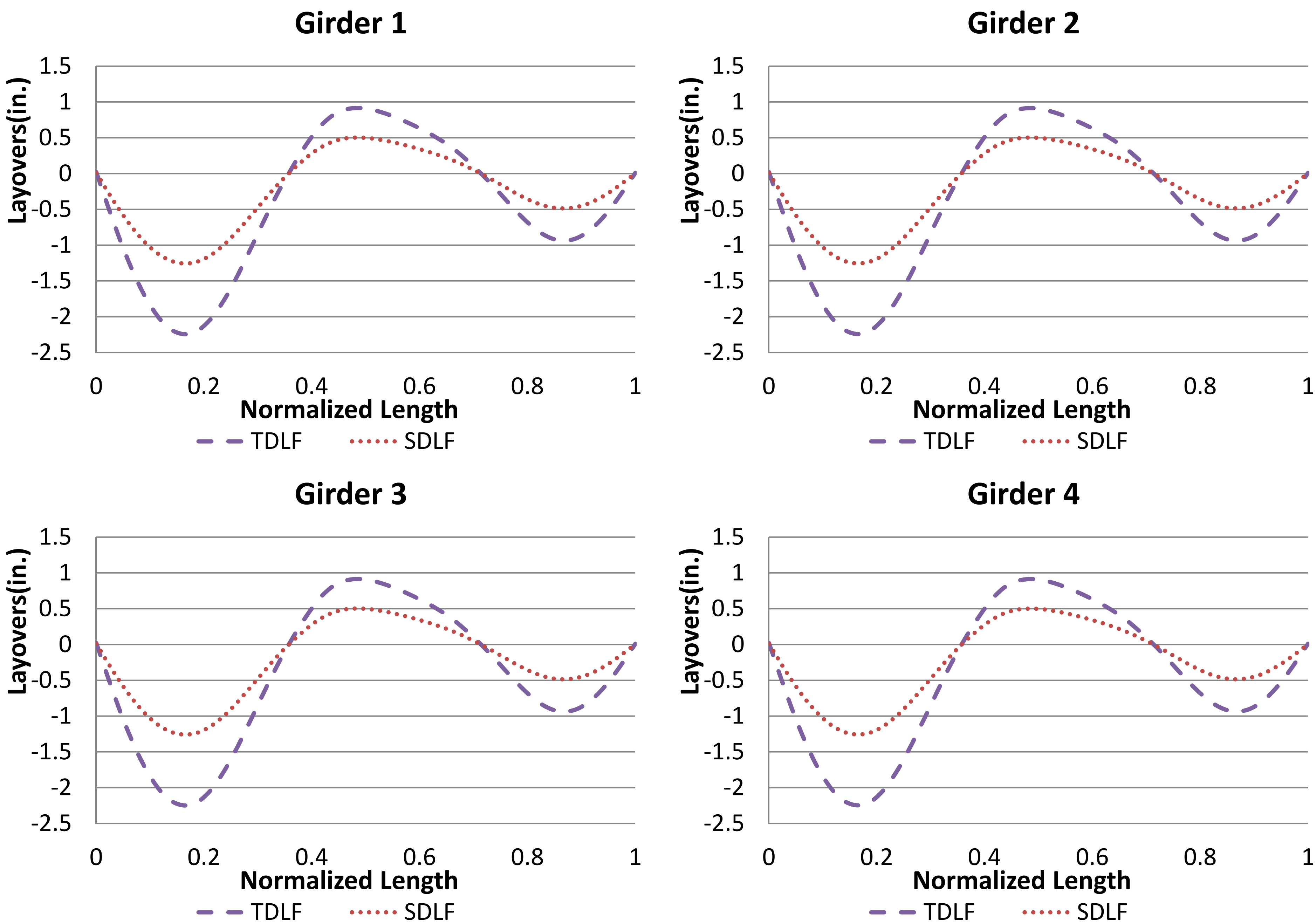


Figure F-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

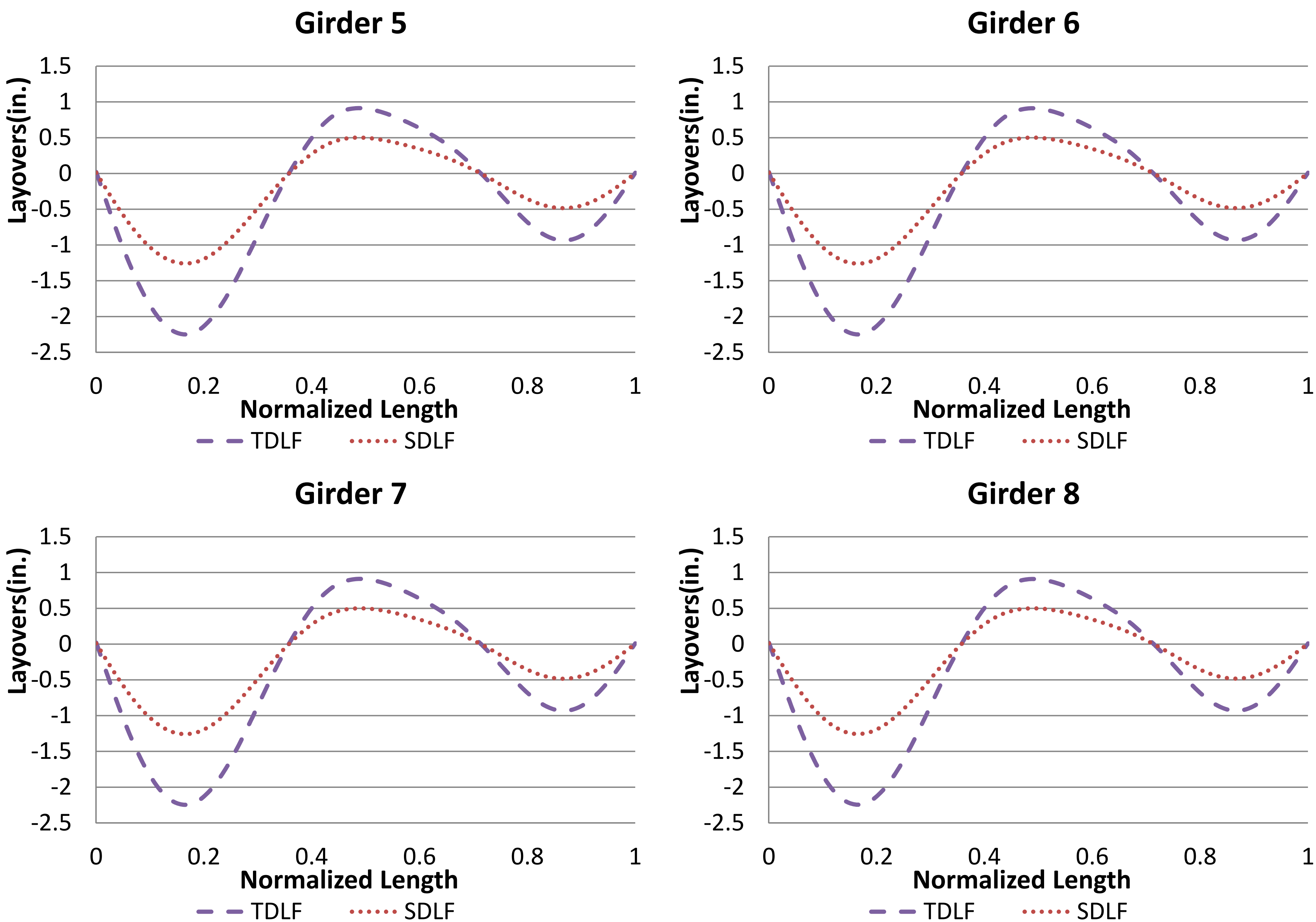


Figure F-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

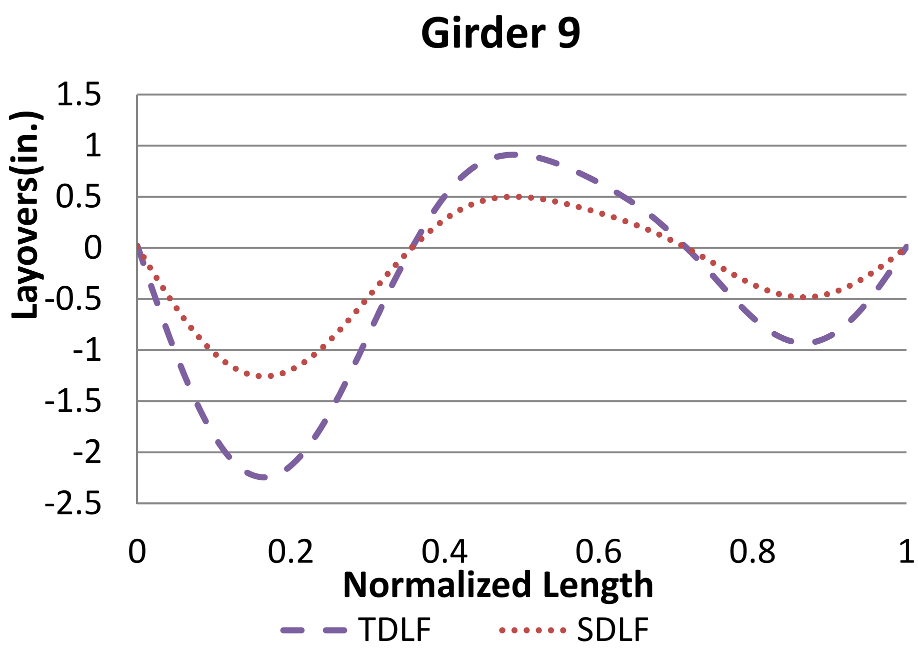


Figure F-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

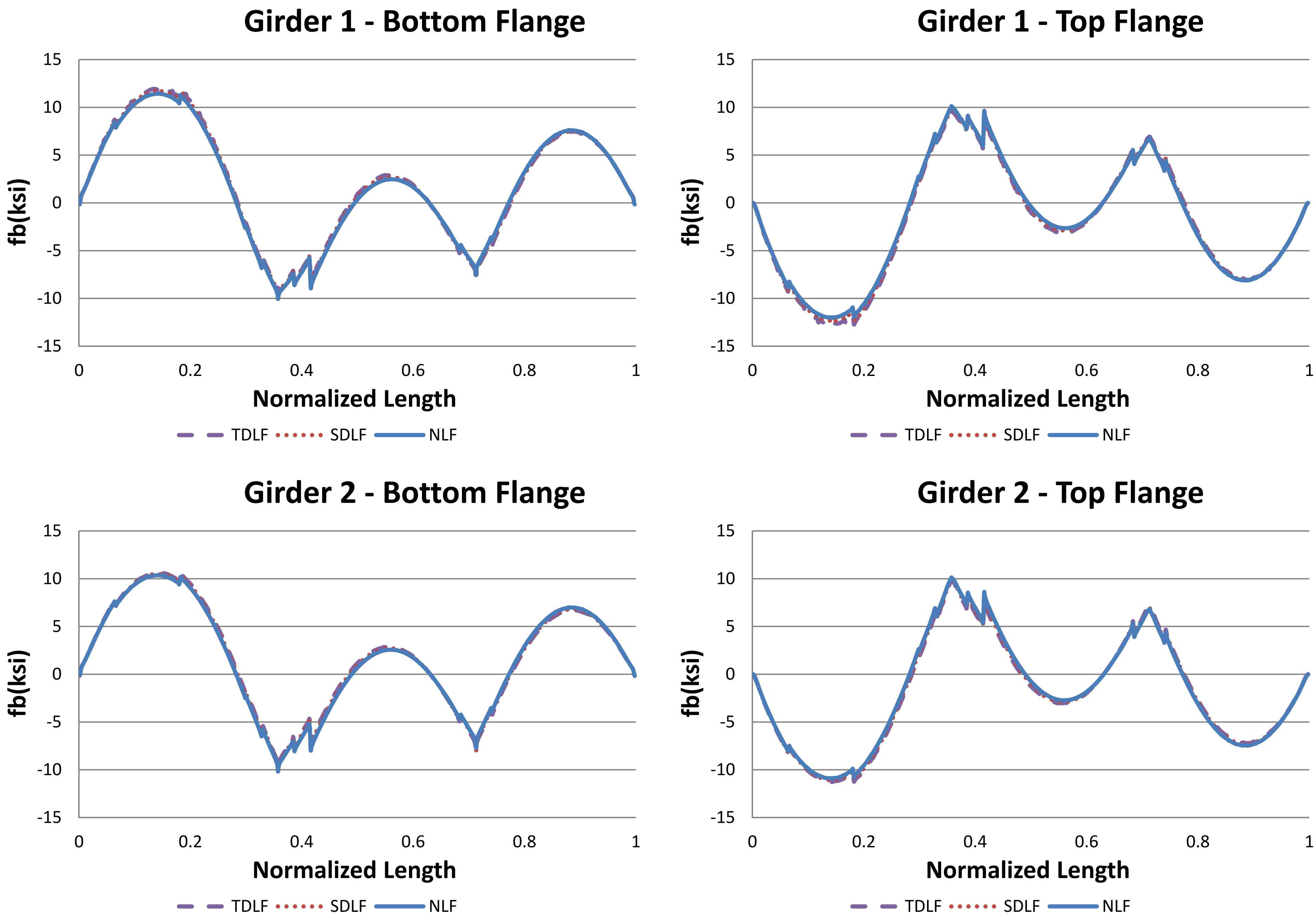


Figure F-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

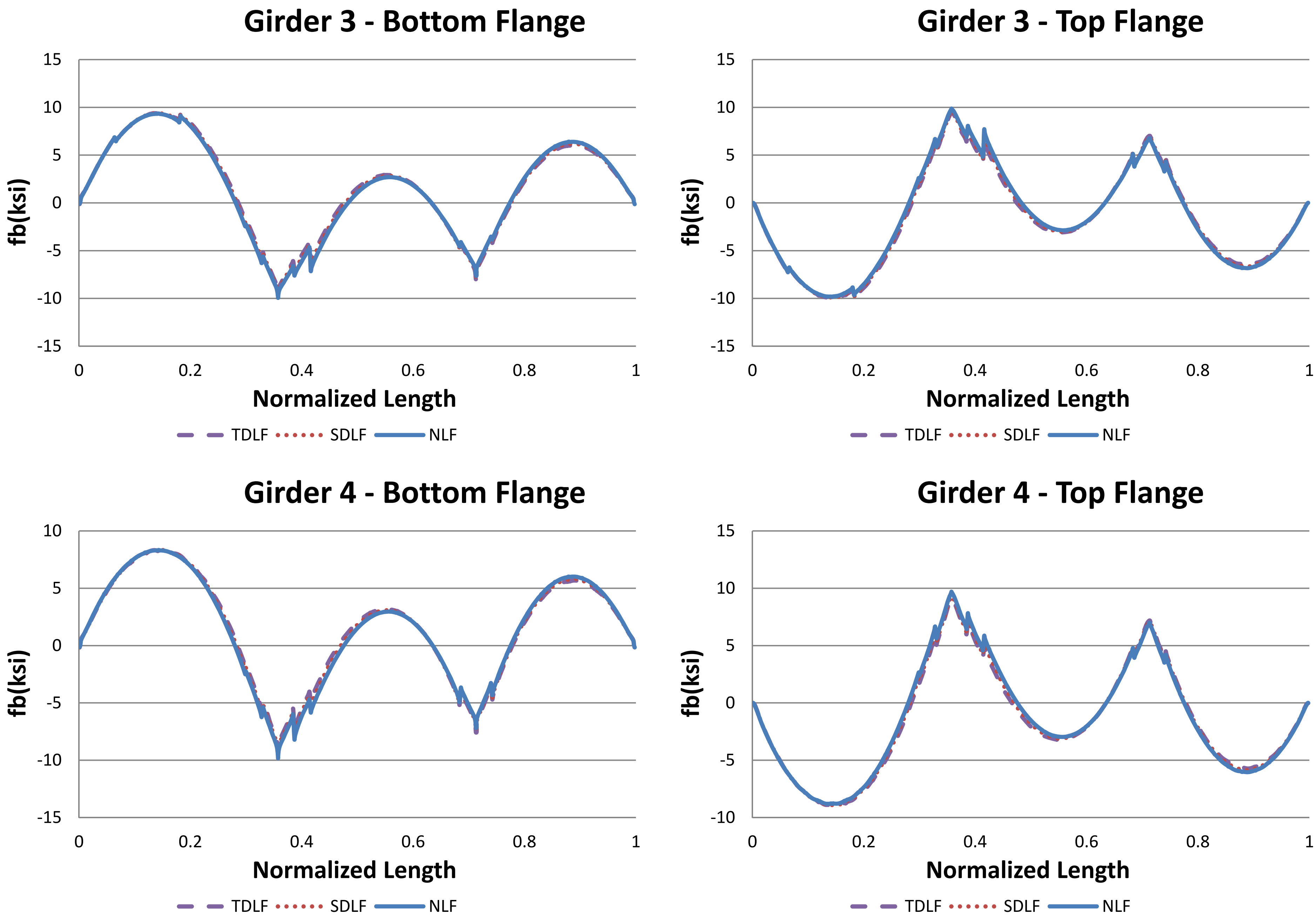


Figure F-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

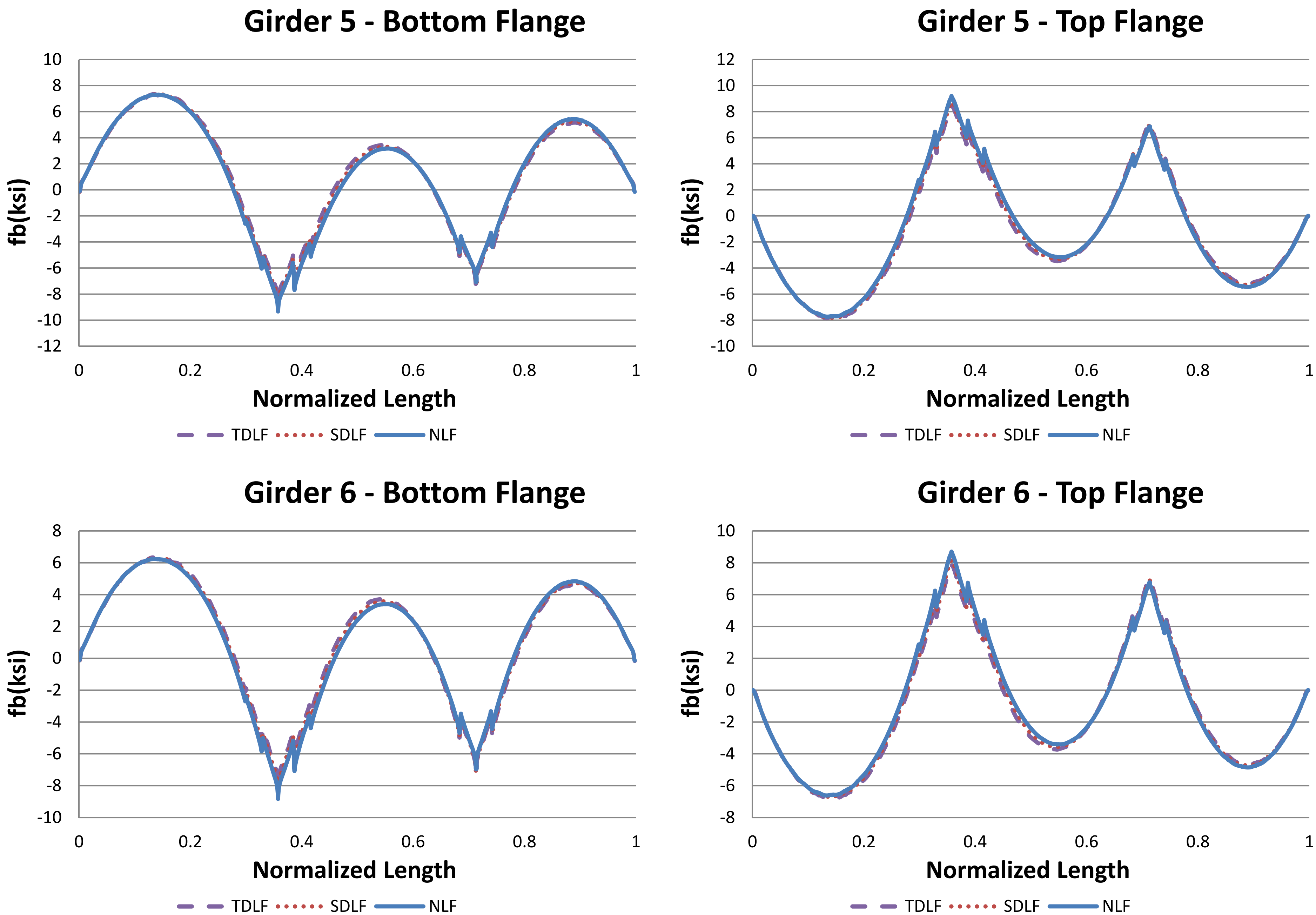


Figure F-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

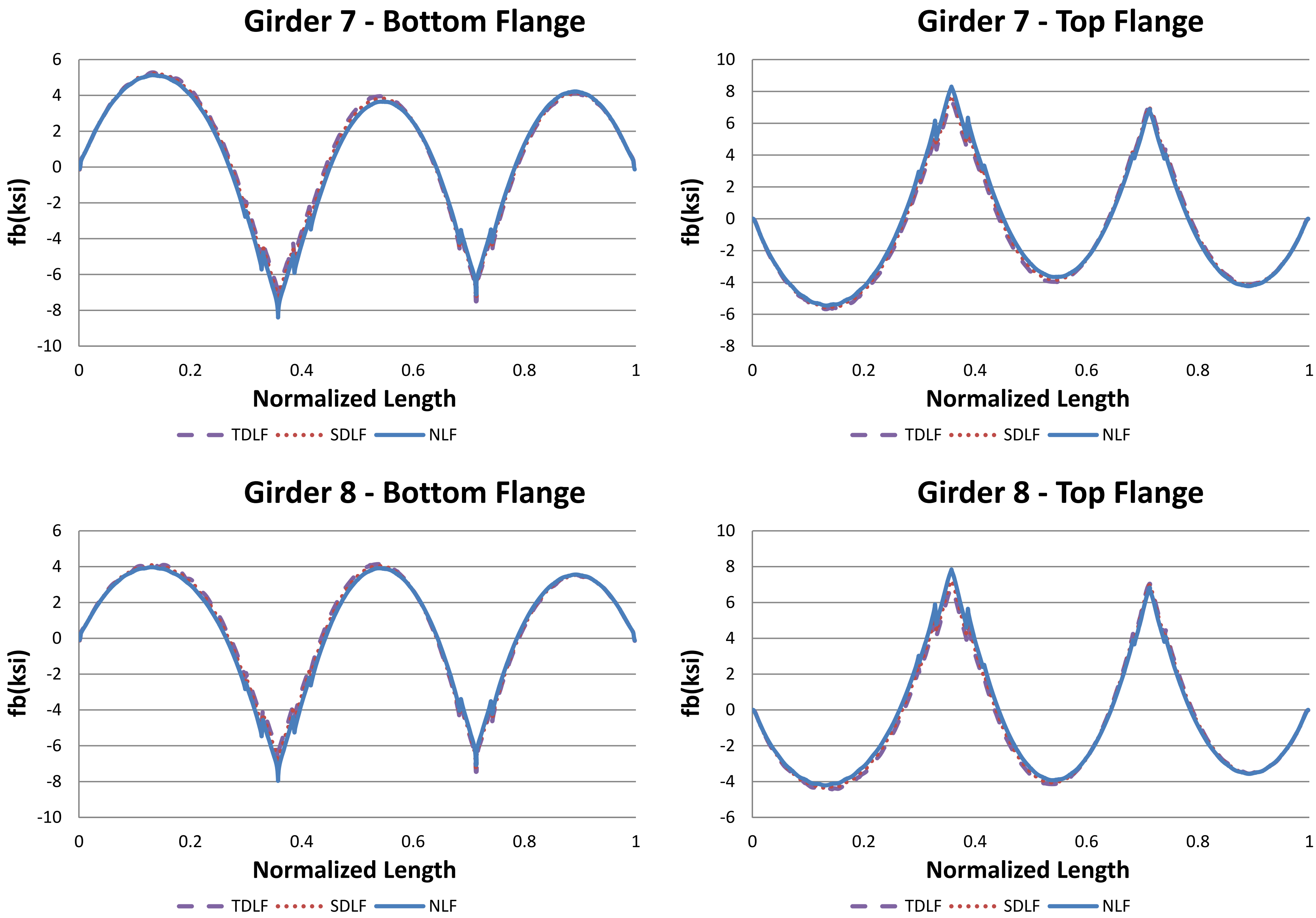
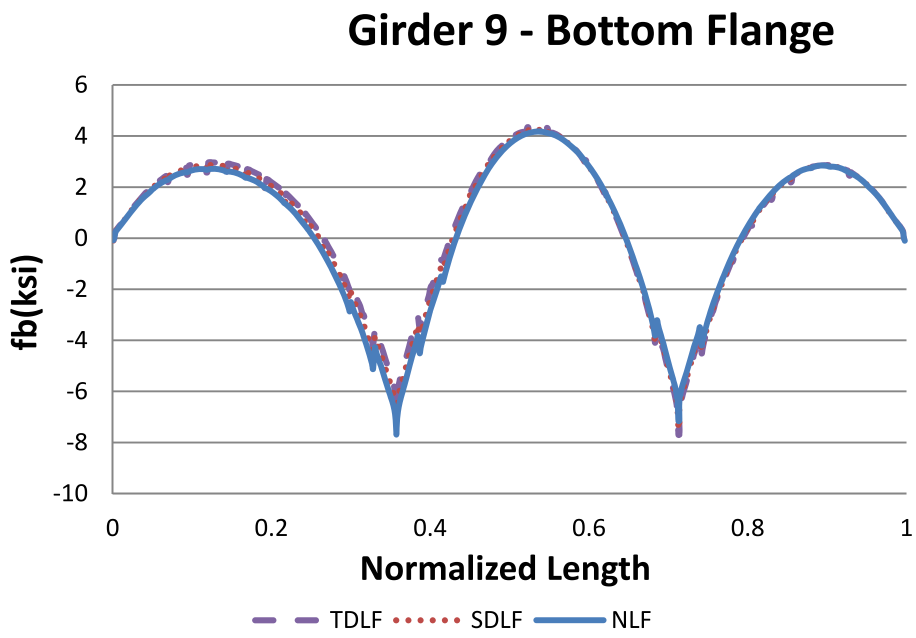


Figure F-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.



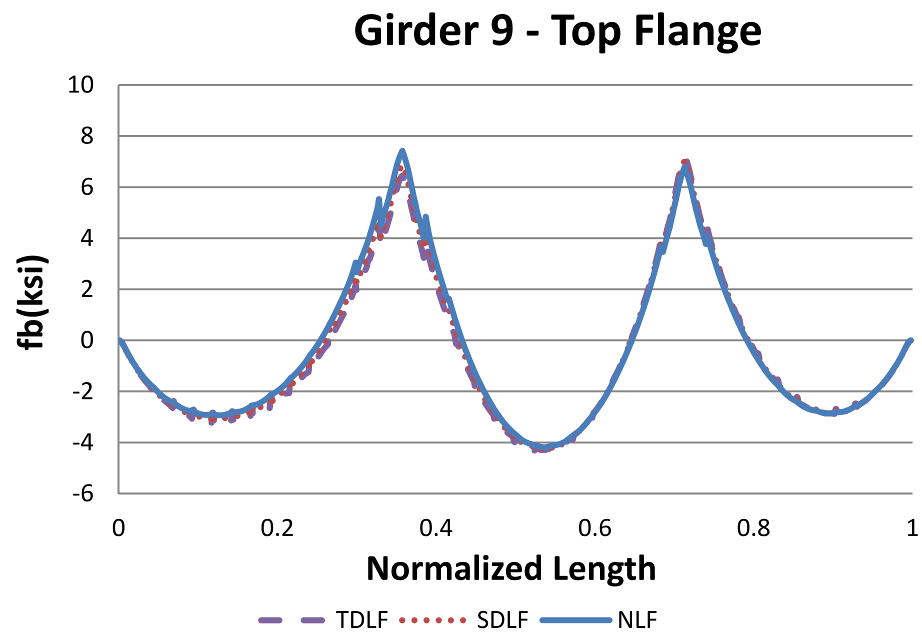


Figure F-4-18(Continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

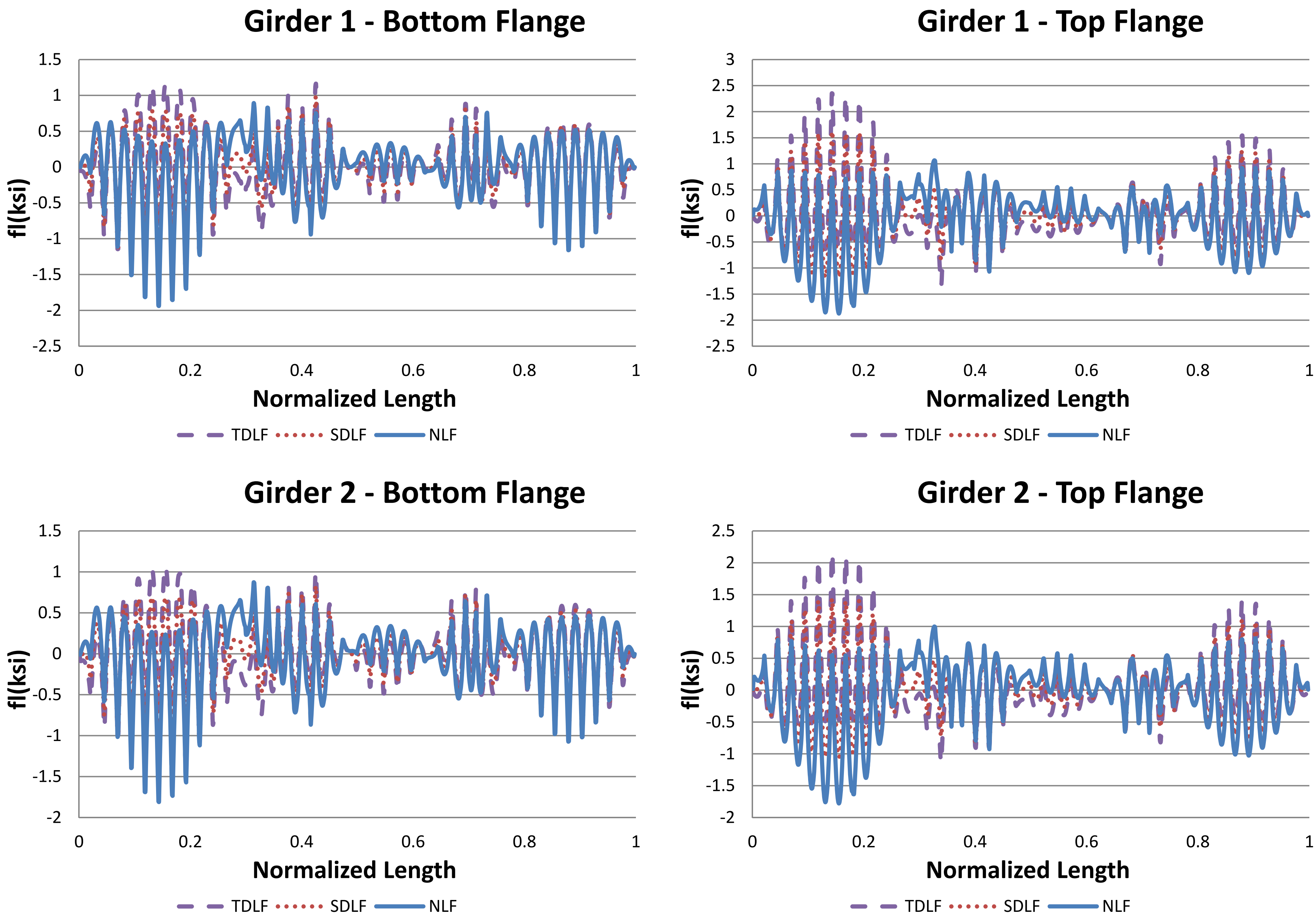


Figure F-4-19. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

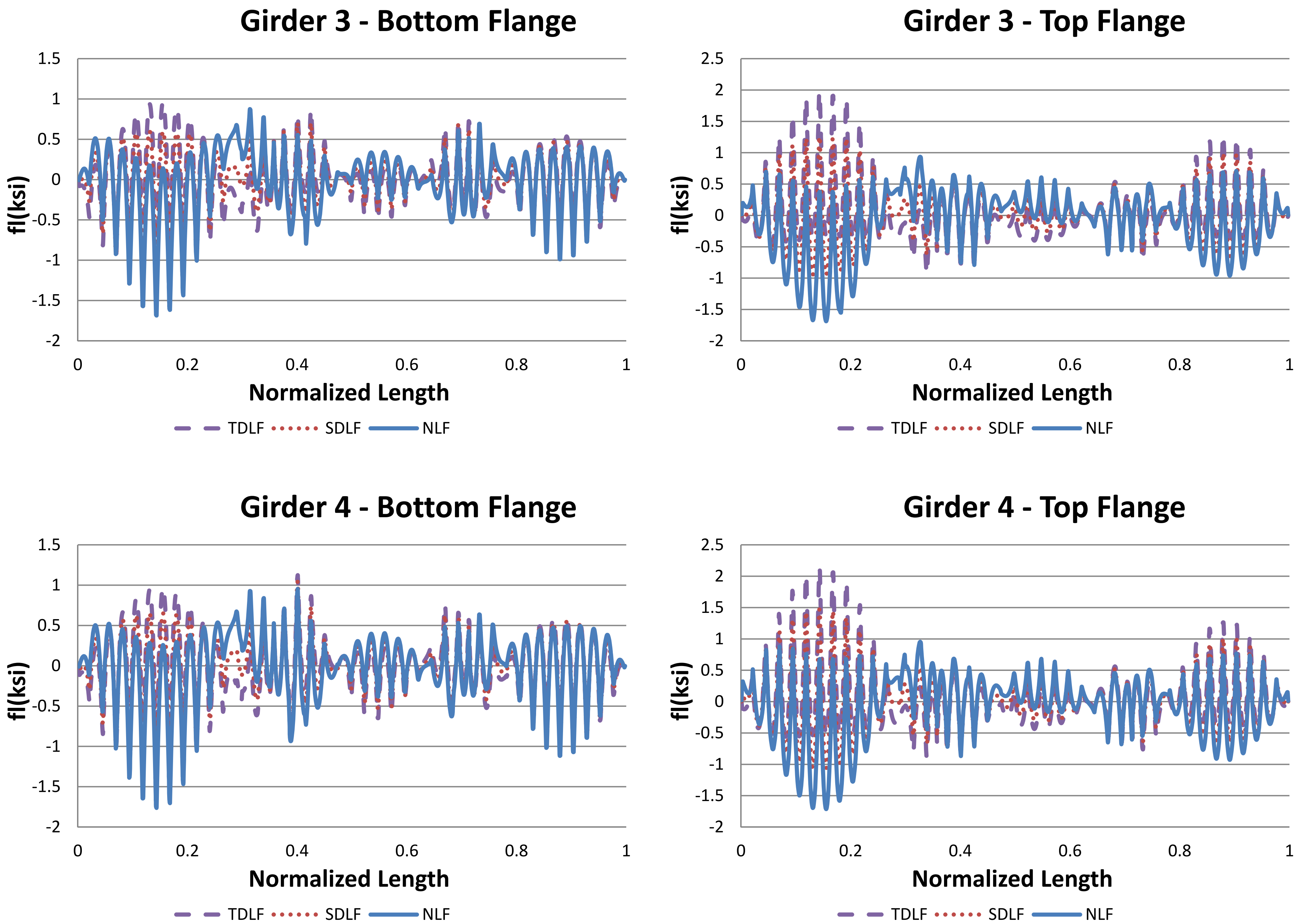


Figure F-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

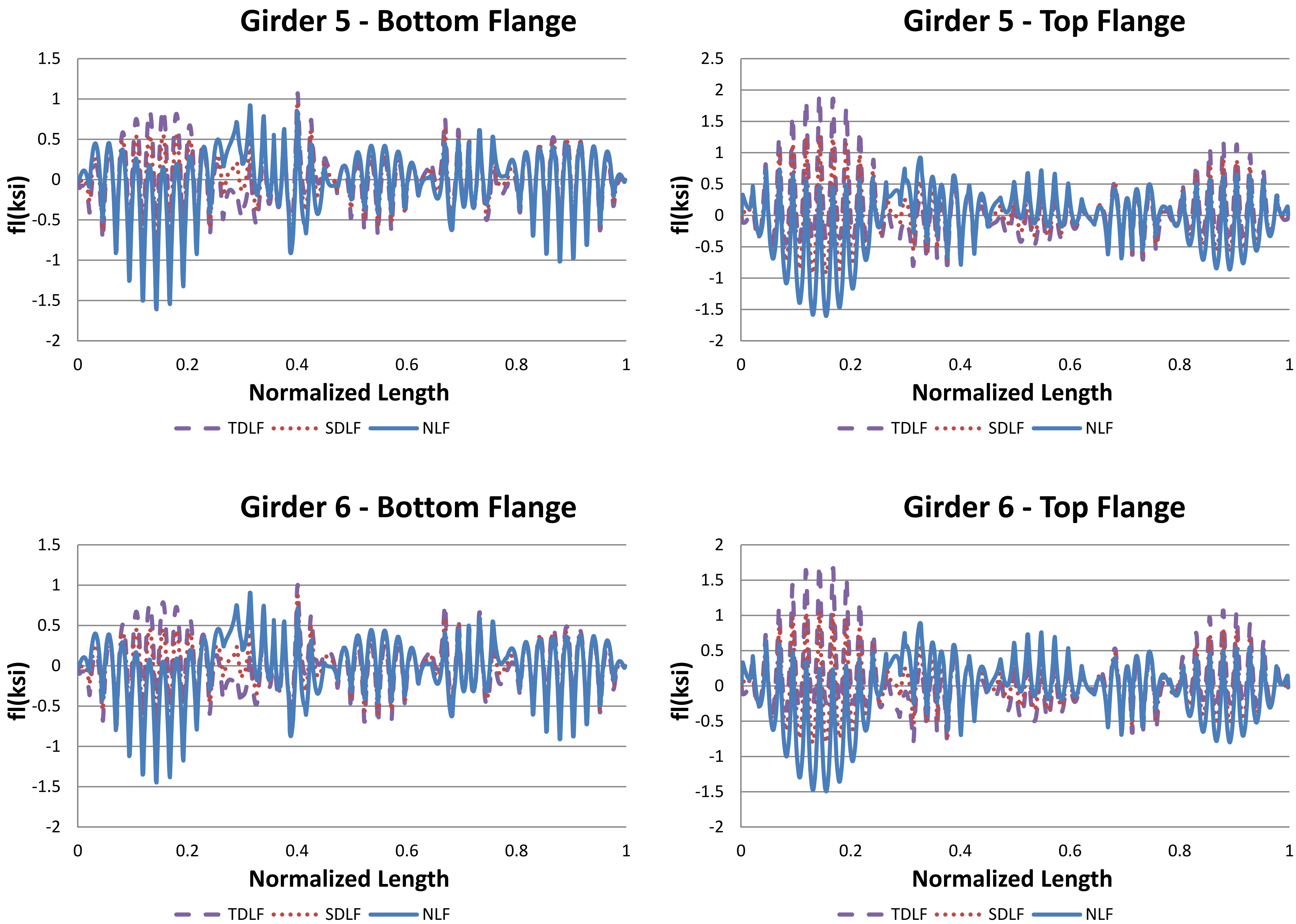


Figure F-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

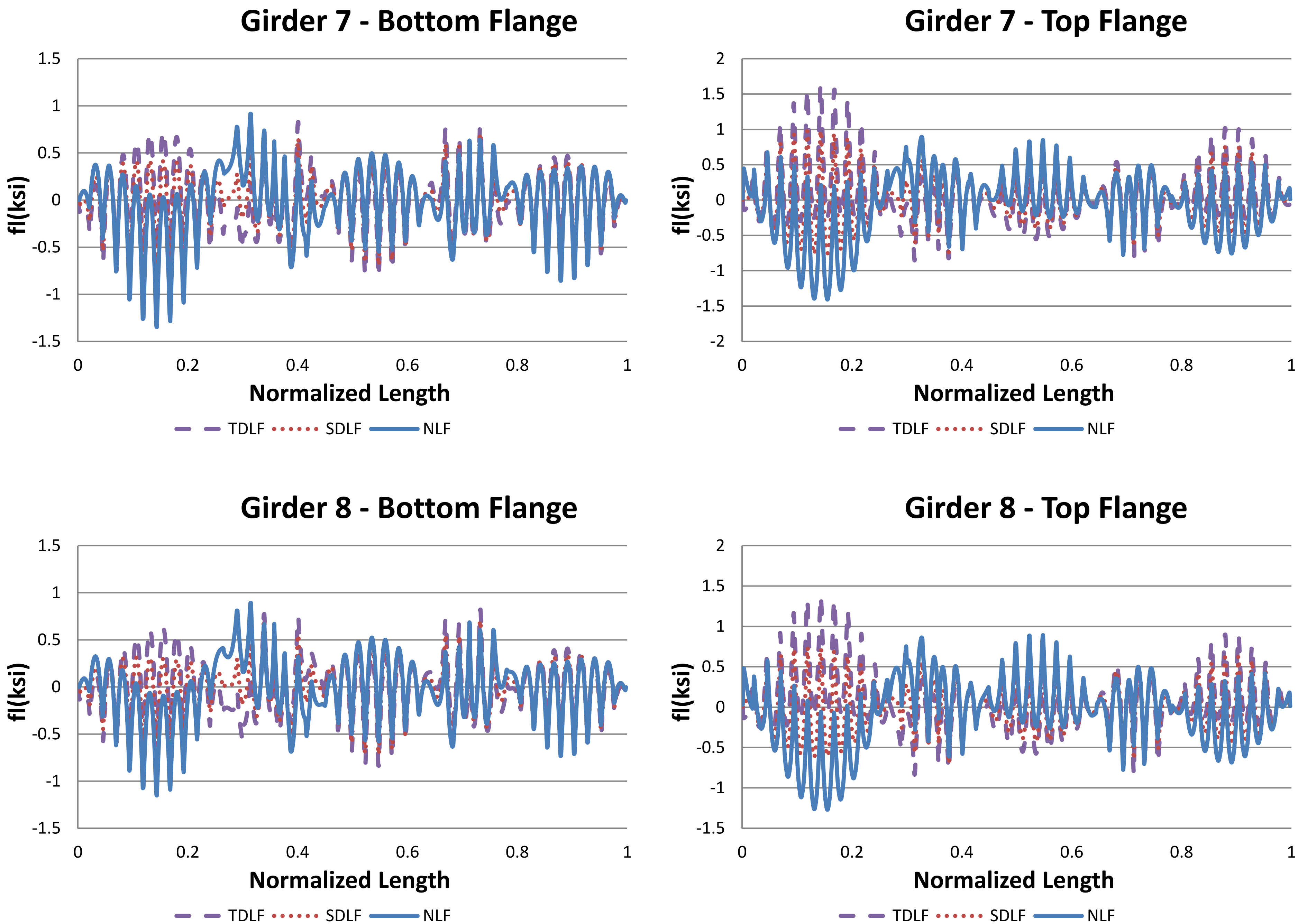
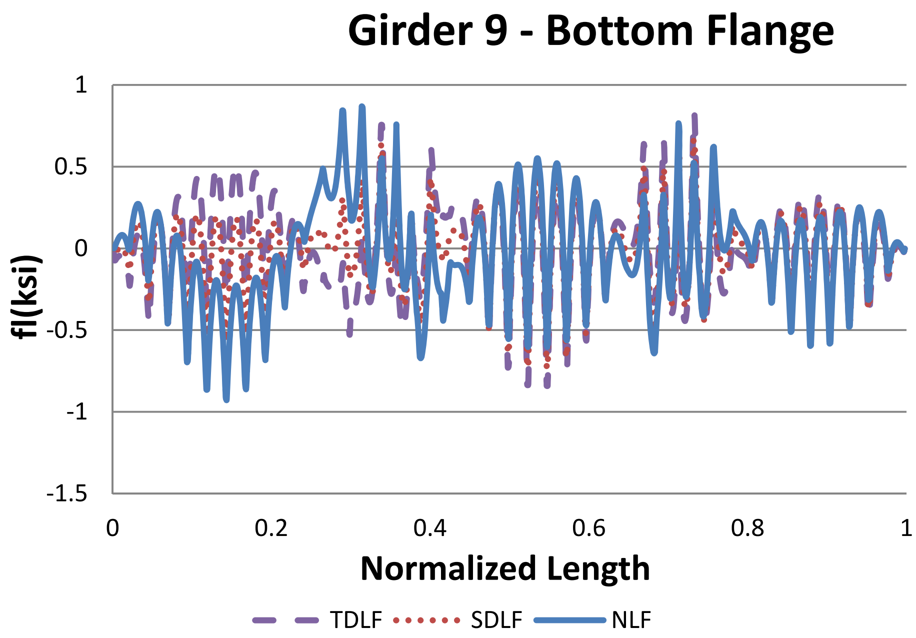


Figure F-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.



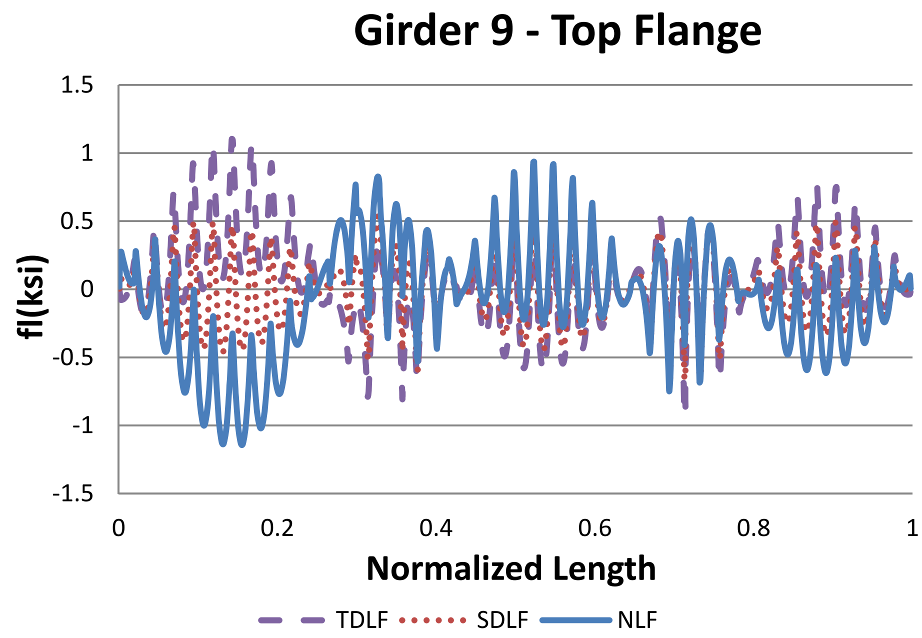


Figure F-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

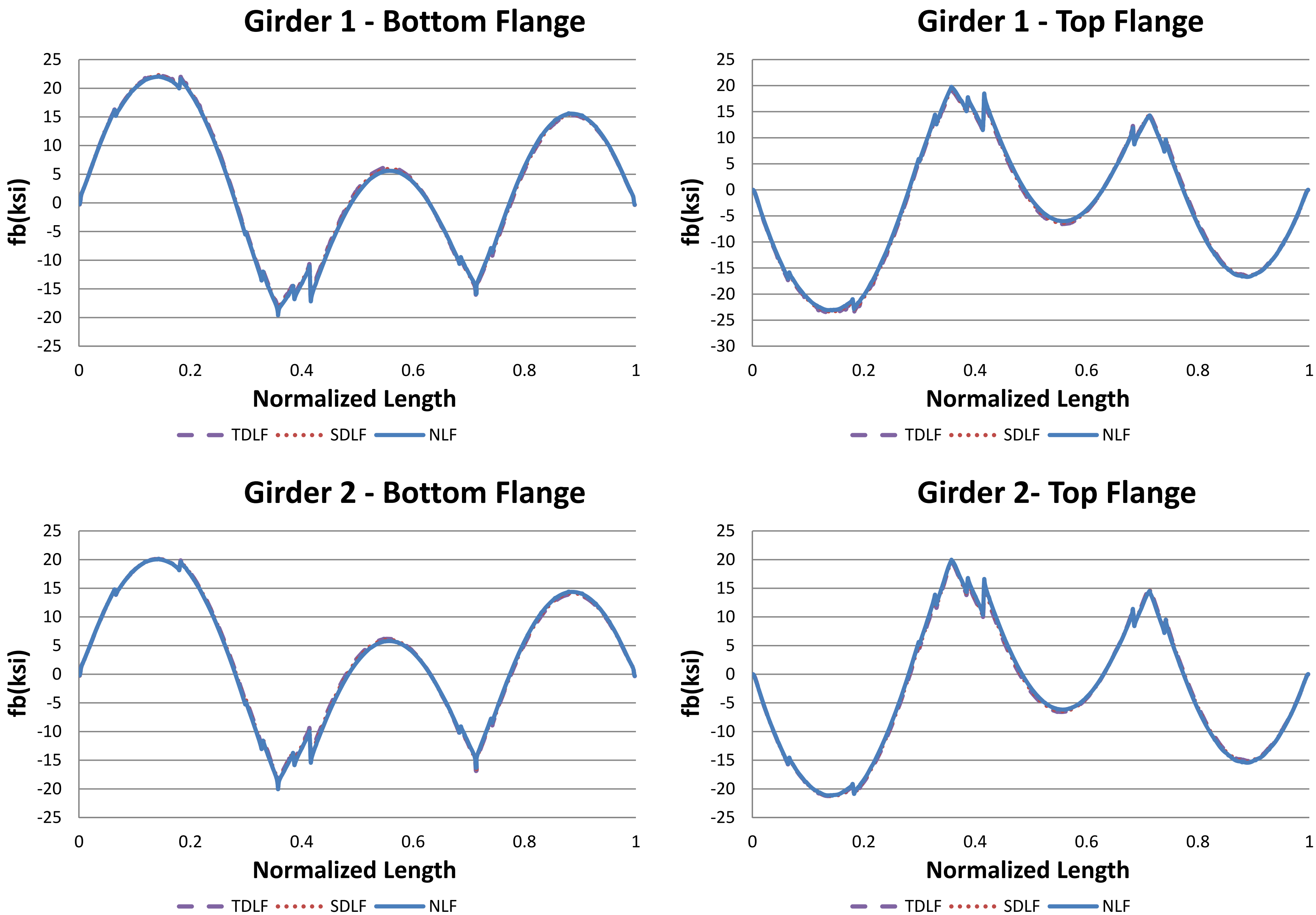


Figure F-4-20. Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

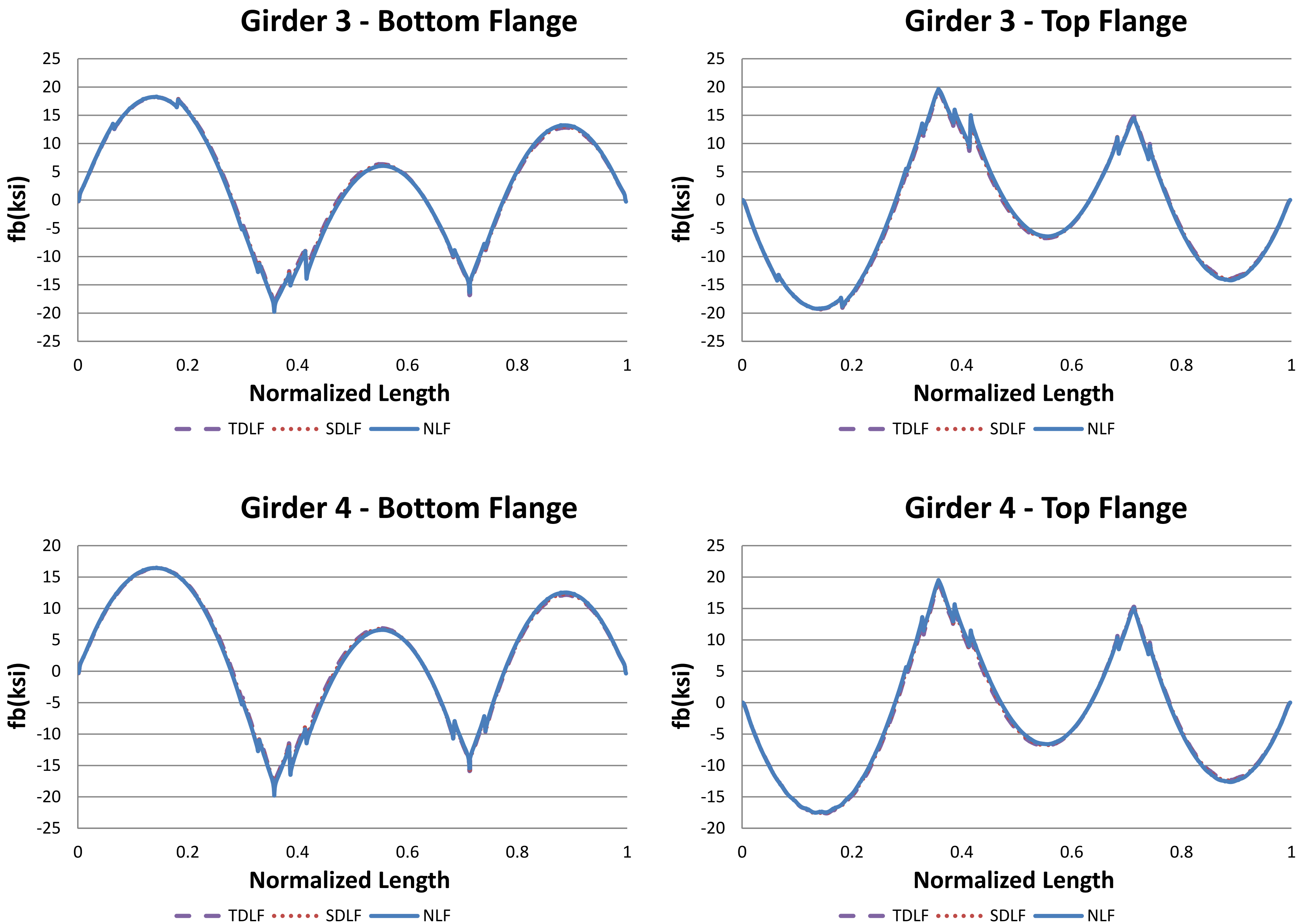


Figure F-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

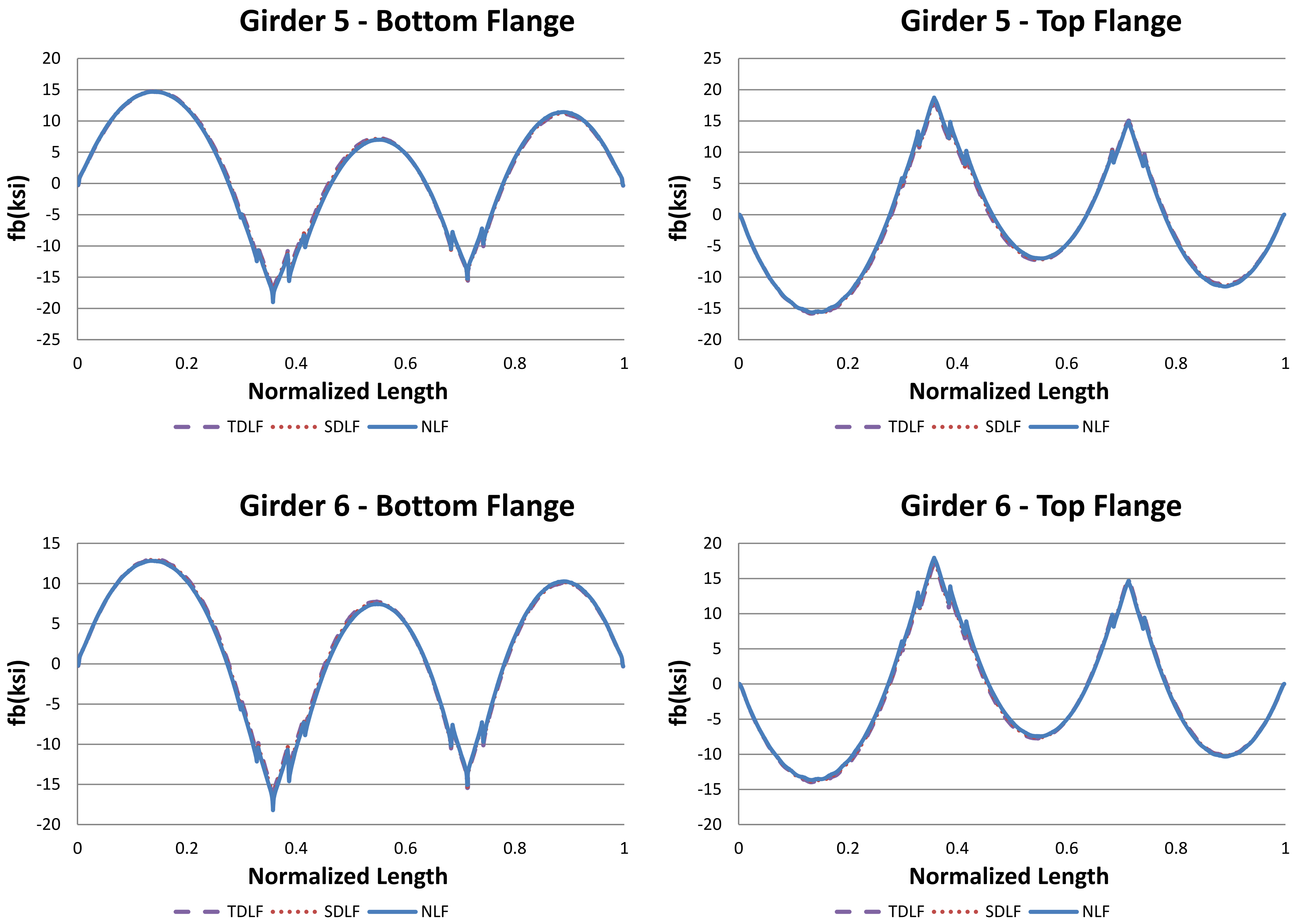


Figure F-4-20(Continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

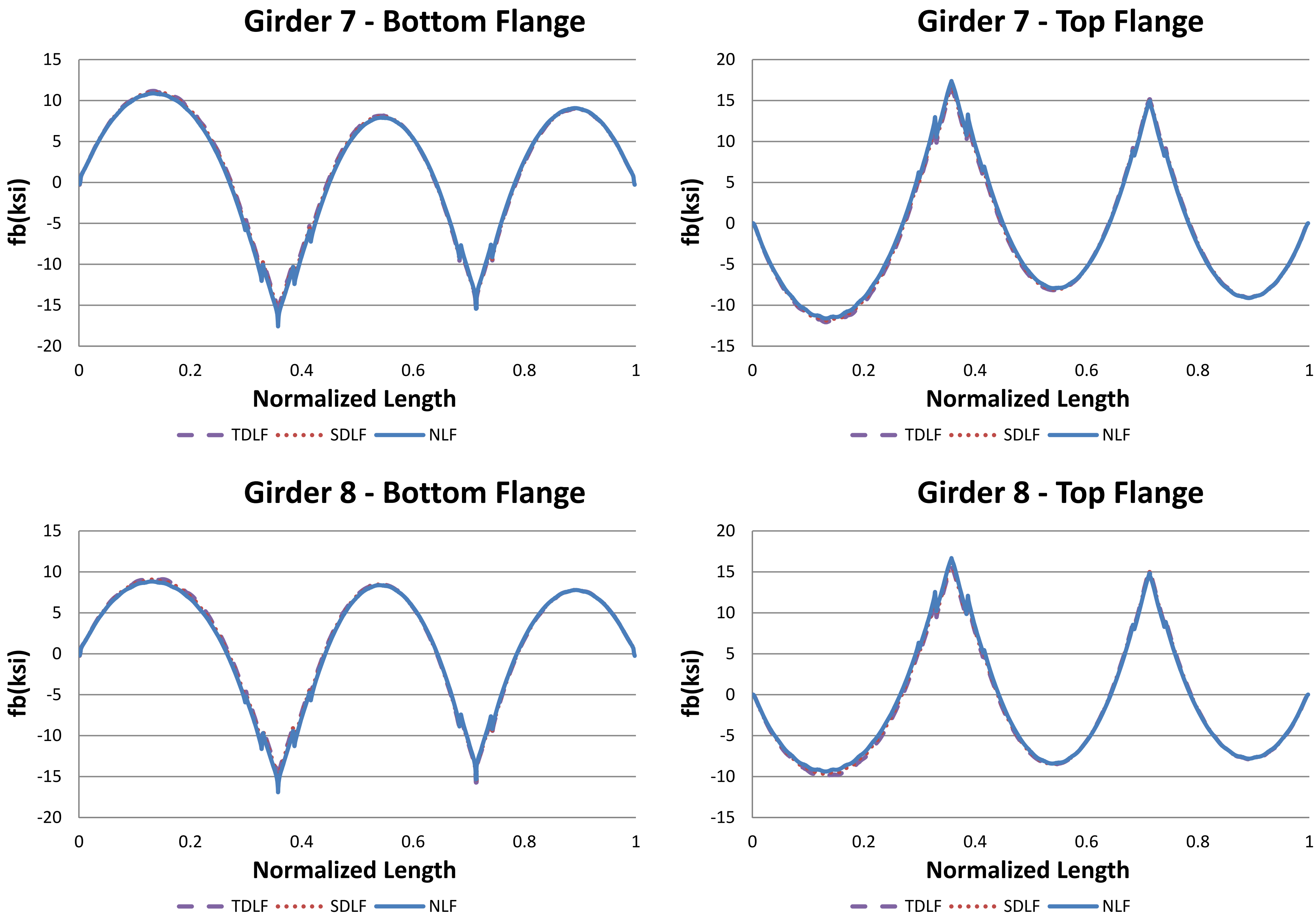
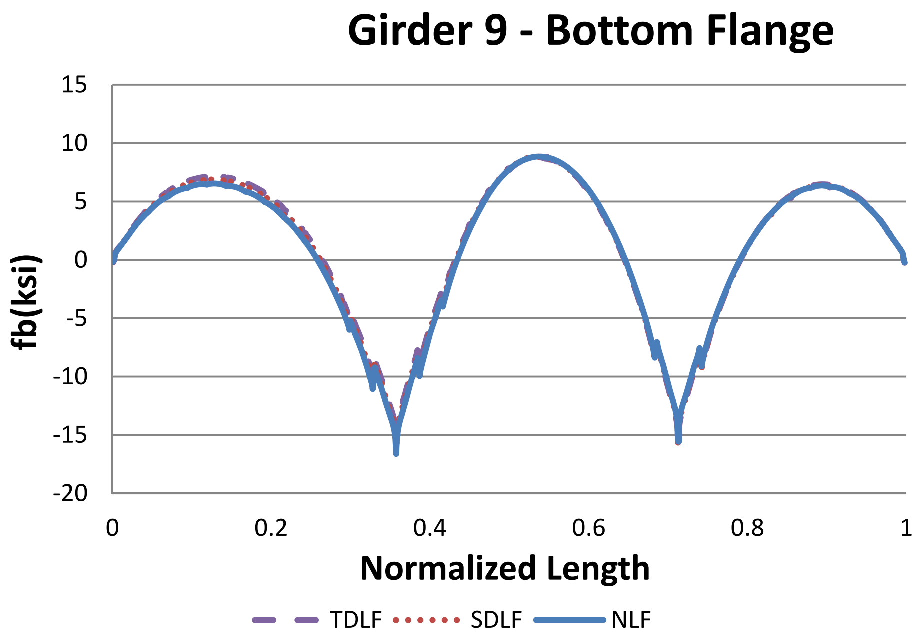


Figure F-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



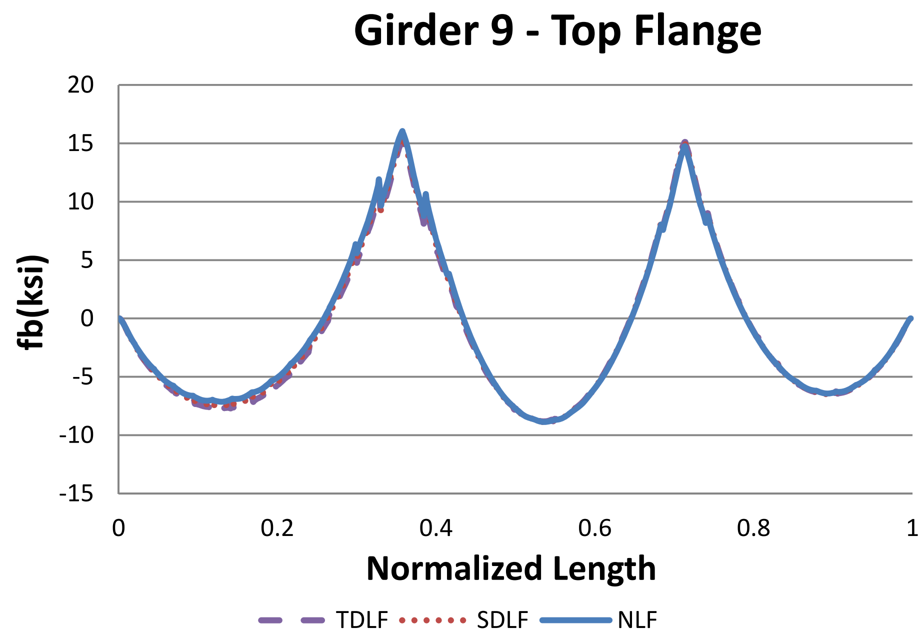


Figure F-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

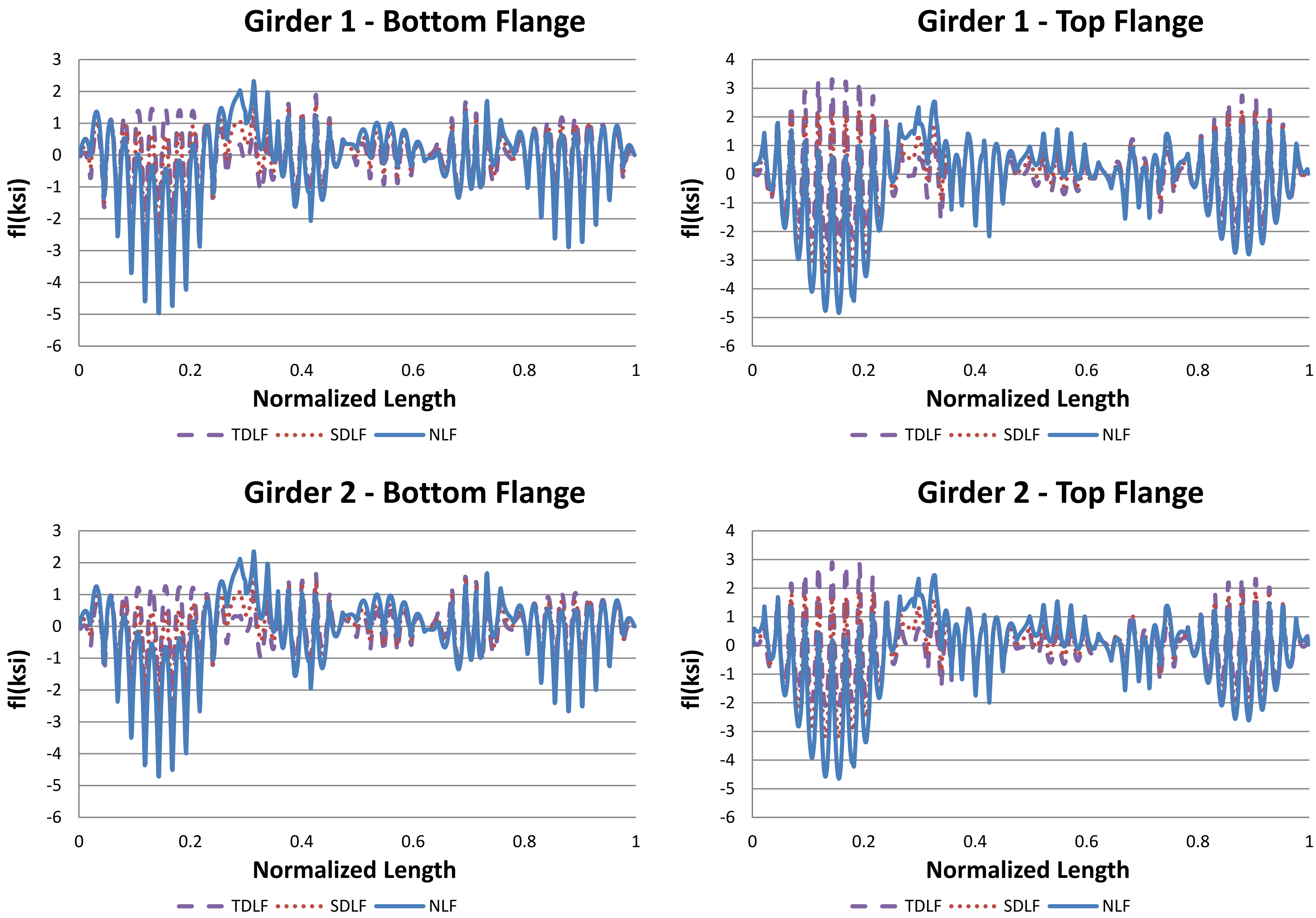


Figure F-4-21. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

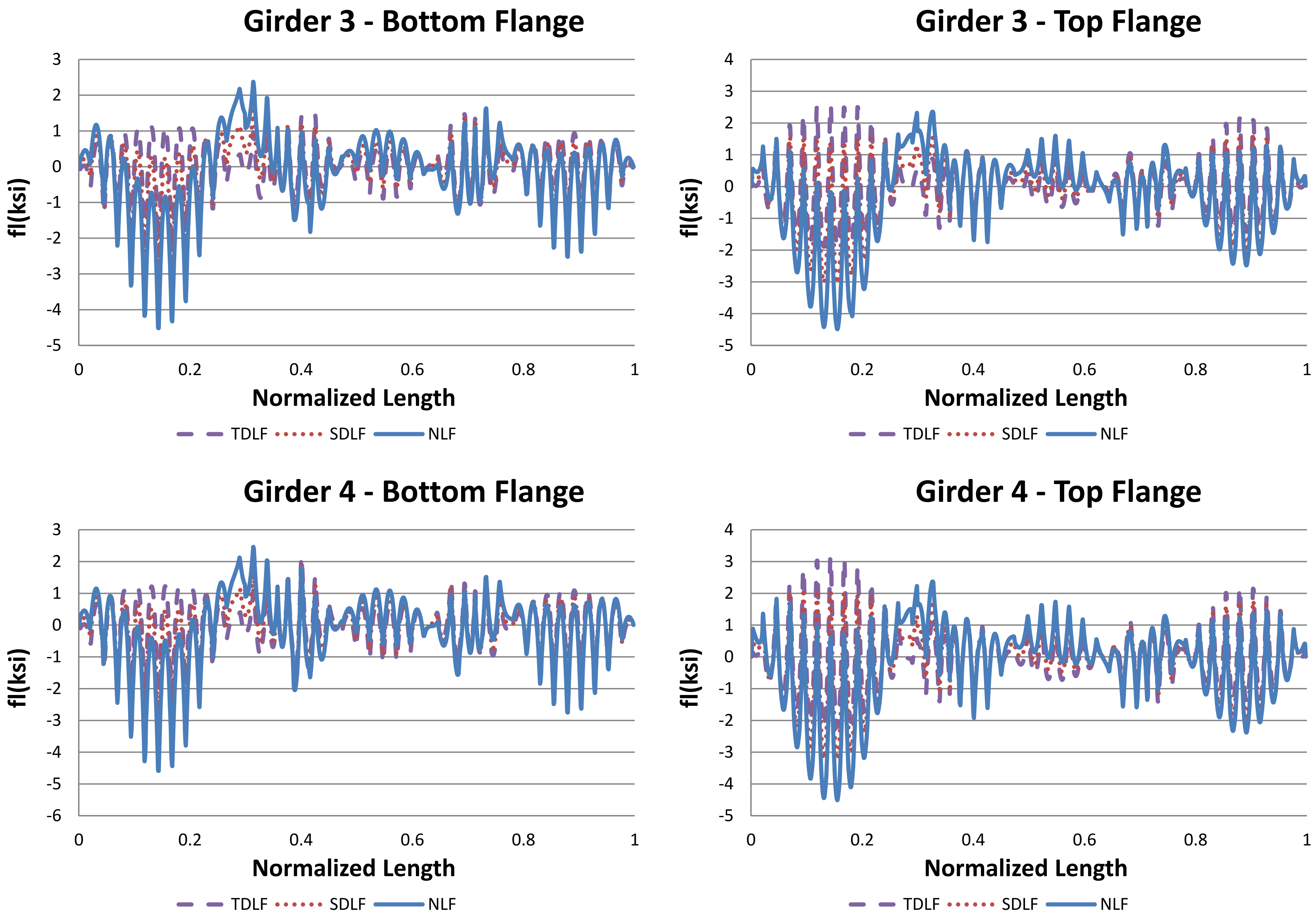


Figure F-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

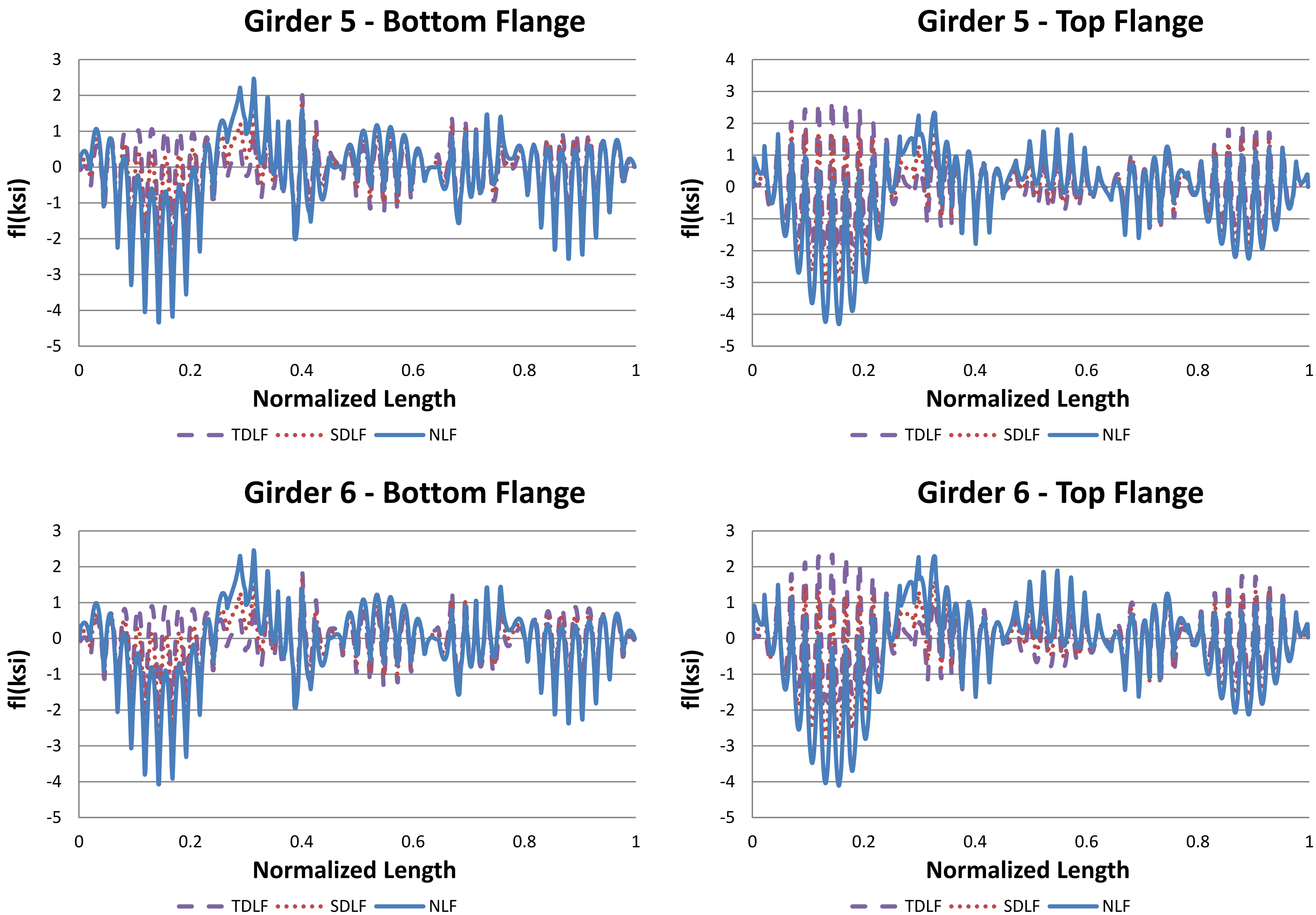


Figure F-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

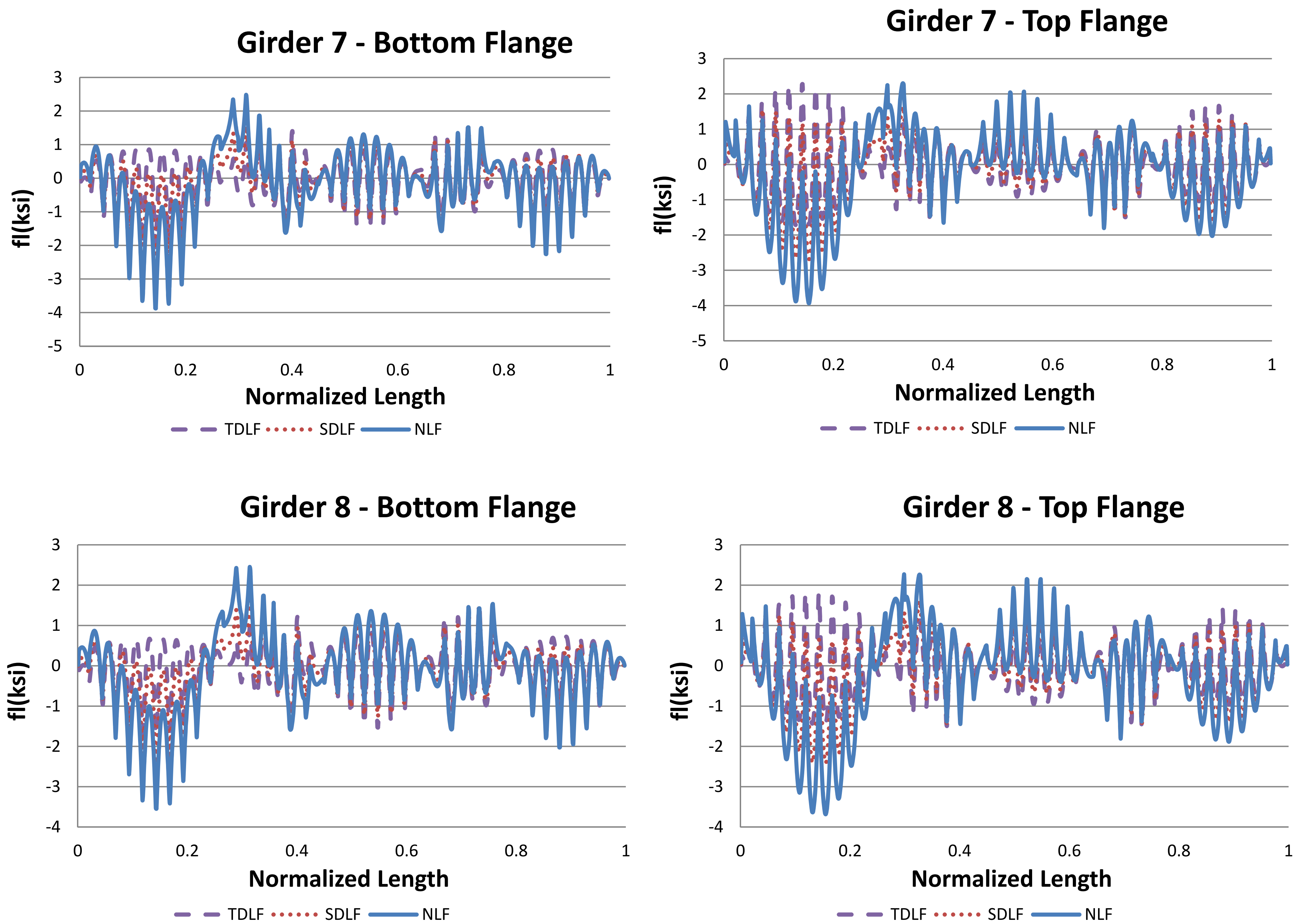
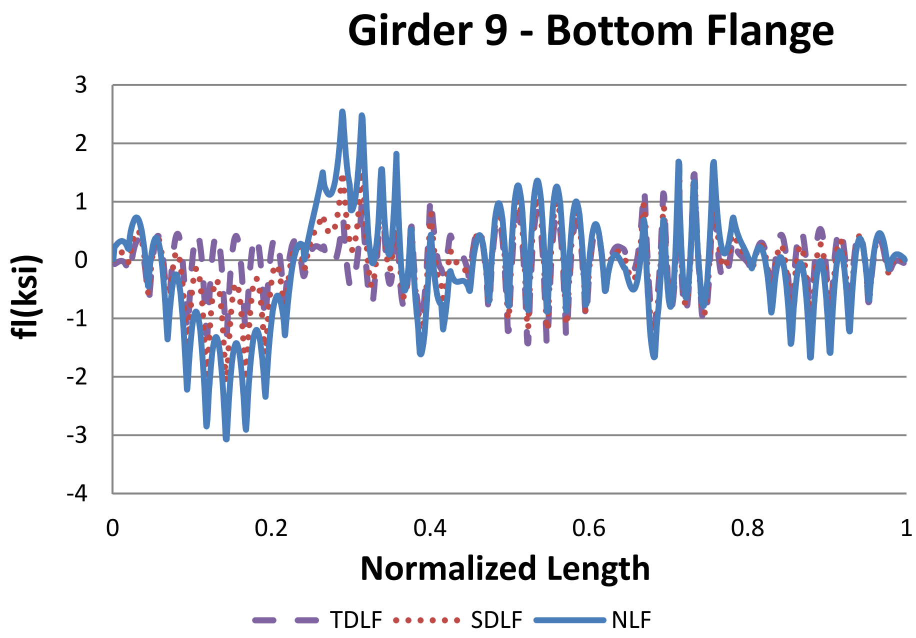


Figure F-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.



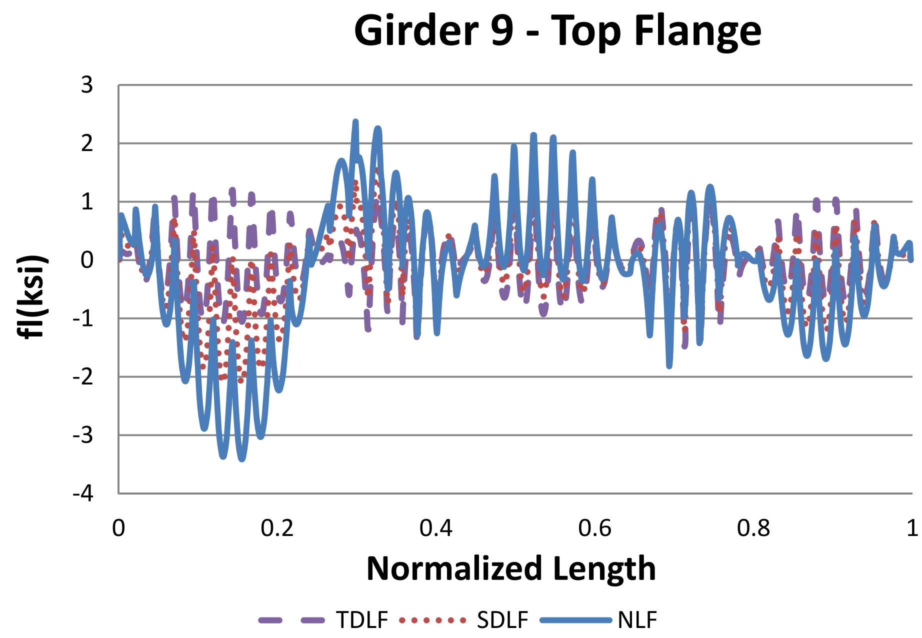


Figure F-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

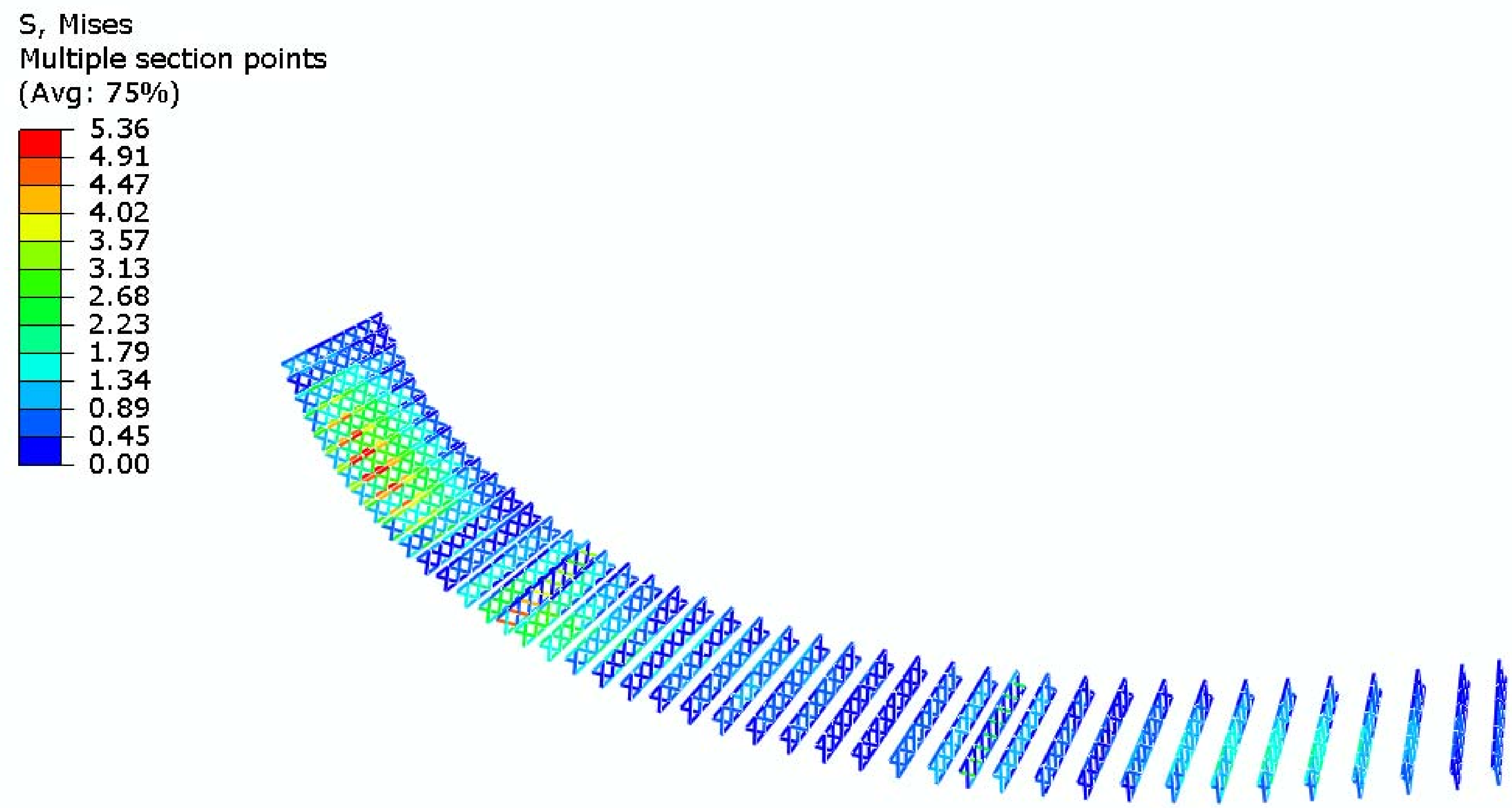


Figure F-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing (all cross-frame member areas = 10.6 in^2).

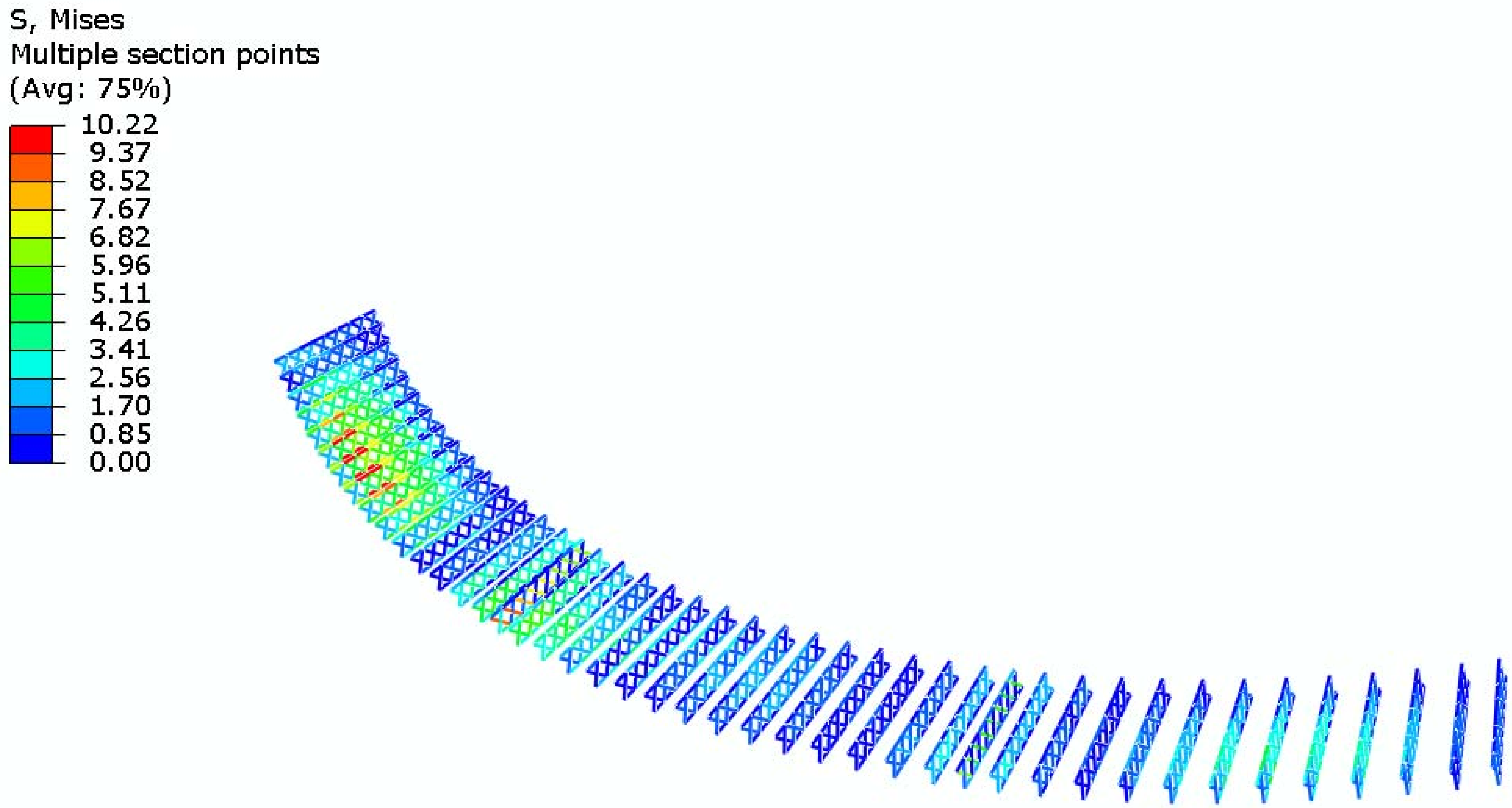


Figure F-4-23. Cross-frame stress contours under TDL, NLF detailing (all cross-frame member areas = 10.6 in^2).

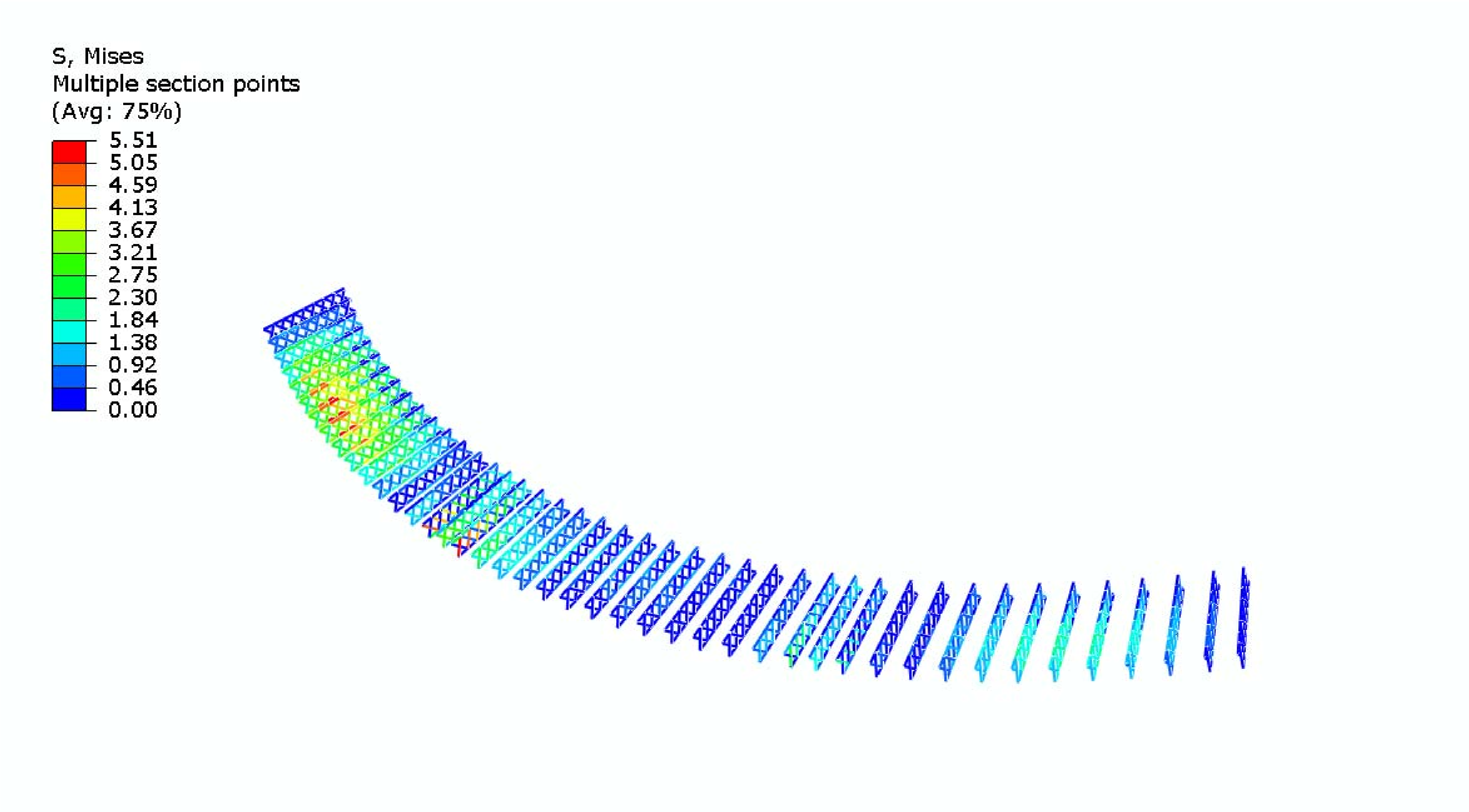


Figure F-4-24. Cross-frame stress contours under SDL, SDLF detailing (all cross-frame member areas = 10.6 in^2).

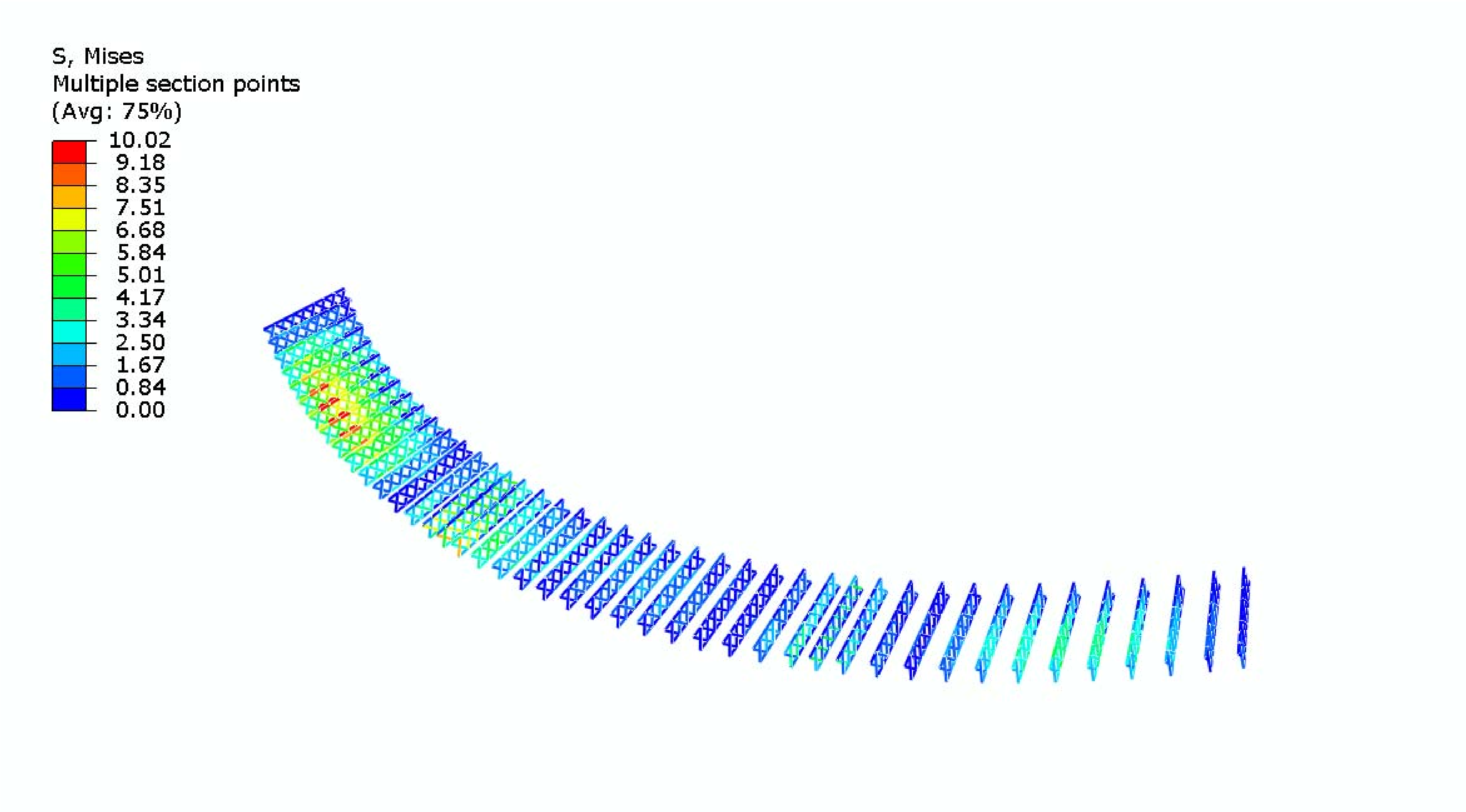


Figure F-4-25. Cross-frame stress contours under TDL, SDLF detailing (all cross-frame member areas = 10.6 in^2).

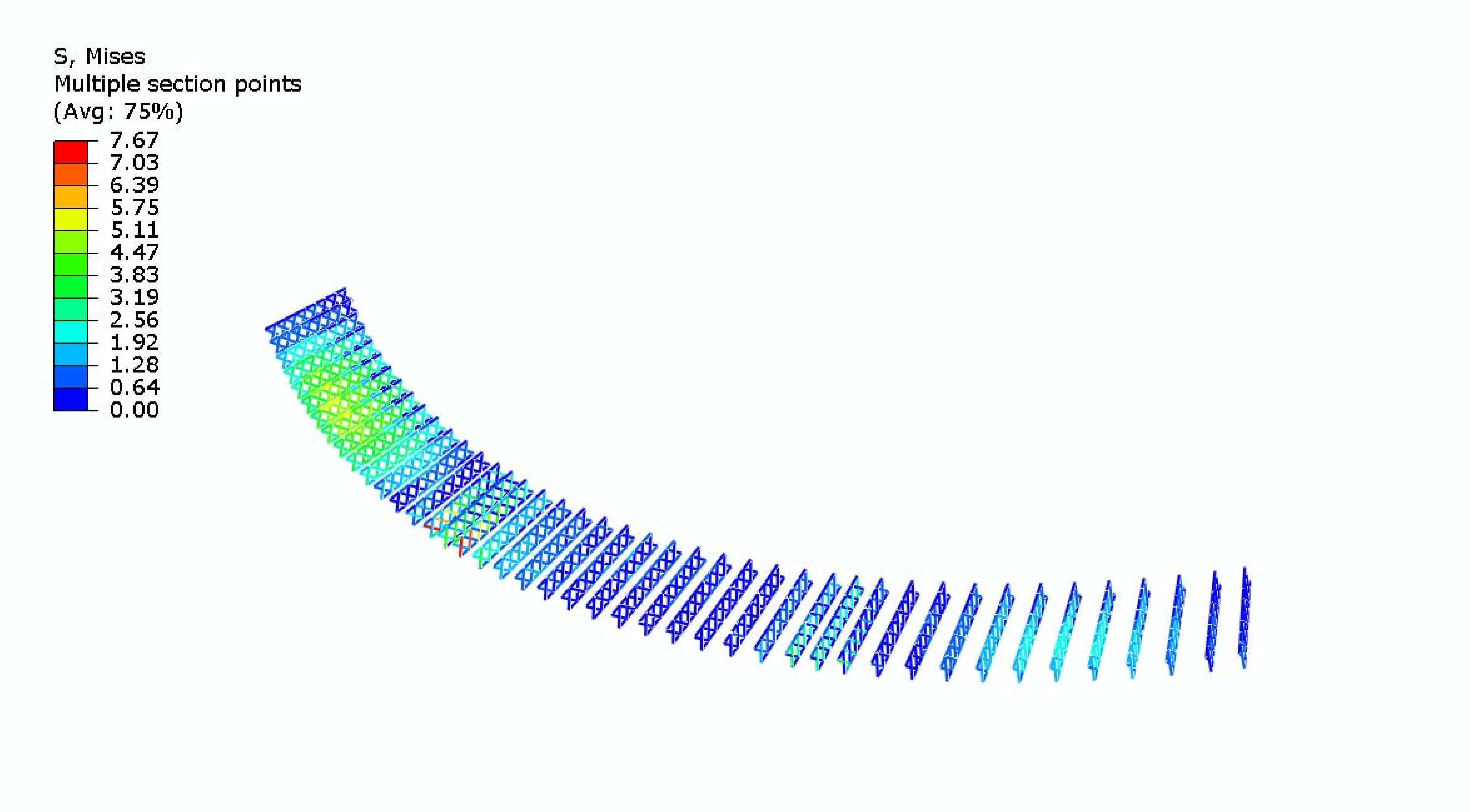


Figure F-4-26. Cross-frame stress contours under SDL, TDLF detailing (all cross-frame member areas = 10.6 in^2).

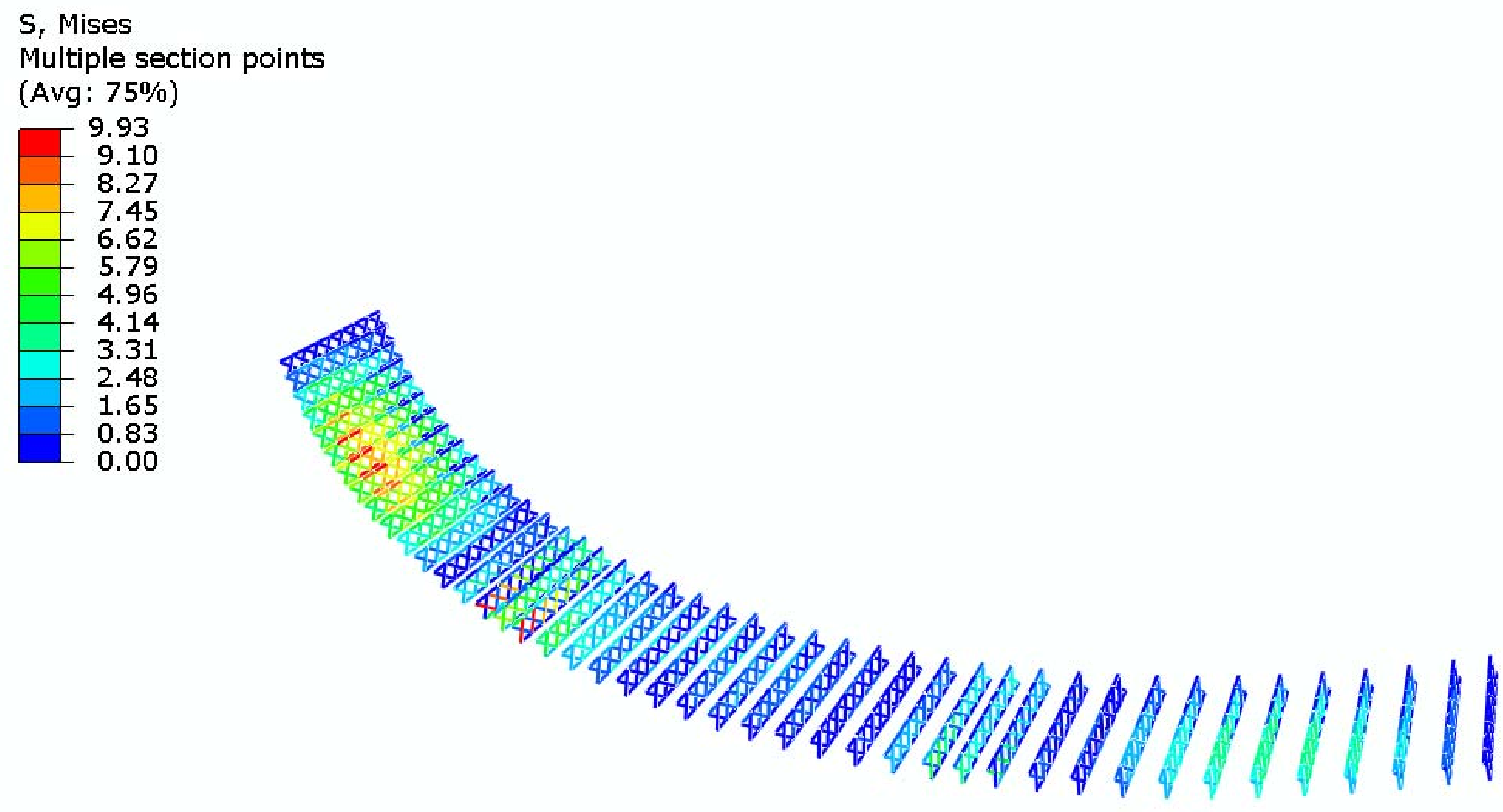


Figure F-4-27. Cross-frame stress contours under TDL, TDLF detailing (all cross-frame member areas = 10.6 in^2).

Table G4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	13.4	12.3	9.3	8.5	7.5	6.0	5.3	4.4
	SDLF	1.0	0.7	0.7	0.7	0.6	0.5	0.5	0.5
	TDLF	12.3	10.9	10.3	8.0	7.3	6.8	5.5	5.1
2	NLF	3.5	5.3	5.6	7.1	7.1	6.1	4.6	2.3
	SDLF	6.4	8.1	8.4	9.4	8.9	7.8	6.2	4.4
	TDLF	9.7	11.2	11.5	12.2	11.3	9.9	8.4	6.0
3	NLF	7.5	11.6	13.0	15.3	14.9	13.2	9.8	5.2
	SDLF	13.4	18.1	19.6	20.7	19.7	17.5	14.3	10.5
	TDLF	20.1	23.3	25.2	25.1	23.3	20.7	17.3	13.2
4	NLF	9.6	16.3	21.0	21.5	20.4	17.8	13.2	7.0
	SDLF	19.3	26.1	30.0	30.0	28.5	25.5	20.8	15.6
	TDLF	28.8	33.3	36.3	35.5	33.4	30.0	25.1	19.1
5	NLF	11.0	19.6	26.8	26.1	24.3	21.0	15.5	8.2
	SDLF	23.9	32.4	38.3	37.4	35.2	31.6	26.1	19.9
	TDLF	35.1	40.7	45.4	43.4	41.0	37.1	31.2	23.7
6	NLF	12.0	21.8	29.6	29.0	26.7	22.9	16.9	8.9
	SDLF	27.4	36.9	43.7	42.4	39.8	35.7	29.8	23.1
	TDLF	39.6	45.8	51.7	48.7	45.9	41.7	35.3	26.9
7	NLF	12.2	22.2	30.6	29.6	27.3	23.4	17.4	9.2
	SDLF	29.2	38.9	45.9	44.4	41.9	37.7	31.6	24.8
	TDLF	42.1	48.2	54.0	51.1	48.4	44.0	37.5	28.6
8	NLF	11.8	21.0	29.0	28.0	26.3	22.8	17.0	9.0
	SDLF	29.4	38.4	44.4	43.6	41.4	37.5	31.7	25.1
	TDLF	42.6	48.1	52.2	50.6	48.1	43.8	37.5	28.8
9	NLF	11.1	18.7	22.4	25.0	24.0	21.0	15.6	8.4
	SDLF	27.7	35.7	39.3	40.0	38.3	35.0	29.8	23.9
	TDLF	39.9	44.7	48.5	47.1	44.7	41.1	35.6	27.7
10	NLF	9.1	14.7	17.3	19.4	19.2	17.3	13.1	7.1
	SDLF	24.1	30.1	32.1	33.3	32.5	30.3	26.2	21.3
	TDLF	35.4	38.5	40.3	40.3	38.9	36.5	32.1	25.4

Table G4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	5.9	9.1	11.3	12.2	12.5	12.0	9.4	5.2
	SDLF	18.4	21.7	23.3	24.1	24.4	23.6	20.8	17.4
	TDLF	28.1	28.8	30.0	30.6	31.0	30.1	26.8	21.8
12	NLF	1.8	2.0	3.1	3.6	4.7	5.6	4.4	2.6
	SDLF	10.6	11.0	12.4	13.6	14.9	15.3	13.7	12.2
	TDLF	17.8	16.3	18.2	19.9	21.6	21.6	19.4	16.4
13	NLF	4.1	7.0	6.8	5.4	3.5	1.5	1.6	0.7
	SDLF	0.1	2.5	0.6	2.7	4.7	5.7	5.1	5.7
	TDLF	4.9	2.7	6.0	9.5	11.7	11.5	10.1	8.9
14	NLF	14.9	19.1	18.7	14.8	12.2	11.0	9.5	6.6
	SDLF	17.2	18.4	14.9	9.7	7.0	5.9	5.5	3.8
	TDLF	20.6	19.2	12.8	6.3	3.4	2.5	3.1	2.8
15	NLF	25.5	27.9	26.7	21.0	18.5	17.8	16.1	13.0
	SDLF	52.5	48.1	41.4	33.4	28.0	23.9	20.0	16.2
	TDLF	75.8	66.1	55.1	45.1	37.4	30.4	24.8	21.0
16	NLF	50.3	49.3	45.0	39.4	36.3	34.0	32.4	33.5
	SDLF	34.0	30.7	25.8	21.3	18.9	17.2	16.4	17.5
	TDLF	44.2	40.7	37.3	34.3	32.9	30.8	30.5	33.6
17	NLF	25.6	28.9	29.7	22.9	20.0	19.0	17.4	14.0
	SDLF	55.8	51.0	45.5	37.0	32.0	27.2	23.5	18.7
	TDLF	81.3	69.5	58.4	48.5	41.9	34.3	29.1	23.6
18	NLF	16.4	22.2	25.6	19.1	16.2	13.5	13.2	9.4
	SDLF	26.8	27.9	25.5	19.9	17.7	15.3	15.2	12.4
	TDLF	35.8	32.8	24.9	20.0	18.3	16.6	16.9	15.8
19	NLF	7.4	12.0	10.2	12.9	11.3	7.4	7.8	5.1
	SDLF	13.0	16.3	14.6	14.0	11.9	9.3	9.7	7.8
	TDLF	17.0	19.4	18.0	14.7	12.7	11.2	11.8	11.0
20	NLF	2.4	4.0	2.4	5.7	5.7	3.9	3.7	2.6
	SDLF	7.4	8.9	7.5	9.1	7.9	5.9	6.1	5.4
	TDLF	10.4	13.7	12.1	12.2	10.3	8.0	8.5	8.7

Table G4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
		CF Location							
21	NLF	1.5	2.1	2.8	1.0	0.1	0.0	0.3	0.7
	SDLF	3.5	2.7	1.8	3.4	3.5	2.9	3.1	3.7
	TDLF	6.8	7.3	6.0	7.3	6.9	5.6	5.7	7.2
22	NLF	3.6	5.5	6.5	5.7	4.6	3.5	2.4	0.7
	SDLF	1.0	2.0	3.0	2.1	1.2	0.5	1.1	2.6
	TDLF	4.3	2.7	1.5	2.5	3.3	3.5	4.0	6.3
23	NLF	4.7	7.4	8.9	8.6	7.6	6.1	4.3	1.7
	SDLF	1.6	4.3	5.7	5.2	4.0	2.6	1.0	1.7
	TDLF	2.5	2.8	3.6	2.6	1.2	1.5	2.8	5.6
24	NLF	5.0	8.0	9.8	9.7	8.9	7.4	5.3	2.3
	SDLF	2.1	5.1	6.8	6.5	5.4	3.8	1.9	1.1
	TDLF	1.5	4.1	5.1	4.2	2.7	1.2	1.9	4.8
25	NLF	4.7	7.5	9.2	9.1	8.4	7.2	5.3	2.4
	SDLF	2.1	4.9	6.3	6.0	5.1	3.8	2.1	0.8
	TDLF	1.2	3.9	4.7	3.8	2.7	1.5	1.4	4.2
26	NLF	3.7	5.8	7.0	6.8	6.4	5.7	4.3	2.0
	SDLF	1.3	3.3	4.3	3.9	3.3	2.6	1.3	0.9
	TDLF	1.6	2.1	2.7	1.9	1.4	0.8	1.7	3.9
27	NLF	2.0	2.7	3.3	3.0	2.9	2.9	2.1	0.9
	SDLF	0.3	0.3	0.9	0.5	0.5	0.5	0.6	1.8
	TDLF	3.1	3.2	2.4	2.5	2.4	2.2	3.3	4.4
28	NLF	0.8	1.9	1.7	2.1	1.6	0.5	1.3	1.1
	SDLF	3.2	4.4	3.9	3.7	3.4	2.7	3.8	3.7
	TDLF	6.0	7.2	6.3	5.4	5.1	4.8	6.2	6.2
29	NLF	6.2	8.5	8.8	7.8	7.1	5.4	6.6	5.0
	SDLF	10.2	11.0	10.1	8.7	8.0	7.2	8.4	7.7
	TDLF	14.2	13.5	11.1	9.2	8.5	8.7	10.1	10.5
30	NLF	12.5	14.0	13.3	11.8	11.0	11.4	10.8	9.0
	SDLF	26.1	24.0	20.8	17.9	15.8	14.1	12.9	11.9
	TDLF	38.5	32.9	27.2	22.9	19.5	16.0	14.4	15.2

Table G4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
31	NLF	30.6	29.6	28.1	26.3	25.3	25.1	24.3	26.0
	SDLF	18.4	17.0	15.1	13.6	12.9	12.7	13.0	14.8
	TDLF	29.9	28.6	27.0	26.2	25.7	24.4	25.1	27.8
32	NLF	12.3	13.6	12.8	11.2	10.4	10.8	10.5	8.9
	SDLF	24.1	22.4	19.3	16.2	14.1	12.6	11.8	10.3
	TDLF	35.4	31.0	25.9	21.1	17.8	14.5	13.2	12.0
33	NLF	5.1	6.8	6.5	5.7	5.0	3.5	5.0	4.0
	SDLF	5.8	6.6	5.3	4.2	3.6	2.8	4.1	3.4
	TDLF	6.9	6.7	4.3	2.8	2.2	2.2	3.3	3.1
34	NLF	0.5	0.3	1.1	0.9	1.4	2.1	0.8	0.2
	SDLF	2.7	2.1	3.2	3.4	3.7	4.2	2.7	2.4
	TDLF	5.2	4.3	5.6	6.4	6.8	6.9	4.9	4.3
35	NLF	3.6	5.4	6.8	6.9	6.9	6.6	5.0	2.6
	SDLF	7.1	8.5	9.7	9.8	9.8	9.5	8.0	6.2
	TDLF	11.7	11.8	12.9	12.7	12.8	12.6	10.8	8.7
36	NLF	5.6	9.0	11.3	11.7	11.4	10.3	8.0	4.3
	SDLF	9.9	13.1	15.0	15.2	14.8	13.8	11.7	8.7
	TDLF	16.0	17.6	18.8	18.3	17.8	16.9	14.9	11.6
37	NLF	6.8	11.2	14.2	14.9	14.5	12.8	9.8	5.2
	SDLF	11.4	15.9	18.4	18.8	18.1	16.6	13.9	10.0
	TDLF	18.4	21.0	22.8	22.2	21.3	19.7	17.1	13.1
38	NLF	7.3	12.1	15.5	16.4	15.9	14.0	10.6	5.6
	SDLF	11.9	16.9	19.9	20.4	19.6	17.7	14.6	10.3
	TDLF	19.1	22.3	24.4	23.9	22.8	20.8	17.7	13.4
39	NLF	7.1	11.9	15.3	16.1	15.6	13.8	10.4	5.5
	SDLF	11.6	16.2	19.3	19.8	19.0	17.1	14.0	9.7
	TDLF	18.1	21.3	23.6	23.2	22.0	20.0	16.8	12.5
40	NLF	6.4	10.5	13.4	14.1	13.7	12.1	9.2	4.8
	SDLF	10.2	14.0	16.6	17.0	16.3	14.7	12.0	8.2
	TDLF	15.6	18.4	20.4	20.0	19.0	17.3	14.5	10.7

Table G4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
41	NLF	5.0	8.0	10.1	10.5	10.2	9.1	7.0	3.7
	SDLF	7.9	10.5	12.4	12.4	11.9	10.8	8.8	6.0
	TDLF	11.6	13.6	15.0	14.7	14.0	12.8	10.8	7.9
42	NLF	2.5	3.9	4.8	5.1	5.0	4.4	3.4	1.8
	SDLF	4.1	5.2	6.1	6.2	6.0	5.4	4.4	2.8
	TDLF	6.1	6.9	7.6	7.5	7.2	6.6	5.7	4.0
43	NLF	8.4	7.9	6.5	6.3	5.8	5.2	4.7	4.3
	SDLF	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.2
	TDLF	8.6	7.5	7.4	6.2	5.9	5.5	4.9	4.5

Table F-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	26.0	24.2	18.8	17.2	15.5	12.6	11.2	9.6
	SDLF	13.1	12.1	9.3	8.8	8.0	6.7	6.1	5.3
	TDLF	1.7	1.2	1.1	1.0	0.8	0.7	0.6	0.4
2	NLF	7.0	10.7	11.8	14.1	13.8	12.0	8.4	3.6
	SDLF	10.0	13.4	14.5	16.3	15.6	13.8	10.2	5.7
	TDLF	13.4	16.7	17.8	19.1	18.0	15.9	12.3	7.5
3	NLF	15.0	23.9	27.9	31.3	30.2	26.8	19.0	9.3
	SDLF	21.1	30.2	34.0	36.2	34.3	30.5	23.0	14.3
	TDLF	28.1	35.9	40.0	40.9	38.2	33.9	26.4	17.0
4	NLF	19.4	33.6	44.8	44.2	41.5	36.3	25.9	12.7
	SDLF	29.2	43.2	52.9	52.1	48.8	43.1	32.9	21.0
	TDLF	38.8	50.5	59.4	57.5	53.7	47.6	37.2	24.4
5	NLF	22.7	41.3	57.4	54.5	50.0	43.0	30.9	15.4
	SDLF	35.4	53.2	67.3	64.5	59.7	52.4	40.6	26.6
	TDLF	46.5	61.3	74.3	70.1	65.1	57.7	45.4	30.1
6	NLF	25.5	46.6	63.7	61.0	55.3	47.2	33.9	17.0
	SDLF	40.2	60.3	75.9	72.7	66.8	58.5	45.6	30.5
	TDLF	52.1	68.6	83.5	78.3	72.3	64.0	50.8	34.0
7	NLF	26.1	47.8	66.0	62.4	56.7	48.5	34.9	17.6
	SDLF	42.3	62.8	79.0	75.4	69.6	61.1	48.0	32.5
	TDLF	54.8	71.4	86.6	81.2	75.3	66.8	53.4	35.9
8	NLF	25.2	45.3	62.5	59.1	54.6	47.1	34.0	17.2
	SDLF	42.0	61.0	75.7	72.7	68.0	60.2	47.5	32.6
	TDLF	54.9	70.1	83.1	79.0	74.0	66.0	53.0	36.0
9	NLF	23.3	39.7	48.4	52.1	49.2	42.9	31.0	15.7
	SDLF	39.5	55.8	63.9	65.8	62.4	55.7	44.3	30.7
	TDLF	51.4	64.3	72.7	72.4	68.2	61.4	49.8	34.2
10	NLF	18.7	30.7	37.2	40.1	39.0	34.9	25.5	13.0
	SDLF	33.6	45.6	51.0	53.1	51.3	47.0	37.9	26.7
	TDLF	44.9	54.0	59.2	59.9	57.6	53.1	43.8	30.6

Table F-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	11.9	18.8	24.2	24.8	24.9	23.8	17.7	9.1
	SDLF	24.4	31.2	35.6	36.1	36.1	34.7	28.6	20.9
	TDLF	34.5	38.6	42.7	42.9	42.9	41.4	34.8	25.2
12	NLF	3.7	4.3	7.3	7.2	8.8	10.7	7.7	3.9
	SDLF	12.4	13.1	16.2	16.7	18.4	19.8	16.4	13.1
	TDLF	20.2	18.9	22.5	23.5	25.5	26.5	22.5	17.2
13	NLF	8.0	13.8	13.0	11.3	8.1	3.9	4.9	3.2
	SDLF	3.8	8.8	6.4	3.7	0.3	3.1	1.6	3.1
	TDLF	3.1	7.2	3.1	3.9	7.4	9.3	7.1	6.8
14	NLF	29.0	37.6	36.7	30.2	25.6	23.1	21.1	15.3
	SDLF	31.5	37.2	33.2	25.4	20.7	18.3	17.4	12.7
	TDLF	35.1	38.2	31.4	22.2	17.3	15.2	15.3	11.9
15	NLF	49.2	54.4	52.2	42.1	37.5	36.3	33.8	27.8
	SDLF	76.6	74.4	66.4	54.2	46.8	42.3	37.9	31.5
	TDLF	100.0	92.6	80.3	66.1	56.4	49.0	43.0	36.4
16	NLF	98.1	97.0	89.5	79.6	74.1	70.4	68.2	71.8
	SDLF	81.6	78.4	70.4	61.5	56.8	53.8	52.5	56.1
	TDLF	68.3	62.1	52.9	44.3	39.8	36.9	35.9	39.0
17	NLF	50.0	56.8	58.4	46.1	40.7	38.8	36.6	30.1
	SDLF	79.9	78.8	74.1	60.1	52.7	47.2	42.8	34.8
	TDLF	105.2	97.2	86.9	71.6	62.7	54.3	48.5	39.9
18	NLF	32.4	44.1	50.4	38.8	33.5	27.9	28.3	20.9
	SDLF	41.4	48.4	49.1	38.6	34.1	28.8	29.3	23.8
	TDLF	50.4	53.2	48.4	38.6	34.6	30.0	31.0	27.1
19	NLF	14.2	23.2	19.1	25.4	22.6	14.9	16.5	11.4
	SDLF	18.7	26.5	22.9	25.8	22.8	16.3	18.1	14.0
	TDLF	22.6	30.0	26.6	26.8	23.7	18.4	20.3	17.2
20	NLF	3.7	6.6	2.9	10.2	10.7	7.4	7.7	6.0
	SDLF	8.0	10.9	7.5	13.0	12.4	8.9	9.6	8.7
	TDLF	11.7	16.1	12.4	16.4	15.1	11.3	12.3	12.1

Table F-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	4.7	6.2	8.1	4.0	1.7	1.1	0.6	2.0
	SDLF	0.6	1.7	4.0	0.2	1.8	1.7	2.9	4.9
	TDLF	4.1	3.5	1.4	4.5	5.4	4.7	5.9	8.4
22	NLF	8.8	13.2	15.7	13.6	10.9	8.3	5.1	1.2
	SDLF	5.2	9.5	12.1	9.8	7.2	4.9	2.0	2.4
	TDLF	2.5	7.7	10.0	7.4	5.0	3.2	1.4	6.1
23	NLF	10.8	16.8	20.6	19.4	16.8	13.4	8.9	3.1
	SDLF	7.7	13.8	17.3	15.8	13.1	9.7	5.3	0.6
	TDLF	5.7	12.6	15.7	13.8	10.9	7.7	3.6	4.4
24	NLF	11.4	17.9	22.3	21.5	19.2	15.8	10.8	4.3
	SDLF	8.6	15.3	19.3	18.1	15.5	12.0	7.1	1.0
	TDLF	7.1	14.5	18.0	16.4	13.5	10.0	5.3	3.2
25	NLF	10.7	16.7	20.8	20.0	18.1	15.2	10.6	4.4
	SDLF	8.1	14.4	18.1	16.9	14.7	11.7	7.3	1.4
	TDLF	7.0	13.5	16.8	15.1	12.7	9.8	5.5	2.5
26	NLF	8.7	13.0	16.1	15.0	13.6	11.8	8.4	3.5
	SDLF	6.4	10.8	13.5	12.1	10.6	8.8	5.5	0.8
	TDLF	5.3	9.6	12.0	10.4	8.8	7.1	3.9	2.8
27	NLF	5.1	6.4	8.1	6.6	6.1	5.9	3.8	1.1
	SDLF	2.8	4.1	5.7	4.2	3.7	3.6	1.2	2.0
	TDLF	1.4	2.6	4.1	2.7	2.3	2.3	1.9	4.6
28	NLF	1.4	4.0	3.2	4.7	4.1	1.9	3.9	3.6
	SDLF	3.9	6.5	5.4	6.3	5.9	4.1	6.3	6.1
	TDLF	6.6	9.3	7.8	8.0	7.6	6.1	8.7	8.6
29	NLF	13.2	18.4	18.6	17.3	15.9	12.3	15.2	12.0
	SDLF	16.5	20.1	19.2	17.5	16.6	13.9	17.0	14.7
	TDLF	20.5	22.6	20.2	17.9	17.0	15.5	18.6	17.4
30	NLF	26.4	29.7	28.2	25.3	23.8	24.6	23.6	20.2
	SDLF	39.9	39.8	35.6	31.4	28.6	27.3	25.7	23.1
	TDLF	52.3	48.6	42.0	36.4	32.3	29.1	27.2	26.4

Table F-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
31	NLF	64.0	62.5	59.8	56.4	54.7	54.3	53.1	57.0
	SDLF	51.8	50.0	46.7	43.8	42.3	42.0	41.8	45.8
	TDLF	39.1	36.6	32.5	29.7	28.2	27.7	28.5	32.4
32	NLF	25.6	28.6	26.7	23.9	22.6	23.3	23.0	19.8
	SDLF	37.6	37.3	33.2	28.9	26.2	25.1	24.4	21.4
	TDLF	49.0	46.1	39.9	34.0	29.9	27.0	25.8	23.2
33	NLF	10.9	14.8	13.8	12.8	11.6	8.3	11.9	9.7
	SDLF	11.7	14.7	12.7	11.4	10.3	7.7	11.1	9.2
	TDLF	12.8	14.9	11.9	10.1	9.0	7.2	10.4	9.0
34	NLF	1.4	0.7	2.8	1.8	2.3	3.8	0.8	1.0
	SDLF	3.7	2.6	4.9	4.1	4.6	5.8	2.5	1.2
	TDLF	6.2	4.8	7.2	7.0	7.6	8.4	4.8	3.5
35	NLF	7.9	11.7	15.1	14.7	14.2	13.3	9.6	4.5
	SDLF	11.7	14.6	17.7	17.0	16.5	15.7	12.0	7.7
	TDLF	16.2	18.2	21.0	20.2	19.8	19.1	15.2	10.3
36	NLF	12.3	19.5	25.0	25.2	23.9	21.2	15.9	8.0
	SDLF	16.7	23.5	28.0	27.9	26.6	24.0	19.0	11.9
	TDLF	22.7	28.0	32.1	31.3	29.9	27.5	22.5	14.8
37	NLF	14.9	24.4	31.5	32.2	30.6	26.8	20.0	10.1
	SDLF	19.6	28.9	34.9	35.2	33.4	29.7	23.3	14.3
	TDLF	26.4	34.0	39.5	38.9	36.8	33.1	26.8	17.3
38	NLF	16.0	26.6	34.5	35.6	33.8	29.5	21.8	11.0
	SDLF	20.8	31.1	38.0	38.6	36.6	32.3	25.1	15.1
	TDLF	27.7	36.4	42.7	42.3	40.0	35.6	28.4	18.0
39	NLF	15.7	26.1	34.0	35.0	33.3	29.1	21.5	10.7
	SDLF	20.2	30.2	37.2	37.7	35.8	31.6	24.3	14.4
	TDLF	26.6	35.3	41.7	41.4	39.1	34.7	27.4	17.1
40	NLF	14.0	22.9	29.9	30.6	29.1	25.6	18.9	9.3
	SDLF	17.9	26.3	32.8	32.9	31.2	27.5	21.0	12.2
	TDLF	23.2	30.7	36.5	36.0	34.0	30.4	23.9	14.6

Table F-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
41	NLF	11.0	17.4	22.6	22.8	21.7	19.2	14.3	7.1
	SDLF	14.1	20.0	24.8	24.6	23.3	20.7	15.9	8.9
	TDLF	17.8	23.1	27.3	26.7	25.3	22.7	17.9	10.9
42	NLF	5.6	8.5	10.6	10.8	10.3	9.1	6.7	3.0
	SDLF	7.2	9.9	12.0	12.0	11.4	10.2	7.8	4.1
	TDLF	9.3	11.6	13.6	13.3	12.6	11.4	9.0	5.3
43	NLF	17.5	16.4	13.9	13.4	12.4	11.1	10.1	9.2
	SDLF	9.6	8.9	7.6	7.4	6.9	6.3	5.8	5.2
	TDLF	1.4	1.0	0.9	0.8	0.8	0.9	0.8	0.5

Table F-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	6.4	5.6	4.2	3.0	3.0	2.6	2.2	2.1
	SDLF	0.3	0.2	0.3	0.3	0.2	0.1	0.1	0.1
	TDLF	6.4	5.8	4.7	3.7	3.7	3.2	2.6	2.7
2	NLF	7.4	10.8	12.2	10.5	7.2	3.8	0.9	0.5
	SDLF	7.6	11.0	11.9	9.6	6.2	3.0	0.4	0.6
	TDLF	7.4	11.1	11.8	9.1	5.5	2.5	0.0	0.9
3	NLF	17.2	25.3	28.2	23.5	16.3	9.0	2.4	0.9
	SDLF	17.4	25.2	26.9	21.3	14.1	7.4	1.6	0.7
	TDLF	16.3	24.2	25.2	18.8	11.6	5.4	0.2	1.5
4	NLF	24.9	37.2	40.0	31.7	21.8	12.1	3.2	1.1
	SDLF	25.7	37.6	39.8	30.9	20.8	11.3	3.1	0.3
	TDLF	23.7	35.6	37.6	28.5	18.3	9.1	1.2	1.6
5	NLF	30.6	45.9	48.8	37.7	25.8	14.3	4.0	1.2
	SDLF	32.2	47.2	49.6	38.2	26.0	14.7	4.7	0.4
	TDLF	29.0	44.3	46.6	35.4	23.1	11.9	2.2	1.5
6	NLF	34.0	51.1	54.3	41.9	28.5	16.0	4.8	1.0
	SDLF	36.3	53.4	56.0	43.1	29.6	17.1	6.1	1.2
	TDLF	32.3	49.7	52.3	39.4	26.1	13.9	3.0	1.3
7	NLF	35.1	52.9	56.2	43.6	30.0	17.2	5.5	0.7
	SDLF	37.8	55.5	58.4	45.4	31.6	18.7	7.2	1.9
	TDLF	33.1	51.1	54.0	41.3	27.6	15.0	3.7	1.1
8	NLF	33.9	51.2	54.8	43.3	30.5	17.9	6.2	0.3
	SDLF	36.6	53.6	56.8	45.1	32.0	19.3	7.9	2.4
	TDLF	31.7	48.7	52.1	40.7	27.6	15.3	4.1	0.7
9	NLF	29.9	44.9	49.7	41.6	29.9	17.9	6.7	0.3
	SDLF	32.8	47.9	51.6	42.3	30.6	19.1	8.2	2.7
	TDLF	28.6	44.1	47.1	37.3	26.0	15.0	4.7	0.2
10	NLF	24.3	36.7	41.3	35.8	26.8	16.9	7.1	1.0
	SDLF	26.7	39.2	43.1	36.9	27.9	18.1	8.4	3.0
	TDLF	23.3	36.2	39.9	33.5	24.6	15.1	5.6	0.6

Table F-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	16.9	26.0	29.9	27.0	21.7	14.8	7.2	1.8
	SDLF	18.8	28.4	32.6	29.6	23.8	16.4	8.4	3.4
	TDLF	16.4	26.8	31.5	28.7	22.8	15.1	6.6	1.6
12	NLF	8.1	13.7	17.3	17.8	16.2	12.3	7.3	3.0
	SDLF	9.7	16.8	21.4	21.6	19.0	14.0	8.2	3.8
	TDLF	8.7	17.3	23.0	23.3	19.8	13.8	7.1	2.6
13	NLF	1.3	1.6	5.8	9.6	11.1	9.7	7.4	4.3
	SDLF	0.5	5.9	11.1	13.9	13.4	10.4	7.3	4.3
	TDLF	0.9	8.7	15.0	17.0	14.6	10.2	6.2	3.2
14	NLF	9.9	7.6	2.6	3.6	6.1	6.6	7.6	6.3
	SDLF	10.6	5.8	0.4	4.3	4.9	4.0	4.3	4.2
	TDLF	11.4	4.2	1.6	4.8	3.6	1.3	0.8	1.7
15	NLF	14.8	12.3	8.6	3.0	1.0	0.2	3.6	5.5
	SDLF	24.6	16.6	11.5	6.1	4.1	3.1	0.2	3.4
	TDLF	32.3	19.6	13.4	8.3	6.5	6.1	3.1	1.1
16	NLF	21.1	16.9	14.1	9.2	7.8	7.0	3.9	1.7
	SDLF	12.8	8.8	7.4	3.8	2.8	2.5	0.5	4.6
	TDLF	6.0	1.6	1.1	1.4	2.2	2.4	5.4	11.7
17	NLF	18.8	19.0	15.6	9.1	6.6	4.7	0.1	3.8
	SDLF	2.1	3.1	3.0	0.9	1.0	1.5	0.8	3.8
	TDLF	11.9	10.8	8.1	6.4	4.0	1.2	1.6	4.0
18	NLF	19.4	23.3	19.9	11.7	7.5	5.0	1.1	2.2
	SDLF	13.7	14.9	13.5	9.1	6.9	5.5	2.3	1.1
	TDLF	9.1	7.5	7.8	6.9	6.7	6.6	4.0	0.2
19	NLF	15.2	20.8	22.4	19.1	13.6	9.7	5.8	1.5
	SDLF	13.5	17.8	17.9	14.9	11.6	9.2	5.9	2.2
	TDLF	12.7	15.7	14.3	11.4	10.2	9.2	6.5	3.2
20	NLF	10.4	16.4	20.4	20.6	17.2	13.4	9.2	4.3
	SDLF	9.3	14.5	16.9	16.2	13.6	11.1	8.2	4.3
	TDLF	9.4	13.7	14.5	12.9	10.7	9.5	7.7	4.8

Table F-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	5.5	10.8	15.3	17.7	17.2	14.9	11.3	6.2
	SDLF	4.6	9.5	13.3	15.2	14.5	12.8	10.2	6.0
	TDLF	5.0	9.5	12.5	13.7	12.8	11.4	9.7	6.4
22	NLF	1.4	5.1	9.5	13.4	15.2	14.8	12.3	7.3
	SDLF	0.7	4.6	9.0	12.7	14.3	13.8	11.6	7.1
	TDLF	1.2	5.2	9.6	13.0	14.2	13.5	11.6	7.6
23	NLF	1.6	0.5	4.5	9.2	12.4	13.5	12.2	7.6
	SDLF	2.1	0.6	5.0	9.8	12.9	13.6	12.1	7.6
	TDLF	1.5	1.7	6.4	11.3	14.0	14.3	12.5	8.2
24	NLF	3.4	2.3	1.2	6.0	9.8	11.7	11.2	7.3
	SDLF	3.6	1.9	2.1	7.2	10.9	12.3	11.4	7.4
	TDLF	3.0	0.7	3.9	9.1	12.5	13.5	12.1	8.0
25	NLF	3.7	3.2	0.2	4.1	7.6	9.6	9.6	6.5
	SDLF	3.8	2.6	0.9	5.3	8.7	10.3	9.9	6.6
	TDLF	3.2	1.3	2.5	7.0	10.1	11.2	10.4	7.1
26	NLF	2.6	2.0	0.2	3.4	5.9	7.4	7.4	5.1
	SDLF	2.5	1.4	1.1	4.3	6.6	7.8	7.6	5.2
	TDLF	2.0	0.5	2.2	5.2	7.2	8.2	7.9	5.6
27	NLF	0.3	0.7	2.1	3.5	4.4	5.0	4.9	3.2
	SDLF	0.2	1.0	2.3	3.8	4.7	5.3	5.0	3.3
	TDLF	0.3	1.4	2.5	3.8	4.7	5.4	5.2	3.6
28	NLF	2.9	4.1	4.2	3.7	2.9	2.7	2.2	1.0
	SDLF	2.9	3.8	3.8	3.5	3.2	3.3	2.6	1.2
	TDLF	2.9	3.4	3.0	2.9	3.2	3.7	3.1	1.6
29	NLF	6.2	6.8	5.4	2.9	1.2	0.6	0.5	1.9
	SDLF	5.1	4.9	3.8	2.3	1.6	1.5	0.2	1.3
	TDLF	3.9	2.7	1.8	1.4	2.0	2.4	1.2	0.5
30	NLF	7.9	7.2	5.8	3.7	2.6	1.2	1.5	3.4
	SDLF	0.7	0.2	0.2	0.7	0.6	0.3	1.5	2.9
	TDLF	6.0	6.7	6.2	5.3	3.8	1.7	1.2	2.1

Table F-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
31	NLF	12.8	10.2	8.9	6.9	6.1	5.3	3.2	2.0
	SDLF	6.5	4.1	3.2	1.6	0.9	0.5	1.4	4.0
	TDLF	0.1	2.3	3.0	4.3	5.0	5.0	6.6	10.9
32	NLF	6.3	4.6	2.6	0.6	0.2	1.0	3.0	4.2
	SDLF	11.4	7.4	4.4	2.0	0.9	0.3	1.8	4.2
	TDLF	15.5	9.2	5.4	2.5	1.5	1.3	0.6	3.9
33	NLF	2.4	0.8	1.6	3.8	4.8	4.2	3.8	3.4
	SDLF	3.1	0.7	1.5	3.0	3.3	2.6	2.6	2.9
	TDLF	3.5	0.2	2.1	2.7	2.1	1.1	1.4	2.2
34	NLF	2.9	5.2	6.7	6.9	6.5	4.8	2.8	1.4
	SDLF	2.6	5.3	7.0	7.2	6.3	4.4	2.6	1.6
	TDLF	2.1	5.5	7.7	7.8	6.5	4.1	2.3	1.4
35	NLF	7.9	11.7	12.6	10.9	8.3	5.0	1.8	0.0
	SDLF	7.3	11.0	12.0	10.5	8.1	5.0	1.9	0.3
	TDLF	6.2	10.1	11.5	10.3	8.0	4.8	1.7	0.2
36	NLF	12.0	17.3	17.9	14.5	9.9	5.0	0.8	1.2
	SDLF	11.4	16.3	16.8	13.6	9.4	4.9	1.0	0.7
	TDLF	9.9	14.7	15.2	12.4	8.6	4.4	0.6	1.0
37	NLF	14.7	21.1	21.6	17.0	11.0	4.9	0.1	2.1
	SDLF	14.2	20.1	20.3	15.8	10.1	4.5	0.0	1.6
	TDLF	12.5	18.2	18.1	13.8	8.6	3.5	0.7	1.9
38	NLF	15.8	22.8	23.2	18.0	11.3	4.6	0.7	2.6
	SDLF	15.4	21.8	21.8	16.5	10.1	4.0	0.8	2.1
	TDLF	13.7	19.9	19.5	14.3	8.2	2.6	1.7	2.6
39	NLF	15.4	22.0	22.3	17.1	10.6	4.0	1.1	2.8
	SDLF	14.9	21.2	21.0	15.7	9.3	3.2	1.4	2.4
	TDLF	13.4	19.4	18.9	13.6	7.4	1.8	2.3	2.8
40	NLF	13.3	18.9	19.1	14.5	8.8	3.1	1.3	2.6
	SDLF	12.8	18.1	17.9	13.2	7.6	2.4	1.6	2.4
	TDLF	11.7	16.8	16.3	11.6	6.2	1.3	2.2	2.7

Table F-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
41	NLF	9.8	13.8	13.8	10.4	6.3	2.2	1.1	2.1
	SDLF	9.3	13.0	12.7	9.3	5.3	1.4	1.4	2.0
	TDLF	8.4	11.9	11.5	8.2	4.3	0.7	1.9	2.2
42	NLF	4.5	6.3	6.3	4.7	2.7	0.7	0.8	1.1
	SDLF	4.3	6.0	5.9	4.3	2.4	0.5	0.9	1.2
	TDLF	4.0	5.8	5.7	4.1	2.2	0.5	0.9	1.2
43	NLF	4.1	3.7	3.3	2.8	2.8	2.6	2.3	2.2
	SDLF	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.1
	TDLF	4.6	4.1	3.7	3.2	3.1	2.8	2.5	2.4

Table F-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	11.6	10.2	7.4	5.4	5.6	4.9	4.4	4.5
	SDLF	5.1	4.7	3.4	2.5	2.7	2.5	2.3	2.4
	TDLF	0.9	0.6	0.7	0.6	0.4	0.3	0.1	0.2
2	NLF	14.9	20.8	22.4	18.4	12.0	5.5	0.4	1.0
	SDLF	15.0	20.8	22.0	17.3	10.7	4.5	0.3	1.3
	TDLF	14.9	20.8	21.7	16.6	9.8	3.8	0.9	1.7
3	NLF	34.0	48.7	52.6	42.1	27.7	13.6	1.6	2.7
	SDLF	33.8	47.9	50.4	38.9	24.6	11.3	0.3	2.8
	TDLF	32.4	46.3	48.0	35.7	21.5	8.8	1.4	3.8
4	NLF	49.0	71.7	75.1	56.7	36.7	17.8	1.8	4.0
	SDLF	49.2	70.9	73.4	54.5	34.4	16.2	1.1	3.5
	TDLF	46.5	67.9	69.9	50.9	30.9	13.2	1.2	5.0
5	NLF	60.6	89.2	92.2	67.8	43.3	21.2	2.4	4.7
	SDLF	61.0	88.6	90.9	66.3	42.0	20.4	2.3	3.4
	TDLF	56.9	84.1	86.2	61.9	37.9	16.8	0.6	5.6
6	NLF	67.7	99.5	103.1	75.5	48.1	23.8	3.2	4.8
	SDLF	68.4	99.5	102.1	74.5	47.4	23.6	3.8	2.9
	TDLF	63.1	93.9	96.3	69.0	42.4	19.4	0.2	5.6
7	NLF	70.1	103.3	106.9	78.7	50.8	25.8	4.4	4.3
	SDLF	71.0	103.3	106.2	78.1	50.5	26.0	5.3	2.0
	TDLF	64.9	96.8	99.5	72.0	45.0	21.2	1.3	5.2
8	NLF	67.4	99.7	104.0	78.3	51.9	27.4	6.0	3.3
	SDLF	68.5	99.5	103.2	77.7	51.5	27.5	6.9	1.0
	TDLF	62.1	92.6	96.2	71.3	45.6	22.4	2.5	4.3
9	NLF	58.9	86.3	93.1	74.6	50.9	27.8	7.4	2.0
	SDLF	60.6	87.4	92.8	73.4	50.0	27.8	8.2	0.2
	TDLF	55.3	82.1	86.6	66.8	44.1	22.9	4.1	3.0
10	NLF	47.4	69.7	76.5	63.6	45.6	26.6	8.9	0.1
	SDLF	48.9	70.8	76.6	63.2	45.3	26.8	9.6	1.7
	TDLF	44.8	66.6	72.0	58.4	40.9	23.0	6.3	1.0

Table F-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	32.5	48.6	54.2	47.2	36.7	23.7	10.2	2.3
	SDLF	33.9	50.1	55.7	48.5	37.7	24.5	10.9	3.5
	TDLF	31.1	47.7	53.7	46.7	35.8	22.5	8.7	1.5
12	NLF	15.2	24.7	30.2	30.1	27.2	20.2	11.7	5.2
	SDLF	16.6	27.2	33.5	33.0	29.2	21.3	12.1	5.9
	TDLF	15.4	27.2	34.5	34.0	29.4	20.6	10.8	4.5
13	NLF	2.7	1.6	8.5	15.4	18.6	16.5	13.1	8.6
	SDLF	1.1	5.5	13.4	19.2	20.5	16.9	12.7	8.5
	TDLF	1.0	8.0	16.9	21.9	21.3	16.4	11.5	7.3
14	NLF	18.9	15.3	6.4	5.3	10.7	12.0	14.7	13.5
	SDLF	19.9	13.9	4.7	5.6	9.2	9.2	11.4	11.4
	TDLF	20.9	12.6	3.0	5.9	7.6	6.3	7.8	8.9
15	NLF	28.1	23.8	17.1	6.3	2.2	0.3	7.6	12.4
	SDLF	38.1	28.3	20.2	9.6	5.4	3.0	4.2	10.4
	TDLF	46.0	31.4	22.2	11.9	7.9	6.1	0.9	8.2
16	NLF	40.0	32.1	27.1	17.6	14.9	13.7	7.2	2.7
	SDLF	31.6	24.0	20.4	12.3	10.0	9.1	2.8	3.7
	TDLF	24.8	16.8	14.1	7.1	5.0	4.2	2.1	11.0
17	NLF	35.6	36.1	29.7	17.1	12.0	8.3	1.3	9.5
	SDLF	18.7	19.9	16.9	8.7	6.3	5.0	2.2	9.5
	TDLF	4.5	5.8	5.7	1.4	1.3	2.3	3.0	9.8
18	NLF	36.6	44.1	37.7	22.0	13.6	8.7	0.8	6.3
	SDLF	30.6	35.3	31.0	19.1	12.7	8.9	1.8	5.4
	TDLF	25.8	27.6	25.1	16.7	12.3	9.7	3.3	4.1
19	NLF	28.3	39.3	42.9	37.0	26.1	18.4	10.7	1.8
	SDLF	26.1	35.6	37.6	32.0	23.5	17.5	10.5	2.3
	TDLF	24.9	32.9	33.3	28.0	21.6	17.2	10.8	3.2
20	NLF	18.3	30.2	38.7	39.9	33.6	26.3	17.9	7.7
	SDLF	16.8	27.6	34.4	34.8	29.3	23.4	16.5	7.5
	TDLF	16.6	26.3	31.4	30.9	26.0	21.4	15.8	7.9

Table F-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	8.5	18.9	28.6	34.5	34.3	30.0	22.8	11.9
	SDLF	7.2	17.1	26.0	31.3	31.0	27.4	21.3	11.5
	TDLF	7.3	16.6	24.7	29.3	28.7	25.7	20.5	11.8
22	NLF	0.4	7.9	17.7	26.6	31.0	30.4	25.2	14.3
	SDLF	0.6	6.9	16.5	25.3	29.5	29.0	24.3	14.1
	TDLF	0.4	7.1	16.6	25.2	29.0	28.4	24.0	14.5
23	NLF	5.5	0.9	8.3	19.0	26.1	28.5	25.4	15.3
	SDLF	6.2	1.3	8.2	19.0	26.1	28.2	25.1	15.2
	TDLF	5.9	0.6	9.2	20.1	26.9	28.7	25.4	15.8
24	NLF	8.6	6.0	2.2	13.2	21.4	25.3	23.8	14.9
	SDLF	9.2	6.0	2.7	14.0	22.1	25.7	23.9	14.9
	TDLF	8.8	5.1	4.1	15.5	23.5	26.6	24.5	15.5
25	NLF	8.9	7.1	0.0	10.0	17.5	21.4	20.7	13.2
	SDLF	9.2	6.9	0.7	10.8	18.2	21.9	20.9	13.3
	TDLF	8.8	5.9	2.0	12.2	19.4	22.6	21.3	13.7
26	NLF	6.3	4.2	1.5	9.0	14.3	16.9	16.3	10.3
	SDLF	6.4	3.9	2.1	9.5	14.7	17.2	16.4	10.4
	TDLF	6.0	3.1	2.9	10.2	15.1	17.4	16.6	10.7
27	NLF	1.2	1.7	5.6	9.3	11.1	11.9	10.9	6.3
	SDLF	1.2	1.8	5.6	9.3	11.2	12.0	10.9	6.4
	TDLF	0.9	2.1	5.6	9.1	11.1	12.0	11.0	6.6
28	NLF	5.6	8.9	10.0	9.4	7.6	6.7	5.0	1.4
	SDLF	5.5	8.5	9.4	9.1	7.8	7.2	5.3	1.6
	TDLF	5.5	7.9	8.5	8.3	7.6	7.5	5.7	2.0
29	NLF	12.6	14.3	11.9	7.1	3.3	1.8	1.1	4.9
	SDLF	11.4	12.4	10.3	6.5	3.7	2.6	0.4	4.3
	TDLF	10.2	10.1	8.3	5.5	4.0	3.5	0.6	3.5
30	NLF	16.2	15.1	12.5	8.3	5.6	2.5	3.5	8.2
	SDLF	8.9	8.0	6.4	3.8	2.4	1.0	3.5	7.6
	TDLF	2.1	1.0	0.3	0.8	0.8	0.3	3.1	6.8

Table F-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
31	NLF	26.0	21.0	18.5	14.6	13.1	11.2	6.7	3.7
	SDLF	19.8	15.0	12.9	9.3	7.9	6.5	2.1	2.3
	TDLF	13.3	8.5	6.7	3.4	2.0	1.1	3.1	9.1
32	NLF	12.9	9.8	6.0	2.1	0.2	1.6	6.3	9.7
	SDLF	18.1	12.7	8.0	3.6	1.5	0.2	5.0	9.5
	TDLF	22.5	14.8	9.2	4.4	2.2	0.9	3.7	9.3
33	NLF	5.0	2.5	1.5	5.8	8.2	7.5	7.3	7.6
	SDLF	5.8	2.7	1.2	4.8	6.5	5.7	6.0	7.1
	TDLF	6.4	2.3	1.6	4.4	5.1	4.1	4.7	6.3
34	NLF	5.9	9.4	11.4	11.4	10.7	7.7	4.6	3.1
	SDLF	5.3	9.2	11.3	11.2	10.2	7.1	4.3	3.2
	TDLF	4.6	9.1	11.7	11.6	10.1	6.6	3.8	2.9
35	NLF	16.3	22.6	23.1	18.8	13.5	7.4	1.9	0.3
	SDLF	15.4	21.5	22.1	18.0	13.0	7.0	1.8	0.0
	TDLF	14.1	20.3	21.1	17.4	12.5	6.6	1.4	0.3
36	NLF	24.8	34.2	34.0	25.8	16.3	6.8	0.7	3.1
	SDLF	23.9	32.8	32.3	24.4	15.3	6.4	0.8	2.6
	TDLF	22.1	30.8	30.3	22.8	14.2	5.6	1.3	3.0
37	NLF	30.6	42.4	41.8	30.9	18.3	6.3	2.8	5.1
	SDLF	29.7	40.9	39.8	29.1	17.0	5.6	3.0	4.6
	TDLF	27.7	38.4	37.1	26.7	15.1	4.3	3.8	5.0
38	NLF	33.2	46.0	45.2	33.1	18.9	5.6	4.2	6.2
	SDLF	32.3	44.5	43.2	31.1	17.3	4.6	4.5	5.8
	TDLF	30.3	42.0	40.3	28.4	15.0	3.0	5.5	6.3
39	NLF	32.3	44.7	43.7	31.6	17.7	4.6	4.9	6.5
	SDLF	31.5	43.3	41.8	29.7	16.0	3.5	5.3	6.2
	TDLF	29.7	41.1	39.2	27.2	13.8	1.9	6.3	6.6
40	NLF	28.0	38.5	37.3	26.7	14.6	3.3	4.8	6.0
	SDLF	27.3	37.3	35.7	25.0	13.1	2.3	5.3	5.8
	TDLF	25.9	35.6	33.7	23.1	11.5	1.1	6.0	6.1

Table F-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
41	NLF	20.8	28.1	27.0	19.2	10.4	2.2	3.7	4.4
	SDLF	20.2	27.1	25.6	17.7	9.2	1.3	4.2	4.4
	TDLF	19.2	25.8	24.2	16.4	8.0	0.4	4.7	4.7
42	NLF	10.0	13.0	12.2	8.5	4.3	0.4	2.2	2.0
	SDLF	9.8	12.6	11.8	8.0	3.9	0.1	2.4	2.1
	TDLF	9.5	12.4	11.5	7.7	3.6	0.0	2.5	2.2
43	NLF	8.0	7.4	6.6	5.9	5.8	5.4	4.9	4.7
	SDLF	3.9	3.7	3.4	3.1	3.1	2.9	2.7	2.5
	TDLF	0.5	0.3	0.2	0.0	0.1	0.1	0.2	0.0

Table F-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	6.9	5.4	4.3	3.5	2.9	2.4	2.1	1.9
	SDLF	0.1	0.3	0.4	0.4	0.4	0.4	0.3	0.3
	TDLF	6.4	5.5	4.7	4.2	3.6	3.3	3.1	2.9
2	NLF	7.6	11.4	13.1	11.2	7.8	4.3	1.1	0.6
	SDLF	7.9	11.0	12.0	9.7	6.2	3.1	0.4	0.9
	TDLF	8.4	11.1	11.6	8.9	5.4	2.5	0.1	0.9
3	NLF	16.6	24.6	27.4	22.7	15.6	8.4	1.9	1.2
	SDLF	17.2	24.6	26.4	20.7	13.4	6.7	0.8	2.0
	TDLF	19.1	26.0	27.0	20.4	13.0	6.6	1.1	1.6
4	NLF	24.6	37.0	40.0	31.5	21.7	11.9	3.1	1.4
	SDLF	24.6	36.0	38.4	29.3	19.2	9.7	1.3	3.0
	TDLF	27.4	37.8	39.5	29.9	19.5	10.1	2.1	2.1
5	NLF	30.4	45.9	49.0	37.8	25.8	14.4	4.0	1.3
	SDLF	29.8	44.4	47.1	35.5	23.3	12.0	1.8	3.6
	TDLF	33.7	47.0	49.0	37.0	24.6	13.3	3.3	2.1
6	NLF	33.9	51.3	54.8	42.2	28.8	16.3	4.9	1.1
	SDLF	32.9	49.4	52.5	39.4	26.0	13.5	2.2	4.0
	TDLF	37.8	52.9	55.0	41.3	27.8	15.4	4.3	2.0
7	NLF	35.1	53.2	56.8	43.9	30.3	17.5	5.6	0.8
	SDLF	33.7	50.8	54.2	41.0	27.3	14.4	2.7	4.1
	TDLF	39.0	54.6	57.0	43.3	29.5	16.7	5.1	1.7
8	NLF	33.8	51.3	55.1	43.5	30.7	18.1	6.3	0.4
	SDLF	32.2	48.7	52.4	40.5	27.4	14.8	3.1	3.8
	TDLF	37.7	52.3	55.3	43.0	29.7	17.1	5.6	1.3
9	NLF	29.9	45.2	50.4	42.1	30.4	18.3	6.9	0.2
	SDLF	28.7	43.1	47.2	38.0	26.4	14.8	3.8	3.1
	TDLF	34.0	46.9	49.7	39.4	27.8	16.6	6.0	0.8
10	NLF	24.1	36.6	41.4	35.8	26.9	17.0	7.1	0.9
	SDLF	23.4	35.1	39.4	33.3	24.3	14.5	4.7	1.9
	TDLF	28.0	38.7	42.3	35.4	26.3	16.6	6.9	0.0

Table F-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	16.6	25.7	29.7	26.8	21.5	14.6	7.0	1.7
	SDLF	16.5	25.4	29.7	26.8	21.1	13.8	5.7	0.4
	TDLF	20.2	28.8	33.5	30.4	24.4	16.5	7.8	1.1
12	NLF	7.7	13.3	17.0	17.4	15.8	12.1	7.1	2.8
	SDLF	8.4	14.8	19.5	19.6	17.1	12.2	6.4	1.3
	TDLF	11.3	18.6	24.2	24.3	20.8	14.7	8.0	2.2
13	NLF	1.5	1.2	5.4	9.2	10.6	9.4	7.2	4.2
	SDLF	0.1	4.9	10.1	12.8	12.4	9.5	6.4	3.0
	TDLF	2.7	9.7	15.9	17.7	15.4	10.9	6.9	3.1
14	NLF	10.3	8.3	3.5	2.8	5.3	5.9	7.0	5.9
	SDLF	4.7	0.6	5.4	9.3	9.1	7.2	6.5	5.2
	TDLF	0.5	9.0	14.0	15.7	13.1	8.8	6.4	5.0
15	NLF	12.3	8.4	4.2	1.5	3.2	3.8	6.5	7.3
	SDLF	1.6	4.1	5.1	7.3	6.5	4.7	5.4	6.4
	TDLF	13.2	15.0	13.2	12.3	9.1	5.3	4.2	5.8
16	NLF	5.2	0.8	0.4	2.7	3.7	3.8	7.3	13.2
	SDLF	11.4	6.2	5.6	2.8	2.1	2.2	0.5	4.9
	TDLF	16.0	10.6	10.1	8.0	7.9	8.5	6.8	4.1
17	NLF	16.4	15.3	11.7	4.7	2.3	0.9	3.1	5.7
	SDLF	28.7	23.1	19.2	13.2	10.5	8.4	3.5	2.2
	TDLF	38.6	29.1	25.2	20.4	17.9	15.5	9.9	1.3
18	NLF	19.4	23.6	20.5	12.3	8.1	5.5	1.4	2.1
	SDLF	20.5	21.4	19.2	13.8	11.2	9.0	4.6	0.5
	TDLF	20.8	18.6	17.2	14.5	13.5	12.0	7.4	0.7
19	NLF	14.8	20.5	22.2	18.9	13.4	9.6	5.7	1.5
	SDLF	14.4	18.0	18.0	14.7	11.3	9.0	5.8	1.7
	TDLF	13.3	15.0	13.3	10.1	8.6	7.8	5.4	1.4
20	NLF	10.1	16.1	20.2	20.4	17.1	13.3	9.1	4.2
	SDLF	10.2	14.8	17.2	16.5	13.7	11.3	8.3	4.1
	TDLF	9.3	12.7	13.5	12.0	9.7	8.5	6.8	3.2

Table F-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	5.4	10.7	15.3	17.7	17.2	14.9	11.3	6.2
	SDLF	5.4	10.0	13.8	15.7	15.0	13.2	10.5	6.0
	TDLF	4.5	8.4	11.6	12.9	11.9	10.6	8.8	5.0
22	NLF	1.4	5.2	9.6	13.4	15.3	14.8	12.3	7.3
	SDLF	1.4	4.9	9.4	13.2	14.7	14.2	12.0	7.2
	TDLF	0.4	3.9	8.5	12.2	13.3	12.7	10.8	6.3
23	NLF	1.5	0.6	4.6	9.3	12.5	13.5	12.2	7.6
	SDLF	1.6	0.8	5.3	10.2	13.3	14.0	12.4	7.7
	TDLF	2.5	0.2	5.2	10.4	13.2	13.6	11.8	7.0
24	NLF	3.3	2.2	1.2	6.0	9.8	11.7	11.2	7.3
	SDLF	3.3	1.9	2.3	7.5	11.2	12.6	11.7	7.5
	TDLF	4.1	2.1	2.7	8.2	11.7	12.7	11.5	6.9
25	NLF	3.6	3.1	0.2	4.1	7.6	9.6	9.6	6.5
	SDLF	3.6	2.6	0.9	5.5	8.9	10.4	10.0	6.6
	TDLF	4.2	2.8	1.3	6.1	9.2	10.4	9.8	6.0
26	NLF	2.5	2.0	0.3	3.4	5.9	7.4	7.5	5.1
	SDLF	2.5	1.6	1.0	4.3	6.6	7.8	7.7	5.1
	TDLF	3.0	1.8	1.1	4.3	6.4	7.4	7.2	4.5
27	NLF	0.3	0.7	2.1	3.5	4.4	5.0	4.9	3.2
	SDLF	0.2	0.8	2.2	3.7	4.6	5.2	5.0	3.1
	TDLF	0.5	0.3	1.6	2.9	3.9	4.6	4.5	2.6
28	NLF	2.8	4.0	4.2	3.7	2.9	2.7	2.2	0.9
	SDLF	2.7	3.4	3.5	3.2	2.9	3.0	2.4	0.8
	TDLF	2.3	2.3	1.9	1.8	2.2	2.8	2.2	0.4
29	NLF	6.3	7.1	5.8	3.4	1.7	1.0	0.2	1.7
	SDLF	6.7	6.3	5.1	3.4	2.5	2.0	0.5	1.8
	TDLF	6.6	4.8	3.6	2.7	2.8	2.7	0.9	1.9
30	NLF	6.9	5.4	3.7	1.2	0.1	0.9	3.2	4.5
	SDLF	13.0	9.7	7.5	4.9	3.5	2.2	0.6	4.0
	TDLF	18.4	13.2	10.6	8.0	6.5	5.3	2.2	3.3

Table F-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
31	NLF	0.3	2.8	3.1	4.5	4.9	5.5	7.7	11.4
	SDLF	5.8	2.7	2.0	0.6	0.1	0.2	2.0	5.1
	TDLF	11.9	8.3	7.3	6.1	5.7	5.9	4.8	2.4
32	NLF	5.4	3.0	0.7	1.6	2.5	3.0	4.6	5.2
	SDLF	0.2	2.0	2.8	3.7	3.4	2.6	3.3	4.3
	TDLF	5.3	6.8	6.3	5.8	4.1	1.9	1.5	3.1
33	NLF	2.6	1.1	1.1	3.2	4.2	3.7	3.3	3.1
	SDLF	1.4	1.1	3.3	4.6	4.6	3.6	3.2	3.2
	TDLF	0.2	3.9	6.3	6.7	5.6	3.8	3.2	3.3
34	NLF	2.8	5.1	6.6	6.9	6.4	4.7	2.8	1.4
	SDLF	2.7	5.1	6.8	7.0	6.2	4.3	2.5	1.3
	TDLF	3.1	5.9	8.0	8.1	6.9	4.5	2.7	1.5
35	NLF	7.8	11.5	12.5	10.9	8.3	5.0	1.8	0.1
	SDLF	7.5	10.8	11.8	10.2	7.8	4.7	1.6	0.4
	TDLF	8.0	11.1	12.3	10.9	8.6	5.3	2.1	0.0
36	NLF	11.8	17.2	17.9	14.5	10.0	5.1	0.8	1.2
	SDLF	11.4	16.0	16.5	13.2	9.0	4.5	0.4	1.7
	TDLF	12.2	16.0	16.2	13.1	9.2	4.9	1.0	1.3
37	NLF	14.5	21.0	21.7	17.1	11.2	5.1	0.0	2.1
	SDLF	14.2	19.7	19.9	15.2	9.6	4.0	0.7	2.8
	TDLF	15.1	19.7	19.3	14.5	9.2	4.0	0.3	2.4
38	NLF	15.7	22.7	23.3	18.2	11.5	4.8	0.6	2.6
	SDLF	15.4	21.5	21.5	16.0	9.6	3.4	1.5	3.4
	TDLF	16.5	21.4	20.7	15.0	8.8	3.1	1.4	3.1
39	NLF	15.2	21.9	22.4	17.3	10.7	4.2	1.0	2.8
	SDLF	15.0	20.9	20.8	15.3	8.9	2.8	1.9	3.5
	TDLF	16.1	20.9	20.1	14.3	8.0	2.3	2.0	3.3
40	NLF	13.1	18.8	19.1	14.6	8.8	3.2	1.2	2.6
	SDLF	13.1	18.1	17.8	13.0	7.4	2.1	1.9	3.2
	TDLF	14.0	18.1	17.3	12.2	6.8	1.8	1.9	3.1

Table F-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
41	NLF	9.4	13.4	13.5	10.1	6.0	2.0	1.3	2.2
	SDLF	9.7	13.1	12.8	9.3	5.3	1.4	1.5	2.4
	TDLF	10.3	13.3	12.7	9.0	5.1	1.4	1.3	2.2
42	NLF	4.6	6.6	6.7	5.1	3.1	1.0	0.6	1.1
	SDLF	4.7	6.3	6.2	4.5	2.5	0.7	0.8	1.2
	TDLF	4.9	6.2	5.9	4.1	2.3	0.5	0.8	1.1
43	NLF	4.5	3.9	3.5	3.2	2.8	2.6	2.3	2.1
	SDLF	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	TDLF	4.6	4.1	3.7	3.4	3.1	2.9	2.7	2.6

Table F-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	13.2	10.2	8.0	6.7	5.5	4.9	4.7	4.8
	SDLF	6.5	4.9	3.8	3.2	2.7	2.5	2.5	2.6
	TDLF	0.4	0.0	0.1	0.2	0.2	0.2	0.1	0.1
2	NLF	15.6	22.2	24.7	20.2	13.4	6.7	0.8	1.3
	SDLF	15.7	21.5	23.2	18.2	11.5	5.2	0.0	1.6
	TDLF	16.2	21.4	22.4	17.1	10.3	4.4	0.3	1.5
3	NLF	32.7	47.1	51.1	40.4	26.1	12.3	0.5	3.4
	SDLF	33.1	46.5	49.3	37.6	23.3	10.1	0.8	4.4
	TDLF	34.8	47.5	49.2	36.6	22.3	9.6	0.8	4.1
4	NLF	48.6	71.3	75.1	56.3	36.3	17.6	1.4	4.5
	SDLF	47.9	69.2	71.9	52.7	32.7	14.5	0.8	6.3
	TDLF	50.2	70.0	71.9	52.2	32.1	14.2	0.5	5.6
5	NLF	60.4	89.2	92.6	67.8	43.4	21.3	2.3	5.1
	SDLF	58.6	85.7	88.5	63.6	39.3	17.7	0.6	7.6
	TDLF	61.5	86.8	88.6	63.5	39.3	18.1	0.4	6.3
6	NLF	67.9	100.2	104.3	76.4	48.8	24.5	3.5	5.0
	SDLF	65.1	95.8	99.1	71.1	44.0	20.3	0.1	8.2
	TDLF	68.6	97.2	99.3	71.0	44.3	21.1	1.5	6.3
7	NLF	70.4	104.1	108.4	79.8	51.7	26.6	4.8	4.5
	SDLF	67.0	98.9	102.5	74.0	46.5	22.0	1.0	8.1
	TDLF	70.8	100.3	102.7	74.1	47.0	23.1	2.7	5.9
8	NLF	67.5	100.0	104.5	78.6	52.4	28.0	6.2	3.6
	SDLF	64.1	94.7	98.8	73.0	47.1	23.2	2.2	7.3
	TDLF	68.1	96.2	99.4	73.5	47.6	24.2	4.0	5.0
9	NLF	59.4	87.6	95.1	76.2	52.3	29.0	8.1	2.0
	SDLF	56.7	83.1	89.2	69.7	46.3	24.0	4.1	5.6
	TDLF	60.7	85.0	89.5	69.1	46.1	24.7	5.6	3.6
10	NLF	47.1	69.7	76.6	63.7	45.7	26.8	9.0	0.3
	SDLF	45.5	66.7	72.9	59.4	41.7	23.3	5.9	3.4
	TDLF	49.4	69.1	74.3	60.2	42.6	24.6	7.6	1.6

Table F-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	31.8	47.8	53.4	46.3	36.0	23.2	9.8	2.0
	SDLF	31.3	46.7	52.5	45.3	34.7	21.6	8.0	0.4
	TDLF	34.7	49.5	55.4	48.1	37.2	23.7	9.8	1.0
12	NLF	14.4	23.6	29.2	29.0	26.2	19.5	11.1	4.9
	SDLF	15.0	24.8	31.1	30.6	26.9	19.2	10.2	3.3
	TDLF	17.8	28.3	35.5	34.8	30.2	21.5	11.6	4.2
13	NLF	3.1	0.9	7.8	14.6	17.8	15.9	12.7	8.5
	SDLF	1.6	4.3	12.1	17.9	19.2	15.8	11.8	7.3
	TDLF	0.9	8.9	17.5	22.4	22.0	17.0	12.2	7.5
14	NLF	19.5	16.6	8.1	3.8	9.1	10.5	13.6	12.9
	SDLF	14.1	7.9	0.5	10.0	12.8	11.8	13.2	12.3
	TDLF	9.0	0.3	8.8	16.3	16.6	13.3	13.2	12.2
15	NLF	23.1	15.9	8.2	2.9	6.5	7.9	13.9	16.4
	SDLF	9.3	3.5	1.0	8.6	9.7	8.8	12.9	15.6
	TDLF	2.2	7.2	9.0	13.5	12.3	9.4	11.8	15.1
16	NLF	9.7	1.0	0.3	6.1	8.2	8.8	16.4	29.2
	SDLF	15.8	6.3	5.4	0.7	2.5	2.8	9.7	21.2
	TDLF	20.4	10.6	9.8	4.4	3.2	3.4	2.5	12.3
17	NLF	30.8	28.8	21.9	8.4	3.3	0.3	7.9	13.8
	SDLF	42.8	36.2	29.1	16.5	11.3	7.6	1.6	10.4
	TDLF	52.5	41.9	34.8	23.5	18.4	14.6	4.7	7.0
18	NLF	36.5	44.7	39.2	23.3	14.7	9.5	1.1	6.3
	SDLF	37.1	41.9	37.2	24.3	17.3	12.7	4.1	4.8
	TDLF	37.1	38.7	34.7	24.6	19.3	15.4	6.7	3.8
19	NLF	27.0	37.9	41.8	35.9	25.2	17.7	10.0	1.3
	SDLF	26.3	35.0	37.1	31.3	22.6	16.8	9.9	1.5
	TDLF	25.0	31.7	32.0	26.3	19.6	15.4	9.3	1.0
20	NLF	17.5	29.3	37.9	39.2	33.0	25.7	17.5	7.3
	SDLF	17.2	27.5	34.3	34.7	29.1	23.3	16.4	7.0
	TDLF	16.1	25.0	30.1	29.7	24.7	20.2	14.6	6.0

Table F-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	8.1	18.6	28.4	34.3	34.0	29.8	22.5	11.5
	SDLF	7.9	17.3	26.3	31.7	31.2	27.6	21.4	11.2
	TDLF	6.7	15.4	23.6	28.4	27.8	24.7	19.5	10.1
22	NLF	0.3	7.8	17.5	26.5	30.8	30.2	25.0	14.0
	SDLF	0.1	7.1	16.7	25.6	29.8	29.2	24.4	13.9
	TDLF	1.3	5.7	15.3	24.1	28.0	27.4	23.0	12.9
23	NLF	5.5	0.8	8.1	18.8	26.0	28.3	25.2	15.0
	SDLF	5.9	1.2	8.2	19.2	26.3	28.4	25.2	15.0
	TDLF	7.0	2.1	7.7	18.9	25.8	27.7	24.5	14.2
24	NLF	8.6	6.0	2.0	13.0	21.2	25.0	23.6	14.6
	SDLF	9.0	6.1	2.6	14.0	22.2	25.7	23.9	14.6
	TDLF	10.0	6.7	2.6	14.3	22.4	25.5	23.5	14.0
25	NLF	8.9	7.1	0.2	9.8	17.3	21.2	20.5	12.9
	SDLF	9.2	7.1	0.5	10.7	18.2	21.7	20.8	12.9
	TDLF	10.0	7.5	0.6	11.0	18.3	21.5	20.4	12.3
26	NLF	6.4	4.3	1.3	8.8	14.0	16.7	16.1	10.0
	SDLF	6.5	4.2	1.8	9.3	14.5	16.9	16.2	9.9
	TDLF	7.1	4.6	1.6	9.1	14.1	16.4	15.6	9.4
27	NLF	1.4	1.5	5.3	9.0	10.9	11.6	10.6	6.1
	SDLF	1.4	1.4	5.3	9.0	10.9	11.7	10.6	5.9
	TDLF	1.8	0.8	4.5	8.1	10.0	11.0	10.1	5.3
28	NLF	5.2	8.5	9.8	9.1	7.3	6.4	4.7	1.1
	SDLF	5.1	7.8	8.8	8.5	7.2	6.6	4.8	0.9
	TDLF	4.6	6.6	7.2	7.0	6.3	6.3	4.6	0.5
29	NLF	12.6	14.8	12.7	7.9	4.1	2.4	0.7	4.7
	SDLF	13.0	13.9	11.9	7.9	4.8	3.4	0.1	4.7
	TDLF	12.9	12.4	10.3	7.1	5.0	4.0	0.4	4.9
30	NLF	13.8	11.0	7.7	2.7	0.2	2.1	7.4	10.7
	SDLF	19.9	15.3	11.5	6.3	3.5	1.0	4.8	10.2
	TDLF	25.2	18.7	14.5	9.4	6.5	4.0	2.0	9.5

Table F-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
31	NLF	0.8	6.1	6.7	9.6	10.7	11.9	16.9	25.5
	SDLF	5.3	0.6	1.6	4.5	5.7	6.6	11.2	19.2
	TDLF	11.4	5.1	3.7	1.0	0.0	0.5	4.5	11.7
32	NLF	10.8	6.2	1.9	2.8	4.8	6.1	10.0	12.1
	SDLF	5.3	1.4	1.5	4.8	5.6	5.6	8.6	11.1
	TDLF	0.3	3.3	4.8	6.8	6.3	4.9	6.9	9.9
33	NLF	5.3	3.1	0.7	4.9	7.2	6.5	6.5	7.2
	SDLF	4.2	1.1	2.7	6.1	7.5	6.3	6.3	7.3
	TDLF	2.7	1.6	5.5	8.0	8.3	6.4	6.3	7.4
34	NLF	5.8	9.3	11.3	11.3	10.6	7.7	4.7	3.2
	SDLF	5.5	9.0	11.1	11.1	10.1	7.1	4.2	3.0
	TDLF	5.8	9.7	12.1	12.0	10.6	7.2	4.3	3.2
35	NLF	16.1	22.4	23.1	18.9	13.6	7.5	2.0	0.2
	SDLF	15.6	21.3	21.9	17.8	12.8	6.9	1.6	0.5
	TDLF	16.0	21.3	22.0	18.1	13.2	7.3	2.0	0.2
36	NLF	24.7	34.2	34.2	26.2	16.6	7.2	0.5	2.9
	SDLF	24.0	32.5	32.2	24.2	15.1	6.2	1.1	3.5
	TDLF	24.5	32.1	31.5	23.7	15.0	6.4	0.7	3.1
37	NLF	30.6	42.6	42.3	31.6	18.9	6.9	2.4	4.8
	SDLF	29.8	40.6	39.8	29.0	16.8	5.4	3.3	5.6
	TDLF	30.4	40.0	38.5	27.7	16.0	5.1	3.2	5.3
38	NLF	33.2	46.3	45.9	33.8	19.6	6.3	3.7	5.9
	SDLF	32.5	44.4	43.3	31.0	17.2	4.5	4.8	6.8
	TDLF	33.2	43.8	41.9	29.5	16.0	3.8	4.9	6.6
39	NLF	32.3	44.8	44.3	32.3	18.3	5.2	4.4	6.3
	SDLF	31.8	43.3	42.0	29.8	16.0	3.5	5.5	7.0
	TDLF	32.4	42.8	40.7	28.2	14.7	2.7	5.7	6.9
40	NLF	27.9	38.5	37.7	27.1	15.0	3.7	4.6	5.8
	SDLF	27.7	37.3	35.9	25.1	13.2	2.4	5.4	6.4
	TDLF	28.3	37.0	35.0	24.0	12.3	1.8	5.5	6.3

Table F-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
41	NLF	20.3	27.4	26.5	18.7	9.9	1.9	4.0	4.5
	SDLF	20.4	26.9	25.6	17.6	9.0	1.2	4.3	4.7
	TDLF	21.0	26.9	25.3	17.1	8.7	1.1	4.2	4.6
42	NLF	10.4	13.7	13.3	9.5	5.2	1.2	1.7	1.8
	SDLF	10.5	13.4	12.7	8.8	4.6	0.8	1.9	1.9
	TDLF	10.7	13.2	12.3	8.3	4.2	0.6	1.9	1.8
43	NLF	9.6	8.1	7.2	6.6	6.0	5.5	5.2	5.0
	SDLF	5.2	4.3	3.8	3.6	3.2	3.0	2.9	2.8
	TDLF	0.6	0.3	0.2	0.2	0.2	0.2	0.2	0.3

Table F-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.18	0.18	0.17	0.16	0.16	0.16	0.16	0.16
	SDLF	0.20	0.19	0.18	0.16	0.15	0.15	0.15	0.15
	TDLF	0.22	0.20	0.18	0.16	0.15	0.15	0.15	0.15
3	NLF	0.41	0.39	0.38	0.36	0.35	0.35	0.35	0.35
	SDLF	0.44	0.42	0.39	0.36	0.34	0.33	0.33	0.34
	TDLF	0.48	0.44	0.39	0.36	0.33	0.32	0.33	0.34
4	NLF	0.60	0.58	0.55	0.54	0.52	0.52	0.52	0.52
	SDLF	0.66	0.62	0.57	0.53	0.51	0.50	0.50	0.51
	TDLF	0.70	0.64	0.58	0.53	0.50	0.48	0.49	0.50
5	NLF	0.76	0.73	0.70	0.68	0.66	0.66	0.66	0.66
	SDLF	0.83	0.78	0.72	0.68	0.65	0.63	0.63	0.64
	TDLF	0.89	0.81	0.73	0.67	0.63	0.61	0.62	0.63
6	NLF	0.87	0.84	0.81	0.79	0.77	0.76	0.76	0.76
	SDLF	0.95	0.89	0.83	0.78	0.75	0.73	0.73	0.74
	TDLF	1.02	0.93	0.84	0.77	0.73	0.71	0.72	0.73
7	NLF	0.94	0.91	0.87	0.85	0.83	0.82	0.82	0.83
	SDLF	1.02	0.96	0.89	0.85	0.81	0.80	0.79	0.80
	TDLF	1.09	1.00	0.91	0.84	0.79	0.77	0.77	0.79
8	NLF	0.96	0.93	0.89	0.87	0.85	0.84	0.84	0.85
	SDLF	1.04	0.98	0.92	0.87	0.83	0.81	0.81	0.82
	TDLF	1.10	1.02	0.93	0.86	0.81	0.79	0.79	0.81
9	NLF	0.92	0.90	0.87	0.85	0.83	0.82	0.82	0.82
	SDLF	1.00	0.95	0.89	0.85	0.81	0.79	0.79	0.80
	TDLF	1.06	0.99	0.91	0.84	0.79	0.77	0.77	0.78
10	NLF	0.84	0.82	0.80	0.78	0.76	0.76	0.75	0.75
	SDLF	0.91	0.87	0.82	0.78	0.75	0.73	0.73	0.73
	TDLF	0.95	0.90	0.83	0.78	0.74	0.71	0.71	0.72

Table F-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.72	0.71	0.69	0.68	0.67	0.66	0.65	0.65
	SDLF	0.77	0.74	0.71	0.68	0.66	0.64	0.63	0.63
	TDLF	0.81	0.77	0.72	0.68	0.65	0.62	0.61	0.62
12	NLF	0.57	0.57	0.56	0.55	0.54	0.53	0.53	0.53
	SDLF	0.60	0.59	0.57	0.55	0.53	0.52	0.51	0.51
	TDLF	0.63	0.61	0.58	0.55	0.53	0.50	0.50	0.49
13	NLF	0.41	0.41	0.41	0.40	0.40	0.39	0.39	0.38
	SDLF	0.43	0.43	0.42	0.41	0.39	0.38	0.37	0.37
	TDLF	0.44	0.44	0.43	0.41	0.39	0.37	0.36	0.35
14	NLF	0.25	0.25	0.26	0.25	0.25	0.25	0.24	0.24
	SDLF	0.25	0.26	0.26	0.26	0.25	0.24	0.23	0.22
	TDLF	0.26	0.27	0.27	0.26	0.24	0.23	0.22	0.21
15	NLF	0.10	0.11	0.11	0.11	0.11	0.10	0.10	0.10
	SDLF	0.10	0.11	0.11	0.11	0.10	0.10	0.10	0.09
	TDLF	0.10	0.11	0.12	0.11	0.10	0.10	0.09	0.08
16	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	NLF	-0.11	-0.10	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
	SDLF	-0.12	-0.10	-0.09	-0.09	-0.09	-0.08	-0.08	-0.09
	TDLF	-0.13	-0.10	-0.09	-0.09	-0.08	-0.08	-0.08	-0.08
18	NLF	-0.22	-0.20	-0.19	-0.19	-0.18	-0.18	-0.18	-0.19
	SDLF	-0.24	-0.21	-0.19	-0.18	-0.18	-0.17	-0.17	-0.17
	TDLF	-0.25	-0.22	-0.19	-0.18	-0.17	-0.16	-0.16	-0.16
19	NLF	-0.30	-0.29	-0.28	-0.26	-0.26	-0.25	-0.25	-0.25
	SDLF	-0.32	-0.29	-0.28	-0.26	-0.24	-0.24	-0.23	-0.23
	TDLF	-0.33	-0.30	-0.28	-0.25	-0.23	-0.22	-0.21	-0.21
20	NLF	-0.34	-0.33	-0.33	-0.31	-0.30	-0.30	-0.29	-0.29
	SDLF	-0.36	-0.34	-0.33	-0.30	-0.29	-0.27	-0.26	-0.26
	TDLF	-0.37	-0.35	-0.33	-0.29	-0.27	-0.26	-0.24	-0.23

Table F-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	-0.35	-0.35	-0.34	-0.33	-0.32	-0.32	-0.31	-0.30
	SDLF	-0.36	-0.35	-0.34	-0.32	-0.31	-0.29	-0.28	-0.27
	TDLF	-0.37	-0.36	-0.34	-0.32	-0.29	-0.27	-0.25	-0.23
22	NLF	-0.34	-0.34	-0.34	-0.33	-0.33	-0.32	-0.31	-0.30
	SDLF	-0.34	-0.34	-0.34	-0.32	-0.31	-0.29	-0.28	-0.26
	TDLF	-0.34	-0.34	-0.34	-0.32	-0.29	-0.27	-0.25	-0.23
23	NLF	-0.32	-0.32	-0.32	-0.32	-0.31	-0.31	-0.30	-0.29
	SDLF	-0.31	-0.32	-0.32	-0.31	-0.30	-0.28	-0.27	-0.25
	TDLF	-0.31	-0.32	-0.32	-0.30	-0.28	-0.26	-0.23	-0.21
24	NLF	-0.29	-0.30	-0.30	-0.30	-0.29	-0.28	-0.28	-0.27
	SDLF	-0.28	-0.29	-0.29	-0.29	-0.28	-0.26	-0.25	-0.23
	TDLF	-0.27	-0.28	-0.29	-0.28	-0.26	-0.24	-0.22	-0.20
25	NLF	-0.26	-0.26	-0.27	-0.27	-0.26	-0.26	-0.25	-0.24
	SDLF	-0.25	-0.25	-0.26	-0.26	-0.25	-0.24	-0.22	-0.21
	TDLF	-0.24	-0.25	-0.26	-0.25	-0.24	-0.22	-0.20	-0.18
26	NLF	-0.23	-0.23	-0.23	-0.23	-0.23	-0.22	-0.22	-0.22
	SDLF	-0.22	-0.22	-0.22	-0.22	-0.22	-0.21	-0.20	-0.19
	TDLF	-0.21	-0.22	-0.22	-0.22	-0.20	-0.19	-0.18	-0.16
27	NLF	-0.19	-0.20	-0.20	-0.19	-0.19	-0.19	-0.19	-0.18
	SDLF	-0.19	-0.19	-0.19	-0.18	-0.18	-0.17	-0.17	-0.16
	TDLF	-0.18	-0.18	-0.18	-0.18	-0.17	-0.16	-0.15	-0.14
28	NLF	-0.16	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
	SDLF	-0.15	-0.15	-0.15	-0.14	-0.14	-0.14	-0.13	-0.13
	TDLF	-0.15	-0.15	-0.14	-0.14	-0.13	-0.13	-0.12	-0.12
29	NLF	-0.11	-0.11	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
	SDLF	-0.11	-0.10	-0.10	-0.10	-0.09	-0.10	-0.09	-0.10
	TDLF	-0.12	-0.10	-0.10	-0.09	-0.09	-0.09	-0.08	-0.09
30	NLF	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
	SDLF	-0.06	-0.05	-0.05	-0.04	-0.04	-0.04	-0.04	-0.05
	TDLF	-0.06	-0.05	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04

Table F-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
31	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32	NLF	0.05	0.06	0.06	0.06	0.06	0.06	0.05	0.05
	SDLF	0.05	0.06	0.06	0.05	0.05	0.05	0.05	0.04
	TDLF	0.05	0.06	0.06	0.05	0.05	0.05	0.05	0.04
33	NLF	0.13	0.13	0.13	0.13	0.12	0.12	0.12	0.12
	SDLF	0.12	0.13	0.13	0.12	0.12	0.11	0.11	0.11
	TDLF	0.12	0.13	0.12	0.12	0.11	0.10	0.10	0.10
34	NLF	0.20	0.20	0.20	0.19	0.19	0.19	0.19	0.19
	SDLF	0.20	0.20	0.19	0.19	0.18	0.17	0.17	0.17
	TDLF	0.20	0.20	0.19	0.18	0.17	0.16	0.16	0.16
35	NLF	0.27	0.27	0.26	0.25	0.25	0.24	0.24	0.24
	SDLF	0.28	0.27	0.25	0.24	0.23	0.23	0.22	0.23
	TDLF	0.28	0.27	0.25	0.23	0.22	0.21	0.21	0.21
36	NLF	0.32	0.31	0.30	0.29	0.29	0.29	0.29	0.29
	SDLF	0.34	0.32	0.30	0.28	0.27	0.26	0.26	0.27
	TDLF	0.35	0.32	0.29	0.27	0.25	0.25	0.25	0.26
37	NLF	0.35	0.34	0.33	0.32	0.31	0.31	0.31	0.31
	SDLF	0.37	0.35	0.32	0.30	0.29	0.28	0.29	0.29
	TDLF	0.39	0.35	0.31	0.29	0.27	0.26	0.27	0.28
38	NLF	0.35	0.34	0.33	0.31	0.31	0.30	0.31	0.31
	SDLF	0.37	0.35	0.32	0.30	0.29	0.28	0.28	0.29
	TDLF	0.39	0.35	0.31	0.28	0.27	0.26	0.27	0.28
39	NLF	0.32	0.31	0.30	0.29	0.28	0.28	0.28	0.28
	SDLF	0.34	0.32	0.29	0.27	0.26	0.26	0.26	0.27
	TDLF	0.37	0.33	0.29	0.26	0.24	0.24	0.25	0.26
40	NLF	0.27	0.26	0.24	0.24	0.23	0.23	0.23	0.23
	SDLF	0.29	0.26	0.24	0.22	0.21	0.21	0.21	0.22
	TDLF	0.30	0.27	0.24	0.21	0.20	0.20	0.20	0.22

Table F-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
41	NLF	0.19	0.18	0.17	0.16	0.16	0.16	0.16	0.16
	SDLF	0.20	0.18	0.17	0.16	0.15	0.15	0.15	0.16
	TDLF	0.21	0.19	0.16	0.15	0.14	0.14	0.14	0.15
42	NLF	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	SDLF	0.09	0.09	0.08	0.07	0.07	0.07	0.07	0.07
	TDLF	0.10	0.09	0.08	0.07	0.07	0.06	0.07	0.07
43	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table F-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.33	0.32	0.31	0.29	0.28	0.28	0.28	0.29
	SDLF	0.34	0.32	0.31	0.29	0.27	0.27	0.27	0.28
	TDLF	0.35	0.33	0.30	0.28	0.27	0.26	0.26	0.27
3	NLF	0.73	0.70	0.67	0.64	0.63	0.62	0.62	0.63
	SDLF	0.75	0.71	0.67	0.63	0.61	0.60	0.60	0.61
	TDLF	0.77	0.72	0.67	0.62	0.59	0.58	0.58	0.60
4	NLF	1.08	1.03	0.99	0.96	0.93	0.92	0.93	0.94
	SDLF	1.11	1.05	0.98	0.93	0.90	0.89	0.89	0.91
	TDLF	1.14	1.06	0.98	0.91	0.87	0.86	0.87	0.89
5	NLF	1.36	1.31	1.25	1.21	1.19	1.18	1.18	1.19
	SDLF	1.40	1.33	1.24	1.18	1.15	1.13	1.13	1.15
	TDLF	1.44	1.34	1.23	1.16	1.11	1.09	1.10	1.12
6	NLF	1.57	1.51	1.44	1.40	1.37	1.36	1.36	1.38
	SDLF	1.61	1.53	1.43	1.37	1.33	1.31	1.31	1.33
	TDLF	1.66	1.55	1.42	1.34	1.29	1.27	1.27	1.30
7	NLF	1.69	1.63	1.56	1.51	1.48	1.47	1.47	1.49
	SDLF	1.74	1.65	1.55	1.48	1.44	1.42	1.42	1.44
	TDLF	1.78	1.66	1.53	1.45	1.39	1.37	1.38	1.40
8	NLF	1.72	1.66	1.59	1.55	1.52	1.51	1.51	1.52
	SDLF	1.76	1.68	1.58	1.52	1.47	1.45	1.45	1.47
	TDLF	1.80	1.69	1.57	1.49	1.43	1.40	1.41	1.43
9	NLF	1.66	1.61	1.55	1.51	1.48	1.46	1.46	1.47
	SDLF	1.70	1.62	1.55	1.48	1.43	1.41	1.41	1.42
	TDLF	1.73	1.63	1.53	1.45	1.39	1.36	1.37	1.38
10	NLF	1.51	1.47	1.43	1.39	1.36	1.35	1.35	1.35
	SDLF	1.54	1.48	1.42	1.36	1.32	1.30	1.29	1.30
	TDLF	1.57	1.49	1.41	1.34	1.29	1.26	1.26	1.27

Table F-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	1.29	1.26	1.23	1.21	1.19	1.17	1.17	1.17
	SDLF	1.31	1.27	1.23	1.19	1.15	1.13	1.12	1.13
	TDLF	1.33	1.28	1.22	1.17	1.12	1.10	1.09	1.09
12	NLF	1.02	1.01	0.99	0.98	0.96	0.95	0.94	0.94
	SDLF	1.03	1.01	0.99	0.96	0.94	0.92	0.91	0.90
	TDLF	1.04	1.02	0.98	0.95	0.91	0.89	0.88	0.87
13	NLF	0.73	0.73	0.73	0.72	0.71	0.70	0.69	0.68
	SDLF	0.73	0.73	0.72	0.71	0.69	0.67	0.66	0.65
	TDLF	0.72	0.73	0.72	0.70	0.67	0.65	0.64	0.63
14	NLF	0.44	0.45	0.46	0.45	0.45	0.44	0.43	0.42
	SDLF	0.43	0.45	0.46	0.45	0.43	0.42	0.41	0.40
	TDLF	0.43	0.45	0.45	0.44	0.42	0.41	0.40	0.38
15	NLF	0.17	0.19	0.20	0.19	0.19	0.19	0.18	0.17
	SDLF	0.17	0.19	0.20	0.19	0.18	0.18	0.17	0.16
	TDLF	0.17	0.19	0.19	0.19	0.18	0.17	0.17	0.15
16	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	NLF	-0.20	-0.18	-0.16	-0.16	-0.16	-0.16	-0.16	-0.17
	SDLF	-0.20	-0.18	-0.16	-0.16	-0.15	-0.15	-0.15	-0.16
	TDLF	-0.21	-0.18	-0.15	-0.15	-0.15	-0.14	-0.14	-0.15
18	NLF	-0.40	-0.37	-0.35	-0.34	-0.33	-0.33	-0.33	-0.34
	SDLF	-0.41	-0.37	-0.34	-0.33	-0.32	-0.31	-0.31	-0.32
	TDLF	-0.42	-0.37	-0.33	-0.32	-0.31	-0.30	-0.29	-0.30
19	NLF	-0.55	-0.52	-0.51	-0.48	-0.47	-0.46	-0.45	-0.46
	SDLF	-0.55	-0.52	-0.49	-0.46	-0.44	-0.43	-0.42	-0.42
	TDLF	-0.56	-0.52	-0.49	-0.45	-0.42	-0.41	-0.39	-0.40
20	NLF	-0.63	-0.61	-0.60	-0.57	-0.55	-0.54	-0.53	-0.52
	SDLF	-0.62	-0.60	-0.58	-0.55	-0.52	-0.50	-0.49	-0.48
	TDLF	-0.62	-0.60	-0.57	-0.53	-0.50	-0.47	-0.45	-0.44

Table F-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	-0.65	-0.64	-0.63	-0.61	-0.59	-0.57	-0.56	-0.55
	SDLF	-0.64	-0.63	-0.61	-0.58	-0.56	-0.53	-0.51	-0.50
	TDLF	-0.63	-0.62	-0.60	-0.56	-0.53	-0.50	-0.47	-0.45
22	NLF	-0.63	-0.63	-0.62	-0.61	-0.60	-0.58	-0.56	-0.55
	SDLF	-0.61	-0.61	-0.60	-0.58	-0.56	-0.54	-0.51	-0.49
	TDLF	-0.59	-0.60	-0.59	-0.57	-0.53	-0.50	-0.47	-0.44
23	NLF	-0.59	-0.59	-0.59	-0.59	-0.57	-0.56	-0.54	-0.52
	SDLF	-0.56	-0.57	-0.57	-0.56	-0.54	-0.52	-0.49	-0.47
	TDLF	-0.54	-0.56	-0.56	-0.54	-0.51	-0.48	-0.45	-0.42
24	NLF	-0.54	-0.54	-0.55	-0.54	-0.53	-0.52	-0.50	-0.49
	SDLF	-0.51	-0.52	-0.53	-0.52	-0.50	-0.48	-0.46	-0.44
	TDLF	-0.48	-0.50	-0.51	-0.50	-0.48	-0.45	-0.42	-0.39
25	NLF	-0.48	-0.49	-0.49	-0.49	-0.48	-0.47	-0.46	-0.44
	SDLF	-0.45	-0.46	-0.47	-0.47	-0.45	-0.44	-0.42	-0.40
	TDLF	-0.43	-0.45	-0.46	-0.45	-0.43	-0.41	-0.38	-0.35
26	NLF	-0.43	-0.43	-0.43	-0.43	-0.42	-0.41	-0.40	-0.39
	SDLF	-0.40	-0.41	-0.41	-0.41	-0.40	-0.38	-0.37	-0.35
	TDLF	-0.38	-0.39	-0.40	-0.39	-0.38	-0.36	-0.34	-0.32
27	NLF	-0.37	-0.37	-0.37	-0.36	-0.36	-0.35	-0.34	-0.34
	SDLF	-0.35	-0.35	-0.35	-0.34	-0.34	-0.33	-0.32	-0.31
	TDLF	-0.34	-0.34	-0.34	-0.33	-0.32	-0.31	-0.29	-0.28
28	NLF	-0.30	-0.29	-0.29	-0.28	-0.28	-0.28	-0.27	-0.27
	SDLF	-0.29	-0.28	-0.28	-0.27	-0.26	-0.26	-0.25	-0.25
	TDLF	-0.28	-0.27	-0.27	-0.26	-0.25	-0.24	-0.24	-0.23
29	NLF	-0.22	-0.21	-0.20	-0.19	-0.19	-0.19	-0.19	-0.19
	SDLF	-0.21	-0.20	-0.19	-0.18	-0.18	-0.18	-0.18	-0.18
	TDLF	-0.21	-0.19	-0.18	-0.17	-0.17	-0.17	-0.17	-0.17
30	NLF	-0.11	-0.10	-0.09	-0.09	-0.09	-0.09	-0.09	-0.10
	SDLF	-0.11	-0.09	-0.09	-0.09	-0.08	-0.08	-0.08	-0.09
	TDLF	-0.11	-0.09	-0.08	-0.08	-0.08	-0.08	-0.08	-0.09

Table F-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
31	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32	NLF	0.10	0.11	0.11	0.11	0.11	0.11	0.10	0.09
	SDLF	0.10	0.10	0.11	0.10	0.10	0.10	0.10	0.09
	TDLF	0.09	0.10	0.10	0.10	0.10	0.09	0.09	0.08
33	NLF	0.24	0.24	0.24	0.24	0.24	0.23	0.23	0.23
	SDLF	0.23	0.24	0.24	0.23	0.23	0.22	0.22	0.21
	TDLF	0.23	0.24	0.23	0.23	0.22	0.21	0.21	0.20
34	NLF	0.39	0.38	0.38	0.37	0.37	0.36	0.36	0.36
	SDLF	0.38	0.38	0.37	0.36	0.35	0.34	0.34	0.34
	TDLF	0.38	0.37	0.36	0.35	0.33	0.32	0.32	0.32
35	NLF	0.52	0.51	0.49	0.48	0.48	0.47	0.47	0.47
	SDLF	0.52	0.50	0.48	0.47	0.45	0.45	0.45	0.45
	TDLF	0.52	0.50	0.47	0.45	0.43	0.42	0.43	0.43
36	NLF	0.62	0.60	0.58	0.57	0.56	0.55	0.56	0.56
	SDLF	0.63	0.60	0.57	0.54	0.53	0.52	0.53	0.54
	TDLF	0.63	0.59	0.55	0.53	0.51	0.50	0.51	0.52
37	NLF	0.68	0.66	0.63	0.61	0.60	0.60	0.60	0.61
	SDLF	0.69	0.65	0.62	0.59	0.57	0.56	0.57	0.58
	TDLF	0.70	0.65	0.60	0.57	0.55	0.54	0.55	0.57
38	NLF	0.69	0.66	0.63	0.61	0.60	0.59	0.60	0.61
	SDLF	0.70	0.66	0.61	0.58	0.57	0.56	0.57	0.58
	TDLF	0.71	0.66	0.60	0.56	0.54	0.54	0.55	0.57
39	NLF	0.63	0.60	0.58	0.56	0.54	0.54	0.55	0.56
	SDLF	0.64	0.60	0.56	0.53	0.52	0.51	0.52	0.54
	TDLF	0.66	0.61	0.55	0.51	0.49	0.49	0.50	0.52
40	NLF	0.52	0.50	0.47	0.46	0.45	0.45	0.45	0.46
	SDLF	0.53	0.50	0.46	0.44	0.43	0.42	0.43	0.44
	TDLF	0.55	0.50	0.45	0.42	0.41	0.40	0.42	0.43

Table F-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
41	NLF	0.36	0.35	0.33	0.32	0.31	0.31	0.31	0.32
	SDLF	0.37	0.35	0.32	0.31	0.30	0.29	0.30	0.31
	TDLF	0.38	0.35	0.32	0.29	0.28	0.28	0.29	0.30
42	NLF	0.17	0.16	0.16	0.15	0.15	0.15	0.15	0.15
	SDLF	0.18	0.17	0.15	0.14	0.14	0.14	0.14	0.15
	TDLF	0.18	0.17	0.15	0.14	0.13	0.13	0.14	0.15
43	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table F-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.26	0.25	0.24	0.23	0.23	0.22	0.22	0.23
	SDLF	0.29	0.27	0.25	0.23	0.22	0.21	0.21	0.22
	TDLF	0.31	0.28	0.26	0.23	0.21	0.21	0.21	0.22
3	NLF	0.58	0.56	0.54	0.52	0.50	0.49	0.49	0.50
	SDLF	0.63	0.59	0.55	0.51	0.49	0.47	0.48	0.48
	TDLF	0.68	0.62	0.56	0.51	0.47	0.46	0.46	0.48
4	NLF	0.85	0.82	0.79	0.76	0.75	0.74	0.74	0.74
	SDLF	0.93	0.88	0.81	0.76	0.73	0.71	0.71	0.72
	TDLF	1.00	0.92	0.82	0.75	0.71	0.68	0.69	0.71
5	NLF	1.08	1.04	1.00	0.97	0.95	0.94	0.93	0.94
	SDLF	1.18	1.11	1.02	0.96	0.92	0.90	0.90	0.91
	TDLF	1.26	1.16	1.03	0.95	0.90	0.87	0.88	0.90
6	NLF	1.24	1.20	1.15	1.12	1.09	1.08	1.08	1.09
	SDLF	1.35	1.27	1.18	1.11	1.07	1.04	1.04	1.06
	TDLF	1.45	1.33	1.19	1.10	1.04	1.01	1.02	1.04
7	NLF	1.34	1.29	1.24	1.21	1.18	1.17	1.17	1.18
	SDLF	1.45	1.37	1.27	1.20	1.16	1.13	1.13	1.14
	TDLF	1.55	1.43	1.29	1.19	1.13	1.10	1.10	1.13
8	NLF	1.36	1.32	1.27	1.24	1.21	1.20	1.20	1.20
	SDLF	1.47	1.40	1.30	1.23	1.19	1.16	1.16	1.17
	TDLF	1.57	1.45	1.32	1.22	1.16	1.13	1.13	1.15
9	NLF	1.31	1.28	1.24	1.20	1.18	1.17	1.16	1.17
	SDLF	1.42	1.35	1.27	1.20	1.16	1.13	1.12	1.13
	TDLF	1.51	1.40	1.29	1.19	1.13	1.10	1.10	1.11
10	NLF	1.20	1.17	1.14	1.11	1.09	1.07	1.07	1.07
	SDLF	1.29	1.23	1.17	1.11	1.07	1.04	1.03	1.04
	TDLF	1.36	1.28	1.19	1.11	1.05	1.01	1.01	1.02

Table F-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
		CF Location							
11	NLF	1.03	1.01	0.99	0.97	0.95	0.94	0.93	0.93
	SDLF	1.10	1.06	1.01	0.97	0.93	0.91	0.90	0.90
	TDLF	1.15	1.09	1.03	0.97	0.92	0.89	0.87	0.88
12	NLF	0.82	0.81	0.80	0.78	0.77	0.76	0.75	0.75
	SDLF	0.86	0.84	0.82	0.79	0.76	0.74	0.73	0.72
	TDLF	0.89	0.87	0.83	0.79	0.75	0.72	0.71	0.70
13	NLF	0.58	0.59	0.58	0.58	0.57	0.56	0.55	0.55
	SDLF	0.61	0.61	0.60	0.58	0.56	0.54	0.53	0.52
	TDLF	0.62	0.63	0.61	0.58	0.55	0.53	0.51	0.50
14	NLF	0.35	0.36	0.37	0.36	0.36	0.35	0.34	0.34
	SDLF	0.36	0.38	0.38	0.36	0.35	0.34	0.33	0.32
	TDLF	0.36	0.39	0.38	0.37	0.35	0.33	0.32	0.30
15	NLF	0.14	0.15	0.16	0.15	0.15	0.15	0.14	0.14
	SDLF	0.14	0.16	0.16	0.15	0.15	0.14	0.14	0.13
	TDLF	0.14	0.16	0.16	0.15	0.15	0.14	0.13	0.12
16	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	NLF	-0.15	-0.14	-0.13	-0.13	-0.13	-0.12	-0.13	-0.13
	SDLF	-0.17	-0.14	-0.13	-0.13	-0.12	-0.12	-0.12	-0.12
	TDLF	-0.18	-0.15	-0.12	-0.12	-0.12	-0.11	-0.11	-0.12
18	NLF	-0.31	-0.29	-0.27	-0.27	-0.26	-0.26	-0.26	-0.26
	SDLF	-0.34	-0.30	-0.27	-0.26	-0.25	-0.25	-0.24	-0.25
	TDLF	-0.36	-0.31	-0.27	-0.25	-0.24	-0.23	-0.22	-0.23
19	NLF	-0.43	-0.41	-0.39	-0.38	-0.37	-0.36	-0.36	-0.36
	SDLF	-0.45	-0.42	-0.39	-0.36	-0.35	-0.34	-0.33	-0.33
	TDLF	-0.47	-0.43	-0.39	-0.35	-0.33	-0.32	-0.30	-0.30
20	NLF	-0.49	-0.48	-0.46	-0.45	-0.43	-0.42	-0.41	-0.41
	SDLF	-0.51	-0.48	-0.46	-0.43	-0.41	-0.39	-0.38	-0.37
	TDLF	-0.52	-0.49	-0.46	-0.42	-0.39	-0.36	-0.34	-0.33

Table F-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	-0.50	-0.50	-0.49	-0.48	-0.46	-0.45	-0.44	-0.43
	SDLF	-0.51	-0.50	-0.49	-0.46	-0.44	-0.41	-0.40	-0.38
	TDLF	-0.52	-0.51	-0.49	-0.45	-0.41	-0.38	-0.36	-0.33
22	NLF	-0.49	-0.49	-0.49	-0.48	-0.46	-0.45	-0.44	-0.43
	SDLF	-0.49	-0.49	-0.48	-0.46	-0.44	-0.42	-0.39	-0.38
	TDLF	-0.49	-0.49	-0.48	-0.45	-0.42	-0.38	-0.35	-0.32
23	NLF	-0.46	-0.46	-0.46	-0.46	-0.45	-0.44	-0.42	-0.41
	SDLF	-0.45	-0.45	-0.45	-0.44	-0.42	-0.40	-0.38	-0.36
	TDLF	-0.44	-0.45	-0.45	-0.43	-0.40	-0.37	-0.33	-0.30
24	NLF	-0.42	-0.42	-0.42	-0.42	-0.41	-0.41	-0.39	-0.38
	SDLF	-0.40	-0.41	-0.41	-0.41	-0.39	-0.37	-0.35	-0.33
	TDLF	-0.38	-0.40	-0.41	-0.40	-0.37	-0.34	-0.31	-0.28
25	NLF	-0.37	-0.38	-0.38	-0.38	-0.37	-0.37	-0.36	-0.35
	SDLF	-0.35	-0.36	-0.37	-0.36	-0.35	-0.34	-0.32	-0.30
	TDLF	-0.34	-0.36	-0.36	-0.36	-0.34	-0.31	-0.28	-0.25
26	NLF	-0.33	-0.33	-0.33	-0.33	-0.33	-0.32	-0.31	-0.31
	SDLF	-0.31	-0.32	-0.32	-0.32	-0.31	-0.30	-0.28	-0.27
	TDLF	-0.30	-0.31	-0.31	-0.31	-0.29	-0.27	-0.25	-0.23
27	NLF	-0.28	-0.28	-0.28	-0.28	-0.27	-0.27	-0.26	-0.26
	SDLF	-0.27	-0.27	-0.27	-0.26	-0.26	-0.25	-0.24	-0.23
	TDLF	-0.26	-0.26	-0.26	-0.25	-0.24	-0.23	-0.21	-0.20
28	NLF	-0.22	-0.22	-0.22	-0.21	-0.21	-0.21	-0.21	-0.21
	SDLF	-0.22	-0.21	-0.21	-0.20	-0.20	-0.20	-0.19	-0.19
	TDLF	-0.22	-0.21	-0.20	-0.19	-0.19	-0.18	-0.17	-0.17
29	NLF	-0.16	-0.15	-0.15	-0.15	-0.14	-0.15	-0.14	-0.15
	SDLF	-0.16	-0.15	-0.14	-0.14	-0.13	-0.14	-0.13	-0.14
	TDLF	-0.16	-0.15	-0.14	-0.13	-0.13	-0.13	-0.12	-0.13
30	NLF	-0.08	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07
	SDLF	-0.08	-0.07	-0.06	-0.06	-0.06	-0.06	-0.06	-0.07
	TDLF	-0.08	-0.07	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06

Table F-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
31	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32	NLF	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.07
	SDLF	0.07	0.08	0.08	0.08	0.07	0.07	0.07	0.06
	TDLF	0.07	0.08	0.08	0.08	0.07	0.07	0.07	0.06
33	NLF	0.18	0.18	0.18	0.18	0.18	0.17	0.17	0.17
	SDLF	0.18	0.18	0.18	0.17	0.17	0.16	0.16	0.15
	TDLF	0.17	0.18	0.18	0.17	0.16	0.15	0.15	0.14
34	NLF	0.29	0.29	0.28	0.28	0.27	0.27	0.27	0.26
	SDLF	0.29	0.29	0.28	0.27	0.25	0.25	0.24	0.24
	TDLF	0.29	0.29	0.27	0.26	0.24	0.23	0.23	0.22
35	NLF	0.39	0.38	0.37	0.36	0.35	0.35	0.35	0.35
	SDLF	0.40	0.38	0.36	0.34	0.33	0.32	0.32	0.32
	TDLF	0.41	0.38	0.35	0.33	0.31	0.30	0.30	0.31
36	NLF	0.46	0.45	0.43	0.42	0.41	0.41	0.41	0.41
	SDLF	0.48	0.45	0.42	0.40	0.38	0.37	0.38	0.38
	TDLF	0.50	0.46	0.41	0.38	0.36	0.35	0.35	0.37
37	NLF	0.50	0.48	0.47	0.45	0.44	0.44	0.44	0.44
	SDLF	0.53	0.49	0.46	0.43	0.41	0.40	0.41	0.42
	TDLF	0.55	0.50	0.45	0.41	0.38	0.38	0.38	0.40
38	NLF	0.50	0.48	0.46	0.45	0.44	0.43	0.44	0.44
	SDLF	0.53	0.49	0.45	0.42	0.41	0.40	0.40	0.42
	TDLF	0.56	0.50	0.45	0.40	0.38	0.37	0.38	0.40
39	NLF	0.46	0.44	0.42	0.41	0.40	0.40	0.40	0.40
	SDLF	0.49	0.45	0.42	0.39	0.37	0.36	0.37	0.38
	TDLF	0.52	0.47	0.41	0.37	0.34	0.34	0.35	0.37
40	NLF	0.38	0.37	0.35	0.34	0.33	0.32	0.33	0.33
	SDLF	0.41	0.38	0.34	0.32	0.30	0.30	0.30	0.32
	TDLF	0.43	0.39	0.34	0.30	0.28	0.28	0.29	0.31

Table F-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
41	NLF	0.27	0.25	0.24	0.23	0.23	0.23	0.23	0.23
	SDLF	0.28	0.26	0.24	0.22	0.21	0.21	0.21	0.22
	TDLF	0.30	0.27	0.23	0.21	0.20	0.19	0.20	0.22
42	NLF	0.13	0.12	0.11	0.11	0.11	0.11	0.11	0.11
	SDLF	0.14	0.12	0.11	0.10	0.10	0.10	0.10	0.11
	TDLF	0.14	0.13	0.11	0.10	0.09	0.09	0.10	0.10
43	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table F-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.47	0.45	0.44	0.42	0.41	0.40	0.40	0.41
	SDLF	0.49	0.46	0.43	0.41	0.39	0.38	0.39	0.39
	TDLF	0.50	0.47	0.43	0.40	0.38	0.37	0.37	0.39
3	NLF	1.04	1.00	0.96	0.92	0.89	0.88	0.89	0.90
	SDLF	1.07	1.01	0.95	0.90	0.86	0.85	0.85	0.87
	TDLF	1.10	1.03	0.95	0.88	0.84	0.82	0.83	0.85
4	NLF	1.53	1.47	1.41	1.36	1.33	1.32	1.32	1.34
	SDLF	1.58	1.50	1.40	1.33	1.28	1.26	1.27	1.29
	TDLF	1.63	1.52	1.39	1.30	1.24	1.22	1.23	1.26
5	NLF	1.94	1.86	1.78	1.72	1.69	1.67	1.68	1.70
	SDLF	2.00	1.89	1.77	1.69	1.63	1.61	1.61	1.64
	TDLF	2.05	1.91	1.75	1.65	1.58	1.55	1.57	1.60
6	NLF	2.23	2.15	2.05	1.99	1.95	1.94	1.94	1.96
	SDLF	2.30	2.18	2.04	1.95	1.89	1.86	1.87	1.89
	TDLF	2.36	2.20	2.02	1.91	1.83	1.80	1.81	1.85
7	NLF	2.40	2.31	2.22	2.15	2.11	2.09	2.10	2.12
	SDLF	2.47	2.35	2.20	2.11	2.05	2.02	2.02	2.04
	TDLF	2.53	2.37	2.18	2.06	1.99	1.95	1.96	2.00
8	NLF	2.44	2.36	2.27	2.21	2.16	2.14	2.14	2.16
	SDLF	2.51	2.39	2.25	2.16	2.10	2.06	2.06	2.09
	TDLF	2.57	2.41	2.23	2.11	2.03	2.00	2.00	2.04
9	NLF	2.36	2.29	2.21	2.15	2.10	2.08	2.08	2.10
	SDLF	2.41	2.31	2.20	2.10	2.04	2.00	2.00	2.02
	TDLF	2.46	2.33	2.18	2.06	1.98	1.94	1.94	1.97
10	NLF	2.15	2.09	2.03	1.98	1.94	1.92	1.92	1.93
	SDLF	2.19	2.11	2.02	1.94	1.88	1.85	1.84	1.86
	TDLF	2.23	2.12	2.01	1.90	1.83	1.79	1.79	1.81

Table F-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	1.83	1.80	1.76	1.72	1.69	1.67	1.66	1.67
	SDLF	1.87	1.81	1.75	1.69	1.64	1.61	1.60	1.60
	TDLF	1.89	1.82	1.73	1.66	1.60	1.56	1.55	1.56
12	NLF	1.45	1.44	1.41	1.39	1.37	1.35	1.34	1.34
	SDLF	1.47	1.44	1.41	1.37	1.33	1.30	1.29	1.29
	TDLF	1.47	1.45	1.40	1.35	1.30	1.26	1.25	1.24
13	NLF	1.03	1.04	1.04	1.02	1.01	0.99	0.98	0.97
	SDLF	1.03	1.04	1.03	1.01	0.98	0.96	0.94	0.93
	TDLF	1.03	1.04	1.02	1.00	0.96	0.93	0.91	0.89
14	NLF	0.62	0.64	0.65	0.64	0.63	0.62	0.61	0.60
	SDLF	0.62	0.64	0.65	0.63	0.62	0.60	0.59	0.56
	TDLF	0.61	0.64	0.64	0.62	0.60	0.58	0.56	0.54
15	NLF	0.25	0.27	0.28	0.27	0.27	0.26	0.26	0.24
	SDLF	0.24	0.27	0.28	0.27	0.26	0.25	0.24	0.23
	TDLF	0.24	0.27	0.28	0.26	0.25	0.25	0.24	0.21
16	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	NLF	-0.28	-0.25	-0.23	-0.23	-0.23	-0.23	-0.23	-0.24
	SDLF	-0.29	-0.25	-0.22	-0.22	-0.22	-0.21	-0.21	-0.23
	TDLF	-0.30	-0.25	-0.22	-0.22	-0.21	-0.20	-0.20	-0.22
18	NLF	-0.57	-0.53	-0.49	-0.48	-0.48	-0.47	-0.47	-0.48
	SDLF	-0.58	-0.53	-0.48	-0.47	-0.45	-0.45	-0.44	-0.45
	TDLF	-0.60	-0.53	-0.47	-0.45	-0.43	-0.43	-0.41	-0.43
19	NLF	-0.78	-0.75	-0.72	-0.69	-0.67	-0.66	-0.65	-0.65
	SDLF	-0.79	-0.74	-0.70	-0.66	-0.63	-0.62	-0.60	-0.60
	TDLF	-0.80	-0.74	-0.69	-0.63	-0.60	-0.59	-0.56	-0.56
20	NLF	-0.89	-0.87	-0.85	-0.81	-0.79	-0.77	-0.75	-0.74
	SDLF	-0.89	-0.86	-0.83	-0.78	-0.74	-0.72	-0.69	-0.68
	TDLF	-0.89	-0.85	-0.81	-0.75	-0.71	-0.67	-0.64	-0.63

Table F-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	-0.92	-0.91	-0.90	-0.87	-0.84	-0.82	-0.80	-0.78
	SDLF	-0.90	-0.89	-0.87	-0.83	-0.79	-0.76	-0.73	-0.71
	TDLF	-0.89	-0.88	-0.85	-0.80	-0.75	-0.71	-0.67	-0.65
22	NLF	-0.89	-0.90	-0.89	-0.87	-0.85	-0.82	-0.80	-0.78
	SDLF	-0.87	-0.87	-0.86	-0.83	-0.80	-0.76	-0.73	-0.70
	TDLF	-0.85	-0.85	-0.84	-0.80	-0.76	-0.71	-0.67	-0.63
23	NLF	-0.84	-0.84	-0.85	-0.83	-0.82	-0.79	-0.77	-0.75
	SDLF	-0.80	-0.81	-0.81	-0.80	-0.77	-0.73	-0.70	-0.67
	TDLF	-0.77	-0.79	-0.79	-0.77	-0.73	-0.68	-0.64	-0.59
24	NLF	-0.76	-0.78	-0.78	-0.77	-0.76	-0.74	-0.72	-0.70
	SDLF	-0.72	-0.74	-0.75	-0.74	-0.72	-0.68	-0.65	-0.62
	TDLF	-0.69	-0.71	-0.73	-0.71	-0.68	-0.64	-0.59	-0.55
25	NLF	-0.68	-0.70	-0.70	-0.70	-0.69	-0.67	-0.65	-0.63
	SDLF	-0.64	-0.66	-0.67	-0.66	-0.65	-0.62	-0.59	-0.56
	TDLF	-0.61	-0.64	-0.65	-0.64	-0.61	-0.58	-0.54	-0.50
26	NLF	-0.61	-0.61	-0.62	-0.61	-0.60	-0.59	-0.57	-0.56
	SDLF	-0.57	-0.58	-0.59	-0.58	-0.57	-0.55	-0.53	-0.50
	TDLF	-0.54	-0.56	-0.57	-0.56	-0.54	-0.51	-0.48	-0.45
27	NLF	-0.52	-0.52	-0.52	-0.52	-0.51	-0.50	-0.49	-0.48
	SDLF	-0.50	-0.50	-0.50	-0.49	-0.48	-0.47	-0.45	-0.44
	TDLF	-0.48	-0.48	-0.48	-0.47	-0.45	-0.43	-0.41	-0.40
28	NLF	-0.43	-0.42	-0.41	-0.40	-0.40	-0.40	-0.39	-0.39
	SDLF	-0.41	-0.40	-0.39	-0.38	-0.38	-0.37	-0.36	-0.36
	TDLF	-0.40	-0.39	-0.38	-0.36	-0.35	-0.35	-0.33	-0.33
29	NLF	-0.31	-0.29	-0.28	-0.28	-0.27	-0.28	-0.27	-0.28
	SDLF	-0.30	-0.28	-0.27	-0.26	-0.26	-0.26	-0.25	-0.26
	TDLF	-0.30	-0.27	-0.26	-0.25	-0.24	-0.24	-0.24	-0.24
30	NLF	-0.15	-0.14	-0.13	-0.13	-0.13	-0.13	-0.13	-0.14
	SDLF	-0.15	-0.13	-0.12	-0.12	-0.12	-0.12	-0.12	-0.13
	TDLF	-0.15	-0.13	-0.12	-0.12	-0.11	-0.11	-0.11	-0.12

Table F-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
31	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32	NLF	0.14	0.15	0.16	0.15	0.15	0.15	0.14	0.13
	SDLF	0.14	0.15	0.15	0.15	0.14	0.14	0.14	0.12
	TDLF	0.13	0.15	0.15	0.14	0.14	0.13	0.13	0.11
33	NLF	0.34	0.35	0.35	0.34	0.34	0.33	0.33	0.32
	SDLF	0.33	0.34	0.34	0.33	0.32	0.31	0.31	0.30
	TDLF	0.32	0.33	0.33	0.32	0.31	0.29	0.29	0.28
34	NLF	0.55	0.55	0.54	0.53	0.52	0.51	0.51	0.51
	SDLF	0.54	0.54	0.52	0.51	0.50	0.48	0.48	0.48
	TDLF	0.54	0.53	0.51	0.49	0.48	0.46	0.46	0.46
35	NLF	0.74	0.72	0.70	0.69	0.68	0.67	0.67	0.68
	SDLF	0.74	0.71	0.68	0.66	0.64	0.63	0.63	0.64
	TDLF	0.74	0.71	0.67	0.64	0.62	0.60	0.61	0.61
36	NLF	0.89	0.86	0.83	0.81	0.79	0.79	0.79	0.80
	SDLF	0.89	0.85	0.81	0.78	0.75	0.75	0.75	0.76
	TDLF	0.90	0.85	0.79	0.75	0.72	0.71	0.72	0.74
37	NLF	0.97	0.93	0.90	0.87	0.85	0.85	0.85	0.87
	SDLF	0.98	0.93	0.88	0.84	0.81	0.80	0.81	0.83
	TDLF	1.00	0.93	0.86	0.81	0.78	0.77	0.78	0.81
38	NLF	0.98	0.94	0.90	0.87	0.85	0.84	0.85	0.87
	SDLF	0.99	0.93	0.88	0.83	0.81	0.80	0.81	0.83
	TDLF	1.01	0.94	0.86	0.80	0.77	0.76	0.78	0.81
39	NLF	0.90	0.86	0.82	0.79	0.78	0.77	0.78	0.80
	SDLF	0.92	0.86	0.80	0.76	0.74	0.73	0.74	0.76
	TDLF	0.94	0.86	0.79	0.73	0.70	0.70	0.72	0.75
40	NLF	0.74	0.71	0.67	0.65	0.64	0.63	0.64	0.66
	SDLF	0.76	0.71	0.66	0.63	0.61	0.60	0.61	0.63
	TDLF	0.78	0.71	0.65	0.60	0.58	0.57	0.59	0.62

Table F-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
41	NLF	0.52	0.49	0.47	0.45	0.44	0.44	0.45	0.46
	SDLF	0.53	0.50	0.46	0.44	0.42	0.42	0.43	0.44
	TDLF	0.55	0.50	0.45	0.42	0.40	0.40	0.41	0.43
42	NLF	0.25	0.23	0.22	0.21	0.21	0.21	0.21	0.22
	SDLF	0.25	0.24	0.22	0.21	0.20	0.20	0.20	0.21
	TDLF	0.26	0.24	0.21	0.20	0.19	0.19	0.20	0.21
43	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table F-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number							
		SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	276.4	443.6	342.9	167.2	276.4	443.6	342.9	167.2
	SDLF	283.2	426.5	337.2	167.3	283.2	426.5	337.2	167.3
	TDLF	288.0	407.3	329.1	167.8	288.0	407.3	329.1	167.8
G2	NLF	254.6	603.5	416.9	157.9	254.6	603.5	416.9	157.9
	SDLF	257.4	622.8	425.9	155.6	257.4	622.8	425.9	155.6
	TDLF	259.2	640.4	434.3	153.7	259.2	640.4	434.3	153.7
G3	NLF	229.6	616.1	422.2	147.0	229.6	616.1	422.2	147.0
	SDLF	233.2	634.7	431.4	145.3	233.2	634.7	431.4	145.3
	TDLF	236.2	652.4	440.1	144.3	236.2	652.4	440.1	144.3
G4	NLF	168.9	528.9	373.9	125.2	168.9	528.9	373.9	125.2
	SDLF	166.2	525.9	376.6	122.3	166.2	525.9	376.6	122.3
	TDLF	163.9	525.5	380.2	119.7	163.9	525.5	380.2	119.7
G5	NLF	149.9	499.6	365.6	116.1	149.9	499.6	365.6	116.1
	SDLF	149.3	492.7	367.1	114.4	149.3	492.7	367.1	114.4
	TDLF	148.9	488.3	368.9	113.2	148.9	488.3	368.9	113.2
G6	NLF	133.3	476.5	358.2	107.5	133.3	476.5	358.2	107.5
	SDLF	134.3	468.8	360.9	106.6	134.3	468.8	360.9	106.6
	TDLF	135.4	463.0	363.3	106.3	135.4	463.0	363.3	106.3
G7	NLF	105.5	401.8	324.1	95.5	105.5	401.8	324.1	95.5
	SDLF	106.1	388.2	323.2	95.2	106.1	388.2	323.2	95.2
	TDLF	106.8	377.2	321.3	95.2	106.8	377.2	321.3	95.2
G8	NLF	89.5	397.7	326.7	85.7	89.5	397.7	326.7	85.7
	SDLF	91.5	377.1	325.3	85.8	91.5	377.1	325.3	85.8
	TDLF	92.9	358.0	320.8	86.0	92.9	358.0	320.8	86.0
G9	NLF	70.0	453.3	370.0	72.4	70.0	453.3	370.0	72.4
	SDLF	73.0	444.4	384.9	73.2	73.0	444.4	384.9	73.2
	TDLF	74.9	440.4	396.7	73.7	74.9	440.4	396.7	73.7

Table F-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number							
		SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	NA	0.6	NA	NA	NA	1.1	NA	NA
	SDLF	NA	0.7	NA	NA	NA	1.1	NA	NA
	TDLF	NA	0.7	NA	NA	NA	1.1	NA	NA
G2	NLF	NA	0.5	NA	NA	NA	0.8	NA	NA
	SDLF	NA	0.5	NA	NA	NA	0.8	NA	NA
	TDLF	NA	0.5	NA	NA	NA	0.8	NA	NA
G3	NLF	NA	0.3	NA	NA	NA	0.5	NA	NA
	SDLF	NA	0.3	NA	NA	NA	0.5	NA	NA
	TDLF	NA	0.3	NA	NA	NA	0.5	NA	NA
G4	NLF	NA	0.1	NA	NA	NA	0.3	NA	NA
	SDLF	NA	0.1	NA	NA	NA	0.2	NA	NA
	TDLF	NA	0.1	NA	NA	NA	0.2	NA	NA
G5	NLF	NA	0.0	NA	NA	NA	0.0	NA	NA
	SDLF	NA	0.0	NA	NA	NA	0.0	NA	NA
	TDLF	NA	0.0	NA	NA	NA	0.0	NA	NA
G6	NLF	NA	-0.2	NA	NA	NA	-0.3	NA	NA
	SDLF	NA	-0.2	NA	NA	NA	-0.3	NA	NA
	TDLF	NA	-0.2	NA	NA	NA	-0.3	NA	NA
G7	NLF	NA	-0.3	NA	NA	NA	-0.6	NA	NA
	SDLF	NA	-0.3	NA	NA	NA	-0.6	NA	NA
	TDLF	NA	-0.4	NA	NA	NA	-0.6	NA	NA
G8	NLF	NA	-0.5	NA	NA	NA	-0.8	NA	NA
	SDLF	NA	-0.5	NA	NA	NA	-0.8	NA	NA
	TDLF	NA	-0.5	NA	NA	NA	-0.8	NA	NA
G9	NLF	NA	-0.7	NA	NA	NA	-1.1	NA	NA
	SDLF	NA	-0.7	NA	NA	NA	-1.1	NA	NA
	TDLF	NA	-0.7	NA	NA	NA	-1.1	NA	NA

Table F-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	0.0	0.2	0.0	0.0	-0.1	0.4	0.0	0.1
	SDLF	0.0	0.1	0.0	0.0	-0.1	0.3	0.0	0.0
	TDLF	-0.1	0.0	0.0	0.0	-0.1	0.2	0.0	0.0
G2	NLF	0.0	0.2	0.0	0.0	-0.1	0.4	-0.1	0.1
	SDLF	0.0	0.1	0.0	0.0	-0.1	0.2	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	-0.1	0.1	0.0	0.0
G3	NLF	-0.1	0.1	0.0	0.0	-0.1	0.3	-0.1	0.1
	SDLF	0.0	0.1	0.0	0.0	-0.1	0.2	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	-0.1	0.1	0.0	0.0
G4	NLF	-0.1	0.1	0.0	0.0	-0.1	0.2	-0.1	0.0
	SDLF	0.0	0.0	0.0	0.0	-0.1	0.1	-0.1	0.0
	TDLF	0.0	0.0	0.0	0.0	-0.1	0.1	0.0	0.0
G5	NLF	-0.1	0.1	-0.1	0.0	-0.1	0.2	-0.2	0.0
	SDLF	0.0	0.0	0.0	0.0	-0.1	0.1	-0.1	0.0
	TDLF	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0
G6	NLF	-0.1	0.1	-0.1	0.0	-0.2	0.2	-0.2	0.0
	SDLF	0.0	0.0	0.0	0.0	-0.1	0.1	-0.1	0.0
	TDLF	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0
G7	NLF	-0.1	0.1	-0.1	0.0	-0.2	0.2	-0.2	0.0
	SDLF	0.0	0.0	0.0	0.0	-0.1	0.1	-0.1	0.0
	TDLF	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0
G8	NLF	-0.1	0.0	-0.1	0.0	-0.2	0.1	-0.2	0.0
	SDLF	0.0	0.0	0.0	0.0	-0.1	0.1	-0.1	0.0
	TDLF	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0
G9	NLF	-0.1	0.0	-0.1	0.0	-0.2	0.2	-0.2	0.0
	SDLF	0.0	0.0	0.0	0.0	-0.1	0.1	-0.1	0.0
	TDLF	0.0	0.0	0.1	0.0	-0.1	0.1	0.0	0.0

Table F-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.65	0.13	-0.23	0.19	-0.70	0.21	-0.32	0.41
	SDLF	-0.77	0.13	-0.19	0.21	-1.08	0.22	-0.33	0.42
	TDLF	-0.88	0.14	-0.17	0.22	-1.39	0.22	-0.36	0.42
G2	NLF	-0.56	0.09	-0.21	0.16	-0.56	0.16	-0.28	0.35
	SDLF	-0.68	0.10	-0.18	0.18	-0.94	0.16	-0.30	0.36
	TDLF	-0.78	0.10	-0.16	0.18	-1.24	0.16	-0.33	0.36
G3	NLF	-0.48	0.06	-0.19	0.14	-0.42	0.10	-0.24	0.31
	SDLF	-0.60	0.06	-0.16	0.15	-0.80	0.11	-0.26	0.31
	TDLF	-0.70	0.06	-0.14	0.15	-1.11	0.11	-0.29	0.31
G4	NLF	-0.41	0.03	-0.17	0.12	-0.29	0.05	-0.20	0.29
	SDLF	-0.52	0.03	-0.14	0.13	-0.67	0.05	-0.22	0.30
	TDLF	-0.62	0.03	-0.12	0.13	-0.98	0.05	-0.25	0.29
G5	NLF	-0.34	0.00	-0.15	0.10	-0.17	0.00	-0.15	0.25
	SDLF	-0.45	0.00	-0.12	0.11	-0.55	0.00	-0.18	0.25
	TDLF	-0.54	-0.01	-0.10	0.11	-0.86	-0.01	-0.21	0.25
G6	NLF	-0.27	-0.03	-0.13	0.08	-0.05	-0.06	-0.11	0.21
	SDLF	-0.38	-0.04	-0.10	0.09	-0.43	-0.06	-0.14	0.21
	TDLF	-0.48	-0.04	-0.08	0.09	-0.74	-0.06	-0.18	0.21
G7	NLF	-0.20	-0.07	-0.10	0.05	0.07	-0.11	-0.06	0.17
	SDLF	-0.32	-0.07	-0.08	0.07	-0.32	-0.11	-0.10	0.18
	TDLF	-0.42	-0.07	-0.06	0.07	-0.64	-0.11	-0.14	0.18
G8	NLF	-0.13	-0.10	-0.08	0.03	0.18	-0.17	-0.01	0.13
	SDLF	-0.25	-0.10	-0.06	0.04	-0.21	-0.17	-0.06	0.13
	TDLF	-0.35	-0.10	-0.04	0.05	-0.53	-0.17	-0.10	0.13
G9	NLF	-0.07	-0.13	-0.06	0.01	0.31	-0.22	0.03	0.08
	SDLF	-0.19	-0.13	-0.04	0.02	-0.10	-0.22	-0.02	0.09
	TDLF	-0.29	-0.13	-0.03	0.02	-0.42	-0.22	-0.06	0.08

Table F-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.01	0.04	0.00	0.01	-0.02	0.09	0.00	0.02
	SDLF	-0.01	0.02	0.00	0.00	-0.01	0.06	0.00	0.01
	TDLF	-0.01	0.00	0.00	-0.01	-0.01	0.03	0.01	0.00
G2	NLF	-0.01	0.03	0.00	0.00	-0.02	0.07	-0.01	0.01
	SDLF	-0.01	0.01	0.00	0.00	-0.02	0.05	-0.01	0.01
	TDLF	-0.01	0.00	0.00	-0.01	-0.01	0.02	0.00	0.00
G3	NLF	-0.01	0.02	0.00	0.00	-0.02	0.06	-0.02	0.01
	SDLF	-0.01	0.01	0.00	0.00	-0.02	0.04	-0.01	0.01
	TDLF	-0.01	0.00	0.00	0.00	-0.01	0.02	0.00	0.00
G4	NLF	-0.01	0.02	-0.01	0.00	-0.03	0.05	-0.03	0.01
	SDLF	-0.01	0.01	0.00	0.00	-0.02	0.03	-0.01	0.00
	TDLF	0.00	0.00	0.00	0.00	-0.01	0.01	0.00	0.00
G5	NLF	-0.01	0.02	-0.01	0.00	-0.03	0.04	-0.03	0.01
	SDLF	-0.01	0.01	0.00	0.00	-0.02	0.02	-0.02	0.00
	TDLF	0.00	0.00	0.00	0.00	-0.01	0.01	-0.01	0.00
G6	NLF	-0.01	0.01	-0.01	0.00	-0.03	0.04	-0.04	0.00
	SDLF	-0.01	0.00	0.00	0.00	-0.02	0.02	-0.02	0.00
	TDLF	0.00	0.00	0.01	0.00	-0.01	0.01	-0.01	0.00
G7	NLF	-0.02	0.01	-0.01	0.00	-0.03	0.03	-0.04	0.00
	SDLF	-0.01	0.00	0.00	0.00	-0.02	0.02	-0.02	0.00
	TDLF	0.00	0.00	0.01	0.00	-0.01	0.01	-0.01	0.00
G8	NLF	-0.02	0.01	-0.02	0.00	-0.03	0.03	-0.04	0.00
	SDLF	-0.01	0.00	0.00	0.00	-0.02	0.02	-0.02	0.00
	TDLF	0.00	0.00	0.01	0.00	-0.01	0.01	-0.01	0.00
G9	NLF	-0.02	0.01	-0.02	0.00	-0.04	0.03	-0.04	0.00
	SDLF	-0.01	0.01	0.00	0.00	-0.02	0.02	-0.02	0.00
	TDLF	0.00	0.01	0.01	0.00	-0.01	0.01	0.00	0.00

Appendix F-5. NICCR12 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NICCR12 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table F-5-1. Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
11	11-1	NLF	-9.3	-9.2	13.1	-9.2	9.2	13.0
		SDLF	17.9	11.9	21.5	23.3	-11.6	26.0
		TDLF	48.3	28.7	56.2	39.6	-27.8	48.4
	11-2	NLF	-0.7	-1.9	2.0	-0.8	2.0	2.1
		SDLF	24.3	17.0	29.7	28.5	-16.7	33.0
		TDLF	51.1	31.6	60.1	43.6	-31.2	53.6
	11-3	NLF	6.2	5.9	8.6	6.1	-5.9	8.5
		SDLF	28.1	22.8	36.2	31.0	-23.0	38.6
		TDLF	50.2	35.7	61.6	44.6	-36.1	57.4
	11-4	NLF	6.4	7.5	9.9	6.4	-7.5	9.9
		SDLF	21.9	19.1	29.1	23.6	-19.3	30.5
		TDLF	37.1	27.8	46.4	33.4	-28.3	43.8
	11-5	NLF	3.6	5.2	6.3	3.8	-5.3	6.5
		SDLF	13.3	12.2	18.1	13.7	-12.4	18.5
		TDLF	22.5	17.5	28.5	19.7	-17.8	26.6
	11-6	NLF	1.6	2.5	3.0	1.5	-2.6	3.0
		SDLF	9.6	6.2	11.4	3.6	-6.1	7.1
		TDLF	16.4	9.0	18.7	4.4	-8.8	9.9
	11-7	NLF	0.7	0.9	1.1	0.7	-1.0	1.2
		SDLF	23.1	2.4	23.2	-19.0	-1.3	19.0
		TDLF	41.5	3.7	41.7	-35.2	-1.6	35.2
	11-8	NLF	-2.9	-2.1	3.5	-2.8	1.9	3.4
		SDLF	-25.5	-2.7	25.6	17.4	2.9	17.6
		TDLF	-44.4	-3.4	44.5	33.9	3.9	34.1
	11-9	NLF	-0.3	-0.2	0.4	-0.3	0.3	0.4
		SDLF	-4.9	-0.7	5.0	2.6	0.9	2.8
		TDLF	-8.2	-1.1	8.3	4.5	1.5	4.8

Table F-5-1(Continued). Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
18	18-1	NLF	-17.8	-5.3	18.6	-17.5	5.2	18.2
		SDLF	-11.6	7.6	13.9	-3.7	-6.6	7.6
		TDLF	3.5	18.1	18.4	3.6	-15.8	16.2
	18-2	NLF	-18.2	-2.2	18.4	-18.1	2.5	18.2
		SDLF	-10.2	10.1	14.3	-3.5	-8.9	9.6
		TDLF	3.5	19.9	20.2	3.6	-18.0	18.4
	18-3	NLF	-8.5	3.0	9.0	-8.5	-2.9	9.0
		SDLF	0.7	14.3	14.4	5.8	-14.0	15.2
		TDLF	12.2	23.0	26.1	12.6	-22.5	25.8
	18-4	NLF	-1.5	5.6	5.8	-1.4	-5.5	5.7
		SDLF	5.1	14.2	15.1	8.5	-14.2	16.6
		TDLF	12.7	20.8	24.4	13.2	-20.9	24.7
	18-5	NLF	-0.1	4.2	4.2	0.0	-4.2	4.2
		SDLF	3.8	9.7	10.4	5.6	-9.7	11.2
		TDLF	8.1	14.0	16.2	8.2	-14.1	16.3
	18-6	NLF	-0.2	2.3	2.3	-0.1	-2.4	2.4
		SDLF	2.2	5.5	5.9	1.9	-5.2	5.6
		TDLF	4.3	8.0	9.1	2.2	-7.5	7.8
	18-7	NLF	-1.3	1.3	1.8	-1.2	-1.4	1.9
		SDLF	1.9	3.1	3.7	-4.2	-1.4	4.4
		TDLF	4.9	4.7	6.8	-8.0	-1.2	8.1
	18-8	NLF	-3.3	-1.5	3.6	-3.2	1.1	3.4
		SDLF	-7.3	-1.3	7.4	-3.3	1.9	3.8
		TDLF	-11.4	-1.0	11.4	-3.4	2.8	4.4
	18-9	NLF	-0.4	0.0	0.4	-0.4	0.1	0.4
		SDLF	-1.3	-0.2	1.3	-1.4	0.6	1.5
		TDLF	-1.6	-0.5	1.6	-2.5	0.9	2.6

Table F-5-2: Erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
11	NLF	11-1
	SDLF	11-3
	TDLF	11-3
18	NLF	18-2
	SDLF	18-4
	TDLF	18-3

Table F-5-3. Erection critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
11	A	NLF	-8.3	-3.4	8.9	NA	NA	NA
		SDLF	29.7	7.8	30.7	NA	NA	NA
		TDLF	47.9	11.7	49.3	NA	NA	NA
	B	NLF	-9.3	-9.2	13.1	-9.2	9.2	13.0
		SDLF	28.1	22.8	36.2	31.0	-23.0	38.6
		TDLF	50.2	35.7	61.6	44.6	-36.1	57.4
18	A	NLF	-28.4	-1.0	28.4	NA	NA	NA
		SDLF	9.9	7.7	12.6	NA	NA	NA
		TDLF	11.1	9.8	14.8	NA	NA	NA
	B	NLF	-18.2	-2.2	18.4	-18.1	2.5	18.2
		SDLF	5.1	14.2	15.1	8.5	-14.2	16.6
		TDLF	12.2	23.0	26.1	12.6	-22.5	25.8

Table F-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
11	A	G1	NLF	112.3	244.6	70.6	142.6		
			SDLF	134.2	314.1	99.8	152.5		
			TDLF	151.3	384.1	124.2	158.0		
		G2	NLF	117.3	279.2	78.7	157.3	78.6	116.1
			SDLF	132.6	140.7	94.1	188.2	94.1	103.7
			TDLF	144.4	11.0	106.7	213.3	106.6	94.6
		G3	NLF	102.4	110.2				
			SDLF	111.3	91.0				
			TDLF	118.5	67.4				
		G4	NLF	87.1	89.9				
			SDLF	87.7	75.1				
			TDLF	88.2	64.9				
		G5	NLF	87.3	94.6				
			SDLF	87.1	85.9				
			TDLF	87.3	81.8				
		G6	NLF	88.0	96.5				
			SDLF	87.4	93.6				
			TDLF	87.5	95.1				
		G7	NLF	79.4	87.2				
			SDLF	77.7	93.6				
			TDLF	76.6	104.5				
		G8	NLF	79.7	86.6				
			SDLF	78.3	94.9				
			TDLF	77.2	106.1				
		G9	NLF	76.9	83.4				
			SDLF	76.3	87.1				
			TDLF	75.4	81.4				

Table F-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
11	B	G1	NLF	112.1	236.3	69.2	142.7		
			SDLF	134.0	318.6	109.5	149.1		
			TDLF	151.2	390.0	138.8	152.4		
		G2	NLF	117.2	289.4	84.9	169.8	84.9	108.2
			SDLF	132.4	154.1	64.0	127.9	63.9	140.3
			TDLF	144.1	30.9	62.2	124.4	62.2	148.7
		G3	NLF	102.3	107.9				
			SDLF	111.1	91.9				
			TDLF	118.3	68.8				
		G4	NLF	87.1	88.9				
			SDLF	87.6	75.2				
			TDLF	88.1	65.0				
		G5	NLF	87.2	94.2				
			SDLF	87.0	85.9				
			TDLF	87.2	81.8				
		G6	NLF	87.9	96.4				
			SDLF	87.4	93.6				
			TDLF	87.4	95.1				
		G7	NLF	79.4	87.1				
			SDLF	77.7	93.6				
			TDLF	76.6	104.6				
		G8	NLF	79.7	86.6				
			SDLF	78.4	94.9				
			TDLF	77.2	106.1				
		G9	NLF	76.9	83.5				
			SDLF	76.4	87.2				
			TDLF	75.5	81.5				

Table F-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
18	A	G1	NLF	90.7	274.6	212.0			
			SDLF	121.8	407.9	217.8			
			TDLF	146.0	526.6	217.2			
		G2	NLF	89.9	311.6	216.4			
			SDLF	113.7	254.5	252.8			
			TDLF	132.1	194.5	283.0			
		G3	NLF	88.0	301.1	210.4			
			SDLF	109.2	190.7	244.5			
			TDLF	125.9	86.3	273.3			
		G4	NLF	73.2	245.9	179.6			
			SDLF	82.8	163.8	191.5			
			TDLF	90.1	98.1	202.3			
		G5	NLF	72.9	237.9	176.5			
			SDLF	83.7	174.2	184.0			
			TDLF	92.4	130.5	190.9			
		G6	NLF	73.0	230.0	174.1			
			SDLF	85.8	186.7	182.7			
			TDLF	96.4	165.1	190.7			
		G7	NLF	66.1	199.8	149.2			
			SDLF	78.4	179.3	154.9			
			TDLF	88.2	179.8	160.6			
		G8	NLF	64.8	177.9	135.5			
			SDLF	79.7	167.7	145.0			
			TDLF	91.1	163.6	146.0			
		G9	NLF	61.2	147.9	114.3	228.5	114.2	19.6
			SDLF	78.7	110.2	122.1	244.1	122.0	25.3
			TDLF	91.6	45.2	151.2	302.2	151.0	0.0

Table F-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
18	B	G1	NLF	90.6	274.9	212.1			
			SDLF	121.8	408.5	218.1			
			TDLF	146.0	527.2	217.4			
		G2	NLF	89.9	311.9	216.5			
			SDLF	113.6	255.0	253.0			
			TDLF	132.1	195.1	283.2			
		G3	NLF	88.0	301.4	210.4			
			SDLF	109.1	190.9	244.7			
			TDLF	125.9	86.8	273.5			
		G4	NLF	73.3	246.0	179.5			
			SDLF	82.8	163.7	191.7			
			TDLF	90.1	98.2	202.2			
		G5	NLF	72.9	237.8	176.3			
			SDLF	83.7	173.6	184.0			
			TDLF	92.4	130.1	190.6			
		G6	NLF	73.0	229.2	173.8			
			SDLF	85.8	185.6	182.1			
			TDLF	96.4	163.9	189.8			
		G7	NLF	66.1	198.1	149.0			
			SDLF	78.4	178.6	153.8			
			TDLF	88.2	178.5	159.5			
		G8	NLF	64.9	175.8	134.5			
			SDLF	79.8	169.4	144.6			
			TDLF	91.1	166.0	150.9			
		G9	NLF	61.3	146.7	121.4	242.6	121.2	12.2
			SDLF	78.8	115.1	114.7	229.2	114.5	37.0
			TDLF	91.6	56.2	134.3	268.4	134.1	19.5

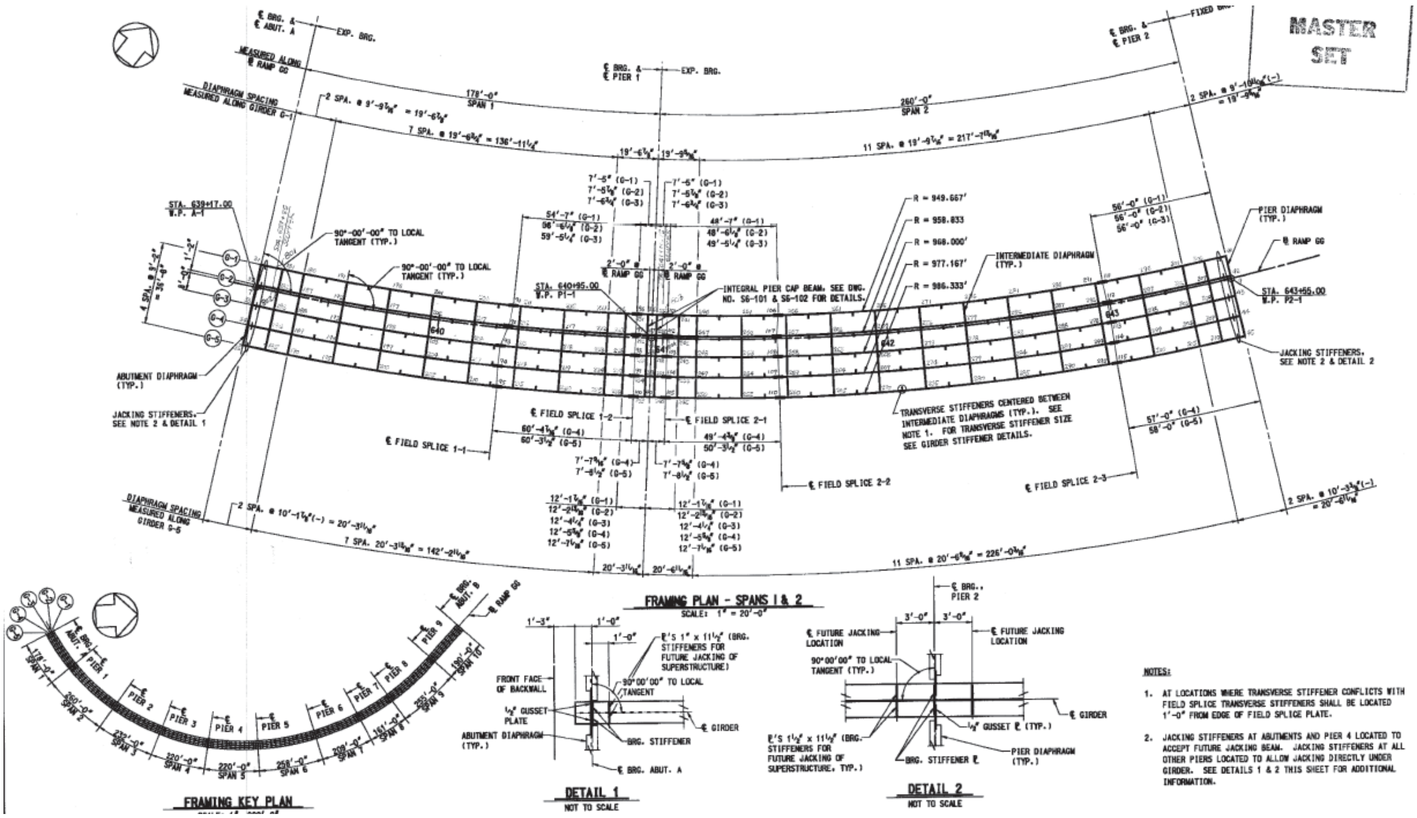
Appendix G-1. EICCR4 Bridge Description

The key characteristics of EICCR4 are as follows:

- Span length along the centerline of the bridge, L_s = 219,260,211,162,256,190 ft.
- Width between the fascia girders, w_g = 36.7 ft.
- Radius of curvature to the centerline of the bridge, R =968,1108,1108,1108,968,infinite ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 6.0,7.15.7,4.4,7.0,5.2
- Subtended angle between the supports, L_s/R = 0.198,0.235,0.190,0.146,0.264,0
- Number of girders in the completed bridge cross-section, n_g =5.

This appendix presents the bridge description of the bridge EICCR4 in its final condition as well as during erection. The following figures and tables are provided:

Figure G-1-1.	Framing plan
Figure G-1-2.	Bridge cross-section
Figure G-1-3.	Girder Elevation
Figure G-1-4.	Cross-frame details
Figure G-1-5.	Erection scheme
Table G-1-1.	Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed NLF



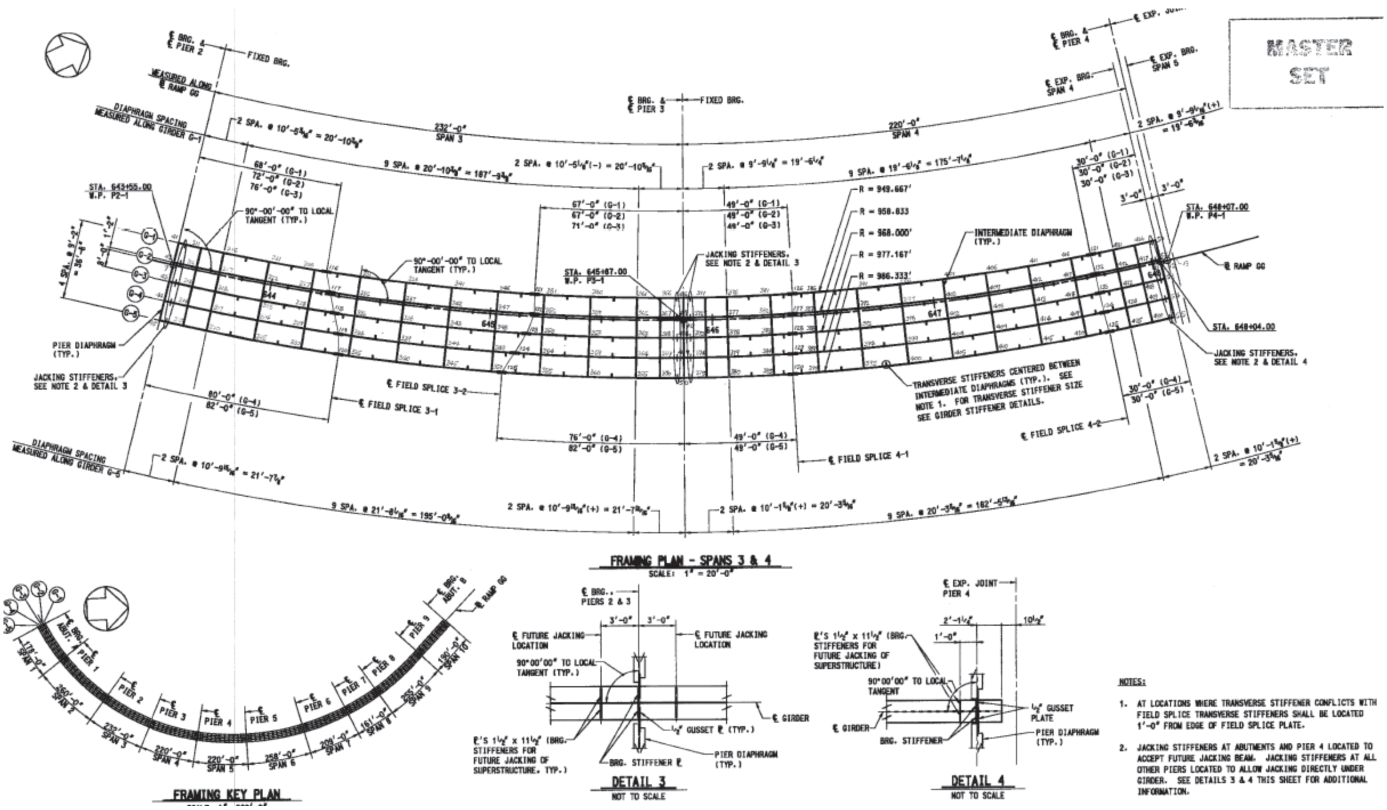


Figure G-1-1. Framing plan.

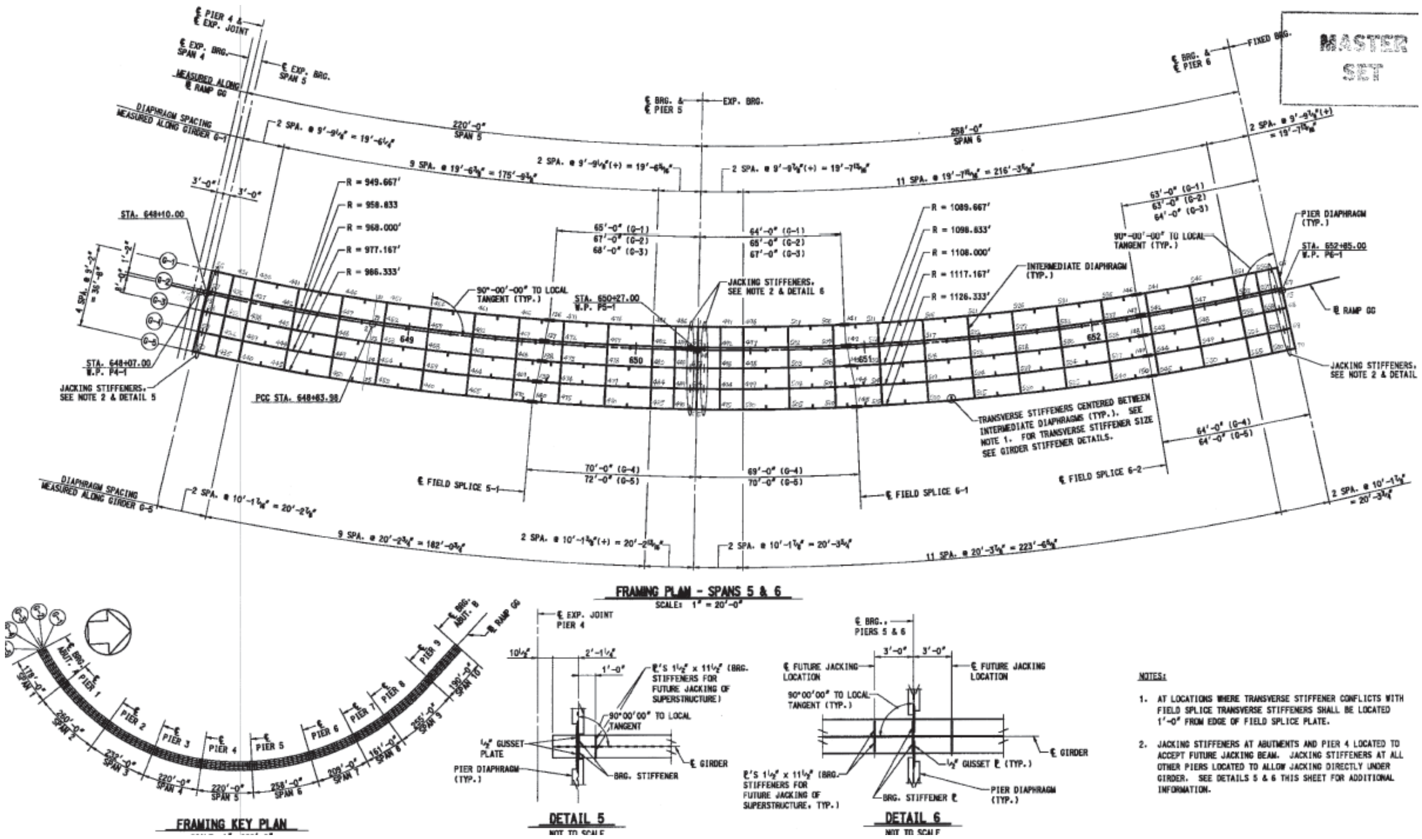
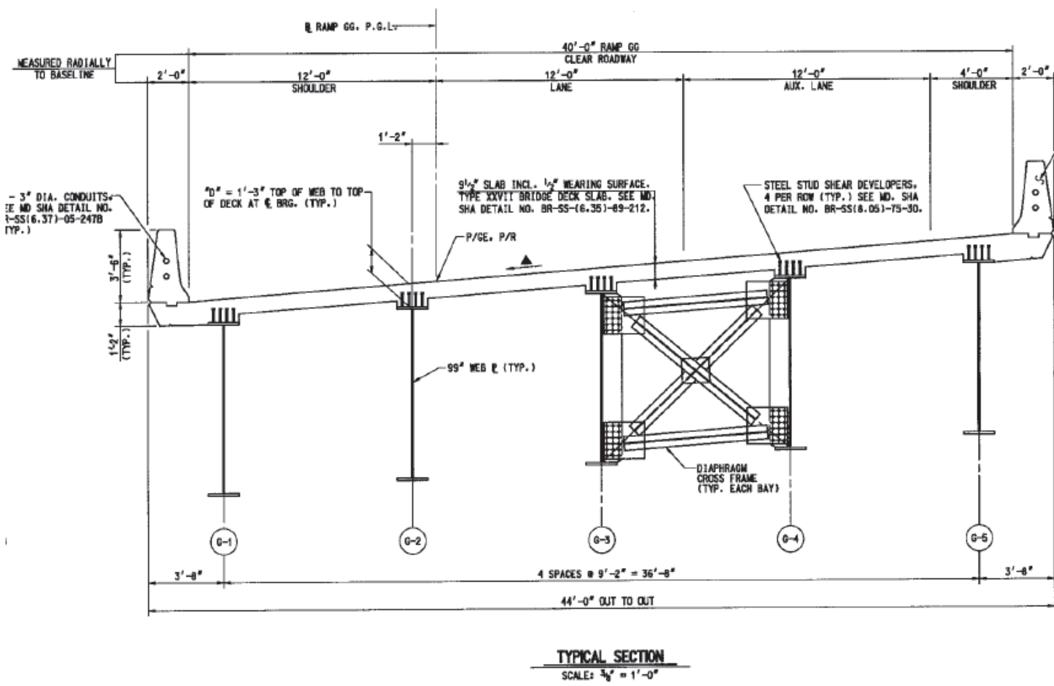


Figure G-1-1(Continued). Framing plan.



▲ RAMP GG	
STATION	X-SLOPE
639+17.00	0.0547'/'
640+27.20	0.0768'/'
648+83.98	0.0768'/'
657+91.61	0.0768'/'
658+86.28	0.0579'/'
660+75.61	0.0200'/'
661+00.00	0.0200'/'
o = 0.0002 ft./ft./ft.	

Figure G-1-2. Bridge cross-section.

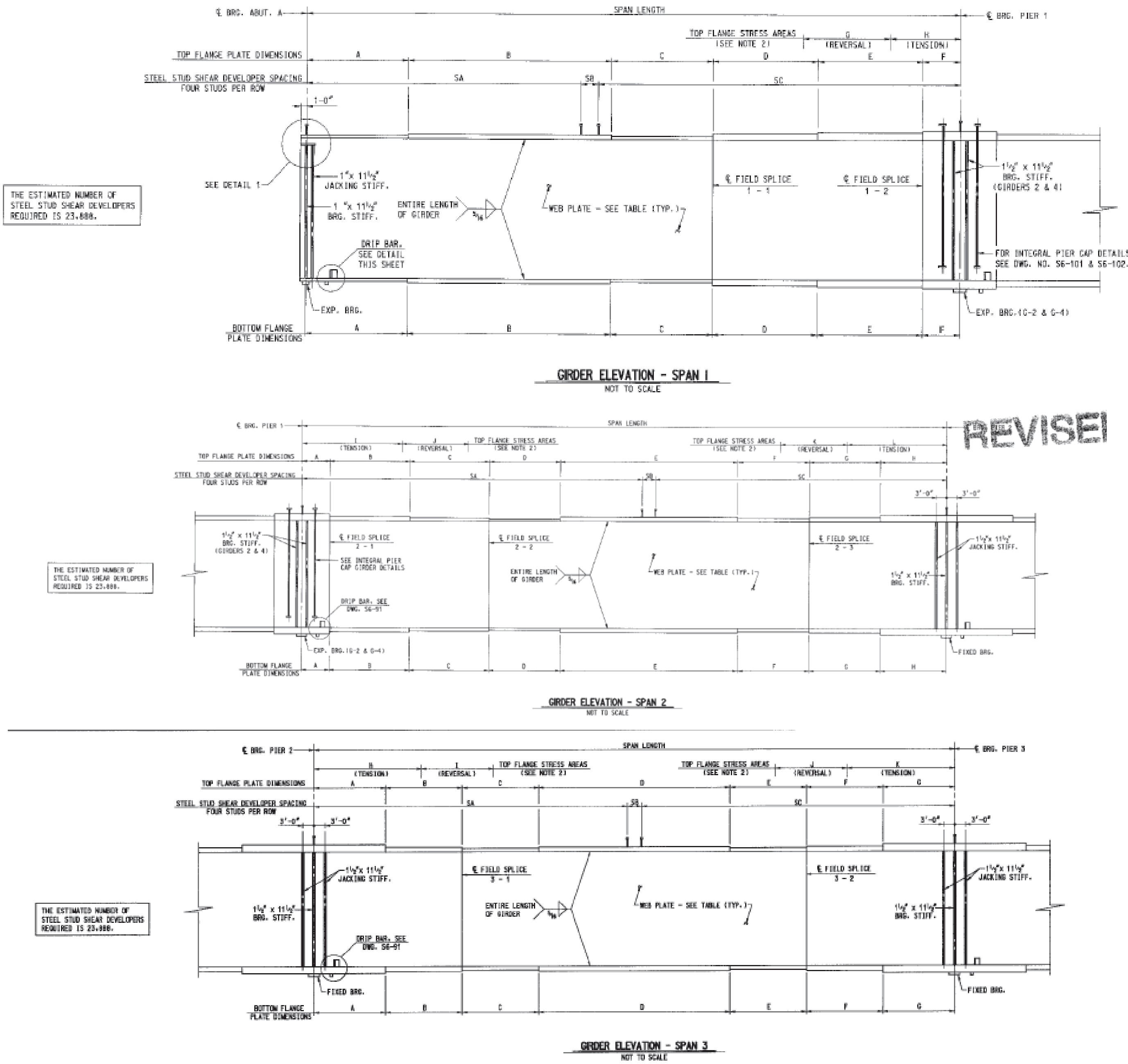


Figure G-1-3. Girder elevations

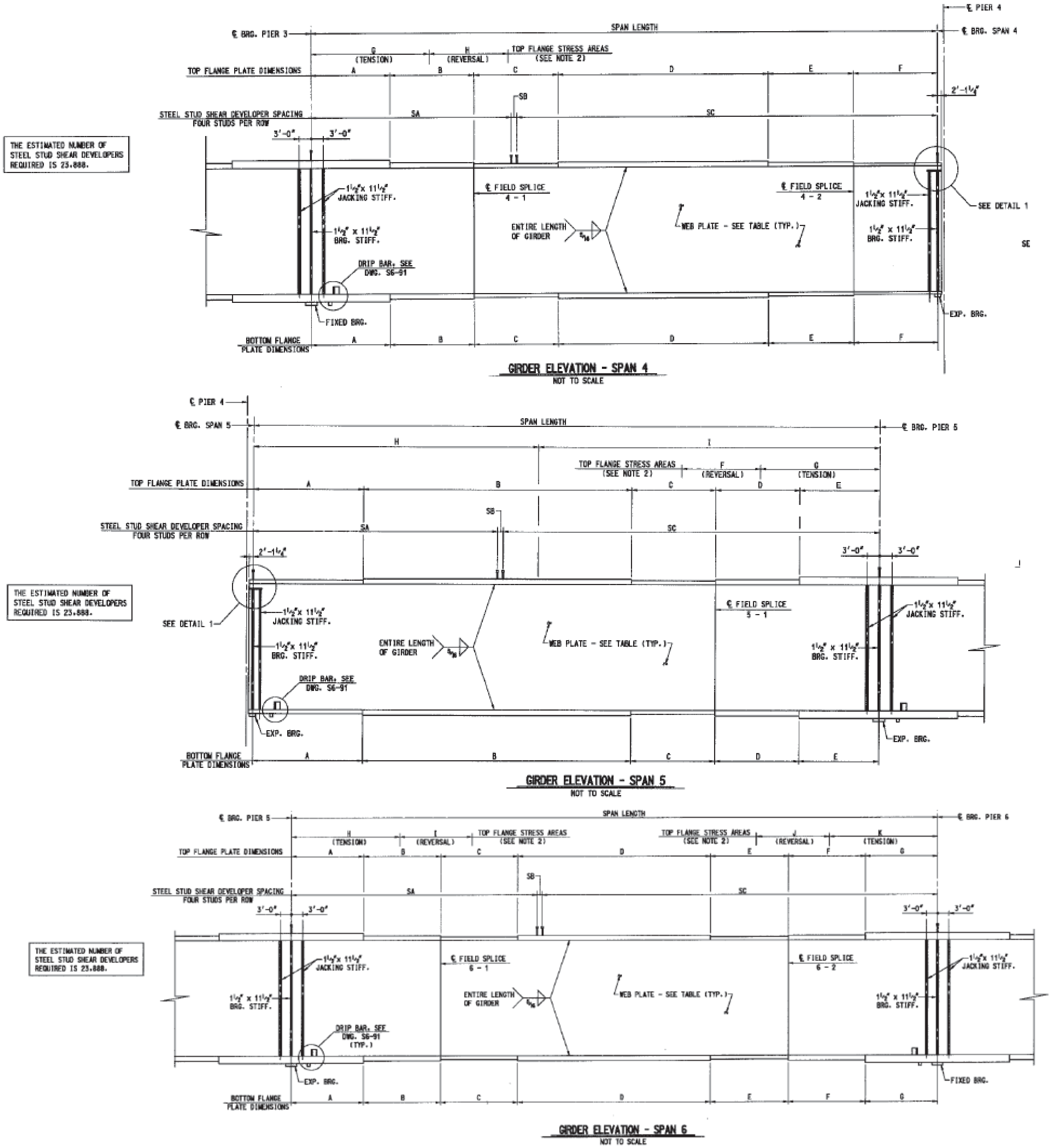


Figure G-1-3(Continued). Girder elevations

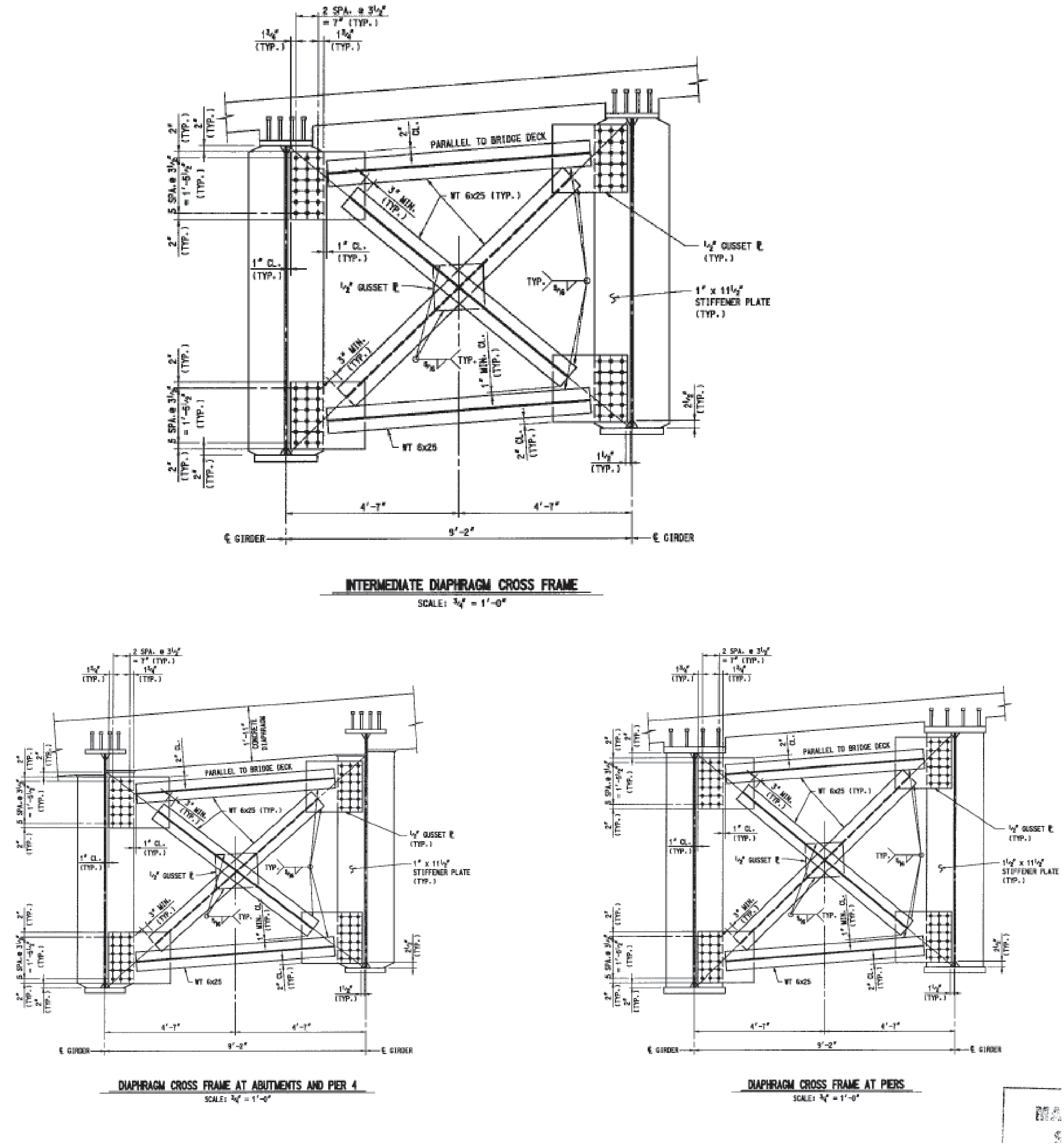


Figure G-1-4. Cross-frame details

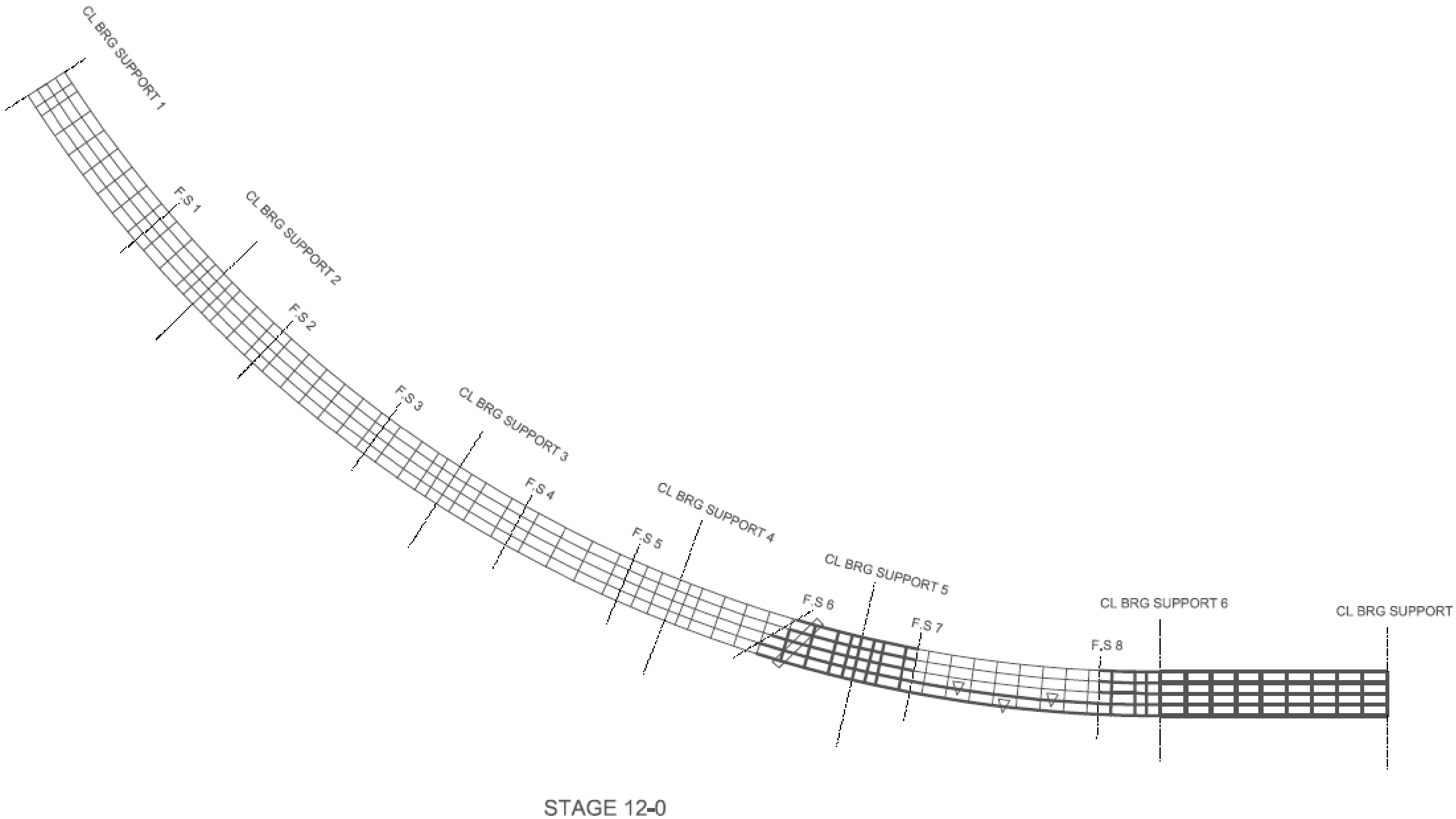


Figure G-1-5. Erection scheme.

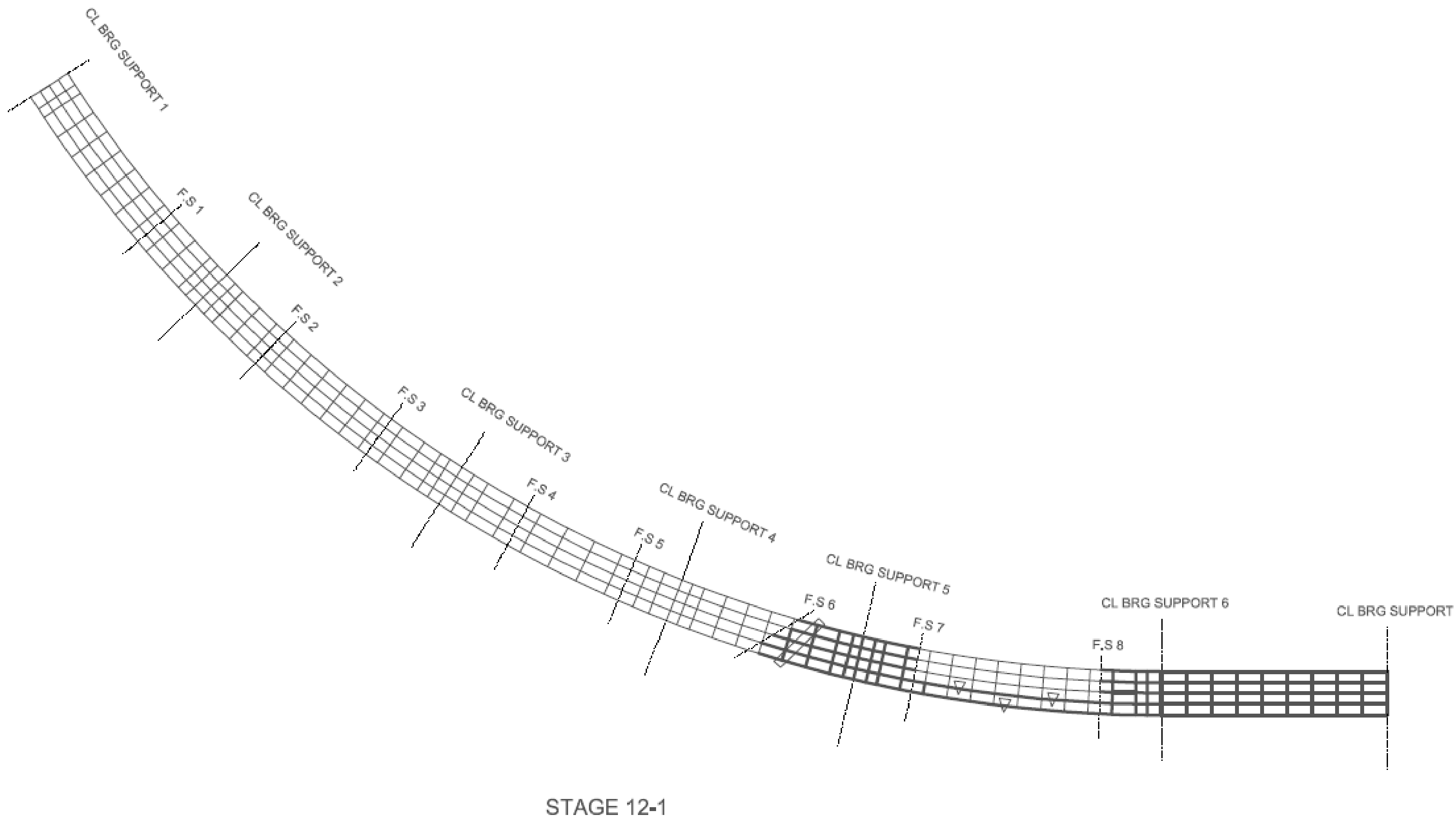


Figure G-1-5(Continued). Erection scheme.

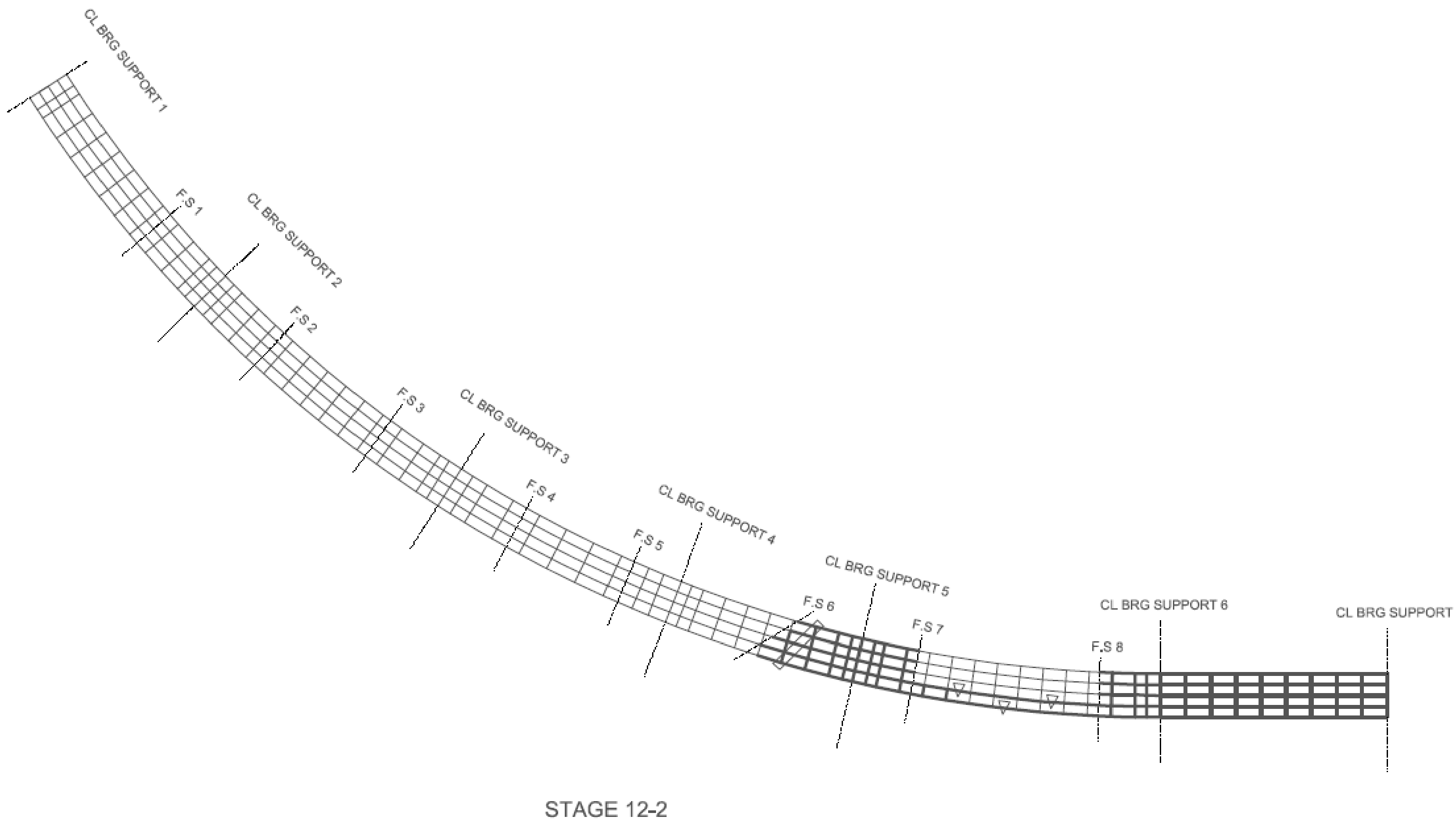


Figure G-1-5(Continued). Erection scheme.

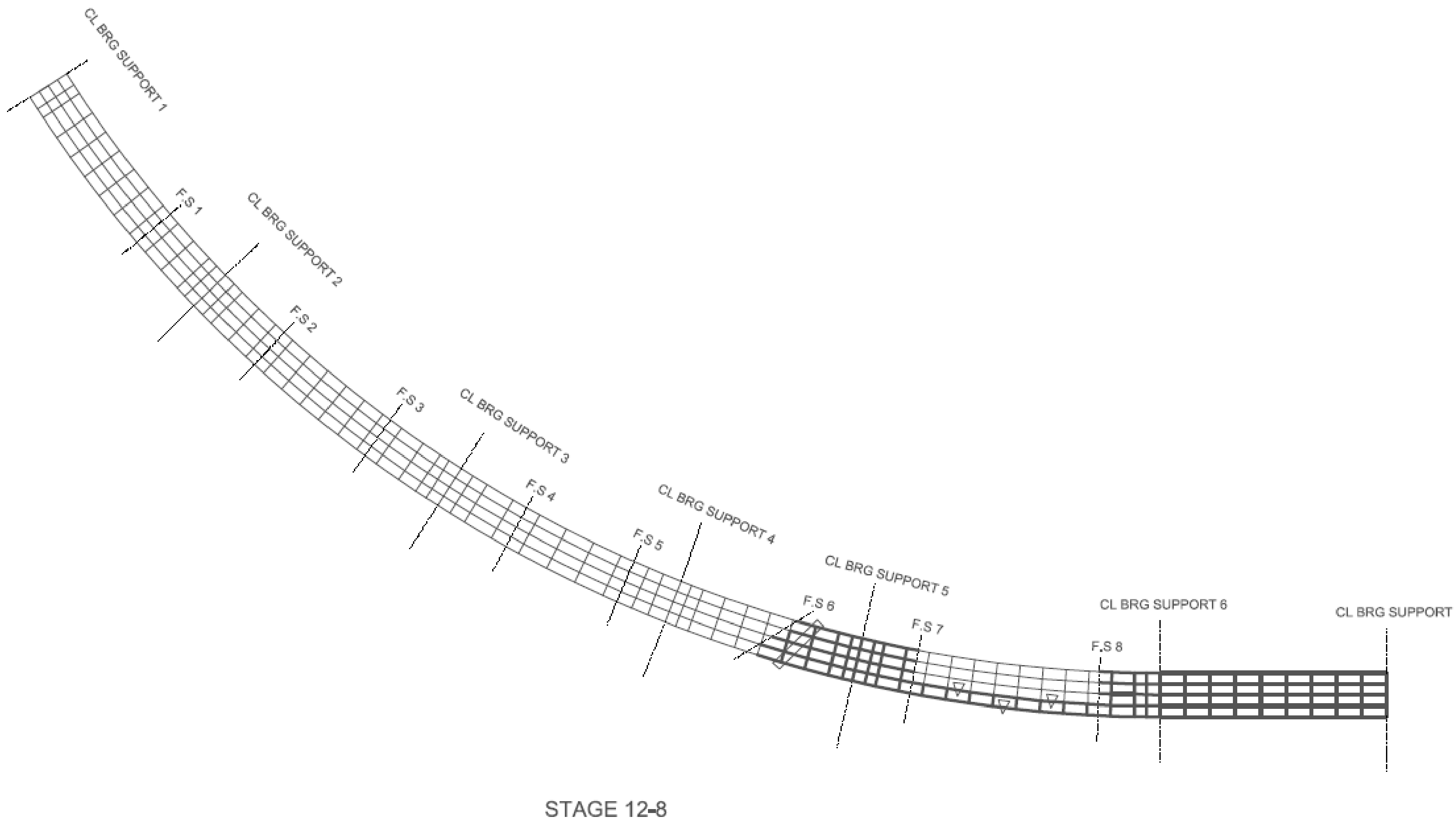


Figure G-1-5(Continued). Erection scheme.

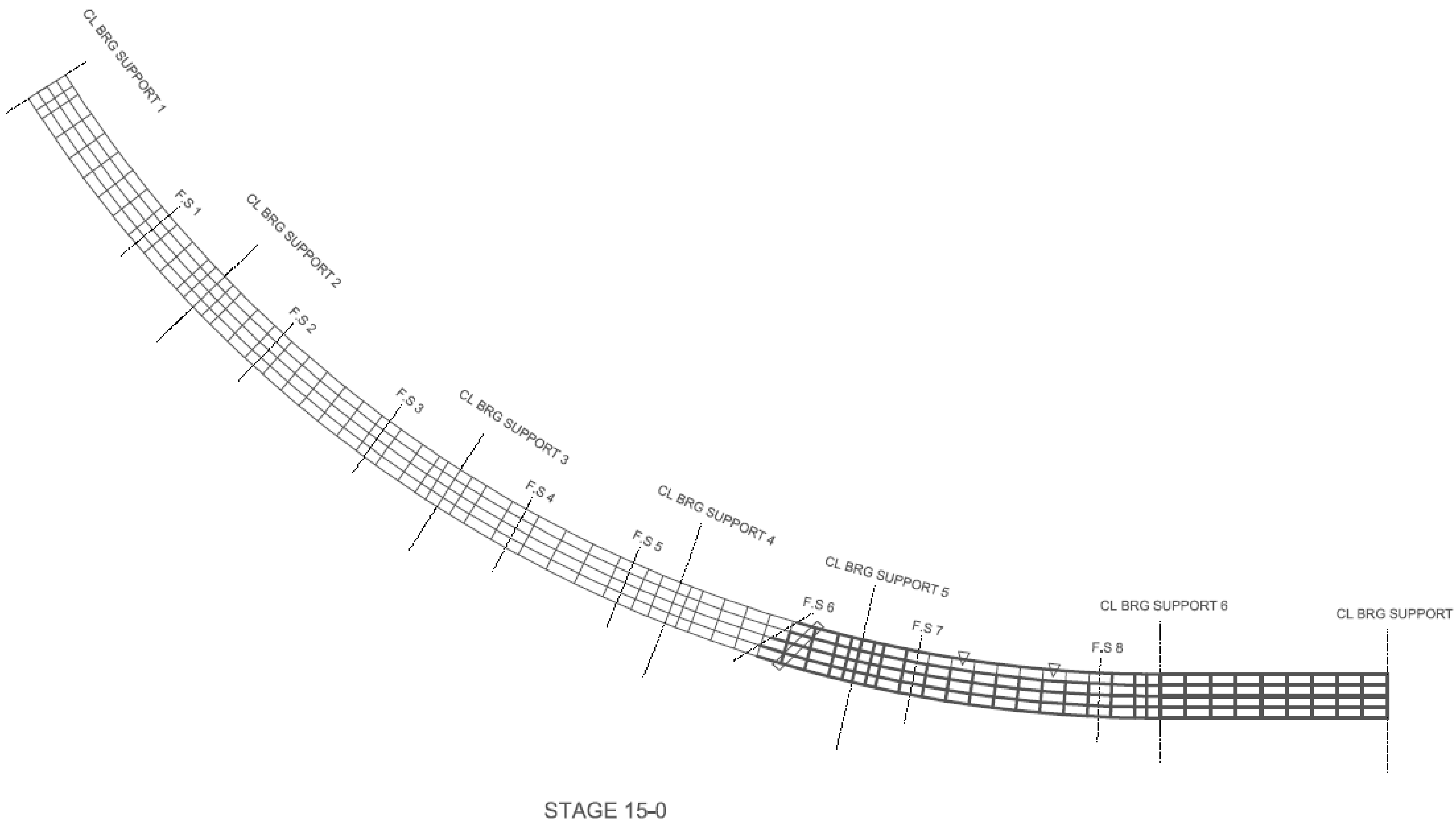


Figure G-1-5(Continued). Erection scheme.

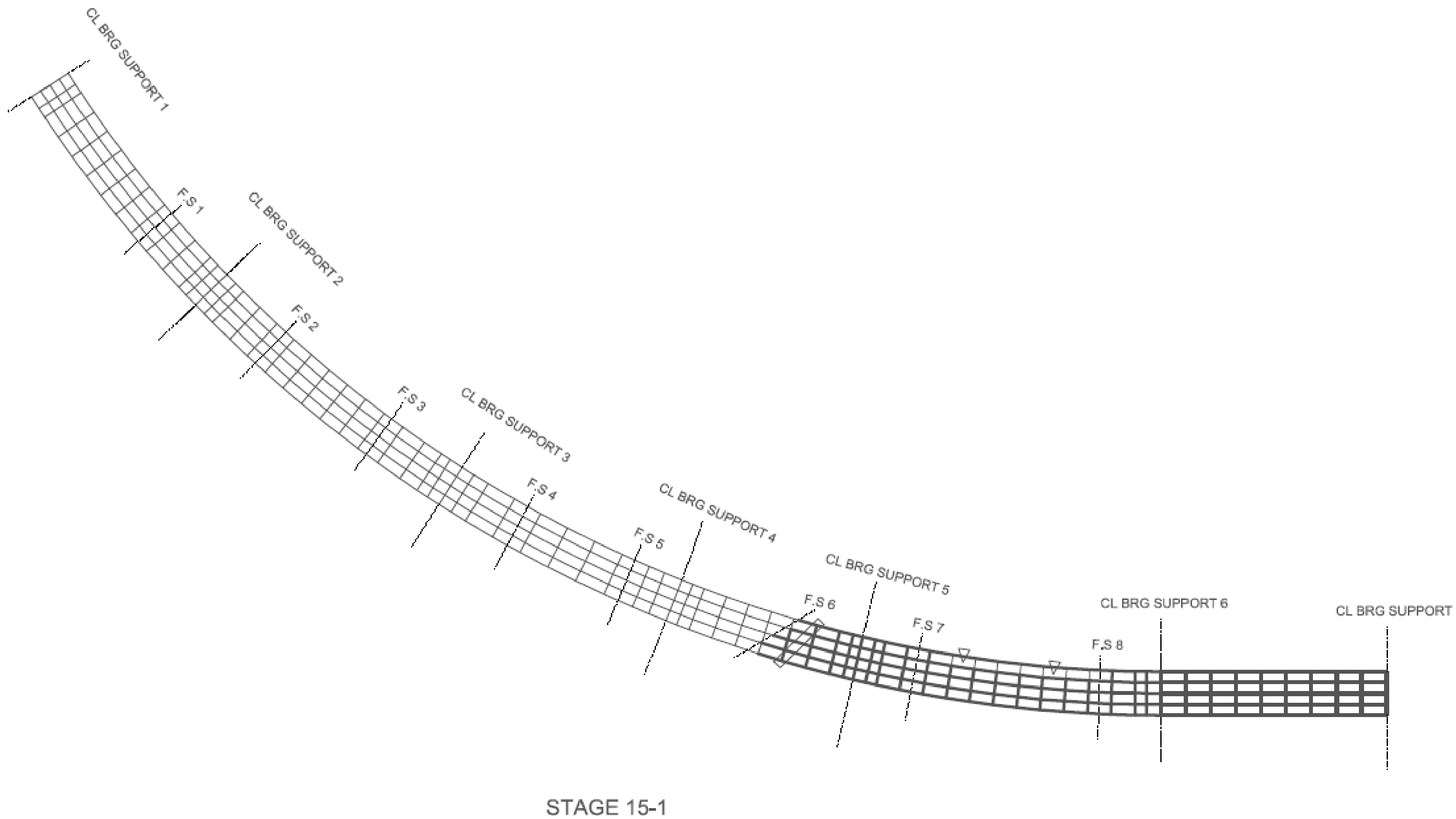


Figure G-1-5(Continued). Erection scheme.

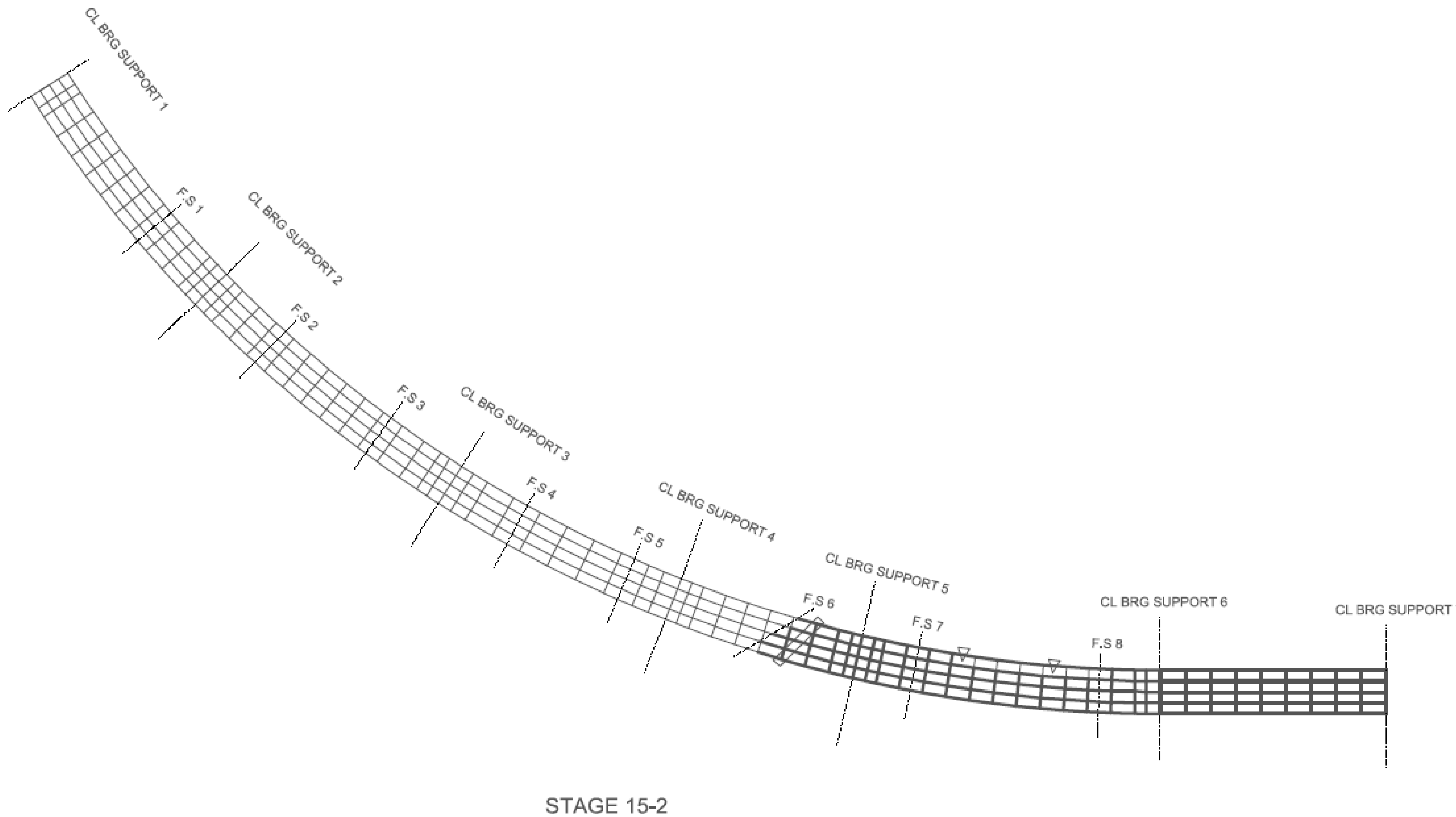


Figure G-1-5(Continued). Erection scheme.

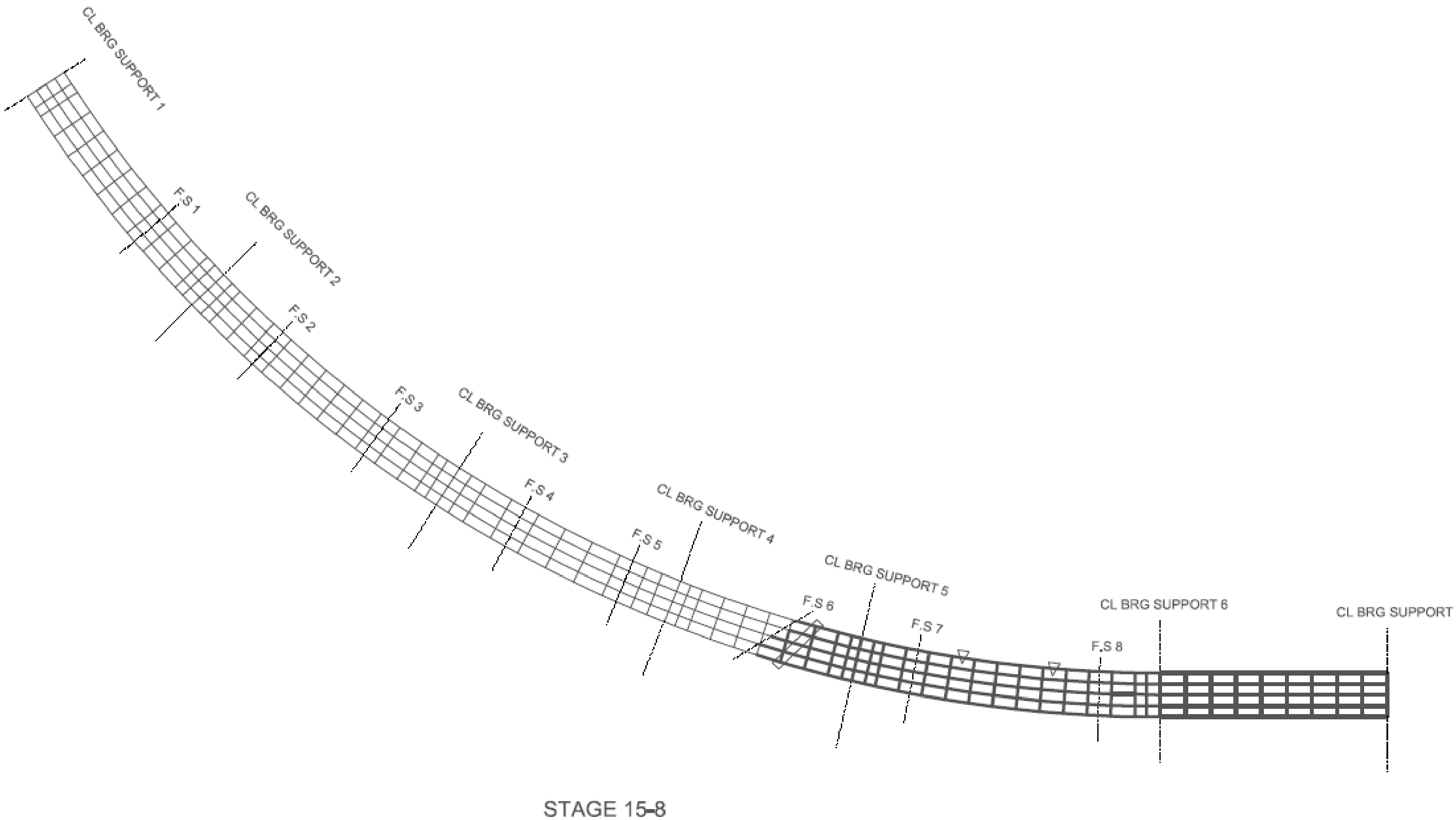


Figure G-1-5(Continued). Erection scheme.

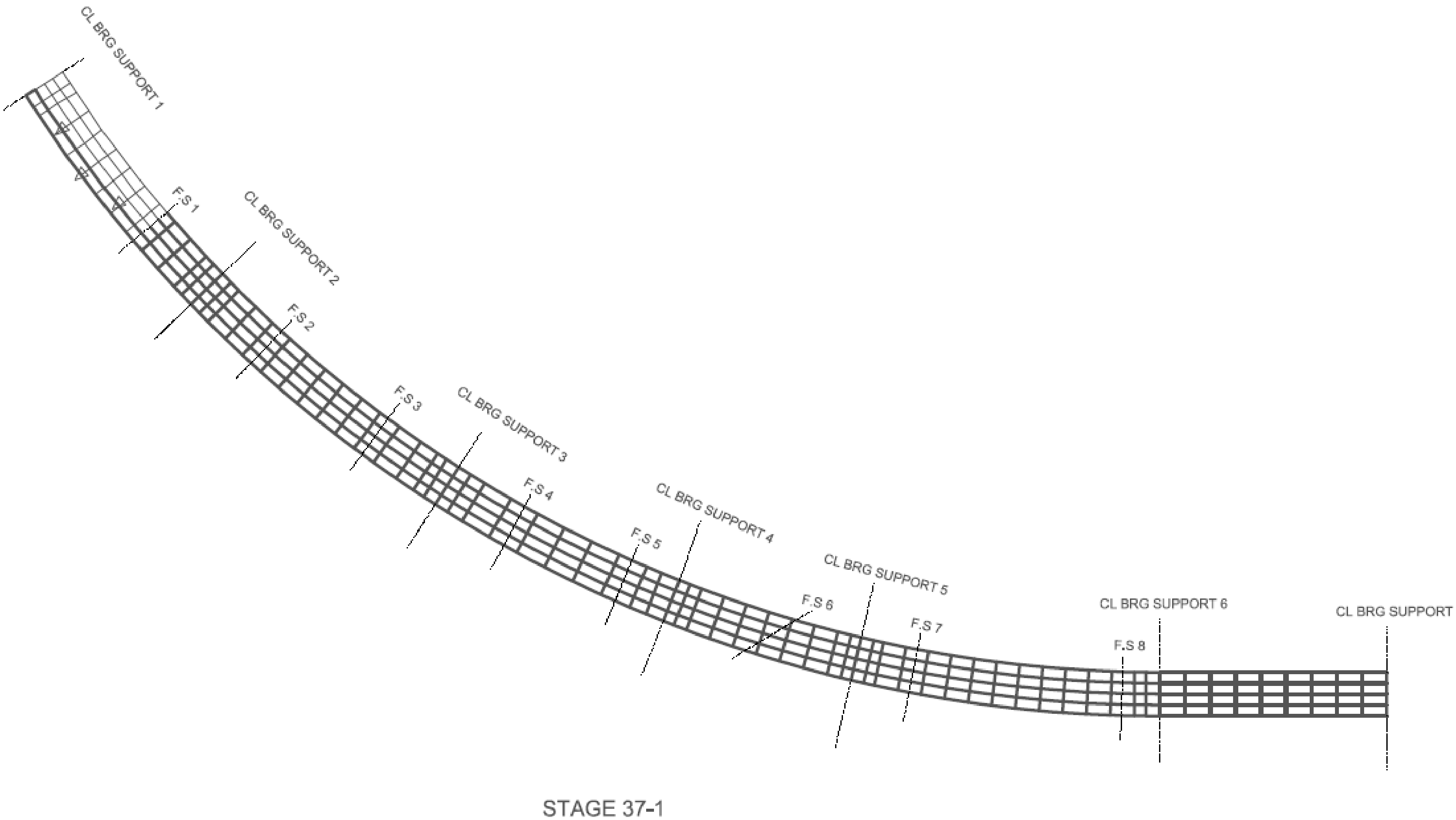


Figure G-1-5(Continued). Erection scheme.

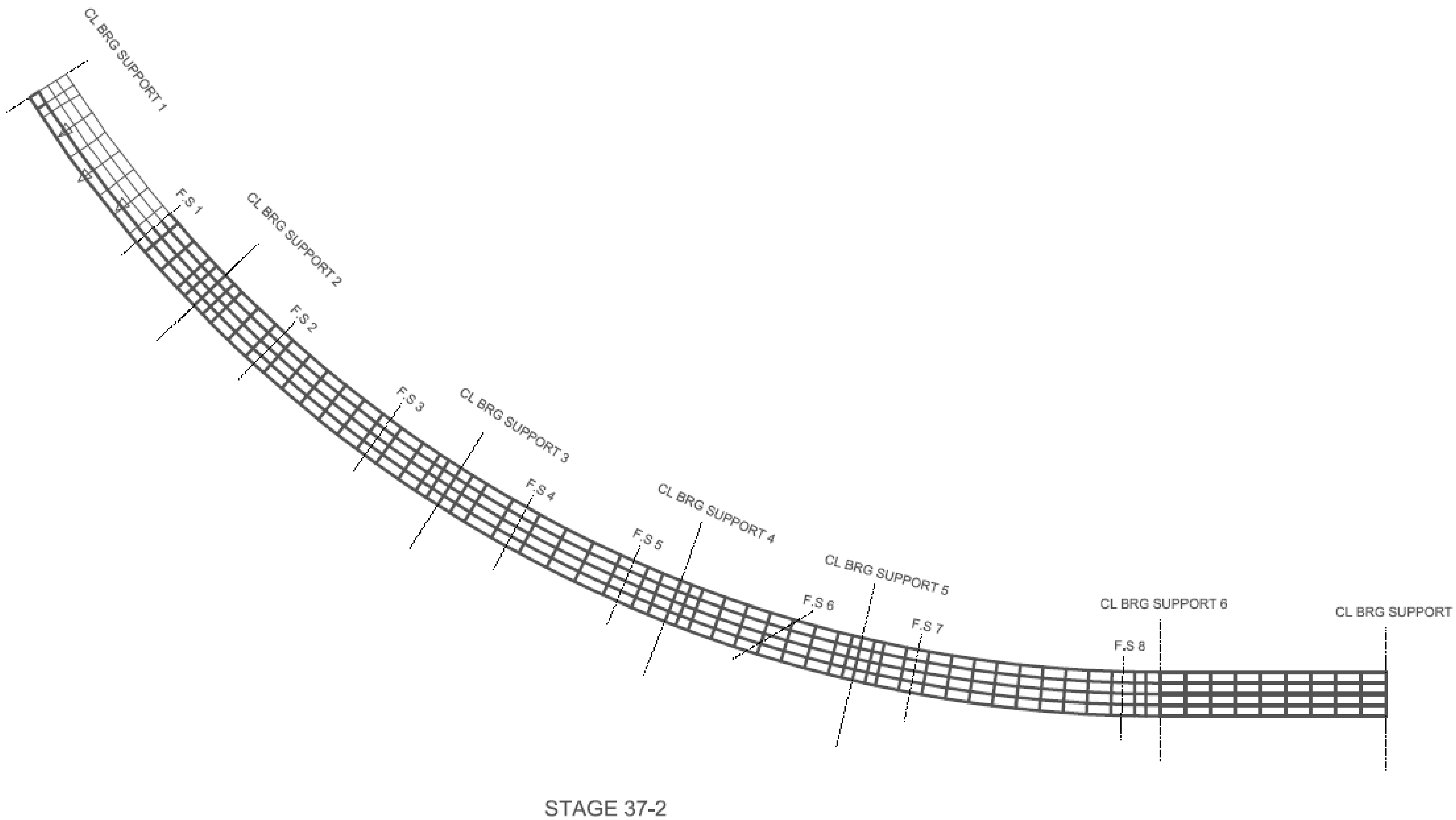


Figure G-1-5(Continued). Erection scheme.

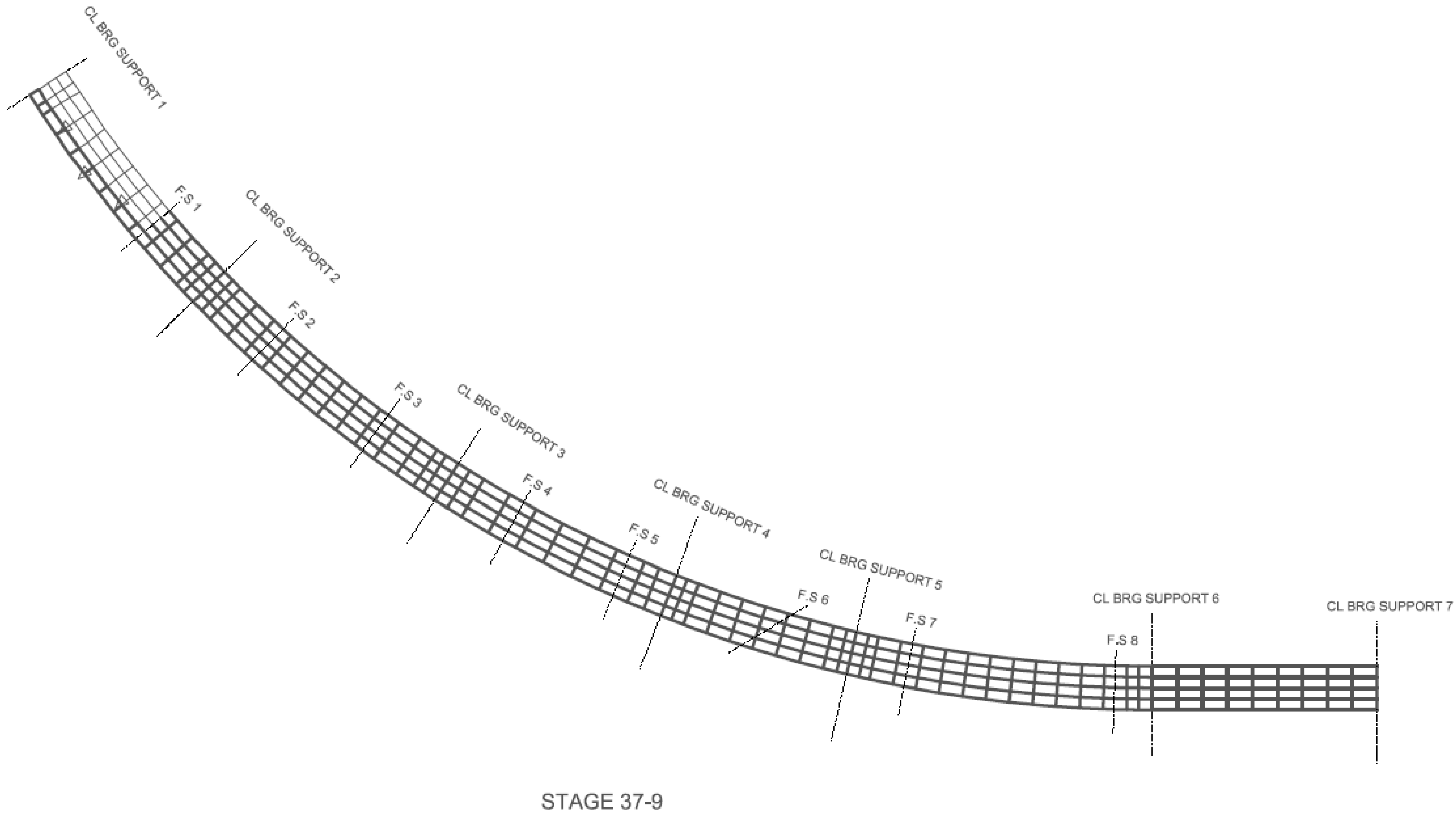


Figure G-1-5(Continued). Erection scheme.

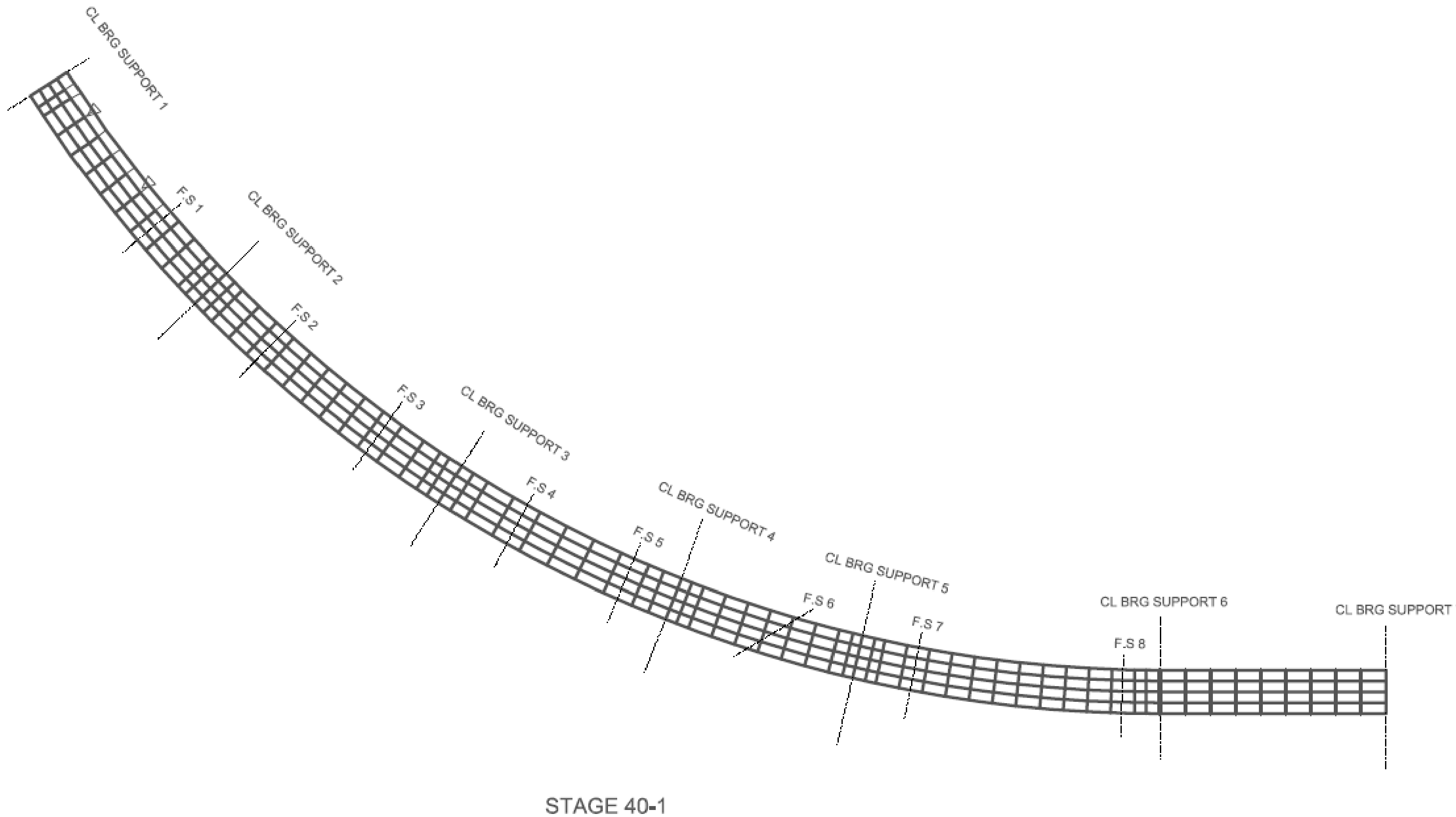


Figure G-1-5(Continued). Erection scheme.

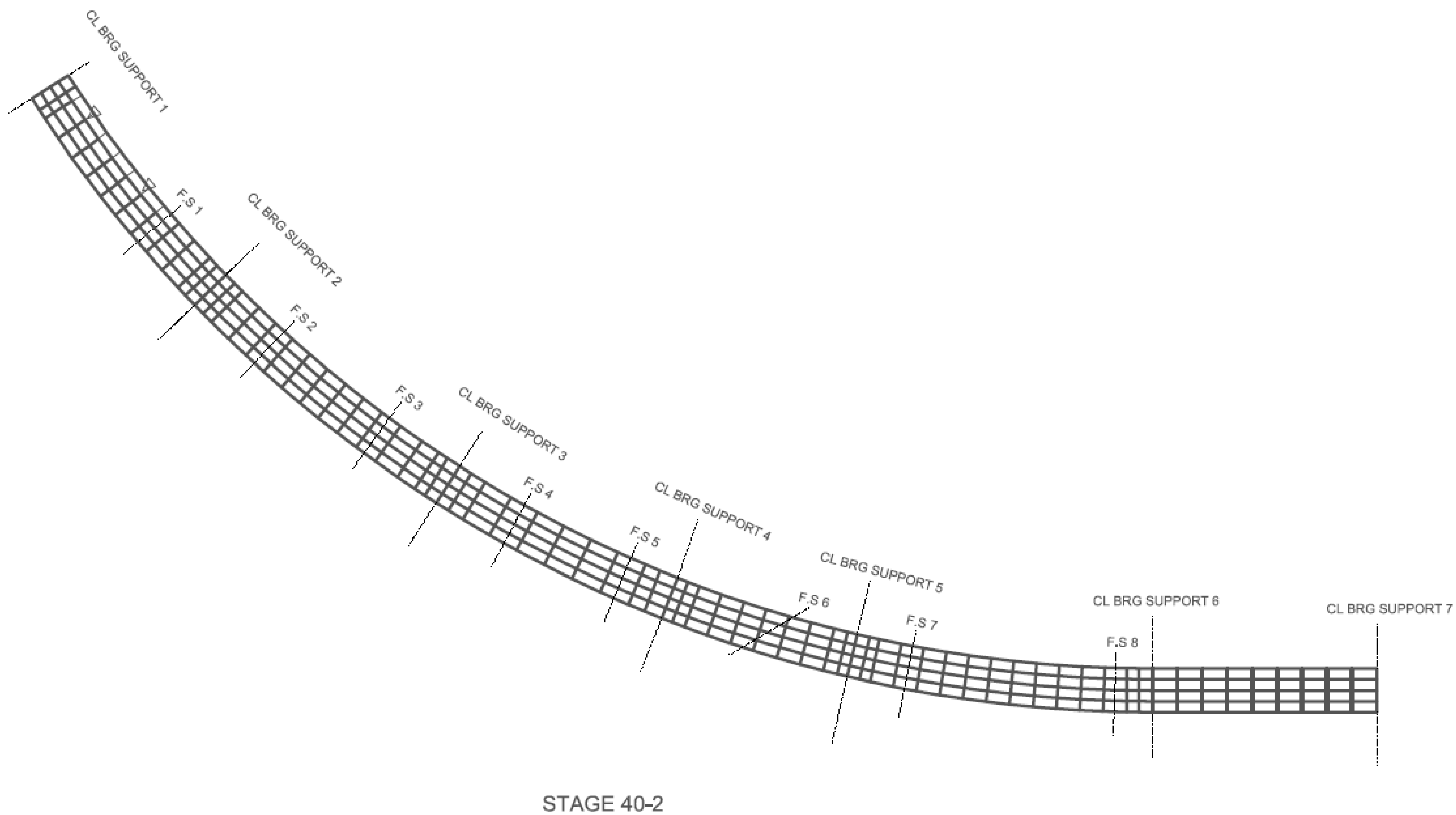


Figure G-1-5(Continued). Erection scheme.

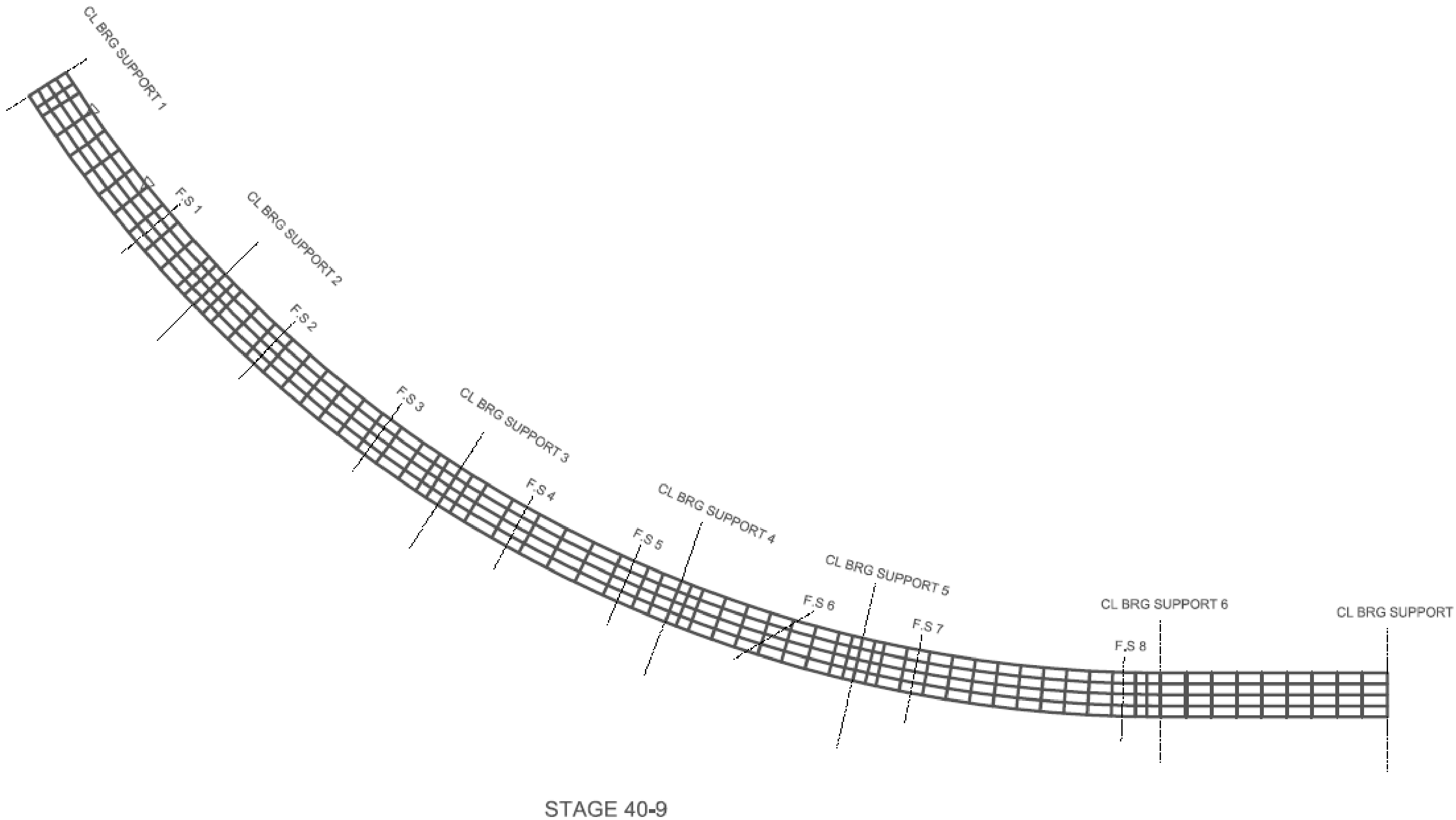


Figure G-1-5(Continued). Erection scheme.

Table G-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

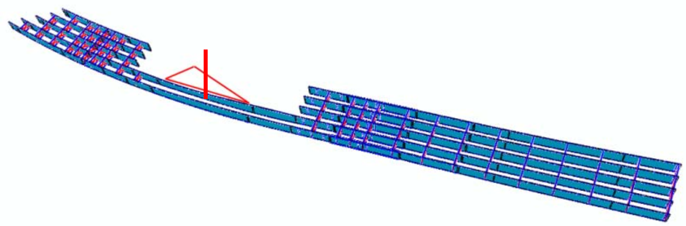
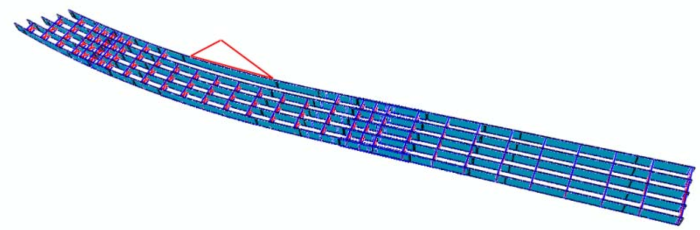
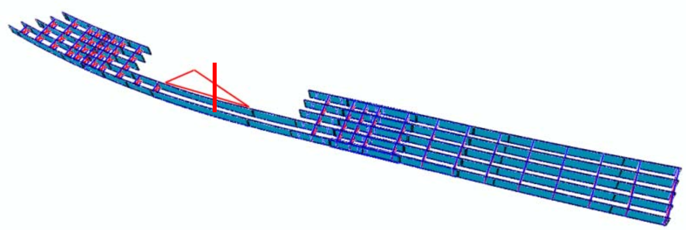
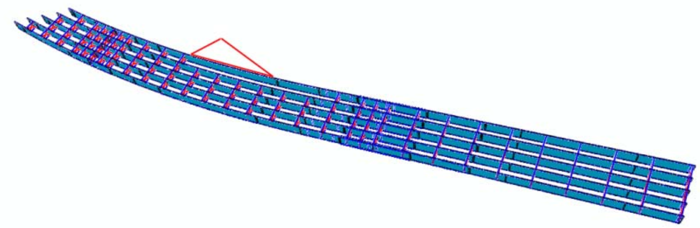
Sub-Stage	Stage	
	12	15
1		
2		

Table G-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

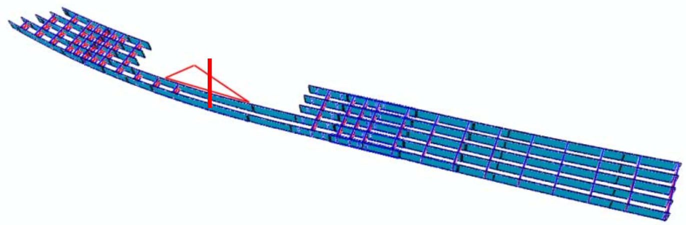
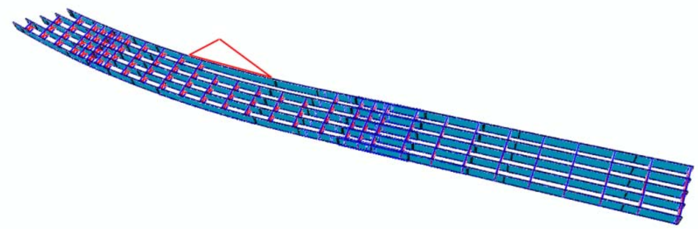
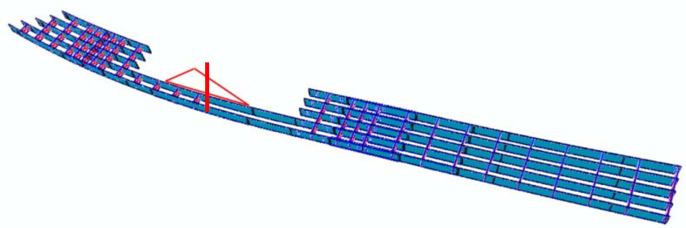
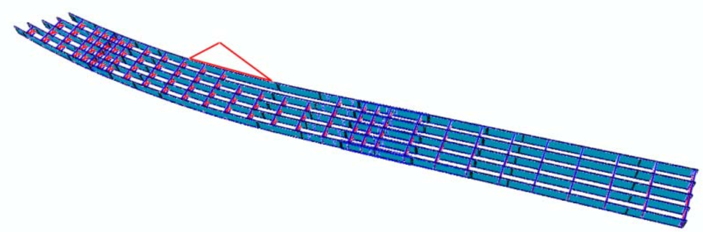
3		
4		

Table G-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

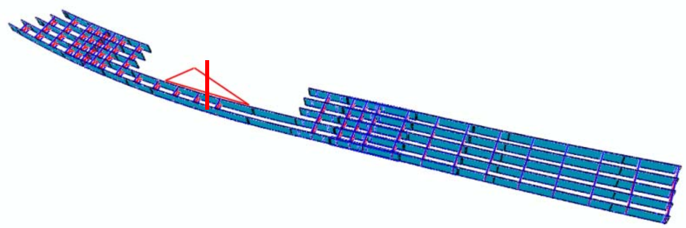
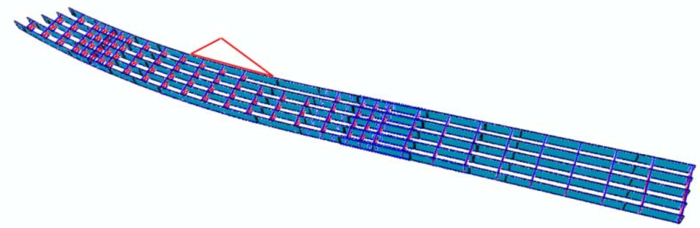
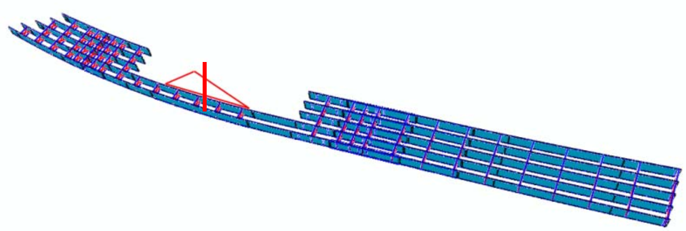
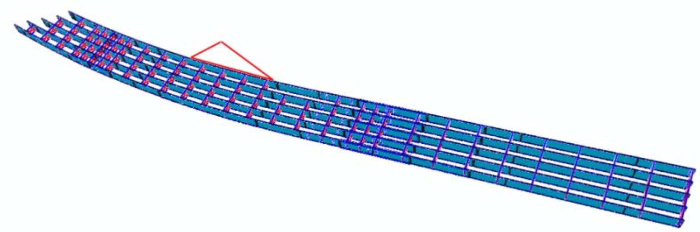
5		
6		

Table G-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

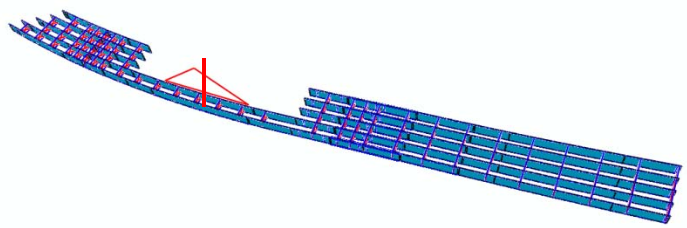
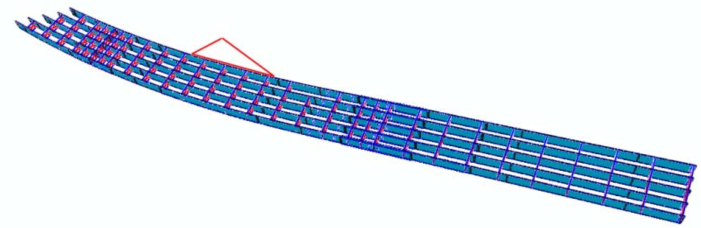
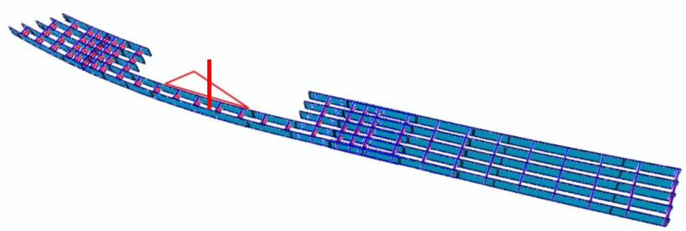
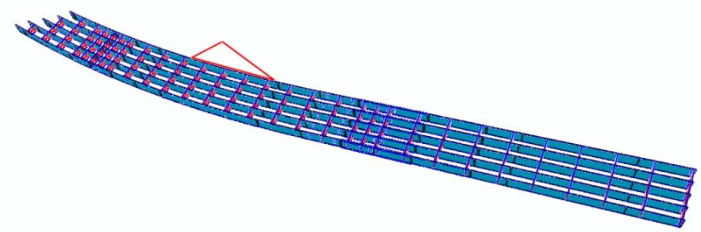
7		
8		

Table G-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

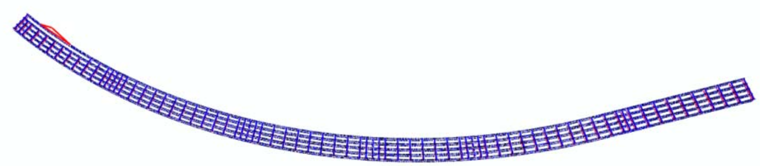
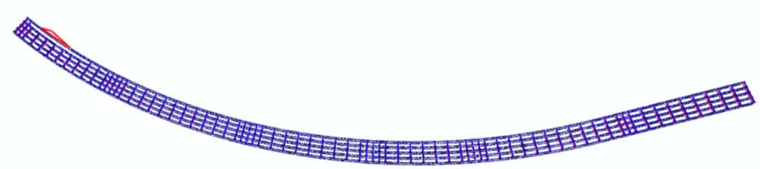
Sub-Stage	Stage	
	37	40
1		
2		

Table G-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

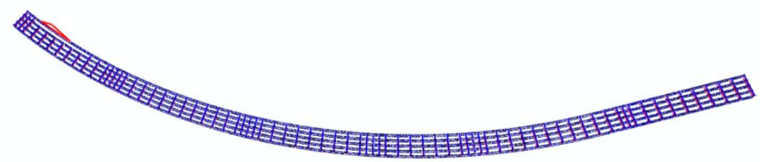
3		
4		

Table G-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

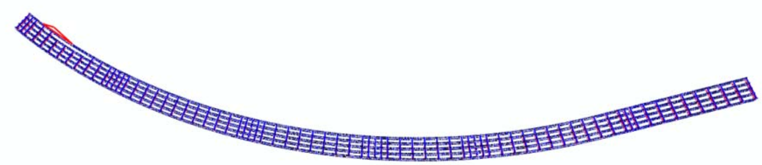
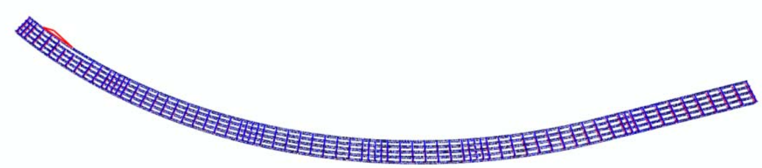
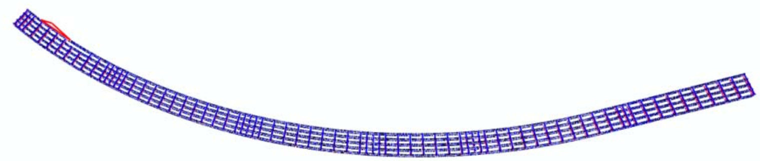
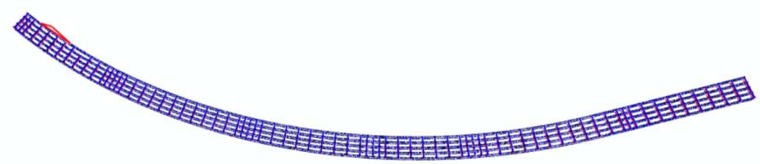
5		
6		

Table G-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

7		
8		

Appendix G-2. EICCR4 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EICCR4 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table G-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	3.0	9.6
	SDLF	2.9	9.5
	TDLF	2.7	9.3
G-2	NLF	2.6	8.5
	SDLF	2.5	8.4
	TDLF	2.3	8.2
G3	NLF	2.3	7.4
	SDLF	2.2	7.3
	TDLF	1.9	7.1
G4	NLF	1.9	6.4
	SDLF	1.8	6.3
	TDLF	1.6	6.0
G5	NLF	1.6	5.3
	SDLF	1.5	5.2
	TDLF	1.4	4.9
All Girders	NLF	3.0	9.6
	SDLF	2.9	9.5
	TDLF	2.7	9.3

Table G-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.34	1.08
	SDLF	0.05	0.79
	TDLF	0.65	0.13
G-2	NLF	0.34	1.06
	SDLF	0.04	0.76
	TDLF	0.66	0.10
G3	NLF	0.34	1.04
	SDLF	0.04	0.74
	TDLF	0.66	0.09
G4	NLF	0.33	1.02
	SDLF	0.04	0.72
	TDLF	0.66	0.08
G5	NLF	0.34	1.01
	SDLF	0.04	0.71
	TDLF	0.65	0.08
All Girders	NLF	0.34	1.08
	SDLF	0.05	0.79
	TDLF	0.66	0.13

Table G-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	5.8	18.7	6.7	21.6	0.5	2.1	1.2	5.0
	SDLF	5.7	18.7	6.8	21.7	0.5	2.2	1.3	5.0
	TDLF	5.7	18.6	7.3	21.9	0.7	2.2	1.5	5.1
G-2	NLF	5.9	18.9	5.8	18.9	0.5	2.0	1.3	4.2
	SDLF	5.9	18.9	5.9	19.0	0.6	2.0	1.4	4.3
	TDLF	5.8	18.7	6.1	19.1	0.7	2.0	1.5	4.5
G3	NLF	5.6	18.3	5.4	17.8	0.5	1.8	1.1	3.7
	SDLF	5.6	18.3	5.4	17.8	0.5	1.8	1.2	3.7
	TDLF	5.5	18.1	5.4	17.6	0.6	1.8	1.4	3.9
G4	NLF	5.3	17.8	5.2	17.3	0.4	1.6	0.9	3.2
	SDLF	5.2	17.7	5.1	17.3	0.4	1.6	1.0	3.3
	TDLF	5.0	17.5	4.9	17.0	0.6	1.7	1.2	3.5
G5	NLF	5.1	17.5	4.9	16.9	0.4	1.6	0.8	1.8
	SDLF	5.0	17.3	4.8	16.8	0.4	1.6	0.9	1.9
	TDLF	4.9	17.2	4.7	16.6	0.5	1.6	1.2	2.2
All Girders	NLF	5.9	18.9	6.7	21.6	0.5	2.1	1.3	5.0
	SDLF	5.9	18.9	6.8	21.7	0.6	2.2	1.4	5.0
	TDLF	5.8	18.7	7.3	21.9	0.7	2.2	1.5	5.1

Table G-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	7.3	3.8	4.1	7.3
	SDLF	10.9	5.3	4.4	10.9
	TDLF	26.6	10.1	9.0	26.6
TDL	NLF	22.1	17.2	18.3	22.1
	SDLF	20.2	18.7	18.6	20.2
	TDLF	35.3	22.2	19.1	35.3

Table G-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	1.7	1.1	1.1	1.4
	SDLF	3.1	1.1	1.0	2.1
	TDLF	7.2	1.6	1.4	4.3
TDL	NLF	5.5	4.2	4.2	4.9
	SDLF	6.8	4.2	4.1	5.5
	TDLF	10.4	4.3	4.0	7.3

Table G-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G-2	G-2-G3	G3-G4	G4-G5	All Girders
NLF	0.35	0.34	0.34	0.35	0.35
SDLF	0.36	0.35	0.35	0.36	0.36
TDLF	0.42	0.38	0.37	0.37	0.42

Table G-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G-2	G-2-G3	G3-G4	G4-G5	All Girders
NLF	1.09	1.06	1.05	1.05	1.09
SDLF	1.10	1.07	1.06	1.06	1.10
TDLF	1.16	1.10	1.07	1.08	1.16

Table G-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G-2	G-2-G3	G3-G4	G4-G5	All Girders
NLF	0.23	0.23	0.23	0.23	0.23
SDLF	0.24	0.24	0.24	0.24	0.24
TDLF	0.28	0.26	0.25	0.25	0.28

Table G-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G-2	G-2-G3	G3-G4	G4-G5	All Girders
NLF	0.73	0.71	0.70	0.70	0.73
SDLF	0.74	0.72	0.71	0.71	0.74
TDLF	0.77	0.74	0.72	0.72	0.77

Table G-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	3832.5	12335.3
SDLF	3832.5	12335.3
TDLF	3832.5	12335.3

Table G-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	187.4	585.6	0.1	0.2	0.1	0.2
SDLF	190.1	584.7	0.1	0.2	0.1	0.2
TDLF	194.5	587.4	0.1	0.2	0.1	0.2

Table G-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.14	0.45	0.00	0.45
SDLF	0.13	0.44	0.00	0.44
TDLF	0.11	0.42	0.00	0.42

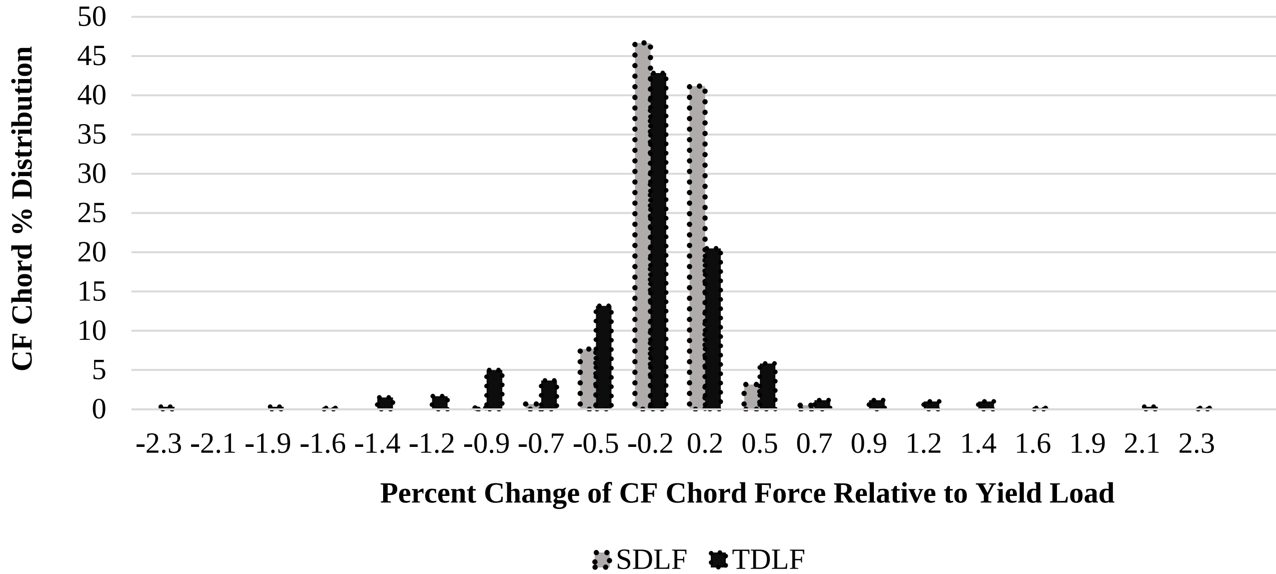


Figure G-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

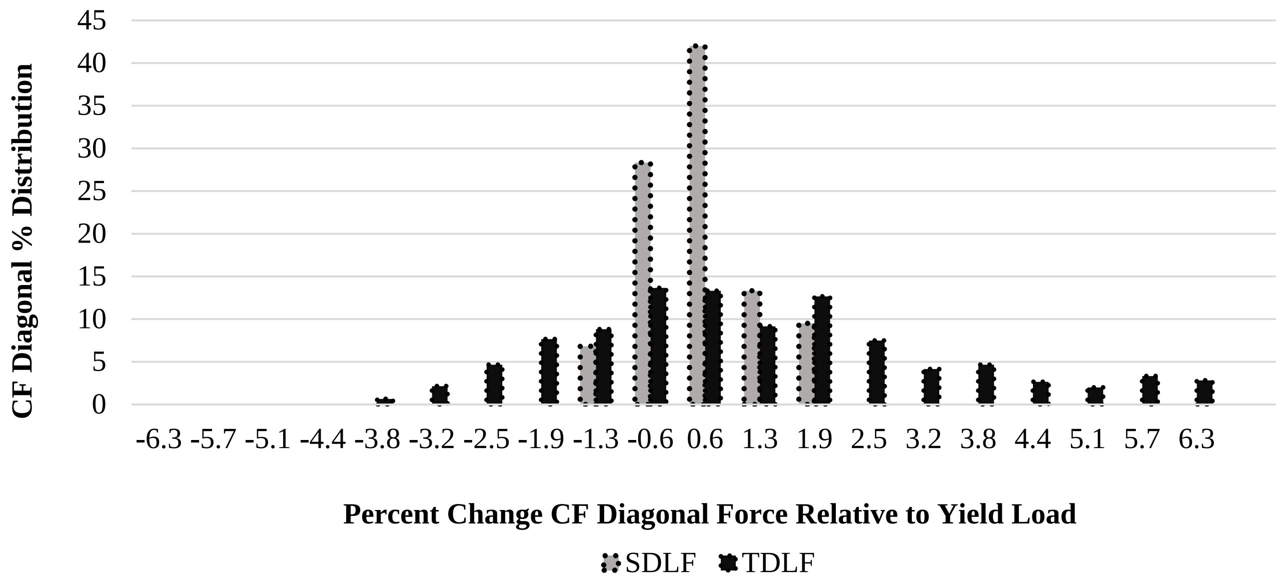


Figure G-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

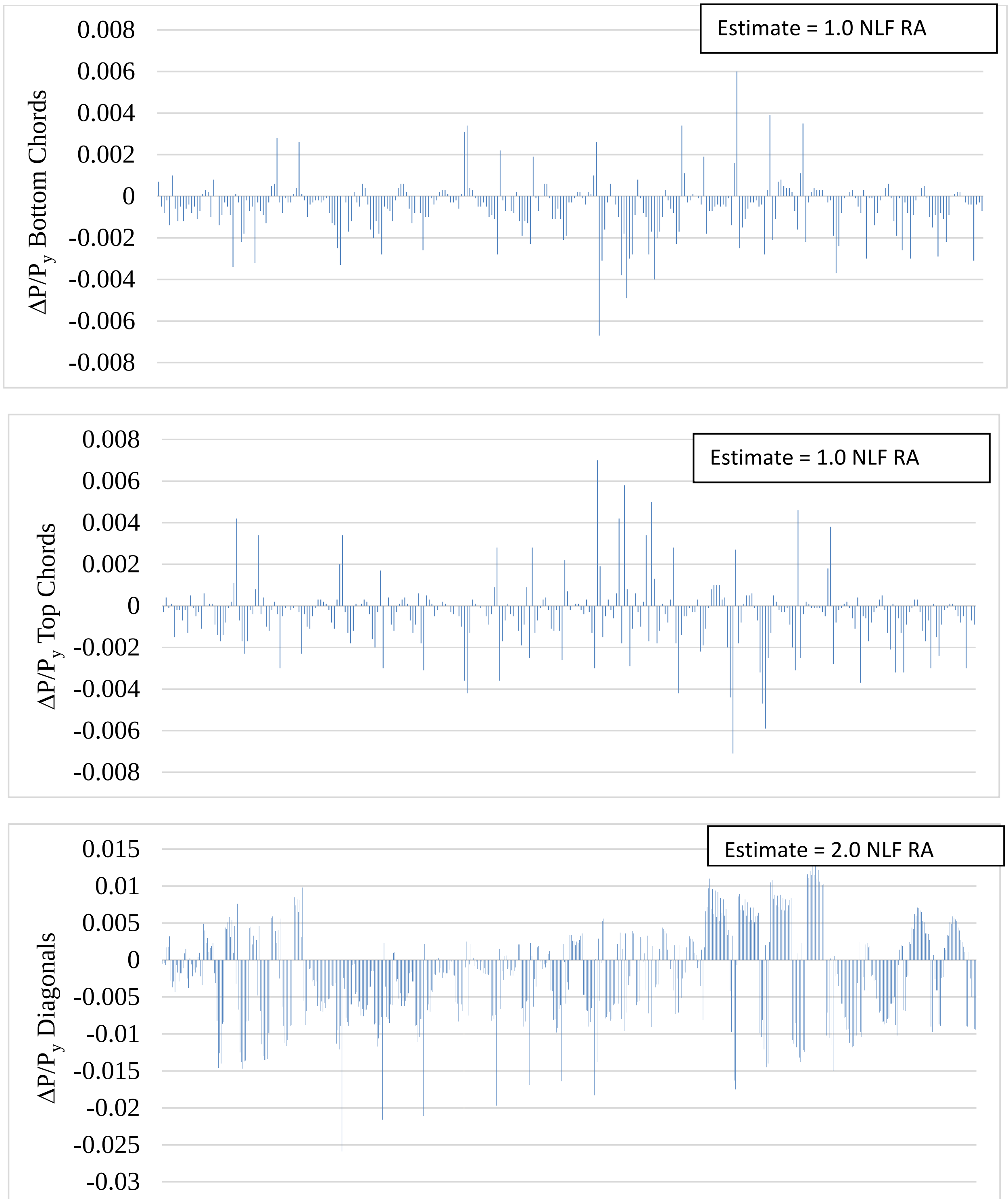


Figure G-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

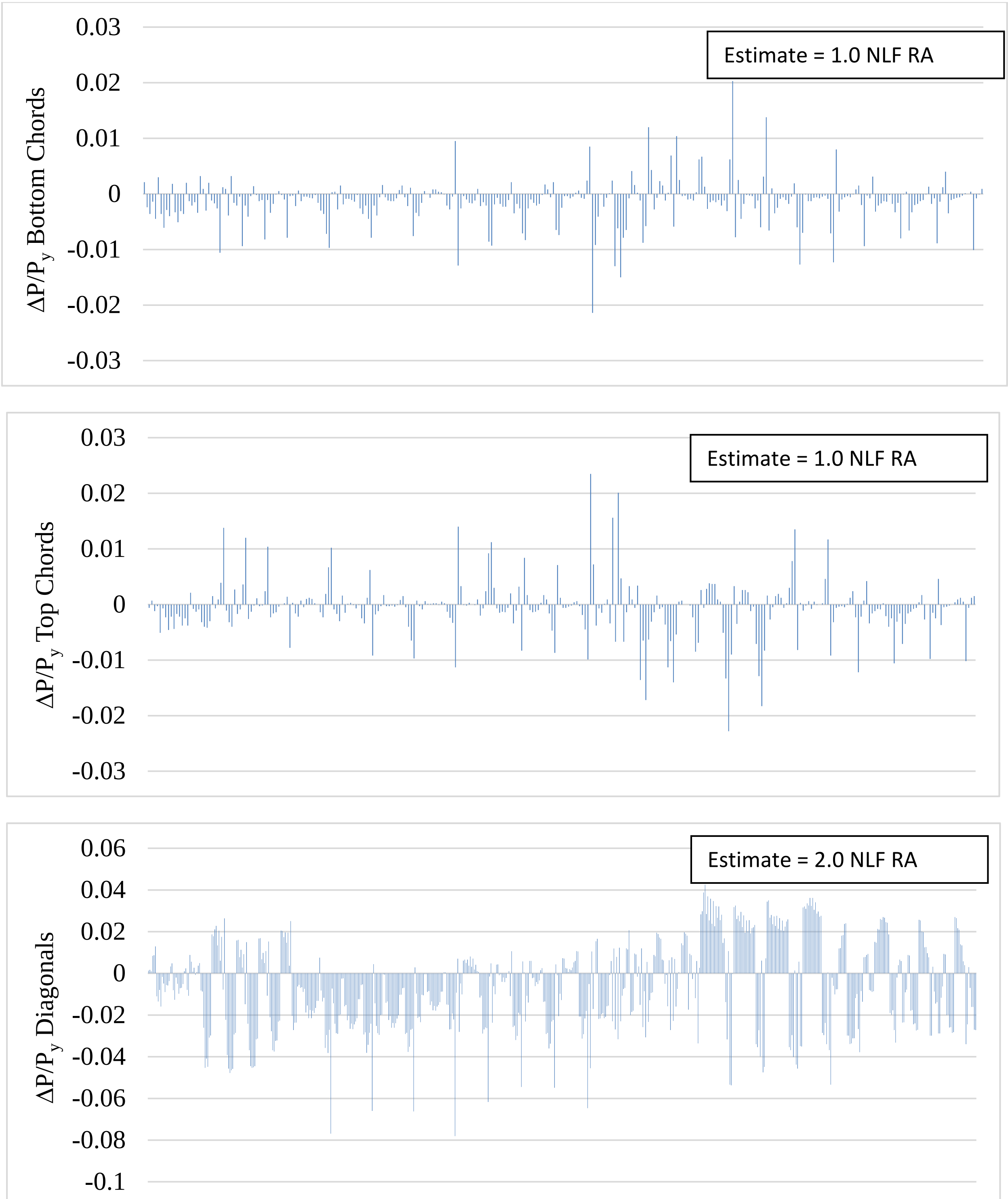


Figure G-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix G-3. EICCR4 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EICCR4 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Table G-3-1. Maximums of the fit-up force resultants (kips)

Reactions

Table G-3-2. Summary of vertical reactions (kips)

Table G-3-3. Summary of crane loads (kips)

Table G-3-4. Total vertical reactions (kips)

Splice Fit-up

Table G-3-5. Splice fit-up moments (kip*ft.)

Table G-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	12.3	7.8	12.3
SDLF	12.6	6.3	12.6
TDLF	6.0	14.3	14.3

Table G-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	193.7	0
	SDLF	191.4	0
	TDLF	189.4	0
G2	NLF	188	0
	SDLF	190.9	0
	TDLF	195.1	0
G3	NLF	174	0
	SDLF	176.1	0
	TDLF	176.6	0
G4	NLF	160	0
	SDLF	158.6	0
	TDLF	152.4	0
G5	NLF	167.8	0
	SDLF	167	0
	TDLF	169.7	0
All Girders	NLF	193.7	0
	SDLF	191.4	0
	TDLF	195.1	0

Table G-3-3. Summary of crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Reaction	Min Reaction	Max Reaction	Min Reaction
NLF	70.7	20.1	56.6	43.1
SDLF	76.5	11.5	56.7	44.5
TDLF	67.3	5.5	58.7	43.4

Table G-3-4. Erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage								
		1	2	3	4	5	6	7	8	9
12	NLF	1208	1209	1210	1211	1212	1213	1214	1215	
	SDLF	1208	1209	1210	1211	1212	1213	1214	1215	
	TDLF	1208	1209	1210	1211	1212	1213	1214	1215	
15	NLF	1442	1443	1444	1445	1446	1447	1448	1449	
	SDLF	1442	1443	1444	1445	1446	1447	1448	1449	
	TDLF	1442	1443	1444	1445	1446	1447	1448	1449	
37	NLF	3544	3545	3546	3547	3549	3550	3551	3552	3553
	SDLF	3544	3545	3546	3547	3549	3550	3551	3552	3553
	TDLF	3544	3545	3546	3547	3549	3550	3551	3552	3553
40	NLF	3824	3825	3826	3827	3828	3829	3830	3831	3832
	SDLF	3824	3825	3826	3827	3828	3829	3830	3831	3832
	TDLF	3824	3825	3826	3827	3828	3829	3830	3831	3832

Table G-3-5: Splice fit-up moments (kip*ft.)

Stage	Detailing Method	M_b	Top Flange M_l	Bottom Flange M_l
12	NLF	851.4	5.0	5.0
	SDLF	839.2	3.9	4.1
	TDLF	827.0	1.7	1.8
15	NLF	264.7	5.8	4.3
	SDLF	279.5	4.6	3.4
	TDLF	306.3	2.2	1.3

Appendix G-4. EICCR4 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge EICCR4 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

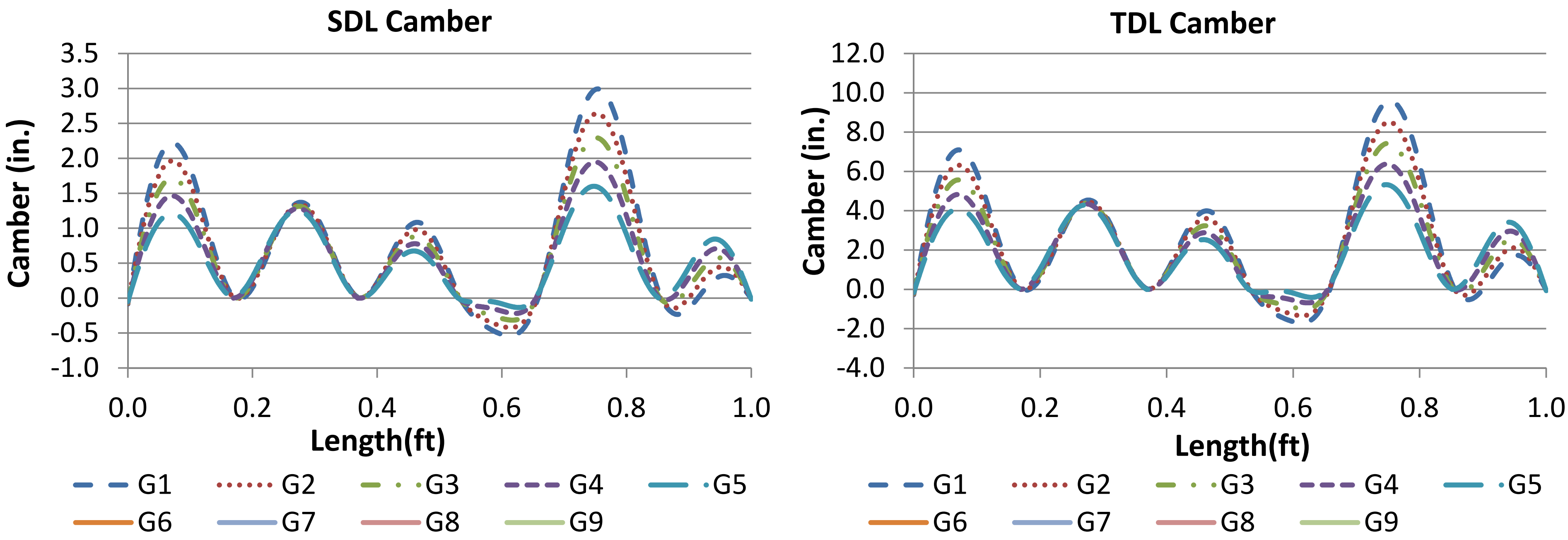


Figure G-4-1. SDL and TDL 3D FEA cambers.

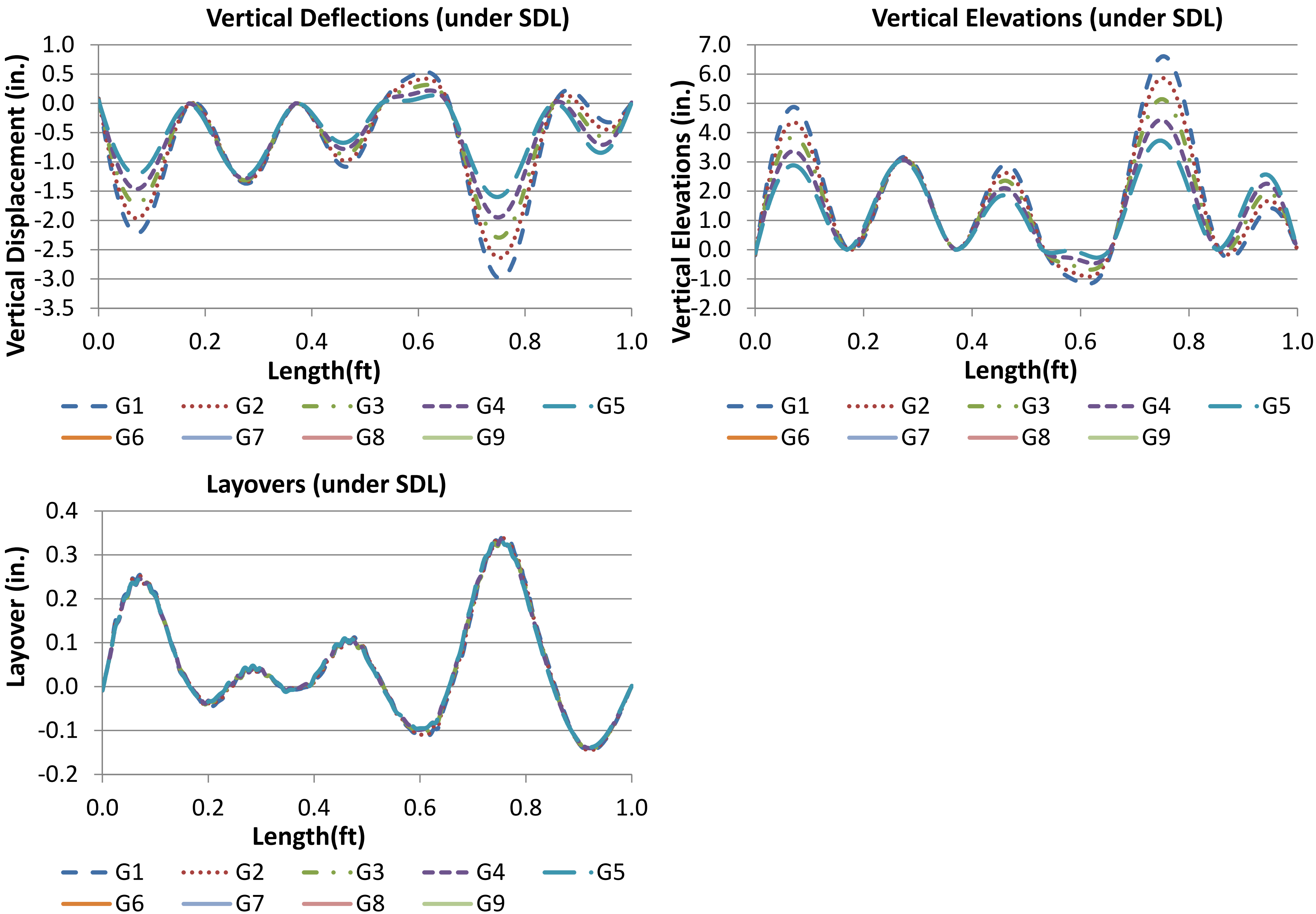


Figure G-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

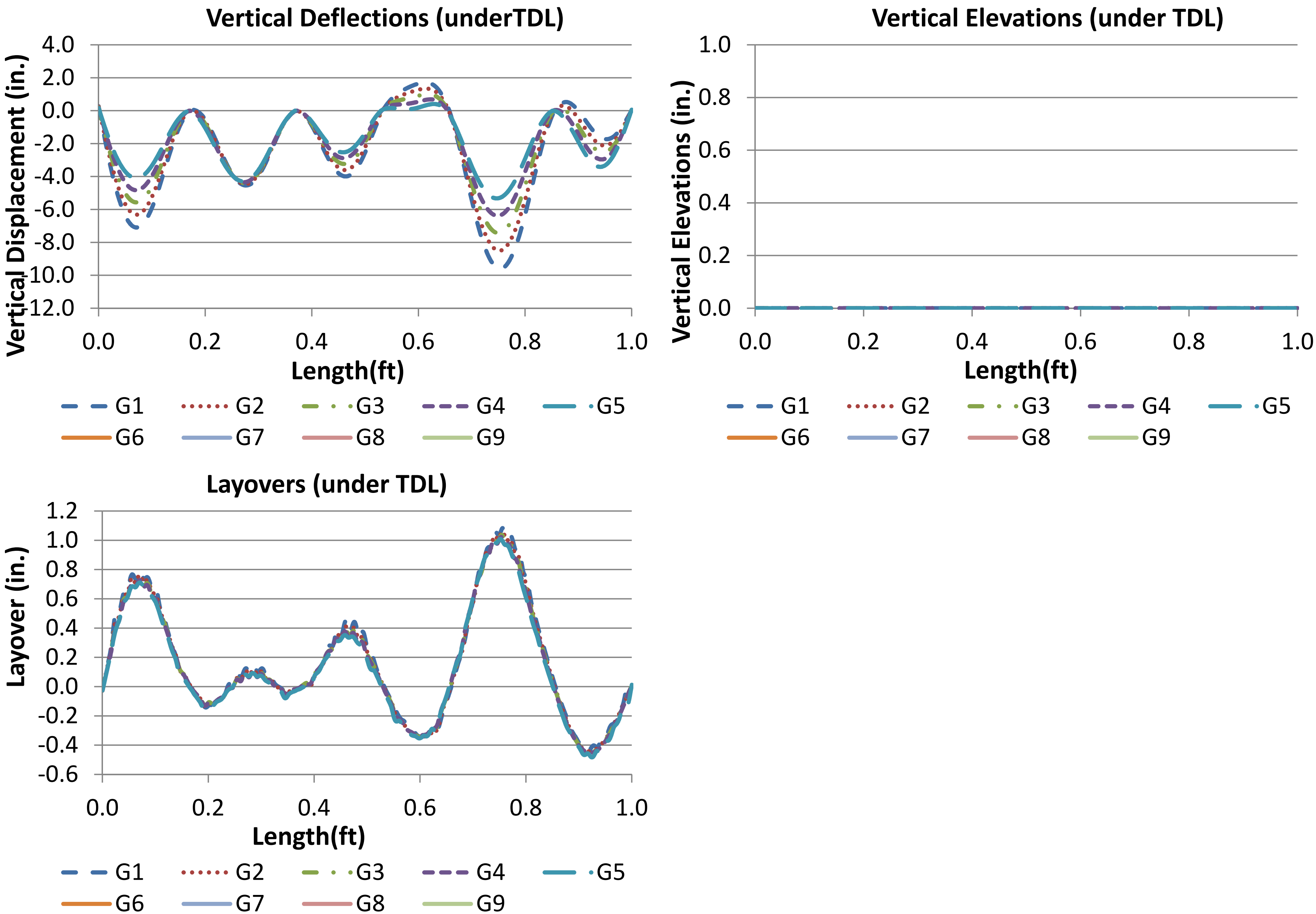


Figure G-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

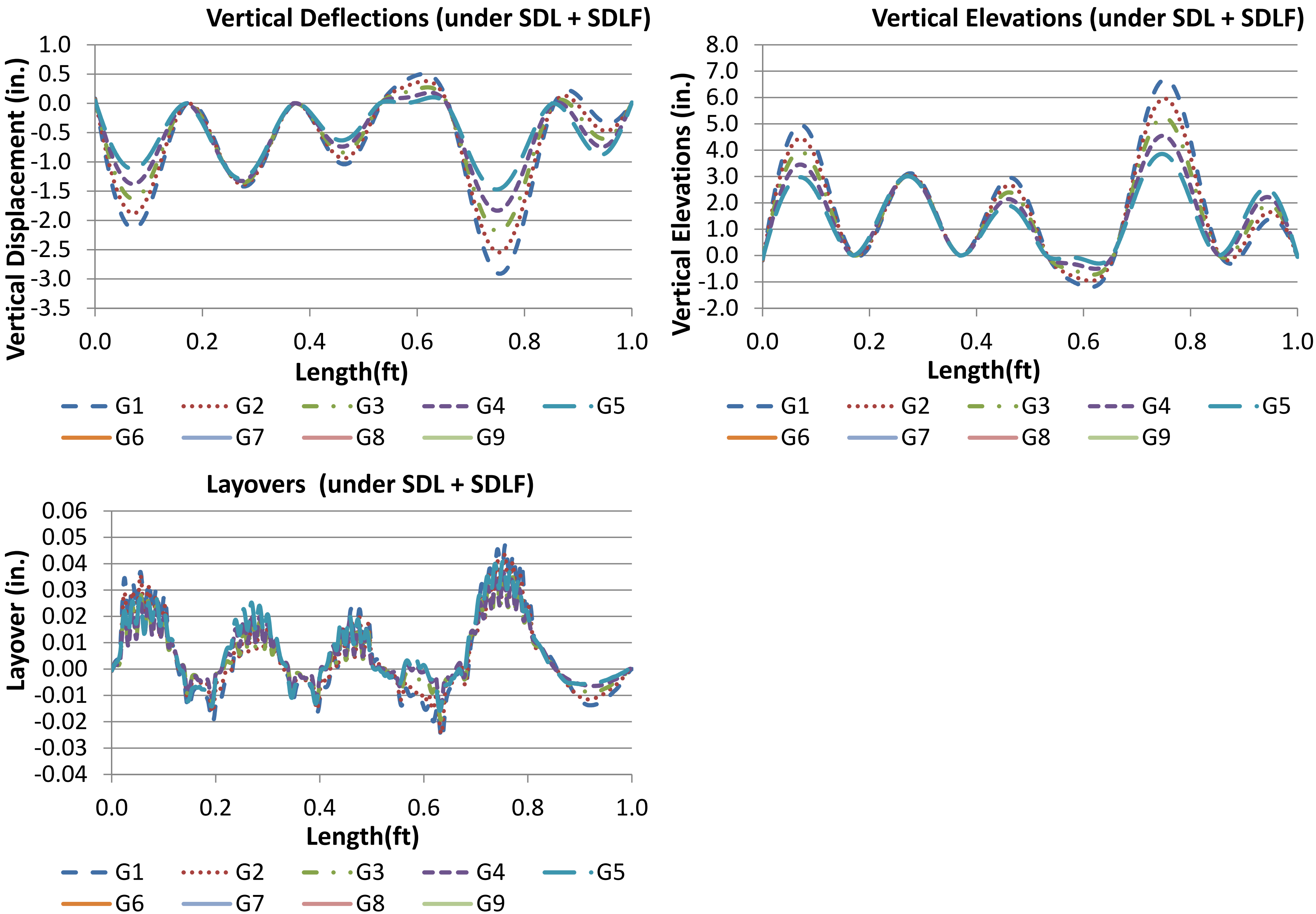


Figure G-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

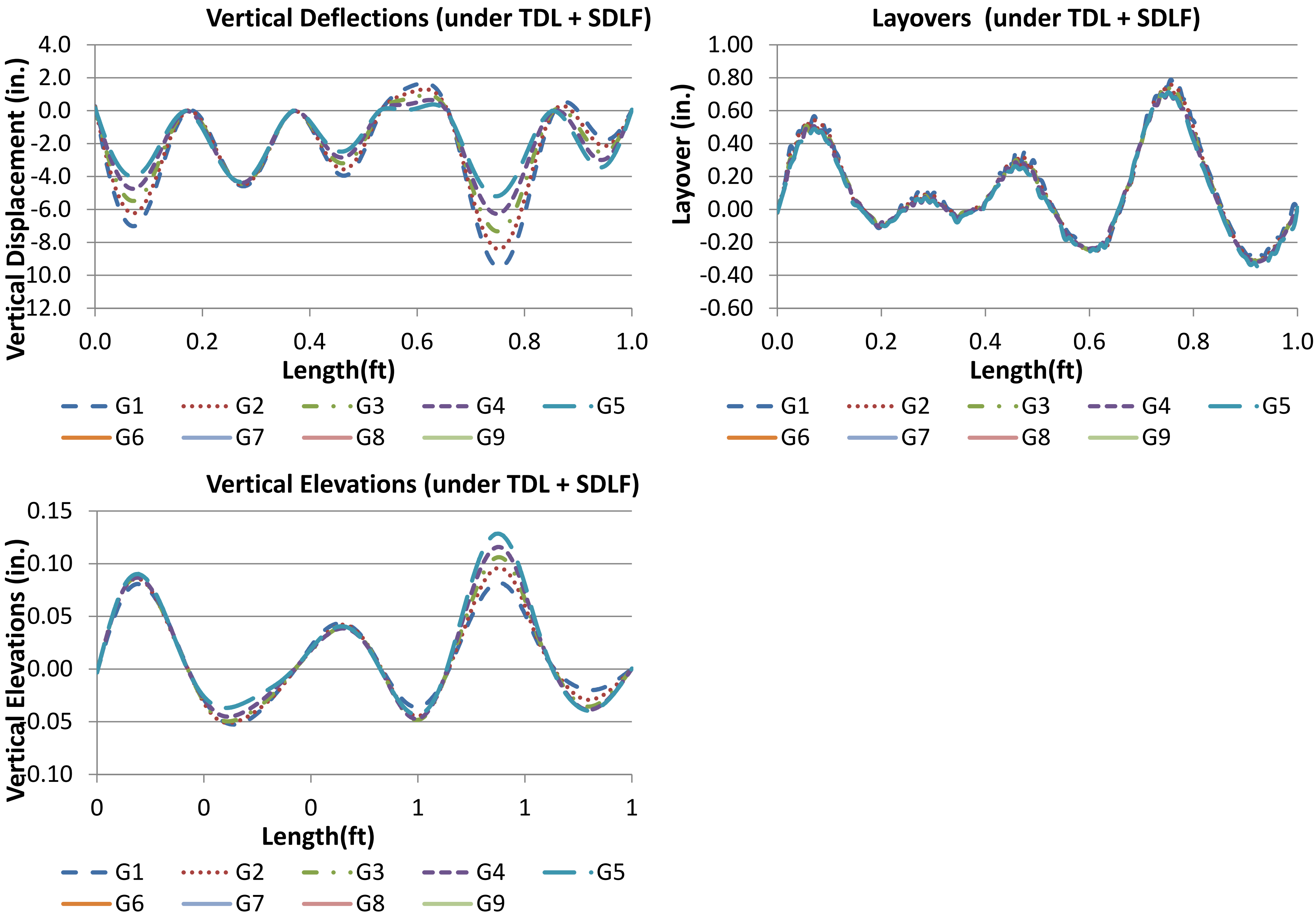


Figure G-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

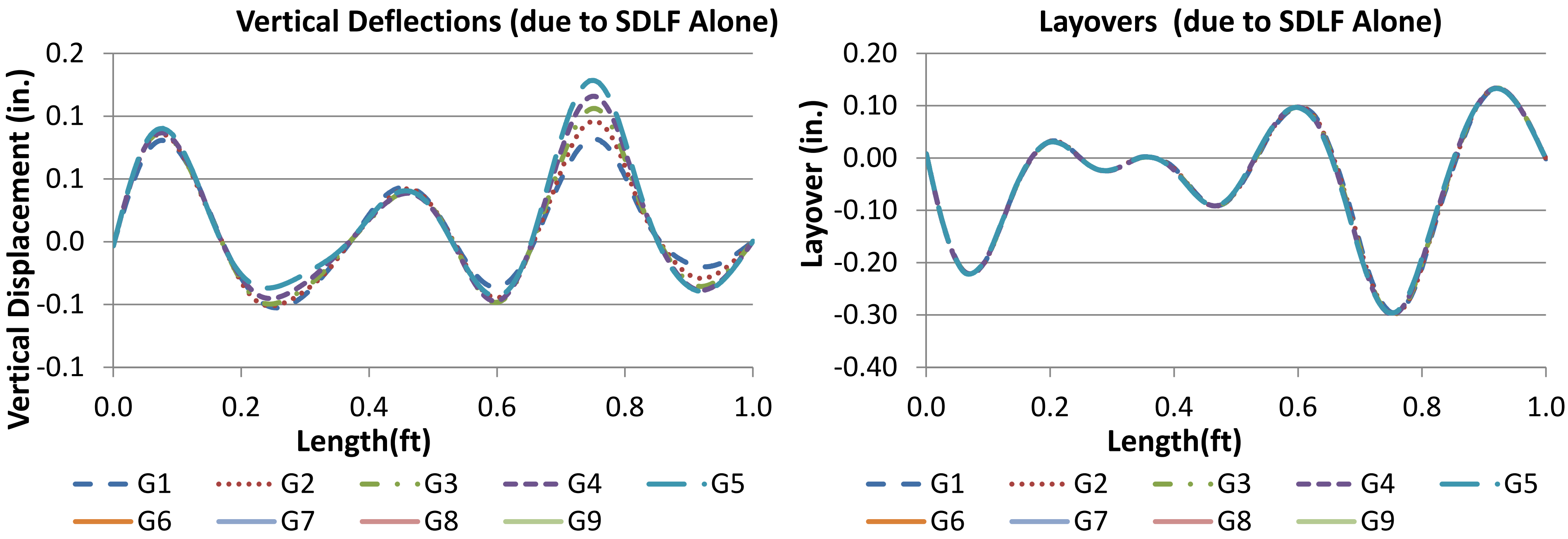


Figure G-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

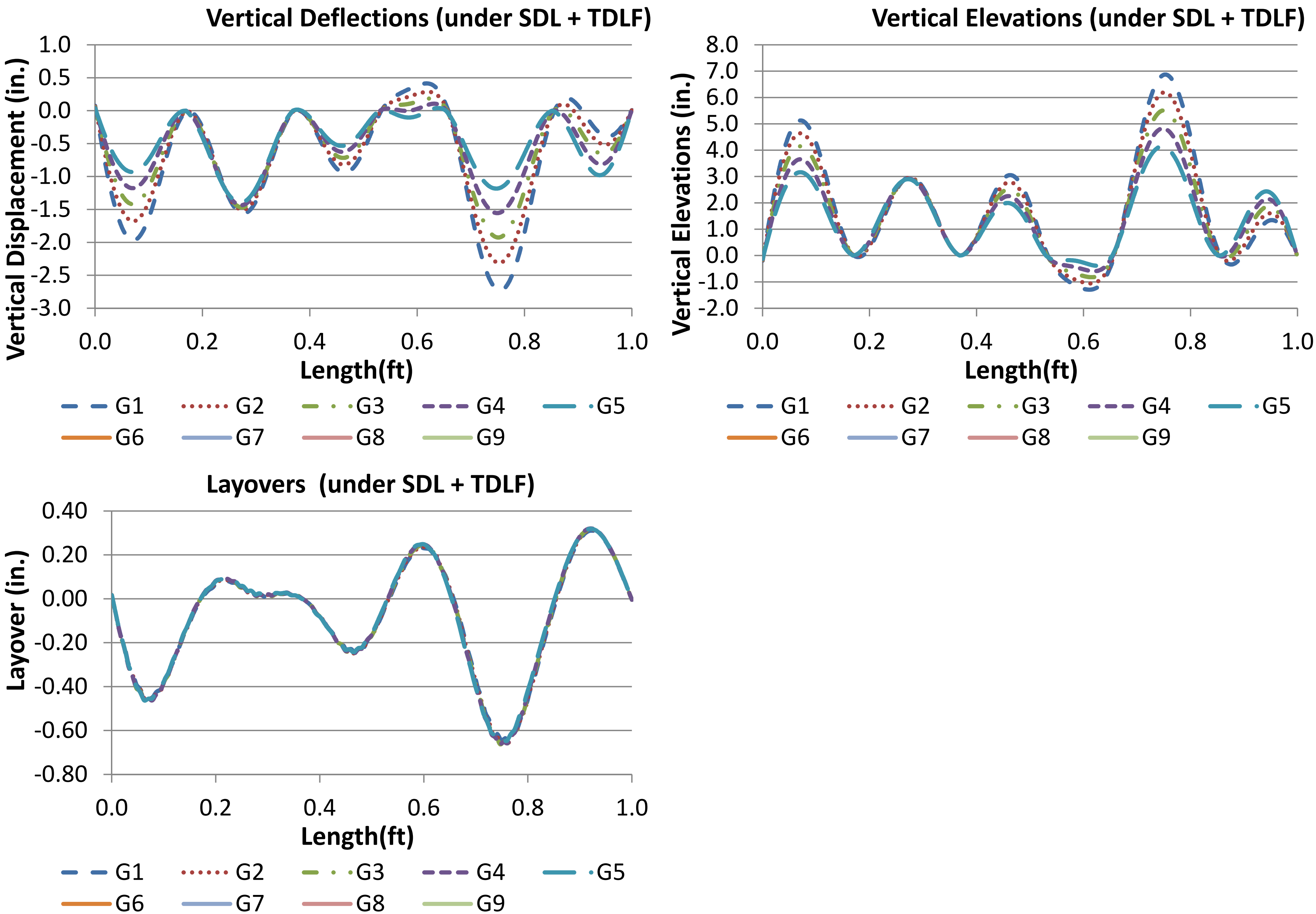
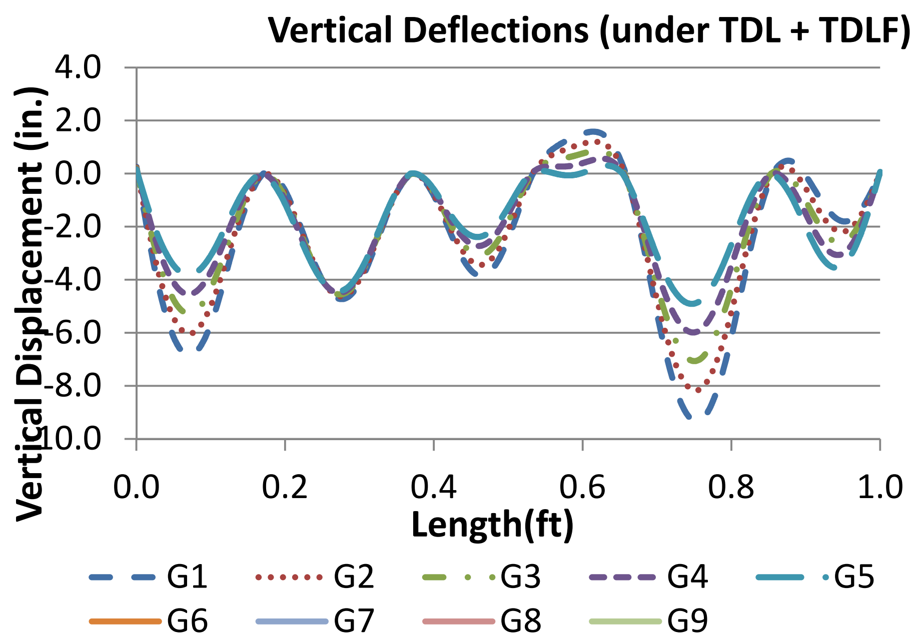
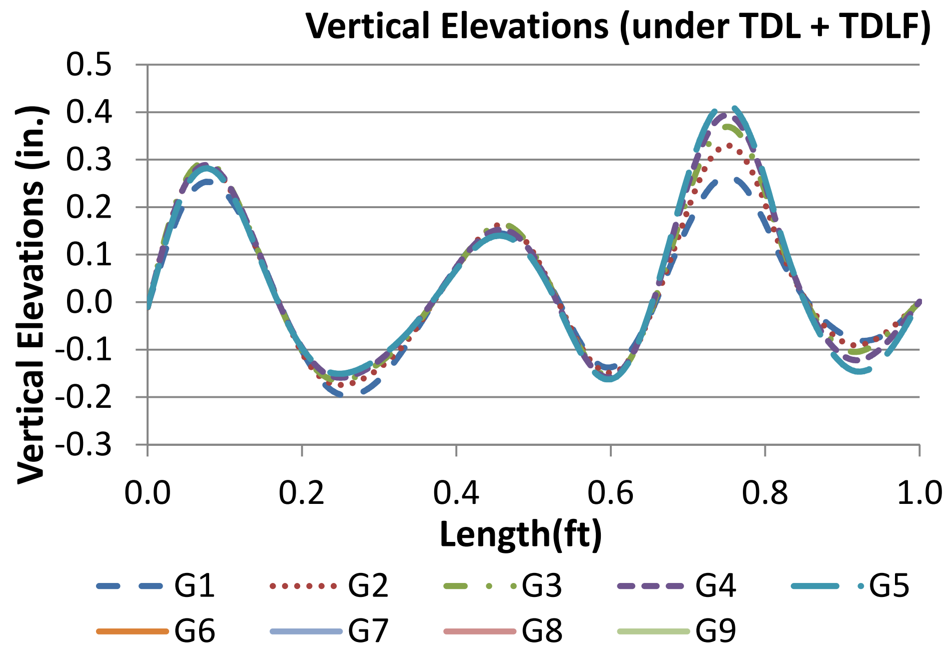


Figure G-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.





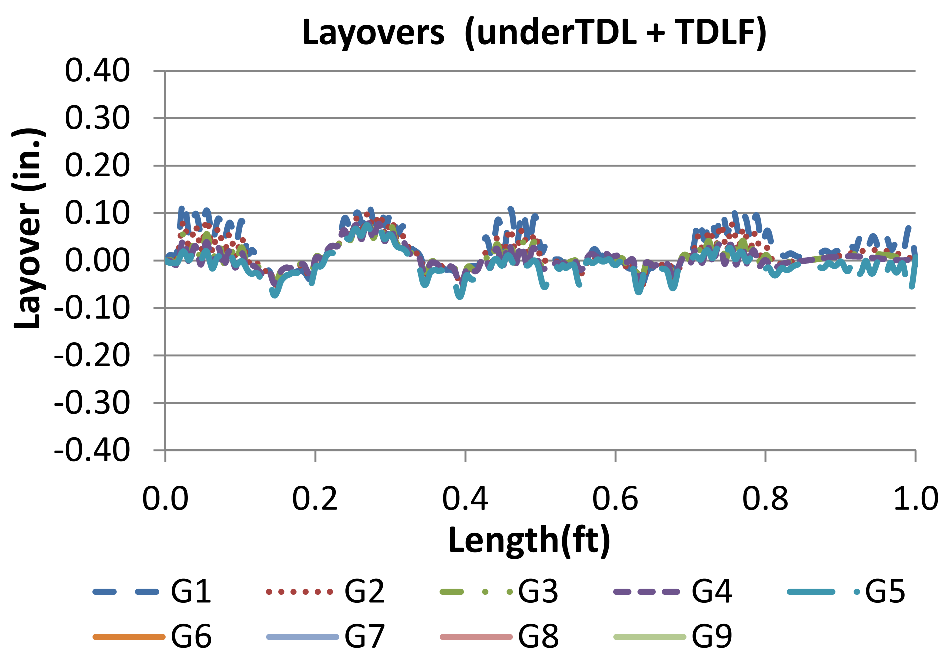


Figure G-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

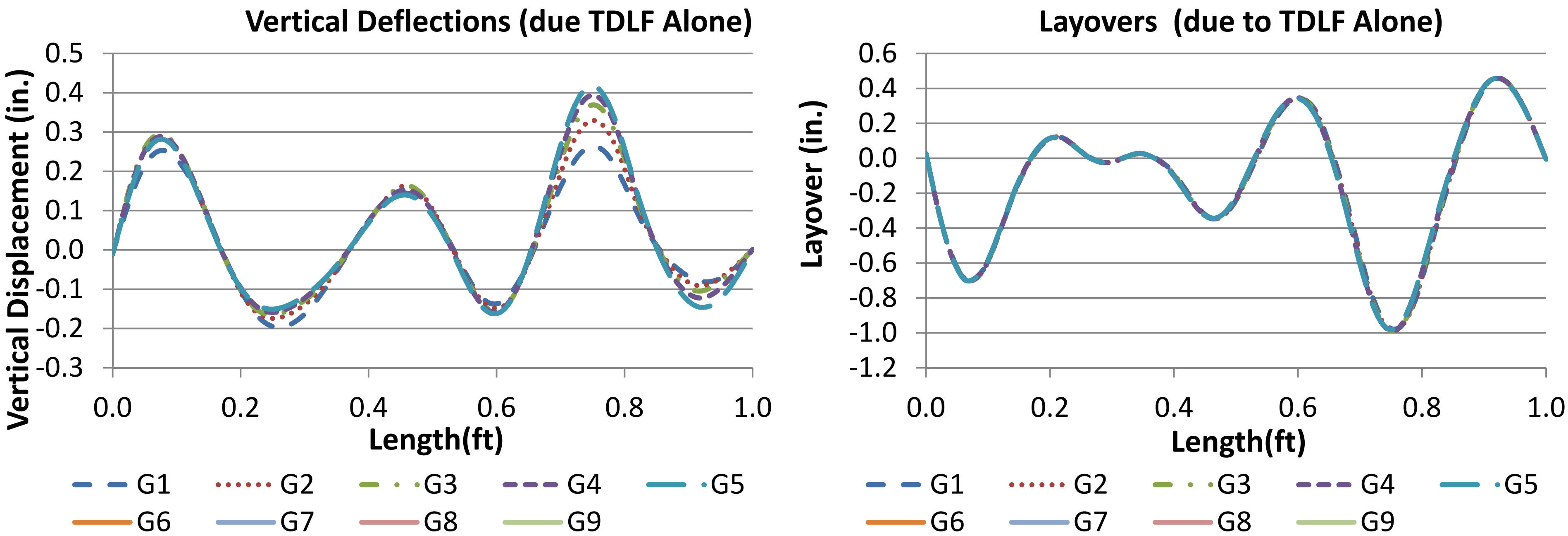


Figure G-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

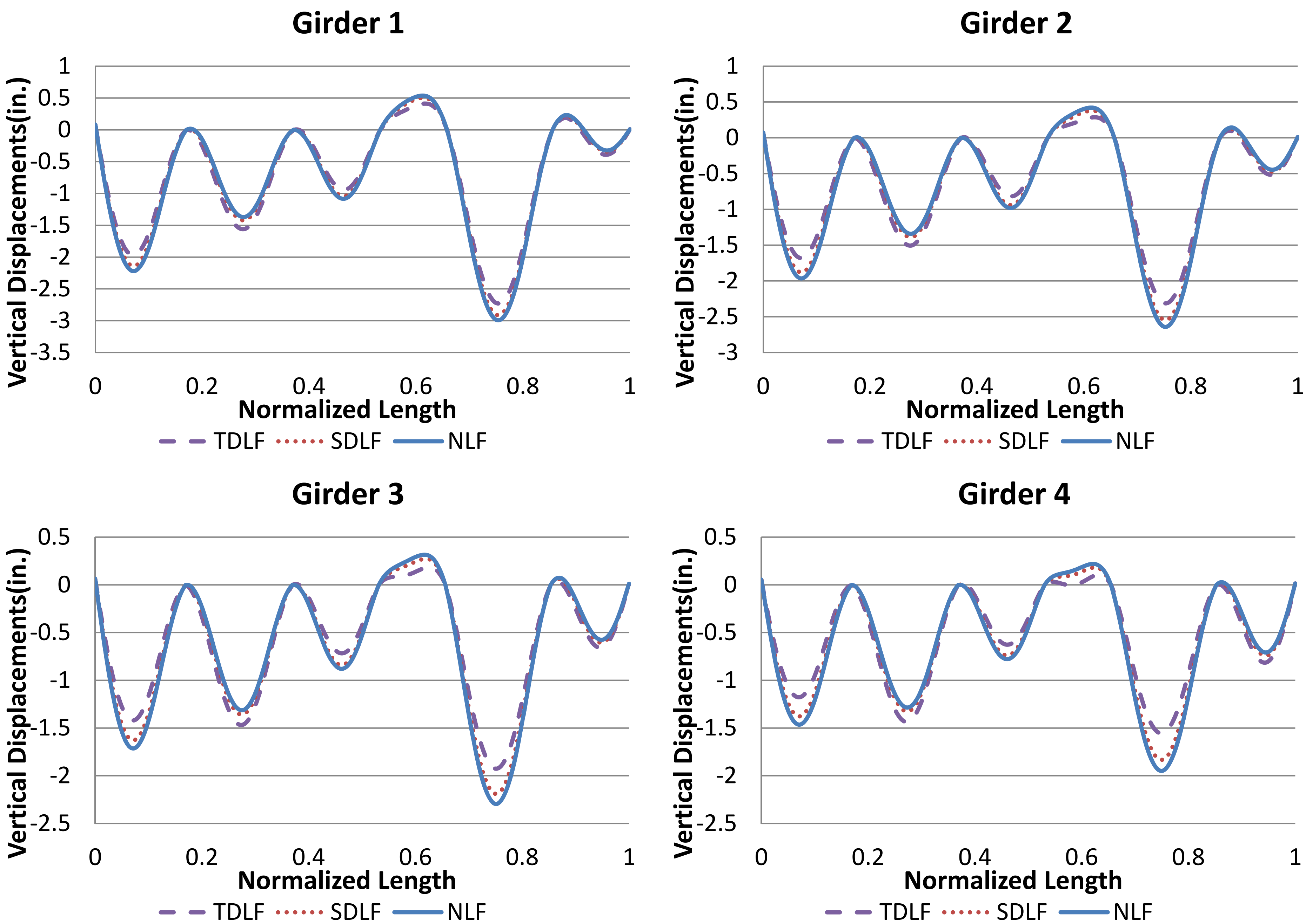


Figure G-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

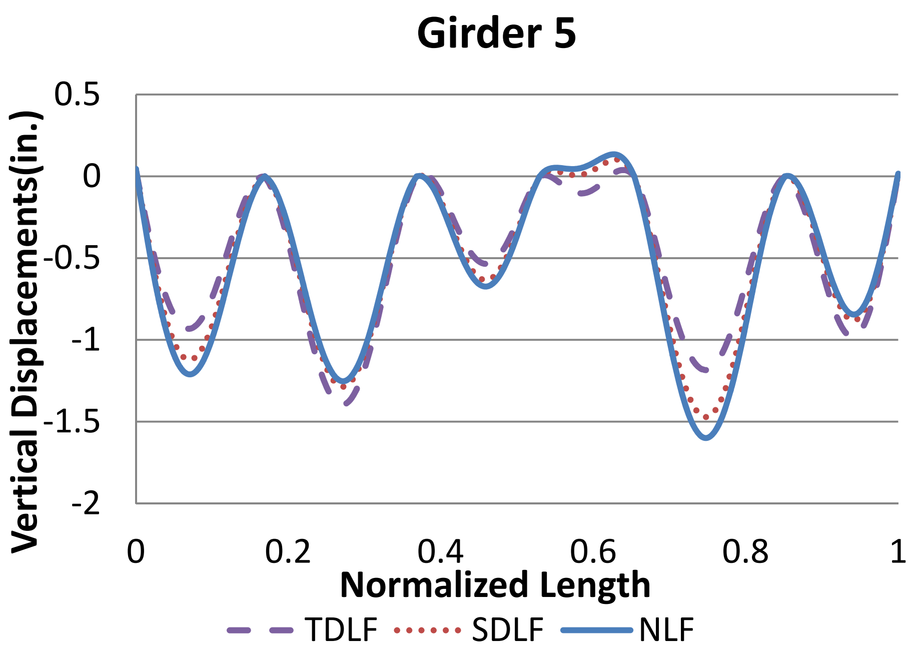


Figure G-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

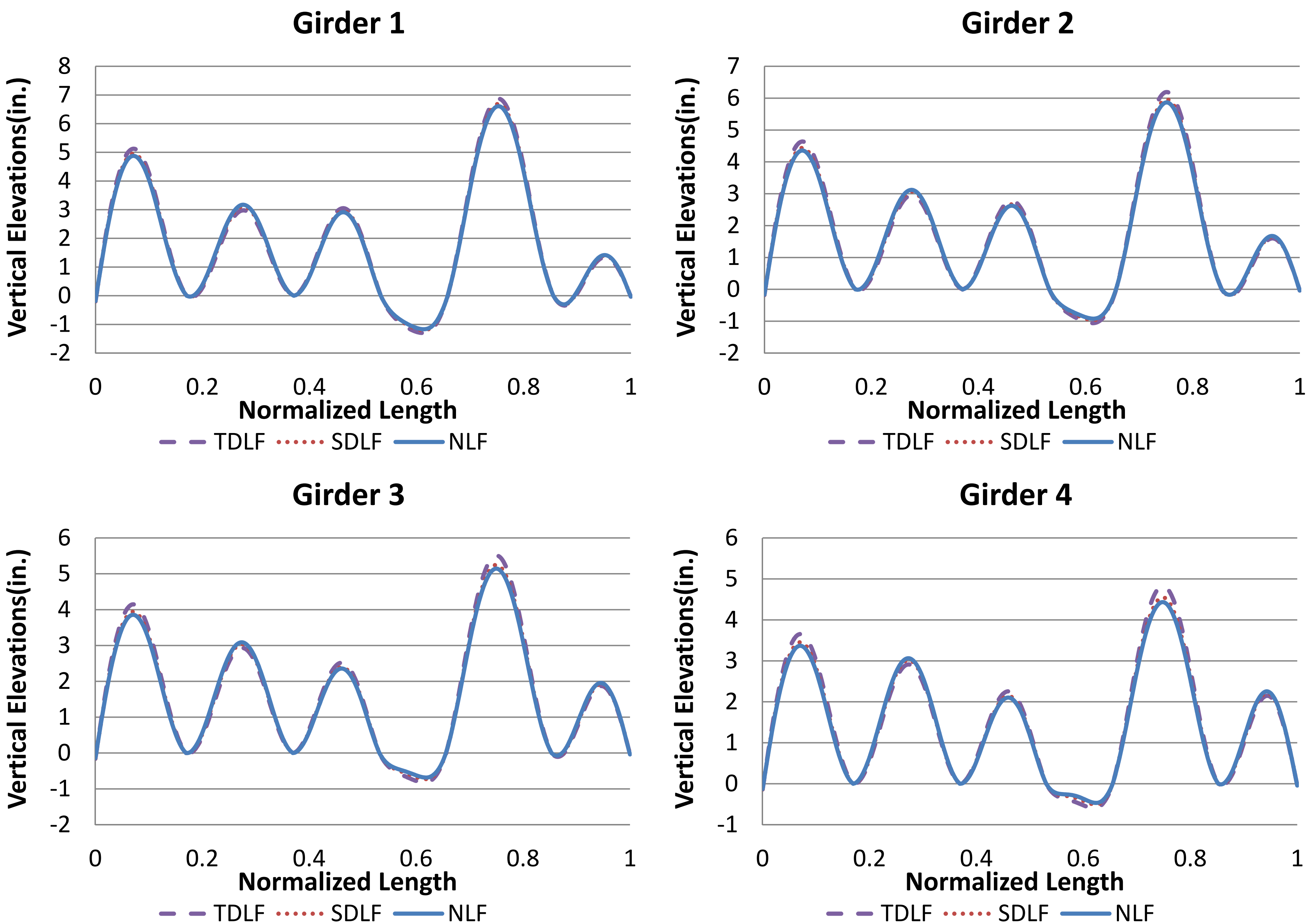


Figure G-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

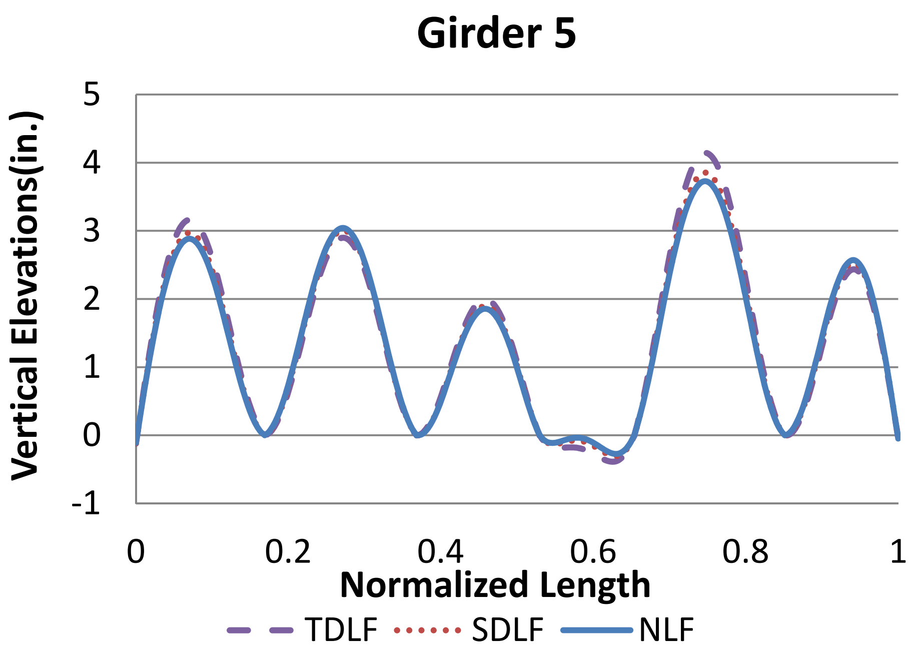


Figure G-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

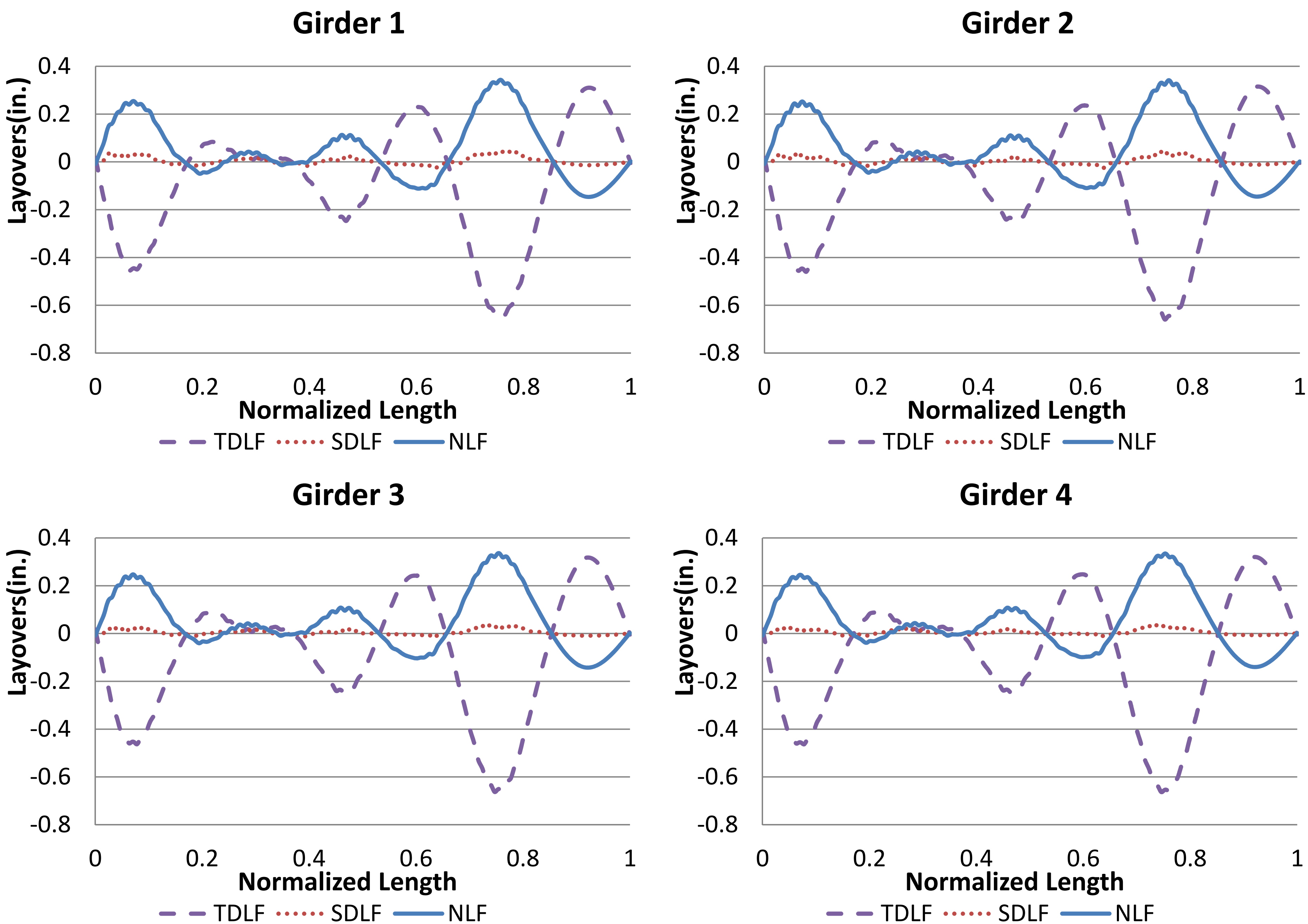


Figure G-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

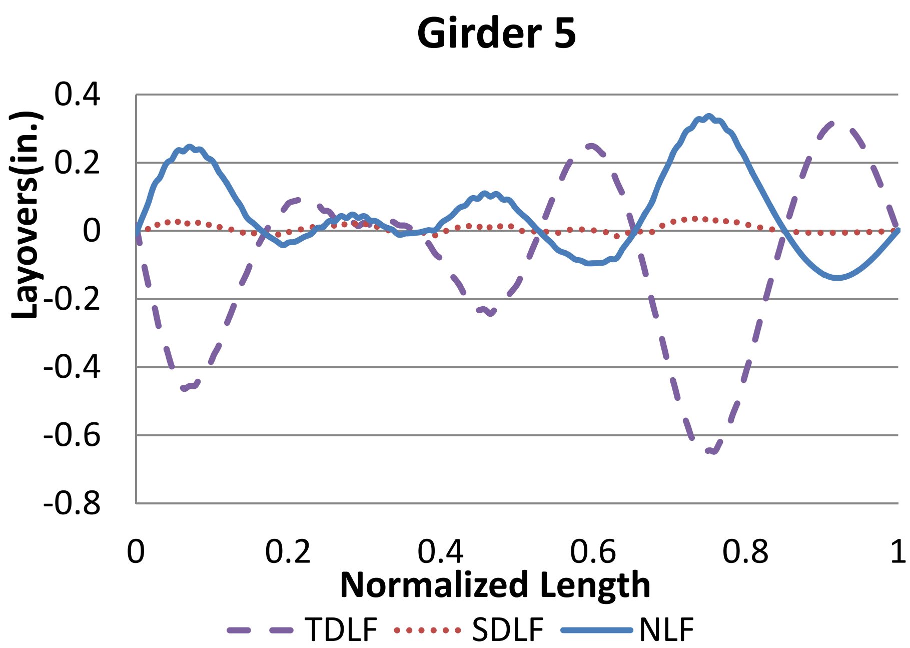


Figure G-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

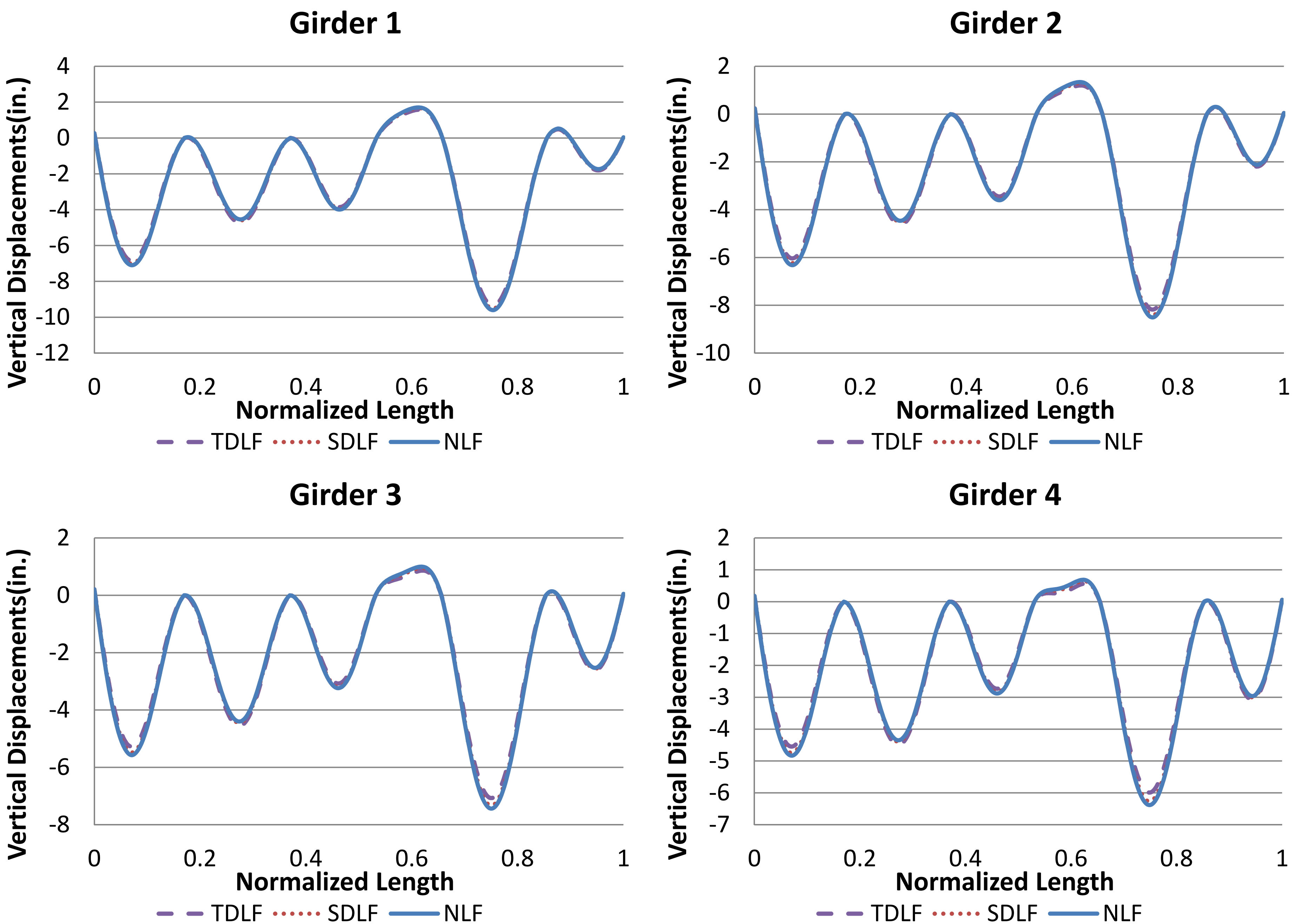


Figure G-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

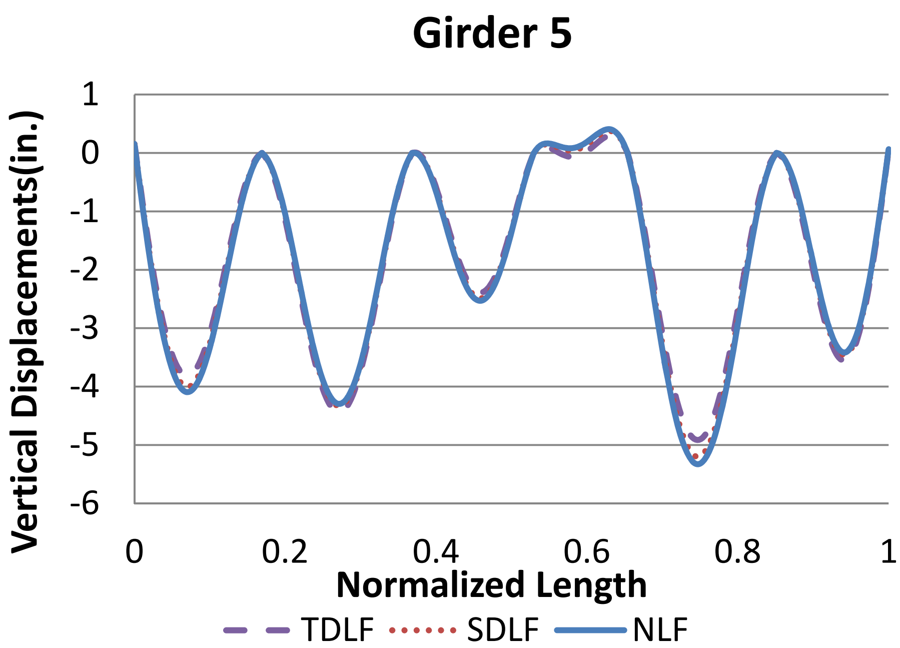


Figure G-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

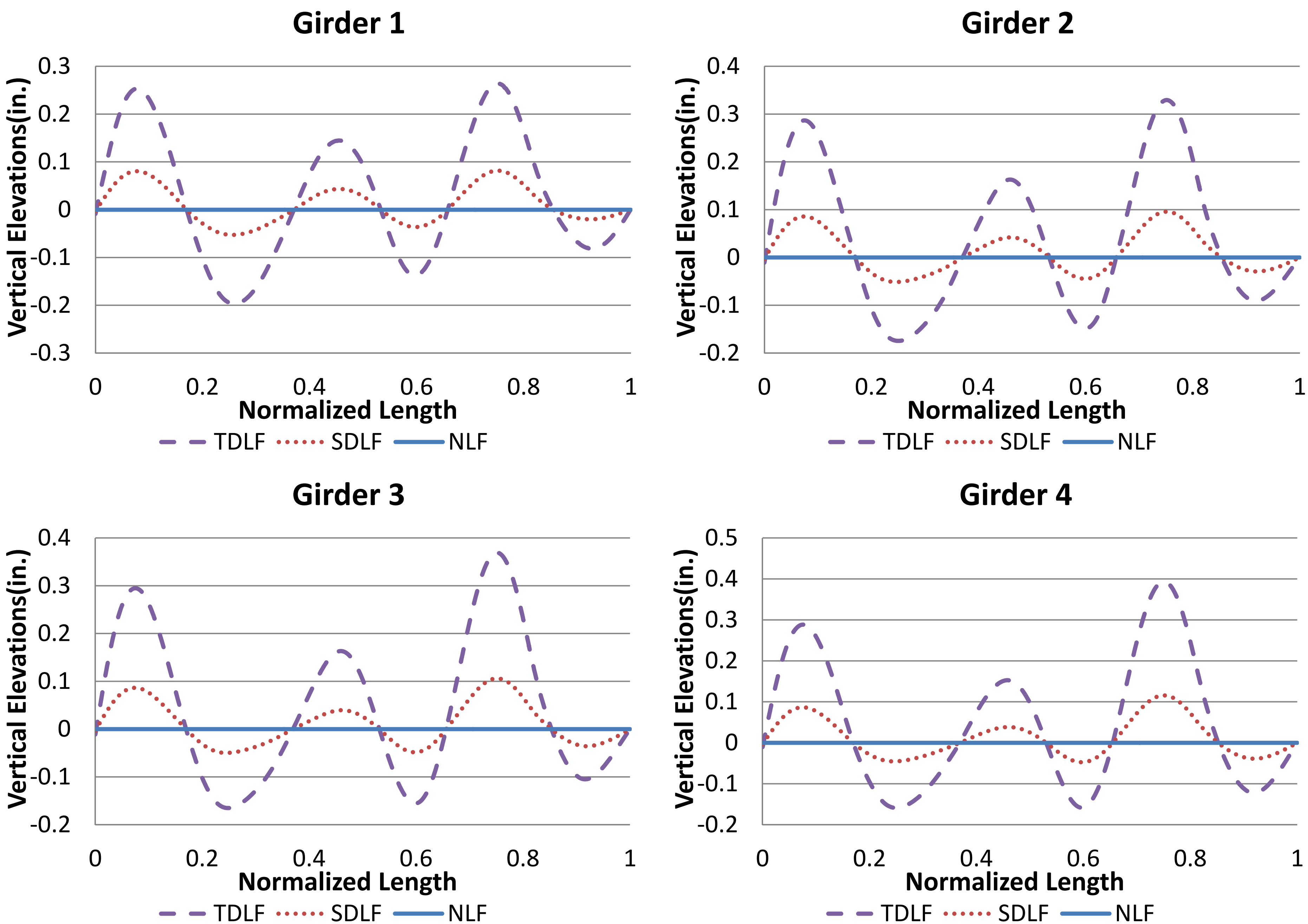


Figure G-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

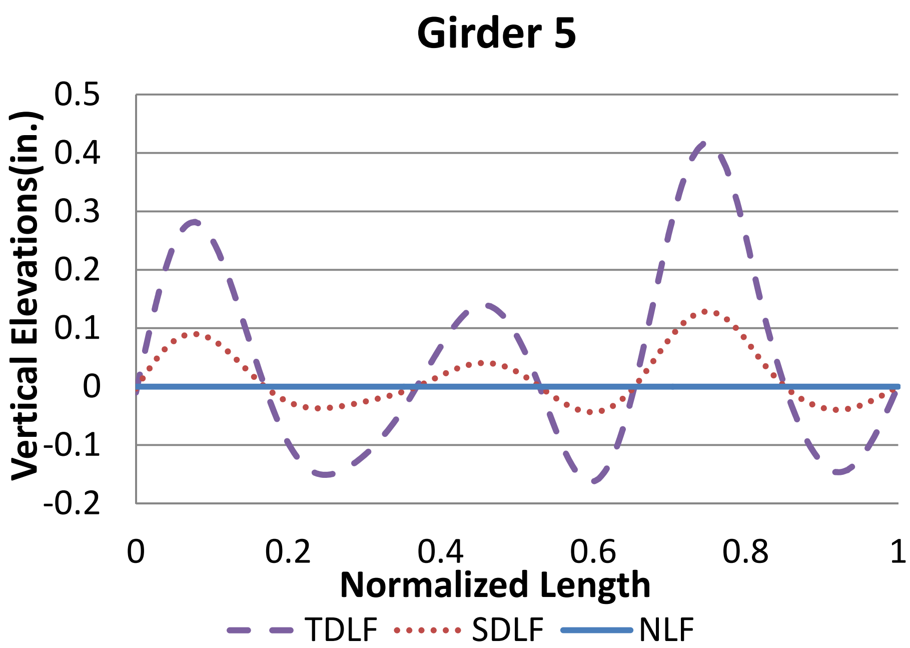


Figure G-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

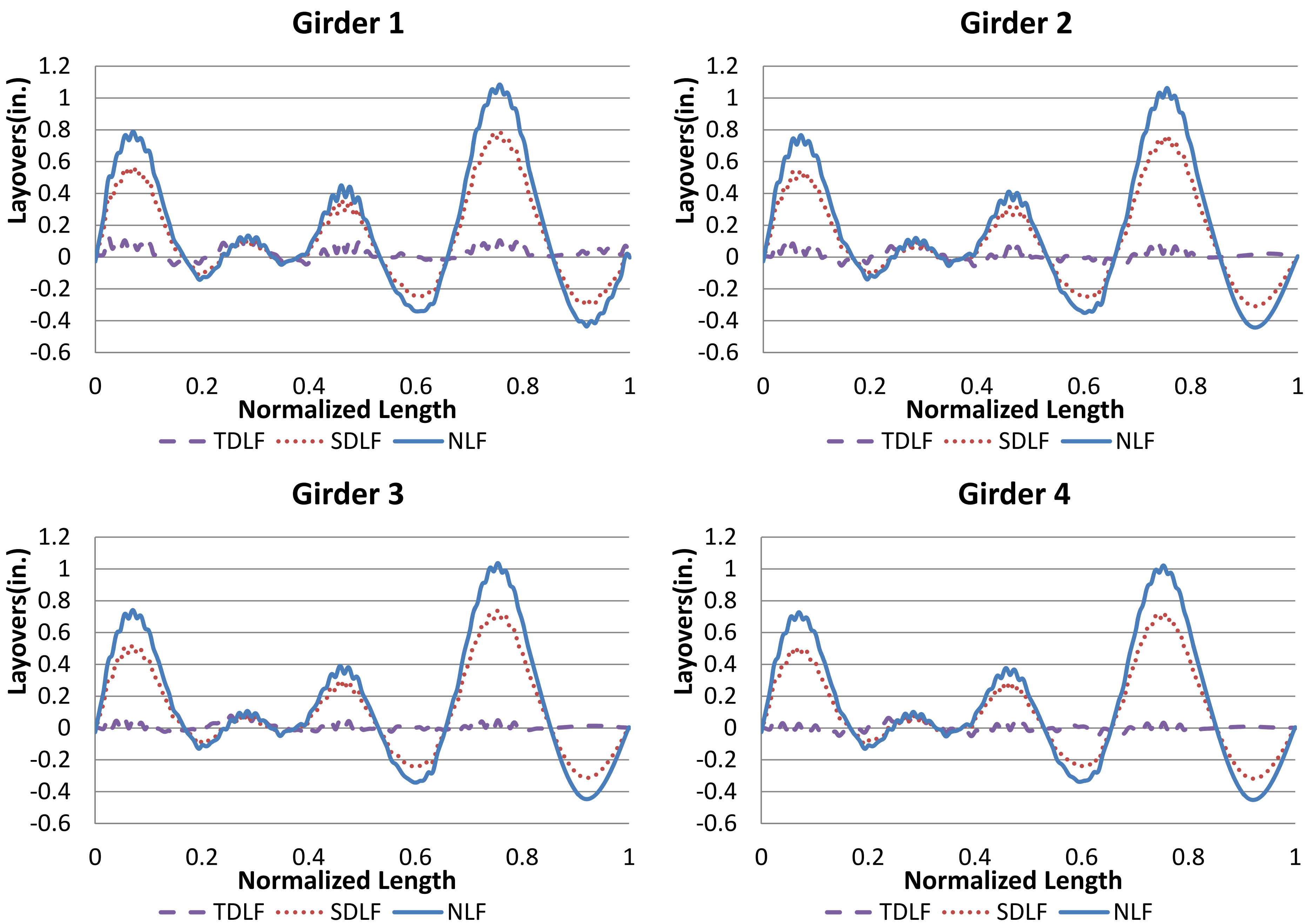


Figure G-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

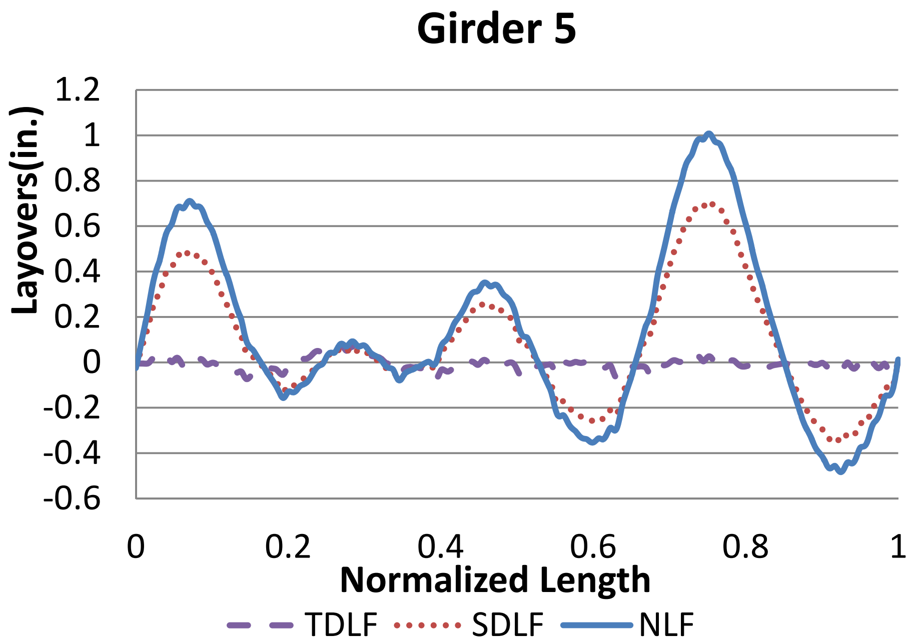


Figure G-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

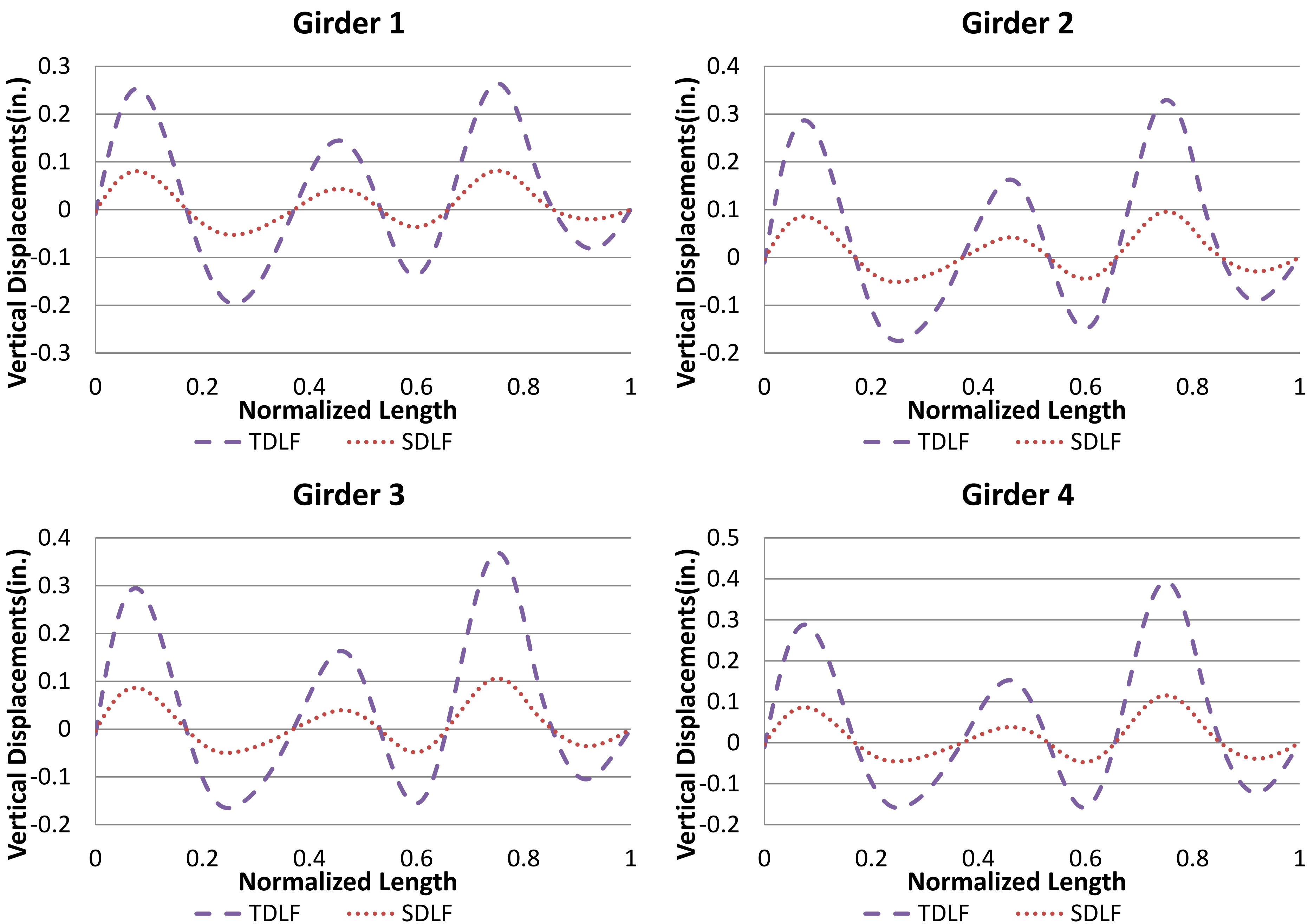


Figure G-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

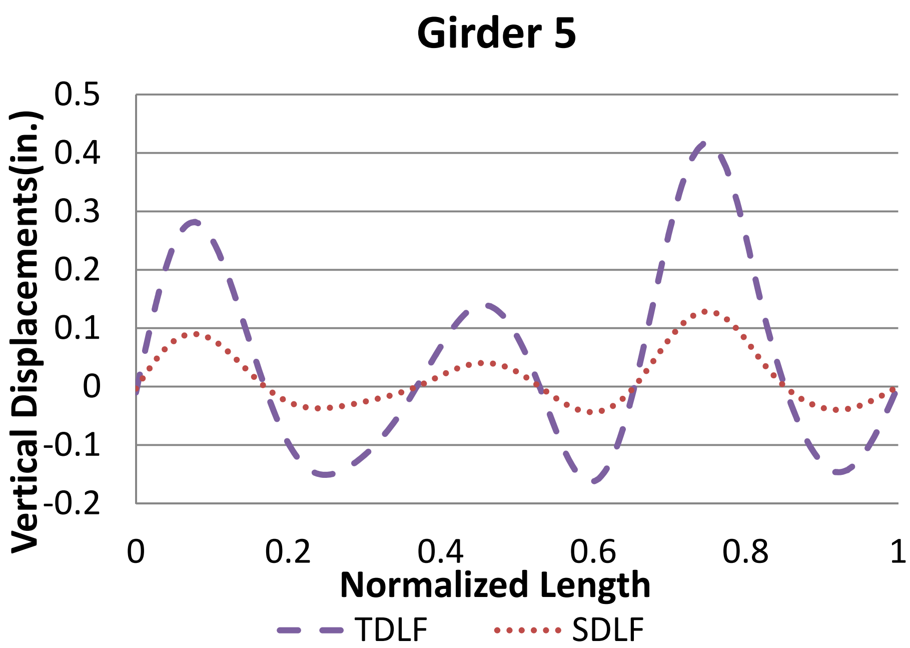


Figure G-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

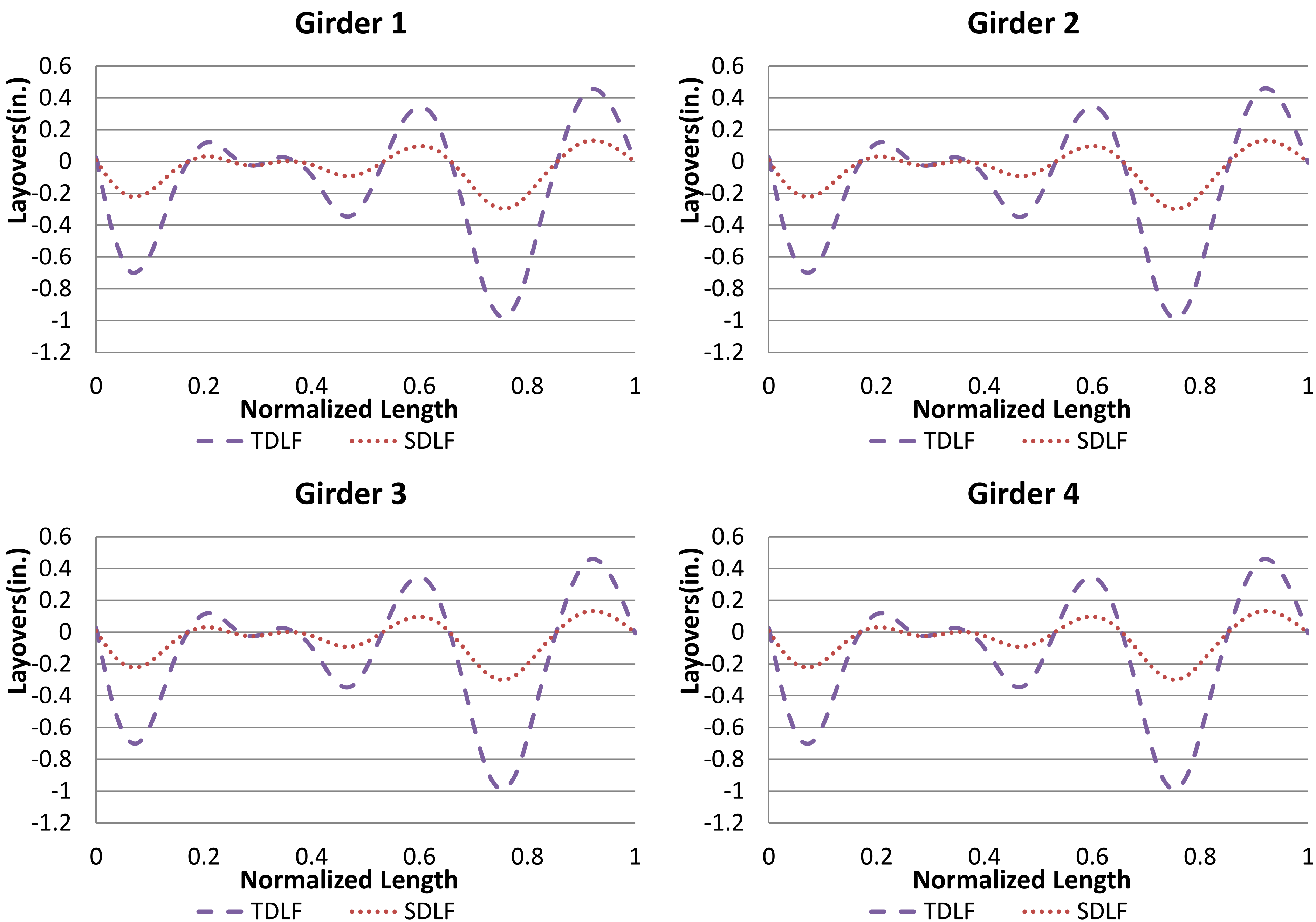


Figure G-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

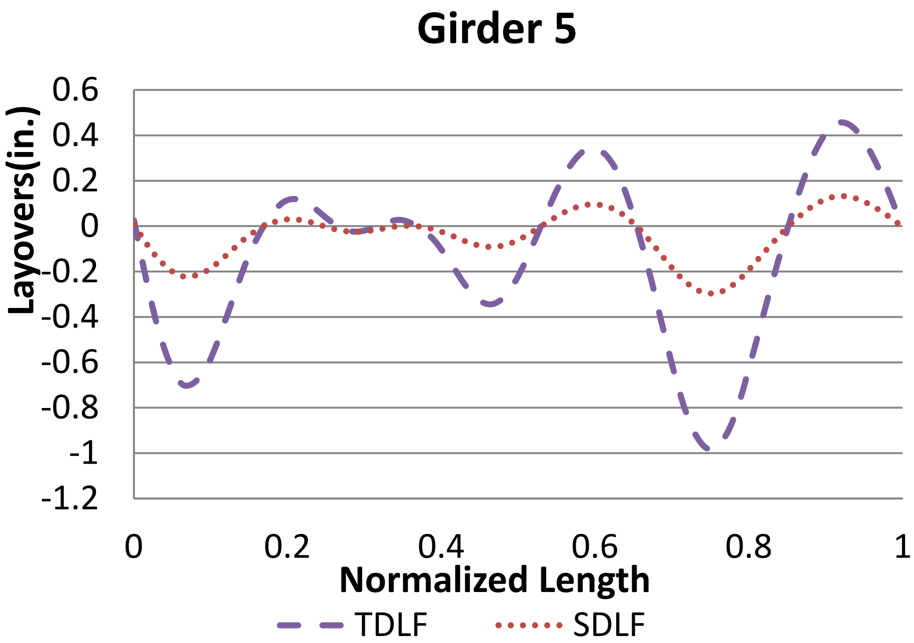


Figure G-4-17(Continued). **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.**

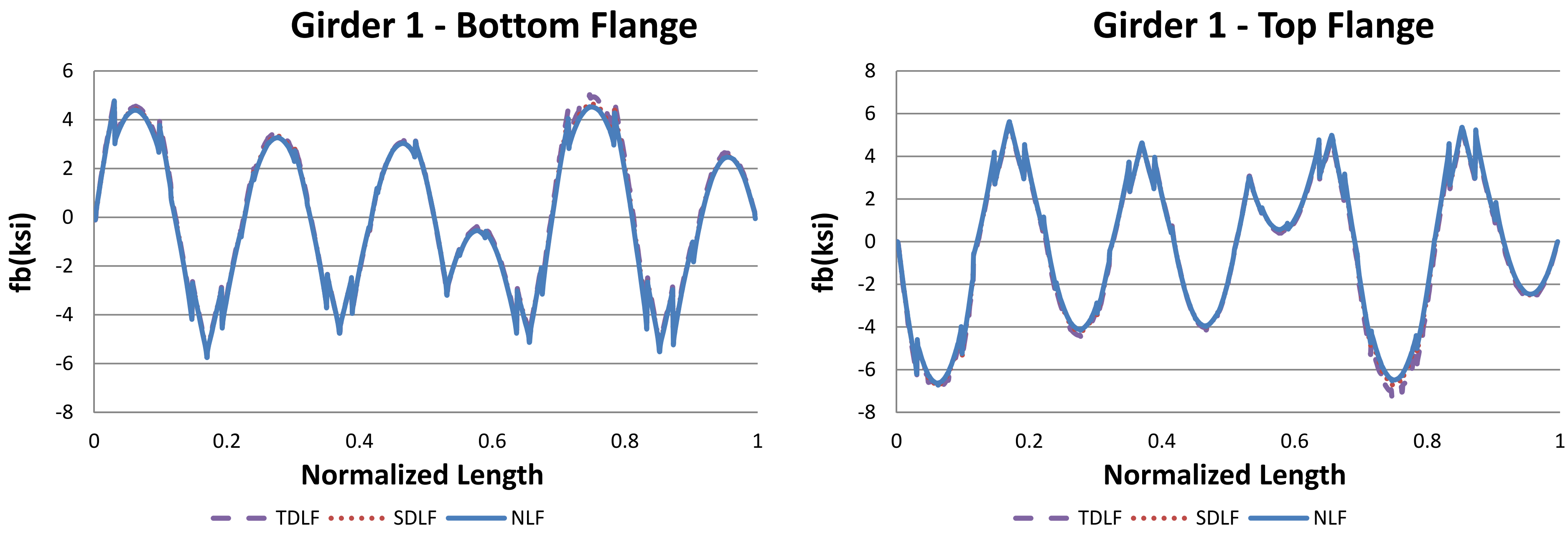


Figure G-4-18. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

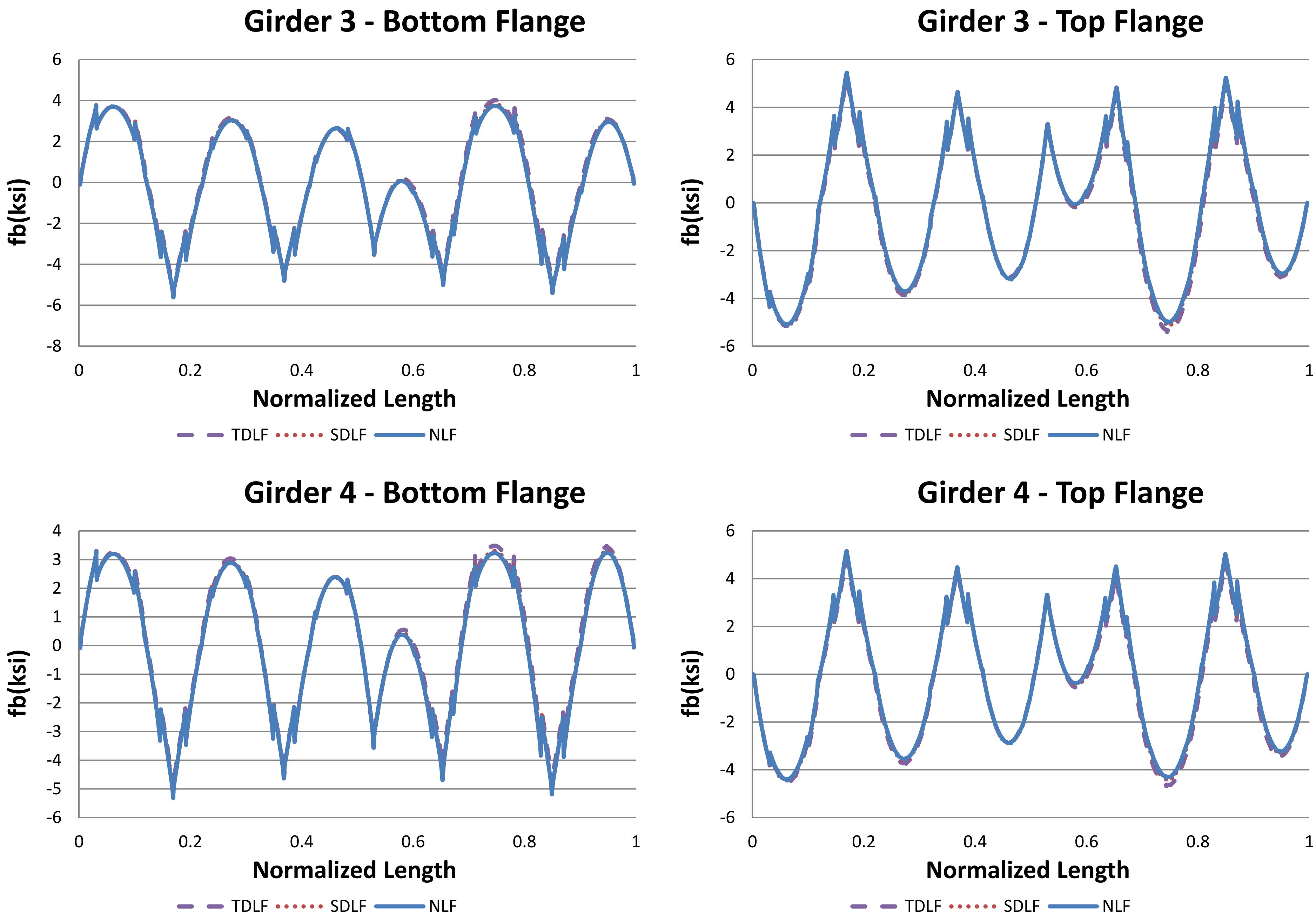
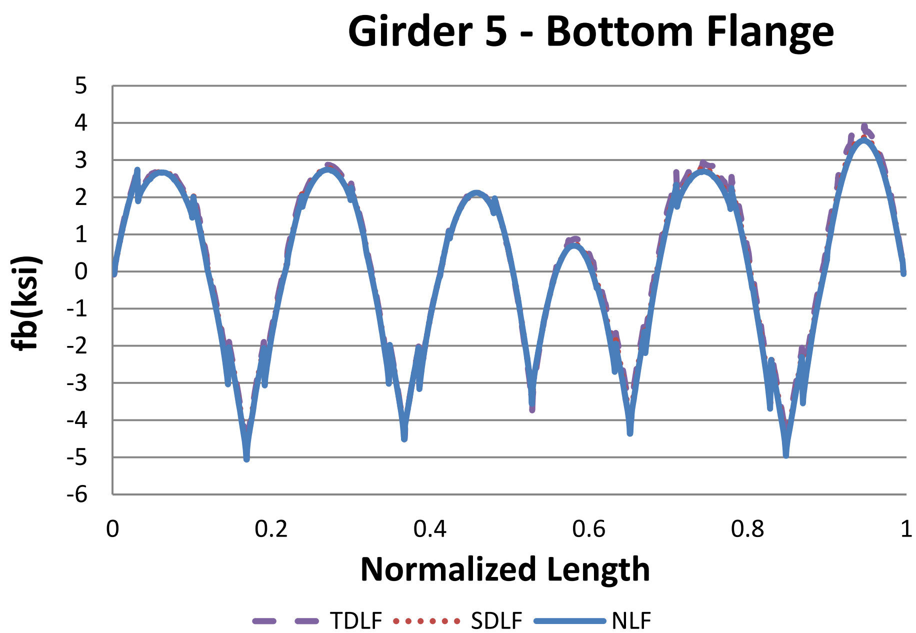


Figure G-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.



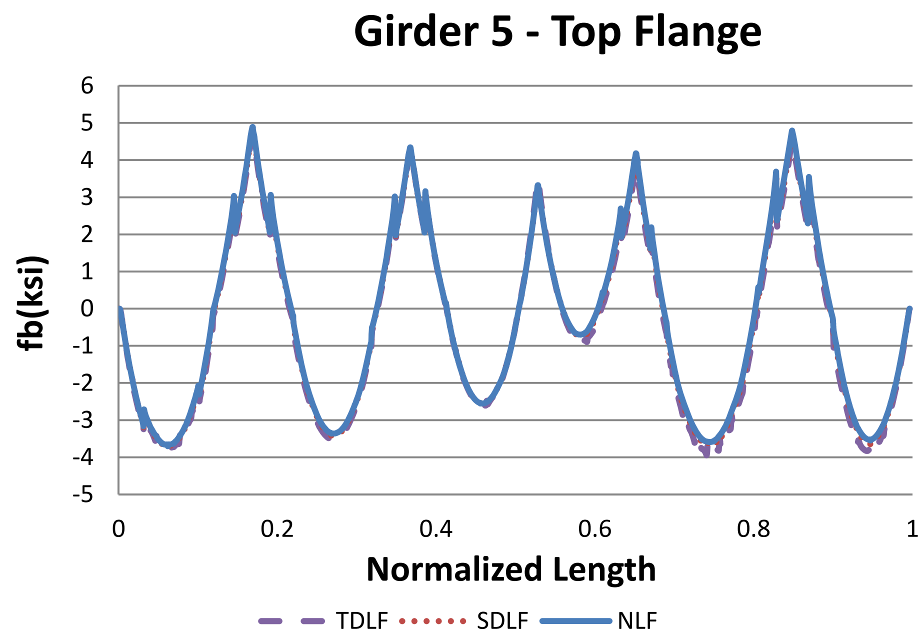


Figure G-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

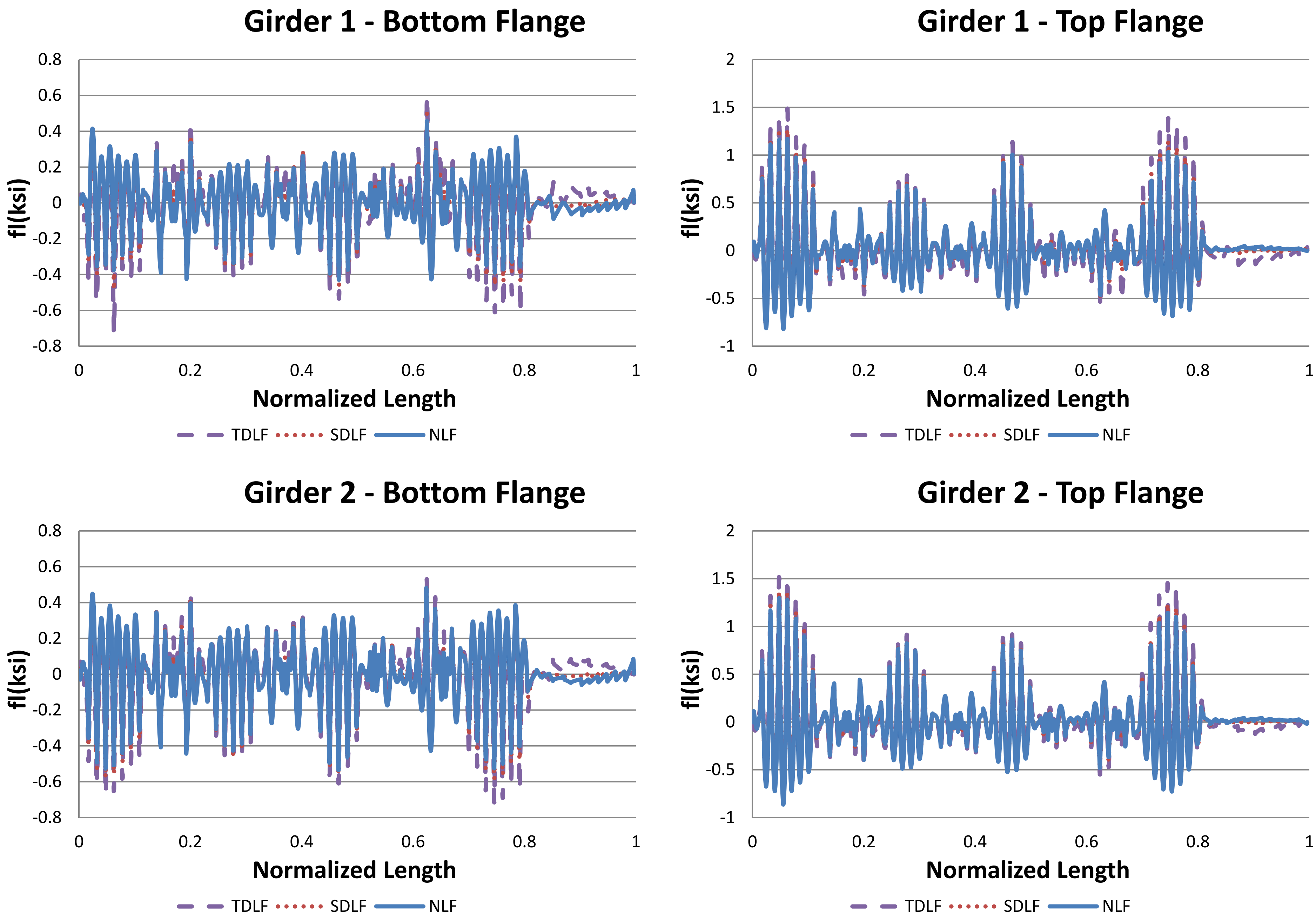


Figure G-4-19. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

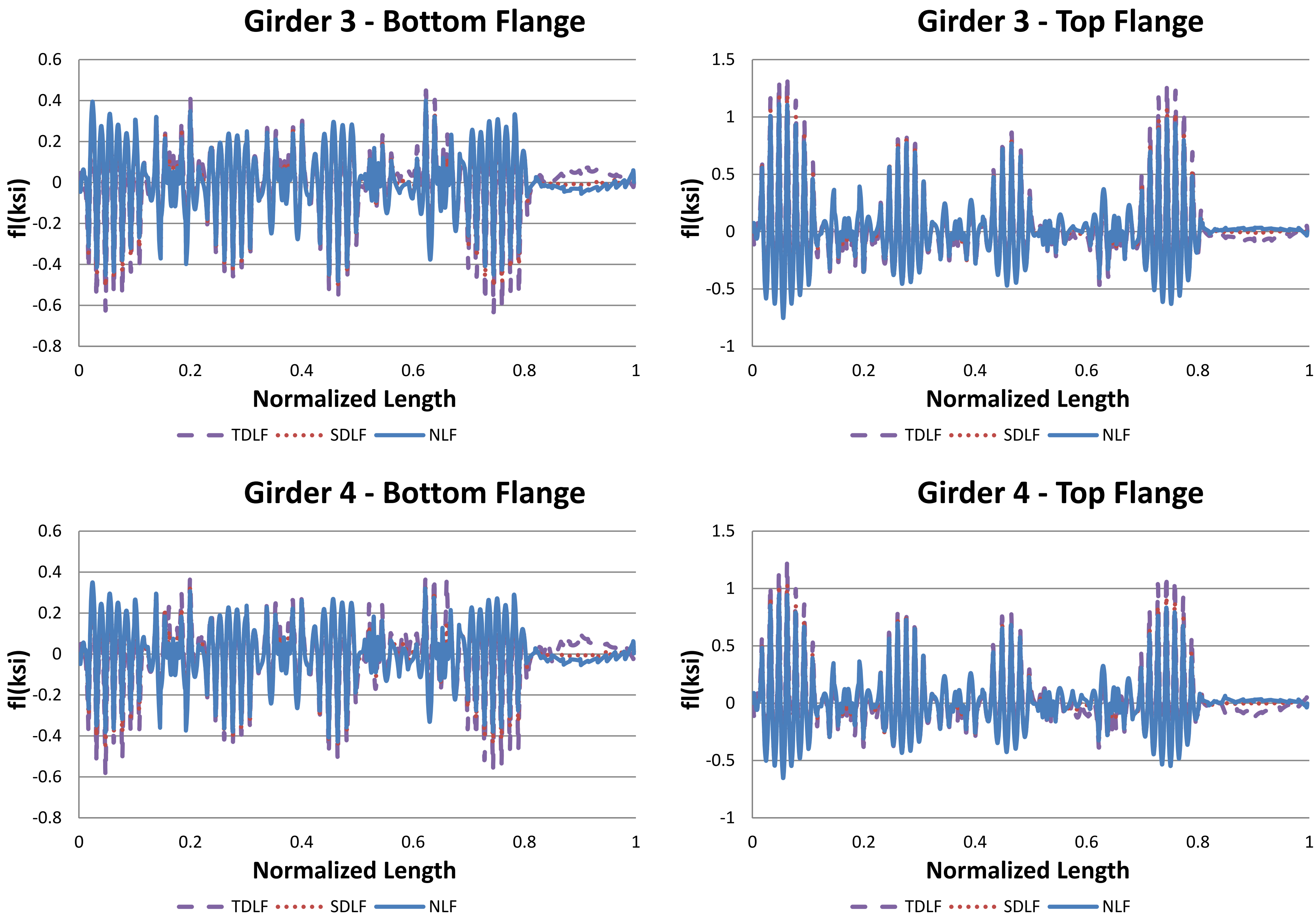
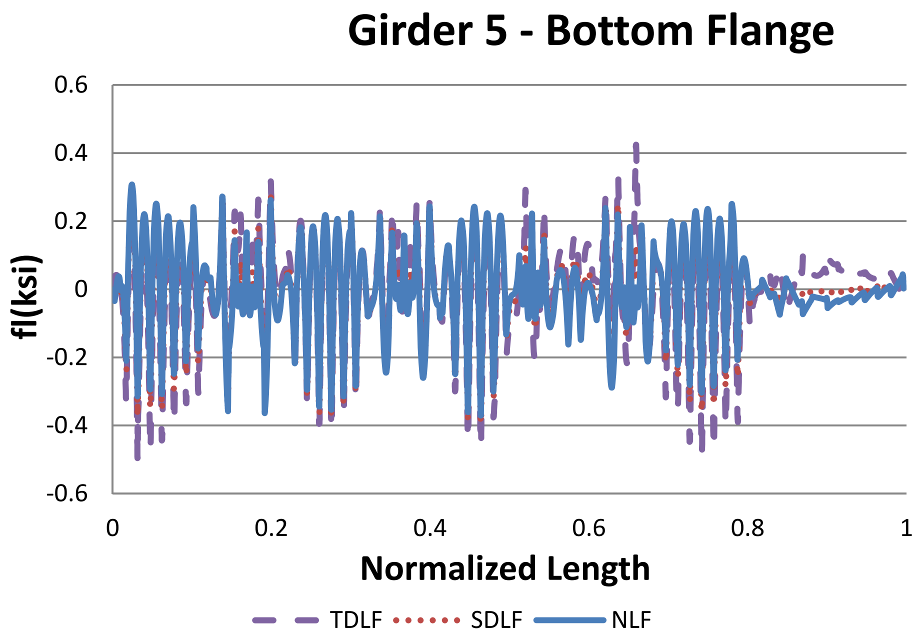


Figure G-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.



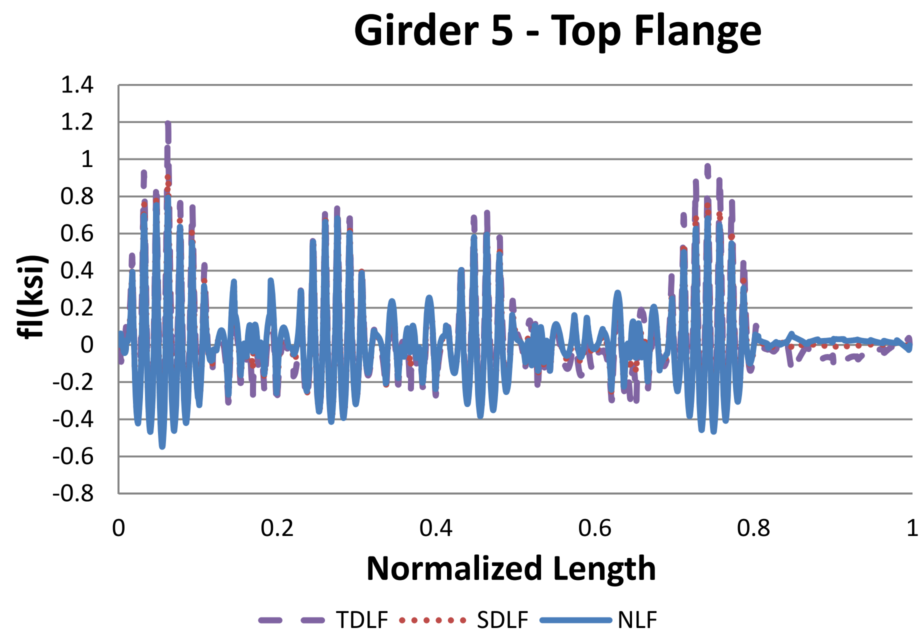


Figure G-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under SDL for different detailing methods.

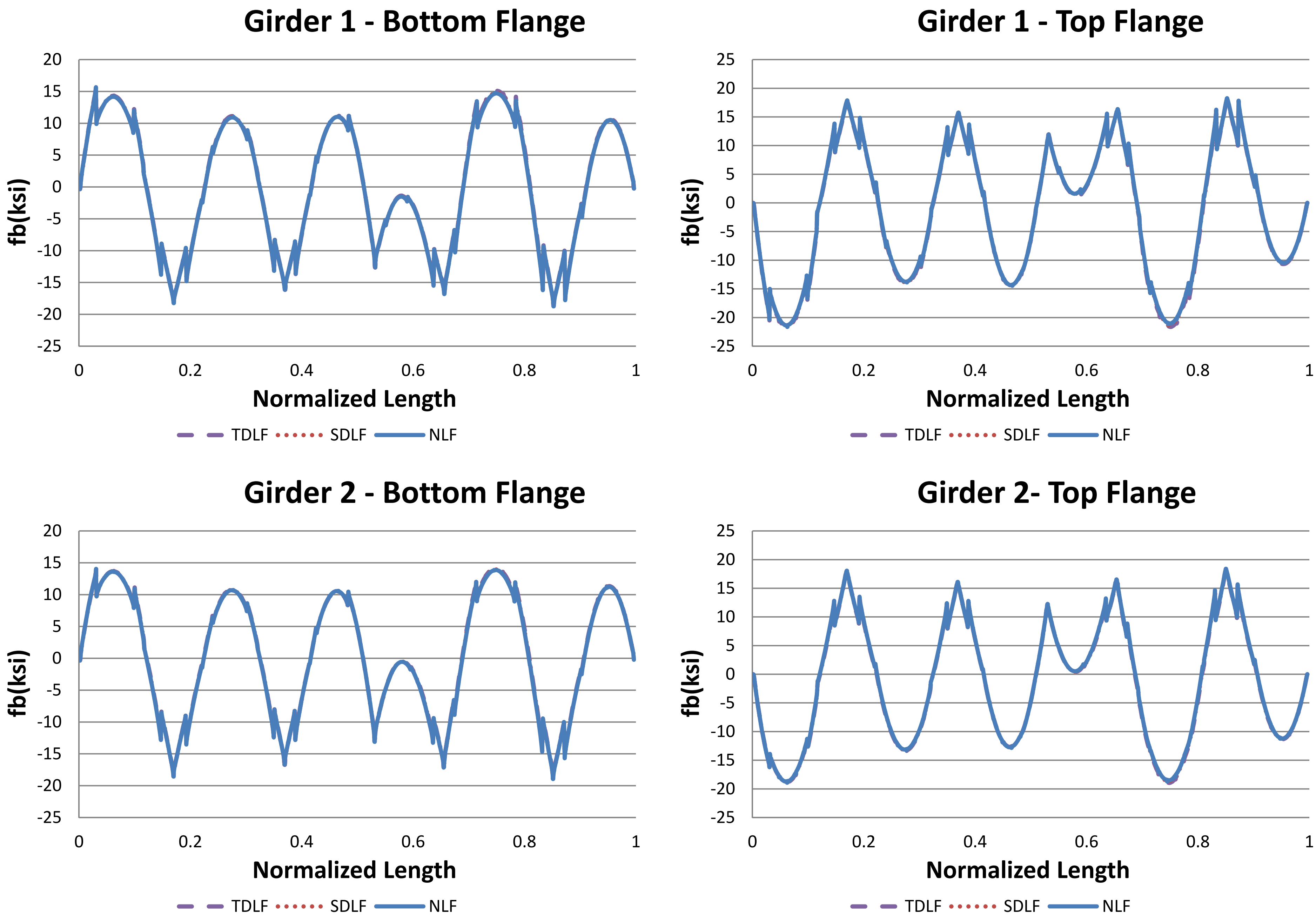


Figure G-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

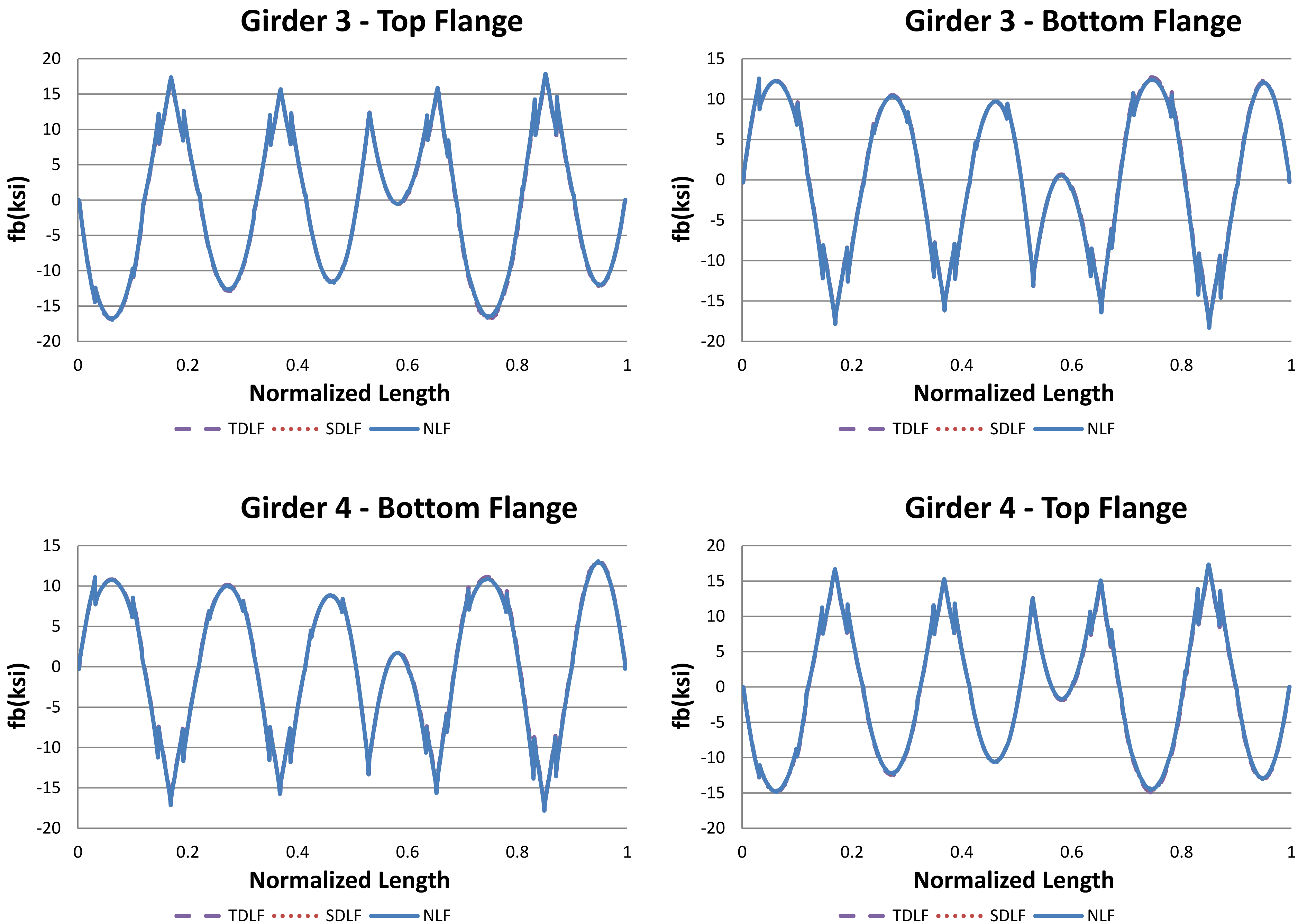
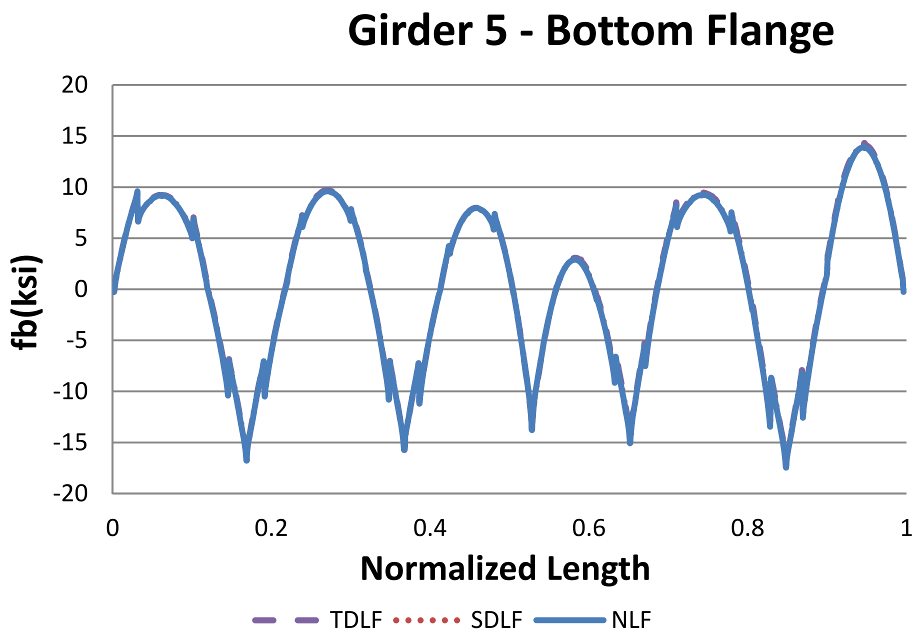


Figure G-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



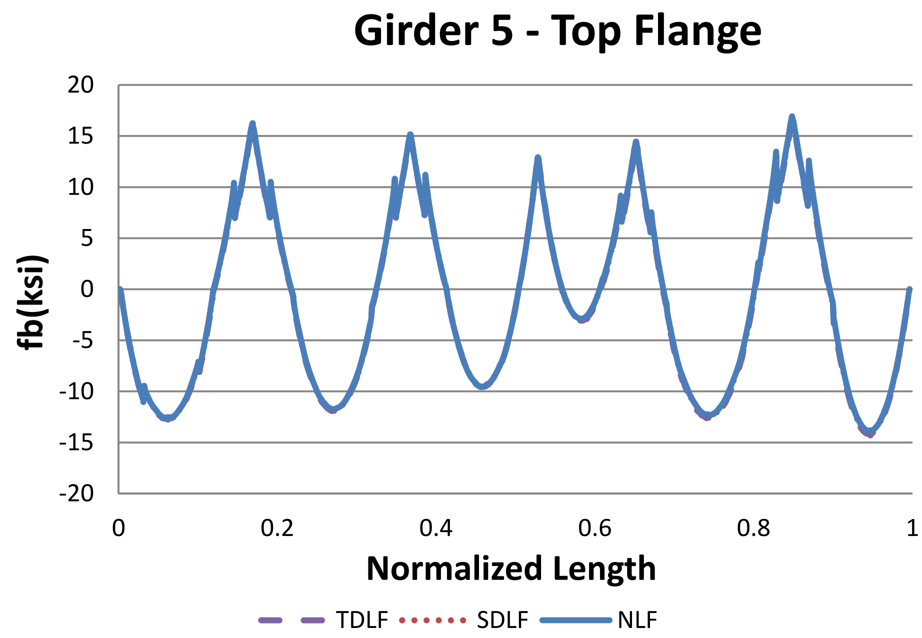


Figure G-4-20(Continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

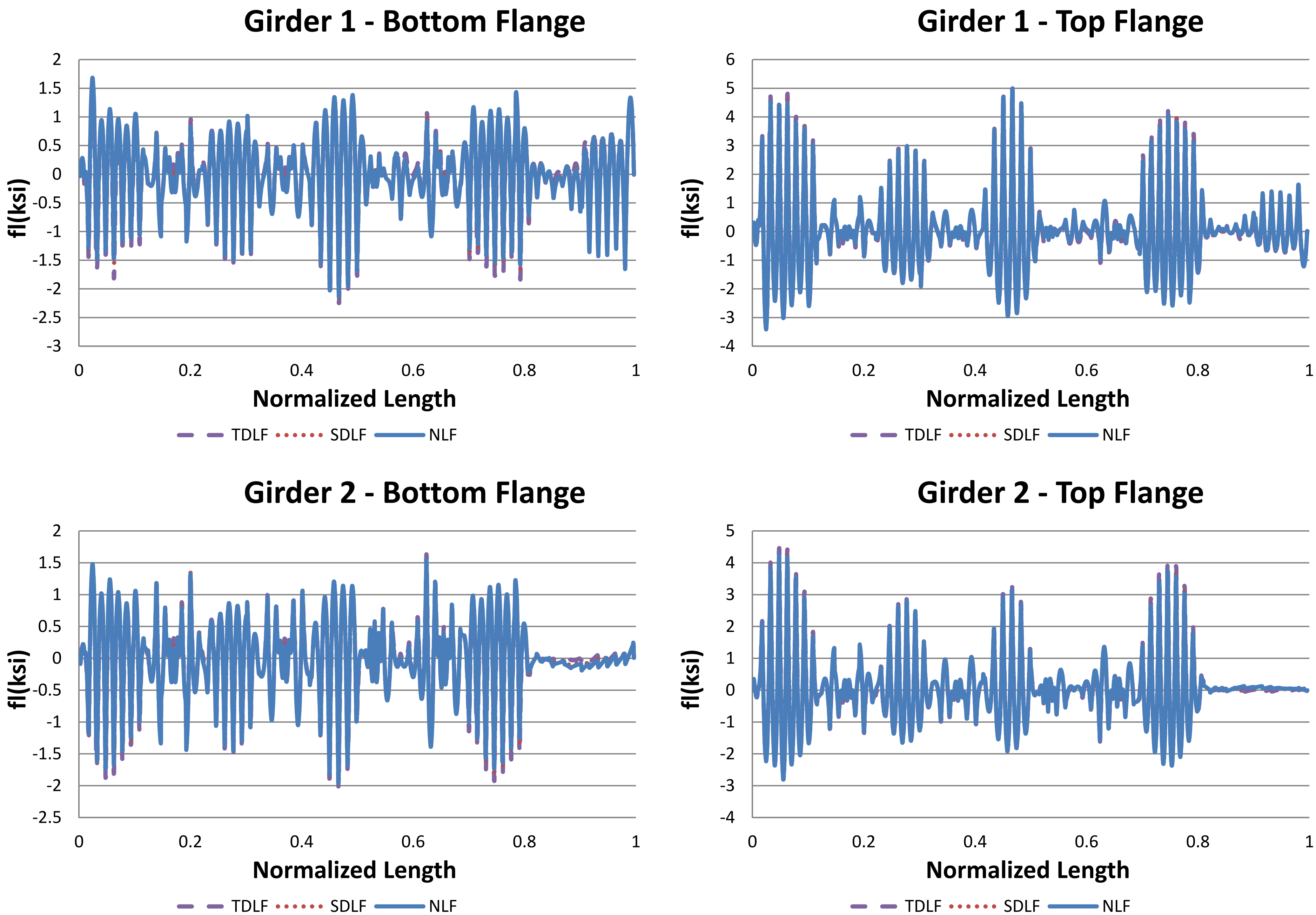


Figure G-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

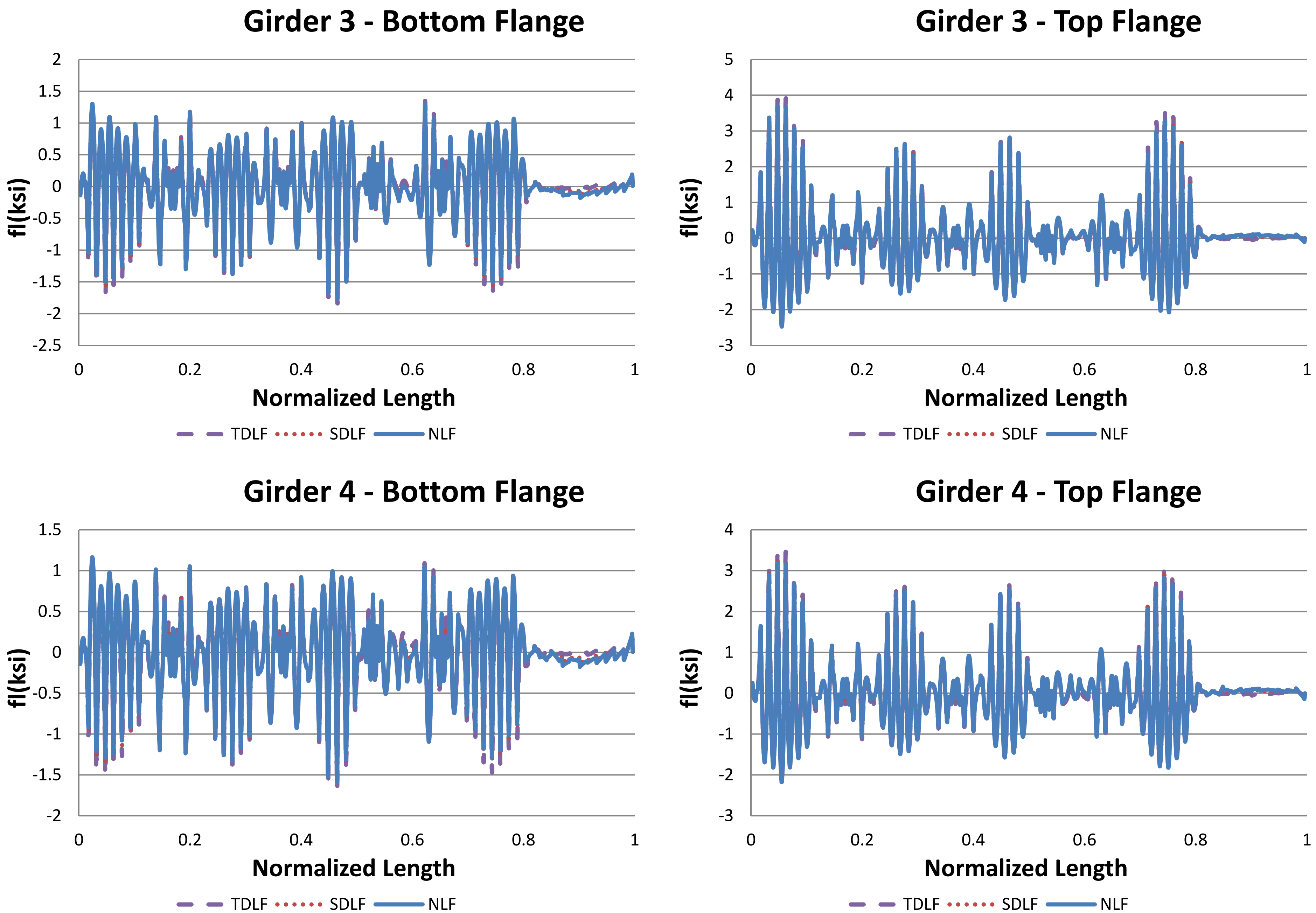
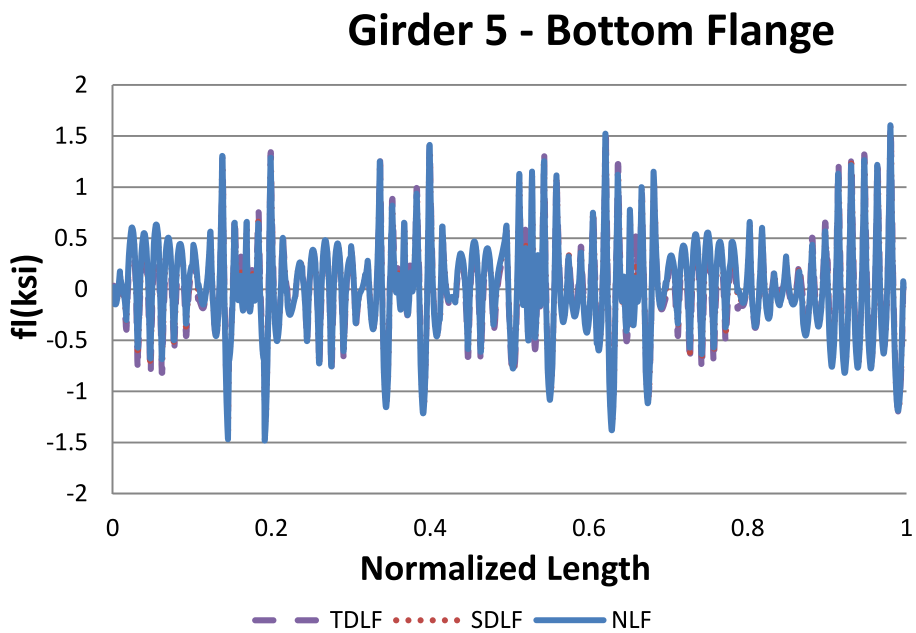


Figure G-4-21(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**



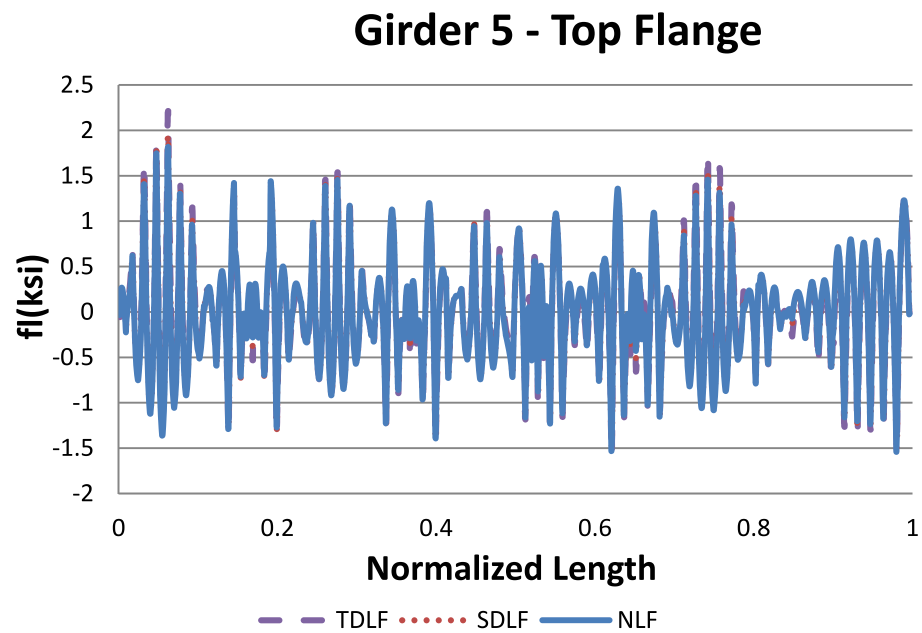


Figure G-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

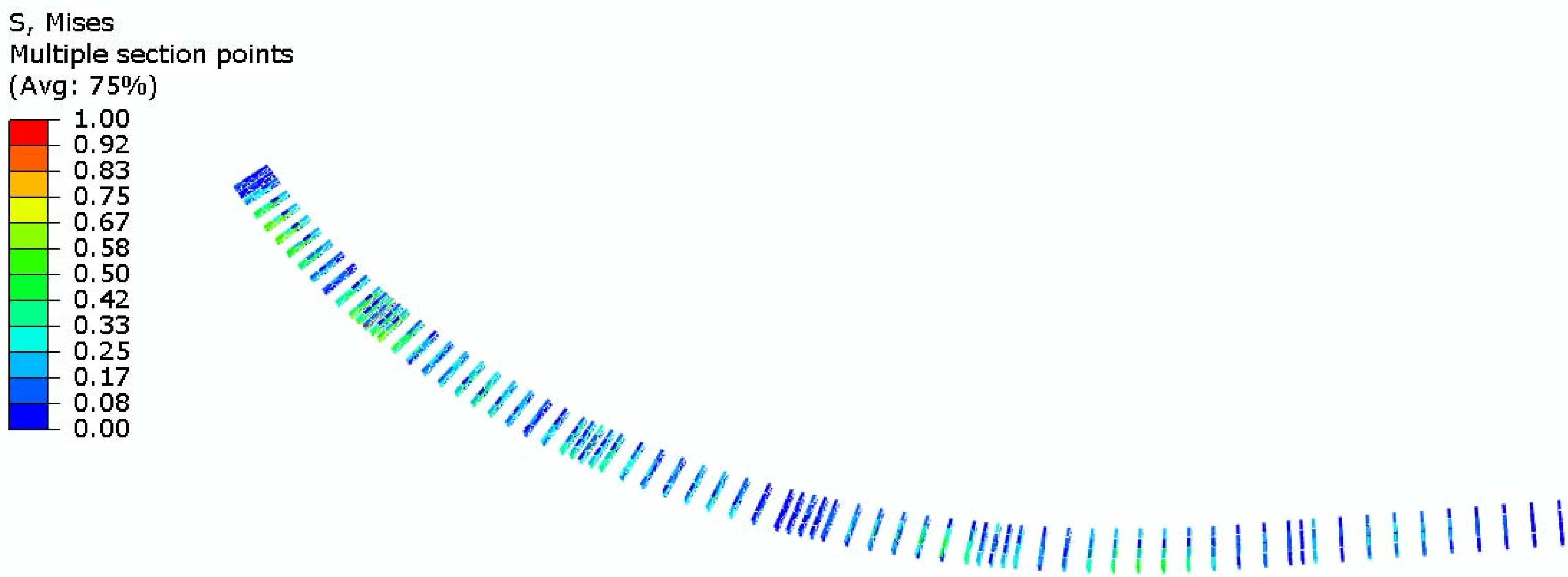


Figure G-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing .

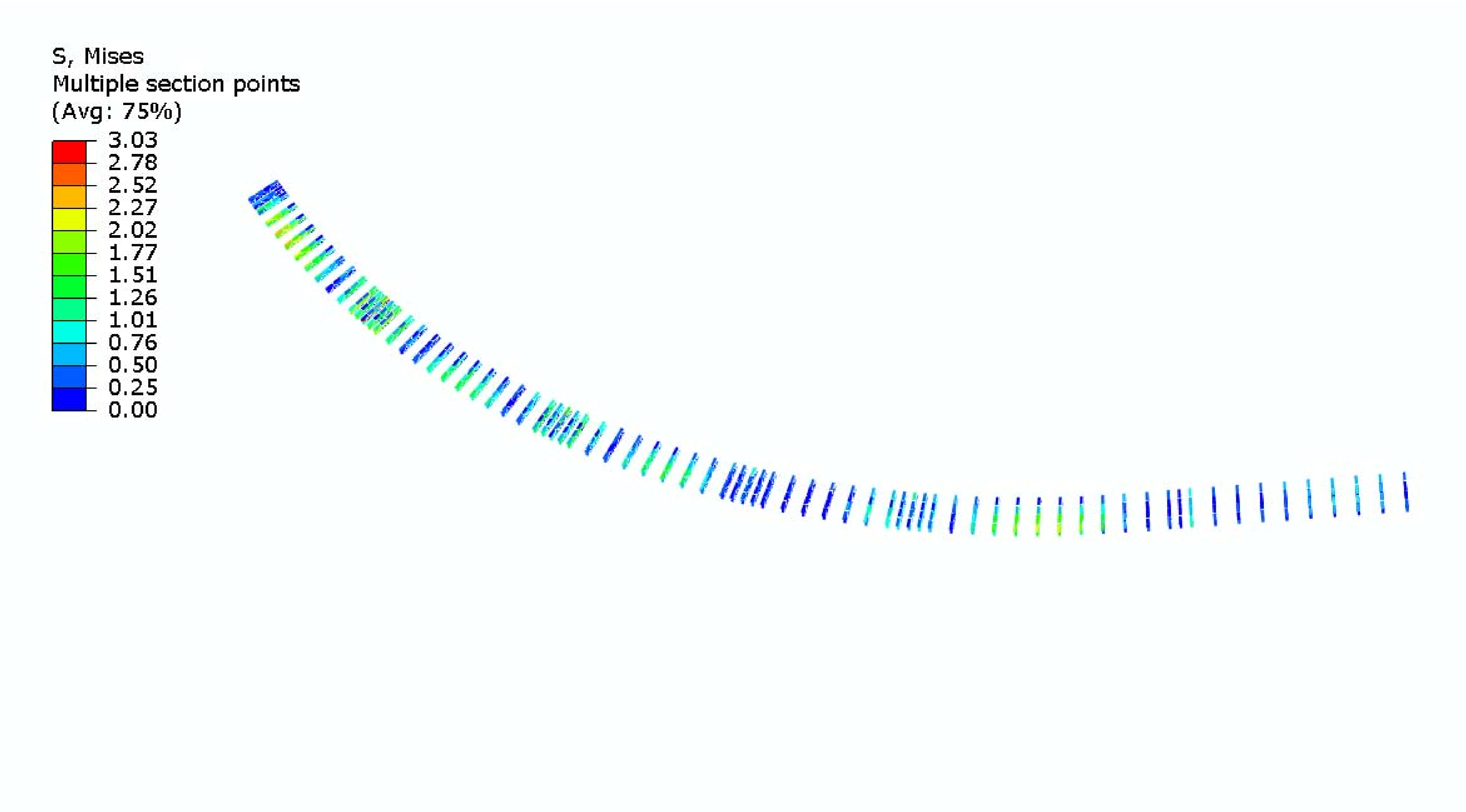


Figure G-4-23. Cross-frame stress contours under TDL, NLF detailing .

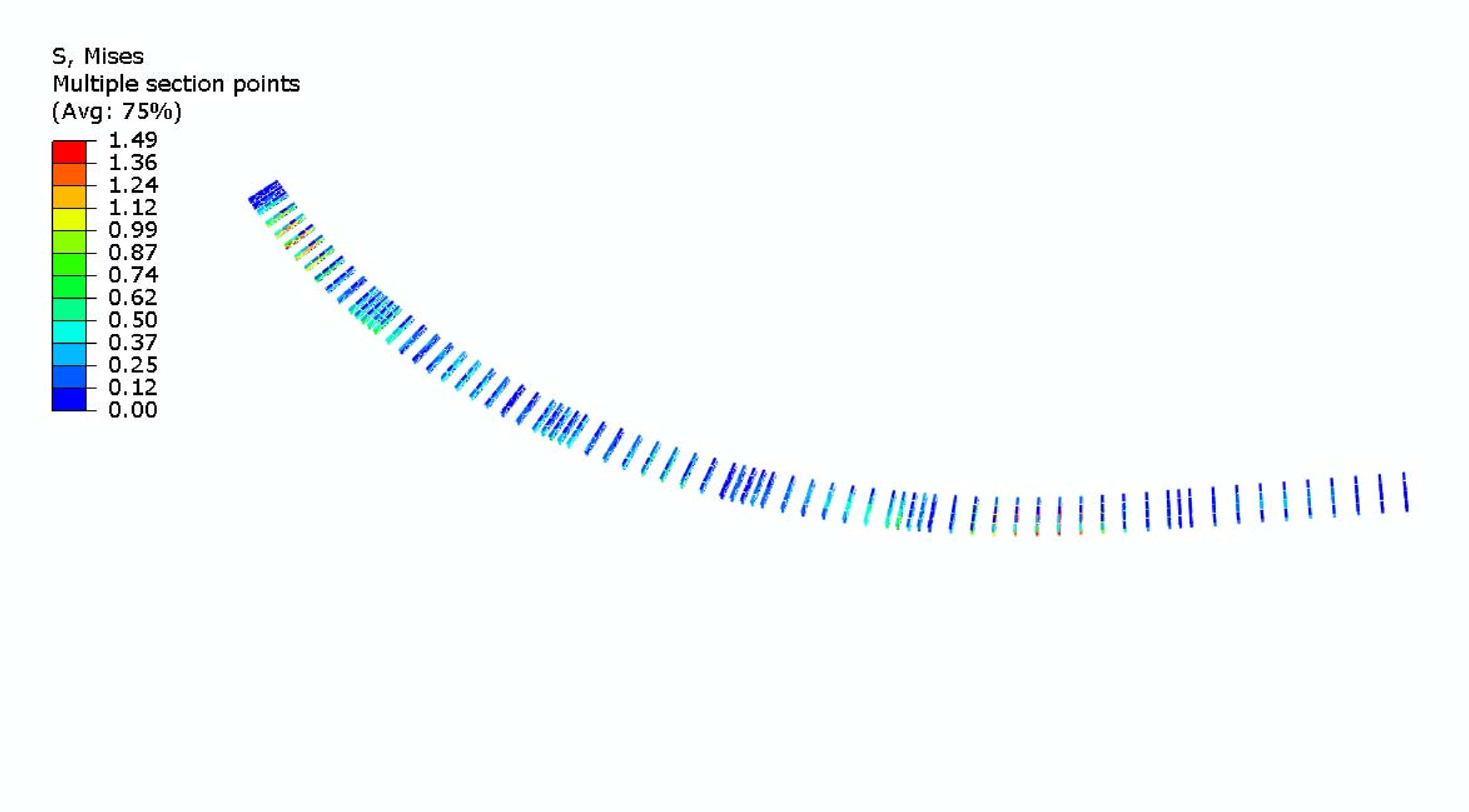


Figure G-4-24. Cross-frame stress contours under SDL, SDLF detailing .

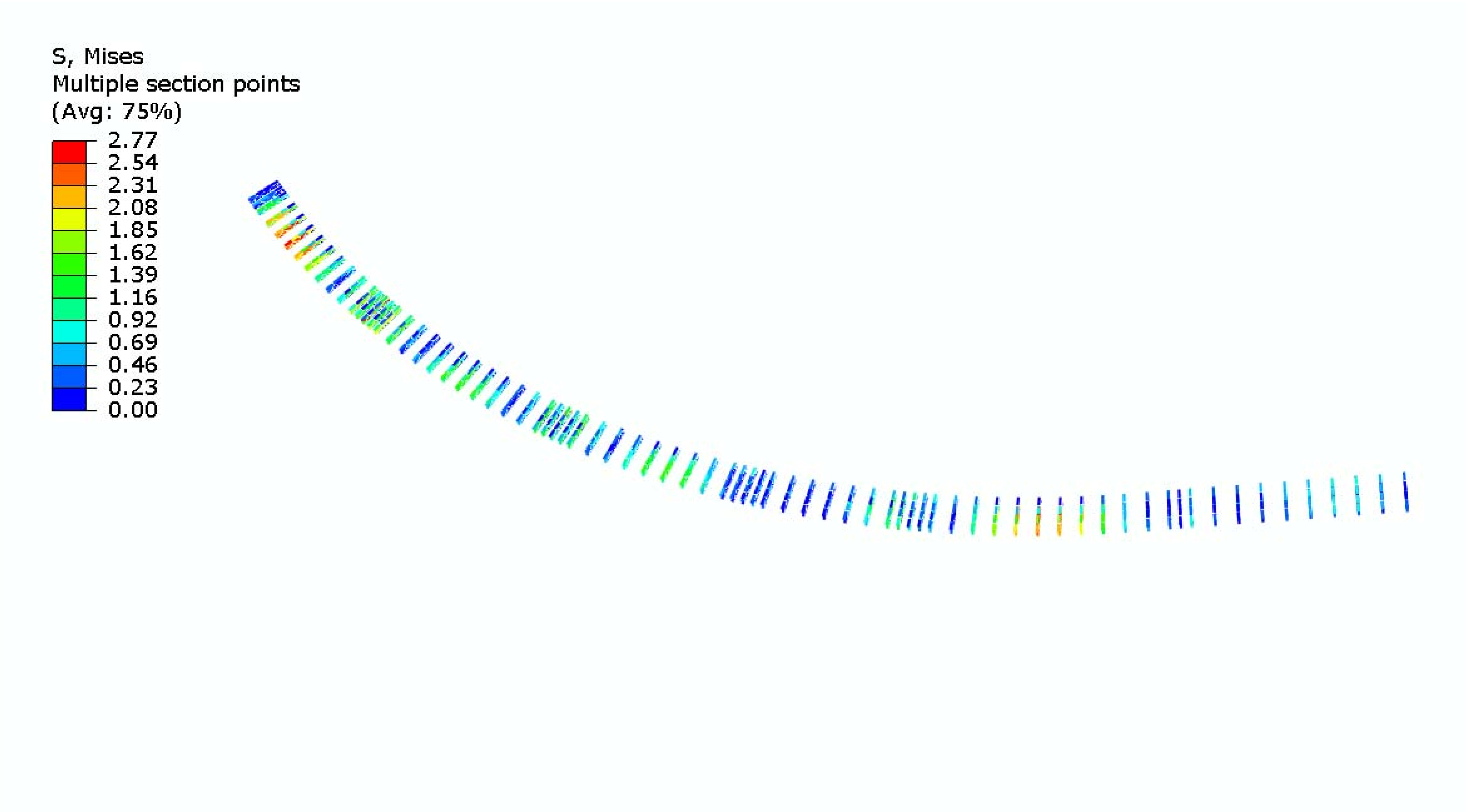


Figure G-4-25. Cross-frame stress contours under TDL, SDLF detailing .

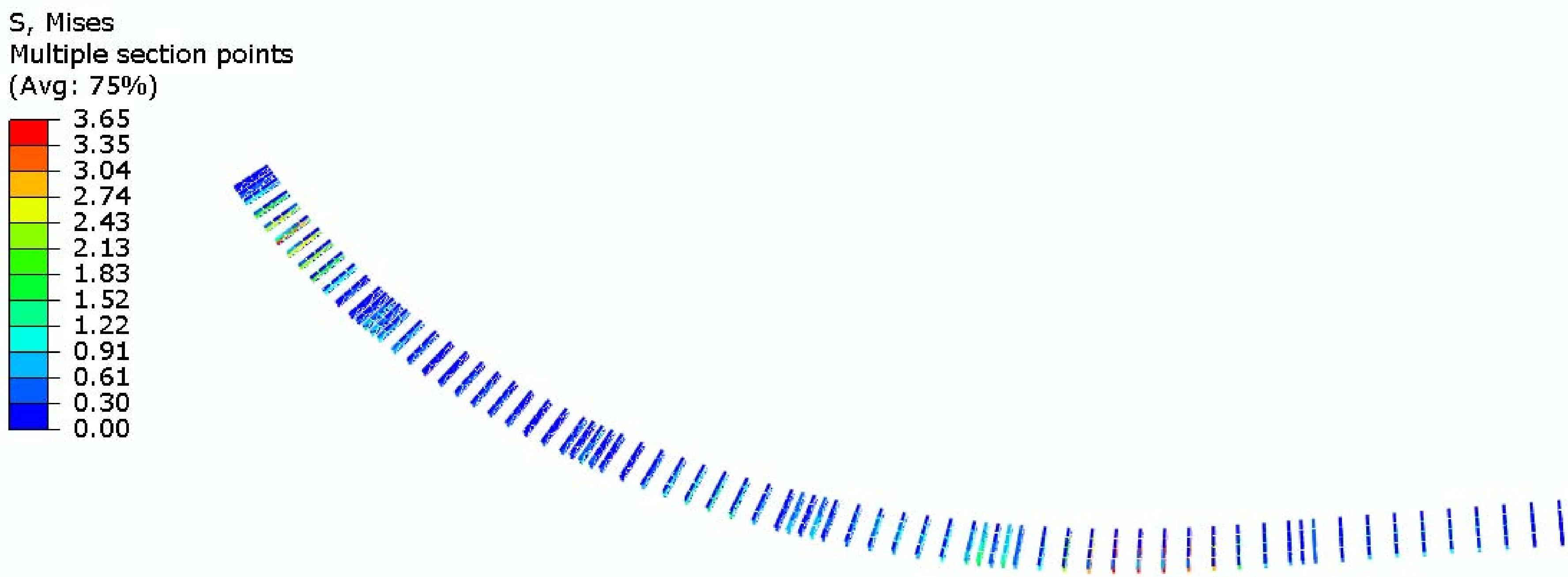


Figure G-4-26. Cross-frame stress contours under SDL, TDLF detailing .

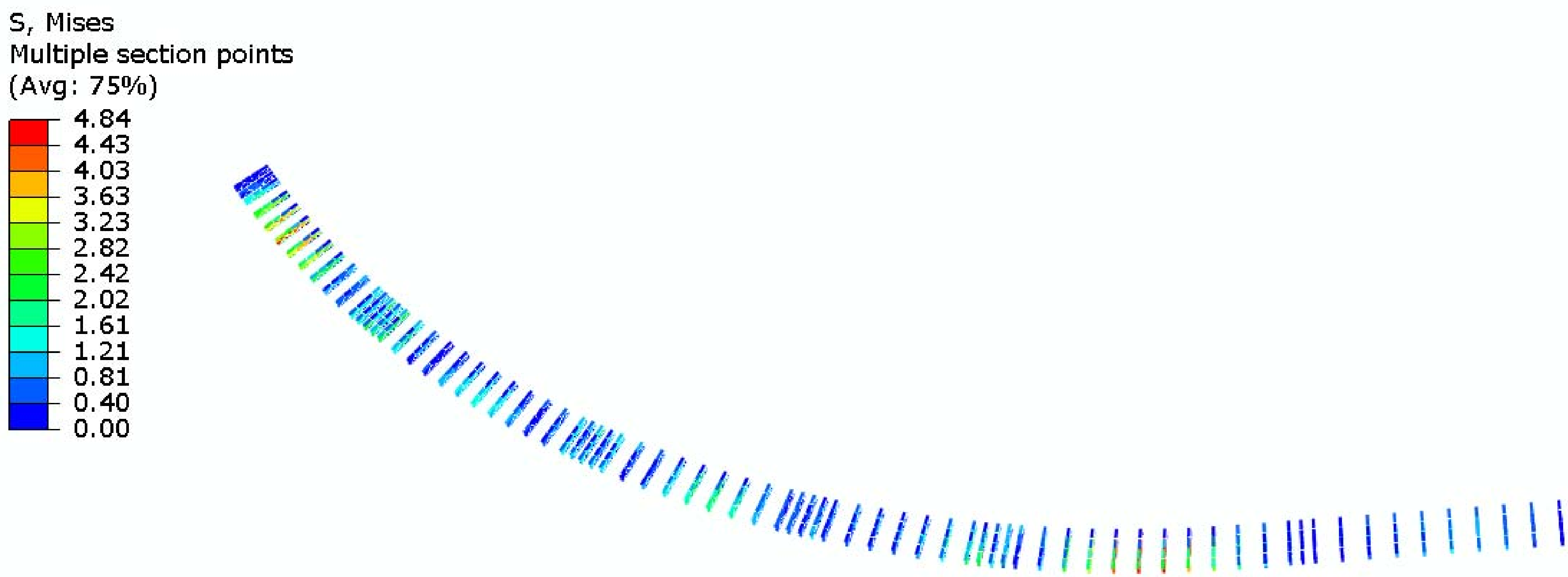


Figure G-4-27. Cross-frame stress contours under TDL, TDLF detailing .

Table G-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
1	NLF	0.9	0.7	0.7	0.6
	SDLF	0.1	0.1	0.1	0.1
	TDLF	1.5	1.4	1.2	1.1
2	NLF	0.3	0.5	0.6	0.1
	SDLF	0.8	1.5	1.4	0.9
	TDLF	3.5	3.9	3.3	2.4
3	NLF	1.2	2.3	2.1	1.1
	SDLF	3.1	3.9	3.6	2.7
	TDLF	8.4	7.9	6.9	5.6
4	NLF	3.3	4.0	3.7	2.2
	SDLF	6.4	7.1	6.6	5.2
	TDLF	14.6	14.3	13.1	11.2
5	NLF	4.5	4.8	4.3	2.6
	SDLF	8.8	9.3	8.8	7.0
	TDLF	18.4	19.2	18.3	16.2
6	NLF	4.3	4.8	4.2	2.5
	SDLF	10.5	10.6	9.9	8.1
	TDLF	25.2	24.0	22.8	20.7
7	NLF	3.9	4.3	3.7	2.1
	SDLF	8.3	8.9	8.3	6.6
	TDLF	19.2	19.6	18.9	16.7
8	NLF	3.1	3.4	3.0	1.5
	SDLF	7.4	7.6	7.1	5.8
	TDLF	17.6	17.1	16.1	14.6
9	NLF	1.8	1.8	1.4	0.6
	SDLF	5.4	5.3	4.9	4.2
	TDLF	13.6	12.8	12.1	11.6
10	NLF	0.6	0.5	0.8	0.5
	SDLF	2.7	2.1	2.1	2.3
	TDLF	8.1	7.9	8.0	7.4

Table G-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
11	NLF	2.2	3.2	2.9	2.3
	SDLF	1.3	1.5	1.0	0.7
	TDLF	1.5	2.7	3.1	2.0
12	NLF	4.5	4.3	3.8	3.6
	SDLF	4.4	3.5	2.9	3.1
	TDLF	3.7	1.5	0.9	2.5
13	NLF	4.2	3.3	3.1	2.8
	SDLF	4.8	3.4	2.8	2.8
	TDLF	6.4	4.1	2.9	3.6
14	NLF	7.3	5.8	5.5	6.5
	SDLF	5.2	3.6	3.4	4.4
	TDLF	9.3	7.7	7.3	8.5
15	NLF	4.2	3.3	3.2	2.9
	SDLF	5.1	3.8	3.4	3.2
	TDLF	7.1	5.0	3.9	4.4
16	NLF	4.6	4.3	4.1	3.6
	SDLF	5.6	4.7	4.3	4.2
	TDLF	7.8	5.6	5.0	6.4
17	NLF	2.4	3.5	3.4	2.6
	SDLF	3.7	3.9	3.6	3.1
	TDLF	6.1	4.9	4.5	5.5
18	NLF	0.3	1.1	1.3	1.0
	SDLF	0.6	1.7	1.6	1.2
	TDLF	2.6	3.2	3.1	3.1
19	NLF	1.6	0.9	0.4	0.1
	SDLF	1.2	0.5	0.2	0.1
	TDLF	0.2	0.9	1.4	1.4
20	NLF	2.4	2.4	1.8	0.8
	SDLF	2.5	2.4	1.8	0.9
	TDLF	2.3	1.7	0.9	0.0

Table G-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
21	NLF	2.9	3.1	2.6	1.3
	SDLF	3.3	3.5	2.9	1.6
	TDLF	3.7	3.5	2.7	1.2
22	NLF	3.0	3.3	2.8	1.4
	SDLF	3.6	3.8	3.3	2.0
	TDLF	4.3	4.2	3.5	1.9
23	NLF	2.8	2.9	2.4	1.2
	SDLF	3.3	3.5	3.0	1.8
	TDLF	4.1	4.0	3.1	1.8
24	NLF	1.8	2.0	1.5	0.6
	SDLF	2.4	2.4	1.9	1.2
	TDLF	3.2	2.3	1.7	1.1
25	NLF	1.1	0.4	0.1	0.2
	SDLF	1.1	0.6	0.5	0.4
	TDLF	1.0	0.3	0.2	0.1
26	NLF	0.9	1.9	1.8	1.4
	SDLF	1.3	1.7	1.4	1.3
	TDLF	2.3	1.5	1.4	2.5
27	NLF	2.9	3.0	2.8	2.5
	SDLF	3.3	3.0	2.7	2.9
	TDLF	4.0	2.9	2.7	4.6
28	NLF	2.8	2.3	2.1	2.0
	SDLF	3.2	2.5	2.3	2.5
	TDLF	3.7	3.3	3.3	4.5
29	NLF	5.5	4.4	4.3	5.1
	SDLF	3.8	2.7	2.6	3.5
	TDLF	7.4	6.2	5.9	7.2
30	NLF	2.9	2.2	2.3	2.3
	SDLF	3.1	2.3	2.3	2.6
	TDLF	2.7	2.1	2.0	3.5

Table G-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
31	NLF	3.1	2.9	3.1	3.0
	SDLF	3.3	2.7	2.7	2.9
	TDLF	3.0	1.8	1.6	3.0
32	NLF	0.8	1.9	2.1	1.9
	SDLF	0.8	1.3	1.3	1.2
	TDLF	0.4	0.9	0.9	0.2
33	NLF	1.3	0.1	0.4	0.5
	SDLF	1.9	1.0	0.7	0.7
	TDLF	4.8	4.0	3.7	3.5
34	NLF	2.0	1.6	1.1	0.3
	SDLF	3.3	2.9	2.4	1.8
	TDLF	8.2	7.1	6.5	5.8
35	NLF	2.3	2.5	2.0	0.9
	SDLF	4.1	4.2	3.7	2.6
	TDLF	10.1	9.5	8.6	7.3
36	NLF	2.3	2.6	2.2	1.1
	SDLF	4.2	4.5	4.0	3.0
	TDLF	10.5	10.2	9.2	7.8
37	NLF	2.0	2.1	1.8	0.9
	SDLF	3.7	3.9	3.5	2.7
	TDLF	9.3	9.0	8.1	7.0
38	NLF	1.2	1.1	0.8	0.2
	SDLF	2.4	2.4	2.2	1.7
	TDLF	6.5	6.2	5.7	4.7
39	NLF	0.0	0.1	0.3	0.5
	SDLF	0.8	0.9	0.8	0.5
	TDLF	3.7	3.4	3.4	2.4
40	NLF	0.8	0.6	0.6	0.7
	SDLF	2.4	1.6	1.4	1.3
	TDLF	6.6	6.0	5.1	3.9

Table G-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
41	NLF	2.1	1.8	1.8	2.1
	SDLF	1.2	0.9	0.9	1.2
	TDLF	3.4	3.1	3.1	3.6
42	NLF	0.7	0.6	0.8	0.8
	SDLF	2.7	2.4	2.2	2.2
	TDLF	7.6	7.1	6.0	5.9
43	NLF	0.4	0.6	0.9	0.9
	SDLF	1.6	1.6	1.7	1.7
	TDLF	4.0	3.9	4.0	4.5
44	NLF	0.6	0.3	0.7	0.8
	SDLF	1.1	1.7	2.0	2.1
	TDLF	4.6	4.9	5.5	6.1
45	NLF	1.0	0.2	0.4	0.7
	SDLF	1.0	1.7	2.2	2.3
	TDLF	5.3	6.3	7.2	7.3
46	NLF	0.7	0.1	0.5	0.8
	SDLF	1.3	2.1	2.7	2.7
	TDLF	5.7	7.5	8.4	8.2
47	NLF	0.6	0.8	1.3	1.1
	SDLF	1.8	3.0	3.2	2.9
	TDLF	6.9	8.1	8.3	8.1
48	NLF	0.5	2.4	2.4	1.9
	SDLF	3.0	3.9	3.7	3.2
	TDLF	8.4	7.6	7.1	7.4
49	NLF	2.5	2.8	2.7	2.3
	SDLF	4.8	4.3	3.9	3.7
	TDLF	9.9	7.9	7.1	7.5
50	NLF	2.3	1.8	1.8	1.6
	SDLF	5.7	4.9	4.3	4.0
	TDLF	13.3	12.0	9.9	9.6

Table G-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
51	NLF	4.8	3.7	3.6	4.0
	SDLF	3.2	2.3	2.1	2.6
	TDLF	6.3	5.4	5.0	5.6
52	NLF	2.3	1.8	1.6	1.5
	SDLF	5.4	3.8	3.2	2.8
	TDLF	12.6	9.9	8.6	6.8
53	NLF	1.8	2.3	2.1	1.9
	SDLF	2.1	1.6	1.0	1.1
	TDLF	4.6	5.2	5.6	4.1
54	NLF	0.5	1.0	1.0	0.8
	SDLF	2.4	1.8	2.2	2.1
	TDLF	7.9	8.8	9.3	8.1
55	NLF	1.7	1.6	1.1	0.4
	SDLF	5.6	5.4	5.2	4.6
	TDLF	15.8	14.9	14.4	13.5
56	NLF	2.8	3.2	2.6	1.3
	SDLF	8.0	8.3	7.7	6.5
	TDLF	21.3	20.7	19.6	18.1
57	NLF	3.8	4.0	3.5	1.9
	SDLF	9.7	10.0	9.5	7.8
	TDLF	24.7	24.8	23.8	21.6
58	NLF	4.1	4.4	3.9	2.2
	SDLF	10.5	10.9	10.3	8.5
	TDLF	26.6	26.4	25.7	23.4
59	NLF	3.9	4.2	3.7	2.1
	SDLF	10.2	10.6	10.1	8.4
	TDLF	26.3	26.2	25.4	23.1
60	NLF	3.3	3.5	3.1	1.7
	SDLF	9.1	9.5	9.0	7.5
	TDLF	24.0	24.0	22.8	20.7

Table G-4-1(Continued). **Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.**

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
61	NLF	1.7	2.5	1.9	0.8
	SDLF	7.0	7.5	6.9	5.8
	TDLF	20.2	19.5	18.3	16.7
62	NLF	0.9	0.6	0.2	0.5
	SDLF	4.4	4.5	4.2	3.6
	TDLF	13.3	13.7	13.3	12.1
63	NLF	1.0	0.1	0.4	0.6
	SDLF	2.6	2.3	2.4	2.2
	TDLF	7.3	8.1	8.5	7.8
64	NLF	0.3	0.3	0.2	0.4
	SDLF	1.3	1.3	1.2	1.1
	TDLF	4.4	3.6	4.1	4.0
65	NLF	0.5	0.4	0.2	0.1
	SDLF	0.4	0.6	0.6	0.7
	TDLF	3.0	2.0	2.2	2.2
66	NLF	2.0	1.9	1.8	1.7
	SDLF	0.2	0.1	0.1	0.1
	TDLF	4.2	3.9	3.7	3.8
67	NLF	0.1	0.6	0.1	0.4
	SDLF	1.0	1.0	1.3	1.3
	TDLF	3.1	4.6	4.2	4.4
68	NLF	1.2	0.1	0.5	0.8
	SDLF	1.4	2.0	2.3	2.5
	TDLF	6.8	6.8	7.0	7.5
69	NLF	1.3	0.1	0.6	0.8
	SDLF	1.7	2.7	3.1	3.3
	TDLF	8.2	9.1	9.5	9.9
10	NLF	1.1	0.2	0.5	0.8
	SDLF	1.9	2.8	3.4	3.6
	TDLF	8.7	10.0	10.7	10.9

Table G-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
71	NLF	0.7	0.2	0.3	0.6
	SDLF	2.0	2.6	3.1	3.5
	TDLF	8.4	9.5	10.3	10.7
72	NLF	0.5	0.2	0.2	0.5
	SDLF	1.8	2.2	2.6	2.9
	TDLF	7.2	7.9	8.7	9.2
73	NLF	0.4	0.1	0.1	0.4
	SDLF	1.3	1.6	1.8	2.1
	TDLF	5.0	5.6	6.4	6.9
74	NLF	0.3	0.1	0.1	0.3
	SDLF	0.7	0.9	1.0	1.1
	TDLF	2.3	3.0	3.4	4.0
75	NLF	0.4	0.4	0.4	0.4
	SDLF	0.0	0.0	0.0	0.0
	TDLF	1.1	1.1	1.2	1.2

Table G-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
1	NLF	3.5	2.5	2.1	1.7
	SDLF	2.8	1.9	1.5	1.3
	TDLF	1.2	0.4	0.2	0.5
2	NLF	1.2	1.7	1.9	0.6
	SDLF	0.1	2.7	2.8	1.4
	TDLF	2.6	5.0	4.6	2.9
3	NLF	3.3	7.4	7.0	4.5
	SDLF	5.1	9.0	8.5	6.1
	TDLF	10.1	12.9	11.7	8.9
4	NLF	9.8	12.9	12.5	8.6
	SDLF	12.8	15.9	15.4	11.6
	TDLF	20.4	23.0	21.6	17.4
5	NLF	13.4	15.0	14.7	10.4
	SDLF	17.7	19.5	19.1	14.8
	TDLF	27.2	29.4	28.6	24.0
6	NLF	12.8	15.0	14.1	10.0
	SDLF	18.3	20.2	19.3	15.1
	TDLF	33.0	33.6	32.2	27.7
7	NLF	11.3	13.2	12.4	8.6
	SDLF	15.5	17.7	17.0	13.1
	TDLF	25.5	28.0	27.1	22.7
8	NLF	8.8	10.4	10.2	6.7
	SDLF	13.1	14.6	14.3	11.0
	TDLF	22.5	23.7	22.9	19.8
9	NLF	4.2	5.2	4.6	3.6
	SDLF	7.8	8.6	8.1	7.2
	TDLF	16.0	16.1	15.4	14.6
10	NLF	0.8	2.3	2.9	0.5
	SDLF	2.9	0.3	0.0	2.3
	TDLF	8.3	6.2	5.9	7.4

Table G-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location			
		G1-G2	G2-G3	G3-G4	G4-G5
11	NLF	7.5	11.0	10.4	7.6
	SDLF	6.6	9.2	8.5	6.0
	TDLF	3.8	5.0	4.4	3.3
12	NLF	14.1	13.9	13.3	12.4
	SDLF	14.0	13.1	12.4	11.9
	TDLF	13.2	11.1	10.4	11.3
13	NLF	12.8	10.4	10.2	9.4
	SDLF	13.0	9.8	9.3	9.0
	TDLF	14.6	10.5	9.4	9.8
14	NLF	21.7	17.7	17.6	22.1
	SDLF	19.5	15.6	15.4	20.0
	TDLF	15.3	11.4	11.0	15.7
15	NLF	12.8	10.5	10.4	9.5
	SDLF	13.7	11.0	10.6	9.8
	TDLF	15.7	12.1	11.1	10.9
16	NLF	14.2	14.1	14.0	12.6
	SDLF	15.1	14.3	14.1	13.2
	TDLF	17.2	15.2	14.8	15.3
17	NLF	8.2	11.9	11.7	8.3
	SDLF	9.3	12.2	11.9	8.8
	TDLF	11.7	13.1	12.8	11.2
18	NLF	0.1	4.1	4.4	1.9
	SDLF	1.0	4.6	4.7	2.2
	TDLF	2.9	6.1	6.2	4.1
19	NLF	3.5	2.7	2.0	1.8
	SDLF	3.2	2.3	1.8	1.8
	TDLF	2.2	0.8	0.2	0.5
20	NLF	6.5	7.5	6.8	4.7
	SDLF	6.6	7.4	6.8	4.9
	TDLF	6.2	6.6	5.7	3.9

Table G-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5
21	NLF	8.1	9.8	9.3	6.4
	SDLF	8.5	10.2	9.6	6.7
	TDLF	8.5	10.0	9.2	6.2
22	NLF	8.6	10.3	9.9	6.8
	SDLF	9.1	10.9	10.4	7.4
	TDLF	9.4	11.0	10.4	7.2
23	NLF	7.7	9.0	8.6	6.0
	SDLF	8.3	9.6	9.2	6.7
	TDLF	8.7	9.9	9.1	6.5
24	NLF	4.4	6.0	5.2	3.7
	SDLF	5.0	6.3	5.7	4.3
	TDLF	5.7	6.3	5.4	4.2
25	NLF	2.4	0.8	0.1	0.4
	SDLF	2.4	1.0	0.4	1.0
	TDLF	2.3	0.7	0.1	0.7
26	NLF	3.7	6.9	6.9	4.8
	SDLF	4.1	6.7	6.5	4.7
	TDLF	5.0	6.5	6.5	5.9
27	NLF	9.7	10.3	10.4	9.6
	SDLF	10.1	10.3	10.3	10.0
	TDLF	10.8	10.2	10.3	11.7
28	NLF	9.1	7.5	7.5	6.9
	SDLF	9.1	7.1	7.2	7.1
	TDLF	9.6	7.9	8.1	9.1
29	NLF	17.1	14.4	14.5	18.4
	SDLF	15.4	12.7	12.9	16.9
	TDLF	11.6	9.0	9.0	13.2
30	NLF	9.4	7.2	8.0	7.8
	SDLF	9.6	7.4	8.0	8.1
	TDLF	9.3	7.2	7.7	9.0

Table G-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
31	NLF	10.1	10.1	11.1	10.9
	SDLF	10.1	9.8	10.6	10.6
	TDLF	9.8	8.7	9.5	10.6
32	NLF	3.1	6.6	7.6	5.7
	SDLF	3.1	6.1	6.8	5.0
	TDLF	2.0	3.9	4.6	3.8
33	NLF	3.2	0.1	0.9	0.2
	SDLF	3.8	0.9	0.3	1.4
	TDLF	6.6	3.9	3.3	4.3
34	NLF	5.1	5.3	4.7	3.5
	SDLF	6.5	6.6	6.1	5.1
	TDLF	11.1	10.7	10.0	9.0
35	NLF	6.1	8.3	8.2	5.8
	SDLF	7.9	10.0	9.8	7.6
	TDLF	13.4	15.1	14.5	12.2
36	NLF	6.2	8.8	8.9	6.4
	SDLF	8.1	10.6	10.7	8.3
	TDLF	13.9	16.1	15.7	13.1
37	NLF	5.3	7.1	7.1	5.2
	SDLF	7.0	8.8	8.8	7.0
	TDLF	12.5	13.9	13.4	11.4
38	NLF	3.0	3.6	2.8	1.9
	SDLF	4.2	4.9	4.2	3.4
	TDLF	8.4	8.8	7.8	6.4
39	NLF	0.2	0.3	1.6	2.0
	SDLF	0.8	0.8	0.9	1.4
	TDLF	3.6	3.4	2.2	1.0
40	NLF	2.9	2.0	2.7	2.8
	SDLF	4.5	3.0	3.3	3.4
	TDLF	8.3	5.6	5.3	5.3

Table G-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
41	NLF	6.7	6.3	6.8	9.1
	SDLF	5.8	5.5	5.9	8.2
	TDLF	3.5	3.3	3.6	5.9
42	NLF	2.6	2.1	3.0	3.0
	SDLF	4.6	3.9	4.5	4.3
	TDLF	9.5	8.6	8.3	8.1
43	NLF	1.7	2.3	3.6	3.5
	SDLF	2.6	3.1	4.3	4.2
	TDLF	5.0	5.4	6.6	6.9
44	NLF	0.8	1.2	2.4	1.8
	SDLF	1.0	2.6	3.6	3.0
	TDLF	4.5	5.8	7.2	7.1
45	NLF	1.7	0.4	0.5	0.1
	SDLF	0.5	1.6	2.3	1.7
	TDLF	4.9	6.2	7.3	6.8
46	NLF	0.9	0.1	0.8	0.2
	SDLF	1.2	2.3	2.9	2.2
	TDLF	5.7	7.7	8.7	7.7
47	NLF	0.7	3.0	3.8	1.7
	SDLF	1.8	5.2	5.6	3.4
	TDLF	7.0	10.4	10.7	8.7
48	NLF	2.0	7.9	8.1	5.4
	SDLF	4.5	9.4	9.3	6.7
	TDLF	9.8	13.0	12.8	10.9
49	NLF	7.6	9.2	9.4	8.2
	SDLF	9.7	10.5	10.4	9.3
	TDLF	14.8	14.1	13.6	13.2
50	NLF	7.2	5.8	6.1	5.5
	SDLF	10.5	8.9	8.6	7.8
	TDLF	18.1	16.0	14.3	13.4

Table G-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
51	NLF	14.5	11.8	11.9	14.7
	SDLF	12.9	10.4	10.4	13.2
	TDLF	9.5	7.3	7.0	9.9
52	NLF	7.0	5.6	5.7	5.1
	SDLF	9.9	7.3	6.9	6.2
	TDLF	17.1	12.3	10.8	9.7
53	NLF	5.5	7.4	7.3	6.7
	SDLF	5.8	6.7	6.3	5.9
	TDLF	5.9	4.8	3.9	4.7
54	NLF	1.3	3.3	3.3	2.1
	SDLF	3.3	0.7	0.3	1.0
	TDLF	8.8	6.5	7.0	7.0
55	NLF	4.2	4.9	3.9	3.1
	SDLF	8.1	8.8	8.0	7.2
	TDLF	18.3	18.2	17.3	16.2
56	NLF	7.8	10.0	9.1	6.2
	SDLF	12.9	15.0	14.1	11.4
	TDLF	25.9	27.3	26.0	22.9
57	NLF	11.0	12.5	12.0	8.2
	SDLF	16.8	18.5	17.9	14.2
	TDLF	31.0	32.8	31.8	27.6
58	NLF	12.1	13.9	13.1	9.0
	SDLF	18.3	20.2	19.5	15.4
	TDLF	33.5	35.3	34.4	29.9
59	NLF	11.3	13.0	12.5	8.8
	SDLF	17.5	19.3	18.9	15.1
	TDLF	32.6	34.5	33.7	29.4
60	NLF	9.0	10.6	10.5	7.5
	SDLF	14.7	16.6	16.3	13.3
	TDLF	28.9	30.8	29.9	26.2

Table G-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
61	NLF	3.6	7.1	6.3	4.3
	SDLF	8.8	12.1	11.3	9.3
	TDLF	21.9	24.1	22.7	20.2
62	NLF	1.5	1.3	0.4	0.4
	SDLF	5.0	5.1	4.5	3.8
	TDLF	13.9	14.4	13.6	12.3
63	NLF	3.0	0.5	1.7	1.6
	SDLF	4.6	2.1	1.2	1.3
	TDLF	9.3	7.9	7.3	7.0
64	NLF	1.3	1.2	1.1	1.7
	SDLF	2.4	2.2	0.5	0.3
	TDLF	5.5	4.5	3.4	2.9
65	NLF	1.5	1.4	0.7	0.3
	SDLF	0.5	1.5	0.5	0.7
	TDLF	2.0	2.4	1.7	2.0
66	NLF	8.0	6.3	5.7	7.3
	SDLF	6.2	4.5	4.0	5.7
	TDLF	2.2	0.5	0.4	2.1
67	NLF	1.2	2.1	0.9	2.0
	SDLF	0.2	0.6	2.0	2.9
	TDLF	2.0	3.0	4.9	6.0
68	NLF	3.6	0.2	1.9	1.7
	SDLF	1.1	2.1	3.8	3.4
	TDLF	4.6	6.9	8.4	8.4
69	NLF	3.0	0.2	1.6	1.1
	SDLF	0.1	3.0	4.1	3.5
	TDLF	6.6	9.4	10.6	10.1
70	NLF	1.2	0.3	0.8	0.3
	SDLF	2.0	3.3	3.7	3.1
	TDLF	8.8	10.4	11.0	10.4

Table G-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location			
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**
71	NLF	0.4	0.2	0.1	0.5
	SDLF	3.2	3.0	2.9	2.4
	TDLF	9.5	9.9	10.0	9.6
72	NLF	1.1	0.3	0.4	1.0
	SDLF	3.4	2.7	2.1	1.6
	TDLF	8.8	8.4	8.2	7.9
73	NLF	1.0	0.3	0.4	0.9
	SDLF	2.8	2.0	1.5	0.9
	TDLF	6.4	6.1	6.0	5.7
74	NLF	0.3	0.3	0.2	0.3
	SDLF	0.8	0.8	1.1	1.2
	TDLF	2.4	3.0	3.5	4.1
75	NLF	2.3	1.6	1.7	2.6
	SDLF	2.0	1.2	1.3	2.2
	TDLF	1.0	0.2	0.2	1.0

Table G-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
1	NLF	0.5	0.5	0.4	0.4
	SDLF	0.0	0.0	0.0	0.0
	TDLF	1.1	1.0	0.9	0.8
2	NLF	0.7	0.8	0.2	0.1
	SDLF	0.6	0.6	0.0	0.2
	TDLF	0.2	0.3	1.0	0.7
3	NLF	2.2	1.8	0.3	0.5
	SDLF	1.9	1.3	0.0	0.7
	TDLF	0.8	0.5	1.6	1.3
4	NLF	3.7	2.4	0.2	1.1
	SDLF	3.5	2.2	0.0	1.2
	TDLF	2.9	1.1	1.0	1.6
5	NLF	4.1	2.3	0.1	1.4
	SDLF	4.4	2.7	0.1	1.1
	TDLF	4.9	3.4	0.5	0.7
6	NLF	4.1	2.2	0.2	1.5
	SDLF	2.9	1.1	1.3	2.4
	TDLF	0.3	1.2	3.2	4.4
7	NLF	3.6	1.8	0.4	1.3
	SDLF	3.3	1.6	0.6	1.5
	TDLF	2.6	1.6	0.8	1.7
8	NLF	2.8	1.4	0.5	1.2
	SDLF	2.6	1.1	0.6	1.2
	TDLF	2.2	0.6	0.9	1.3
9	NLF	1.2	0.2	0.7	0.8
	SDLF	1.1	0.2	0.6	0.6
	TDLF	0.8	0.4	0.8	0.6
10	NLF	1.0	1.4	0.7	0.0
	SDLF	0.7	0.8	0.3	0.1
	TDLF	0.3	0.3	0.2	0.1

Table G-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
11	NLF	3.0	2.0	0.2	1.0
	SDLF	2.5	1.2	0.1	1.0
	TDLF	1.9	0.6	0.4	0.3
12	NLF	2.9	1.2	0.3	1.5
	SDLF	3.0	1.1	0.0	1.2
	TDLF	3.3	1.5	1.2	0.3
13	NLF	2.6	0.9	0.0	0.9
	SDLF	2.9	0.9	0.1	0.8
	TDLF	3.7	1.3	0.8	0.5
14	NLF	3.3	1.5	0.9	0.5
	SDLF	2.1	0.5	0.1	1.7
	TDLF	0.2	1.4	1.9	4.0
15	NLF	2.7	1.1	0.1	0.8
	SDLF	1.8	0.4	0.2	0.9
	TDLF	0.1	0.6	0.3	0.6
16	NLF	3.2	1.6	0.0	1.4
	SDLF	2.7	1.2	0.0	1.2
	TDLF	1.9	0.9	0.9	0.4
17	NLF	3.7	2.9	0.9	0.8
	SDLF	3.2	2.2	0.6	0.7
	TDLF	2.6	1.6	1.2	0.0
18	NLF	2.3	2.9	1.8	0.5
	SDLF	2.0	2.3	1.3	0.4
	TDLF	1.7	1.9	1.2	0.5
19	NLF	0.6	1.9	2.1	1.3
	SDLF	0.5	1.8	1.8	1.2
	TDLF	0.6	2.0	1.8	1.1
20	NLF	0.8	0.8	1.9	1.7
	SDLF	0.7	1.0	2.0	1.7
	TDLF	0.5	1.3	2.2	1.8

Table G-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
21	NLF	1.6	0.1	1.7	1.8
	SDLF	1.5	0.3	1.9	1.9
	TDLF	1.4	0.6	2.2	2.1
22	NLF	1.9	0.1	1.5	1.8
	SDLF	1.8	0.0	1.7	1.9
	TDLF	1.7	0.2	2.0	2.1
23	NLF	1.6	0.0	1.4	1.6
	SDLF	1.5	0.1	1.5	1.7
	TDLF	1.4	0.3	1.9	1.8
24	NLF	0.9	0.3	1.3	1.2
	SDLF	0.8	0.4	1.3	1.1
	TDLF	0.4	1.0	1.5	1.2
25	NLF	0.5	1.3	1.2	0.6
	SDLF	0.3	0.9	0.8	0.4
	TDLF	0.3	0.7	0.6	0.4
26	NLF	2.0	1.7	0.4	0.5
	SDLF	1.6	1.0	0.2	0.5
	TDLF	1.2	0.6	0.6	0.1
27	NLF	2.1	0.9	0.2	1.2
	SDLF	2.0	0.8	0.0	0.9
	TDLF	2.0	1.1	1.2	0.2
28	NLF	1.8	0.6	0.0	0.7
	SDLF	1.8	0.6	0.1	0.3
	TDLF	1.6	0.7	0.7	0.6
29	NLF	2.4	1.2	0.8	0.3
	SDLF	1.4	0.3	0.0	1.2
	TDLF	0.7	1.4	1.6	3.4
30	NLF	1.9	0.9	0.3	0.5
	SDLF	1.4	0.4	0.1	0.9
	TDLF	1.1	0.1	0.4	1.4

Table G-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
31	NLF	2.3	1.4	0.4	1.0
	SDLF	2.0	1.0	0.2	1.0
	TDLF	1.8	0.8	0.6	0.7
32	NLF	2.3	2.4	1.2	0.3
	SDLF	2.0	1.7	0.7	0.3
	TDLF	1.6	1.1	0.9	0.0
33	NLF	1.1	2.1	1.7	0.7
	SDLF	0.9	1.7	1.3	0.5
	TDLF	0.7	1.3	1.0	0.4
34	NLF	0.4	0.9	1.5	1.1
	SDLF	0.3	1.0	1.5	1.1
	TDLF	0.0	1.3	1.6	1.1
35	NLF	1.4	0.1	1.1	1.2
	SDLF	1.2	0.2	1.4	1.3
	TDLF	0.8	0.7	1.8	1.4
36	NLF	1.7	0.5	0.8	1.2
	SDLF	1.5	0.3	1.0	1.2
	TDLF	1.1	0.3	1.6	1.4
37	NLF	1.4	0.4	0.7	0.9
	SDLF	1.3	0.4	0.7	0.9
	TDLF	1.0	0.2	1.3	1.1
38	NLF	0.6	0.0	0.5	0.5
	SDLF	0.7	0.3	0.3	0.4
	TDLF	0.5	0.3	0.8	0.6
39	NLF	0.1	0.2	0.2	0.1
	SDLF	0.2	0.1	0.1	0.0
	TDLF	1.0	0.9	1.1	0.8
40	NLF	0.4	0.1	0.0	0.2
	SDLF	1.6	0.9	0.7	0.5
	TDLF	5.1	3.5	3.1	2.5

Table G-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
41	NLF	1.1	0.7	0.6	0.3
	SDLF	0.4	0.1	0.0	0.4
	TDLF	1.2	1.4	1.6	2.2
42	NLF	0.5	0.4	0.3	0.1
	SDLF	0.9	0.6	0.6	0.8
	TDLF	4.2	2.7	2.3	2.4
43	NLF	0.9	1.0	0.7	0.0
	SDLF	0.5	0.7	0.4	0.2
	TDLF	0.0	0.6	0.6	0.1
44	NLF	1.3	2.1	1.7	0.6
	SDLF	1.1	1.8	1.5	0.6
	TDLF	1.2	2.2	2.1	1.1
45	NLF	1.3	2.5	2.3	1.1
	SDLF	1.3	2.5	2.2	1.1
	TDLF	1.6	3.1	2.9	1.5
46	NLF	1.5	2.6	2.4	1.2
	SDLF	1.7	2.9	2.5	1.2
	TDLF	2.3	4.1	3.3	1.5
47	NLF	2.4	3.5	2.5	0.9
	SDLF	2.3	3.1	2.2	0.8
	TDLF	2.4	3.2	2.3	1.0
48	NLF	3.4	3.8	2.0	0.2
	SDLF	2.8	2.7	1.4	0.1
	TDLF	1.9	1.4	1.0	0.3
49	NLF	2.8	2.0	0.7	0.6
	SDLF	1.7	0.9	0.0	1.0
	TDLF	0.6	0.9	0.9	1.5
50	NLF	1.8	0.9	0.3	0.4
	SDLF	0.7	0.9	1.1	1.6
	TDLF	6.1	4.6	4.1	4.2

Table G-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
51	NLF	2.3	1.1	0.9	0.1
	SDLF	1.3	0.4	0.1	0.8
	TDLF	0.6	1.3	1.7	2.8
52	NLF	1.6	0.7	0.1	0.4
	SDLF	3.7	2.1	1.4	0.9
	TDLF	9.0	5.7	4.8	4.1
53	NLF	2.0	1.3	0.2	0.7
	SDLF	2.5	1.3	0.6	0.0
	TDLF	4.2	2.4	2.4	1.9
54	NLF	1.5	1.8	0.8	0.0
	SDLF	1.0	0.7	0.2	0.0
	TDLF	0.3	0.4	0.1	0.3
55	NLF	0.8	0.2	0.8	0.7
	SDLF	0.8	0.0	0.6	0.6
	TDLF	0.4	0.6	1.0	0.8
56	NLF	2.4	1.0	0.7	1.2
	SDLF	2.2	0.8	0.7	1.2
	TDLF	1.7	0.1	1.3	1.3
57	NLF	3.2	1.5	0.5	1.3
	SDLF	3.1	1.4	0.7	1.4
	TDLF	2.8	1.3	0.9	1.6
58	NLF	3.7	1.9	0.4	1.4
	SDLF	3.5	1.8	0.5	1.5
	TDLF	3.2	1.8	0.6	1.6
59	NLF	3.6	1.9	0.3	1.3
	SDLF	3.4	1.7	0.5	1.4
	TDLF	3.1	1.8	0.6	1.5
60	NLF	3.0	1.6	0.2	1.0
	SDLF	2.9	1.4	0.5	1.2
	TDLF	2.5	1.0	1.1	1.5

Table G-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
61	NLF	2.0	1.1	0.3	0.7
	SDLF	1.8	0.8	0.6	0.8
	TDLF	1.0	0.5	1.6	1.2
62	NLF	0.0	0.8	1.0	0.5
	SDLF	0.2	0.2	0.6	0.4
	TDLF	0.4	0.1	0.7	0.6
63	NLF	0.9	1.7	1.4	0.5
	SDLF	0.4	0.6	0.5	0.2
	TDLF	0.2	0.7	0.1	0.2
64	NLF	0.1	0.6	0.7	0.2
	SDLF	0.1	0.3	0.3	0.1
	TDLF	0.4	0.5	0.2	0.2
65	NLF	0.3	0.3	0.5	0.4
	SDLF	0.3	0.2	0.2	0.2
	TDLF	0.4	0.3	0.1	0.1
66	NLF	0.9	1.0	1.1	1.1
	SDLF	0.2	0.0	0.1	0.1
	TDLF	2.5	1.9	2.2	2.6
67	NLF	0.2	0.6	0.9	0.5
	SDLF	0.3	0.6	0.6	0.3
	TDLF	0.9	1.2	0.6	0.4
68	NLF	1.0	2.1	1.7	0.6
	SDLF	0.7	1.4	1.2	0.5
	TDLF	0.4	0.9	1.0	0.6
69	NLF	1.1	2.4	1.9	0.7
	SDLF	1.0	1.9	1.6	0.6
	TDLF	0.9	1.7	1.5	0.7
70	NLF	0.9	2.0	1.7	0.7
	SDLF	0.9	1.9	1.7	0.7
	TDLF	2.0	1.1	0.3	0.7

Table G-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
71	NLF	0.6	1.3	1.3	0.5
	SDLF	0.7	1.5	1.5	0.6
	TDLF	0.8	1.8	1.7	0.7
72	NLF	0.4	1.0	1.0	0.4
	SDLF	0.5	1.1	1.1	0.5
	TDLF	0.5	1.5	1.5	0.7
73	NLF	0.3	0.8	0.8	0.3
	SDLF	0.3	0.8	0.8	0.4
	TDLF	0.5	1.4	1.4	0.7
74	NLF	0.2	0.5	0.5	0.2
	SDLF	0.2	0.4	0.4	0.2
	TDLF	0.6	1.3	1.2	0.6
75	NLF	0.4	0.4	0.4	0.4
	SDLF	0.1	0.1	0.1	0.1
	TDLF	0.8	0.8	0.8	0.9

Table G-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
1	NLF	0.8	1.4	1.3	0.7
	SDLF	0.3	0.9	0.9	0.3
	TDLF	0.8	0.0	0.0	0.6
2	NLF	4.5	5.0	2.8	1.5
	SDLF	4.4	4.8	2.7	1.4
	TDLF	4.0	3.9	1.7	0.9
3	NLF	10.8	9.9	5.1	1.7
	SDLF	10.5	9.5	4.8	1.6
	TDLF	9.4	7.7	3.2	0.9
4	NLF	17.3	14.0	6.6	1.2
	SDLF	17.1	13.8	6.4	1.1
	TDLF	16.5	12.7	5.4	0.7
5	NLF	18.3	13.8	6.2	0.3
	SDLF	18.6	14.1	6.4	0.6
	TDLF	19.1	14.9	6.8	1.1
6	NLF	18.3	13.5	5.7	0.2
	SDLF	17.1	12.4	4.7	0.8
	TDLF	14.5	10.1	2.8	2.7
7	NLF	16.4	12.2	5.4	0.7
	SDLF	16.1	12.0	5.1	0.6
	TDLF	15.5	12.0	5.0	0.3
8	NLF	14.2	11.0	5.3	1.3
	SDLF	14.0	10.7	5.1	1.3
	TDLF	13.6	10.2	4.8	1.2
9	NLF	8.8	7.2	4.6	2.7
	SDLF	8.7	7.1	4.7	2.8
	TDLF	8.3	6.6	4.5	2.9
10	NLF	1.3	1.0	3.8	5.2
	SDLF	1.6	1.6	4.3	5.3
	TDLF	2.0	2.2	4.4	5.1

Table G-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
11	NLF	5.7	2.5	3.9	7.9
	SDLF	5.2	1.7	4.2	7.9
	TDLF	4.6	1.0	3.7	7.3
12	NLF	7.0	2.0	3.2	8.2
	SDLF	7.0	1.8	2.9	7.9
	TDLF	7.3	2.3	1.7	7.0
13	NLF	6.9	2.0	1.2	4.5
	SDLF	7.2	2.0	1.1	4.4
	TDLF	8.1	2.4	0.4	4.1
14	NLF	9.0	4.1	2.1	3.5
	SDLF	7.8	3.1	1.2	4.6
	TDLF	5.5	1.2	0.6	7.0
15	NLF	7.3	2.5	0.8	4.4
	SDLF	6.4	1.9	1.1	4.4
	TDLF	4.6	0.9	1.2	4.2
16	NLF	7.8	3.2	2.3	8.0
	SDLF	7.3	2.7	2.3	7.8
	TDLF	6.5	2.4	1.5	6.9
17	NLF	7.8	5.0	1.9	7.2
	SDLF	7.3	4.3	2.2	7.1
	TDLF	6.7	3.7	1.7	6.4
18	NLF	2.2	3.0	0.8	3.8
	SDLF	1.9	2.4	1.3	3.9
	TDLF	1.6	2.0	1.4	3.8
19	NLF	3.7	1.3	0.7	1.3
	SDLF	3.8	1.4	1.0	1.4
	TDLF	3.6	1.2	1.0	1.4
20	NLF	8.5	4.9	1.3	0.0
	SDLF	8.4	4.7	1.2	0.1
	TDLF	8.1	4.4	1.0	0.2

Table G-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
21	NLF	10.9	7.0	1.9	0.6
	SDLF	10.8	6.8	1.6	0.7
	TDLF	10.7	6.6	1.4	0.9
22	NLF	11.6	7.7	2.3	0.6
	SDLF	11.5	7.5	2.1	0.7
	TDLF	11.4	7.4	1.9	0.9
23	NLF	10.6	7.1	2.6	0.1
	SDLF	10.6	7.0	2.4	0.0
	TDLF	10.4	6.8	2.1	0.2
24	NLF	7.9	5.6	2.5	1.2
	SDLF	7.8	5.5	2.6	1.2
	TDLF	7.5	4.9	2.3	1.2
25	NLF	3.1	1.4	1.9	3.0
	SDLF	3.2	1.8	2.3	3.1
	TDLF	3.3	1.9	2.5	3.2
26	NLF	2.8	1.6	2.9	6.1
	SDLF	2.5	1.0	3.1	6.1
	TDLF	2.1	0.6	2.7	5.5
27	NLF	4.5	1.4	2.9	7.3
	SDLF	4.4	1.3	2.7	6.9
	TDLF	4.3	1.6	1.5	5.8
28	NLF	4.8	1.4	1.1	3.7
	SDLF	4.9	1.3	0.9	3.4
	TDLF	4.7	1.4	0.3	2.5
29	NLF	6.7	3.5	2.0	2.7
	SDLF	5.7	2.6	1.3	3.6
	TDLF	3.6	0.9	0.3	5.8
30	NLF	4.9	1.9	0.2	3.5
	SDLF	4.5	1.4	0.6	3.9
	TDLF	4.1	0.9	1.0	4.4

Table G-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
31	NLF	4.9	2.4	1.6	7.0
	SDLF	4.6	2.0	1.8	7.0
	TDLF	4.4	1.8	1.4	6.6
32	NLF	3.2	3.0	1.6	5.9
	SDLF	2.9	2.3	2.1	6.0
	TDLF	2.4	1.7	1.9	5.7
33	NLF	2.1	0.2	1.8	3.3
	SDLF	2.3	0.7	2.2	3.4
	TDLF	2.5	1.0	2.4	3.5
34	NLF	7.8	5.5	3.2	2.1
	SDLF	7.7	5.4	3.3	2.1
	TDLF	7.4	5.1	3.2	2.2
35	NLF	11.4	9.3	4.8	1.6
	SDLF	11.2	9.0	4.6	1.6
	TDLF	10.8	8.5	4.2	1.4
36	NLF	12.4	10.6	5.7	1.9
	SDLF	12.2	10.4	5.5	1.8
	TDLF	11.8	9.8	5.0	1.6
37	NLF	10.8	9.4	5.6	2.4
	SDLF	10.8	9.4	5.6	2.4
	TDLF	10.5	8.7	5.0	2.2
38	NLF	7.4	6.1	4.4	3.6
	SDLF	7.5	6.3	4.7	3.7
	TDLF	7.2	5.8	4.1	3.4
39	NLF	2.9	2.2	2.4	3.8
	SDLF	2.8	2.3	2.5	3.7
	TDLF	2.0	1.5	1.5	2.9
40	NLF	0.0	0.7	1.2	2.4
	SDLF	1.2	0.1	0.5	1.7
	TDLF	4.7	2.7	1.9	0.3

Table G-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
41	NLF	2.6	2.2	1.8	0.6
	SDLF	2.0	1.6	1.1	1.3
	TDLF	0.4	0.1	0.4	3.0
42	NLF	0.6	0.3	0.4	2.1
	SDLF	0.8	0.7	1.3	2.8
	TDLF	4.1	2.9	3.0	4.3
43	NLF	0.2	0.5	0.7	3.4
	SDLF	0.6	0.2	1.0	3.6
	TDLF	1.1	0.1	0.8	3.5
44	NLF	0.8	1.0	0.4	2.9
	SDLF	1.0	0.7	0.6	3.0
	TDLF	0.9	1.1	0.1	2.5
45	NLF	1.5	0.6	0.0	1.7
	SDLF	1.5	0.5	0.1	1.7
	TDLF	1.2	1.2	0.6	1.4
46	NLF	1.1	0.7	0.1	1.7
	SDLF	0.9	1.0	0.2	1.7
	TDLF	0.3	2.2	1.0	1.4
47	NLF	2.3	4.2	1.0	2.4
	SDLF	2.2	3.9	0.6	2.5
	TDLF	2.3	3.9	0.7	2.3
48	NLF	6.5	7.1	1.1	4.1
	SDLF	5.9	6.1	0.5	4.2
	TDLF	5.0	4.8	0.1	4.0
49	NLF	6.0	4.1	0.4	5.2
	SDLF	4.9	3.0	1.1	5.6
	TDLF	2.7	1.2	1.9	6.2
50	NLF	4.4	1.9	0.2	2.8
	SDLF	2.0	0.2	1.6	4.0
	TDLF	3.4	3.5	4.5	6.6

Table G-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
51	NLF	6.1	3.3	2.4	1.3
	SDLF	5.2	2.5	1.5	2.2
	TDLF	3.2	0.9	0.2	4.3
52	NLF	3.9	1.2	0.7	2.8
	SDLF	6.1	2.6	0.6	1.5
	TDLF	11.3	6.2	3.9	1.7
53	NLF	3.5	1.8	1.8	5.5
	SDLF	4.1	1.9	1.4	4.8
	TDLF	5.8	3.0	0.4	2.9
54	NLF	0.3	0.9	2.3	4.5
	SDLF	0.2	0.1	2.9	4.6
	TDLF	0.9	1.3	3.0	4.2
55	NLF	7.9	6.0	3.9	2.6
	SDLF	7.9	6.2	4.1	2.7
	TDLF	7.4	5.6	3.7	2.5
56	NLF	13.3	10.3	4.9	1.4
	SDLF	13.1	10.1	4.8	1.4
	TDLF	12.6	9.3	4.3	1.2
57	NLF	15.8	11.7	5.3	0.7
	SDLF	15.6	11.6	5.1	0.7
	TDLF	15.3	11.6	4.9	0.5
58	NLF	17.3	12.8	5.6	0.6
	SDLF	17.1	12.7	5.4	0.5
	TDLF	16.7	12.7	5.4	0.4
59	NLF	16.7	12.7	6.0	1.0
	SDLF	16.5	12.6	5.8	0.9
	TDLF	16.2	12.6	5.7	0.7
60	NLF	15.0	12.2	6.5	1.9
	SDLF	14.8	12.0	6.2	1.8
	TDLF	14.4	11.5	5.6	1.4

Table G-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
61	NLF	11.6	10.6	6.2	3.0
	SDLF	11.4	10.2	5.9	2.9
	TDLF	10.6	8.9	4.9	2.5
62	NLF	4.8	3.7	3.2	3.6
	SDLF	5.0	4.3	3.6	3.8
	TDLF	5.2	4.7	3.6	3.6
63	NLF	1.3	1.1	0.4	3.0
	SDLF	1.8	0.0	1.2	3.2
	TDLF	2.4	1.3	1.9	3.3
64	NLF	2.3	0.2	0.1	2.2
	SDLF	2.3	0.5	0.5	2.3
	TDLF	2.0	0.4	0.5	2.2
65	NLF	0.2	0.1	0.5	0.1
	SDLF	0.3	0.2	0.2	0.1
	TDLF	0.1	0.0	0.0	0.2
66	NLF	1.1	2.7	3.1	1.5
	SDLF	0.0	1.7	2.0	0.4
	TDLF	2.4	0.2	0.2	2.2
67	NLF	3.0	0.3	0.5	2.2
	SDLF	2.9	0.4	0.2	2.4
	TDLF	2.3	0.2	0.2	2.3
68	NLF	1.2	1.9	0.3	2.7
	SDLF	1.4	1.2	0.2	2.8
	TDLF	1.7	0.7	0.3	2.7
69	NLF	1.9	0.4	1.1	3.4
	SDLF	2.1	0.0	1.5	3.5
	TDLF	2.2	0.3	1.6	3.5
70	NLF	3.2	2.4	3.2	4.0
	SDLF	3.2	2.4	3.3	4.0
	TDLF	3.1	2.3	3.2	3.9

Table G-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
71	NLF	4.6	5.1	5.2	4.7
	SDLF	4.6	4.9	5.0	4.7
	TDLF	4.4	4.6	4.8	4.5
72	NLF	5.2	6.3	6.3	5.1
	SDLF	5.1	6.2	6.1	5.0
	TDLF	5.0	5.8	5.8	4.9
73	NLF	5.0	6.1	6.0	5.0
	SDLF	5.0	6.1	6.0	4.9
	TDLF	4.8	5.5	5.4	4.6
74	NLF	4.6	4.3	4.2	4.5
	SDLF	4.6	4.3	4.3	4.6
	TDLF	4.2	3.5	3.5	4.2
75	NLF	0.3	1.2	1.2	0.4
	SDLF	0.0	0.9	0.9	0.0
	TDLF	0.9	0.0	0.0	0.9

Table G-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
1	NLF	0.6	0.5	0.4	0.3
	SDLF	0.1	0.1	0.0	0.0
	TDLF	1.2	1.1	0.9	0.8
2	NLF	0.6	0.7	0.1	0.2
	SDLF	0.6	0.7	0.0	0.2
	TDLF	0.5	0.1	0.8	0.5
3	NLF	2.0	1.7	0.2	0.6
	SDLF	1.9	1.4	0.0	0.7
	TDLF	1.5	0.0	1.2	1.1
4	NLF	3.4	2.3	0.0	1.3
	SDLF	3.5	2.2	0.0	1.3
	TDLF	3.6	1.4	0.8	1.6
5	NLF	3.7	2.1	0.3	1.6
	SDLF	3.6	2.0	0.5	1.8
	TDLF	3.4	1.8	0.9	2.4
6	NLF	3.7	1.9	0.5	1.7
	SDLF	5.3	3.2	0.6	0.8
	TDLF	8.8	6.3	3.3	1.2
7	NLF	3.1	1.6	0.6	1.5
	SDLF	3.5	1.9	0.4	1.4
	TDLF	4.5	2.9	0.3	1.0
8	NLF	2.5	1.2	0.6	1.4
	SDLF	2.6	1.1	0.7	1.4
	TDLF	2.8	0.8	0.7	1.3
9	NLF	1.0	0.2	0.7	0.8
	SDLF	1.0	0.1	0.7	0.8
	TDLF	0.7	0.5	0.9	0.8
10	NLF	1.0	1.4	0.7	0.0
	SDLF	0.7	0.8	0.3	0.1
	TDLF	0.5	0.5	0.3	0.2

Table G-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location			
		G1-G2	G2-G3	G3-G4	G4-G5
11	NLF	3.0	2.1	0.3	1.0
	SDLF	2.5	1.2	0.1	1.0
	TDLF	1.9	0.6	0.3	0.5
12	NLF	3.0	1.3	0.2	1.5
	SDLF	2.4	0.6	0.3	1.4
	TDLF	1.5	0.1	0.3	0.9
13	NLF	2.2	0.4	0.5	1.2
	SDLF	1.7	0.1	0.4	1.0
	TDLF	0.7	0.1	0.4	0.4
14	NLF	0.9	0.7	1.2	3.0
	SDLF	2.1	0.4	0.1	1.7
	TDLF	4.6	2.7	2.3	1.1
15	NLF	2.3	0.5	0.4	1.2
	SDLF	3.0	1.2	0.3	0.8
	TDLF	4.8	2.8	2.0	0.1
16	NLF	3.3	1.7	0.1	1.4
	SDLF	3.4	1.6	0.3	1.2
	TDLF	4.0	2.1	1.6	0.5
17	NLF	3.7	3.0	0.9	0.7
	SDLF	3.3	2.2	0.6	0.7
	TDLF	2.9	1.7	1.1	0.3
18	NLF	2.3	2.9	1.8	0.5
	SDLF	2.0	2.3	1.3	0.3
	TDLF	1.8	2.0	1.2	0.4
19	NLF	0.6	1.9	2.1	1.3
	SDLF	0.6	1.8	1.9	1.2
	TDLF	0.6	2.0	1.8	1.1
20	NLF	0.7	0.9	2.0	1.8
	SDLF	0.7	1.0	2.0	1.8
	TDLF	0.8	1.2	2.1	1.7

Table G-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
21	NLF	1.4	0.3	1.8	2.0
	SDLF	1.5	0.4	2.0	2.0
	TDLF	1.7	0.3	2.0	2.0
22	NLF	1.6	0.0	1.7	1.9
	SDLF	1.7	0.1	1.8	2.0
	TDLF	2.1	0.1	1.7	2.0
23	NLF	1.4	0.1	1.5	1.7
	SDLF	1.5	0.1	1.6	1.7
	TDLF	1.8	0.1	1.6	1.8
24	NLF	0.7	0.4	1.4	1.3
	SDLF	0.7	0.4	1.3	1.2
	TDLF	0.5	0.9	1.5	1.2
25	NLF	0.5	1.3	1.2	0.6
	SDLF	0.3	0.9	0.7	0.4
	TDLF	0.2	0.7	0.6	0.4
26	NLF	2.0	1.7	0.4	0.5
	SDLF	1.6	1.0	0.1	0.5
	TDLF	1.2	0.6	0.5	0.2
27	NLF	2.1	1.0	0.2	1.2
	SDLF	1.8	0.5	0.3	1.3
	TDLF	1.5	0.4	0.3	1.0
28	NLF	1.5	0.2	0.4	0.9
	SDLF	1.3	0.1	0.5	1.1
	TDLF	1.6	0.6	0.2	1.2
29	NLF	0.4	0.7	1.1	2.4
	SDLF	1.4	0.2	0.1	1.3
	TDLF	3.7	2.3	2.1	1.2
30	NLF	1.5	0.5	0.1	0.8
	SDLF	1.9	0.8	0.4	0.3
	TDLF	2.4	1.6	1.6	0.8

Table G-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location			
		G1-G2	G2-G3	G3-G4	G4-G5
31	NLF	2.4	1.5	0.4	1.0
	SDLF	2.3	1.2	0.4	0.8
	TDLF	2.1	1.1	1.0	0.2
32	NLF	2.4	2.4	1.2	0.2
	SDLF	2.0	1.7	0.7	0.4
	TDLF	1.7	1.2	0.8	0.1
33	NLF	1.1	2.1	1.7	0.7
	SDLF	0.9	1.7	1.3	0.5
	TDLF	0.8	1.4	1.0	0.5
34	NLF	0.2	1.0	1.6	1.2
	SDLF	0.2	1.0	1.5	1.1
	TDLF	0.2	1.2	1.5	1.0
35	NLF	1.2	0.0	1.2	1.3
	SDLF	1.2	0.2	1.4	1.4
	TDLF	1.2	0.5	1.6	1.4
36	NLF	1.5	0.4	0.9	1.3
	SDLF	1.5	0.3	1.0	1.3
	TDLF	1.6	0.0	1.4	1.4
37	NLF	1.3	0.4	0.7	1.0
	SDLF	1.3	0.4	0.7	1.0
	TDLF	1.2	0.2	1.2	1.2
38	NLF	0.6	0.0	0.5	0.5
	SDLF	0.7	0.2	0.3	0.4
	TDLF	0.5	0.3	0.9	0.7
39	NLF	0.1	0.2	0.2	0.1
	SDLF	0.4	0.4	0.3	0.3
	TDLF	1.1	0.9	0.4	0.5
40	NLF	0.3	0.1	0.0	0.3
	SDLF	1.2	1.2	1.1	1.1
	TDLF	4.8	4.0	3.1	2.9

Table G-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
41	NLF	0.2	0.6	0.7	1.1
	SDLF	0.4	0.0	0.1	0.5
	TDLF	2.2	1.8	1.7	1.4
42	NLF	0.5	0.4	0.2	0.2
	SDLF	2.0	1.6	1.2	0.6
	TDLF	6.2	5.3	4.3	2.9
43	NLF	0.9	1.1	0.7	0.0
	SDLF	1.1	1.1	0.8	0.1
	TDLF	2.1	2.3	2.0	0.8
44	NLF	1.3	2.1	1.7	0.6
	SDLF	1.1	1.8	1.4	0.5
	TDLF	1.0	1.9	1.9	0.7
45	NLF	1.3	2.5	2.3	1.1
	SDLF	1.3	2.4	2.2	1.0
	TDLF	1.3	2.9	2.6	1.1
46	NLF	1.5	2.6	2.4	1.2
	SDLF	1.6	2.9	2.5	1.1
	TDLF	2.1	3.8	3.0	1.2
47	NLF	2.4	3.5	2.5	0.9
	SDLF	2.2	3.1	2.1	0.7
	TDLF	2.1	3.0	2.0	0.6
48	NLF	3.4	3.8	2.0	0.2
	SDLF	2.9	2.7	1.3	0.0
	TDLF	2.0	1.3	0.9	0.0
49	NLF	2.8	2.1	0.8	0.5
	SDLF	3.5	2.4	1.3	0.0
	TDLF	5.5	3.8	3.1	1.5
50	NLF	1.5	0.6	0.1	0.5
	SDLF	4.1	2.8	1.9	1.0
	TDLF	10.1	8.0	6.4	4.6

Table G-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location			
		G1-G2	G2-G3	G3-G4	G4-G5
51	NLF	0.3	0.7	0.9	1.9
	SDLF	1.3	0.2	0.0	0.9
	TDLF	3.6	2.3	2.0	1.5
52	NLF	1.3	0.4	0.1	0.6
	SDLF	1.2	1.8	1.8	2.0
	TDLF	7.0	6.3	5.1	4.8
53	NLF	2.0	1.3	0.3	0.6
	SDLF	0.4	0.4	0.9	1.3
	TDLF	2.8	3.4	2.6	2.3
54	NLF	1.5	1.8	0.8	0.0
	SDLF	0.8	0.6	0.1	0.2
	TDLF	0.4	0.8	0.3	0.1
55	NLF	0.7	0.2	0.9	0.8
	SDLF	0.9	0.0	0.5	0.6
	TDLF	0.9	0.3	0.8	0.8
56	NLF	2.2	0.9	0.7	1.2
	SDLF	2.3	0.9	0.7	1.2
	TDLF	2.5	0.5	1.0	1.3
57	NLF	2.8	1.3	0.7	1.5
	SDLF	3.2	1.5	0.6	1.5
	TDLF	4.2	2.1	0.3	1.4
58	NLF	3.3	1.6	0.6	1.6
	SDLF	3.6	1.8	0.5	1.6
	TDLF	4.6	2.6	0.1	1.3
59	NLF	3.1	1.6	0.5	1.5
	SDLF	3.5	1.8	0.4	1.5
	TDLF	4.5	2.5	0.1	1.3
60	NLF	2.7	1.4	0.3	1.2
	SDLF	3.0	1.5	0.4	1.2
	TDLF	3.7	1.6	0.5	1.3

Table G-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location			
		G1-G2	G2-G3	G3-G4	G4-G5
61	NLF	1.9	1.1	0.4	0.8
	SDLF	1.8	0.8	0.5	0.9
	TDLF	1.7	0.2	1.3	1.2
62	NLF	0.1	0.8	1.1	0.5
	SDLF	0.3	0.2	0.6	0.4
	TDLF	0.9	0.4	0.5	0.4
63	NLF	0.9	1.8	1.4	0.5
	SDLF	0.3	0.6	0.5	0.2
	TDLF	0.6	0.8	0.3	0.0
64	NLF	0.2	0.7	0.8	0.3
	SDLF	0.0	0.2	0.2	0.0
	TDLF	0.0	0.1	0.1	0.2
65	NLF	0.0	0.1	0.1	0.1
	SDLF	0.2	0.1	0.1	0.1
	TDLF	0.8	1.0	0.6	0.4
66	NLF	1.6	1.2	1.1	1.2
	SDLF	0.2	0.0	0.0	0.1
	TDLF	2.9	2.6	2.5	2.5
67	NLF	0.0	0.4	0.8	0.4
	SDLF	0.2	0.5	0.5	0.2
	TDLF	0.9	1.3	0.8	0.2
68	NLF	1.0	2.1	1.7	0.7
	SDLF	0.6	1.3	1.1	0.4
	TDLF	0.1	0.6	0.8	0.2
69	NLF	1.1	2.3	1.9	0.7
	SDLF	0.9	1.9	1.5	0.5
	TDLF	0.7	1.6	1.3	0.4
70	NLF	0.9	2.0	1.7	0.7
	SDLF	0.9	1.9	1.6	0.6
	TDLF	0.9	1.9	1.6	0.5

Table G-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
71	NLF	0.6	1.3	1.3	0.5
	SDLF	0.6	1.5	1.4	0.5
	TDLF	0.7	1.7	1.5	0.5
72	NLF	0.4	1.0	1.0	0.4
	SDLF	0.4	1.1	1.1	0.4
	TDLF	0.5	1.3	1.3	0.5
73	NLF	0.3	0.8	0.8	0.3
	SDLF	0.3	0.7	0.7	0.3
	TDLF	0.5	1.2	1.2	0.5
74	NLF	0.2	0.5	0.5	0.2
	SDLF	0.2	0.4	0.4	0.2
	TDLF	0.5	1.1	1.1	0.4
75	NLF	0.3	0.4	0.4	0.4
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.9	0.9	0.9	1.0

Table G-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location			
		G1-G2	G2-G3	G3-G4	G4-G5
1	NLF	3.0	1.9	1.6	2.0
	SDLF	2.4	1.5	1.2	1.7
	TDLF	1.1	0.3	0.3	0.8
2	NLF	4.2	4.8	2.7	1.4
	SDLF	4.2	4.7	2.6	1.4
	TDLF	4.1	4.0	1.8	1.1
3	NLF	10.2	9.8	4.9	1.6
	SDLF	10.2	9.5	4.7	1.5
	TDLF	9.8	8.1	3.5	1.1
4	NLF	16.3	13.5	6.2	0.8
	SDLF	16.4	13.4	6.2	0.8
	TDLF	16.6	12.7	5.4	0.5
5	NLF	16.9	13.1	5.6	0.3
	SDLF	16.8	13.1	5.4	0.5
	TDLF	16.7	12.9	5.0	1.1
6	NLF	17.2	12.6	5.0	0.5
	SDLF	18.7	13.9	6.1	0.4
	TDLF	22.2	17.0	8.8	2.4
7	NLF	15.0	11.5	4.8	0.1
	SDLF	15.4	11.8	4.9	0.2
	TDLF	16.4	12.8	5.7	0.6
8	NLF	13.2	10.5	4.8	0.8
	SDLF	13.3	10.4	4.8	0.8
	TDLF	13.5	10.1	4.7	0.9
9	NLF	8.2	7.0	4.4	2.5
	SDLF	8.2	6.9	4.5	2.6
	TDLF	8.0	6.3	4.3	2.5
10	NLF	1.4	1.1	4.0	5.3
	SDLF	1.7	1.7	4.4	5.4
	TDLF	2.0	2.1	4.4	5.1

Table G-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location			
		G1-G2	G2-G3	G3-G4	G4-G5
11	NLF	5.7	2.5	3.9	8.0
	SDLF	5.2	1.6	4.2	8.0
	TDLF	4.6	1.0	3.8	7.5
12	NLF	7.0	2.0	3.1	8.2
	SDLF	6.4	1.4	3.2	8.2
	TDLF	5.4	0.9	2.6	7.6
13	NLF	5.6	0.3	2.8	5.6
	SDLF	5.1	0.1	2.7	5.4
	TDLF	4.2	0.1	1.9	4.8
14	NLF	1.8	2.3	4.2	11.2
	SDLF	3.0	1.2	3.0	9.9
	TDLF	5.5	1.1	0.6	7.1
15	NLF	6.0	0.9	2.4	5.5
	SDLF	6.8	1.5	1.7	5.1
	TDLF	8.5	3.1	0.0	4.3
16	NLF	7.8	3.3	2.2	7.9
	SDLF	7.9	3.2	2.0	7.8
	TDLF	8.5	3.7	0.7	7.1
17	NLF	7.8	5.1	1.9	7.2
	SDLF	7.4	4.3	2.2	7.3
	TDLF	7.0	3.8	1.7	6.8
18	NLF	2.0	2.9	0.9	4.0
	SDLF	1.7	2.3	1.4	4.1
	TDLF	1.5	1.9	1.5	4.0
19	NLF	3.6	1.3	0.7	1.3
	SDLF	3.7	1.4	0.9	1.4
	TDLF	3.6	1.2	1.0	1.4
20	NLF	8.1	4.7	1.1	0.3
	SDLF	8.2	4.7	1.0	0.3
	TDLF	8.2	4.5	1.0	0.3

Table G-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
21	NLF	10.3	6.7	1.6	1.0
	SDLF	10.4	6.6	1.4	1.1
	TDLF	10.7	6.6	1.4	1.1
22	NLF	11.0	7.4	2.0	1.0
	SDLF	11.1	7.3	1.9	1.0
	TDLF	11.4	7.5	1.9	1.0
23	NLF	10.1	6.9	2.3	0.3
	SDLF	10.3	6.9	2.3	0.3
	TDLF	10.5	6.9	2.2	0.3
24	NLF	7.6	5.5	2.4	1.1
	SDLF	7.6	5.4	2.5	1.1
	TDLF	7.4	4.9	2.3	1.1
25	NLF	3.2	1.5	2.0	3.1
	SDLF	3.4	1.9	2.5	3.2
	TDLF	3.4	2.1	2.6	3.3
26	NLF	2.9	1.7	2.9	6.2
	SDLF	2.5	1.0	3.2	6.2
	TDLF	2.1	0.6	2.8	5.8
27	NLF	4.5	1.5	2.8	7.2
	SDLF	4.1	1.0	2.9	7.3
	TDLF	3.9	0.9	2.3	7.1
28	NLF	3.8	0.0	2.5	4.7
	SDLF	3.6	0.1	2.5	4.8
	TDLF	3.9	0.3	1.8	4.9
29	NLF	0.2	2.4	3.8	9.7
	SDLF	1.2	1.5	2.9	8.6
	TDLF	3.5	0.6	0.7	6.1
30	NLF	3.9	0.6	1.5	4.4
	SDLF	4.2	0.9	1.1	3.9
	TDLF	4.7	1.7	0.2	2.8

Table G-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
31	NLF	5.0	2.6	1.4	6.9
	SDLF	4.9	2.2	1.5	6.8
	TDLF	4.7	2.2	0.8	6.2
32	NLF	3.2	2.9	1.7	6.0
	SDLF	2.9	2.2	2.1	6.1
	TDLF	2.5	1.7	2.0	5.9
33	NLF	2.1	0.3	1.9	3.4
	SDLF	2.3	0.7	2.3	3.5
	TDLF	2.5	1.0	2.5	3.6
34	NLF	7.5	5.4	3.1	2.0
	SDLF	7.4	5.3	3.2	2.0
	TDLF	7.4	5.1	3.2	2.1
35	NLF	10.8	9.1	4.6	1.4
	SDLF	10.7	8.9	4.5	1.3
	TDLF	10.8	8.6	4.2	1.3
36	NLF	11.7	10.4	5.5	1.6
	SDLF	11.7	10.2	5.4	1.6
	TDLF	11.8	9.9	5.0	1.4
37	NLF	10.6	9.3	5.5	2.4
	SDLF	10.6	9.4	5.6	2.4
	TDLF	10.5	8.8	5.0	2.1
38	NLF	7.2	6.1	4.4	3.6
	SDLF	7.4	6.3	4.7	3.7
	TDLF	7.2	5.8	4.1	3.4
39	NLF	3.0	2.3	2.5	3.9
	SDLF	3.5	2.9	3.0	4.1
	TDLF	4.2	3.4	3.1	4.3
40	NLF	0.3	1.0	1.5	2.6
	SDLF	1.8	2.3	2.5	3.4
	TDLF	5.4	5.1	4.5	5.2

Table G-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
41	NLF	2.2	2.4	3.0	5.8
	SDLF	1.6	1.8	2.3	5.1
	TDLF	0.2	0.0	0.5	3.3
42	NLF	0.3	0.0	0.8	2.4
	SDLF	1.8	1.2	0.2	1.5
	TDLF	6.0	4.9	3.3	0.7
43	NLF	0.2	0.6	0.7	3.5
	SDLF	0.0	0.6	0.6	3.3
	TDLF	1.0	1.8	0.6	2.6
44	NLF	0.9	1.0	0.4	3.0
	SDLF	1.1	0.6	0.7	3.2
	TDLF	1.2	0.8	0.3	3.0
45	NLF	1.5	0.5	0.1	1.9
	SDLF	1.6	0.4	0.2	1.9
	TDLF	1.6	0.8	0.2	1.8
46	NLF	1.2	0.6	0.0	1.8
	SDLF	1.1	0.9	0.1	1.9
	TDLF	0.6	1.8	0.6	1.8
47	NLF	2.3	4.1	0.9	2.6
	SDLF	2.1	3.7	0.5	2.7
	TDLF	2.0	3.6	0.4	2.8
48	NLF	6.4	7.1	1.1	4.3
	SDLF	5.9	6.0	0.4	4.4
	TDLF	5.0	4.6	0.1	4.4
49	NLF	6.1	4.3	0.2	5.2
	SDLF	6.8	4.6	0.2	4.7
	TDLF	8.7	6.0	2.1	3.2
50	NLF	3.7	1.0	1.0	3.4
	SDLF	6.2	3.1	0.8	1.8
	TDLF	12.2	8.3	5.2	1.7

Table G-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
51	NLF	0.3	2.5	3.5	7.9
	SDLF	0.7	1.6	2.6	6.9
	TDLF	3.0	0.5	0.5	4.6
52	NLF	3.1	0.2	1.6	3.5
	SDLF	0.5	1.9	3.3	4.8
	TDLF	5.2	6.4	6.6	7.7
53	NLF	3.6	2.0	1.7	5.4
	SDLF	2.0	0.3	2.9	6.1
	TDLF	1.3	2.7	4.5	7.1
54	NLF	0.2	0.8	2.4	4.6
	SDLF	0.5	0.3	3.1	4.8
	TDLF	1.7	1.8	3.5	4.7
55	NLF	7.6	6.0	3.8	2.6
	SDLF	7.8	6.2	4.2	2.7
	TDLF	7.8	5.8	3.9	2.6
56	NLF	12.7	10.1	4.7	1.2
	SDLF	12.9	10.1	4.8	1.2
	TDLF	13.1	9.7	4.5	1.2
57	NLF	14.5	11.1	4.7	0.2
	SDLF	14.8	11.3	4.8	0.2
	TDLF	15.8	11.9	5.1	0.4
58	NLF	15.9	12.1	5.0	0.1
	SDLF	16.2	12.3	5.1	0.0
	TDLF	17.2	13.0	5.7	0.2
59	NLF	15.3	12.0	5.4	0.4
	SDLF	15.7	12.2	5.5	0.4
	TDLF	16.7	13.0	6.0	0.6
60	NLF	13.9	11.7	6.1	1.4
	SDLF	14.2	11.7	6.0	1.4
	TDLF	14.9	11.9	5.9	1.3

Table G-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
61	NLF	11.2	10.5	6.1	3.0
	SDLF	11.2	10.2	6.0	2.9
	TDLF	11.0	9.2	5.1	2.5
62	NLF	4.8	3.8	3.3	3.7
	SDLF	5.2	4.4	3.8	3.9
	TDLF	5.7	4.9	3.9	3.8
63	NLF	1.4	1.1	0.4	3.0
	SDLF	2.0	0.1	1.3	3.4
	TDLF	2.9	1.5	2.1	3.6
64	NLF	2.2	0.0	0.1	2.1
	SDLF	2.4	0.5	0.4	2.4
	TDLF	2.4	0.6	0.8	2.6
65	NLF	1.4	1.5	0.8	0.8
	SDLF	1.2	1.2	0.8	0.8
	TDLF	0.5	0.3	0.3	0.6
66	NLF	7.0	4.3	4.0	6.1
	SDLF	5.7	3.1	2.9	5.0
	TDLF	2.6	0.5	0.4	2.4
67	NLF	3.5	0.9	0.1	2.6
	SDLF	3.3	0.9	0.3	2.8
	TDLF	2.7	0.0	0.1	2.8
68	NLF	1.2	1.9	0.4	2.7
	SDLF	1.6	1.1	0.3	3.0
	TDLF	2.1	0.4	0.6	3.1
69	NLF	2.1	0.3	1.2	3.6
	SDLF	2.3	0.2	1.7	3.8
	TDLF	2.5	0.5	1.9	3.9
70	NLF	3.3	2.5	3.3	4.1
	SDLF	3.3	2.6	3.4	4.2
	TDLF	3.3	2.6	3.5	4.3

Table G-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
71	NLF	4.8	5.2	5.3	4.9
	SDLF	4.7	5.0	5.2	4.8
	TDLF	4.6	4.9	5.1	4.9
72	NLF	5.3	6.4	6.3	5.2
	SDLF	5.3	6.3	6.2	5.2
	TDLF	5.2	6.1	6.0	5.2
73	NLF	5.1	6.2	6.1	5.1
	SDLF	5.2	6.2	6.2	5.1
	TDLF	5.0	5.7	5.7	5.0
74	NLF	4.7	4.3	4.3	4.7
	SDLF	4.8	4.4	4.4	4.7
	TDLF	4.5	3.7	3.7	4.5
75	NLF	2.4	1.6	1.6	2.6
	SDLF	2.1	1.3	1.3	2.2
	TDLF	1.2	0.3	0.3	1.2

Table G-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location			
		G1-G2	G2-G3	G3-G4	G4-G5
1	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
2	NLF	0.05	0.05	0.05	0.05
	SDLF	0.05	0.05	0.05	0.05
	TDLF	0.06	0.05	0.04	0.04
3	NLF	0.09	0.09	0.09	0.09
	SDLF	0.10	0.09	0.09	0.09
	TDLF	0.11	0.09	0.08	0.08
4	NLF	0.17	0.17	0.16	0.17
	SDLF	0.18	0.17	0.16	0.17
	TDLF	0.20	0.17	0.16	0.16
5	NLF	0.22	0.22	0.22	0.22
	SDLF	0.23	0.22	0.22	0.22
	TDLF	0.26	0.23	0.21	0.21
6	NLF	0.25	0.25	0.25	0.25
	SDLF	0.26	0.25	0.25	0.25
	TDLF	0.29	0.25	0.24	0.24
7	NLF	0.25	0.25	0.25	0.25
	SDLF	0.26	0.25	0.25	0.26
	TDLF	0.29	0.26	0.24	0.25
8	NLF	0.23	0.23	0.23	0.23
	SDLF	0.23	0.23	0.23	0.23
	TDLF	0.26	0.23	0.22	0.22
9	NLF	0.19	0.19	0.19	0.19
	SDLF	0.19	0.19	0.19	0.19
	TDLF	0.21	0.19	0.19	0.18
10	NLF	0.13	0.13	0.14	0.14
	SDLF	0.13	0.13	0.14	0.14
	TDLF	0.14	0.14	0.14	0.13

Table G-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location			
		G1-G2	G2-G3	G3-G4	G4-G5
11	NLF	0.08	0.08	0.08	0.08
	SDLF	0.07	0.08	0.08	0.08
	TDLF	0.08	0.09	0.09	0.07
12	NLF	0.03	0.04	0.04	0.03
	SDLF	0.03	0.04	0.04	0.03
	TDLF	0.03	0.04	0.04	0.03
13	NLF	0.02	0.02	0.02	0.02
	SDLF	0.01	0.02	0.02	0.02
	TDLF	0.01	0.02	0.02	0.01
14	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
15	NLF	-0.01	-0.01	-0.01	-0.01
	SDLF	-0.01	-0.01	-0.01	-0.01
	TDLF	-0.02	-0.01	-0.01	-0.01
16	NLF	-0.03	-0.02	-0.02	-0.02
	SDLF	-0.03	-0.02	-0.02	-0.02
	TDLF	-0.03	-0.02	-0.02	-0.02
17	NLF	-0.04	-0.03	-0.03	-0.03
	SDLF	-0.04	-0.03	-0.03	-0.03
	TDLF	-0.04	-0.03	-0.02	-0.03
18	NLF	-0.04	-0.03	-0.03	-0.03
	SDLF	-0.04	-0.03	-0.02	-0.02
	TDLF	-0.04	-0.02	-0.02	-0.02
19	NLF	-0.02	-0.02	-0.01	-0.01
	SDLF	-0.02	-0.02	-0.01	0.00
	TDLF	-0.01	-0.01	-0.01	-0.01
20	NLF	0.00	0.00	0.00	0.01
	SDLF	0.00	0.00	0.01	0.02
	TDLF	0.02	0.01	0.01	0.02

Table G-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
21	NLF	0.02	0.02	0.02	0.02
	SDLF	0.02	0.02	0.02	0.03
	TDLF	0.04	0.03	0.02	0.03
22	NLF	0.03	0.03	0.03	0.03
	SDLF	0.03	0.03	0.03	0.04
	TDLF	0.06	0.04	0.03	0.04
23	NLF	0.03	0.03	0.03	0.04
	SDLF	0.04	0.03	0.04	0.04
	TDLF	0.06	0.04	0.04	0.04
24	NLF	0.03	0.02	0.03	0.03
	SDLF	0.03	0.03	0.03	0.04
	TDLF	0.05	0.03	0.03	0.03
25	NLF	0.01	0.01	0.02	0.02
	SDLF	0.01	0.02	0.02	0.02
	TDLF	0.02	0.02	0.02	0.02
26	NLF	0.00	0.00	0.01	0.01
	SDLF	0.00	0.01	0.01	0.01
	TDLF	0.00	0.01	0.01	0.00
27	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
28	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
29	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
30	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00

Table G-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
31	NLF	0.01	0.01	0.01	0.01
	SDLF	0.00	0.01	0.01	0.01
	TDLF	0.00	0.01	0.01	0.01
32	NLF	0.02	0.03	0.03	0.03
	SDLF	0.02	0.02	0.03	0.03
	TDLF	0.02	0.03	0.03	0.02
33	NLF	0.04	0.05	0.05	0.05
	SDLF	0.04	0.05	0.05	0.06
	TDLF	0.04	0.05	0.05	0.05
34	NLF	0.07	0.07	0.08	0.08
	SDLF	0.07	0.07	0.08	0.08
	TDLF	0.08	0.07	0.07	0.07
35	NLF	0.10	0.09	0.10	0.10
	SDLF	0.09	0.09	0.09	0.10
	TDLF	0.11	0.09	0.09	0.09
36	NLF	0.10	0.10	0.10	0.11
	SDLF	0.10	0.10	0.10	0.11
	TDLF	0.12	0.10	0.09	0.09
37	NLF	0.10	0.09	0.09	0.10
	SDLF	0.10	0.09	0.09	0.10
	TDLF	0.11	0.10	0.09	0.09
38	NLF	0.07	0.07	0.07	0.07
	SDLF	0.07	0.07	0.07	0.07
	TDLF	0.09	0.07	0.07	0.07
39	NLF	0.04	0.04	0.04	0.04
	SDLF	0.04	0.04	0.04	0.04
	TDLF	0.04	0.04	0.04	0.04
40	NLF	0.02	0.02	0.02	0.02
	SDLF	0.02	0.02	0.02	0.02
	TDLF	0.02	0.02	0.02	0.02

Table G-4-7(Continued). **Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.**

CF	Detailing Method	CF Location			
		G1-G2	G2-G3	G3-G4	G4-G5
41	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
42	NLF	-0.02	-0.02	-0.02	-0.02
	SDLF	-0.02	-0.02	-0.02	-0.02
	TDLF	-0.02	-0.02	-0.02	-0.02
43	NLF	-0.04	-0.04	-0.04	-0.04
	SDLF	-0.04	-0.04	-0.04	-0.04
	TDLF	-0.04	-0.04	-0.04	-0.04
44	NLF	-0.08	-0.07	-0.07	-0.07
	SDLF	-0.08	-0.08	-0.07	-0.07
	TDLF	-0.08	-0.08	-0.07	-0.07
45	NLF	-0.10	-0.10	-0.10	-0.09
	SDLF	-0.11	-0.10	-0.09	-0.09
	TDLF	-0.11	-0.10	-0.10	-0.10
46	NLF	-0.12	-0.11	-0.11	-0.10
	SDLF	-0.12	-0.12	-0.11	-0.10
	TDLF	-0.13	-0.12	-0.11	-0.11
47	NLF	-0.12	-0.11	-0.11	-0.10
	SDLF	-0.13	-0.11	-0.10	-0.10
	TDLF	-0.13	-0.12	-0.11	-0.11
48	NLF	-0.10	-0.09	-0.09	-0.09
	SDLF	-0.11	-0.09	-0.09	-0.09
	TDLF	-0.12	-0.10	-0.09	-0.09
49	NLF	-0.06	-0.05	-0.05	-0.05
	SDLF	-0.06	-0.06	-0.05	-0.05
	TDLF	-0.07	-0.06	-0.05	-0.06
50	NLF	-0.03	-0.03	-0.03	-0.03
	SDLF	-0.03	-0.03	-0.03	-0.03
	TDLF	-0.03	-0.03	-0.03	-0.03

Table G-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
51	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
52	NLF	0.03	0.03	0.03	0.03
	SDLF	0.03	0.03	0.03	0.03
	TDLF	0.03	0.04	0.03	0.03
53	NLF	0.06	0.06	0.07	0.06
	SDLF	0.06	0.07	0.07	0.07
	TDLF	0.07	0.07	0.07	0.07
54	NLF	0.13	0.14	0.14	0.14
	SDLF	0.13	0.14	0.14	0.14
	TDLF	0.15	0.15	0.15	0.15
55	NLF	0.21	0.21	0.21	0.21
	SDLF	0.22	0.22	0.22	0.22
	TDLF	0.24	0.23	0.23	0.23
56	NLF	0.28	0.27	0.27	0.28
	SDLF	0.29	0.28	0.28	0.29
	TDLF	0.33	0.30	0.30	0.30
57	NLF	0.32	0.32	0.32	0.32
	SDLF	0.34	0.33	0.33	0.34
	TDLF	0.39	0.36	0.34	0.35
58	NLF	0.35	0.34	0.34	0.35
	SDLF	0.36	0.35	0.35	0.36
	TDLF	0.42	0.38	0.37	0.37
59	NLF	0.35	0.34	0.34	0.35
	SDLF	0.36	0.35	0.35	0.36
	TDLF	0.41	0.38	0.37	0.37
60	NLF	0.32	0.32	0.32	0.32
	SDLF	0.33	0.33	0.33	0.33
	TDLF	0.38	0.36	0.34	0.34

Table G-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
61	NLF	0.27	0.27	0.27	0.27
	SDLF	0.28	0.28	0.28	0.28
	TDLF	0.32	0.30	0.29	0.29
62	NLF	0.20	0.20	0.20	0.21
	SDLF	0.21	0.21	0.21	0.21
	TDLF	0.24	0.23	0.23	0.22
63	NLF	0.12	0.13	0.13	0.13
	SDLF	0.13	0.13	0.14	0.14
	TDLF	0.14	0.14	0.15	0.14
64	NLF	0.06	0.06	0.06	0.06
	SDLF	0.06	0.06	0.07	0.07
	TDLF	0.07	0.07	0.07	0.07
65	NLF	0.03	0.03	0.03	0.03
	SDLF	0.03	0.03	0.03	0.03
	TDLF	0.04	0.03	0.03	0.03
66	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
67	NLF	-0.06	-0.06	-0.06	-0.06
	SDLF	-0.06	-0.06	-0.06	-0.06
	TDLF	-0.07	-0.07	-0.06	-0.06
68	NLF	-0.11	-0.11	-0.11	-0.10
	SDLF	-0.12	-0.11	-0.11	-0.11
	TDLF	-0.13	-0.12	-0.12	-0.12
69	NLF	-0.15	-0.14	-0.14	-0.14
	SDLF	-0.16	-0.15	-0.14	-0.14
	TDLF	-0.16	-0.16	-0.15	-0.16
70	NLF	-0.16	-0.16	-0.15	-0.15
	SDLF	-0.17	-0.16	-0.16	-0.15
	TDLF	0.27	0.27	0.27	0.27

Table G-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
71	NLF	-0.15	-0.15	-0.15	-0.15
	SDLF	-0.16	-0.16	-0.15	-0.15
	TDLF	-0.16	-0.16	-0.17	-0.17
72	NLF	-0.13	-0.13	-0.13	-0.12
	SDLF	-0.14	-0.13	-0.13	-0.13
	TDLF	-0.13	-0.14	-0.14	-0.15
73	NLF	-0.09	-0.09	-0.09	-0.09
	SDLF	-0.10	-0.10	-0.09	-0.09
	TDLF	-0.09	-0.10	-0.11	-0.11
74	NLF	-0.05	-0.05	-0.05	-0.05
	SDLF	-0.05	-0.05	-0.05	-0.05
	TDLF	-0.05	-0.05	-0.06	-0.06
75	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00

Table G-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
1	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
2	NLF	0.15	0.14	0.14	0.13
	SDLF	0.15	0.14	0.13	0.13
	TDLF	0.16	0.14	0.13	0.13
3	NLF	0.30	0.28	0.26	0.26
	SDLF	0.30	0.28	0.26	0.26
	TDLF	0.32	0.28	0.26	0.26
4	NLF	0.53	0.50	0.49	0.48
	SDLF	0.53	0.50	0.48	0.49
	TDLF	0.56	0.51	0.48	0.48
5	NLF	0.68	0.66	0.64	0.64
	SDLF	0.69	0.66	0.64	0.65
	TDLF	0.72	0.66	0.63	0.63
6	NLF	0.77	0.74	0.73	0.73
	SDLF	0.77	0.74	0.73	0.73
	TDLF	0.80	0.75	0.72	0.72
7	NLF	0.77	0.74	0.73	0.73
	SDLF	0.77	0.74	0.73	0.73
	TDLF	0.80	0.75	0.73	0.73
8	NLF	0.70	0.68	0.67	0.66
	SDLF	0.70	0.68	0.67	0.67
	TDLF	0.73	0.69	0.66	0.66
9	NLF	0.57	0.55	0.55	0.54
	SDLF	0.57	0.55	0.55	0.54
	TDLF	0.59	0.56	0.55	0.54
10	NLF	0.39	0.40	0.39	0.38
	SDLF	0.39	0.40	0.39	0.38
	TDLF	0.40	0.40	0.40	0.38

Table G-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
11	NLF	0.23	0.24	0.24	0.23
	SDLF	0.23	0.24	0.24	0.23
	TDLF	0.23	0.25	0.24	0.22
12	NLF	0.10	0.11	0.11	0.10
	SDLF	0.10	0.11	0.11	0.10
	TDLF	0.10	0.11	0.11	0.09
13	NLF	0.05	0.05	0.05	0.04
	SDLF	0.05	0.05	0.05	0.04
	TDLF	0.05	0.05	0.05	0.04
14	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
15	NLF	-0.04	-0.04	-0.04	-0.04
	SDLF	-0.04	-0.04	-0.04	-0.04
	TDLF	-0.04	-0.04	-0.04	-0.04
16	NLF	-0.08	-0.07	-0.07	-0.08
	SDLF	-0.08	-0.07	-0.07	-0.08
	TDLF	-0.08	-0.07	-0.06	-0.08
17	NLF	-0.12	-0.10	-0.10	-0.11
	SDLF	-0.12	-0.10	-0.10	-0.11
	TDLF	-0.12	-0.10	-0.09	-0.11
18	NLF	-0.11	-0.10	-0.10	-0.10
	SDLF	-0.11	-0.10	-0.09	-0.10
	TDLF	-0.11	-0.09	-0.09	-0.10
19	NLF	-0.06	-0.07	-0.07	-0.07
	SDLF	-0.06	-0.06	-0.06	-0.06
	TDLF	-0.05	-0.06	-0.06	-0.06
20	NLF	0.00	-0.01	-0.02	-0.02
	SDLF	0.00	-0.01	-0.01	-0.01
	TDLF	0.02	0.00	-0.01	-0.01

Table G-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
21	NLF	0.05	0.04	0.03	0.03
	SDLF	0.05	0.04	0.03	0.04
	TDLF	0.08	0.05	0.03	0.04
22	NLF	0.08	0.06	0.06	0.06
	SDLF	0.09	0.07	0.06	0.07
	TDLF	0.11	0.08	0.06	0.07
23	NLF	0.08	0.07	0.06	0.06
	SDLF	0.09	0.07	0.07	0.07
	TDLF	0.11	0.08	0.07	0.07
24	NLF	0.06	0.05	0.04	0.04
	SDLF	0.06	0.05	0.05	0.05
	TDLF	0.08	0.06	0.05	0.05
25	NLF	0.02	0.02	0.02	0.01
	SDLF	0.02	0.02	0.02	0.02
	TDLF	0.03	0.03	0.02	0.01
26	NLF	-0.01	-0.01	-0.01	-0.02
	SDLF	-0.01	0.00	0.00	-0.01
	TDLF	-0.01	0.00	0.00	-0.02
27	NLF	-0.02	-0.01	-0.01	-0.02
	SDLF	-0.02	-0.01	-0.01	-0.02
	TDLF	-0.02	-0.01	-0.01	-0.02
28	NLF	-0.01	-0.01	-0.01	-0.01
	SDLF	-0.01	-0.01	-0.01	-0.01
	TDLF	-0.01	-0.01	-0.01	-0.02
29	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
30	NLF	0.01	0.02	0.02	0.01
	SDLF	0.01	0.02	0.02	0.01
	TDLF	0.01	0.02	0.02	0.01

Table G-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
31	NLF	0.03	0.04	0.04	0.03
	SDLF	0.03	0.04	0.04	0.03
	TDLF	0.03	0.04	0.04	0.03
32	NLF	0.10	0.10	0.11	0.10
	SDLF	0.09	0.10	0.11	0.10
	TDLF	0.09	0.10	0.11	0.09
33	NLF	0.19	0.19	0.19	0.18
	SDLF	0.18	0.19	0.19	0.19
	TDLF	0.19	0.19	0.19	0.18
34	NLF	0.29	0.28	0.27	0.27
	SDLF	0.29	0.28	0.27	0.27
	TDLF	0.30	0.28	0.27	0.26
35	NLF	0.37	0.35	0.34	0.33
	SDLF	0.36	0.34	0.34	0.34
	TDLF	0.38	0.35	0.33	0.32
36	NLF	0.39	0.37	0.36	0.35
	SDLF	0.39	0.37	0.36	0.36
	TDLF	0.41	0.37	0.35	0.34
37	NLF	0.36	0.34	0.33	0.32
	SDLF	0.36	0.34	0.33	0.32
	TDLF	0.38	0.34	0.32	0.31
38	NLF	0.27	0.26	0.25	0.24
	SDLF	0.27	0.26	0.25	0.24
	TDLF	0.28	0.26	0.24	0.23
39	NLF	0.14	0.14	0.13	0.13
	SDLF	0.14	0.14	0.13	0.13
	TDLF	0.14	0.14	0.13	0.12
40	NLF	0.07	0.07	0.07	0.07
	SDLF	0.07	0.07	0.07	0.06
	TDLF	0.07	0.07	0.07	0.06

Table G-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
41	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
42	NLF	-0.07	-0.07	-0.07	-0.07
	SDLF	-0.07	-0.07	-0.07	-0.07
	TDLF	-0.07	-0.07	-0.07	-0.07
43	NLF	-0.13	-0.13	-0.13	-0.13
	SDLF	-0.13	-0.13	-0.13	-0.13
	TDLF	-0.13	-0.13	-0.13	-0.13
44	NLF	-0.25	-0.25	-0.24	-0.25
	SDLF	-0.25	-0.25	-0.24	-0.24
	TDLF	-0.25	-0.25	-0.24	-0.25
45	NLF	-0.33	-0.33	-0.33	-0.33
	SDLF	-0.34	-0.33	-0.33	-0.32
	TDLF	-0.34	-0.33	-0.33	-0.33
46	NLF	-0.37	-0.37	-0.37	-0.37
	SDLF	-0.38	-0.37	-0.37	-0.37
	TDLF	-0.38	-0.38	-0.37	-0.37
47	NLF	-0.37	-0.36	-0.36	-0.36
	SDLF	-0.38	-0.36	-0.36	-0.36
	TDLF	-0.38	-0.37	-0.36	-0.37
48	NLF	-0.32	-0.30	-0.29	-0.30
	SDLF	-0.32	-0.30	-0.29	-0.30
	TDLF	-0.33	-0.30	-0.29	-0.30
49	NLF	-0.18	-0.17	-0.17	-0.17
	SDLF	-0.19	-0.17	-0.17	-0.17
	TDLF	-0.19	-0.18	-0.17	-0.18
50	NLF	-0.09	-0.09	-0.09	-0.09
	SDLF	-0.10	-0.09	-0.09	-0.09
	TDLF	-0.10	-0.09	-0.09	-0.10

Table G-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
51	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
52	NLF	0.10	0.10	0.10	0.09
	SDLF	0.10	0.10	0.10	0.10
	TDLF	0.10	0.10	0.10	0.10
53	NLF	0.20	0.20	0.20	0.20
	SDLF	0.20	0.21	0.21	0.20
	TDLF	0.20	0.21	0.21	0.20
54	NLF	0.42	0.43	0.43	0.42
	SDLF	0.43	0.43	0.43	0.43
	TDLF	0.44	0.45	0.44	0.43
55	NLF	0.67	0.66	0.65	0.65
	SDLF	0.68	0.66	0.66	0.65
	TDLF	0.70	0.68	0.67	0.66
56	NLF	0.87	0.85	0.84	0.84
	SDLF	0.88	0.86	0.85	0.85
	TDLF	0.92	0.88	0.86	0.86
57	NLF	1.02	0.99	0.98	0.98
	SDLF	1.03	1.00	0.99	0.99
	TDLF	1.08	1.03	1.00	1.00
58	NLF	1.09	1.06	1.05	1.05
	SDLF	1.10	1.07	1.06	1.06
	TDLF	1.16	1.10	1.07	1.08
59	NLF	1.08	1.06	1.04	1.04
	SDLF	1.10	1.07	1.05	1.06
	TDLF	1.15	1.10	1.07	1.07
60	NLF	1.00	0.97	0.96	0.96
	SDLF	1.01	0.98	0.97	0.97
	TDLF	1.06	1.01	0.98	0.98

Table G-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
61	NLF	0.85	0.82	0.81	0.81
	SDLF	0.86	0.83	0.82	0.82
	TDLF	0.90	0.86	0.84	0.83
62	NLF	0.62	0.62	0.61	0.61
	SDLF	0.63	0.63	0.62	0.62
	TDLF	0.66	0.65	0.64	0.63
63	NLF	0.39	0.39	0.39	0.39
	SDLF	0.39	0.40	0.40	0.40
	TDLF	0.41	0.41	0.41	0.40
64	NLF	0.19	0.19	0.19	0.19
	SDLF	0.19	0.19	0.19	0.19
	TDLF	0.20	0.20	0.20	0.20
65	NLF	0.10	0.09	0.09	0.09
	SDLF	0.10	0.09	0.09	0.09
	TDLF	0.10	0.10	0.10	0.10
66	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
67	NLF	-0.18	-0.19	-0.18	-0.18
	SDLF	-0.19	-0.19	-0.19	-0.19
	TDLF	-0.19	-0.20	-0.19	-0.19
68	NLF	-0.34	-0.34	-0.34	-0.34
	SDLF	-0.35	-0.34	-0.34	-0.34
	TDLF	-0.36	-0.35	-0.35	-0.35
69	NLF	-0.45	-0.44	-0.44	-0.45
	SDLF	-0.45	-0.45	-0.44	-0.45
	TDLF	-0.46	-0.46	-0.46	-0.46
70	NLF	-0.48	-0.49	-0.49	-0.50
	SDLF	-0.49	-0.49	-0.49	-0.50
	TDLF	-0.50	-0.50	-0.51	-0.52

Table G-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
71	NLF	-0.46	-0.47	-0.47	-0.48
	SDLF	-0.47	-0.47	-0.48	-0.48
	TDLF	-0.46	-0.48	-0.49	-0.51
72	NLF	-0.38	-0.39	-0.40	-0.41
	SDLF	-0.39	-0.40	-0.41	-0.41
	TDLF	-0.38	-0.40	-0.42	-0.44
73	NLF	-0.27	-0.28	-0.29	-0.30
	SDLF	-0.28	-0.29	-0.29	-0.30
	TDLF	-0.27	-0.29	-0.31	-0.32
74	NLF	-0.14	-0.15	-0.15	-0.16
	SDLF	-0.14	-0.15	-0.15	-0.16
	TDLF	-0.14	-0.15	-0.16	-0.17
75	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00

Table G-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
1	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
2	NLF	0.05	0.04	0.04	0.04
	SDLF	0.05	0.04	0.04	0.04
	TDLF	0.05	0.04	0.04	0.04
3	NLF	0.09	0.08	0.08	0.08
	SDLF	0.09	0.08	0.08	0.08
	TDLF	0.11	0.09	0.08	0.08
4	NLF	0.16	0.15	0.15	0.15
	SDLF	0.16	0.15	0.15	0.16
	TDLF	0.19	0.16	0.15	0.15
5	NLF	0.21	0.20	0.20	0.21
	SDLF	0.21	0.20	0.20	0.21
	TDLF	0.24	0.21	0.19	0.20
6	NLF	0.23	0.23	0.23	0.23
	SDLF	0.24	0.23	0.23	0.23
	TDLF	0.27	0.24	0.22	0.22
7	NLF	0.24	0.23	0.23	0.23
	SDLF	0.24	0.23	0.23	0.24
	TDLF	0.27	0.24	0.23	0.23
8	NLF	0.22	0.21	0.21	0.21
	SDLF	0.22	0.21	0.21	0.22
	TDLF	0.24	0.22	0.21	0.21
9	NLF	0.17	0.17	0.17	0.18
	SDLF	0.18	0.17	0.18	0.18
	TDLF	0.19	0.18	0.17	0.17
10	NLF	0.12	0.12	0.13	0.13
	SDLF	0.12	0.13	0.13	0.13
	TDLF	0.13	0.13	0.13	0.12

Table G-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
11	NLF	0.07	0.08	0.08	0.08
	SDLF	0.07	0.08	0.08	0.08
	TDLF	0.07	0.08	0.08	0.07
12	NLF	0.03	0.03	0.03	0.03
	SDLF	0.03	0.03	0.03	0.03
	TDLF	0.03	0.04	0.04	0.03
13	NLF	0.01	0.02	0.02	0.01
	SDLF	0.01	0.02	0.02	0.01
	TDLF	0.01	0.02	0.02	0.01
14	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
15	NLF	-0.01	-0.01	-0.01	-0.01
	SDLF	-0.01	-0.01	-0.01	-0.01
	TDLF	-0.01	-0.01	-0.01	-0.01
16	NLF	-0.02	-0.02	-0.02	-0.02
	SDLF	-0.03	-0.02	-0.02	-0.02
	TDLF	-0.03	-0.02	-0.02	-0.02
17	NLF	-0.04	-0.03	-0.03	-0.03
	SDLF	-0.04	-0.03	-0.03	-0.03
	TDLF	-0.04	-0.03	-0.02	-0.03
18	NLF	-0.03	-0.03	-0.03	-0.02
	SDLF	-0.04	-0.03	-0.02	-0.02
	TDLF	-0.03	-0.02	-0.02	-0.02
19	NLF	-0.02	-0.02	-0.01	-0.01
	SDLF	-0.02	-0.02	-0.01	0.00
	TDLF	-0.01	-0.01	-0.01	-0.01
20	NLF	0.00	0.00	0.00	0.01
	SDLF	0.00	0.00	0.01	0.01
	TDLF	0.02	0.01	0.01	0.01

Table G-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
21	NLF	0.02	0.02	0.02	0.02
	SDLF	0.02	0.02	0.02	0.03
	TDLF	0.04	0.03	0.02	0.03
22	NLF	0.03	0.03	0.03	0.03
	SDLF	0.03	0.03	0.03	0.04
	TDLF	0.05	0.04	0.03	0.04
23	NLF	0.03	0.03	0.03	0.03
	SDLF	0.03	0.03	0.03	0.04
	TDLF	0.05	0.04	0.03	0.04
24	NLF	0.02	0.02	0.02	0.03
	SDLF	0.03	0.02	0.03	0.03
	TDLF	0.04	0.03	0.03	0.03
25	NLF	0.01	0.01	0.02	0.02
	SDLF	0.01	0.02	0.02	0.02
	TDLF	0.02	0.02	0.02	0.02
26	NLF	0.00	0.00	0.01	0.00
	SDLF	0.00	0.01	0.01	0.01
	TDLF	0.00	0.01	0.01	0.00
27	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
28	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
29	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
30	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00

Table G-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
31	NLF	0.01	0.01	0.01	0.01
	SDLF	0.00	0.01	0.01	0.01
	TDLF	0.00	0.01	0.01	0.01
32	NLF	0.02	0.02	0.03	0.03
	SDLF	0.01	0.02	0.03	0.03
	TDLF	0.01	0.02	0.03	0.02
33	NLF	0.04	0.05	0.05	0.05
	SDLF	0.04	0.04	0.05	0.05
	TDLF	0.04	0.05	0.05	0.04
34	NLF	0.07	0.07	0.07	0.07
	SDLF	0.06	0.07	0.07	0.08
	TDLF	0.08	0.07	0.07	0.06
35	NLF	0.09	0.09	0.09	0.09
	SDLF	0.09	0.09	0.09	0.09
	TDLF	0.10	0.09	0.08	0.08
36	NLF	0.10	0.09	0.10	0.10
	SDLF	0.10	0.09	0.09	0.10
	TDLF	0.12	0.10	0.09	0.09
37	NLF	0.09	0.09	0.09	0.09
	SDLF	0.09	0.09	0.09	0.09
	TDLF	0.11	0.09	0.08	0.08
38	NLF	0.07	0.07	0.07	0.07
	SDLF	0.07	0.07	0.07	0.07
	TDLF	0.08	0.07	0.06	0.06
39	NLF	0.04	0.04	0.04	0.04
	SDLF	0.04	0.04	0.04	0.04
	TDLF	0.04	0.04	0.04	0.03
40	NLF	0.02	0.02	0.02	0.02
	SDLF	0.02	0.02	0.02	0.02
	TDLF	0.02	0.02	0.02	0.02

Table G-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
41	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
42	NLF	-0.02	-0.02	-0.02	-0.02
	SDLF	-0.02	-0.02	-0.02	-0.02
	TDLF	-0.02	-0.02	-0.02	-0.02
43	NLF	-0.04	-0.04	-0.03	-0.03
	SDLF	-0.04	-0.04	-0.03	-0.03
	TDLF	-0.04	-0.04	-0.03	-0.04
44	NLF	-0.07	-0.07	-0.07	-0.06
	SDLF	-0.08	-0.07	-0.07	-0.06
	TDLF	-0.08	-0.07	-0.07	-0.07
45	NLF	-0.10	-0.09	-0.09	-0.09
	SDLF	-0.10	-0.10	-0.09	-0.08
	TDLF	-0.10	-0.10	-0.09	-0.09
46	NLF	-0.11	-0.10	-0.10	-0.10
	SDLF	-0.12	-0.11	-0.10	-0.09
	TDLF	-0.12	-0.11	-0.10	-0.10
47	NLF	-0.11	-0.10	-0.10	-0.10
	SDLF	-0.12	-0.11	-0.10	-0.09
	TDLF	-0.12	-0.11	-0.10	-0.10
48	NLF	-0.09	-0.09	-0.08	-0.08
	SDLF	-0.10	-0.09	-0.08	-0.08
	TDLF	-0.11	-0.09	-0.08	-0.09
49	NLF	-0.05	-0.05	-0.05	-0.05
	SDLF	-0.06	-0.05	-0.05	-0.05
	TDLF	-0.06	-0.05	-0.05	-0.05
50	NLF	-0.03	-0.03	-0.03	-0.03
	SDLF	-0.03	-0.03	-0.03	-0.03
	TDLF	-0.03	-0.03	-0.03	-0.03

Table G-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
51	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
52	NLF	0.03	0.03	0.03	0.03
	SDLF	0.03	0.03	0.03	0.03
	TDLF	0.03	0.03	0.03	0.03
53	NLF	0.06	0.06	0.06	0.06
	SDLF	0.06	0.06	0.06	0.06
	TDLF	0.06	0.07	0.07	0.06
54	NLF	0.12	0.13	0.13	0.13
	SDLF	0.13	0.13	0.13	0.13
	TDLF	0.14	0.14	0.14	0.14
55	NLF	0.20	0.20	0.20	0.20
	SDLF	0.20	0.20	0.20	0.21
	TDLF	0.23	0.22	0.21	0.21
56	NLF	0.26	0.26	0.26	0.26
	SDLF	0.27	0.26	0.26	0.27
	TDLF	0.30	0.28	0.27	0.28
57	NLF	0.30	0.30	0.30	0.30
	SDLF	0.31	0.31	0.31	0.31
	TDLF	0.36	0.33	0.32	0.32
58	NLF	0.33	0.32	0.32	0.32
	SDLF	0.34	0.33	0.33	0.34
	TDLF	0.39	0.36	0.34	0.35
59	NLF	0.32	0.32	0.32	0.32
	SDLF	0.34	0.33	0.33	0.33
	TDLF	0.39	0.36	0.34	0.34
60	NLF	0.30	0.29	0.29	0.30
	SDLF	0.31	0.30	0.30	0.31
	TDLF	0.36	0.33	0.32	0.32

Table G-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5
61	NLF	0.25	0.25	0.25	0.25
	SDLF	0.26	0.26	0.26	0.26
	TDLF	0.30	0.28	0.27	0.27
62	NLF	0.19	0.19	0.19	0.19
	SDLF	0.19	0.19	0.20	0.20
	TDLF	0.22	0.21	0.21	0.21
63	NLF	0.12	0.12	0.12	0.12
	SDLF	0.12	0.12	0.13	0.13
	TDLF	0.13	0.14	0.14	0.13
64	NLF	0.06	0.06	0.06	0.06
	SDLF	0.06	0.06	0.06	0.06
	TDLF	0.06	0.06	0.07	0.07
65	NLF	0.03	0.03	0.03	0.03
	SDLF	0.03	0.03	0.03	0.03
	TDLF	0.03	0.03	0.03	0.03
66	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
67	NLF	-0.06	-0.06	-0.05	-0.05
	SDLF	-0.06	-0.06	-0.06	-0.05
	TDLF	-0.06	-0.06	-0.06	-0.06
68	NLF	-0.11	-0.10	-0.10	-0.10
	SDLF	-0.11	-0.11	-0.10	-0.10
	TDLF	-0.12	-0.11	-0.11	-0.11
69	NLF	-0.14	-0.13	-0.13	-0.13
	SDLF	-0.15	-0.14	-0.13	-0.13
	TDLF	-0.15	-0.15	-0.14	-0.14
70	NLF	-0.15	-0.15	-0.14	-0.14
	SDLF	-0.16	-0.15	-0.15	-0.14
	TDLF	-0.16	-0.16	-0.16	-0.16

Table G-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5
71	NLF	-0.14	-0.14	-0.14	-0.14
	SDLF	-0.15	-0.15	-0.14	-0.14
	TDLF	-0.15	-0.15	-0.16	-0.16
72	NLF	-0.12	-0.12	-0.12	-0.12
	SDLF	-0.13	-0.12	-0.12	-0.12
	TDLF	-0.12	-0.13	-0.13	-0.14
73	NLF	-0.09	-0.09	-0.08	-0.08
	SDLF	-0.09	-0.09	-0.09	-0.08
	TDLF	-0.08	-0.09	-0.10	-0.10
74	NLF	-0.05	-0.05	-0.04	-0.04
	SDLF	-0.05	-0.05	-0.05	-0.04
	TDLF	-0.04	-0.05	-0.05	-0.06
75	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00

Table G-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location			
		G1-G2	G2-G3	G3-G4	G4-G5
1	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
2	NLF	0.14	0.13	0.13	0.12
	SDLF	0.14	0.13	0.13	0.12
	TDLF	0.15	0.13	0.12	0.12
3	NLF	0.28	0.26	0.25	0.24
	SDLF	0.28	0.26	0.25	0.24
	TDLF	0.29	0.26	0.24	0.24
4	NLF	0.49	0.47	0.45	0.45
	SDLF	0.50	0.47	0.45	0.45
	TDLF	0.52	0.47	0.44	0.44
5	NLF	0.64	0.61	0.60	0.60
	SDLF	0.64	0.61	0.60	0.60
	TDLF	0.67	0.62	0.59	0.59
6	NLF	0.71	0.69	0.68	0.68
	SDLF	0.72	0.69	0.68	0.68
	TDLF	0.75	0.70	0.67	0.67
7	NLF	0.72	0.69	0.68	0.68
	SDLF	0.72	0.69	0.68	0.68
	TDLF	0.75	0.70	0.68	0.68
8	NLF	0.65	0.63	0.62	0.62
	SDLF	0.65	0.63	0.62	0.62
	TDLF	0.68	0.64	0.62	0.61
9	NLF	0.53	0.52	0.51	0.50
	SDLF	0.53	0.52	0.51	0.51
	TDLF	0.55	0.52	0.51	0.50
10	NLF	0.37	0.37	0.37	0.36
	SDLF	0.37	0.37	0.37	0.36
	TDLF	0.37	0.38	0.37	0.35

Table G-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
11	NLF	0.21	0.22	0.22	0.21
	SDLF	0.21	0.22	0.22	0.21
	TDLF	0.21	0.23	0.23	0.20
12	NLF	0.09	0.10	0.10	0.09
	SDLF	0.09	0.10	0.10	0.09
	TDLF	0.09	0.10	0.10	0.08
13	NLF	0.04	0.05	0.05	0.04
	SDLF	0.04	0.05	0.05	0.04
	TDLF	0.04	0.05	0.05	0.04
14	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
15	NLF	-0.04	-0.04	-0.04	-0.04
	SDLF	-0.04	-0.04	-0.03	-0.04
	TDLF	-0.04	-0.03	-0.03	-0.04
16	NLF	-0.07	-0.06	-0.06	-0.07
	SDLF	-0.07	-0.06	-0.06	-0.07
	TDLF	-0.07	-0.06	-0.06	-0.07
17	NLF	-0.11	-0.10	-0.09	-0.10
	SDLF	-0.11	-0.10	-0.09	-0.10
	TDLF	-0.11	-0.09	-0.09	-0.11
18	NLF	-0.10	-0.09	-0.09	-0.10
	SDLF	-0.10	-0.09	-0.09	-0.09
	TDLF	-0.10	-0.09	-0.08	-0.10
19	NLF	-0.06	-0.06	-0.06	-0.06
	SDLF	-0.06	-0.06	-0.06	-0.06
	TDLF	-0.05	-0.05	-0.05	-0.06
20	NLF	0.00	-0.01	-0.02	-0.01
	SDLF	0.00	-0.01	-0.01	-0.01
	TDLF	0.02	0.00	-0.01	-0.01

Table G-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
21	NLF	0.05	0.03	0.03	0.03
	SDLF	0.05	0.03	0.03	0.04
	TDLF	0.07	0.04	0.03	0.04
22	NLF	0.08	0.06	0.05	0.06
	SDLF	0.08	0.06	0.06	0.06
	TDLF	0.10	0.07	0.06	0.06
23	NLF	0.08	0.06	0.06	0.06
	SDLF	0.08	0.07	0.06	0.07
	TDLF	0.10	0.07	0.06	0.06
24	NLF	0.06	0.05	0.04	0.04
	SDLF	0.06	0.05	0.04	0.05
	TDLF	0.08	0.06	0.05	0.04
25	NLF	0.02	0.02	0.02	0.01
	SDLF	0.02	0.02	0.02	0.02
	TDLF	0.03	0.03	0.02	0.01
26	NLF	-0.01	-0.01	-0.01	-0.02
	SDLF	-0.01	0.00	0.00	-0.01
	TDLF	-0.01	0.00	0.00	-0.02
27	NLF	-0.02	-0.01	-0.01	-0.02
	SDLF	-0.02	-0.01	-0.01	-0.02
	TDLF	-0.02	-0.01	-0.01	-0.02
28	NLF	-0.01	-0.01	-0.01	-0.01
	SDLF	-0.01	-0.01	-0.01	-0.01
	TDLF	-0.01	-0.01	-0.01	-0.01
29	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
30	NLF	0.01	0.02	0.02	0.01
	SDLF	0.01	0.02	0.02	0.01
	TDLF	0.01	0.01	0.02	0.01

Table G-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
31	NLF	0.03	0.04	0.04	0.03
	SDLF	0.03	0.04	0.04	0.03
	TDLF	0.03	0.04	0.04	0.03
32	NLF	0.09	0.10	0.10	0.09
	SDLF	0.08	0.10	0.10	0.09
	TDLF	0.08	0.10	0.10	0.09
33	NLF	0.18	0.18	0.18	0.17
	SDLF	0.17	0.18	0.18	0.17
	TDLF	0.18	0.18	0.17	0.16
34	NLF	0.27	0.26	0.26	0.25
	SDLF	0.27	0.26	0.26	0.26
	TDLF	0.28	0.26	0.25	0.24
35	NLF	0.34	0.32	0.31	0.31
	SDLF	0.34	0.32	0.31	0.31
	TDLF	0.36	0.32	0.30	0.30
36	NLF	0.36	0.34	0.33	0.33
	SDLF	0.36	0.34	0.33	0.33
	TDLF	0.38	0.35	0.32	0.32
37	NLF	0.33	0.32	0.30	0.30
	SDLF	0.33	0.31	0.30	0.30
	TDLF	0.35	0.32	0.30	0.29
38	NLF	0.25	0.24	0.23	0.23
	SDLF	0.25	0.24	0.23	0.23
	TDLF	0.26	0.24	0.23	0.22
39	NLF	0.13	0.13	0.12	0.12
	SDLF	0.13	0.13	0.12	0.12
	TDLF	0.13	0.13	0.12	0.12
40	NLF	0.07	0.06	0.06	0.06
	SDLF	0.07	0.06	0.06	0.06
	TDLF	0.07	0.06	0.06	0.06

Table G-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location			
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**
41	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
42	NLF	-0.06	-0.06	-0.06	-0.06
	SDLF	-0.06	-0.06	-0.06	-0.06
	TDLF	-0.06	-0.06	-0.06	-0.06
43	NLF	-0.12	-0.12	-0.12	-0.12
	SDLF	-0.13	-0.12	-0.12	-0.12
	TDLF	-0.13	-0.12	-0.12	-0.13
44	NLF	-0.23	-0.23	-0.23	-0.23
	SDLF	-0.24	-0.23	-0.23	-0.23
	TDLF	-0.24	-0.23	-0.23	-0.23
45	NLF	-0.31	-0.31	-0.30	-0.31
	SDLF	-0.31	-0.31	-0.30	-0.30
	TDLF	-0.31	-0.31	-0.31	-0.31
46	NLF	-0.34	-0.34	-0.34	-0.34
	SDLF	-0.35	-0.35	-0.34	-0.34
	TDLF	-0.35	-0.35	-0.34	-0.35
47	NLF	-0.34	-0.34	-0.33	-0.33
	SDLF	-0.35	-0.34	-0.33	-0.33
	TDLF	-0.36	-0.34	-0.33	-0.34
48	NLF	-0.29	-0.28	-0.27	-0.28
	SDLF	-0.30	-0.28	-0.27	-0.28
	TDLF	-0.31	-0.28	-0.27	-0.28
49	NLF	-0.17	-0.16	-0.16	-0.16
	SDLF	-0.17	-0.16	-0.16	-0.16
	TDLF	-0.18	-0.16	-0.16	-0.17
50	NLF	-0.09	-0.08	-0.08	-0.09
	SDLF	-0.09	-0.09	-0.08	-0.09
	TDLF	-0.09	-0.09	-0.08	-0.09

Table G-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
51	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
52	NLF	0.09	0.09	0.09	0.09
	SDLF	0.09	0.09	0.09	0.09
	TDLF	0.09	0.10	0.09	0.09
53	NLF	0.18	0.19	0.19	0.18
	SDLF	0.18	0.19	0.19	0.19
	TDLF	0.19	0.20	0.20	0.19
54	NLF	0.39	0.40	0.40	0.39
	SDLF	0.40	0.40	0.40	0.40
	TDLF	0.41	0.42	0.41	0.40
55	NLF	0.62	0.61	0.61	0.60
	SDLF	0.63	0.62	0.61	0.61
	TDLF	0.65	0.63	0.62	0.61
56	NLF	0.81	0.79	0.78	0.78
	SDLF	0.82	0.80	0.79	0.79
	TDLF	0.86	0.82	0.80	0.80
57	NLF	0.95	0.93	0.91	0.91
	SDLF	0.96	0.93	0.92	0.93
	TDLF	1.00	0.96	0.93	0.93
58	NLF	1.01	0.99	0.98	0.98
	SDLF	1.03	1.00	0.99	0.99
	TDLF	1.08	1.03	1.00	1.00
59	NLF	1.01	0.98	0.97	0.97
	SDLF	1.02	0.99	0.98	0.98
	TDLF	1.07	1.02	0.99	0.99
60	NLF	0.93	0.91	0.89	0.89
	SDLF	0.94	0.92	0.90	0.90
	TDLF	0.99	0.94	0.92	0.91

Table G-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
61	NLF	0.79	0.77	0.76	0.75
	SDLF	0.80	0.77	0.76	0.76
	TDLF	0.84	0.80	0.78	0.77
62	NLF	0.58	0.58	0.57	0.57
	SDLF	0.59	0.58	0.58	0.58
	TDLF	0.62	0.60	0.59	0.58
63	NLF	0.36	0.36	0.37	0.36
	SDLF	0.36	0.37	0.37	0.37
	TDLF	0.38	0.38	0.38	0.37
64	NLF	0.18	0.17	0.18	0.18
	SDLF	0.18	0.18	0.18	0.18
	TDLF	0.18	0.18	0.18	0.18
65	NLF	0.09	0.09	0.09	0.09
	SDLF	0.09	0.09	0.09	0.09
	TDLF	0.09	0.09	0.09	0.09
66	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00
67	NLF	-0.17	-0.17	-0.17	-0.17
	SDLF	-0.17	-0.18	-0.17	-0.17
	TDLF	-0.18	-0.18	-0.18	-0.18
68	NLF	-0.32	-0.32	-0.31	-0.32
	SDLF	-0.33	-0.32	-0.32	-0.32
	TDLF	-0.33	-0.33	-0.32	-0.33
69	NLF	-0.41	-0.41	-0.41	-0.42
	SDLF	-0.42	-0.42	-0.41	-0.42
	TDLF	-0.43	-0.43	-0.42	-0.43
10	NLF	-0.45	-0.45	-0.46	-0.46
	SDLF	-0.46	-0.46	-0.46	-0.46
	TDLF	-0.46	-0.47	-0.47	-0.49

Table G-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location			
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5
71	NLF	-0.43	-0.43	-0.44	-0.45
	SDLF	-0.43	-0.44	-0.45	-0.45
	TDLF	-0.43	-0.45	-0.46	-0.48
72	NLF	-0.36	-0.37	-0.38	-0.39
	SDLF	-0.36	-0.37	-0.38	-0.39
	TDLF	-0.36	-0.37	-0.39	-0.41
73	NLF	-0.25	-0.26	-0.27	-0.28
	SDLF	-0.26	-0.27	-0.27	-0.28
	TDLF	-0.25	-0.27	-0.29	-0.30
74	NLF	-0.13	-0.14	-0.14	-0.15
	SDLF	-0.13	-0.14	-0.14	-0.15
	TDLF	-0.13	-0.14	-0.15	-0.16
75	NLF	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00

Table G-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number													
		SDL 1	SDL 2	SDL 3	SDL 4	SDL 5	SDL 6	SDL 7	TDL 1	TDL 2	TDL 3	TDL 4	TDL 5	TDL 6	TDL 7
G1	NLF	58.3	185.9	150.8	77.3	138.1	177.5	25.3	192.8	549.3	477.6	289.6	443.3	573.0	102.3
	SDLF	58.8	184.2	149.4	76.8	136.5	176.6	25.4	193.4	547.5	476.2	289.1	441.7	572.1	102.5
	TDLF	60.9	183.8	149.5	79.2	136.5	178.2	26.5	195.4	547.1	476.3	291.6	441.6	573.7	103.5
G2	NLF	50.4	187.4	151.1	79.5	128.5	155.7	27.2	162.2	547.6	469.1	280.0	402.5	488.4	101.9
	SDLF	50.4	190.1	153.2	80.2	130.7	155.6	27.4	162.2	550.3	471.2	280.7	404.7	488.2	102.1
	TDLF	49.6	194.5	156.1	79.6	134.0	152.9	27.5	161.5	554.7	474.1	280.1	408.0	485.6	102.1
G3	NLF	45.1	181.9	146.1	77.7	126.3	149.2	28.4	145.6	532.8	453.9	271.9	396.6	470.0	105.7
	SDLF	45.1	182.8	147.3	78.7	127.7	150.6	28.7	145.6	533.7	455.1	273.0	398.0	471.5	106.0
	TDLF	44.2	182.0	147.5	78.4	128.1	151.3	28.8	144.7	532.9	455.4	272.6	398.4	472.2	106.0
G4	NLF	40.1	175.8	142.7	78.0	122.1	146.8	29.5	130.7	521.5	448.3	276.2	389.4	467.5	109.1
	SDLF	40.2	173.3	141.5	78.4	120.8	147.0	29.8	130.9	519.1	447.1	276.6	388.1	467.7	109.4
	TDLF	39.9	164.6	135.5	76.4	115.0	144.9	30.1	130.6	510.3	441.1	274.6	382.3	465.6	109.6
G5	NLF	33.9	186.1	152.5	79.8	124.3	143.3	30.0	118.5	585.6	507.5	304.2	423.4	480.5	116.9
	SDLF	34.2	185.1	152.2	79.8	122.3	141.3	30.3	118.8	584.7	507.2	304.2	421.4	478.5	117.2
	TDLF	35.7	187.9	155.5	83.6	122.1	140.6	31.6	120.3	587.4	510.6	308.0	421.1	477.8	118.5

Table G-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	SDL 5	SDL 6	SDL 7	TDL 1	TDL 2	TDL 3	TDL 4	TDL 5	TDL 6	TDL 7
		Load Type & Support Number													
G1	NLF	NA	NA	NA	0.1	NA	NA	NA	NA	NA	NA	0.2	NA	NA	NA
	SDLF	NA	NA	NA	0.1	NA	NA	NA	NA	NA	NA	0.2	NA	NA	NA
	TDLF	NA	NA	NA	0.1	NA	NA	NA	NA	NA	NA	0.2	NA	NA	NA
G2	NLF	NA	NA	NA	0.0	NA	NA	NA	NA	NA	NA	0.1	NA	NA	NA
	SDLF	NA	NA	NA	0.0	NA	NA	NA	NA	NA	NA	0.1	NA	NA	NA
	TDLF	NA	NA	NA	0.0	NA	NA	NA	NA	NA	NA	0.1	NA	NA	NA
G3	NLF	NA	NA	NA	0.0	NA	NA	NA	NA	NA	NA	0.0	NA	NA	NA
	SDLF	NA	NA	NA	0.0	NA	NA	NA	NA	NA	NA	0.0	NA	NA	NA
	TDLF	NA	NA	NA	0.0	NA	NA	NA	NA	NA	NA	0.0	NA	NA	NA
G4	NLF	NA	NA	NA	0.0	NA	NA	NA	NA	NA	NA	-0.1	NA	NA	NA
	SDLF	NA	NA	NA	0.0	NA	NA	NA	NA	NA	NA	-0.1	NA	NA	NA
	TDLF	NA	NA	NA	0.0	NA	NA	NA	NA	NA	NA	-0.1	NA	NA	NA
G5	NLF	NA	NA	NA	-0.1	NA	NA	NA	NA	NA	NA	-0.2	NA	NA	NA
	SDLF	NA	NA	NA	-0.1	NA	NA	NA	NA	NA	NA	-0.2	NA	NA	NA
	TDLF	NA	NA	NA	-0.1	NA	NA	NA	NA	NA	NA	-0.2	NA	NA	NA

Table G-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number													
		SDL 1	SDL 2	SDL 3	SDL 4	SDL 5	SDL 6	SDL 7	TDL 1	TDL 2	TDL 3	TDL 4	TDL 5	TDL 6	TDL 7
G1	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
G2	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G3	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G4	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
G5	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.2
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.2
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2

Table G-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	SDL 5	SDL 6	SDL 7	TDL 1	TDL 2	TDL 3	TDL 4	TDL 5	TDL 6	TDL 7
G1	NLF	-0.13	0.01	-0.02	0.01	-0.13	-0.13	-0.13	-0.44	0.02	-0.08	0.04	-0.44	-0.44	-0.44
	SDLF	-0.13	0.01	-0.01	0.01	-0.12	-0.12	-0.12	-0.43	0.02	-0.08	0.04	-0.43	-0.43	-0.43
	TDLF	-0.11	0.01	0.00	0.01	-0.11	-0.11	-0.11	-0.41	0.02	-0.07	0.04	-0.41	-0.41	-0.41
G2	NLF	-0.14	0.00	-0.02	0.01	-0.12	-0.12	-0.12	-0.45	-0.01	-0.09	0.02	-0.40	-0.40	-0.40
	SDLF	-0.13	0.00	-0.02	0.01	-0.11	-0.11	-0.11	-0.44	-0.01	-0.08	0.02	-0.39	-0.39	-0.39
	TDLF	-0.11	0.00	0.00	0.01	-0.09	-0.09	-0.09	-0.42	-0.01	-0.07	0.02	-0.37	-0.37	-0.37
G3	NLF	-0.12	-0.01	-0.02	0.00	-0.11	-0.11	-0.11	-0.41	-0.03	-0.09	0.00	-0.35	-0.35	-0.35
	SDLF	-0.12	-0.01	-0.02	0.00	-0.10	-0.10	-0.10	-0.40	-0.04	-0.08	0.00	-0.35	-0.35	-0.35
	TDLF	-0.10	-0.01	0.00	0.00	-0.08	-0.08	-0.08	-0.38	-0.04	-0.07	0.00	-0.33	-0.33	-0.33
G4	NLF	-0.11	-0.01	-0.02	-0.01	-0.09	-0.09	-0.09	-0.37	-0.05	-0.08	-0.02	-0.31	-0.31	-0.31
	SDLF	-0.10	-0.01	-0.02	-0.01	-0.09	-0.09	-0.09	-0.37	-0.06	-0.08	-0.02	-0.31	-0.31	-0.31
	TDLF	-0.08	-0.02	0.00	-0.01	-0.07	-0.07	-0.07	-0.35	-0.06	-0.06	-0.02	-0.29	-0.29	-0.29
G5	NLF	-0.10	-0.02	-0.02	-0.01	-0.08	-0.08	-0.08	-0.33	-0.07	-0.08	-0.05	-0.27	-0.27	-0.27
	SDLF	-0.09	-0.02	-0.01	-0.01	-0.07	-0.07	-0.07	-0.33	-0.08	-0.07	-0.05	-0.27	-0.27	-0.27
	TDLF	-0.07	-0.02	0.00	-0.01	-0.05	-0.05	-0.05	-0.31	-0.08	-0.06	-0.05	-0.25	-0.25	-0.25

Table G-4-15. Transverse displacements at supports (in).

		Load Type & Support Number													
Girder	Detailing Method	SDL	SDL	SDL	SDL	SDL	SDL	SDL	TDL	TDL	TDL	TDL	TDL	TDL	TDL
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
G1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01
G2	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01
G3	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
G4	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
G5	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01

Appendix G-5. EICCR4 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge EICCR4 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table G-5-1. Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
12	12-1	NLF	1.6	2.2	2.7	1.6	-2.1	2.6
		SDLF	2.0	2.7	3.4	1.9	-2.6	3.2
		TDLF	3.1	4.1	5.1	2.7	-3.9	4.7
	12-2	NLF	1.3	2.4	2.7	1.3	-2.3	2.6
		SDLF	1.9	3.1	3.6	1.7	-3.0	3.4
		TDLF	3.4	4.8	5.9	2.7	-4.6	5.3
	12-3	NLF	0.7	2.3	2.4	0.7	-2.2	2.3
		SDLF	1.5	3.2	3.5	1.2	-3.0	3.2
		TDLF	3.4	5.2	6.2	2.2	-5.0	5.5
	12-4	NLF	0.1	1.5	1.5	0.0	-1.4	1.4
		SDLF	0.9	2.4	2.6	0.5	-2.3	2.4
		TDLF	3.0	4.6	5.5	1.7	-4.5	4.8
	12-5	NLF	-0.4	-0.2	0.5	-0.4	0.3	0.5
		SDLF	0.4	0.7	0.9	0.1	-0.7	0.7
		TDLF	2.5	3.0	3.9	1.2	-2.9	3.2
	12-6	NLF	-0.6	-1.6	1.7	-0.7	1.6	1.8
		SDLF	0.1	-0.7	0.7	-0.2	0.8	0.8
		TDLF	1.8	1.2	2.2	0.8	-1.2	1.4
	12-7	NLF	-0.6	-1.7	1.8	-0.6	1.7	1.8
		SDLF	-0.1	-1.1	1.1	-0.3	1.1	1.1
		TDLF	1.0	0.3	1.0	0.5	-0.3	0.5
	12-8	NLF	-0.3	-0.9	1.0	-0.3	0.9	1.0
		SDLF	-0.1	-0.7	0.7	-0.2	0.6	0.7
		TDLF	0.5	0.0	0.5	0.1	0.0	0.1

Table G-5-1(Continued). Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
15	15-1	NLF	-5.9	0.8	6.0	-5.9	-0.8	6.0
		SDLF	-4.9	1.4	5.1	-5.0	-1.3	5.1
		TDLF	-3.0	2.7	4.0	-3.1	-2.5	4.0
	15-2	NLF	-6.5	0.4	6.5	-6.5	-0.3	6.5
		SDLF	-5.4	1.2	5.6	-5.5	-1.1	5.6
		TDLF	-3.2	2.9	4.3	-3.3	-2.8	4.3
	15-3	NLF	-5.8	0.1	5.8	-5.8	0.0	5.8
		SDLF	-4.8	1.0	4.9	-4.8	-0.9	4.9
		TDLF	-2.4	3.1	3.9	-2.7	-3.0	4.0
	15-4	NLF	-5.2	-0.8	5.3	-5.2	0.9	5.3
		SDLF	-4.2	0.3	4.2	-4.3	-0.1	4.3
		TDLF	-2.1	2.6	3.3	-2.3	-2.5	3.4
	15-5	NLF	-5.3	-2.0	5.7	-5.3	2.2	5.7
		SDLF	-4.4	-1.0	4.5	-4.5	1.1	4.6
		TDLF	-2.6	1.3	2.9	-2.9	-1.2	3.1
	15-6	NLF	-5.0	-2.5	5.6	-5.1	2.7	5.8
		SDLF	-4.3	-1.7	4.6	-4.5	1.8	4.8
		TDLF	-3.0	0.3	3.0	-3.2	-0.2	3.3
	15-7	NLF	-3.1	-1.8	3.6	-3.2	1.8	3.7
		SDLF	-2.7	-1.2	3.0	-2.7	1.2	3.0
		TDLF	-2.0	0.1	2.0	-2.0	-0.1	2.0
	15-8	NLF	-1.4	-0.9	1.6	-1.4	0.9	1.7
		SDLF	-1.1	-0.6	1.2	-1.1	0.6	1.3
		TDLF	-0.6	0.1	0.6	-0.8	-0.1	0.8

Table G-5-1(Continued). Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
37	37-1	NLF	0.6	0.6	0.9	0.2	-0.6	0.6
		SDLF	0.2	0.7	0.7	0.6	-0.6	0.8
		TDLF	-0.6	0.7	0.9	1.4	-0.7	1.6
	37-2	NLF	1.5	2.9	3.3	1.5	-2.7	3.1
		SDLF	1.7	3.1	3.6	1.6	-2.9	3.3
		TDLF	2.3	3.8	4.4	1.9	-3.5	4.0
	37-3	NLF	1.5	3.1	3.4	1.5	-2.8	3.2
		SDLF	1.9	3.4	3.9	1.7	-3.2	3.6
		TDLF	2.6	4.3	5.0	2.1	-4.0	4.5
	37-4	NLF	1.5	3.3	3.6	1.5	-3.2	3.5
		SDLF	2.0	3.8	4.3	1.7	-3.6	4.0
		TDLF	3.1	5.0	5.9	2.3	-4.8	5.3
	37-5	NLF	1.2	3.2	3.4	1.2	-3.0	3.3
		SDLF	1.6	3.8	4.1	1.9	-3.7	4.1
		TDLF	2.4	5.3	5.8	3.3	-5.2	6.1
	37-6	NLF	0.8	1.7	1.9	0.8	-1.7	1.8
		SDLF	2.2	2.5	3.3	0.4	-2.4	2.4
		TDLF	5.5	4.1	6.9	-0.5	-4.0	4.0
	37-7	NLF	0.2	0.0	0.2	0.2	0.1	0.3
		SDLF	0.9	0.7	1.1	0.5	-0.6	0.8
		TDLF	2.4	2.1	3.2	1.1	-2.1	2.3
	37-8	NLF	-0.2	-1.1	1.1	-0.2	1.2	1.2
		SDLF	0.3	-0.5	0.6	0.1	0.6	0.6
		TDLF	1.3	0.6	1.4	0.7	-0.6	0.9
	37-9	NLF	-0.4	-1.3	1.4	-0.4	1.3	1.4
		SDLF	-0.1	-0.9	1.0	-0.2	0.9	0.9
		TDLF	0.4	-0.2	0.5	0.3	0.1	0.3

Table G-5-1(Continued). Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
40	40-1	NLF	0.1	-0.2	0.2	-0.2	0.2	0.2
		SDLF	-0.2	-0.1	0.2	0.1	0.1	0.1
		TDLF	-0.8	0.0	0.8	0.6	0.0	0.6
	40-2	NLF	-7.7	-0.3	7.7	-7.7	0.4	7.8
		SDLF	-6.2	0.8	6.3	-6.3	-0.7	6.3
		TDLF	-3.4	3.2	4.7	-3.6	-3.1	4.7
	40-3	NLF	-6.7	0.2	6.7	-6.7	-0.1	6.7
		SDLF	-4.8	2.1	5.2	-4.9	-2.0	5.3
		TDLF	-1.2	6.1	6.2	-1.4	-6.0	6.1
	40-4	NLF	-5.9	0.6	5.9	-5.9	-0.5	5.9
		SDLF	-3.3	3.7	4.9	-3.3	-3.6	4.9
		TDLF	2.0	10.1	10.3	1.9	-10.0	10.2
	40-5	NLF	-4.4	0.4	4.4	-4.4	-0.3	4.4
		SDLF	-1.6	4.4	4.7	-1.2	-4.4	4.5
		TDLF	4.5	13.0	13.7	5.7	-13.0	14.1
	40-6	NLF	-4.2	-0.8	4.3	-4.2	1.0	4.3
		SDLF	-0.3	3.9	3.9	-1.5	-3.8	4.1
		TDLF	8.0	13.8	16.0	4.2	-13.7	14.3
	40-7	NLF	-4.3	-1.6	4.6	-4.3	1.7	4.6
		SDLF	-1.1	2.9	3.1	-1.3	-2.8	3.1
		TDLF	5.6	12.2	13.4	5.2	-12.3	13.3
	40-8	NLF	-3.0	-1.2	3.2	-3.0	1.3	3.3
		SDLF	-0.3	2.7	2.8	-0.3	-2.7	2.7
		TDLF	5.4	10.9	12.2	5.3	-10.9	12.1
	40-9	NLF	-1.1	-0.6	1.2	-1.1	0.5	1.2
		SDLF	1.0	2.5	2.7	1.0	-2.5	2.7
		TDLF	5.2	8.9	10.3	5.3	-8.9	10.4

Table G-5-2: Erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
12	NLF	12-2
	SDLF	12-2
	TDLF	12-3
15	NLF	15-2
	SDLF	15-2
	TDLF	15-2
37	NLF	37-4
	SDLF	37-5
	TDLF	37-5
40	NLF	40-2
	SDLF	40-2
	TDLF	40-6

Table G-5-3. Erection critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
12	A	NLF	1.5	0.9	1.7	NA	NA	NA
		SDLF	2.1	1.1	2.4	NA	NA	NA
		TDLF	3.0	2.0	3.6	NA	NA	NA
	B	NLF	1.3	2.4	2.7	1.3	-2.3	2.6
		SDLF	1.9	3.1	3.6	1.7	-3.0	3.4
		TDLF	3.4	5.2	6.2	2.2	-5.0	5.5
15	A	NLF	-11.2	0.2	11.2	NA	NA	NA
		SDLF	-9.5	0.5	9.5	NA	NA	NA
		TDLF	-5.9	1.1	6.0	NA	NA	NA
	B	NLF	-6.5	0.4	6.5	-6.5	-0.3	6.5
		SDLF	-5.4	1.2	5.6	-5.5	-1.1	5.6
		TDLF	-3.2	2.9	4.3	-3.3	-2.8	4.3
37	A	NLF	1.5	1.4	2.1	NA	NA	NA
		SDLF	1.8	1.7	2.5	NA	NA	NA
		TDLF	3.3	2.2	3.9	NA	NA	NA
	B	NLF	1.5	3.3	3.6	1.5	-3.2	3.5
		SDLF	1.6	3.8	4.1	1.9	-3.7	4.1
		TDLF	2.4	5.3	5.8	3.3	-5.2	6.1
40	A	NLF	-12.3	-0.1	12.3	NA	NA	NA
		SDLF	-12.4	1.8	12.6	NA	NA	NA
		TDLF	2.7	2.9	4.0	NA	NA	NA
	B	NLF	-7.7	-0.3	7.7	-7.7	0.4	7.8
		SDLF	-6.2	0.8	6.3	-6.3	-0.7	6.3
		TDLF	8.0	13.8	16.0	4.2	-13.7	14.3

Table G-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
12	A	G1	NLF	27.7	69.8	55.8	136.3	33.5		
			SDLF	25.2	67.5	55.7	135.8	33.4		
			TDLF	24.1	66.8	56.9	140.2	33.8		
		G2	NLF	22.7	59.0	21.4	42.8	21.4	101.3	36.3
			SDLF	26.5	60.4	21.4	42.8	21.3	101.3	36.3
			TDLF	30.2	63.7	18.6	37.1	18.5	98.9	35.7
		G3	NLF	16.0	54.9	109.0	38.3			
			SDLF	18.4	55.7	110.6	38.4			
			TDLF	20.2	55.6	112.3	37.8			
		G4	NLF	12.0	53.7	104.0	40.3			
			SDLF	10.0	53.0	104.6	40.3			
			TDLF	7.0	48.2	104.0	39.9			
		G-5	NLF	6.8	54.5	91.6	41.6			
			SDLF	6.2	54.1	90.3	41.6			
			TDLF	7.4	55.9	91.1	42.2			
	B	G1	NLF	27.7	69.9	56.6	137.0	33.4		
			SDLF	25.3	67.5	56.7	136.5	33.3		
			TDLF	24.0	67.3	58.7	141.1	33.8		
		G2	NLF	22.7	59.6	20.6	41.1	20.5	101.2	36.2
			SDLF	26.5	61.1	20.4	40.7	20.3	101.1	36.2
			TDLF	30.0	64.4	16.5	33.0	16.5	98.8	35.6
		G3	NLF	16.1	55.1	109.2	38.3			
			SDLF	18.4	55.9	110.8	38.3			
			TDLF	20.1	56.0	112.7	37.7			
		G4	NLF	12.1	53.5	104.3	40.2			
			SDLF	10.1	52.8	104.9	40.3			
			TDLF	6.9	48.4	104.4	39.9			
		G-5	NLF	6.9	54.3	91.7	41.5			
			SDLF	6.3	53.9	90.4	41.5			
			TDLF	7.4	55.9	91.3	42.2			

Table G-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
15	A	G1	NLF	0.0	134.8	188.6	22.7			
			SDLF	0.0	133.3	186.8	23.0			
			TDLF	0.0	133.2	186.5	24.4			
		G2	NLF	0.0	111.1	156.4	26.5			
			SDLF	0.0	113.3	156.0	26.8			
			TDLF	0.0	116.9	152.9	26.9			
		G3	NLF	0.0	97.0	139.3	29.5			
			SDLF	0.0	98.9	141.2	29.7			
			TDLF	0.0	100.1	143.0	29.6			
		G4	NLF	0.0	81.6	123.8	32.3			
			SDLF	0.0	81.0	125.2	32.4			
			TDLF	0.0	76.3	125.6	32.3			
		G-5	NLF	4.6	66.7	35.1	70.2	35.1	122.5	34.6
			SDLF	5.7	65.2	34.0	68.1	34.1	121.0	34.6
			TDLF	9.4	64.3	32.1	64.3	32.2	121.2	35.3
	B	G1	NLF	0.0	134.8	188.6	22.7			
			SDLF	0.0	133.3	186.8	23.0			
			TDLF	0.0	133.4	186.4	24.4			
		G2	NLF	0.0	111.1	156.4	26.5			
			SDLF	0.0	113.3	156.0	26.8			
			TDLF	0.0	116.9	152.9	26.9			
		G3	NLF	0.0	97.1	139.3	29.5			
			SDLF	0.0	98.9	141.3	29.7			
			TDLF	0.0	100.0	143.2	29.6			
		G4	NLF	0.0	81.7	123.9	32.3			
			SDLF	0.0	81.1	125.4	32.4			
			TDLF	0.0	76.3	126.1	32.3			
		G-5	NLF	4.7	66.5	35.3	70.7	35.4	122.3	34.6
			SDLF	5.9	65.0	34.2	68.4	34.3	120.8	34.6
			TDLF	9.8	64.2	32.0	64.0	32.1	121.2	35.2

Table G-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number									
				1	2	3	4	5	6	7	8	9	10
37	A	G1	NLF	18.5	43.1	165.8	158.5	72.7	139.8	176.9	25.4		
			SDLF	19.8	44.5	165.7	156.7	72.4	138.1	176.1	25.5		
			TDLF	21.7	43.4	166.4	156.2	75.3	137.9	177.7	26.6		
		G2	NLF	15.2	12.2	24.4	12.2	153.2	161.1	74.9	129.9	155.4	27.3
			SDLF	18.9	8.0	16.0	8.0	156.6	162.7	75.8	132.1	155.2	27.5
			TDLF	20.4	5.7	11.4	5.7	161.6	164.8	75.6	135.2	152.6	27.6
		G3	NLF	0.0	146.0	156.4	73.6	127.6	148.9	28.5			
			SDLF	0.0	147.5	157.2	74.8	128.9	150.4	28.8			
			TDLF	0.0	147.6	156.8	74.7	129.2	151.1	28.8			
		G4	NLF	0.0	134.3	153.8	74.2	123.2	146.6	29.6			
			SDLF	0.0	132.8	152.2	74.8	121.9	146.8	29.9			
			TDLF	0.0	125.5	145.6	72.9	116.0	144.7	30.1			
		G-5	NLF	0.0	119.8	167.8	75.9	125.4	143.2	30.1			
			SDLF	0.0	120.4	167.0	76.1	123.4	141.2	30.3			
			TDLF	0.0	125.3	169.7	80.1	123.1	140.5	31.6			
	B	G1	NLF	18.5	44.6	166.5	158.4	72.8	139.8	176.9	25.4		
			SDLF	19.6	46.2	166.2	156.6	72.5	138.1	176.1	25.5		
			TDLF	21.4	45.6	167.1	156.1	75.3	137.9	177.8	26.6		
		G2	NLF	17.2	10.0	20.1	10.0	153.3	161.0	74.9	129.9	155.4	27.3
			SDLF	21.0	5.8	11.5	5.8	156.8	162.6	75.8	132.1	155.2	27.5
			TDLF	23.2	2.8	5.5	2.8	161.9	164.7	75.6	135.2	152.6	27.6
		G3	NLF	0.0	146.1	156.3	73.6	127.6	148.9	28.5			
			SDLF	0.0	147.7	157.1	74.8	128.9	150.4	28.8			
			TDLF	0.0	147.9	156.7	74.7	129.2	151.1	28.8			
		G4	NLF	0.0	134.6	153.7	74.3	123.2	146.6	29.6			
			SDLF	0.0	133.0	152.2	74.8	121.9	146.8	29.9			
			TDLF	0.0	125.8	145.6	73.0	116.0	144.7	30.1			
		G-5	NLF	0.0	120.2	167.7	76.0	125.4	143.2	30.1			
			SDLF	0.0	120.6	166.9	76.1	123.4	141.2	30.3			
			TDLF	0.0	125.6	169.7	80.1	123.1	140.5	31.6			

Table G-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number									
				1	2	3	4	5	6	7	8	9	10
40	A	G1	NLF	62.2	193.6	149.9	77.6	138.0	177.5	25.3			
			SDLF	64.5	191.0	148.4	77.1	136.4	176.6	25.4			
			TDLF	65.8	189.4	148.7	79.6	136.4	178.2	26.5			
		G2	NLF	50.5	188.0	151.1	79.5	128.4	155.7	27.2			
			SDLF	48.8	190.9	153.1	80.3	130.7	155.6	27.4			
			TDLF	48.3	195.1	156.0	79.6	133.9	152.9	27.5			
		G3	NLF	40.6	174.0	147.1	77.3	126.4	149.2	28.4			
			SDLF	36.0	176.1	148.3	78.4	127.8	150.6	28.7			
			TDLF	36.2	176.4	148.4	78.1	128.1	151.3	28.8			
		G4	NLF	15.4	160.0	145.1	77.2	122.3	146.7	29.6			
			SDLF	22.8	158.6	144.0	77.6	121.0	146.9	29.9			
			TDLF	24.4	151.9	137.6	75.7	115.2	144.9	30.1			
		G-5	NLF	14.0	34.3	68.6	34.3	164.6	157.5	78.4	124.7	143.2	30.0
			SDLF	9.6	38.3	76.5	38.2	159.9	157.4	78.3	122.7	141.3	30.3
			TDLF	13.9	33.7	67.3	33.6	165.8	160.0	82.4	122.4	140.5	31.6
	B	G1	NLF	62.6	193.7	149.9	77.6	138.0	177.5	25.3			
			SDLF	62.8	191.4	148.6	77.1	136.4	176.6	25.4			
			TDLF	65.6	189.3	148.7	79.6	136.4	178.2	26.5			
		G2	NLF	51.0	188.0	151.1	79.5	128.4	155.7	27.2			
			SDLF	50.7	190.7	153.2	80.2	130.7	155.6	27.4			
			TDLF	48.3	195.1	156.0	79.6	133.9	152.9	27.5			
		G3	NLF	40.7	173.9	147.1	77.3	126.4	149.2	28.5			
			SDLF	40.7	175.3	148.3	78.4	127.8	150.6	28.7			
			TDLF	36.6	176.6	148.4	78.1	128.1	151.3	28.8			
		G4	NLF	12.0	159.9	145.1	77.2	122.3	146.7	29.6			
			SDLF	14.8	158.2	143.8	77.7	121.0	146.9	29.9			
			TDLF	25.2	152.4	137.5	75.7	115.2	144.9	30.1			
		G-5	NLF	16.3	34.7	69.5	34.7	164.3	157.6	78.4	124.7	143.2	30.0
			SDLF	15.5	33.8	67.7	33.8	163.8	157.0	78.5	122.7	141.3	30.3
			TDLF	14.8	32.4	64.8	32.4	166.4	159.9	82.4	122.4	140.5	31.6

Appendix H1-1. EISSS57 Bridge Description

The key characteristics of EISSS57 are as follows:

- Span length along the centerline of the bridge, L_s = 137 ft.
- Width between the fascia girders, w_g = 61 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 3.5
- Number of girders in the completed bridge cross-section, n_g = 7.
- Parallel skew
- Skew angle, θ = 69,-4^o
- Skew index, I_s = 0.68

This appendix presents the bridge description of the bridge EISSS57 in its final condition as well as during erection. The following figures and tables are provided:

Figure H1-1-1. Framing plan

Figure H1-1-2. Bridge cross-section

Figure H1-1-3. Girder Elevation

Figure H1-1-4. Cross-section dimension

Figure H1-1-5. Cross-frame details

Figure H1-1-6. Erection scheme

Table H1-1-1. Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

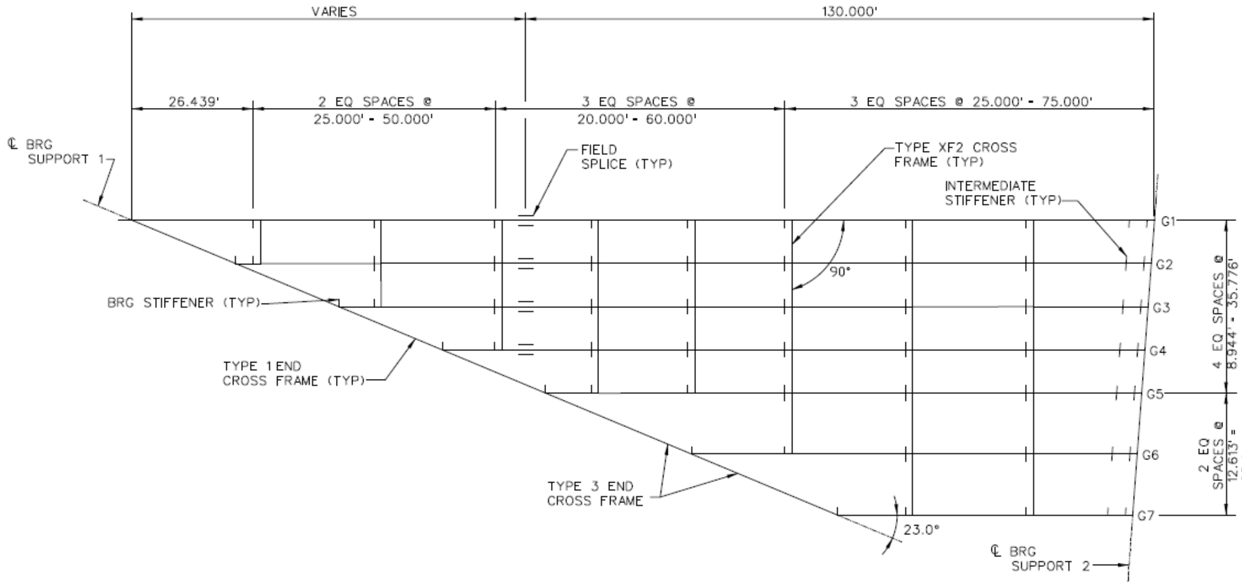


Figure H1-1-1. Framing plan.

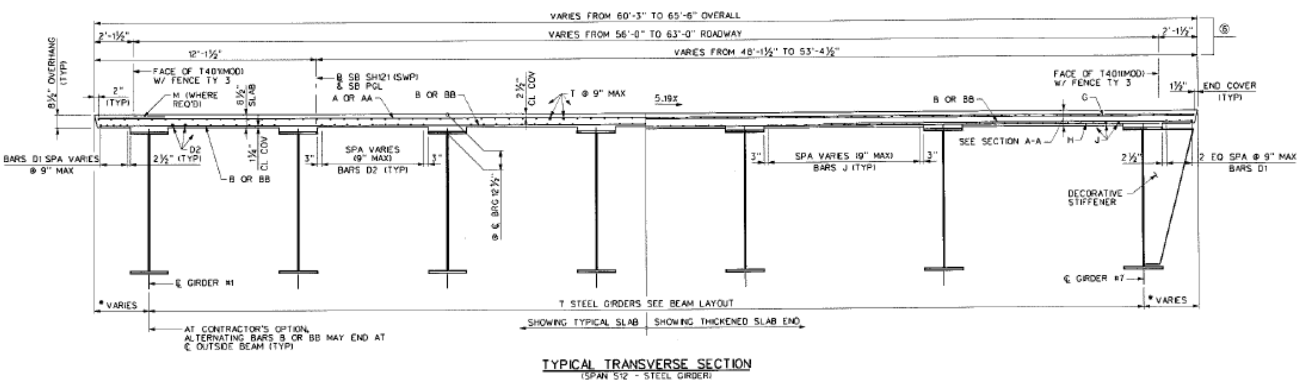


Figure H1-1-2. Bridge cross-section.

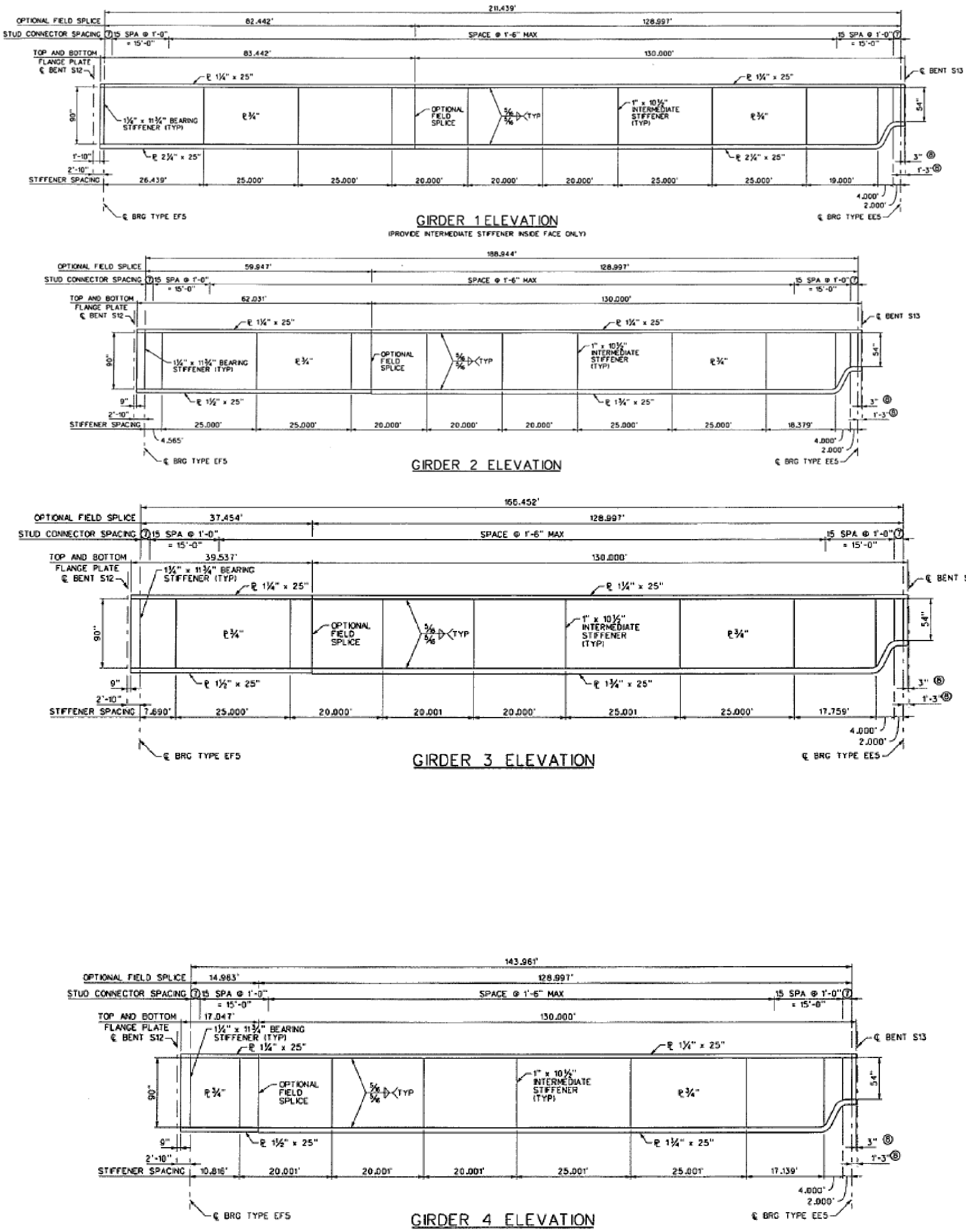
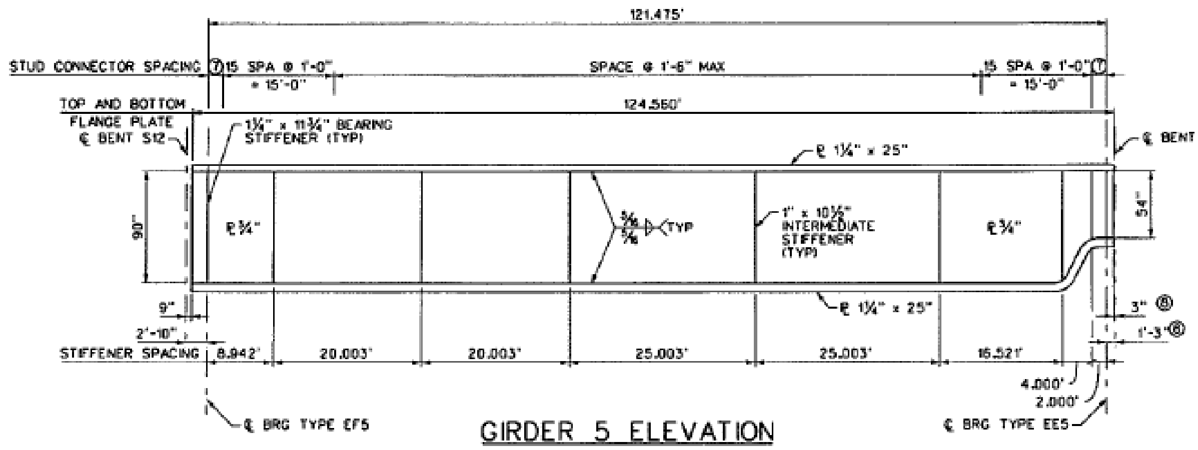


Figure H1-1-3. Girder elevations



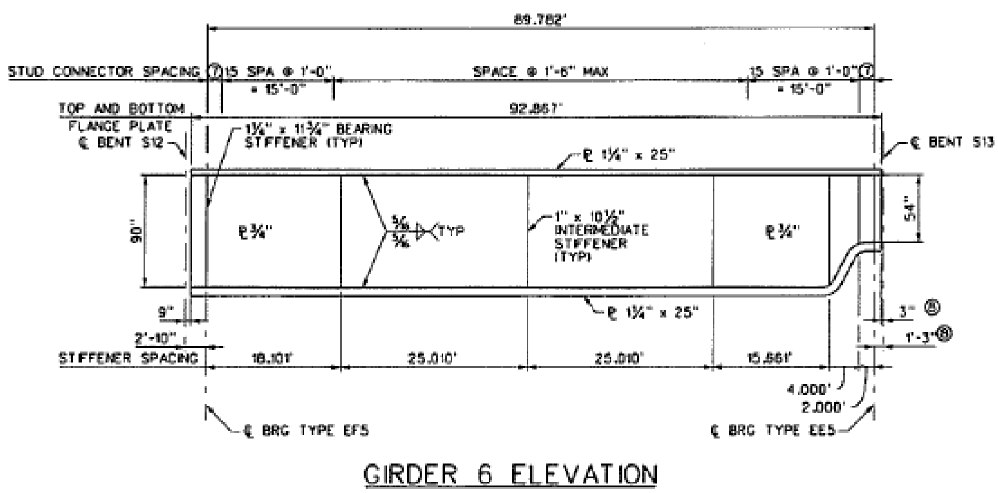


Figure H1-1-3(cont.). Girder elevations

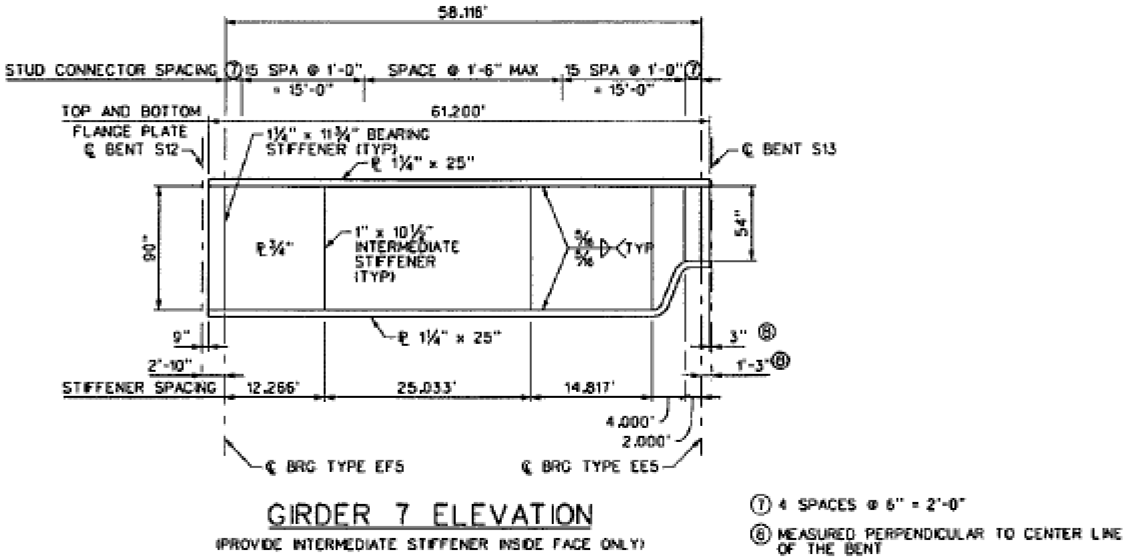
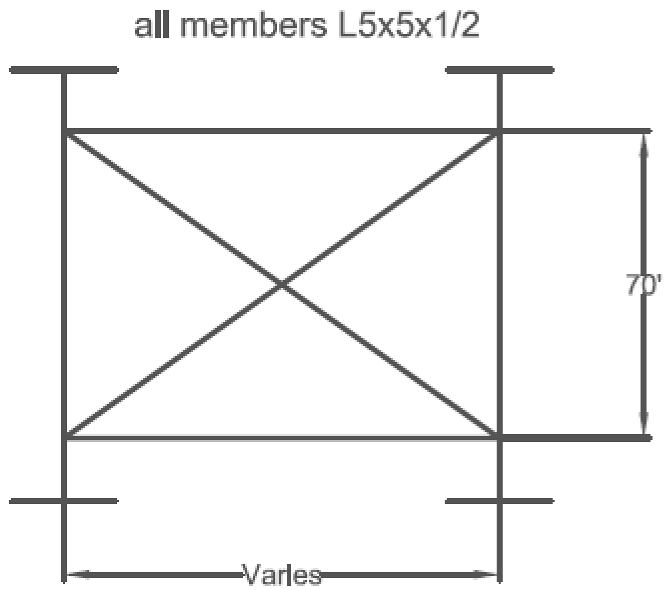


Figure H1-1-3(cont.). Girder elevations



TYPICAL INTERMEDIATE DIAPHRAGM

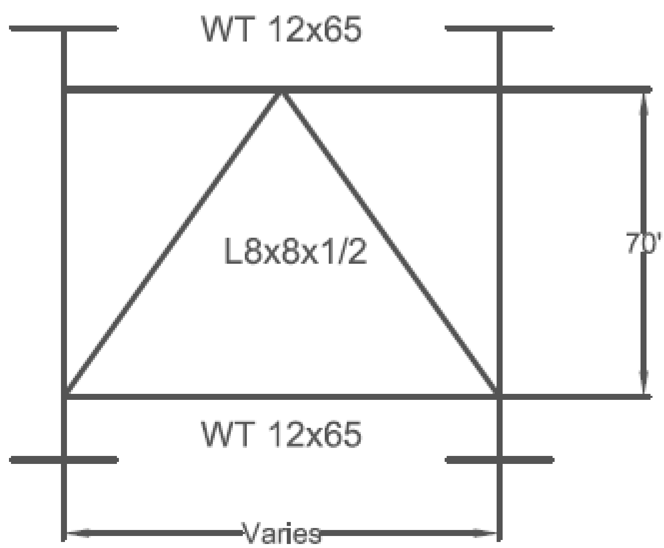


Figure H1-1-5. Cross-frame details.

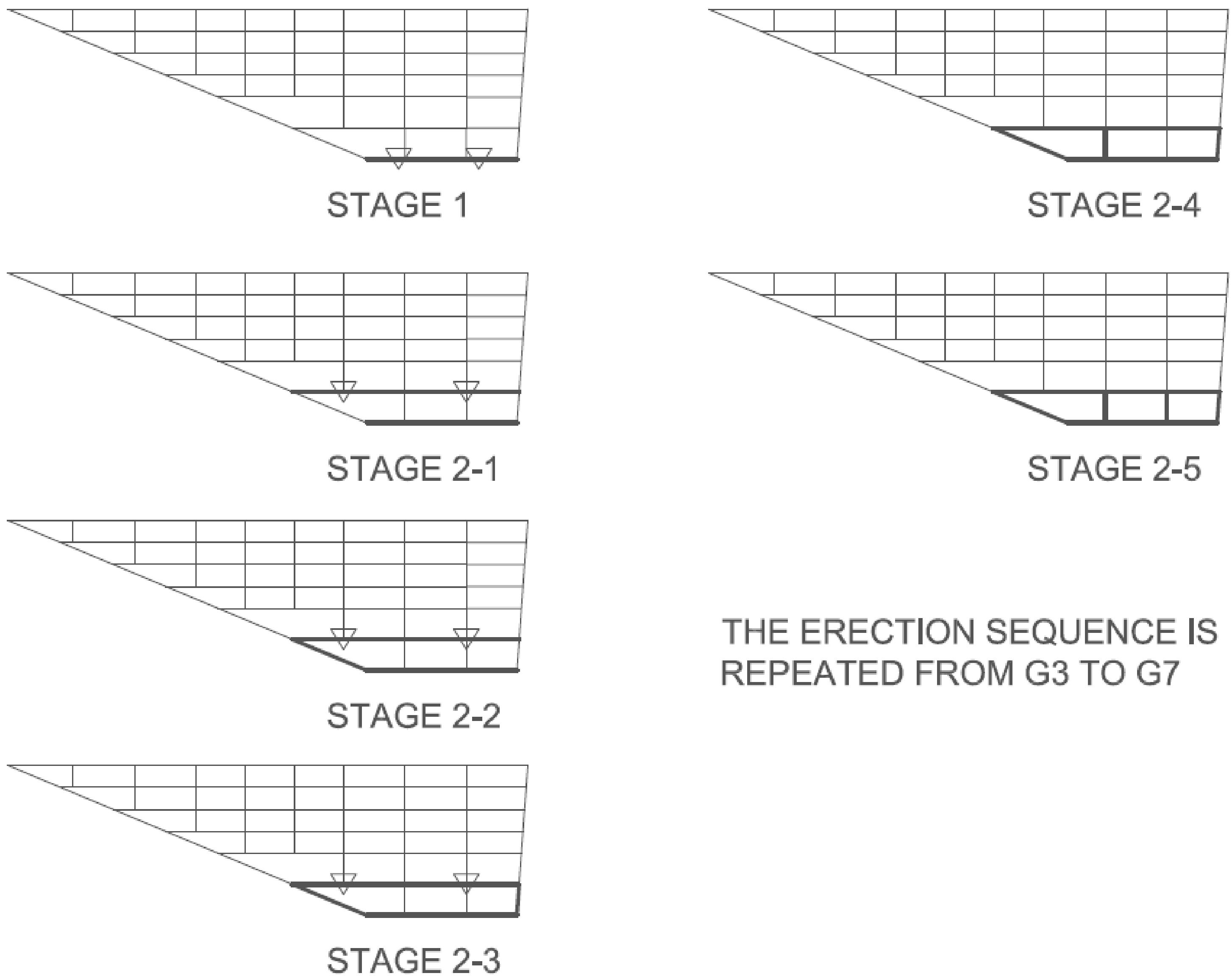


Figure H1-1-6. Erection scheme.

Table H1-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

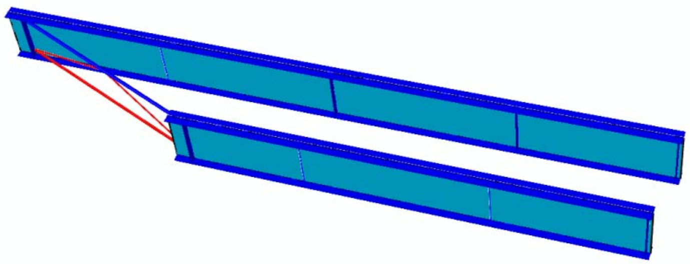
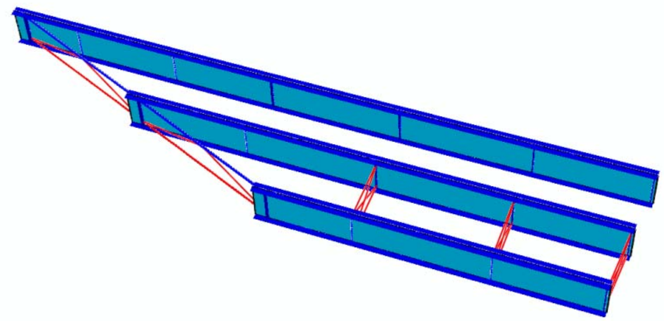
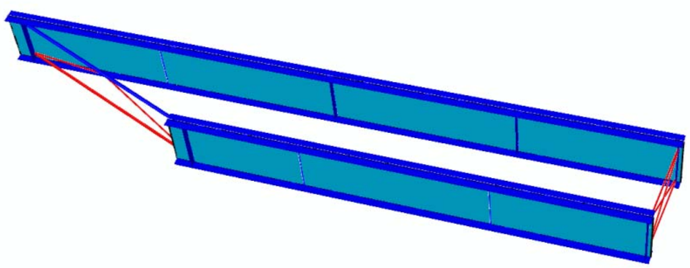
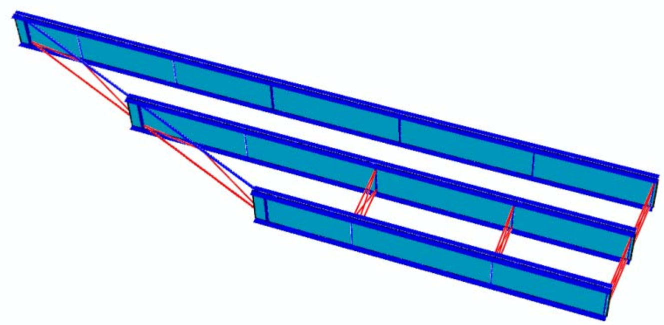
Sub-Stage	Stage	
	2	3
1		
2		

Table H1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

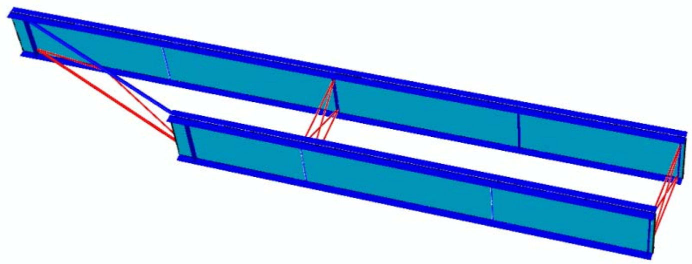
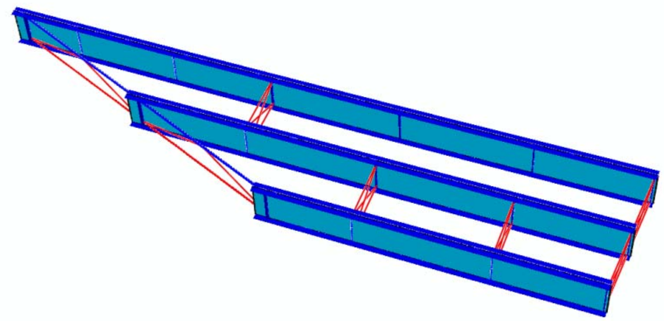
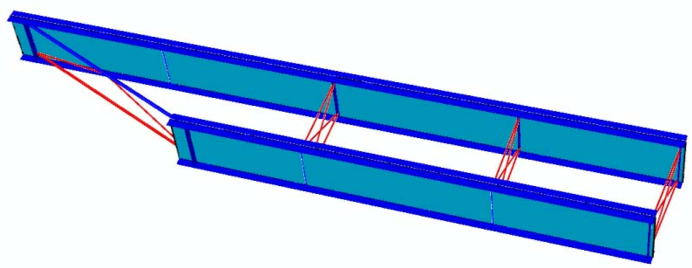
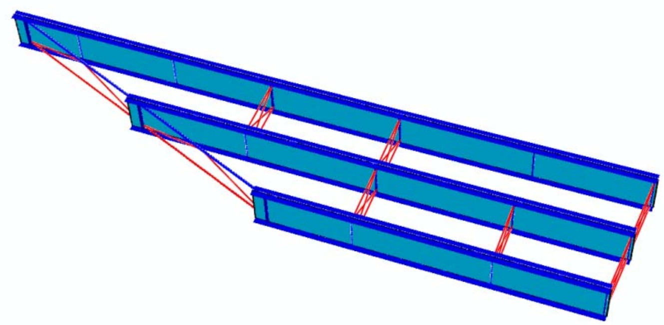
Sub-Stage	Stage	
	2	3
3		
4		

Table H1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

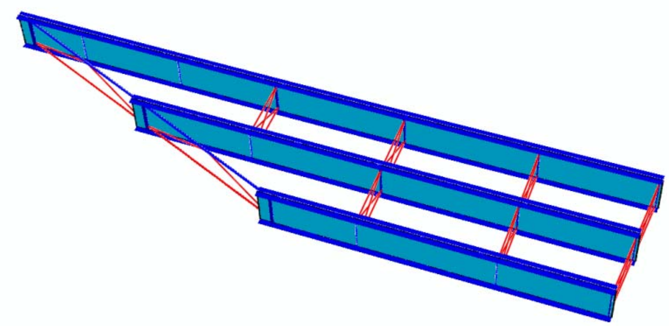
Sub-Stage	Stage	
	2	**3**
5		

Table H1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

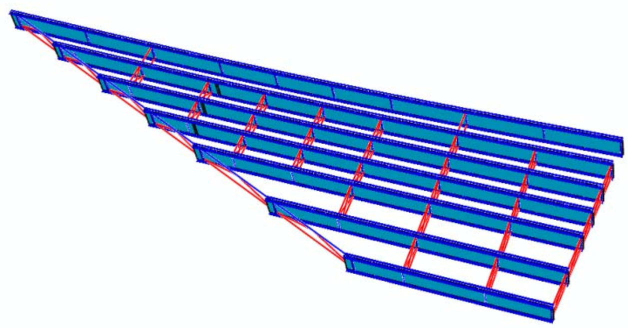
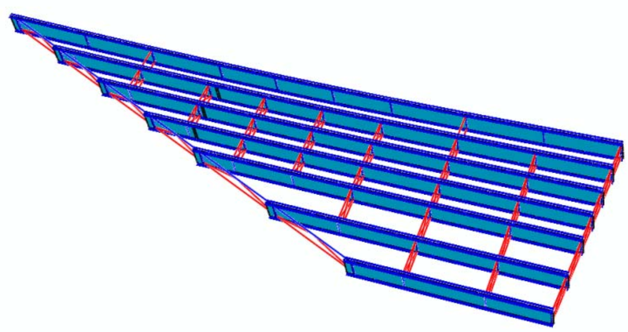
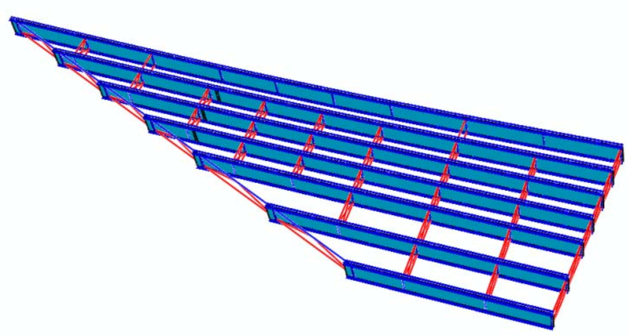
Sub-Stage	Stage 7
1	
2	
3	

Table H1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

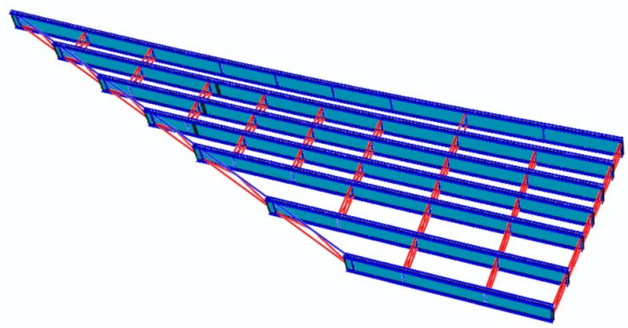
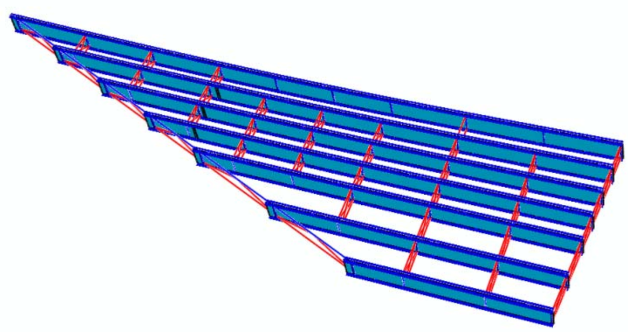
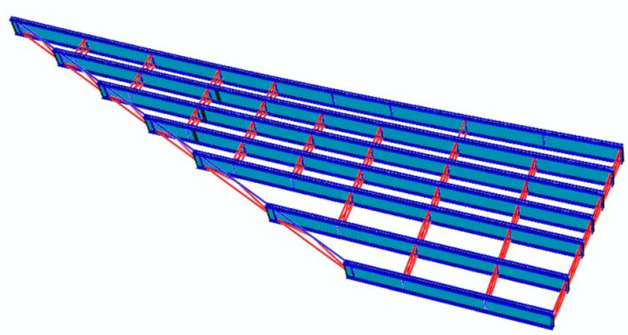
Sub-Stage	Stage 7
4	
5	
6	

Table H1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

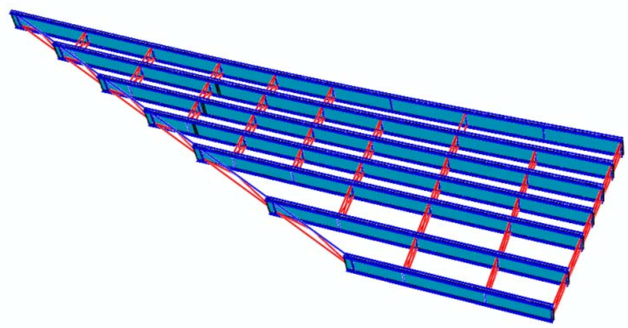
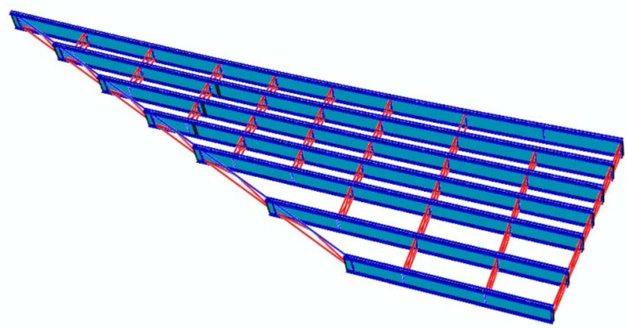
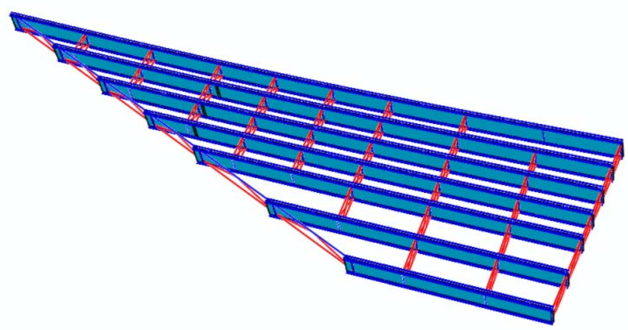
Sub-Stage	Stage 7
7	
8	
9	

Table H1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

<table>
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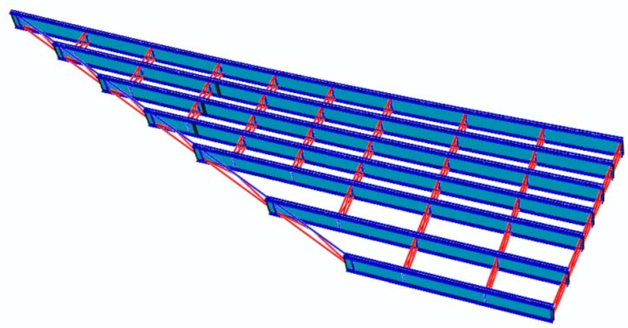
<tr><th>7</th></tr>
<tr><td>10</td><td></td></tr>
</table>

Appendix H1-2. EISSS57 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EISSS57 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table H1-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.0	0.1
	SDLF	0.0	0.1
	TDLF	0.1	0.1
G2	NLF	0.2	0.8
	SDLF	0.2	0.7
	TDLF	0.1	0.6
G3	NLF	0.7	2.2
	SDLF	0.5	2.0
	TDLF	0.3	1.8
G4	NLF	1.2	3.6
	SDLF	0.9	3.3
	TDLF	0.4	2.8
G5	NLF	1.8	5.3
	SDLF	1.6	5.2
	TDLF	1.4	4.9
G6	NLF	2.4	7.2
	SDLF	2.7	7.5
	TDLF	3.4	8.1
G7	NLF	3.2	9.3
	SDLF	3.8	10.0
	TDLF	4.5	10.6
All Girders	NLF	3.2	9.3
	SDLF	3.8	10.0
	TDLF	4.5	10.6

Table H1-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.1	0.5
	SDLF	0.0	0.3
	TDLF	0.4	0.0
G2	NLF	0.3	1.0
	SDLF	0.0	0.7
	TDLF	0.7	0.0
G3	NLF	0.6	1.7
	SDLF	0.0	1.1
	TDLF	1.1	0.0
G4	NLF	0.7	2.0
	SDLF	0.0	1.3
	TDLF	1.3	0.0
G5	NLF	0.8	2.3
	SDLF	0.0	1.5
	TDLF	1.5	0.0
G6	NLF	0.9	2.5
	SDLF	0.0	1.7
	TDLF	1.6	0.1
G7	NLF	0.9	2.6
	SDLF	0.0	1.7
	TDLF	1.6	0.1
All Girders	NLF	0.9	2.6
	SDLF	0.0	1.7
	TDLF	1.6	0.1

Table H1-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	0.3	1.6	0.3	1.6	0.5	1.1	1.1	4.8
	SDLF	0.7	1.9	0.7	1.9	0.0	0.9	0.1	3.3
	TDLF	1.1	2.3	1.1	2.3	1.5	0.4	2.5	0.4
G2	NLF	2.5	8.6	2.5	8.5	1.0	0.7	1.6	6.1
	SDLF	1.6	7.7	1.6	7.6	0.0	0.4	0.0	3.8
	TDLF	1.0	6.4	1.0	6.4	1.7	0.0	2.8	0.0
G3	NLF	4.3	13.3	4.3	13.3	2.0	3.3	2.5	8.4
	SDLF	2.8	11.8	2.8	11.8	0.1	1.9	0.1	5.3
	TDLF	1.9	10.4	1.9	10.3	3.4	0.1	4.4	0.1
G4	NLF	4.5	13.7	5.4	16.3	1.8	3.3	2.4	7.9
	SDLF	3.5	12.5	4.2	14.9	0.1	2.0	0.1	5.0
	TDLF	1.8	10.5	2.2	12.6	3.3	0.1	4.3	0.2
G5	NLF	5.0	15.0	6.0	17.9	1.6	3.4	2.0	6.3
	SDLF	4.6	14.6	5.5	17.4	0.1	2.0	0.2	3.9
	TDLF	4.3	14.1	5.1	16.7	3.1	0.3	3.9	0.4
G6	NLF	5.4	15.9	6.4	19.0	1.0	2.6	1.3	3.8
	SDLF	6.0	16.5	7.1	19.6	0.2	1.4	0.3	2.2
	TDLF	7.6	18.1	9.1	21.6	2.5	0.6	3.1	0.7
G7	NLF	5.3	15.6	7.3	21.5	0.1	0.8	0.1	1.0
	SDLF	6.4	16.6	8.8	22.9	0.0	0.5	0.1	0.7
	TDLF	7.6	17.7	10.4	24.4	0.2	0.4	0.5	0.8
All Girders	NLF	5.4	15.9	7.3	21.5	2.0	3.4	2.5	8.4
	SDLF	6.4	16.6	8.8	22.9	0.2	2.0	0.3	5.3
	TDLF	7.6	18.1	10.4	24.4	3.4	0.6	4.4	0.8

Table H1-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	14.1	19.2	19.0	19.2
	SDLF	5.0	4.9	1.2	5.0
	TDLF	21.3	27.3	26.4	27.3
TDL	NLF	37.9	48.9	47.0	48.9
	SDLF	23.8	30.5	28.9	30.5
	TDLF	15.3	18.1	4.7	18.1

Table H1-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	3.7	5.4	5.3	4.6
	SDLF	0.3	0.4	0.2	0.3
	TDLF	5.0	7.2	7.5	6.2
TDL	NLF	9.5	15.1	13.8	12.1
	SDLF	6.0	9.8	8.5	7.7
	TDLF	1.3	2.5	1.7	1.7

Table H1-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	0.21	0.53	0.63	0.78	0.91	1.00	1.00
SDLF	0.13	0.37	0.48	0.78	1.17	1.37	1.37
TDLF	0.03	0.24	0.08	1.07	2.04	1.62	2.04

Table H1-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	0.75	1.61	1.87	2.32	2.71	2.95	2.95
SDLF	0.67	1.46	1.70	2.26	2.84	3.23	3.23
TDLF	0.55	1.32	1.31	2.38	3.55	3.47	3.55

Table H1-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	0.15	0.37	0.44	0.55	0.65	0.71	0.71
SDLF	0.09	0.27	0.34	0.56	0.83	0.97	0.97
TDLF	0.02	0.17	0.06	0.76	1.45	1.15	1.45

Table H1-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	0.53	1.14	1.32	1.64	1.92	2.09	2.09
SDLF	0.47	1.03	1.20	1.60	2.01	2.29	2.29
TDLF	0.39	0.94	0.93	1.69	2.52	2.46	2.52

Table H1-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	563.2	1707.8
SDLF	563.2	1707.5
TDLF	563.2	1707.8

Table H1-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	59.0	163.9	0.2	1.5	0.5	1.5
SDLF	61.8	160.5	0.1	1.1	0.0	1.1
TDLF	73.0	169.4	0.3	0.2	0.9	0.2

Table H1-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.34	0.86	0.05	0.86
SDLF	0.37	0.83	0.00	0.83
TDLF	0.53	1.12	0.09	1.12

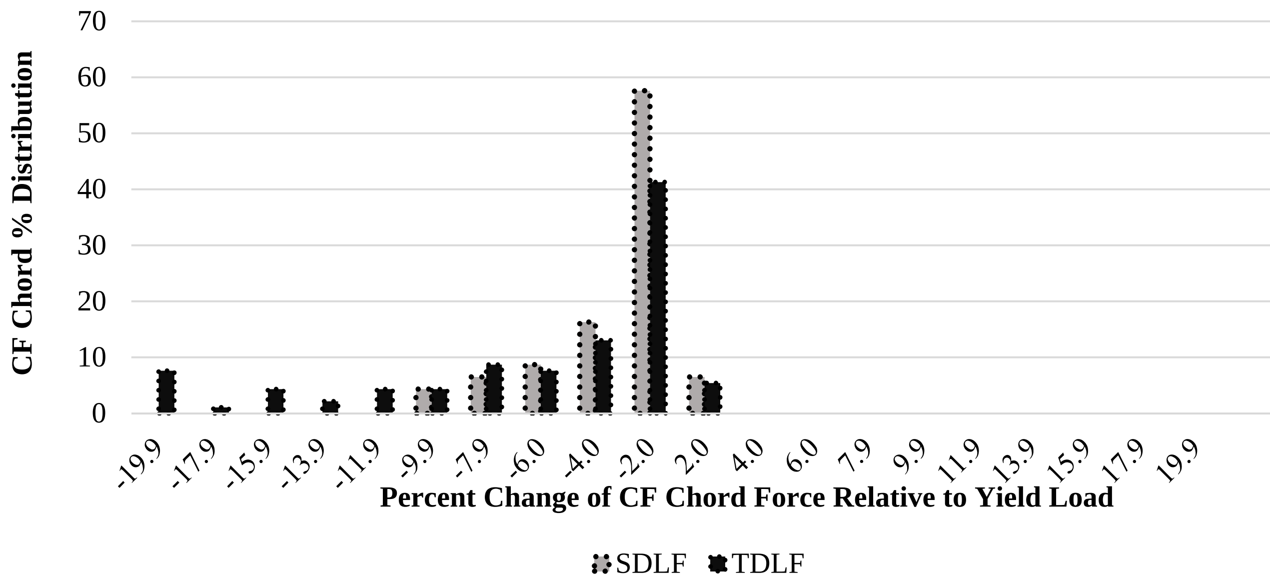


Figure H1-2-1. **Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.**

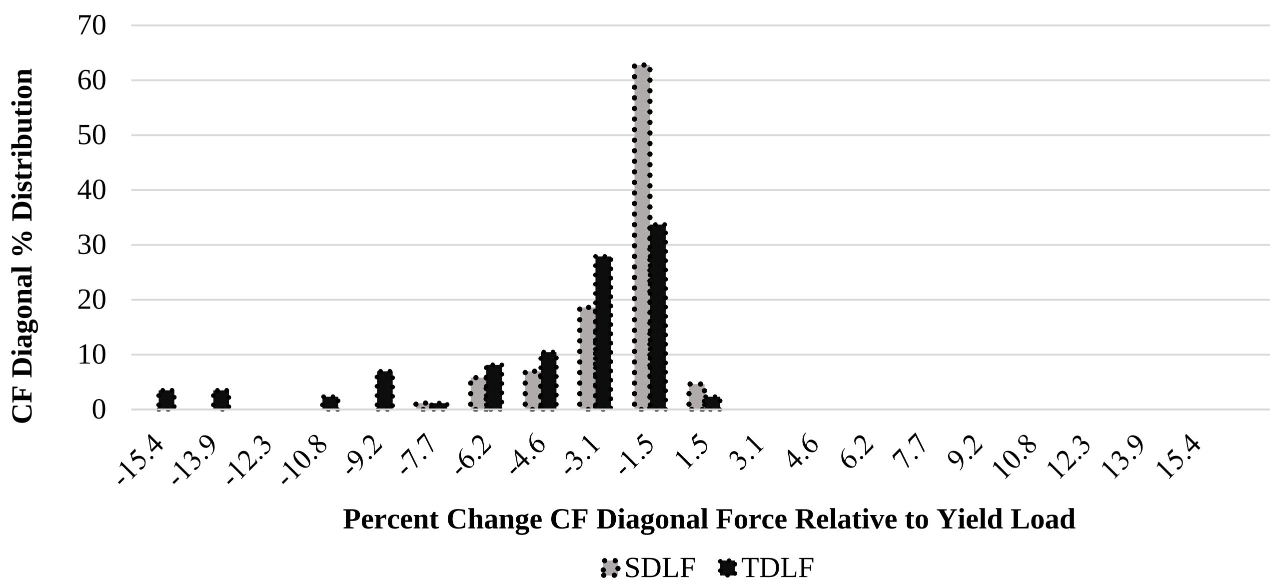


Figure H1-2-2. **Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.**

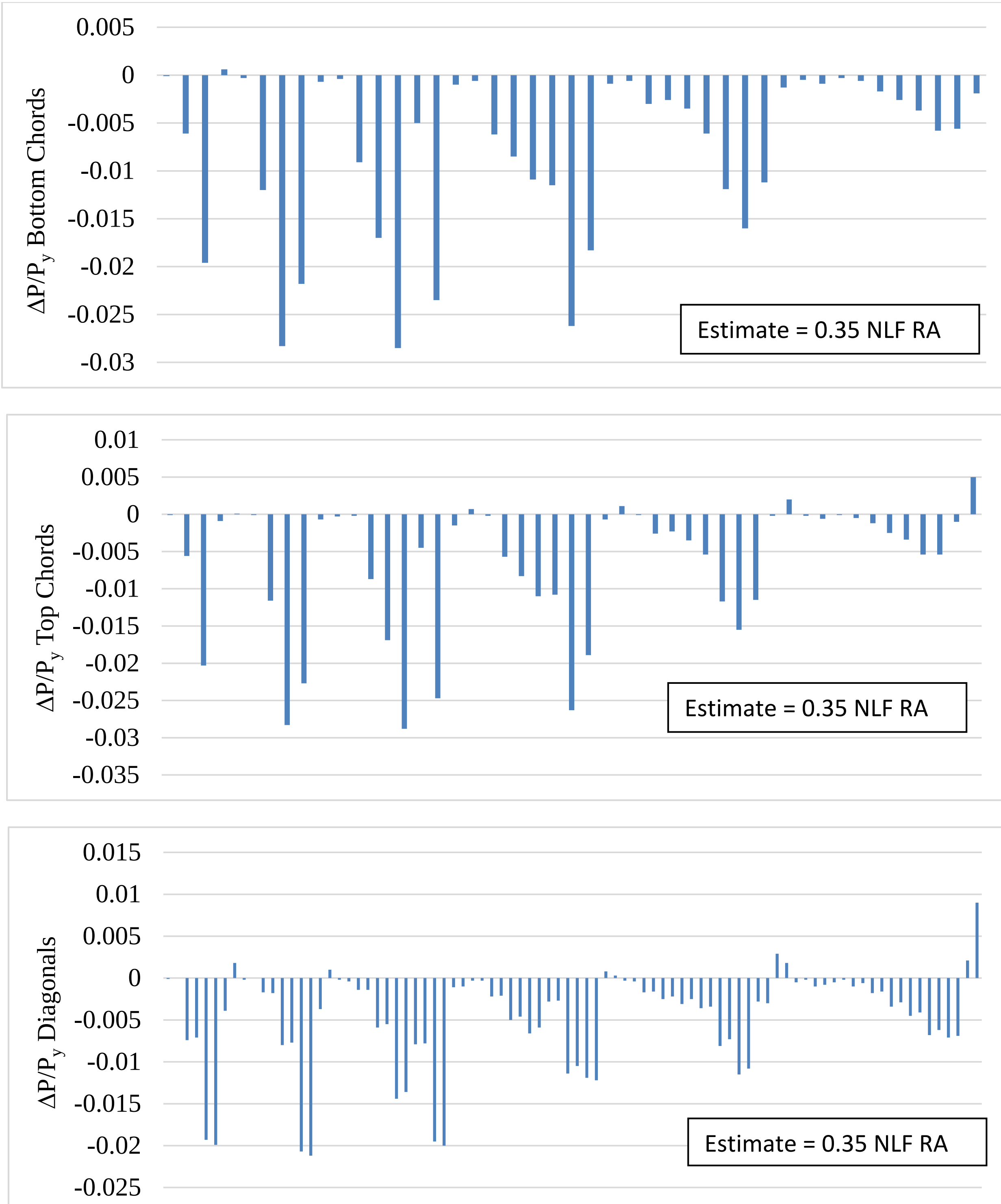


Figure H1-2-3. **Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.**

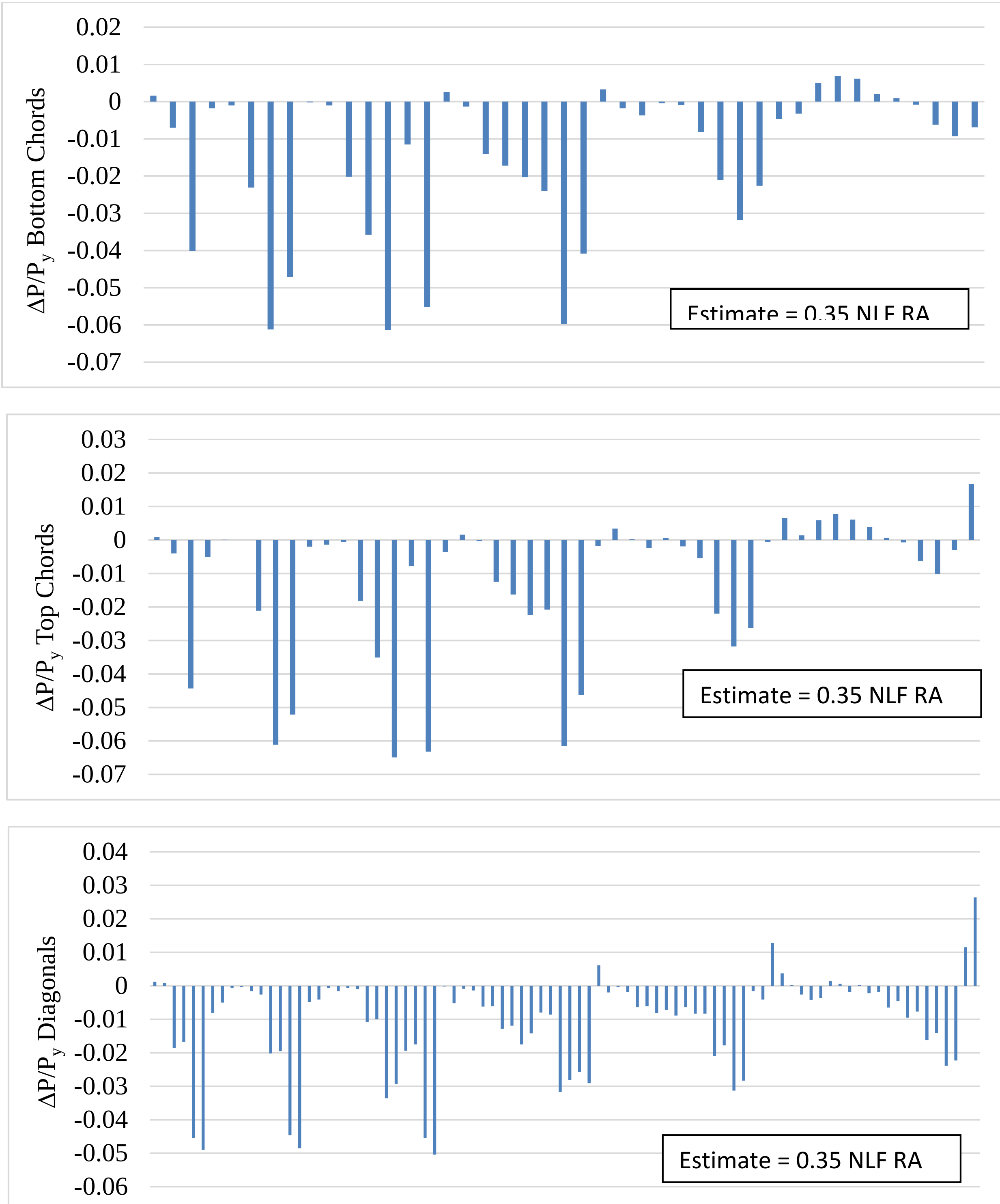


Figure H1-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix H1-3. EISSS57 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EISSS57 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table H1-3-1. Maximums of the fit-up force resultants (kips)

Detailing Method	F1	F2	F_{max}
SDLF	0.4	5.0	5.0
TDLF	0.9	15.0	15.0

Table H1-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	SDLF	19	15
	TDLF	31	15
G2	SDLF	29	22
	TDLF	29	13
G3	SDLF	36	29
	TDLF	47	28
G4	SDLF	43	40
	TDLF	29	22
G5	SDLF	49	46
	TDLF	47	37
G6	SDLF	55	51
	TDLF	73	64
G7	SDLF	61	58
	TDLF	59	58
All Girders	SDLF	61	15
	TDLF	73	13

Table H1-3-3. Total Vertical Reactions (kips)

Stage	Detailing Method	Sub-Stage									
		1	2	3	4	5	6	7	8	9	10
2	SDLF	80	81	82	83						
	TDLF	80	81	82	83						
3	SDLF	148	148	149	150	151					
	TDLF	148	148	149	150	151					
7	SDLF	558	559	559	560	560	561	562	562	563	563
	TDLF	558	559	559	560	560	561	562	562	563	563

Appendix H1-4. EISSS57 Detailed Results, Completed Bridge Responses

This appendix presents the SDL and TDL responses of the bridge EISSS57 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

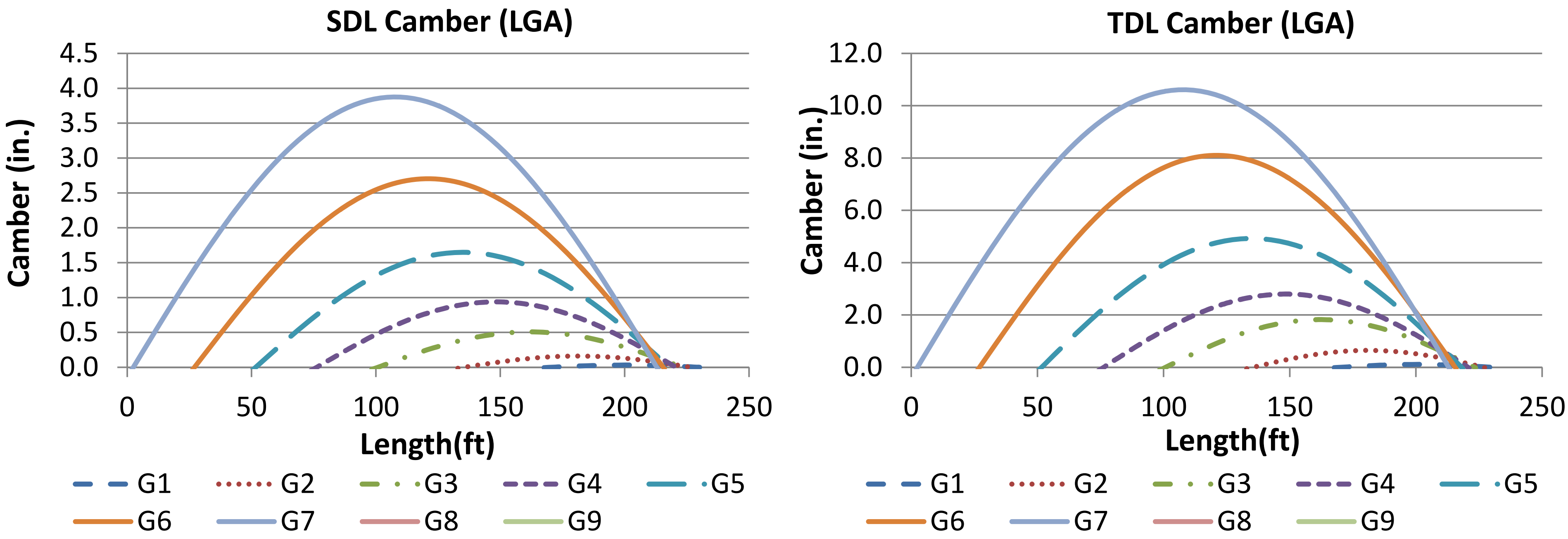


Figure H1-4-1. **SDL and TDL Line Girder Analysis cambers.**

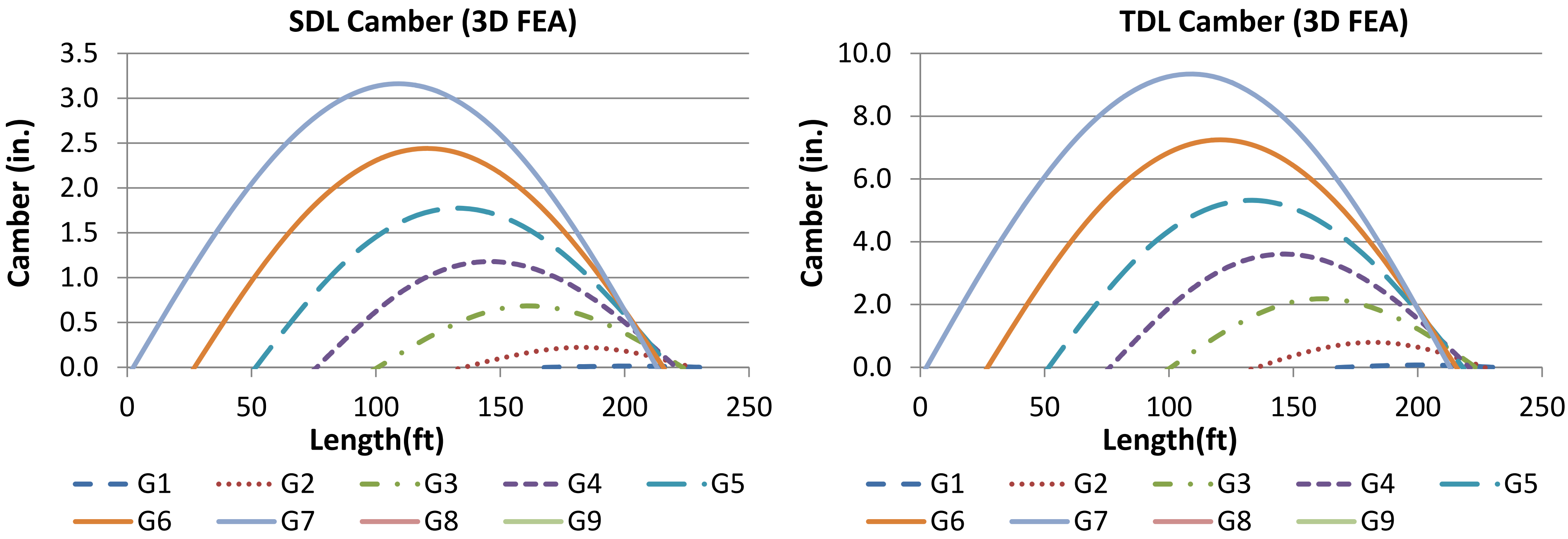


Figure H1-4-2. SDL and TDL 3D FEA cambers.

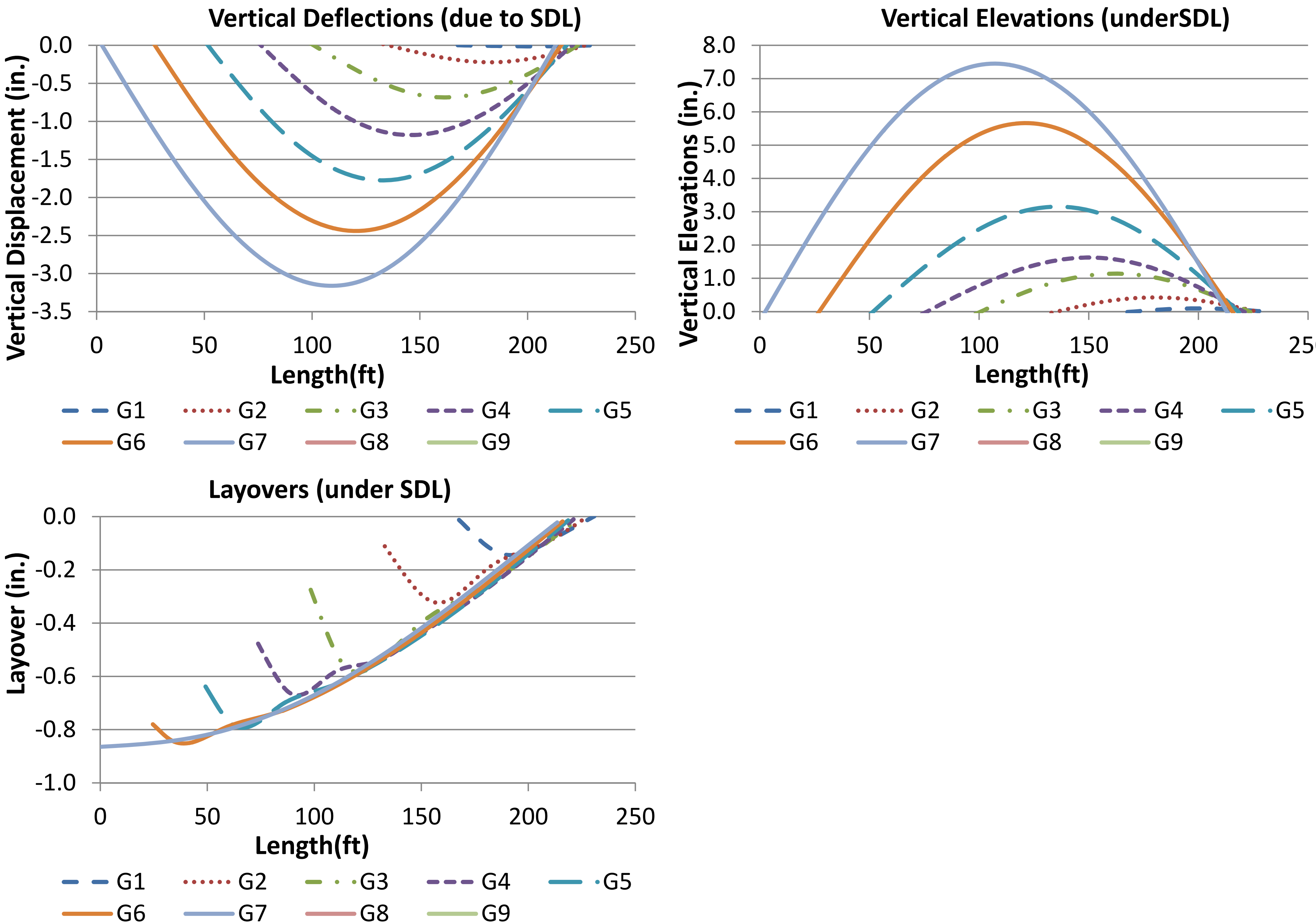


Figure H1-4-3. **Bridge displacements and elevation profiles (in) under SDL, NLF detailing.**

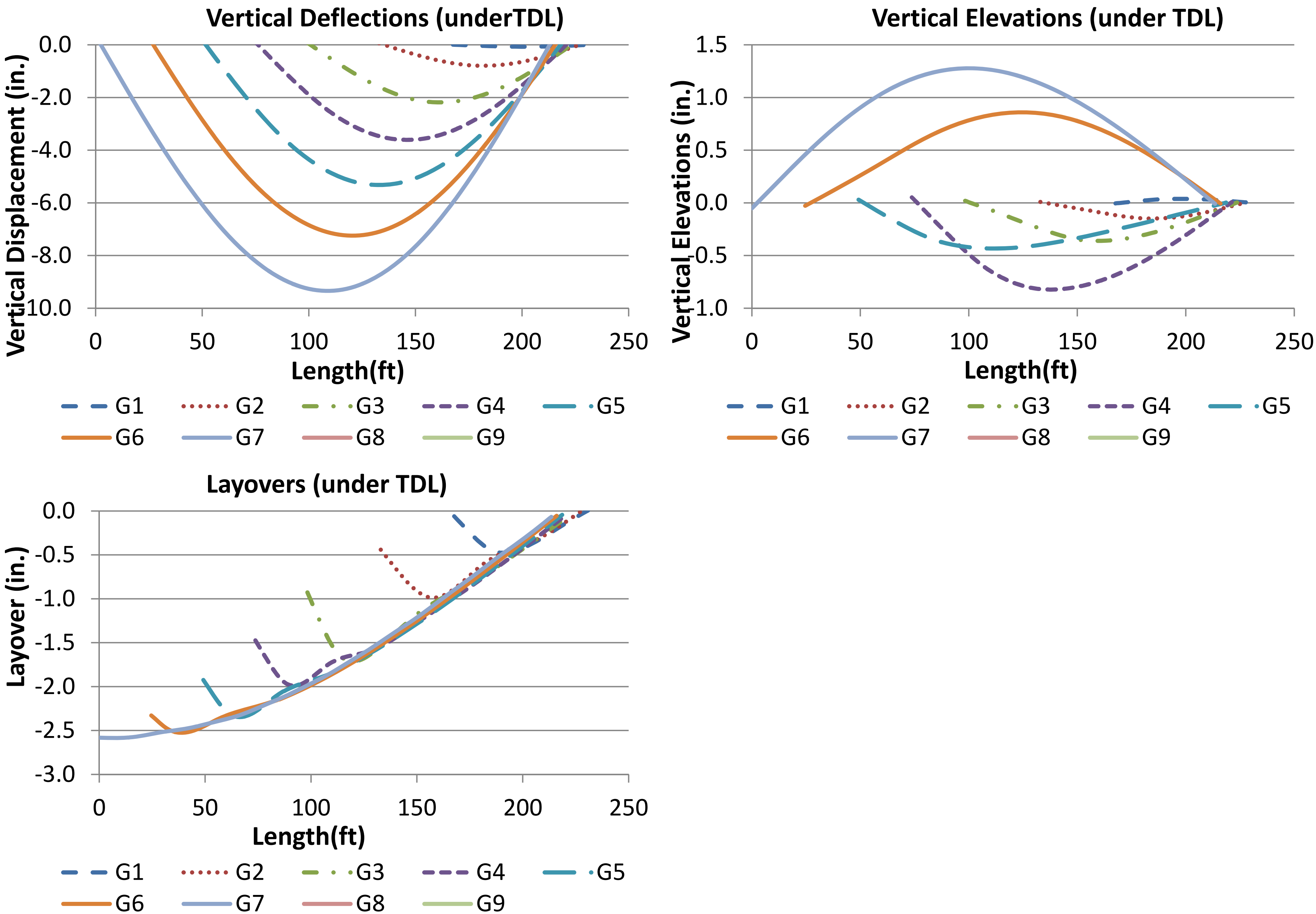


Figure H1-4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

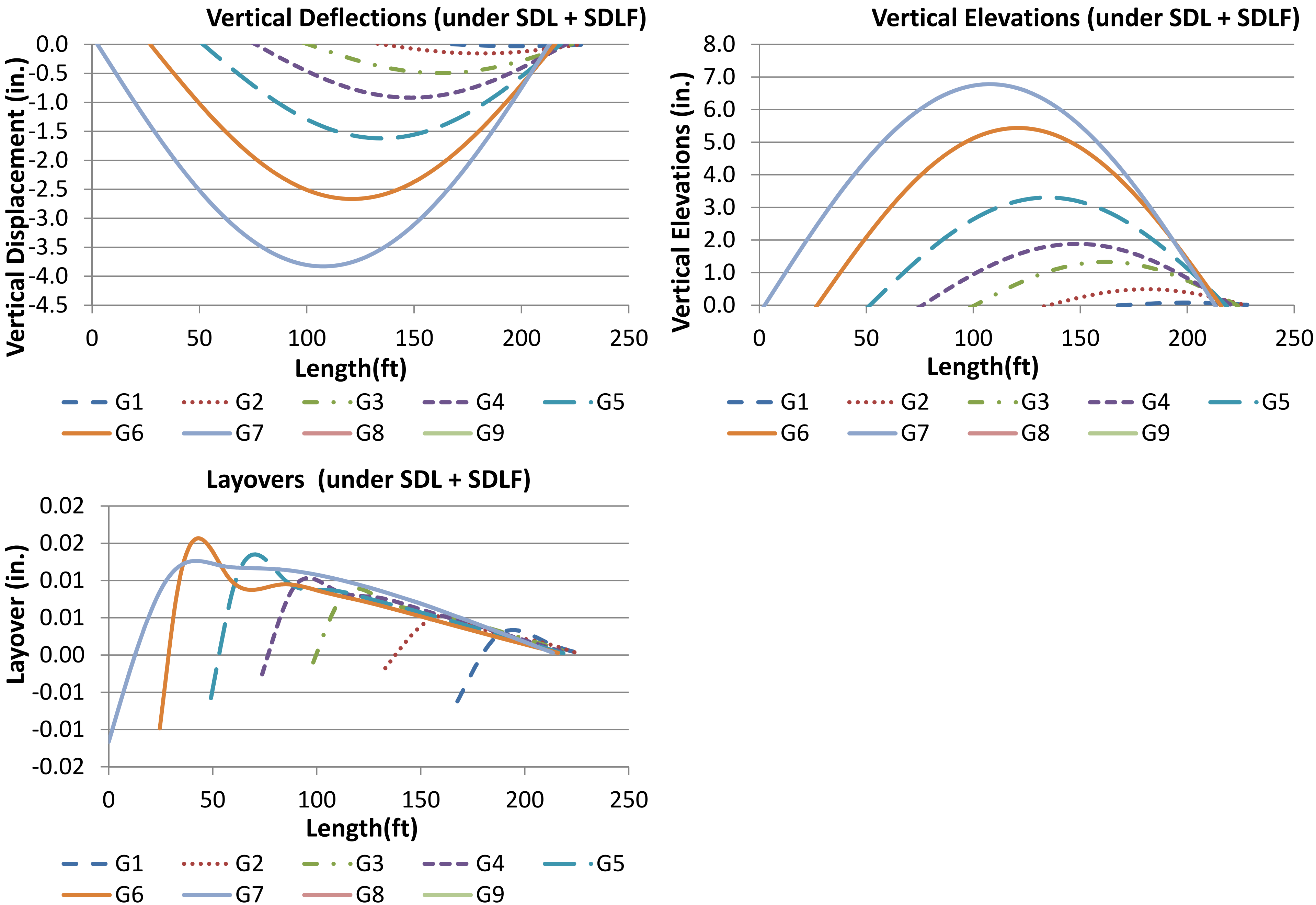


Figure H1-4-5. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

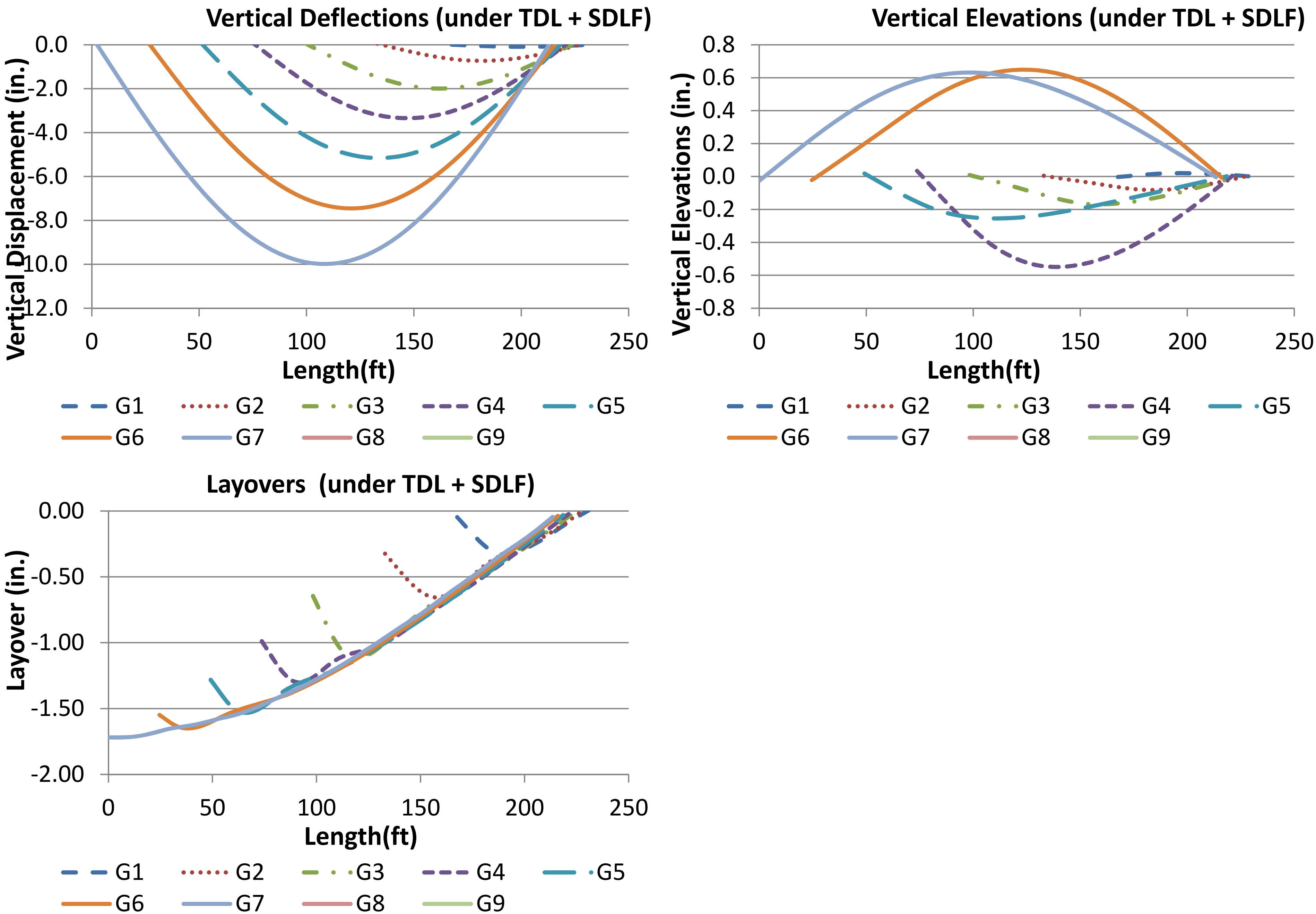


Figure H1-4-6. **Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.**

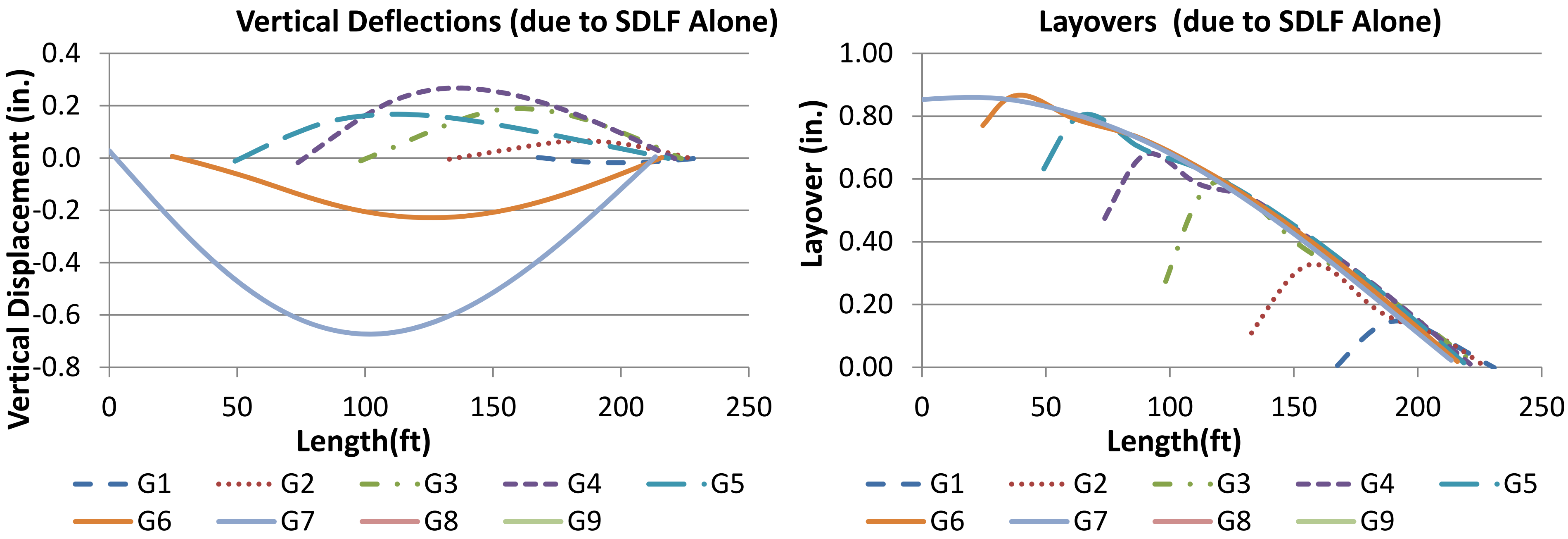


Figure H1-4-7. Bridge displacements due to SDLF detailing effects alone under NL(in).

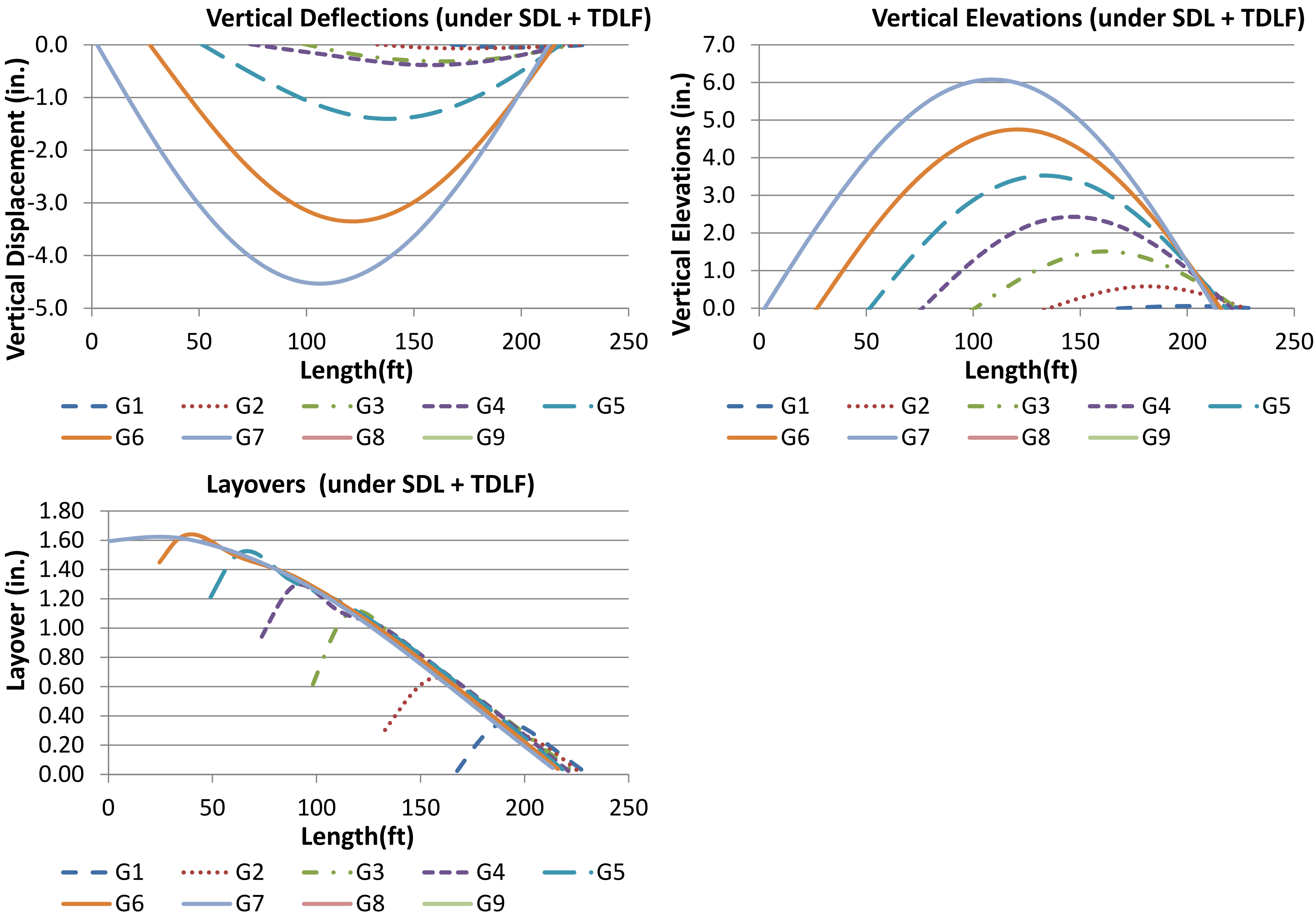


Figure H1-4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

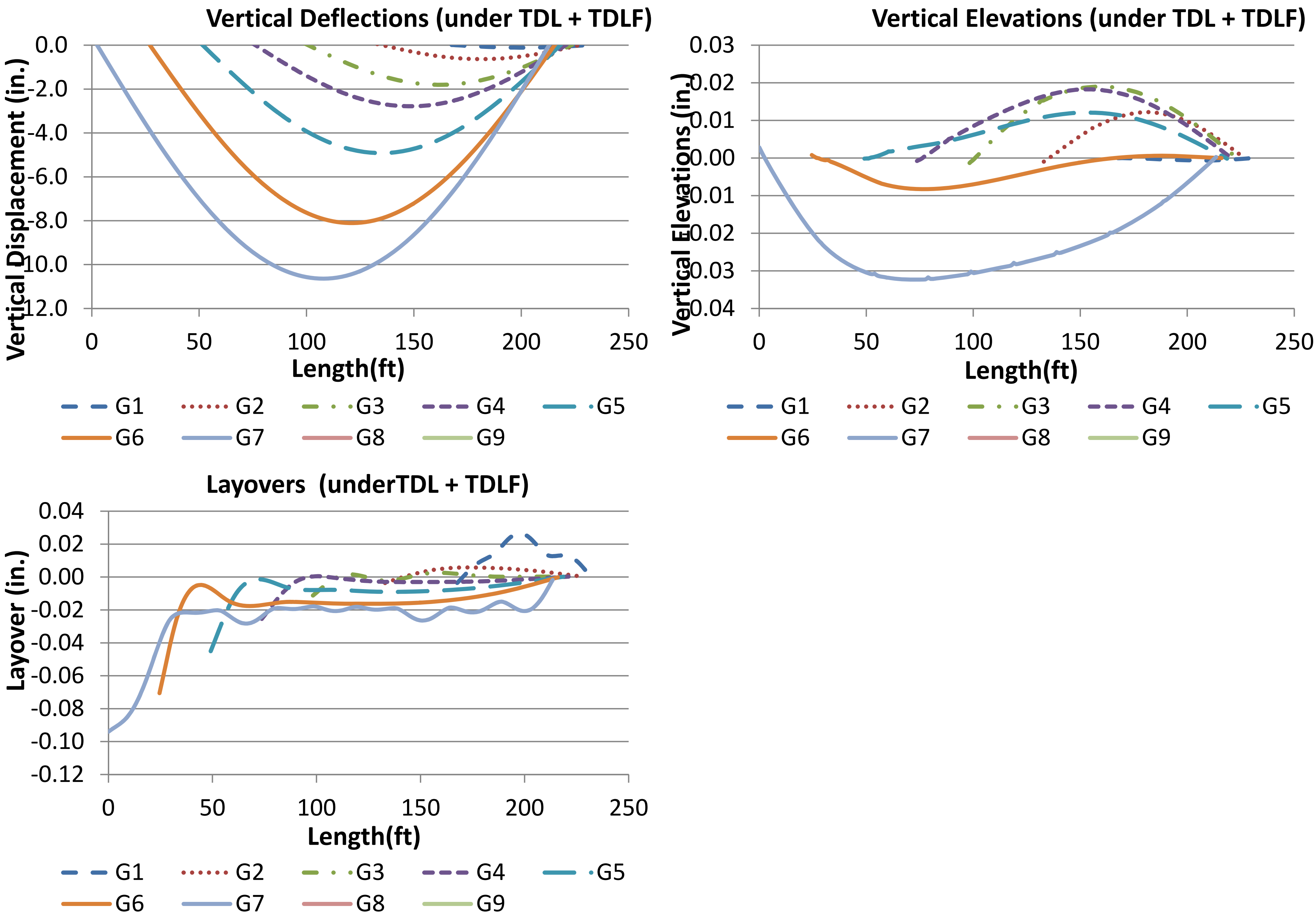


Figure H1-4-9. **Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.**

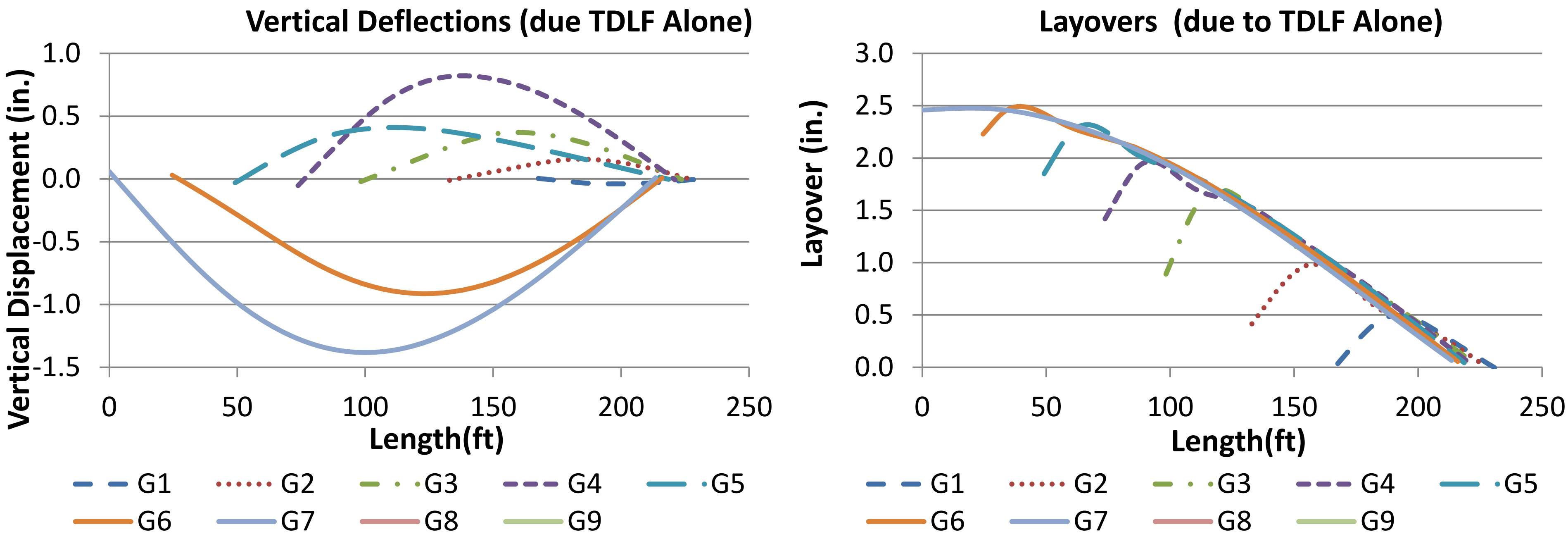


Figure H1-4-10. Bridge displacements due to TDLF detailing effects alone under NL (in).

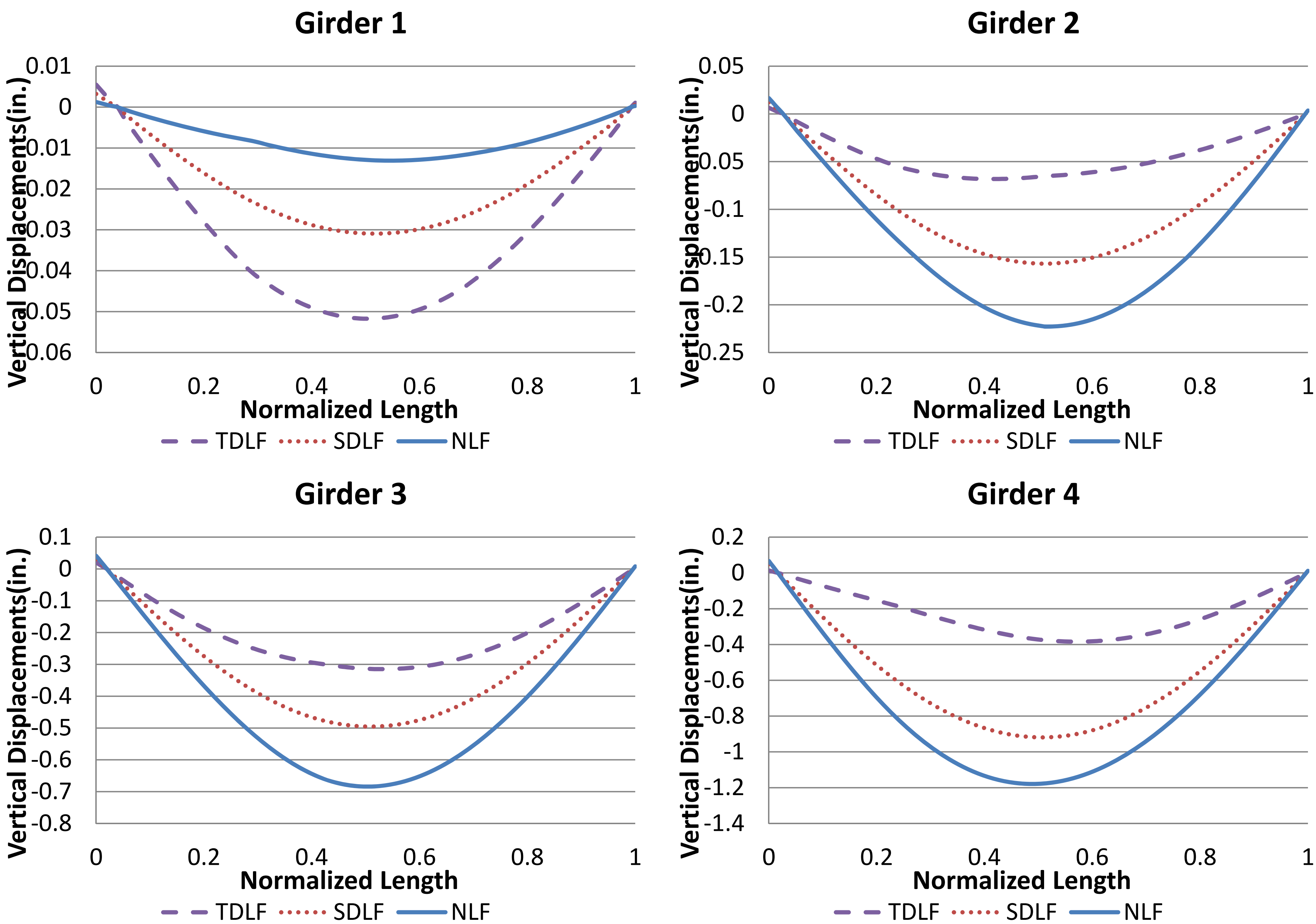


Figure H1-4-11. **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

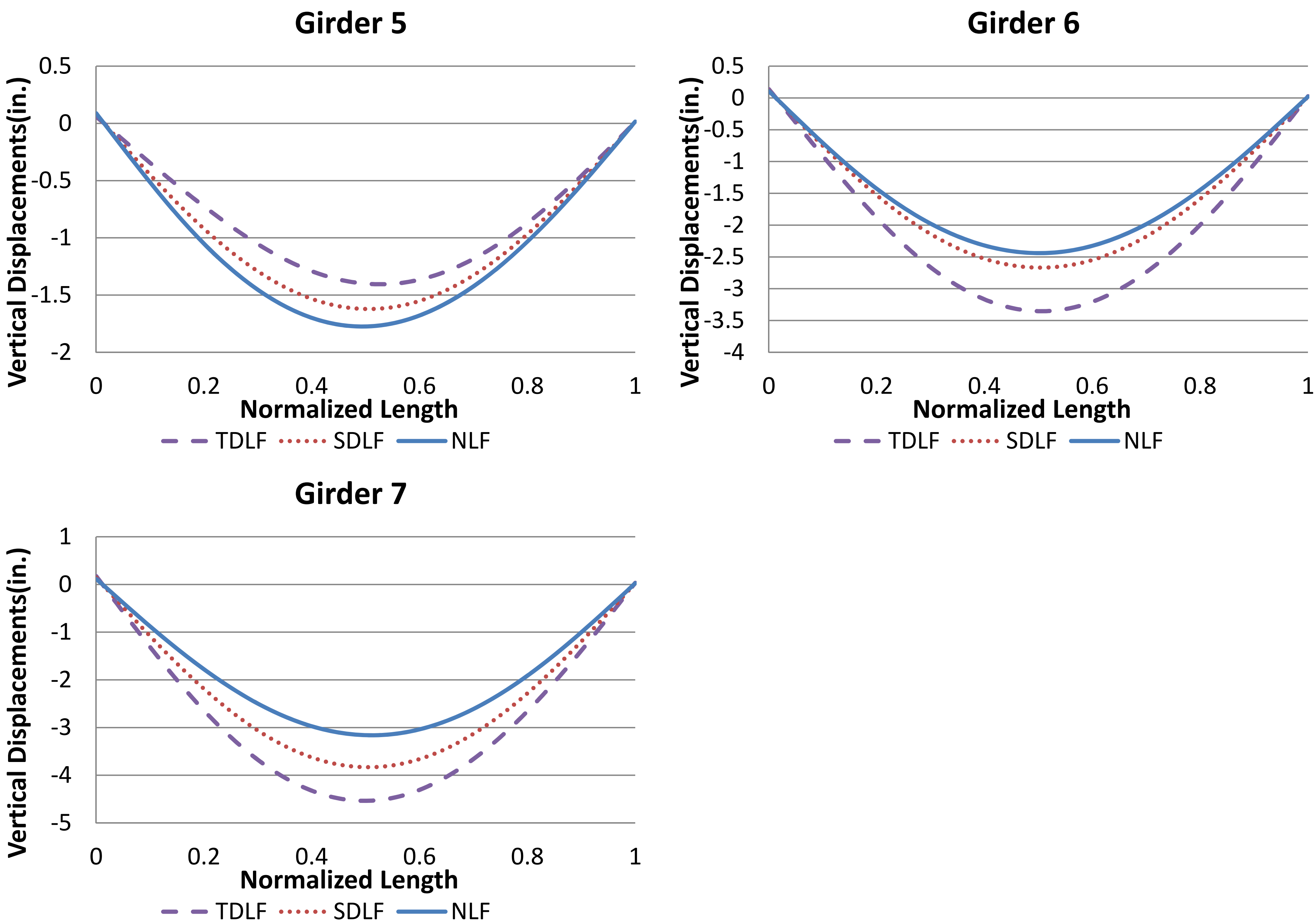


Figure H1-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

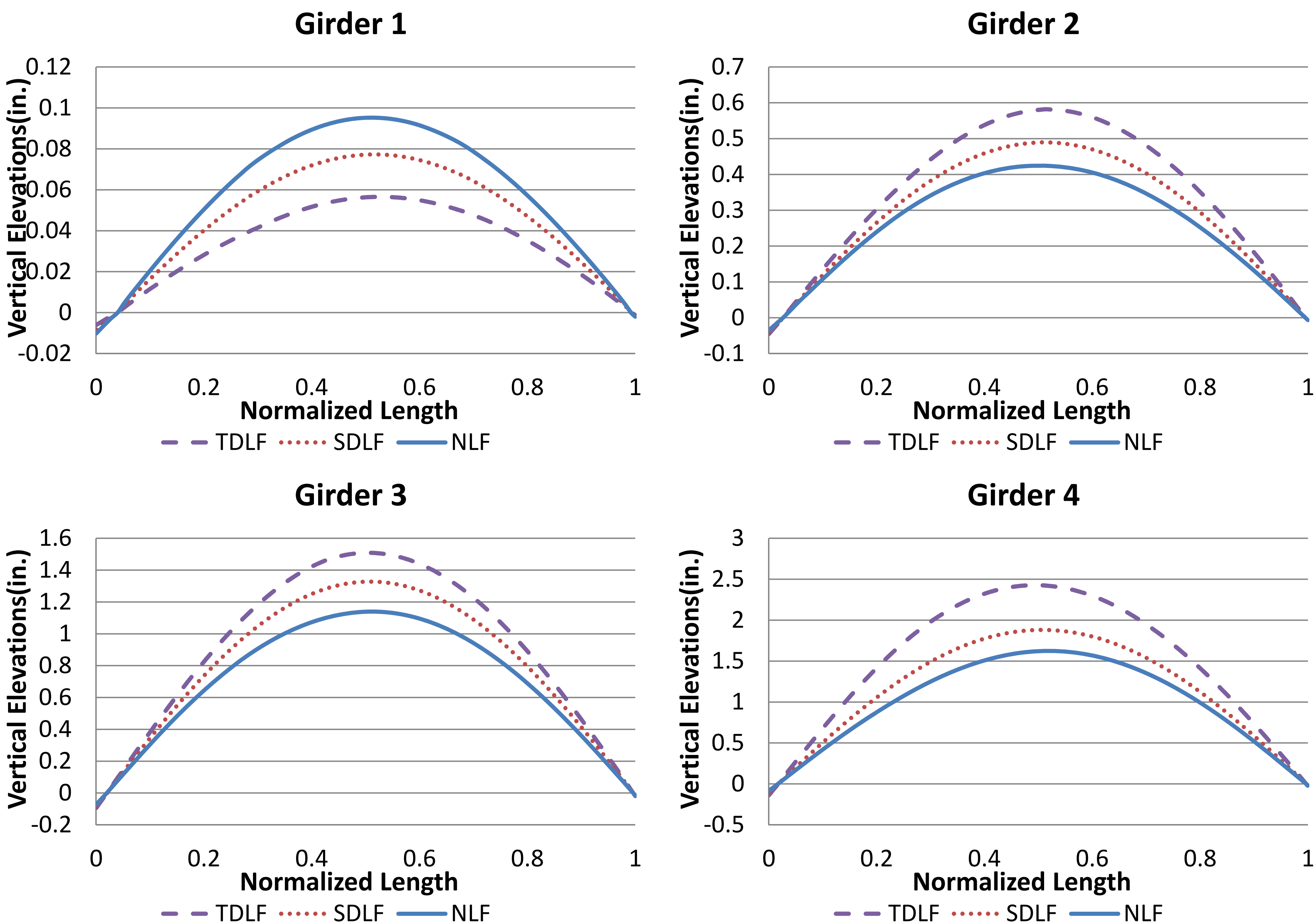


Figure H1-4-12. **Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.**

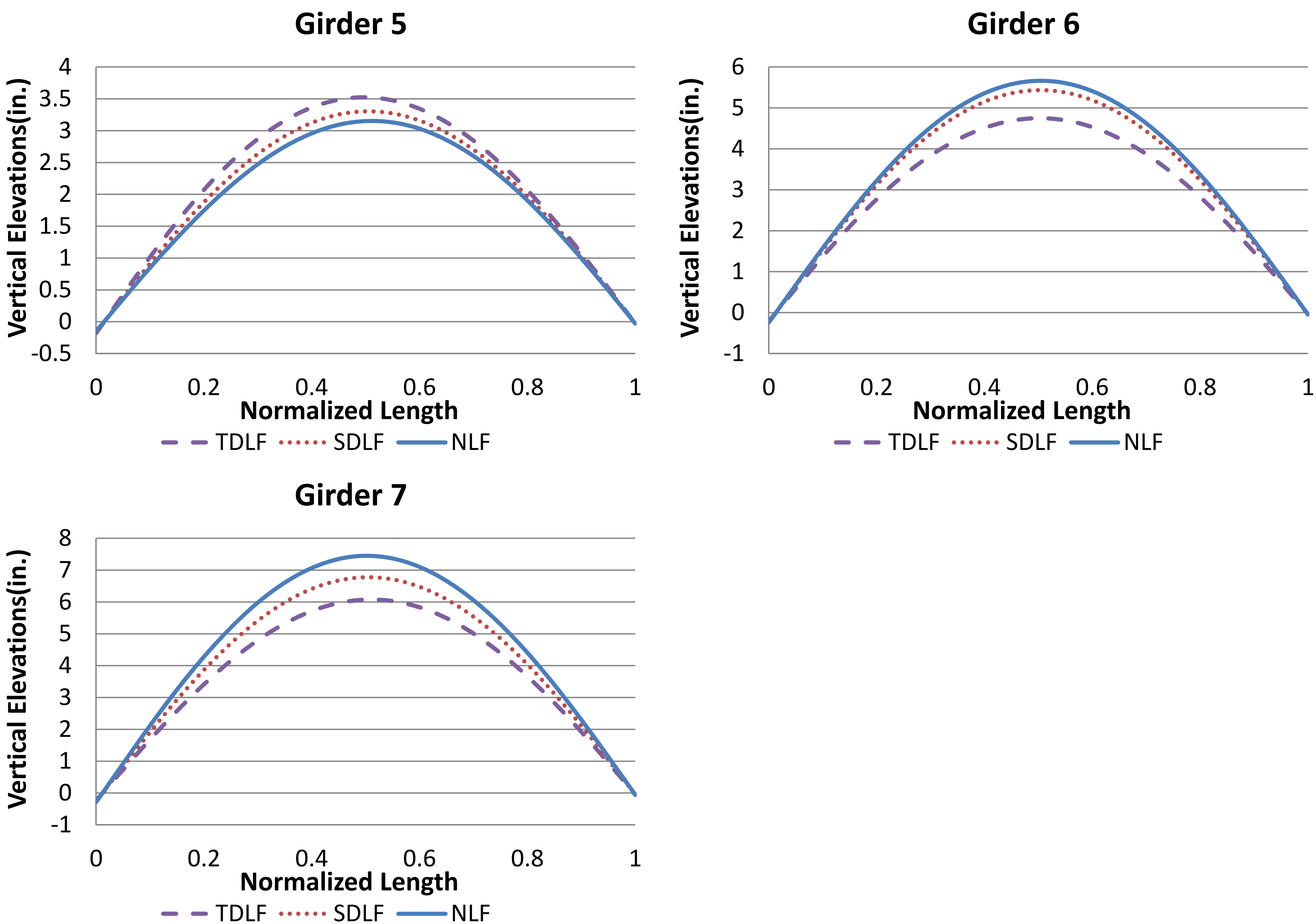


Figure H1-4-12(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

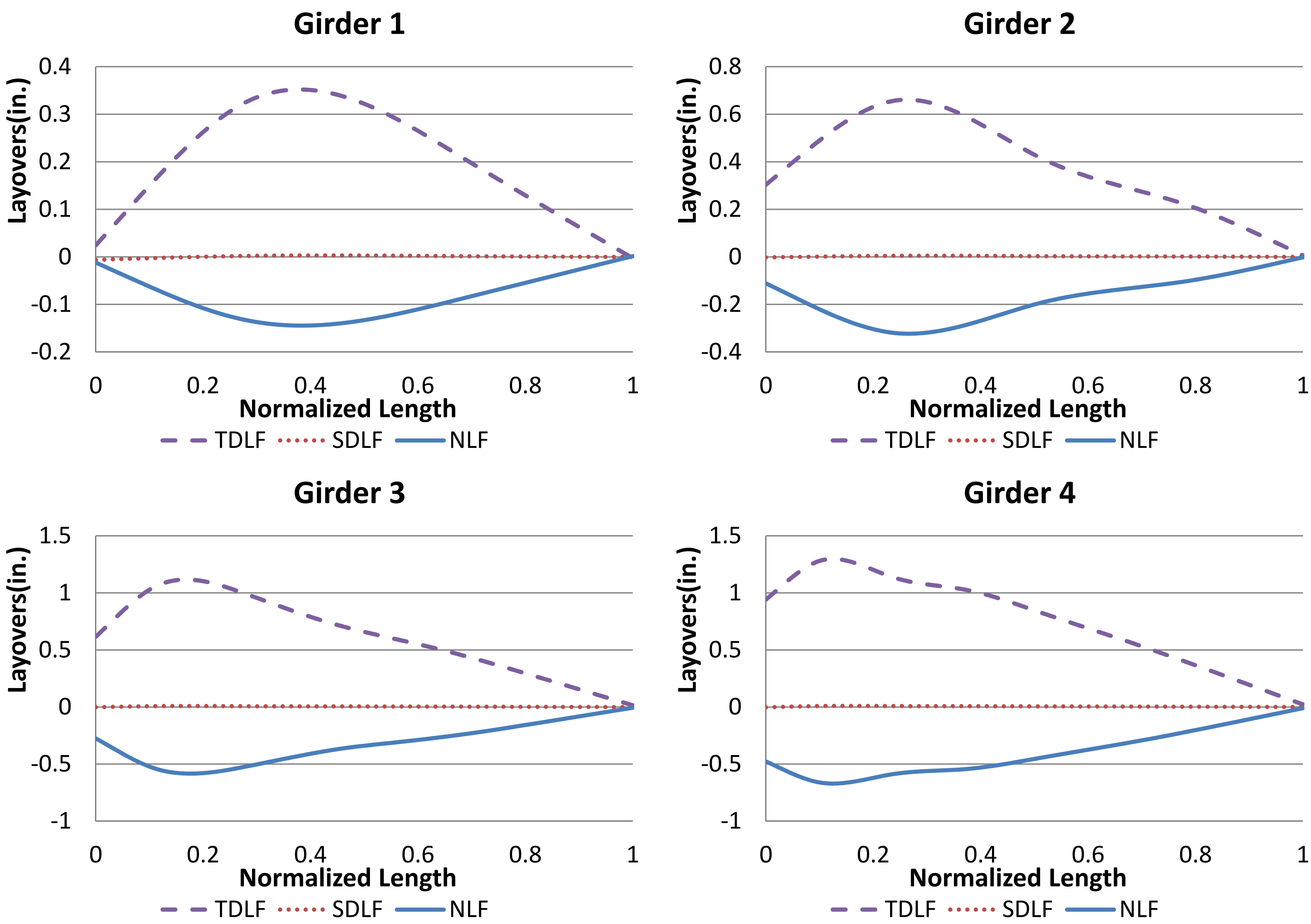


Figure H1-4-13. Comparison of individual girder layovers (in) under SDL for different detailing methods.

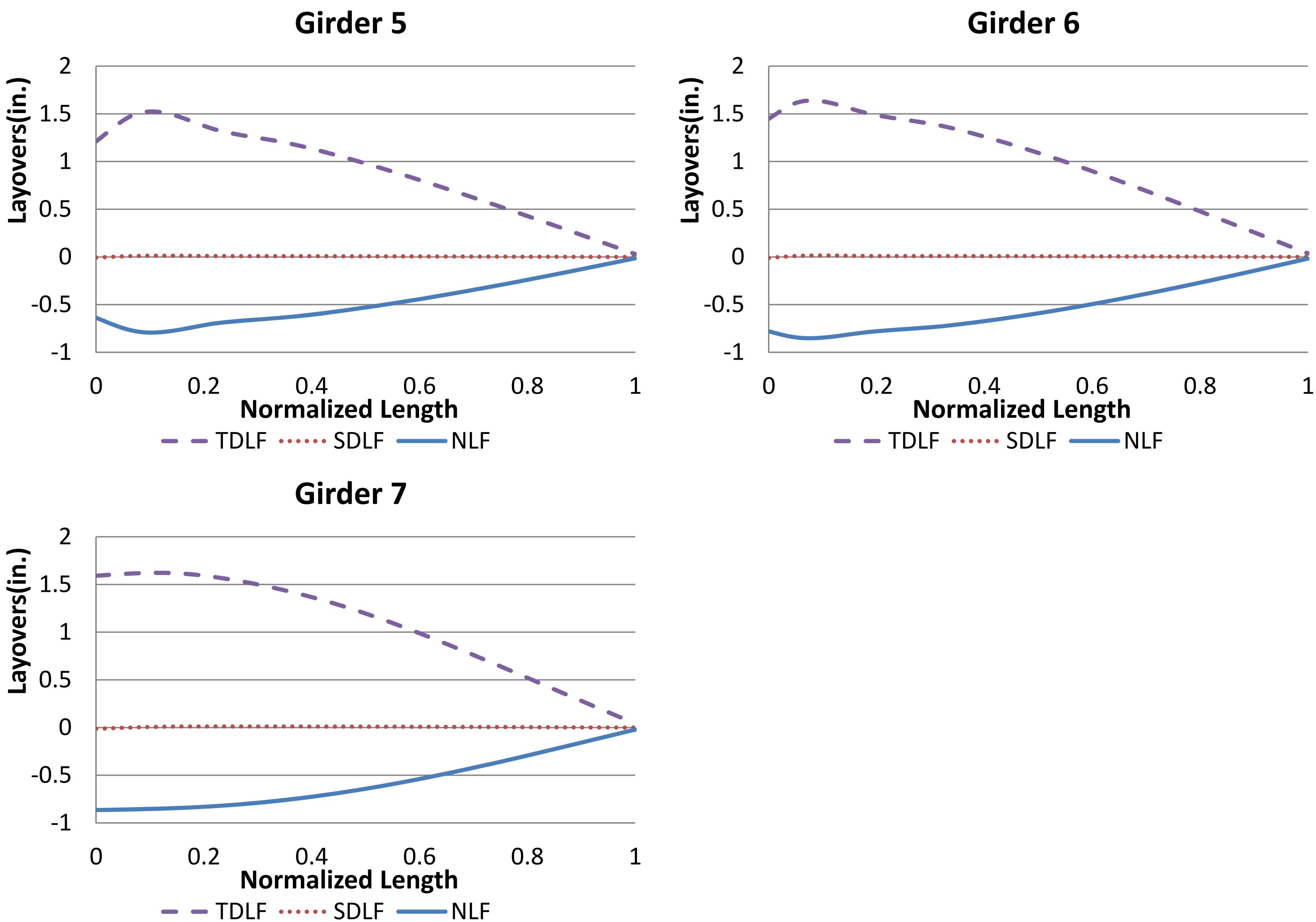


Figure H1-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

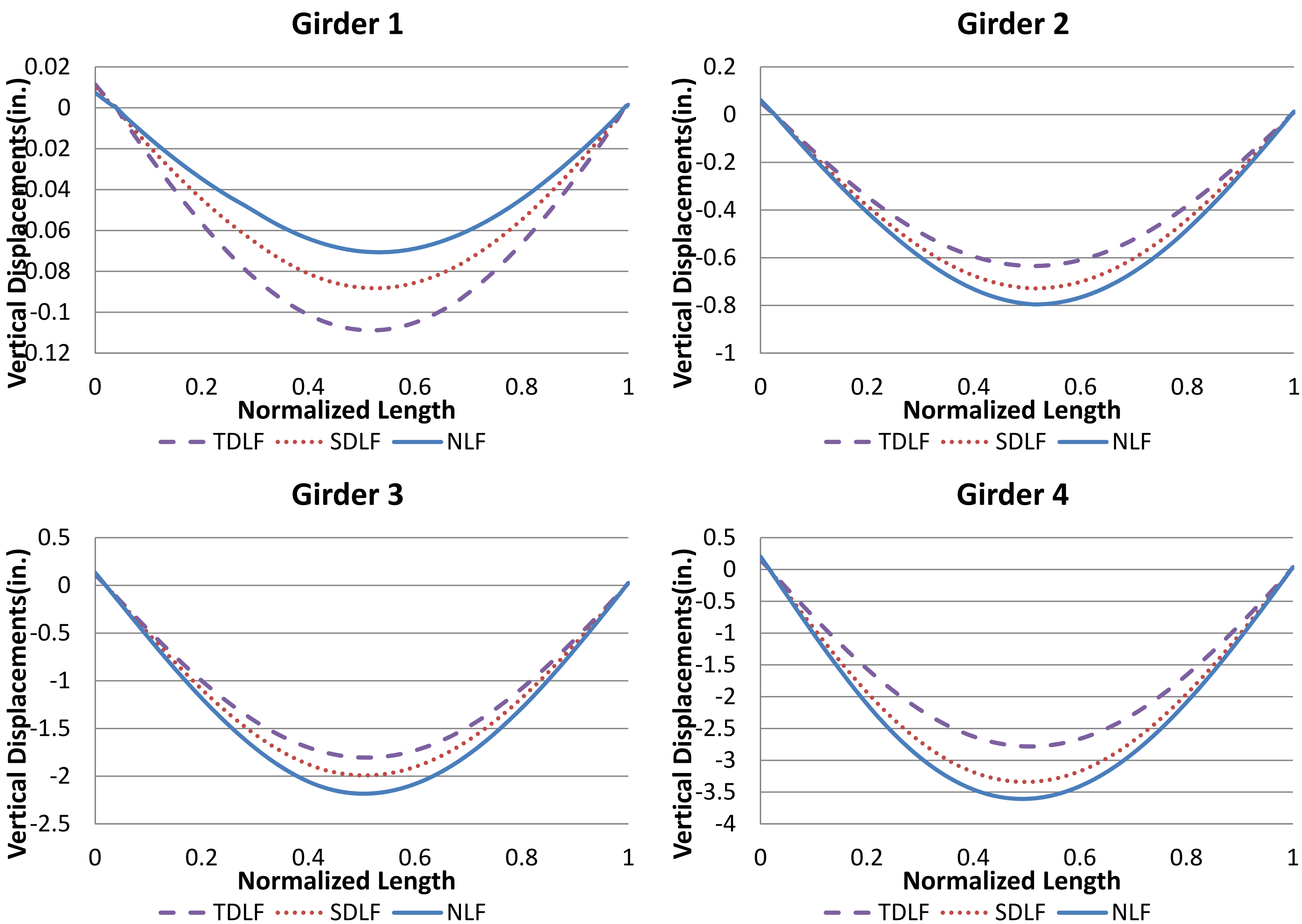


Figure H1-4-14. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

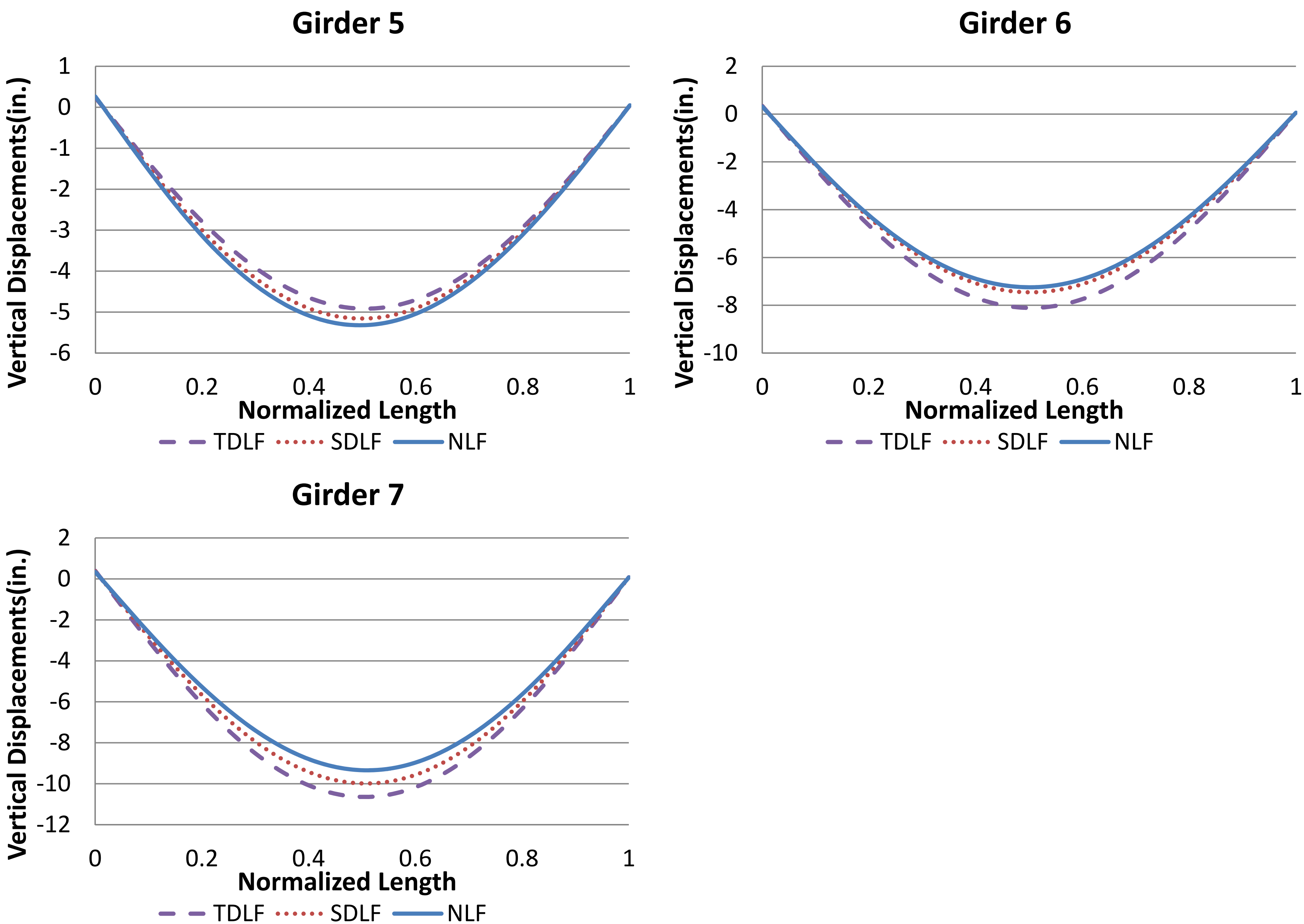


Figure H1-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

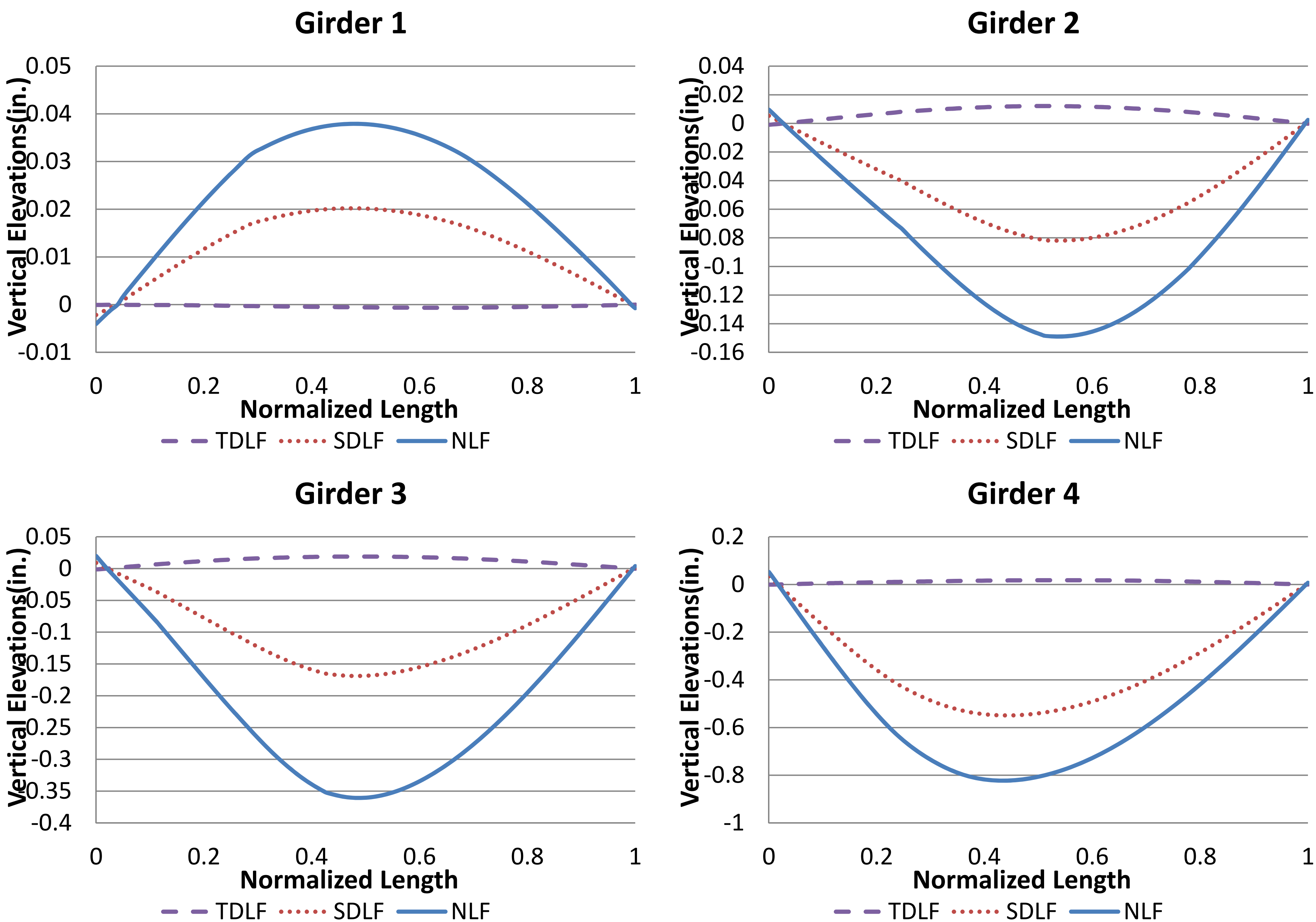


Figure H1-4-15. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

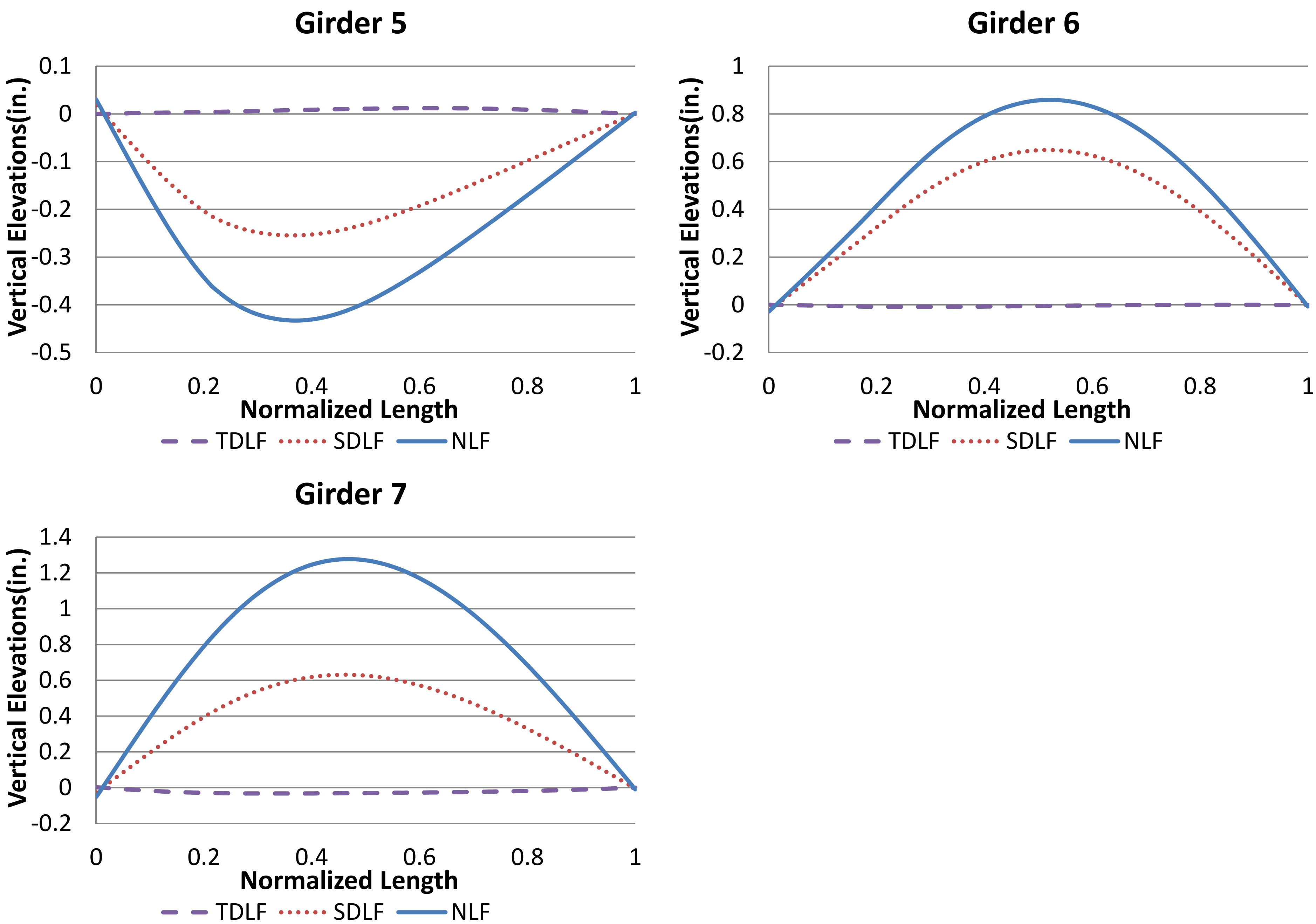


Figure H1-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

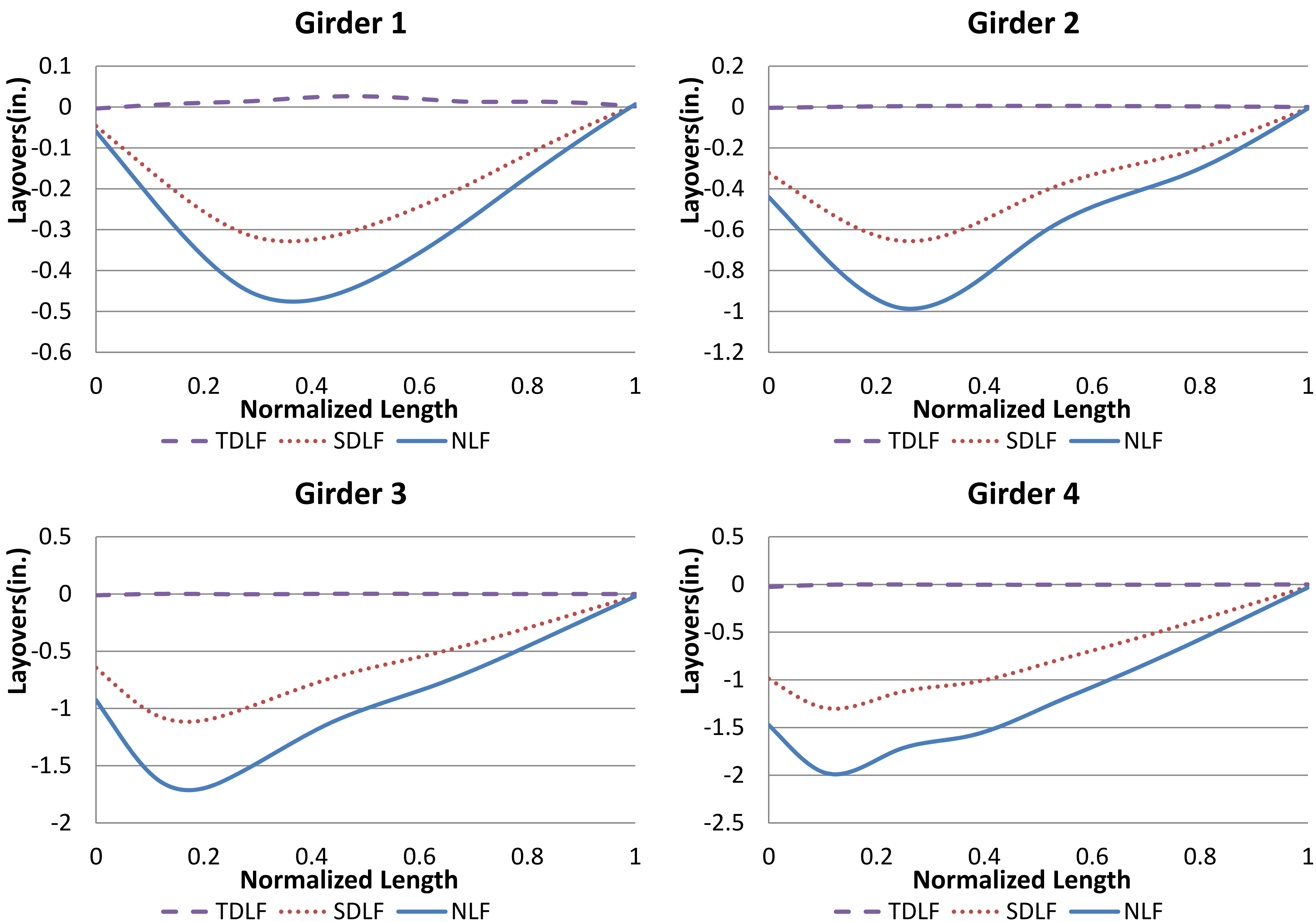


Figure H1-4-16. Comparison of individual girder layovers (in) under TDL for different detailing methods.

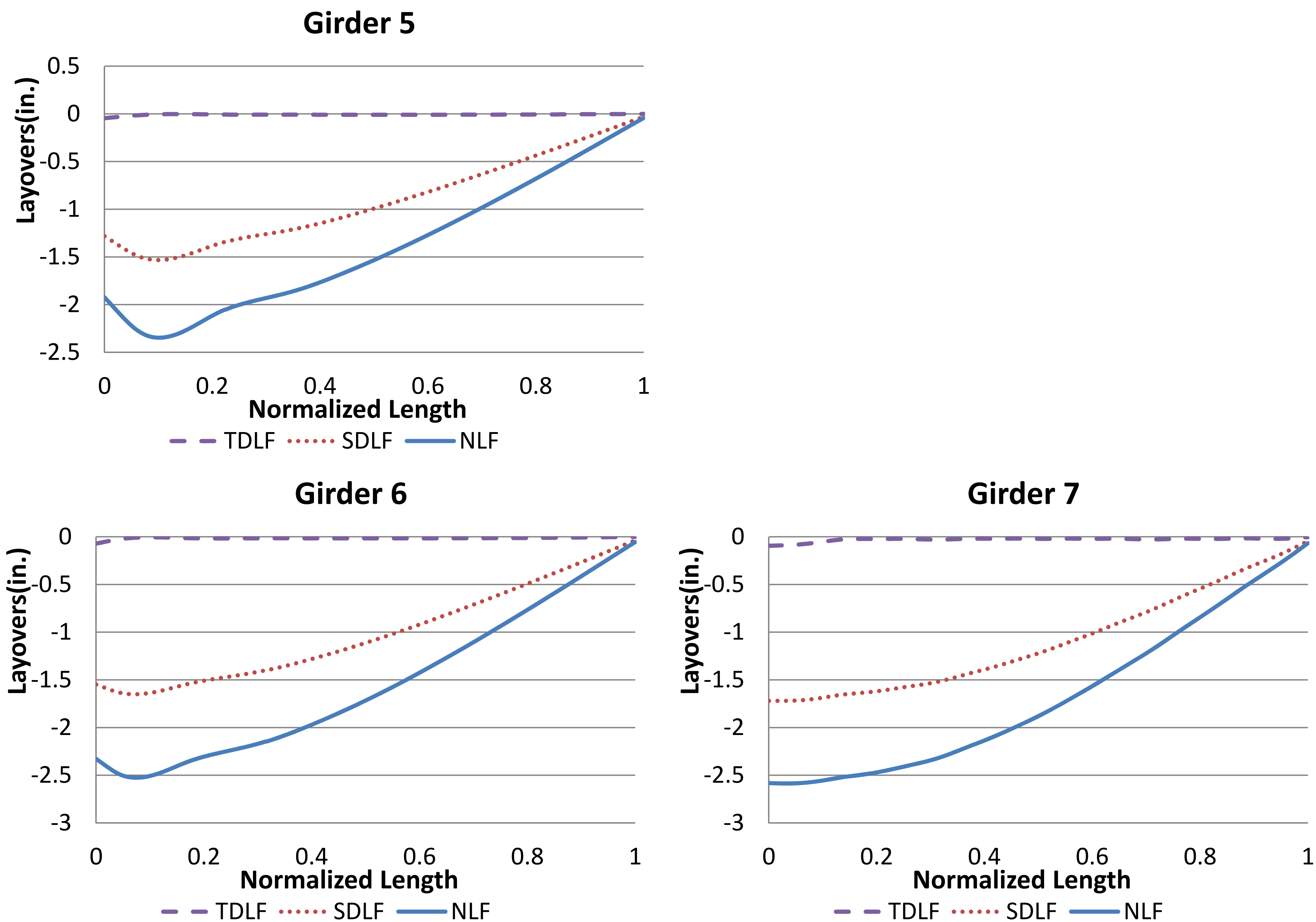


Figure H1-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

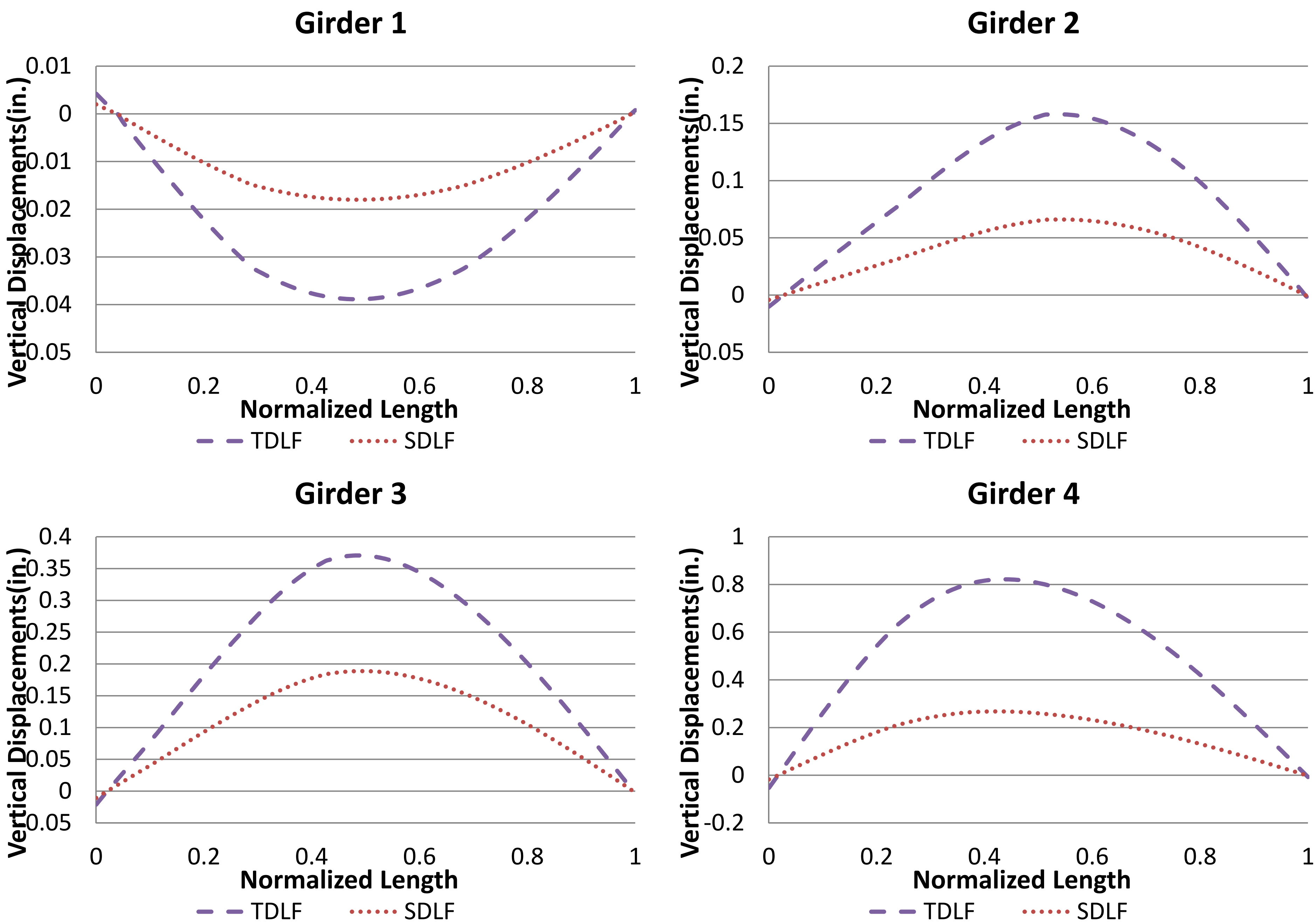


Figure H1-4-17. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

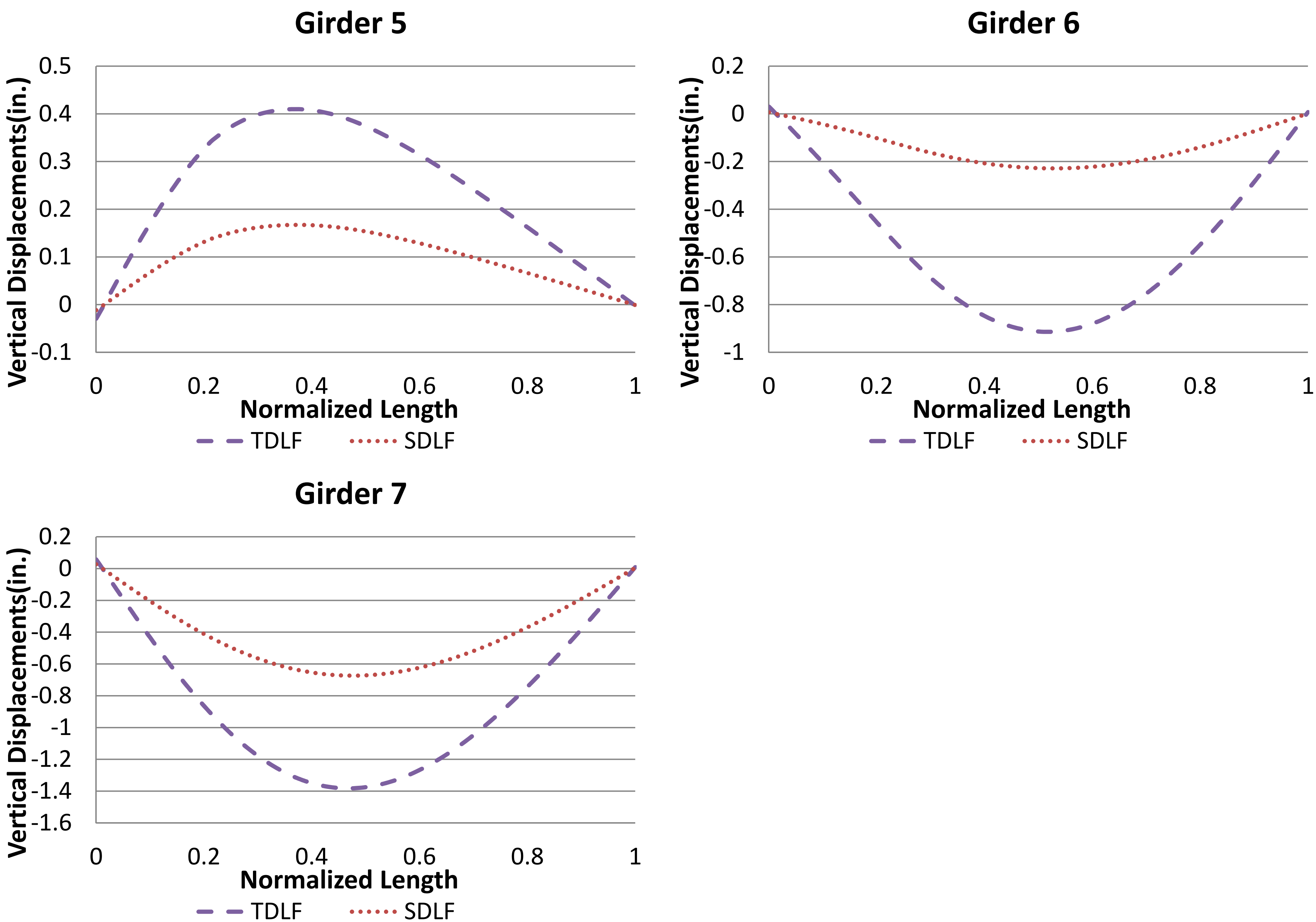


Figure H1-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

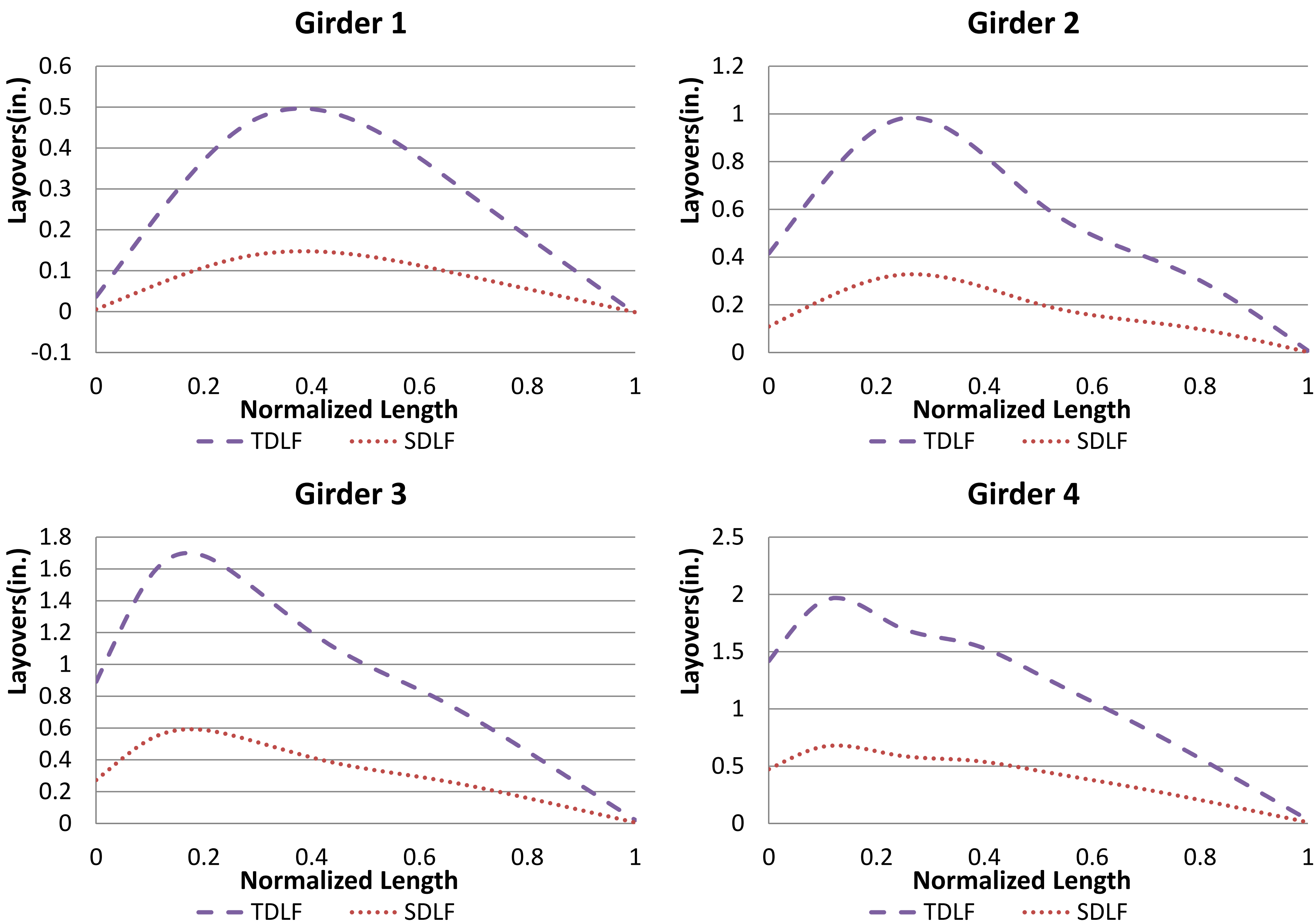


Figure H1-4-18. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

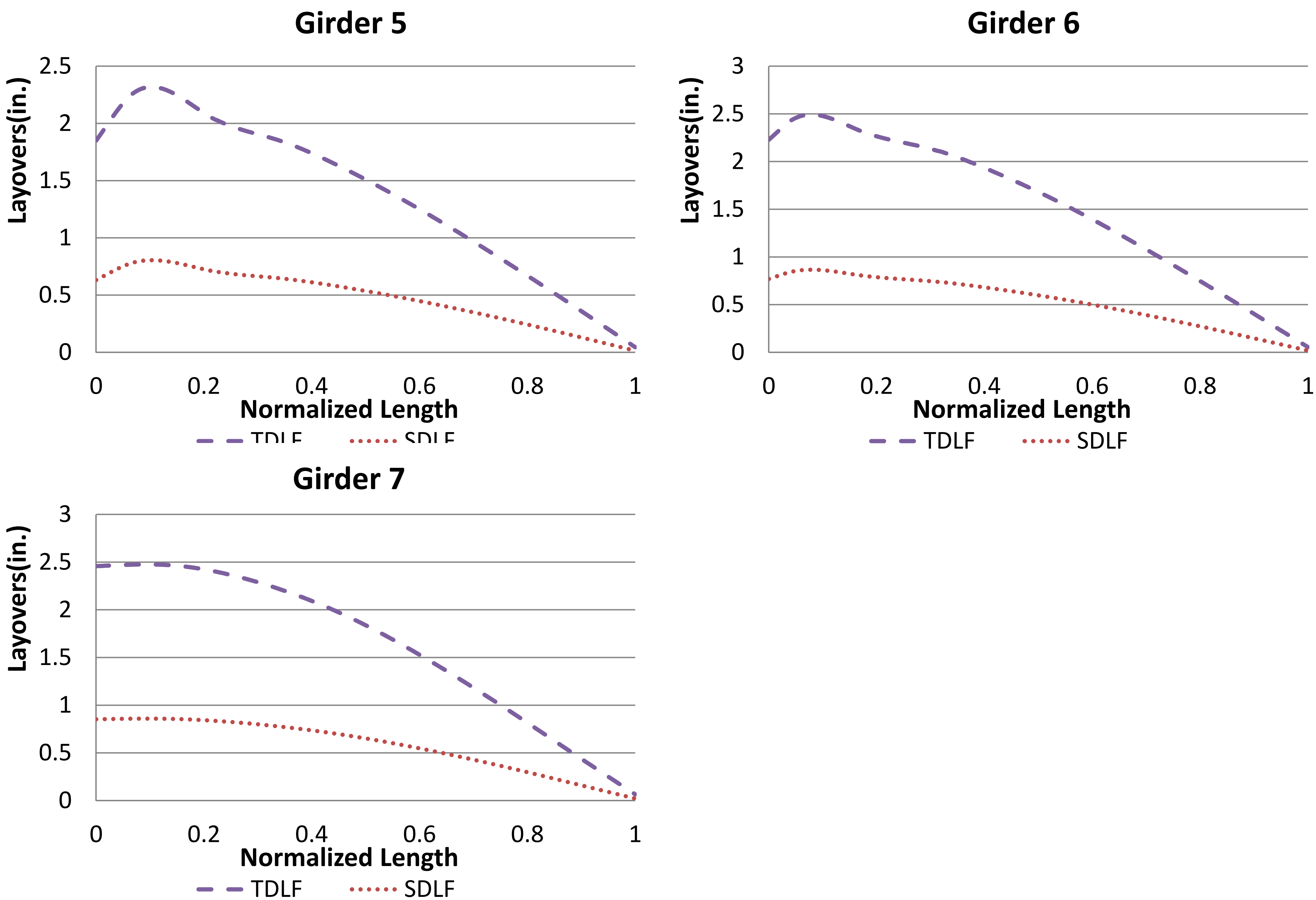


Figure H1-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

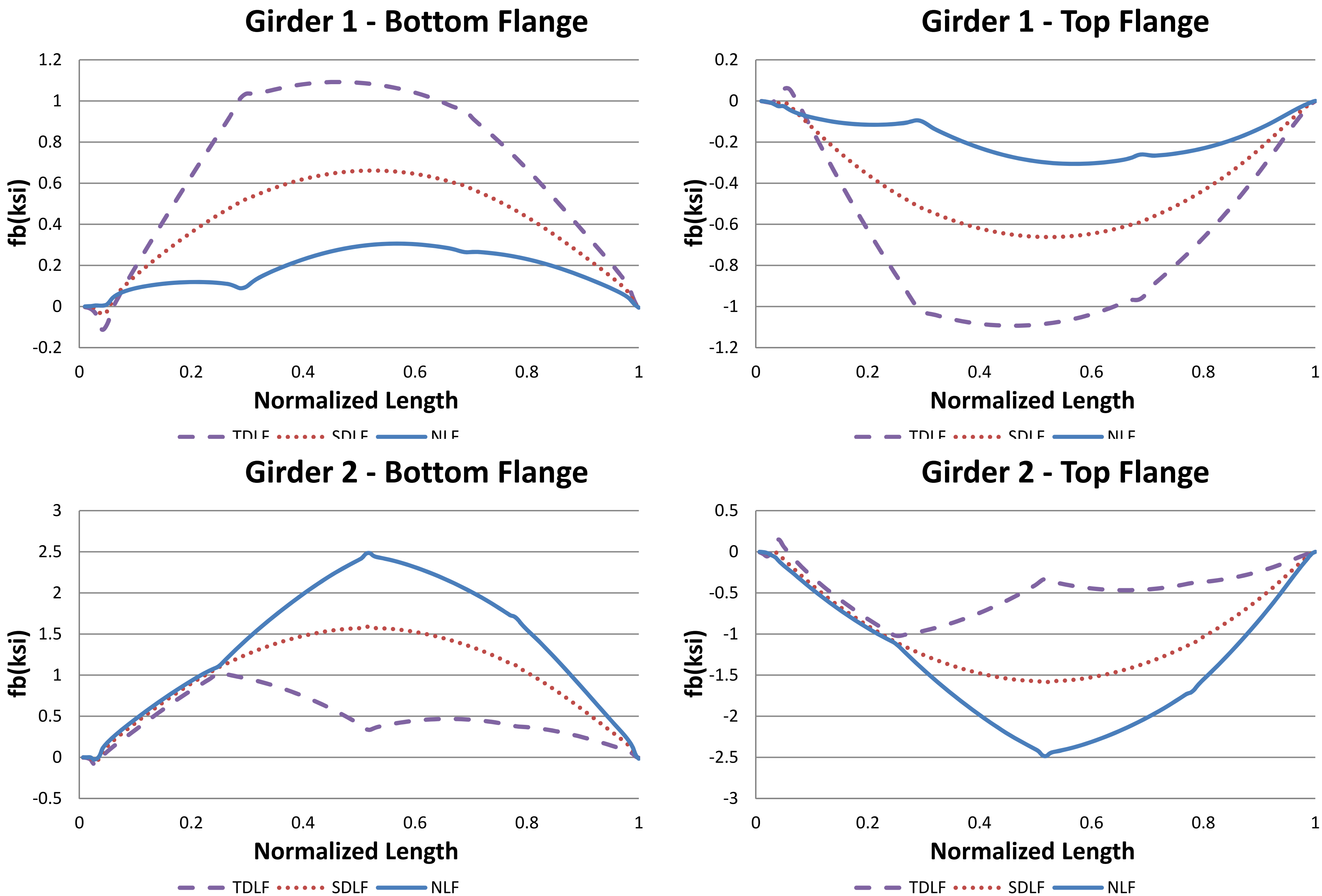


Figure H1-4-19. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

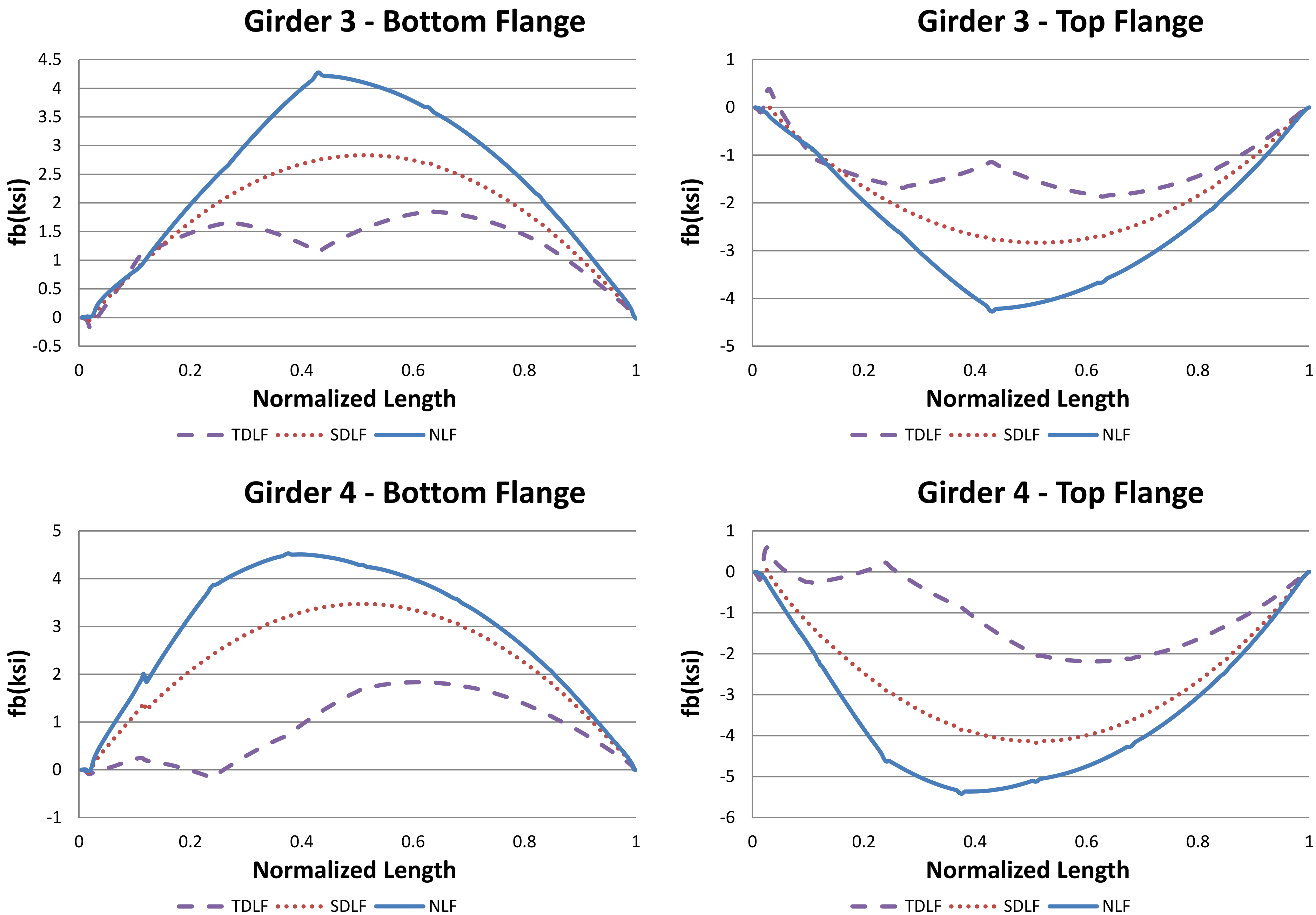


Figure H1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

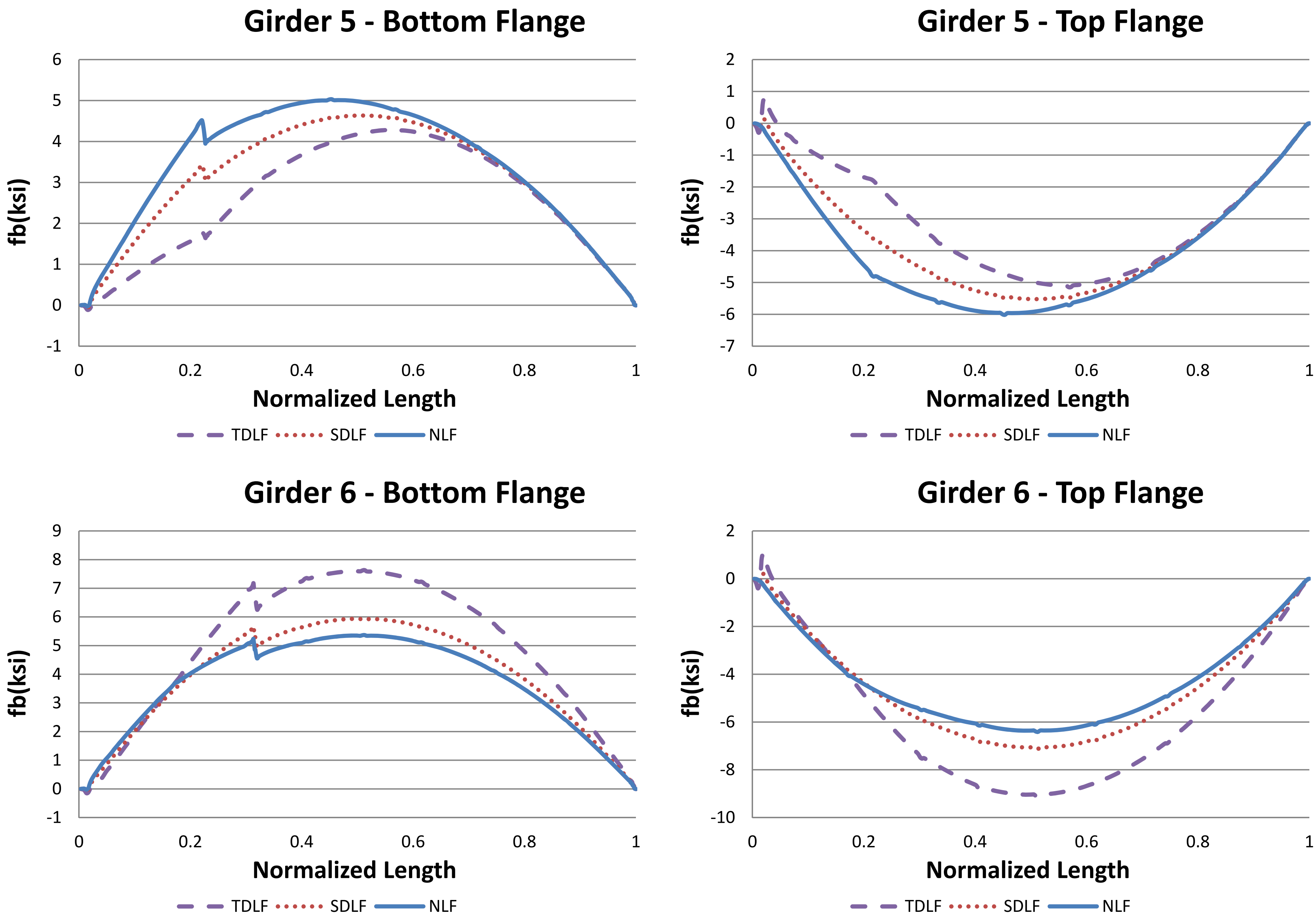
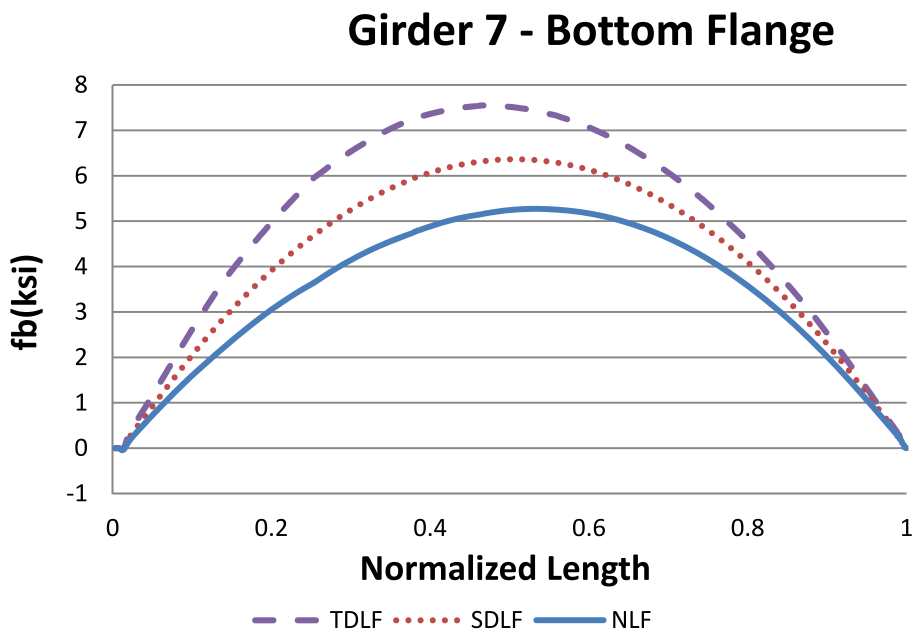


Figure H1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.



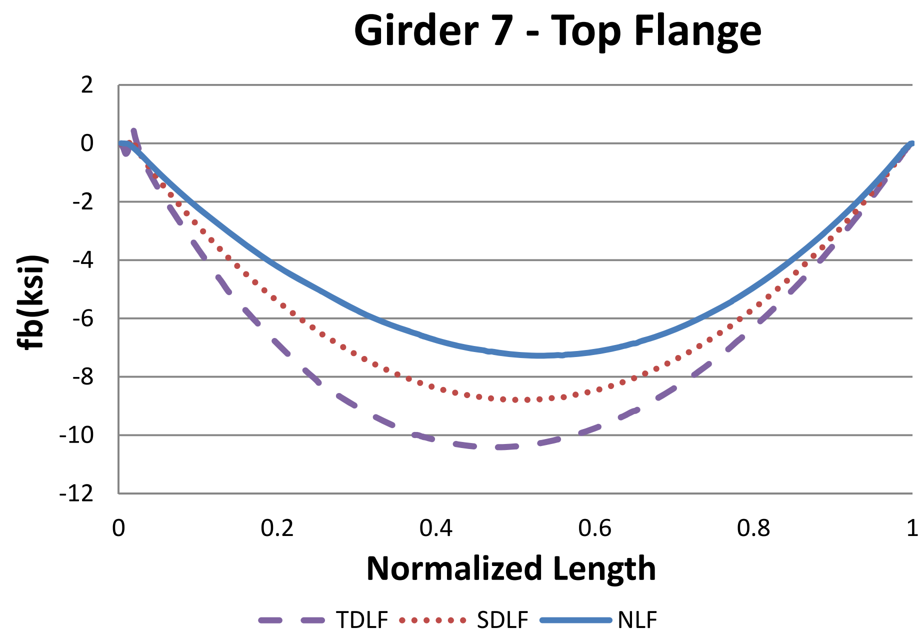


Figure H1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

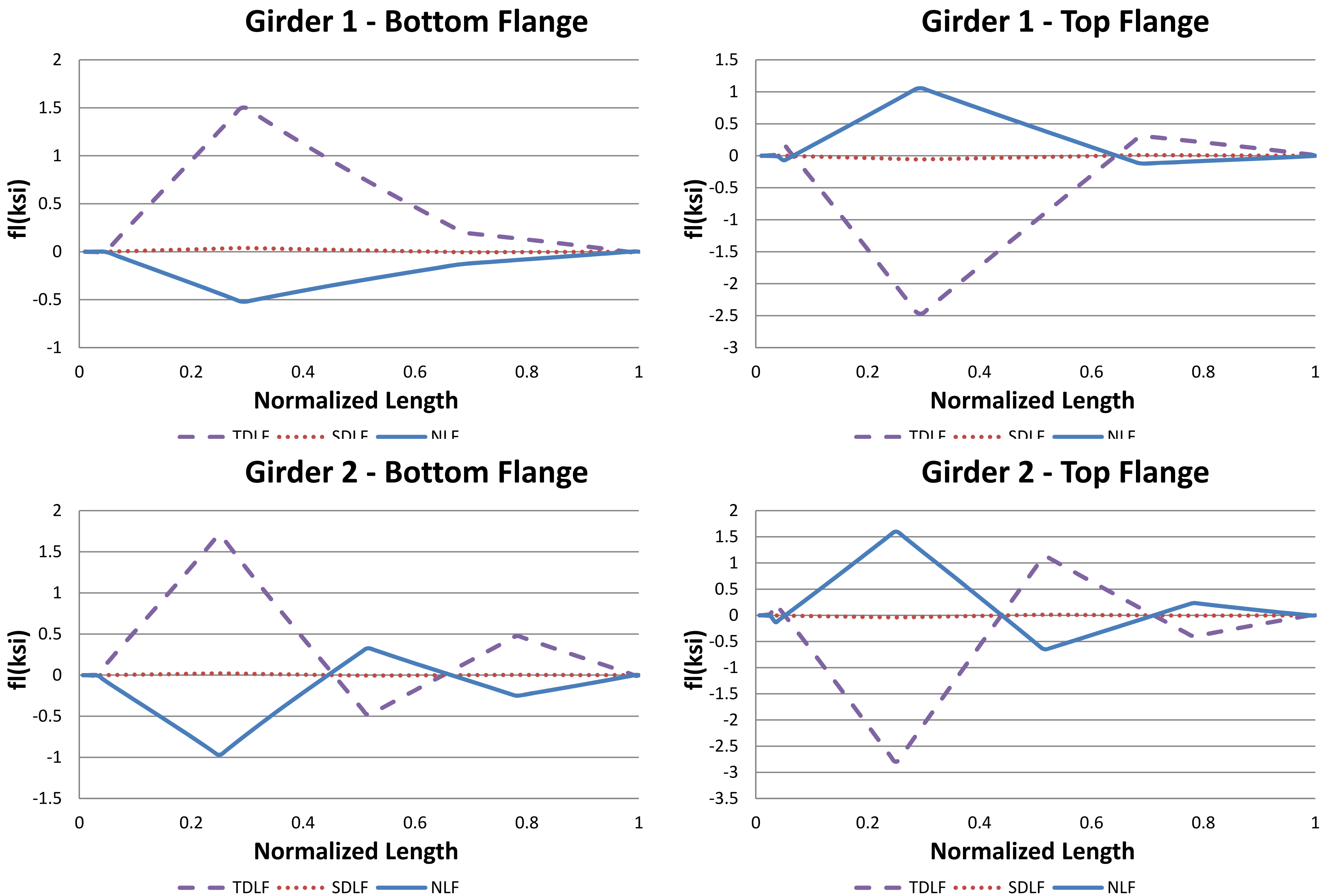


Figure H1-4-20. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

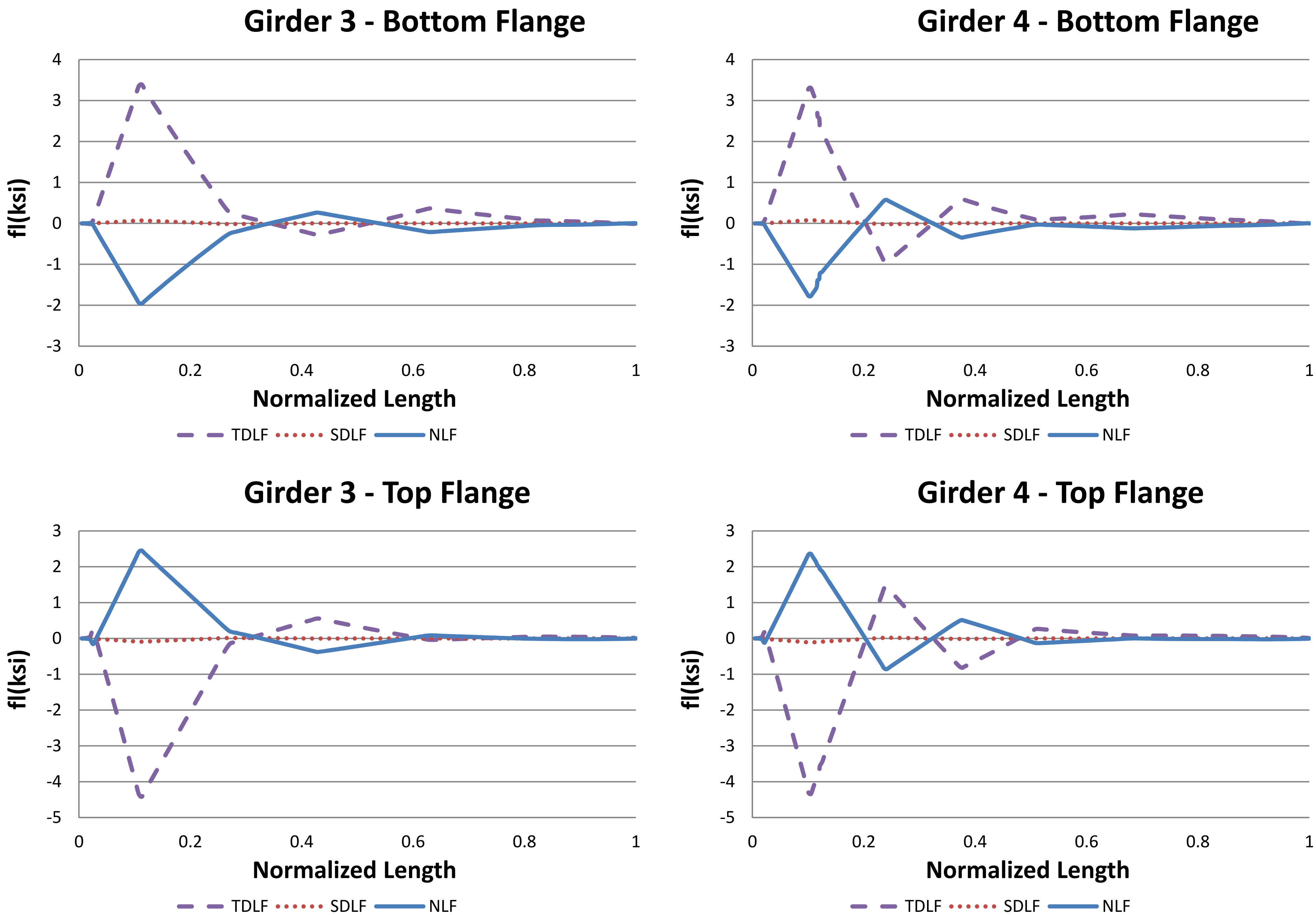


Figure H1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

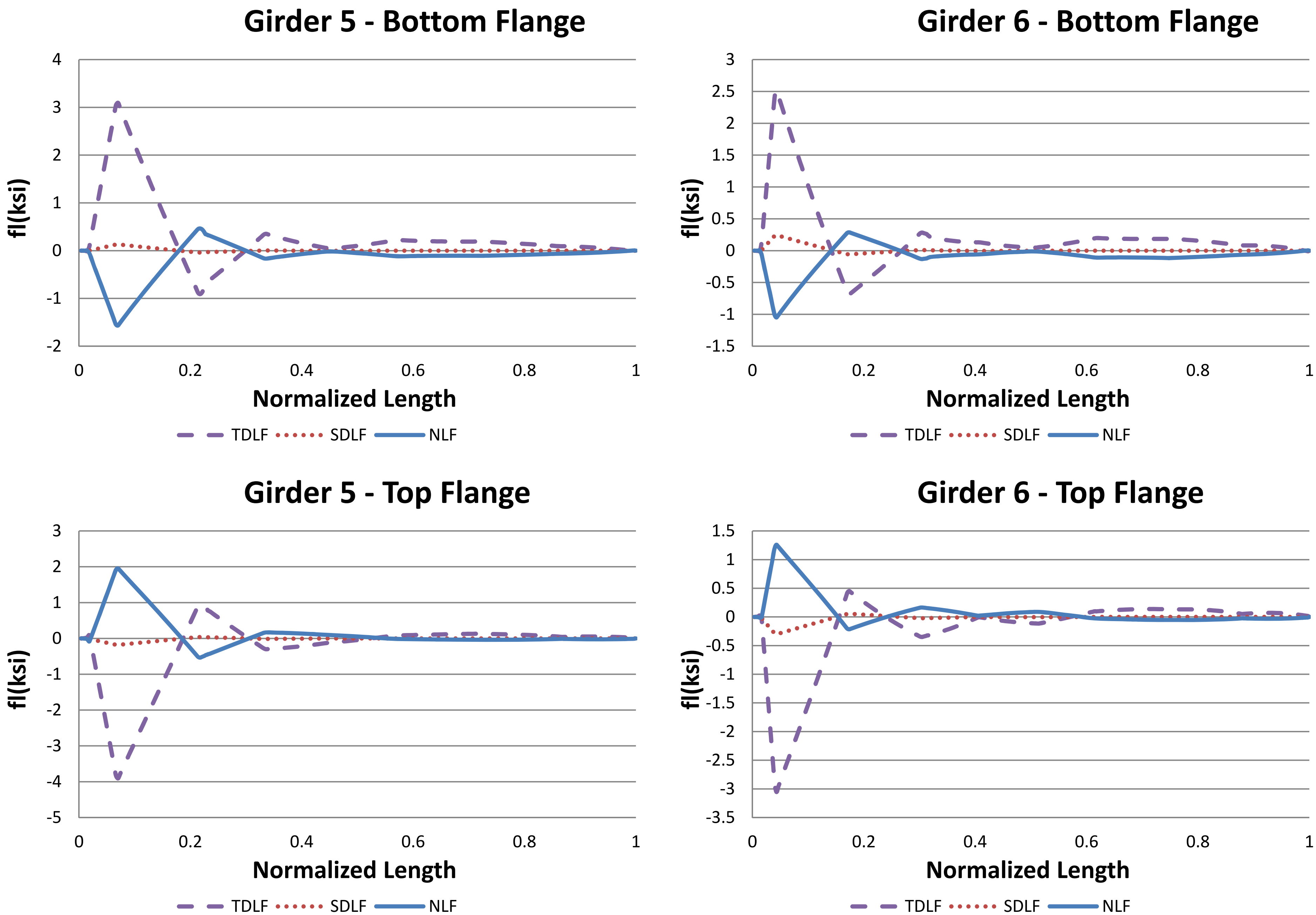
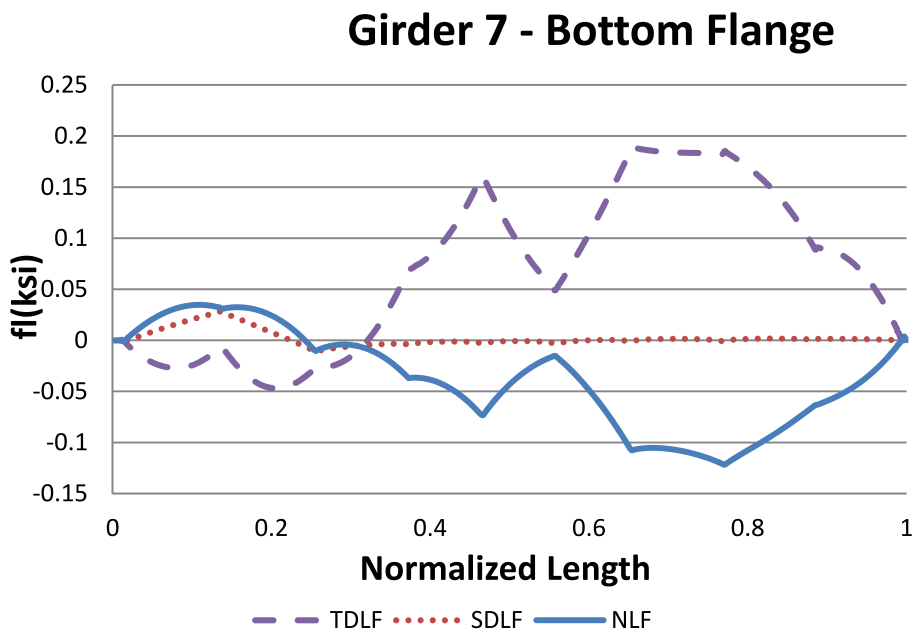


Figure H1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.



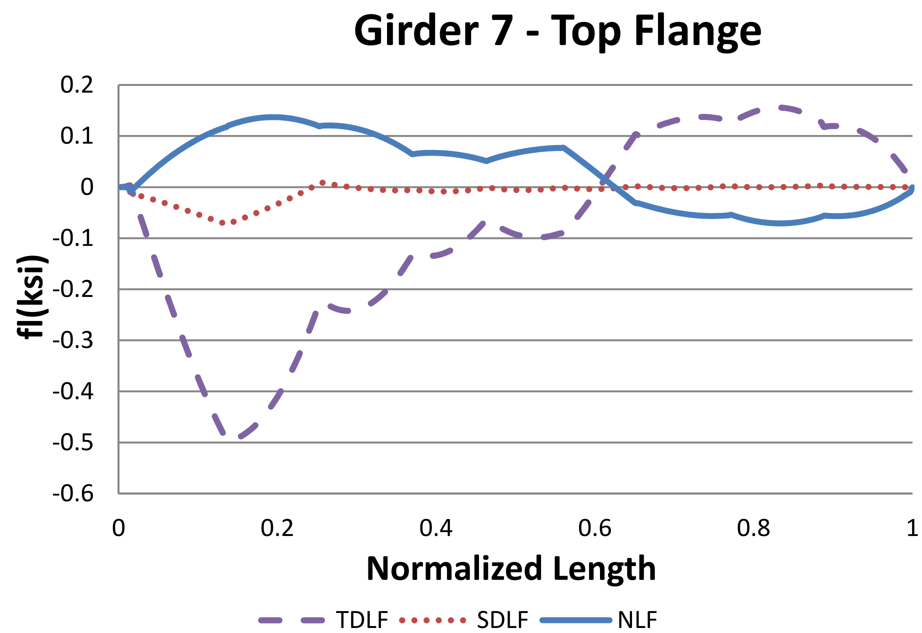


Figure H1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

Figure H1-4-21. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

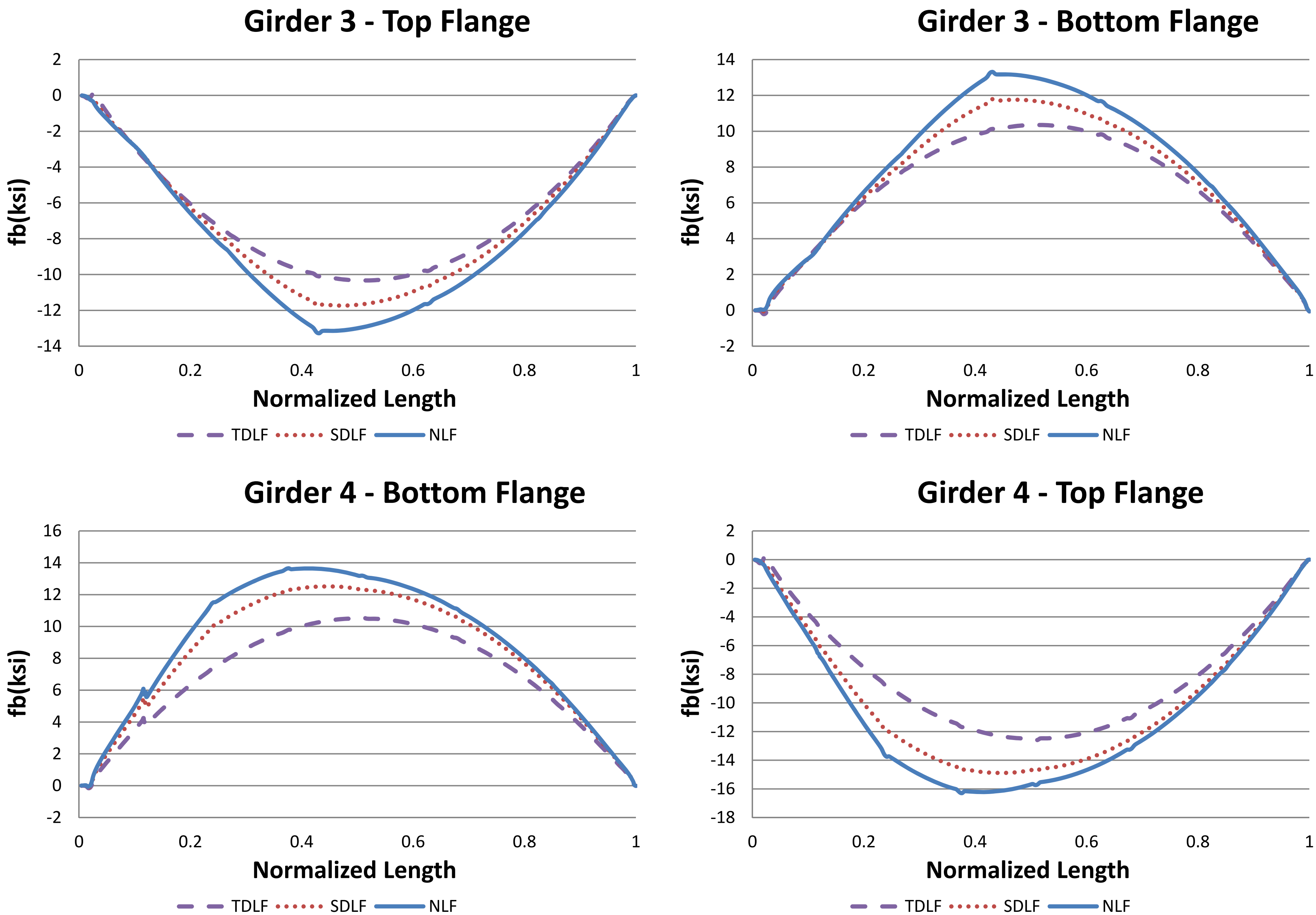


Figure H1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

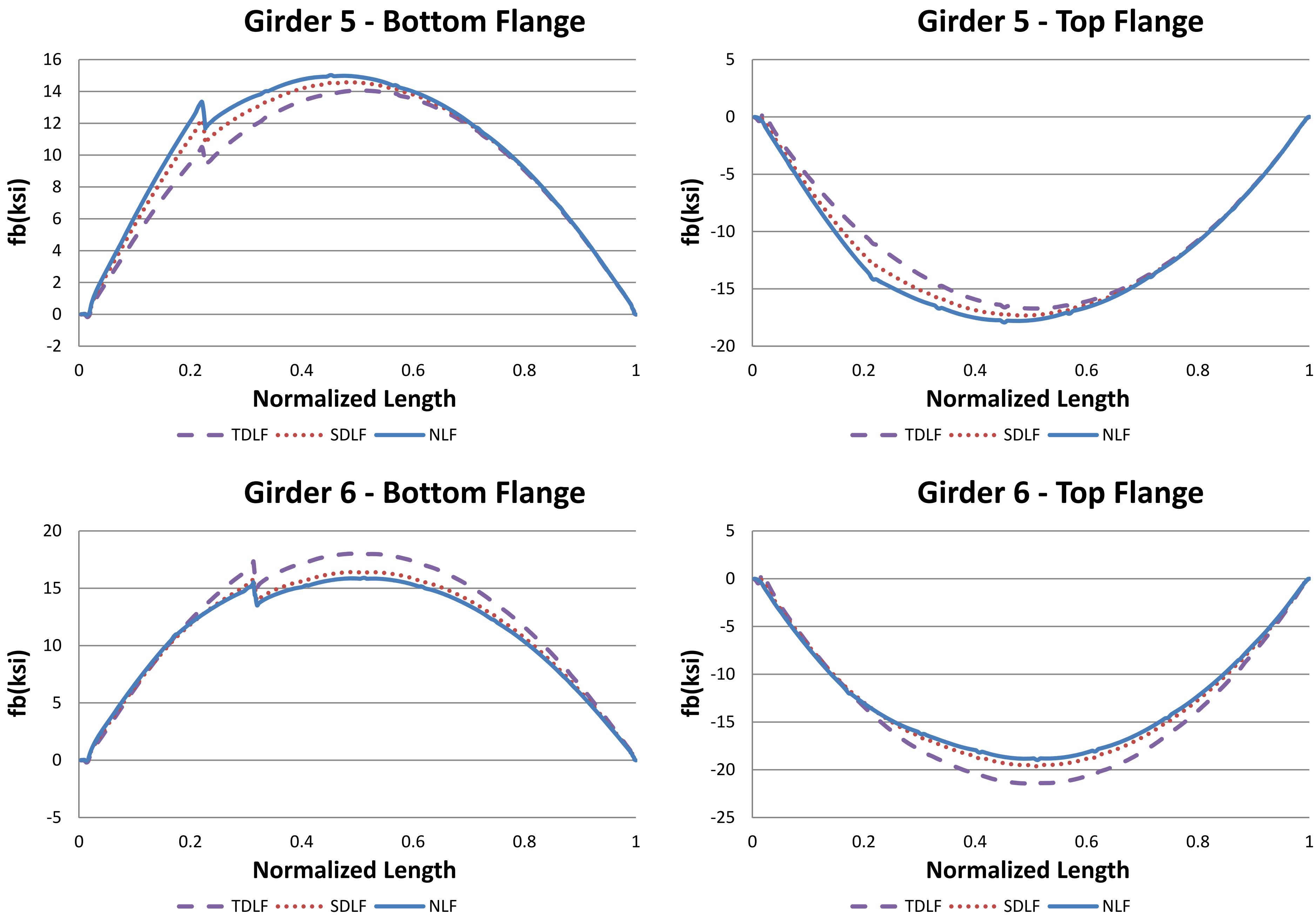
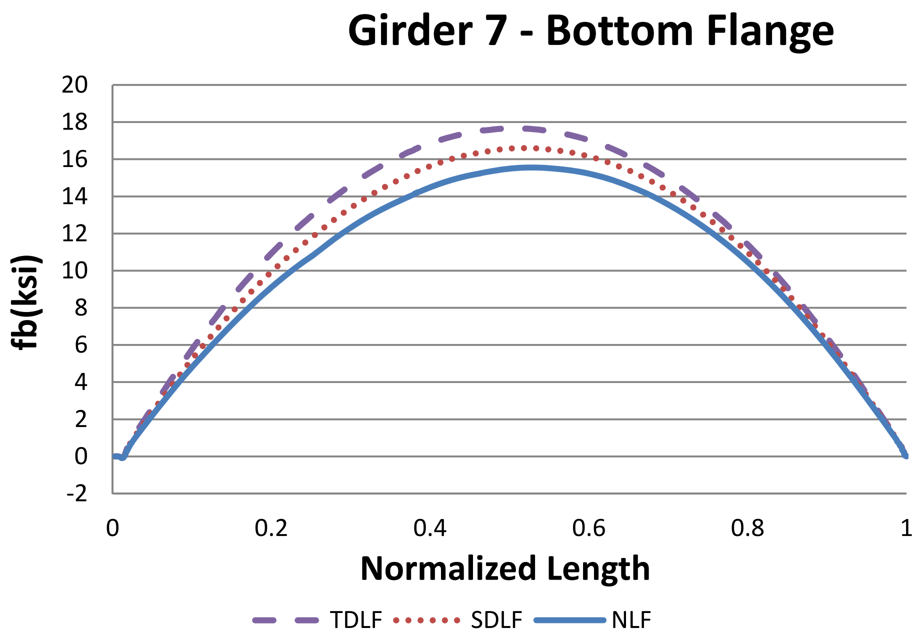


Figure H1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



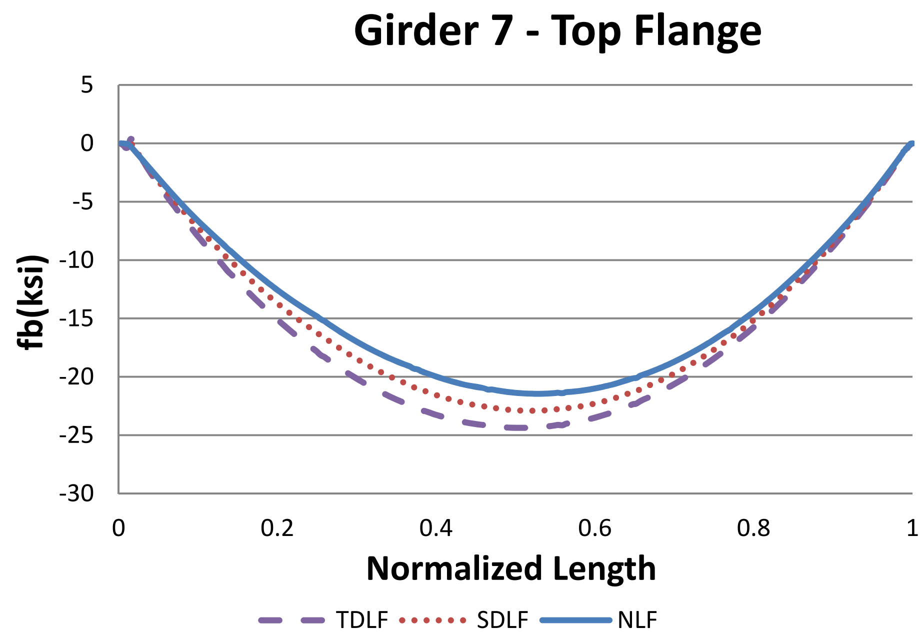


Figure H1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

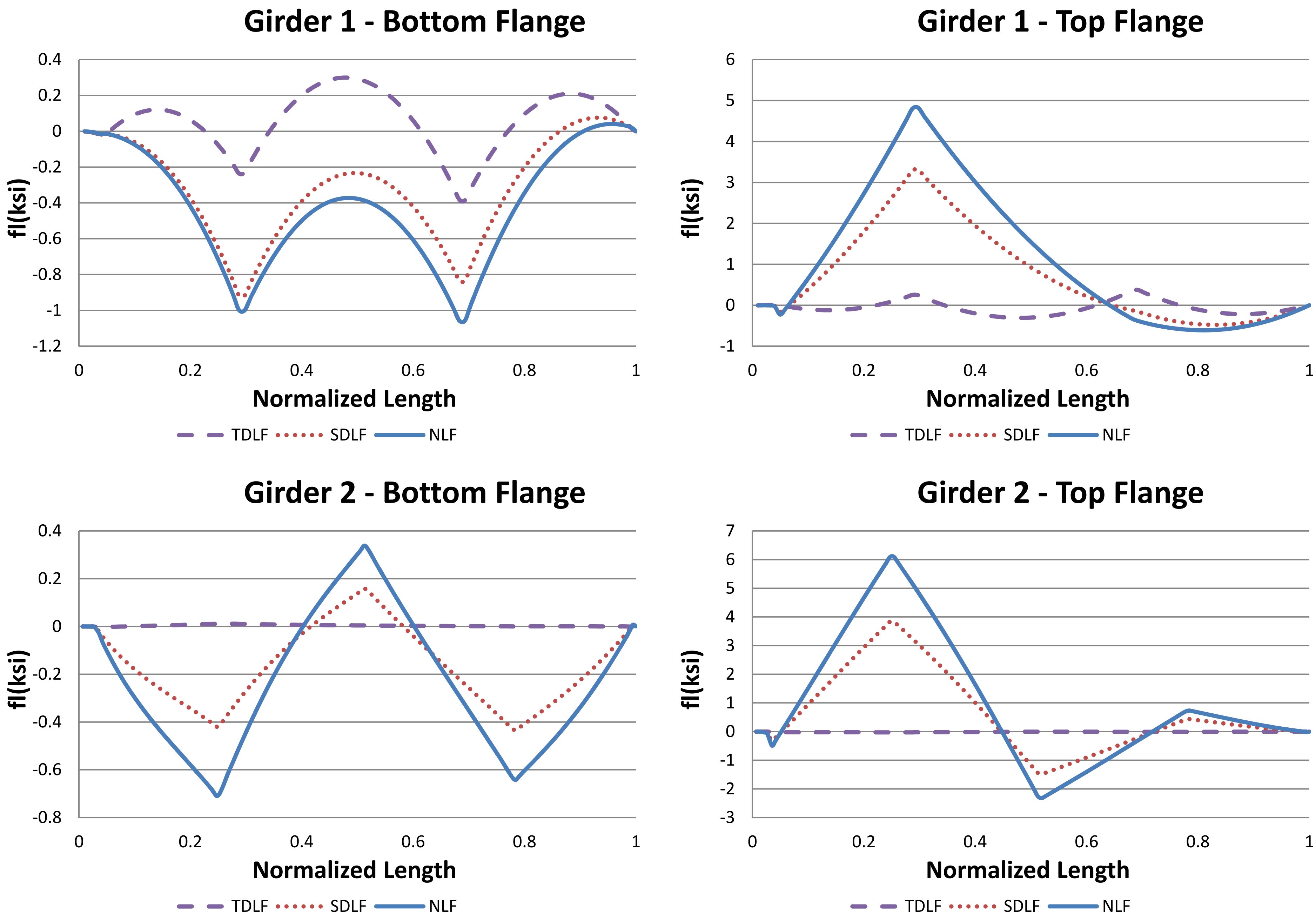


Figure H1-4-22. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

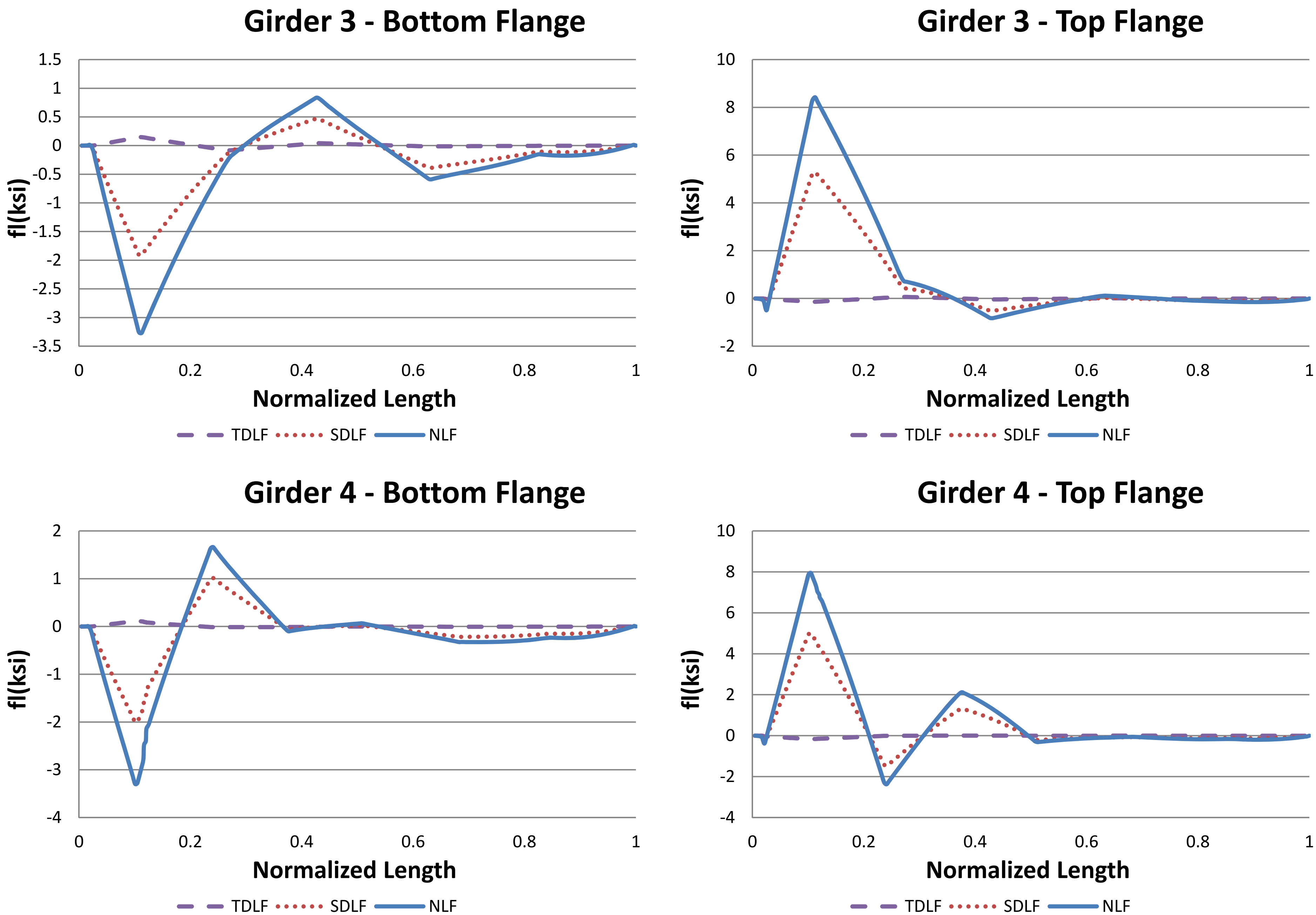


Figure H1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

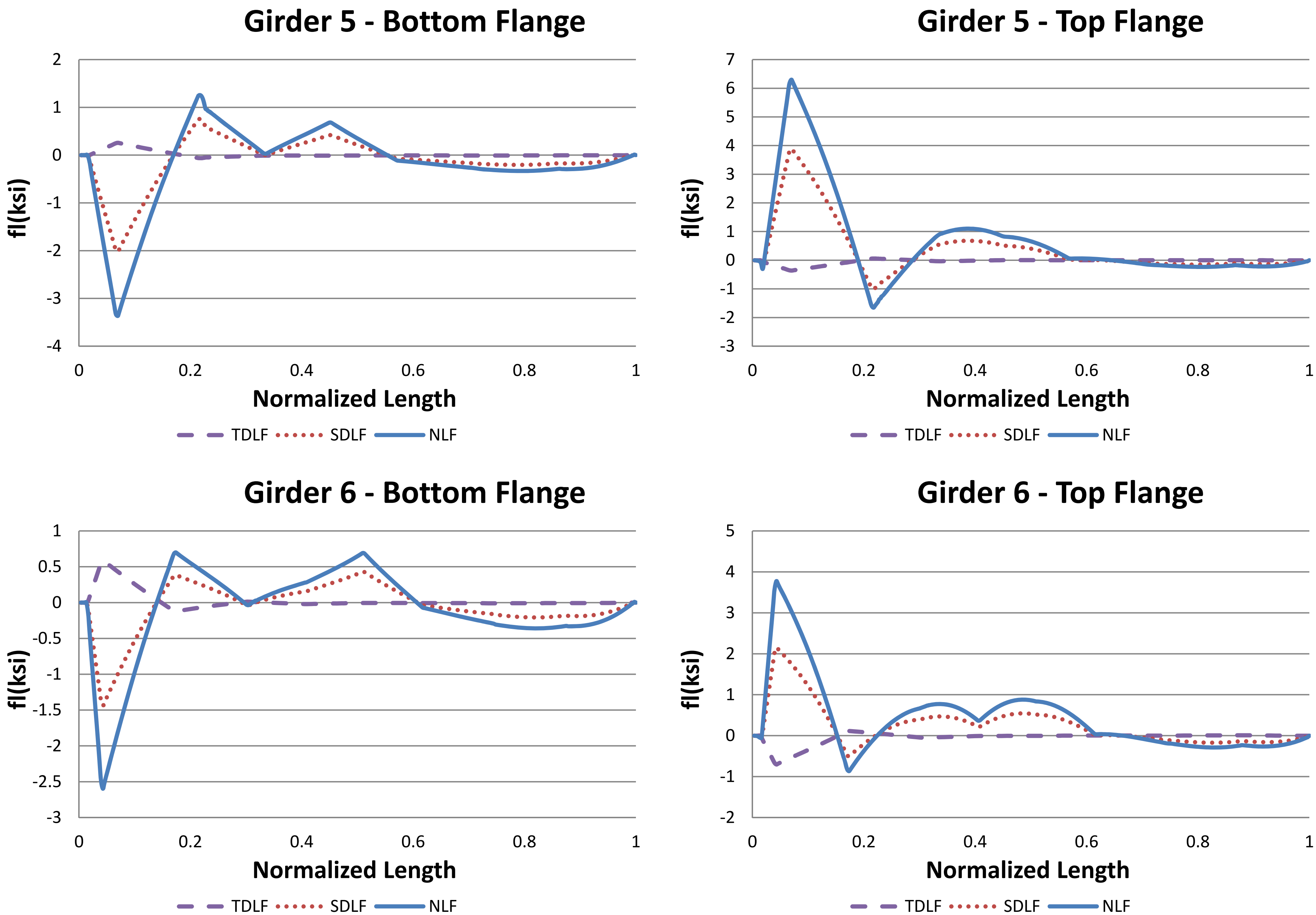


Figure H1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.

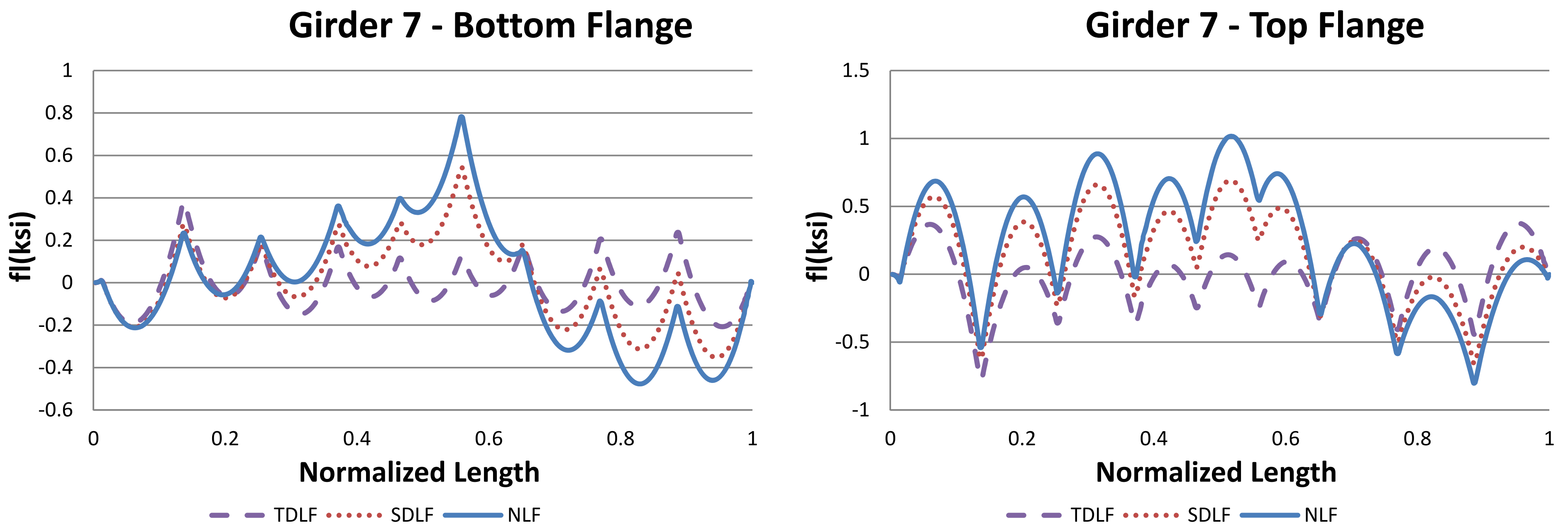


Figure H1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

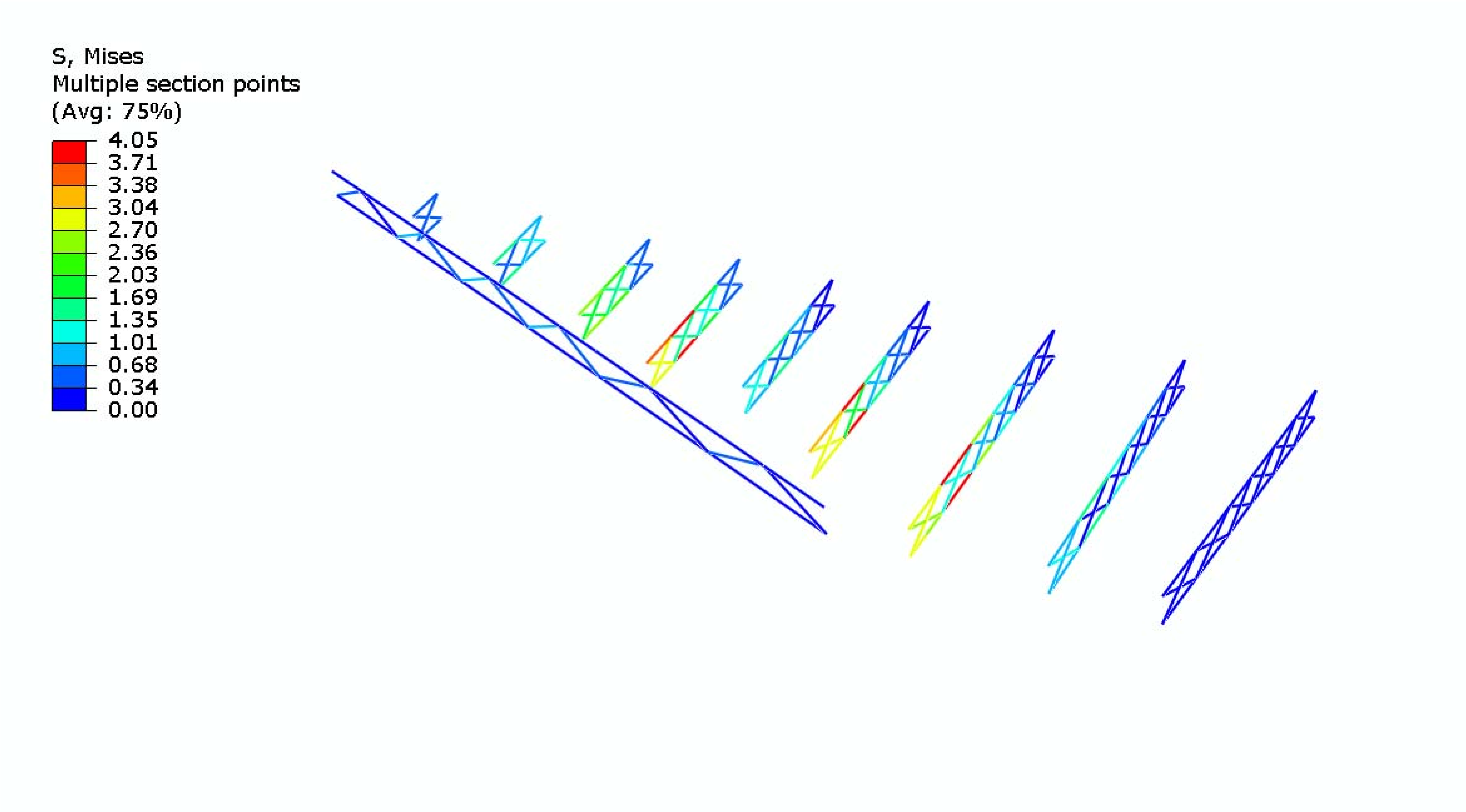


Figure H1-4-23. Cross-frame stress contours (ksi) under SDL, NLF detailing

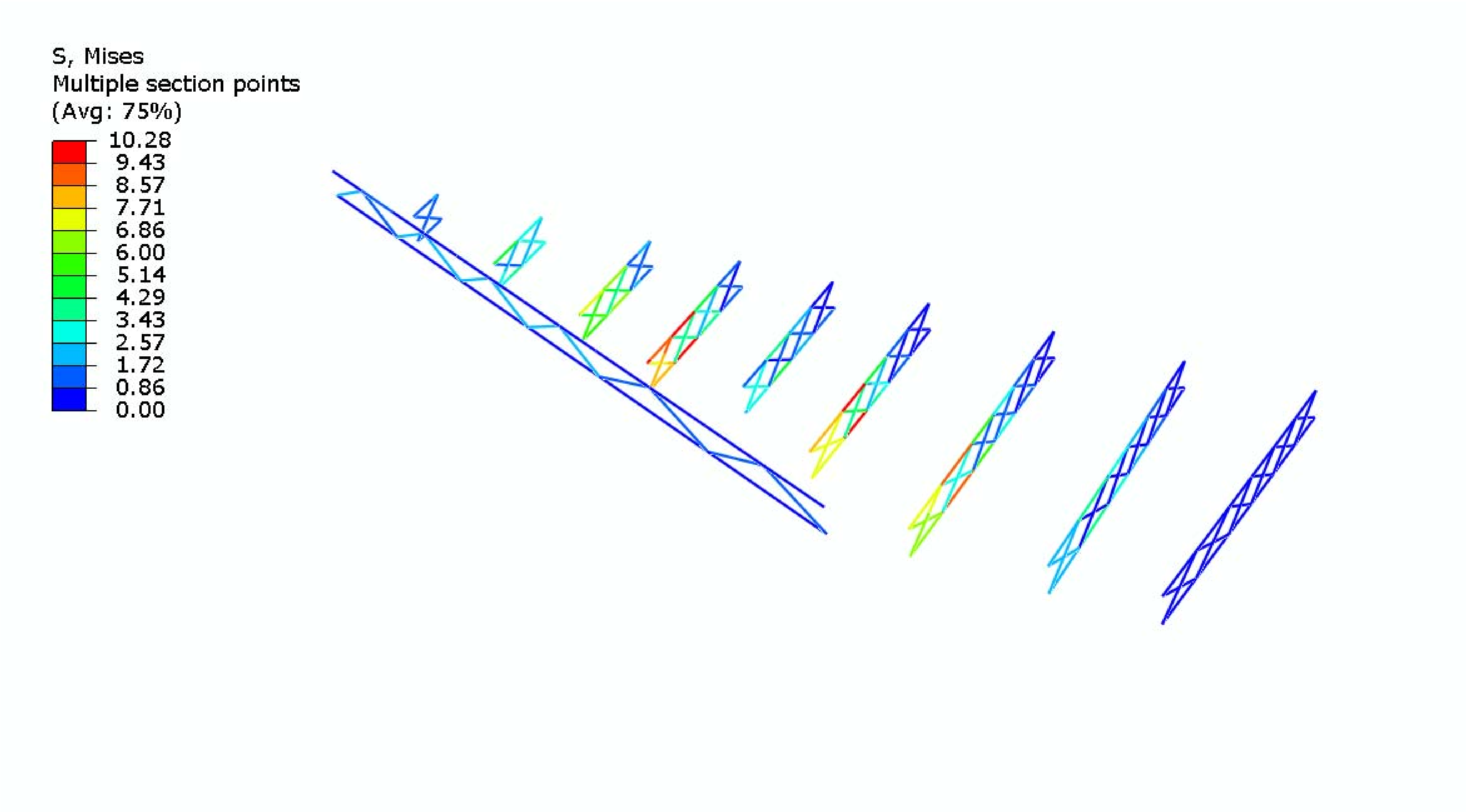


Figure H1-4-24. Cross-frame stress contours under TDL, NLF detailing

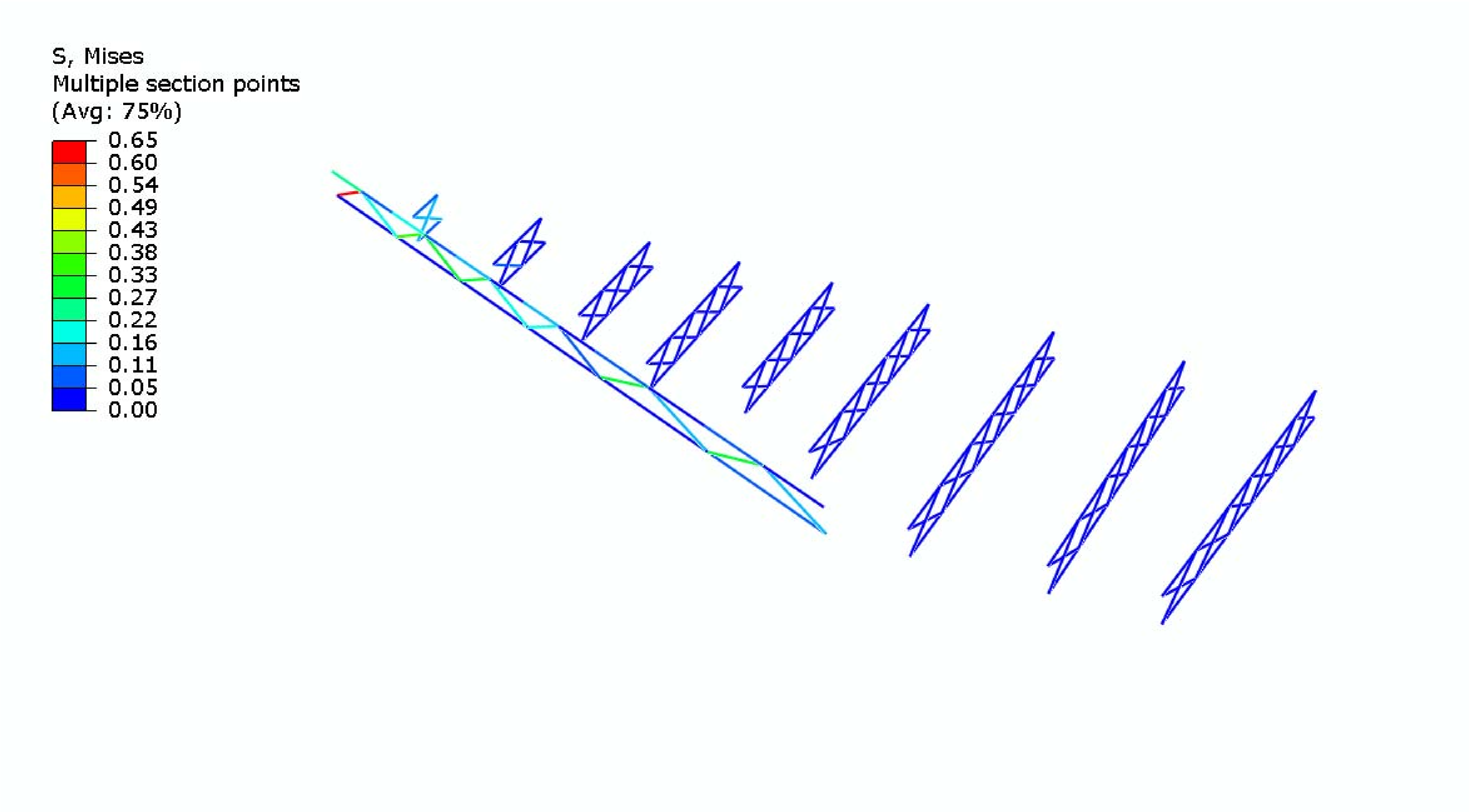


Figure H1-4-25. Cross-frame stress contours under SDL, SDLF detailing

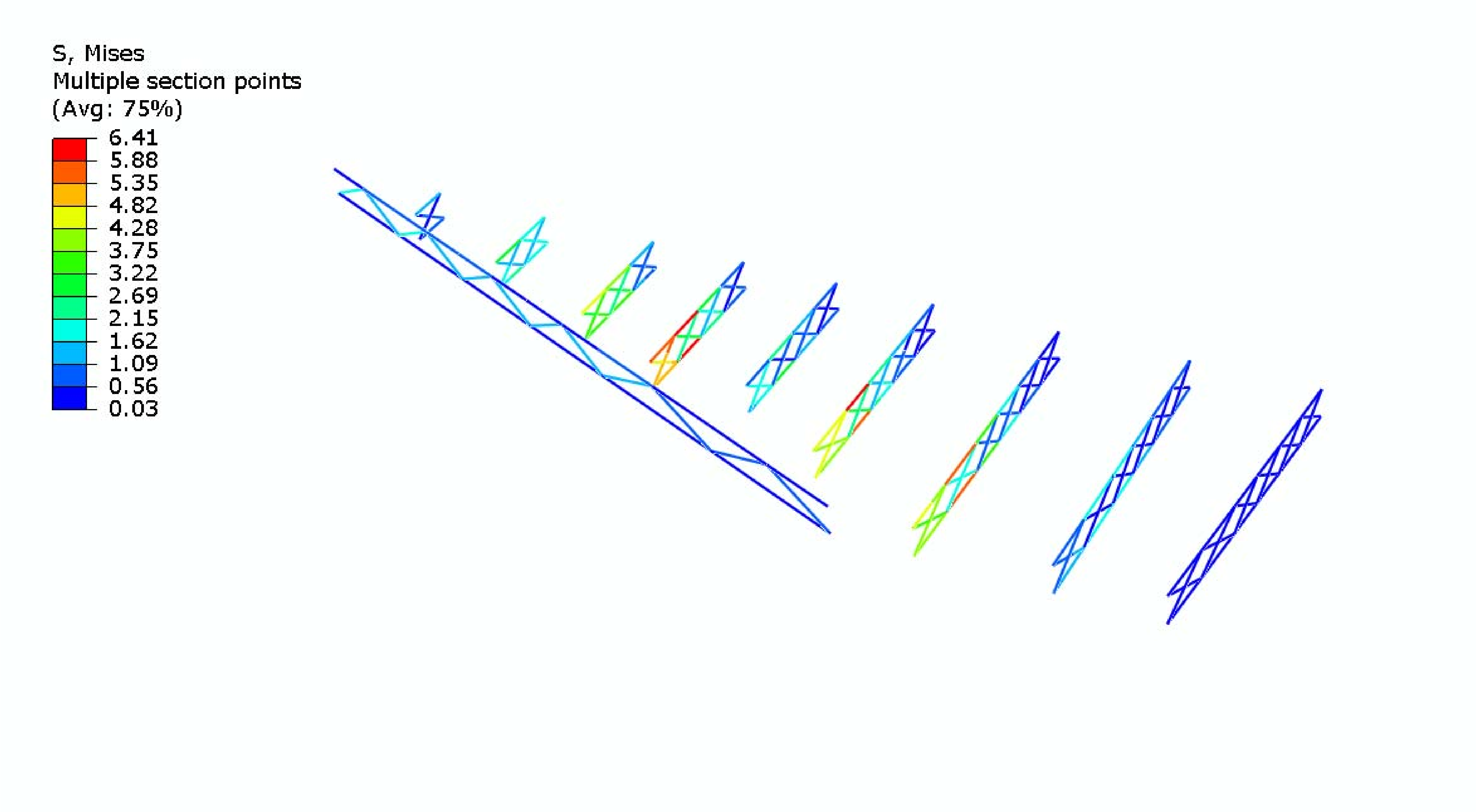


Figure H1-4-26. Cross-frame stress contours under TDL, SDLF detailing

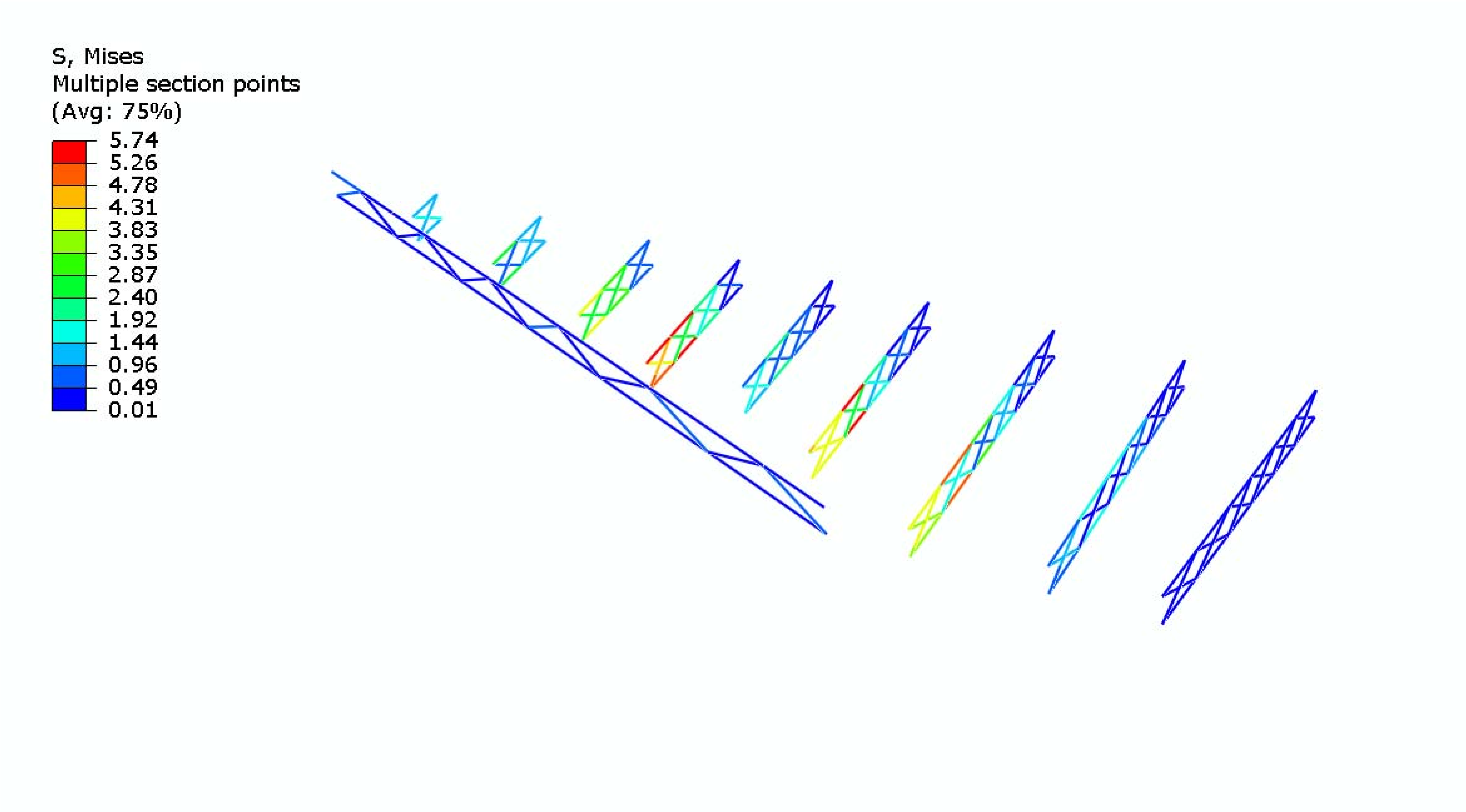


Figure H1-4-27. Cross-frame stress contours under SDL, TDLF detailing

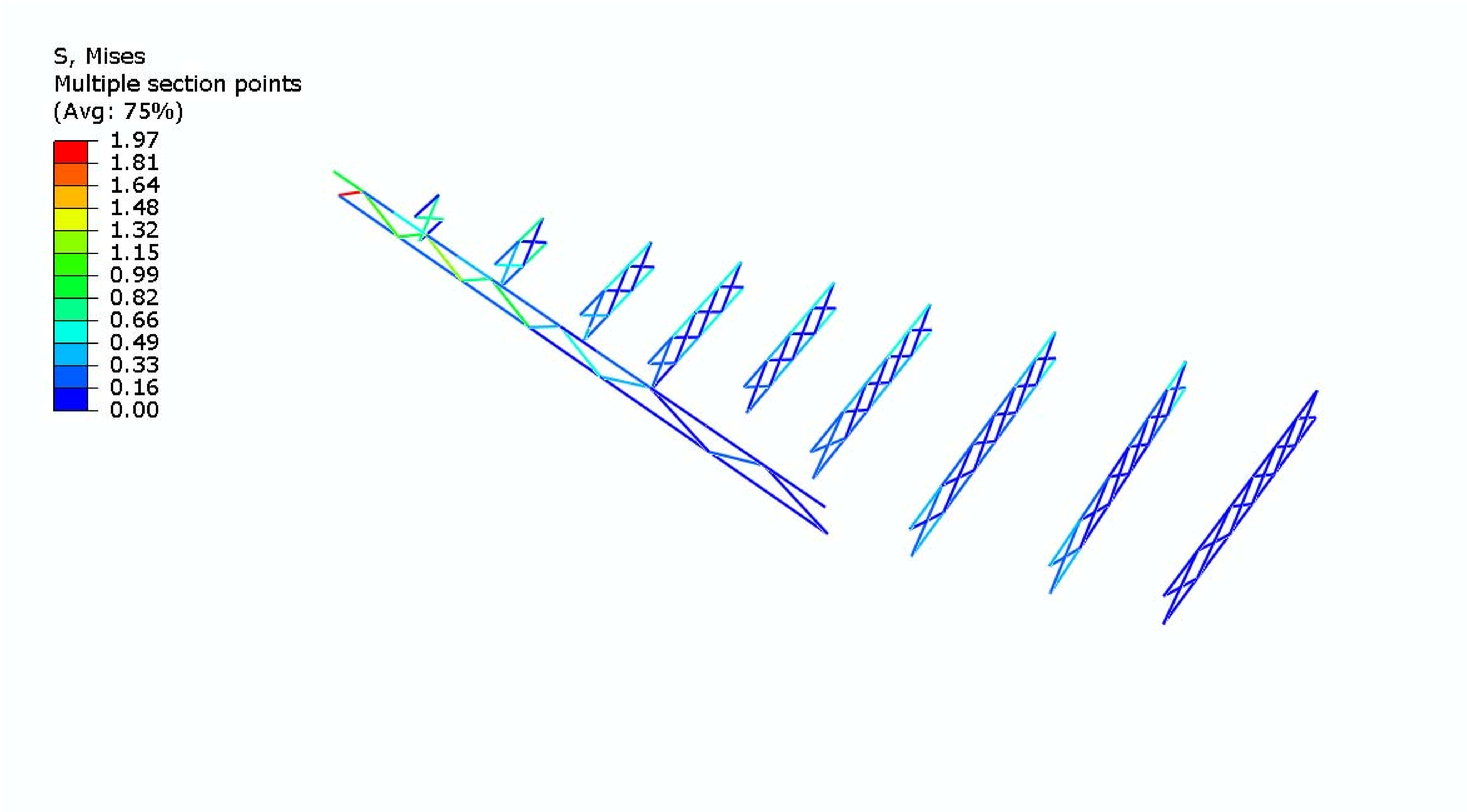


Figure H1-4-28. Cross-frame stress contours under TDL, TDLF

Table H1-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location					
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	5.0	5.1	5.7	5.8	5.7	4.5
	SDLF	2.5	2.2	1.6	2.1	2.7	5.0
	TDLF	4.7	4.1	4.8	3.8	2.1	6.8
2	NLF	13.1	14.1	13.5	8.5	2.8	2.9
	SDLF	0.1	0.1	0.0	0.1	0.3	0.7
	TDLF	17.7	18.7	21.3	12.4	2.6	6.9
3	NLF	4.9	5.1	5.4	7.3	7.6	5.2
	SDLF	0.1	0.1	0.0	0.1	0.1	0.2
	TDLF	5.3	8.8	8.0	13.4	13.2	6.8
4	NLF	0.1	1.2	9.3	1.8	5.4	3.3
	SDLF	0.0	0.0	0.2	0.1	0.0	0.1
	TDLF	0.1	1.0	12.6	3.7	8.7	3.4
5	NLF	NA	0.2	3.8	4.3	2.4	2.5
	SDLF	NA	0.0	0.1	0.1	0.0	0.1
	TDLF	NA	0.4	3.4	6.7	3.6	2.4
6	NLF	NA	NA	1.0	3.2	2.0	1.4
	SDLF	NA	NA	0.0	0.1	0.0	0.1
	TDLF	NA	NA	0.5	4.9	3.2	0.8
7	NLF	NA	NA	0.3	1.4	1.7	0.8
	SDLF	NA	NA	0.0	0.0	0.0	0.1
	TDLF	NA	NA	0.5	2.4	2.9	0.4
8	NLF	NA	NA	NA	0.3	1.1	0.5
	SDLF	NA	NA	NA	0.0	0.0	0.0
	TDLF	NA	NA	NA	0.5	2.2	0.5
9	NLF	NA	NA	NA	NA	0.3	0.7
	SDLF	NA	NA	NA	NA	0.0	0.0
	TDLF	NA	NA	NA	NA	0.8	0.5
10	NLF	NA	NA	NA	NA	NA	0.4
	SDLF	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	0.9

Table H1-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	11.5	12.8	16.5	16.8	16.7	14.5
	SDLF	8.2	9.0	11.7	12.4	13.1	14.5
	TDLF	2.1	2.9	4.8	7.4	9.9	15.3
2	NLF	30.9	35.5	37.9	24.4	9.2	5.7
	SDLF	17.4	20.7	23.8	15.4	6.2	2.3
	TDLF	0.8	1.0	1.4	1.8	2.4	3.7
3	NLF	9.7	13.7	15.7	20.3	20.6	12.7
	SDLF	4.6	8.5	9.7	12.8	12.8	7.6
	TDLF	1.1	0.1	0.9	0.4	0.2	0.6
4	NLF	0.8	2.8	22.5	4.9	14.0	6.9
	SDLF	0.7	1.5	12.8	3.1	8.5	3.7
	TDLF	0.5	0.3	0.1	0.5	0.1	0.2
5	NLF	NA	0.4	7.0	11.0	5.6	5.1
	SDLF	NA	0.3	3.1	6.4	3.4	2.6
	TDLF	NA	0.1	0.1	0.3	0.2	0.2
6	NLF	NA	NA	0.8	7.7	5.1	1.8
	SDLF	NA	NA	0.8	4.4	2.9	0.6
	TDLF	NA	NA	0.1	0.3	0.3	0.1
7	NLF	NA	NA	1.2	3.7	4.1	0.9
	SDLF	NA	NA	0.7	2.3	2.3	0.5
	TDLF	NA	NA	0.0	0.3	0.5	0.1
8	NLF	NA	NA	NA	1.0	2.9	0.4
	SDLF	NA	NA	NA	0.8	1.9	0.7
	TDLF	NA	NA	NA	0.0	0.6	0.3
9	NLF	NA	NA	NA	NA	1.1	0.5
	SDLF	NA	NA	NA	NA	1.0	0.3
	TDLF	NA	NA	NA	NA	0.1	0.8
10	NLF	NA	NA	NA	NA	NA	1.7
	SDLF	NA	NA	NA	NA	NA	1.6
	TDLF	NA	NA	NA	NA	NA	0.6

Table H1-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	1.9	0.6	0.4	0.0	0.8	3.6
	SDLF	1.2	0.5	0.8	0.9	1.0	0.5
	TDLF	1.2	1.8	2.9	2.5	3.9	7.1
2	NLF	12.7	14.4	15.3	11.9	7.1	2.4
	SDLF	0.2	0.1	0.2	0.2	0.2	0.5
	TDLF	18.6	19.9	25.2	19.4	11.6	5.5
3	NLF	4.1	18.7	3.5	17.7	11.2	4.3
	SDLF	0.0	0.2	0.1	0.0	0.1	0.1
	TDLF	3.8	24.3	4.8	26.4	15.0	5.5
4	NLF	0.1	8.0	19.0	8.0	8.2	2.7
	SDLF	0.0	0.1	0.1	0.1	0.1	0.1
	TDLF	0.3	8.6	25.6	10.7	10.1	2.7
5	NLF	NA	0.2	11.4	7.5	4.4	1.9
	SDLF	NA	0.0	0.0	0.0	0.1	0.1
	TDLF	NA	0.5	14.3	9.5	4.4	1.6
6	NLF	NA	NA	6.1	5.8	2.6	1.3
	SDLF	NA	NA	0.0	0.0	0.1	0.0
	TDLF	NA	NA	8.1	7.8	2.0	0.8
7	NLF	NA	NA	0.3	4.2	1.9	0.6
	SDLF	NA	NA	0.0	0.0	0.1	0.0
	TDLF	NA	NA	0.6	6.5	1.6	0.1
8	NLF	NA	NA	NA	0.4	2.1	0.3
	SDLF	NA	NA	NA	0.0	0.0	0.0
	TDLF	NA	NA	NA	0.6	2.7	0.3
9	NLF	NA	NA	NA	NA	0.4	0.6
	SDLF	NA	NA	NA	NA	0.0	0.0
	TDLF	NA	NA	NA	NA	0.8	0.5
10	NLF	NA	NA	NA	NA	NA	0.3
	SDLF	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	0.7

Table H1-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	1.9	4.4	0.7	1.6	0.1	5.3
	SDLF	1.2	3.1	1.5	2.4	1.7	1.3
	TDLF	1.1	1.3	2.8	3.7	4.4	4.7
2	NLF	32.3	34.3	39.5	30.8	18.6	7.9
	SDLF	19.7	20.1	24.7	19.4	11.8	5.1
	TDLF	1.8	0.8	0.7	1.1	1.1	0.5
3	NLF	10.4	44.5	10.2	47.0	29.8	13.3
	SDLF	6.2	25.4	6.4	28.9	18.3	8.9
	TDLF	2.0	1.0	0.9	2.3	2.9	3.2
4	NLF	0.2	17.8	46.1	21.7	21.4	8.5
	SDLF	0.3	9.6	26.9	13.3	13.0	5.7
	TDLF	0.5	0.8	1.6	1.9	2.5	2.8
5	NLF	NA	0.6	27.4	18.9	12.2	6.3
	SDLF	NA	0.4	15.7	11.3	7.5	4.3
	TDLF	NA	0.0	1.1	1.8	2.3	2.4
6	NLF	NA	NA	15.1	15.6	7.0	5.3
	SDLF	NA	NA	8.9	9.6	4.4	3.8
	TDLF	NA	NA	0.5	1.4	2.2	2.4
7	NLF	NA	NA	0.8	11.7	5.9	3.1
	SDLF	NA	NA	0.5	7.5	3.9	2.5
	TDLF	NA	NA	0.0	0.7	2.0	2.6
8	NLF	NA	NA	NA	0.9	6.3	2.8
	SDLF	NA	NA	NA	0.5	4.2	2.5
	TDLF	NA	NA	NA	0.0	1.3	2.6
9	NLF	NA	NA	NA	NA	1.0	3.6
	SDLF	NA	NA	NA	NA	0.8	2.9
	TDLF	NA	NA	NA	NA	0.1	2.4
10	NLF	NA	NA	NA	NA	NA	0.3
	SDLF	NA	NA	NA	NA	NA	0.1
	TDLF	NA	NA	NA	NA	NA	0.6

Table H1-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	2.9	5.1	4.2	4.8	4.3	5.8
	SDLF	1.1	1.5	2.1	2.7	3.3	4.9
	TDLF	5.7	4.0	6.5	4.0	3.4	13.3
2	NLF	13.3	15.0	16.2	12.4	7.3	2.2
	SDLF	0.2	0.1	0.2	0.1	0.2	0.5
	TDLF	19.3	20.6	26.3	19.7	11.7	5.5
3	NLF	3.8	18.8	3.3	17.9	11.0	4.0
	SDLF	0.0	0.2	0.1	0.0	0.1	0.1
	TDLF	3.2	24.5	4.2	27.3	15.4	5.6
4	NLF	0.1	7.7	19.2	7.6	8.2	2.5
	SDLF	0.0	0.0	0.1	0.1	0.1	0.1
	TDLF	0.2	8.1	26.3	10.1	10.6	2.6
5	NLF	NA	0.1	11.4	7.7	4.0	1.8
	SDLF	NA	0.0	0.0	0.1	0.1	0.0
	TDLF	NA	0.2	14.2	9.9	3.9	1.6
6	NLF	NA	NA	5.9	5.8	2.7	1.0
	SDLF	NA	NA	0.0	0.0	0.1	0.0
	TDLF	NA	NA	7.5	7.7	2.1	0.4
7	NLF	NA	NA	0.2	3.9	1.8	0.5
	SDLF	NA	NA	0.0	0.0	0.1	0.0
	TDLF	NA	NA	0.5	6.0	1.4	0.3
8	NLF	NA	NA	NA	0.1	1.9	0.2
	SDLF	NA	NA	NA	0.0	0.0	0.0
	TDLF	NA	NA	NA	0.4	2.3	0.5
9	NLF	NA	NA	NA	NA	0.1	0.5
	SDLF	NA	NA	NA	NA	0.0	0.0
	TDLF	NA	NA	NA	NA	0.1	0.2
10	NLF	NA	NA	NA	NA	NA	0.2
	SDLF	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	0.2

Table H1-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	9.6	15.0	14.6	14.2	15.5	17.8
	SDLF	6.0	10.7	10.1	11.4	11.4	12.4
	TDLF	2.9	3.9	6.0	8.0	10.5	18.1
2	NLF	35.4	37.9	45.4	34.7	21.2	8.5
	SDLF	21.6	22.2	28.1	21.6	13.3	5.7
	TDLF	1.9	0.9	0.9	1.2	1.2	0.6
3	NLF	8.6	44.8	8.0	48.6	30.2	13.3
	SDLF	5.0	25.7	4.9	30.5	19.3	9.3
	TDLF	2.1	1.1	1.0	2.4	3.0	3.2
4	NLF	0.9	16.6	48.9	19.8	22.5	8.6
	SDLF	0.8	8.9	29.0	12.3	14.1	6.0
	TDLF	0.5	0.8	1.7	2.0	2.6	2.8
5	NLF	NA	0.2	27.3	20.7	10.6	6.5
	SDLF	NA	0.2	15.7	12.7	6.7	4.6
	TDLF	NA	0.1	1.2	1.9	2.4	2.4
6	NLF	NA	NA	14.0	15.3	8.0	4.1
	SDLF	NA	NA	8.2	9.5	5.2	3.1
	TDLF	NA	NA	0.6	1.5	2.3	2.4
7	NLF	NA	NA	0.5	10.8	5.6	3.3
	SDLF	NA	NA	0.5	6.9	3.8	2.7
	TDLF	NA	NA	0.0	0.8	2.1	2.6
8	NLF	NA	NA	NA	0.3	5.7	2.4
	SDLF	NA	NA	NA	0.4	3.8	2.2
	TDLF	NA	NA	NA	0.0	1.4	2.7
9	NLF	NA	NA	NA	NA	0.3	3.2
	SDLF	NA	NA	NA	NA	0.1	2.7
	TDLF	NA	NA	NA	NA	0.1	2.5
10	NLF	NA	NA	NA	NA	NA	1.1
	SDLF	NA	NA	NA	NA	NA	0.8
	TDLF	NA	NA	NA	NA	NA	0.7

Table H1-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location					
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.21	-0.53	-0.63	-0.78	-0.91	-1.00
	SDLF	-0.13	-0.37	-0.46	-0.73	-1.04	-1.27
	TDLF	-0.02	-0.24	-0.08	-0.70	-1.40	-1.53
3	NLF	-0.14	-0.41	-0.62	-0.74	-0.86	-0.96
	SDLF	-0.08	-0.31	-0.48	-0.78	-1.17	-1.37
	TDLF	0.00	-0.24	-0.06	-0.96	-1.90	-1.62
4	NLF	0.00	-0.21	-0.51	-0.66	-0.78	-0.88
	SDLF	0.00	-0.16	-0.44	-0.76	-1.16	-1.35
	TDLF	0.00	-0.14	-0.07	-1.07	-2.04	-1.50
5	NLF	NA	0.00	-0.35	-0.55	-0.68	-0.79
	SDLF	NA	0.00	-0.33	-0.67	-1.07	-1.26
	TDLF	NA	0.00	-0.05	-1.02	-1.99	-1.32
6	NLF	NA	NA	-0.18	-0.38	-0.56	-0.69
	SDLF	NA	NA	-0.17	-0.49	-0.92	-1.11
	TDLF	NA	NA	-0.03	-0.79	-1.77	-1.10
7	NLF	NA	NA	0.00	-0.20	-0.39	-0.57
	SDLF	NA	NA	0.00	-0.25	-0.66	-0.92
	TDLF	NA	NA	0.00	-0.41	-1.29	-0.87
8	NLF	NA	NA	NA	0.00	-0.21	-0.40
	SDLF	NA	NA	NA	0.00	-0.34	-0.65
	TDLF	NA	NA	NA	0.00	-0.67	-0.57
9	NLF	NA	NA	NA	NA	0.00	-0.21
	SDLF	NA	NA	NA	NA	0.00	-0.34
	TDLF	NA	NA	NA	NA	0.00	-0.29
10	NLF	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	0.00

Table H1-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.75	-1.61	-1.87	-2.32	-2.71	-2.95
	SDLF	-0.67	-1.46	-1.70	-2.26	-2.83	-3.21
	TDLF	-0.55	-1.32	-1.31	-2.22	-3.17	-3.46
3	NLF	-0.47	-1.23	-1.81	-2.18	-2.54	-2.83
	SDLF	-0.40	-1.12	-1.67	-2.21	-2.84	-3.23
	TDLF	-0.32	-1.05	-1.24	-2.38	-3.55	-3.47
4	NLF	0.00	-0.61	-1.49	-1.91	-2.29	-2.58
	SDLF	0.00	-0.57	-1.41	-2.01	-2.66	-3.04
	TDLF	0.00	-0.54	-1.04	-2.31	-3.53	-3.18
5	NLF	NA	0.00	-1.01	-1.58	-1.97	-2.32
	SDLF	NA	0.00	-0.98	-1.70	-2.36	-2.77
	TDLF	NA	0.00	-0.71	-2.04	-3.27	-2.82
6	NLF	NA	NA	-0.50	-1.09	-1.62	-2.00
	SDLF	NA	NA	-0.49	-1.19	-1.97	-2.41
	TDLF	NA	NA	-0.35	-1.49	-2.81	-2.39
7	NLF	NA	NA	0.00	-0.56	-1.12	-1.63
	SDLF	NA	NA	0.00	-0.61	-1.38	-1.98
	TDLF	NA	NA	0.00	-0.77	-2.01	-1.91
8	NLF	NA	NA	NA	0.00	-0.59	-1.13
	SDLF	NA	NA	NA	0.00	-0.72	-1.37
	TDLF	NA	NA	NA	0.00	-1.05	-1.29
9	NLF	NA	NA	NA	NA	0.00	-0.60
	SDLF	NA	NA	NA	NA	0.00	-0.72
	TDLF	NA	NA	NA	NA	0.00	-0.67
10	NLF	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	0.00

Table H1-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.15	-0.37	-0.44	-0.55	-0.65	-0.71
	SDLF	-0.09	-0.27	-0.33	-0.52	-0.74	-0.90
	TDLF	-0.02	-0.17	-0.06	-0.50	-0.99	-1.09
3	NLF	-0.10	-0.29	-0.44	-0.52	-0.61	-0.68
	SDLF	-0.05	-0.22	-0.34	-0.56	-0.83	-0.97
	TDLF	0.00	-0.17	-0.04	-0.68	-1.34	-1.15
4	NLF	0.00	-0.15	-0.36	-0.47	-0.55	-0.62
	SDLF	0.00	-0.11	-0.31	-0.54	-0.82	-0.96
	TDLF	0.00	-0.10	-0.05	-0.76	-1.45	-1.07
5	NLF	NA	0.00	-0.25	-0.39	-0.48	-0.56
	SDLF	NA	0.00	-0.23	-0.48	-0.76	-0.89
	TDLF	NA	0.00	-0.04	-0.72	-1.41	-0.94
6	NLF	NA	NA	-0.13	-0.27	-0.40	-0.49
	SDLF	NA	NA	-0.12	-0.35	-0.65	-0.79
	TDLF	NA	NA	-0.02	-0.56	-1.25	-0.78
7	NLF	NA	NA	0.00	-0.14	-0.28	-0.40
	SDLF	NA	NA	0.00	-0.18	-0.47	-0.65
	TDLF	NA	NA	0.00	-0.29	-0.92	-0.61
8	NLF	NA	NA	NA	0.00	-0.15	-0.28
	SDLF	NA	NA	NA	0.00	-0.24	-0.46
	TDLF	NA	NA	NA	0.00	-0.48	-0.41
9	NLF	NA	NA	NA	NA	0.00	-0.15
	SDLF	NA	NA	NA	NA	0.00	-0.24
	TDLF	NA	NA	NA	NA	0.00	-0.21
10	NLF	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	0.00

Table H1-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.53	-1.14	-1.32	-1.64	-1.92	-2.09
	SDLF	-0.47	-1.03	-1.20	-1.60	-2.00	-2.27
	TDLF	-0.39	-0.94	-0.93	-1.57	-2.25	-2.45
3	NLF	-0.33	-0.87	-1.28	-1.54	-1.80	-2.00
	SDLF	-0.29	-0.79	-1.18	-1.57	-2.01	-2.29
	TDLF	-0.23	-0.74	-0.88	-1.69	-2.52	-2.46
4	NLF	0.00	-0.43	-1.05	-1.36	-1.62	-1.83
	SDLF	0.00	-0.40	-1.00	-1.42	-1.88	-2.16
	TDLF	0.00	-0.38	-0.74	-1.63	-2.50	-2.25
5	NLF	NA	0.00	-0.72	-1.12	-1.40	-1.64
	SDLF	NA	0.00	-0.70	-1.20	-1.67	-1.97
	TDLF	NA	0.00	-0.50	-1.44	-2.31	-2.00
6	NLF	NA	NA	-0.35	-0.77	-1.15	-1.41
	SDLF	NA	NA	-0.35	-0.85	-1.40	-1.71
	TDLF	NA	NA	-0.25	-1.05	-1.99	-1.69
7	NLF	NA	NA	0.00	-0.39	-0.80	-1.15
	SDLF	NA	NA	0.00	-0.43	-0.98	-1.40
	TDLF	NA	NA	0.00	-0.55	-1.43	-1.35
8	NLF	NA	NA	NA	0.00	-0.42	-0.80
	SDLF	NA	NA	NA	0.00	-0.51	-0.97
	TDLF	NA	NA	NA	0.00	-0.74	-0.91
9	NLF	NA	NA	NA	NA	0.00	-0.42
	SDLF	NA	NA	NA	NA	0.00	-0.51
	TDLF	NA	NA	NA	NA	0.00	-0.48
10	NLF	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	0.00

Table H1-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	8.0	10.2	32.4	41.7
	SDLF	18.6	15.5	43.4	46.9
	TDLF	32.9	21.5	58.5	52.7
G2	NLF	28.2	33.0	98.8	113.3
	SDLF	29.0	24.0	99.9	104.3
	TDLF	29.6	12.5	101.0	92.7
G3	NLF	29.6	38.4	94.8	124.0
	SDLF	36.1	31.5	101.7	116.9
	TDLF	51.0	26.2	117.5	111.5
G4	NLF	54.6	44.5	156.1	136.3
	SDLF	43.8	40.0	145.7	131.9
	TDLF	22.3	27.4	124.6	119.0
G5	NLF	57.6	46.3	163.1	138.6
	SDLF	49.7	46.0	155.2	138.3
	TDLF	37.4	45.0	142.9	137.1
G6	NLF	59.0	47.9	163.9	139.9
	SDLF	55.7	51.9	160.5	143.2
	TDLF	56.0	63.6	160.7	154.9
G7	NLF	52.4	53.5	150.8	153.9
	SDLF	61.8	59.5	159.4	160.1
	TDLF	73.0	64.7	169.4	165.0

Table H1-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number: SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.1	NA	0.8	NA
	SDLF	0.0	NA	0.5	NA
	TDLF	-0.1	NA	0.1	NA
G2	NLF	0.1	NA	0.8	NA
	SDLF	0.0	NA	0.5	NA
	TDLF	-0.1	NA	0.0	NA
G3	NLF	0.2	NA	1.2	NA
	SDLF	0.0	NA	0.8	NA
	TDLF	-0.3	NA	0.0	NA
G4	NLF	0.0	NA	0.3	NA
	SDLF	0.0	NA	0.3	NA
	TDLF	0.1	NA	0.2	NA
G5	NLF	-0.1	NA	-0.4	NA
	SDLF	0.0	NA	-0.2	NA
	TDLF	0.1	NA	0.1	NA
G6	NLF	-0.2	NA	-1.1	NA
	SDLF	0.0	NA	-0.7	NA
	TDLF	0.1	NA	-0.2	NA
G7	NLF	-0.2	NA	-1.5	NA
	SDLF	-0.1	NA	-1.1	NA
	TDLF	0.2	NA	-0.2	NA

Table H1-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.4	0.0	2.7	-0.5
	SDLF	0.0	0.0	1.7	-0.3
	TDLF	-0.8	0.0	0.0	0.0
G2	NLF	0.4	0.0	2.7	-0.6
	SDLF	0.0	0.0	1.7	-0.4
	TDLF	-0.6	0.1	0.0	0.0
G3	NLF	0.5	-0.1	3.6	-0.8
	SDLF	0.0	0.0	2.3	-0.5
	TDLF	-0.9	0.2	0.0	0.0
G4	NLF	0.1	-0.1	1.5	-0.8
	SDLF	0.0	0.0	1.0	-0.6
	TDLF	-0.4	0.2	0.0	0.0
G5	NLF	-0.1	-0.2	-0.2	-0.9
	SDLF	0.0	0.0	0.0	-0.6
	TDLF	0.0	0.3	0.0	0.0
G6	NLF	-0.3	-0.2	-1.8	-1.0
	SDLF	0.0	0.0	-1.2	-0.6
	TDLF	0.5	0.3	0.0	0.0
G7	NLF	-0.2	-0.2	-2.8	-1.0
	SDLF	0.0	0.0	-1.9	-0.6
	TDLF	0.8	0.3	0.0	0.0

Table H1-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.01	0.02	0.08	0.10
	SDLF	0.00	0.01	0.05	0.08
	TDLF	-0.01	0.00	0.01	0.05
G2	NLF	0.01	0.07	0.08	0.27
	SDLF	0.00	0.04	0.05	0.23
	TDLF	-0.01	0.01	0.00	0.17
G3	NLF	0.02	0.15	0.12	0.54
	SDLF	0.00	0.10	0.08	0.46
	TDLF	-0.03	0.04	0.00	0.35
G4	NLF	0.00	0.19	0.03	0.59
	SDLF	0.00	0.14	0.03	0.53
	TDLF	0.01	0.06	0.02	0.45
G5	NLF	-0.01	0.25	-0.04	0.71
	SDLF	0.00	0.22	-0.02	0.66
	TDLF	0.01	0.21	0.01	0.69
G6	NLF	-0.02	0.31	-0.11	0.83
	SDLF	0.00	0.32	-0.07	0.80
	TDLF	0.01	0.45	-0.02	1.01
G7	NLF	-0.02	0.34	-0.15	0.86
	SDLF	-0.01	0.37	-0.11	0.83
	TDLF	0.02	0.53	-0.02	1.12

Table H1-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	-0.04	0.00	-0.27	0.05
	SDLF	0.00	0.00	-0.17	0.03
	TDLF	0.08	0.00	0.00	0.00
G2	NLF	-0.04	0.00	-0.27	0.06
	SDLF	0.00	0.00	-0.17	0.04
	TDLF	0.06	-0.01	0.00	0.00
G3	NLF	-0.05	0.01	-0.36	0.08
	SDLF	0.00	0.00	-0.23	0.05
	TDLF	0.09	-0.02	0.00	0.00
G4	NLF	-0.01	0.01	-0.15	0.08
	SDLF	0.00	0.00	-0.10	0.06
	TDLF	0.04	-0.02	0.00	0.00
G5	NLF	0.01	0.02	0.02	0.09
	SDLF	0.00	0.00	0.00	0.06
	TDLF	0.00	-0.03	0.00	0.00
G6	NLF	0.03	0.02	0.18	0.10
	SDLF	0.00	0.00	0.12	0.06
	TDLF	-0.05	-0.03	0.00	0.00
G7	NLF	0.02	0.02	0.28	0.10
	SDLF	0.00	0.00	0.19	0.06
	TDLF	-0.08	-0.03	0.00	0.00

Appendix H1-5. EISSS57 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge EISSS57 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table H1-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	SDLF	-0.7	0.2	0.7	0.0	-0.2	0.2
		TDLF	-0.9	1.1	1.4	0.0	-1.0	1.0
	2-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.1	0.0	0.1	0.1	0.0	0.1
	2-4	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.4	-0.1	0.4	-0.4	0.2	0.5
	2-5	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.2	-0.2	0.3	0.2	0.1	0.2

Table H1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
3	3-2	SDLF	-0.7	0.7	0.9	0.0	-0.6	0.6
		TDLF	-0.9	2.6	2.7	0.0	-2.7	2.7
	3-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.1	0.0	0.1	0.1	0.1	0.1
	3-4	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.9	-0.1	0.9	-0.9	0.3	1.0
	3-5	SDLF	-0.1	0.0	0.1	-0.1	0.0	0.1
		TDLF	-2.8	0.1	2.8	-2.6	0.0	2.6
	3-6	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.1	-0.1	0.1	-0.1	-0.1	0.1

Table H1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
7	7-2	SDLF	-2.3	5.3	5.7	0.0	-5.0	5.0
		TDLF	-5.3	15.2	16.1	0.0	-15.0	15.0
	7-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.1	0.0	0.1	0.5	0.0	0.5
	7-4	SDLF	-0.4	-0.1	0.4	-0.4	0.1	0.4
		TDLF	-8.9	-1.5	9.1	-9.2	2.0	9.4
	7-5	SDLF	0.0	0.0	0.1	0.0	0.0	0.0
		TDLF	-6.5	0.7	6.6	-7.1	0.9	7.1
	7-6	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-2.8	0.2	2.8	-3.2	0.7	3.3
	7-7	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-1.2	0.0	1.2	-1.5	0.4	1.6
	7-8	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.2	0.0	0.2	-0.4	0.0	0.4
	7-9	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.3	0.1	0.3	0.0	0.2	0.2
	7-10	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.2	-0.2	0.3	0.1	0.0	0.1
	7-11	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.2	-0.1	0.2	-0.3	-0.1	0.3

Table H1-5-2: Erection Critical Sub-Stages

Stage	Detailing Method	Critical Sub-Stage
2	SDLF	2-2
	TDLF	2-2
3	SDLF	3-2
	TDLF	3-2
7	SDLF	7-2
	TDLF	7-2

Table H1-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	SDLF	-0.4	0.0	0.4	NA	NA	NA
		TDLF	-0.4	0.0	0.4	NA	NA	NA
	B	SDLF	-0.7	0.2	0.7	0.0	-0.2	0.2
		TDLF	-0.9	1.1	1.4	0.0	-1.0	1.0
3	A	SDLF	-0.4	0.0	0.4	NA	NA	NA
		TDLF	-0.2	-0.1	0.2	NA	NA	NA
	B	SDLF	-0.7	0.7	0.9	0.0	-0.6	0.6
		TDLF	-0.9	2.6	2.7	0.0	-2.7	2.7
7	A	SDLF	-0.3	0.1	0.3	NA	NA	NA
		TDLF	0.2	-0.9	0.9	NA	NA	NA
	B	SDLF	-2.3	5.3	5.7	0.0	-5.0	5.0
		TDLF	-5.3	15.2	16.1	0.0	-15.0	15.0

Table H1-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
2	A	G1	SDLF	18	15
			TDLF	18	15
		G2	SDLF	25	22
			TDLF	25	22
	B	G1	SDLF	18	15
			TDLF	18	15
		G2	SDLF	25	22
			TDLF	25	22
3	A	G1	SDLF	19	15
			TDLF	19	15
		G2	SDLF	28	23
			TDLF	28	23
		G3	SDLF	32	29
			TDLF	32	29
	B	G1	SDLF	18	15
			TDLF	19	15
		G2	SDLF	29	23
			TDLF	29	23
		G3	SDLF	33	29
			TDLF	32	29

Table H1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
7	A	G1	SDLF	19	16
			TDLF	31	21
		G2	SDLF	29	24
			TDLF	28	13
		G3	SDLF	36	31
			TDLF	47	28
		G4	SDLF	43	40
			TDLF	22	29
		G5	SDLF	49	46
			TDLF	37	47
		G6	SDLF	55	51
			TDLF	73	64
		G7	SDLF	61	58
			TDLF	59	58

Table H1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
7	B	G1	SDLF	19	16
			TDLF	31	21
		G2	SDLF	29	24
			TDLF	28	13
		G3	SDLF	36	31
			TDLF	47	28
		G4	SDLF	43	40
			TDLF	22	29
		G5	SDLF	49	46
			TDLF	37	47
		G6	SDLF	55	51
			TDLF	73	64
		G7	SDLF	61	58
			TDLF	59	58

Appendix H2-1. EISSS57 Bridge Description

The key characteristics of EISSS57 are as follows:

- Span length along the centerline of the bridge, L_s = 137 ft.
- Width between the fascia girders, w_g = 61 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 3.5
- Number of girders in the completed bridge cross-section, n_g = 7.
- Parallel skew
- Skew angle, θ = 69,-4^{o}
- Skew index, I_s = 0.68

This appendix presents the bridge description of the bridge EISSS57 in its final condition as well as during erection. The following figures and tables are provided:

Figure H2-1-1. Framing plan

Figure H2-1-2. Bridge cross-section

Figure H2-1-3. Girder Elevation

Figure H2-1-4. Cross-section dimension

Figure H2-1-5. Cross-frame details

Figure H2-1-6. Erection scheme

Table H2-1-1. Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

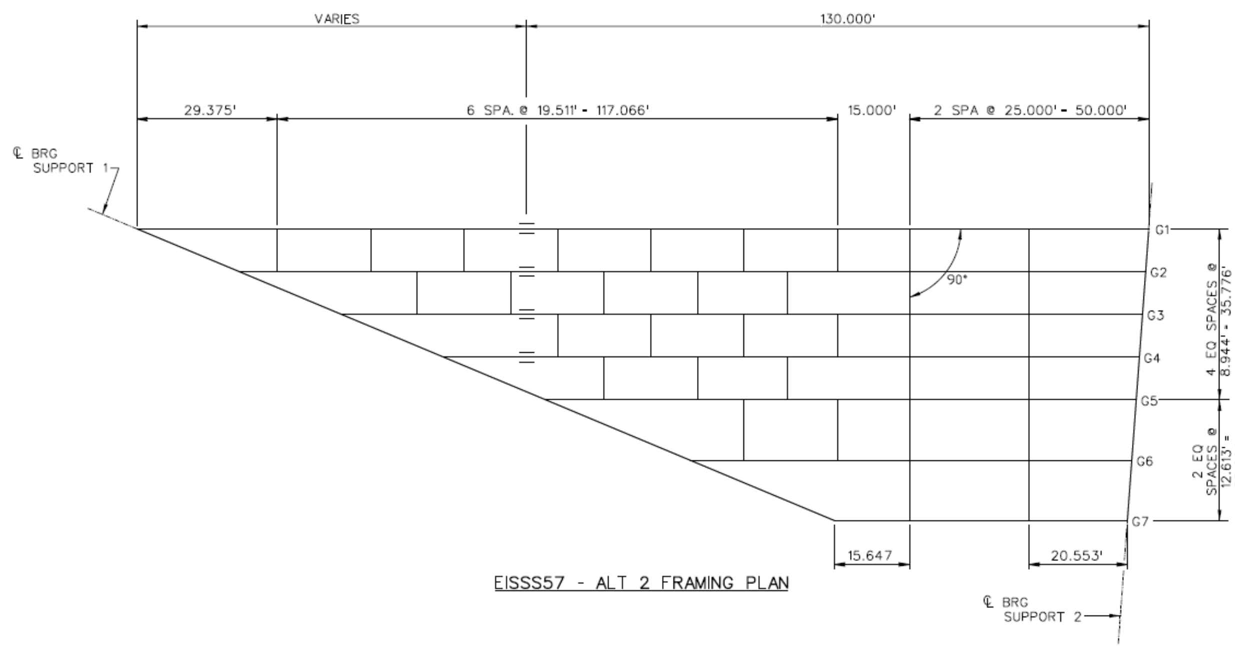


Figure H2-1-1. Framing plan.

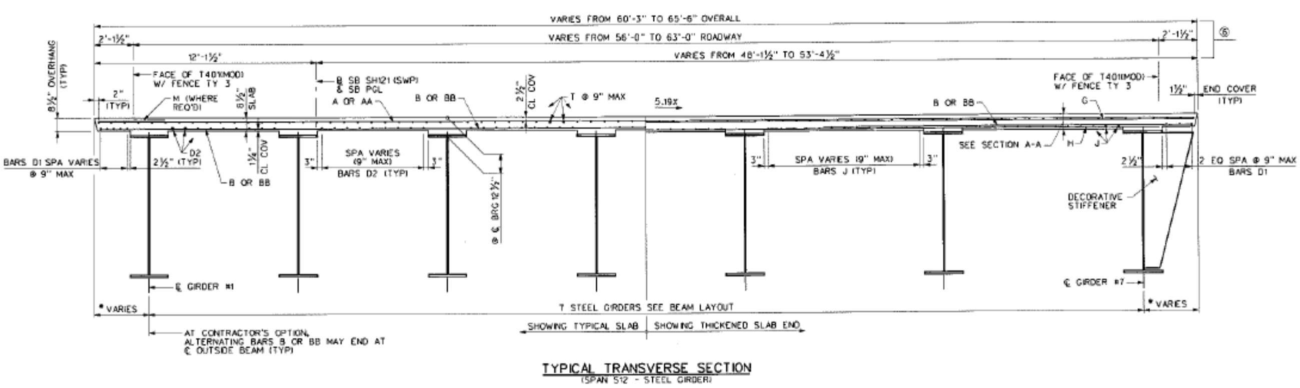


Figure H2-1-2. Bridge cross-section.

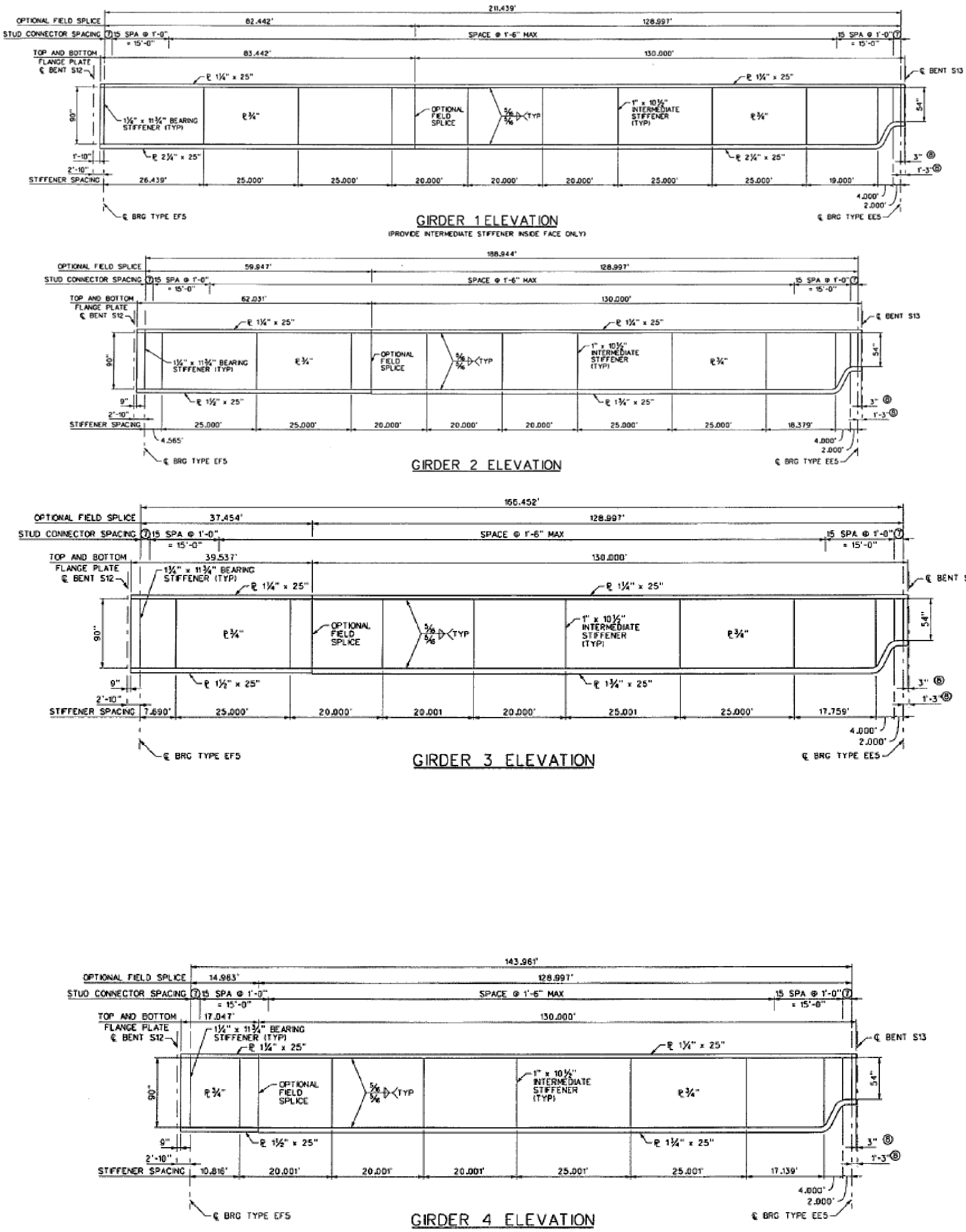
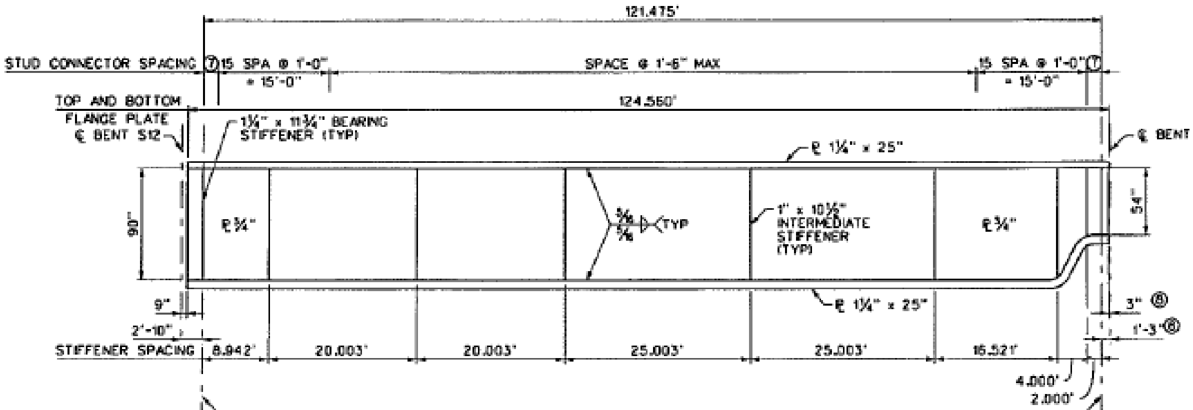
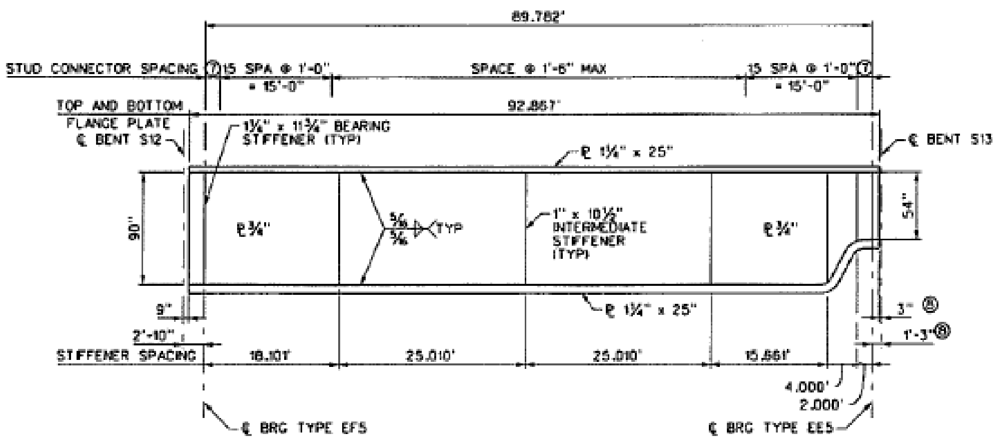


Figure H2-1-3. Girder elevations



GIRDER 5 ELEVATION



GIRDER 6 ELEVATION

Figure H2-1-3(cont.). Girder elevations

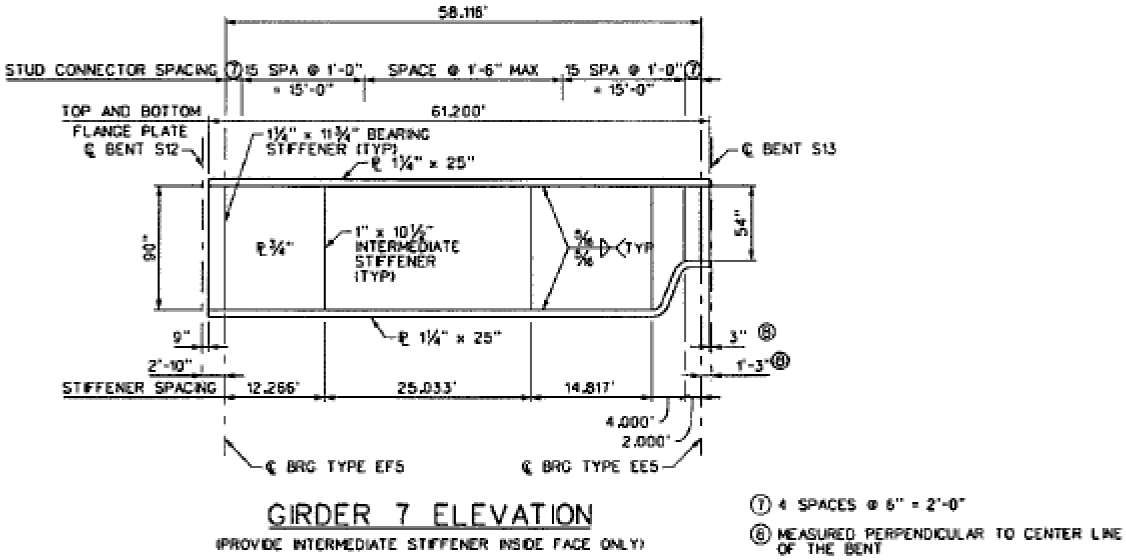
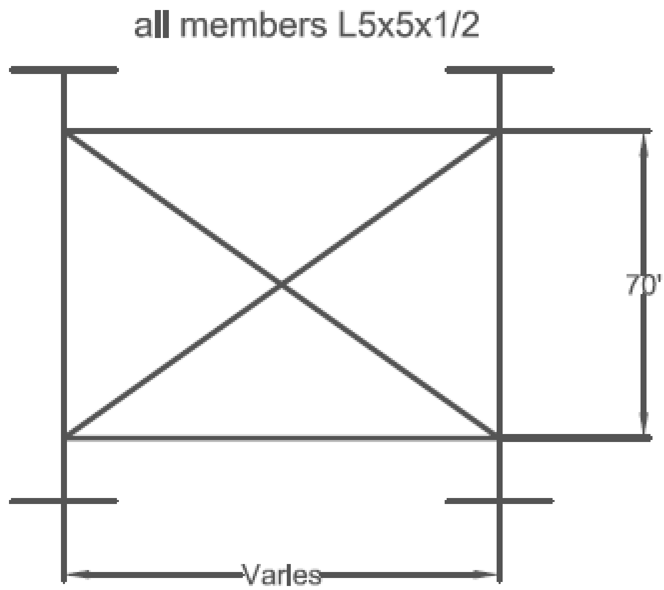


Figure H2-1-3(cont.). Girder elevations



TYPICAL INTERMEDIATE DIAPHRAGM

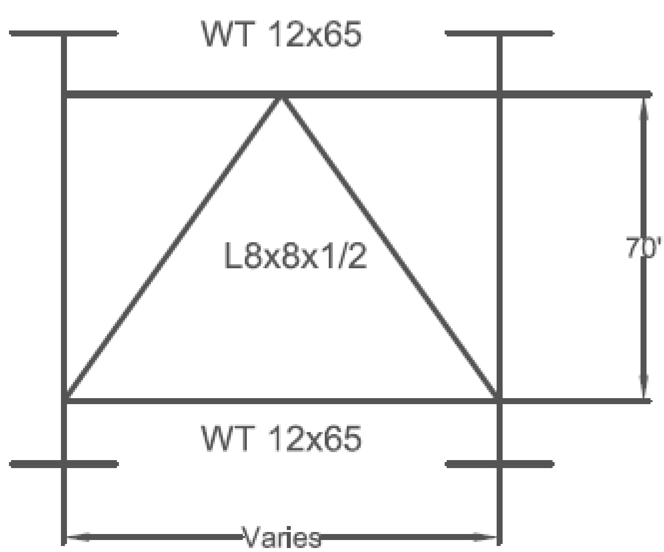


Figure H2-1-5. Cross-frame details.

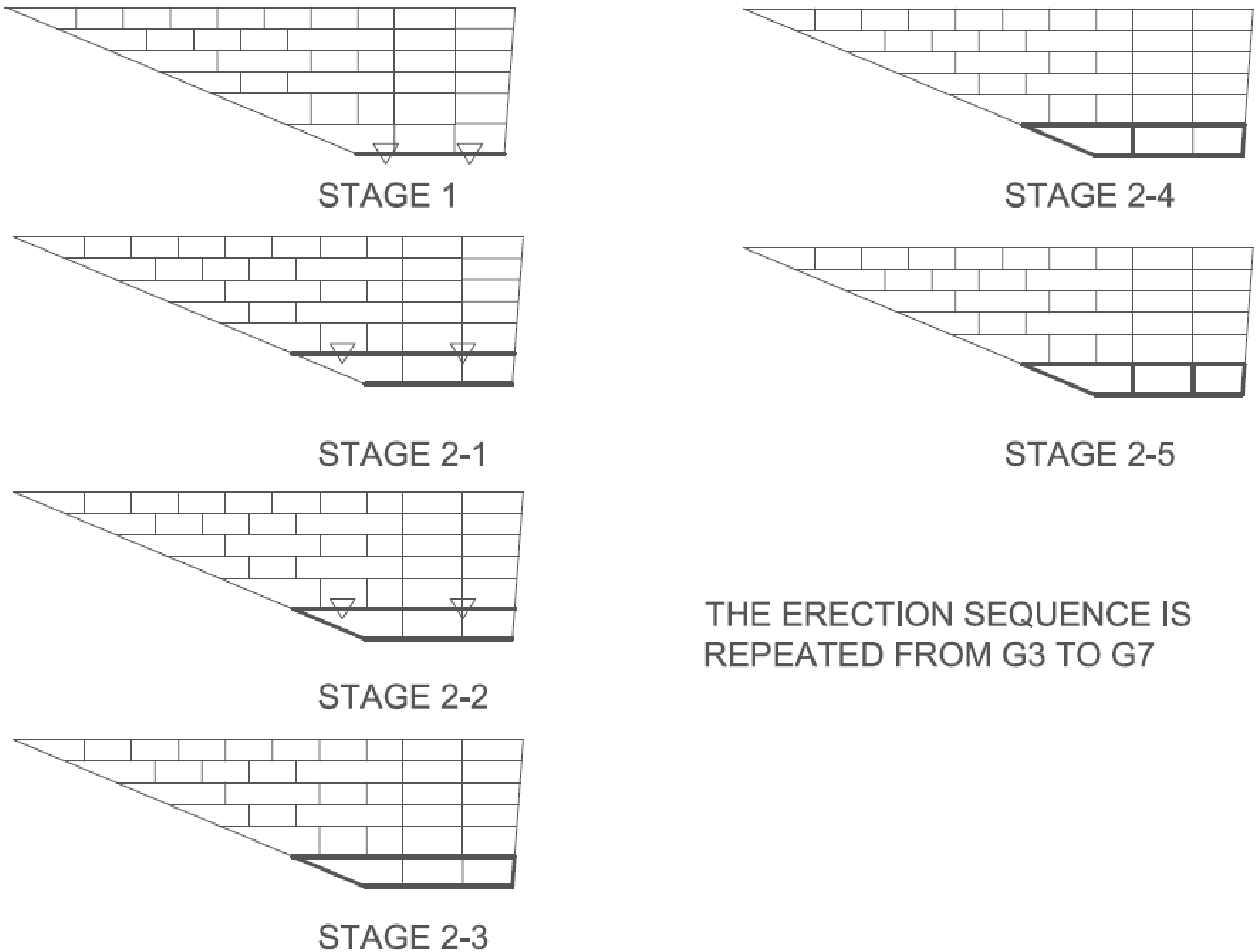


Figure H2-1-6. Erection scheme.

Table H2-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

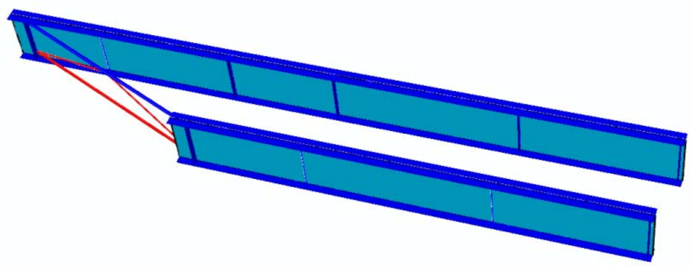
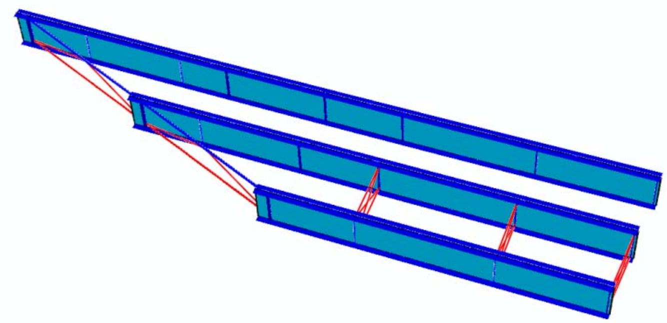
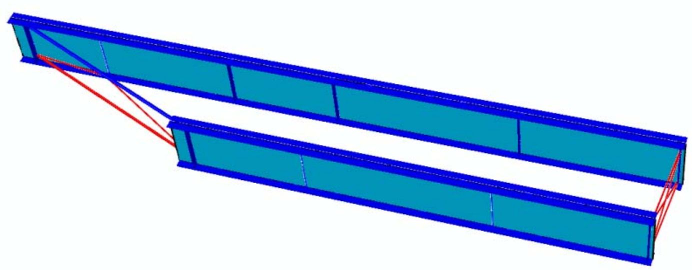
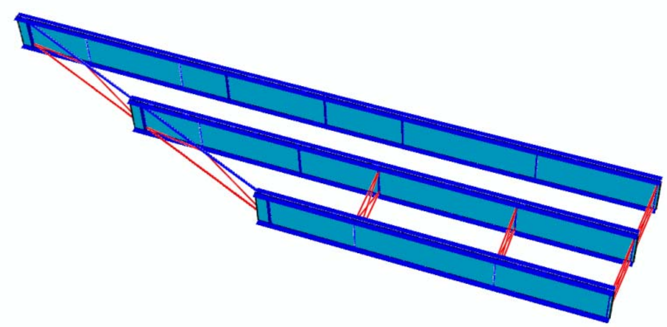
Sub-Stage	Stage	
	2	**3**
1		
2		

Table H2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

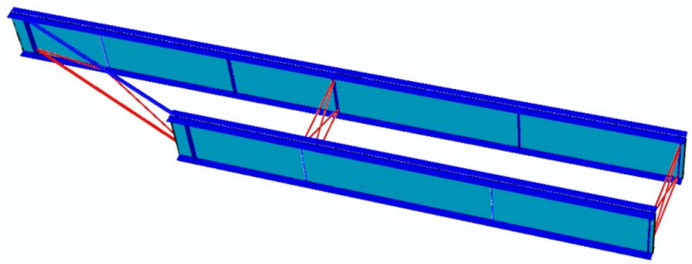
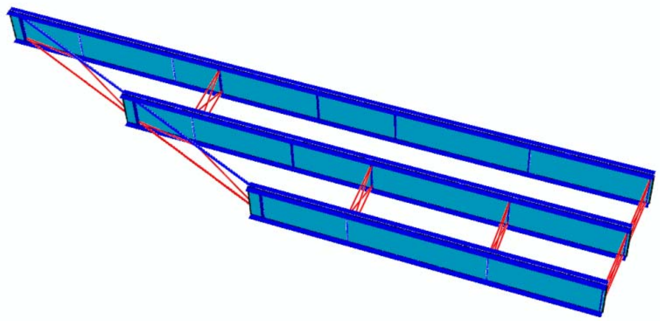
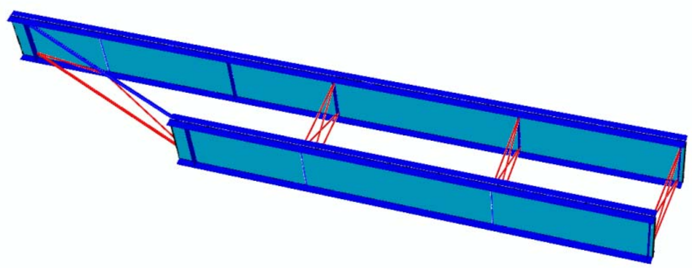
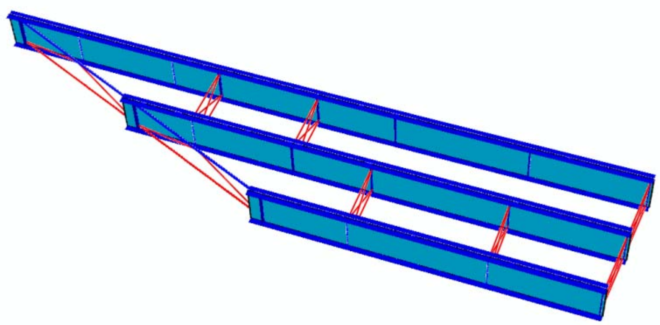
Sub-Stage	Stage	
	2	3
3		
4		

Table H2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

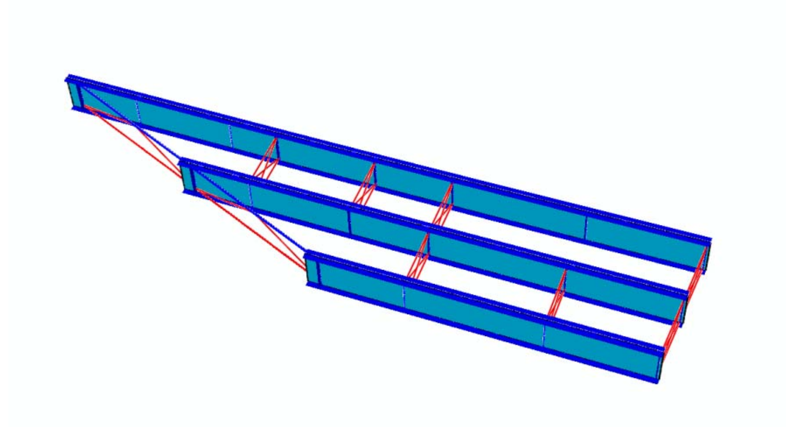
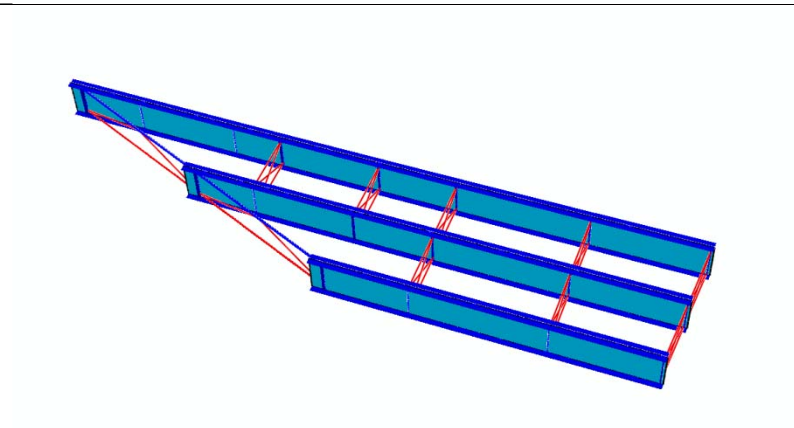
Sub-Stage	Stage	
	2	3
5		
6		

Table H2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

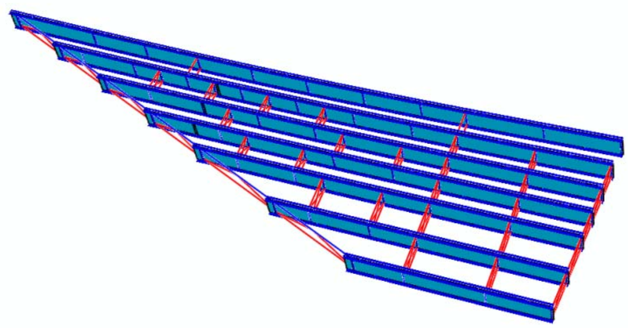
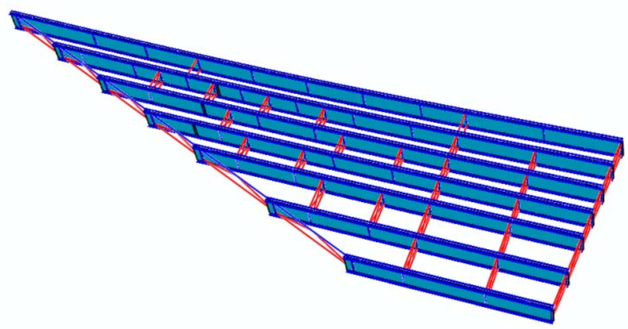
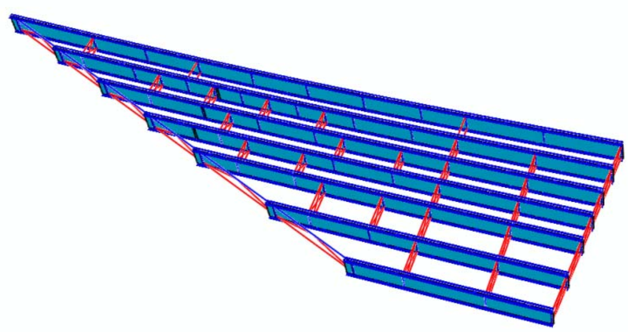
Sub-Stage	Stage 7
1	
2	
3	

Table H2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

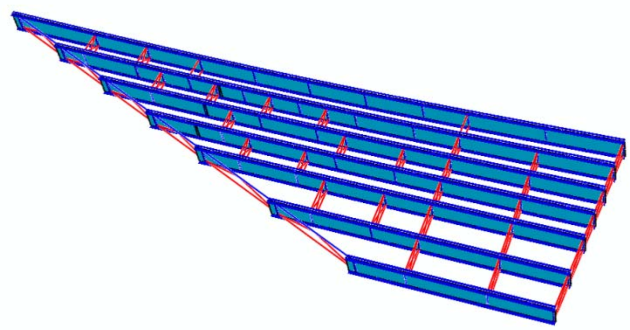
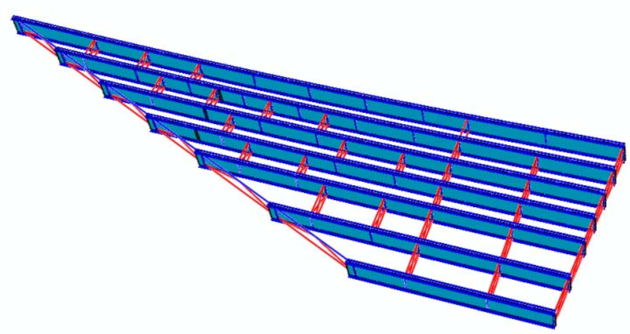
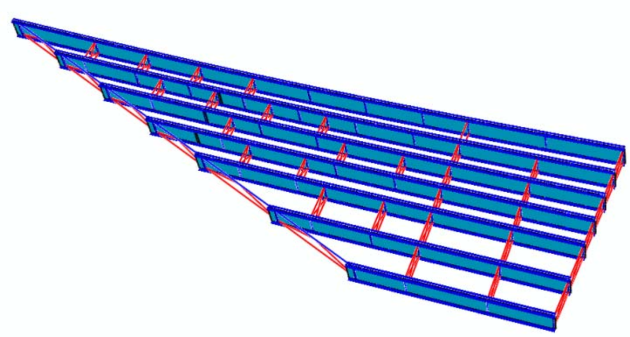
Sub-Stage	Stage 7
4	
5	
6	

Table H2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

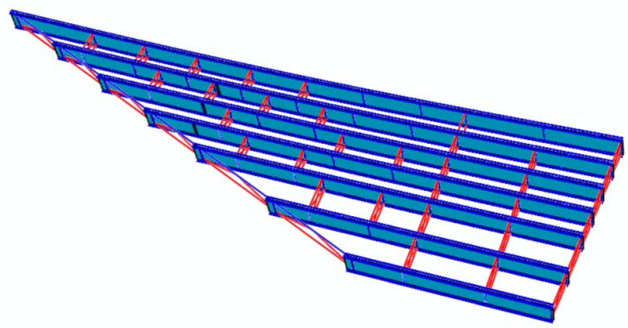
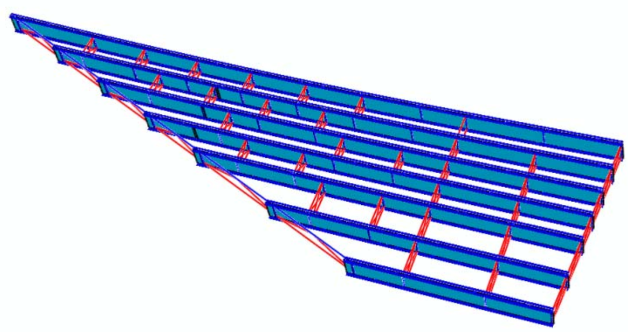
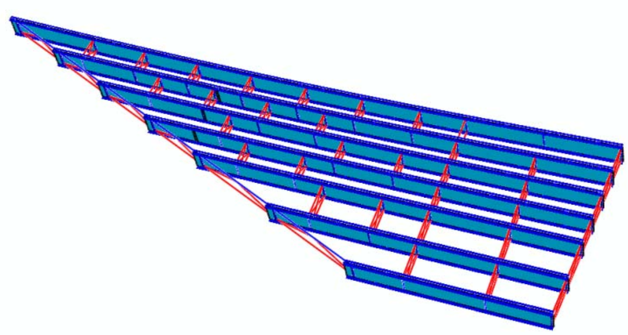
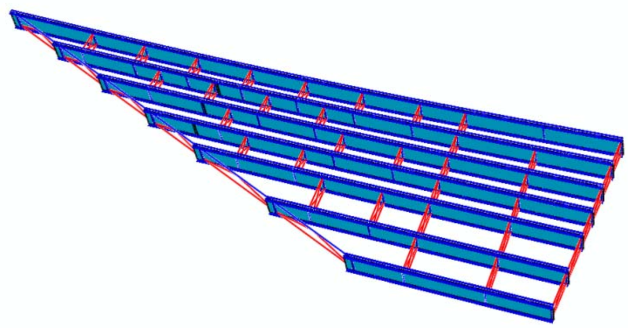
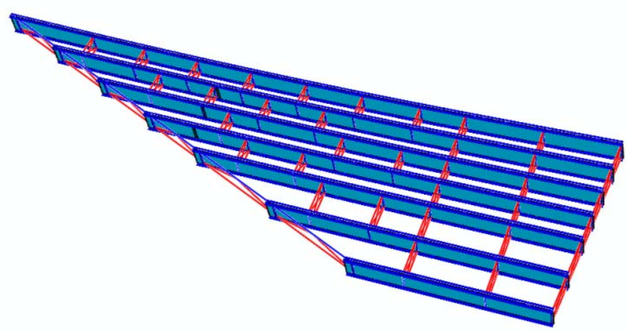
Sub-Stage	Stage 7
7	
8	
9	

Table H2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

Sub-Stage	Stage 7
10	
11	

Appendix H2-2. EISSS57 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EISSS57 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table H2-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.0	0.1
	SDLF	0.0	0.1
	TDLF	0.0	0.1
G2	NLF	0.2	0.8
	SDLF	0.2	0.7
	TDLF	0.1	0.7
G3	NLF	0.6	2.0
	SDLF	0.5	1.9
	TDLF	0.5	1.9
G4	NLF	1.1	3.3
	SDLF	0.9	3.1
	TDLF	0.5	2.7
G5	NLF	1.7	5.2
	SDLF	1.6	5.0
	TDLF	1.4	4.8
G6	NLF	2.5	7.5
	SDLF	2.7	7.6
	TDLF	3.2	8.1
G7	NLF	3.4	9.9
	SDLF	3.8	10.3
	TDLF	4.2	10.6
All Girders	NLF	3.4	9.9
	SDLF	3.8	10.3
	TDLF	4.2	10.6

Table H2-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.1	0.4
	SDLF	0.0	0.3
	TDLF	0.3	0.0
G2	NLF	0.3	0.9
	SDLF	0.0	0.6
	TDLF	0.6	0.0
G3	NLF	0.5	1.5
	SDLF	0.0	1.0
	TDLF	1.0	0.0
G4	NLF	0.7	2.0
	SDLF	0.0	1.3
	TDLF	1.3	0.0
G5	NLF	0.9	2.6
	SDLF	0.0	1.7
	TDLF	1.6	0.0
G6	NLF	1.0	2.8
	SDLF	0.0	1.8
	TDLF	1.8	0.1
G7	NLF	0.9	2.8
	SDLF	0.0	1.8
	TDLF	1.7	0.1
All Girders	NLF	1.0	2.8
	SDLF	0.0	1.8
	TDLF	1.8	0.1

Table H2-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	0.4	1.8	0.4	1.7	0.5	1.0	1.0	4.5
	SDLF	0.7	2.0	0.7	2.0	0.0	0.8	0.1	3.1
	TDLF	1.0	2.4	1.0	2.3	1.4	0.4	2.3	0.4
G2	NLF	2.2	7.9	2.2	7.8	1.0	1.2	1.5	6.0
	SDLF	1.7	7.3	1.7	7.3	0.0	0.8	0.1	3.9
	TDLF	1.0	6.5	1.0	6.5	2.2	0.1	3.1	0.1
G3	NLF	3.5	11.3	3.5	11.2	1.9	3.5	2.3	6.5
	SDLF	2.9	10.7	2.9	10.7	0.1	1.9	0.1	3.8
	TDLF	2.7	10.5	2.7	10.5	2.4	0.2	3.3	0.2
G4	NLF	4.1	12.5	4.9	14.8	2.7	5.7	4.3	13.8
	SDLF	3.4	11.9	4.1	14.1	0.0	3.5	0.1	8.6
	TDLF	2.0	10.4	2.4	12.4	4.4	0.1	7.2	0.2
G5	NLF	5.0	14.8	6.0	17.7	2.7	6.7	4.2	12.1
	SDLF	4.6	14.4	5.5	17.2	0.1	4.1	0.1	7.5
	TDLF	4.2	13.9	5.1	16.6	3.7	0.6	5.8	0.9
G6	NLF	5.7	16.5	6.7	19.7	1.3	3.1	1.6	5.0
	SDLF	6.1	17.0	7.3	20.2	0.2	2.0	0.3	2.9
	TDLF	7.4	18.2	8.8	21.7	2.8	0.5	3.4	0.6
G7	NLF	5.7	16.6	7.9	23.0	0.2	0.6	0.3	1.1
	SDLF	6.4	17.2	8.8	23.8	0.0	0.4	0.1	0.9
	TDLF	7.0	17.7	9.6	24.4	0.3	0.4	0.4	0.9
All Girders	NLF	5.7	16.6	7.9	23.0	2.7	6.7	4.3	13.8
	SDLF	6.4	17.2	8.8	23.8	0.2	4.1	0.3	8.6
	TDLF	7.4	18.2	9.6	24.4	4.4	0.6	7.2	0.9

Table H2-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	10.3	22.3	22.0	22.3
	SDLF	5.4	4.9	1.2	5.4
	TDLF	13.1	29.5	29.0	29.5
TDL	NLF	23.4	55.7	53.6	55.7
	SDLF	14.7	32.5	31.2	32.5
	TDLF	16.1	18.4	4.8	18.4

Table H2-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	2.3	4.4	4.4	3.4
	SDLF	0.4	0.5	0.2	0.3
	TDLF	3.0	6.1	6.0	4.6
TDL	NLF	5.9	12.5	11.2	9.0
	SDLF	3.8	8.2	7.0	5.8
	TDLF	1.4	2.5	1.6	1.7

Table H2-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	0.20	0.45	0.54	0.81	1.01	1.09	1.09
SDLF	0.14	0.39	0.44	0.77	1.22	1.33	1.33
TDLF	0.07	0.39	0.17	0.93	1.90	1.42	1.90

Table H2-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	0.72	1.43	1.57	2.35	2.92	3.19	3.19
SDLF	0.66	1.37	1.47	2.30	3.09	3.39	3.39
TDLF	0.58	1.36	1.20	2.31	3.61	3.46	3.61

Table H2-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	0.14	0.32	0.38	0.57	0.71	0.77	0.77
SDLF	0.10	0.28	0.31	0.54	0.87	0.94	0.94
TDLF	0.05	0.28	0.12	0.66	1.35	1.01	1.35

Table H2-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	0.51	1.01	1.11	1.66	2.07	2.26	2.26
SDLF	0.47	0.97	1.04	1.63	2.19	2.40	2.40
TDLF	0.41	0.97	0.85	1.64	2.56	2.45	2.56

Table H2-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	568.5	1713.1
SDLF	568.5	1712.8
TDLF	568.5	1713.1

Table H2-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	60.1	165.0	0.2	1.7	0.5	1.7
SDLF	62.3	166.4	0.1	1.2	0.0	1.2
TDLF	68.0	170.7	0.2	0.2	0.9	0.2

Table H2-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.37	0.89	0.05	0.89
SDLF	0.37	0.84	0.00	0.84
TDLF	0.50	1.11	0.09	1.11

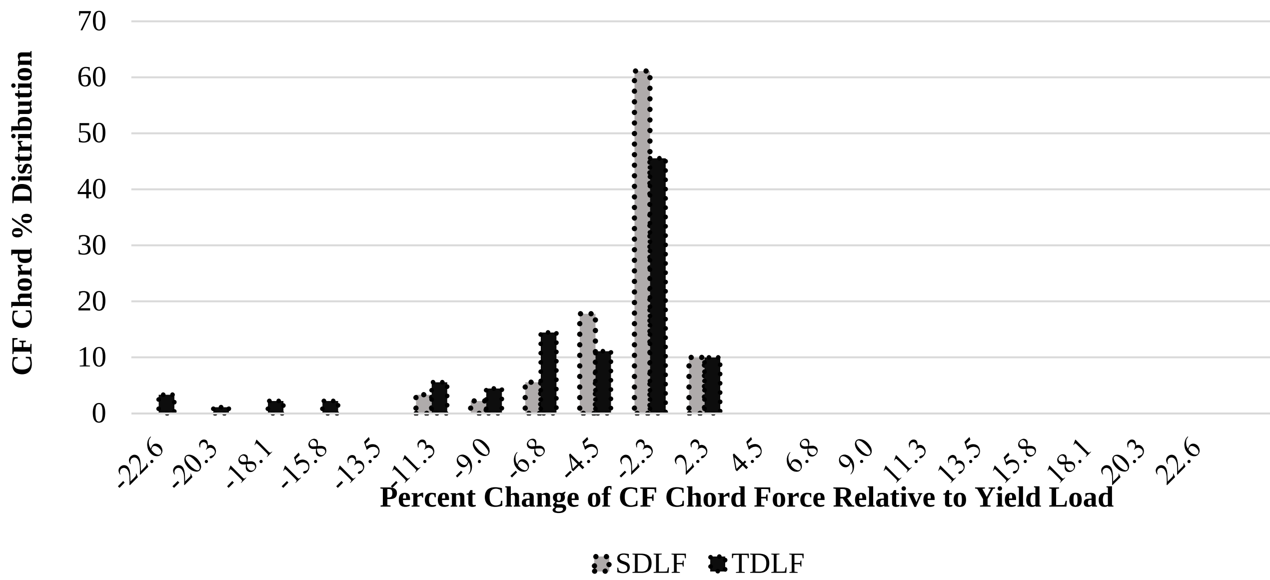


Figure H2-2-1. **Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.**

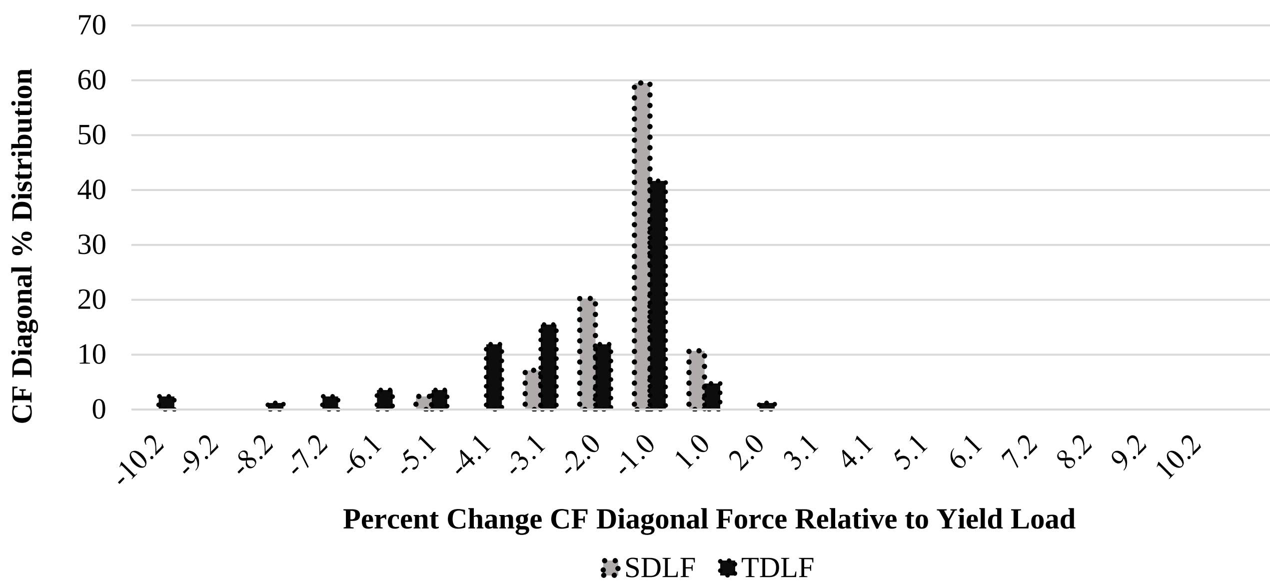


Figure H2-2-2. **Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.**

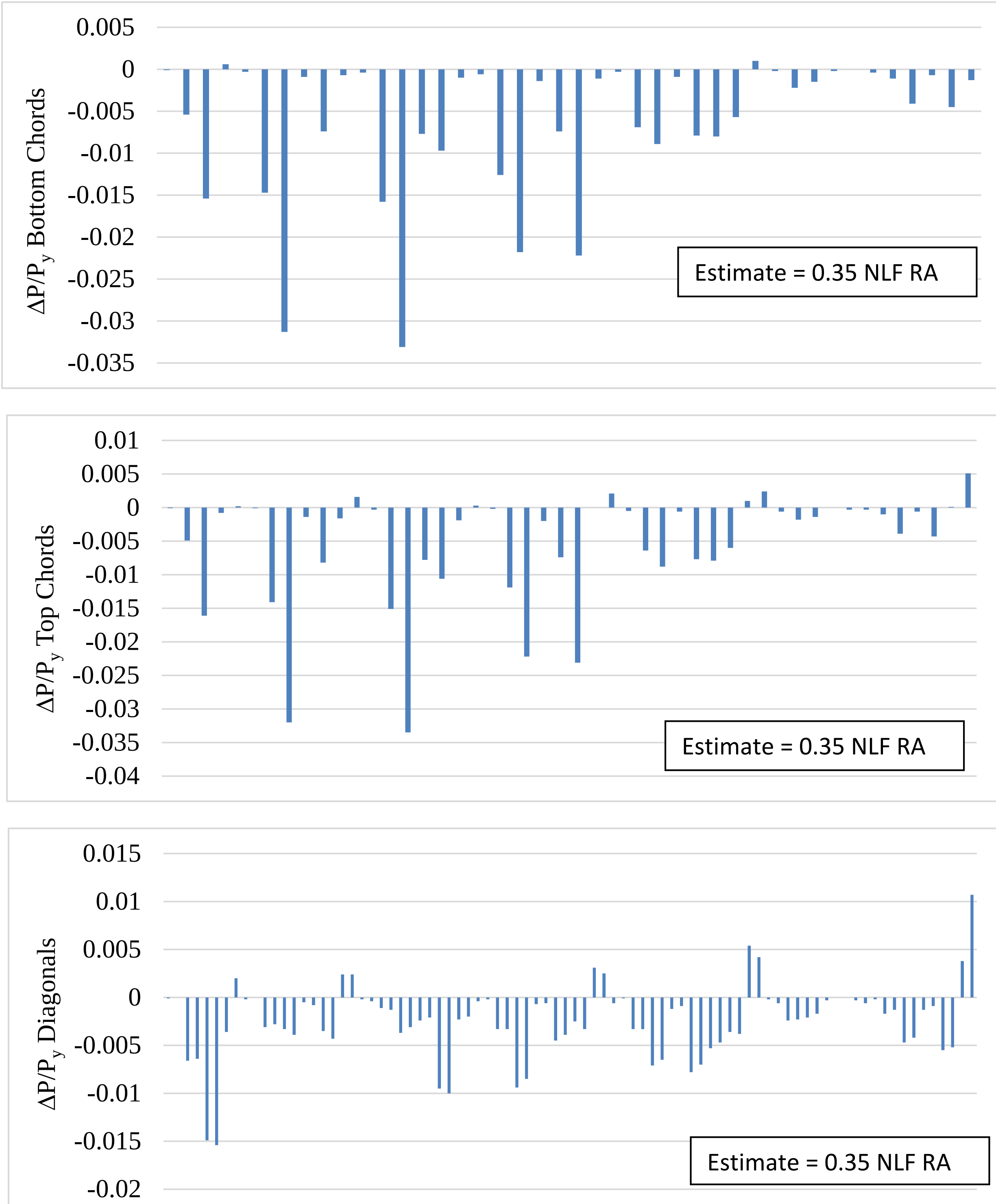


Figure H2-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

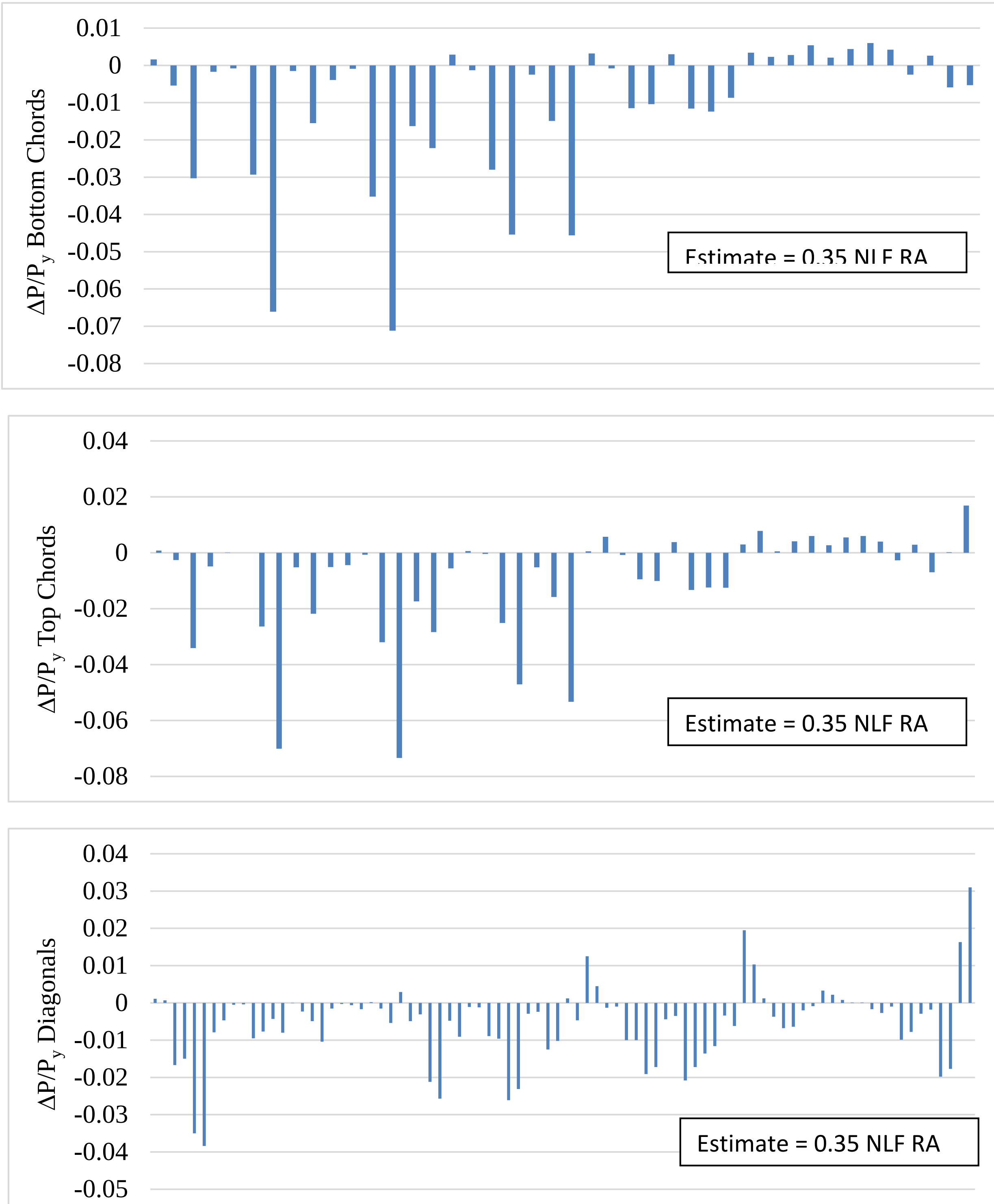


Figure H2-2-4. **Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.**

Appendix H2-3. EISSS57 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EISSS57 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table H2-3-1. Maximums of the fit-up force resultants (kips)

Detailing Method	F1	F2	F_{max}
SDLF	0.6	5.0	5.0
TDLF	0.8	14.2	14.2

Table H2-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	SDLF	19	15
	TDLF	29	15
G2	SDLF	30	22
	TDLF	29	19
G3	SDLF	36	30
	TDLF	47	29
G4	SDLF	44	40
	TDLF	27	26
G5	SDLF	50	46
	TDLF	45	43
G6	SDLF	57	52
	TDLF	69	65
G7	SDLF	61	58
	TDLF	60	58
All Girders	SDLF	61	15
	TDLF	69	15

Table H2-3-3. Total Vertical Reactions (kips)

Stage	Detailing Method	Sub-Stage										
		1	2	3	4	5	6	7	8	9	10	11
2	SDLF	81	82	83	83							
	TDLF	81	82	83	83							
3	SDLF	149	149	150	151	152	153					
	TDLF	149	149	150	151	152	153					
7	SDLF	563	563	564	565	565	566	566	567	567	568	568
	TDLF	563	563	564	565	565	566	566	567	567	568	568

Appendix H2-4. NISSS14 Detailed Results, Completed Bridge Responses

This appendix presents the SDL and TDL responses of the bridge NISSS14 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

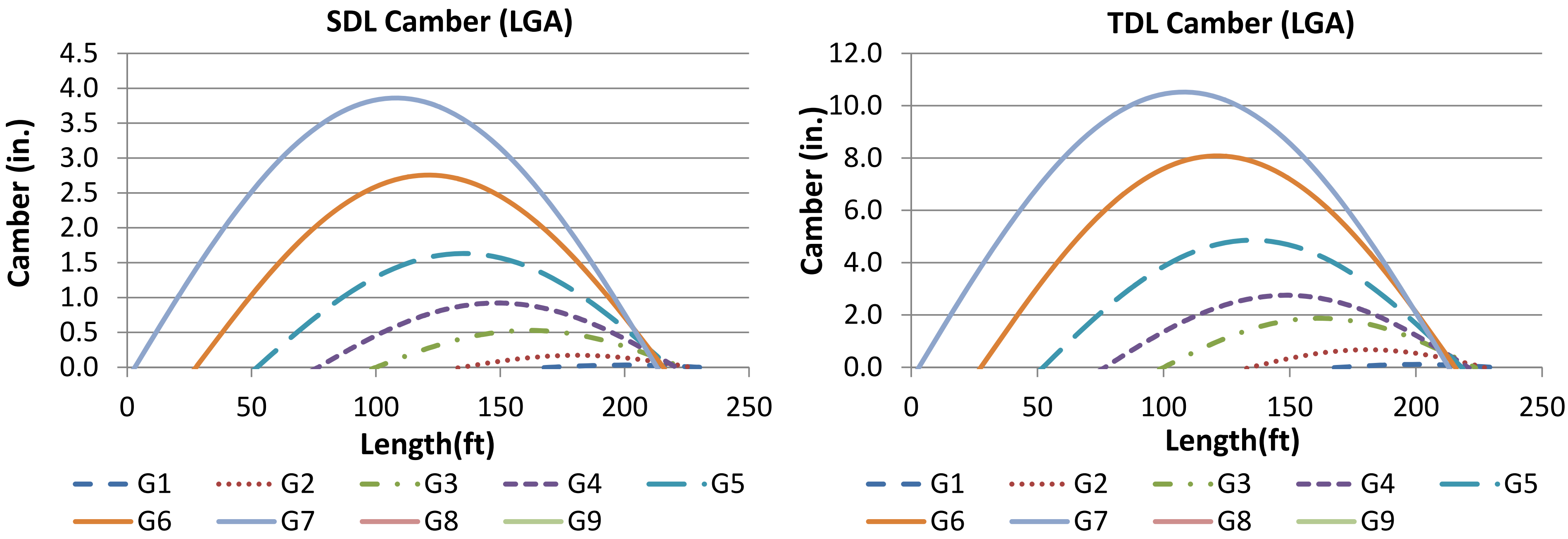


Figure H2-4-1. SDL and TDL Line Girder Analysis cambers.

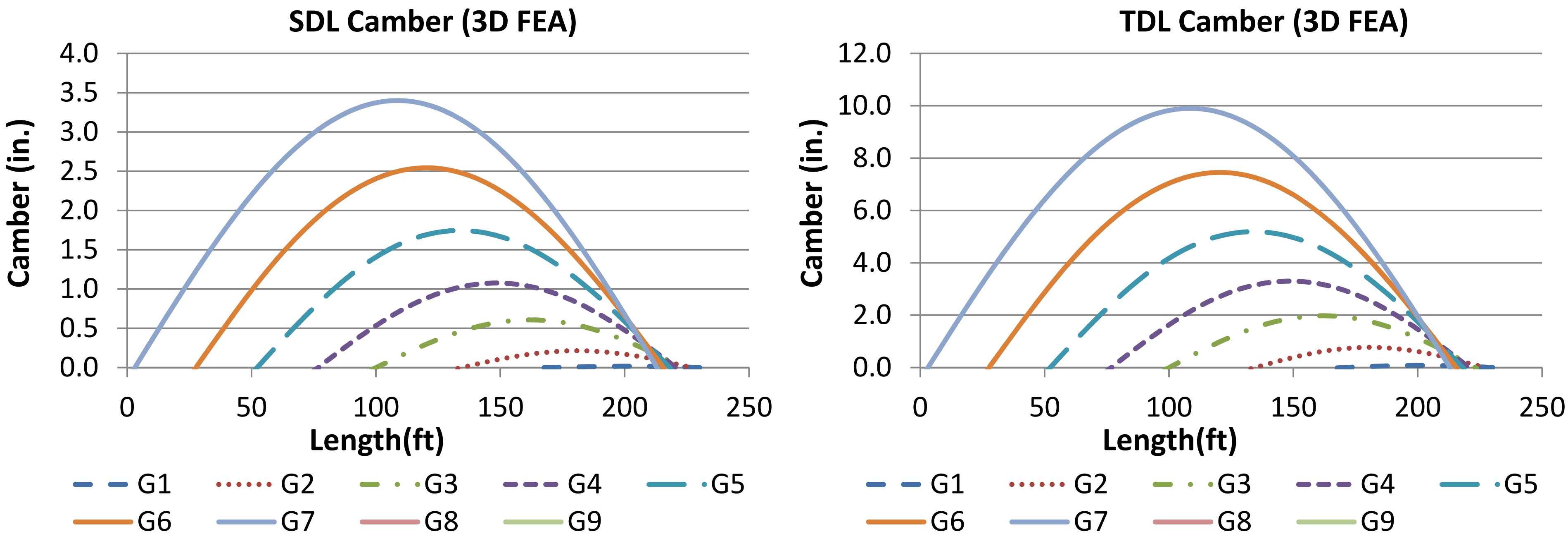


Figure H2-4-2. SDL and TDL 3D FEA cambers.

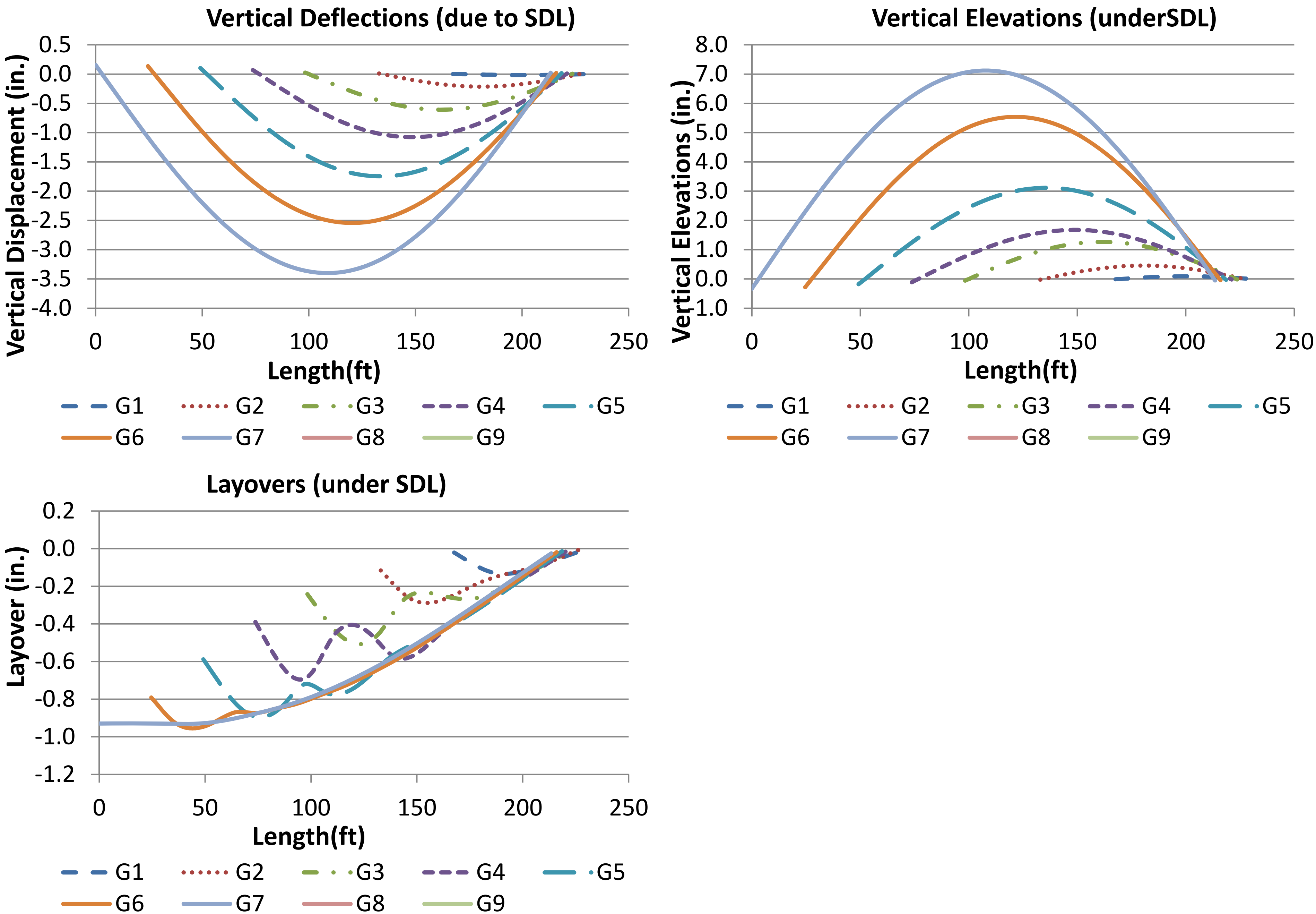


Figure H2-4-3. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

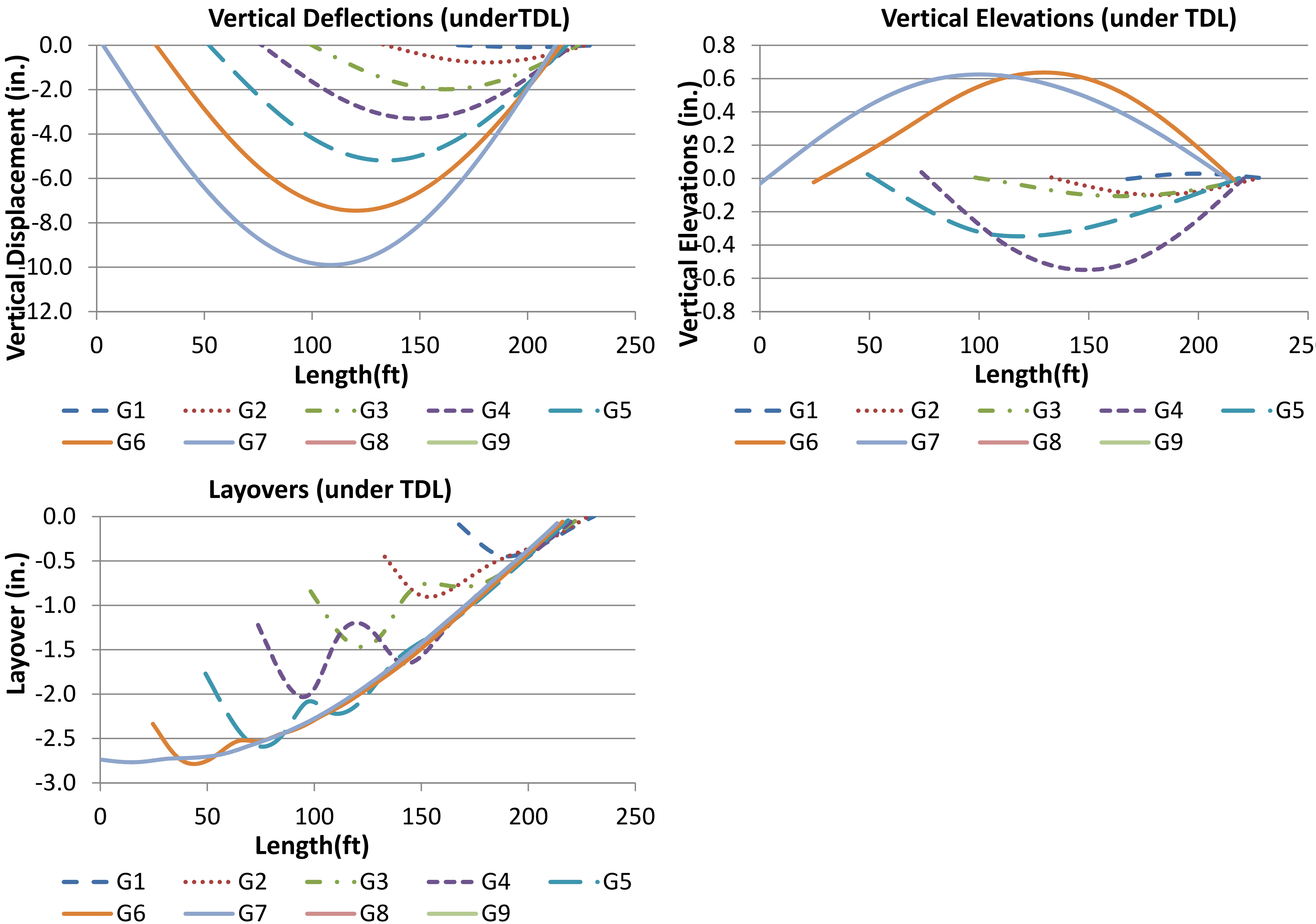


Figure H2-4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

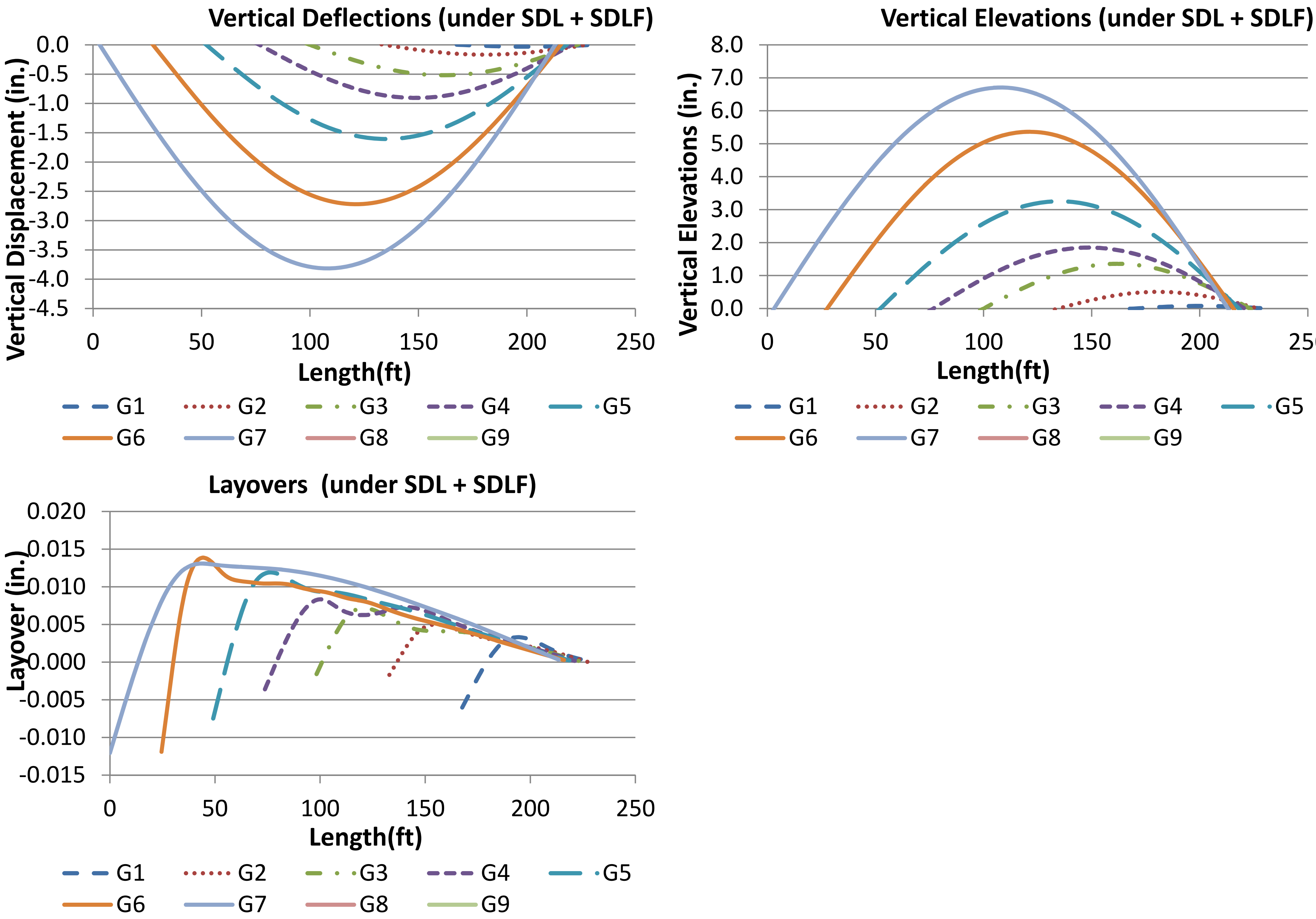


Figure H2-4-5. **Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.**

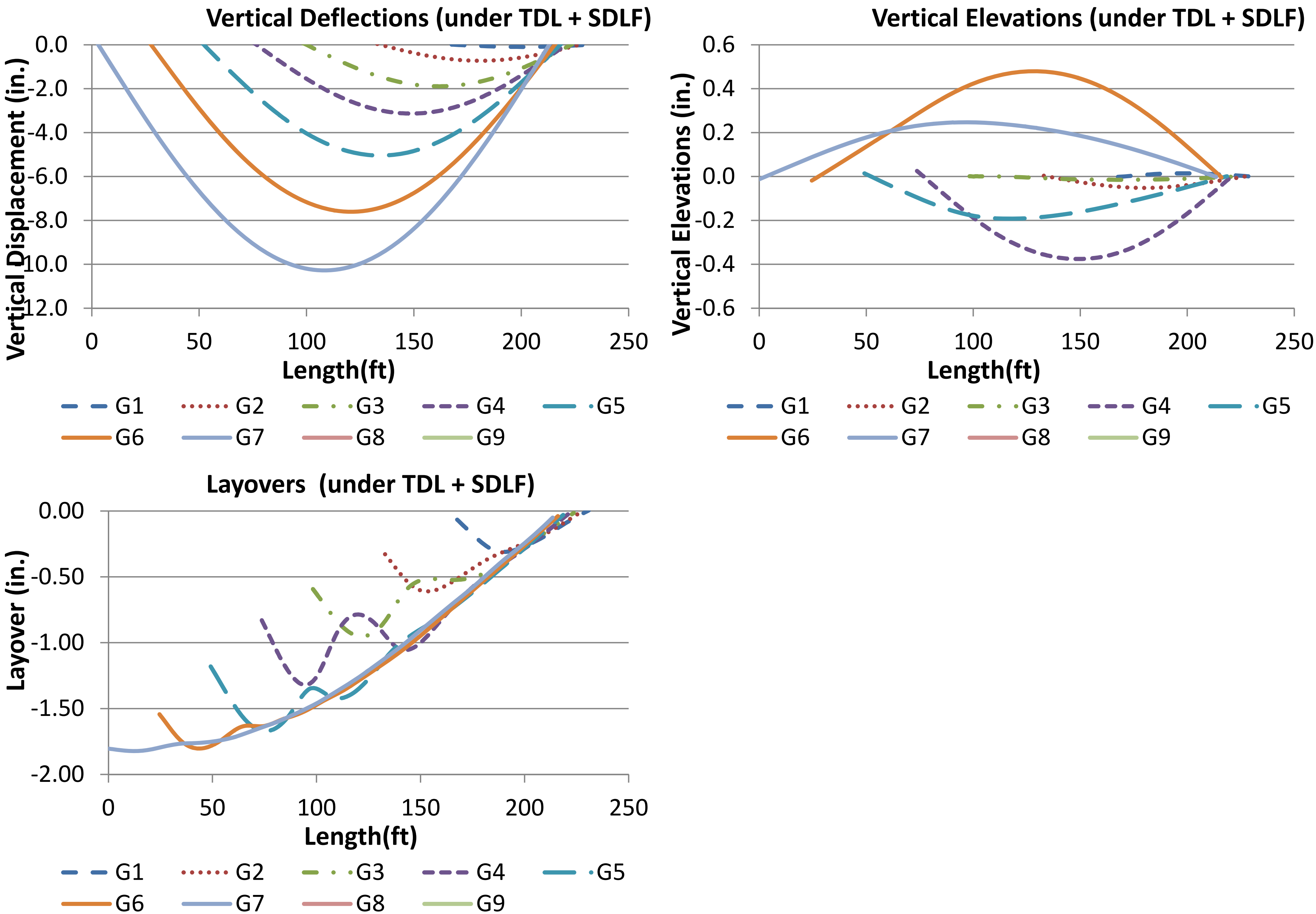


Figure H2-4-6. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

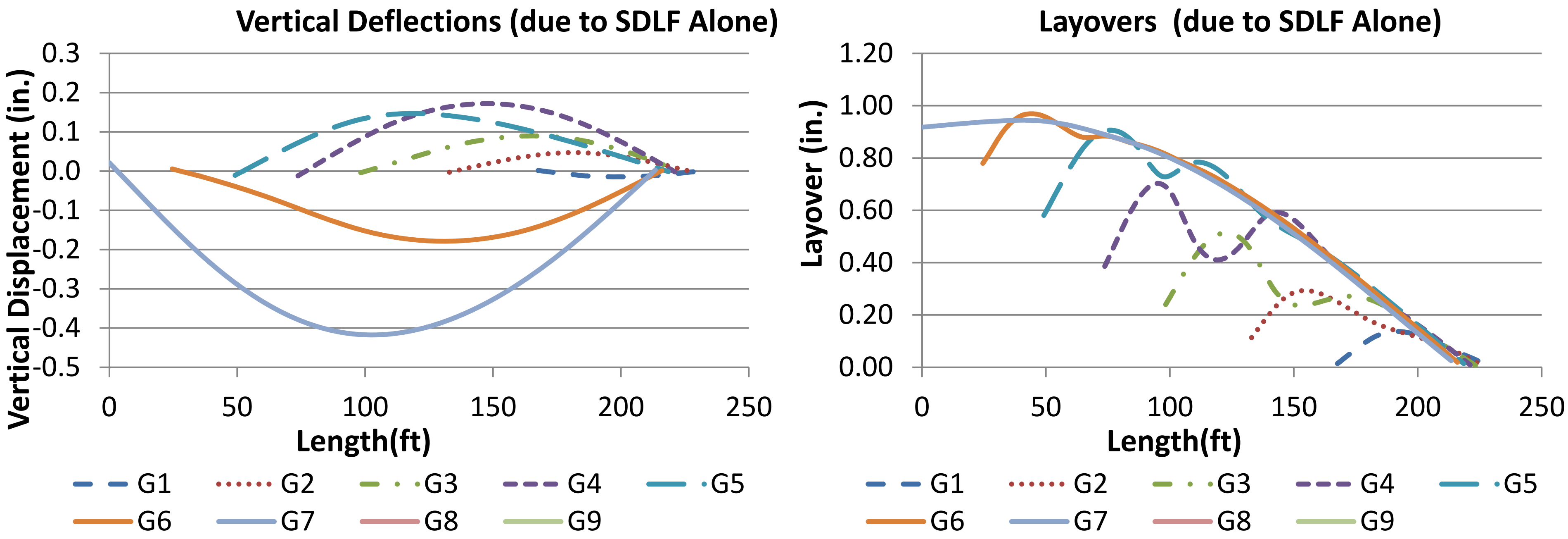


Figure H2-4-7. Bridge displacements due to SDLF detailing effects alone under NL(in).

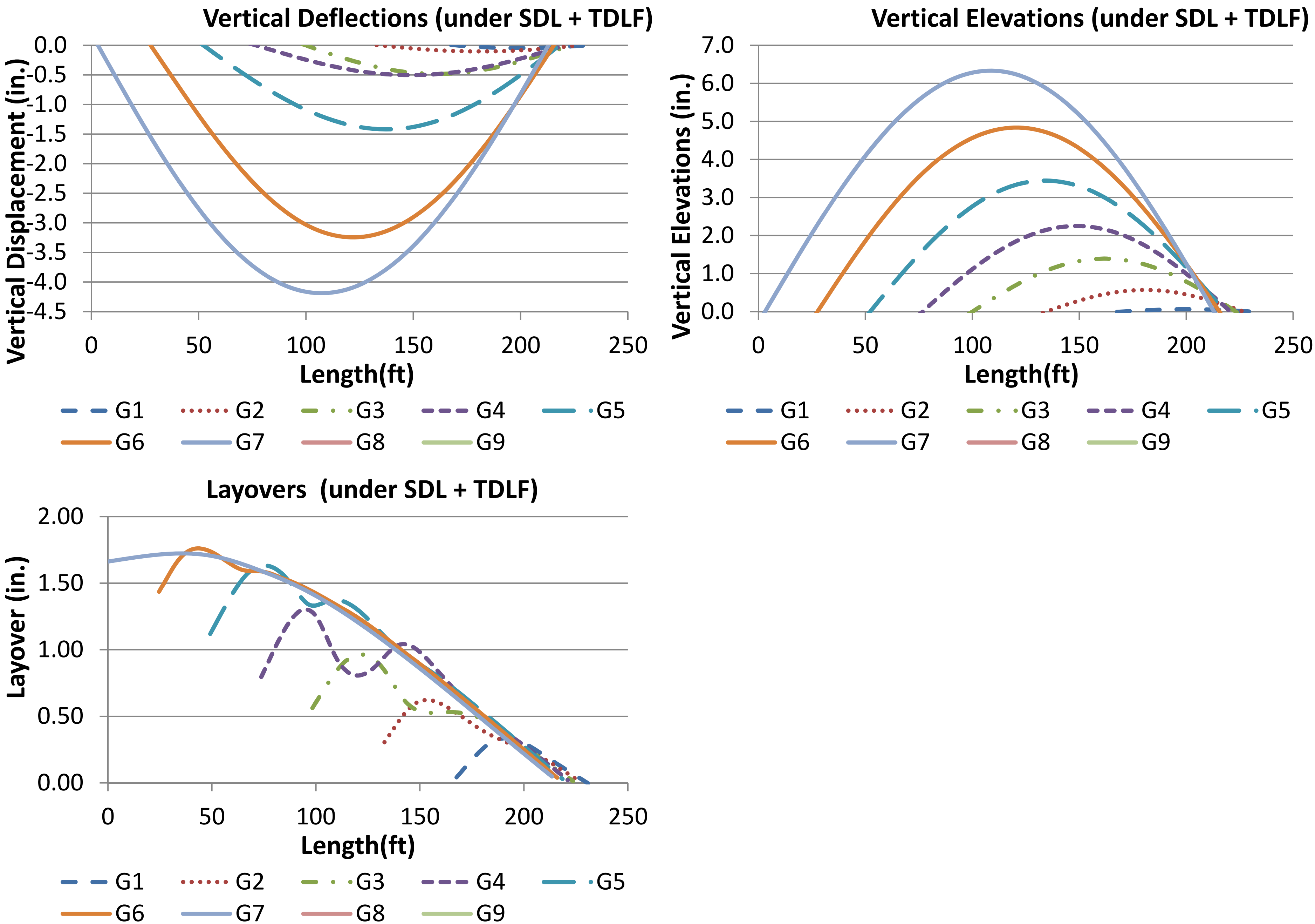


Figure H2-4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

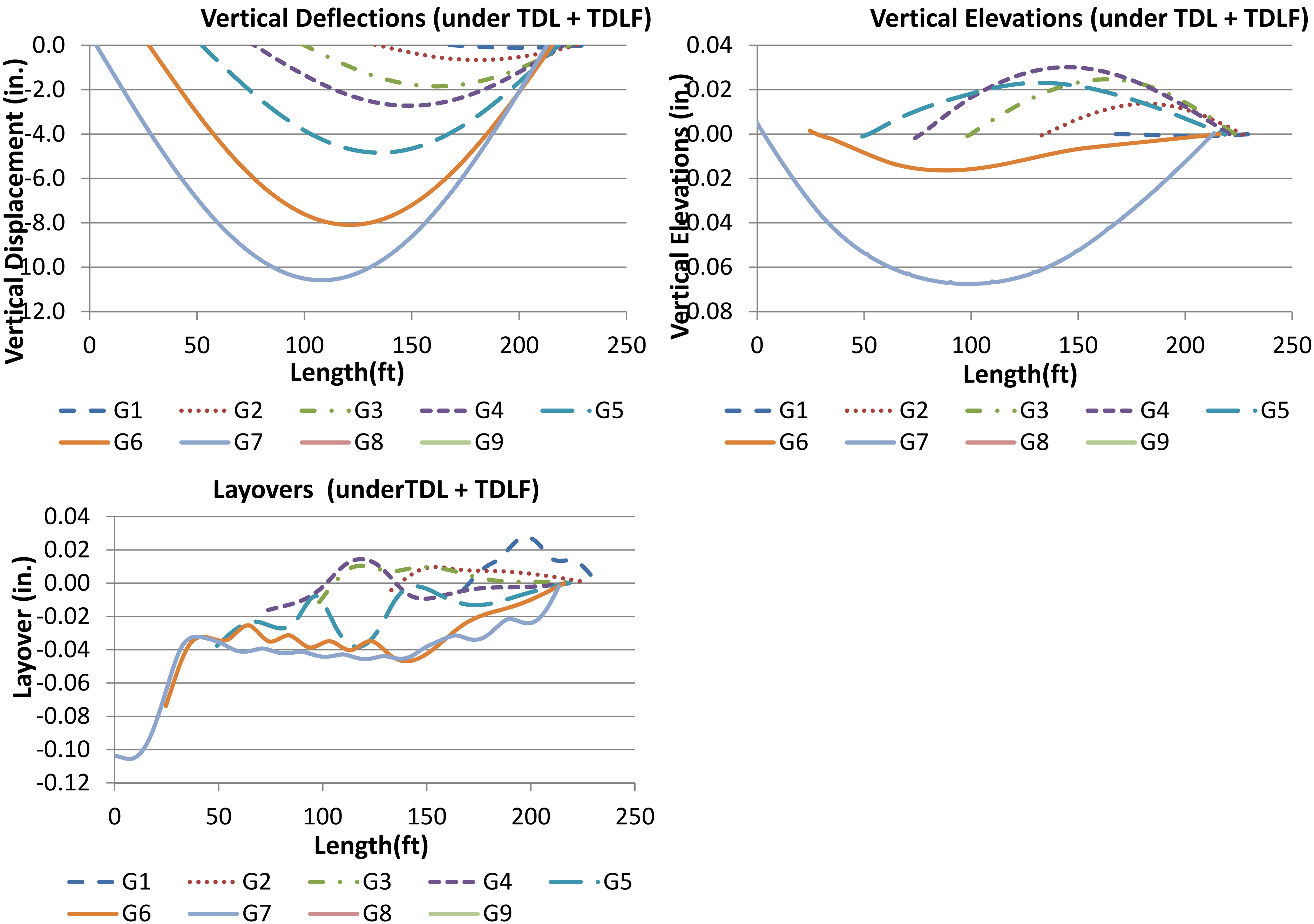
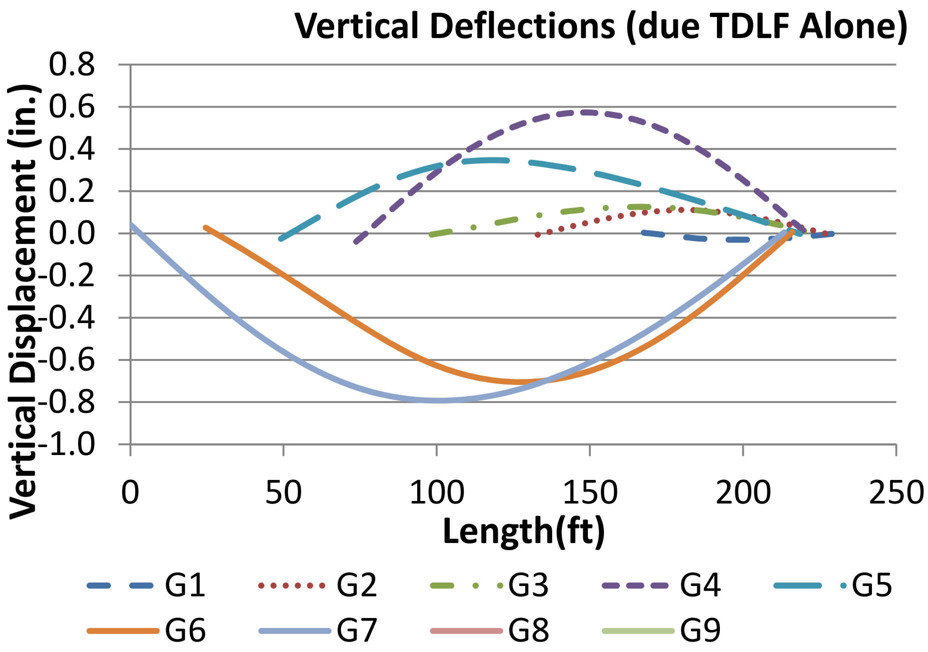


Figure H2-4-9. **Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.**



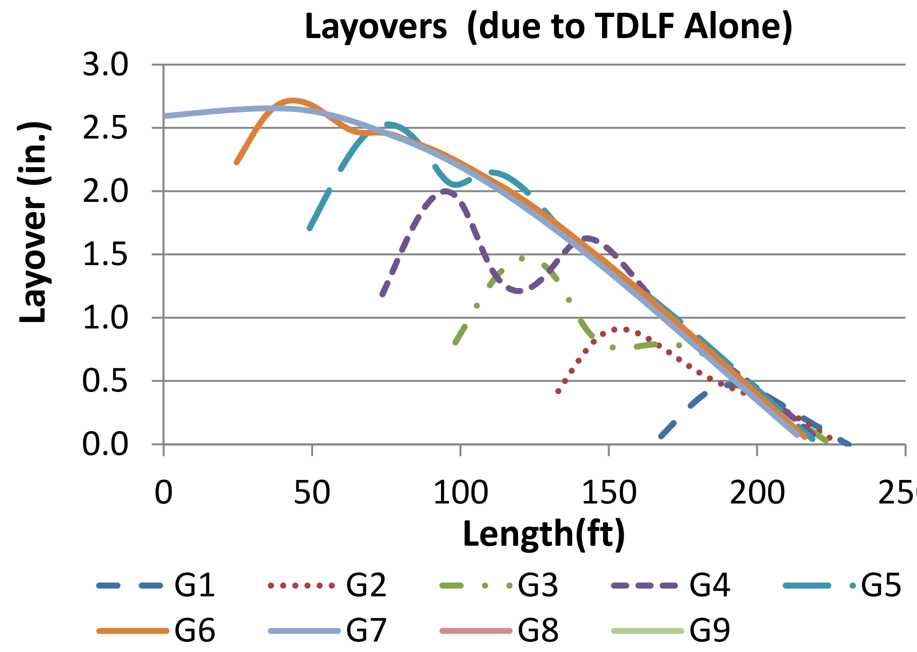


Figure H2-4-10. **Bridge displacements due to TDLF detailing effects alone under NL (in).**

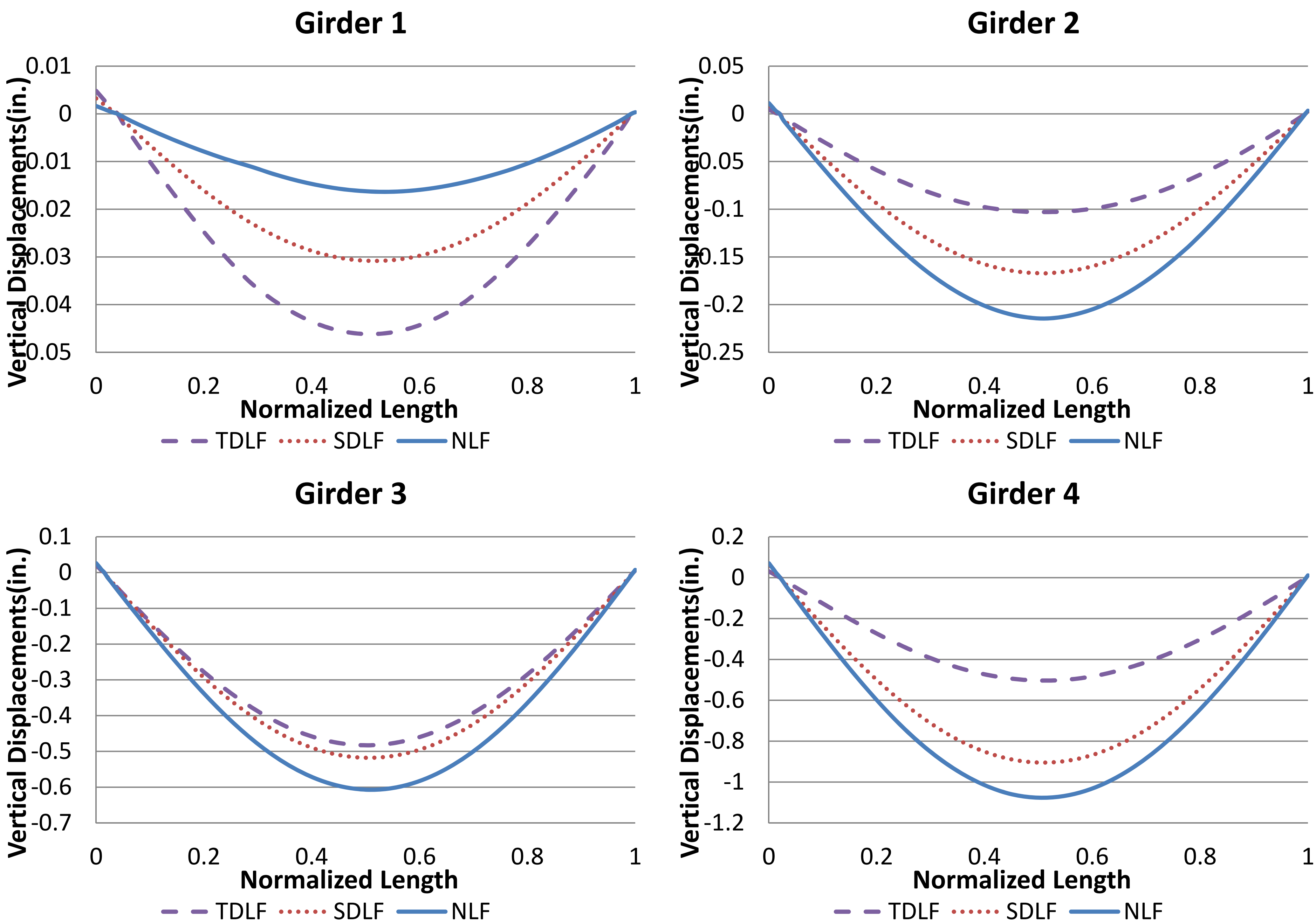


Figure H2-4-11. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

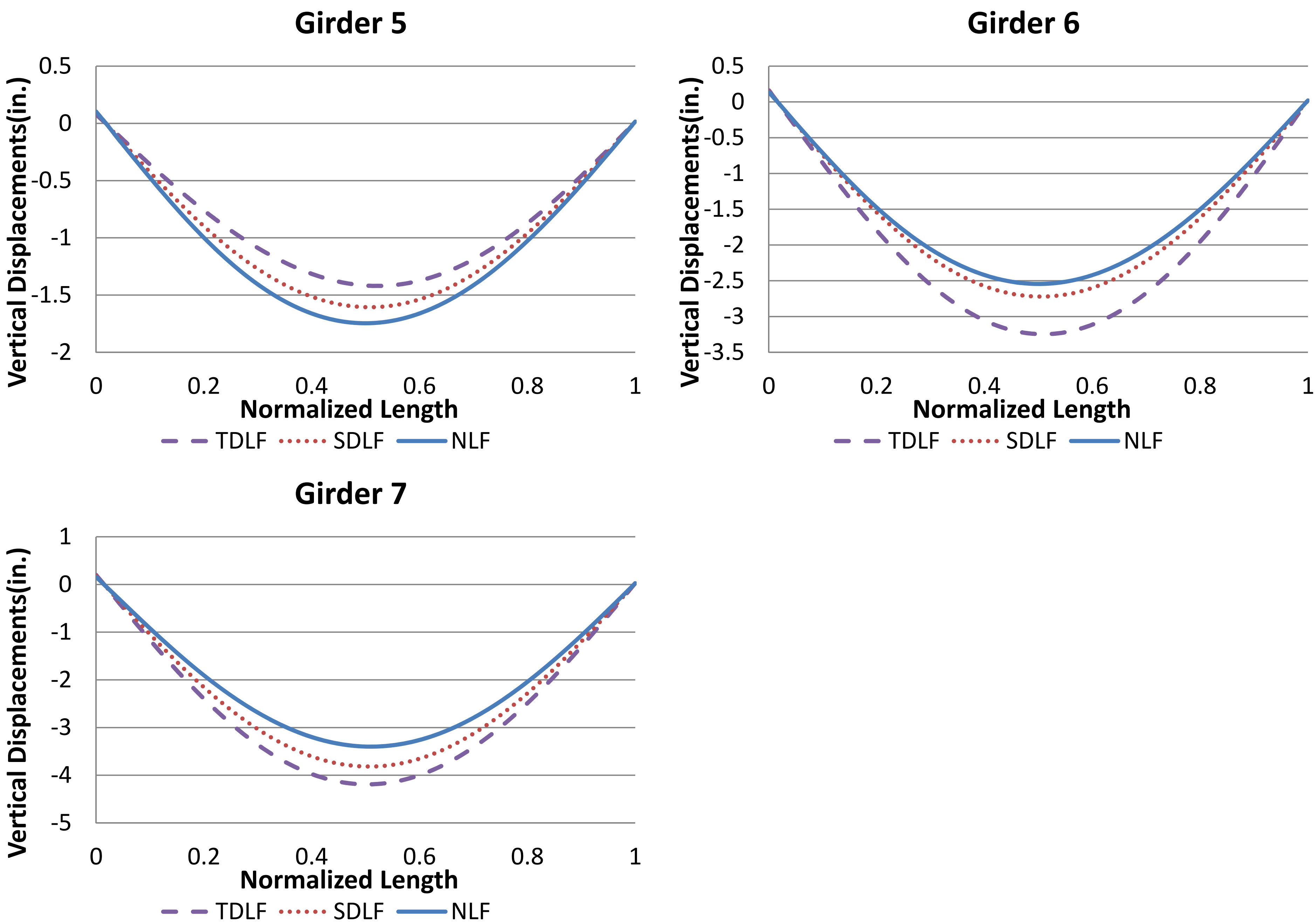


Figure H2-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

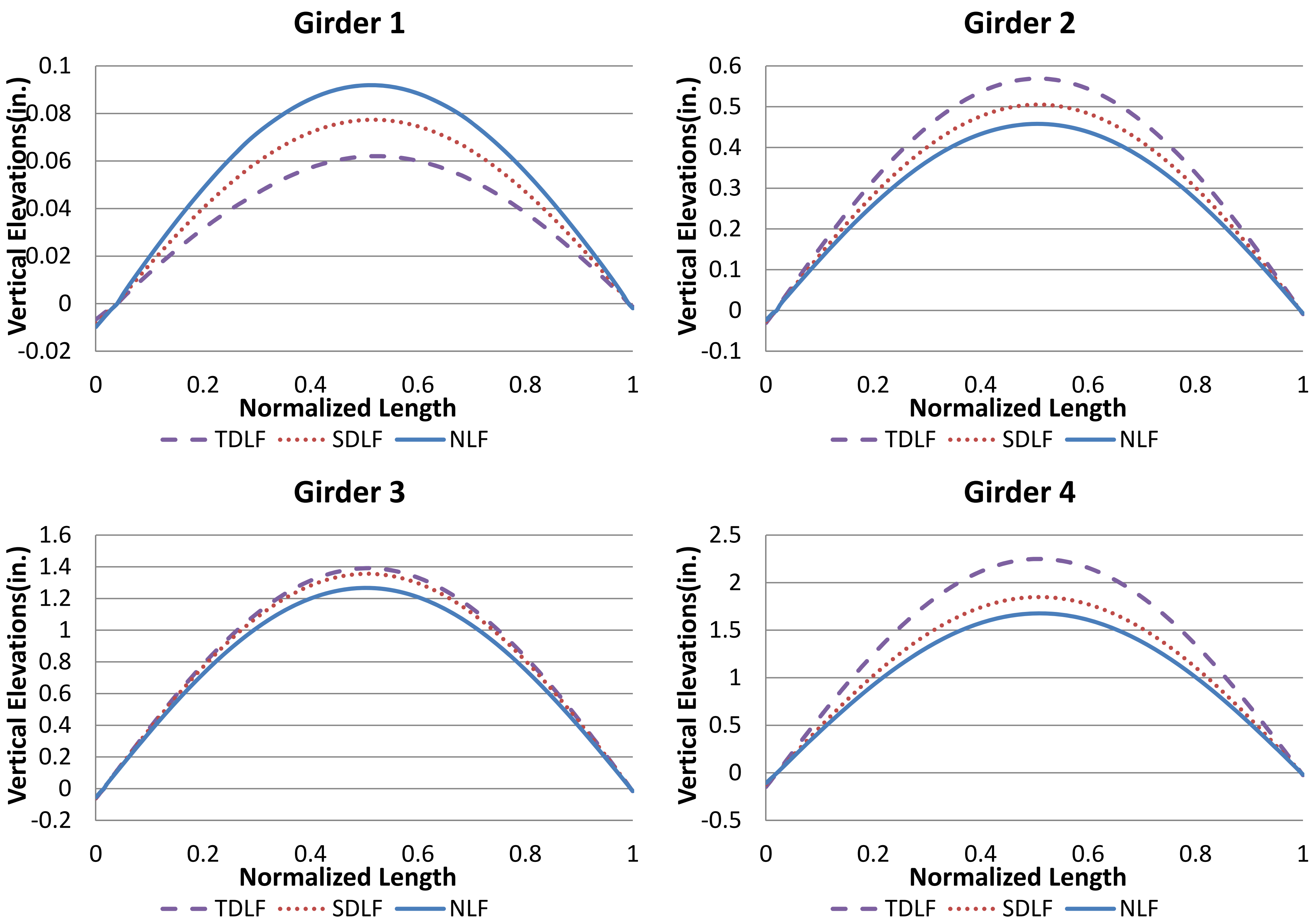


Figure H2-4-12. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

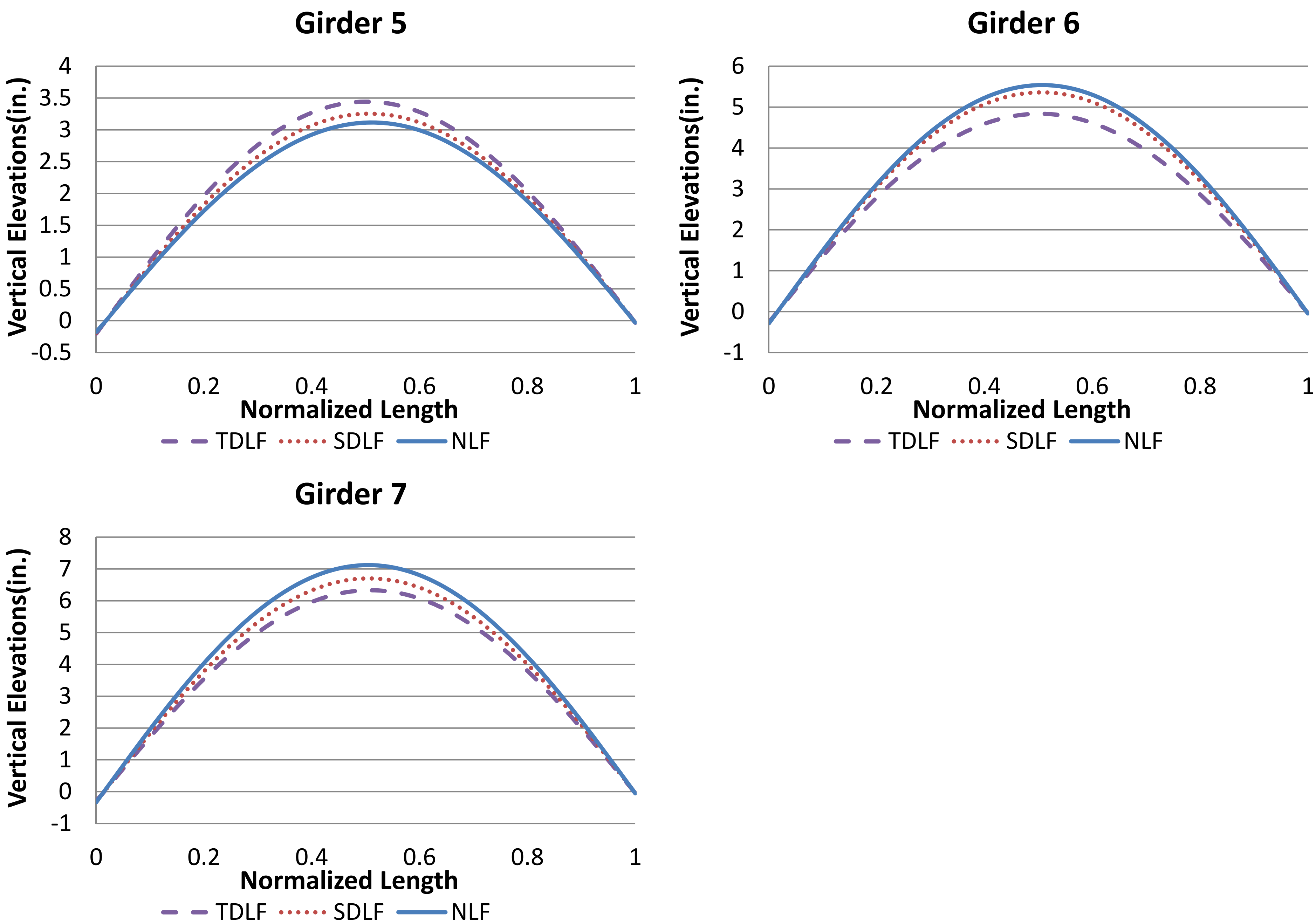


Figure H2-4-12(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

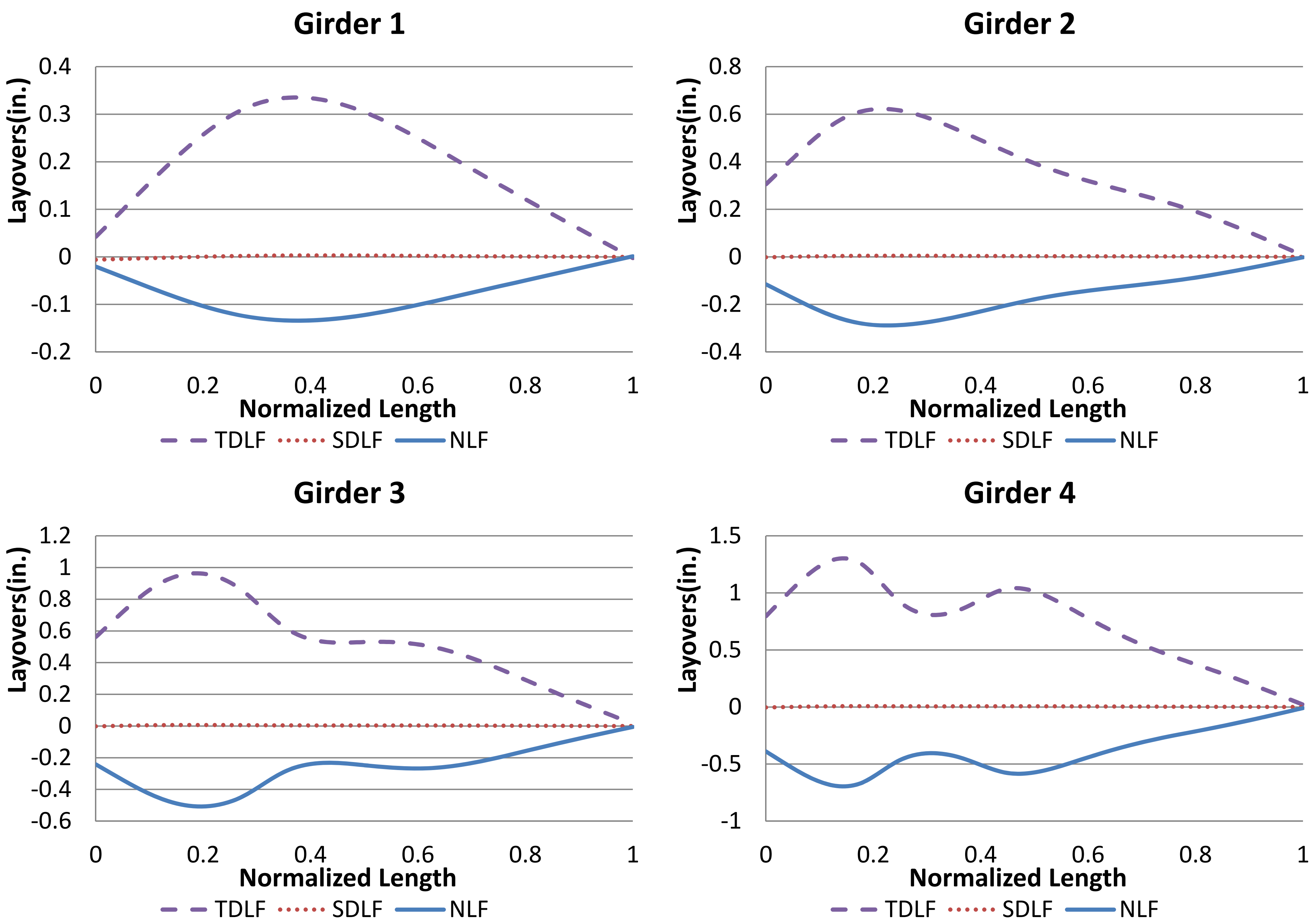


Figure H2-4-13. Comparison of individual girder layovers (in) under SDL for different detailing methods.

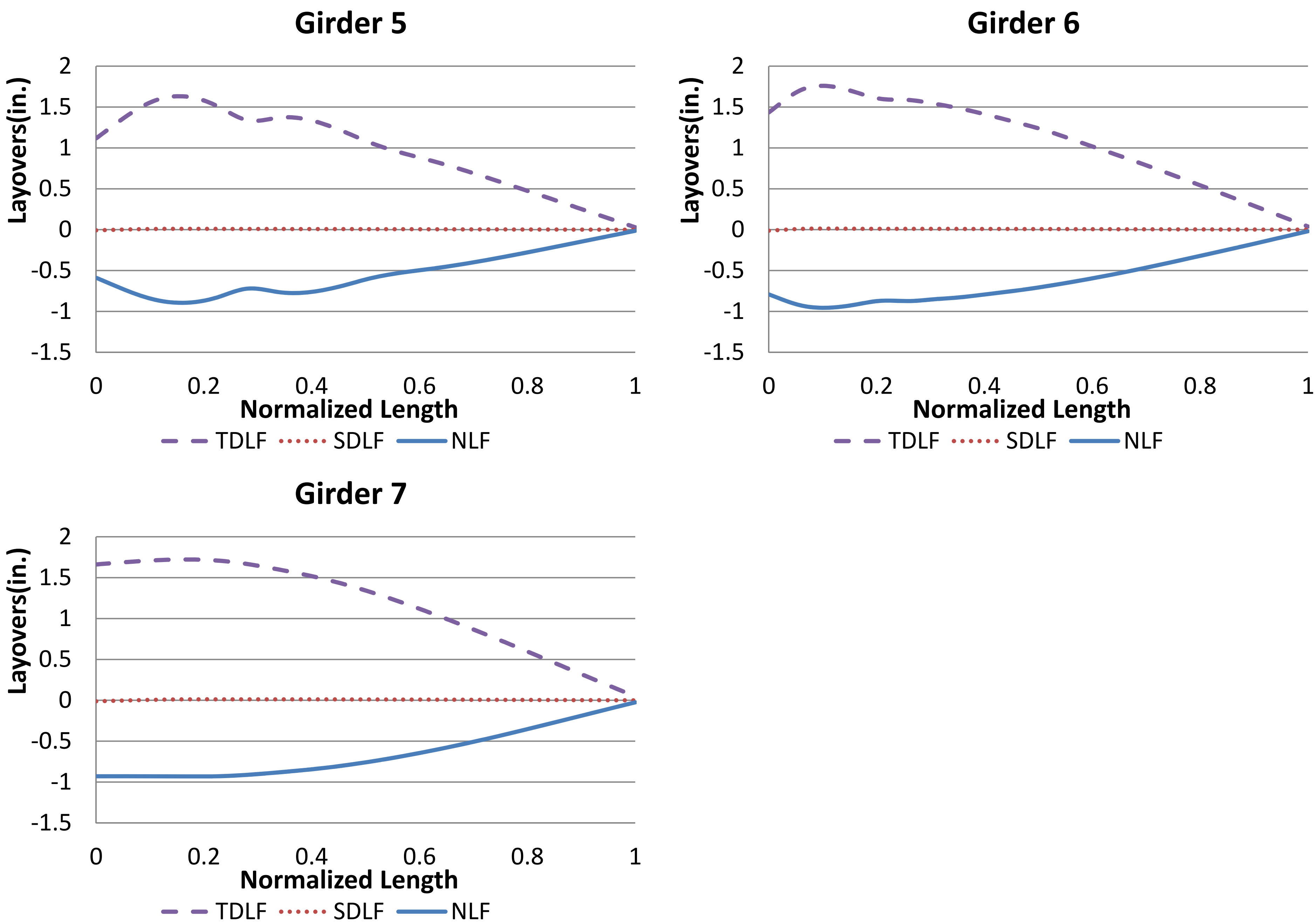


Figure H2-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

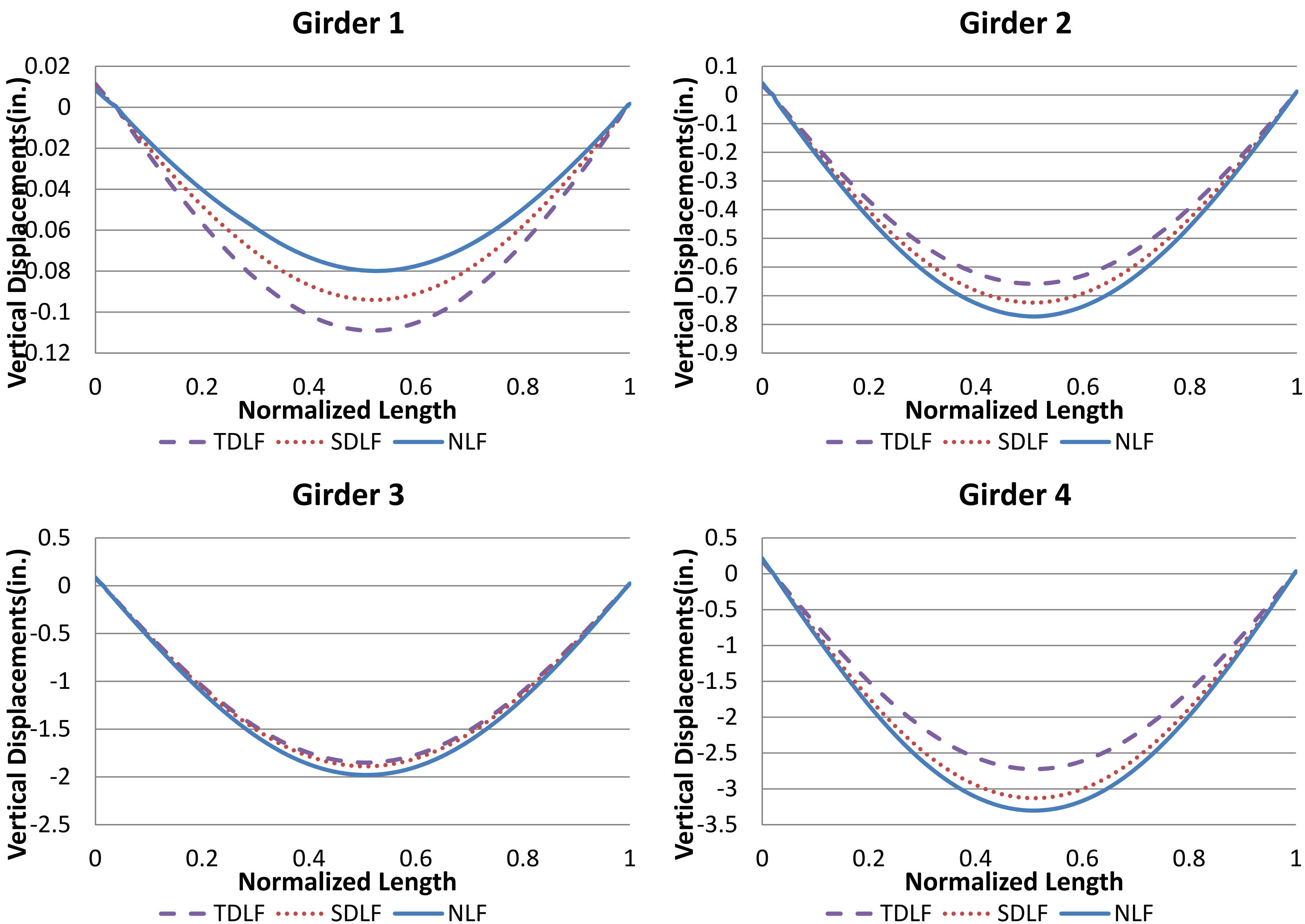


Figure H2-4-14. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

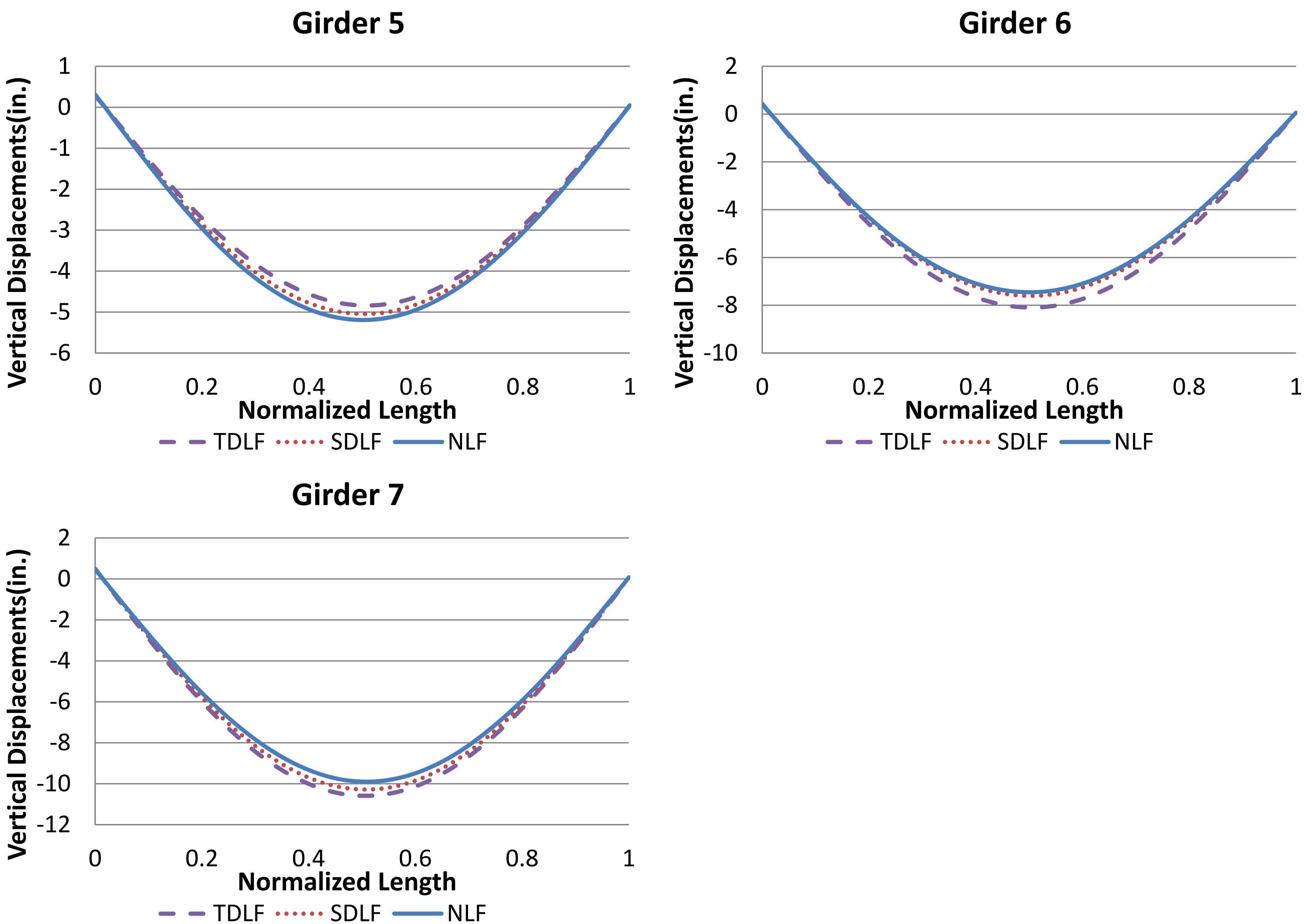


Figure H2-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

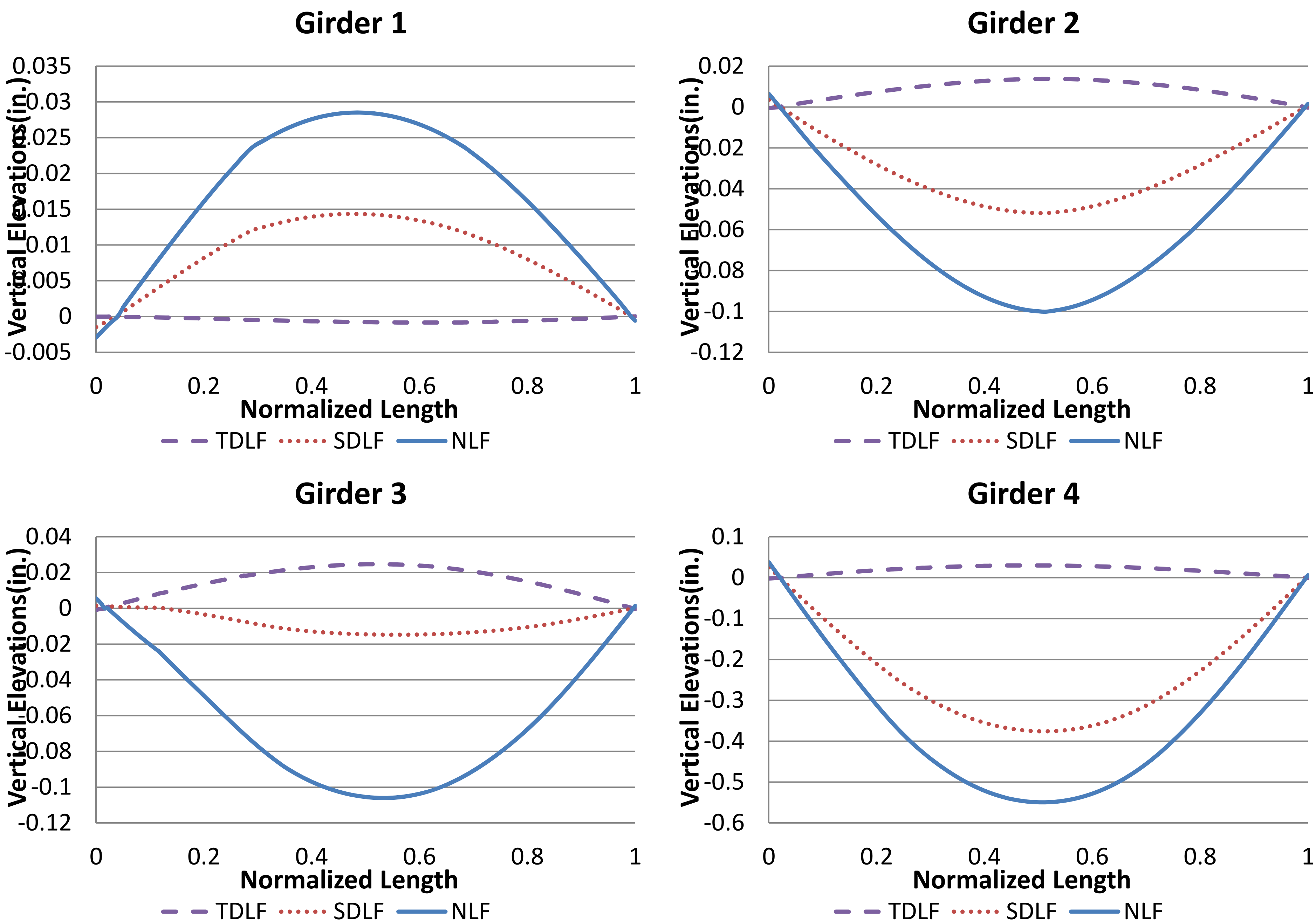
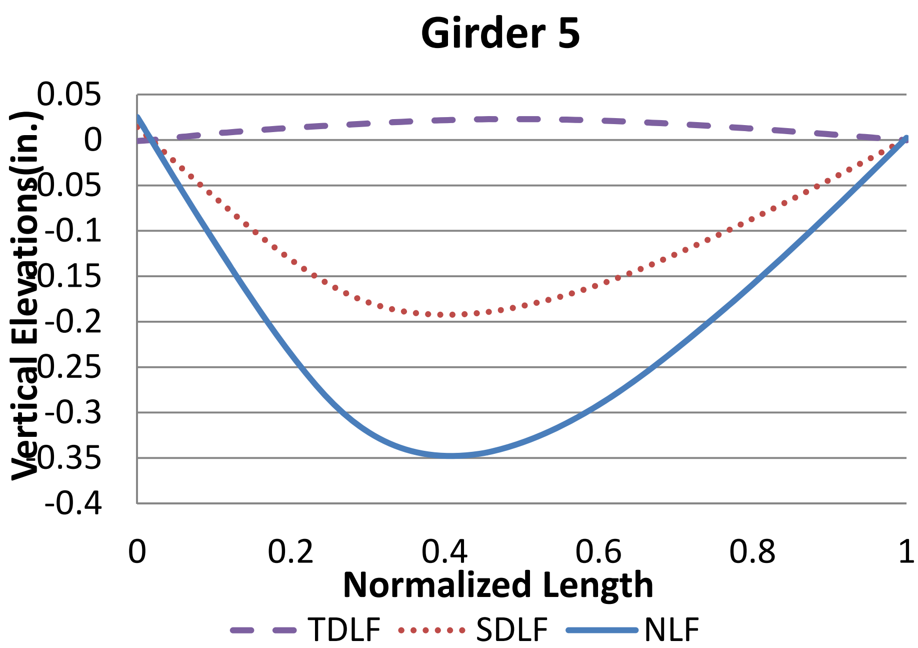
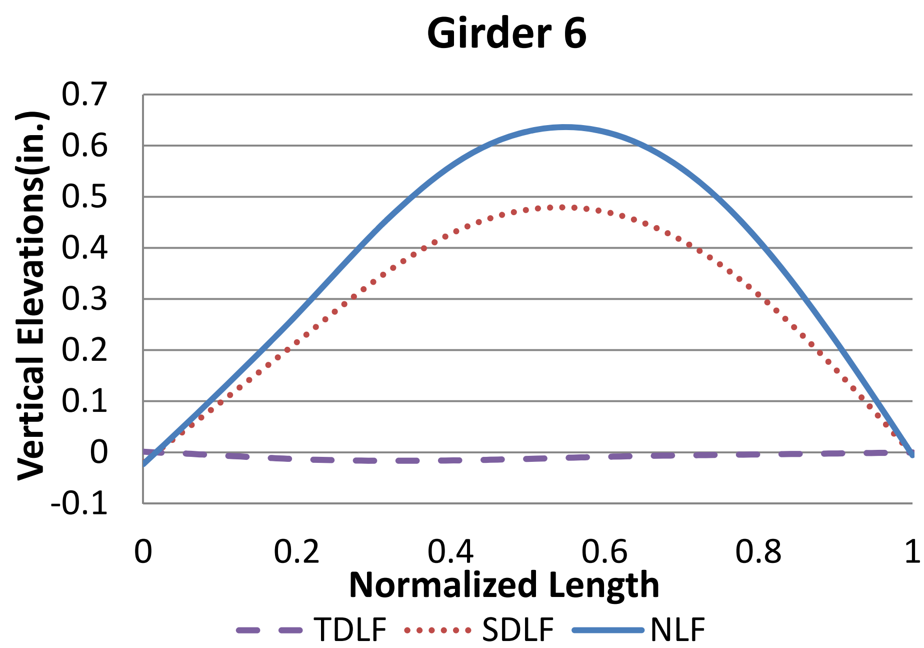


Figure H2-4-15. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.





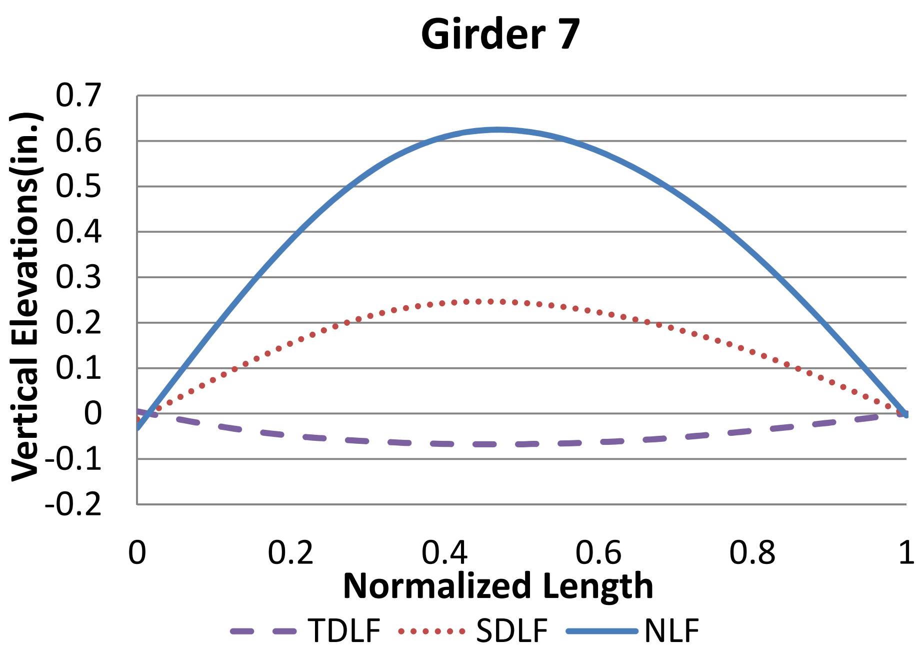


Figure H2-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

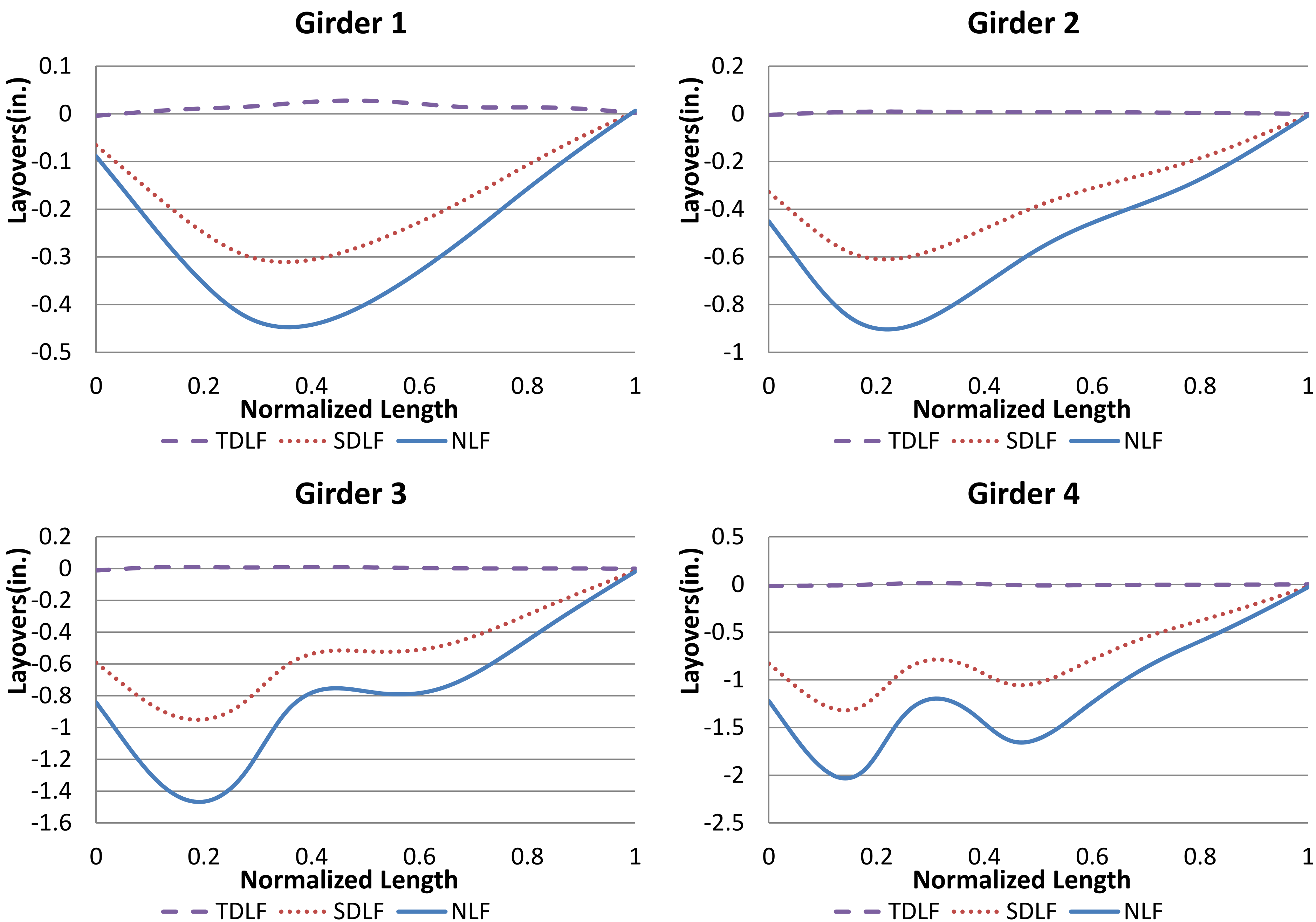


Figure H2-4-16. Comparison of individual girder layovers (in) under TDL for different detailing methods.

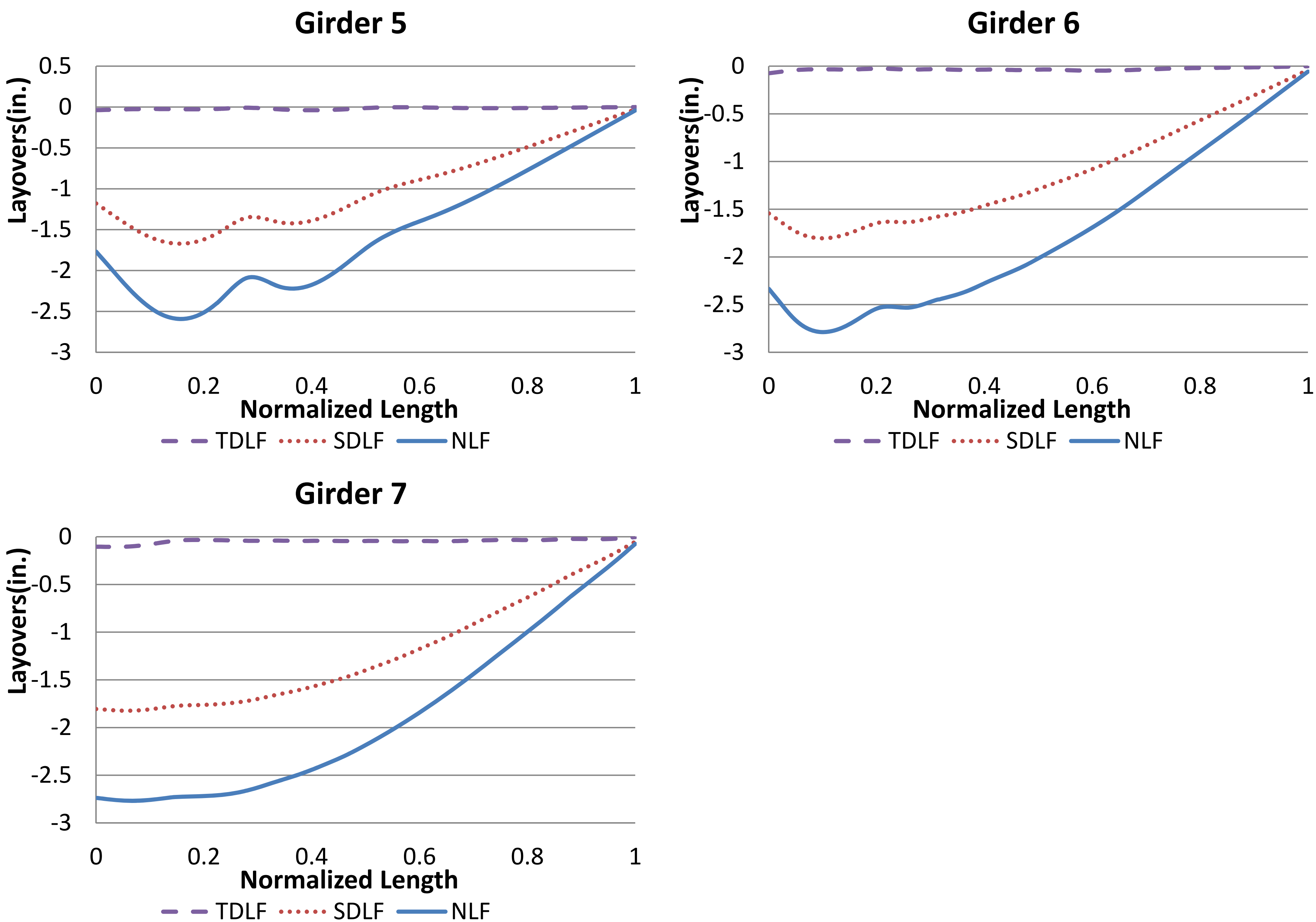


Figure H2-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

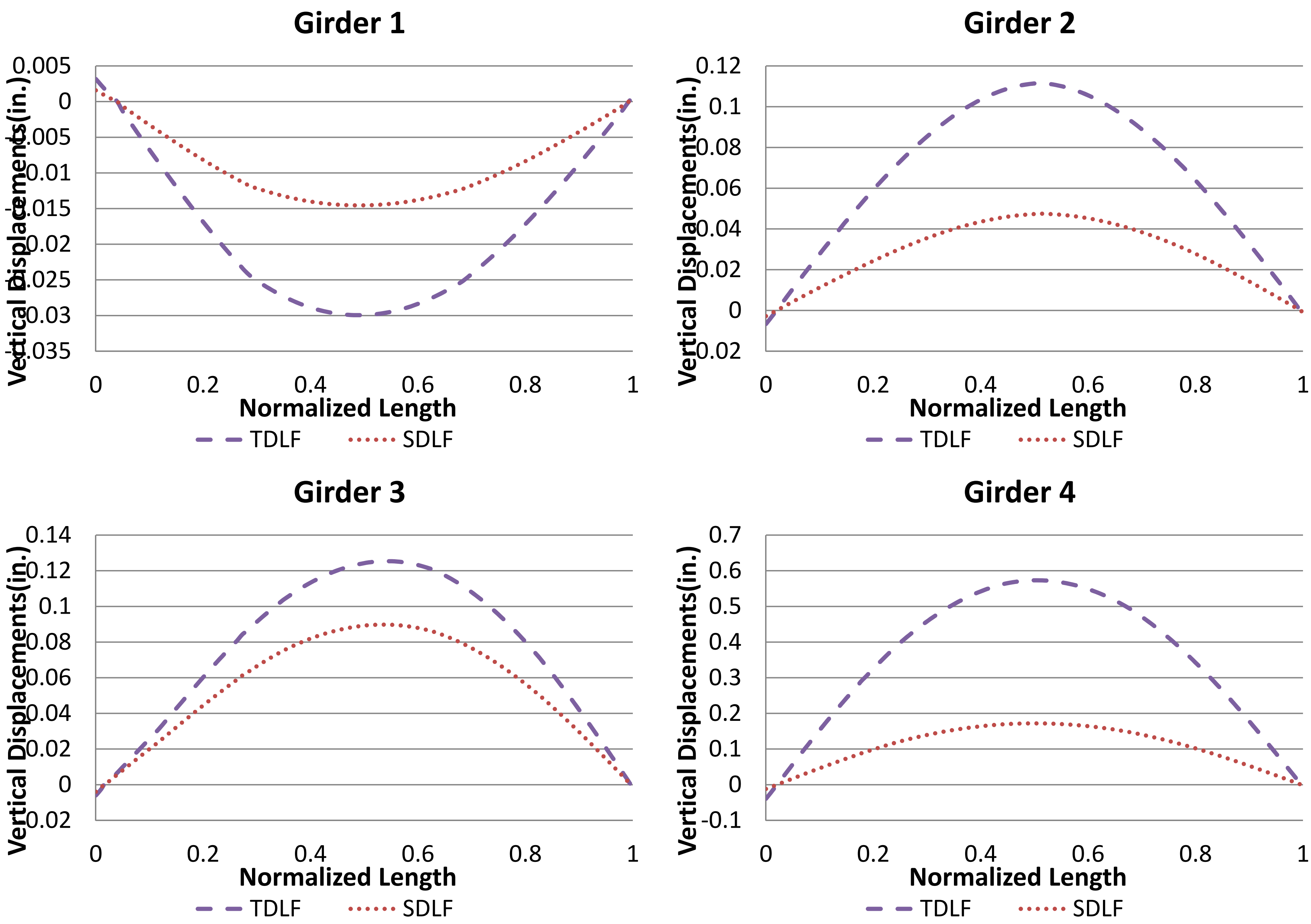


Figure H2-4-17. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

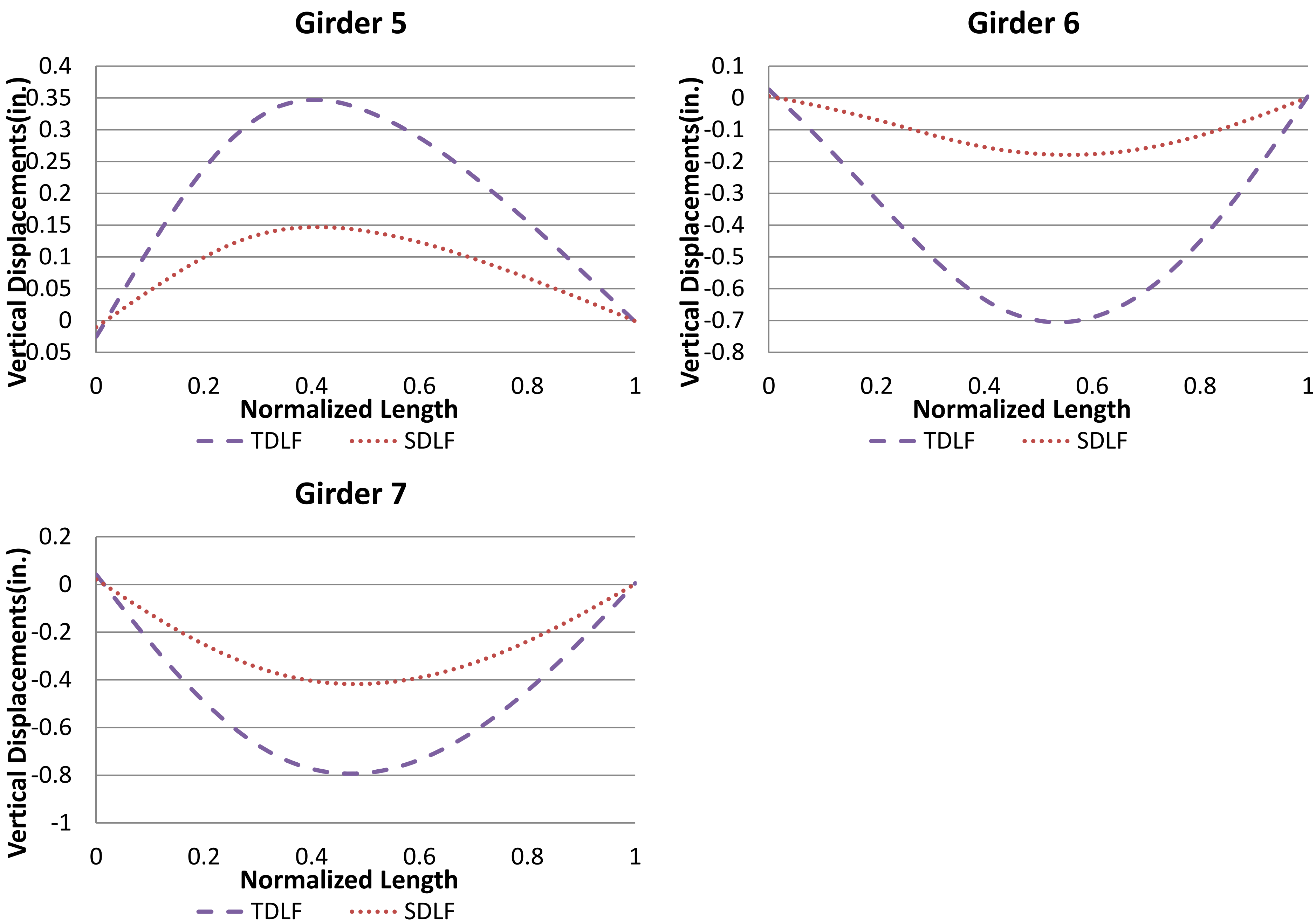


Figure H2-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

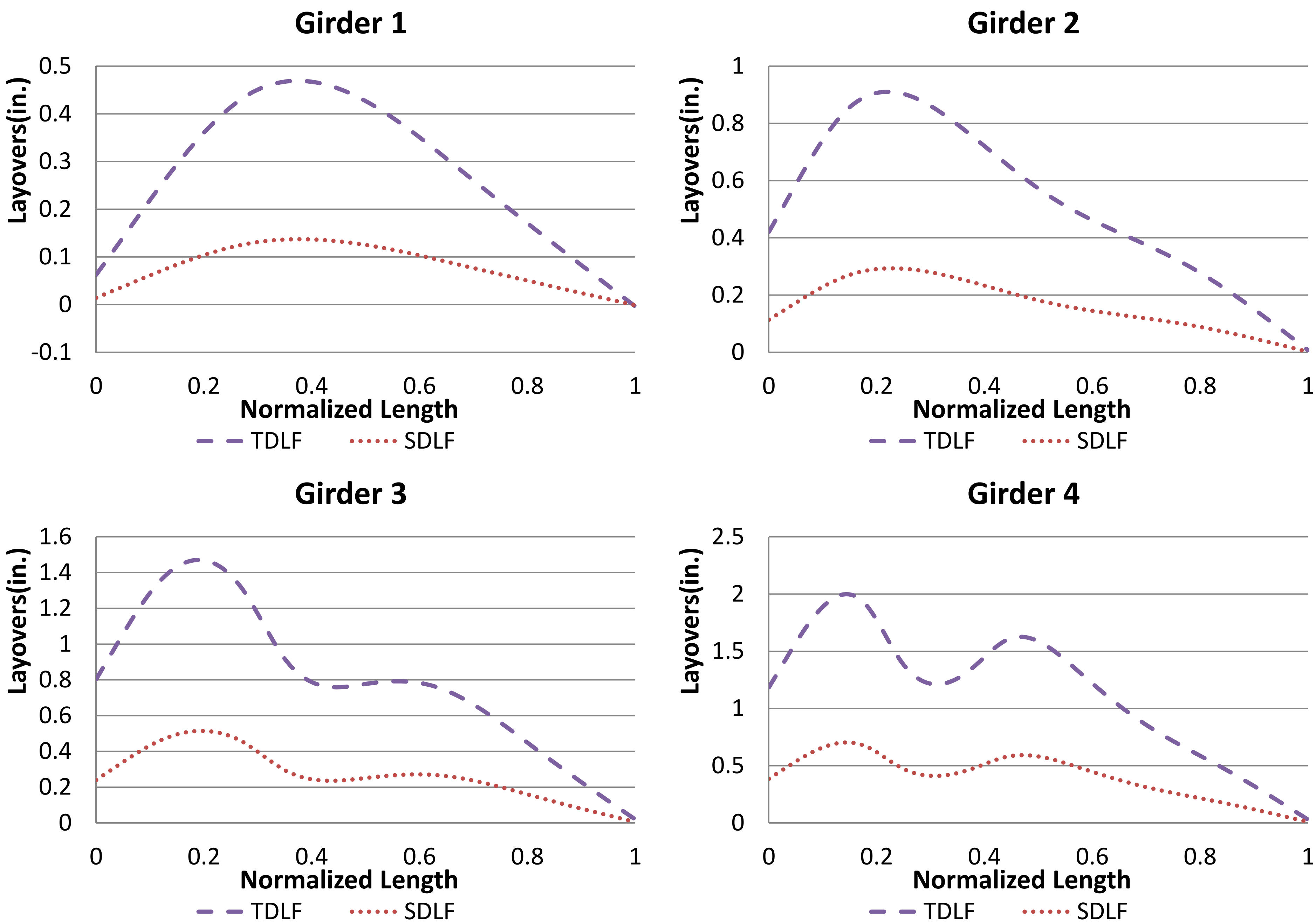


Figure H2-4-18. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

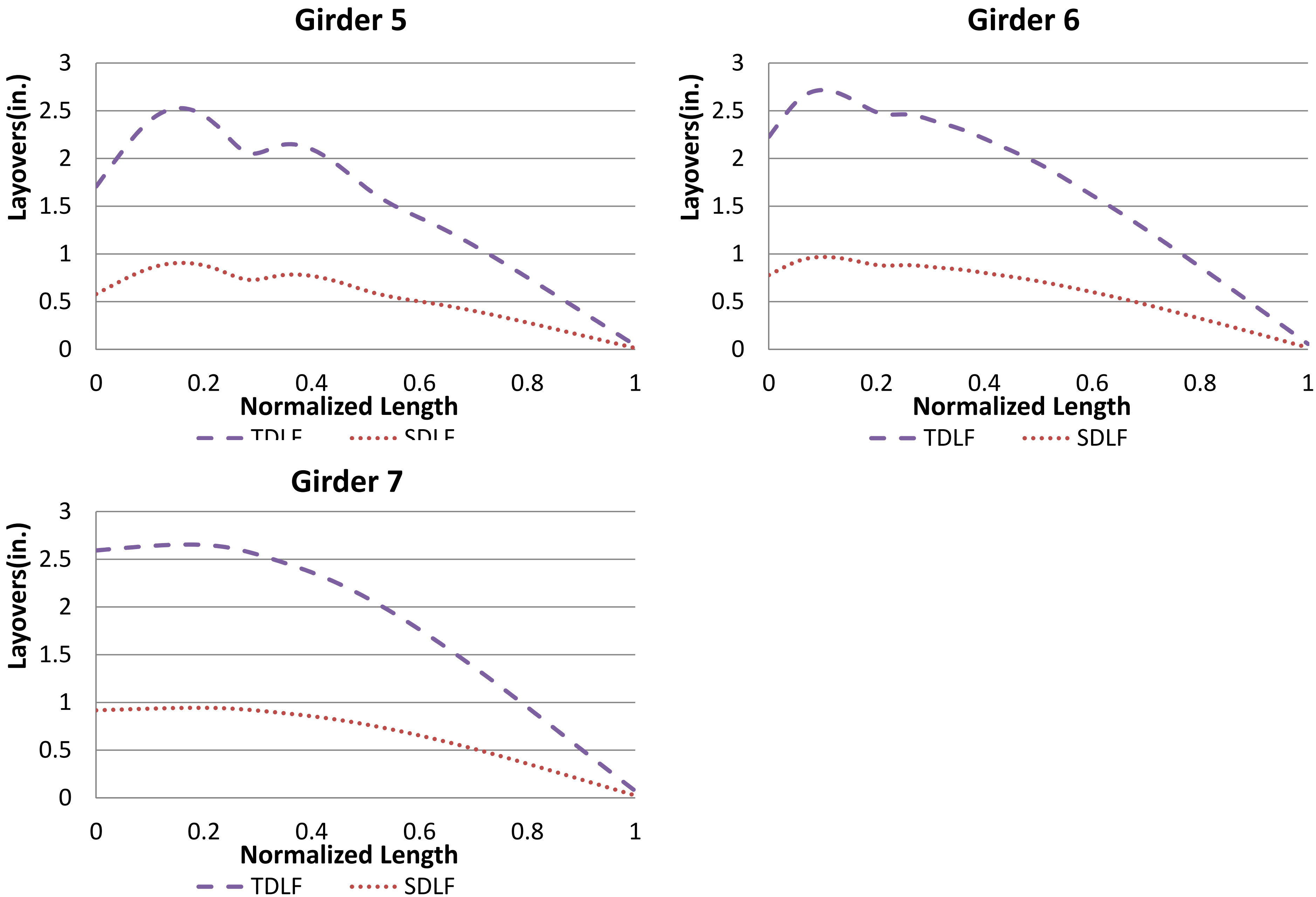


Figure H2-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

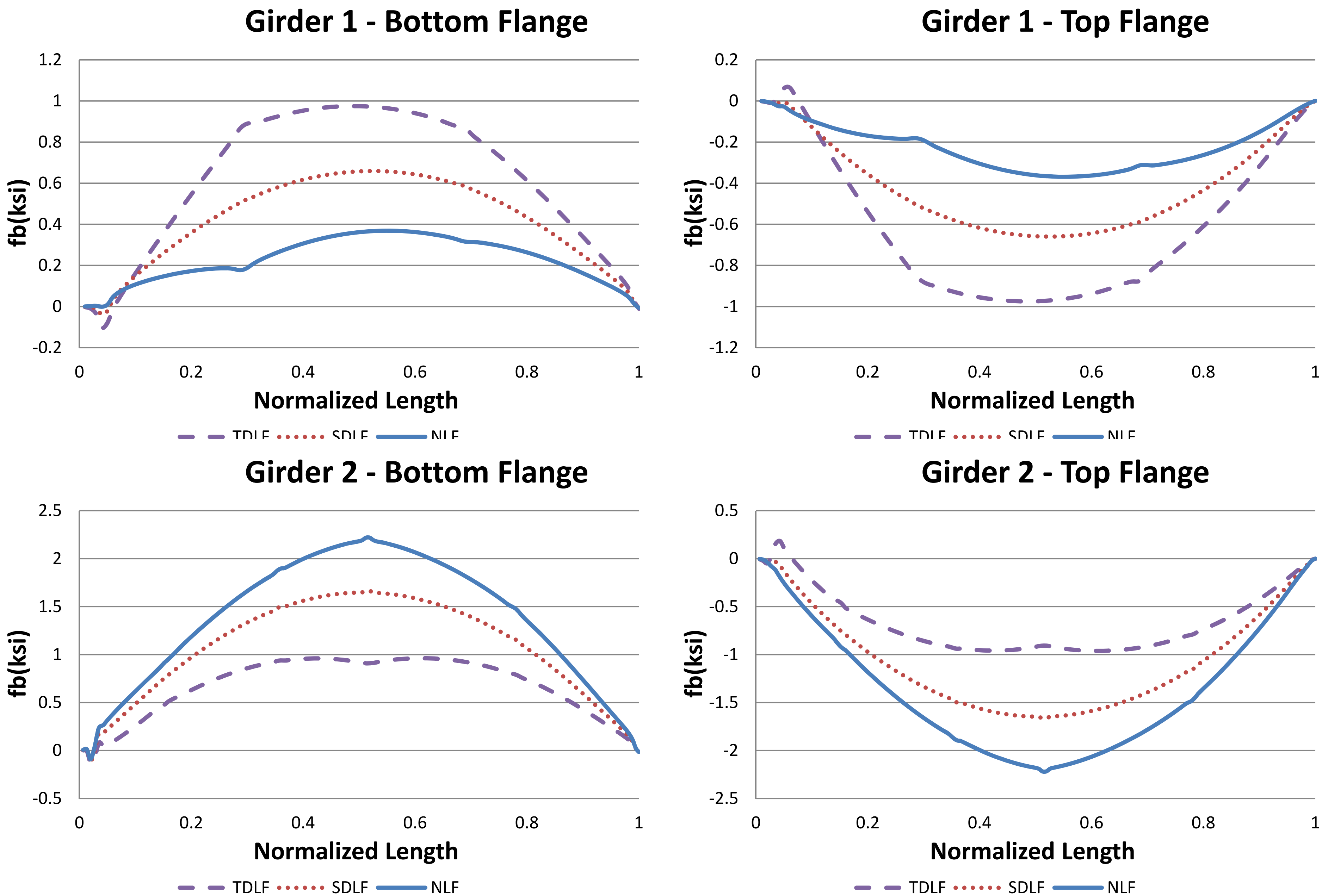


Figure H2-4-19. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

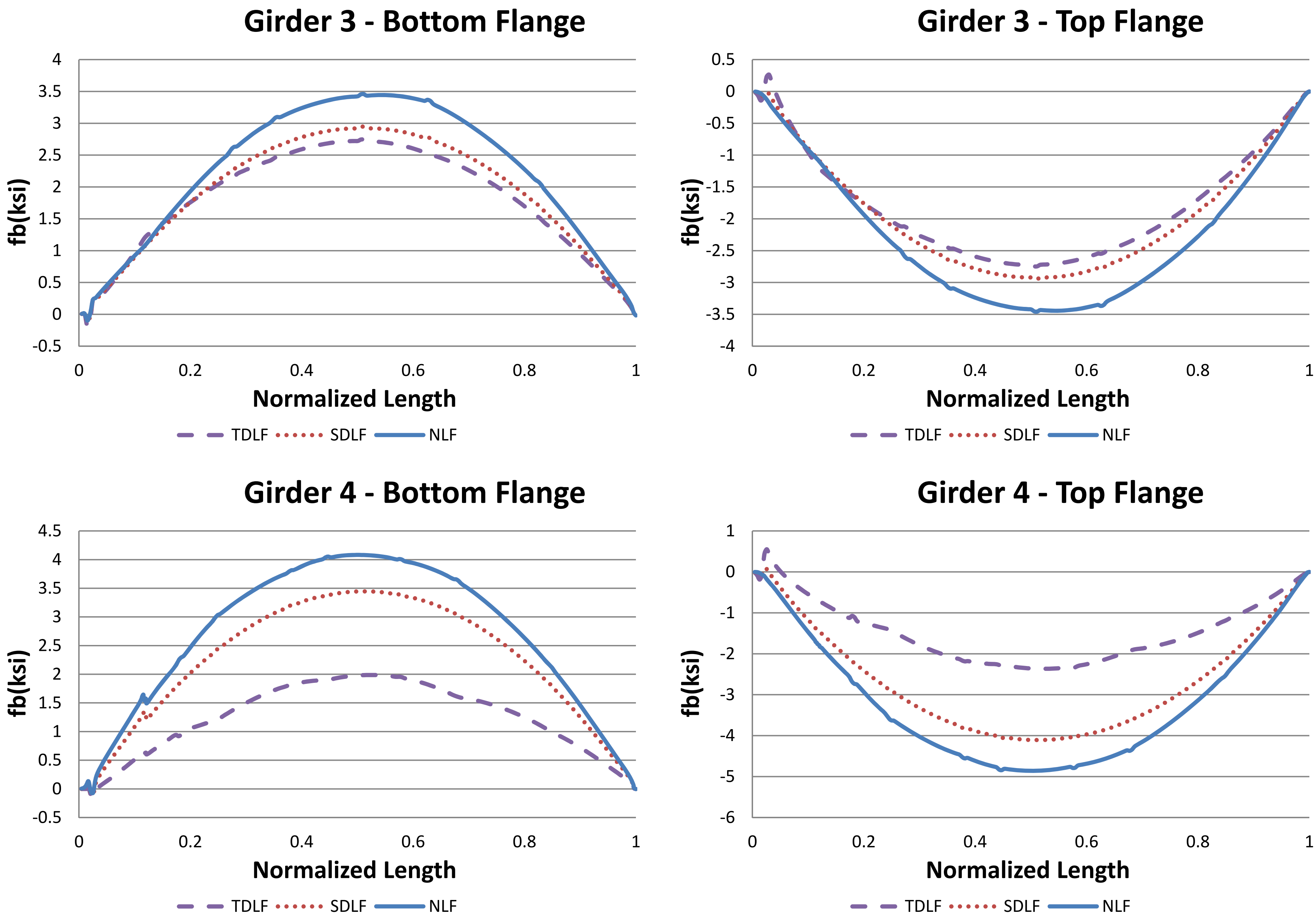


Figure H2-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

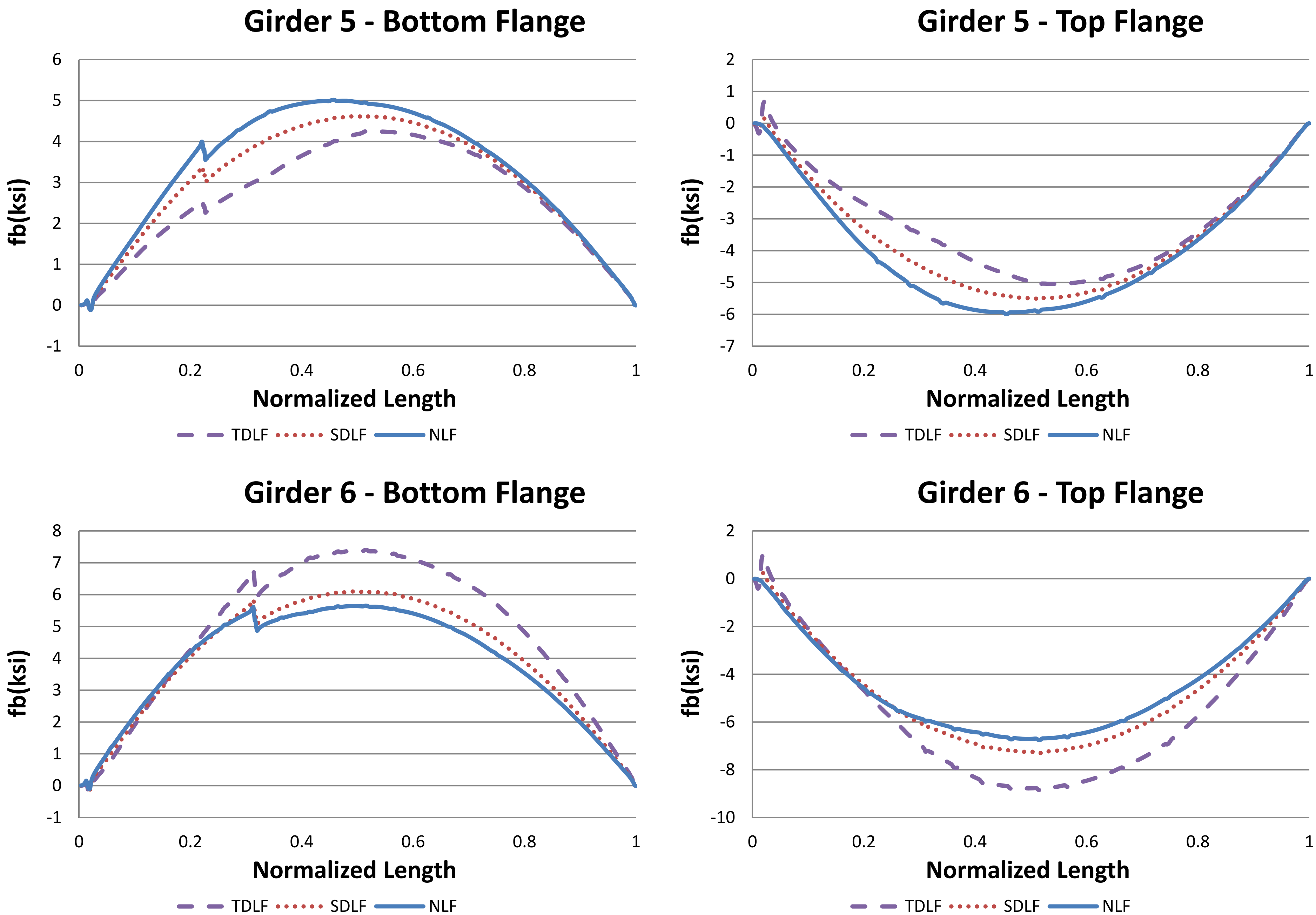


Figure H2-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

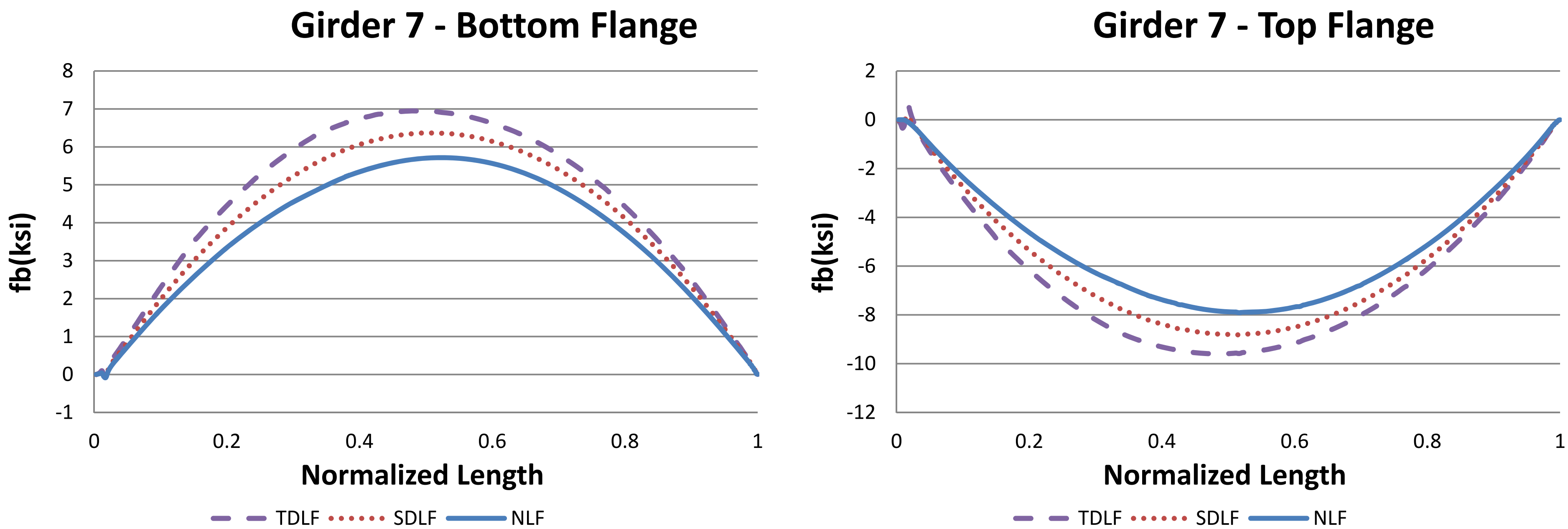


Figure H2-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

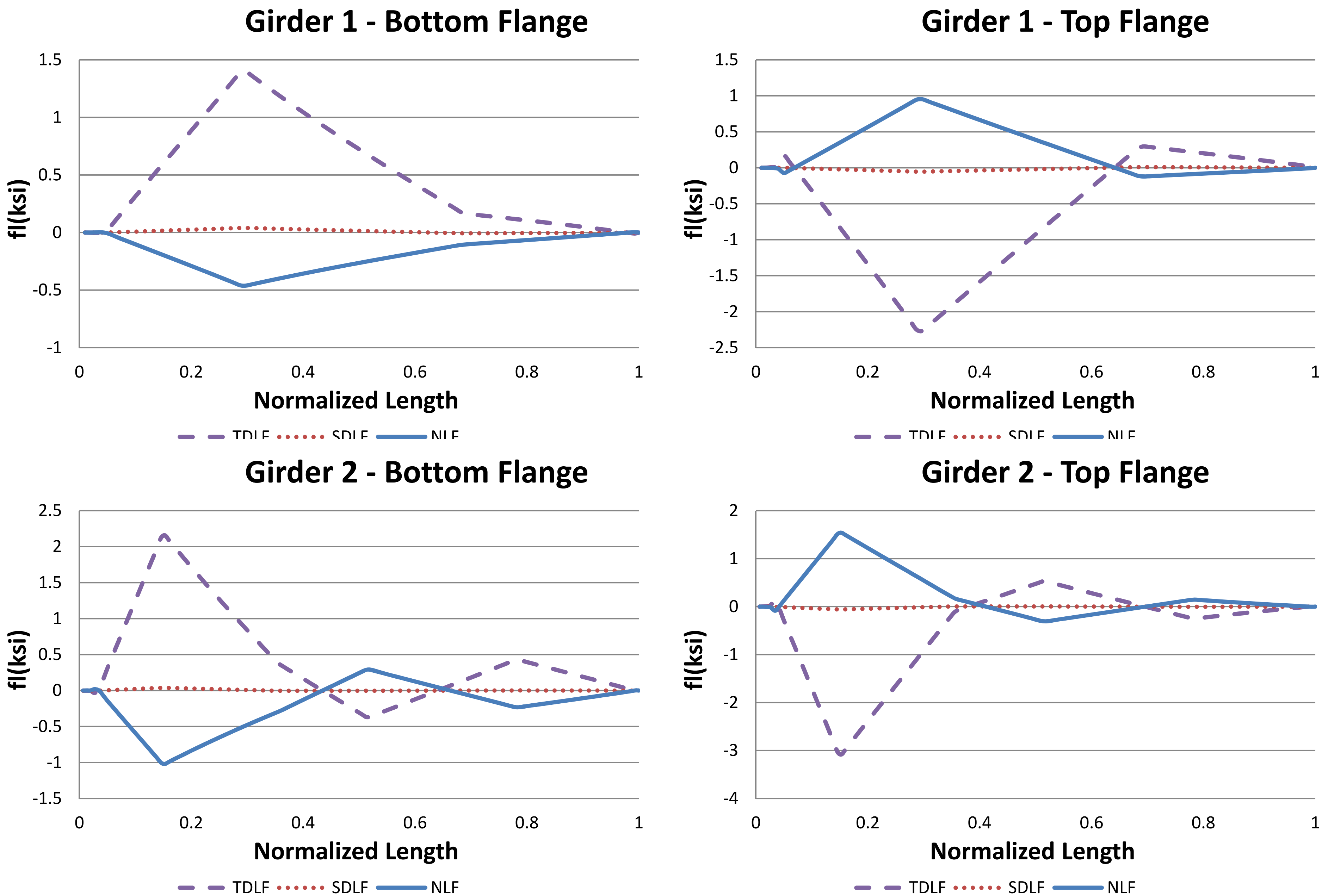


Figure H2-4-20. **Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under SDL for different detailing methods.**

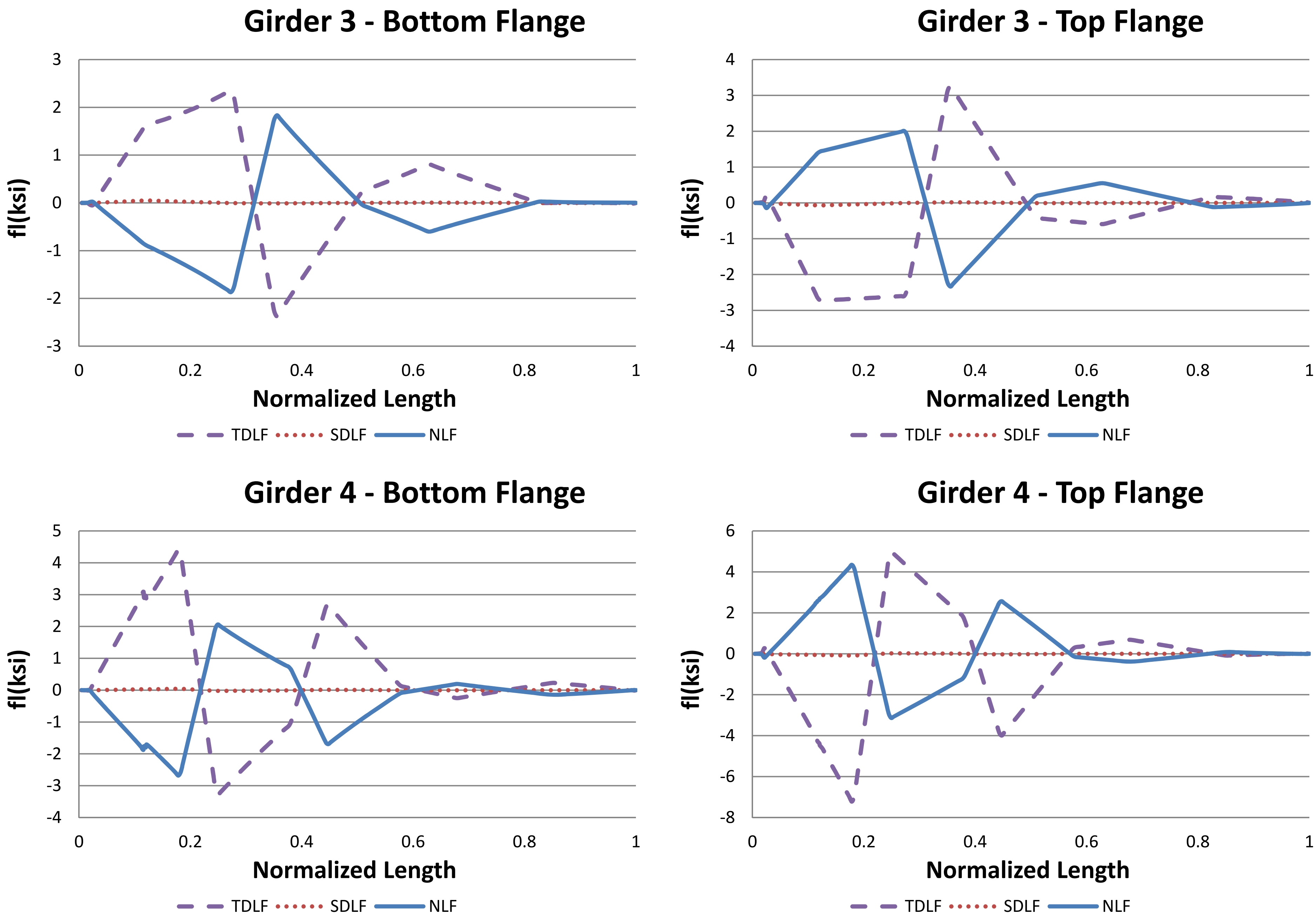


Figure H2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

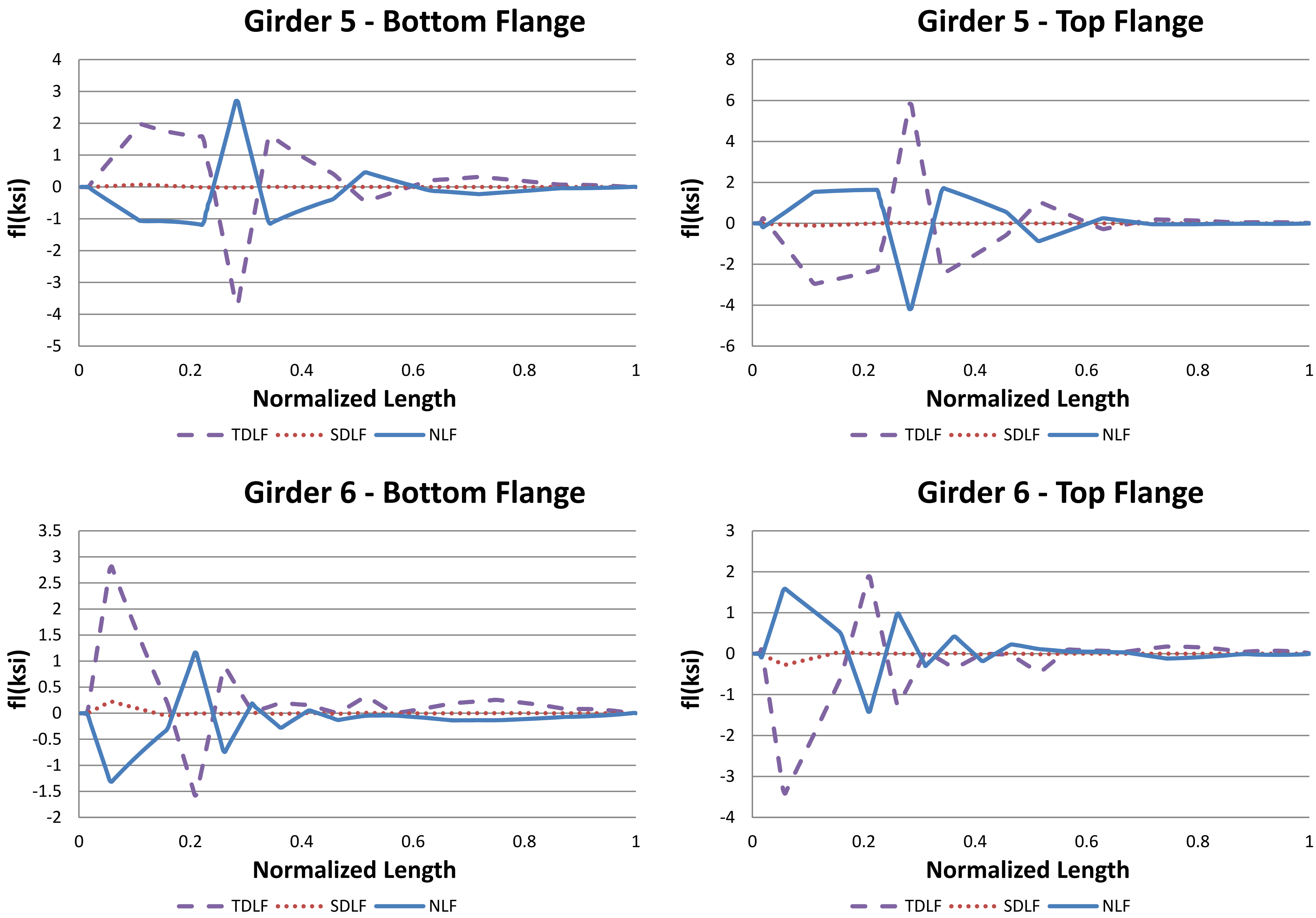


Figure H2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

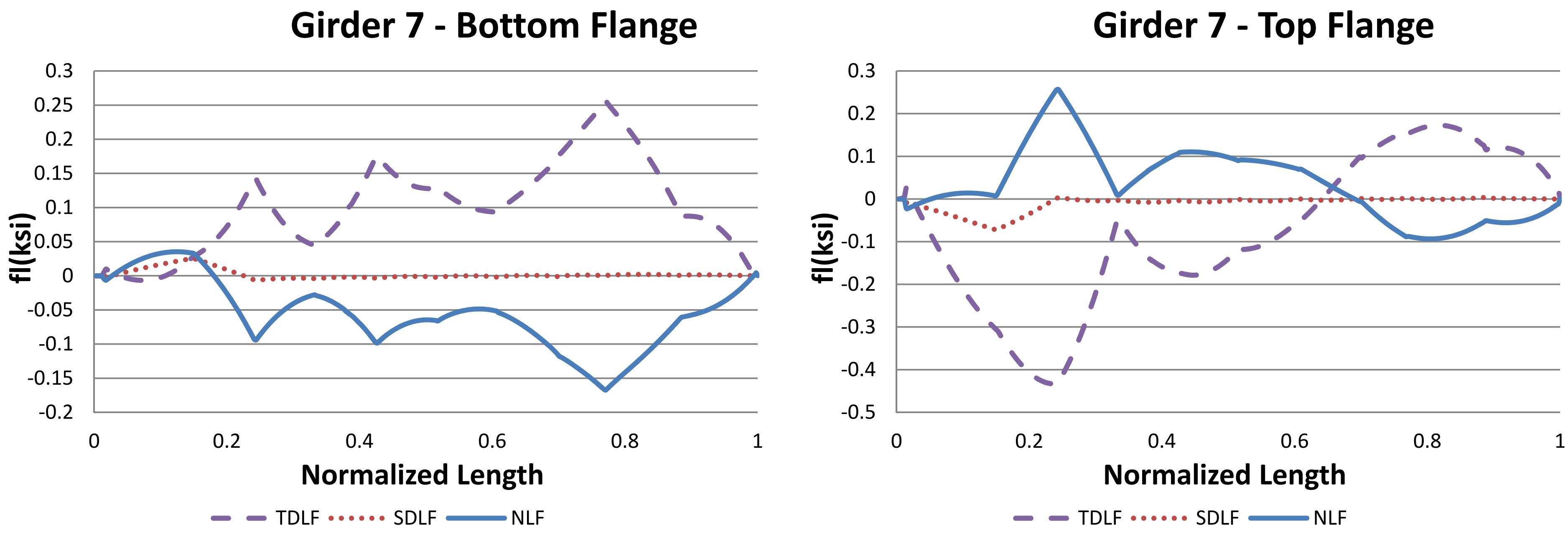


Figure H2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

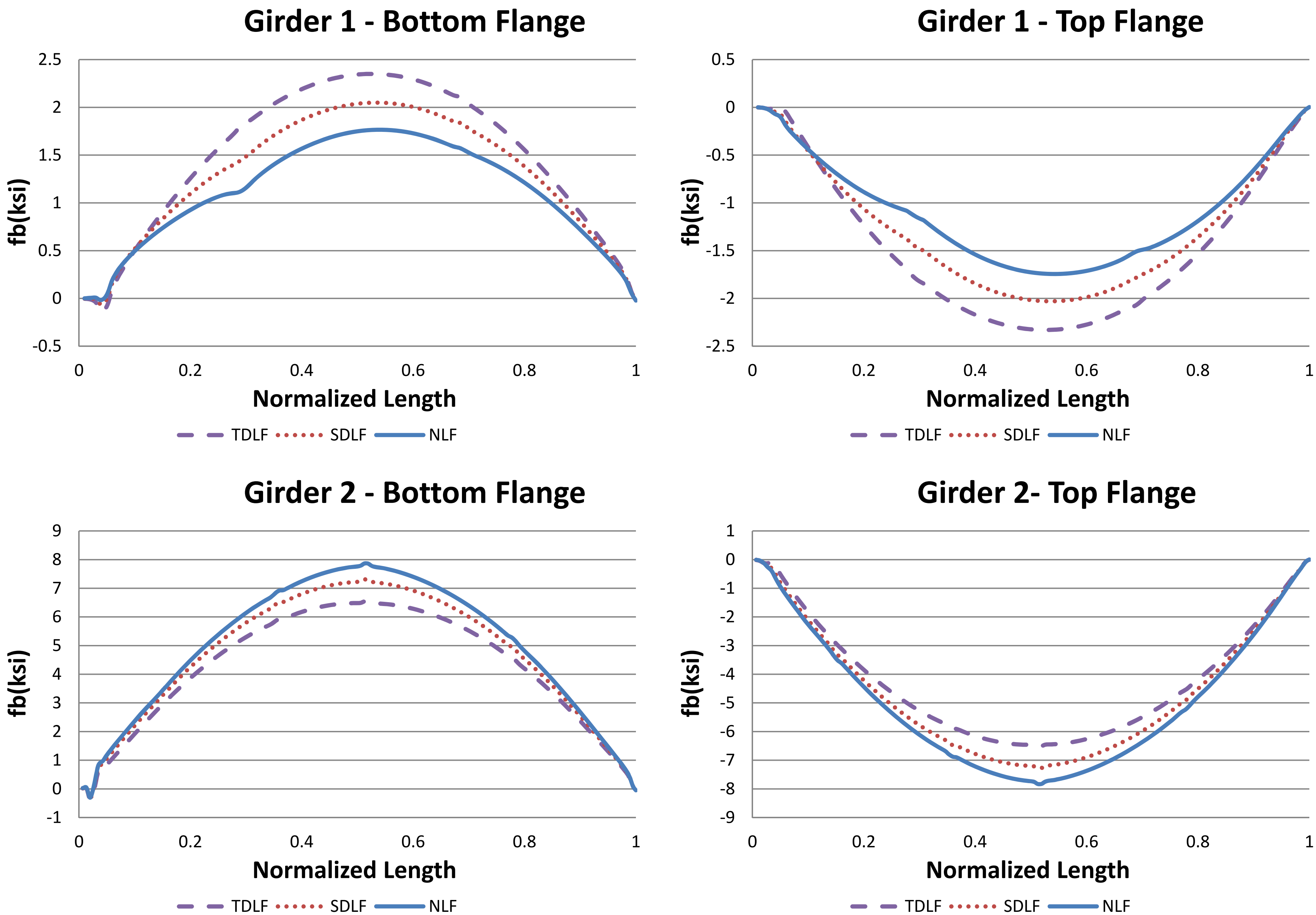


Figure H2-4-21. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

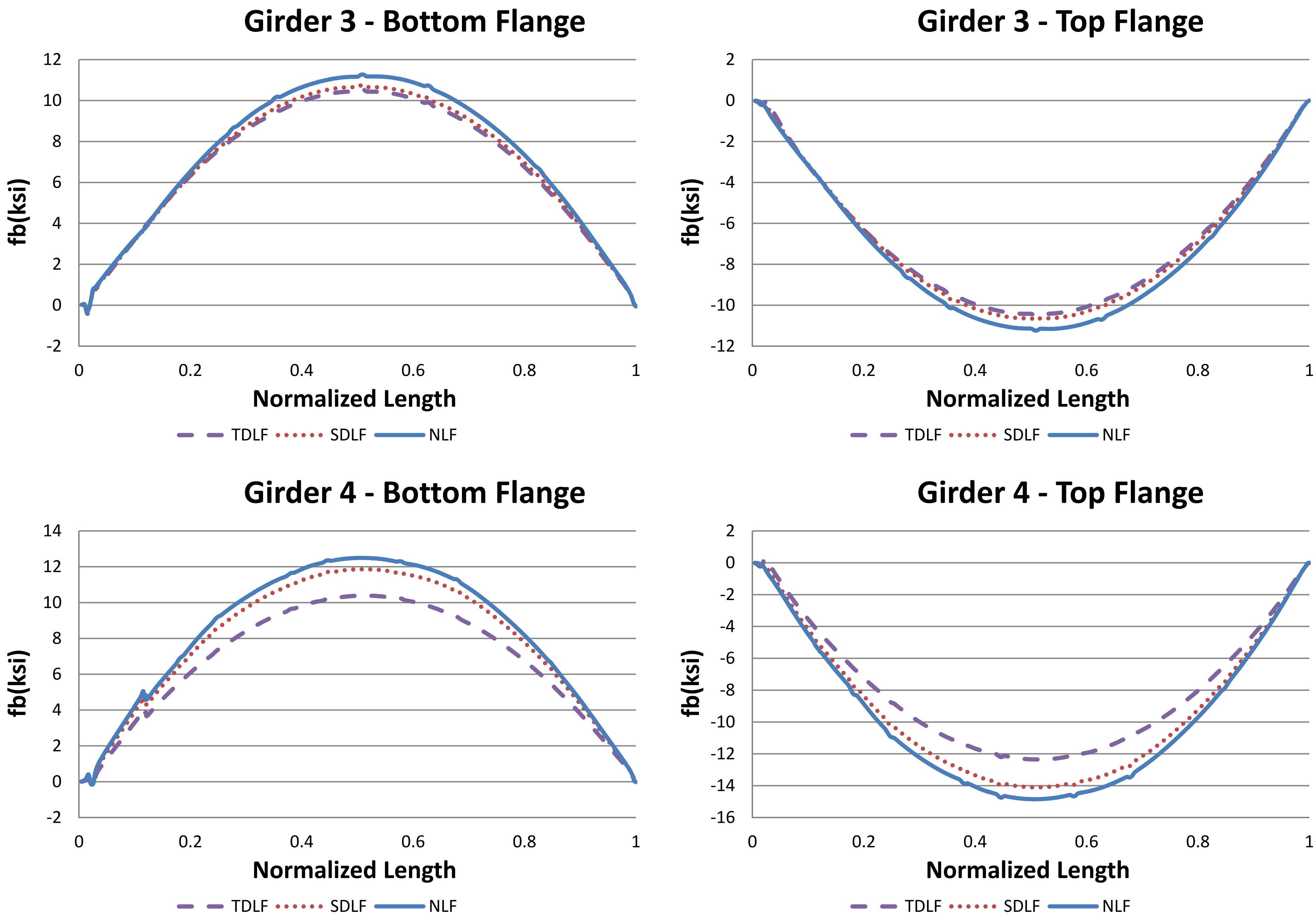


Figure H2-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

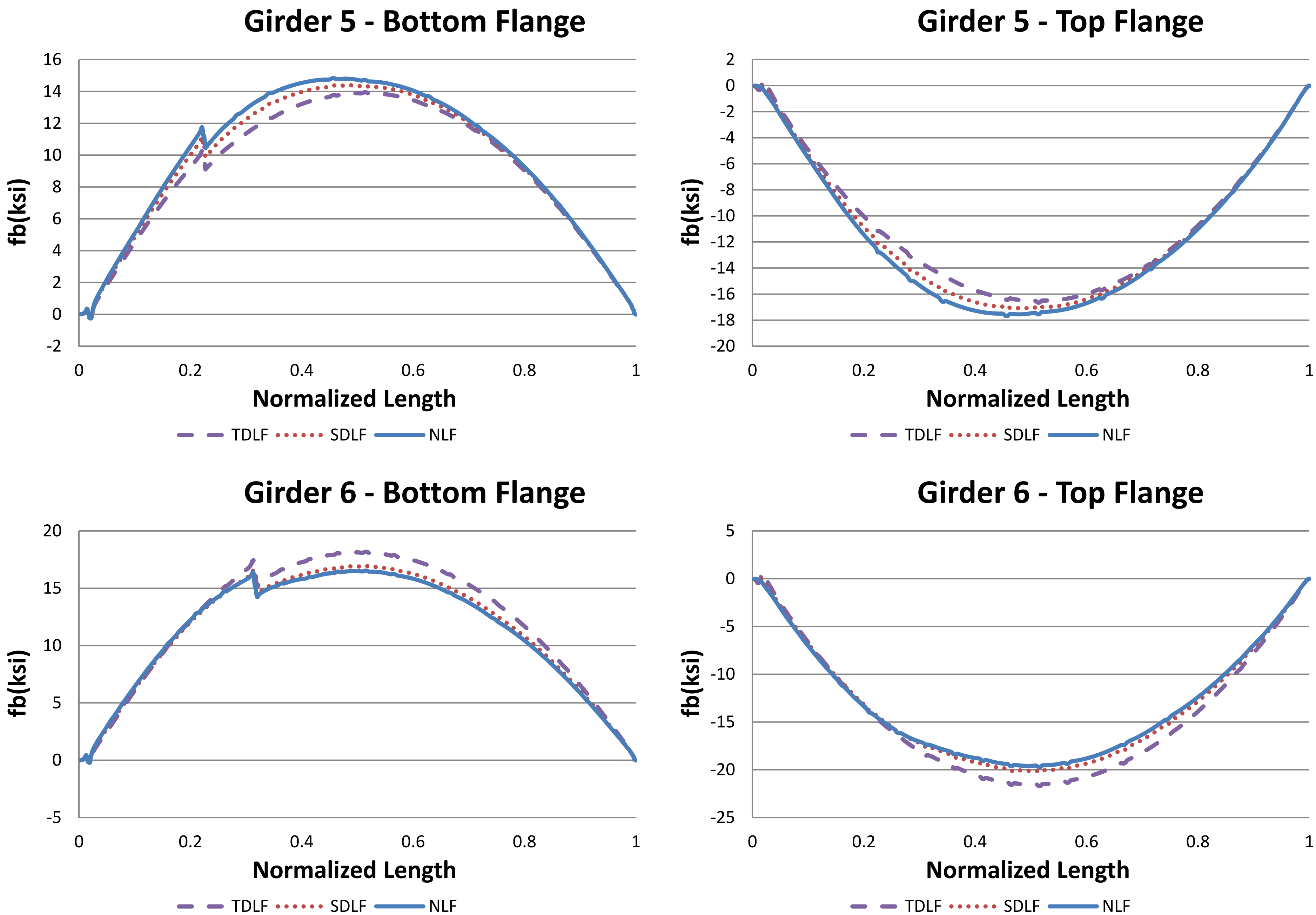


Figure H2-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

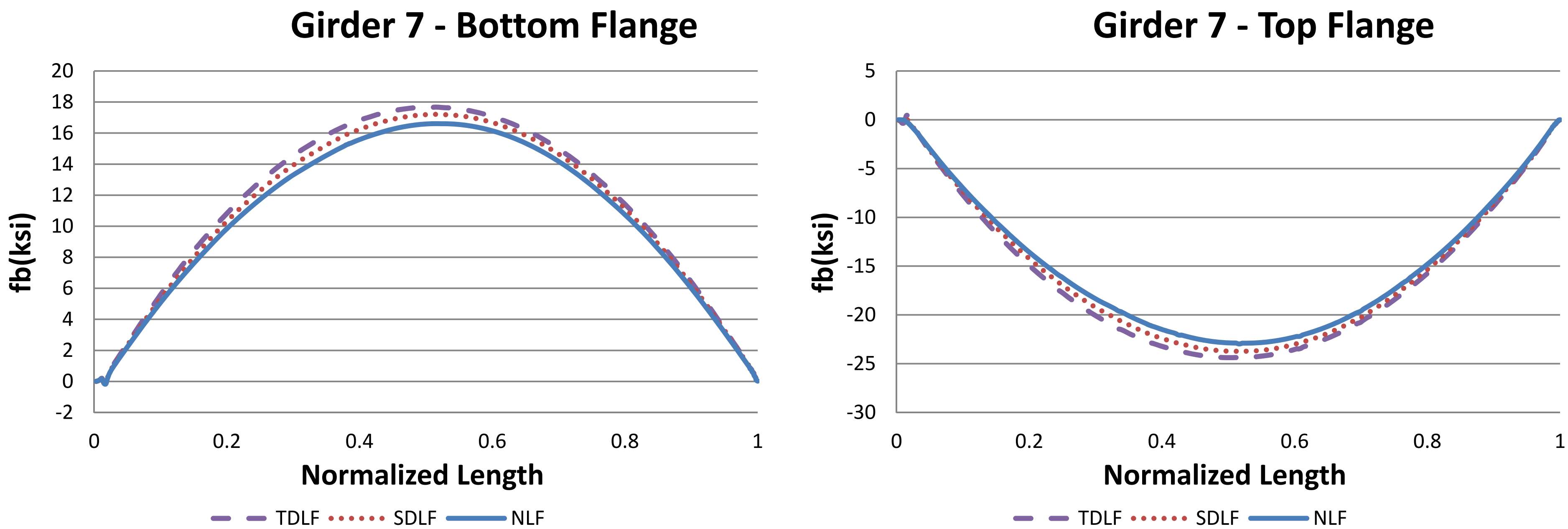


Figure H2-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

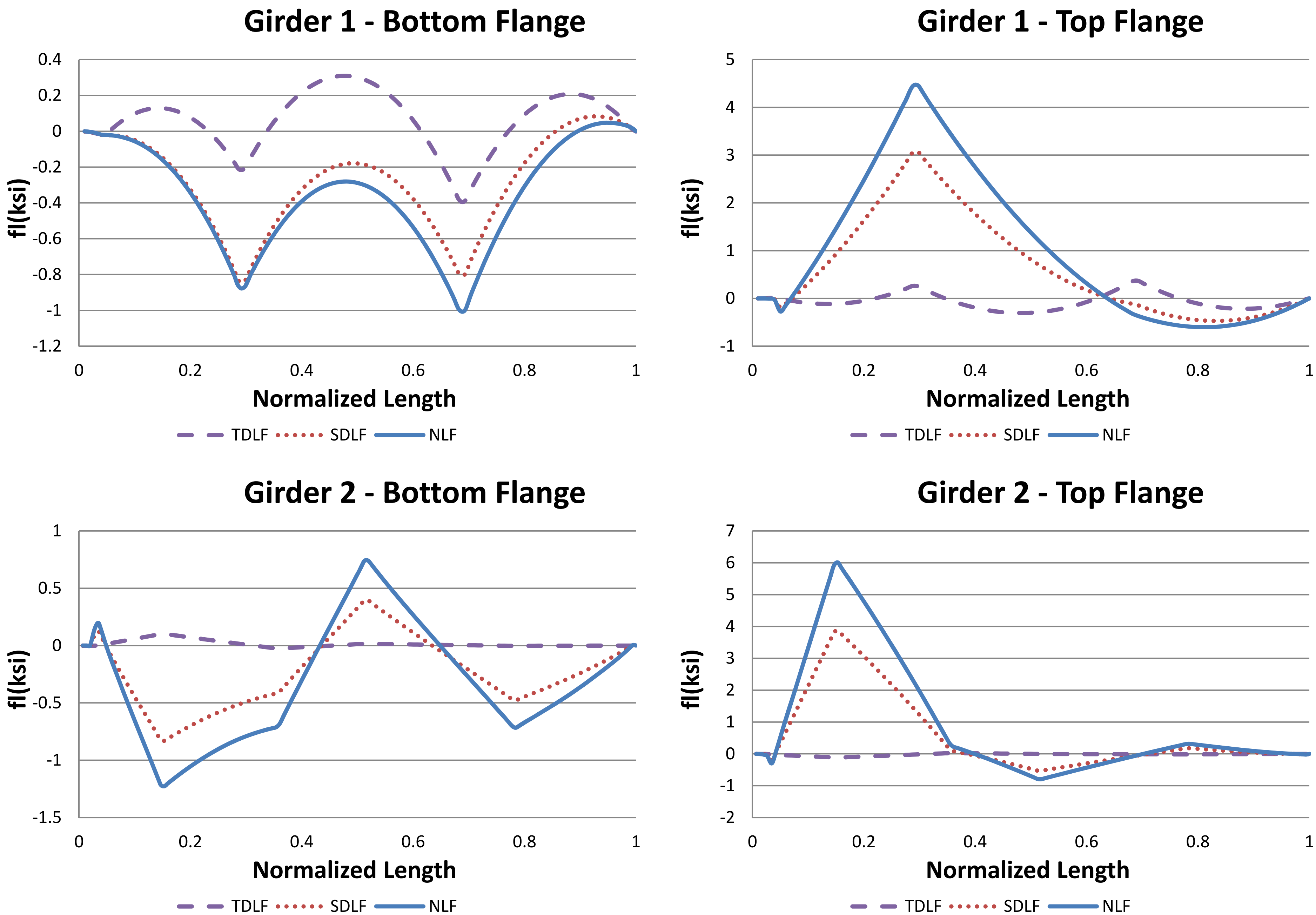


Figure H2-4-22. **Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.**

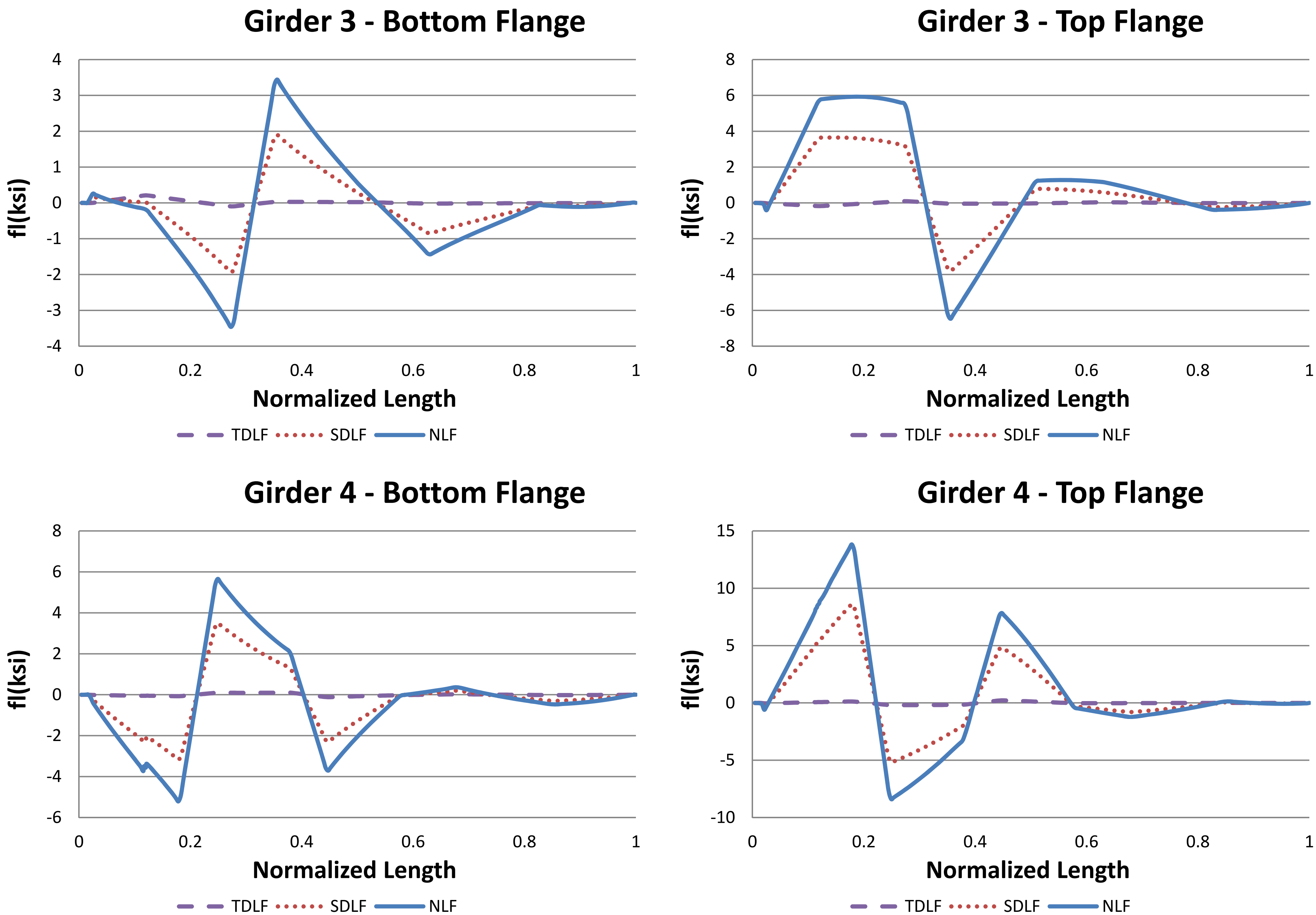


Figure H2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

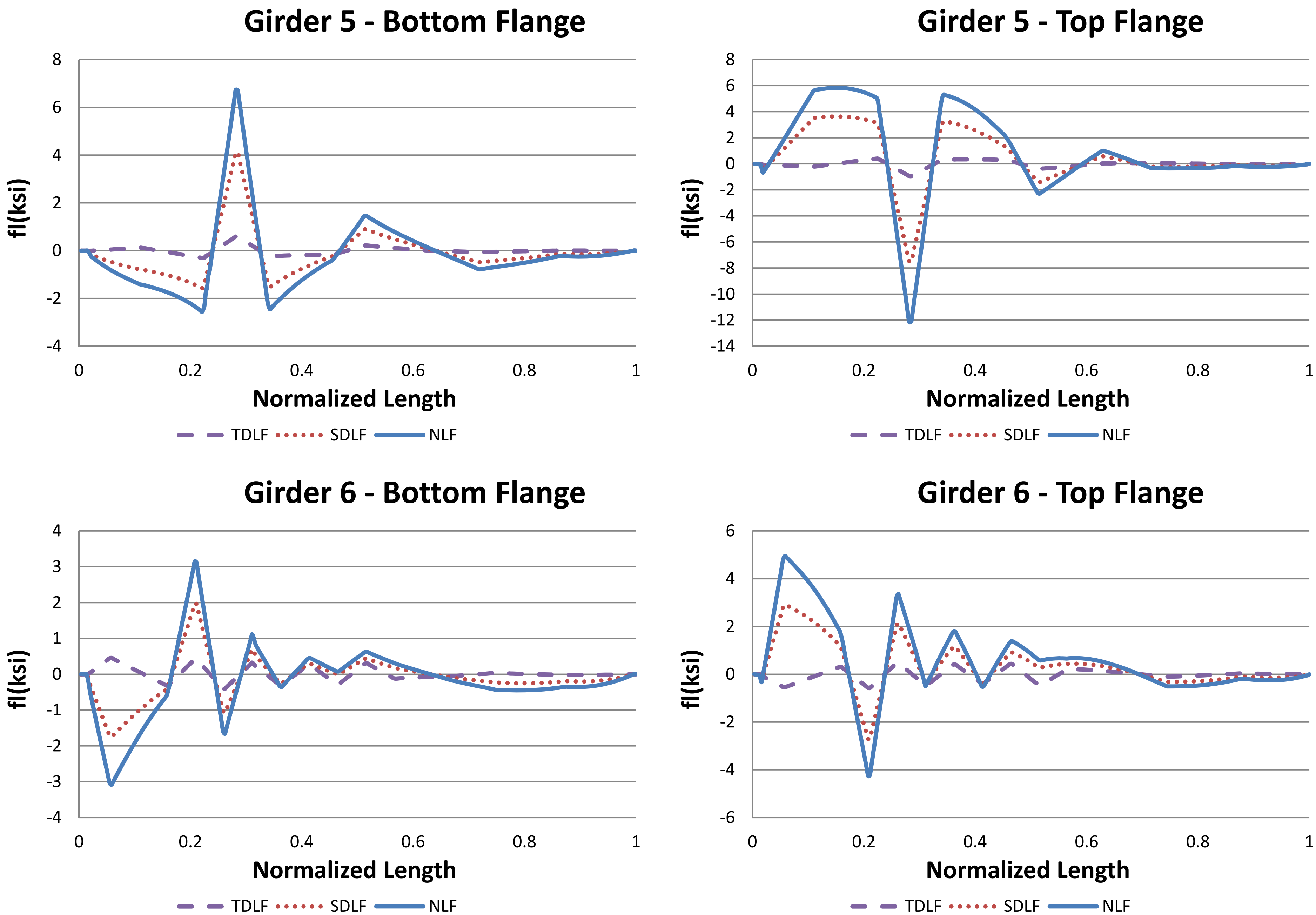


Figure H2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

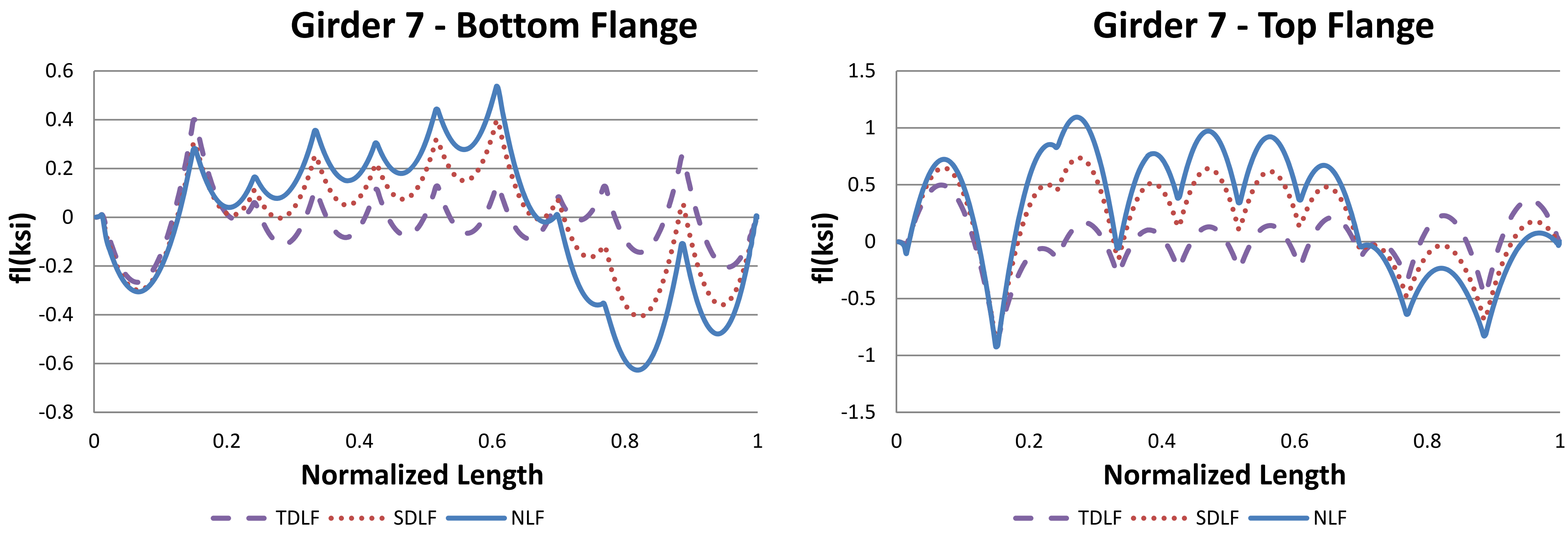


Figure H2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

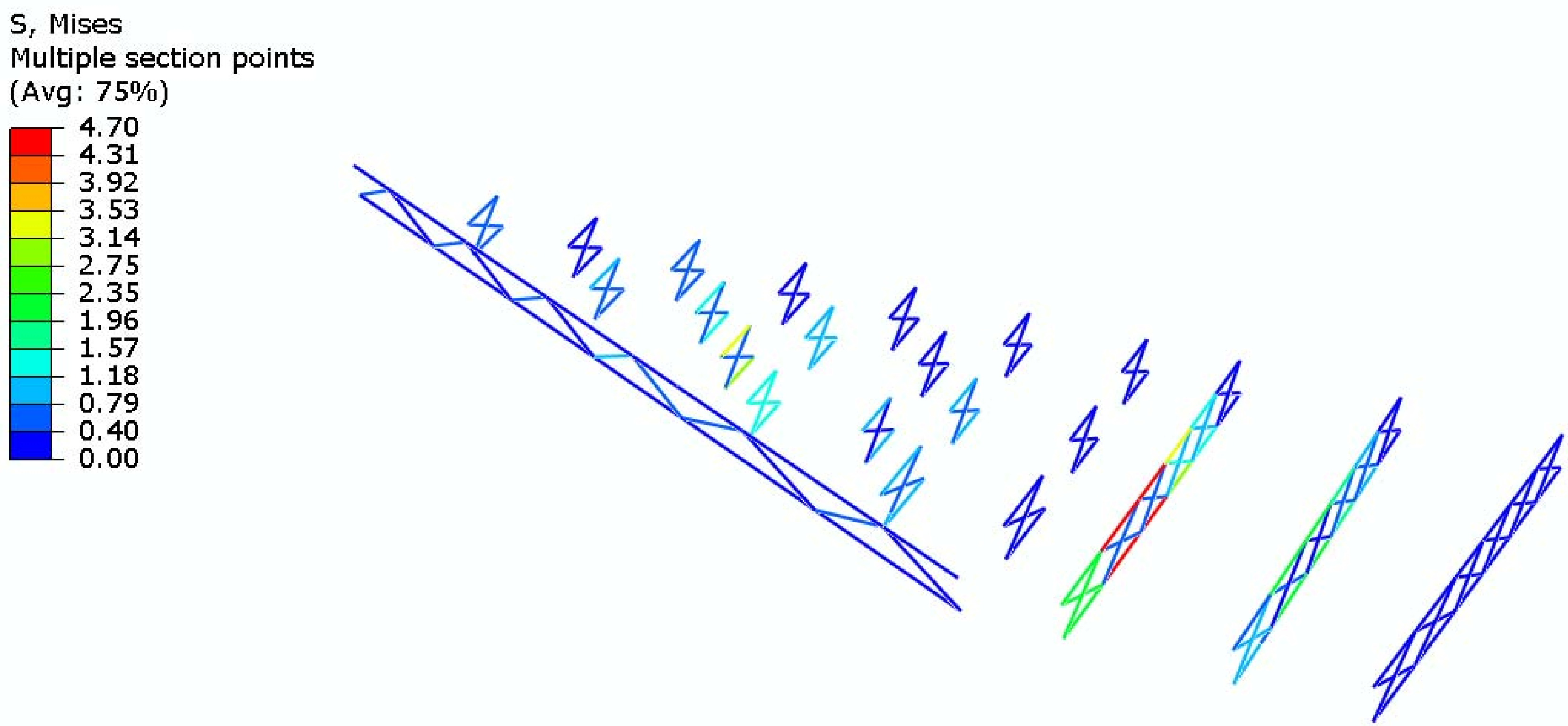


Figure H2-4-23. Cross-frame stress contours (ksi) under SDL, NLF detailing .

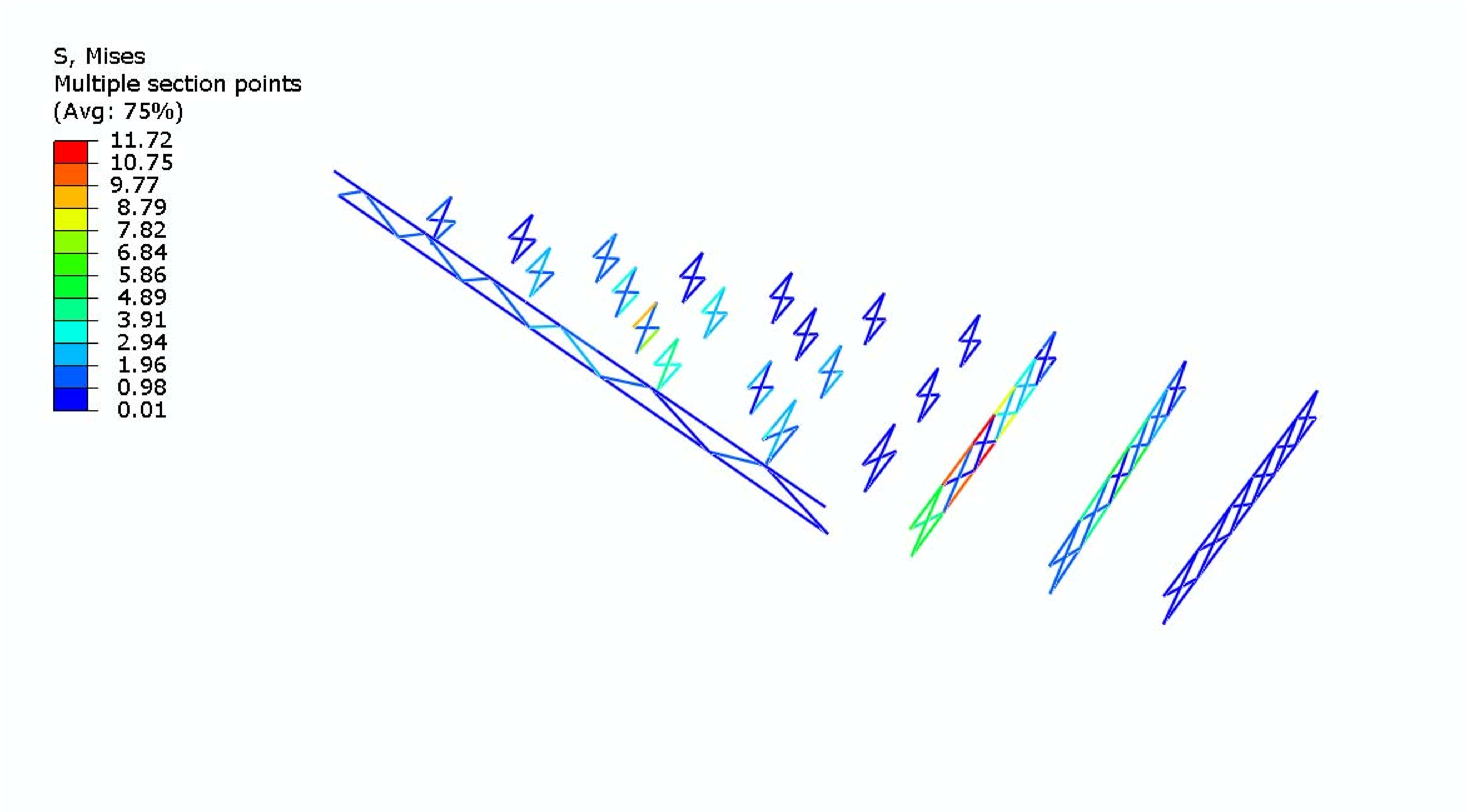


Figure H2-4-24. Cross-frame stress contours under TDL, NLF detailing .

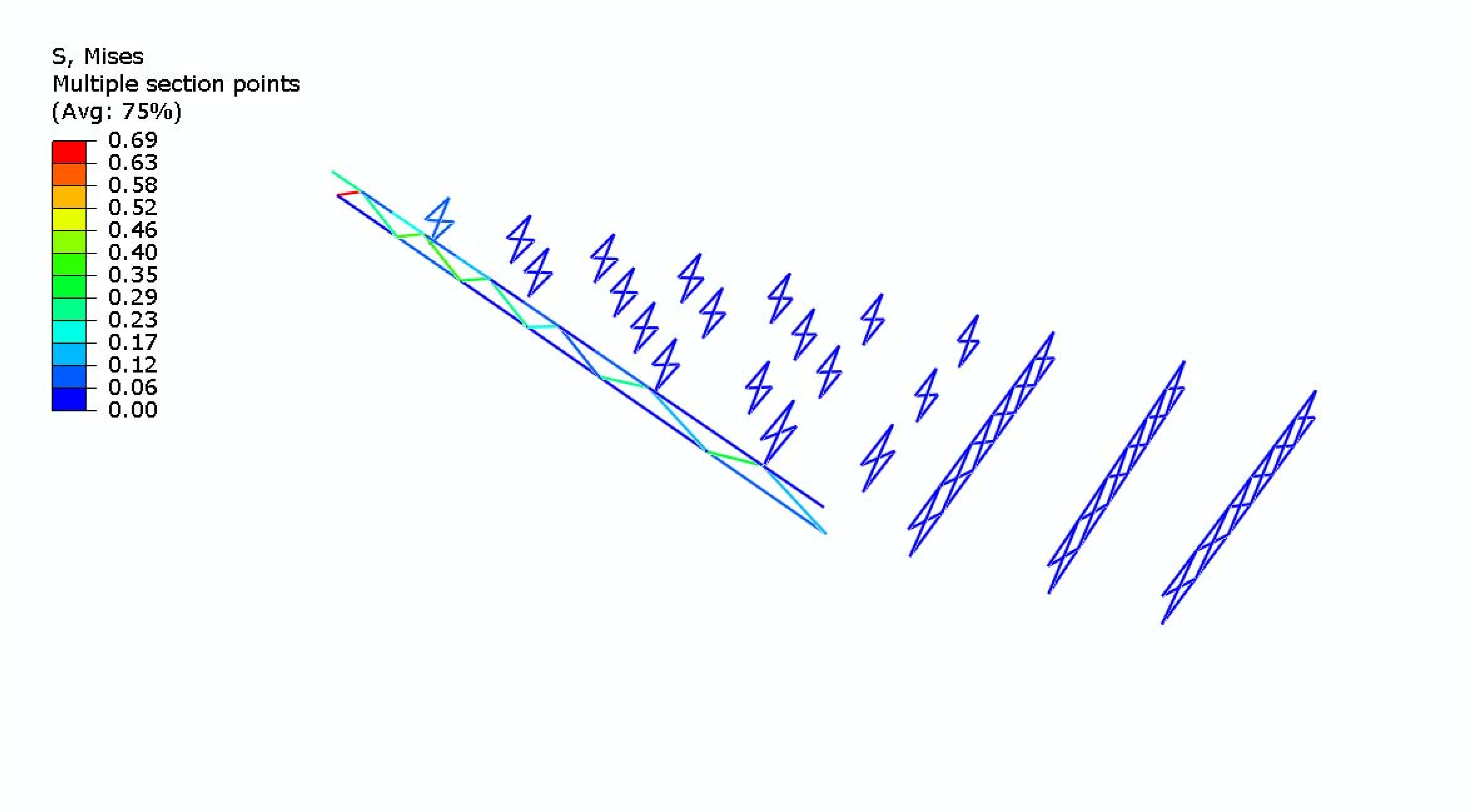


Figure H2-4-25. **Cross-frame stress contours under SDL, SDLF detailing .**

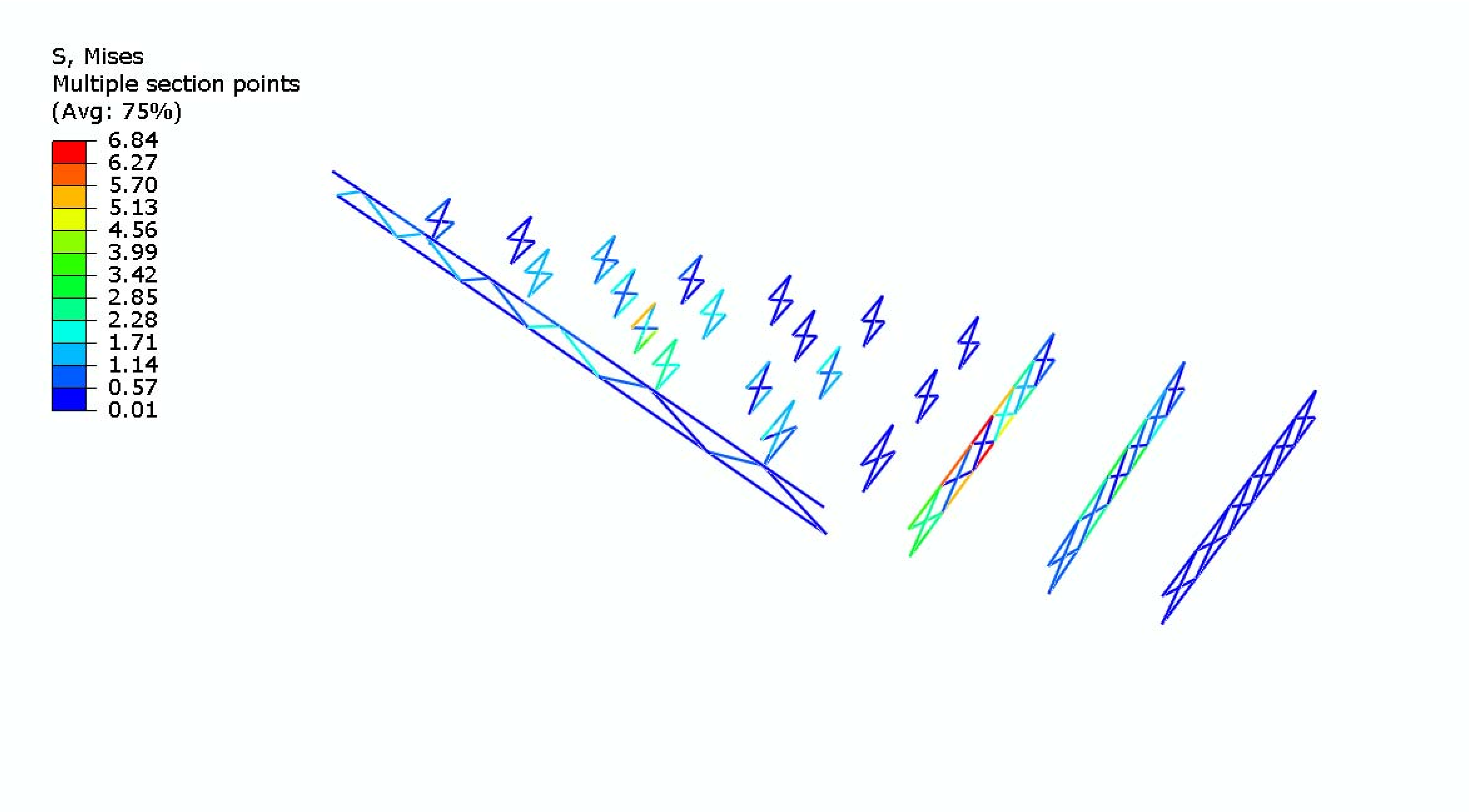


Figure H2-4-26. Cross-frame stress contours under TDL, SDLF detailing .

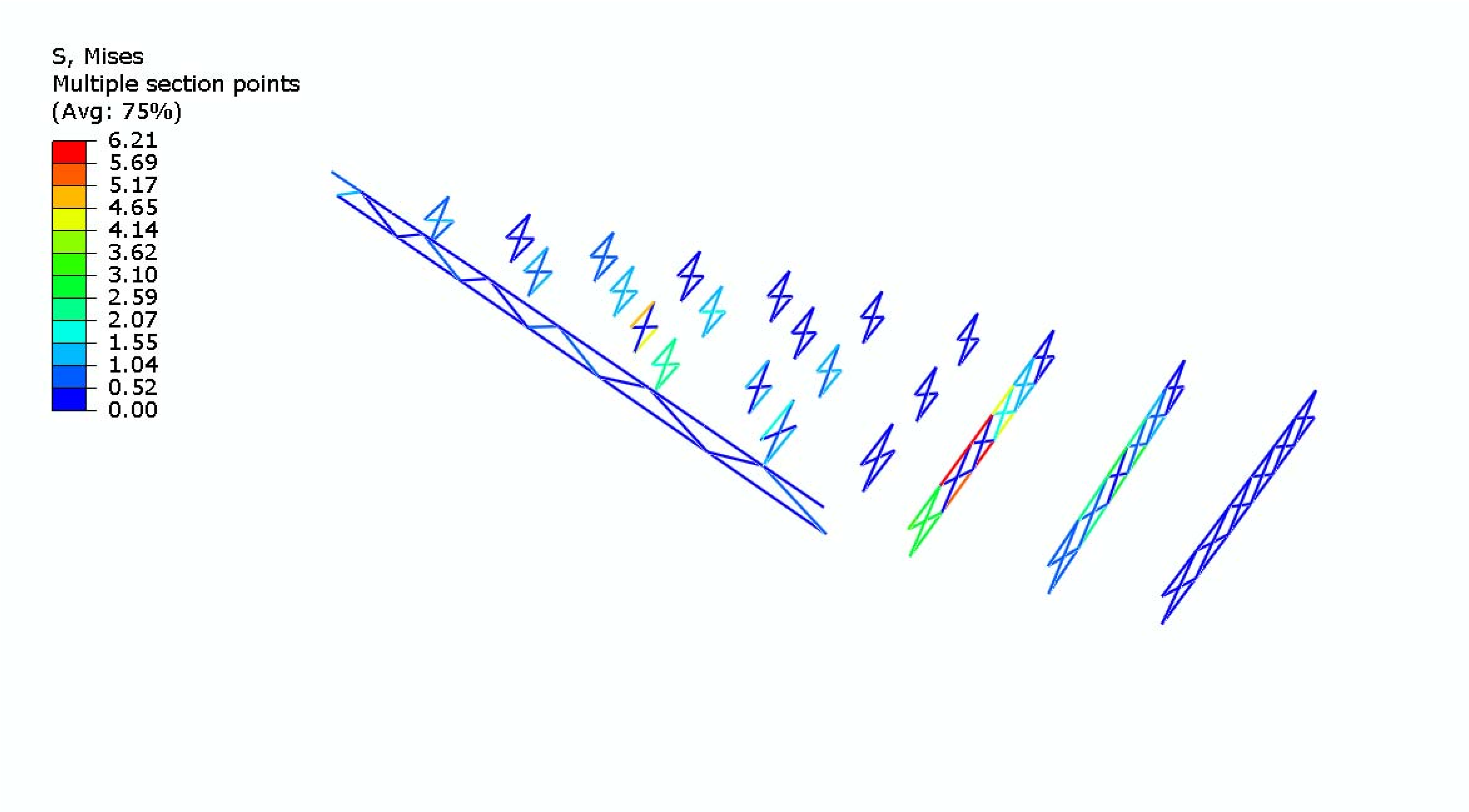


Figure H2-4-27. Cross-frame stress contours under SDL, TDLF detailing .

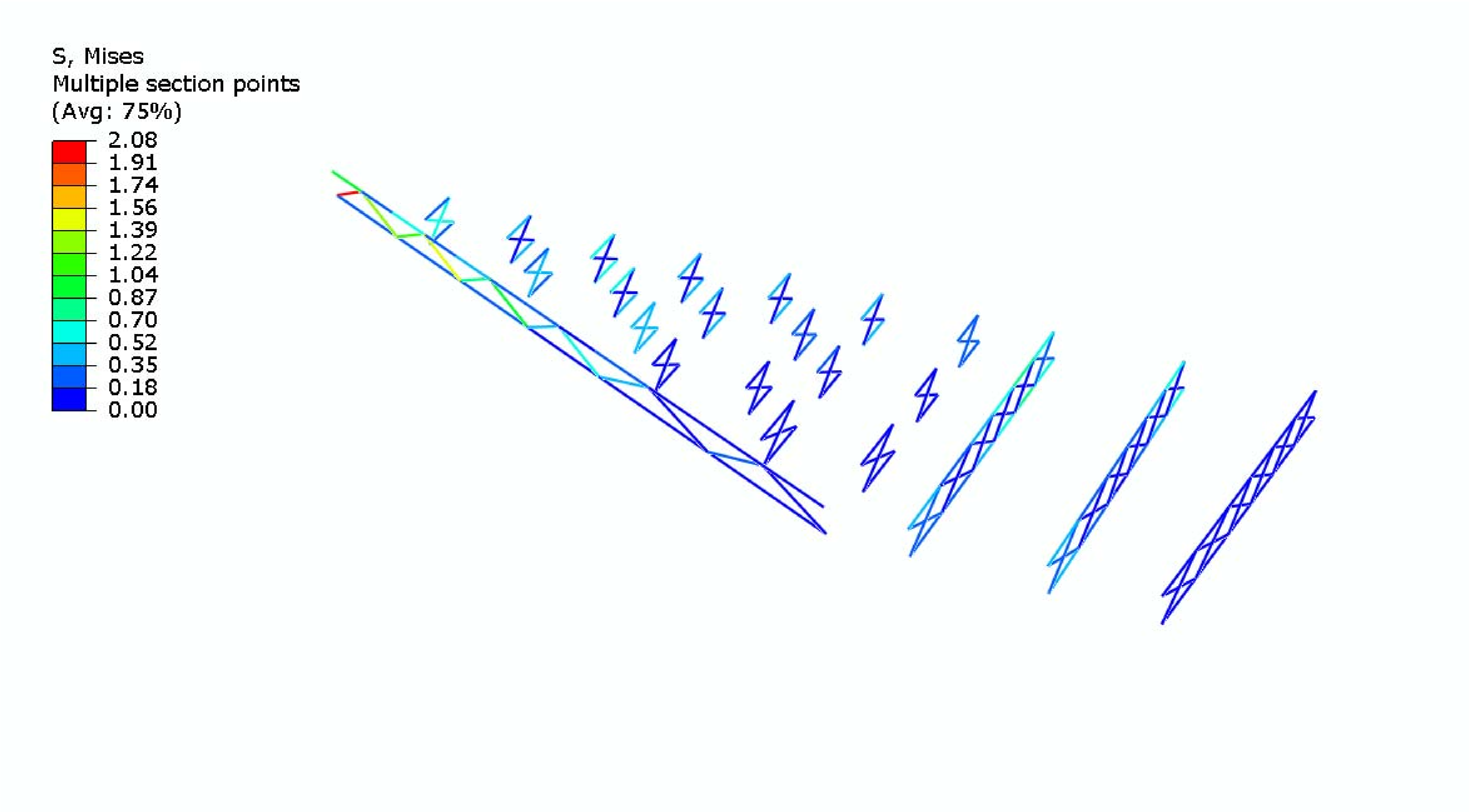


Figure H2-4-28. Cross-frame stress contours under TDL, TDLF .

Table H2-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
1	NLF	4.8	3.7	6.8	3.7	4.0	3.5
	SDLF	2.5	2.2	1.6	2.3	3.0	5.4
	TDLF	4.4	1.6	7.7	3.3	4.9	9.5
2	NLF	10.3	3.0	6.7	2.4	3.0	2.3
	SDLF	0.1	0.1	0.0	0.1	0.2	0.5
	TDLF	13.1	3.1	10.4	1.6	3.1	5.4
3	NLF	4.4	0.6	1.7	2.9	3.5	1.5
	SDLF	0.0	0.0	0.1	0.1	0.0	0.2
	TDLF	4.4	0.7	1.5	5.3	5.6	1.2
4	NLF	0.1	2.6	2.4	0.5	5.0	3.3
	SDLF	0.0	0.0	0.0	0.0	0.1	0.0
	TDLF	0.1	2.1	0.5	0.8	8.2	3.9
5	NLF	NA	2.1	0.9	6.1	0.7	1.3
	SDLF	NA	0.0	0.0	0.1	0.0	0.1
	TDLF	NA	3.7	0.8	9.7	1.5	0.9
6	NLF	NA	0.1	0.3	2.2	4.7	0.6
	SDLF	NA	0.0	0.0	0.0	0.1	0.0
	TDLF	NA	0.3	0.5	3.5	7.4	0.7
7	NLF	NA	NA	NA	0.3	2.2	0.2
	SDLF	NA	NA	NA	0.0	0.0	0.0
	TDLF	NA	NA	NA	0.6	3.8	0.7
8	NLF	NA	NA	NA	NA	0.4	0.2
	SDLF	NA	NA	NA	NA	0.0	0.0
	TDLF	NA	NA	NA	NA	0.6	0.3
9	NLF	NA	NA	NA	NA	NA	1.6
	SDLF	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	0.9
10	NLF	NA	NA	NA	NA	NA	1.7
	SDLF	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	1.7

Table H2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	NA	NA	NA	NA	NA	0.4
	SDLF	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	0.7

Table H2-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	11.2	8.7	20.6	10.6	11.9	11.9
	SDLF	7.9	6.5	14.7	8.4	10.3	13.1
	TDLF	2.1	2.9	4.6	7.7	10.9	16.1
2	NLF	23.4	7.6	18.8	8.6	9.9	4.2
	SDLF	12.7	4.2	11.6	5.3	6.5	1.4
	TDLF	0.9	0.3	0.6	2.0	2.2	3.2
3	NLF	8.3	1.8	3.0	7.5	8.6	2.4
	SDLF	3.7	1.1	1.3	4.6	5.1	1.3
	TDLF	1.2	0.1	0.1	0.3	0.2	0.3
4	NLF	0.9	6.1	1.5	2.1	12.9	7.7
	SDLF	0.8	3.0	1.7	1.3	7.7	4.4
	TDLF	0.5	0.3	0.8	0.1	0.4	0.4
5	NLF	NA	6.3	0.9	15.8	0.4	2.3
	SDLF	NA	4.0	1.5	9.2	0.1	1.0
	TDLF	NA	0.2	0.4	0.7	0.9	0.2
6	NLF	NA	0.5	1.2	5.7	12.3	0.7
	SDLF	NA	0.4	0.7	3.4	7.3	0.7
	TDLF	NA	0.1	0.0	0.5	0.2	0.2
7	NLF	NA	NA	NA	0.9	5.9	2.1
	SDLF	NA	NA	NA	0.7	3.7	1.8
	TDLF	NA	NA	NA	0.0	0.5	0.8
8	NLF	NA	NA	NA	NA	1.2	1.4
	SDLF	NA	NA	NA	NA	0.7	1.3
	TDLF	NA	NA	NA	NA	0.1	1.1
9	NLF	NA	NA	NA	NA	NA	4.0
	SDLF	NA	NA	NA	NA	NA	2.2
	TDLF	NA	NA	NA	NA	NA	0.9
10	NLF	NA	NA	NA	NA	NA	3.2
	SDLF	NA	NA	NA	NA	NA	1.5
	TDLF	NA	NA	NA	NA	NA	0.5

Table H2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
11	NLF	NA	NA	NA	NA	NA	1.0
	SDLF	NA	NA	NA	NA	NA	1.1
	TDLF	NA	NA	NA	NA	NA	0.6

Table H2-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	1.9	3.1	0.4	0.2	0.6	2.7
	SDLF	1.2	0.5	0.8	1.0	1.1	0.3
	TDLF	1.1	5.7	3.4	2.4	1.8	4.7
2	NLF	10.1	4.8	6.2	14.7	3.7	2.1
	SDLF	0.1	0.1	0.1	0.1	0.0	0.3
	TDLF	14.3	7.4	10.7	21.9	5.5	4.4
3	NLF	3.7	0.6	5.2	4.9	5.6	0.9
	SDLF	0.0	0.0	0.0	0.0	0.1	0.1
	TDLF	3.1	1.2	7.0	7.0	6.5	0.5
4	NLF	0.1	20.8	22.0	0.9	5.4	2.9
	SDLF	0.0	0.2	0.2	0.0	0.0	0.0
	TDLF	0.2	26.3	29.0	1.4	6.5	3.3
5	NLF	NA	9.8	10.5	14.6	0.7	0.9
	SDLF	NA	0.1	0.1	0.1	0.0	0.0
	TDLF	NA	10.8	14.1	20.4	0.2	0.3
6	NLF	NA	0.2	0.3	8.4	6.1	0.4
	SDLF	NA	0.0	0.0	0.1	0.0	0.0
	TDLF	NA	0.5	0.5	12.4	6.8	0.3
7	NLF	NA	NA	NA	0.4	4.7	0.1
	SDLF	NA	NA	NA	0.0	0.0	0.0
	TDLF	NA	NA	NA	0.6	6.3	0.3
8	NLF	NA	NA	NA	NA	0.2	0.1
	SDLF	NA	NA	NA	NA	0.0	0.0
	TDLF	NA	NA	NA	NA	0.4	0.2
9	NLF	NA	NA	NA	NA	NA	1.1
	SDLF	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	0.5
10	NLF	NA	NA	NA	NA	NA	1.5
	SDLF	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	1.6

Table H2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	NA	NA	NA	NA	NA	0.2
	SDLF	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	0.4

Table H2-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	1.9	6.9	0.2	1.7	4.3	2.1
	SDLF	1.2	4.5	1.0	2.7	4.6	0.5
	TDLF	1.0	1.3	2.8	3.7	4.8	4.3
2	NLF	25.1	10.4	14.8	36.8	9.2	6.8
	SDLF	15.2	6.2	9.2	22.7	5.9	4.6
	TDLF	1.6	0.0	0.1	2.1	1.2	1.0
3	NLF	9.2	0.9	12.2	12.5	15.3	3.6
	SDLF	5.4	0.7	7.1	7.6	9.4	2.7
	TDLF	1.9	0.0	0.4	0.8	2.4	1.9
4	NLF	0.3	47.7	53.6	2.2	14.0	9.2
	SDLF	0.3	26.9	31.2	1.4	8.5	6.1
	TDLF	0.5	1.0	1.9	0.2	2.1	2.6
5	NLF	NA	22.3	26.6	39.3	2.3	3.9
	SDLF	NA	12.1	15.7	24.1	1.5	2.9
	TDLF	NA	0.8	1.0	3.0	1.5	2.4
6	NLF	NA	0.5	0.7	23.4	17.9	2.8
	SDLF	NA	0.4	0.4	14.5	11.4	2.3
	TDLF	NA	0.0	0.0	1.5	3.8	2.4
7	NLF	NA	NA	NA	1.0	13.8	1.8
	SDLF	NA	NA	NA	0.5	8.8	1.7
	TDLF	NA	NA	NA	0.0	2.1	1.7
8	NLF	NA	NA	NA	NA	0.4	1.3
	SDLF	NA	NA	NA	NA	0.3	1.1
	TDLF	NA	NA	NA	NA	0.1	0.9
9	NLF	NA	NA	NA	NA	NA	5.1
	SDLF	NA	NA	NA	NA	NA	3.8
	TDLF	NA	NA	NA	NA	NA	3.1
10	NLF	NA	NA	NA	NA	NA	6.2
	SDLF	NA	NA	NA	NA	NA	4.6
	TDLF	NA	NA	NA	NA	NA	2.9

Table H2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
11	NLF	NA	NA	NA	NA	NA	0.2
	SDLF	NA	NA	NA	NA	NA	0.2
	TDLF	NA	NA	NA	NA	NA	0.6

Table H2-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	2.8	3.1	5.2	2.7	3.8	4.1
	SDLF	1.1	1.6	2.2	2.9	3.7	4.9
	TDLF	5.4	7.5	9.8	3.7	3.9	13.4
2	NLF	10.6	5.4	6.8	15.3	4.0	2.0
	SDLF	0.1	0.1	0.1	0.1	0.0	0.3
	TDLF	15.0	8.3	11.5	23.0	5.8	4.3
3	NLF	3.4	0.9	5.3	5.0	5.6	0.7
	SDLF	0.0	0.0	0.0	0.0	0.1	0.1
	TDLF	2.5	1.8	7.1	7.3	6.8	0.5
4	NLF	0.1	21.3	22.3	1.3	5.3	2.7
	SDLF	0.0	0.1	0.1	0.0	0.0	0.0
	TDLF	0.2	27.0	29.5	2.0	6.9	3.3
5	NLF	NA	9.5	10.1	14.9	0.6	0.8
	SDLF	NA	0.0	0.0	0.0	0.1	0.0
	TDLF	NA	10.2	13.3	21.0	0.4	0.3
6	NLF	NA	0.1	0.2	8.0	6.1	0.3
	SDLF	NA	0.0	0.0	0.0	0.0	0.0
	TDLF	NA	0.2	0.5	11.6	6.9	0.5
7	NLF	NA	NA	NA	0.1	4.4	0.1
	SDLF	NA	NA	NA	0.0	0.0	0.0
	TDLF	NA	NA	NA	0.4	5.7	0.6
8	NLF	NA	NA	NA	NA	0.3	0.0
	SDLF	NA	NA	NA	NA	0.0	0.0
	TDLF	NA	NA	NA	NA	0.6	0.1
9	NLF	NA	NA	NA	NA	NA	1.1
	SDLF	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	0.3
10	NLF	NA	NA	NA	NA	NA	1.3
	SDLF	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	1.3

Table H2-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	NA	NA	NA	NA	NA	0.4
	SDLF	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	0.6

Table H2-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	9.3	13.2	19.3	8.9	12.1	12.6
	SDLF	5.8	8.7	13.1	8.1	11.8	10.8
	TDLF	2.9	3.9	6.0	8.3	11.7	18.4
2	NLF	28.1	14.9	19.5	42.5	11.9	7.8
	SDLF	17.1	9.0	12.1	26.3	7.5	5.4
	TDLF	1.7	0.0	0.1	2.2	1.2	1.1
3	NLF	7.5	3.2	13.3	13.6	15.9	3.3
	SDLF	4.3	2.0	7.9	8.5	10.1	2.6
	TDLF	2.0	0.1	0.5	1.0	2.6	1.8
4	NLF	0.9	50.7	55.7	3.9	15.4	9.6
	SDLF	0.8	28.8	32.5	2.4	9.9	6.6
	TDLF	0.5	1.1	2.1	0.1	2.2	2.7
5	NLF	NA	20.4	24.6	41.1	2.1	4.1
	SDLF	NA	11.0	14.4	25.4	1.5	3.1
	TDLF	NA	0.9	1.0	3.2	1.6	2.4
6	NLF	NA	0.2	0.6	21.5	18.3	2.9
	SDLF	NA	0.2	0.5	13.4	11.8	2.4
	TDLF	NA	0.1	0.0	1.6	4.0	2.4
7	NLF	NA	NA	NA	0.4	12.6	1.2
	SDLF	NA	NA	NA	0.4	8.1	1.3
	TDLF	NA	NA	NA	0.0	2.1	1.7
8	NLF	NA	NA	NA	NA	0.9	0.8
	SDLF	NA	NA	NA	NA	0.5	0.9
	TDLF	NA	NA	NA	NA	0.1	0.9
9	NLF	NA	NA	NA	NA	NA	5.0
	SDLF	NA	NA	NA	NA	NA	3.8
	TDLF	NA	NA	NA	NA	NA	3.2
10	NLF	NA	NA	NA	NA	NA	5.5
	SDLF	NA	NA	NA	NA	NA	4.2
	TDLF	NA	NA	NA	NA	NA	2.9

Table H2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
11	NLF	NA	NA	NA	NA	NA	1.6
	SDLF	NA	NA	NA	NA	NA	1.1
	TDLF	NA	NA	NA	NA	NA	0.7

Table H2-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.01	0.01	0.02	0.01	0.01	0.01
	SDLF	0.01	0.01	0.02	0.01	0.01	0.01
	TDLF	0.00	0.01	0.02	0.01	0.02	0.01
2	NLF	0.20	0.45	0.53	0.81	1.01	1.09
	SDLF	0.14	0.39	0.43	0.77	1.13	1.27
	TDLF	0.07	0.39	0.17	0.79	1.47	1.40
3	NLF	0.13	0.42	0.54	0.69	0.99	1.09
	SDLF	0.08	0.37	0.44	0.72	1.22	1.33
	TDLF	0.03	0.39	0.10	0.93	1.77	1.42
4	NLF	0.00	0.35	0.36	0.56	0.92	1.04
	SDLF	0.00	0.31	0.30	0.61	1.22	1.32
	TDLF	0.00	0.34	0.01	0.84	1.90	1.33
5	NLF	NA	0.18	0.18	0.44	0.81	0.97
	SDLF	NA	0.16	0.15	0.49	1.14	1.24
	TDLF	NA	0.18	0.01	0.71	1.86	1.17
6	NLF	NA	0.00	0.00	0.22	0.47	0.87
	SDLF	NA	0.00	0.00	0.25	0.71	1.12
	TDLF	NA	0.00	0.00	0.38	1.23	0.98
7	NLF	NA	NA	NA	0.00	0.24	0.75
	SDLF	NA	NA	NA	0.00	0.37	0.96
	TDLF	NA	NA	NA	0.00	0.65	0.77
8	NLF	NA	NA	NA	NA	0.00	0.60
	SDLF	NA	NA	NA	NA	0.00	0.76
	TDLF	NA	NA	NA	NA	0.00	0.58
9	NLF	NA	NA	NA	NA	NA	0.48
	SDLF	NA	NA	NA	NA	NA	0.60
	TDLF	NA	NA	NA	NA	NA	0.44
10	NLF	NA	NA	NA	NA	NA	0.25
	SDLF	NA	NA	NA	NA	NA	0.32
	TDLF	NA	NA	NA	NA	NA	0.23

Table H2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
11	NLF	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	0.00

Table H2-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.02	0.02	0.07	0.02	0.02	0.01
	SDLF	0.02	0.02	0.07	0.02	0.02	0.02
	TDLF	0.02	0.02	0.07	0.02	0.03	0.02
2	NLF	0.72	1.43	1.57	2.35	2.92	3.19
	SDLF	0.66	1.37	1.47	2.30	3.03	3.35
	TDLF	0.58	1.36	1.20	2.31	3.35	3.46
3	NLF	0.43	1.30	1.56	1.96	2.87	3.16
	SDLF	0.39	1.25	1.46	1.98	3.09	3.39
	TDLF	0.34	1.27	1.12	2.17	3.61	3.45
4	NLF	0.00	1.07	1.00	1.56	2.64	3.01
	SDLF	0.00	1.03	0.94	1.61	2.92	3.27
	TDLF	0.00	1.06	0.63	1.83	3.58	3.26
5	NLF	NA	0.55	0.51	1.22	2.31	2.80
	SDLF	NA	0.53	0.48	1.27	2.62	3.05
	TDLF	NA	0.55	0.31	1.48	3.32	2.95
6	NLF	NA	0.00	0.00	0.61	1.32	2.50
	SDLF	NA	0.00	0.00	0.64	1.54	2.73
	TDLF	NA	0.00	0.00	0.77	2.06	2.56
7	NLF	NA	NA	NA	0.00	0.68	2.12
	SDLF	NA	NA	NA	0.00	0.80	2.32
	TDLF	NA	NA	NA	0.00	1.07	2.11
8	NLF	NA	NA	NA	NA	0.00	1.69
	SDLF	NA	NA	NA	NA	0.00	1.85
	TDLF	NA	NA	NA	NA	0.00	1.64
9	NLF	NA	NA	NA	NA	NA	1.34
	SDLF	NA	NA	NA	NA	NA	1.46
	TDLF	NA	NA	NA	NA	NA	1.27
10	NLF	NA	NA	NA	NA	NA	0.71
	SDLF	NA	NA	NA	NA	NA	0.77
	TDLF	NA	NA	NA	NA	NA	0.67

Table H2-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	0.00

Table H2-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
1	NLF	0.00	0.00	0.02	0.00	0.00	0.00
	SDLF	0.00	0.00	0.01	0.00	0.01	0.01
	TDLF	0.00	0.01	0.01	0.01	0.01	0.01
2	NLF	0.14	0.32	0.37	0.57	0.71	0.77
	SDLF	0.10	0.28	0.31	0.54	0.80	0.90
	TDLF	0.05	0.27	0.12	0.56	1.04	0.99
3	NLF	0.09	0.30	0.38	0.49	0.70	0.77
	SDLF	0.06	0.26	0.31	0.51	0.87	0.94
	TDLF	0.02	0.28	0.07	0.66	1.25	1.01
4	NLF	0.00	0.25	0.25	0.39	0.65	0.74
	SDLF	0.00	0.22	0.21	0.43	0.87	0.93
	TDLF	0.00	0.24	0.01	0.60	1.35	0.94
5	NLF	NA	0.13	0.13	0.31	0.58	0.69
	SDLF	NA	0.12	0.11	0.35	0.81	0.88
	TDLF	NA	0.13	0.01	0.51	1.32	0.83
6	NLF	NA	0.00	0.00	0.16	0.33	0.62
	SDLF	NA	0.00	0.00	0.18	0.50	0.79
	TDLF	NA	0.00	0.00	0.27	0.87	0.69
7	NLF	NA	NA	NA	0.00	0.17	0.53
	SDLF	NA	NA	NA	0.00	0.26	0.68
	TDLF	NA	NA	NA	0.00	0.46	0.55
8	NLF	NA	NA	NA	NA	0.00	0.43
	SDLF	NA	NA	NA	NA	0.00	0.54
	TDLF	NA	NA	NA	NA	0.00	0.41
9	NLF	NA	NA	NA	NA	NA	0.34
	SDLF	NA	NA	NA	NA	NA	0.43
	TDLF	NA	NA	NA	NA	NA	0.31
10	NLF	NA	NA	NA	NA	NA	0.18
	SDLF	NA	NA	NA	NA	NA	0.23
	TDLF	NA	NA	NA	NA	NA	0.16

Table H2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
11	NLF	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	0.00

Table H2-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.02	0.01	0.05	0.01	0.01	0.01
	SDLF	0.02	0.01	0.05	0.01	0.01	0.01
	TDLF	0.01	0.01	0.05	0.01	0.02	0.01
2	NLF	0.51	1.01	1.11	1.66	2.07	2.26
	SDLF	0.47	0.97	1.04	1.63	2.15	2.37
	TDLF	0.41	0.97	0.85	1.64	2.37	2.45
3	NLF	0.31	0.92	1.11	1.39	2.03	2.24
	SDLF	0.28	0.89	1.04	1.40	2.19	2.40
	TDLF	0.24	0.90	0.79	1.54	2.56	2.45
4	NLF	0.00	0.76	0.71	1.11	1.87	2.14
	SDLF	0.00	0.73	0.67	1.14	2.07	2.32
	TDLF	0.00	0.75	0.44	1.30	2.54	2.31
5	NLF	NA	0.39	0.36	0.86	1.64	1.98
	SDLF	NA	0.38	0.34	0.90	1.86	2.16
	TDLF	NA	0.39	0.22	1.05	2.35	2.09
6	NLF	NA	0.00	0.00	0.43	0.93	1.77
	SDLF	NA	0.00	0.00	0.46	1.09	1.93
	TDLF	NA	0.00	0.00	0.54	1.46	1.81
7	NLF	NA	NA	NA	0.00	0.48	1.50
	SDLF	NA	NA	NA	0.00	0.57	1.64
	TDLF	NA	NA	NA	0.00	0.76	1.50
8	NLF	NA	NA	NA	NA	0.00	1.20
	SDLF	NA	NA	NA	NA	0.00	1.31
	TDLF	NA	NA	NA	NA	0.00	1.16
9	NLF	NA	NA	NA	NA	NA	0.95
	SDLF	NA	NA	NA	NA	NA	1.03
	TDLF	NA	NA	NA	NA	NA	0.90
10	NLF	NA	NA	NA	NA	NA	0.50
	SDLF	NA	NA	NA	NA	NA	0.54
	TDLF	NA	NA	NA	NA	NA	0.47

Table H2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	0.00

Table H2-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	9.9	11.0	37.6	44.1
	SDLF	18.5	15.5	46.7	48.4
	TDLF	29.7	20.1	58.6	52.8
G2	NLF	31.4	29.5	105.5	104.0
	SDLF	29.6	24.5	103.8	99.1
	TDLF	26.6	18.9	101.3	93.4
G3	NLF	32.2	37.6	101.8	120.7
	SDLF	36.3	32.0	106.2	115.0
	TDLF	47.6	29.1	118.1	112.1
G4	NLF	50.4	45.6	145.6	139.1
	SDLF	43.7	39.9	139.4	133.4
	TDLF	27.6	25.4	124.0	118.5
G5	NLF	53.6	46.9	150.9	139.7
	SDLF	50.0	46.0	147.4	138.9
	TDLF	45.1	44.6	142.9	137.1
G6	NLF	60.1	49.0	165.0	142.3
	SDLF	57.7	52.8	162.5	145.3
	TDLF	58.3	63.2	163.1	155.6
G7	NLF	56.7	54.3	161.8	154.9
	SDLF	62.3	59.7	166.4	160.4
	TDLF	68.0	64.2	170.7	164.7

Table H2-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.2	NA	0.8	NA
	SDLF	0.0	NA	0.5	NA
	TDLF	-0.2	NA	0.1	NA
G2	NLF	0.1	NA	1.1	NA
	SDLF	0.0	NA	0.7	NA
	TDLF	-0.2	NA	0.0	NA
G3	NLF	0.1	NA	1.0	NA
	SDLF	0.0	NA	0.7	NA
	TDLF	-0.2	NA	0.0	NA
G4	NLF	0.0	NA	0.3	NA
	SDLF	0.0	NA	0.2	NA
	TDLF	0.1	NA	0.2	NA
G5	NLF	-0.1	NA	-0.4	NA
	SDLF	0.0	NA	-0.2	NA
	TDLF	0.2	NA	0.1	NA
G6	NLF	-0.2	NA	-1.1	NA
	SDLF	0.0	NA	-0.7	NA
	TDLF	0.1	NA	-0.2	NA
G7	NLF	-0.2	NA	-1.7	NA
	SDLF	-0.1	NA	-1.2	NA
	TDLF	0.2	NA	-0.2	NA

Table H2-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.4	0.0	2.7	-0.6
	SDLF	0.0	0.0	1.7	-0.4
	TDLF	-0.8	0.0	0.0	0.0
G2	NLF	0.5	0.0	3.6	-0.7
	SDLF	0.0	0.0	2.3	-0.5
	TDLF	-0.8	0.1	0.0	0.0
G3	NLF	0.5	-0.1	3.5	-0.8
	SDLF	0.0	0.0	2.3	-0.6
	TDLF	-0.9	0.2	0.0	0.0
G4	NLF	0.2	-0.1	1.5	-0.9
	SDLF	0.0	0.0	1.0	-0.6
	TDLF	-0.4	0.2	0.1	0.0
G5	NLF	0.0	-0.2	0.0	-1.0
	SDLF	0.0	0.0	0.1	-0.6
	TDLF	-0.1	0.3	0.0	0.0
G6	NLF	-0.4	-0.2	-1.9	-1.1
	SDLF	0.0	0.0	-1.2	-0.7
	TDLF	0.6	0.4	0.0	0.0
G7	NLF	-0.3	-0.2	-3.3	-1.1
	SDLF	0.0	0.0	-2.2	-0.7
	TDLF	0.9	0.4	0.0	0.0

(Column group header: Load Type & Support Number)

Table H2-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.02	0.02	0.08	0.11
	SDLF	0.00	0.01	0.05	0.09
	TDLF	-0.02	0.00	0.01	0.05
G2	NLF	0.01	0.07	0.11	0.31
	SDLF	0.00	0.04	0.07	0.25
	TDLF	-0.02	0.01	0.00	0.17
G3	NLF	0.01	0.13	0.10	0.49
	SDLF	0.00	0.10	0.07	0.43
	TDLF	-0.02	0.07	0.00	0.36
G4	NLF	0.00	0.17	0.03	0.54
	SDLF	0.00	0.14	0.02	0.49
	TDLF	0.01	0.08	0.02	0.44
G5	NLF	-0.01	0.24	-0.04	0.69
	SDLF	0.00	0.22	-0.02	0.65
	TDLF	0.02	0.22	0.01	0.69
G6	NLF	-0.02	0.32	-0.11	0.85
	SDLF	0.00	0.33	-0.07	0.82
	TDLF	0.01	0.44	-0.02	1.01
G7	NLF	-0.02	0.37	-0.17	0.89
	SDLF	-0.01	0.37	-0.12	0.84
	TDLF	0.02	0.50	-0.02	1.11

(Column group header: Load Type & Support Number)

Table H2-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	-0.04	0.00	-0.27	0.06
	SDLF	0.00	0.00	-0.17	0.04
	TDLF	0.08	0.00	0.00	0.00
G2	NLF	-0.05	0.00	-0.36	0.07
	SDLF	0.00	0.00	-0.23	0.05
	TDLF	0.08	-0.01	0.00	0.00
G3	NLF	-0.05	0.01	-0.35	0.08
	SDLF	0.00	0.00	-0.23	0.06
	TDLF	0.09	-0.02	0.00	0.00
G4	NLF	-0.02	0.01	-0.15	0.09
	SDLF	0.00	0.00	-0.10	0.06
	TDLF	0.04	-0.02	-0.01	0.00
G5	NLF	0.00	0.02	0.00	0.10
	SDLF	0.00	0.00	-0.01	0.06
	TDLF	0.01	-0.03	0.00	0.00
G6	NLF	0.04	0.02	0.19	0.11
	SDLF	0.00	0.00	0.12	0.07
	TDLF	-0.06	-0.04	0.00	0.00
G7	NLF	0.03	0.02	0.33	0.11
	SDLF	0.00	0.00	0.22	0.07
	TDLF	-0.09	-0.04	0.00	0.00

Appendix H2-5. EISSS57 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge EISSS57 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table H2-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	SDLF	-0.7	0.2	0.7	0.0	-0.2	0.2
		TDLF	-0.9	1.2	1.4	0.0	-1.1	1.1
	2-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.1	0.0	0.1	0.1	0.0	0.1
	2-4	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.4	-0.1	0.4	-0.4	0.2	0.5
	2-5	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.2	-0.2	0.3	0.2	0.1	0.2

Table H2-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
3	3-2	SDLF	-0.7	0.7	1.0	0.0	-0.7	0.7
		TDLF	-0.9	2.7	2.8	0.0	-2.7	2.7
	3-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.1	0.0	0.1	0.1	0.1	0.1
	3-4	SDLF	0.0	0.0	0.0	-0.1	0.0	0.1
		TDLF	-1.3	0.0	1.3	-1.3	0.3	1.4
	3-5	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.3	-0.2	0.4	-0.4	0.3	0.5
	3-6	SDLF	-0.1	0.0	0.1	-0.1	0.0	0.1
		TDLF	-2.6	0.2	2.6	-2.6	-0.1	2.6
	3-7	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	-0.1	0.1	0.0	0.0	0.1

Table H2-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
7	7-2	SDLF	-1.7	5.5	5.7	0.0	-5.0	5.0
		TDLF	-4.0	14.9	15.4	0.0	-14.2	14.2
	7-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.3	-0.1	0.3	0.2	-0.1	0.2
	7-4	SDLF	-0.2	-0.1	0.2	-0.2	0.1	0.2
		TDLF	-3.7	-1.2	3.8	-3.9	1.8	4.2
	7-5	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-2.0	-2.9	3.5	-2.2	3.7	4.3
	7-6	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-1.7	0.2	1.7	-2.0	1.0	2.3
	7-7	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.2	-0.1	0.2	-0.5	0.7	0.9
	7-8	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.1	0.0	0.1	-0.1	0.3	0.3
	7-9	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	-0.2	0.2	-0.1	0.2	0.3
	7-10	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.2	-0.5	0.5	-0.4	0.7	0.8
	7-11	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.6	-0.3	0.6	-0.7	0.2	0.7
	7-12	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.7	-0.2	0.7	-0.7	-0.1	0.7

Table H2-5-2: Erection Critical Sub-Stages

Stage	Detailing Method	Critical Sub-Stage
2	SDLF	2-2
	TDLF	2-2
3	SDLF	3-2
	TDLF	3-2
7	SDLF	7-2
	TDLF	7-2

Table H2-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	SDLF	-0.6	0.0	0.6	NA	NA	NA
		TDLF	-0.6	-0.1	0.6	NA	NA	NA
	B	SDLF	-0.7	0.2	0.7	0.0	-0.2	0.2
		TDLF	-0.9	1.2	1.4	0.0	-1.1	1.1
3	A	SDLF	-0.5	0.0	0.5	NA	NA	NA
		TDLF	-0.2	-0.2	0.2	NA	NA	NA
	B	SDLF	-0.7	0.7	1.0	0.0	-0.7	0.7
		TDLF	-0.9	2.7	2.8	0.0	-2.7	2.7
7	A	SDLF	-0.3	0.1	0.3	NA	NA	NA
		TDLF	0.1	-0.8	0.8	NA	NA	NA
	B	SDLF	-1.7	5.5	5.7	0.0	-5.0	5.0
		TDLF	-4.0	14.9	15.4	0.0	-14.2	14.2

Table H2-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
2	A	G1	SDLF	18	15
			TDLF	18	15
		G2	SDLF	25	22
			TDLF	25	22
	B	G1	SDLF	18	15
			TDLF	18	15
		G2	SDLF	26	22
			TDLF	26	22
3	A	G1	SDLF	19	15
			TDLF	19	15
		G2	SDLF	28	23
			TDLF	29	24
		G3	SDLF	32	30
			TDLF	32	30
	B	G1	SDLF	18	15
			TDLF	19	15
		G2	SDLF	29	23
			TDLF	29	24
		G3	SDLF	33	30
			TDLF	32	30

Table H2-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
7	A	G1	SDLF	19	16
			TDLF	29	20
		G2	SDLF	30	25
			TDLF	26	19
		G3	SDLF	36	32
			TDLF	47	30
		G4	SDLF	44	40
			TDLF	27	26
		G5	SDLF	50	46
			TDLF	43	45
		G6	SDLF	56	52
			TDLF	66	65
		G7	SDLF	61	58
			TDLF	60	58

Table H2-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
7	B	G1	SDLF	19	16
			TDLF	29	20
		G2	SDLF	30	25
			TDLF	26	19
		G3	SDLF	36	32
			TDLF	47	29
		G4	SDLF	44	40
			TDLF	27	26
		G5	SDLF	49	46
			TDLF	43	45
		G6	SDLF	57	52
			TDLF	69	65
		G7	SDLF	61	58
			TDLF	60	58

Appendix I1-1. NISSS14 Bridge Description

The key characteristics of NISSS14 are as follows:

- Span length along the centerline of the bridge, L_s = 150 ft.
- Width between the fascia girders, w_g = 74 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 2.0
- Number of girders in the completed bridge cross-section, n_g = 9.
- Parallel skew
- Skew angle, θ = 70^o
- Skew index, I_s = 1.35

This appendix presents the bridge description of the bridge NISSS14 in its final condition as well as during erection. The following figures and tables are provided:

Figure I1-1-1. Framing plan

Figure I1-1-2. Bridge cross-section

Figure I1-1-3. Girder Elevation

Figure I1-1-4. Cross-section dimension

Figure I1-1-5. Cross-frame details

Figure I1-1-6. Erection scheme

Table I1-1-1. Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

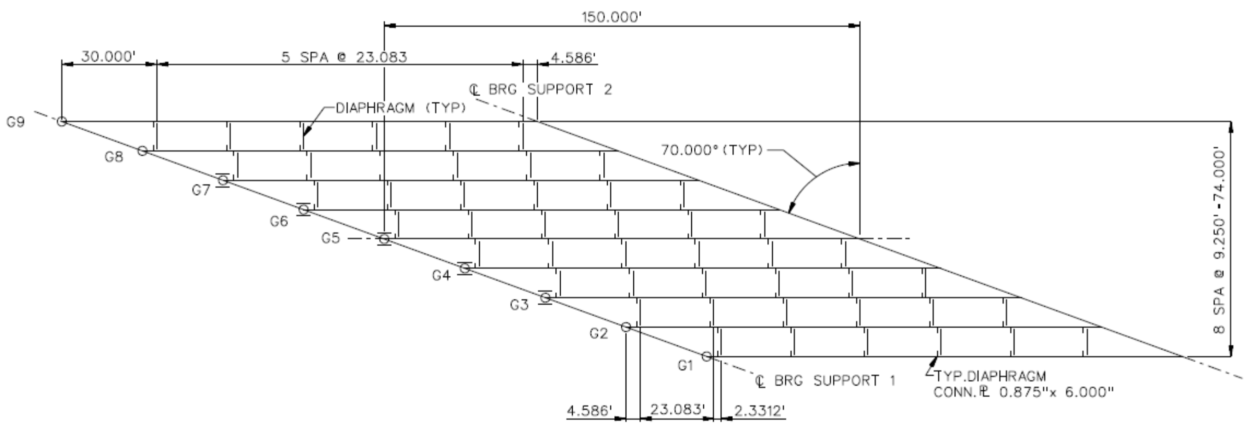


Figure I1-1-1. Framing plan.

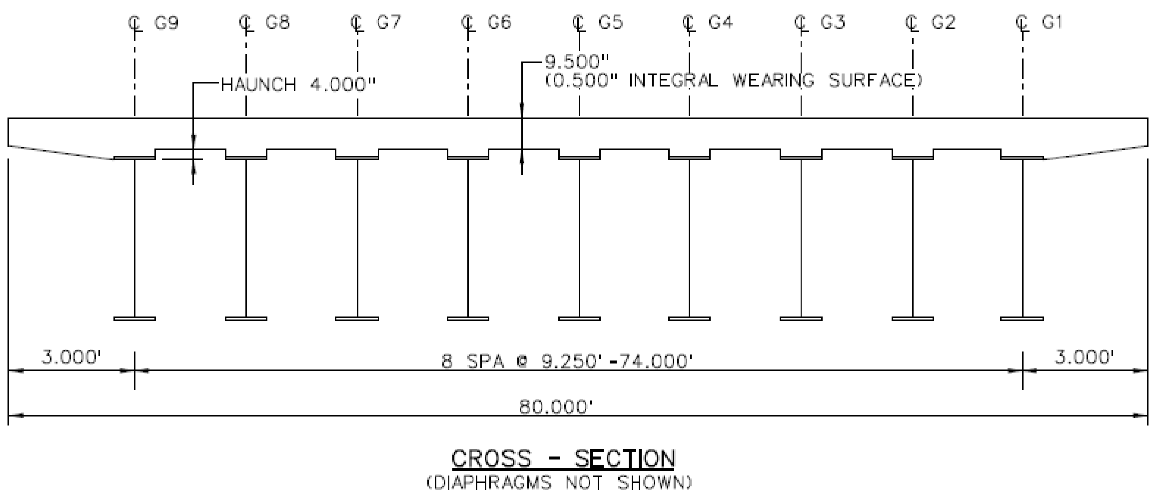


Figure I1-1-2. Bridge cross-section.

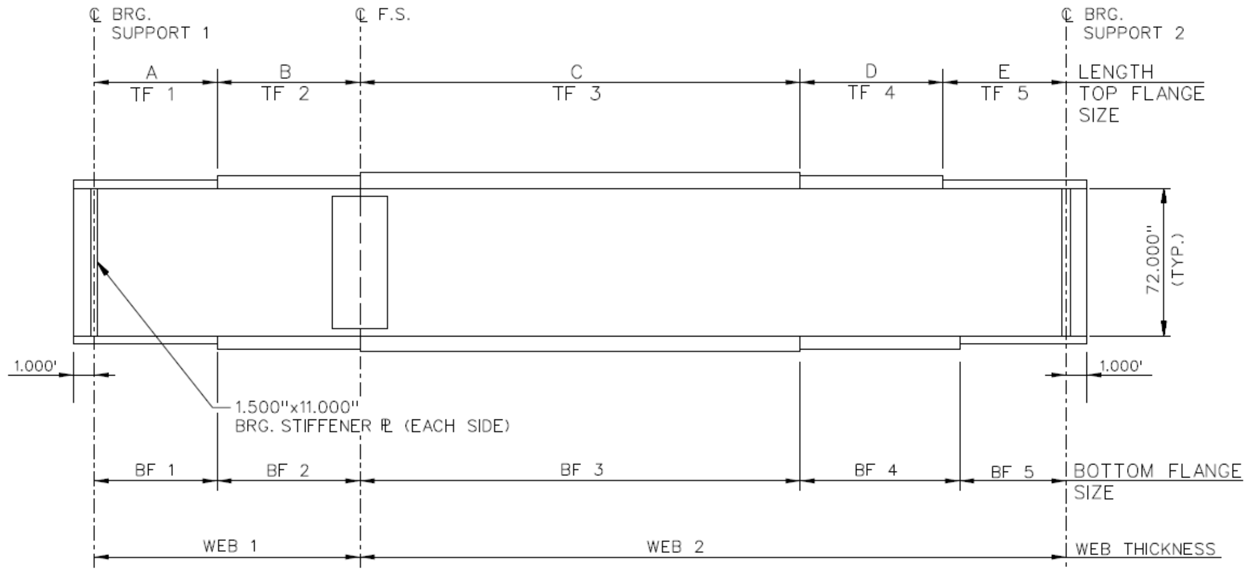


Figure I1-1-3. Girder elevations

	GIRDER PLATE LENGTHS *		
LENGTH	G1, G2, G3	G4, G5, G6	G7, G8, G9
A	20.000	20.000	20.000
B	20.000	20.000	20.000
C	70.000	70.000	70.000
D	20.000	20.000	20.000
E	20.000	20.000	20.000

* ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS **					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	16.000	0.750	16.000	0.750	16.000	0.750
TF2	16.000	0.750	16.000	0.750	16.000	0.750
TF3	16.000	1.000	16.000	1.000	16.000	1.000
TF4	16.000	0.750	16.000	0.750	16.000	0.750
TF5	16.000	0.750	16.000	0.750	16.000	0.750

** ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS **					
BOTTOM FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
BF1	18.000	1.000	18.000	1.000	18.000	1.000
BF2	18.000	1.500	18.000	1.500	18.000	1.500
BF3	18.000	2.000	18.000	2.000	18.000	2.000
BF4	18.000	1.500	18.000	1.500	18.000	1.500
BF5	18.000	1.000	18.000	1.000	18.000	1.000

** ALL DIMENSIONS ARE IN INCHES.

Figure I1-1-4. Cross-section dimensions.

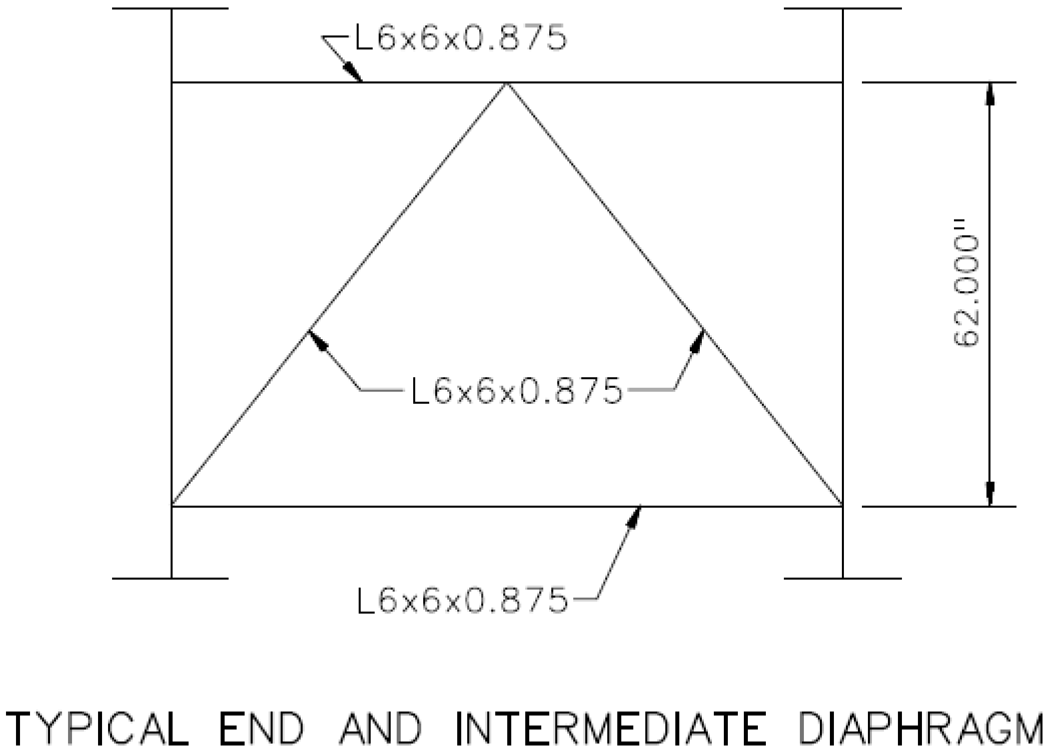


Figure I1-1-5. Cross-frame details.

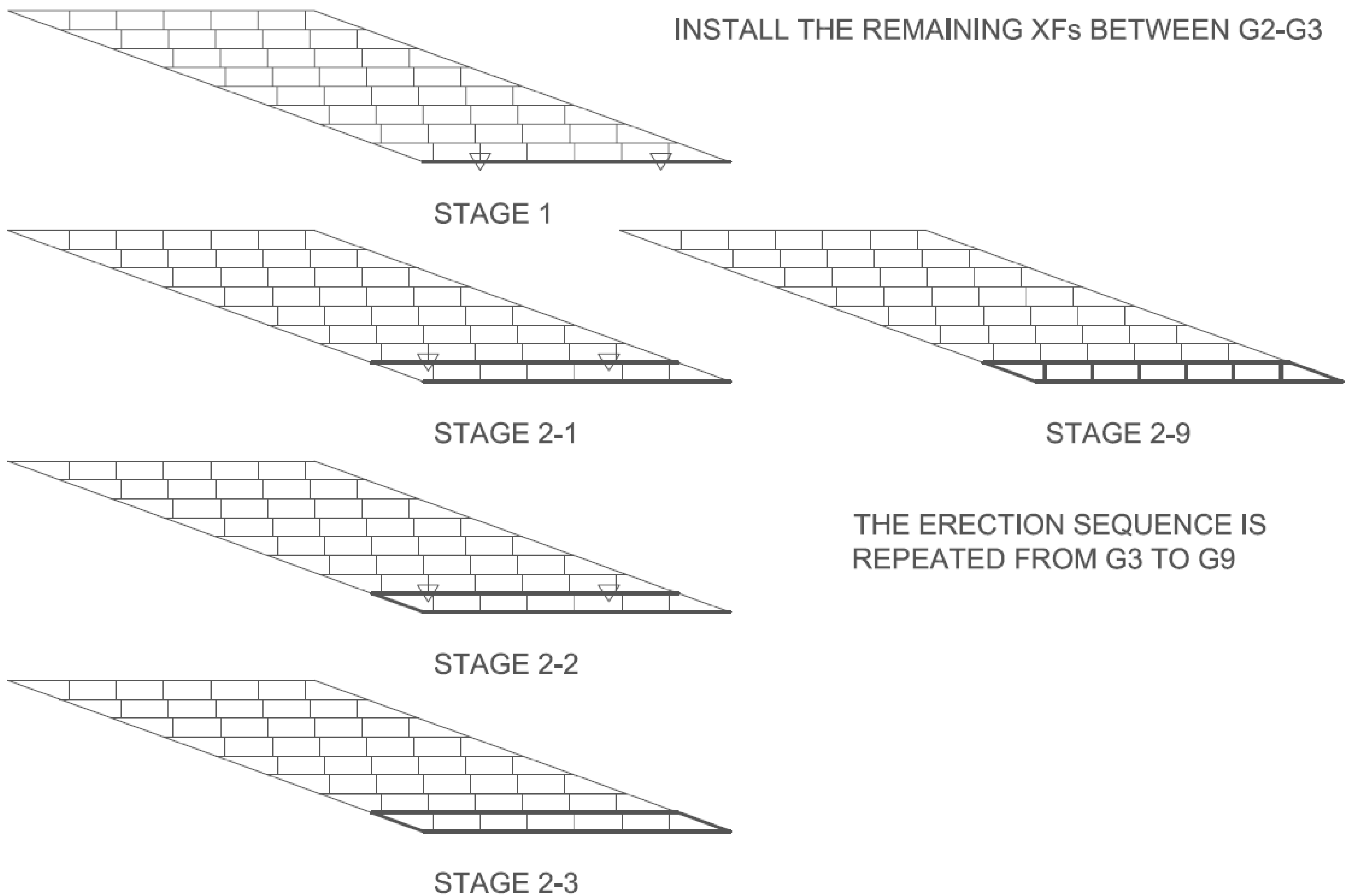


Figure I1-1-6. Erection scheme.

Table I1-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

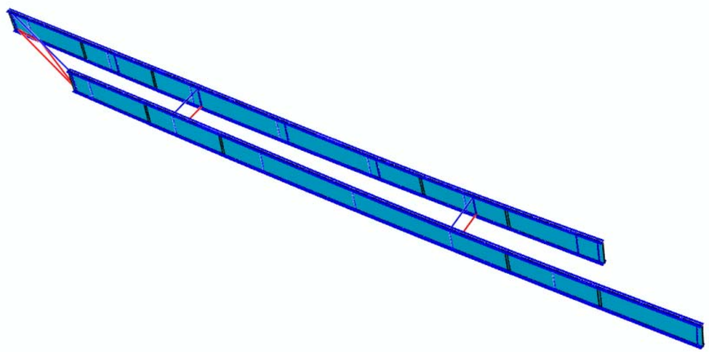
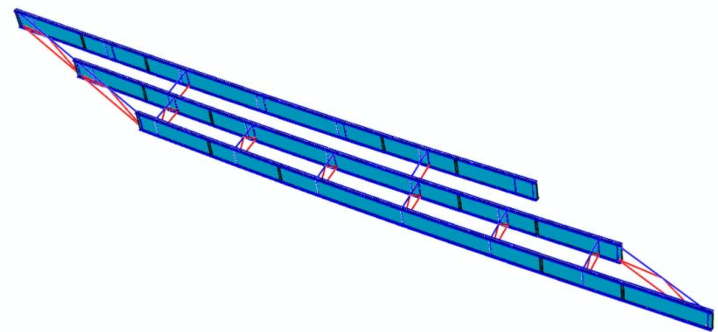
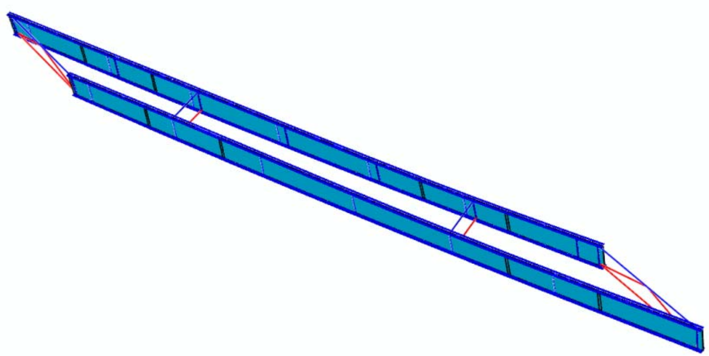
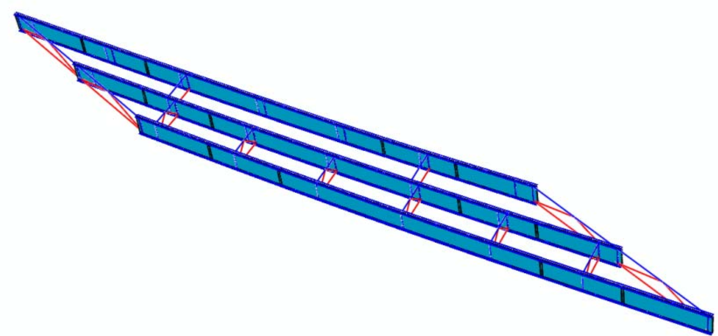
Sub-Stage	Stage	
	2	**3**
1		
2		

Table I1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

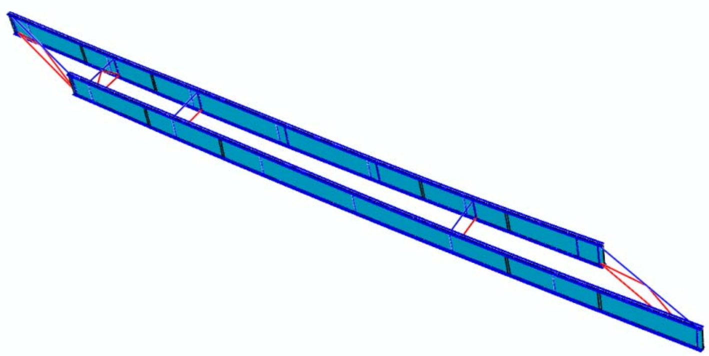
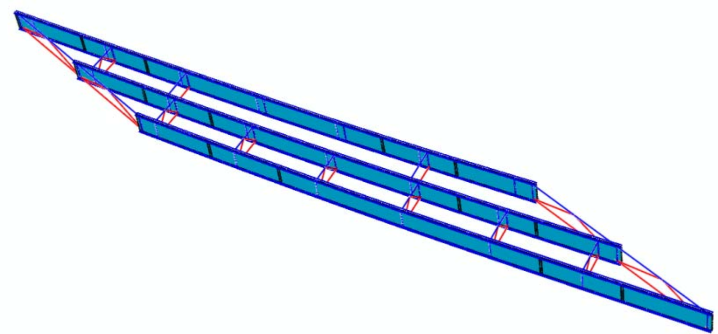
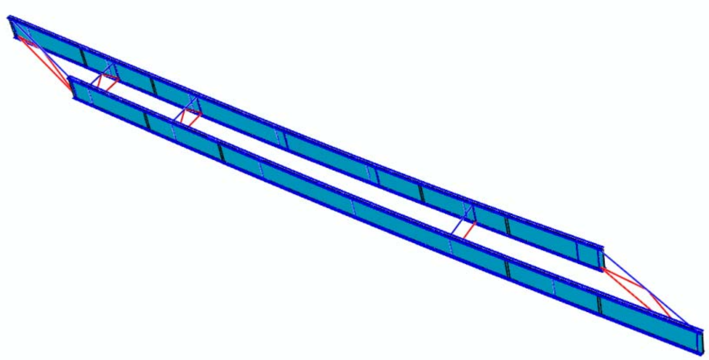
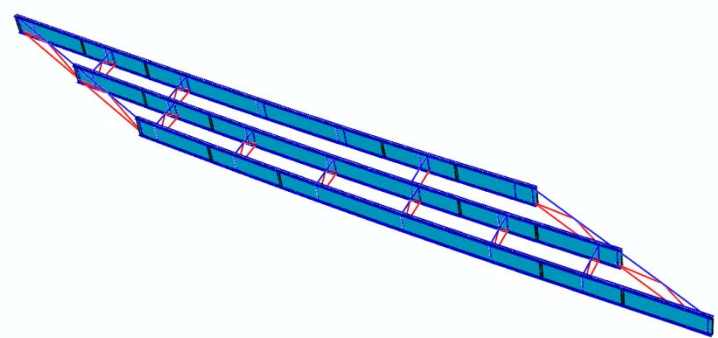
Sub-Stage	Stage	
	2	3
3		
4		

Table I1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

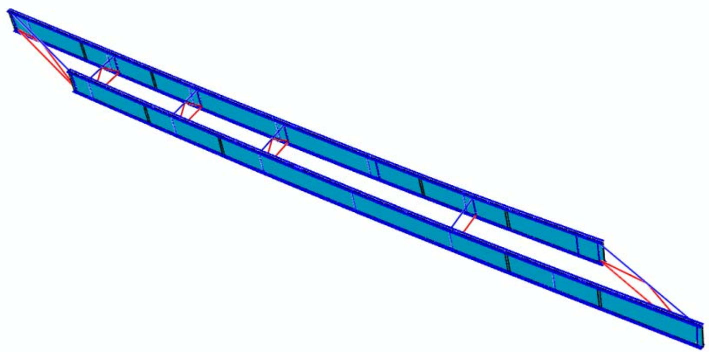
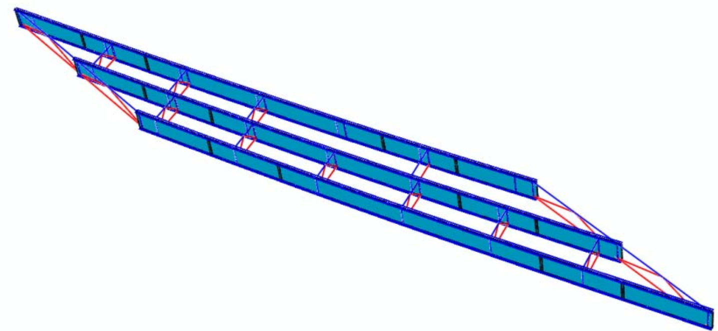
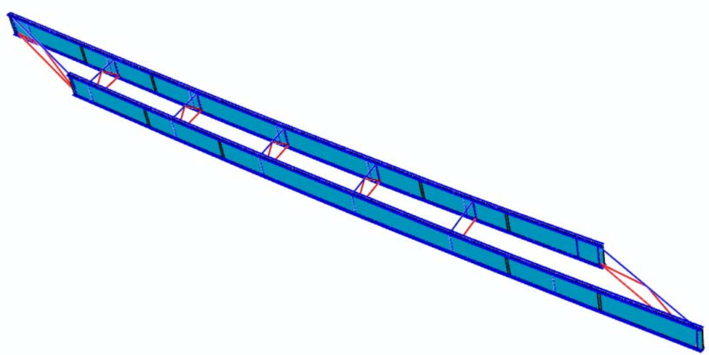
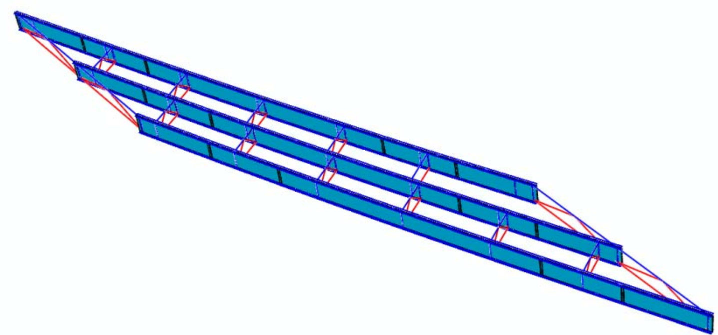
Sub-Stage	Stage	
	2	3
5		
6		

Table I1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

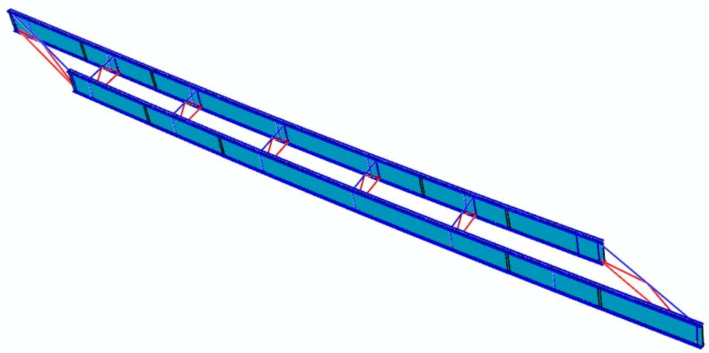
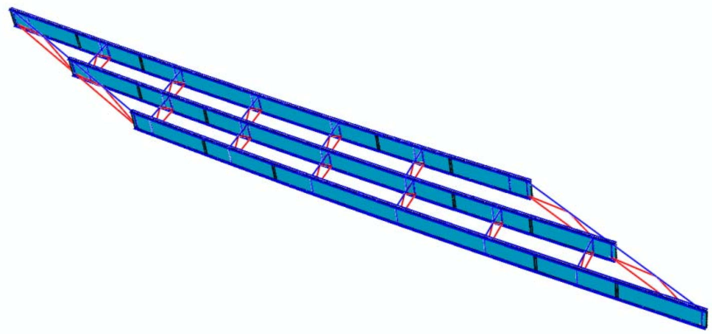
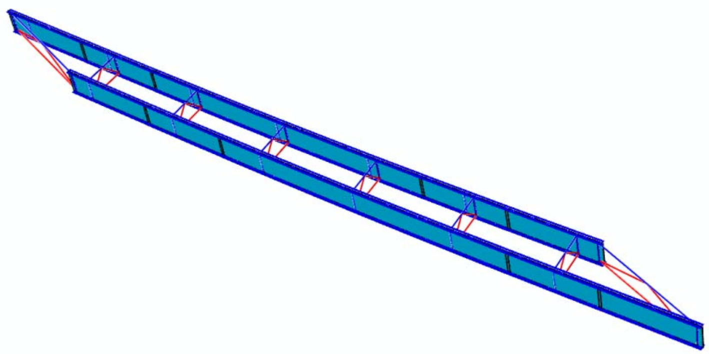
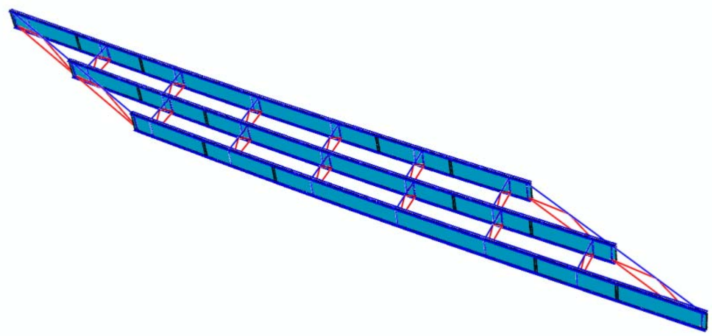
Sub-Stage	Stage	
	2	3
7		
8		

Table I1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

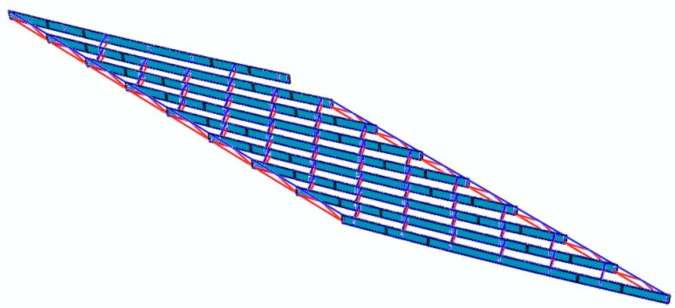
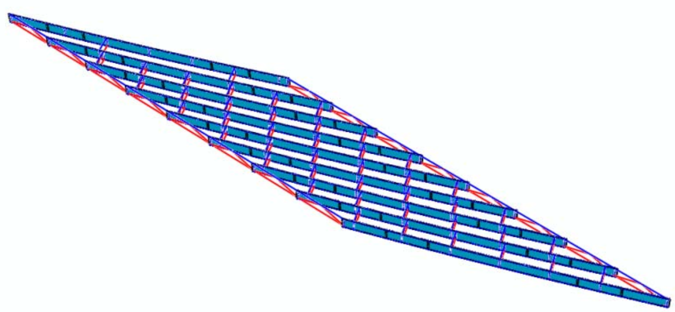
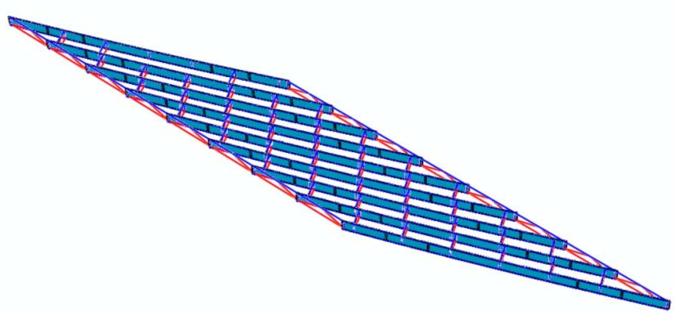
Sub-Stage	Stage 9
1	
2	
3	

Table I1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

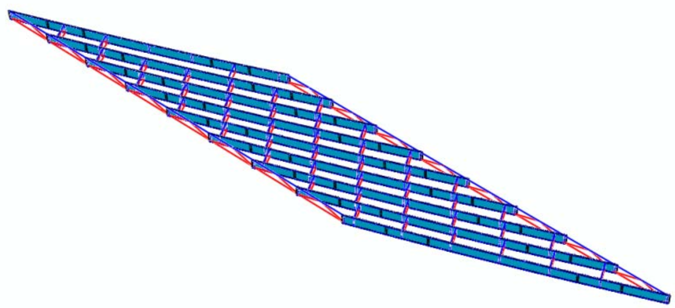
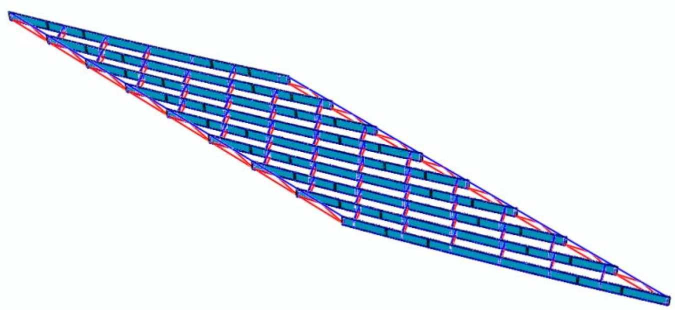
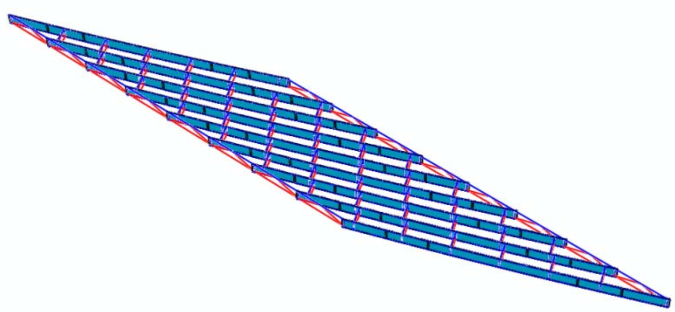
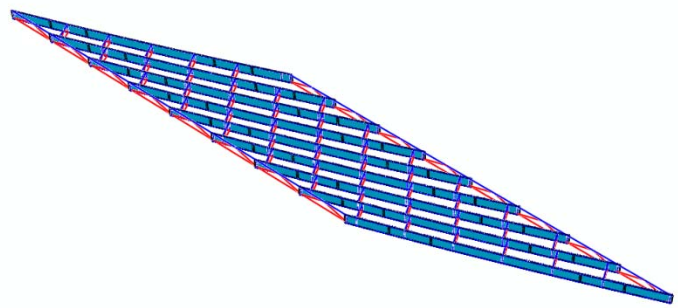
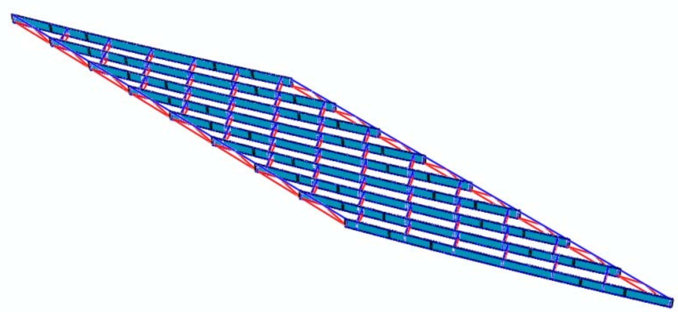
Sub-Stage	Stage 9
4	
5	
6	

Table I1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

Sub-Stage	Stage 9
7	
8	

Appendix I1-2. NISSS14 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISSS14 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table I1-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.9	8.4
	SDLF	1.7	8.2
	TDLF	3.5	7.1
G2	NLF	1.4	6.0
	SDLF	1.8	6.5
	TDLF	1.9	7.9
G3	NLF	1.1	4.8
	SDLF	1.8	5.6
	TDLF	3.2	7.9
G4	NLF	1.0	4.5
	SDLF	1.8	5.3
	TDLF	4.0	7.9
G5	NLF	1.0	4.4
	SDLF	1.8	5.2
	TDLF	4.3	7.9
G6	NLF	1.0	4.5
	SDLF	1.8	5.3
	TDLF	4.0	7.9
G7	NLF	1.1	4.8
	SDLF	1.8	5.6
	TDLF	3.2	7.9
G8	NLF	1.4	6.0
	SDLF	1.8	6.5
	TDLF	1.9	7.9
G9	NLF	1.9	8.5
	SDLF	1.7	8.2
	TDLF	3.5	7.2
All Girders	NLF	1.9	8.5
	SDLF	1.8	8.2
	TDLF	4.3	7.9

Table I1-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.7	3.3
	SDLF	0.0	2.6
	TDLF	2.6	0.3
G2	NLF	0.7	3.1
	SDLF	0.0	2.4
	TDLF	2.5	0.1
G3	NLF	0.5	2.4
	SDLF	0.0	1.9
	TDLF	2.1	0.1
G4	NLF	0.4	1.7
	SDLF	0.0	1.3
	TDLF	1.6	0.1
G5	NLF	0.4	1.7
	SDLF	0.0	1.3
	TDLF	1.4	0.1
G6	NLF	0.4	1.7
	SDLF	0.0	1.3
	TDLF	1.6	0.1
G7	NLF	0.5	2.4
	SDLF	0.0	1.9
	TDLF	2.1	0.1
G8	NLF	0.7	3.1
	SDLF	0.0	2.4
	TDLF	2.5	0.1
G9	NLF	0.7	3.3
	SDLF	0.0	2.6
	TDLF	2.6	0.3
All Girders	NLF	0.7	3.3
	SDLF	0.0	2.6
	TDLF	2.6	0.3

Table I1-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	5.1	22.5	7.4	32.5	2.3	13.0	6.6	26.2
	SDLF	3.9	21.3	6.0	30.8	0.3	9.9	0.5	19.5
	TDLF	3.2	17.1	5.8	25.7	0.4	1.4	5.7	4.7
G2	NLF	3.9	17.3	5.7	25.2	4.6	19.3	13.2	58.6
	SDLF	4.4	17.7	6.7	25.7	0.3	14.9	0.7	44.0
	TDLF	6.3	19.1	10.1	28.7	4.0	1.3	14.7	3.1
G3	NLF	2.8	12.5	4.1	18.0	3.9	17.0	10.9	48.7
	SDLF	4.4	14.0	6.7	20.2	0.3	13.1	0.8	36.8
	TDLF	8.0	18.9	12.4	28.5	7.6	1.3	23.1	3.7
G4	NLF	2.5	11.0	3.9	16.8	3.6	16.0	9.4	41.6
	SDLF	4.4	12.8	6.7	19.5	0.4	12.4	0.9	31.5
	TDLF	10.8	18.8	15.5	28.5	11.6	1.6	31.2	3.8
G5	NLF	2.5	10.7	3.8	16.5	3.2	14.7	8.5	37.2
	SDLF	4.4	12.6	6.7	19.3	0.4	11.4	0.9	28.4
	TDLF	10.4	18.8	16.2	28.5	8.2	1.7	23.2	3.8
G6	NLF	2.5	11.0	3.9	16.8	3.6	16.0	9.4	41.7
	SDLF	4.4	12.8	6.7	19.5	0.4	12.4	0.9	32.2
	TDLF	10.9	18.8	16.4	28.5	11.4	1.5	28.4	3.9
G7	NLF	2.9	12.5	4.1	18.0	3.9	16.9	10.9	48.7
	SDLF	4.4	14.0	6.7	20.2	0.3	13.1	0.9	37.5
	TDLF	8.1	18.8	13.3	28.5	7.7	1.4	20.1	3.8
G8	NLF	3.9	17.4	5.7	25.2	4.6	19.4	13.1	58.3
	SDLF	4.4	17.7	6.8	25.7	0.2	15.1	0.9	44.5
	TDLF	6.2	18.9	10.7	29.0	5.2	1.0	12.3	3.7
G9	NLF	5.1	22.6	7.4	32.6	2.4	13.6	6.5	25.7
	SDLF	4.0	21.3	6.0	30.8	0.3	10.8	1.1	18.9
	TDLF	3.3	17.2	5.6	25.7	1.8	1.5	8.7	5.2
All Girders	NLF	5.1	22.6	7.4	32.6	4.6	19.4	13.2	58.6
	SDLF	4.4	21.3	6.8	30.8	0.4	15.1	1.1	44.5
	TDLF	10.9	19.1	16.4	29.0	11.6	1.7	31.2	5.2

Table I1-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	20.6	33.5	32.7	33.5
	SDLF	5.6	4.3	1.0	5.6
	TDLF	73.7	93.1	83.9	93.1
TDL	NLF	88.6	144.4	139.9	144.4
	SDLF	62.6	109.4	106.9	109.4
	TDLF	22.9	17.3	3.4	22.9

Table I1-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	5.2	11.3	10.9	8.8
	SDLF	2.5	1.6	0.4	1.7
	TDLF	20.7	31.6	26.1	26.2
TDL	NLF	22.0	49.5	46.2	37.8
	SDLF	16.1	37.3	35.4	28.4
	TDLF	9.3	6.5	1.1	6.5

Table I1-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.97	0.78	0.59	0.51	0.51	0.59	0.78	0.97	0.97
SDLF	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.96	0.96
TDLF	3.86	2.90	2.26	2.20	2.21	2.26	2.90	3.89	3.89

Table I1-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	4.32	3.44	2.59	2.25	2.26	2.60	3.45	4.33	4.33
SDLF	4.15	3.58	2.93	2.67	2.67	2.93	3.58	4.16	4.16
TDLF	4.09	4.05	4.02	4.01	4.01	4.02	4.05	4.10	4.10

Table I1-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.54	0.43	0.33	0.29	0.29	0.33	0.44	0.54	0.54
SDLF	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.53	0.53
TDLF	2.15	1.62	1.26	1.23	1.23	1.26	1.62	2.17	2.17

Table I1-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	2.41	1.92	1.45	1.26	1.26	1.45	1.93	2.42	2.42
SDLF	2.32	2.00	1.64	1.49	1.49	1.64	2.00	2.32	2.32
TDLF	2.28	2.26	2.25	2.24	2.24	2.25	2.26	2.29	2.29

Table I1-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	521	2163
SDLF	521	2163
TDLF	521	2163

Table I1-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	53	224	0.8	2.2	2.7	10.6
SDLF	30	197	0.1	1.5	0.1	7.0
TDLF	56	123	2.9	0.1	3.1	0.4

Table I1-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.25	1.04	0.27	1.04
SDLF	0.21	0.88	0.01	0.68
TDLF	0.47	0.96	0.31	0.04

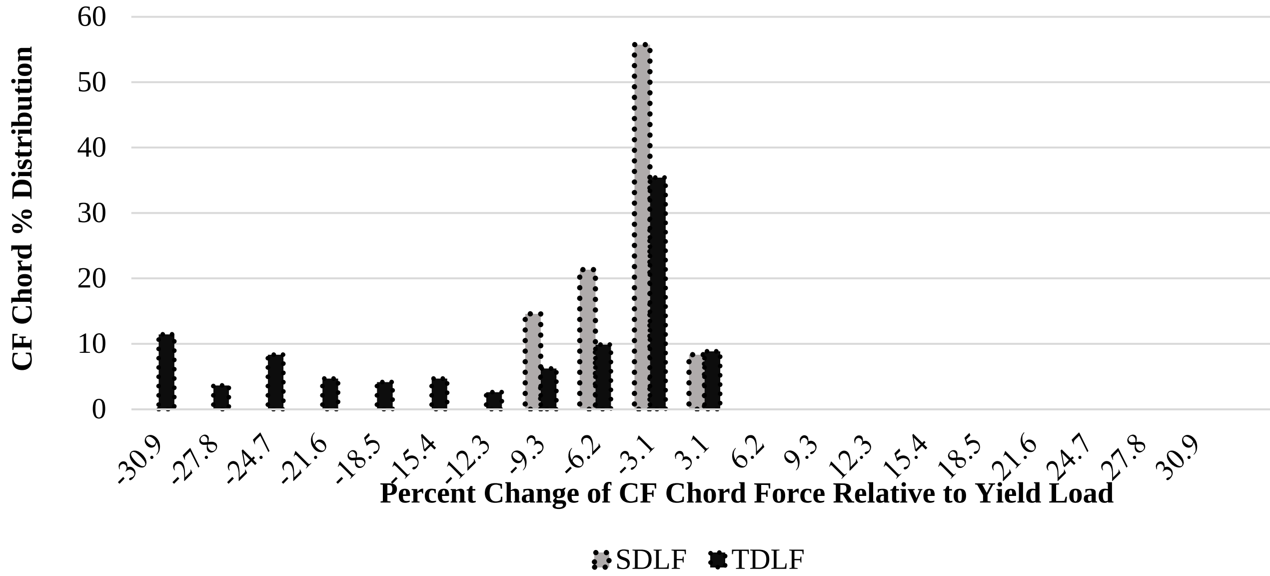


Figure I1-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

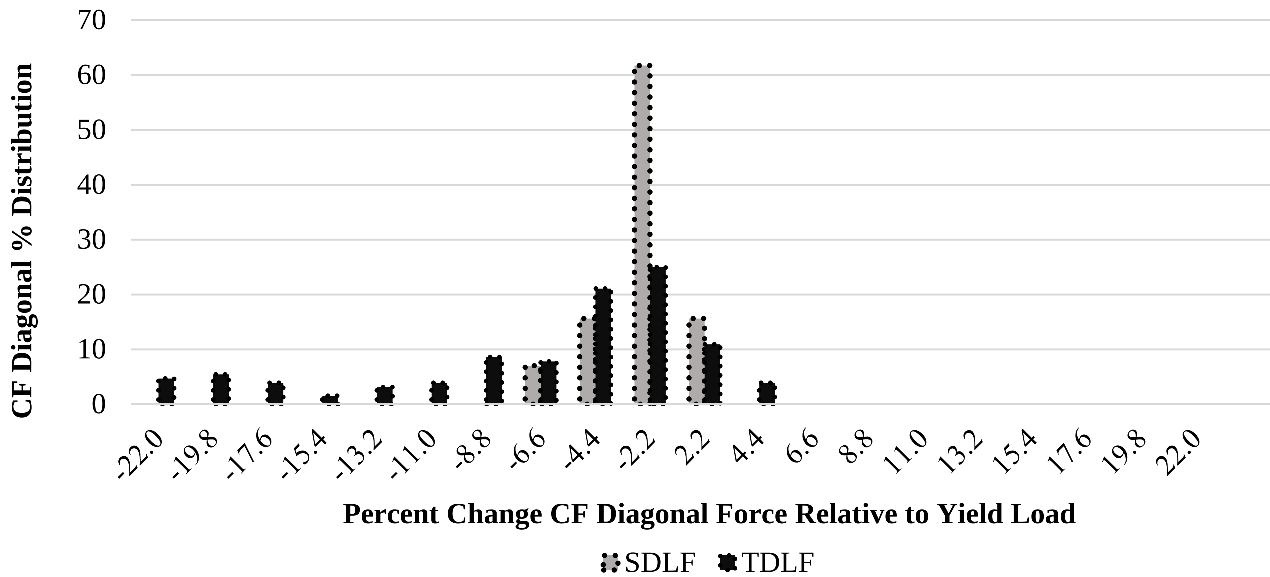


Figure I1-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

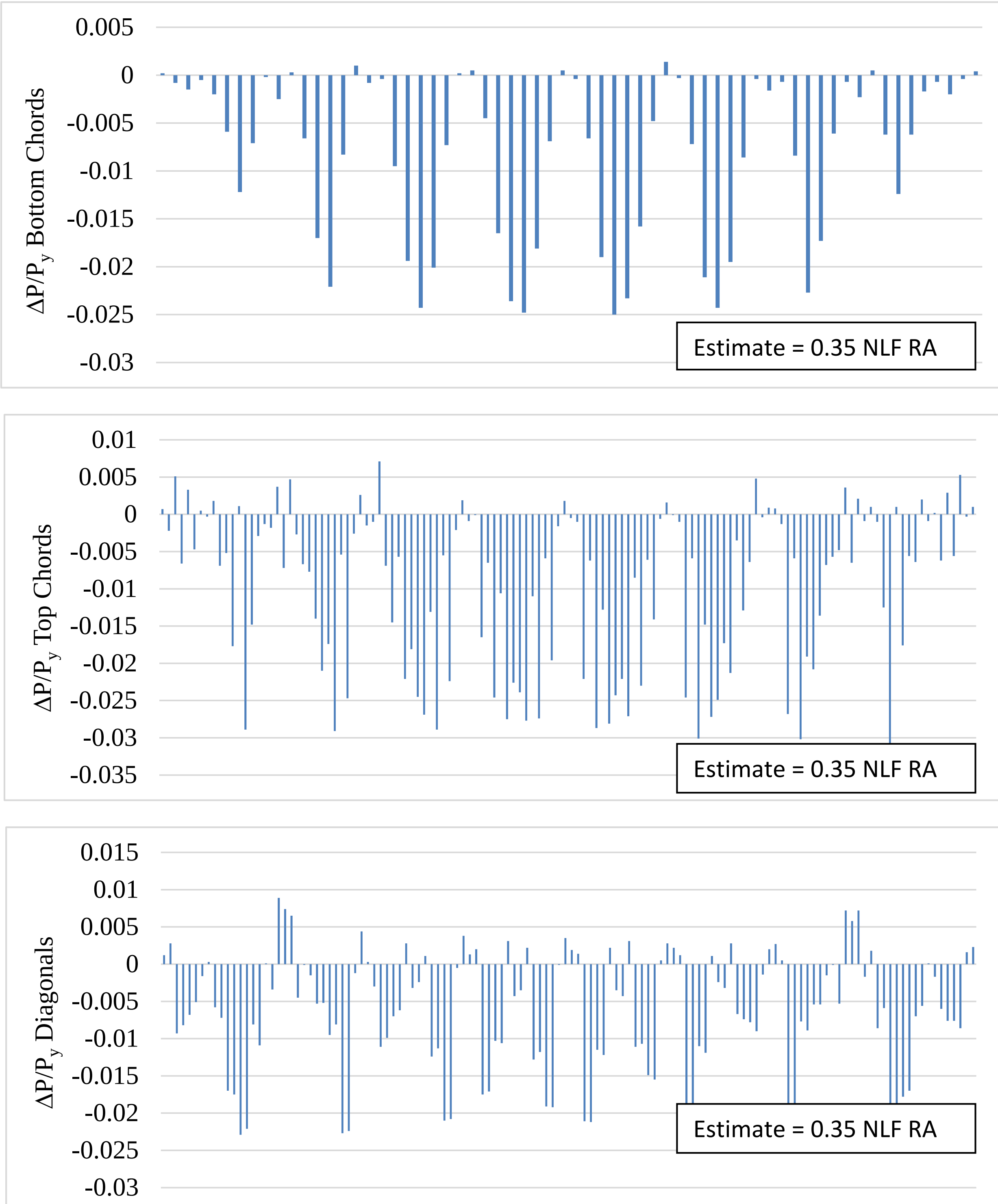


Figure I1-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

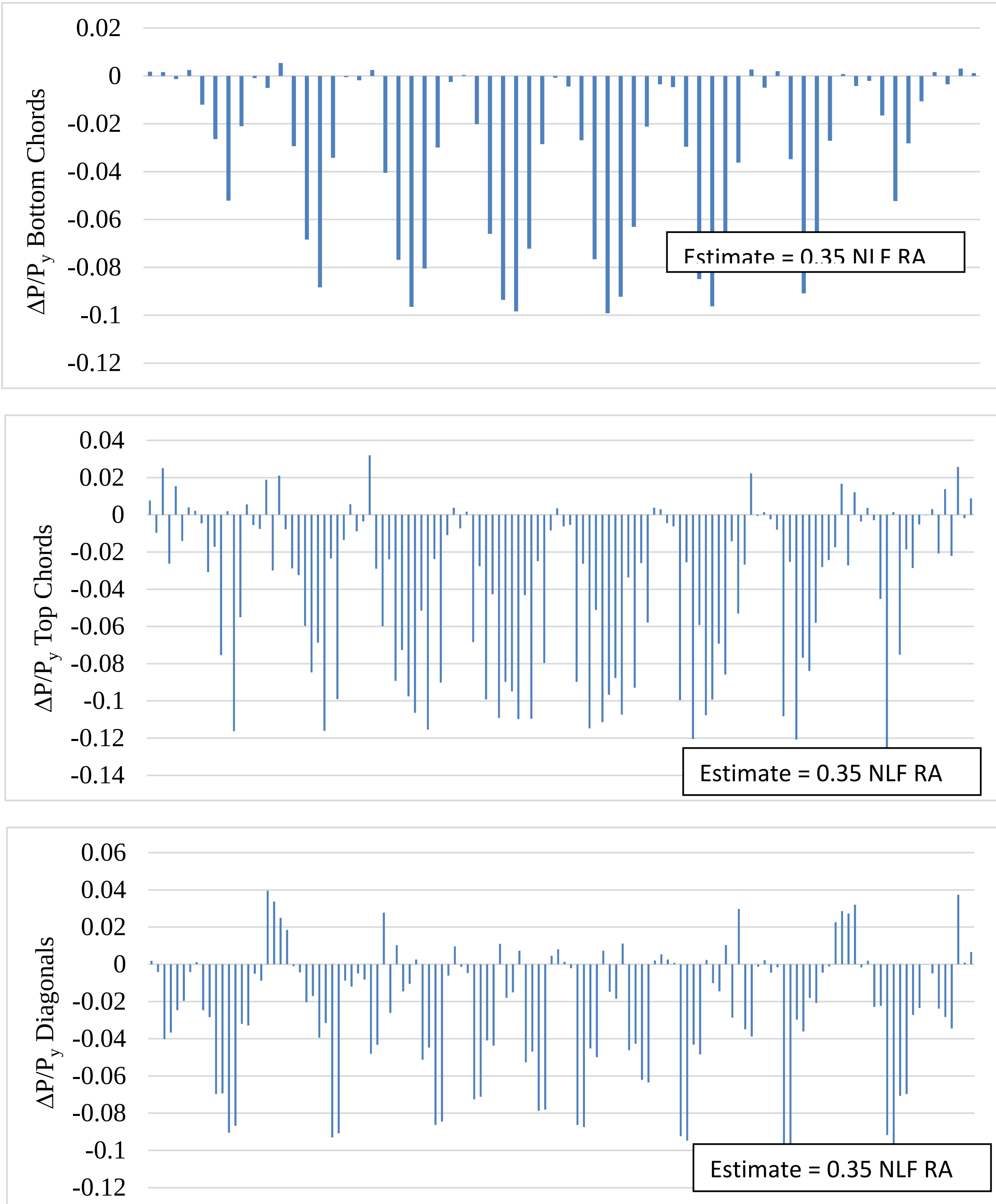


Figure I1-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix I1-3. NISSS14 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISSS14 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table I1-3-1. Maximums of the fit-up force resultants (kips)

Detailing Method	F1	F2	F_{max}
SDLF	1.3	3.6	3.6
TDLF	5.4	15.3	15.3

Table I1-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	SDLF	26	25
	TDLF	26	0
G2	SDLF	30	26
	TDLF	39	0
G3	SDLF	30	25
	TDLF	46	0
G4	SDLF	30	30
	TDLF	56	52
G5	SDLF	31	30
	TDLF	63	52
G6	SDLF	30	30
	TDLF	55	50
G7	SDLF	30	28
	TDLF	24	5
G8	SDLF	30	27
	TDLF	42	0
G9	SDLF	26	25
	TDLF	19	0
All Girders	SDLF	31	25
	TDLF	63	0

Table I1-3-3. Total Vertical Reactions (kips)

Stage	Detailing Method	Sub-Stage							
		1	2	3	4	5	6	7	8
2	SDLF	98	101	102	102	103	104	105	106
	TDLF	98	101	102	102	103	104	105	106
3	SDLF	157	160	161	162	163	164	164	165
	TDLF	157	160	161	162	163	164	164	165
9	SDLF	513	515	516	517	518	519	519	521
	TDLF	513	515	516	517	518	519	519	521

Appendix I1-4. NISSS14 Detailed Results, Completed Bridge Responses

This appendix presents the SDL and TDL responses of the bridge NISSS14 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

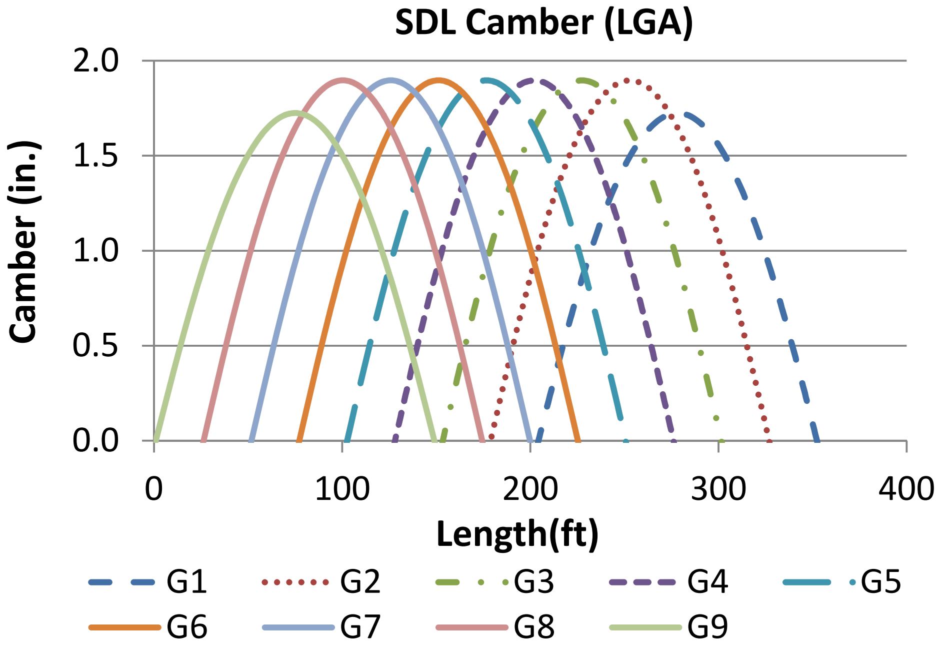
Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Reactions

Support Displacements



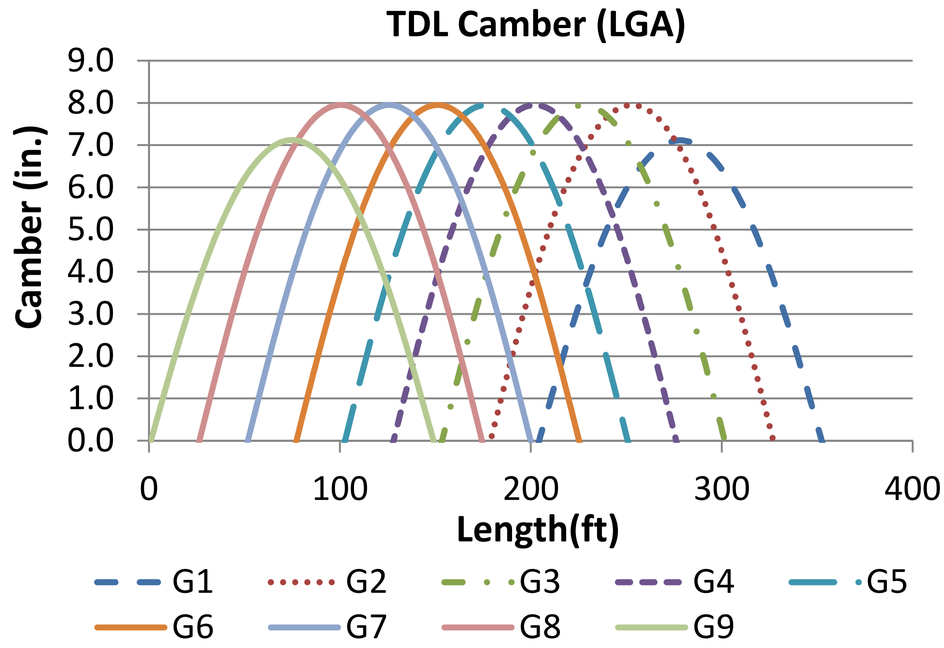


Figure I1-4-1. SDL and TDL Line Girder Analysis cambers.

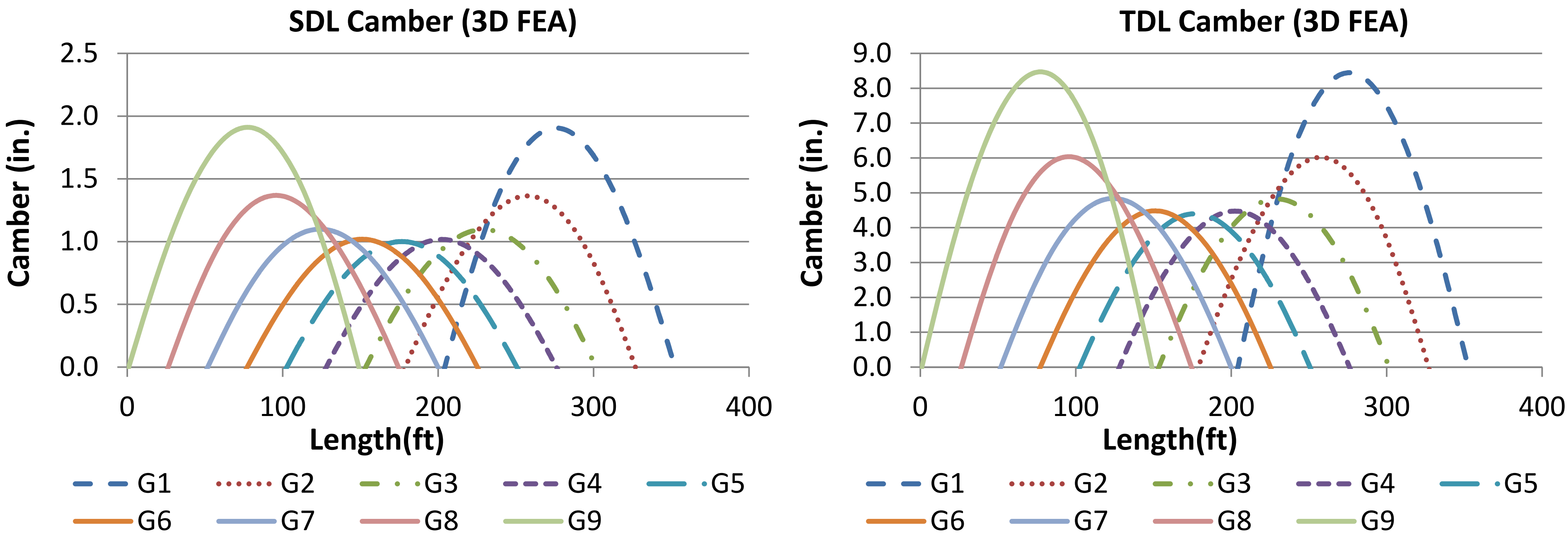


Figure I1-4-2. SDL and TDL 3D FEA cambers.

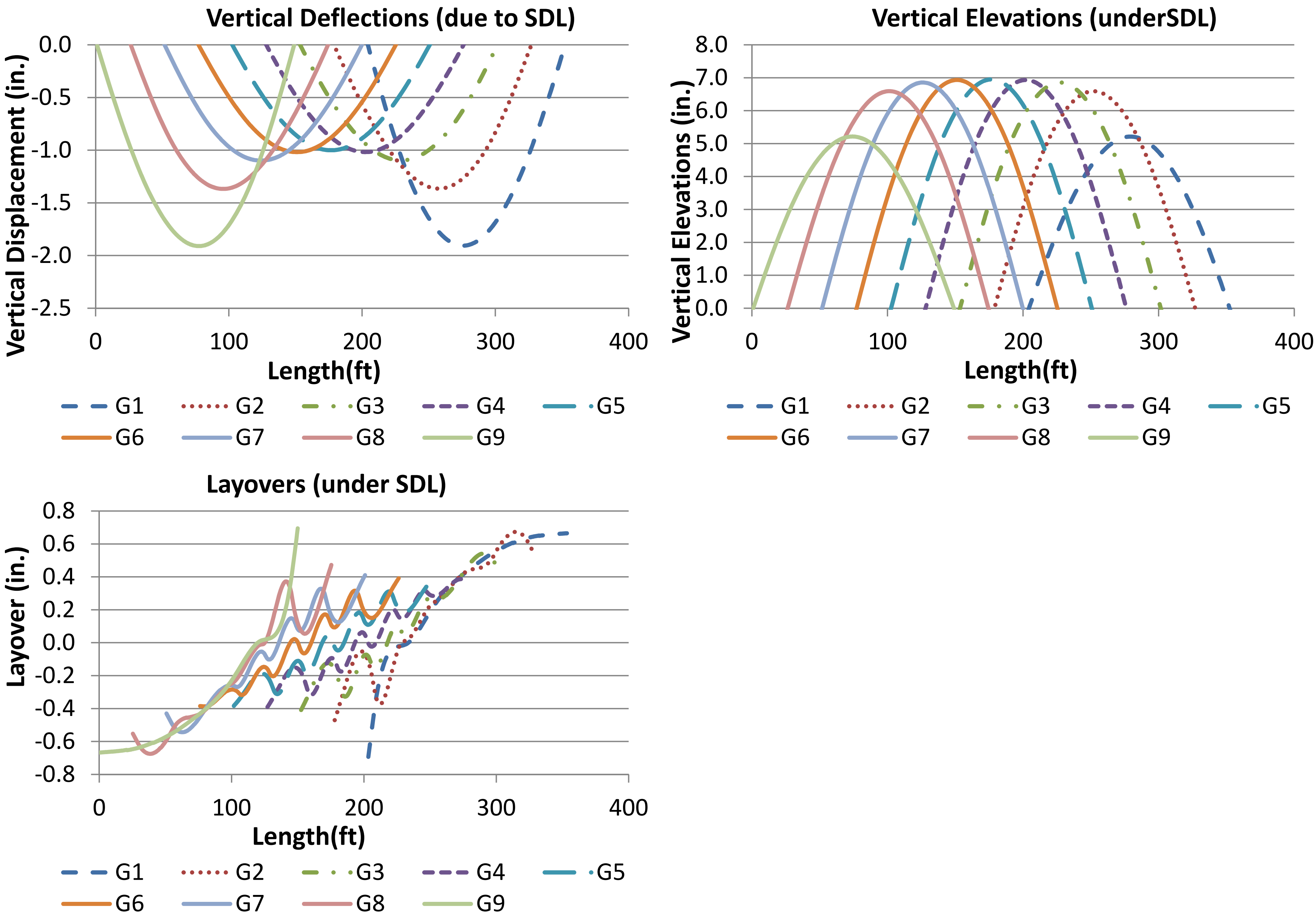


Figure I1-4-3. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

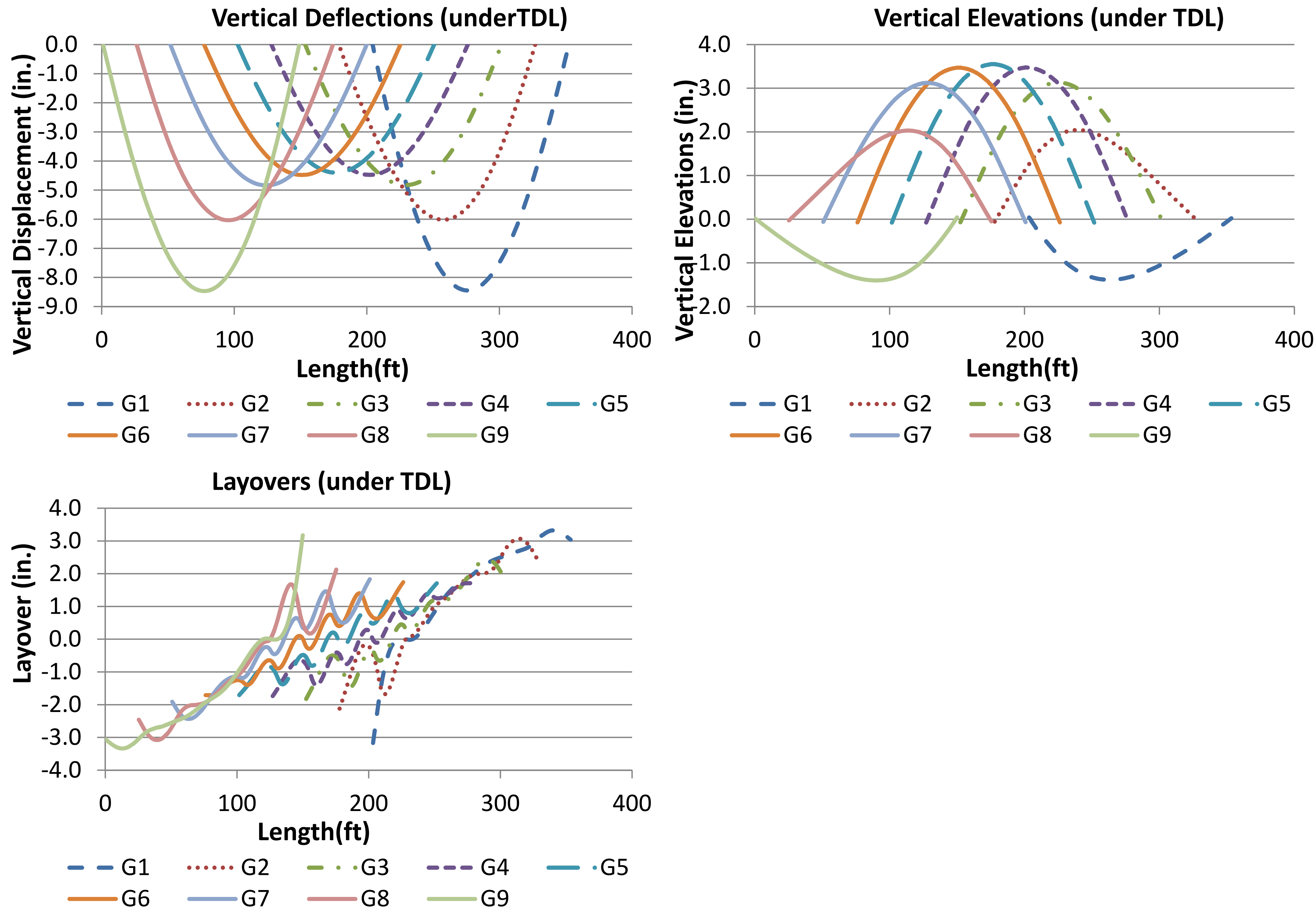


Figure I1-4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

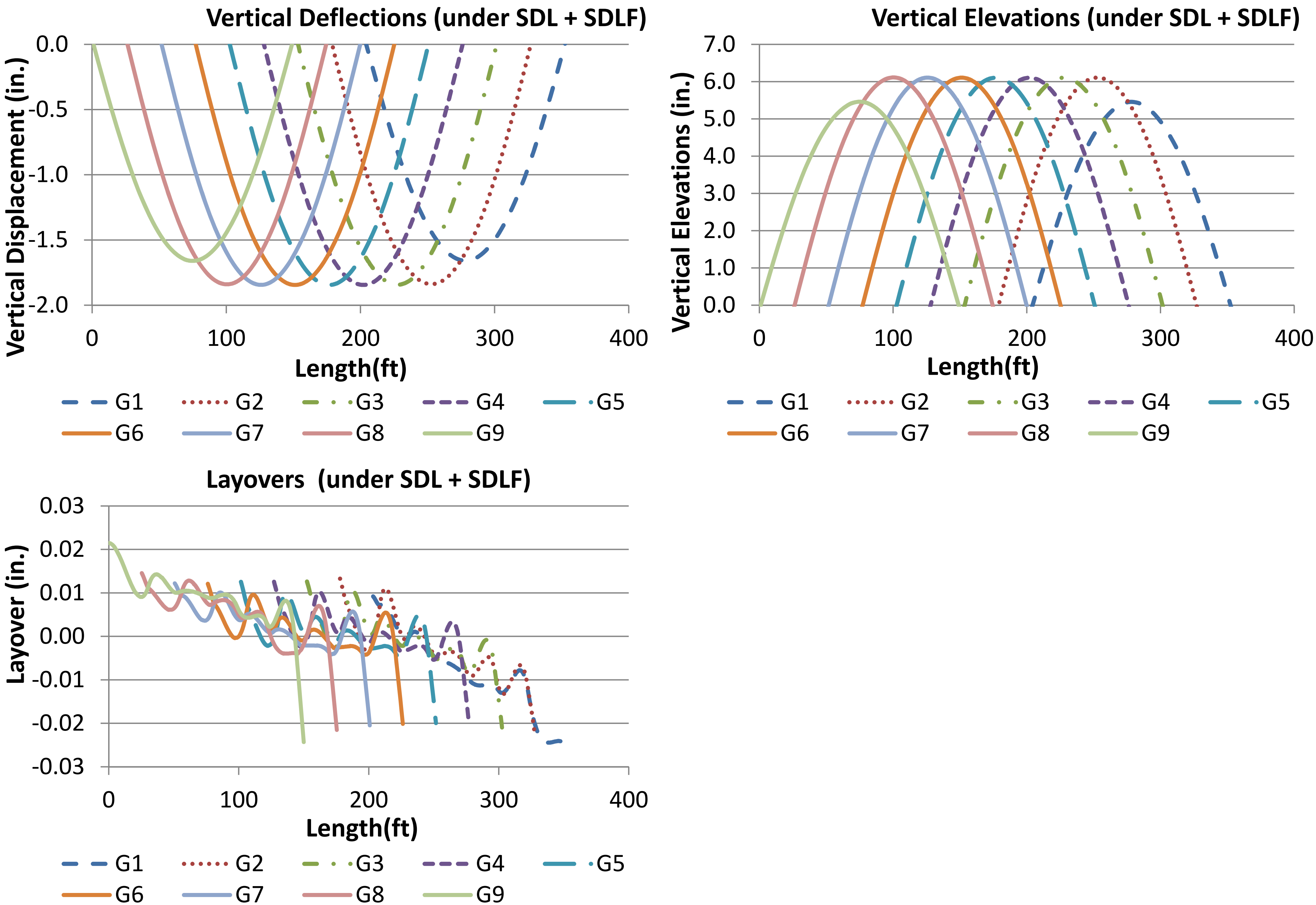


Figure I1-4-5. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

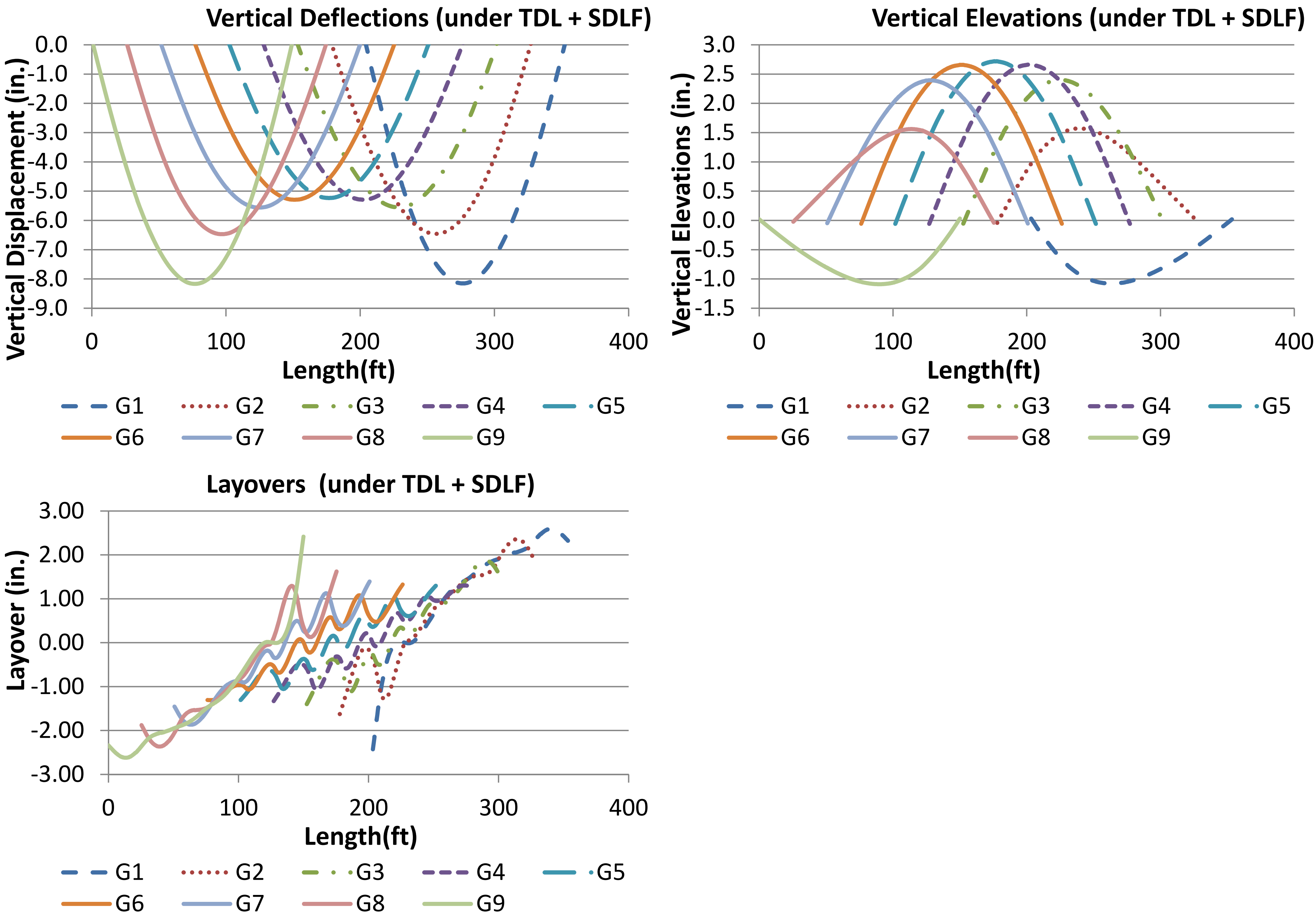


Figure I1-4-6. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

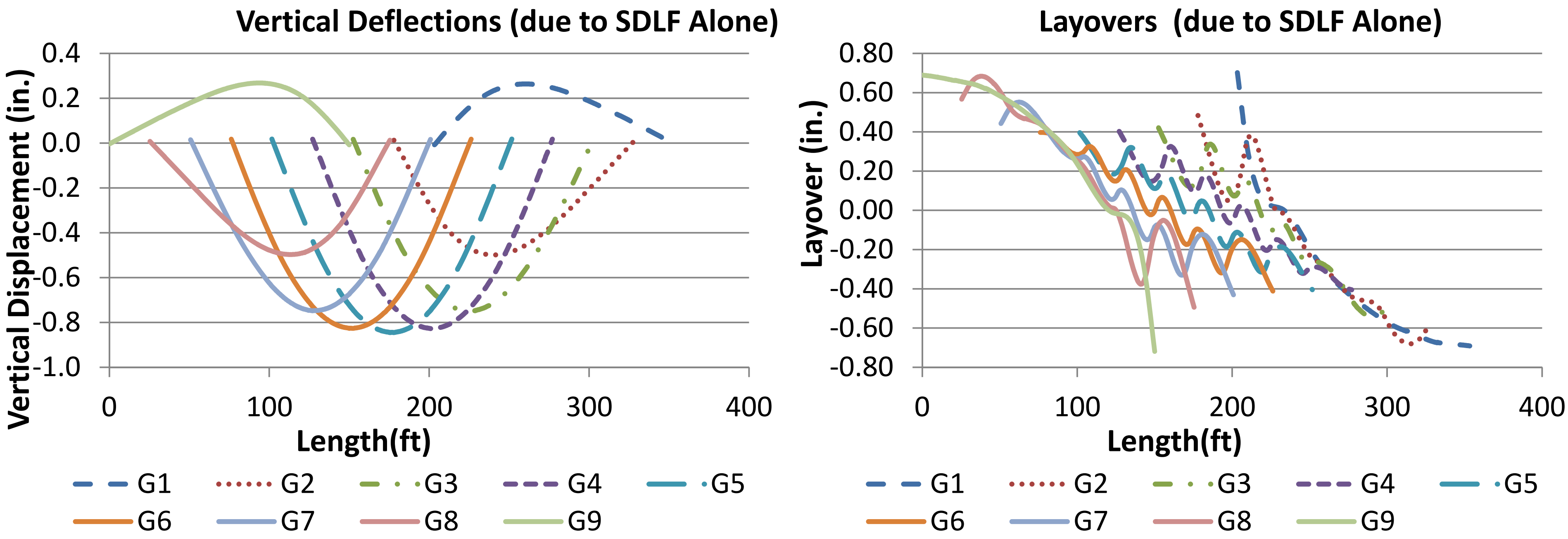


Figure I1-4-7. Bridge displacements due to SDLF detailing effects alone under NL(in).

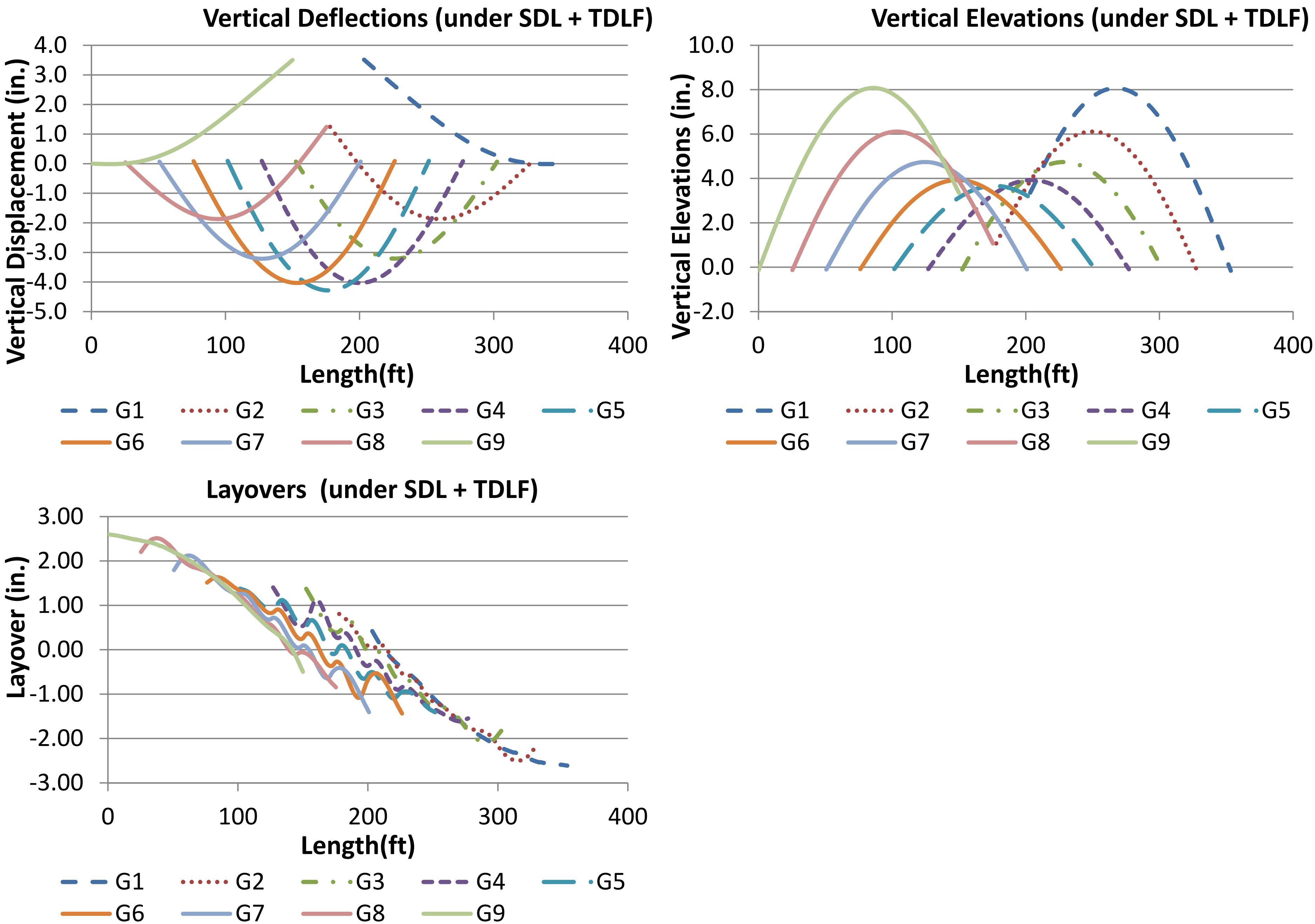


Figure I1-4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

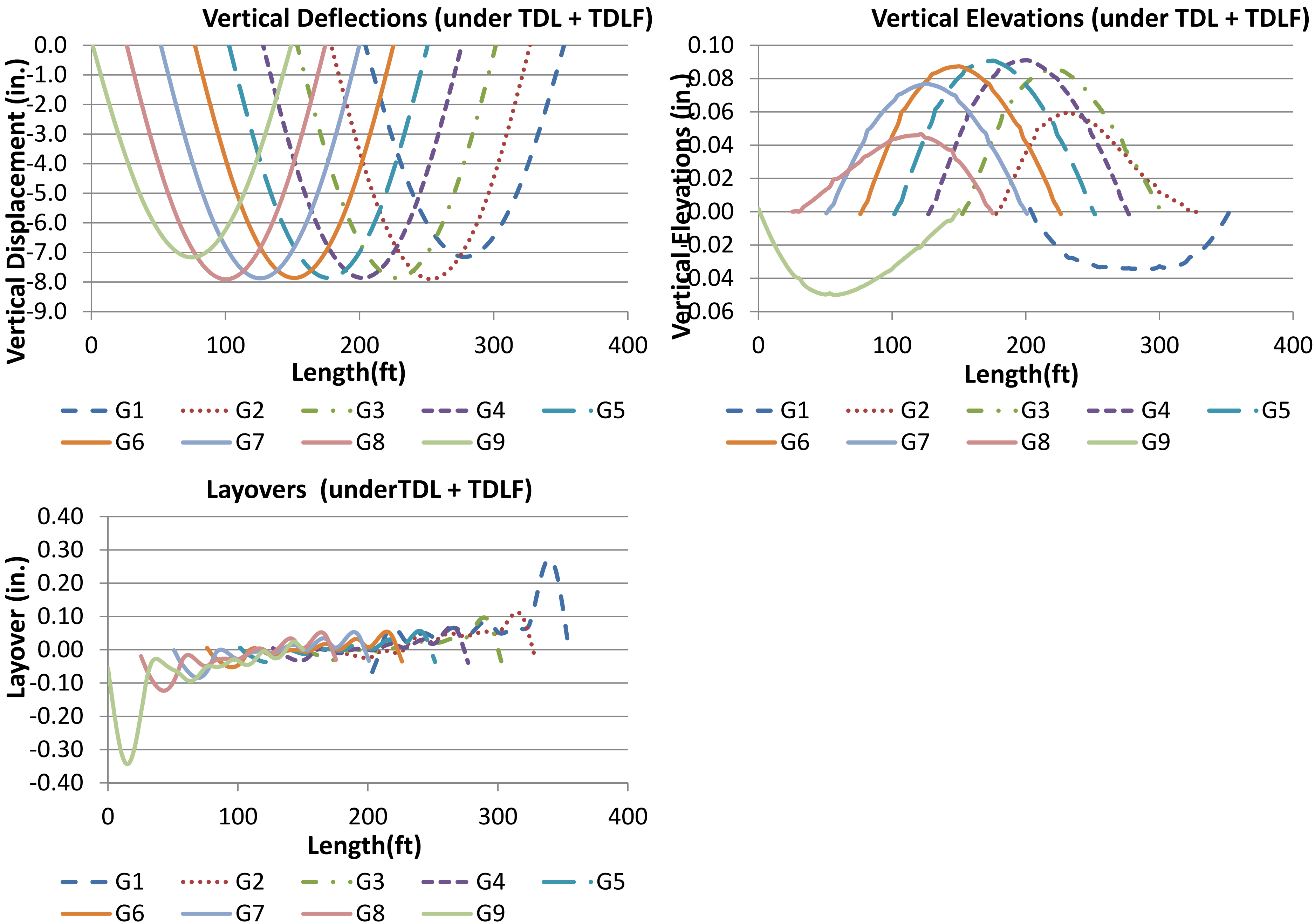


Figure I1-4-9. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

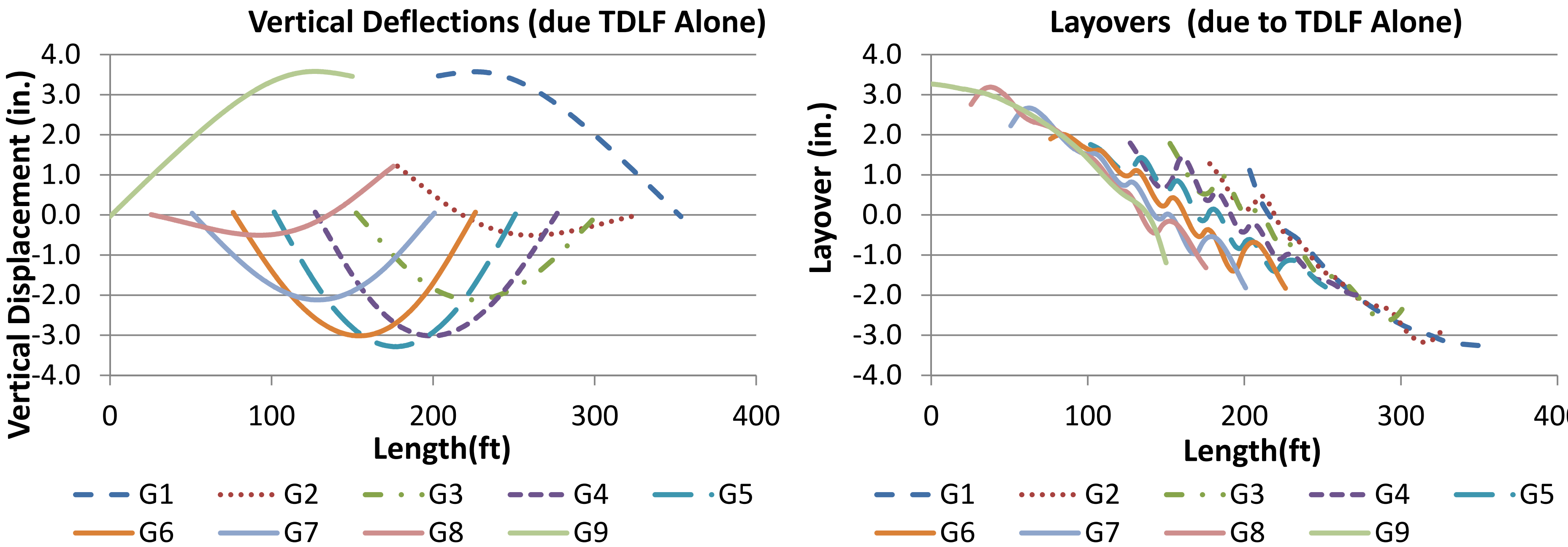


Figure I1-4-10. **Bridge displacements due to TDLF detailing effects alone under NL (in).**

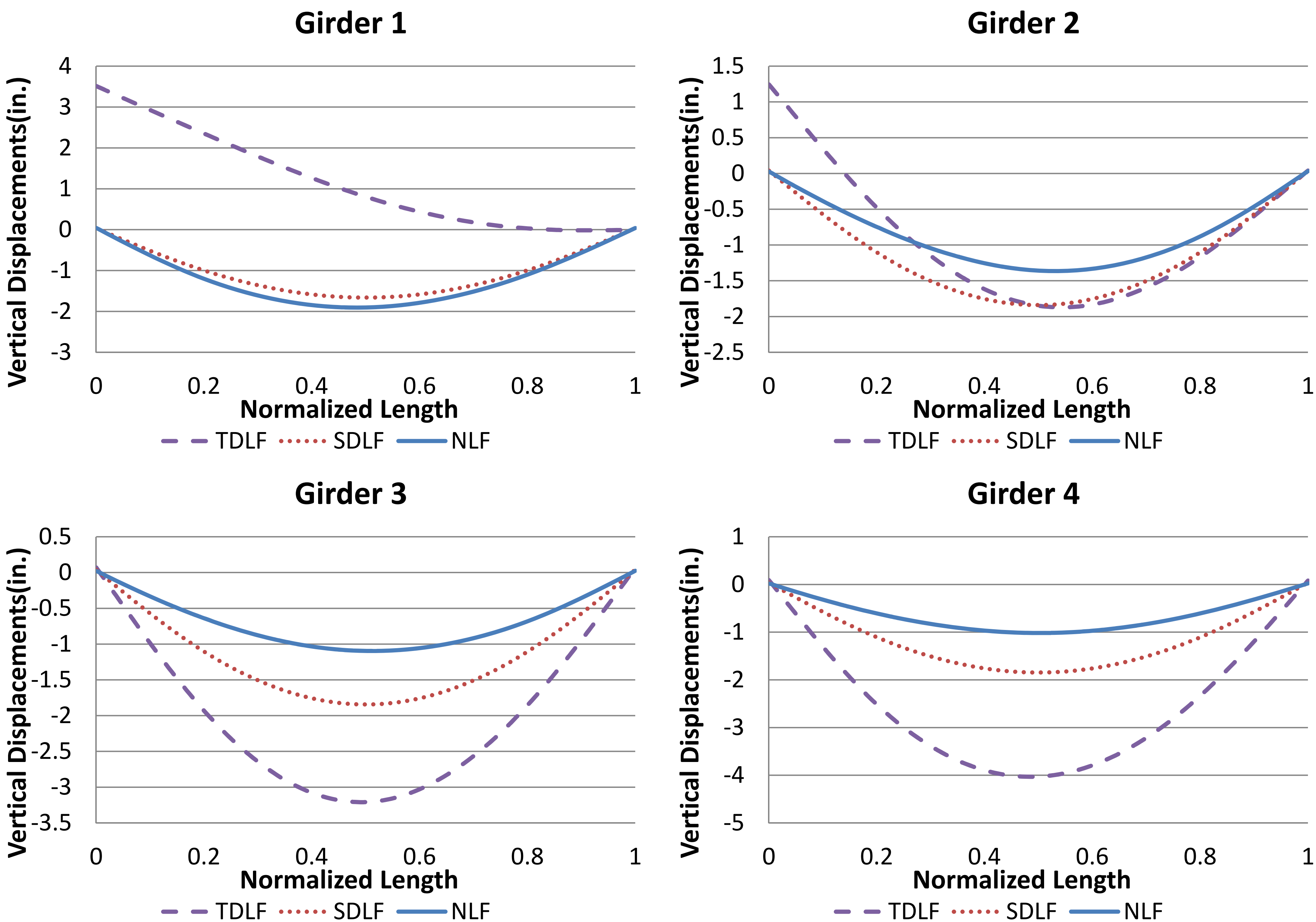


Figure I1-4-11.Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

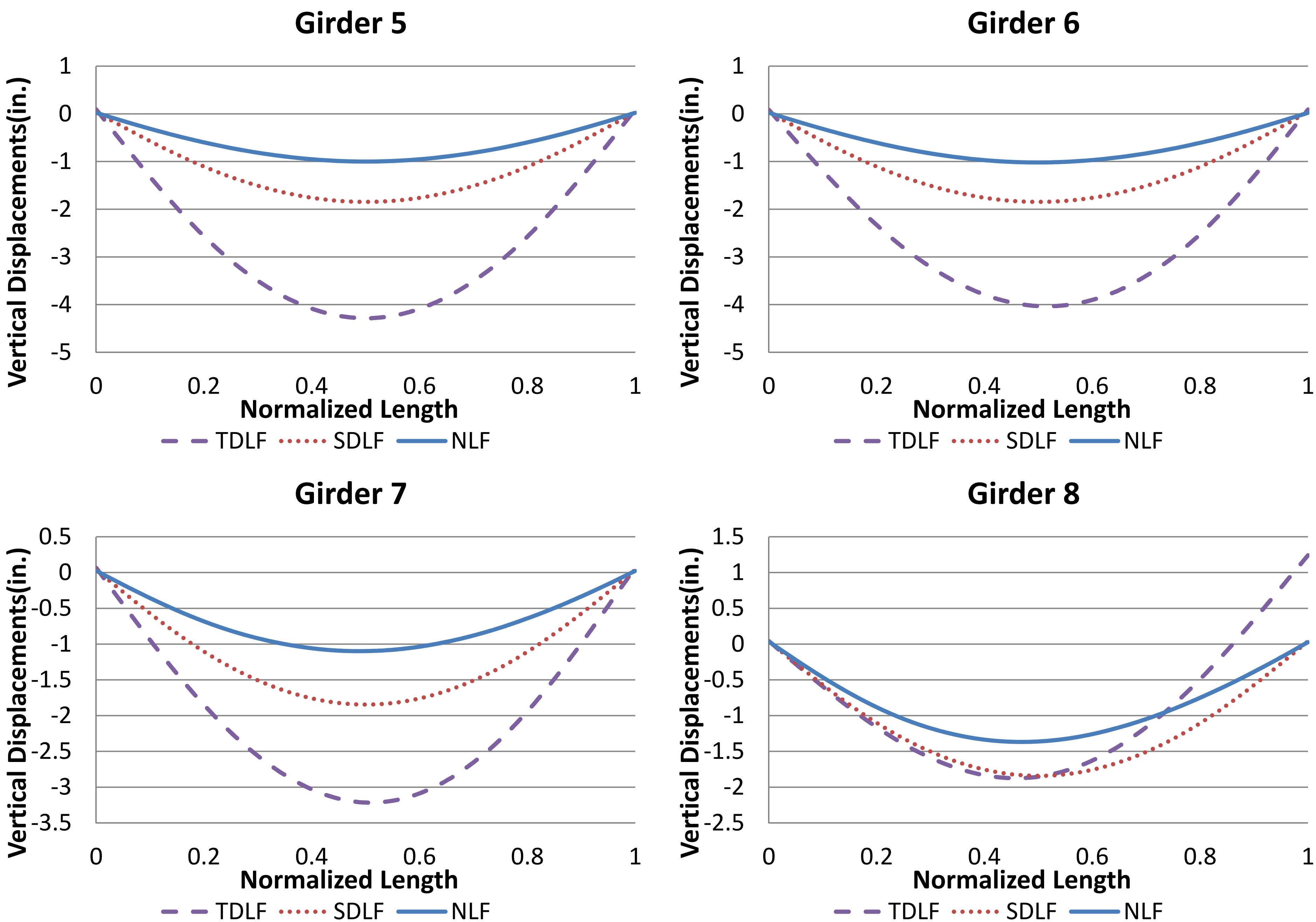


Figure I1-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

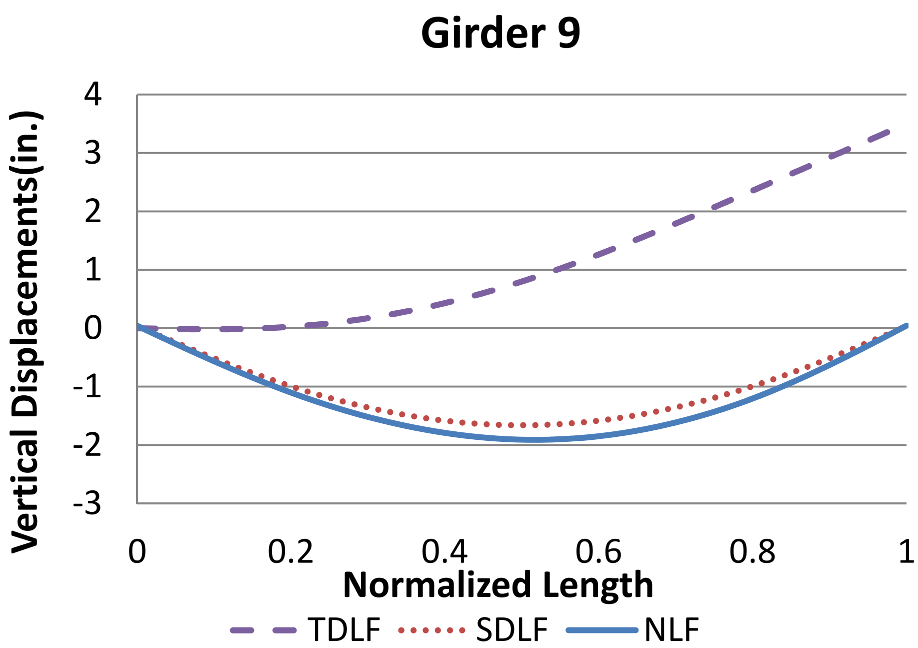


Figure I1-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

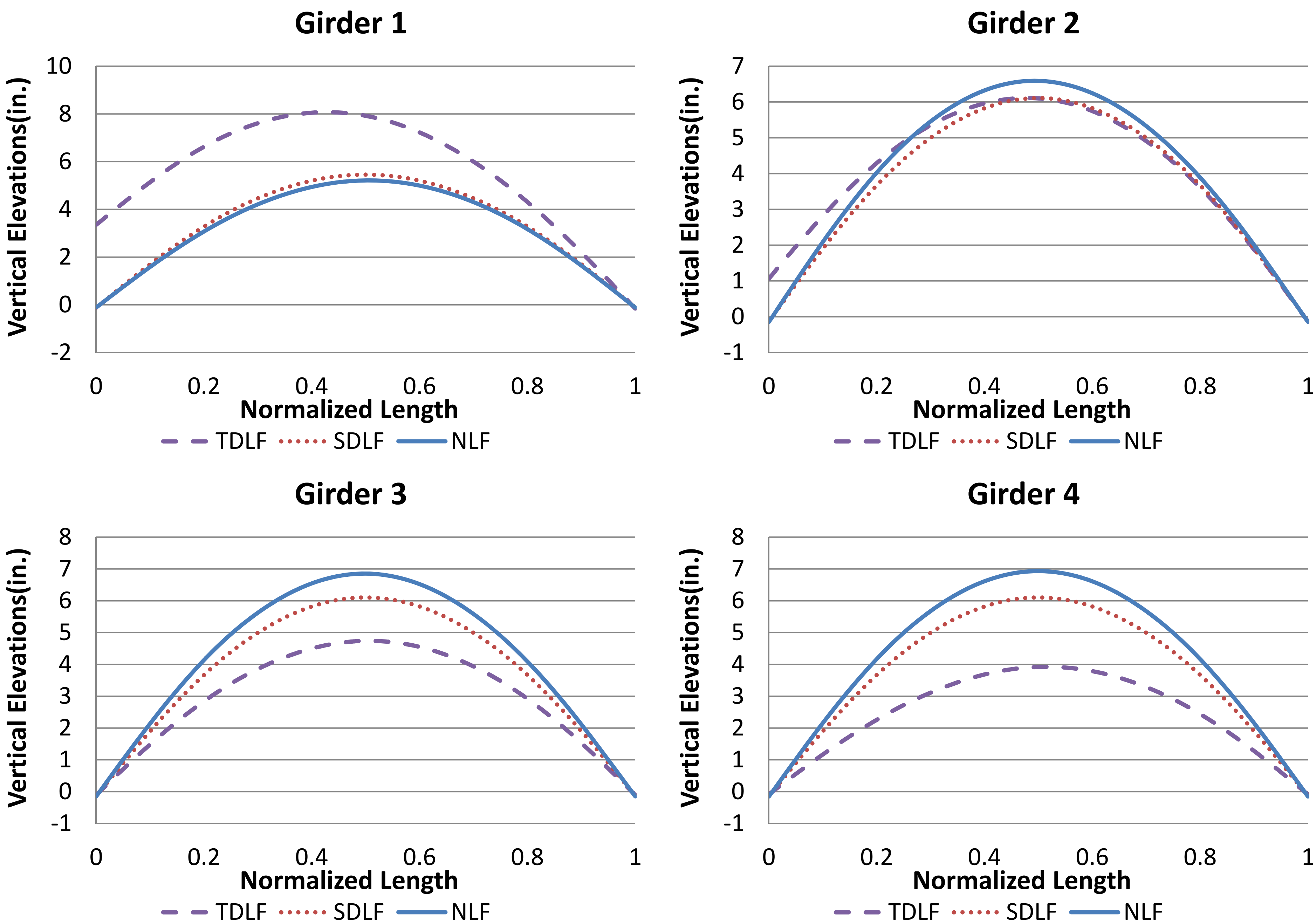


Figure I1-4-12.Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

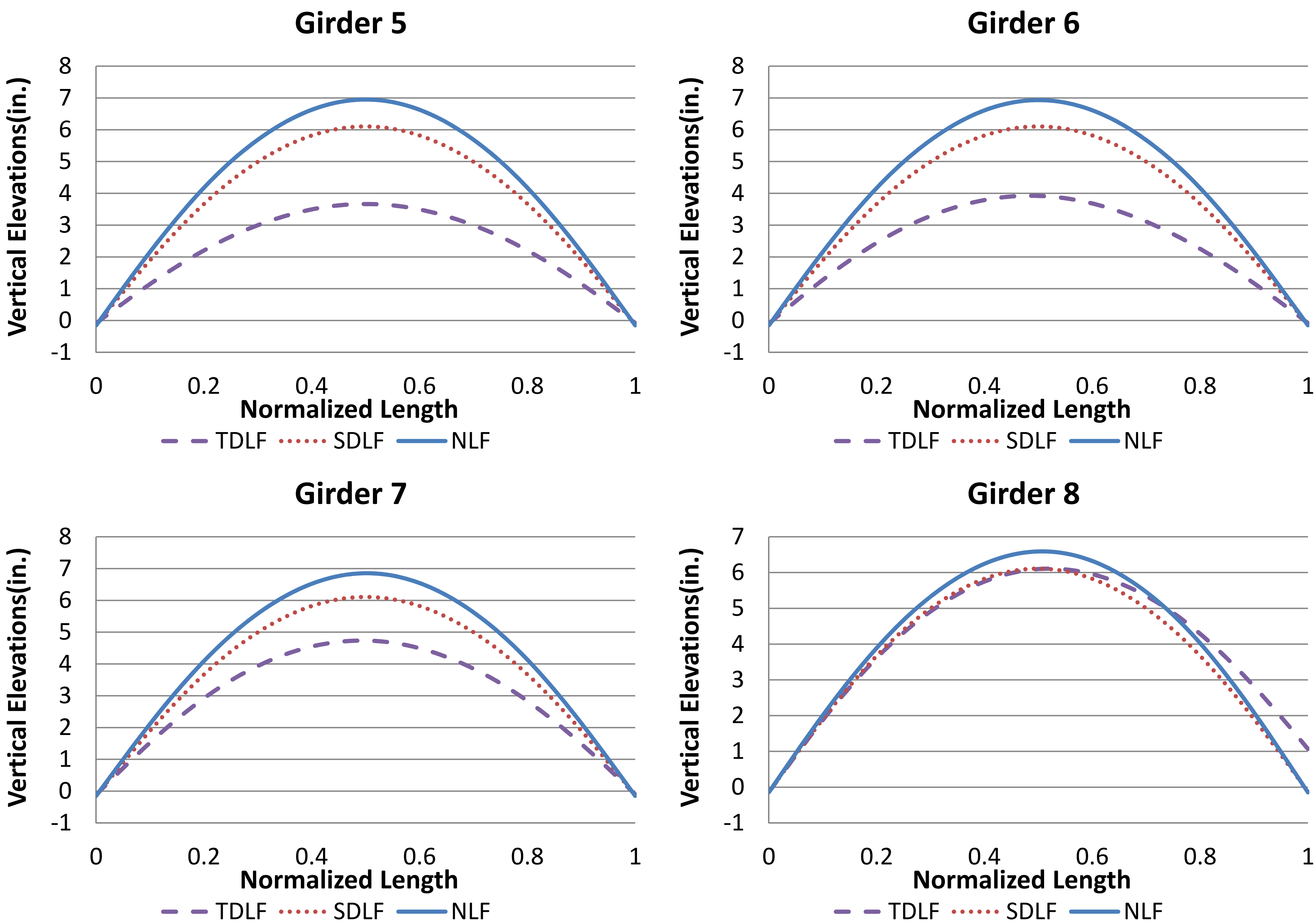


Figure I1-4-12(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

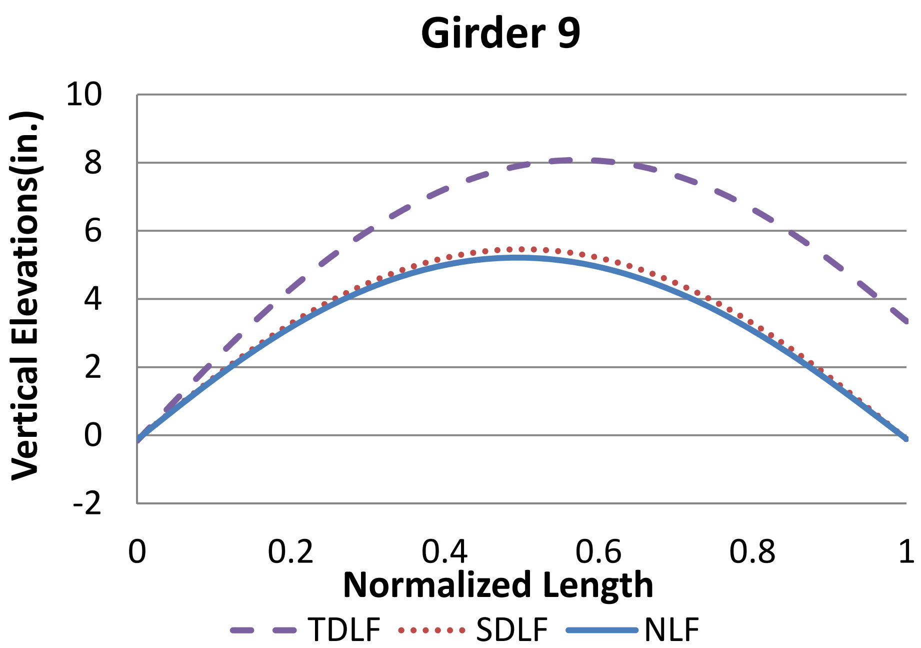


Figure I1-4-12(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

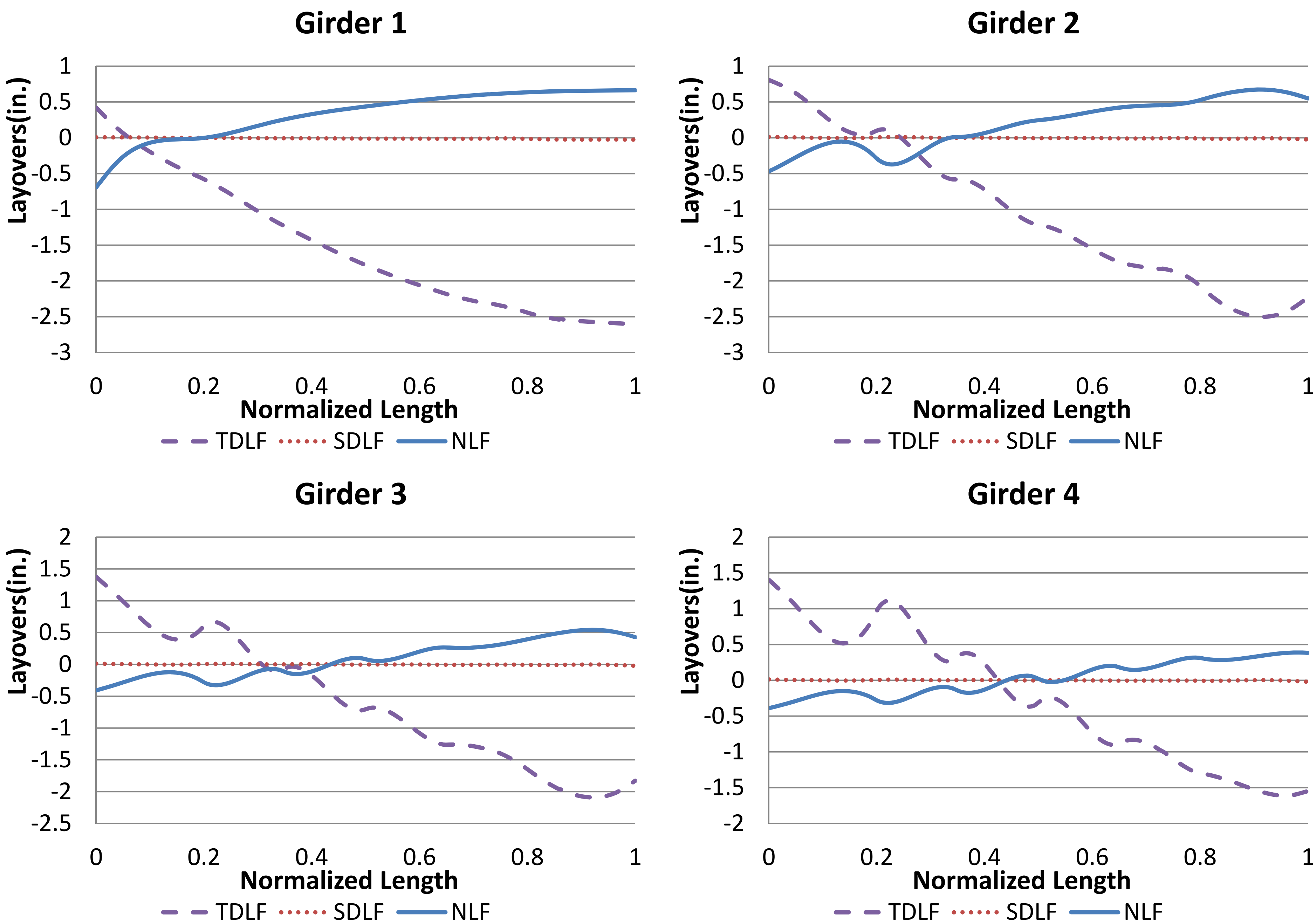


Figure I1-4-13.Comparison of individual girder layovers (in) under SDL for different detailing methods.

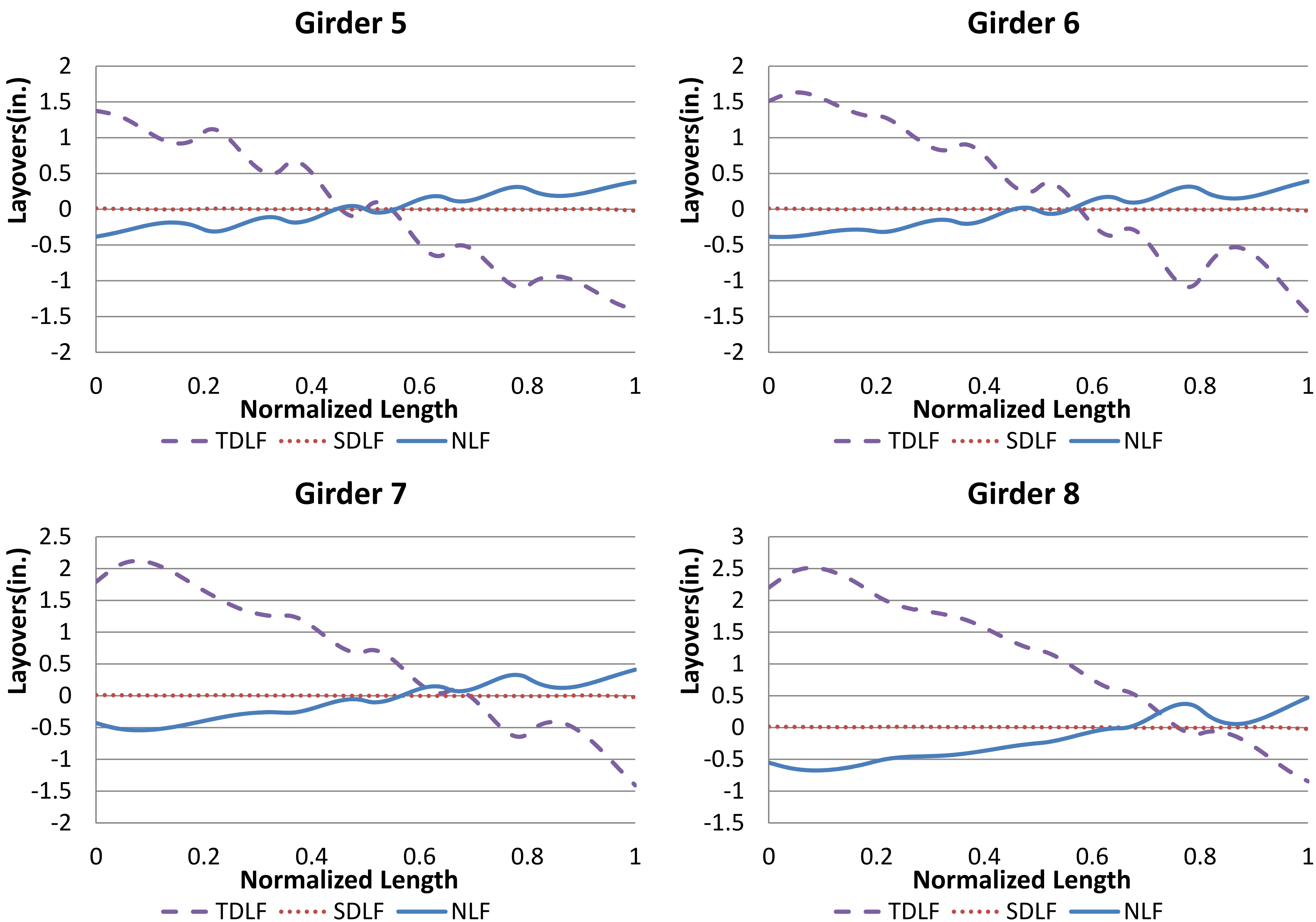


Figure I1-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

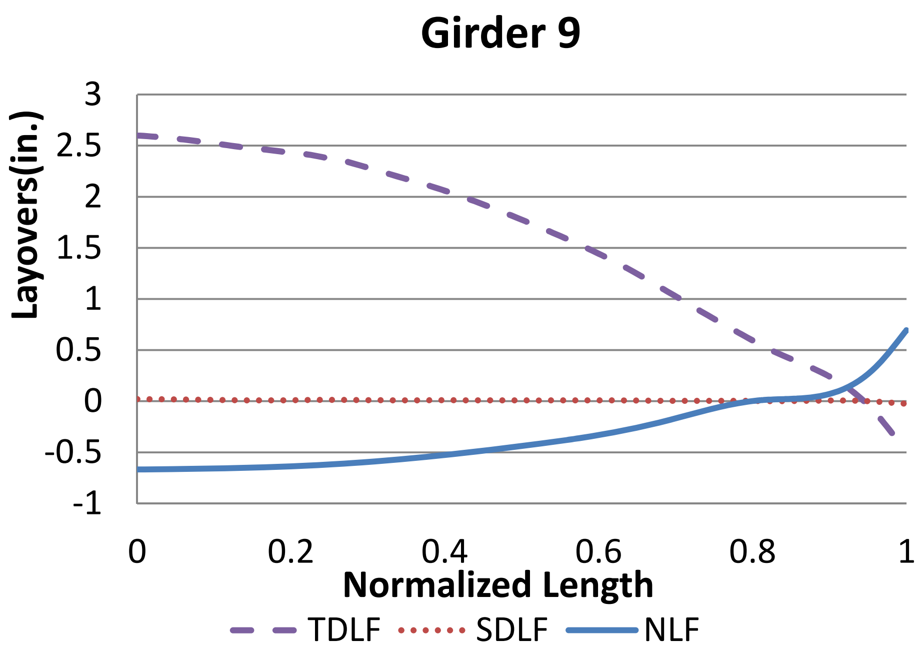


Figure I1-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

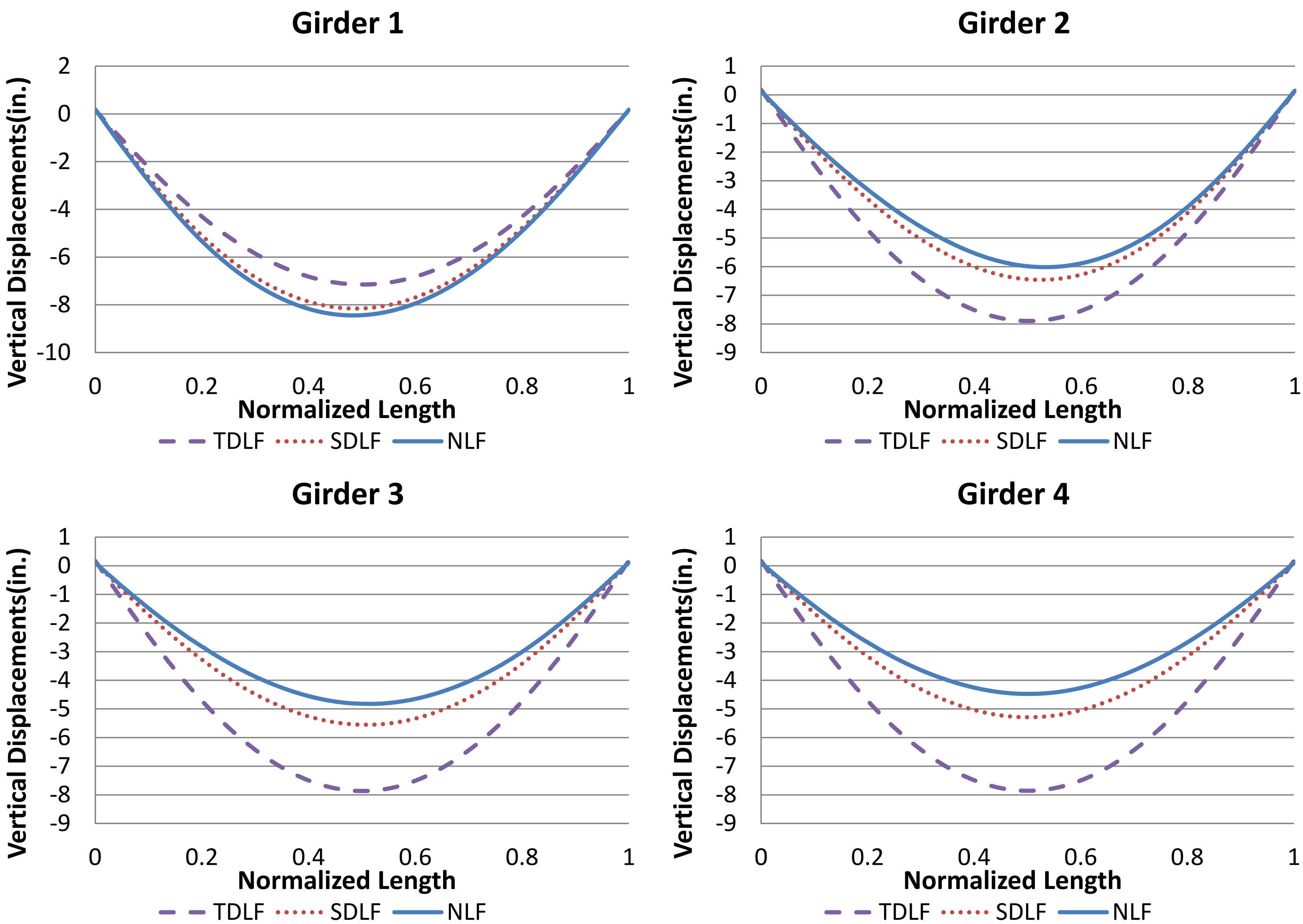


Figure I1-4-14.Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

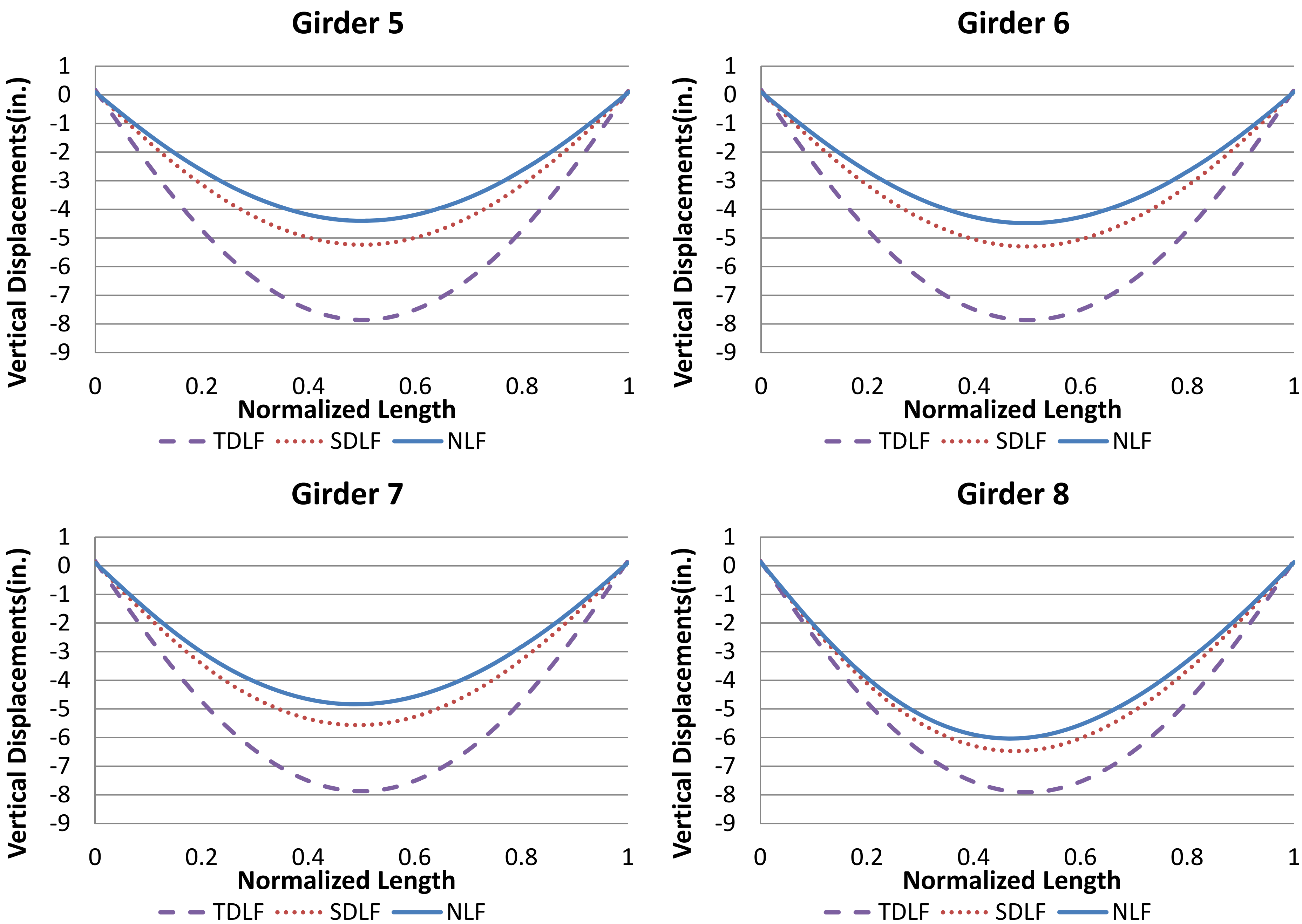


Figure I1-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

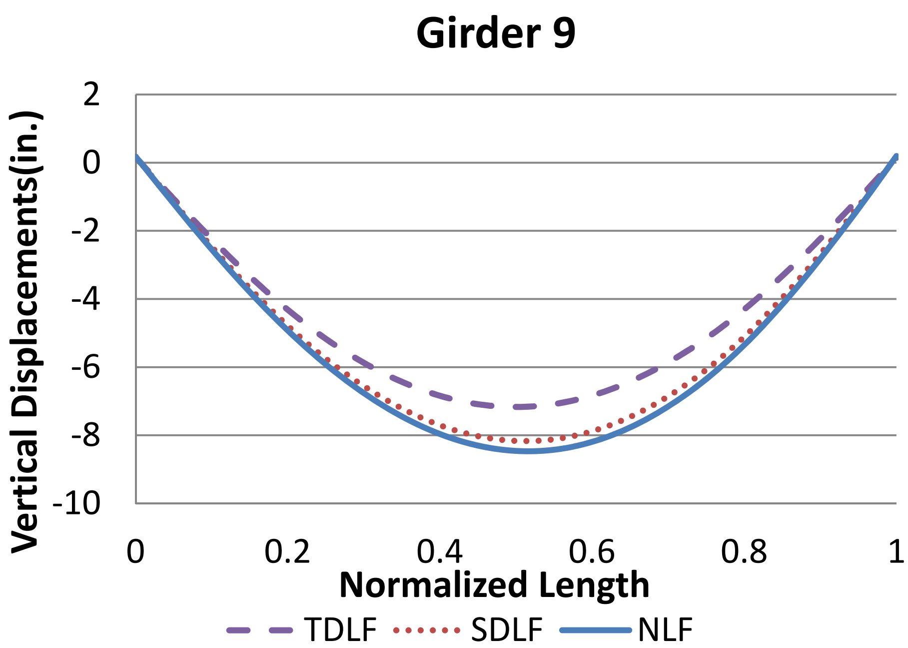


Figure I1-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

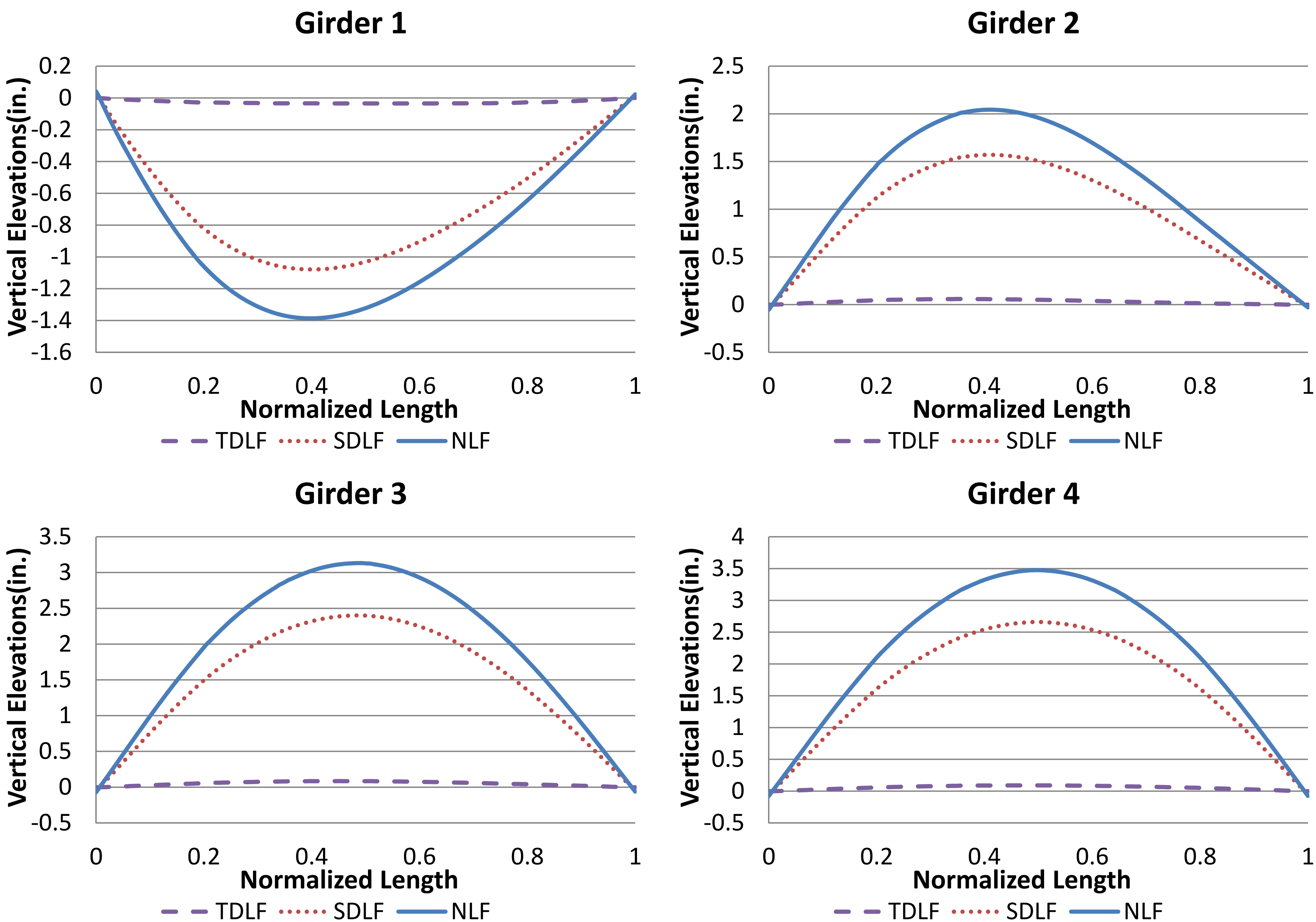


Figure I1-4-15.Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

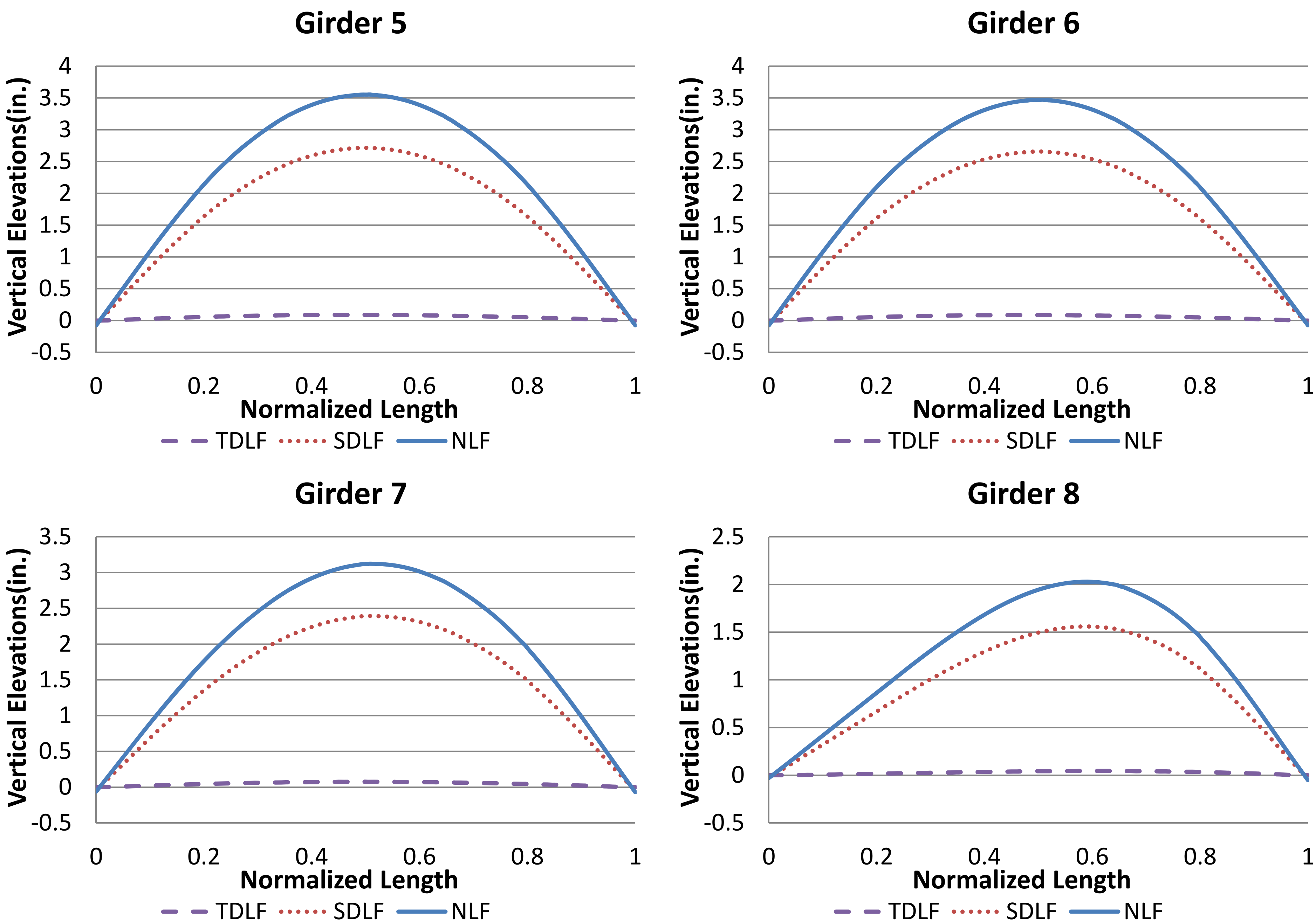


Figure I1-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

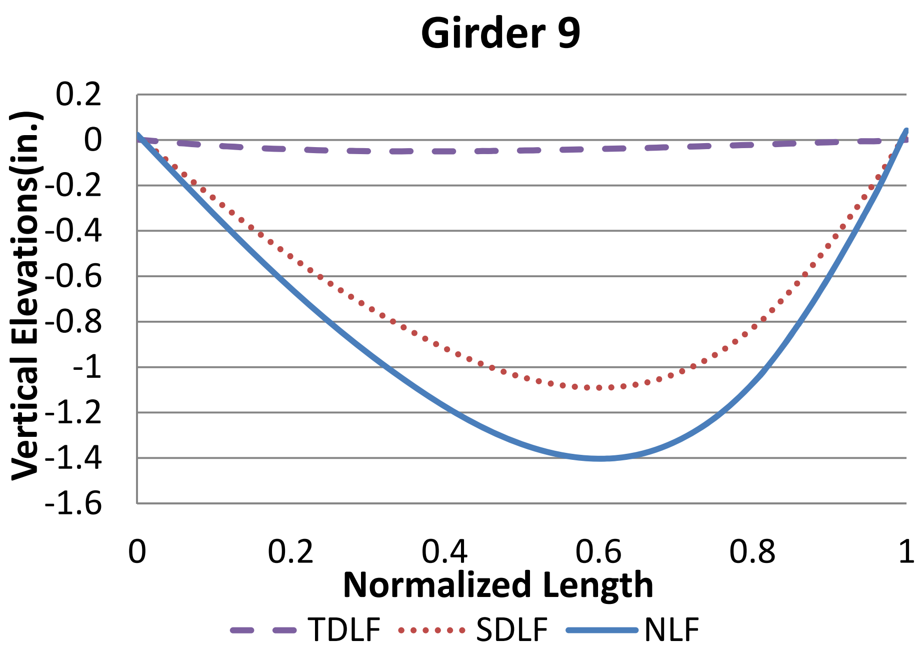


Figure I1-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

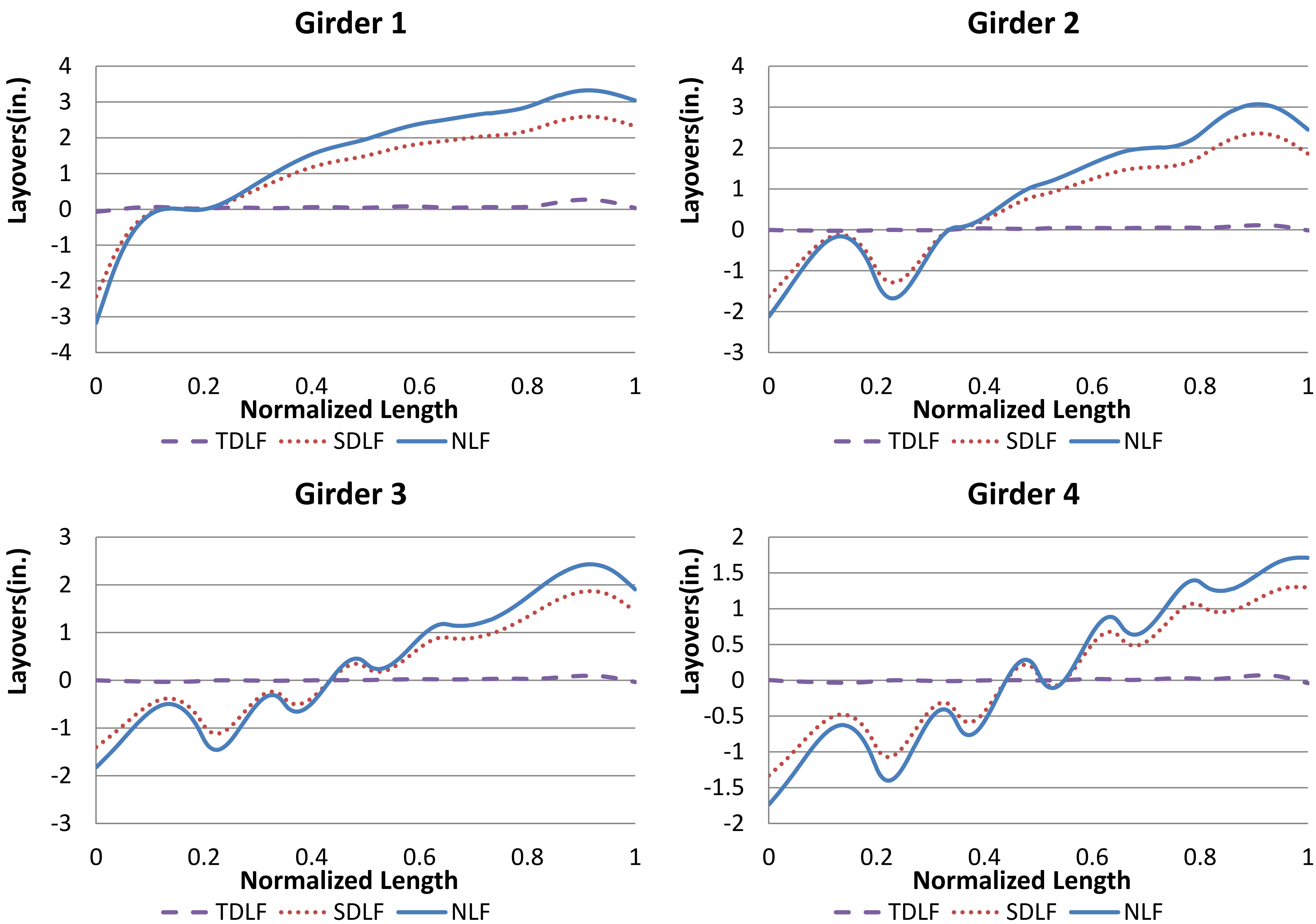


Figure I1-4-16.Comparison of individual girder layovers (in) under TDL for different detailing methods.

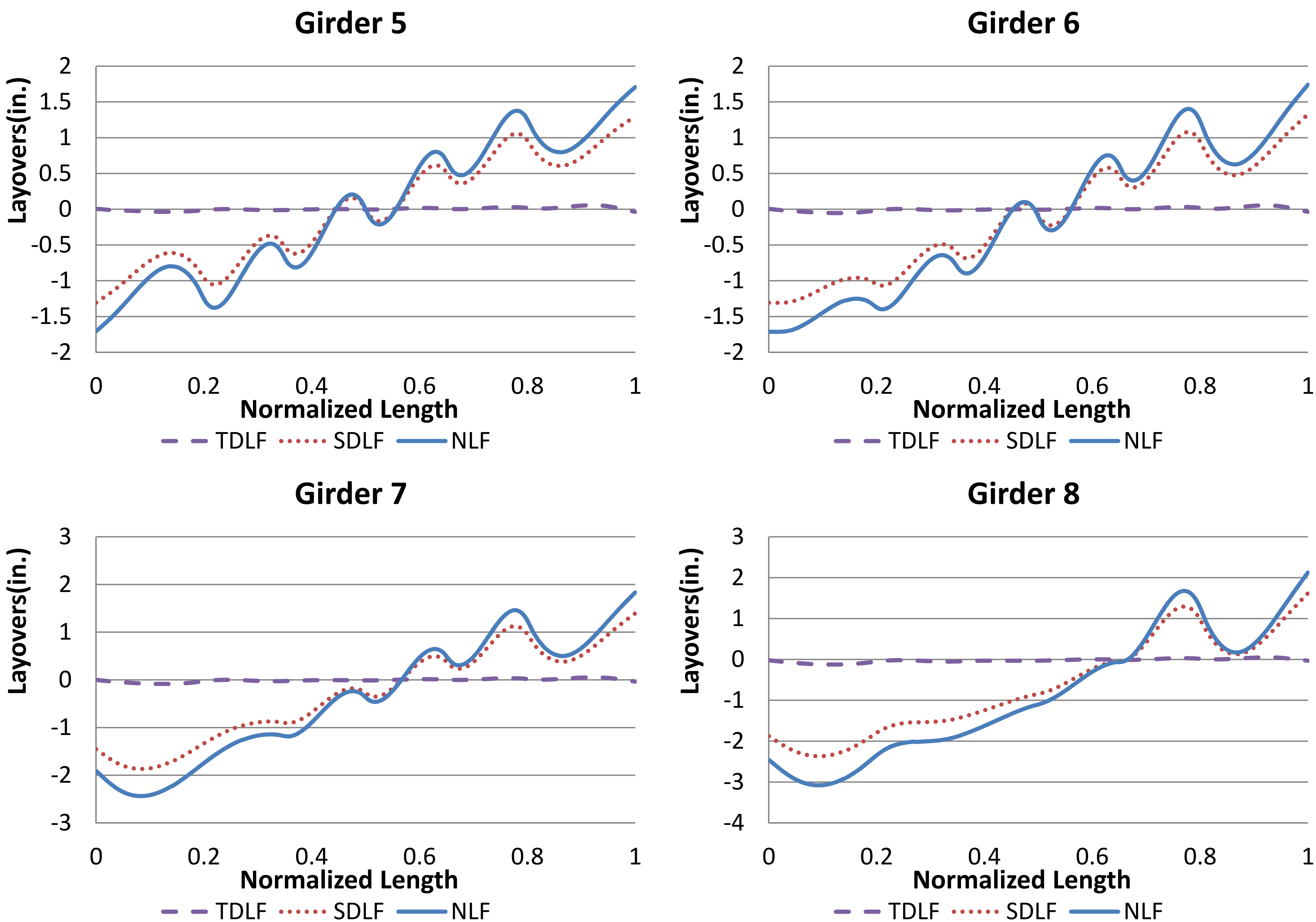


Figure I1-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

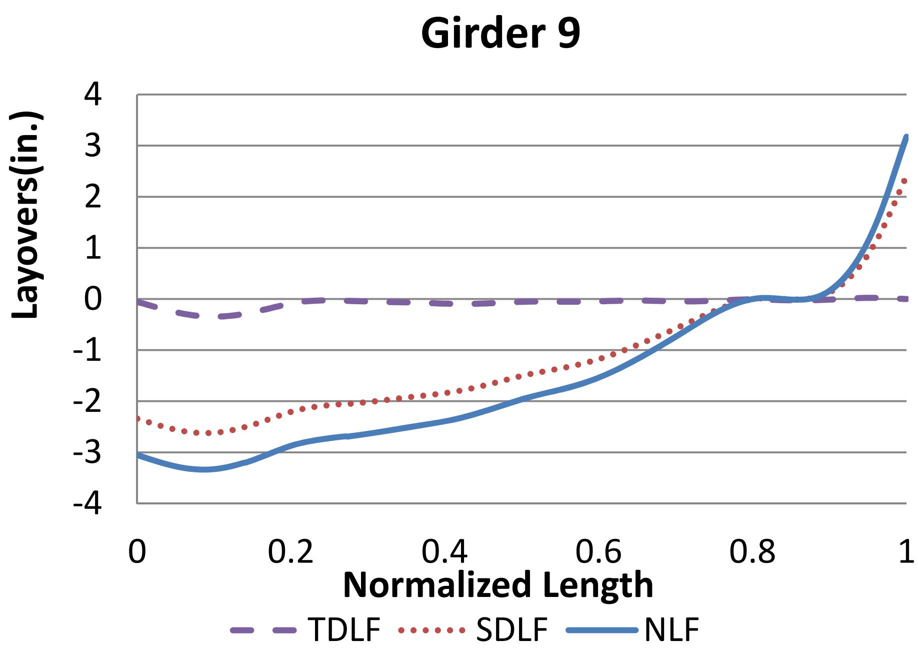


Figure I1-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

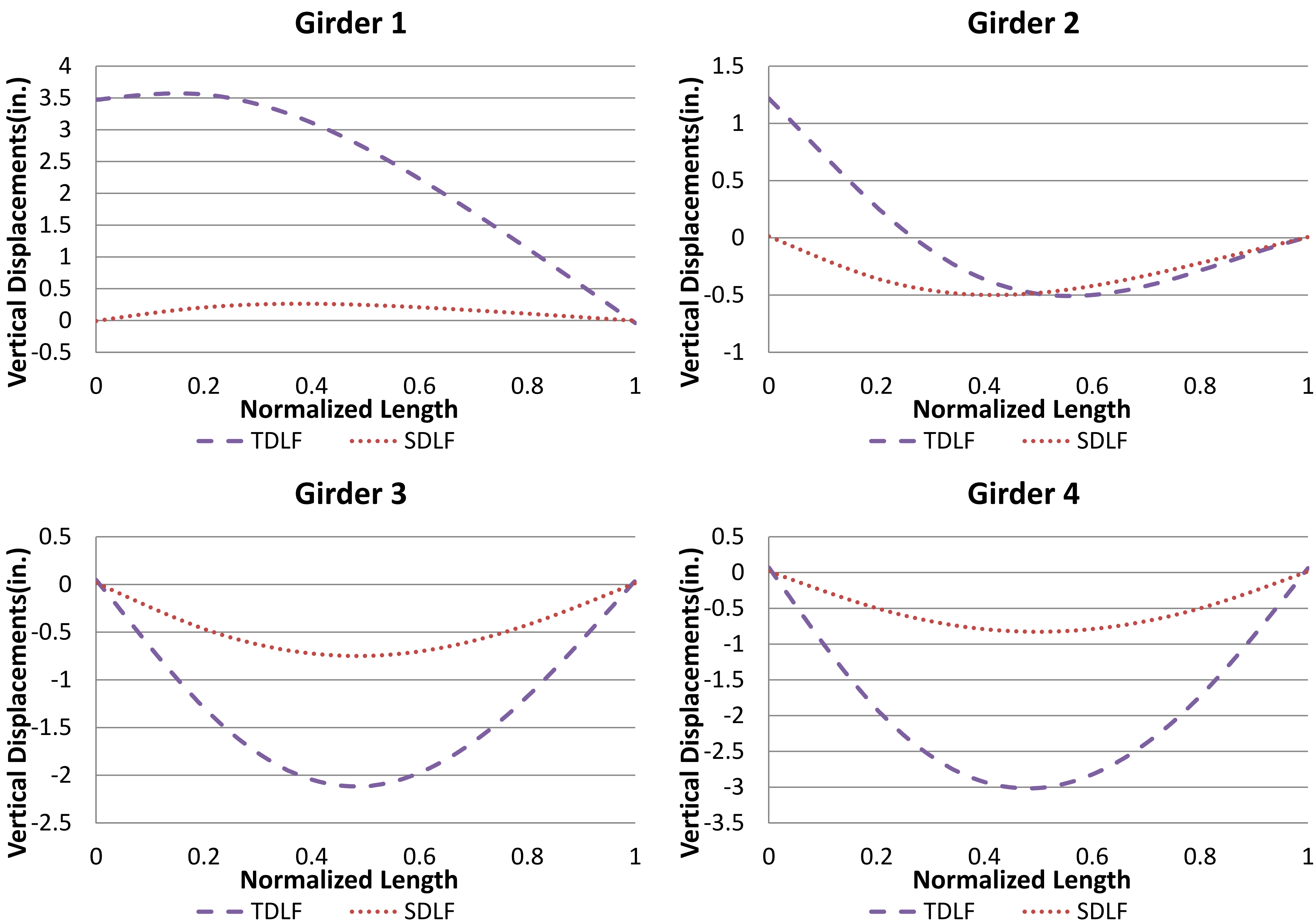


Figure I1-4-17.Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

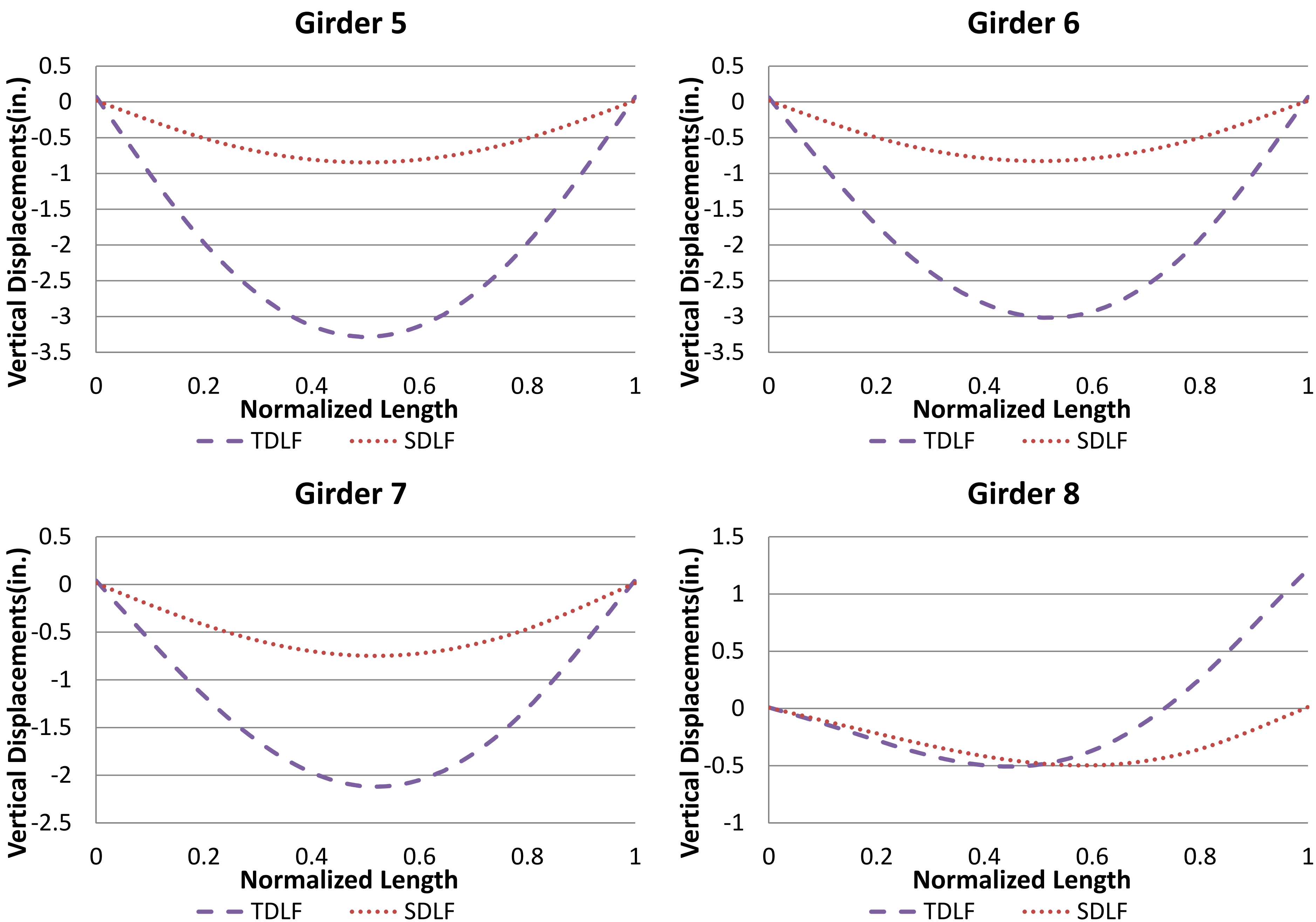


Figure I1-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

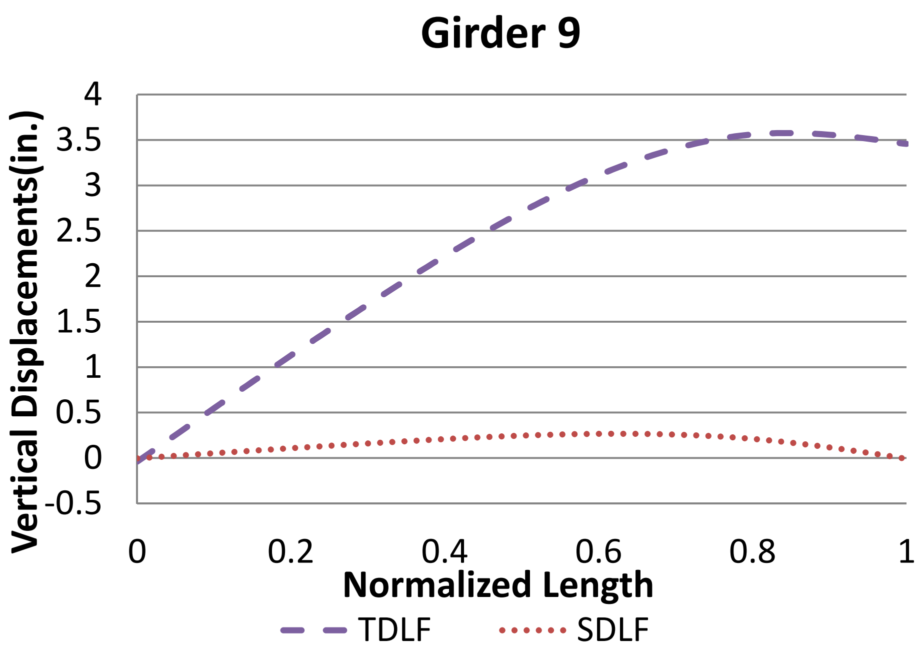


Figure I1-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

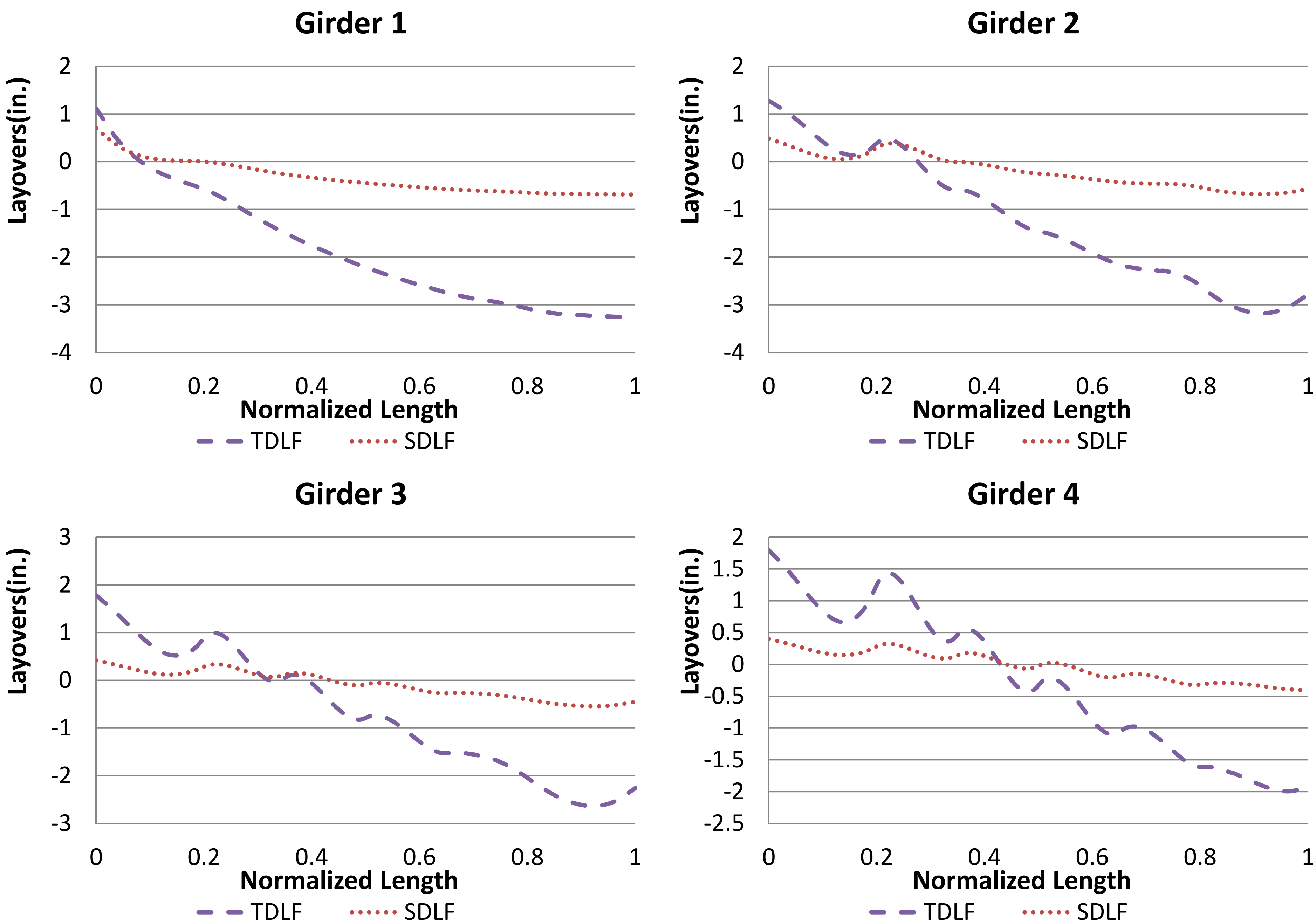


Figure I1-4-18.Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

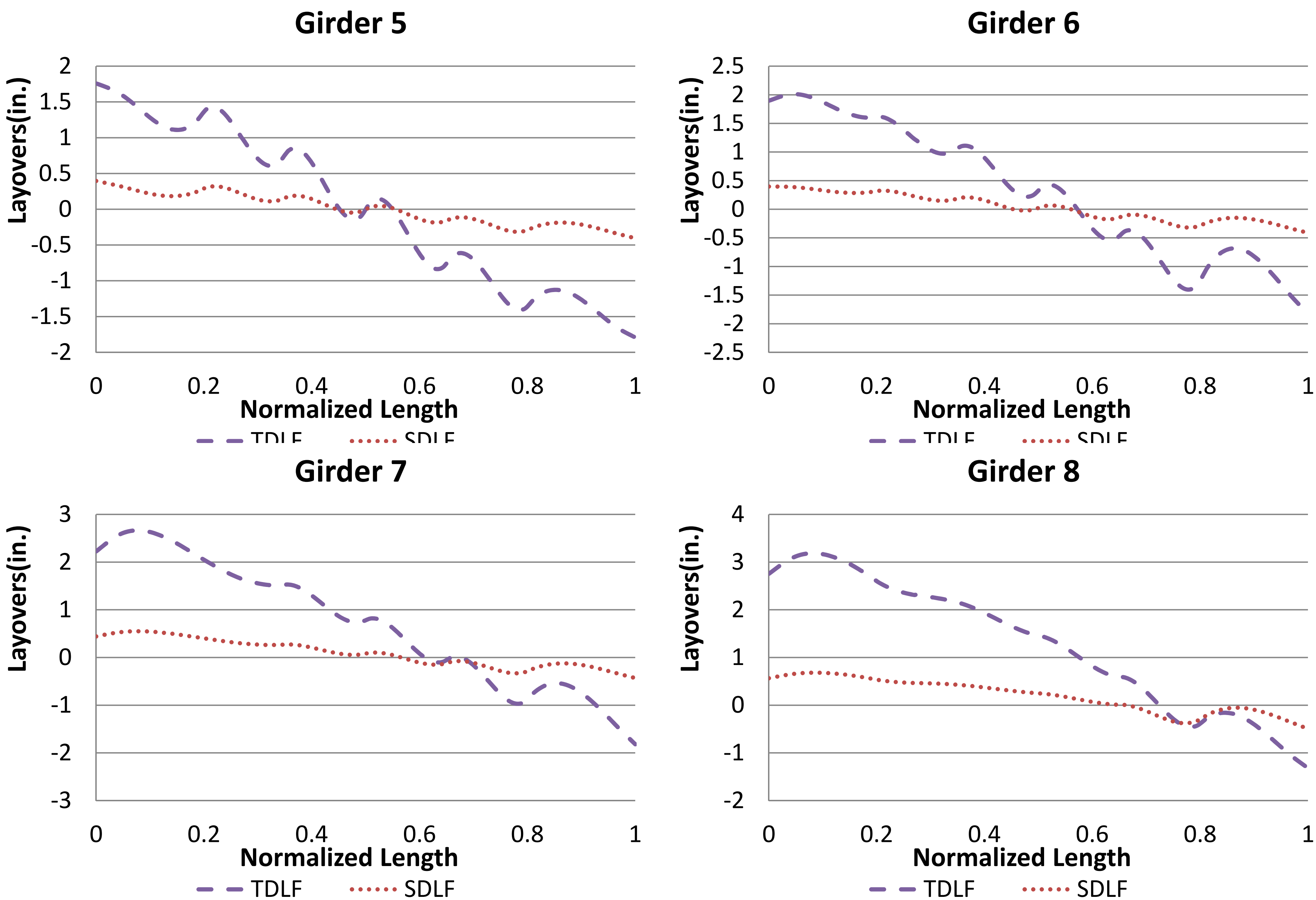


Figure I1-4-18(Continued). **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.**

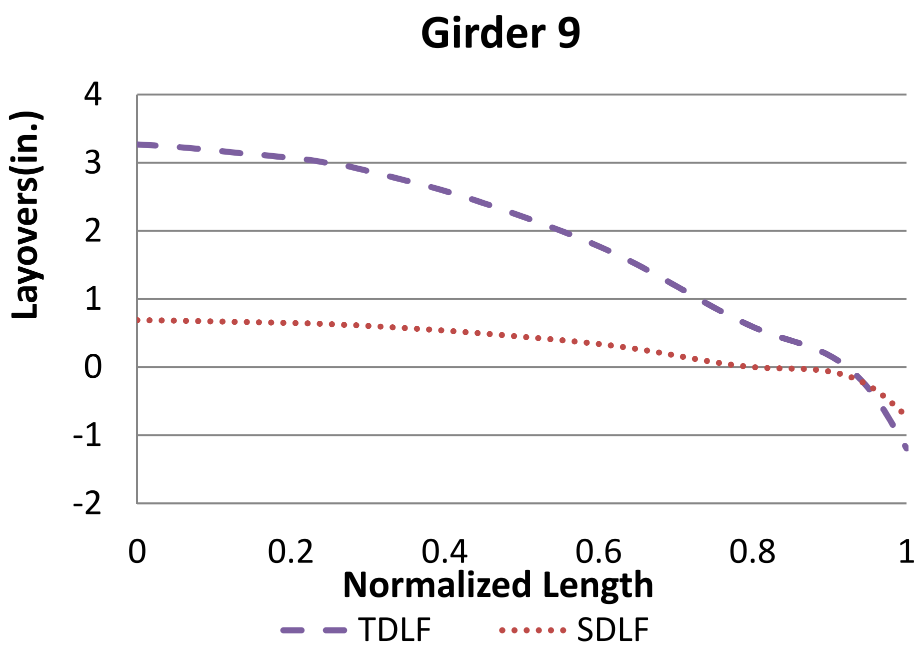


Figure I1-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

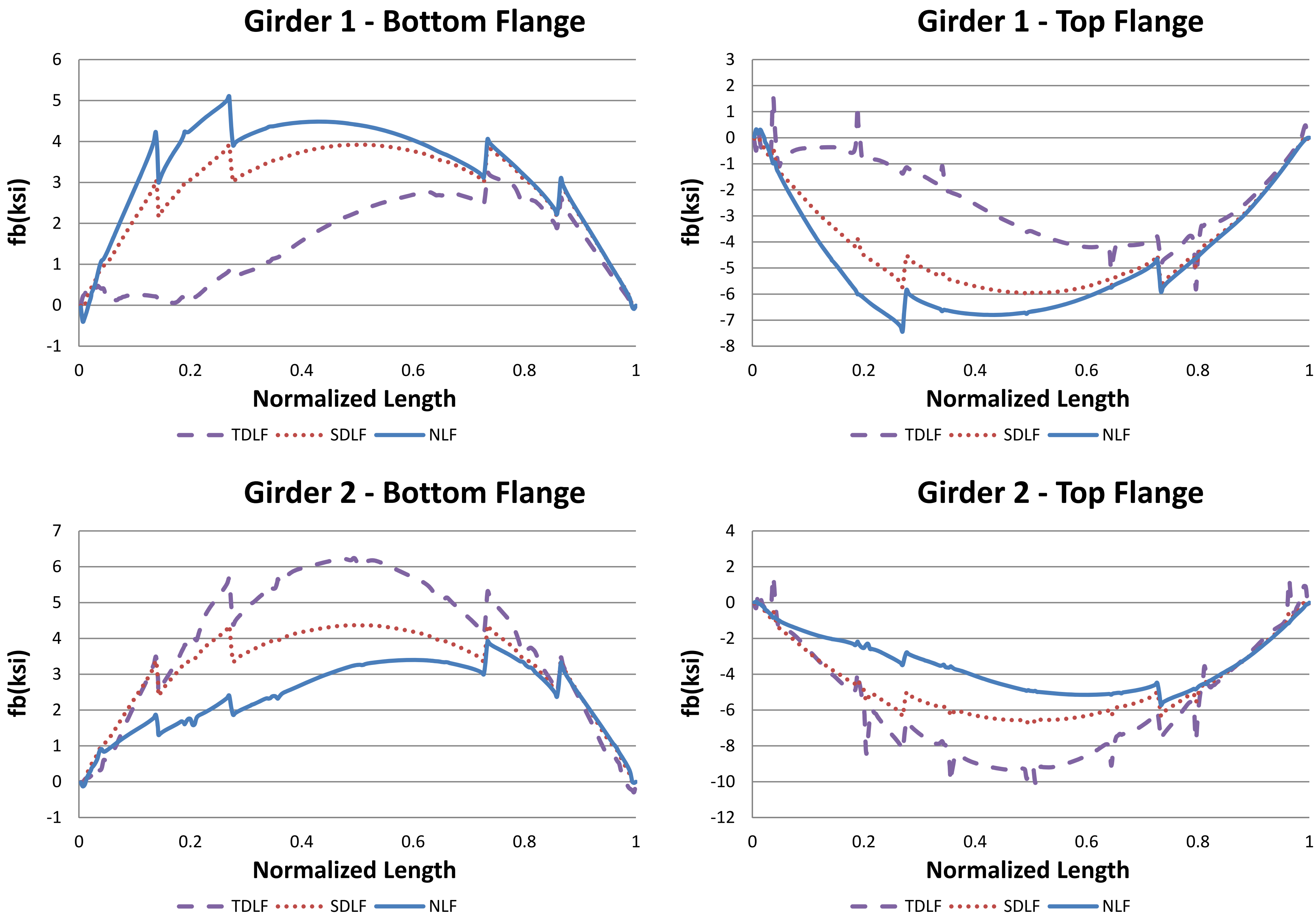


Figure I1-4-19. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

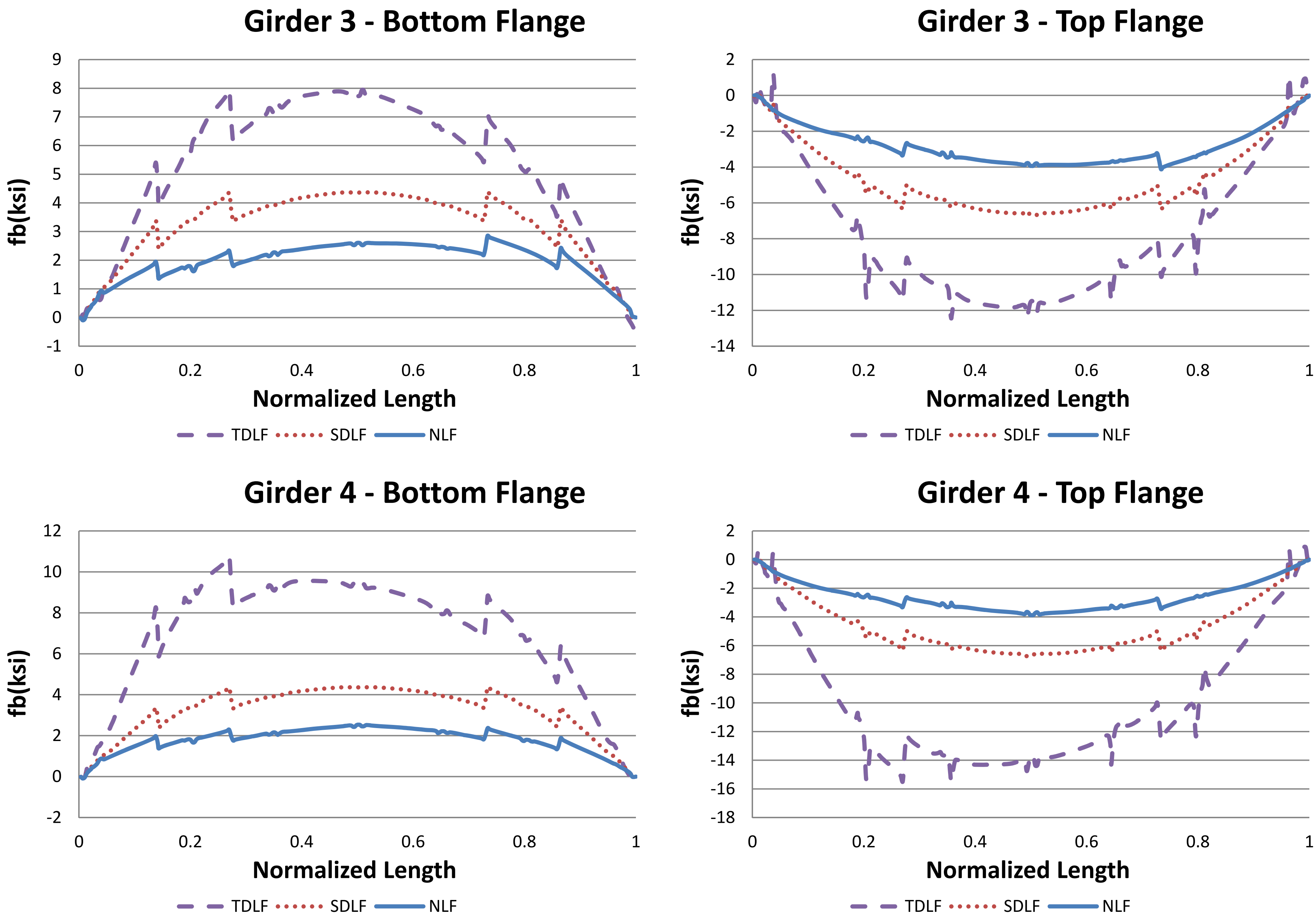


Figure I1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

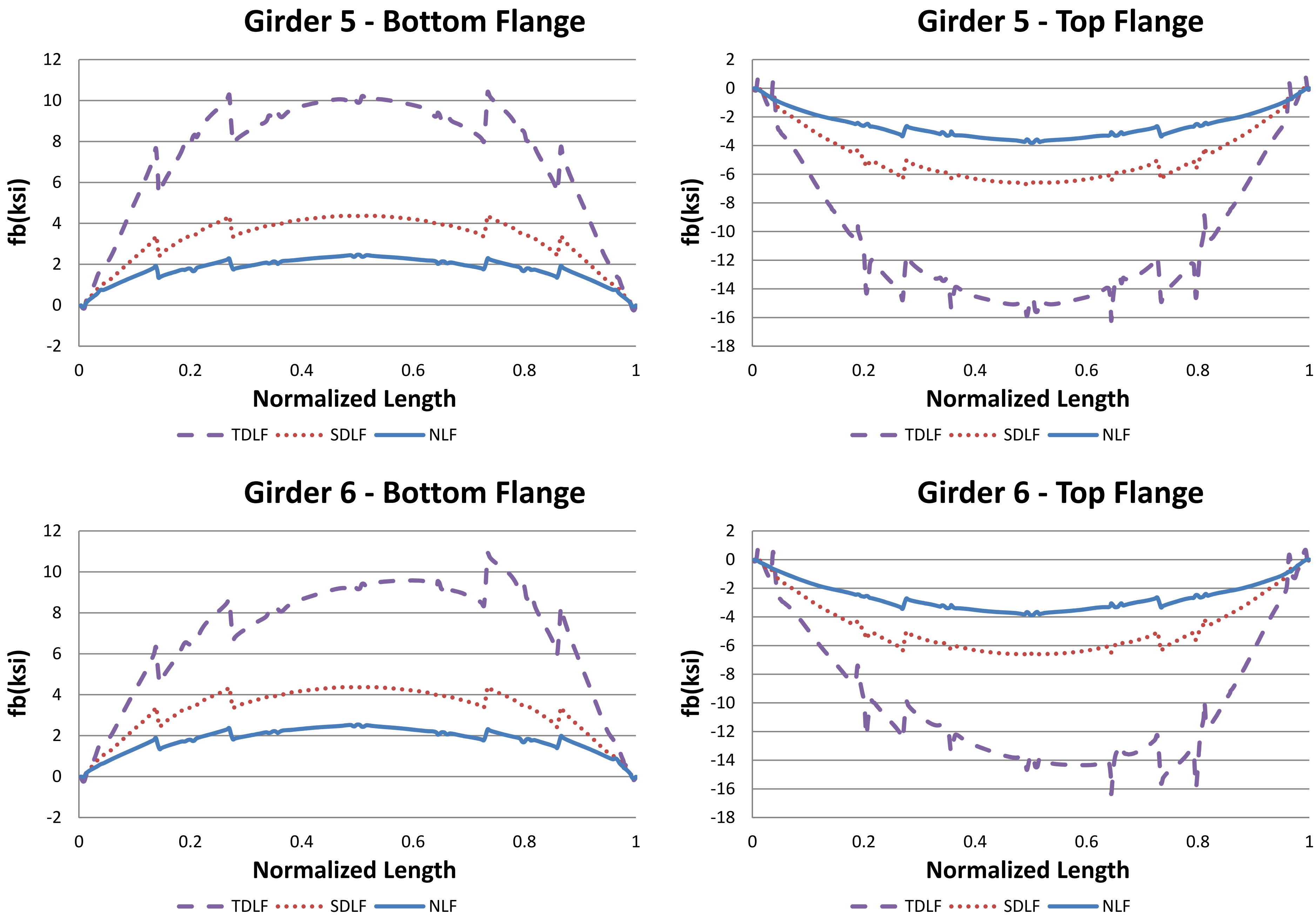


Figure I1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

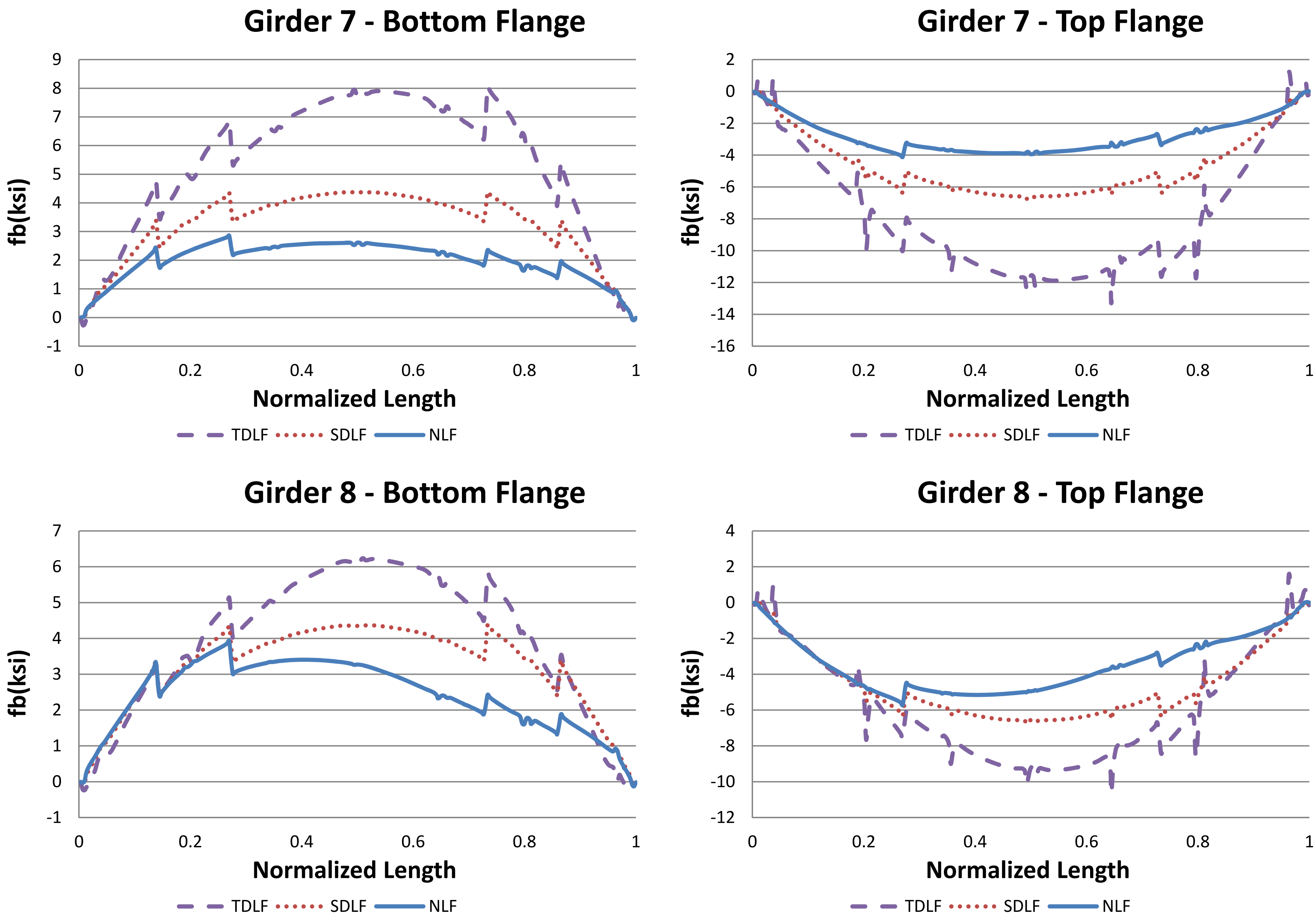
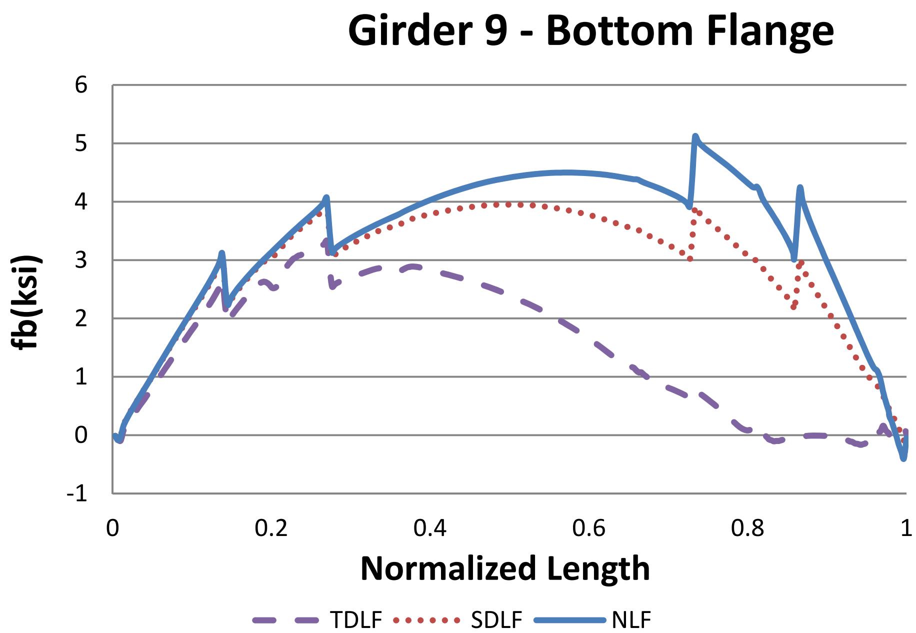


Figure I1-4-19 (continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**



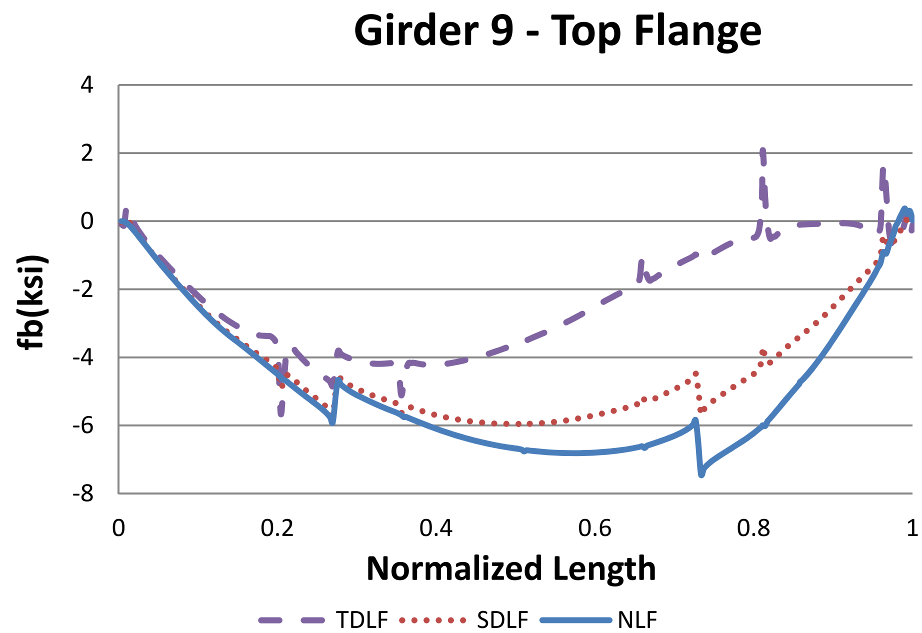


Figure I1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

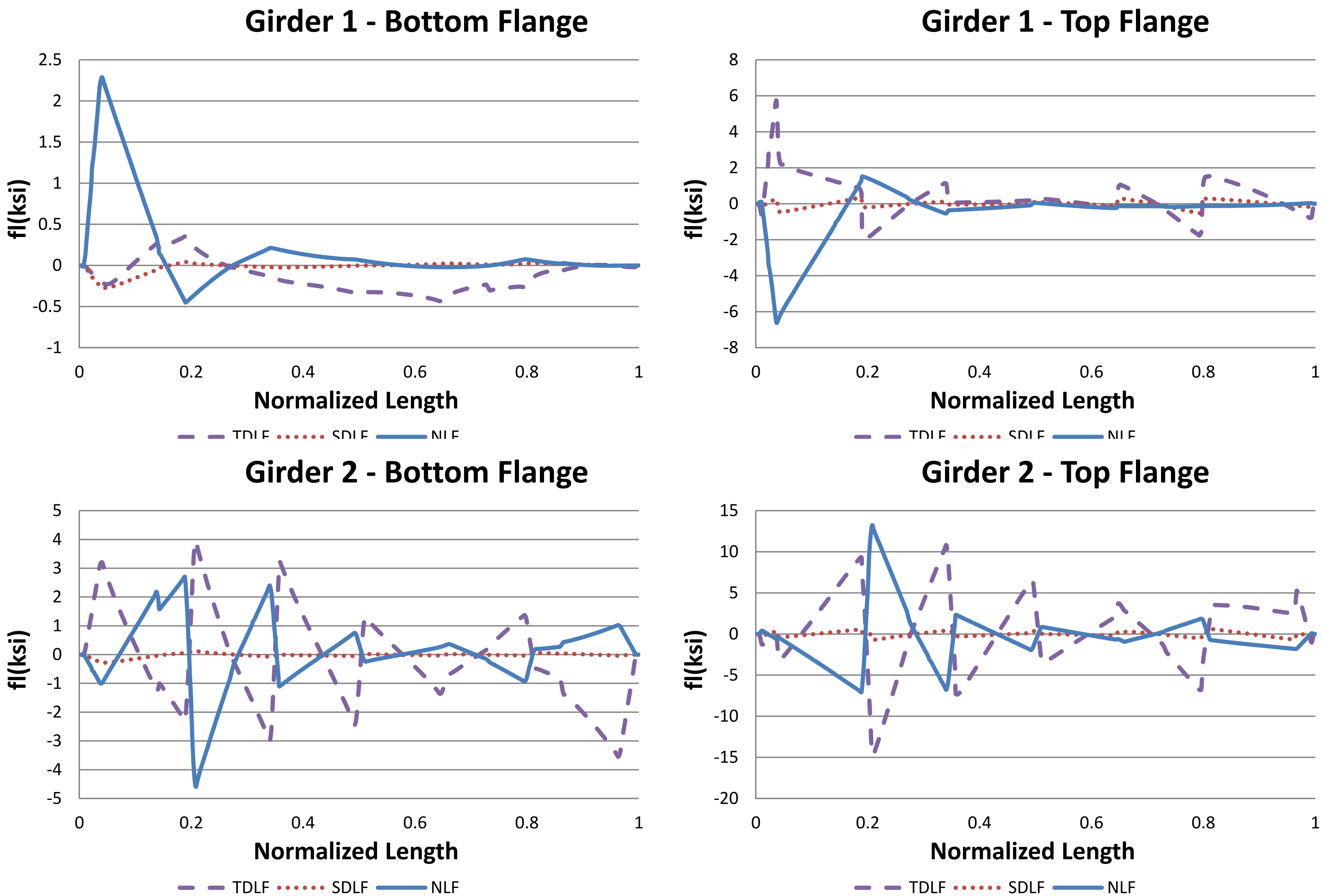


Figure I1-4-20. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

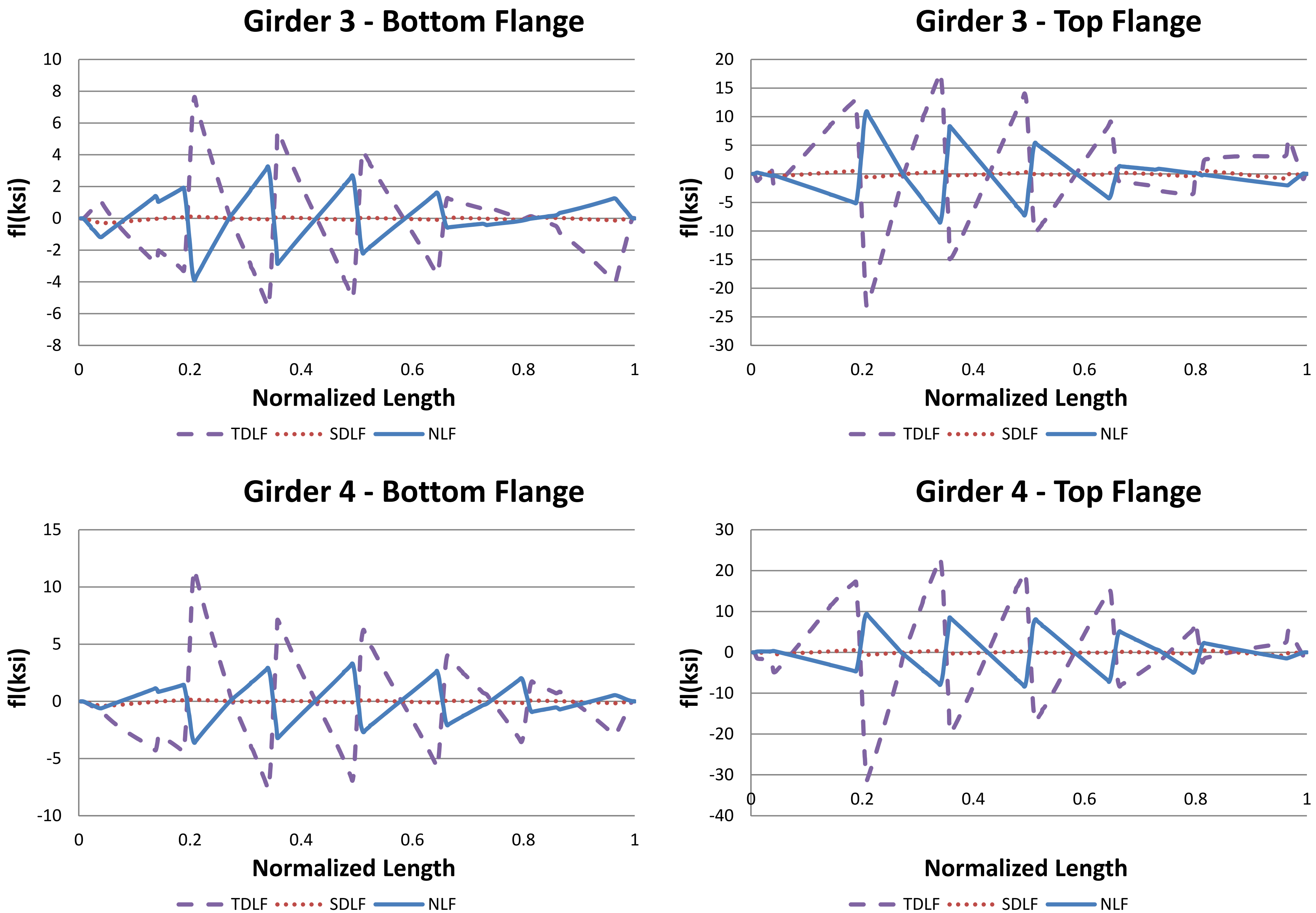


Figure I1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

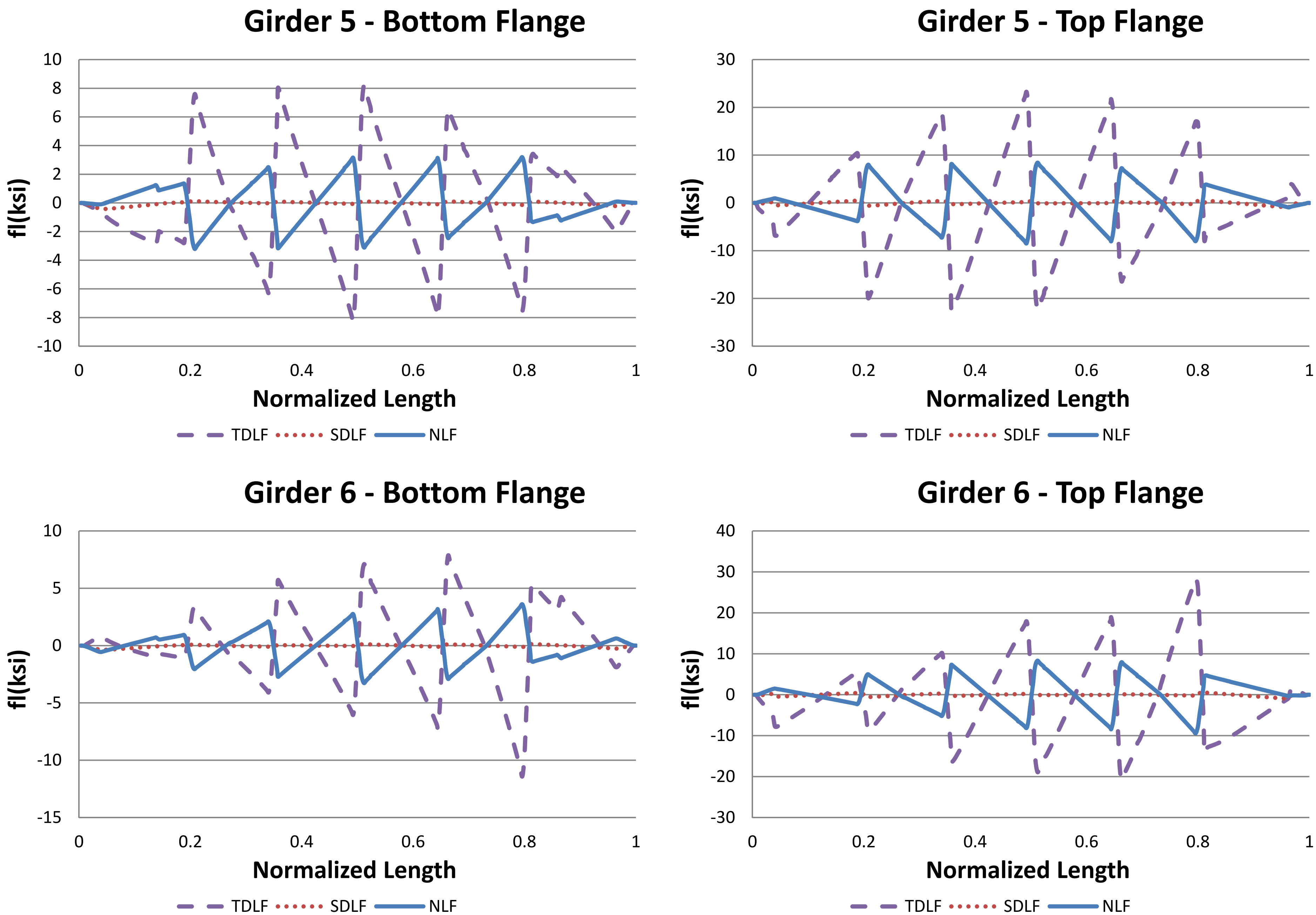


Figure I1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

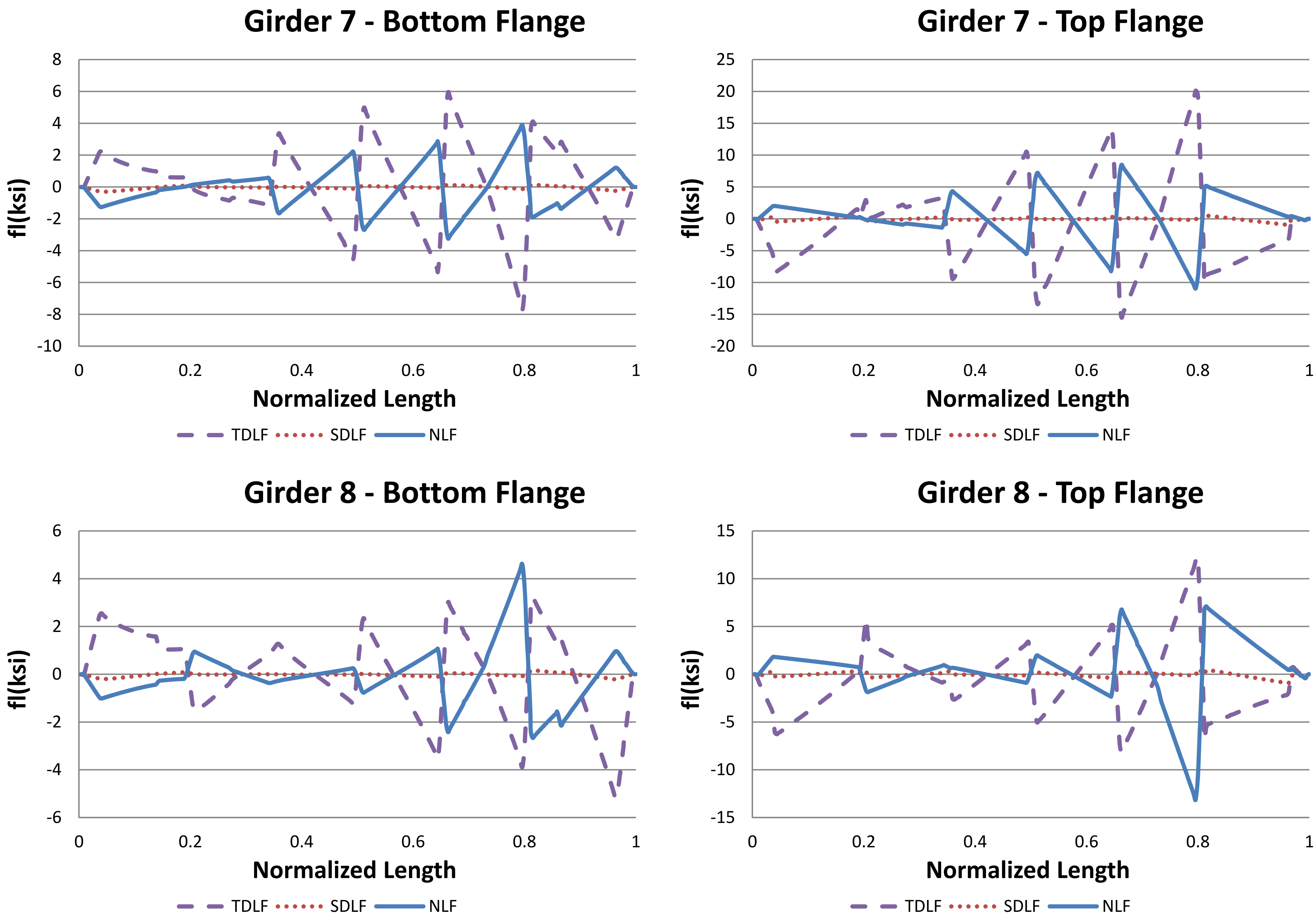
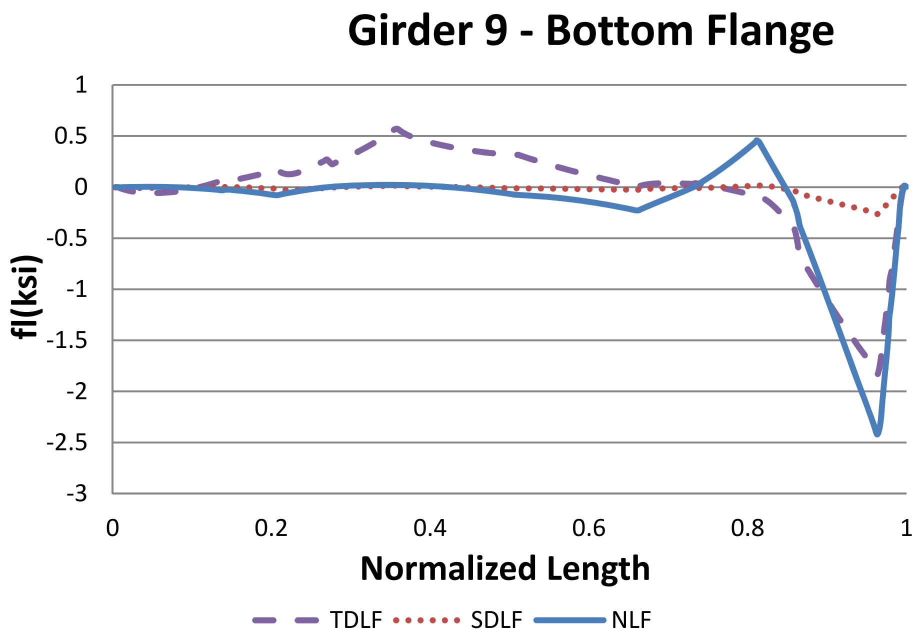


Figure I1-4-20 (continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**



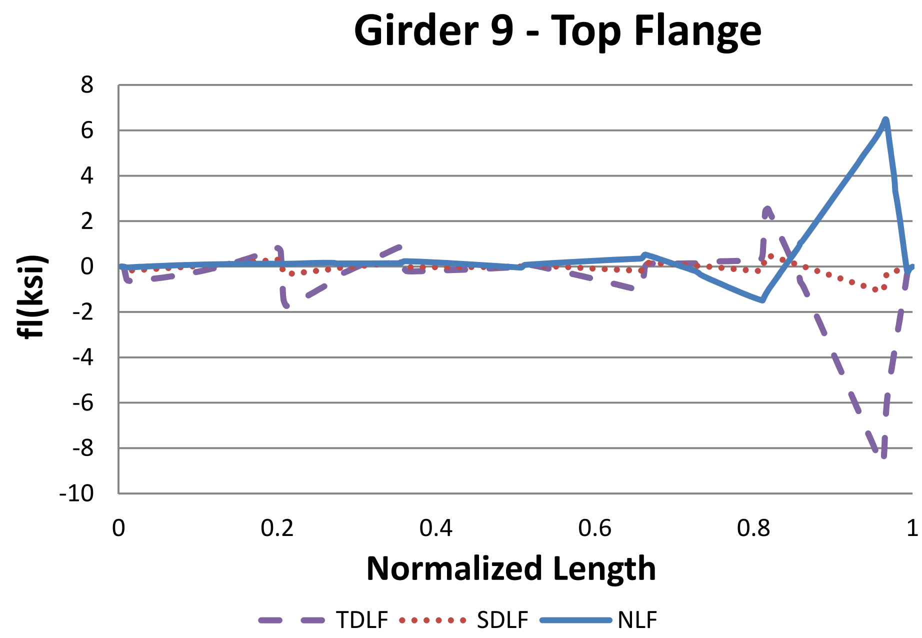


Figure I1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

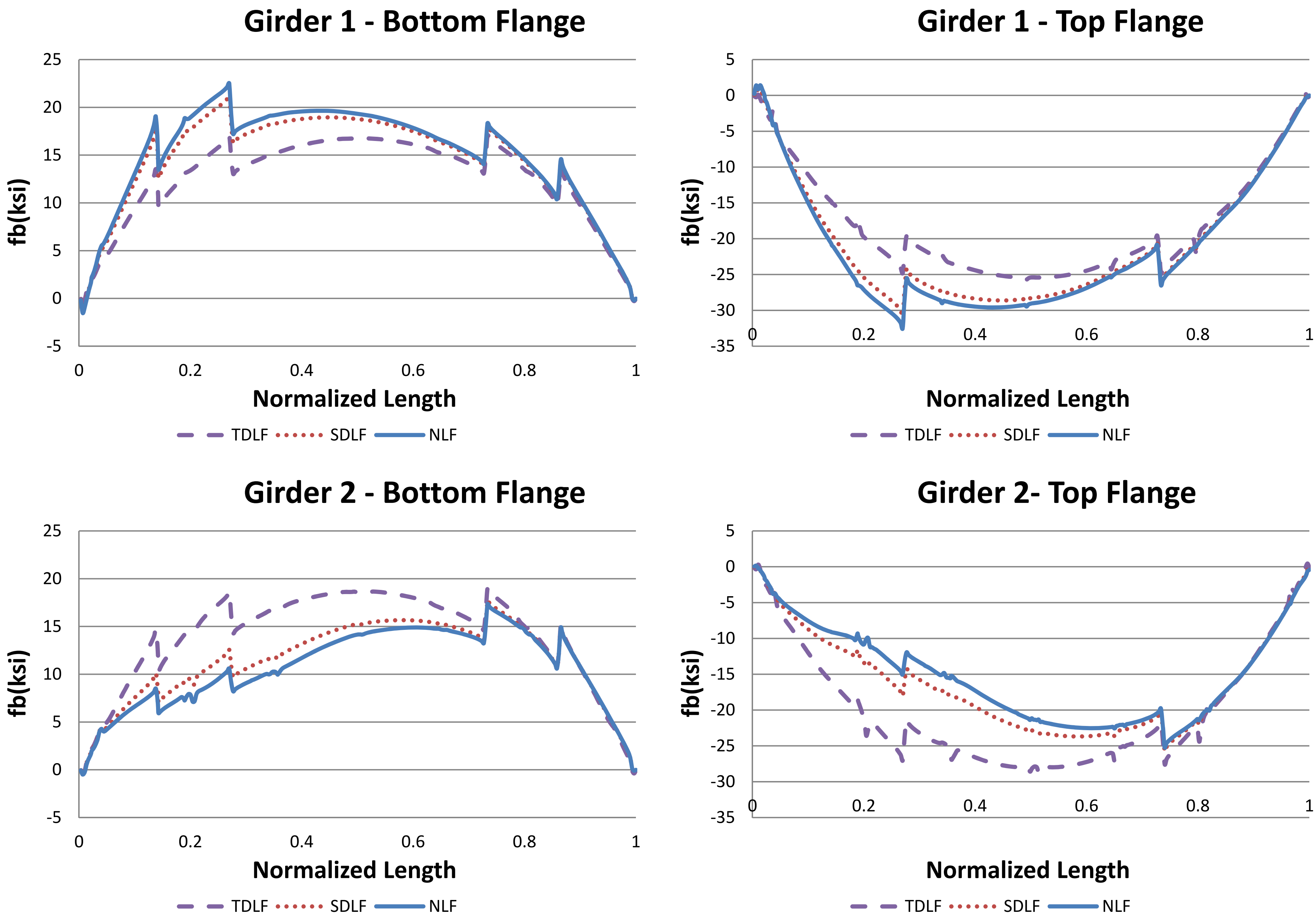


Figure I1-4-21. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

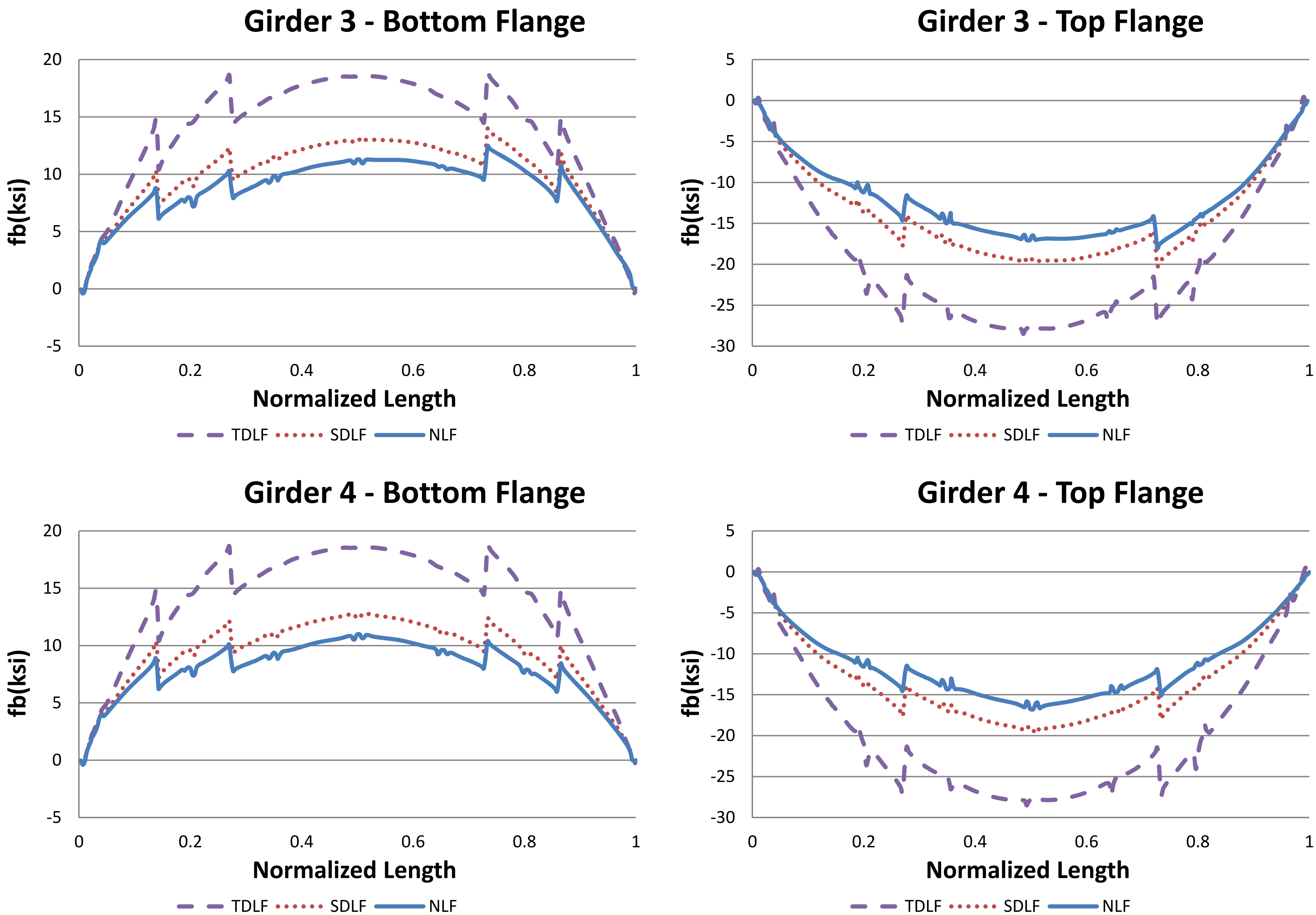


Figure I1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

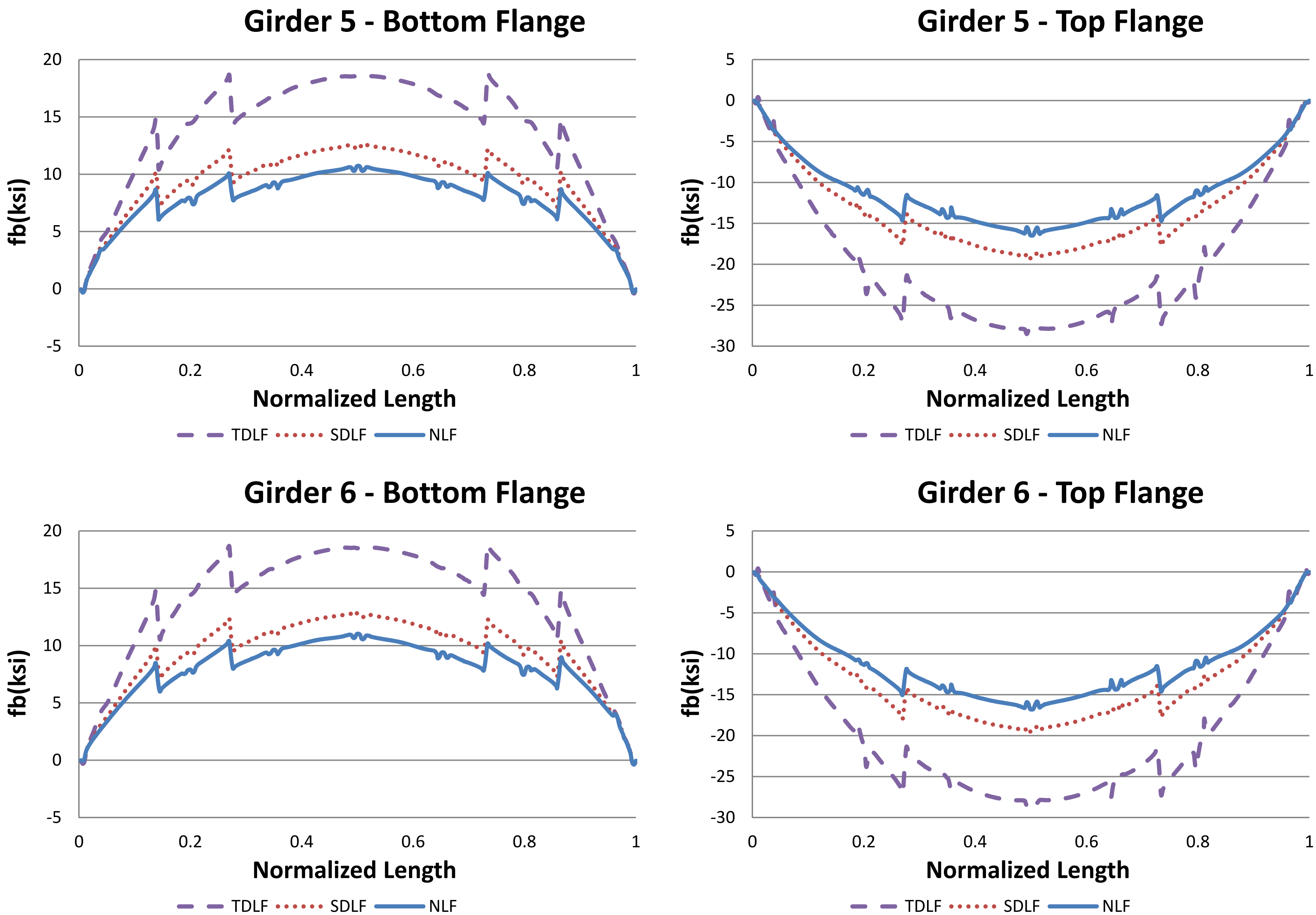


Figure I1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

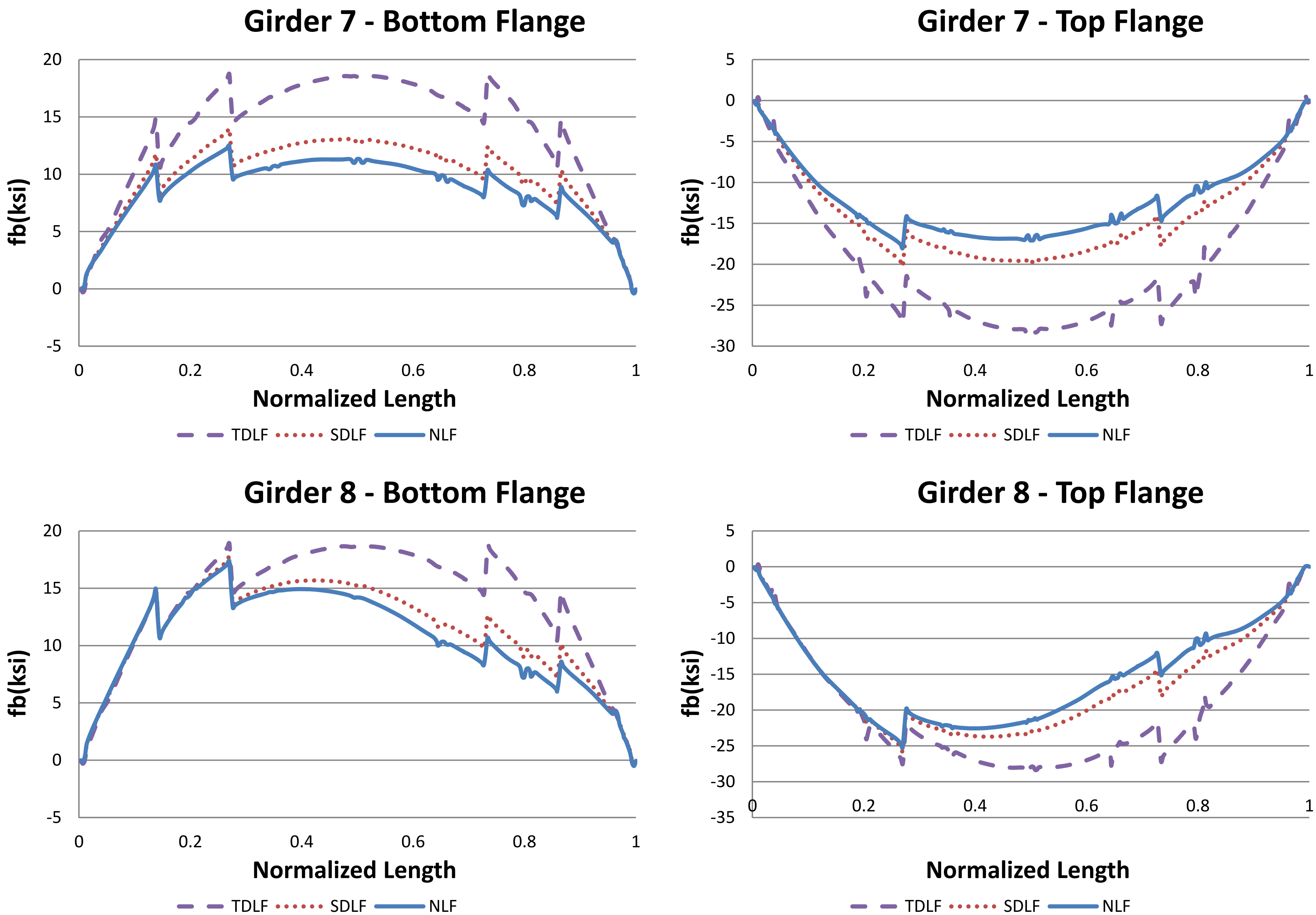


Figure I1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

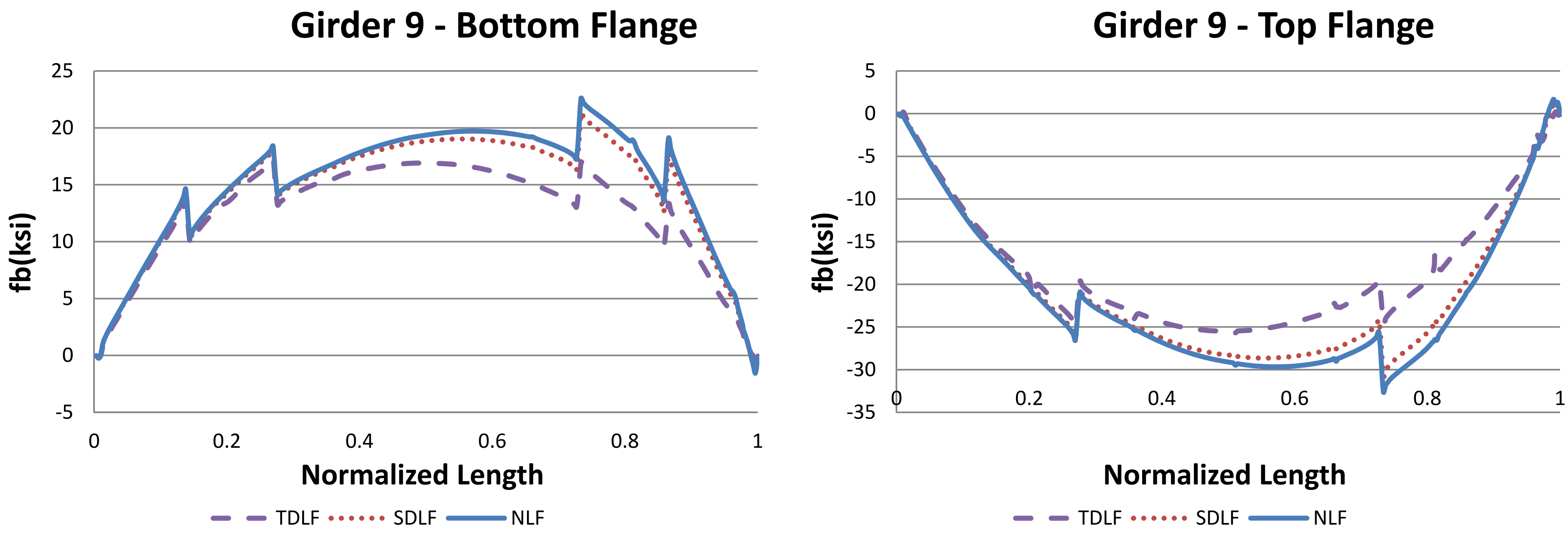


Figure I1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

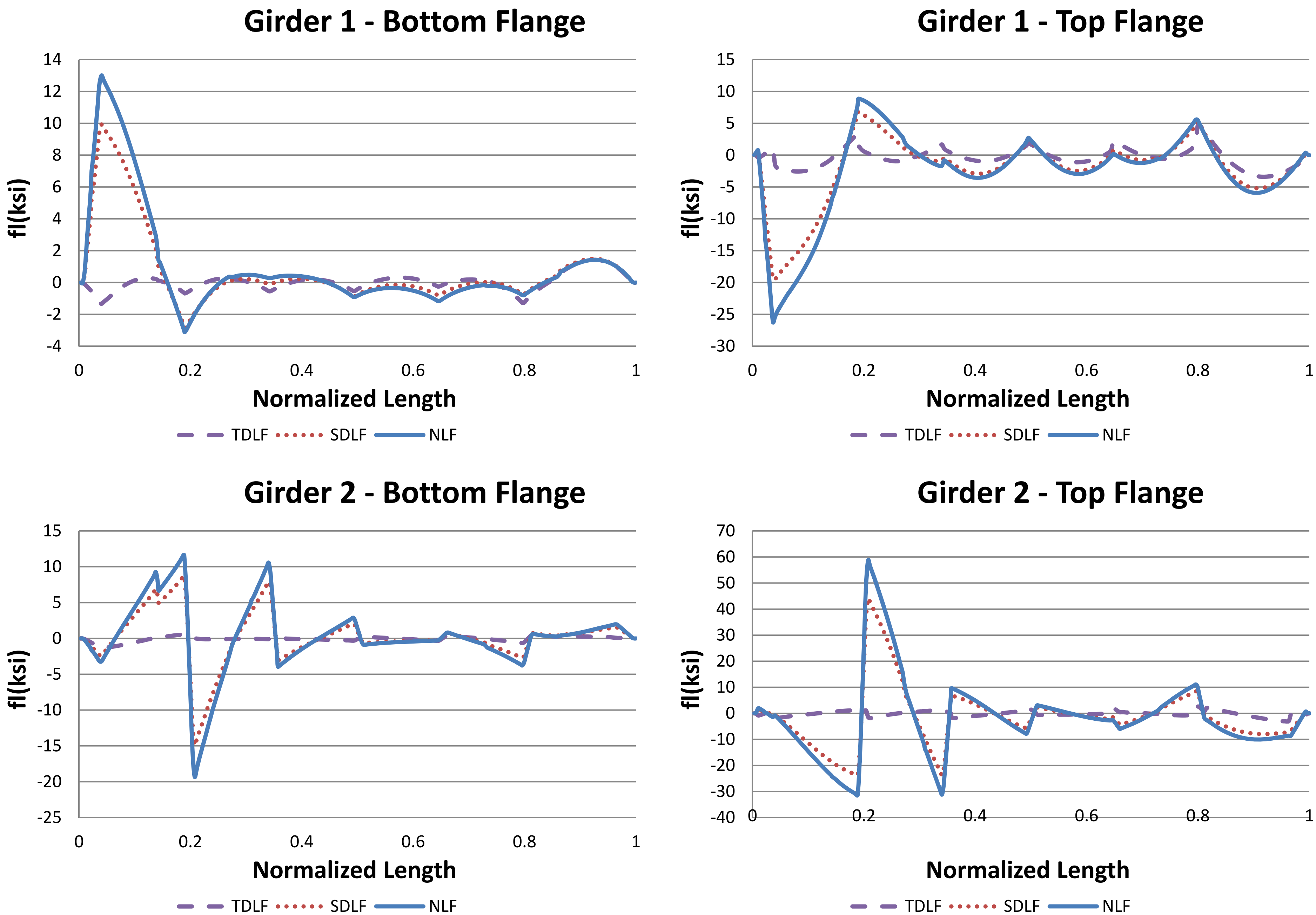


Figure I1-4-22. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

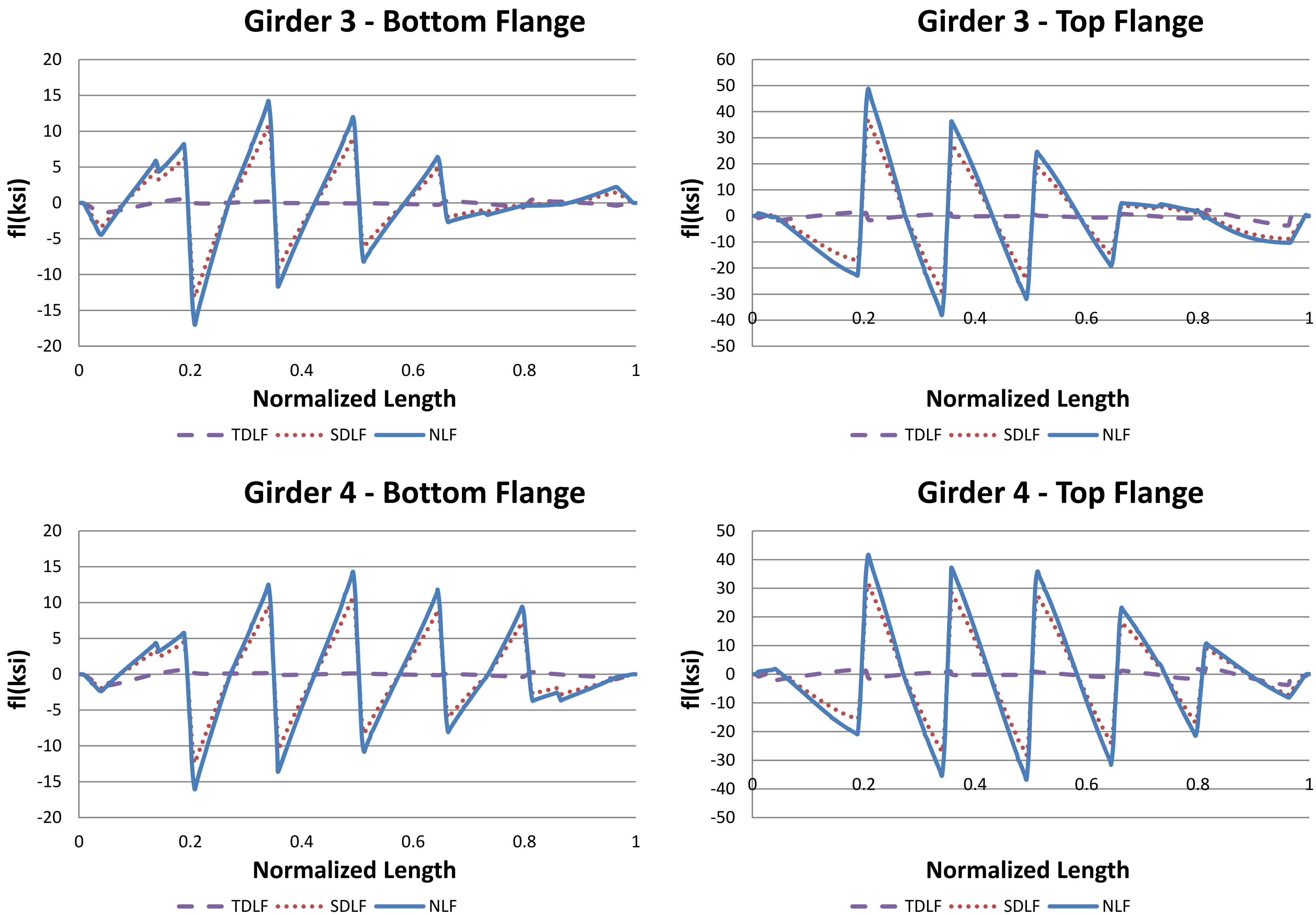


Figure I1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

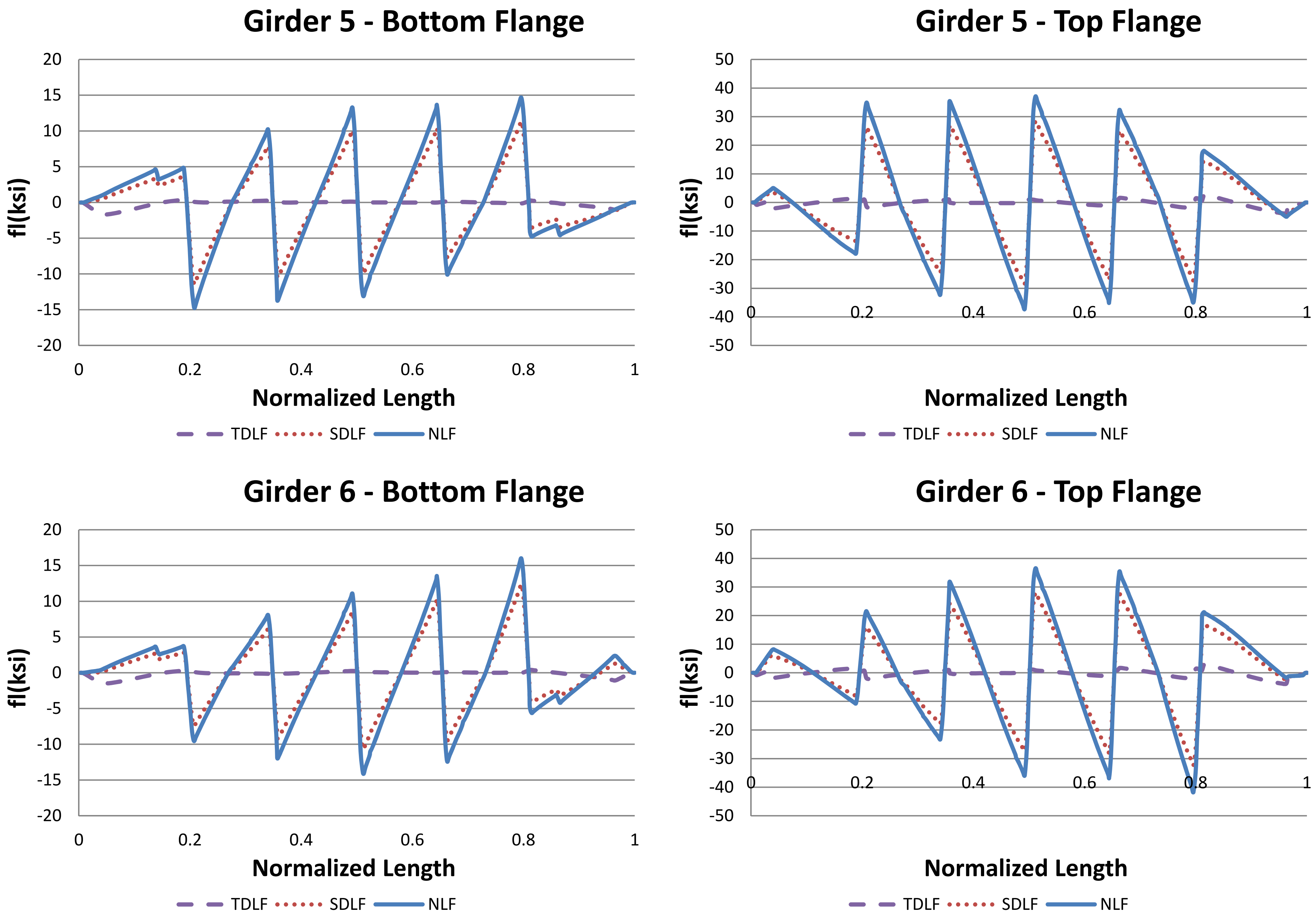


Figure I1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

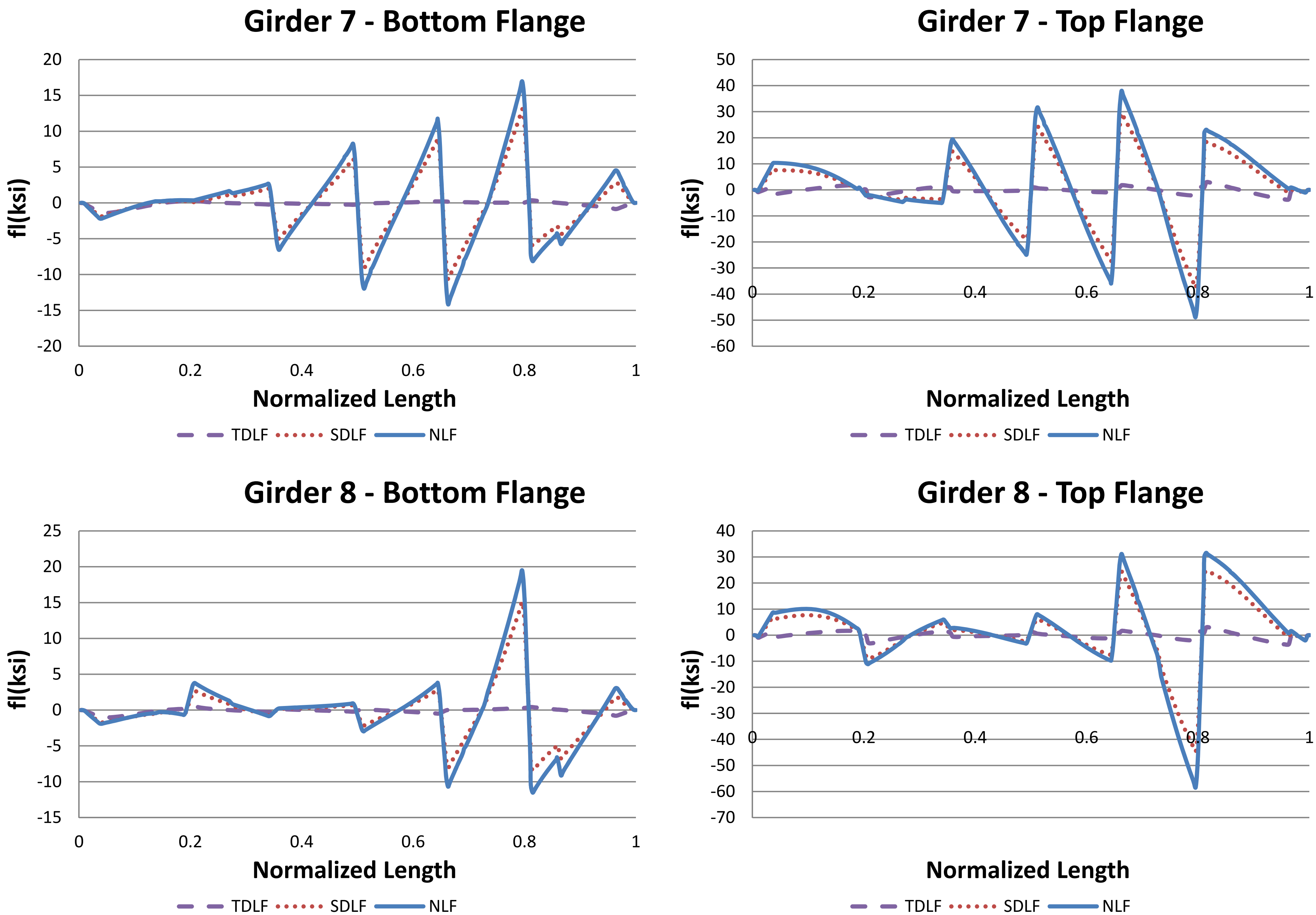
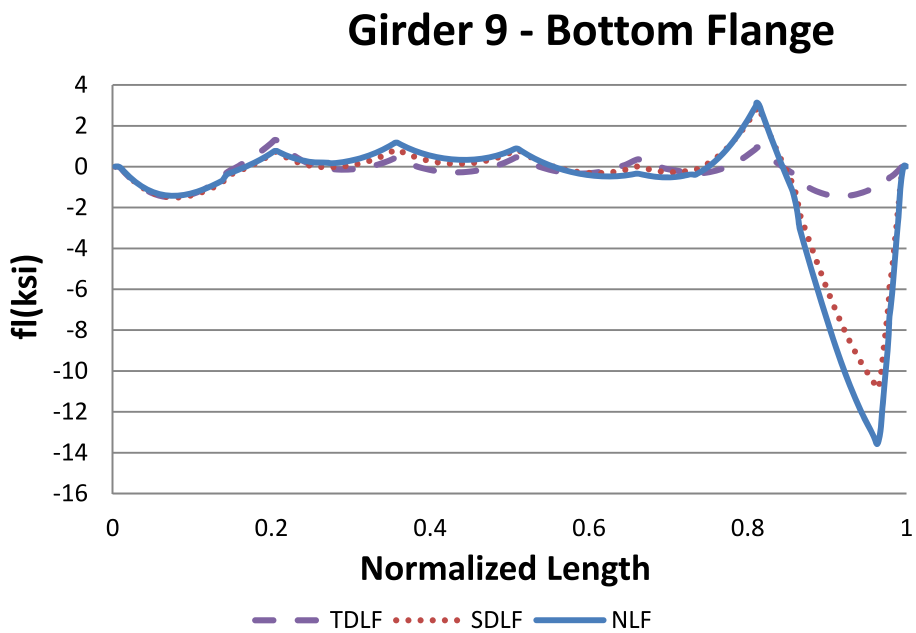


Figure I1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.



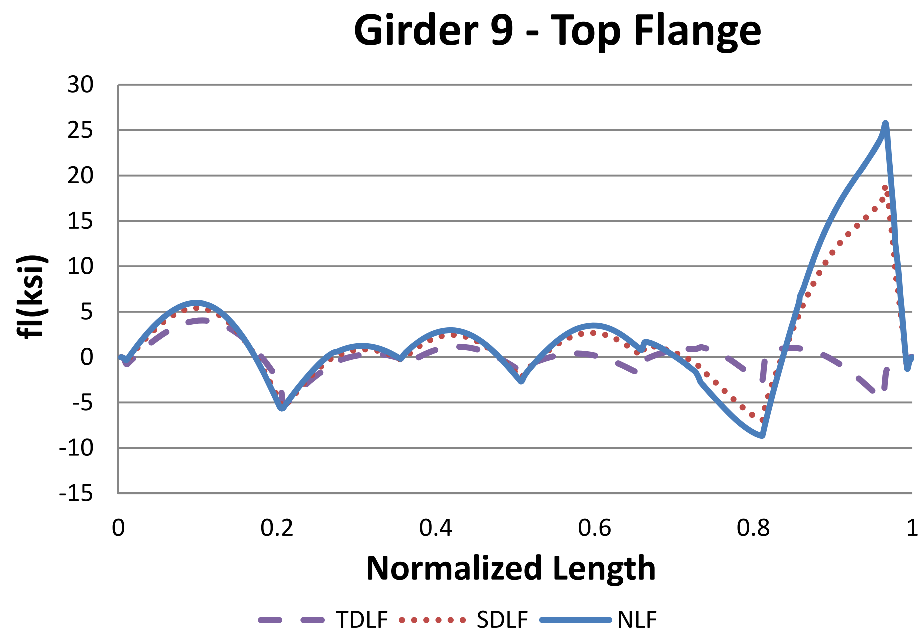


Figure I1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

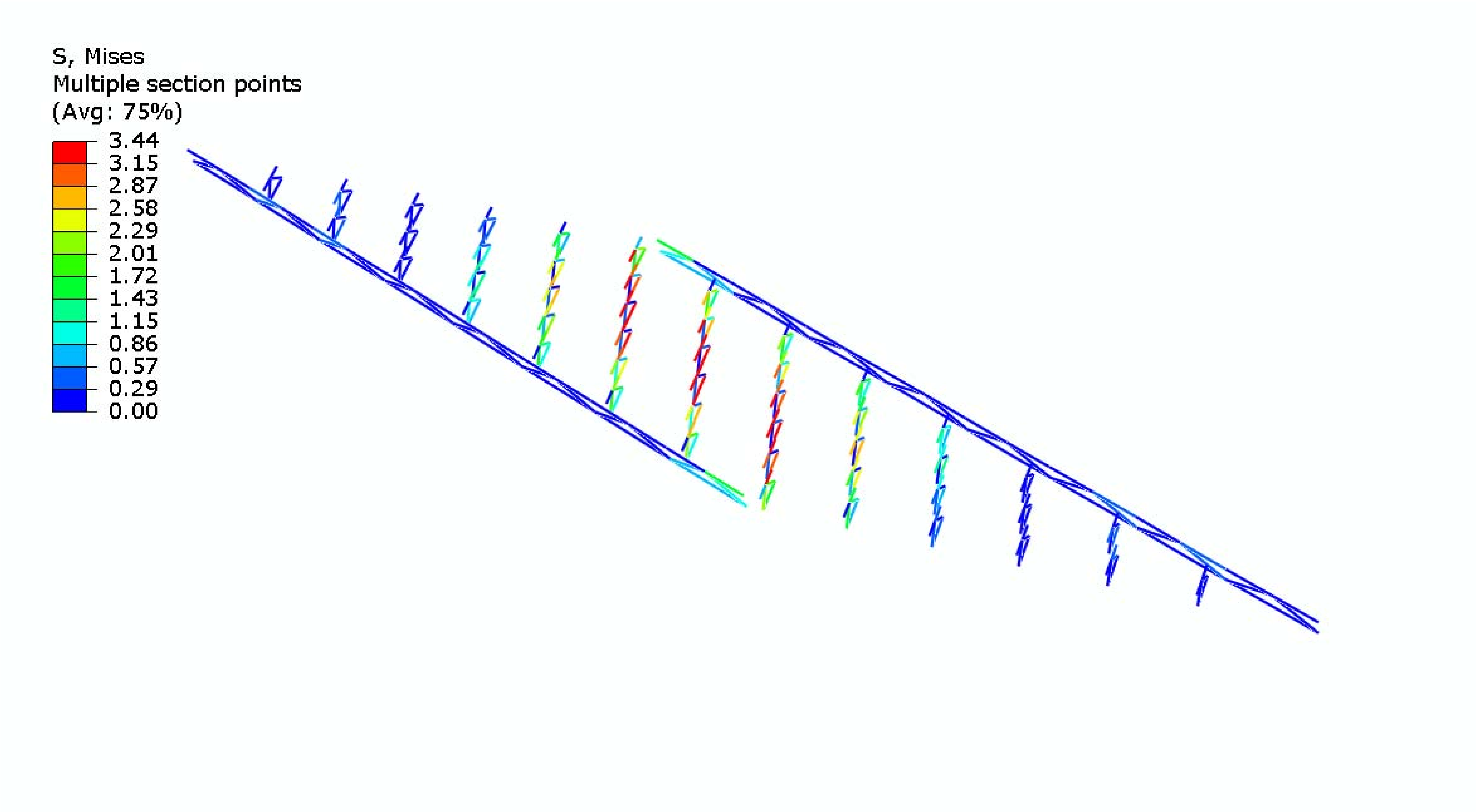


Figure I1-4-23. Cross-frame stress contours (ksi) under SDL, NLF detailing (all cross-frame member areas = 9.75 in^2).

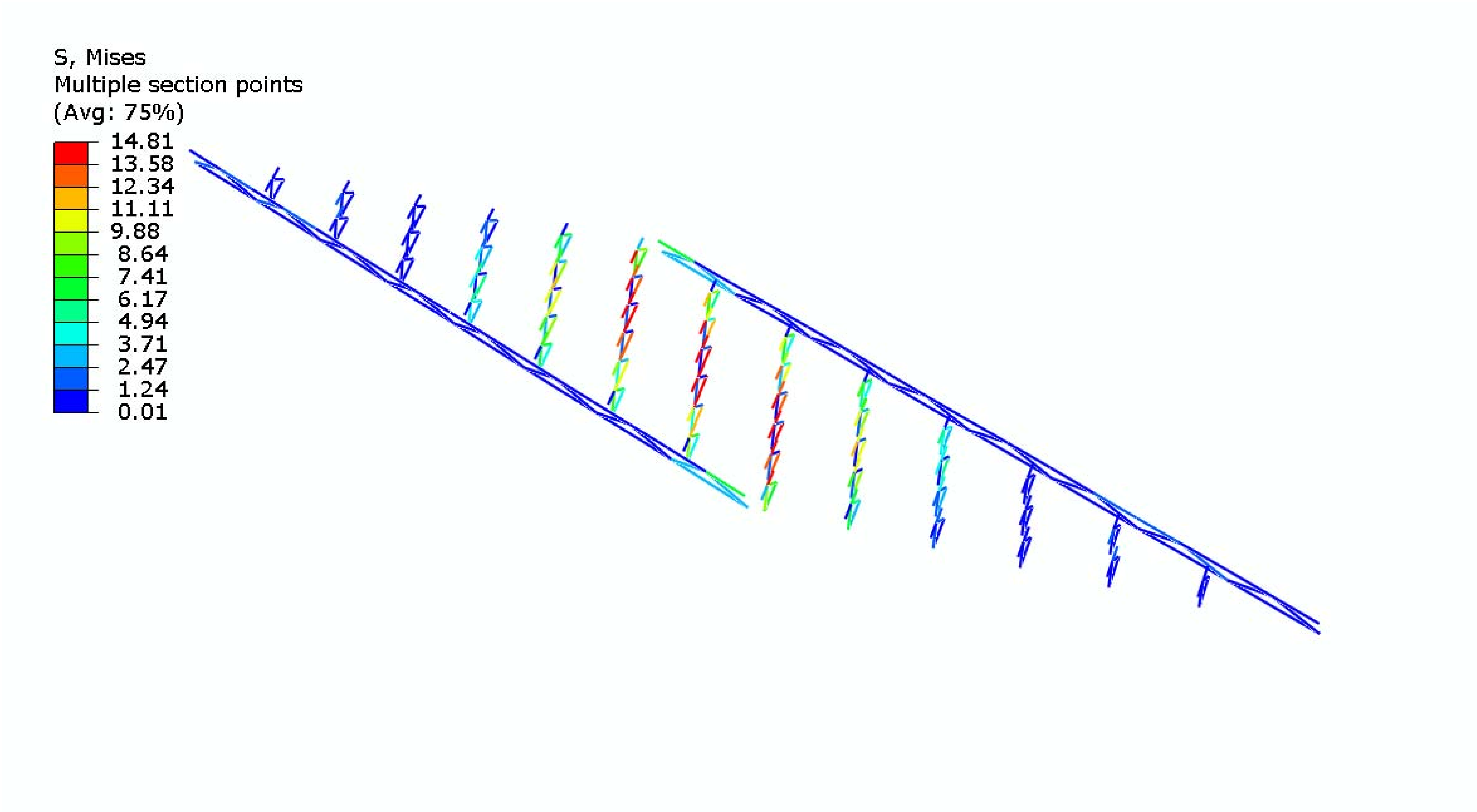


Figure I1-4-24. Cross-frame stress contours under TDL, NLF detailing (all cross-frame member areas = 9.75 in^2).

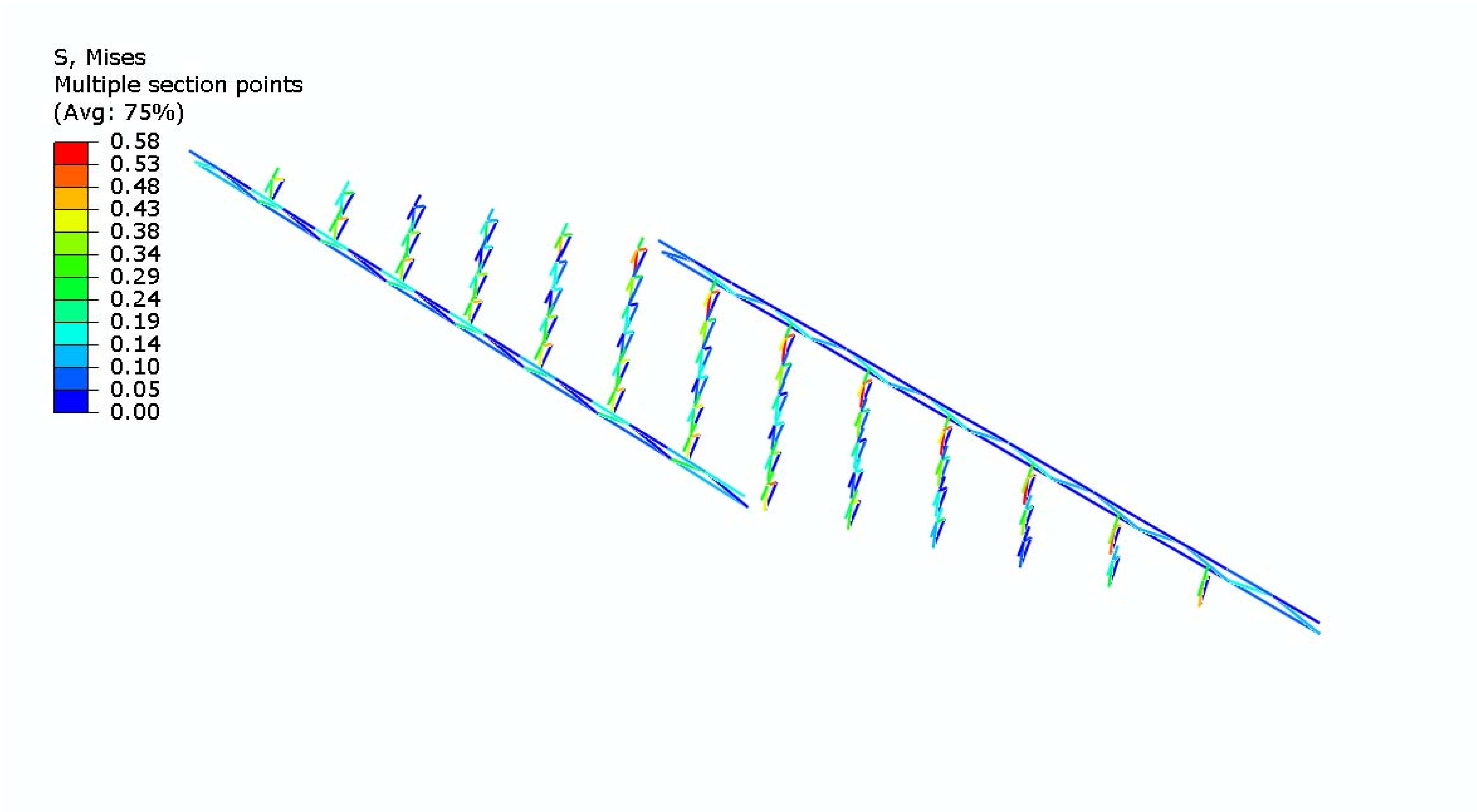


Figure I1-4-25. Cross-frame stress contours under SDL, SDLF detailing (all cross-frame member areas = 9.75 in^2).

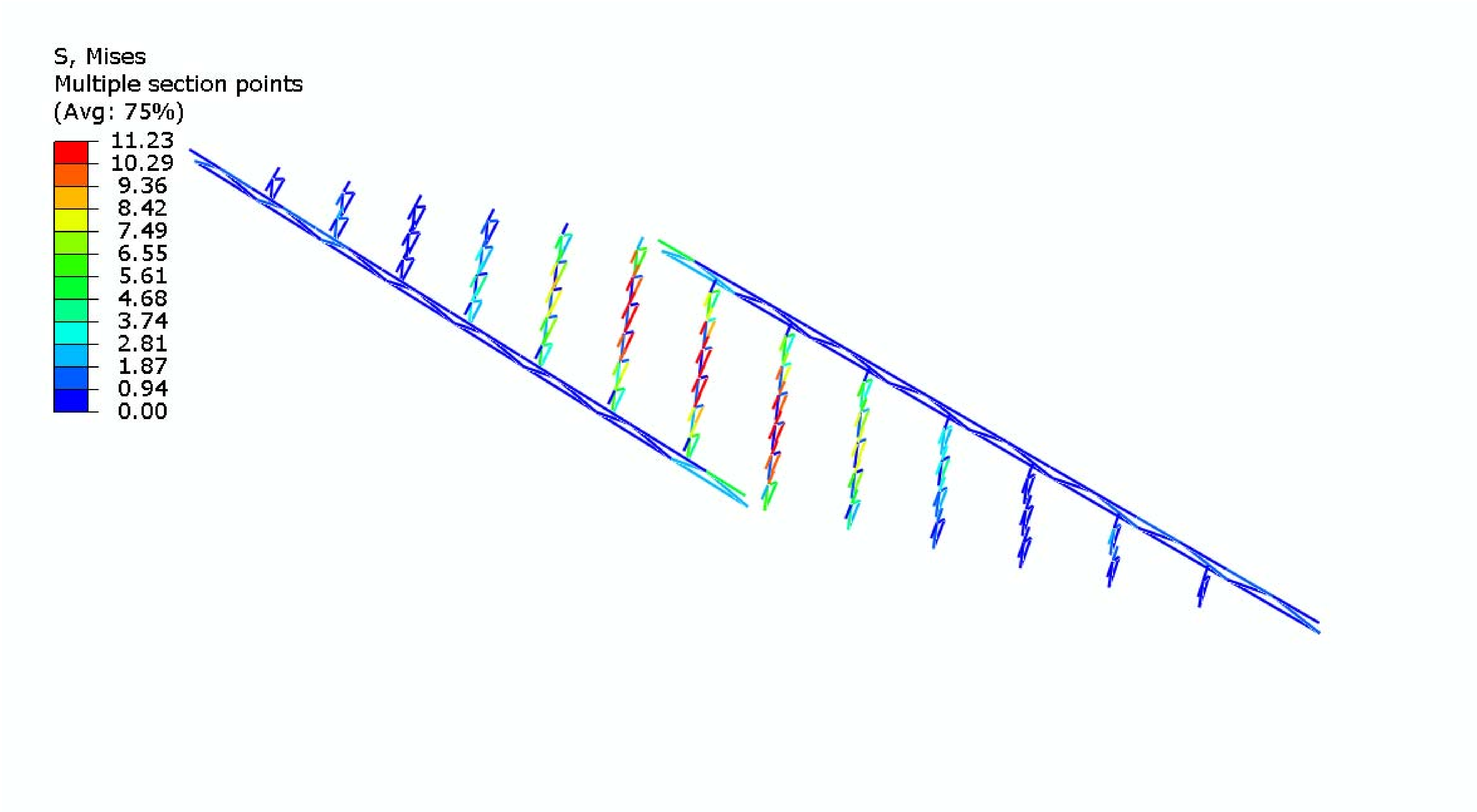


Figure I1-4-26. Cross-frame stress contours under TDL, SDLF detailing (all cross-frame member areas = 9.75 in^2).

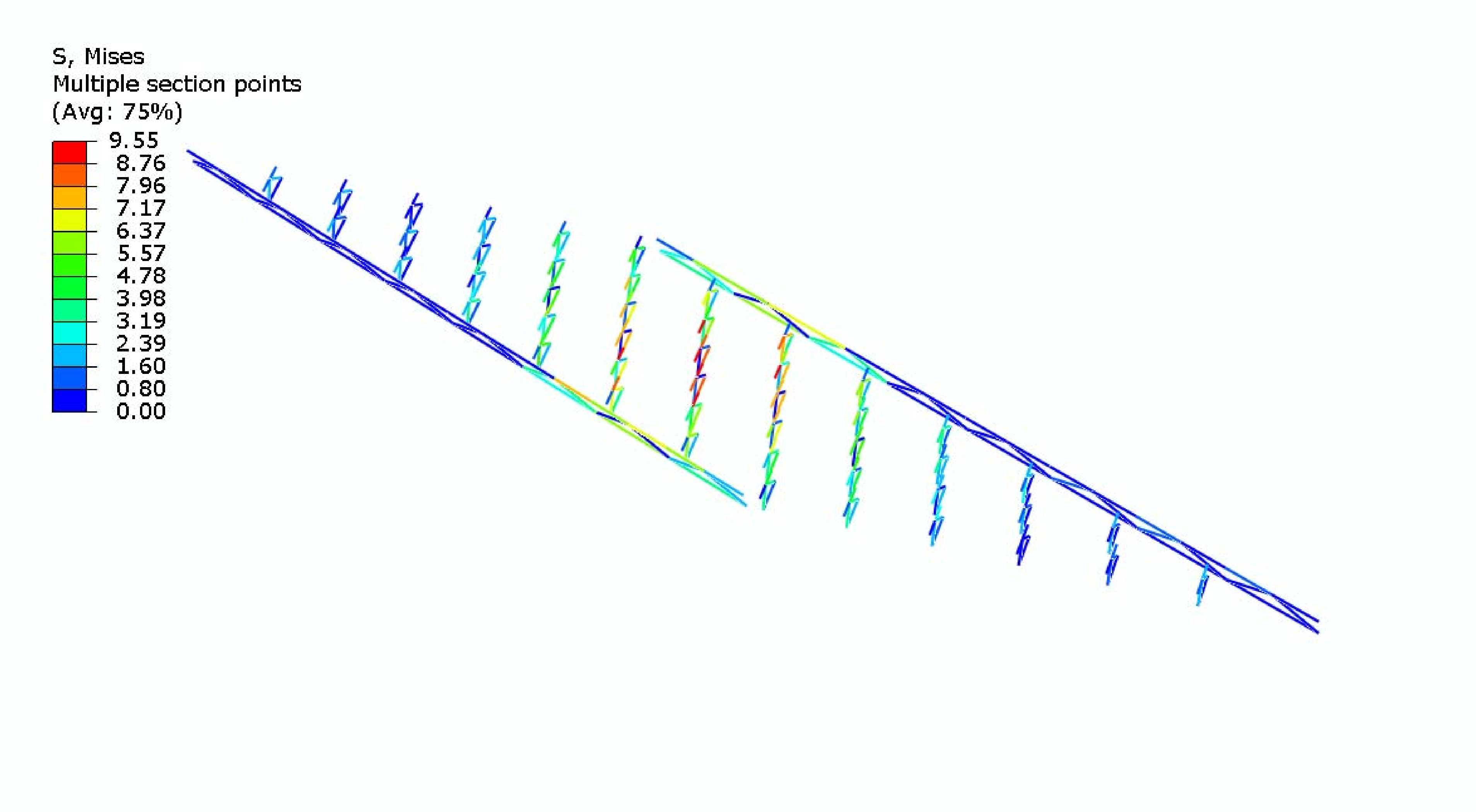


Figure I1-4-27. Cross-frame stress contours under SDL, TDLF detailing (all cross-frame member areas = 9.75 in^2).

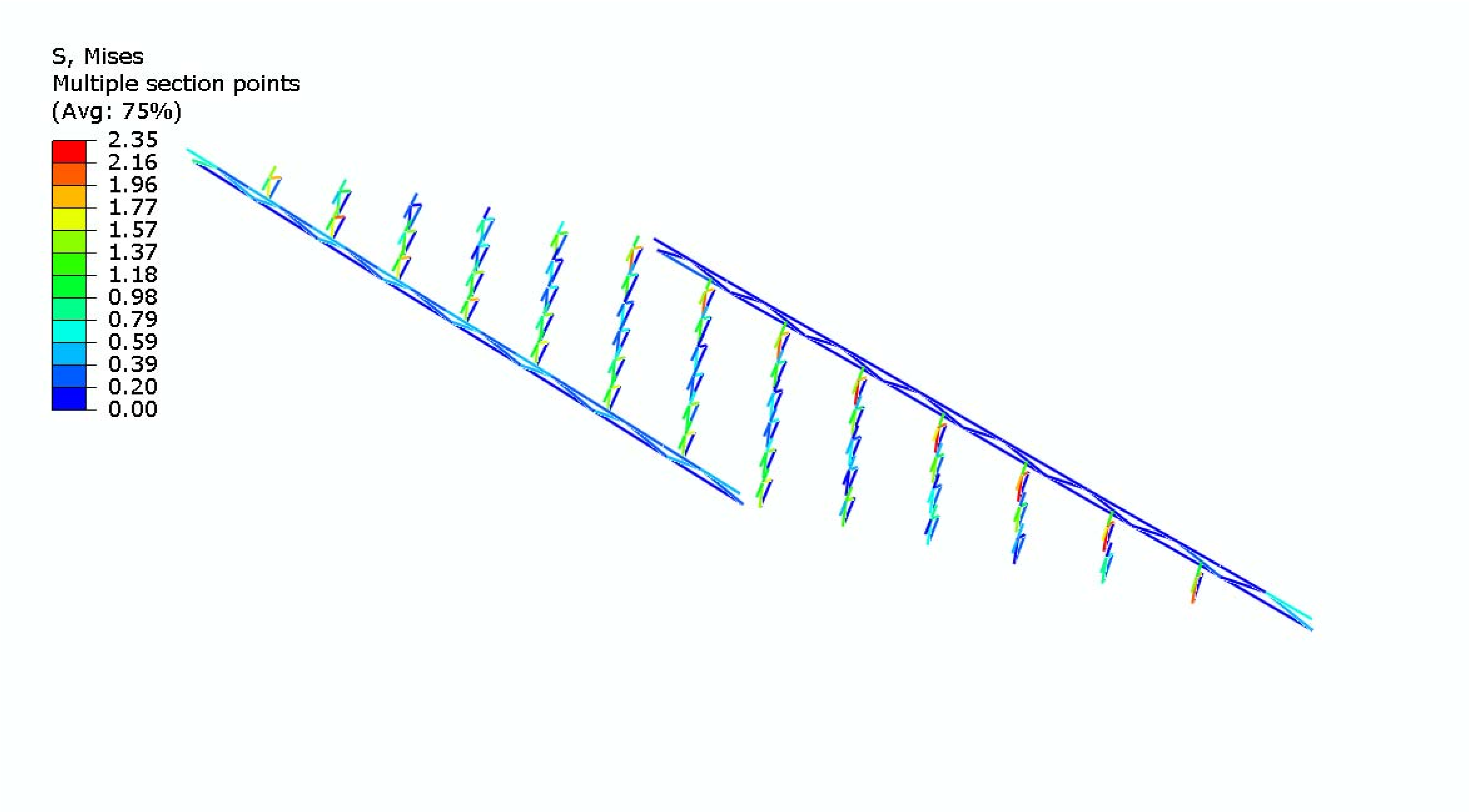


Figure I1-4-28. Cross-frame stress contours under TDL, TDLF (all cross-frame member areas = 9.75 in^2).

Table I1-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	10.1	2.3	1.5	1.4	2.2	3.4	3.8	2.1
	SDLF	2.7	2.2	2.2	2.2	2.2	2.2	2.2	1.9
	TDLF	22.3	2.9	37.4	3.3	2.8	4.9	5.2	3.9
2	NLF	20.3	20.5	18.2	15.7	10.2	1.0	2.2	1.5
	SDLF	4.8	4.6	4.6	4.6	4.5	4.2	4.2	3.9
	TDLF	37.5	56.0	69.6	51.2	33.8	19.2	14.5	19.0
3	NLF	14.5	5.4	9.5	9.9	7.8	2.2	0.5	3.3
	SDLF	4.2	3.7	3.8	3.8	3.7	3.6	3.6	2.8
	TDLF	38.3	37.9	40.9	27.1	23.4	18.5	17.9	16.6
4	NLF	4.1	5.9	3.2	3.5	4.6	3.4	4.4	1.3
	SDLF	2.6	1.7	1.6	1.7	1.7	1.6	1.5	0.7
	TDLF	22.0	16.8	14.9	14.6	5.1	6.7	2.8	1.3
5	NLF	1.2	4.5	3.4	4.8	3.8	2.9	6.0	4.0
	SDLF	0.6	1.5	1.6	1.6	1.6	1.6	1.8	2.5
	TDLF	2.0	2.9	6.6	4.8	14.5	14.7	17.0	21.4
6	NLF	3.1	0.4	2.1	7.9	10.0	9.6	5.6	14.4
	SDLF	2.5	3.3	3.4	3.5	3.6	3.5	3.4	4.4
	TDLF	14.7	16.1	17.3	22.0	25.7	39.5	36.1	38.7
7	NLF	1.5	2.1	0.8	10.2	15.7	18.3	20.6	20.4
	SDLF	4.2	5.1	5.3	5.5	5.6	5.6	5.6	5.6
	TDLF	20.5	18.2	23.6	37.9	54.7	73.7	60.1	41.0
8	NLF	2.0	3.7	3.4	2.3	1.4	1.5	2.3	10.1
	SDLF	1.5	1.3	1.4	1.4	1.4	1.4	1.4	1.6
	TDLF	6.2	8.6	8.1	6.0	2.5	34.0	3.5	26.4

Table I1-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	34.1	4.7	1.4	2.9	6.7	11.9	13.3	12.8
	SDLF	24.5	2.2	2.2	3.6	6.4	10.3	11.5	11.7
	TDLF	5.0	5.0	5.0	4.9	5.0	5.2	5.6	7.7
2	NLF	86.1	88.2	78.3	67.5	43.2	1.9	10.9	0.7
	SDLF	60.8	62.6	55.3	47.3	29.0	2.7	12.3	4.8
	TDLF	15.8	16.5	16.7	16.9	17.3	18.4	19.3	18.5
3	NLF	63.7	22.4	39.6	41.5	32.2	6.4	3.6	10.4
	SDLF	45.4	14.3	27.2	28.5	21.4	4.9	6.6	5.7
	TDLF	14.3	14.7	14.4	14.4	14.6	14.9	15.2	10.4
4	NLF	16.5	23.8	14.7	13.6	18.6	13.5	19.4	3.8
	SDLF	11.3	17.5	12.9	9.6	13.2	9.5	16.5	3.0
	TDLF	9.3	5.1	6.4	6.3	6.2	6.1	6.2	1.5
5	NLF	3.3	19.7	13.9	19.8	15.1	13.5	24.2	16.2
	SDLF	2.7	16.8	9.8	14.3	10.8	11.9	17.8	11.1
	TDLF	1.7	6.4	5.9	5.8	5.9	5.9	5.8	8.9
6	NLF	10.0	4.6	5.8	32.5	42.2	40.4	23.3	63.4
	SDLF	5.9	7.1	5.0	21.9	29.4	28.2	15.4	45.2
	TDLF	8.9	13.8	14.2	13.6	13.3	13.3	13.2	15.1
7	NLF	0.2	11.6	1.4	42.8	67.6	78.8	88.6	86.8
	SDLF	4.6	13.3	3.9	27.7	46.4	54.7	61.9	60.5
	TDLF	19.6	22.8	22.9	22.0	21.2	21.0	20.8	19.3
8	NLF	12.0	13.1	12.0	6.9	3.1	1.4	4.9	34.3
	SDLF	10.6	10.5	9.5	5.8	3.0	1.6	3.2	25.7
	TDLF	5.1	2.1	1.8	1.8	1.7	1.6	1.5	1.1

Table I1-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	6.9	0.1	1.2	1.1	0.0	0.2	1.1	2.1
	SDLF	1.0	0.5	0.5	0.6	0.7	0.7	0.7	1.0
	TDLF	34.6	55.3	29.6	0.7	2.2	3.5	2.7	0.0
2	NLF	16.4	11.0	9.5	8.8	6.0	0.5	3.0	0.5
	SDLF	0.2	0.2	0.2	0.3	0.2	0.0	0.1	0.1
	TDLF	13.6	20.3	32.0	21.4	9.4	2.2	6.8	1.8
3	NLF	8.3	29.8	27.2	24.5	21.2	12.0	0.0	1.8
	SDLF	0.0	0.3	0.3	0.2	0.3	0.0	0.3	0.4
	TDLF	15.7	41.4	59.5	68.2	45.2	20.9	0.2	4.5
4	NLF	2.9	22.5	32.0	32.7	30.9	25.5	8.5	0.3
	SDLF	0.0	0.4	0.7	0.7	0.6	0.6	0.0	0.2
	TDLF	9.3	40.3	64.1	83.4	72.5	49.9	20.6	0.2
5	NLF	0.3	8.3	25.3	30.7	32.6	32.1	22.7	3.0
	SDLF	0.1	0.3	0.6	0.7	0.8	0.6	0.5	0.2
	TDLF	0.6	21.6	49.5	72.8	83.9	64.3	41.1	8.7
6	NLF	1.7	0.0	11.9	21.1	24.4	27.2	29.8	8.3
	SDLF	0.1	0.2	0.5	0.6	0.7	0.8	0.6	0.1
	TDLF	3.5	2.4	22.9	46.6	70.2	61.8	43.2	16.6
7	NLF	0.5	3.1	0.6	6.0	8.9	9.6	11.3	16.9
	SDLF	0.2	0.1	0.0	0.1	0.1	0.1	0.2	0.1
	TDLF	2.7	7.3	2.4	8.7	20.7	32.2	20.7	13.9
8	NLF	2.3	1.2	0.1	0.1	1.1	1.0	0.2	7.2
	SDLF	0.9	0.4	0.3	0.2	0.2	0.2	0.3	0.5
	TDLF	0.4	1.0	1.5	0.1	0.9	29.1	54.9	32.6

Table I1-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
1	NLF	27.3	1.3	5.0	3.6	2.0	4.3	0.4	1.7
	SDLF	20.9	1.4	4.1	3.0	1.3	3.1	0.4	2.0
	TDLF	0.7	0.2	0.5	0.9	1.0	0.9	0.9	1.2
2	NLF	70.3	48.1	41.4	38.1	27.1	0.1	10.8	2.4
	SDLF	54.2	37.5	32.5	29.7	21.0	0.1	8.2	2.4
	TDLF	0.8	0.2	0.1	0.6	0.9	1.3	1.7	2.4
3	NLF	31.6	127.7	117.6	105.7	90.3	50.5	2.3	9.9
	SDLF	23.7	97.8	90.3	81.4	69.4	38.8	1.7	7.6
	TDLF	1.8	1.6	1.9	1.8	0.9	0.0	1.2	1.8
4	NLF	8.7	93.8	136.4	139.9	131.7	107.2	33.9	5.2
	SDLF	5.9	71.2	104.2	106.9	100.8	81.6	25.6	4.5
	TDLF	2.8	0.5	0.7	1.0	1.1	0.2	1.3	2.6
5	NLF	5.2	33.1	106.4	130.9	139.7	136.9	94.6	9.2
	SDLF	4.7	24.7	81.0	100.0	106.6	104.6	71.7	6.5
	TDLF	3.0	2.8	0.3	0.2	0.5	1.0	1.0	2.0
6	NLF	9.6	2.2	50.1	89.9	105.2	117.5	127.8	31.8
	SDLF	7.7	2.2	38.0	68.7	80.6	89.7	97.6	23.6
	TDLF	2.7	3.4	2.2	0.7	0.5	0.3	0.4	2.6
7	NLF	3.0	11.3	0.3	27.3	38.5	42.0	49.4	72.9
	SDLF	2.6	8.6	0.1	21.4	30.3	33.1	38.6	56.4
	TDLF	1.8	1.5	1.4	0.3	0.4	0.3	0.3	0.0
8	NLF	1.1	0.2	3.8	1.8	3.3	4.1	0.1	28.5
	SDLF	1.5	0.3	3.0	1.6	2.3	3.2	0.3	22.2
	TDLF	1.2	0.4	0.5	0.8	1.0	0.8	1.0	1.9

Table I1-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
1	NLF	16.3	2.4	1.8	1.7	2.1	3.1	2.9	1.5
	SDLF	1.5	1.4	1.4	1.5	1.5	1.5	1.5	0.5
	TDLF	58.4	64.1	70.2	5.7	1.7	5.2	7.4	5.4
2	NLF	31.0	25.4	22.3	18.8	11.6	1.5	4.4	1.6
	SDLF	3.3	3.2	3.1	3.0	2.8	2.6	2.6	2.6
	TDLF	42.2	61.0	79.7	53.0	28.1	16.6	16.9	13.9
3	NLF	16.4	32.6	32.4	30.3	24.9	11.8	0.7	3.9
	SDLF	2.9	2.8	2.8	2.7	2.5	2.2	2.1	1.6
	TDLF	40.6	67.8	87.2	85.7	58.3	31.5	11.4	15.0
4	NLF	4.7	24.3	33.0	33.4	32.6	25.5	10.1	1.4
	SDLF	1.7	1.7	1.8	1.8	1.8	1.5	0.9	0.2
	TDLF	24.3	50.9	74.6	92.4	75.6	51.6	21.7	0.7
5	NLF	1.3	9.9	25.4	32.7	33.5	32.8	24.5	4.8
	SDLF	0.3	1.4	1.9	2.0	2.0	1.9	1.6	1.5
	TDLF	1.9	23.8	53.0	76.2	93.1	75.4	50.7	23.3
6	NLF	3.8	0.6	11.6	24.8	30.4	32.5	32.7	16.5
	SDLF	1.6	2.5	3.0	3.3	3.3	3.3	3.3	2.8
	TDLF	11.8	12.8	34.6	61.1	88.2	89.7	70.4	40.4
7	NLF	1.7	4.5	1.5	11.5	18.8	22.3	25.3	30.9
	SDLF	2.6	3.4	3.7	4.0	4.2	4.2	4.2	4.3
	TDLF	15.8	18.2	17.6	33.0	57.9	84.3	65.4	46.9
8	NLF	1.4	2.9	3.2	2.2	1.7	1.6	2.0	16.0
	SDLF	0.6	0.4	0.4	0.3	0.3	0.4	0.4	0.5
	TDLF	9.2	9.0	6.8	6.8	6.6	67.5	64.5	61.8

Table I1-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	63.8	9.5	6.3	7.4	9.1	11.8	13.0	12.6
	SDLF	47.0	5.8	5.7	6.7	8.0	10.0	10.8	10.7
	TDLF	4.5	3.8	3.9	4.3	4.6	4.8	5.1	7.3
2	NLF	132.8	109.8	96.6	81.9	49.7	6.9	22.2	6.4
	SDLF	97.5	80.7	70.9	59.9	35.6	5.9	19.7	8.3
	TDLF	10.2	10.7	10.7	10.9	10.8	12.5	13.7	14.8
3	NLF	71.2	140.3	139.8	131.1	107.3	48.4	7.4	17.5
	SDLF	51.4	104.3	104.3	97.7	79.7	36.7	8.0	11.9
	TDLF	11.8	9.8	9.7	9.5	9.4	9.0	10.7	8.2
4	NLF	17.2	104.5	143.4	143.8	140.3	109.8	41.2	10.1
	SDLF	11.1	78.2	109.4	108.2	105.5	82.4	31.7	8.1
	TDLF	9.0	4.7	3.4	3.2	3.3	3.4	5.0	3.5
5	NLF	9.7	40.9	109.3	140.7	144.4	142.4	105.1	17.2
	SDLF	8.1	31.0	81.7	105.6	108.6	108.4	78.8	11.3
	TDLF	4.4	7.6	5.2	4.0	3.8	3.8	4.1	7.9
6	NLF	17.0	8.0	47.7	107.3	131.6	140.4	140.9	71.5
	SDLF	12.3	9.0	35.7	79.0	97.5	104.2	104.4	51.7
	TDLF	9.0	13.1	12.5	10.8	9.9	9.6	9.6	11.7
7	NLF	6.5	22.5	6.6	49.5	81.9	96.8	109.9	132.7
	SDLF	8.2	20.7	7.3	34.2	58.8	70.0	79.7	96.4
	TDLF	14.5	17.1	17.3	16.0	15.1	14.6	14.3	14.6
8	NLF	11.9	12.3	12.2	9.3	7.2	5.4	8.1	62.4
	SDLF	9.3	9.8	9.0	6.9	5.5	4.2	5.3	47.0
	TDLF	6.6	0.7	0.9	1.2	1.3	1.1	1.1	1.0

Table I1-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	-2.29	-1.18	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.55	-0.52	-0.50	-0.50	-0.51	-0.59	-0.78	-0.97
	SDLF	-0.95	-0.93	-0.93	-0.93	-0.93	-0.93	-0.93	-0.82
	TDLF	-3.81	-2.88	-2.24	-2.18	-1.93	-1.49	-0.87	0.23
3	NLF	-0.03	-0.27	-0.31	-0.32	-0.35	-0.43	-0.63	-0.85
	SDLF	-0.72	-0.62	-0.62	-0.62	-0.62	-0.62	-0.61	-0.45
	TDLF	-3.86	-2.53	-1.89	-1.48	-1.14	-0.64	0.01	1.41
4	NLF	0.37	0.04	-0.07	-0.11	-0.14	-0.20	-0.37	-0.65
	SDLF	-0.37	-0.22	-0.22	-0.22	-0.22	-0.22	-0.21	-0.04
	TDLF	-3.43	-1.84	-1.17	-0.64	-0.25	0.27	0.94	2.55
5	NLF	0.65	0.37	0.20	0.14	0.10	0.07	-0.05	-0.37
	SDLF	0.04	0.21	0.21	0.22	0.22	0.22	0.22	0.38
	TDLF	-2.55	-0.95	-0.28	0.24	0.64	1.16	1.84	3.44
6	NLF	0.85	0.63	0.43	0.35	0.32	0.31	0.27	0.03
	SDLF	0.45	0.61	0.61	0.62	0.62	0.62	0.62	0.72
	TDLF	-1.42	-0.01	0.64	1.13	1.48	1.88	2.53	3.87
7	NLF	0.97	0.78	0.59	0.51	0.50	0.50	0.52	0.55
	SDLF	0.82	0.93	0.93	0.93	0.94	0.93	0.93	0.95
	TDLF	-0.23	0.87	1.49	1.94	2.19	2.25	2.89	3.81
8	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	1.18	2.28

Table I1-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-2.42	-2.28	-2.21	-2.20	-2.25	-2.60	-3.45	-4.33
	SDLF	-2.81	-2.69	-2.64	-2.63	-2.67	-2.93	-3.58	-4.16
	TDLF	-4.06	-3.98	-3.98	-3.98	-3.99	-4.00	-4.02	-3.57
3	NLF	-0.09	-1.15	-1.34	-1.41	-1.53	-1.90	-2.80	-3.79
	SDLF	-0.78	-1.50	-1.65	-1.70	-1.79	-2.07	-2.76	-3.37
	TDLF	-3.04	-2.61	-2.62	-2.62	-2.62	-2.63	-2.66	-1.96
4	NLF	1.65	0.21	-0.28	-0.46	-0.60	-0.88	-1.65	-2.91
	SDLF	0.89	-0.06	-0.44	-0.57	-0.68	-0.89	-1.48	-2.28
	TDLF	-1.58	-0.90	-0.92	-0.92	-0.92	-0.93	-0.95	-0.17
5	NLF	2.91	1.64	0.87	0.60	0.45	0.28	-0.22	-1.65
	SDLF	2.27	1.47	0.88	0.67	0.57	0.43	0.05	-0.89
	TDLF	0.16	0.94	0.92	0.91	0.91	0.91	0.90	1.58
6	NLF	3.78	2.79	1.89	1.52	1.41	1.34	1.15	0.09
	SDLF	3.36	2.75	2.06	1.79	1.70	1.65	1.50	0.79
	TDLF	1.94	2.65	2.63	2.62	2.61	2.61	2.61	3.06
7	NLF	4.32	3.44	2.59	2.25	2.20	2.22	2.29	2.43
	SDLF	4.14	3.58	2.93	2.67	2.63	2.64	2.70	2.82
	TDLF	3.55	4.03	4.00	3.99	3.99	3.99	4.00	4.08
8	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table I1-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	-1.28	-0.66	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.31	-0.29	-0.28	-0.28	-0.29	-0.33	-0.44	-0.54
	SDLF	-0.53	-0.52	-0.52	-0.52	-0.52	-0.52	-0.52	-0.46
	TDLF	-2.13	-1.61	-1.25	-1.22	-1.08	-0.83	-0.48	0.13
3	NLF	-0.02	-0.15	-0.17	-0.18	-0.20	-0.24	-0.35	-0.47
	SDLF	-0.40	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.25
	TDLF	-2.15	-1.42	-1.05	-0.83	-0.63	-0.36	0.00	0.79
4	NLF	0.20	0.03	-0.04	-0.06	-0.08	-0.11	-0.21	-0.36
	SDLF	-0.21	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.02
	TDLF	-1.92	-1.03	-0.65	-0.36	-0.14	0.15	0.53	1.42
5	NLF	0.36	0.21	0.11	0.08	0.06	0.04	-0.03	-0.20
	SDLF	0.02	0.12	0.12	0.12	0.12	0.12	0.12	0.21
	TDLF	-1.43	-0.53	-0.16	0.14	0.36	0.65	1.03	1.92
6	NLF	0.47	0.35	0.24	0.19	0.18	0.17	0.15	0.02
	SDLF	0.25	0.34	0.34	0.34	0.34	0.34	0.34	0.40
	TDLF	-0.79	-0.01	0.36	0.63	0.82	1.05	1.41	2.16
7	NLF	0.54	0.43	0.33	0.29	0.28	0.28	0.29	0.31
	SDLF	0.46	0.52	0.52	0.52	0.52	0.52	0.52	0.53
	TDLF	-0.13	0.49	0.83	1.08	1.22	1.25	1.61	2.13
8	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.66	1.27

Table I1-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-1.35	-1.27	-1.24	-1.23	-1.26	-1.45	-1.93	-2.42
	SDLF	-1.57	-1.50	-1.47	-1.47	-1.49	-1.64	-2.00	-2.32
	TDLF	-2.27	-2.22	-2.22	-2.22	-2.23	-2.23	-2.25	-1.99
3	NLF	-0.05	-0.64	-0.75	-0.79	-0.85	-1.06	-1.56	-2.12
	SDLF	-0.44	-0.84	-0.92	-0.95	-1.00	-1.16	-1.54	-1.88
	TDLF	-1.70	-1.46	-1.46	-1.46	-1.46	-1.47	-1.49	-1.10
4	NLF	0.92	0.12	-0.16	-0.26	-0.34	-0.49	-0.92	-1.63
	SDLF	0.50	-0.03	-0.24	-0.32	-0.38	-0.50	-0.83	-1.27
	TDLF	-0.88	-0.50	-0.51	-0.51	-0.52	-0.52	-0.53	-0.10
5	NLF	1.62	0.92	0.49	0.33	0.25	0.15	-0.12	-0.92
	SDLF	1.27	0.82	0.49	0.38	0.32	0.24	0.03	-0.50
	TDLF	0.09	0.53	0.51	0.51	0.51	0.51	0.50	0.88
6	NLF	2.11	1.56	1.05	0.85	0.79	0.75	0.64	0.05
	SDLF	1.87	1.54	1.15	1.00	0.95	0.92	0.84	0.44
	TDLF	1.08	1.48	1.47	1.46	1.46	1.46	1.46	1.71
7	NLF	2.41	1.92	1.45	1.26	1.23	1.24	1.28	1.36
	SDLF	2.32	2.00	1.63	1.49	1.47	1.48	1.51	1.58
	TDLF	1.99	2.25	2.23	2.23	2.23	2.23	2.23	2.28
8	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table I1-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	53	26	224	119
	SDLF	26	26	197	117
	TDLF	0	21	112	111
G2	NLF	29	30	119	119
	SDLF	30	30	120	120
	TDLF	0	31	123	123
G3	NLF	30	21	124	82
	SDLF	30	30	124	92
	TDLF	0	46	123	122
G4	NLF	29	19	119	74
	SDLF	30	30	120	86
	TDLF	56	53	123	122
G5	NLF	25	25	102	102
	SDLF	30	30	107	107
	TDLF	53	53	123	122
G6	NLF	19	29	74	119
	SDLF	30	30	86	120
	TDLF	53	56	122	123
G7	NLF	21	30	82	124
	SDLF	30	30	91	124
	TDLF	45	0	122	123
G8	NLF	30	28	119	119
	SDLF	30	30	119	120
	TDLF	30	0	122	123
G9	NLF	27	53	119	224
	SDLF	26	26	118	197
	TDLF	22	0	112	112

Table I1-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	-0.8	NA	-3.2	NA
	SDLF	0.1	NA	-2.1	NA
	TDLF	2.9	NA	0.1	NA
G2	NLF	-0.3	NA	-1.4	NA
	SDLF	0.0	NA	-0.8	NA
	TDLF	1.8	NA	0.0	NA
G3	NLF	-0.2	NA	-1.2	NA
	SDLF	0.0	NA	-0.8	NA
	TDLF	0.7	NA	0.1	NA
G4	NLF	0.0	NA	-0.6	NA
	SDLF	0.0	NA	-0.5	NA
	TDLF	-0.5	NA	0.0	NA
G5	NLF	0.2	NA	0.7	NA
	SDLF	0.0	NA	0.5	NA
	TDLF	-0.9	NA	-0.1	NA
G6	NLF	0.3	NA	2.0	NA
	SDLF	0.0	NA	1.3	NA
	TDLF	-0.9	NA	-0.1	NA
G7	NLF	0.4	NA	2.2	NA
	SDLF	0.0	NA	1.5	NA
	TDLF	-0.9	NA	0.0	NA
G8	NLF	0.2	NA	1.1	NA
	SDLF	0.0	NA	0.7	NA
	TDLF	-1.2	NA	-0.1	NA
G9	NLF	0.1	NA	0.4	NA
	SDLF	0.0	NA	0.3	NA
	TDLF	-1.0	NA	0.1	NA

Table I1-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-2.6	0.3	-10.4	2.7
	SDLF	0.0	0.0	-6.8	1.9
	TDLF	3.1	0.5	-0.2	0.4
G2	NLF	-1.7	0.1	-7.2	0.5
	SDLF	0.1	0.1	-4.6	0.5
	TDLF	2.7	0.2	0.1	0.3
G3	NLF	-1.3	-0.3	-6.8	-2.6
	SDLF	0.1	0.1	-4.6	-1.8
	TDLF	2.8	-0.2	0.1	0.2
G4	NLF	-0.8	-0.2	-4.8	-2.5
	SDLF	0.0	0.0	-3.3	-1.9
	TDLF	1.3	-0.4	-0.1	-0.2
G5	NLF	-0.3	0.2	-1.0	0.7
	SDLF	-0.1	-0.1	-0.7	0.3
	TDLF	0.3	-0.7	-0.3	-0.4
G6	NLF	0.1	0.7	2.3	4.6
	SDLF	-0.1	-0.1	1.7	3.1
	TDLF	0.3	-1.7	-0.1	-0.4
G7	NLF	0.3	1.3	2.5	6.8
	SDLF	0.0	-0.1	1.8	4.5
	TDLF	0.5	-2.9	0.1	-0.2
G8	NLF	-0.1	1.7	-0.5	7.3
	SDLF	0.1	0.0	-0.3	4.7
	TDLF	0.2	-2.8	0.2	0.0
G9	NLF	-0.3	2.7	-2.4	10.6
	SDLF	0.1	0.0	-1.6	7.0
	TDLF	0.1	-3.1	0.2	0.2

Table I1-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	-0.08	0.16	-0.32	0.68
	SDLF	0.01	0.19	-0.21	0.64
	TDLF	0.29	0.40	0.01	0.87
G2	NLF	-0.03	0.15	-0.14	0.61
	SDLF	0.00	0.21	-0.08	0.60
	TDLF	0.18	0.47	0.00	0.95
G3	NLF	-0.02	0.13	-0.12	0.49
	SDLF	0.00	0.21	-0.08	0.52
	TDLF	0.07	0.47	0.01	0.96
G4	NLF	0.00	0.13	-0.06	0.50
	SDLF	0.00	0.21	-0.05	0.52
	TDLF	-0.05	0.46	0.00	0.94
G5	NLF	0.02	0.15	0.07	0.63
	SDLF	0.00	0.20	0.05	0.61
	TDLF	-0.09	0.44	-0.01	0.94
G6	NLF	0.03	0.17	0.20	0.76
	SDLF	0.00	0.20	0.13	0.70
	TDLF	-0.09	0.41	-0.01	0.94
G7	NLF	0.04	0.18	0.22	0.83
	SDLF	0.00	0.20	0.15	0.75
	TDLF	-0.09	0.30	0.00	0.95
G8	NLF	0.02	0.20	0.11	0.85
	SDLF	0.00	0.20	0.07	0.76
	TDLF	-0.12	0.17	-0.01	0.95
G9	NLF	0.01	0.25	0.04	1.04
	SDLF	0.00	0.18	0.03	0.88
	TDLF	-0.10	0.00	0.01	0.87

Table I1-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.26	-0.03	1.04	-0.27
	SDLF	0.00	0.00	0.68	-0.19
	TDLF	-0.31	-0.05	0.02	-0.04
G2	NLF	0.17	-0.01	0.72	-0.05
	SDLF	-0.01	-0.01	0.46	-0.05
	TDLF	-0.27	-0.02	-0.01	-0.03
G3	NLF	0.13	0.03	0.68	0.26
	SDLF	-0.01	-0.01	0.46	0.18
	TDLF	-0.28	0.02	-0.01	-0.02
G4	NLF	0.08	0.02	0.48	0.25
	SDLF	0.00	0.00	0.33	0.19
	TDLF	-0.13	0.04	0.01	0.02
G5	NLF	0.03	-0.02	0.10	-0.07
	SDLF	0.01	0.01	0.07	-0.03
	TDLF	-0.03	0.07	0.03	0.04
G6	NLF	-0.01	-0.07	-0.23	-0.46
	SDLF	0.01	0.01	-0.17	-0.31
	TDLF	-0.03	0.17	0.01	0.04
G7	NLF	-0.03	-0.13	-0.25	-0.68
	SDLF	0.00	0.01	-0.18	-0.45
	TDLF	-0.05	0.29	-0.01	0.02
G8	NLF	0.01	-0.17	0.05	-0.73
	SDLF	-0.01	0.00	0.03	-0.47
	TDLF	-0.02	0.28	-0.02	0.00
G9	NLF	0.03	-0.27	0.24	-1.06
	SDLF	-0.01	0.00	0.16	-0.70
	TDLF	-0.01	0.31	-0.02	-0.02

(Columns SDL 1 through TDL 2 fall under the spanning header "Load Type & Support Number".)

Appendix I1-5. NISSS14 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISSS14 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table I1-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	SDLF	-1.6	0.1	1.6	0.0	-0.5	0.5
		TDLF	-3.0	-0.1	3.0	0.0	-1.1	1.1
	2-3	SDLF	-0.4	-1.4	1.4	0.0	0.9	0.9
		TDLF	0.8	-5.3	5.4	0.0	3.1	3.1
	2-4	SDLF	-2.4	5.6	6.1	0.0	-3.6	3.6
		TDLF	-10.0	24.6	26.6	0.0	-15.3	15.3
	2-5	SDLF	-1.2	2.7	2.9	0.0	-1.9	1.9
		TDLF	-4.5	10.7	11.7	0.0	-8.1	8.1
	2-6	SDLF	-0.6	1.3	1.5	0.0	-0.8	0.8
		TDLF	-2.3	5.5	6.0	0.0	-3.4	3.4
	2-7	SDLF	0.3	-0.9	1.0	0.0	0.8	0.8
		TDLF	1.2	-3.8	4.0	0.0	3.0	3.0
	2-8	SDLF	0.6	-1.8	1.9	0.0	1.3	1.3
		TDLF	2.7	-7.1	7.6	0.0	5.2	5.2
	2-9	SDLF	1.0	-2.7	2.9	0.0	1.6	1.6
		TDLF	3.9	-7.8	8.8	0.0	4.6	4.6

Table I1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
3	3-2	SDLF	-1.2	0.2	1.2	0.0	-0.5	0.5
		TDLF	-2.2	-0.6	2.3	0.0	-1.3	1.3
	3-3	SDLF	0.4	-0.9	1.0	0.0	0.6	0.6
		TDLF	4.3	-4.6	6.3	0.0	3.0	3.0
	3-4	SDLF	-2.1	4.7	5.1	0.0	-3.1	3.1
		TDLF	-8.2	19.9	21.5	0.0	-12.7	12.7
	3-5	SDLF	-1.0	2.7	2.8	0.0	-1.7	1.7
		TDLF	1.2	6.6	6.7	0.0	-6.8	6.8
	3-6	SDLF	0.3	0.2	0.4	0.0	-0.5	0.5
		TDLF	3.7	-1.6	4.0	0.0	-1.7	1.7
	3-7	SDLF	1.2	-1.8	2.1	0.0	1.0	1.0
		TDLF	7.1	-9.8	12.0	0.0	4.7	4.7
	3-8	SDLF	1.2	-2.8	3.1	0.0	1.8	1.8
		TDLF	7.7	-13.2	15.3	0.0	7.1	7.1
	3-9	SDLF	1.7	-4.0	4.3	0.0	2.2	2.2
		TDLF	9.9	-11.3	15.1	0.0	2.5	2.5

Table I1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	SDLF	-1.3	0.2	1.3	0.0	-0.4	0.4
		TDLF	-1.9	-1.6	2.5	0.0	-1.2	1.2
	9-3	SDLF	-0.1	-0.6	0.6	0.0	0.3	0.3
		TDLF	38.4	-3.3	38.5	0.0	5.9	5.9
	9-4	SDLF	-1.6	3.8	4.1	0.0	-2.7	2.7
		TDLF	-5.1	14.0	14.9	0.0	-11.1	11.1
	9-5	SDLF	-0.4	1.7	1.7	0.0	-1.3	1.3
		TDLF	7.7	-0.4	7.7	0.0	-3.9	3.9
	9-6	SDLF	0.4	-0.2	0.5	0.0	-0.1	0.1
		TDLF	13.2	-10.9	17.1	0.0	1.8	1.8
	9-7	SDLF	1.2	-2.2	2.5	0.0	1.3	1.3
		TDLF	20.2	-22.9	30.6	0.0	8.8	8.8
	9-8	SDLF	1.3	-3.1	3.4	0.0	2.0	2.0
		TDLF	19.0	-23.9	30.5	0.0	8.5	8.5
	9-9	SDLF	0.1	-1.5	1.5	0.0	0.7	0.7
		TDLF	8.2	-12.5	14.9	0.0	-0.9	0.9

Table I1-5-2: Erection Critical Sub-Stages

Stage	Detailing Method	Critical Sub-Stage
2	SDLF	2-4
	TDLF	2-4
3	SDLF	3-4
	TDLF	3-4
9	SDLF	9-4
	TDLF	9-4

Table I1-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	SDLF	-1.3	0.1	1.3	NA	NA	NA
		TDLF	-5.3	1.1	5.4	NA	NA	NA
	B	SDLF	-2.4	5.6	6.1	0.0	-3.6	3.6
		TDLF	-10.0	24.6	26.6	0.0	-15.3	15.3
3	A	SDLF	-1.0	0.0	1.0	NA	NA	NA
		TDLF	-3.2	0.6	3.3	NA	NA	NA
	B	SDLF	-2.1	4.7	5.1	0.0	-3.1	3.1
		TDLF	-8.2	19.9	21.5	0.0	-12.7	12.7
9	A	SDLF	-0.4	0.0	0.4	NA	NA	NA
		TDLF	1.3	-1.1	1.7	NA	NA	NA
	B	SDLF	-1.6	3.8	4.1	0.0	-2.7	2.7
		TDLF	-5.1	14.0	14.9	0.0	-11.1	11.1

Table I1-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
2	A	G1	SDLF	26	25
			TDLF	26	24
		G2	SDLF	26	26
			TDLF	25	26
	B	G1	SDLF	26	25
			TDLF	26	25
		G2	SDLF	26	26
			TDLF	25	26
3	A	G1	SDLF	26	26
			TDLF	20	26
		G2	SDLF	30	28
			TDLF	39	31
		G3	SDLF	25	26
			TDLF	21	23
	B	G1	SDLF	26	26
			TDLF	21	26
		G2	SDLF	30	28
			TDLF	39	32
		G3	SDLF	25	26
			TDLF	22	23

Table I1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
9	A	G1	SDLF	26	26
			TDLF	0	21
		G2	SDLF	30	30
			TDLF	0	32
		G3	SDLF	30	30
			TDLF	0	46
		G4	SDLF	30	30
			TDLF	56	52
		G5	SDLF	31	30
			TDLF	63	52
		G6	SDLF	30	30
			TDLF	55	50
		G7	SDLF	28	30
			TDLF	23	5
		G8	SDLF	30	27
			TDLF	42	0
		G9	SDLF	25	26
			TDLF	19	0

Table I1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
9	B	G1	SDLF	26	26
			TDLF	0	21
		G2	SDLF	30	30
			TDLF	0	32
		G3	SDLF	30	30
			TDLF	0	46
		G4	SDLF	30	30
			TDLF	56	52
		G5	SDLF	31	30
			TDLF	63	52
		G6	SDLF	30	30
			TDLF	55	50
		G7	SDLF	28	30
			TDLF	24	5
		G8	SDLF	30	27
			TDLF	42	0
		G9	SDLF	25	26
			TDLF	19	0

Appendix I2-1. NISSS14 Bridge Description

The key characteristics of NISSS14 are as follows:

- Span length along the centerline of the bridge, L_s = 150 ft.
- Width between the fascia girders, w_g = 74 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 2.0
- Number of girders in the completed bridge cross-section, n_g = 9.
- Parallel skew
- Skew angle, $\theta = 70^o$
- Skew index, I_s = 1.35

This appendix presents the bridge description of the bridge NISSS14 in its final condition as well as during erection. The following figures and tables are provided:

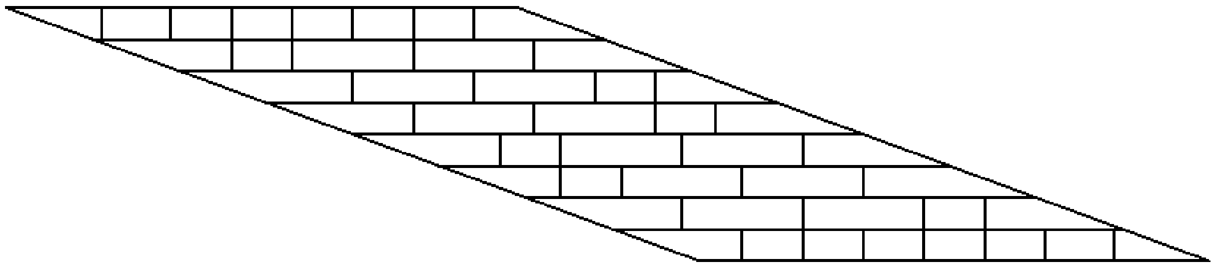


Figure I2-1-1. Framing plan.

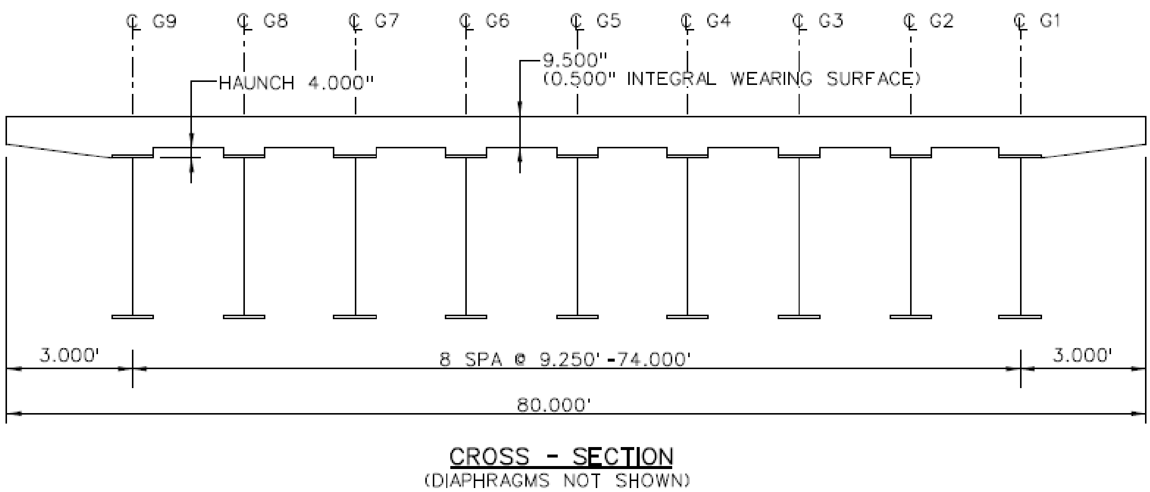


Figure I2-1-2. Bridge cross-section.

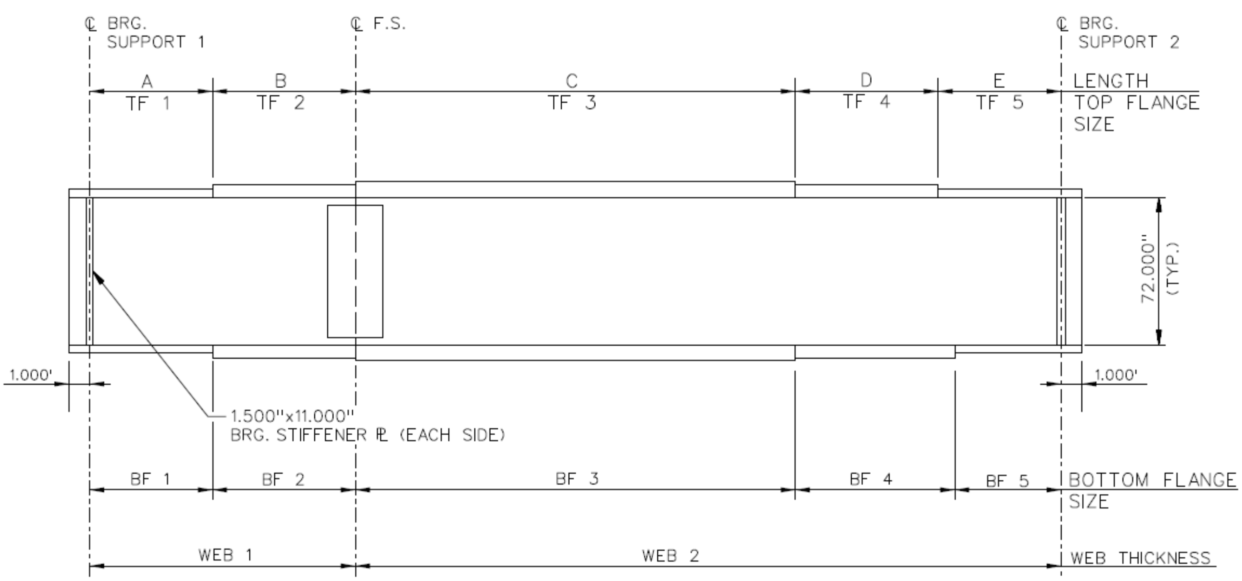


Figure I2-1-3. Girder elevations

	GIRDER PLATE LENGTHS ⚹		
LENGTH	G1, G2, G3	G4, G5, G6	G7, G8, G9
A	20.000	20.000	20.000
B	20.000	20.000	20.000
C	70.000	70.000	70.000
D	20.000	20.000	20.000
E	20.000	20.000	20.000

⚹ ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS ⚹⚹					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	16.000	0.750	16.000	0.750	16.000	0.750
TF2	16.000	0.750	16.000	0.750	16.000	0.750
TF3	16.000	1.000	16.000	1.000	16.000	1.000
TF4	16.000	0.750	16.000	0.750	16.000	0.750
TF5	16.000	0.750	16.000	0.750	16.000	0.750

⚹⚹ ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS ⚹⚹					
BOTTOM FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
BF1	18.000	1.000	18.000	1.000	18.000	1.000
BF2	18.000	1.500	18.000	1.500	18.000	1.500
BF3	18.000	2.000	18.000	2.000	18.000	2.000
BF4	18.000	1.500	18.000	1.500	18.000	1.500
BF5	18.000	1.000	18.000	1.000	18.000	1.000

⚹⚹ ALL DIMENSIONS ARE IN INCHES.

Figure I2-1-4. Cross-section dimensions.

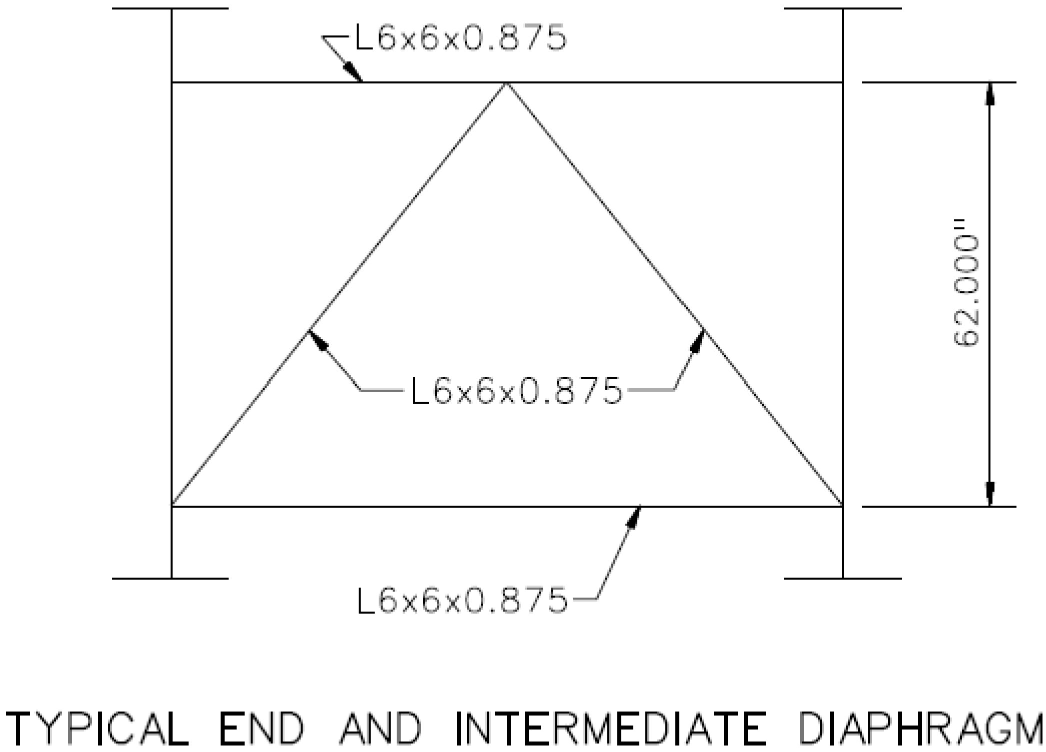


Figure I2-1-5. Cross-frame details.

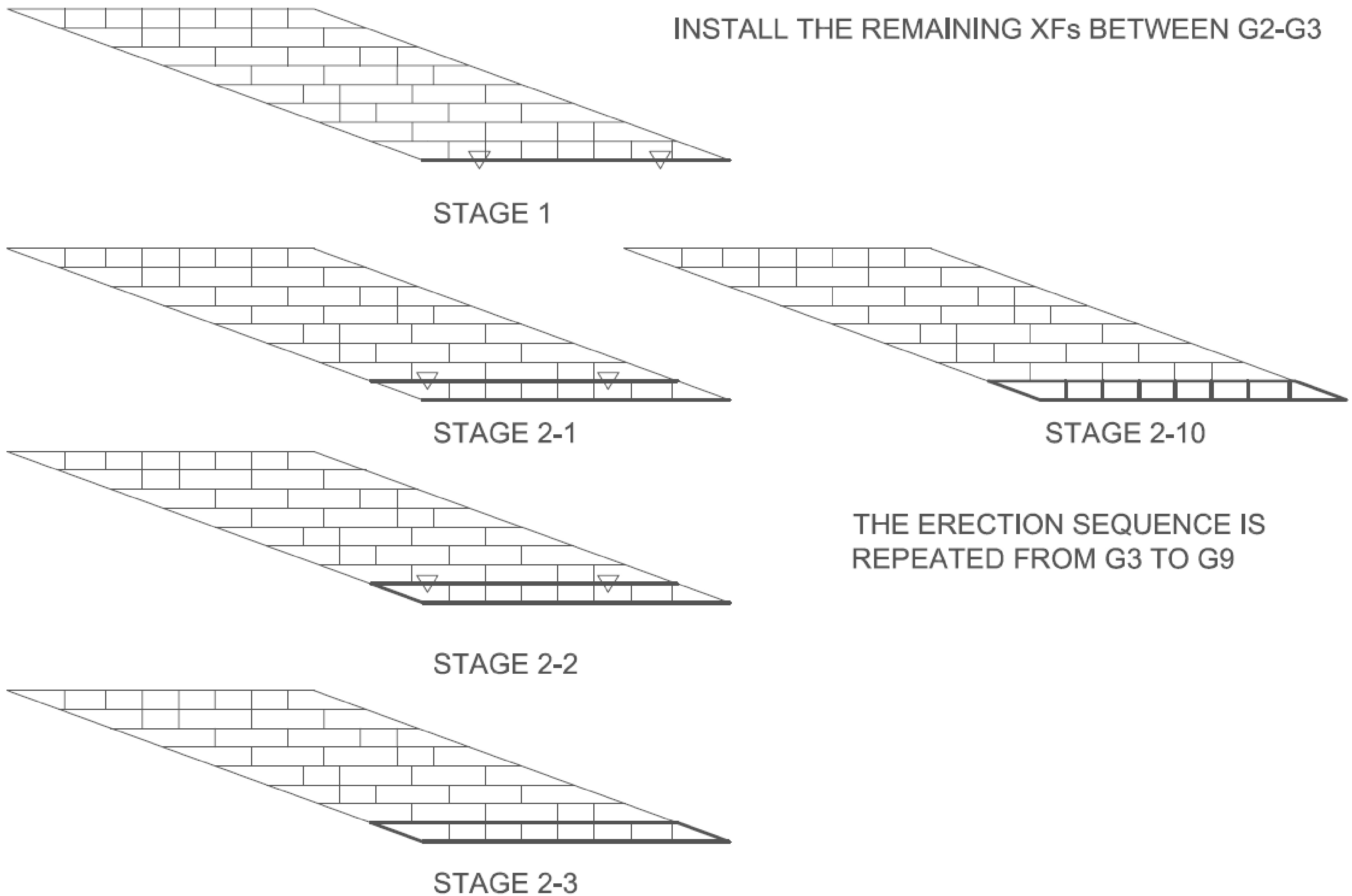


Figure I2-1-6. Erection scheme.

Table I2-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

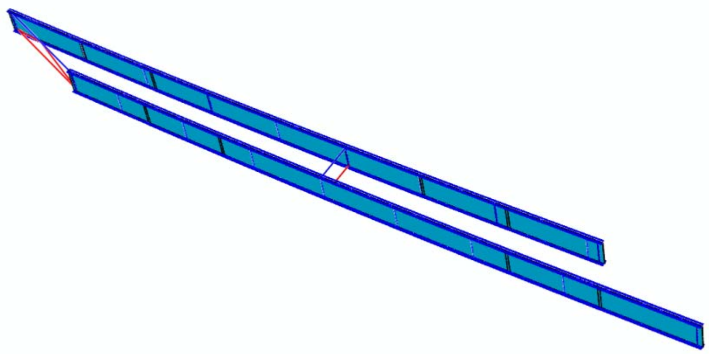
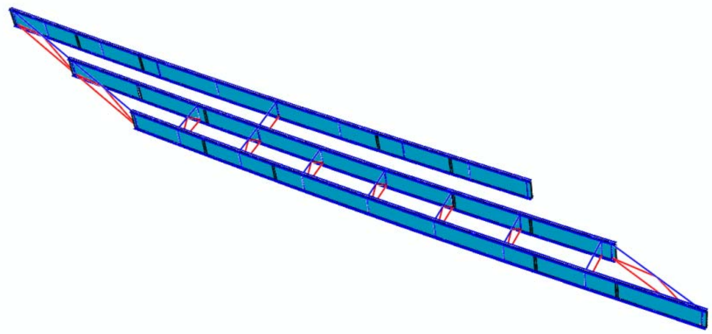
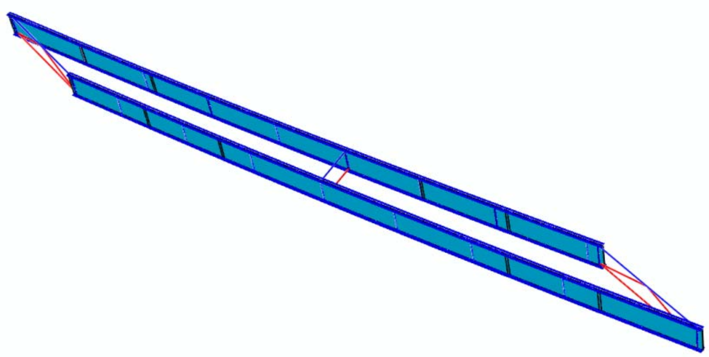
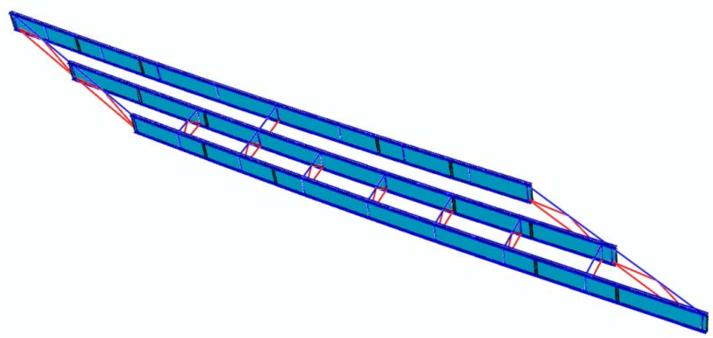
Sub-Stage	Stage	
	2	3
1		
2		

Table I2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

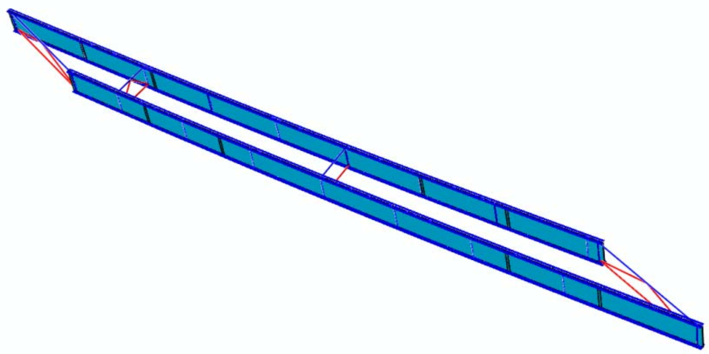
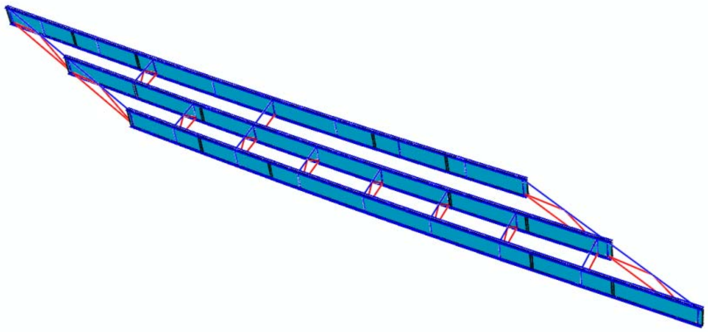
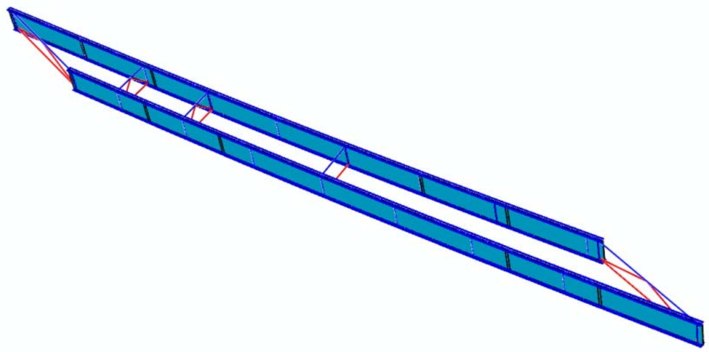
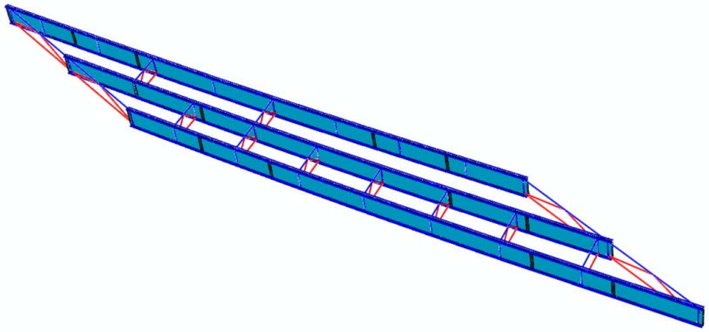
Sub-Stage	Stage	
	2	3
3		
4		

Table I2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

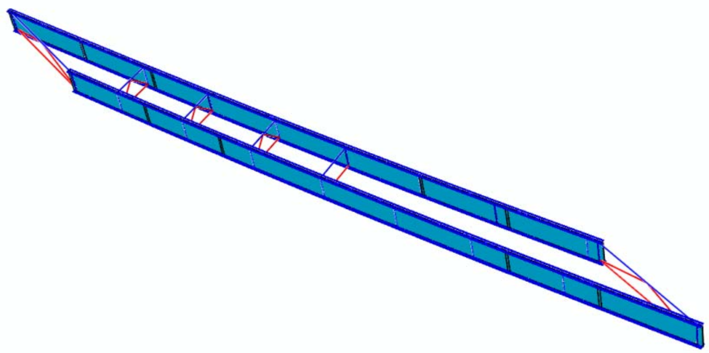
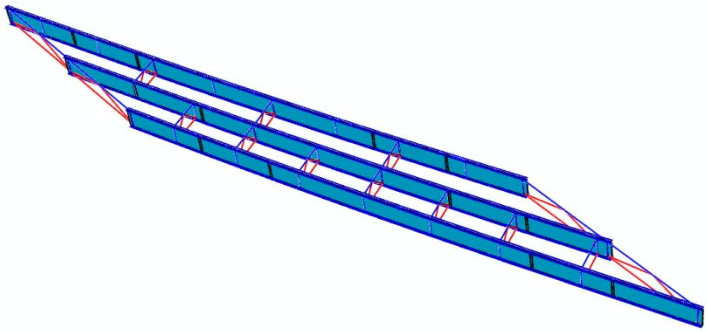
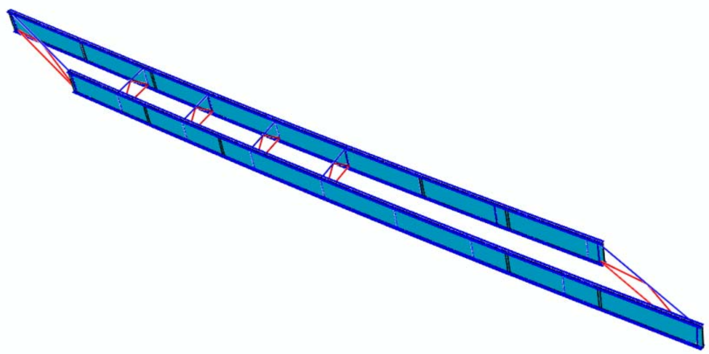
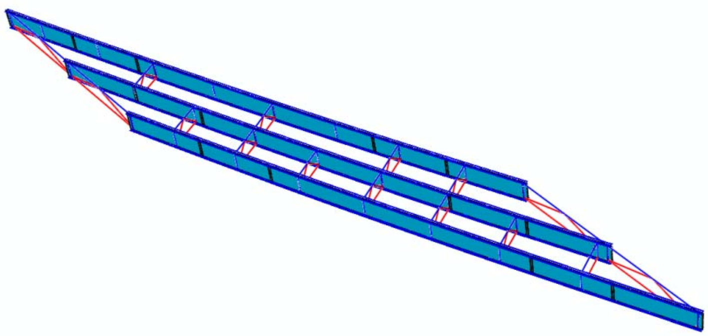
Sub-Stage	Stage	
	2	3
5		
6		

Table I2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

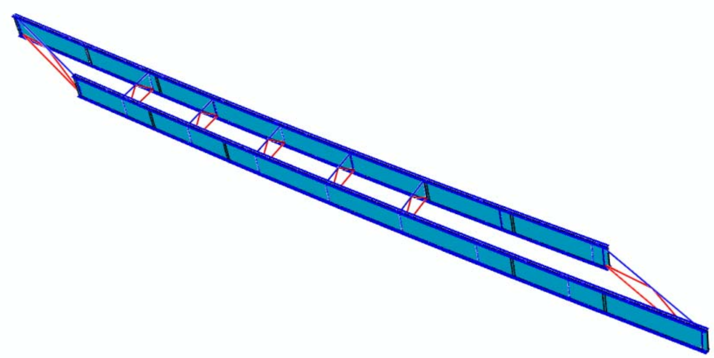
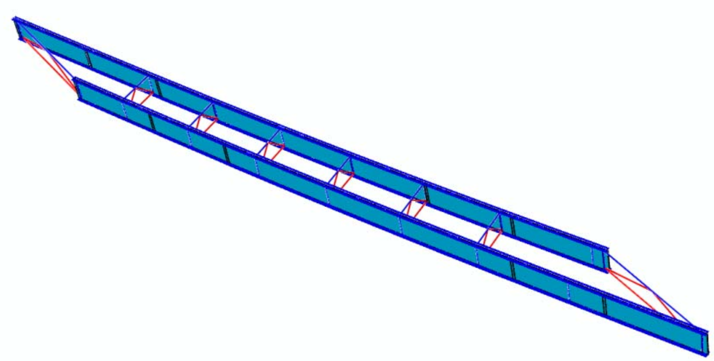
Sub-Stage	Stage	
	2	3
7		
8		

Table I2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

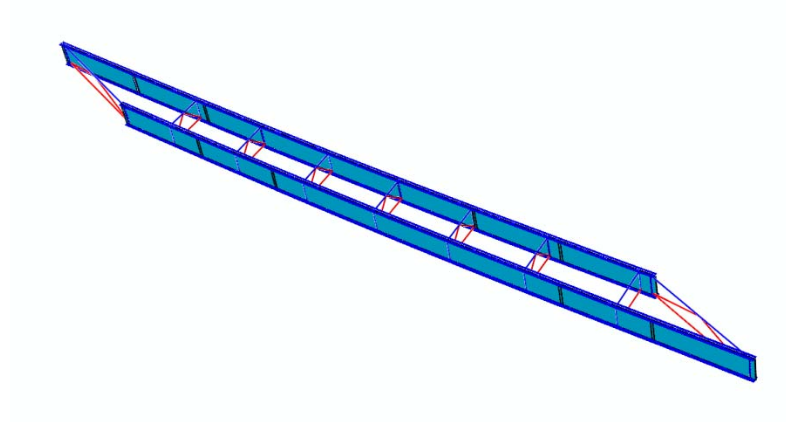
Sub-Stage	Stage	
	2	3
9		

Table I2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

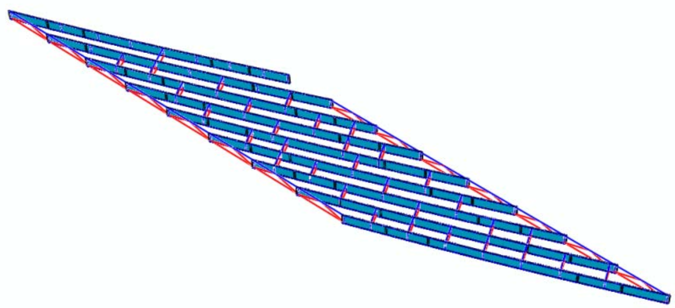
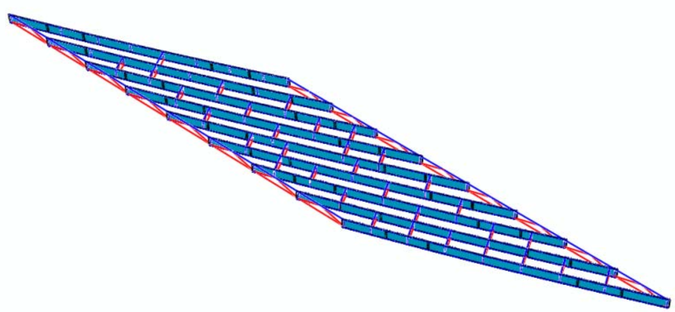
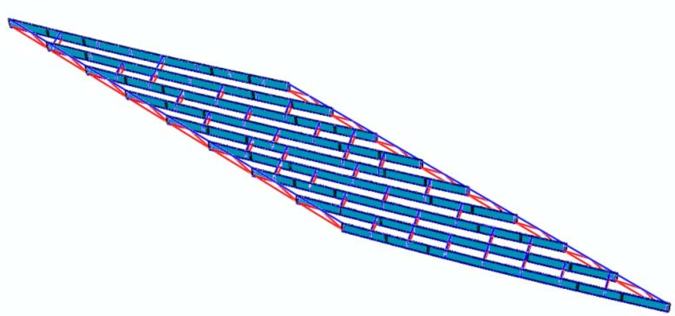
Sub-Stage	Stage 9
1	
2	
3	

Table I2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

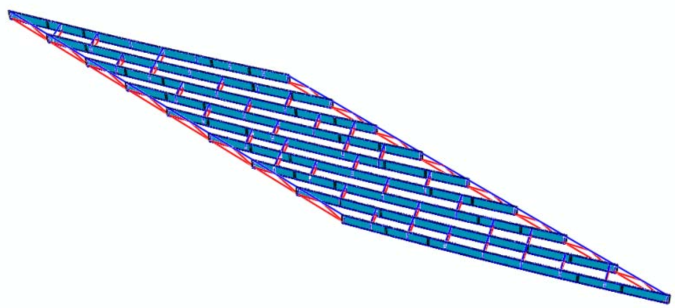
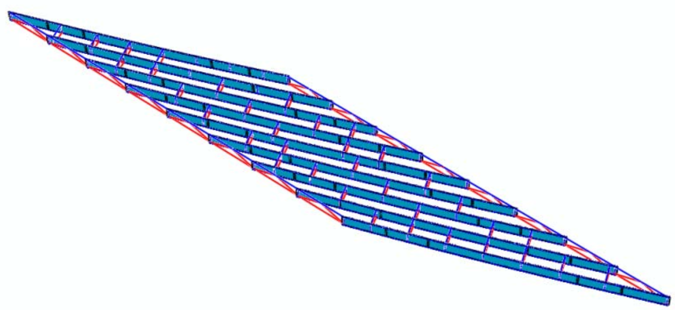
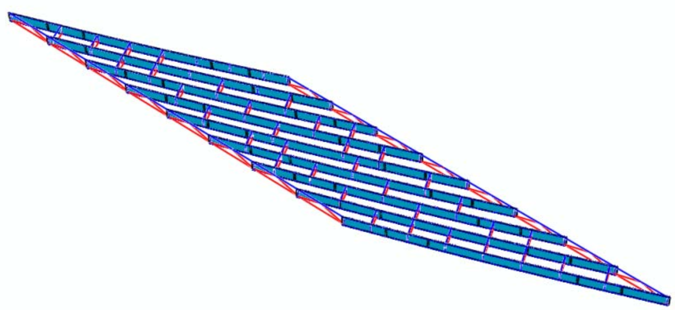
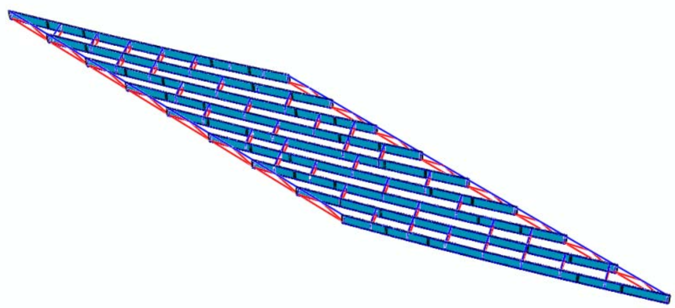
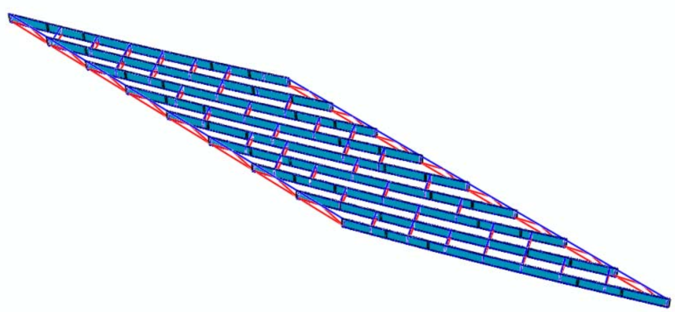
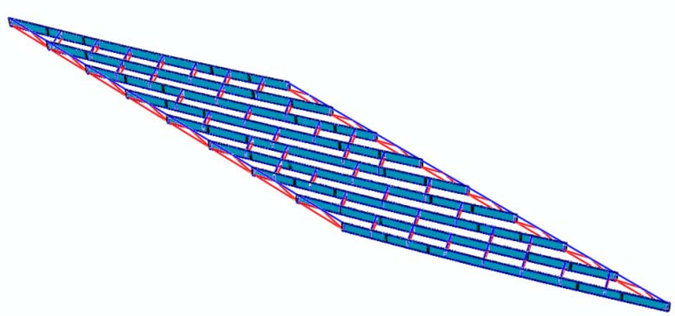
Sub-Stage	Stage 9
4	
5	
6	

Table I2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

Sub-Stage	Stage 9
7	
8	
9	

Appendix I2-2. NISSS14 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISSS14 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table I2-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.9	8.4
	SDLF	1.7	8.1
	TDLF	1.0	7.2
G2	NLF	1.5	7.0
	SDLF	1.8	7.2
	TDLF	2.7	7.9
G3	NLF	1.6	7.6
	SDLF	1.7	7.6
	TDLF	2.2	7.7
G4	NLF	1.5	7.1
	SDLF	1.7	7.2
	TDLF	2.6	7.8
G5	NLF	1.5	6.9
	SDLF	1.8	7.1
	TDLF	2.7	7.8
G6	NLF	1.5	7.1
	SDLF	1.7	7.2
	TDLF	2.6	7.8
G7	NLF	1.6	7.6
	SDLF	1.7	7.6
	TDLF	2.2	7.7
G8	NLF	1.5	7.0
	SDLF	1.8	7.2
	TDLF	2.7	7.9
G9	NLF	1.9	8.4
	SDLF	1.7	8.1
	TDLF	0.9	7.2
All Girders	NLF	1.9	8.4
	SDLF	1.8	8.1
	TDLF	2.7	7.9

Table I2-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.7	3.2
	SDLF	0.1	2.5
	TDLF	2.3	0.6
G2	NLF	0.6	2.8
	SDLF	0.1	2.2
	TDLF	2.0	0.6
G3	NLF	0.7	3.1
	SDLF	0.0	2.4
	TDLF	2.2	0.1
G4	NLF	0.6	2.8
	SDLF	0.0	2.2
	TDLF	2.1	0.0
G5	NLF	0.6	2.8
	SDLF	0.0	2.2
	TDLF	2.0	0.1
G6	NLF	0.6	2.8
	SDLF	0.0	2.2
	TDLF	2.1	0.0
G7	NLF	0.7	3.1
	SDLF	0.0	2.4
	TDLF	2.2	0.0
G8	NLF	0.6	2.8
	SDLF	0.1	2.2
	TDLF	2.0	0.5
G9	NLF	0.7	3.2
	SDLF	0.1	2.5
	TDLF	2.3	0.6
All Girders	NLF	0.7	3.2
	SDLF	0.1	2.5
	TDLF	2.3	0.6

Table I2-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	4.7	20.5	6.8	29.6	0.6	3.3	2.5	7.5
	SDLF	4.1	19.8	6.2	28.8	0.3	2.7	1.2	5.9
	TDLF	2.5	17.3	4.5	26.1	1.3	2.0	7.3	4.4
G2	NLF	3.8	16.4	5.5	24.7	0.9	4.3	2.2	10.0
	SDLF	4.3	16.9	6.5	25.4	1.6	2.9	3.4	8.0
	TDLF	6.6	18.8	10.8	28.2	6.1	7.6	12.4	16.7
G3	NLF	4.0	18.3	5.8	26.6	2.5	11.0	7.7	39.7
	SDLF	4.1	18.4	6.2	26.7	0.5	8.7	0.7	30.5
	TDLF	5.5	18.6	8.4	27.6	8.2	2.0	26.9	3.3
G4	NLF	4.1	19.0	6.1	27.5	1.3	8.7	4.6	23.6
	SDLF	4.1	19.0	6.4	27.6	0.2	6.8	0.6	18.2
	TDLF	11.3	18.6	16.1	28.1	4.5	0.9	16.5	2.3
G5	NLF	3.7	16.9	5.5	24.8	4.5	16.6	12.5	61.6
	SDLF	4.1	17.2	6.3	25.5	0.3	12.9	0.6	48.0
	TDLF	6.8	18.4	10.4	27.7	14.7	1.5	41.1	2.5
G6	NLF	4.1	19.0	6.1	27.6	1.3	8.7	4.7	23.7
	SDLF	4.2	18.9	6.3	27.6	0.3	6.4	0.5	18.3
	TDLF	10.8	18.6	17.3	27.8	5.2	0.9	16.5	2.3
G7	NLF	4.0	18.4	5.8	26.6	2.5	10.8	7.7	39.7
	SDLF	4.1	18.4	6.2	26.6	0.5	7.7	0.9	30.7
	TDLF	5.7	18.5	8.8	27.6	8.7	2.6	26.3	3.6
G8	NLF	3.8	16.4	5.5	24.6	0.9	4.2	2.2	10.0
	SDLF	4.3	16.9	6.5	25.4	1.7	2.4	2.4	7.3
	TDLF	6.6	18.6	10.5	28.2	6.4	7.9	8.4	12.3
G9	NLF	4.7	20.5	6.8	29.6	0.6	3.2	2.4	7.7
	SDLF	4.1	19.8	6.2	28.7	0.3	2.6	0.9	6.2
	TDLF	2.5	17.1	4.1	25.8	3.3	2.3	8.6	4.7
All Girders	NLF	4.7	20.5	6.8	29.6	4.5	16.6	12.5	61.6
	SDLF	4.3	19.8	6.5	28.8	1.7	12.9	3.4	48.0
	TDLF	11.3	18.8	17.3	28.2	14.7	7.9	41.1	16.7

Table I2-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	22.2	29.7	21.4	29.7
	SDLF	5.6	6.5	3.4	6.5
	TDLF	86.4	103.9	66.9	103.9
TDL	NLF	95.7	130.7	89.2	130.7
	SDLF	70.4	101.8	70.1	101.8
	TDLF	23.4	30.1	13.6	30.1

Table I2-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	3.3	3.4	3.2	3.3
	SDLF	2.2	1.5	0.6	1.6
	TDLF	17.2	16.0	11.0	15.4
TDL	NLF	13.8	14.7	12.5	13.9
	SDLF	11.0	11.8	10.1	11.1
	TDLF	9.1	6.6	2.2	6.7

Table I2-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.98	0.71	0.59	0.71	0.71	0.59	0.71	0.98	0.98
SDLF	0.86	0.82	0.83	0.73	0.73	0.83	0.81	0.86	0.86
TDLF	1.97	1.37	1.81	0.98	0.97	1.81	1.35	2.00	2.00

Table I2-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	4.36	3.36	2.58	3.07	3.27	2.70	2.88	4.37	4.37
SDLF	4.21	3.25	2.83	3.11	3.25	2.68	3.01	4.20	4.21
TDLF	3.76	3.03	3.68	3.24	3.23	2.74	3.50	3.77	3.77

Table I2-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.55	0.40	0.33	0.39	0.39	0.33	0.40	0.55	0.55
SDLF	0.48	0.46	0.46	0.41	0.41	0.46	0.45	0.48	0.48
TDLF	1.10	0.77	1.01	0.55	0.54	1.01	0.75	1.12	1.12

Table I2-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	2.44	1.88	1.44	1.71	1.83	1.51	1.61	2.44	2.44
SDLF	2.35	1.81	1.58	1.74	1.82	1.50	1.68	2.35	2.35
TDLF	2.10	1.69	2.05	1.81	1.81	1.53	1.96	2.10	2.10

Table I2-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	505.9	2148.6
SDLF	505.9	2147.7
TDLF	505.9	2148.5

Table I2-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	40.0	172.2	0.31	1.39	1.25	5.18
SDLF	30.1	160.8	0.09	0.89	0.27	3.53
TDLF	54.8	124.0	1.29	0.57	3.78	1.22

Table I2-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.24	1.02	0.12	0.51
SDLF	0.20	0.87	0.03	0.33
TDLF	0.34	0.95	0.38	0.12

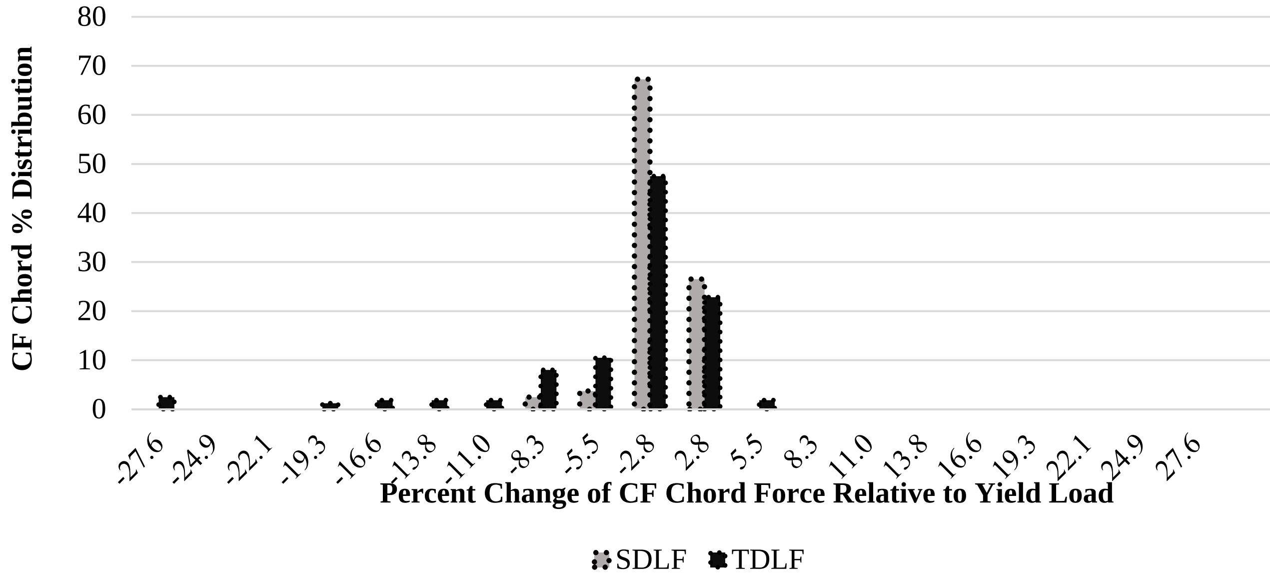


Figure I2-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

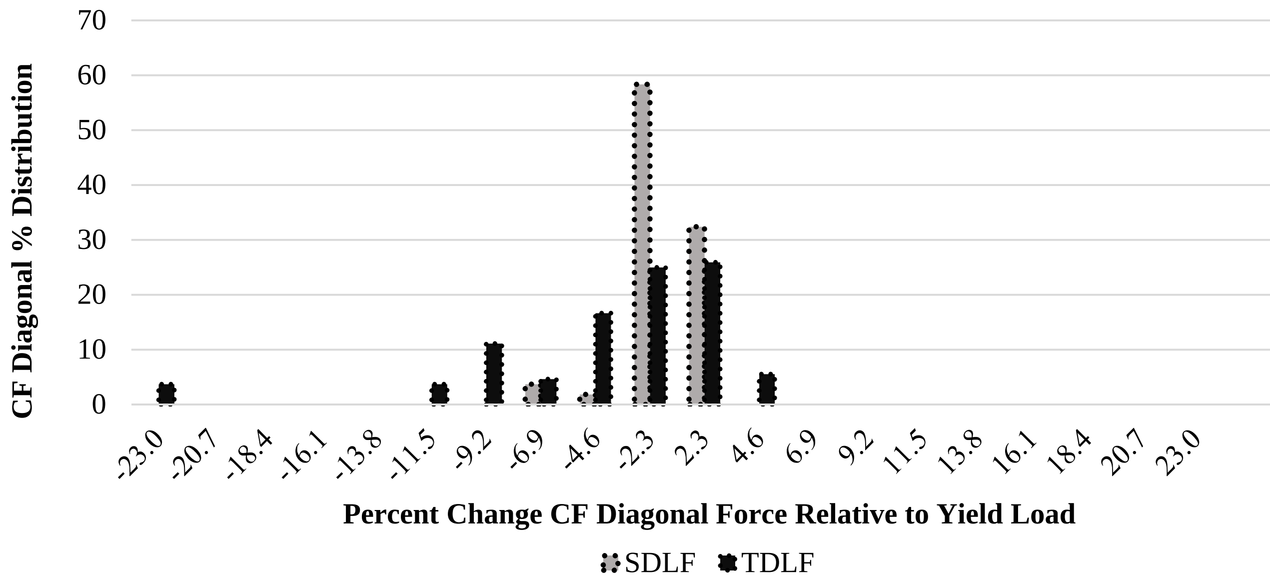


Figure I2-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

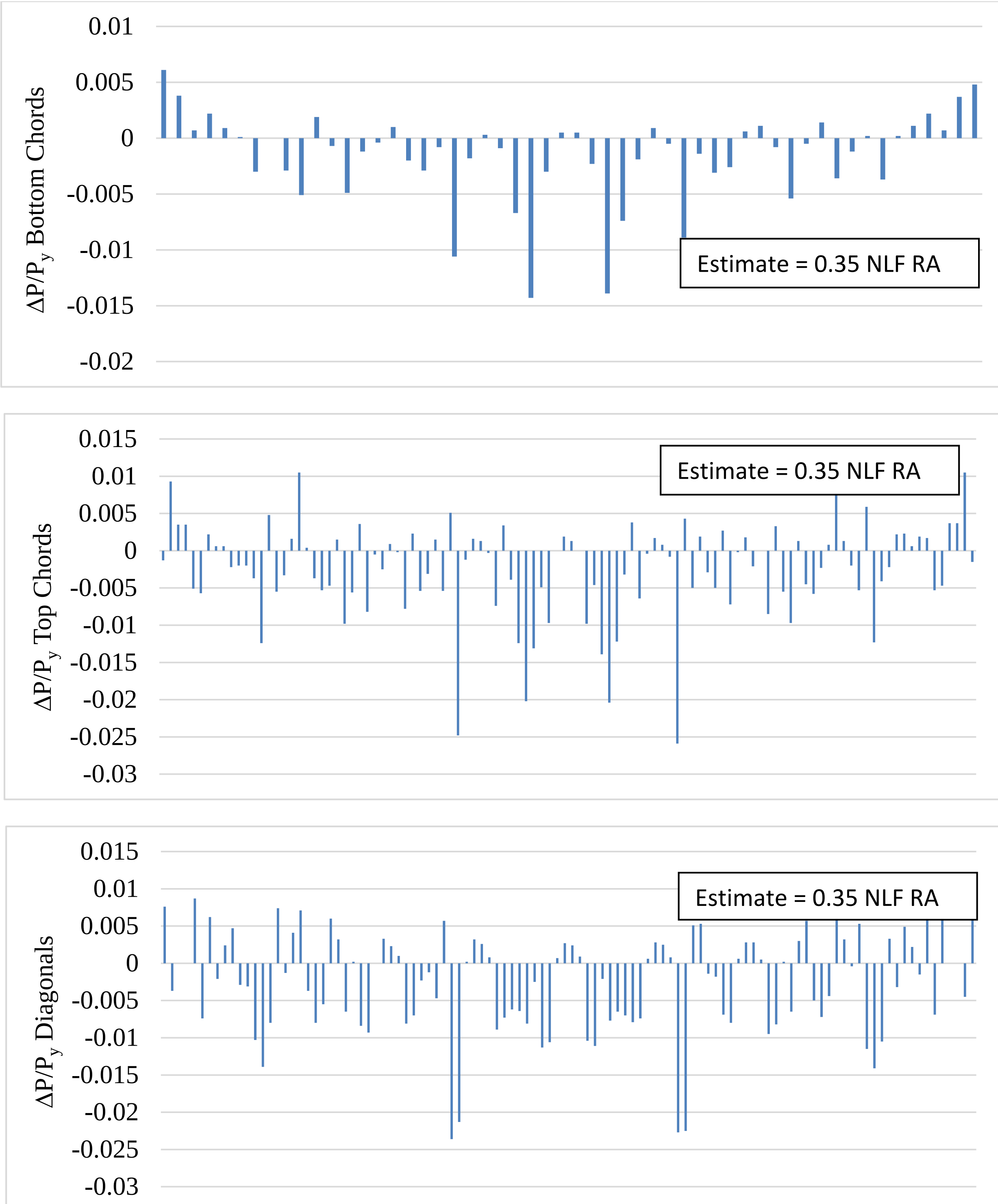


Figure I2-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

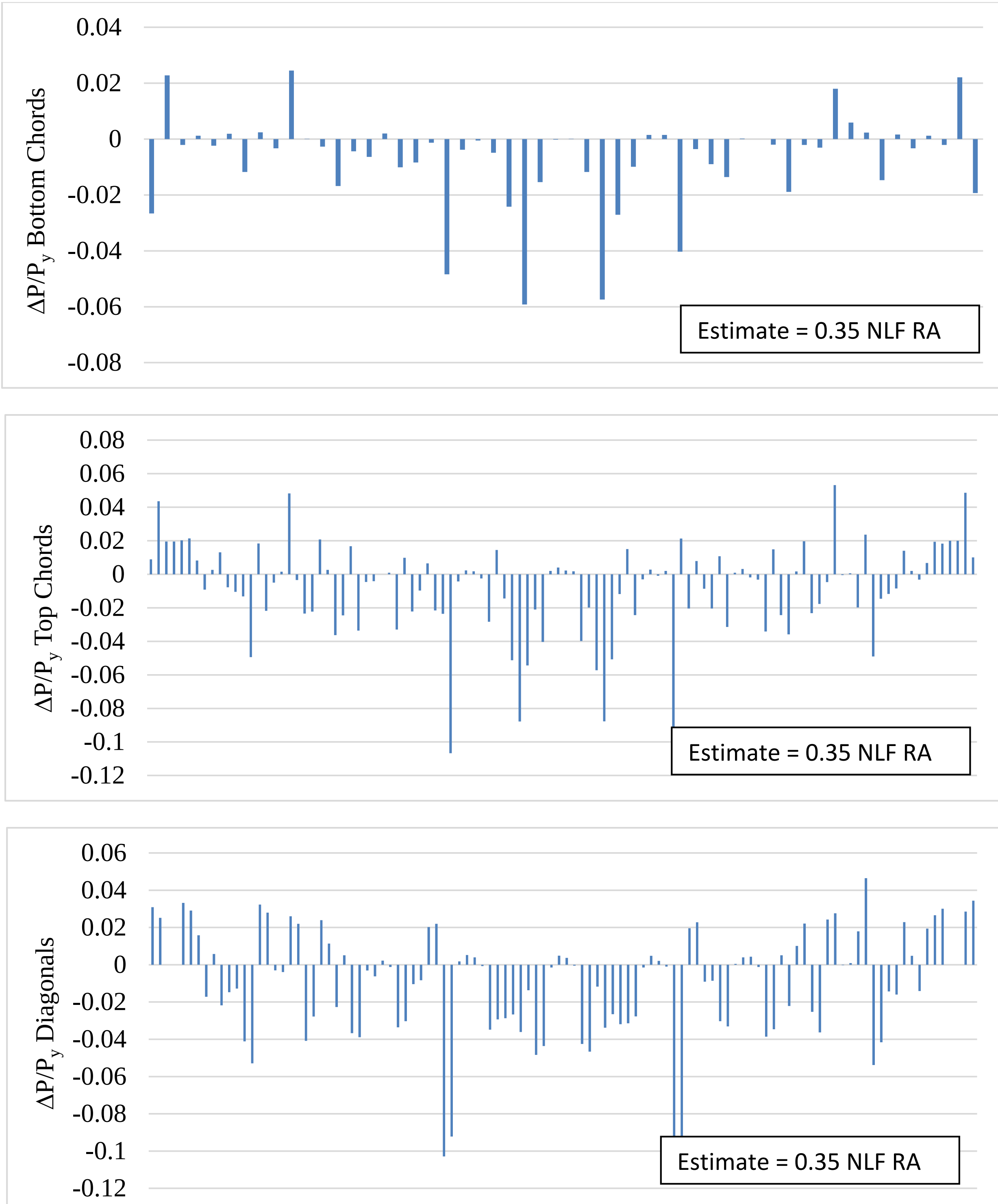


Figure I2-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix I2-3. NISSS14 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISSS14 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table I2-3-1. Maximums of the fit-up force resultants (kips)

Detailing Method	F1	F2	F_{max}
SDLF	0.3	3.3	3.3
TDLF	4.3	11.4	11.4

Table I2-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	SDLF	27	25
	TDLF	26	10
G2	SDLF	30	25
	TDLF	43	25
G3	SDLF	28	24
	TDLF	31	0
G4	SDLF	29	28
	TDLF	55	26
G5	SDLF	28	28
	TDLF	40	39
G6	SDLF	29	28
	TDLF	55	26
G7	SDLF	29	28
	TDLF	31	0
G8	SDLF	30	29
	TDLF	43	29
G9	SDLF	27	26
	TDLF	19	11
All Girders	SDLF	30	24
	TDLF	55	0

Table I2-3-3. Total Vertical Reactions (kips)

Stage	Detailing Method	Sub-Stage								
		1	2	3	4	5	6	7	8	9
2	SDLF	97	100	101	102	103	104	105	106	106
	TDLF	97	100	101	102	103	104	105	106	106
3	SDLF	157	159	160	161	162	163			
	TDLF	157	159	160	161	162	163			
9	SDLF	497	500	500	501	502	503	504	505	506
	TDLF	497	500	500	501	502	503	504	505	506

Appendix I2-4. NISSS14 Detailed Results, Completed Bridge Responses

This appendix presents the SDL and TDL responses of the bridge NISSS14 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

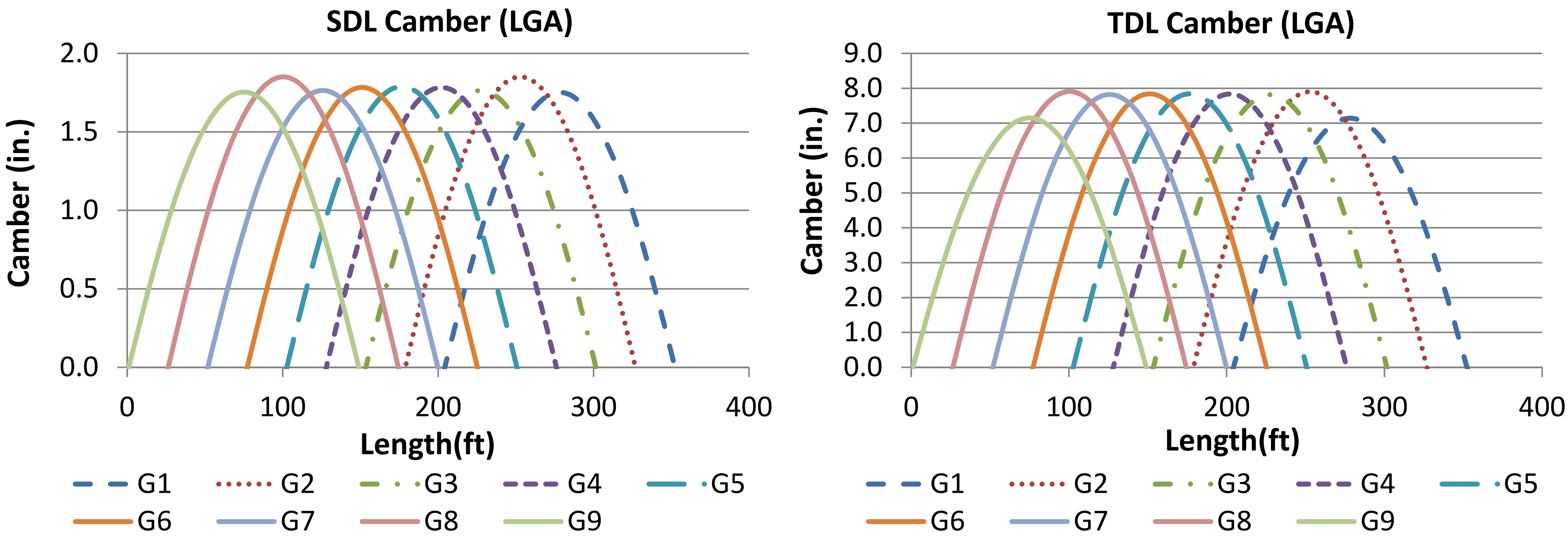


Figure I2-4-1. SDL and TDL Line Girder Analysis cambers.

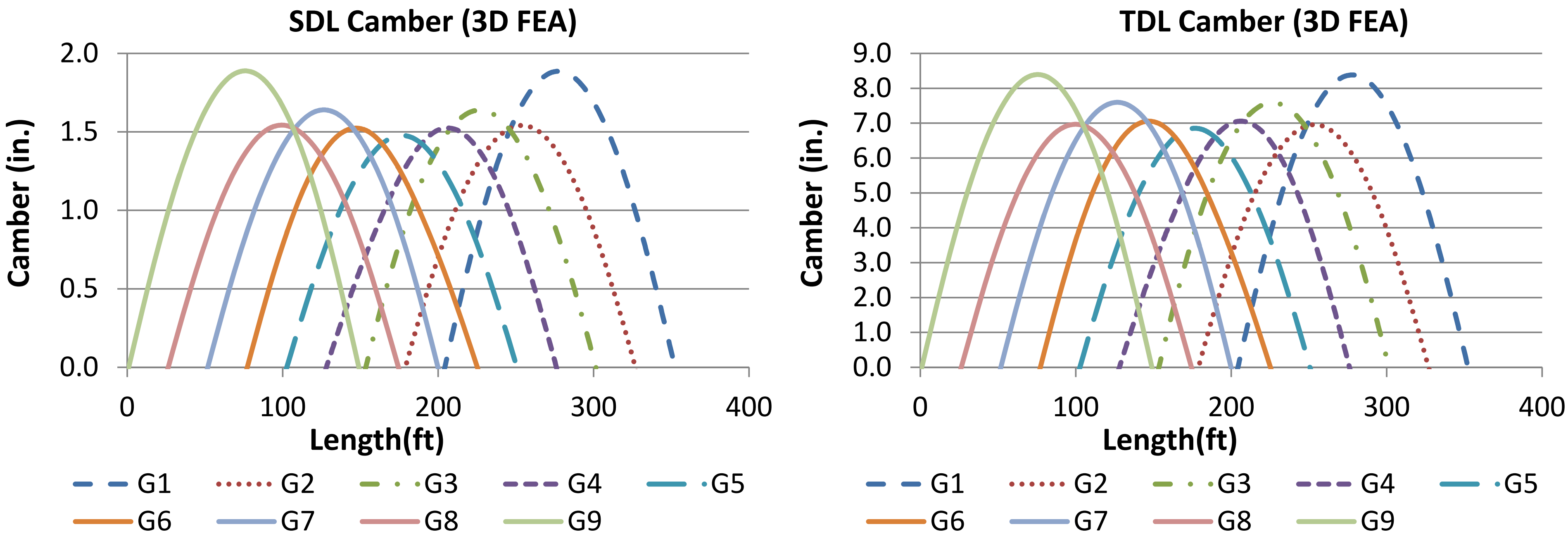


Figure I2-4-2. SDL and TDL 3D FEA cambers.

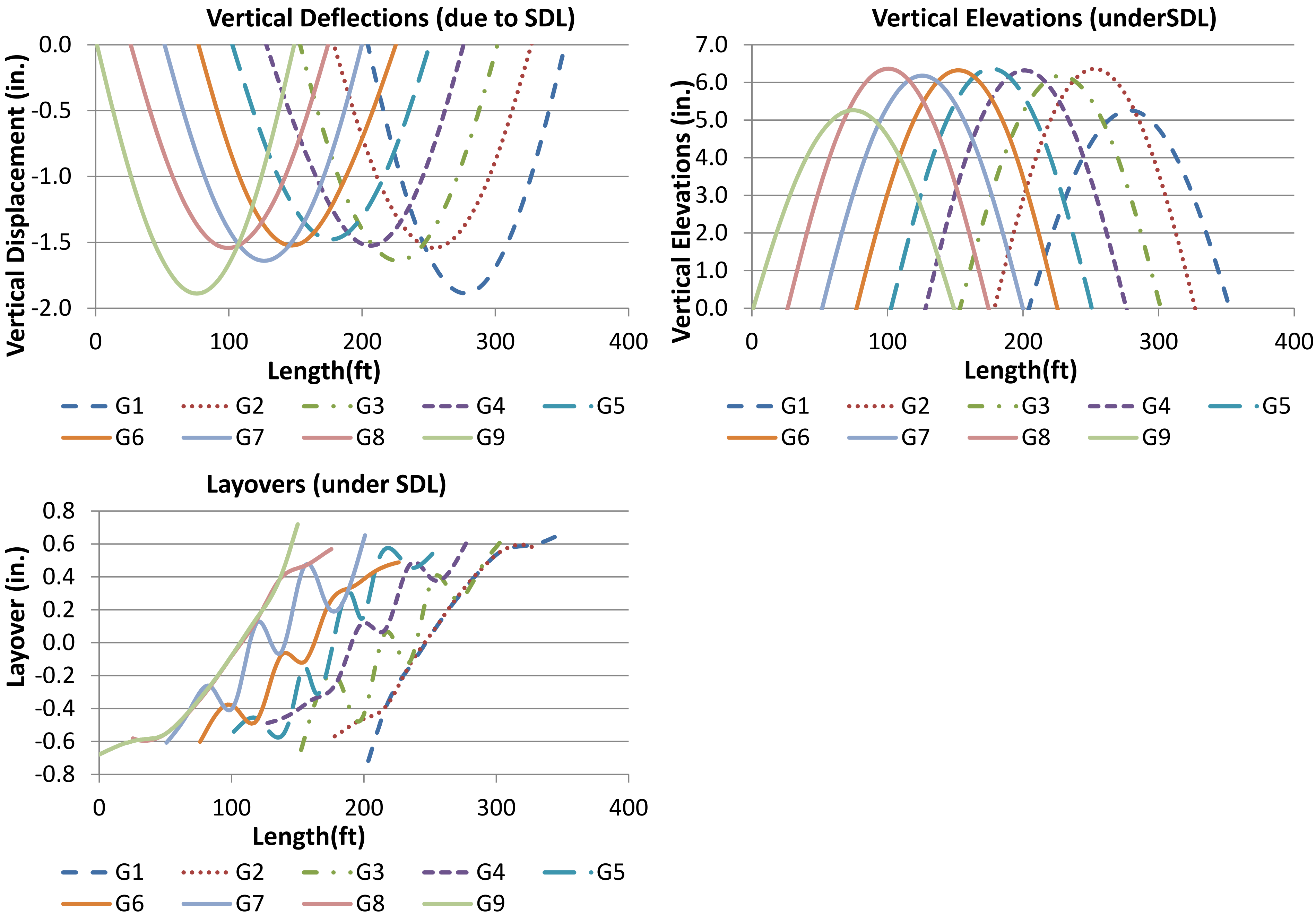


Figure I2-4-3. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

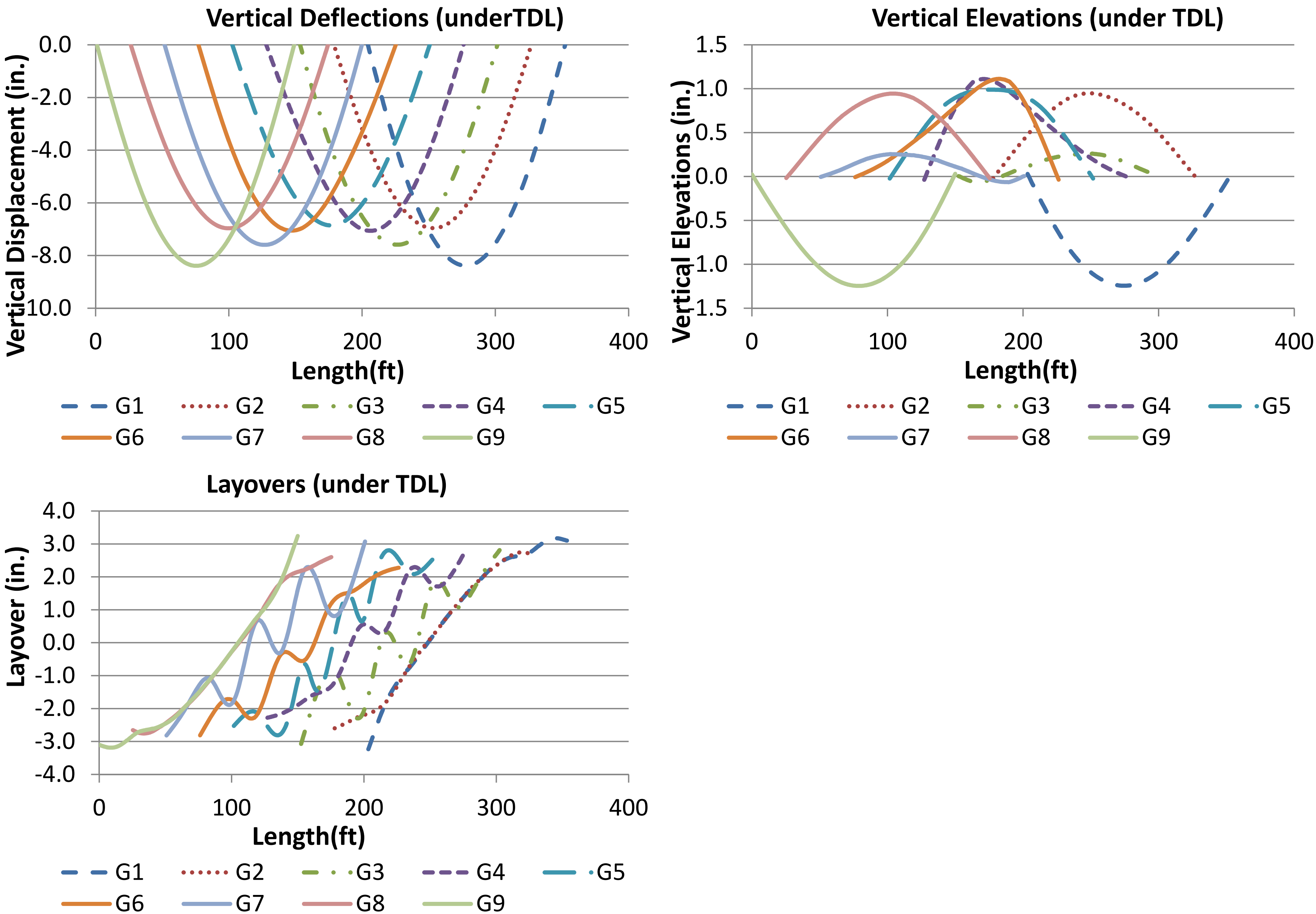


Figure I2-4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

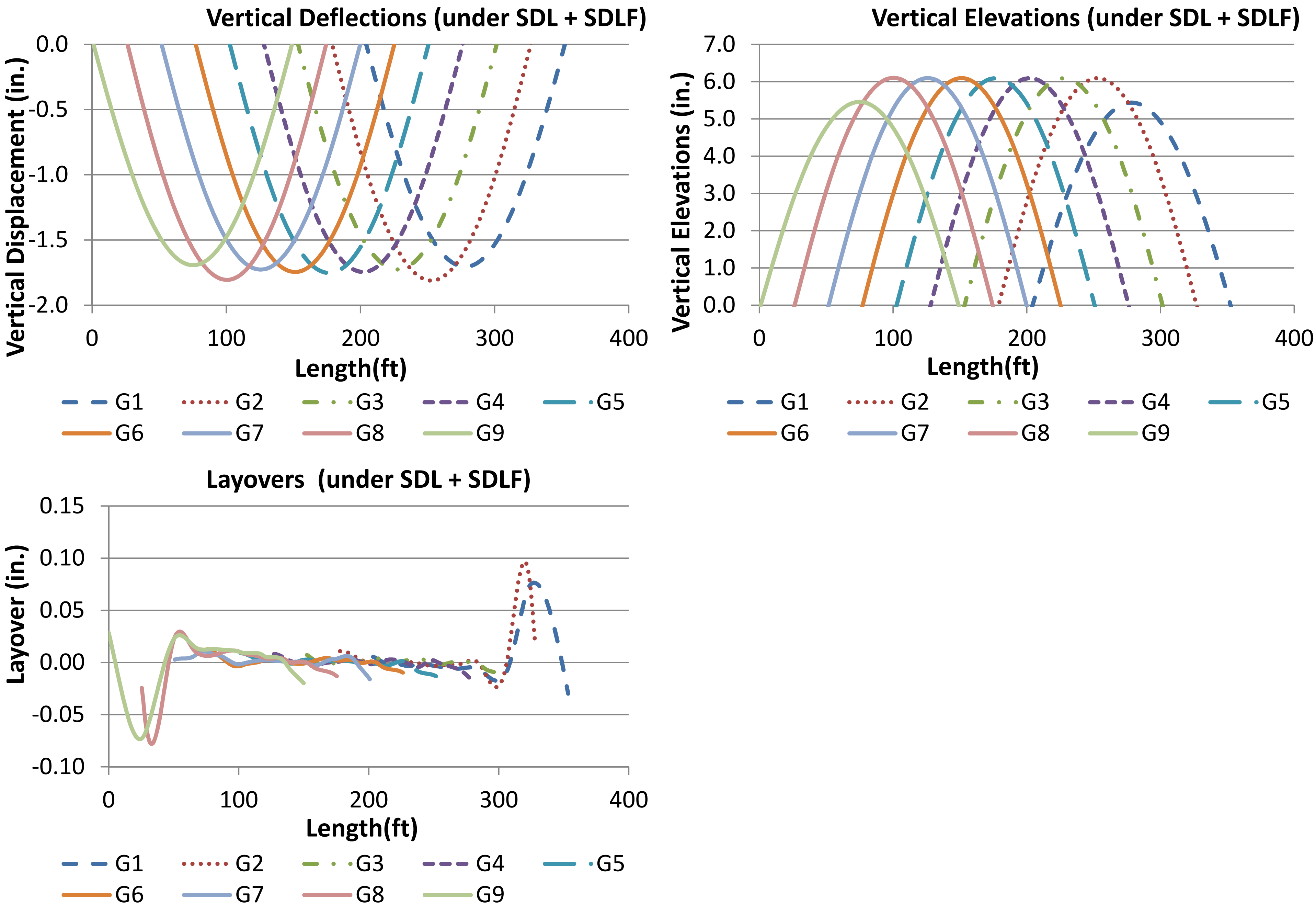


Figure I2-4-5. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

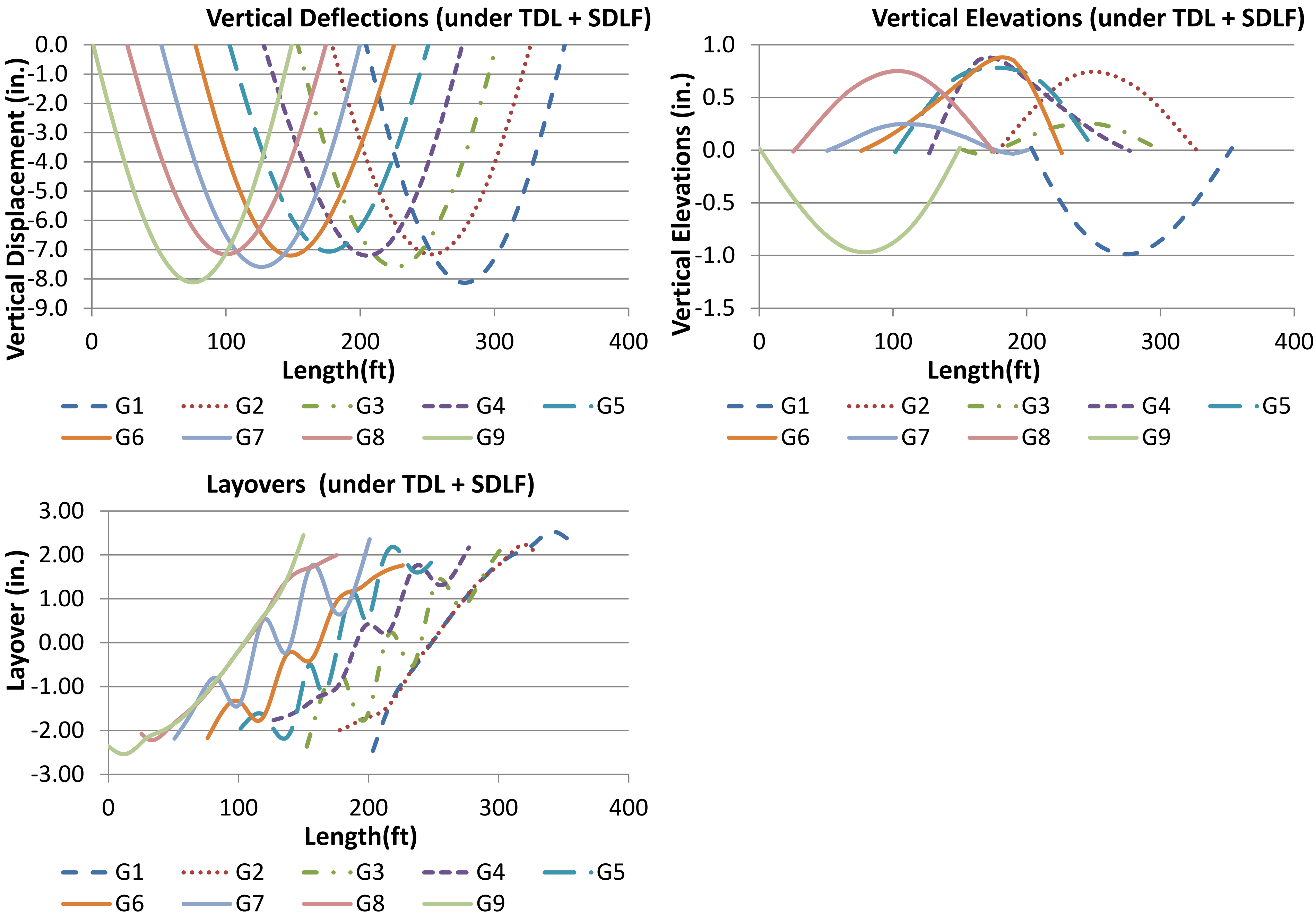


Figure I2-4-6. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

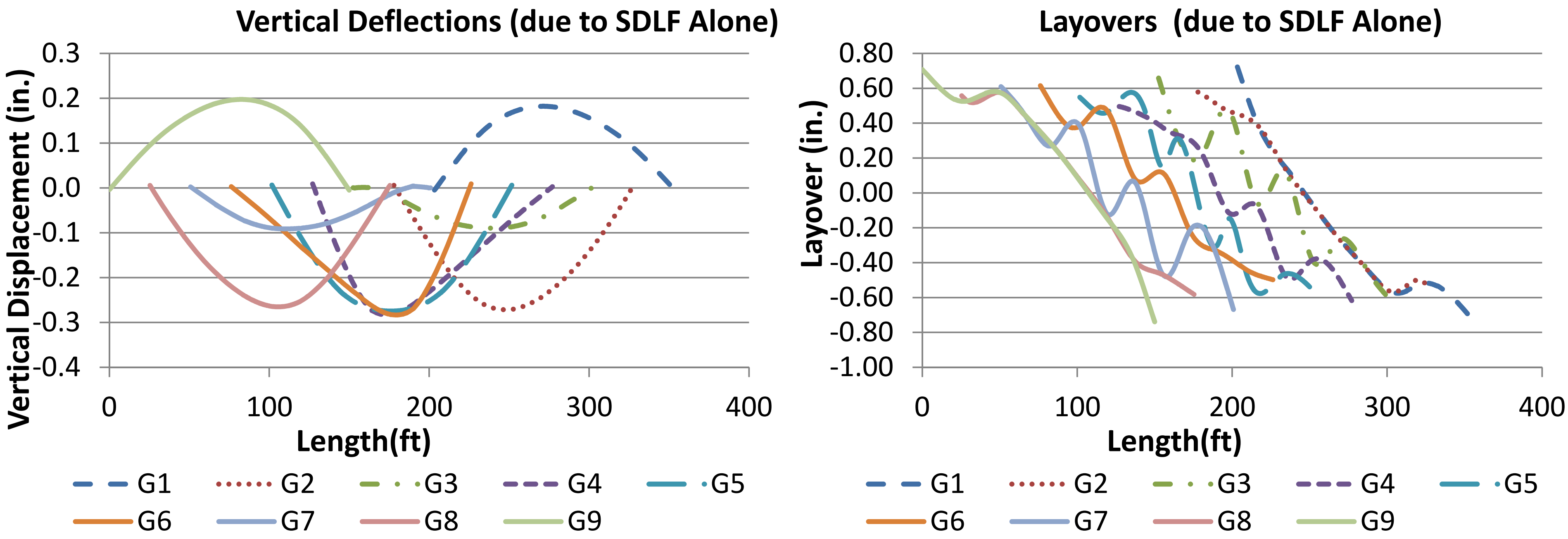


Figure I2-4-7. Bridge displacements due to SDLF detailing effects alone under NL(in).

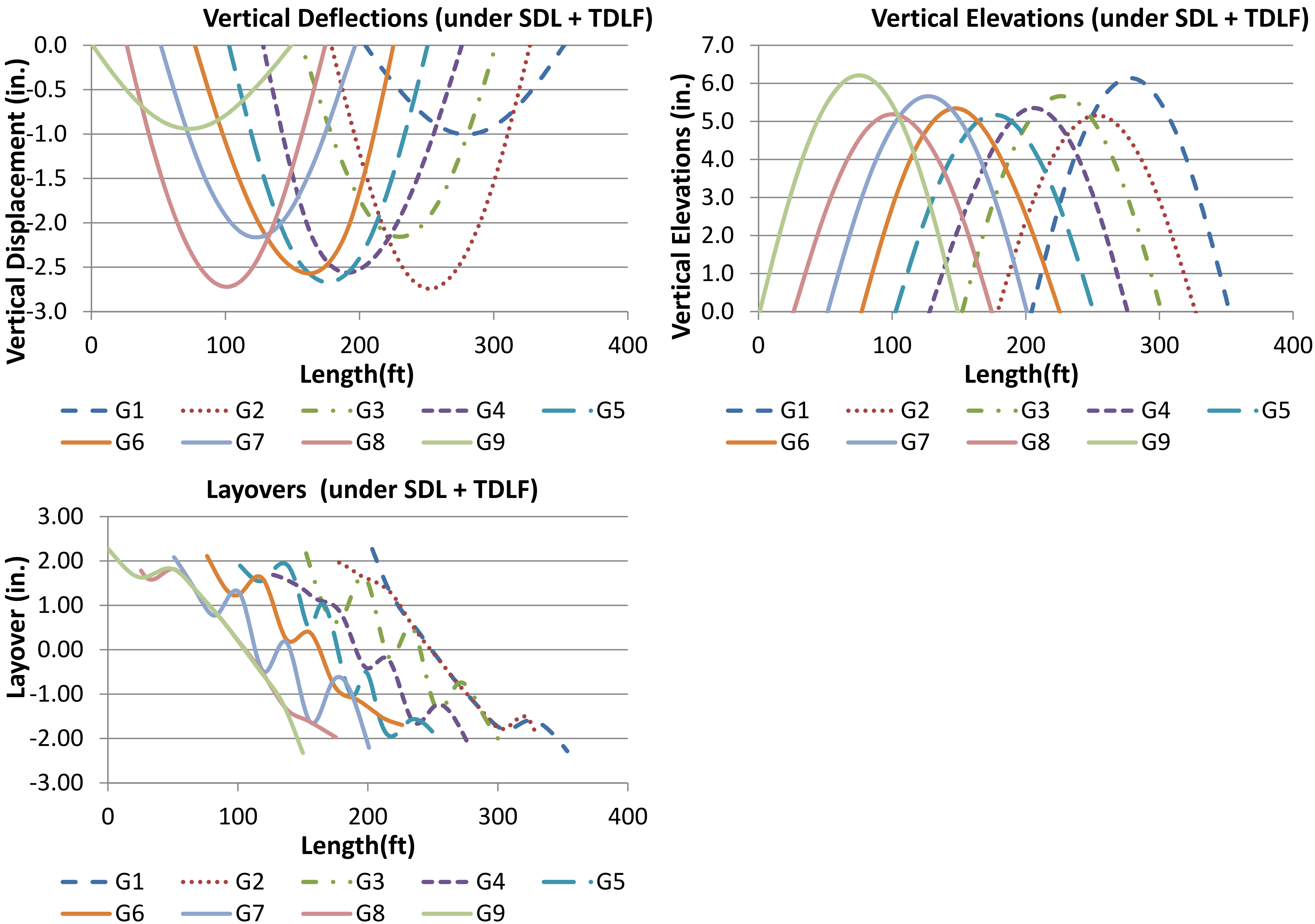


Figure I2-4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

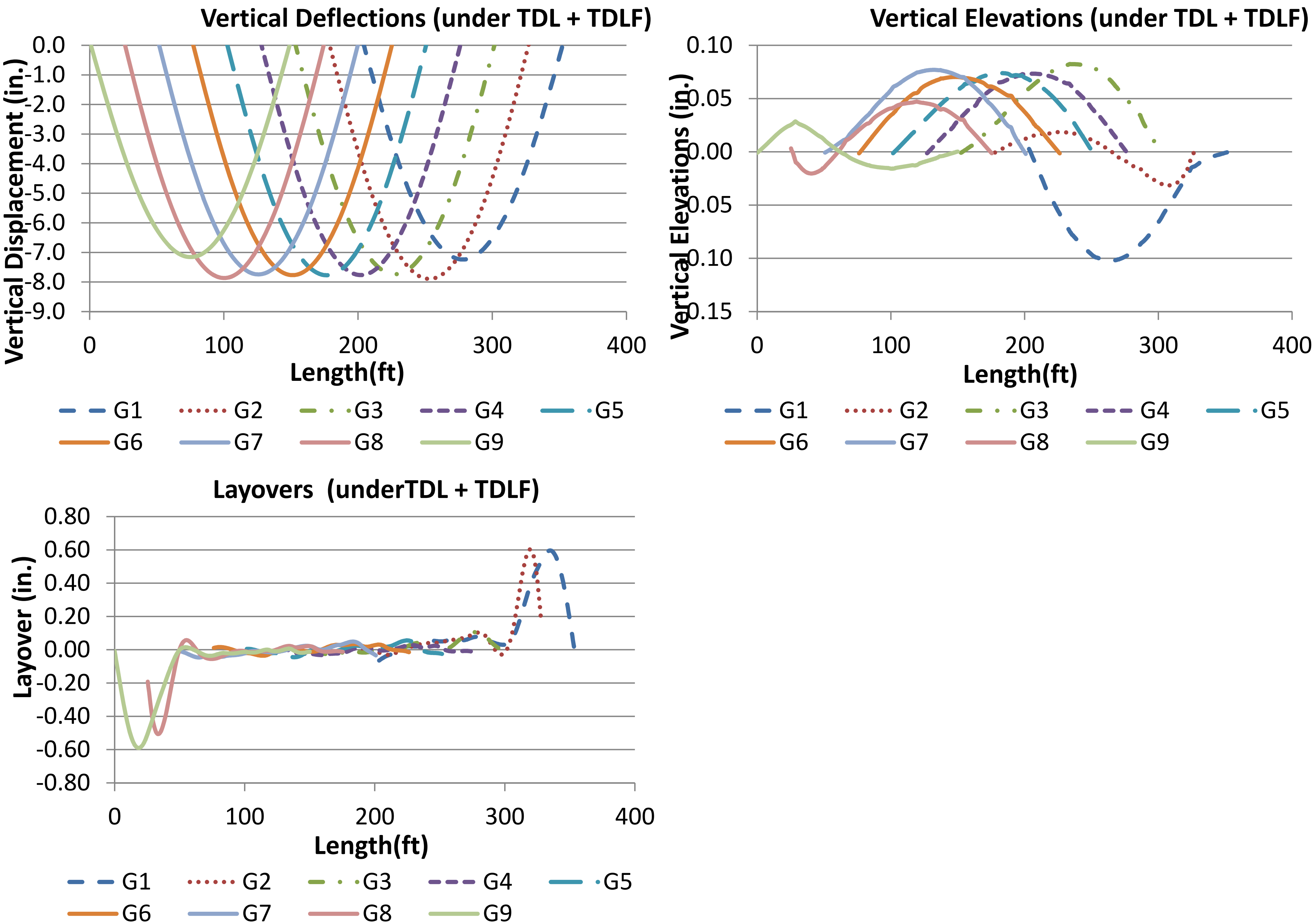


Figure I2-4-9. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

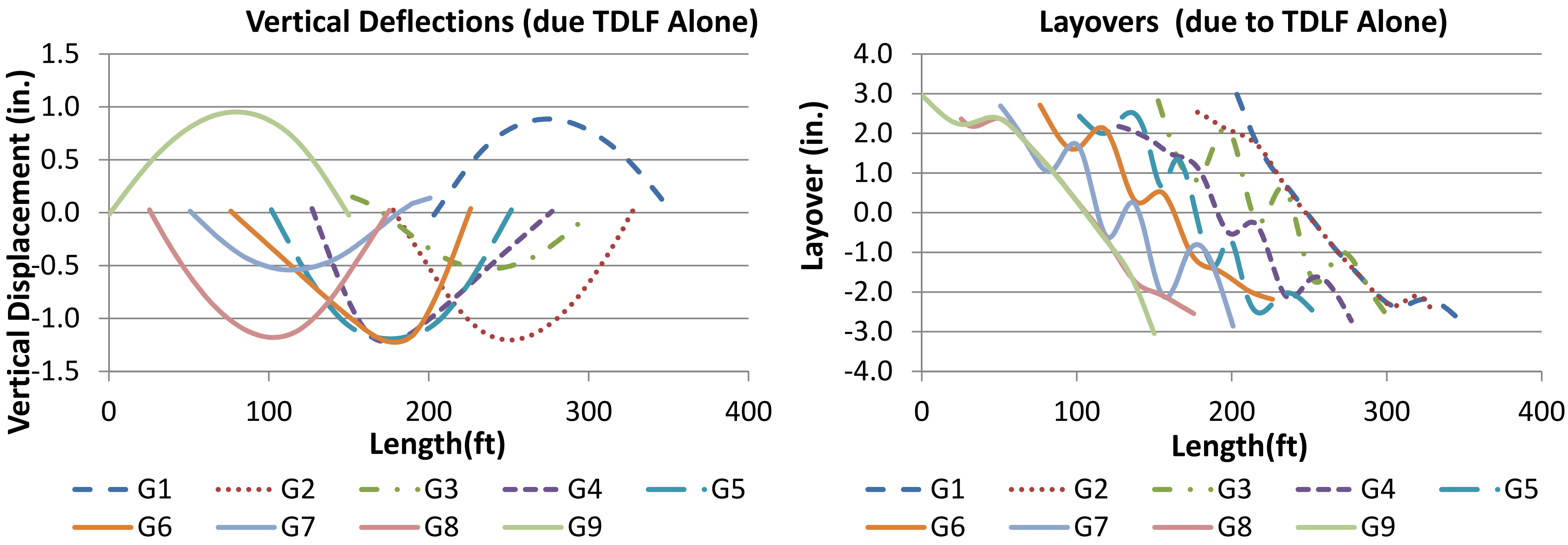


Figure I2-4-10. Bridge displacements due to TDLF detailing effects alone under NL (in).

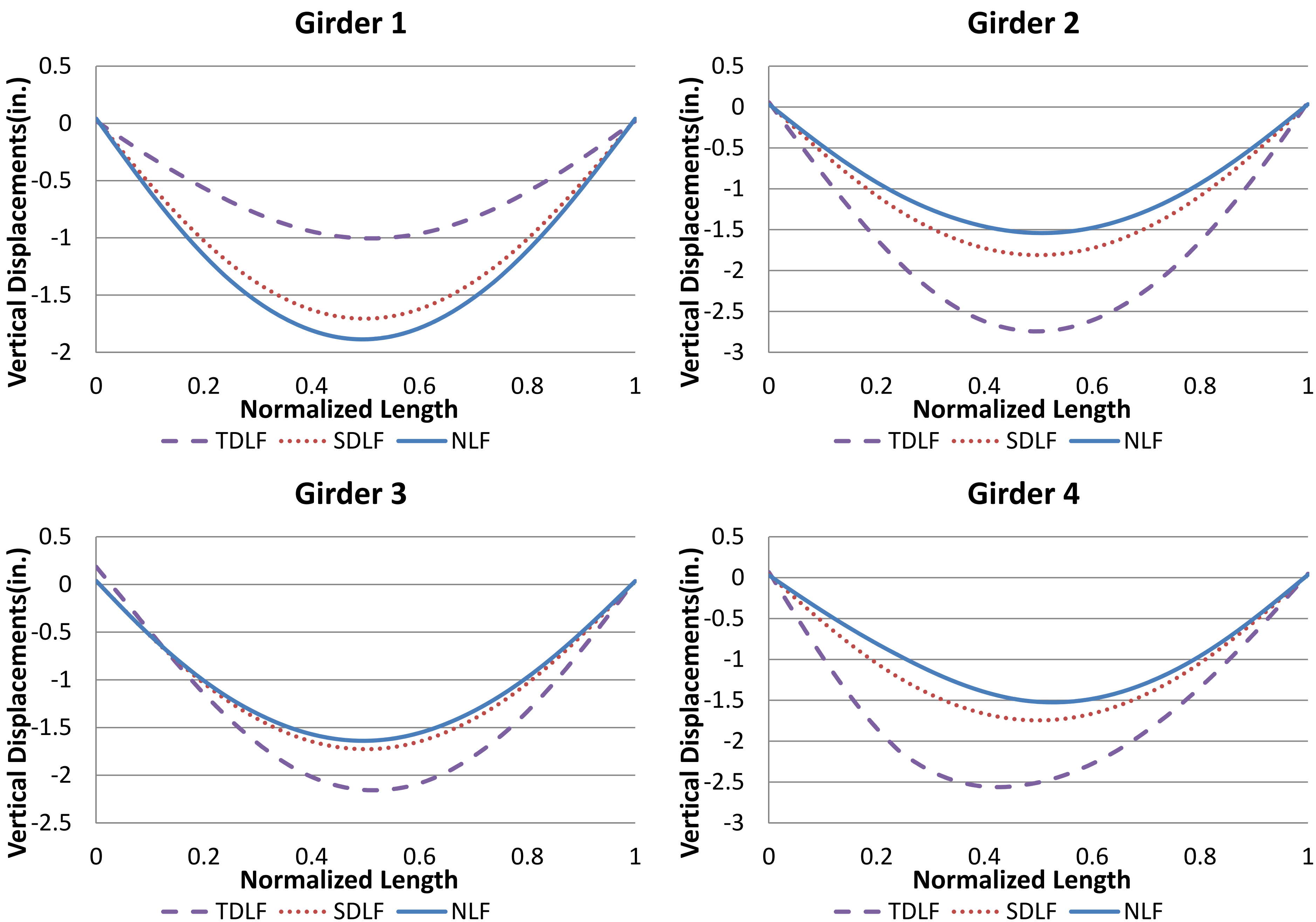


Figure I2-4-11.Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

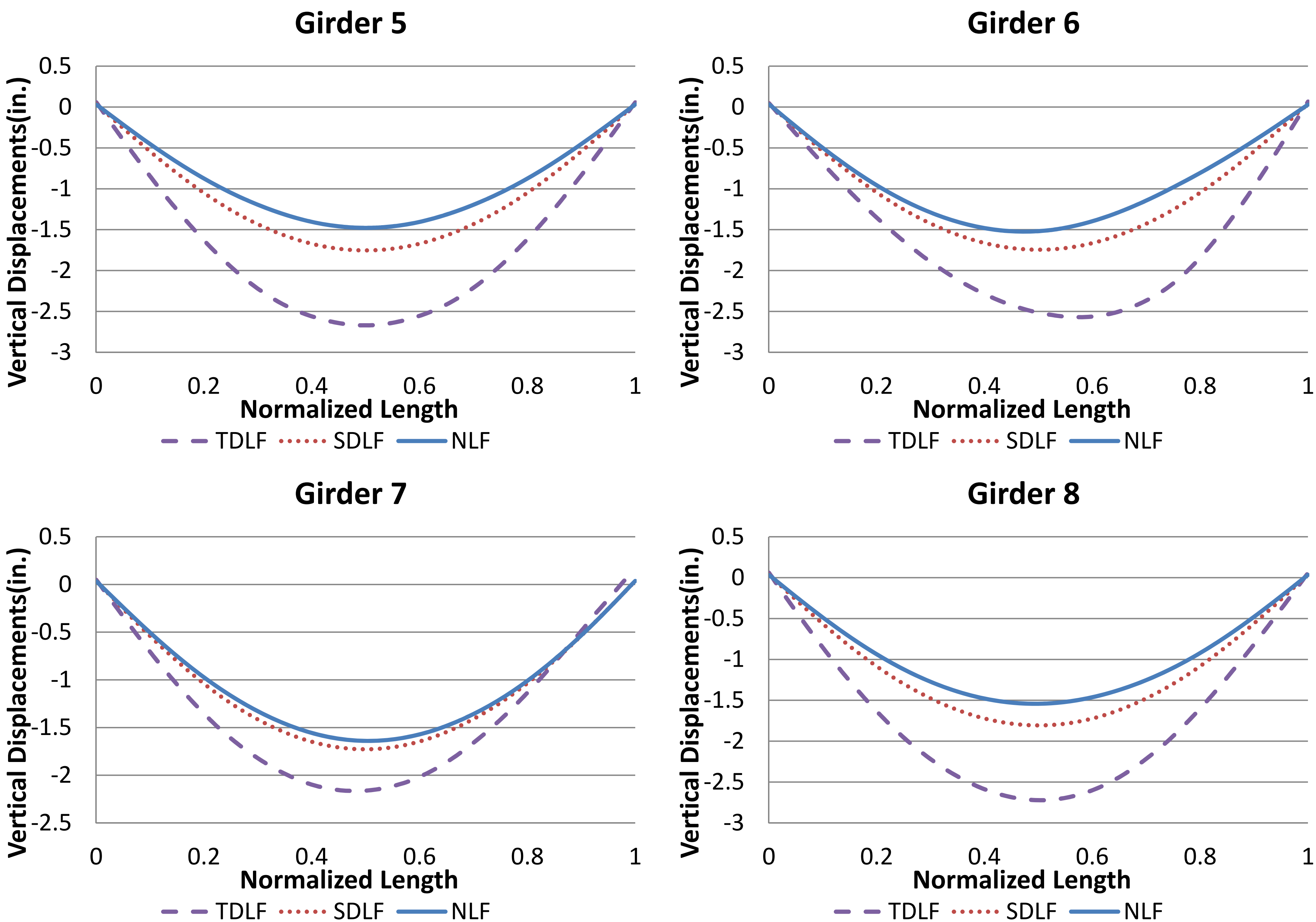


Figure I2-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

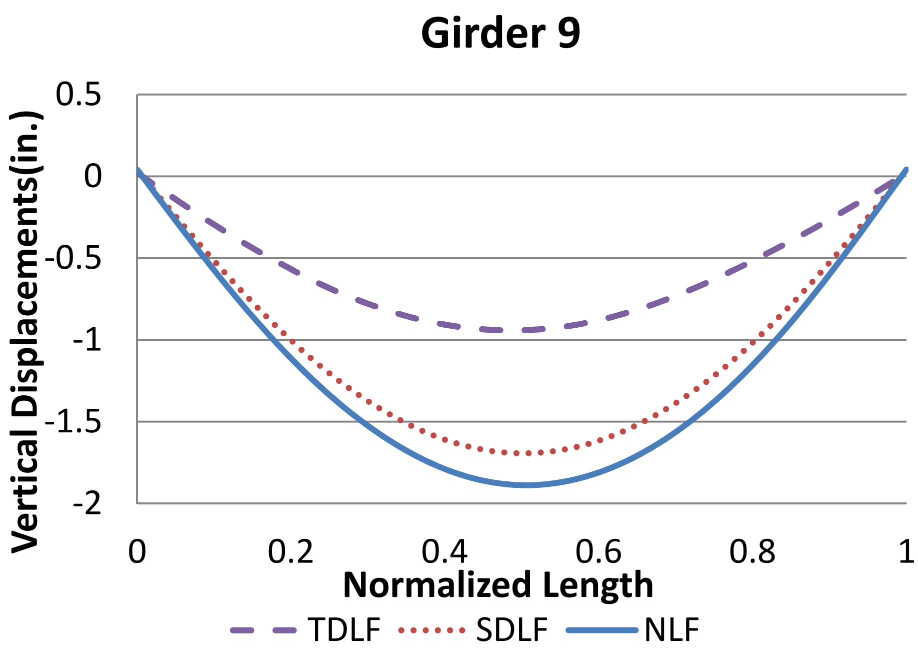


Figure I2-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

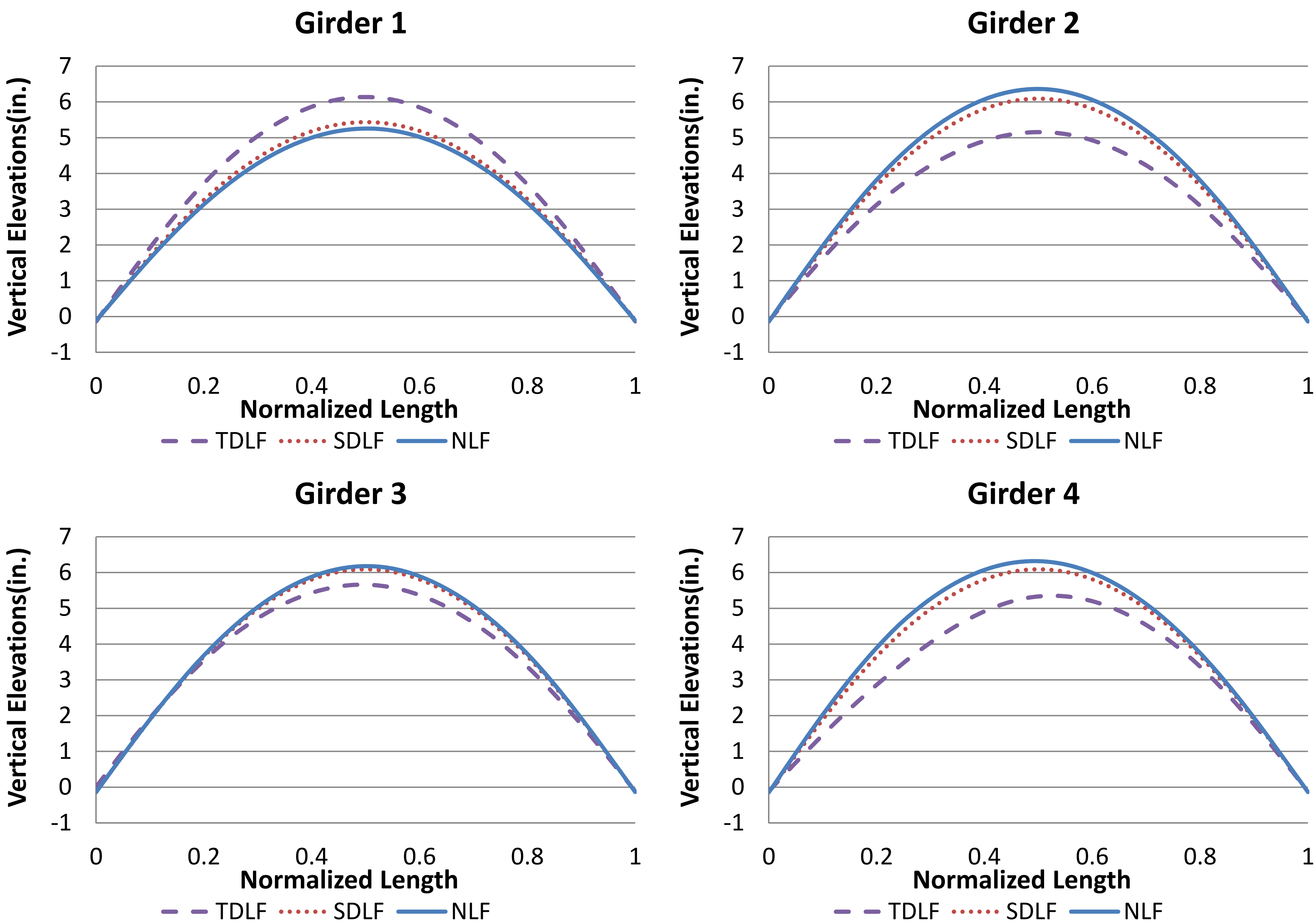


Figure I2-4-12.Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

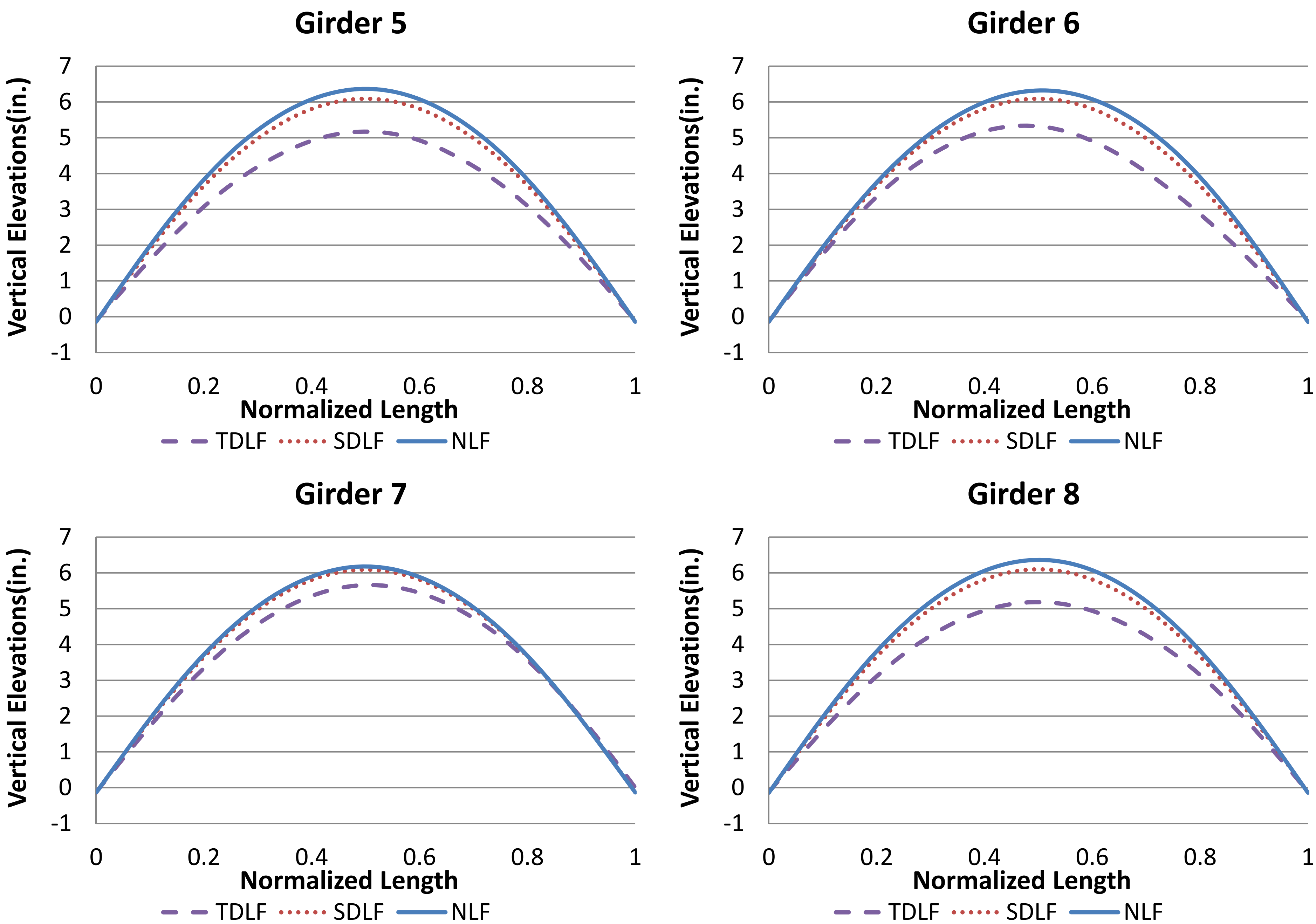


Figure I2-4-12.Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

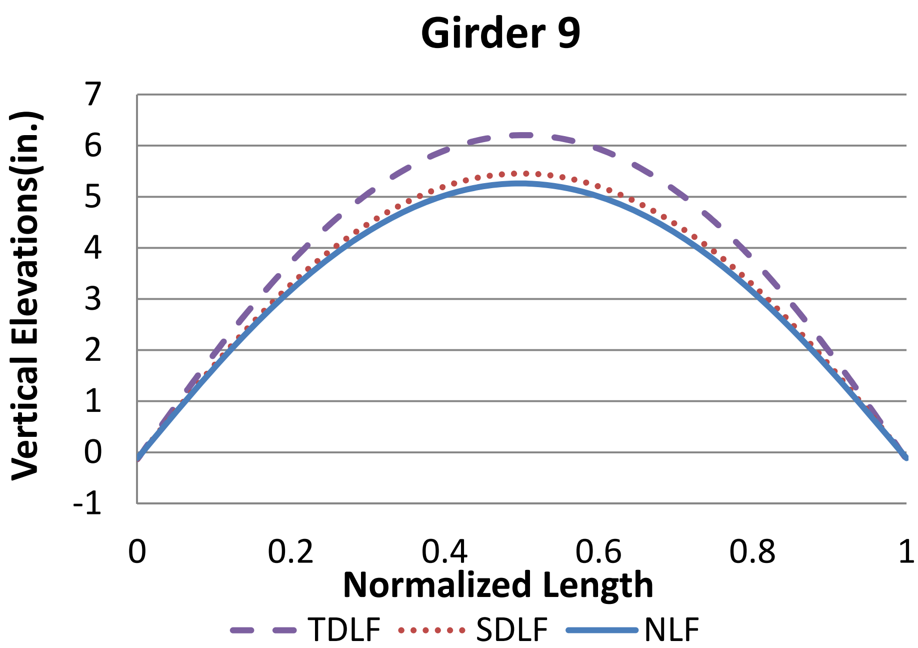


Figure I2-4-12(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

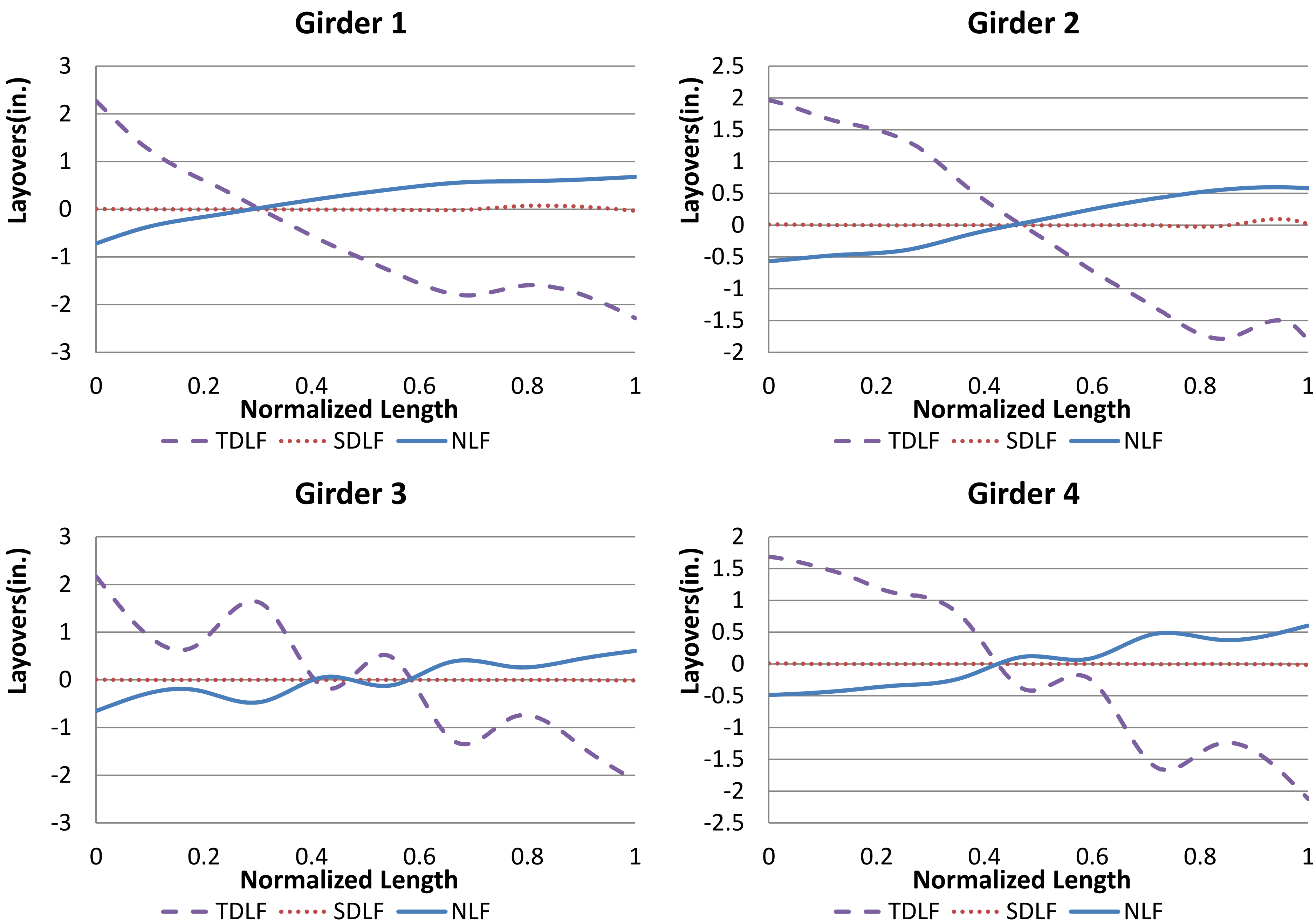


Figure I2-4-13.Comparison of individual girder layovers (in) under SDL for different detailing methods.

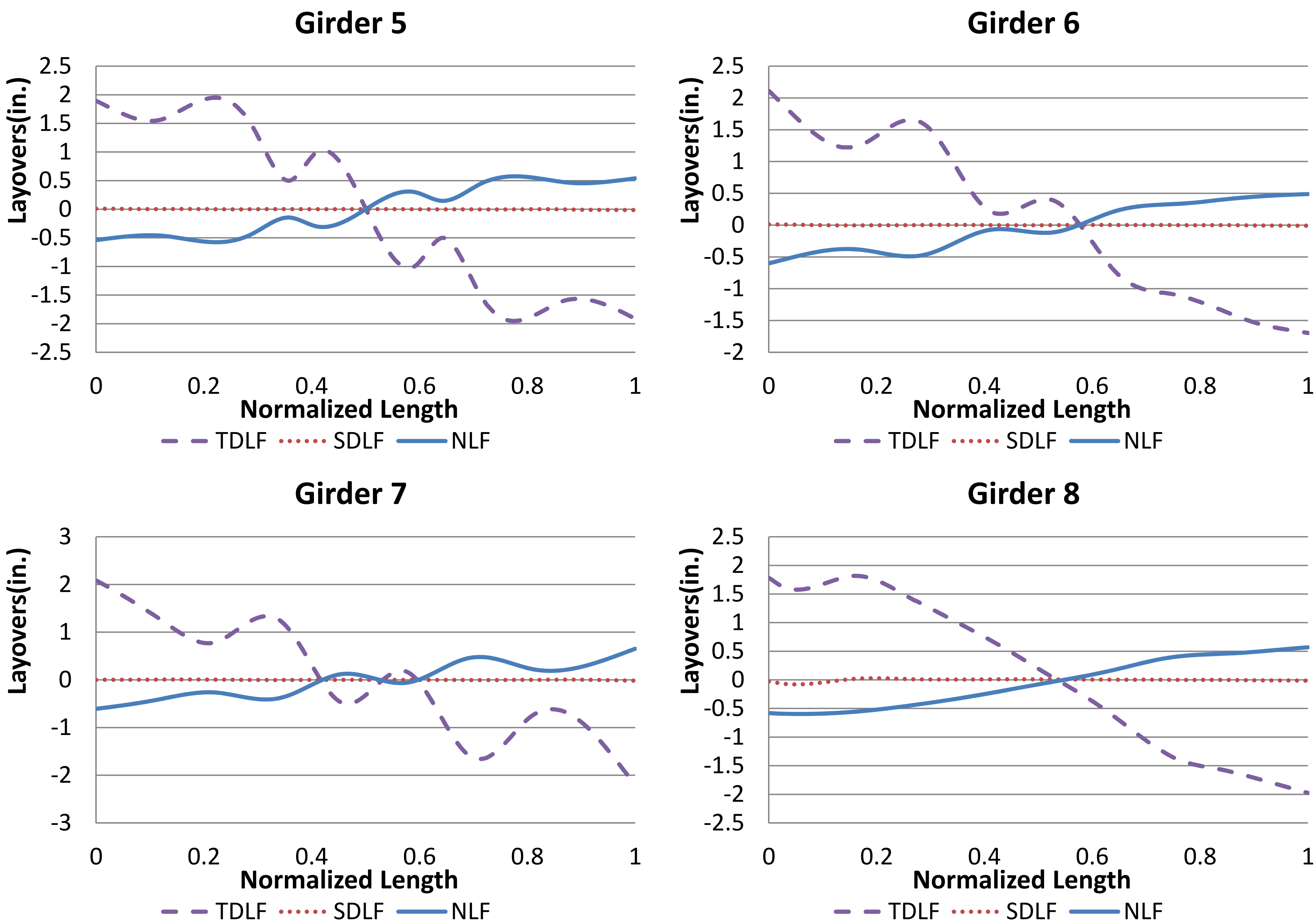


Figure I2-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

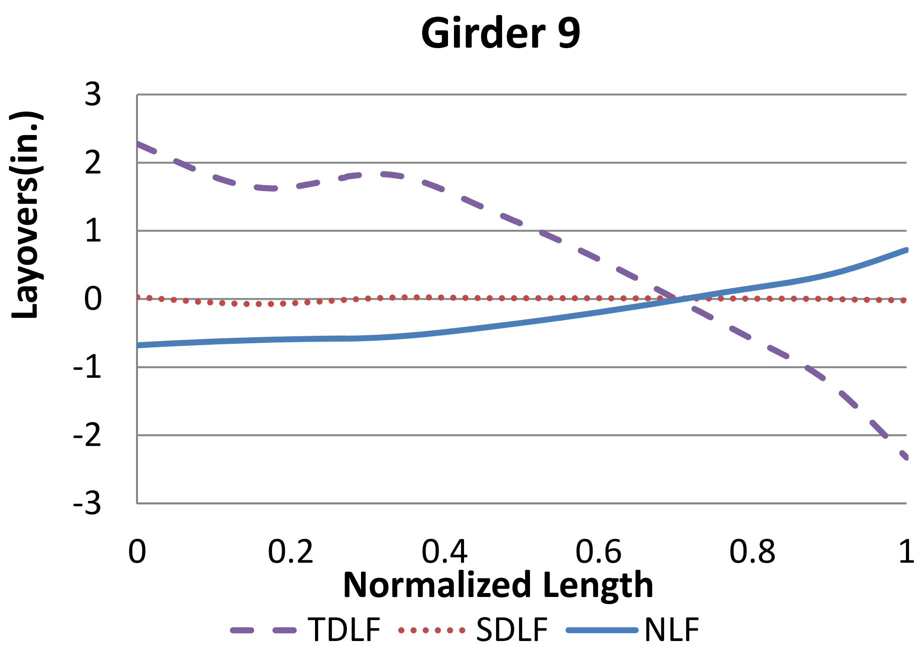


Figure I2-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

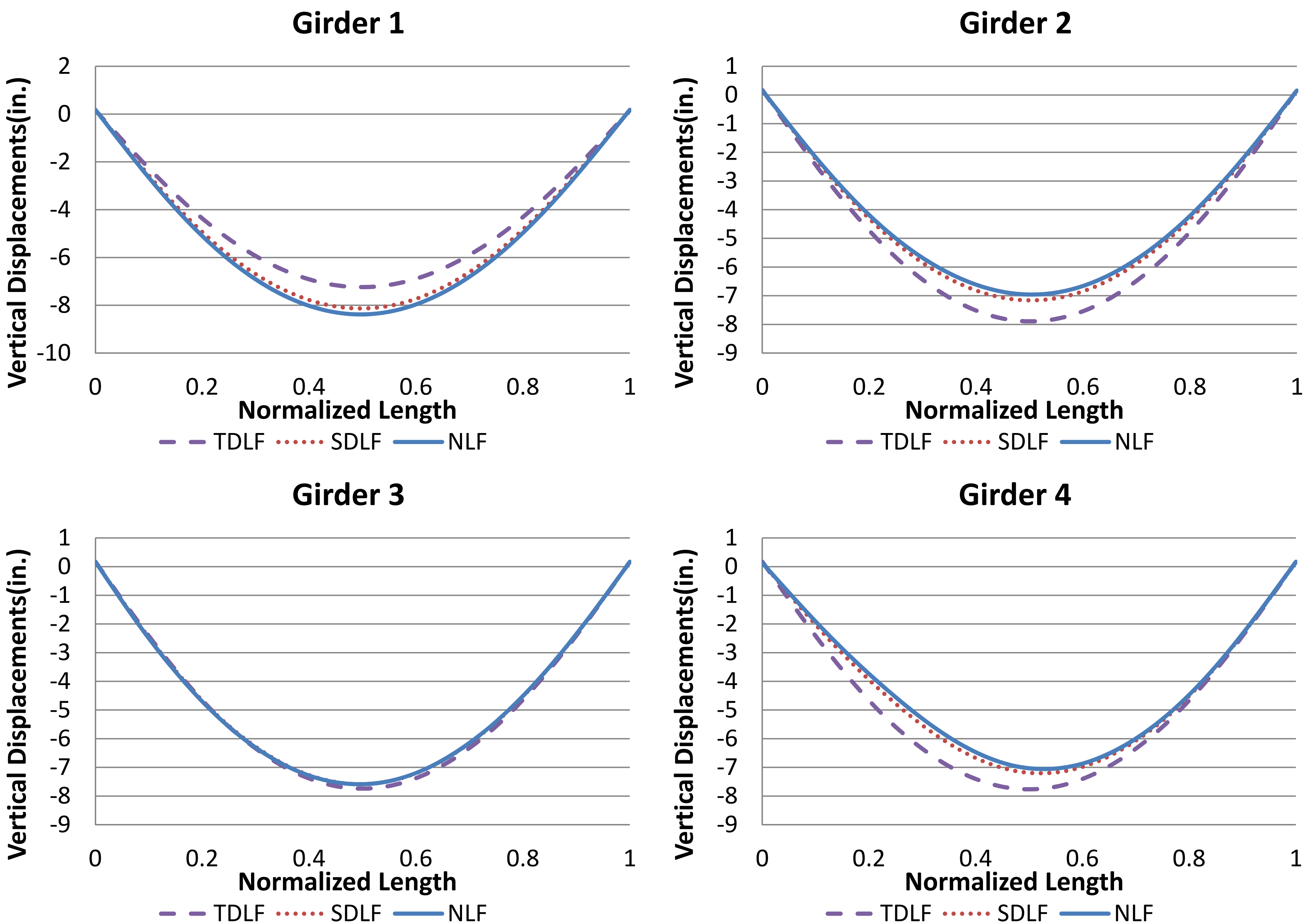


Figure I2-4-14.Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

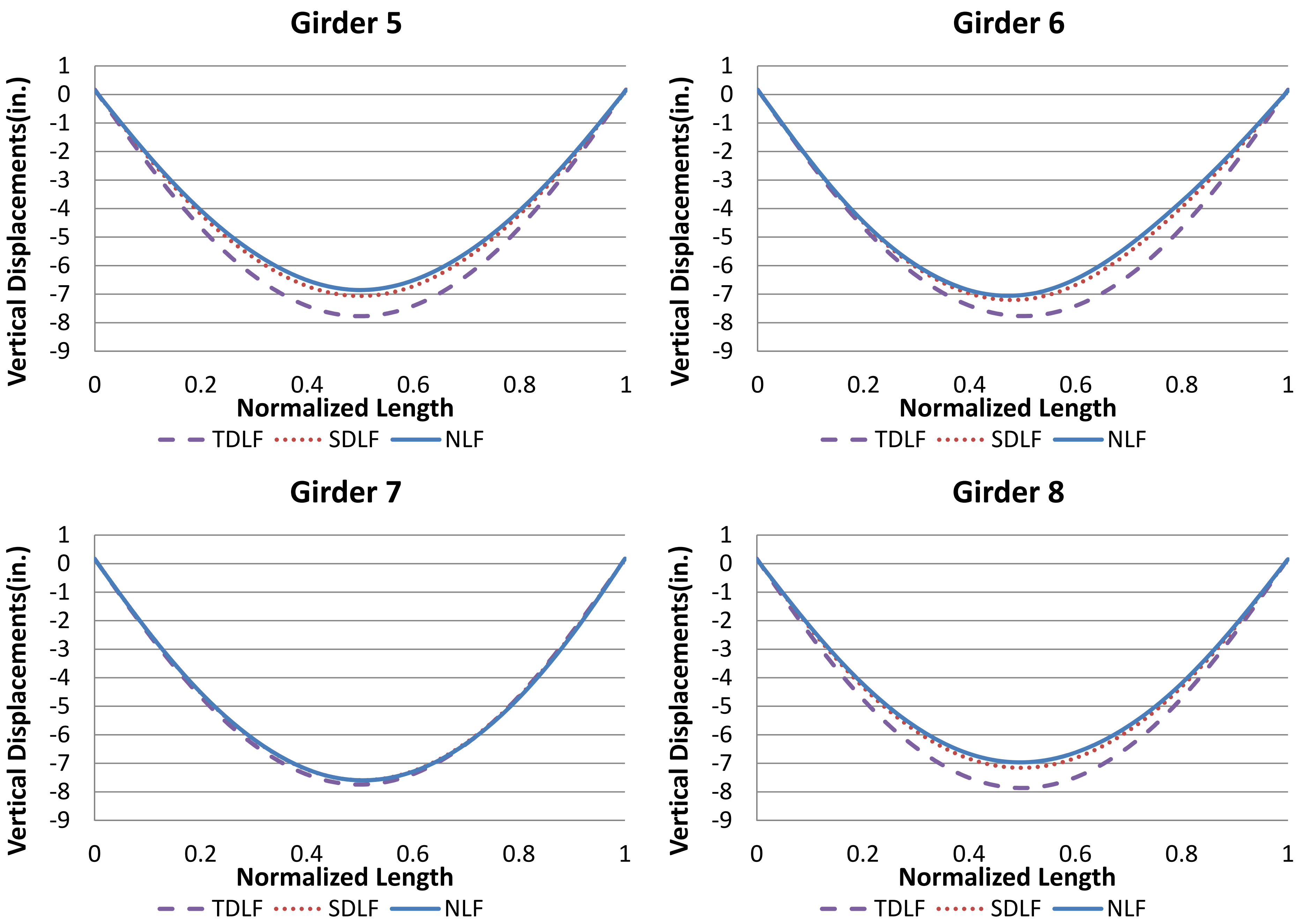


Figure I2-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

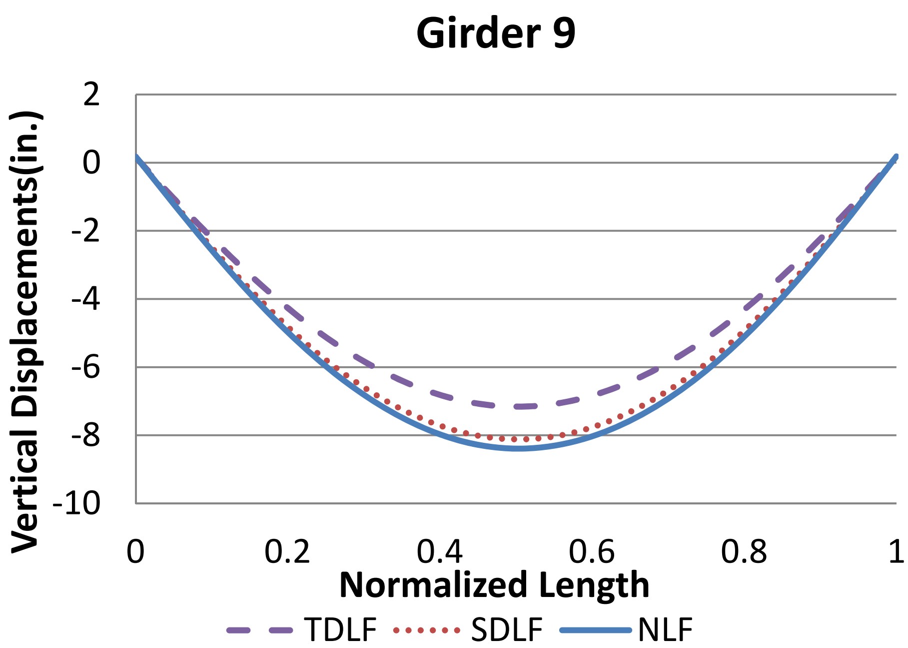


Figure I2-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

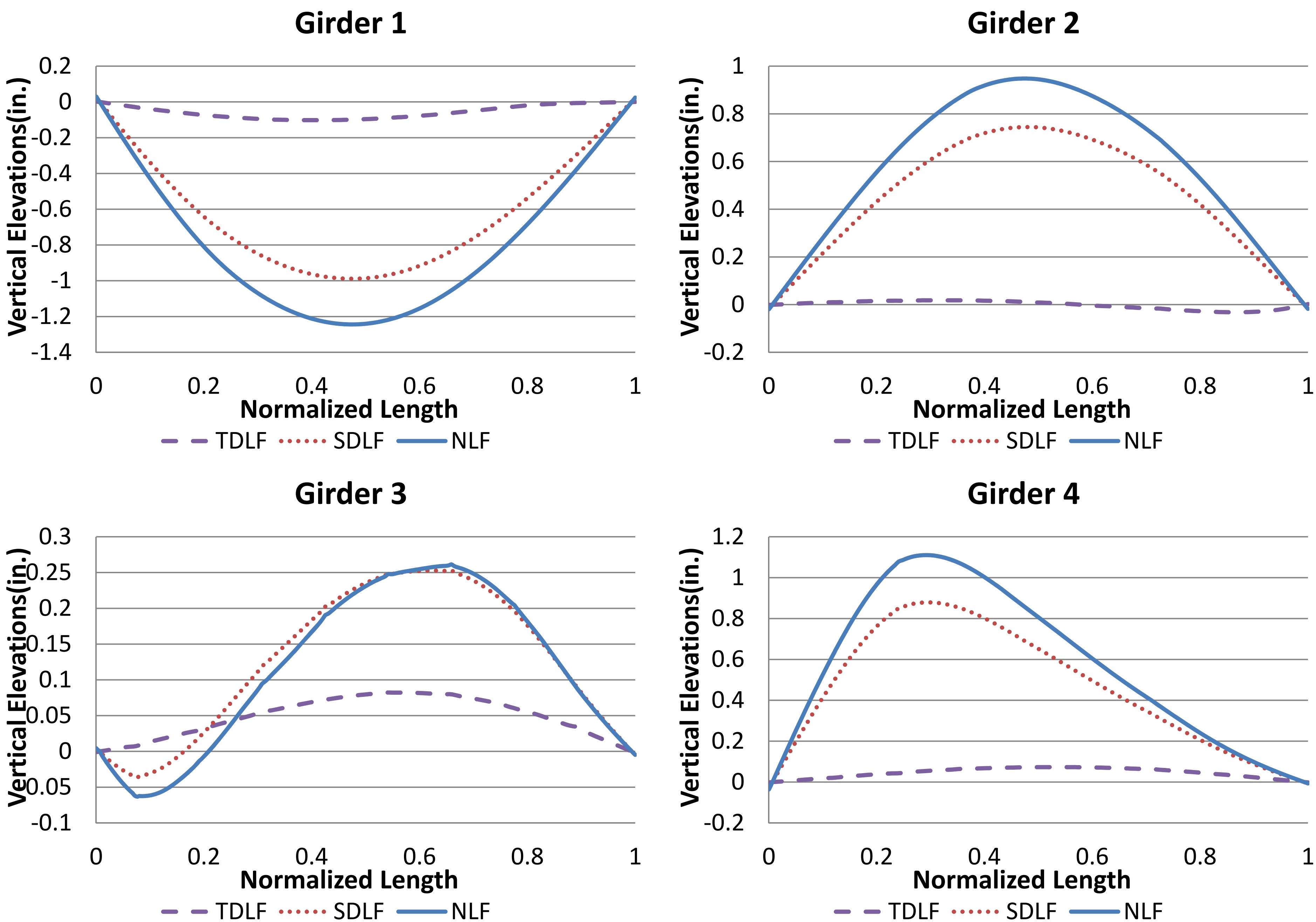


Figure I2-4-15.Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

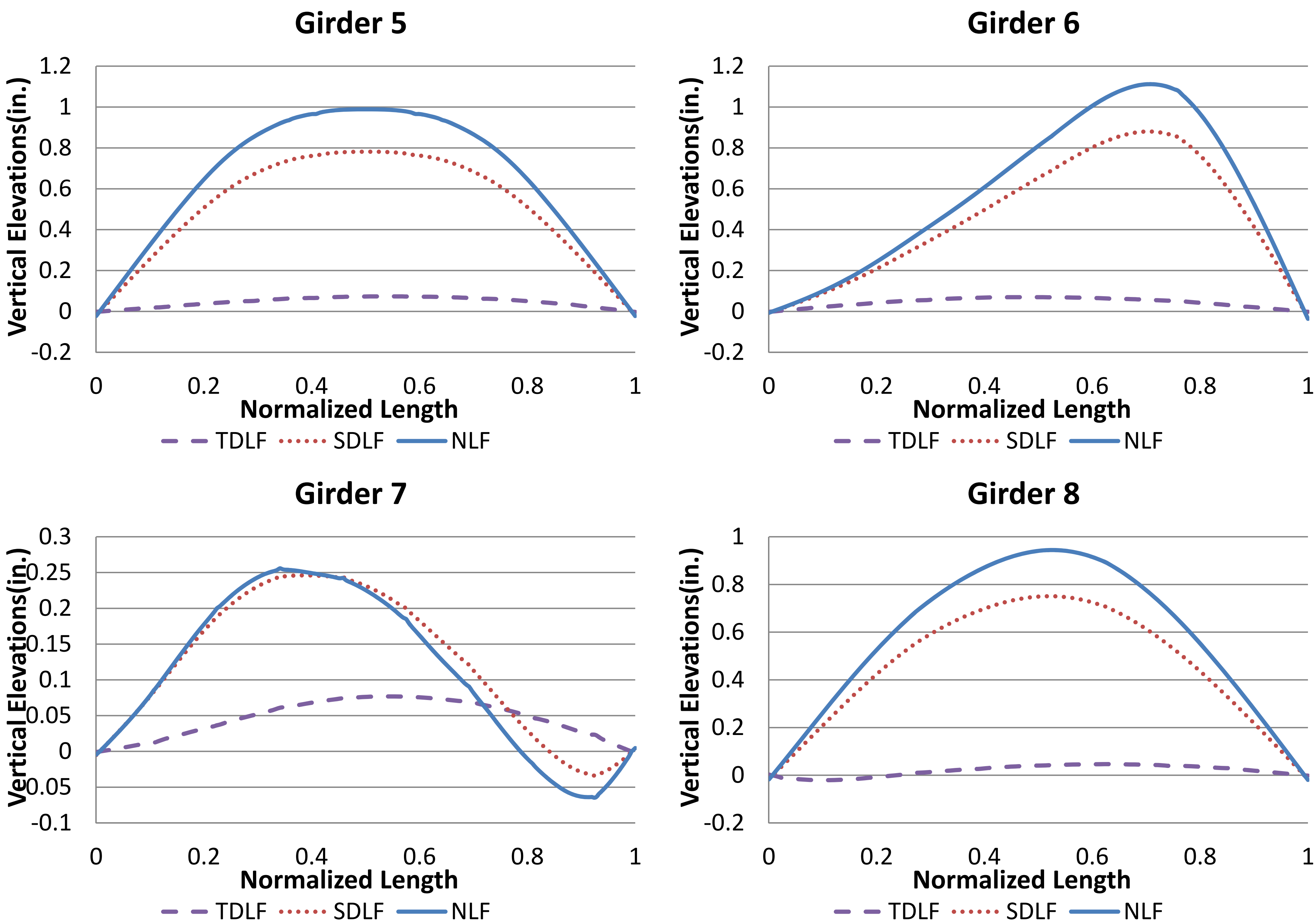


Figure I2-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

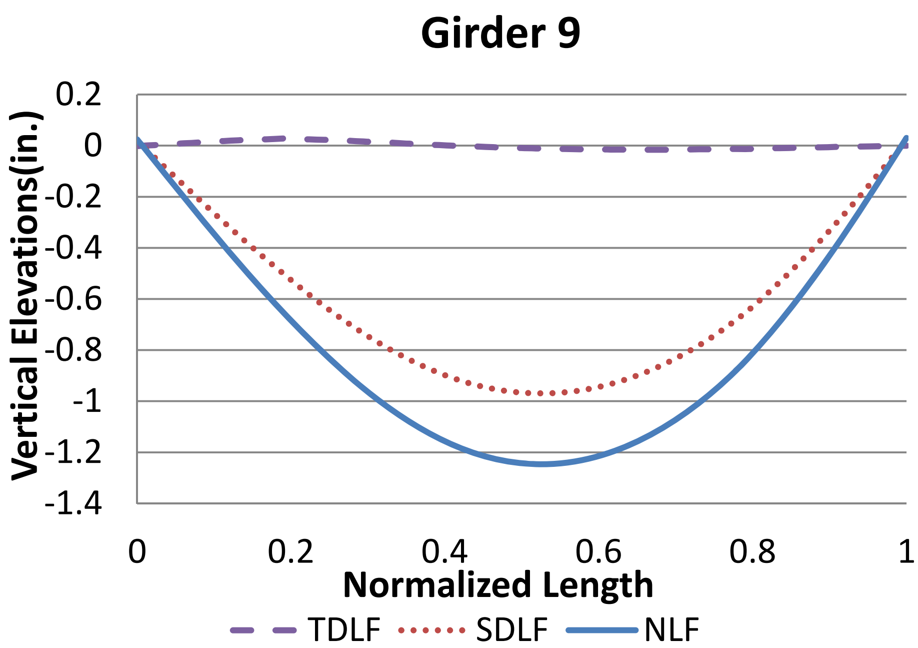


Figure I2-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

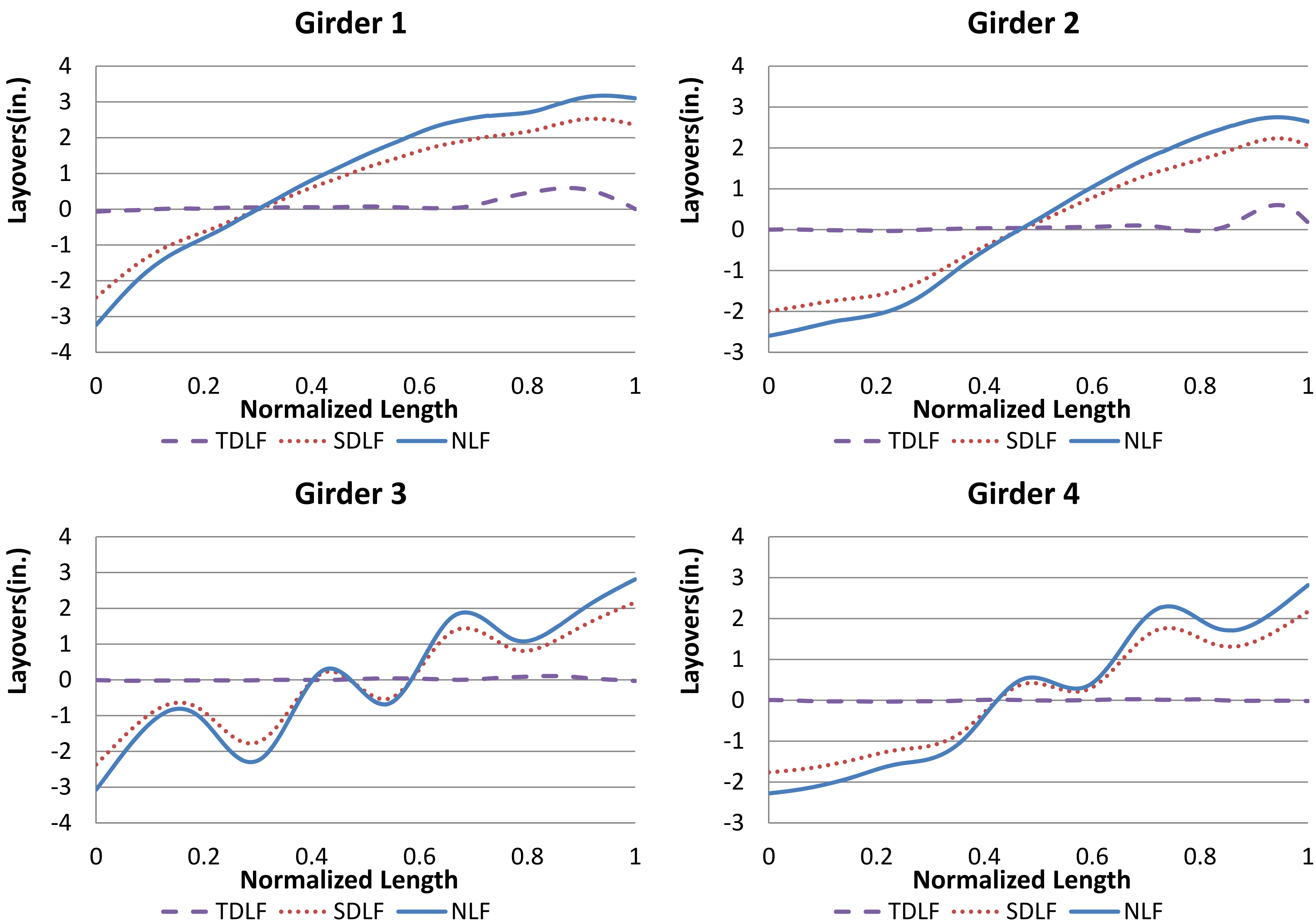


Figure I2-4-16.Comparison of individual girder layovers (in) under TDL for different detailing methods.

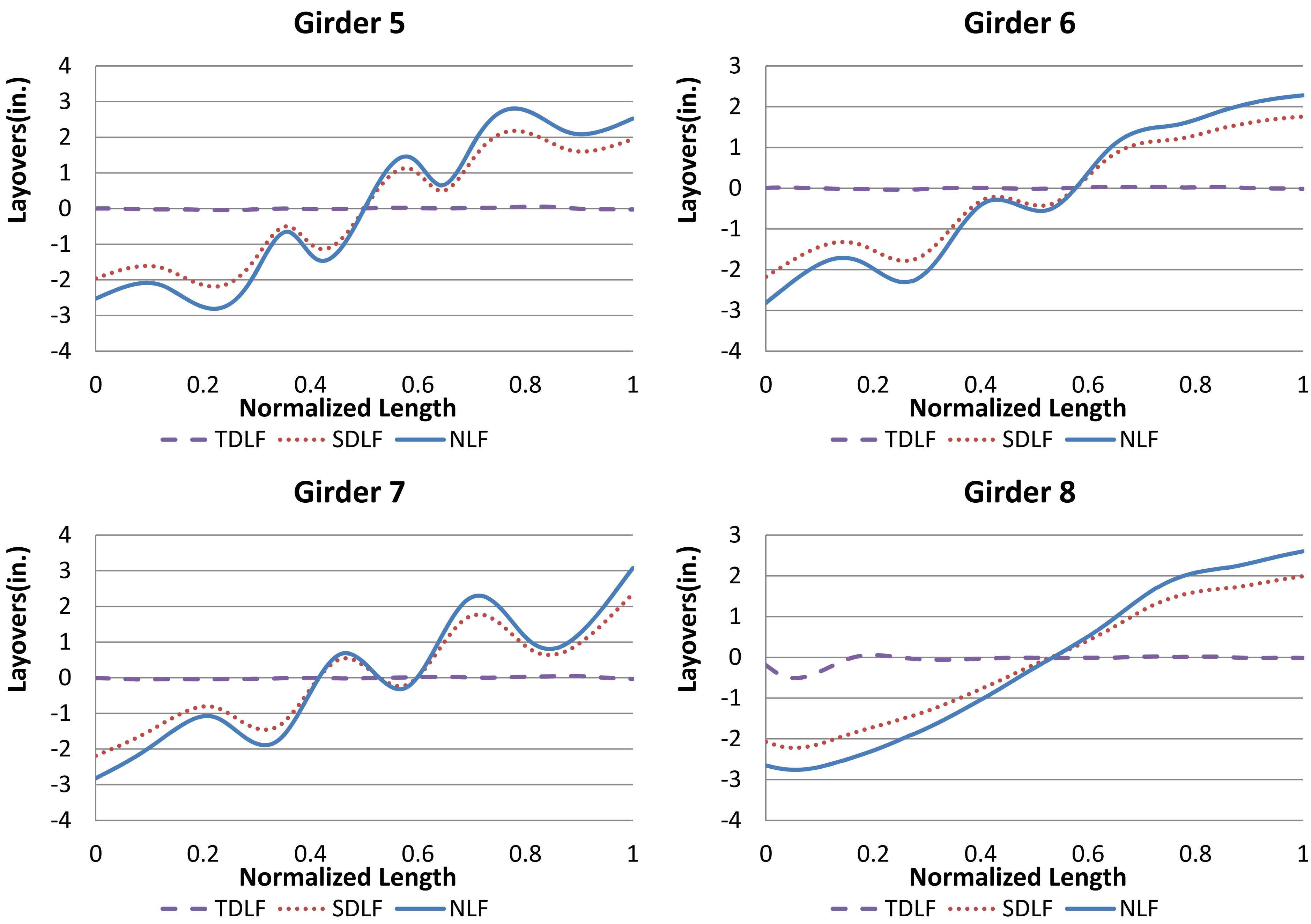


Figure I2-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

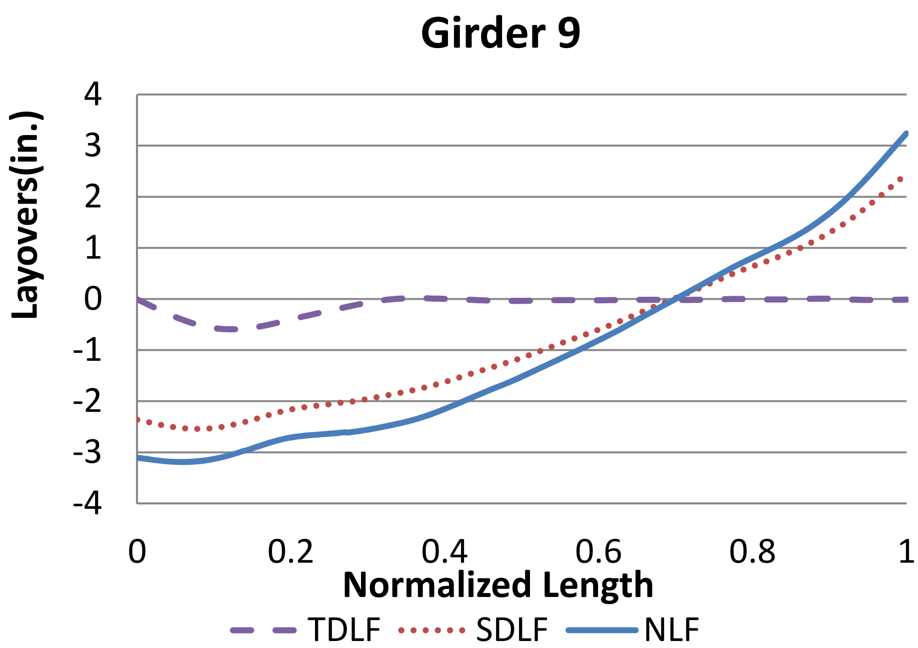


Figure I2-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

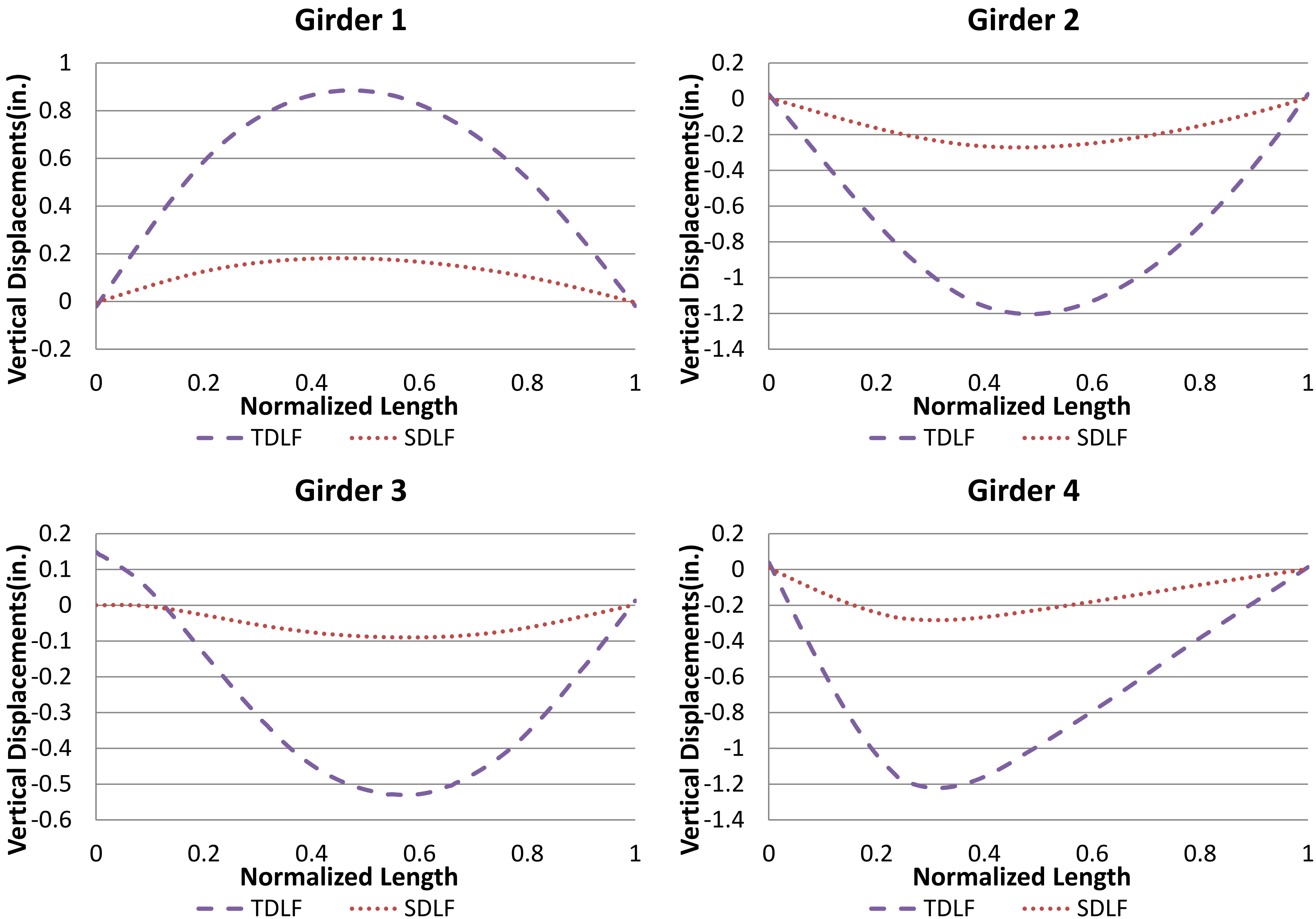


Figure I2-4-17.Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

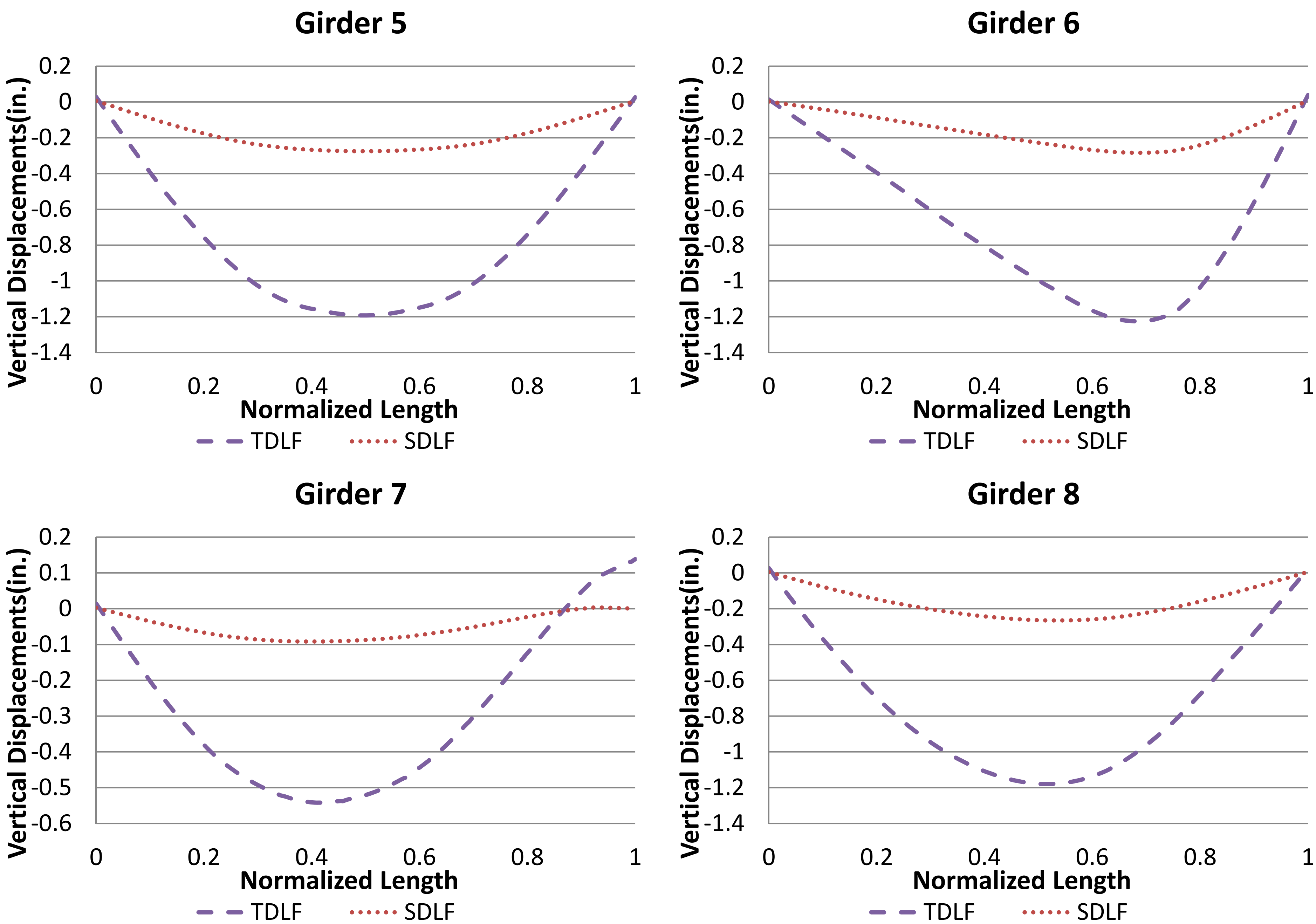


Figure I2-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

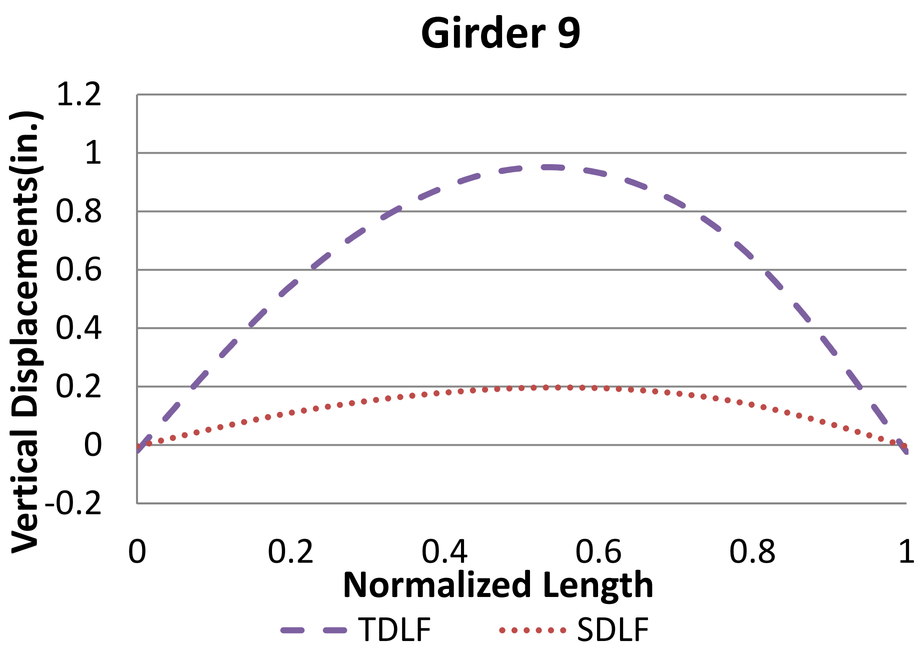


Figure I2-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

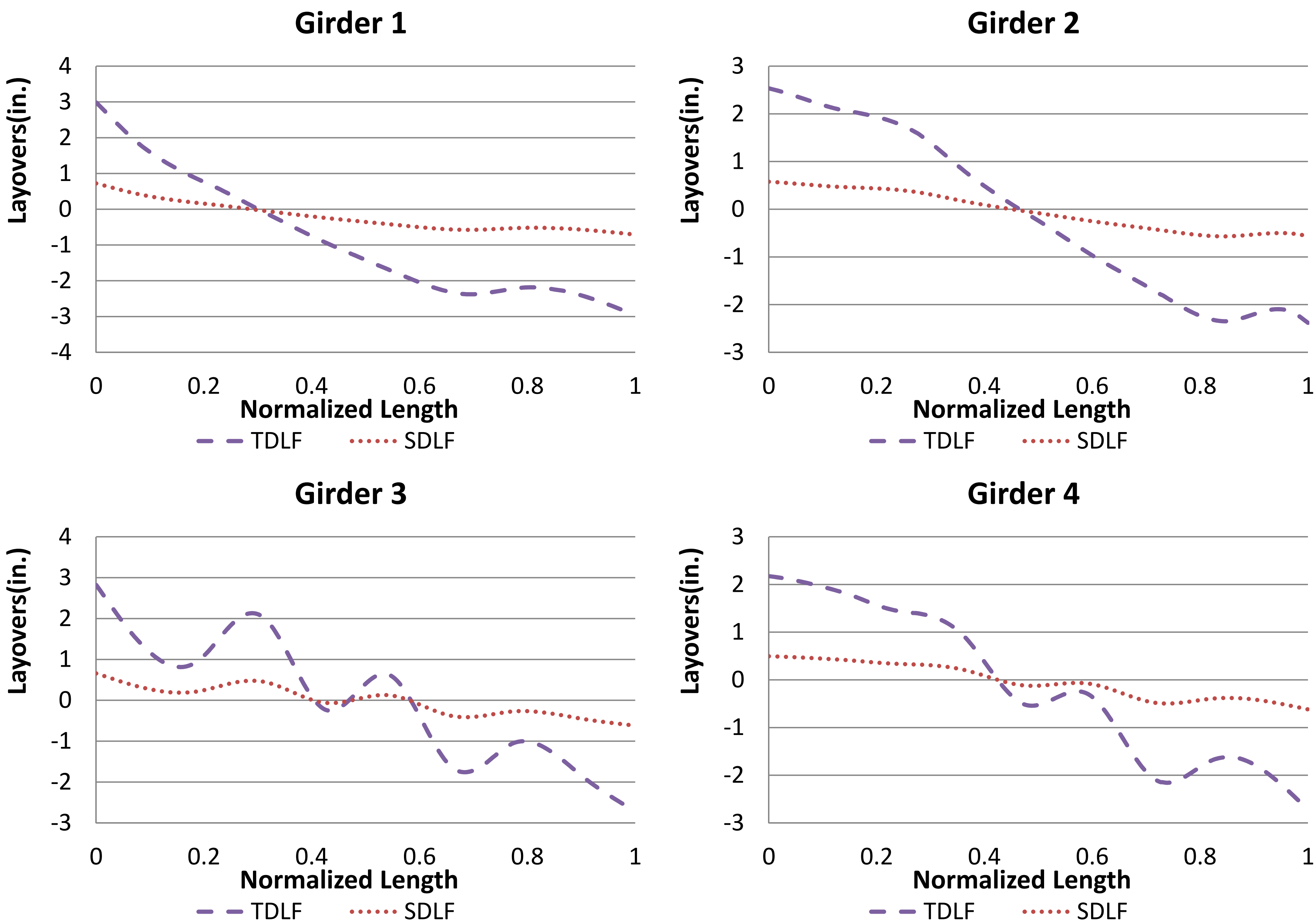


Figure I2-4-18.Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

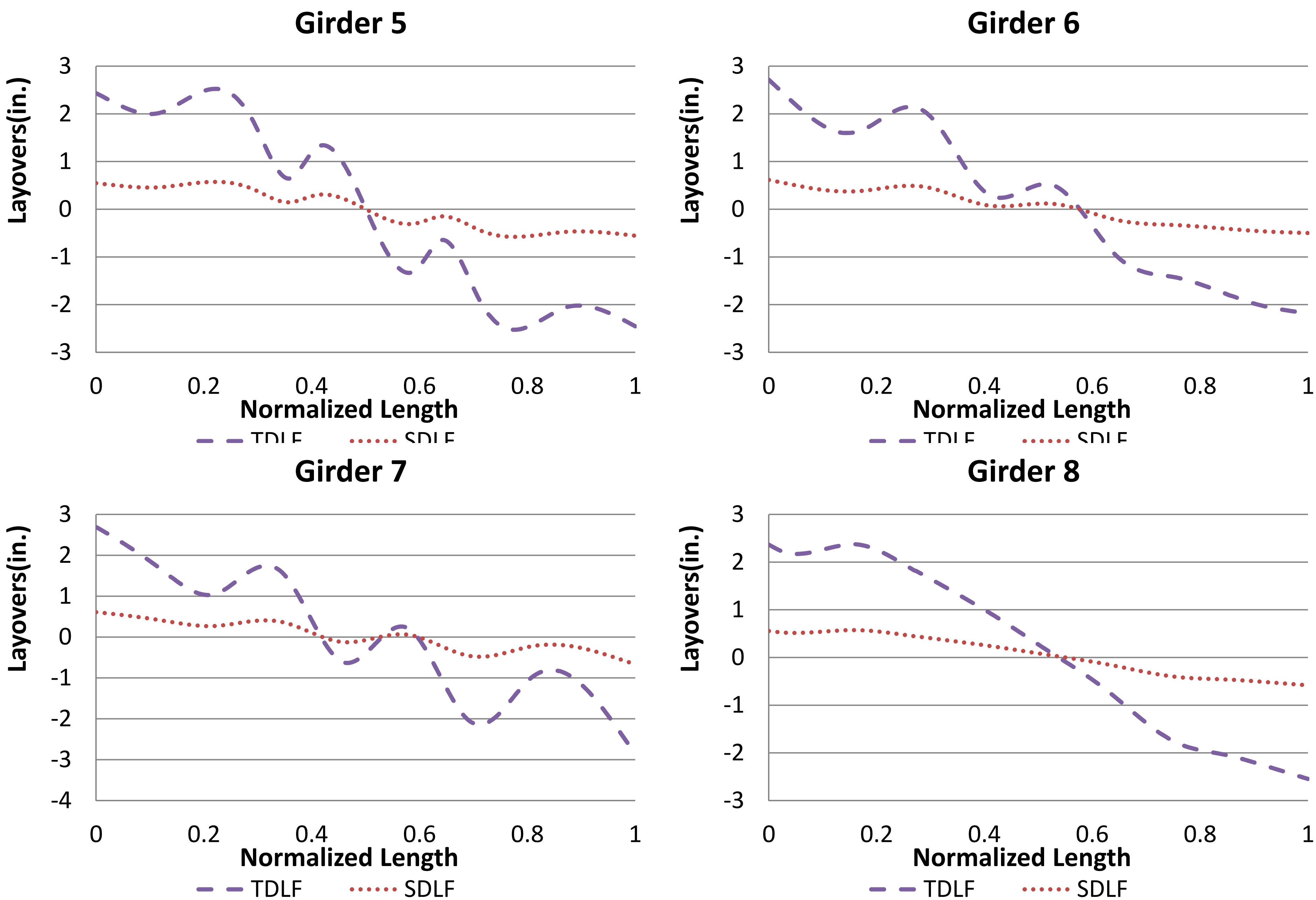


Figure I2-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

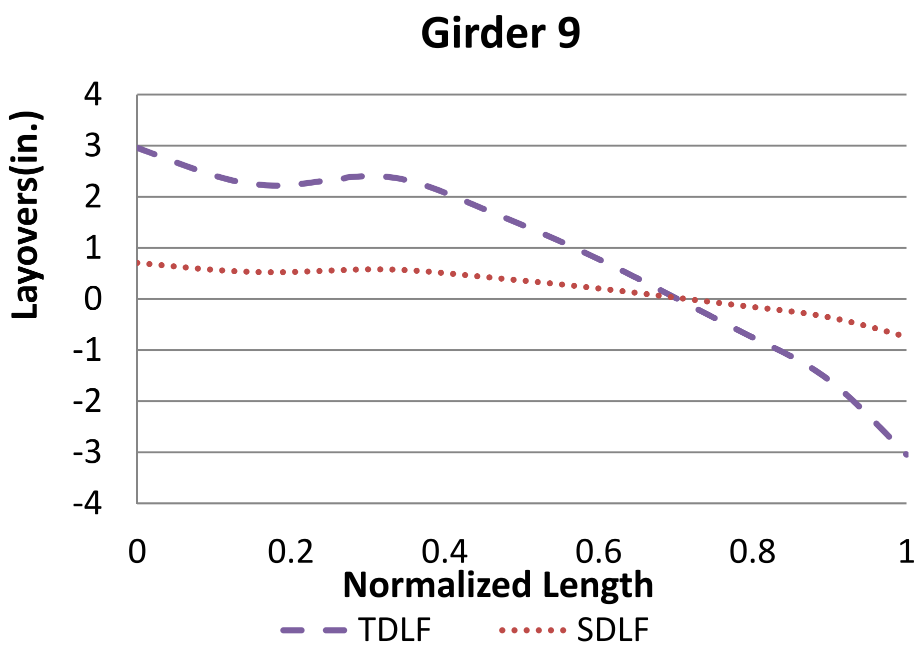


Figure I2-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

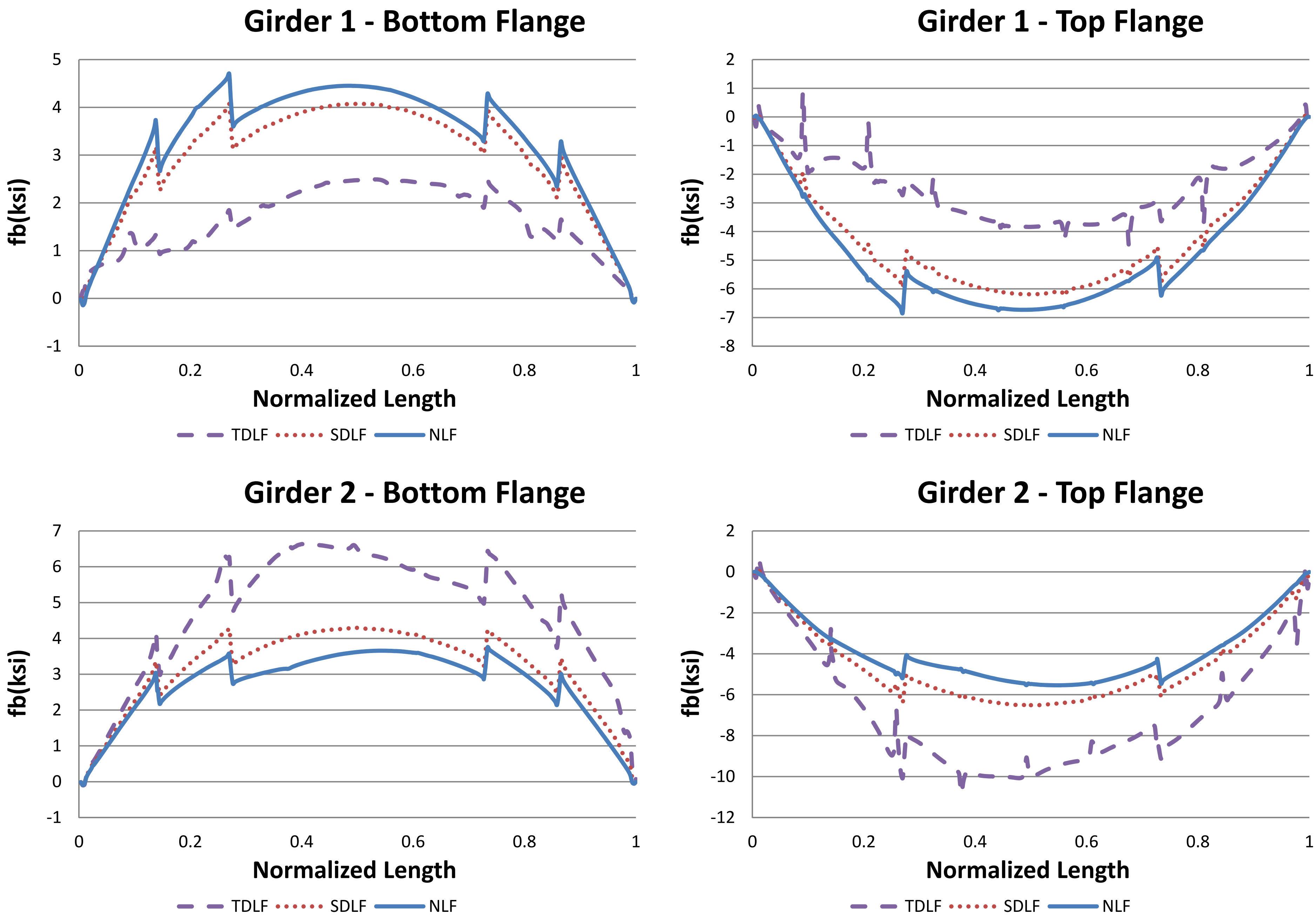


Figure I2-4-19. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

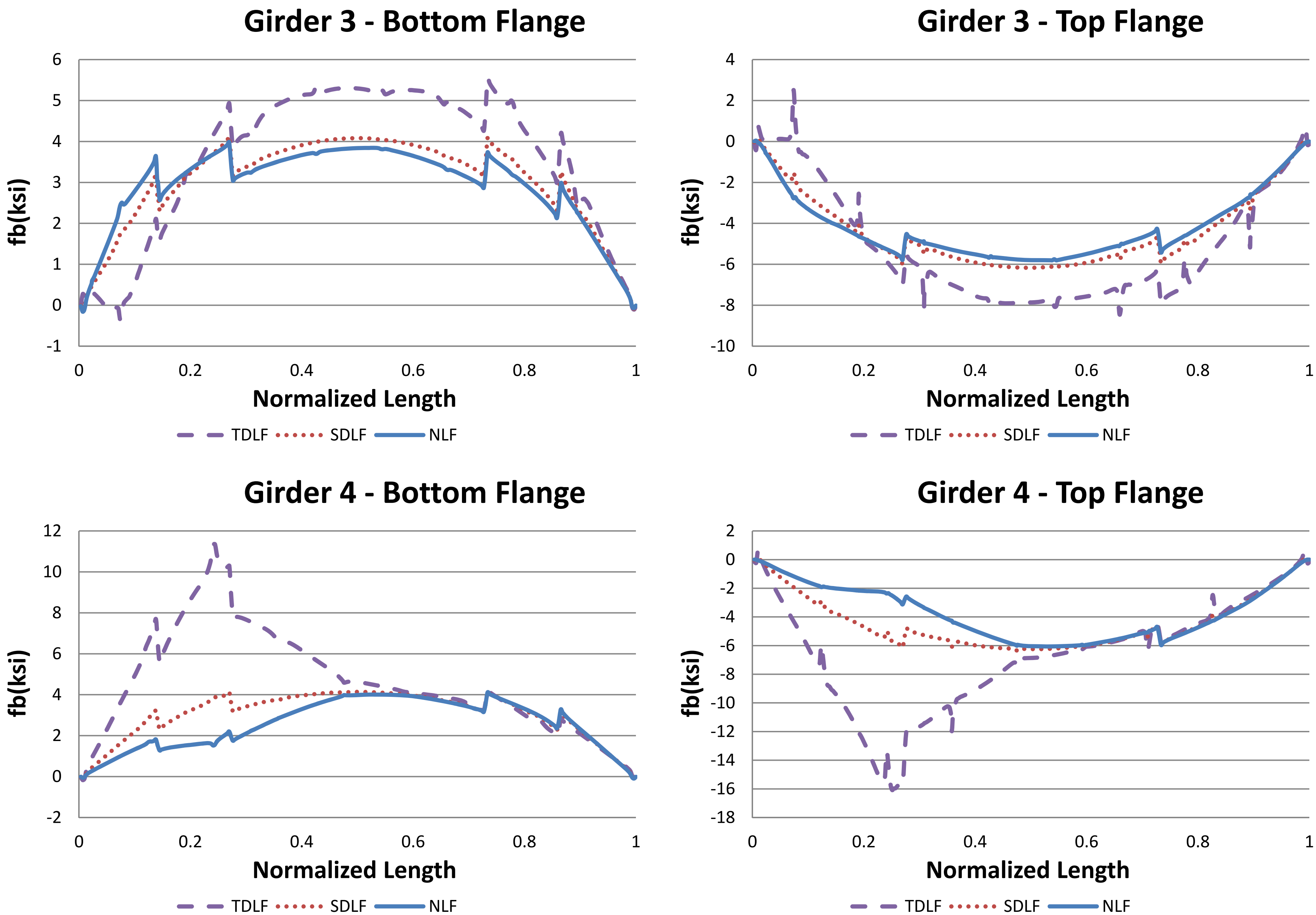


Figure I2-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

Figure I2-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

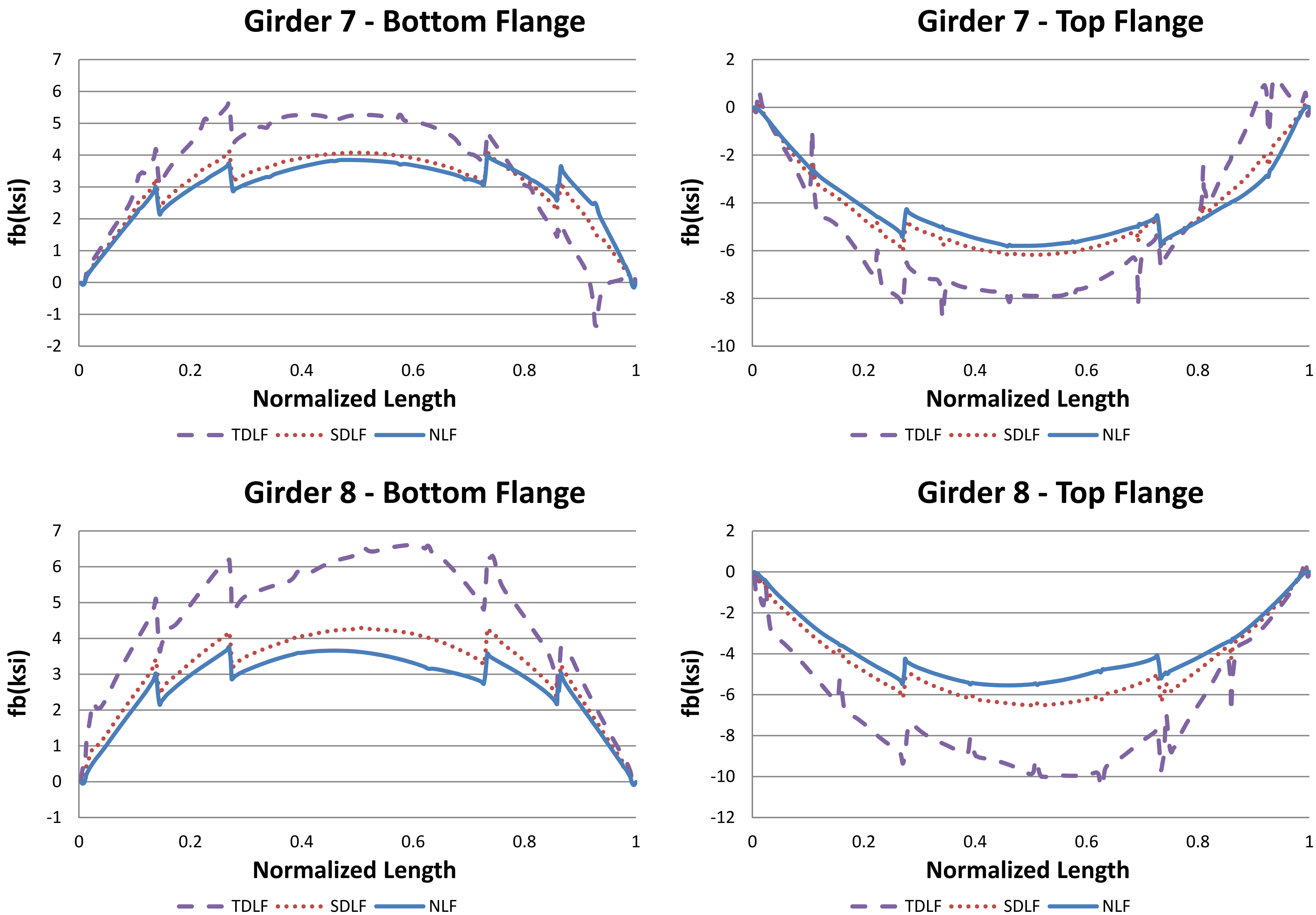
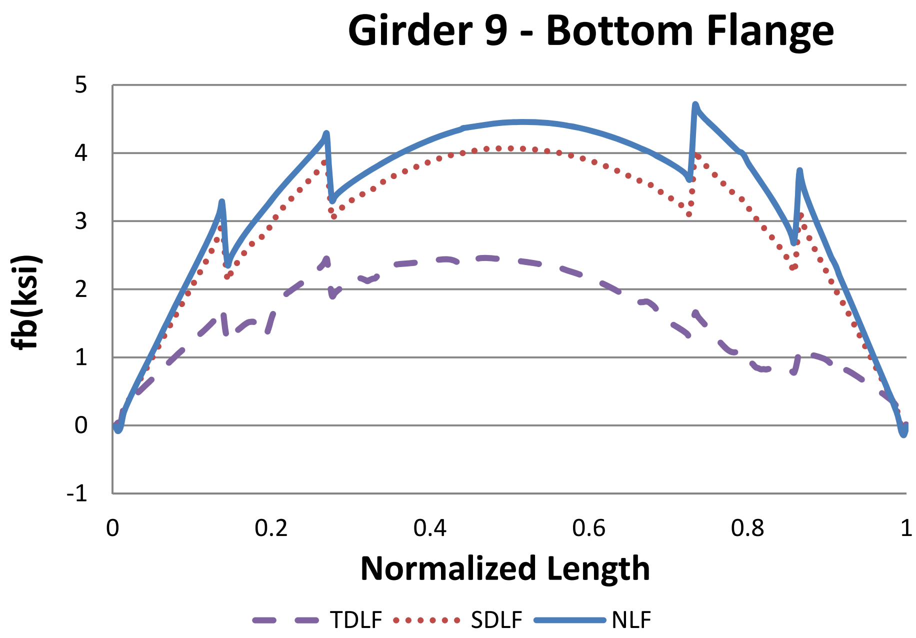


Figure I2-4-19 (continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**



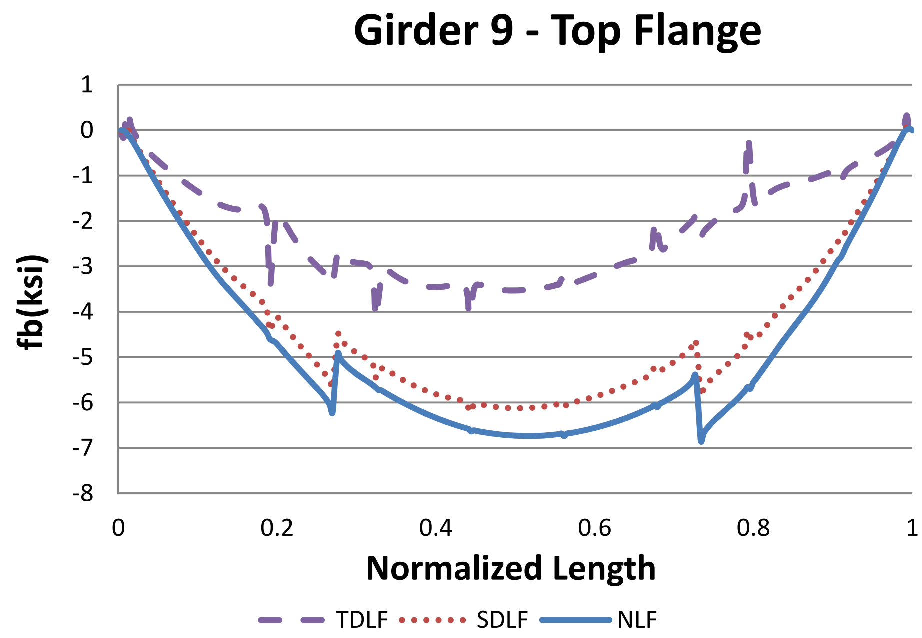


Figure I2-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

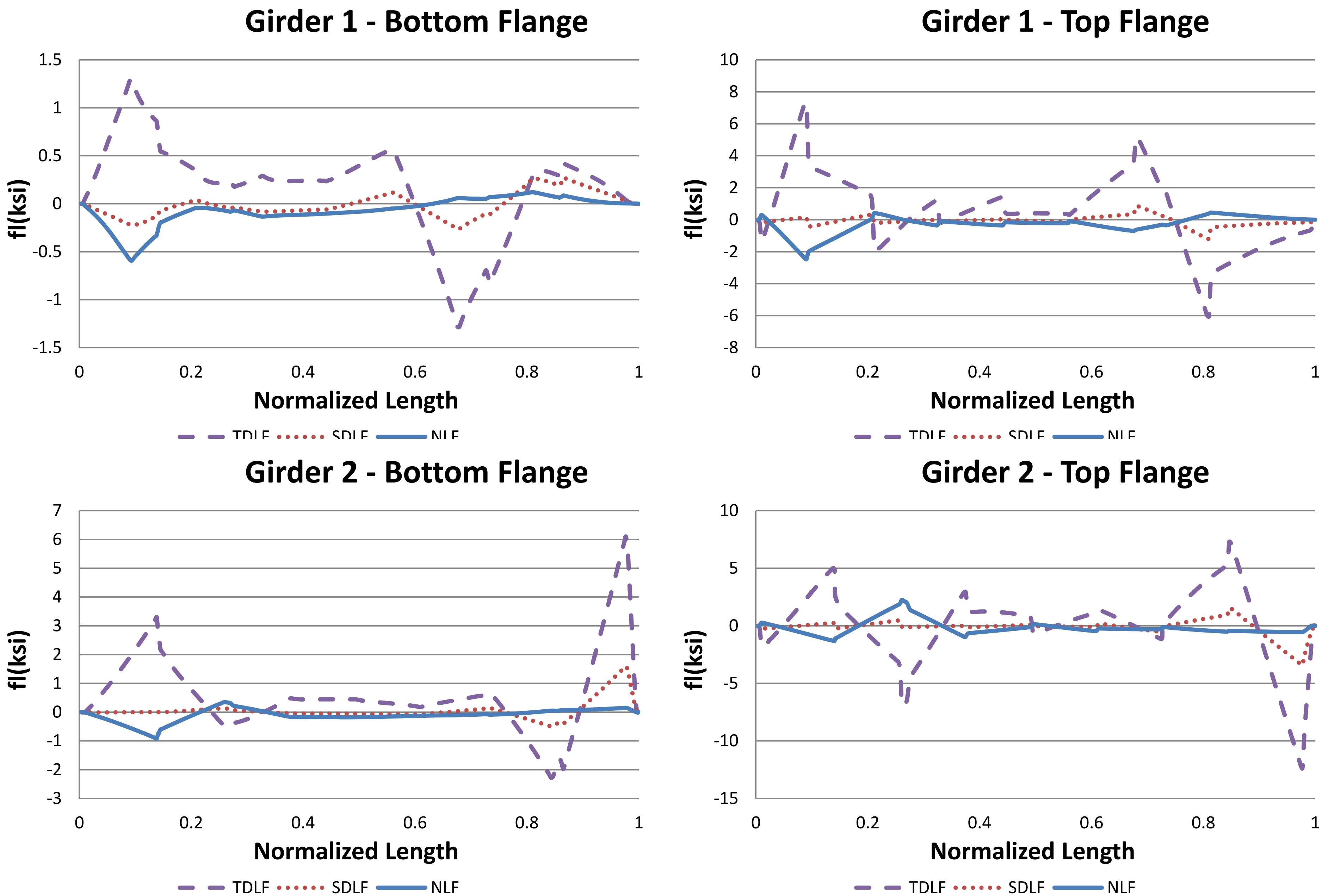


Figure I2-4-20. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

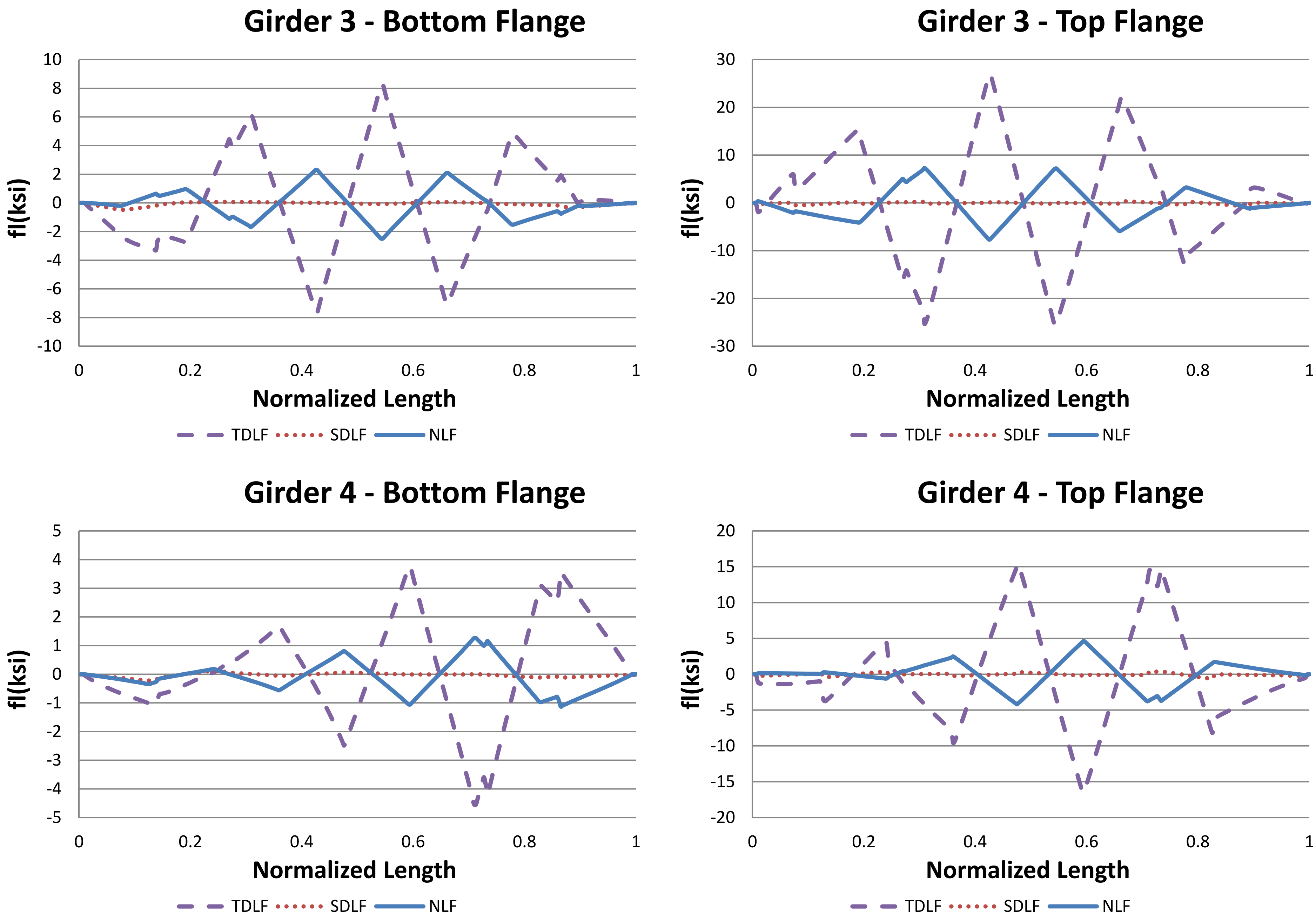


Figure I2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

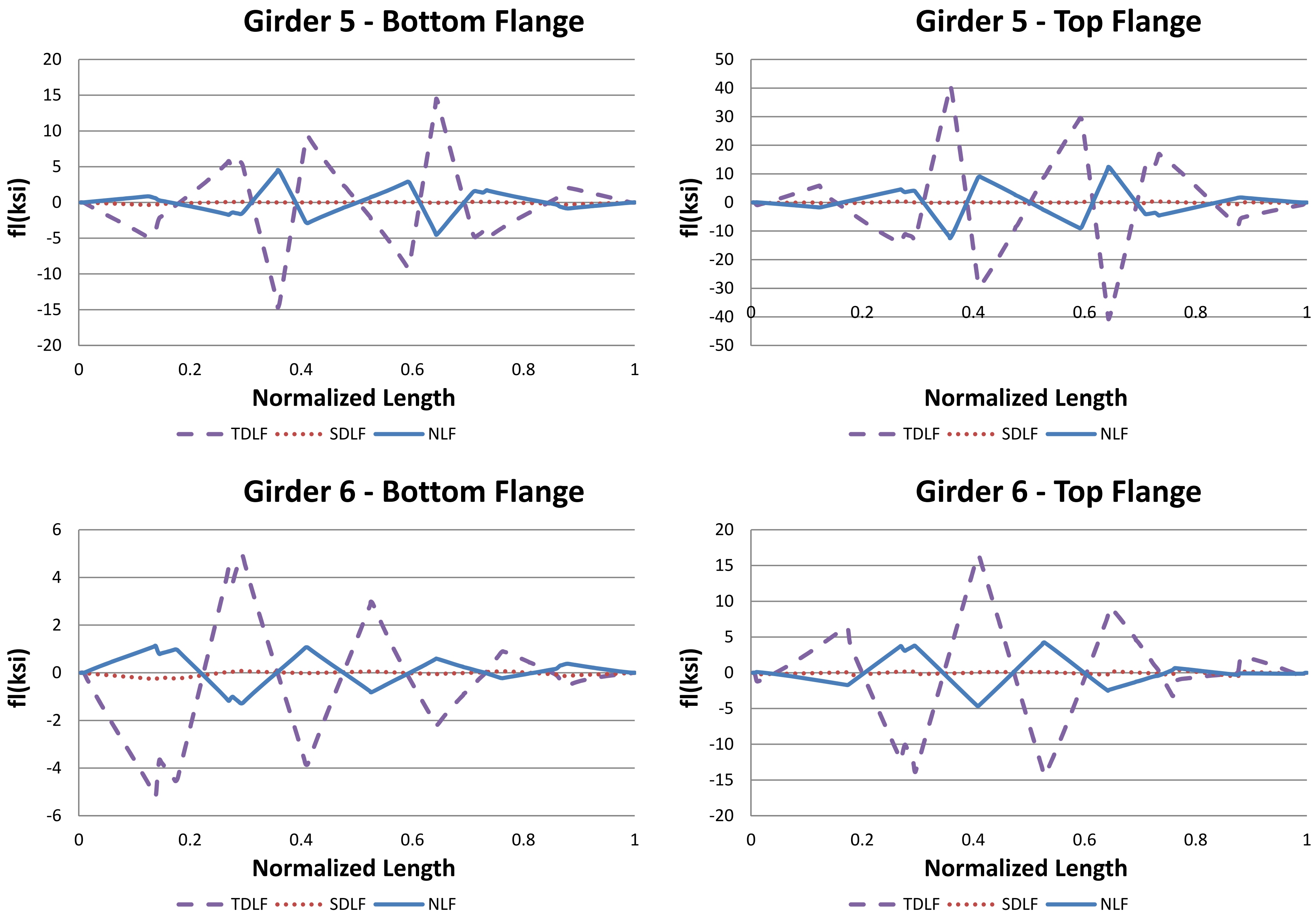


Figure I2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

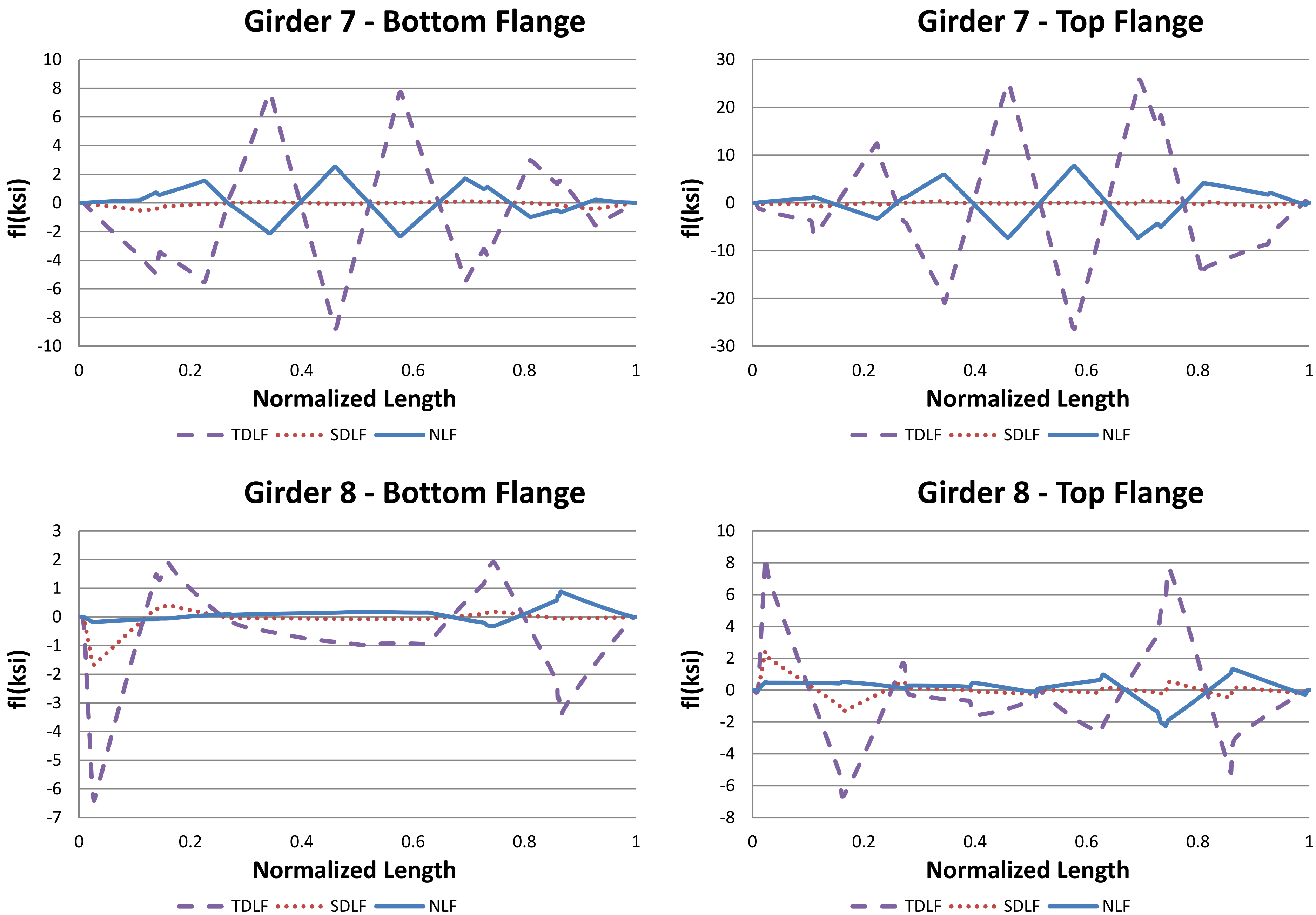
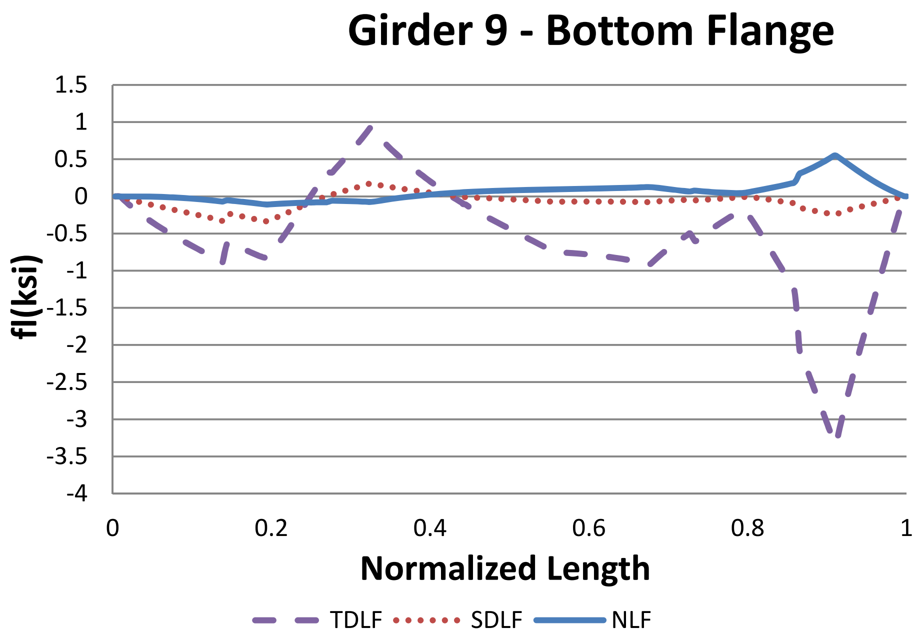


Figure I2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.



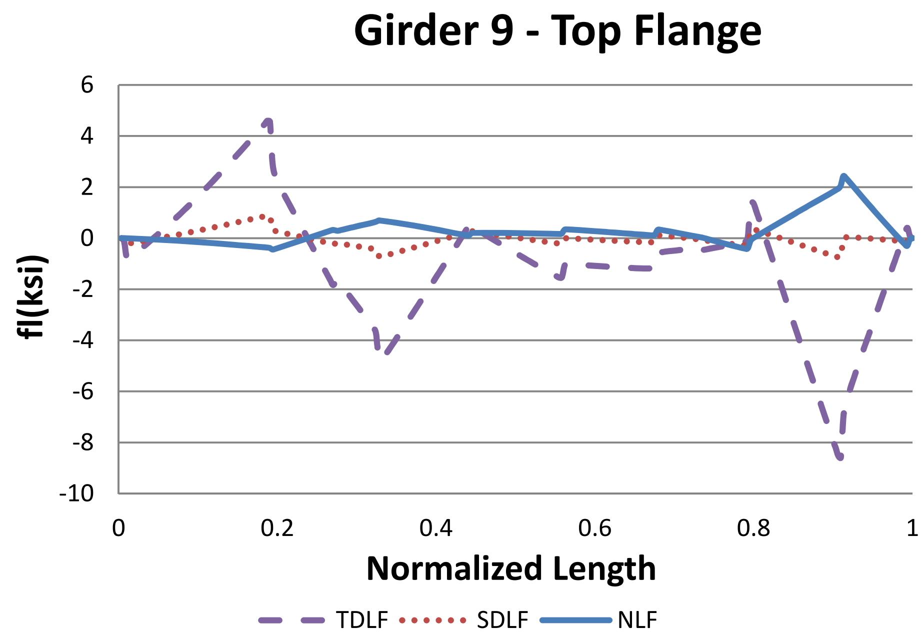


Figure I2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under SDL for different detailing methods.

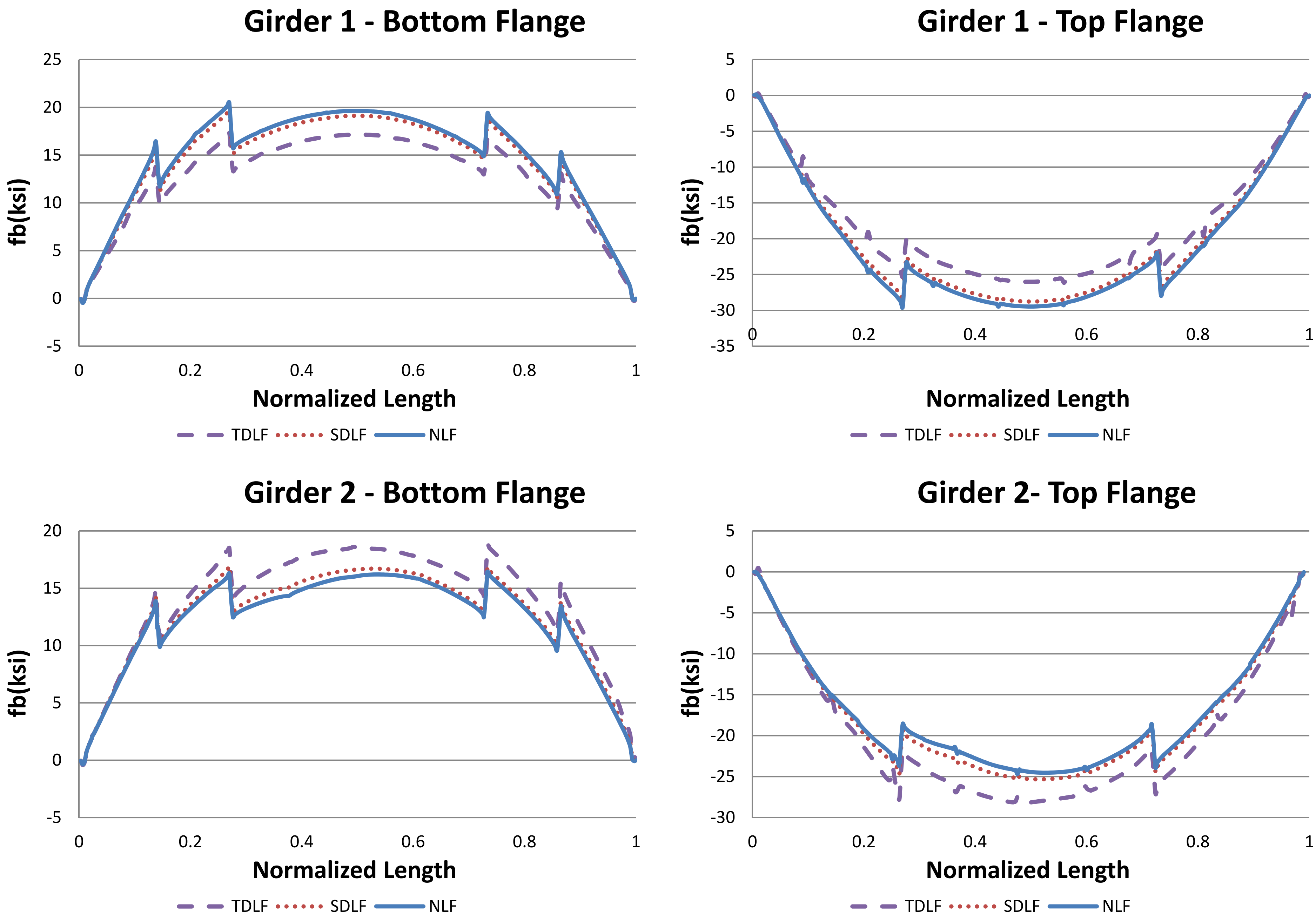


Figure I2-4-21. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

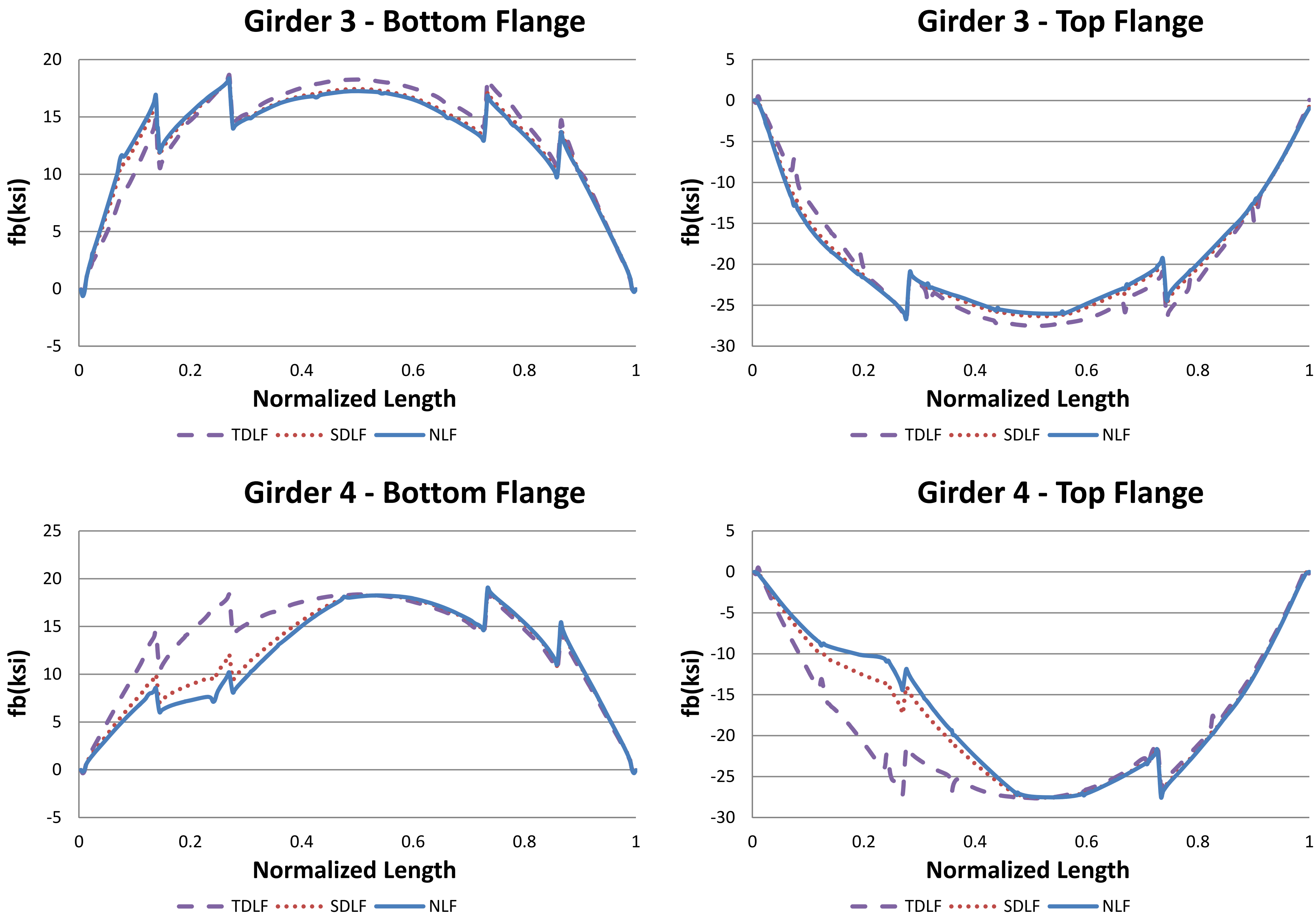


Figure I2-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

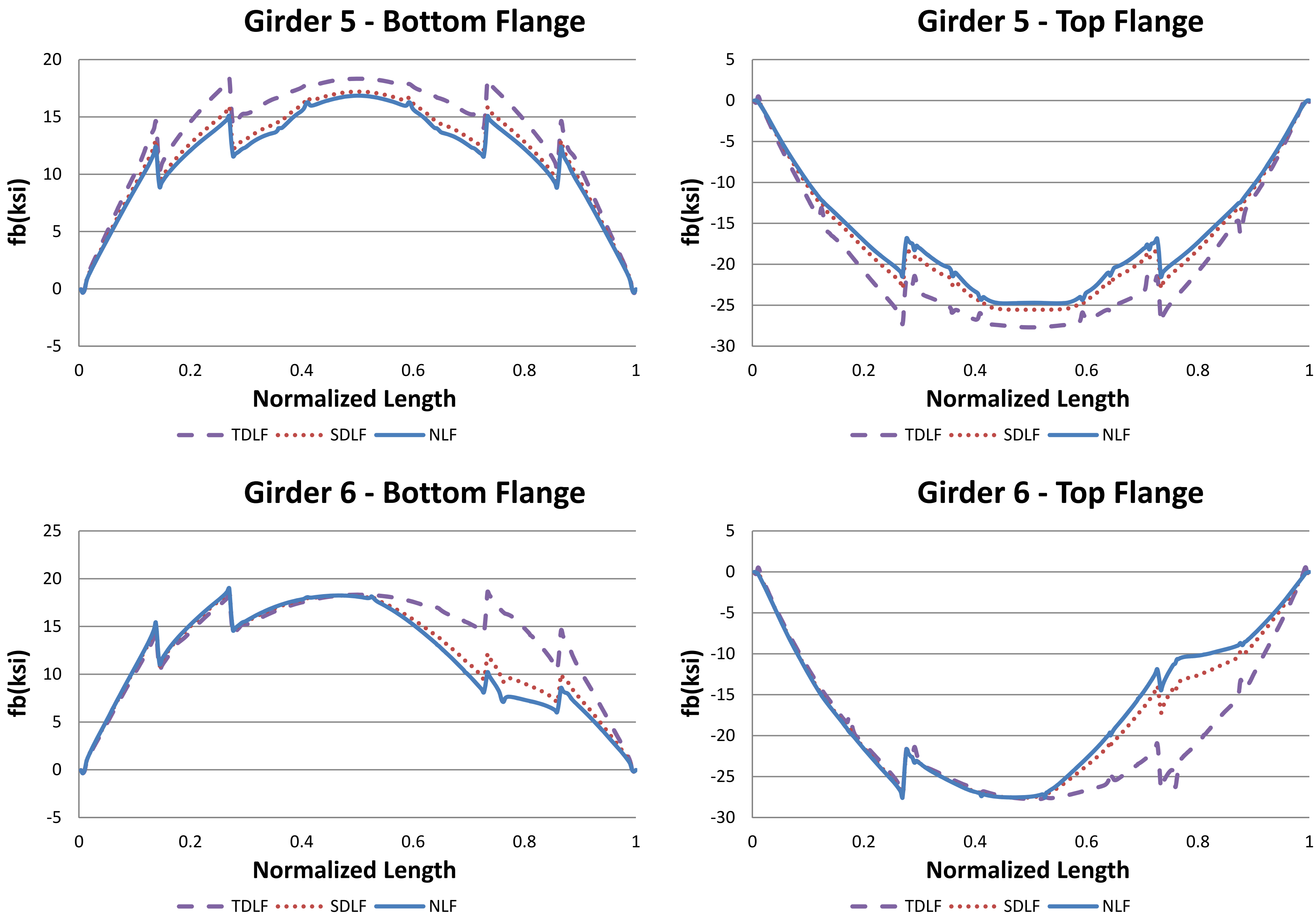


Figure I2-4-21 (continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

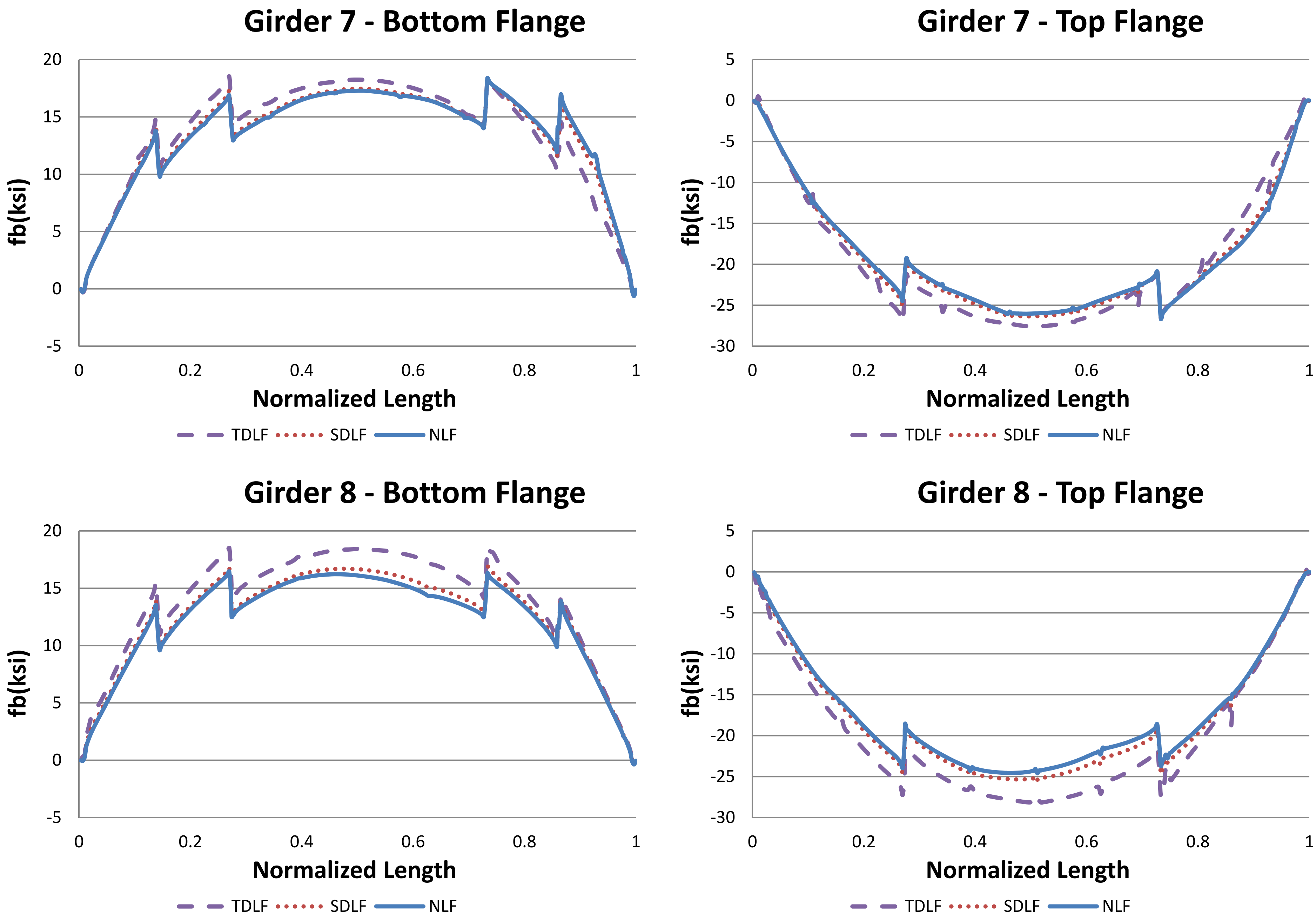
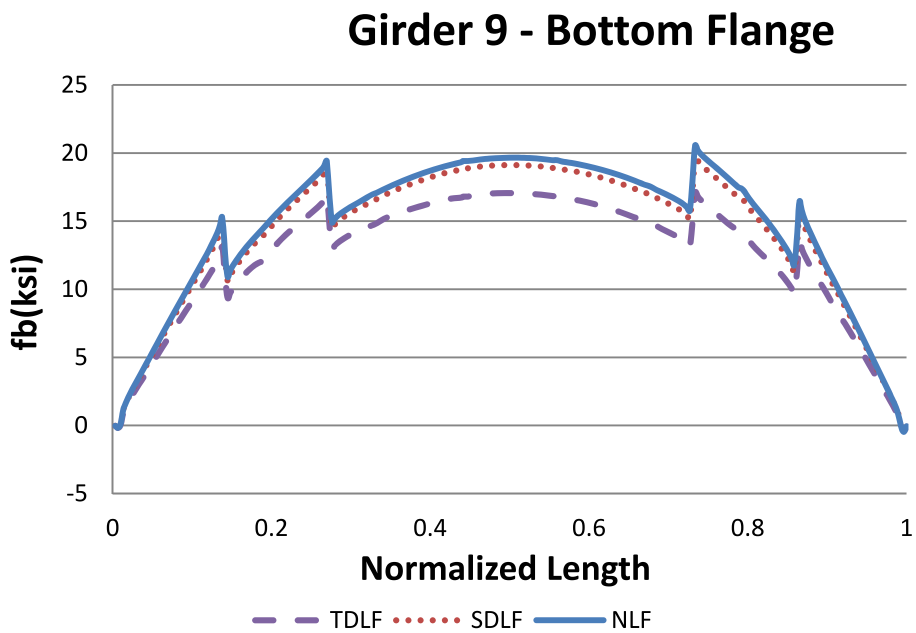


Figure I2-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



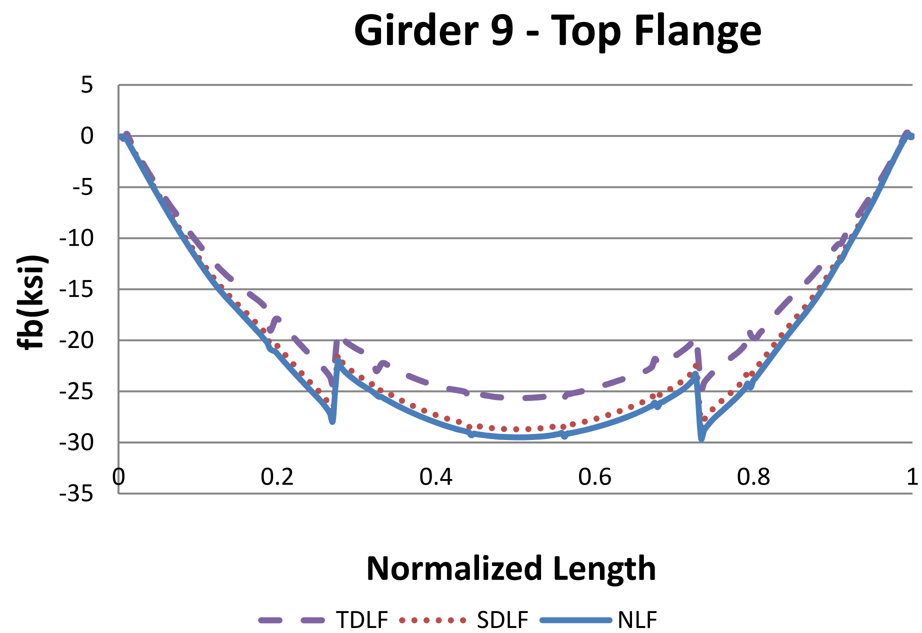


Figure I2-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

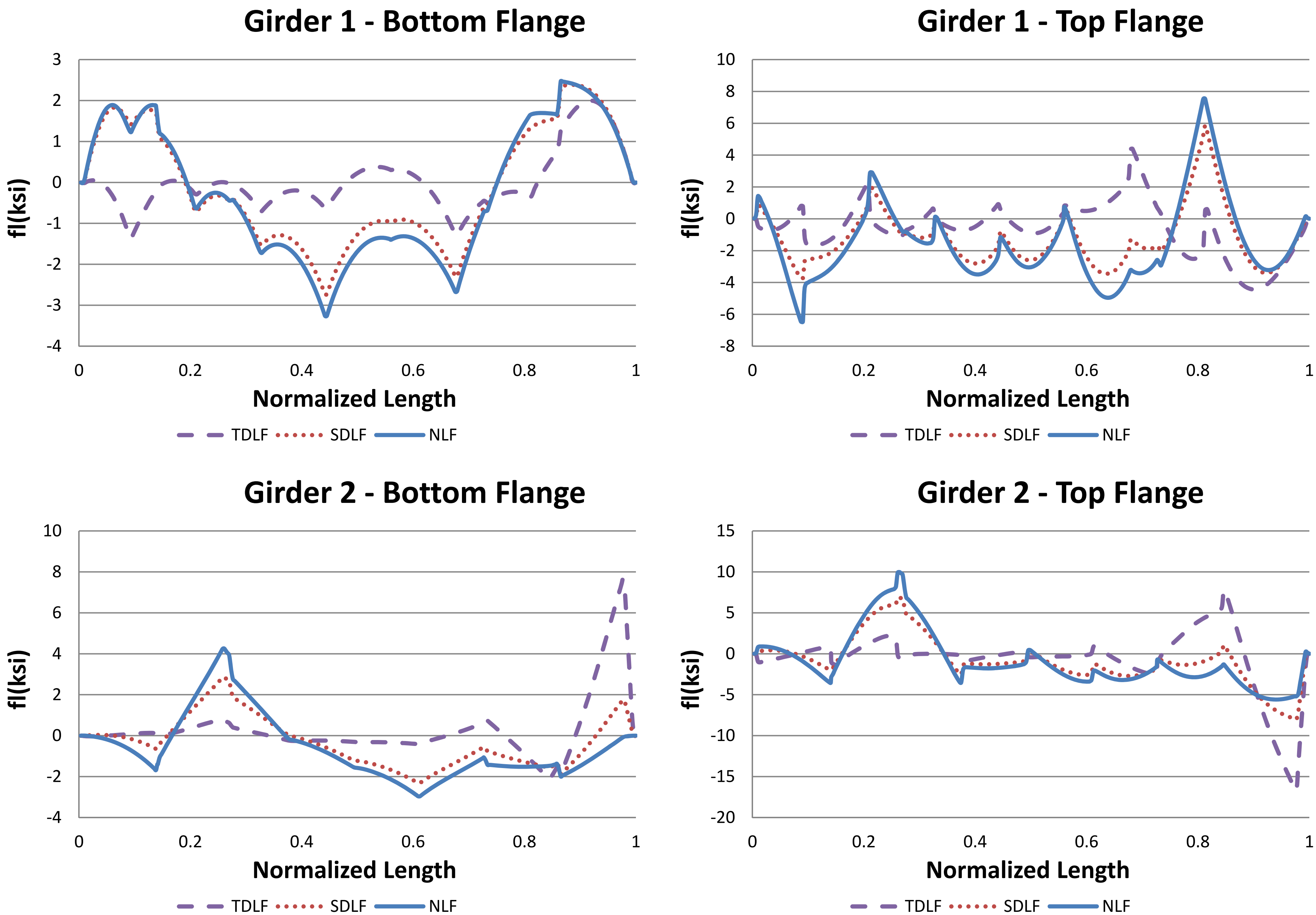


Figure I2-4-22. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

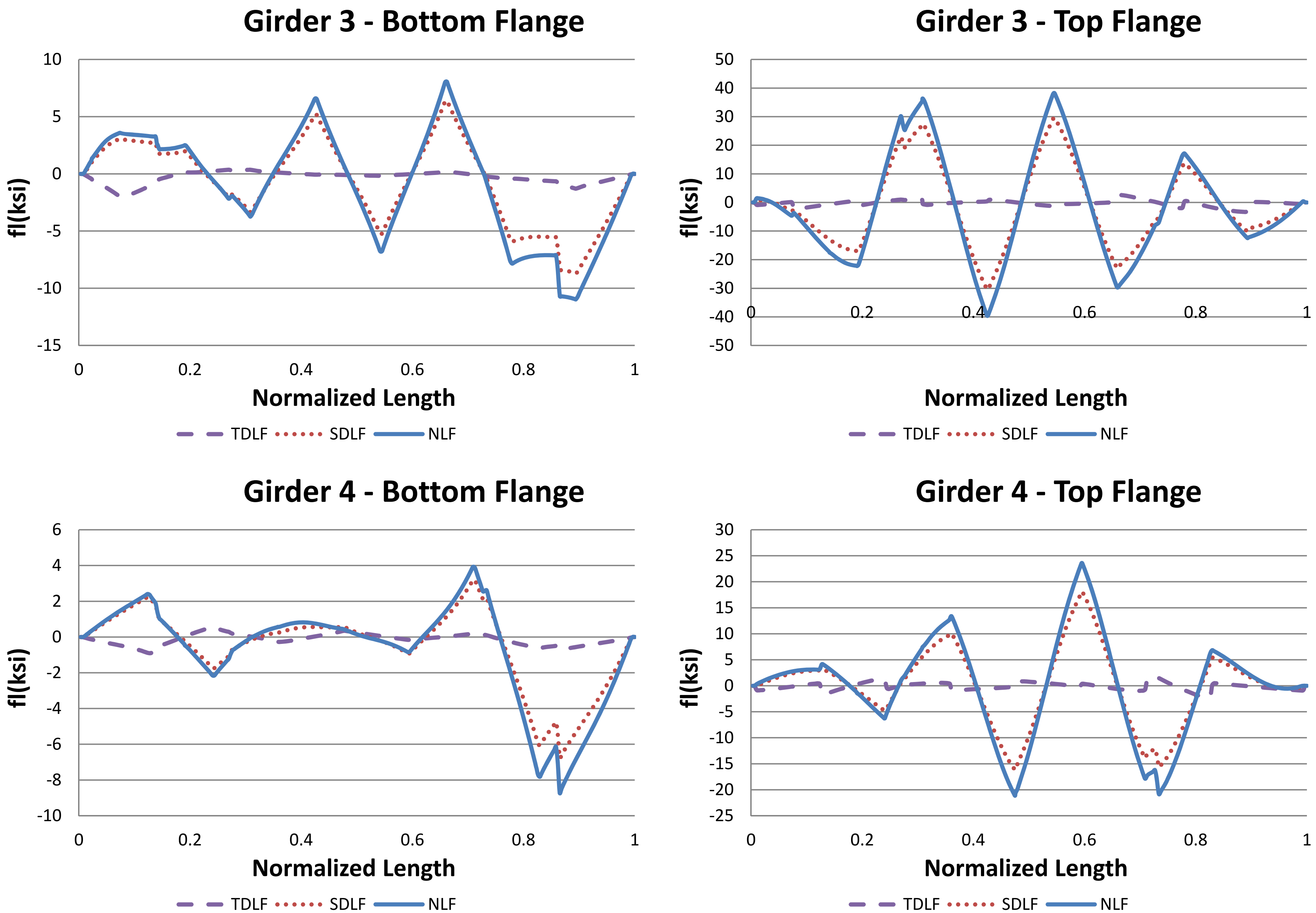


Figure I2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

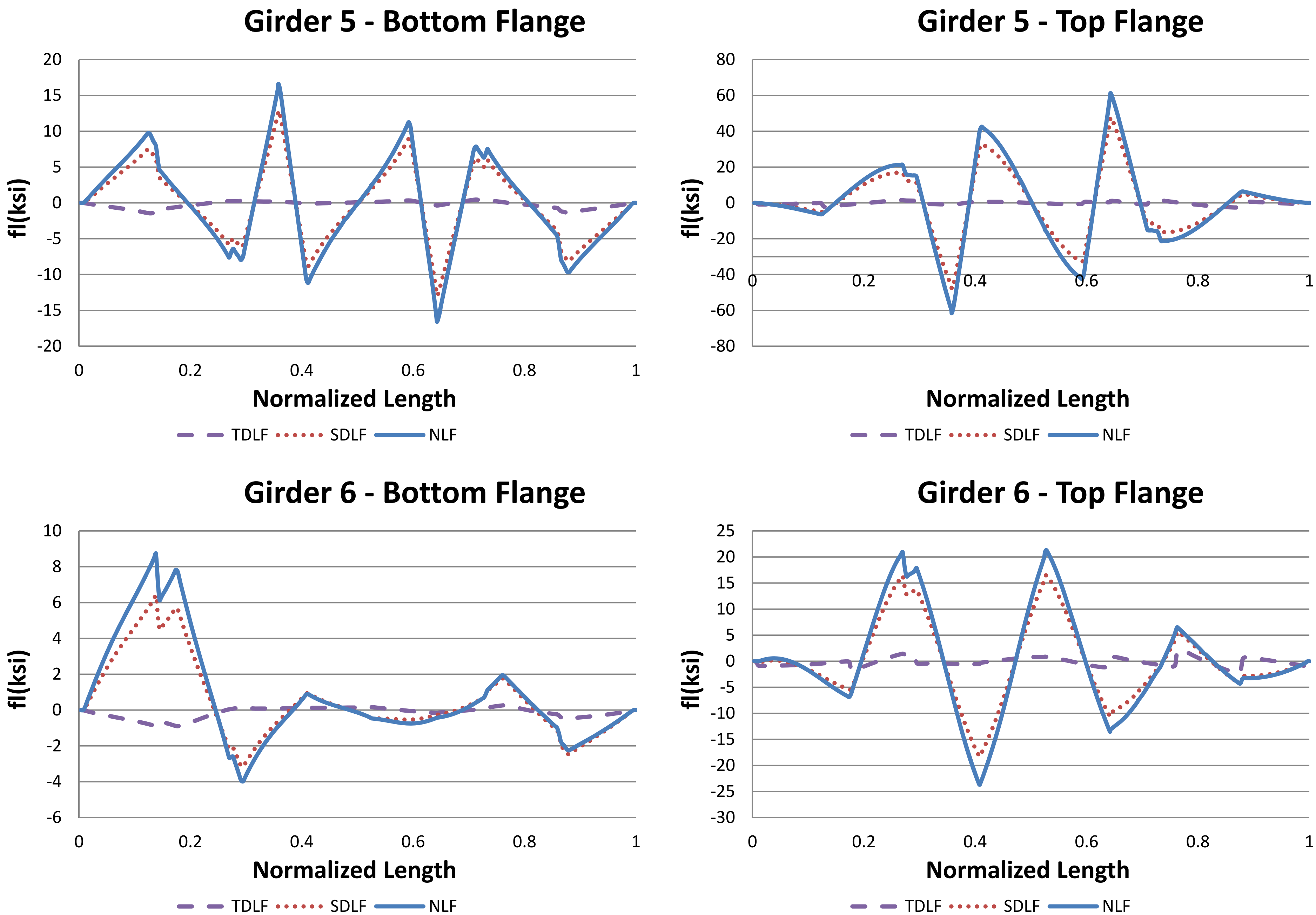


Figure I2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

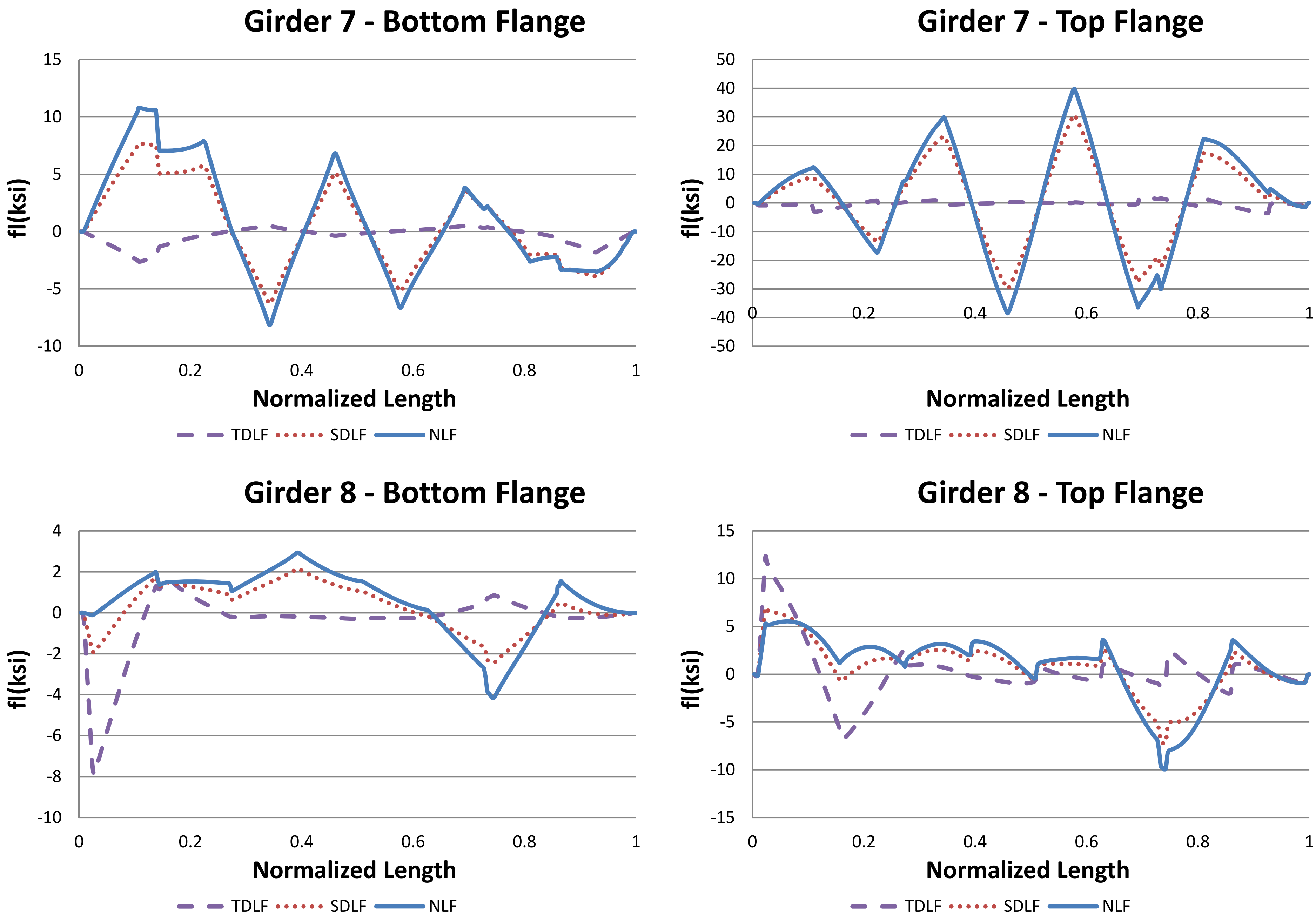
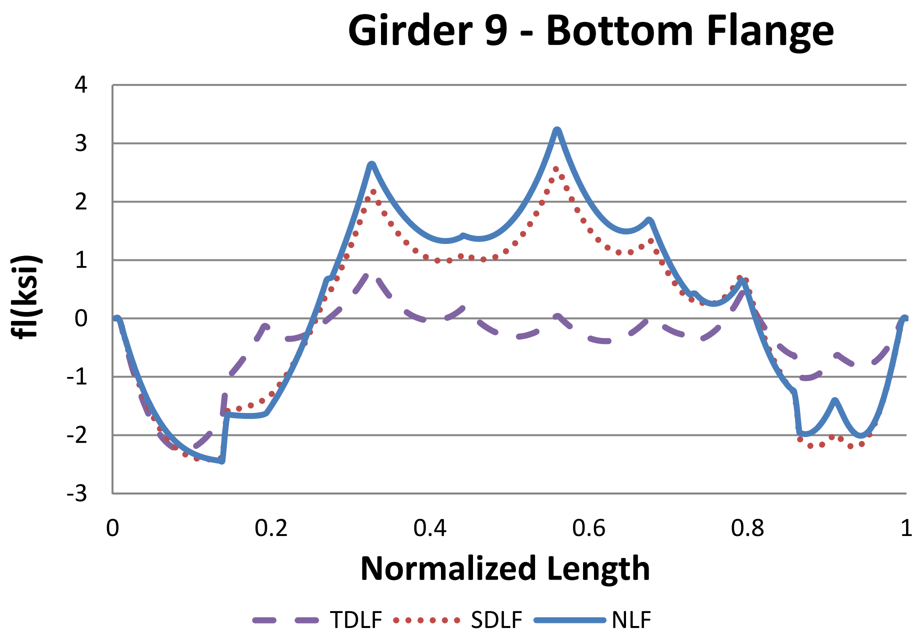


Figure I2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.



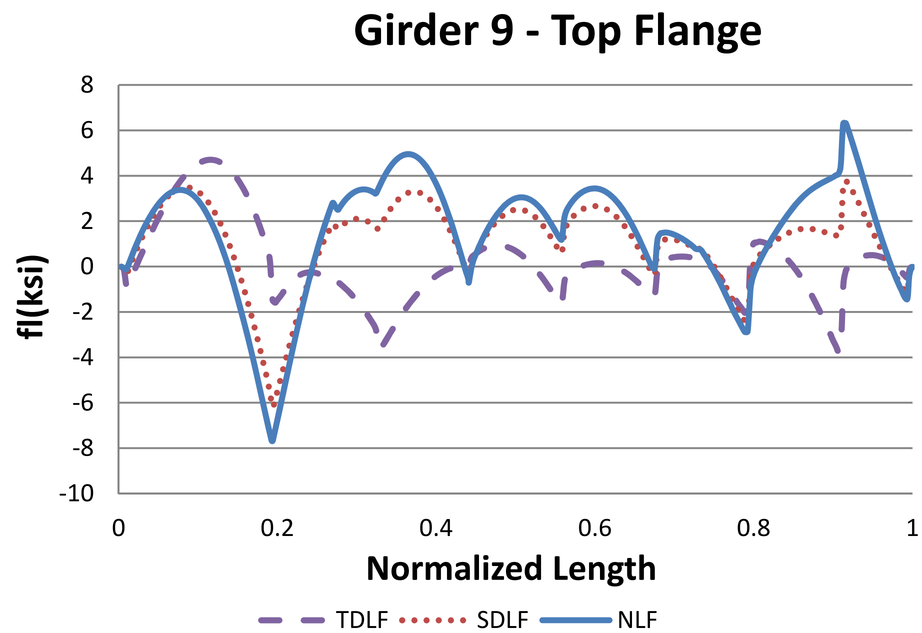


Figure I2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

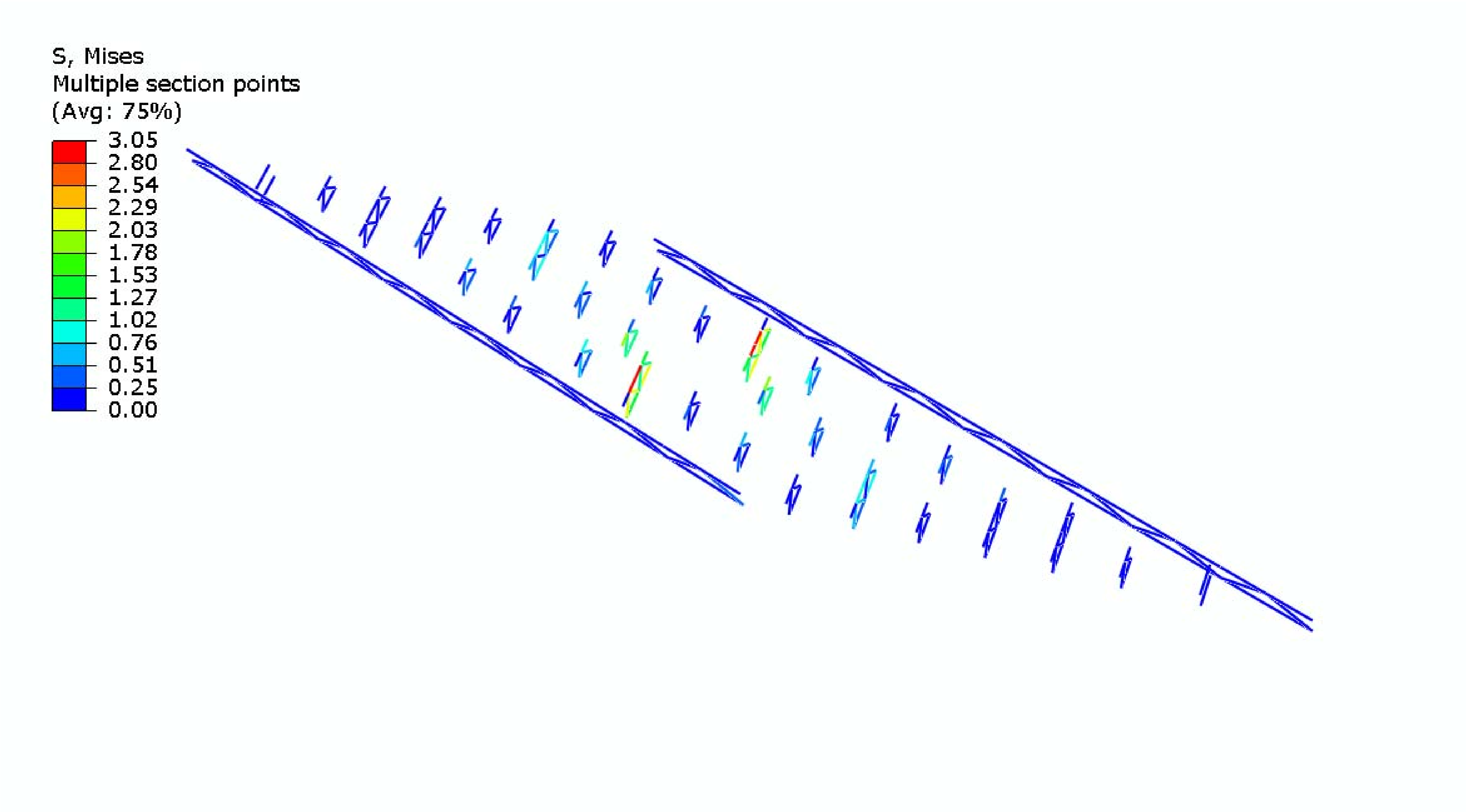


Figure I2-4-23. Cross-frame stress contours (ksi) under SDL, NLF detailing (all cross-frame member areas = 9.75 in^2).

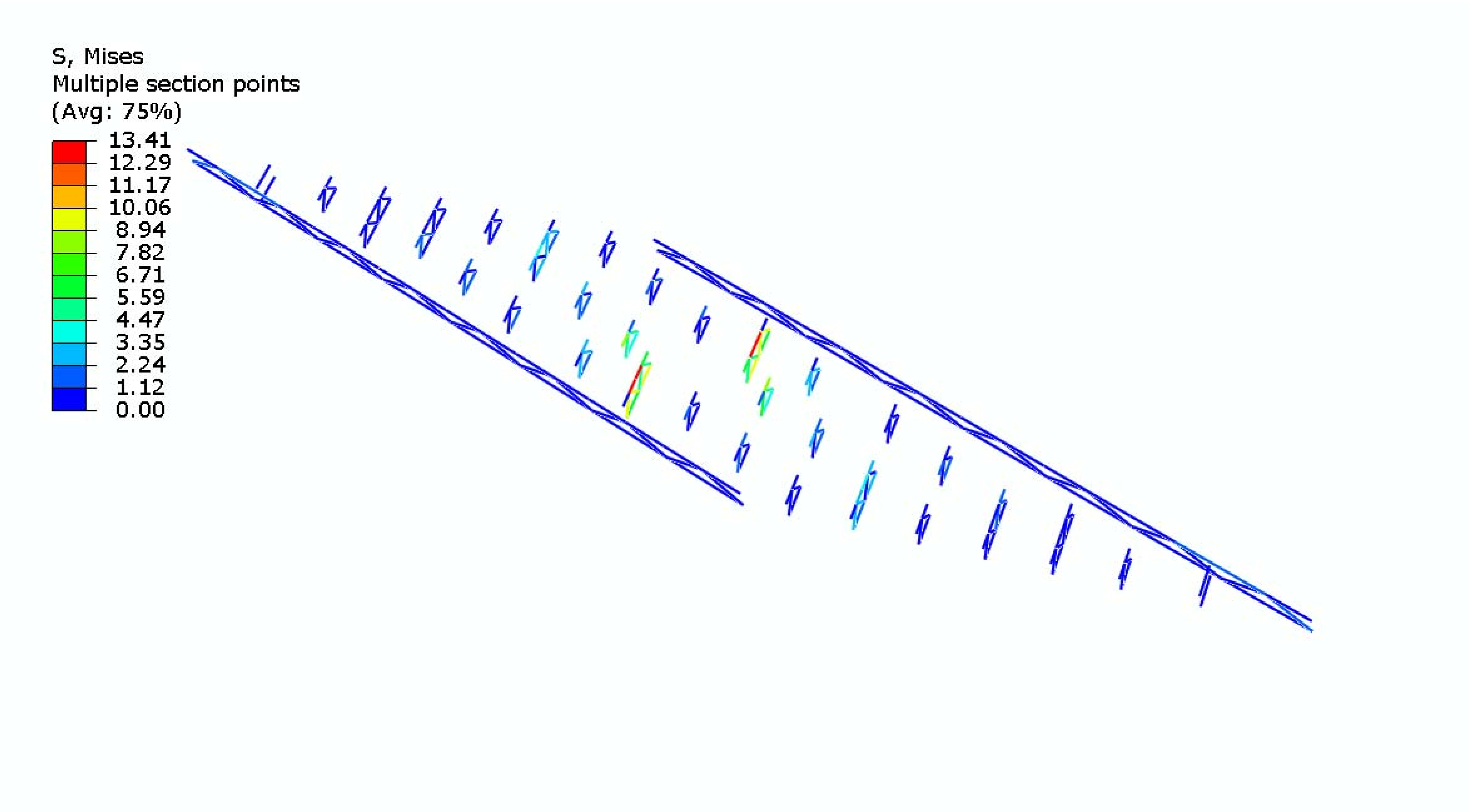


Figure I2-4-24. Cross-frame stress contours under TDL, NLF detailing (all cross-frame member areas = 9.75 in^2).

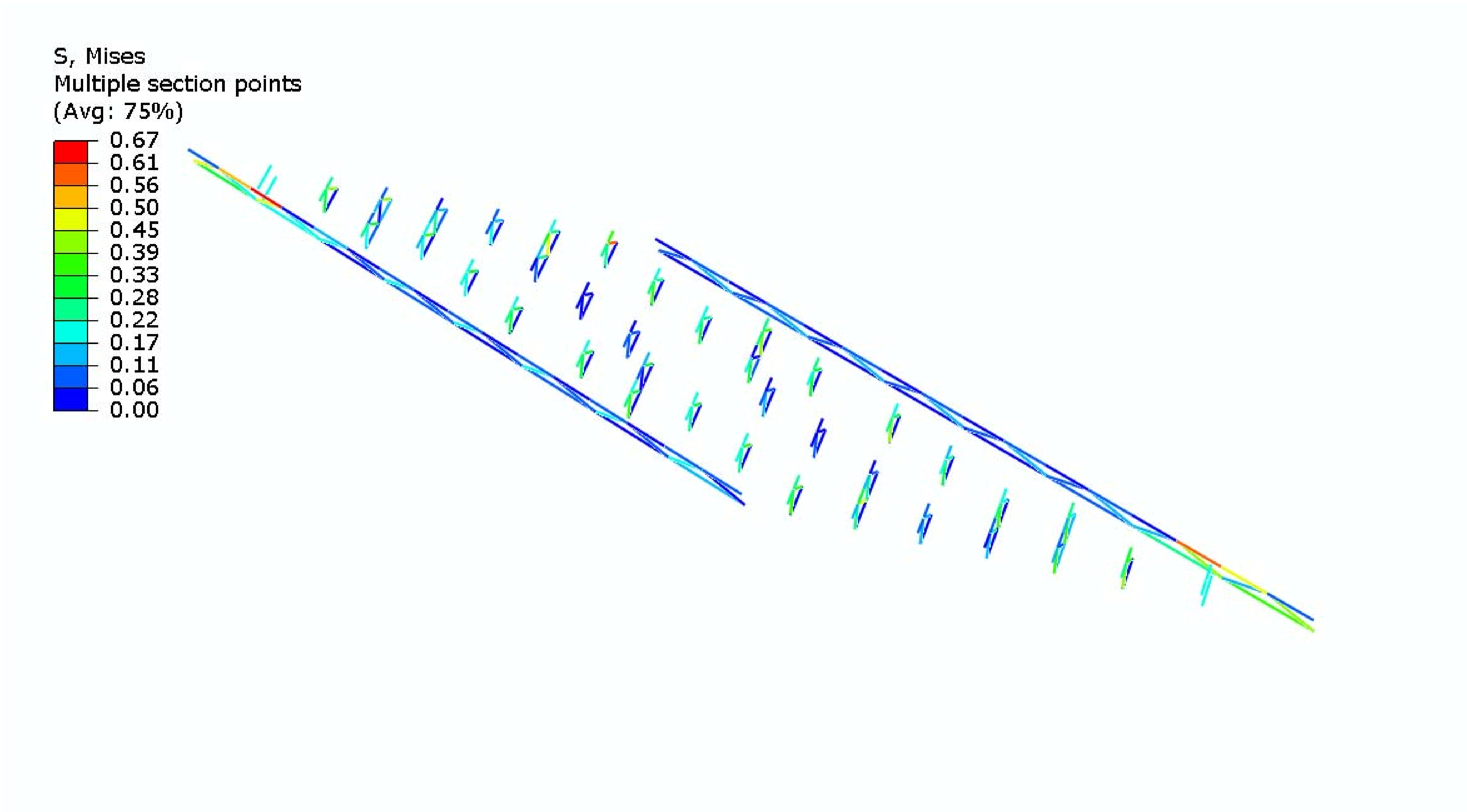


Figure I2-4-25. **Cross-frame stress contours under SDL, SDLF detailing (all cross-frame member areas = 9.75 in^2).**

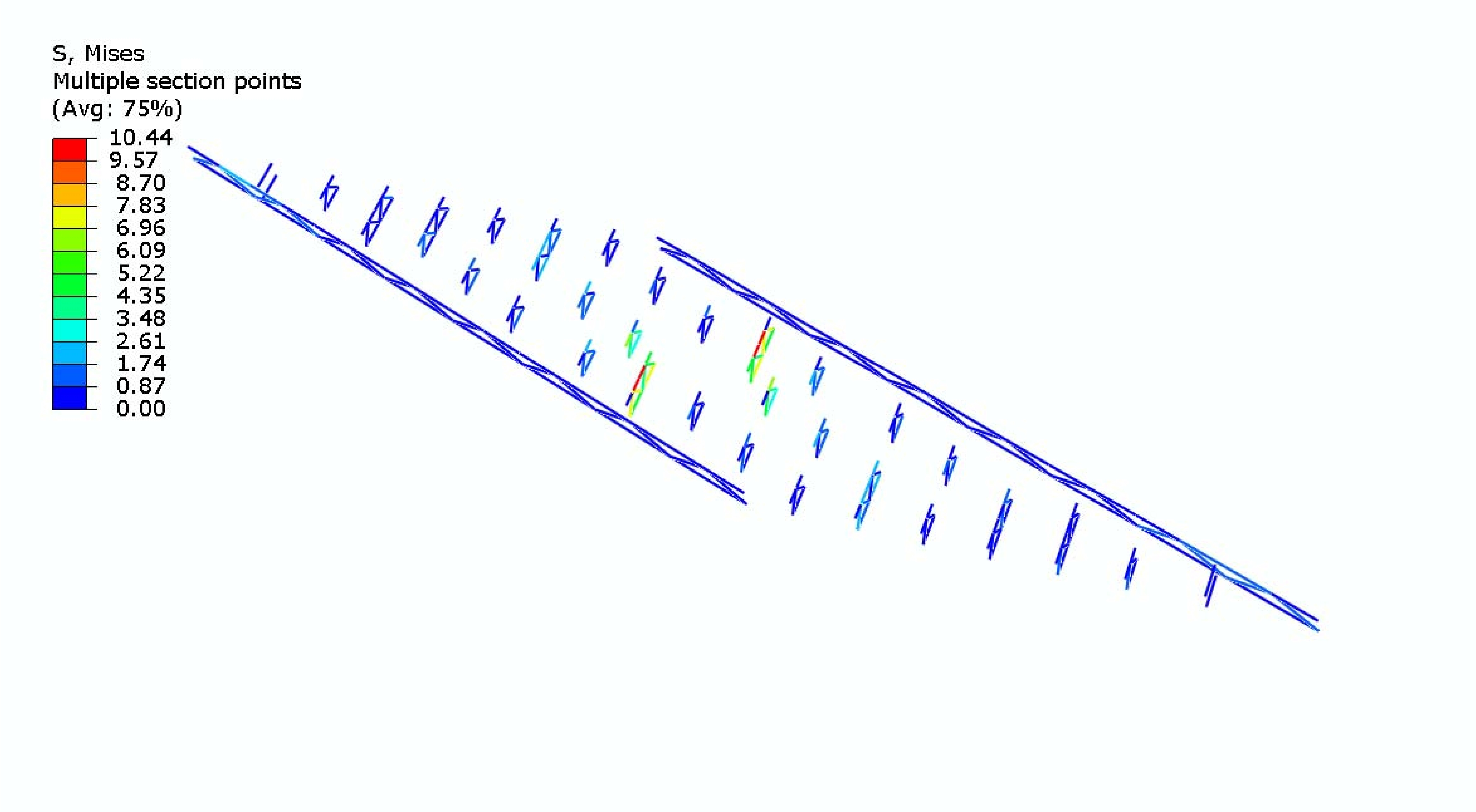


Figure I2-4-26. Cross-frame stress contours under TDL, SDLF detailing (all cross-frame member areas = 9.75 in^2).

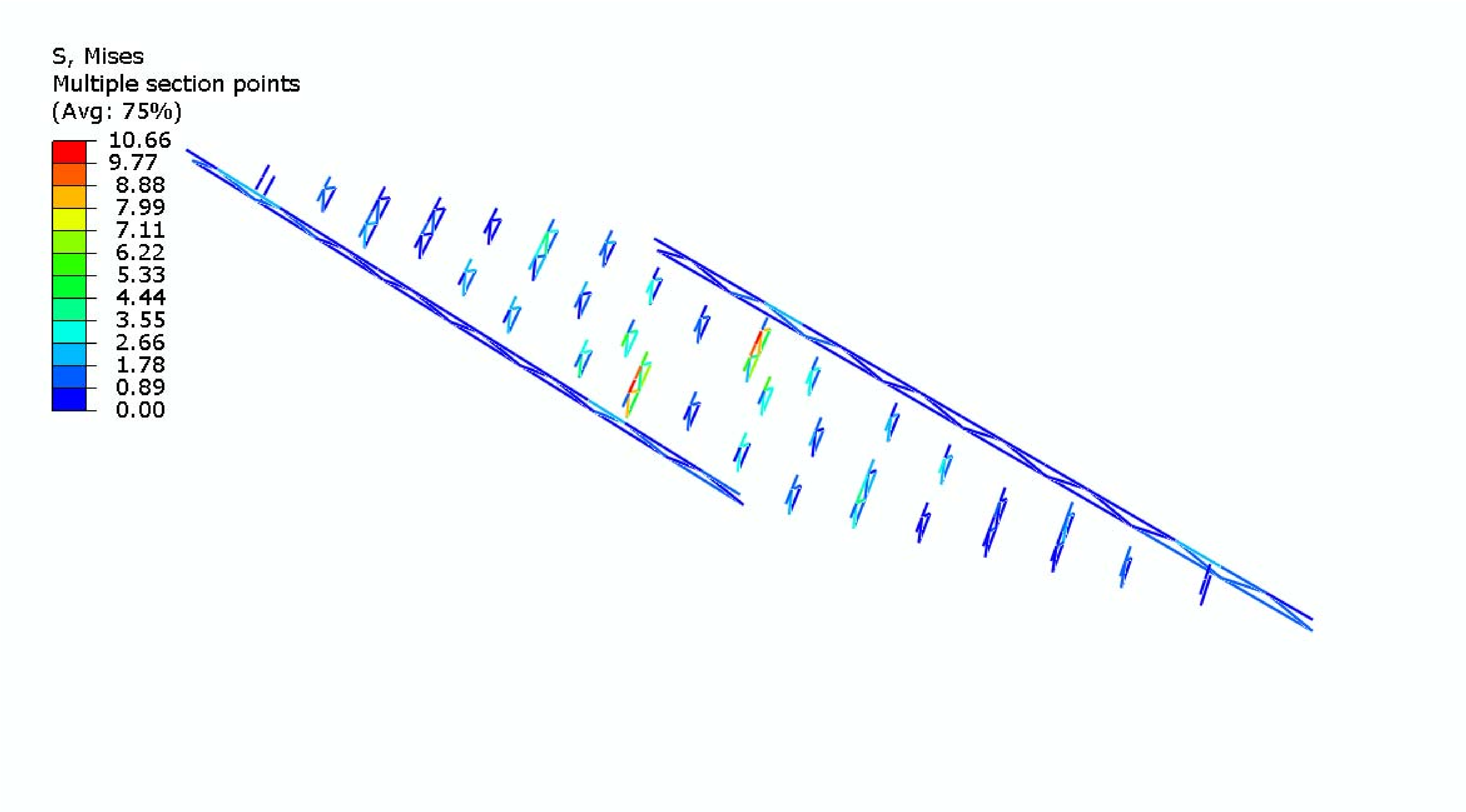


Figure I2-4-27. Cross-frame stress contours under SDL, TDLF detailing (all cross-frame member areas = 9.75 in^2).

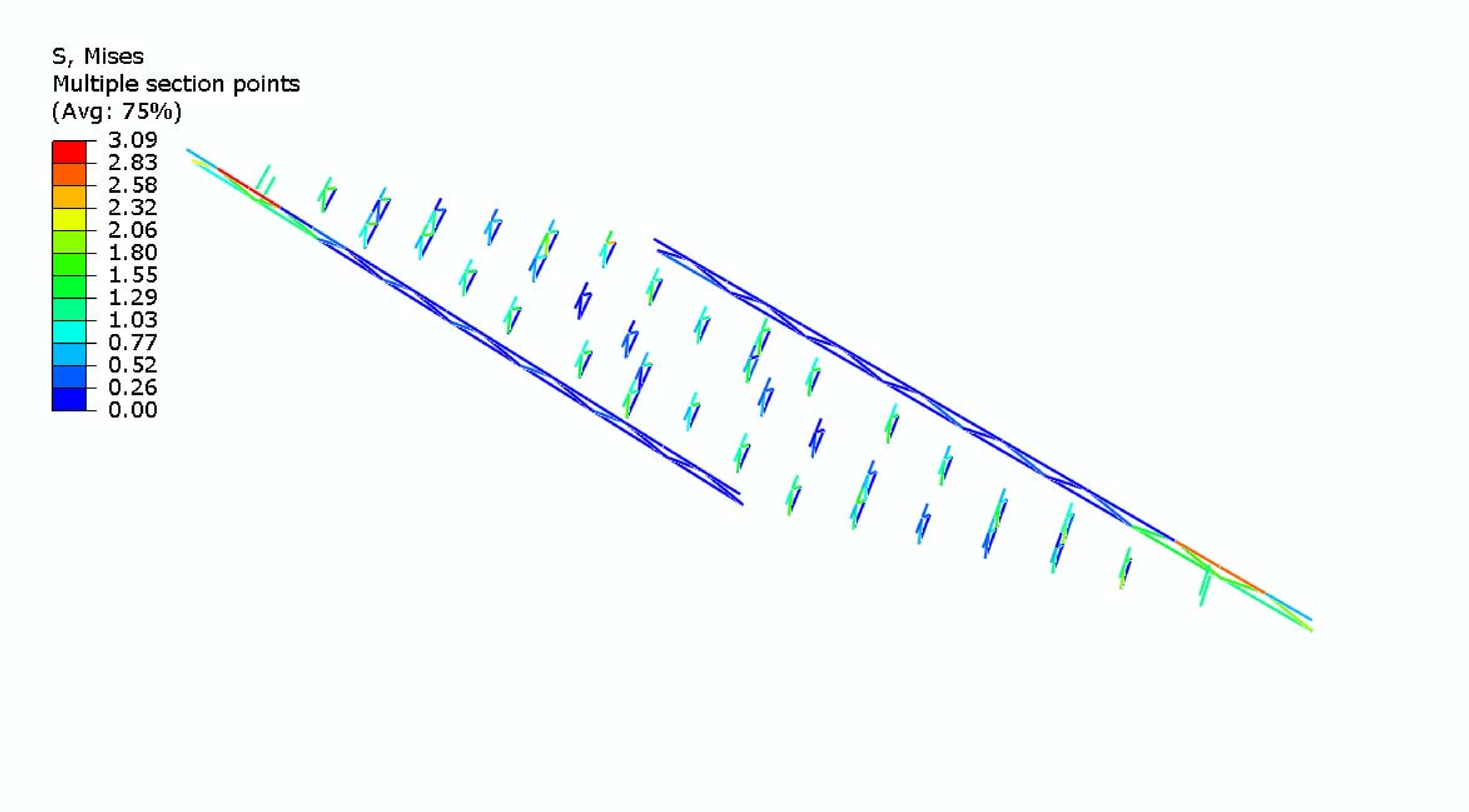


Figure I2-4-28. Cross-frame stress contours under TDL, TDLF (all cross-frame member areas = 9.75 in^2).

Table I2-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.5	2.1	1.8	1.5	1.6	1.3	2.0	1.6
	SDLF	2.0	1.7	1.8	1.7	1.7	1.8	4.4	4.7
	TDLF	4.6	16.1	7.6	6.6	4.4	3.5	12.9	13.8
2	NLF	0.5	4.6	22.2	6.6	1.9	3.4	2.0	NA
	SDLF	3.8	3.4	3.7	3.2	3.2	3.1	3.0	NA
	TDLF	17.9	27.4	86.4	34.9	20.3	21.9	23.3	NA
3	NLF	7.4	2.5	1.0	12.0	11.8	2.7	2.2	0.7
	SDLF	4.5	2.6	3.1	3.0	0.7	0.3	3.5	4.0
	TDLF	39.4	12.6	10.2	35.9	34.9	8.0	7.1	15.2
4	NLF	0.6	2.2	2.9	12.3	12.0	0.7	2.7	1.4
	SDLF	1.5	3.7	0.6	1.3	3.2	2.7	2.6	3.8
	TDLF	8.6	7.6	7.9	34.1	34.7	10.6	12.5	10.8
5	NLF	0.5	1.7	3.2	1.7	6.3	21.7	4.2	0.5
	SDLF	2.4	3.5	3.2	4.0	3.2	3.9	3.5	2.6
	TDLF	10.3	24.5	21.9	21.3	33.6	85.5	27.4	10.5
6	NLF	1.4	2.0	1.3	1.6	1.4	1.8	2.1	0.4
	SDLF	3.5	4.1	1.6	1.6	1.6	1.5	1.5	1.7
	TDLF	12.0	11.0	3.0	3.6	5.9	8.7	15.1	8.6
7	NLF	0.6	NA	NA	NA	NA	NA	NA	7.2
	SDLF	4.3	NA	NA	NA	NA	NA	NA	4.7
	TDLF	16.1	NA	NA	NA	NA	NA	NA	39.3
8	NLF	NA	NA	NA	NA	NA	NA	NA	0.3
	SDLF	NA	NA	NA	NA	NA	NA	NA	5.6
	TDLF	NA	NA	NA	NA	NA	NA	NA	24.3
9	NLF	1.5	NA	NA	NA	NA	NA	NA	2.4
	SDLF	4.2	NA	NA	NA	NA	NA	NA	1.6
	TDLF	12.4	NA	NA	NA	NA	NA	NA	2.2

Table I2-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.6	2.7	2.8	2.0	2.0	5.3	10.2	12.8
	SDLF	1.5	1.5	2.9	2.5	2.2	4.9	11.8	14.9
	TDLF	1.8	3.0	3.5	3.1	3.0	3.8	17.0	21.3
2	NLF	0.2	15.0	95.7	26.4	3.1	11.0	6.7	NA
	SDLF	3.7	8.8	70.4	16.7	1.5	6.2	3.8	NA
	TDLF	15.8	15.3	16.7	14.4	14.2	13.8	15.5	NA
3	NLF	26.9	6.9	5.7	54.2	52.2	11.6	13.9	5.3
	SDLF	17.7	5.6	7.4	45.2	41.0	8.9	14.6	8.2
	TDLF	17.2	9.5	12.7	12.3	3.9	1.1	15.7	16.5
4	NLF	4.8	13.6	12.5	54.5	54.2	3.9	7.9	9.2
	SDLF	2.7	14.5	9.7	43.4	45.5	5.6	6.4	11.6
	TDLF	5.5	16.4	2.6	5.1	13.3	11.8	9.2	12.7
5	NLF	3.2	6.0	9.6	1.8	24.3	93.9	13.1	2.2
	SDLF	3.6	2.4	4.9	3.1	15.2	68.5	7.4	2.7
	TDLF	10.3	17.8	14.0	16.6	14.2	16.0	15.2	11.2
6	NLF	9.5	9.7	5.3	2.1	2.2	3.3	2.5	3.3
	SDLF	11.4	11.3	4.5	2.3	2.5	3.1	1.8	1.2
	TDLF	11.0	16.0	2.9	2.7	2.6	2.2	2.1	6.7
7	NLF	5.5	NA	NA	NA	NA	NA	NA	25.7
	SDLF	8.8	NA	NA	NA	NA	NA	NA	16.6
	TDLF	18.1	NA	NA	NA	NA	NA	NA	18.1
8	NLF	NA	NA	NA	NA	NA	NA	NA	2.2
	SDLF	NA	NA	NA	NA	NA	NA	NA	7.0
	TDLF	NA	NA	NA	NA	NA	NA	NA	23.4
9	NLF	12.1	NA	NA	NA	NA	NA	NA	2.4
	SDLF	13.9	NA	NA	NA	NA	NA	NA	1.7
	TDLF	19.3	NA	NA	NA	NA	NA	NA	1.3

Table I2-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.6	0.8	0.2	0.7	0.6	0.3	0.2	1.3
	SDLF	1.2	0.1	0.8	0.5	0.6	0.4	1.7	2.8
	TDLF	9.9	7.3	1.4	3.0	0.6	0.4	6.7	6.9
2	NLF	0.3	2.2	13.8	3.9	2.3	3.7	0.6	0.2
	SDLF	0.1	0.2	0.3	0.1	0.1	0.0	0.9	1.9
	TDLF	0.4	6.8	47.5	13.9	8.7	12.9	1.7	7.4
3	NLF	4.8	7.9	2.2	21.3	10.3	4.7	1.6	0.3
	SDLF	0.2	0.4	0.4	0.5	0.0	0.1	0.3	0.4
	TDLF	14.0	23.6	5.4	66.9	33.8	15.6	3.6	1.1
4	NLF	0.1	1.6	4.7	10.3	21.4	2.0	7.9	0.9
	SDLF	0.1	0.2	0.2	0.3	0.7	0.0	0.1	1.4
	TDLF	0.0	3.8	15.4	32.6	66.5	6.3	24.5	0.4
5	NLF	0.2	0.6	3.6	2.2	3.8	13.9	2.1	0.3
	SDLF	0.5	1.2	0.3	0.3	0.2	0.5	0.3	0.6
	TDLF	1.9	0.4	11.4	6.4	12.0	44.0	5.8	2.2
6	NLF	0.9	0.3	0.4	0.6	0.6	0.2	0.7	0.1
	SDLF	1.4	2.4	0.6	0.4	0.5	0.1	0.8	0.1
	TDLF	0.4	9.8	1.2	0.4	2.9	1.2	3.7	0.2
7	NLF	0.2	NA	NA	NA	NA	NA	NA	4.8
	SDLF	0.4	NA	NA	NA	NA	NA	NA	0.1
	TDLF	1.2	NA	NA	NA	NA	NA	NA	15.4
8	NLF	0.1	NA	NA	NA	NA	NA	NA	0.2
	SDLF	1.9	NA	NA	NA	NA	NA	NA	0.2
	TDLF	7.6	NA	NA	NA	NA	NA	NA	0.1
9	NLF	1.2	NA	NA	NA	NA	NA	NA	0.6
	SDLF	3.4	NA	NA	NA	NA	NA	NA	0.4
	TDLF	10.6	NA	NA	NA	NA	NA	NA	5.6

Table I2-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.4	3.0	1.8	0.7	0.5	0.4	5.0	3.4
	SDLF	0.2	2.0	1.6	0.8	0.8	0.3	6.4	0.4
	TDLF	1.4	2.1	1.3	0.1	0.9	0.3	10.5	8.2
2	NLF	3.3	6.1	62.5	18.9	11.0	17.1	7.6	0.4
	SDLF	2.2	5.5	49.2	14.9	8.6	13.1	7.0	2.9
	TDLF	2.3	0.0	1.8	0.9	1.0	0.6	1.2	10.9
3	NLF	13.3	25.6	4.7	88.6	37.8	13.0	2.9	2.0
	SDLF	9.4	19.6	3.9	69.3	29.6	10.5	2.0	1.5
	TDLF	1.1	0.8	1.0	2.2	0.0	0.2	0.0	0.3
4	NLF	1.2	2.7	13.2	37.9	89.2	3.9	25.7	4.8
	SDLF	1.2	1.7	10.8	30.0	70.1	3.0	19.4	5.1
	TDLF	1.3	0.4	0.5	1.5	3.2	0.4	0.2	2.3
5	NLF	4.5	7.5	16.4	10.5	18.1	62.6	5.8	4.4
	SDLF	3.8	7.3	12.9	8.6	14.6	50.3	5.5	3.5
	TDLF	0.4	2.7	0.8	1.3	0.6	2.3	1.0	0.1
6	NLF	4.7	4.7	0.0	0.5	0.6	2.1	2.5	1.2
	SDLF	5.0	6.9	0.3	0.5	0.7	2.5	2.4	1.1
	TDLF	2.2	13.6	1.0	0.1	0.3	1.4	0.9	1.2
7	NLF	2.0	NA	NA	NA	NA	NA	NA	13.4
	SDLF	1.5	NA	NA	NA	NA	NA	NA	9.2
	TDLF	0.3	NA	NA	NA	NA	NA	NA	2.4
8	NLF	0.4	NA	NA	NA	NA	NA	NA	3.0
	SDLF	2.9	NA	NA	NA	NA	NA	NA	2.0
	TDLF	11.3	NA	NA	NA	NA	NA	NA	2.2
9	NLF	3.6	NA	NA	NA	NA	NA	NA	0.3
	SDLF	0.0	NA	NA	NA	NA	NA	NA	0.6
	TDLF	11.7	NA	NA	NA	NA	NA	NA	3.0

Table I2-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.4	0.8	1.6	0.5	1.0	1.0	1.7	0.7
	SDLF	0.8	0.9	1.0	0.9	1.0	1.3	6.5	5.3
	TDLF	10.3	19.8	7.5	6.5	3.1	2.3	22.4	19.0
2	NLF	1.1	5.7	29.1	7.9	3.2	5.1	1.2	0.5
	SDLF	2.6	2.0	2.6	2.3	2.2	1.8	2.5	2.0
	TDLF	13.1	28.7	102.0	34.0	20.1	25.6	14.0	6.7
3	NLF	8.7	9.3	2.6	29.7	18.6	6.9	2.7	0.3
	SDLF	3.0	1.5	1.9	1.4	0.6	0.0	2.1	2.5
	TDLF	39.2	33.6	15.6	93.9	57.7	23.9	9.0	9.9
4	NLF	0.4	2.7	6.7	18.6	29.7	2.7	9.4	1.3
	SDLF	1.0	2.2	0.3	0.8	1.7	1.9	1.5	1.4
	TDLF	5.7	9.2	24.4	58.0	94.4	14.9	33.4	6.1
5	NLF	0.1	1.1	4.9	3.0	7.7	28.9	5.6	0.1
	SDLF	1.1	2.3	2.1	2.5	2.2	2.5	2.2	1.2
	TDLF	5.1	16.4	26.4	21.7	33.7	103.9	29.1	5.4
6	NLF	1.3	1.7	1.1	1.0	0.4	1.5	0.9	0.3
	SDLF	1.1	5.7	0.8	0.8	0.7	0.6	0.7	1.1
	TDLF	8.6	18.7	2.4	2.3	6.1	8.4	18.4	5.9
7	NLF	0.2	NA	NA	NA	NA	NA	NA	8.6
	SDLF	2.7	NA	NA	NA	NA	NA	NA	3.0
	TDLF	10.6	NA	NA	NA	NA	NA	NA	38.6
8	NLF	0.5	NA	NA	NA	NA	NA	NA	1.2
	SDLF	1.9	NA	NA	NA	NA	NA	NA	3.3
	TDLF	6.1	NA	NA	NA	NA	NA	NA	12.3
9	NLF	0.6	NA	NA	NA	NA	NA	NA	2.3
	SDLF	4.7	NA	NA	NA	NA	NA	NA	0.7
	TDLF	16.9	NA	NA	NA	NA	NA	NA	7.2

Table I2-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	5.5	1.8	3.1	1.0	2.4	6.8	11.9	14.0
	SDLF	3.2	0.4	2.9	1.5	2.4	6.2	16.1	17.7
	TDLF	1.7	1.7	2.2	2.1	2.2	4.0	30.1	28.6
2	NLF	1.6	19.7	125.3	32.0	10.1	19.5	4.3	6.8
	SDLF	3.1	13.2	94.9	22.6	7.5	13.2	3.4	8.2
	TDLF	10.2	9.5	11.2	9.8	9.7	8.5	9.8	12.1
3	NLF	30.6	33.2	11.6	130.7	80.2	27.3	14.1	3.3
	SDLF	19.9	23.3	10.7	101.8	62.6	20.9	12.4	5.0
	TDLF	13.4	6.1	7.9	5.3	3.4	0.6	10.7	10.3
4	NLF	3.5	14.4	26.3	80.2	130.4	11.8	33.4	6.4
	SDLF	2.4	12.7	20.0	62.5	101.5	11.1	23.4	7.0
	TDLF	4.2	11.2	1.6	3.1	6.5	8.0	5.8	5.2
5	NLF	4.6	4.0	18.8	9.0	31.1	124.7	19.3	3.9
	SDLF	4.4	2.5	12.5	7.7	21.9	94.0	12.8	3.7
	TDLF	7.0	10.0	9.5	10.7	9.4	10.6	9.8	7.7
6	NLF	6.5	11.2	6.7	2.6	1.3	3.1	1.3	2.5
	SDLF	6.3	15.0	5.5	2.4	1.7	2.5	0.5	1.4
	TDLF	6.1	27.4	2.4	1.8	1.3	1.1	1.1	5.1
7	NLF	3.5	NA	NA	NA	NA	NA	NA	29.8
	SDLF	5.4	NA	NA	NA	NA	NA	NA	19.2
	TDLF	11.3	NA	NA	NA	NA	NA	NA	13.5
8	NLF	6.8	NA	NA	NA	NA	NA	NA	3.1
	SDLF	8.1	NA	NA	NA	NA	NA	NA	4.9
	TDLF	11.9	NA	NA	NA	NA	NA	NA	12.6
9	NLF	13.2	NA	NA	NA	NA	NA	NA	4.7
	SDLF	16.4	NA	NA	NA	NA	NA	NA	3.3
	TDLF	25.8	NA	NA	NA	NA	NA	NA	1.9

Table I2-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.14	-0.14	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.59	-0.71	-0.56	-0.66	-0.71	-0.59	-0.66	-0.98
	SDLF	-0.85	-0.65	-0.83	-0.73	-0.72	-0.60	-0.81	-0.86
	TDLF	-1.74	-0.54	-1.81	-0.98	-0.80	-0.77	-1.33	-0.38
3	NLF	-0.23	-0.20	-0.33	-0.47	-0.17	-0.11	-0.40	-0.85
	SDLF	-0.62	-0.03	-0.59	-0.46	-0.15	0.00	-0.56	-0.57
	TDLF	-1.97	0.40	-1.42	-0.46	-0.09	0.24	-1.08	0.50
4	NLF	0.10	0.40	0.11	0.17	0.47	0.33	0.20	-0.65
	SDLF	-0.34	0.57	0.01	0.15	0.46	0.59	0.04	-0.28
	TDLF	-1.91	1.12	-0.23	0.09	0.46	1.44	-0.37	1.16
5	NLF	0.40	0.66	0.59	0.71	0.66	0.56	0.71	-0.40
	SDLF	-0.03	0.82	0.60	0.72	0.73	0.83	0.65	0.04
	TDLF	-1.60	1.37	0.76	0.81	0.97	1.81	0.55	1.65
6	NLF	0.65	0.00	0.00	0.00	0.00	0.00	0.00	-0.10
	SDLF	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.35
	TDLF	-1.11	0.00	0.00	0.00	0.00	0.13	-0.13	1.95
7	NLF	0.85	NA	NA	NA	NA	NA	NA	0.23
	SDLF	0.58	NA	NA	NA	NA	NA	NA	0.62
	TDLF	-0.46	NA	NA	NA	NA	NA	NA	2.00
8	NLF	0.98	NA	NA	NA	NA	NA	NA	0.59
	SDLF	0.86	NA	NA	NA	NA	NA	NA	0.85
	TDLF	0.41	NA	NA	NA	NA	NA	NA	1.75
9	NLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	SDLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	TDLF	0.00	NA	NA	NA	NA	NA	NA	0.00

Table I2-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-2.73	-3.36	-2.57	-3.06	-3.27	-2.69	-2.88	-4.36
	SDLF	-2.96	-3.24	-2.82	-3.11	-3.25	-2.68	-3.01	-4.20
	TDLF	-3.76	-3.01	-3.68	-3.24	-3.23	-2.72	-3.48	-3.62
3	NLF	-1.17	-1.07	-1.52	-2.17	-0.78	-0.52	-1.65	-3.75
	SDLF	-1.54	-0.88	-1.77	-2.15	-0.75	-0.39	-1.81	-3.44
	TDLF	-2.81	-0.36	-2.56	-2.03	-0.70	-0.08	-2.32	-2.29
4	NLF	0.30	1.65	0.51	0.78	2.17	1.51	1.08	-2.85
	SDLF	-0.13	1.82	0.39	0.75	2.15	1.77	0.89	-2.45
	TDLF	-1.66	2.37	0.08	0.70	2.04	2.59	0.40	-0.96
5	NLF	1.66	2.87	2.69	3.27	3.06	2.57	3.36	-1.67
	SDLF	1.23	3.02	2.67	3.25	3.10	2.82	3.25	-1.22
	TDLF	-0.34	3.53	2.71	3.24	3.23	3.69	3.02	0.40
6	NLF	2.84	0.00	0.00	0.00	0.00	0.00	0.00	-0.30
	SDLF	2.45	0.00	0.00	0.00	0.00	0.00	0.00	0.14
	TDLF	1.02	0.00	0.00	0.00	0.00	0.00	0.00	1.70
7	NLF	3.75	NA	NA	NA	NA	NA	NA	1.17
	SDLF	3.45	NA	NA	NA	NA	NA	NA	1.54
	TDLF	2.34	NA	NA	NA	NA	NA	NA	2.84
8	NLF	4.36	NA	NA	NA	NA	NA	NA	2.73
	SDLF	4.21	NA	NA	NA	NA	NA	NA	2.97
	TDLF	3.67	NA	NA	NA	NA	NA	NA	3.77
9	NLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	SDLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	TDLF	0.00	NA	NA	NA	NA	NA	NA	0.00

Table I2-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.08	-0.08	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.33	-0.40	-0.31	-0.37	-0.39	-0.33	-0.37	-0.55
	SDLF	-0.48	-0.36	-0.46	-0.41	-0.40	-0.34	-0.45	-0.48
	TDLF	-0.97	-0.30	-1.01	-0.55	-0.45	-0.43	-0.74	-0.21
3	NLF	-0.13	-0.11	-0.19	-0.26	-0.10	-0.06	-0.22	-0.47
	SDLF	-0.35	-0.02	-0.33	-0.26	-0.08	0.00	-0.31	-0.32
	TDLF	-1.10	0.22	-0.79	-0.26	-0.05	0.13	-0.60	0.28
4	NLF	0.05	0.22	0.06	0.10	0.26	0.19	0.11	-0.37
	SDLF	-0.19	0.32	0.00	0.09	0.26	0.33	0.02	-0.15
	TDLF	-1.07	0.63	-0.13	0.05	0.26	0.80	-0.21	0.65
5	NLF	0.22	0.37	0.33	0.39	0.37	0.31	0.40	-0.22
	SDLF	-0.02	0.46	0.34	0.40	0.41	0.46	0.36	0.02
	TDLF	-0.90	0.77	0.43	0.45	0.54	1.01	0.31	0.92
6	NLF	0.36	0.00	0.00	0.00	0.00	0.00	0.00	-0.05
	SDLF	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.20
	TDLF	-0.62	0.00	0.00	0.00	0.00	0.07	-0.07	1.09
7	NLF	0.47	NA	NA	NA	NA	NA	NA	0.13
	SDLF	0.32	NA	NA	NA	NA	NA	NA	0.35
	TDLF	-0.26	NA	NA	NA	NA	NA	NA	1.11
8	NLF	0.55	NA	NA	NA	NA	NA	NA	0.33
	SDLF	0.48	NA	NA	NA	NA	NA	NA	0.48
	TDLF	0.23	NA	NA	NA	NA	NA	NA	0.98
9	NLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	SDLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	TDLF	0.00	NA	NA	NA	NA	NA	NA	0.00

Table I2-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-1.52	-1.88	-1.44	-1.71	-1.83	-1.51	-1.61	-2.44
	SDLF	-1.66	-1.81	-1.58	-1.74	-1.82	-1.50	-1.68	-2.35
	TDLF	-2.10	-1.68	-2.05	-1.81	-1.81	-1.52	-1.95	-2.02
3	NLF	-0.65	-0.60	-0.85	-1.21	-0.44	-0.29	-0.92	-2.10
	SDLF	-0.86	-0.49	-0.99	-1.20	-0.42	-0.22	-1.01	-1.92
	TDLF	-1.57	-0.20	-1.43	-1.14	-0.39	-0.04	-1.30	-1.28
4	NLF	0.17	0.92	0.29	0.44	1.21	0.85	0.60	-1.59
	SDLF	-0.07	1.02	0.22	0.42	1.20	0.99	0.50	-1.37
	TDLF	-0.92	1.33	0.05	0.39	1.14	1.44	0.22	-0.54
5	NLF	0.93	1.61	1.50	1.83	1.71	1.43	1.88	-0.93
	SDLF	0.69	1.68	1.49	1.82	1.73	1.58	1.81	-0.68
	TDLF	-0.19	1.97	1.51	1.81	1.81	2.06	1.69	0.22
6	NLF	1.59	0.00	0.00	0.00	0.00	0.00	0.00	-0.17
	SDLF	1.37	0.00	0.00	0.00	0.00	0.00	0.00	0.08
	TDLF	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.95
7	NLF	2.09	NA	NA	NA	NA	NA	NA	0.65
	SDLF	1.93	NA	NA	NA	NA	NA	NA	0.86
	TDLF	1.30	NA	NA	NA	NA	NA	NA	1.59
8	NLF	2.44	NA	NA	NA	NA	NA	NA	1.53
	SDLF	2.35	NA	NA	NA	NA	NA	NA	1.66
	TDLF	2.05	NA	NA	NA	NA	NA	NA	2.10
9	NLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	SDLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	TDLF	0.00	NA	NA	NA	NA	NA	NA	0.00

Table I2-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	31.9	27.4	131.7	123.2
	SDLF	26.5	25.8	127.1	120.7
	TDLF	10.2	19.1	113.1	111.6
G2	NLF	27.0	27.1	115.8	108.1
	SDLF	29.2	30.1	117.3	111.1
	TDLF	30.0	43.0	121.9	124.0
G3	NLF	40.0	26.7	172.2	112.3
	SDLF	28.4	27.9	160.8	113.7
	TDLF	0.0	31.0	122.2	117.0
G4	NLF	19.0	28.8	80.5	124.6
	SDLF	28.6	28.1	89.5	123.9
	TDLF	54.7	25.8	121.8	121.3
G5	NLF	25.0	25.0	105.7	105.7
	SDLF	28.4	28.3	109.6	109.4
	TDLF	39.5	39.1	121.7	121.1
G6	NLF	28.7	19.0	124.6	80.5
	SDLF	28.1	28.5	123.8	89.5
	TDLF	25.9	54.8	121.0	121.6
G7	NLF	26.7	40.0	112.3	172.2
	SDLF	28.0	28.5	114.1	160.7
	TDLF	31.1	0.0	118.1	122.2
G8	NLF	27.1	27.0	108.1	115.7
	SDLF	29.9	29.0	110.8	117.3
	TDLF	42.7	29.1	123.2	121.3
G9	NLF	27.4	32.0	123.4	132.0
	SDLF	25.9	26.8	120.9	127.4
	TDLF	19.0	11.1	111.5	113.7

Table I2-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	-0.3	NA	-0.9	NA
	SDLF	0.1	NA	-0.5	NA
	TDLF	1.3	NA	0.3	NA
G2	NLF	0.0	NA	-0.9	NA
	SDLF	-0.1	NA	-0.7	NA
	TDLF	-0.4	NA	-0.6	NA
G3	NLF	-0.2	NA	-1.4	NA
	SDLF	0.1	NA	-0.9	NA
	TDLF	0.8	NA	0.2	NA
G4	NLF	0.1	NA	0.4	NA
	SDLF	0.0	NA	0.3	NA
	TDLF	-0.2	NA	-0.1	NA
G5	NLF	0.1	NA	0.3	NA
	SDLF	0.0	NA	0.2	NA
	TDLF	-0.2	NA	0.0	NA
G6	NLF	0.1	NA	0.2	NA
	SDLF	0.0	NA	0.0	NA
	TDLF	-0.4	NA	-0.1	NA
G7	NLF	0.1	NA	1.1	NA
	SDLF	0.0	NA	0.8	NA
	TDLF	-0.2	NA	0.2	NA
G8	NLF	0.1	NA	1.3	NA
	SDLF	-0.1	NA	0.9	NA
	TDLF	-0.8	NA	-0.3	NA
G9	NLF	0.0	NA	-0.1	NA
	SDLF	0.1	NA	-0.1	NA
	TDLF	0.2	NA	0.4	NA

Table I2-4-13. Individual support transverse reactions under SDL and TDL (kips).

		Load Type & Support Number			
Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-1.2	0.2	-3.8	2.3
	SDLF	0.1	0.0	-2.2	1.8
	TDLF	3.8	0.0	0.4	0.7
G2	NLF	-0.5	0.0	-3.8	-1.7
	SDLF	-0.2	0.0	-2.9	-1.4
	TDLF	0.4	0.1	-1.2	-0.2
G3	NLF	-0.9	-0.1	-5.1	-1.6
	SDLF	0.1	0.1	-3.3	-1.0
	TDLF	2.8	0.4	0.5	0.3
G4	NLF	-0.2	0.0	-0.4	0.7
	SDLF	-0.1	-0.1	-0.1	0.5
	TDLF	0.2	-0.4	-0.3	-0.5
G5	NLF	-0.1	0.0	-0.4	0.3
	SDLF	0.0	0.0	-0.2	0.1
	TDLF	0.4	-0.3	0.1	-0.2
G6	NLF	0.0	0.1	-0.8	0.2
	SDLF	-0.1	-0.1	-0.7	-0.2
	TDLF	-0.2	-0.8	-0.2	-0.5
G7	NLF	0.1	0.9	1.6	5.2
	SDLF	0.1	0.1	1.3	3.5
	TDLF	0.5	-2.1	0.5	0.3
G8	NLF	0.0	0.5	1.7	3.9
	SDLF	-0.3	-0.1	1.2	2.6
	TDLF	-1.5	-2.0	-1.1	-0.4
G9	NLF	-0.1	1.2	-2.2	3.9
	SDLF	0.3	0.1	-1.5	2.5
	TDLF	1.4	-2.6	0.8	0.8

Table I2-4-14. Longitudinal displacements at supports (in).

		Load Type & Support Number			
Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.03	0.21	-0.09	0.89
	SDLF	0.01	0.20	-0.05	0.79
	TDLF	0.13	0.25	0.03	0.89
G2	NLF	0.00	0.20	-0.09	0.76
	SDLF	-0.01	0.20	-0.07	0.67
	TDLF	-0.04	0.31	-0.06	0.90
G3	NLF	-0.02	0.19	-0.14	0.77
	SDLF	0.01	0.20	-0.09	0.70
	TDLF	0.08	0.34	0.02	0.95
G4	NLF	0.01	0.20	0.04	0.86
	SDLF	0.00	0.19	0.03	0.75
	TDLF	-0.02	0.31	-0.01	0.92
G5	NLF	0.01	0.20	0.03	0.84
	SDLF	0.00	0.19	0.02	0.74
	TDLF	-0.02	0.31	0.00	0.93
G6	NLF	0.01	0.20	0.02	0.84
	SDLF	0.00	0.19	0.00	0.73
	TDLF	-0.04	0.29	-0.01	0.92
G7	NLF	0.01	0.23	0.11	1.02
	SDLF	0.00	0.20	0.08	0.87
	TDLF	-0.02	0.24	0.02	0.95
G8	NLF	0.01	0.21	0.13	0.97
	SDLF	-0.01	0.19	0.09	0.84
	TDLF	-0.08	0.26	-0.03	0.93
G9	NLF	0.00	0.24	-0.01	0.97
	SDLF	0.01	0.19	-0.01	0.83
	TDLF	0.02	0.14	0.04	0.89

Table I2-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.12	-0.02	0.38	-0.23
	SDLF	-0.01	0.00	0.22	-0.18
	TDLF	-0.38	0.00	-0.04	-0.07
G2	NLF	0.05	0.00	0.38	0.17
	SDLF	0.02	0.00	0.29	0.14
	TDLF	-0.04	-0.01	0.12	0.02
G3	NLF	0.09	0.01	0.51	0.16
	SDLF	-0.01	-0.01	0.33	0.10
	TDLF	-0.28	-0.04	-0.05	-0.03
G4	NLF	0.02	0.00	0.04	-0.07
	SDLF	0.01	0.01	0.01	-0.05
	TDLF	-0.02	0.04	0.03	0.05
G5	NLF	0.01	0.00	0.04	-0.03
	SDLF	0.00	0.00	0.02	-0.01
	TDLF	-0.04	0.03	-0.01	0.02
G6	NLF	0.00	-0.01	0.08	-0.02
	SDLF	0.01	0.01	0.07	0.02
	TDLF	0.02	0.08	0.02	0.05
G7	NLF	-0.01	-0.09	-0.16	-0.52
	SDLF	-0.01	-0.01	-0.13	-0.35
	TDLF	-0.05	0.21	-0.05	-0.03
G8	NLF	0.00	-0.05	-0.17	-0.39
	SDLF	0.03	0.01	-0.12	-0.26
	TDLF	0.15	0.20	0.11	0.04
G9	NLF	0.01	-0.12	0.22	-0.39
	SDLF	-0.03	-0.01	0.15	-0.25
	TDLF	-0.14	0.26	-0.08	-0.08

Appendix I2-5. NISSS14 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISSS14 during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table I2-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	SDLF	-1.2	-0.2	1.2	0.0	-0.2	0.2
		TDLF	-1.5	-0.6	1.6	0.0	-0.1	0.1
	2-3	SDLF	-0.6	-0.8	1.0	0.0	0.3	0.3
		TDLF	-0.3	-3.2	3.3	0.0	0.7	0.7
	2-4	SDLF	-1.3	3.4	3.6	0.0	-2.3	2.3
		TDLF	-5.7	15.8	16.8	0.0	-10.6	10.6
	2-5	SDLF	-1.1	2.5	2.7	0.0	-1.8	1.8
		TDLF	-4.6	10.9	11.8	0.0	-8.6	8.6
	2-6	SDLF	-0.5	1.3	1.4	0.0	-0.8	0.8
		TDLF	-3.1	8.2	8.7	0.0	-5.4	5.4
	2-7	SDLF	-0.2	0.1	0.2	0.0	-0.1	0.1
		TDLF	-0.6	1.3	1.4	0.0	-1.0	1.0
	2-8	SDLF	0.4	-1.3	1.3	0.0	0.9	0.9
		TDLF	1.3	-3.7	3.9	0.0	2.7	2.7
	2-9	SDLF	0.8	-2.3	2.5	0.0	1.6	1.6
		TDLF	3.2	-8.4	9.0	0.0	6.0	6.0
	2-10	SDLF	0.0	1.5	1.5	0.0	-1.8	1.8
		TDLF	0.0	7.9	7.9	0.0	-8.6	8.6

Table I2-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
3	3-2	SDLF	-1.1	0.2	1.1	0.0	-0.3	0.3
		TDLF	-1.2	0.2	1.3	0.0	-0.6	0.6
	3-3	SDLF	1.7	0.0	1.7	0.0	0.4	0.4
		TDLF	9.7	-1.0	9.8	0.0	1.8	1.8
	3-4	SDLF	-1.2	3.1	3.3	0.0	-2.1	2.1
		TDLF	-4.9	14.1	14.9	0.0	-9.0	9.0
	3-5	SDLF	-0.6	0.6	0.8	0.0	-0.3	0.3
		TDLF	0.9	0.8	1.2	0.0	-2.2	2.2
	3-6	SDLF	0.7	-2.3	2.4	0.0	1.6	1.6
		TDLF	5.6	-10.8	12.2	0.0	6.0	6.0
	3-7	SDLF	0.9	-3.3	3.4	0.0	2.1	2.1
		TDLF	8.9	-15.3	17.7	0.0	7.1	7.1

Table I2-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	SDLF	-1.1	0.2	1.2	0.0	-0.3	0.3
		TDLF	-2.1	-0.7	2.2	0.0	-0.6	0.6
	9-3	SDLF	-0.3	-0.7	0.8	0.0	0.3	0.3
		TDLF	-0.3	-4.6	4.6	0.0	1.8	1.8
	9-4	SDLF	0.0	1.9	1.9	0.0	-1.9	1.9
		TDLF	0.0	9.9	9.9	0.0	-8.5	8.5
	9-5	SDLF	-1.4	3.1	3.4	0.0	-2.0	2.0
		TDLF	-3.9	9.4	10.2	0.0	-6.2	6.2
	9-6	SDLF	-0.9	1.7	1.9	0.0	-0.8	0.8
		TDLF	5.2	-0.6	5.3	0.0	-1.4	1.4
	9-7	SDLF	0.0	0.2	0.2	0.0	-0.3	0.3
		TDLF	7.3	-7.1	10.2	0.0	0.0	0.0
	9-8	SDLF	0.5	-1.4	1.5	0.0	1.0	1.0
		TDLF	3.6	-9.3	10.0	0.0	5.5	5.5
	9-9	SDLF	1.0	-2.5	2.7	0.0	1.6	1.6
		TDLF	12.2	-18.3	22.0	0.0	6.8	6.8
	9-10	SDLF	2.0	-5.1	5.5	0.0	3.3	3.3
		TDLF	8.7	-22.9	24.5	0.0	11.4	11.4

Table I2-5-2: Erection Critical Sub-Stages

Stage	Detailing Method	Critical Sub-Stage
2	SDLF	2-4
	TDLF	2-4
3	SDLF	3-4
	TDLF	3-4
9	SDLF	9-10
	TDLF	9-10

Table I2-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	SDLF	-0.2	0.1	0.2	NA	NA	NA
		TDLF	-0.5	0.5	0.7	NA	NA	NA
	B	SDLF	-1.3	3.4	3.6	0.0	-2.3	2.3
		TDLF	-5.7	15.8	16.8	0.0	-10.6	10.6
3	A	SDLF	-0.2	0.2	0.3	NA	NA	NA
		TDLF	0.3	1.3	1.3	NA	NA	NA
	B	SDLF	-1.2	3.1	3.3	0.0	-2.1	2.1
		TDLF	-4.9	14.1	14.9	0.0	-9.0	9.0
9	A	SDLF	-0.1	-0.2	0.2	NA	NA	NA
		TDLF	1.4	-4.1	4.3	NA	NA	NA
	B	SDLF	2.0	-5.1	5.5	0.0	3.3	3.3
		TDLF	8.7	-22.9	24.5	0.0	11.4	11.4

Table I2-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
2	A	G1	SDLF	25.5	24.9
			TDLF	25.9	24.6
		G2	SDLF	25.2	25.2
			TDLF	24.8	25.5
	B	G1	SDLF	25.5	25.0
			TDLF	25.9	24.9
		G2	SDLF	25.3	25.1
			TDLF	25.0	25.2
3	A	G1	SDLF	26.8	25.5
			TDLF	23.0	22.8
		G2	SDLF	28.4	30.1
			TDLF	34.2	37.9
		G3	SDLF	25.3	24.2
			TDLF	23.3	19.1
	B	G1	SDLF	26.8	25.5
			TDLF	23.1	22.7
		G2	SDLF	28.4	30.1
			TDLF	34.0	38.1
		G3	SDLF	25.4	24.2
			TDLF	23.5	19.0

Table I2-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
9	A	G1	SDLF	26.5	25.8
			TDLF	10.2	19.1
		G2	SDLF	29.2	30.1
			TDLF	30.0	43.0
		G3	SDLF	28.4	27.9
			TDLF	0.0	31.0
		G4	SDLF	28.5	28.1
			TDLF	54.7	25.8
		G5	SDLF	28.4	28.3
			TDLF	39.5	39.1
		G6	SDLF	28.1	28.5
			TDLF	25.9	54.8
		G7	SDLF	28.0	28.5
			TDLF	31.1	0.0
		G8	SDLF	29.9	29.1
			TDLF	42.6	28.9
		G9	SDLF	25.9	26.6
			TDLF	19.0	11.1

Table I2-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
9	B	G1	SDLF	26.5	25.8
			TDLF	10.2	19.1
		G2	SDLF	29.2	30.1
			TDLF	30.0	43.0
		G3	SDLF	28.4	27.9
			TDLF	0.0	31.0
		G4	SDLF	28.6	28.1
			TDLF	54.7	25.8
		G5	SDLF	28.4	28.3
			TDLF	39.5	39.1
		G6	SDLF	28.1	28.5
			TDLF	25.9	54.8
		G7	SDLF	28.0	28.5
			TDLF	31.1	0.0
		G8	SDLF	29.9	29.0
			TDLF	42.7	29.1
		G9	SDLF	25.9	26.7
			TDLF	19.0	11.0

Appendix J1-1. NISSS54 Bridge Description

The key characteristics of NISSS54 are as follows:

- Span length along the centerline of the bridge, L_s = 300 ft.
- Width between the fascia girders, w_g = 74 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 4.05
- Number of girders in the completed bridge cross-section, n_g = 9.
- Parallel skew
- Skew angle, $\theta = 70^o$
- Skew index, I_s = 0.68

This appendix presents the bridge description of the bridge NISSS54 in its final condition as well as during erection. The following figures and tables are provided:

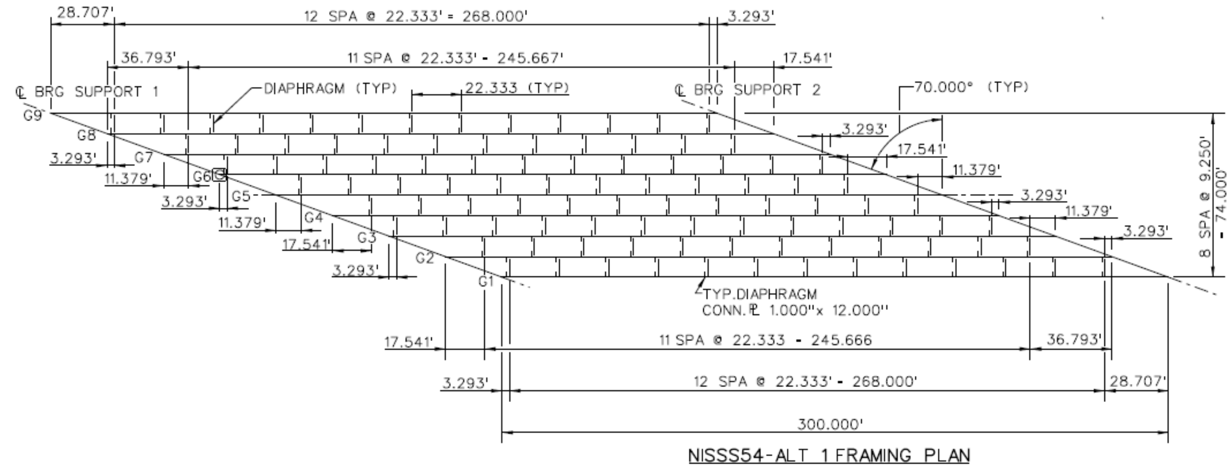


Figure J1-1-1. Framing plan.

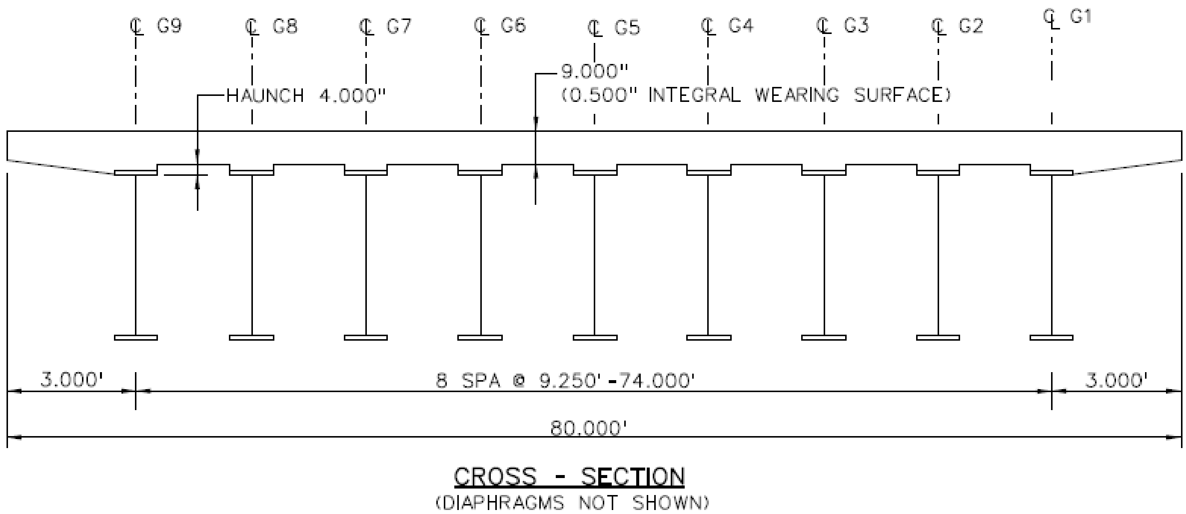


Figure J1-1-2. Bridge cross-section.

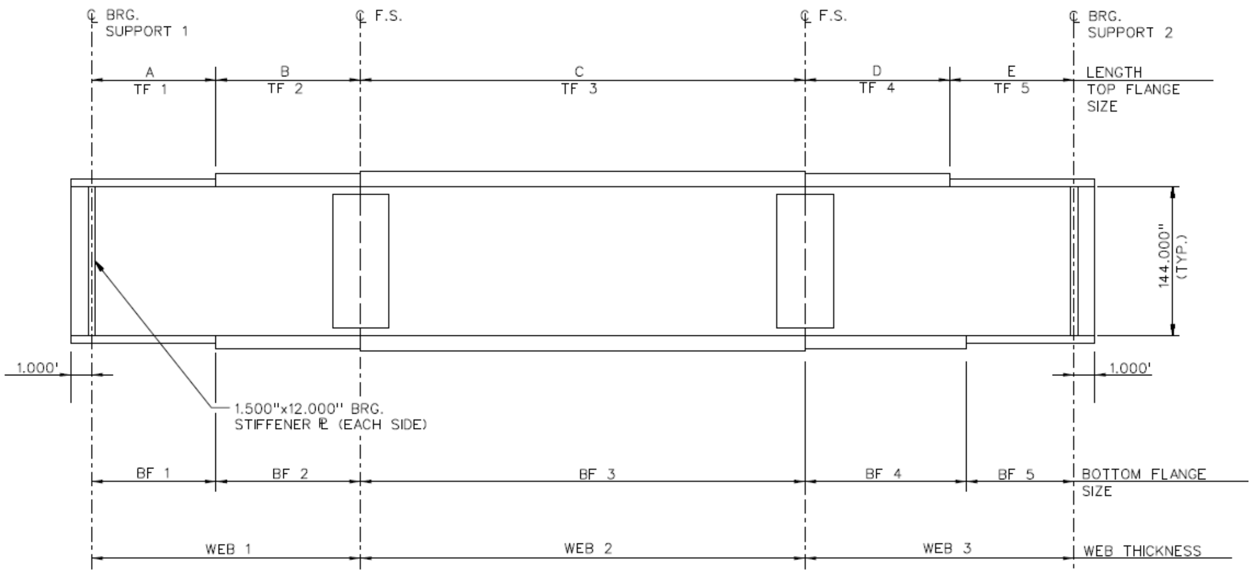


Figure J1-1-3. Girder elevations

	GIRDER PLATE LENGTHS ⁎								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000
B	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000
C	120.000	120.000	120.000	120.000	120.000	120.000	120.000	120.000	120.000
D	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000
E	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000

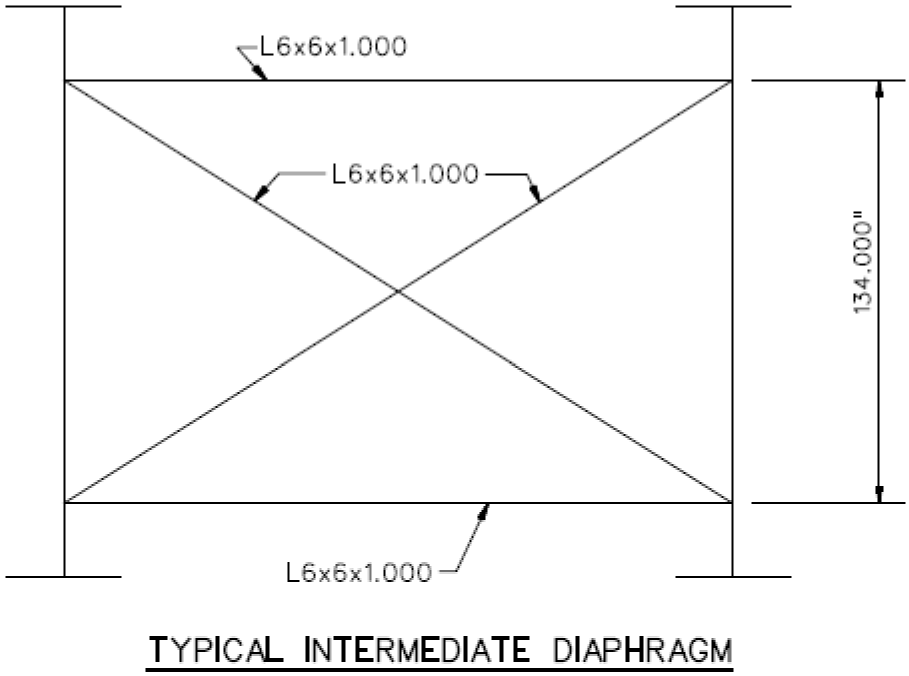
⁎ ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS ⁎⁎					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	28.000	1.250	28.000	1.250	28.000	1.250
TF2	28.000	2.000	28.000	2.000	28.000	2.000
TF3	28.000	2.000	28.000	2.000	28.000	2.000
TF4	28.000	2.000	28.000	2.000	28.000	2.000
TF5	28.000	1.250	28.000	1.250	28.000	1.250

⁎⁎ ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS ⁎⁎					
BOTTOM FLANGE	G1		G2		G3	
	BF	TF	BF	TF	BF	TF
BF1	30.000	1.250	30.000	1.250	30.000	1.250
BF2	30.000	2.250	30.000	2.250	30.000	2.250
BF3	30.000	2.750	30.000	2.750	30.000	2.750
BF4	30.000	2.250	30.000	2.250	30.000	2.250
BF5	30.000	1.250	30.000	1.250	30.000	1.250

Figure J1-1-4. Cross-section dimensions.



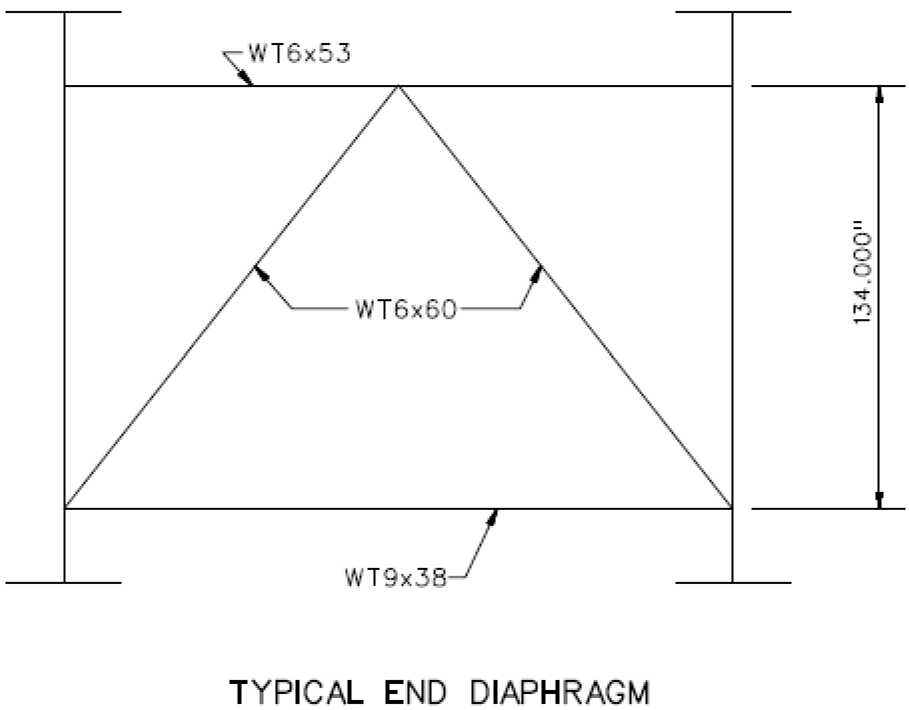


Figure J1-1-5. Cross-frame details.

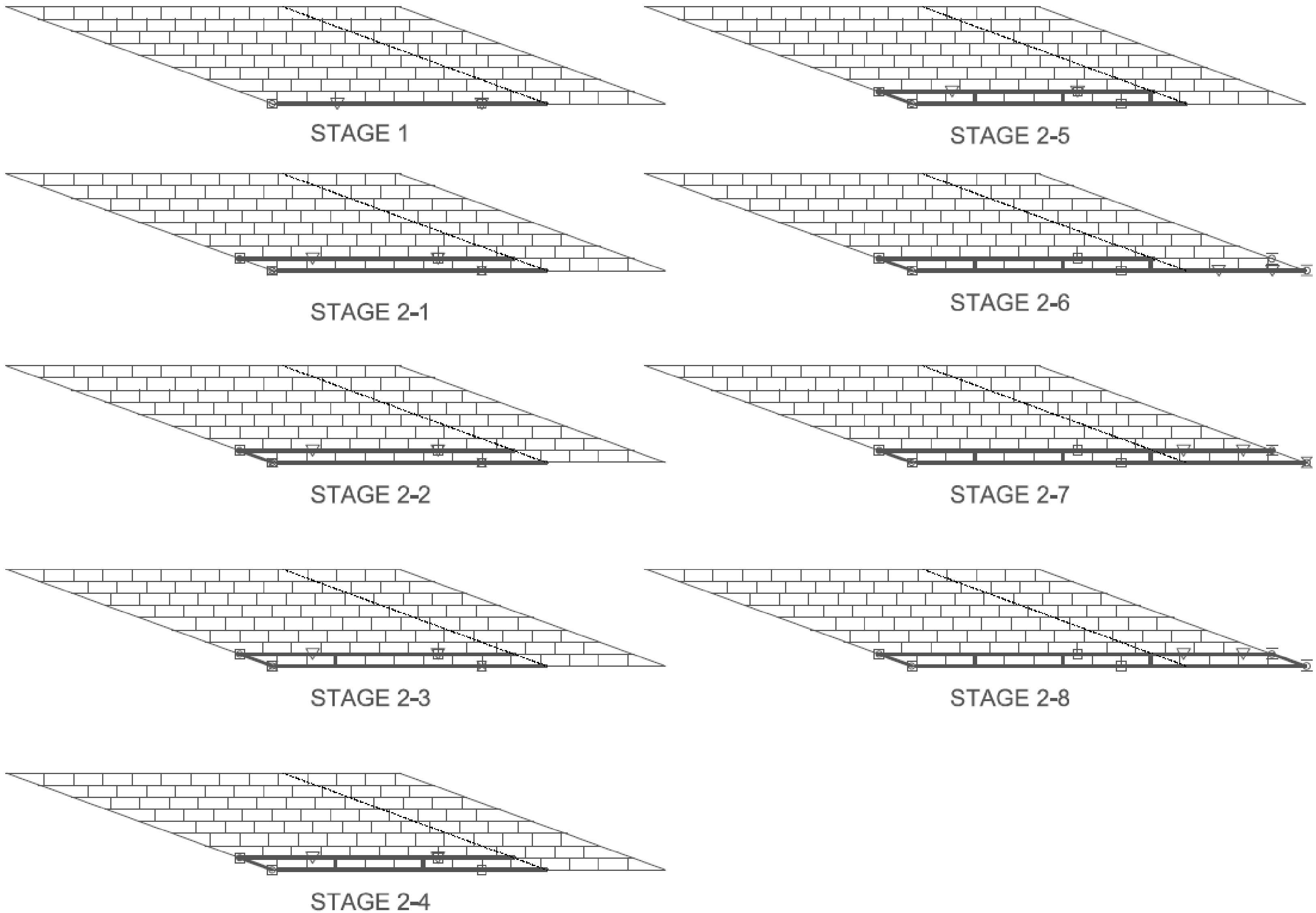
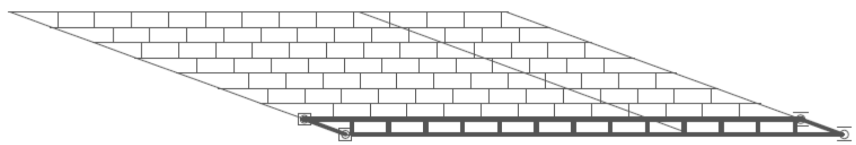


Figure J1-1-6. Erection scheme.

STAGE 2-9: REMOVE G1, G2 TEMP. SUPPORTS
STAGE 2-10: G1-G2 XF 2
STAGE 2-11: G1-G2 XF3
STAGE 2-12: G1-G2 XF 5
STAGE 2-13: G1-G2 XF 6
STAGE 2-14: G1-G2 XF 8
STAGE 2-15: G1-G2 XF 9
STAGE 2-16: G1-G2 XF 11
STAGE 2-17: G1-G2 XF 12
STAGE 2-18: G1-G2 XF 13



STAGE 2-19

Figure J1-1-6(Continued). Erection scheme.

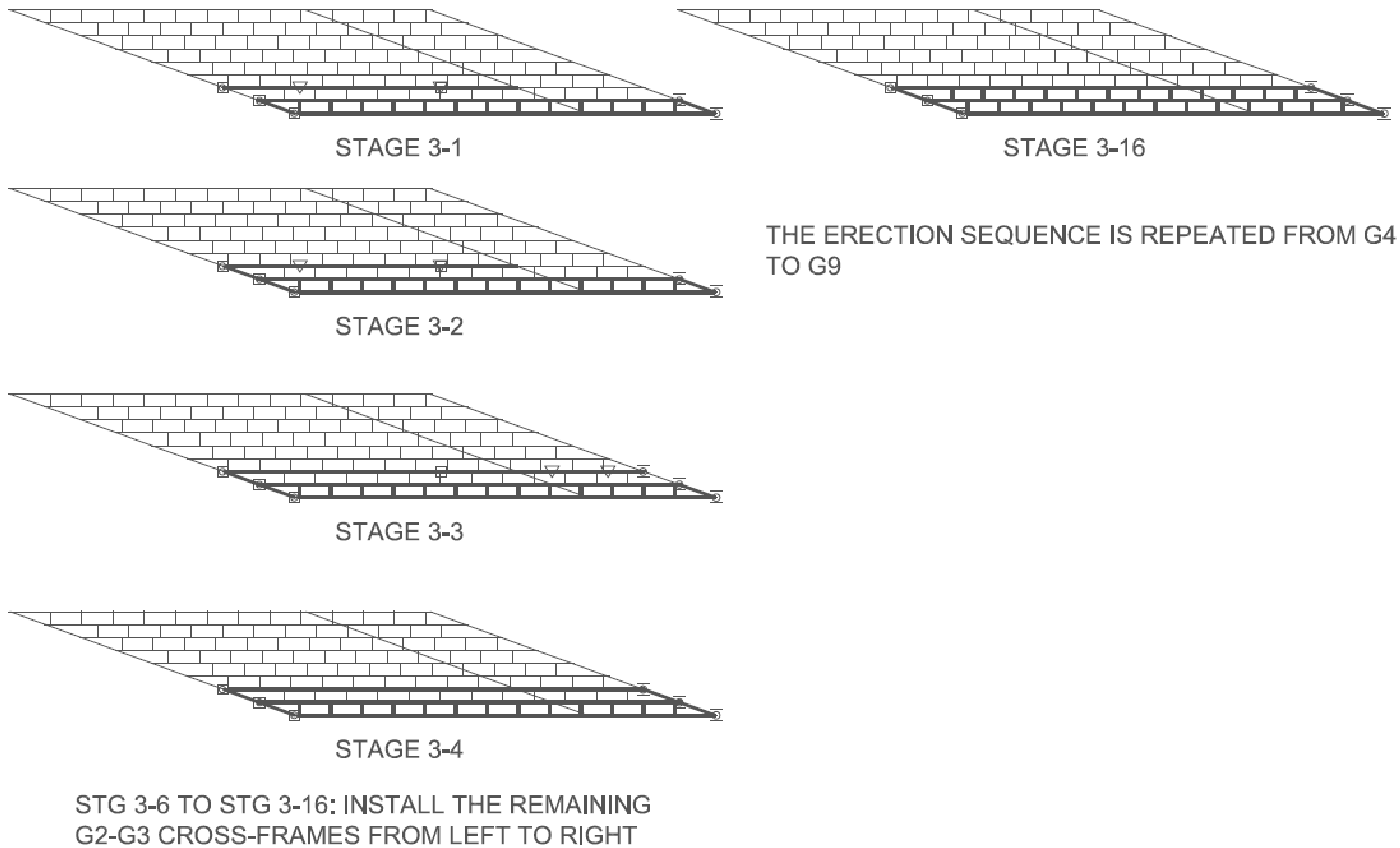


Figure J1-1-6(Continued). Erection scheme.

Table J1-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

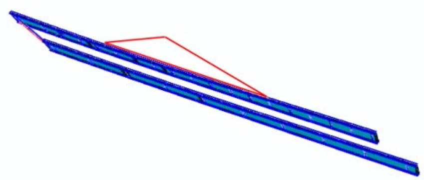
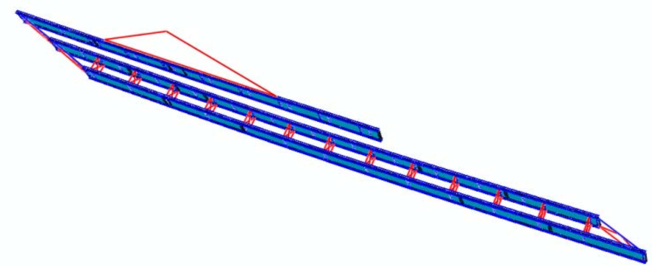
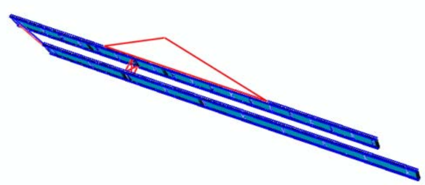
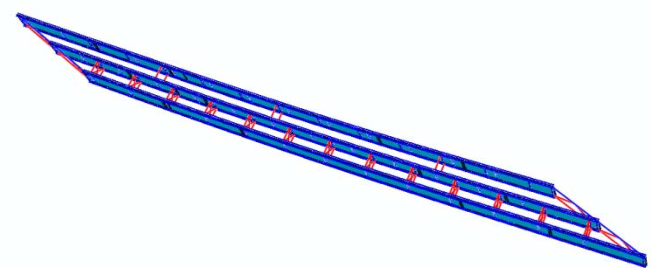
Sub-Stage	Stage	
	2	3
1		
2		

Table J1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

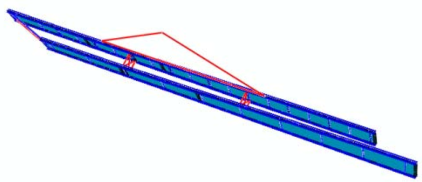
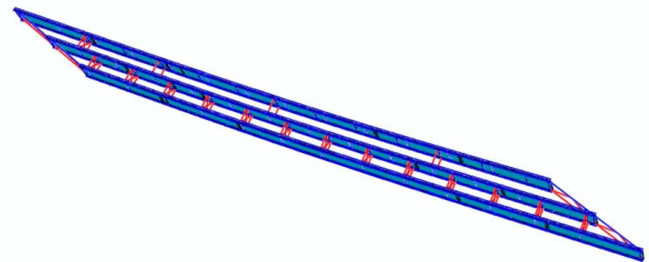
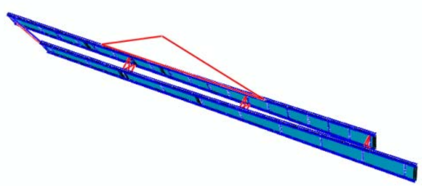
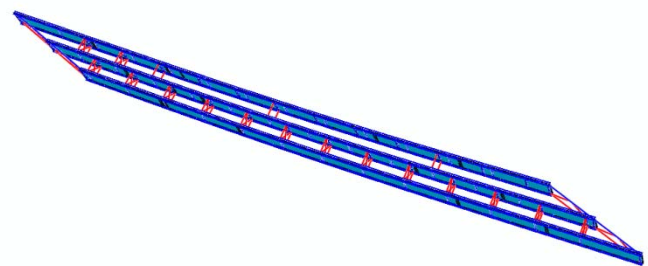
Sub-Stage	Stage	
	2	3
3		
4		

Table J1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

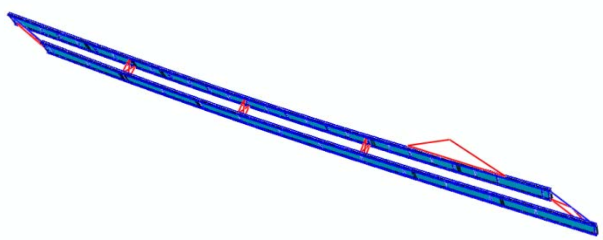
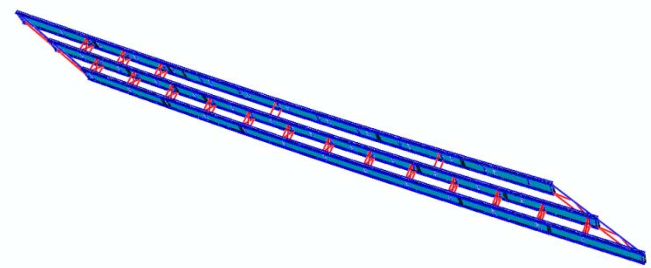
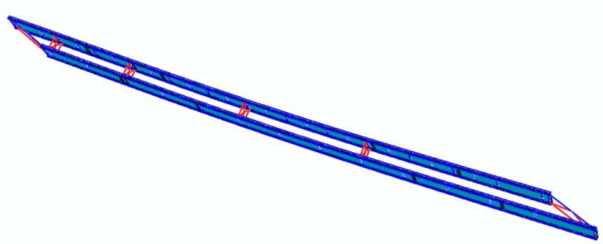
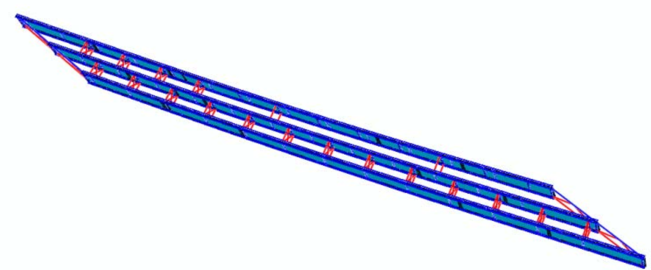
Sub-Stage	Stage	
	2	3
5		
6		

Table J1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

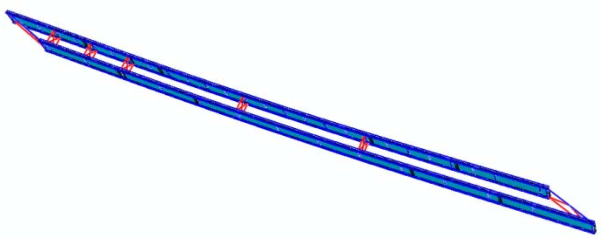
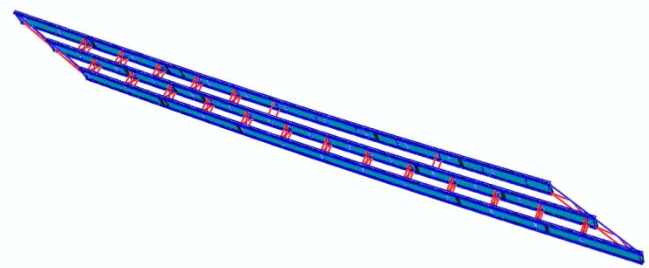
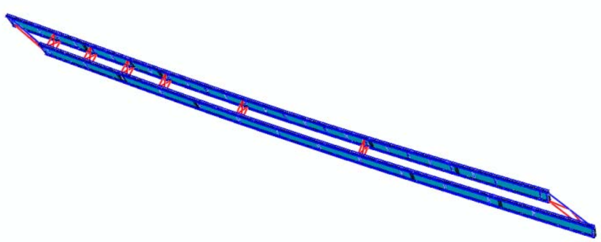
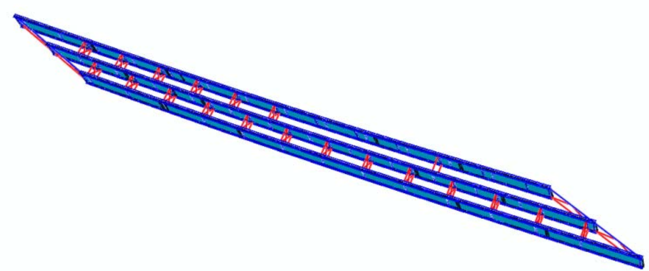
Sub-Stage	Stage	
	2	3
7		
8		

Table J1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

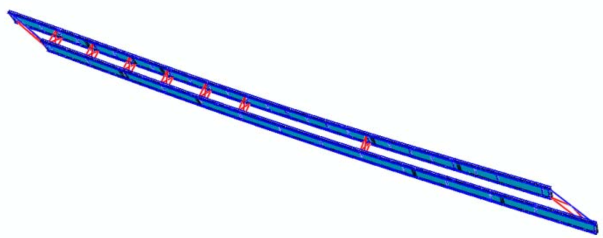
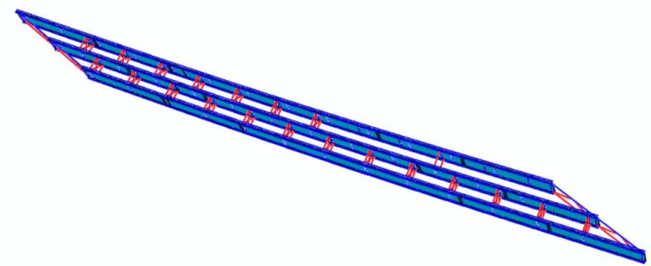
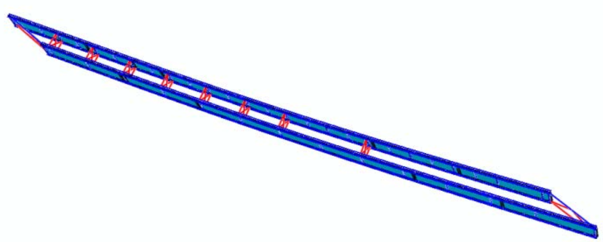
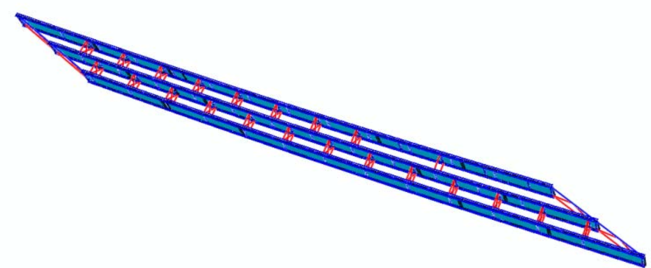
Sub-Stage	Stage	
	2	3
9		
10		

Table J1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

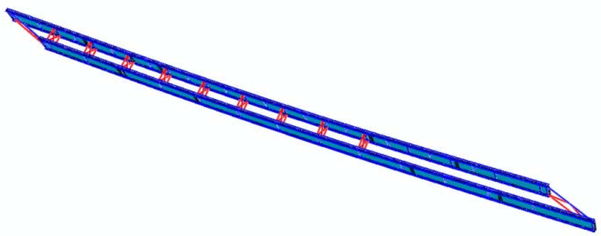
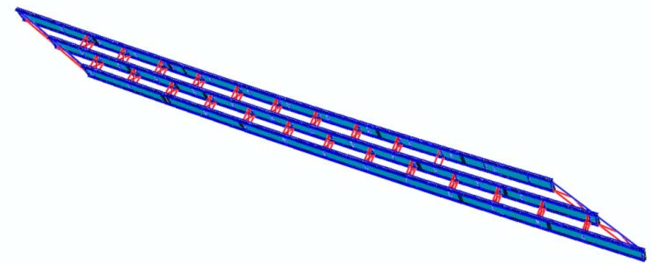
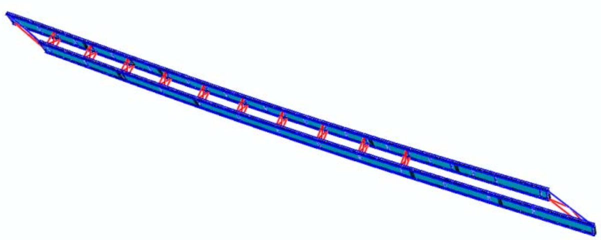
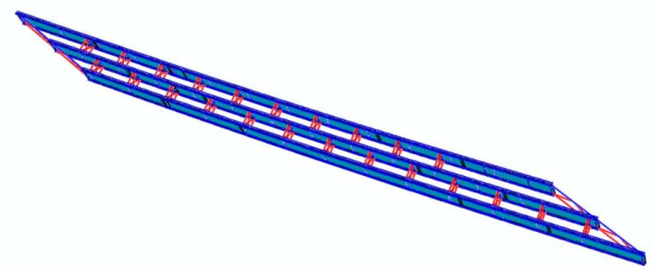
Sub-Stage	Stage	
	2	3
11		
12		

Table J1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

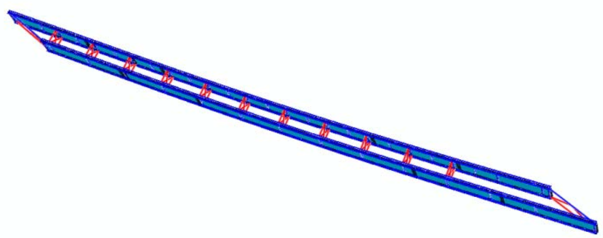
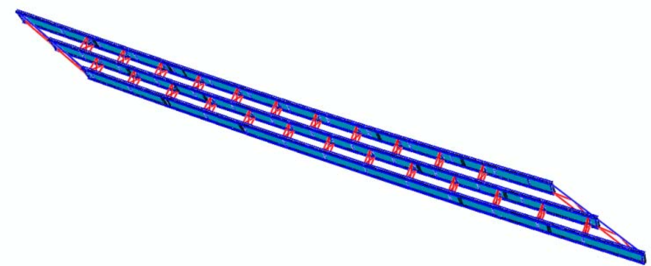
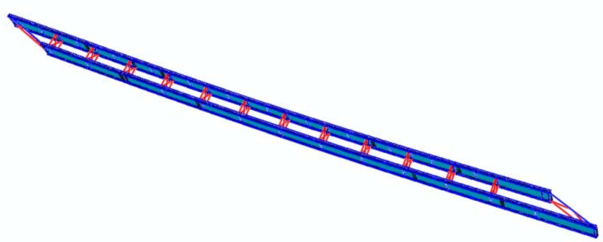
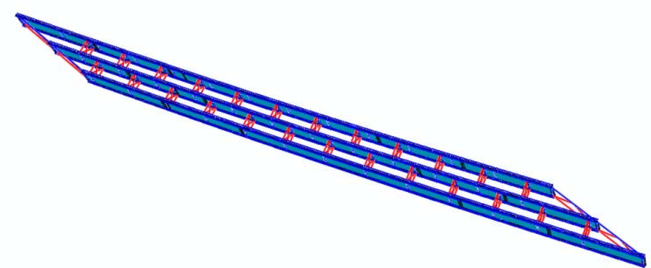
Sub-Stage	Stage	
	2	3
13		
14		

Table J1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

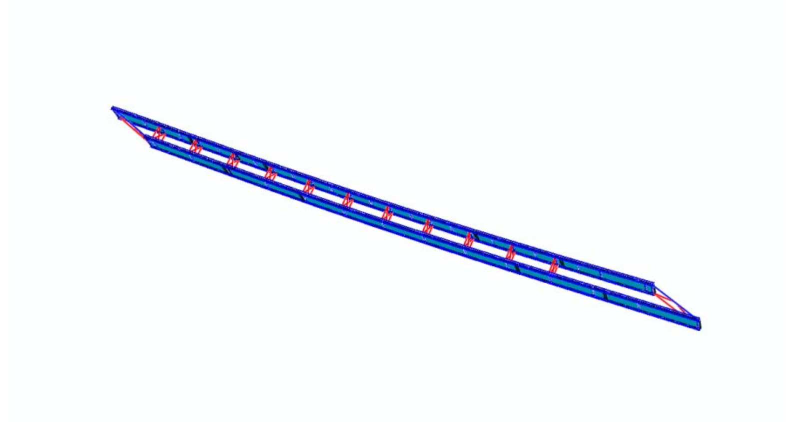
Sub-Stage	Stage	
	2	3
15		NA

Table J1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

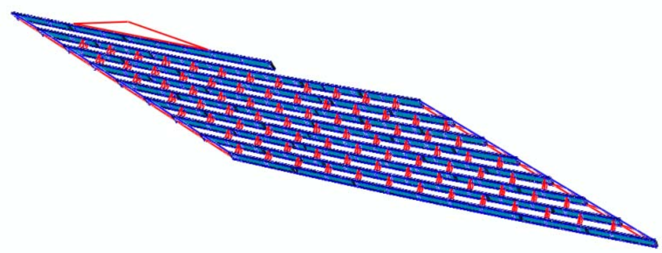
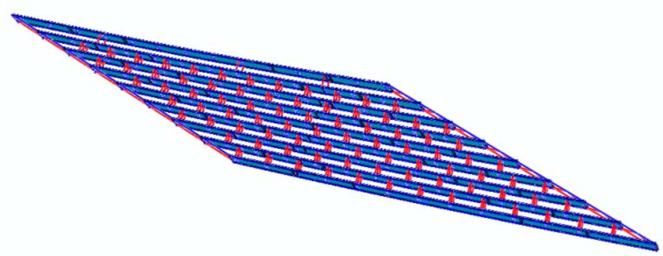
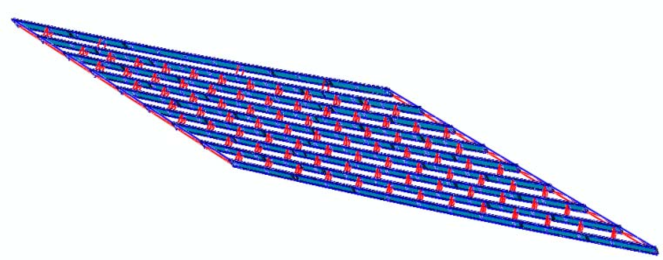
Sub-Stage	Stage 9
1	
2	
3	

Table J1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

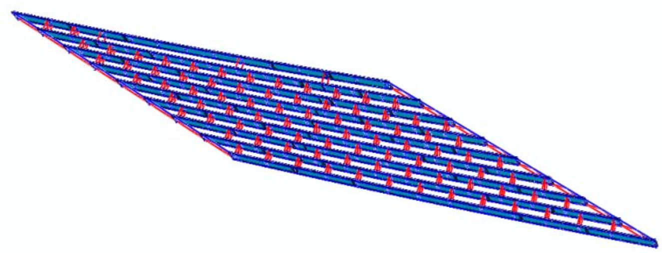
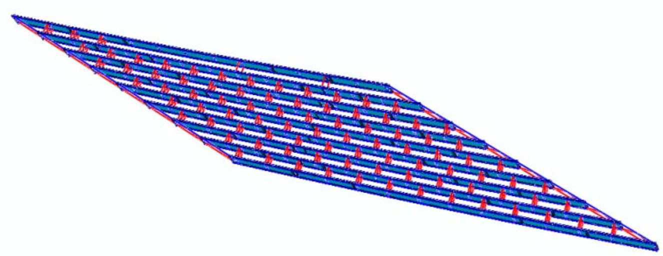
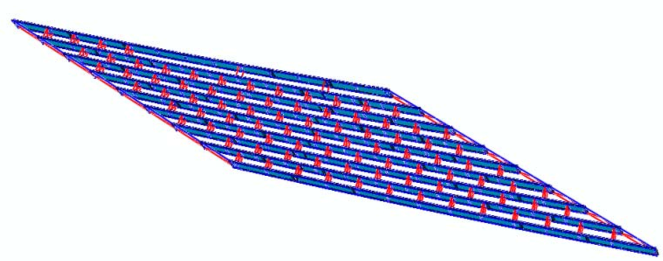
Sub-Stage	Stage 9
4	
5	
6	

Table J1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

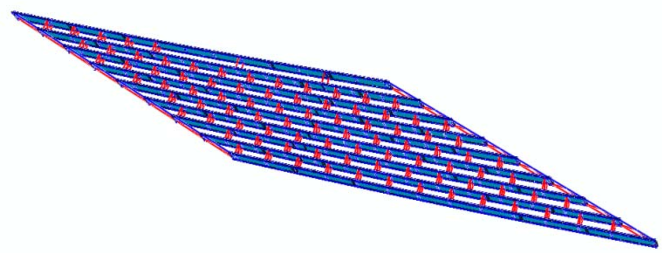
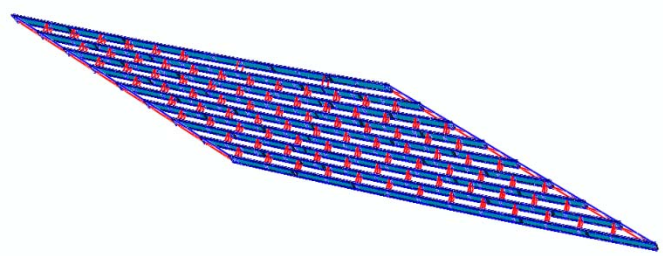
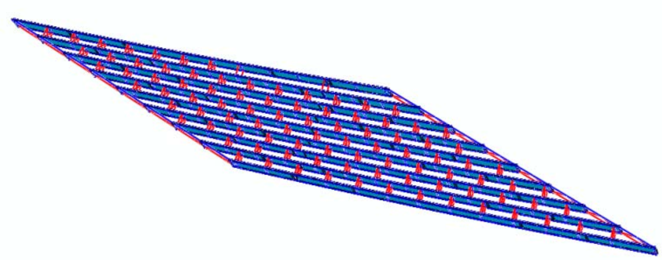
Sub-Stage	Stage 9
7	
8	
9	

Table J1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

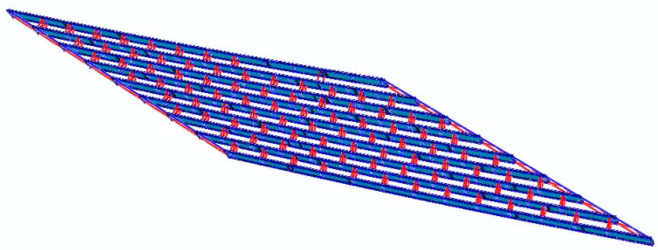
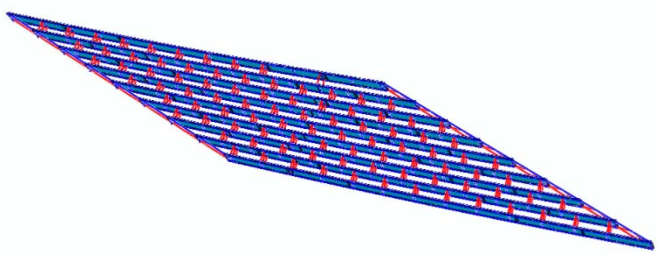
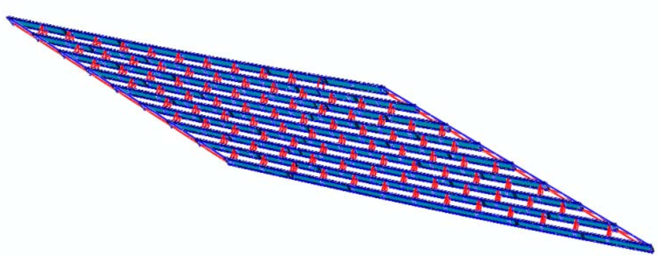
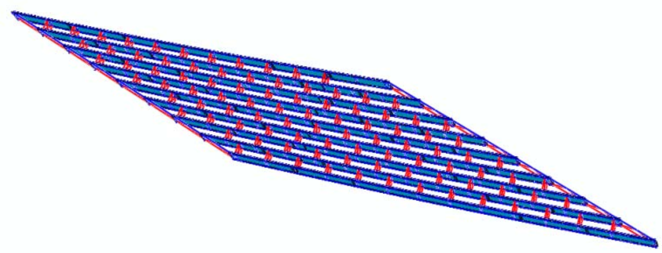
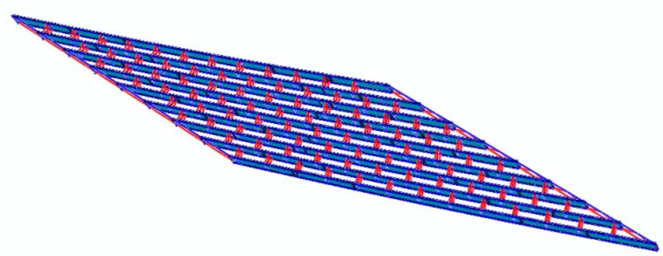
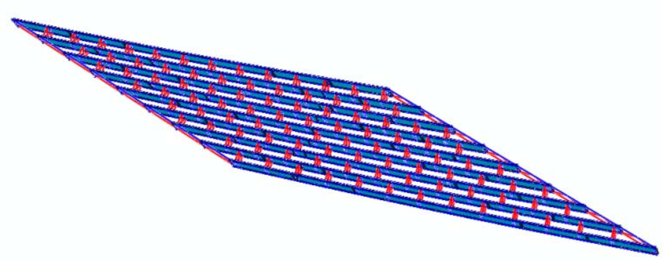
Sub-Stage	Stage 9
10	
11	
12	

Table J1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

Sub-Stage	Stage 9
13	
14	
15	

Appendix J1-2. NISSS54 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISSS54 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table J1-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	7.9	17.4
	SDLF	6.5	15.8
	TDLF	4.6	13.9
G2	NLF	6.8	15.0
	SDLF	7.1	15.1
	TDLF	7.2	15.3
G3	NLF	6.0	13.1
	SDLF	7.1	14.1
	TDLF	8.3	15.4
G4	NLF	5.5	12.0
	SDLF	7.1	13.6
	TDLF	8.9	15.4
G5	NLF	5.3	11.7
	SDLF	7.1	13.4
	TDLF	9.1	15.4
G6	NLF	5.5	12.0
	SDLF	7.1	13.6
	TDLF	8.9	15.4
G7	NLF	6.0	13.1
	SDLF	7.1	14.1
	TDLF	8.3	15.4
G8	NLF	6.8	15.0
	SDLF	7.1	15.1
	TDLF	7.3	15.4
G9	NLF	7.9	17.4
	SDLF	6.5	15.8
	TDLF	4.6	13.9
All Girders	NLF	7.9	17.4
	SDLF	7.1	15.8
	TDLF	9.1	15.4

Table J1-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	2.8	6.1
	SDLF	0.1	3.2
	TDLF	3.3	0.1
G2	NLF	2.7	6.0
	SDLF	0.1	3.2
	TDLF	3.3	0.1
G3	NLF	2.5	5.5
	SDLF	0.1	2.9
	TDLF	3.0	0.0
G4	NLF	2.4	5.2
	SDLF	0.1	2.8
	TDLF	2.9	0.0
G5	NLF	2.1	4.6
	SDLF	0.0	2.4
	TDLF	2.5	0.0
G6	NLF	2.4	5.3
	SDLF	0.1	2.8
	TDLF	2.9	0.0
G7	NLF	2.5	5.5
	SDLF	0.1	2.9
	TDLF	3.0	0.0
G8	NLF	2.7	6.0
	SDLF	0.1	3.2
	TDLF	3.3	0.0
G9	NLF	2.8	6.1
	SDLF	0.1	3.3
	TDLF	3.3	0.1
All Girders	NLF	2.8	6.1
	SDLF	0.1	3.3
	TDLF	3.3	0.1

Table J1-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	11.7	26.0	13.1	28.5	10.1	26.2	11.2	24.0
	SDLF	8.9	22.3	10.7	25.9	0.1	13.4	0.2	12.7
	TDLF	7.8	18.9	8.4	22.7	7.3	0.3	8.8	0.4
G2	NLF	9.7	21.2	11.7	25.5	17.7	40.3	24.3	53.7
	SDLF	9.6	21.0	11.6	25.3	0.6	20.6	0.8	28.4
	TDLF	10.6	20.8	11.6	25.1	10.6	0.7	16.7	1.0
G3	NLF	8.9	19.7	10.1	22.1	7.4	17.1	10.8	23.3
	SDLF	9.7	19.8	11.6	23.5	0.3	8.9	0.4	12.2
	TDLF	12.7	20.9	13.5	25.1	7.9	0.4	11.9	0.6
G4	NLF	7.9	17.5	8.9	19.3	6.8	15.1	10.3	23.4
	SDLF	9.7	18.5	11.7	22.0	0.3	7.9	0.4	12.2
	TDLF	12.4	20.9	15.0	25.2	6.6	0.6	9.6	0.6
G5	NLF	7.1	15.5	8.6	18.8	5.0	10.9	8.5	19.3
	SDLF	9.7	18.0	11.7	21.7	0.2	5.7	0.3	10.1
	TDLF	12.6	20.9	15.2	25.2	4.9	0.3	8.1	0.5
G6	NLF	7.9	17.5	8.9	19.4	6.7	15.1	10.2	23.2
	SDLF	9.7	18.6	11.7	22.0	0.3	7.9	0.3	12.2
	TDLF	12.4	20.9	15.0	25.2	6.6	0.5	9.5	0.6
G7	NLF	9.2	20.3	10.1	22.1	7.5	17.2	10.8	23.4
	SDLF	9.7	19.8	11.7	23.5	0.3	9.0	0.3	12.3
	TDLF	12.7	20.9	13.6	25.1	8.0	0.4	11.9	0.5
G8	NLF	9.7	21.2	11.7	25.5	17.4	39.6	23.7	52.6
	SDLF	9.6	21.0	11.6	25.3	0.5	20.3	0.7	27.8
	TDLF	10.6	20.9	11.6	25.1	10.4	0.7	16.3	1.0
G9	NLF	11.7	26.0	13.1	28.5	10.2	26.5	11.2	24.0
	SDLF	8.9	22.2	10.7	25.9	0.1	13.6	0.1	12.7
	TDLF	7.8	18.9	8.4	22.7	7.4	0.3	8.8	0.4
All Girders	NLF	11.7	26.0	13.1	28.5	17.7	40.3	24.3	53.7
	SDLF	9.7	22.3	11.7	25.9	0.6	20.6	0.8	28.4
	TDLF	12.7	20.9	15.2	25.2	10.6	0.7	16.7	1.0

Table J1-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	98.3	162.4	90.1	162.4
	SDLF	6.4	5.8	3.1	6.4
	TDLF	88.3	145.5	114.7	145.5
TDL	NLF	204.3	354.0	199.2	354.0
	SDLF	103.8	181.9	103.7	181.9
	TDLF	8.7	8.8	4.3	8.8

Table J1-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	11.9	27.2	25.7	19.5
	SDLF	0.8	1.4	1.0	1.0
	TDLF	11.5	29.5	27.6	20.3
TDL	NLF	26.8	60.1	55.5	42.9
	SDLF	14.1	31.3	29.1	22.5
	TDLF	1.5	2.9	2.0	2.0

Table J1-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	2.06	1.93	1.78	1.60	1.60	1.79	1.93	2.07	2.07
SDLF	1.98	1.89	1.97	1.90	1.91	1.97	1.90	1.98	1.98
TDLF	3.64	2.54	2.56	2.32	2.32	2.56	2.54	3.67	3.67

Table J1-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	4.55	4.25	3.94	3.51	3.52	3.94	4.26	4.56	4.56
SDLF	4.24	4.17	4.06	3.79	3.79	4.07	4.18	4.23	4.24
TDLF	4.30	4.12	4.26	4.13	4.13	4.26	4.13	4.30	4.30

Table J1-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	2.49	2.33	2.15	1.93	1.93	2.16	2.33	2.50	2.50
SDLF	2.39	2.28	2.37	2.30	2.30	2.37	2.29	2.39	2.39
TDLF	4.40	3.06	3.09	2.80	2.80	3.09	3.07	4.44	4.44

Table J1-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	5.50	5.13	4.75	4.24	4.25	4.76	5.14	5.50	5.50
SDLF	5.12	5.04	4.90	4.57	4.58	4.91	5.05	5.11	5.12
TDLF	5.19	4.97	5.14	4.99	4.99	5.14	4.98	5.19	5.19

Table J1-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	2777	6047
SDLF	2777	6046
TDLF	2777	6047

Table J1-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	387	833	6	7	9	22
SDLF	160	588	0	4	0	12
TDLF	233	347	7	1	6	0

Table J1-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	1	2	0	1
SDLF	1	2	0	0
TDLF	1	2	0	0

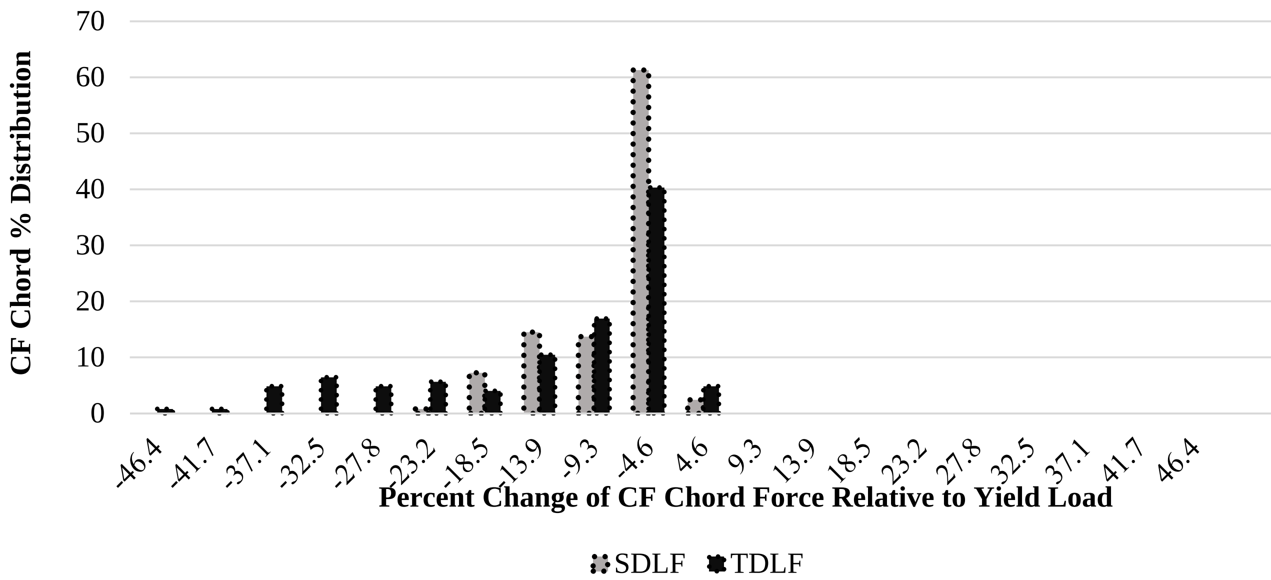


Figure J1-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

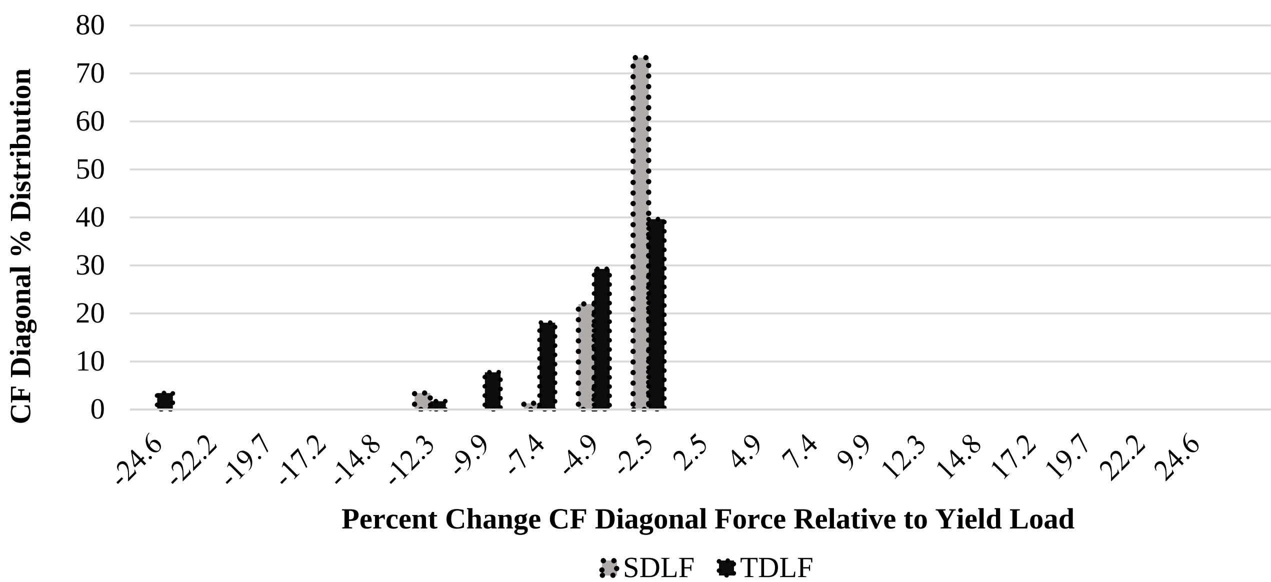


Figure J1-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

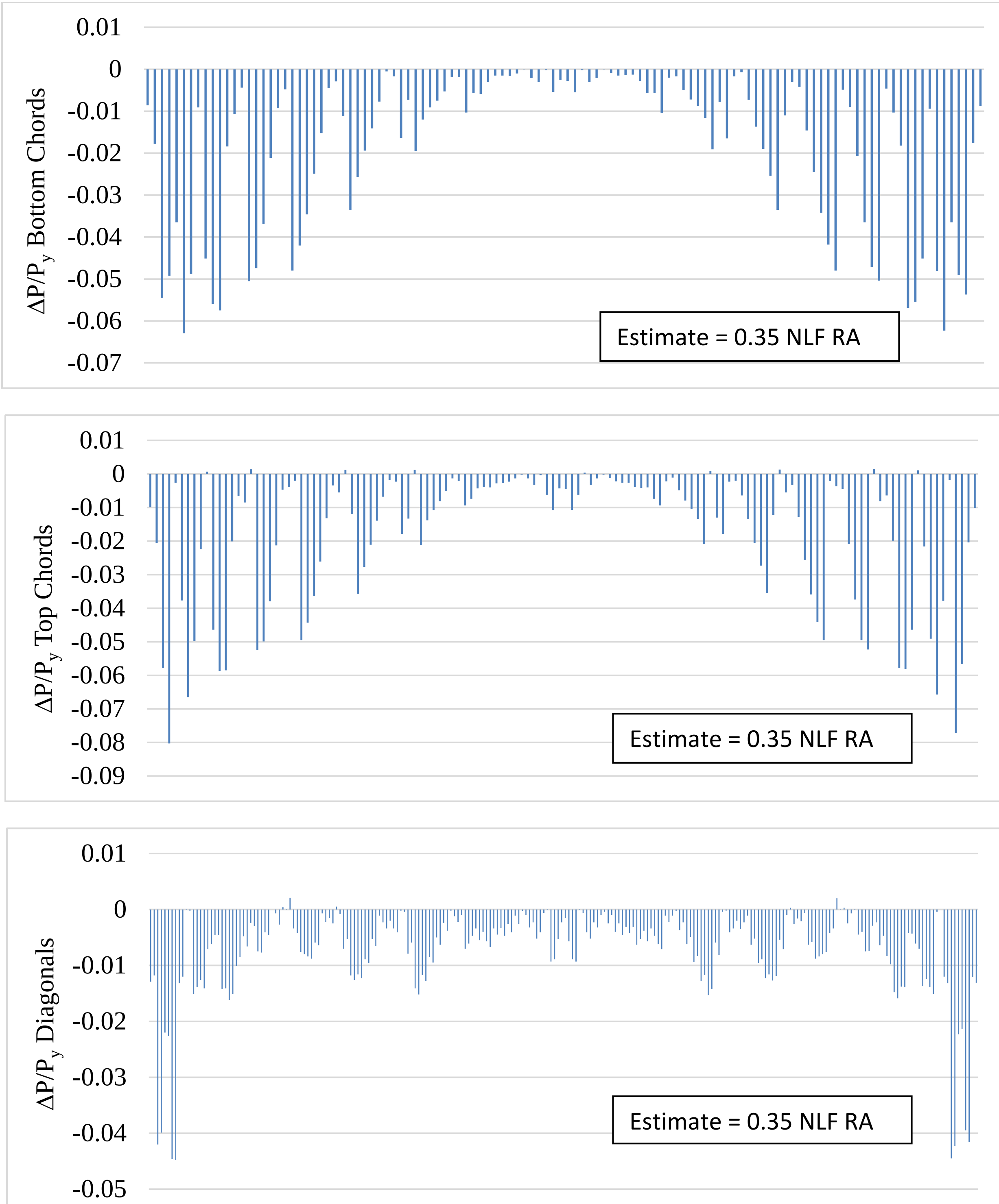


Figure J1-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

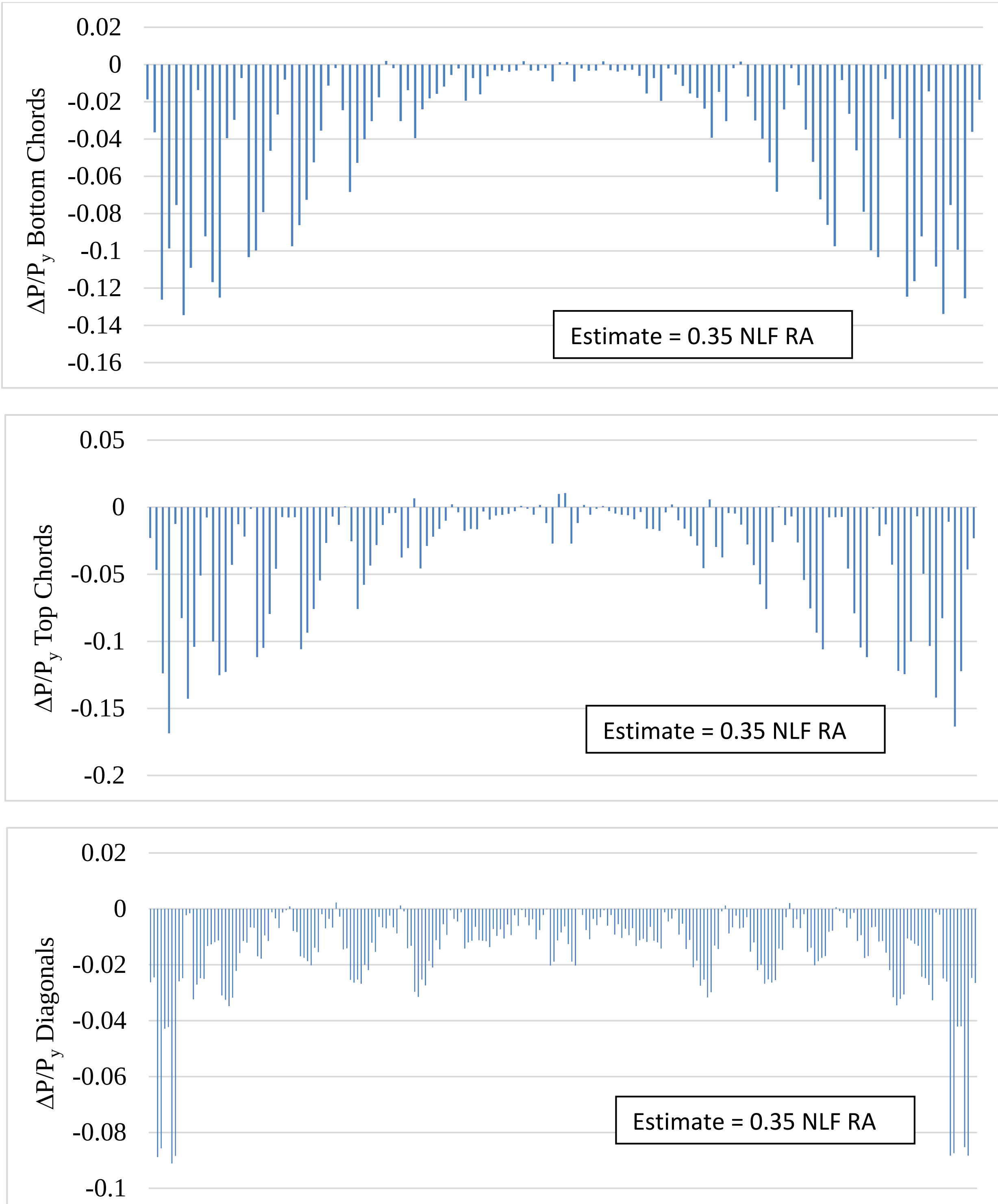


Figure J1-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix J1-3. NISSS54 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISSS54 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table J1-3-1. Maximums of the fit-up force resultants (kips)

Detailing Method	F1	F2	F_{max}
SDLF	9.2	4.5	9.2
TDLF	73.5	50.1	73.5

Table J1-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	SDLF	153	141
	TDLF	162	0
G2	SDLF	160	141
	TDLF	187	101
G3	SDLF	159	141
	TDLF	233	138
G4	SDLF	158	156
	TDLF	232	192
G5	SDLF	158	156
	TDLF	209	208
G6	SDLF	159	155
	TDLF	232	191
G7	SDLF	156	153
	TDLF	232	138
G8	SDLF	157	145
	TDLF	146	99
G9	SDLF	142	83
	TDLF	139	0
All Girders	SDLF	160	83
	TDLF	233	0

Table J1-3-3. Total Vertical Reactions (kips)

Stage	Detailing Method	Sub-Stage														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	SDLF	403	405	407	409	573	575	577	578	580	582	584	585	587	589	591
	TDLF	403	405	407	409	573	575	577	578	580	582	584	585	587	589	591
3	SDLF	677	884	886	888	889	891	892	893	895	897	899	900	902	903	NA
	TDLF	677	884	886	888	889	891	892	893	895	897	899	900	902	903	NA
9	SDLF	2556	2756	2758	2760	2761	2763	2765	2766	2768	2769	2771	2773	2774	2776	2777
	TDLF	2556	2756	2758	2760	2761	2763	2765	2766	2768	2769	2771	2773	2774	2776	2777

Appendix J1-4. NISSS54 Detailed Results, Completed Bridge Responses

This appendix presents the SDL and TDL responses of the bridge NISSS54 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

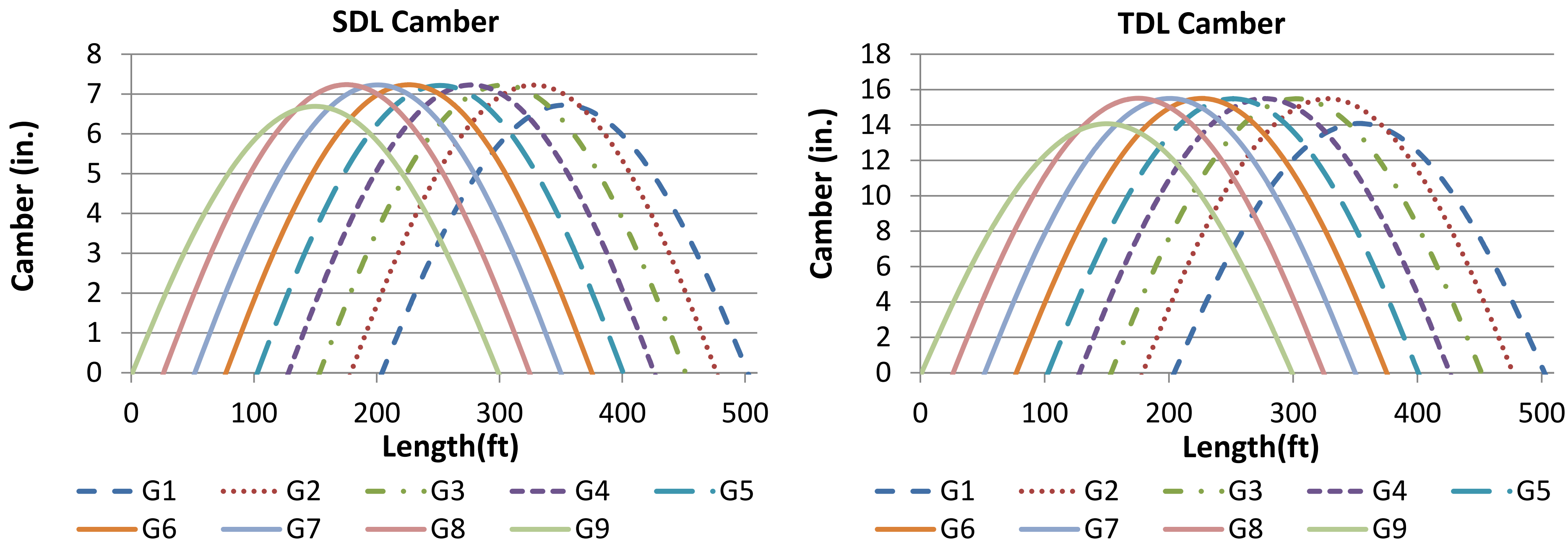


Figure J1-4-1. SDL and TDL Line Girder Analysis cambers.

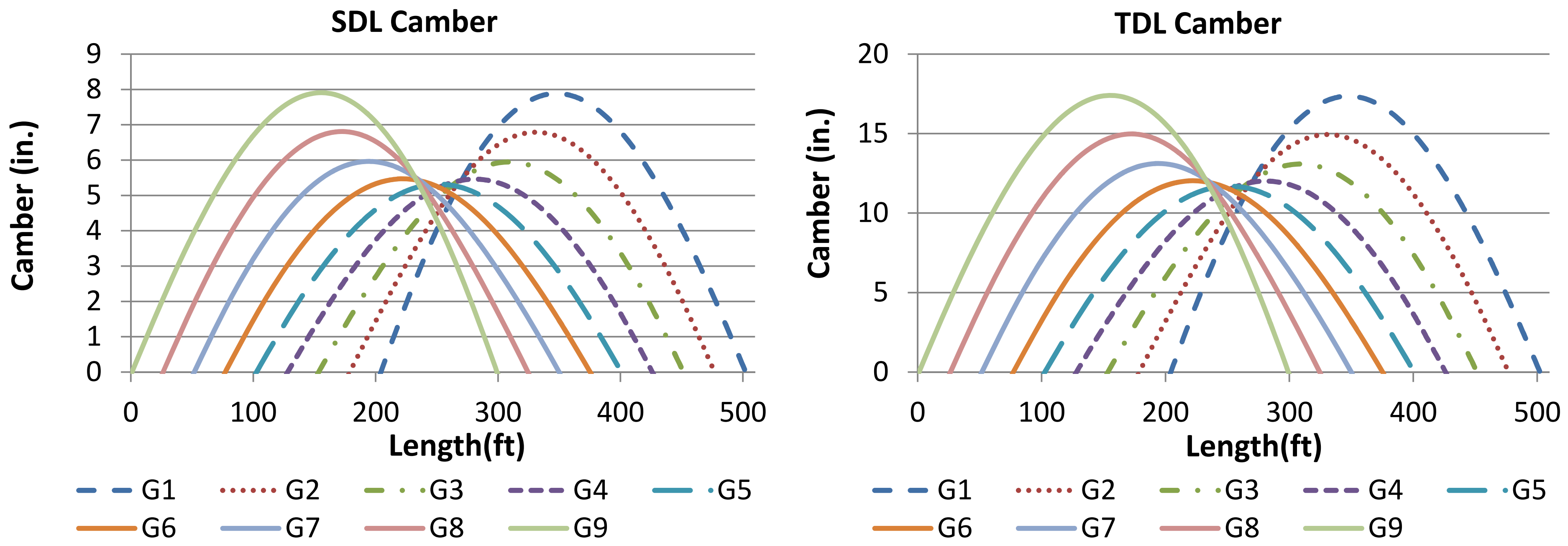


Figure J1-4-2. SDL and TDL 3D FEA cambers.

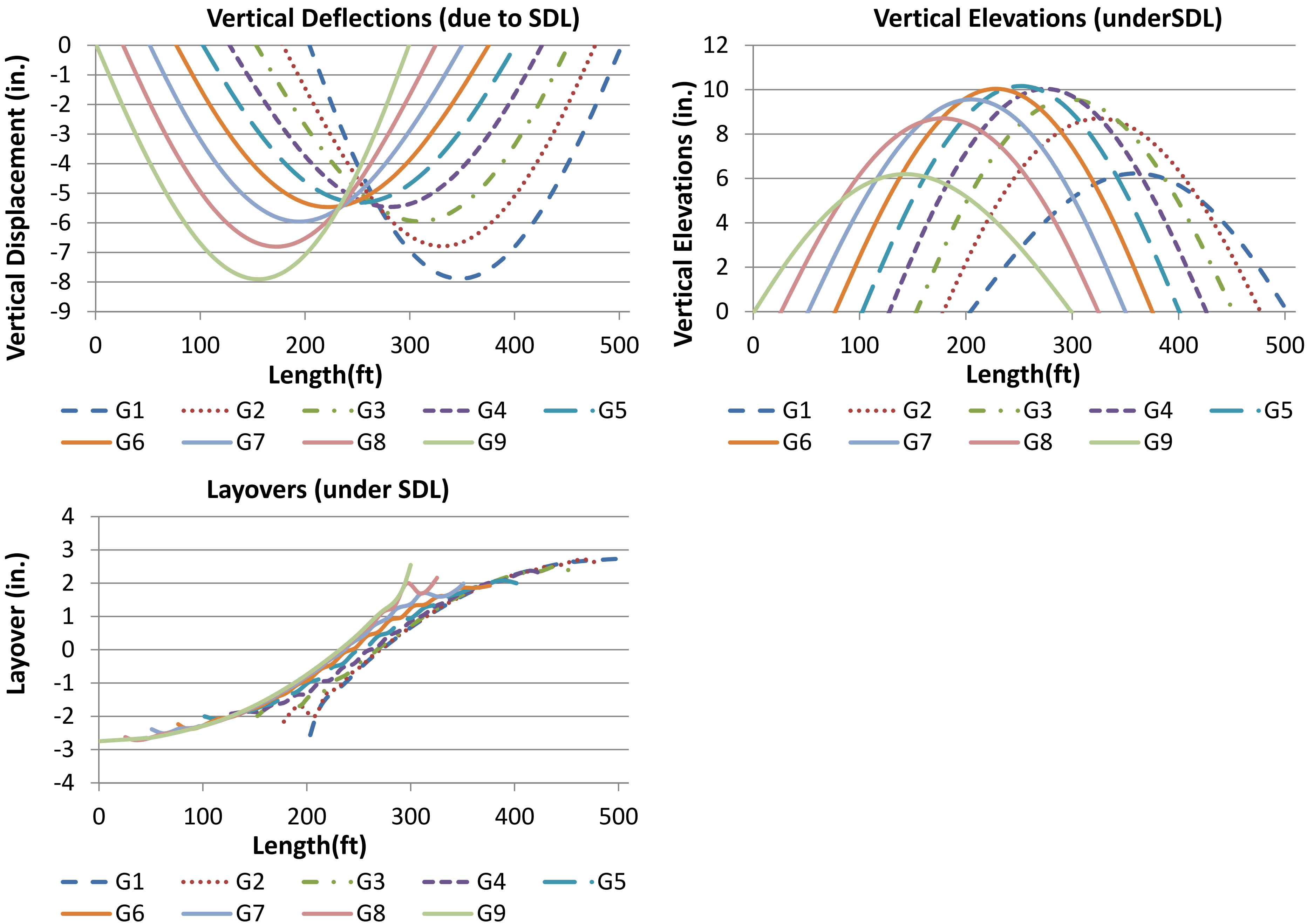


Figure J1-4-3. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

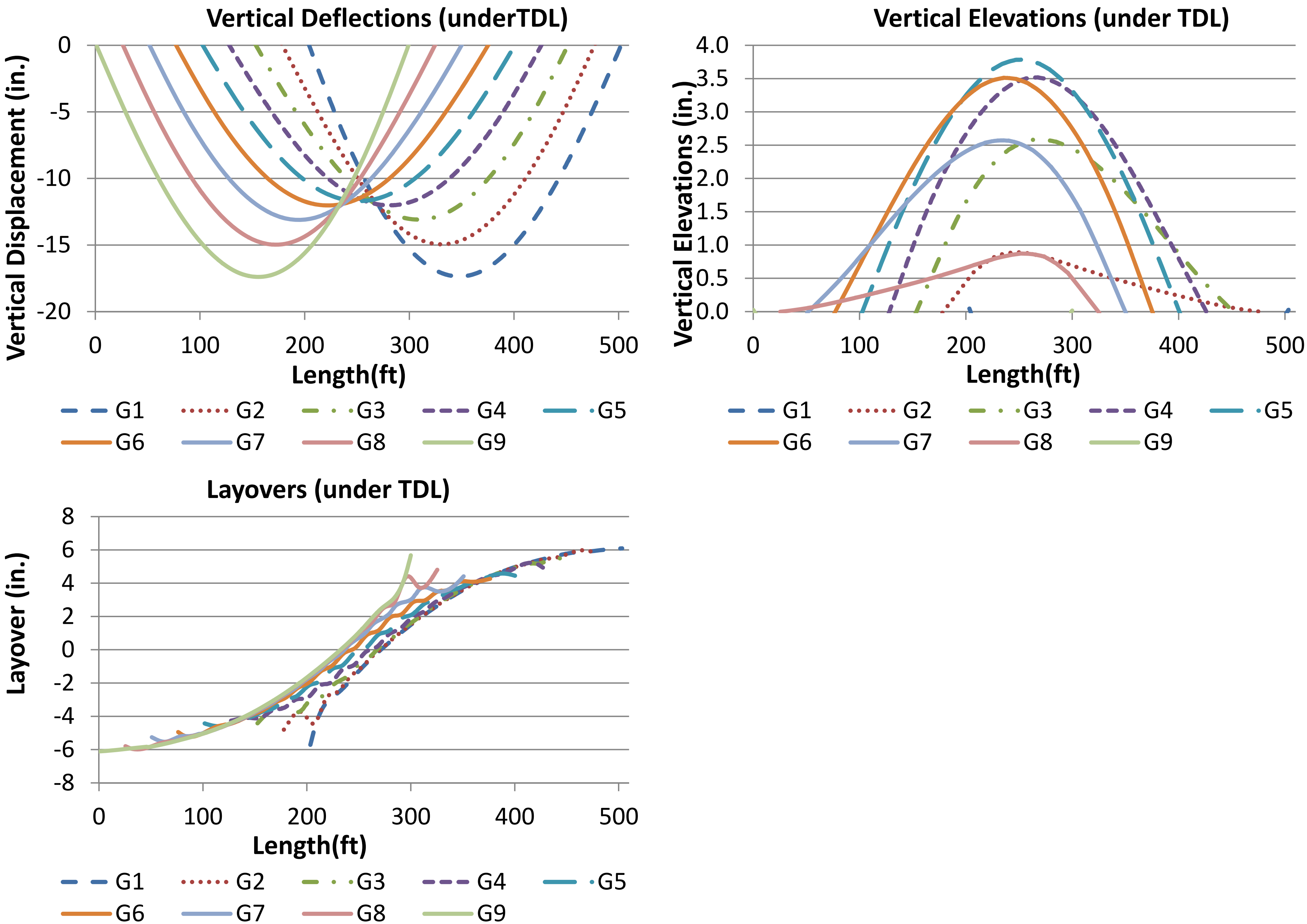
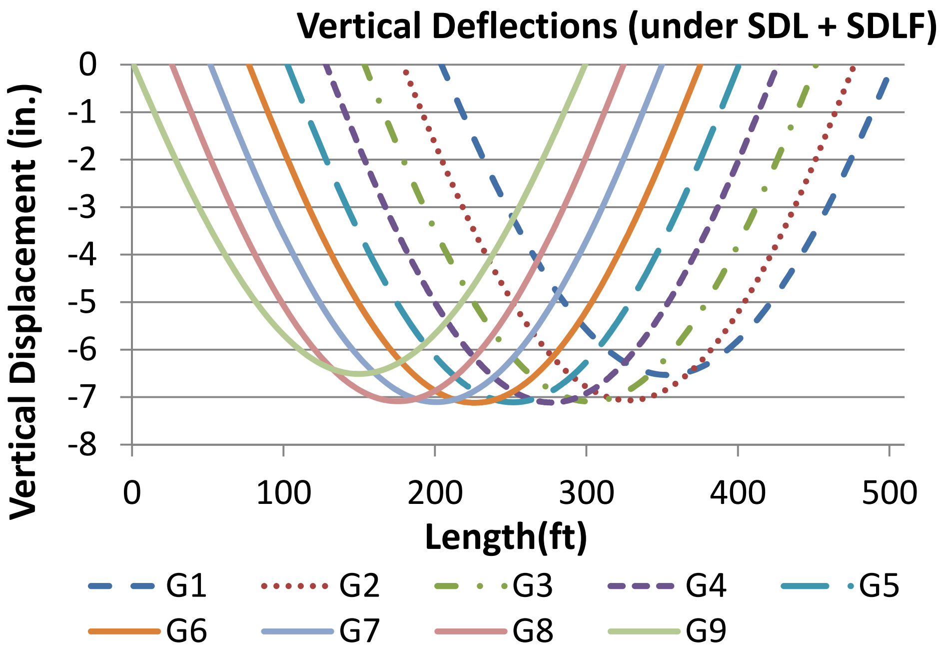
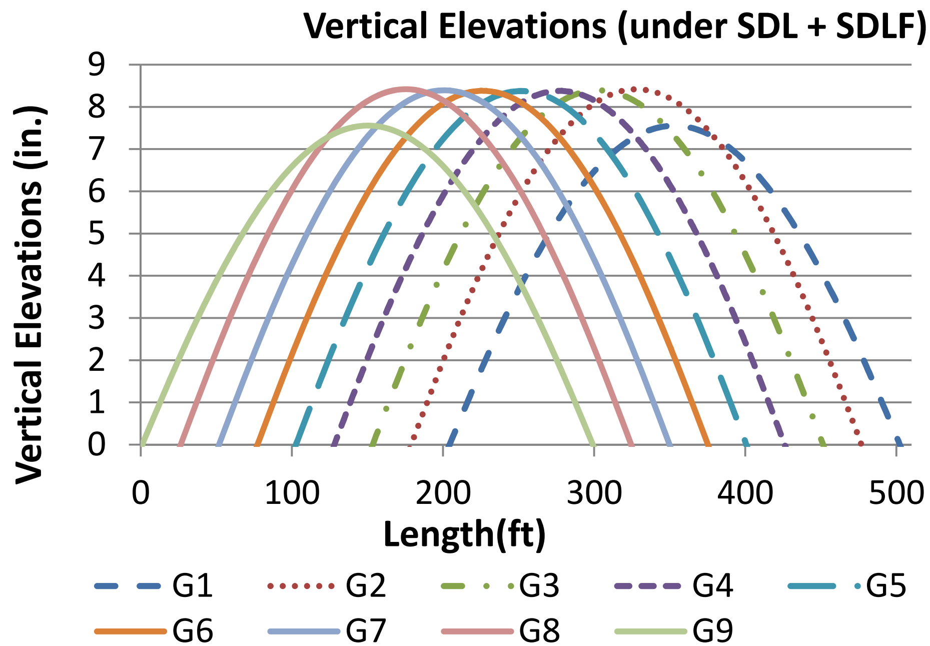


Figure J1-4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.





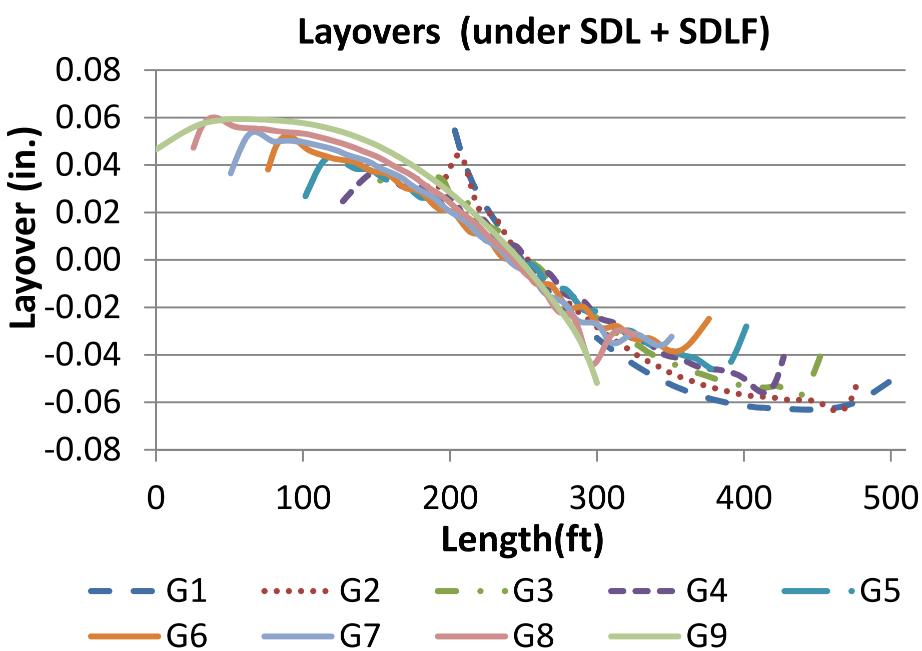


Figure J1-4-5. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

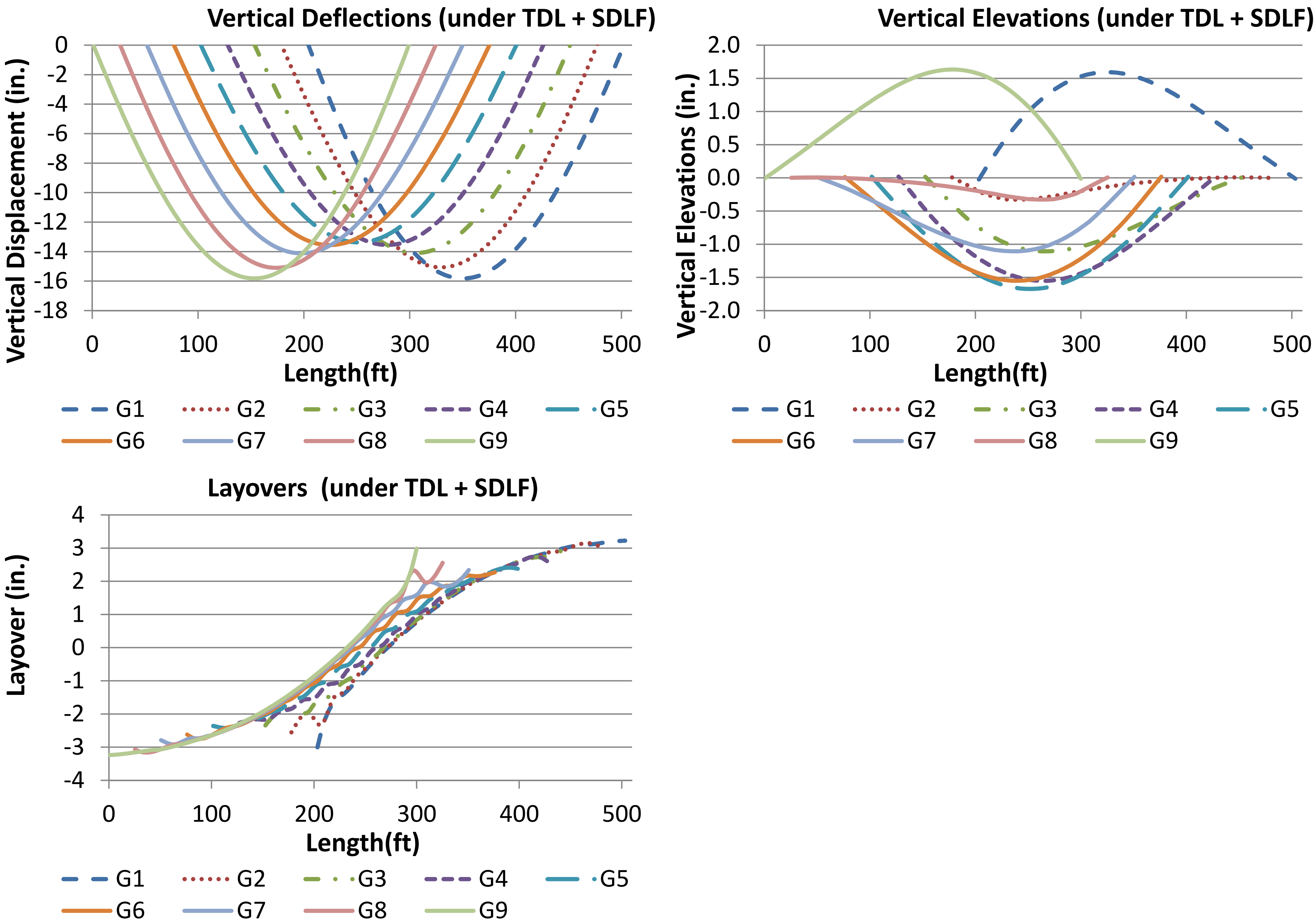


Figure J1-4-6. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

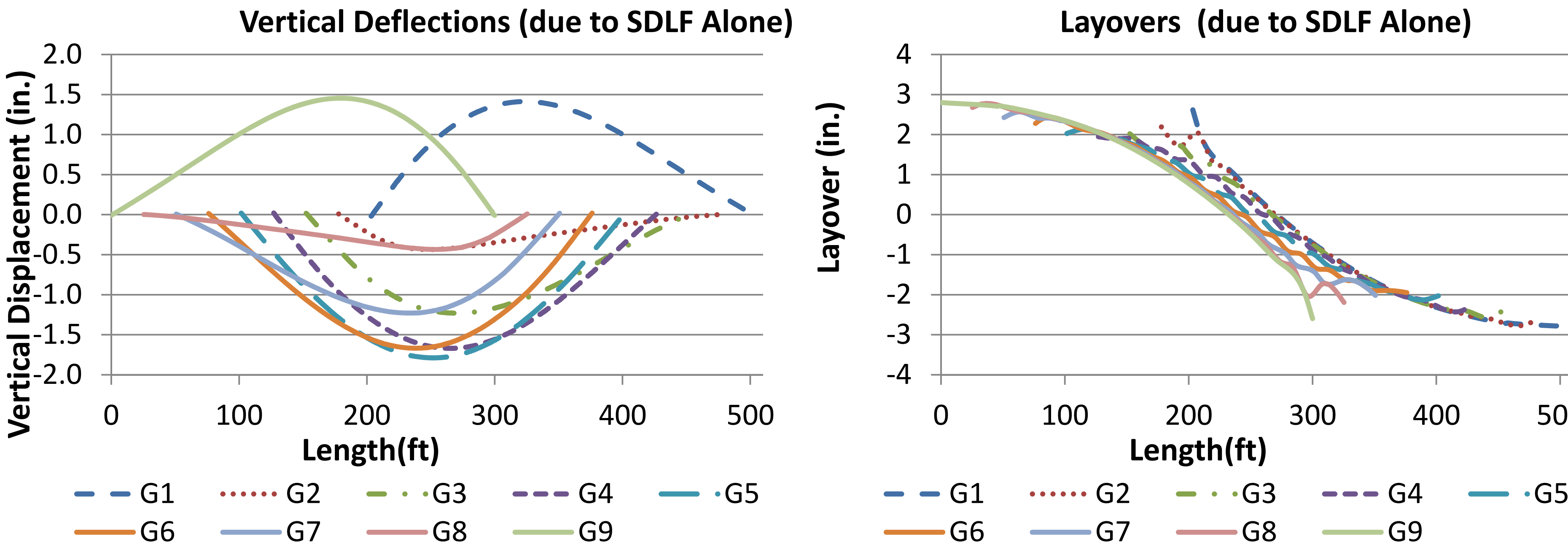


Figure J1-4-7. Bridge displacements due to SDLF detailing effects alone under NL(in).

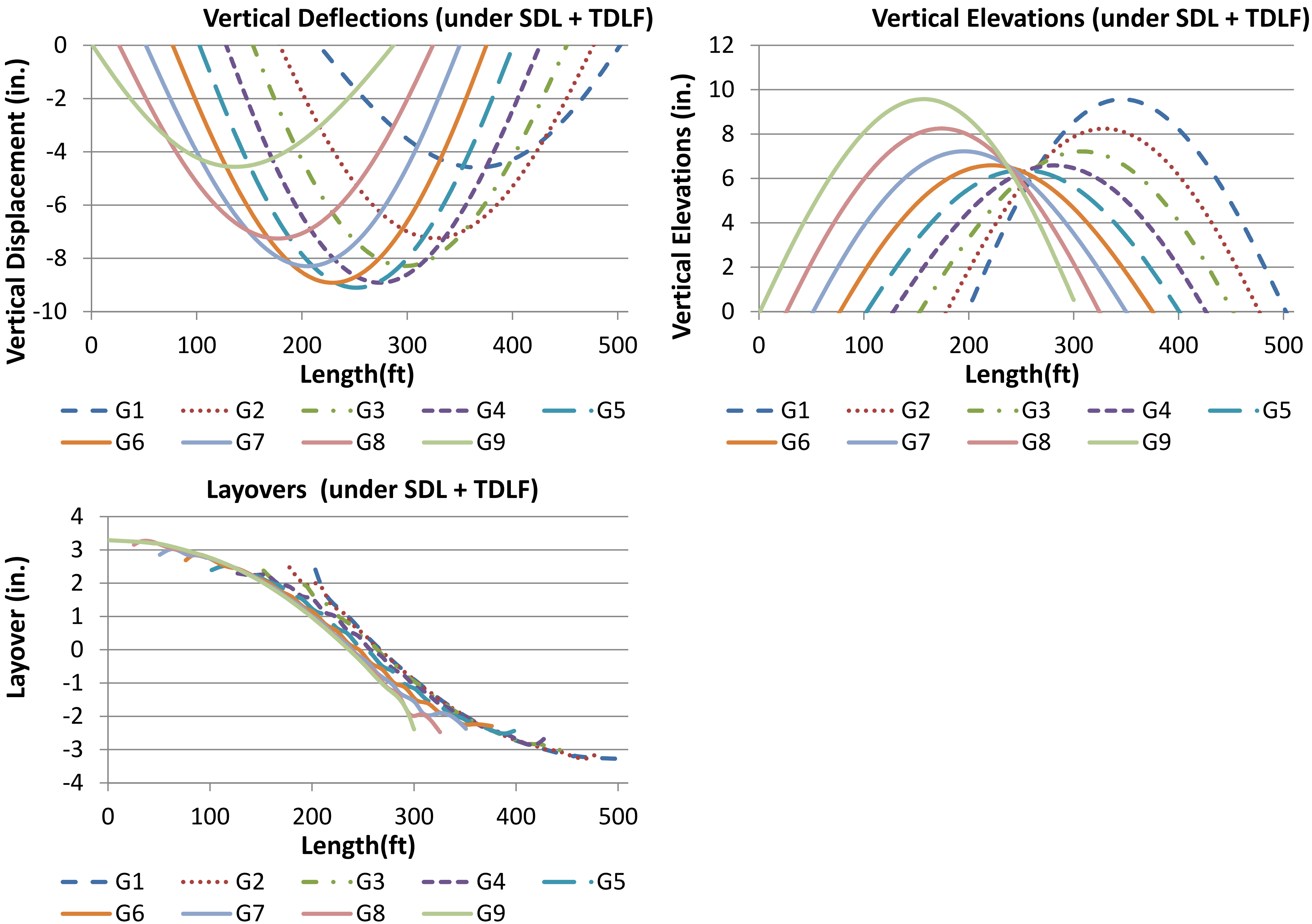


Figure J1-4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

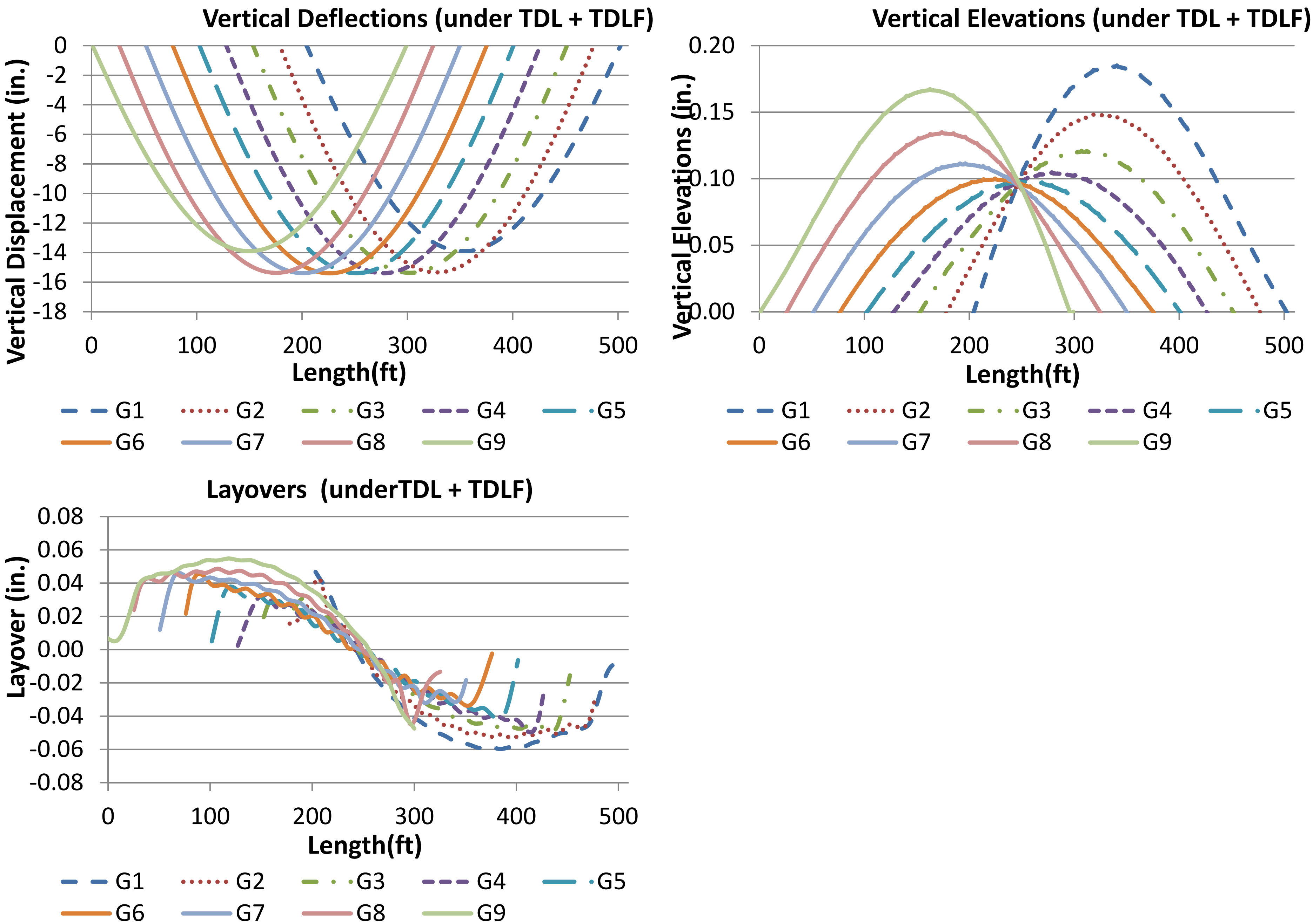


Figure J1-4-9. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

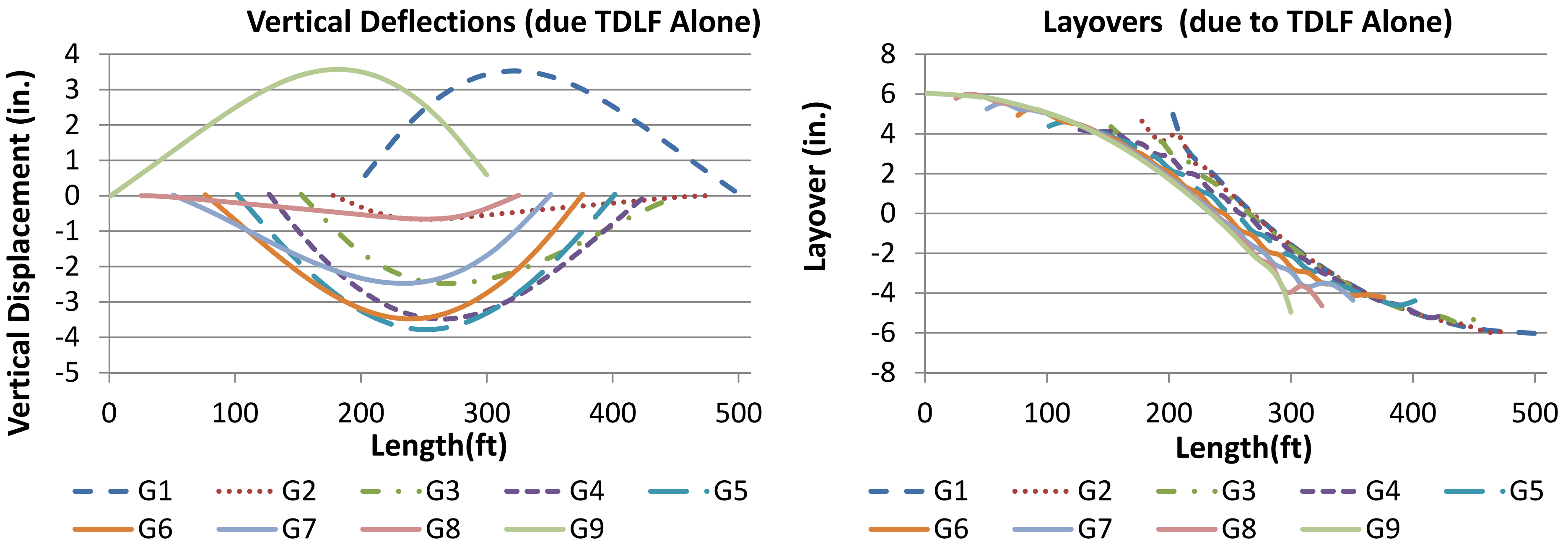


Figure J1-4-10. **Bridge displacements due to TDLF detailing effects alone under NL (in).**

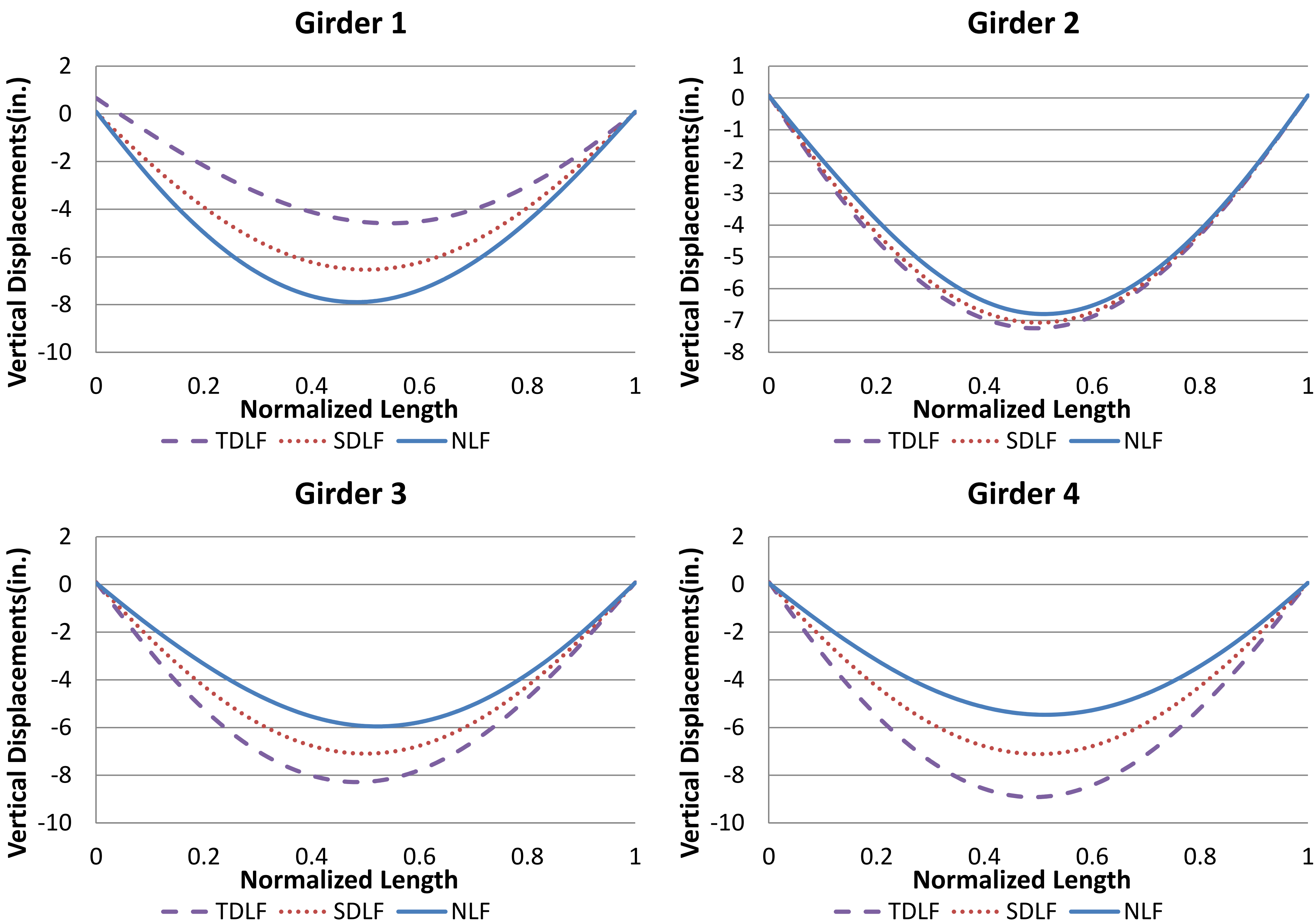


Figure J1-4-11. **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

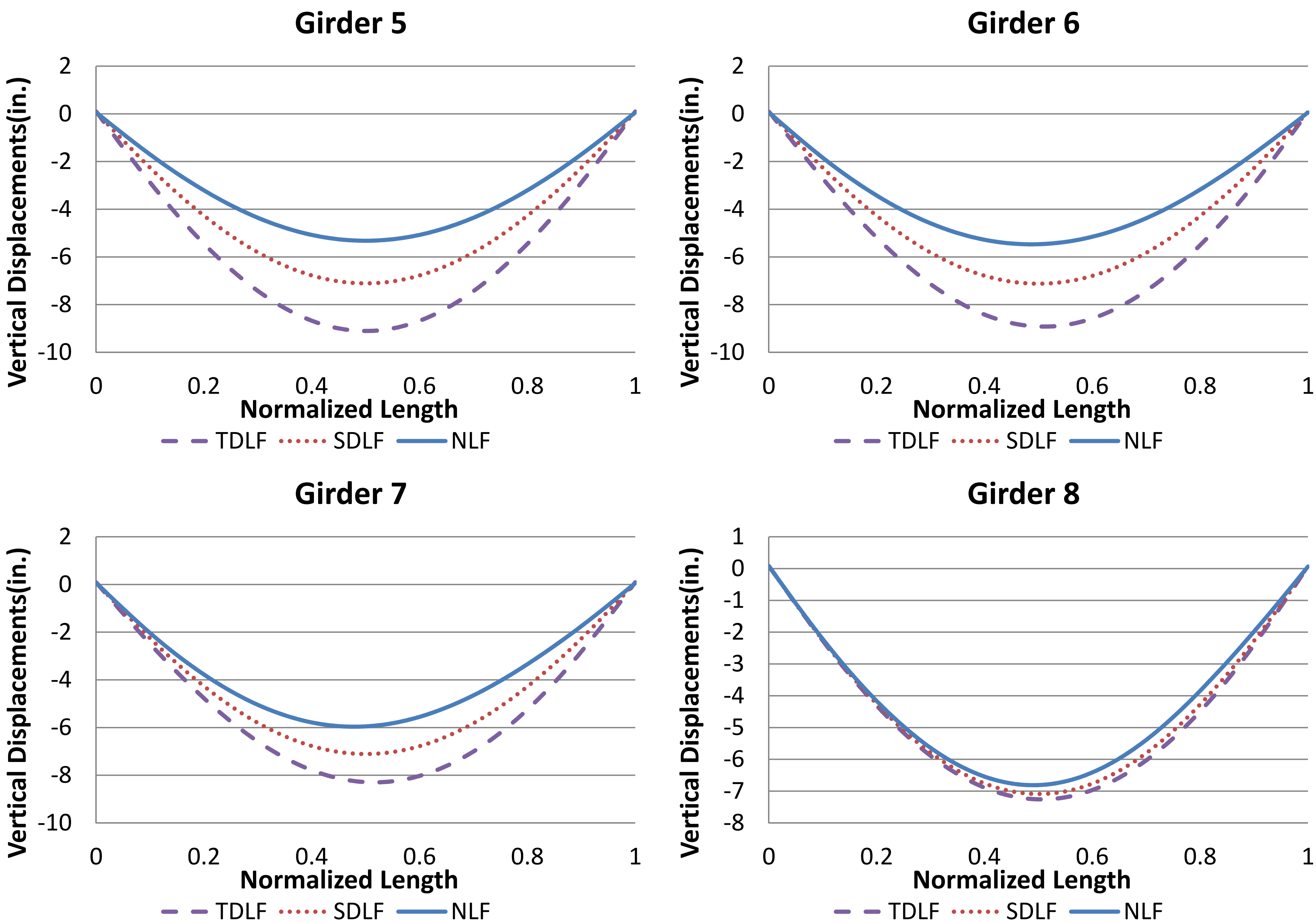


Figure J1-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

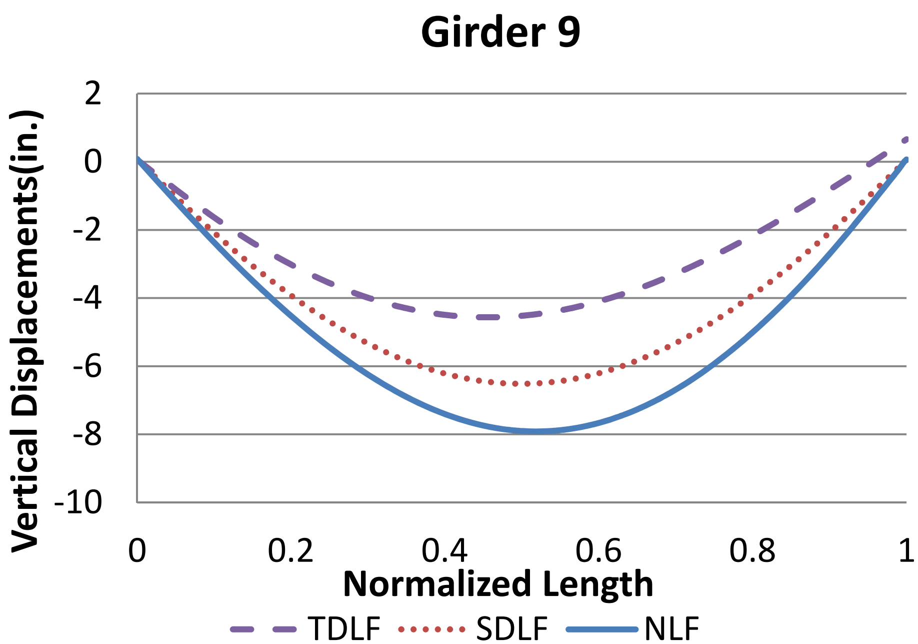


Figure J1-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

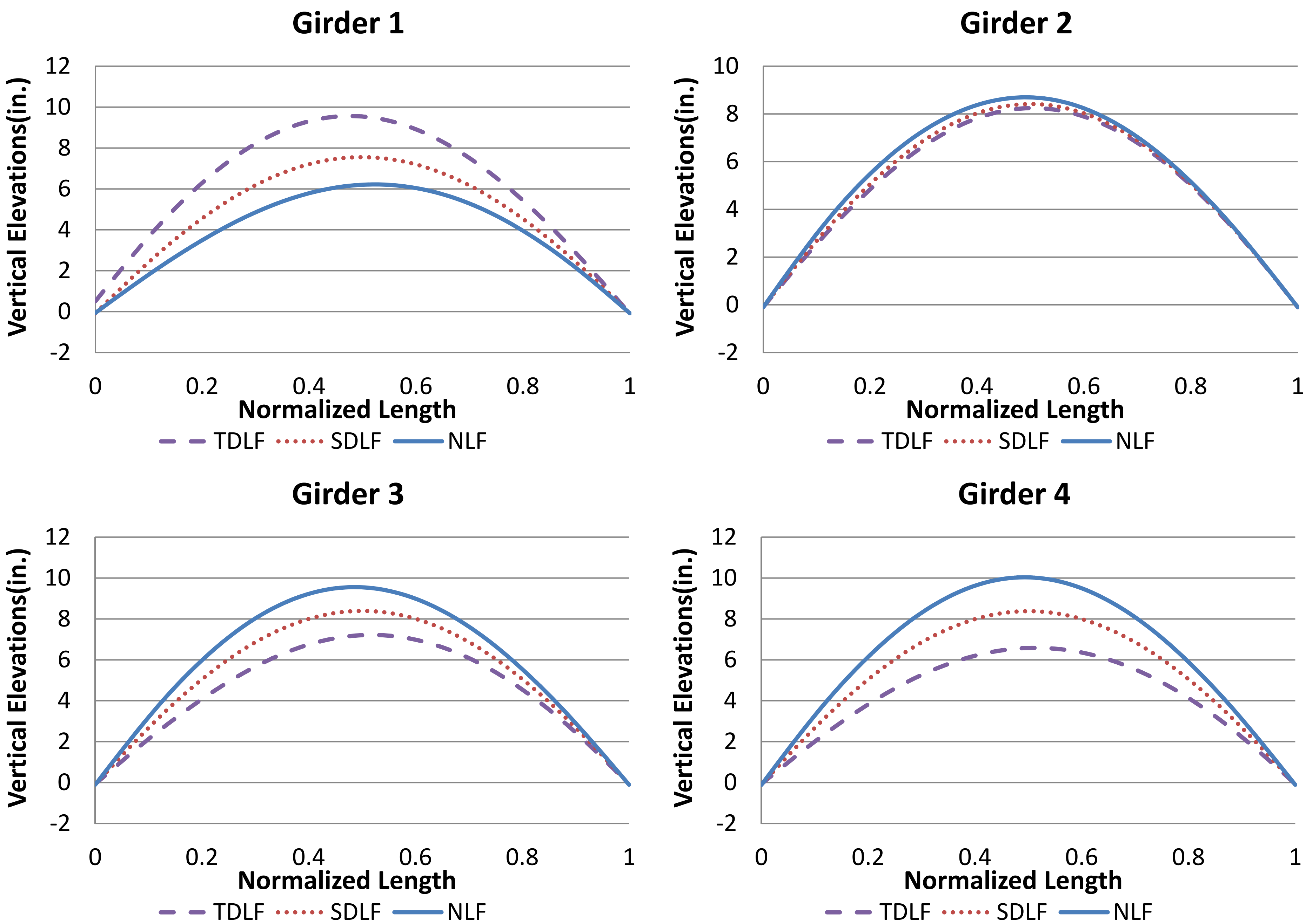


Figure J1-4-12. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

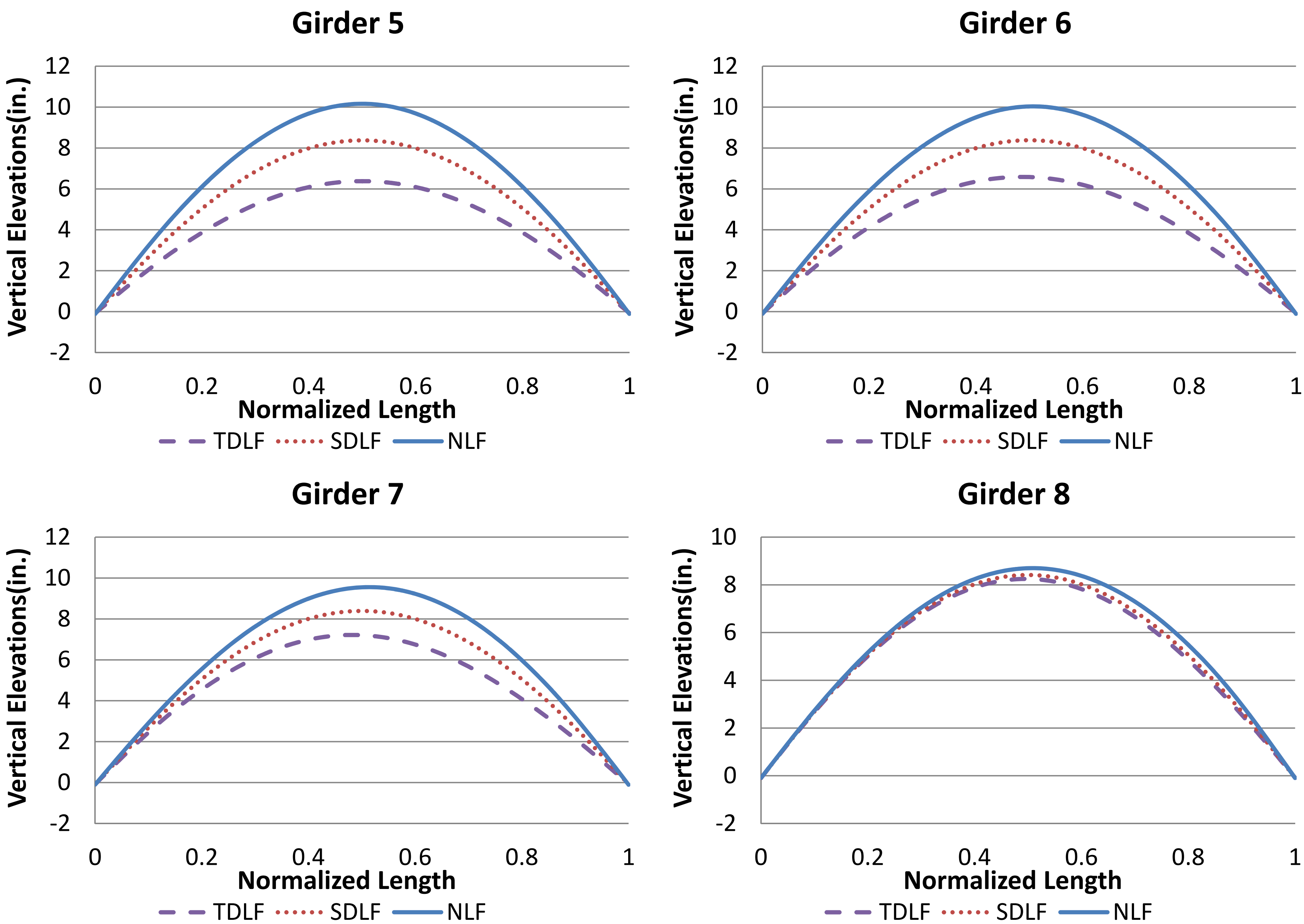


Figure J1-4-12(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

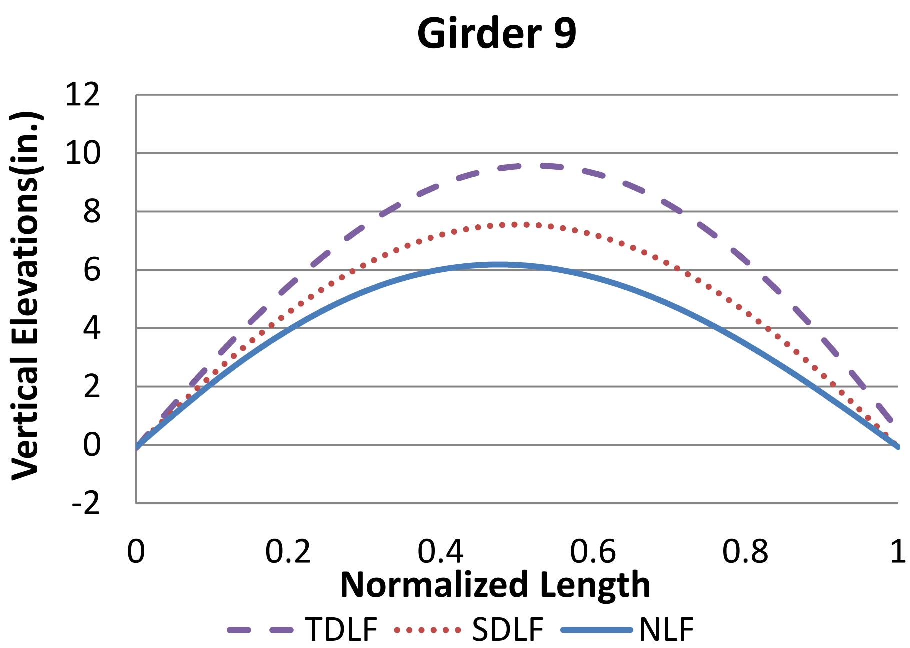


Figure J1-4-12(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

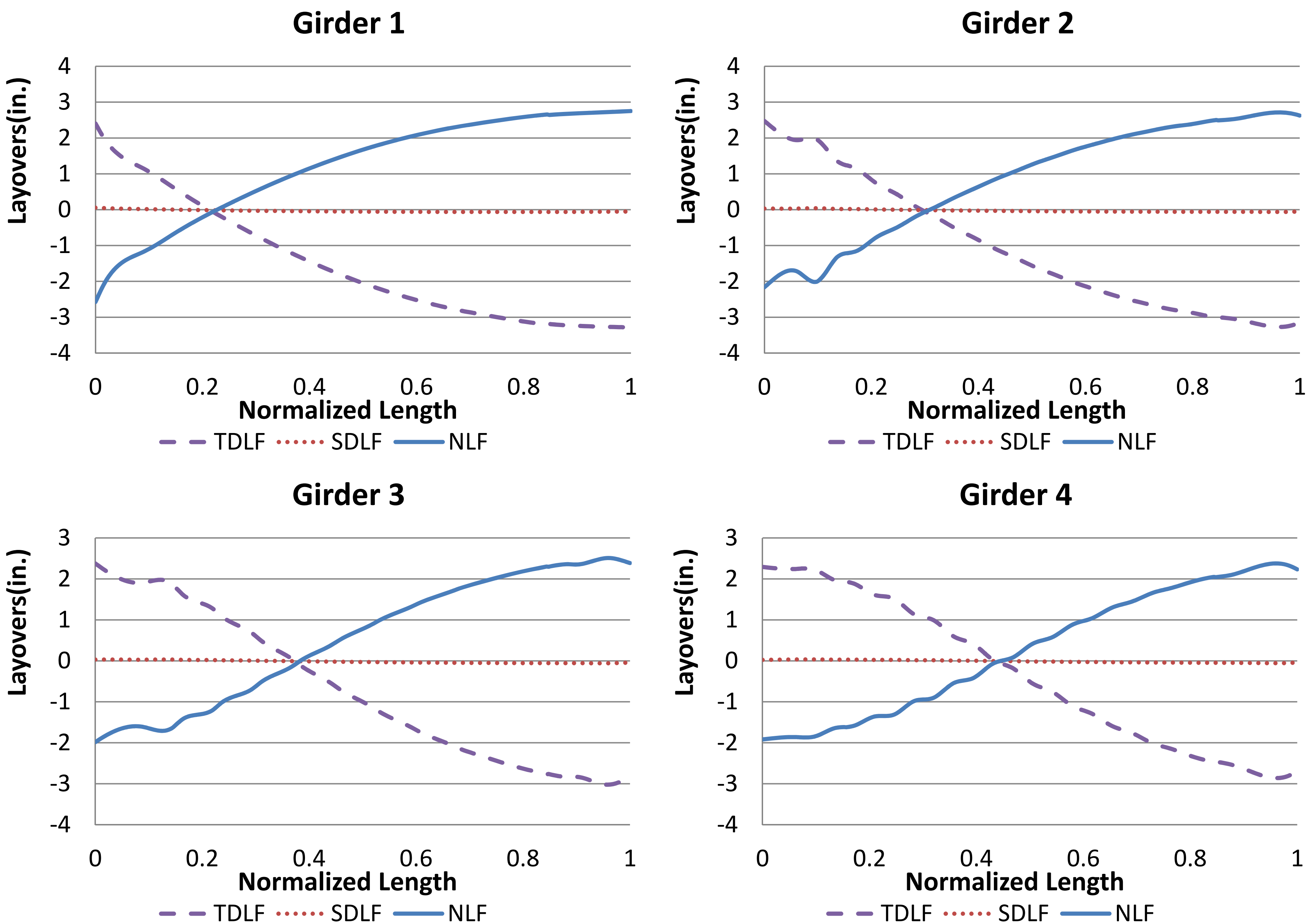


Figure J1-4-13. **Comparison of individual girder layovers (in) under SDL for different detailing methods.**

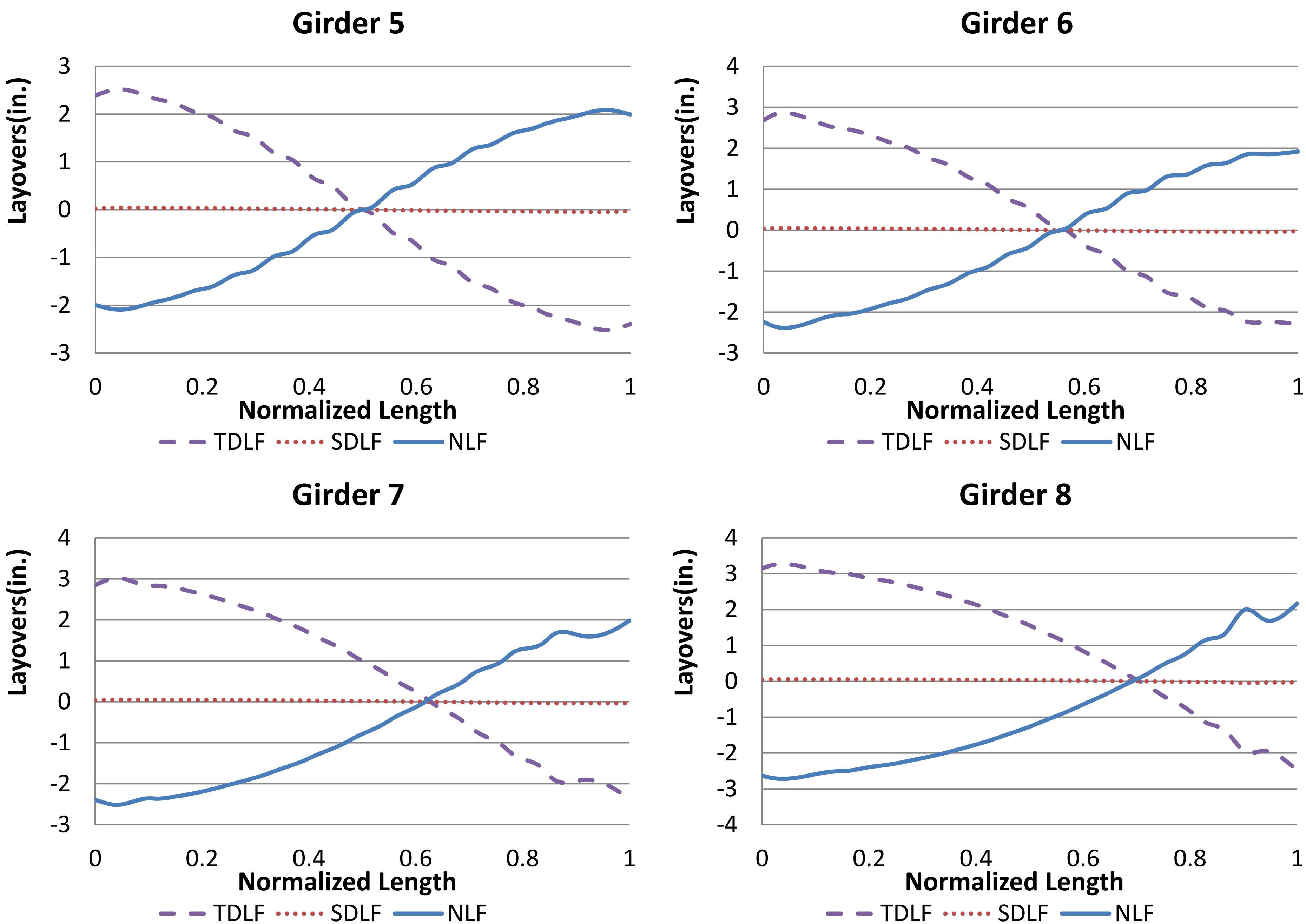


Figure J1-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

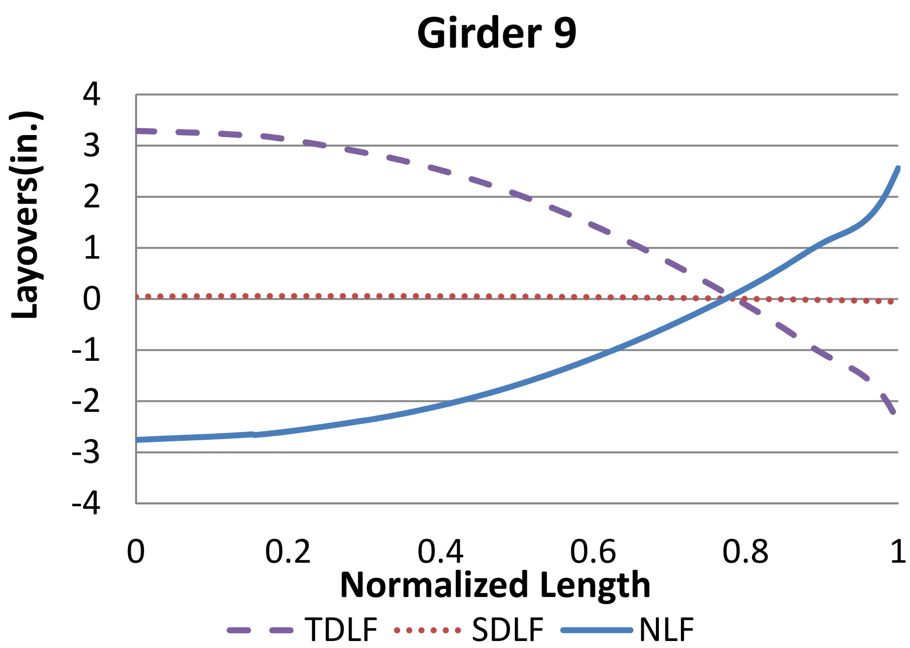


Figure J1-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

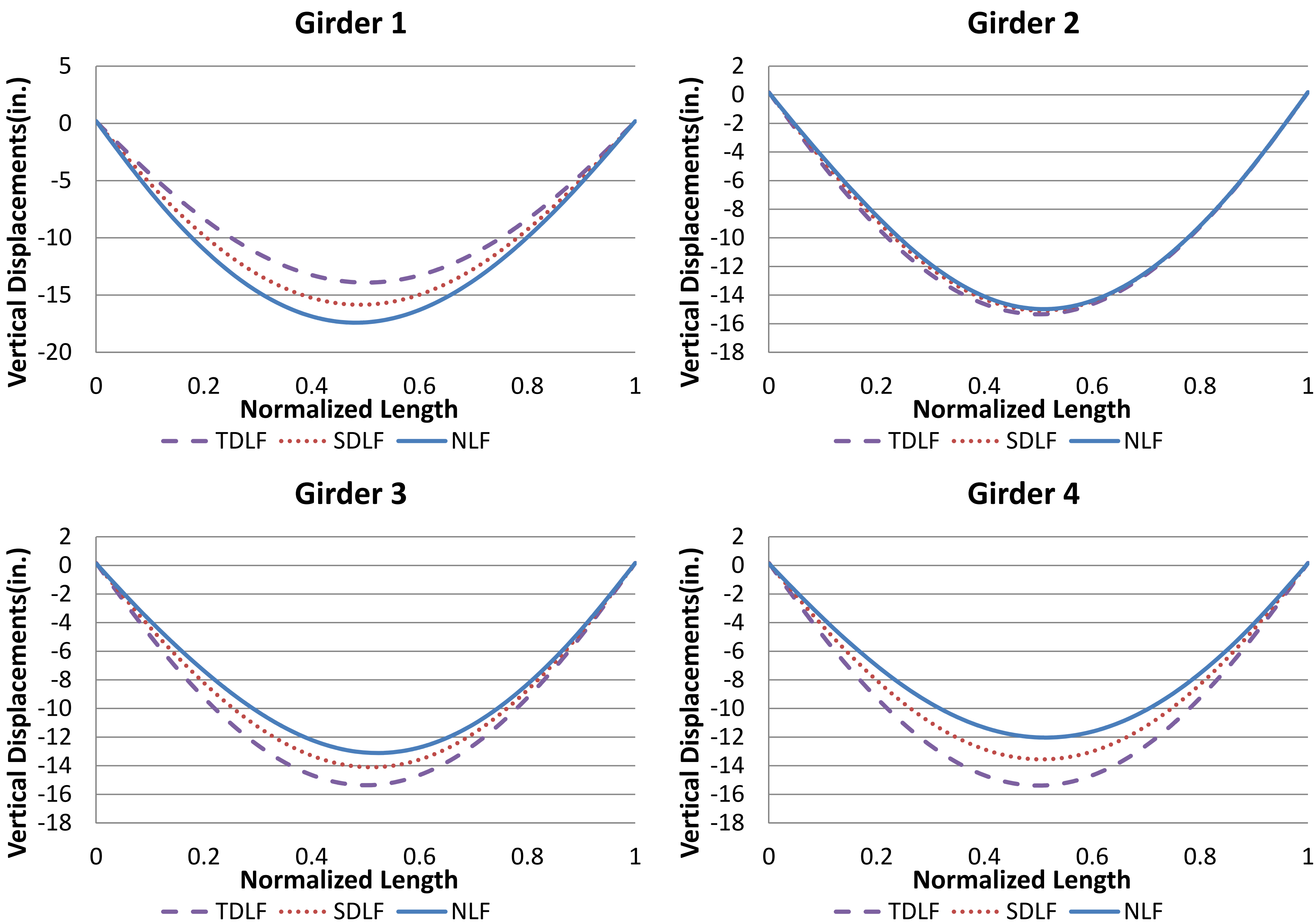


Figure J1-4-14. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

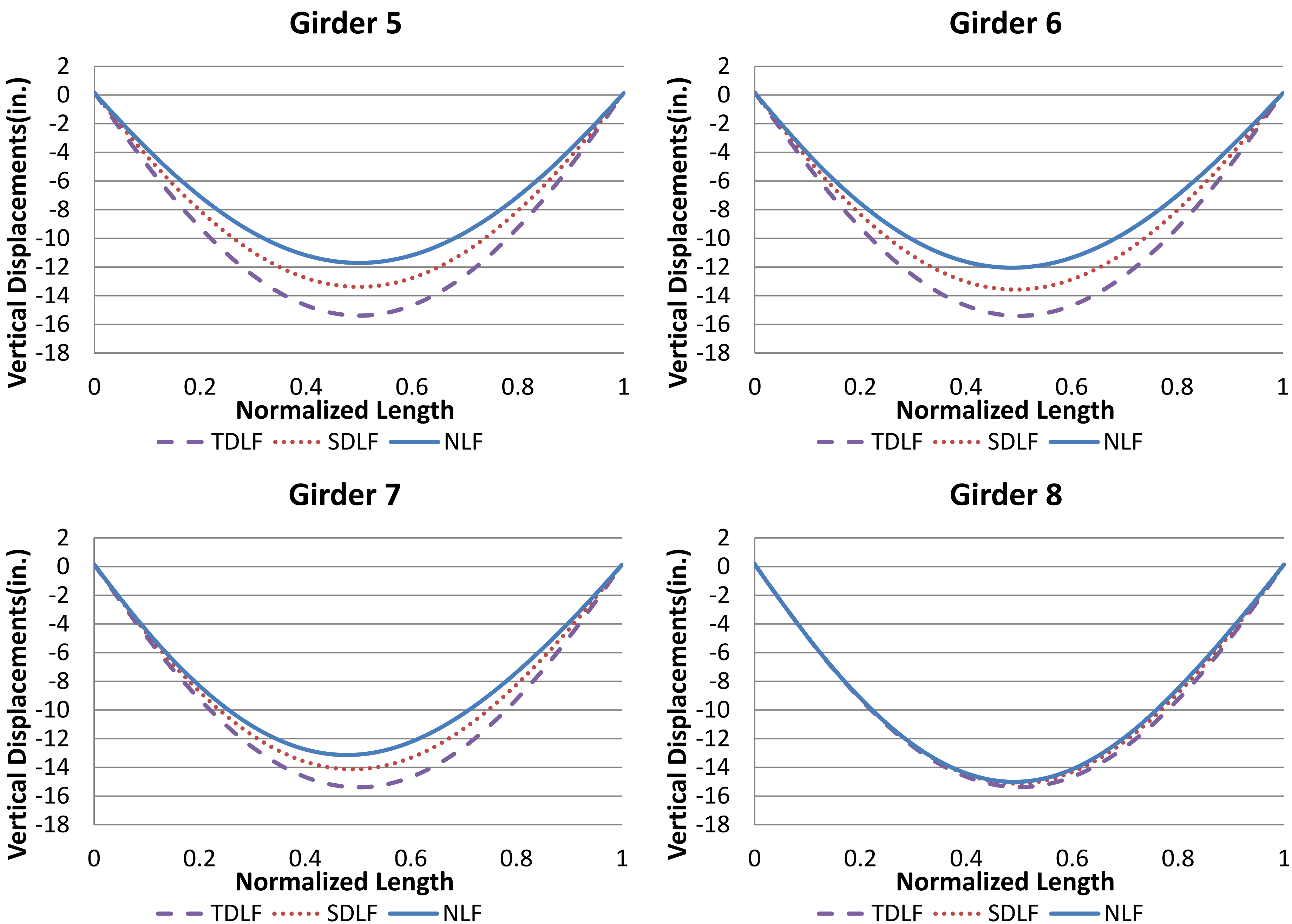


Figure J1-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

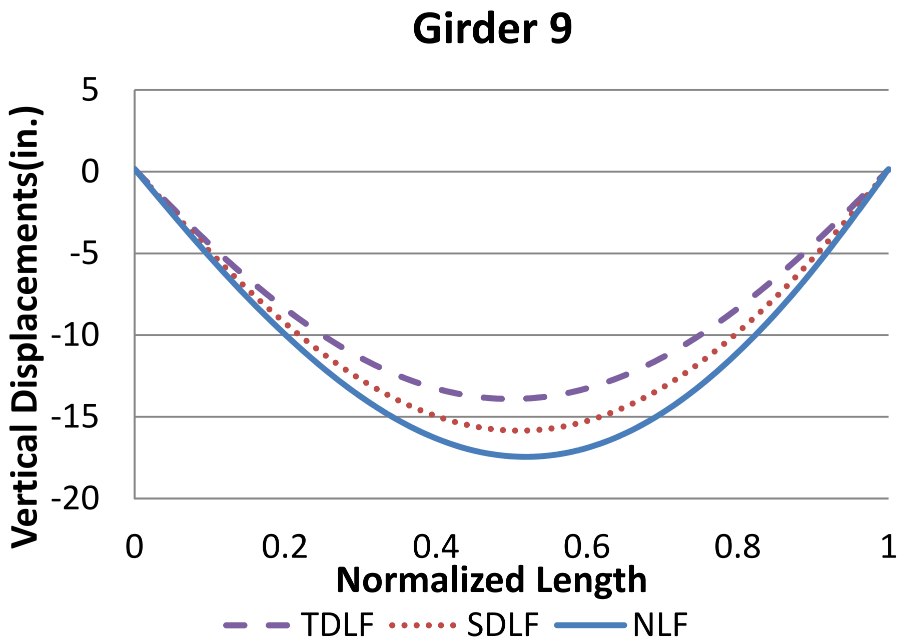


Figure J1-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

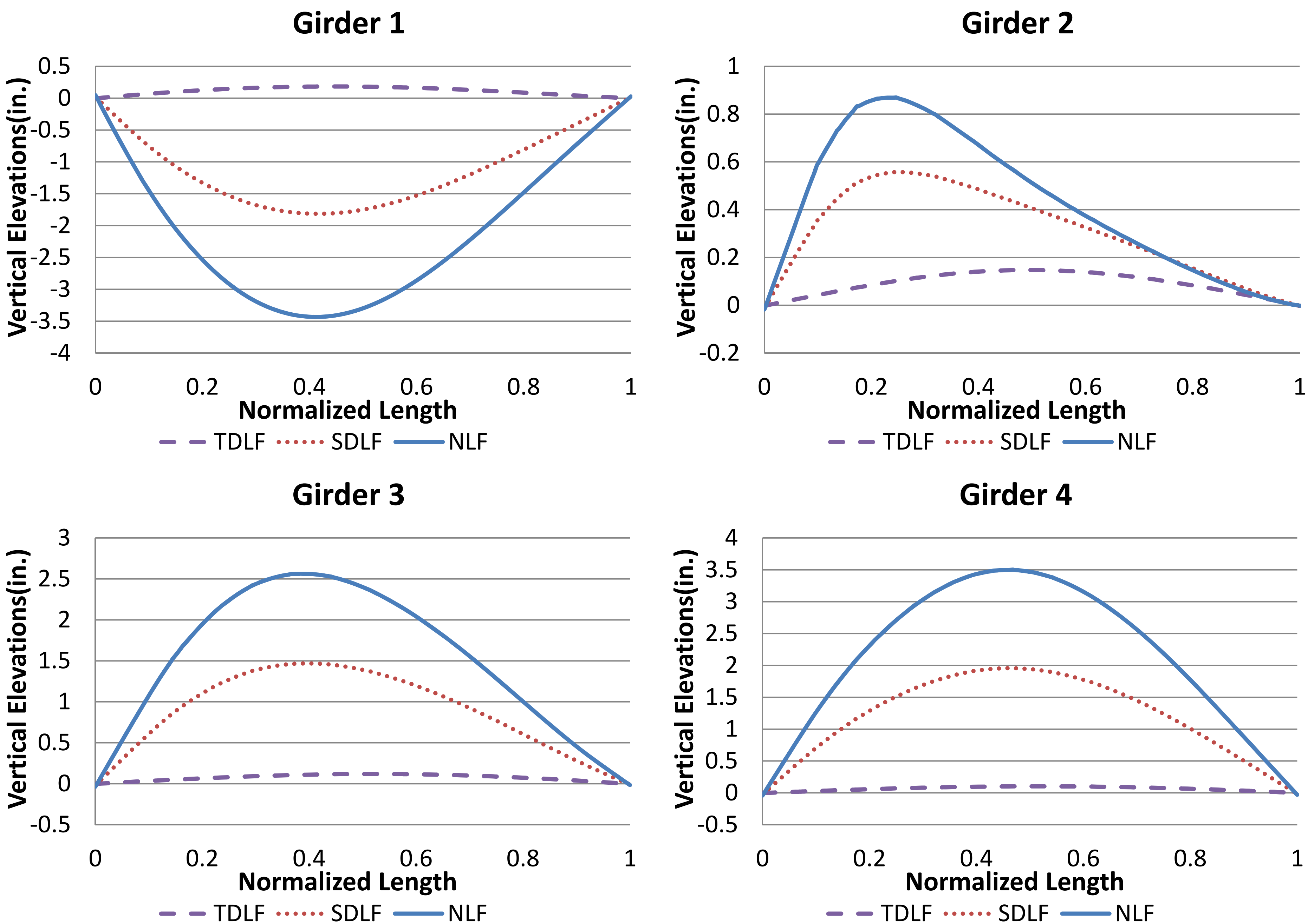


Figure J1-4-15. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

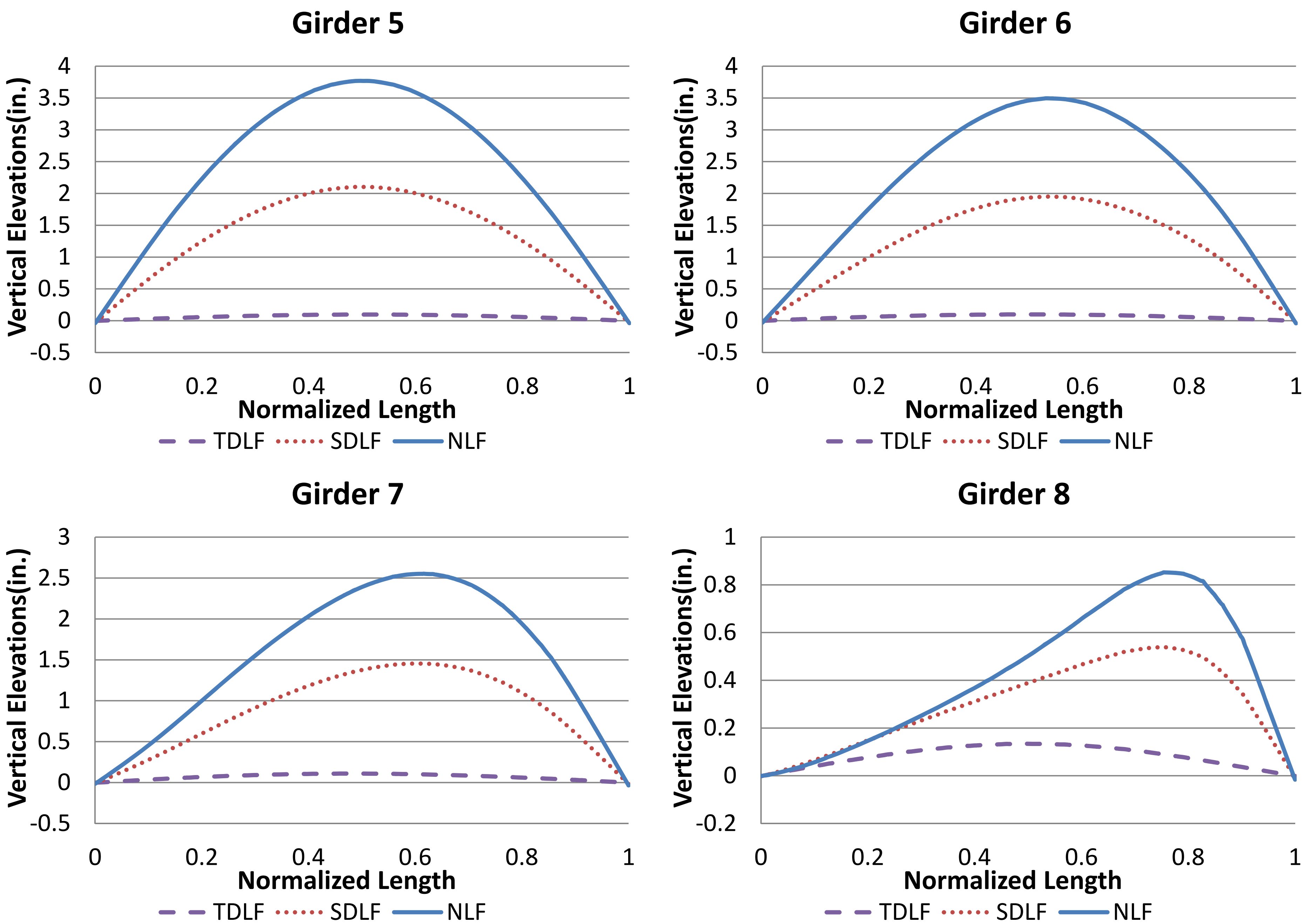


Figure J1-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

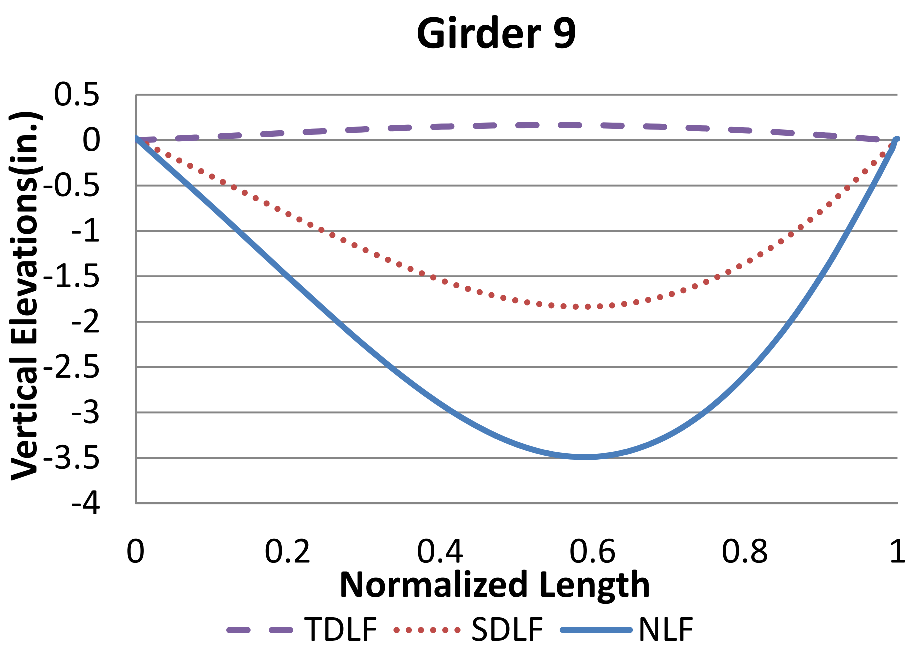


Figure J1-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

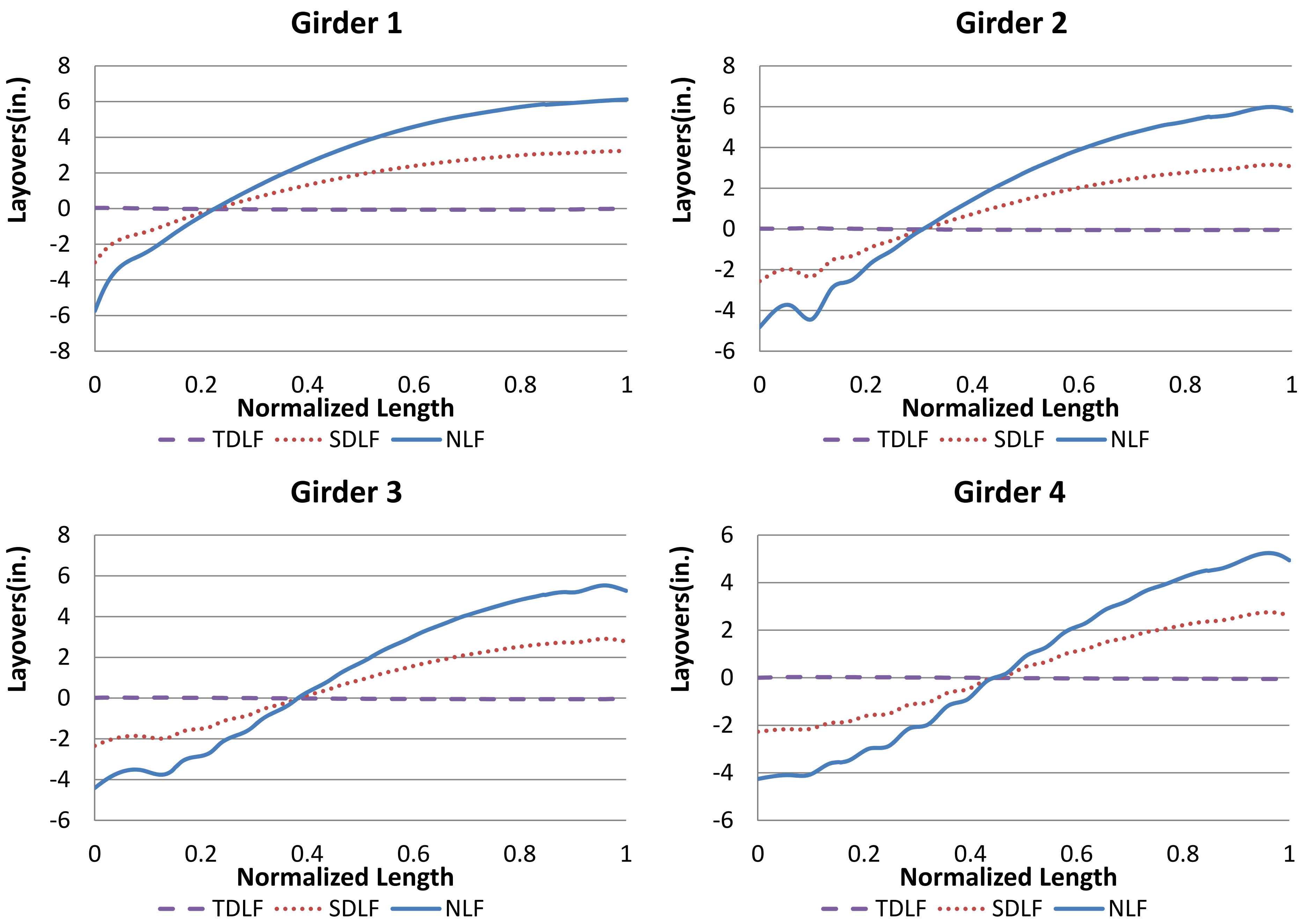


Figure J1-4-16. Comparison of individual girder layovers (in) under TDL for different detailing methods.

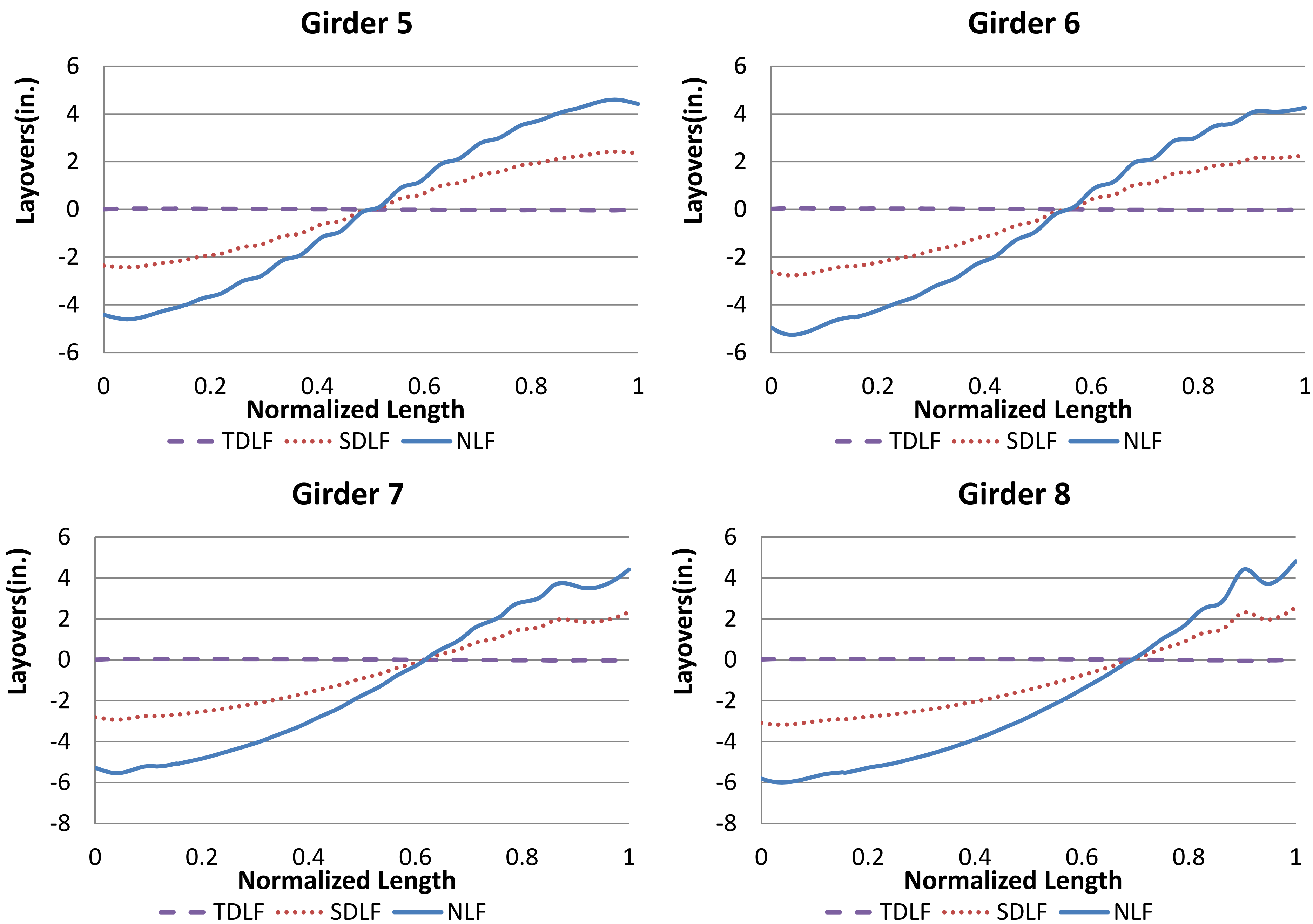


Figure J1-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

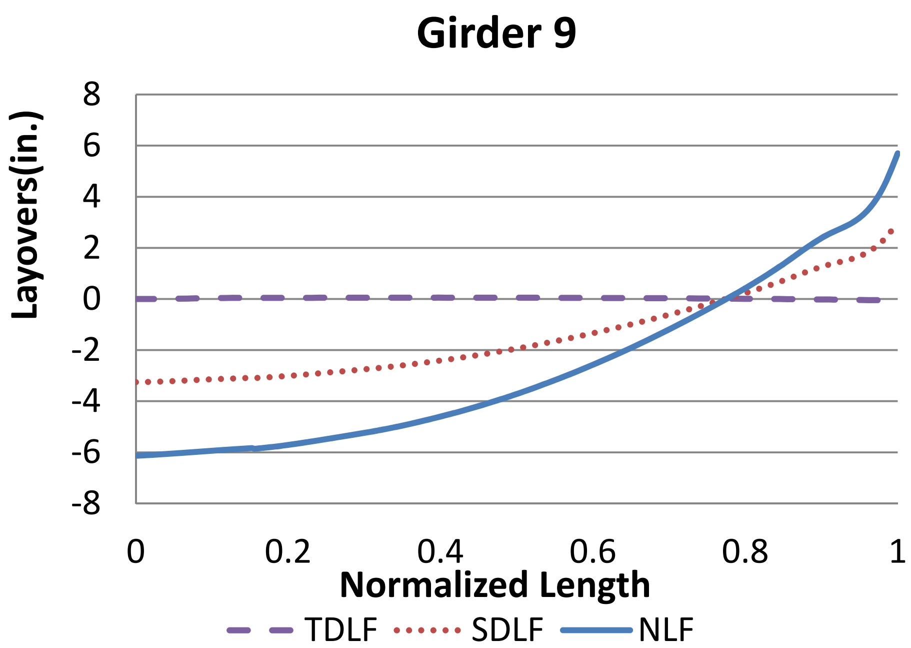


Figure J1-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

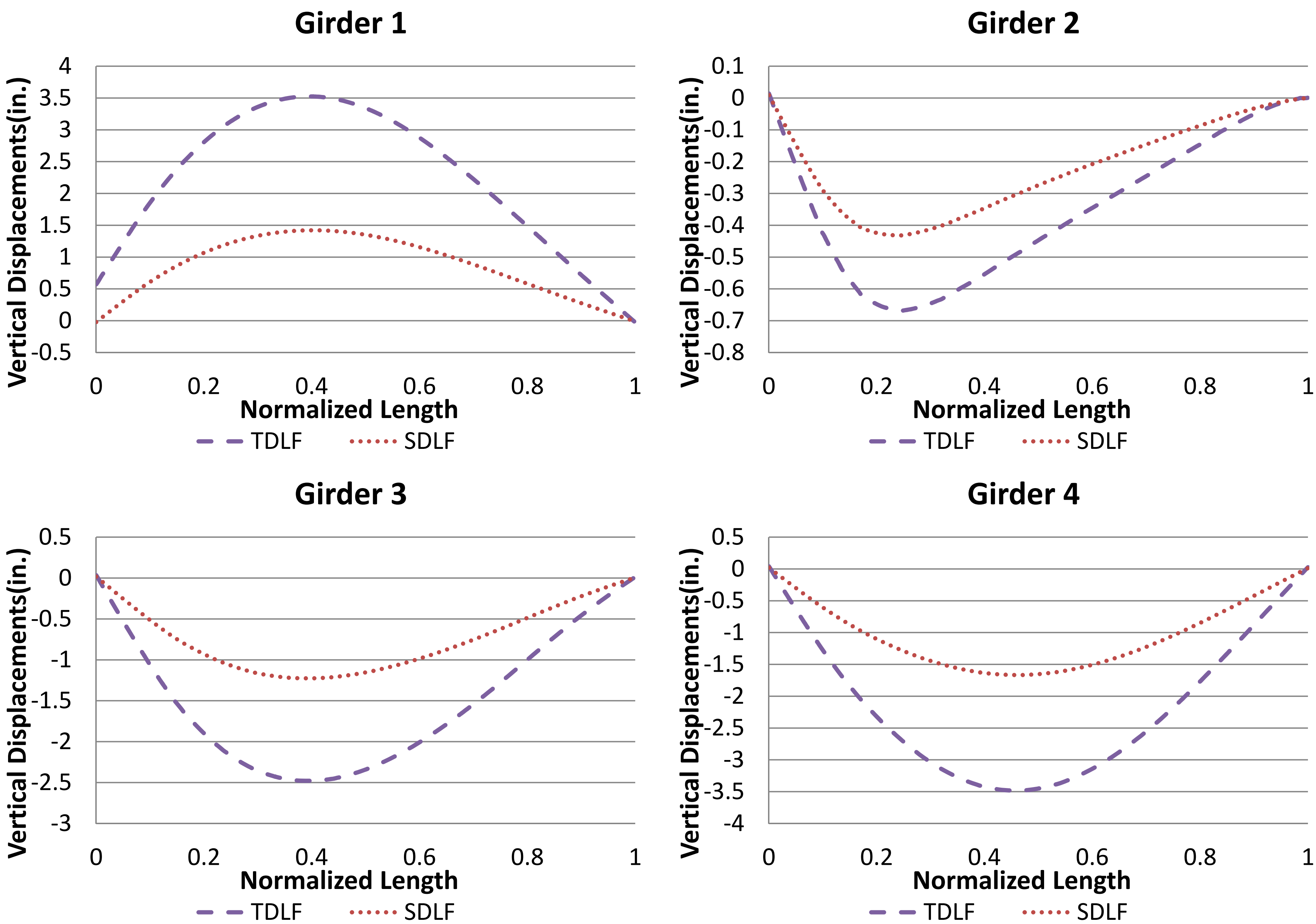


Figure J1-4-17. **Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.**

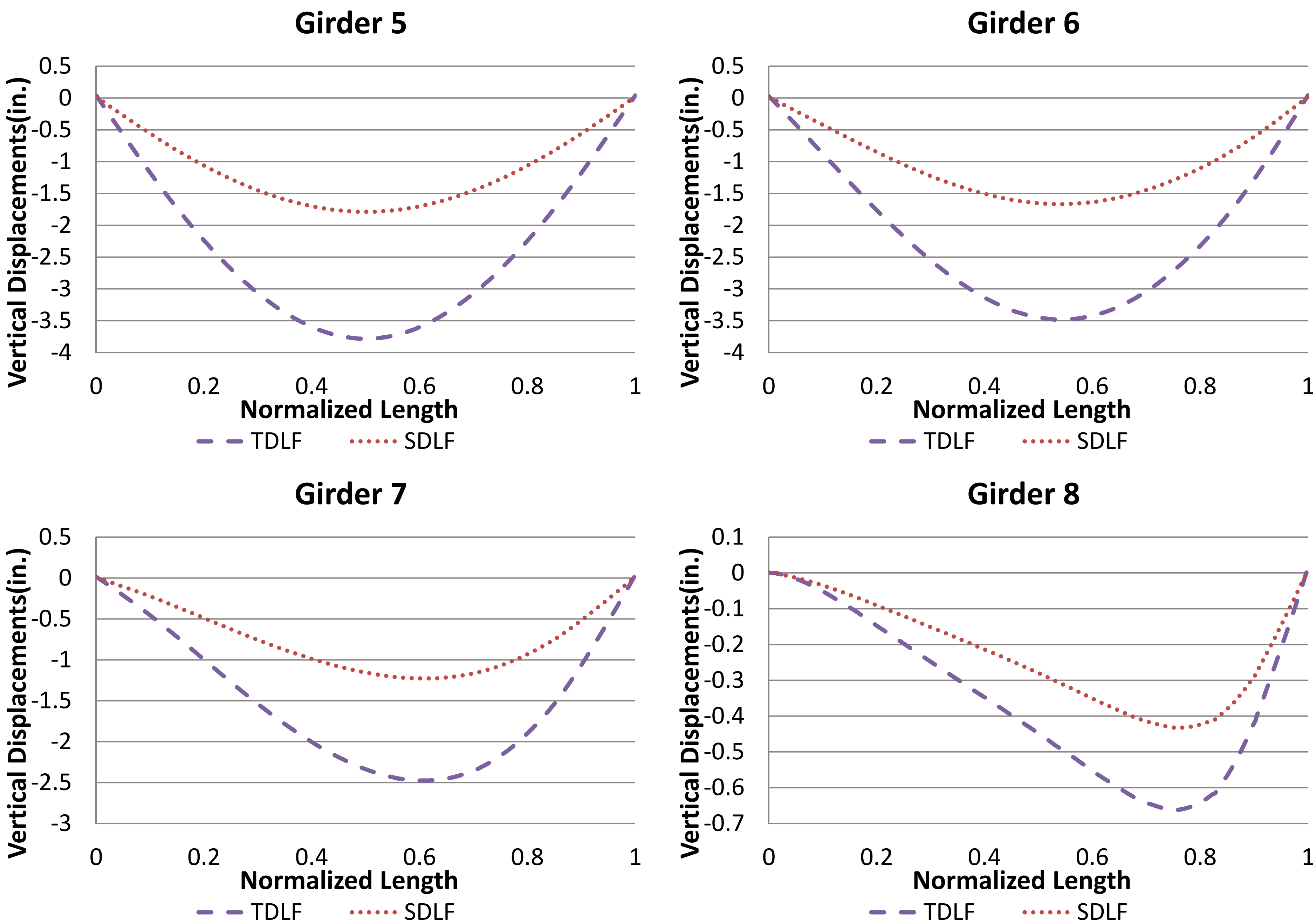


Figure J1-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

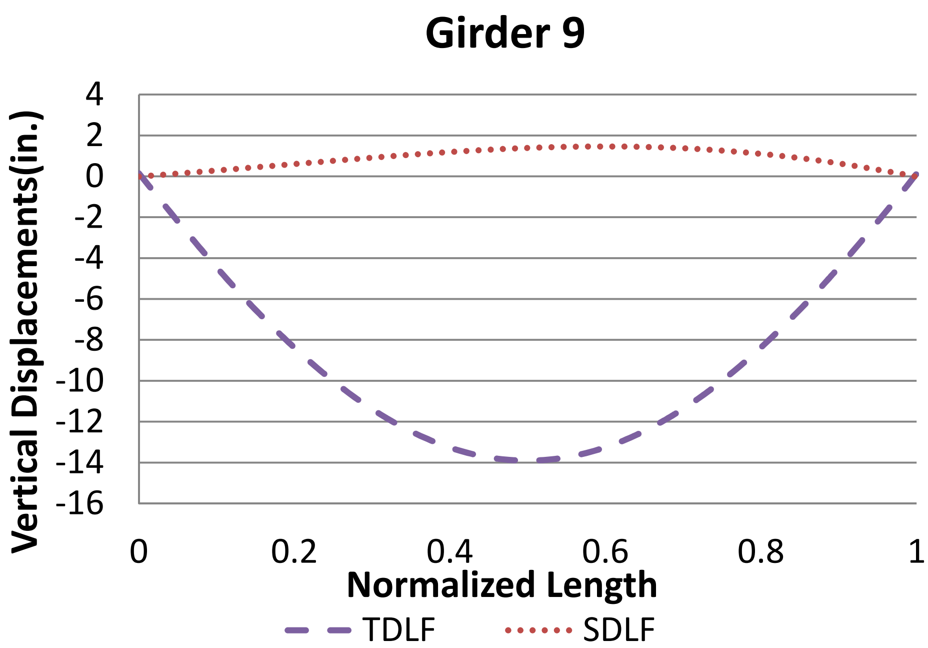


Figure J1-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

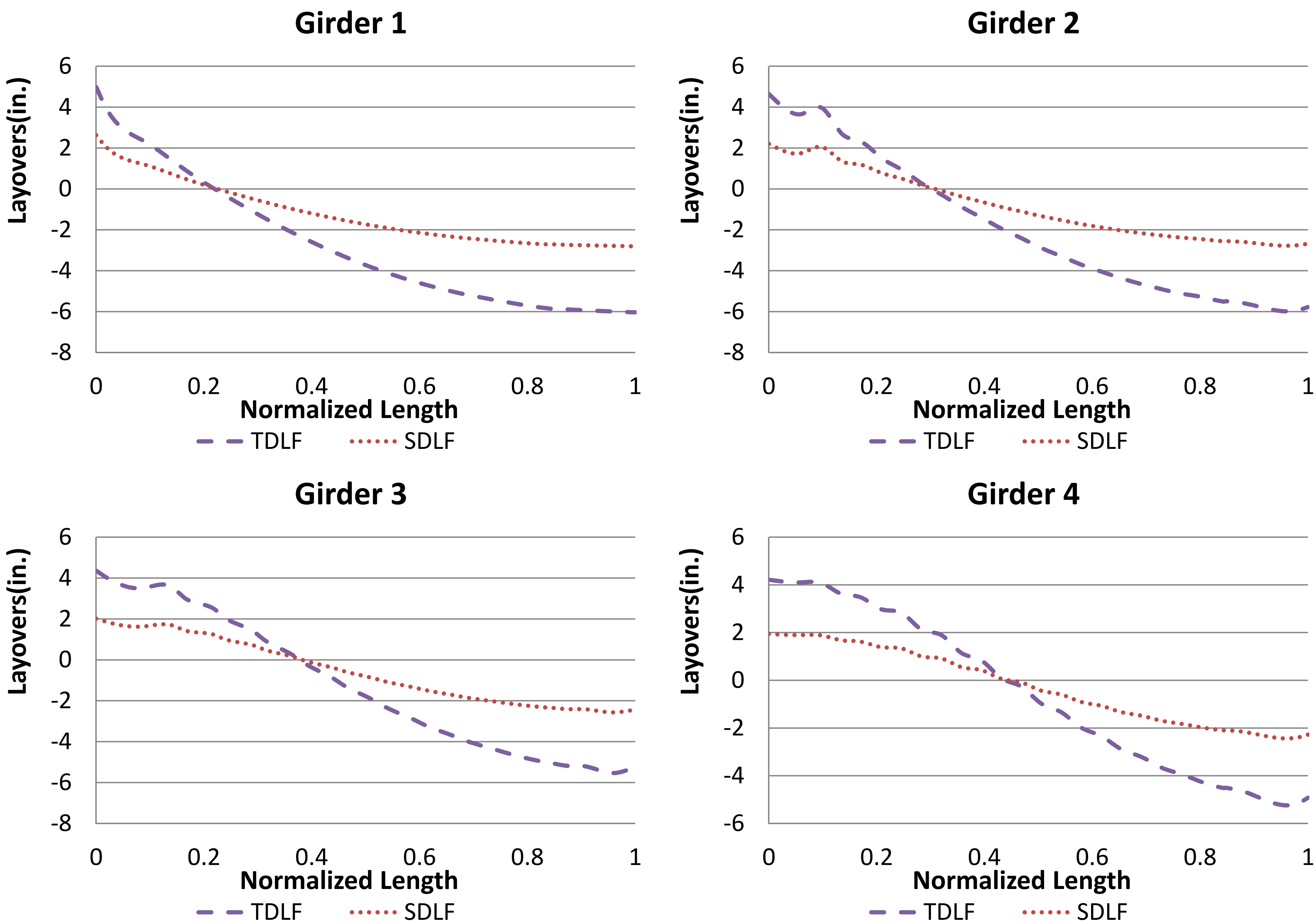


Figure J1-4-18. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

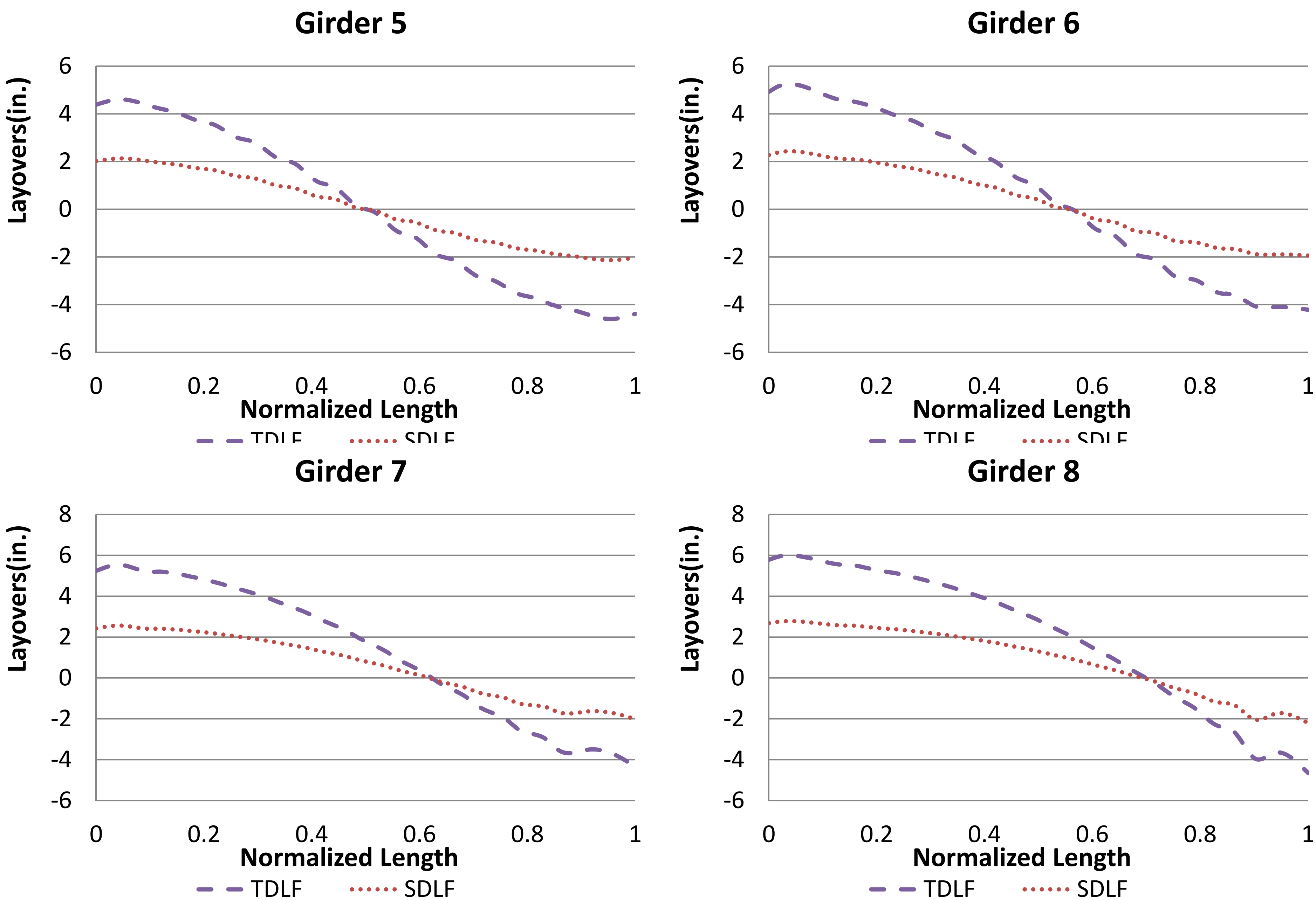


Figure J1-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

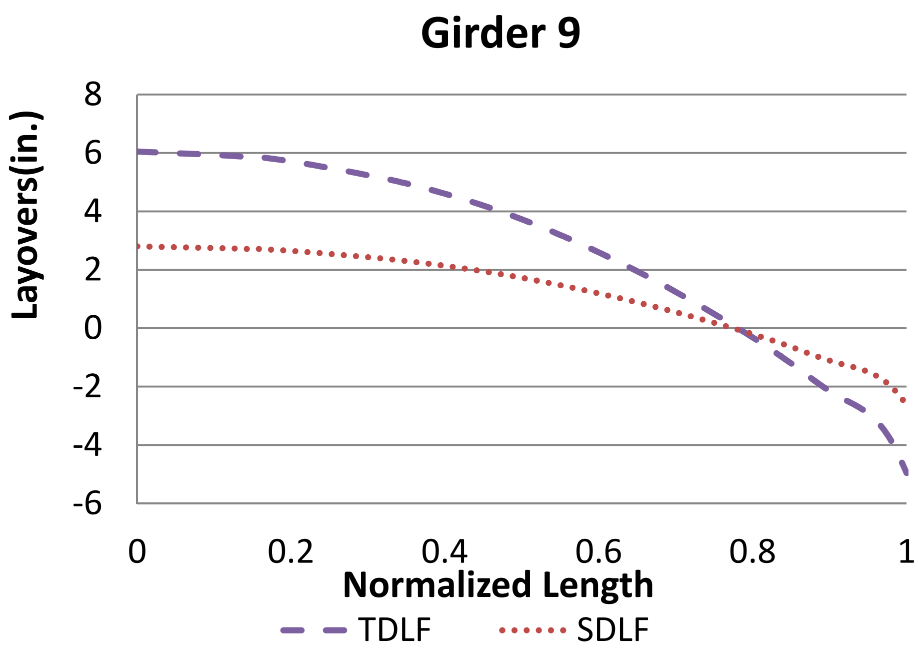


Figure J1-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

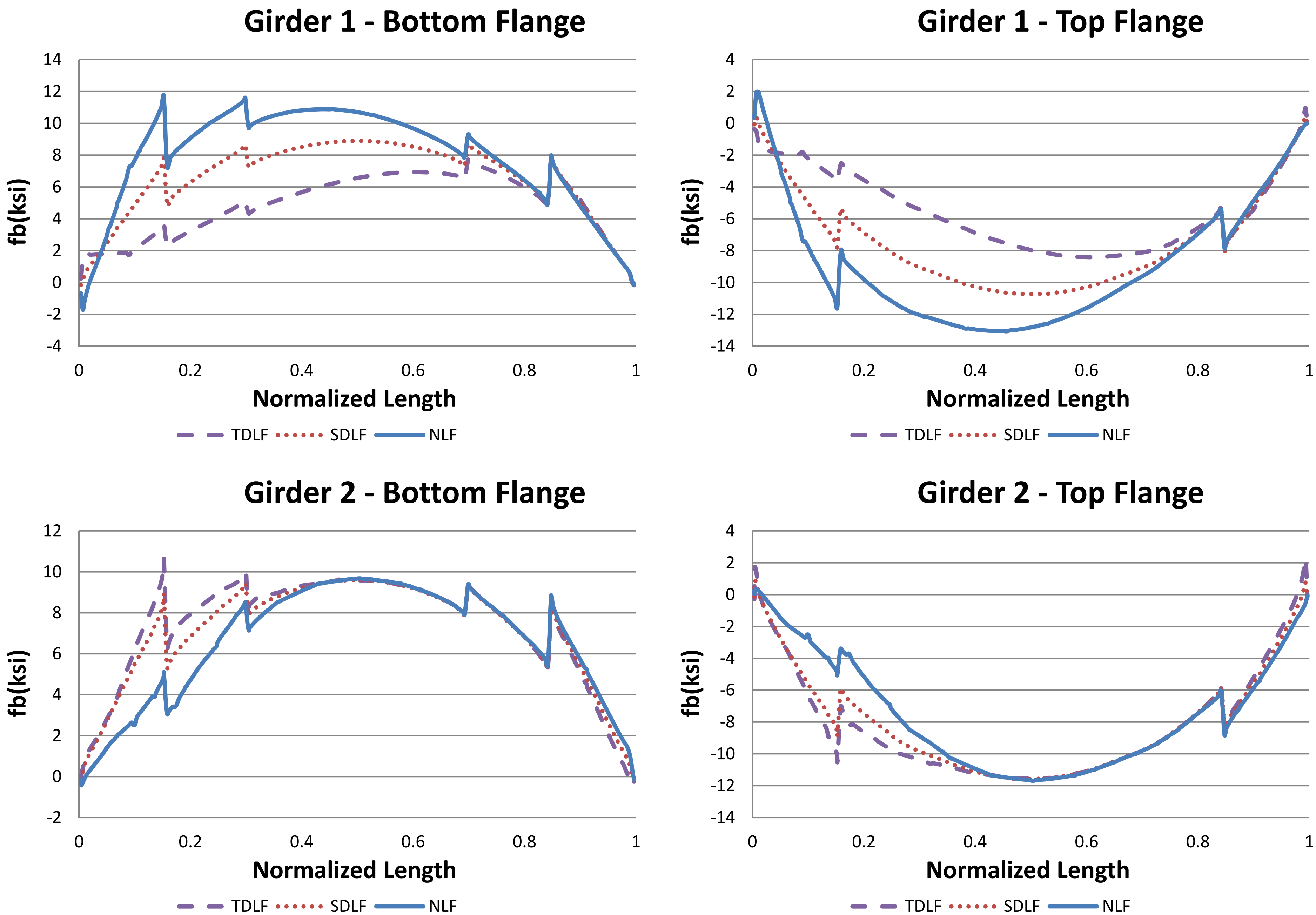


Figure J1-4-19. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

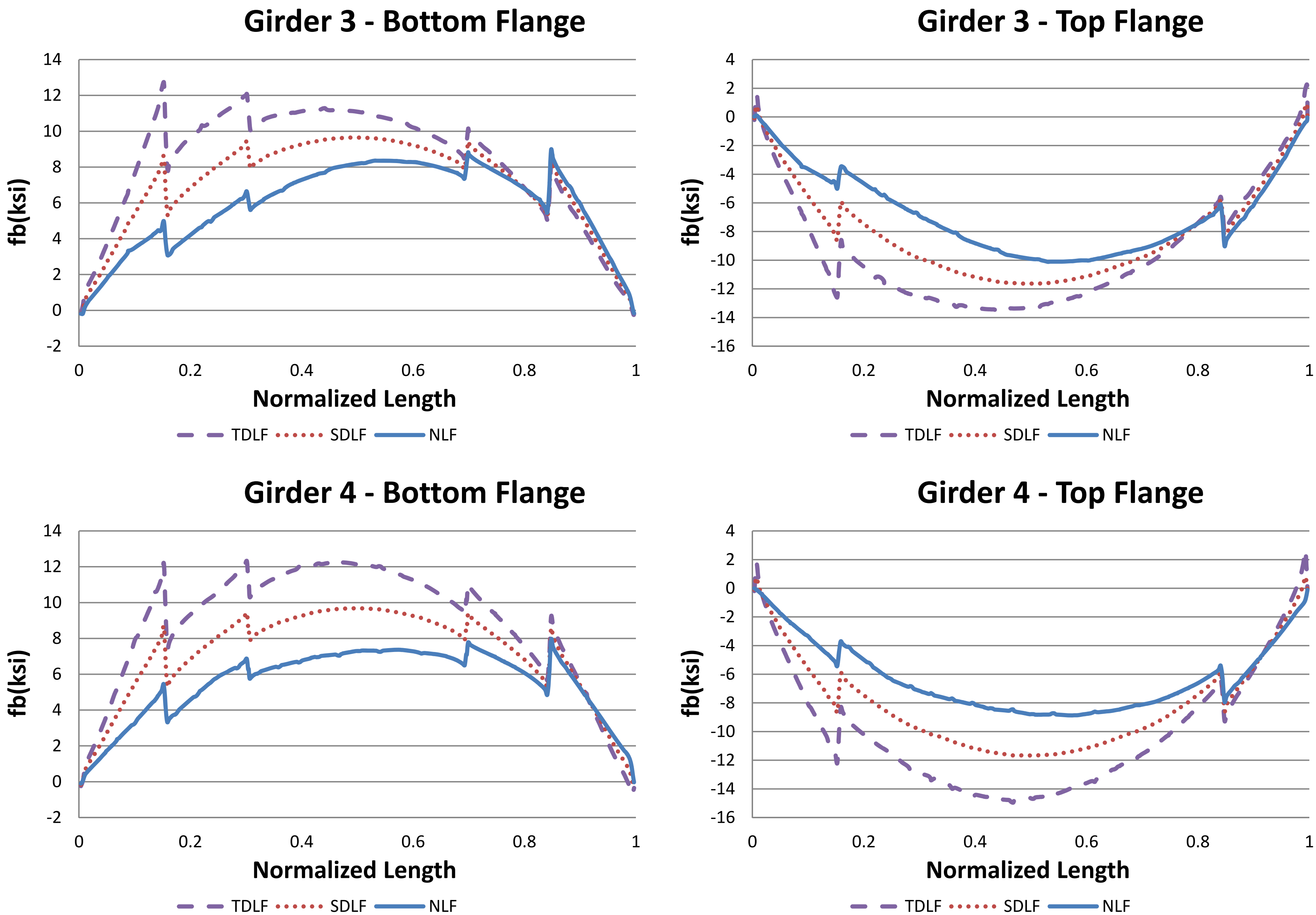


Figure J1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

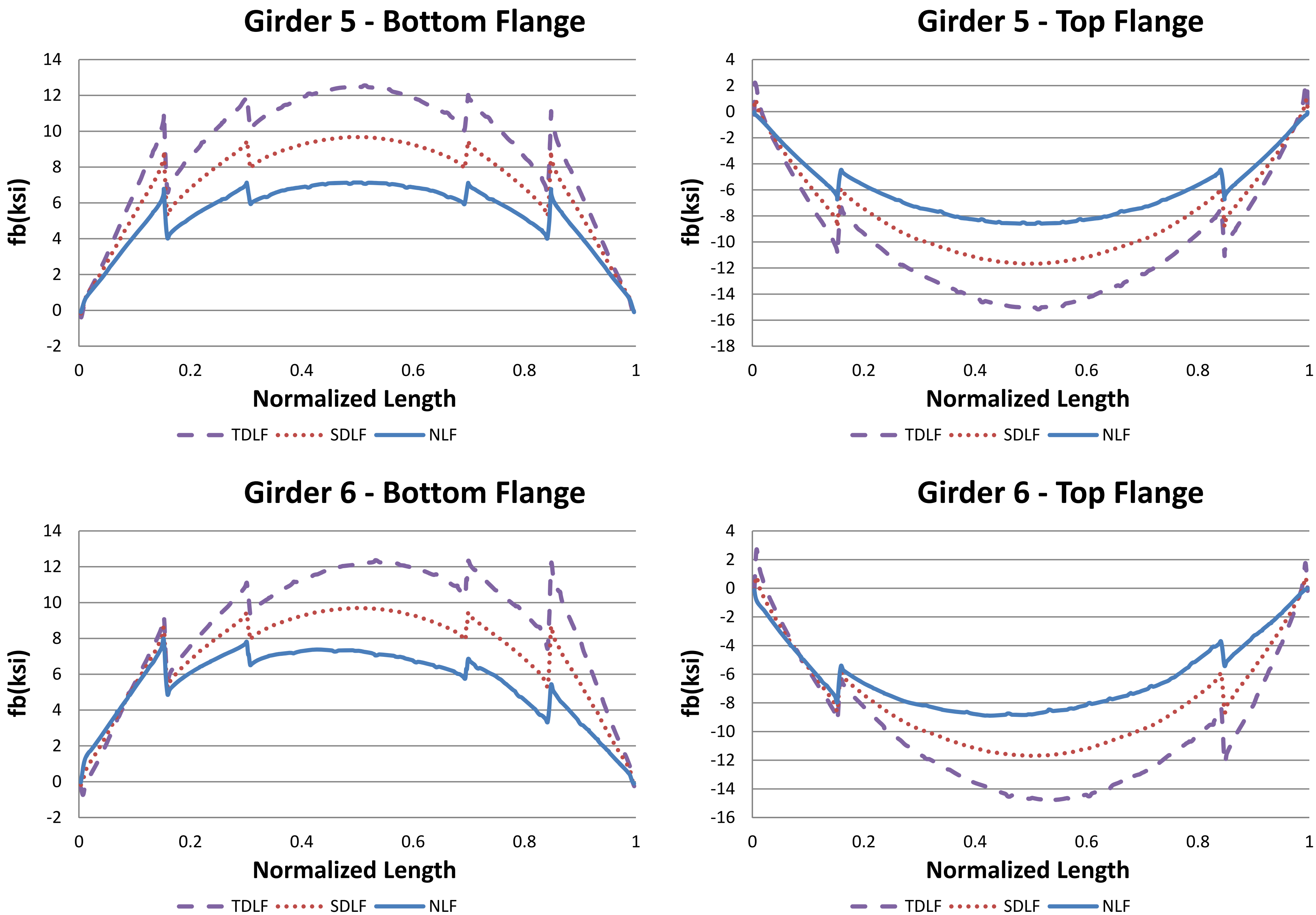


Figure J1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

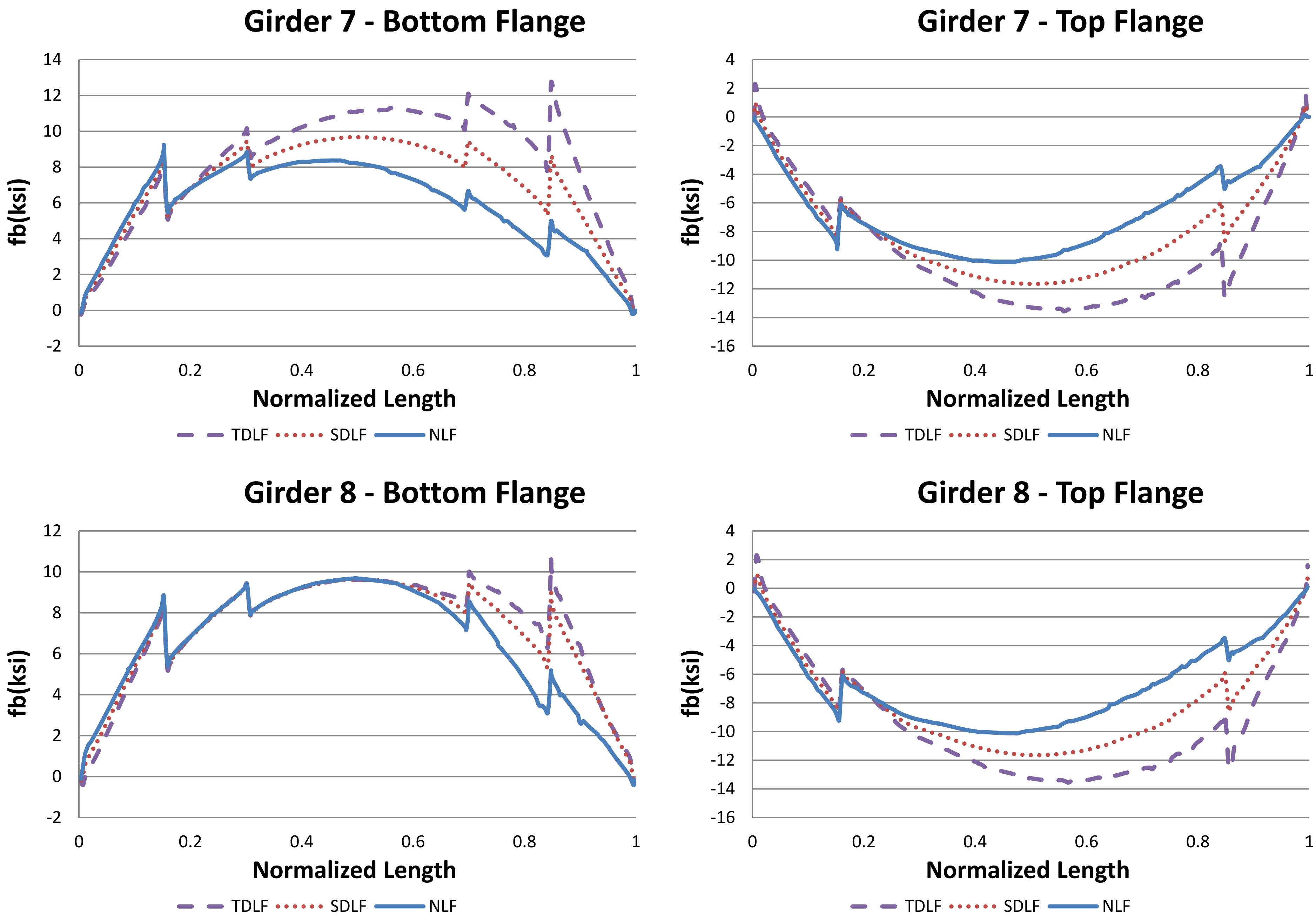
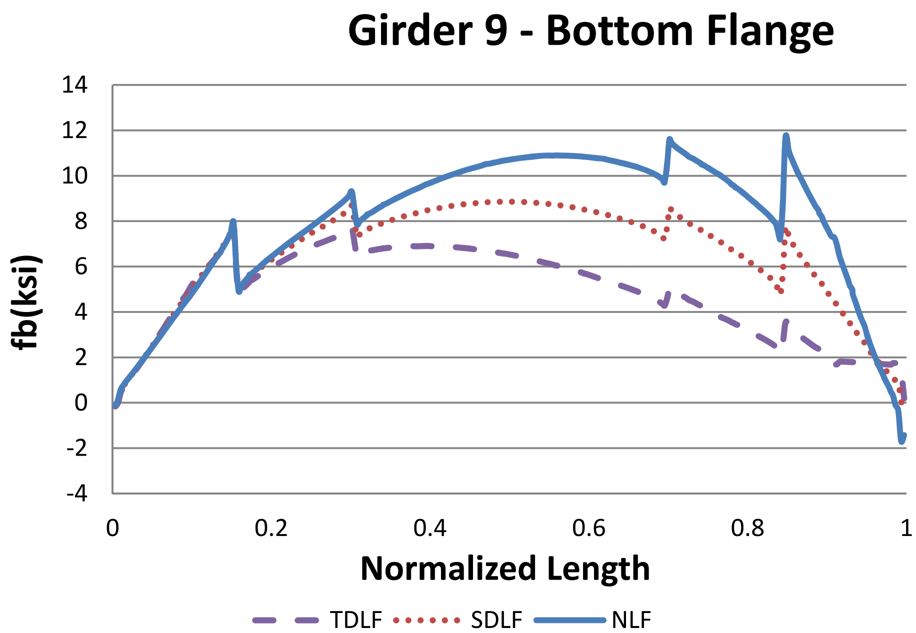


Figure J1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.



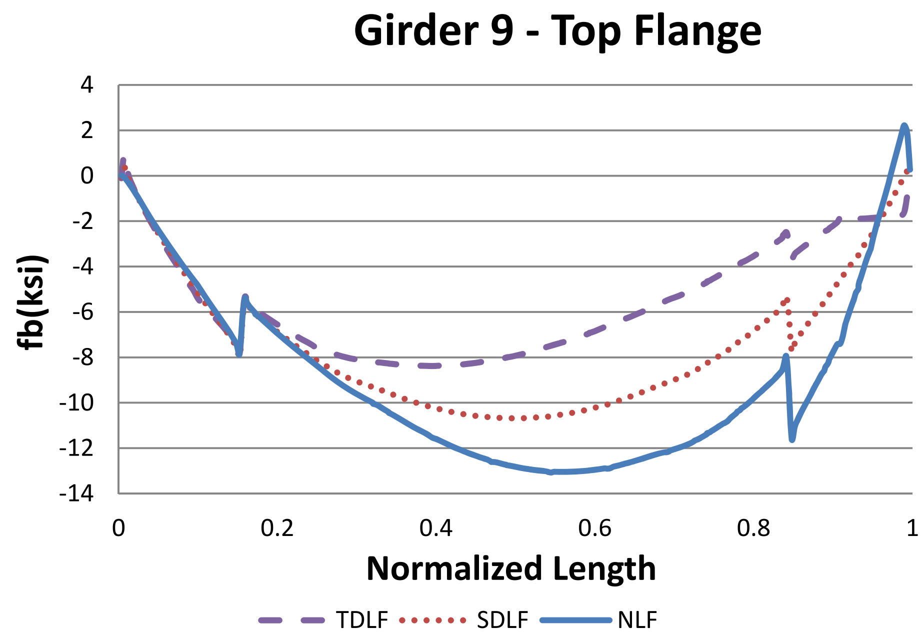


Figure J1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

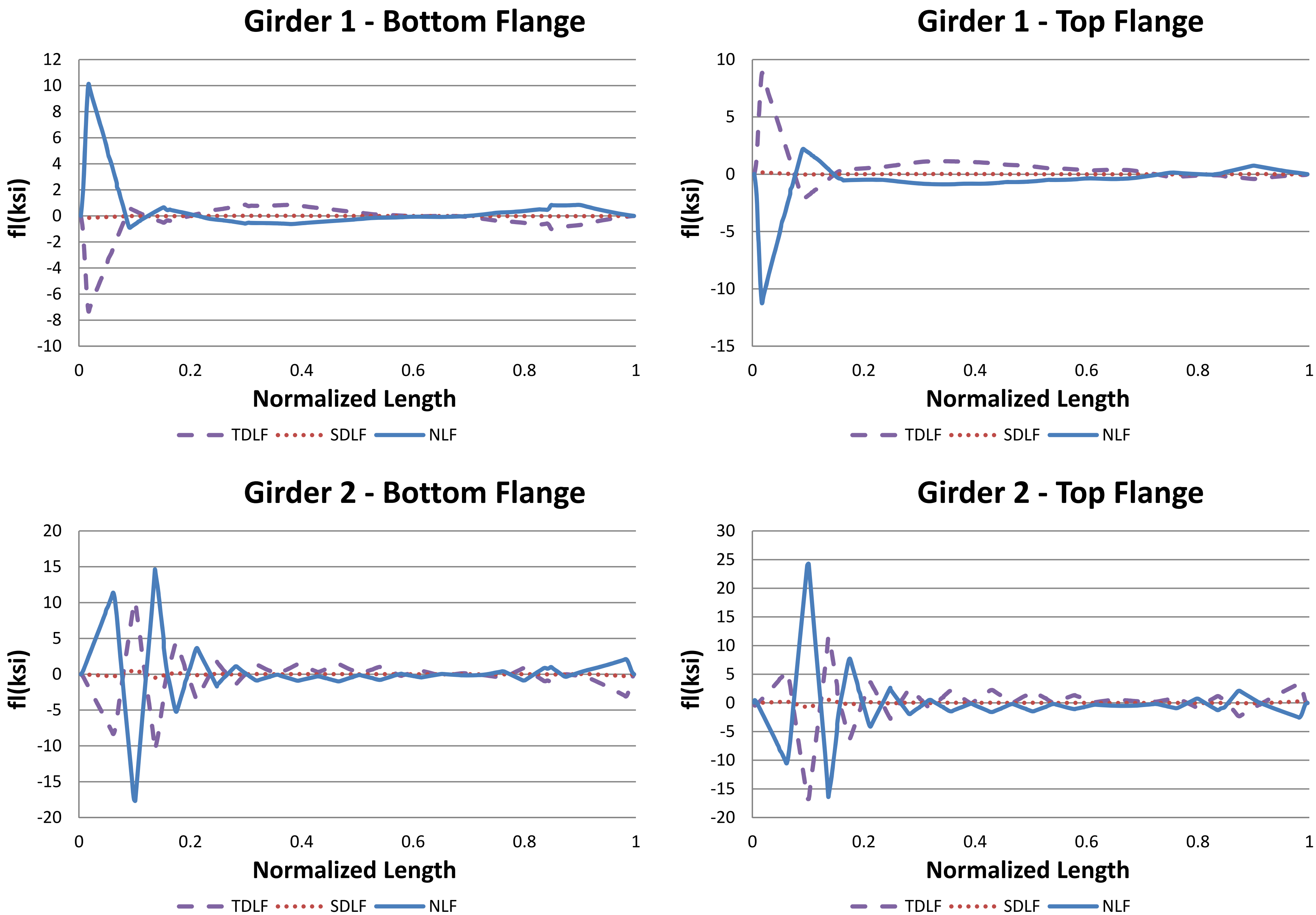


Figure J1-4-20. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

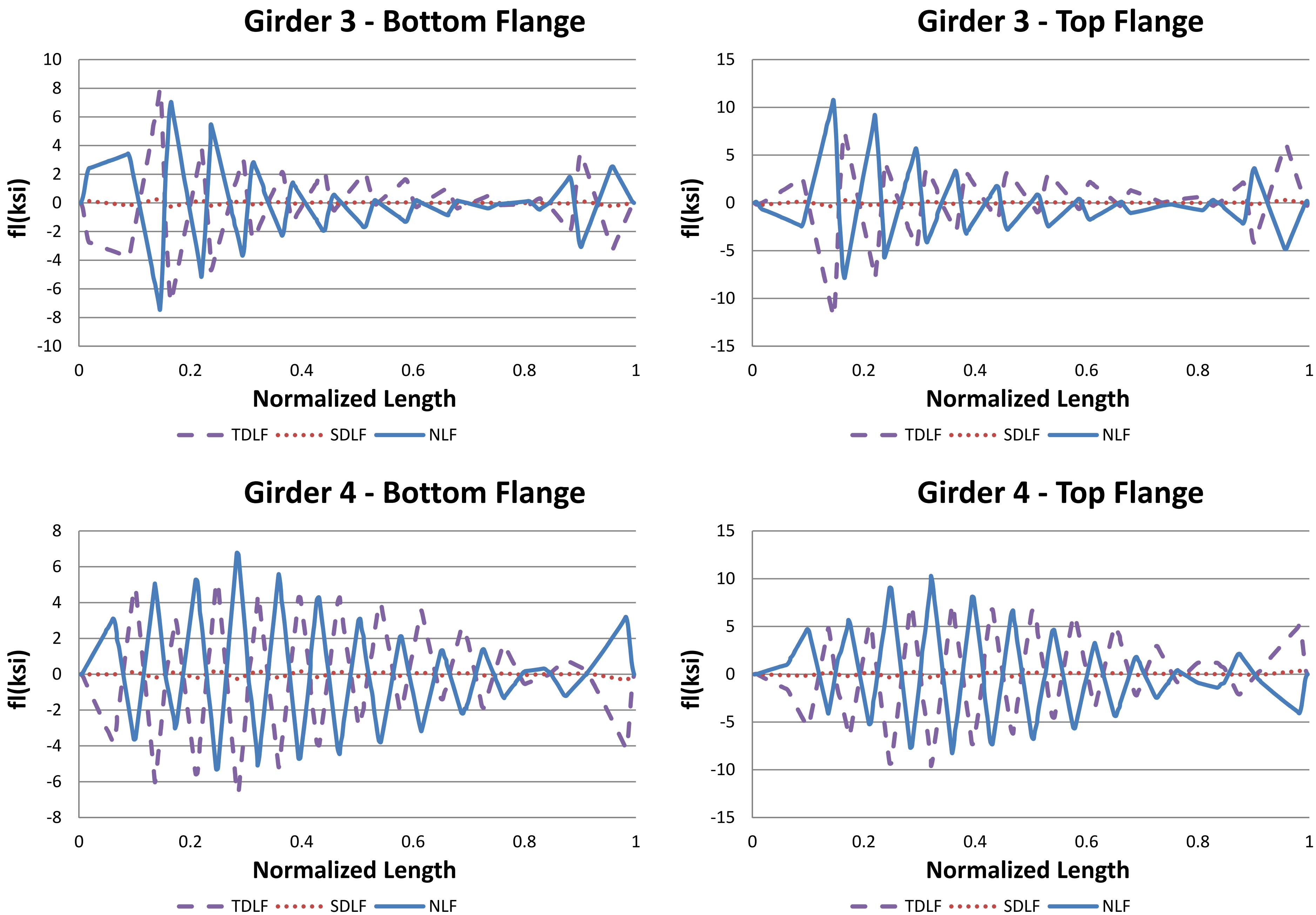


Figure J1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

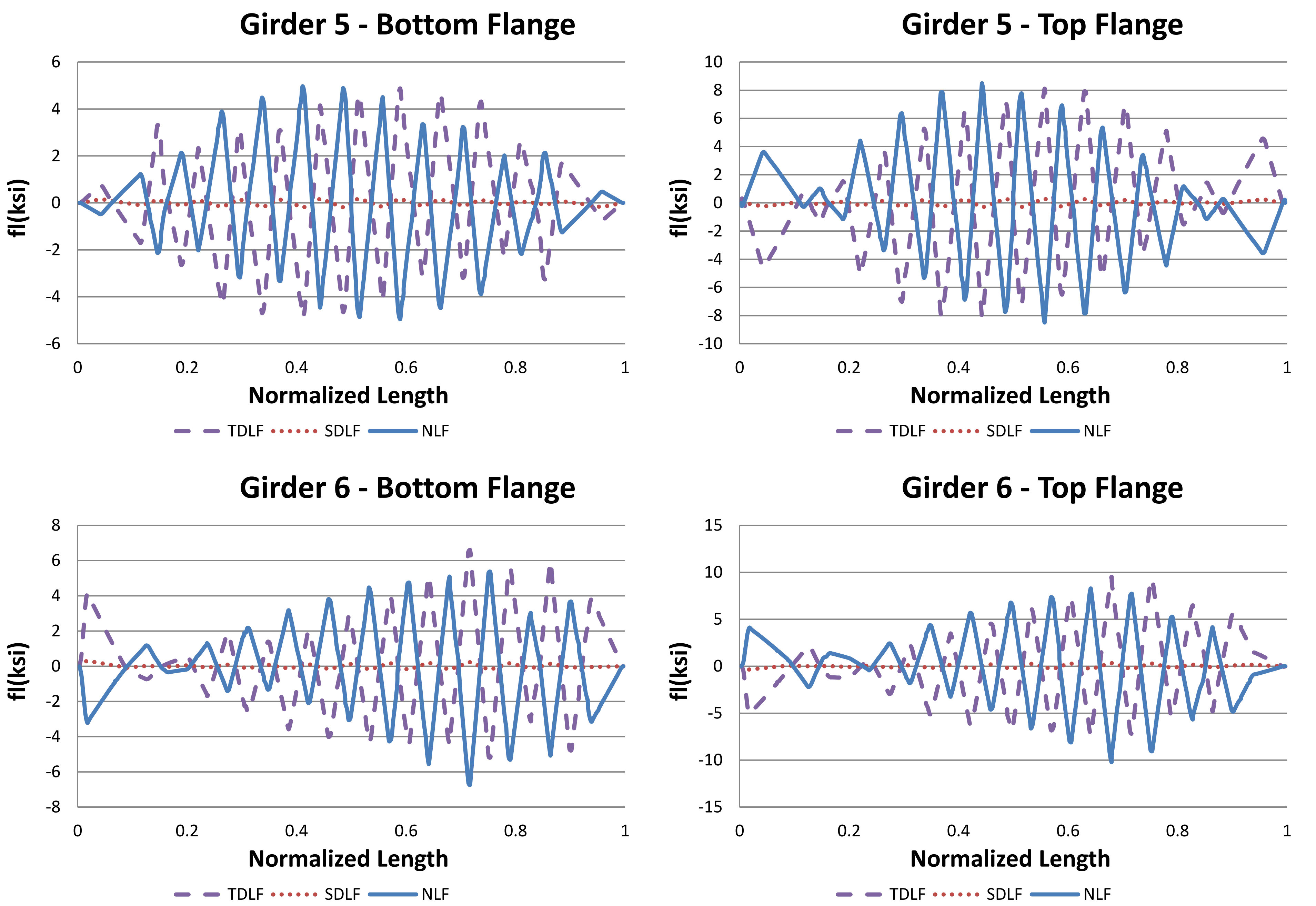


Figure J1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

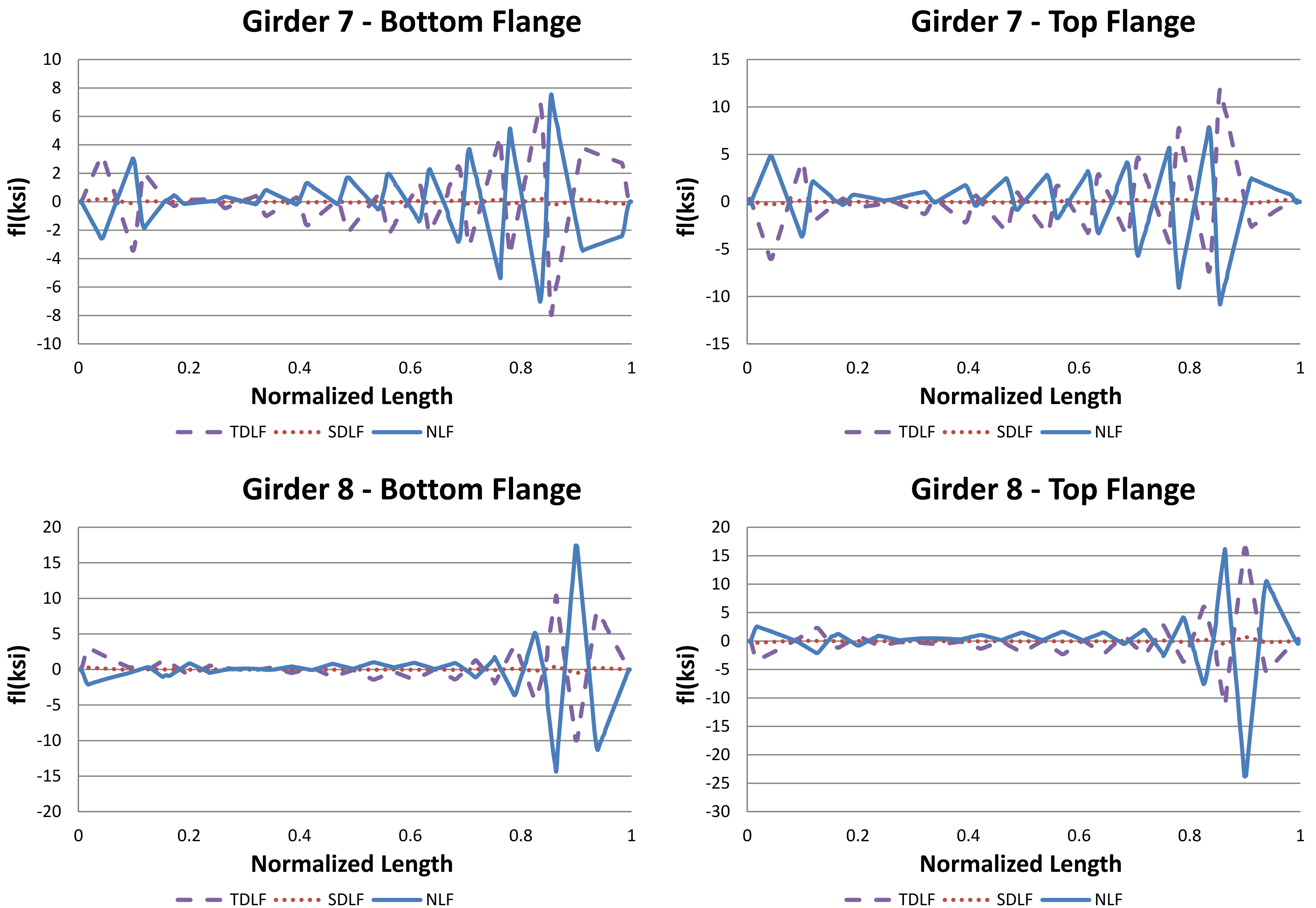
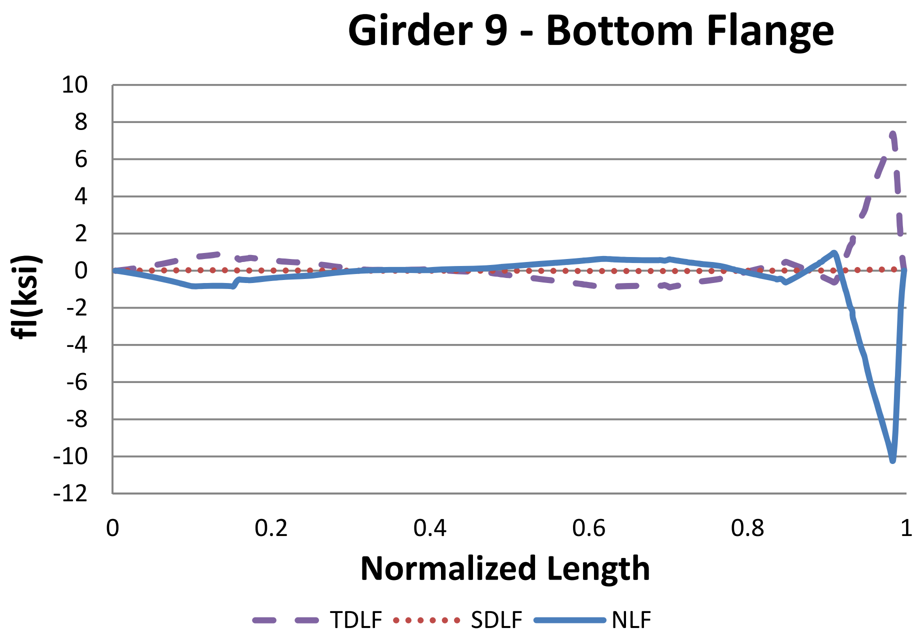


Figure J1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.



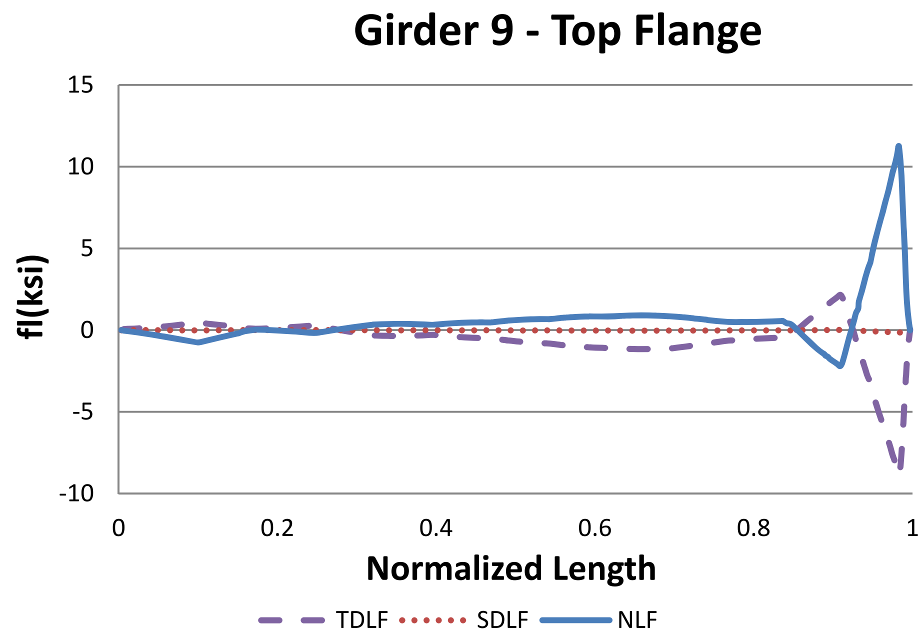


Figure J1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

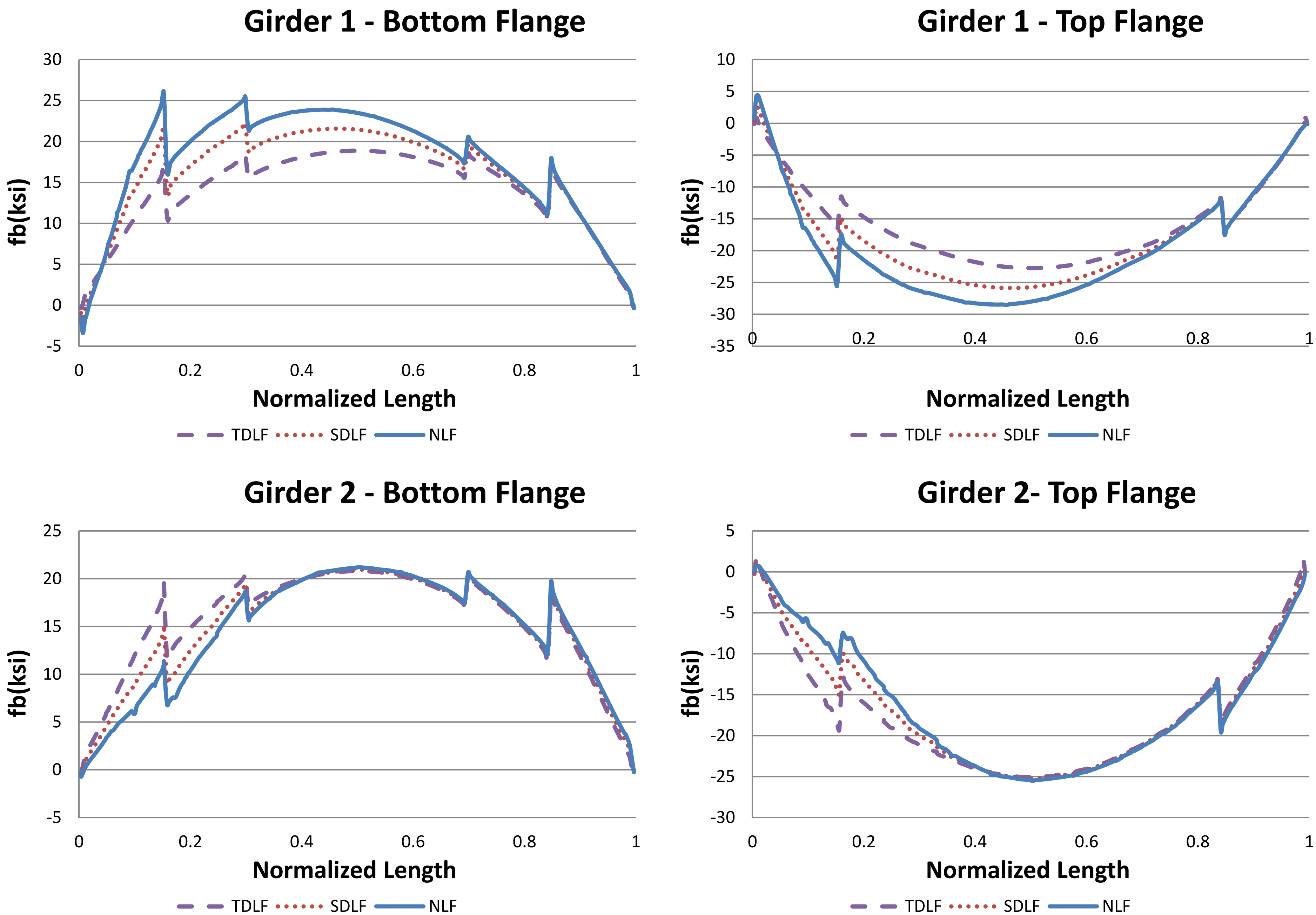


Figure J1-4-21. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

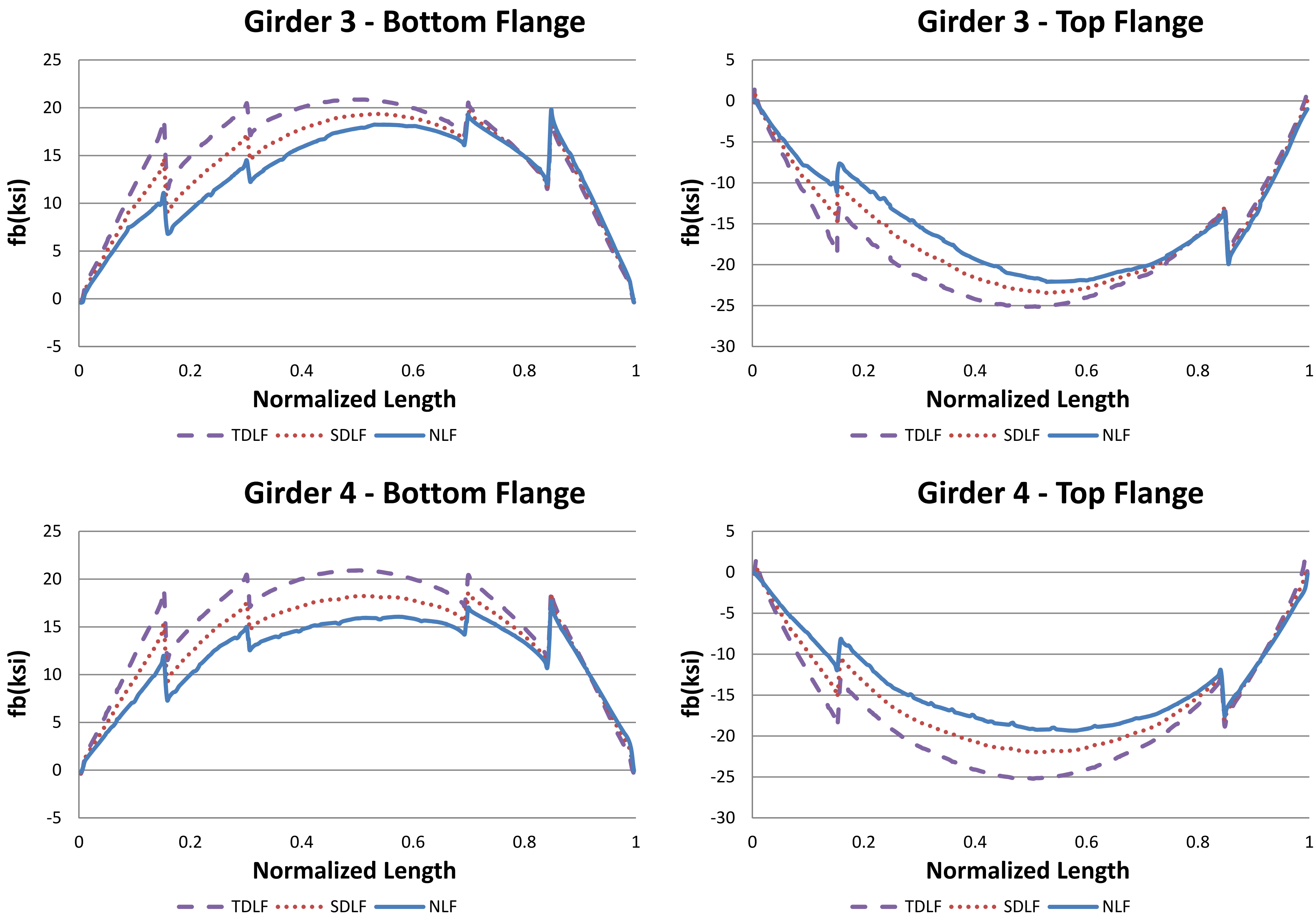


Figure J1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

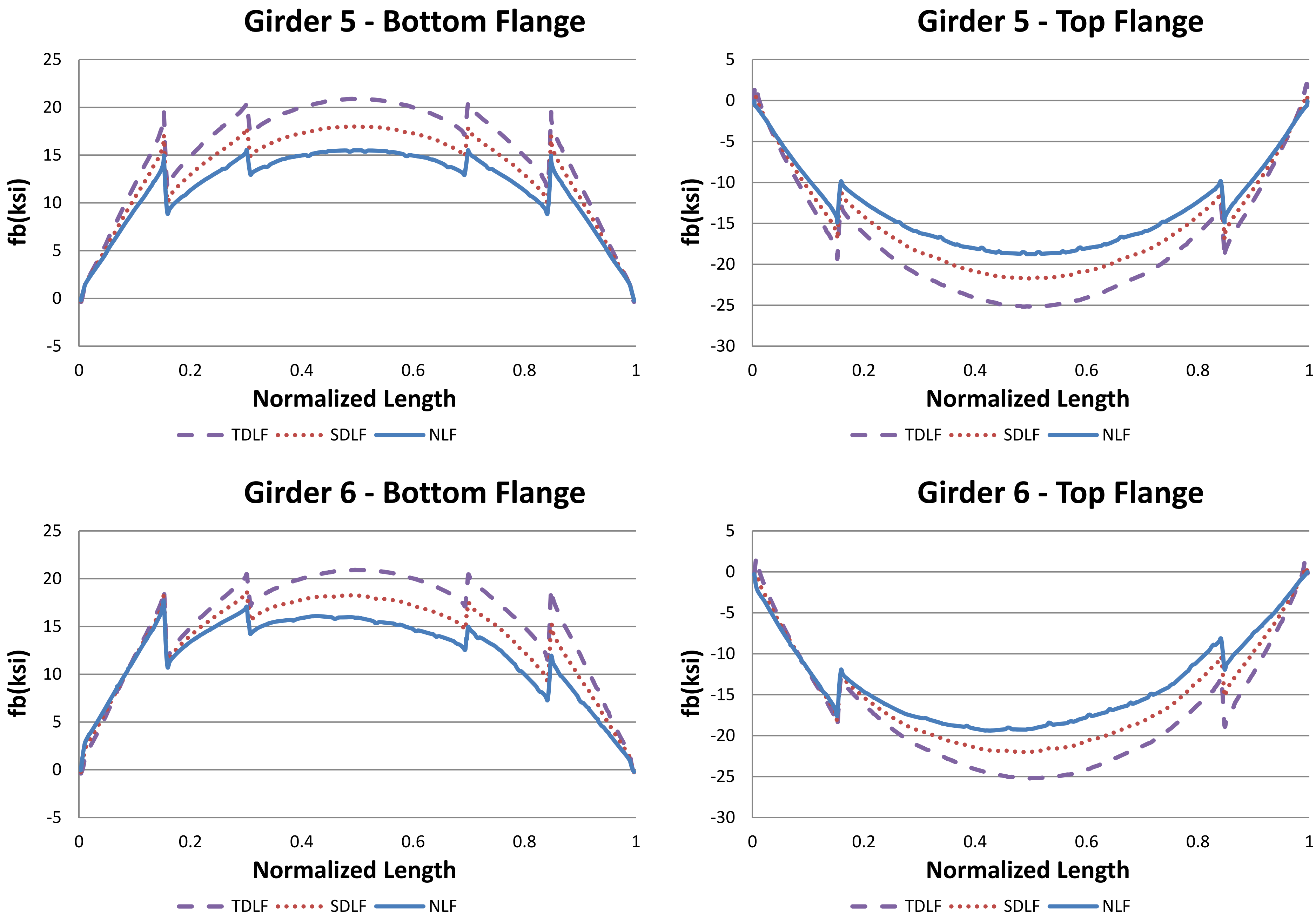


Figure J1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

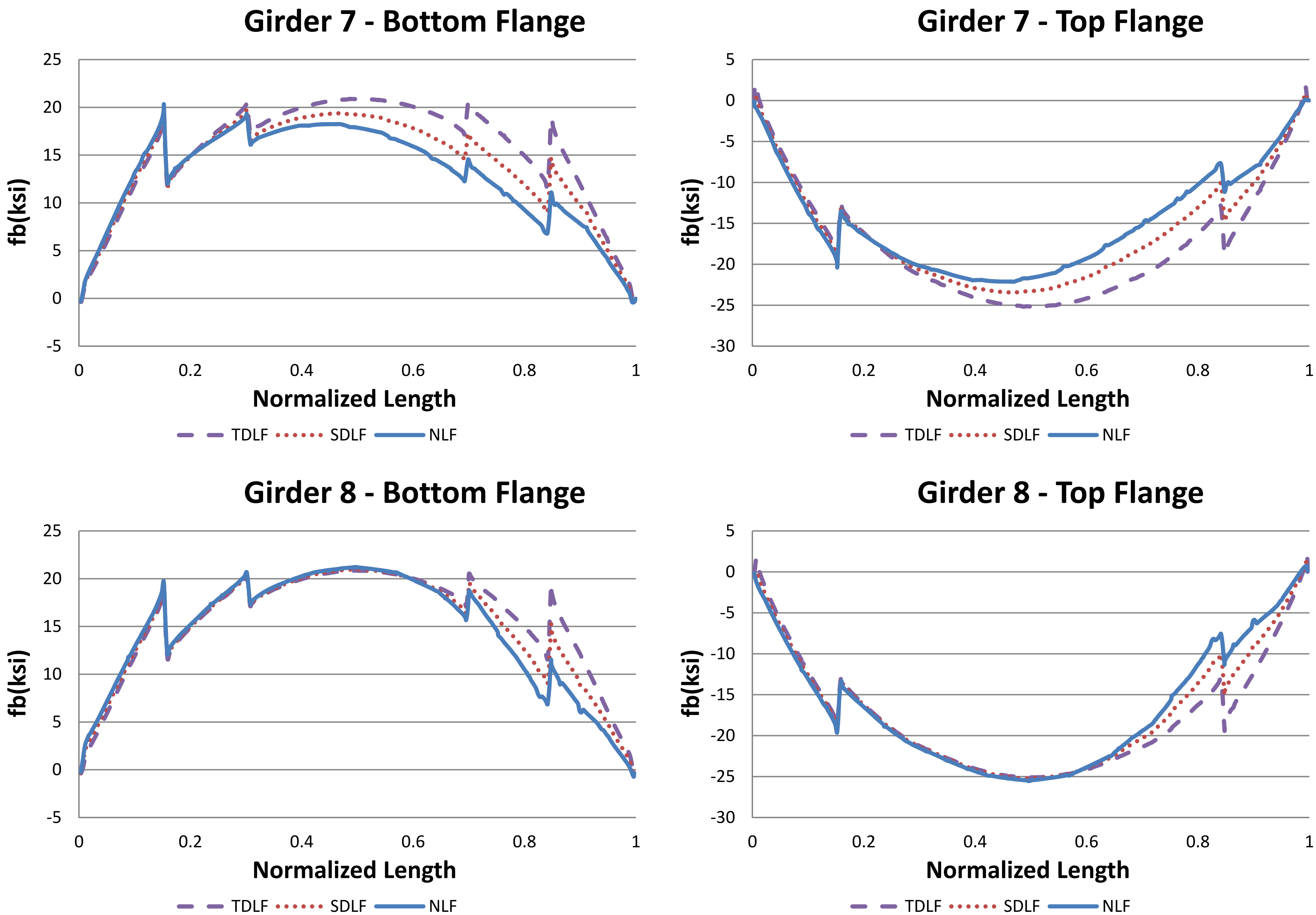
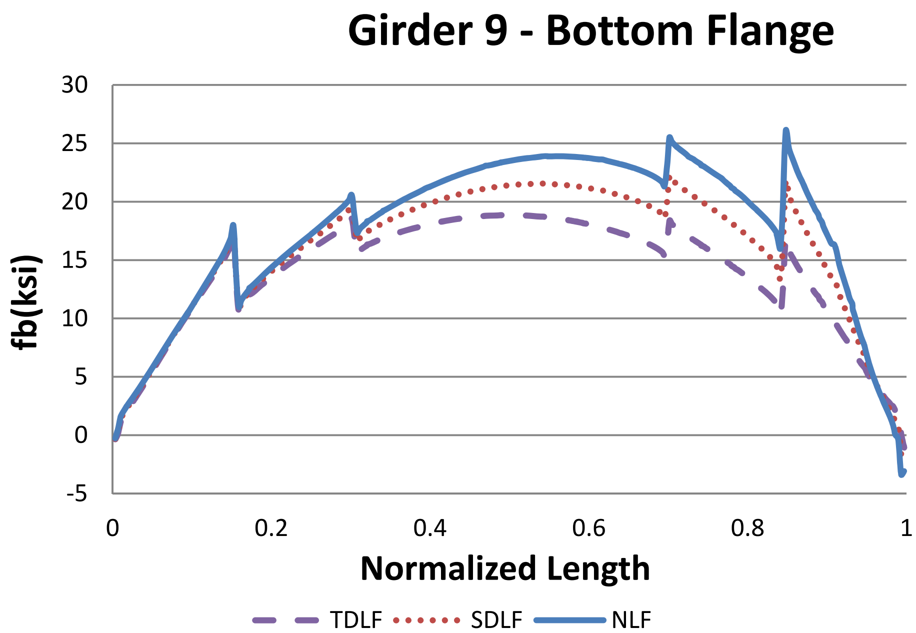


Figure J1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



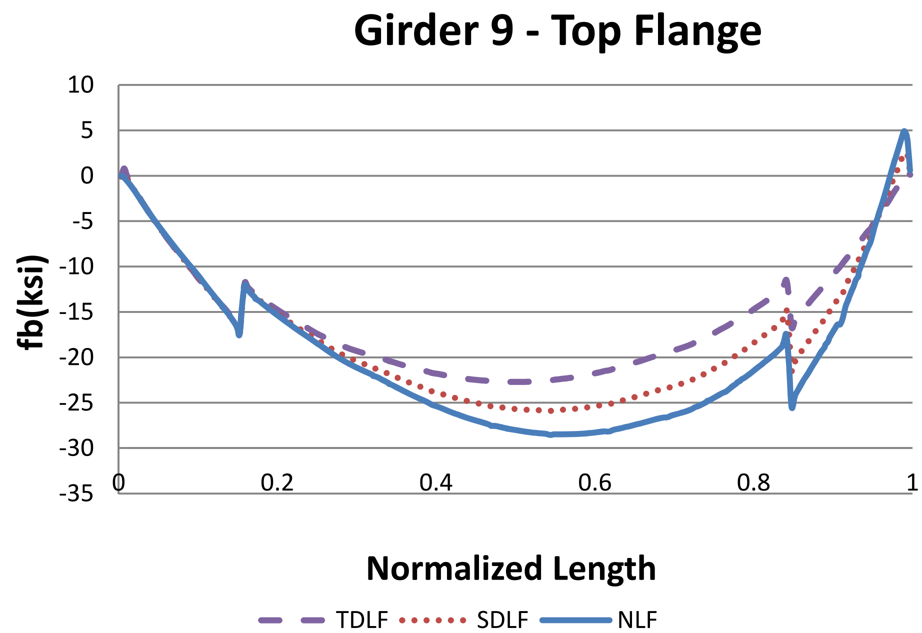


Figure J1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

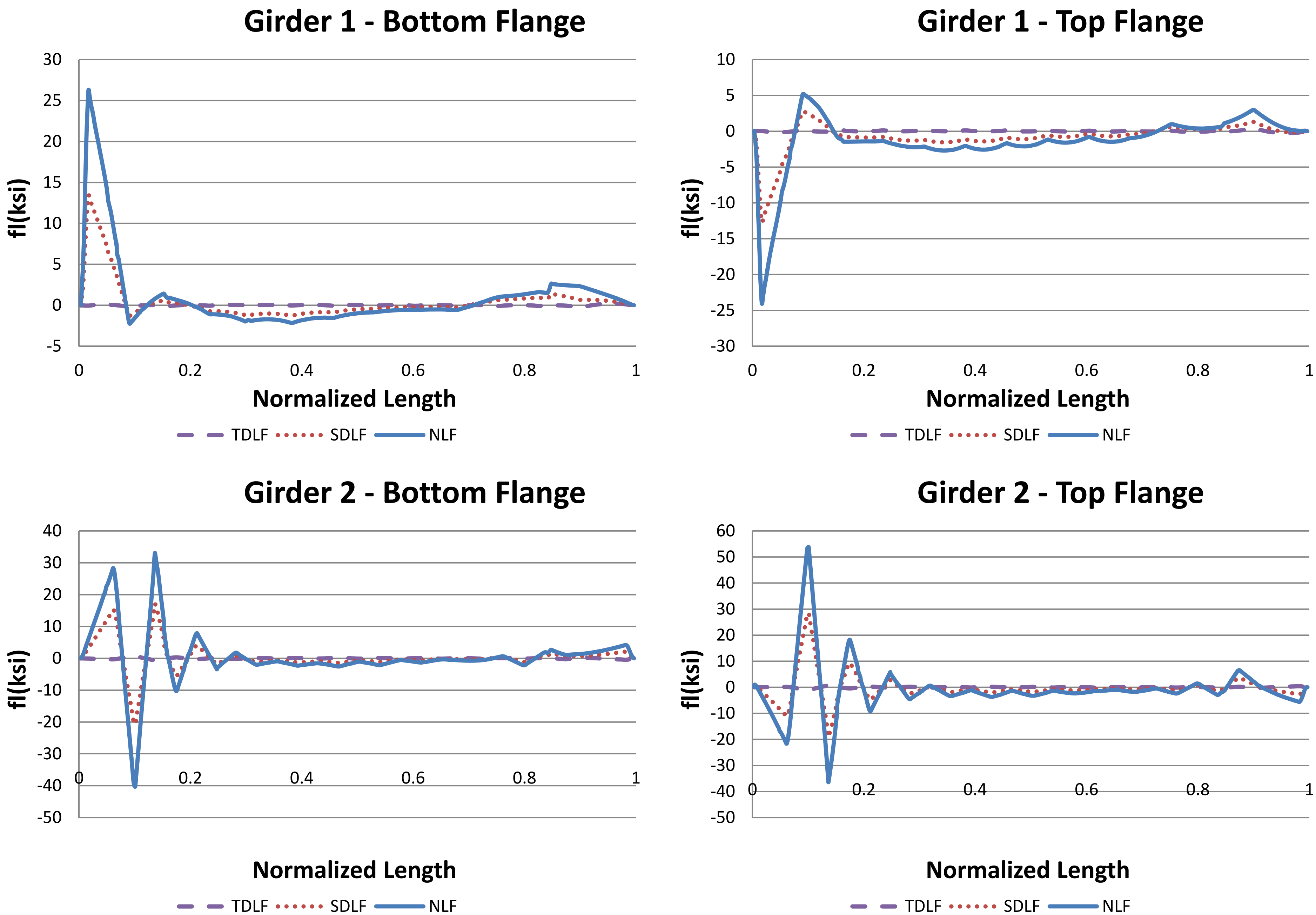


Figure J1-4-22. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

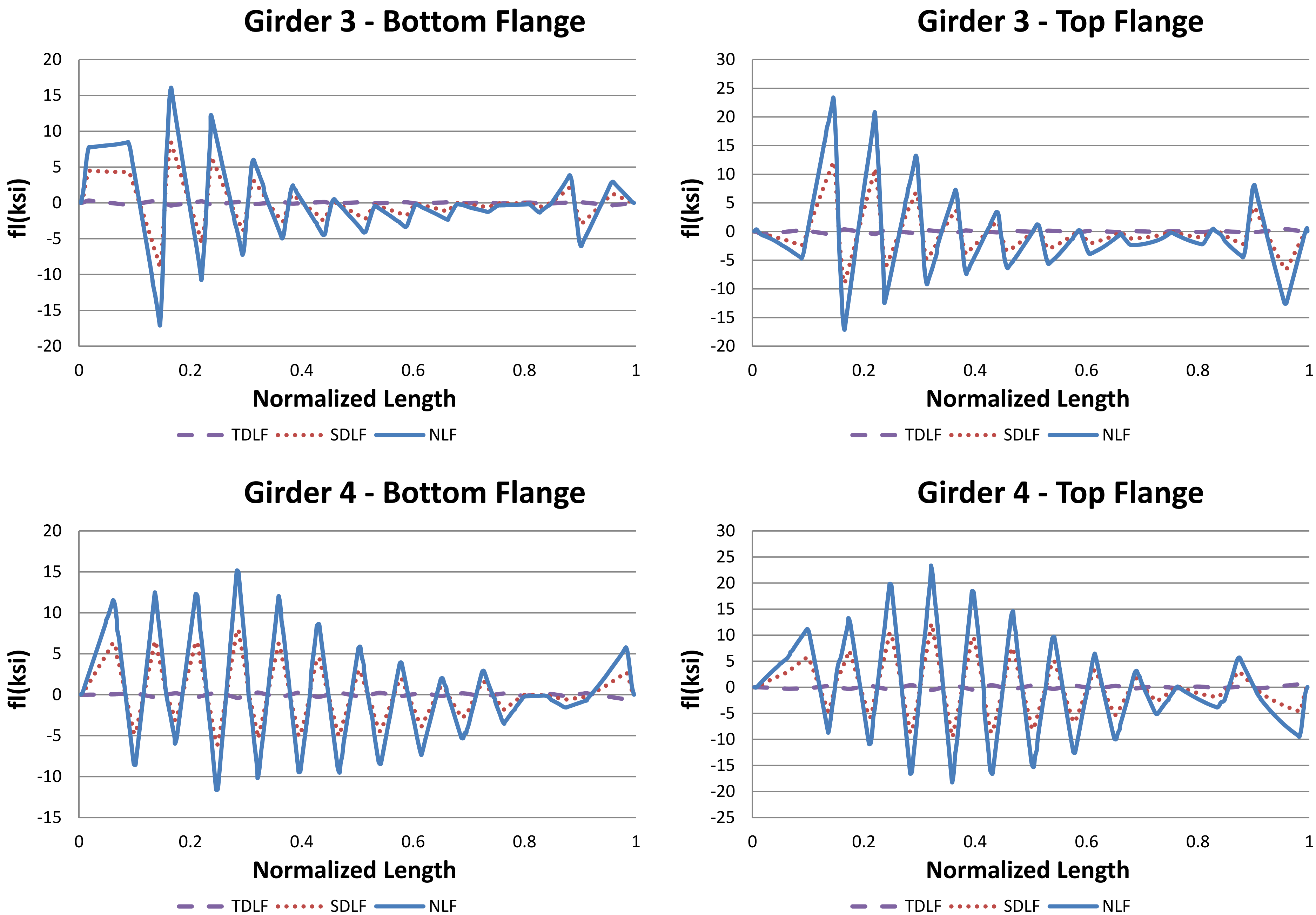


Figure J1-4-22 (continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

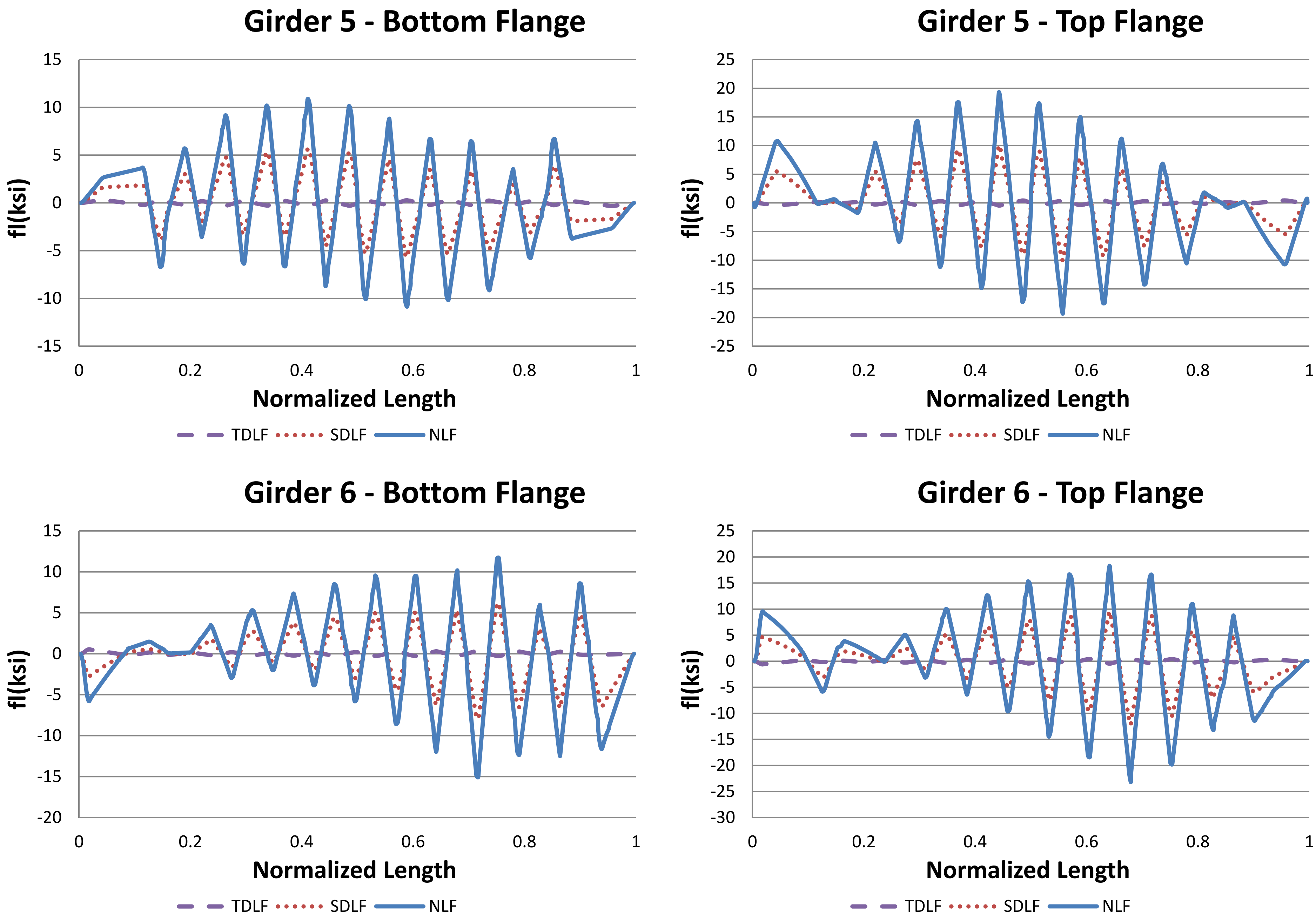


Figure J1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

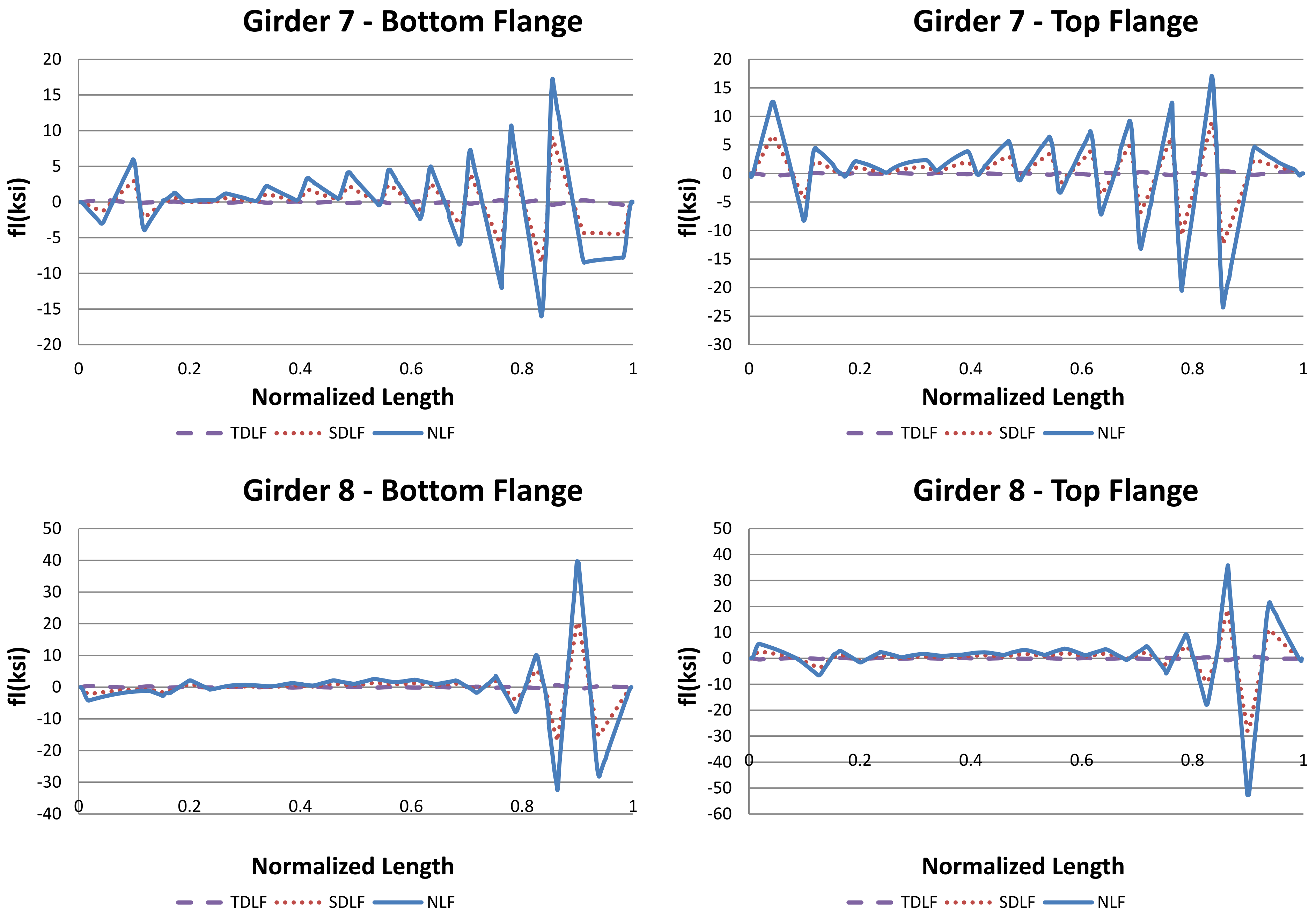


Figure J1-4-22 (continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

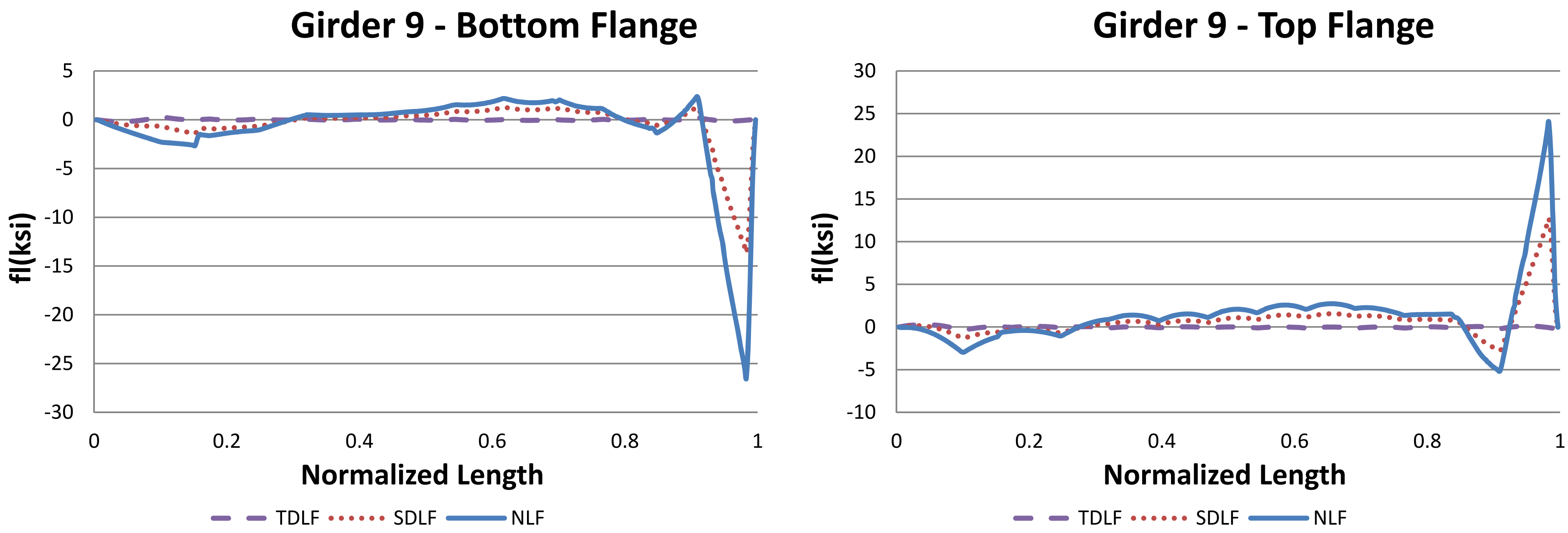


Figure J1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

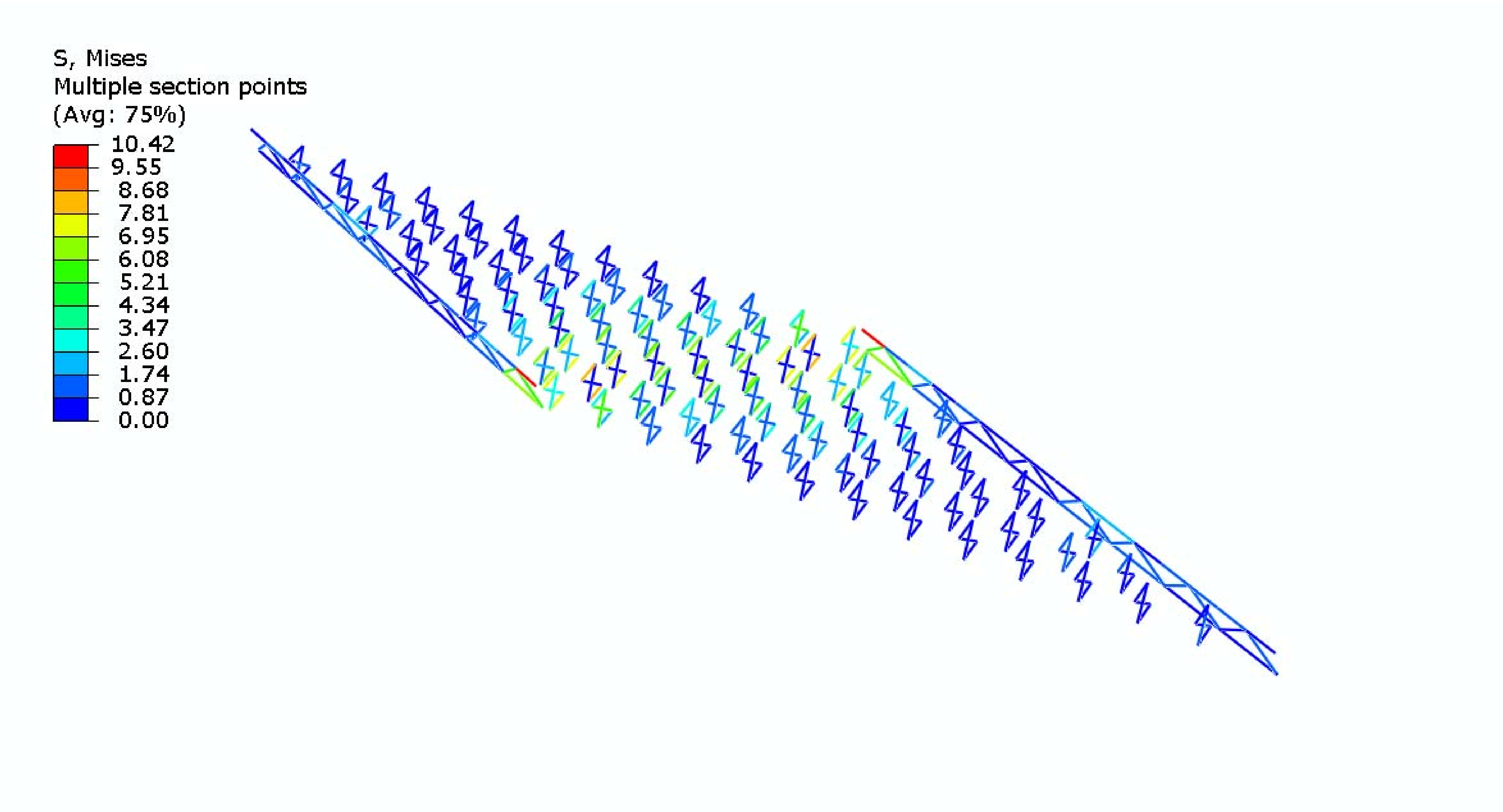


Figure J1-4-23. Cross-frame stress contours (ksi) under SDL, NLF detailing (intermediate cross-frame member areas = 11.0 in^2, end cross-frame bottom chord area = 11.2 in^2, end cross-frame top chord area = 15.6 in^2, end cross-frame diagonal area = 17.6 in^2).

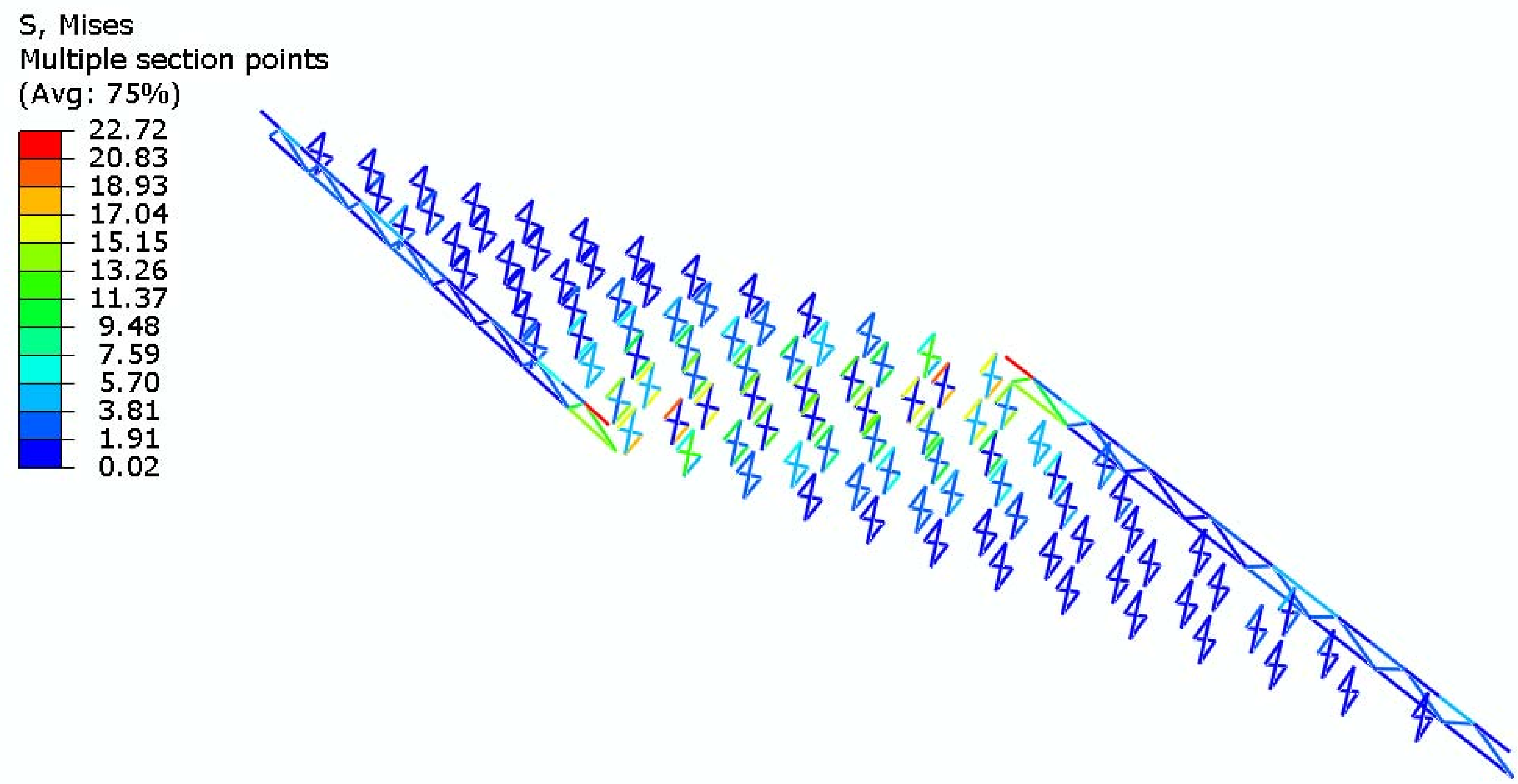


Figure J1-4-24. Cross-frame stress contours under TDL, NLF detailing (intermediate cross-frame member areas = 11.0 in^2, end cross-frame bottom chord area = 11.2 in^2, end cross-frame top chord area = 15.6 in^2, end cross-frame diagonal area = 17.6 in^2).

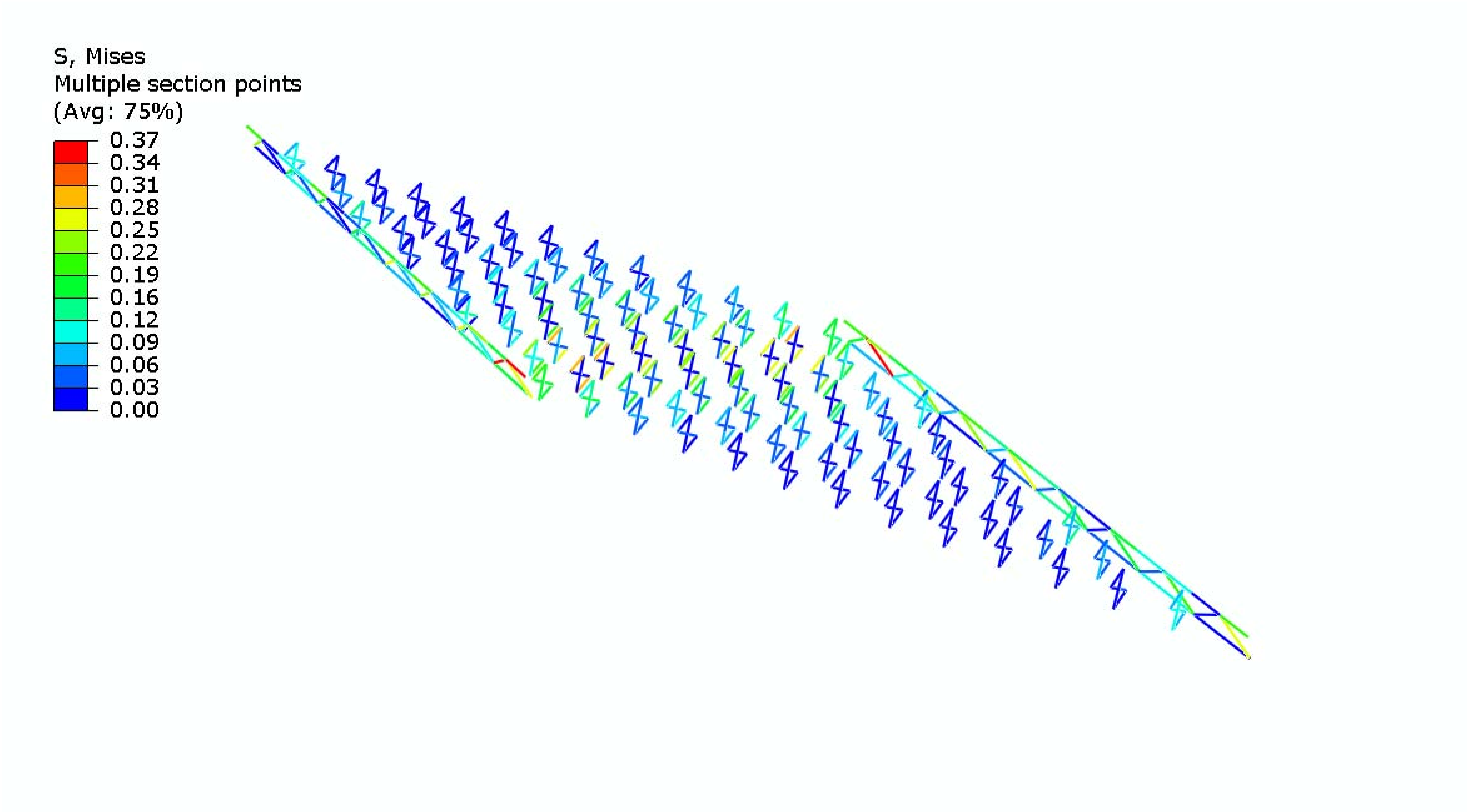


Figure J1-4-25. Cross-frame stress contours under SDL, SDLF detailing (intermediate cross-frame member areas = 11.0 in^2, end cross-frame bottom chord area = 11.2 in^2, end cross-frame top chord area = 15.6 in^2, end cross-frame diagonal area = 17.6 in^2).

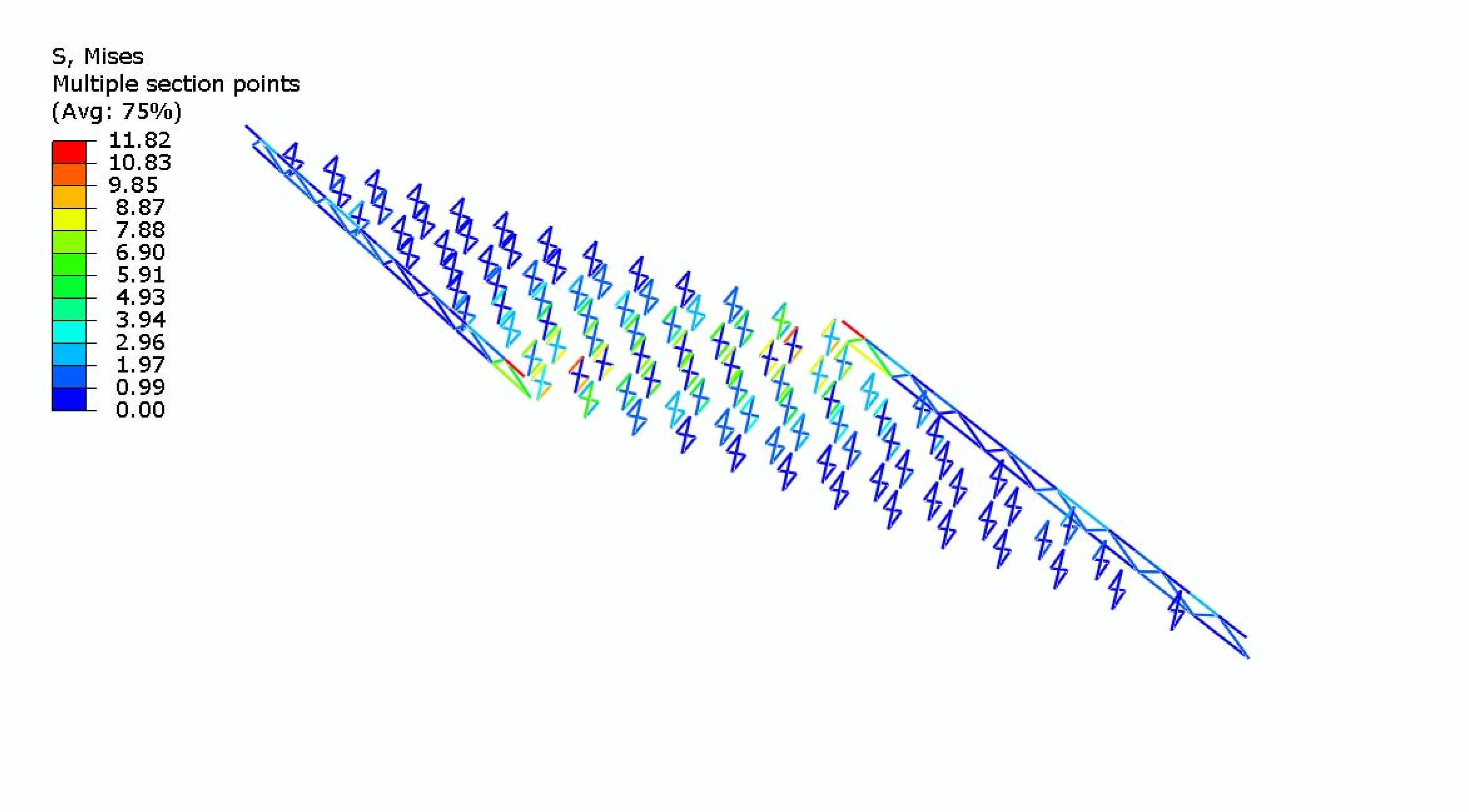


Figure J1-4-26. **Cross-frame stress contours under TDL, SDLF detailing (intermediate cross-frame member areas = 11.0 in^2, end cross-frame bottom chord area = 11.2 in^2, end cross-frame top chord area = 15.6 in^2, end cross-frame diagonal area = 17.6 in^2).**

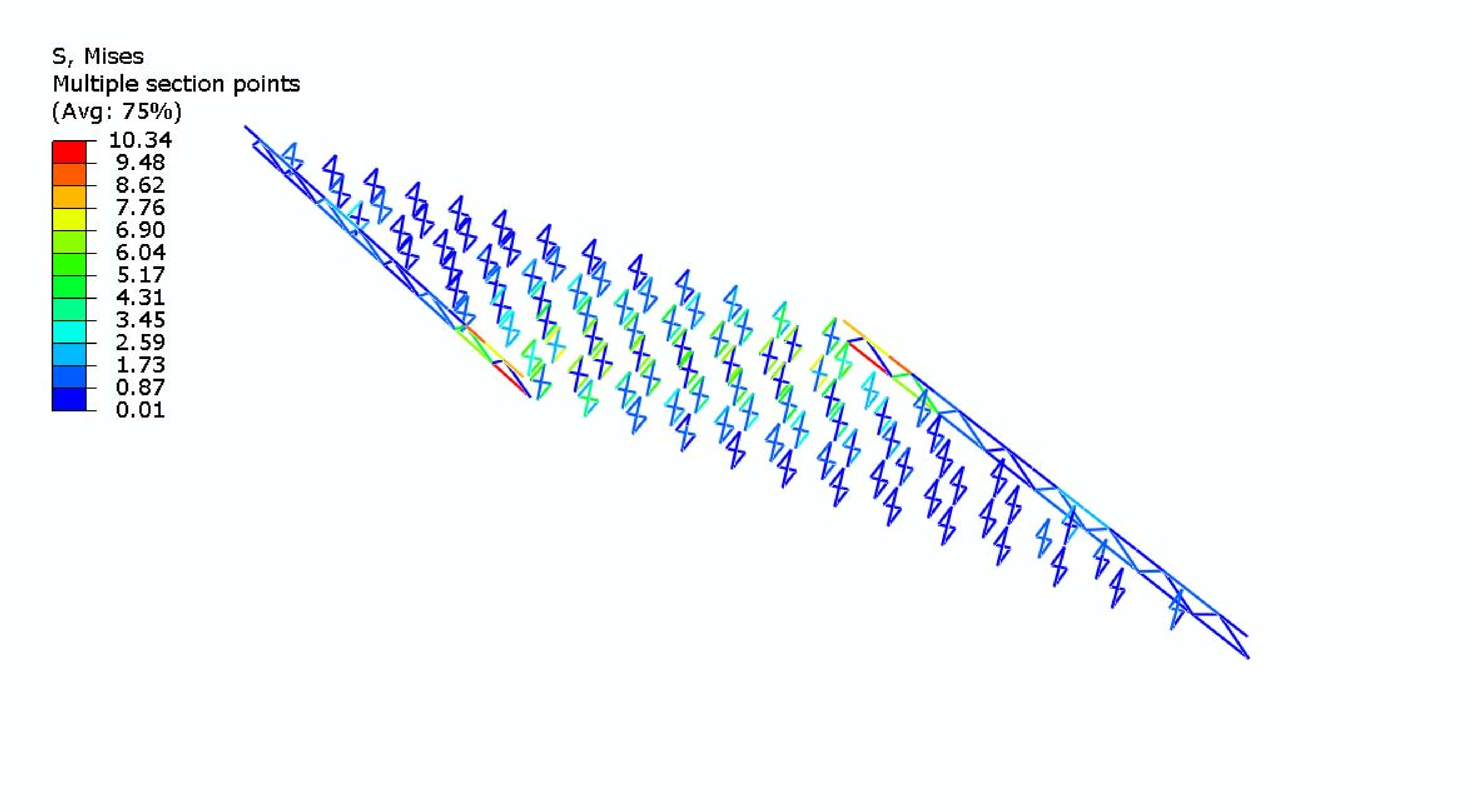


Figure J1-4-27. Cross-frame stress contours under SDL, TDLF detailing (intermediate cross-frame member areas = 11.0 in^2, end cross-frame bottom chord area = 11.2 in^2, end cross-frame top chord area = 15.6 in^2, end cross-frame diagonal area = 17.6 in^2).

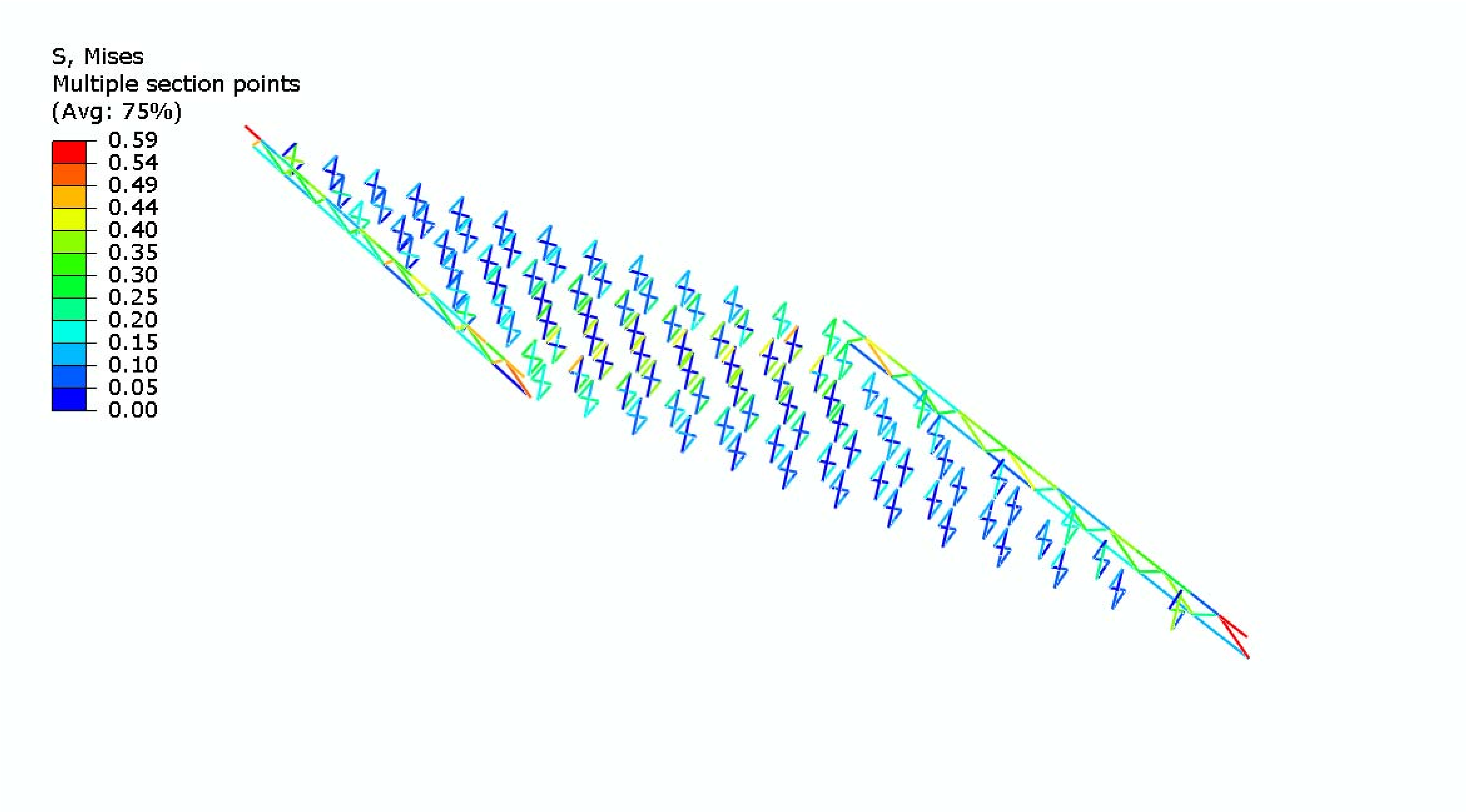


Figure J1-4-28. **Cross-frame stress contours under TDL, TDLF detailing (intermediate cross-frame member areas = 11.0 in^2, end cross-frame bottom chord area = 11.2 in^2, end cross-frame top chord area = 15.6 in^2, end cross-frame diagonal area = 17.6 in^2).**

Table J1-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	98.3	25.4	7.6	7.4	22.4	24.1	19.3	16.8
	SDLF	6.4	4.6	4.2	4.5	3.2	3.2	3.3	3.9
	TDLF	7.6	88.3	17.3	1.5	20.6	23.0	15.1	12.9
2	NLF	30.6	20.0	11.9	2.2	2.7	2.9	5.2	10.7
	SDLF	1.8	1.3	1.4	0.7	0.7	0.8	0.8	1.3
	TDLF	15.2	38.1	16.5	5.0	2.0	0.8	8.3	15.0
3	NLF	60.4	0.9	23.0	1.3	3.6	5.4	9.7	1.4
	SDLF	2.0	0.3	0.8	0.3	0.1	0.4	0.5	0.4
	TDLF	47.7	8.6	24.6	1.9	3.7	6.2	11.2	0.7
4	NLF	18.0	18.5	20.8	6.6	3.1	4.9	3.2	7.7
	SDLF	0.8	0.8	0.7	0.2	0.1	0.2	0.1	0.1
	TDLF	19.0	14.2	19.6	6.4	3.5	5.2	3.1	7.8
5	NLF	8.7	21.8	7.1	11.1	9.2	3.1	1.3	4.9
	SDLF	0.4	0.8	0.2	0.3	0.3	0.2	0.2	0.1
	TDLF	12.1	17.1	0.9	9.5	9.3	3.7	2.4	4.6
6	NLF	5.8	18.3	10.0	4.5	12.8	9.1	5.2	1.0
	SDLF	0.3	0.6	0.4	0.1	0.4	0.4	0.3	0.2
	TDLF	8.9	16.9	11.9	2.2	12.0	9.6	6.7	2.1
7	NLF	6.3	13.5	18.1	6.0	11.7	13.9	8.8	3.4
	SDLF	0.3	0.5	0.7	0.2	0.4	0.5	0.4	0.2
	TDLF	8.8	14.1	16.9	6.8	10.8	13.2	10.1	4.8
8	NLF	5.5	8.8	17.7	11.6	6.2	17.7	13.4	5.5
	SDLF	0.3	0.3	0.6	0.4	0.2	0.6	0.6	0.3
	TDLF	7.4	10.1	16.2	10.8	6.8	16.1	14.1	7.5
9	NLF	3.4	5.2	13.9	12.8	4.3	18.1	18.3	6.3
	SDLF	0.2	0.2	0.4	0.4	0.1	0.6	0.7	0.4
	TDLF	4.7	6.6	13.3	12.1	2.0	16.9	16.8	8.9
10	NLF	1.1	1.3	9.1	9.2	10.9	9.9	21.6	5.8
	SDLF	0.2	0.2	0.3	0.3	0.3	0.4	0.8	0.4
	TDLF	2.1	2.4	9.6	9.3	9.4	11.8	16.9	9.0

Table J1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
		CF Location							
11	NLF	4.8	3.2	3.2	3.2	6.6	6.6	18.5	8.8
	SDLF	0.1	0.1	0.1	0.2	0.2	0.1	0.8	0.6
	TDLF	4.5	3.1	3.7	3.6	6.4	1.2	14.2	12.2
12	NLF	7.7	9.6	4.8	3.7	1.3	20.6	0.8	18.0
	SDLF	0.2	0.5	0.2	0.2	0.2	0.6	0.3	0.9
	TDLF	7.7	11.2	5.2	3.7	1.9	19.5	8.8	19.1
13	NLF	1.3	5.2	5.4	2.6	2.2	23.2	20.5	60.1
	SDLF	0.4	0.8	0.4	0.6	0.6	0.6	1.1	1.8
	TDLF	0.7	8.3	6.1	1.9	4.9	24.6	38.4	47.5
14	NLF	10.8	19.2	2.9	22.5	7.6	11.9	26.4	30.1
	SDLF	1.3	3.4	0.8	3.1	4.4	1.2	4.0	2.0
	TDLF	15.0	15.5	0.8	20.8	1.7	16.4	88.1	15.0
15	NLF	16.5	NA	24.1	NA	NA	7.8	NA	98.4
	SDLF	4.5	NA	3.2	NA	NA	3.9	NA	6.2
	TDLF	14.0	NA	23.2	NA	NA	17.0	NA	6.5

Table J1-4-2. Axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	204.3	46.3	14.6	20.3	51.4	49.7	46.1	46.0
	SDLF	103.8	20.8	3.9	15.3	30.6	30.1	27.4	27.4
	TDLF	8.7	7.1	6.7	7.9	5.6	5.8	6.1	8.7
2	NLF	60.6	43.7	26.6	5.5	8.1	7.7	11.3	21.0
	SDLF	32.8	22.0	12.8	2.7	4.3	5.0	5.3	9.2
	TDLF	2.6	2.6	2.9	1.9	2.1	2.6	2.3	3.8
3	NLF	133.3	5.4	50.5	6.0	10.5	13.0	18.6	2.4
	SDLF	69.9	3.0	26.2	3.1	5.3	6.4	9.1	0.9
	TDLF	2.2	0.6	1.4	1.0	0.7	0.5	1.3	0.4
4	NLF	38.1	37.9	47.8	17.2	10.4	9.4	5.8	16.2
	SDLF	20.3	20.0	25.5	9.2	5.7	4.4	2.6	7.9
	TDLF	1.2	1.0	1.1	0.3	0.5	0.6	0.4	0.4
5	NLF	18.9	46.9	19.2	26.5	23.1	9.5	4.5	8.6
	SDLF	9.6	24.1	10.4	14.1	12.3	4.9	2.3	4.0
	TDLF	0.7	1.0	0.3	0.6	0.4	0.3	0.4	0.3
6	NLF	13.2	40.8	19.3	10.5	30.3	22.7	13.2	3.7
	SDLF	6.7	21.1	10.2	5.8	16.0	11.9	6.8	1.8
	TDLF	0.5	0.8	0.6	0.2	0.5	0.6	0.5	0.4
7	NLF	14.9	31.0	39.1	11.9	26.2	32.6	21.2	8.6
	SDLF	7.6	16.1	20.3	6.3	13.9	17.1	10.9	4.3
	TDLF	0.5	0.7	0.9	0.4	0.5	0.6	0.6	0.4
8	NLF	13.3	21.2	40.0	26.0	12.2	40.0	30.9	13.3
	SDLF	6.8	11.0	20.9	13.8	6.5	20.9	16.0	6.7
	TDLF	0.4	0.5	0.8	0.5	0.3	0.8	0.7	0.5
9	NLF	8.6	13.2	32.7	30.3	10.0	39.2	40.6	15.0
	SDLF	4.4	6.9	17.2	16.0	5.5	20.4	21.0	7.6
	TDLF	0.3	0.4	0.6	0.5	0.3	0.8	0.9	0.6
10	NLF	3.8	4.7	22.7	23.2	26.0	19.2	46.4	13.3
	SDLF	1.9	2.4	12.0	12.4	14.0	10.2	23.9	6.6
	TDLF	0.3	0.3	0.5	0.4	0.6	0.6	1.1	0.6

Table J1-4-2(Continued). Axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	8.4	5.7	9.7	10.6	17.2	18.1	37.9	19.1
	SDLF	3.9	2.5	5.1	5.9	9.2	9.8	20.0	9.6
	TDLF	0.3	0.5	0.3	0.6	0.3	0.4	1.1	0.8
12	NLF	16.2	18.5	9.3	10.6	6.0	47.6	5.0	38.3
	SDLF	7.9	9.0	4.3	5.3	3.1	25.4	2.8	20.3
	TDLF	0.4	1.3	0.6	0.7	0.9	1.0	0.6	1.2
13	NLF	2.3	11.2	12.9	8.1	5.4	50.8	44.8	132.6
	SDLF	0.9	5.3	6.4	4.1	2.8	26.6	22.8	69.8
	TDLF	0.4	2.3	0.5	2.0	1.8	1.2	2.3	2.2
14	NLF	21.1	46.0	7.6	51.7	20.6	26.7	48.3	59.4
	SDLF	9.2	27.5	4.9	30.6	15.4	13.0	22.3	32.1
	TDLF	3.8	6.7	2.6	5.6	7.8	2.7	5.8	3.3
15	NLF	45.2	NA	49.7	NA	NA	15.0	NA	204.3
	SDLF	27.6	NA	30.1	NA	NA	4.2	NA	105.7
	TDLF	10.2	NA	5.9	NA	NA	6.3	NA	8.2

Table J1-4-3. Axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	73.5	10.2	7.3	5.6	13.6	10.1	6.3	4.0
	SDLF	1.8	1.5	0.1	0.7	1.5	0.6	1.1	0.0
	TDLF	114.7	68.8	16.2	8.6	16.2	15.3	9.6	6.8
2	NLF	80.1	70.0	17.2	13.4	4.1	21.7	8.0	6.2
	SDLF	1.9	2.3	0.1	0.5	0.2	1.4	0.3	0.8
	TDLF	55.3	61.5	21.2	18.0	3.7	26.3	8.5	8.9
3	NLF	25.1	90.1	25.7	29.6	5.4	3.2	15.0	0.0
	SDLF	1.0	3.1	1.1	1.3	0.6	0.2	0.4	0.1
	TDLF	22.5	68.4	28.5	34.6	9.0	2.0	15.9	0.9
4	NLF	12.3	51.9	81.6	51.8	20.6	1.7	3.3	4.5
	SDLF	0.4	1.9	3.0	2.1	1.1	0.3	0.1	0.1
	TDLF	13.1	46.0	80.1	54.0	26.2	1.2	2.0	4.3
5	NLF	3.8	26.9	79.5	66.8	34.4	9.9	1.9	3.1
	SDLF	0.2	1.1	2.9	2.7	1.6	0.8	0.4	0.0
	TDLF	6.3	27.8	68.6	64.8	38.1	14.3	4.3	3.0
6	NLF	1.6	16.1	63.9	71.4	48.3	18.9	6.7	0.1
	SDLF	0.1	0.8	2.5	2.8	2.1	1.1	0.6	0.1
	TDLF	3.7	19.7	57.6	66.8	49.7	23.6	9.9	0.6
7	NLF	1.7	12.0	47.2	67.8	58.9	26.5	9.8	1.1
	SDLF	0.2	0.6	1.9	2.7	2.5	1.4	0.7	0.2
	TDLF	3.3	15.7	45.6	64.1	57.5	30.2	13.4	2.0
8	NLF	1.9	9.8	35.7	59.1	67.7	35.5	11.9	1.9
	SDLF	0.2	0.6	1.5	2.3	2.7	1.7	0.8	0.2
	TDLF	3.2	13.3	37.6	57.5	64.0	37.6	15.8	3.3
9	NLF	1.1	6.6	26.7	48.5	71.5	47.0	16.1	1.7
	SDLF	0.1	0.4	1.1	1.8	2.7	2.0	1.0	0.2
	TDLF	2.0	9.7	30.1	49.7	66.9	45.5	19.8	3.4
10	NLF	0.1	1.9	19.0	34.7	67.0	63.8	26.9	1.6
	SDLF	0.1	0.3	0.9	1.3	2.4	2.5	1.3	0.2
	TDLF	0.6	4.2	23.4	38.1	64.9	57.6	27.9	3.8

Table J1-4-3(Continued). Axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	3.1	3.3	9.9	20.8	52.1	79.1	51.9	3.8
	SDLF	0.0	0.1	0.6	0.8	1.8	2.8	1.9	0.3
	TDLF	3.0	2.0	14.1	26.1	54.0	68.4	46.0	6.4
12	NLF	4.5	15.0	1.6	5.5	29.9	81.8	89.8	12.4
	SDLF	0.1	0.4	0.2	0.4	0.9	2.6	2.8	0.5
	TDLF	4.4	15.9	1.2	9.0	34.7	80.1	68.1	13.2
13	NLF	0.0	7.9	3.2	4.1	13.6	25.9	69.9	24.9
	SDLF	0.1	0.4	0.2	0.2	0.2	0.9	2.0	1.0
	TDLF	0.9	8.4	2.0	3.8	17.9	28.7	61.3	22.3
14	NLF	6.2	5.9	21.6	13.4	6.0	17.3	11.8	80.3
	SDLF	0.8	1.1	1.5	1.5	0.7	0.4	1.1	1.4
	TDLF	8.9	9.0	26.3	15.8	8.8	21.1	70.0	55.0
15	NLF	4.5	NA	10.5	NA	NA	8.1	NA	75.6
	SDLF	0.0	NA	0.7	NA	NA	0.3	NA	1.0
	TDLF	7.1	NA	16.0	NA	NA	16.8	NA	115.8

Table J1-4-4. Axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	157.4	16.3	15.3	11.0	33.3	17.3	22.3	3.4
	SDLF	87.2	6.4	9.5	5.3	15.2	9.7	12.0	0.5
	TDLF	0.2	2.0	1.3	0.7	2.1	1.7	1.2	1.9
2	NLF	191.9	162.8	49.0	40.1	2.7	41.7	11.6	12.6
	SDLF	100.3	86.3	28.0	22.2	0.8	20.6	5.3	6.8
	TDLF	2.2	3.0	0.8	0.7	0.1	2.1	0.0	0.5
3	NLF	50.4	199.2	57.2	67.1	13.8	5.8	32.0	0.6
	SDLF	28.8	103.7	30.6	35.6	7.5	3.1	16.3	0.5
	TDLF	2.4	4.2	1.7	2.0	1.4	1.0	0.5	0.9
4	NLF	24.8	109.1	184.3	115.1	49.4	1.0	6.8	8.6
	SDLF	13.3	57.9	95.9	60.0	26.3	0.0	3.5	4.6
	TDLF	1.6	3.3	4.3	3.3	2.2	1.4	1.2	1.2
5	NLF	5.6	54.9	171.5	145.4	74.4	22.0	4.3	8.3
	SDLF	2.8	29.0	89.4	75.6	38.6	11.6	2.3	4.6
	TDLF	1.4	2.4	4.2	4.0	2.9	2.0	1.6	1.2
6	NLF	0.5	31.3	133.7	150.3	104.2	40.8	13.4	1.0
	SDLF	0.0	16.3	70.3	78.5	54.0	21.0	6.8	0.8
	TDLF	1.4	2.1	3.9	4.3	3.5	2.4	1.8	1.3
7	NLF	0.9	22.6	98.0	141.4	124.4	55.2	19.0	1.0
	SDLF	0.1	11.5	51.3	74.0	64.6	28.3	9.5	0.2
	TDLF	1.4	1.9	3.3	4.1	3.9	2.7	2.0	1.4
8	NLF	1.9	19.0	74.4	124.7	141.1	74.1	22.6	2.0
	SDLF	0.7	9.7	38.7	65.0	73.8	38.3	11.3	0.7
	TDLF	1.4	1.9	2.8	3.7	4.2	3.1	2.1	1.5
9	NLF	0.9	13.2	55.5	104.7	150.4	97.6	31.3	0.9
	SDLF	0.2	6.8	28.7	54.5	78.6	50.9	16.0	0.1
	TDLF	1.4	1.7	2.5	3.2	4.2	3.4	2.3	1.5
10	NLF	1.0	4.3	40.9	74.7	145.7	133.5	54.8	0.5
	SDLF	0.8	2.3	21.3	39.1	76.0	70.1	28.7	0.1
	TDLF	1.3	1.5	2.2	2.6	3.8	4.0	2.6	1.4

Table J1-4-4(Continued). Axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
		CF Location							
11	NLF	8.4	6.8	21.9	49.6	115.7	170.6	108.9	5.6
	SDLF	4.6	3.4	11.8	26.8	60.7	89.1	57.8	2.7
	TDLF	1.2	1.2	1.8	1.9	2.9	4.2	3.4	1.5
12	NLF	8.6	32.1	0.9	14.0	67.7	184.5	198.3	25.0
	SDLF	4.6	16.3	0.2	7.8	36.3	96.4	103.5	13.3
	TDLF	1.2	0.5	1.2	1.2	1.6	4.0	4.2	1.6
13	NLF	0.6	11.5	5.8	2.7	40.4	57.8	162.5	49.8
	SDLF	0.5	5.2	3.1	0.7	22.7	31.1	86.5	28.6
	TDLF	1.0	0.0	0.9	0.2	0.4	1.5	2.8	2.4
14	NLF	12.6	21.3	41.6	32.8	11.7	49.3	19.5	192.1
	SDLF	6.8	11.4	20.5	14.9	5.6	28.4	8.4	100.9
	TDLF	0.6	1.2	2.2	2.0	0.6	1.1	1.2	1.7
15	NLF	2.4	NA	18.4	NA	NA	16.9	NA	162.0
	SDLF	0.1	NA	10.2	NA	NA	10.4	NA	90.3
	TDLF	1.6	NA	1.8	NA	NA	1.6	NA	1.0

Table J1-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	162.4	40.3	15.8	12.1	29.1	29.3	14.4	24.1
	SDLF	5.8	3.4	3.3	2.7	2.1	2.9	1.7	3.2
	TDLF	131.0	145.5	26.0	7.7	31.5	30.2	14.4	24.0
2	NLF	84.7	71.3	11.3	6.2	8.2	24.0	10.7	7.4
	SDLF	2.1	2.5	0.3	0.4	0.1	1.4	0.3	0.8
	TDLF	58.4	60.4	10.6	8.0	8.4	28.6	12.3	10.3
3	NLF	29.2	94.9	27.9	29.6	3.6	4.4	14.1	0.0
	SDLF	1.1	3.3	1.3	1.4	0.6	0.3	0.2	0.2
	TDLF	20.8	73.4	30.2	34.5	6.7	2.8	15.0	0.5
4	NLF	14.1	53.7	82.8	53.2	17.6	3.8	3.8	5.1
	SDLF	0.5	2.0	3.2	2.2	1.1	0.4	0.2	0.0
	TDLF	13.7	45.2	82.4	56.3	22.1	1.6	2.6	5.1
5	NLF	5.2	29.6	83.2	70.5	36.1	8.4	1.0	2.2
	SDLF	0.3	1.1	3.1	2.8	1.7	0.8	0.4	0.1
	TDLF	7.4	29.5	72.0	68.7	40.8	12.4	3.2	1.8
6	NLF	3.6	18.9	65.9	74.3	50.9	18.7	6.6	0.0
	SDLF	0.2	0.8	2.5	2.8	2.2	1.1	0.5	0.1
	TDLF	5.8	22.1	57.8	68.7	52.9	23.6	9.8	0.8
7	NLF	3.6	14.5	50.4	70.3	62.4	29.0	10.8	1.6
	SDLF	0.2	0.6	1.9	2.6	2.5	1.4	0.7	0.1
	TDLF	5.4	18.8	47.8	65.2	60.5	33.6	14.9	2.6
8	NLF	3.0	10.8	38.7	62.6	70.1	38.6	14.5	3.0
	SDLF	0.2	0.5	1.5	2.3	2.7	1.7	0.8	0.2
	TDLF	4.4	14.8	40.6	60.6	65.1	40.7	19.0	4.4
9	NLF	1.6	6.5	29.1	51.0	74.4	50.1	18.9	3.6
	SDLF	0.1	0.4	1.2	1.9	2.8	2.1	1.0	0.2
	TDLF	2.6	9.6	33.5	52.8	68.8	47.7	22.3	5.5
10	NLF	0.0	1.0	18.8	36.3	70.6	65.8	29.5	3.6
	SDLF	0.1	0.3	0.9	1.4	2.5	2.5	1.3	0.3
	TDLF	0.8	3.2	23.5	40.7	68.6	57.8	29.5	5.9

Table J1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	2.2	3.8	8.5	17.8	53.3	82.9	53.7	5.2
	SDLF	0.0	0.1	0.6	0.8	1.9	3.0	2.0	0.4
	TDLF	1.8	2.6	12.3	22.1	56.1	71.6	45.3	7.5
12	NLF	5.1	14.1	3.7	3.7	30.1	82.8	94.5	14.2
	SDLF	0.0	0.3	0.2	0.5	1.0	2.8	3.1	0.6
	TDLF	5.1	14.9	1.6	6.7	34.6	82.1	72.9	13.8
13	NLF	0.0	10.7	4.4	8.1	6.6	28.1	71.1	29.0
	SDLF	0.2	0.3	0.2	0.2	0.1	1.1	2.1	1.1
	TDLF	0.5	12.4	2.8	8.4	8.1	30.3	60.0	20.7
14	NLF	7.4	13.7	23.8	29.3	12.0	11.7	40.5	83.8
	SDLF	0.8	1.7	1.5	2.2	2.6	0.6	2.7	1.8
	TDLF	10.3	14.8	28.5	31.9	7.7	10.8	144.5	57.4
15	NLF	23.6	NA	28.6	NA	NA	15.6	NA	162.5
	SDLF	3.3	NA	2.9	NA	NA	3.2	NA	3.6
	TDLF	23.9	NA	29.5	NA	NA	25.4	NA	127.0

Table J1-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	354.0	93.6	40.8	31.4	62.5	72.4	50.7	65.4
	SDLF	181.9	42.5	17.2	19.1	34.6	37.6	27.1	32.6
	TDLF	7.6	7.1	6.3	5.2	5.5	5.8	4.9	8.8
2	NLF	187.0	154.1	22.9	9.3	21.3	53.5	26.4	17.7
	SDLF	95.8	79.3	12.0	4.9	10.8	26.9	14.2	9.2
	TDLF	2.7	3.4	1.0	0.8	0.2	1.9	0.3	0.3
3	NLF	65.3	210.2	61.2	65.3	6.1	10.7	30.6	1.2
	SDLF	30.9	109.4	31.0	34.2	3.2	5.6	16.3	1.5
	TDLF	2.8	5.0	2.2	2.4	1.7	1.4	1.1	1.3
4	NLF	30.3	119.6	179.3	114.7	35.0	11.9	10.5	13.5
	SDLF	14.5	61.1	93.9	59.9	18.3	6.3	5.7	7.7
	TDLF	2.0	3.6	4.8	3.6	2.4	1.7	1.6	1.7
5	NLF	9.2	63.9	183.0	152.4	76.9	14.8	1.7	6.2
	SDLF	3.9	32.3	95.3	79.3	40.1	7.5	1.1	3.8
	TDLF	1.7	2.7	4.8	4.4	3.2	2.2	1.7	1.5
6	NLF	4.7	38.5	145.4	162.8	108.6	37.0	10.3	2.8
	SDLF	1.8	19.4	74.8	84.3	56.4	19.0	5.1	2.0
	TDLF	1.6	2.3	4.1	4.5	3.7	2.5	1.9	1.5
7	NLF	4.3	28.0	109.4	154.1	135.2	60.1	19.5	0.3
	SDLF	1.6	14.2	56.2	79.5	69.9	31.0	9.7	0.4
	TDLF	1.6	2.1	3.5	4.3	4.1	2.9	2.1	1.5
8	NLF	3.0	19.5	81.8	135.6	153.7	81.6	28.0	3.1
	SDLF	1.0	9.9	42.2	70.3	79.3	41.9	14.0	1.0
	TDLF	1.6	2.0	3.0	4.0	4.4	3.3	2.3	1.6
9	NLF	0.3	10.2	60.2	108.8	163.0	108.8	38.5	4.3
	SDLF	0.4	5.1	31.3	56.7	84.5	55.8	19.1	1.6
	TDLF	1.5	1.8	2.7	3.4	4.5	3.7	2.5	1.6
10	NLF	2.8	1.6	37.1	77.3	152.5	145.2	63.7	4.8
	SDLF	2.0	1.0	19.4	40.6	79.6	74.7	32.0	1.7
	TDLF	1.5	1.6	2.3	2.8	4.2	4.2	2.8	1.7

Table J1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	6.2	10.5	14.9	35.4	114.9	182.1	119.6	9.2
	SDLF	3.7	5.7	7.8	18.8	60.3	95.0	61.0	3.8
	TDLF	1.5	1.5	2.0	2.1	3.3	4.7	3.6	1.8
12	NLF	13.5	30.5	11.8	6.4	66.2	179.2	209.0	30.5
	SDLF	7.7	16.2	6.1	3.5	35.1	94.3	109.0	14.5
	TDLF	1.6	1.0	1.5	1.5	2.0	4.4	4.9	2.1
13	NLF	1.2	26.4	10.6	21.1	9.9	61.7	153.6	64.8
	SDLF	1.5	14.2	5.5	10.7	5.5	31.5	79.4	30.8
	TDLF	1.3	0.3	1.3	0.1	0.6	2.0	3.1	2.8
14	NLF	17.7	49.2	53.1	63.2	31.4	23.7	94.1	185.0
	SDLF	9.2	26.4	26.6	34.8	19.0	12.7	43.5	95.2
	TDLF	0.3	4.7	2.0	5.5	5.1	1.3	5.7	2.5
15	NLF	64.3	NA	70.8	NA	NA	40.5	NA	354.4
	SDLF	32.1	NA	36.8	NA	NA	17.3	NA	184.4
	TDLF	9.2	NA	5.8	NA	NA	6.1	NA	6.9

Table J1-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	-0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	NLF	-1.6	-1.3	-1.4	-1.4	-1.6	-1.8	-1.9	-2.1
	SDLF	-2.0	-1.8	-2.0	-1.8	-1.9	-2.0	-1.9	-1.8
	TDLF	-2.8	-2.5	-2.6	-2.3	-2.2	-2.1	-1.8	-1.3
3	NLF	-1.0	-1.0	-1.2	-1.2	-1.5	-1.7	-1.8	-2.0
	SDLF	-1.9	-1.6	-1.8	-1.6	-1.7	-1.8	-1.7	-1.5
	TDLF	-3.3	-2.4	-2.4	-2.0	-1.9	-1.8	-1.4	-0.7
4	NLF	-0.4	-0.6	-1.0	-1.0	-1.3	-1.6	-1.7	-1.9
	SDLF	-1.8	-1.3	-1.5	-1.3	-1.4	-1.5	-1.4	-1.1
	TDLF	-3.6	-2.3	-2.1	-1.6	-1.5	-1.4	-1.0	0.1
5	NLF	0.0	-0.1	-0.7	-0.7	-1.0	-1.3	-1.5	-1.8
	SDLF	-1.5	-1.0	-1.2	-0.9	-1.0	-1.2	-1.0	-0.7
	TDLF	-3.6	-2.0	-1.8	-1.2	-1.1	-0.9	-0.5	0.8
6	NLF	0.4	0.3	-0.4	-0.4	-0.7	-1.1	-1.3	-1.6
	SDLF	-1.3	-0.6	-0.8	-0.5	-0.7	-0.8	-0.7	-0.3
	TDLF	-3.5	-1.6	-1.4	-0.8	-0.6	-0.4	0.1	1.5
7	NLF	0.8	0.6	0.0	0.0	-0.3	-0.8	-1.0	-1.4
	SDLF	-0.9	-0.2	-0.4	-0.1	-0.3	-0.4	-0.2	0.2
	TDLF	-3.2	-1.1	-1.0	-0.3	-0.1	0.1	0.6	2.2
8	NLF	1.1	1.0	0.4	0.3	0.0	-0.4	-0.6	-1.1
	SDLF	-0.5	0.2	0.0	0.3	0.1	0.0	0.2	0.6
	TDLF	-2.8	-0.6	-0.5	0.1	0.3	0.5	1.1	2.8
9	NLF	1.4	1.3	0.8	0.7	0.4	0.0	-0.3	-0.8
	SDLF	-0.1	0.6	0.4	0.7	0.5	0.4	0.6	1.0
	TDLF	-2.2	-0.1	-0.1	0.6	0.8	1.0	1.6	3.2
10	NLF	1.6	1.5	1.1	1.0	0.7	0.4	0.1	-0.5
	SDLF	0.3	1.0	0.8	1.0	0.9	0.8	0.9	1.3
	TDLF	-1.5	0.4	0.4	1.1	1.2	1.4	2.0	3.5

Table J1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	1.8	1.7	1.3	1.3	1.0	0.7	0.6	-0.1
	SDLF	0.7	1.4	1.2	1.4	1.3	1.2	1.3	1.6
	TDLF	-0.8	1.0	0.9	1.5	1.6	1.8	2.3	3.7
12	NLF	1.9	1.8	1.6	1.5	1.2	1.0	1.0	0.4
	SDLF	1.1	1.6	1.5	1.7	1.6	1.5	1.6	1.8
	TDLF	0.0	1.4	1.4	1.9	2.0	2.1	2.4	3.6
13	NLF	2.0	1.9	1.7	1.6	1.4	1.2	1.3	1.0
	SDLF	1.5	1.9	1.7	1.9	1.8	1.8	1.8	1.9
	TDLF	0.7	1.8	1.8	2.2	2.3	2.4	2.5	3.3
14	NLF	2.1	0.0	1.8	0.0	0.0	1.4	0.0	1.6
	SDLF	1.8	0.0	2.0	0.0	0.0	2.0	0.0	2.0
	TDLF	1.4	0.0	2.1	0.0	0.0	2.6	0.0	2.8
15	NLF	0.0	NA	0.0	NA	NA	0.0	NA	0.0
	SDLF	0.0	NA	0.0	NA	NA	0.0	NA	0.0
	TDLF	0.0	NA	0.0	NA	NA	0.0	NA	0.6

Table J1-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	NLF	-3.6	-2.9	-3.2	-3.1	-3.5	-3.9	-4.3	-4.6
	SDLF	-3.9	-3.4	-3.7	-3.5	-3.8	-4.1	-4.2	-4.2
	TDLF	-4.3	-4.0	-4.3	-4.0	-4.1	-4.3	-4.1	-3.8
3	NLF	-2.1	-2.1	-2.7	-2.7	-3.2	-3.8	-4.0	-4.4
	SDLF	-3.0	-2.7	-3.2	-3.0	-3.4	-3.8	-3.8	-3.8
	TDLF	-4.2	-3.4	-3.8	-3.4	-3.6	-3.8	-3.6	-3.0
4	NLF	-0.9	-1.2	-2.2	-2.2	-2.8	-3.4	-3.7	-4.2
	SDLF	-2.2	-2.0	-2.7	-2.4	-2.9	-3.3	-3.4	-3.3
	TDLF	-3.9	-2.8	-3.2	-2.8	-3.0	-3.2	-3.0	-2.2
5	NLF	0.1	-0.3	-1.6	-1.5	-2.2	-3.0	-3.3	-3.9
	SDLF	-1.5	-1.1	-2.0	-1.7	-2.2	-2.7	-2.8	-2.8
	TDLF	-3.5	-2.0	-2.5	-2.0	-2.3	-2.5	-2.2	-1.3
6	NLF	1.0	0.6	-0.8	-0.8	-1.5	-2.4	-2.8	-3.5
	SDLF	-0.7	-0.3	-1.2	-1.0	-1.5	-2.1	-2.1	-2.1
	TDLF	-2.9	-1.2	-1.8	-1.2	-1.4	-1.7	-1.4	-0.3
7	NLF	1.8	1.4	0.0	0.0	-0.8	-1.7	-2.2	-3.1
	SDLF	0.0	0.6	-0.4	-0.2	-0.7	-1.3	-1.4	-1.5
	TDLF	-2.2	-0.4	-0.9	-0.3	-0.6	-0.9	-0.6	0.6
8	NLF	2.5	2.2	0.9	0.7	0.0	-0.9	-1.4	-2.5
	SDLF	0.8	1.4	0.4	0.7	0.1	-0.5	-0.6	-0.7
	TDLF	-1.4	0.5	0.0	0.6	0.3	0.0	0.3	1.5
9	NLF	3.0	2.8	1.7	1.5	0.8	-0.1	-0.6	-1.8
	SDLF	1.5	2.1	1.3	1.5	1.0	0.4	0.3	0.0
	TDLF	-0.5	1.4	0.9	1.4	1.2	0.9	1.2	2.3
10	NLF	3.5	3.3	2.4	2.2	1.5	0.8	0.3	-1.0
	SDLF	2.2	2.8	2.0	2.2	1.7	1.2	1.1	0.8
	TDLF	0.4	2.2	1.7	2.2	2.0	1.7	2.0	3.0

Table J1-4-8(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	3.9	3.7	2.9	2.8	2.2	1.6	1.2	-0.1
	SDLF	2.8	3.4	2.7	2.9	2.4	2.0	2.0	1.5
	TDLF	1.3	3.0	2.5	3.0	2.8	2.5	2.8	3.5
12	NLF	4.2	4.0	3.4	3.2	2.7	2.2	2.1	0.9
	SDLF	3.4	3.8	3.3	3.4	3.0	2.7	2.7	2.3
	TDLF	2.2	3.6	3.2	3.6	3.4	3.2	3.4	4.0
13	NLF	4.4	4.2	3.8	3.5	3.1	2.7	2.9	2.1
	SDLF	3.8	4.2	3.8	3.8	3.5	3.2	3.4	3.1
	TDLF	3.1	4.1	3.8	4.1	4.0	3.8	4.0	4.2
14	NLF	4.6	0.0	3.9	0.0	0.0	3.2	0.0	3.6
	SDLF	4.2	0.0	4.1	0.0	0.0	3.7	0.0	3.9
	TDLF	3.8	0.0	4.2	0.0	0.0	4.3	0.0	4.3
15	NLF	0.0	NA	0.0	NA	NA	0.0	NA	0.0
	SDLF	0.0	NA	0.0	NA	NA	0.0	NA	0.0
	TDLF	0.0	NA	0.0	NA	NA	0.0	NA	0.0

Table J1-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	-0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	NLF	-1.9	-1.6	-1.7	-1.7	-1.9	-2.2	-2.3	-2.5
	SDLF	-2.4	-2.2	-2.4	-2.2	-2.3	-2.4	-2.3	-2.2
	TDLF	-3.4	-3.1	-3.1	-2.8	-2.7	-2.6	-2.2	-1.6
3	NLF	-1.2	-1.2	-1.5	-1.5	-1.8	-2.1	-2.2	-2.4
	SDLF	-2.3	-1.9	-2.1	-1.9	-2.0	-2.1	-2.0	-1.8
	TDLF	-4.0	-2.9	-2.9	-2.4	-2.3	-2.2	-1.7	-0.8
4	NLF	-0.5	-0.7	-1.2	-1.2	-1.5	-1.9	-2.0	-2.3
	SDLF	-2.1	-1.6	-1.8	-1.5	-1.7	-1.8	-1.7	-1.3
	TDLF	-4.3	-2.7	-2.5	-1.9	-1.8	-1.7	-1.2	0.1
5	NLF	0.1	-0.2	-0.9	-0.8	-1.2	-1.6	-1.8	-2.1
	SDLF	-1.9	-1.2	-1.4	-1.1	-1.3	-1.4	-1.2	-0.8
	TDLF	-4.4	-2.4	-2.1	-1.5	-1.3	-1.1	-0.5	1.0
6	NLF	0.5	0.3	-0.4	-0.4	-0.8	-1.3	-1.5	-1.9
	SDLF	-1.5	-0.7	-1.0	-0.7	-0.8	-1.0	-0.8	-0.3
	TDLF	-4.2	-1.9	-1.7	-0.9	-0.7	-0.5	0.1	1.9
7	NLF	1.0	0.8	0.0	0.0	-0.4	-0.9	-1.2	-1.7
	SDLF	-1.1	-0.2	-0.5	-0.2	-0.3	-0.5	-0.3	0.2
	TDLF	-3.9	-1.4	-1.2	-0.4	-0.2	0.1	0.8	2.7
8	NLF	1.3	1.2	0.5	0.4	0.0	-0.5	-0.8	-1.3
	SDLF	-0.6	0.3	0.0	0.3	0.2	0.0	0.2	0.7
	TDLF	-3.3	-0.8	-0.7	0.2	0.4	0.6	1.4	3.4
9	NLF	1.7	1.5	0.9	0.8	0.4	0.0	-0.3	-1.0
	SDLF	-0.1	0.8	0.5	0.8	0.7	0.5	0.7	1.2
	TDLF	-2.6	-0.1	-0.1	0.7	0.9	1.2	1.9	3.9
10	NLF	1.9	1.8	1.3	1.2	0.8	0.4	0.2	-0.5
	SDLF	0.4	1.2	0.9	1.3	1.1	1.0	1.1	1.6
	TDLF	-1.8	0.5	0.5	1.3	1.5	1.7	2.4	4.3

Table J1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	2.1	2.0	1.6	1.5	1.2	0.9	0.7	-0.1
	SDLF	0.9	1.6	1.4	1.7	1.5	1.4	1.6	1.9
	TDLF	-0.9	1.2	1.1	1.8	1.9	2.1	2.7	4.4
12	NLF	2.3	2.2	1.9	1.8	1.5	1.2	1.2	0.5
	SDLF	1.3	2.0	1.8	2.0	1.9	1.8	1.9	2.2
	TDLF	0.0	1.7	1.7	2.3	2.4	2.5	2.9	4.4
13	NLF	2.4	2.3	2.1	1.9	1.7	1.5	1.6	1.2
	SDLF	1.8	2.3	2.1	2.3	2.2	2.1	2.2	2.3
	TDLF	0.8	2.2	2.1	2.7	2.8	2.9	3.1	4.0
14	NLF	2.5	0.0	2.2	0.0	0.0	1.7	0.0	1.9
	SDLF	2.2	0.0	2.4	0.0	0.0	2.4	0.0	2.4
	TDLF	1.6	0.0	2.6	0.0	0.0	3.1	0.0	3.4
15	NLF	0.0	NA	0.0	NA	NA	0.0	NA	0.0
	SDLF	0.0	NA	0.0	NA	NA	0.0	NA	0.0
	TDLF	0.0	NA	0.0	NA	NA	0.0	NA	0.7

Table J1-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	NLF	-4.3	-3.5	-3.8	-3.8	-4.2	-4.8	-5.1	-5.5
	SDLF	-4.7	-4.1	-4.4	-4.2	-4.6	-4.9	-5.0	-5.1
	TDLF	-5.2	-4.8	-5.1	-4.8	-5.0	-5.1	-5.0	-4.6
3	NLF	-2.5	-2.5	-3.3	-3.3	-3.9	-4.5	-4.8	-5.3
	SDLF	-3.7	-3.3	-3.9	-3.7	-4.1	-4.6	-4.6	-4.6
	TDLF	-5.1	-4.2	-4.6	-4.1	-4.4	-4.6	-4.3	-3.7
4	NLF	-1.1	-1.5	-2.7	-2.6	-3.4	-4.1	-4.5	-5.1
	SDLF	-2.7	-2.4	-3.3	-3.0	-3.5	-4.0	-4.1	-4.0
	TDLF	-4.8	-3.4	-3.9	-3.4	-3.6	-3.9	-3.6	-2.6
5	NLF	0.1	-0.4	-1.9	-1.8	-2.6	-3.6	-4.0	-4.7
	SDLF	-1.8	-1.4	-2.4	-2.1	-2.7	-3.3	-3.4	-3.3
	TDLF	-4.2	-2.5	-3.1	-2.4	-2.7	-3.0	-2.7	-1.5
6	NLF	1.2	0.7	-1.0	-1.0	-1.8	-2.9	-3.4	-4.3
	SDLF	-0.9	-0.3	-1.5	-1.2	-1.8	-2.5	-2.6	-2.6
	TDLF	-3.6	-1.5	-2.1	-1.4	-1.7	-2.1	-1.7	-0.4
7	NLF	2.1	1.7	0.0	0.0	-0.9	-2.0	-2.6	-3.7
	SDLF	0.0	0.7	-0.5	-0.2	-0.8	-1.6	-1.7	-1.8
	TDLF	-2.7	-0.4	-1.1	-0.4	-0.7	-1.1	-0.7	0.7
8	NLF	3.0	2.6	1.1	0.9	0.0	-1.1	-1.7	-3.0
	SDLF	0.9	1.7	0.5	0.8	0.2	-0.6	-0.7	-0.9
	TDLF	-1.7	0.7	0.0	0.7	0.4	0.0	0.4	1.8
9	NLF	3.7	3.4	2.0	1.8	1.0	-0.1	-0.7	-2.2
	SDLF	1.8	2.6	1.5	1.8	1.2	0.5	0.3	0.0
	TDLF	-0.7	1.7	1.0	1.7	1.4	1.1	1.5	2.7
10	NLF	4.2	4.0	2.8	2.6	1.8	0.9	0.4	-1.2
	SDLF	2.6	3.4	2.5	2.7	2.1	1.5	1.3	0.9
	TDLF	0.5	2.7	2.1	2.7	2.4	2.1	2.5	3.6

Table J1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	4.7	4.5	3.6	3.3	2.6	1.9	1.5	-0.2
	SDLF	3.4	4.0	3.3	3.5	2.9	2.4	2.4	1.8
	TDLF	1.6	3.6	3.0	3.6	3.4	3.1	3.4	4.3
12	NLF	5.1	4.8	4.1	3.9	3.3	2.7	2.5	1.1
	SDLF	4.1	4.6	4.0	4.1	3.7	3.2	3.3	2.7
	TDLF	2.7	4.3	3.9	4.3	4.1	3.9	4.2	4.8
13	NLF	5.3	5.1	4.5	4.2	3.8	3.3	3.4	2.5
	SDLF	4.6	5.0	4.5	4.6	4.2	3.9	4.1	3.7
	TDLF	3.7	5.0	4.6	5.0	4.8	4.6	4.8	5.1
14	NLF	5.5	0.0	4.8	0.0	0.0	3.8	0.0	4.3
	SDLF	5.1	0.0	4.9	0.0	0.0	4.4	0.0	4.7
	TDLF	4.6	0.0	5.1	0.0	0.0	5.1	0.0	5.2
15	NLF	0.0	NA	0.0	NA	NA	0.0	NA	0.0
	SDLF	0.0	NA	0.0	NA	NA	0.0	NA	0.0
	TDLF	0.0	NA	0.0	NA	NA	0.0	NA	0.0

Table J1-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	387	145	833	329
	SDLF	138	145	588	323
	TDLF	0	140	304	314
G2	NLF	61	171	133	367
	SDLF	160	157	231	353
	TDLF	100	145	345	341
G3	NLF	121	174	267	375
	SDLF	157	157	302	359
	TDLF	233	139	343	343
G4	NLF	94	127	202	279
	SDLF	159	158	270	309
	TDLF	232	192	345	344
G5	NLF	109	109	238	238
	SDLF	158	158	288	288
	TDLF	209	209	344	344
G6	NLF	127	94	279	201
	SDLF	158	159	309	269
	TDLF	192	233	344	345
G7	NLF	174	121	375	267
	SDLF	157	158	360	302
	TDLF	139	233	343	343
G8	NLF	170	63	366	139
	SDLF	157	160	353	234
	TDLF	145	98	342	347
G9	NLF	146	384	330	828
	SDLF	144	137	323	584
	TDLF	139	0	313	302

Table J1-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-5.8	NA	-10.9	NA
	SDLF	0.4	NA	-4.7	NA
	TDLF	7.0	NA	0.8	NA
G2	NLF	-0.4	NA	0.8	NA
	SDLF	0.0	NA	0.5	NA
	TDLF	1.6	NA	-0.3	NA
G3	NLF	2.1	NA	7.0	NA
	SDLF	0.0	NA	3.8	NA
	TDLF	-2.3	NA	0.0	NA
G4	NLF	1.5	NA	3.2	NA
	SDLF	0.0	NA	1.5	NA
	TDLF	-1.8	NA	-0.1	NA
G5	NLF	1.8	NA	3.7	NA
	SDLF	0.0	NA	1.8	NA
	TDLF	-2.2	NA	0.0	NA
G6	NLF	1.4	NA	2.9	NA
	SDLF	0.0	NA	1.4	NA
	TDLF	-1.8	NA	0.0	NA
G7	NLF	-0.4	NA	-3.6	NA
	SDLF	0.0	NA	-2.1	NA
	TDLF	0.2	NA	-0.1	NA
G8	NLF	-0.5	NA	-2.6	NA
	SDLF	-0.1	NA	-1.4	NA
	TDLF	-0.2	NA	-0.3	NA
G9	NLF	0.3	NA	-0.6	NA
	SDLF	0.0	NA	-0.8	NA
	TDLF	-0.5	NA	0.0	NA

(Column group header: Load Type & Support Number)

Table J1-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number: SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-7.8	1.3	-10.1	5.6
	SDLF	0.2	-0.1	-2.5	3.8
	TDLF	0.0	-2.2	0.0	-0.2
G2	NLF	0.0	3.3	6.6	10.4
	SDLF	0.0	-0.1	4.0	4.8
	TDLF	-1.2	-3.8	-0.2	-0.2
G3	NLF	5.6	2.5	21.6	10.7
	SDLF	-0.1	-0.1	11.9	5.6
	TDLF	-5.9	-3.1	-0.2	-0.1
G4	NLF	3.2	-1.8	9.3	-5.5
	SDLF	-0.1	0.0	4.6	-2.8
	TDLF	-2.9	1.5	-0.2	-0.1
G5	NLF	3.3	-4.0	9.3	-10.6
	SDLF	-0.1	0.1	4.5	-5.2
	TDLF	-3.1	3.8	-0.1	0.2
G6	NLF	1.2	-3.7	4.4	-10.3
	SDLF	0.0	0.1	2.3	-5.1
	TDLF	-0.9	3.5	0.1	0.2
G7	NLF	-2.7	-5.7	-11.0	-21.9
	SDLF	0.1	0.1	-5.8	-12.0
	TDLF	3.3	6.1	0.1	0.2
G8	NLF	-3.1	0.2	-9.9	-6.0
	SDLF	0.1	0.1	-4.6	-3.7
	TDLF	3.5	0.8	0.2	0.2
G9	NLF	-0.6	8.6	-4.3	11.8
	SDLF	0.0	-0.1	-3.2	3.5
	TDLF	1.3	-1.0	0.0	0.0

Table J1-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.2	0.9	-0.4	1.9
	SDLF	0.0	0.9	-0.2	1.8
	TDLF	0.2	0.9	0.0	1.9
G2	NLF	0.0	0.9	0.0	2.0
	SDLF	0.0	0.9	0.0	1.9
	TDLF	0.1	1.1	0.0	2.1
G3	NLF	0.1	0.9	0.2	2.0
	SDLF	0.0	0.9	0.1	1.9
	TDLF	-0.1	1.1	0.0	2.1
G4	NLF	0.1	0.8	0.1	1.8
	SDLF	0.0	0.9	0.1	1.8
	TDLF	-0.1	1.2	0.0	2.1
G5	NLF	0.1	0.8	0.1	1.7
	SDLF	0.0	0.9	0.1	1.7
	TDLF	-0.1	1.2	0.0	2.1
G6	NLF	0.0	0.8	0.1	1.8
	SDLF	0.0	0.9	0.0	1.8
	TDLF	-0.1	1.2	0.0	2.1
G7	NLF	0.0	0.8	-0.1	1.7
	SDLF	0.0	0.9	-0.1	1.7
	TDLF	0.0	1.2	0.0	2.1
G8	NLF	0.0	0.9	-0.1	1.9
	SDLF	0.0	0.9	0.0	1.8
	TDLF	0.0	1.0	0.0	2.1
G9	NLF	0.0	1.1	0.0	2.3
	SDLF	0.0	0.8	0.0	1.9
	TDLF	0.0	0.7	0.0	1.9

Table J1-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.3	0.0	0.3	-0.2
	SDLF	0.0	0.0	0.1	-0.1
	TDLF	0.0	0.1	0.0	0.0
G2	NLF	0.0	-0.1	-0.2	-0.3
	SDLF	0.0	0.0	-0.1	-0.2
	TDLF	0.0	0.1	0.0	0.0
G3	NLF	-0.2	-0.1	-0.7	-0.4
	SDLF	0.0	0.0	-0.4	-0.2
	TDLF	0.2	0.1	0.0	0.0
G4	NLF	-0.1	0.1	-0.3	0.2
	SDLF	0.0	0.0	-0.2	0.1
	TDLF	0.1	-0.1	0.0	0.0
G5	NLF	-0.1	0.1	-0.3	0.4
	SDLF	0.0	0.0	-0.2	0.2
	TDLF	0.1	-0.1	0.0	0.0
G6	NLF	0.0	0.1	-0.1	0.3
	SDLF	0.0	0.0	-0.1	0.2
	TDLF	0.0	-0.1	0.0	0.0
G7	NLF	0.1	0.2	0.4	0.7
	SDLF	0.0	0.0	0.2	0.4
	TDLF	-0.1	-0.2	0.0	0.0
G8	NLF	0.1	0.0	0.3	0.2
	SDLF	0.0	0.0	0.2	0.1
	TDLF	-0.1	0.0	0.0	0.0
G9	NLF	0.0	-0.3	0.1	-0.4
	SDLF	0.0	0.0	0.1	-0.1
	TDLF	0.0	0.0	0.0	0.0

Appendix J1-5. NISSS54 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISSS54 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table J1-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	SDLF	-2.6	2.4	3.6	0.0	-2.3	2.3
		TDLF	-1.7	2.6	3.1	0.0	-2.1	2.1
	2-3	SDLF	-0.1	-0.1	0.2	0.3	0.1	0.4
		TDLF	-0.2	-0.5	0.5	0.8	0.2	0.8
	2-4	SDLF	-1.0	-0.1	1.0	0.3	0.1	0.4
		TDLF	0.1	-1.6	1.7	3.1	1.4	3.4
	2-5	SDLF	-0.1	-0.8	0.8	1.2	0.6	1.3
		TDLF	0.0	-1.3	1.3	2.8	1.3	3.1
	2-8	SDLF	1.4	-4.5	4.7	0.0	3.5	3.5
		TDLF	-1.4	-4.3	4.5	0.0	0.4	0.4
	2-10	SDLF	-4.9	1.0	5.0	-4.4	0.8	4.5
		TDLF	-15.8	5.7	16.8	-13.9	3.6	14.4
	2-11	SDLF	0.5	0.0	0.5	0.4	-1.1	1.2
		TDLF	1.6	-1.0	1.9	1.1	-4.3	4.5
	2-12	SDLF	0.1	-0.2	0.2	0.2	0.0	0.2
		TDLF	0.9	-1.5	1.8	1.9	1.7	2.5
	2-13	SDLF	-0.1	0.0	0.1	0.0	-0.1	0.1
		TDLF	-0.9	-0.1	0.9	0.5	0.7	0.9
	2-14	SDLF	0.7	-0.4	0.8	0.8	0.8	1.1
		TDLF	3.0	-3.1	4.3	4.5	2.2	5.0
	2-15	SDLF	0.3	0.0	0.3	0.4	0.5	0.7
		TDLF	2.6	-2.5	3.6	4.1	1.7	4.5
	2-16	SDLF	0.1	-0.5	0.5	0.0	-0.2	0.2
		TDLF	-3.5	2.0	4.0	-2.4	-2.0	3.2
	2-17	SDLF	-0.2	-0.4	0.4	-0.2	-0.6	0.6
		TDLF	-2.3	1.4	2.7	-1.5	-2.0	2.5
	2-18	SDLF	-0.4	0.0	0.4	-0.5	-1.4	1.5
		TDLF	-2.0	2.7	3.4	-1.4	-3.3	3.6
	2-19	SDLF	-2.3	3.8	4.5	-2.5	-5.0	5.6
		TDLF	-9.1	17.9	20.1	-9.1	-17.6	19.8

Table J1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
3	3-2	SDLF	-2.6	3.2	4.1	0.0	-3.2	3.2
		TDLF	-3.0	3.7	4.7	0.0	-3.6	3.6
	3-4	SDLF	5.7	-4.8	7.4	0.0	3.7	3.7
		TDLF	15.8	-3.5	16.2	0.0	3.3	3.3
	3-5	SDLF	-2.5	0.5	2.5	-2.2	0.2	2.2
		TDLF	-1.0	3.9	4.0	0.9	2.0	2.2
	3-6	SDLF	-0.3	-0.3	0.4	0.1	1.2	1.2
		TDLF	6.3	-3.2	7.1	7.1	3.4	7.9
	3-7	SDLF	1.7	-0.4	1.8	1.8	-0.2	1.8
		TDLF	7.5	-3.5	8.3	8.4	2.4	8.8
	3-8	SDLF	1.5	-0.2	1.5	1.6	0.1	1.6
		TDLF	5.5	-2.7	6.1	6.9	2.6	7.3
	3-9	SDLF	1.0	-0.2	1.1	1.0	0.0	1.0
		TDLF	3.1	-1.3	3.4	4.8	1.7	5.1
	3-10	SDLF	0.8	-0.5	1.0	0.9	0.6	1.1
		TDLF	2.0	-1.7	2.7	3.5	0.6	3.5
	3-11	SDLF	0.6	-0.3	0.7	0.6	0.4	0.8
		TDLF	1.3	-0.9	1.5	2.7	-0.1	2.7
	3-12	SDLF	0.5	-0.2	0.5	0.5	0.3	0.6
		TDLF	1.1	-1.0	1.5	2.5	0.0	2.5
	3-13	SDLF	0.5	-0.2	0.6	0.6	0.4	0.7
		TDLF	2.1	-2.2	3.0	3.1	0.8	3.2
	3-14	SDLF	0.6	0.0	0.6	0.7	-0.2	0.7
		TDLF	2.9	2.8	4.1	4.2	-1.2	4.4
	3-15	SDLF	0.8	0.1	0.8	1.0	-0.3	1.0
		TDLF	4.7	3.7	5.9	6.0	-0.9	6.1
	3-16	SDLF	0.9	1.0	1.3	1.0	-1.2	1.6
		TDLF	5.8	11.0	12.4	7.7	-4.4	8.9

Table J1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	SDLF	-3.0	3.0	4.3	0.0	-3.0	3.0
		TDLF	-4.5	2.3	5.1	0.0	-2.2	2.2
	9-4	SDLF	1.7	-2.3	2.9	0.0	2.2	2.2
		TDLF	8.9	3.7	9.6	0.0	5.5	5.5
	9-5	SDLF	-0.3	0.0	0.3	-0.3	0.0	0.3
		TDLF	17.9	0.4	17.9	17.8	0.3	17.8
	9-6	SDLF	0.7	-0.4	0.8	0.9	0.3	0.9
		TDLF	23.2	-14.1	27.2	22.9	9.2	24.7
	9-7	SDLF	0.7	0.0	0.7	0.9	0.1	0.9
		TDLF	26.1	-1.0	26.1	27.5	3.6	27.7
	9-8	SDLF	1.1	-0.1	1.1	1.2	0.1	1.2
		TDLF	30.6	-1.4	30.6	32.1	2.9	32.2
	9-9	SDLF	1.4	-0.1	1.4	1.5	0.1	1.5
		TDLF	35.3	-1.9	35.3	37.1	3.5	37.3
	9-10	SDLF	1.6	-0.2	1.6	1.6	0.2	1.6
		TDLF	37.5	-3.5	37.7	39.5	4.1	39.7
	9-11	SDLF	1.8	-0.4	1.9	1.8	0.4	1.9
		TDLF	39.9	-9.0	40.9	41.9	8.8	42.8
	9-12	SDLF	1.8	-0.2	1.8	1.8	0.2	1.8
		TDLF	38.9	-5.8	39.3	40.8	5.1	41.1
	9-13	SDLF	1.7	-0.2	1.8	1.8	0.2	1.8
		TDLF	39.4	-6.2	39.9	41.2	6.9	41.7
	9-14	SDLF	1.8	-0.4	1.8	1.9	0.5	1.9
		TDLF	43.4	-11.0	44.7	45.3	13.8	47.3
	9-15	SDLF	1.6	-0.1	1.6	1.7	0.0	1.7
		TDLF	42.6	1.6	42.6	43.8	-1.7	43.8
	9-16	SDLF	1.6	-0.1	1.6	1.8	0.0	1.8
		TDLF	46.6	5.1	46.9	47.3	-6.9	47.8
	9-17	SDLF	1.3	0.3	1.4	1.5	-0.5	1.6
		TDLF	11.5	45.4	46.9	10.1	-49.1	50.1

Table J1-5-2: Erection Critical Sub-Stages

Stage	Detailing Method	Critical Sub-Stage
2	SDLF	2-10
	TDLF	2-19
3	SDLF	3-4
	TDLF	3-16
9	SDLF	9-2
	TDLF	9-17

Table J1-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	SDLF	-8.3	3.9	9.2	NA	NA	NA
		TDLF	2.1	0.4	2.1	NA	NA	NA
	B	SDLF	-4.9	1.0	5.0	-4.4	0.8	4.5
		TDLF	-9.1	17.9	20.1	-9.1	-17.6	19.8
3	A	SDLF	2.3	-0.8	2.5	NA	NA	NA
		TDLF	12.5	4.6	13.3	NA	NA	NA
	B	SDLF	5.7	-4.8	7.4	0.0	3.7	3.7
		TDLF	5.8	11.0	12.4	7.7	-4.4	8.9
9	A	SDLF	-0.5	-0.5	0.7	NA	NA	NA
		TDLF	73.2	6.9	73.5	NA	NA	NA
	B	SDLF	-3.0	3.0	4.3	0.0	-3.0	3.0
		TDLF	11.5	45.4	46.9	10.1	-49.1	50.1

Table J1-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
2	A	G1	SDLF	146	142
			TDLF	162	140
		G2	SDLF	141	142
			TDLF	134	153
	B	G1	SDLF	147	142
			TDLF	158	141
		G2	SDLF	142	143
			TDLF	138	154
3	A	G1	SDLF	153	143
			TDLF	158	126
		G2	SDLF	143	157
			TDLF	145	185
		G3	SDLF	149	142
			TDLF	148	138
	B	G1	SDLF	148	143
			TDLF	158	126
		G2	SDLF	151	158
			TDLF	146	187
		G3	SDLF	143	141
			TDLF	148	138

Table J1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
9	A	G1	SDLF	141	144
			TDLF	0	138
		G2	SDLF	160	156
			TDLF	101	145
		G3	SDLF	159	157
			TDLF	233	138
		G4	SDLF	156	158
			TDLF	232	192
		G5	SDLF	156	157
			TDLF	208	209
		G6	SDLF	155	159
			TDLF	191	231
		G7	SDLF	153	155
			TDLF	138	224
		G8	SDLF	153	145
			TDLF	144	107
		G9	SDLF	83	116
			TDLF	138	0

Table J1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
9	B	G1	SDLF	141	144
			TDLF	0	139
		G2	SDLF	160	157
			TDLF	101	145
		G3	SDLF	159	157
			TDLF	232	139
		G4	SDLF	157	158
			TDLF	232	192
		G5	SDLF	156	158
			TDLF	209	209
		G6	SDLF	155	159
			TDLF	192	232
		G7	SDLF	156	156
			TDLF	139	232
		G8	SDLF	157	150
			TDLF	146	99
		G9	SDLF	142	140
			TDLF	139	0

Appendix J2-1. NISSS54 Bridge Description

The key characteristics of NISSS54 are as follows:

- Span length along the centerline of the bridge, L_s = 300 ft.
- Width between the fascia girders, w_g = 74 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 4.05
- Number of girders in the completed bridge cross-section, n_g = 9.
- Parallel skew
- Skew angle, θ = 70°
- Skew index, I_s = 0.68

This appendix presents the bridge description of the bridge NISSS54 in its final condition as well as during erection. The following figures and tables are provided:

Figure J2-1-1. Framing plan

Figure J2-1-2. Bridge cross-section

Figure J2-1-3. Girder Elevation

Figure J2-1-4. Cross-section dimension

Figure J2-1-5. Cross-frame details

Figure J2-1-6. Erection scheme

Table J2-1-1. Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

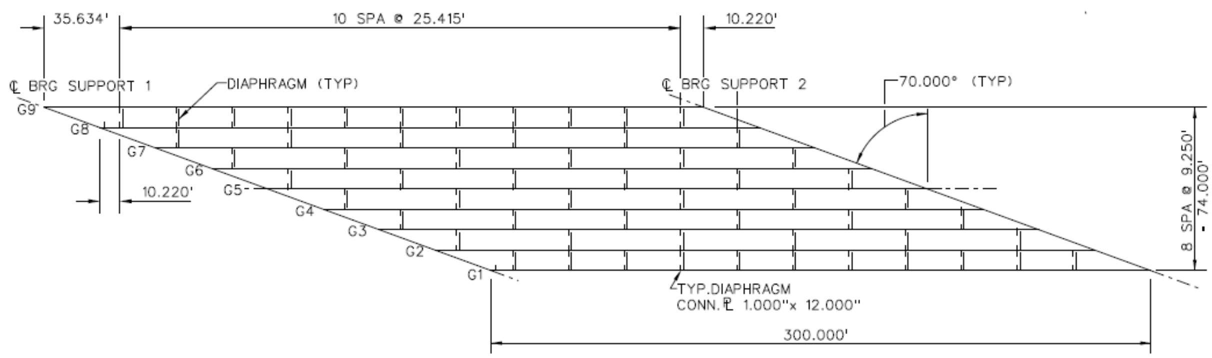


Figure J2-1-1. Framing plan.

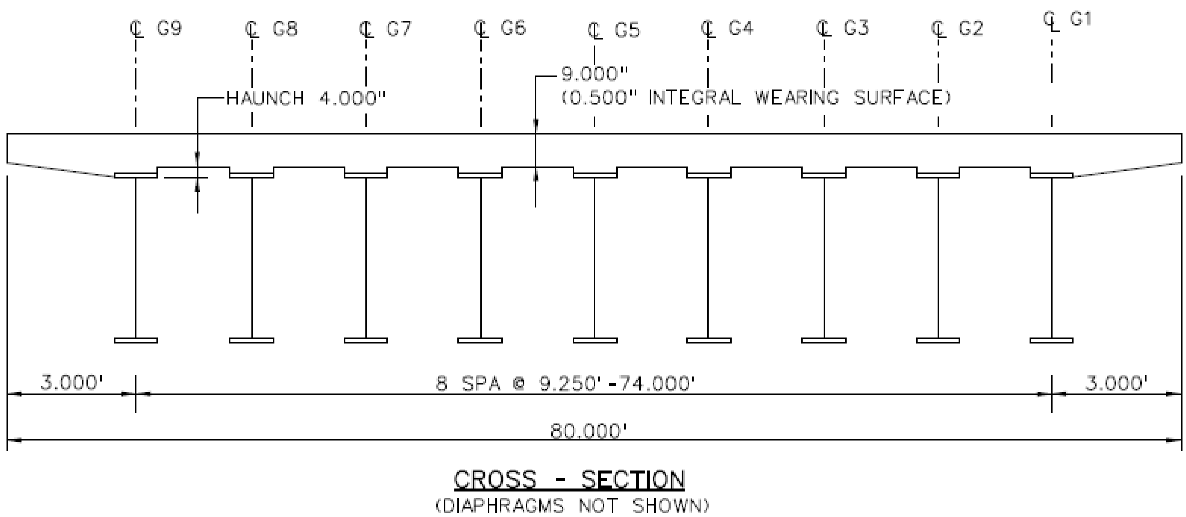


Figure J2-1-2. Bridge cross-section.

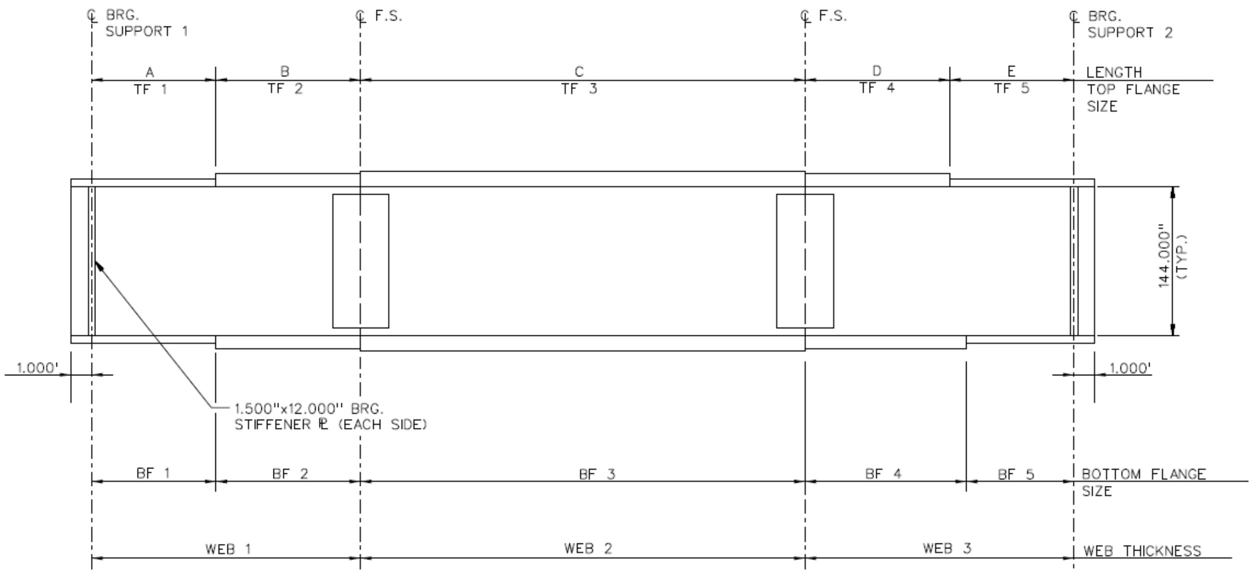


Figure J2-1-3. Girder elevations

	GIRDER PLATE LENGTHS ⚹								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000
B	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000
C	120.000	120.000	120.000	120.000	120.000	120.000	120.000	120.000	120.000
D	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000
E	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000	45.000

⚹ ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS ⚹⚹					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	28.000	1.250	28.000	1.250	28.000	1.250
TF2	28.000	2.000	28.000	2.000	28.000	2.000
TF3	28.000	2.000	28.000	2.000	28.000	2.000
TF4	28.000	2.000	28.000	2.000	28.000	2.000
TF5	28.000	1.250	28.000	1.250	28.000	1.250

⚹⚹ ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS ⚹⚹					
BOTTOM FLANGE	G1		G2		G3	
	BF	TF	BF	TF	BF	TF
BF1	30.000	1.250	30.000	1.250	30.000	1.250
BF2	30.000	2.250	30.000	2.250	30.000	2.250
BF3	30.000	2.750	30.000	2.750	30.000	2.750
BF4	30.000	2.250	30.000	2.250	30.000	2.250
BF5	30.000	1.250	30.000	1.250	30.000	1.250

Figure J2-1-4. Cross-section dimensions.

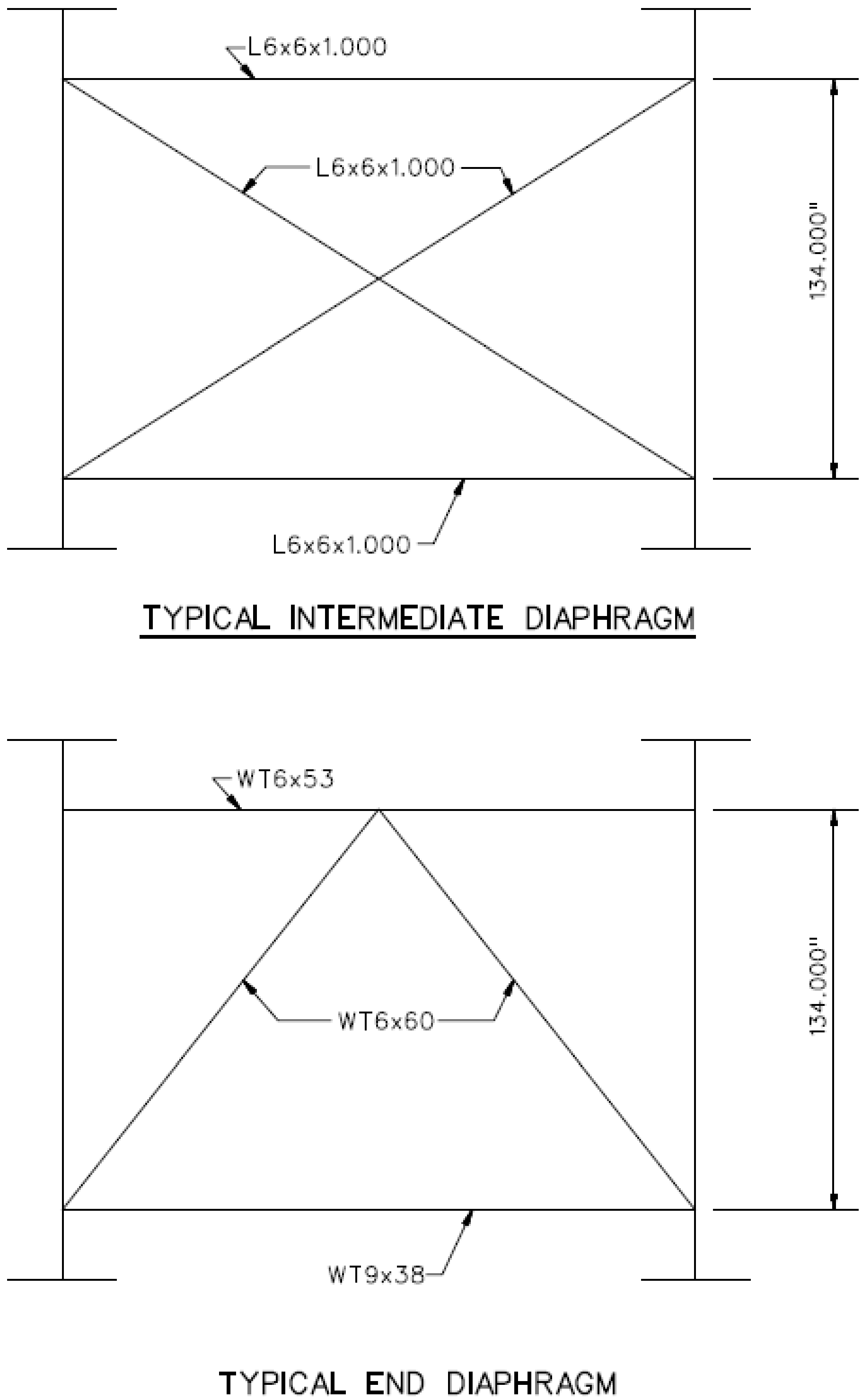


Figure J2-1-5. Cross-frame details.

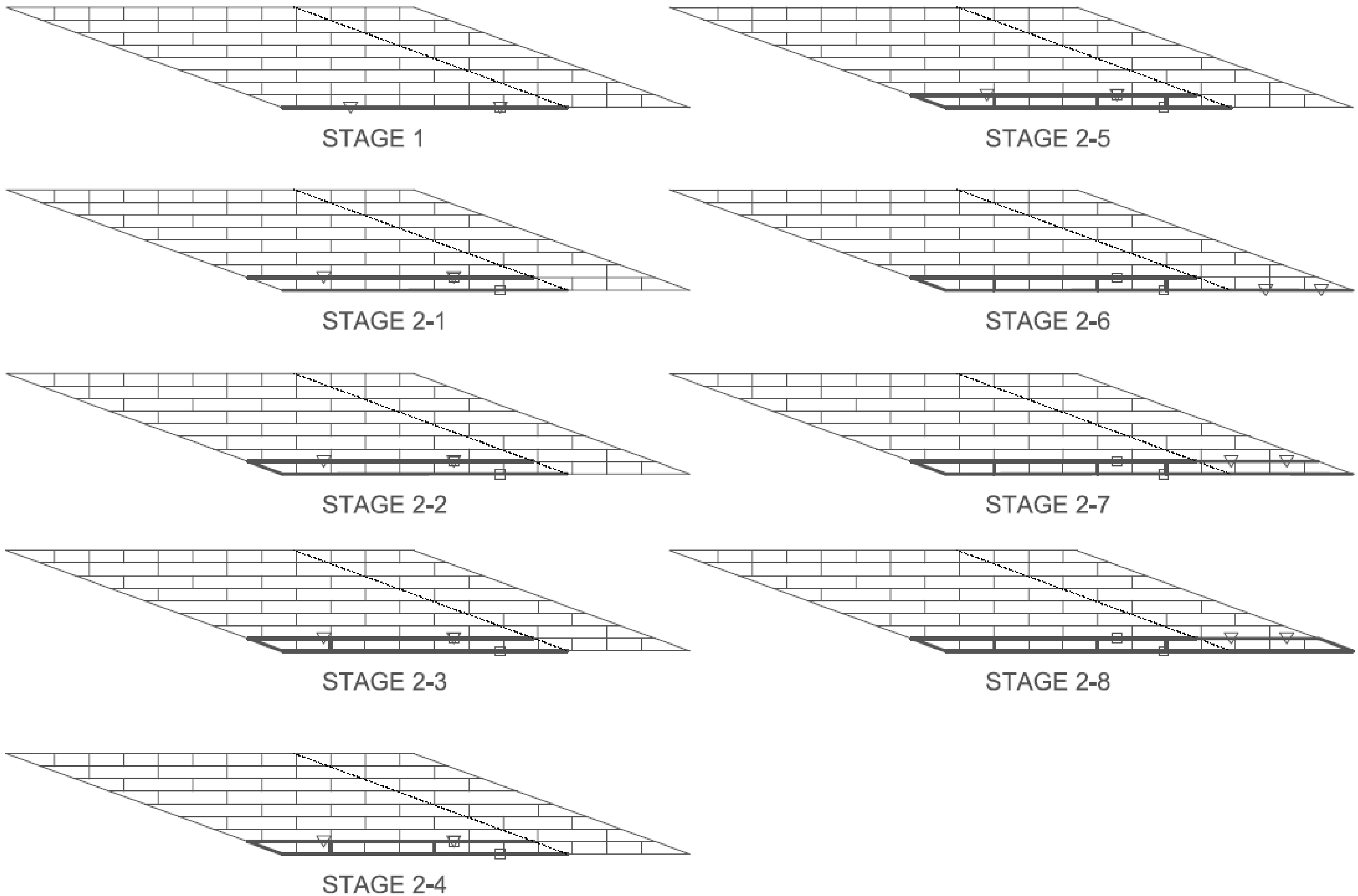
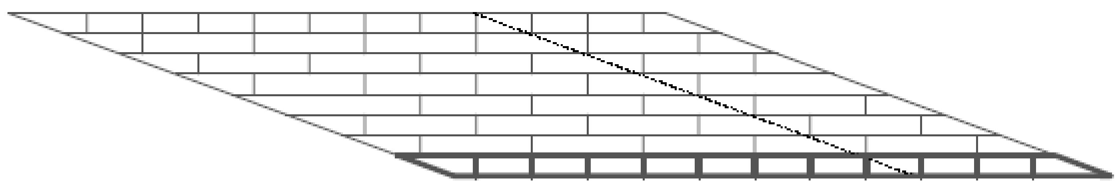


Figure J2-1-6. Erection scheme.

REMOVE G1, G2 TEMP. SUPPORTS AFTER STAGE 2-8
STAGE 2-9: G1-G2 XF 2
STAGE 2-10: G1-G2 XF4
STAGE 2-11: G1-G2 XF 5
STAGE 2-12: G1-G2 XF 7
STAGE 2-13: G1-G2 XF 9
STAGE 2-14: G1-G2 XF 10
STAGE 2-15: G1-G2 XF 11
STAGE 2-16: G1-G2 XF 12



STAGE 2-16

Figure J2-1-6(Continued). Erection scheme.

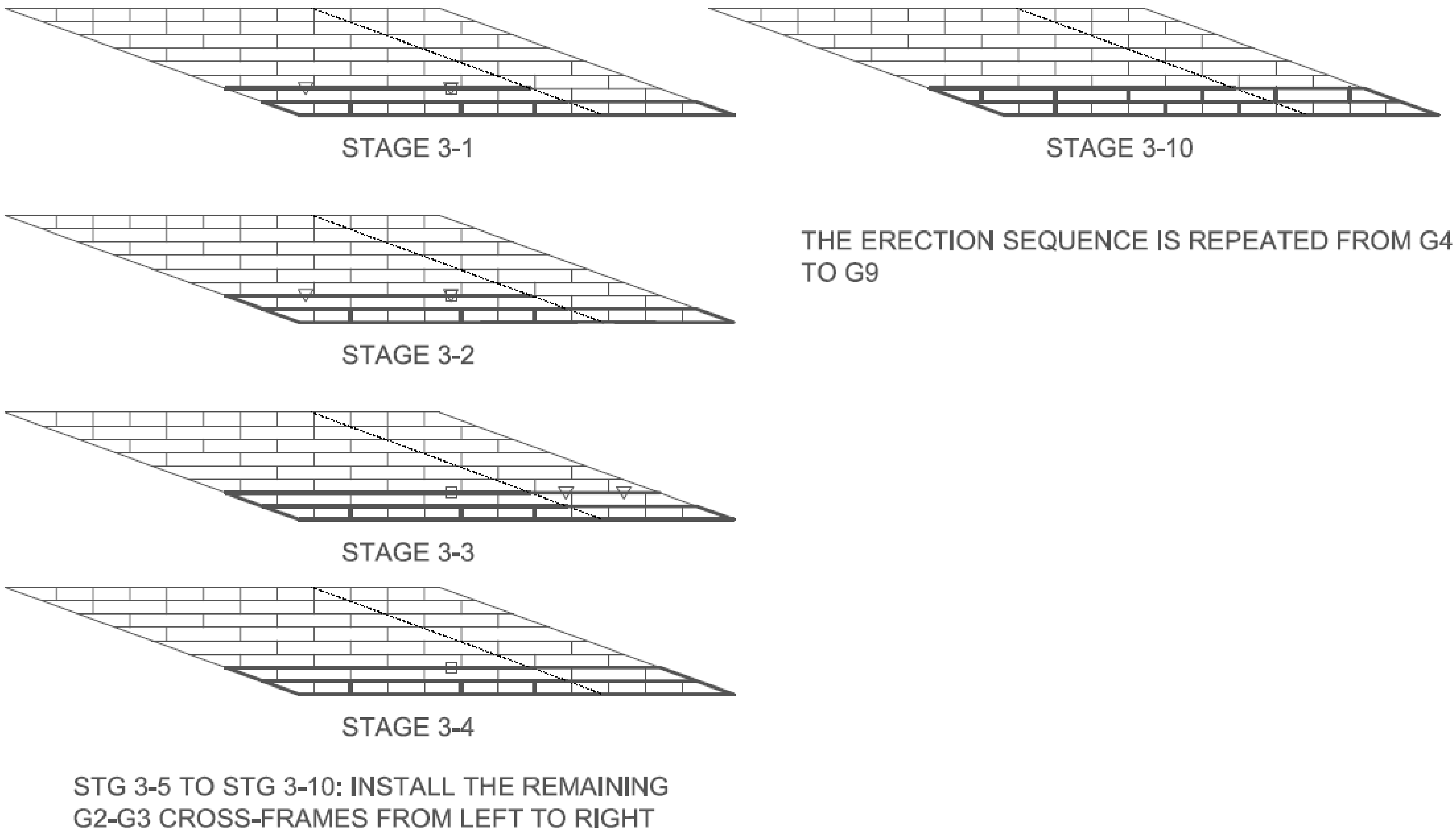


Figure J2-1-6(Continued). Erection scheme.

Table J2-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

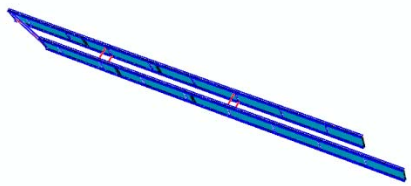
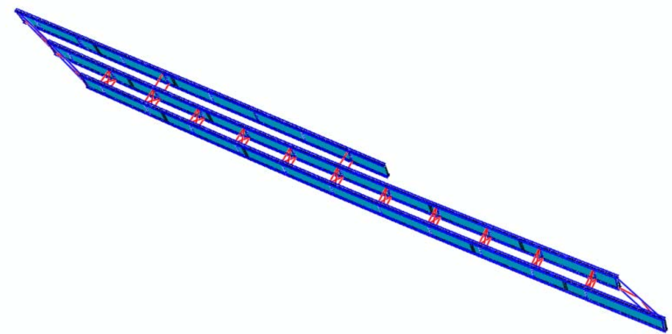
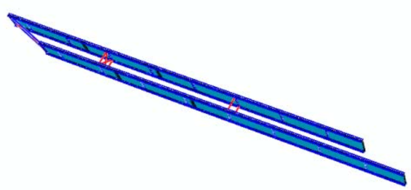
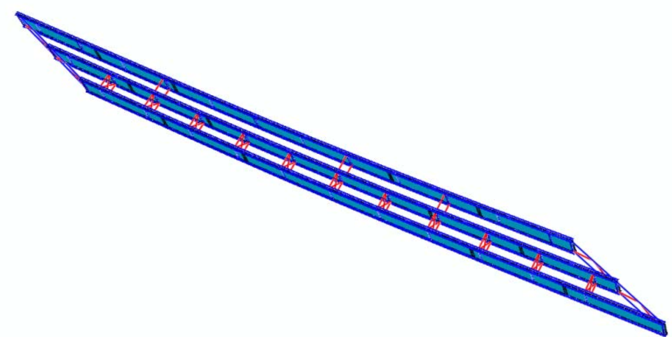
Sub-Stage	Stage	
	2	3
1		
2		

Table J2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

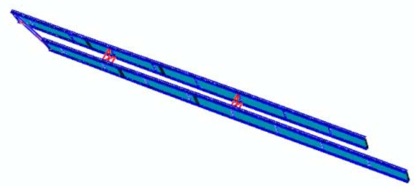
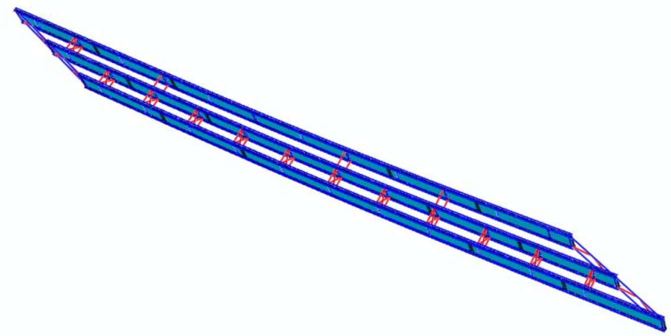
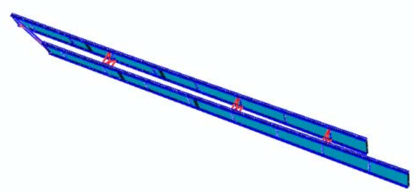
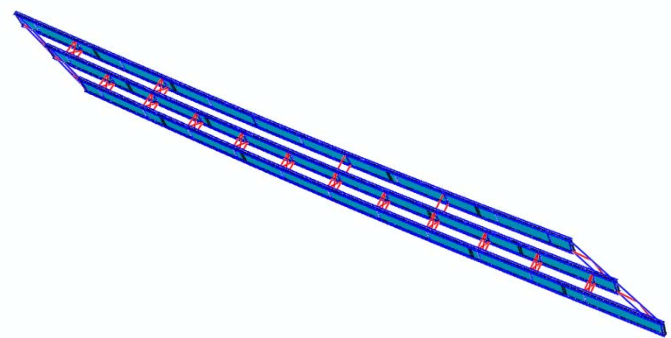
Sub-Stage	Stage	
	2	3
3		
4		

Table J2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

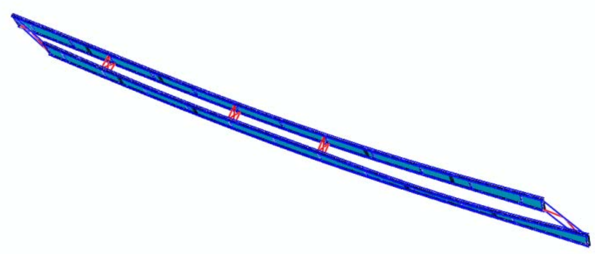
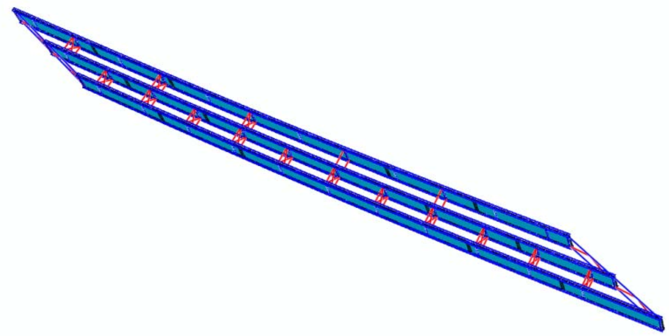
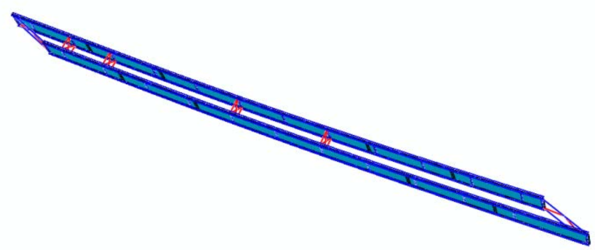
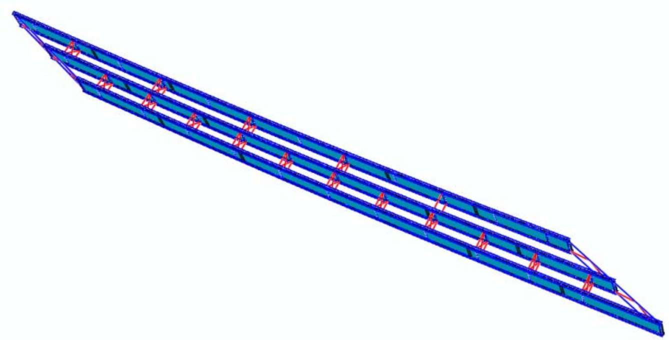
Sub-Stage	Stage 2	Stage 3
5		
6		

Table J2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

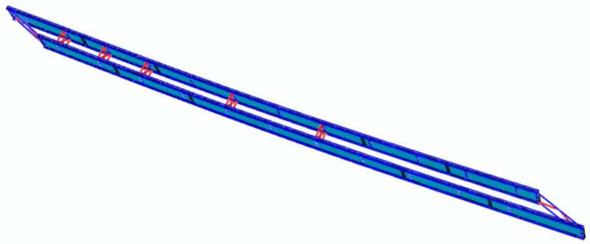
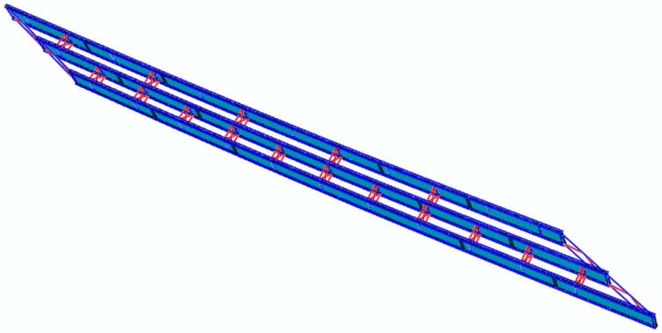
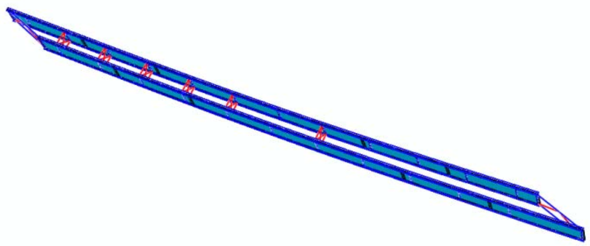
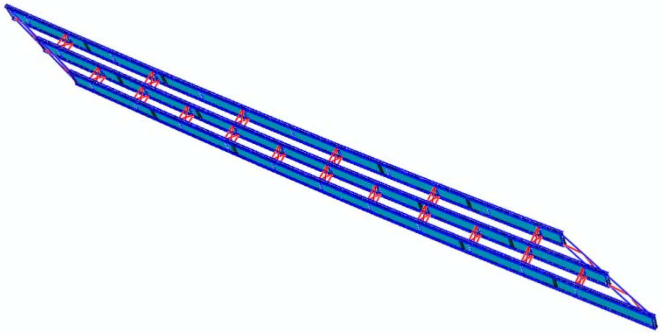
Sub-Stage	Stage	
	2	3
7		
8		

Table J2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

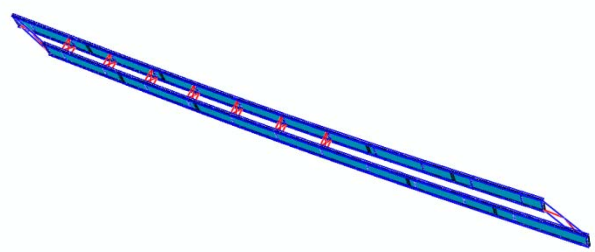
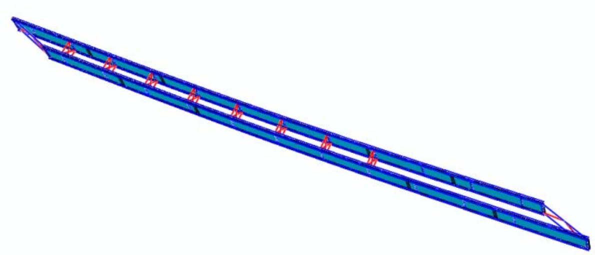
Sub-Stage	Stage	
	2	3
9		
10		

Table J2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

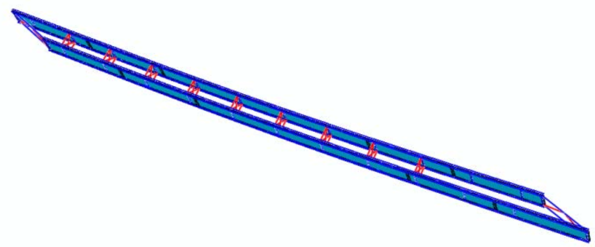
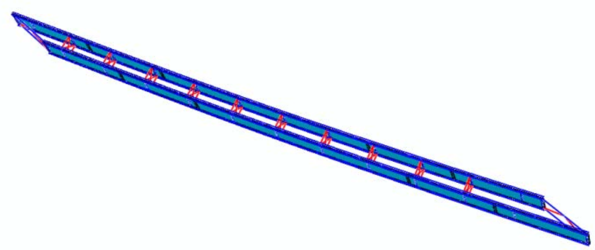
Sub-Stage	Stage	
	2	3
11		
12		

Table J2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

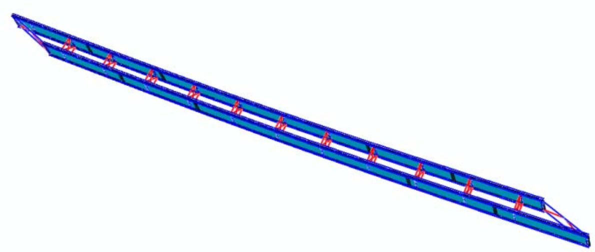
Sub-Stage	Stage	
	2	3
13		

Table J2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

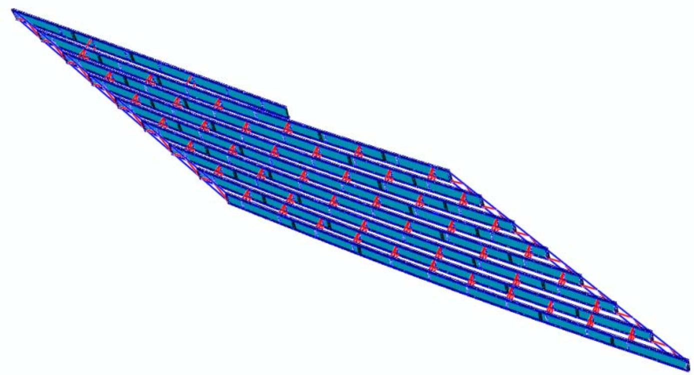
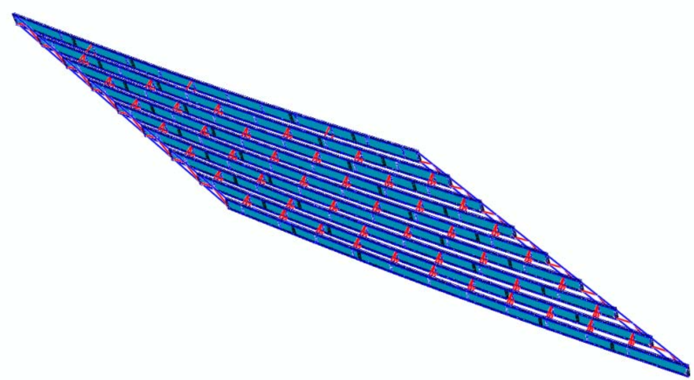
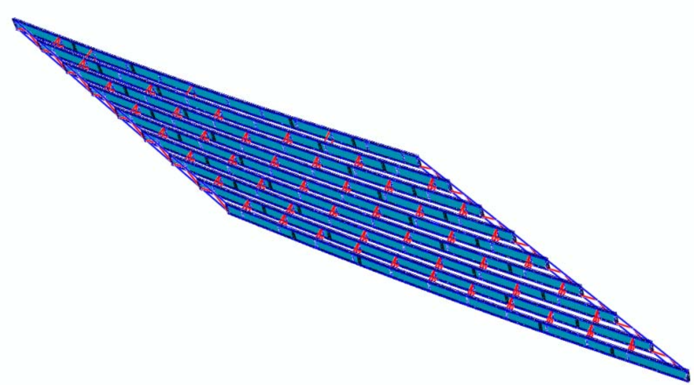
Sub-Stage	Stage 9
1	
2	
3	

Table J2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

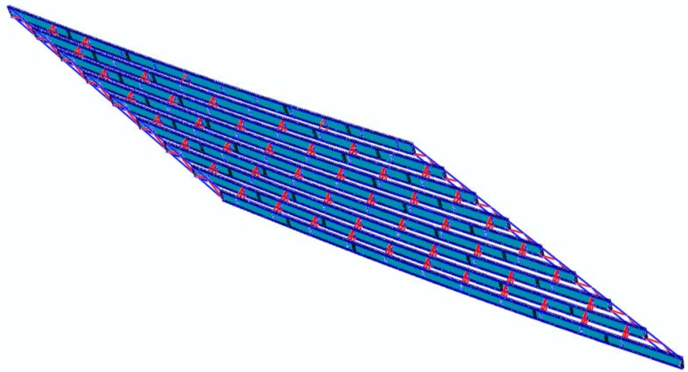
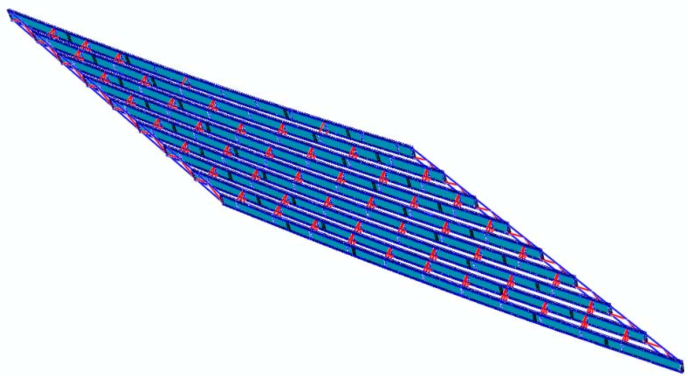
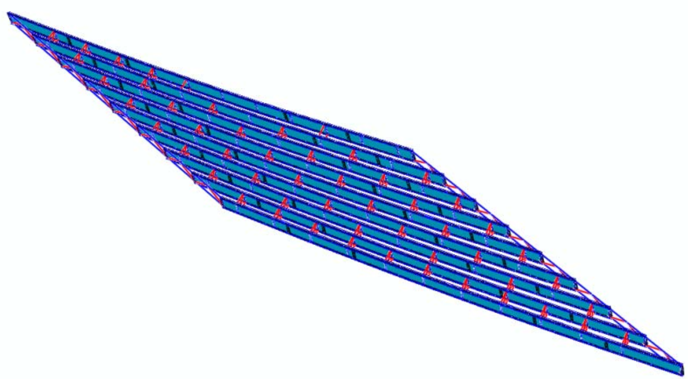
Sub-Stage	Stage 9
4	
5	
6	

Table J2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

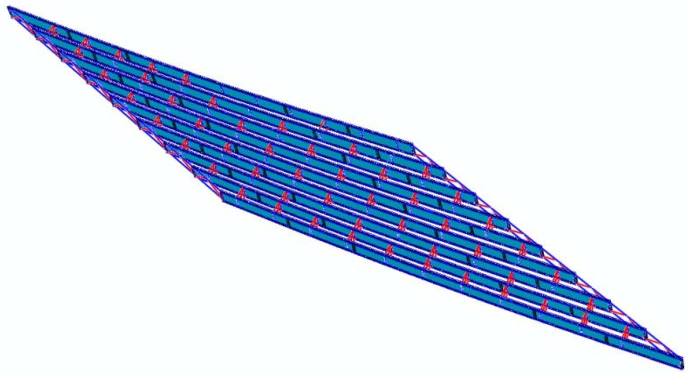
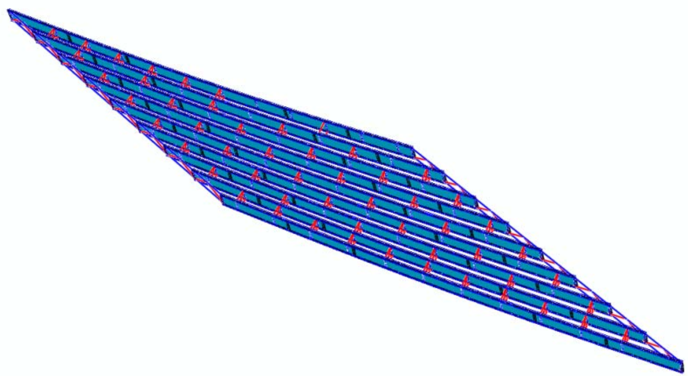
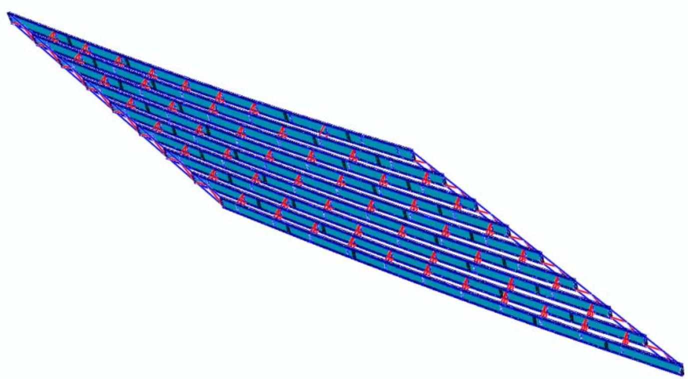
Sub-Stage	Stage 9
7	
8	
9	

Table J2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

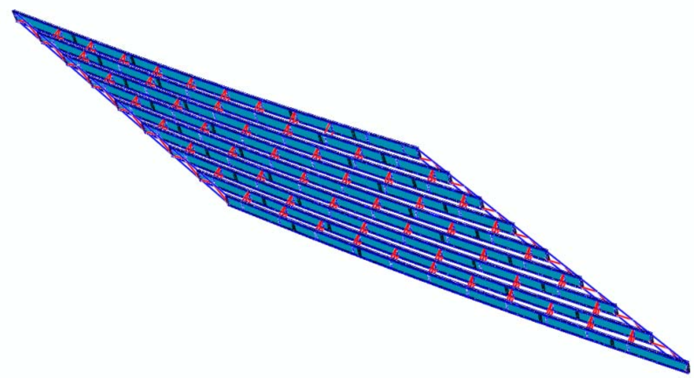
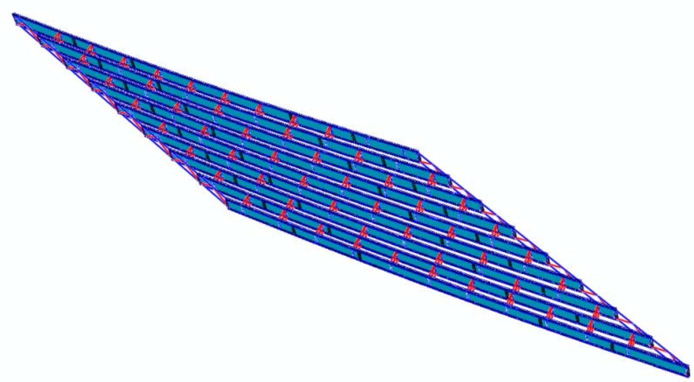
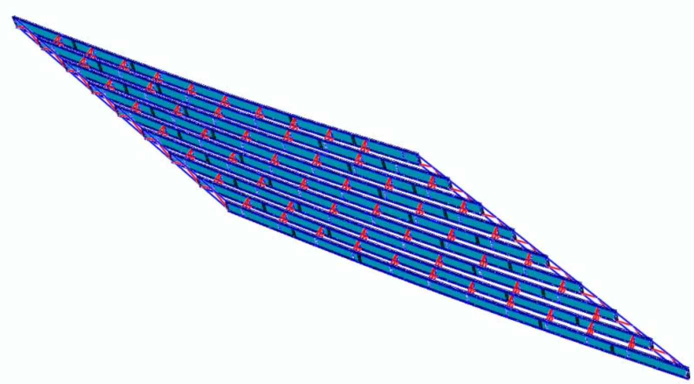
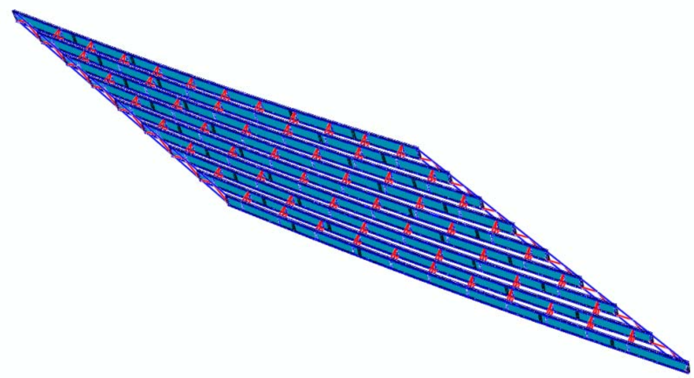
Sub-Stage	Stage 9
10	
11	
12	

Table J2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

Sub-Stage	Stage
	9
13	

Appendix J2-2. NISSS54 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISSS54 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table J2-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	7.3	16.5
	SDLF	6.5	15.5
	TDLF	5.2	13.9
G2	NLF	6.6	14.9
	SDLF	6.7	14.9
	TDLF	7.1	15.0
G3	NLF	6.3	14.3
	SDLF	6.6	14.5
	TDLF	7.3	14.9
G4	NLF	6.2	14.1
	SDLF	6.6	14.4
	TDLF	7.3	14.9
G5	NLF	6.2	14.1
	SDLF	6.6	14.4
	TDLF	7.3	14.9
G6	NLF	6.2	14.1
	SDLF	6.6	14.4
	TDLF	7.3	14.9
G7	NLF	6.3	14.3
	SDLF	6.6	14.5
	TDLF	7.3	14.9
G8	NLF	6.6	15.0
	SDLF	6.7	14.9
	TDLF	7.1	15.1
G9	NLF	7.3	16.6
	SDLF	6.5	15.5
	TDLF	5.2	14.0
All Girders	NLF	7.3	16.6
	SDLF	6.7	15.5
	TDLF	7.3	15.1

Table J2-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	2.7	6.3
	SDLF	0.1	3.4
	TDLF	3.3	0.1
G2	NLF	2.6	5.9
	SDLF	0.1	3.1
	TDLF	3.2	0.1
G3	NLF	2.4	5.5
	SDLF	0.1	2.9
	TDLF	3.0	0.1
G4	NLF	2.3	5.2
	SDLF	0.1	2.8
	TDLF	2.9	0.1
G5	NLF	2.3	5.2
	SDLF	0.1	2.8
	TDLF	2.9	0.1
G6	NLF	2.3	5.2
	SDLF	0.1	2.8
	TDLF	2.9	0.1
G7	NLF	2.4	5.5
	SDLF	0.1	2.9
	TDLF	3.0	0.1
G8	NLF	2.6	5.9
	SDLF	0.1	3.2
	TDLF	3.2	0.1
G9	NLF	2.7	6.3
	SDLF	0.1	3.4
	TDLF	3.3	0.1
All Girders	NLF	2.7	6.3
	SDLF	0.1	3.4
	TDLF	3.3	0.1

Table J2-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	10.0	22.5	12.0	26.9	3.0	10.7	4.1	6.5
	SDLF	8.9	21.0	10.7	25.3	0.2	5.8	0.3	3.3
	TDLF	7.2	18.9	8.5	22.8	2.4	0.6	3.2	0.7
G2	NLF	9.1	20.4	10.9	24.4	2.5	8.7	4.9	10.6
	SDLF	9.2	20.3	11.0	24.3	0.2	4.8	0.3	5.3
	TDLF	9.6	20.4	11.5	24.6	2.5	0.6	5.1	0.8
G3	NLF	8.4	19.1	10.2	22.8	3.8	12.7	6.9	18.0
	SDLF	9.1	19.5	10.9	23.4	0.2	6.9	0.4	9.4
	TDLF	10.0	20.2	12.0	24.4	4.6	0.6	8.8	1.0
G4	NLF	8.4	19.0	10.1	22.8	4.0	13.1	7.1	18.1
	SDLF	9.0	19.5	10.9	23.5	0.2	7.2	0.4	9.7
	TDLF	9.9	20.2	11.9	24.3	5.2	0.5	9.9	0.9
G5	NLF	8.4	19.0	10.1	22.8	4.0	11.8	7.5	19.8
	SDLF	9.0	19.5	10.9	23.5	0.2	6.6	0.5	10.6
	TDLF	9.9	20.2	11.8	24.3	5.5	0.3	10.5	0.8
G6	NLF	8.4	19.0	10.1	22.8	4.0	13.0	7.0	18.2
	SDLF	9.0	19.5	10.9	23.5	0.2	7.1	0.4	9.8
	TDLF	9.9	20.2	11.9	24.4	5.2	0.5	10.0	0.9
G7	NLF	8.4	19.1	10.2	22.9	3.8	12.6	6.8	17.8
	SDLF	9.1	19.5	10.9	23.5	0.2	6.9	0.4	9.4
	TDLF	10.0	20.3	12.1	24.4	4.6	0.6	8.8	1.0
G8	NLF	9.1	20.4	10.9	24.5	2.5	8.7	4.8	10.5
	SDLF	9.2	20.3	11.0	24.4	0.2	4.8	0.3	5.2
	TDLF	9.7	20.4	11.5	24.6	2.5	0.6	5.1	0.7
G9	NLF	10.0	22.5	12.0	27.0	3.0	10.7	4.0	6.4
	SDLF	8.9	21.1	10.7	25.3	0.2	5.9	0.3	3.3
	TDLF	7.2	19.0	8.5	22.9	2.4	0.6	3.2	0.7
All Girders	NLF	10.0	22.5	12.0	27.0	4.0	13.1	7.5	19.8
	SDLF	9.2	21.1	11.0	25.3	0.2	7.2	0.5	10.6
	TDLF	10.0	20.4	12.1	24.6	5.5	0.6	10.5	1.0

Table J2-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	18.9	25.4	20.2	25.4
	SDLF	8.0	6.2	1.5	8.0
	TDLF	25.8	35.2	28.7	35.2
TDL	NLF	40.8	58.5	42.3	58.5
	SDLF	22.6	31.2	23.3	31.2
	TDLF	18.1	14.6	3.0	18.1

Table J2-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	3.6	7.7	7.4	5.7
	SDLF	1.5	2.0	0.5	1.4
	TDLF	6.6	12.4	10.6	9.2
TDL	NLF	8.7	18.0	17.9	13.5
	SDLF	5.3	10.0	9.9	7.7
	TDLF	3.5	4.8	1.4	3.4

Table J2-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.98	1.85	1.72	1.67	1.67	1.72	1.85	1.98	1.98
SDLF	1.83	1.83	1.80	1.79	1.79	1.80	1.82	1.83	1.83
TDLF	2.59	1.94	1.96	1.97	1.98	1.96	1.94	2.59	2.59

Table J2-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	4.49	4.17	3.89	3.78	3.78	3.90	4.18	4.49	4.49
SDLF	4.17	4.09	3.93	3.87	3.87	3.93	4.10	4.18	4.18
TDLF	4.17	4.08	4.03	4.02	4.03	4.04	4.09	4.17	4.17

Table J2-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	2.39	2.23	2.08	2.01	2.01	2.08	2.23	2.39	2.39
SDLF	2.21	2.20	2.17	2.16	2.16	2.17	2.20	2.22	2.22
TDLF	3.13	2.35	2.36	2.38	2.38	2.36	2.35	3.13	3.13

Table J2-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	5.41	5.04	4.70	4.56	4.56	4.70	5.05	5.42	5.42
SDLF	5.03	4.94	4.74	4.68	4.68	4.74	4.95	5.04	5.04
TDLF	5.03	4.93	4.87	4.86	4.86	4.88	4.94	5.04	5.04

Table J2-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	2662.0	5940.8
SDLF	2662.0	5939.7
TDLF	2662.0	5940.8

Table J2-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	184	391	0.9	1.9	2.4	6.7
SDLF	152	359	0.1	1.1	0.0	3.9
TDLF	167	340	1.2	0.5	1.8	0.1

Table J2-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	1.0	2.2	0.2	0.5
SDLF	0.9	1.9	0.0	0.3
TDLF	1.0	2.0	0.1	0.0

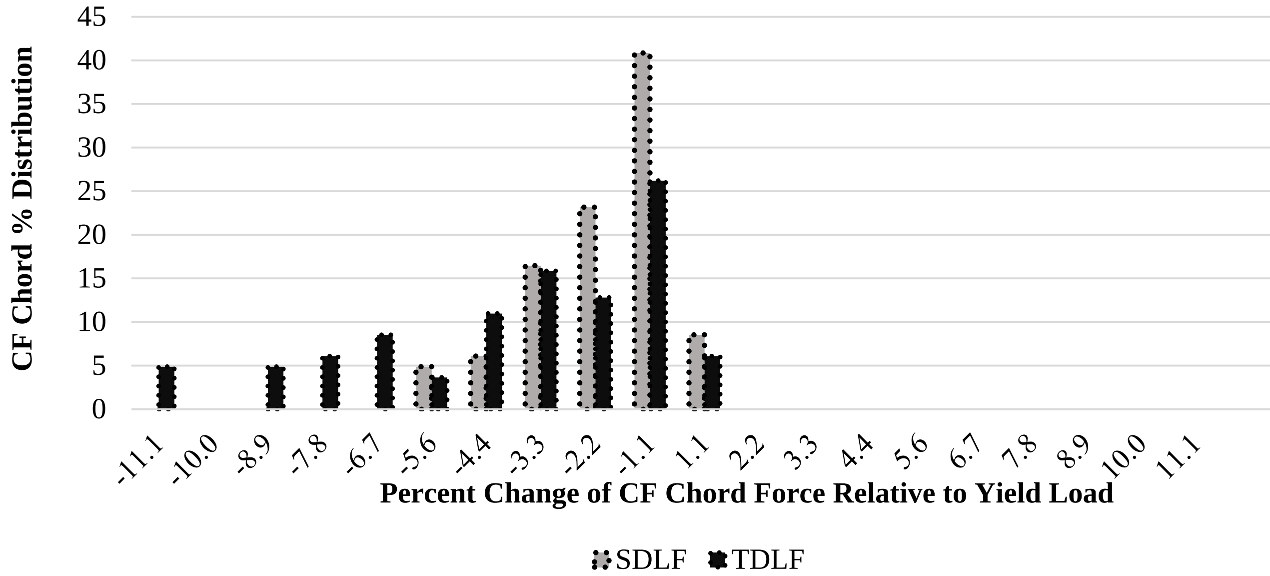


Figure J2-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

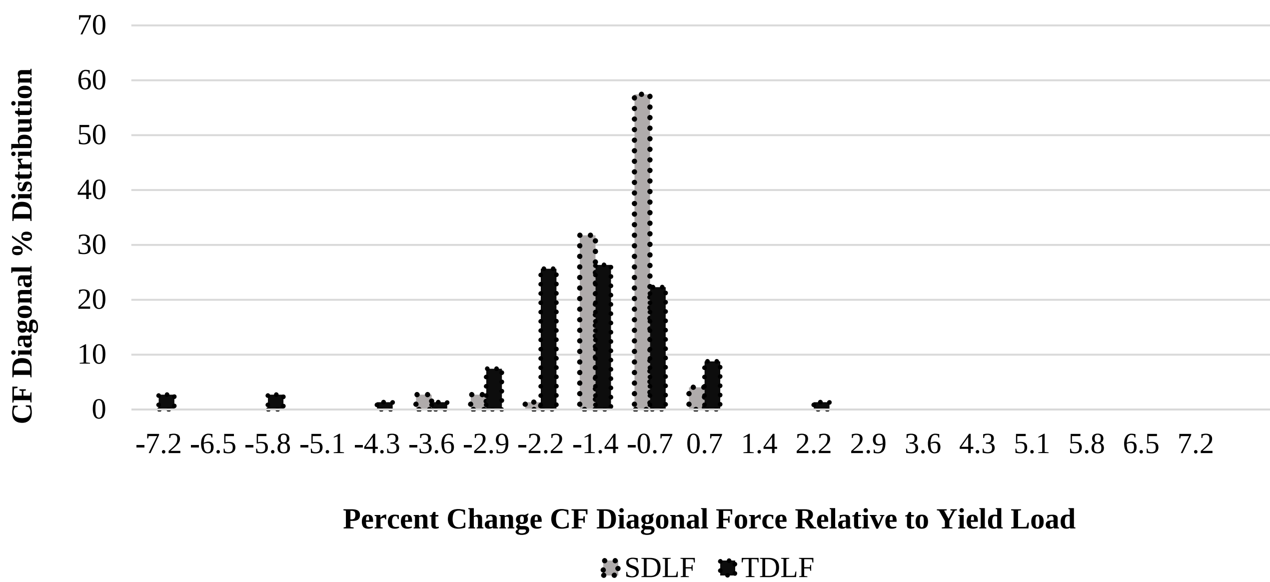


Figure J2-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

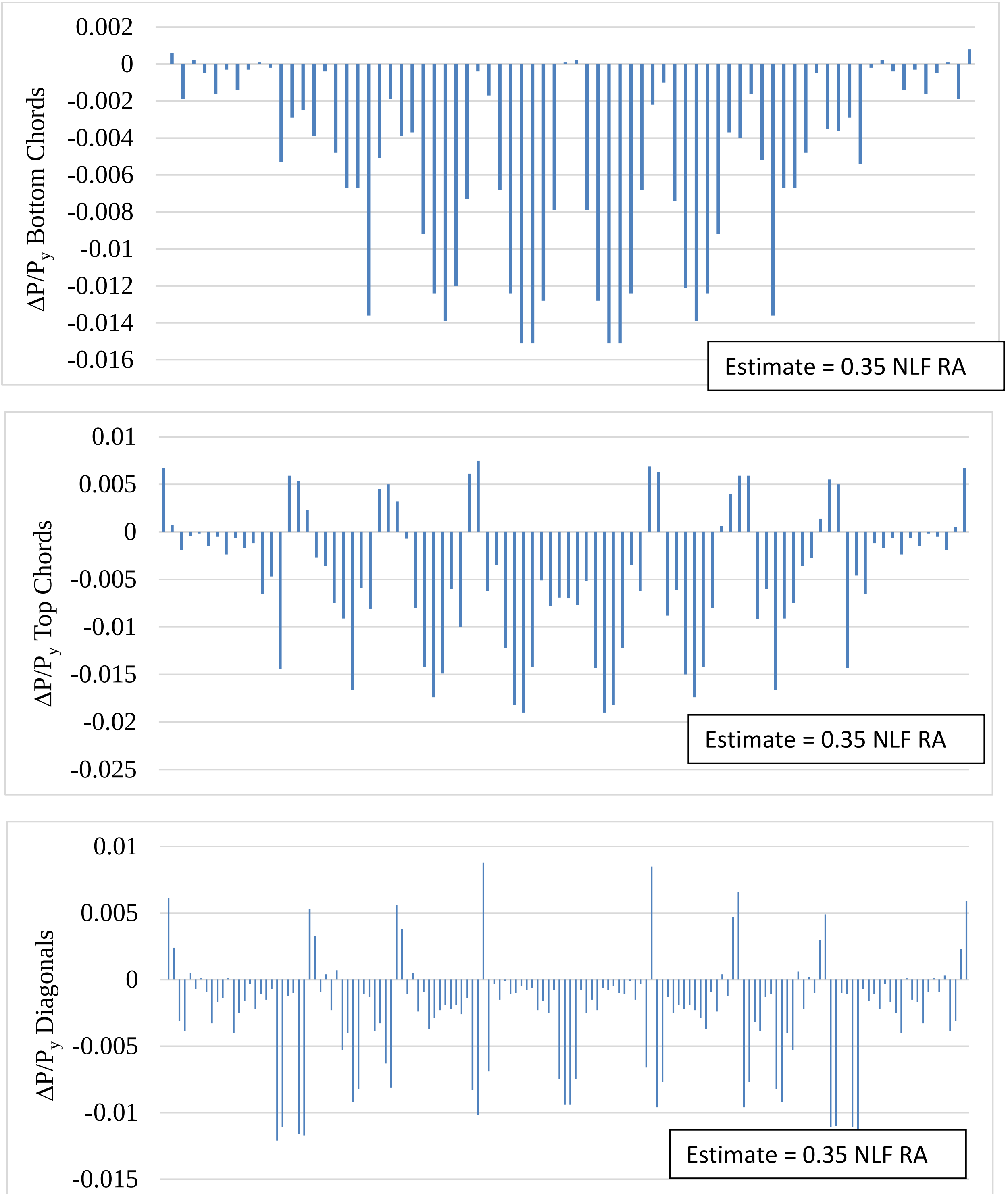


Figure J2-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

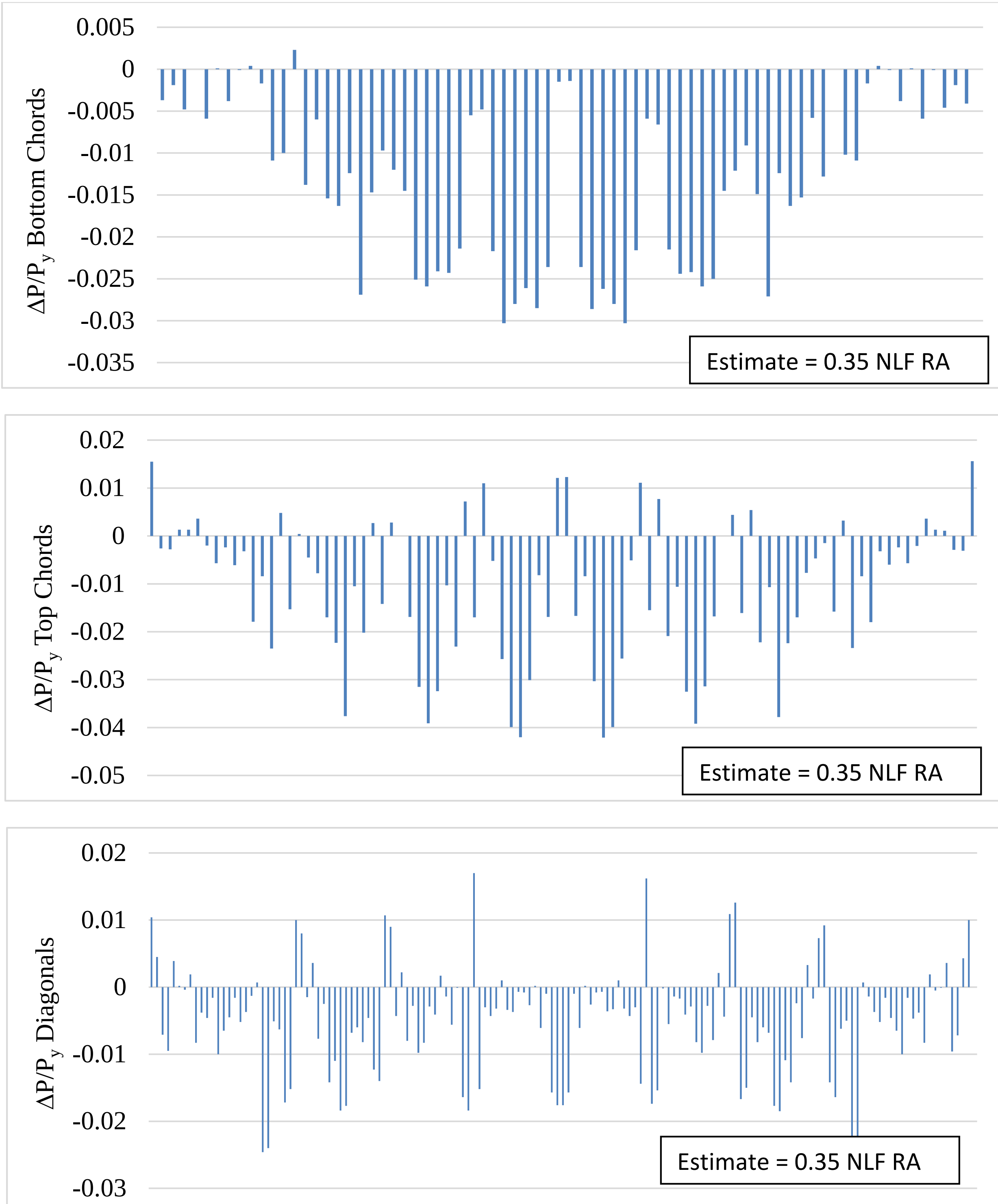


Figure J2-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix J2-3. NISSS54 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISSS54 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table J2-3-1. Maximums of the fit-up force resultants (kips)

Detailing Method	F1	F2	F_{max}
SDLF	5.0	8.4	8.4
TDLF	47.9	24.9	47.9

Table J2-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	SDLF	149	142
	TDLF	175	94
G2	SDLF	153	137
	TDLF	169	122
G3	SDLF	148	136
	TDLF	162	133
G4	SDLF	149	149
	TDLF	168	161
G5	SDLF	149	148
	TDLF	163	160
G6	SDLF	148	148
	TDLF	155	153
G7	SDLF	148	146
	TDLF	154	125
G8	SDLF	148	143
	TDLF	201	114
G9	SDLF	127	68
	TDLF	131	105
All Girders	SDLF	153	68
	TDLF	201	94

Table J2-3-3. Total Vertical Reactions (kips)

Stage	Detailing Method	Sub-Stage												
		1	2	3	4	5	6	7	8	9	10	11	12	13
2	SDLF	399	400	401	403	569	570	572	573	575	577	579	580	582
	TDLF	399	400	401	403	568	570	572	573	575	577	579	580	582
3	SDLF	782	869	871	872	874	875	876	878	NA	NA	NA	NA	NA
	TDLF	782	869	871	872	874	875	876	878	NA	NA	NA	NA	NA
9	SDLF	2557	2645	2646	2647	2649	2651	2652	2654	2656	2657	2658	2660	2662
	TDLF	2557	2645	2646	2647	2649	2651	2652	2654	2656	2657	2658	2660	2662

Appendix J2-4. NISSS54 Detailed Results, Completed Bridge Responses

This appendix presents the SDL and TDL responses of the bridge NISSS54 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Figure J2-4-1. SDL and TDL Line Girder Analysis cambers.

Figure J2-4-2. SDL and TDL 3D FEA cambers.

Overview of Bridge Displacements and Elevation Profiles

Figure J2-4-3. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.
Figure J2-4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.
Figure J2-4-5. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.
Figure J2-4-6. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.
Figure J2-4-7. Bridge displacements due to SDLF detailing effects alone under NL (in).
Figure J2-4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.
Figure J2-4-9. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.
Figure J2-4-10. Bridge displacements due to TDLF detailing effects alone under NL (in).

Girder Displacements and Elevations for Different Detailing Methods

Figure J2-4-11. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.
Figure J2-4-12. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.
Figure J2-4-13. Comparison of individual girder layovers (in) under SDL for different detailing methods.
Figure J2-4-14. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.
Figure J2-4-15. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.
Figure J2-4-16. Comparison of individual girder layovers (in) under TDL for different detailing methods.
Figure J2-4-17. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing under NL.
Figure J2-4-18. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing under NL.

Girder Flange Stresses for Different Detailing Methods

Figure J2-4-19. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.
Figure J2-4-20. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

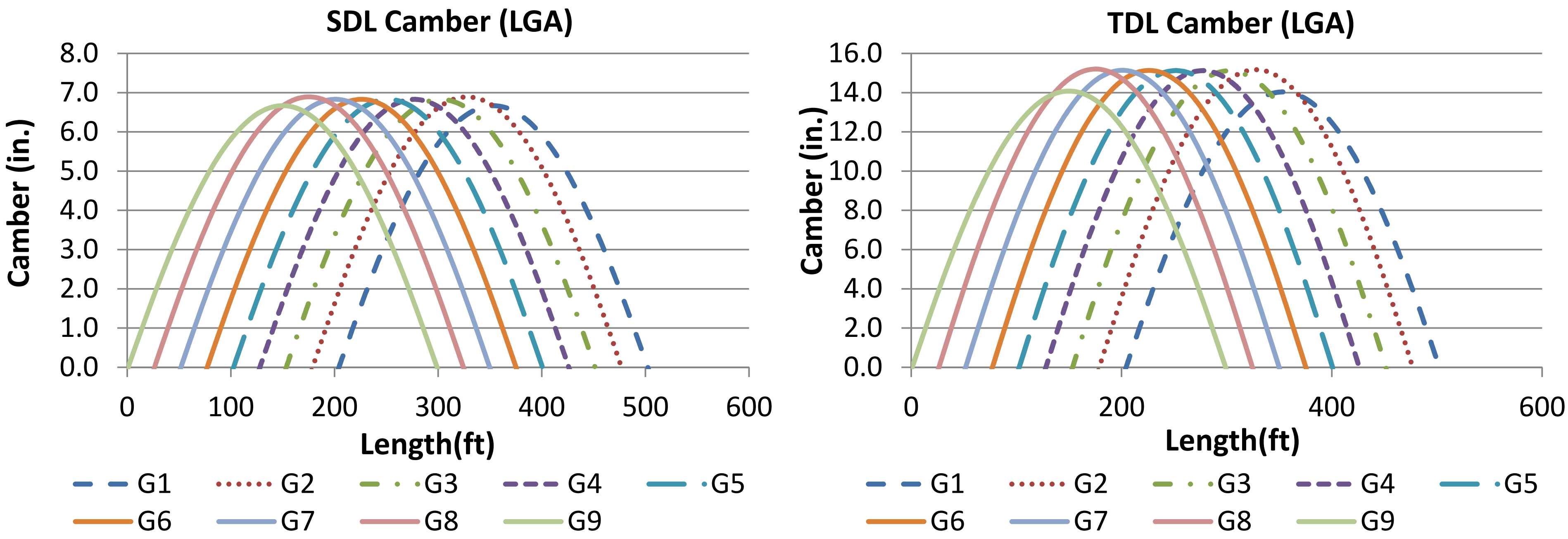


Figure J2-4-1. SDL and TDL Line Girder Analysis cambers.

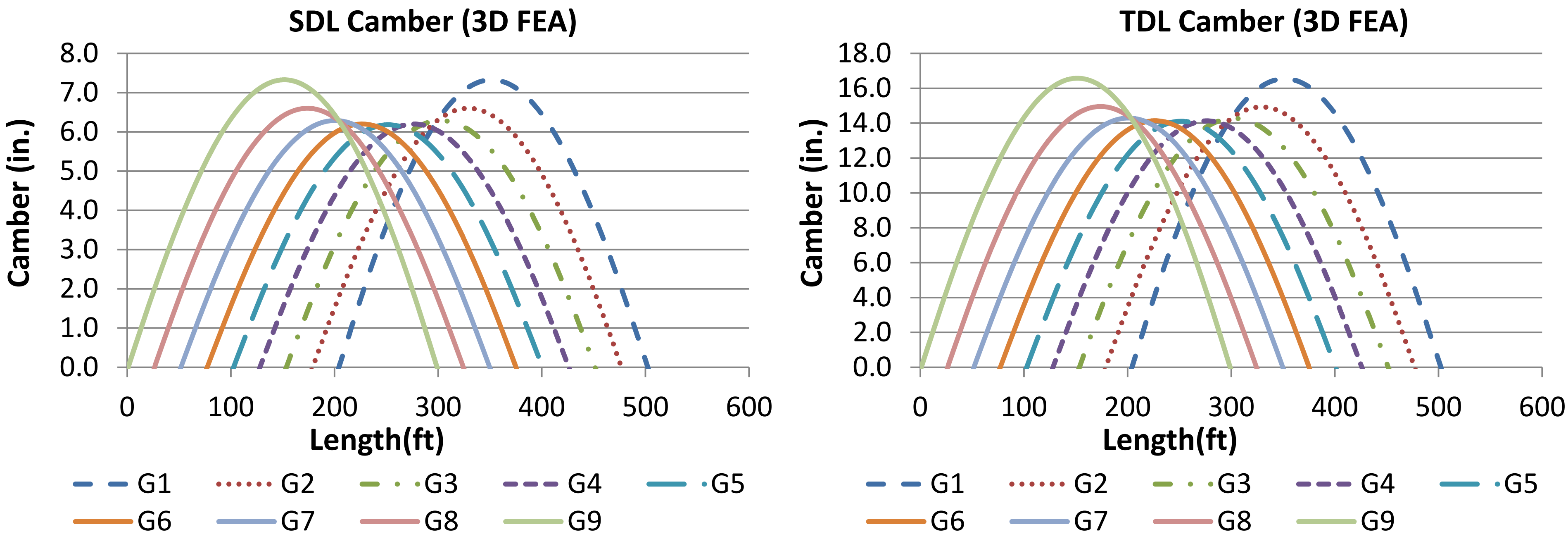


Figure J2-4-2. SDL and TDL 3D FEA cambers.

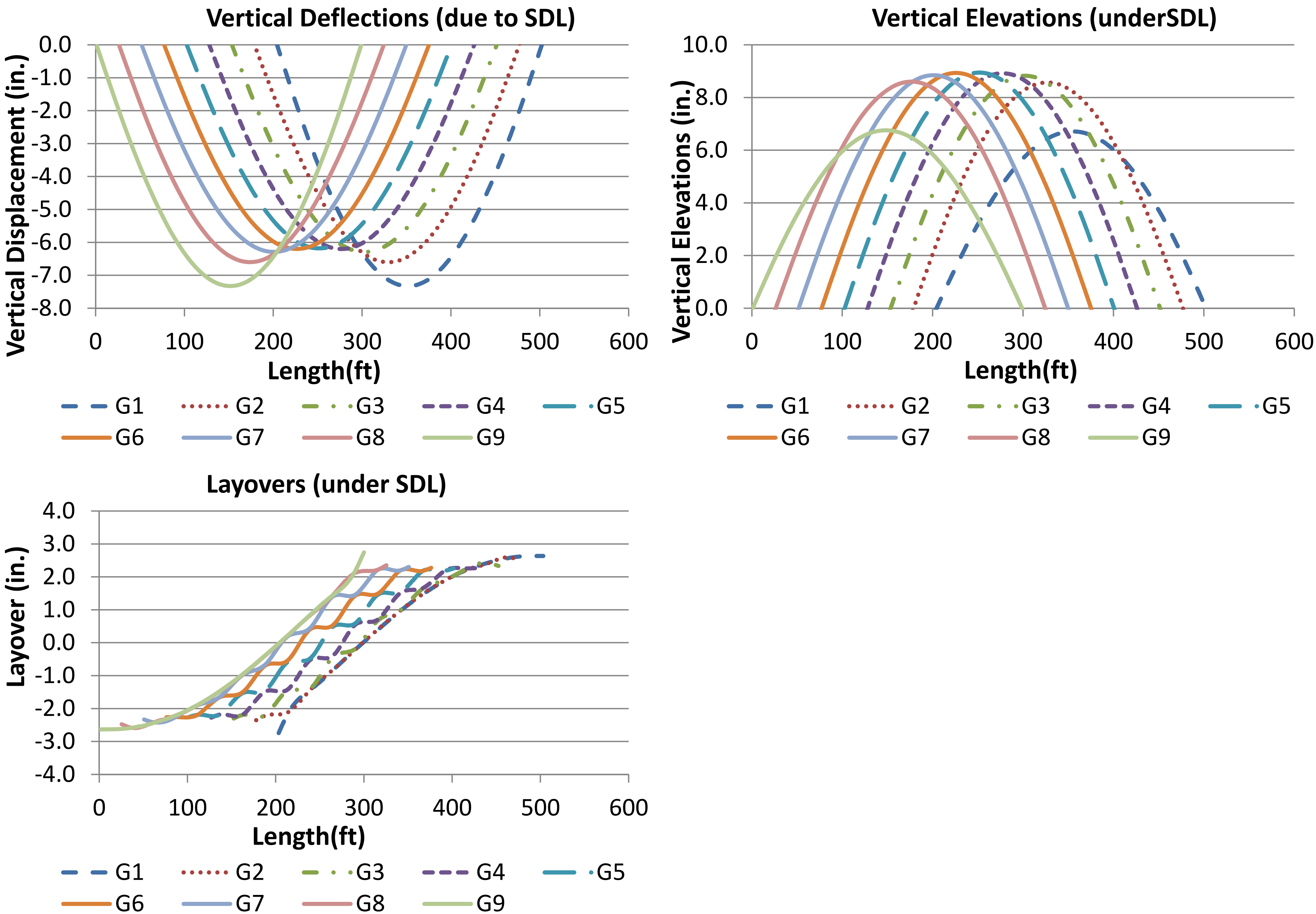


Figure J2-4-3. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

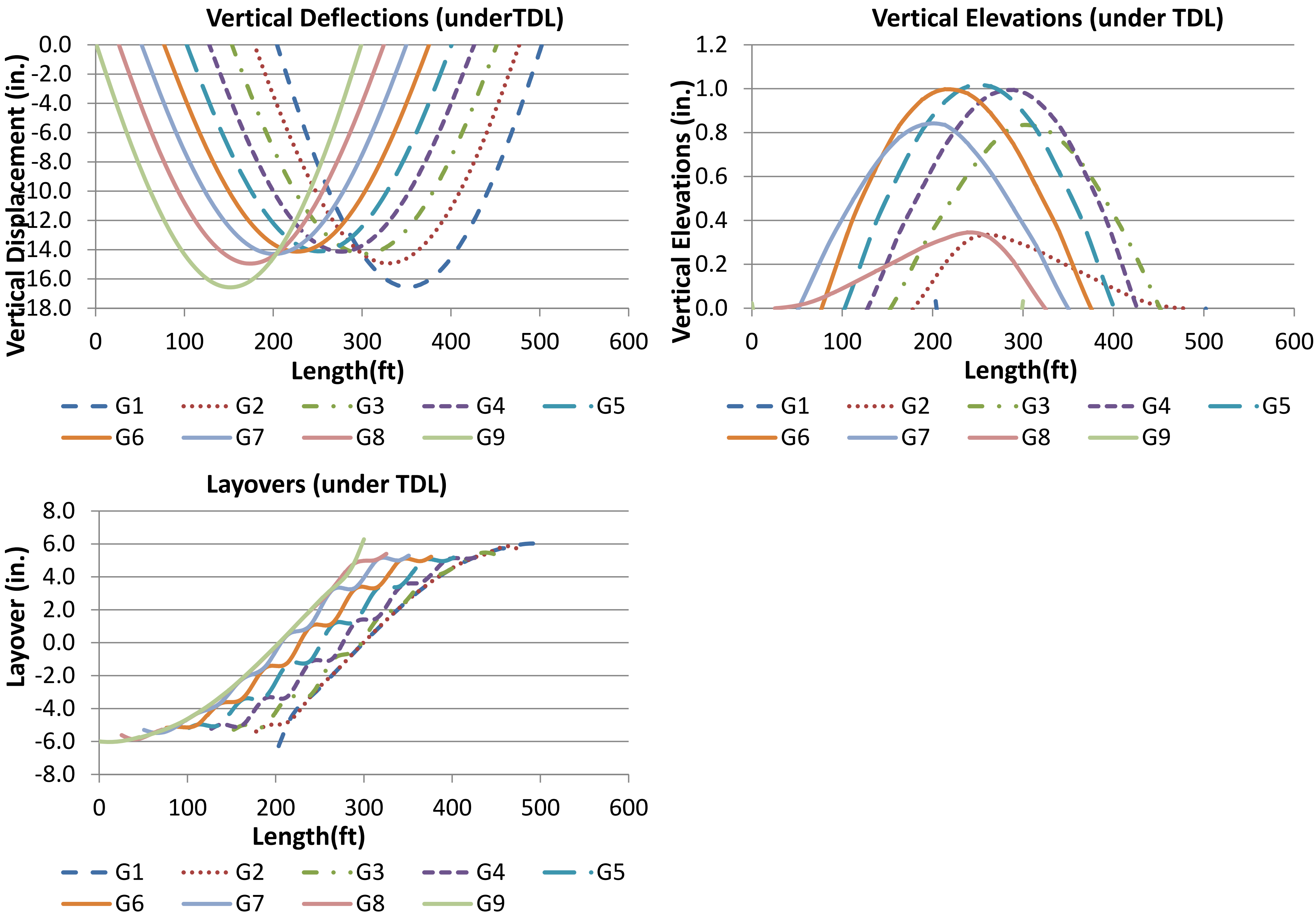


Figure J2-4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

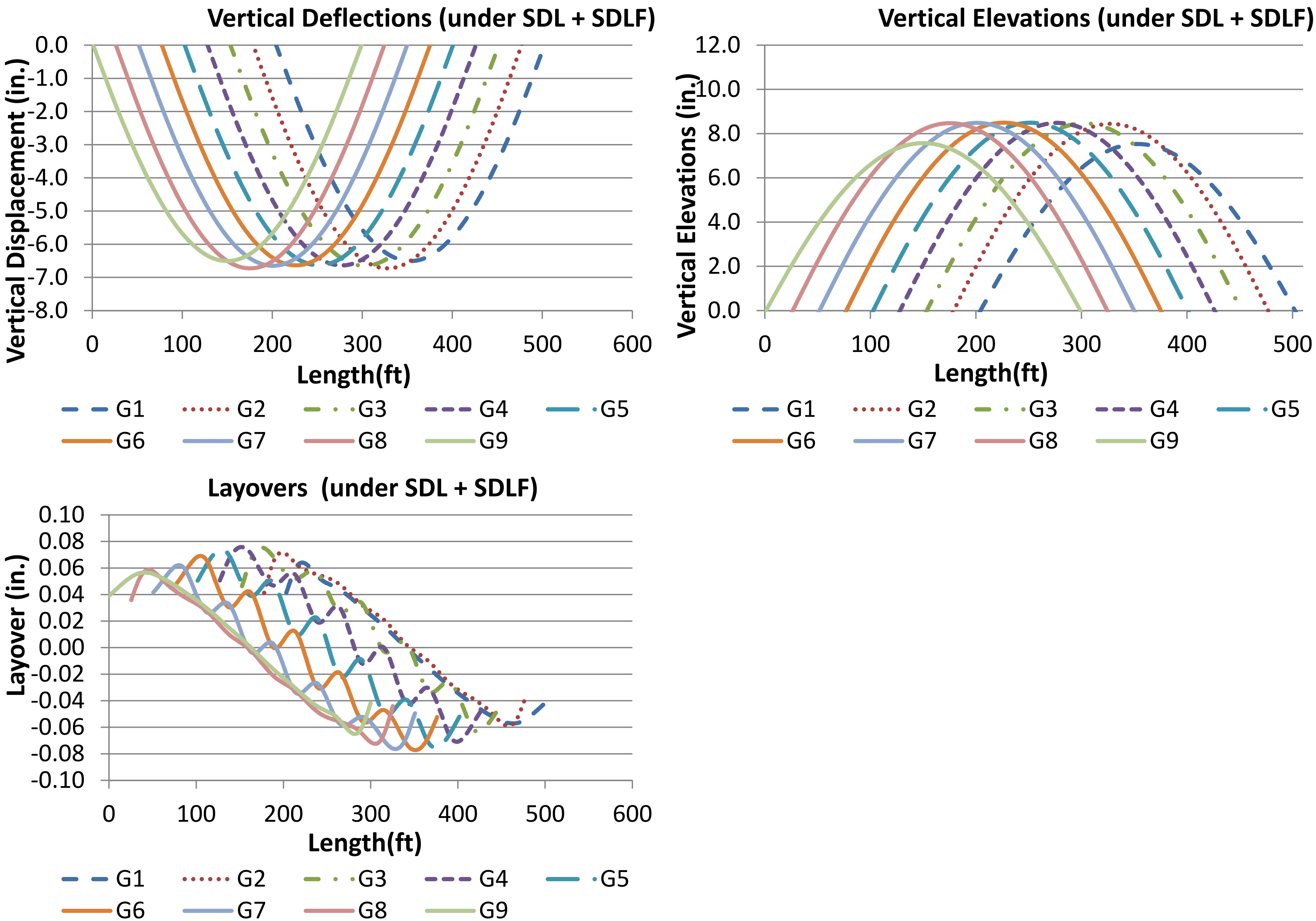


Figure J2-4-5. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

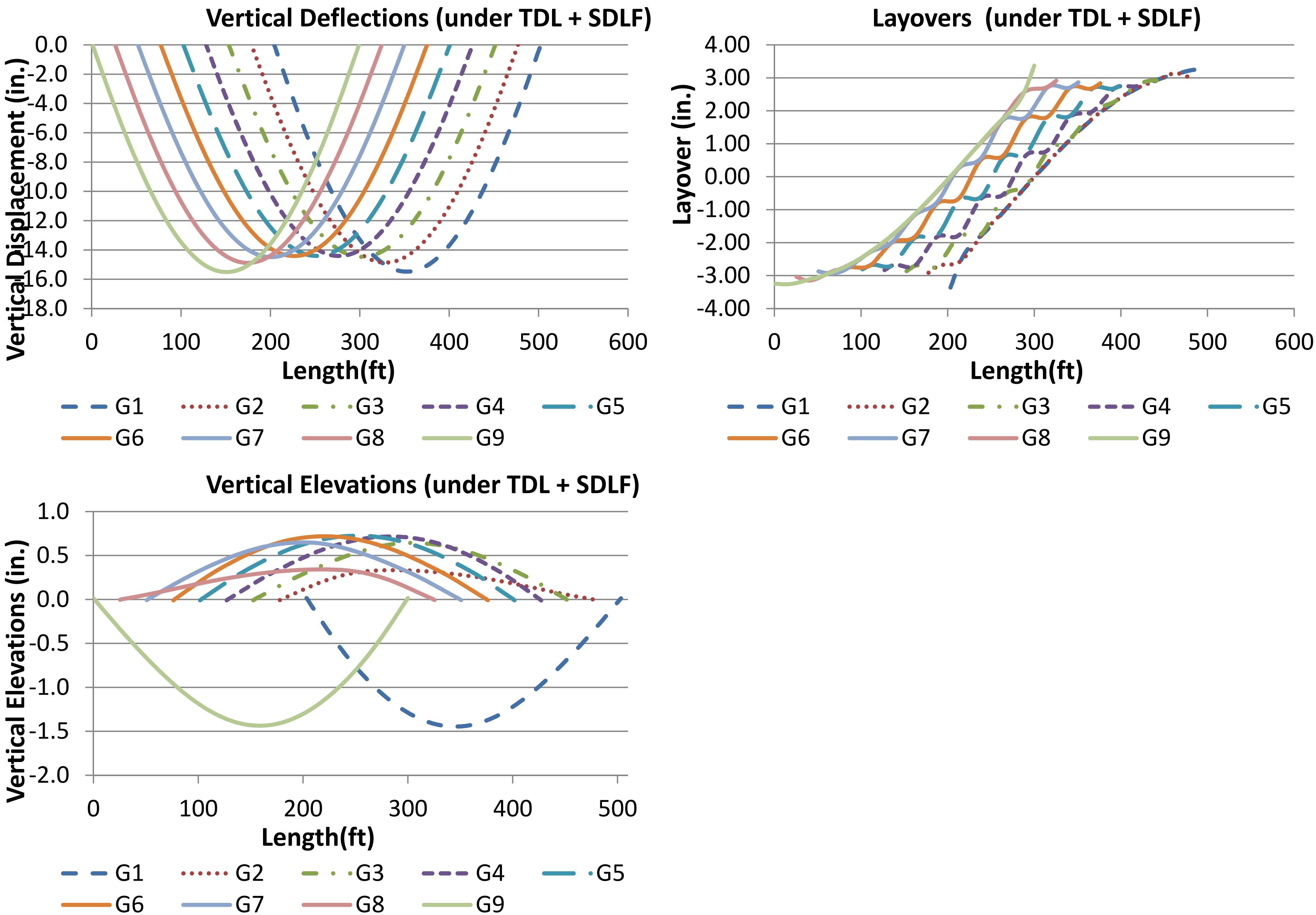


Figure J2-4-6. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

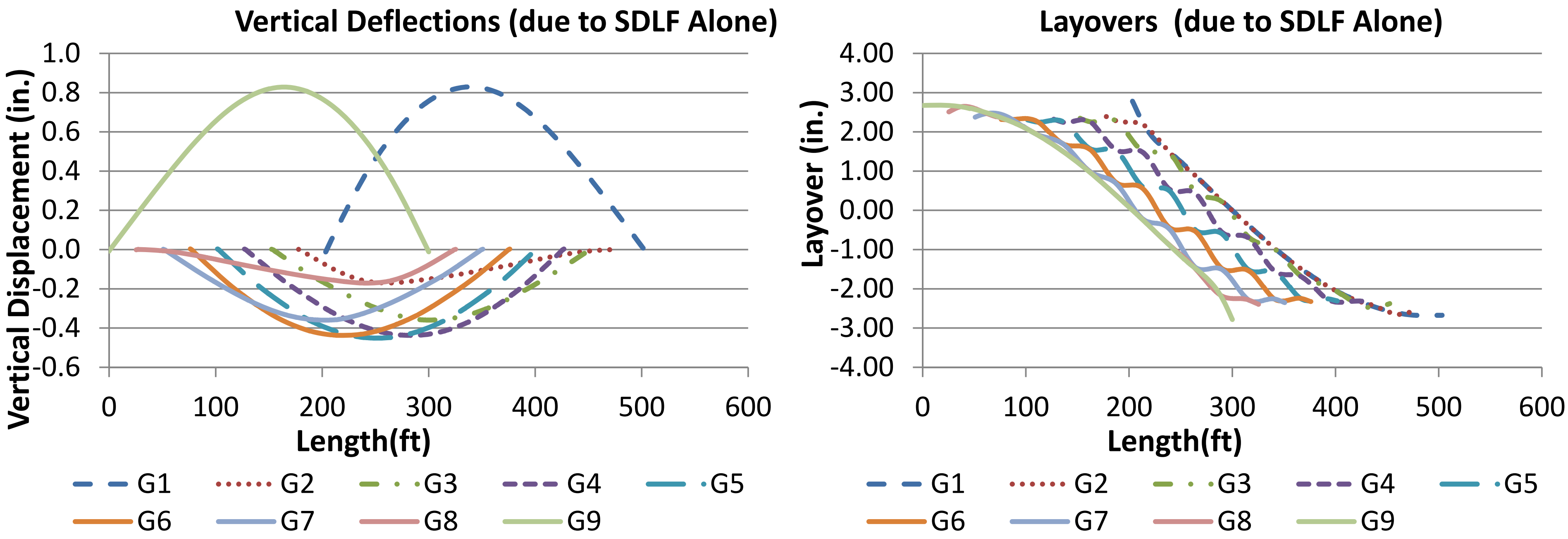


Figure J2-4-7. Bridge displacements due to SDLF detailing effects alone under NL(in).

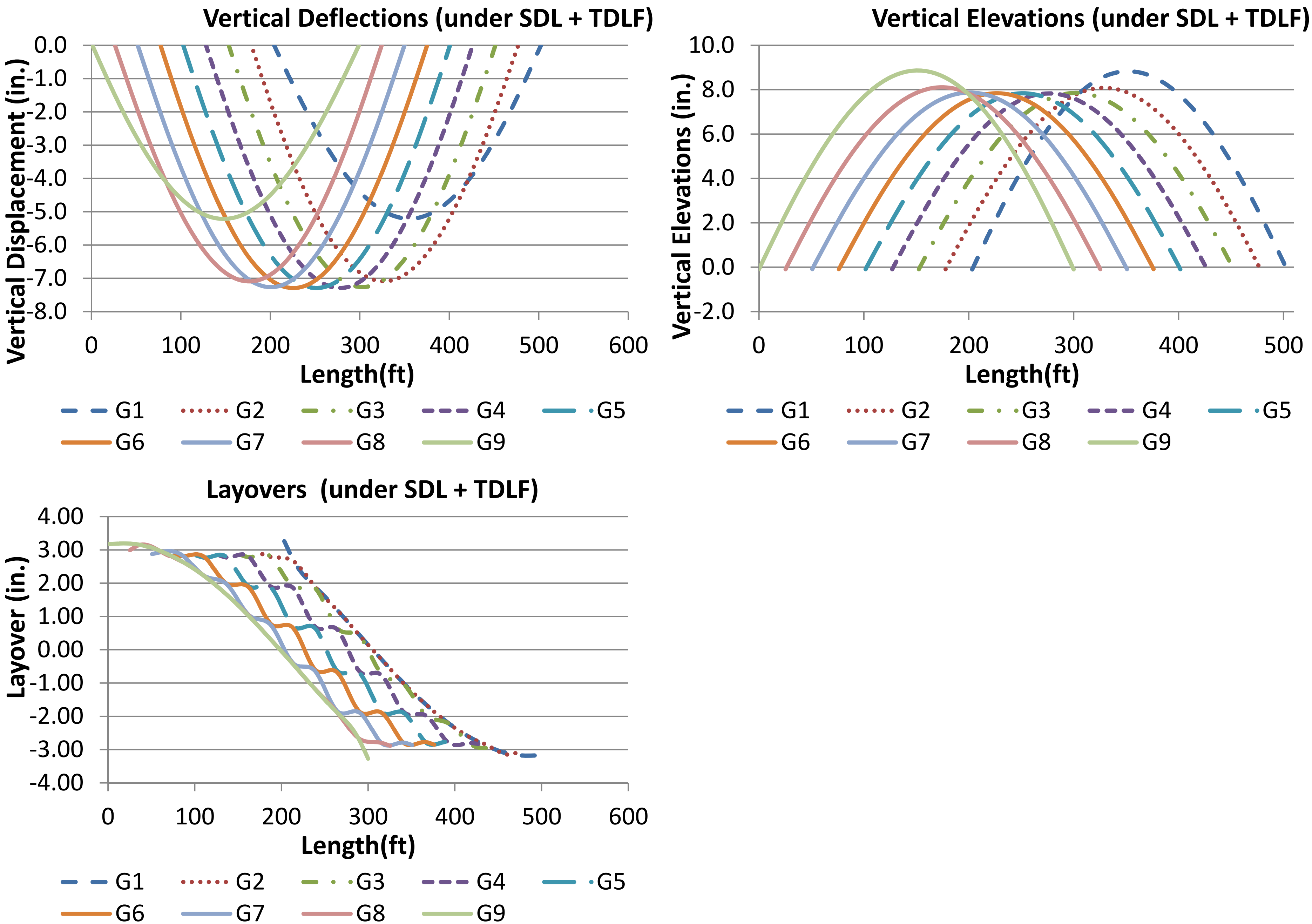


Figure J2-4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

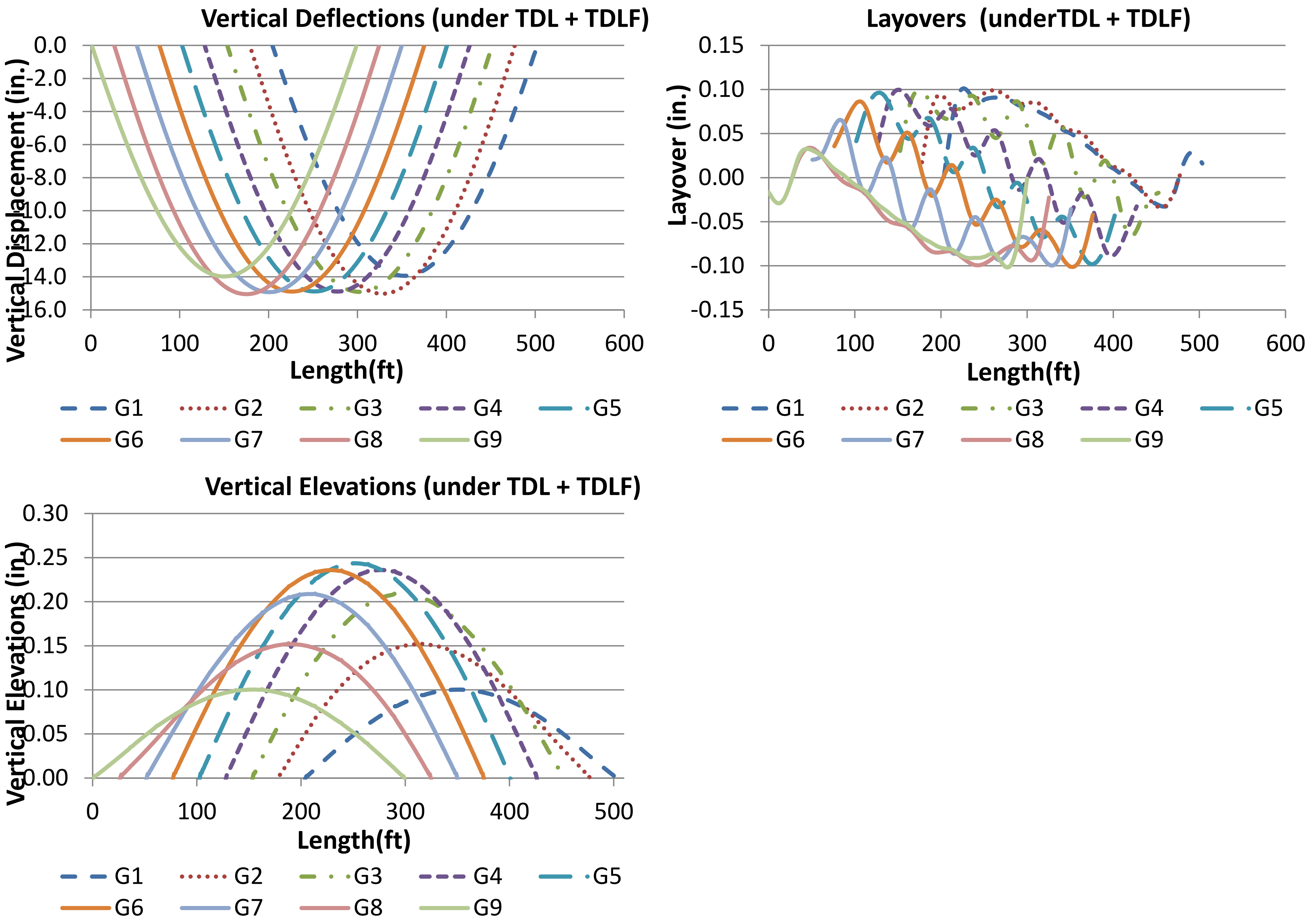


Figure J2-4-9. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

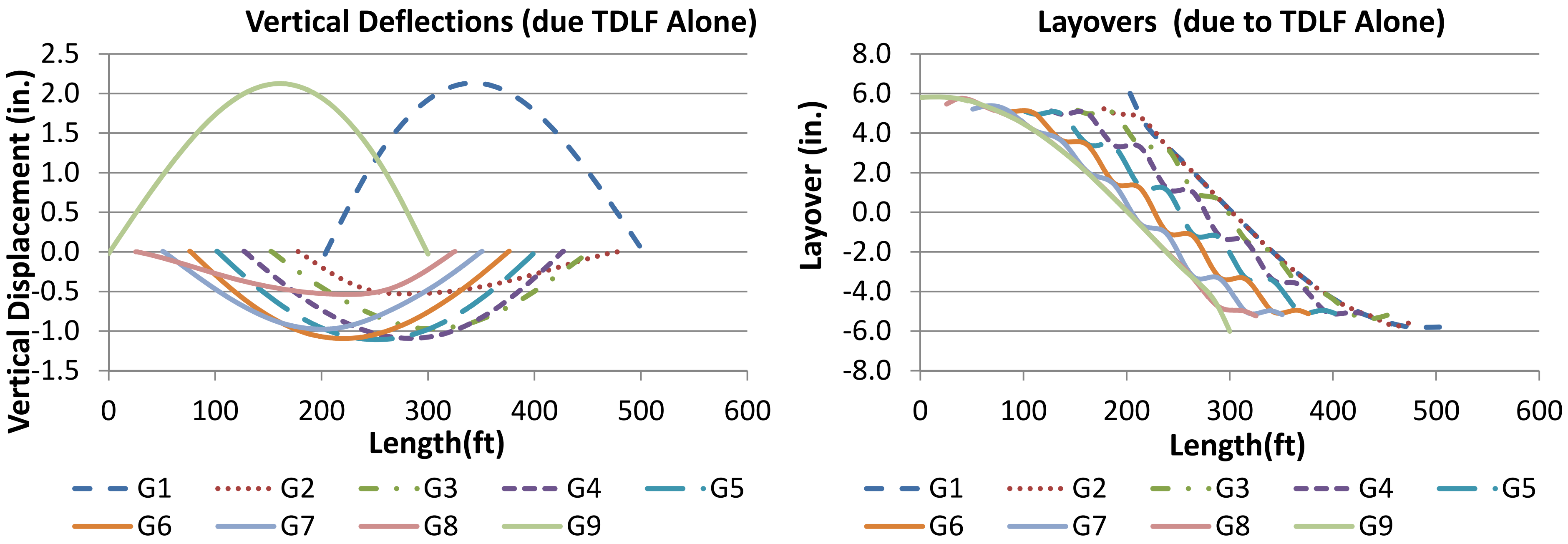


Figure J2-4-10. Bridge displacements due to TDLF detailing effects alone under NL (in).

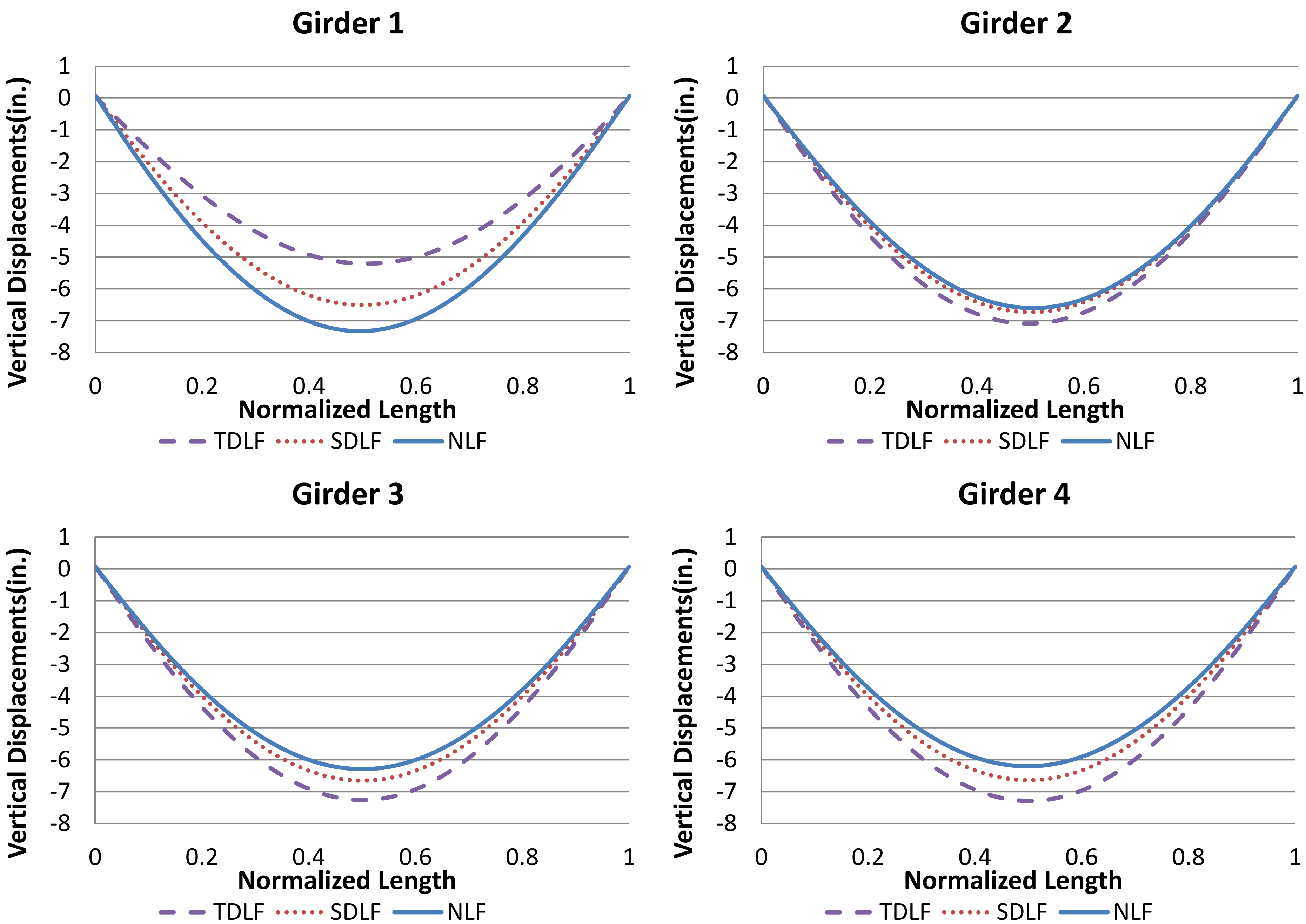


Figure J2-4-11. **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

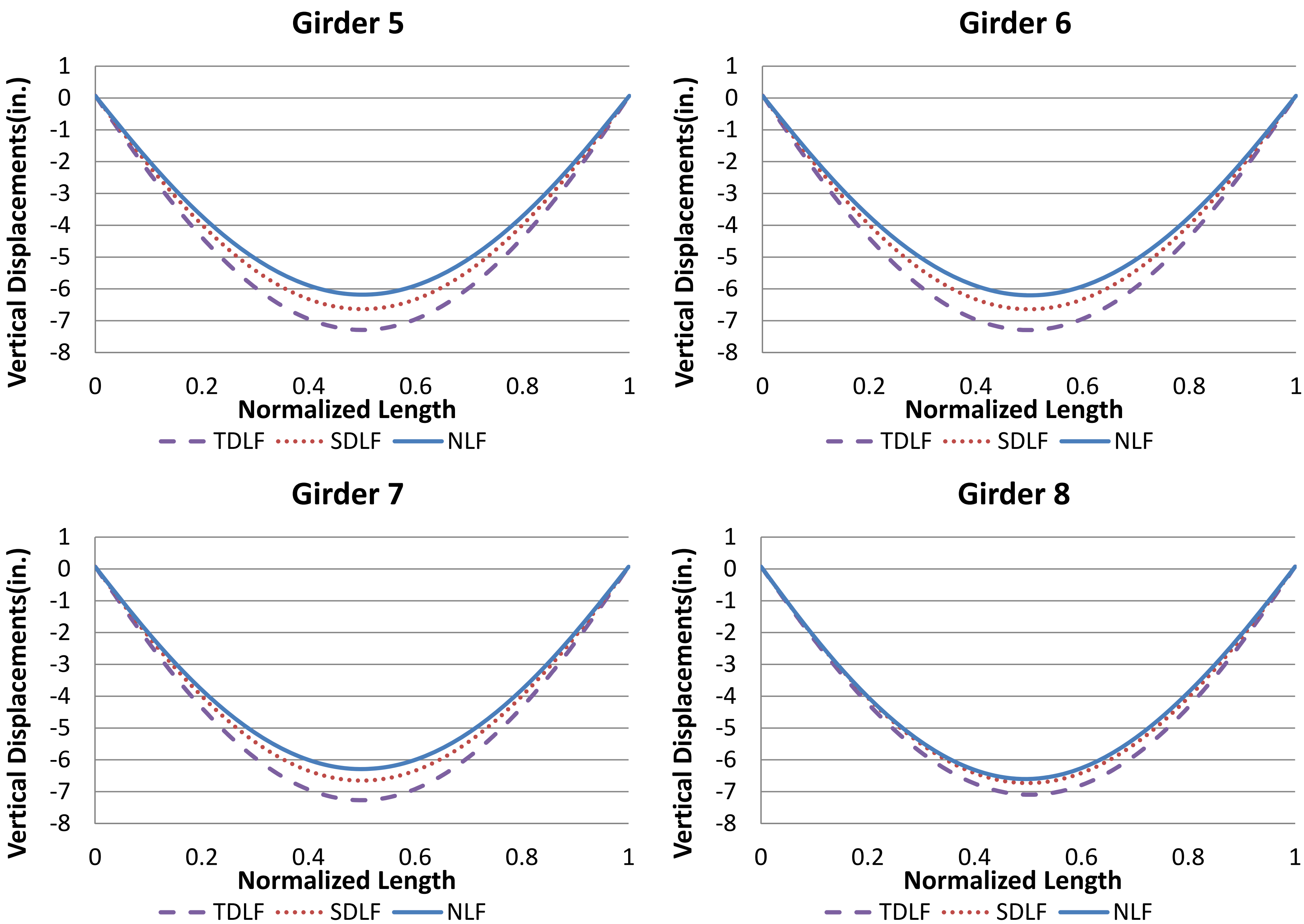


Figure J2-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

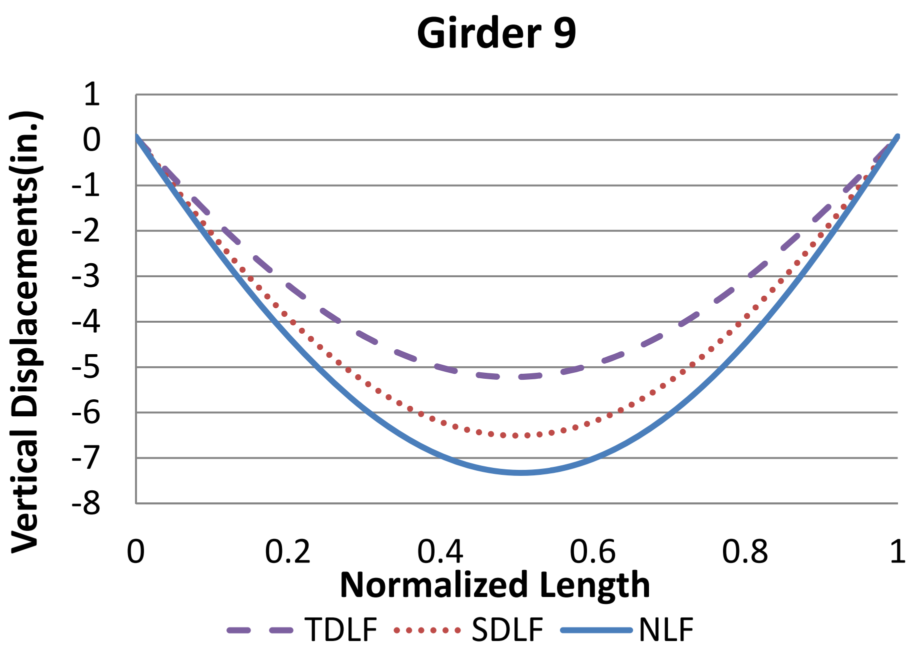


Figure J2-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

Figure J2-4-12. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

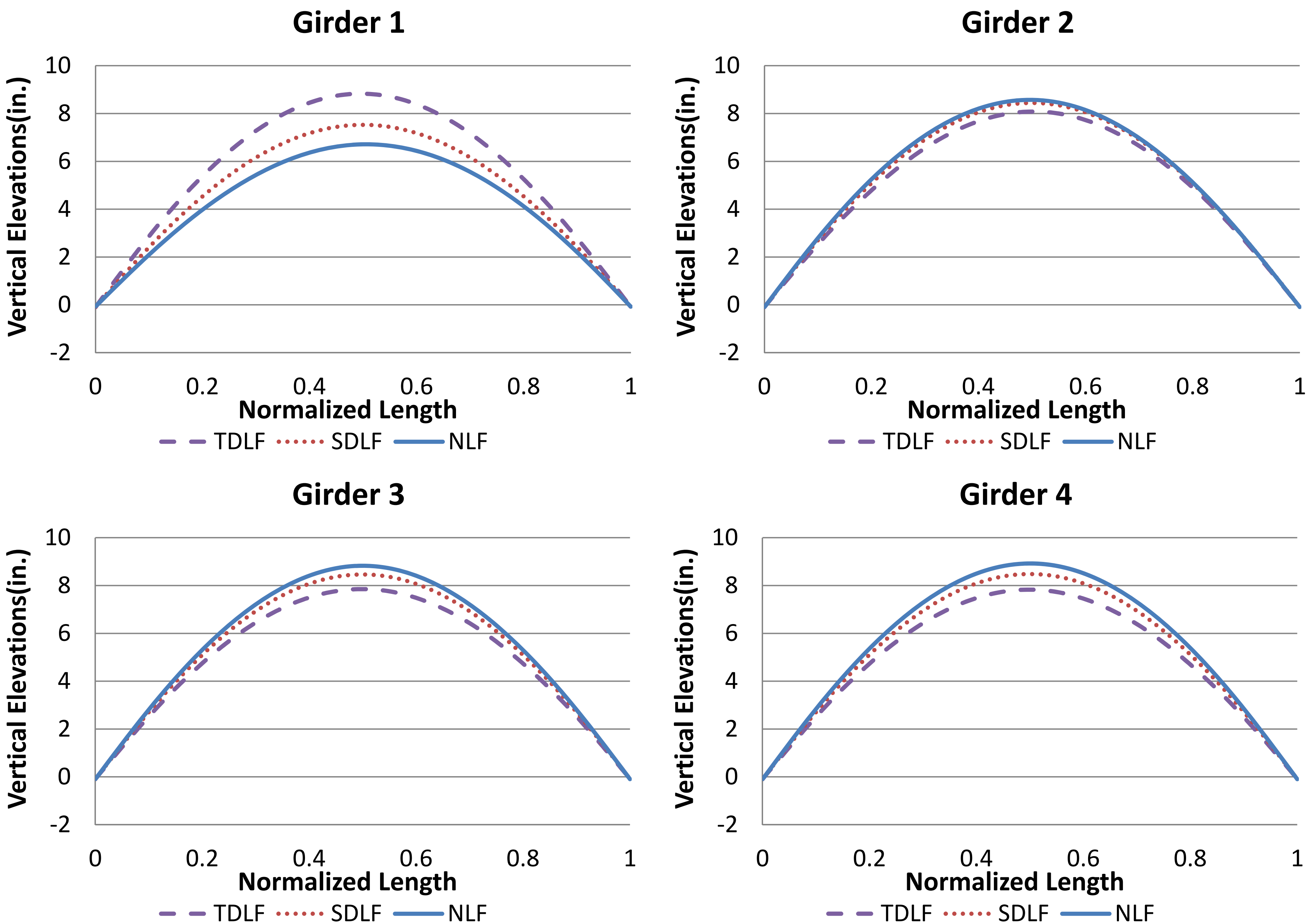


Figure J2-4-12. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

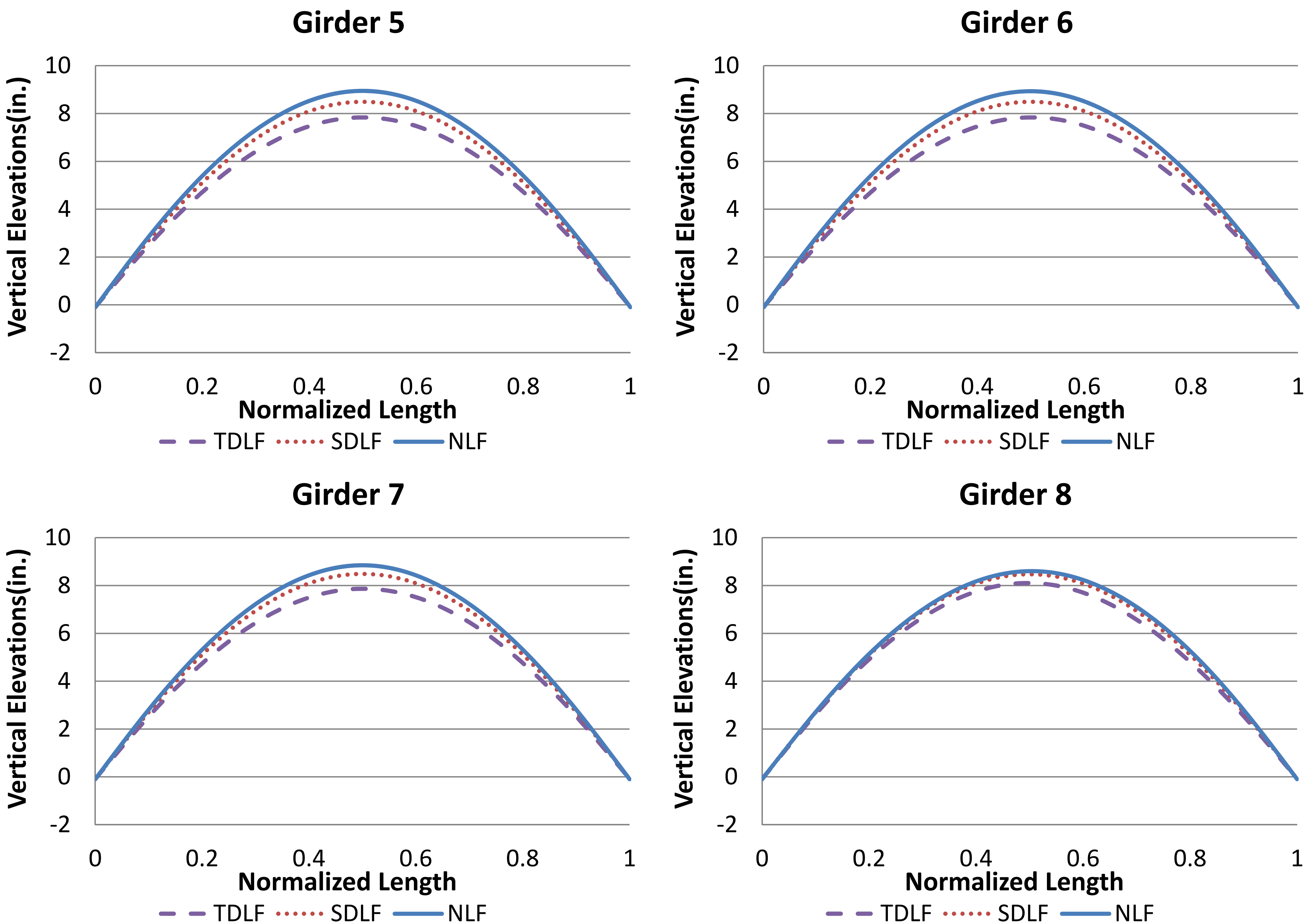


Figure J2-4-12(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

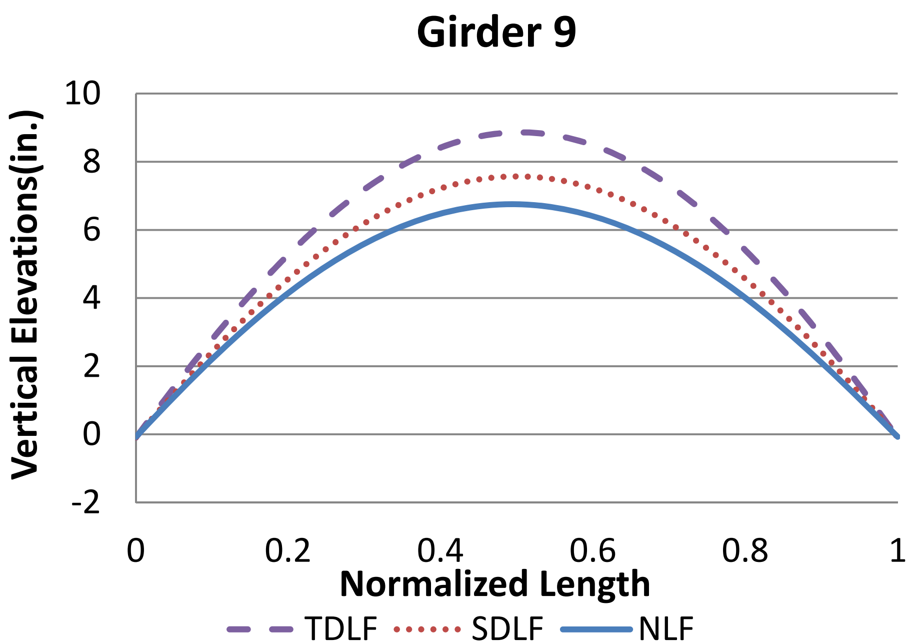


Figure J2-4-12(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

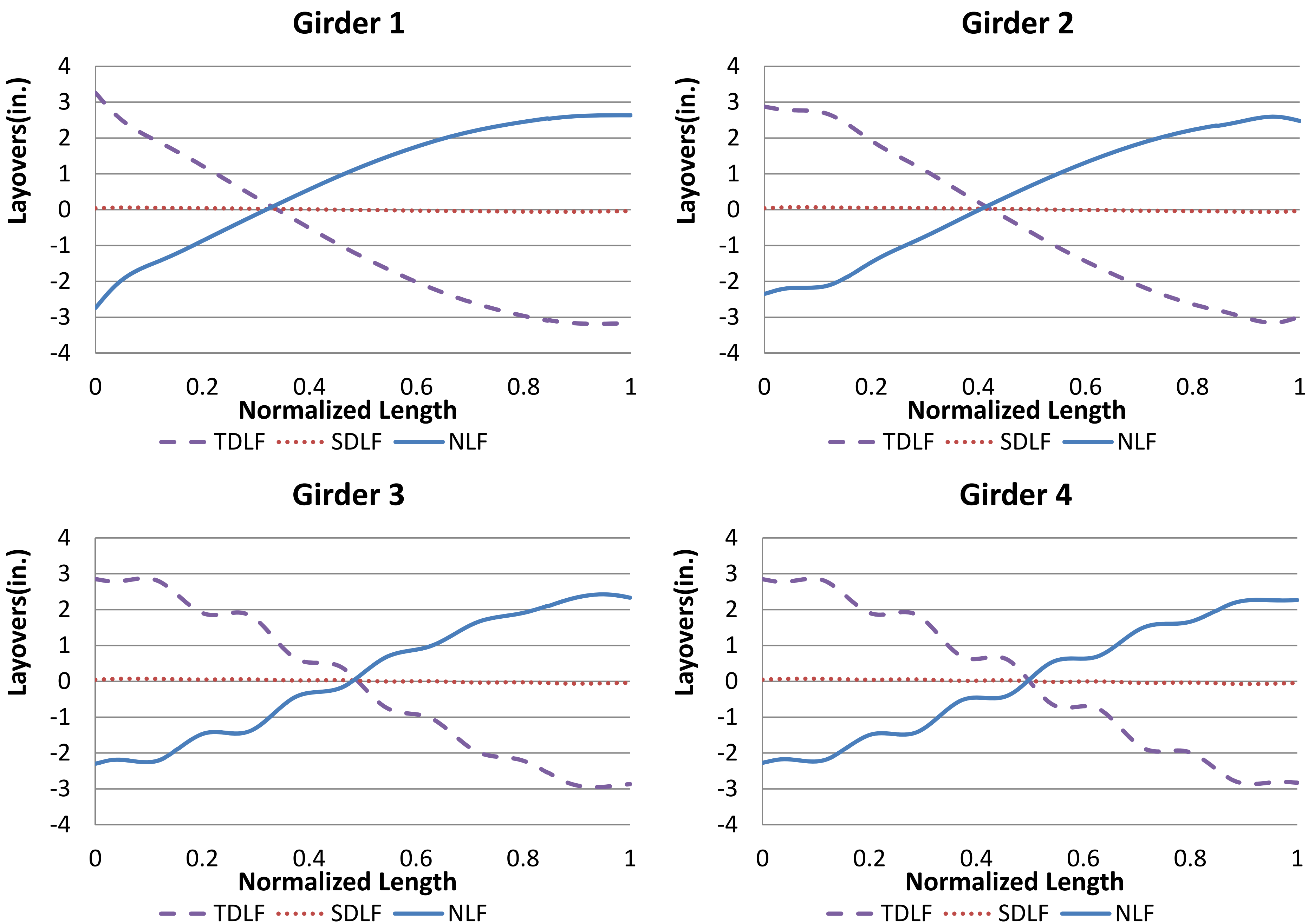


Figure J2-4-13. Comparison of individual girder layovers (in) under SDL for different detailing methods.

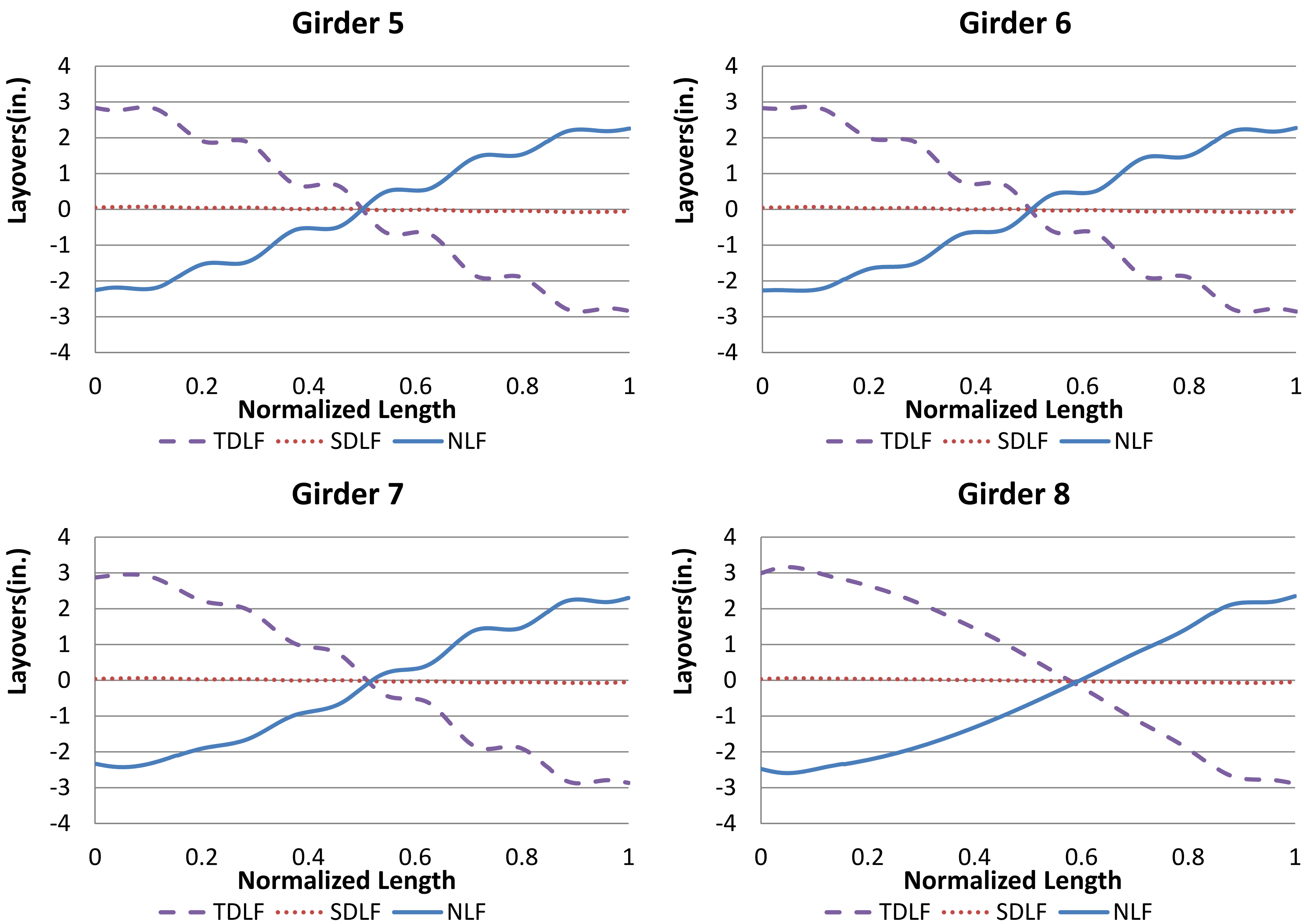


Figure J2-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

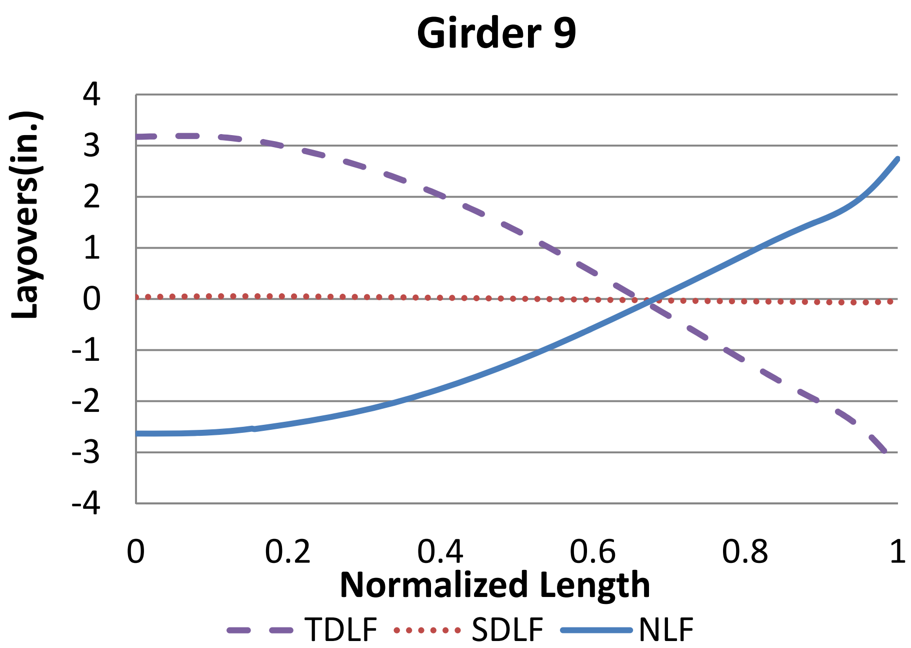


Figure J2-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

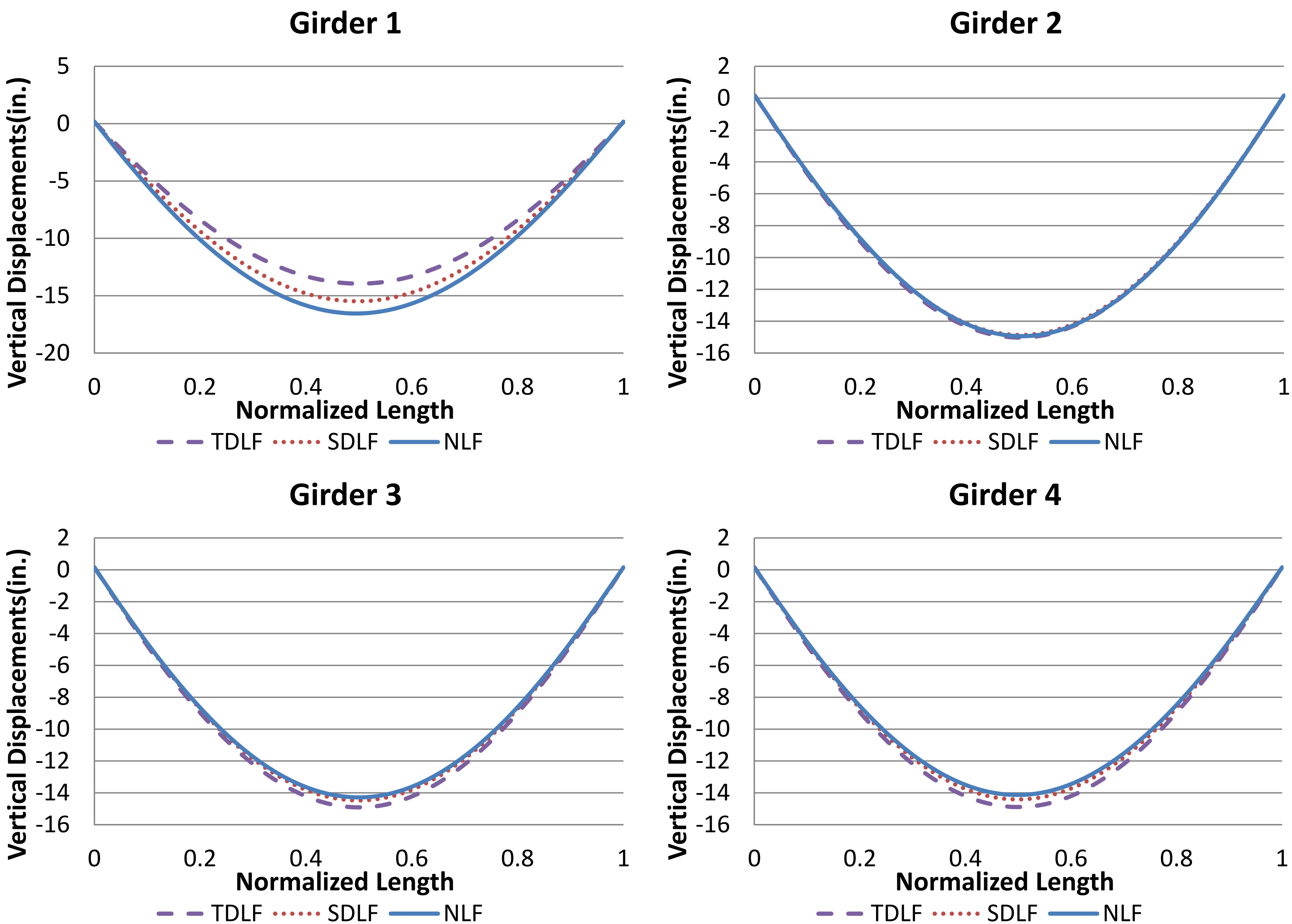


Figure J2-4-14. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

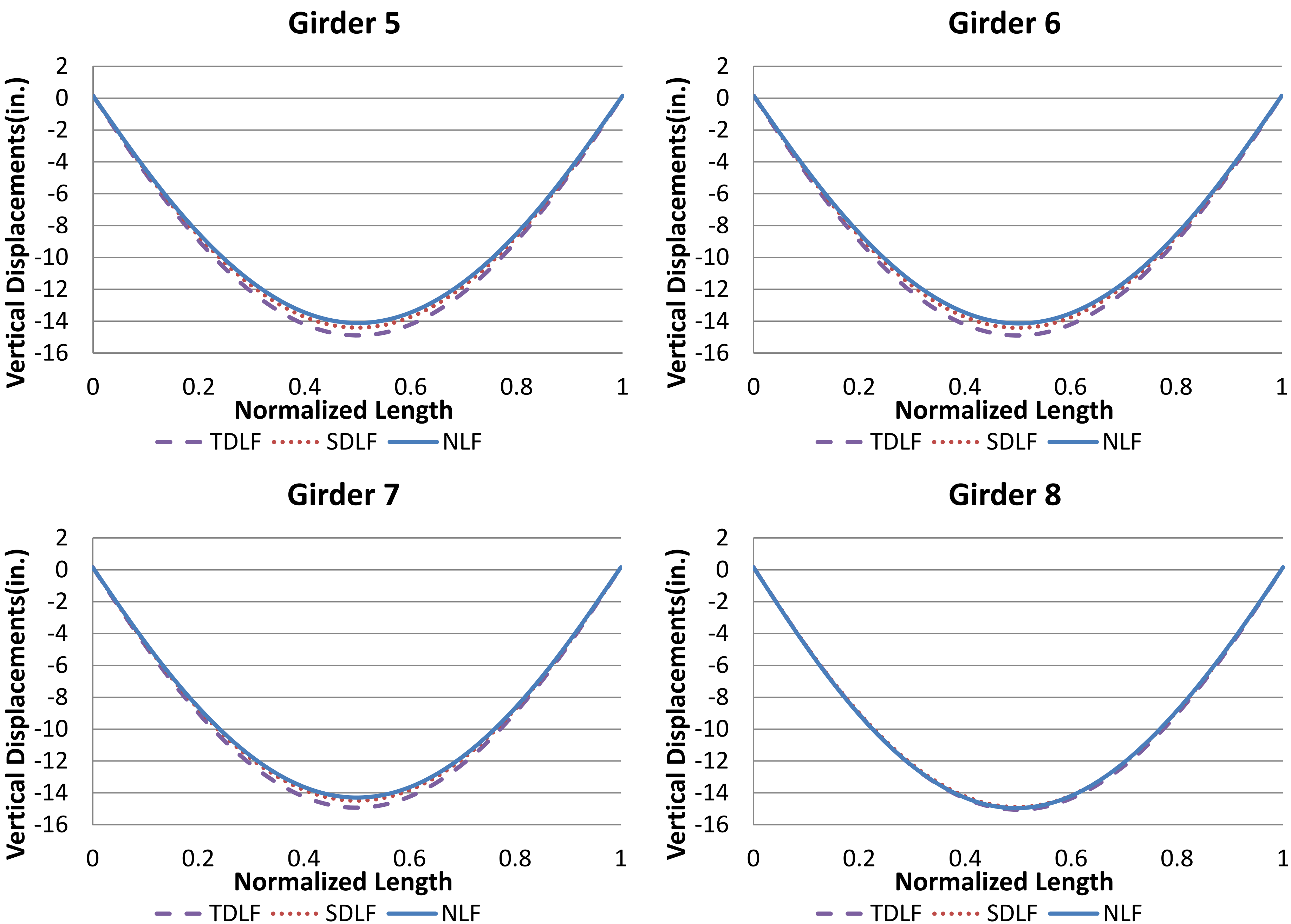


Figure J2-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

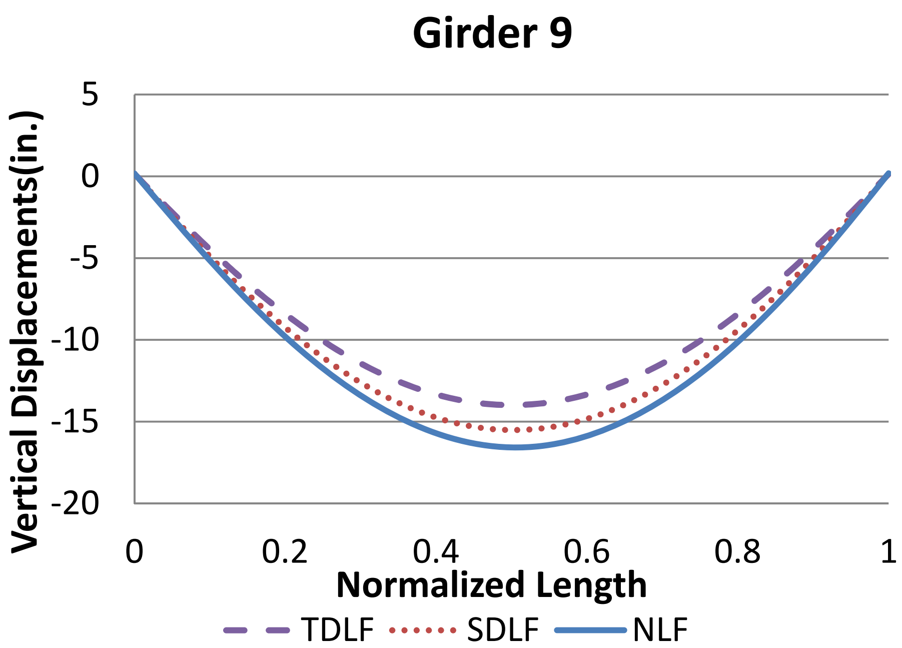


Figure J2-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

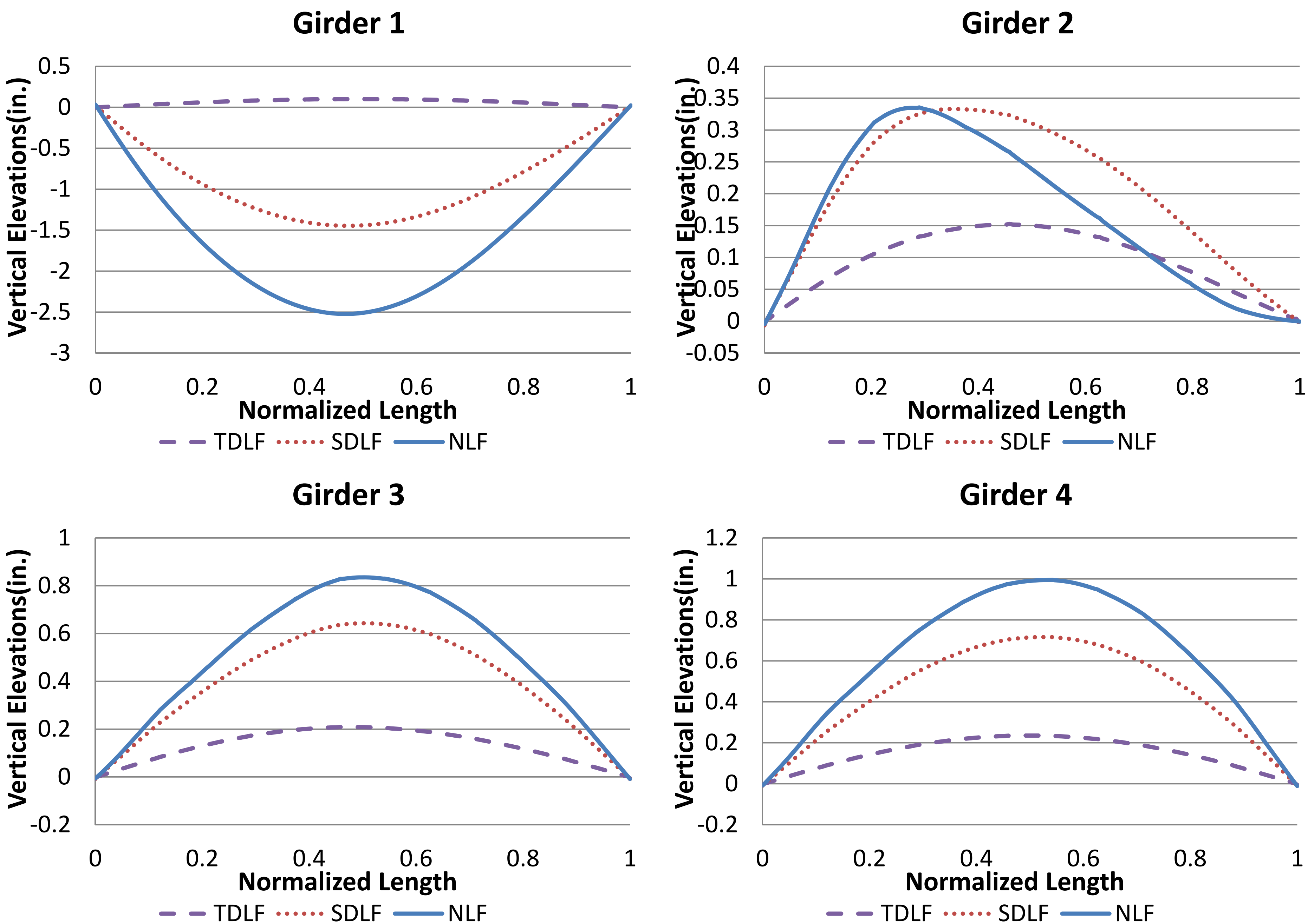


Figure J2-4-15. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

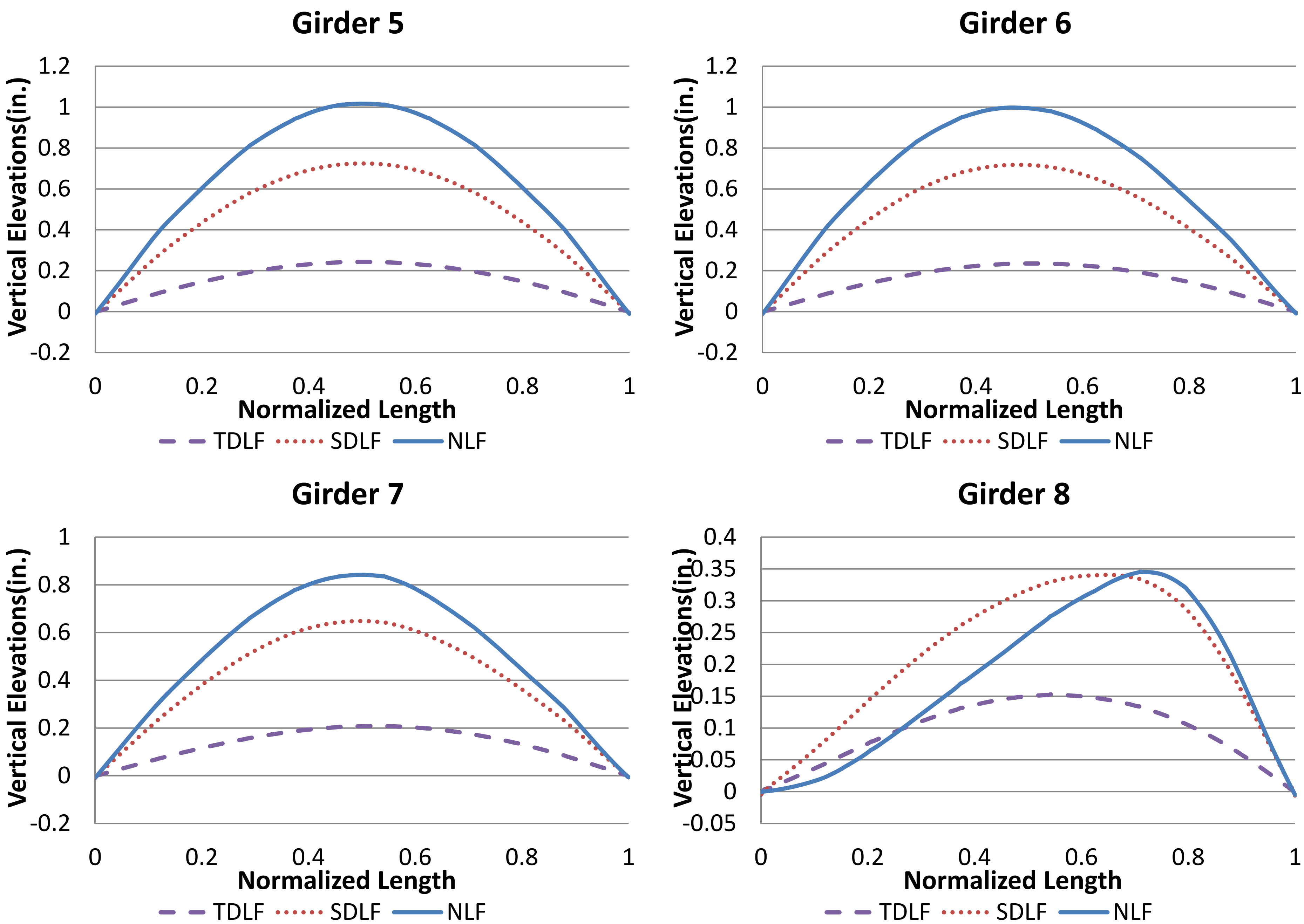


Figure J2-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

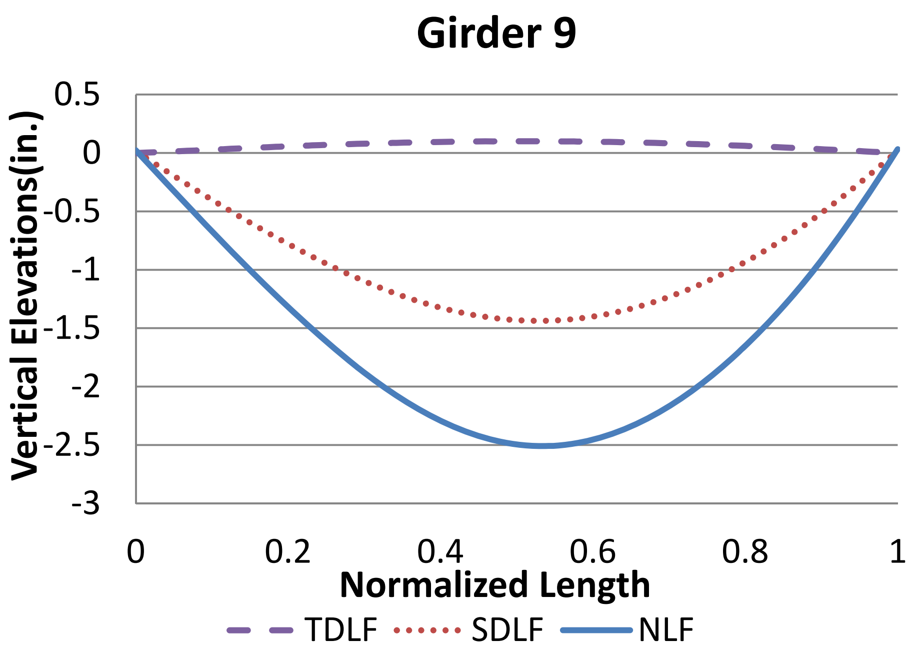


Figure J2-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

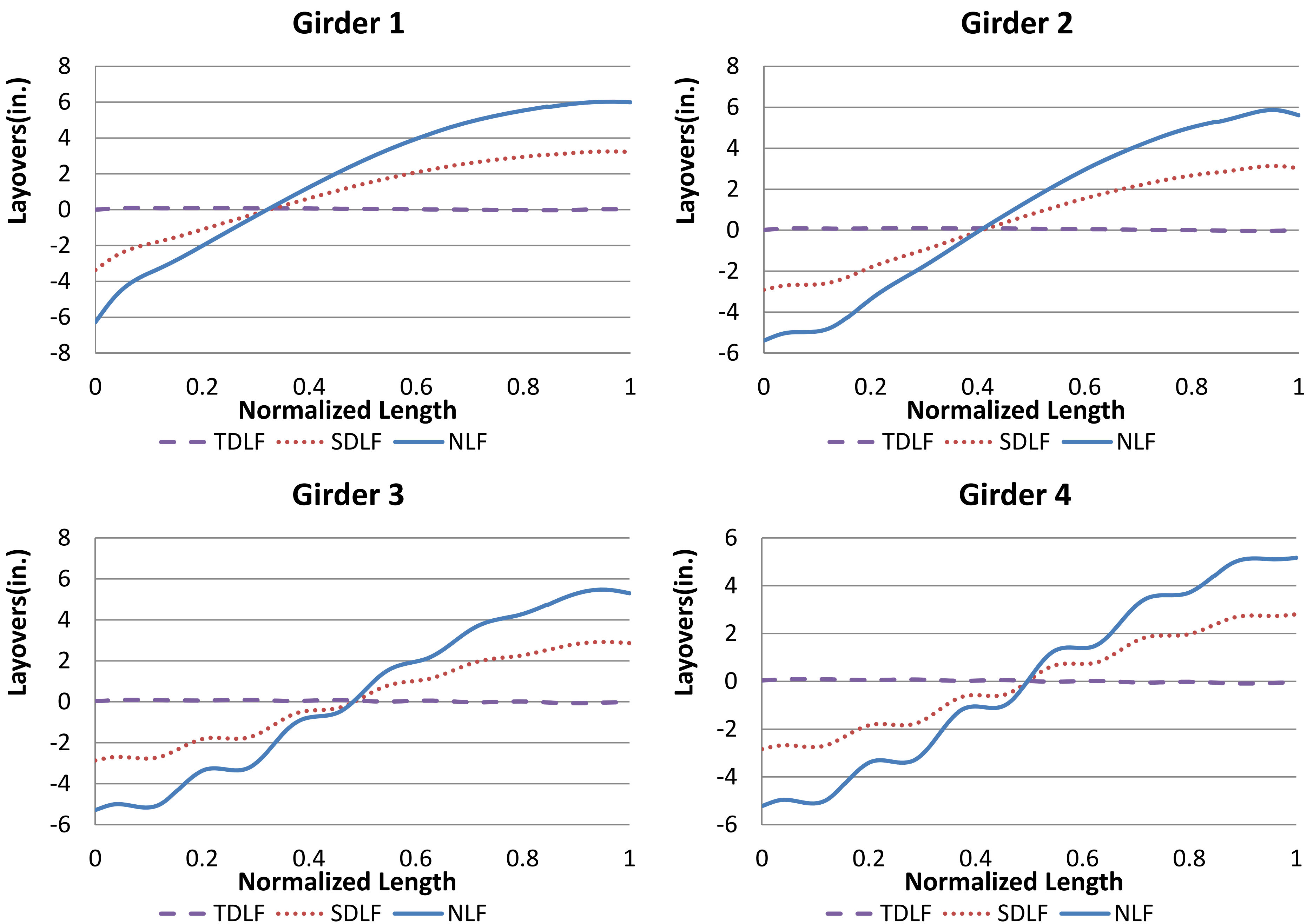


Figure J2-4-16. Comparison of individual girder layovers (in) under TDL for different detailing methods.

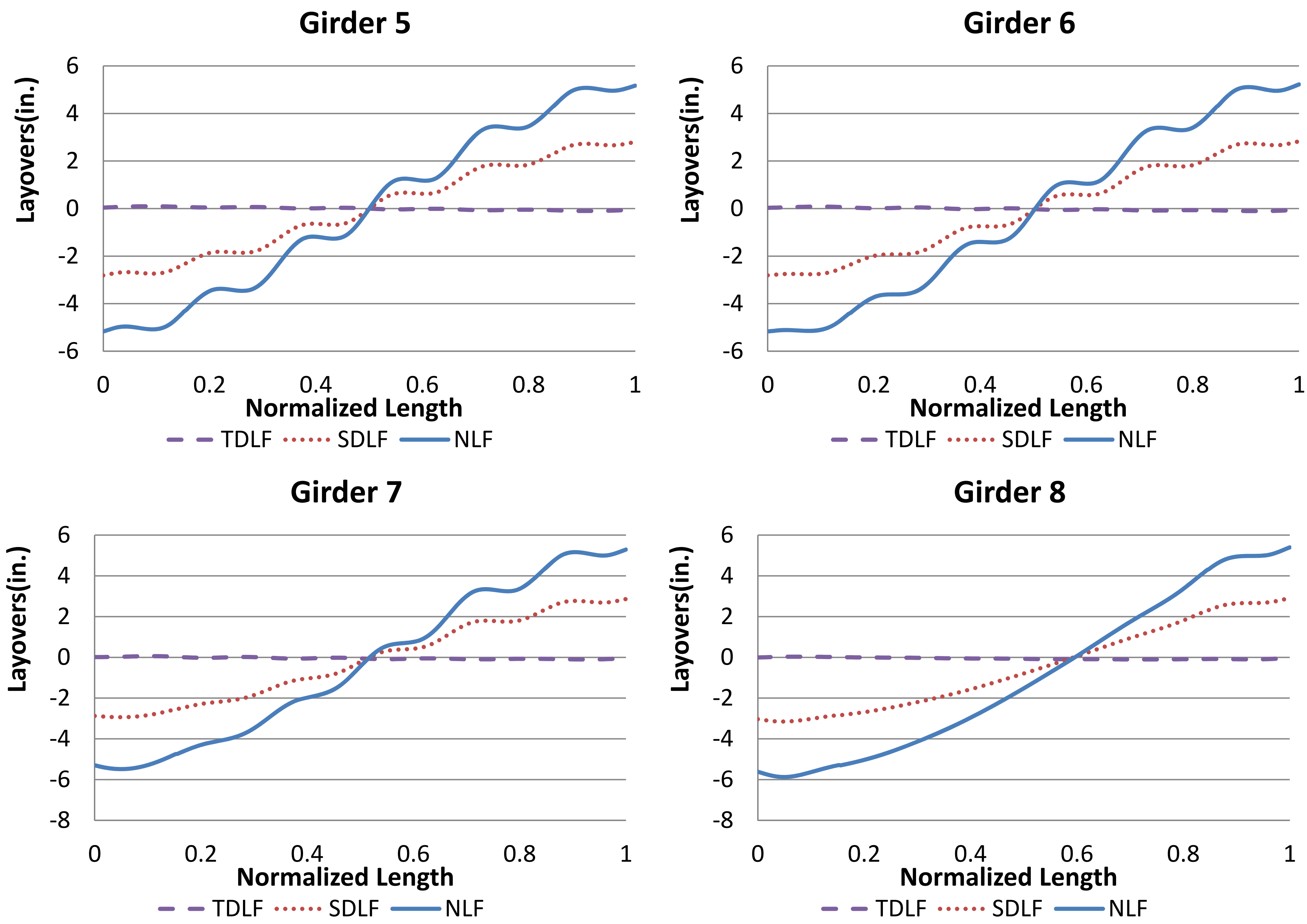


Figure J2-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

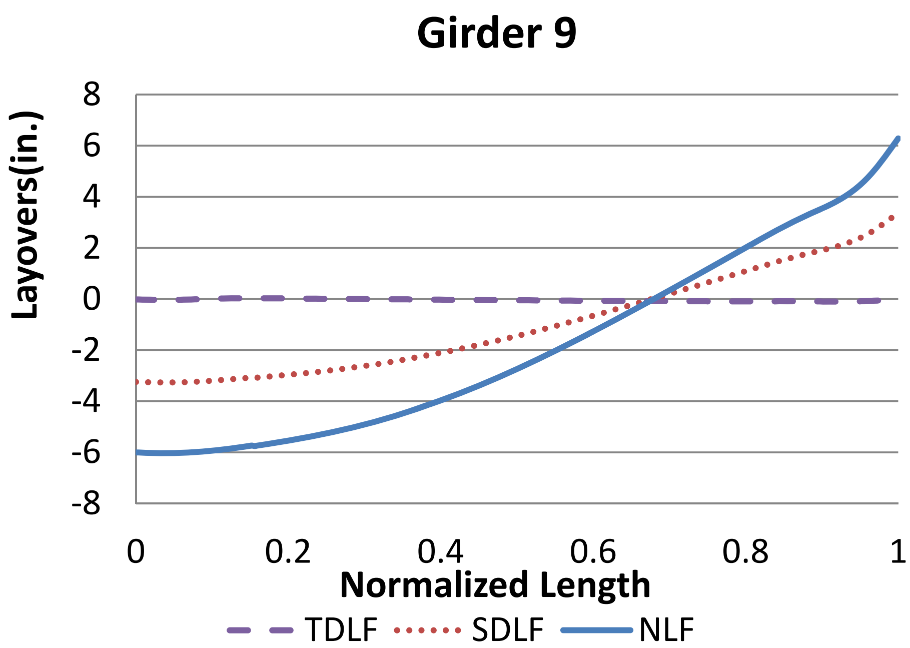


Figure J2-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

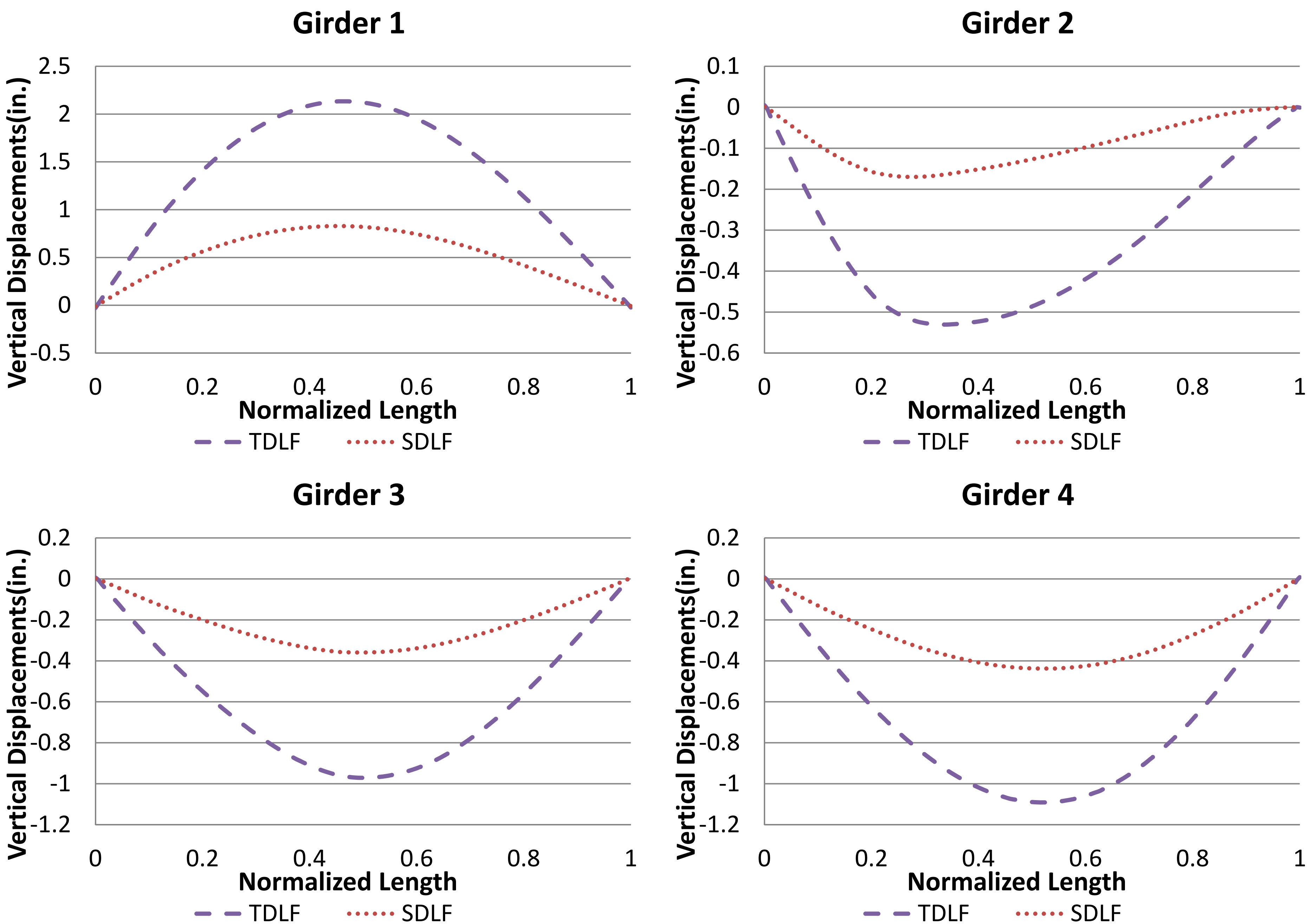


Figure J2-4-17. **Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.**

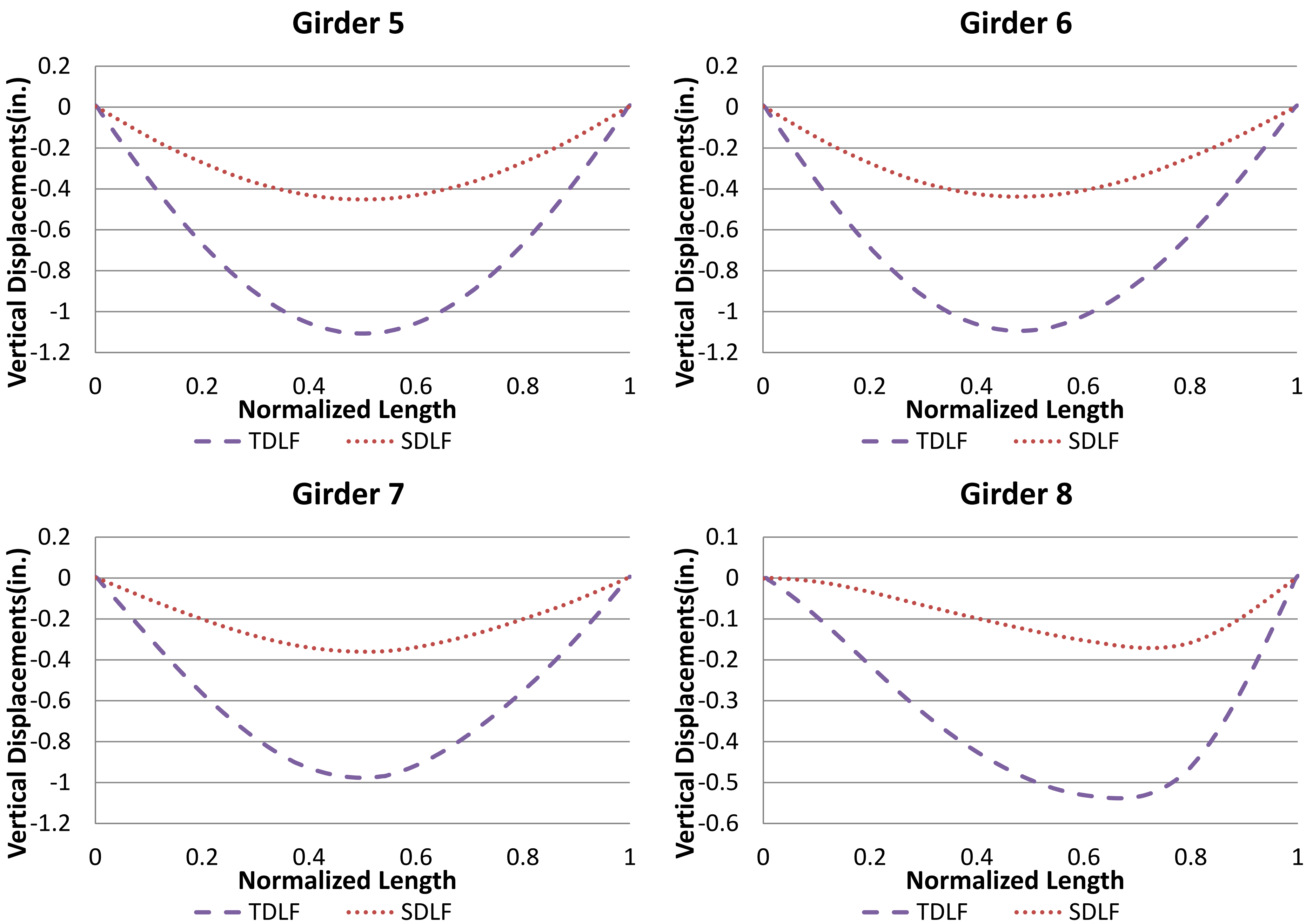


Figure J2-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

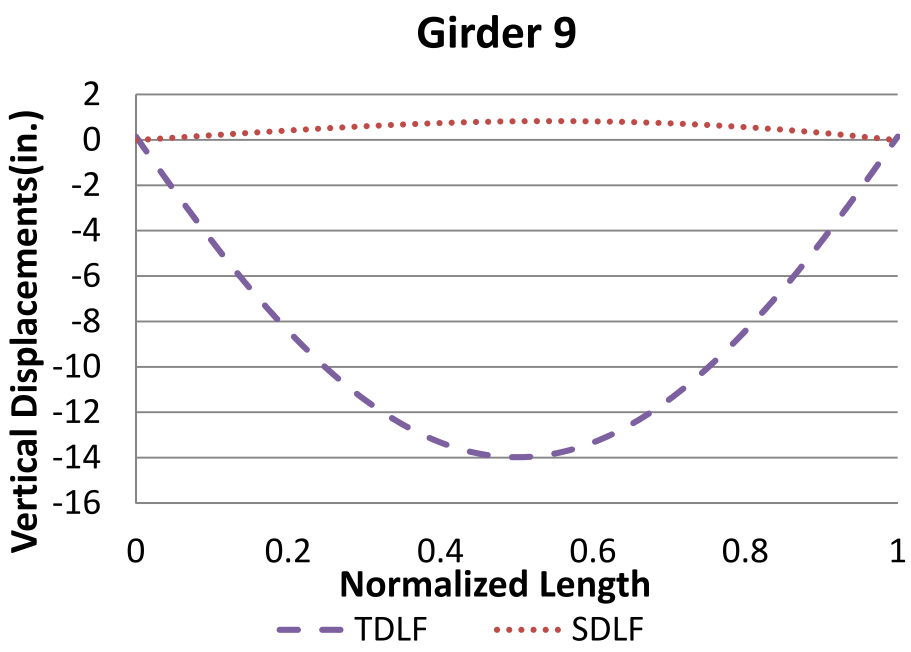


Figure J2-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

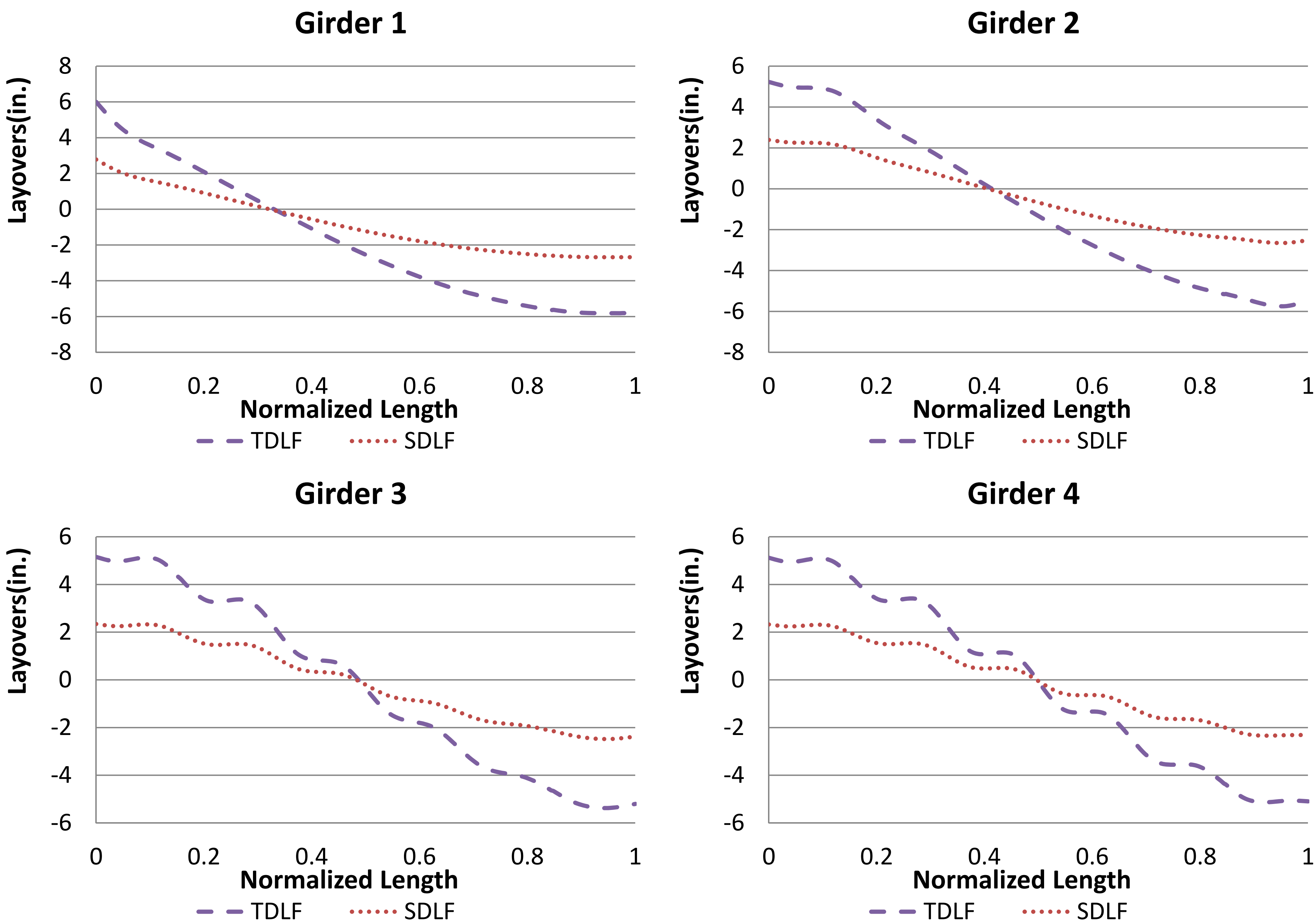


Figure J2-4-18. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

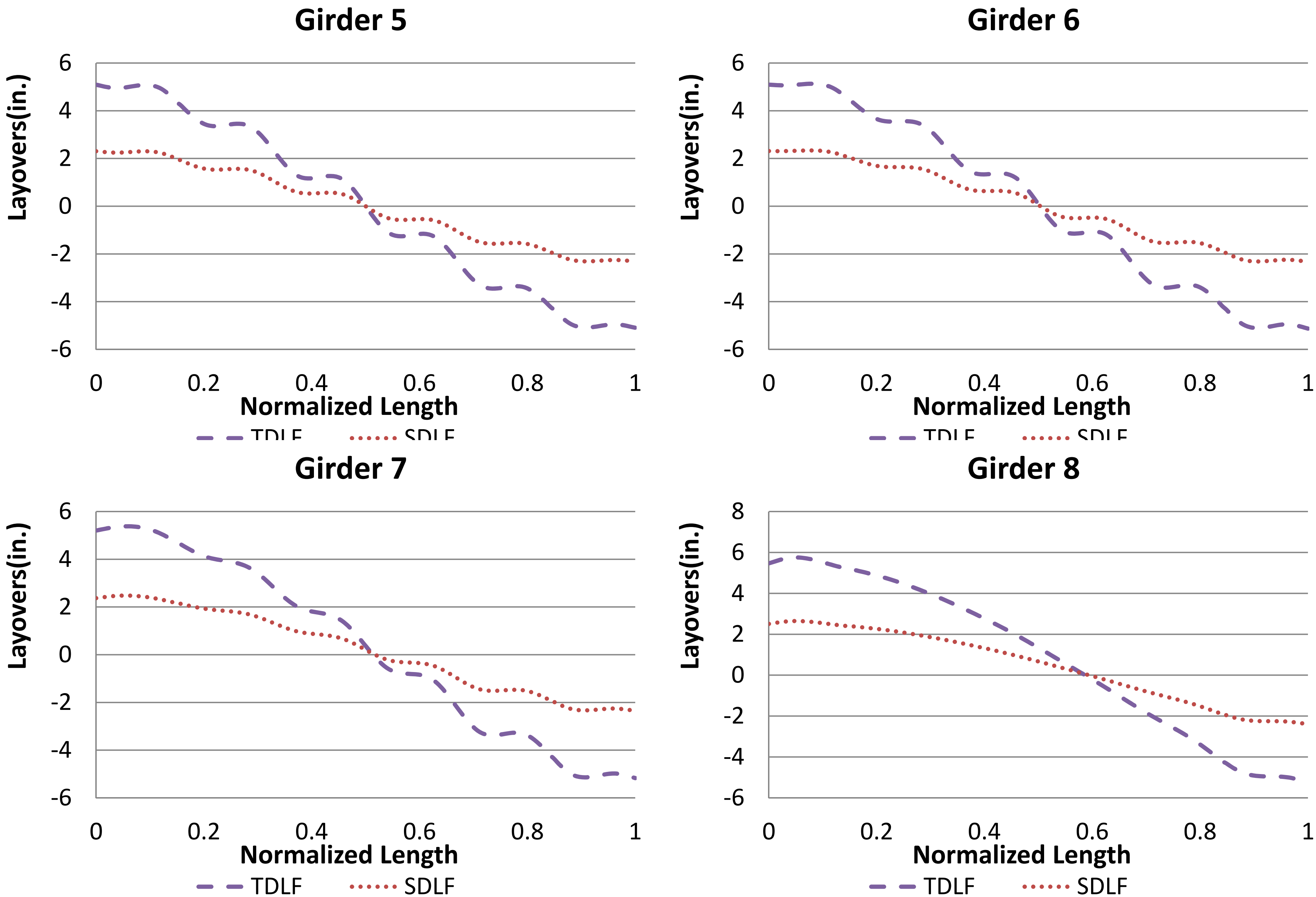


Figure J2-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

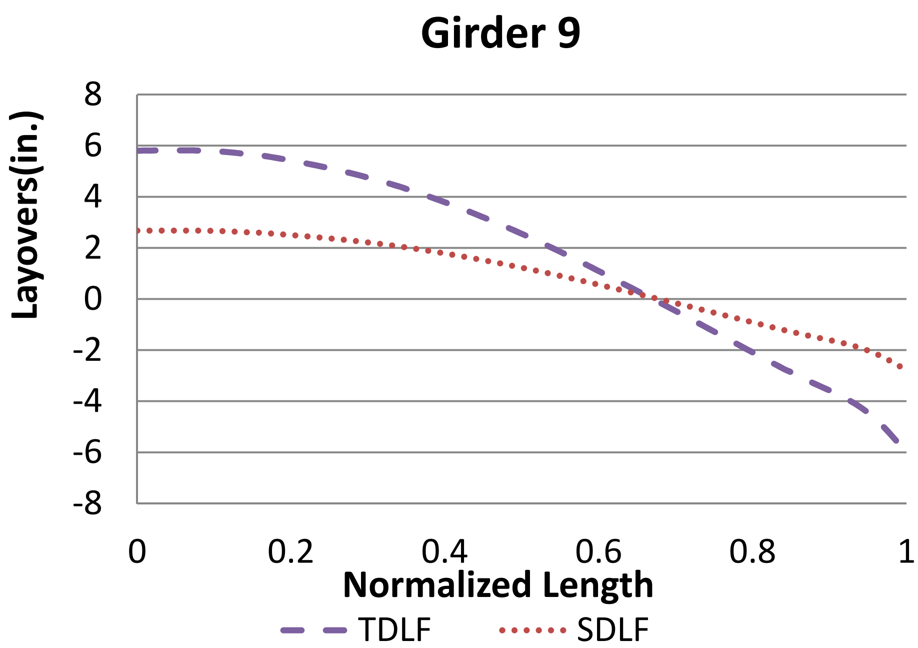


Figure J2-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

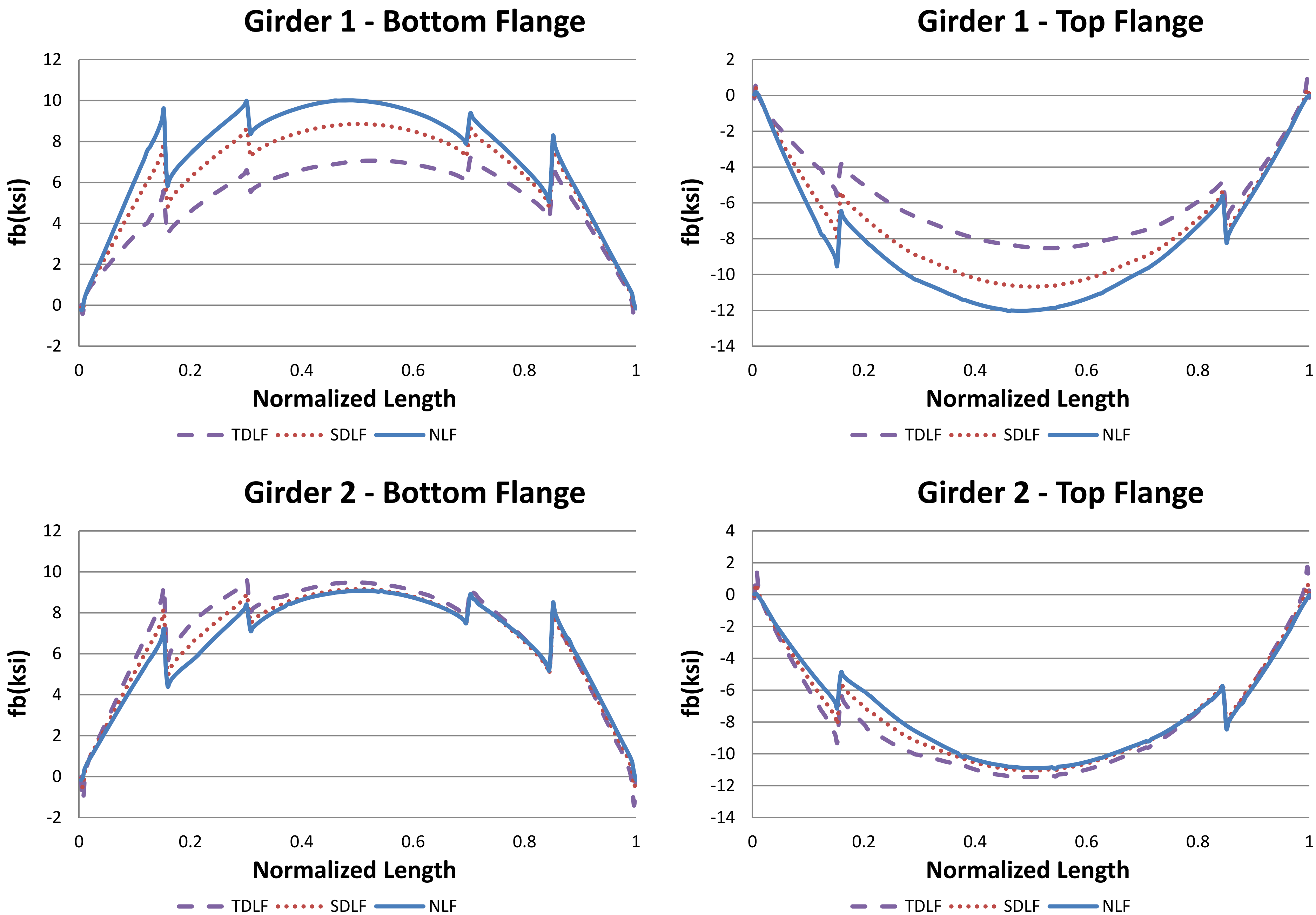


Figure J2-4-19. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

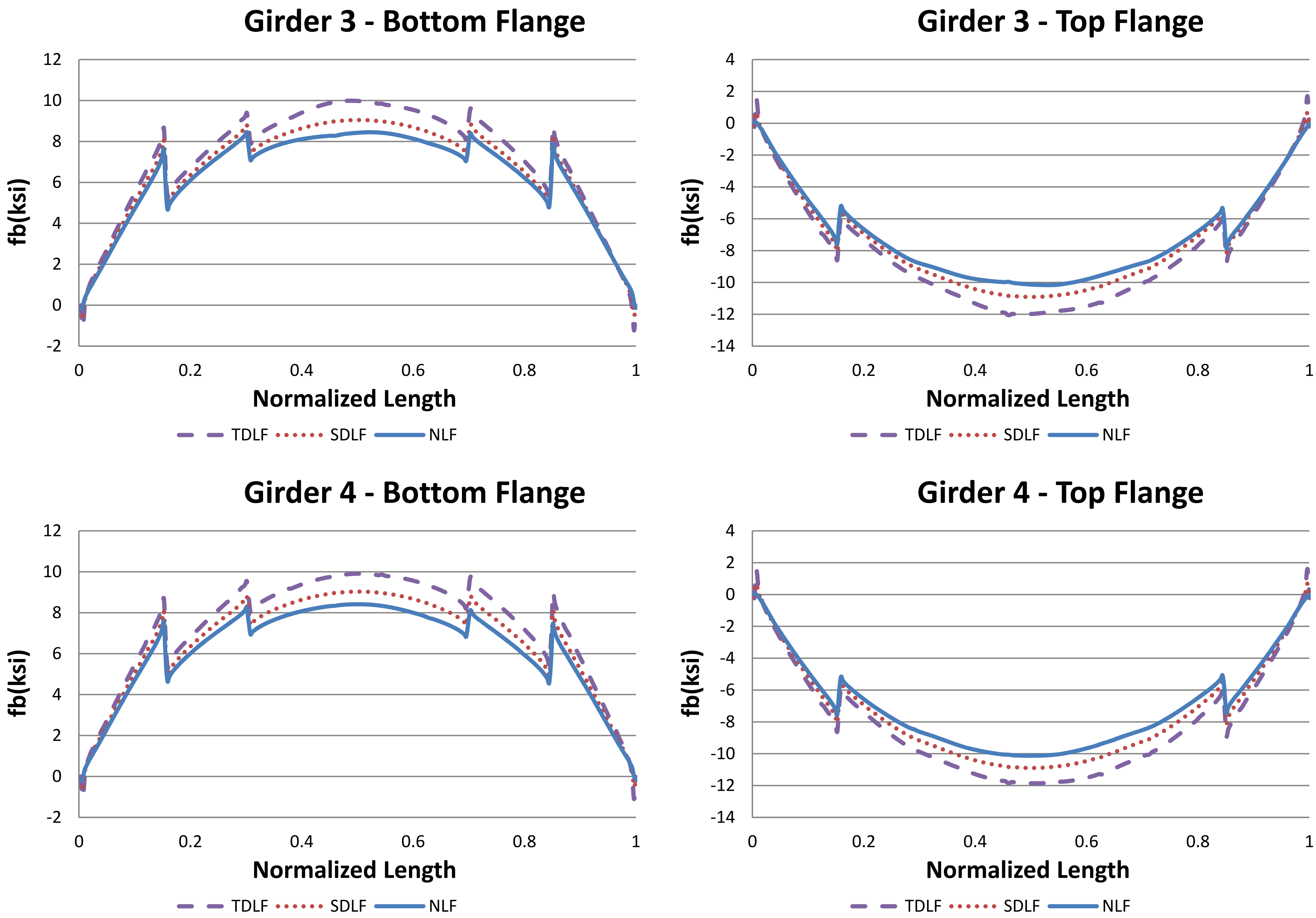


Figure J2-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

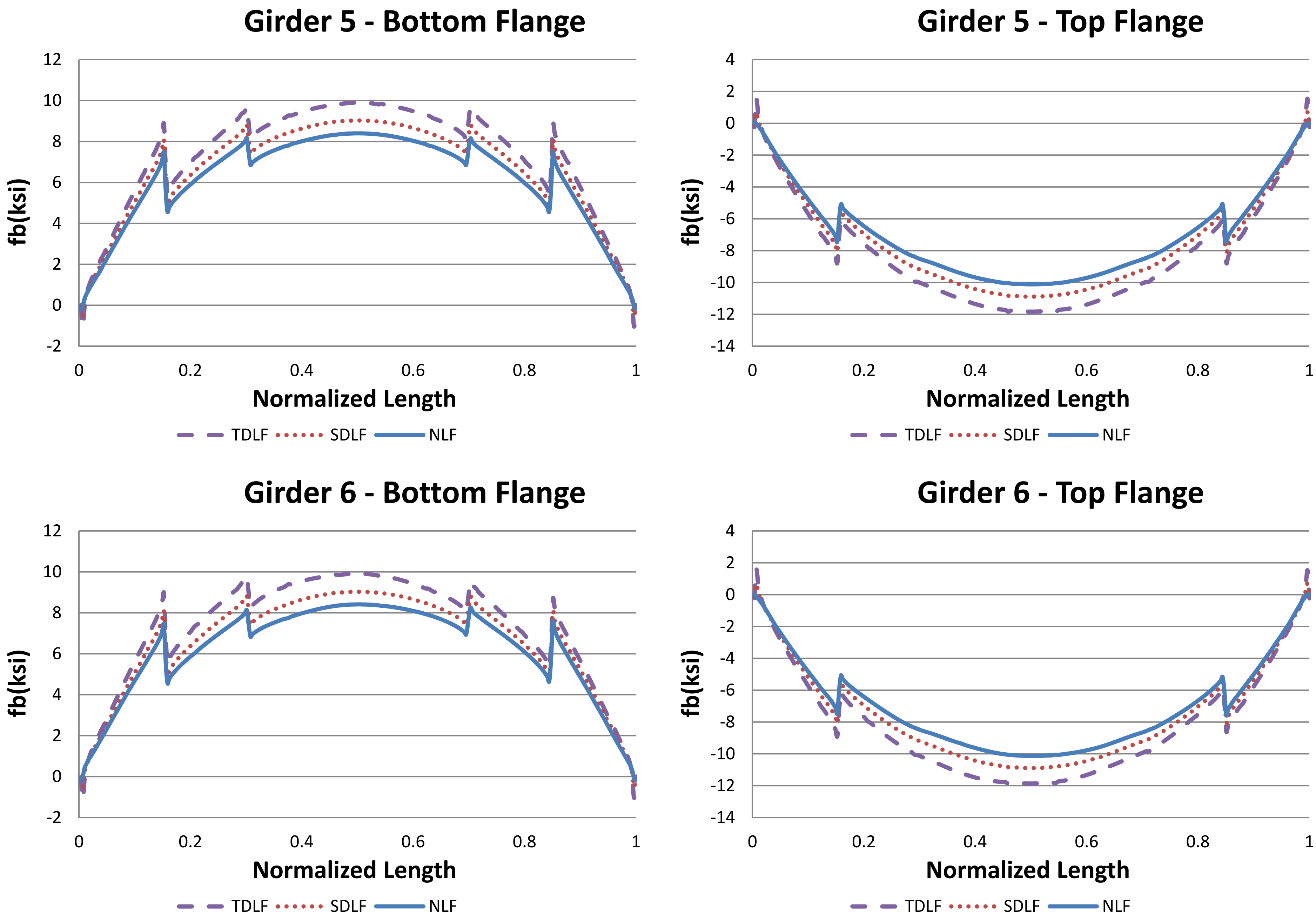


Figure J2-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

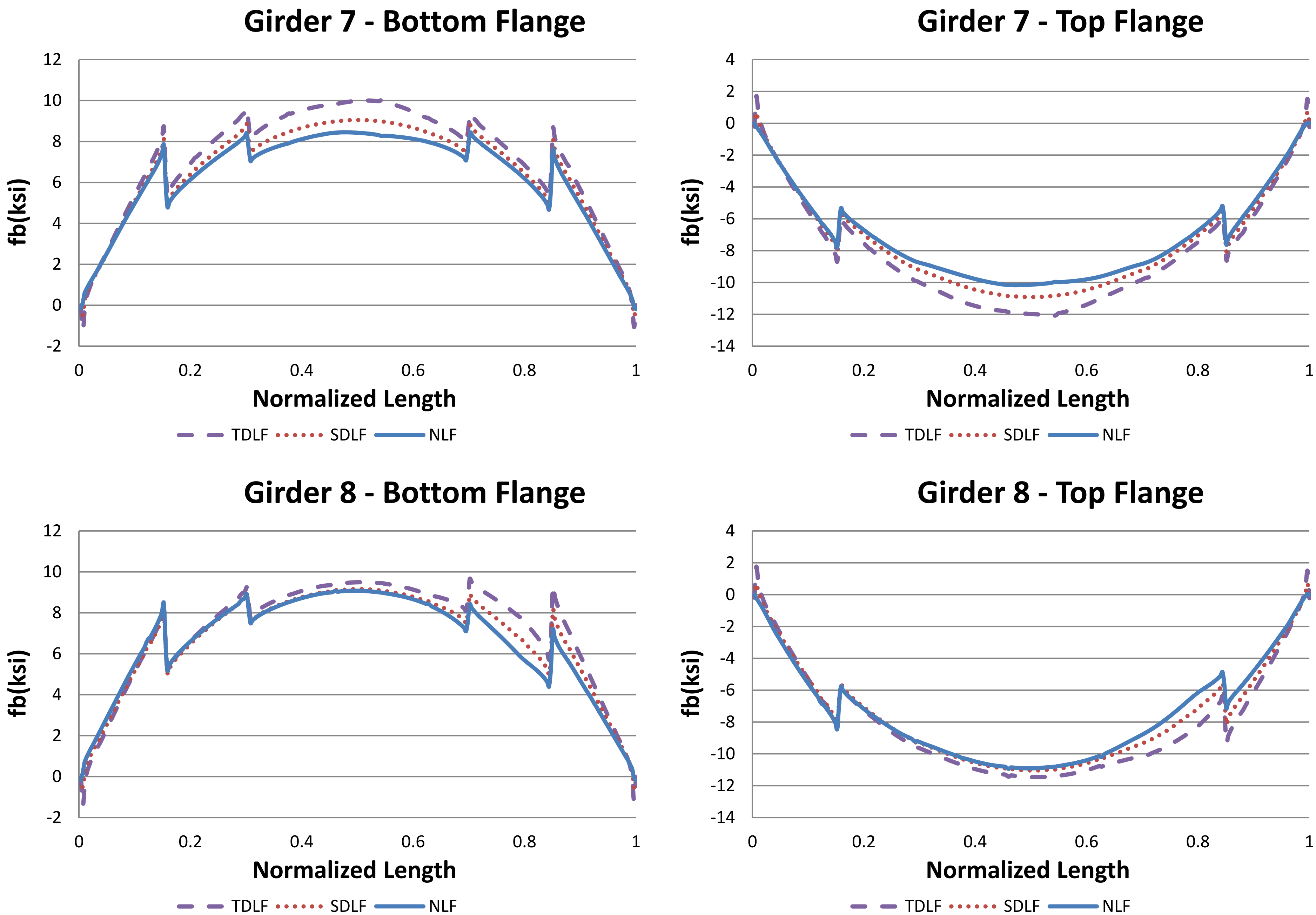


Figure J2-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

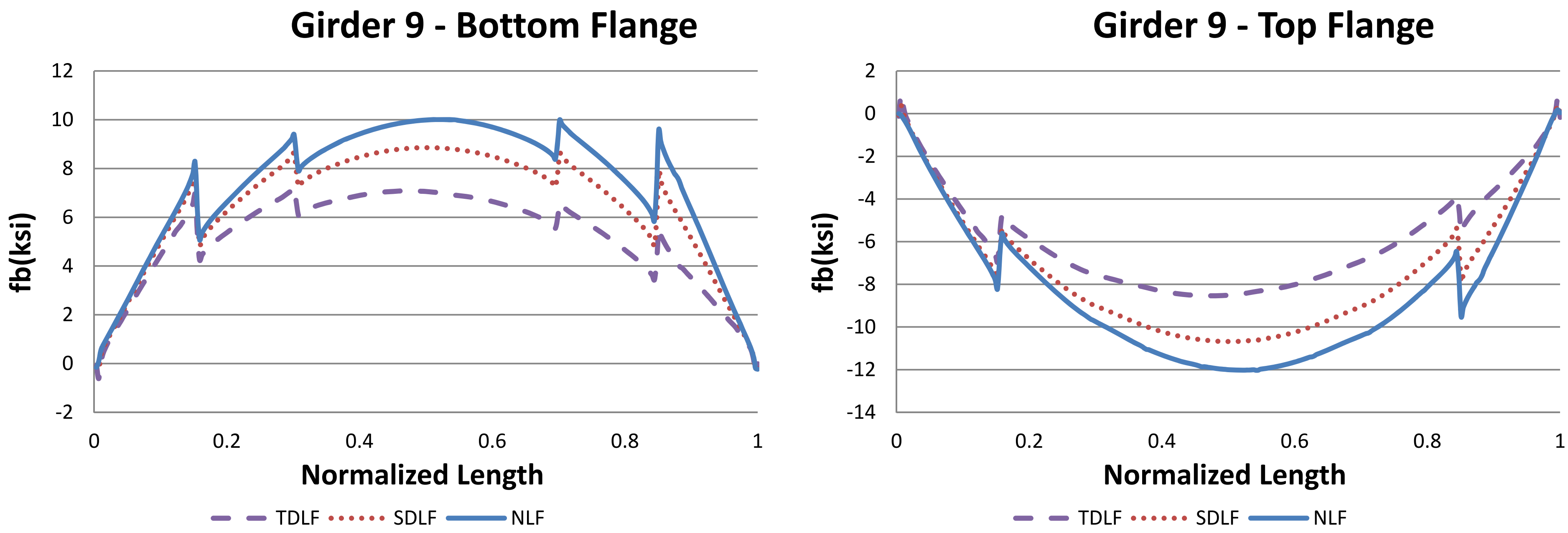


Figure J2-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

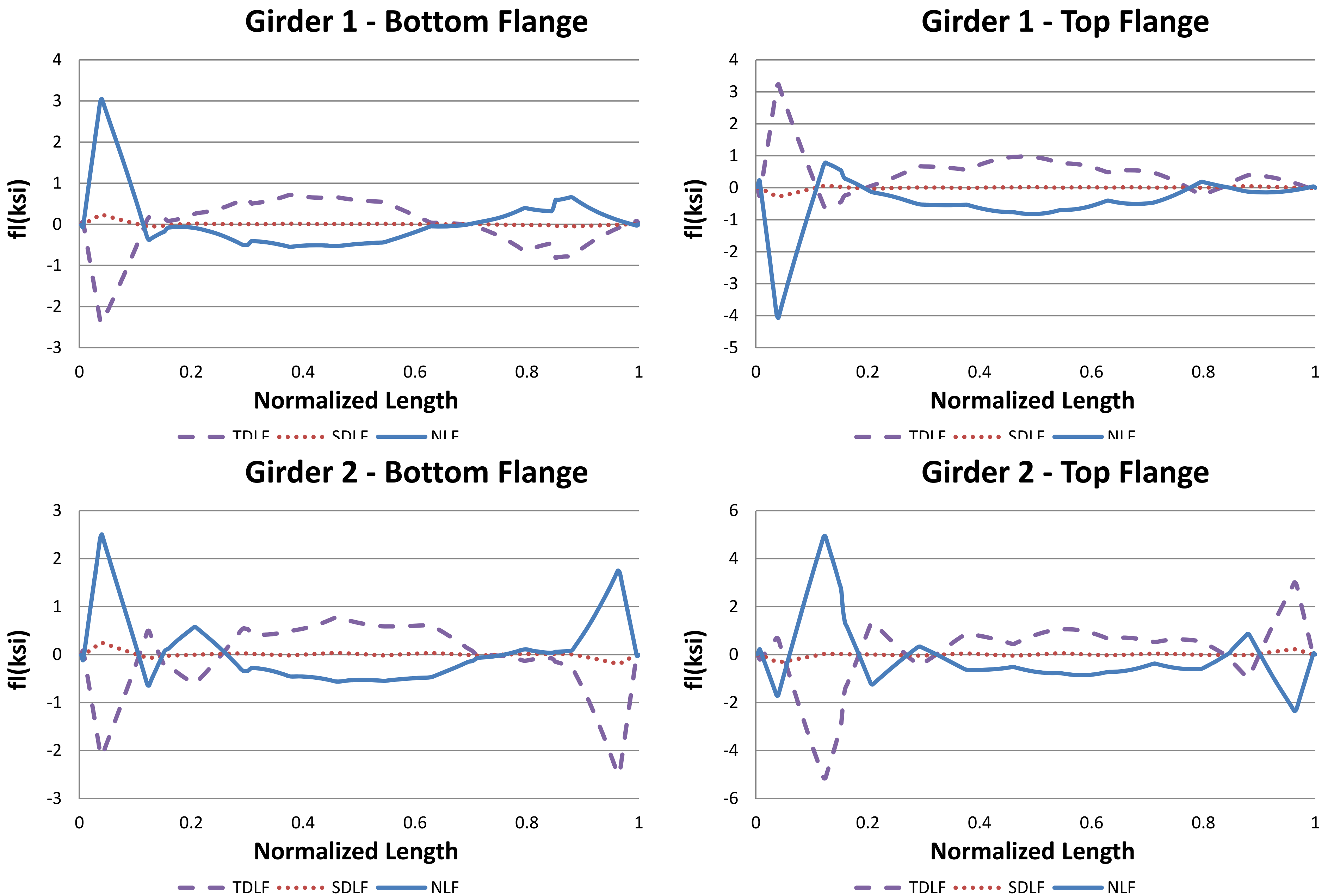


Figure J2-4-20. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

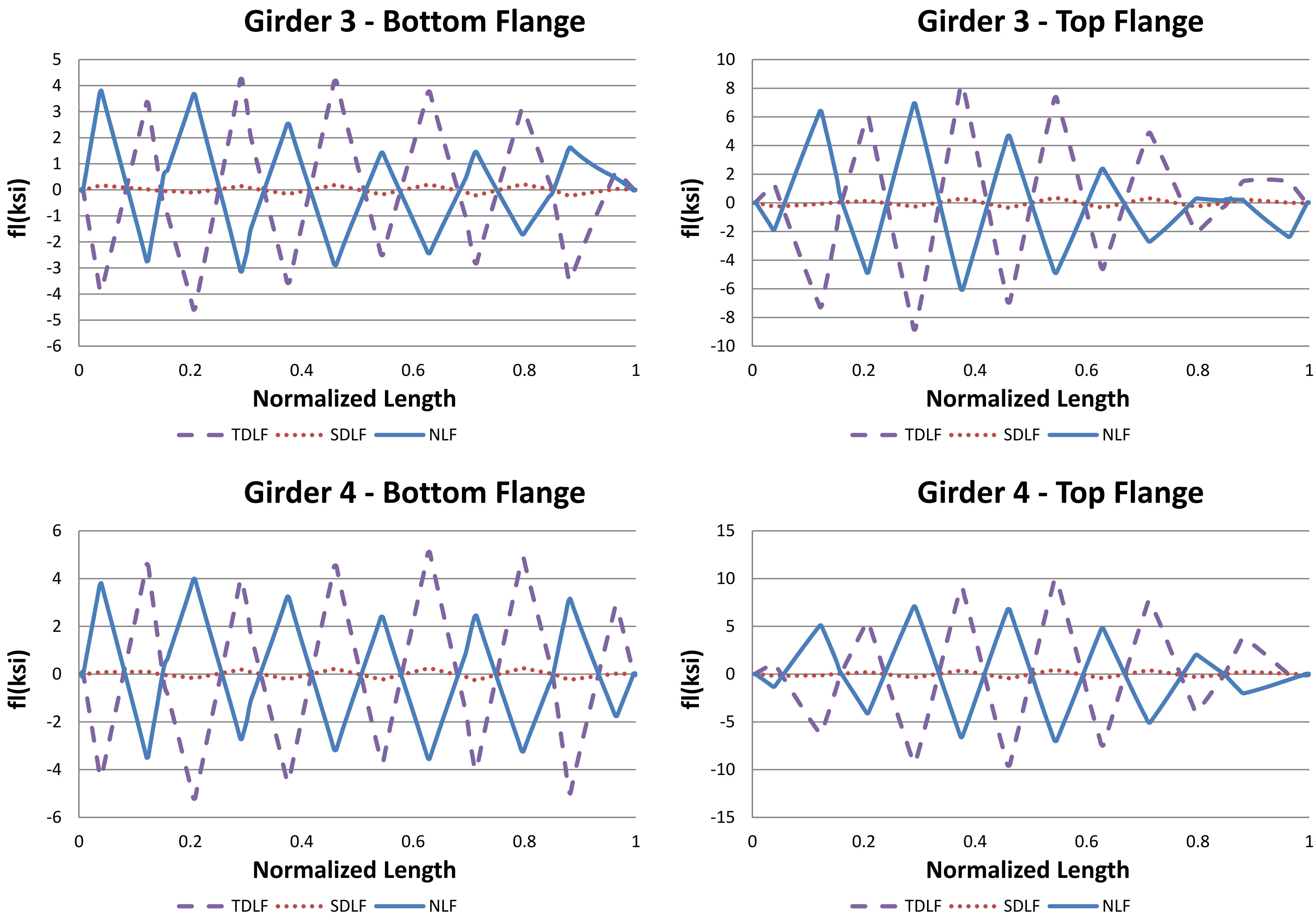


Figure J2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

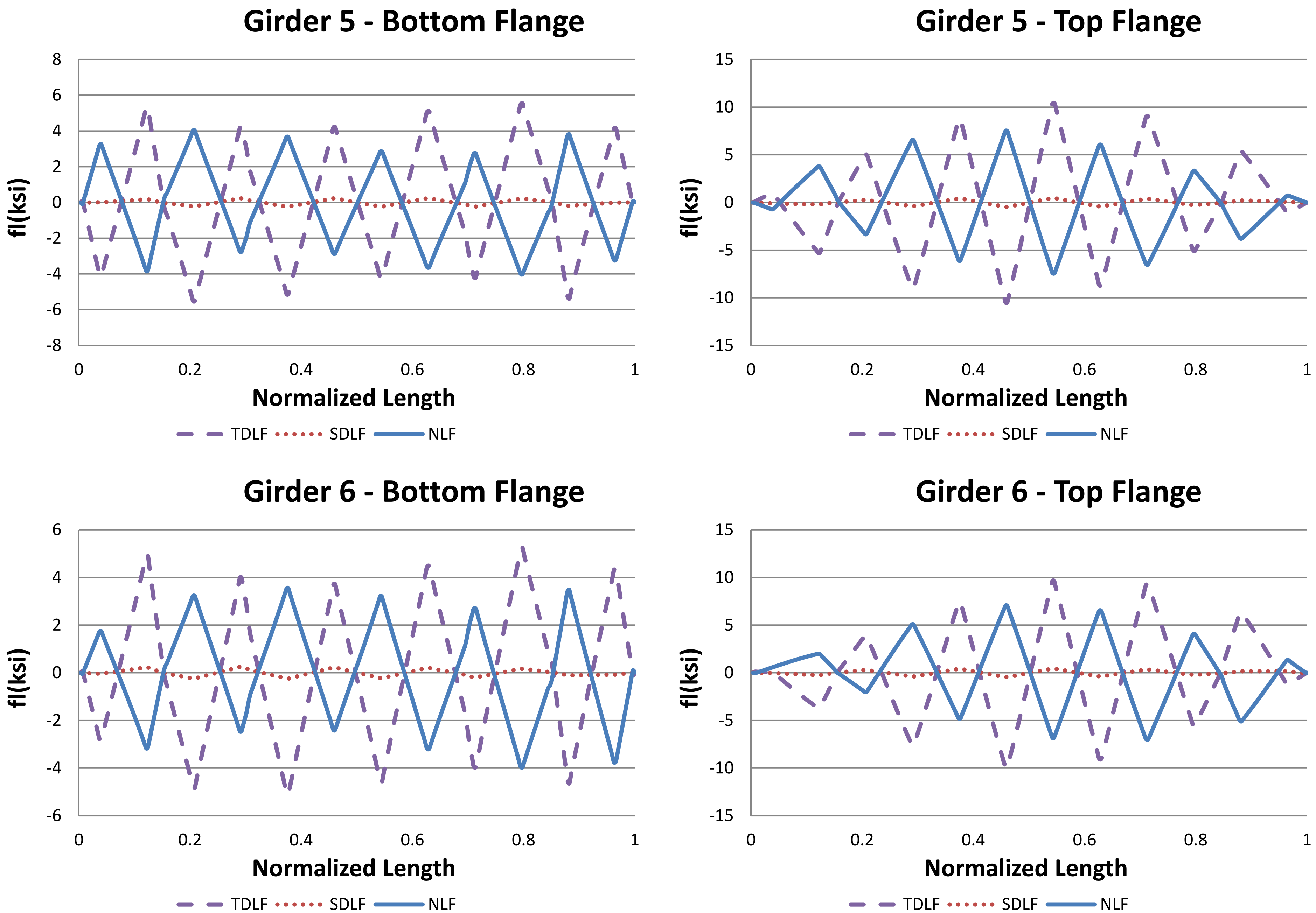


Figure J2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

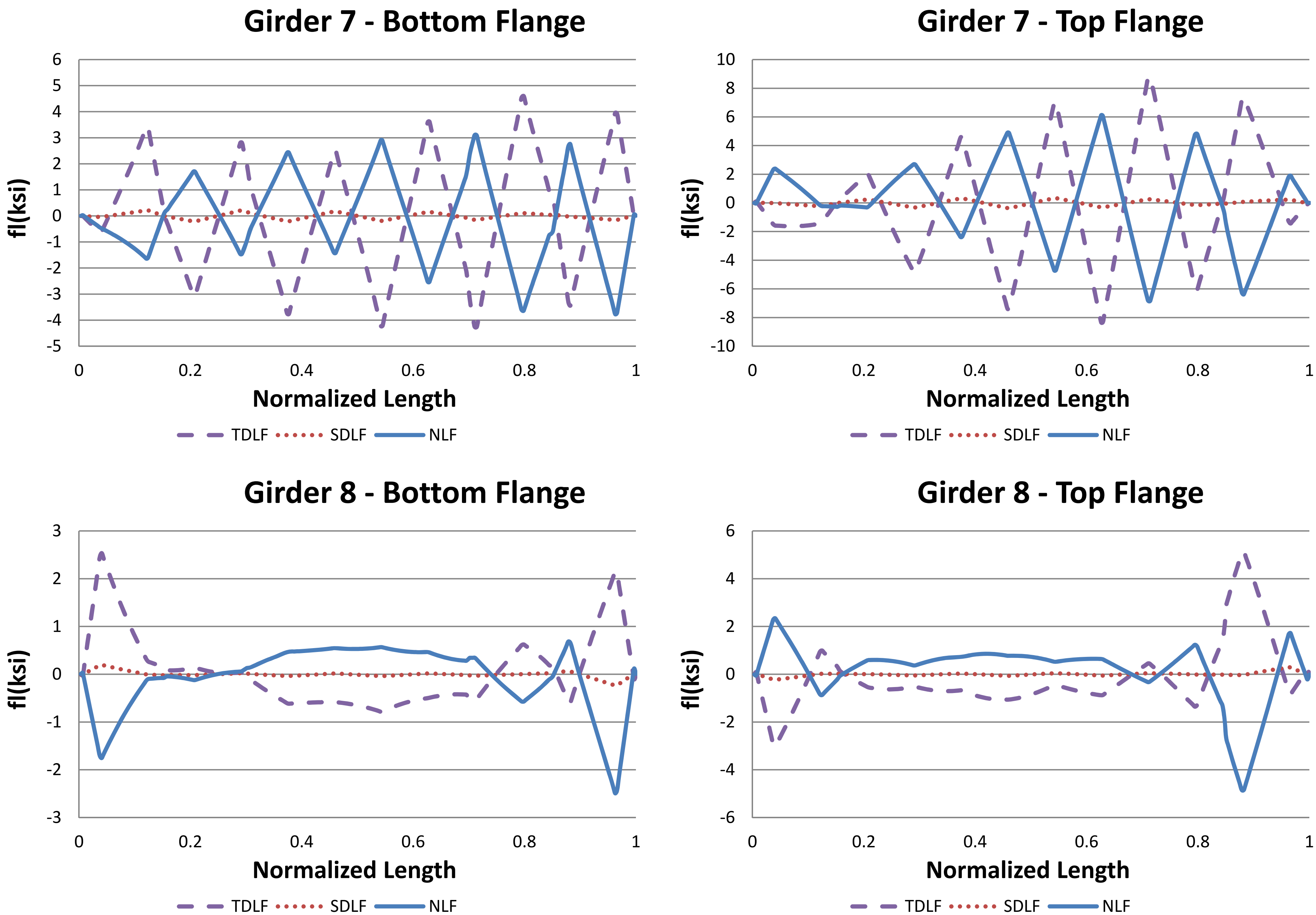
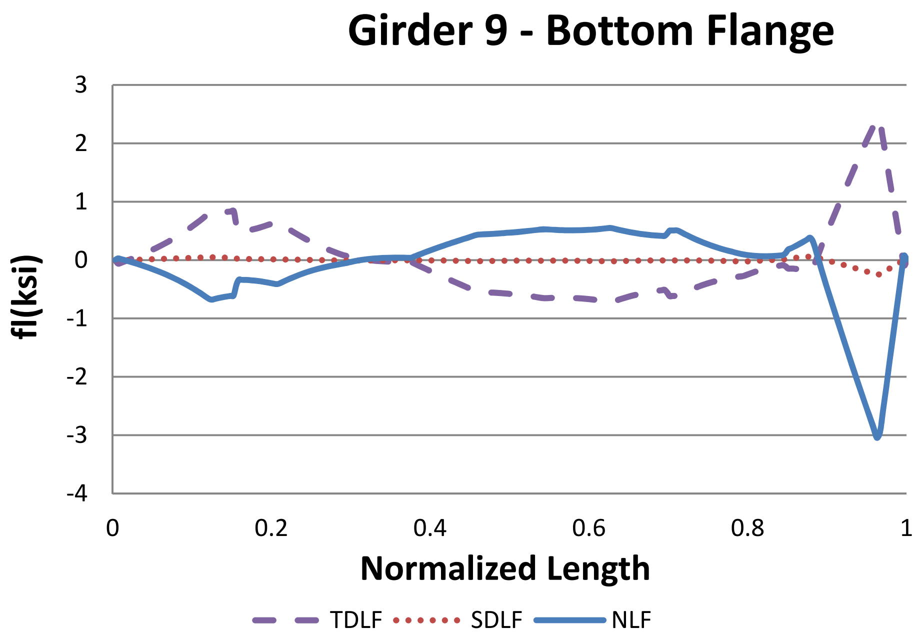


Figure J2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.



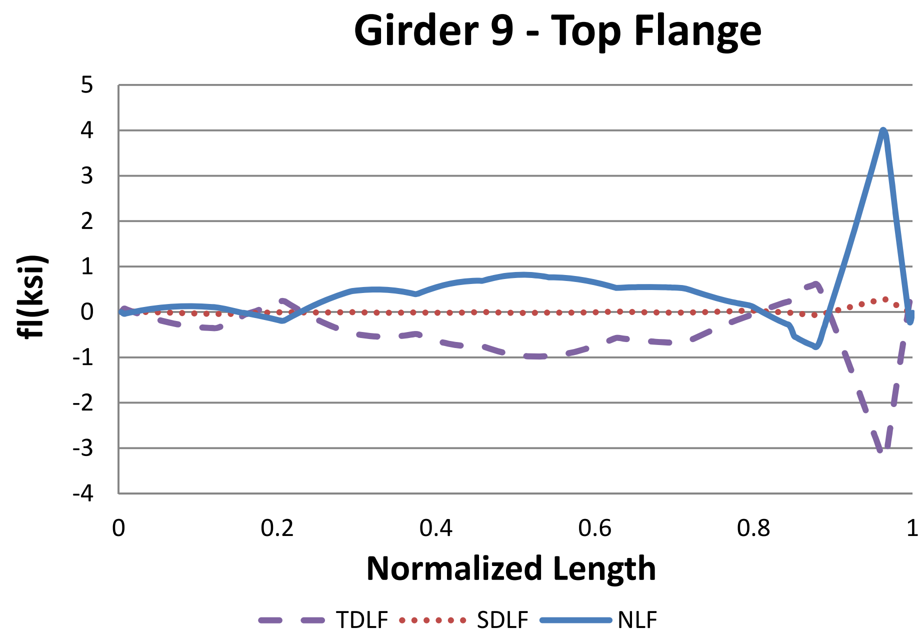


Figure J2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

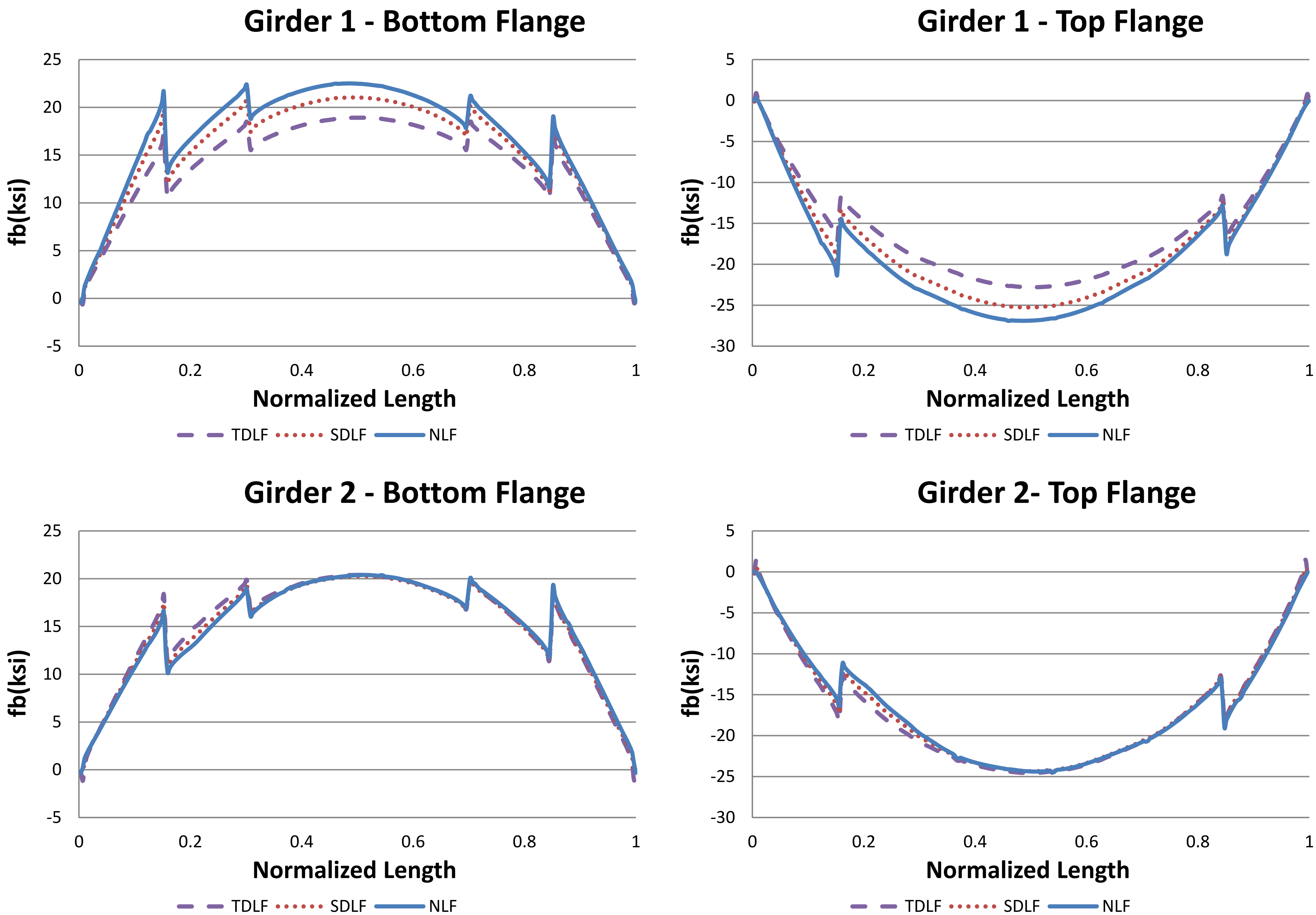


Figure J2-4-21. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

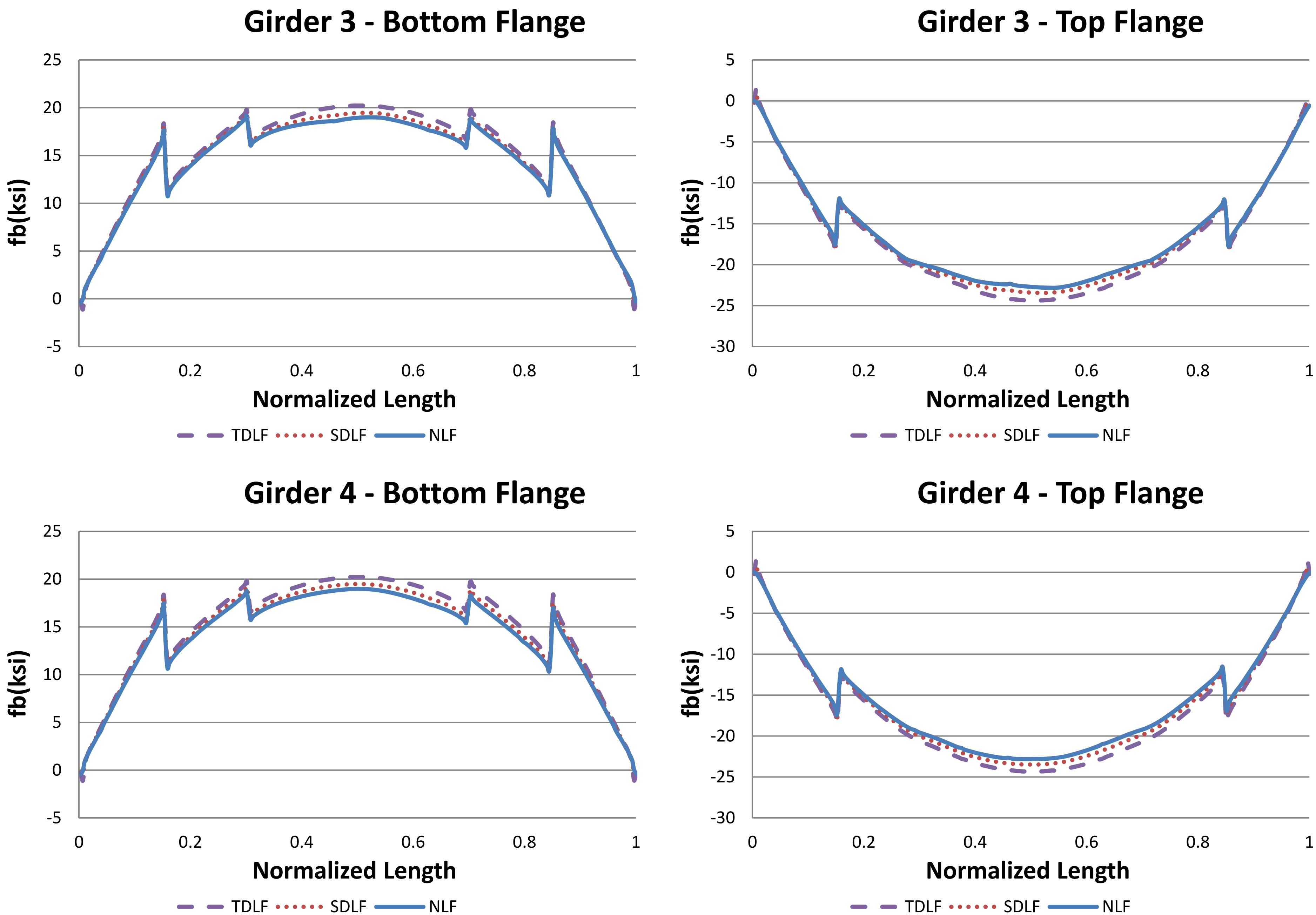


Figure J2-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

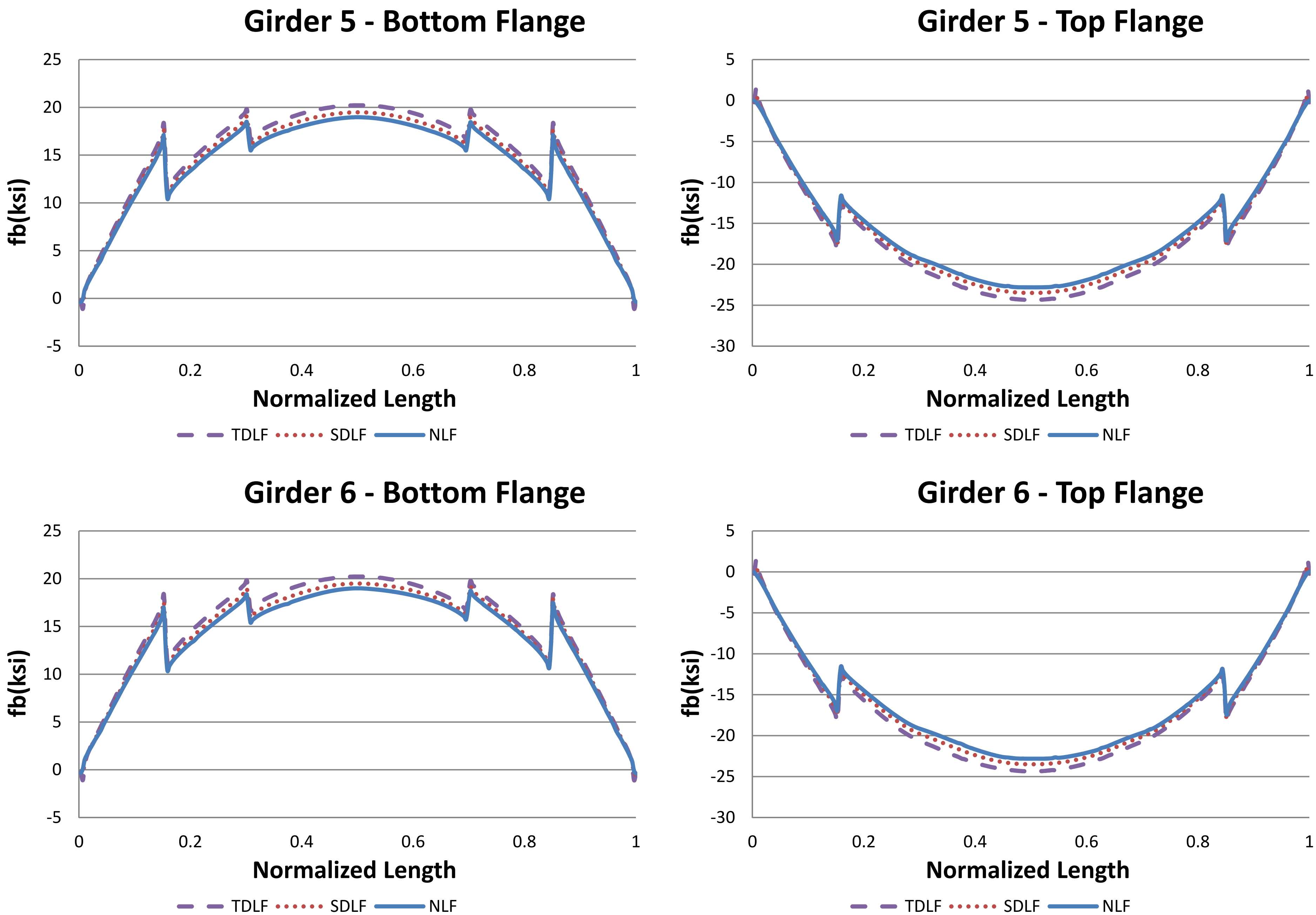


Figure J2-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

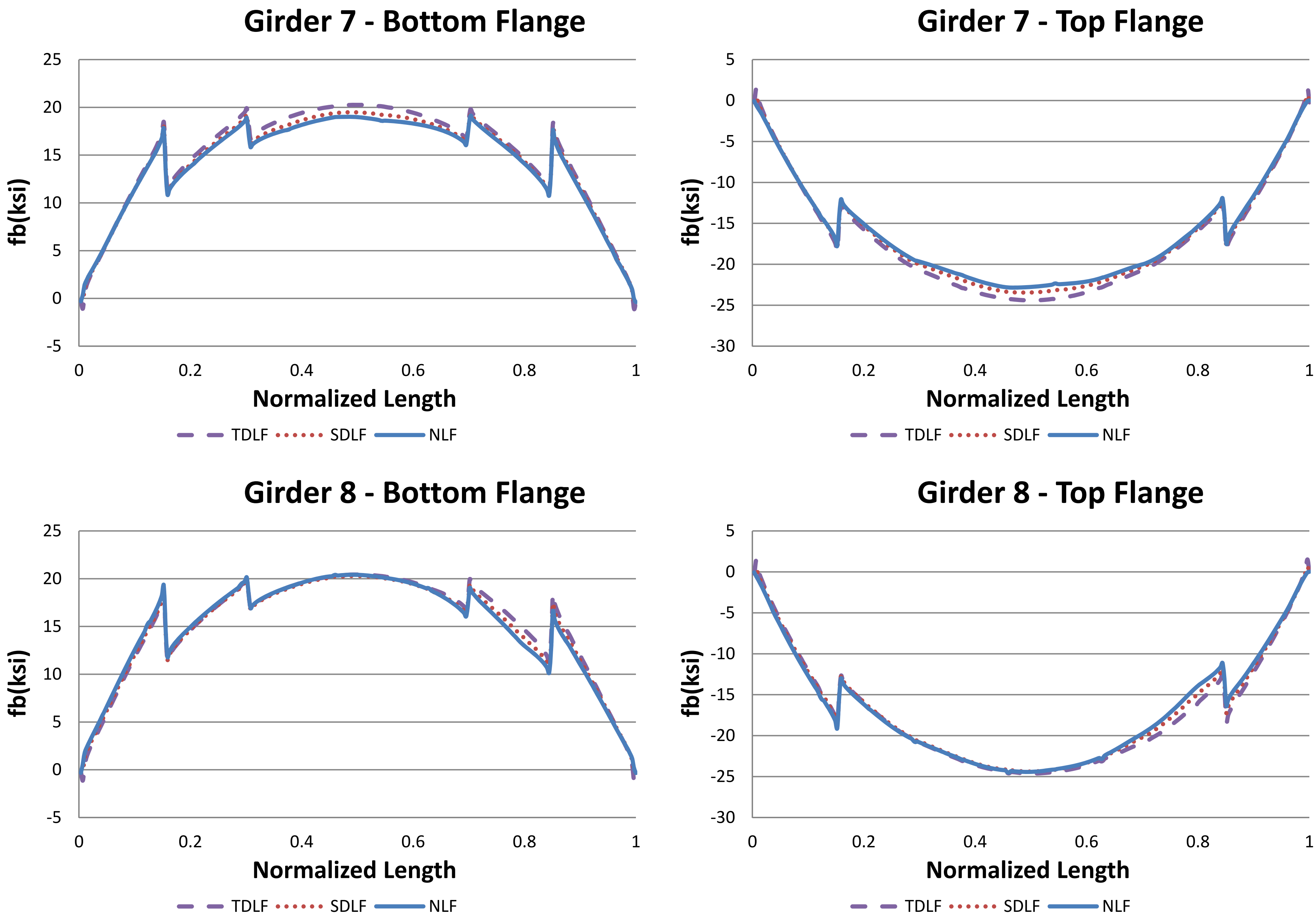


Figure J2-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

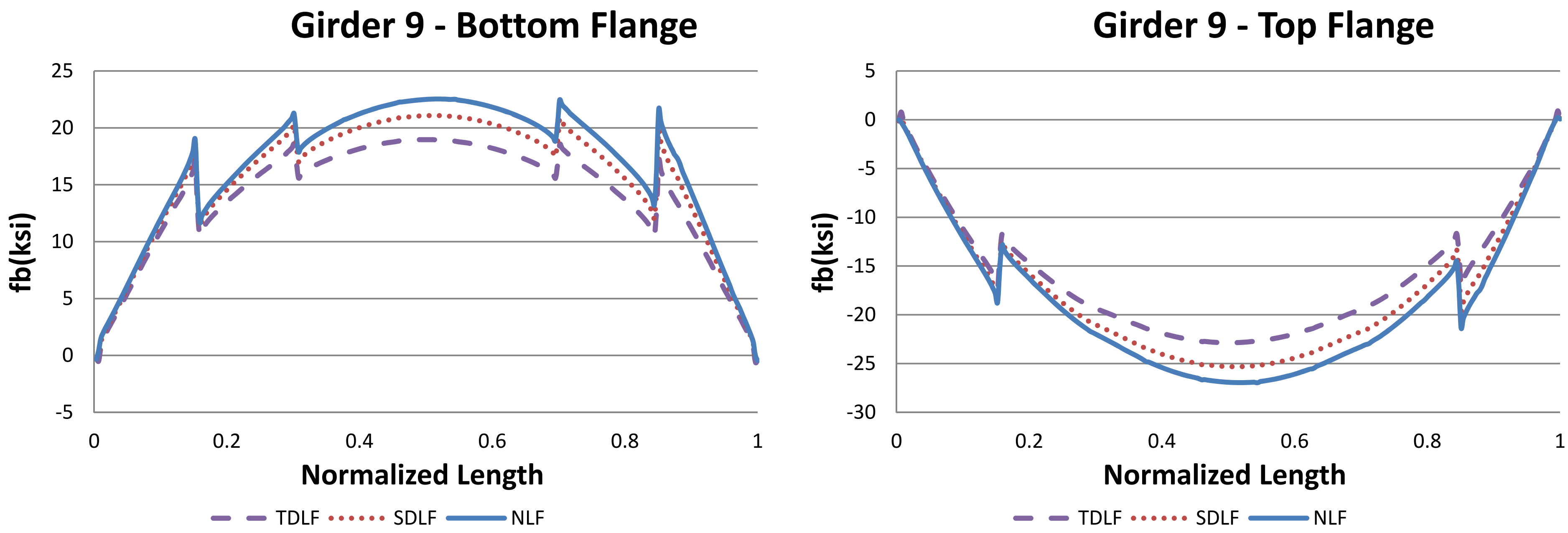


Figure J2-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

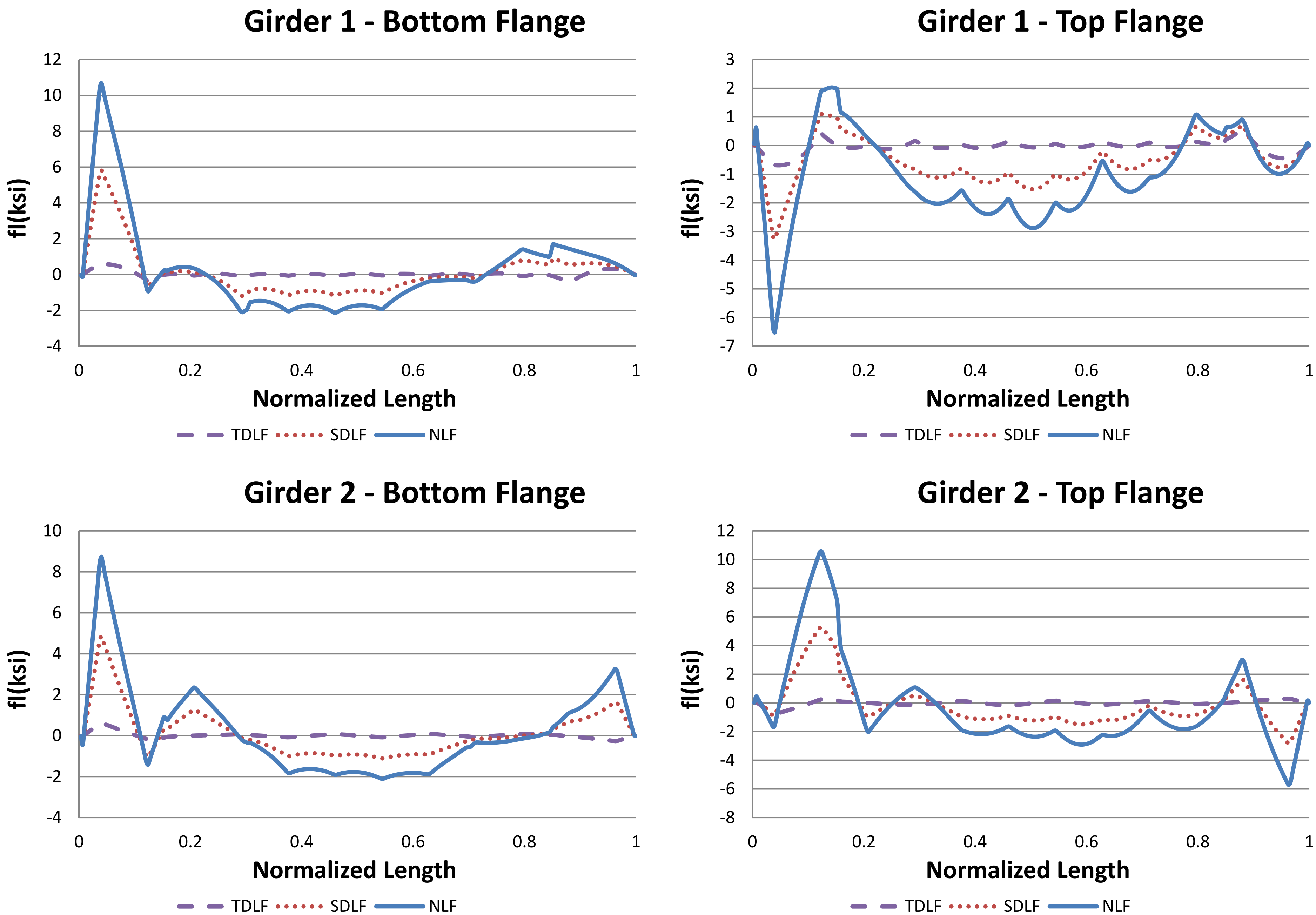


Figure J2-4-22. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

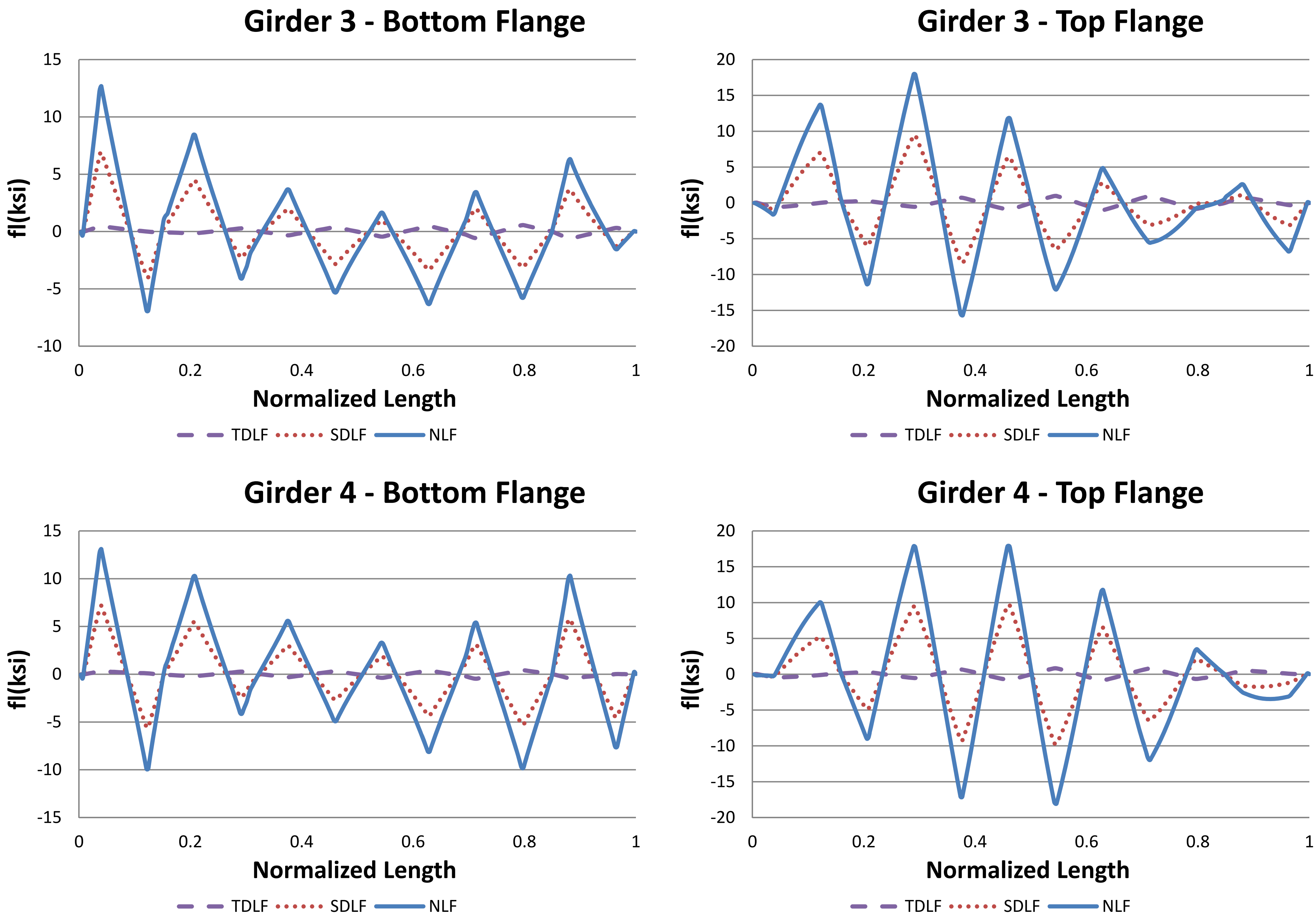


Figure J2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

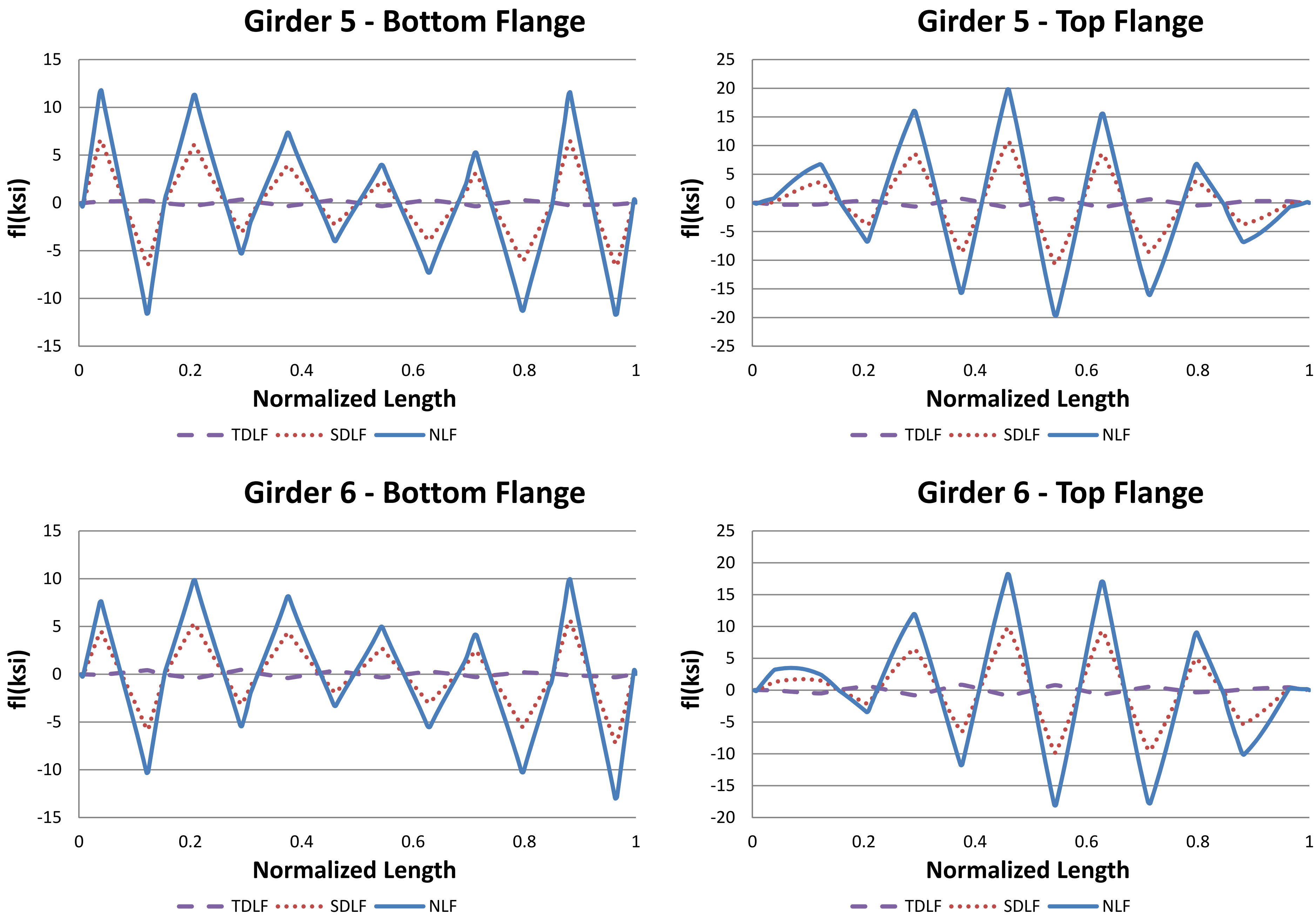


Figure J2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

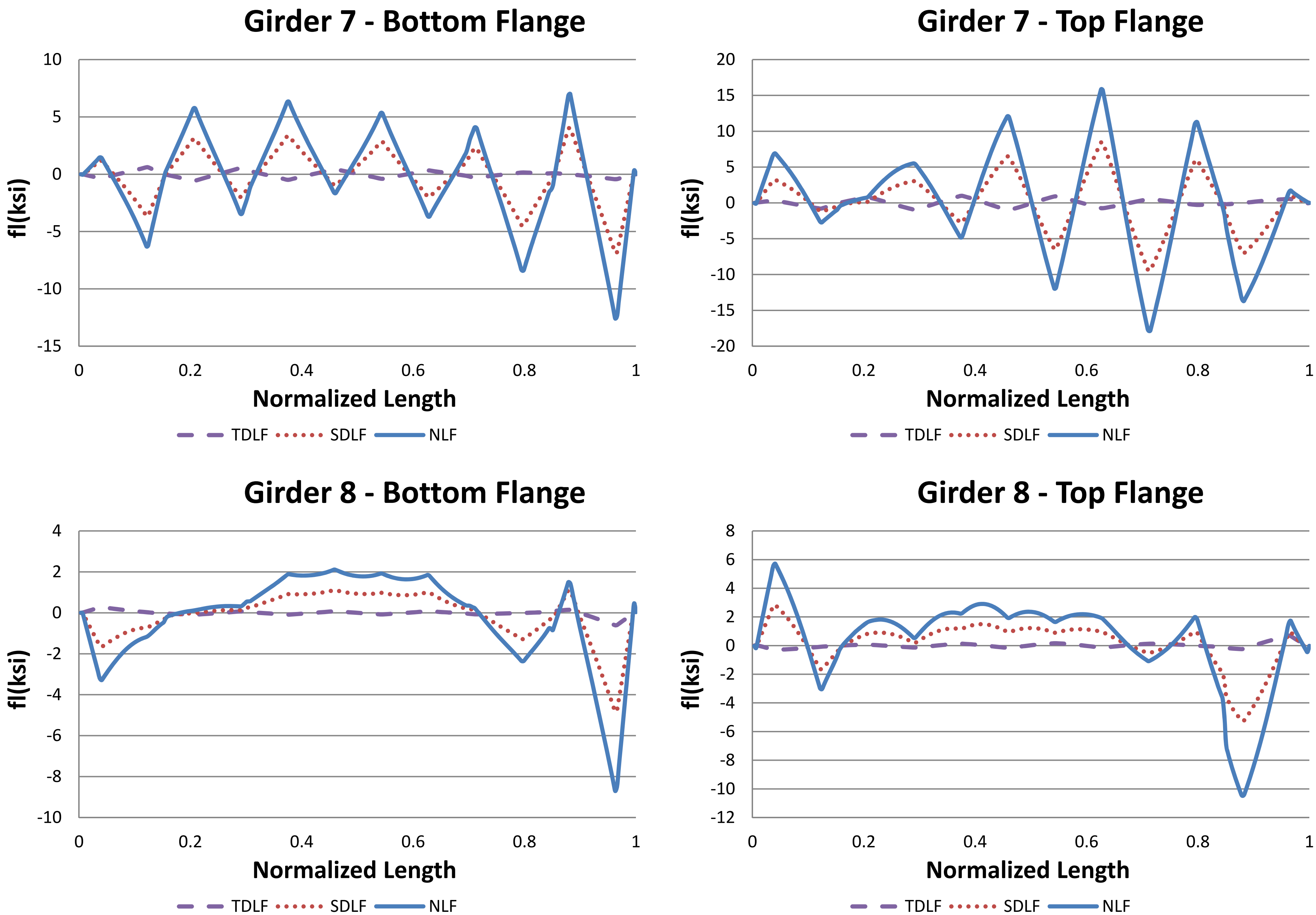
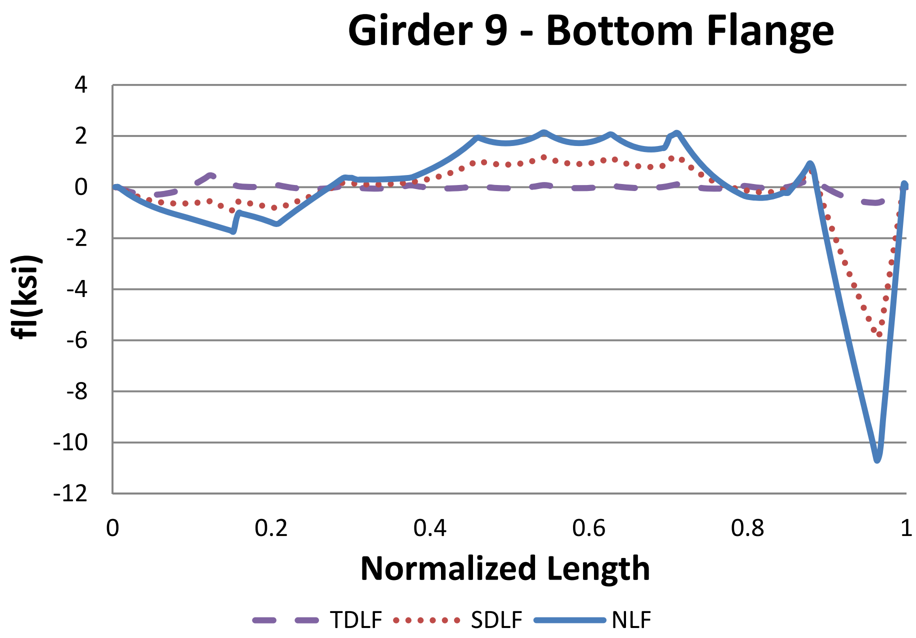


Figure J2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.



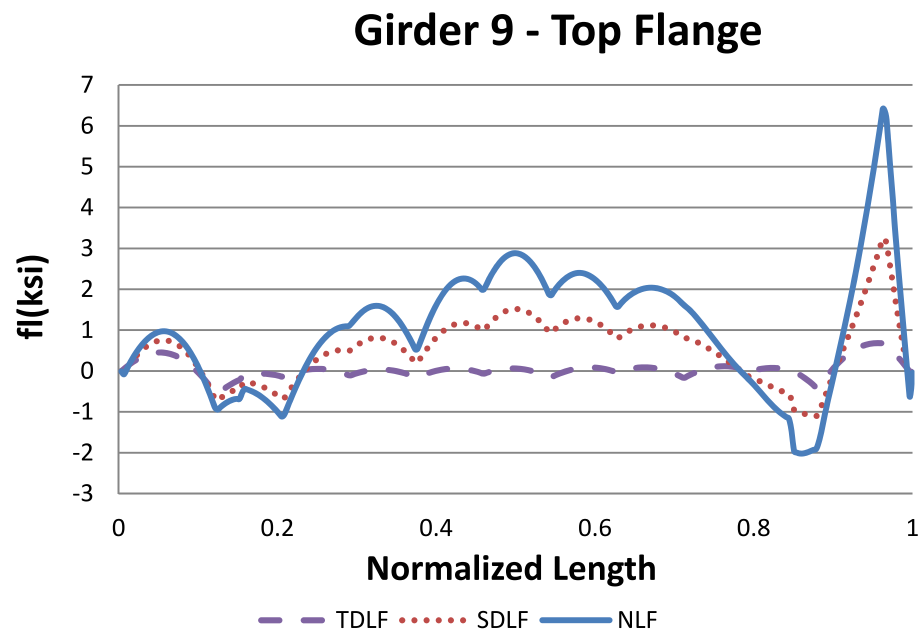


Figure J2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

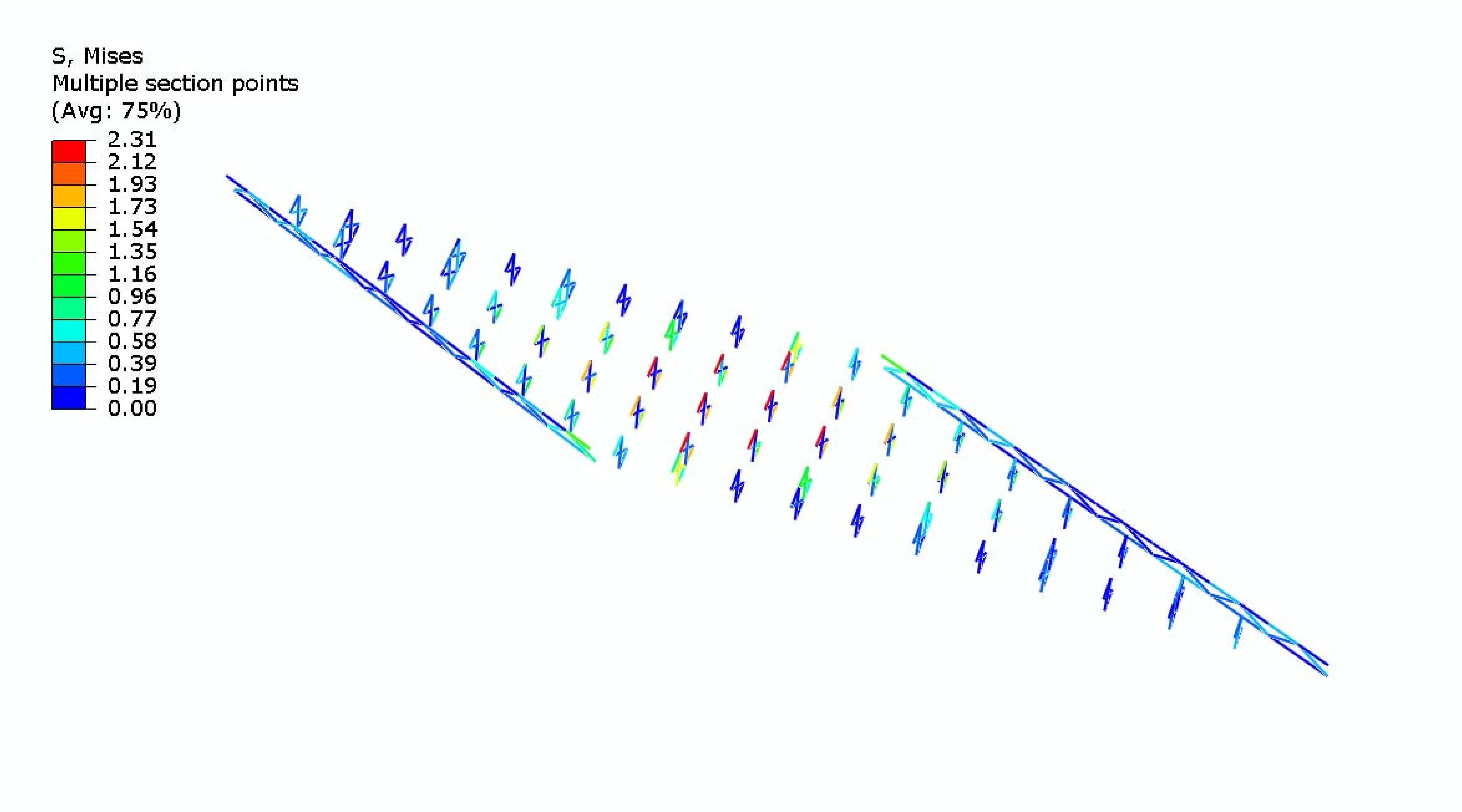


Figure J2-4-23. Cross-frame stress contours (ksi) under SDL, NLF detailing (intermediate cross-frame member areas = 11.0 in^2, end cross-frame bottom chord area = 11.2 in^2, end cross-frame top chord area = 15.6 in^2, end cross-frame diagonal area = 17.6 in^2).

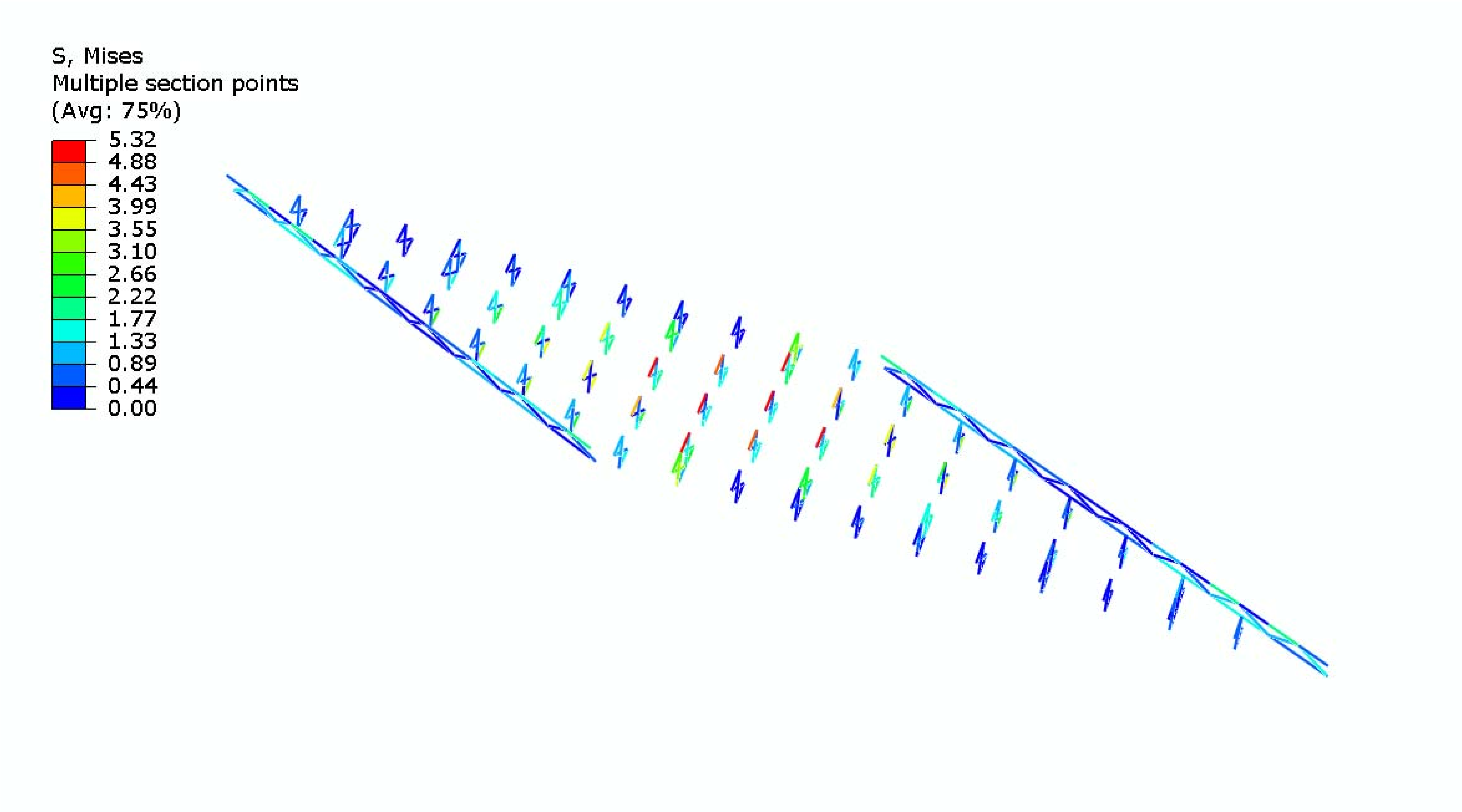


Figure J2-4-24. Cross-frame stress contours under TDL, NLF detailing (intermediate cross-frame member areas = 11.0 in^2, end cross-frame bottom chord area = 11.2 in^2, end cross-frame top chord area = 15.6 in^2, end cross-frame diagonal area = 17.6 in^2).

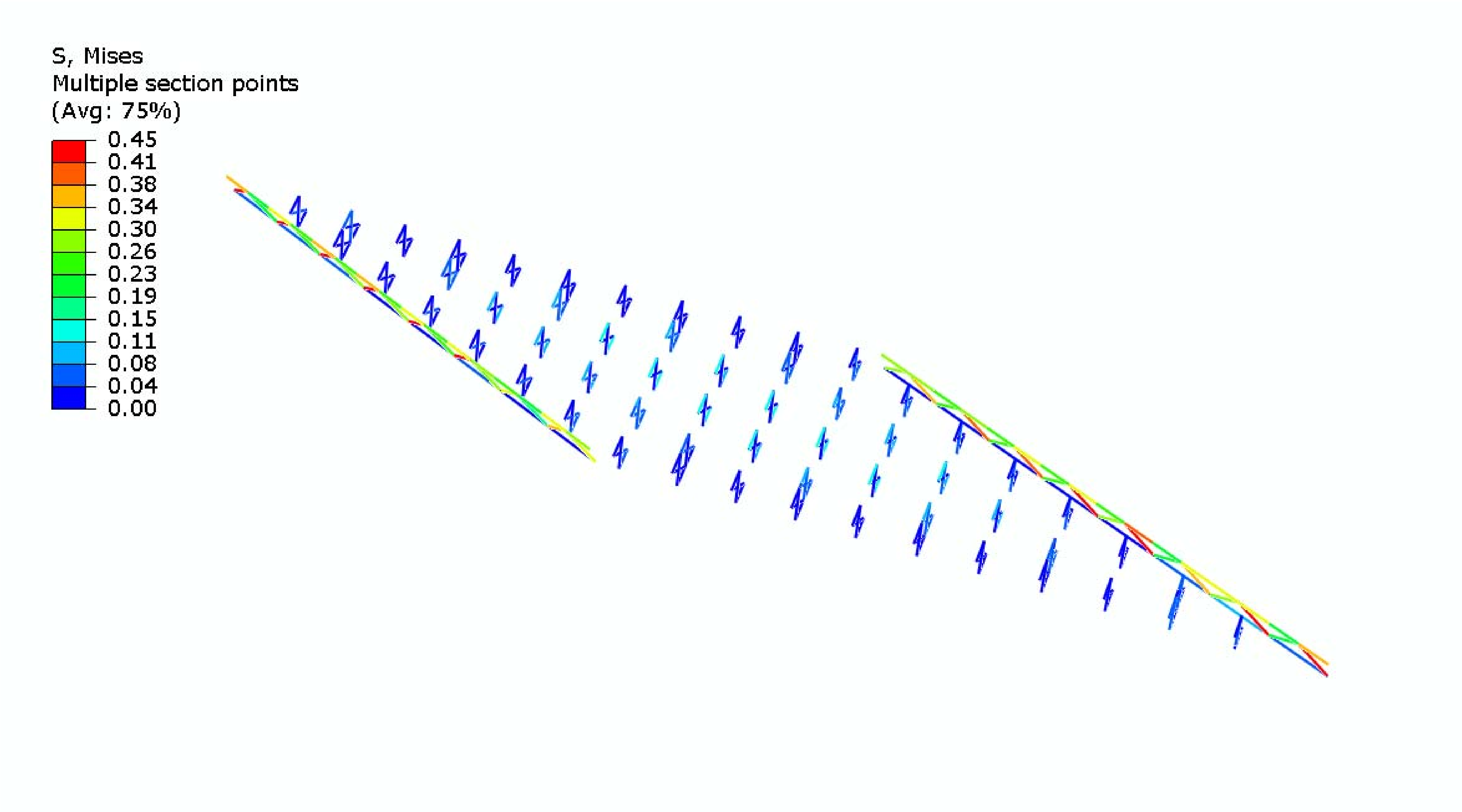


Figure J2-4-25. **Cross-frame stress contours under SDL, SDLF detailing (intermediate cross-frame member areas = 11.0 in^2, end cross-frame bottom chord area = 11.2 in^2, end cross-frame top chord area = 15.6 in^2, end cross-frame diagonal area = 17.6 in^2).**

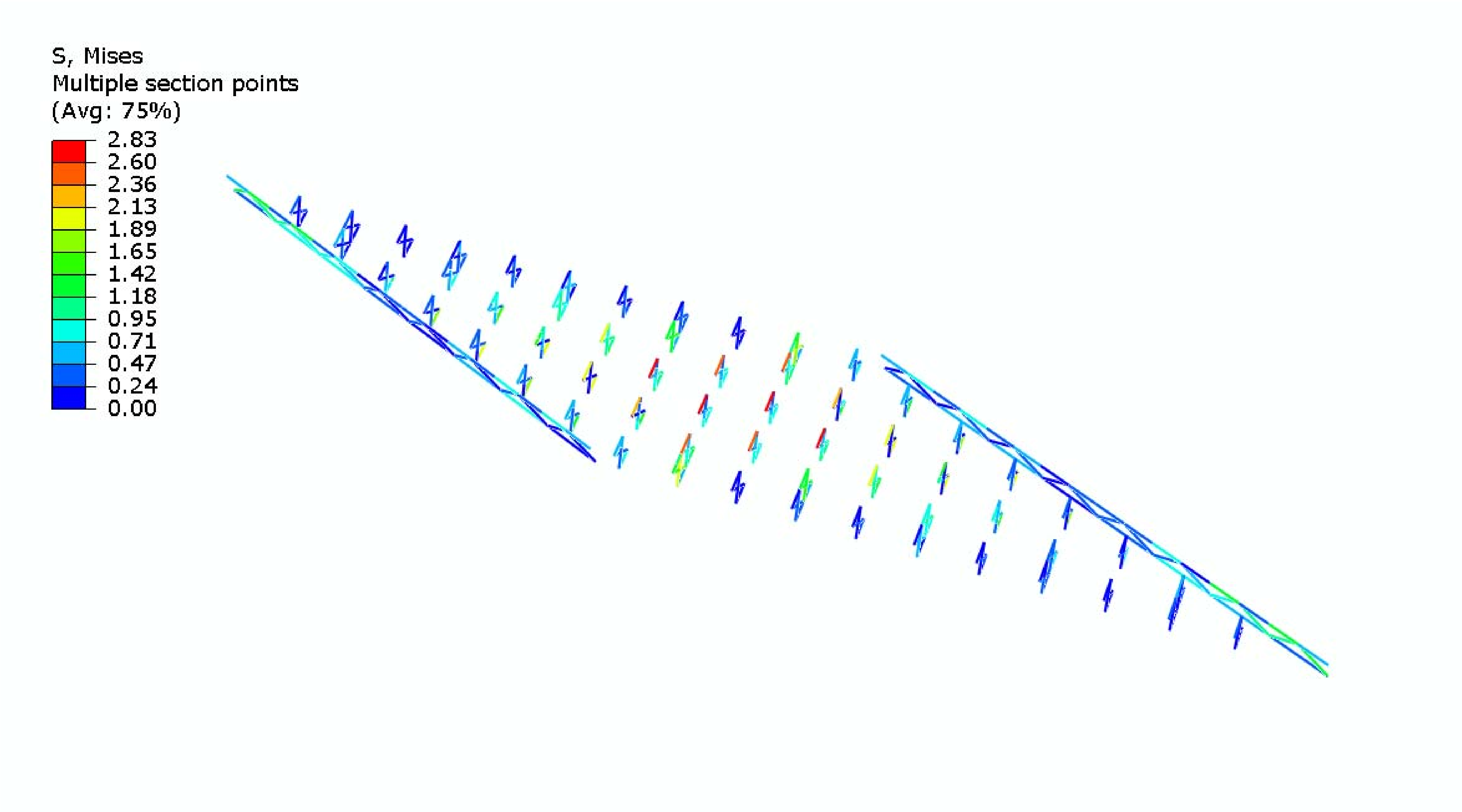


Figure J2-4-26. **Cross-frame stress contours under TDL, SDLF detailing (intermediate cross-frame member areas = 11.0 in^2, end cross-frame bottom chord area = 11.2 in^2, end cross-frame top chord area = 15.6 in^2, end cross-frame diagonal area = 17.6 in^2).**

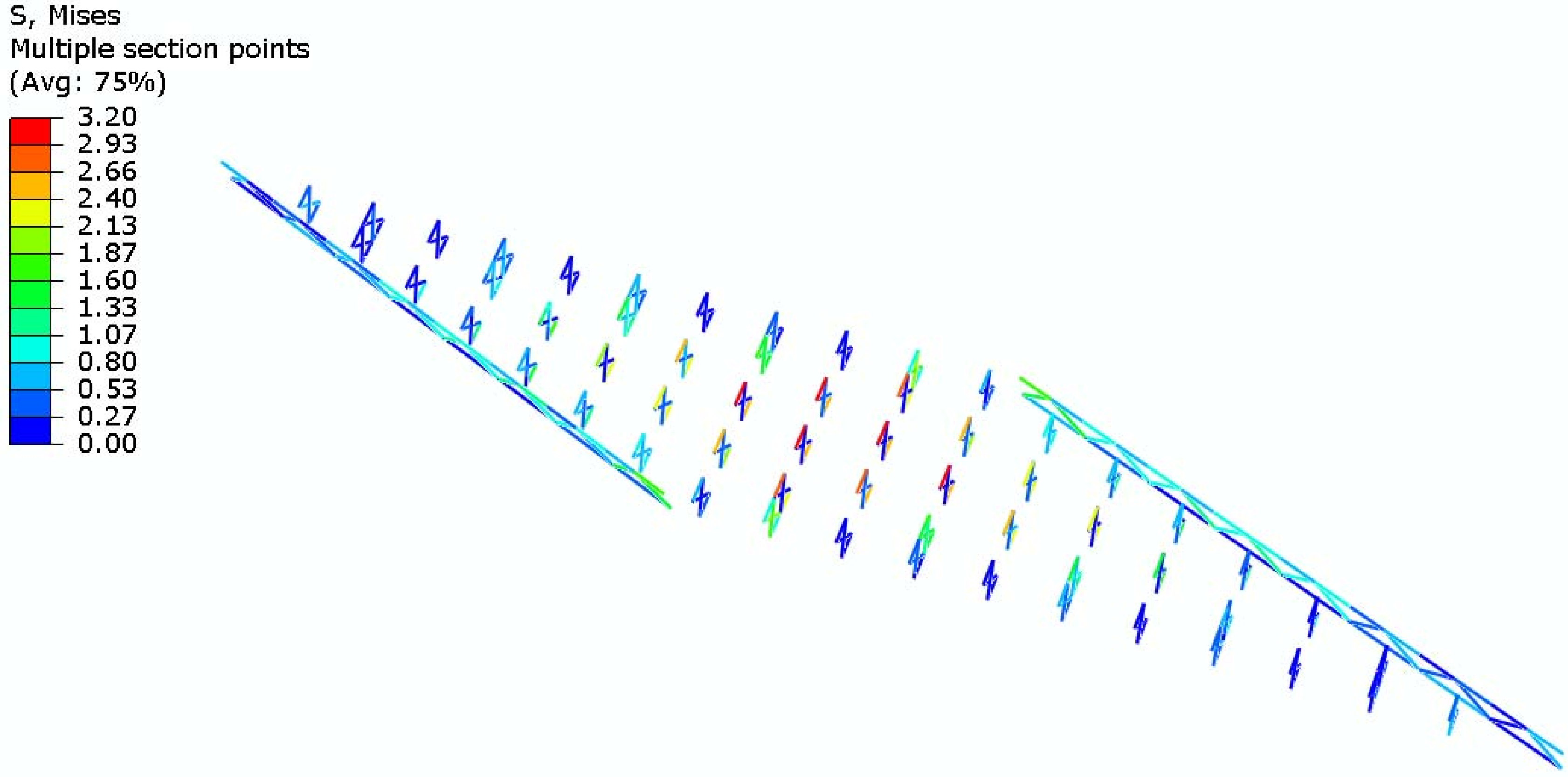


Figure J2-4-27. Cross-frame stress contours under SDL, TDLF detailing (intermediate cross-frame member areas = 11.0 in^2, end cross-frame bottom chord area = 11.2 in^2, end cross-frame top chord area = 15.6 in^2, end cross-frame diagonal area = 17.6 in^2).

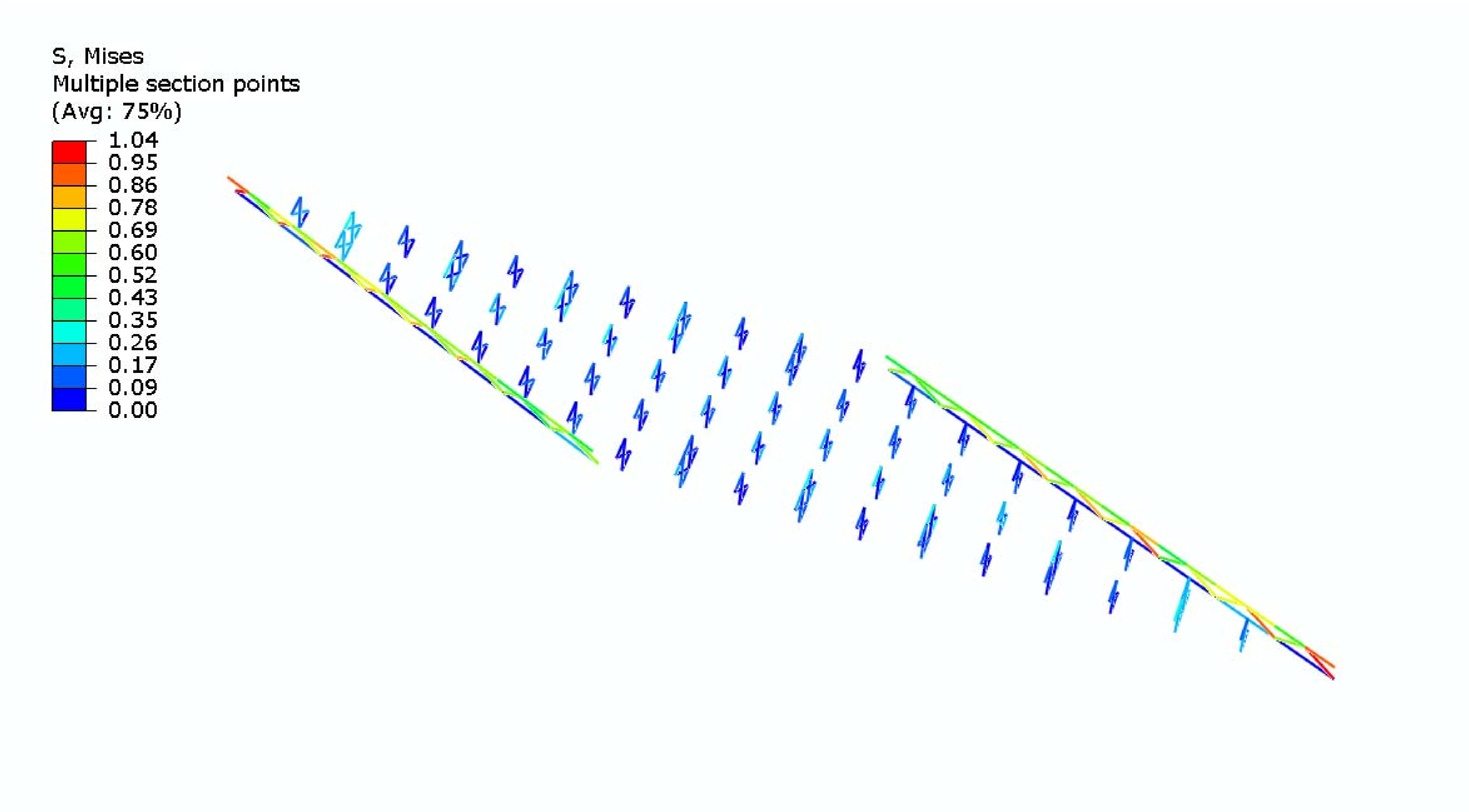


Figure J2-4-28. Cross-frame stress contours under TDL, TDLF detailing (intermediate cross-frame member areas = 11.0 in^2, end cross-frame bottom chord area = 11.2 in^2, end cross-frame top chord area = 15.6 in^2, end cross-frame diagonal area = 17.6 in^2).

Table J2-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	13.7	6.3	7.4	5.7	2.9	5.1	8.7	7.6
	SDLF	6.6	6.0	7.4	7.3	7.5	7.6	7.4	7.9
	TDLF	25.8	14.6	20.5	19.5	17.7	13.3	7.5	9.5
2	NLF	3.0	4.1	2.0	1.9	1.4	2.4	2.3	4.6
	SDLF	0.4	0.7	0.7	0.7	0.6	0.4	0.4	0.5
	TDLF	1.6	7.1	4.9	4.8	3.0	1.7	1.7	6.2
3	NLF	18.9	3.6	1.9	2.1	0.8	3.6	1.7	2.6
	SDLF	0.2	0.6	0.6	0.5	0.4	0.1	0.6	0.7
	TDLF	21.0	1.6	4.3	4.5	2.4	3.6	4.6	3.7
4	NLF	1.6	12.5	2.6	0.7	1.6	5.2	6.4	1.3
	SDLF	0.3	0.7	0.3	0.2	0.0	0.2	0.7	0.2
	TDLF	2.7	15.9	4.1	1.5	1.5	6.4	9.6	1.3
5	NLF	2.6	6.4	5.2	1.6	0.7	2.6	12.5	4.5
	SDLF	0.3	0.7	0.2	0.0	0.2	0.3	0.7	0.2
	TDLF	5.4	9.6	6.5	1.5	1.4	4.1	16.0	6.7
6	NLF	2.0	1.7	3.6	0.8	2.2	1.9	3.6	1.7
	SDLF	0.2	0.7	0.1	0.4	0.5	0.6	0.6	0.2
	TDLF	2.8	4.7	3.6	2.4	4.4	4.3	1.7	2.3
7	NLF	5.4	2.3	2.4	1.4	1.9	1.9	4.1	5.4
	SDLF	0.3	0.6	0.5	0.6	0.7	0.7	0.7	0.3
	TDLF	8.4	1.9	1.7	3.0	4.7	4.7	7.1	8.4
8	NLF	1.7	9.0	4.6	2.5	5.6	6.9	7.4	2.0
	SDLF	0.2	7.8	6.6	8.0	7.4	7.1	6.9	0.2
	TDLF	2.3	8.5	11.5	18.7	19.6	19.5	17.5	2.8
9	NLF	4.5	NA	NA	NA	NA	NA	NA	2.5
	SDLF	0.2	NA	NA	NA	NA	NA	NA	0.3
	TDLF	6.7	NA	NA	NA	NA	NA	NA	5.3
10	NLF	1.3	NA	NA	NA	NA	NA	NA	1.6
	SDLF	0.1	NA	NA	NA	NA	NA	NA	0.3
	TDLF	1.2	NA	NA	NA	NA	NA	NA	2.7

Table J2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	2.6	NA	NA	NA	NA	NA	NA	18.8
	SDLF	0.8	NA	NA	NA	NA	NA	NA	0.2
	TDLF	4.0	NA	NA	NA	NA	NA	NA	21.2
12	NLF	4.6	NA	NA	NA	NA	NA	NA	3.0
	SDLF	0.5	NA	NA	NA	NA	NA	NA	0.5
	TDLF	6.1	NA	NA	NA	NA	NA	NA	1.6
13	NLF	7.3	NA	NA	NA	NA	NA	NA	13.4
	SDLF	7.9	NA	NA	NA	NA	NA	NA	6.2
	TDLF	9.7	NA	NA	NA	NA	NA	NA	25.4

Table J2-4-2. Axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	9.4	5.7	7.4	6.4	2.1	13.4	21.5	26.6
	SDLF	2.9	5.0	4.9	4.7	7.2	13.1	18.2	21.8
	TDLF	11.9	11.3	14.7	14.4	15.0	15.8	15.6	18.1
2	NLF	9.0	8.0	4.3	5.1	6.9	9.1	8.3	7.5
	SDLF	4.3	4.0	2.2	2.6	3.5	4.9	4.6	2.6
	TDLF	0.4	1.7	1.6	1.6	1.7	1.6	2.7	2.6
3	NLF	40.7	12.4	1.2	1.1	6.8	14.0	10.4	5.4
	SDLF	22.4	6.2	1.2	0.6	3.2	7.3	5.8	1.7
	TDLF	1.0	0.6	1.0	1.1	1.2	1.2	0.5	2.7
4	NLF	3.1	29.5	6.6	2.1	6.9	16.1	21.3	2.1
	SDLF	1.9	16.4	4.0	1.2	3.8	8.4	11.3	1.2
	TDLF	1.0	0.6	0.2	0.4	0.4	0.5	0.4	1.1
5	NLF	5.0	21.3	16.1	6.9	2.1	6.6	29.6	10.9
	SDLF	3.1	11.3	8.4	3.9	1.2	4.0	16.4	5.9
	TDLF	1.1	0.4	0.5	0.4	0.3	0.2	0.6	0.7
6	NLF	8.4	10.5	14.0	6.8	1.1	1.2	12.4	8.7
	SDLF	4.5	5.9	7.3	3.2	0.6	1.2	6.2	4.5
	TDLF	0.8	0.6	1.2	1.2	1.1	1.0	0.6	0.8
7	NLF	12.8	8.3	9.2	6.9	5.1	4.2	8.0	12.8
	SDLF	6.8	4.7	5.0	3.5	2.6	2.2	4.0	6.9
	TDLF	1.1	2.9	1.7	1.7	1.6	1.5	1.7	1.0
8	NLF	8.7	22.2	11.5	2.9	6.3	7.1	6.8	8.5
	SDLF	4.5	18.8	11.1	7.9	4.7	4.5	5.6	4.5
	TDLF	0.8	16.6	13.4	16.0	14.4	13.9	13.4	0.8
9	NLF	10.9	NA	NA	NA	NA	NA	NA	5.0
	SDLF	5.9	NA	NA	NA	NA	NA	NA	3.1
	TDLF	0.7	NA	NA	NA	NA	NA	NA	1.1
10	NLF	2.2	NA	NA	NA	NA	NA	NA	3.2
	SDLF	1.3	NA	NA	NA	NA	NA	NA	1.9
	TDLF	1.1	NA	NA	NA	NA	NA	NA	1.0

Table J2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	5.2	NA	NA	NA	NA	NA	NA	40.8
	SDLF	1.6	NA	NA	NA	NA	NA	NA	22.6
	TDLF	2.8	NA	NA	NA	NA	NA	NA	1.0
12	NLF	7.4	NA	NA	NA	NA	NA	NA	8.9
	SDLF	2.5	NA	NA	NA	NA	NA	NA	4.4
	TDLF	2.6	NA	NA	NA	NA	NA	NA	0.4
13	NLF	26.0	NA	NA	NA	NA	NA	NA	9.4
	SDLF	21.6	NA	NA	NA	NA	NA	NA	2.2
	TDLF	18.2	NA	NA	NA	NA	NA	NA	11.2

Table J2-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	4.5	3.6	2.0	0.5	2.5	4.8	3.4	0.8
	SDLF	0.1	0.2	0.5	0.2	0.4	0.5	0.8	0.7
	TDLF	4.9	5.0	2.0	0.7	2.9	5.8	6.5	1.0
2	NLF	6.0	9.2	11.9	12.0	9.8	4.8	1.9	2.2
	SDLF	0.5	0.4	0.1	0.1	0.3	0.4	0.4	0.3
	TDLF	4.8	9.7	13.9	15.2	14.0	9.2	3.1	3.1
3	NLF	8.0	20.2	16.8	17.3	16.2	11.3	5.9	0.7
	SDLF	0.1	0.4	0.7	1.0	1.1	1.1	0.6	0.3
	TDLF	10.8	25.0	22.5	24.3	24.0	18.8	10.7	2.7
4	NLF	0.5	8.3	18.3	19.7	19.4	15.6	8.1	0.6
	SDLF	0.0	0.8	1.2	1.4	1.5	1.4	0.8	0.0
	TDLF	0.4	14.4	26.5	28.5	28.7	24.3	14.1	0.8
5	NLF	0.0	8.1	15.6	19.4	19.7	18.3	8.3	2.4
	SDLF	0.1	0.8	1.4	1.5	1.4	1.3	0.8	0.0
	TDLF	1.7	14.2	24.4	28.7	28.6	26.6	14.4	3.6
6	NLF	0.7	5.9	11.3	16.2	17.3	16.8	20.2	0.7
	SDLF	0.1	0.6	1.1	1.2	1.0	0.8	0.4	0.1
	TDLF	0.5	10.8	18.9	24.2	24.5	22.8	25.3	0.5
7	NLF	1.8	1.9	4.9	9.8	12.0	11.9	9.2	1.9
	SDLF	0.1	0.4	0.3	0.3	0.1	0.1	0.4	0.1
	TDLF	3.7	3.5	9.3	14.1	15.4	14.1	9.9	3.7
8	NLF	0.7	2.9	4.7	2.7	0.4	2.1	3.2	0.7
	SDLF	0.1	1.2	0.5	0.0	0.2	0.2	0.2	0.1
	TDLF	0.5	7.2	5.8	2.3	0.5	2.6	4.5	0.5
9	NLF	2.4	NA	NA	NA	NA	NA	NA	0.1
	SDLF	0.0	NA	NA	NA	NA	NA	NA	0.1
	TDLF	3.6	NA	NA	NA	NA	NA	NA	1.7
10	NLF	0.6	NA	NA	NA	NA	NA	NA	0.5
	SDLF	0.0	NA	NA	NA	NA	NA	NA	0.0
	TDLF	0.8	NA	NA	NA	NA	NA	NA	0.5

Table J2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.7	NA	NA	NA	NA	NA	NA	8.0
	SDLF	0.4	NA	NA	NA	NA	NA	NA	0.2
	TDLF	2.9	NA	NA	NA	NA	NA	NA	10.9
12	NLF	2.2	NA	NA	NA	NA	NA	NA	6.1
	SDLF	0.3	NA	NA	NA	NA	NA	NA	0.5
	TDLF	3.1	NA	NA	NA	NA	NA	NA	5.0
13	NLF	1.1	NA	NA	NA	NA	NA	NA	5.3
	SDLF	0.7	NA	NA	NA	NA	NA	NA	0.1
	TDLF	1.4	NA	NA	NA	NA	NA	NA	6.5

Table J2-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.7	14.7	10.3	2.4	9.3	18.9	16.6	7.5
	SDLF	2.3	8.3	6.0	1.6	4.4	9.4	8.7	3.6
	TDLF	2.2	0.3	0.5	0.0	0.1	0.2	1.4	0.3
2	NLF	18.3	26.3	35.6	37.8	33.1	20.0	1.7	4.6
	SDLF	9.9	14.8	19.7	21.0	18.6	11.7	1.9	2.7
	TDLF	0.9	1.1	0.7	0.3	0.3	1.0	2.6	0.6
3	NLF	12.5	38.6	35.1	41.0	42.2	32.1	17.0	0.1
	SDLF	6.7	20.5	19.2	22.5	23.2	17.7	9.3	0.4
	TDLF	1.6	1.3	1.1	1.3	1.9	2.5	2.5	2.5
4	NLF	1.0	11.5	31.5	35.0	37.3	32.6	16.9	2.1
	SDLF	0.3	6.5	17.1	19.2	20.4	17.8	9.2	1.4
	TDLF	0.6	2.8	2.2	2.1	2.3	2.8	3.0	0.7
5	NLF	5.0	17.0	32.6	37.4	35.1	31.5	11.5	4.5
	SDLF	2.7	9.2	17.8	20.5	19.2	17.2	6.4	2.1
	TDLF	2.0	3.0	2.8	2.3	2.1	2.3	2.8	1.7
6	NLF	2.6	17.1	32.2	42.3	41.1	35.3	38.8	2.3
	SDLF	1.6	9.3	17.8	23.3	22.7	19.4	20.7	1.5
	TDLF	0.9	2.5	2.5	1.9	1.3	1.1	1.3	0.9
7	NLF	0.6	1.9	20.2	33.2	37.9	35.8	26.5	0.6
	SDLF	0.3	2.1	11.9	18.7	21.1	19.8	15.0	0.2
	TDLF	1.9	2.6	0.9	0.3	0.3	0.7	1.1	1.9
8	NLF	2.3	15.6	18.5	9.8	2.2	10.1	13.7	2.6
	SDLF	1.5	7.9	9.2	5.0	1.5	5.5	7.9	1.6
	TDLF	0.9	2.3	0.2	0.7	0.0	0.1	0.3	0.9
9	NLF	4.5	NA	NA	NA	NA	NA	NA	5.0
	SDLF	2.1	NA	NA	NA	NA	NA	NA	2.8
	TDLF	1.7	NA	NA	NA	NA	NA	NA	2.0
10	NLF	2.1	NA	NA	NA	NA	NA	NA	1.0
	SDLF	1.4	NA	NA	NA	NA	NA	NA	0.3
	TDLF	0.7	NA	NA	NA	NA	NA	NA	0.6

Table J2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.1	NA	NA	NA	NA	NA	NA	12.5
	SDLF	0.4	NA	NA	NA	NA	NA	NA	6.7
	TDLF	2.6	NA	NA	NA	NA	NA	NA	1.6
12	NLF	4.6	NA	NA	NA	NA	NA	NA	18.5
	SDLF	2.6	NA	NA	NA	NA	NA	NA	10.1
	TDLF	0.6	NA	NA	NA	NA	NA	NA	0.9
13	NLF	6.9	NA	NA	NA	NA	NA	NA	4.2
	SDLF	3.2	NA	NA	NA	NA	NA	NA	2.7
	TDLF	0.4	NA	NA	NA	NA	NA	NA	1.5

Table J2-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	19.9	8.8	9.5	6.0	2.3	2.8	8.5	8.7
	SDLF	5.0	3.9	4.9	5.2	5.4	5.5	5.2	5.5
	TDLF	28.3	13.0	18.7	15.1	13.3	11.1	7.3	10.9
2	NLF	8.4	10.0	9.6	7.6	4.6	0.0	5.5	2.4
	SDLF	0.4	0.3	0.1	0.1	0.3	0.4	0.4	0.2
	TDLF	7.3	9.8	10.6	9.7	7.6	3.4	1.1	3.1
3	NLF	9.4	24.2	20.8	19.1	15.6	9.2	3.7	2.0
	SDLF	0.3	0.6	0.9	1.1	1.3	1.2	0.7	0.4
	TDLF	10.9	29.4	26.8	26.1	23.3	16.7	8.5	1.1
4	NLF	1.6	11.6	23.5	25.4	23.9	18.1	9.0	0.0
	SDLF	0.1	1.0	1.4	1.6	1.6	1.5	1.0	0.1
	TDLF	1.9	17.9	32.2	35.1	33.9	27.3	15.7	0.3
5	NLF	1.9	9.0	18.1	23.9	25.4	23.5	11.6	2.0
	SDLF	0.3	1.0	1.5	1.6	1.6	1.4	1.0	0.1
	TDLF	4.0	15.7	27.4	33.9	35.2	32.3	17.9	3.6
6	NLF	0.7	3.7	9.2	15.6	19.1	20.8	24.1	0.6
	SDLF	0.1	0.7	1.2	1.3	1.2	0.9	0.7	0.1
	TDLF	1.0	8.6	16.8	23.5	26.3	27.0	29.7	0.9
7	NLF	3.1	5.5	0.0	4.6	7.6	9.6	10.0	3.1
	SDLF	0.2	0.5	0.4	0.3	0.2	0.0	0.2	0.2
	TDLF	5.4	0.8	3.6	7.9	9.9	10.9	10.1	5.4
8	NLF	0.6	8.6	2.6	2.3	5.8	8.5	9.3	0.7
	SDLF	0.1	5.2	4.8	6.2	5.3	4.9	4.7	0.1
	TDLF	0.9	7.1	9.7	14.9	14.8	16.6	14.6	1.1
9	NLF	2.0	NA	NA	NA	NA	NA	NA	1.9
	SDLF	0.1	NA	NA	NA	NA	NA	NA	0.3
	TDLF	3.6	NA	NA	NA	NA	NA	NA	3.9
10	NLF	0.0	NA	NA	NA	NA	NA	NA	1.6
	SDLF	0.1	NA	NA	NA	NA	NA	NA	0.1
	TDLF	0.2	NA	NA	NA	NA	NA	NA	1.9

Table J2-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	2.0	NA	NA	NA	NA	NA	NA	9.4
	SDLF	0.5	NA	NA	NA	NA	NA	NA	0.3
	TDLF	1.3	NA	NA	NA	NA	NA	NA	11.0
12	NLF	2.4	NA	NA	NA	NA	NA	NA	8.3
	SDLF	0.2	NA	NA	NA	NA	NA	NA	0.4
	TDLF	3.1	NA	NA	NA	NA	NA	NA	7.4
13	NLF	8.3	NA	NA	NA	NA	NA	NA	19.8
	SDLF	5.5	NA	NA	NA	NA	NA	NA	4.4
	TDLF	10.8	NA	NA	NA	NA	NA	NA	28.5

Table J2-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	30.1	23.0	20.9	10.5	2.7	18.4	33.4	31.3
	SDLF	13.4	12.0	10.4	5.9	5.5	13.3	20.9	19.3
	TDLF	10.0	7.8	10.7	10.5	11.4	12.3	11.3	14.6
2	NLF	14.5	18.6	17.3	12.8	6.5	3.5	15.4	7.4
	SDLF	7.1	9.5	9.2	7.1	4.1	1.0	7.3	4.5
	TDLF	0.4	0.7	0.4	0.0	0.5	1.2	2.8	1.0
3	NLF	21.9	53.7	46.4	42.1	33.5	18.0	3.8	6.8
	SDLF	10.2	27.8	24.3	22.4	18.1	10.1	2.1	3.8
	TDLF	2.2	1.9	1.6	1.8	2.3	2.9	2.9	3.0
4	NLF	2.3	25.2	53.5	58.5	54.6	40.0	16.5	1.0
	SDLF	0.6	12.9	28.3	31.1	29.2	21.5	8.8	1.1
	TDLF	1.0	3.5	2.8	2.6	2.8	3.3	3.6	1.1
5	NLF	2.3	16.5	40.1	54.6	58.5	53.6	25.2	0.2
	SDLF	0.6	8.8	21.5	29.2	31.2	28.4	12.9	0.6
	TDLF	2.5	3.6	3.3	2.8	2.6	2.8	3.5	2.1
6	NLF	0.7	3.9	18.2	33.6	42.2	46.5	53.8	0.2
	SDLF	0.3	2.2	10.2	18.2	22.5	24.5	28.0	0.5
	TDLF	1.1	2.9	2.9	2.4	1.9	1.6	1.9	1.1
7	NLF	2.2	15.1	3.3	6.7	13.0	17.5	18.7	2.2
	SDLF	0.7	7.1	0.8	4.3	7.3	9.3	9.6	0.6
	TDLF	2.4	2.8	1.2	0.5	0.0	0.3	0.7	2.4
8	NLF	0.2	33.7	16.3	2.4	10.3	19.8	23.1	0.7
	SDLF	0.5	21.7	11.5	5.2	5.8	10.1	12.0	0.3
	TDLF	1.1	12.1	10.6	13.1	10.7	9.9	9.4	1.1
9	NLF	0.2	NA	NA	NA	NA	NA	NA	2.3
	SDLF	0.6	NA	NA	NA	NA	NA	NA	0.6
	TDLF	2.1	NA	NA	NA	NA	NA	NA	2.5
10	NLF	1.0	NA	NA	NA	NA	NA	NA	2.3
	SDLF	1.1	NA	NA	NA	NA	NA	NA	0.6
	TDLF	1.1	NA	NA	NA	NA	NA	NA	1.0

Table J2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	6.7	NA	NA	NA	NA	NA	NA	22.0
	SDLF	3.8	NA	NA	NA	NA	NA	NA	10.3
	TDLF	3.0	NA	NA	NA	NA	NA	NA	2.2
12	NLF	7.4	NA	NA	NA	NA	NA	NA	14.5
	SDLF	4.4	NA	NA	NA	NA	NA	NA	7.1
	TDLF	1.0	NA	NA	NA	NA	NA	NA	0.4
13	NLF	30.4	NA	NA	NA	NA	NA	NA	29.9
	SDLF	19.1	NA	NA	NA	NA	NA	NA	12.4
	TDLF	14.6	NA	NA	NA	NA	NA	NA	8.8

Table J2-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-1.61	-1.68	-1.67	-1.66	-1.66	-1.72	-1.85	-1.98
	SDLF	-1.83	-1.78	-1.79	-1.79	-1.79	-1.79	-1.82	-1.73
	TDLF	-2.20	-1.94	-1.96	-1.97	-1.97	-1.94	-1.87	-1.25
3	NLF	-1.10	-1.06	-1.09	-1.11	-1.14	-1.24	-1.43	-1.85
	SDLF	-1.63	-1.18	-1.22	-1.22	-1.23	-1.23	-1.29	-1.41
	TDLF	-2.49	-1.34	-1.36	-1.36	-1.36	-1.30	-1.17	-0.58
4	NLF	-0.63	-0.17	-0.32	-0.38	-0.42	-0.51	-0.73	-1.68
	SDLF	-1.37	-0.37	-0.43	-0.43	-0.44	-0.45	-0.51	-1.06
	TDLF	-2.59	-0.60	-0.52	-0.49	-0.49	-0.44	-0.29	0.10
5	NLF	-0.16	0.73	0.51	0.42	0.38	0.32	0.17	-1.42
	SDLF	-1.03	0.51	0.45	0.44	0.43	0.43	0.37	-0.65
	TDLF	-2.50	0.29	0.43	0.48	0.49	0.51	0.60	0.76
6	NLF	0.29	1.43	1.24	1.14	1.11	1.09	1.06	-1.11
	SDLF	-0.65	1.29	1.23	1.23	1.22	1.22	1.18	-0.22
	TDLF	-2.26	1.17	1.30	1.36	1.36	1.36	1.34	1.36
7	NLF	0.72	1.85	1.72	1.66	1.66	1.67	1.68	-0.72
	SDLF	-0.22	1.82	1.79	1.79	1.79	1.79	1.78	0.22
	TDLF	-1.87	1.86	1.94	1.97	1.97	1.96	1.94	1.87
8	NLF	1.11	0.00	0.00	0.00	0.00	0.00	0.00	-0.29
	SDLF	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.65
	TDLF	-1.36	0.00	0.00	0.00	0.00	0.00	0.00	2.26
9	NLF	1.42	NA	NA	NA	NA	NA	NA	0.16
	SDLF	0.65	NA	NA	NA	NA	NA	NA	1.03
	TDLF	-0.77	NA	NA	NA	NA	NA	NA	2.50
10	NLF	1.68	NA	NA	NA	NA	NA	NA	0.63
	SDLF	1.06	NA	NA	NA	NA	NA	NA	1.37
	TDLF	-0.11	NA	NA	NA	NA	NA	NA	2.59

Table J2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
		CF Location							
11	NLF	1.85	NA	NA	NA	NA	NA	NA	1.10
	SDLF	1.41	NA	NA	NA	NA	NA	NA	1.64
	TDLF	0.57	NA	NA	NA	NA	NA	NA	2.50
12	NLF	1.98	NA	NA	NA	NA	NA	NA	1.61
	SDLF	1.73	NA	NA	NA	NA	NA	NA	1.83
	TDLF	1.25	NA	NA	NA	NA	NA	NA	2.20
13	NLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	SDLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	TDLF	0.00	NA	NA	NA	NA	NA	NA	0.00

Table J2-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-3.68	-3.85	-3.81	-3.78	-3.78	-3.89	-4.18	-4.49
	SDLF	-3.85	-3.90	-3.89	-3.87	-3.87	-3.93	-4.10	-4.18
	TDLF	-4.17	-4.01	-4.02	-4.02	-4.02	-4.04	-4.09	-3.65
3	NLF	-2.53	-2.44	-2.49	-2.52	-2.57	-2.77	-3.22	-4.19
	SDLF	-3.04	-2.54	-2.60	-2.62	-2.64	-2.73	-3.02	-3.70
	TDLF	-3.87	-2.68	-2.73	-2.74	-2.75	-2.77	-2.85	-2.80
4	NLF	-1.46	-0.42	-0.76	-0.87	-0.94	-1.11	-1.61	-3.79
	SDLF	-2.20	-0.63	-0.87	-0.92	-0.95	-1.03	-1.36	-3.11
	TDLF	-3.41	-0.88	-0.96	-0.97	-0.99	-1.01	-1.10	-1.90
5	NLF	-0.40	1.61	1.10	0.93	0.86	0.76	0.41	-3.21
	SDLF	-1.29	1.35	1.02	0.94	0.91	0.87	0.63	-2.38
	TDLF	-2.77	1.09	1.00	0.98	0.96	0.95	0.87	-0.91
6	NLF	0.64	3.21	2.76	2.57	2.52	2.49	2.44	-2.49
	SDLF	-0.34	3.01	2.73	2.63	2.61	2.60	2.54	-1.55
	TDLF	-1.98	2.84	2.76	2.74	2.73	2.72	2.68	0.09
7	NLF	1.61	4.17	3.89	3.78	3.78	3.81	3.85	-1.62
	SDLF	0.61	4.09	3.93	3.87	3.87	3.89	3.90	-0.62
	TDLF	-1.08	4.08	4.03	4.02	4.02	4.02	4.01	1.07
8	NLF	2.48	0.00	0.00	0.00	0.00	0.00	0.00	-0.64
	SDLF	1.54	0.00	0.00	0.00	0.00	0.00	0.00	0.34
	TDLF	-0.10	0.00	0.00	0.00	0.00	0.00	0.00	1.98
9	NLF	3.20	NA	NA	NA	NA	NA	NA	0.39
	SDLF	2.37	NA	NA	NA	NA	NA	NA	1.28
	TDLF	0.89	NA	NA	NA	NA	NA	NA	2.76
10	NLF	3.78	NA	NA	NA	NA	NA	NA	1.46
	SDLF	3.10	NA	NA	NA	NA	NA	NA	2.20
	TDLF	1.88	NA	NA	NA	NA	NA	NA	3.41

Table J2-4-8(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	4.18	NA	NA	NA	NA	NA	NA	2.53
	SDLF	3.69	NA	NA	NA	NA	NA	NA	3.04
	TDLF	2.79	NA	NA	NA	NA	NA	NA	3.87
12	NLF	4.48	NA	NA	NA	NA	NA	NA	3.68
	SDLF	4.17	NA	NA	NA	NA	NA	NA	3.86
	TDLF	3.64	NA	NA	NA	NA	NA	NA	4.17
13	NLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	SDLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	TDLF	0.00	NA	NA	NA	NA	NA	NA	0.00

Table J2-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-1.94	-2.03	-2.01	-2.00	-2.01	-2.08	-2.23	-2.39
	SDLF	-2.21	-2.15	-2.16	-2.16	-2.16	-2.17	-2.20	-2.08
	TDLF	-2.65	-2.34	-2.36	-2.37	-2.38	-2.34	-2.25	-1.51
3	NLF	-1.33	-1.28	-1.31	-1.34	-1.38	-1.49	-1.73	-2.24
	SDLF	-1.97	-1.42	-1.47	-1.47	-1.48	-1.49	-1.55	-1.71
	TDLF	-3.01	-1.62	-1.65	-1.64	-1.64	-1.57	-1.41	-0.70
4	NLF	-0.76	-0.20	-0.39	-0.46	-0.51	-0.61	-0.88	-2.03
	SDLF	-1.66	-0.44	-0.52	-0.52	-0.53	-0.54	-0.62	-1.28
	TDLF	-3.13	-0.72	-0.62	-0.59	-0.59	-0.53	-0.35	0.12
5	NLF	-0.19	0.88	0.61	0.51	0.46	0.39	0.20	-1.72
	SDLF	-1.25	0.62	0.54	0.53	0.52	0.51	0.44	-0.78
	TDLF	-3.02	0.35	0.52	0.58	0.59	0.62	0.72	0.92
6	NLF	0.36	1.73	1.49	1.38	1.34	1.31	1.28	-1.34
	SDLF	-0.78	1.55	1.49	1.48	1.47	1.47	1.42	-0.27
	TDLF	-2.73	1.41	1.57	1.64	1.64	1.64	1.61	1.64
7	NLF	0.87	2.23	2.08	2.01	2.00	2.01	2.03	-0.87
	SDLF	-0.27	2.20	2.17	2.16	2.16	2.16	2.15	0.27
	TDLF	-2.26	2.25	2.34	2.38	2.37	2.36	2.35	2.26
8	NLF	1.34	0.00	0.00	0.00	0.00	0.00	0.00	-0.36
	SDLF	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.78
	TDLF	-1.65	0.00	0.00	0.00	0.00	0.00	0.00	2.73
9	NLF	1.72	NA	NA	NA	NA	NA	NA	0.19
	SDLF	0.78	NA	NA	NA	NA	NA	NA	1.25
	TDLF	-0.93	NA	NA	NA	NA	NA	NA	3.02
10	NLF	2.03	NA	NA	NA	NA	NA	NA	0.76
	SDLF	1.28	NA	NA	NA	NA	NA	NA	1.66
	TDLF	-0.13	NA	NA	NA	NA	NA	NA	3.13

Table J2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	2.24	NA	NA	NA	NA	NA	NA	1.33
	SDLF	1.70	NA	NA	NA	NA	NA	NA	1.97
	TDLF	0.69	NA	NA	NA	NA	NA	NA	3.01
12	NLF	2.39	NA	NA	NA	NA	NA	NA	1.94
	SDLF	2.08	NA	NA	NA	NA	NA	NA	2.21
	TDLF	1.51	NA	NA	NA	NA	NA	NA	2.66
13	NLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	SDLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	TDLF	0.00	NA	NA	NA	NA	NA	NA	0.00

Table J2-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-4.44	-4.65	-4.60	-4.56	-4.56	-4.70	-5.04	-5.42
	SDLF	-4.65	-4.71	-4.70	-4.68	-4.68	-4.74	-4.95	-5.04
	TDLF	-5.03	-4.84	-4.85	-4.85	-4.86	-4.88	-4.94	-4.40
3	NLF	-3.05	-2.95	-3.01	-3.05	-3.10	-3.34	-3.88	-5.06
	SDLF	-3.67	-3.07	-3.14	-3.16	-3.18	-3.30	-3.64	-4.46
	TDLF	-4.67	-3.23	-3.29	-3.30	-3.32	-3.34	-3.44	-3.38
4	NLF	-1.76	-0.50	-0.92	-1.05	-1.13	-1.34	-1.95	-4.58
	SDLF	-2.66	-0.76	-1.05	-1.11	-1.15	-1.25	-1.64	-3.76
	TDLF	-4.12	-1.06	-1.16	-1.17	-1.19	-1.22	-1.33	-2.29
5	NLF	-0.48	1.94	1.33	1.13	1.04	0.92	0.50	-3.88
	SDLF	-1.56	1.63	1.24	1.14	1.10	1.04	0.76	-2.87
	TDLF	-3.34	1.31	1.20	1.18	1.16	1.15	1.05	-1.10
6	NLF	0.77	3.87	3.33	3.10	3.04	3.00	2.95	-3.01
	SDLF	-0.41	3.63	3.29	3.17	3.15	3.14	3.06	-1.87
	TDLF	-2.40	3.42	3.33	3.31	3.30	3.29	3.23	0.10
7	NLF	1.94	5.04	4.70	4.56	4.56	4.60	4.65	-1.95
	SDLF	0.74	4.94	4.74	4.67	4.68	4.70	4.71	-0.75
	TDLF	-1.30	4.93	4.87	4.85	4.85	4.85	4.85	1.29
8	NLF	3.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.78
	SDLF	1.85	0.00	0.00	0.00	0.00	0.00	0.00	0.40
	TDLF	-0.12	0.00	0.00	0.00	0.00	0.00	0.00	2.39
9	NLF	3.87	NA	NA	NA	NA	NA	NA	0.47
	SDLF	2.86	NA	NA	NA	NA	NA	NA	1.55
	TDLF	1.08	NA	NA	NA	NA	NA	NA	3.34
10	NLF	4.57	NA	NA	NA	NA	NA	NA	1.76
	SDLF	3.74	NA	NA	NA	NA	NA	NA	2.66
	TDLF	2.27	NA	NA	NA	NA	NA	NA	4.12

Table J2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	5.05	NA	NA	NA	NA	NA	NA	3.05
	SDLF	4.45	NA	NA	NA	NA	NA	NA	3.67
	TDLF	3.36	NA	NA	NA	NA	NA	NA	4.68
12	NLF	5.41	NA	NA	NA	NA	NA	NA	4.44
	SDLF	5.03	NA	NA	NA	NA	NA	NA	4.65
	TDLF	4.39	NA	NA	NA	NA	NA	NA	5.04
13	NLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	SDLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	TDLF	0.00	NA	NA	NA	NA	NA	NA	0.00

Table J2-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	184	150	390	347
	SDLF	144	143	357	334
	TDLF	93	125	315	311
G2	NLF	137	160	314	349
	SDLF	150	152	323	340
	TDLF	167	153	335	340
G3	NLF	145	139	325	308
	SDLF	147	148	329	318
	TDLF	150	162	332	332
G4	NLF	143	135	323	301
	SDLF	148	150	329	317
	TDLF	154	167	334	336
G5	NLF	138	138	311	310
	SDLF	148	148	322	321
	TDLF	160	159	334	333
G6	NLF	134	143	300	323
	SDLF	149	148	315	329
	TDLF	166	154	334	334
G7	NLF	139	144	310	325
	SDLF	149	148	320	330
	TDLF	163	153	334	335
G8	NLF	159	138	349	315
	SDLF	152	149	341	323
	TDLF	152	165	340	334
G9	NLF	150	184	348	391
	SDLF	143	145	335	359
	TDLF	126	93	312	316

Table J2-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number: SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.9	NA	-0.1	NA
	SDLF	0.1	NA	0.3	NA
	TDLF	1.2	NA	0.5	NA
G2	NLF	0.2	NA	1.9	NA
	SDLF	0.0	NA	1.1	NA
	TDLF	-0.6	NA	-0.2	NA
G3	NLF	0.4	NA	1.7	NA
	SDLF	0.0	NA	0.9	NA
	TDLF	-0.5	NA	0.0	NA
G4	NLF	0.4	NA	1.3	NA
	SDLF	0.0	NA	0.7	NA
	TDLF	-0.5	NA	0.0	NA
G5	NLF	0.3	NA	0.7	NA
	SDLF	0.0	NA	0.3	NA
	TDLF	-0.3	NA	0.0	NA
G6	NLF	0.2	NA	0.0	NA
	SDLF	0.0	NA	-0.1	NA
	TDLF	-0.1	NA	0.0	NA
G7	NLF	0.0	NA	-0.8	NA
	SDLF	0.0	NA	-0.5	NA
	TDLF	0.1	NA	0.0	NA
G8	NLF	-0.3	NA	-2.1	NA
	SDLF	-0.1	NA	-1.2	NA
	TDLF	0.1	NA	-0.3	NA
G9	NLF	-0.4	NA	-2.5	NA
	SDLF	-0.1	NA	-1.5	NA
	TDLF	0.5	NA	-0.1	NA

Table J2-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-2.2	1.3	1.5	6.7
	SDLF	0.0	0.0	1.4	3.8
	TDLF	1.5	-1.8	-0.1	0.1
G2	NLF	0.6	1.1	6.7	5.1
	SDLF	0.0	0.0	3.9	2.6
	TDLF	-1.2	-0.9	0.0	0.1
G3	NLF	1.2	0.0	6.7	0.8
	SDLF	0.0	0.0	3.7	0.4
	TDLF	-1.7	-0.1	0.1	0.0
G4	NLF	1.4	-0.8	6.1	-2.3
	SDLF	0.0	0.0	3.3	-1.1
	TDLF	-1.7	0.6	0.1	-0.1
G5	NLF	1.2	-1.3	4.5	-4.7
	SDLF	0.0	0.0	2.4	-2.5
	TDLF	-1.2	1.3	0.1	-0.1
G6	NLF	0.7	-1.5	2.2	-6.3
	SDLF	0.0	0.0	1.1	-3.4
	TDLF	-0.5	1.8	0.1	-0.2
G7	NLF	0.0	-1.3	-0.9	-6.8
	SDLF	0.0	0.0	-0.5	-3.8
	TDLF	0.2	1.8	0.0	-0.1
G8	NLF	-1.0	-0.6	-5.0	-6.6
	SDLF	0.0	0.0	-2.6	-3.9
	TDLF	1.0	1.2	-0.1	0.0
G9	NLF	-1.2	2.4	-6.4	-1.2
	SDLF	0.0	0.0	-3.7	-1.2
	TDLF	1.7	-1.7	-0.1	0.1

Table J2-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.1	1.0	0.0	2.2
	SDLF	0.0	0.9	0.0	1.9
	TDLF	0.1	0.8	0.0	1.9
G2	NLF	0.0	0.9	0.1	2.2
	SDLF	0.0	0.9	0.1	1.9
	TDLF	0.0	1.0	0.0	2.0
G3	NLF	0.0	0.9	0.1	2.1
	SDLF	0.0	0.9	0.1	1.9
	TDLF	0.0	1.0	0.0	2.0
G4	NLF	0.0	0.9	0.1	2.0
	SDLF	0.0	0.9	0.1	1.8
	TDLF	0.0	1.0	0.0	2.0
G5	NLF	0.0	0.9	0.1	1.9
	SDLF	0.0	0.9	0.0	1.8
	TDLF	0.0	1.0	0.0	2.0
G6	NLF	0.0	0.9	0.0	1.9
	SDLF	0.0	0.9	0.0	1.8
	TDLF	0.0	1.0	0.0	2.0
G7	NLF	0.0	0.9	-0.1	1.9
	SDLF	0.0	0.9	0.0	1.8
	TDLF	0.0	1.0	0.0	2.0
G8	NLF	0.0	0.9	-0.2	1.9
	SDLF	0.0	0.9	-0.1	1.8
	TDLF	0.0	1.0	0.0	2.0
G9	NLF	0.0	1.0	-0.2	2.0
	SDLF	0.0	0.8	-0.1	1.8
	TDLF	0.0	0.8	0.0	1.9

Table J2-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	0.2	-0.1	-0.1	-0.5
	SDLF	0.0	0.0	-0.1	-0.3
	TDLF	-0.1	0.1	0.0	0.0
G2	NLF	0.0	-0.1	-0.5	-0.4
	SDLF	0.0	0.0	-0.3	-0.2
	TDLF	0.1	0.1	0.0	0.0
G3	NLF	-0.1	0.0	-0.5	-0.1
	SDLF	0.0	0.0	-0.3	0.0
	TDLF	0.1	0.0	0.0	0.0
G4	NLF	-0.1	0.1	-0.5	0.2
	SDLF	0.0	0.0	-0.2	0.1
	TDLF	0.1	0.0	0.0	0.0
G5	NLF	-0.1	0.1	-0.3	0.4
	SDLF	0.0	0.0	-0.2	0.2
	TDLF	0.1	-0.1	0.0	0.0
G6	NLF	-0.1	0.1	-0.2	0.5
	SDLF	0.0	0.0	-0.1	0.3
	TDLF	0.0	-0.1	0.0	0.0
G7	NLF	0.0	0.1	0.1	0.5
	SDLF	0.0	0.0	0.0	0.3
	TDLF	0.0	-0.1	0.0	0.0
G8	NLF	0.1	0.0	0.4	0.5
	SDLF	0.0	0.0	0.2	0.3
	TDLF	-0.1	-0.1	0.0	0.0
G9	NLF	0.1	-0.2	0.5	0.1
	SDLF	0.0	0.0	0.3	0.1
	TDLF	-0.1	0.1	0.0	0.0

Appendix J2-5. NISSS54 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISSS54 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table J2-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	SDLF	-7.3	2.1	7.6	0	-5.1	5.1
		TDLF	-12.6	5	13.6	0	-10	10
	2-3	SDLF	0.1	0.0	0.2	-0.2	0.1	0.2
		TDLF	-0.6	0.0	0.6	-1.6	1.2	2.0
	2-4	SDLF	3.0	2.7	4.0	1.8	-2.7	3.3
		TDLF	0.8	-1.9	2.0	-1.7	0.2	1.7
	2-5	SDLF	3.4	0.6	3.4	-1.3	-0.8	1.5
		TDLF	5.1	1.1	5.2	-1.4	-1.5	2.0
	2-8	SDLF	5.6	-4.2	7	0	7.1	7.1
		TDLF	4.5	-8.8	9.9	0	9.6	9.6
	2-9	SDLF	-1.4	0.5	1.5	-1.9	0.9	2.1
		TDLF	-7.7	3.3	8.4	-10.4	6.7	12.4
	2-10	SDLF	0.2	0.3	0.3	0.0	-0.2	0.2
		TDLF	1.7	3.3	3.7	0.1	-0.7	0.7
	2-11	SDLF	0.4	0.1	0.4	0.3	-0.4	0.5
		TDLF	1.0	1.4	1.7	-0.5	-0.8	1.0
	2-12	SDLF	0.1	0.3	0.3	-0.1	0.1	0.2
		TDLF	7.2	2.6	7.6	6.2	-5.7	8.4
	2-13	SDLF	0.3	0.1	0.3	0.2	-0.4	0.4
		TDLF	-2.3	-1.6	2.7	-3.9	1.9	4.3
	2-14	SDLF	0.0	-0.2	0.2	0.0	-0.2	0.2
		TDLF	-1.7	-1.8	2.5	-2.7	1.2	3.0
	2-15	SDLF	0.0	-0.4	0.4	-0.1	-0.2	0.2
		TDLF	-1.5	-2.7	3.1	-2.1	1.2	2.4
	2-16	SDLF	-0.7	-1.7	1.8	-0.7	0.8	1.1
		TDLF	-4.7	-10.3	11.4	-5.1	9.3	10.6

Table J2-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
3	3-2	SDLF	-7.2	2.9	7.8	0	-5.9	5.9
		TDLF	-14	4.2	14.6	0	-9.6	9.6
	3-4	SDLF	7.4	-3.6	8.2	0	6.1	6.1
		TDLF	20.4	0.9	20.4	0	11.8	11.8
	3-5	SDLF	-1.1	0.0	1.1	-1.3	0.5	1.5
		TDLF	3.3	1.1	3.5	1.5	5.2	5.4
	3-6	SDLF	0.5	0.2	0.5	0.2	-0.2	0.3
		TDLF	8.4	3.1	9.0	7.3	-3.5	8.1
	3-7	SDLF	1.0	0.1	1.0	0.9	-0.2	0.9
		TDLF	6.3	1.8	6.6	4.7	-2.4	5.3
	3-8	SDLF	0.6	0.3	0.6	0.4	-0.2	0.4
		TDLF	3.5	0.3	3.5	1.9	-0.9	2.1
	3-9	SDLF	0.7	0.0	0.7	0.5	0.0	0.5
		TDLF	4.4	-1.4	4.6	3.1	2.2	3.8
	3-10	SDLF	1.7	-0.7	1.9	1.6	0.5	1.7
		TDLF	12.2	-3.9	12.8	10.9	7.6	13.3

Table J2-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	SDLF	-7.9	2.9	8.4	0	-6.3	6.3
		TDLF	-16	5.2	16.8	0	-12.3	12.3
	9-4	SDLF	6	-3.1	6.8	0	5.5	5.5
		TDLF	12.7	6	14	0	9.6	9.6
	9-5	SDLF	0.2	0.0	0.2	0.0	-0.1	0.1
		TDLF	13.3	3.3	13.7	12.8	-3.6	13.3
	9-6	SDLF	1.0	0.1	1.0	0.8	0.0	0.8
		TDLF	26.0	1.1	26.0	24.9	0.0	24.9
	9-7	SDLF	0.4	0.1	0.4	0.3	-0.2	0.3
		TDLF	8.0	3.9	8.9	6.7	-3.4	7.5
	9-8	SDLF	1.1	0.1	1.1	1.0	-0.1	1.0
		TDLF	25.1	1.9	25.1	23.3	-1.3	23.4
	9-9	SDLF	0.4	0.1	0.4	0.4	-0.1	0.4
		TDLF	8.6	3.4	9.2	7.0	-3.9	8.0
	9-10	SDLF	1.0	0.1	1.0	0.9	-0.1	0.9
		TDLF	22.4	2.2	22.5	20.7	-2.5	20.8
	9-11	SDLF	0.4	0.1	0.4	0.3	-0.2	0.4
		TDLF	7.9	3.8	8.8	6.2	-4.0	7.4
	9-12	SDLF	0.7	0.1	0.7	0.6	-0.1	0.6
		TDLF	17.8	1.9	17.9	16.3	-1.6	16.3
	9-13	SDLF	0.3	0.0	0.3	0.2	-0.1	0.2
		TDLF	3.9	-0.5	3.9	3.1	-1.5	3.5
	9-14	SDLF	0.3	0.1	0.3	0.1	-0.1	0.1
		TDLF	16.7	-2.4	16.9	16.4	0.6	16.5
	9-15	SDLF	0.3	0.6	0.7	0.2	-0.6	0.7
		TDLF	-0.9	-7.8	7.9	-1.0	5.7	5.8

Table J2-5-2: Erection Critical Sub-Stages

Stage	Detailing Method	Critical Sub-Stage
2	SDLF	2-8
	TDLF	2-9
3	SDLF	3-4
	TDLF	3-4
9	SDLF	9-2
	TDLF	9-6

Table J2-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	SDLF	0.8	-0.2	0.8	NA	NA	NA
		TDLF	-13.3	6.7	14.9	NA	NA	NA
	B	SDLF	0.0	-5.1	5.1	-7.3	2.1	7.6
		TDLF	0.0	-10.0	10.0	-12.6	5.0	13.6
3	A	SDLF	4.0	2.9	5.0	NA	NA	NA
		TDLF	11.8	9.9	15.4	NA	NA	NA
	B	SDLF	0.0	6.1	6.1	7.4	-3.6	8.2
		TDLF	0.0	11.8	11.8	20.4	0.9	20.4
9	A	SDLF	-2.2	-1.0	2.4	NA	NA	NA
		TDLF	47.9	1.0	47.9	NA	NA	NA
	B	SDLF	0.0	-6.3	6.3	-7.9	2.9	8.4
		TDLF	26.0	1.1	26.0	24.9	0.0	24.9

Table J2-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
2	A	G1	SDLF	149	145
			TDLF	160	135
		G2	SDLF	137	137
			TDLF	127	147
	B	G1	SDLF	146	144
			TDLF	158	134
		G2	SDLF	140	139
			TDLF	129	149
3	A	G1	SDLF	149	146
			TDLF	175	143
		G2	SDLF	146	150
			TDLF	122	154
		G3	SDLF	140	136
			TDLF	140	133
	B	G1	SDLF	147	144
			TDLF	172	140
		G2	SDLF	148	151
			TDLF	125	155
		G3	SDLF	140	140
			TDLF	140	136

Table J2-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
9	A	G1	SDLF	145	142
			TDLF	94	126
		G2	SDLF	150	153
			TDLF	169	153
		G3	SDLF	148	148
			TDLF	154	162
		G4	SDLF	149	149
			TDLF	161	168
		G5	SDLF	149	148
			TDLF	163	160
		G6	SDLF	148	148
			TDLF	153	155
		G7	SDLF	146	148
			TDLF	125	154
		G8	SDLF	148	143
			TDLF	199	114
		G9	SDLF	68	127
			TDLF	106	131

Table J2-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
9	B	G1	SDLF	145	142
			TDLF	94	126
		G2	SDLF	150	153
			TDLF	169	153
		G3	SDLF	148	148
			TDLF	154	162
		G4	SDLF	149	149
			TDLF	161	168
		G5	SDLF	149	148
			TDLF	163	160
		G6	SDLF	148	148
			TDLF	153	155
		G7	SDLF	146	148
			TDLF	125	154
		G8	SDLF	148	143
			TDLF	201	114
		G9	SDLF	69	127
			TDLF	105	131

Appendix K1-1. EICSS12 Bridge Description

The key characteristics of EICSS12 are as follows:

- Span length along the centerline of the bridge, L_s 150,139 ft.
- Width between the fascia girders, w_g = 41ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 3.7,3.4
- Number of girders in the completed bridge cross-section, n_g = 6.
- Parallel skew
- Skew angle, θ = 59.6,59.6,59.6°
- Skew index, I_s = 0.46,0.51

This appendix presents the bridge description of the bridge EICSS12 in its final condition as well as during erection. The following figures and tables are provided:

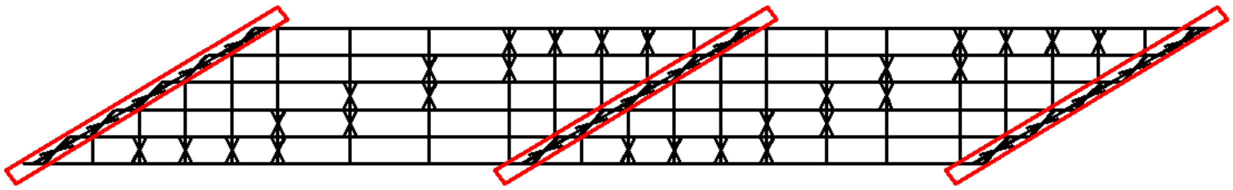


Figure K1-1-1. Framing plan.

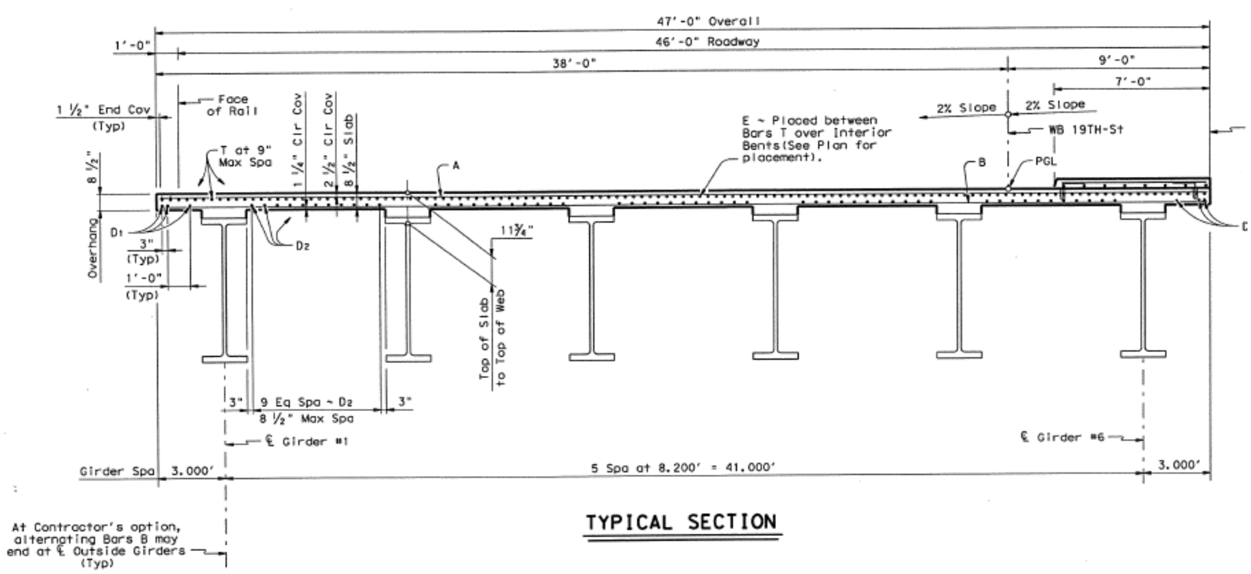


Figure K1-1-2. Bridge cross-section.

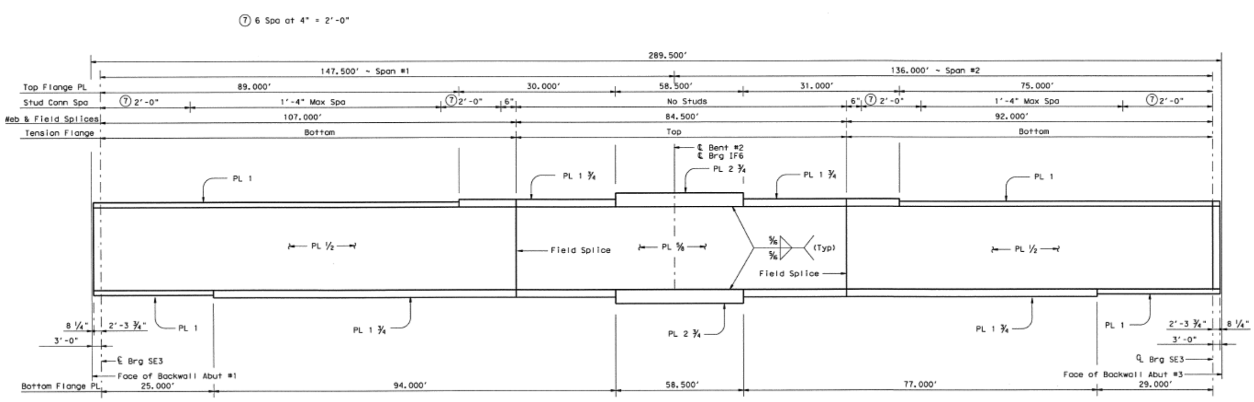


Figure K1-1-3. Girder elevations

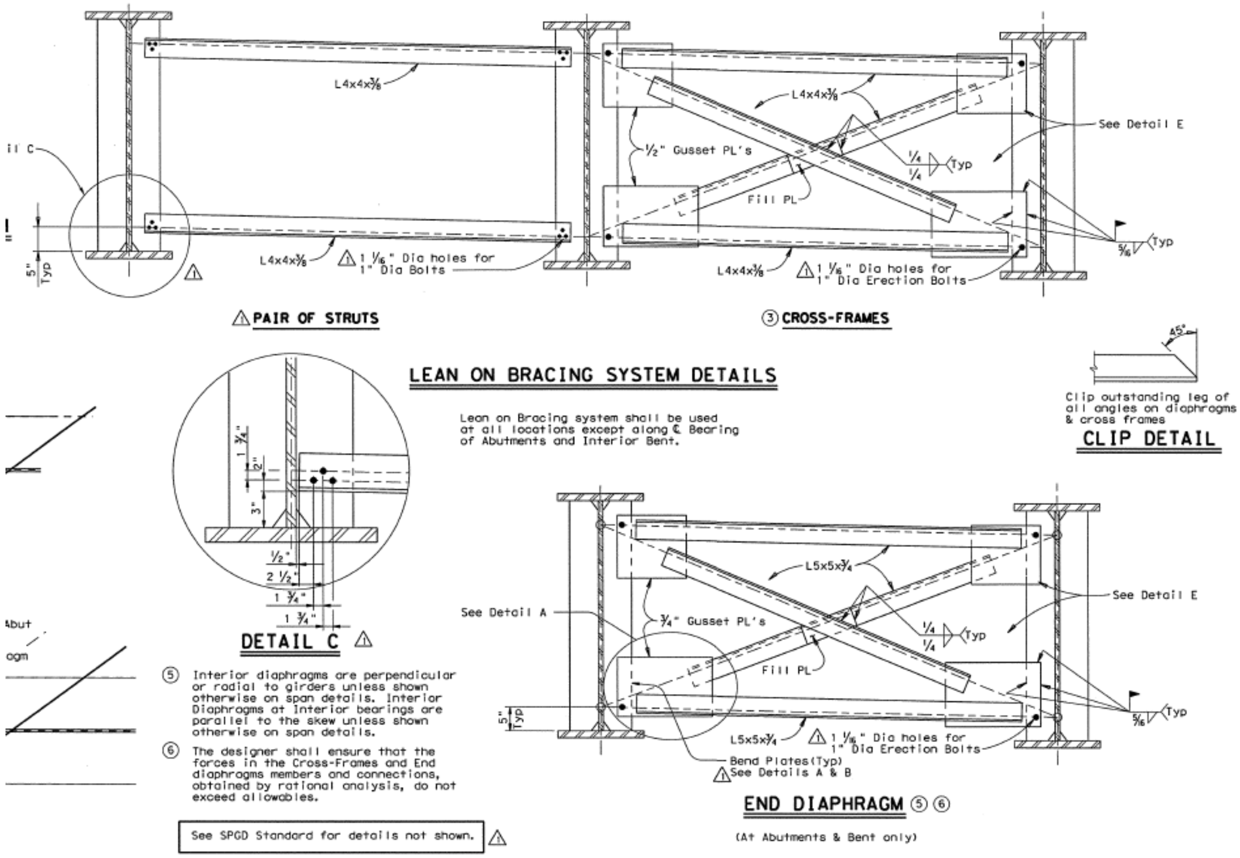


Figure K1-1-5. Cross-frame details.

THE ERECTION FROM STAGE 1 TO STAGE 5
IS SIMILAR TO STAGE 6

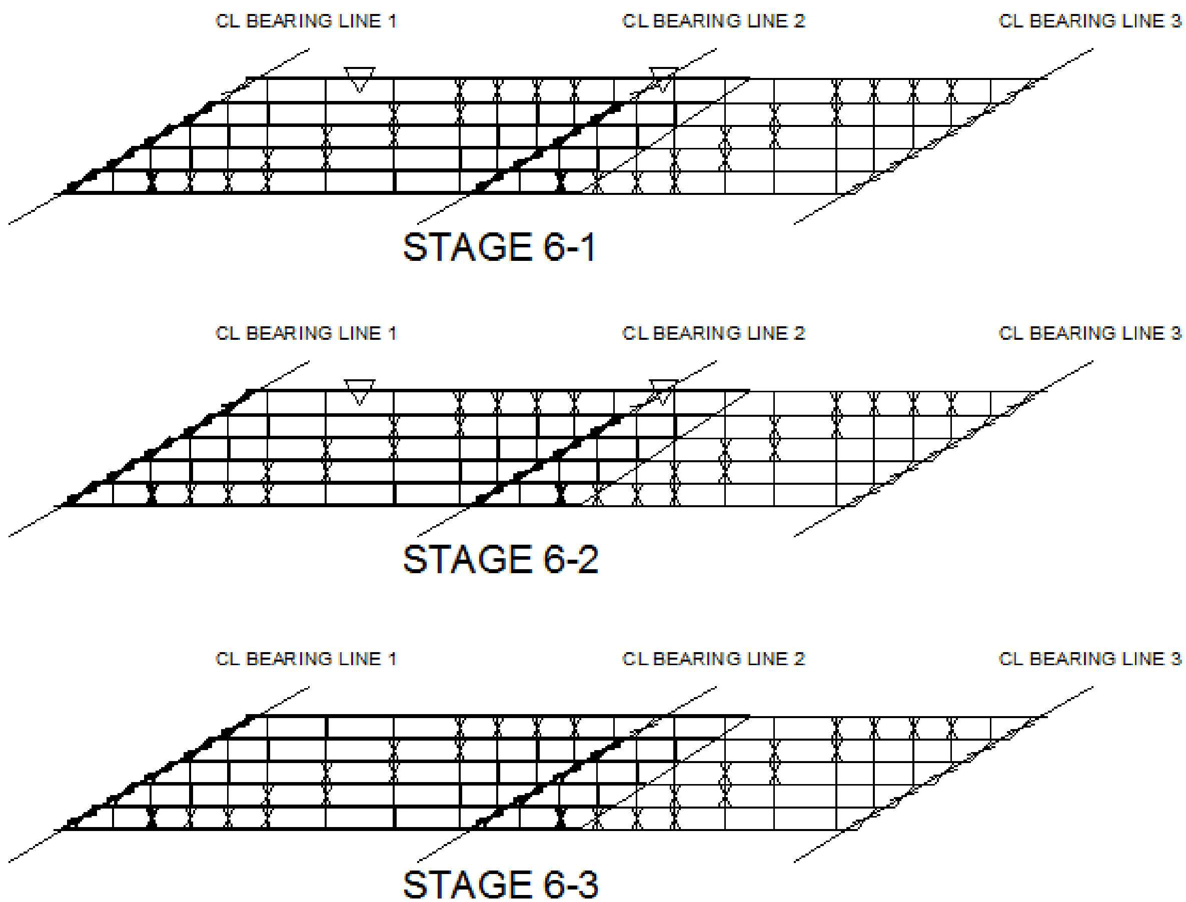


Figure K1-1-6. Erection scheme.

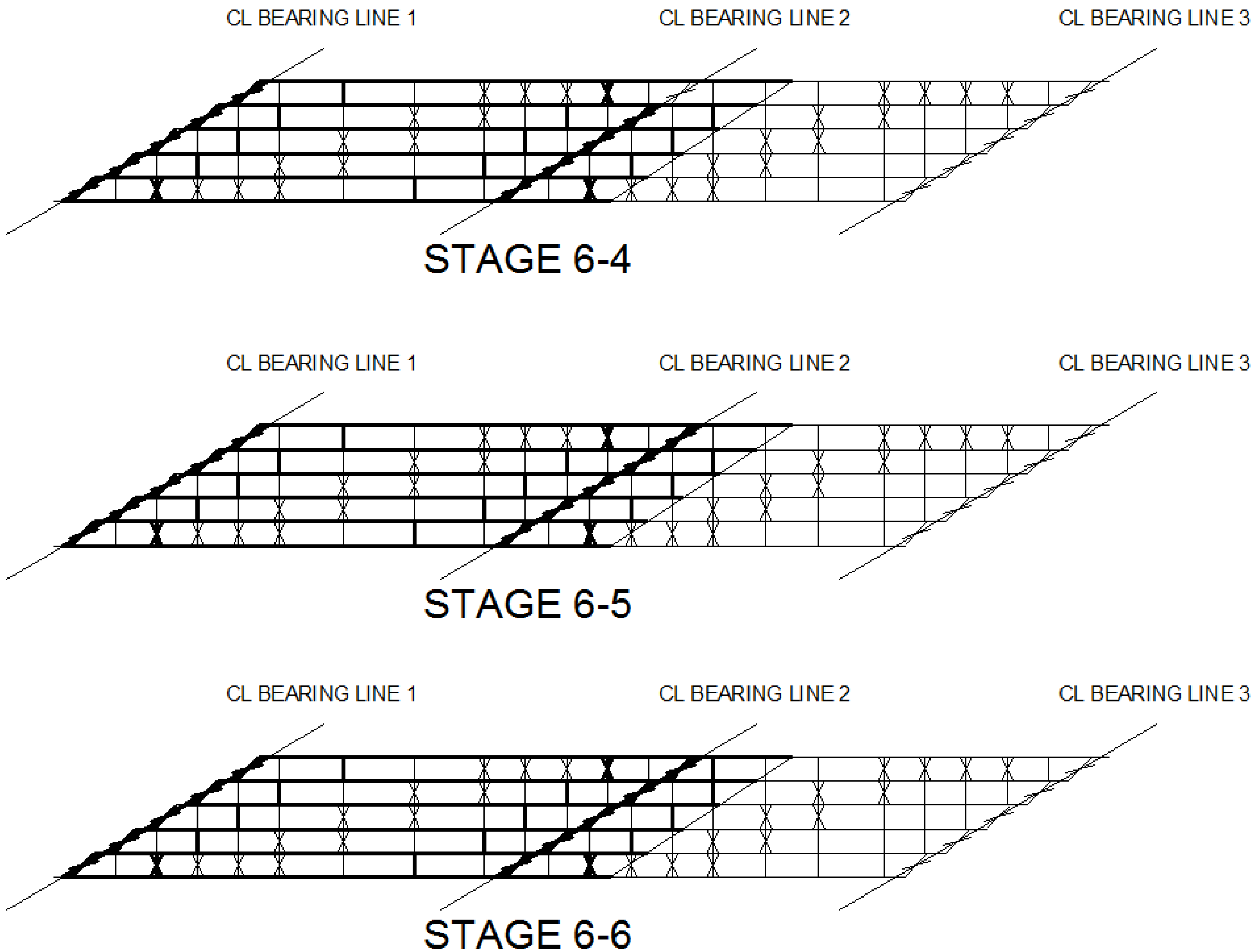
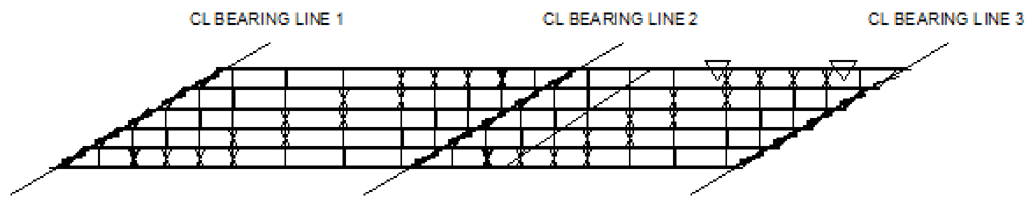
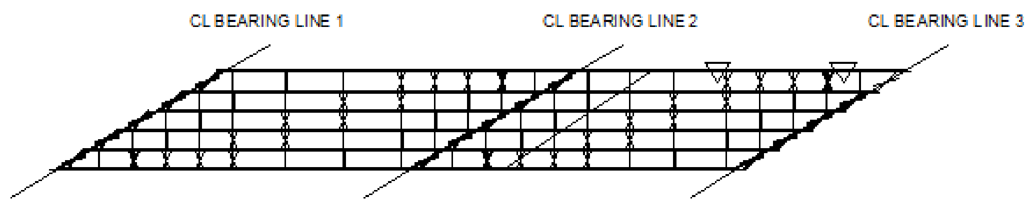


Figure K1-1-6(Continued). Erection scheme.

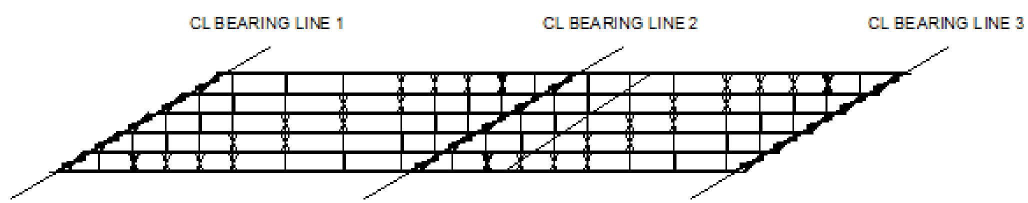
THE ERECTION FROM STAGE 7 TO STAGE 11
IS SIMILAR TO STAGE 12



STAGE 12-1



STAGE 12-2



STAGE 12-3

STAGE 13 TO 22: INSTALL THE REMAINING XFs
GIRDER BY GIRDER, SPAN BY SPAN.

Figure K1-1-6(Continued). Erection scheme.

Table K1-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

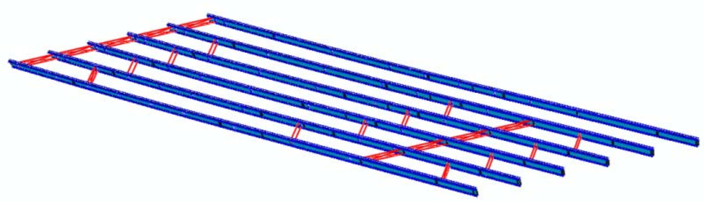
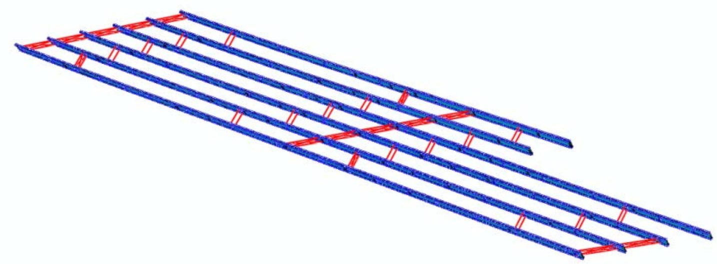
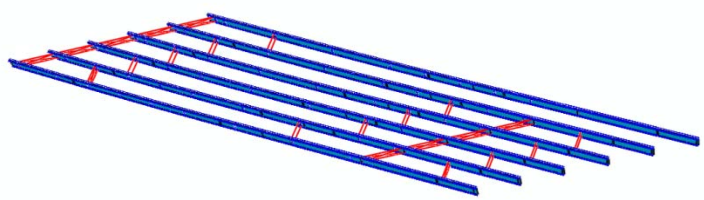
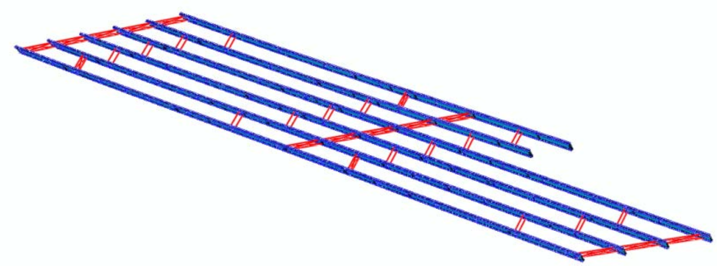
Sub-Stage	Stage	
	6	10
1		
2		

Table K1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

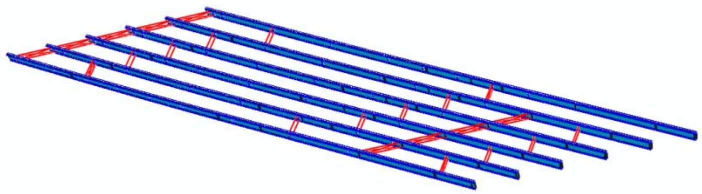
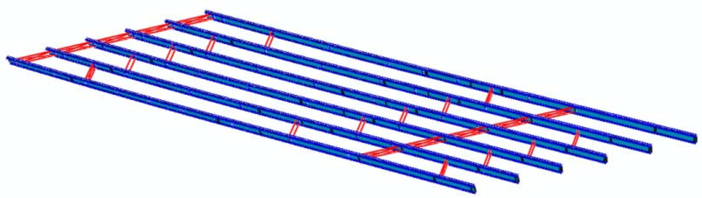
Sub-Stage	Stage	
	6	10
3		
4		

Table K1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

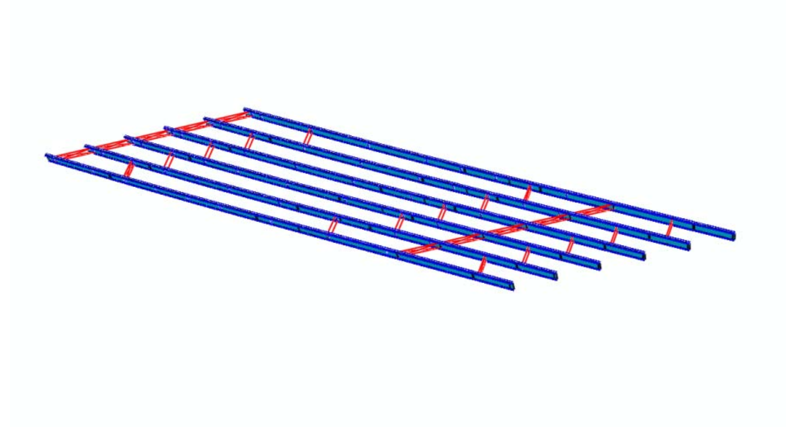
Sub-Stage	Stage	
	6	10
5		

Table K1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

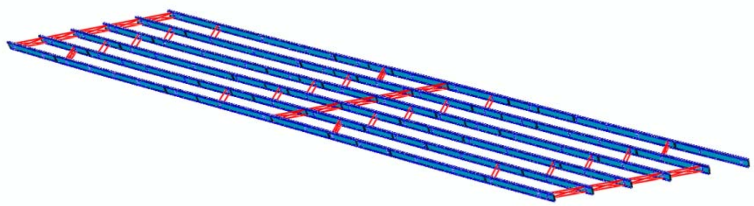
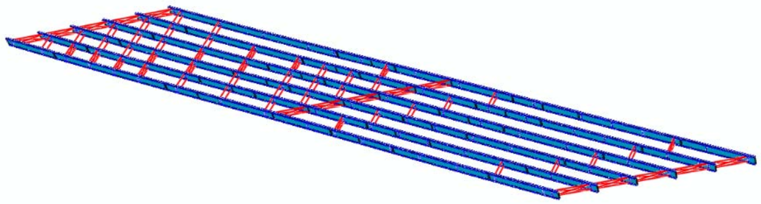
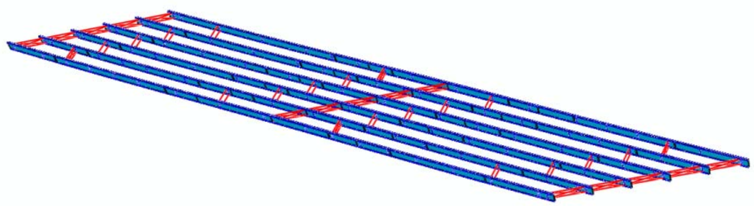
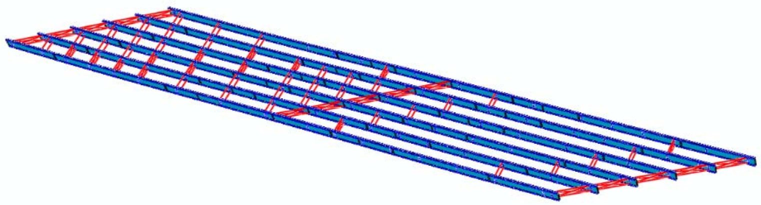
Sub-Stage	Stage	
	12	17
1		
2		

Table K1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

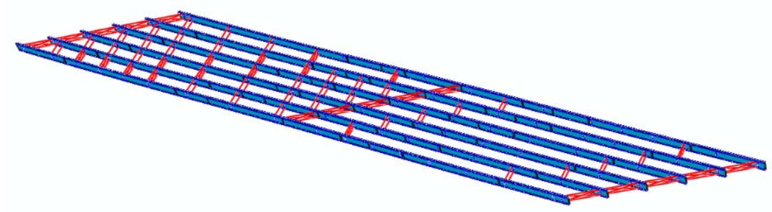
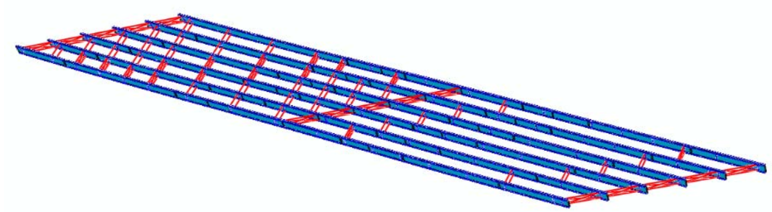
Sub-Stage	Stage	
	12	17
3		
4		

Table K1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

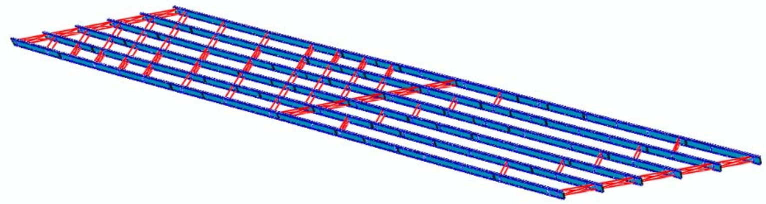
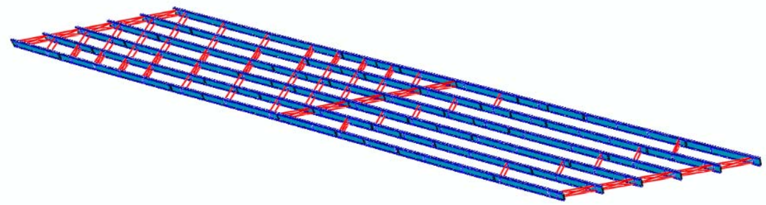
Sub-Stage	Stage	
	12	17
5		
6		

Table K1-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

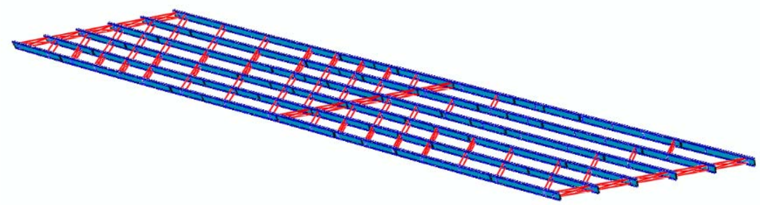
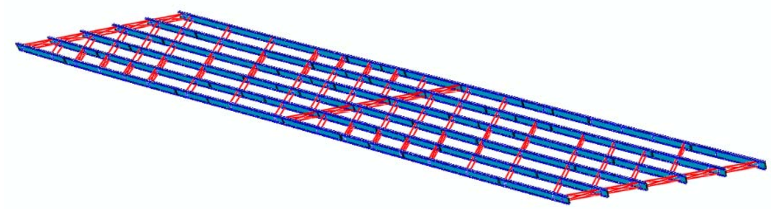
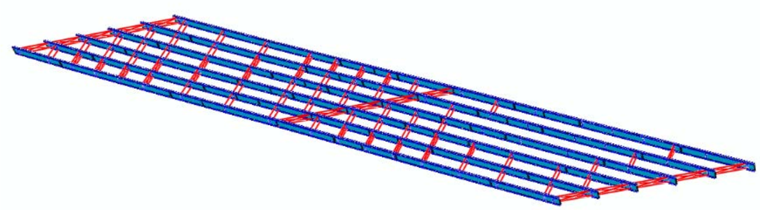
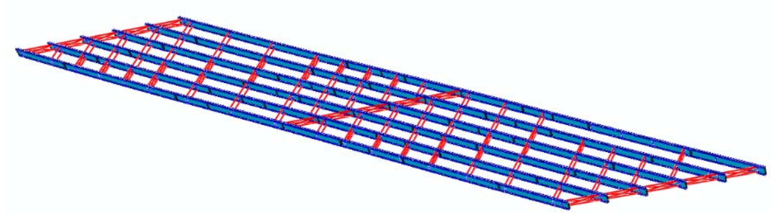
Sub-Stage	Stage	
	20	22
1		
2		

Table K1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

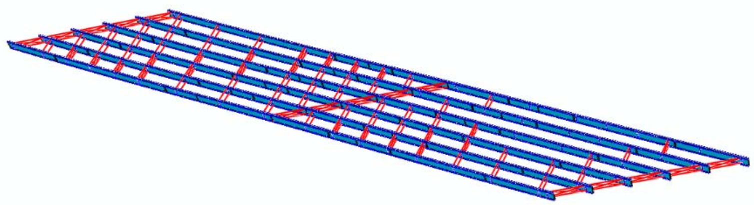
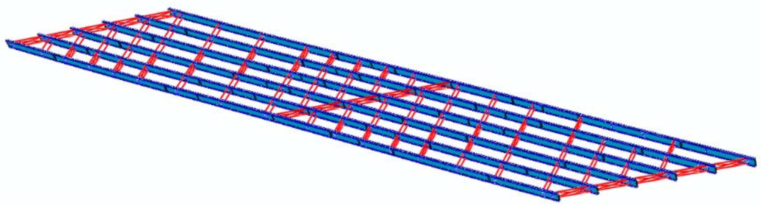
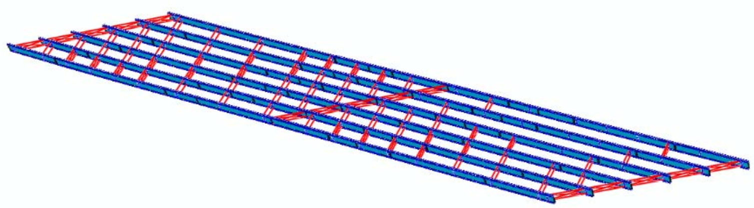
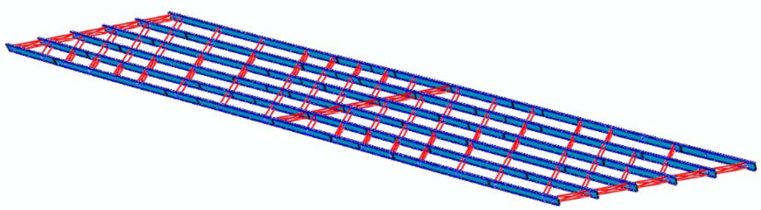
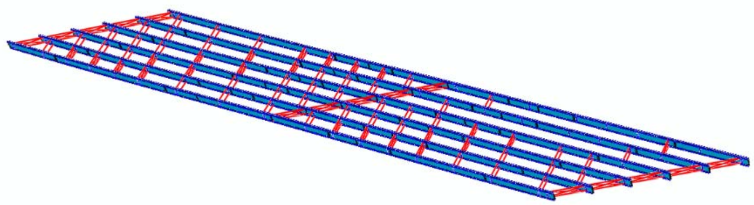
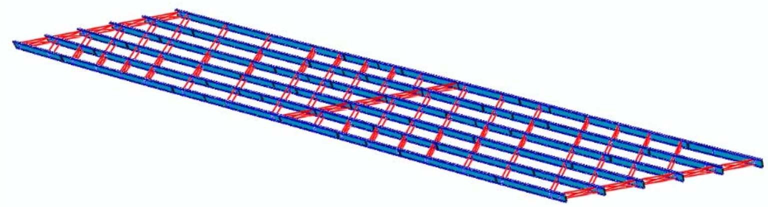
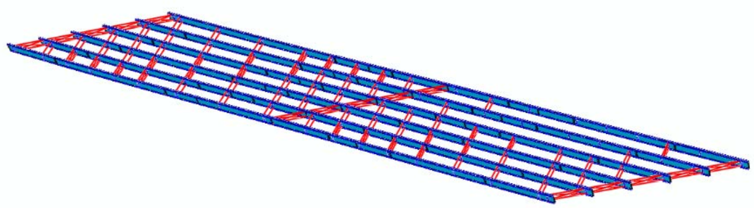
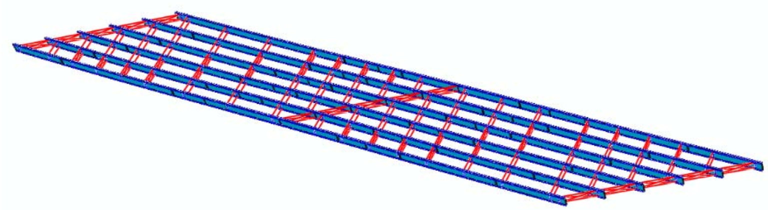
Sub-Stage	Stage	
	20	22
3		
4		

Table K1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

Sub-Stage	Stage	
	20	22
5		
6		

Appendix K1-2. EICSS12 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EICSS12 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table K1-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.1	4.6
	SDLF	0.9	4.4
	TDLF	0.8	3.9
G2	NLF	0.9	4.0
	SDLF	0.9	4.0
	TDLF	1.0	4.1
G3	NLF	0.9	3.8
	SDLF	0.9	3.9
	TDLF	1.1	4.0
G4	NLF	0.9	3.8
	SDLF	0.9	3.9
	TDLF	1.2	4.1
G5	NLF	0.9	3.8
	SDLF	0.9	3.9
	TDLF	1.2	4.1
G6	NLF	0.8	3.7
	SDLF	0.9	3.7
	TDLF	1.1	3.9
All Girders	NLF	1.1	4.6
	SDLF	0.9	4.4
	TDLF	1.2	4.1

Table K1-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.2	1.0
	SDLF	0.0	0.8
	TDLF	0.7	0.1
G2	NLF	0.2	0.9
	SDLF	0.0	0.7
	TDLF	0.7	0.0
G3	NLF	0.2	0.8
	SDLF	0.0	0.7
	TDLF	0.6	0.0
G4	NLF	0.2	0.9
	SDLF	0.0	0.7
	TDLF	0.7	0.0
G5	NLF	0.2	0.9
	SDLF	0.0	0.7
	TDLF	0.7	0.0
G6	NLF	0.2	0.9
	SDLF	0.0	0.7
	TDLF	0.7	0.1
All Girders	NLF	0.2	1.0
	SDLF	0.0	0.8
	TDLF	0.7	0.1

Table K1-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	3.7	14.9	4.1	17.6	1.1	4.2	1.2	5.1
	SDLF	3.7	14.8	3.6	17.1	0.0	3.2	0.0	3.9
	TDLF	3.4	14.5	3.3	15.2	3.8	1.0	4.0	1.1
G2	NLF	3.8	14.9	3.7	15.0	0.9	4.1	0.9	3.3
	SDLF	3.8	15.0	3.7	15.2	0.1	3.1	0.1	2.5
	TDLF	4.1	15.2	4.5	16.0	3.5	1.3	3.5	1.4
G3	NLF	3.7	14.7	3.6	14.5	0.7	3.3	0.6	2.5
	SDLF	3.8	14.8	3.7	14.8	0.1	2.5	0.1	2.0
	TDLF	4.1	15.1	5.0	15.8	2.0	0.8	1.9	0.8
G4	NLF	3.7	14.7	3.6	15.6	0.7	3.3	0.6	2.6
	SDLF	3.8	14.8	3.7	15.7	0.1	2.5	0.1	2.0
	TDLF	4.1	15.1	4.9	16.0	2.1	0.8	1.9	0.8
G5	NLF	3.7	14.7	3.7	15.7	1.0	5.0	0.9	3.3
	SDLF	3.8	14.8	3.7	15.8	0.1	3.7	0.1	2.5
	TDLF	4.2	15.2	4.5	15.9	4.1	1.3	3.8	1.4
G6	NLF	3.7	14.7	3.6	14.9	1.2	5.0	1.5	6.3
	SDLF	3.7	14.7	3.6	15.0	0.0	3.9	0.0	4.7
	TDLF	3.5	14.4	3.6	15.0	4.3	1.0	5.2	1.5
All Girders	NLF	3.8	14.9	4.1	17.6	1.2	5.0	1.5	6.3
	SDLF	3.8	15.0	3.7	17.1	0.1	3.9	0.1	4.7
	TDLF	4.2	15.2	5.0	16.0	4.3	1.3	5.2	1.5

Table K1-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	4.2	4.0	4.0	4.2
	SDLF	0.2	0.2	0.2	0.2
	TDLF	13.8	11.6	11.9	13.8
TDL	NLF	17.4	16.5	17.7	17.7
	SDLF	13.1	12.6	13.6	13.6
	TDLF	2.8	4.1	4.0	4.1

Table K1-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	1.6	1.3	1.3	1.4
	SDLF	0.1	0.0	0.0	0.0
	TDLF	5.2	4.4	4.3	4.6
TDL	NLF	6.7	5.8	5.6	6.0
	SDLF	5.1	4.5	4.3	4.6
	TDLF	0.7	1.9	1.9	1.5

Table K1-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.38	0.34	0.32	0.32	0.32	0.38
SDLF	0.32	0.34	0.34	0.34	0.34	0.34
TDLF	0.69	0.37	0.41	0.39	0.47	0.69

Table K1-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	1.69	1.45	1.37	1.40	1.42	1.69
SDLF	1.62	1.45	1.39	1.42	1.44	1.62
TDLF	1.39	1.48	1.46	1.47	1.50	1.50

Table K1-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.21	0.19	0.18	0.18	0.18	0.21
SDLF	0.18	0.19	0.19	0.19	0.19	0.19
TDLF	0.39	0.21	0.23	0.22	0.26	0.39

Table K1-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.94	0.81	0.77	0.78	0.79	0.94
SDLF	0.91	0.81	0.78	0.79	0.80	0.91
TDLF	0.77	0.82	0.82	0.82	0.84	0.84

Table K1-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	592.5	2240.1
SDLF	592.5	2239.9
TDLF	592.5	2240.1

Table K1-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	71.0	252.9	0.0	0.2	0.3	0.2
SDLF	69.3	251.3	0.0	0.1	0.0	0.1
TDLF	70.8	247.5	0.1	0.0	0.8	0.0

Table K1-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.09	0.36	0.03	0.36
SDLF	0.08	0.31	0.00	0.31
TDLF	0.10	0.37	0.08	0.37

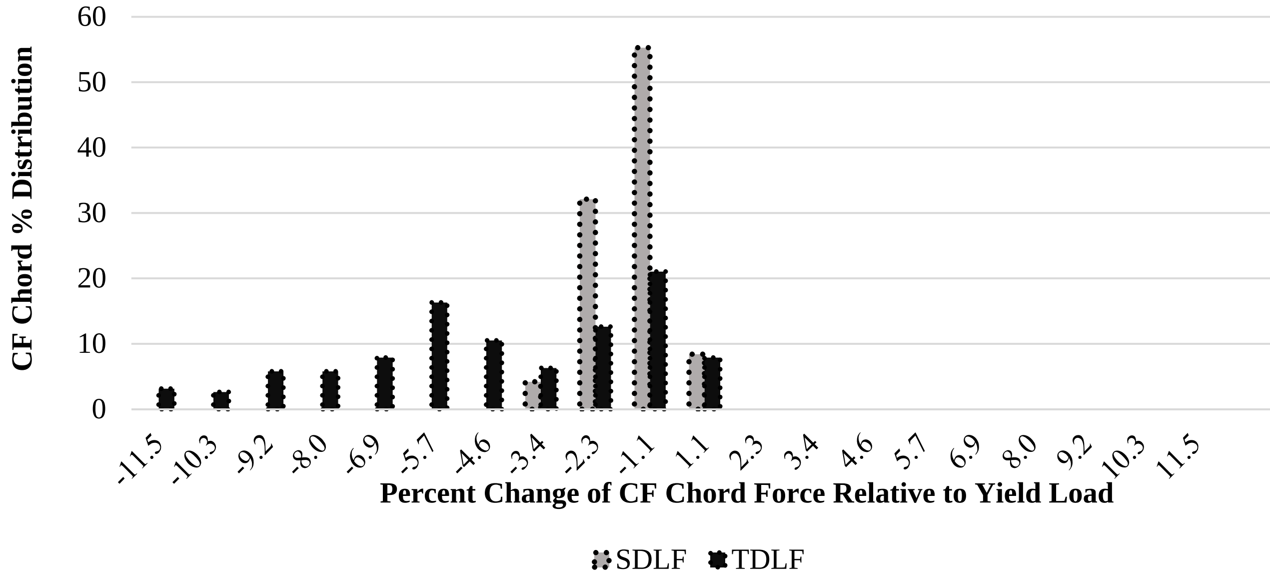


Figure K1-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

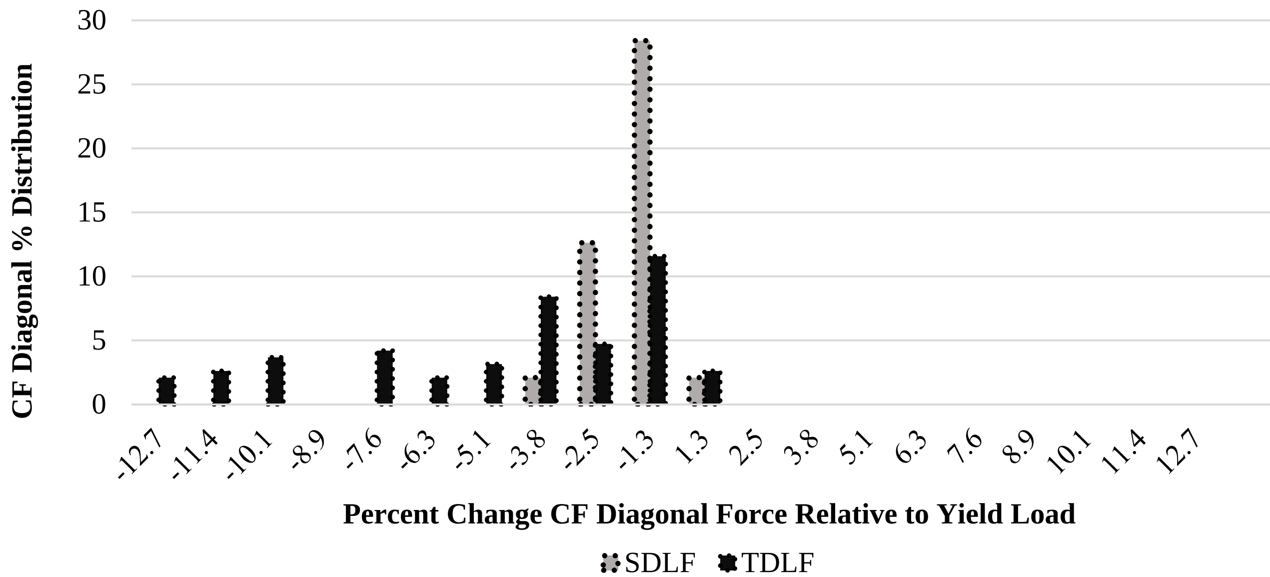


Figure K1-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

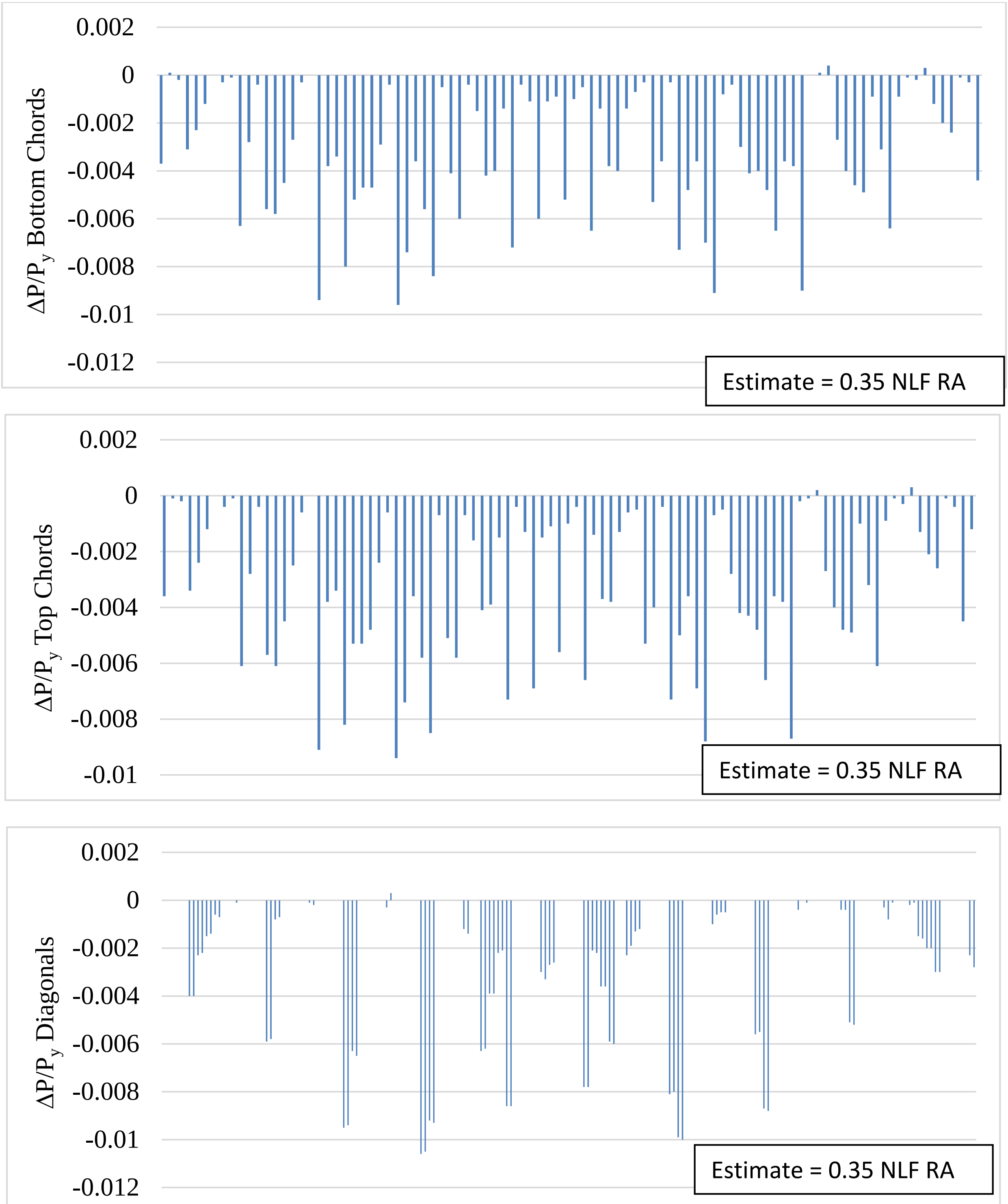


Figure K1-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

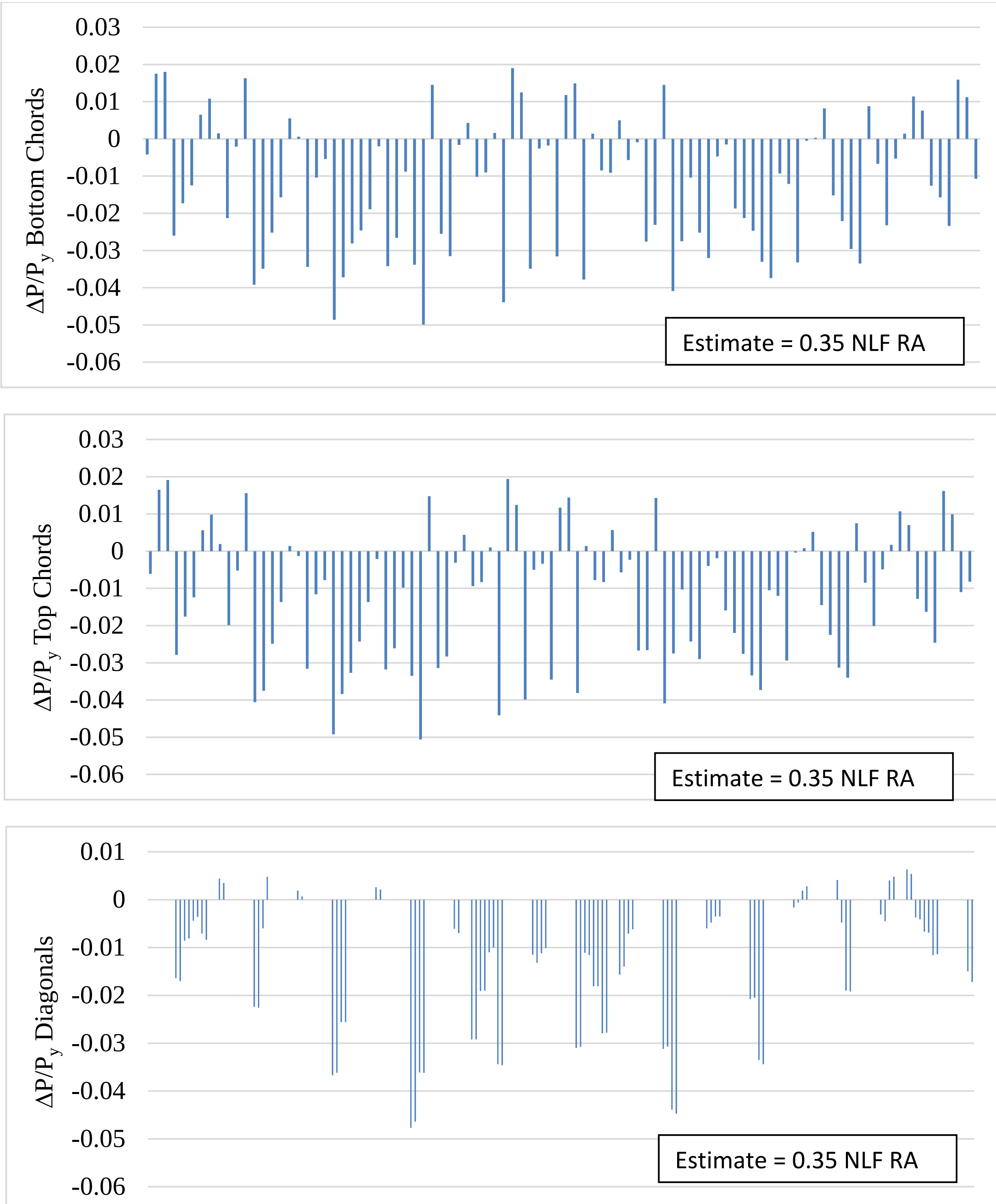


Figure K1-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix K1-3. EICSS12 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EICSS12 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table K1-3-1. Maximums of the fit-up force resultants (kips)

Detailing Method	F1	F2	F_{max}
SDLF	0.6	0.4	0.6
TDLF	2.9	6.3	6.3

Table K1-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	SDLF	66	13
	TDLF	66	12
G2	SDLF	69	14
	TDLF	70	13
G3	SDLF	69	14
	TDLF	70	14
G4	SDLF	69	13
	TDLF	71	13
G5	SDLF	69	14
	TDLF	65	15
G6	SDLF	66	13
	TDLF	72	11
All Girders	SDLF	69	13
	TDLF	72	11

Table K1-3-3. Total Vertical Reactions (kips)

Stage	Detailing Method	Sub-Stage					
		1	2	3	4	5	6
6	SDLF	412	412	412	414	414	NA
	TDLF	412	412	412	414	414	NA
10	SDLF	522	523	NA	NA	NA	NA
	TDLF	522	523	NA	NA	NA	NA
12	SDLF	577	579	NA	NA	NA	NA
	TDLF	577	579	NA	NA	NA	NA
17	SDLF	584	584	584	584	585	585
	TDLF	584	584	584	584	585	585
20	SDLF	587	588	588	588	588	589
	TDLF	587	588	588	588	588	589
22	SDLF	590	590	590	591	591	591
	TDLF	590	590	590	591	591	591

Appendix K1-4. EICSS12 Detailed Results, Completed Bridge Responses

This appendix presents the SDL and TDL responses of the bridge EICSS12 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

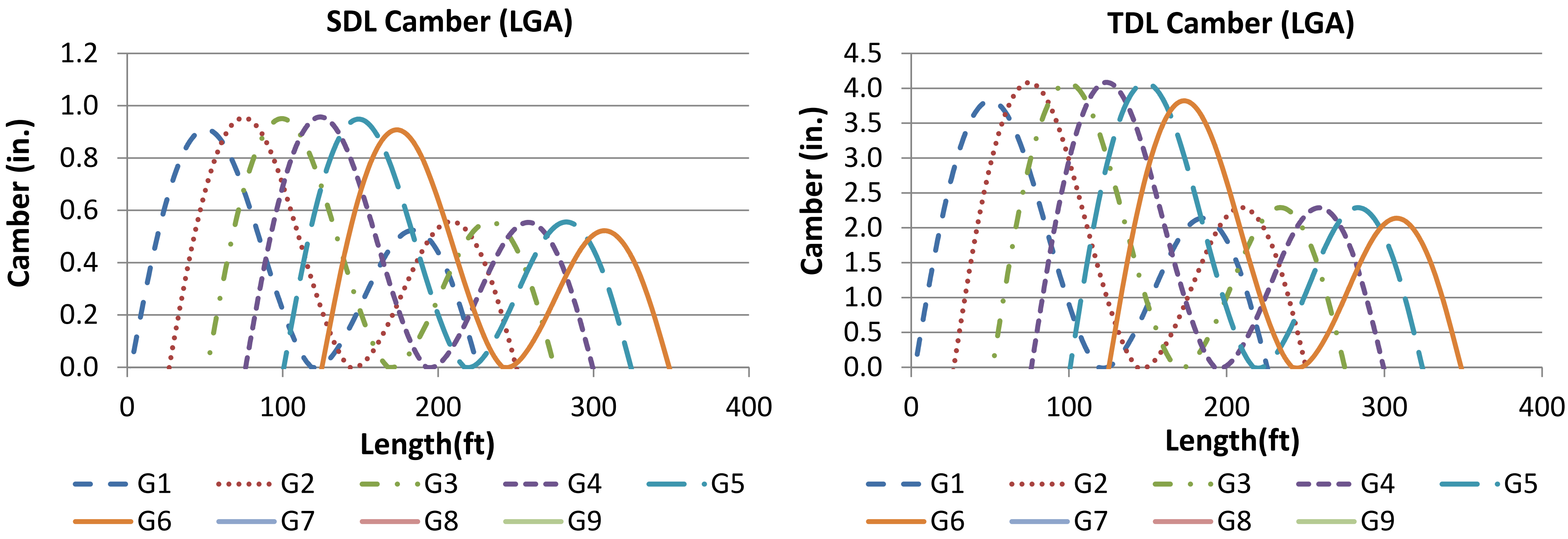


Figure K1-4-1. SDL and TDL Line Girder Analysis cambers.

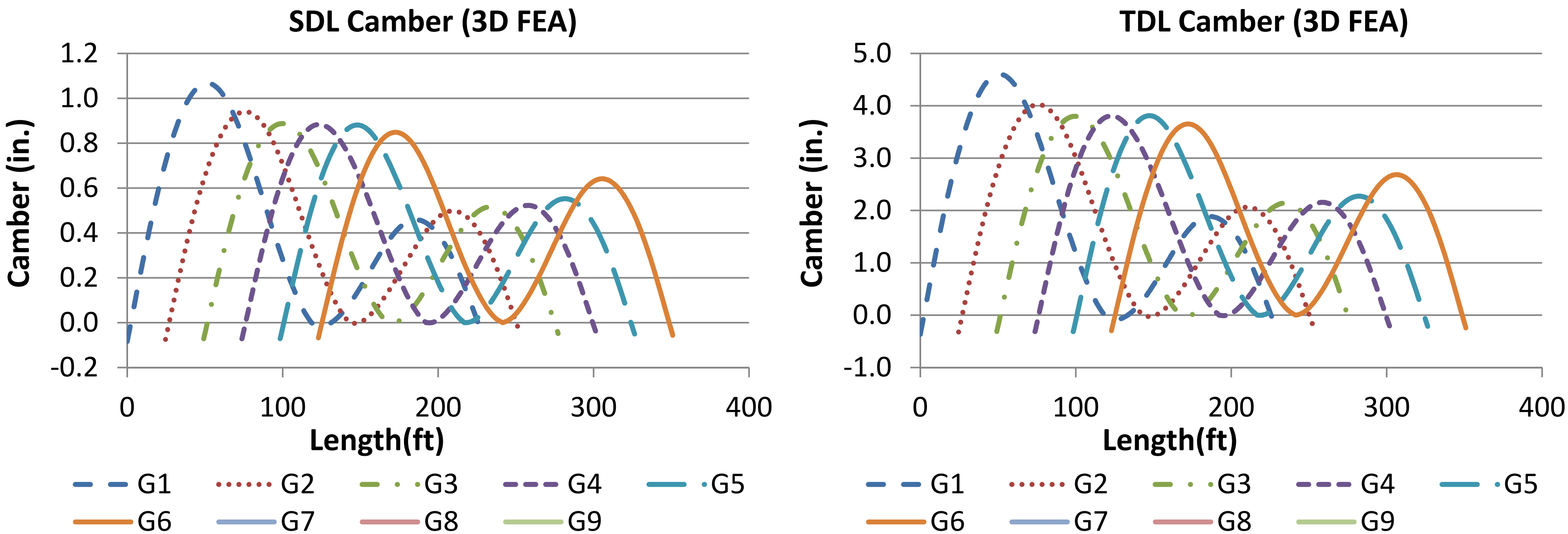


Figure K1-4-2. SDL and TDL 3D FEA cambers.

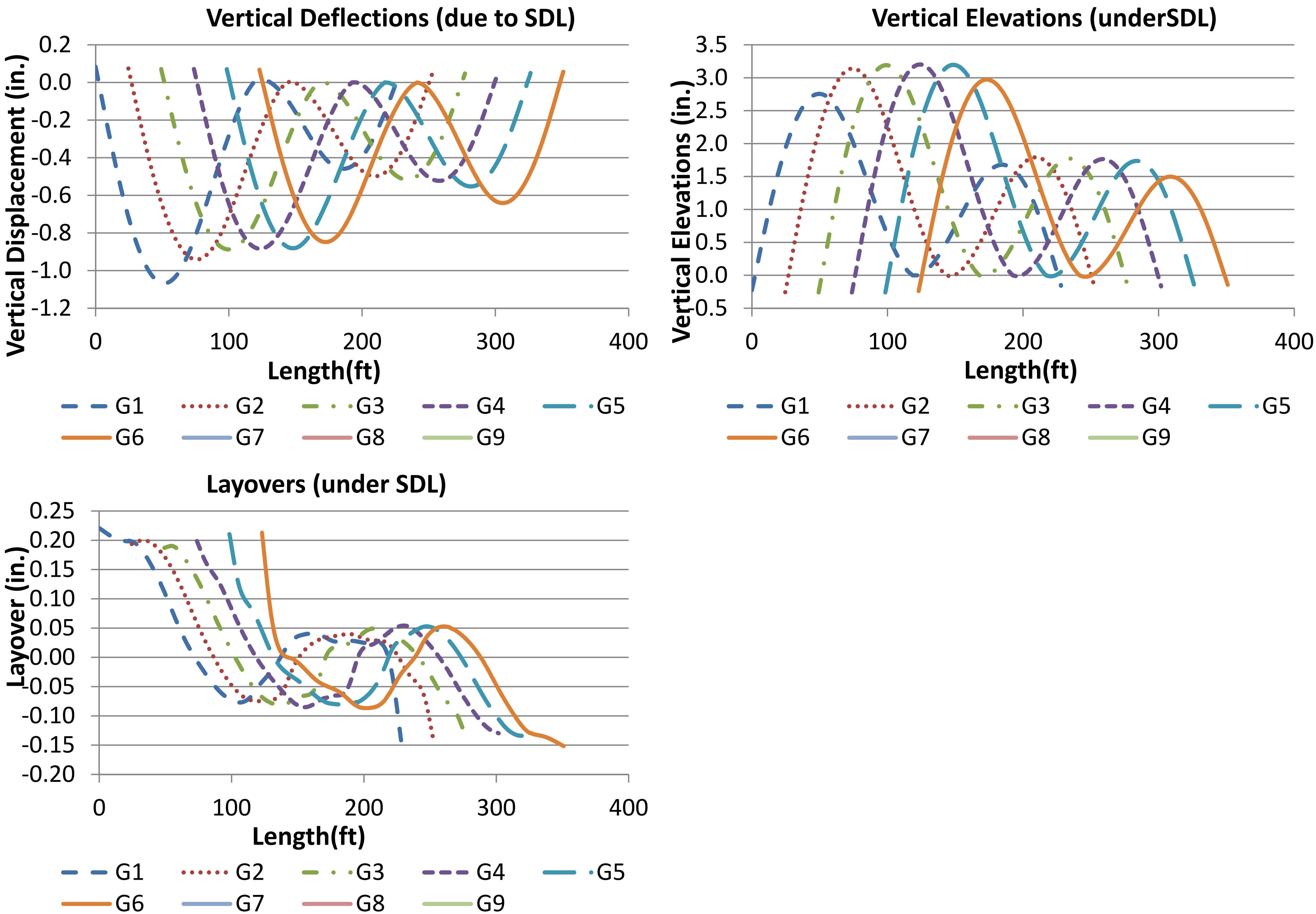


Figure K1-4-3. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

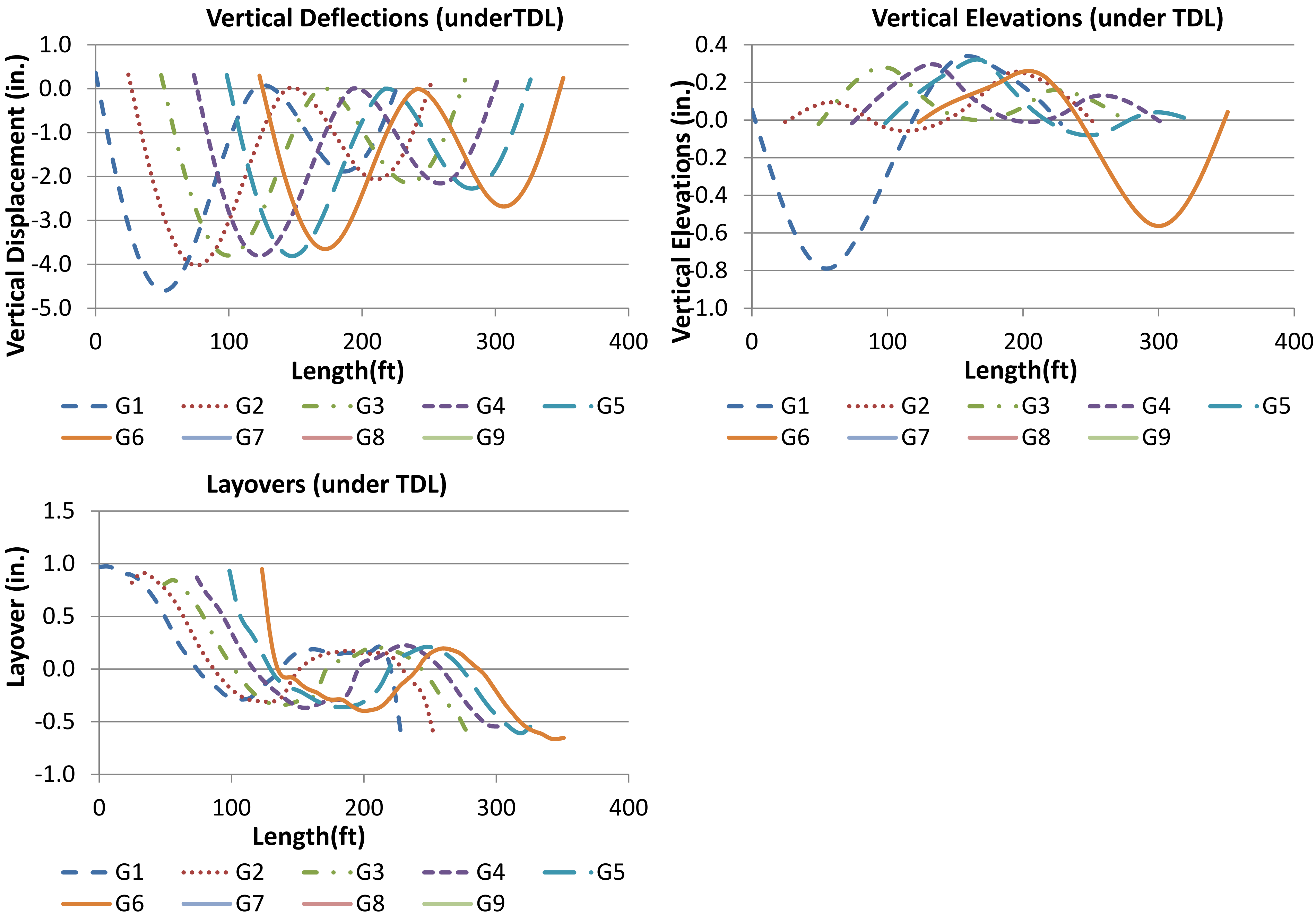


Figure K1-4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

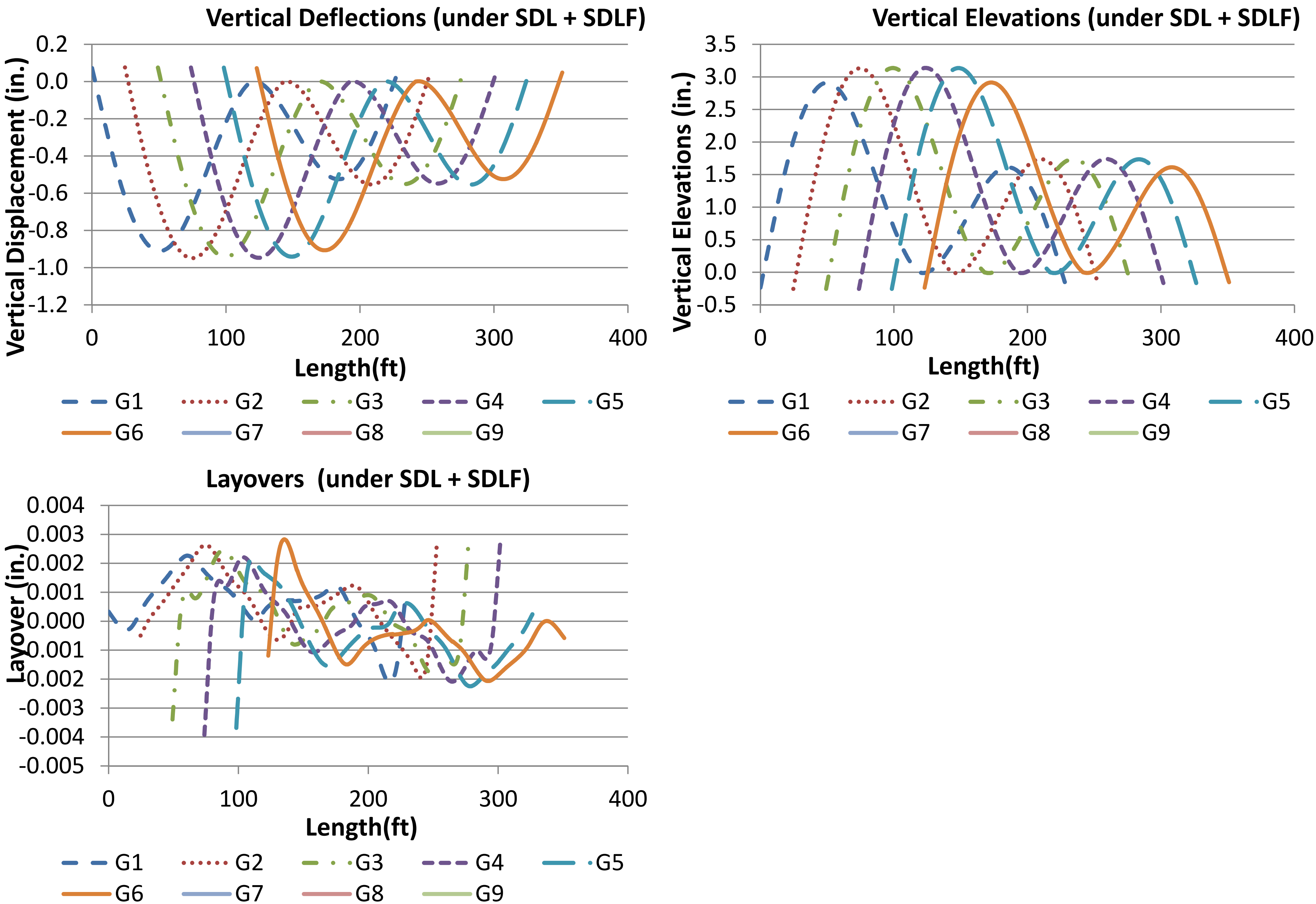


Figure K1-4-5. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

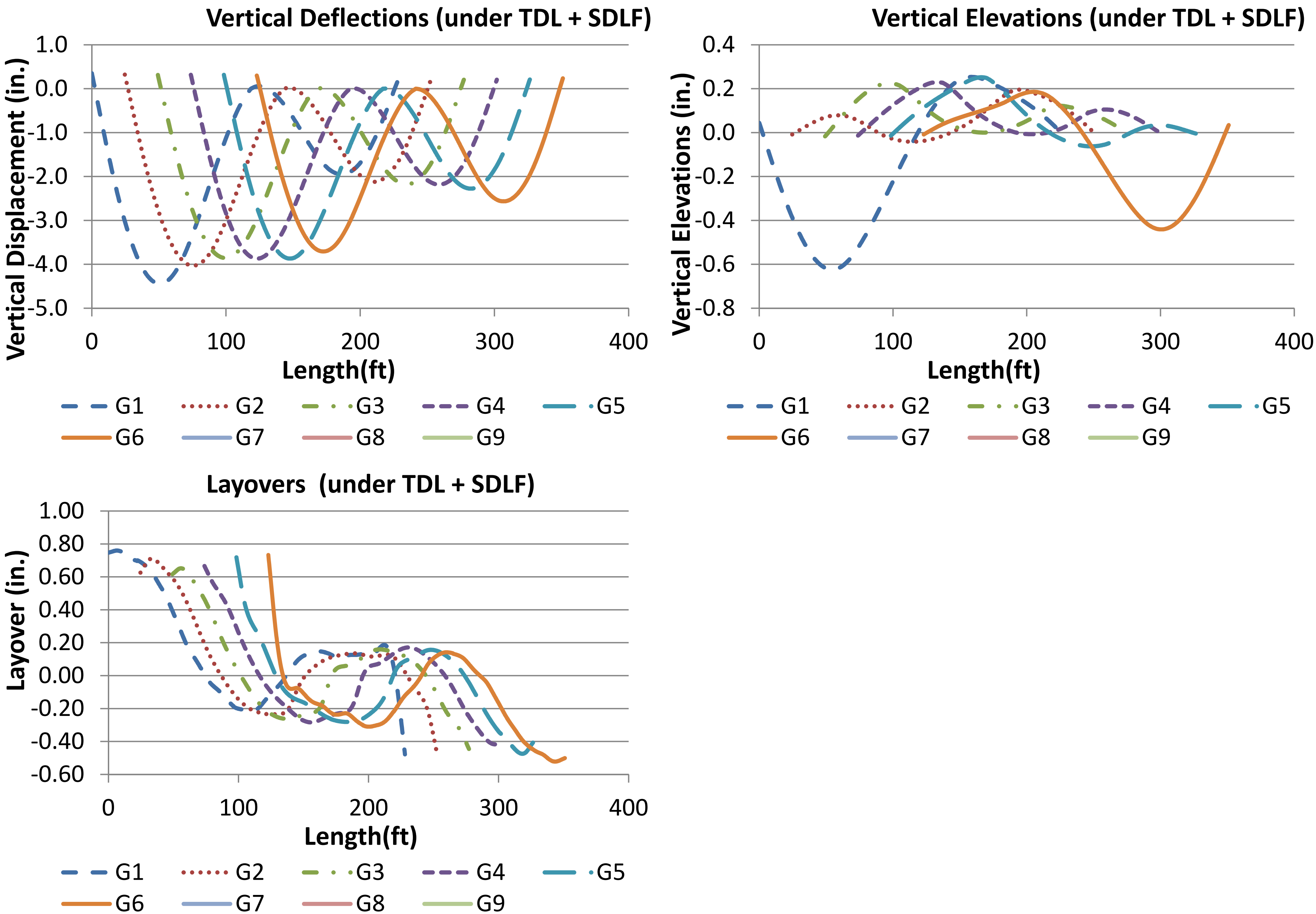


Figure K1-4-6. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

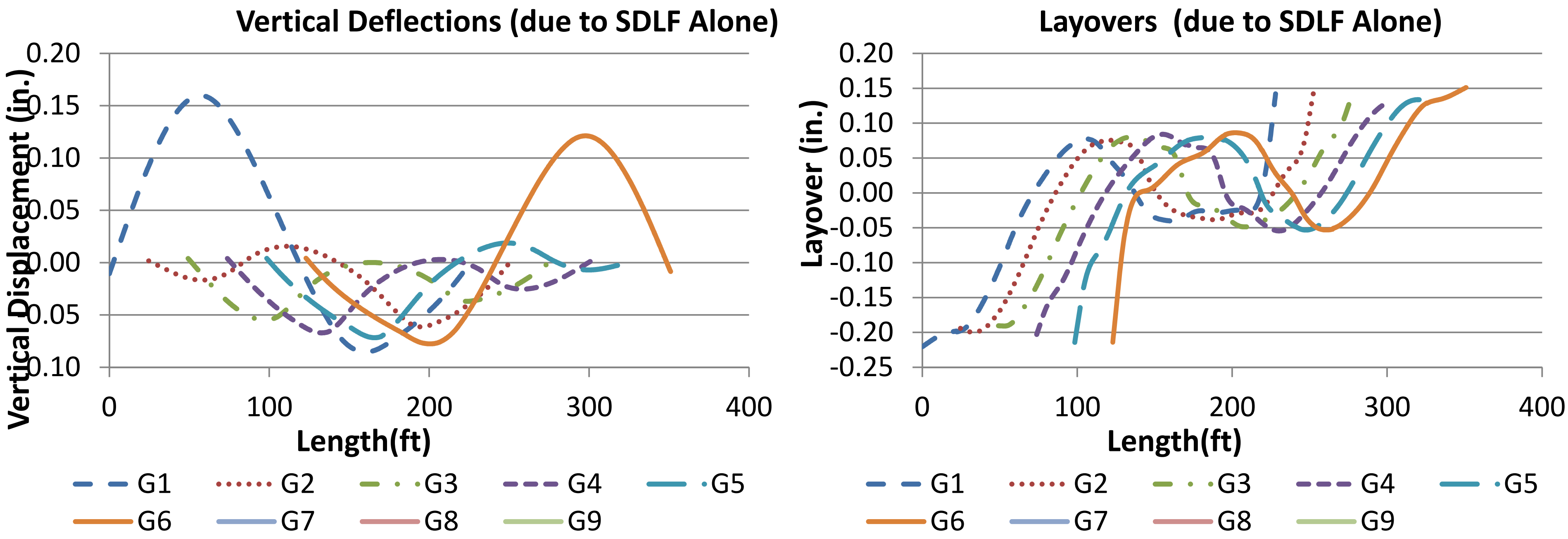


Figure K1-4-7. Bridge displacements due to SDLF detailing effects alone under NL(in).

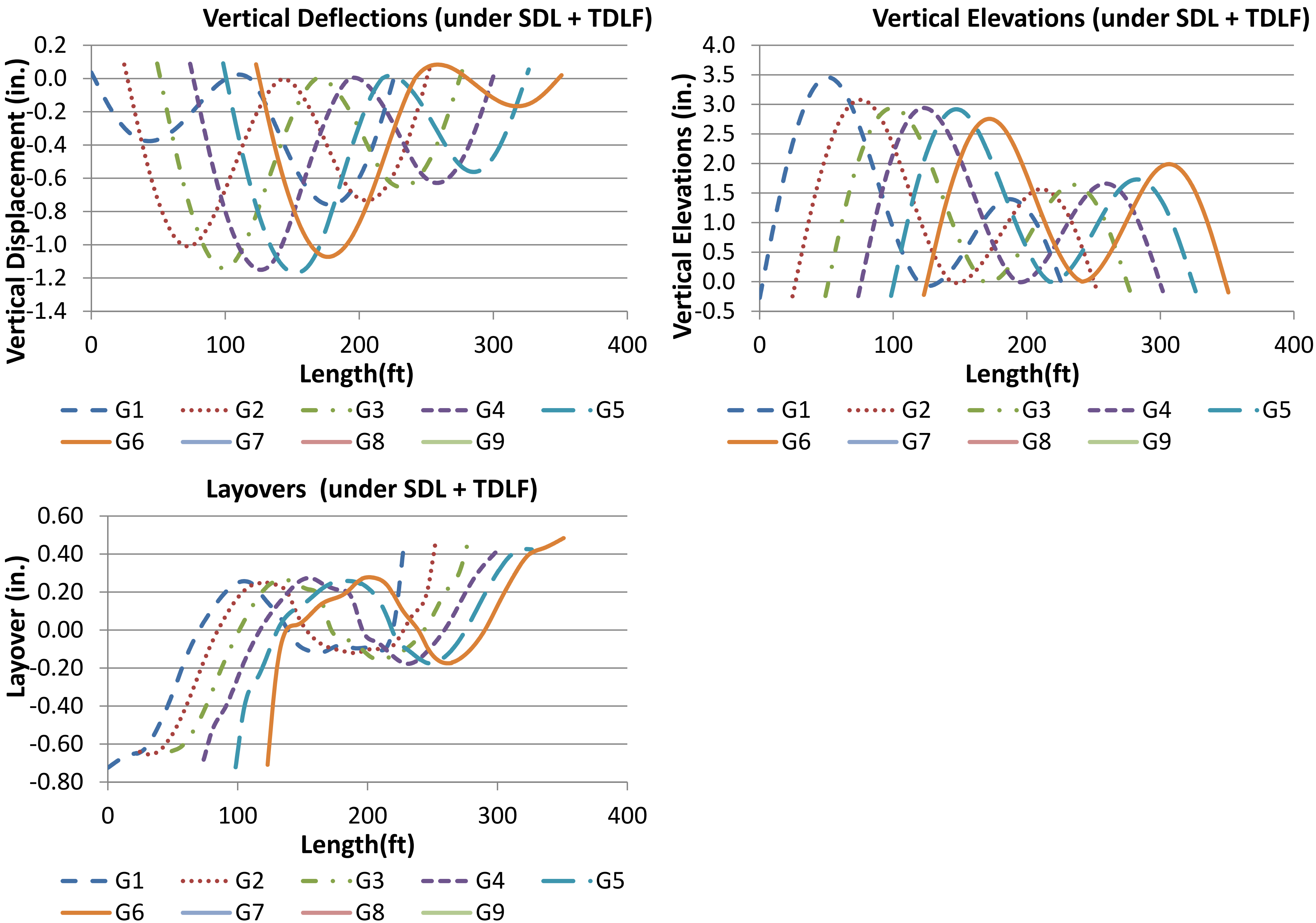


Figure K1-4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

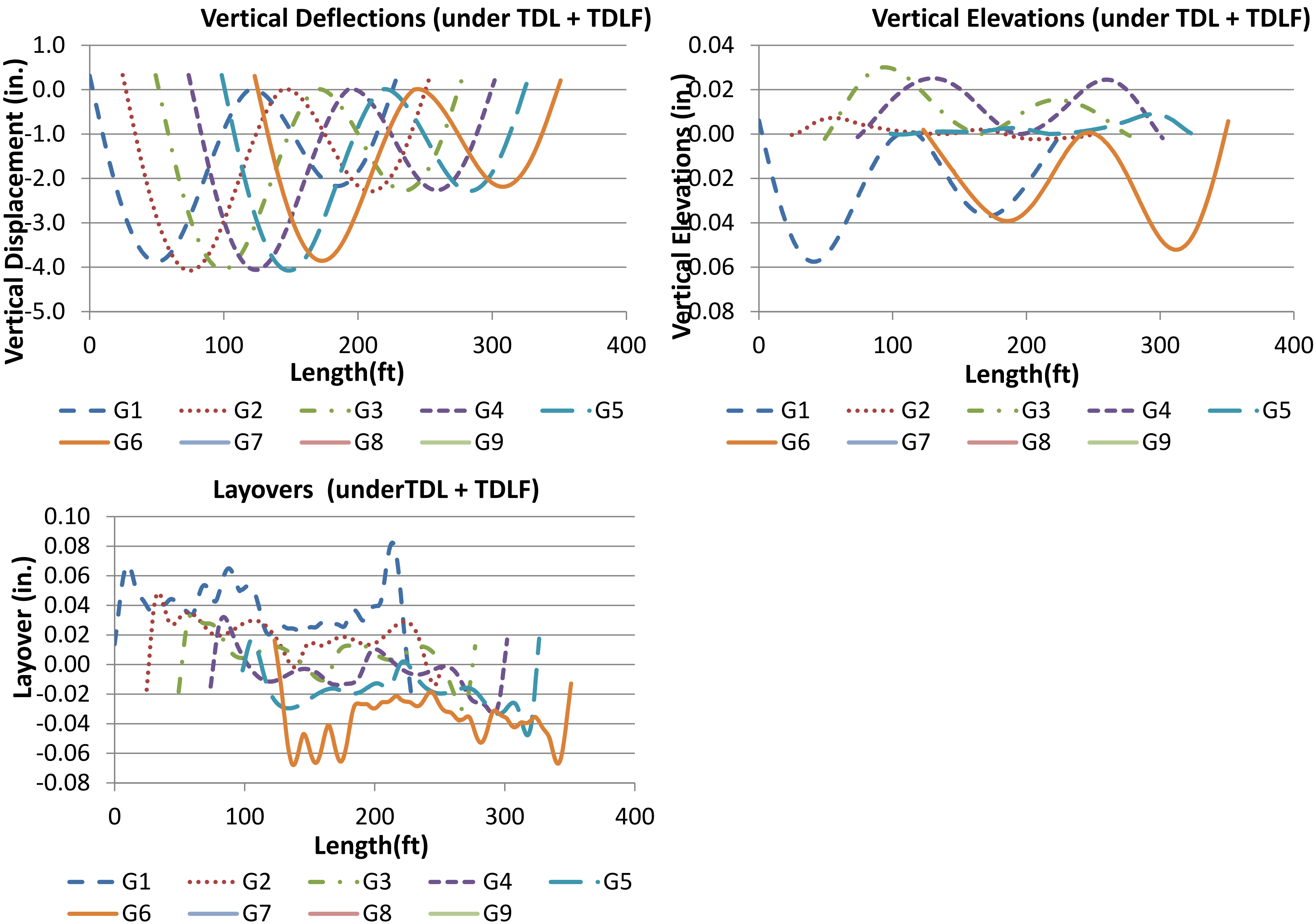


Figure K1-4-9. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

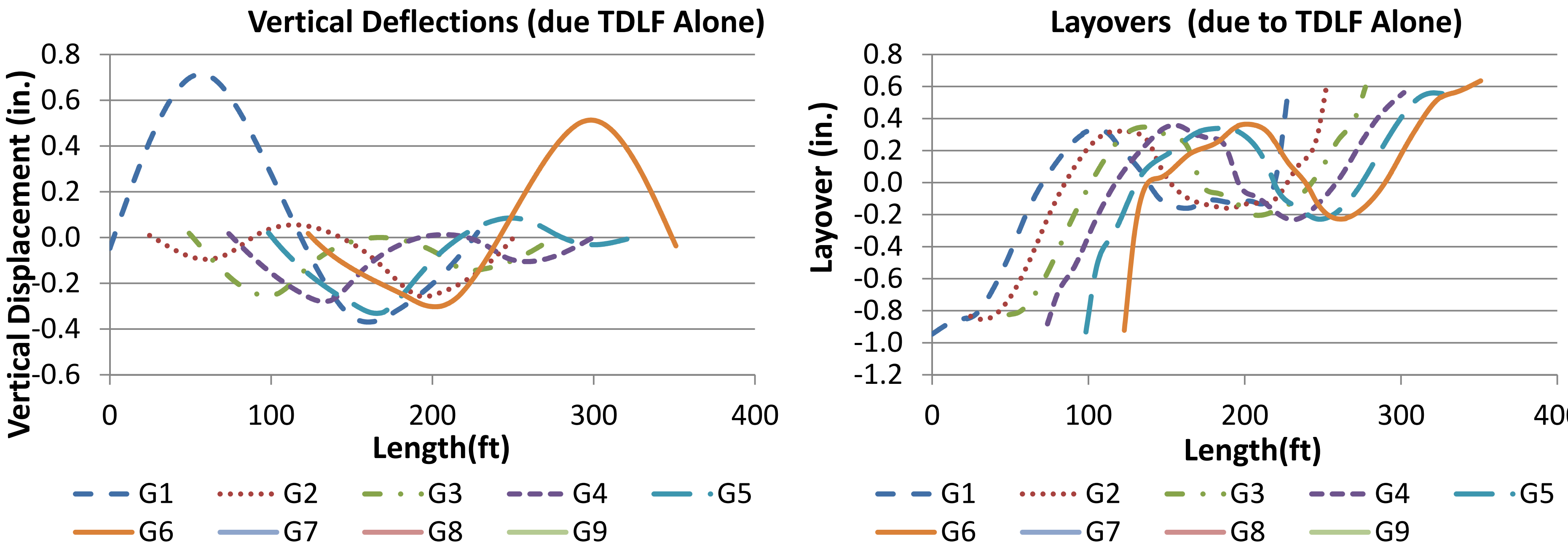


Figure K1-4-10. Bridge displacements due to TDLF detailing effects alone under NL (in).

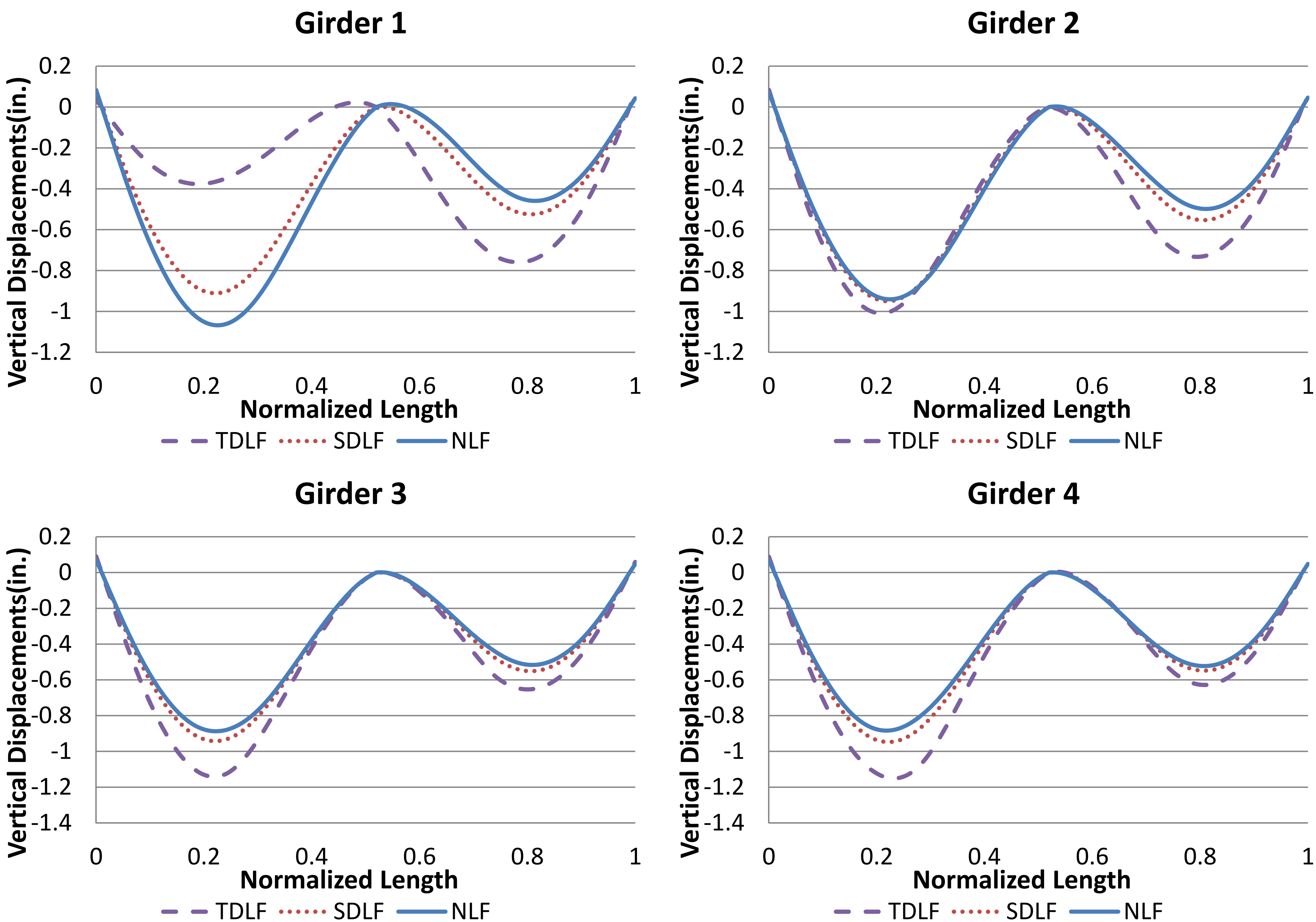


Figure K1-4-11. **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

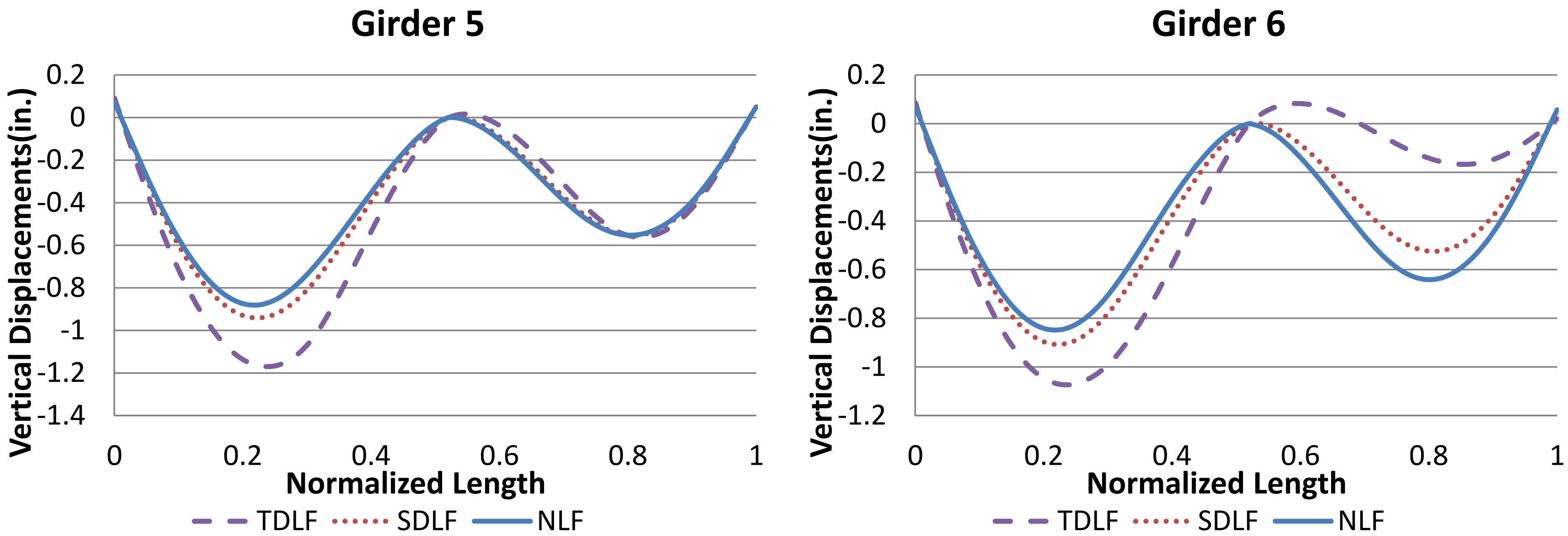


Figure K1-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

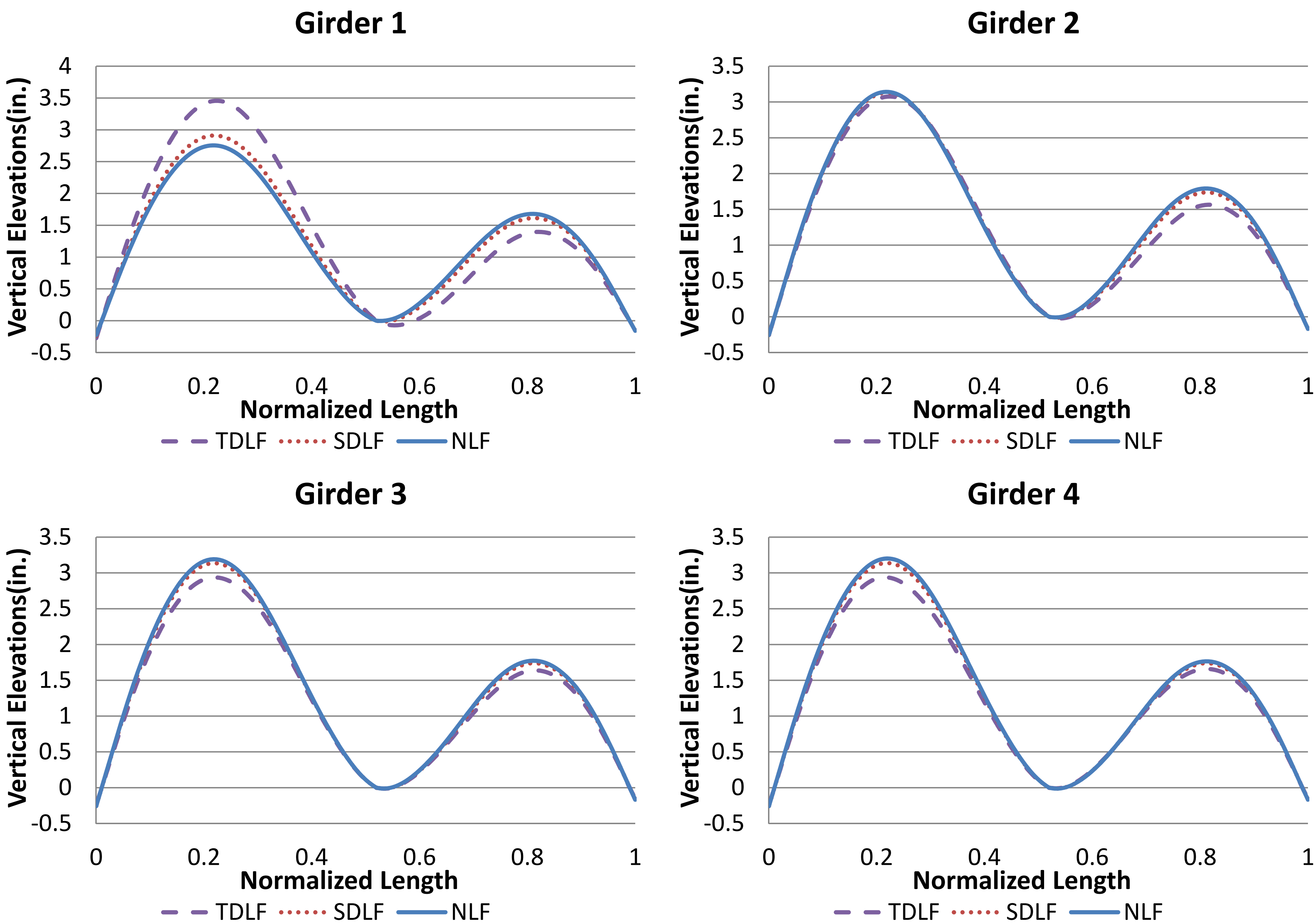


Figure K1-4-12. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

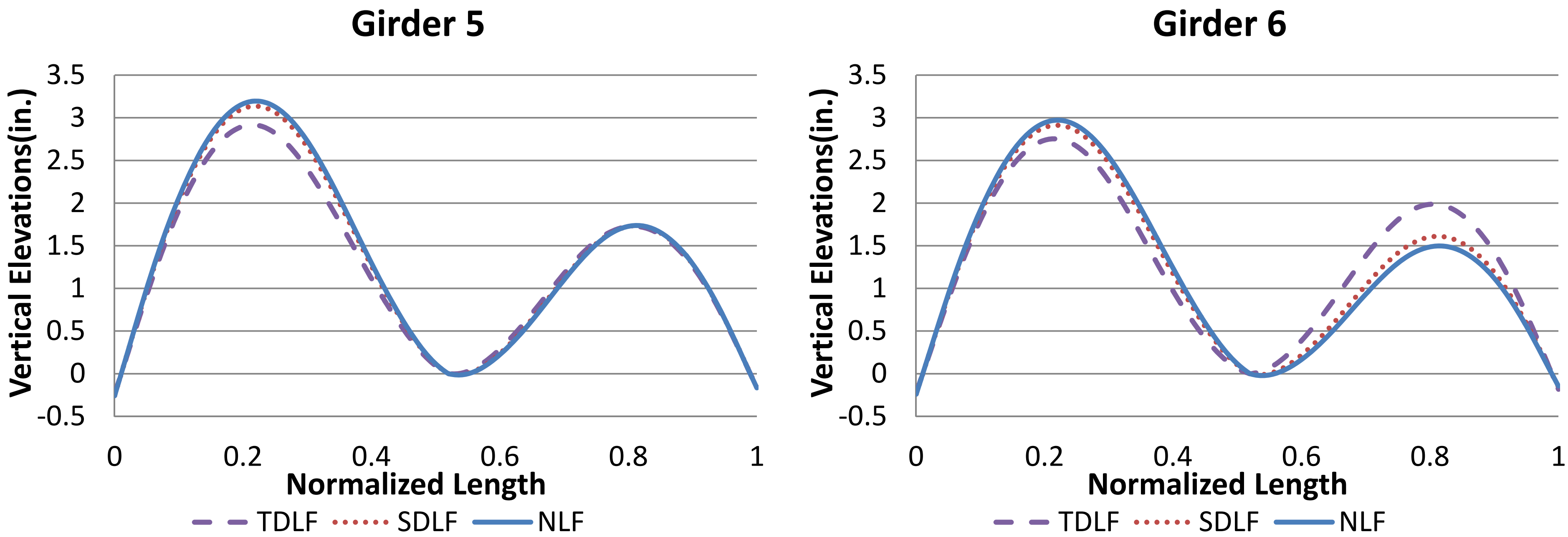


Figure K1-4-12(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

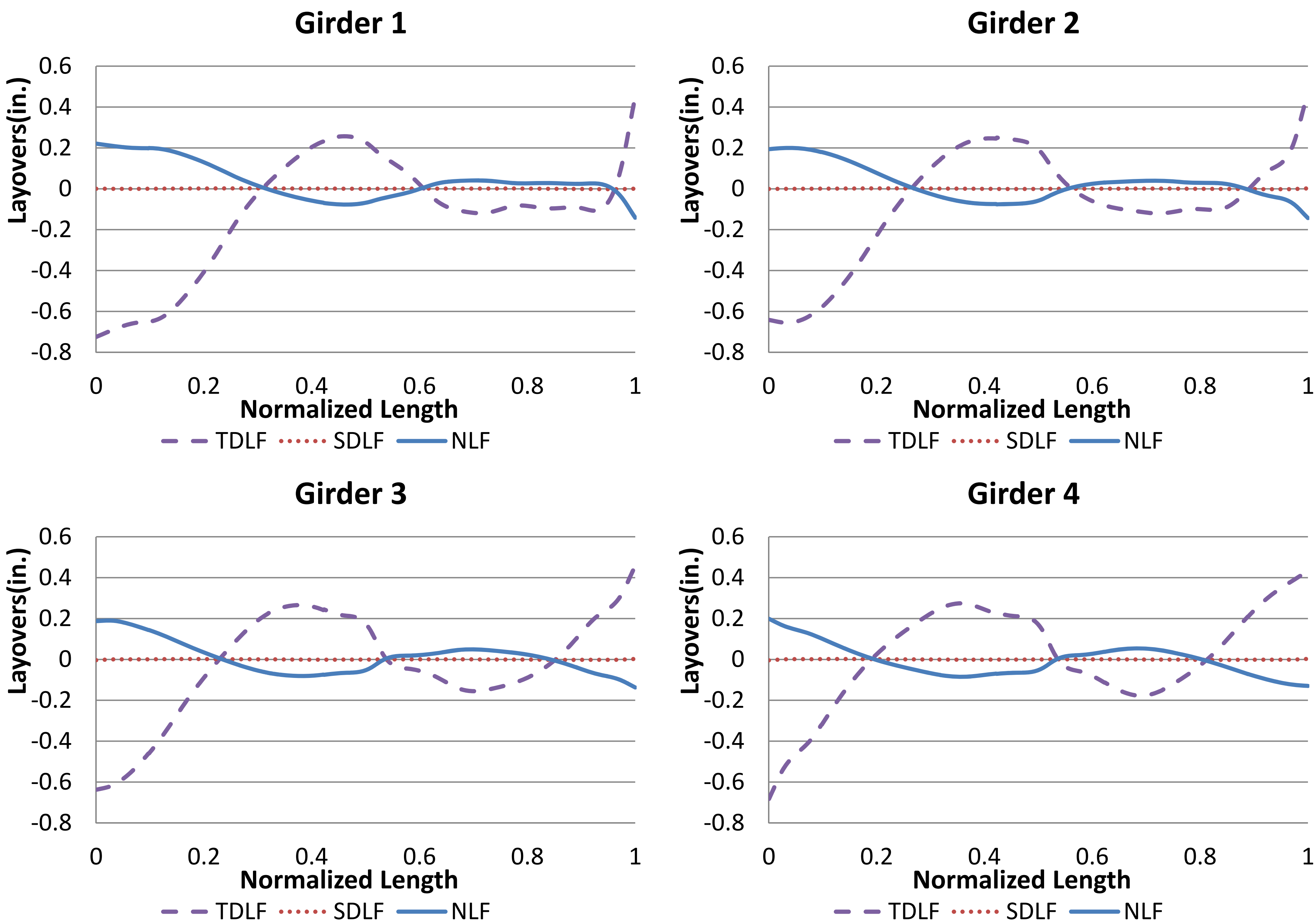
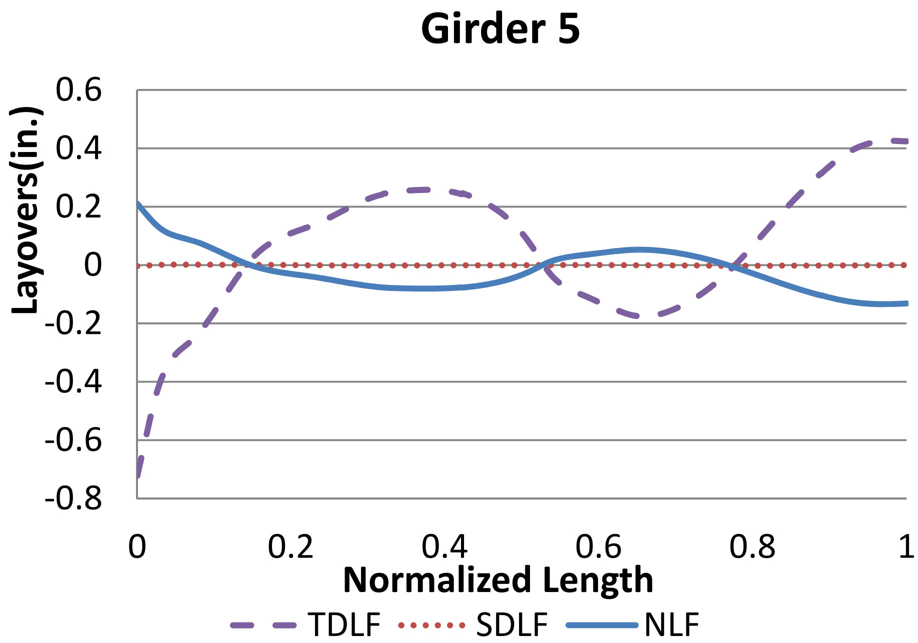


Figure K1-4-13. **Comparison of individual girder layovers (in) under SDL for different detailing methods.**



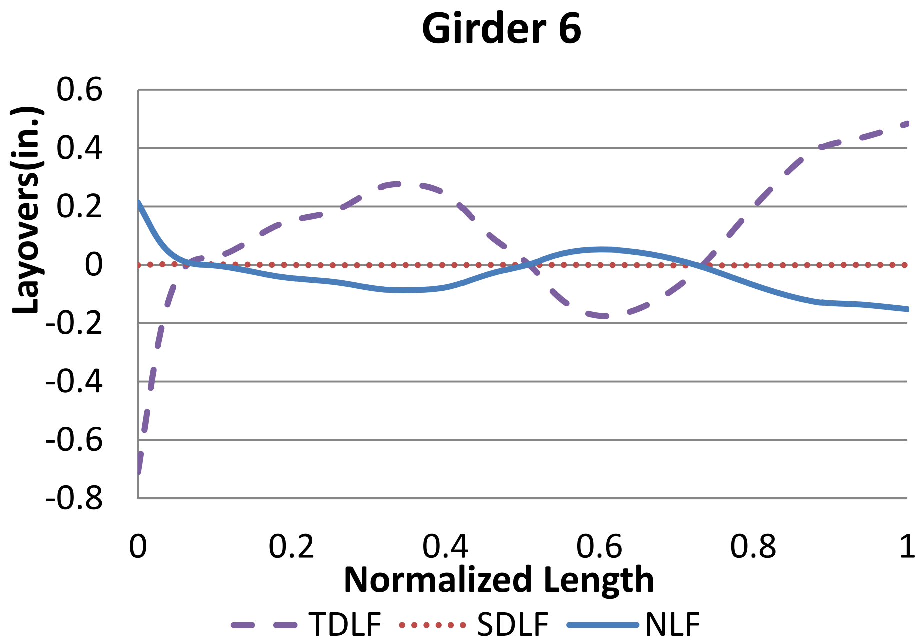


Figure K1-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

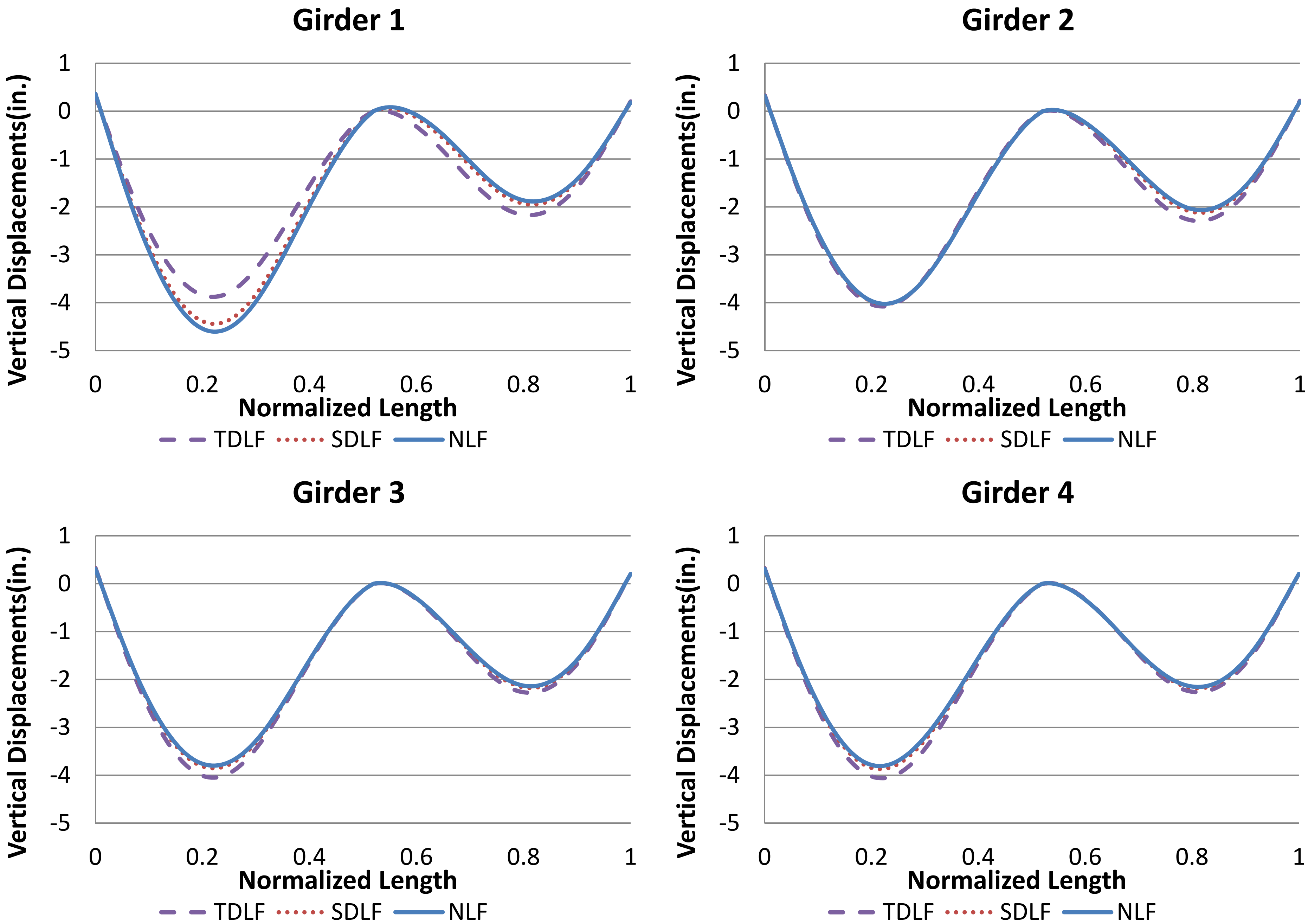
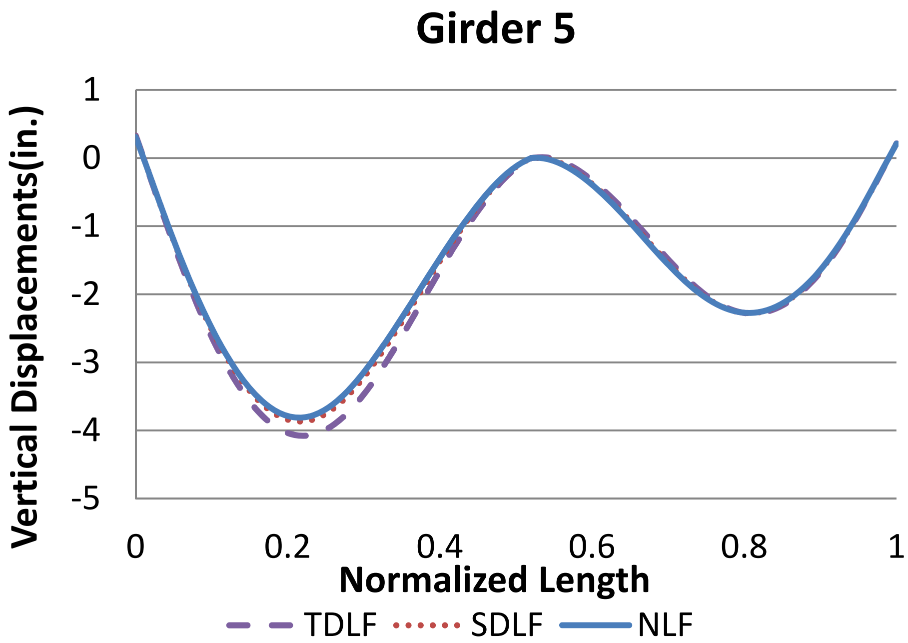


Figure K1-4-14. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**



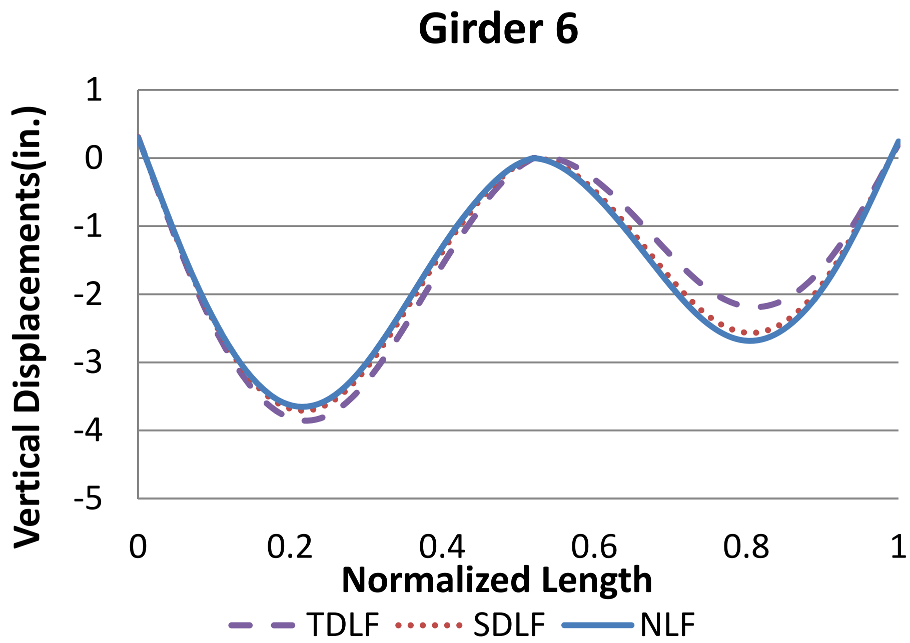


Figure K1-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

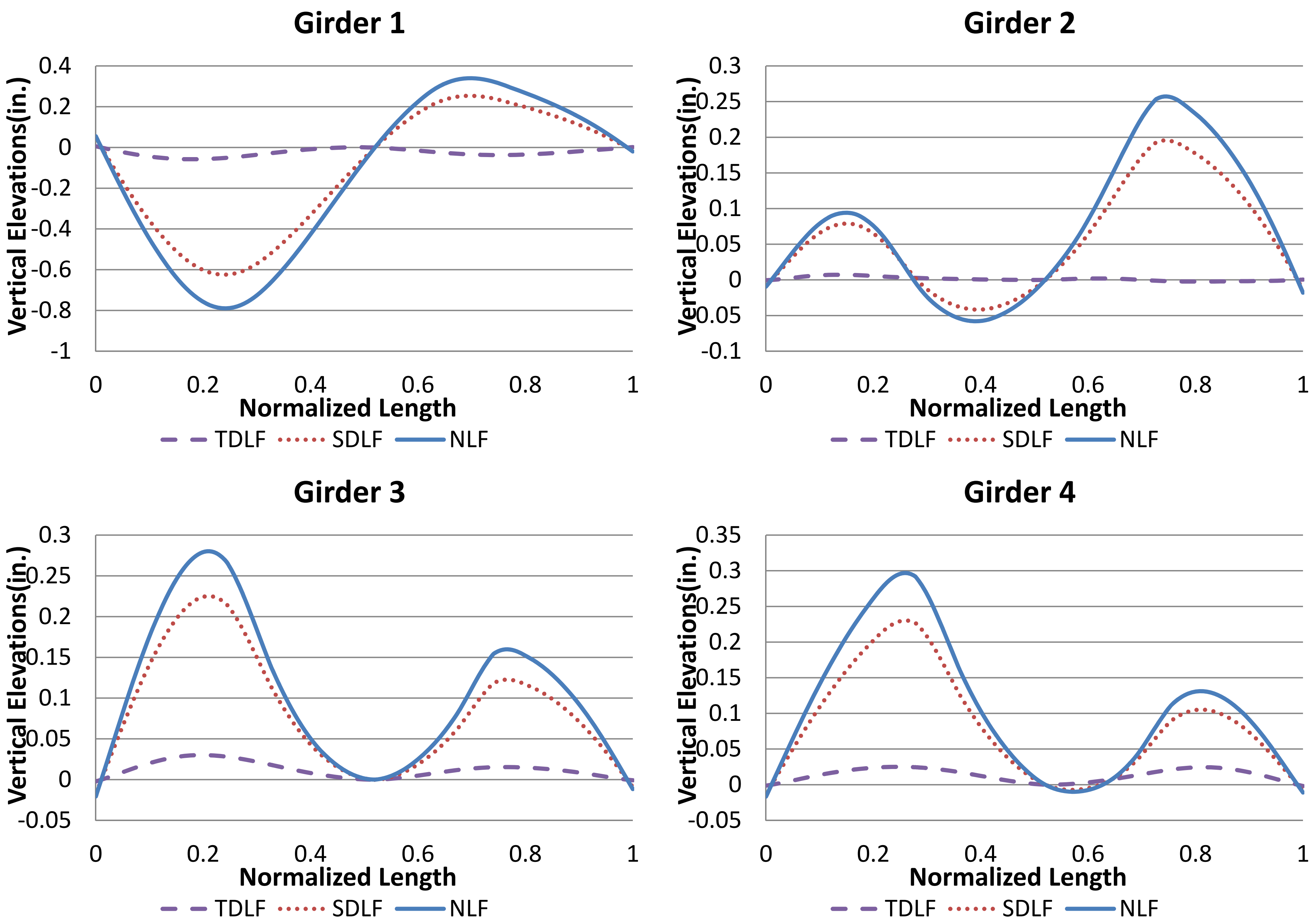
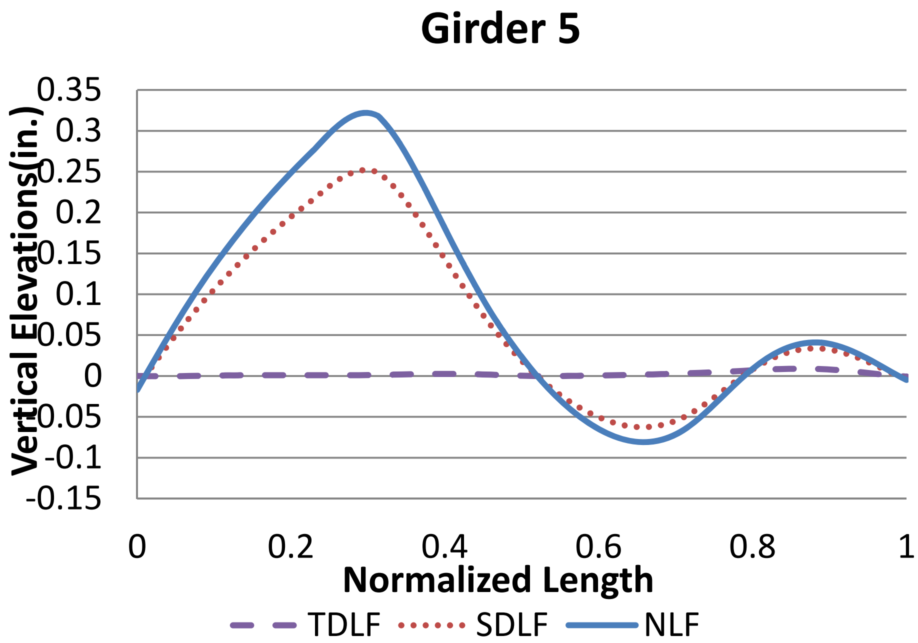


Figure K1-4-15. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.



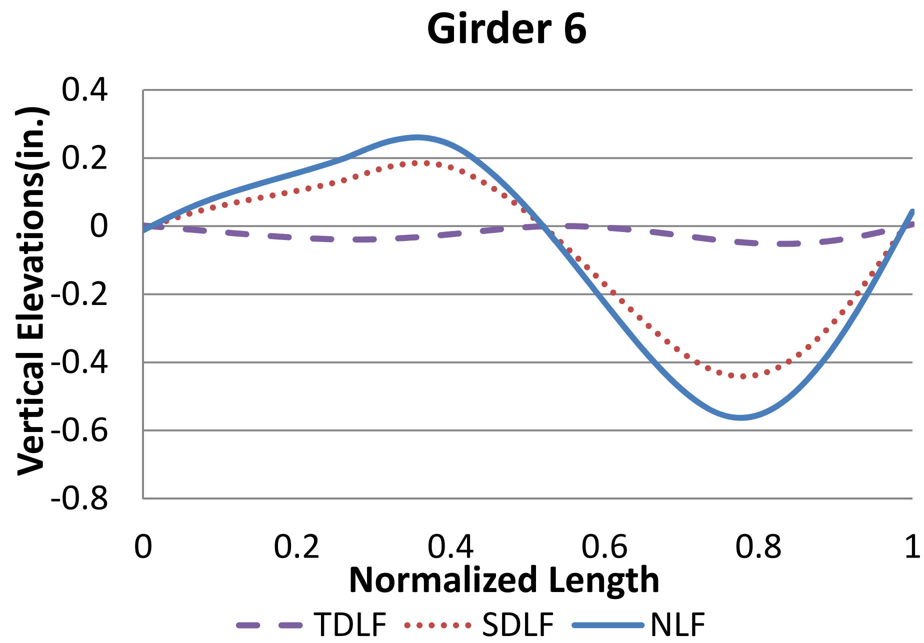


Figure K1-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

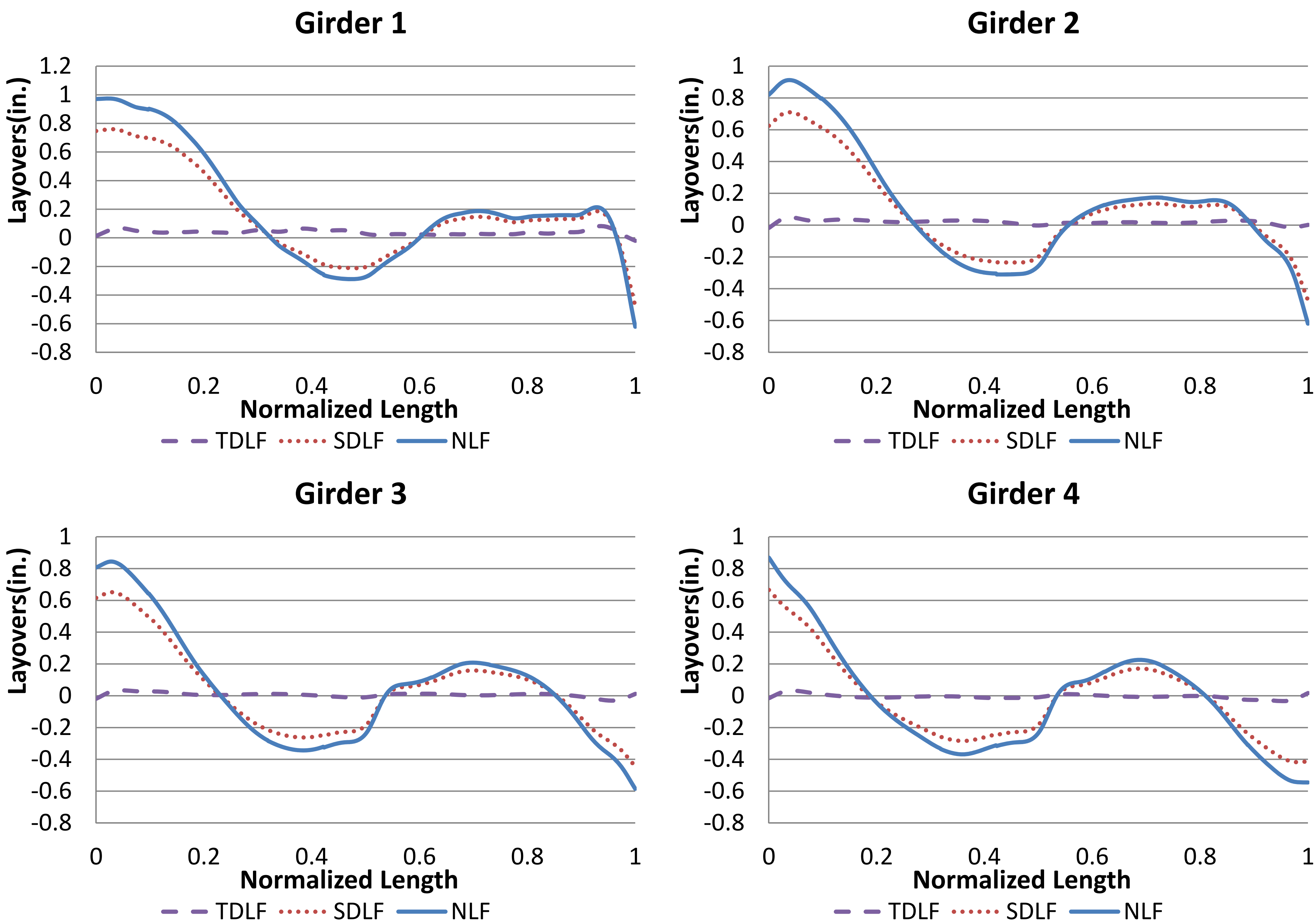


Figure K1-4-16. **Comparison of individual girder layovers (in) under TDL for different detailing methods.**

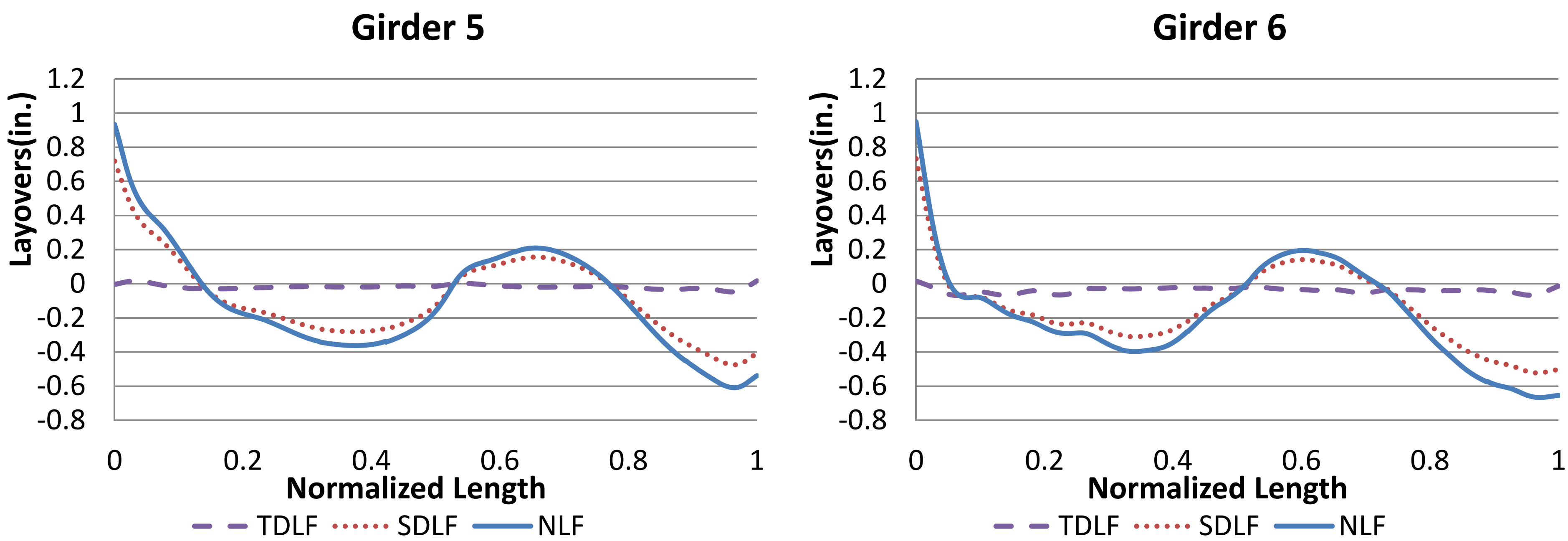


Figure K1-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

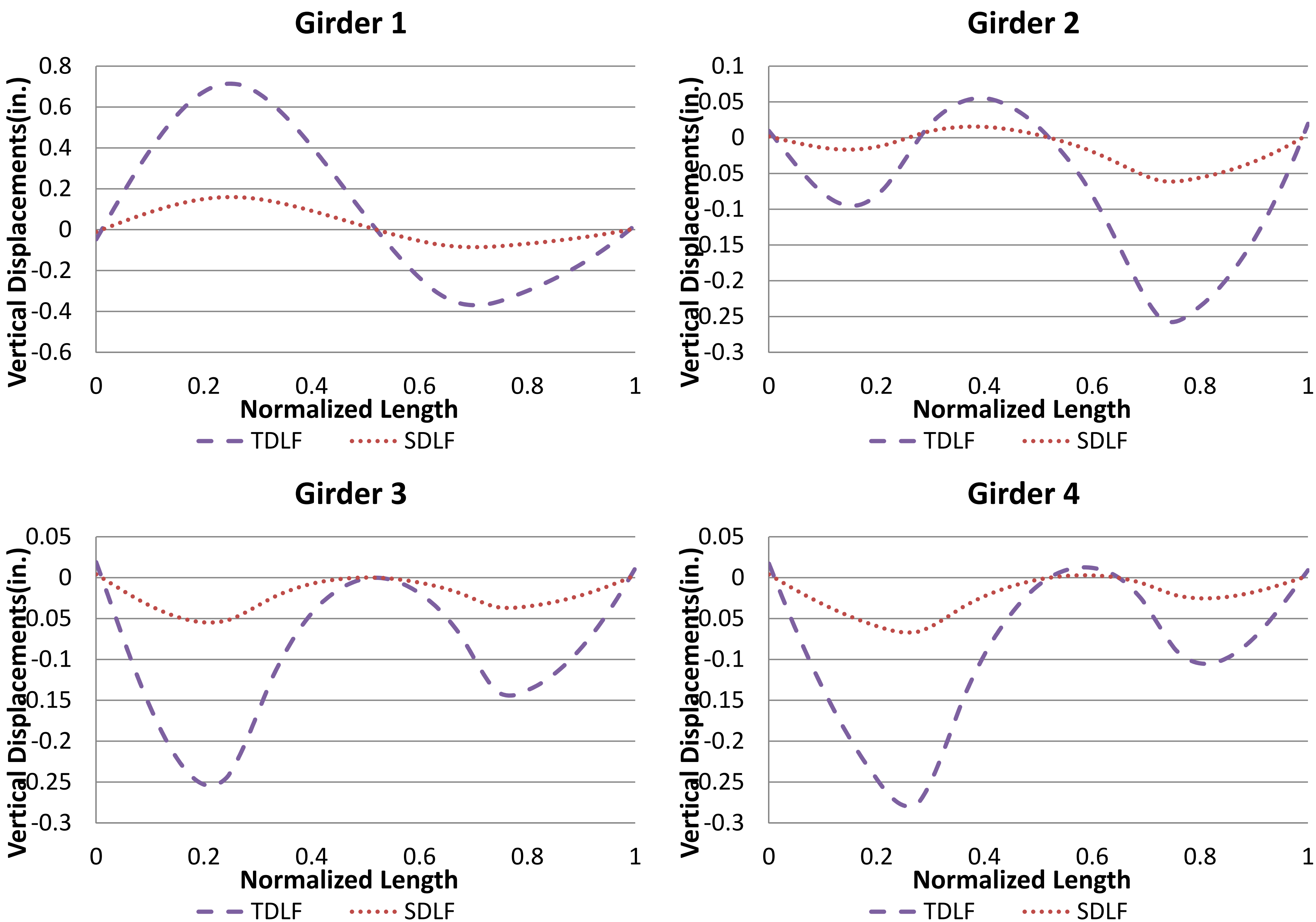


Figure K1-4-17. **Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.**

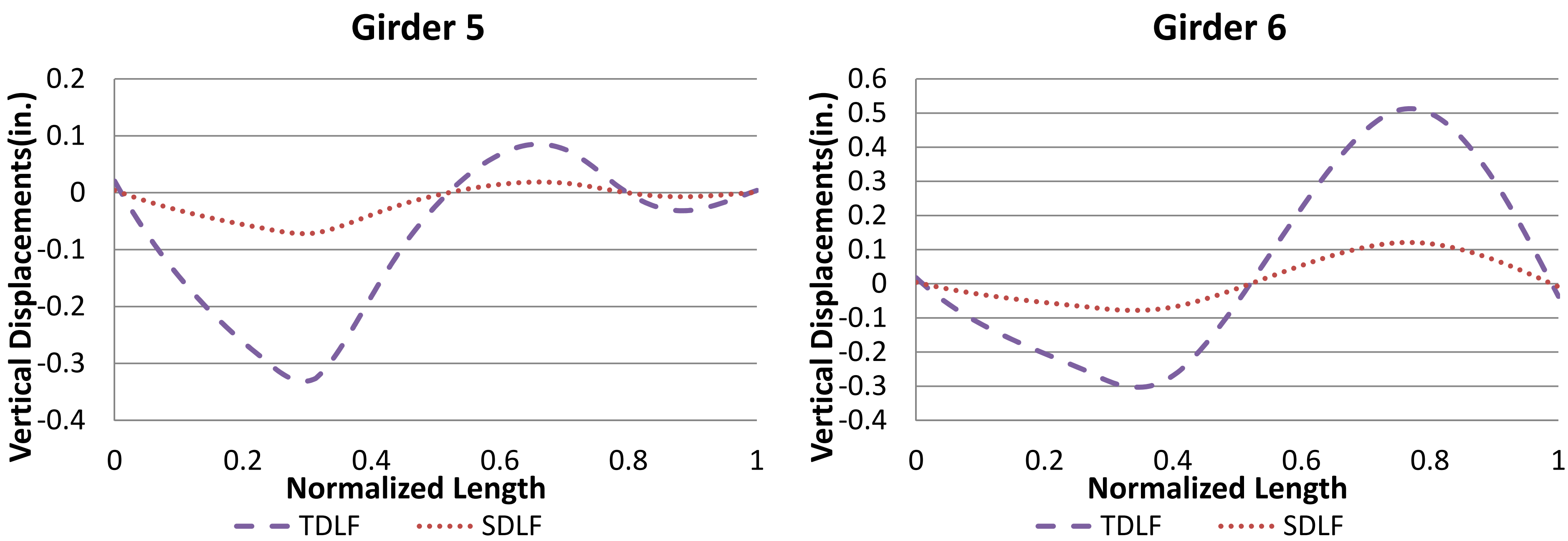


Figure K1-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

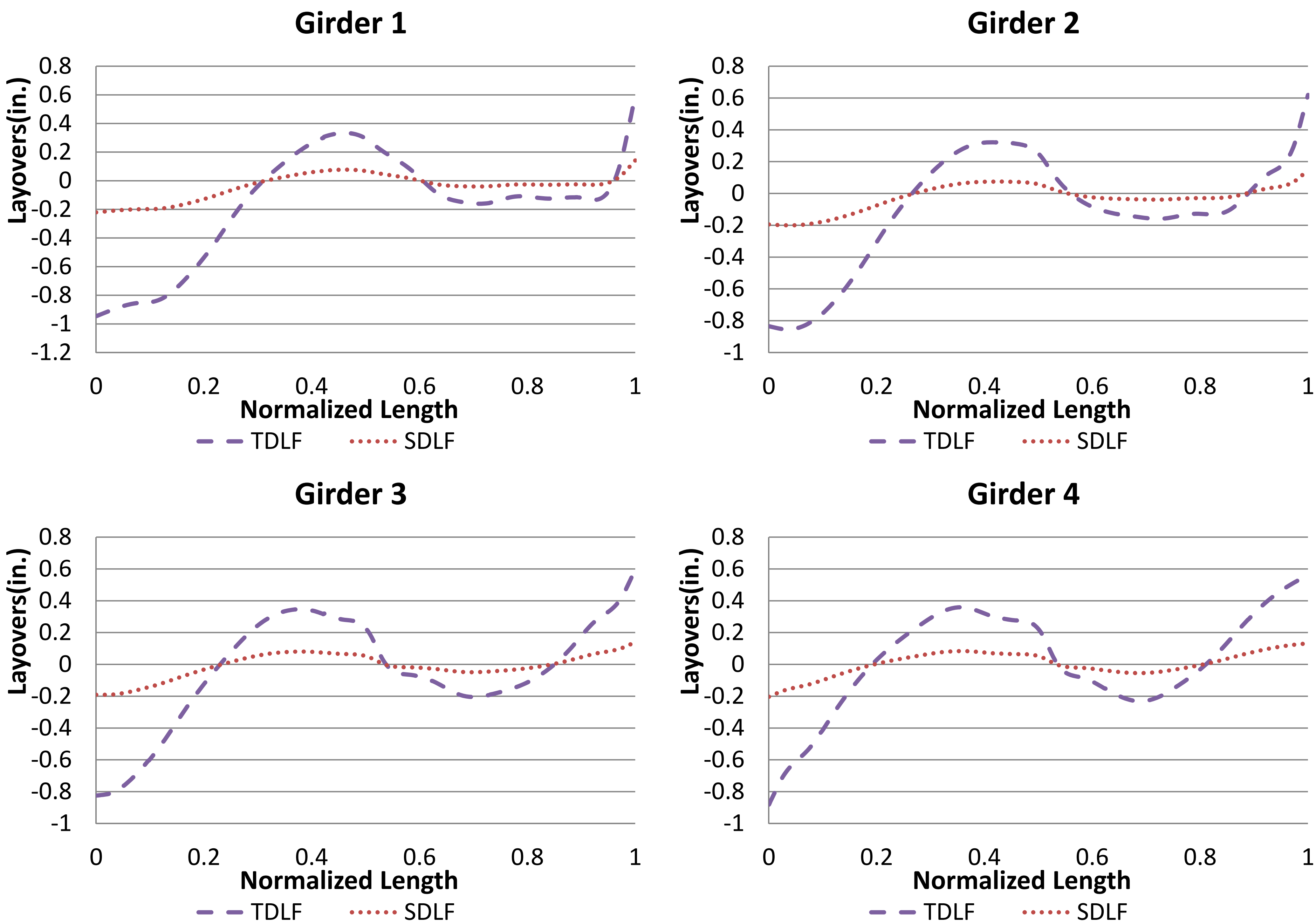
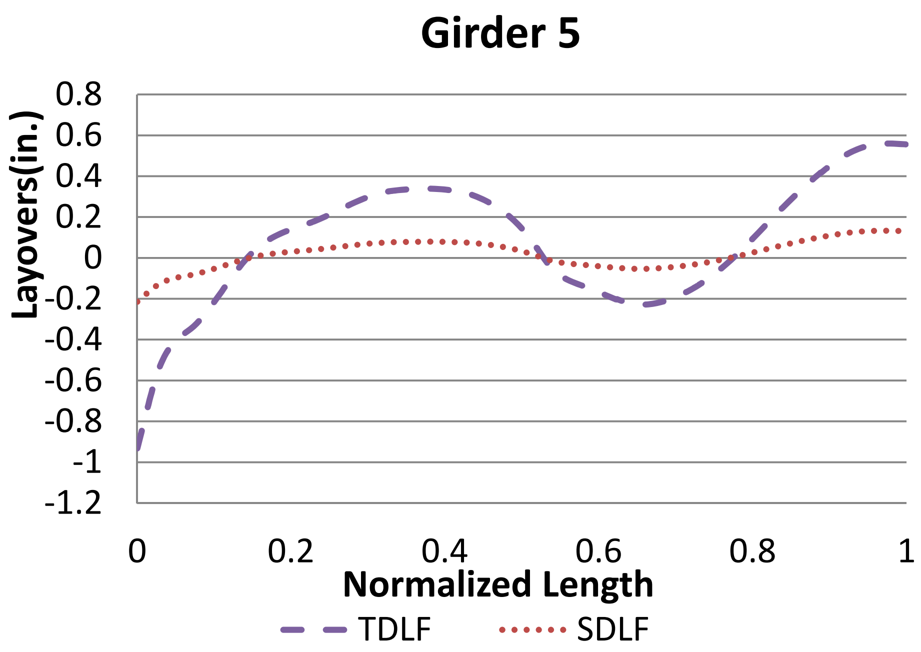


Figure K1-4-18. **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.**



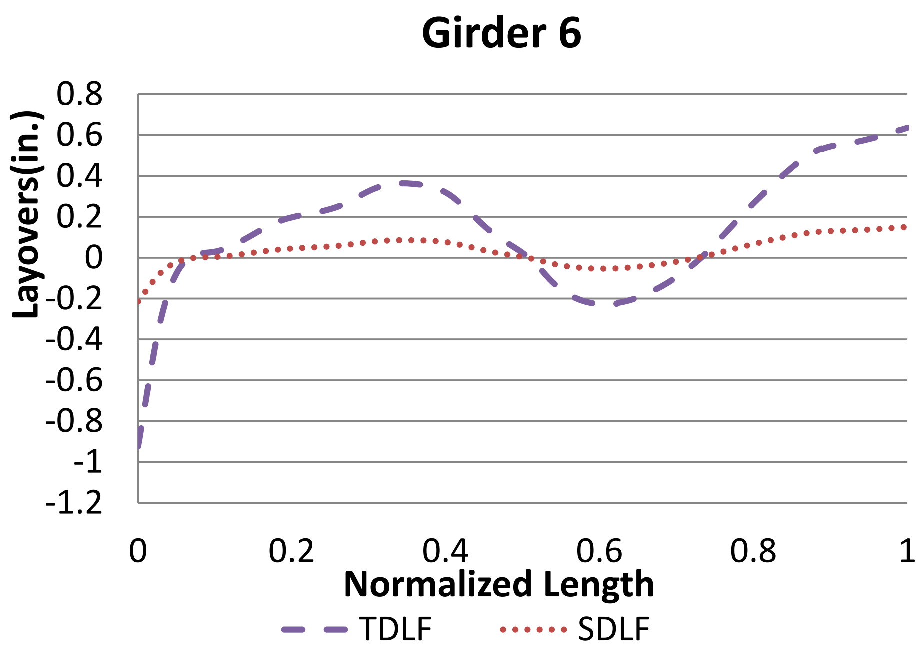


Figure K1-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

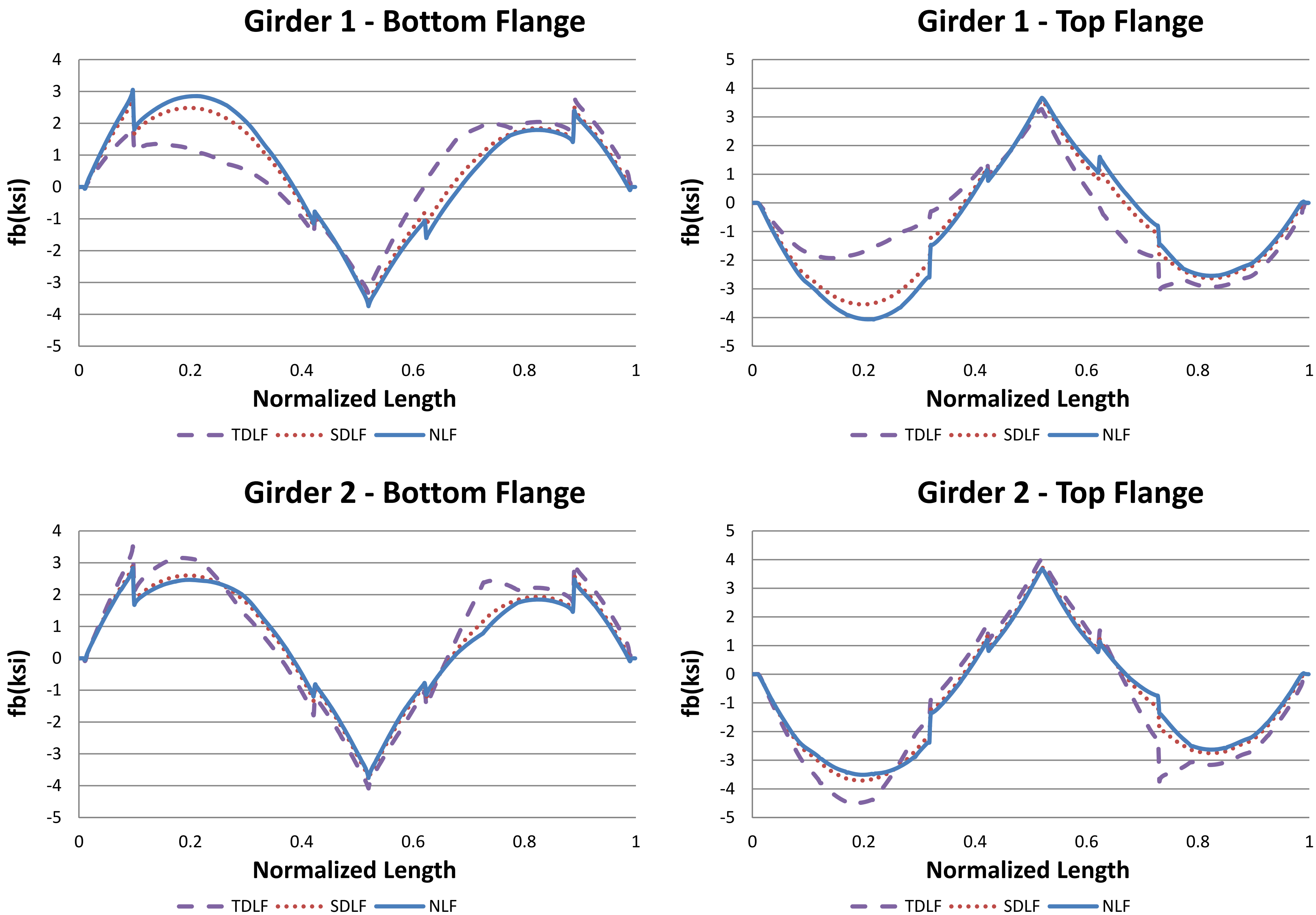


Figure K1-4-19. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

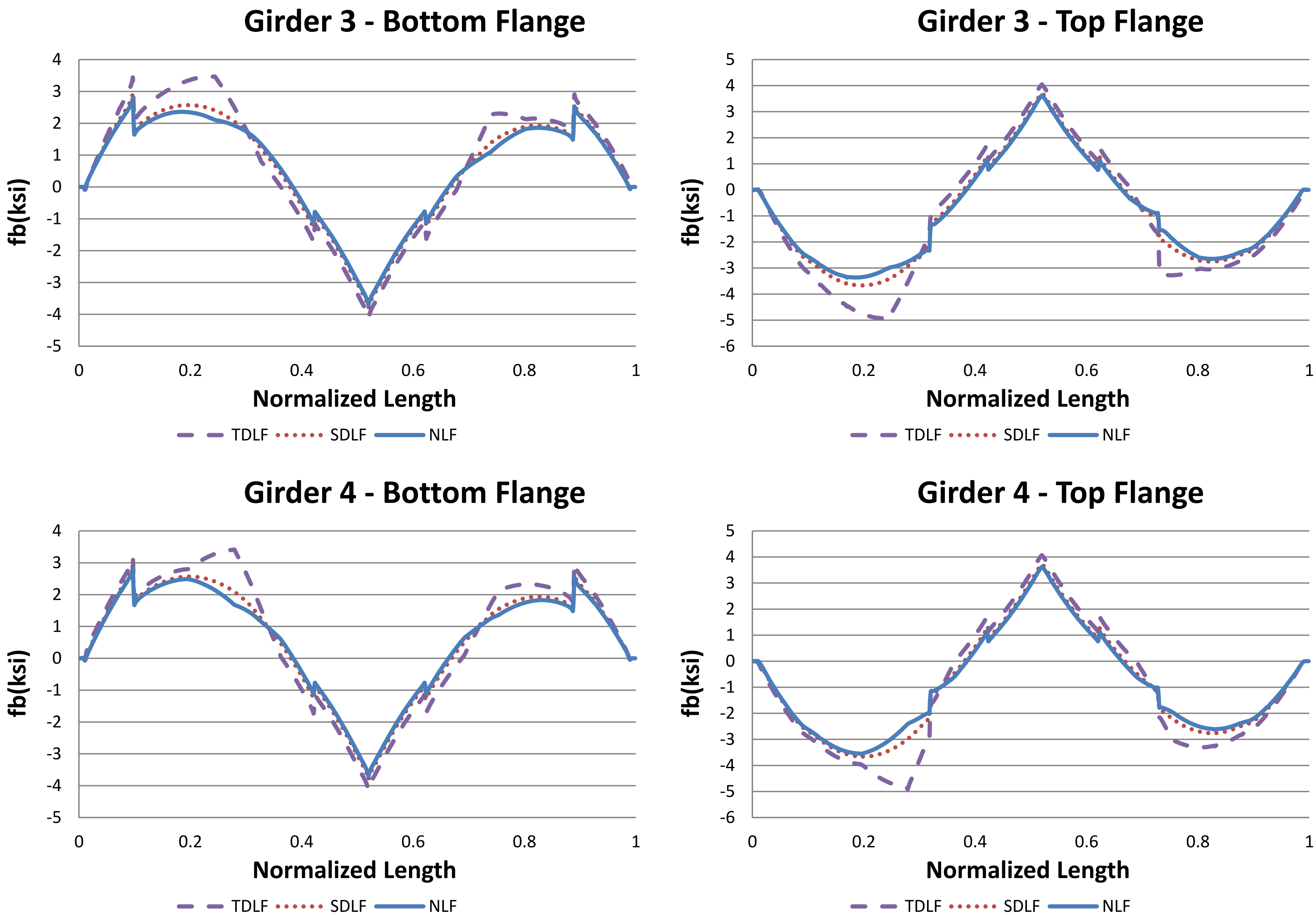


Figure K1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

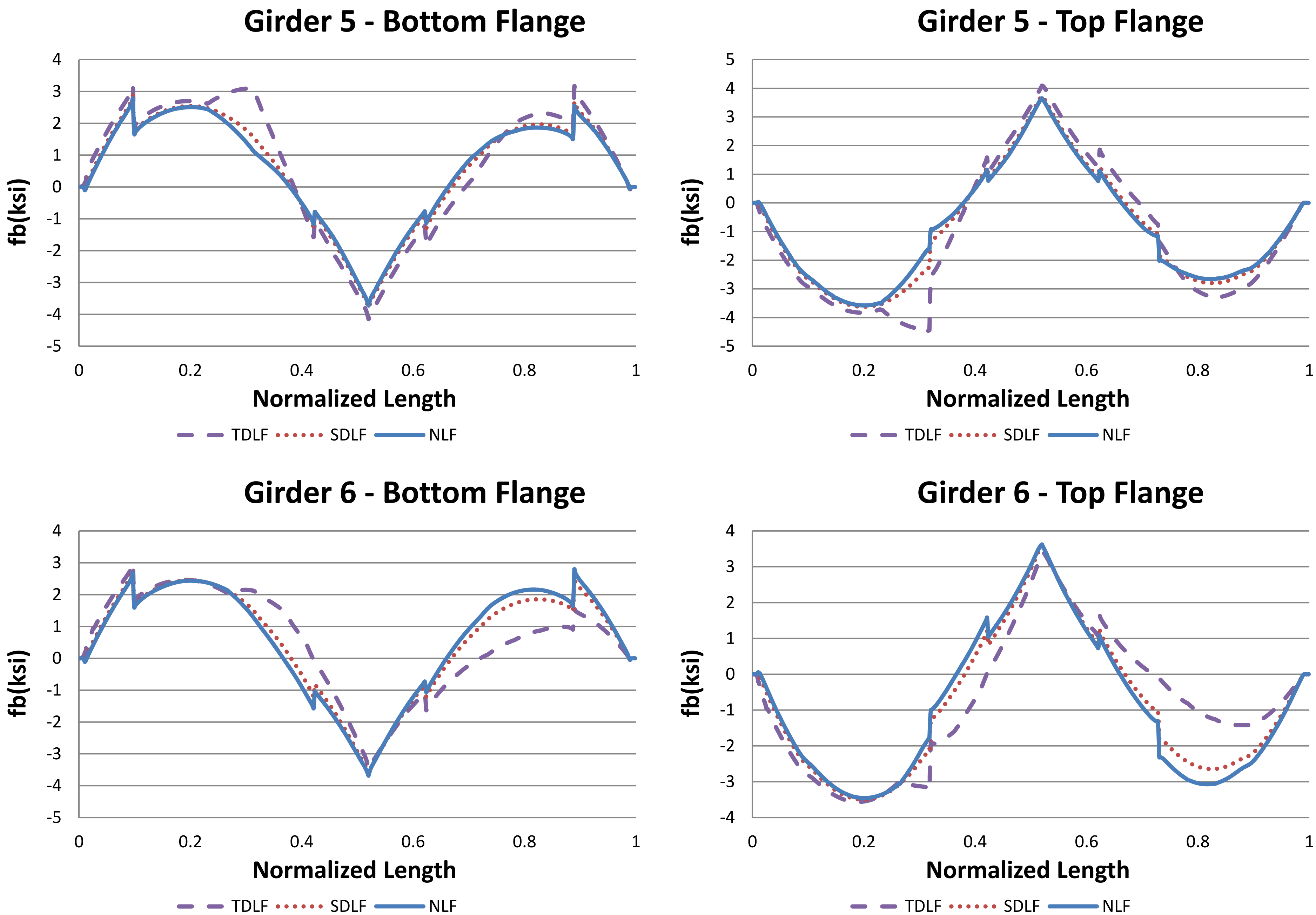


Figure K1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

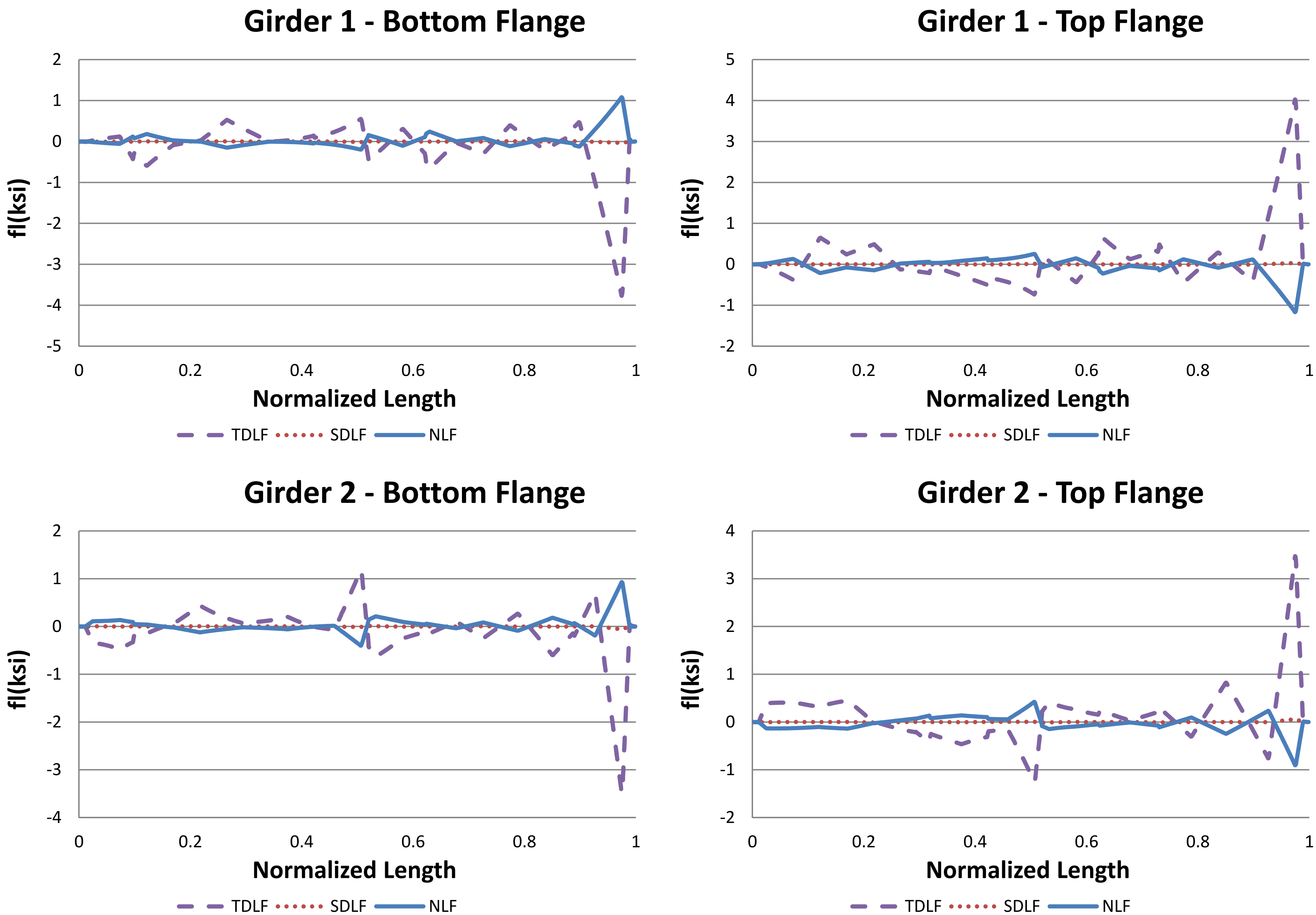


Figure K1-4-20. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

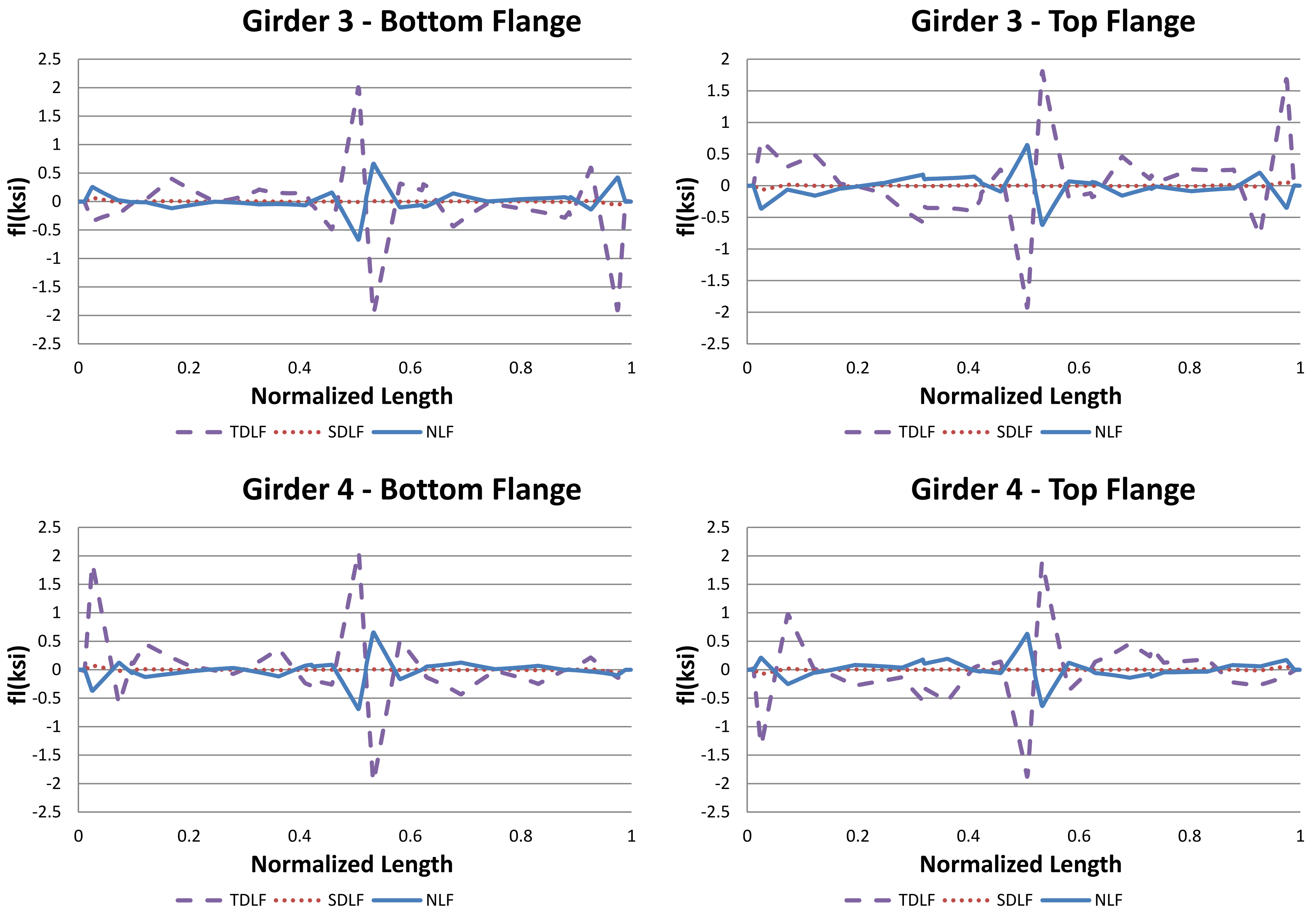


Figure K1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

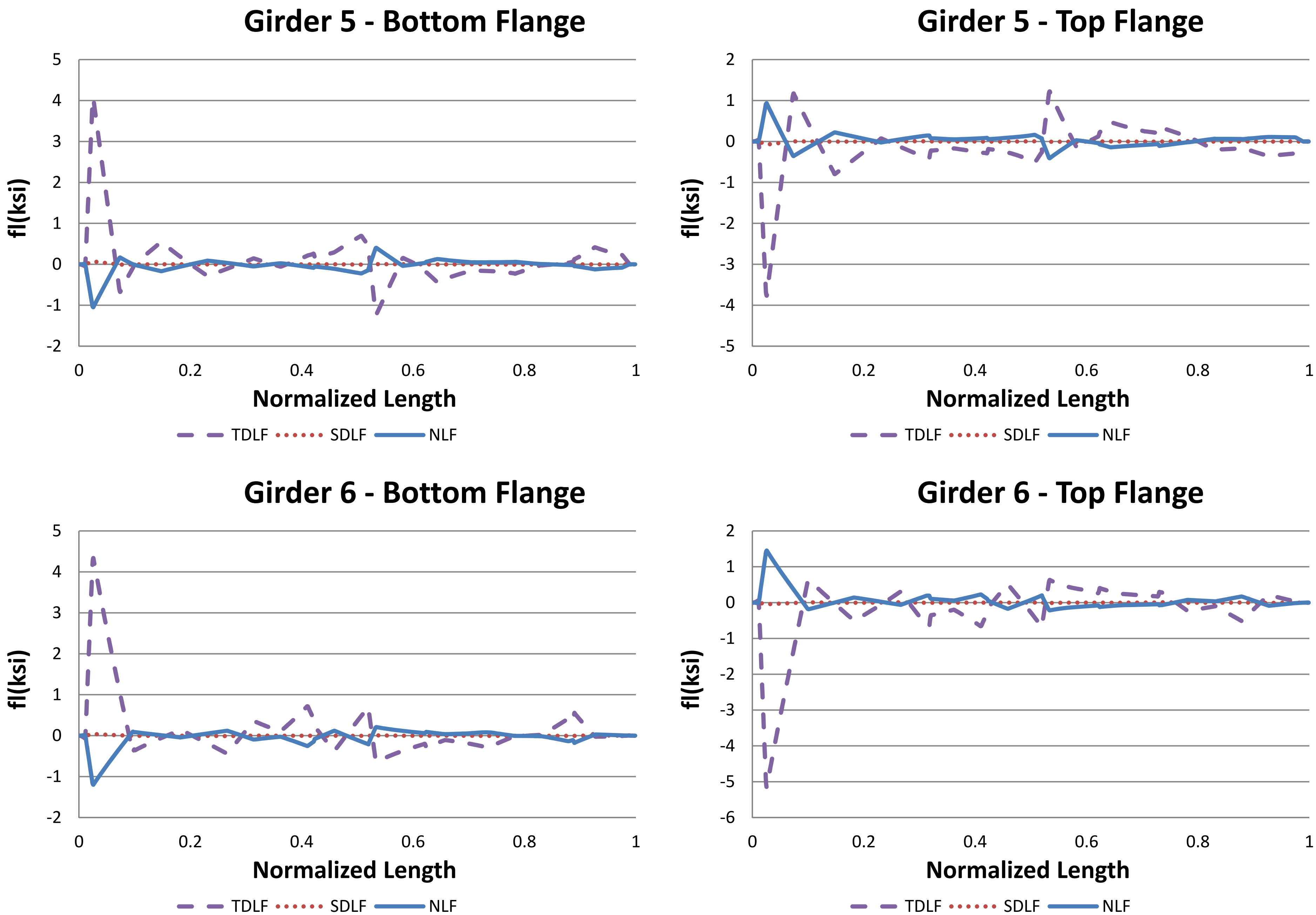


Figure K1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

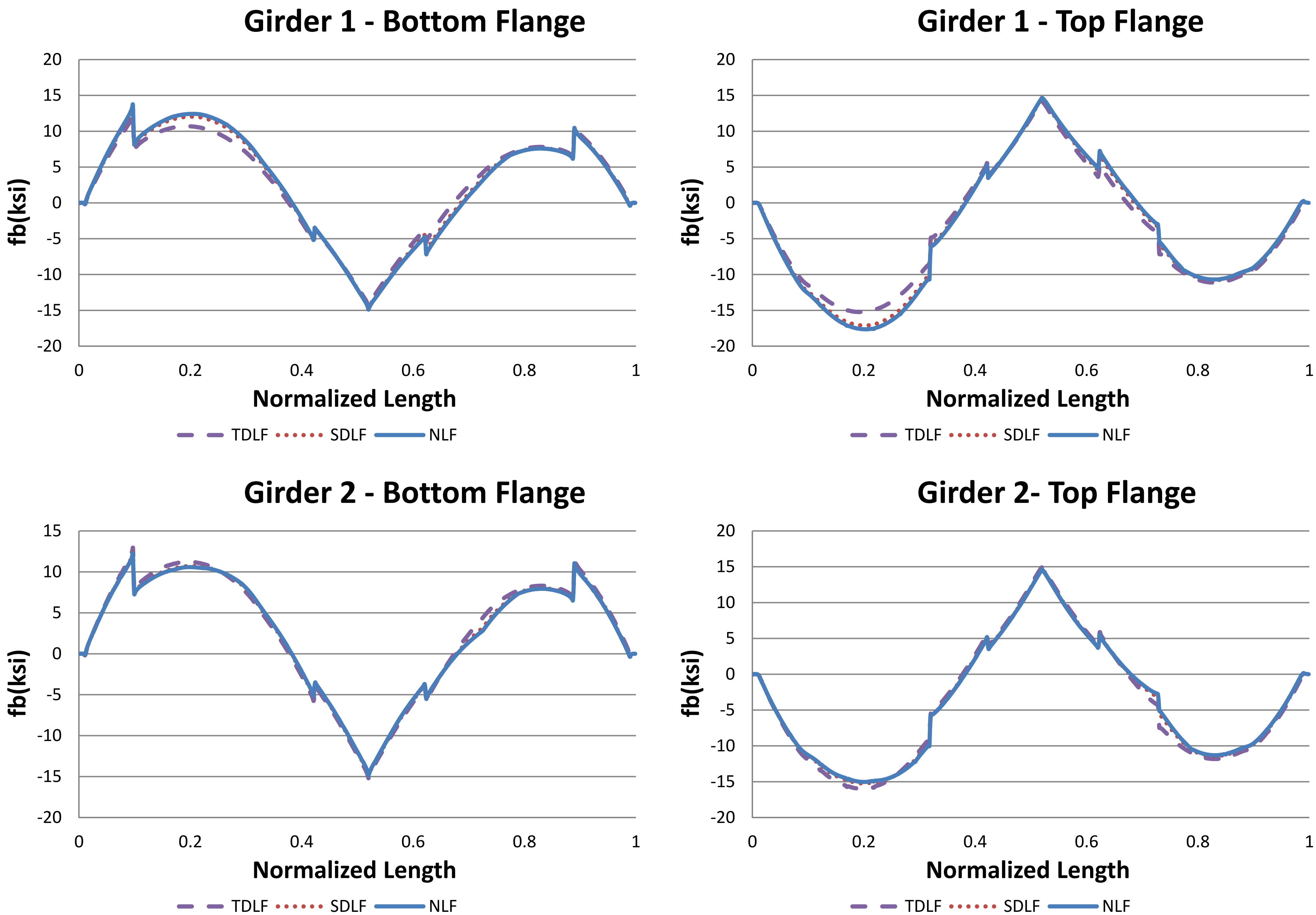


Figure K1-4-21. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

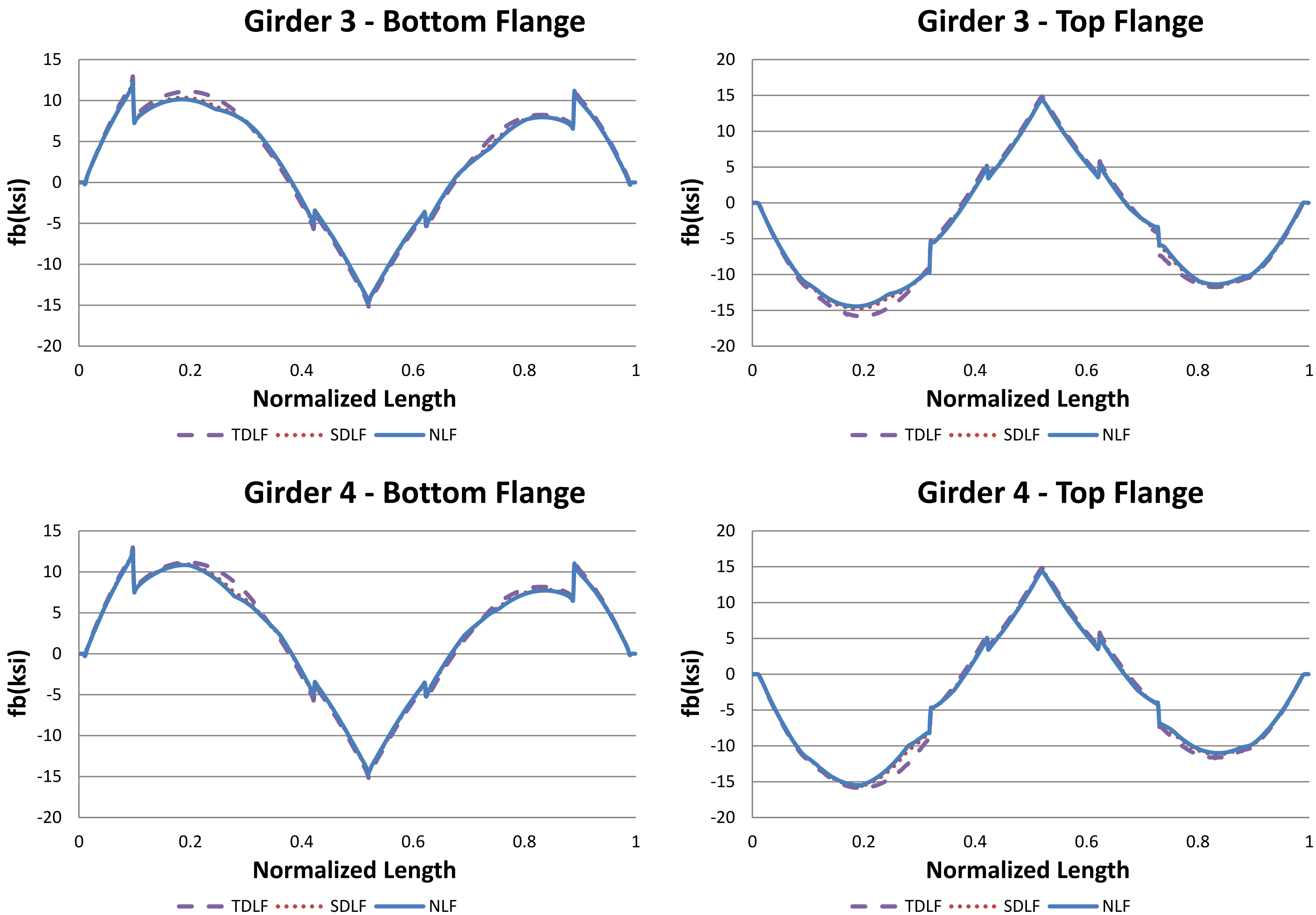


Figure K1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

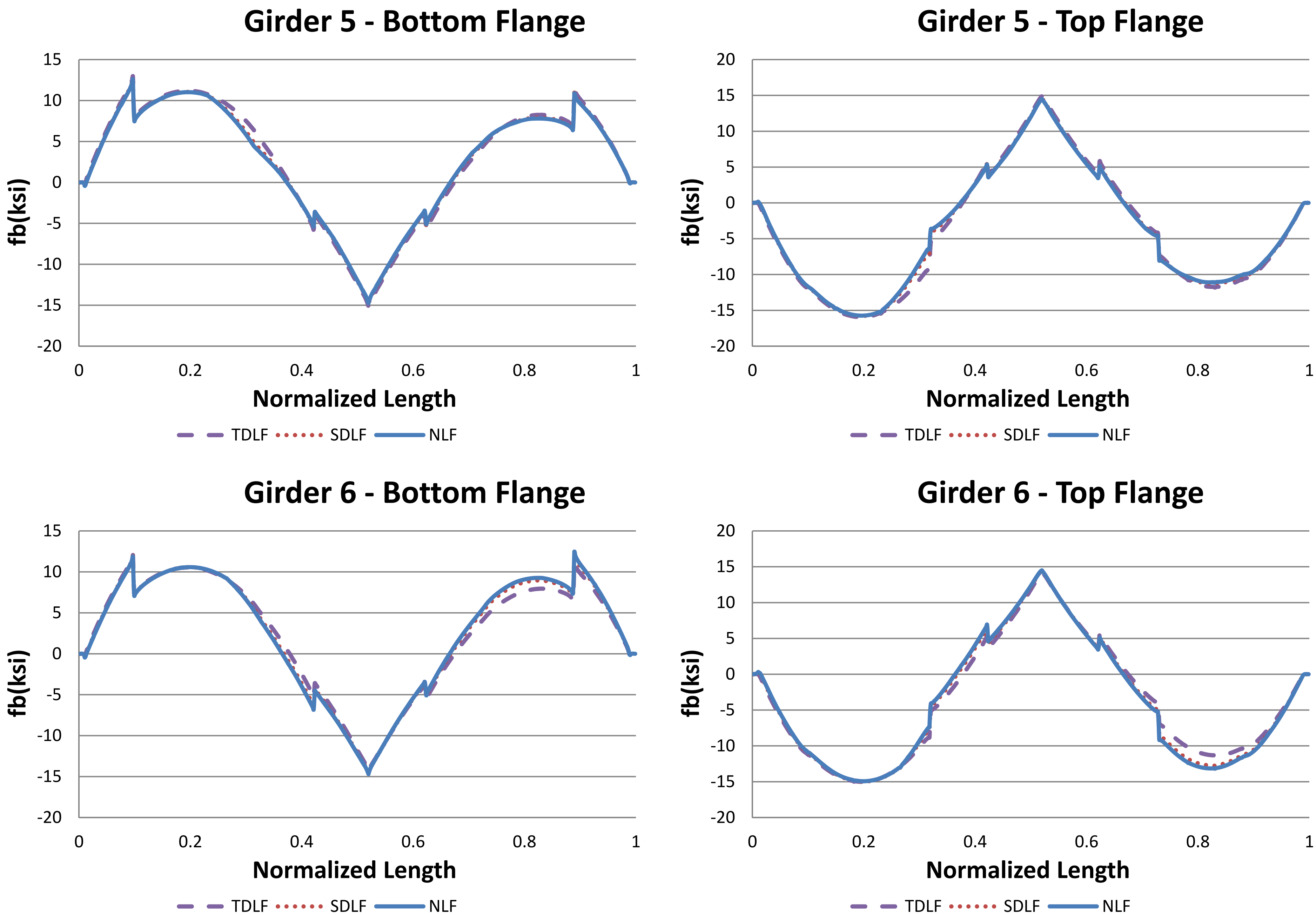


Figure K1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

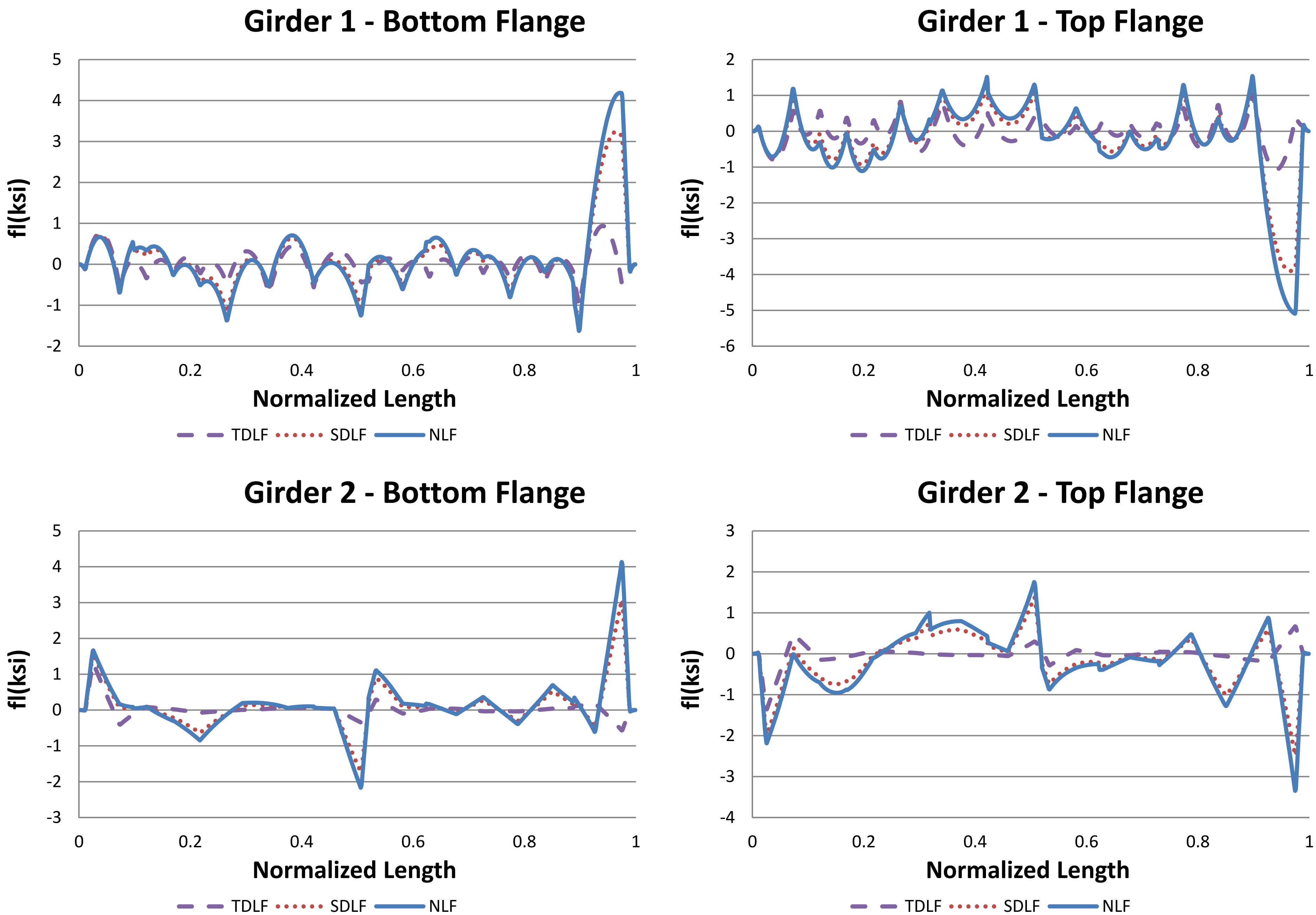


Figure K1-4-22. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

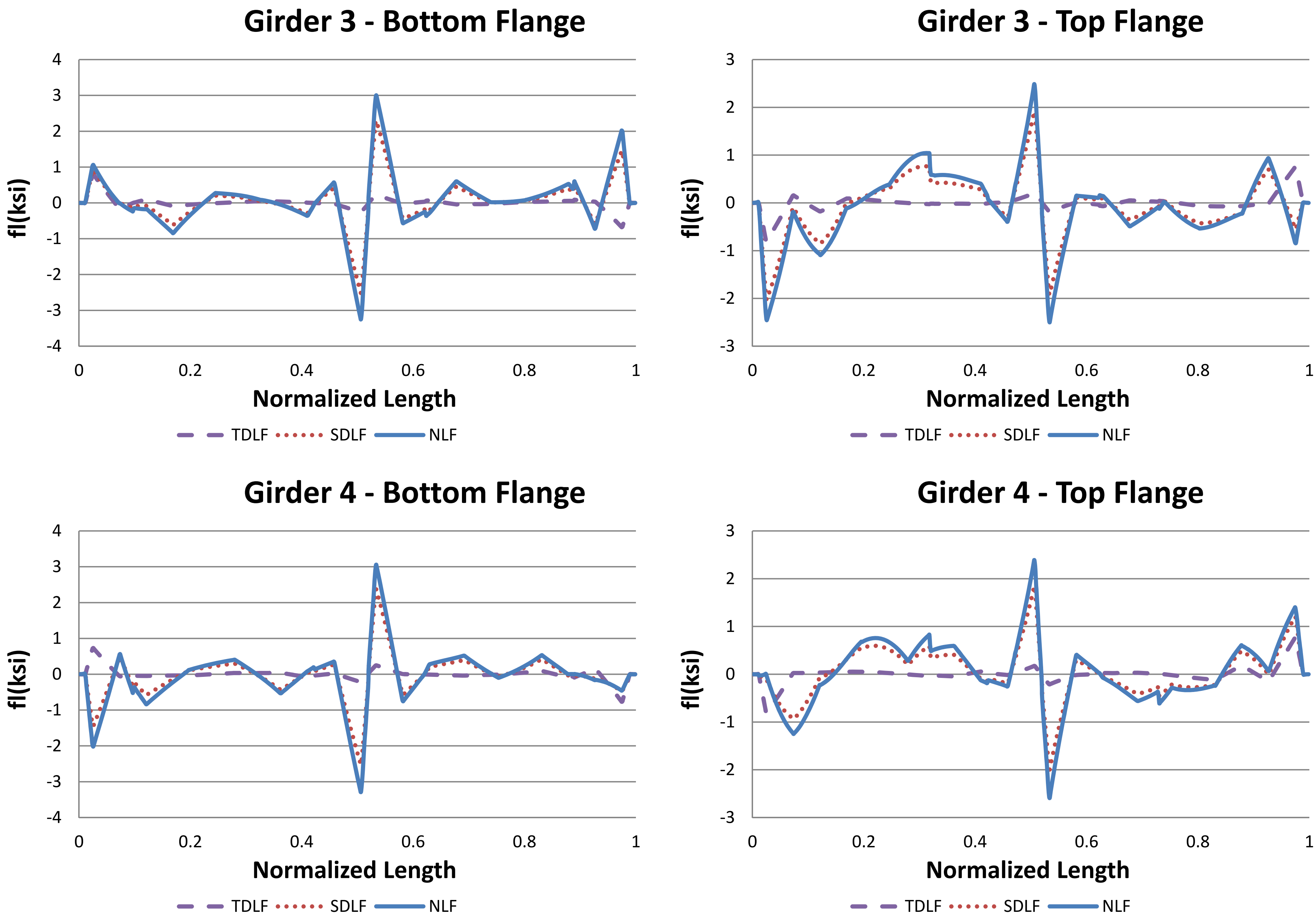


Figure K1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.

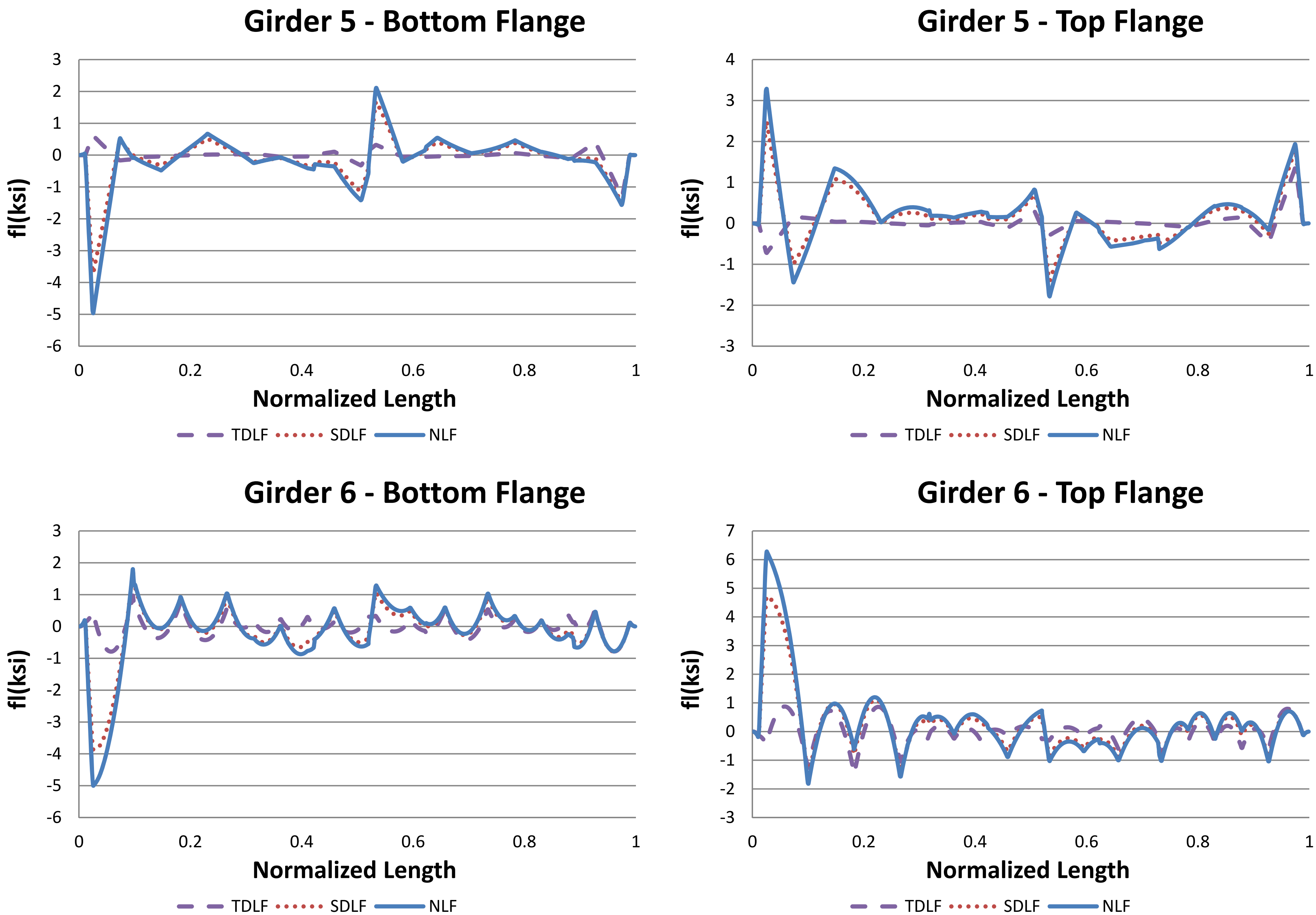


Figure K1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

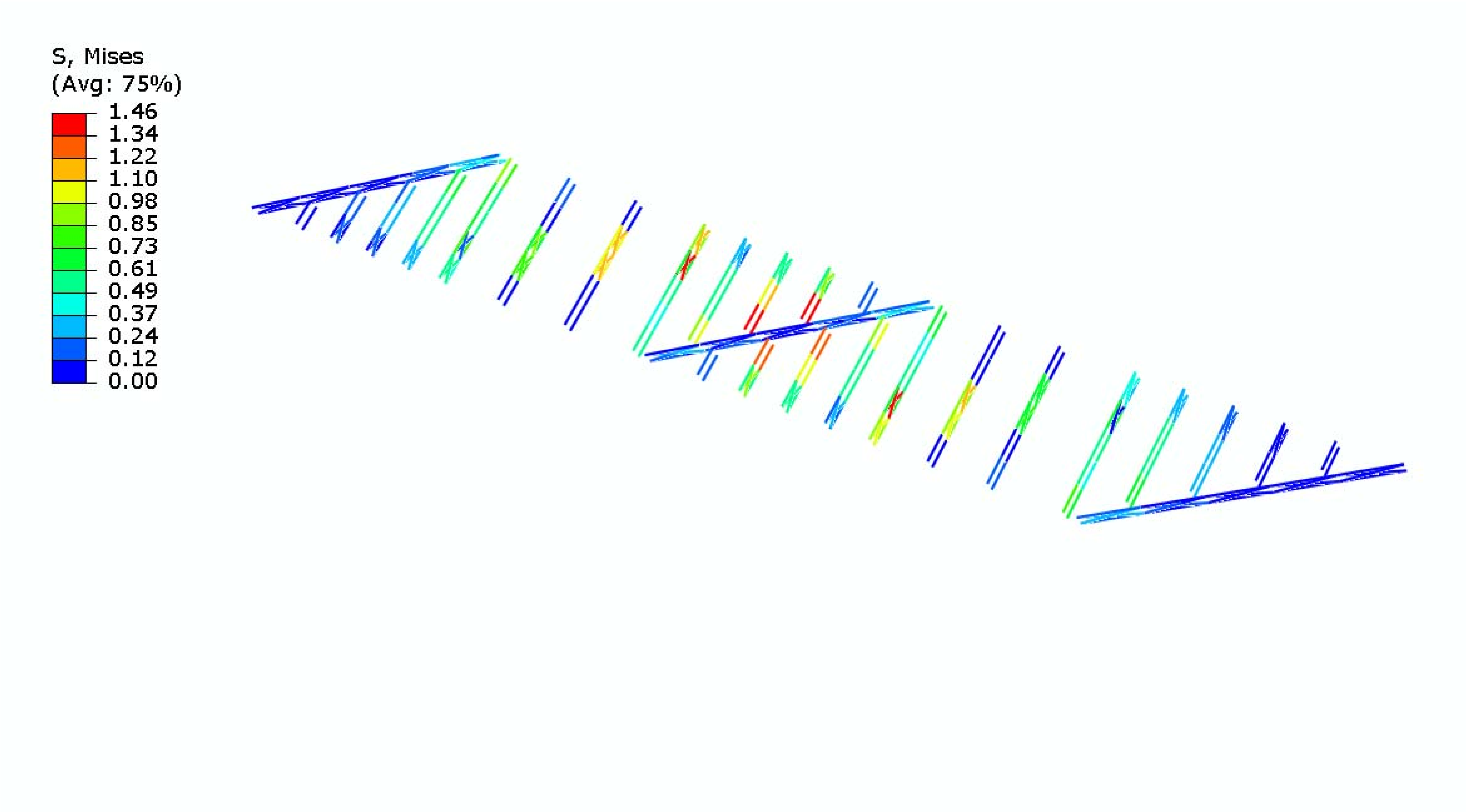


Figure K1-4-23. Cross-frame stress contours (ksi) under SDL, NLF detailing

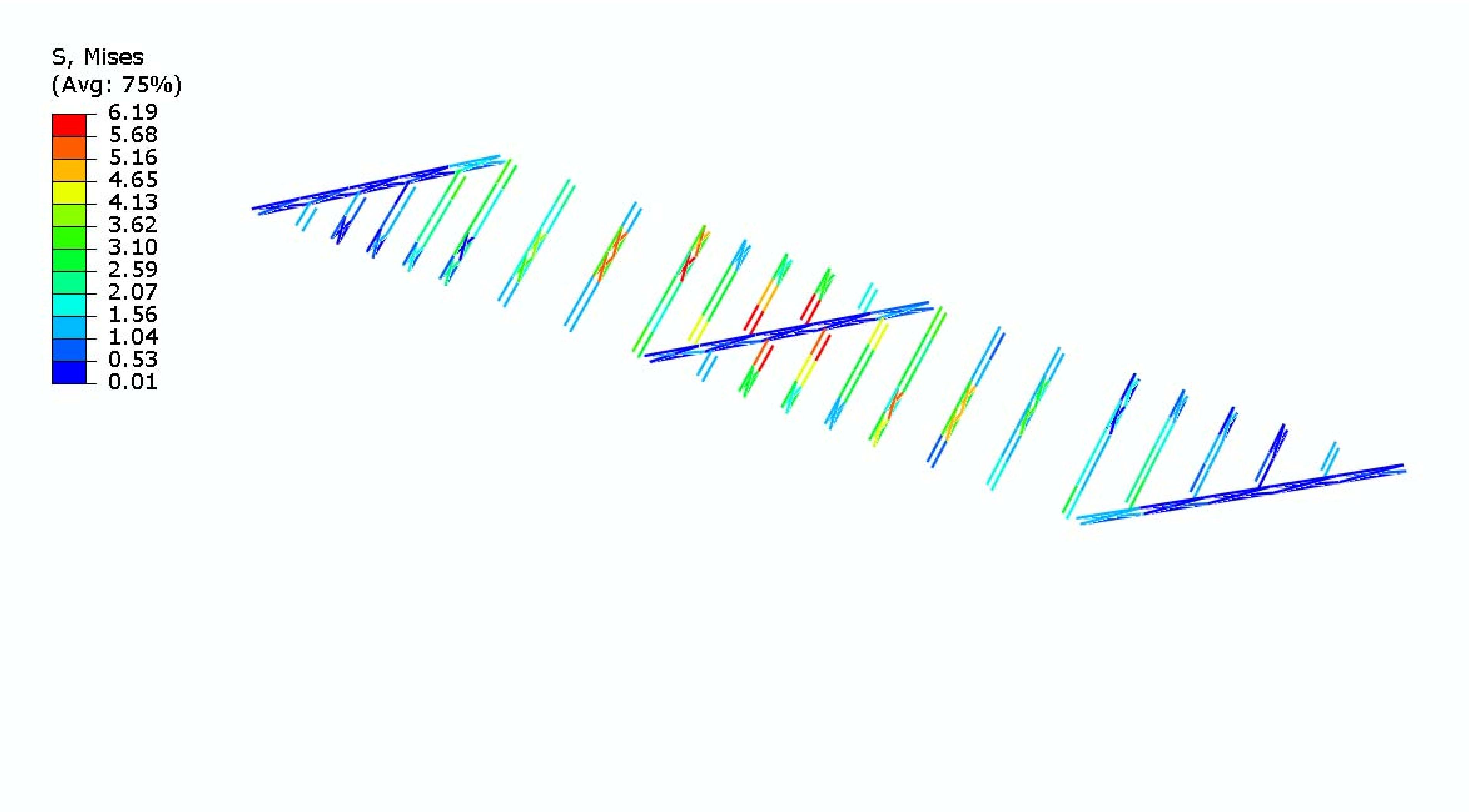


Figure K1-4-24. Cross-frame stress contours under TDL, NLF detailing

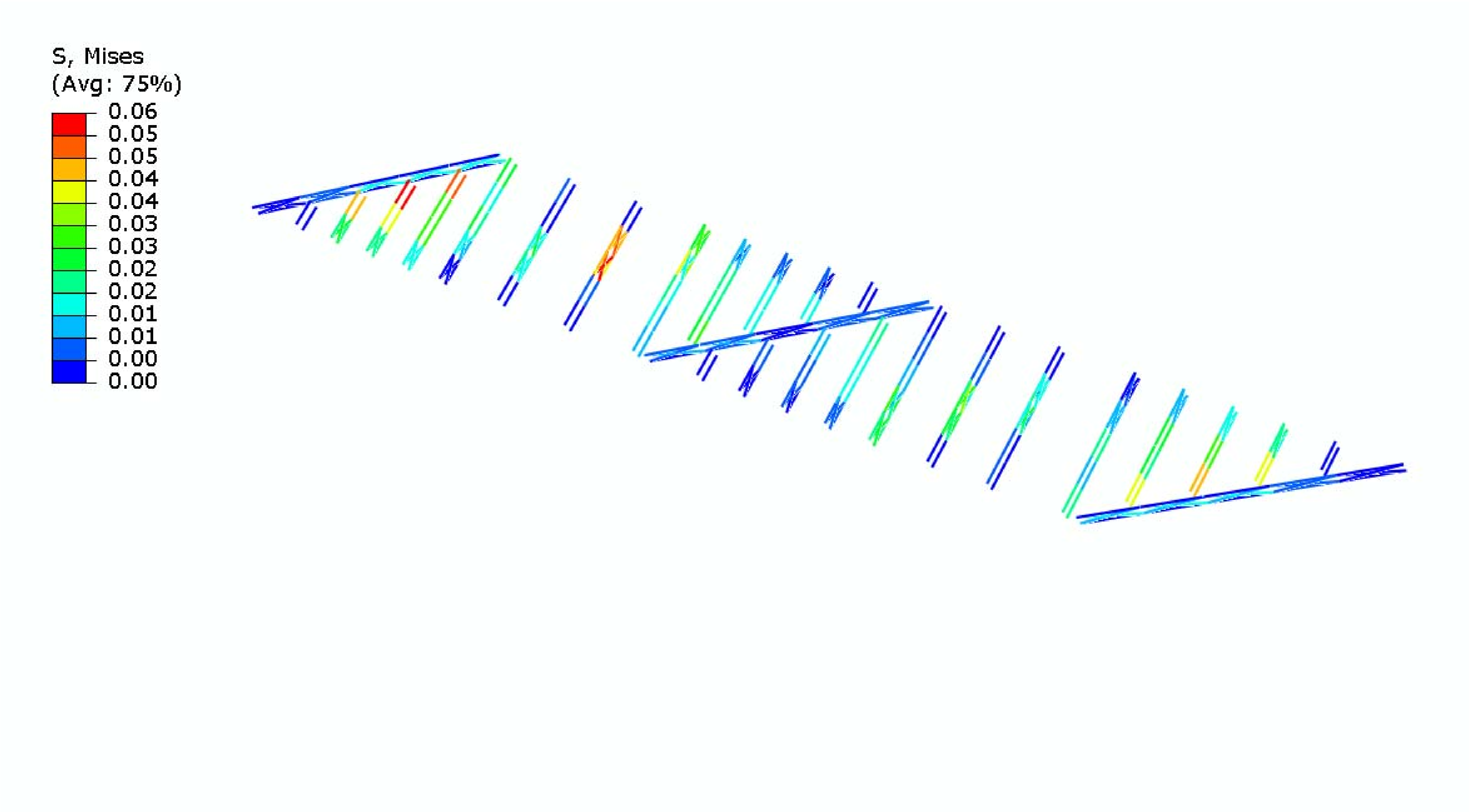


Figure K1-4-25. Cross-frame stress contours under SDL, SDLF detailing

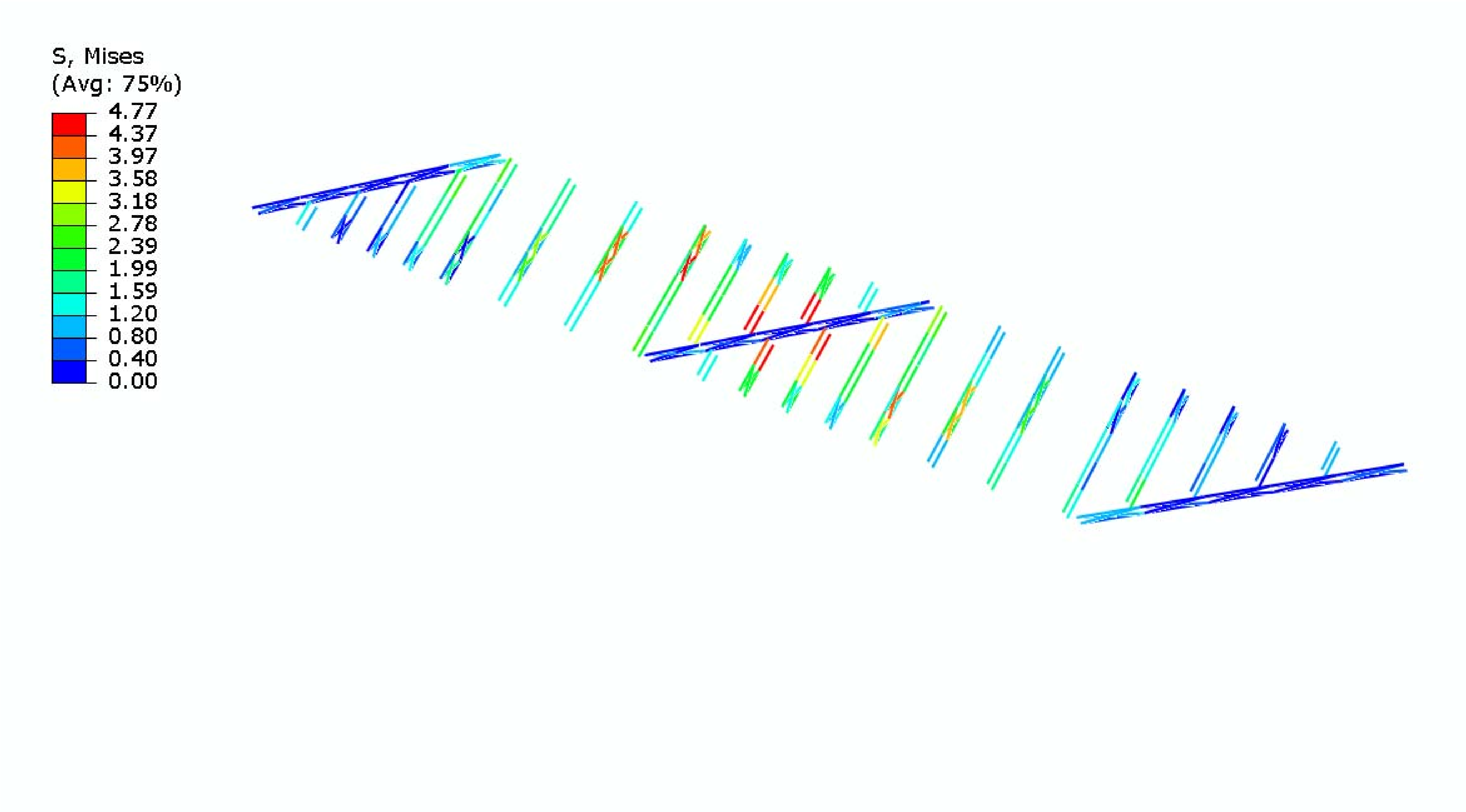


Figure K1-4-26. Cross-frame stress contours under TDL, SDLF detailing

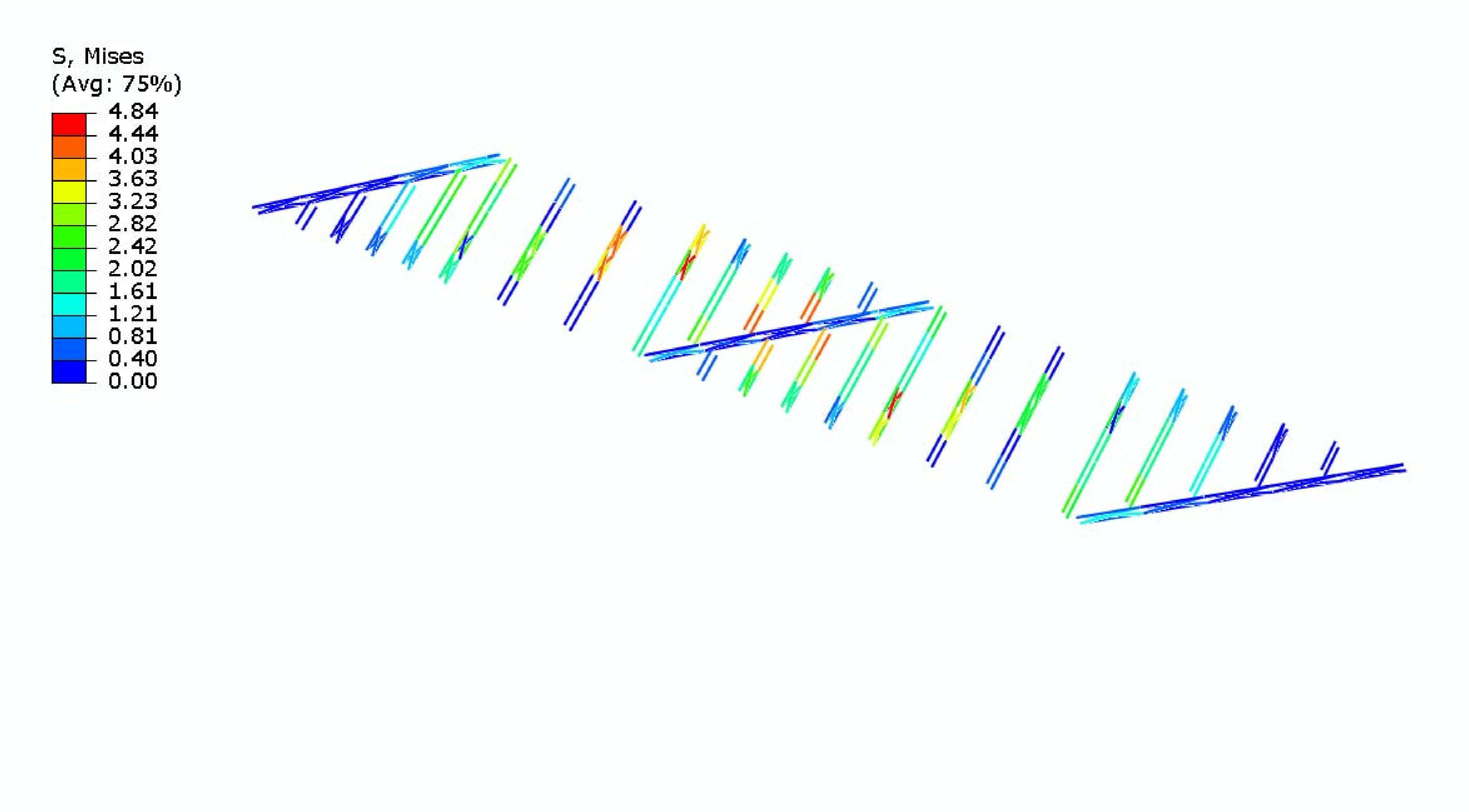


Figure K1-4-27. Cross-frame stress contours under SDL, TDLF detailing

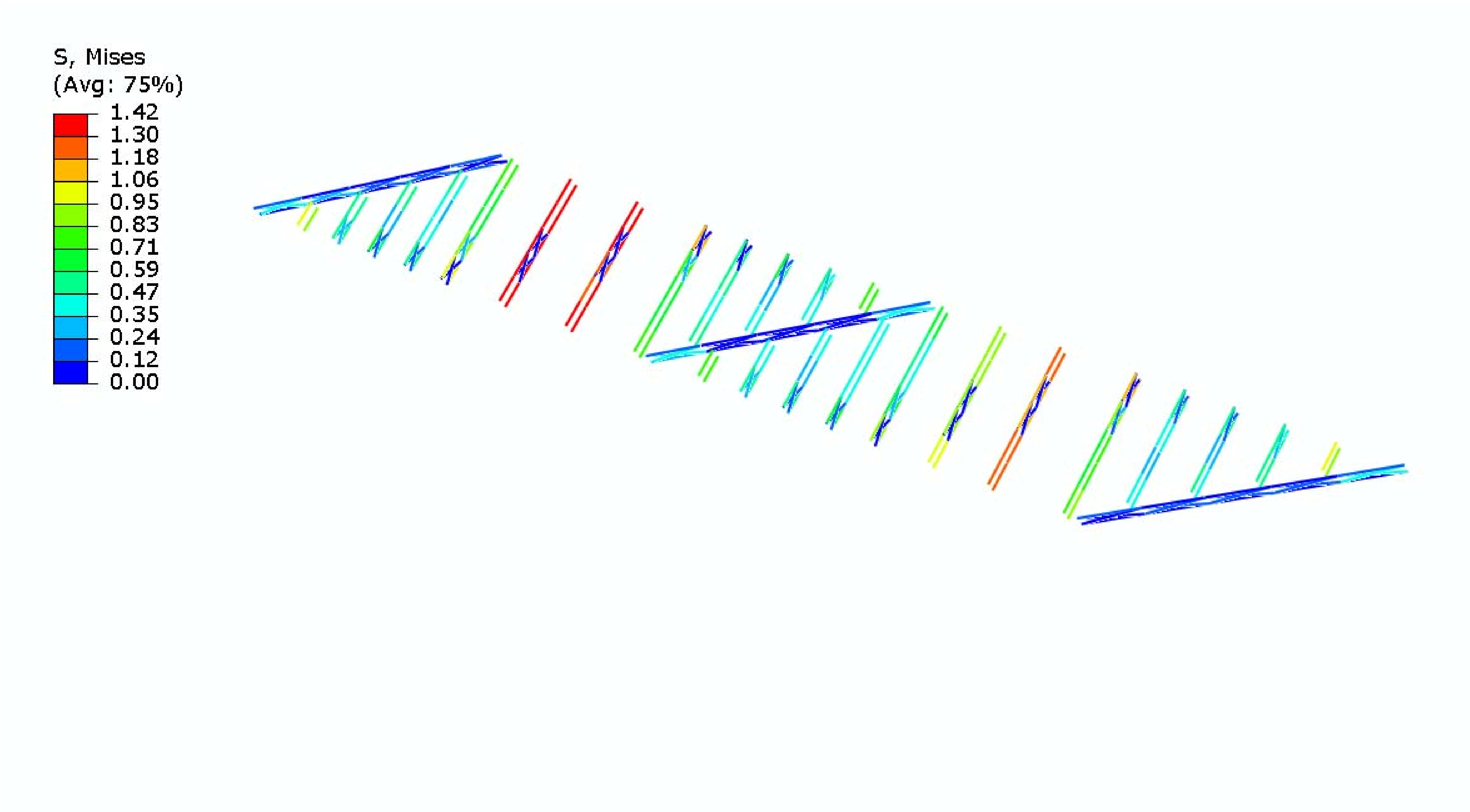


Figure K1-4-28. Cross-frame stress contours under TDL, TDLF

Table K1-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.1	0.4	0.0	1.1	2.9
	SDLF	0.0	0.1	0.1	0.1	0.1
	TDLF	0.3	0.8	0.8	4.5	10.5
2	NLF	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA
3	NLF	0.5	NA	NA	NA	NA
	SDLF	0.1	NA	NA	NA	NA
	TDLF	1.1	NA	NA	NA	NA
4	NLF	0.5	NA	NA	NA	NA
	SDLF	0.1	NA	NA	NA	NA
	TDLF	2.0	NA	NA	NA	NA
5	NLF	0.8	0.5	2.5	3.4	3.3
	SDLF	0.0	0.0	0.1	0.1	0.1
	TDLF	3.1	1.3	8.5	11.6	11.2
6	NLF	1.6	2.3	3.4	4.2	1.0
	SDLF	0.0	0.0	0.2	0.0	0.0
	TDLF	5.5	7.8	11.8	13.8	3.0
7	NLF	NA	NA	NA	NA	1.7
	SDLF	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	5.0
8	NLF	NA	NA	NA	NA	2.6
	SDLF	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	7.6
9	NLF	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA
10	NLF	2.5	1.2	0.4	0.9	2.9
	SDLF	0.1	0.1	0.0	0.0	0.0
	TDLF	7.4	3.4	1.2	2.9	9.3

Table K1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA
12	NLF	2.4	NA	NA	NA	NA
	SDLF	0.0	NA	NA	NA	NA
	TDLF	7.2	NA	NA	NA	NA
13	NLF	1.5	NA	NA	NA	NA
	SDLF	0.0	NA	NA	NA	NA
	TDLF	4.7	NA	NA	NA	NA
14	NLF	0.9	4.0	3.3	2.0	1.2
	SDLF	0.0	0.0	0.1	0.0	0.0
	TDLF	3.0	12.8	10.7	6.4	3.8
15	NLF	3.0	3.1	2.1	0.3	0.7
	SDLF	0.1	0.1	0.1	0.0	0.0
	TDLF	9.7	10.0	6.8	0.5	2.7
16	NLF	NA	NA	NA	NA	0.5
	SDLF	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	2.1
17	NLF	NA	NA	NA	NA	0.3
	SDLF	NA	NA	NA	NA	0.1
	TDLF	NA	NA	NA	NA	0.4
18	NLF	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA
19	NLF	2.4	1.0	0.2	0.2	0.1
	SDLF	0.1	0.1	0.1	0.1	0.0
	TDLF	8.6	4.2	1.4	0.3	0.3

Table K1-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	4.6	4.0	1.5	3.7	12.7
	SDLF	4.1	3.4	1.3	2.7	9.8
	TDLF	2.8	1.7	1.3	1.1	0.2
2	NLF	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA
3	NLF	0.6	NA	NA	NA	NA
	SDLF	0.2	NA	NA	NA	NA
	TDLF	1.0	NA	NA	NA	NA
4	NLF	3.3	NA	NA	NA	NA
	SDLF	2.7	NA	NA	NA	NA
	TDLF	0.5	NA	NA	NA	NA
5	NLF	4.7	0.5	10.8	15.4	14.8
	SDLF	3.7	0.3	8.3	11.8	11.4
	TDLF	0.4	0.8	0.1	0.2	0.2
6	NLF	7.0	9.5	14.9	17.4	3.6
	SDLF	5.4	7.4	11.4	13.1	2.7
	TDLF	0.0	0.1	0.0	0.7	0.3
7	NLF	NA	NA	NA	NA	6.0
	SDLF	NA	NA	NA	NA	4.4
	TDLF	NA	NA	NA	NA	0.7
8	NLF	NA	NA	NA	NA	9.1
	SDLF	NA	NA	NA	NA	6.6
	TDLF	NA	NA	NA	NA	1.0
9	NLF	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA
10	NLF	8.3	4.5	1.7	2.8	10.0
	SDLF	5.8	3.4	1.3	2.1	7.0
	TDLF	2.7	0.5	0.1	0.6	2.6

Table K1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA
12	NLF	8.7	NA	NA	NA	NA
	SDLF	6.3	NA	NA	NA	NA
	TDLF	1.0	NA	NA	NA	NA
13	NLF	5.7	NA	NA	NA	NA
	SDLF	4.2	NA	NA	NA	NA
	TDLF	0.7	NA	NA	NA	NA
14	NLF	3.4	16.1	14.1	8.4	5.1
	SDLF	2.5	12.0	10.7	6.4	3.9
	TDLF	0.5	0.8	0.1	0.2	0.1
15	NLF	12.9	13.5	9.2	0.4	4.0
	SDLF	9.8	10.3	7.0	0.5	3.2
	TDLF	0.1	0.3	0.2	0.7	0.4
16	NLF	NA	NA	NA	NA	3.3
	SDLF	NA	NA	NA	NA	2.7
	TDLF	NA	NA	NA	NA	0.6
17	NLF	NA	NA	NA	NA	0.6
	SDLF	NA	NA	NA	NA	0.7
	TDLF	NA	NA	NA	NA	1.0
18	NLF	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA
19	NLF	10.9	4.2	0.2	2.7	4.1
	SDLF	8.4	3.1	0.1	2.4	3.7
	TDLF	0.1	1.0	1.2	1.6	2.8

Table K1-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.2	0.2	0.4	0.4	1.1
	SDLF	0.0	0.1	0.0	0.0	0.0
	TDLF	0.6	0.2	1.5	1.4	3.7
2	NLF	0.2	0.5	0.7	2.1	2.2
	SDLF	0.0	0.1	0.2	0.1	0.1
	TDLF	0.5	0.6	3.7	8.0	8.1
3	NLF	0.2	0.8	1.7	1.6	0.4
	SDLF	0.1	0.1	0.1	0.0	0.0
	TDLF	0.1	3.6	6.4	5.6	1.5
4	NLF	0.3	1.6	1.7	0.2	0.1
	SDLF	0.1	0.1	0.1	0.0	0.0
	TDLF	1.5	6.1	6.2	0.7	0.5
5	NLF	0.8	2.3	2.0	3.1	2.7
	SDLF	0.0	0.0	0.0	0.1	0.1
	TDLF	3.1	7.9	6.9	10.5	9.3
6	NLF	1.3	2.1	3.0	2.0	0.7
	SDLF	0.0	0.1	0.1	0.1	0.0
	TDLF	4.4	7.4	10.1	7.3	1.9
7	NLF	0.1	0.1	1.5	1.6	1.7
	SDLF	0.0	0.0	0.1	0.1	0.0
	TDLF	0.2	0.4	4.5	4.8	5.1
8	NLF	0.0	1.2	1.7	3.2	1.8
	SDLF	0.0	0.0	0.1	0.0	0.0
	TDLF	0.0	3.7	5.0	9.5	5.1
9	NLF	1.6	2.8	4.0	4.0	0.6
	SDLF	0.0	0.1	0.1	0.0	0.0
	TDLF	4.8	8.3	11.9	11.9	1.9
10	NLF	0.6	0.9	0.0	1.1	1.0
	SDLF	0.0	0.0	0.0	0.1	0.0
	TDLF	1.9	2.6	0.1	3.0	3.6

Table K1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.5	3.8	3.8	2.8	1.8
	SDLF	0.0	0.0	0.0	0.1	0.0
	TDLF	1.6	11.2	11.5	8.7	6.0
12	NLF	1.6	2.9	1.7	1.3	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	4.8	9.0	5.3	4.3	0.4
13	NLF	1.6	1.6	1.6	0.3	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	4.9	5.0	5.0	1.2	0.2
14	NLF	0.6	1.8	2.5	1.9	1.0
	SDLF	0.0	0.1	0.1	0.0	0.0
	TDLF	2.0	5.8	8.0	6.0	3.2
15	NLF	2.5	2.8	1.8	1.8	0.7
	SDLF	0.1	0.1	0.0	0.0	0.0
	TDLF	8.0	8.9	5.8	6.0	2.6
16	NLF	0.2	0.1	1.5	1.4	0.4
	SDLF	0.0	0.0	0.1	0.1	0.0
	TDLF	0.6	0.3	5.2	5.3	1.6
17	NLF	0.4	1.4	1.5	0.9	0.0
	SDLF	0.0	0.0	0.1	0.1	0.1
	TDLF	1.3	4.7	5.5	3.6	0.3
18	NLF	2.0	1.9	0.9	0.2	0.1
	SDLF	0.1	0.1	0.1	0.1	0.0
	TDLF	6.9	7.0	3.9	0.3	0.3
19	NLF	0.9	0.3	0.3	0.0	0.1
	SDLF	0.0	0.0	0.0	0.1	0.0
	TDLF	3.0	1.1	1.2	0.2	0.3

Table K1-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.7	0.5	2.2	1.9	5.0
	SDLF	0.7	0.5	1.7	1.5	4.1
	TDLF	0.8	0.4	0.0	0.1	0.8
2	NLF	3.2	2.3	3.6	9.3	7.6
	SDLF	3.1	2.0	2.6	7.0	5.5
	TDLF	2.7	1.6	1.4	1.3	2.3
3	NLF	1.6	3.9	7.3	4.7	6.0
	SDLF	1.5	2.9	5.4	3.3	5.6
	TDLF	1.5	0.9	1.0	2.0	3.9
4	NLF	0.3	6.7	5.8	5.1	3.7
	SDLF	0.1	4.9	4.1	4.9	3.8
	TDLF	1.7	1.3	2.0	3.9	4.0
5	NLF	2.2	7.4	4.5	9.4	9.2
	SDLF	1.4	5.2	2.6	6.3	6.3
	TDLF	1.7	2.4	3.7	3.8	3.1
6	NLF	2.2	5.3	9.3	7.4	4.1
	SDLF	1.0	3.2	6.3	5.3	3.5
	TDLF	3.0	3.8	3.7	2.3	1.7
7	NLF	3.7	4.1	7.1	7.5	8.4
	SDLF	3.7	4.0	5.7	6.0	6.7
	TDLF	3.9	3.8	1.7	1.4	1.7
8	NLF	3.7	5.8	7.6	13.6	8.4
	SDLF	3.7	4.8	6.0	10.4	6.7
	TDLF	3.8	1.7	1.2	0.9	1.5
9	NLF	8.0	12.6	17.7	17.5	4.9
	SDLF	6.5	9.8	13.6	13.5	4.3
	TDLF	2.2	1.4	1.3	1.2	2.3
10	NLF	0.8	3.1	0.4	3.8	3.1
	SDLF	0.2	2.2	0.3	2.7	2.1
	TDLF	1.7	0.5	0.0	0.5	1.6

Table K1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	4.4	16.6	17.1	13.2	9.5
	SDLF	3.8	12.7	13.2	10.4	7.7
	TDLF	2.2	1.2	1.2	1.3	1.8
12	NLF	8.0	12.9	8.0	6.6	2.9
	SDLF	6.3	10.0	6.4	5.4	2.8
	TDLF	1.5	0.9	1.1	1.3	2.6
13	NLF	8.1	7.8	7.6	3.8	3.2
	SDLF	6.5	6.3	6.1	3.5	3.2
	TDLF	1.6	1.3	1.3	2.6	3.4
14	NLF	4.3	5.8	8.2	4.5	0.8
	SDLF	3.7	4.0	5.7	2.6	0.1
	TDLF	1.7	1.9	2.5	3.2	3.1
15	NLF	8.0	9.1	4.3	5.1	1.7
	SDLF	5.4	6.3	2.4	3.3	1.0
	TDLF	2.6	2.7	3.2	2.5	1.6
16	NLF	2.2	3.9	4.2	5.5	0.5
	SDLF	2.3	3.8	2.7	4.0	0.0
	TDLF	2.9	3.4	2.1	1.2	1.6
17	NLF	5.1	3.4	6.0	3.9	1.1
	SDLF	4.7	2.1	4.5	2.9	1.1
	TDLF	3.5	2.1	0.9	0.8	1.5
18	NLF	5.9	7.9	3.9	1.0	3.0
	SDLF	4.0	5.9	2.8	1.0	2.9
	TDLF	2.4	1.2	1.3	1.5	2.7
19	NLF	4.0	1.2	1.6	0.9	0.9
	SDLF	3.2	0.9	1.2	0.8	0.8
	TDLF	0.8	0.1	0.1	0.4	0.8

Table K1-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.1	0.1	0.5	0.7	1.5
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.3	0.0	1.9	2.4	4.9
2	NLF	0.2	0.6	0.6	2.0	2.6
	SDLF	0.0	0.1	0.2	0.1	0.1
	TDLF	0.6	1.1	3.1	7.8	9.2
3	NLF	0.2	0.7	1.7	1.9	0.5
	SDLF	0.1	0.1	0.1	0.0	0.0
	TDLF	0.2	3.3	6.5	6.7	1.7
4	NLF	0.3	1.6	2.0	0.3	0.1
	SDLF	0.1	0.1	0.1	0.0	0.0
	TDLF	1.6	6.2	7.0	1.0	0.5
5	NLF	0.8	2.4	2.0	3.1	2.8
	SDLF	0.0	0.0	0.0	0.1	0.1
	TDLF	3.2	8.3	6.9	10.7	9.5
6	NLF	1.4	2.2	3.0	2.0	0.7
	SDLF	0.0	0.1	0.1	0.1	0.0
	TDLF	4.7	7.4	10.2	7.3	2.0
7	NLF	0.1	0.1	1.5	1.6	1.6
	SDLF	0.0	0.0	0.1	0.1	0.0
	TDLF	0.2	0.4	4.6	4.8	5.0
8	NLF	0.0	1.3	1.7	3.1	1.7
	SDLF	0.0	0.0	0.1	0.0	0.0
	TDLF	0.1	3.8	5.1	9.4	5.1
9	NLF	1.6	2.7	3.9	4.0	0.6
	SDLF	0.0	0.1	0.1	0.0	0.0
	TDLF	4.8	8.0	11.6	11.6	1.9
10	NLF	0.5	0.8	0.2	1.0	1.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	1.7	2.3	0.2	3.0	3.9

Table K1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.5	3.7	3.7	2.7	1.9
	SDLF	0.0	0.0	0.0	0.1	0.0
	TDLF	1.5	10.8	11.0	8.3	6.0
12	NLF	1.6	2.9	1.7	1.4	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	4.7	8.9	5.3	4.5	0.5
13	NLF	1.6	1.6	1.6	0.3	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	4.8	5.0	5.1	1.2	0.1
14	NLF	0.7	1.8	2.5	1.9	1.0
	SDLF	0.0	0.1	0.1	0.1	0.0
	TDLF	2.0	5.8	8.1	5.9	3.3
15	NLF	2.5	2.8	1.8	1.9	0.8
	SDLF	0.1	0.1	0.0	0.0	0.0
	TDLF	8.2	9.0	5.8	6.2	2.8
16	NLF	0.1	0.1	1.6	1.4	0.4
	SDLF	0.0	0.0	0.1	0.1	0.0
	TDLF	0.5	0.5	5.5	5.4	1.7
17	NLF	0.4	1.5	1.5	0.8	0.0
	SDLF	0.0	0.0	0.1	0.1	0.1
	TDLF	1.3	5.1	5.6	3.6	0.3
18	NLF	2.1	1.8	0.8	0.3	0.1
	SDLF	0.1	0.1	0.1	0.1	0.0
	TDLF	7.2	7.0	3.6	0.0	0.4
19	NLF	1.1	0.5	0.5	0.0	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.6	1.7	1.6	0.3	0.2

Table K1-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.4	0.1	2.2	3.3	7.5
	SDLF	0.5	0.1	1.7	2.6	6.0
	TDLF	0.8	0.4	0.0	0.1	0.9
2	NLF	3.8	4.0	1.2	7.6	9.8
	SDLF	3.6	3.4	0.8	5.7	7.0
	TDLF	2.7	1.6	1.5	1.4	2.3
3	NLF	2.0	2.8	7.0	7.5	6.2
	SDLF	1.8	2.1	5.3	5.3	5.6
	TDLF	1.5	1.0	1.0	1.9	3.9
4	NLF	0.1	6.5	8.0	5.3	3.7
	SDLF	0.2	4.8	5.7	5.0	3.8
	TDLF	1.7	1.3	1.9	4.0	4.1
5	NLF	2.4	8.5	4.7	9.6	9.1
	SDLF	1.5	5.9	2.7	6.4	6.3
	TDLF	1.7	2.4	3.9	3.9	3.1
6	NLF	2.9	5.5	9.5	7.1	4.4
	SDLF	1.6	3.3	6.3	4.9	3.7
	TDLF	3.0	3.9	3.7	2.3	1.7
7	NLF	3.5	4.2	8.1	7.9	8.3
	SDLF	3.6	4.1	6.6	6.3	6.7
	TDLF	4.0	3.7	1.7	1.4	1.7
8	NLF	4.0	7.3	8.2	13.4	8.2
	SDLF	3.9	6.0	6.5	10.3	6.6
	TDLF	3.7	1.8	1.2	1.0	1.5
9	NLF	9.1	12.0	16.3	16.5	4.9
	SDLF	7.4	9.4	12.6	12.6	4.3
	TDLF	2.3	1.4	1.2	1.2	2.4
10	NLF	1.0	2.5	0.6	3.4	3.8
	SDLF	0.4	1.8	0.4	2.5	2.6
	TDLF	1.6	0.5	0.1	0.5	1.5

Table K1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	4.2	15.3	15.3	11.9	9.9
	SDLF	3.7	11.7	11.8	9.4	8.0
	TDLF	2.3	1.2	1.2	1.3	1.9
12	NLF	7.8	12.5	8.1	7.5	3.3
	SDLF	6.2	9.7	6.5	6.1	3.2
	TDLF	1.5	0.9	1.1	1.4	2.6
13	NLF	7.9	7.9	8.2	4.2	3.3
	SDLF	6.4	6.4	6.6	3.8	3.4
	TDLF	1.7	1.3	1.4	2.5	3.5
14	NLF	4.4	5.7	8.2	4.4	1.3
	SDLF	3.8	3.8	5.5	2.5	0.2
	TDLF	1.8	1.9	2.5	3.3	3.1
15	NLF	8.1	9.1	4.1	5.8	1.9
	SDLF	5.5	6.3	2.3	3.8	1.1
	TDLF	2.6	2.7	3.3	2.4	1.7
16	NLF	2.3	4.3	5.8	5.7	0.4
	SDLF	2.4	4.2	4.0	4.1	0.0
	TDLF	2.9	3.6	1.9	1.2	1.7
17	NLF	5.4	5.3	6.1	3.4	1.3
	SDLF	4.9	3.6	4.6	2.5	1.3
	TDLF	3.5	1.9	1.0	0.9	1.5
18	NLF	7.5	7.2	2.5	2.2	3.5
	SDLF	5.2	5.3	1.7	2.0	3.3
	TDLF	2.3	1.3	1.4	1.5	2.8
19	NLF	6.0	2.6	2.1	0.6	0.6
	SDLF	4.8	2.1	1.6	0.6	0.7
	TDLF	0.9	0.1	0.1	0.5	0.8

Table K1-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	0.38	0.34	0.32	0.32	0.32
	SDLF	0.32	0.34	0.34	0.34	0.34
	TDLF	0.09	0.37	0.41	0.39	0.41
3	NLF	0.35	0.28	0.25	0.25	0.22
	SDLF	0.24	0.27	0.26	0.27	0.24
	TDLF	-0.17	0.26	0.34	0.31	0.31
4	NLF	0.29	0.20	0.16	0.11	0.06
	SDLF	0.13	0.18	0.17	0.12	0.07
	TDLF	-0.41	0.11	0.23	0.14	0.16
5	NLF	0.20	0.11	0.00	-0.07	-0.11
	SDLF	0.02	0.07	0.00	-0.06	-0.10
	TDLF	-0.60	-0.06	0.01	-0.08	-0.03
6	NLF	0.09	-0.04	-0.13	-0.16	-0.15
	SDLF	-0.08	-0.10	-0.17	-0.20	-0.17
	TDLF	-0.69	-0.29	-0.28	-0.34	-0.19
7	NLF	-0.08	-0.17	-0.19	-0.18	-0.15
	SDLF	-0.20	-0.21	-0.22	-0.22	-0.20
	TDLF	-0.65	-0.34	-0.30	-0.35	-0.29
8	NLF	-0.16	-0.17	-0.18	-0.17	-0.13
	SDLF	-0.22	-0.19	-0.20	-0.19	-0.18
	TDLF	-0.44	-0.25	-0.25	-0.29	-0.31
9	NLF	-0.13	-0.13	-0.13	-0.12	-0.09
	SDLF	-0.13	-0.13	-0.14	-0.13	-0.13
	TDLF	-0.14	-0.15	-0.16	-0.19	-0.24
10	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.01	0.04	0.05	0.05	0.06
	SDLF	0.05	0.06	0.06	0.05	0.05
	TDLF	0.19	0.10	0.07	0.06	0.04
12	NLF	0.05	0.09	0.10	0.10	0.10
	SDLF	0.10	0.12	0.12	0.11	0.13
	TDLF	0.29	0.20	0.15	0.15	0.22
13	NLF	0.07	0.11	0.13	0.12	0.08
	SDLF	0.12	0.15	0.15	0.14	0.16
	TDLF	0.31	0.27	0.20	0.23	0.38
14	NLF	0.07	0.10	0.10	0.07	-0.01
	SDLF	0.11	0.14	0.13	0.11	0.10
	TDLF	0.24	0.28	0.21	0.23	0.47
15	NLF	0.05	0.05	0.04	-0.03	-0.10
	SDLF	0.06	0.07	0.05	0.00	0.03
	TDLF	0.12	0.15	0.09	0.08	0.43
16	NLF	-0.04	-0.05	-0.08	-0.10	-0.17
	SDLF	-0.04	-0.03	-0.08	-0.09	-0.05
	TDLF	-0.03	0.01	-0.09	-0.04	0.32
17	NLF	-0.13	-0.16	-0.16	-0.17	-0.23
	SDLF	-0.14	-0.16	-0.16	-0.17	-0.14
	TDLF	-0.16	-0.16	-0.18	-0.15	0.16
18	NLF	-0.21	-0.21	-0.21	-0.23	-0.26
	SDLF	-0.23	-0.22	-0.22	-0.23	-0.21
	TDLF	-0.28	-0.25	-0.25	-0.24	-0.04
19	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K1-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	1.69	1.45	1.37	1.40	1.42
	SDLF	1.62	1.45	1.39	1.42	1.44
	TDLF	1.39	1.48	1.46	1.47	1.50
3	NLF	1.55	1.19	1.04	1.08	0.99
	SDLF	1.43	1.18	1.06	1.10	1.00
	TDLF	1.01	1.16	1.13	1.14	1.07
4	NLF	1.27	0.85	0.64	0.42	0.25
	SDLF	1.12	0.83	0.65	0.44	0.26
	TDLF	0.56	0.75	0.72	0.46	0.35
5	NLF	0.88	0.47	-0.02	-0.33	-0.48
	SDLF	0.70	0.42	-0.02	-0.33	-0.48
	TDLF	0.07	0.29	-0.01	-0.34	-0.41
6	NLF	0.39	-0.16	-0.56	-0.70	-0.67
	SDLF	0.22	-0.22	-0.60	-0.74	-0.69
	TDLF	-0.40	-0.42	-0.71	-0.88	-0.70
7	NLF	-0.35	-0.71	-0.82	-0.76	-0.68
	SDLF	-0.48	-0.75	-0.85	-0.80	-0.72
	TDLF	-0.93	-0.89	-0.93	-0.93	-0.81
8	NLF	-0.70	-0.73	-0.74	-0.69	-0.57
	SDLF	-0.76	-0.75	-0.76	-0.72	-0.62
	TDLF	-0.98	-0.80	-0.81	-0.81	-0.75
9	NLF	-0.56	-0.54	-0.52	-0.49	-0.39
	SDLF	-0.56	-0.54	-0.53	-0.50	-0.43
	TDLF	-0.57	-0.56	-0.56	-0.56	-0.53
10	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.01	0.13	0.17	0.19	0.21
	SDLF	0.05	0.15	0.18	0.19	0.21
	TDLF	0.19	0.19	0.19	0.19	0.19
12	NLF	0.19	0.34	0.40	0.40	0.39
	SDLF	0.24	0.37	0.42	0.41	0.42
	TDLF	0.43	0.46	0.45	0.45	0.52
13	NLF	0.30	0.43	0.51	0.48	0.35
	SDLF	0.35	0.47	0.53	0.50	0.42
	TDLF	0.54	0.60	0.59	0.59	0.65
14	NLF	0.32	0.41	0.43	0.31	-0.06
	SDLF	0.36	0.45	0.46	0.35	0.06
	TDLF	0.49	0.59	0.54	0.47	0.43
15	NLF	0.21	0.23	0.19	-0.11	-0.42
	SDLF	0.22	0.25	0.20	-0.08	-0.29
	TDLF	0.28	0.33	0.24	0.01	0.12
16	NLF	-0.15	-0.16	-0.31	-0.41	-0.74
	SDLF	-0.15	-0.15	-0.31	-0.39	-0.62
	TDLF	-0.14	-0.10	-0.31	-0.34	-0.24
17	NLF	-0.54	-0.67	-0.64	-0.70	-0.99
	SDLF	-0.55	-0.67	-0.64	-0.69	-0.90
	TDLF	-0.57	-0.66	-0.66	-0.68	-0.60
18	NLF	-0.90	-0.91	-0.90	-0.94	-1.13
	SDLF	-0.92	-0.92	-0.91	-0.94	-1.08
	TDLF	-0.97	-0.95	-0.94	-0.95	-0.90
19	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K1-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	0.21	0.19	0.18	0.18	0.18
	SDLF	0.18	0.19	0.19	0.19	0.19
	TDLF	0.05	0.21	0.23	0.22	0.23
3	NLF	0.19	0.16	0.14	0.14	0.12
	SDLF	0.13	0.15	0.15	0.15	0.13
	TDLF	-0.10	0.14	0.19	0.17	0.18
4	NLF	0.16	0.11	0.09	0.06	0.03
	SDLF	0.07	0.10	0.09	0.07	0.04
	TDLF	-0.23	0.06	0.13	0.08	0.09
5	NLF	0.11	0.06	0.00	-0.04	-0.06
	SDLF	0.01	0.04	0.00	-0.04	-0.06
	TDLF	-0.33	-0.03	0.00	-0.05	-0.02
6	NLF	0.05	-0.02	-0.07	-0.09	-0.08
	SDLF	-0.05	-0.05	-0.09	-0.11	-0.10
	TDLF	-0.39	-0.16	-0.16	-0.19	-0.11
7	NLF	-0.04	-0.09	-0.11	-0.10	-0.09
	SDLF	-0.11	-0.12	-0.12	-0.12	-0.11
	TDLF	-0.36	-0.19	-0.17	-0.20	-0.16
8	NLF	-0.09	-0.10	-0.10	-0.09	-0.07
	SDLF	-0.12	-0.11	-0.11	-0.11	-0.10
	TDLF	-0.24	-0.14	-0.14	-0.16	-0.17
9	NLF	-0.07	-0.07	-0.07	-0.07	-0.05
	SDLF	-0.07	-0.07	-0.08	-0.08	-0.07
	TDLF	-0.08	-0.08	-0.09	-0.11	-0.13
10	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.01	0.02	0.03	0.03	0.03
	SDLF	0.03	0.03	0.03	0.03	0.03
	TDLF	0.11	0.06	0.04	0.03	0.02
12	NLF	0.03	0.05	0.06	0.06	0.05
	SDLF	0.06	0.07	0.07	0.06	0.07
	TDLF	0.16	0.11	0.08	0.08	0.12
13	NLF	0.04	0.06	0.07	0.07	0.05
	SDLF	0.07	0.08	0.08	0.08	0.09
	TDLF	0.17	0.15	0.11	0.13	0.21
14	NLF	0.04	0.05	0.06	0.04	-0.01
	SDLF	0.06	0.08	0.07	0.06	0.06
	TDLF	0.13	0.15	0.12	0.13	0.26
15	NLF	0.03	0.03	0.02	-0.02	-0.05
	SDLF	0.03	0.04	0.03	0.00	0.02
	TDLF	0.07	0.08	0.05	0.05	0.24
16	NLF	-0.02	-0.03	-0.05	-0.06	-0.09
	SDLF	-0.02	-0.02	-0.05	-0.05	-0.03
	TDLF	-0.01	0.01	-0.05	-0.02	0.18
17	NLF	-0.07	-0.09	-0.09	-0.10	-0.13
	SDLF	-0.08	-0.09	-0.09	-0.09	-0.08
	TDLF	-0.09	-0.09	-0.10	-0.08	0.09
18	NLF	-0.12	-0.12	-0.12	-0.13	-0.15
	SDLF	-0.13	-0.13	-0.13	-0.13	-0.12
	TDLF	-0.16	-0.14	-0.14	-0.13	-0.02
19	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K1-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	0.94	0.81	0.77	0.78	0.79
	SDLF	0.91	0.81	0.78	0.79	0.80
	TDLF	0.77	0.82	0.82	0.82	0.84
3	NLF	0.86	0.66	0.58	0.60	0.55
	SDLF	0.80	0.66	0.59	0.61	0.56
	TDLF	0.56	0.65	0.63	0.64	0.60
4	NLF	0.71	0.48	0.36	0.24	0.14
	SDLF	0.62	0.46	0.36	0.25	0.15
	TDLF	0.31	0.42	0.40	0.26	0.20
5	NLF	0.49	0.26	-0.01	-0.19	-0.27
	SDLF	0.39	0.24	-0.01	-0.18	-0.27
	TDLF	0.04	0.16	-0.01	-0.19	-0.23
6	NLF	0.22	-0.09	-0.31	-0.39	-0.37
	SDLF	0.12	-0.12	-0.33	-0.41	-0.39
	TDLF	-0.22	-0.23	-0.39	-0.49	-0.39
7	NLF	-0.20	-0.40	-0.46	-0.43	-0.38
	SDLF	-0.27	-0.42	-0.47	-0.45	-0.40
	TDLF	-0.52	-0.49	-0.52	-0.52	-0.45
8	NLF	-0.39	-0.41	-0.41	-0.39	-0.32
	SDLF	-0.42	-0.42	-0.42	-0.40	-0.35
	TDLF	-0.55	-0.45	-0.45	-0.45	-0.42
9	NLF	-0.31	-0.30	-0.29	-0.27	-0.22
	SDLF	-0.31	-0.30	-0.30	-0.28	-0.24
	TDLF	-0.32	-0.31	-0.31	-0.31	-0.30
10	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.01	0.07	0.10	0.10	0.12
	SDLF	0.03	0.08	0.10	0.10	0.12
	TDLF	0.11	0.11	0.11	0.11	0.11
12	NLF	0.10	0.19	0.23	0.22	0.22
	SDLF	0.14	0.21	0.23	0.23	0.24
	TDLF	0.24	0.25	0.25	0.25	0.29
13	NLF	0.17	0.24	0.28	0.27	0.20
	SDLF	0.20	0.26	0.30	0.28	0.24
	TDLF	0.30	0.33	0.33	0.33	0.36
14	NLF	0.18	0.23	0.24	0.17	-0.03
	SDLF	0.20	0.25	0.26	0.19	0.03
	TDLF	0.27	0.33	0.30	0.26	0.24
15	NLF	0.12	0.13	0.11	-0.06	-0.23
	SDLF	0.13	0.14	0.11	-0.05	-0.16
	TDLF	0.16	0.19	0.13	0.00	0.07
16	NLF	-0.09	-0.09	-0.17	-0.23	-0.41
	SDLF	-0.09	-0.08	-0.17	-0.22	-0.35
	TDLF	-0.08	-0.06	-0.18	-0.19	-0.13
17	NLF	-0.30	-0.37	-0.35	-0.39	-0.55
	SDLF	-0.31	-0.37	-0.36	-0.39	-0.50
	TDLF	-0.32	-0.37	-0.37	-0.38	-0.33
18	NLF	-0.50	-0.51	-0.50	-0.52	-0.63
	SDLF	-0.51	-0.51	-0.51	-0.53	-0.60
	TDLF	-0.54	-0.53	-0.53	-0.53	-0.50
19	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K1-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number					
		SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
G1	NLF	16.4	64.4	14.4	73.3	231.9	62.1
	SDLF	15.3	65.8	13.3	72.1	233.3	61.0
	TDLF	11.6	69.2	9.5	67.9	236.7	57.4
G2	NLF	16.8	70.7	14.0	67.4	252.3	58.5
	SDLF	17.2	69.2	14.7	67.9	250.9	59.1
	TDLF	19.0	65.6	16.9	69.9	247.1	61.3
G3	NLF	16.1	69.1	14.3	66.7	247.8	59.5
	SDLF	16.9	69.0	14.7	67.5	247.7	60.0
	TDLF	19.8	68.8	16.3	70.6	247.5	61.6
G4	NLF	16.2	69.3	14.3	68.3	248.3	58.6
	SDLF	16.8	69.2	14.8	68.9	248.2	59.2
	TDLF	18.7	68.6	16.7	70.9	247.5	61.2
G5	NLF	16.0	71.0	14.7	67.6	252.9	58.2
	SDLF	16.7	69.3	15.1	68.2	251.3	58.7
	TDLF	19.0	65.3	16.6	70.6	247.2	60.4
G6	NLF	16.7	64.0	14.3	72.3	230.7	63.7
	SDLF	15.2	65.9	13.3	71.0	232.5	62.6
	TDLF	10.0	70.8	10.0	66.1	237.0	59.1

Table K1-4-12. **Individual support longitudinal reactions under SDL and TDL (kips).**

		Load Type & Support Number					
Girder	Detailing Method	SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
G1	NLF	0.0	NA	NA	-0.2	NA	NA
	SDLF	0.0	NA	NA	-0.1	NA	NA
	TDLF	0.1	NA	NA	0.0	NA	NA
G2	NLF	0.0	NA	NA	0.0	NA	NA
	SDLF	0.0	NA	NA	0.0	NA	NA
	TDLF	-0.1	NA	NA	0.0	NA	NA
G3	NLF	0.0	NA	NA	0.1	NA	NA
	SDLF	0.0	NA	NA	0.1	NA	NA
	TDLF	-0.1	NA	NA	0.0	NA	NA
G4	NLF	0.0	NA	NA	0.1	NA	NA
	SDLF	0.0	NA	NA	0.1	NA	NA
	TDLF	0.0	NA	NA	0.0	NA	NA
G5	NLF	0.0	NA	NA	0.0	NA	NA
	SDLF	0.0	NA	NA	0.0	NA	NA
	TDLF	0.0	NA	NA	0.0	NA	NA
G6	NLF	0.0	NA	NA	-0.1	NA	NA
	SDLF	0.0	NA	NA	0.0	NA	NA
	TDLF	0.1	NA	NA	0.0	NA	NA

Table K1-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
G1	NLF	0.0	-0.3	0.0	0.5	-0.7	0.4
	SDLF	0.0	0.0	0.0	0.4	-0.5	0.3
	TDLF	-0.2	0.8	-0.1	0.1	0.1	0.0
G2	NLF	0.0	-0.1	0.0	0.1	-0.4	0.1
	SDLF	0.0	0.0	0.0	0.1	-0.3	0.1
	TDLF	0.0	0.4	0.0	0.0	0.0	0.0
G3	NLF	0.0	0.0	0.0	-0.1	-0.2	-0.1
	SDLF	0.0	0.0	0.0	-0.1	-0.1	0.0
	TDLF	-0.1	0.1	0.0	0.0	0.0	0.0
G4	NLF	0.0	0.0	0.0	-0.1	-0.1	-0.2
	SDLF	0.0	0.0	0.0	-0.1	-0.1	-0.1
	TDLF	-0.1	0.0	0.1	0.0	0.0	0.0
G5	NLF	0.0	0.1	0.0	-0.1	0.3	-0.1
	SDLF	0.0	0.0	0.0	-0.1	0.2	-0.1
	TDLF	0.0	-0.3	0.0	0.0	0.0	0.0
G6	NLF	0.0	0.3	0.0	-0.2	1.0	-0.2
	SDLF	0.0	0.0	0.0	-0.1	0.7	-0.2
	TDLF	0.1	-0.8	0.1	0.0	-0.1	-0.1

Table K1-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
		Load Type & Support Number					
G1	NLF	0.00	0.07	0.09	-0.02	0.28	0.34
	SDLF	0.00	0.05	0.08	-0.01	0.23	0.30
	TDLF	0.01	0.02	0.08	0.00	0.24	0.35
G2	NLF	0.00	0.06	0.09	0.00	0.26	0.35
	SDLF	0.00	0.05	0.08	0.00	0.22	0.31
	TDLF	-0.01	0.05	0.10	0.00	0.25	0.36
G3	NLF	0.00	0.06	0.09	0.01	0.25	0.36
	SDLF	0.00	0.05	0.08	0.01	0.22	0.31
	TDLF	-0.01	0.07	0.10	0.00	0.25	0.37
G4	NLF	0.00	0.06	0.09	0.01	0.25	0.36
	SDLF	0.00	0.05	0.08	0.01	0.21	0.31
	TDLF	0.00	0.07	0.10	0.00	0.25	0.36
G5	NLF	0.00	0.06	0.09	0.00	0.23	0.35
	SDLF	0.00	0.05	0.08	0.00	0.20	0.31
	TDLF	0.00	0.08	0.10	0.00	0.25	0.36
G6	NLF	0.00	0.05	0.09	-0.01	0.20	0.35
	SDLF	0.00	0.05	0.08	0.00	0.18	0.31
	TDLF	0.01	0.09	0.08	0.00	0.24	0.35

Table K1-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
G1	NLF	0.00	0.03	0.00	-0.05	0.07	-0.04
	SDLF	0.00	0.00	0.00	-0.04	0.05	-0.03
	TDLF	0.02	-0.08	0.01	-0.01	-0.01	0.00
G2	NLF	0.00	0.01	0.00	-0.01	0.04	-0.01
	SDLF	0.00	0.00	0.00	-0.01	0.03	-0.01
	TDLF	0.00	-0.04	0.00	0.00	0.00	0.00
G3	NLF	0.00	0.00	0.00	0.01	0.02	0.01
	SDLF	0.00	0.00	0.00	0.01	0.01	0.00
	TDLF	0.01	-0.01	0.00	0.00	0.00	0.00
G4	NLF	0.00	0.00	0.00	0.01	0.01	0.02
	SDLF	0.00	0.00	0.00	0.01	0.01	0.01
	TDLF	0.01	0.00	-0.01	0.00	0.00	0.00
G5	NLF	0.00	-0.01	0.00	0.01	-0.03	0.01
	SDLF	0.00	0.00	0.00	0.01	-0.02	0.01
	TDLF	0.00	0.03	0.00	0.00	0.00	0.00
G6	NLF	0.00	-0.03	0.00	0.02	-0.10	0.02
	SDLF	0.00	0.00	0.00	0.01	-0.07	0.02
	TDLF	-0.01	0.08	-0.01	0.00	0.01	0.01

Appendix K1-5. EICSS12 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge EICSS12 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table K1-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-2	SDLF	0.0	0.1	0.1	0.0	0.0	0.0
		TDLF	0.0	-0.2	0.3	0.0	0.3	0.3
	6-3	SDLF	0.0	0.1	0.1	0.0	-0.1	0.1
		TDLF	0.0	-0.1	0.1	0.0	0.1	0.1
	6-4	SDLF	-0.3	0.3	0.4	-0.3	-0.3	0.4
		TDLF	-1.2	-0.3	1.2	-1.2	0.3	1.2
	6-5	SDLF	0.1	0.2	0.2	0.1	-0.2	0.2
		TDLF	0.4	1.4	1.5	0.5	-1.7	1.8
	6-6	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	0.1	0.1	0.0	-0.1	0.1

Table K1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
10	10-2	SDLF	0.0	-0.1	0.1	0.0	0.1	0.1
		TDLF	0.0	-0.4	0.4	0.0	0.2	0.2
	10-3	SDLF	0.0	0.1	0.1	0.0	0.1	0.1
		TDLF	0.0	0.2	0.2	0.0	-0.1	0.1

Table K1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
12	12-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.2	-0.2	0.3	0.2	0.1	0.2
	12-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	0.1	0.1	0.0	-0.3	0.3

Table K1-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
17	17-1	SDLF	0.0	-0.1	0.1	0.0	0.1	0.1
		TDLF	0.0	-7.1	7.1	0.0	6.3	6.3
	17-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	-0.5	0.5	0.0	0.5	0.5
	17-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.1	1.0	1.5	1.1	-1.3	1.7
	17-4	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-1.9	-1.0	2.2	-2.0	1.2	2.3
	17-5	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-1.3	0.2	1.3	-1.3	-0.3	1.3
	17-6	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	0.8	0.8	0.0	-0.6	0.6

Table K1-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
20	20-1	SDLF	0.0	-0.2	0.2	0.0	0.2	0.2
		TDLF	0.0	5.2	5.2	0.0	-5.5	5.5
	20-2	SDLF	0.0	-0.1	0.1	0.0	0.1	0.1
		TDLF	0.0	-1.5	1.5	0.0	1.3	1.3
	20-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.3	1.8	2.3	1.3	-1.6	2.1
	20-4	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.3	-0.6	0.7	-0.3	0.3	0.5
	20-5	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	0.2	0.2	0.0	-0.2	0.2
	20-6	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	-0.6	0.6	0.0	0.8	0.8

Table K1-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
22	22-1	SDLF	0.0	-0.1	0.1	0.0	0.1	0.1
		TDLF	0.0	-0.1	0.1	0.0	0.3	0.3
	22-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	-0.9	0.9	0.0	0.6	0.6
	22-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	2.0	0.3	2.0	2.0	-0.4	2.0
	22-4	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.1	-0.3	1.2	1.1	0.3	1.1
	22-5	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.6	0.1	0.6	0.5	-0.1	0.5
	22-6	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	0.7	0.7	0.0	-0.6	0.6

Table K1-5-2: Erection Critical Sub-Stages

Stage	Detailing Method	Critical Sub-Stage
6	SDLF	6-4
	TDLF	6-5
10	SDLF	10-2
	TDLF	10-2
12	SDLF	12-3
	TDLF	12-3
17	SDLF	17-1
	TDLF	17-1
20	SDLF	20-1
	TDLF	20-1
22	SDLF	22-1
	TDLF	22-2

Table K1-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
6	A	SDLF	-0.6	0.1	0.6	NA	NA	NA
		TDLF	0.4	0.7	0.8	NA	NA	NA
	B	SDLF	-0.3	0.3	0.4	-0.3	-0.3	0.4
		TDLF	0.4	1.4	1.5	0.5	-1.7	1.8
10	A	SDLF	0.0	-0.1	0.1	NA	NA	NA
		TDLF	0.0	-0.3	0.3	NA	NA	NA
	B	SDLF	0.0	-0.1	0.1	0.0	0.1	0.1
		TDLF	0.0	-0.4	0.4	0.0	0.2	0.2
12	A	SDLF	0.0	0.0	0.0	NA	NA	NA
		TDLF	-0.1	0.0	0.1	NA	NA	NA
	B	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	0.1	0.1	0.0	-0.3	0.3
17	A	SDLF	0.0	0.0	0.0	NA	NA	NA
		TDLF	0.0	-2.9	2.9	NA	NA	NA
	B	SDLF	0.0	-0.1	0.1	0.0	0.1	0.1
		TDLF	0.0	-7.1	7.1	0.0	6.3	6.3
20	A	SDLF	0.0	-0.1	0.1	NA	NA	NA
		TDLF	0.0	2.2	2.2	NA	NA	NA
	B	SDLF	0.0	-0.2	0.2	0.0	0.2	0.2
		TDLF	0.0	5.2	5.2	0.0	-5.5	5.5
22	A	SDLF	0.0	0.0	0.0	NA	NA	NA
		TDLF	0.0	-0.2	0.2	NA	NA	NA
	B	SDLF	0.0	-0.1	0.1	0.0	0.1	0.1
		TDLF	0.0	-0.9	0.9	0.0	0.6	0.6

Table K1-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
6	A	G1	SDLF	19	49
			TDLF	18	50
		G2	SDLF	20	50
			TDLF	21	48
		G3	SDLF	20	50
			TDLF	20	50
		G4	SDLF	20	50
			TDLF	20	50
		G5	SDLF	20	48
			TDLF	20	47
		G6	SDLF	19	48
			TDLF	19	49
	B	G1	SDLF	19	49
			TDLF	18	50
		G2	SDLF	20	50
			TDLF	21	48
		G3	SDLF	20	50
			TDLF	20	50
		G4	SDLF	20	50
			TDLF	20	50
		G5	SDLF	20	48
			TDLF	20	48
		G6	SDLF	19	48
			TDLF	19	49

Table K1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
10	A	G1	SDLF	15	65	13
			TDLF	15	66	13
		G2	SDLF	16	67	14
			TDLF	17	65	14
		G3	SDLF	16	67	14
			TDLF	16	68	14
		G4	SDLF	16	68	13
			TDLF	16	68	13
		G5	SDLF	20	50	
			TDLF	20	49	
		G6	SDLF	19	47	
			TDLF	19	48	
	B	G1	SDLF	15	65	13
			TDLF	15	66	13
		G2	SDLF	16	67	14
			TDLF	17	65	14
		G3	SDLF	16	67	14
			TDLF	16	68	14
		G4	SDLF	16	68	13
			TDLF	16	68	13
		G5	SDLF	20	50	
			TDLF	20	49	
		G6	SDLF	19	47	
			TDLF	19	48	

Table K1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
12	A	G1	SDLF	15	65	13
			TDLF	15	66	14
		G2	SDLF	17	67	14
			TDLF	17	65	14
		G3	SDLF	16	67	14
			TDLF	16	68	14
		G4	SDLF	16	67	14
			TDLF	16	68	14
		G5	SDLF	16	67	14
			TDLF	16	65	15
		G6	SDLF	15	65	13
			TDLF	15	66	12
	B	G1	SDLF	15	65	13
			TDLF	15	66	14
		G2	SDLF	17	67	14
			TDLF	17	65	14
		G3	SDLF	16	67	14
			TDLF	16	68	14
		G4	SDLF	16	67	14
			TDLF	16	68	14
		G5	SDLF	16	67	14
			TDLF	16	65	15
		G6	SDLF	15	65	13
			TDLF	15	66	13

Table K1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
17	A	G1	SDLF	15	65	13
			TDLF	12	64	14
		G2	SDLF	17	68	14
			TDLF	21	69	13
		G3	SDLF	17	68	14
			TDLF	18	68	14
		G4	SDLF	17	68	14
			TDLF	18	69	14
		G5	SDLF	17	68	14
			TDLF	16	61	15
		G6	SDLF	15	65	13
			TDLF	14	70	12
	B	G1	SDLF	15	65	13
			TDLF	12	63	14
		G2	SDLF	17	68	14
			TDLF	21	70	13
		G3	SDLF	17	68	14
			TDLF	18	68	14
		G4	SDLF	17	68	14
			TDLF	18	69	14
		G5	SDLF	17	68	14
			TDLF	18	61	15
		G6	SDLF	15	65	13
			TDLF	12	70	12

Table K1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
20	A	G1	SDLF	15	66	13
			TDLF	12	66	15
		G2	SDLF	17	69	15
			TDLF	21	69	14
		G3	SDLF	17	68	14
			TDLF	17	67	15
		G4	SDLF	17	68	14
			TDLF	18	71	14
		G5	SDLF	17	68	14
			TDLF	18	61	15
		G6	SDLF	15	66	13
			TDLF	12	71	12
	B	G1	SDLF	15	66	13
			TDLF	12	66	15
		G2	SDLF	17	69	15
			TDLF	21	68	14
		G3	SDLF	17	68	14
			TDLF	17	67	15
		G4	SDLF	17	68	14
			TDLF	18	71	14
		G5	SDLF	17	68	14
			TDLF	18	62	15
		G6	SDLF	15	66	13
			TDLF	12	71	12

Table K1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
22	A	G1	SDLF	15	66	13
			TDLF	12	66	14
		G2	SDLF	17	69	15
			TDLF	21	68	14
		G3	SDLF	17	69	15
			TDLF	17	70	15
		G4	SDLF	17	69	15
			TDLF	18	68	14
		G5	SDLF	17	69	15
			TDLF	18	63	18
		G6	SDLF	15	65	13
			TDLF	12	72	11
	B	G1	SDLF	15	66	13
			TDLF	12	66	14
		G2	SDLF	17	69	15
			TDLF	21	68	14
		G3	SDLF	17	69	15
			TDLF	17	70	15
		G4	SDLF	17	69	15
			TDLF	18	68	14
		G5	SDLF	17	69	15
			TDLF	18	63	18
		G6	SDLF	15	65	13
			TDLF	12	72	11

Appendix K2-1. EICSS12 Bridge Description

The key characteristics of EICSS12 are as follows:

- Span length along the centerline of the bridge, L_s 150,139 ft.
- Width between the fascia girders, w_g = 41ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 3.7,3.4
- Number of girders in the completed bridge cross-section, n_g = 6.
- Parallel skew
- Skew angle, θ = 59.6,59.6,59.6^o
- Skew index, I_s = 0.46,0.51

This appendix presents the bridge description of the bridge EICSS12 in its final condition as well as during erection. The following figures and tables are provided:

Figure K2-1-1. Framing plan

Figure K2-1-2. Bridge cross-section

Figure K2-1-3. Girder Elevation

Figure K2-1-4. Cross-section dimension

Figure K2-1-5. Cross-frame details

Figure K2-1-6. Erection scheme

Table K2-1-1. Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

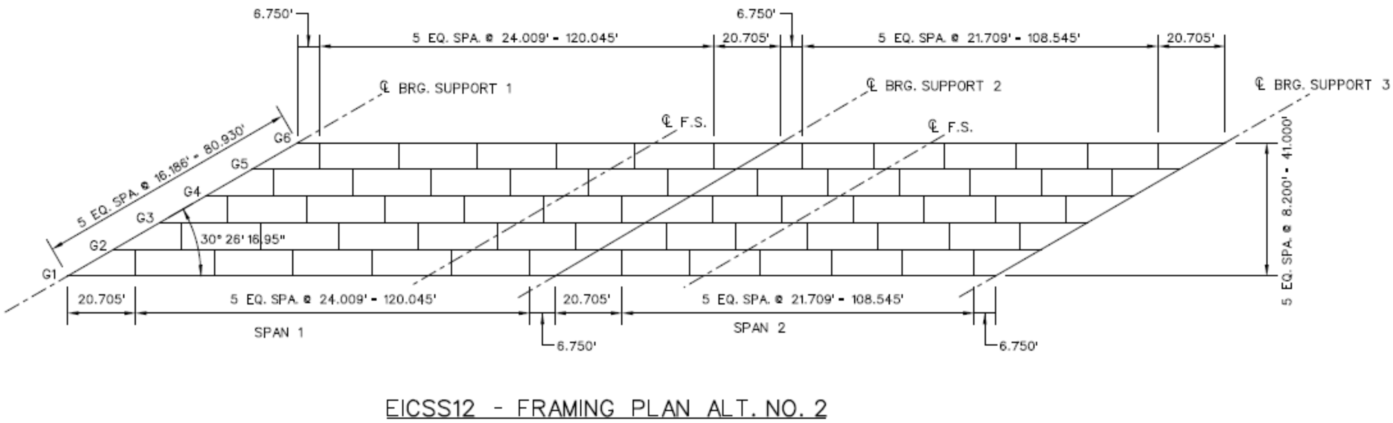


Figure K2-1-1. Framing plan.

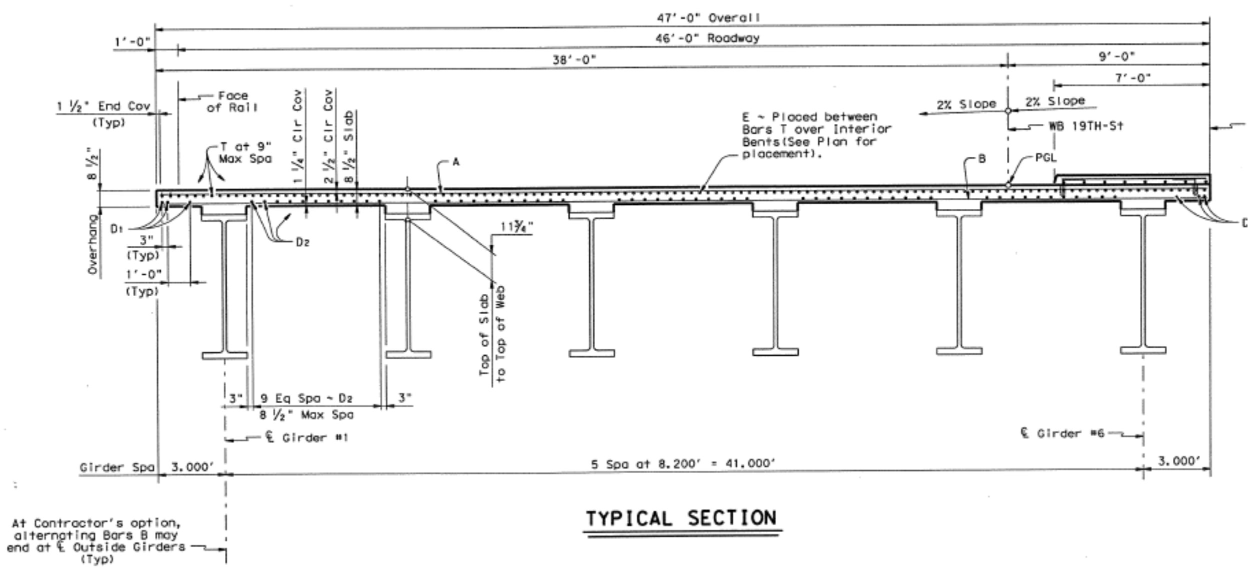


Figure K2-1-2. Bridge cross-section.

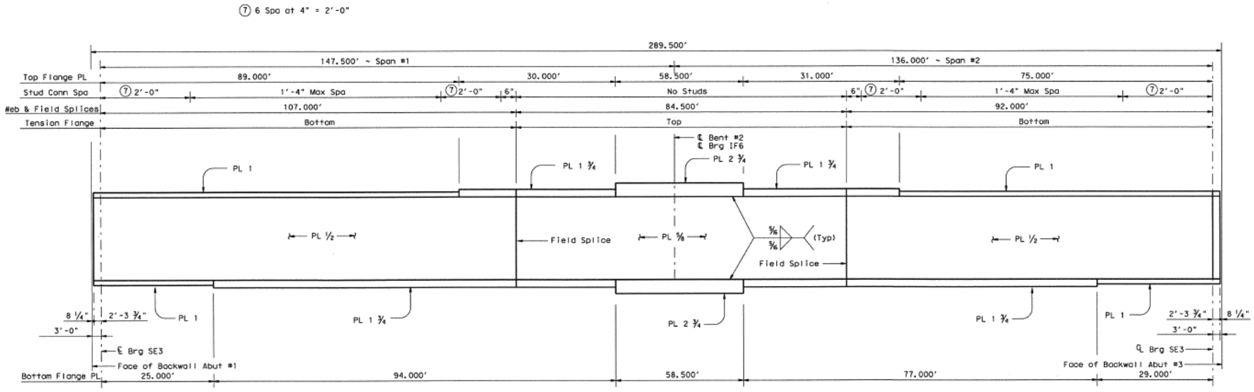


Figure K2-1-3. Girder elevations

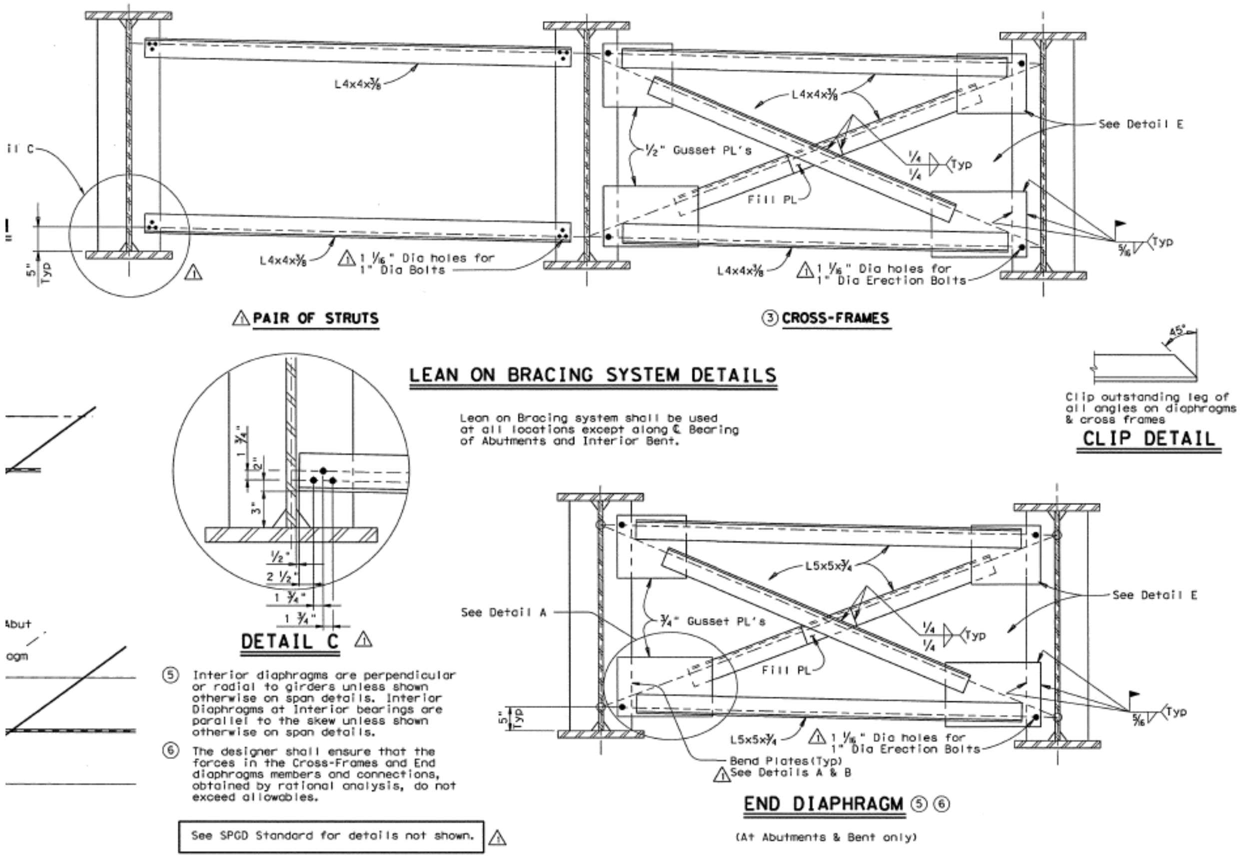


Figure K2-1-5. Cross-frame details.

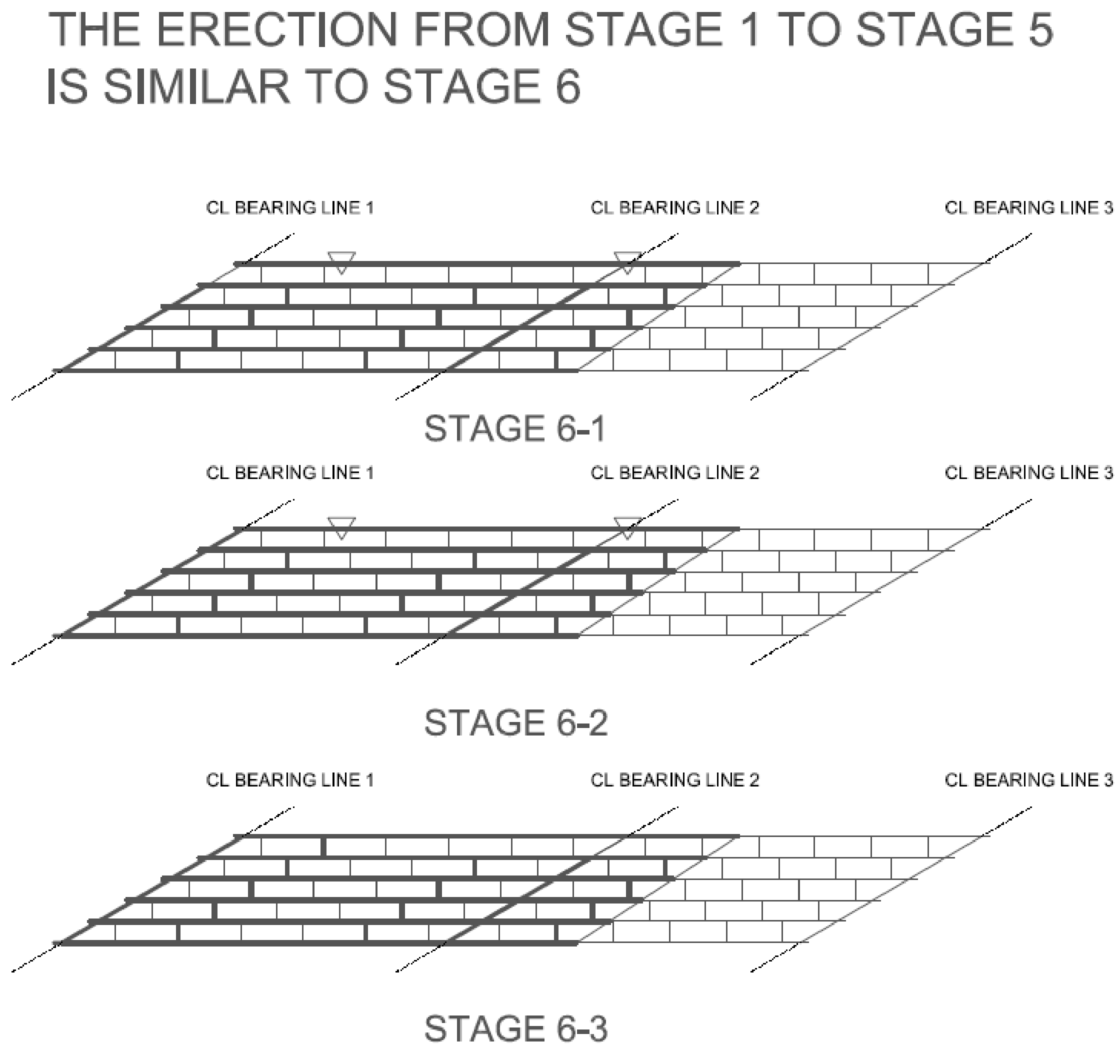
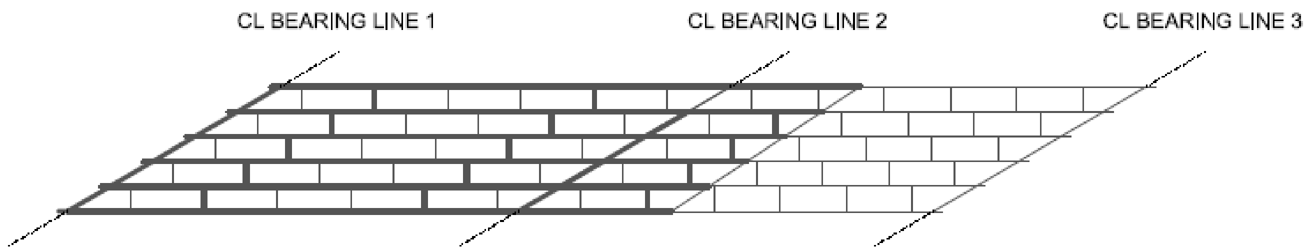
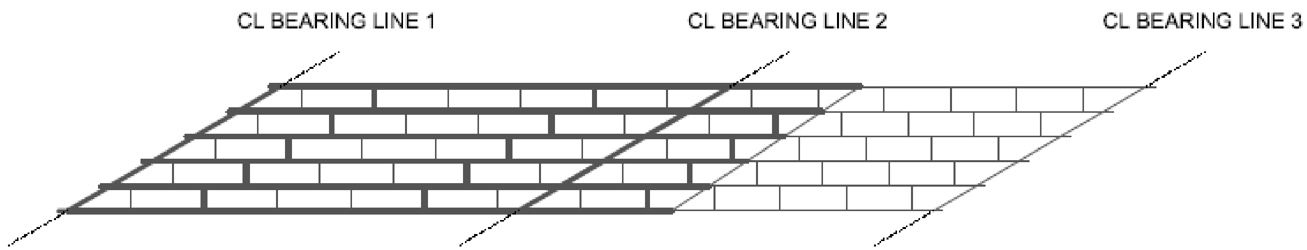


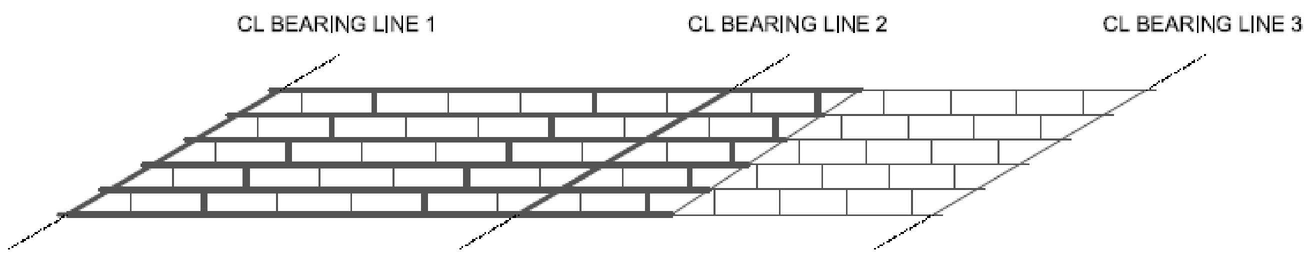
Figure K2-1-6. Erection scheme.



STAGE 6-4



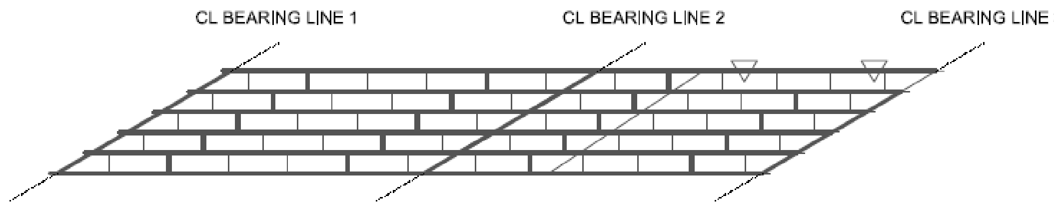
STAGE 6-5



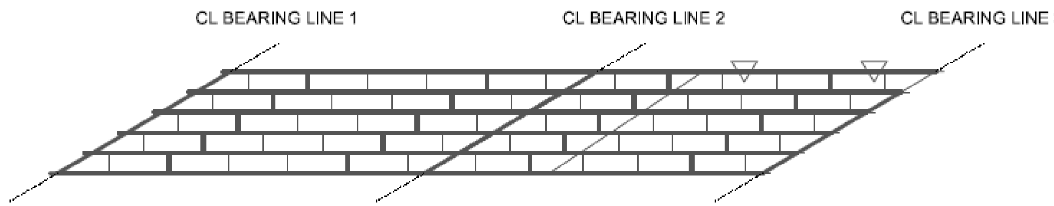
STAGE 6-6

Figure K2-1-6(Continued). Erection scheme.

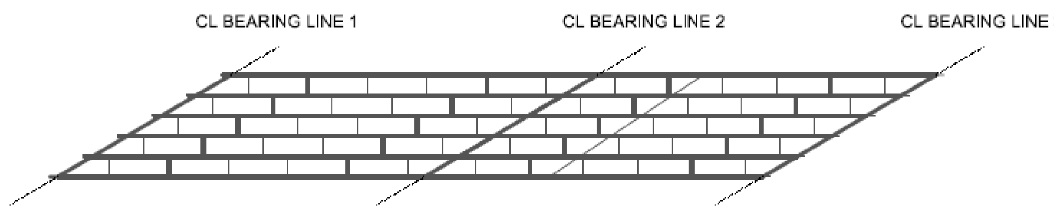
THE ERECTION FROM STAGE 7 TO STAGE 11
IS SIMILAR TO STAGE 12



STAGE 12-1



STAGE 12-2



STAGE 12-3

STAGE 13 TO 22: INSTALL THE REMAINING XFs
GIRDER BY GIRDER, SPAN BY SPAN.

Figure K2-1-6(Continued). Erection scheme.

Table K2-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

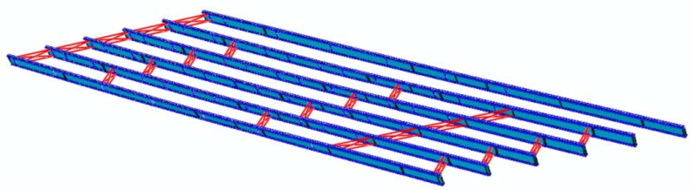
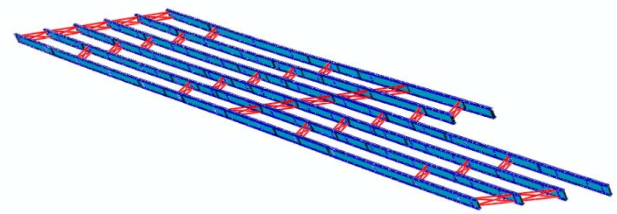
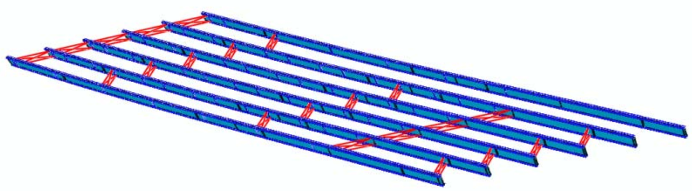
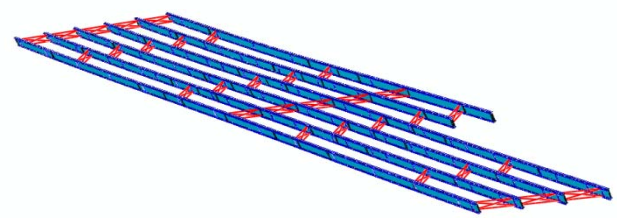
Sub-Stage	Stage	
	6	10
1		
2		

Table K2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

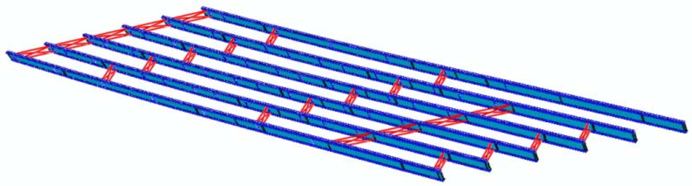
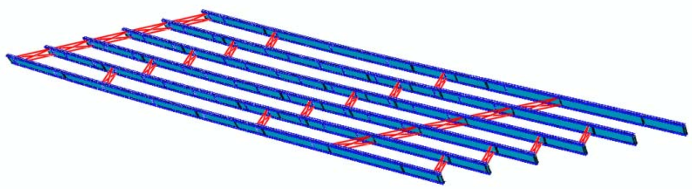
Sub-Stage	Stage 6	Stage 10
3		
4		

Table K2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

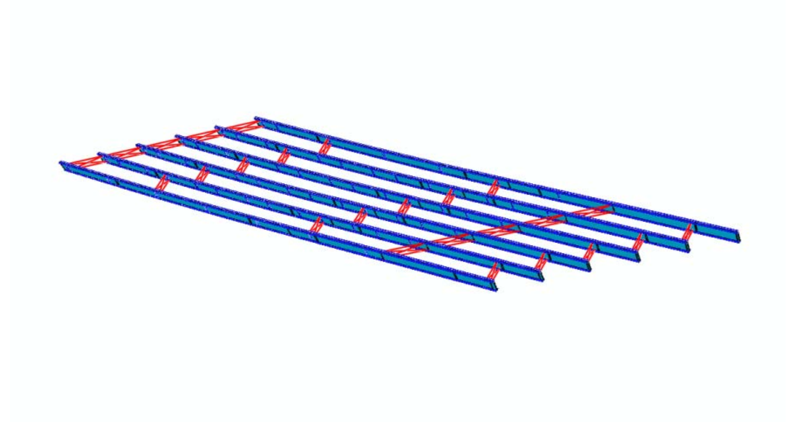
Sub-Stage	Stage	
	6	10
5		

Table K2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

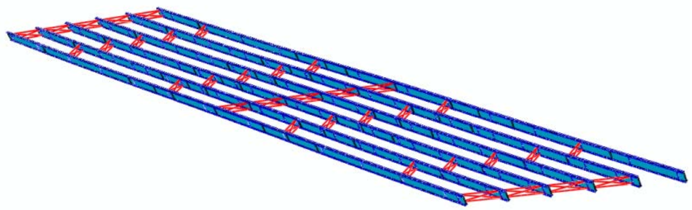
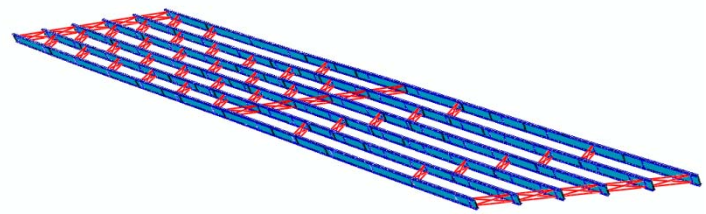
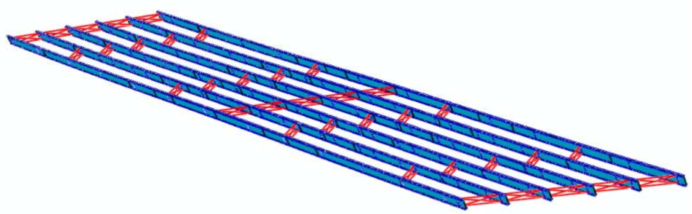
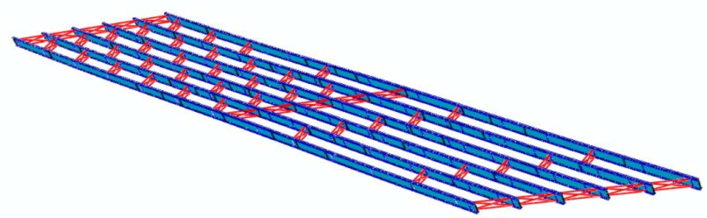
Sub-Stage	Stage	
	12	17
1		
2		

Table K2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

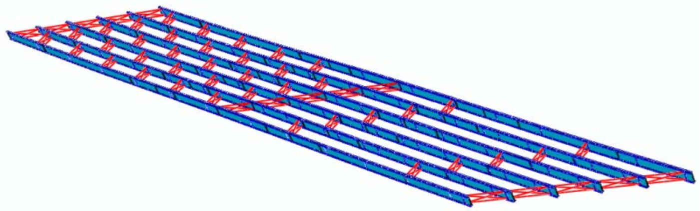
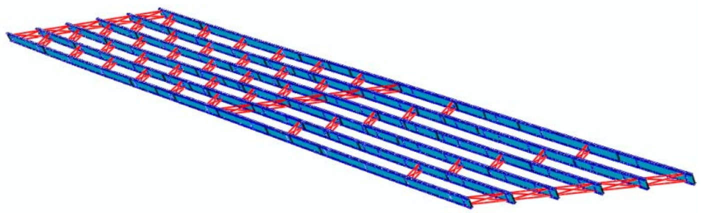
Sub-Stage	Stage	
	12	17
3		
4		

Table K2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

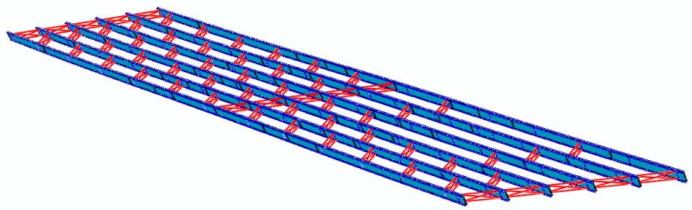
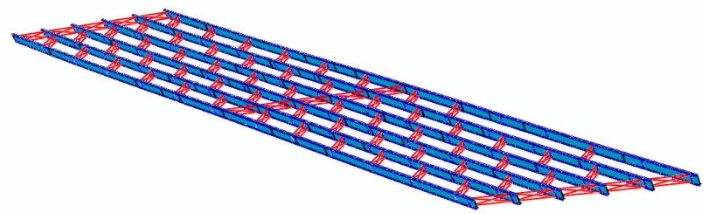
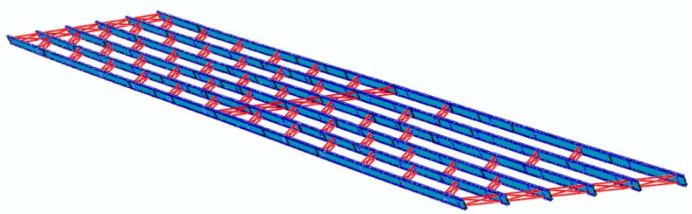
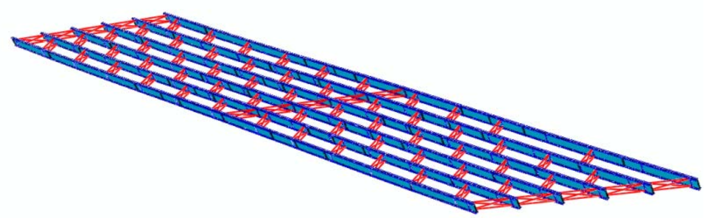
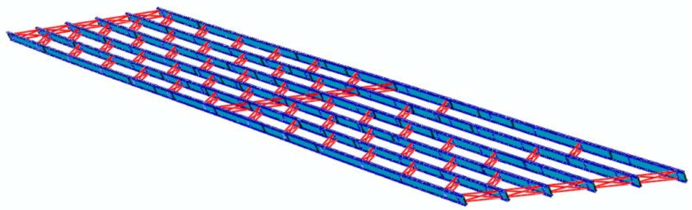
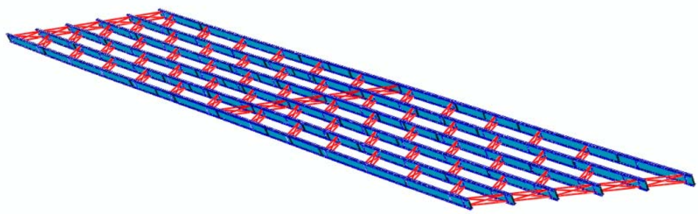
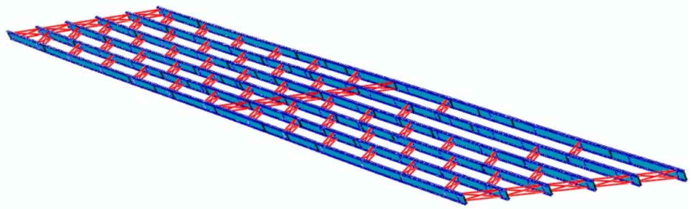
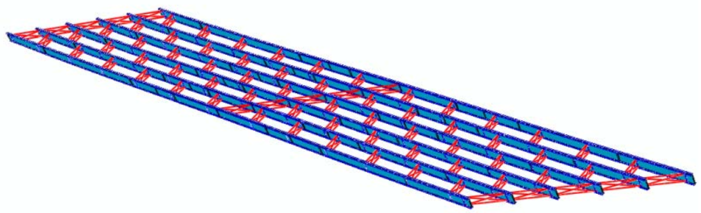
Sub-Stage	Stage	
	20	22
1		
2		

Table K2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

Sub-Stage	Stage	
	20	22
3		
4		

Appendix K2-2. EICSS12 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EICSS12 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table K2-2-1. Summary of girder maximum vertical displacements (in).

Table K2-2-2. Summary of girder maximum layovers (in).

Table K2-2-3. Summary of girder maximum stresses (ksi.)

Table K2-2-4. Summary of maximum cross-frame forces (kip.)

Table K2-2-5. Summary of average cross-frame forces (kip.)

Table K2-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in.)

Table K2-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in.)

Table K2-2-8. Summary of maximum SDL approximate horizontal differential displacements at the cross-frame locations (in.)

Table K2-2-9. Summary of maximum TDL approximate horizontal differential displacements at the cross-frame locations (in.)

Table K2-2-10. Total vertical reactions under SDL and TDL (kips.)

Table K2-2-11. Summary of maximum reactions under SDL and TDL (kips)

Table K2-2-12. Summary of maximum support displacements under SDL and TDL (in)

Figure K2-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative to the member yield load.

Figure K2-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative to the member yield load.

Figure K2-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load ($\Delta P/P_y$), under SDL, SDLF detailing.

Figure K2-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load ($\Delta P/P_y$), under TDL, TDLF detailing.

Table K2-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.0	4.5
	SDLF	0.9	4.4
	TDLF	0.6	3.9
G2	NLF	1.0	4.0
	SDLF	1.0	4.0
	TDLF	1.0	4.1
G3	NLF	0.9	3.9
	SDLF	1.0	3.9
	TDLF	1.1	4.0
G4	NLF	0.9	3.8
	SDLF	1.0	3.8
	TDLF	1.2	4.0
G5	NLF	0.9	3.7
	SDLF	1.0	3.8
	TDLF	1.2	4.1
G6	NLF	0.9	3.9
	SDLF	0.9	3.9
	TDLF	0.9	3.9
All Girders	NLF	1.0	4.5
	SDLF	1.0	4.4
	TDLF	1.2	4.1

Table K2-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.2	1.0
	SDLF	0.0	0.8
	TDLF	0.7	0.1
G2	NLF	0.2	0.9
	SDLF	0.0	0.7
	TDLF	0.7	0.1
G3	NLF	0.2	0.8
	SDLF	0.0	0.6
	TDLF	0.6	0.0
G4	NLF	0.2	0.8
	SDLF	0.0	0.6
	TDLF	0.6	0.0
G5	NLF	0.2	0.8
	SDLF	0.0	0.6
	TDLF	0.6	0.1
G6	NLF	0.2	0.9
	SDLF	0.0	0.7
	TDLF	0.7	0.1
All Girders	NLF	0.2	1.0
	SDLF	0.0	0.8
	TDLF	0.7	0.1

Table K2-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	3.7	14.7	3.9	17.1	0.8	2.8	0.8	3.2
	SDLF	3.7	14.7	3.6	16.7	0.0	2.3	0.0	2.5
	TDLF	3.5	14.5	3.4	15.2	2.7	0.9	2.9	1.0
G2	NLF	3.7	14.7	3.7	14.4	0.8	3.3	0.8	2.5
	SDLF	3.8	14.8	3.7	14.5	0.1	2.3	0.1	2.3
	TDLF	4.1	15.1	5.1	15.8	3.1	1.3	3.1	1.4
G3	NLF	3.8	15.1	3.7	16.0	0.5	2.3	0.5	2.5
	SDLF	3.8	15.1	3.7	16.0	0.1	1.8	0.1	1.9
	TDLF	3.9	15.2	3.8	15.9	1.4	0.8	1.6	0.9
G4	NLF	3.8	15.3	3.7	15.9	0.5	2.2	0.5	2.3
	SDLF	3.8	15.3	3.7	16.0	0.1	1.7	0.1	1.7
	TDLF	3.8	15.2	3.8	16.0	1.5	0.9	1.6	0.9
G5	NLF	3.7	14.7	3.7	15.7	0.9	3.8	0.8	2.2
	SDLF	3.8	14.8	3.7	15.7	0.1	2.7	0.1	2.0
	TDLF	4.1	15.0	4.0	15.8	3.5	1.3	3.2	1.4
G6	NLF	3.6	14.6	3.6	14.6	0.9	3.4	1.1	3.9
	SDLF	3.6	14.6	3.6	14.7	0.0	2.7	0.0	2.9
	TDLF	3.6	14.4	3.8	15.0	3.2	0.9	3.9	1.5
All Girders	NLF	3.8	15.3	3.9	17.1	0.9	3.8	1.1	3.9
	SDLF	3.8	15.3	3.7	16.7	0.1	2.7	0.1	2.9
	TDLF	4.1	15.2	5.1	16.0	3.5	1.3	3.9	1.5

Table K2-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	2.0	3.1	3.2	3.2
	SDLF	0.0	0.0	0.0	0.0
	TDLF	5.8	9.7	10.0	10.0
TDL	NLF	6.4	13.0	13.7	13.7
	SDLF	5.1	10.1	10.6	10.6
	TDLF	2.2	3.4	3.3	3.4

Table K2-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	0.6	1.2	1.2	0.9
	SDLF	0.0	0.0	0.0	0.0
	TDLF	1.7	3.8	3.8	2.8
TDL	NLF	2.4	4.6	4.5	3.5
	SDLF	1.9	3.5	3.5	2.7
	TDLF	0.7	1.5	1.4	1.1

Table K2-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.36	0.33	0.32	0.31	0.30	0.36
SDLF	0.30	0.34	0.34	0.34	0.35	0.35
TDLF	0.60	0.34	0.38	0.40	0.53	0.60

Table K2-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	1.62	1.43	1.36	1.32	1.25	1.62
SDLF	1.55	1.43	1.37	1.34	1.30	1.55
TDLF	1.34	1.44	1.41	1.41	1.45	1.45

Table K2-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.16	0.15	0.14	0.14	0.13	0.16
SDLF	0.14	0.15	0.15	0.15	0.16	0.16
TDLF	0.27	0.15	0.17	0.18	0.24	0.27

Table K2-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.73	0.64	0.61	0.59	0.56	0.73
SDLF	0.70	0.64	0.62	0.60	0.58	0.70
TDLF	0.60	0.64	0.63	0.63	0.65	0.65

Table K2-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	599.3	2246.9
SDLF	599.3	2246.7
TDLF	599.3	2246.9

Table K2-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	71.8	253.0	0.0	0.2	0.2	0.2
SDLF	70.4	251.5	0.0	0.2	0.0	0.2
TDLF	74.3	246.8	0.1	0.0	0.6	0.0

Table K2-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.09	0.36	0.02	0.36
SDLF	0.08	0.32	0.00	0.32
TDLF	0.11	0.37	0.06	0.37

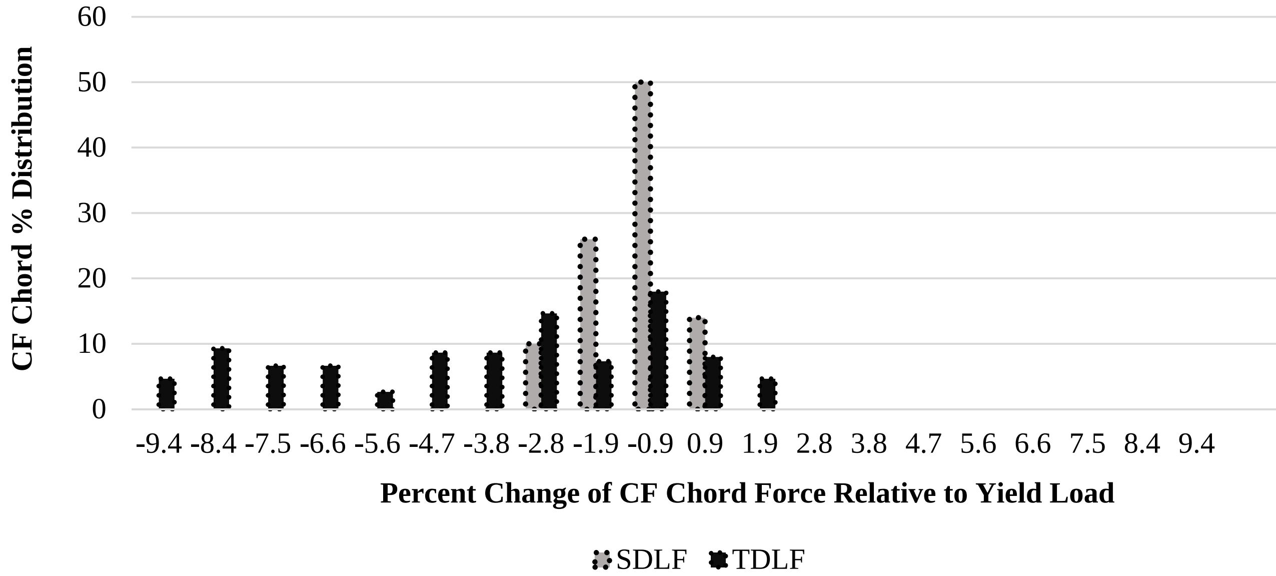


Figure K2-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

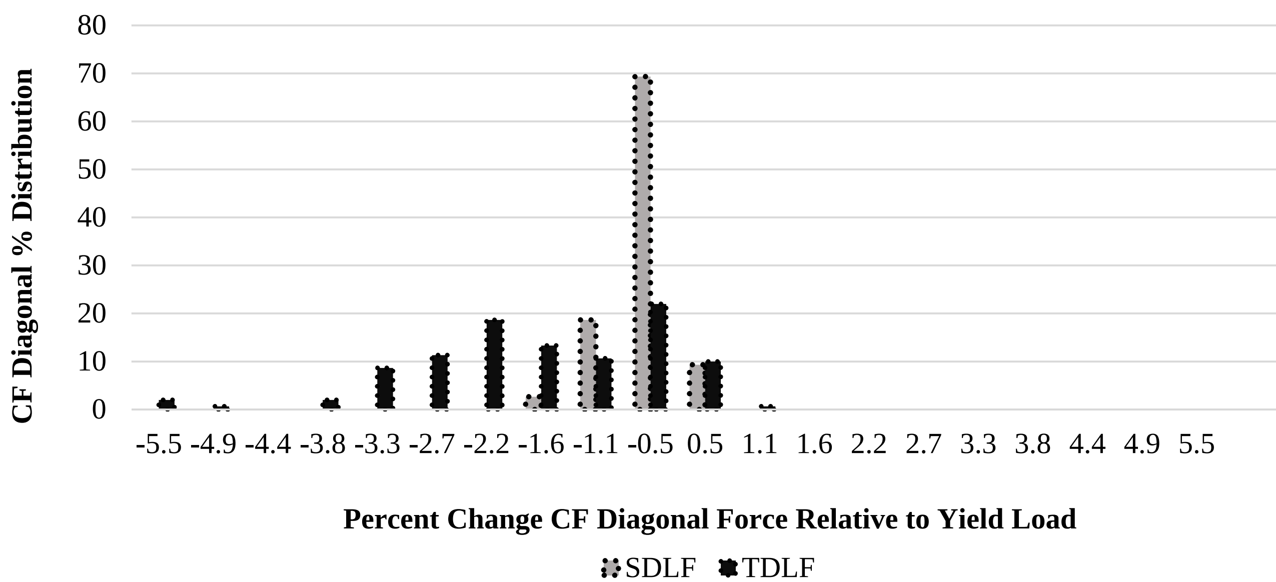


Figure K2-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

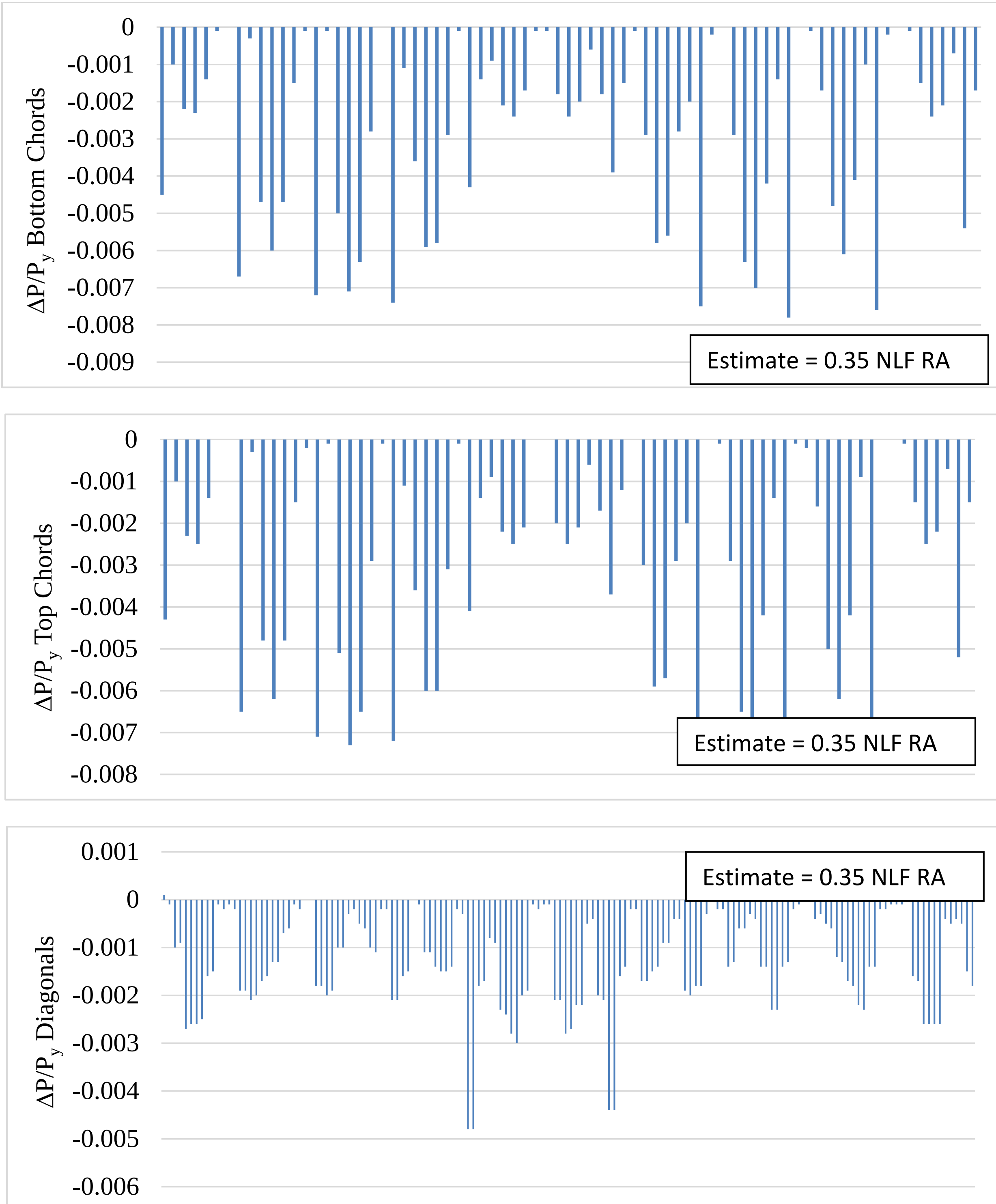


Figure K2-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

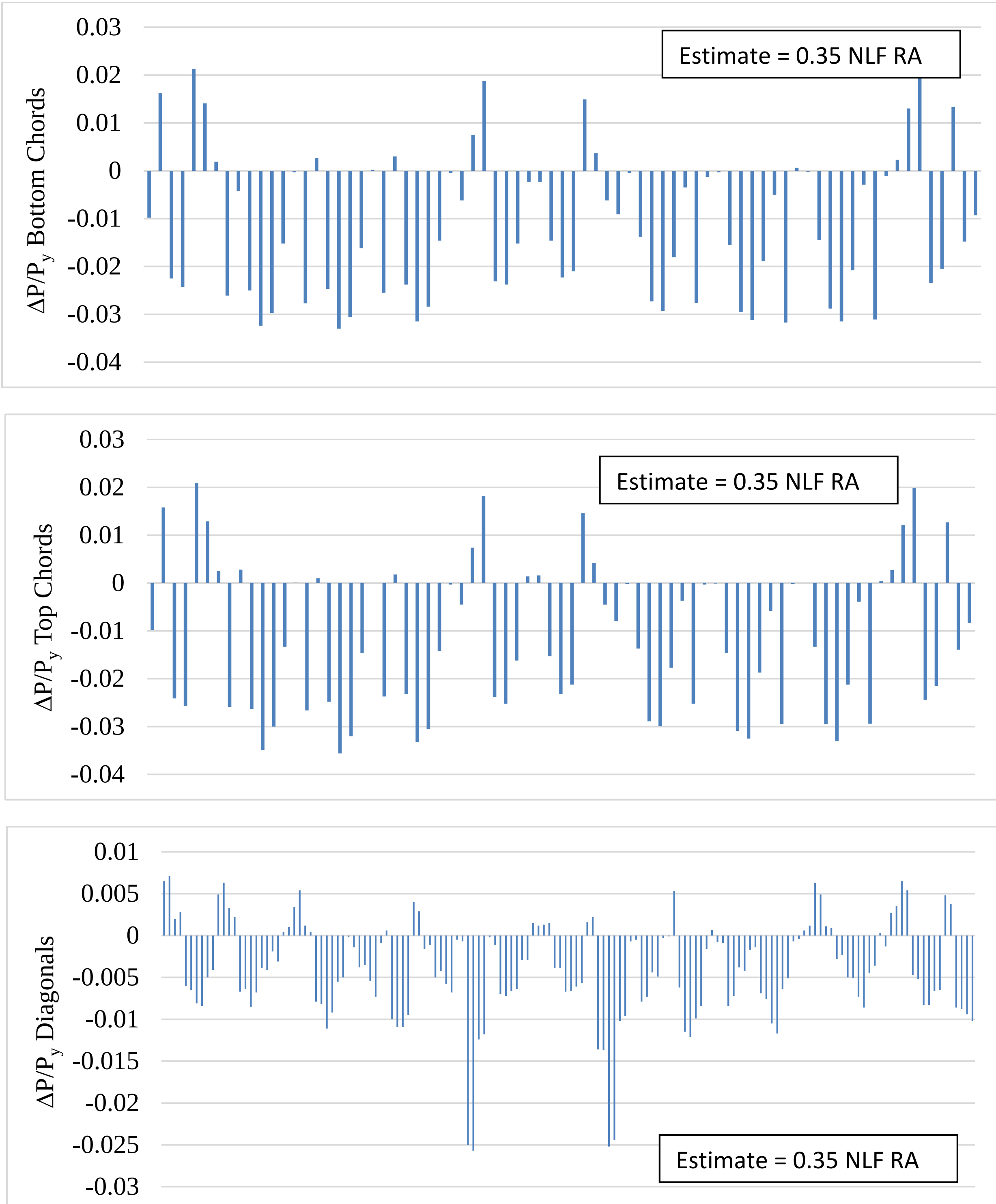


Figure K2-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix K2-3. EICSS12 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EICSS12 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table K2-3-1. Maximums of the fit-up force resultants (kips)

Detailing Method	F1	F2	F_{max}
SDLF	0.3	0.4	0.4
TDLF	4.5	7.7	7.7

Table K2-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	SDLF	66	13
	TDLF	66	12
G2	SDLF	70	15
	TDLF	69	14
G3	SDLF	69	14
	TDLF	71	14
G4	SDLF	69	12
	TDLF	71	12
G5	SDLF	69	14
	TDLF	70	15
G6	SDLF	66	13
	TDLF	72	10
All Girders	SDLF	70	12
	TDLF	72	10

Table K2-3-3. Total Vertical Reactions (kips)

Stage	Detailing Method	Sub-Stage				
		1	2	3	4	5
6	SDLF	416	416	416	418	418
	TDLF	416	416	416	418	418
10	SDLF	528	530			
	TDLF	528	530			
12	SDLF	586	586			
	TDLF	586	586			
17	SDLF	592	592	592	593	
	TDLF	592	592	592	593	
20	SDLF	596	596	596	597	
	TDLF	596	596	596	597	
22	SDLF	598	599	599	599	
	TDLF	598	599	599	599	

Appendix K2-4. NISSS14 Detailed Results, Completed Bridge Responses

This appendix presents the SDL and TDL responses of the bridge NISSS14 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

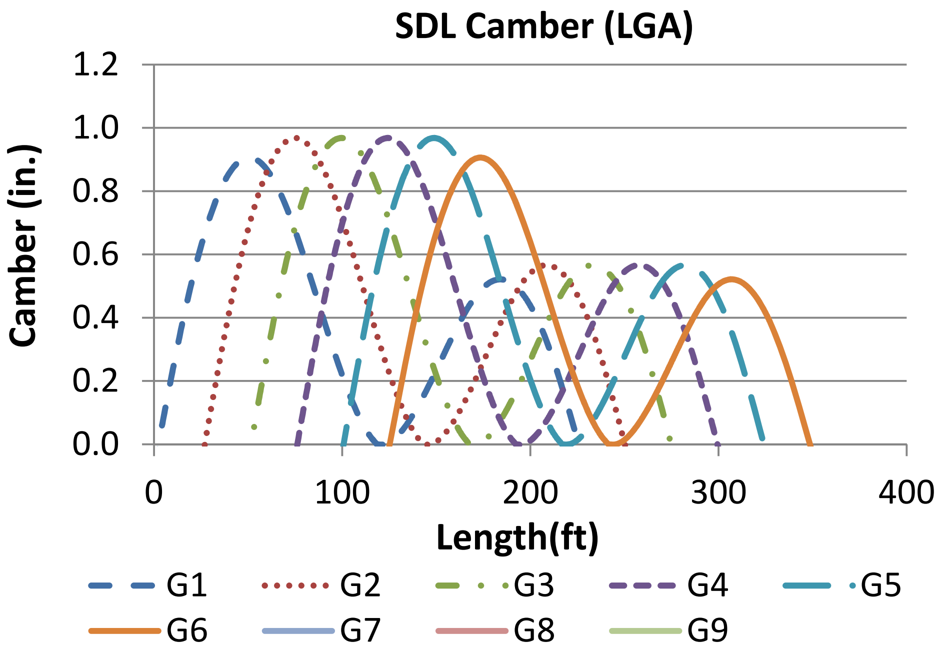
Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

Table K2-4-14. Longitudinal displacements at supports (in).

Table K2-4-15. Transverse displacements at supports (in).



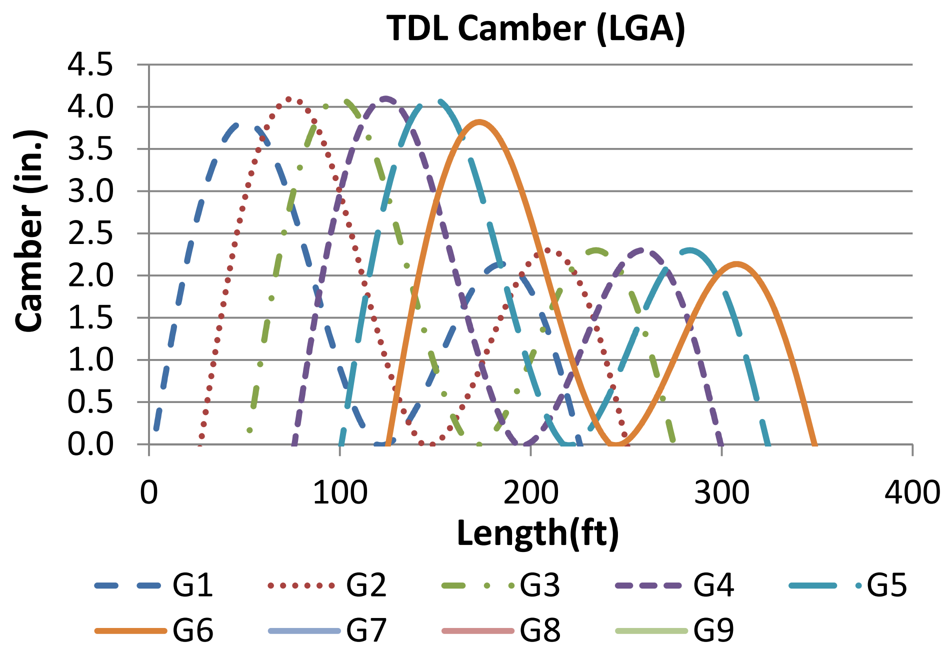


Figure K2-4-1. SDL and TDL Line Girder Analysis cambers.

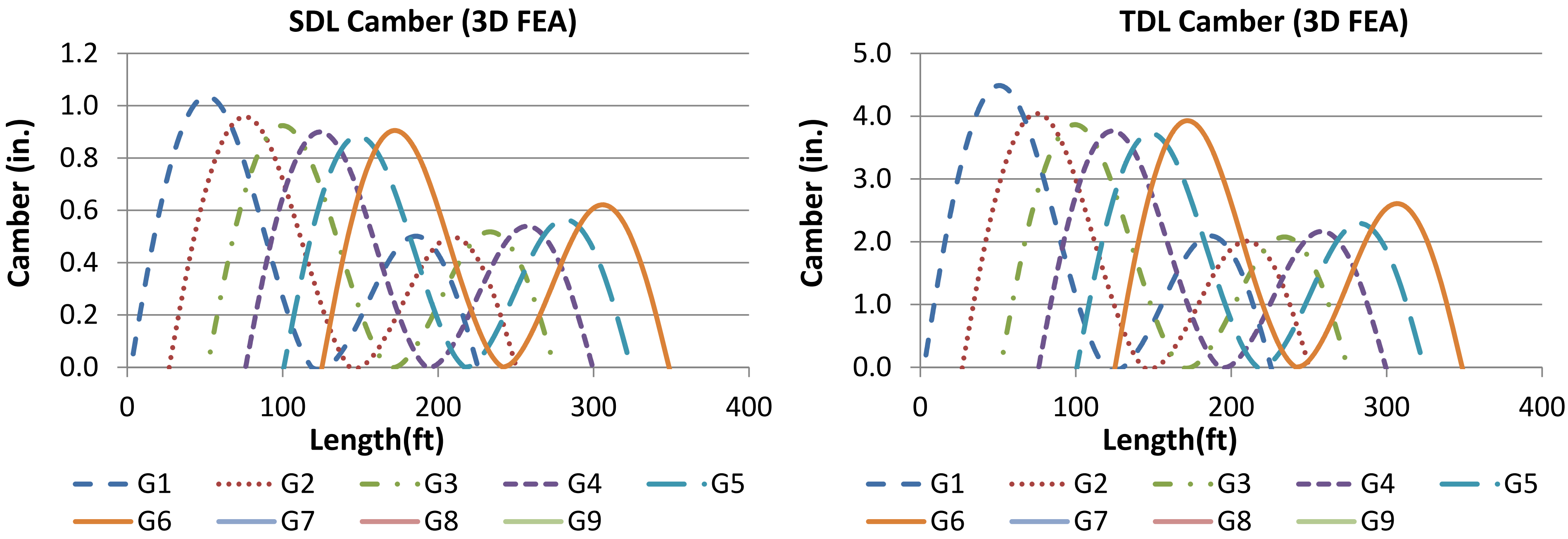


Figure K2-4-2. SDL and TDL 3D FEA cambers.

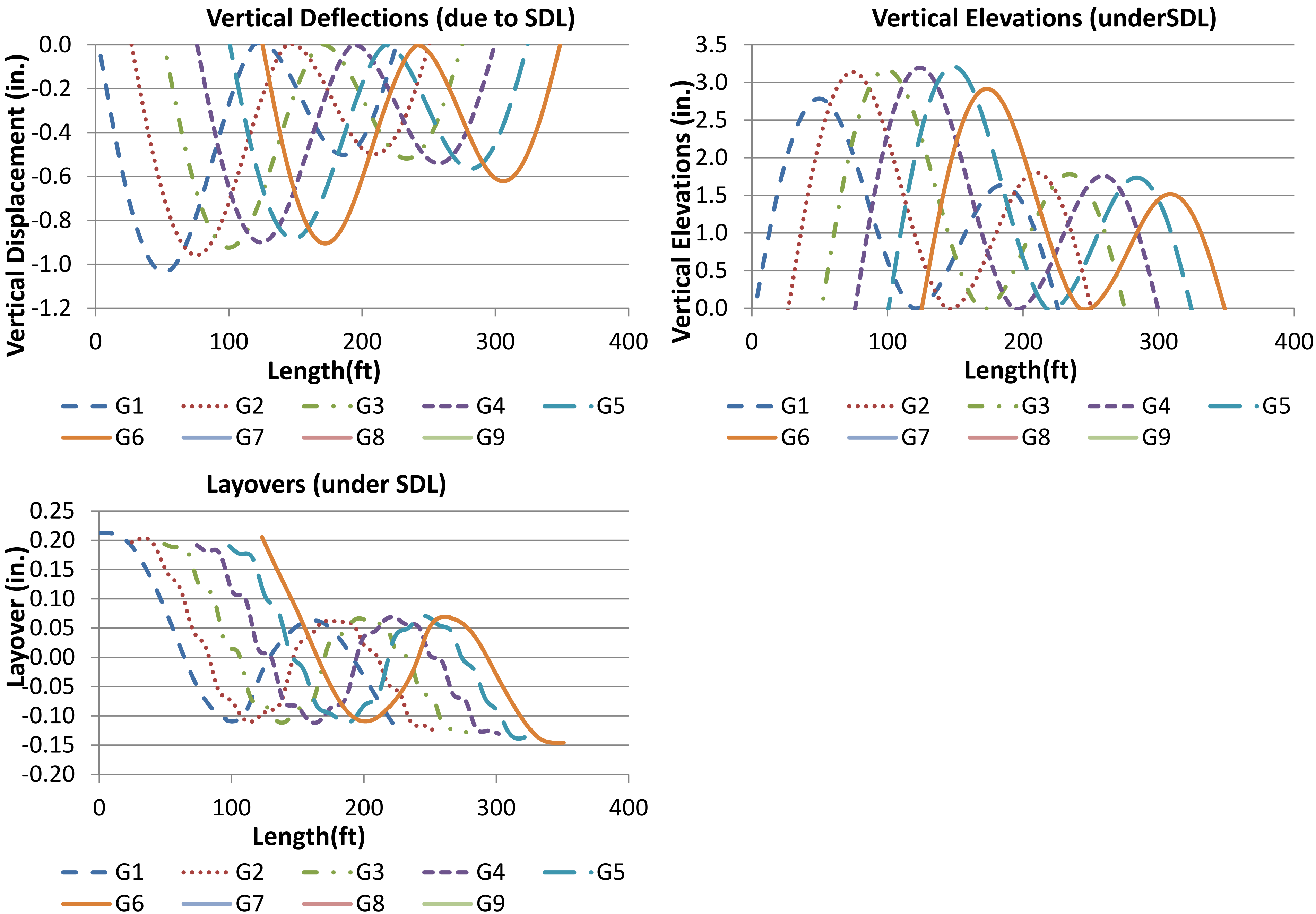


Figure K2-4-3. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

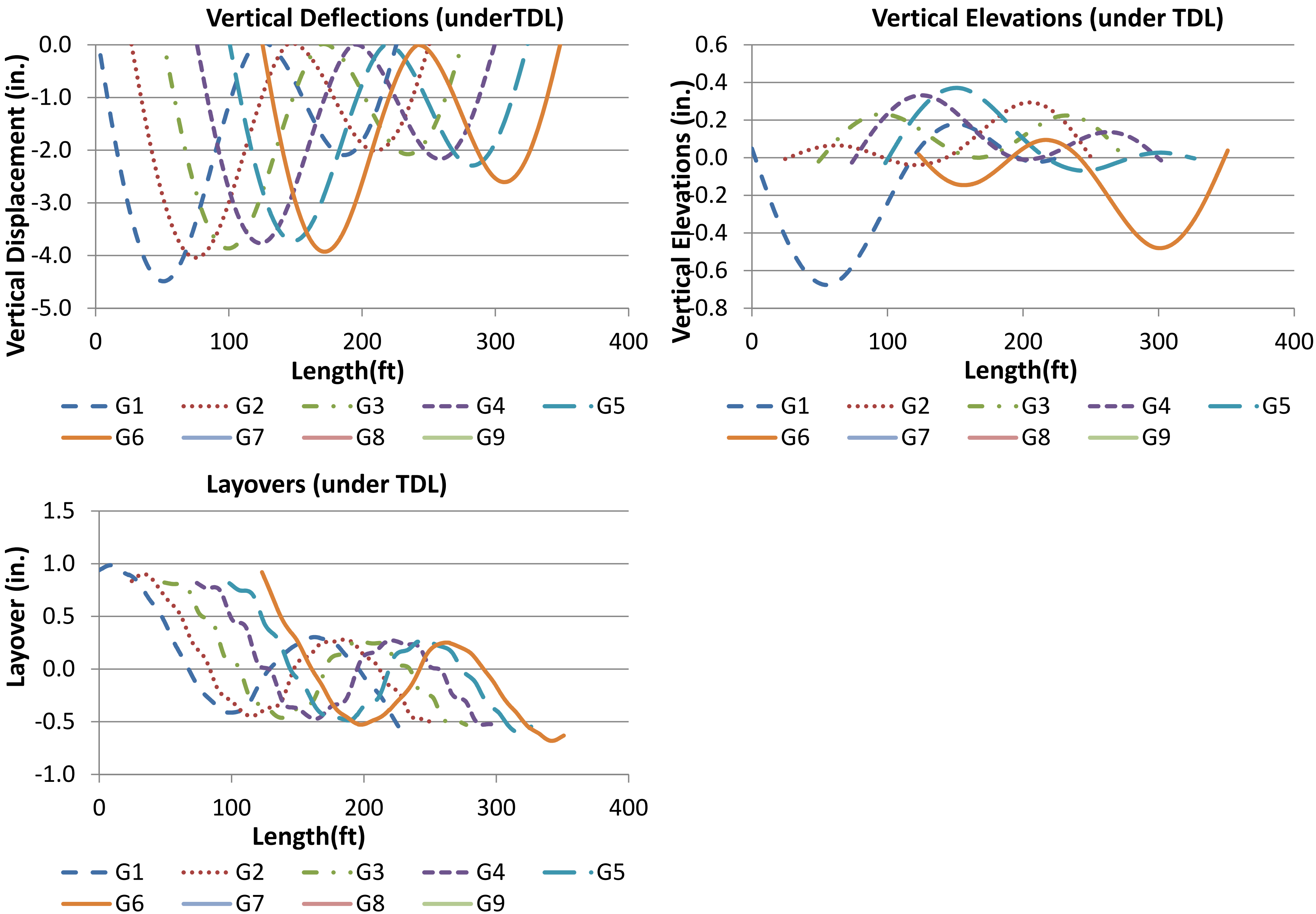


Figure K2-4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

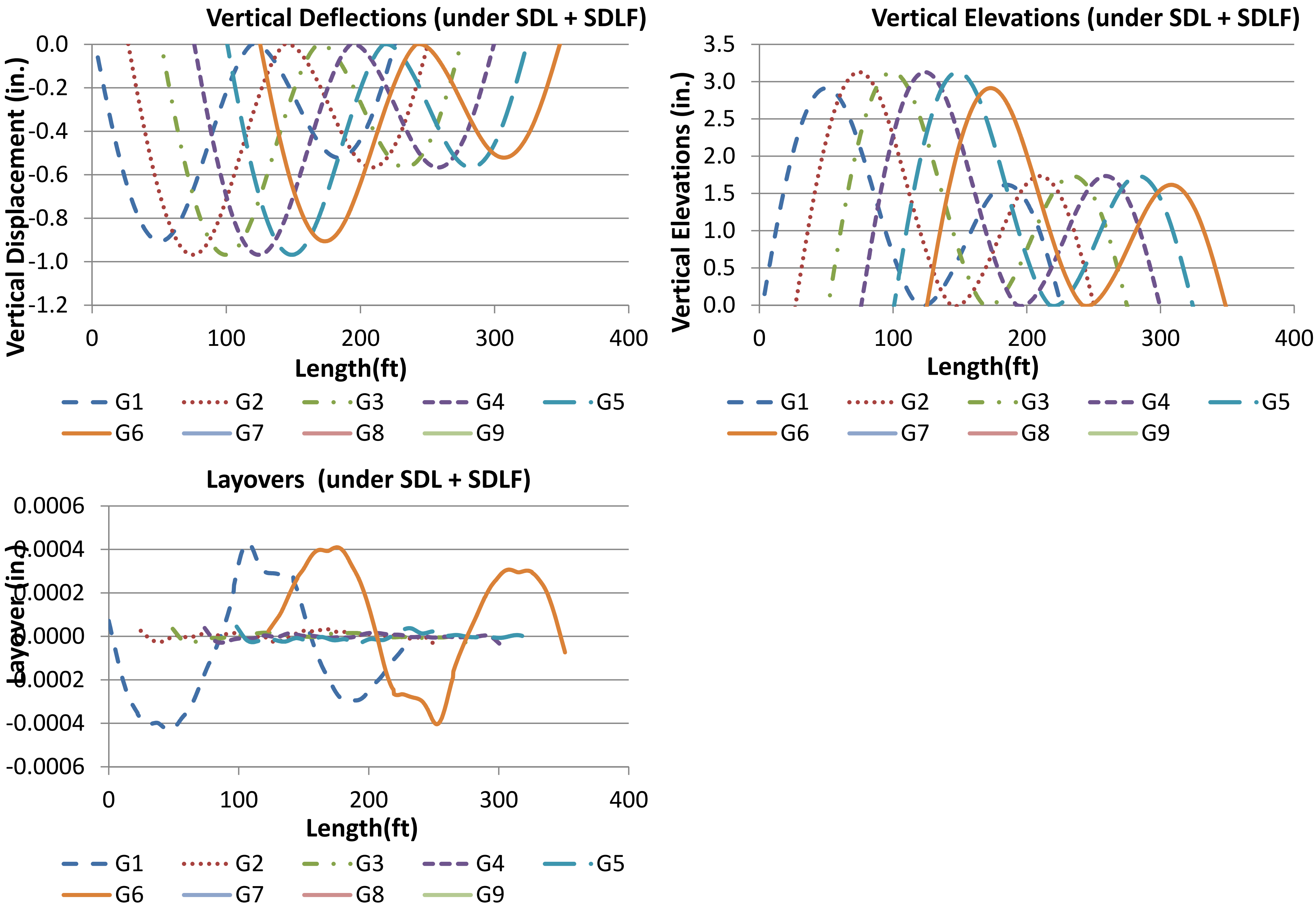


Figure K2-4-5. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

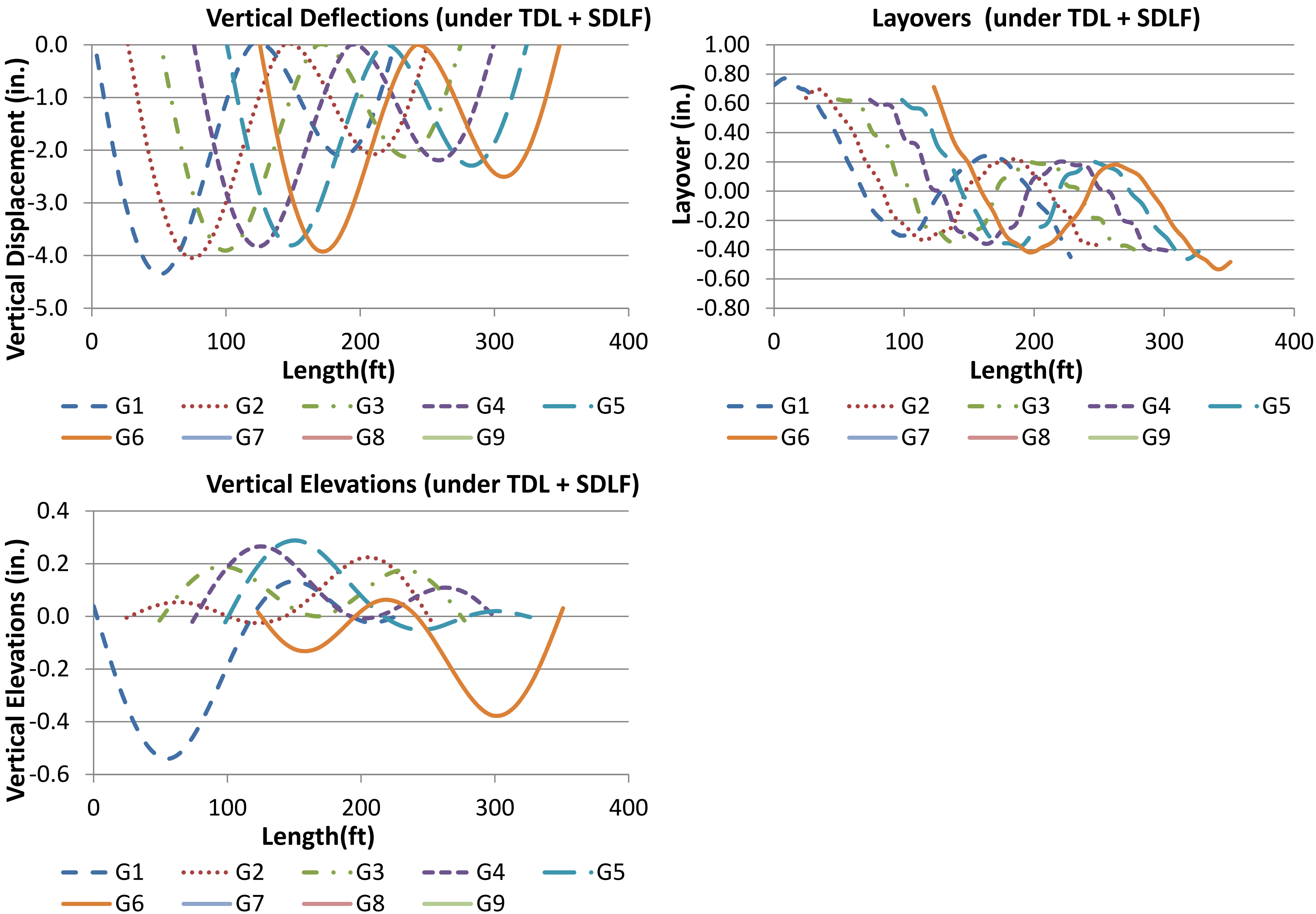


Figure K2-4-6. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

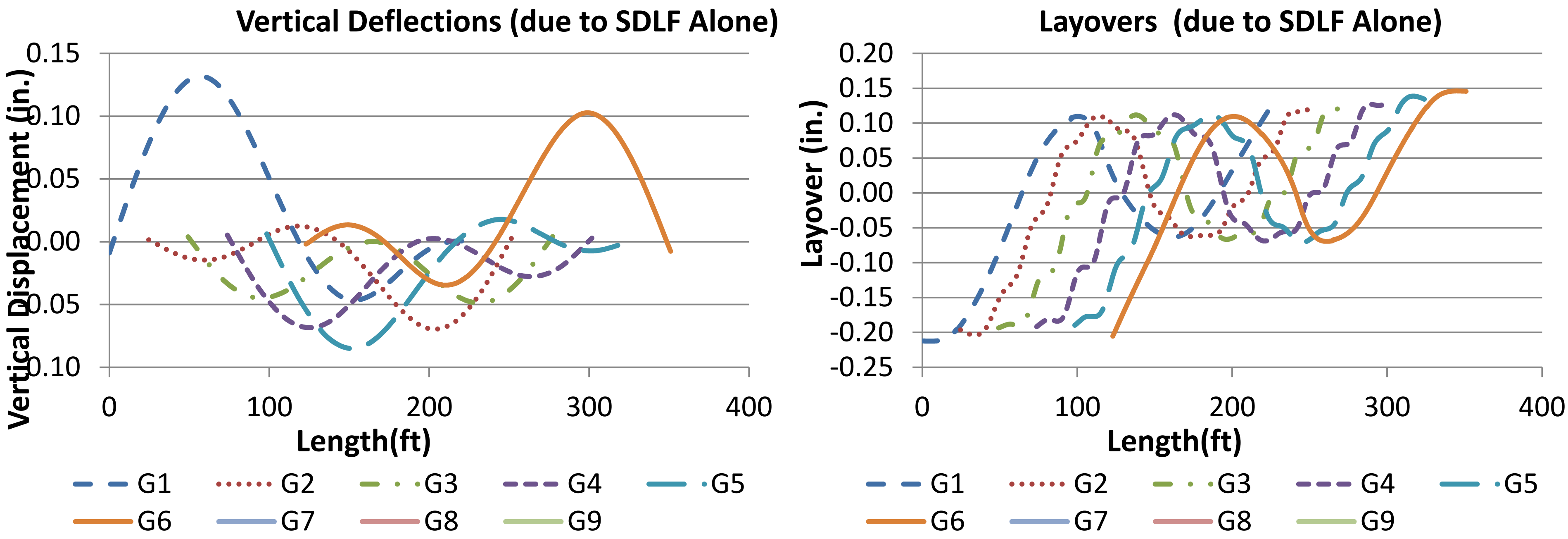


Figure K2-4-7. Bridge displacements due to SDLF detailing effects alone under NL(in).

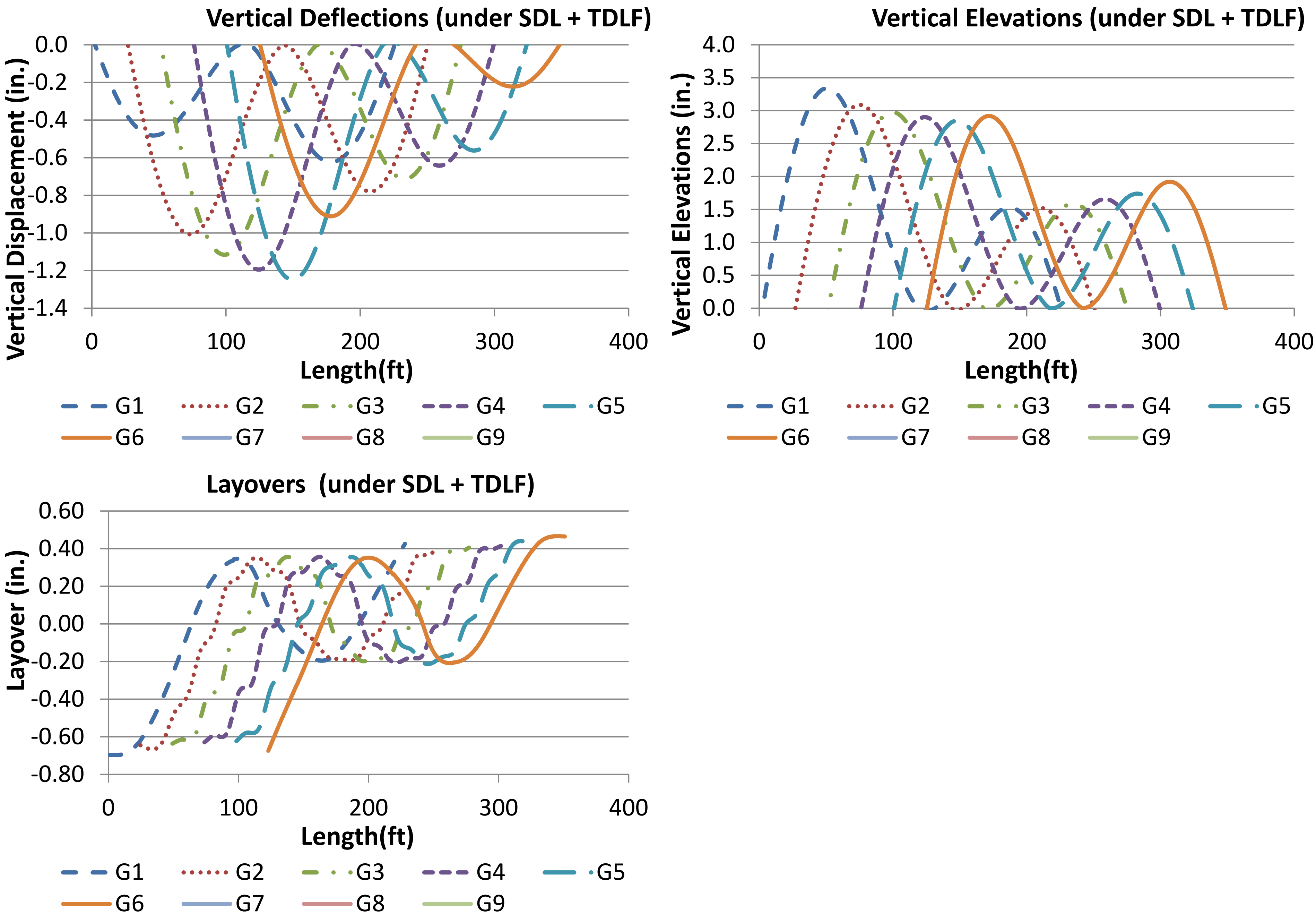


Figure K2-4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

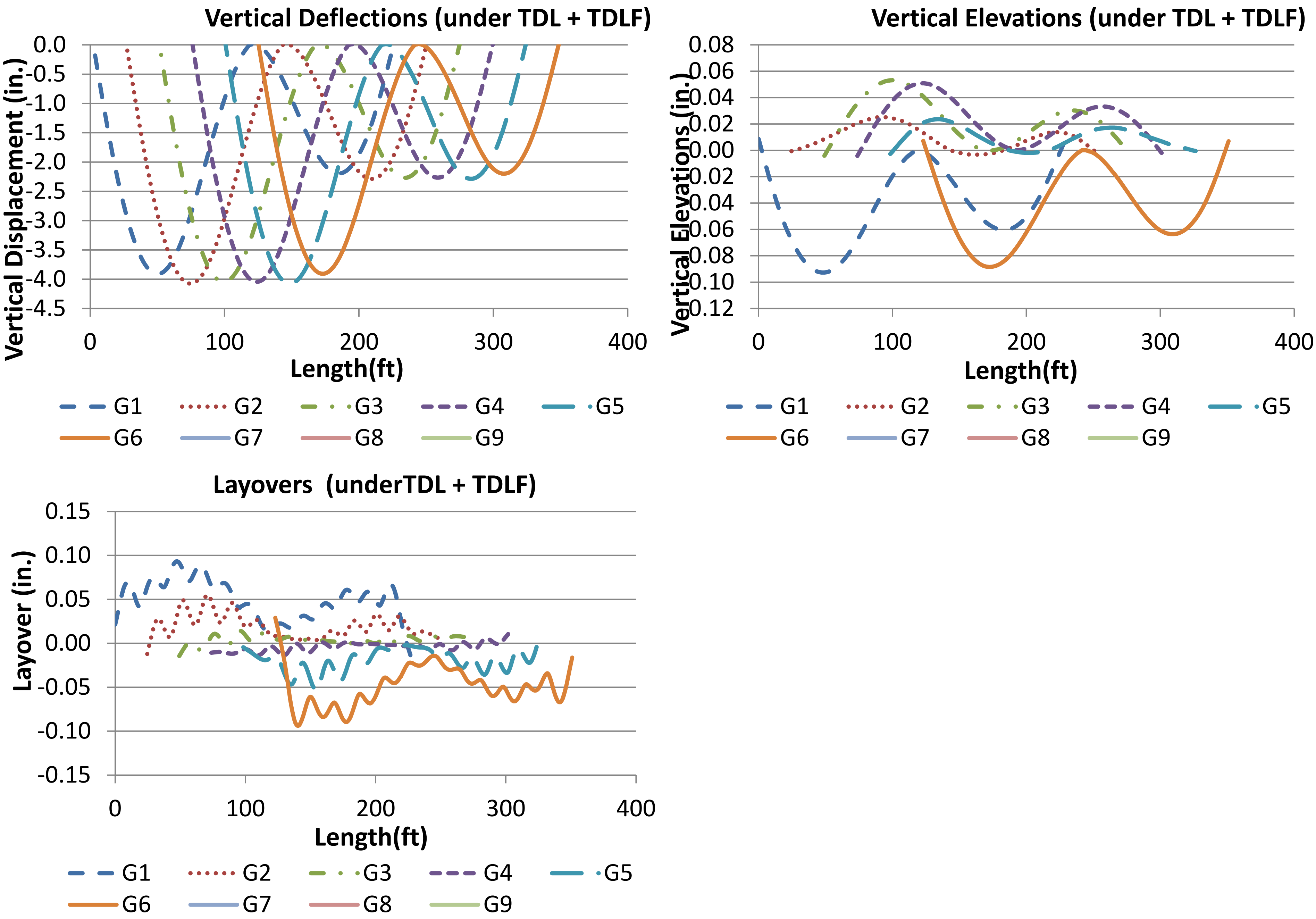


Figure K2-4-9. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

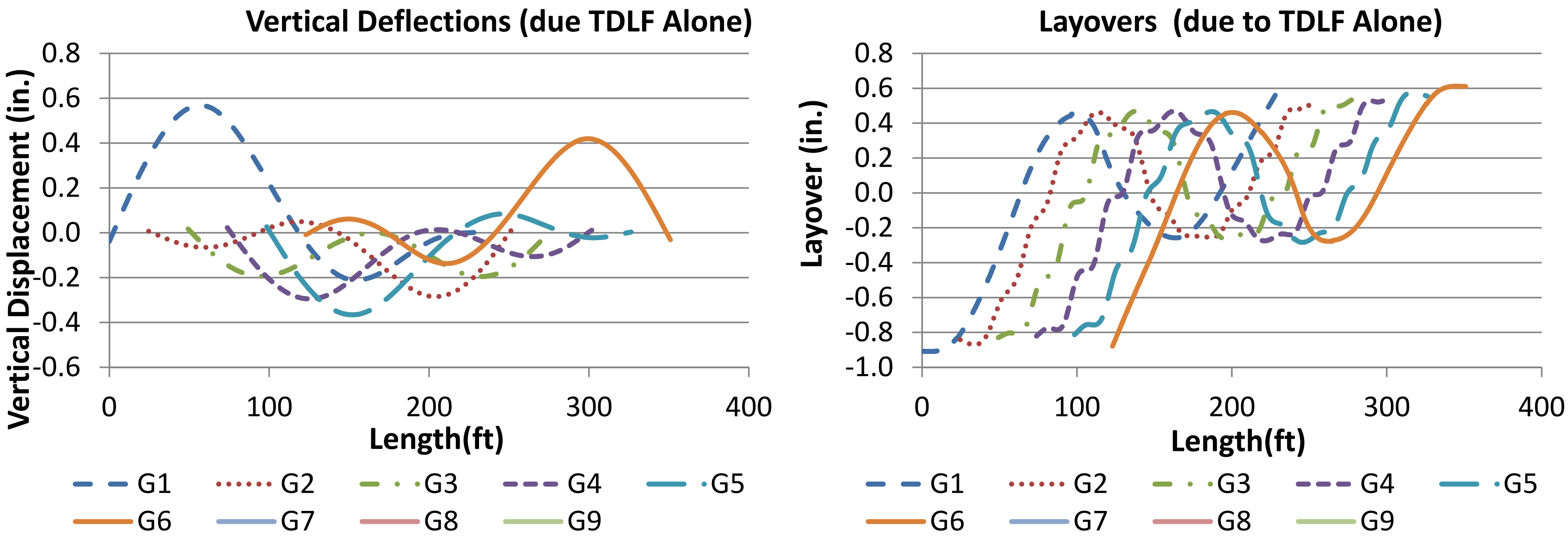


Figure K2-4-10. Bridge displacements due to TDLF detailing effects alone under NL (in).

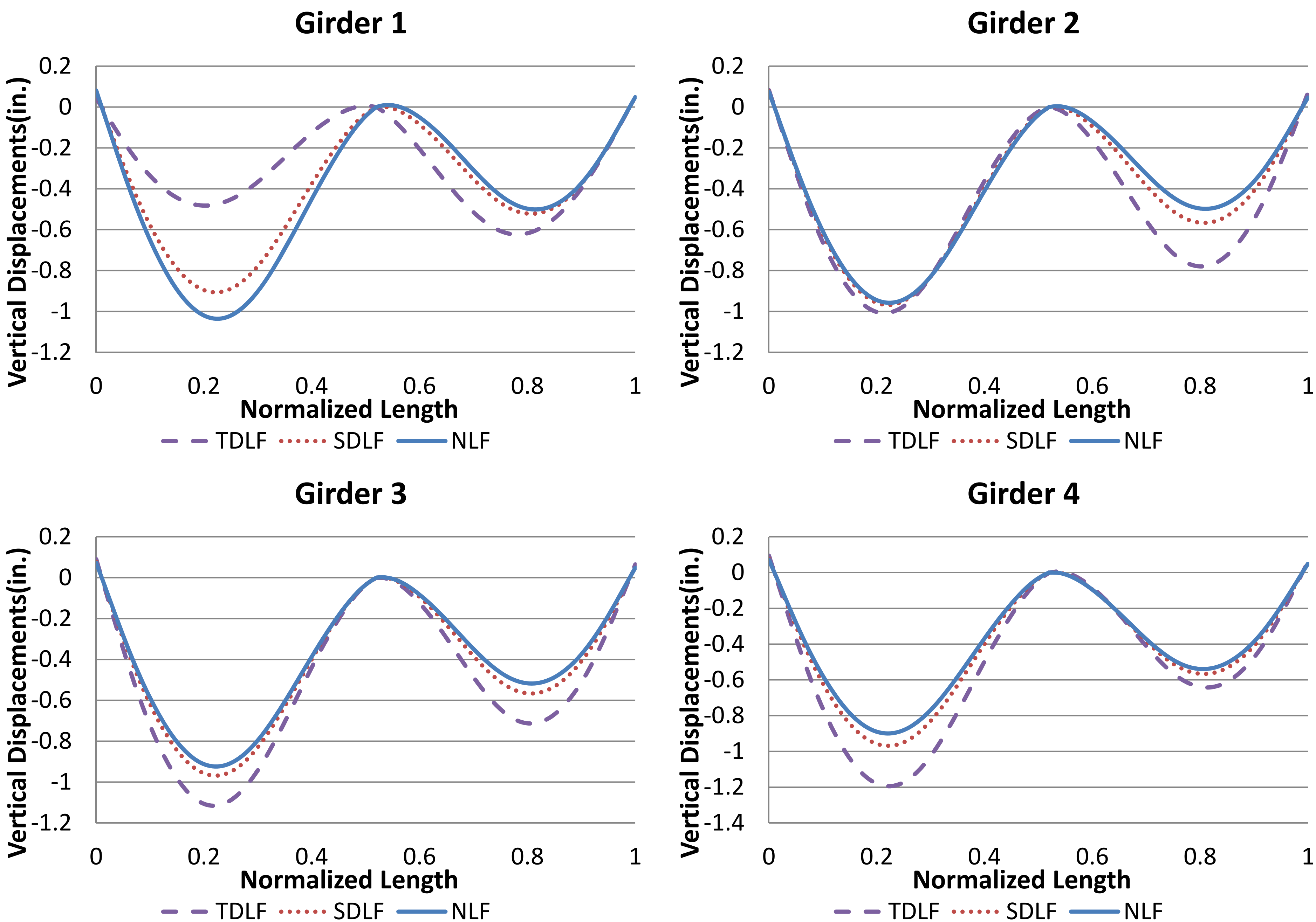


Figure K2-4-11. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

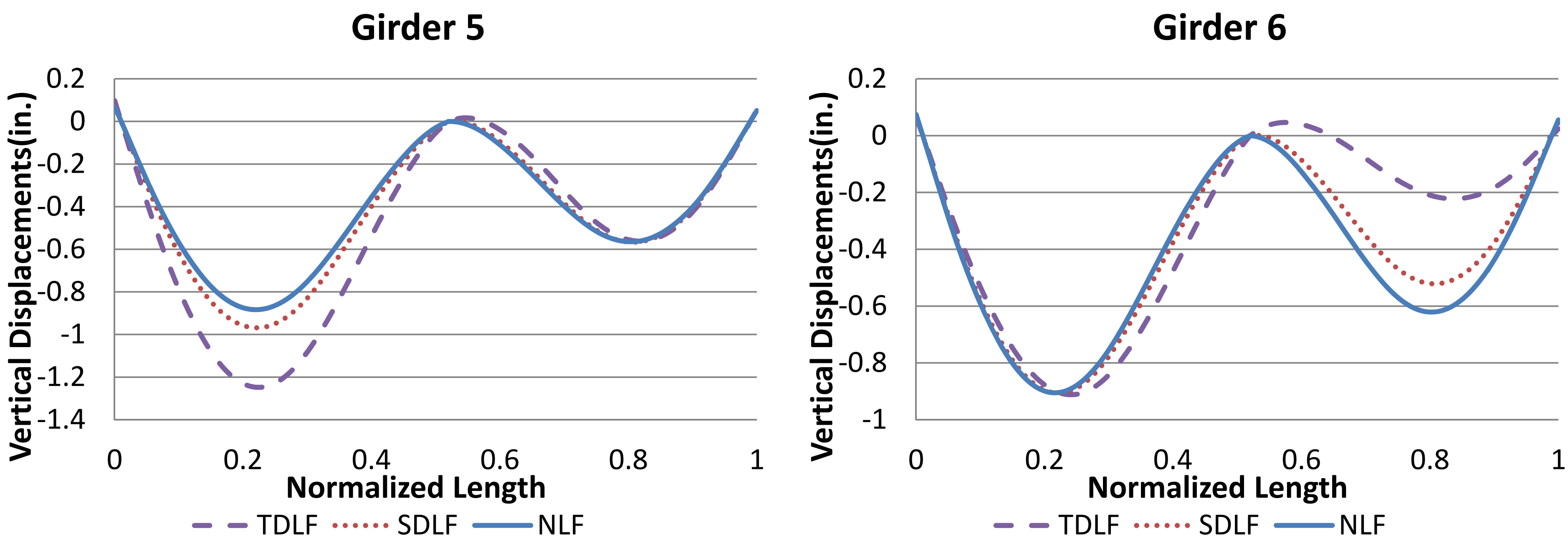


Figure K2-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

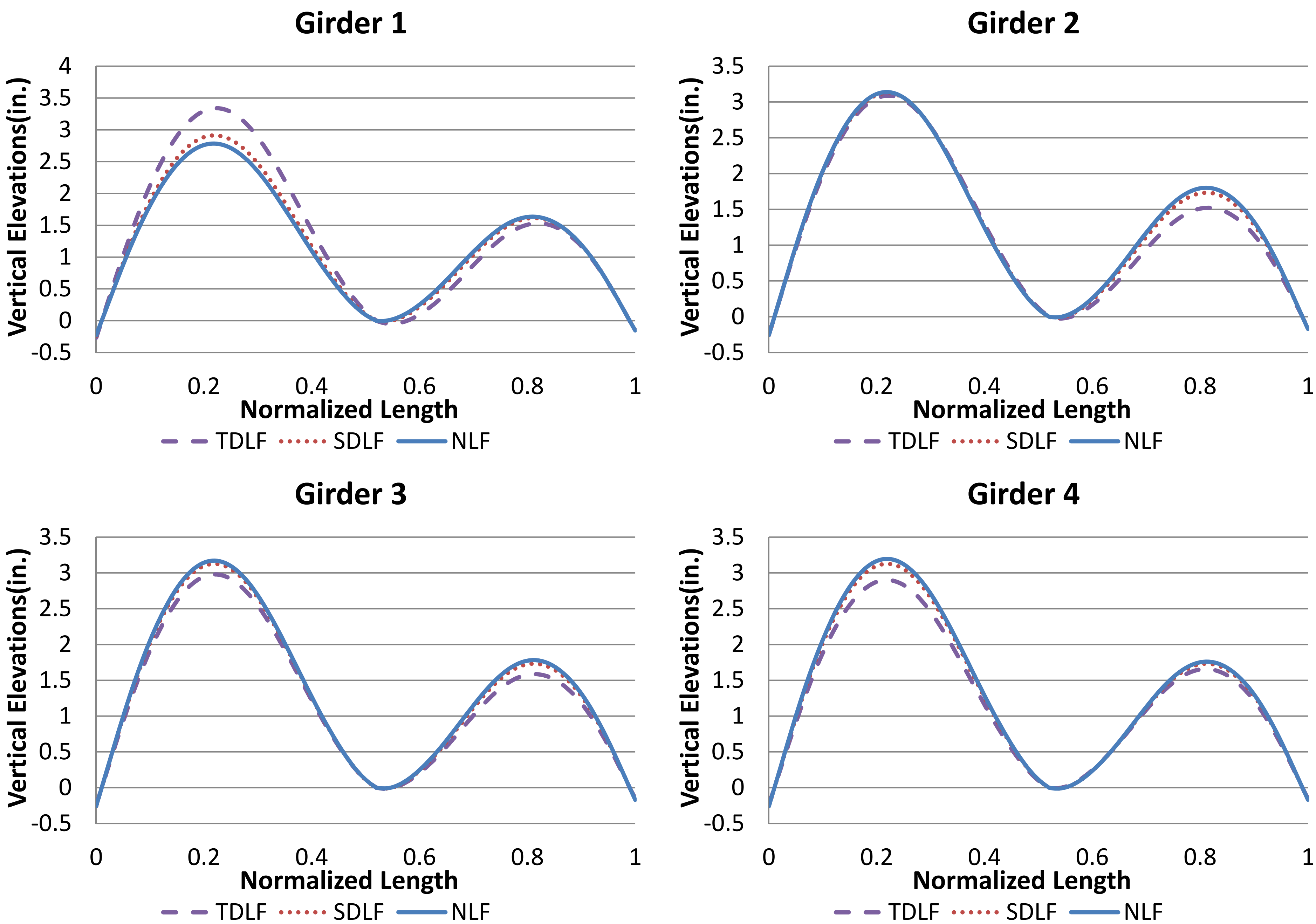


Figure K2-4-12. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

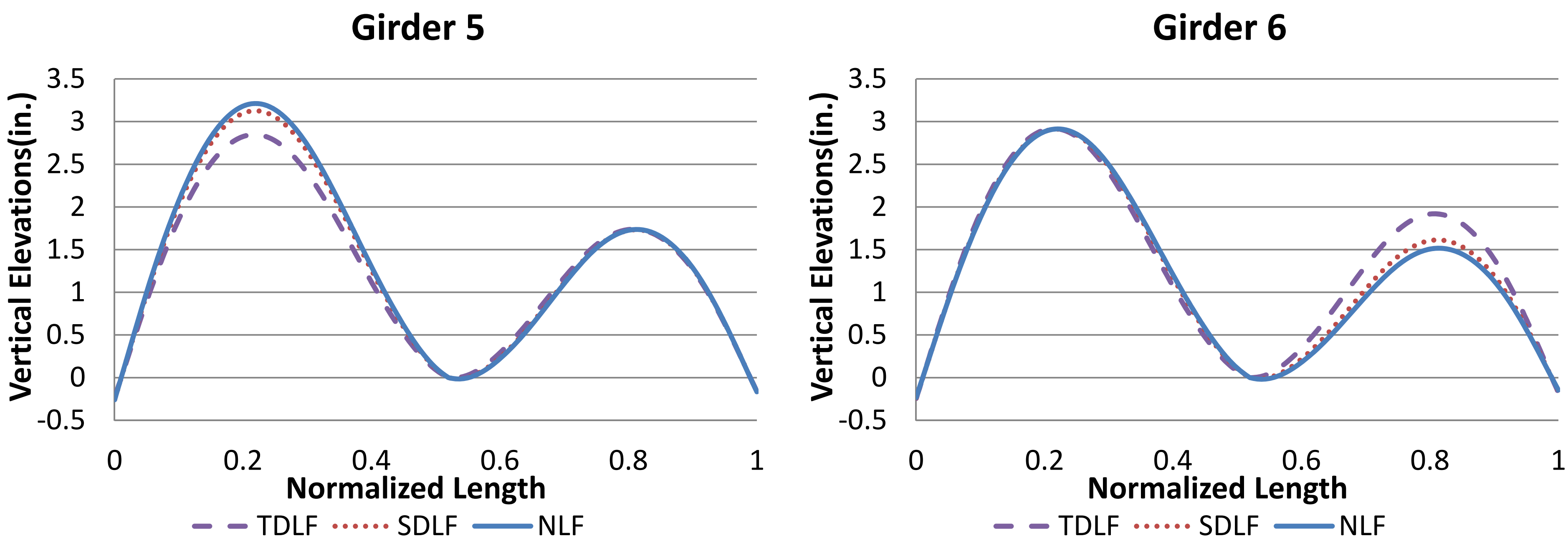


Figure K2-4-12(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

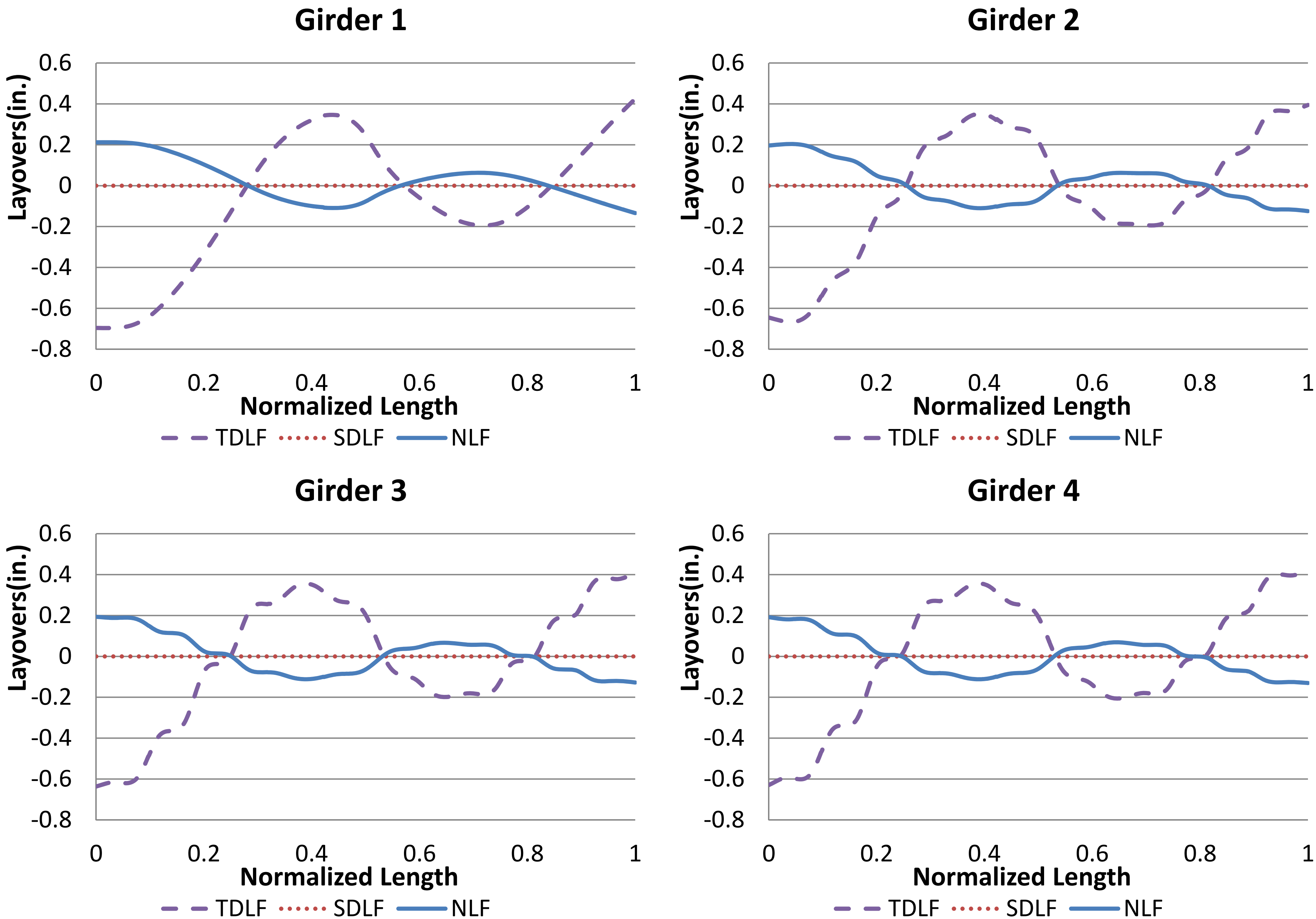


Figure K2-4-13. **Comparison of individual girder layovers (in) under SDL for different detailing methods.**

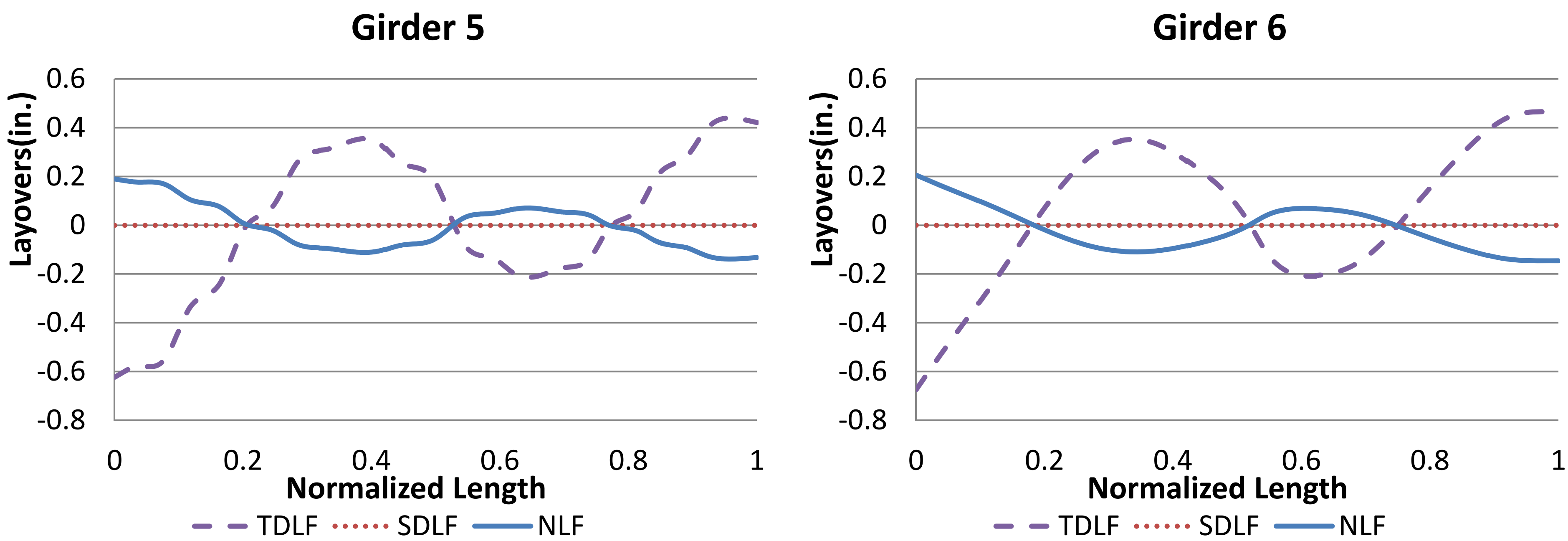


Figure K2-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

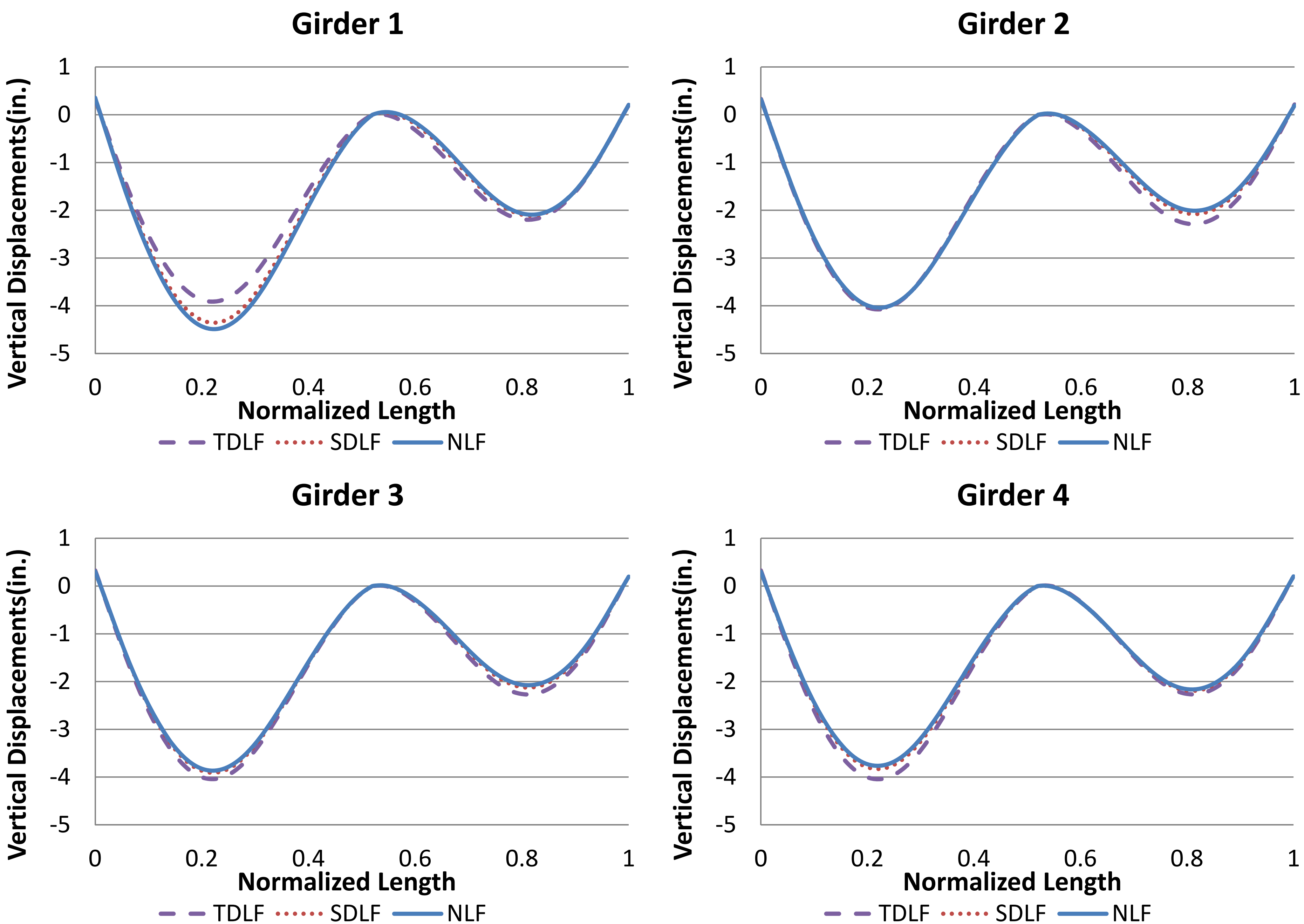


Figure K2-4-14. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

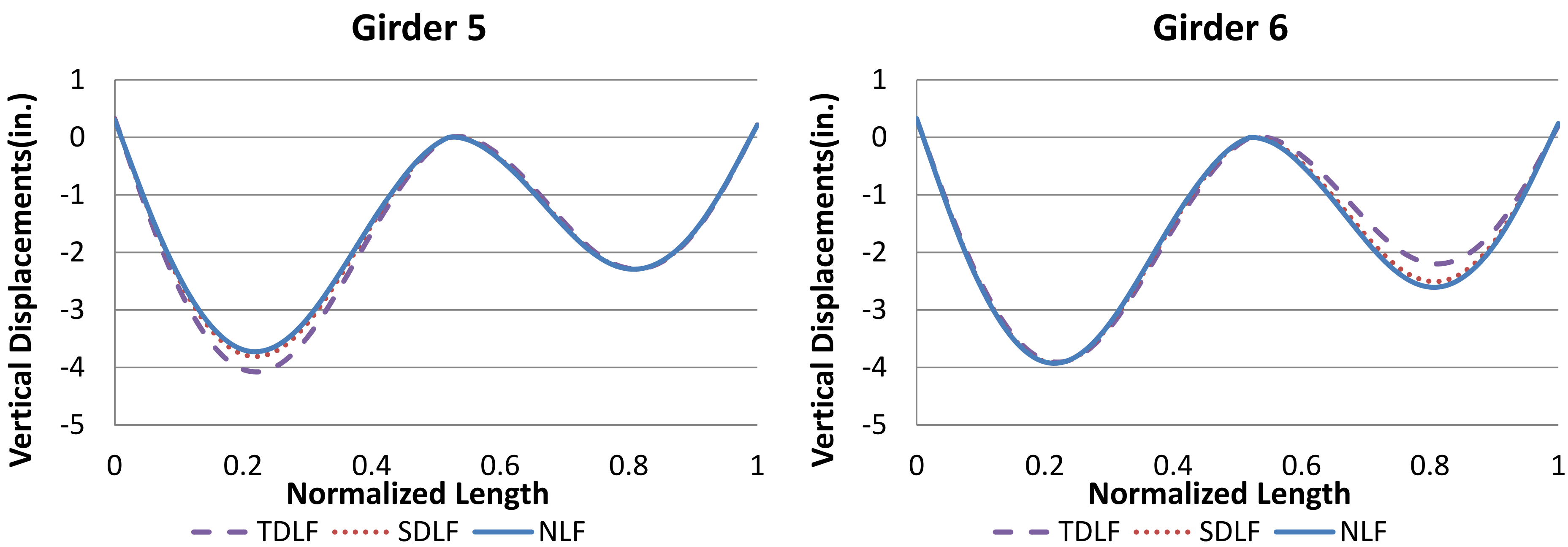


Figure K2-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

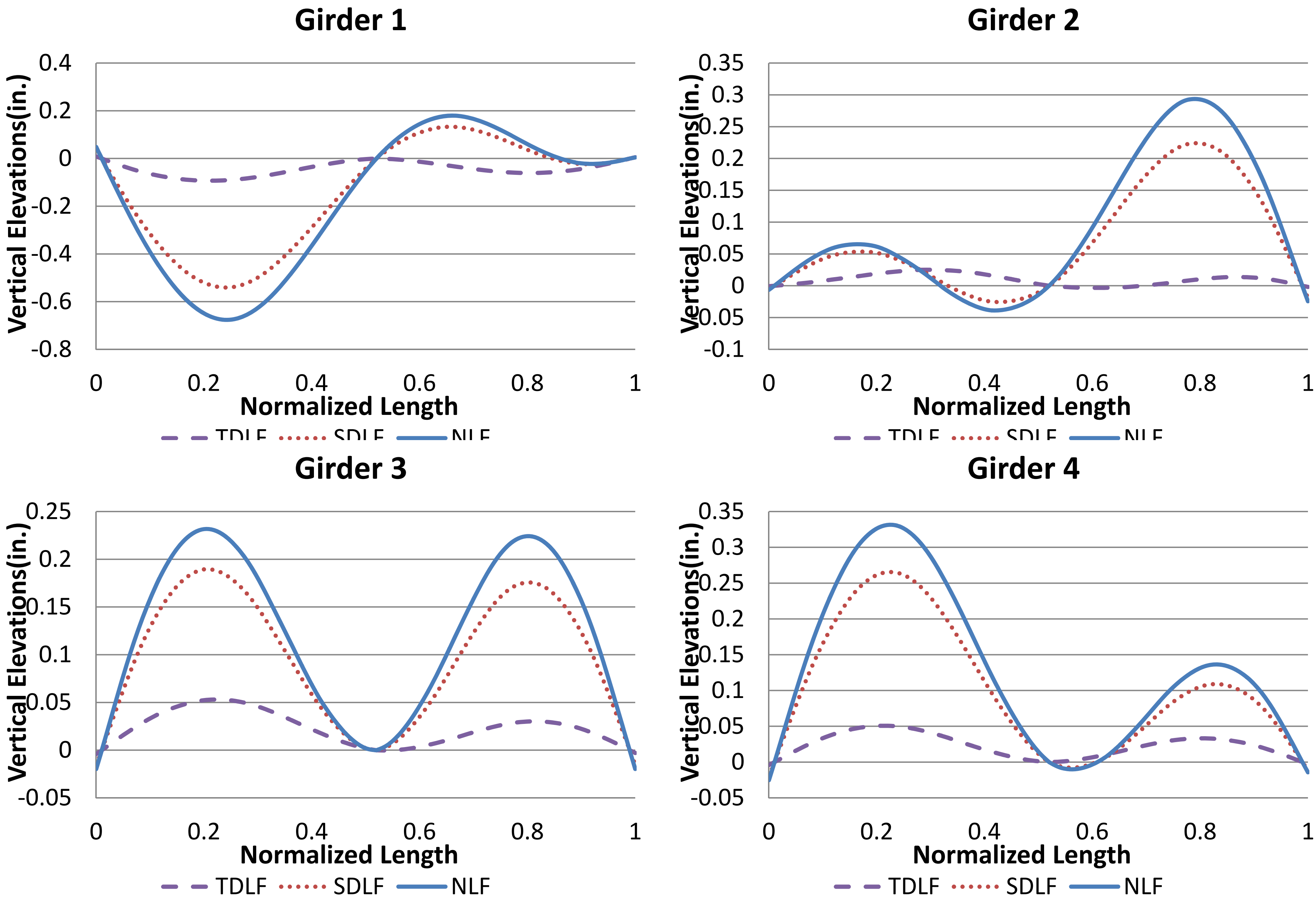


Figure K2-4-15. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

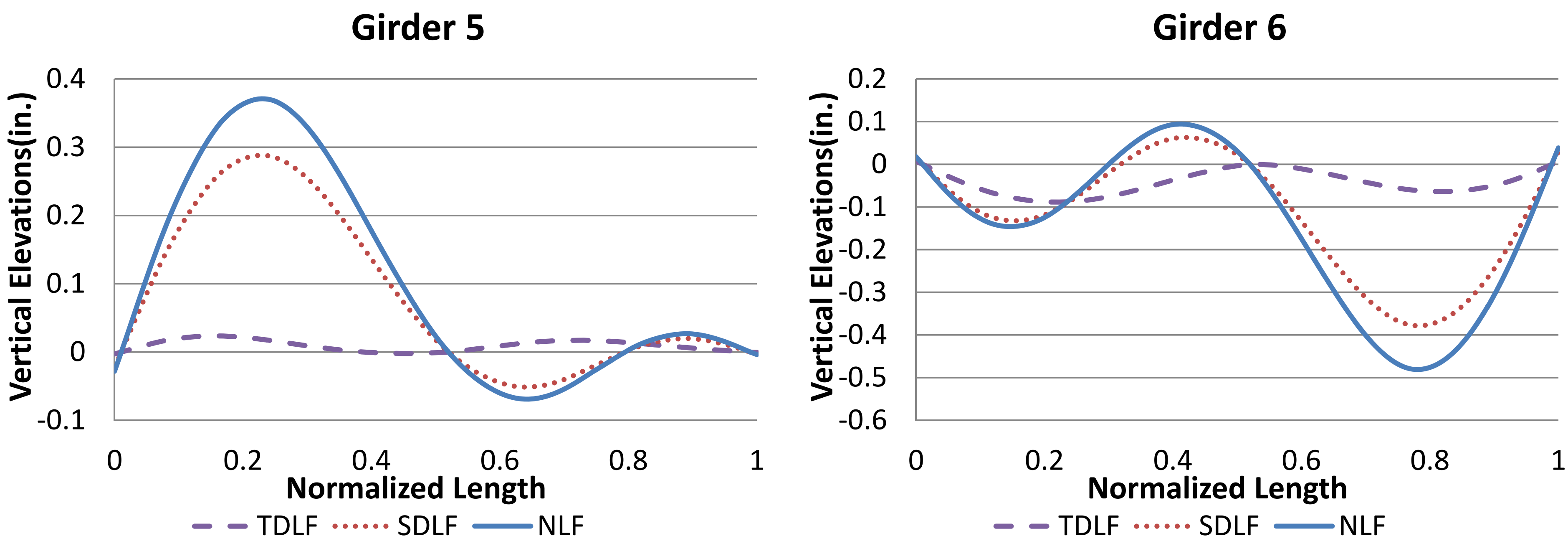


Figure K2-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

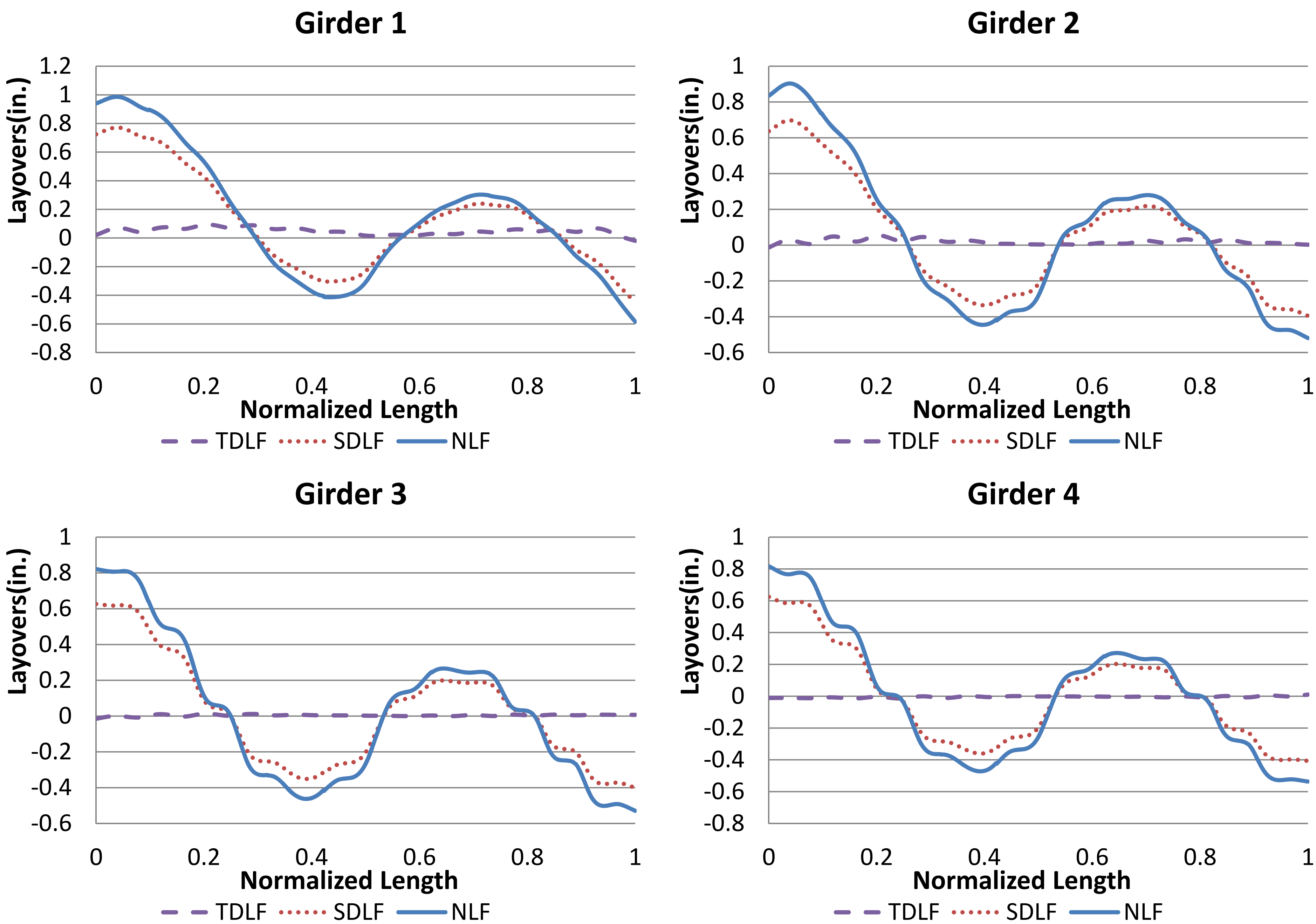


Figure K2-4-16. **Comparison of individual girder layovers (in) under TDL for different detailing methods.**

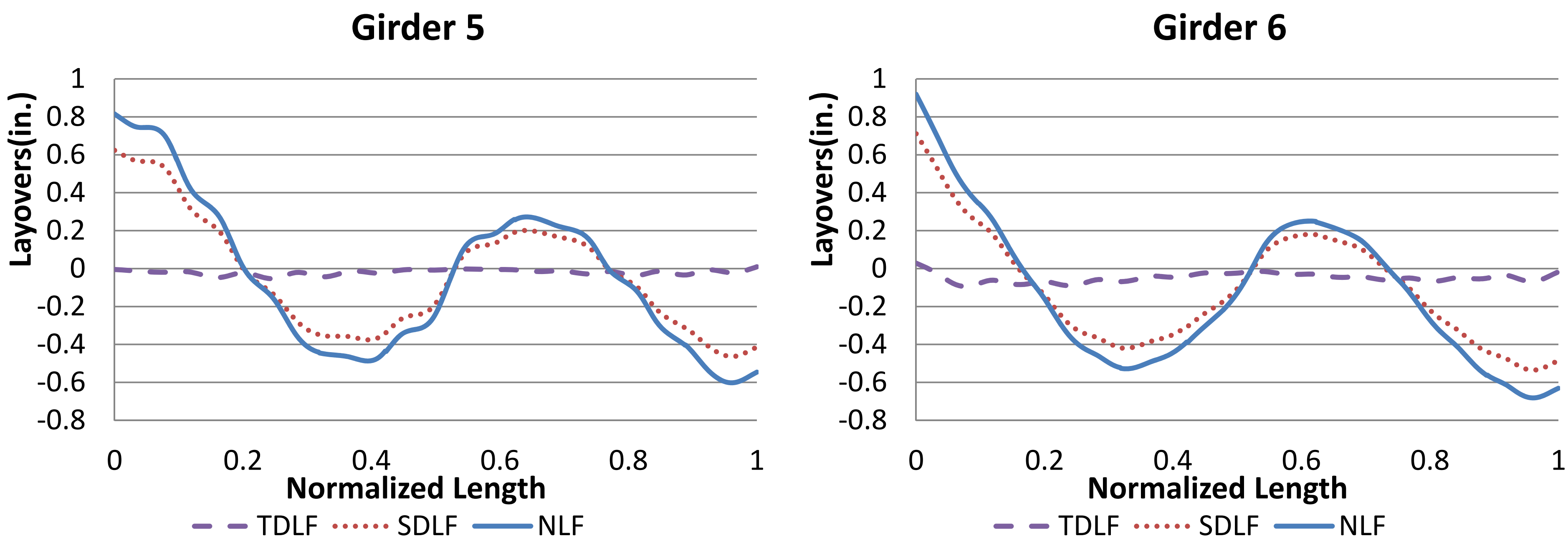


Figure K2-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

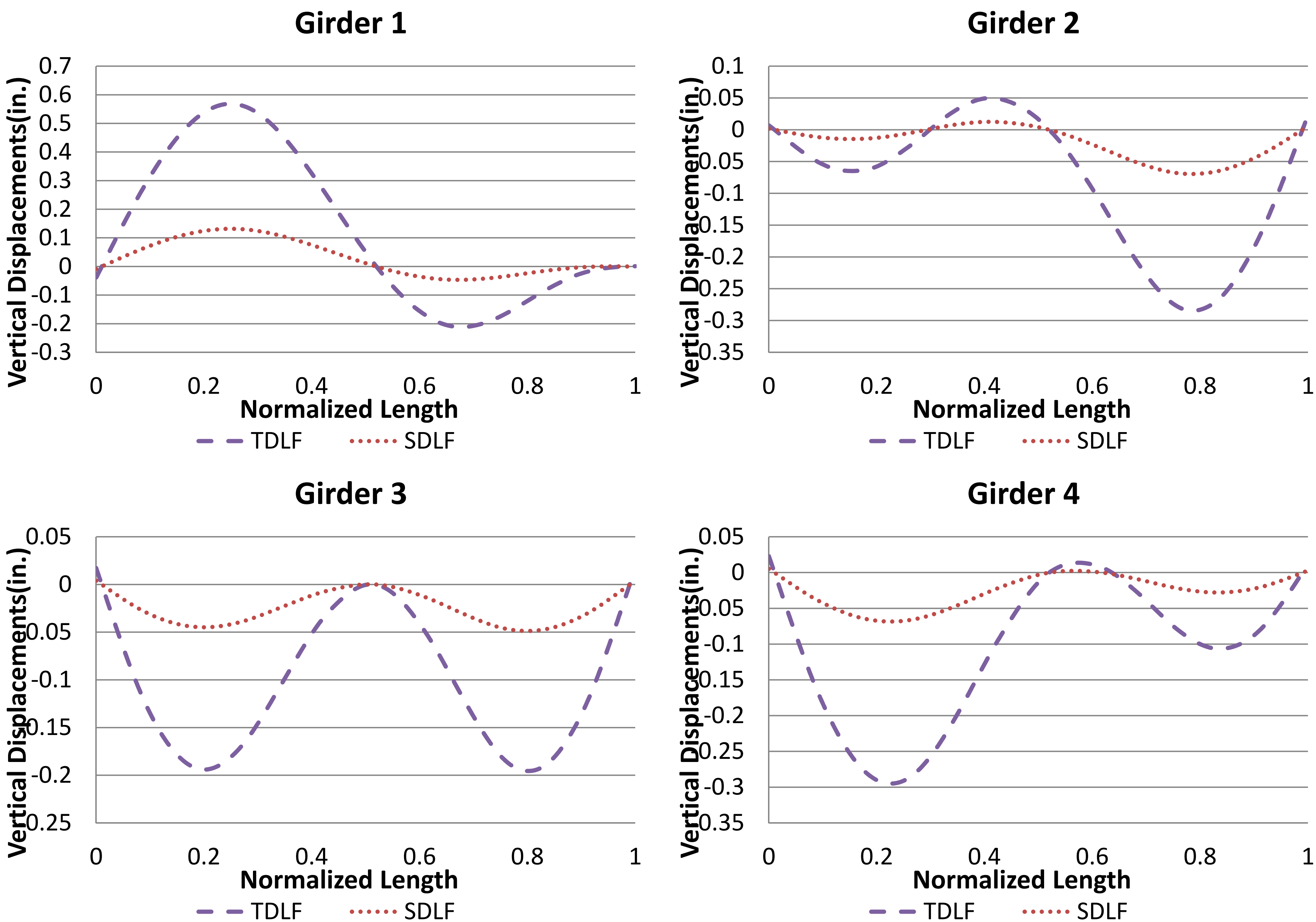


Figure K2-4-17. **Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.**

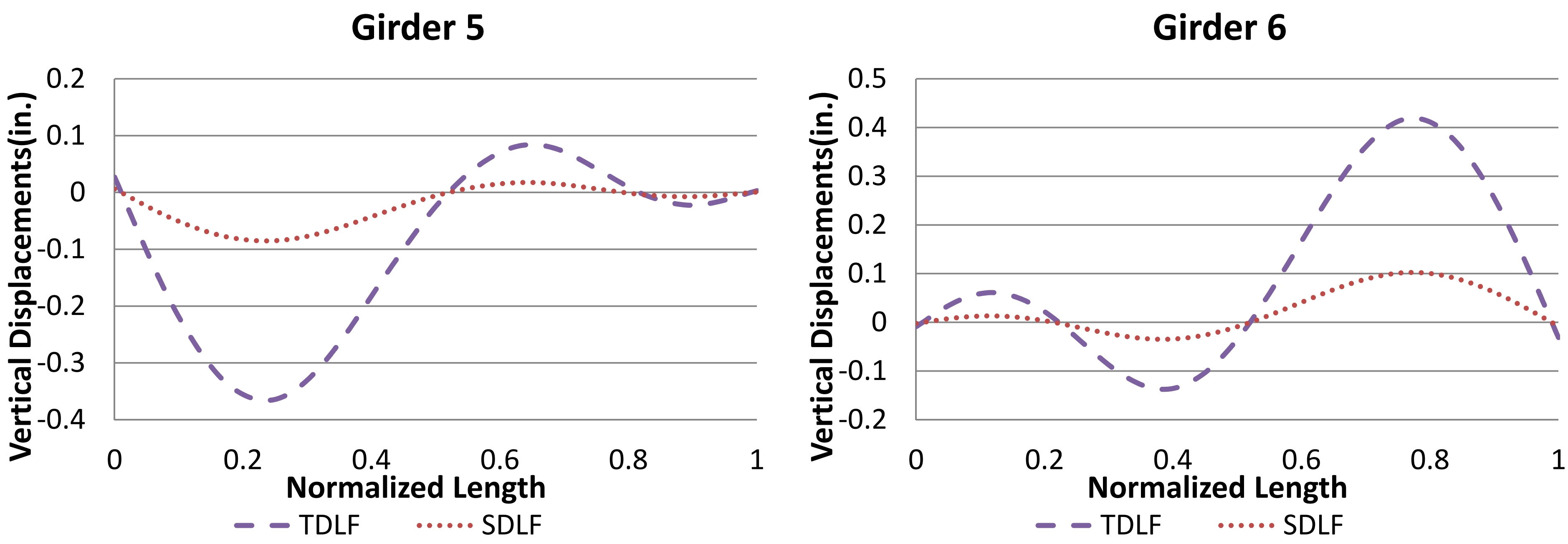


Figure K2-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

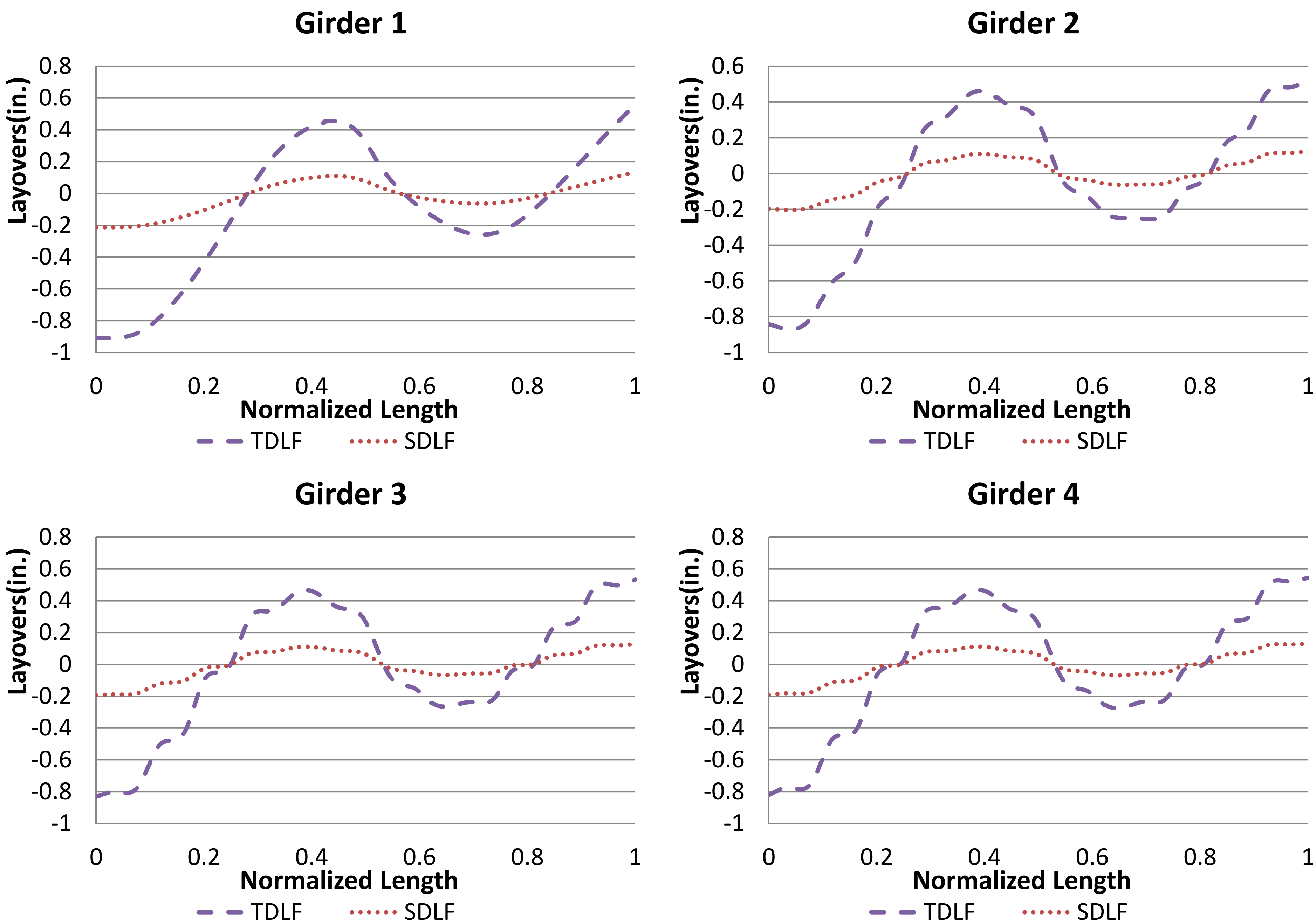
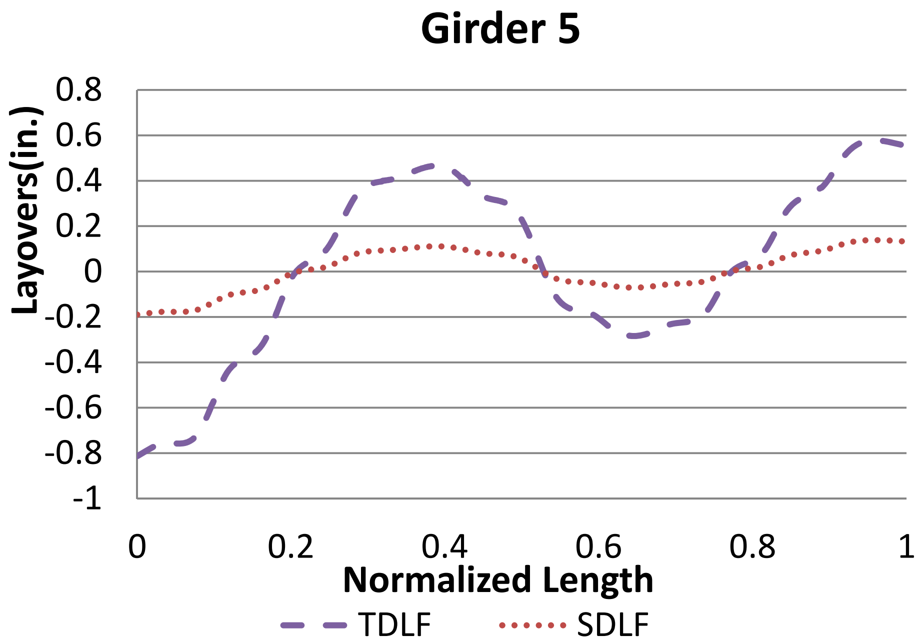


Figure K2-4-18. **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.**



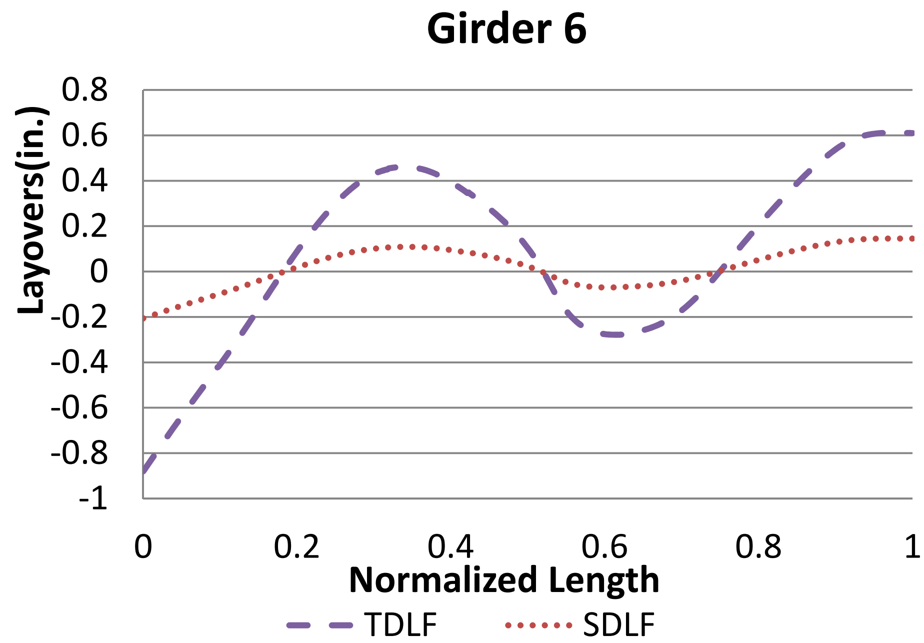


Figure K2-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

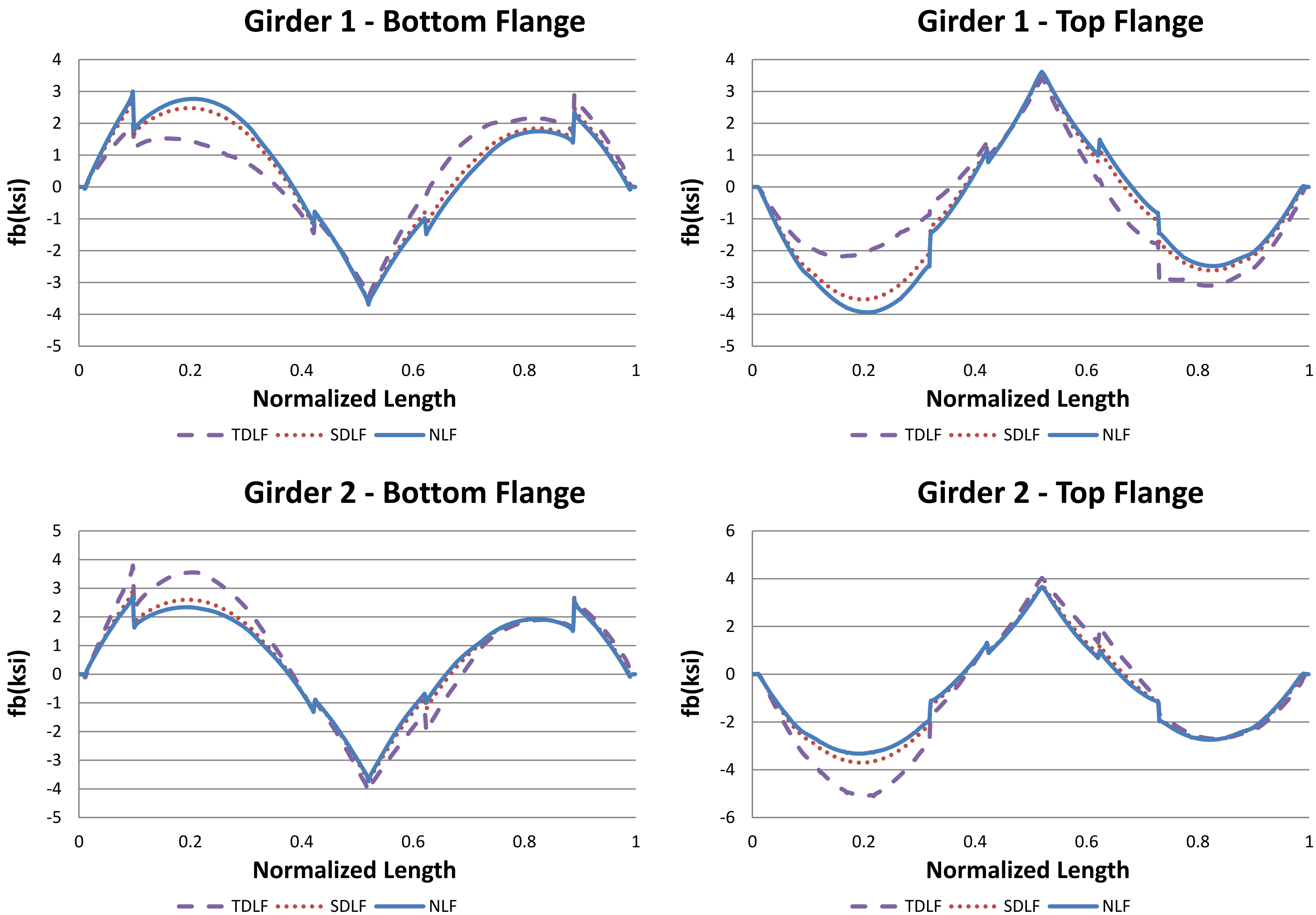


Figure K2-4-19. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

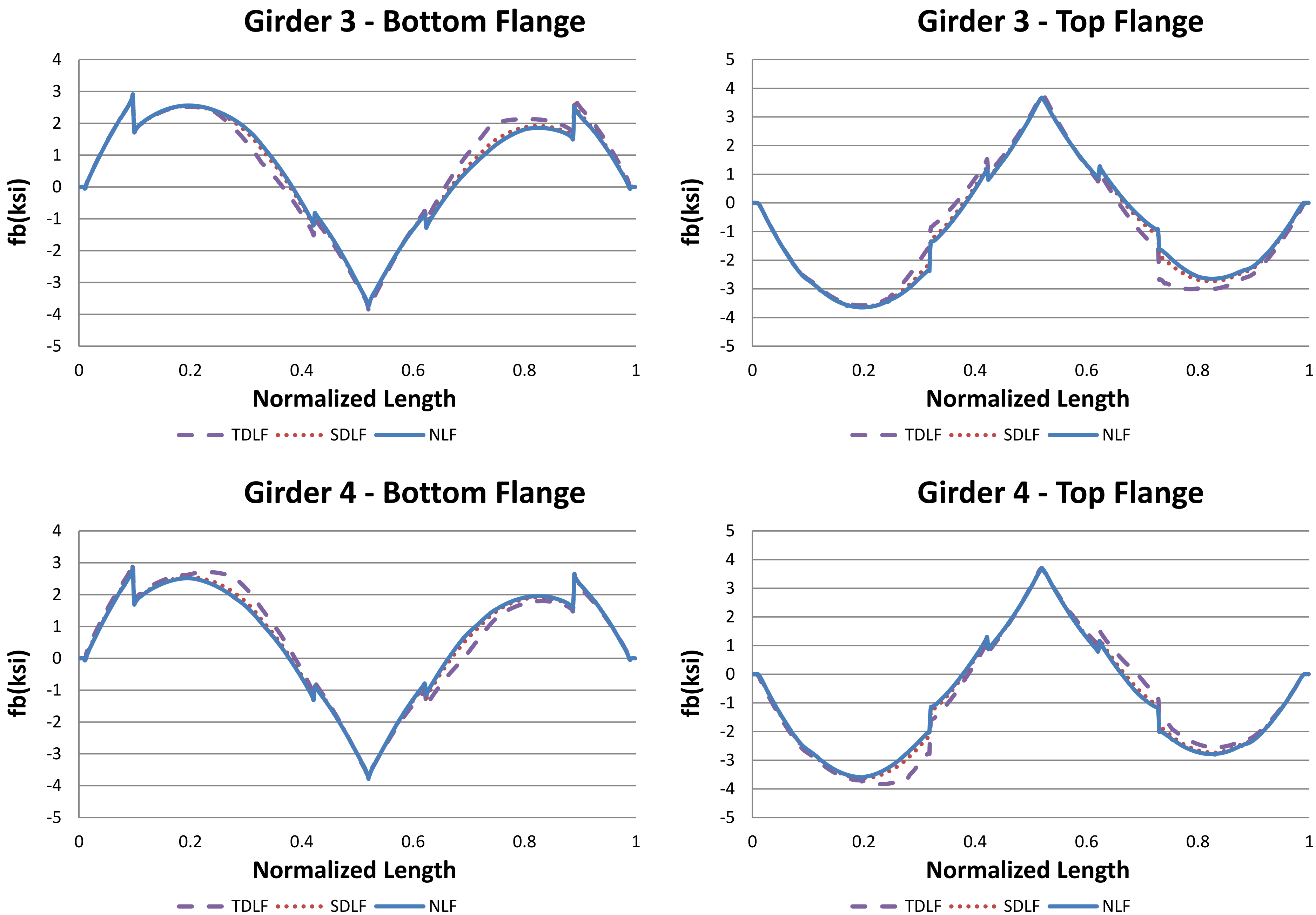


Figure K2-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

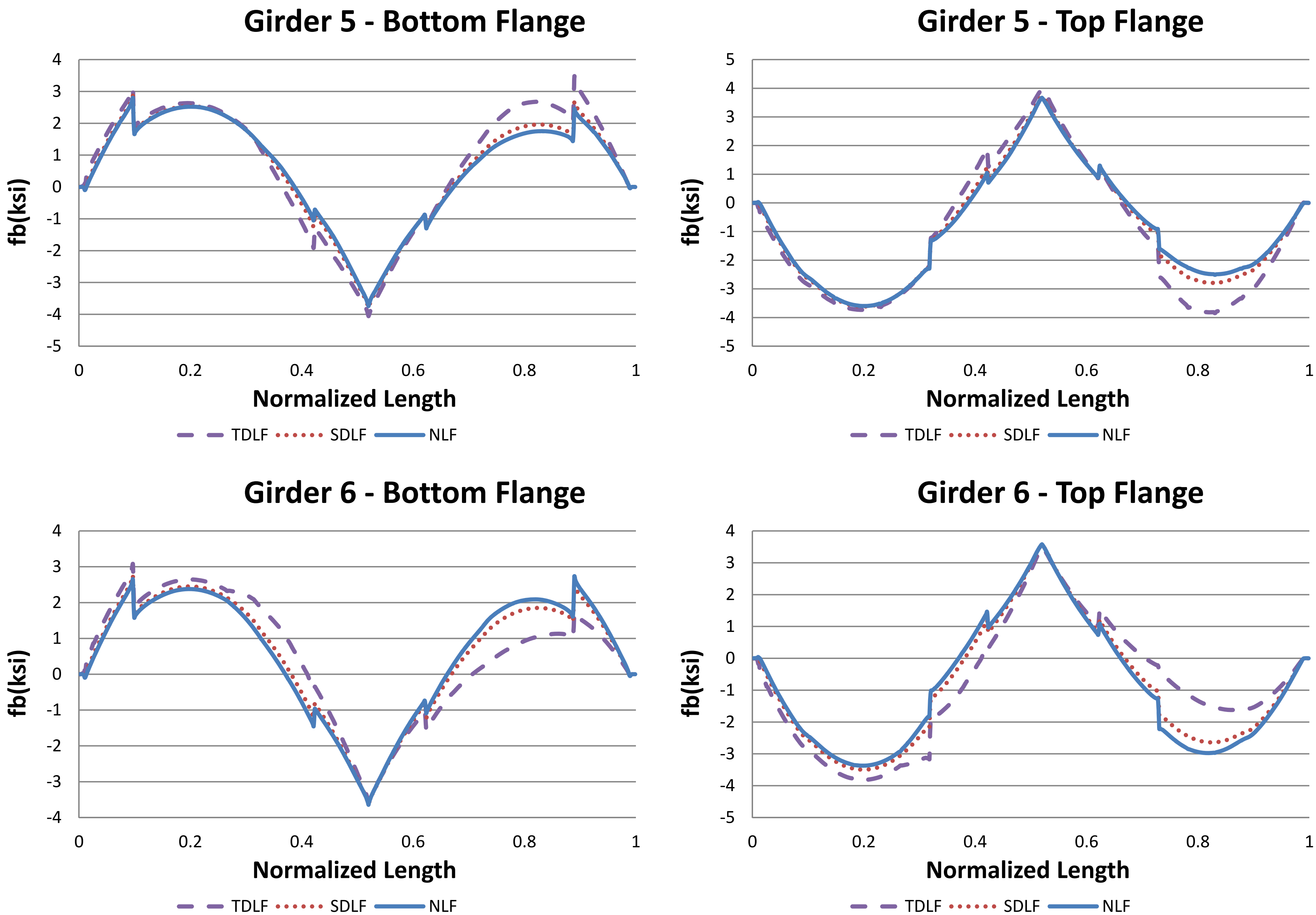


Figure K2-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

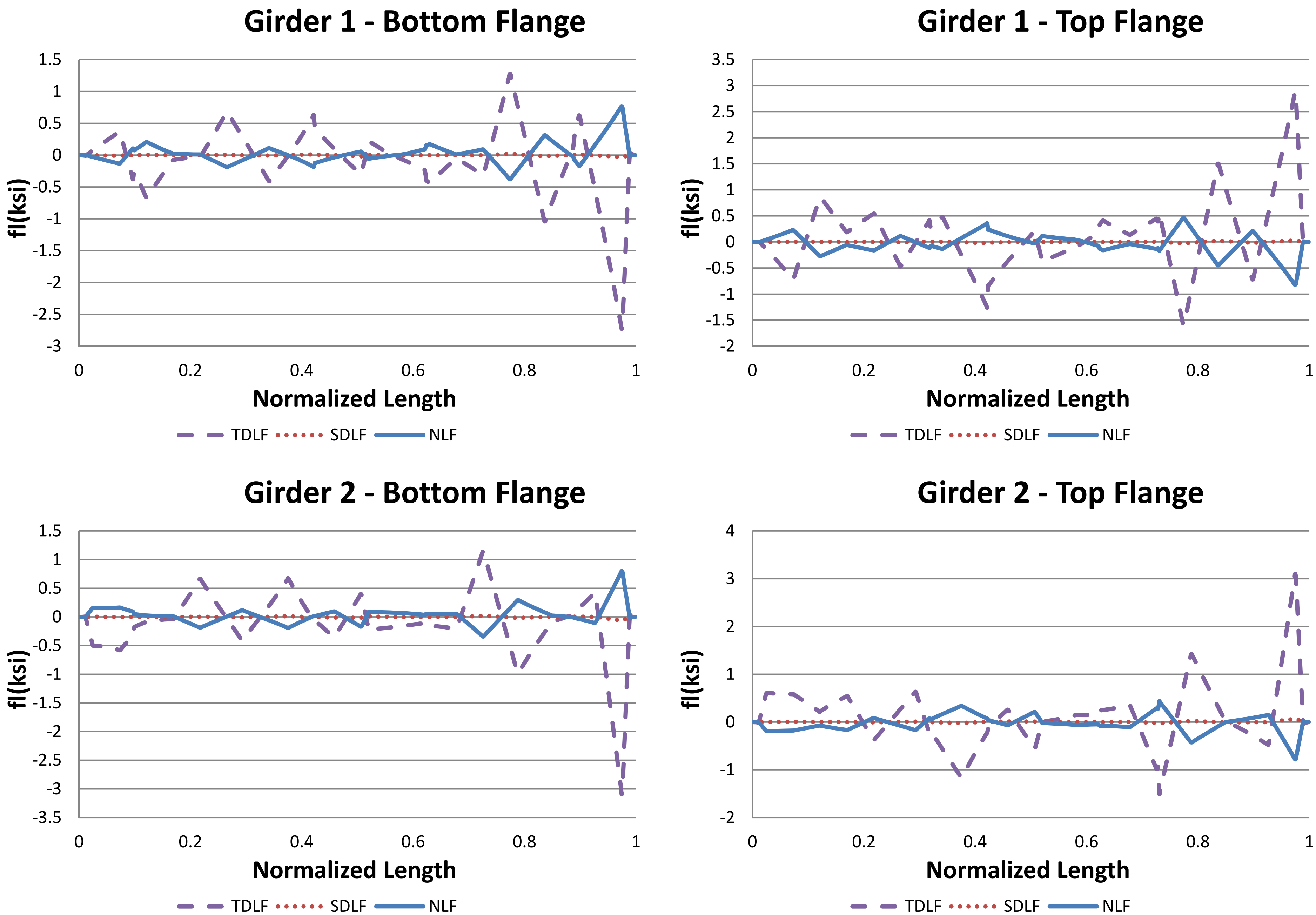


Figure K2-4-20. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

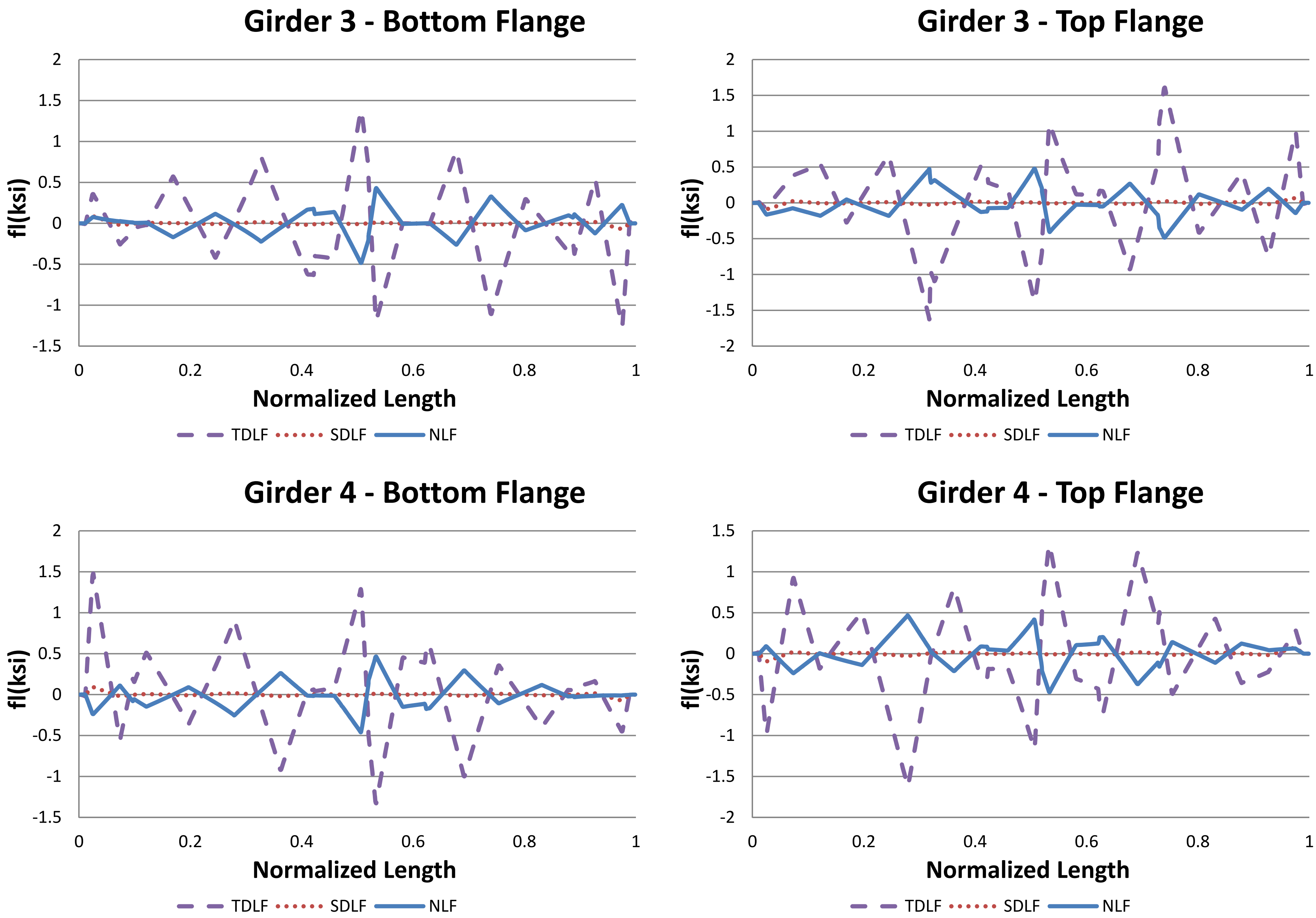


Figure K2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

Figure K2-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

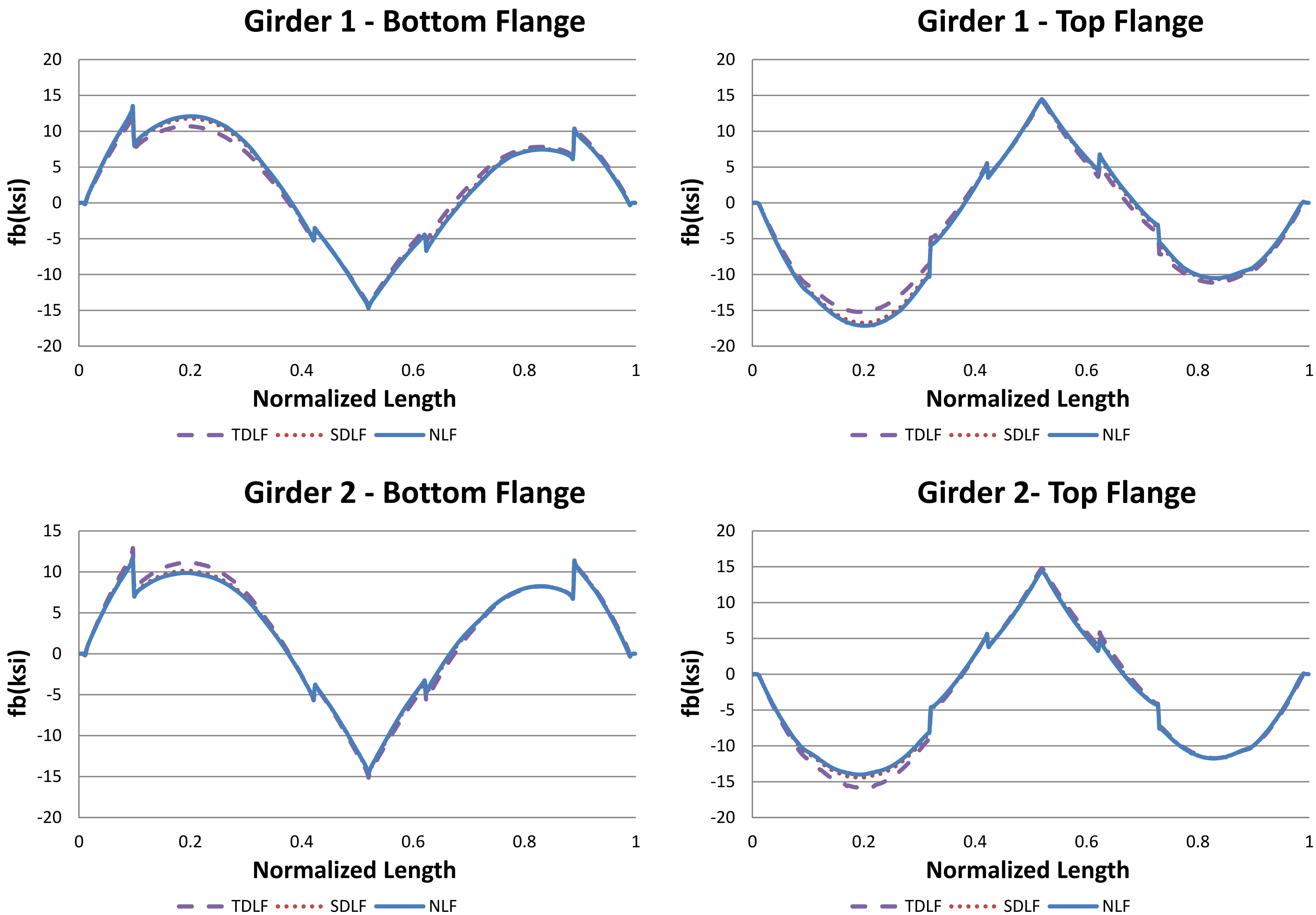


Figure K2-4-21. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

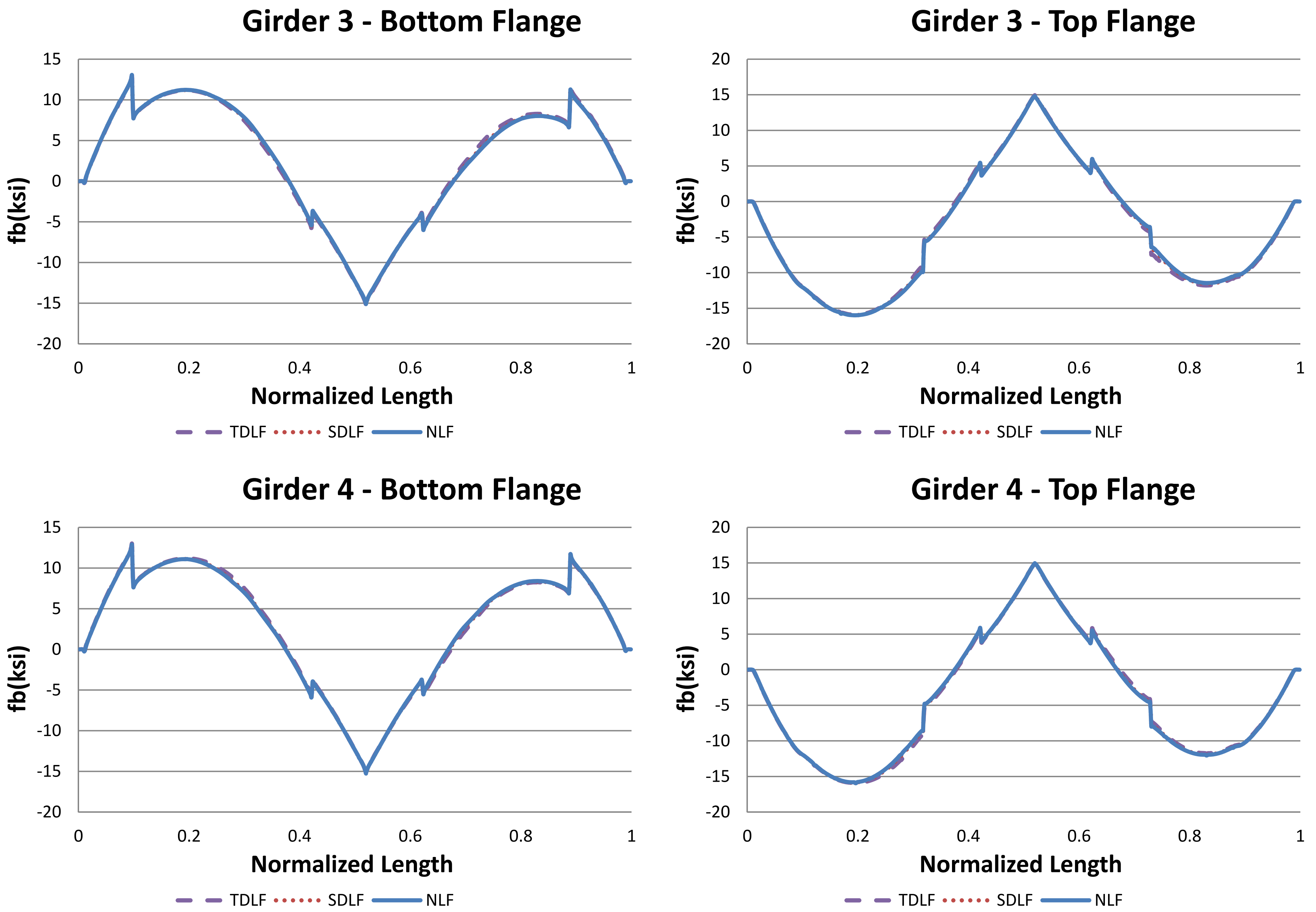


Figure K2-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

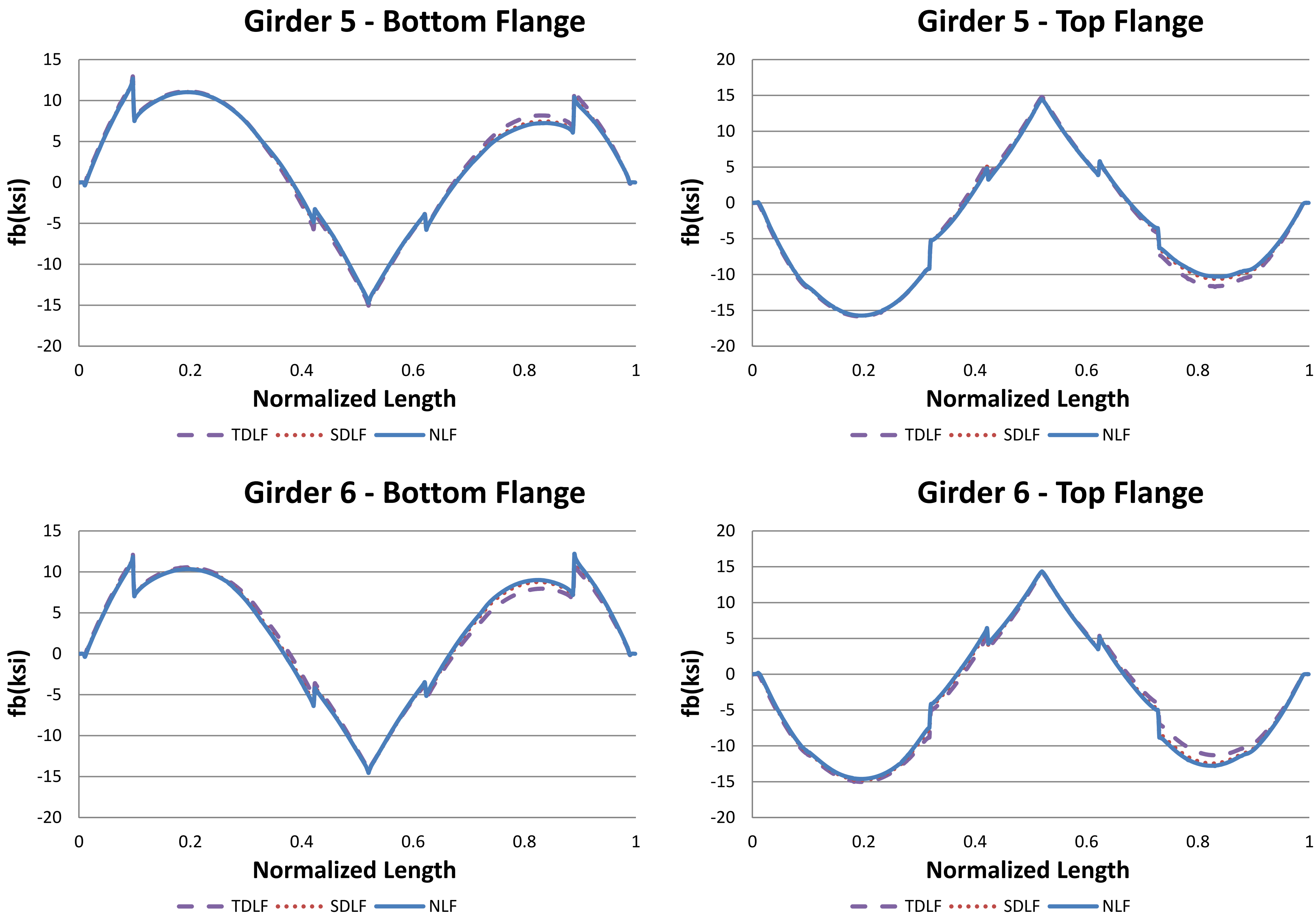


Figure K2-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

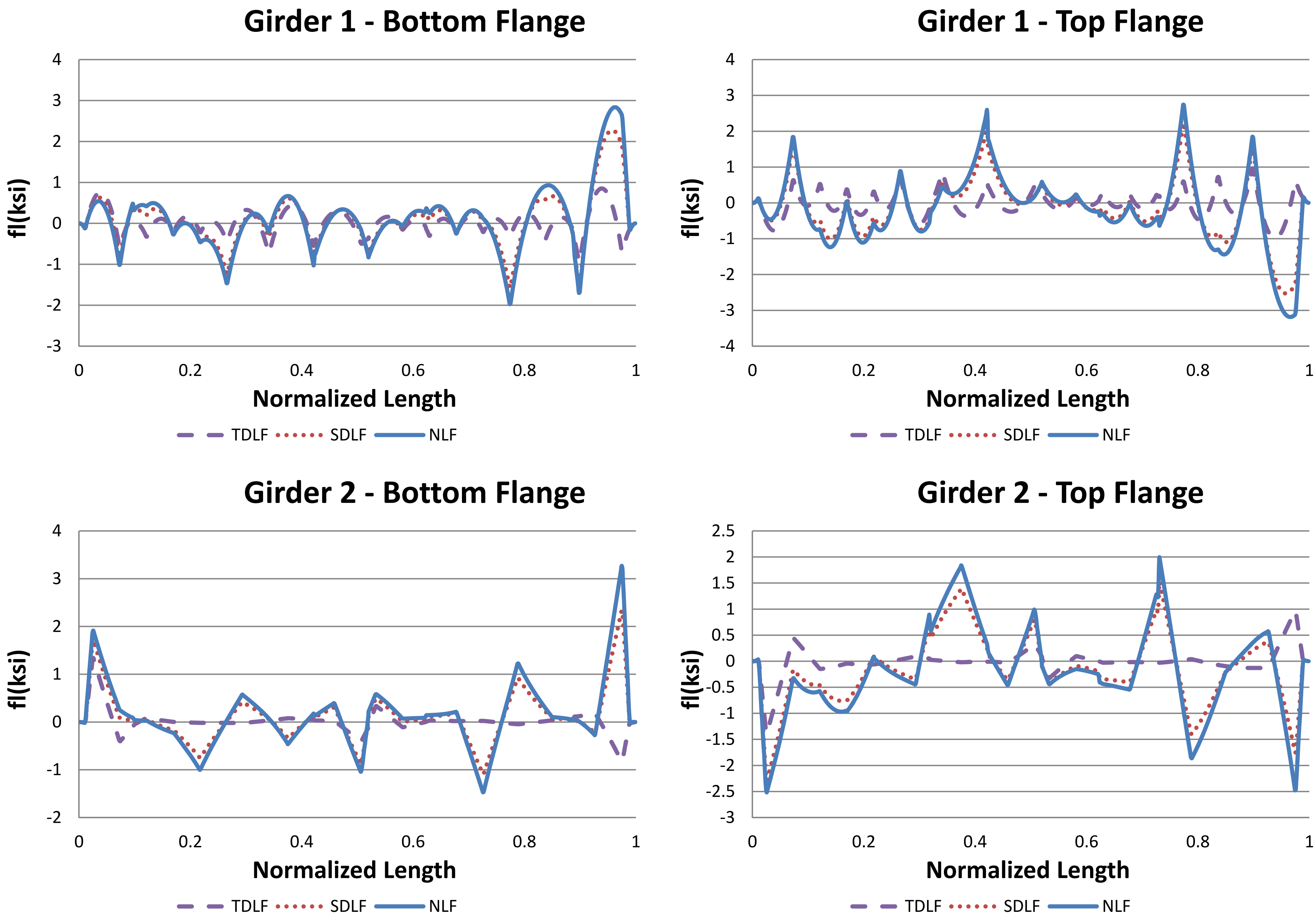


Figure K2-4-22. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

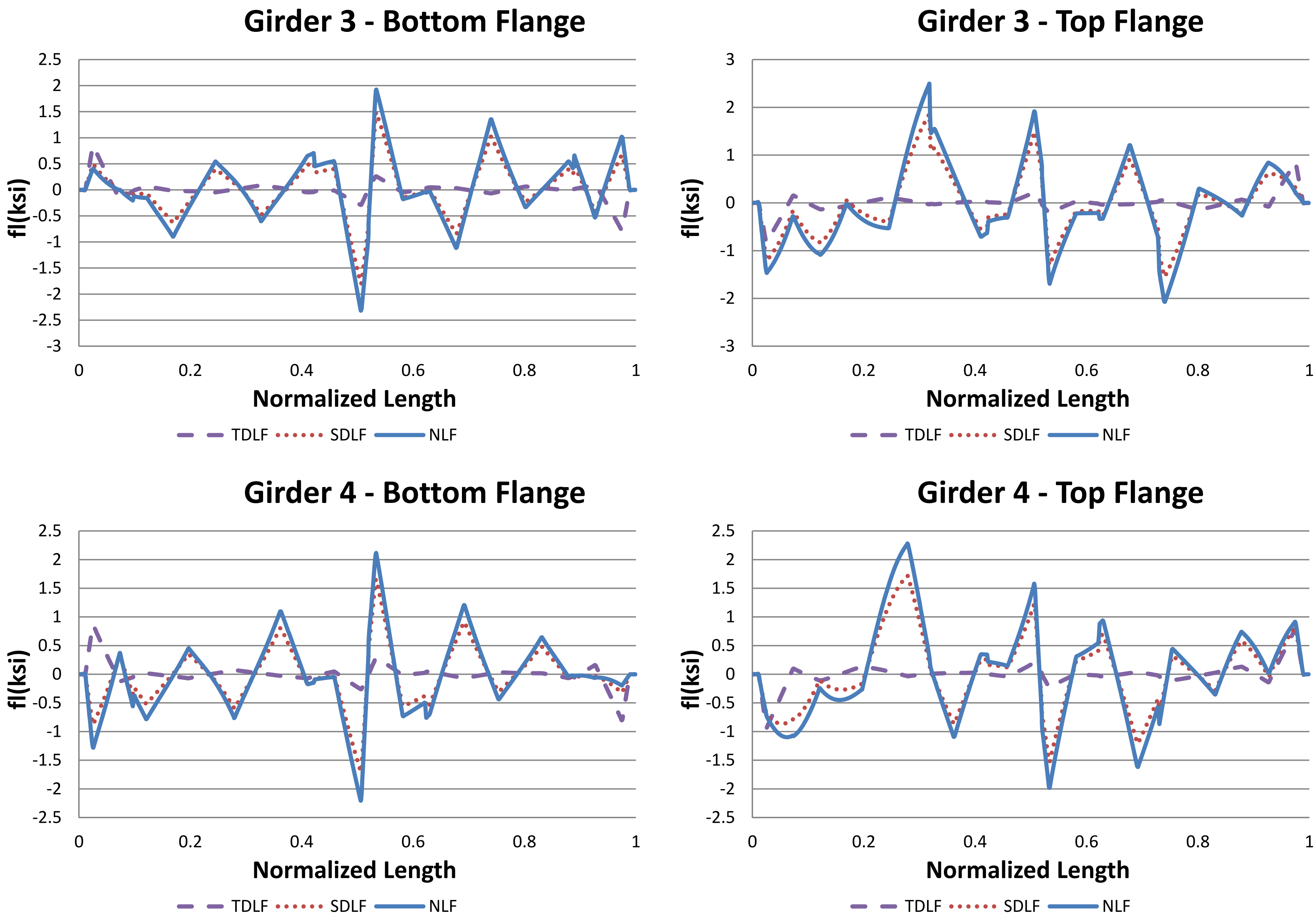


Figure K2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.

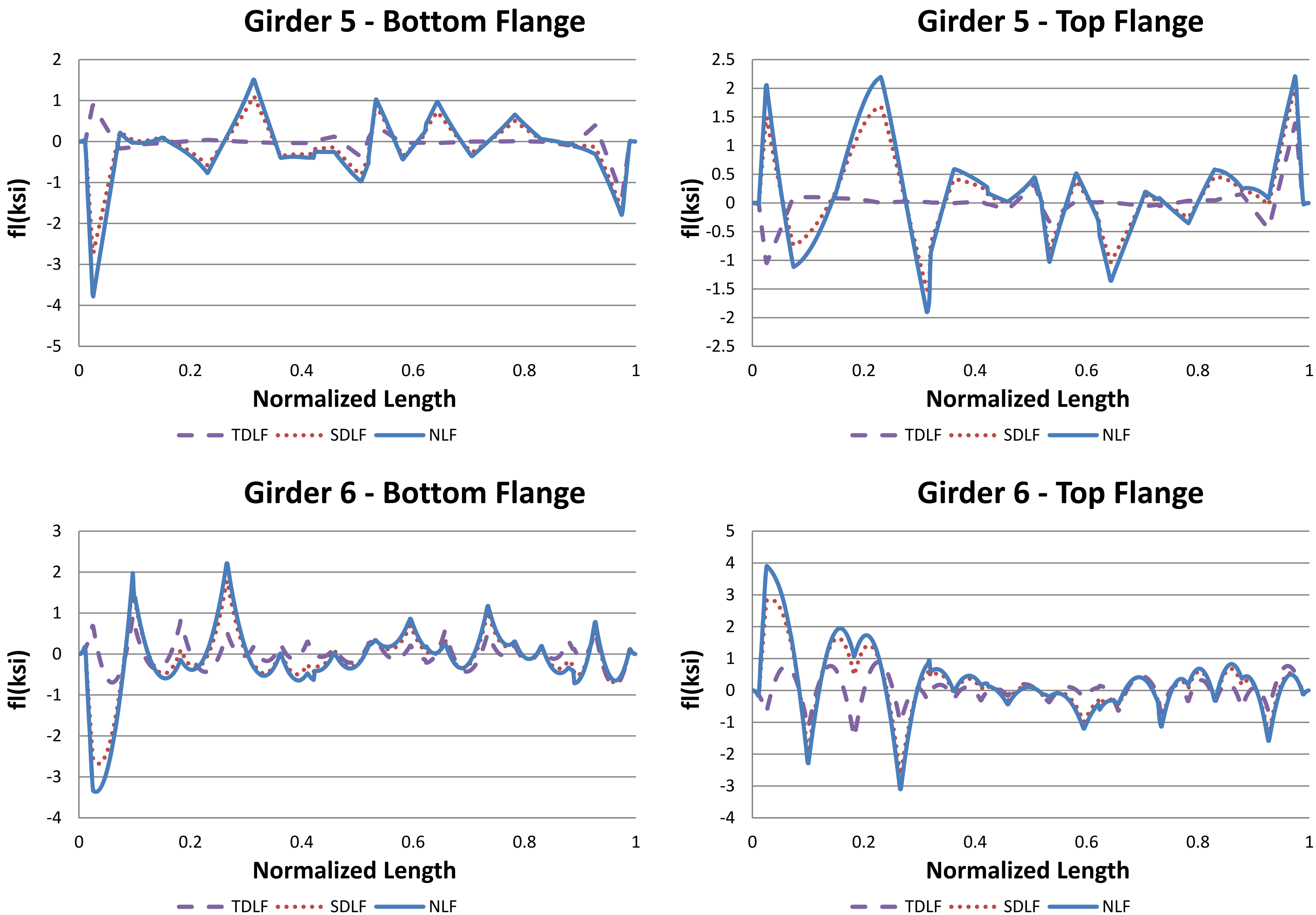


Figure K2-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

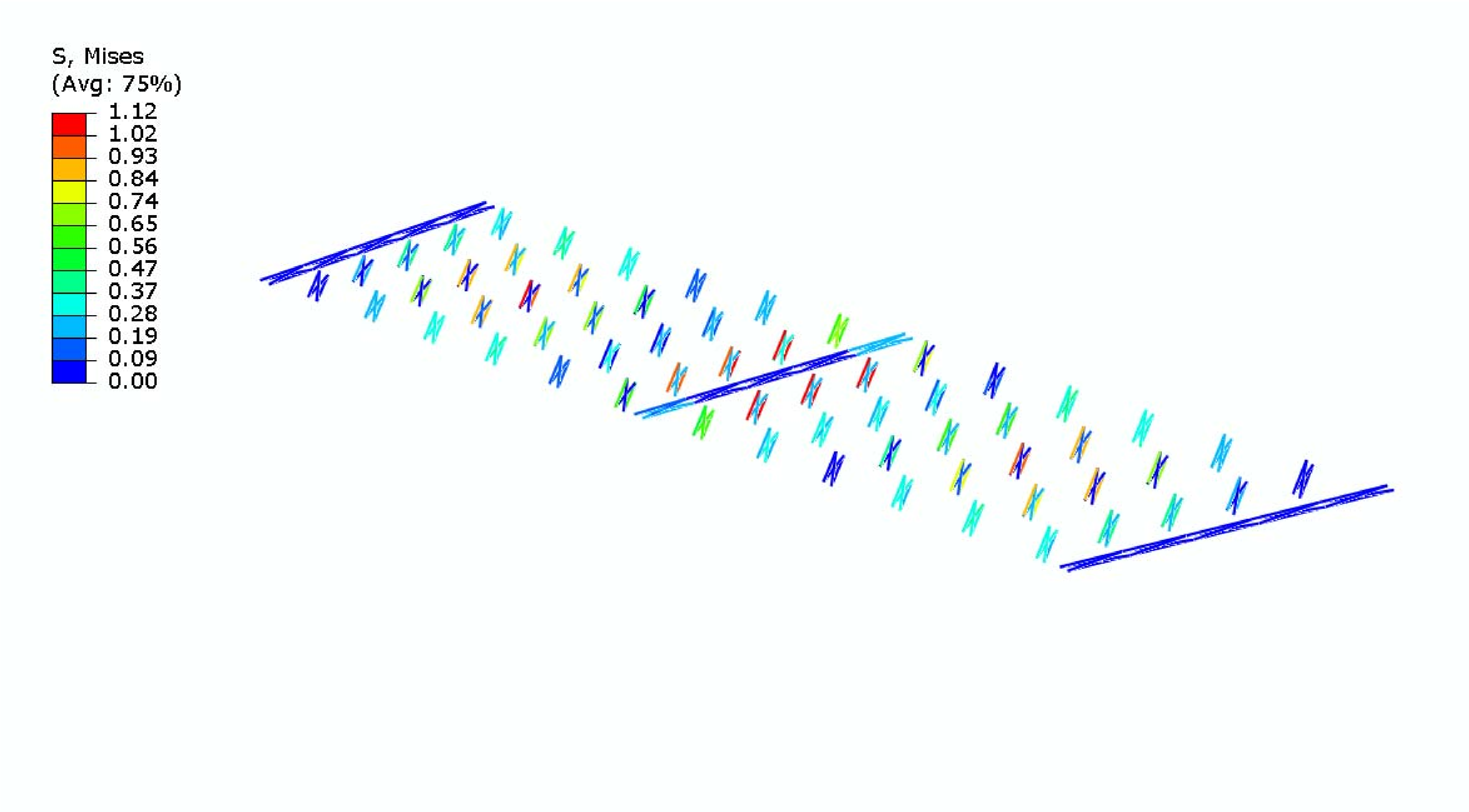


Figure K2-4-23. Cross-frame stress contours (ksi) under SDL, NLF detailing

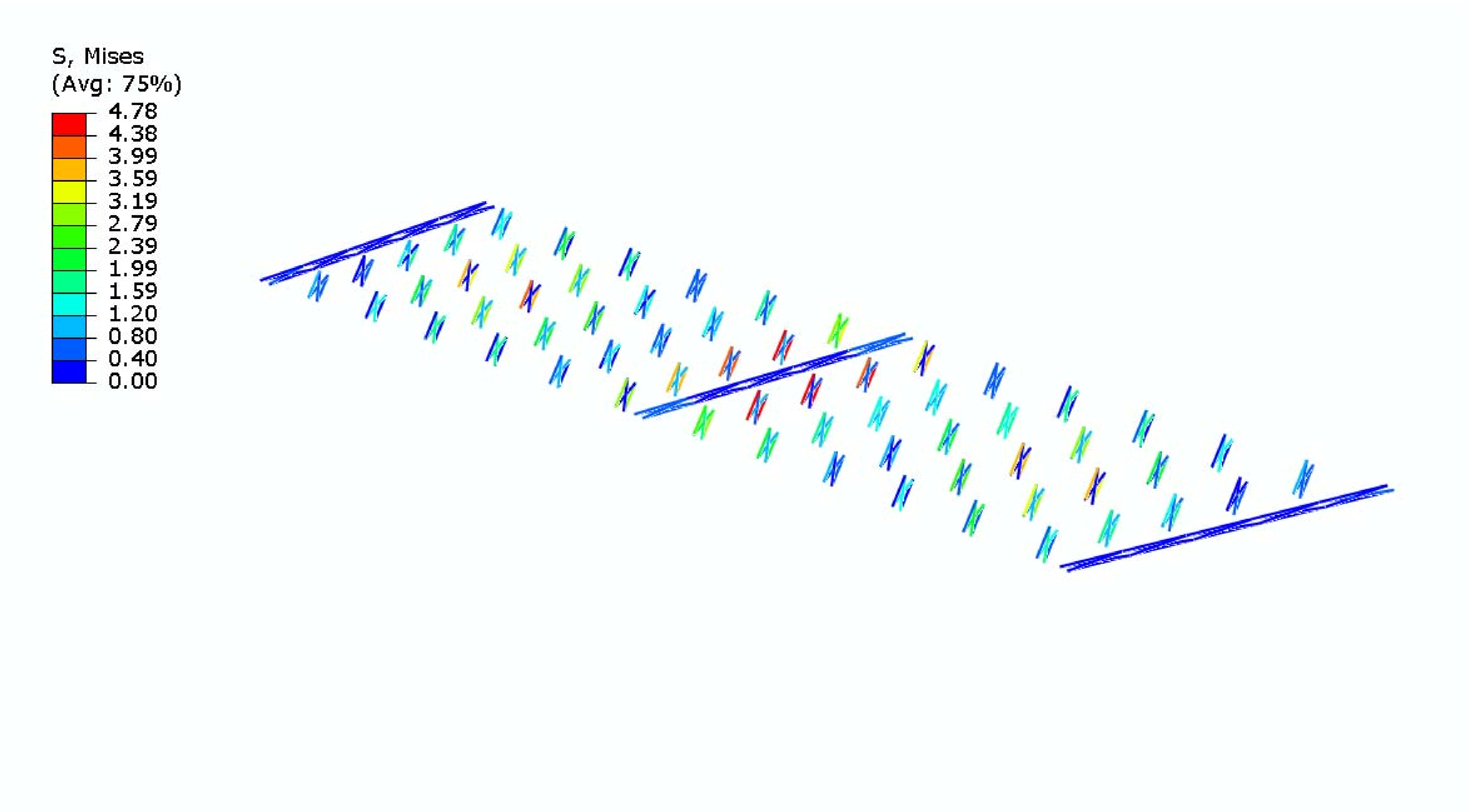


Figure K2-4-24. **Cross-frame stress contours under TDL, NLF detailing**

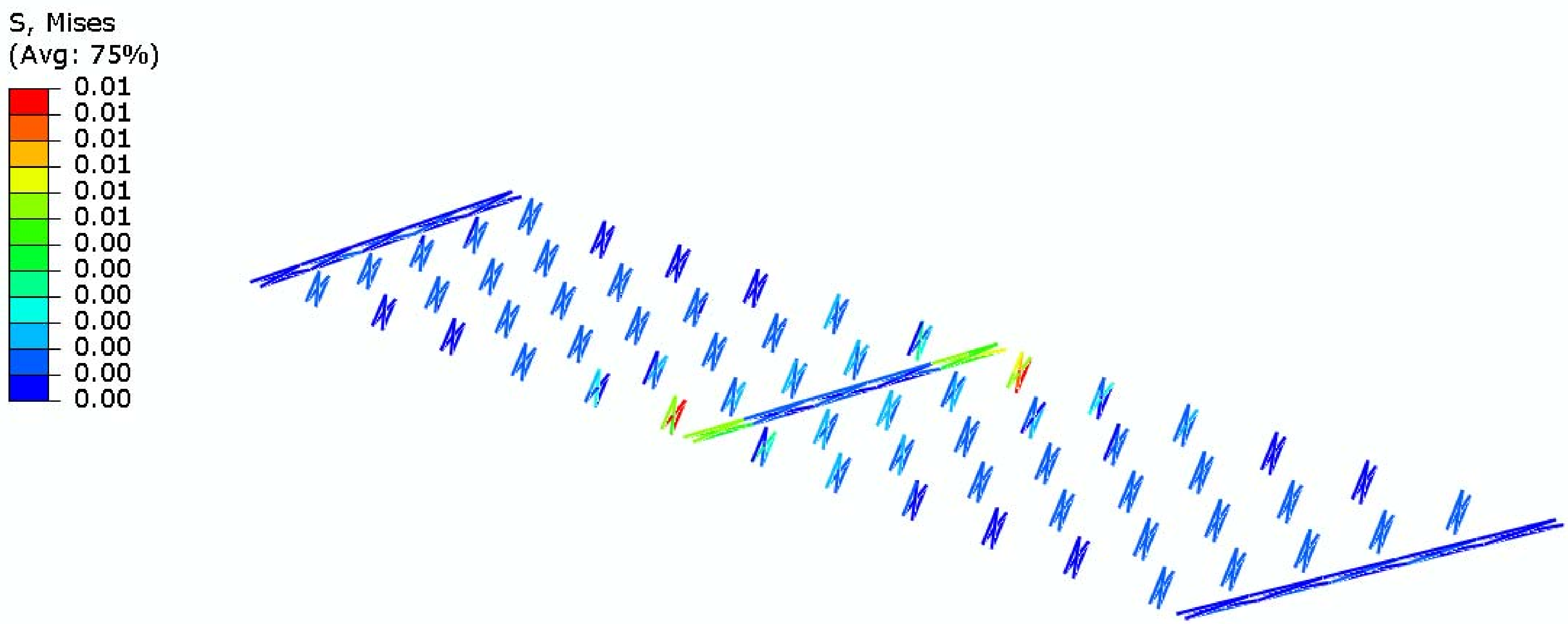


Figure K2-4-25. Cross-frame stress contours under SDL, SDLF detailing

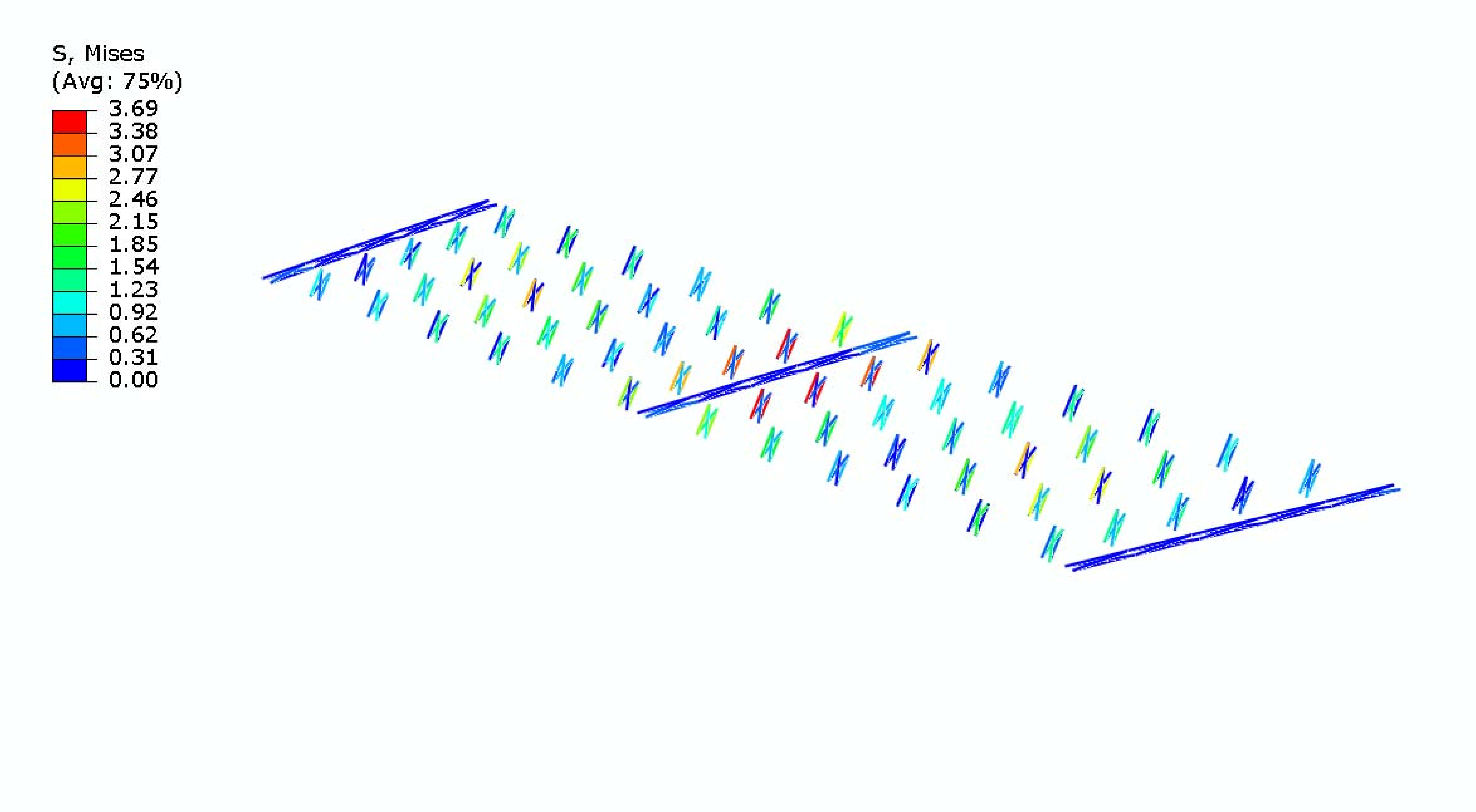


Figure K2-4-26. **Cross-frame stress contours under TDL, SDLF detailing**

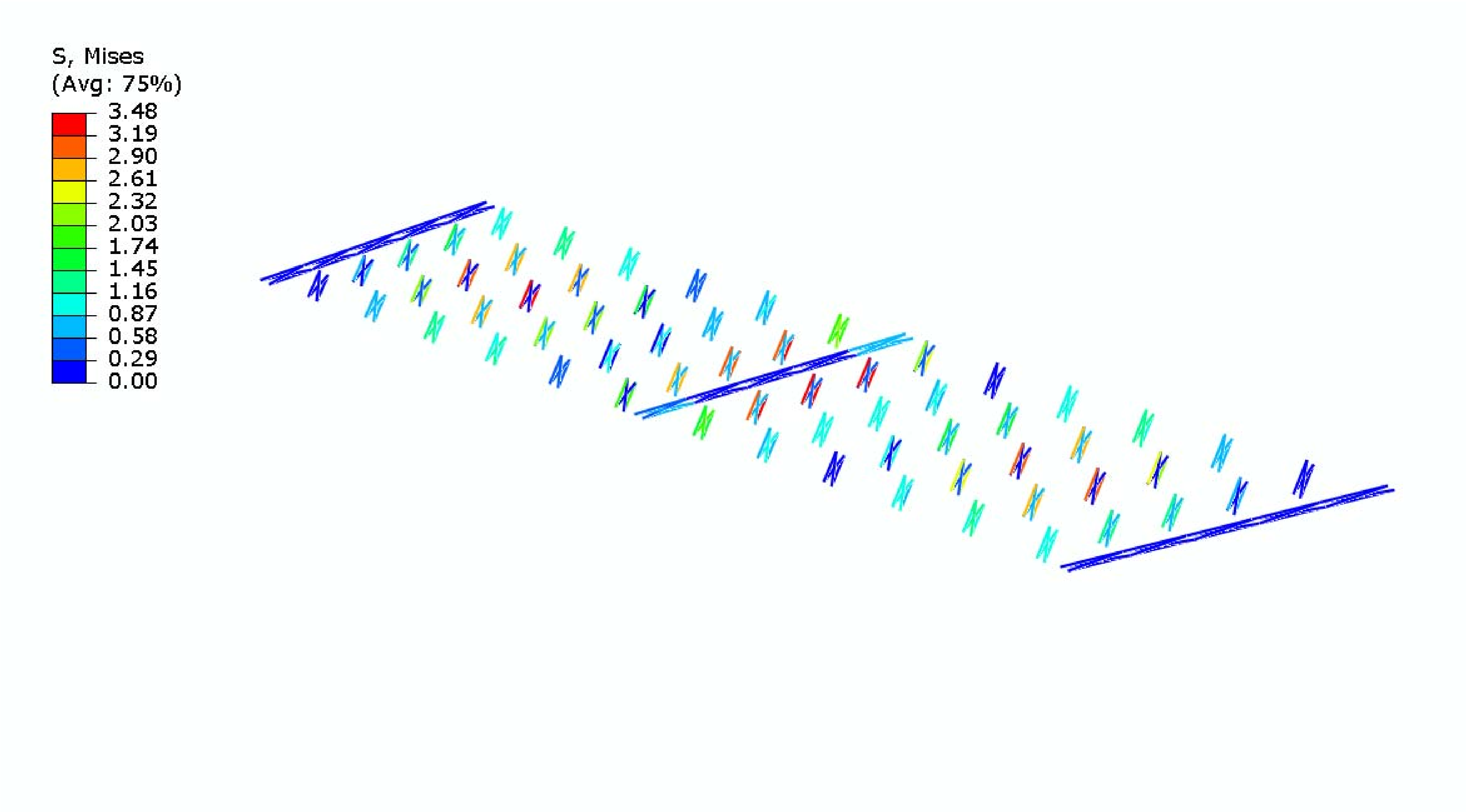


Figure K2-4-27. Cross-frame stress contours under SDL, TDLF detailing

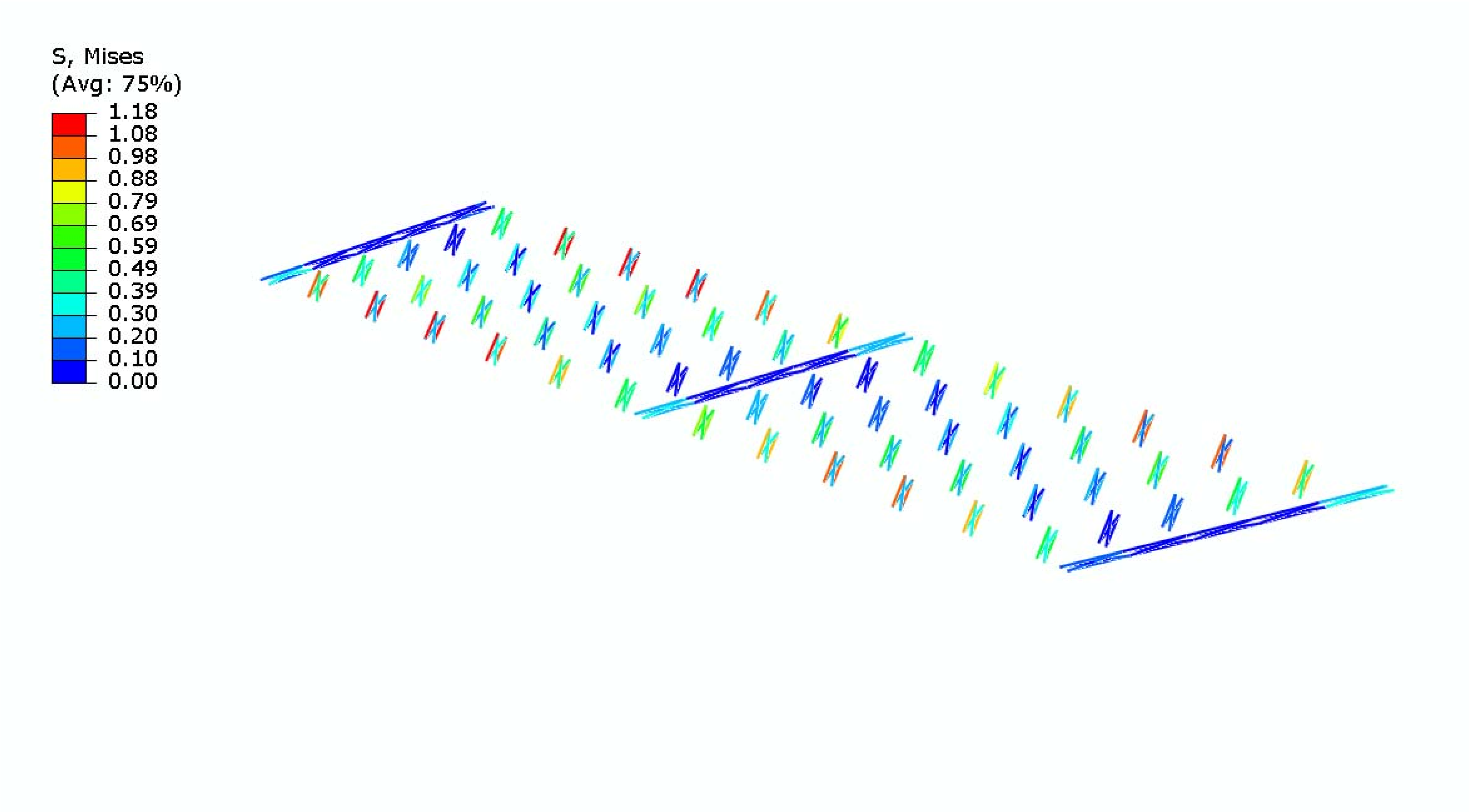


Figure K2-4-28. Cross-frame stress contours under TDL, TDLF

Table K2-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.2	0.0	0.2	0.2	0.2
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.5	0.1	0.6	0.8	0.6
2	NLF	0.1	0.1	0.4	0.6	0.8
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.2	0.3	1.4	2.0	2.8
3	NLF	0.6	0.3	0.2	0.6	1.2
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.2	0.9	0.7	1.9	4.0
4	NLF	1.0	0.5	0.1	0.5	1.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.4	1.8	0.4	1.4	3.1
5	NLF	1.1	0.7	0.4	0.0	0.4
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.4	2.2	1.4	0.0	1.0
6	NLF	0.4	0.9	0.8	0.6	0.7
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	1.2	2.7	2.5	2.0	2.5
7	NLF	0.0	0.8	0.7	0.9	2.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.3	2.1	2.0	2.3	5.8
8	NLF	1.5	0.3	0.2	0.2	1.7
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	4.6	0.9	0.6	0.5	5.0
9	NLF	1.8	0.8	0.6	0.6	0.2
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	5.3	2.0	1.3	1.3	1.1
10	NLF	0.8	0.8	0.9	0.9	0.2
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.9	2.6	2.9	2.8	0.4

Table K2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.2	0.2	0.6	0.7	1.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.3	0.8	2.0	2.3	3.3
12	NLF	0.9	0.4	0.2	0.5	1.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.7	1.0	0.6	1.7	3.4
13	NLF	1.2	0.6	0.3	0.2	0.7
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.7	1.8	0.7	0.8	2.3
14	NLF	0.9	0.7	0.6	0.2	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.9	2.3	1.9	0.6	0.1
15	NLF	0.1	0.2	0.2	0.0	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.5	0.7	0.6	0.1	0.4

Table K2-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	4.1	1.6	0.2	0.5	0.6
	SDLF	3.6	1.4	0.1	0.3	0.6
	TDLF	2.2	0.7	0.3	0.1	0.7
2	NLF	1.4	1.3	1.5	2.4	4.5
	SDLF	1.4	1.2	1.1	1.9	3.7
	TDLF	1.2	0.9	0.5	0.1	1.2
3	NLF	3.8	2.4	0.3	2.8	6.2
	SDLF	3.1	2.1	0.1	2.2	5.1
	TDLF	0.6	0.9	0.5	0.3	1.2
4	NLF	5.2	3.3	0.8	2.8	4.9
	SDLF	4.1	2.7	0.7	2.3	3.9
	TDLF	0.6	0.7	0.1	0.8	0.7
5	NLF	5.3	3.3	1.4	1.2	2.3
	SDLF	4.3	2.7	1.0	1.1	1.8
	TDLF	0.9	0.5	0.3	0.9	0.6
6	NLF	2.9	3.9	3.1	1.9	2.2
	SDLF	2.5	3.0	2.2	1.2	1.5
	TDLF	1.4	0.2	0.5	0.9	1.0
7	NLF	0.9	2.7	2.2	2.5	6.4
	SDLF	1.0	1.9	1.5	1.7	4.4
	TDLF	1.3	0.0	0.4	0.7	1.5
8	NLF	4.4	1.0	1.0	1.1	4.5
	SDLF	2.8	0.7	0.8	0.9	2.9
	TDLF	2.1	0.3	0.1	0.5	2.0
9	NLF	5.7	2.3	1.8	2.1	0.3
	SDLF	3.9	1.5	1.2	1.5	0.1
	TDLF	1.6	0.6	0.3	0.1	1.2
10	NLF	2.8	2.6	3.5	4.1	1.9
	SDLF	2.0	1.8	2.6	3.2	1.7
	TDLF	1.0	0.8	0.4	0.2	1.2

Table K2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location				
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**
11	NLF	1.2	0.2	2.3	3.5	5.1
	SDLF	1.0	0.2	1.7	2.8	4.1
	TDLF	0.7	0.8	0.3	0.5	0.9
12	NLF	4.3	2.1	0.9	3.0	5.1
	SDLF	3.4	1.8	0.8	2.4	4.0
	TDLF	0.6	0.7	0.1	0.6	0.6
13	NLF	5.8	2.7	0.6	2.0	3.7
	SDLF	4.6	2.1	0.4	1.8	2.9
	TDLF	1.1	0.2	0.4	0.9	0.5
14	NLF	4.7	2.9	2.1	0.7	1.5
	SDLF	3.9	2.2	1.5	0.7	1.5
	TDLF	1.1	0.1	0.5	0.9	1.3
15	NLF	0.6	0.6	0.4	0.9	3.4
	SDLF	0.6	0.5	0.2	0.8	3.1
	TDLF	0.7	0.0	0.2	0.6	2.2

Table K2-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.0	0.1	0.0	0.1	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.2	0.3	0.1	0.3	0.4
2	NLF	0.0	0.6	1.2	1.2	0.7
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.2	2.3	3.9	4.1	2.5
3	NLF	0.6	1.9	2.6	2.4	1.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.0	6.4	8.6	8.0	3.3
4	NLF	0.9	2.4	2.9	2.4	0.8
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.1	7.9	9.4	7.7	2.7
5	NLF	0.9	1.9	2.1	1.5	0.4
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.9	6.1	6.4	4.4	1.0
6	NLF	0.4	0.1	0.0	0.5	0.6
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	1.2	0.2	0.4	1.7	1.9
7	NLF	1.8	2.7	2.9	3.0	1.7
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	5.3	8.2	9.0	9.2	5.2
8	NLF	1.4	0.2	0.0	0.2	1.6
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	4.0	0.6	0.0	0.5	4.8
9	NLF	1.6	3.0	3.2	3.1	2.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	4.6	9.4	10.0	9.6	6.7
10	NLF	0.7	0.8	0.6	0.4	0.3
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.5	3.3	2.5	1.9	0.6

Table K2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.2	1.2	1.7	1.7	0.9
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.4	3.1	4.7	4.8	2.6
12	NLF	0.8	2.3	2.9	2.5	1.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.4	7.0	8.8	7.7	3.2
13	NLF	1.0	2.4	2.6	2.0	0.6
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.2	7.7	8.4	6.5	2.0
14	NLF	0.7	1.2	1.2	0.7	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.5	4.0	4.0	2.4	0.2
15	NLF	0.1	0.1	0.0	0.1	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.3	0.2	0.0	0.3	0.2

Table K2-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	1.8	1.1	0.2	0.4	0.2
	SDLF	1.7	0.9	0.2	0.3	0.0
	TDLF	1.3	0.3	0.1	0.0	0.7
2	NLF	2.4	1.8	5.1	5.5	1.7
	SDLF	2.5	1.1	3.8	4.2	1.1
	TDLF	2.9	1.5	0.6	0.2	1.6
3	NLF	0.8	6.3	10.0	8.9	0.8
	SDLF	1.3	4.4	7.5	6.7	0.1
	TDLF	3.3	2.0	0.9	0.9	3.1
4	NLF	0.4	8.0	10.8	8.0	0.3
	SDLF	0.4	5.7	8.0	5.7	0.6
	TDLF	3.3	1.8	0.9	1.7	3.2
5	NLF	0.4	6.4	7.6	4.2	1.8
	SDLF	0.4	4.5	5.6	2.7	2.2
	TDLF	3.1	1.3	0.9	2.0	3.3
6	NLF	0.9	0.1	0.7	3.7	5.5
	SDLF	1.4	0.1	0.8	3.3	4.9
	TDLF	2.6	0.6	0.6	1.7	3.0
7	NLF	8.3	10.8	12.3	13.6	9.7
	SDLF	6.6	8.1	9.4	10.6	7.9
	TDLF	1.5	0.1	0.4	1.1	2.5
8	NLF	3.9	0.8	0.1	0.6	5.0
	SDLF	2.4	0.6	0.2	0.4	3.4
	TDLF	1.8	0.2	0.2	0.2	1.5
9	NLF	8.5	13.5	13.7	13.0	10.4
	SDLF	6.8	10.4	10.4	9.9	8.2
	TDLF	2.1	0.8	0.3	0.1	1.5
10	NLF	5.8	5.5	3.4	2.5	1.3
	SDLF	5.1	4.7	2.8	2.1	1.6
	TDLF	2.6	1.4	0.5	0.5	2.4

Table K2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	2.2	2.8	6.0	5.4	0.6
	SDLF	2.5	1.6	4.2	3.8	0.2
	TDLF	2.9	1.6	0.6	1.1	2.7
12	NLF	0.3	7.8	10.7	8.4	1.0
	SDLF	0.5	5.6	7.9	5.9	0.0
	TDLF	2.9	1.4	0.7	1.6	3.0
13	NLF	1.2	9.0	10.0	6.6	0.3
	SDLF	0.3	6.7	7.5	4.7	0.9
	TDLF	2.8	0.8	0.7	1.8	2.9
14	NLF	1.8	5.2	5.0	2.0	2.2
	SDLF	1.0	4.0	3.7	1.2	2.3
	TDLF	1.5	0.1	0.5	1.4	2.6
15	NLF	0.2	0.5	0.0	0.8	1.7
	SDLF	0.0	0.4	0.0	0.7	1.7
	TDLF	0.7	0.0	0.1	0.2	1.4

Table K2-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.0	0.2	0.1	0.1	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.6	0.4	0.2	0.0
2	NLF	0.0	0.6	1.2	1.3	0.8
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.1	2.1	3.9	4.3	2.8
3	NLF	0.6	2.0	2.6	2.5	1.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.0	6.6	8.8	8.1	3.3
4	NLF	1.0	2.5	3.0	2.4	0.9
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.3	8.2	9.7	7.9	2.9
5	NLF	0.9	2.0	2.1	1.5	0.4
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.0	6.1	6.5	4.5	1.1
6	NLF	0.4	0.1	0.1	0.5	0.6
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	1.1	0.1	0.5	1.8	1.9
7	NLF	1.7	2.7	2.9	3.0	1.7
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	5.2	8.1	8.9	9.1	5.1
8	NLF	1.1	0.0	0.1	0.0	1.4
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.4	0.2	0.3	0.2	4.3
9	NLF	1.5	3.0	3.1	3.0	2.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	4.4	9.1	9.7	9.4	6.5
10	NLF	0.7	0.8	0.6	0.4	0.3
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.4	3.3	2.6	1.9	0.5

Table K2-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.2	1.2	1.7	1.7	0.9
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.4	3.1	4.8	4.9	2.7
2	NLF	0.8	2.3	2.9	2.5	1.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.5	7.1	8.9	7.9	3.3
3	NLF	1.0	2.4	2.6	2.0	0.6
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.2	7.8	8.6	6.7	2.1
4	NLF	0.8	1.2	1.2	0.7	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.6	4.1	4.0	2.3	0.2
5	NLF	0.0	0.0	0.1	0.2	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.1	0.1	0.3	0.6	0.0

Table K2-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	1.5	0.8	0.6	0.4	0.6
	SDLF	1.4	0.7	0.5	0.3	0.6
	TDLF	1.4	0.3	0.2	0.0	0.7
2	NLF	3.1	0.8	4.2	5.2	2.0
	SDLF	3.1	0.2	3.1	3.9	1.1
	TDLF	2.9	1.6	0.6	0.2	1.6
3	NLF	1.0	6.3	10.5	9.7	1.3
	SDLF	1.5	4.4	7.8	7.2	0.3
	TDLF	3.3	2.1	0.9	1.0	3.1
4	NLF	0.9	8.9	11.7	8.5	0.4
	SDLF	0.1	6.3	8.7	6.1	0.5
	TDLF	3.4	1.9	1.0	1.8	3.3
5	NLF	0.9	6.8	7.5	3.7	2.2
	SDLF	0.1	4.8	5.5	2.3	2.5
	TDLF	3.1	1.4	0.9	2.0	3.4
6	NLF	1.2	0.6	1.6	4.3	5.6
	SDLF	1.6	0.7	1.5	3.8	5.1
	TDLF	2.7	0.6	0.7	1.8	3.0
7	NLF	8.5	11.0	12.0	13.0	9.1
	SDLF	6.8	8.3	9.2	10.1	7.5
	TDLF	1.6	0.1	0.4	1.1	2.5
8	NLF	2.9	0.0	0.7	0.1	4.1
	SDLF	1.7	0.0	0.6	0.1	2.7
	TDLF	1.8	0.1	0.2	0.2	1.5
9	NLF	7.9	12.7	12.9	12.5	10.2
	SDLF	6.5	9.8	9.8	9.5	8.1
	TDLF	2.1	0.8	0.3	0.2	1.6
10	NLF	5.7	5.7	3.8	3.0	1.7
	SDLF	5.0	4.8	3.2	2.6	1.9
	TDLF	2.6	1.4	0.5	0.5	2.4

Table K2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	2.4	2.5	5.7	5.5	0.9
	SDLF	2.6	1.3	4.0	3.7	0.0
	TDLF	2.9	1.7	0.7	1.1	2.8
12	NLF	0.3	7.9	11.1	8.9	1.3
	SDLF	0.5	5.6	8.2	6.3	0.3
	TDLF	2.9	1.5	0.8	1.6	3.0
13	NLF	1.5	9.5	10.5	6.8	0.3
	SDLF	0.5	7.1	7.9	4.8	0.9
	TDLF	2.8	0.8	0.7	1.8	3.0
14	NLF	2.0	5.1	4.5	1.3	2.7
	SDLF	1.2	3.9	3.3	0.7	2.6
	TDLF	1.5	0.2	0.5	1.5	2.7
15	NLF	0.6	0.4	0.5	0.9	1.6
	SDLF	0.6	0.3	0.5	0.7	1.6
	TDLF	0.8	0.1	0.2	0.3	1.5

Table K2-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	0.36	0.33	0.32	0.31	0.30
	SDLF	0.30	0.34	0.34	0.34	0.35
	TDLF	0.09	0.34	0.38	0.40	0.50
3	NLF	0.25	0.21	0.19	0.18	0.14
	SDLF	0.13	0.18	0.18	0.18	0.23
	TDLF	0.29	0.12	0.17	0.20	0.53
4	NLF	0.08	0.03	0.02	0.01	0.03
	SDLF	0.07	0.01	0.01	0.01	0.06
	TDLF	0.55	0.13	0.09	0.05	0.36
5	NLF	0.10	0.13	0.13	0.14	0.16
	SDLF	0.21	0.17	0.17	0.17	0.11
	TDLF	0.60	0.31	0.29	0.27	0.06
6	NLF	0.18	0.19	0.19	0.19	0.19
	SDLF	0.24	0.22	0.22	0.22	0.19
	TDLF	0.43	0.32	0.33	0.32	0.17
7	NLF	0.15	0.14	0.14	0.13	0.12
	SDLF	0.15	0.15	0.15	0.15	0.14
	TDLF	0.17	0.18	0.20	0.22	0.20
8	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
9	NLF	0.04	0.05	0.06	0.07	0.08
	SDLF	0.06	0.07	0.07	0.07	0.07
	TDLF	0.16	0.13	0.10	0.08	0.06
10	NLF	0.10	0.11	0.11	0.12	0.12
	SDLF	0.12	0.14	0.14	0.14	0.15
	TDLF	0.19	0.24	0.23	0.21	0.24

Table K2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.11	0.10	0.09	0.09	0.08
	SDLF	0.09	0.13	0.13	0.13	0.16
	TDLF	0.07	0.23	0.23	0.24	0.38
12	NLF	0.03	0.01	0.00	-0.01	-0.04
	SDLF	-0.02	0.03	0.03	0.03	0.07
	TDLF	-0.15	0.09	0.11	0.13	0.38
13	NLF	-0.08	-0.11	-0.11	-0.12	-0.16
	SDLF	-0.14	-0.11	-0.11	-0.11	-0.06
	TDLF	-0.31	-0.09	-0.07	-0.04	0.23
14	NLF	-0.19	-0.21	-0.21	-0.22	-0.25
	SDLF	-0.23	-0.22	-0.22	-0.22	-0.19
	TDLF	-0.35	-0.27	-0.25	-0.22	-0.03
15	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K2-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	1.62	1.43	1.36	1.32	1.25
	SDLF	1.55	1.43	1.37	1.34	1.30
	TDLF	1.34	1.43	1.41	1.41	1.45
3	NLF	1.17	0.89	0.79	0.74	0.51
	SDLF	1.04	0.87	0.78	0.74	0.59
	TDLF	0.62	0.80	0.77	0.75	0.89
4	NLF	0.43	0.15	0.07	0.00	0.26
	SDLF	0.28	0.11	0.04	0.02	0.17
	TDLF	0.20	0.01	0.04	0.07	0.13
5	NLF	0.34	0.53	0.57	0.63	0.80
	SDLF	0.46	0.57	0.61	0.66	0.74
	TDLF	0.84	0.71	0.73	0.75	0.57
6	NLF	0.72	0.78	0.79	0.81	0.85
	SDLF	0.78	0.81	0.82	0.84	0.85
	TDLF	0.97	0.91	0.92	0.94	0.82
7	NLF	0.61	0.59	0.56	0.55	0.52
	SDLF	0.61	0.59	0.57	0.57	0.54
	TDLF	0.63	0.62	0.62	0.63	0.59
8	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
9	NLF	0.13	0.19	0.21	0.24	0.27
	SDLF	0.15	0.21	0.22	0.25	0.27
	TDLF	0.25	0.26	0.26	0.26	0.25
10	NLF	0.43	0.45	0.45	0.47	0.45
	SDLF	0.44	0.48	0.48	0.49	0.49
	TDLF	0.52	0.58	0.56	0.56	0.57

Table K2-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.49	0.42	0.40	0.38	0.28
	SDLF	0.48	0.45	0.43	0.42	0.36
	TDLF	0.45	0.55	0.54	0.53	0.59
12	NLF	0.22	0.06	0.03	-0.02	-0.20
	SDLF	0.17	0.08	0.05	0.01	-0.10
	TDLF	0.04	0.15	0.13	0.12	0.21
13	NLF	-0.25	-0.41	-0.45	-0.51	-0.72
	SDLF	-0.31	-0.41	-0.44	-0.49	-0.62
	TDLF	-0.48	-0.40	-0.41	-0.43	-0.33
14	NLF	-0.78	-0.84	-0.87	-0.93	-1.08
	SDLF	-0.81	-0.86	-0.88	-0.93	-1.02
	TDLF	-0.93	-0.90	-0.90	-0.92	-0.86
15	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K2-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	0.16	0.15	0.14	0.14	0.13
	SDLF	0.14	0.15	0.15	0.15	0.16
	TDLF	0.04	0.15	0.17	0.18	0.23
3	NLF	0.11	0.09	0.09	0.08	0.06
	SDLF	0.06	0.08	0.08	0.08	0.10
	TDLF	0.13	0.05	0.08	0.09	0.24
4	NLF	0.04	0.01	0.01	0.00	0.01
	SDLF	0.03	0.00	0.00	0.00	0.03
	TDLF	0.25	0.06	0.04	0.02	0.16
5	NLF	0.04	0.06	0.06	0.06	0.07
	SDLF	0.10	0.08	0.08	0.08	0.05
	TDLF	0.27	0.14	0.13	0.12	0.03
6	NLF	0.08	0.09	0.08	0.09	0.09
	SDLF	0.11	0.10	0.10	0.10	0.08
	TDLF	0.19	0.15	0.15	0.14	0.07
7	NLF	0.07	0.06	0.06	0.06	0.05
	SDLF	0.07	0.07	0.07	0.07	0.06
	TDLF	0.07	0.08	0.09	0.10	0.09
8	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
9	NLF	0.02	0.02	0.03	0.03	0.03
	SDLF	0.03	0.03	0.03	0.03	0.03
	TDLF	0.07	0.06	0.05	0.04	0.02
10	NLF	0.05	0.05	0.05	0.05	0.05
	SDLF	0.05	0.06	0.06	0.06	0.07
	TDLF	0.09	0.11	0.10	0.10	0.11

Table K2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.05	0.04	0.04	0.04	0.04
	SDLF	0.04	0.06	0.06	0.06	0.07
	TDLF	0.03	0.10	0.11	0.11	0.17
2	NLF	0.01	0.00	0.00	0.00	-0.02
	SDLF	-0.01	0.01	0.01	0.01	0.03
	TDLF	-0.07	0.04	0.05	0.06	0.17
3	NLF	-0.04	-0.05	-0.05	-0.06	-0.07
	SDLF	-0.06	-0.05	-0.05	-0.05	-0.03
	TDLF	-0.14	-0.04	-0.03	-0.02	0.10
4	NLF	-0.09	-0.09	-0.10	-0.10	-0.11
	SDLF	-0.10	-0.10	-0.10	-0.10	-0.09
	TDLF	-0.15	-0.12	-0.11	-0.10	-0.01
5	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K2-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	0.73	0.64	0.61	0.59	0.56
	SDLF	0.70	0.64	0.62	0.60	0.58
	TDLF	0.60	0.64	0.63	0.63	0.65
3	NLF	0.52	0.40	0.35	0.33	0.23
	SDLF	0.47	0.39	0.35	0.33	0.27
	TDLF	0.28	0.36	0.34	0.34	0.40
4	NLF	0.19	0.07	0.03	0.00	0.12
	SDLF	0.13	0.05	0.02	0.01	0.08
	TDLF	0.09	0.00	0.02	0.03	0.06
5	NLF	0.15	0.24	0.26	0.28	0.36
	SDLF	0.21	0.26	0.27	0.30	0.33
	TDLF	0.38	0.32	0.33	0.34	0.25
6	NLF	0.33	0.35	0.35	0.37	0.38
	SDLF	0.35	0.37	0.37	0.38	0.38
	TDLF	0.44	0.41	0.41	0.42	0.37
7	NLF	0.27	0.26	0.25	0.25	0.23
	SDLF	0.28	0.27	0.26	0.25	0.24
	TDLF	0.28	0.28	0.28	0.28	0.27
8	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
9	NLF	0.06	0.08	0.10	0.11	0.12
	SDLF	0.07	0.09	0.10	0.11	0.12
	TDLF	0.11	0.12	0.12	0.12	0.11
10	NLF	0.19	0.20	0.20	0.21	0.20
	SDLF	0.20	0.21	0.22	0.22	0.22
	TDLF	0.23	0.26	0.25	0.25	0.26

Table K2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.22	0.19	0.18	0.17	0.13
	SDLF	0.21	0.20	0.19	0.19	0.16
	TDLF	0.20	0.25	0.24	0.24	0.26
12	NLF	0.10	0.03	0.01	-0.01	-0.09
	SDLF	0.07	0.04	0.02	0.01	-0.04
	TDLF	0.02	0.07	0.06	0.05	0.10
13	NLF	-0.11	-0.19	-0.20	-0.23	-0.32
	SDLF	-0.14	-0.18	-0.20	-0.22	-0.28
	TDLF	-0.22	-0.18	-0.18	-0.19	-0.15
14	NLF	-0.35	-0.38	-0.39	-0.42	-0.48
	SDLF	-0.37	-0.38	-0.39	-0.42	-0.46
	TDLF	-0.42	-0.40	-0.41	-0.41	-0.39
15	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K2-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
G1	NLF	16.2	65.8	14.6	72.7	240.9	63.9
	SDLF	15.2	65.7	13.4	71.6	240.8	62.7
	TDLF	12.1	65.3	9.7	68.0	240.6	59.4
G2	NLF	16.6	71.5	14.7	67.6	250.9	59.4
	SDLF	17.1	70.4	15.1	68.2	249.8	59.8
	TDLF	18.9	66.9	16.4	70.1	246.1	61.1
G3	NLF	16.4	69.1	14.7	66.6	241.7	59.5
	SDLF	17.1	70.4	15.1	67.4	242.9	59.9
	TDLF	19.7	74.2	16.4	70.1	246.7	61.3
G4	NLF	16.6	69.1	14.4	68.1	241.5	57.9
	SDLF	17.1	70.4	15.1	68.6	242.8	58.6
	TDLF	18.9	74.3	17.3	70.5	246.7	60.9
G5	NLF	16.7	71.8	14.5	68.3	253.0	58.2
	SDLF	17.1	70.4	15.1	68.7	251.5	58.8
	TDLF	18.8	65.9	16.9	70.2	246.8	60.7
G6	NLF	16.8	65.5	14.2	73.8	239.5	63.4
	SDLF	15.4	65.7	13.2	72.5	239.6	62.3
	TDLF	10.7	66.6	10.2	68.3	240.3	59.1

Table K2-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

		Load Type & Support Number					
Girder	Detailing Method	SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
G1	NLF	0.0	NA	NA	-0.2	NA	NA
	SDLF	0.0	NA	NA	-0.2	NA	NA
	TDLF	0.1	NA	NA	0.0	NA	NA
G2	NLF	0.0	NA	NA	0.0	NA	NA
	SDLF	0.0	NA	NA	0.0	NA	NA
	TDLF	0.0	NA	NA	0.0	NA	NA
G3	NLF	0.0	NA	NA	0.1	NA	NA
	SDLF	0.0	NA	NA	0.1	NA	NA
	TDLF	0.0	NA	NA	0.0	NA	NA
G4	NLF	0.0	NA	NA	0.1	NA	NA
	SDLF	0.0	NA	NA	0.1	NA	NA
	TDLF	-0.1	NA	NA	0.0	NA	NA
G5	NLF	0.0	NA	NA	0.1	NA	NA
	SDLF	0.0	NA	NA	0.1	NA	NA
	TDLF	-0.1	NA	NA	0.0	NA	NA
G6	NLF	0.0	NA	NA	-0.1	NA	NA
	SDLF	0.0	NA	NA	-0.1	NA	NA
	TDLF	0.1	NA	NA	0.0	NA	NA

Table K2-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
G1	NLF	0.0	-0.2	0.0	0.4	-0.5	0.0
	SDLF	0.0	0.0	0.0	0.4	-0.3	0.1
	TDLF	-0.1	0.6	0.1	0.1	0.1	0.0
G2	NLF	0.0	-0.1	0.0	0.1	-0.1	0.2
	SDLF	0.0	0.0	0.0	0.1	-0.1	0.2
	TDLF	0.0	0.2	0.0	0.0	0.0	0.0
G3	NLF	0.0	0.0	0.0	-0.2	-0.1	0.1
	SDLF	0.0	0.0	0.0	-0.1	0.0	0.1
	TDLF	0.0	0.1	-0.1	-0.1	0.0	0.1
G4	NLF	0.0	0.0	0.0	-0.3	0.0	0.0
	SDLF	0.0	0.0	0.0	-0.2	0.0	0.0
	TDLF	0.0	0.0	0.0	-0.1	0.0	0.0
G5	NLF	0.0	0.1	0.0	-0.2	0.1	-0.1
	SDLF	0.0	0.0	0.0	-0.2	0.1	-0.1
	TDLF	0.0	-0.2	0.0	-0.1	0.0	0.0
G6	NLF	0.1	0.2	0.0	0.2	0.6	-0.3
	SDLF	0.0	0.0	0.0	0.1	0.4	-0.2
	TDLF	-0.2	-0.5	0.1	0.0	-0.1	-0.1

Table K2-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
		Load Type & Support Number					
G1	NLF	0.00	0.07	0.09	-0.02	0.26	0.35
	SDLF	0.00	0.05	0.08	-0.02	0.22	0.30
	TDLF	0.01	0.03	0.07	0.00	0.24	0.35
G2	NLF	0.00	0.06	0.09	0.00	0.25	0.34
	SDLF	0.00	0.05	0.08	0.00	0.22	0.30
	TDLF	0.00	0.06	0.10	0.00	0.25	0.36
G3	NLF	0.00	0.06	0.09	0.01	0.25	0.35
	SDLF	0.00	0.05	0.08	0.01	0.22	0.31
	TDLF	0.00	0.07	0.11	0.00	0.25	0.37
G4	NLF	0.00	0.06	0.09	0.01	0.25	0.36
	SDLF	0.00	0.05	0.08	0.01	0.21	0.31
	TDLF	-0.01	0.07	0.10	0.00	0.25	0.37
G5	NLF	0.00	0.06	0.09	0.01	0.24	0.36
	SDLF	0.00	0.05	0.08	0.01	0.21	0.31
	TDLF	-0.01	0.08	0.10	0.00	0.25	0.36
G6	NLF	0.00	0.05	0.09	-0.01	0.22	0.36
	SDLF	0.00	0.05	0.08	-0.01	0.19	0.32
	TDLF	0.01	0.08	0.08	0.00	0.24	0.35

Table K2-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
		Load Type & Support Number					
G1	NLF	0.00	0.02	0.00	-0.04	0.05	0.00
	SDLF	0.00	0.00	0.00	-0.04	0.03	-0.01
	TDLF	0.01	-0.06	-0.01	-0.01	-0.01	0.00
G2	NLF	0.00	0.01	0.00	-0.01	0.01	-0.02
	SDLF	0.00	0.00	0.00	-0.01	0.01	-0.02
	TDLF	0.00	-0.02	0.00	0.00	0.00	0.00
G3	NLF	0.00	0.00	0.00	0.02	0.01	-0.01
	SDLF	0.00	0.00	0.00	0.01	0.00	-0.01
	TDLF	0.00	-0.01	0.01	0.01	0.00	-0.01
G4	NLF	0.00	0.00	0.00	0.03	0.00	0.00
	SDLF	0.00	0.00	0.00	0.02	0.00	0.00
	TDLF	0.00	0.00	0.00	0.01	0.00	0.00
G5	NLF	0.00	-0.01	0.00	0.02	-0.01	0.01
	SDLF	0.00	0.00	0.00	0.02	-0.01	0.01
	TDLF	0.00	0.02	0.00	0.01	0.00	0.00
G6	NLF	-0.01	-0.02	0.00	-0.02	-0.06	0.03
	SDLF	0.00	0.00	0.00	-0.01	-0.04	0.02
	TDLF	0.02	0.05	-0.01	0.00	0.01	0.01

Appendix K2-5. EICSS12 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge EICSS12 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table K2-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-2	SDLF	-0.1	-0.2	0.3	0.0	0.3	0.3
		TDLF	-0.1	-0.2	0.3	0.0	0.3	0.3
	6-3	SDLF	-0.1	0.0	0.1	-0.1	0.1	0.1
		TDLF	0.2	-0.1	0.2	0.2	0.1	0.2
	6-4	SDLF	-0.2	0.2	0.3	-0.2	-0.1	0.2
		TDLF	-0.5	-0.6	0.7	-0.5	0.6	0.8
	6-5	SDLF	0.0	0.1	0.1	0.0	-0.1	0.1
		TDLF	0.1	1.2	1.2	0.2	-1.3	1.3
	6-6	SDLF	0.1	0.3	0.3	0.0	-0.2	0.2
		TDLF	0.2	1.2	1.3	0.2	-1.2	1.3

Table K2-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
10	10-2	SDLF	-0.1	0.3	0.3	-0.1	-0.4	0.4
		TDLF	0.0	-0.1	0.1	0.0	-0.1	0.1
	10-3	SDLF	0.0	-0.1	0.1	0.0	0.3	0.3
		TDLF	0.0	0.0	0.0	0.0	0.3	0.3

Table K2-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
12	12-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.2	-0.4	0.4	0.2	0.3	0.3
	12-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	0.1	0.1	0.0	-0.3	0.3

Table K2-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
17	17-1	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.4	-0.4	1.5	1.5	-0.1	1.5
	17-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.1	-0.1	1.1	1.0	0.1	1.0
	17-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	0.0	0.1	-0.1	0.2	0.2
	17-4	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-2.7	-0.4	2.7	-2.7	0.0	2.7

Table K2-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
20	20-1	SDLF	0.0	0.0	0.1	0.0	0.0	0.1
		TDLF	0.6	7.4	7.4	0.6	-7.6	7.7
	20-2	SDLF	0.0	-0.1	0.2	0.0	0.1	0.1
		TDLF	1.0	-2.4	2.6	1.0	2.4	2.6
	20-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.5	1.1	1.8	1.5	-1.2	1.9
	20-4	SDLF	0.0	0.1	0.1	0.0	-0.1	0.1
		TDLF	-1.0	-5.1	5.2	-1.1	5.2	5.3

Table K2-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
22	**22-1**	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	5.8	5.8	0.1	-6.0	6.0
	22-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.7	0.3	1.7	1.7	-0.3	1.7
	22-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.4	-0.1	1.4	1.4	0.0	1.4
	22-4	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	-0.2	0.2	-0.1	0.3	0.4

Table K2-5-2: Erection Critical Sub-Stages

Stage	Detailing Method	Critical Sub-Stage
6	SDLF	6-6
	TDLF	6-6
10	SDLF	10-2
	TDLF	10-3
12	SDLF	12-3
	TDLF	12-3
17	SDLF	17-4
	TDLF	17-4
20	SDLF	20-1
	TDLF	20-1
22	SDLF	22-1
	TDLF	22-1

Table K2-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
6	A	SDLF	0.0	0.0	0.1	NA	NA	NA
		TDLF	0.0	0.1	0.1	NA	NA	NA
	B	SDLF	0.1	0.3	0.3	0.0	-0.2	0.2
		TDLF	0.2	1.2	1.3	0.2	-1.2	1.3
10	A	SDLF	-0.2	0.1	0.3	NA	NA	NA
		TDLF	0.0	0.0	0.0	NA	NA	NA
	B	SDLF	-0.1	0.3	0.3	-0.1	-0.4	0.4
		TDLF	0.0	0.0	0.0	0.0	0.3	0.3
12	A	SDLF	0.0	0.0	0.0	NA	NA	NA
		TDLF	0.0	0.1	0.1	NA	NA	NA
	B	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	0.1	0.1	0.0	-0.3	0.3
17	A	SDLF	-0.1	0.0	0.1	NA	NA	NA
		TDLF	-4.5	-0.3	4.5	NA	NA	NA
	B	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-2.7	-0.4	2.7	-2.7	0.0	2.7
20	A	SDLF	0.1	0.0	0.1	NA	NA	NA
		TDLF	-1.4	0.9	1.7	NA	NA	NA
	B	SDLF	0.0	0.0	0.1	0.0	0.0	0.1
		TDLF	0.6	7.4	7.4	0.6	-7.6	7.7
22	A	SDLF	0.0	0.0	0.0	NA	NA	NA
		TDLF	-1.8	0.9	2.0	NA	NA	NA
	B	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	5.8	5.8	0.1	-6.0	6.0

Table K2-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
6	A	G1	SDLF	19	49
			TDLF	18	49
		G2	SDLF	20	51
			TDLF	21	51
		G3	SDLF	21	50
			TDLF	21	50
		G4	SDLF	21	50
			TDLF	21	50
		G5	SDLF	21	50
			TDLF	21	50
		G6	SDLF	19	48
			TDLF	19	48
	B	G1	SDLF	19	49
			TDLF	18	49
		G2	SDLF	20	51
			TDLF	21	51
		G3	SDLF	21	50
			TDLF	21	50
		G4	SDLF	21	50
			TDLF	21	50
		G5	SDLF	21	50
			TDLF	21	50
		G6	SDLF	19	48
			TDLF	19	48

Table K2-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
10	A	G1	SDLF	15	65	13
			TDLF	15	64	13
		G2	SDLF	17	69	15
			TDLF	17	69	15
		G3	SDLF	17	68	14
			TDLF	17	68	14
		G4	SDLF	17	68	12
			TDLF	18	68	12
		G5	SDLF	19	54	
			TDLF	19	54	
		G6	SDLF	19	47	
			TDLF	19	46	
	B	G1	SDLF	15	65	13
			TDLF	15	64	13
		G2	SDLF	17	69	15
			TDLF	17	69	15
		G3	SDLF	17	69	14
			TDLF	17	68	15
		G4	SDLF	17	68	12
			TDLF	18	68	13
		G5	SDLF	19	54	
			TDLF	19	54	
		G6	SDLF	19	47	
			TDLF	19	46	

Table K2-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
12	A	G1	SDLF	15	65	13
			TDLF	15	64	13
		G2	SDLF	17	69	15
			TDLF	17	69	15
		G3	SDLF	17	69	15
			TDLF	17	68	15
		G4	SDLF	17	69	15
			TDLF	17	68	15
		G5	SDLF	17	69	14
			TDLF	17	70	15
		G6	SDLF	15	65	13
			TDLF	15	64	12
	B	G1	SDLF	15	65	13
			TDLF	15	64	13
		G2	SDLF	17	69	15
			TDLF	17	69	15
		G3	SDLF	17	69	15
			TDLF	17	68	15
		G4	SDLF	17	69	15
			TDLF	17	68	15
		G5	SDLF	17	69	15
			TDLF	17	70	15
		G6	SDLF	15	65	13
			TDLF	15	64	13

Table K2-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
17	A	G1	SDLF	15	65	13
			TDLF	12	63	14
		G2	SDLF	17	70	15
			TDLF	19	69	15
		G3	SDLF	17	69	15
			TDLF	20	71	14
		G4	SDLF	17	69	15
			TDLF	19	71	14
		G5	SDLF	17	69	15
			TDLF	19	68	15
		G6	SDLF	15	65	13
			TDLF	10	67	13
	B	G1	SDLF	15	65	13
			TDLF	12	63	14
		G2	SDLF	17	70	15
			TDLF	19	69	15
		G3	SDLF	17	69	15
			TDLF	20	71	14
		G4	SDLF	17	69	15
			TDLF	19	71	14
		G5	SDLF	17	69	15
			TDLF	19	67	15
		G6	SDLF	15	65	13
			TDLF	10	68	12

Table K2-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
20	A	G1	SDLF	15	66	14
			TDLF	12	65	12
		G2	SDLF	17	70	15
			TDLF	19	68	16
		G3	SDLF	17	70	15
			TDLF	20	71	16
		G4	SDLF	17	70	15
			TDLF	19	72	13
		G5	SDLF	17	69	15
			TDLF	19	66	15
		G6	SDLF	16	65	13
			TDLF	10	68	12
	B	G1	SDLF	15	66	14
			TDLF	12	65	12
		G2	SDLF	17	70	15
			TDLF	19	68	16
		G3	SDLF	17	70	15
			TDLF	20	72	16
		G4	SDLF	17	70	15
			TDLF	19	70	13
		G5	SDLF	17	69	15
			TDLF	19	67	14
		G6	SDLF	16	65	13
			TDLF	11	68	12

Table K2-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
22	A	G1	SDLF	15	66	13
			TDLF	12	65	10
		G2	SDLF	17	70	15
			TDLF	19	67	17
		G3	SDLF	17	70	15
			TDLF	20	74	17
		G4	SDLF	17	70	15
			TDLF	19	74	15
		G5	SDLF	17	70	15
			TDLF	19	65	17
		G6	SDLF	15	65	13
			TDLF	11	67	10
	B	G1	SDLF	15	66	13
			TDLF	12	65	10
		G2	SDLF	17	70	15
			TDLF	19	67	17
		G3	SDLF	17	70	15
			TDLF	20	74	17
		G4	SDLF	17	70	15
			TDLF	19	74	15
		G5	SDLF	17	70	15
			TDLF	19	64	17
		G6	SDLF	15	65	13
			TDLF	11	68	10

Appendix K3-1. EICSS12 Bridge Description

The key characteristics of EICSS12 are as follows:

- Span length along the centerline of the bridge, L_s 150,139 ft.
- Width between the fascia girders, w_g = 41ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 3.7,3.4
- Number of girders in the completed bridge cross-section, n_g = 6.
- Parallel skew
- Skew angle, θ = 59.6,59.6,59.6^o
- Skew index, I_s = 0.46,0.51

This appendix presents the bridge description of the bridge EICSS12 in its final condition as well as during erection. The following figures and tables are provided:

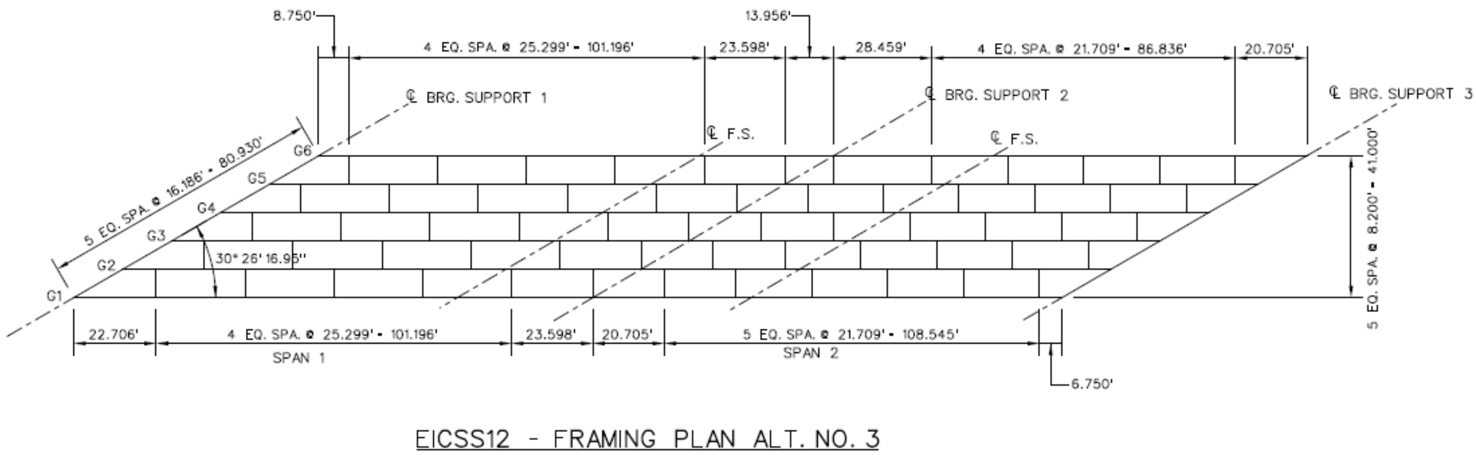


Figure K3-1-1. Framing plan.

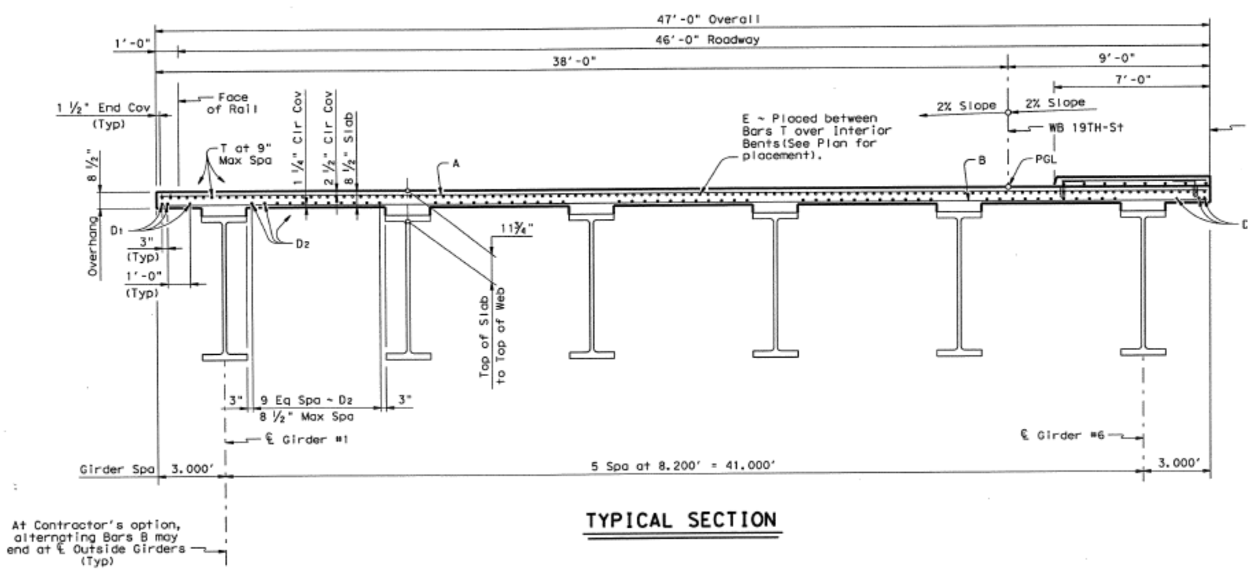


Figure K3-1-2. Bridge cross-section.

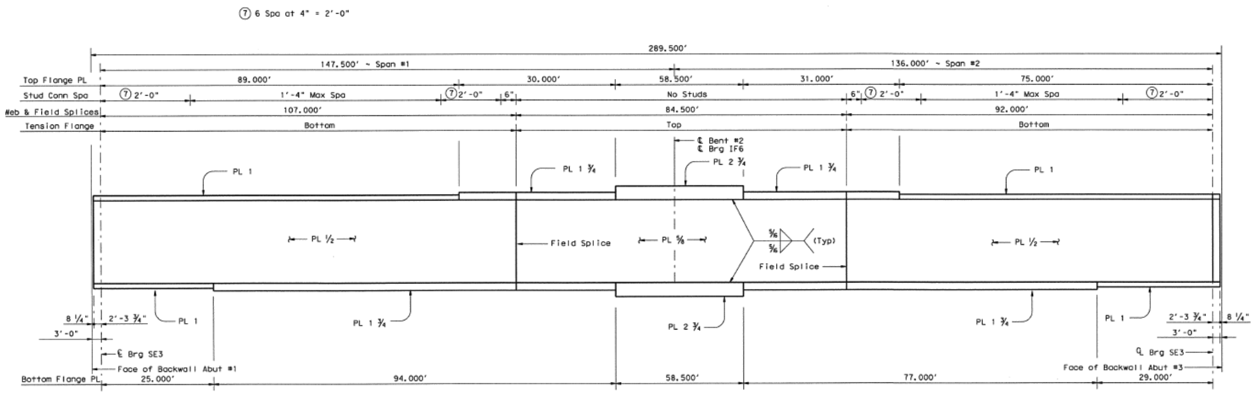


Figure K3-1-3. Girder elevations

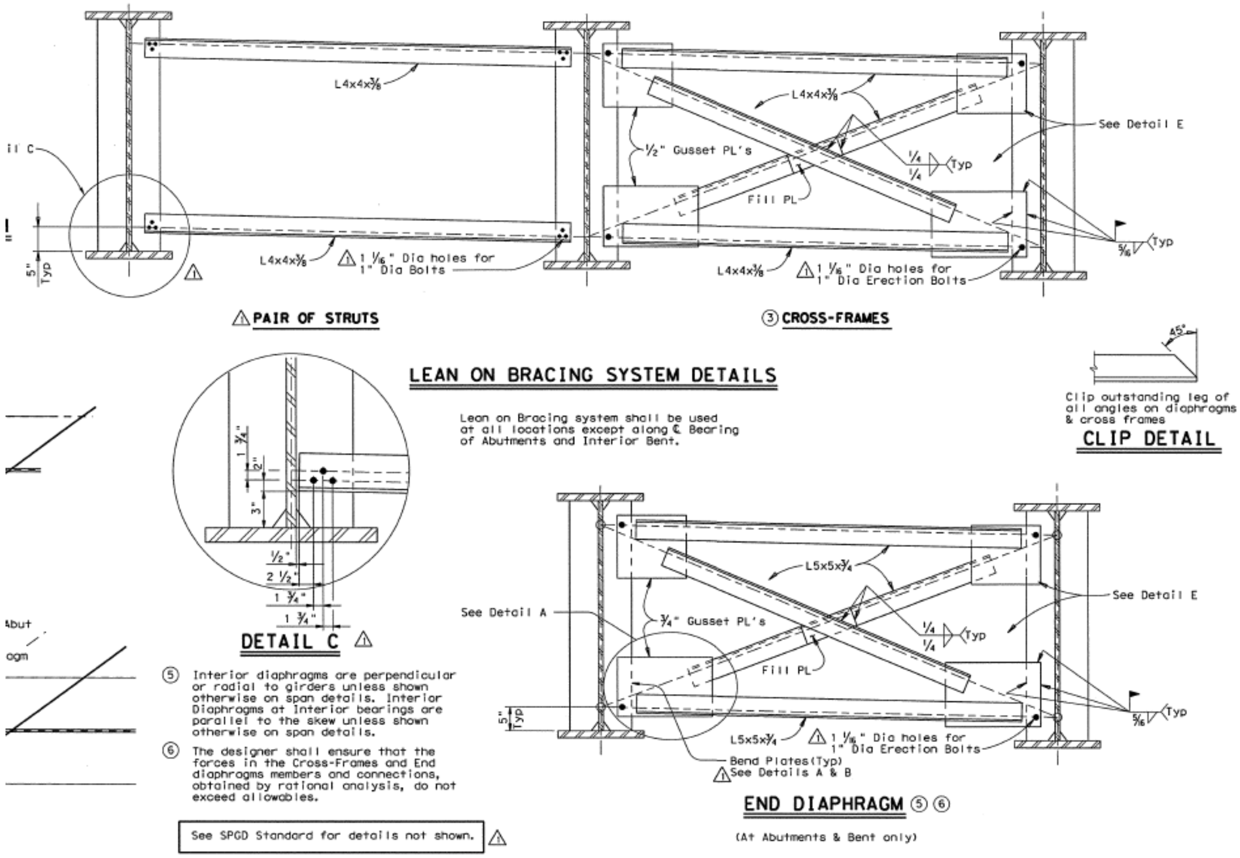


Figure K3-1-5. Cross-frame details.

THE ERECTION FROM STAGE 1 TO STAGE 5
IS SIMILAR TO STAGE 6

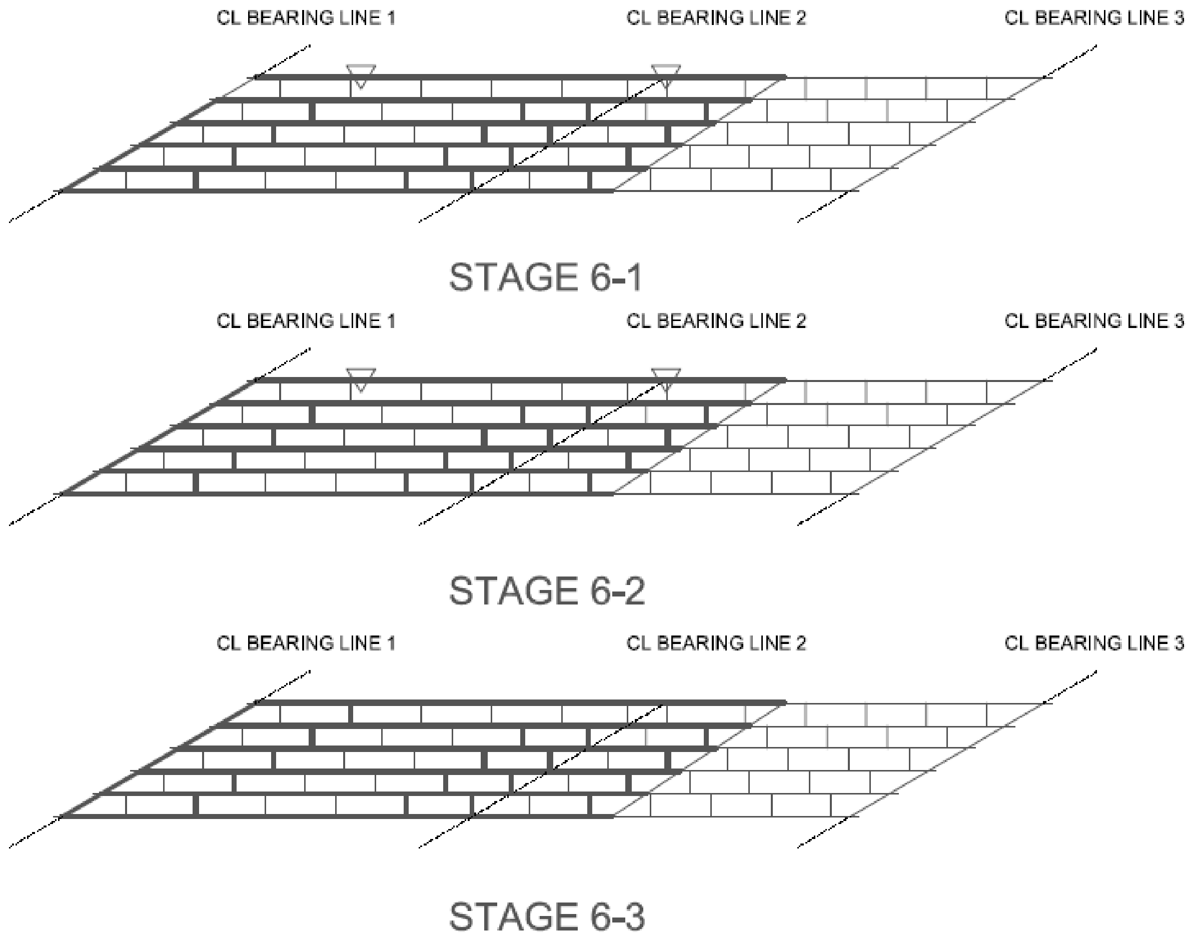
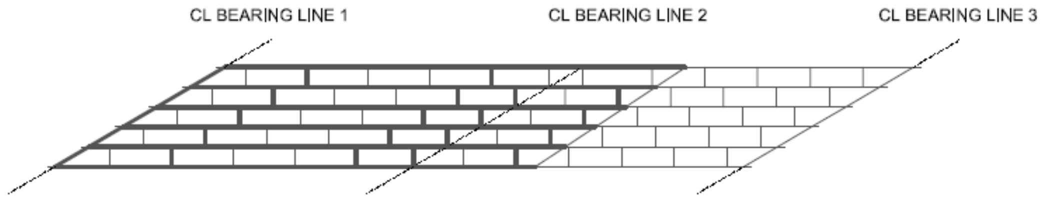
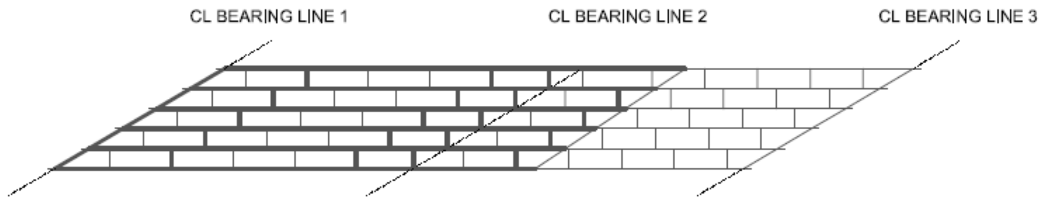


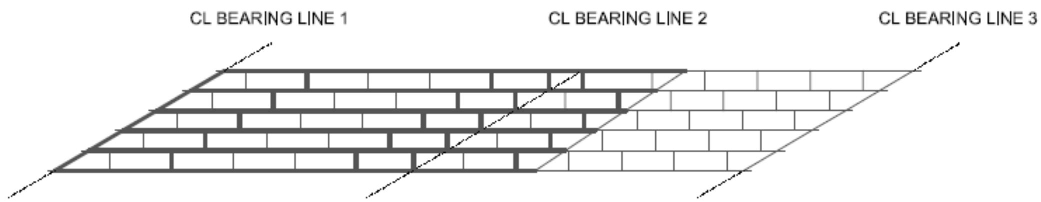
Figure K3-1-6. Erection scheme.



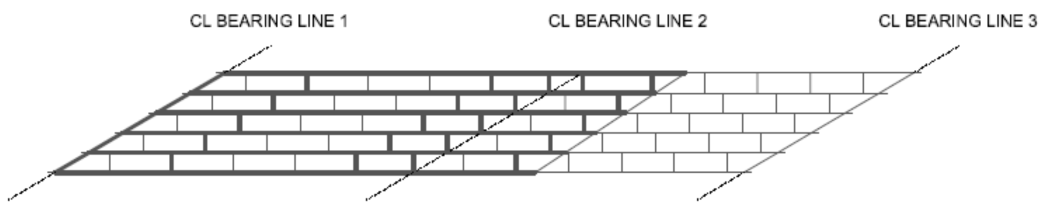
STAGE 6-4



STAGE 6-5



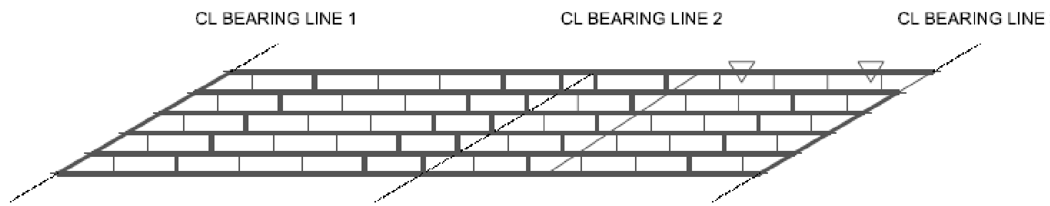
STAGE 6-6



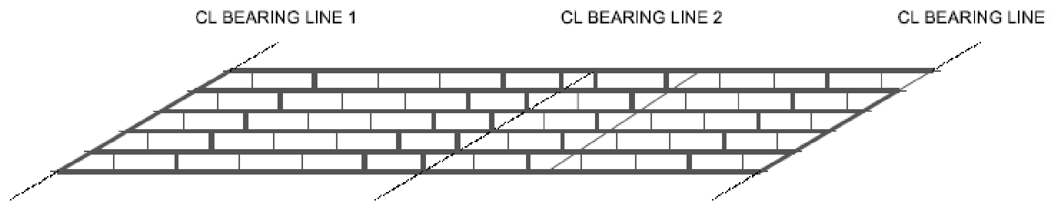
STAGE 6-7

Figure K3-1-6(Continued). Erection scheme.

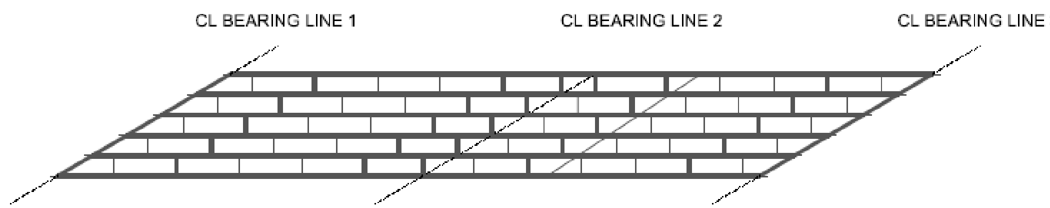
THE ERECTION FROM STAGE 7 TO STAGE 11
IS SIMILAR TO STAGE 12



STAGE 12-1



STAGE 12-2



STAGE 12-3

STAGE 13 TO 22: INSTALL THE REMAINING XFs
GIRDER BY GIRDER, SPAN BY SPAN.

Figure K3-1-6(Continued). Erection scheme.

Table K3-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

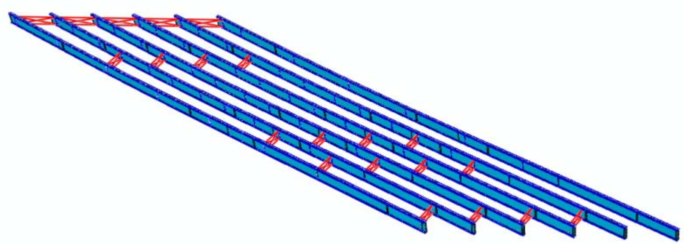
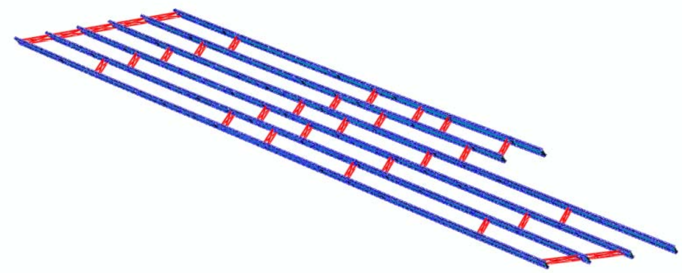
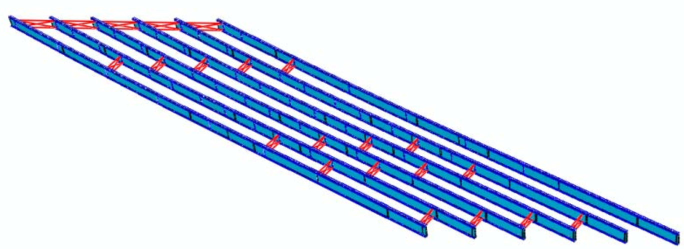
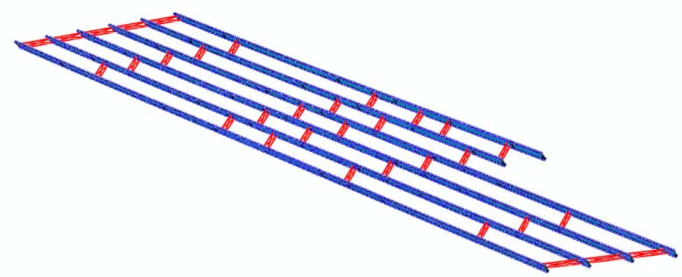
Sub-Stage	Stage	
	6	10
1		
2		

Table K3-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

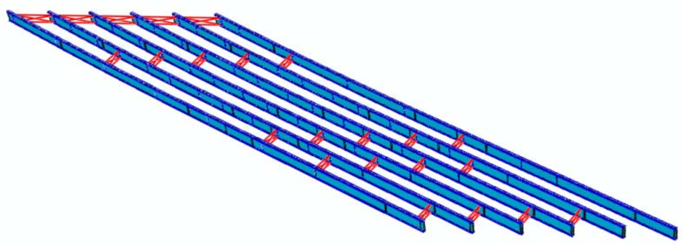
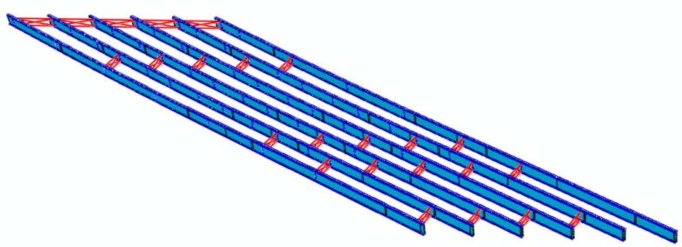
Sub-Stage	Stage	
	6	10
3		
4		

Table K3-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

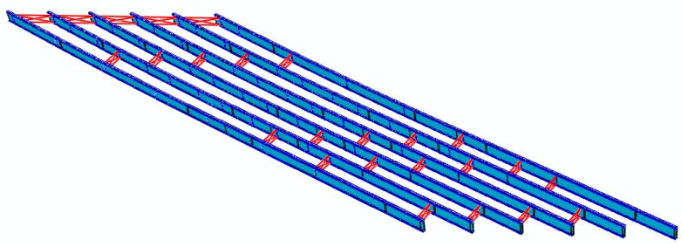
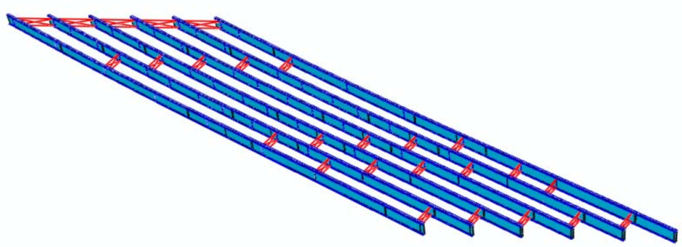
Sub-Stage	Stage	
	6	10
5		
6		

Table K3-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

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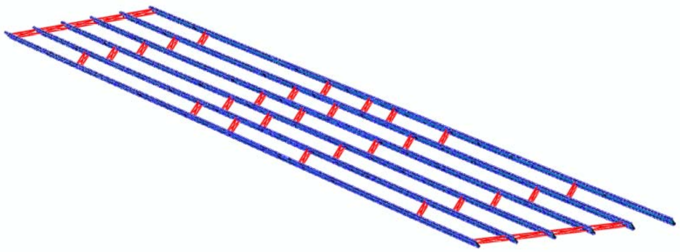
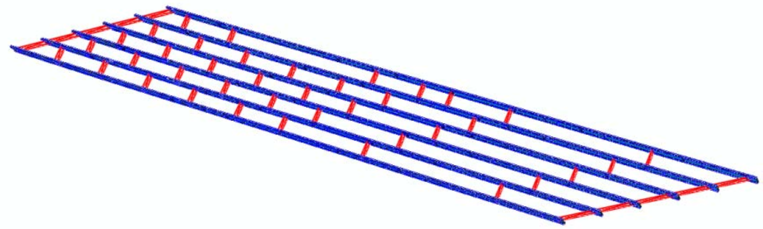
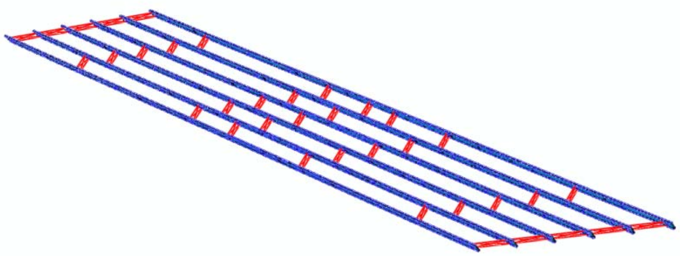
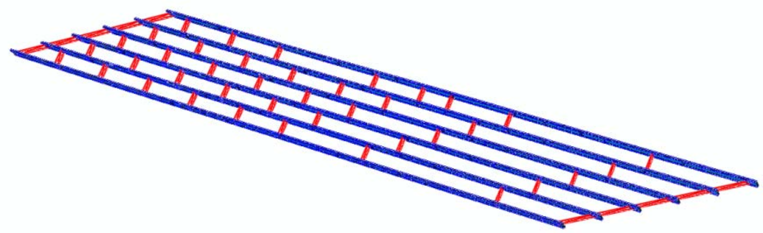
<tr><td>1</td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td></tr>
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Table K3-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

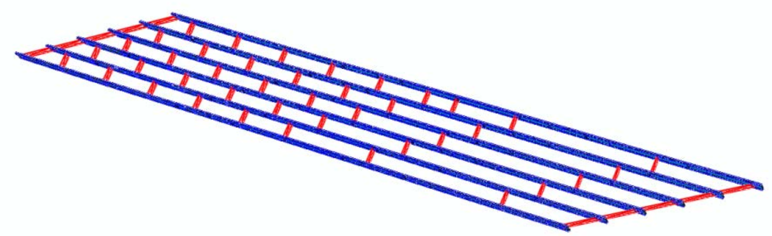
Sub-Stage	Stage	
	12	17
3		

Table K3-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

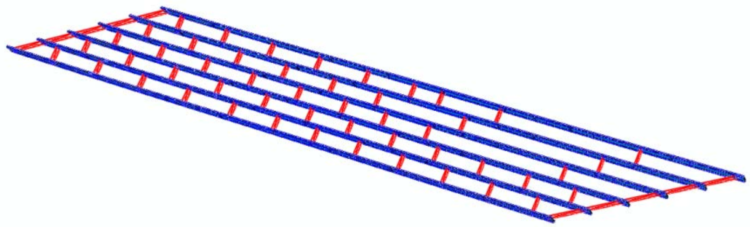
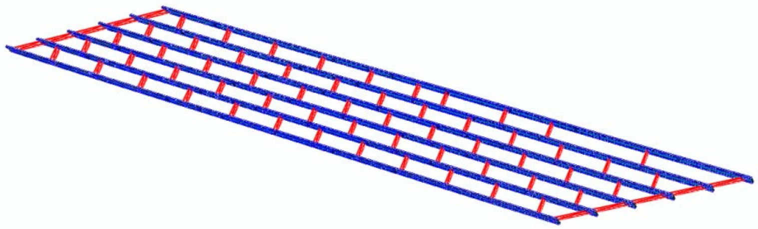
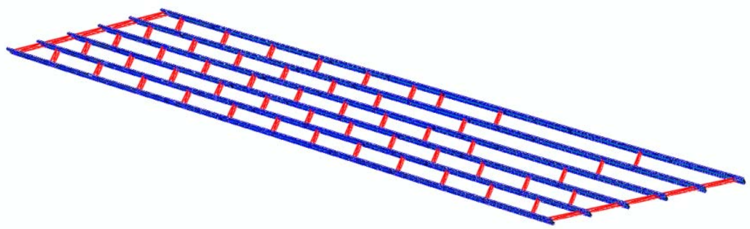
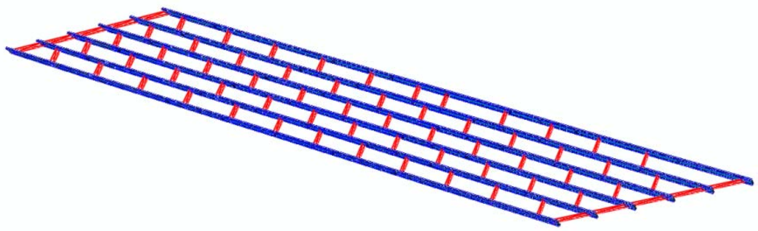
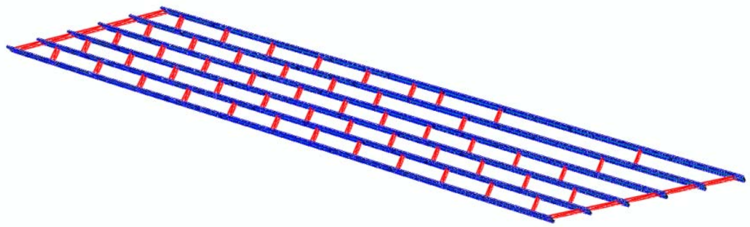
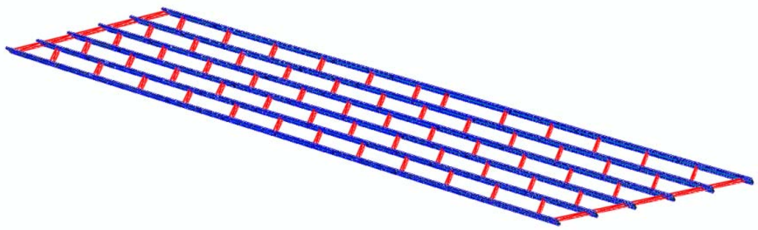
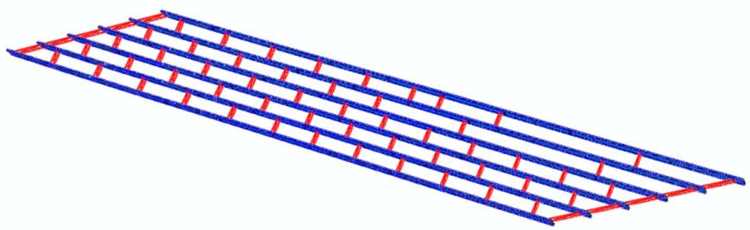
Sub-Stage	Stage	
	20	22
1		
2		

Table K3-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

Sub-Stage	Stage	
	20	22
3		
4		

Appendix K3-2. EICSS12 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EICSS12 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table K3-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.0	4.5
	SDLF	0.9	4.4
	TDLF	0.7	3.9
G2	NLF	1.0	4.1
	SDLF	1.0	4.1
	TDLF	1.0	4.1
G3	NLF	0.9	3.9
	SDLF	1.0	3.9
	TDLF	1.1	4.0
G4	NLF	0.9	3.8
	SDLF	1.0	3.8
	TDLF	1.2	4.0
G5	NLF	0.9	3.7
	SDLF	1.0	3.8
	TDLF	1.3	4.1
G6	NLF	0.9	3.8
	SDLF	0.9	3.9
	TDLF	1.0	3.9
All Girders	NLF	1.0	4.5
	SDLF	1.0	4.4
	TDLF	1.3	4.1

Table K3-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.2	1.0
	SDLF	0.0	0.8
	TDLF	0.7	0.1
G2	NLF	0.2	0.9
	SDLF	0.0	0.7
	TDLF	0.7	0.1
G3	NLF	0.2	0.8
	SDLF	0.0	0.6
	TDLF	0.6	0.0
G4	NLF	0.2	0.8
	SDLF	0.0	0.6
	TDLF	0.6	0.0
G5	NLF	0.2	0.8
	SDLF	0.0	0.6
	TDLF	0.6	0.1
G6	NLF	0.2	0.9
	SDLF	0.0	0.7
	TDLF	0.7	0.1
All Girders	NLF	0.2	1.0
	SDLF	0.0	0.8
	TDLF	0.7	0.1

Table K3-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	3.8	15.1	3.9	17.1	0.2	1.2	0.2	1.6
	SDLF	3.7	15.1	3.5	16.7	0.0	1.2	0.0	1.4
	TDLF	3.4	14.8	3.2	15.3	0.5	1.4	0.6	1.7
G2	NLF	3.8	14.7	3.7	15.5	0.9	3.7	1.0	3.6
	SDLF	3.9	14.8	3.8	15.6	0.0	2.8	0.0	2.5
	TDLF	4.3	15.2	4.2	16.0	2.6	1.1	3.3	1.7
G3	NLF	3.7	14.3	3.6	15.1	1.0	4.1	1.5	6.3
	SDLF	3.9	14.5	3.8	15.2	0.0	3.0	0.0	4.7
	TDLF	4.5	15.1	4.4	15.8	3.3	0.5	5.0	0.7
G4	NLF	3.7	14.3	3.6	14.8	1.0	4.2	1.5	6.6
	SDLF	3.9	14.5	3.8	15.0	0.0	3.1	0.0	5.0
	TDLF	4.5	15.1	4.5	15.8	3.1	0.5	5.0	0.6
G5	NLF	3.7	14.6	3.7	14.6	1.0	4.0	1.0	4.0
	SDLF	3.9	14.8	3.8	14.9	0.0	3.0	0.0	2.9
	TDLF	4.3	15.1	4.7	15.8	2.8	1.1	3.4	1.5
G6	NLF	3.7	15.0	3.7	15.7	0.2	1.3	0.3	1.8
	SDLF	3.6	14.9	3.6	15.6	0.0	1.2	0.0	1.6
	TDLF	3.3	14.6	3.4	15.3	0.6	1.2	0.7	1.6
All Girders	NLF	3.8	15.1	3.9	17.1	1.0	4.2	1.5	6.6
	SDLF	3.9	15.1	3.8	16.7	0.0	3.1	0.0	5.0
	TDLF	4.5	15.2	4.7	16.0	3.3	1.4	5.0	1.7

Table K3-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	3.9	4.9	5.0	5.0
	SDLF	0.1	0.1	0.1	0.1
	TDLF	11.4	14.9	15.2	15.2
TDL	NLF	14.3	20.2	20.5	20.5
	SDLF	10.3	15.2	15.4	15.4
	TDLF	2.3	3.5	3.5	3.5

Table K3-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	0.7	1.4	1.4	1.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	2.2	4.3	4.3	3.2
TDL	NLF	3.1	5.4	5.3	4.2
	SDLF	2.4	4.1	4.0	3.2
	TDLF	0.7	1.5	1.5	1.1

Table K3-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.36	0.33	0.31	0.31	0.29	0.36
SDLF	0.29	0.32	0.32	0.32	0.33	0.33
TDLF	0.55	0.33	0.35	0.38	0.49	0.55

Table K3-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	1.60	1.40	1.33	1.30	1.21	1.60
SDLF	1.53	1.40	1.34	1.31	1.25	1.53
TDLF	1.30	1.39	1.37	1.36	1.41	1.41

Table K3-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.16	0.15	0.14	0.14	0.13	0.16
SDLF	0.13	0.15	0.15	0.14	0.15	0.15
TDLF	0.25	0.15	0.16	0.17	0.22	0.25

Table K3-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.72	0.63	0.60	0.58	0.54	0.72
SDLF	0.69	0.63	0.60	0.59	0.56	0.69
TDLF	0.58	0.63	0.61	0.61	0.63	0.63

Table K3-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	590.4	2238.1
SDLF	590.4	2237.9
TDLF	590.4	2238.1

Table K3-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	72.2	259.1	0.0	0.2	0.3	0.2
SDLF	68.8	255.4	0.0	0.1	0.0	0.1
TDLF	72.7	245.2	0.1	0.0	0.7	0.0

Table K3-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.09	0.36	0.03	0.36
SDLF	0.08	0.32	0.00	0.32
TDLF	0.11	0.36	0.07	0.36

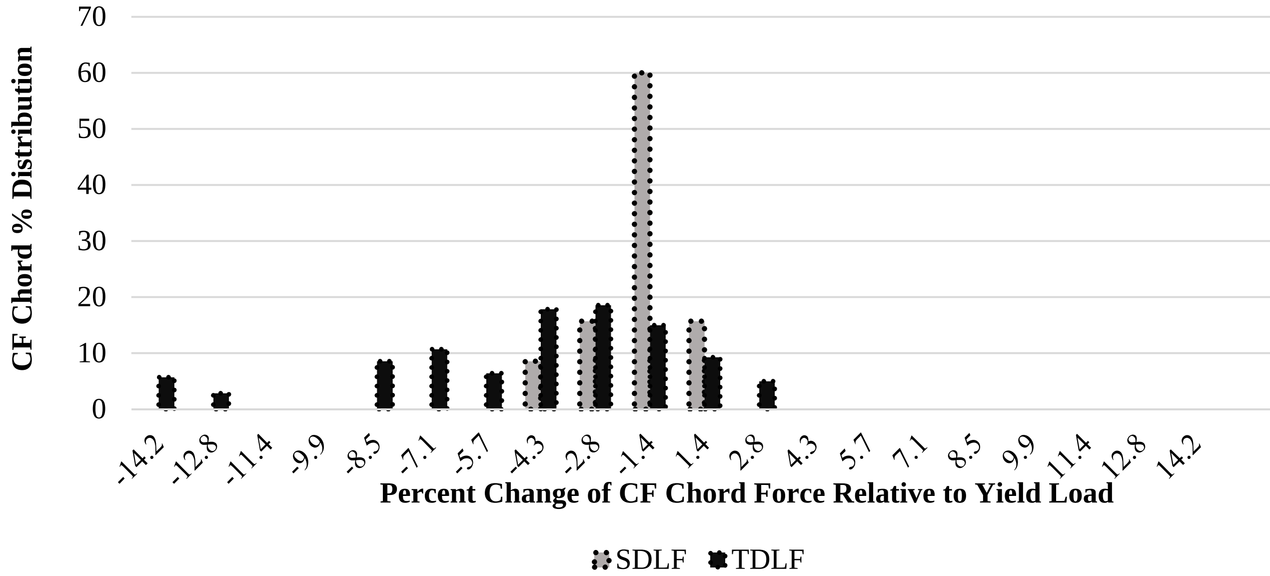


Figure K3-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

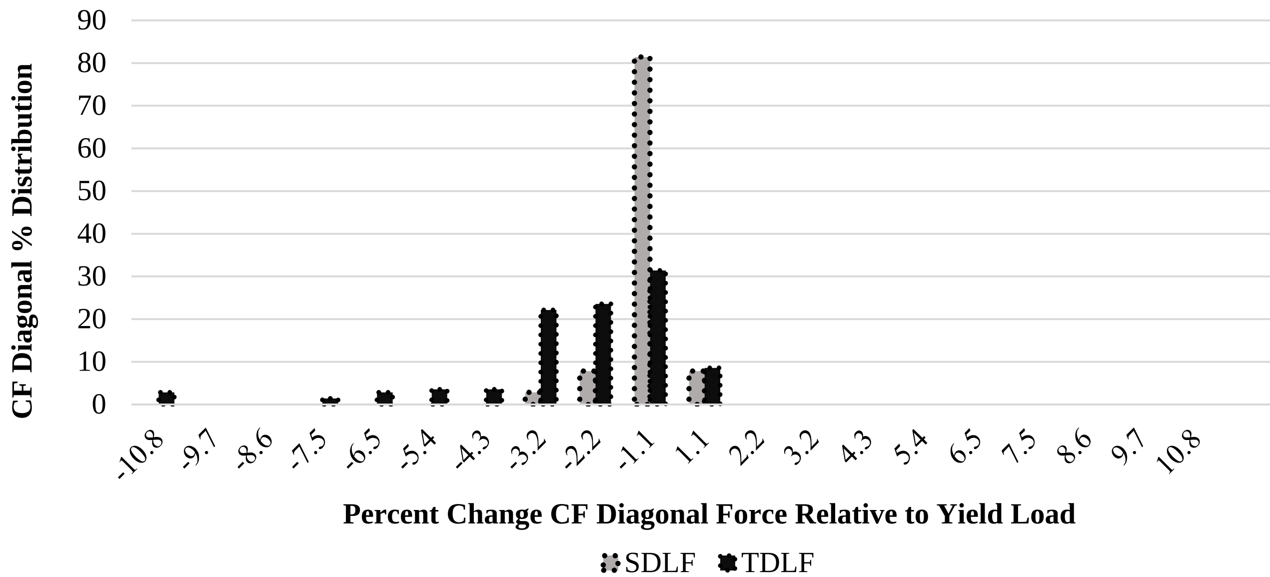


Figure K3-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

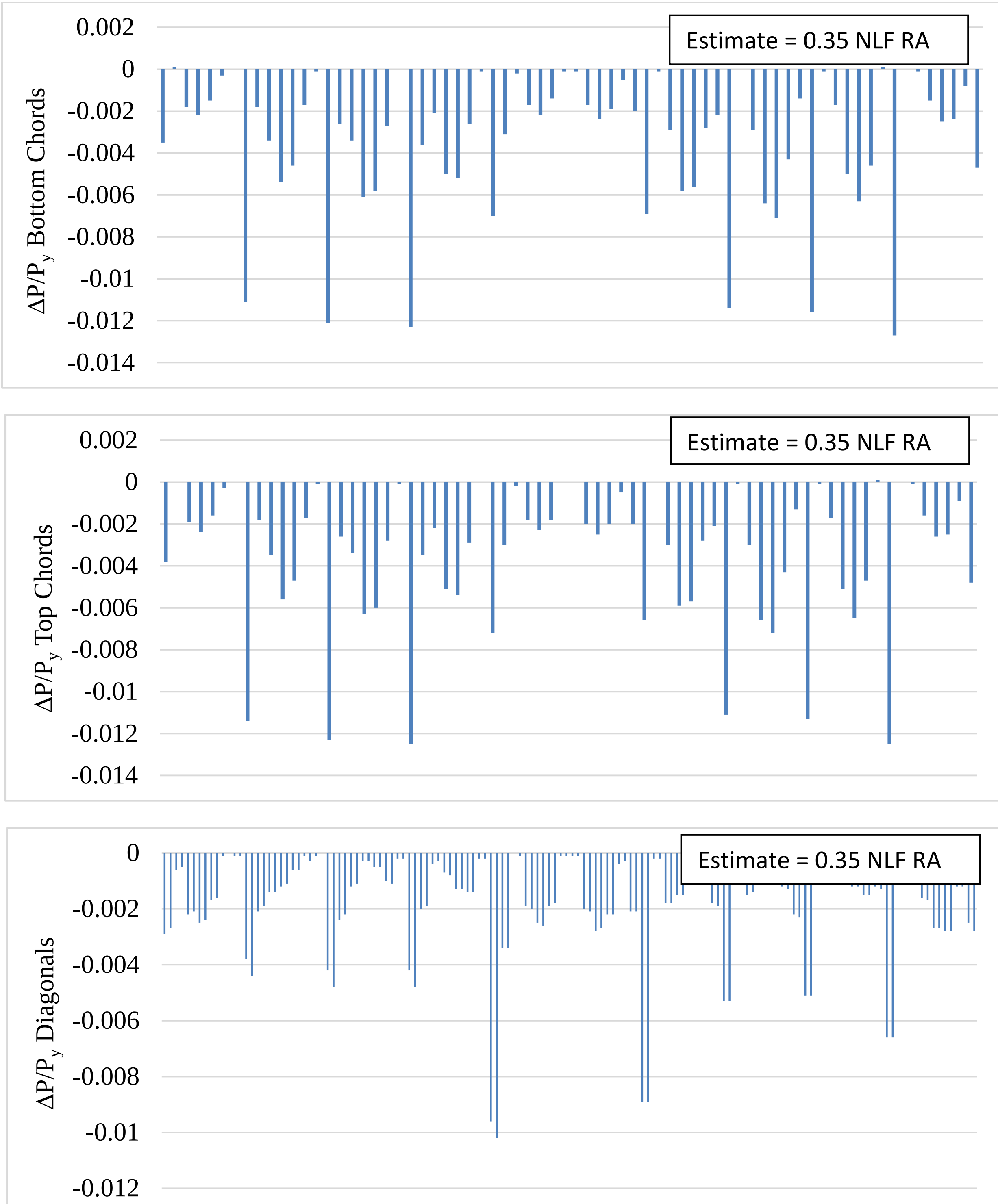
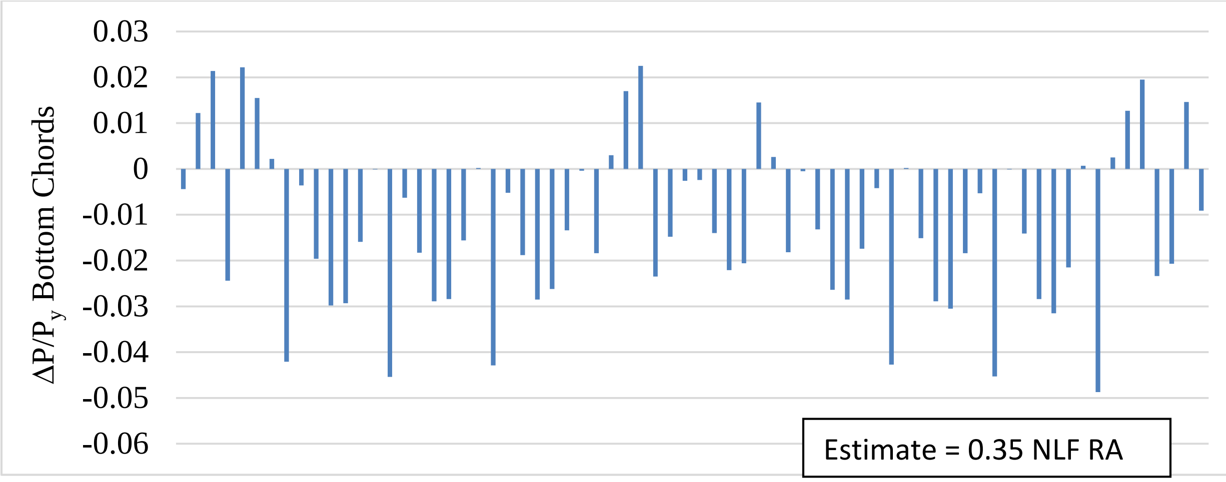
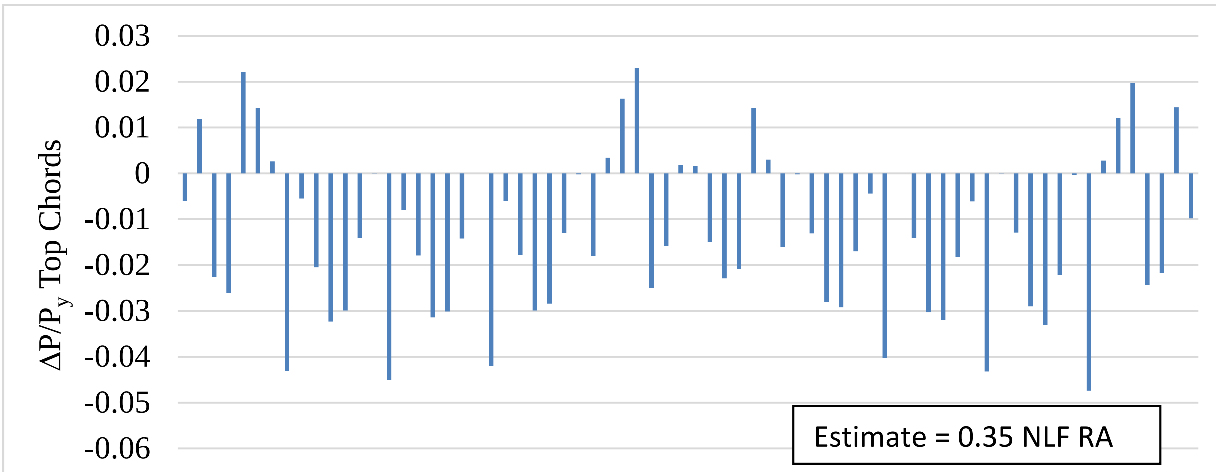


Figure K3-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.





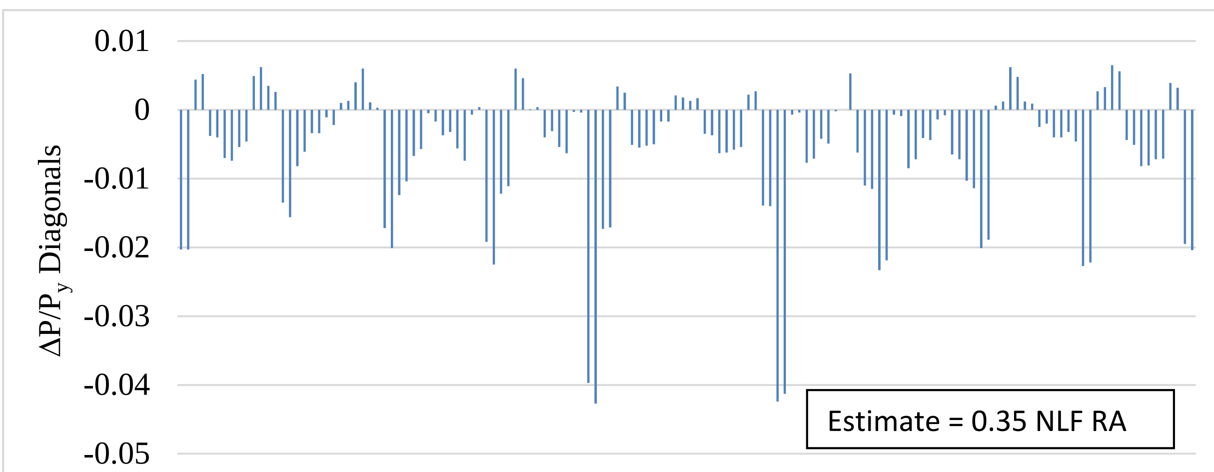


Figure K3-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix K3-3. EICSS12 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EICSS12 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table K3-3-1. Maximums of the fit-up force resultants (kips)

Detailing Method	F1	F2	F_{max}
SDLF	1.2	1.2	1.2
TDLF	3.1	17.0	17.0

Table K3-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	SDLF	65	13
	TDLF	70	10
G2	SDLF	69	15
	TDLF	67	15
G3	SDLF	69	13
	TDLF	71	14
G4	SDLF	71	12
	TDLF	73	12
G5	SDLF	69	14
	TDLF	69	14
G6	SDLF	65	12
	TDLF	72	10
All Girders	SDLF	71	12
	TDLF	73	10

Table K3-3-3. Total Vertical Reactions (kips)

Stage	Detailing Method	Sub-Stage					
		1	2	3	4	5	
6	SDLF	411	411	412	412	412	413
	TDLF	411	411	412	412	412	413
10	SDLF	522	524	NA	NA	NA	NA
	TDLF	522	524	NA	NA	NA	NA
12	SDLF	578	579	NA	NA	NA	NA
	TDLF	578	579	NA	NA	NA	NA
17	SDLF	583	584	584	NA	NA	NA
	TDLF	583	584	584	NA	NA	NA
20	SDLF	587	587	588	588	NA	NA
	TDLF	587	587	588	588	NA	NA
22	SDLF	590	590	590	NA	NA	NA
	TDLF	590	590	590	NA	NA	NA

Appendix K3-4. NISSS14 Detailed Results, Completed Bridge Responses

This appendix presents the SDL and TDL responses of the bridge NISSS14 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

Table K3-4-14. Longitudinal displacements at supports (in).

Table K3-4-15. Transverse displacements at supports (in).

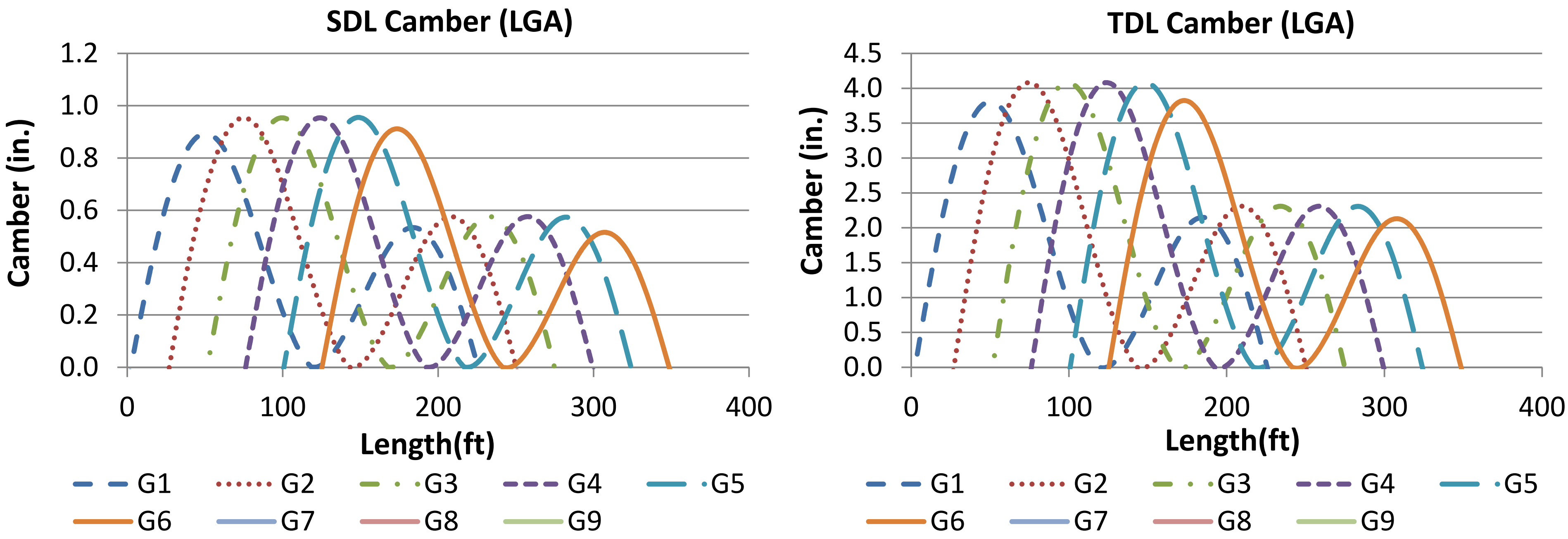


Figure K3-4-1. SDL and TDL Line Girder Analysis cambers.

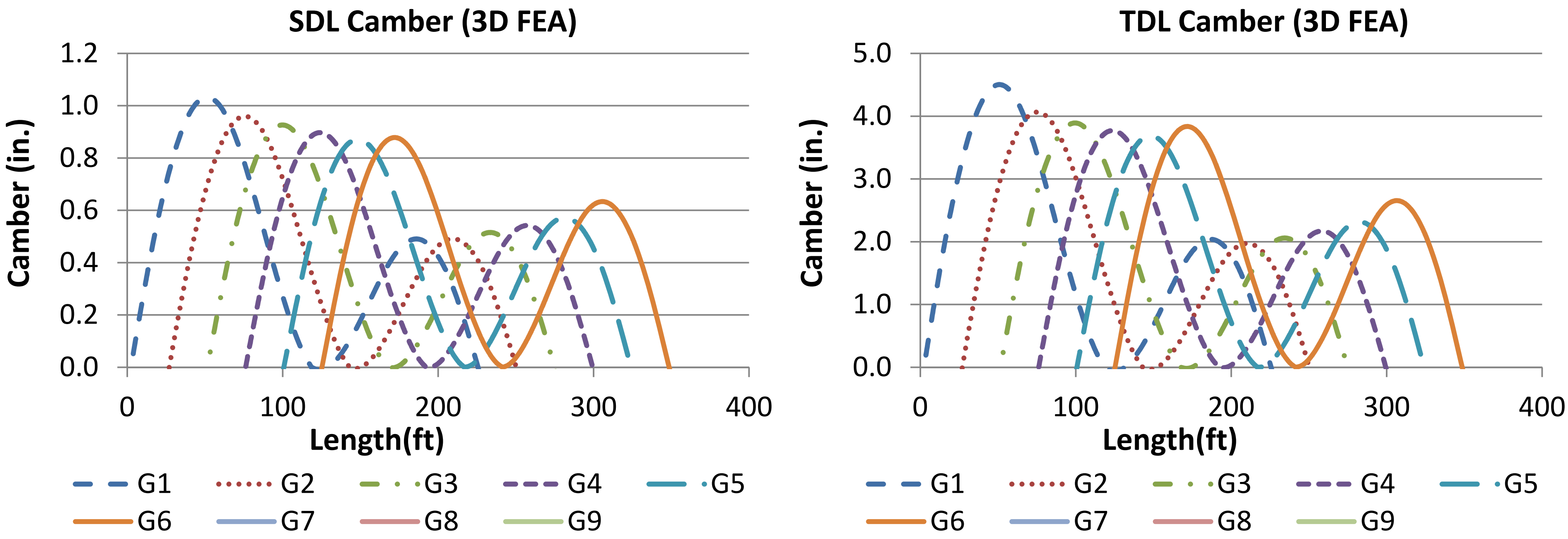


Figure K3-4-2. SDL and TDL 3D FEA cambers.

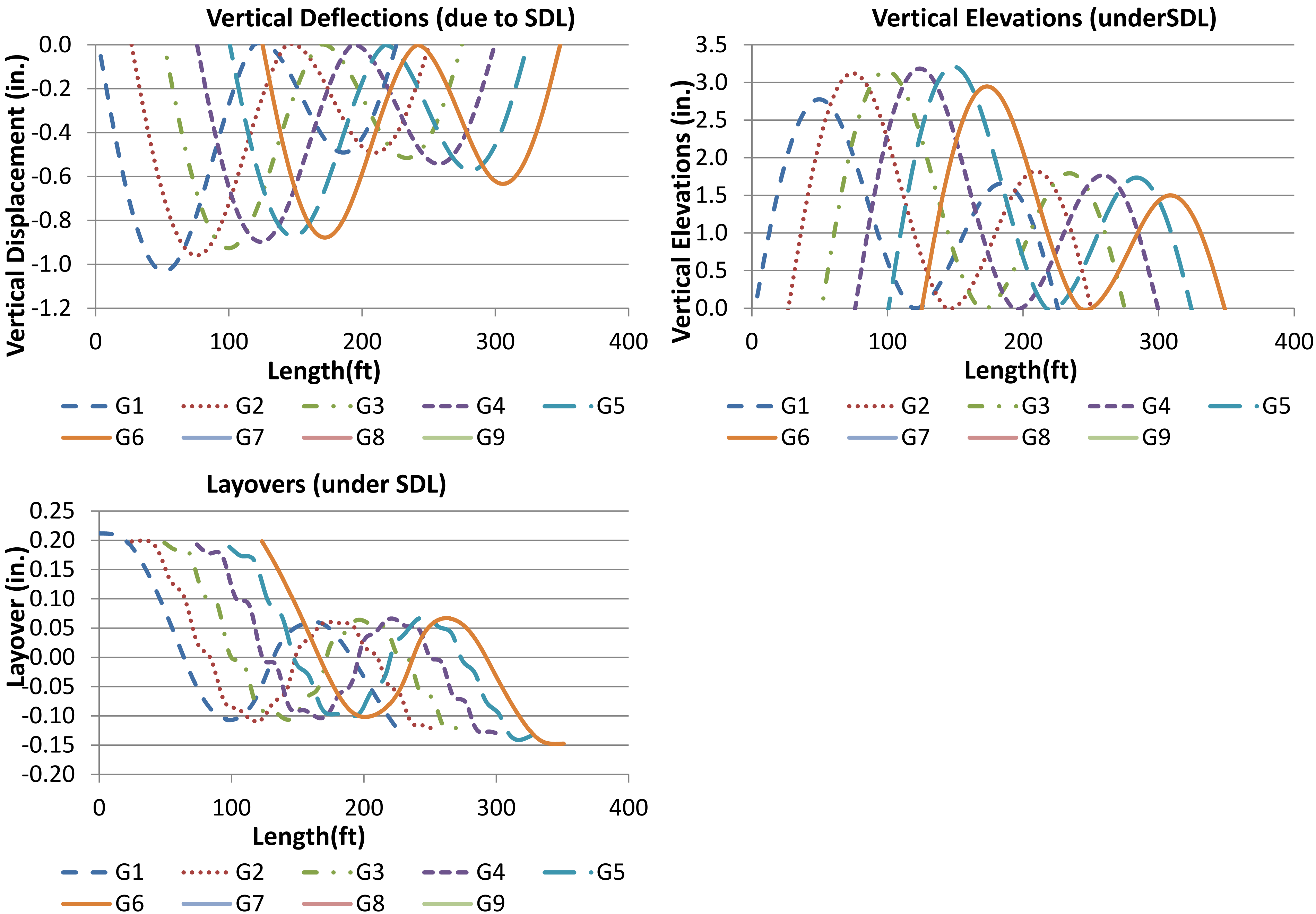


Figure K3-4-3. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

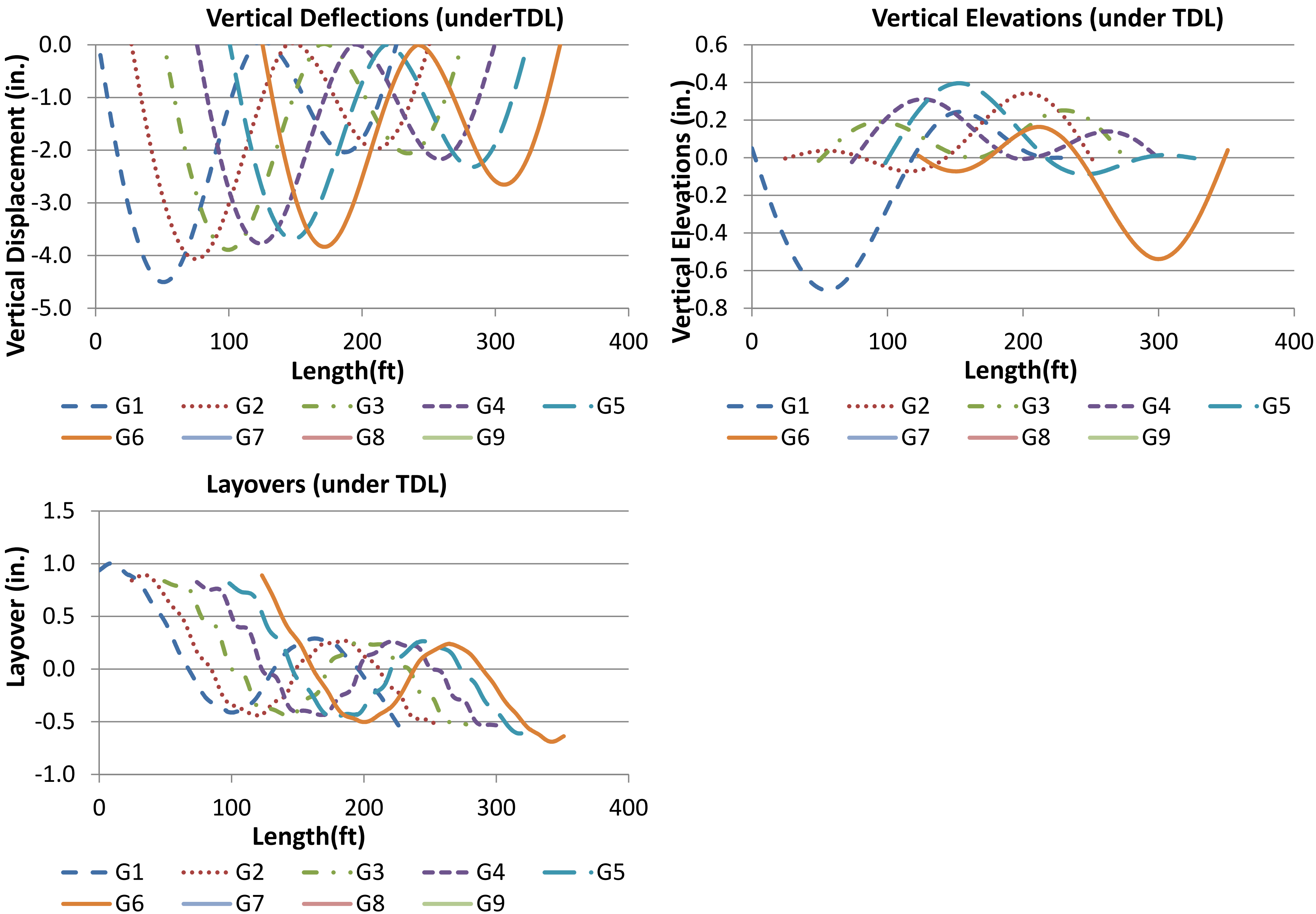


Figure K3-4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

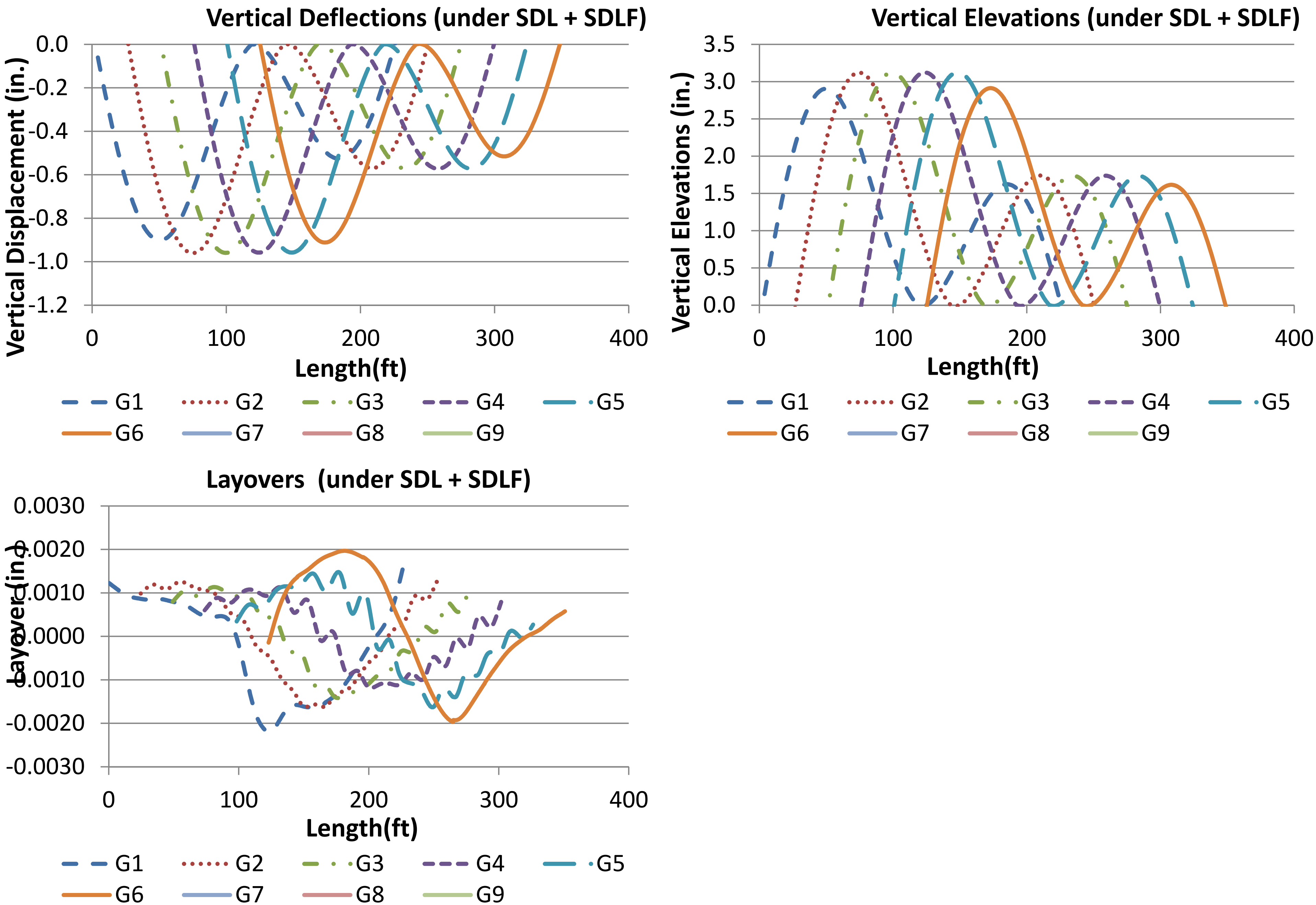


Figure K3-4-5. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

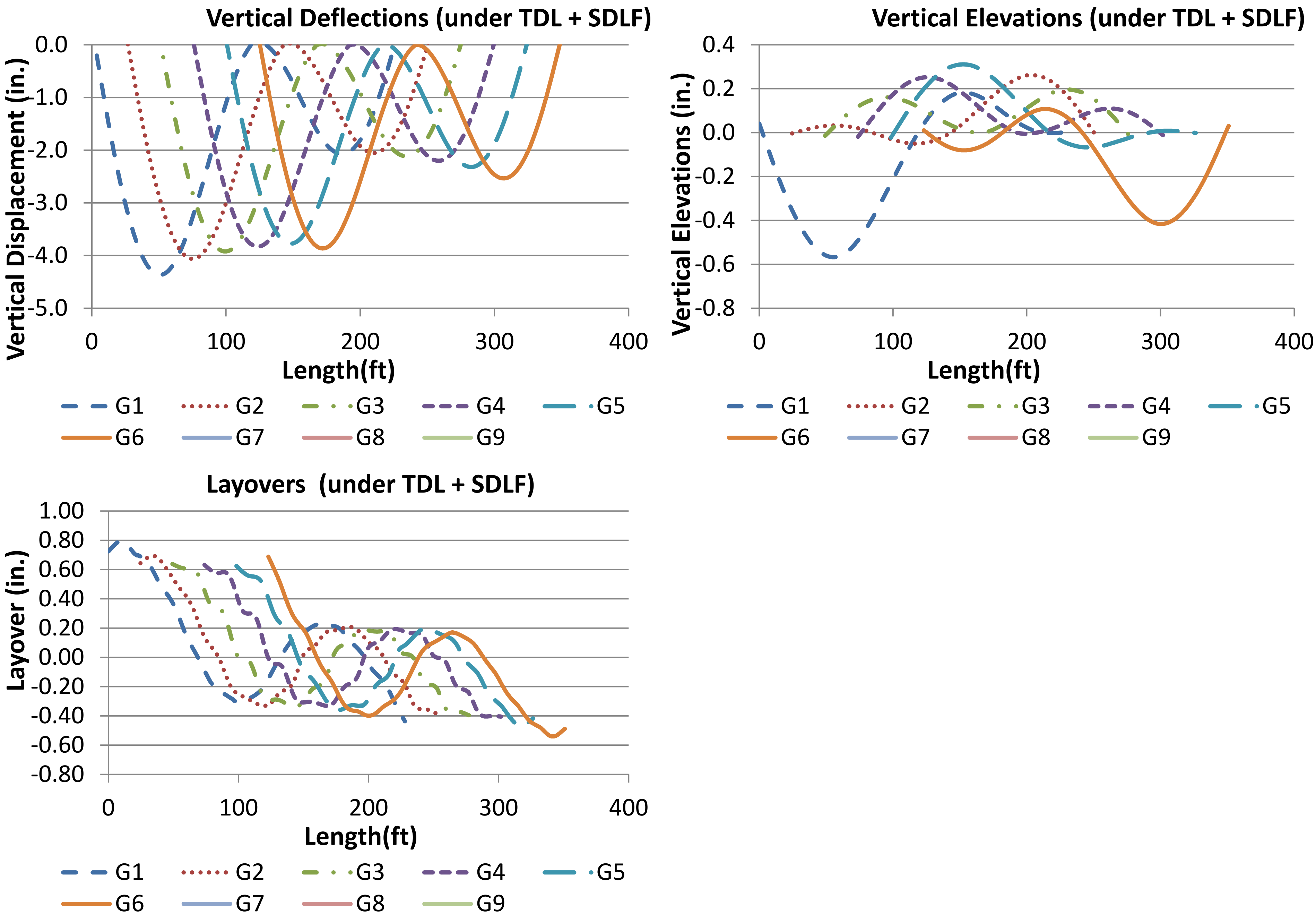


Figure K3-4-6. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

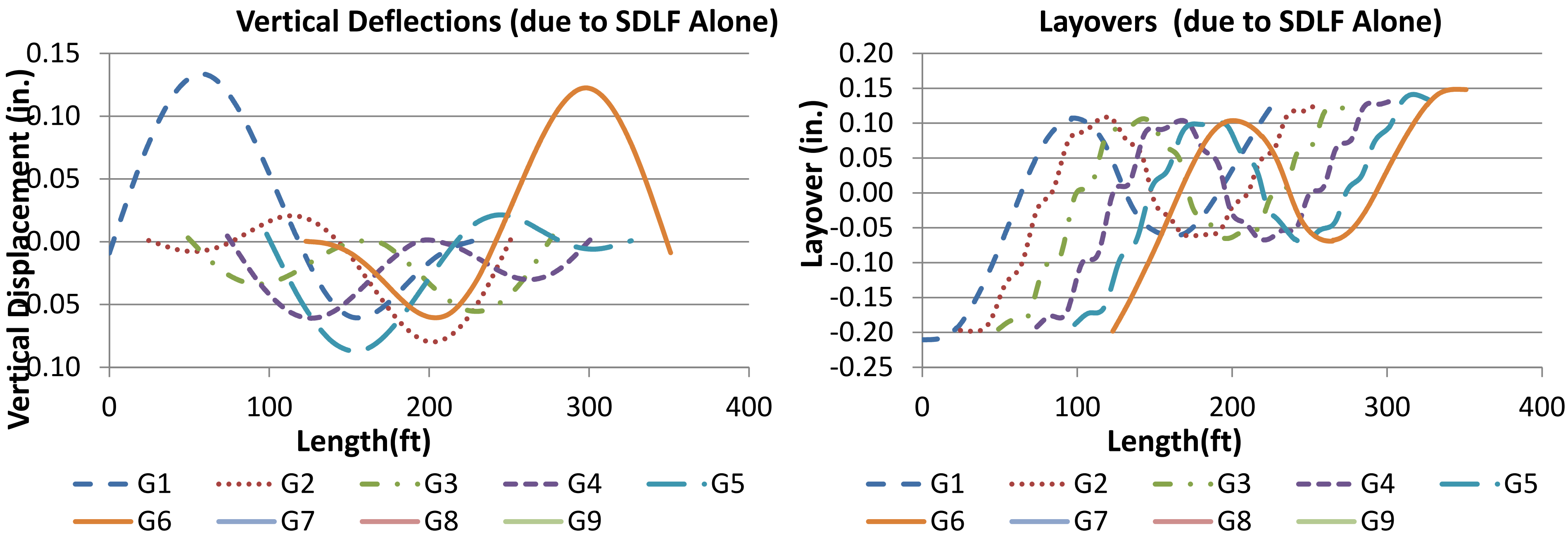


Figure K3-4-7. Bridge displacements due to SDLF detailing effects alone under NL(in).

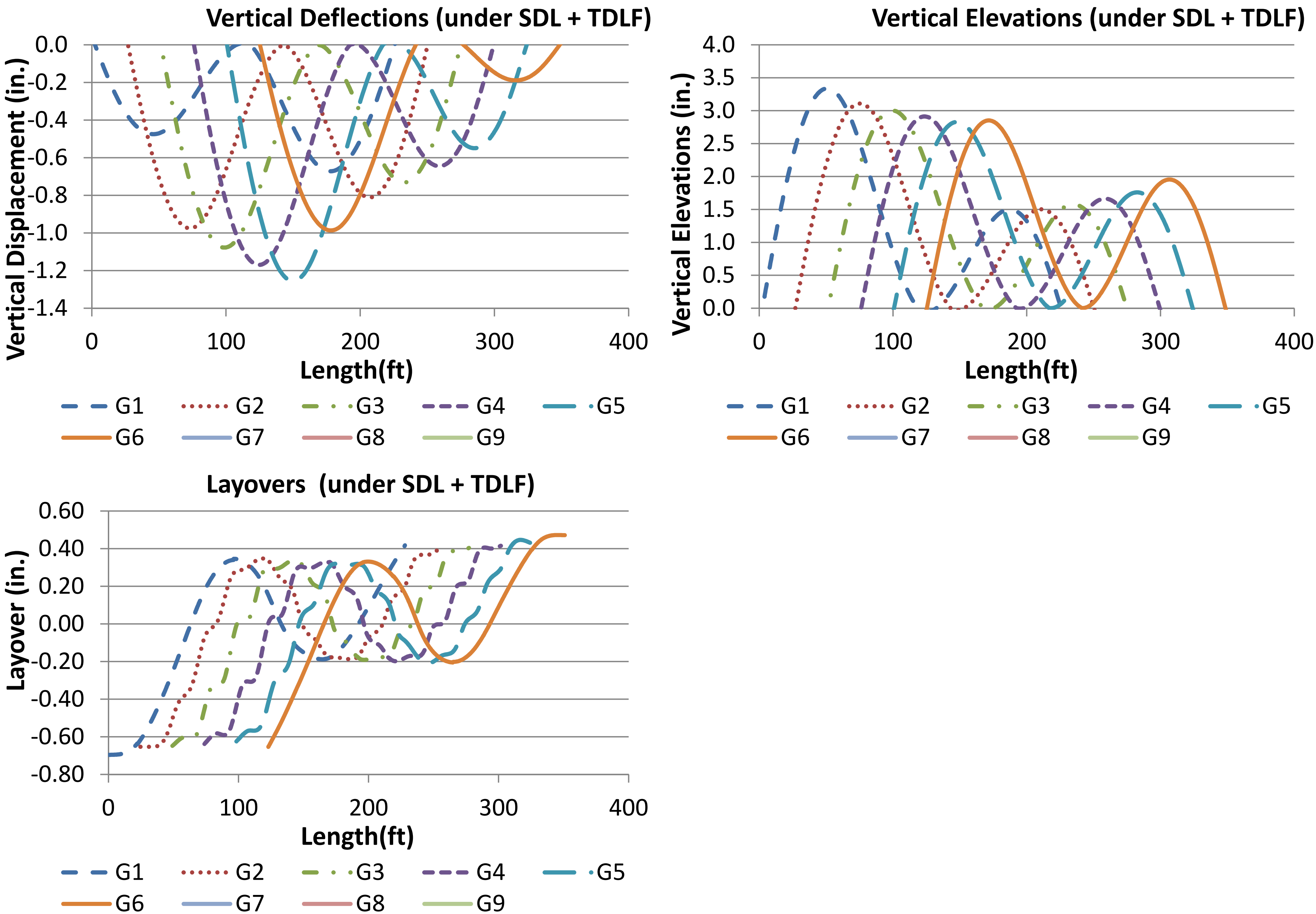


Figure K3-4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

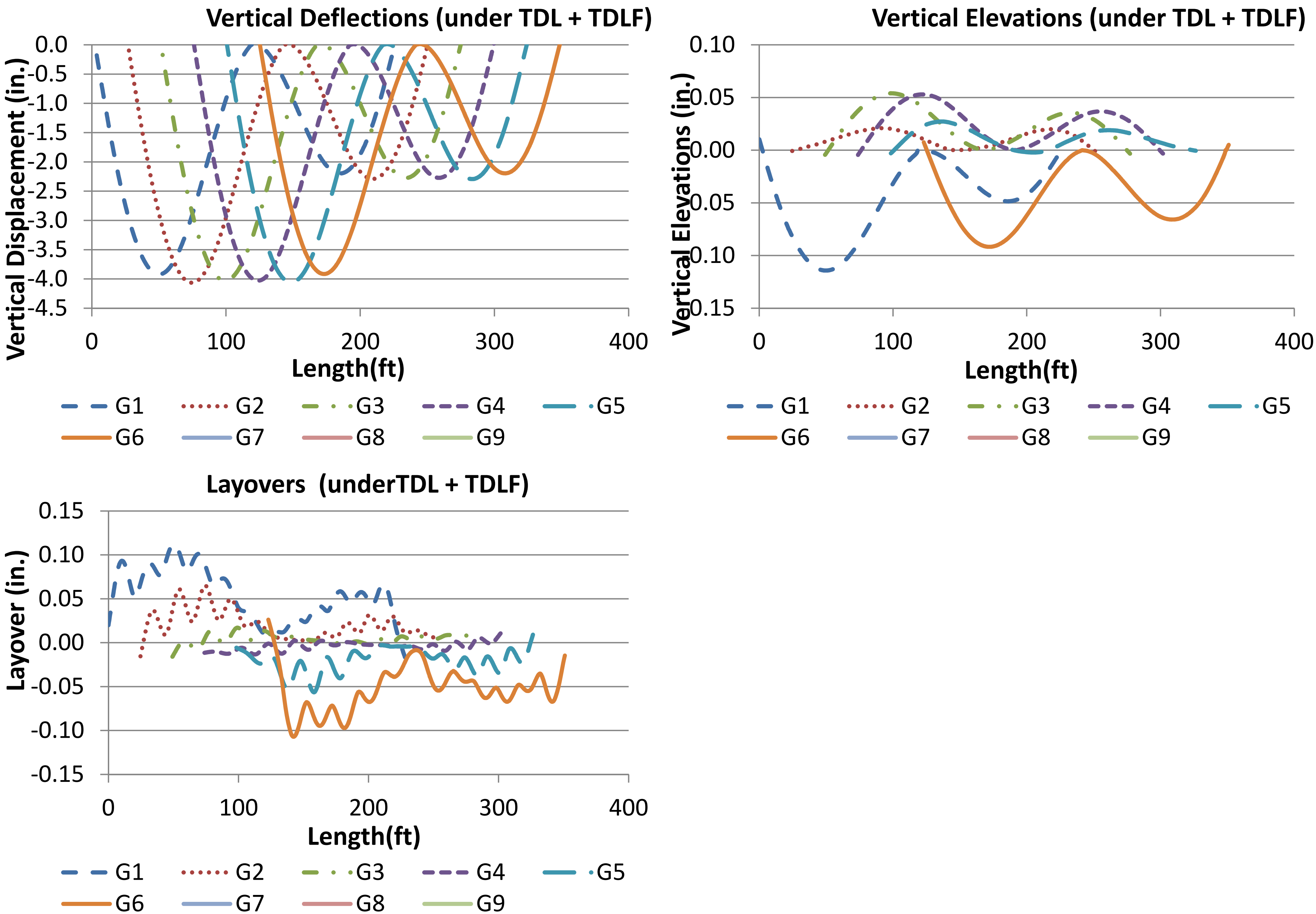


Figure K3-4-9. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

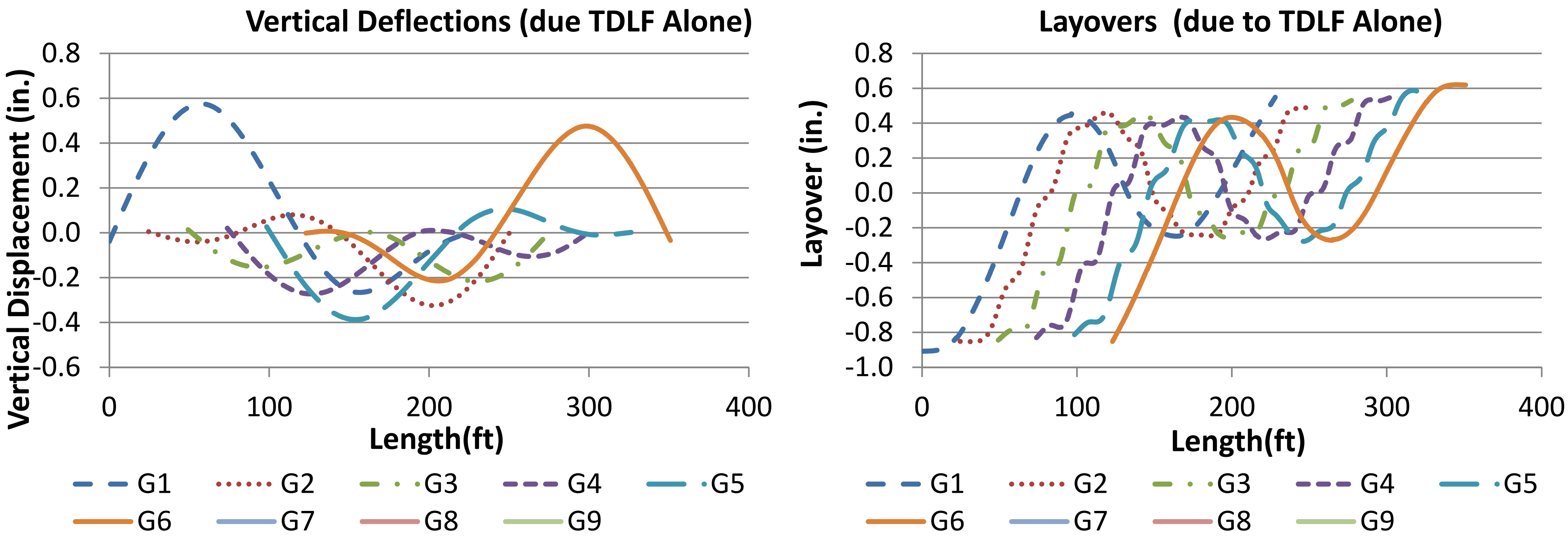


Figure K3-4-10. **Bridge displacements due to TDLF detailing effects alone under NL (in).**

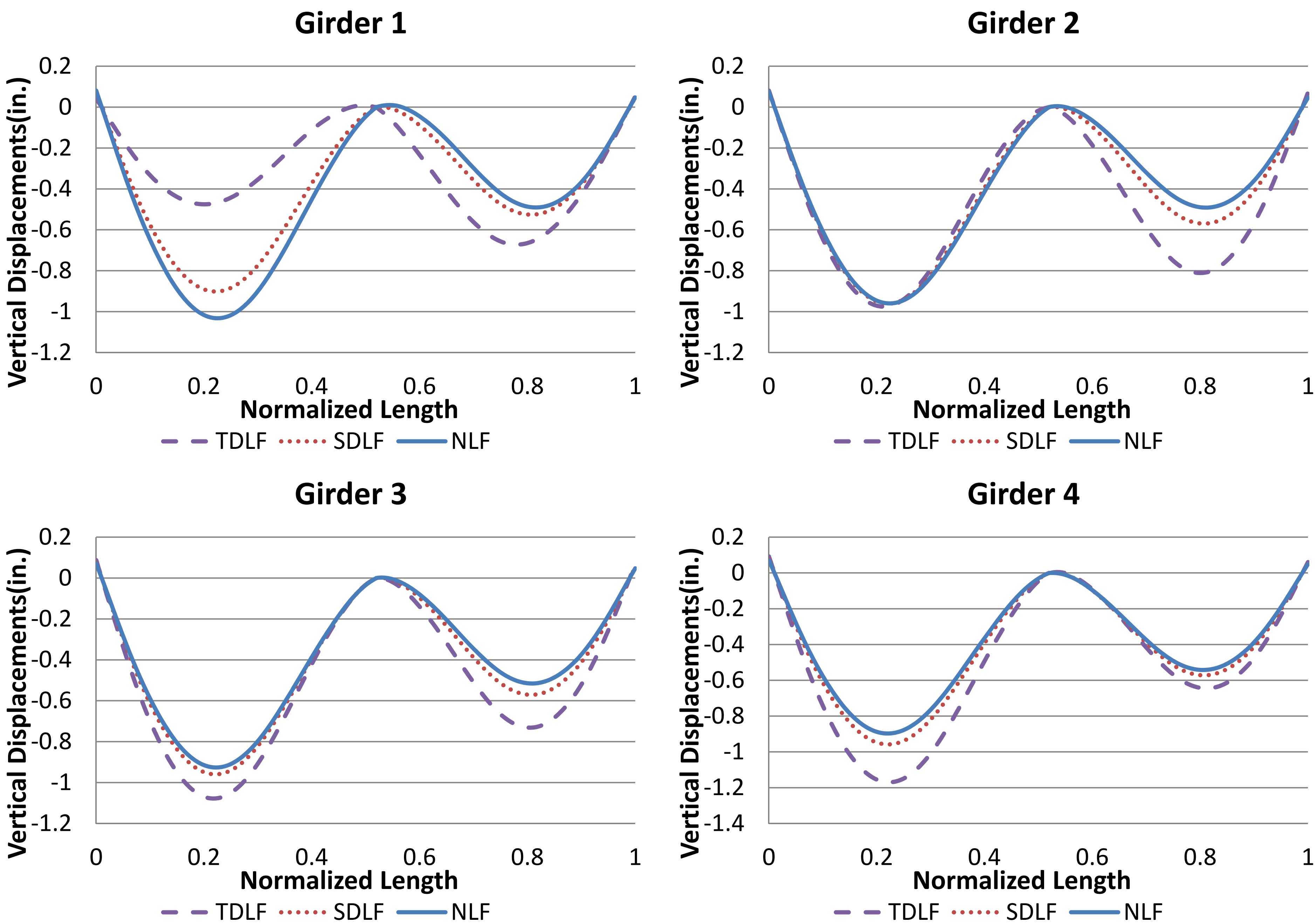


Figure K3-4-11. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

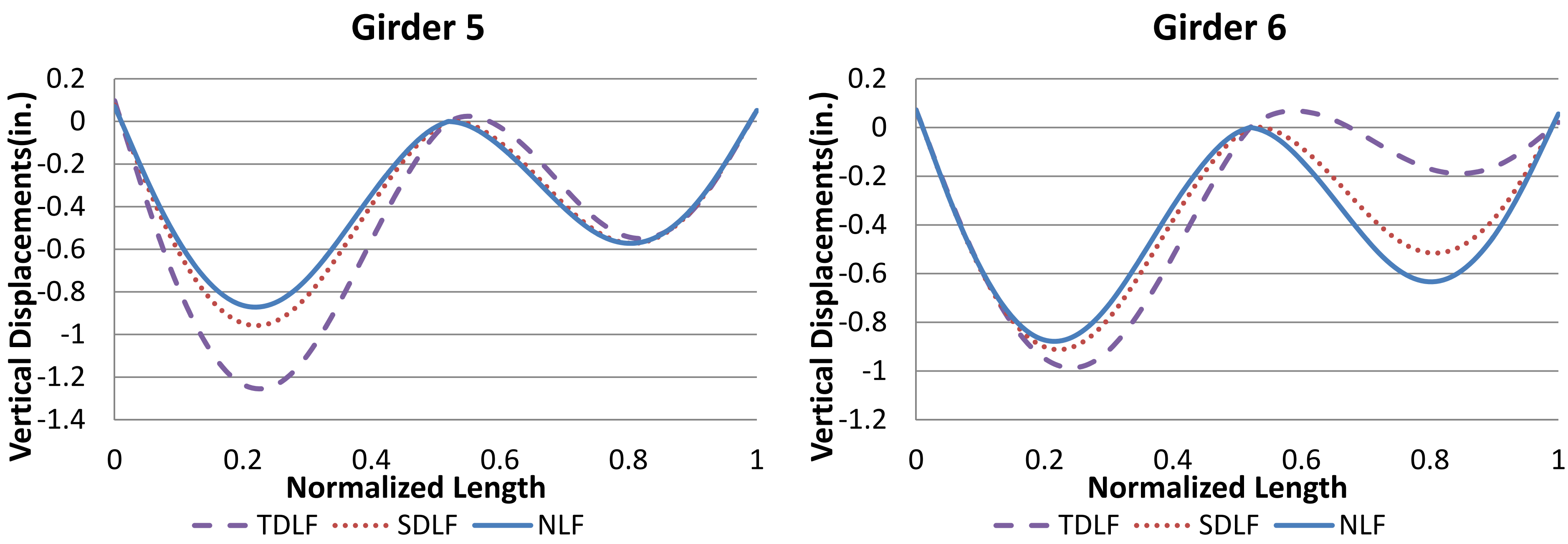


Figure K3-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

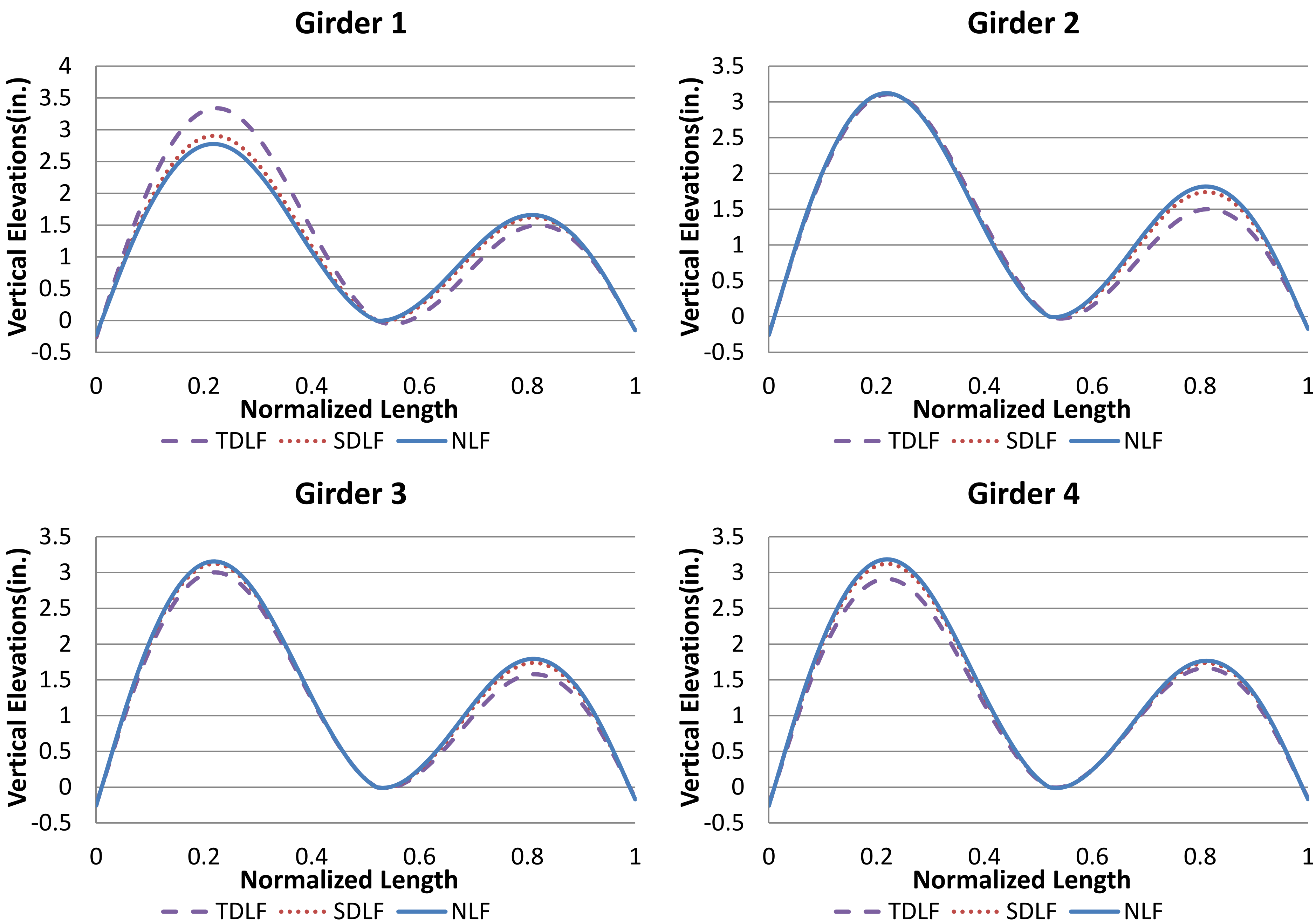


Figure K3-4-12. **Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.**

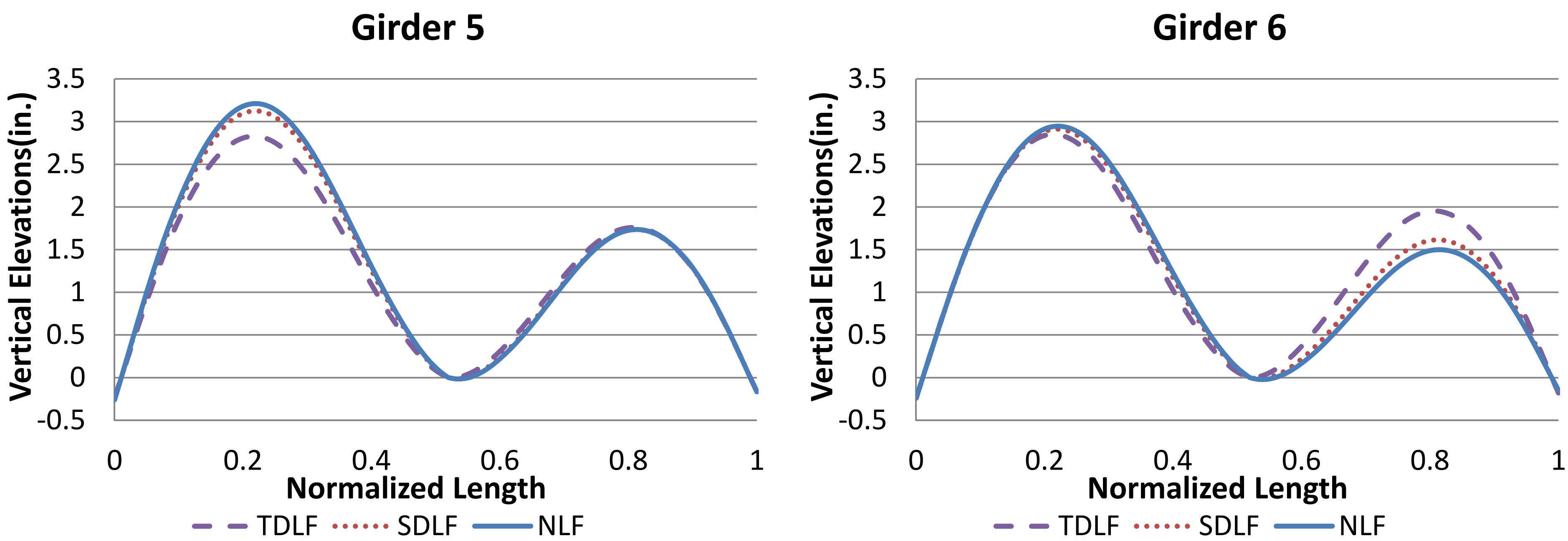


Figure K3-4-12(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

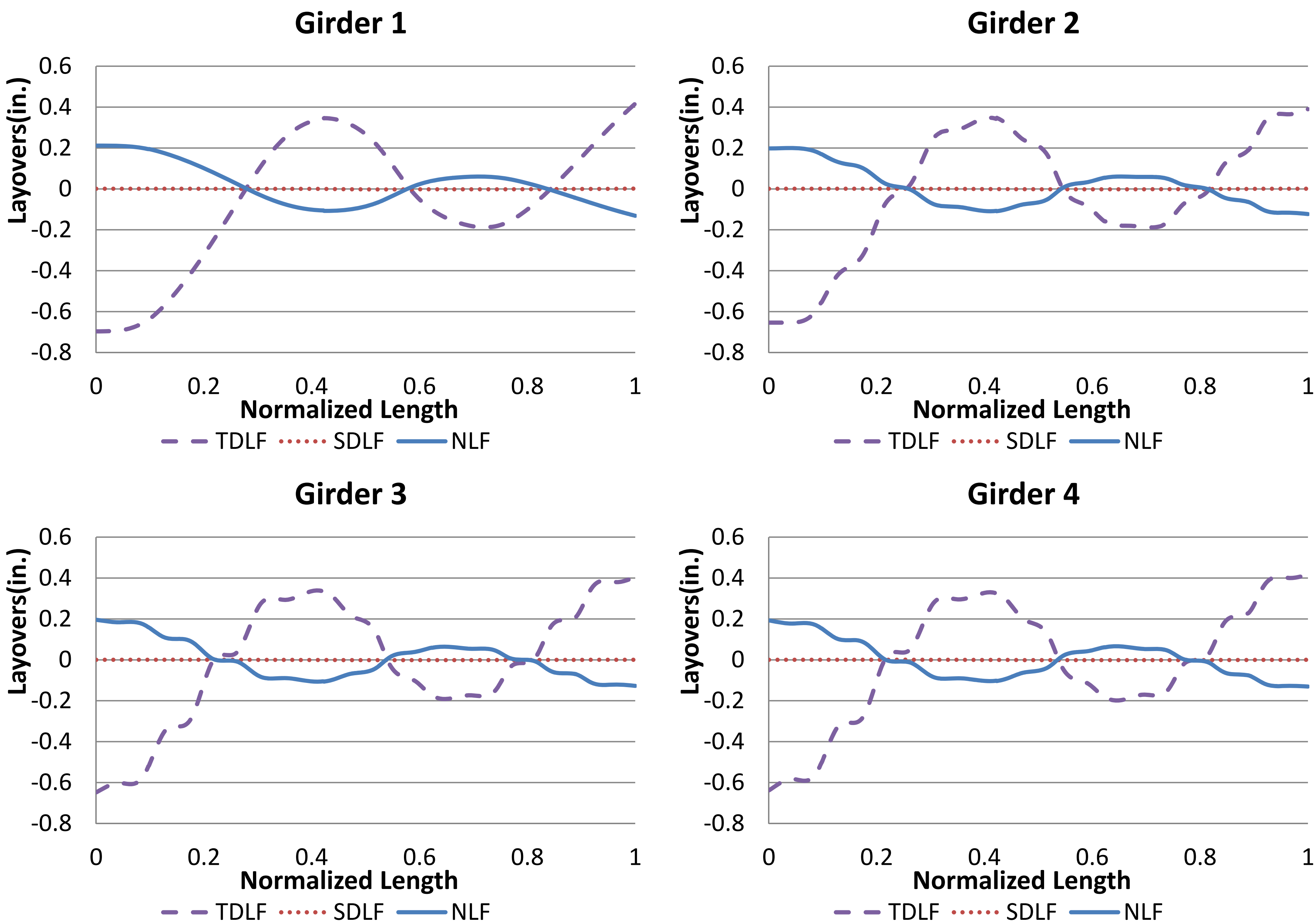
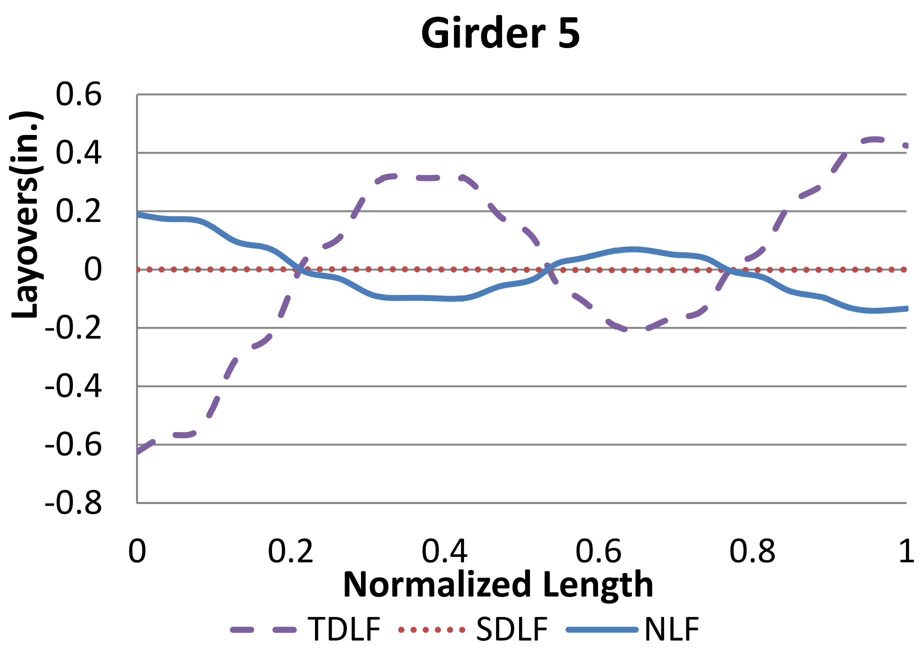


Figure K3-4-13. Comparison of individual girder layovers (in) under SDL for different detailing methods.



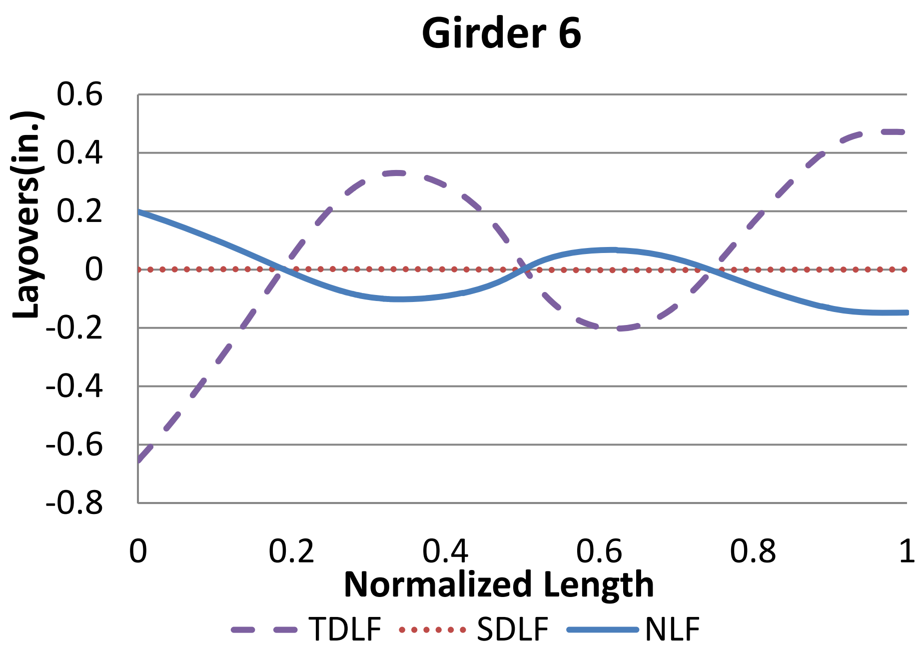


Figure K3-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

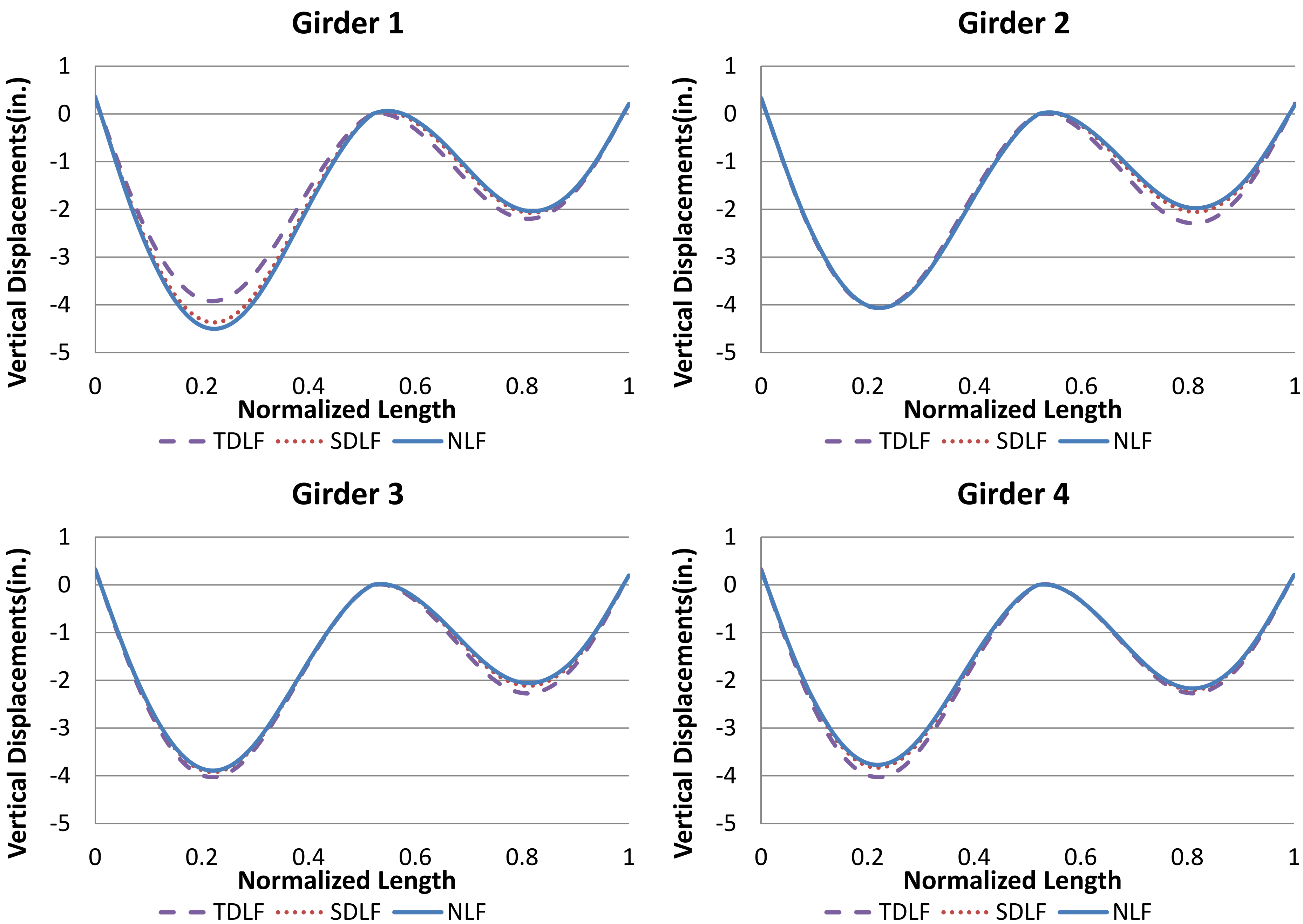
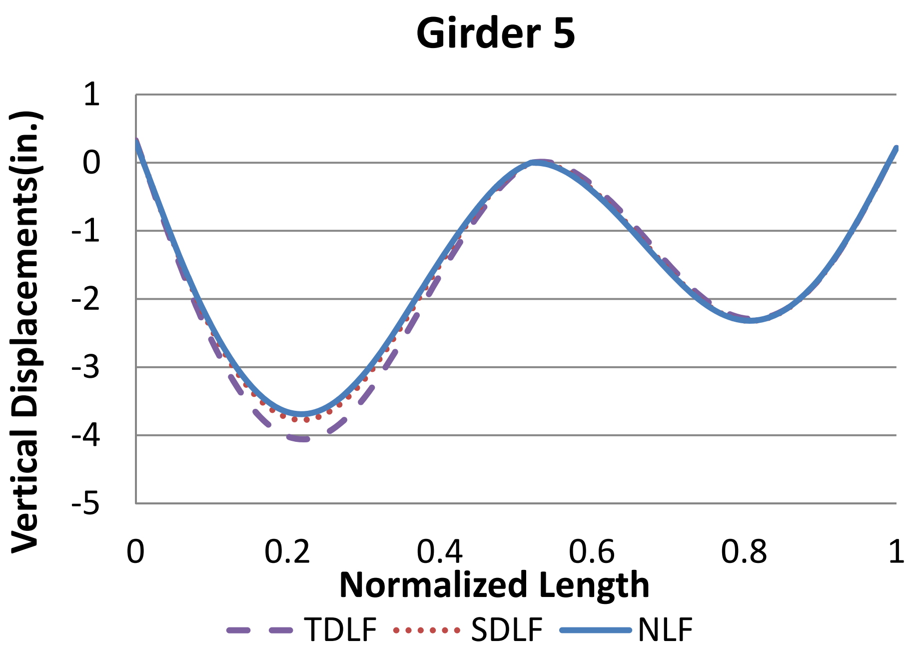


Figure K3-4-14. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**



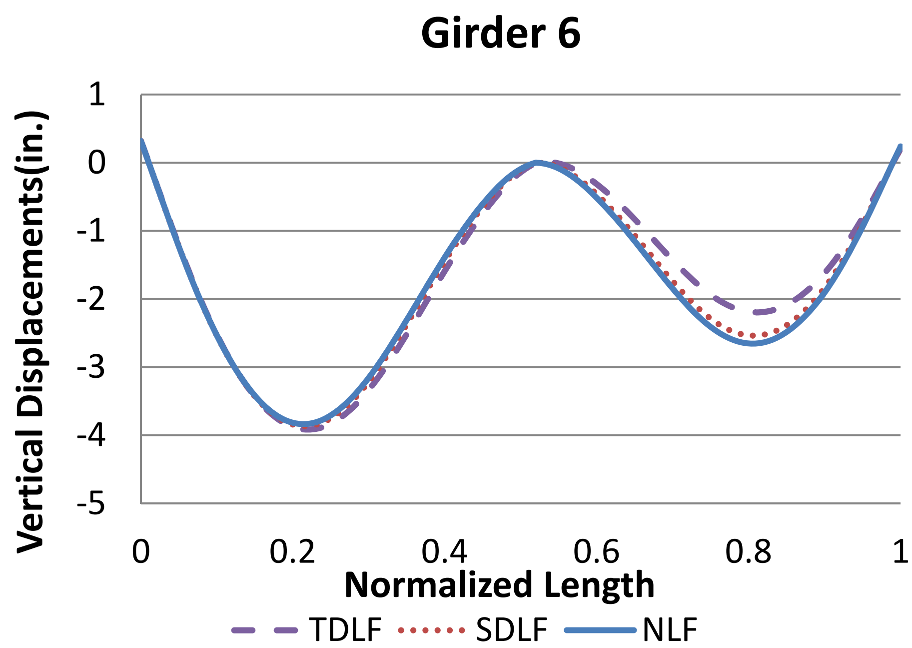


Figure K3-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

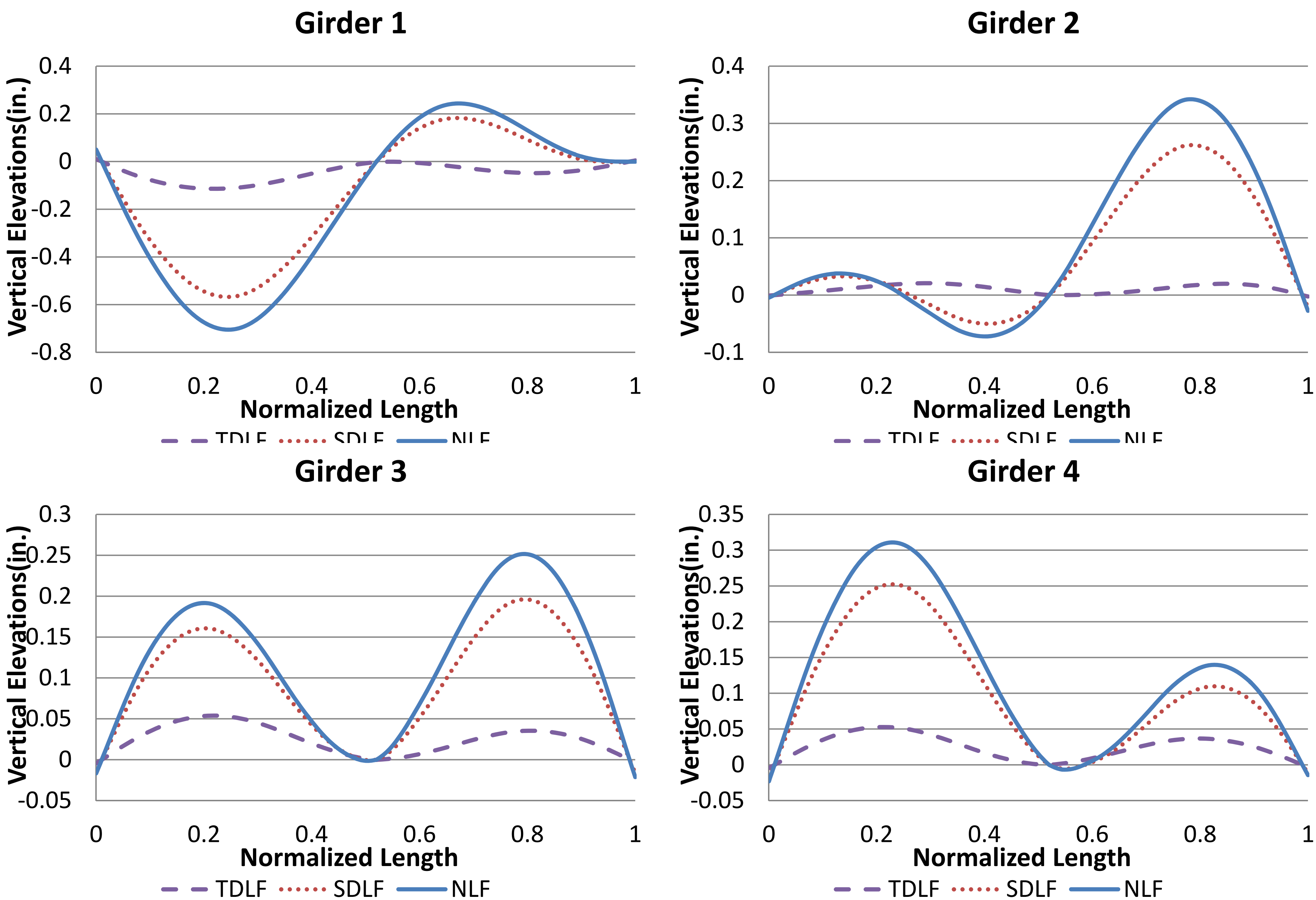
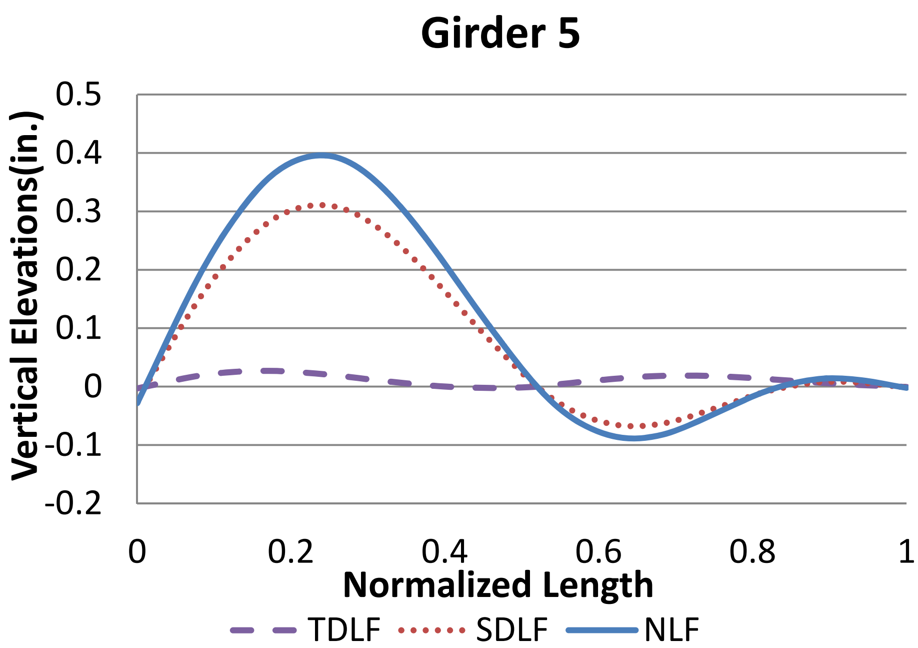


Figure K3-4-15. **Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.**



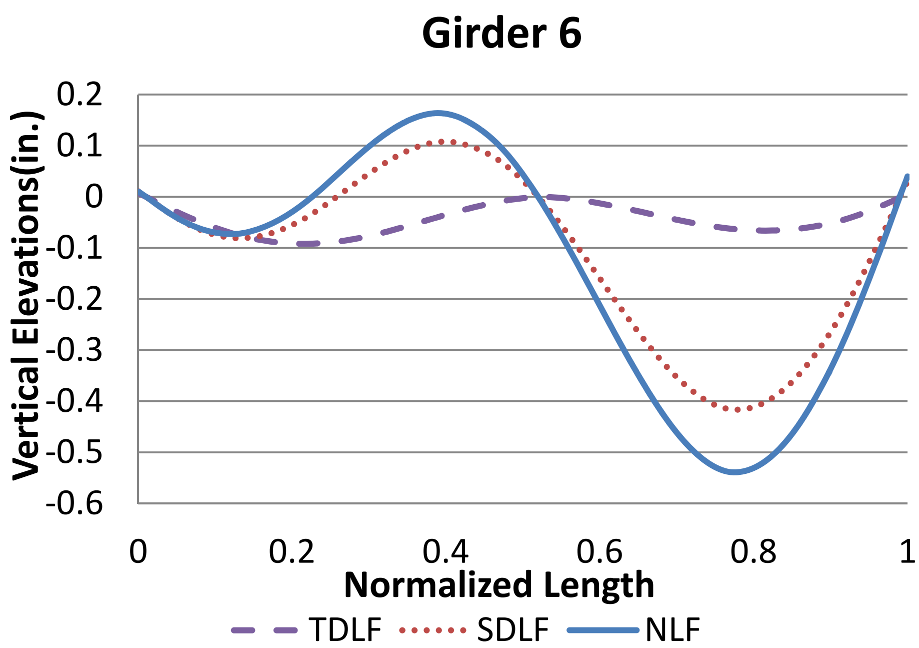


Figure K3-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

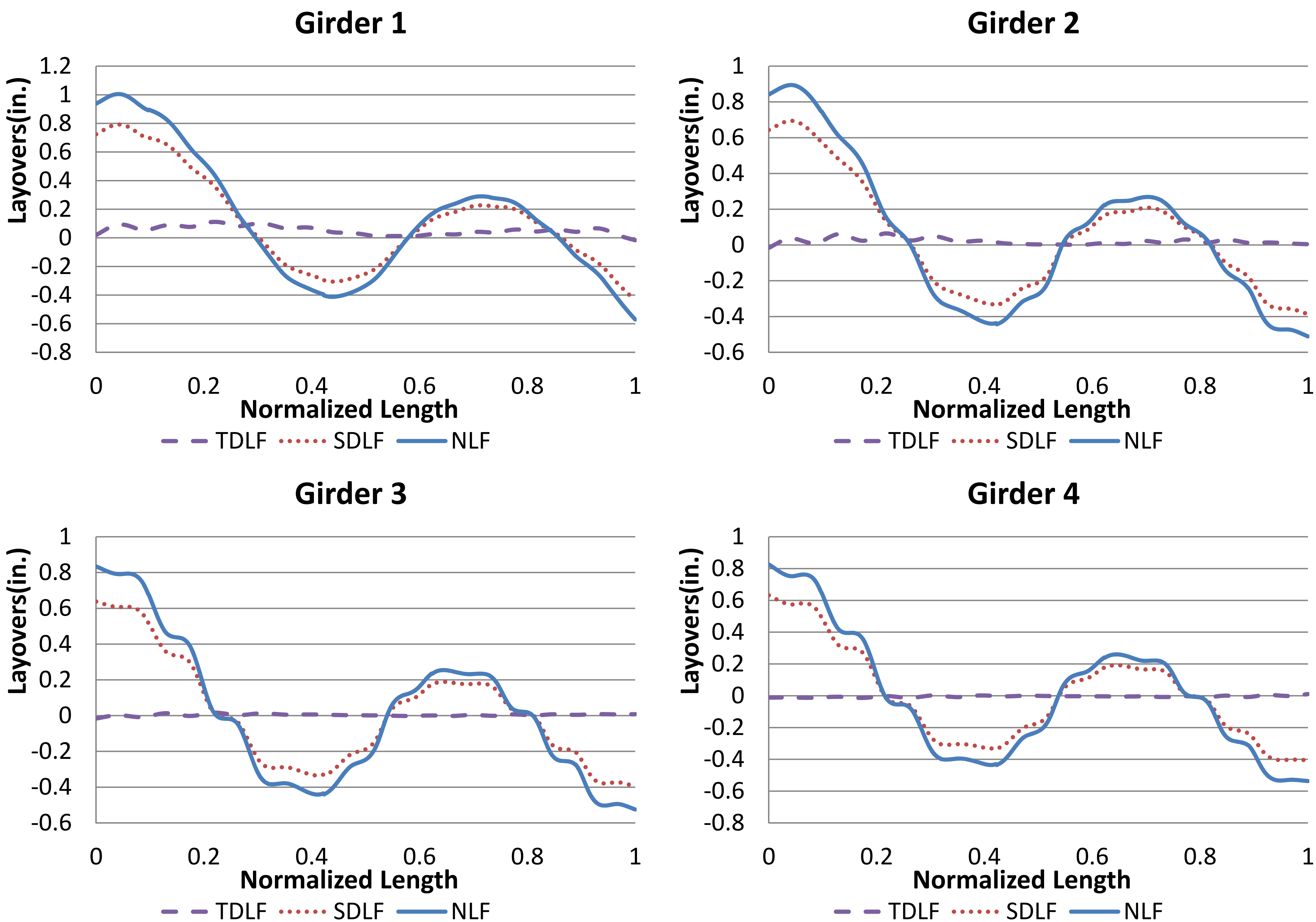


Figure K3-4-16. Comparison of individual girder layovers (in) under TDL for different detailing methods.

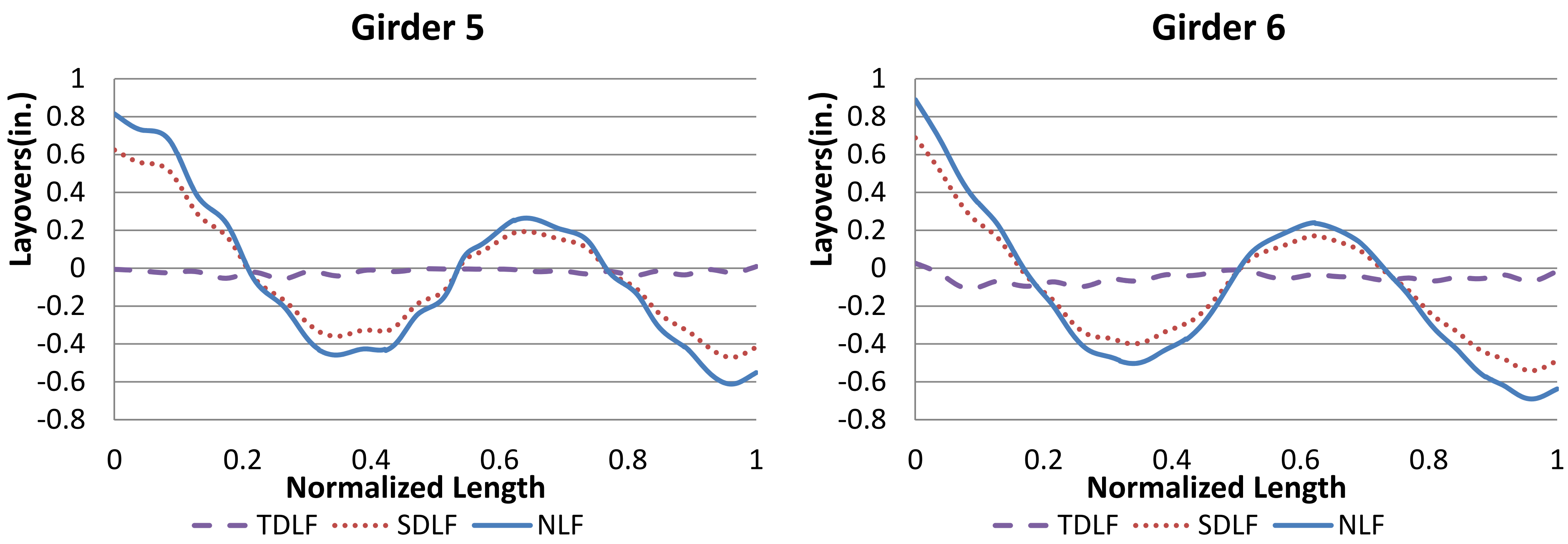


Figure K3-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

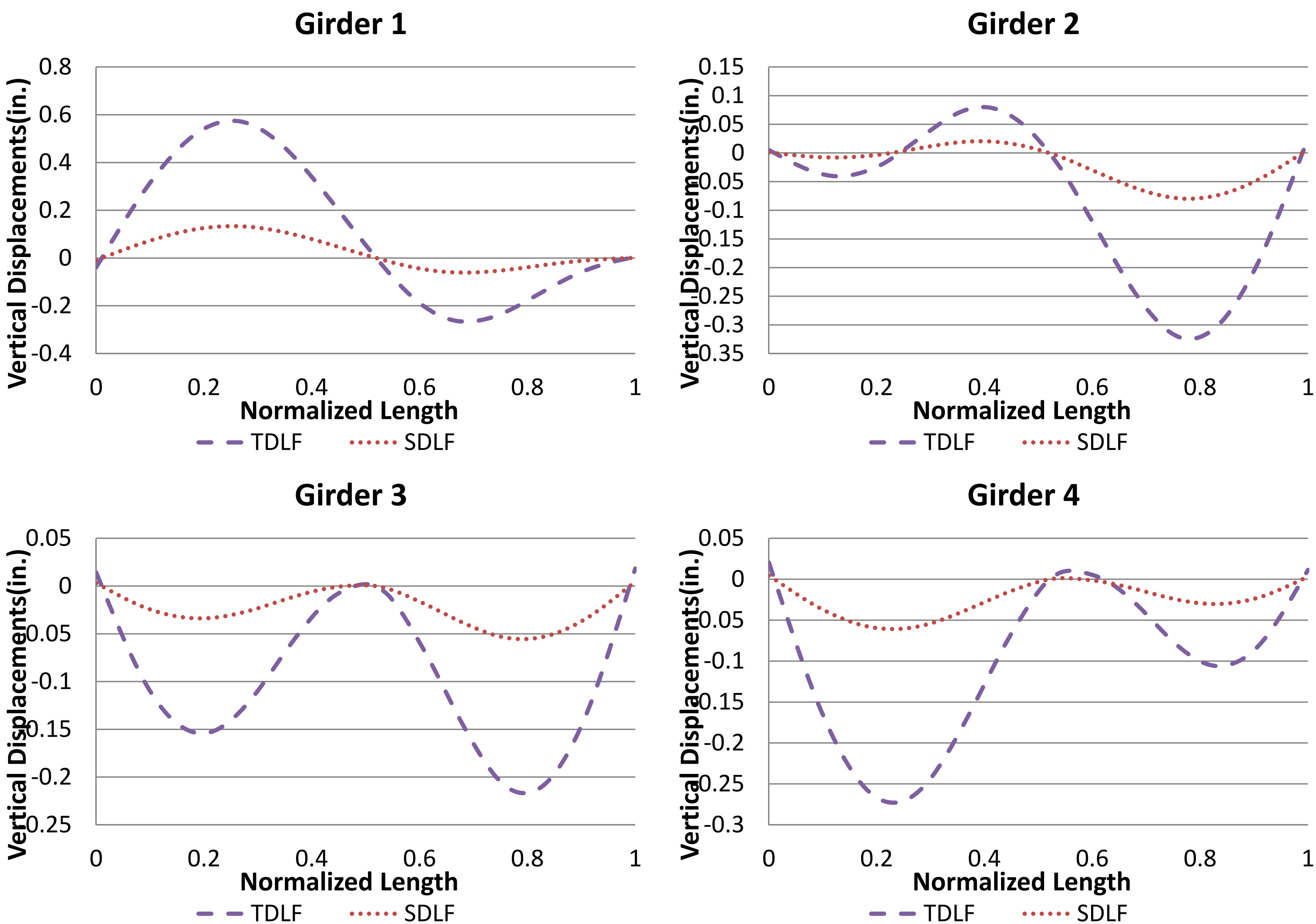


Figure K3-4-17. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

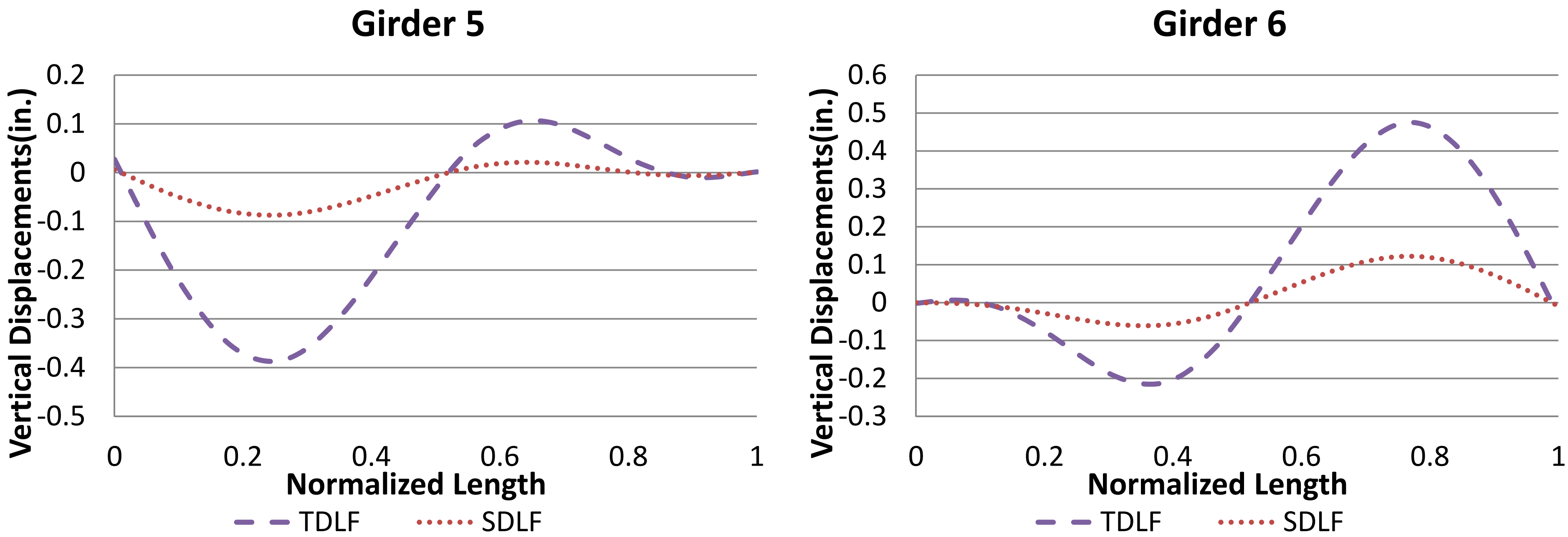


Figure K3-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

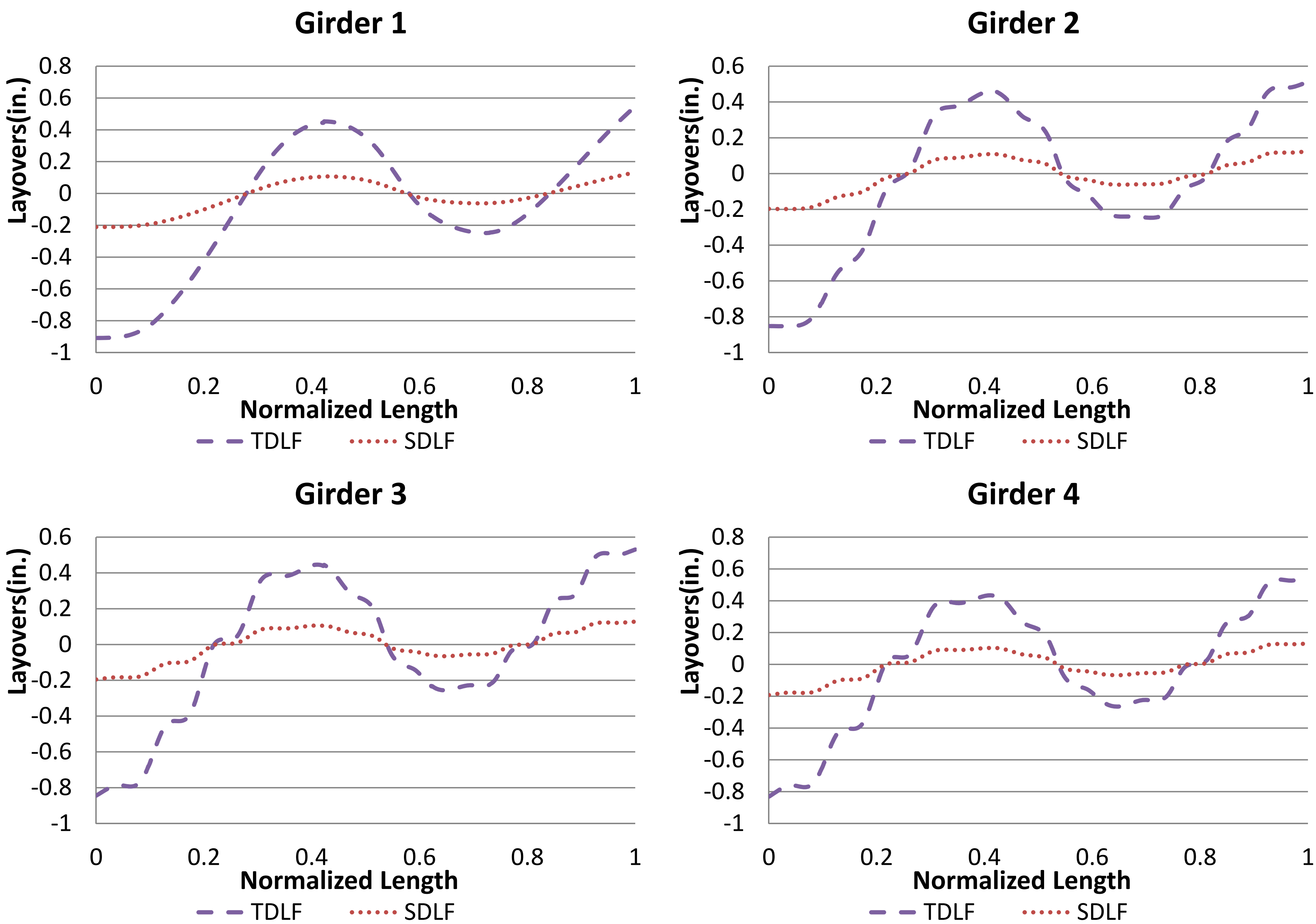


Figure K3-4-18. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

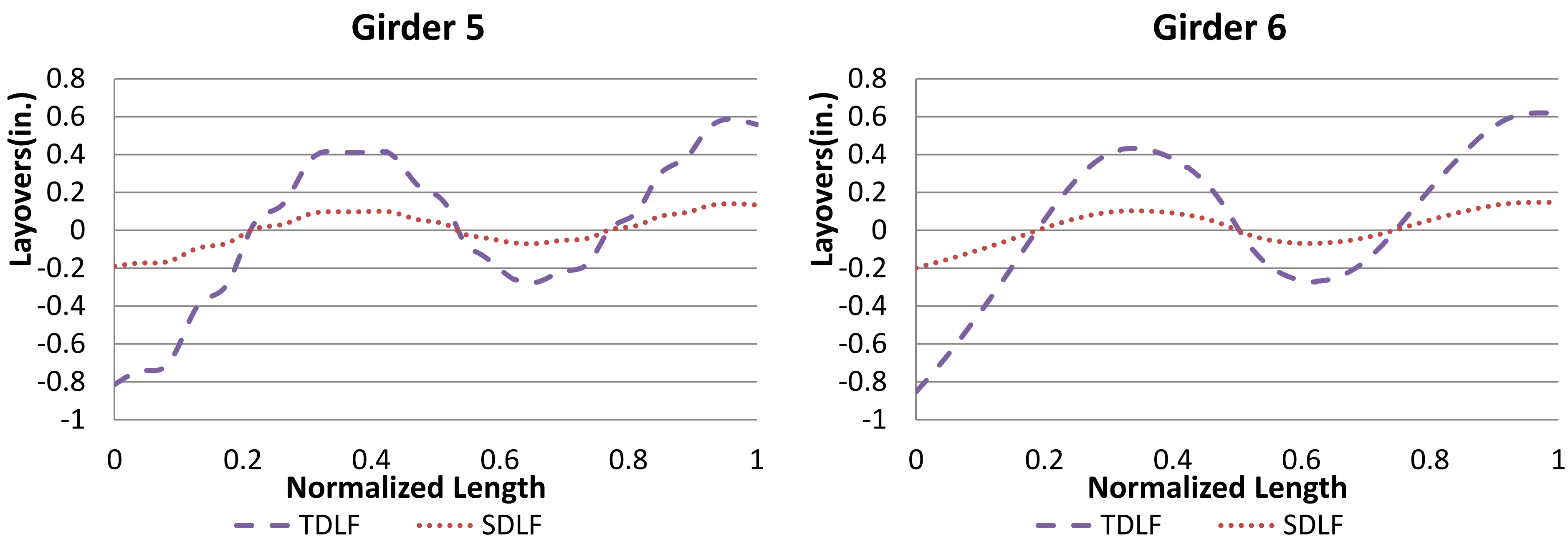


Figure K3-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

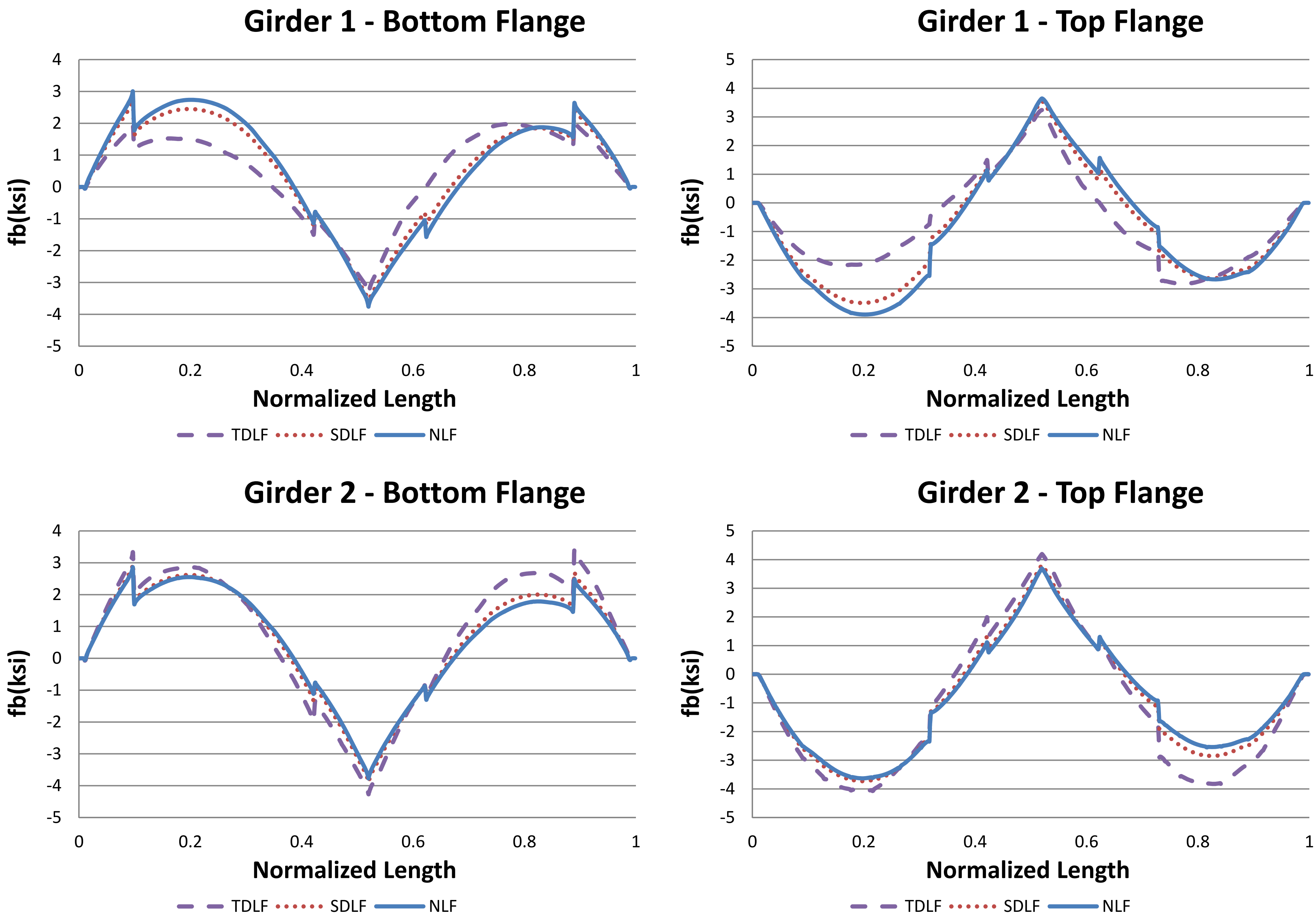


Figure K3-4-19. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

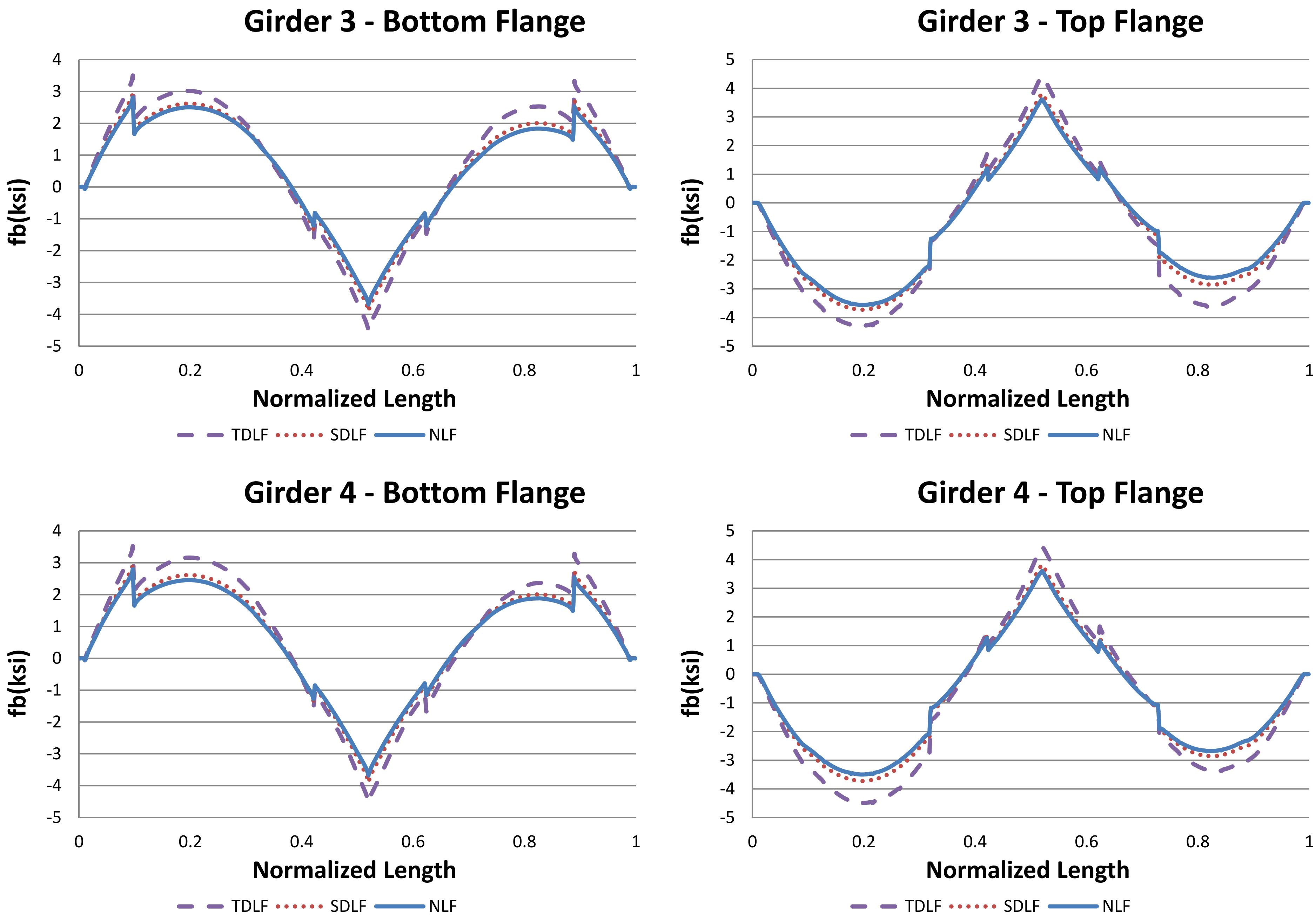


Figure K3-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

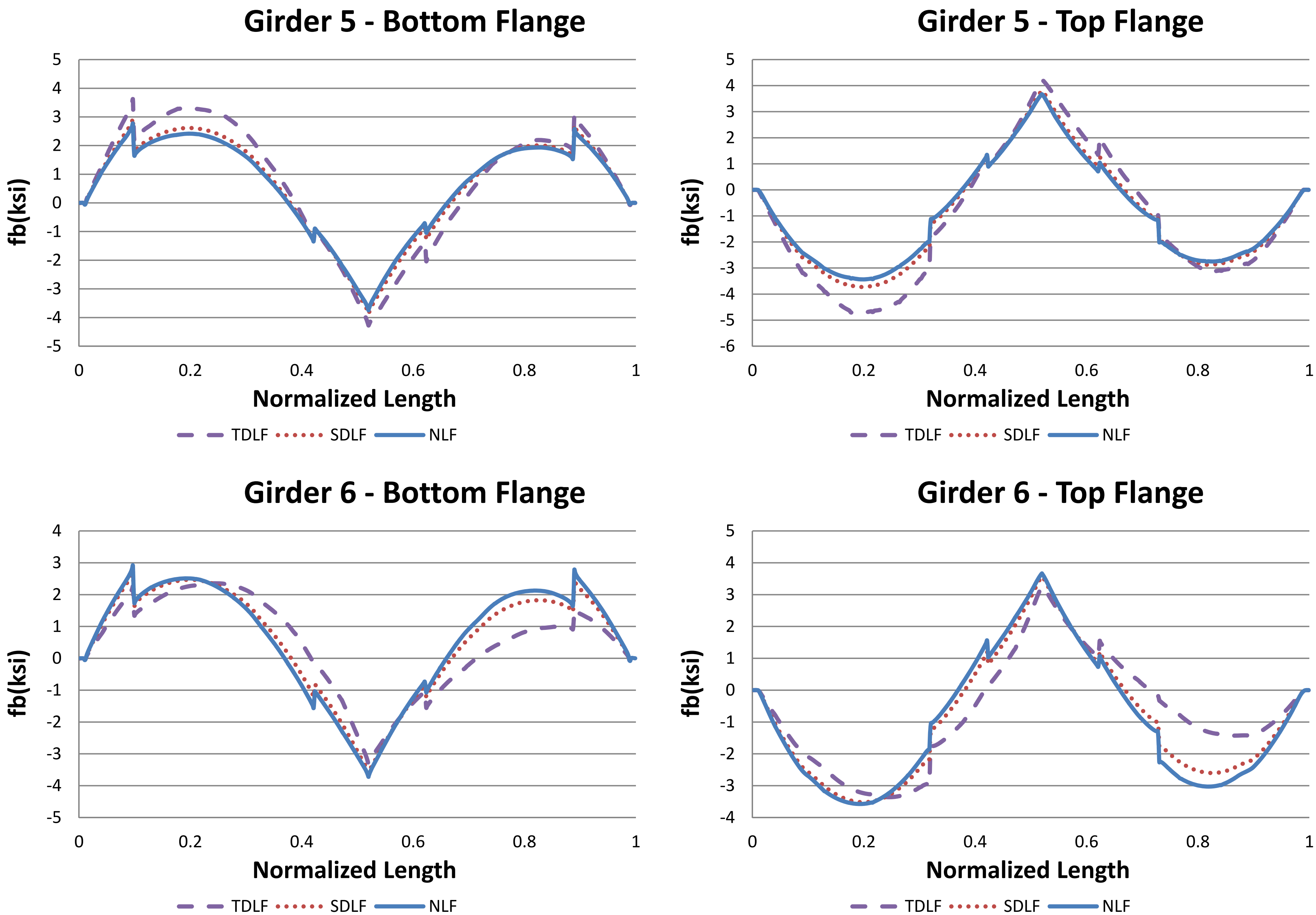


Figure K3-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

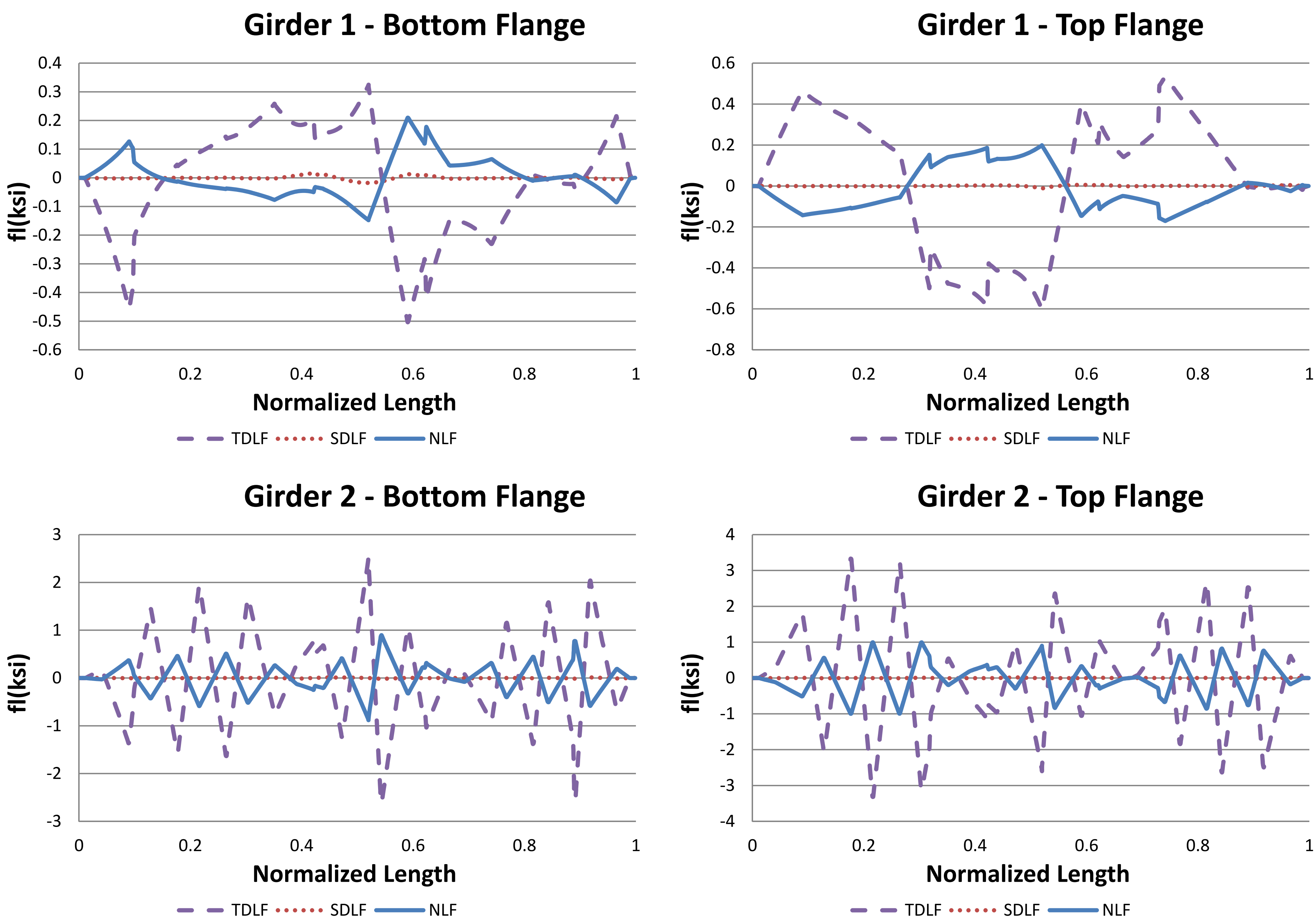


Figure K3-4-20. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

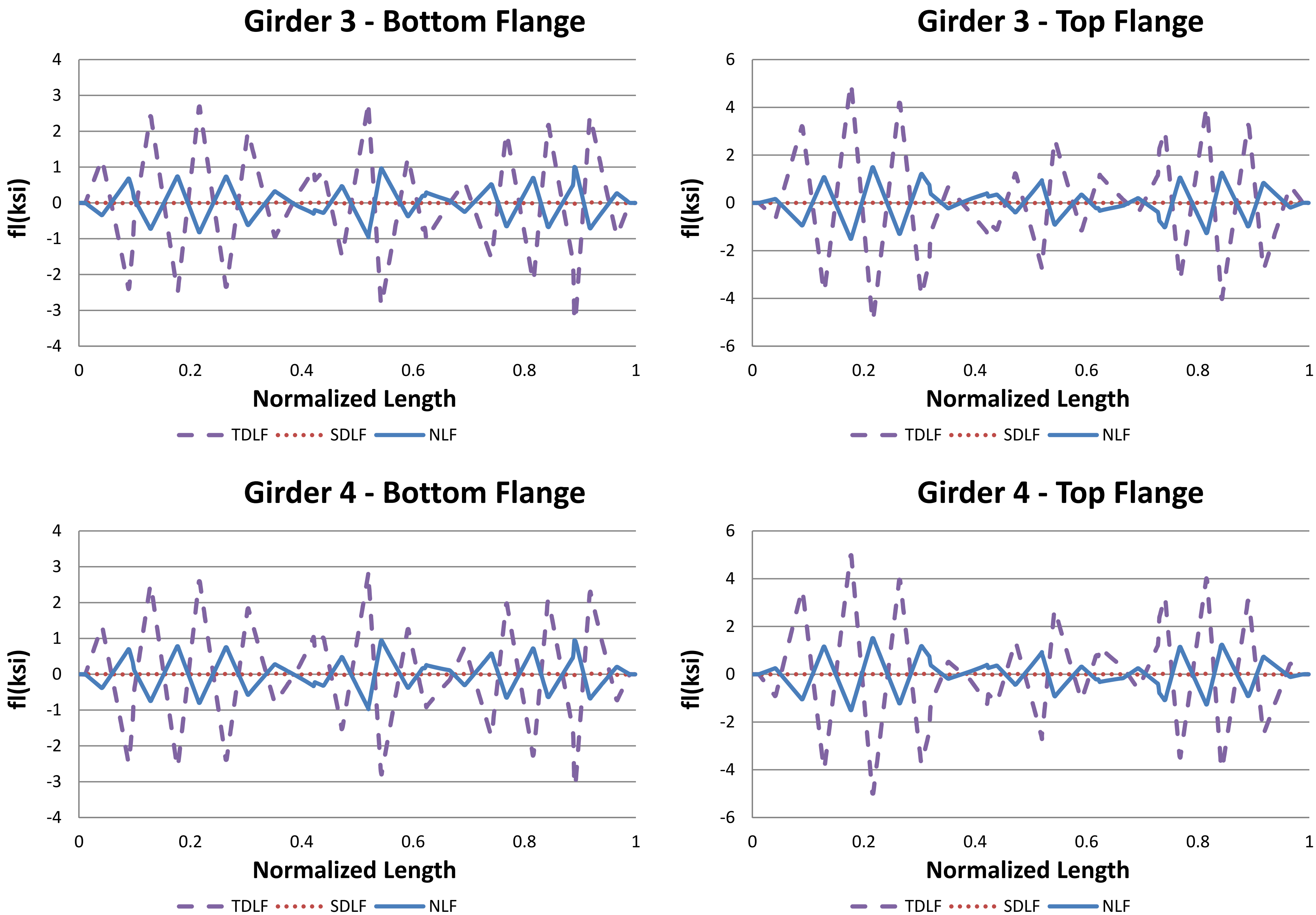


Figure K3-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

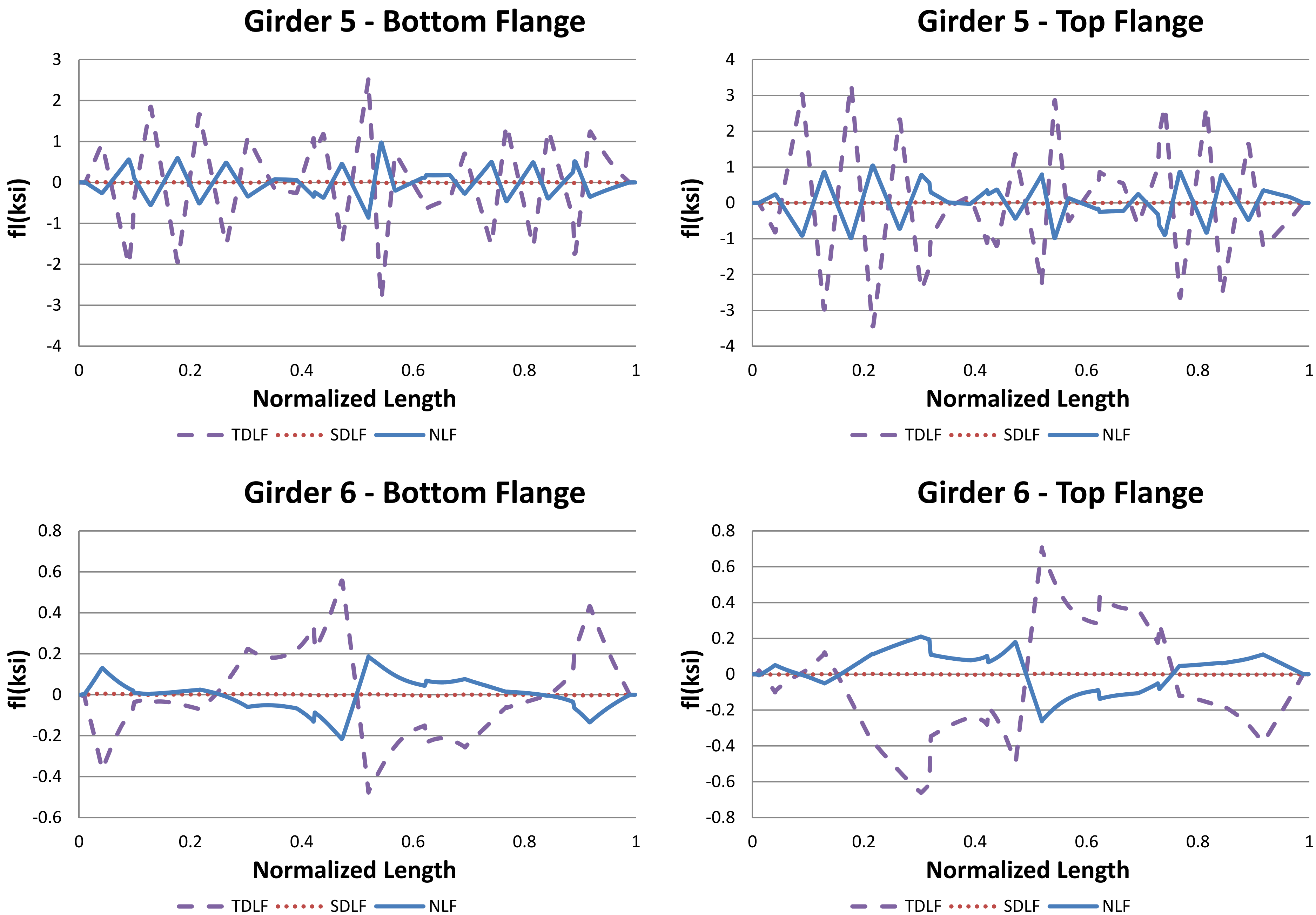


Figure K3-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

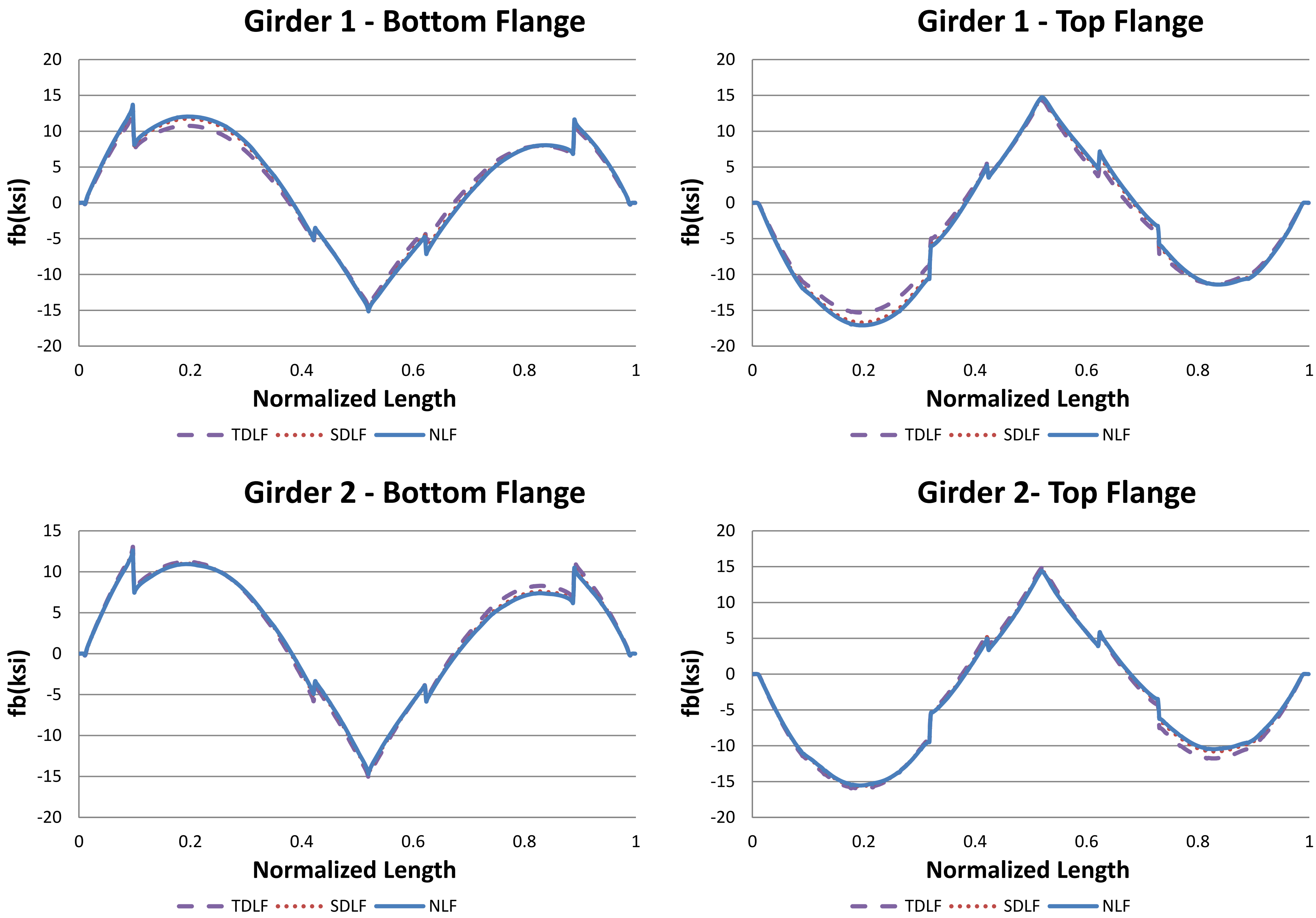


Figure K3-4-21. Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

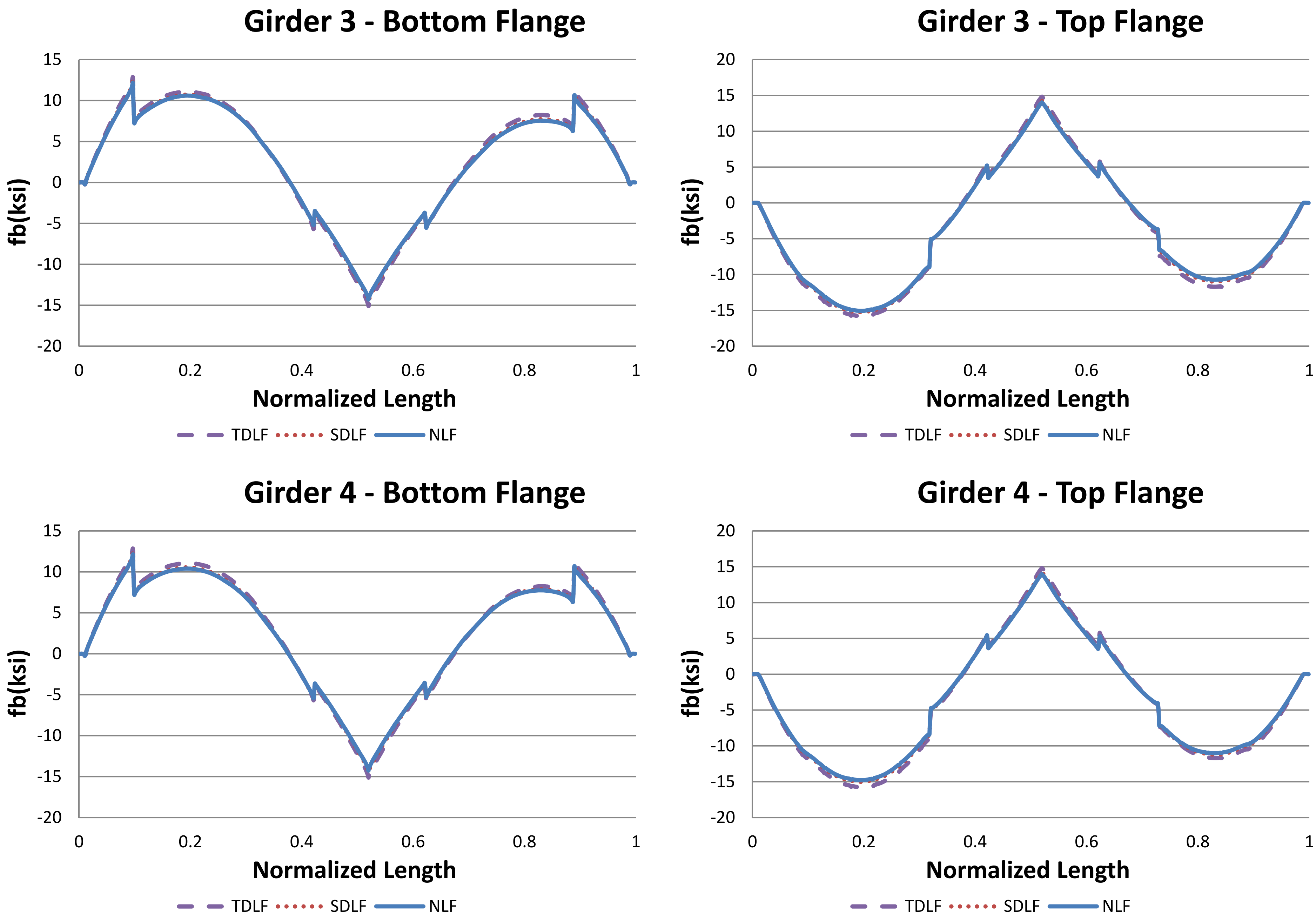


Figure K3-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

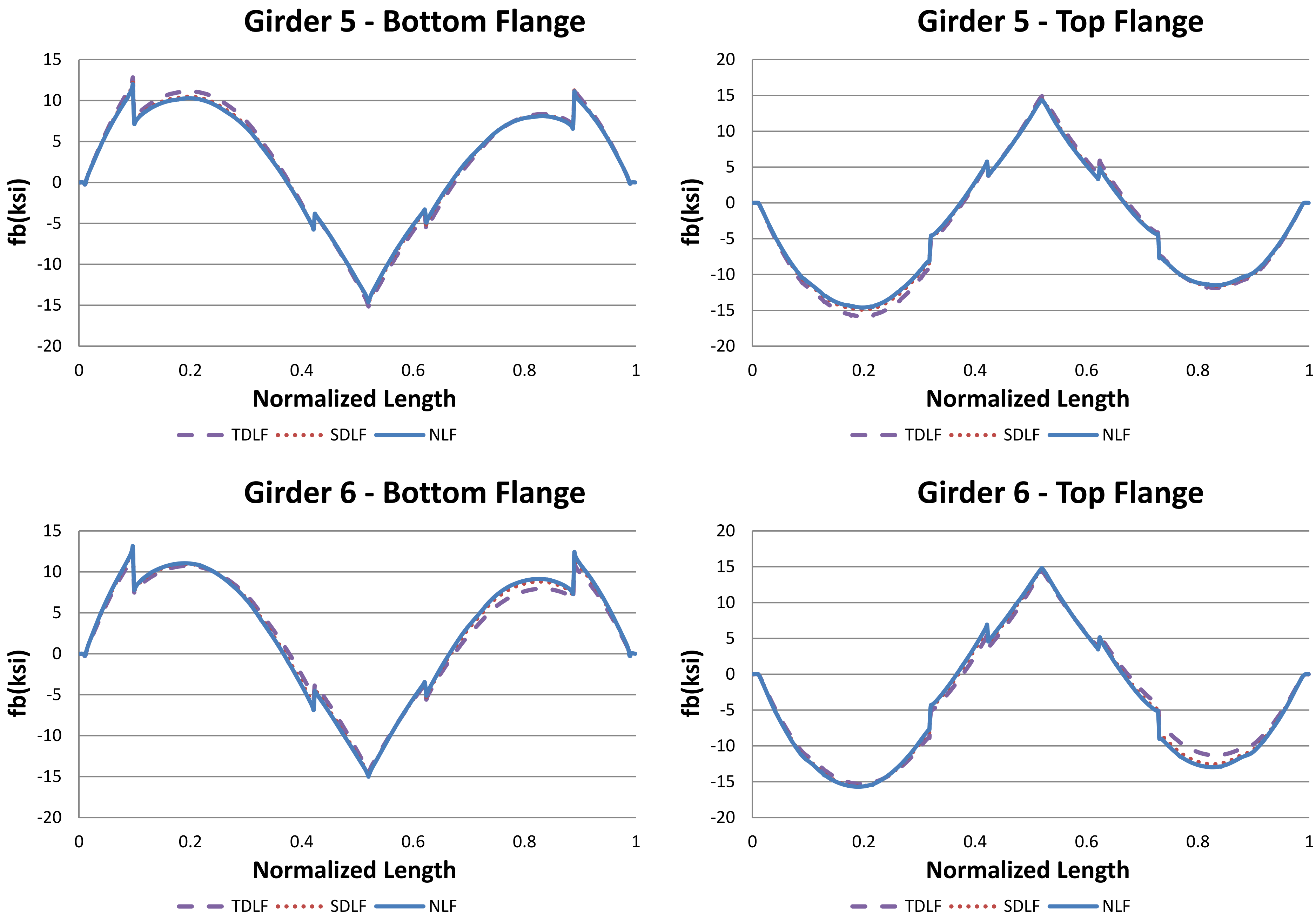


Figure K3-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

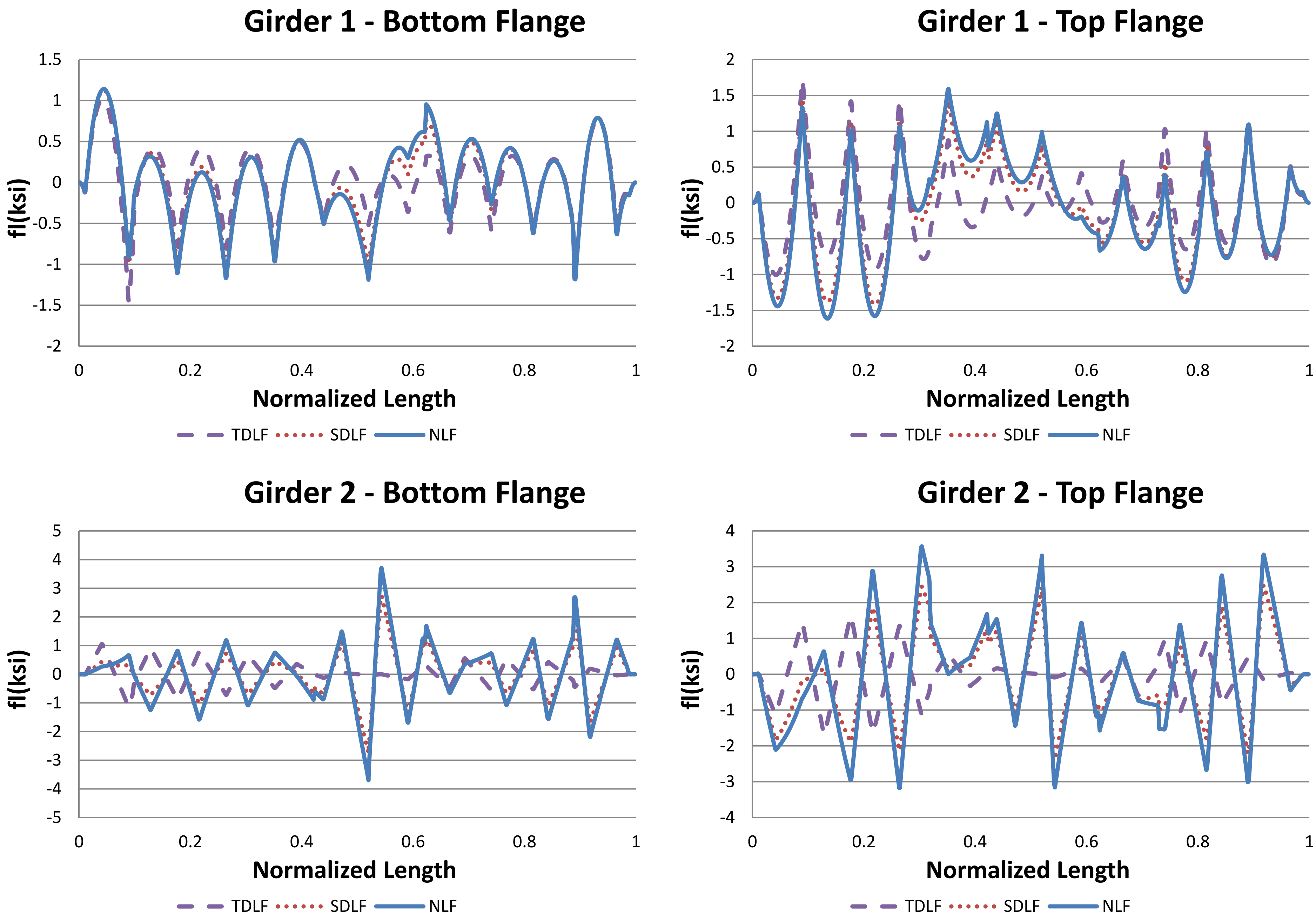


Figure K3-4-22. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

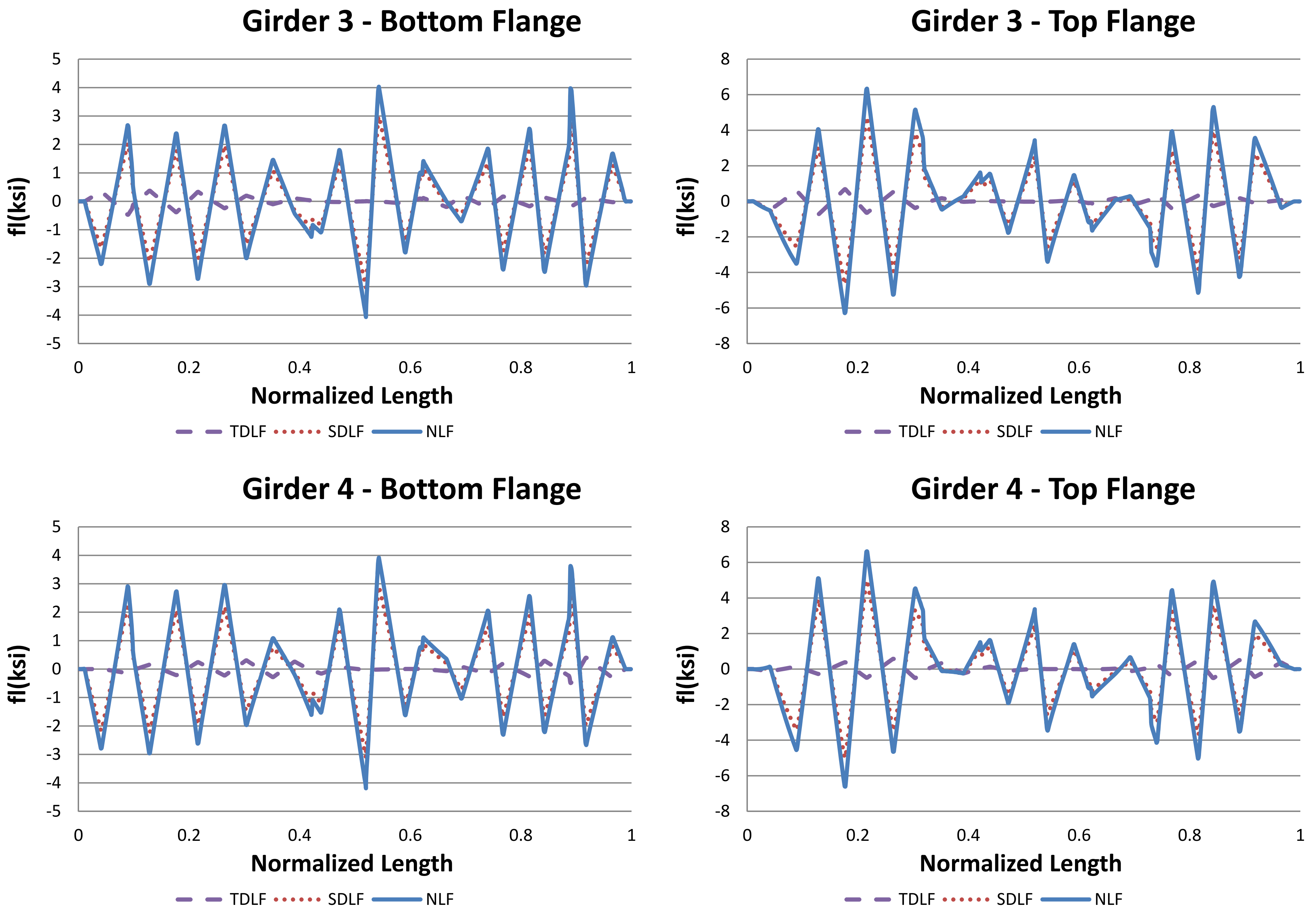


Figure K3-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

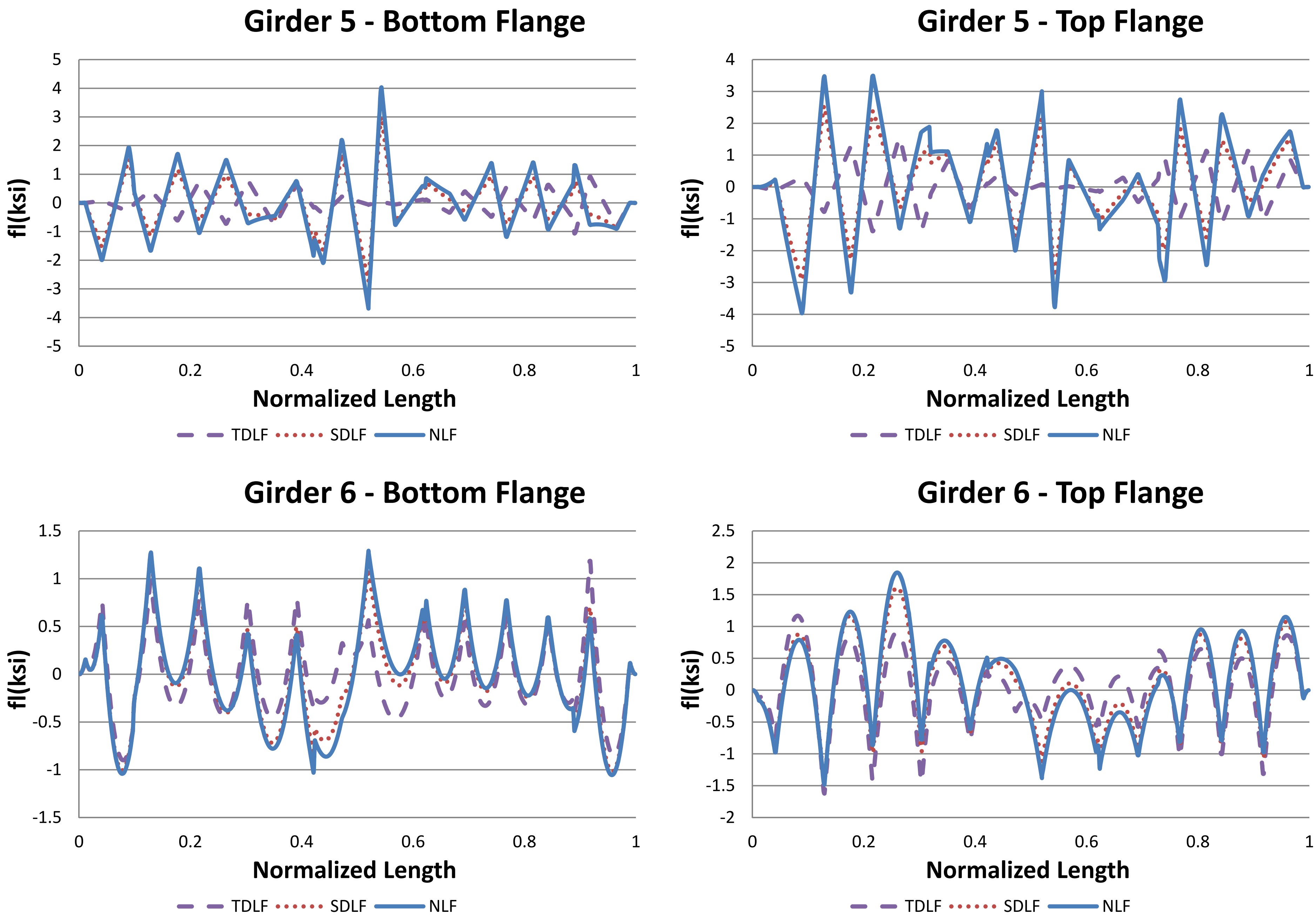


Figure K3-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

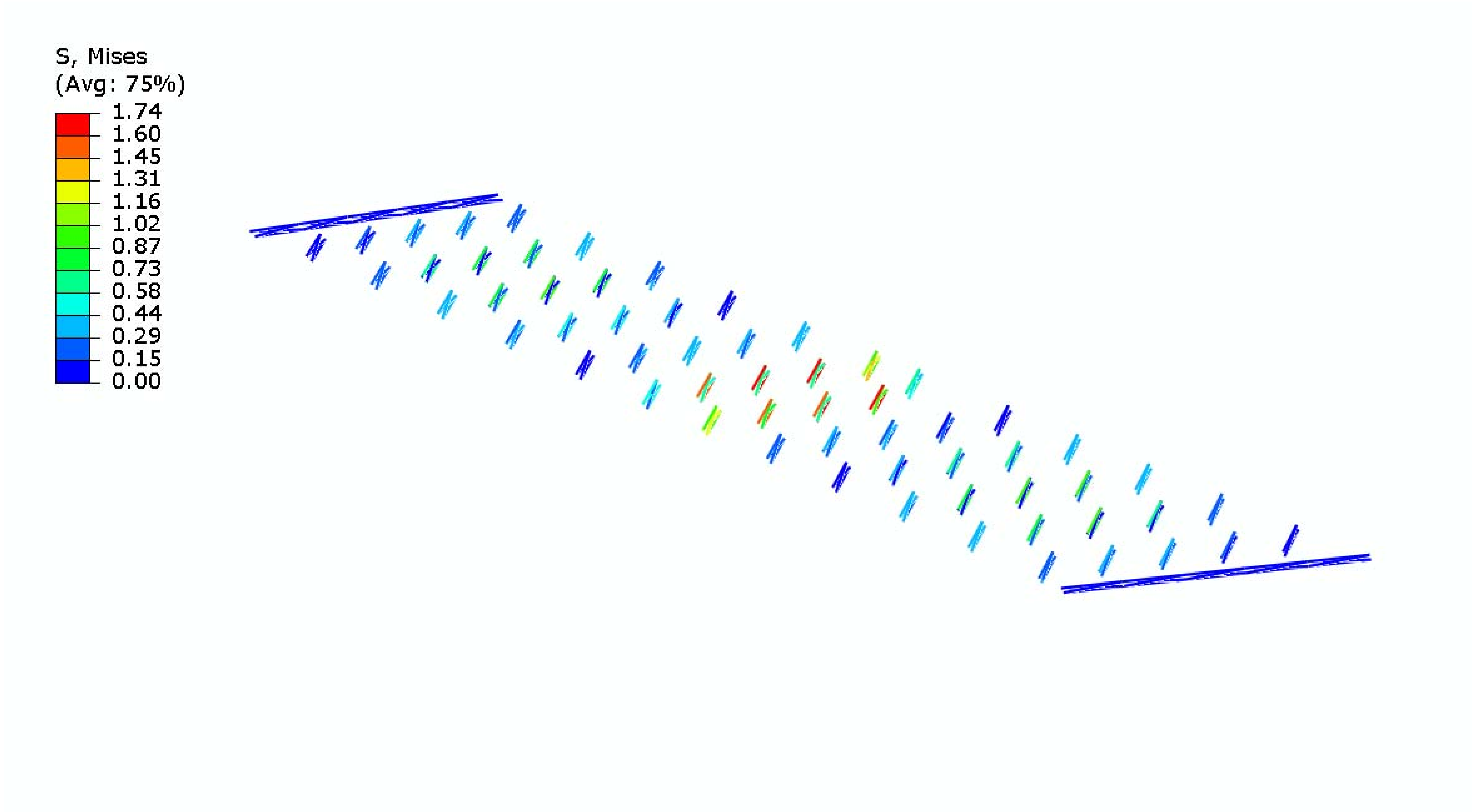


Figure K3-4-23. Cross-frame stress contours (ksi) under SDL, NLF detailing

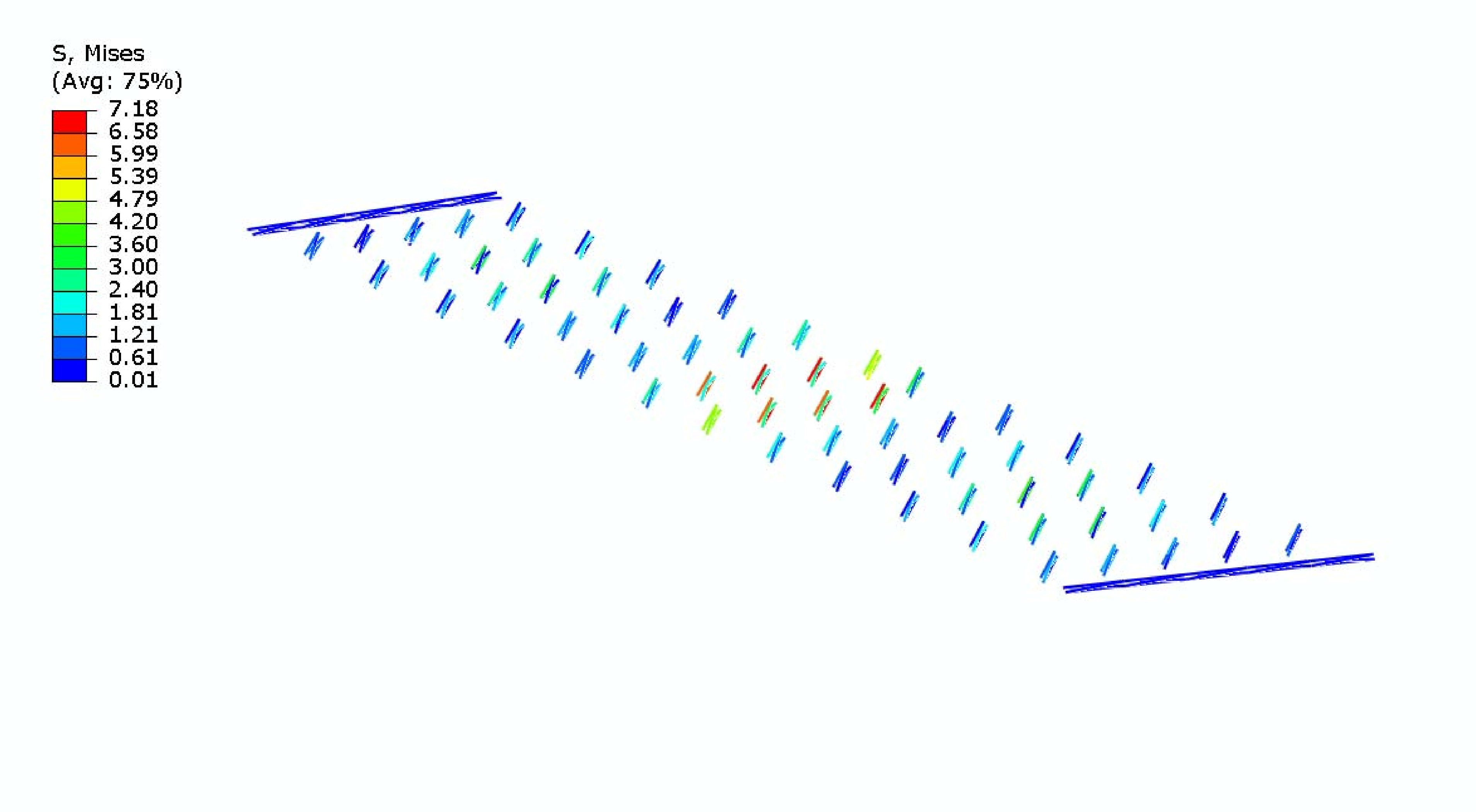


Figure K3-4-24. Cross-frame stress contours under TDL, NLF detailing

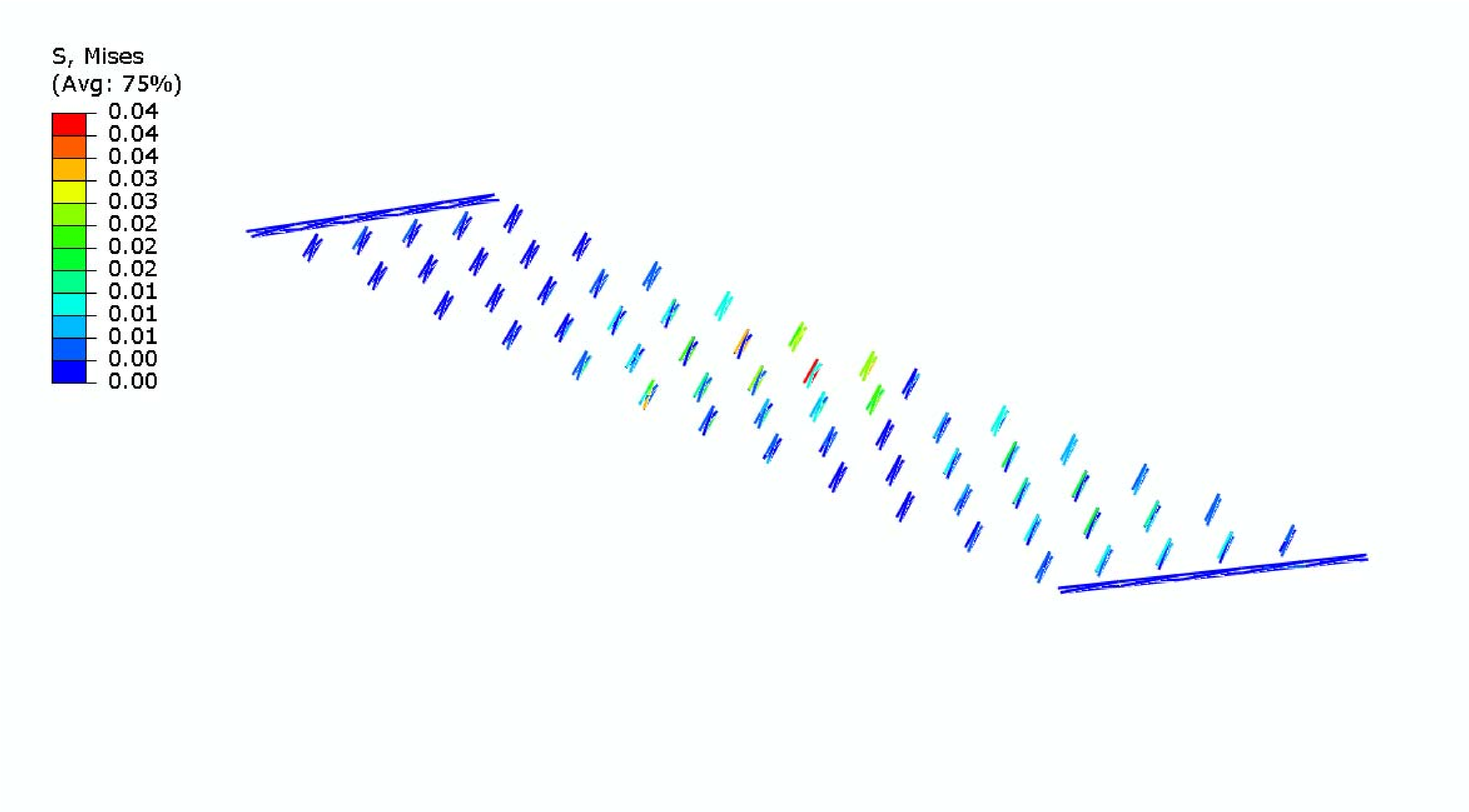


Figure K3-4-25. Cross-frame stress contours under SDL, SDLF detailing

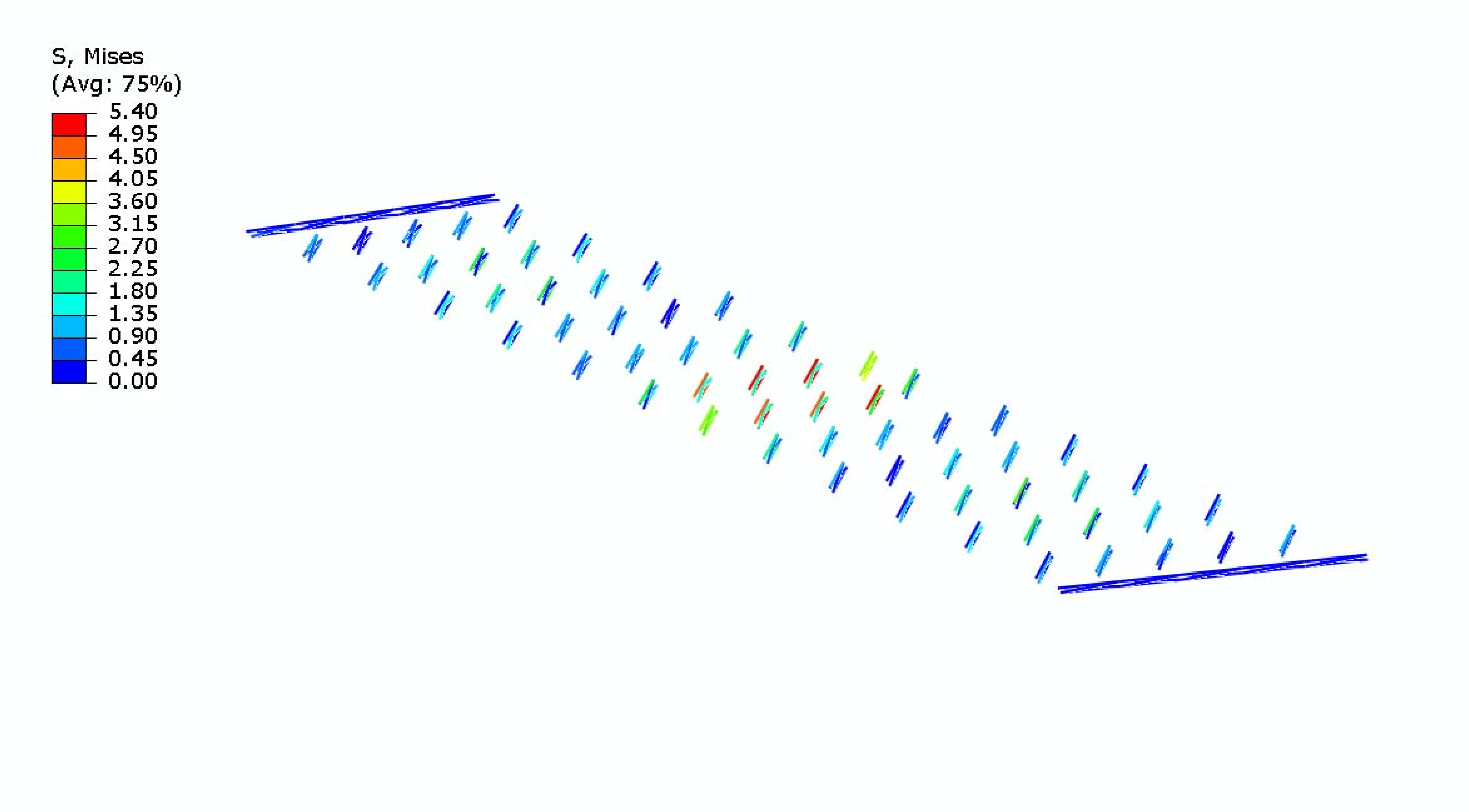


Figure K3-4-26. Cross-frame stress contours under TDL, SDLF detailing

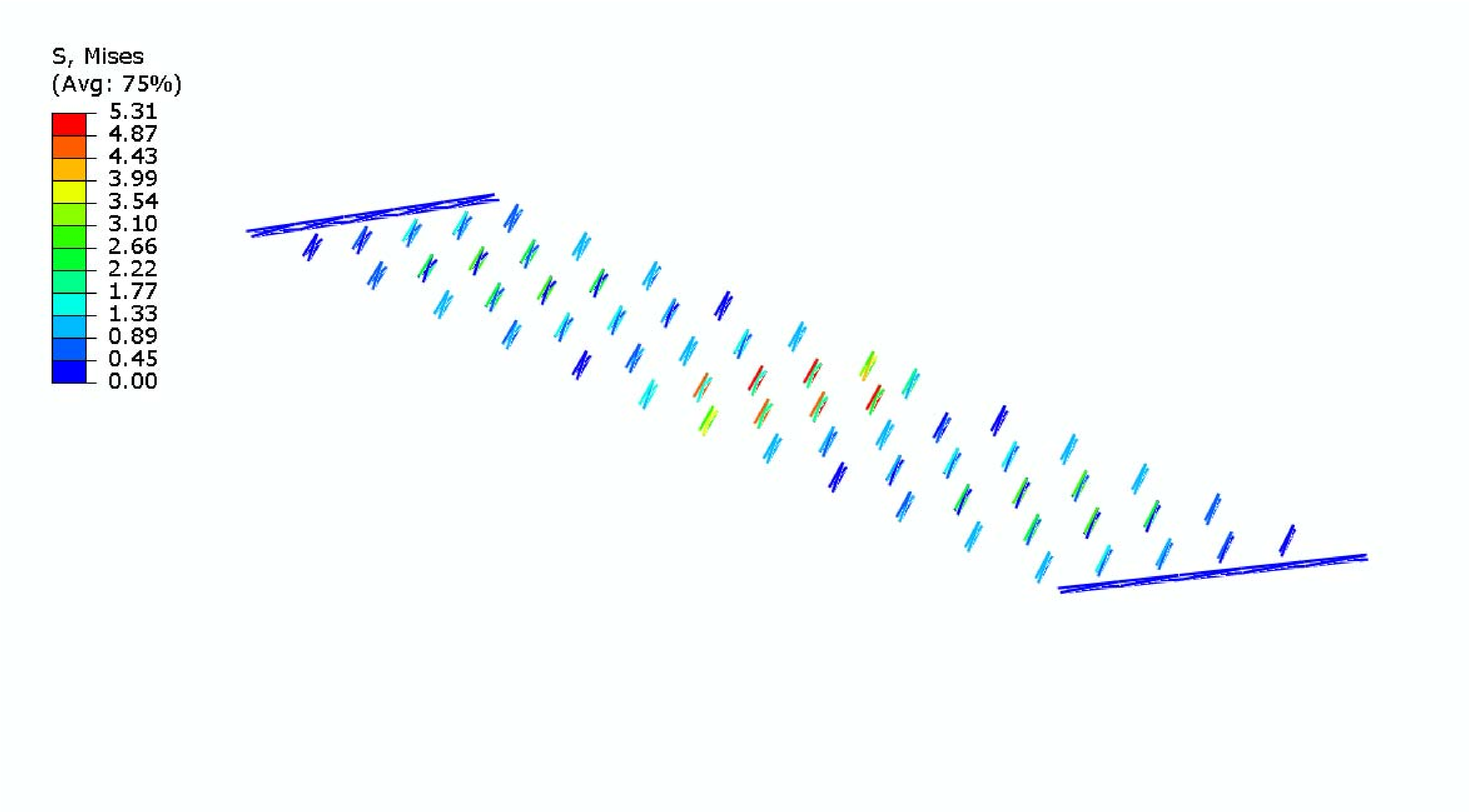


Figure K3-4-27. Cross-frame stress contours under SDL, TDLF detailing

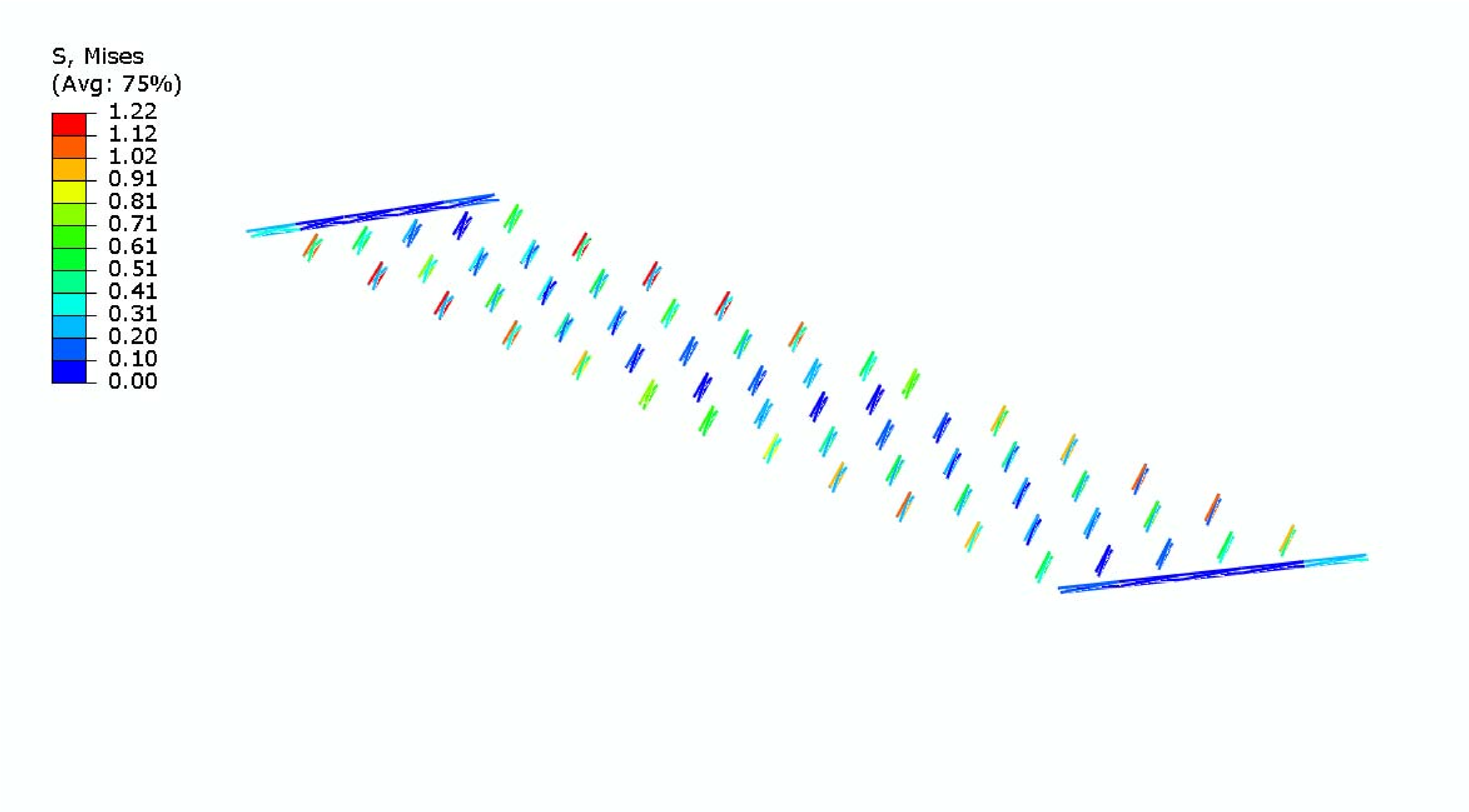


Figure K3-4-28. **Cross-frame stress contours under TDL, TDLF**

Table K3-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.2	0.1	0.2	0.2	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.4	0.3	0.6	0.6	0.4
2	NLF	0.0	0.1	0.4	0.6	0.8
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.2	0.4	1.5	2.0	2.6
3	NLF	0.7	0.2	0.2	0.6	1.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.3	0.9	0.6	1.8	3.6
4	NLF	1.0	0.5	0.1	0.3	0.8
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.3	1.6	0.5	1.0	2.7
5	NLF	0.9	0.6	0.5	0.1	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.9	2.0	1.6	0.5	0.3
6	NLF	0.2	0.8	1.0	0.8	1.1
	SDLF	0.0	0.0	0.0	0.0	0.1
	TDLF	0.6	2.6	3.0	2.5	3.7
7	NLF	1.2	1.8	2.0	2.1	3.9
	SDLF	0.1	0.0	0.0	0.0	0.1
	TDLF	3.6	5.0	5.6	5.9	11.4
8	NLF	3.6	2.1	2.0	2.6	1.1
	SDLF	0.0	0.0	0.0	0.1	0.0
	TDLF	10.4	6.1	5.6	7.2	3.8
9	NLF	0.8	0.8	0.9	0.5	0.4
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.9	2.4	2.8	1.5	1.0
10	NLF	0.2	0.2	0.5	0.6	1.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.2	0.8	1.8	2.1	3.3

Table K3-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.9	0.4	0.1	0.5	1.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.6	1.0	0.5	1.6	3.3
12	NLF	1.1	0.6	0.3	0.2	0.6
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.5	1.8	0.8	0.8	2.2
13	NLF	0.8	0.7	0.6	0.2	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.8	2.3	1.9	0.6	0.2
14	NLF	0.1	0.2	0.2	0.1	0.2
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.4	0.7	0.6	0.1	0.5

Table K3-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	4.0	1.4	0.3	0.1	0.3
	SDLF	3.6	1.2	0.3	0.1	0.3
	TDLF	2.3	0.6	0.2	0.1	0.8
2	NLF	2.1	1.3	1.6	2.4	4.3
	SDLF	2.0	1.2	1.1	1.9	3.6
	TDLF	1.4	1.0	0.5	0.1	1.3
3	NLF	4.1	2.3	0.4	2.8	5.7
	SDLF	3.3	2.0	0.2	2.2	4.7
	TDLF	0.7	1.0	0.4	0.4	1.3
4	NLF	5.1	3.0	0.8	2.4	4.6
	SDLF	4.1	2.5	0.7	2.1	3.7
	TDLF	0.7	0.7	0.0	0.9	0.8
5	NLF	4.8	3.0	1.8	0.7	1.5
	SDLF	3.9	2.4	1.3	0.7	1.4
	TDLF	1.1	0.5	0.3	0.9	0.9
6	NLF	2.3	3.9	3.7	2.5	3.7
	SDLF	2.1	3.0	2.7	1.7	2.4
	TDLF	1.4	0.3	0.5	0.9	1.2
7	NLF	3.3	6.6	7.3	7.3	14.3
	SDLF	2.1	4.9	5.3	5.3	10.3
	TDLF	2.1	0.1	0.3	0.7	1.1
8	NLF	12.6	7.9	7.6	10.0	3.1
	SDLF	9.0	5.7	5.5	7.4	2.0
	TDLF	1.6	0.6	0.3	0.3	1.9
9	NLF	2.6	2.4	3.4	2.3	2.9
	SDLF	1.8	1.7	2.5	1.7	2.4
	TDLF	1.1	0.8	0.4	0.2	1.5
10	NLF	1.1	0.2	2.2	3.2	5.0
	SDLF	0.9	0.2	1.6	2.6	3.9
	TDLF	0.7	0.8	0.3	0.6	0.7

Table K3-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location				
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	4.2	2.1	0.8	2.9	4.9
	SDLF	3.3	1.7	0.7	2.4	3.9
	TDLF	0.7	0.7	0.1	0.6	0.6
12	NLF	5.6	2.7	0.7	1.9	3.5
	SDLF	4.5	2.1	0.4	1.7	2.8
	TDLF	1.1	0.2	0.4	0.8	0.5
13	NLF	4.6	2.8	2.0	0.7	1.4
	SDLF	3.8	2.1	1.4	0.7	1.4
	TDLF	1.1	0.1	0.5	0.9	1.3
14	NLF	0.6	0.5	0.3	1.2	3.5
	SDLF	0.6	0.4	0.2	1.1	3.1
	TDLF	0.7	0.1	0.2	0.6	2.2

Table K3-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.0	0.1	0.0	0.1	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.0	0.2	0.1	0.2	0.4
2	NLF	0.1	0.7	1.1	1.1	0.6
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.5	2.5	3.8	3.7	2.0
3	NLF	0.6	1.9	2.4	2.1	0.9
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.1	6.3	8.0	7.2	3.0
4	NLF	0.9	2.2	2.5	2.1	0.7
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.0	7.3	8.3	6.7	2.4
5	NLF	0.8	1.5	1.5	1.0	0.2
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.4	4.6	4.6	3.1	0.5
6	NLF	0.1	0.6	0.9	1.2	1.0
	SDLF	0.0	0.0	0.1	0.1	0.1
	TDLF	0.0	2.1	2.9	3.9	3.3
7	NLF	1.5	4.4	4.7	4.7	2.6
	SDLF	0.0	0.1	0.1	0.1	0.1
	TDLF	4.3	13.0	14.1	14.0	7.8
8	NLF	2.7	4.5	4.6	5.0	1.9
	SDLF	0.1	0.0	0.0	0.1	0.0
	TDLF	7.9	13.6	14.0	15.2	5.8
9	NLF	0.8	0.8	0.6	0.0	0.3
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.7	3.3	2.6	0.7	0.5
10	NLF	0.2	1.1	1.7	1.7	0.9
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.4	2.9	4.6	5.0	2.7

Table K3-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location				
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.8	2.2	2.8	2.4	1.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.3	6.8	8.6	7.6	3.1
12	NLF	1.0	2.3	2.5	1.9	0.6
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.1	7.4	8.1	6.3	1.9
13	NLF	0.7	1.1	1.1	0.6	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.3	3.8	3.8	2.2	0.2
14	NLF	0.1	0.1	0.0	0.1	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.3	0.2	0.0	0.4	0.2

Table K3-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	2.2	0.9	0.1	0.4	0.2
	SDLF	2.0	0.7	0.1	0.3	0.1
	TDLF	1.5	0.3	0.1	0.0	0.9
2	NLF	2.2	2.1	4.9	4.8	0.9
	SDLF	2.4	1.3	3.7	3.7	0.3
	TDLF	3.0	1.5	0.5	0.2	1.8
3	NLF	0.8	6.0	9.1	7.7	0.3
	SDLF	1.4	4.2	6.9	5.7	0.5
	TDLF	3.5	2.1	0.9	1.0	3.3
4	NLF	0.1	7.1	9.4	6.9	0.3
	SDLF	0.7	5.0	7.0	4.9	1.0
	TDLF	3.4	1.8	0.8	1.7	3.3
5	NLF	0.2	4.7	5.5	2.6	2.6
	SDLF	0.9	3.3	4.1	1.6	2.7
	TDLF	3.1	1.2	0.7	1.8	3.3
6	NLF	2.2	2.8	3.9	6.5	7.6
	SDLF	2.3	2.2	3.0	5.2	6.4
	TDLF	2.5	0.5	0.5	1.5	3.1
7	NLF	7.3	17.3	19.2	19.8	12.1
	SDLF	5.9	12.9	14.4	14.9	9.4
	TDLF	1.9	0.0	0.2	0.8	1.6
8	NLF	12.7	19.2	19.2	20.5	9.6
	SDLF	9.9	14.5	14.5	15.4	7.7
	TDLF	1.8	0.6	0.2	0.2	2.1
9	NLF	6.1	5.5	3.4	0.8	1.7
	SDLF	5.3	4.6	2.8	0.9	2.1
	TDLF	2.5	1.3	0.4	0.4	2.7
10	NLF	2.2	2.6	5.8	5.5	0.8
	SDLF	2.5	1.4	4.1	3.7	0.1
	TDLF	2.9	1.6	0.6	1.2	2.7

Table K3-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.2	7.5	10.3	8.1	0.8
	SDLF	0.6	5.3	7.6	5.7	0.1
	TDLF	2.9	1.4	0.7	1.6	3.1
12	NLF	1.1	8.5	9.6	6.3	0.5
	SDLF	0.2	6.3	7.1	4.4	1.0
	TDLF	2.8	0.8	0.8	1.9	3.0
13	NLF	1.5	4.9	4.6	1.7	2.3
	SDLF	0.8	3.7	3.4	1.0	2.4
	TDLF	1.5	0.2	0.5	1.4	2.6
14	NLF	0.2	0.5	0.1	1.0	1.7
	SDLF	0.0	0.4	0.1	0.8	1.6
	TDLF	0.8	0.0	0.1	0.3	1.4

Table K3-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.1	0.1	0.1	0.1	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.2	0.4	0.2	0.1	0.1
2	NLF	0.1	0.7	1.1	1.1	0.7
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.4	2.4	3.8	3.9	2.3
3	NLF	0.6	1.9	2.4	2.2	0.9
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.2	6.5	8.2	7.4	3.1
4	NLF	1.0	2.3	2.6	2.1	0.8
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	3.2	7.5	8.5	6.9	2.5
5	NLF	0.8	1.5	1.5	1.0	0.2
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.5	4.6	4.6	3.1	0.5
6	NLF	0.1	0.6	0.9	1.2	1.0
	SDLF	0.0	0.0	0.1	0.1	0.1
	TDLF	0.0	2.2	3.0	3.9	3.3
7	NLF	1.7	4.5	4.8	4.8	2.7
	SDLF	0.0	0.0	0.1	0.1	0.1
	TDLF	4.7	13.3	14.4	14.2	8.1
8	NLF	2.6	4.5	4.5	4.9	2.0
	SDLF	0.0	0.0	0.0	0.1	0.0
	TDLF	7.7	13.4	13.8	14.9	5.9
9	NLF	0.8	0.8	0.6	0.0	0.3
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.7	3.3	2.6	0.7	0.5
10	NLF	0.2	1.1	1.7	1.8	0.9
	SDLF	0.0	0.0	0.0	0.1	0.0
	TDLF	0.4	2.9	4.6	5.0	2.8

Table K3-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.8	2.3	2.8	2.5	1.0
	SDLF	0.0	0.0	0.0	0.1	0.0
	TDLF	2.4	6.9	8.7	7.8	3.2
12	NLF	1.0	2.3	2.6	2.0	0.6
	SDLF	0.0	0.0	0.1	0.0	0.0
	TDLF	3.1	7.5	8.3	6.5	2.0
13	NLF	0.8	1.2	1.1	0.6	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	2.5	3.9	3.8	2.1	0.1
14	NLF	0.0	0.0	0.1	0.2	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0
	TDLF	0.1	0.1	0.2	0.5	0.0

Table K3-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	1.9	0.6	0.3	0.3	0.6
	SDLF	1.8	0.5	0.3	0.2	0.6
	TDLF	1.6	0.3	0.1	0.0	0.8
2	NLF	2.9	1.1	4.0	4.5	1.1
	SDLF	2.9	0.5	3.0	3.4	0.4
	TDLF	3.1	1.6	0.6	0.3	1.9
3	NLF	0.9	6.2	9.8	8.6	0.8
	SDLF	1.5	4.3	7.3	6.3	0.1
	TDLF	3.5	2.1	0.9	1.1	3.3
4	NLF	0.7	8.0	10.3	7.2	0.2
	SDLF	0.3	5.7	7.7	5.1	1.0
	TDLF	3.5	1.8	0.9	1.7	3.4
5	NLF	0.2	4.8	5.2	2.0	3.0
	SDLF	0.6	3.4	3.8	1.1	3.0
	TDLF	3.2	1.2	0.7	1.8	3.4
6	NLF	2.7	3.6	4.7	6.9	7.4
	SDLF	2.7	2.9	3.7	5.6	6.3
	TDLF	2.6	0.5	0.5	1.6	3.1
7	NLF	8.4	17.9	19.2	19.5	12.2
	SDLF	6.8	13.3	14.4	14.7	9.5
	TDLF	2.1	0.1	0.3	0.8	1.7
8	NLF	12.2	18.3	18.4	20.2	10.0
	SDLF	9.6	13.9	13.9	15.2	8.0
	TDLF	2.0	0.6	0.3	0.3	2.1
9	NLF	5.9	5.6	3.8	1.3	2.0
	SDLF	5.2	4.7	3.2	1.3	2.3
	TDLF	2.5	1.3	0.5	0.4	2.8
10	NLF	2.4	2.3	5.6	5.6	1.0
	SDLF	2.6	1.2	3.9	3.8	0.1
	TDLF	2.9	1.6	0.7	1.2	2.7

Table K3-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.2	7.6	10.8	8.7	1.2
	SDLF	0.6	5.4	7.9	6.1	0.1
	TDLF	2.9	1.5	0.8	1.7	3.1
12	NLF	1.4	9.1	10.1	6.5	0.5
	SDLF	0.3	6.7	7.5	4.5	1.1
	TDLF	2.8	0.8	0.8	1.9	3.0
13	NLF	1.8	4.7	4.1	1.0	2.7
	SDLF	1.0	3.6	3.0	0.4	2.7
	TDLF	1.5	0.2	0.6	1.5	2.7
14	NLF	0.6	0.3	0.5	0.9	1.8
	SDLF	0.6	0.3	0.4	0.8	1.7
	TDLF	0.8	0.0	0.2	0.3	1.6

Table K3-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	0.36	0.33	0.31	0.31	0.29
	SDLF	0.29	0.32	0.32	0.32	0.33
	TDLF	0.06	0.32	0.35	0.38	0.49
3	NLF	0.23	0.18	0.17	0.16	0.13
	SDLF	0.10	0.16	0.16	0.16	0.20
	TDLF	0.32	0.08	0.12	0.14	0.47
4	NLF	0.04	0.00	0.01	0.01	0.05
	SDLF	0.10	0.04	0.04	0.04	0.00
	TDLF	0.55	0.17	0.15	0.13	0.24
5	NLF	0.13	0.15	0.15	0.16	0.17
	SDLF	0.23	0.19	0.19	0.19	0.16
	TDLF	0.55	0.33	0.33	0.32	0.06
6	NLF	0.19	0.18	0.18	0.17	0.17
	SDLF	0.22	0.21	0.21	0.21	0.19
	TDLF	0.34	0.29	0.31	0.33	0.23
7	NLF	0.12	0.11	0.10	0.09	0.08
	SDLF	0.11	0.11	0.11	0.11	0.11
	TDLF	0.07	0.11	0.14	0.17	0.19
8	NLF	0.03	0.05	0.06	0.07	0.05
	SDLF	0.07	0.07	0.07	0.07	0.03
	TDLF	0.18	0.14	0.12	0.09	0.02
9	NLF	0.10	0.11	0.11	0.11	0.12
	SDLF	0.12	0.14	0.14	0.14	0.16
	TDLF	0.21	0.25	0.24	0.23	0.26
10	NLF	0.10	0.09	0.09	0.09	0.07
	SDLF	0.09	0.13	0.13	0.13	0.17
	TDLF	0.08	0.24	0.25	0.26	0.41

Table K3-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.03	0.00	0.00	-0.01	-0.04
	SDLF	-0.02	0.02	0.02	0.03	0.08
	TDLF	-0.14	0.10	0.12	0.15	0.41
12	NLF	-0.08	-0.11	-0.12	-0.13	-0.16
	SDLF	-0.14	-0.11	-0.11	-0.11	-0.05
	TDLF	-0.31	-0.09	-0.07	-0.03	0.25
13	NLF	-0.19	-0.21	-0.21	-0.23	-0.25
	SDLF	-0.23	-0.22	-0.22	-0.22	-0.19
	TDLF	-0.35	-0.27	-0.25	-0.21	-0.01
14	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K3-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	1.60	1.40	1.33	1.30	1.21
	SDLF	1.53	1.40	1.34	1.31	1.25
	TDLF	1.30	1.39	1.37	1.36	1.41
3	NLF	1.08	0.80	0.71	0.67	0.44
	SDLF	0.95	0.77	0.70	0.66	0.51
	TDLF	0.52	0.70	0.66	0.64	0.77
4	NLF	0.27	0.01	0.05	0.10	0.34
	SDLF	0.13	0.03	0.08	0.13	0.28
	TDLF	0.32	0.16	0.19	0.22	0.04
5	NLF	0.49	0.63	0.65	0.68	0.81
	SDLF	0.59	0.67	0.69	0.72	0.80
	TDLF	0.91	0.81	0.82	0.85	0.70
6	NLF	0.74	0.75	0.74	0.73	0.74
	SDLF	0.77	0.78	0.77	0.77	0.77
	TDLF	0.89	0.86	0.87	0.88	0.80
7	NLF	0.50	0.45	0.41	0.38	0.34
	SDLF	0.49	0.45	0.42	0.40	0.36
	TDLF	0.45	0.45	0.45	0.46	0.44
8	NLF	0.11	0.17	0.20	0.23	0.15
	SDLF	0.14	0.19	0.21	0.24	0.14
	TDLF	0.25	0.26	0.26	0.26	0.09
9	NLF	0.41	0.42	0.43	0.44	0.44
	SDLF	0.43	0.46	0.46	0.47	0.48
	TDLF	0.52	0.57	0.56	0.56	0.58
10	NLF	0.48	0.40	0.37	0.36	0.26
	SDLF	0.46	0.43	0.41	0.40	0.36
	TDLF	0.45	0.55	0.54	0.53	0.60

Table K3-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location				
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**
11	NLF	0.20	0.05	0.00	-0.04	-0.23
	SDLF	0.16	0.07	0.03	-0.01	-0.11
	TDLF	0.03	0.15	0.13	0.11	0.22
12	NLF	-0.26	-0.42	-0.46	-0.53	-0.74
	SDLF	-0.32	-0.42	-0.45	-0.51	-0.63
	TDLF	-0.49	-0.40	-0.41	-0.43	-0.32
13	NLF	-0.77	-0.84	-0.87	-0.94	-1.10
	SDLF	-0.81	-0.86	-0.88	-0.94	-1.03
	TDLF	-0.93	-0.90	-0.91	-0.92	-0.86
14	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K3-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	0.16	0.15	0.14	0.14	0.13
	SDLF	0.13	0.15	0.15	0.14	0.15
	TDLF	0.03	0.14	0.16	0.17	0.22
3	NLF	0.10	0.08	0.08	0.07	0.06
	SDLF	0.05	0.07	0.07	0.07	0.09
	TDLF	0.14	0.04	0.05	0.06	0.21
4	NLF	0.02	0.00	0.00	0.01	0.02
	SDLF	0.04	0.02	0.02	0.02	0.00
	TDLF	0.25	0.08	0.07	0.06	0.11
5	NLF	0.06	0.07	0.07	0.07	0.08
	SDLF	0.10	0.09	0.09	0.09	0.07
	TDLF	0.25	0.15	0.15	0.14	0.03
6	NLF	0.08	0.08	0.08	0.08	0.08
	SDLF	0.10	0.09	0.09	0.09	0.09
	TDLF	0.15	0.13	0.14	0.15	0.10
7	NLF	0.05	0.05	0.04	0.04	0.03
	SDLF	0.05	0.05	0.05	0.05	0.05
	TDLF	0.03	0.05	0.06	0.08	0.08
8	NLF	0.02	0.02	0.03	0.03	0.02
	SDLF	0.03	0.03	0.03	0.03	0.01
	TDLF	0.08	0.06	0.05	0.04	0.01
9	NLF	0.04	0.05	0.05	0.05	0.05
	SDLF	0.05	0.06	0.06	0.06	0.07
	TDLF	0.09	0.11	0.11	0.10	0.12
10	NLF	0.05	0.04	0.04	0.04	0.03
	SDLF	0.04	0.06	0.06	0.06	0.08
	TDLF	0.04	0.11	0.11	0.12	0.18

Table K3-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**
11	NLF	0.01	0.00	0.00	0.00	-0.02
	SDLF	-0.01	0.01	0.01	0.01	0.04
	TDLF	-0.06	0.05	0.05	0.07	0.19
12	NLF	-0.04	-0.05	-0.05	-0.06	-0.07
	SDLF	-0.06	-0.05	-0.05	-0.05	-0.02
	TDLF	-0.14	-0.04	-0.03	-0.01	0.11
13	NLF	-0.09	-0.09	-0.10	-0.10	-0.11
	SDLF	-0.10	-0.10	-0.10	-0.10	-0.09
	TDLF	-0.16	-0.12	-0.11	-0.09	-0.01
14	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K3-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	0.72	0.63	0.60	0.58	0.54
	SDLF	0.69	0.63	0.60	0.59	0.56
	TDLF	0.58	0.63	0.61	0.61	0.63
3	NLF	0.48	0.36	0.32	0.30	0.20
	SDLF	0.43	0.35	0.31	0.30	0.23
	TDLF	0.24	0.31	0.30	0.29	0.35
4	NLF	0.12	0.00	0.02	0.05	0.15
	SDLF	0.06	0.01	0.04	0.06	0.13
	TDLF	0.15	0.07	0.08	0.10	0.02
5	NLF	0.22	0.28	0.29	0.31	0.36
	SDLF	0.26	0.30	0.31	0.32	0.36
	TDLF	0.41	0.36	0.37	0.38	0.31
6	NLF	0.33	0.34	0.33	0.33	0.33
	SDLF	0.35	0.35	0.35	0.35	0.34
	TDLF	0.40	0.39	0.39	0.40	0.36
7	NLF	0.23	0.20	0.19	0.17	0.15
	SDLF	0.22	0.20	0.19	0.18	0.16
	TDLF	0.20	0.20	0.20	0.21	0.20
8	NLF	0.05	0.07	0.09	0.10	0.07
	SDLF	0.06	0.09	0.10	0.11	0.06
	TDLF	0.11	0.12	0.12	0.12	0.04
9	NLF	0.18	0.19	0.19	0.20	0.20
	SDLF	0.19	0.21	0.21	0.21	0.22
	TDLF	0.23	0.26	0.25	0.25	0.26
10	NLF	0.21	0.18	0.17	0.16	0.12
	SDLF	0.21	0.19	0.19	0.18	0.16
	TDLF	0.20	0.25	0.24	0.24	0.27

Table K3-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**
11	NLF	0.09	0.02	0.00	-0.02	-0.10
	SDLF	0.07	0.03	0.01	0.00	-0.05
	TDLF	0.02	0.07	0.06	0.05	0.10
12	NLF	-0.12	-0.19	-0.21	-0.24	-0.33
	SDLF	-0.14	-0.19	-0.20	-0.23	-0.28
	TDLF	-0.22	-0.18	-0.18	-0.19	-0.14
13	NLF	-0.35	-0.38	-0.39	-0.42	-0.49
	SDLF	-0.36	-0.38	-0.40	-0.42	-0.46
	TDLF	-0.42	-0.41	-0.41	-0.41	-0.38
14	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00

Table K3-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number					
		SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
G1	NLF	16.1	63.1	14.5	72.8	233.1	63.3
	SDLF	15.2	64.9	13.4	71.7	234.8	62.3
	TDLF	12.0	69.7	10.1	68.1	239.9	59.4
G2	NLF	16.5	71.4	14.7	67.3	255.1	59.2
	SDLF	17.0	68.7	15.1	67.8	252.4	59.6
	TDLF	18.8	61.0	16.6	69.8	244.4	61.1
G3	NLF	16.4	67.9	14.7	67.2	241.7	59.4
	SDLF	17.0	68.8	15.1	67.8	242.5	59.9
	TDLF	19.1	71.2	16.5	70.0	244.9	61.3
G4	NLF	16.6	67.5	14.4	68.5	239.7	57.9
	SDLF	17.0	68.8	15.1	68.9	241.1	58.7
	TDLF	18.4	72.7	17.3	70.3	244.9	60.9
G5	NLF	16.6	72.2	14.6	68.3	259.1	58.6
	SDLF	17.0	68.6	15.2	68.7	255.4	59.1
	TDLF	18.5	58.6	16.7	70.1	245.2	60.8
G6	NLF	16.4	62.9	14.1	72.2	231.4	63.4
	SDLF	15.4	65.1	13.1	71.4	233.5	62.3
	TDLF	11.9	71.4	9.9	68.4	239.6	58.9

Table K3-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
G1	NLF	0.0	NA	NA	-0.2	NA	NA
	SDLF	0.0	NA	NA	-0.1	NA	NA
	TDLF	0.0	NA	NA	0.0	NA	NA
G2	NLF	0.0	NA	NA	0.0	NA	NA
	SDLF	0.0	NA	NA	0.0	NA	NA
	TDLF	-0.1	NA	NA	0.0	NA	NA
G3	NLF	0.0	NA	NA	0.1	NA	NA
	SDLF	0.0	NA	NA	0.1	NA	NA
	TDLF	-0.1	NA	NA	0.0	NA	NA
G4	NLF	0.0	NA	NA	0.1	NA	NA
	SDLF	0.0	NA	NA	0.1	NA	NA
	TDLF	0.0	NA	NA	0.0	NA	NA
G5	NLF	0.0	NA	NA	0.0	NA	NA
	SDLF	0.0	NA	NA	0.0	NA	NA
	TDLF	0.0	NA	NA	0.0	NA	NA
G6	NLF	0.0	NA	NA	-0.1	NA	NA
	SDLF	0.0	NA	NA	-0.1	NA	NA
	TDLF	0.1	NA	NA	0.0	NA	NA

Table K3-4-13. Individual support transverse reactions under SDL and TDL (kips).

		Load Type & Support Number					
Girder	Detailing Method	SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
G1	NLF	0.0	-0.2	-0.1	0.4	-0.6	0.0
	SDLF	0.0	0.0	0.0	0.3	-0.4	0.0
	TDLF	-0.1	0.5	0.2	0.1	0.1	0.0
G2	NLF	0.0	0.0	0.0	0.0	-0.2	0.1
	SDLF	0.0	0.0	0.0	0.0	-0.1	0.1
	TDLF	0.0	0.2	0.0	0.0	0.1	0.0
G3	NLF	0.0	0.0	0.0	-0.2	-0.1	0.0
	SDLF	0.0	0.0	0.0	-0.1	-0.1	0.1
	TDLF	0.0	0.1	0.0	-0.1	0.0	0.1
G4	NLF	0.0	0.0	0.0	-0.2	-0.1	0.0
	SDLF	0.0	0.0	0.0	-0.1	-0.1	0.0
	TDLF	0.0	0.0	0.0	-0.1	0.0	0.1
G5	NLF	0.0	0.0	0.0	-0.1	-0.1	0.0
	SDLF	0.0	0.0	0.0	-0.1	-0.1	0.0
	TDLF	-0.1	0.0	0.0	-0.1	0.0	0.0
G6	NLF	0.1	0.3	0.0	0.1	1.0	-0.2
	SDLF	0.0	0.0	0.0	0.1	0.7	-0.2
	TDLF	-0.2	-0.7	0.0	0.0	-0.1	-0.1

Table K3-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
		Load Type & Support Number					
G1	NLF	0.00	0.07	0.09	-0.02	0.27	0.35
	SDLF	0.00	0.05	0.08	-0.01	0.23	0.30
	TDLF	0.00	0.02	0.07	0.00	0.24	0.35
G2	NLF	0.00	0.07	0.09	0.00	0.26	0.35
	SDLF	0.00	0.05	0.08	0.00	0.22	0.30
	TDLF	-0.01	0.05	0.10	0.00	0.25	0.36
G3	NLF	0.00	0.06	0.09	0.01	0.25	0.35
	SDLF	0.00	0.05	0.08	0.01	0.22	0.31
	TDLF	-0.01	0.06	0.10	0.00	0.25	0.36
G4	NLF	0.00	0.06	0.09	0.01	0.24	0.35
	SDLF	0.00	0.05	0.08	0.01	0.21	0.31
	TDLF	0.00	0.07	0.11	0.00	0.25	0.36
G5	NLF	0.00	0.05	0.09	0.00	0.23	0.35
	SDLF	0.00	0.05	0.08	0.00	0.20	0.31
	TDLF	0.00	0.08	0.11	0.00	0.25	0.36
G6	NLF	0.00	0.05	0.09	-0.01	0.22	0.36
	SDLF	0.00	0.05	0.08	-0.01	0.19	0.32
	TDLF	0.01	0.09	0.08	0.00	0.24	0.35

Table K3-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number					
		SDL 1	SDL 2	SDL 3	TDL 1	TDL 2	TDL 3
G1	NLF	0.00	0.02	0.01	-0.04	0.06	0.00
	SDLF	0.00	0.00	0.00	-0.03	0.04	0.00
	TDLF	0.01	-0.05	-0.02	-0.01	-0.01	0.00
G2	NLF	0.00	0.00	0.00	0.00	0.02	-0.01
	SDLF	0.00	0.00	0.00	0.00	0.01	-0.01
	TDLF	0.00	-0.02	0.00	0.00	-0.01	0.00
G3	NLF	0.00	0.00	0.00	0.02	0.01	0.00
	SDLF	0.00	0.00	0.00	0.01	0.01	-0.01
	TDLF	0.00	-0.01	0.00	0.01	0.00	-0.01
G4	NLF	0.00	0.00	0.00	0.02	0.01	0.00
	SDLF	0.00	0.00	0.00	0.01	0.01	0.00
	TDLF	0.00	0.00	0.00	0.01	0.00	-0.01
G5	NLF	0.00	0.00	0.00	0.01	0.01	0.00
	SDLF	0.00	0.00	0.00	0.01	0.01	0.00
	TDLF	0.01	0.00	0.00	0.01	0.00	0.00
G6	NLF	-0.01	-0.03	0.00	-0.01	-0.10	0.02
	SDLF	0.00	0.00	0.00	-0.01	-0.07	0.02
	TDLF	0.02	0.07	0.00	0.00	0.01	0.01

Appendix K3-5. EICSS12 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge EICSS12 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table K3-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-2	SDLF	0.0	0.1	0.1	0.0	0.0	0.0
		TDLF	-0.1	-0.2	0.2	0.0	0.3	0.3
	6-3	SDLF	-0.1	0.0	0.1	-0.1	0.1	0.2
		TDLF	0.1	-0.1	0.1	0.0	0.1	0.1
	6-4	SDLF	-0.7	0.3	0.7	-0.7	-0.3	0.7
		TDLF	-1.7	-0.5	1.8	-1.7	0.5	1.8
	6-5	SDLF	0.2	2.0	2.0	0.1	-1.2	1.2
		TDLF	-0.8	1.6	1.8	-0.6	-1.4	1.5
	6-6	SDLF	0.2	0.4	0.4	0.1	-0.3	0.3
		TDLF	1.0	3.0	3.2	1.2	-3.3	3.5
	6-7	SDLF	0.0	0.1	0.1	0.0	-0.1	0.1
		TDLF	0.0	0.4	0.4	0.0	-0.4	0.4

Table K3-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
10	10-2	SDLF	-0.1	0.2	0.2	-0.1	-0.3	0.3
		TDLF	0.0	-0.2	0.2	0.0	0.0	0.0
	10-3	SDLF	0.0	-0.1	0.1	0.0	0.1	0.1
		TDLF	0.0	0.0	0.1	0.0	0.1	0.1

Table K3-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
12	12-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.2	-0.3	0.4	0.2	0.2	0.3
	12-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.1	0.1	0.1	0.0	-0.3	0.3

Table K3-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
17	17-1	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.3	-0.1	1.3	1.4	-0.4	1.4
	17-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.0	-0.2	1.0	0.9	0.2	1.0
	17-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.1	-0.2	0.2	-0.1	0.3	0.4

Table K3-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
20	20-1	SDLF	0.0	0.0	0.1	0.0	0.0	0.0
		TDLF	2.6	16.6	16.8	2.6	-16.8	17.0
	20-2	SDLF	0.0	-0.2	0.2	0.0	0.2	0.2
		TDLF	0.9	-2.7	2.8	0.9	2.6	2.7
	20-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.4	1.1	1.8	1.4	-1.2	1.9
	20-4	SDLF	0.0	0.1	0.1	0.0	-0.1	0.1
		TDLF	-1.0	-5.0	5.1	-1.1	5.0	5.1

Table K3-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
22	22-1	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.7	0.2	1.7	1.7	-0.3	1.7
	22-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.4	-0.1	1.4	1.4	0.0	1.4
	22-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	-0.2	0.2	-0.1	0.3	0.3

Table K3-5-2: Erection Critical Sub-Stages

Stage	Detailing Method	Critical Sub-Stage
6	SDLF	6-5
	TDLF	6-6
10	SDLF	10-2
	TDLF	10-3
12	SDLF	12-3
	TDLF	12-3
17	SDLF	17-1
	TDLF	17-1
20	SDLF	20-2
	TDLF	20-1
22	SDLF	22-1
	TDLF	22-1

Table K3-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
6	A	SDLF	-0.1	1.2	1.2	NA	NA	NA
		TDLF	1.0	0.7	1.2	NA	NA	NA
	B	SDLF	0.2	2.0	2.0	0.1	-1.2	1.2
		TDLF	1.0	3.0	3.2	1.2	-3.3	3.5
10	A	SDLF	-0.2	0.1	0.2	NA	NA	NA
		TDLF	0.0	0.0	0.0	NA	NA	NA
	B	SDLF	-0.1	0.2	0.2	-0.1	-0.3	0.3
		TDLF	0.0	0.0	0.1	0.0	0.1	0.1
12	A	SDLF	0.0	0.0	0.0	NA	NA	NA
		TDLF	-0.1	0.1	0.1	NA	NA	NA
	B	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.1	0.1	0.1	0.0	-0.3	0.3
17	A	SDLF	0.0	0.0	0.0	NA	NA	NA
		TDLF	2.5	-0.4	2.5	NA	NA	NA
	B	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.3	-0.1	1.3	1.4	-0.4	1.4
20	A	SDLF	0.0	0.0	0.0	NA	NA	NA
		TDLF	-0.8	2.8	2.9	NA	NA	NA
	B	SDLF	0.0	-0.2	0.2	0.0	0.2	0.2
		TDLF	2.6	16.6	16.8	2.6	-16.8	17.0
22	A	SDLF	0.0	0.0	0.0	NA	NA	NA
		TDLF	3.1	0.0	3.1	NA	NA	NA
	B	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	1.7	0.2	1.7	1.7	-0.3	1.7

Table K3-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
6	A	G1	SDLF	19	49
			TDLF	18	54
		G2	SDLF	20	49
			TDLF	20	46
		G3	SDLF	20	49
			TDLF	20	48
		G4	SDLF	21	49
			TDLF	21	47
		G5	SDLF	21	48
			TDLF	21	46
		G6	SDLF	19	49
			TDLF	20	51
	B	G1	SDLF	19	49
			TDLF	18	54
		G2	SDLF	20	49
			TDLF	20	46
		G3	SDLF	20	49
			TDLF	20	48
		G4	SDLF	21	49
			TDLF	21	47
		G5	SDLF	21	48
			TDLF	21	47
		G6	SDLF	19	48
			TDLF	20	51

Table K3-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
10	A	G1	SDLF	15	63	13
			TDLF	14	67	13
		G2	SDLF	17	66	15
			TDLF	17	63	15
		G3	SDLF	17	66	13
			TDLF	17	65	14
		G4	SDLF	17	71	12
			TDLF	18	69	12
		G5	SDLF	18	57	
			TDLF	19	57	
		G6	SDLF	19	42	
			TDLF	19	44	
	B	G1	SDLF	15	63	13
			TDLF	14	67	13
		G2	SDLF	17	66	15
			TDLF	17	63	15
		G3	SDLF	17	66	13
			TDLF	17	65	15
		G4	SDLF	17	70	12
			TDLF	18	69	12
		G5	SDLF	18	57	
			TDLF	19	57	
		G6	SDLF	19	42	
			TDLF	19	44	

Table K3-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
12	A	G1	SDLF	15	64	13
			TDLF	14	68	13
		G2	SDLF	17	67	15
			TDLF	17	64	15
		G3	SDLF	17	67	15
			TDLF	16	66	15
		G4	SDLF	17	67	15
			TDLF	17	66	15
		G5	SDLF	17	67	14
			TDLF	17	67	15
		G6	SDLF	15	64	13
			TDLF	15	67	12
	B	G1	SDLF	15	64	13
			TDLF	14	68	13
		G2	SDLF	17	67	15
			TDLF	17	64	15
		G3	SDLF	17	67	15
			TDLF	16	66	15
		G4	SDLF	17	67	15
			TDLF	17	66	14
		G5	SDLF	17	67	14
			TDLF	17	67	14
		G6	SDLF	15	64	12
			TDLF	15	67	12

Table K3-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
17	A	G1	SDLF	15	65	13
			TDLF	12	63	14
		G2	SDLF	17	68	15
			TDLF	19	67	15
		G3	SDLF	17	68	15
			TDLF	19	69	14
		G4	SDLF	17	68	15
			TDLF	18	67	14
		G5	SDLF	17	68	15
			TDLF	19	65	15
		G6	SDLF	15	65	13
			TDLF	11	68	12
	B	G1	SDLF	15	65	13
			TDLF	12	63	14
		G2	SDLF	17	68	15
			TDLF	19	67	15
		G3	SDLF	17	68	15
			TDLF	19	69	14
		G4	SDLF	17	68	15
			TDLF	18	68	14
		G5	SDLF	17	68	15
			TDLF	19	65	15
		G6	SDLF	15	65	13
			TDLF	11	68	12

Table K3-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
20	A	G1	SDLF	15	65	14
			TDLF	12	69	13
		G2	SDLF	17	69	15
			TDLF	19	63	16
		G3	SDLF	17	69	15
			TDLF	19	65	16
		G4	SDLF	17	68	15
			TDLF	19	72	13
		G5	SDLF	17	68	15
			TDLF	19	64	14
		G6	SDLF	15	65	13
			TDLF	11	69	12
	B	G1	SDLF	15	65	14
			TDLF	12	69	13
		G2	SDLF	17	69	15
			TDLF	19	63	16
		G3	SDLF	17	69	15
			TDLF	19	70	16
		G4	SDLF	17	68	15
			TDLF	19	63	13
		G5	SDLF	17	68	15
			TDLF	19	69	14
		G6	SDLF	15	65	13
			TDLF	12	69	12

Table K3-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
22	A	G1	SDLF	15	65	13
			TDLF	12	70	10
		G2	SDLF	17	69	15
			TDLF	19	61	17
		G3	SDLF	17	69	15
			TDLF	19	71	17
		G4	SDLF	17	69	15
			TDLF	18	73	16
		G5	SDLF	17	69	15
			TDLF	18	58	16
		G6	SDLF	15	65	13
			TDLF	12	72	10
	B	G1	SDLF	15	65	13
			TDLF	12	70	10
		G2	SDLF	17	69	15
			TDLF	19	61	17
		G3	SDLF	17	69	15
			TDLF	19	71	17
		G4	SDLF	17	69	15
			TDLF	18	73	17
		G5	SDLF	17	69	15
			TDLF	18	58	16
		G6	SDLF	15	65	13
			TDLF	12	72	10

Appendix L1. NICSS16 Bridge Description

The key characteristics of NICSS16 are as follows:

- Span length along the centerline of the bridge, L_s = 120,150,150 ft.
- Width between the fascia girders, w_g = 74ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 1.6, 2.0, 2.0
- Number of girders in the completed bridge cross-section, n_g = 9.
- Parallel skew
- Skew angle, θ = 70,70,70,70^o
- Skew index, I_s = 1.69, 1.35, 1.35

This appendix presents the bridge description of the bridge NICSS16 in its final condition as well as during erection. The following figures and tables are provided:

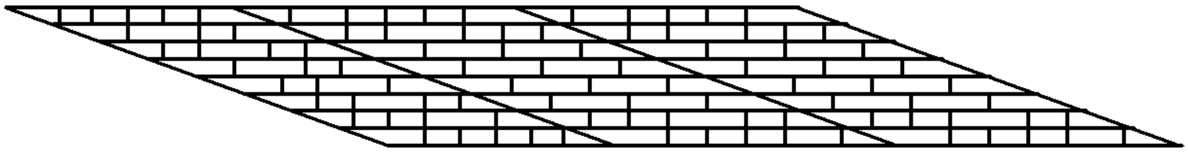


Figure L1-1. Framing plan.

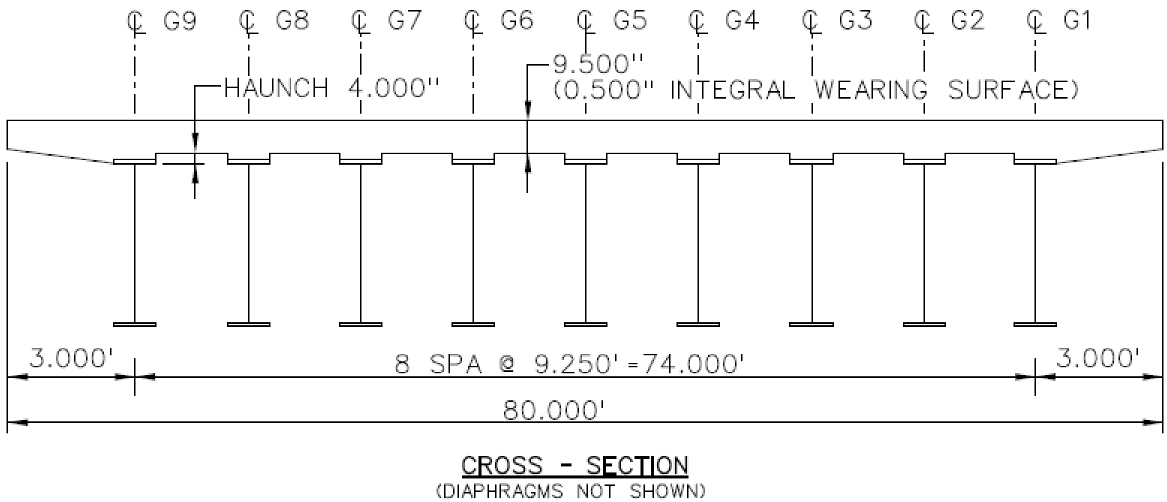


Figure L1-2. Bridge cross-section.

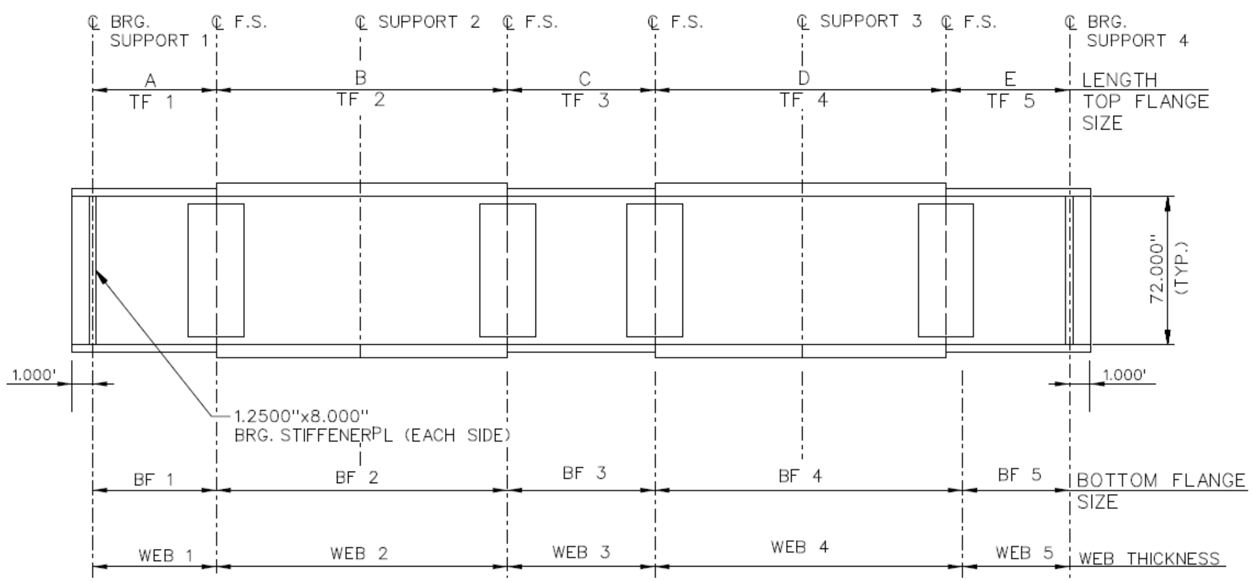


Figure L1-3. Girder elevations

	GIRDER PLATE LENGTHS *								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	90	90	90	90	90	90	90	90	90
B	65	65	65	65	65	65	65	65	65
C	70	70	70	70	70	70	70	70	70
D	75	75	75	75	75	75	75	75	75
E	120	120	120	120	120	120	120	120	120

* ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS **	
TOP FLANGE	G1 THRU G9	
	BF	TF
TF1	18	0.75
TF2	18	1.75
TF3	18	0.75
TF4	18	1.75
TF5	18	0.75

** ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS **	
BOTTOM FLANGE	G1 THRU G9	
	BF	TF
BF1	18	0.75
BF2	18	1.75
BF3	18	0.75
BF4	18	1.75
BF5	18	0.75

** ALL DIMENSIONS ARE IN INCHES.

Figure L1-4. Cross-section dimensions.

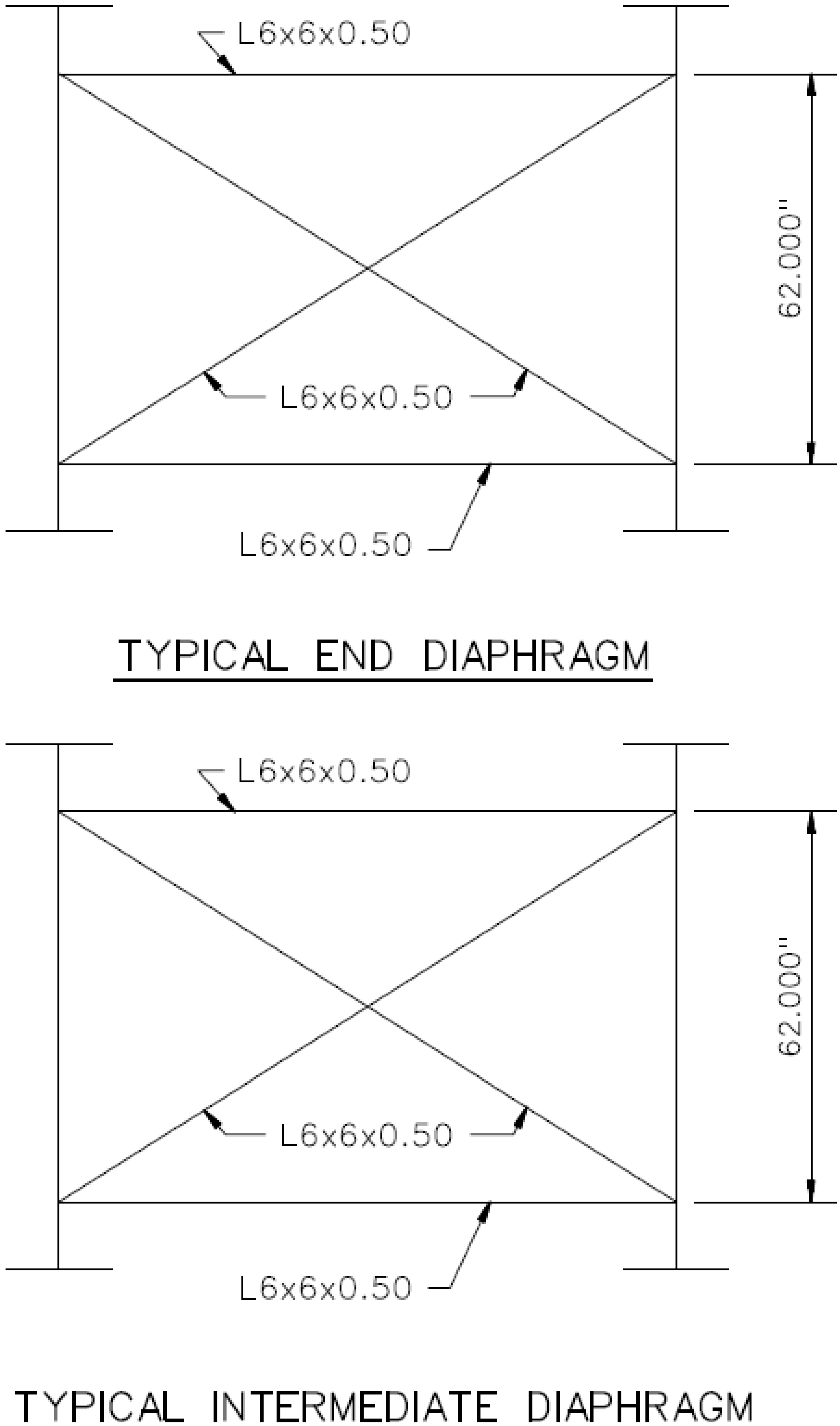


Figure L1-5. Cross-frame details.

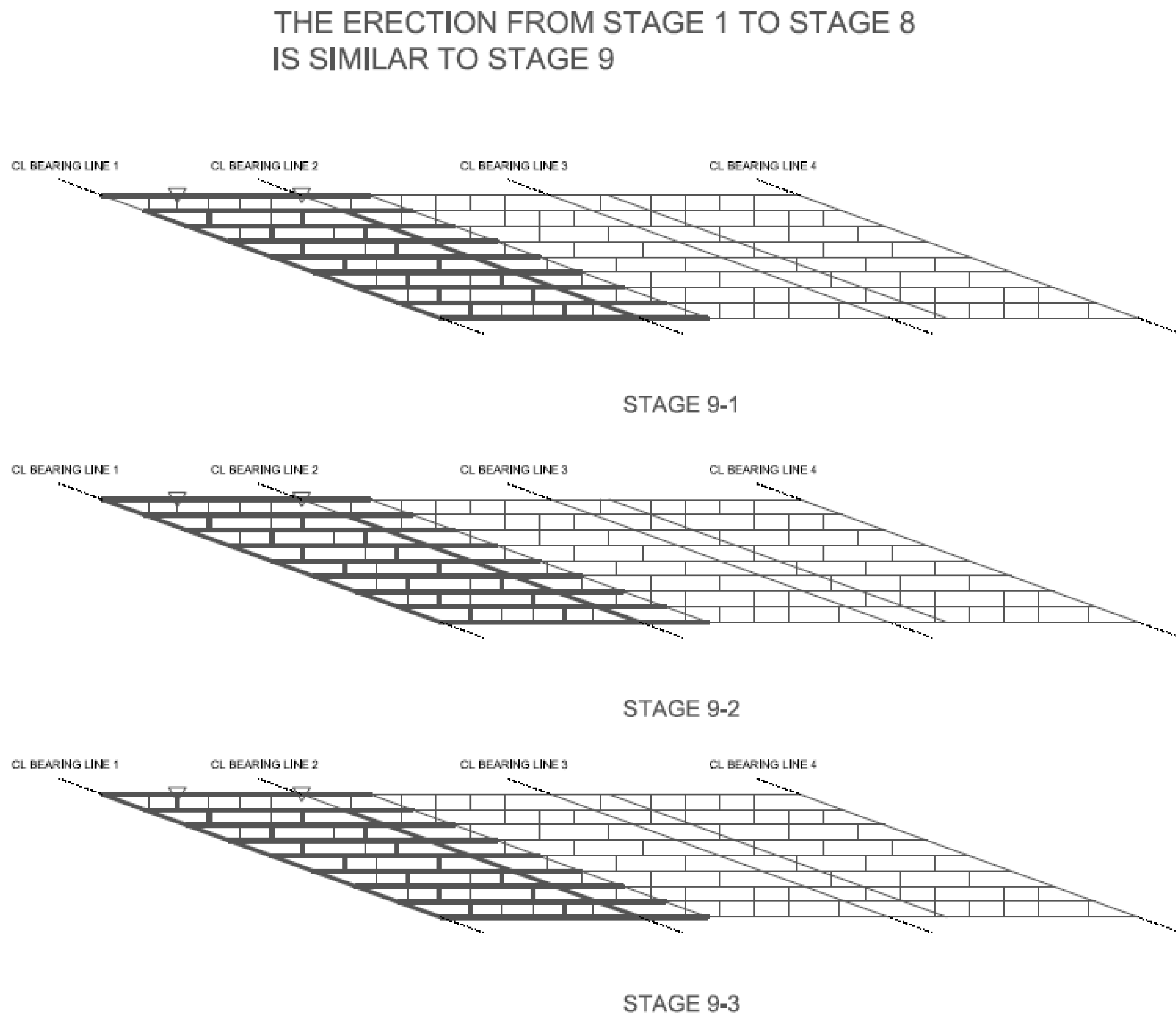
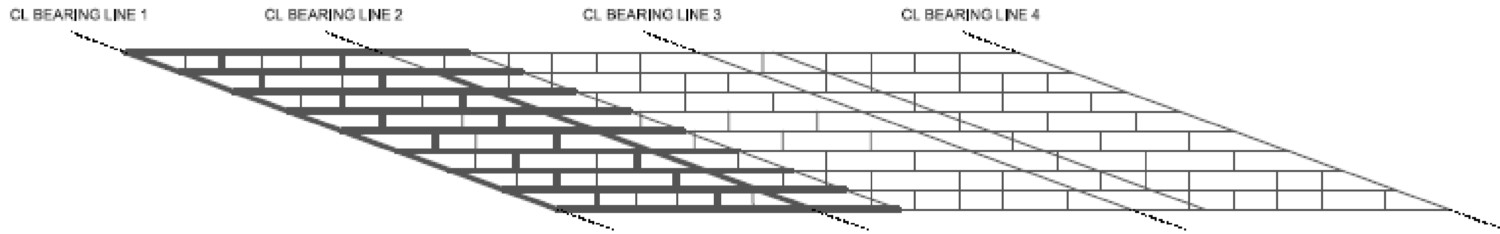
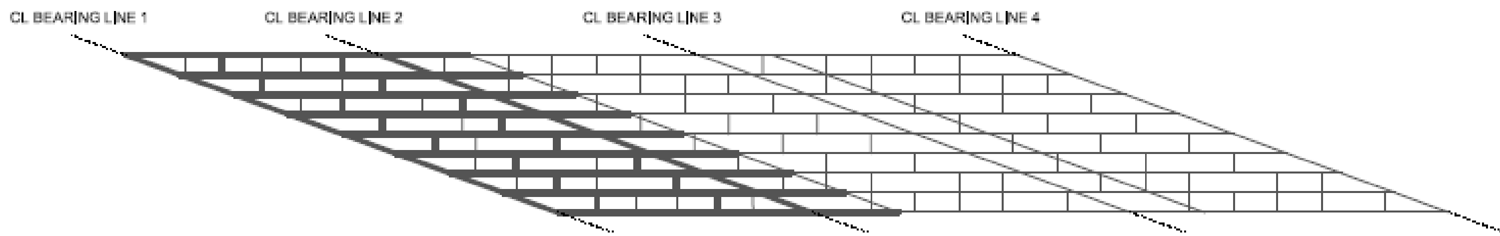


Figure L1-6. Erection scheme.



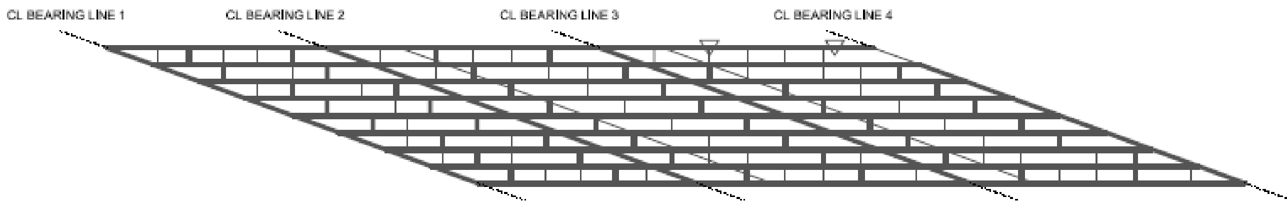
STAGE 9-4



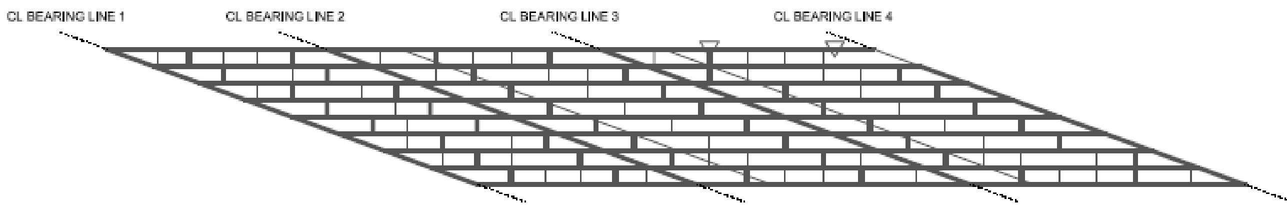
STAGE 9-5

Figure L1-6(Continued). Erection scheme.

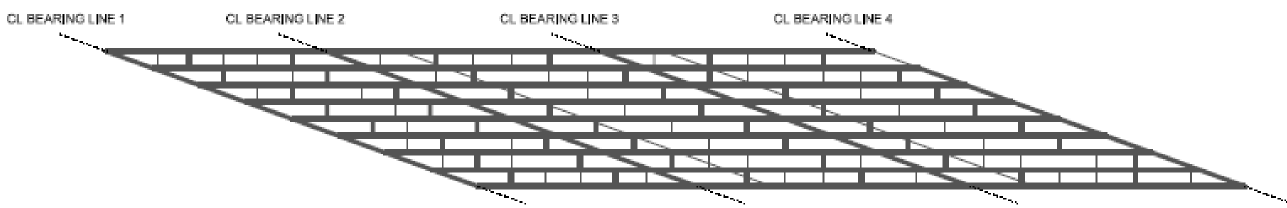
THE ERECTION FROM STAGE 10 TO STAGE 26
IS SIMILAR TO STAGE 27



STAGE 27-1

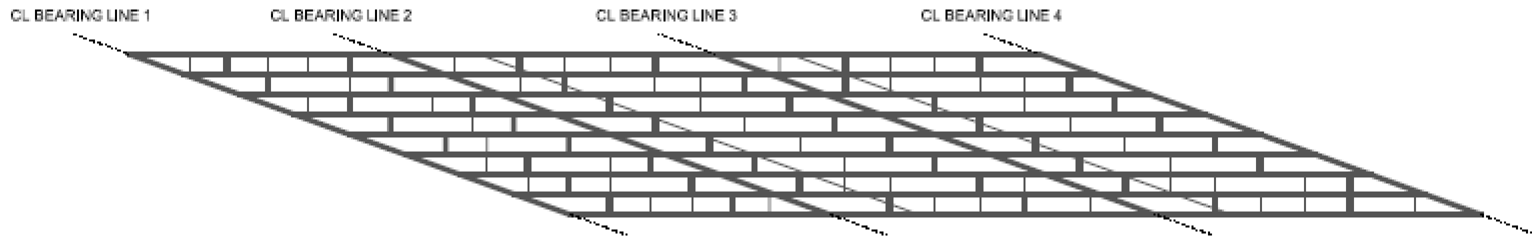


STAGE 27-2



STAGE 27-3

Figure L1-6(Continued). Erection scheme.



STAGE 27-4

STAGE 28 TO 36: INSTALL THE REMAINING XFs GIRDER BY GIRDER, SPAN BY SPAN.

Figure L1-6(Continued). Erection scheme.

Table L1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

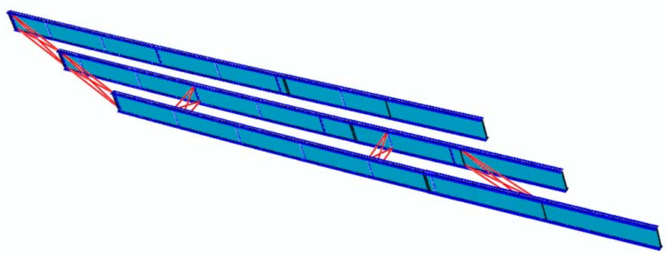
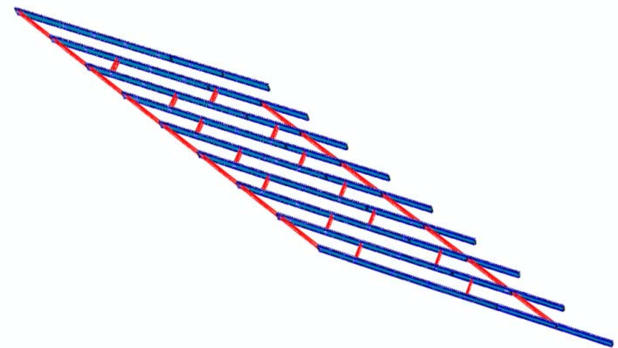
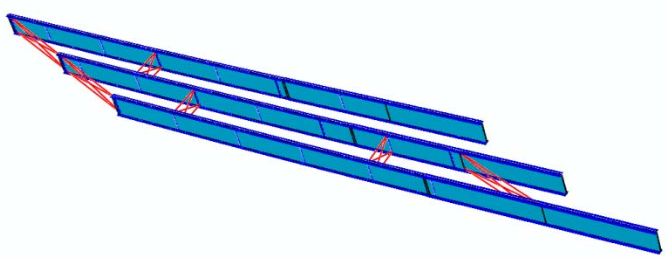
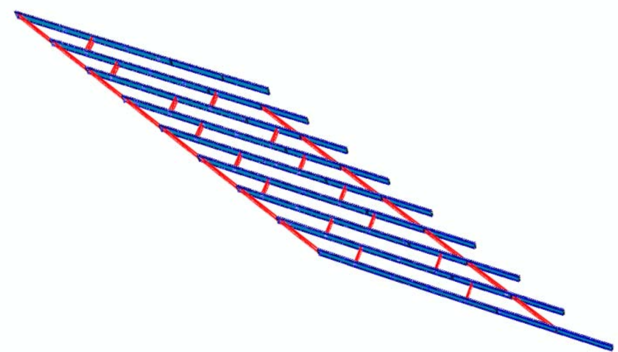
Sub-Stage	Stage	
	3	9
1		
2		

Table L1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

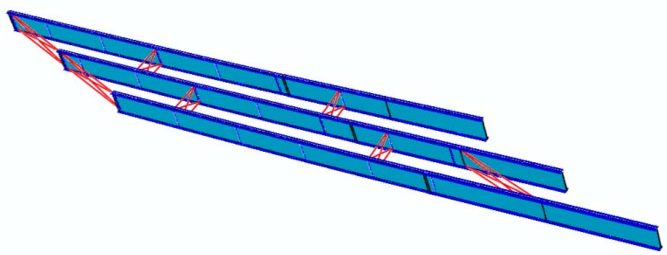
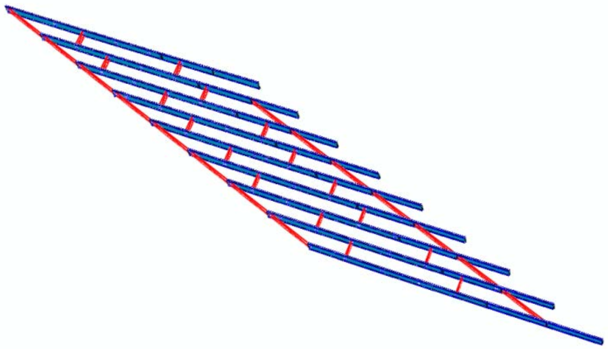
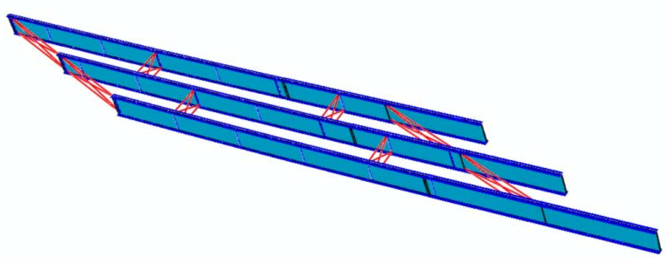
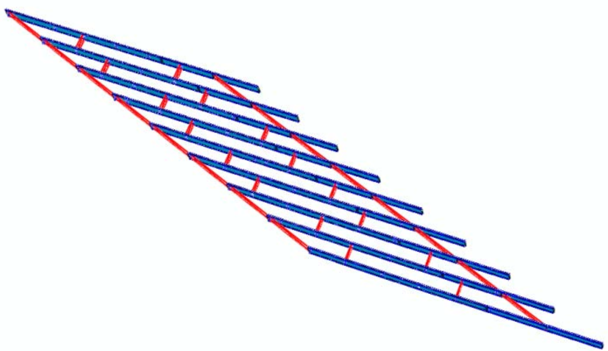
Sub-Stage	Stage	
	3	9
3		
4		

Table L1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

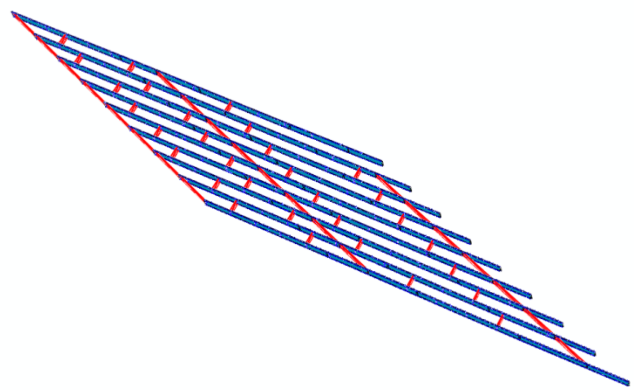
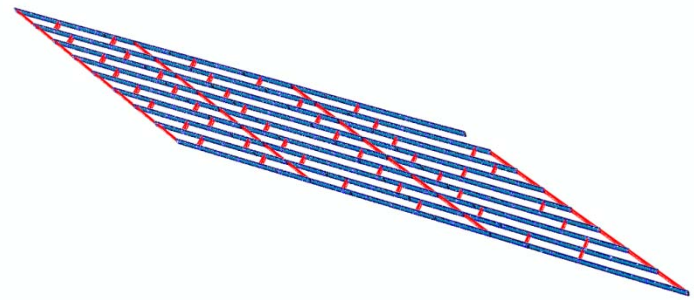
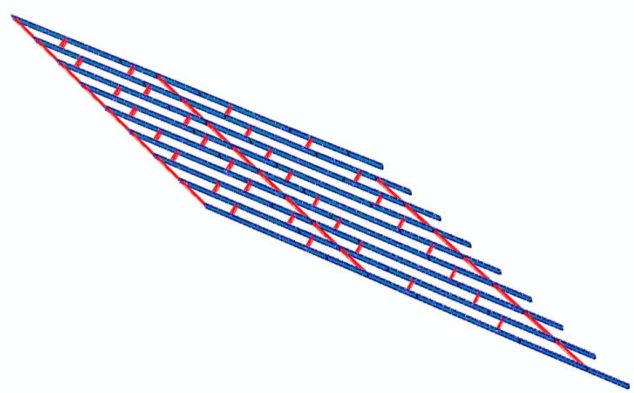
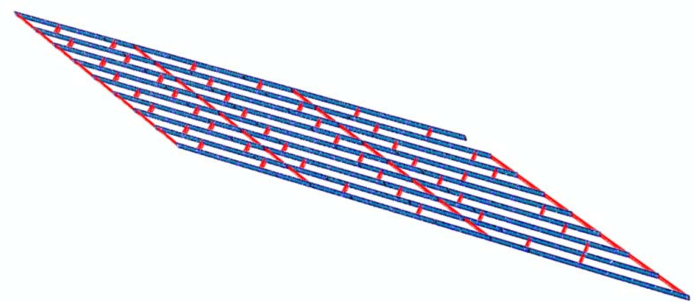
Sub-Stage	Stage	
	18	27
1		
2		

Table L1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

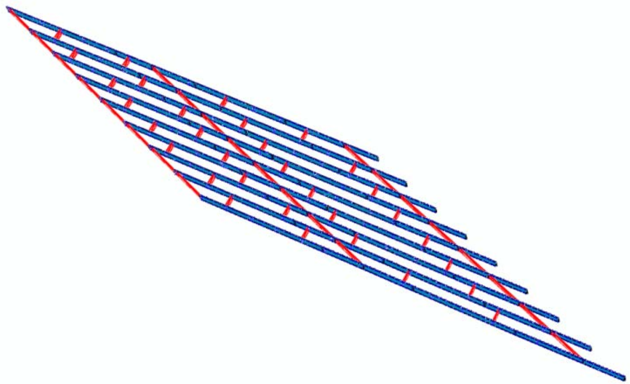
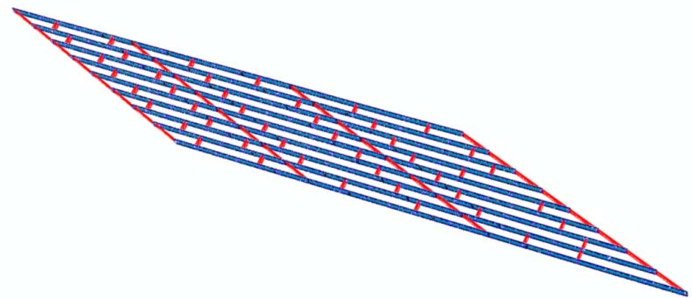
Sub-Stage	Stage	
	18	27
3		

Table L1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

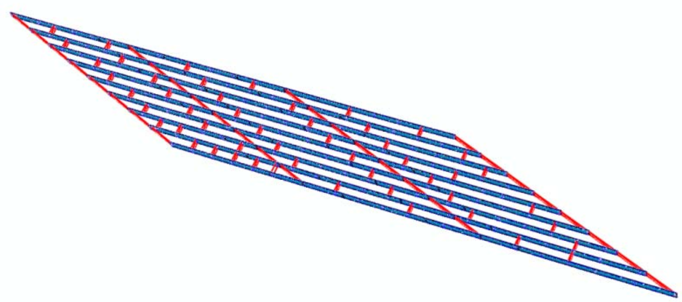
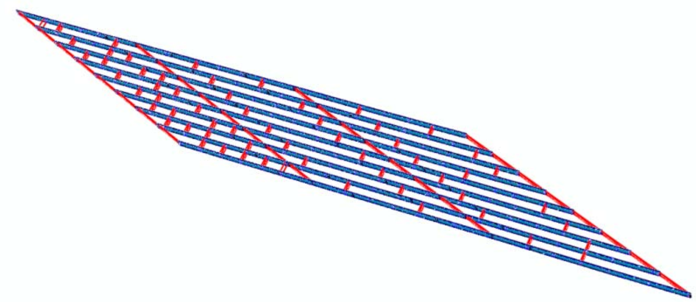
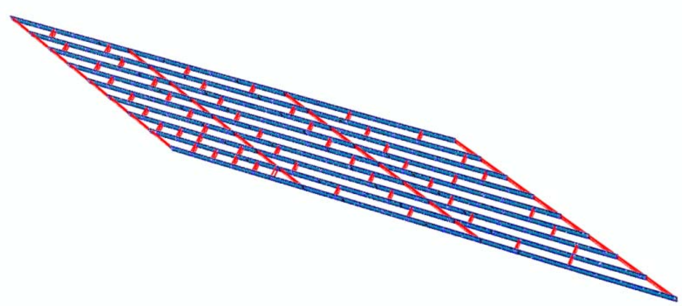
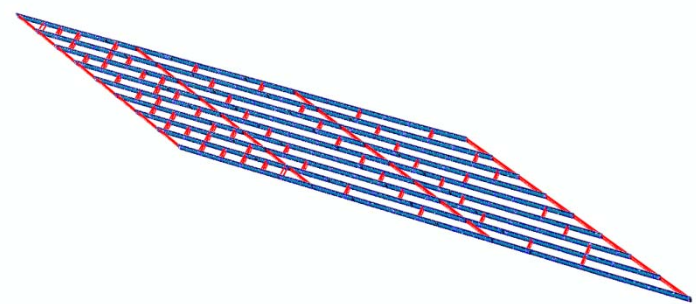
Sub-Stage	Stage	
	29	36
1		
2		

Table L1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

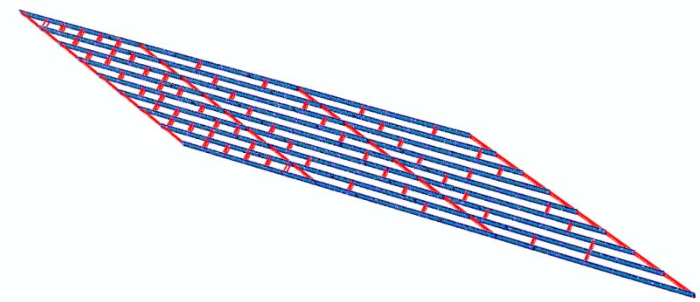
Sub-Stage	Stage	
	29	36
3		

Table L1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

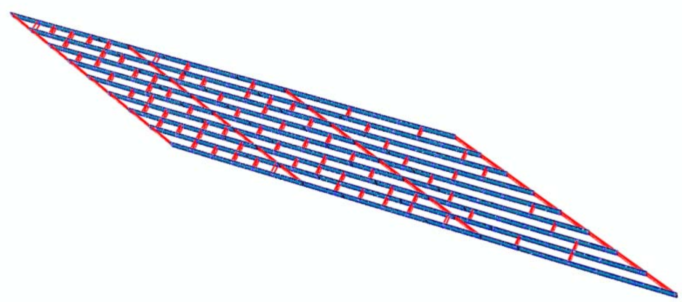
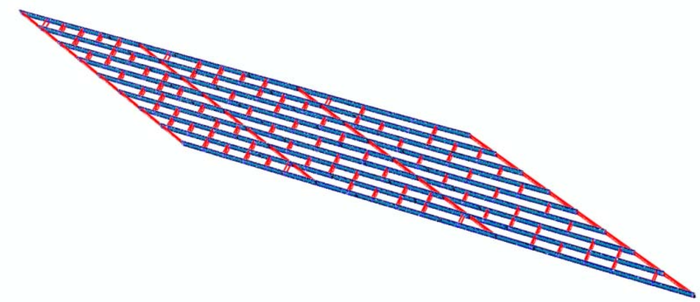
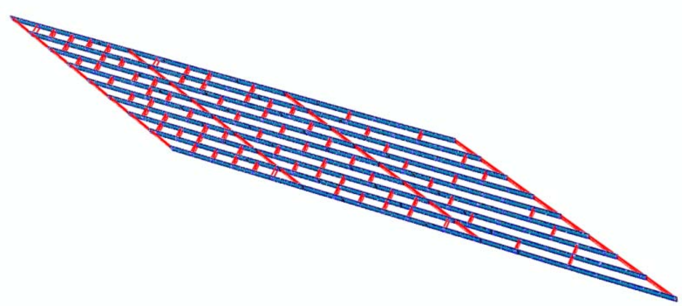
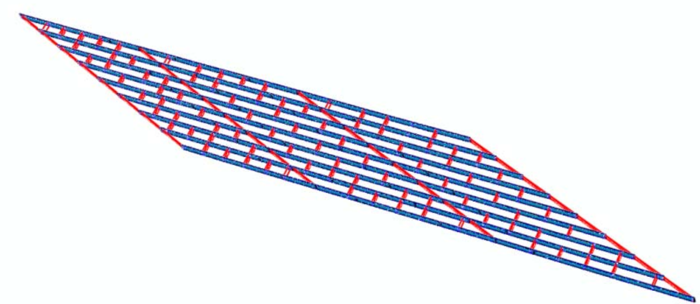
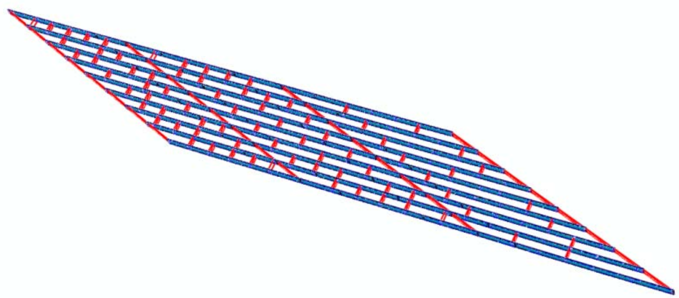
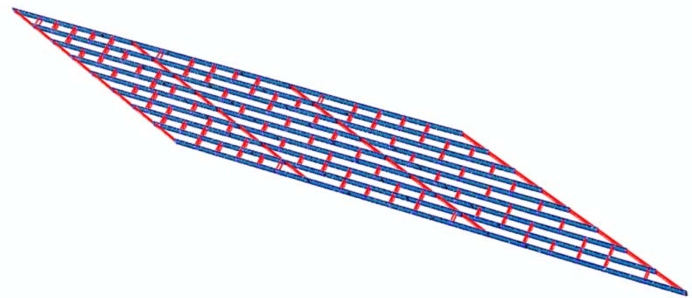
Sub-Stage	Stage	
	45	54
1		
2		

Table L1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

Sub-Stage	Stage	
	45	54
3		

Appendix L2. NICSS16 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NICSS16 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table L-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.9	4.9
	SDLF	0.8	4.8
	TDLF	0.3	4.2
G2	NLF	0.7	3.9
	SDLF	0.9	4.0
	TDLF	1.5	4.6
G3	NLF	0.8	4.2
	SDLF	0.9	4.2
	TDLF	1.3	4.6
G4	NLF	0.9	4.7
	SDLF	0.8	4.7
	TDLF	0.8	4.5
G5	NLF	0.9	4.7
	SDLF	0.8	4.7
	TDLF	0.8	4.6
G6	NLF	0.9	4.9
	SDLF	0.8	4.8
	TDLF	0.7	4.5
G7	NLF	0.7	3.8
	SDLF	0.9	3.9
	TDLF	1.6	4.6
G8	NLF	0.7	3.6
	SDLF	0.9	3.8
	TDLF	1.8	4.6
G9	NLF	0.8	4.4
	SDLF	0.8	4.4
	TDLF	0.7	4.2
All Girders	NLF	0.9	4.9
	SDLF	0.9	4.8
	TDLF	1.8	4.6

Table L-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.4	2.3
	SDLF	0.0	1.9
	TDLF	1.6	0.4
G2	NLF	0.3	2.0
	SDLF	0.0	1.7
	TDLF	1.3	0.4
G3	NLF	0.3	1.9
	SDLF	0.0	1.5
	TDLF	1.5	0.0
G4	NLF	0.4	2.0
	SDLF	0.0	1.6
	TDLF	1.6	0.0
G5	NLF	0.4	2.0
	SDLF	0.0	1.6
	TDLF	1.6	0.0
G6	NLF	0.4	2.0
	SDLF	0.0	1.6
	TDLF	1.6	0.0
G7	NLF	0.3	1.7
	SDLF	0.0	1.4
	TDLF	1.4	0.0
G8	NLF	0.3	1.6
	SDLF	0.0	1.3
	TDLF	1.3	0.2
G9	NLF	0.4	2.0
	SDLF	0.0	1.6
	TDLF	1.6	0.3
All Girders	NLF	0.4	2.3
	SDLF	0.0	1.9
	TDLF	1.6	0.4

Table L-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	3.8	19.2	3.7	19.2	0.9	4.1	0.7	4.0
	SDLF	3.6	18.9	3.4	18.8	0.0	3.3	0.0	3.8
	TDLF	2.5	16.9	2.5	16.8	3.4	2.3	2.2	2.7
G2	NLF	3.4	16.4	3.2	15.7	0.8	5.2	0.6	7.0
	SDLF	3.7	16.7	3.6	16.0	0.0	4.2	0.0	6.5
	TDLF	6.8	18.5	6.8	18.5	3.2	3.6	2.1	4.4
G3	NLF	3.4	17.3	3.3	17.4	1.2	7.0	1.8	12.5
	SDLF	3.6	17.5	3.5	17.5	0.1	5.5	0.1	10.0
	TDLF	6.8	18.1	6.8	18.0	5.6	0.2	8.0	0.5
G4	NLF	3.8	19.2	3.6	18.8	1.9	6.1	3.0	19.6
	SDLF	3.6	18.9	3.5	18.6	0.1	5.2	0.1	15.8
	TDLF	7.0	18.1	7.1	18.1	8.8	0.2	13.0	0.2
G5	NLF	3.7	18.8	3.6	18.5	5.3	27.3	5.5	30.9
	SDLF	3.6	18.7	3.4	18.4	0.3	21.9	0.3	24.7
	TDLF	3.4	18.2	3.2	18.1	23.0	0.2	24.0	0.3
G6	NLF	3.8	19.2	3.7	19.0	2.6	11.6	3.7	24.6
	SDLF	3.6	18.9	3.4	18.8	0.1	9.6	0.1	19.8
	TDLF	3.4	18.1	3.3	18.1	11.8	0.2	16.2	0.3
G7	NLF	3.3	16.0	3.1	15.5	1.0	5.6	1.0	4.2
	SDLF	3.7	16.4	3.5	15.8	0.0	4.4	0.1	3.3
	TDLF	9.0	18.4	9.1	18.3	4.1	0.3	4.0	0.4
G8	NLF	3.5	16.9	3.4	16.3	0.7	4.9	0.7	2.9
	SDLF	3.7	17.1	3.6	16.5	0.0	4.0	0.0	2.7
	TDLF	9.8	18.4	9.9	18.4	2.6	1.7	2.7	1.8
G9	NLF	3.7	18.9	3.7	18.9	0.3	3.6	0.8	4.0
	SDLF	3.6	18.5	3.4	18.5	0.0	3.3	0.0	3.7
	TDLF	4.0	16.8	3.9	16.8	1.5	2.1	3.0	2.4
All Girders	NLF	3.8	19.2	3.7	19.2	5.3	27.3	5.5	30.9
	SDLF	3.7	18.9	3.6	18.8	0.3	21.9	0.3	24.7
	TDLF	9.8	18.5	9.9	18.5	23.0	3.6	24.0	4.4

Table L-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	8.3	12.0	11.7	12.0
	SDLF	0.5	0.7	0.7	0.7
	TDLF	35.2	51.4	50.2	51.4
TDL	NLF	43.4	63.5	62.1	63.5
	SDLF	35.1	51.0	50.0	51.0
	TDLF	7.1	4.5	4.2	7.1

Table L-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	1.3	1.6	1.5	1.4
	SDLF	0.1	0.1	0.1	0.1
	TDLF	5.4	6.5	6.4	6.0
TDL	NLF	6.9	8.1	7.9	7.5
	SDLF	5.6	6.5	6.4	6.0
	TDLF	0.9	1.1	1.0	1.0

Table L-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.53	0.37	0.35	0.35	0.37	0.48	0.34	0.32	0.53
SDLF	0.46	0.47	0.32	0.34	0.35	0.38	0.43	0.32	0.47
TDLF	1.30	0.93	0.65	0.33	0.36	1.02	0.82	1.40	1.40

Table L-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	2.81	1.92	1.92	1.96	2.02	2.66	1.87	1.67	2.81
SDLF	2.73	2.02	1.88	1.94	1.98	2.54	1.95	1.65	2.73
TDLF	2.34	2.47	1.78	1.86	1.87	2.09	2.31	1.78	2.47

Table L-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.30	0.20	0.19	0.20	0.21	0.27	0.19	0.18	0.30
SDLF	0.26	0.26	0.18	0.19	0.19	0.21	0.24	0.18	0.26
TDLF	0.73	0.52	0.36	0.18	0.20	0.57	0.46	0.78	0.78

Table L-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.57	1.07	1.07	1.09	1.13	1.48	1.05	0.93	1.57
SDLF	1.53	1.13	1.05	1.08	1.10	1.42	1.09	0.92	1.53
TDLF	1.30	1.38	1.00	1.04	1.05	1.16	1.29	0.99	1.38

Table L-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	1312.1	5873.0
SDLF	1312.1	5872.6
TDLF	1312.1	5872.9

Table L-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	64.4	287.6	0.1	0.5	0.4	0.5
SDLF	62.3	285.1	0.0	0.3	0.0	0.3
TDLF	85.5	276.5	0.4	0.1	1.9	0.1

Table L-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.11	0.55	0.04	0.55
SDLF	0.10	0.49	0.00	0.49
TDLF	0.20	0.56	0.19	0.56

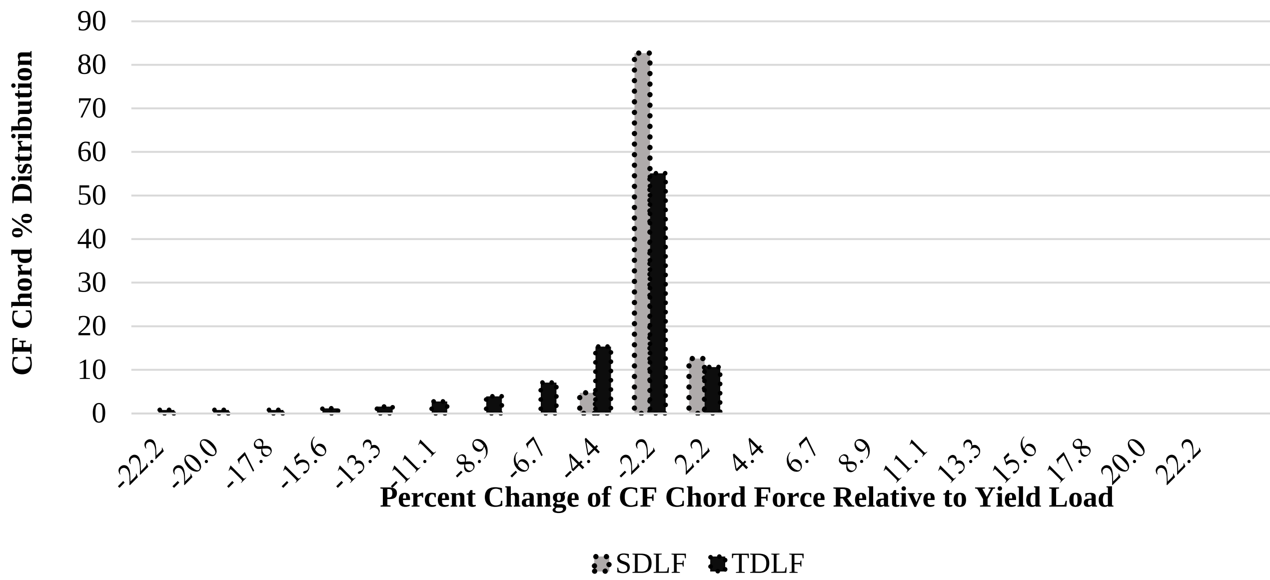


Figure L-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

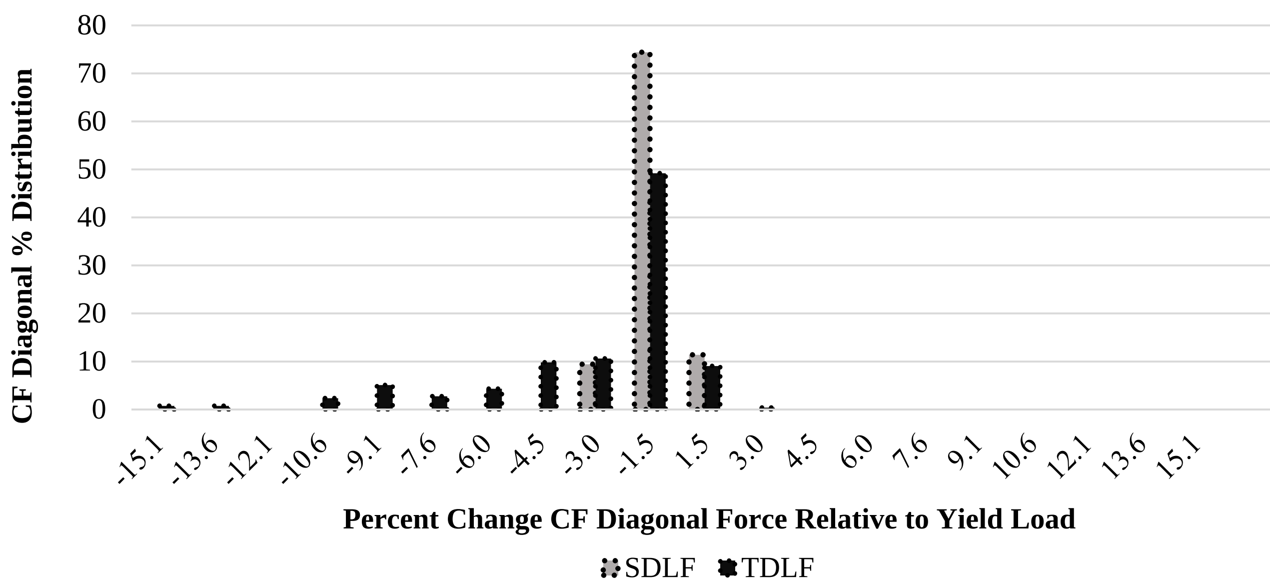


Figure L-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

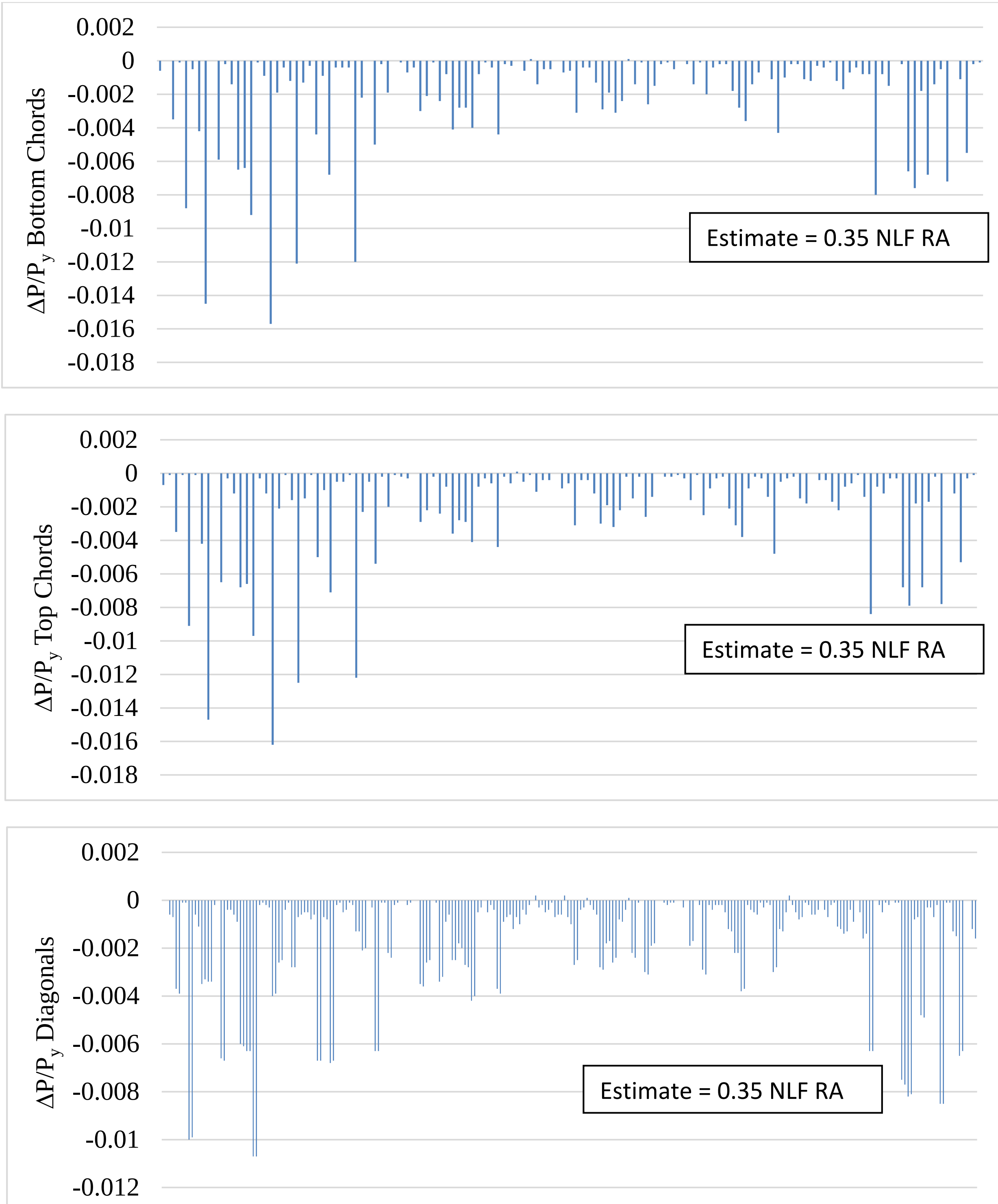
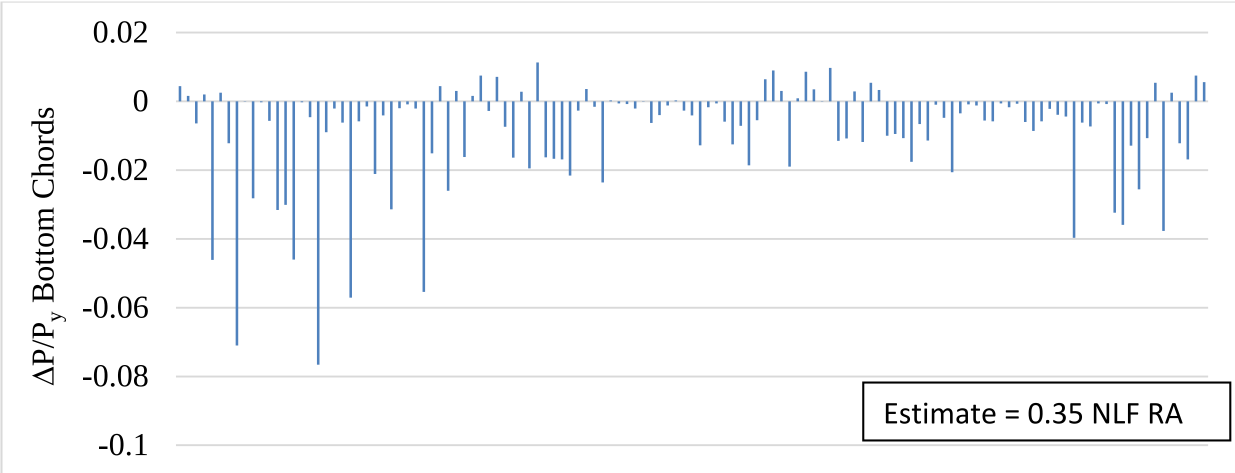
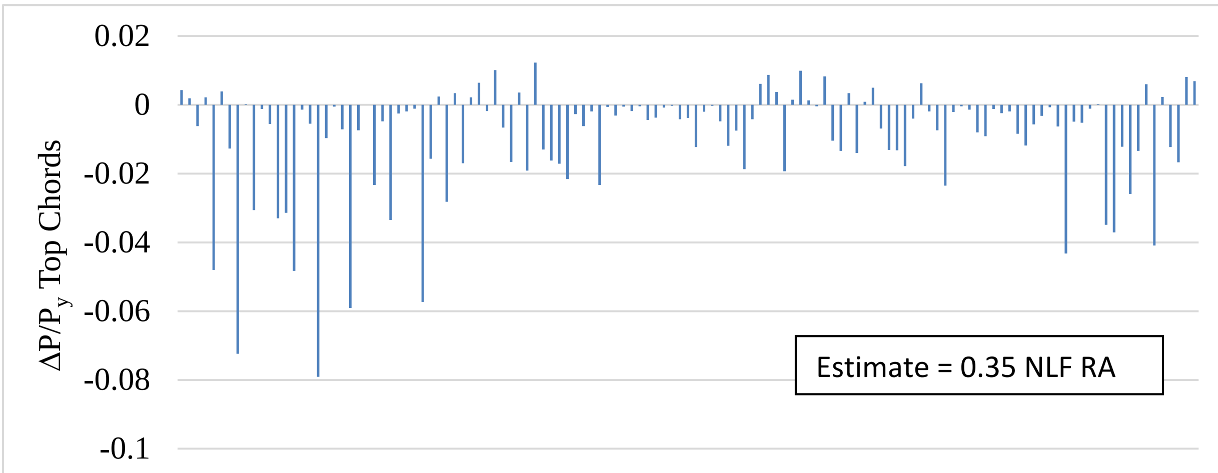


Figure L-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.





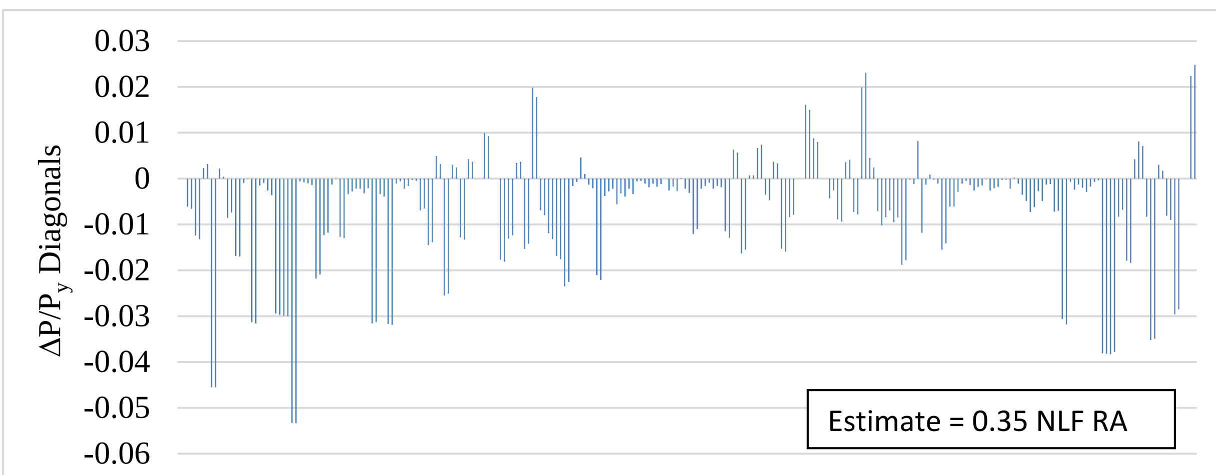


Figure L-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix L3. NICSS16 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NICSS16 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table L3-1. Maximums of the fit-up force resultants (kips)

Detailing Method	F1	F2	F_{max}
SDLF	0.5	0.8	0.8
TDLF	5.0	36.9	36.9

Table L3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	SDLF	59	12
	TDLF	58	0
G2	SDLF	62	13
	TDLF	69	5
G3	SDLF	62	13
	TDLF	86	13
G4	SDLF	61	13
	TDLF	60	13
G5	SDLF	60	13
	TDLF	61	13
G6	SDLF	60	13
	TDLF	59	5
G7	SDLF	62	13
	TDLF	84	13
G8	SDLF	62	13
	TDLF	80	14
G9	SDLF	59	12
	TDLF	59	0
All Girders	SDLF	62	12
	TDLF	86	0

Table L3-3. Total Vertical Reactions (kips)

Stage	Detailing Method	Sub-Stage			
		1	2	3	4
3	SDLF	147	148	149	151
	TDLF	147	148	149	151
9	SDLF	459	460	461	463
	TDLF	459	460	461	463
18	SDLF	940	941	943	NA
	TDLF	940	941	943	NA
27	SDLF	1275	1276	1278	NA
	TDLF	1275	1276	1278	NA
29	SDLF	1280	1281	NA	NA
	TDLF	1280	1281	NA	NA
36	SDLF	1287	1288	1289	NA
	TDLF	1287	1288	1289	NA
45	SDLF	1299	1300	1301	NA
	TDLF	1299	1300	1301	NA
54	SDLF	1310	1311	1312	NA
	TDLF	1310	1311	1312	NA

Appendix L4. NICSS16 Detailed Results, Completed Bridge Responses

This appendix presents the SDL and TDL responses of the bridge NICSS16 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Figure L4-1. SDL and TDL Line Girder Analysis cambers.

Figure L4-2. SDL and TDL 3D FEA cambers.

Overview of Bridge Displacements and Elevation Profiles

Figure L4-3. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.
Figure L4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.
Figure L4-5. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.
Figure L4-6. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.
Figure L4-7. Bridge displacements due to SDLF detailing effects alone under NL (in).
Figure L4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.
Figure L4-9. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.
Figure L4-10. Bridge displacements due to TDLF detailing effects alone under NL (in).

Girder Displacements and Elevations for Different Detailing Methods

Figure L4-11. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.
Figure L4-12. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.
Figure L4-13. Comparison of individual girder layovers (in) under SDL for different detailing methods.
Figure L4-14. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.
Figure L4-15. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.
Figure L4-16. Comparison of individual girder layovers (in) under TDL for different detailing methods.
Figure L4-17. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing under NL.
Figure L4-18. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing under NL.

Girder Flange Stresses for Different Detailing Methods

Figure L4-19. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.
Figure L4-20. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

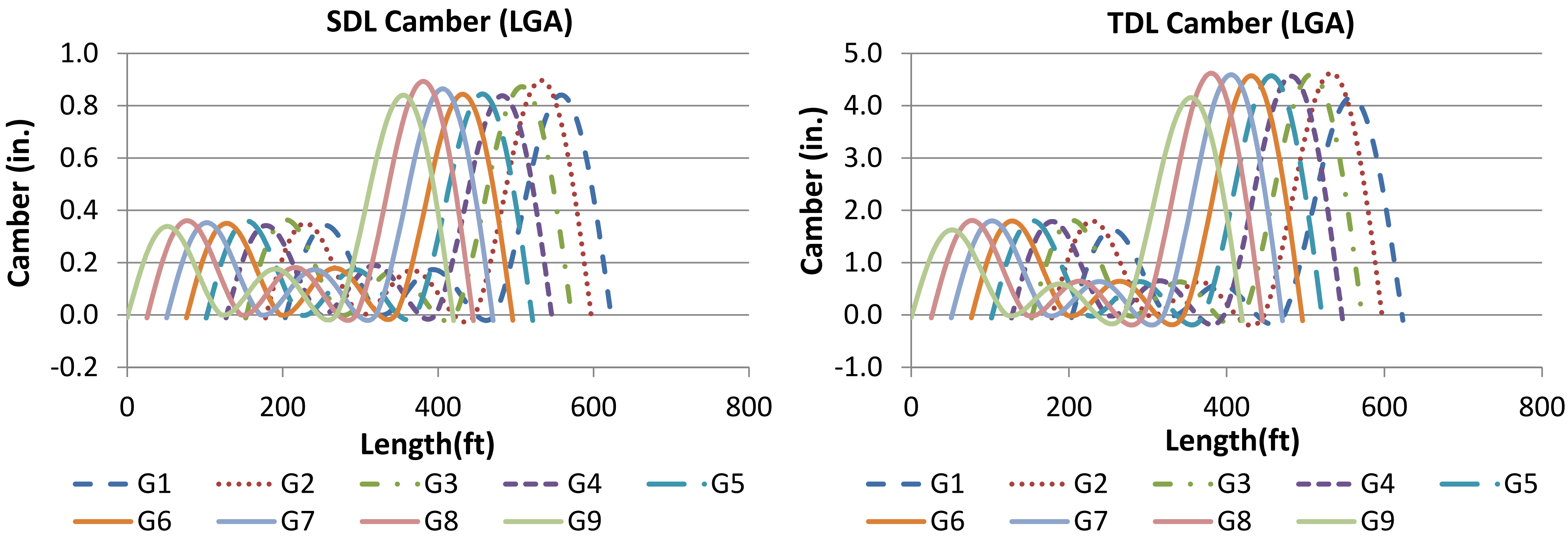


Figure L4-1. SDL and TDL Line Girder Analysis cambers.

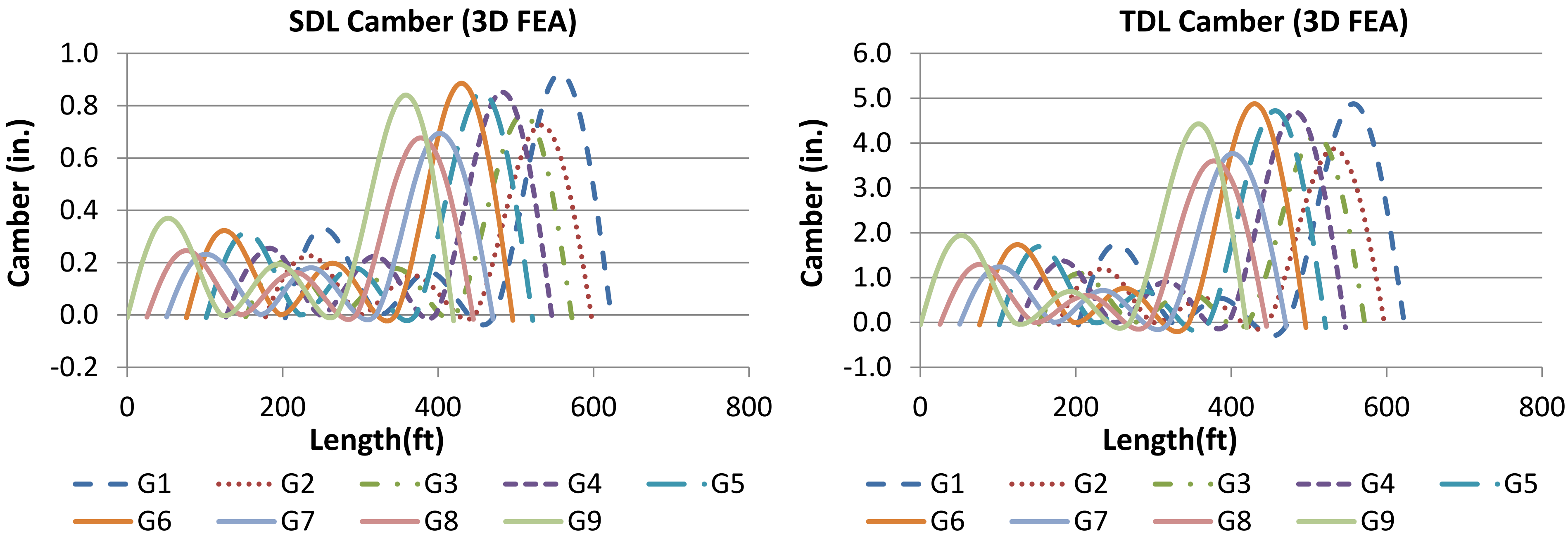


Figure L4-2. SDL and TDL 3D FEA cambers.

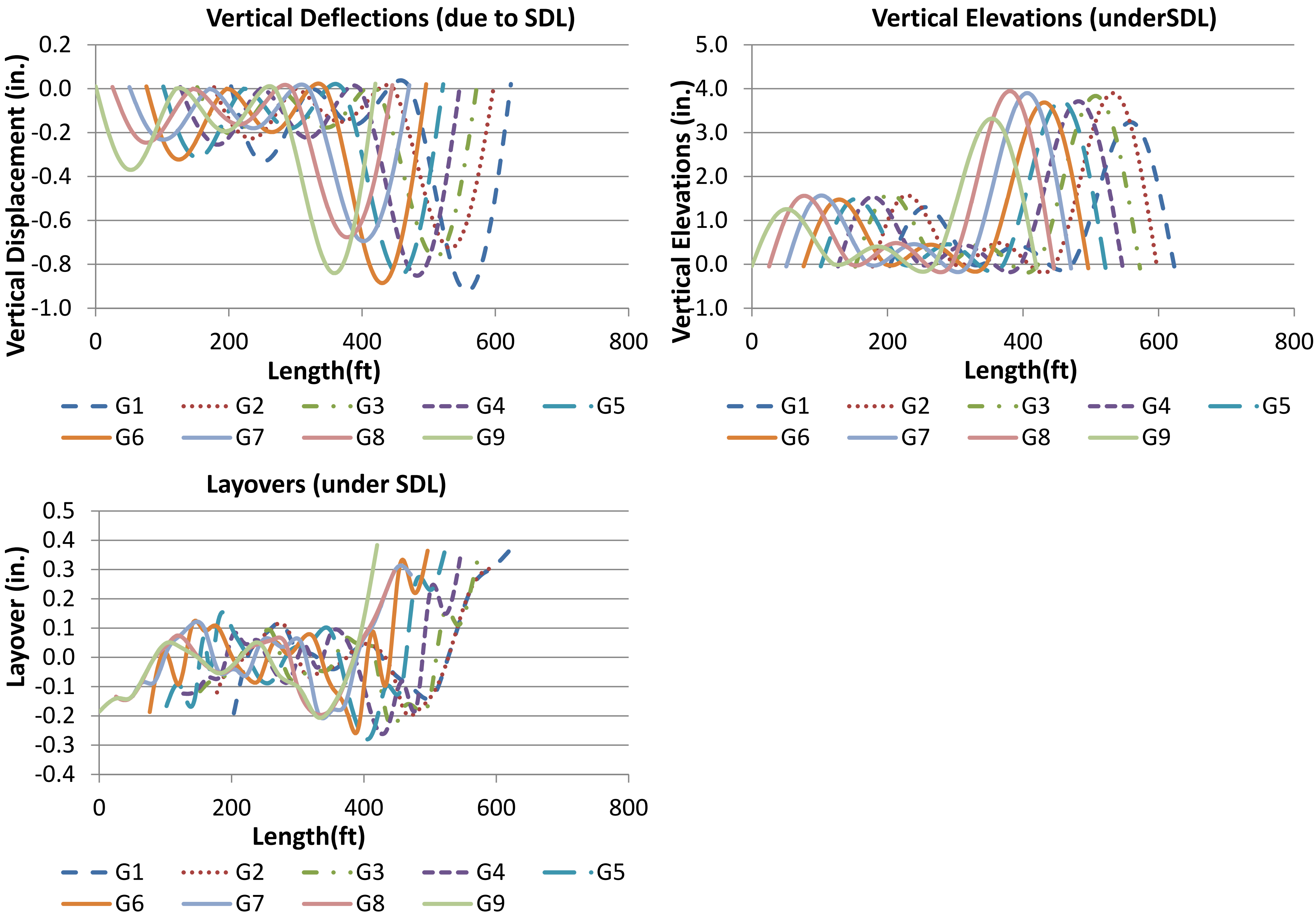


Figure L4-3. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

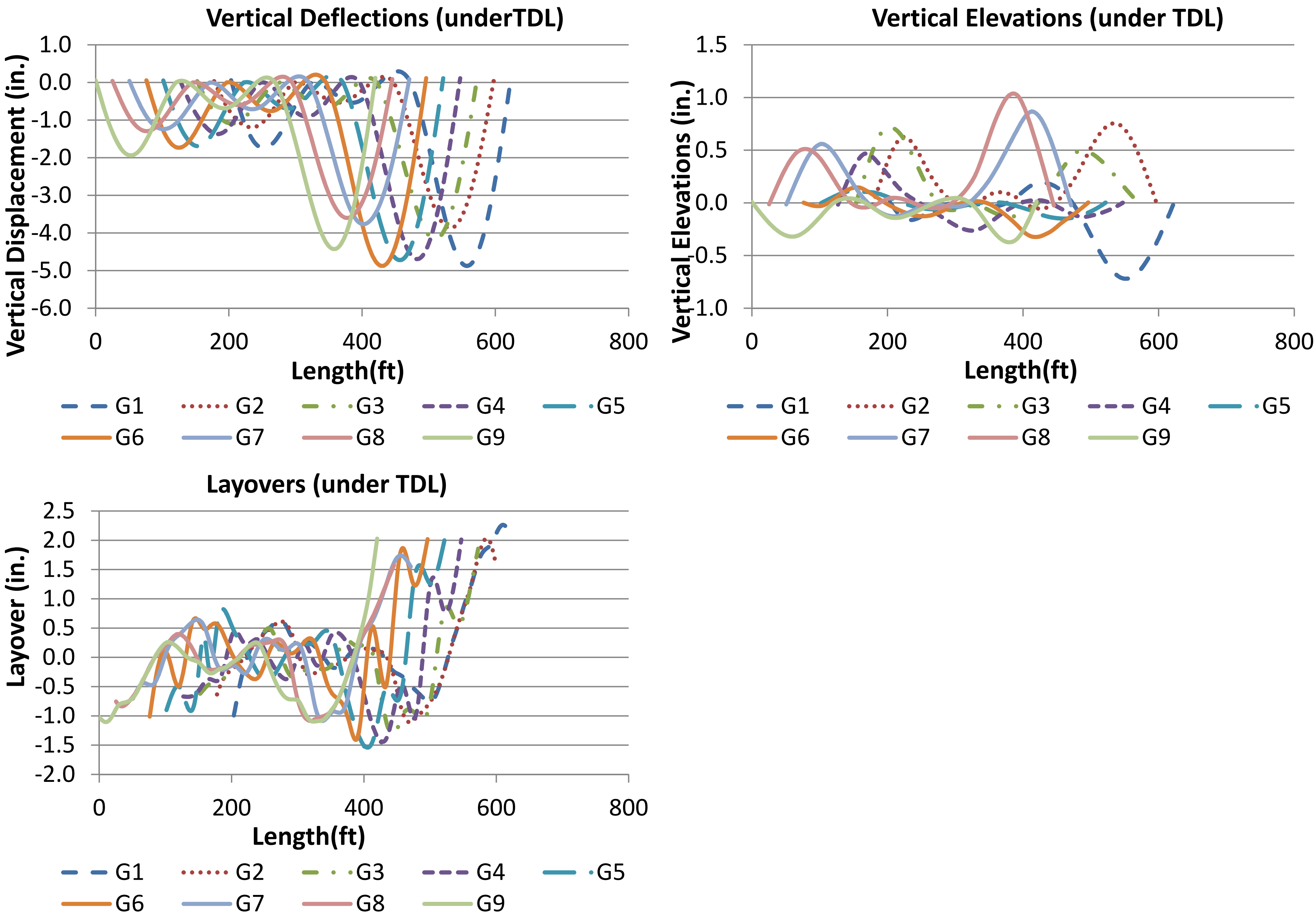


Figure L4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

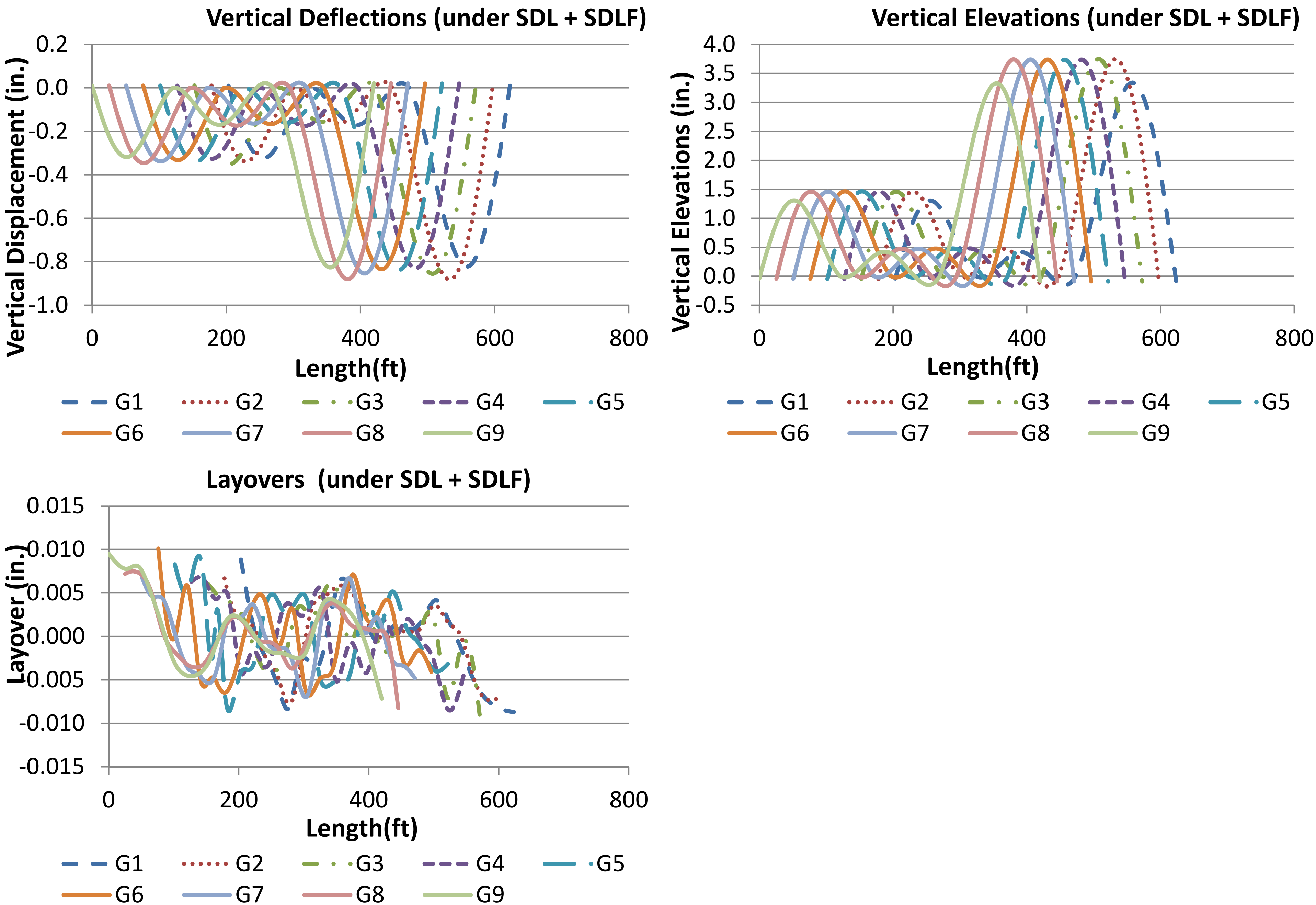


Figure L4-5. **Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.**

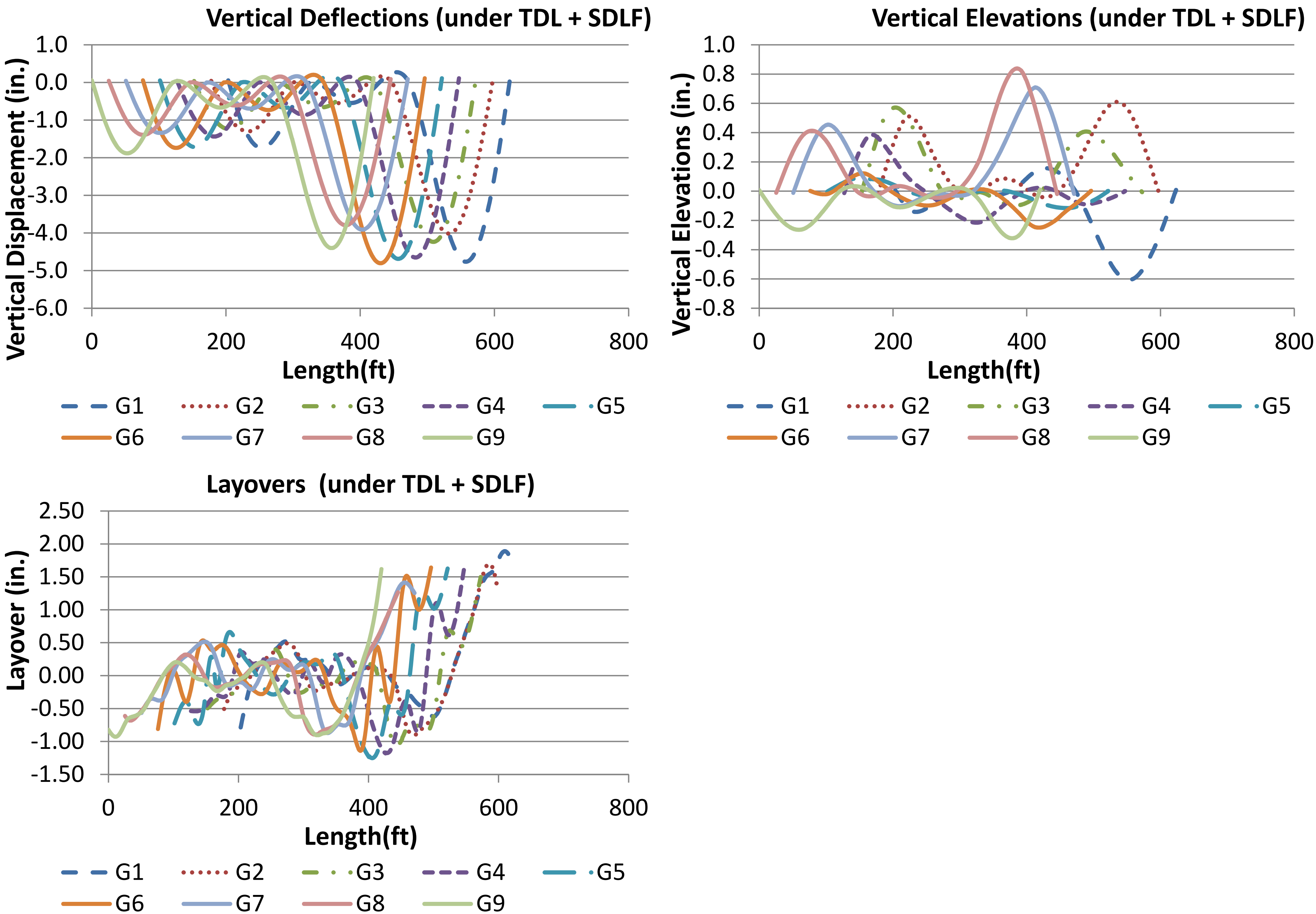


Figure L4-6. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

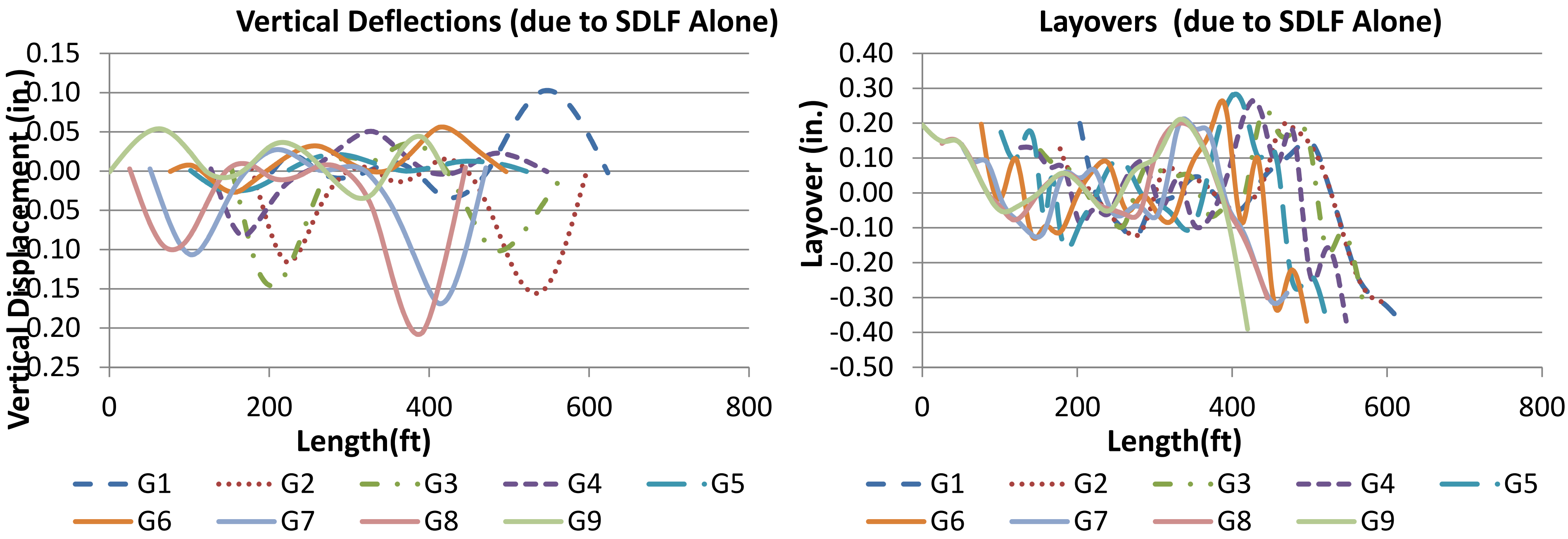


Figure L4-7. Bridge displacements due to SDLF detailing effects alone under NL(in).

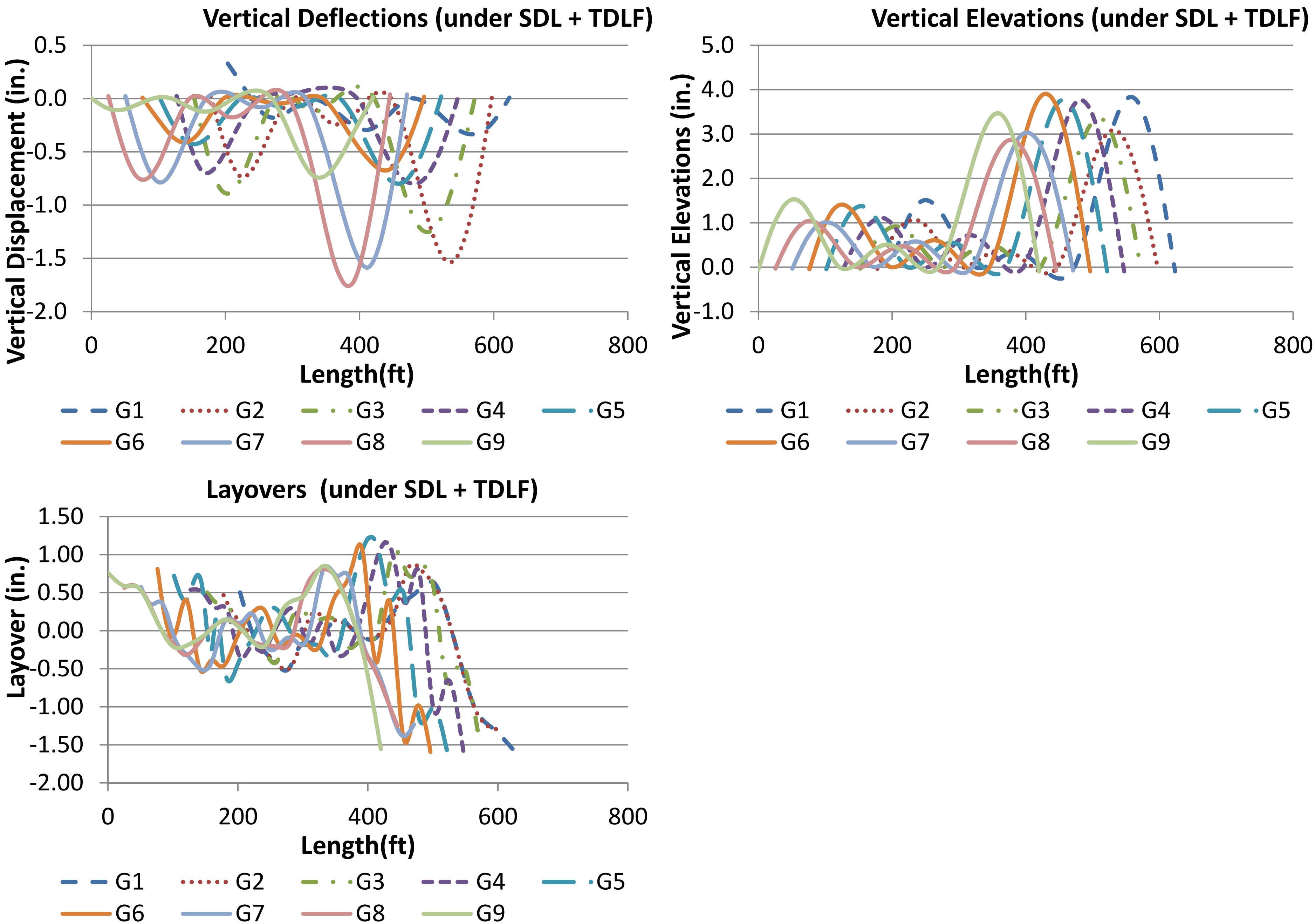


Figure L4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

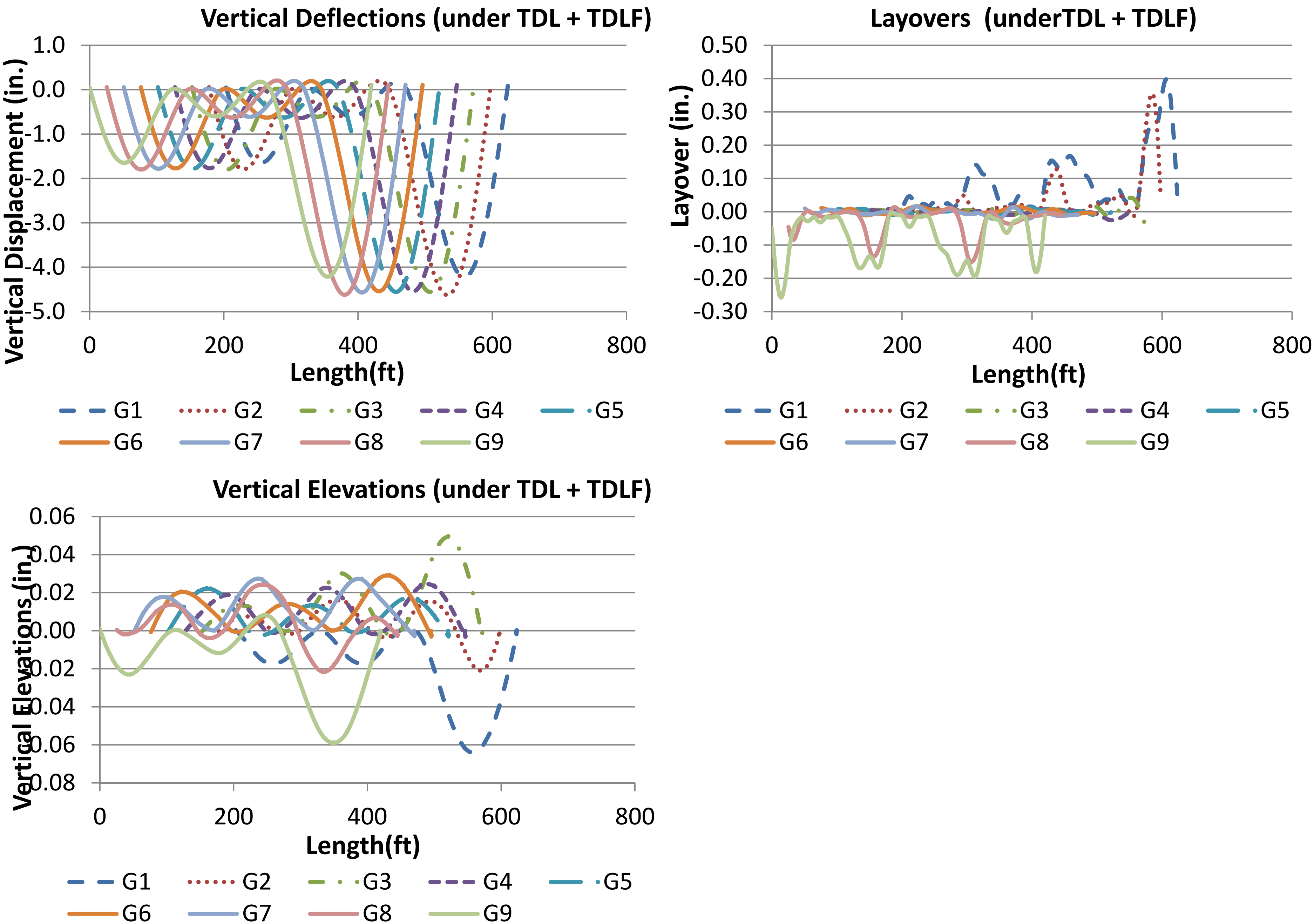


Figure L4-9. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

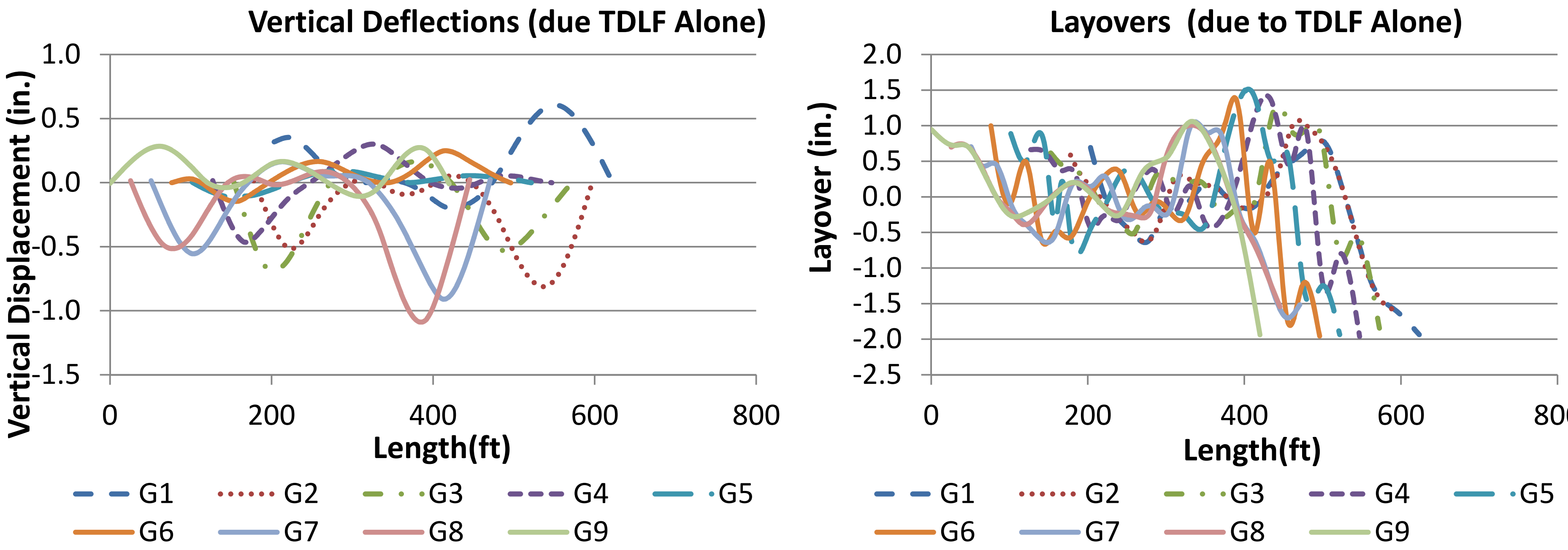


Figure L4-10. Bridge displacements due to TDLF detailing effects alone under NL (in).

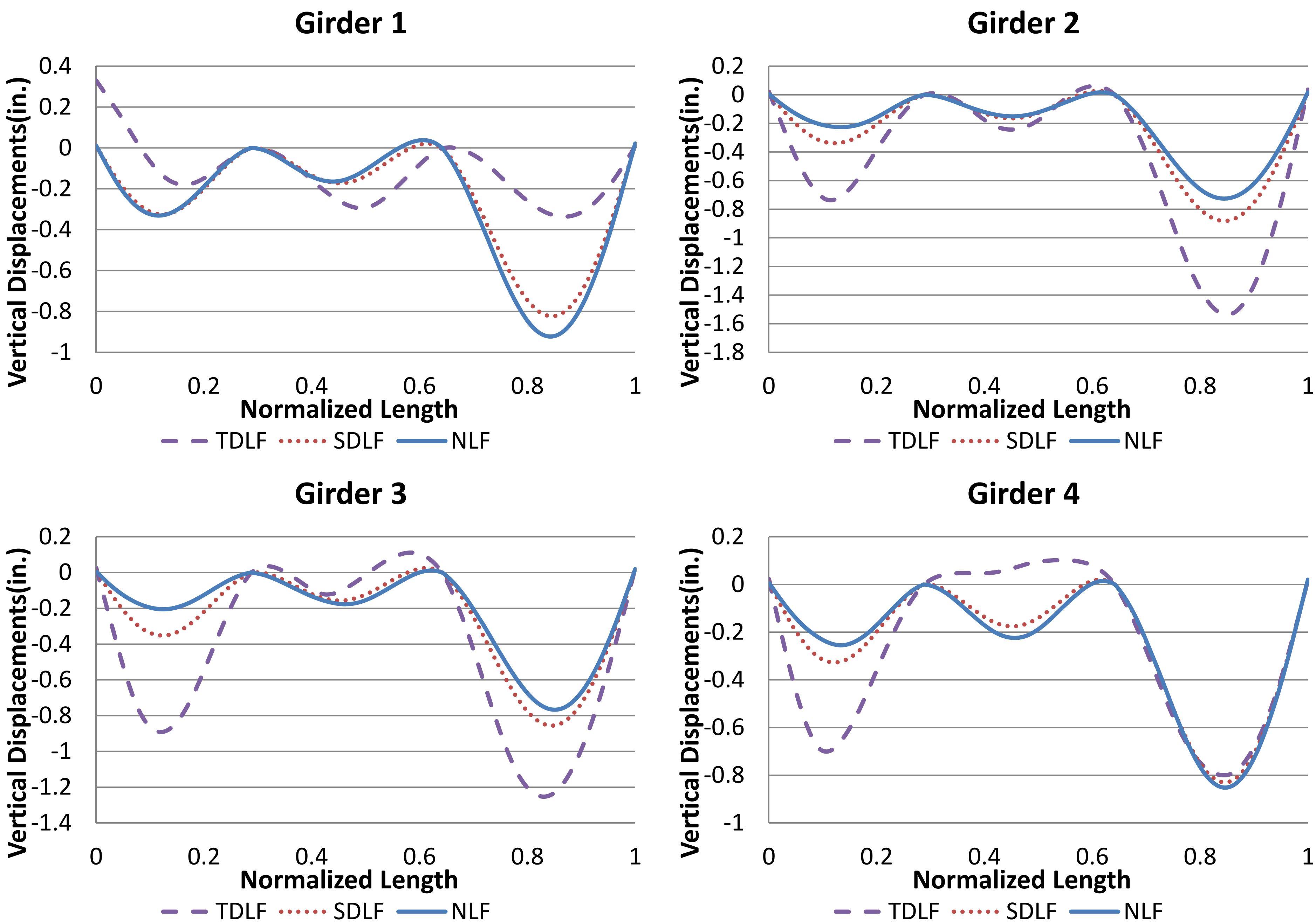


Figure L4-11. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

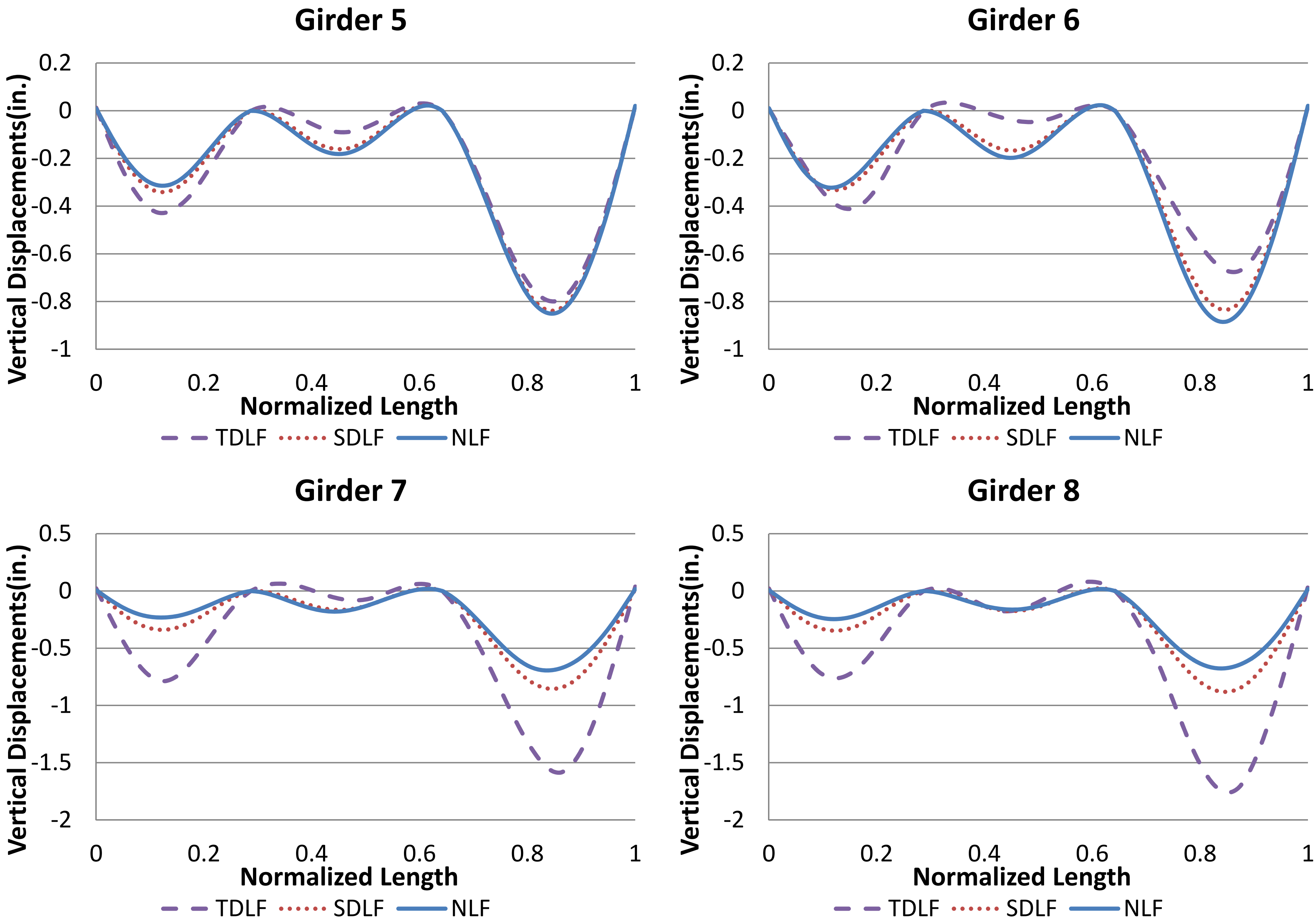


Figure L4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

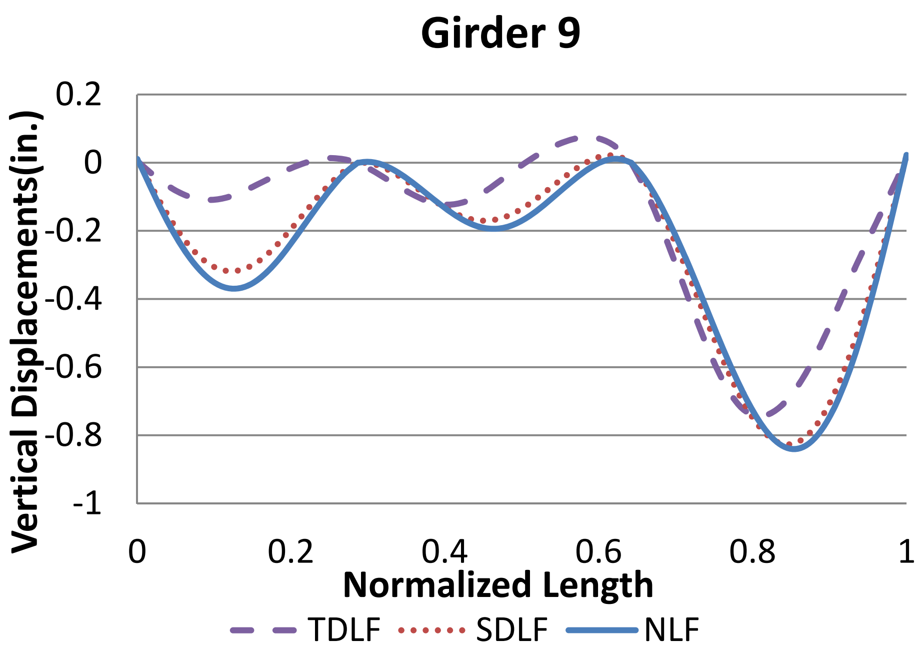


Figure L4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

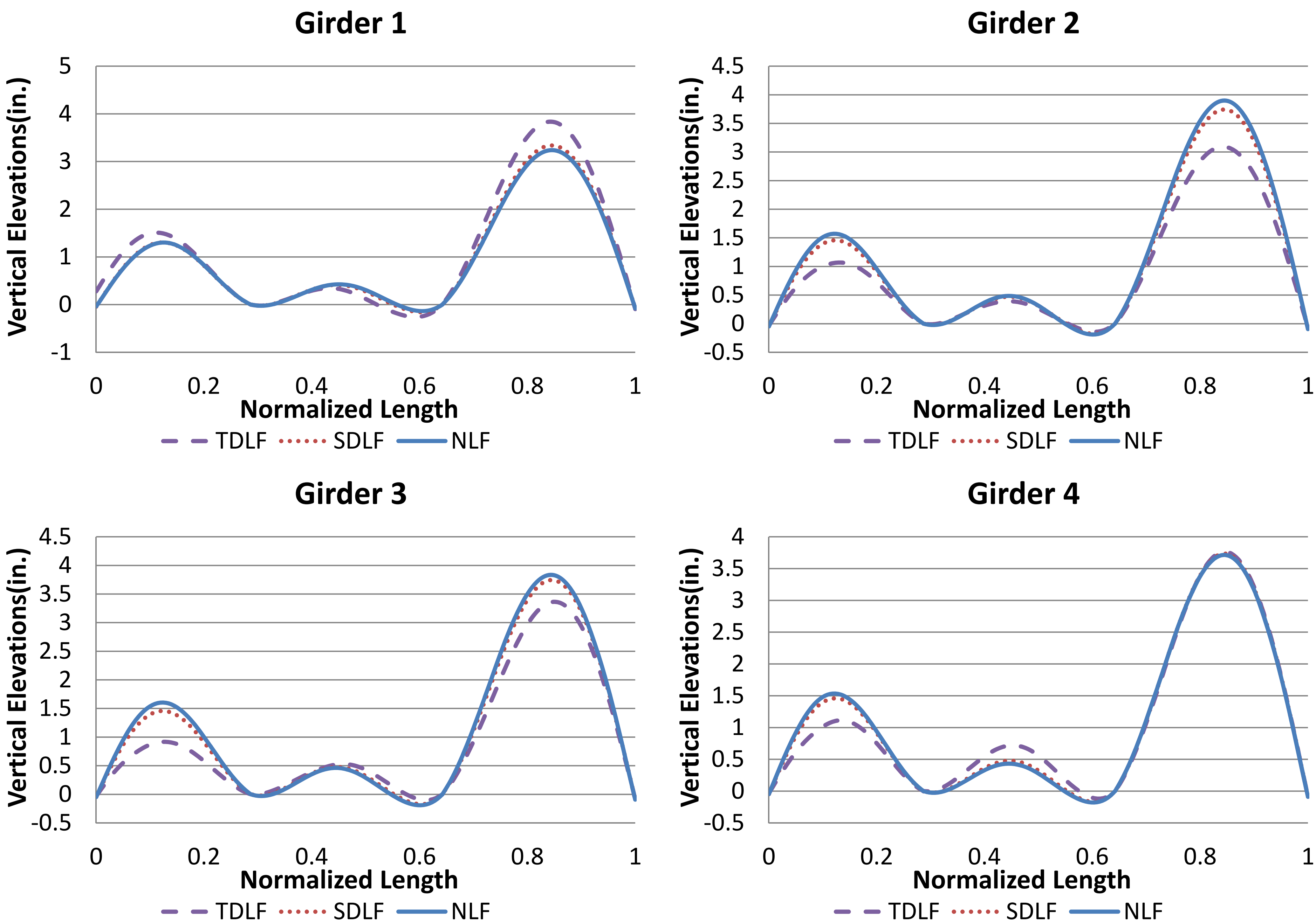


Figure L4-12. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

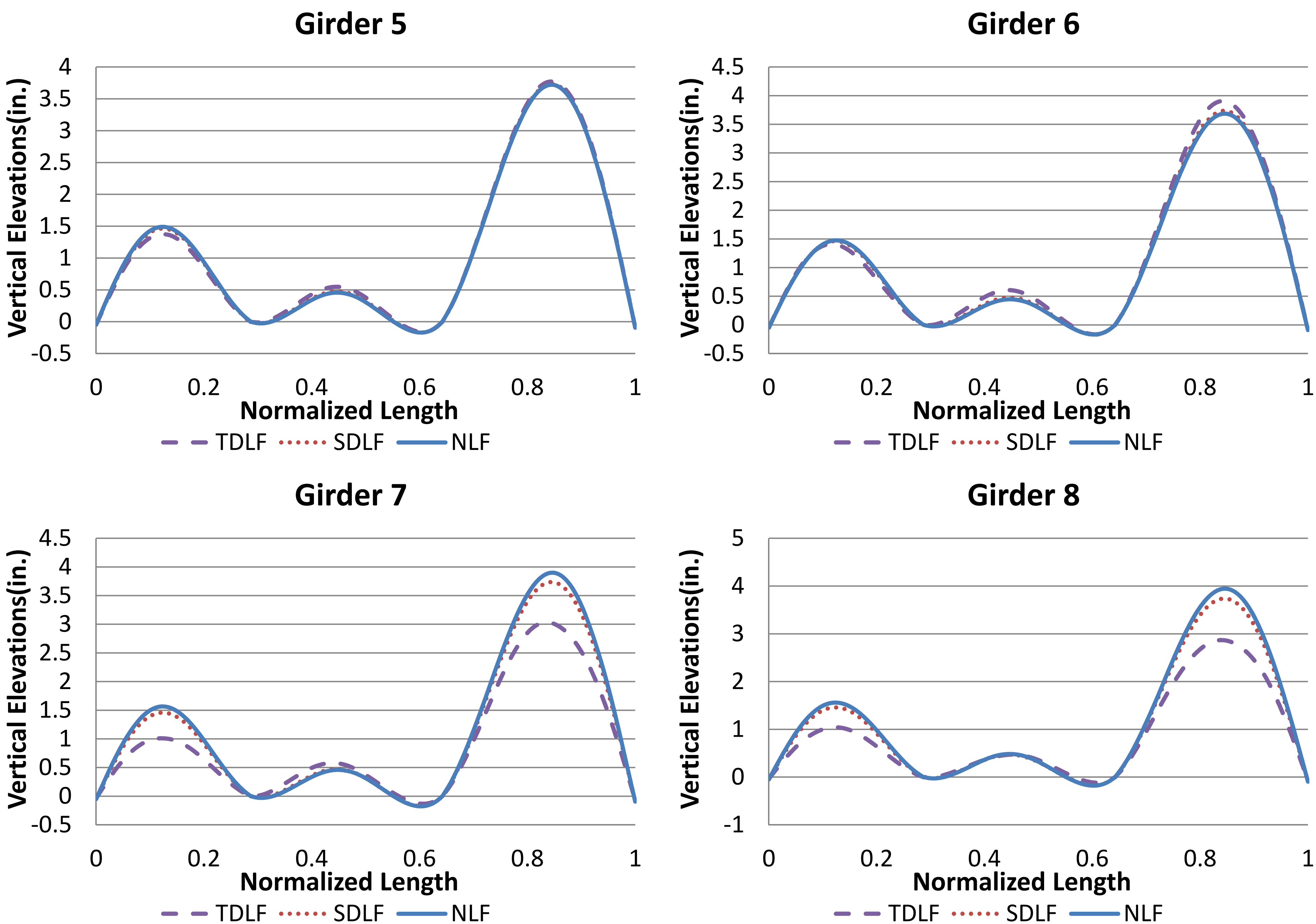


Figure L4-12(Continued). **Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.**

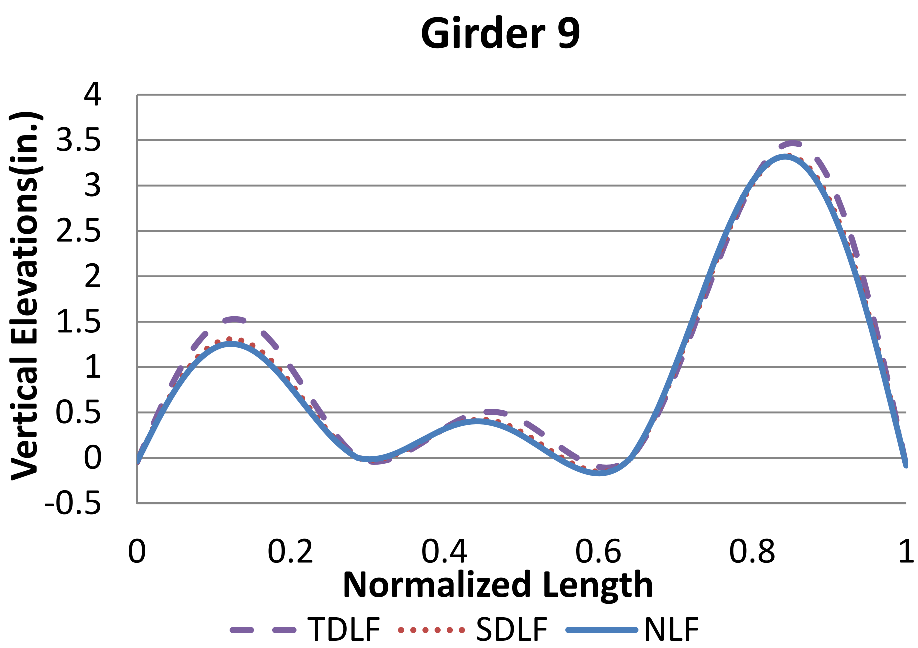


Figure L4-12(Continued). **Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.**

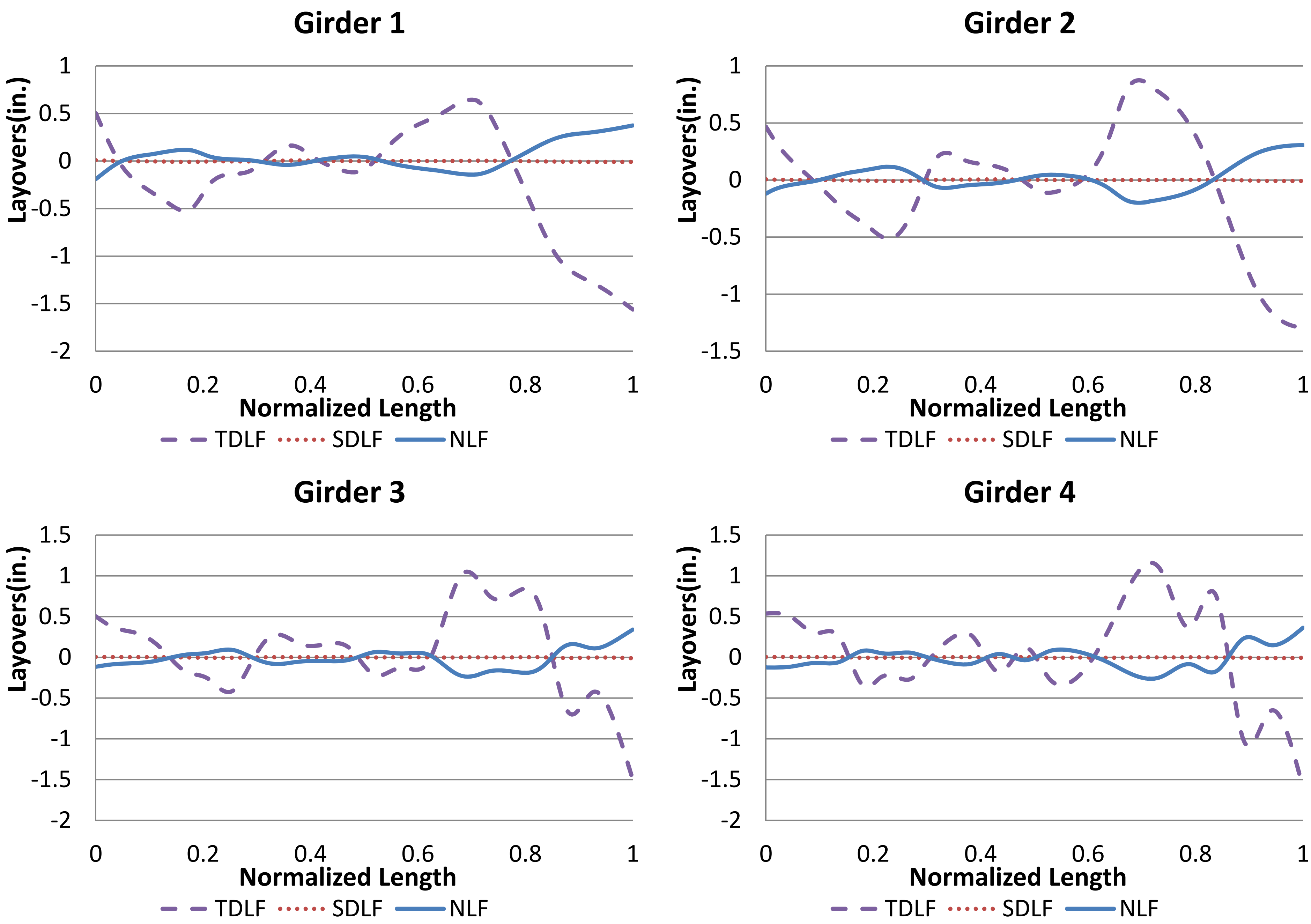


Figure L4-13. Comparison of individual girder layovers (in) under SDL for different detailing methods.

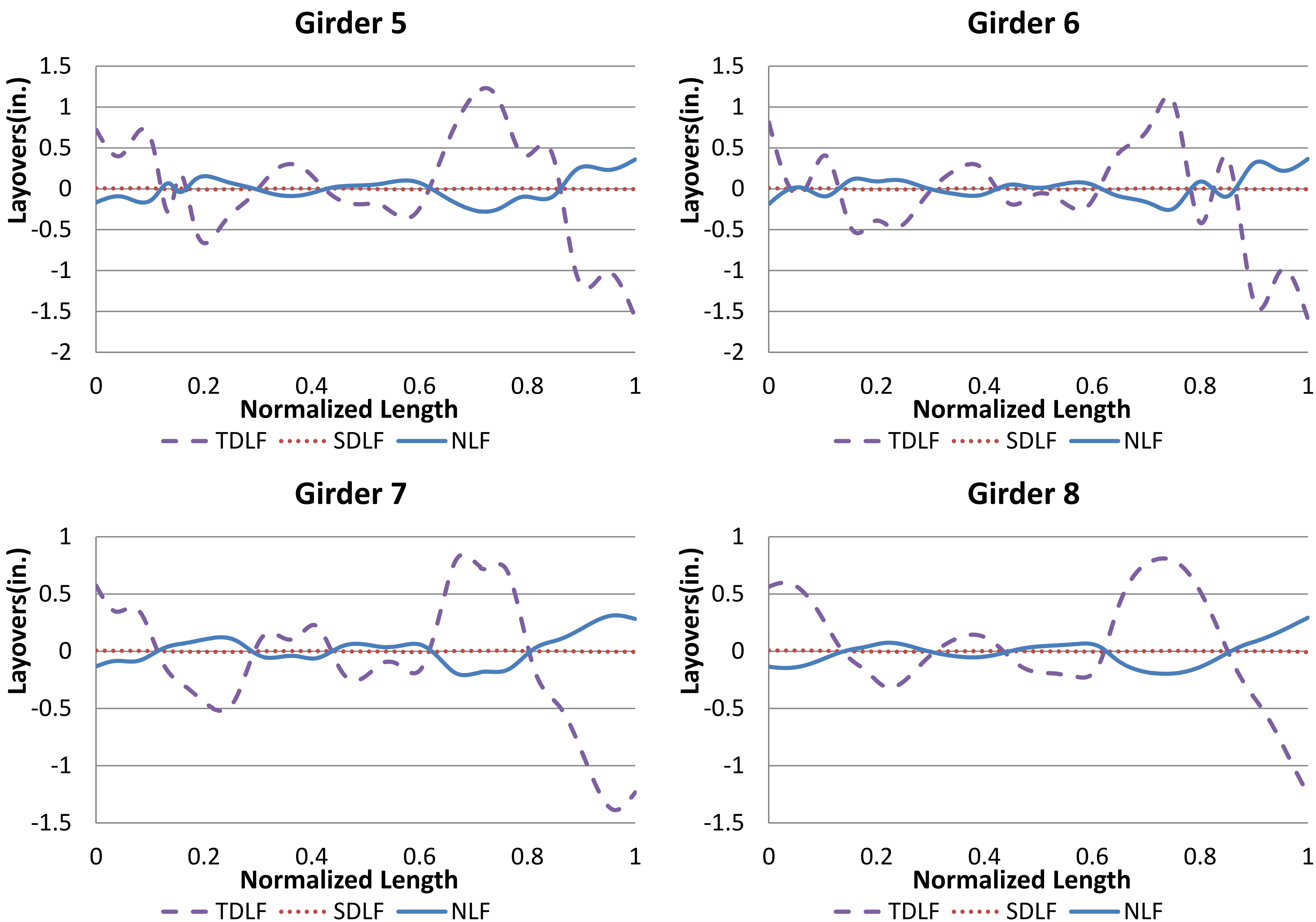


Figure L4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

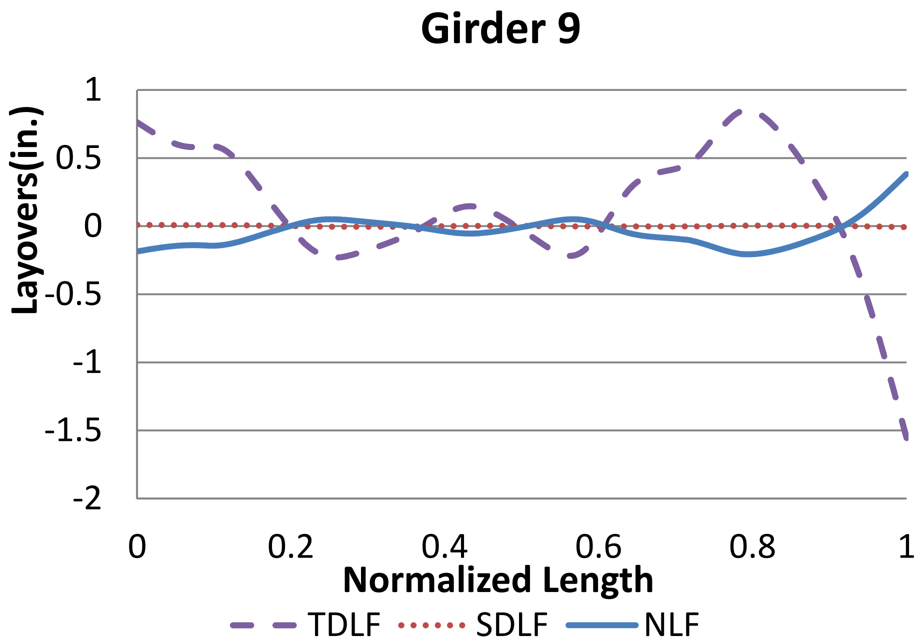


Figure L4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

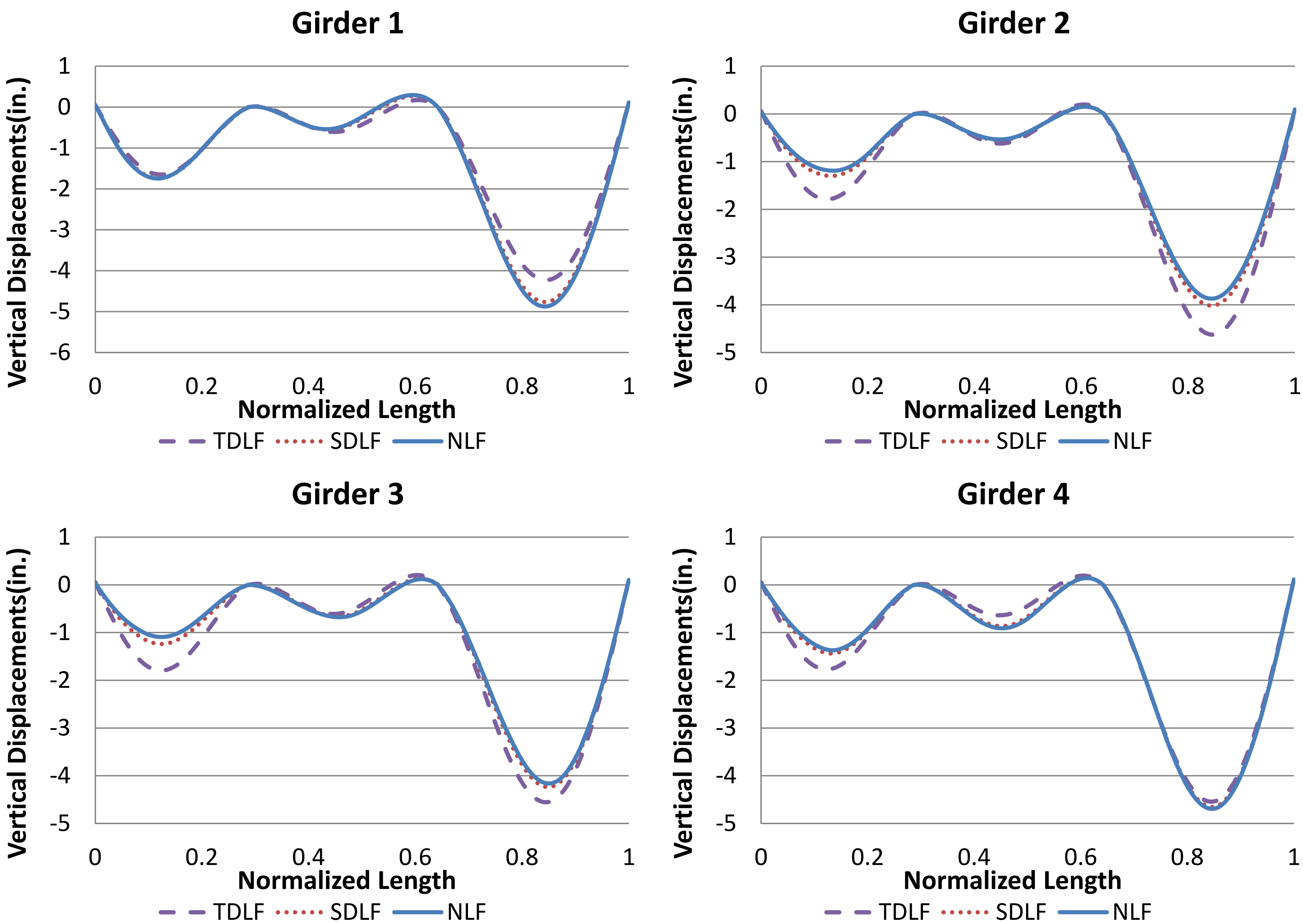


Figure L4-14. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

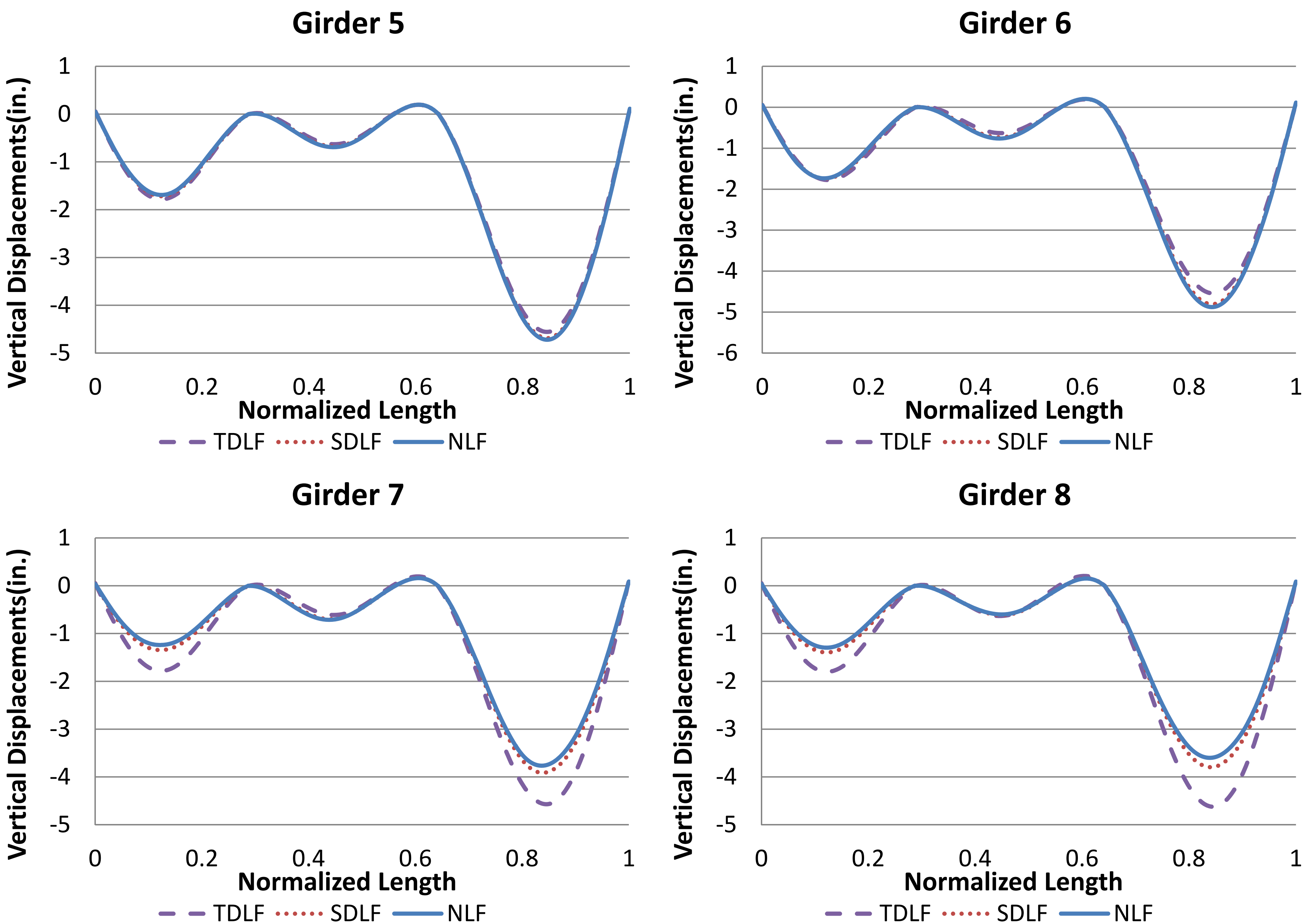


Figure L4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

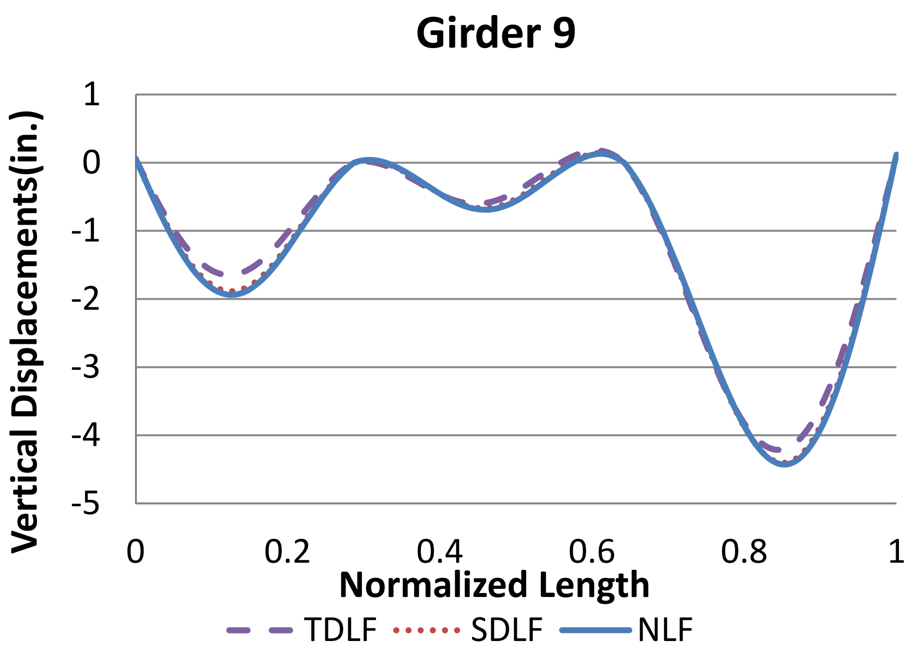


Figure L4-14(Continued). **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

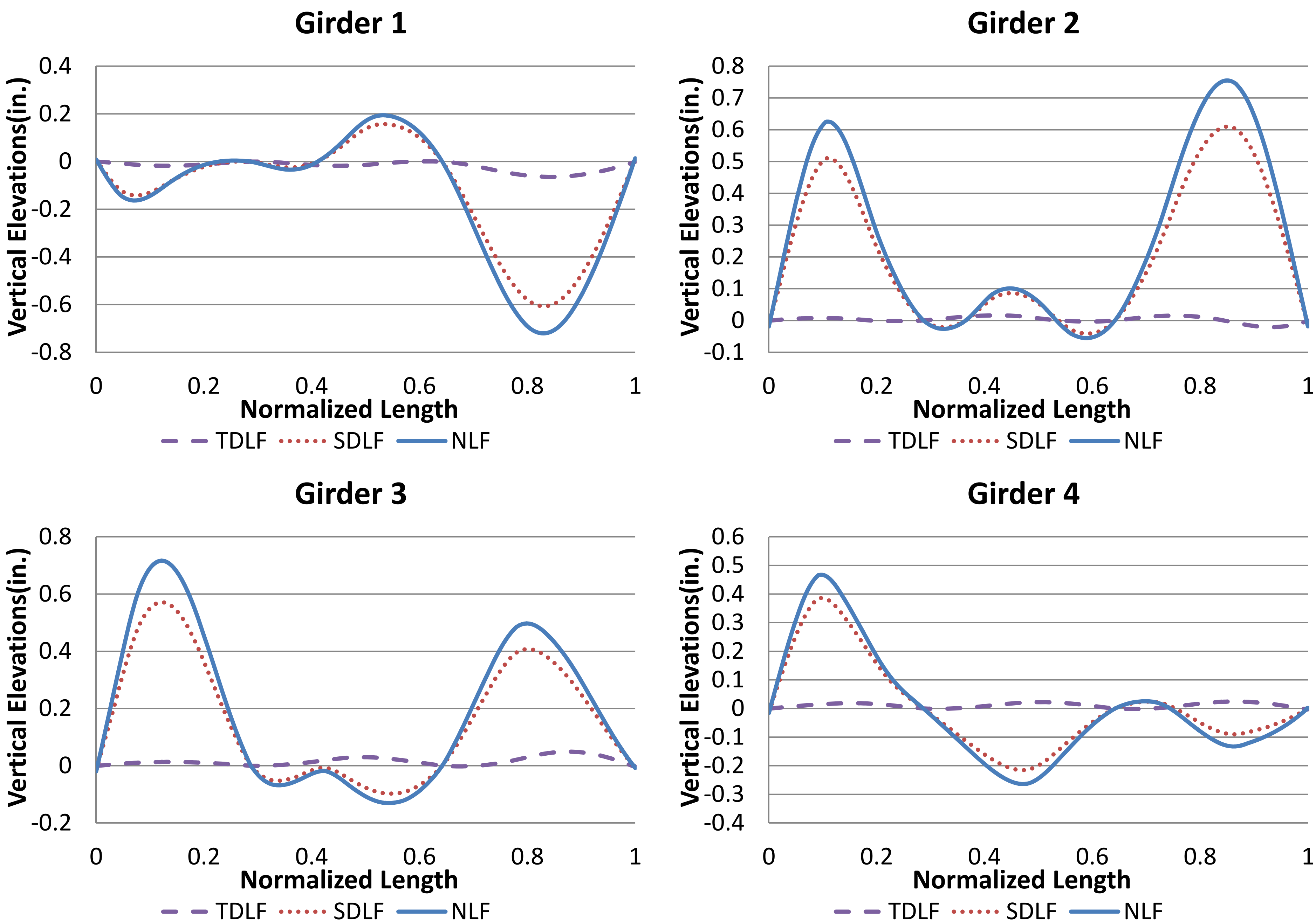


Figure L4-15. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

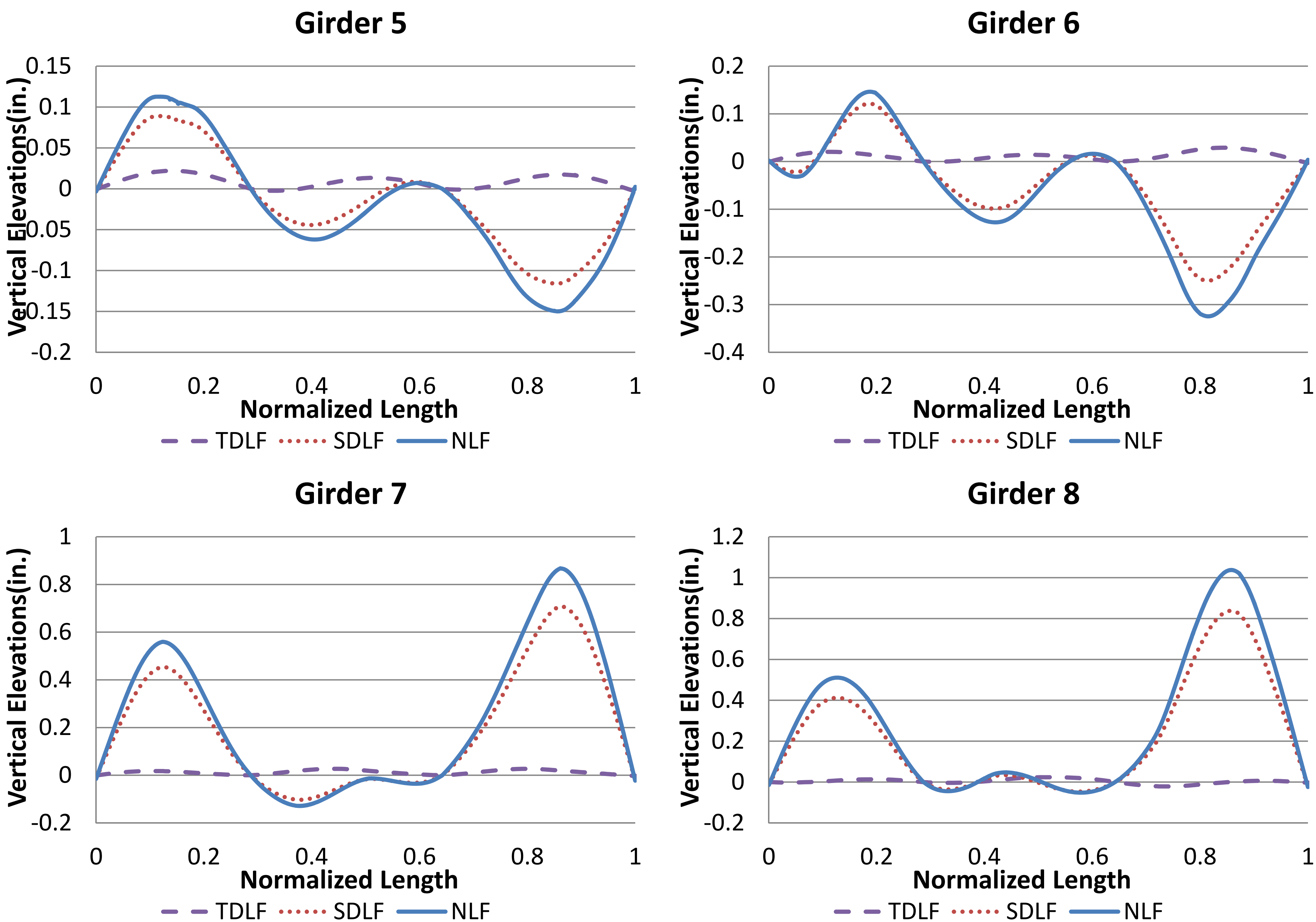


Figure L4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

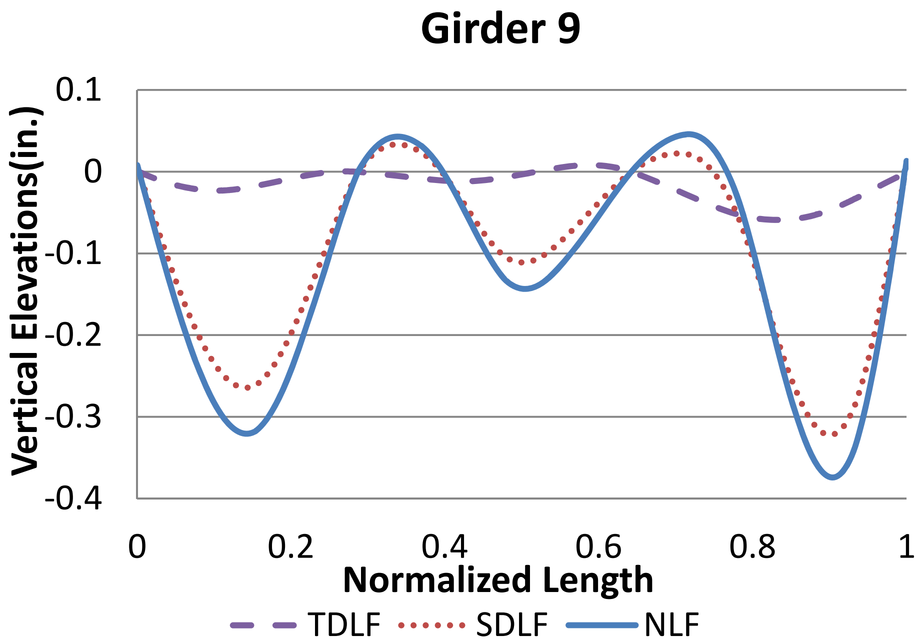


Figure L4-15(Continued). **Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.**

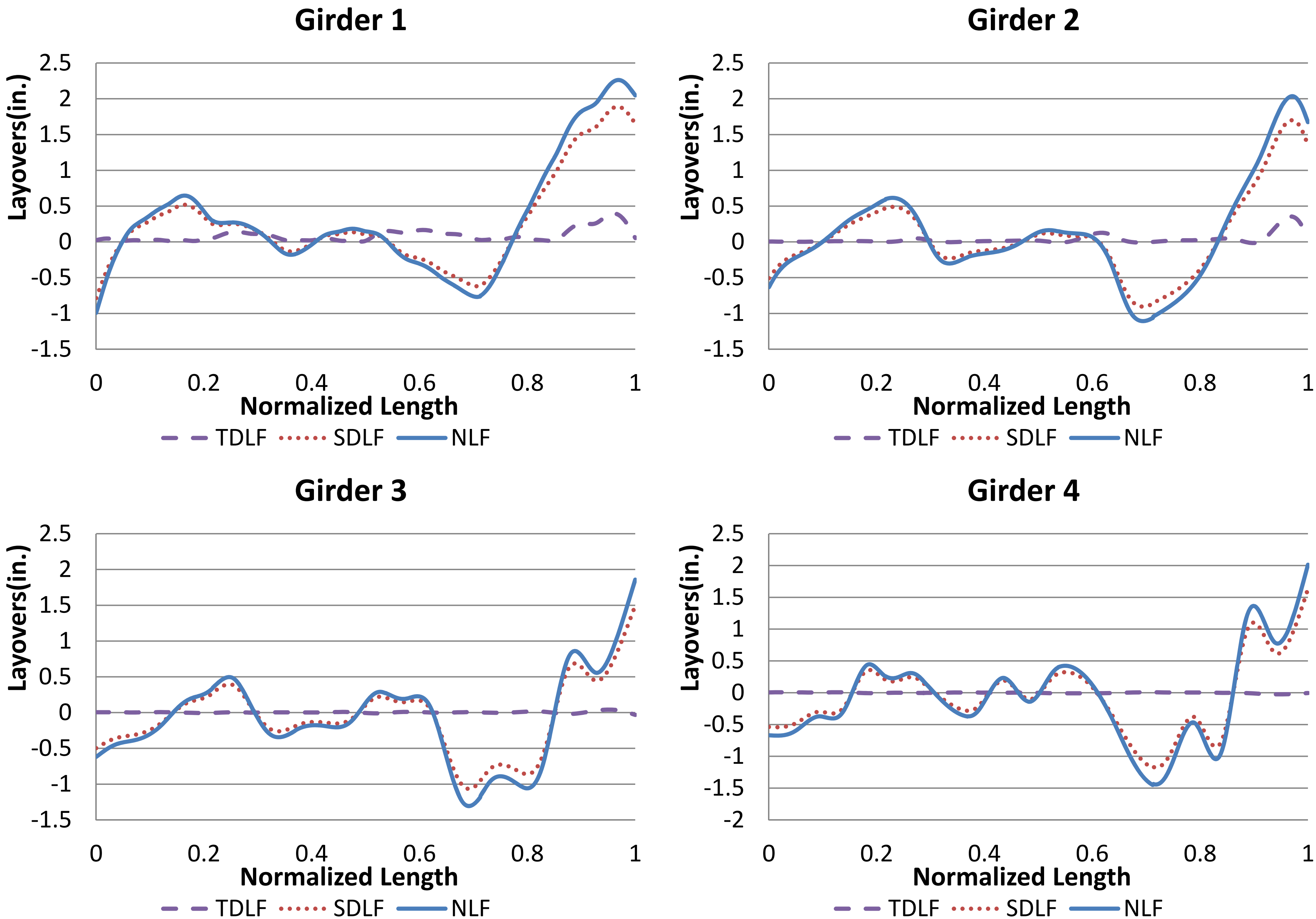


Figure L4-16. Comparison of individual girder layovers (in) under TDL for different detailing methods.

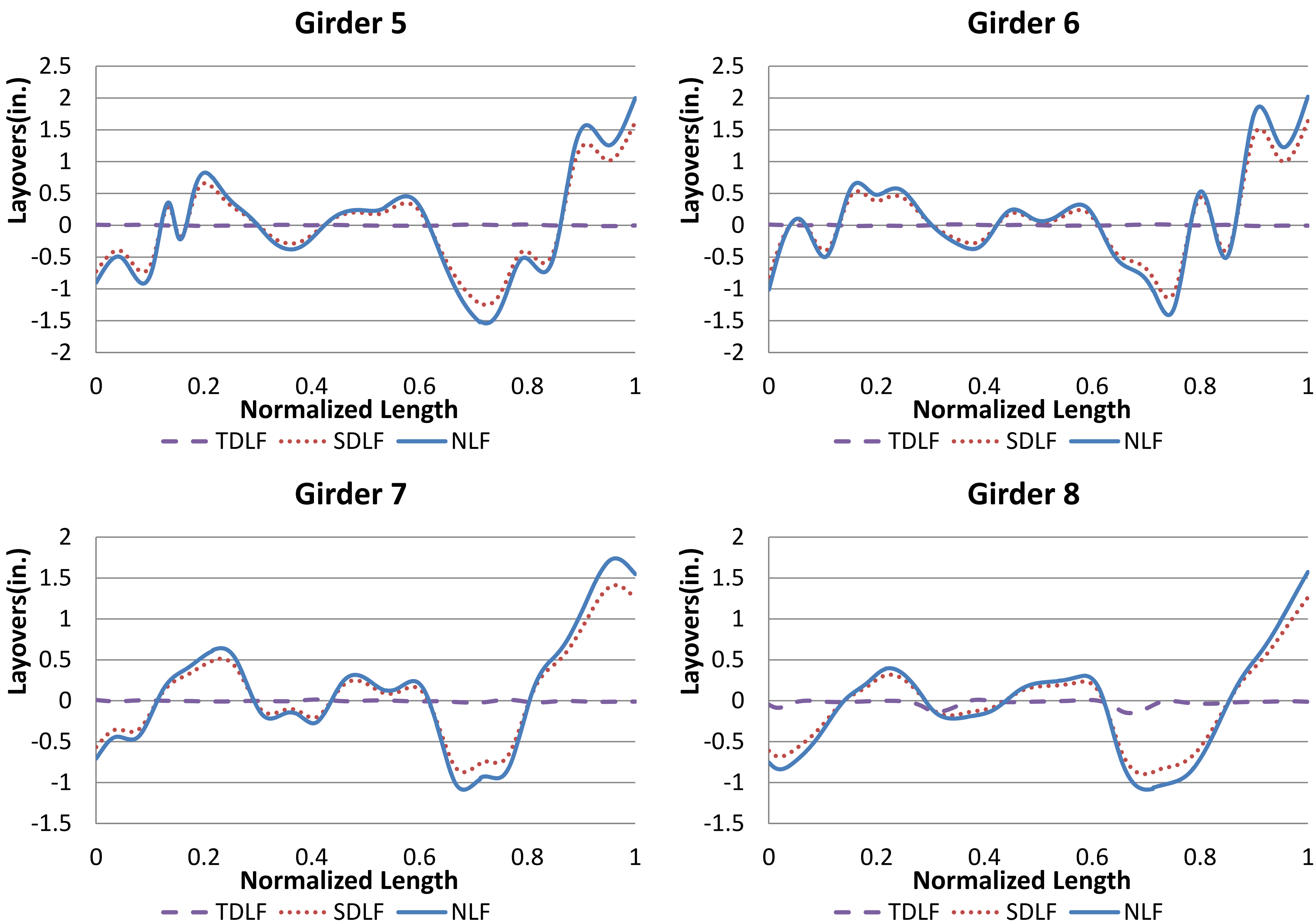


Figure L4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

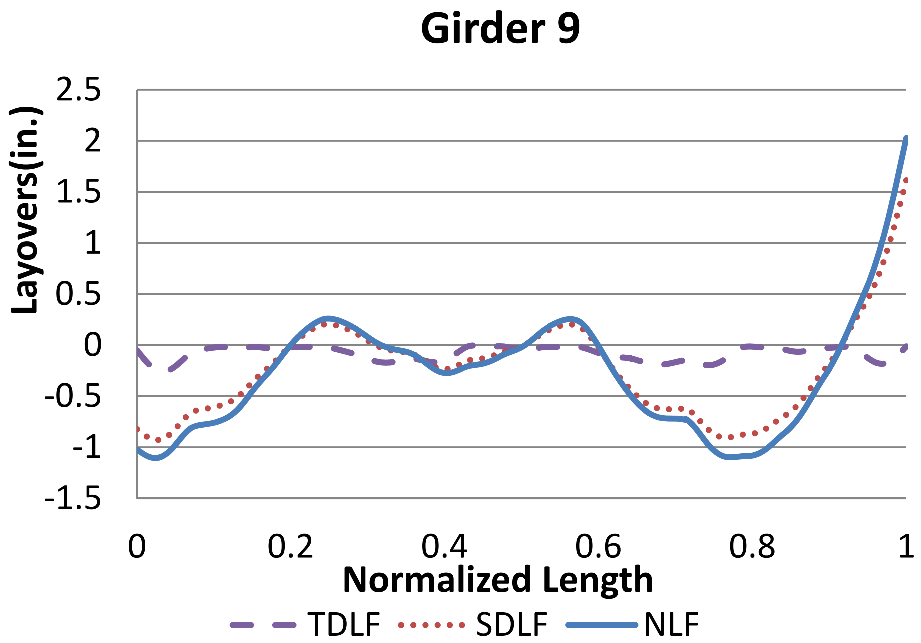


Figure L4-16(Continued). **Comparison of individual girder layovers (in) under TDL for different detailing methods.**

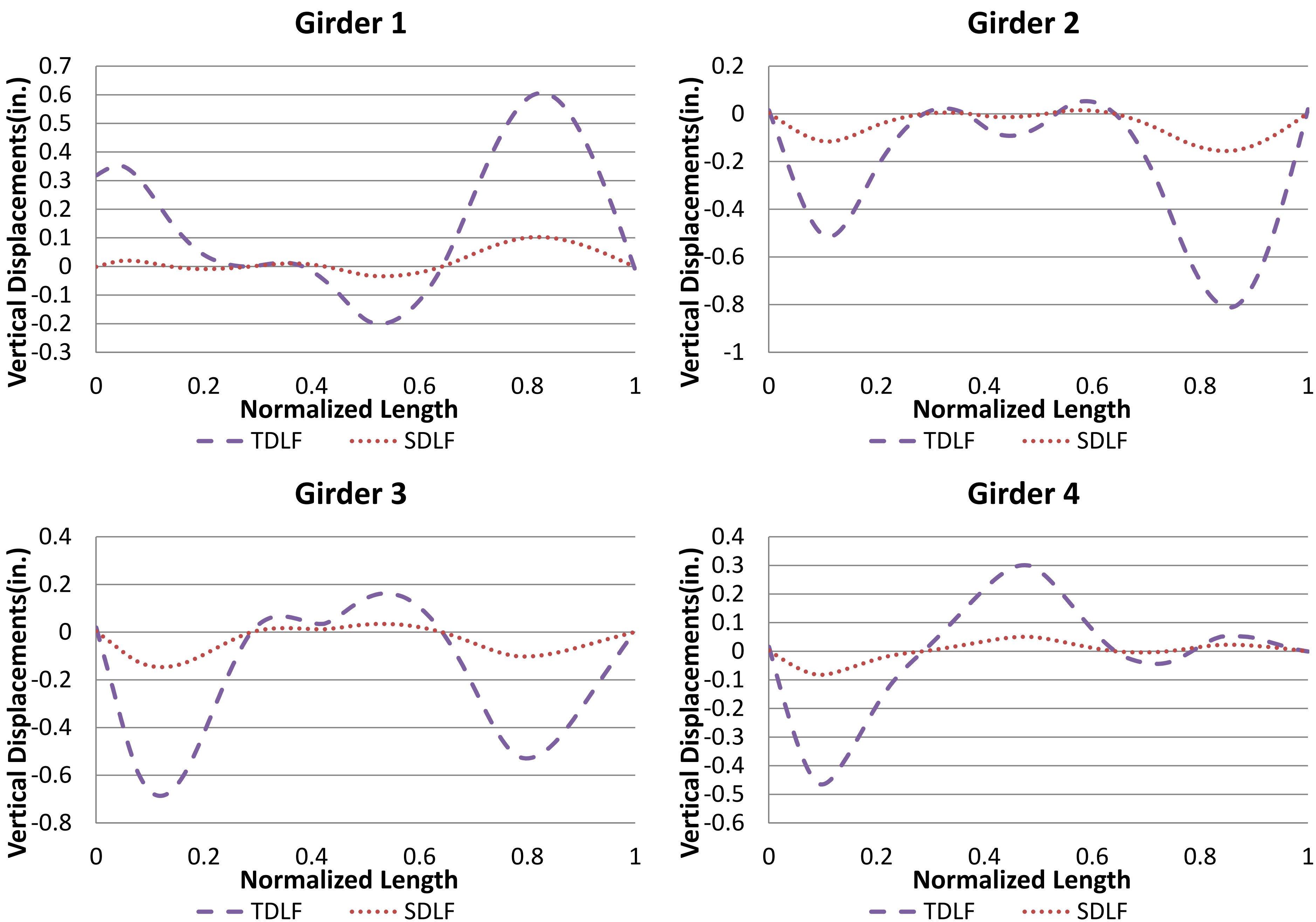


Figure L4-17. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

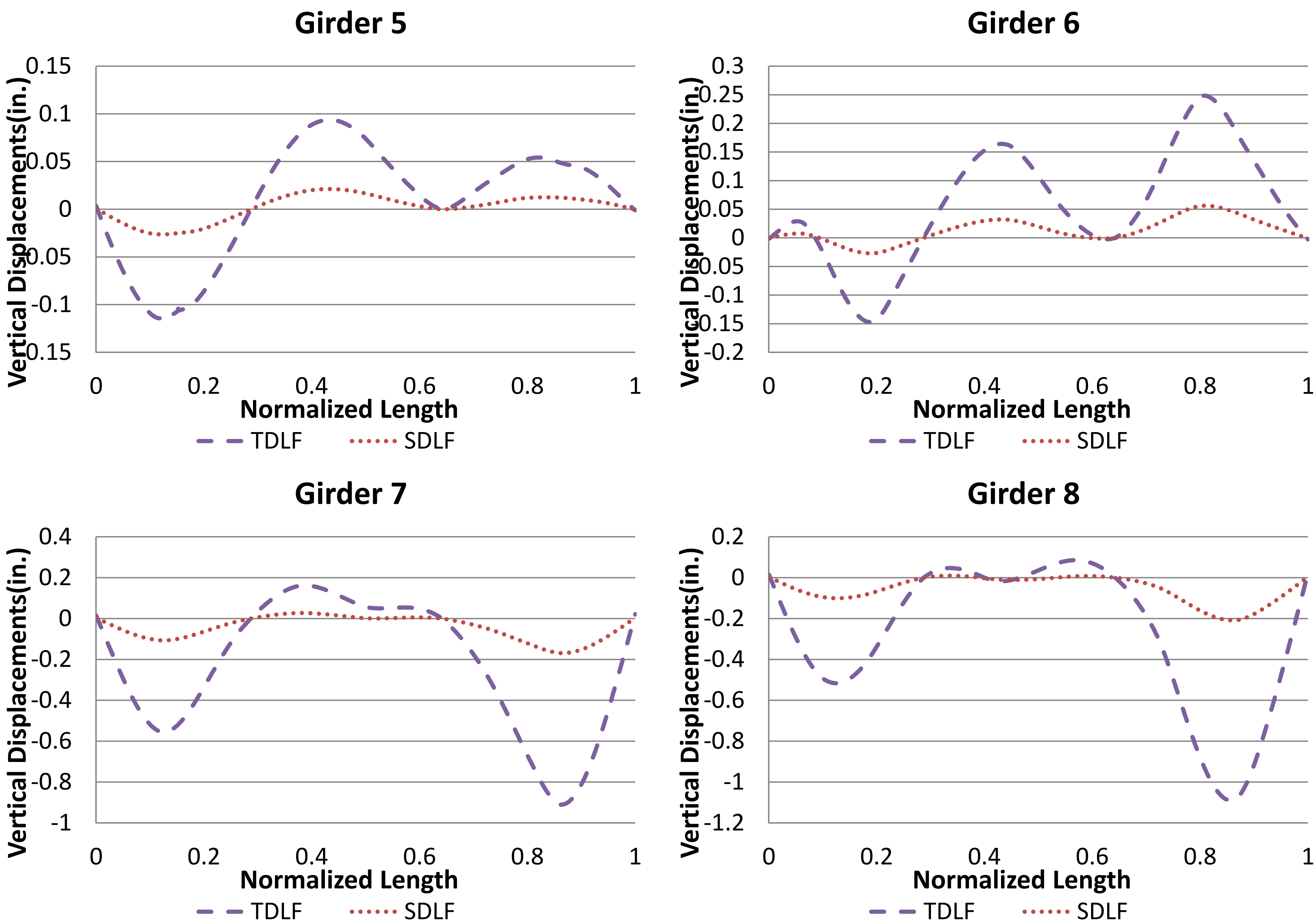


Figure L4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

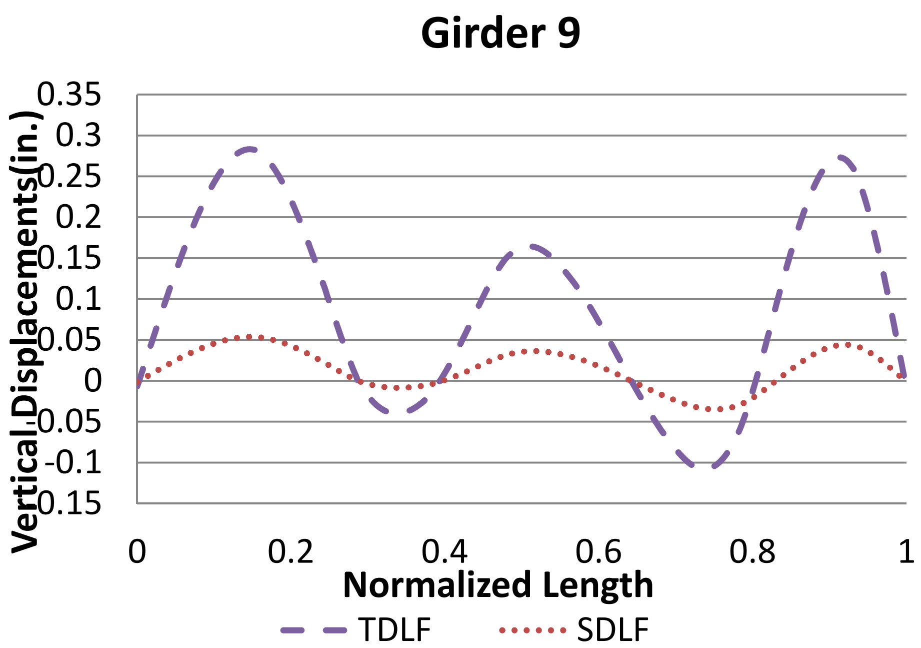


Figure L4-17(Continued). **Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.**

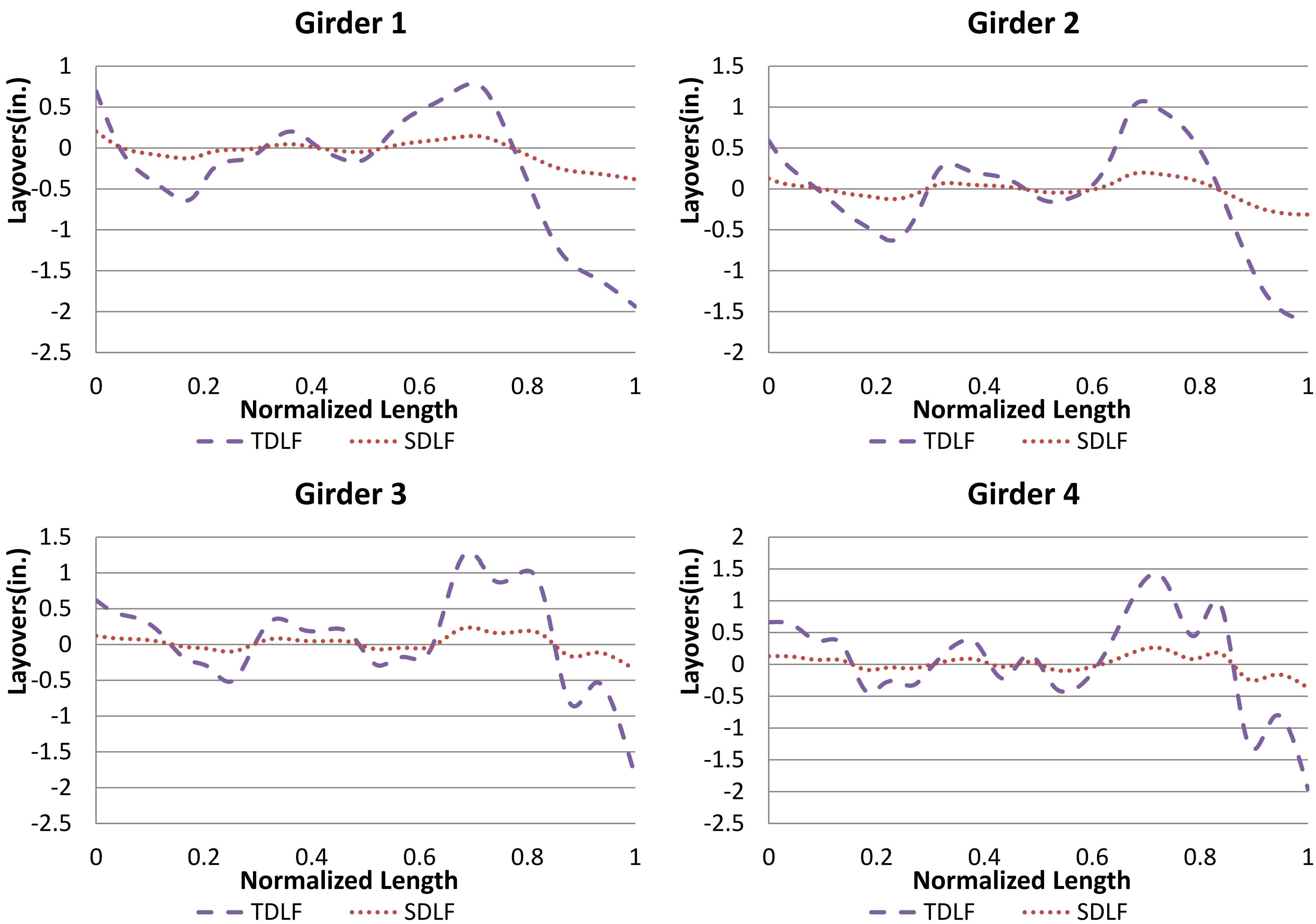


Figure L4-18. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

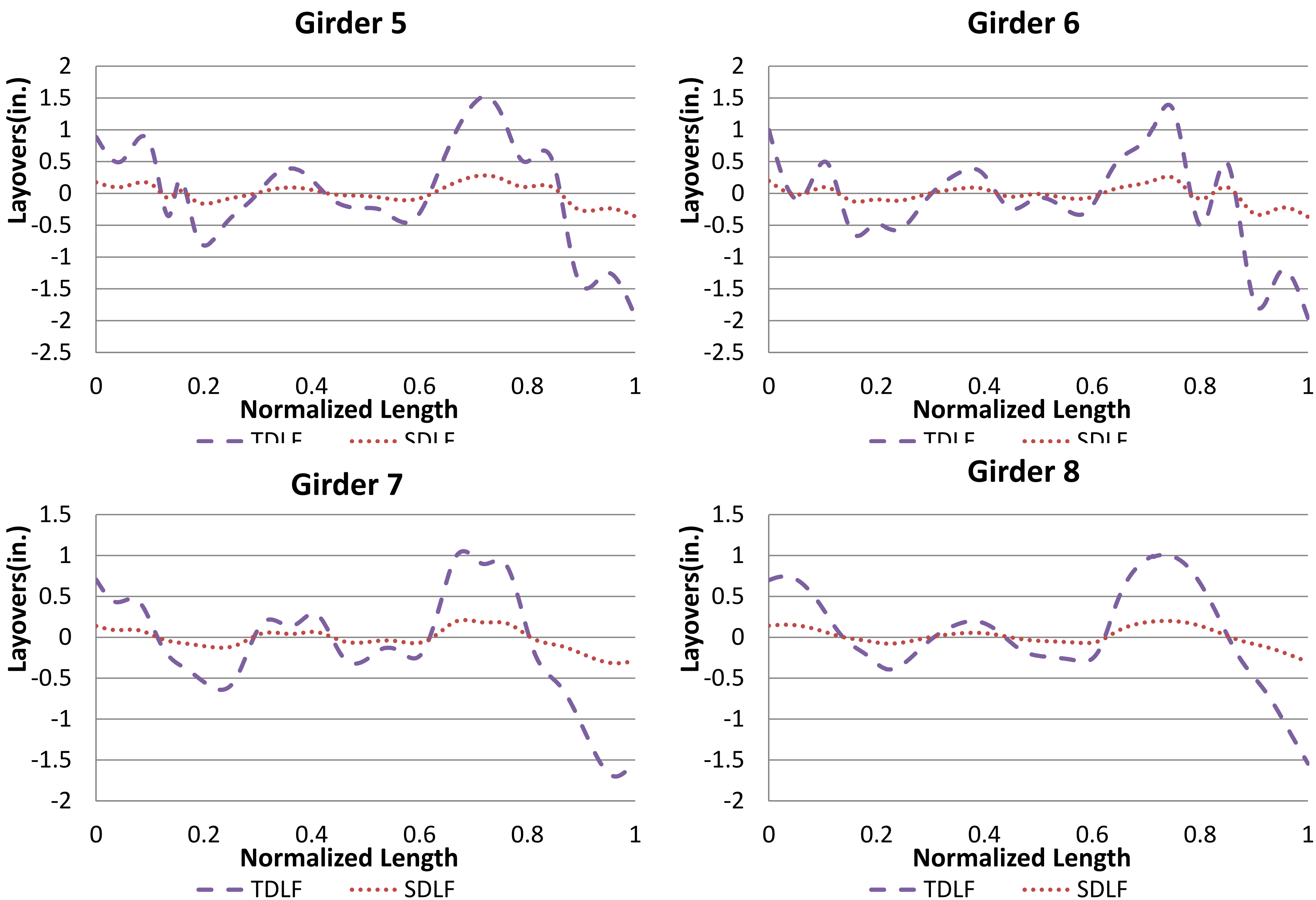


Figure L4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

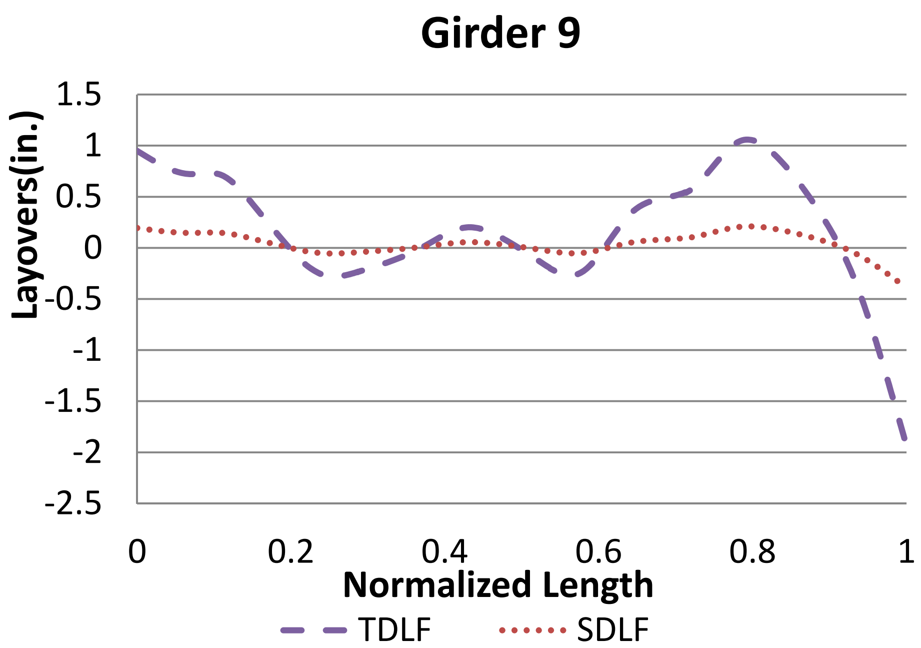


Figure L4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

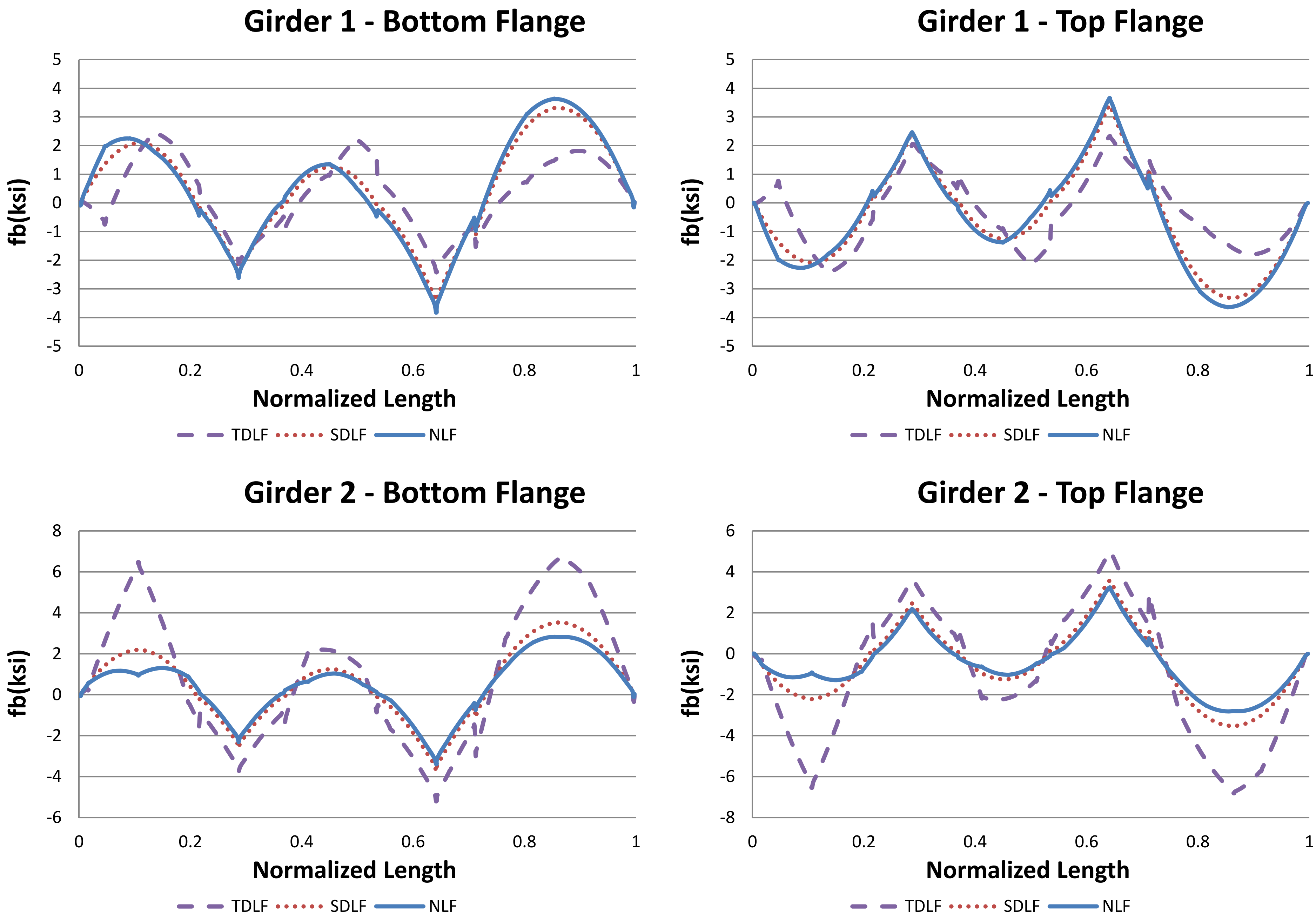


Figure L4-19. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

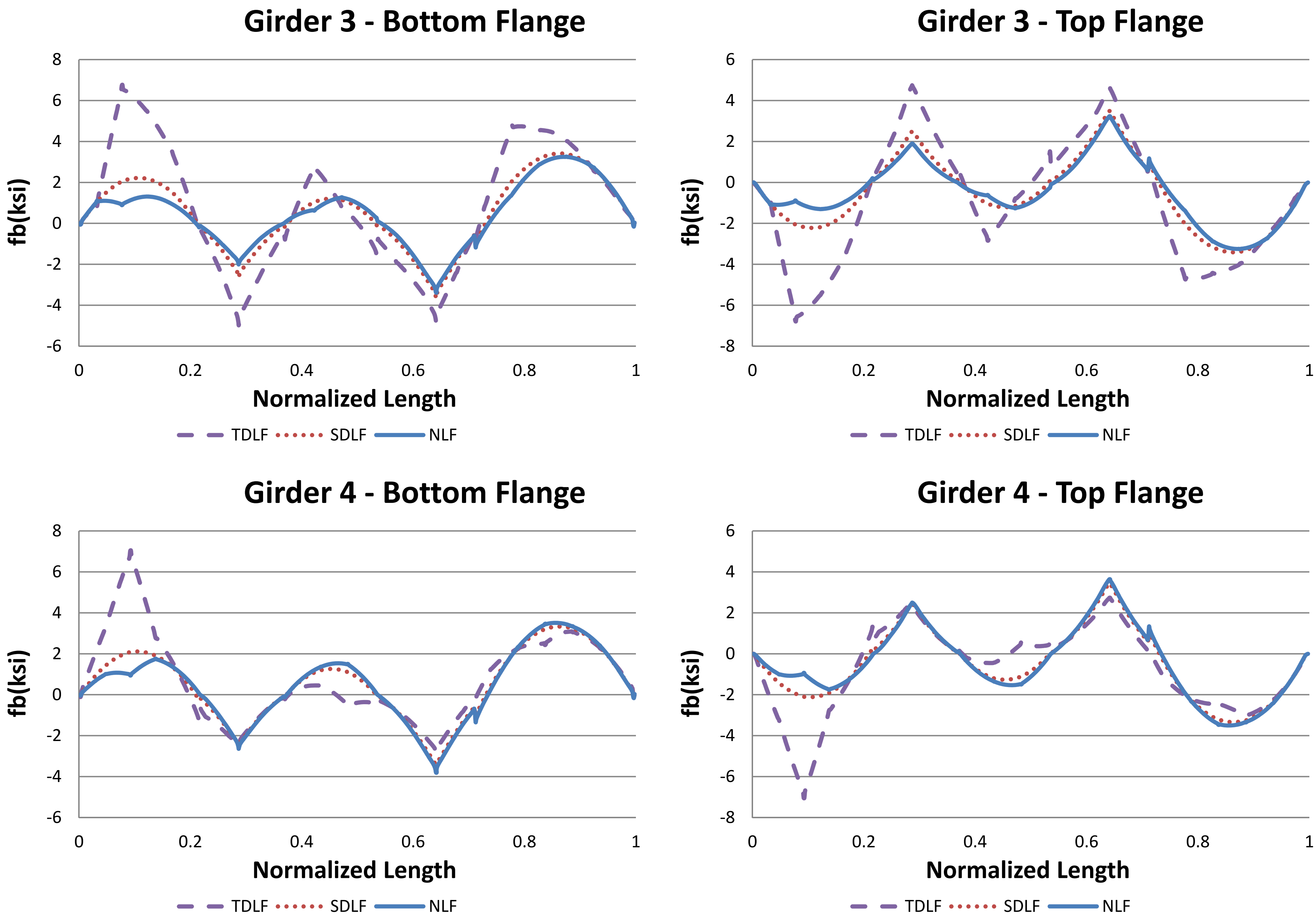


Figure L4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

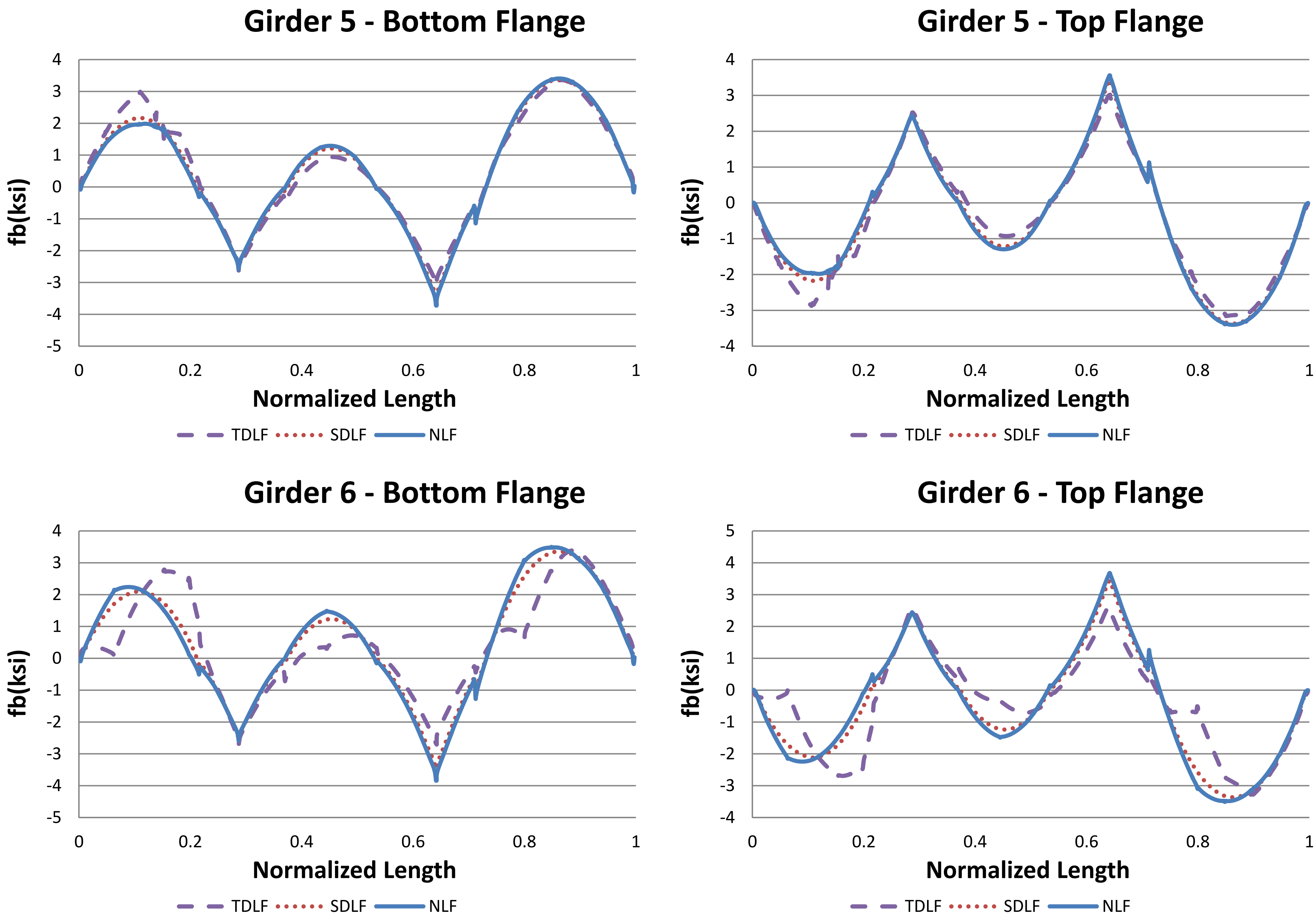


Figure L4-19 (continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

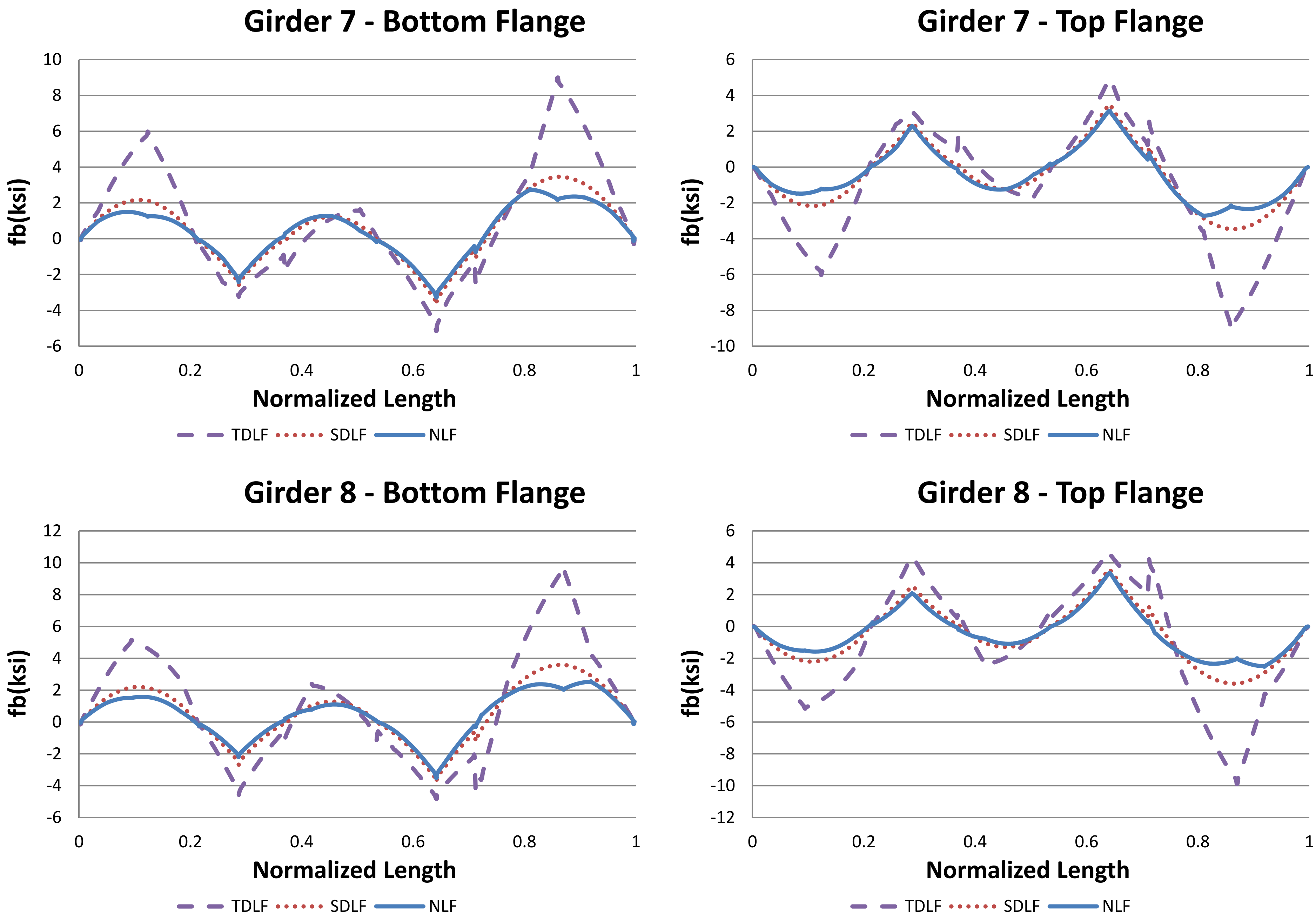


Figure L4-19 (continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

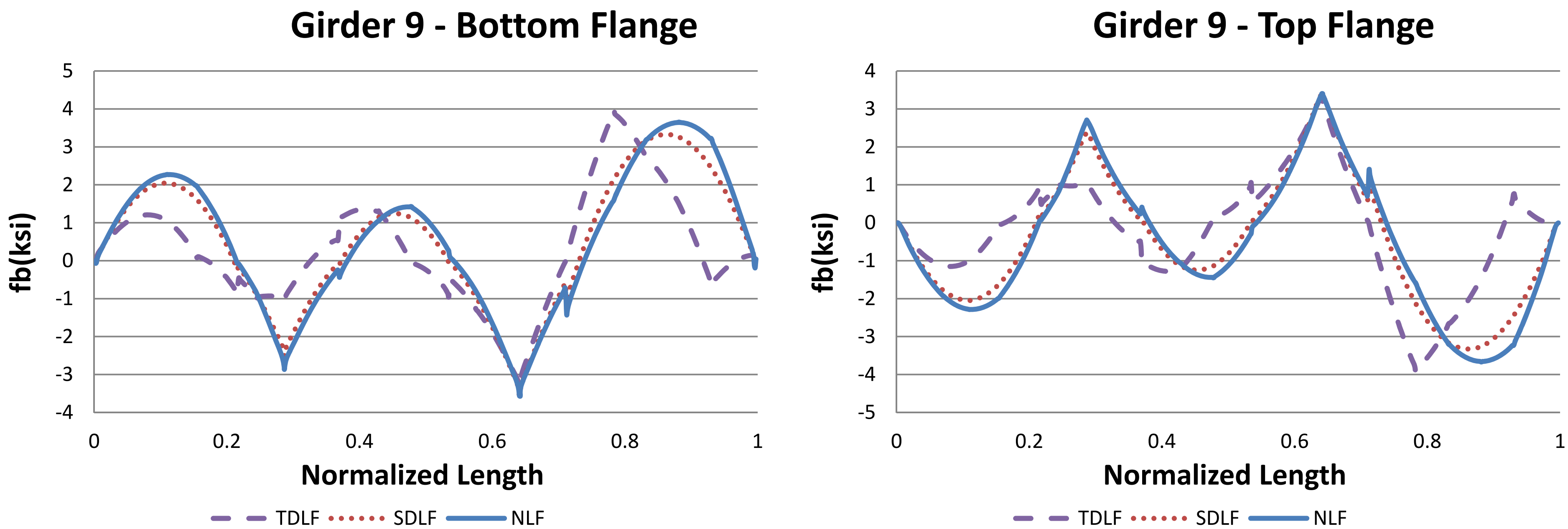


Figure L4-19 (continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

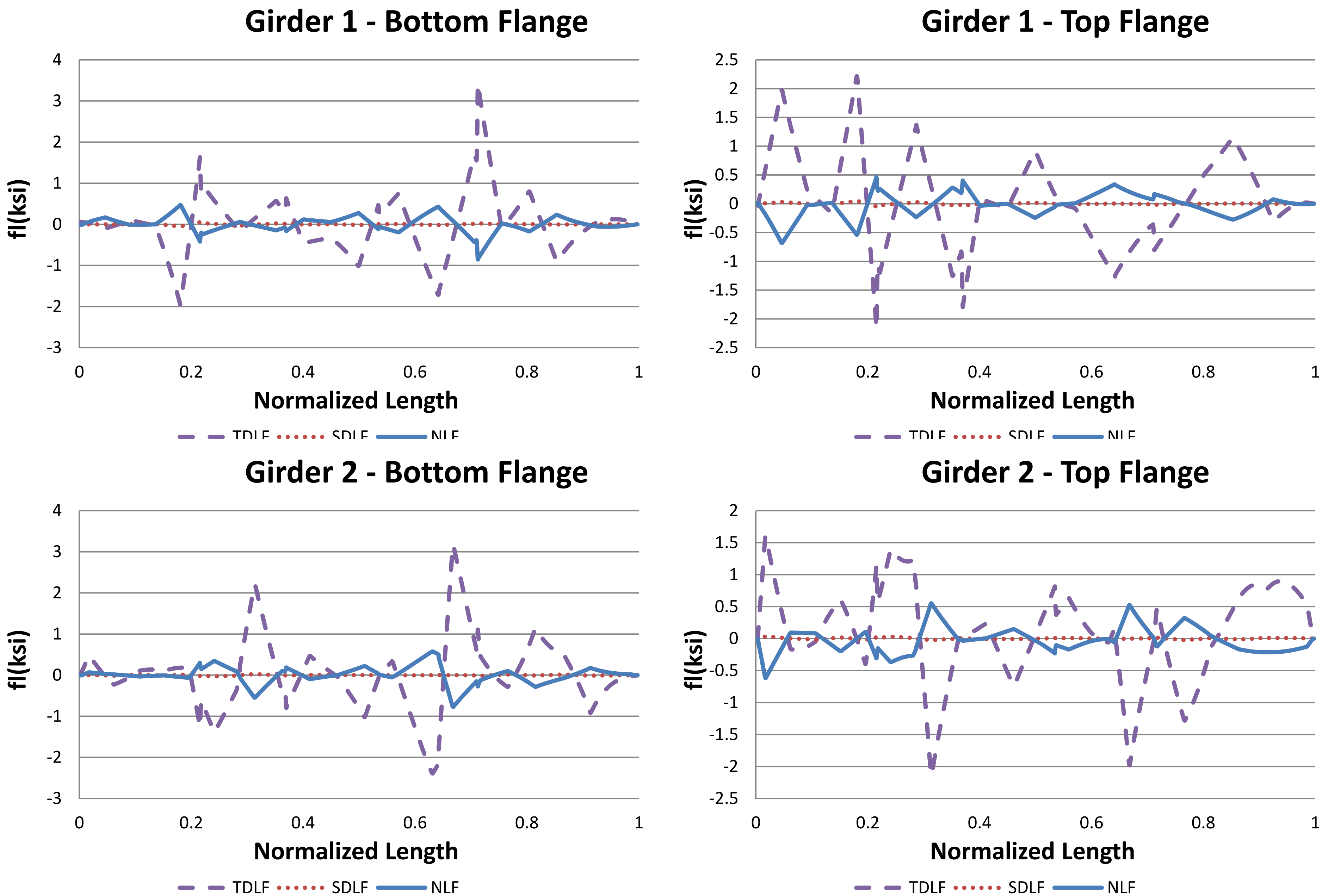


Figure L4-20. Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under SDL for different detailing methods.

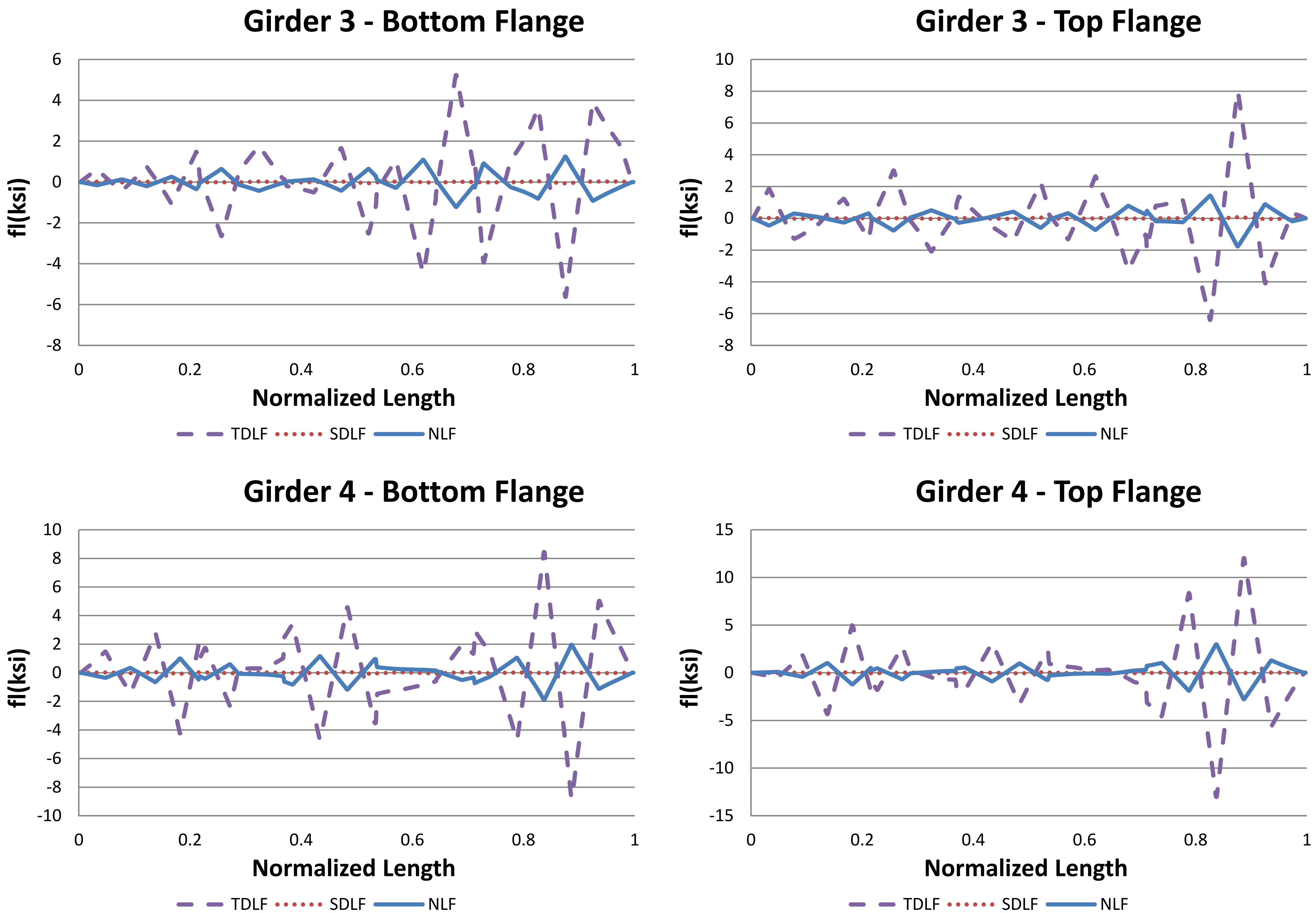


Figure L4-20 (continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

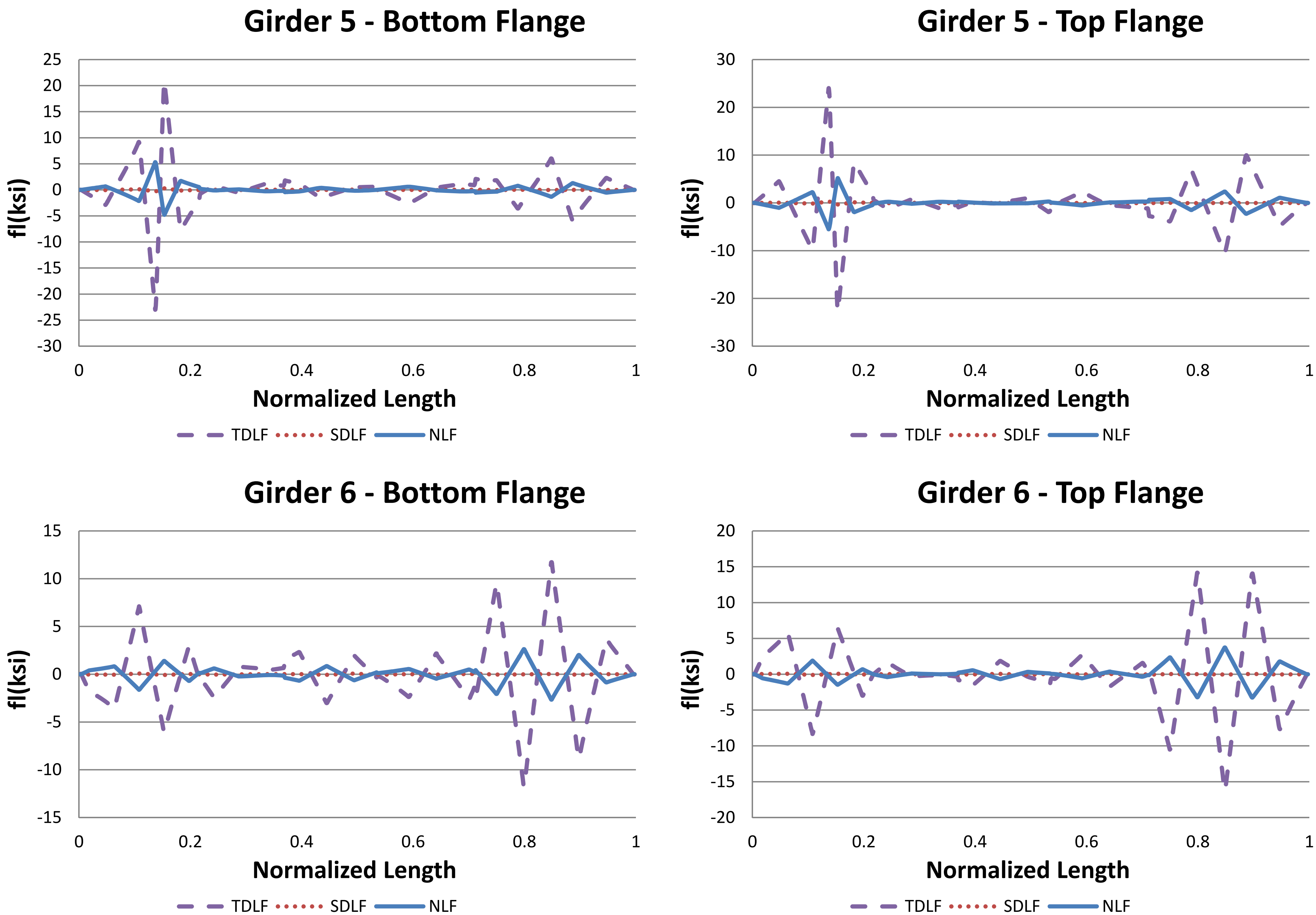


Figure L4-20 (continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

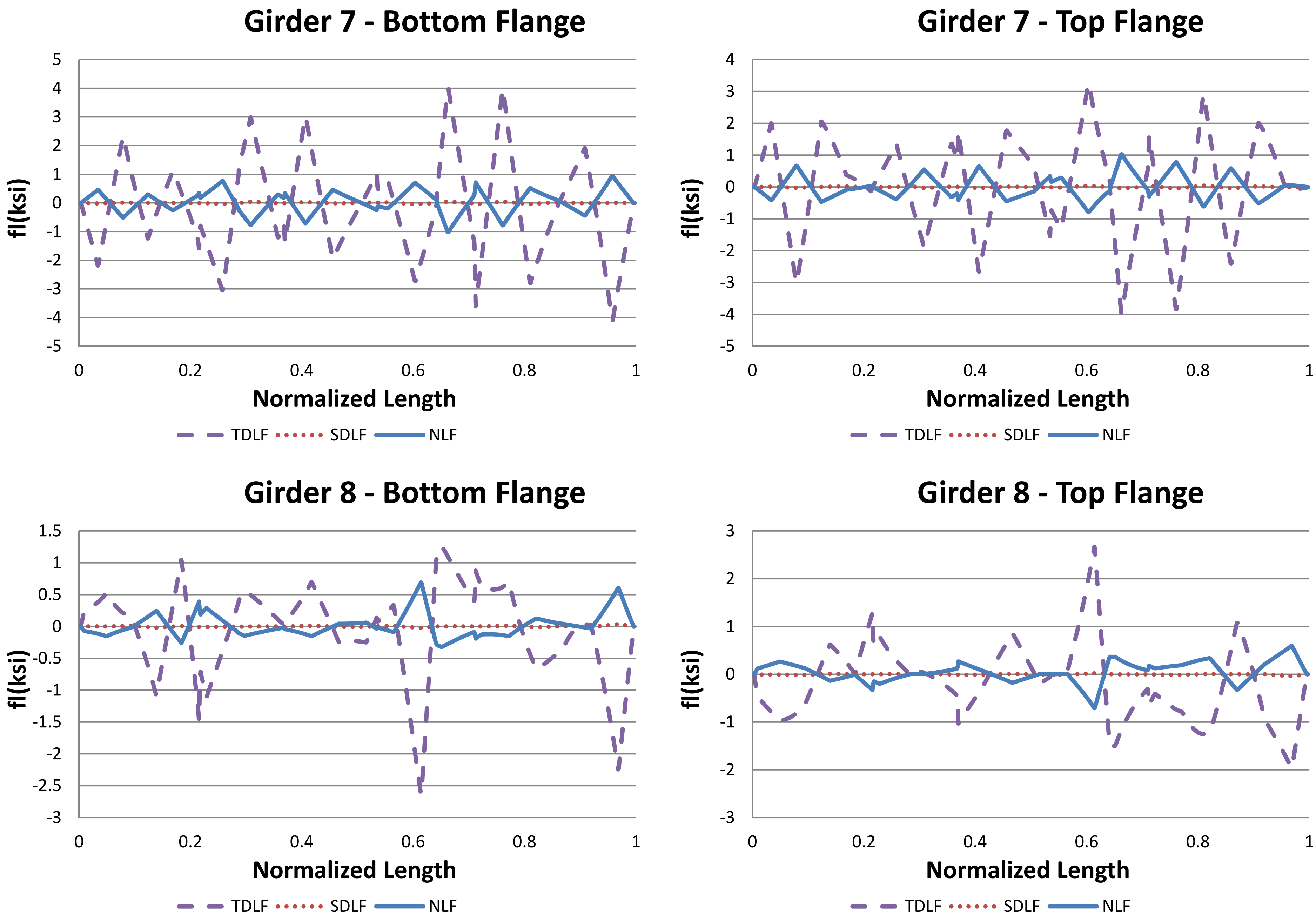


Figure L4-20 (continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

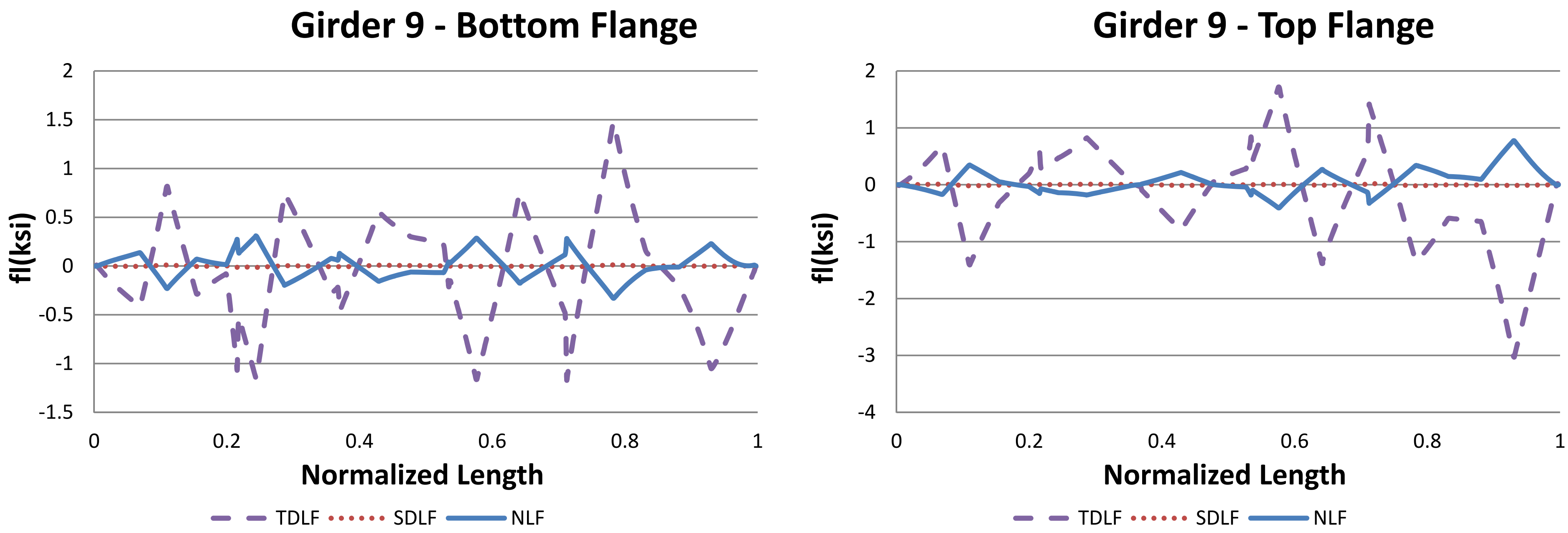


Figure L4-20 (continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

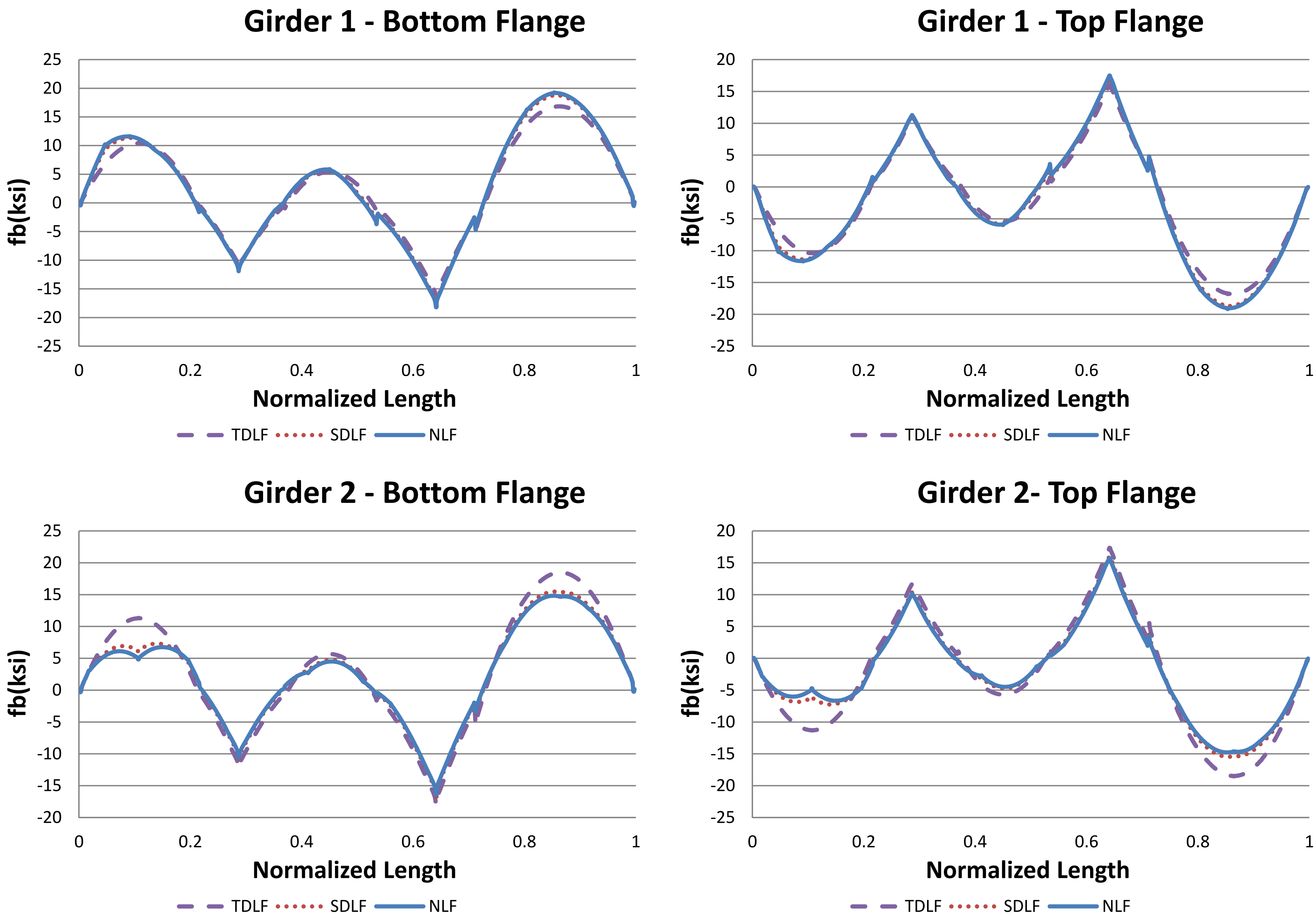


Figure L4-21. Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

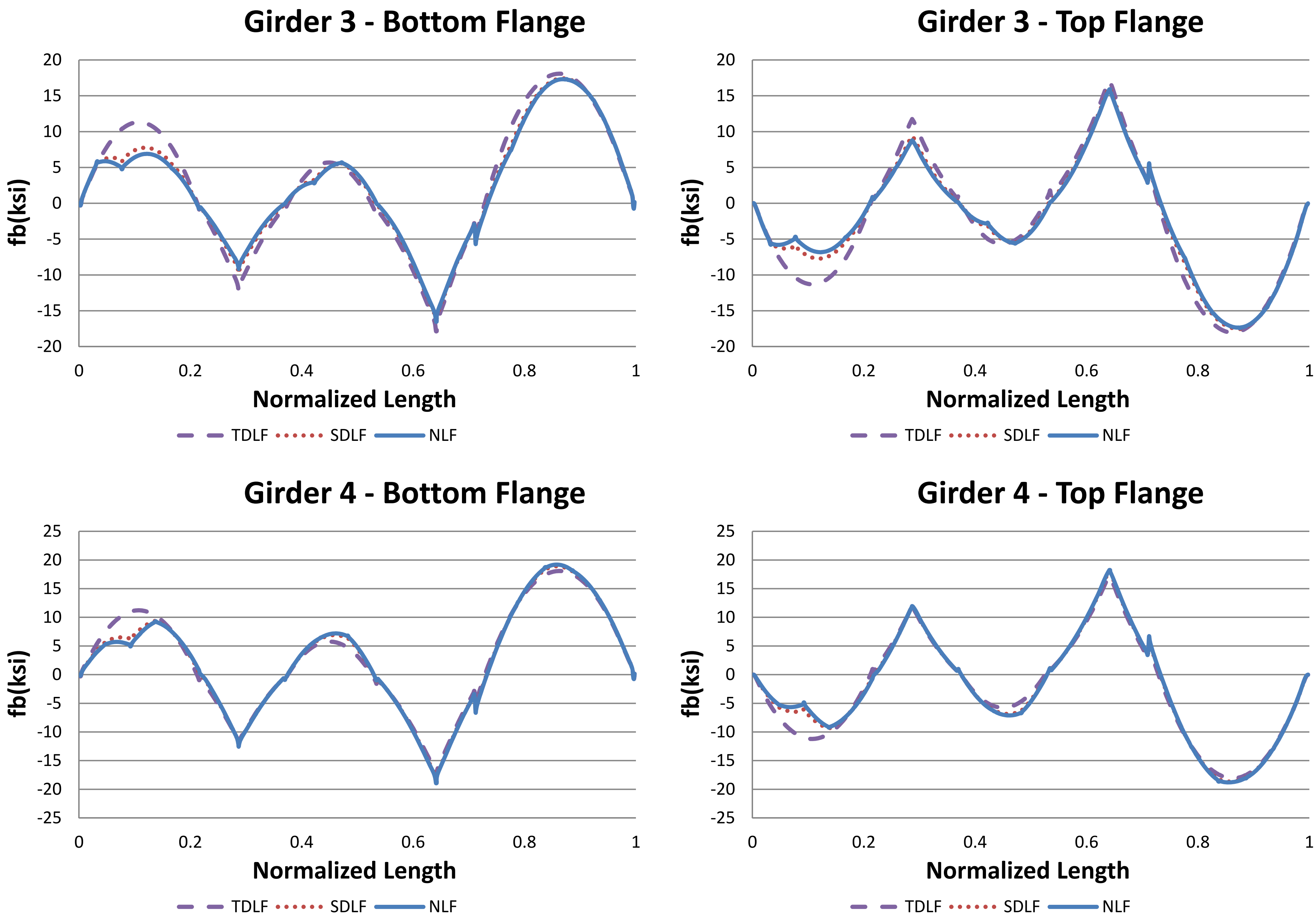


Figure L4-21 (continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

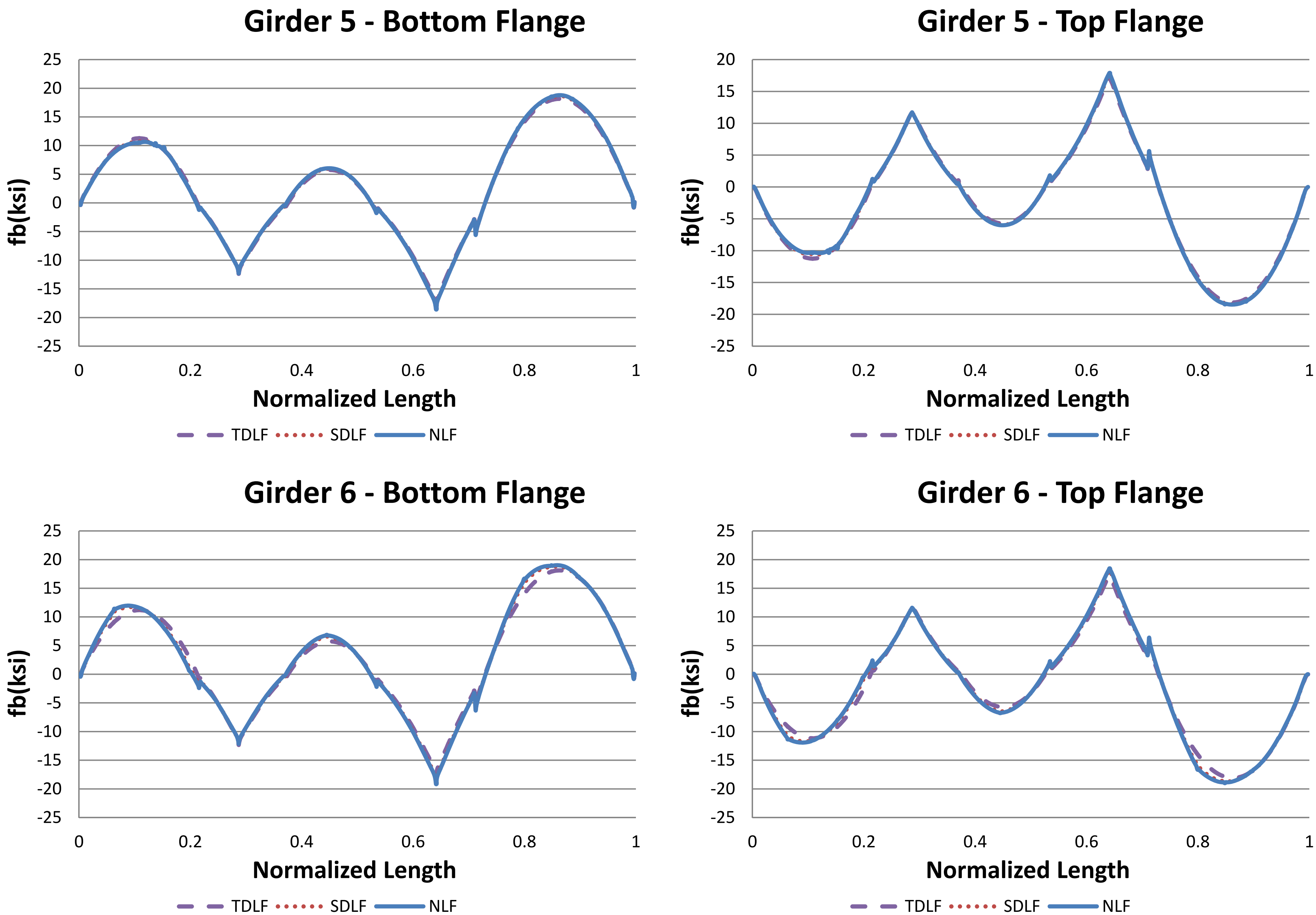


Figure L4-21 (continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

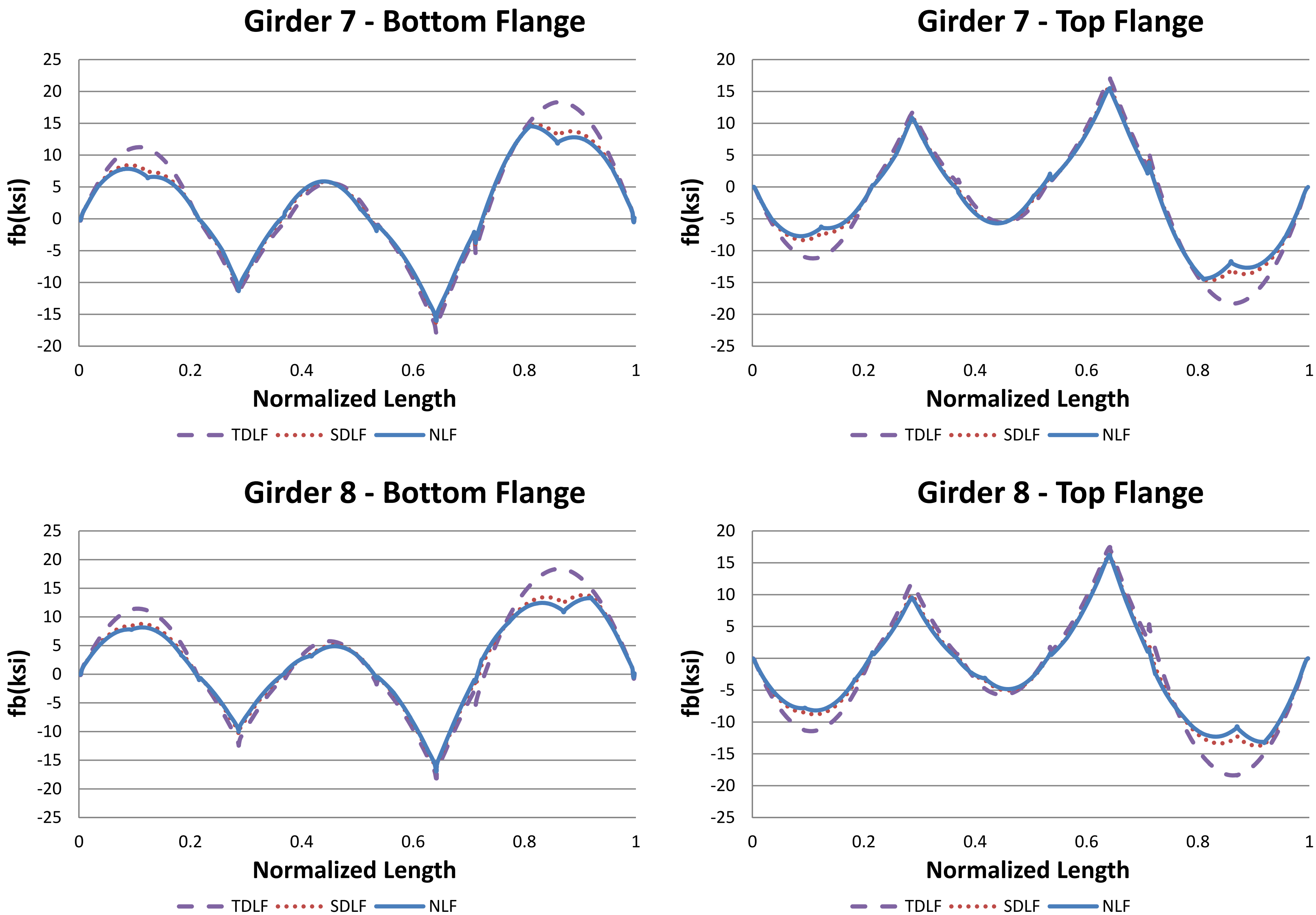
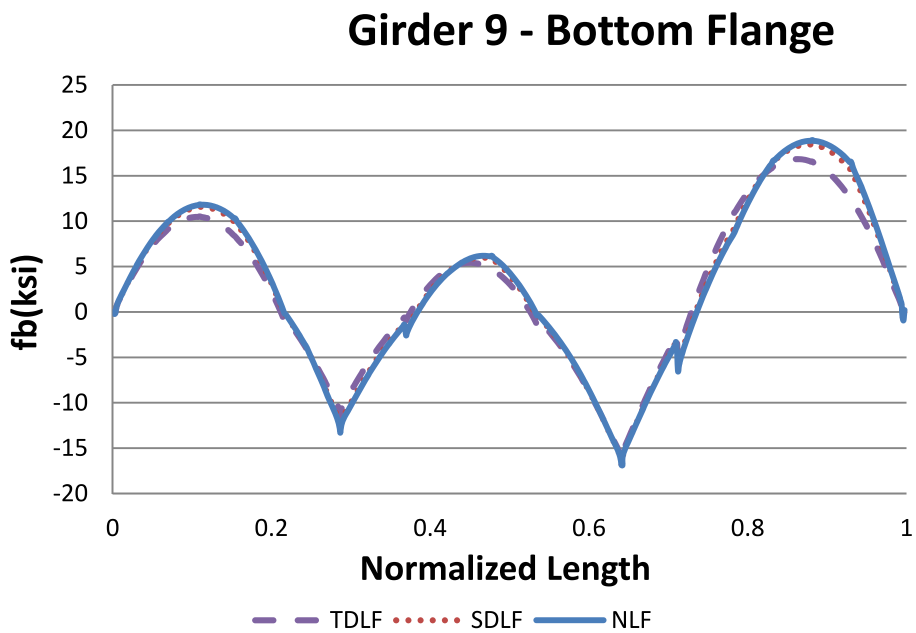


Figure L4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



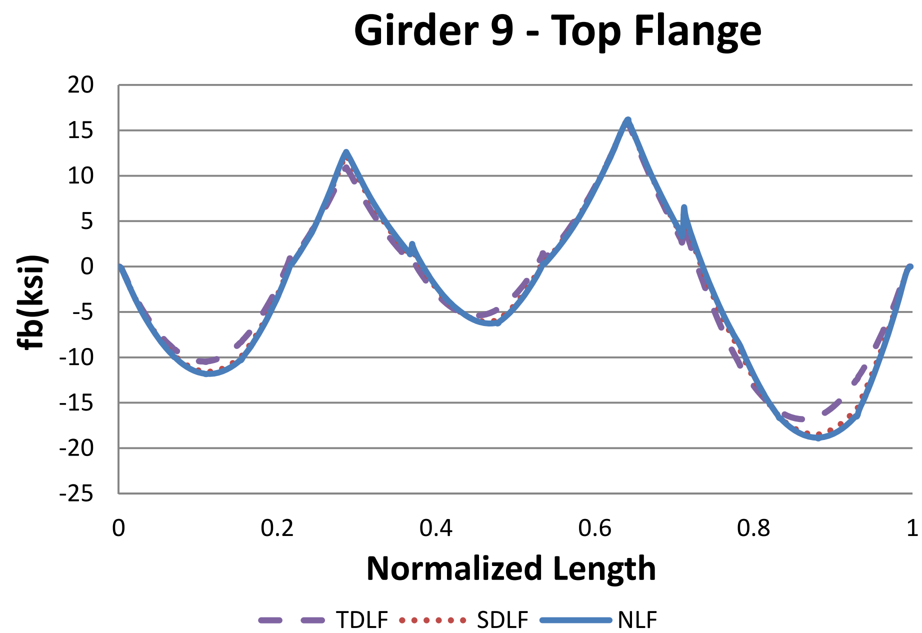


Figure L4-21 (continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

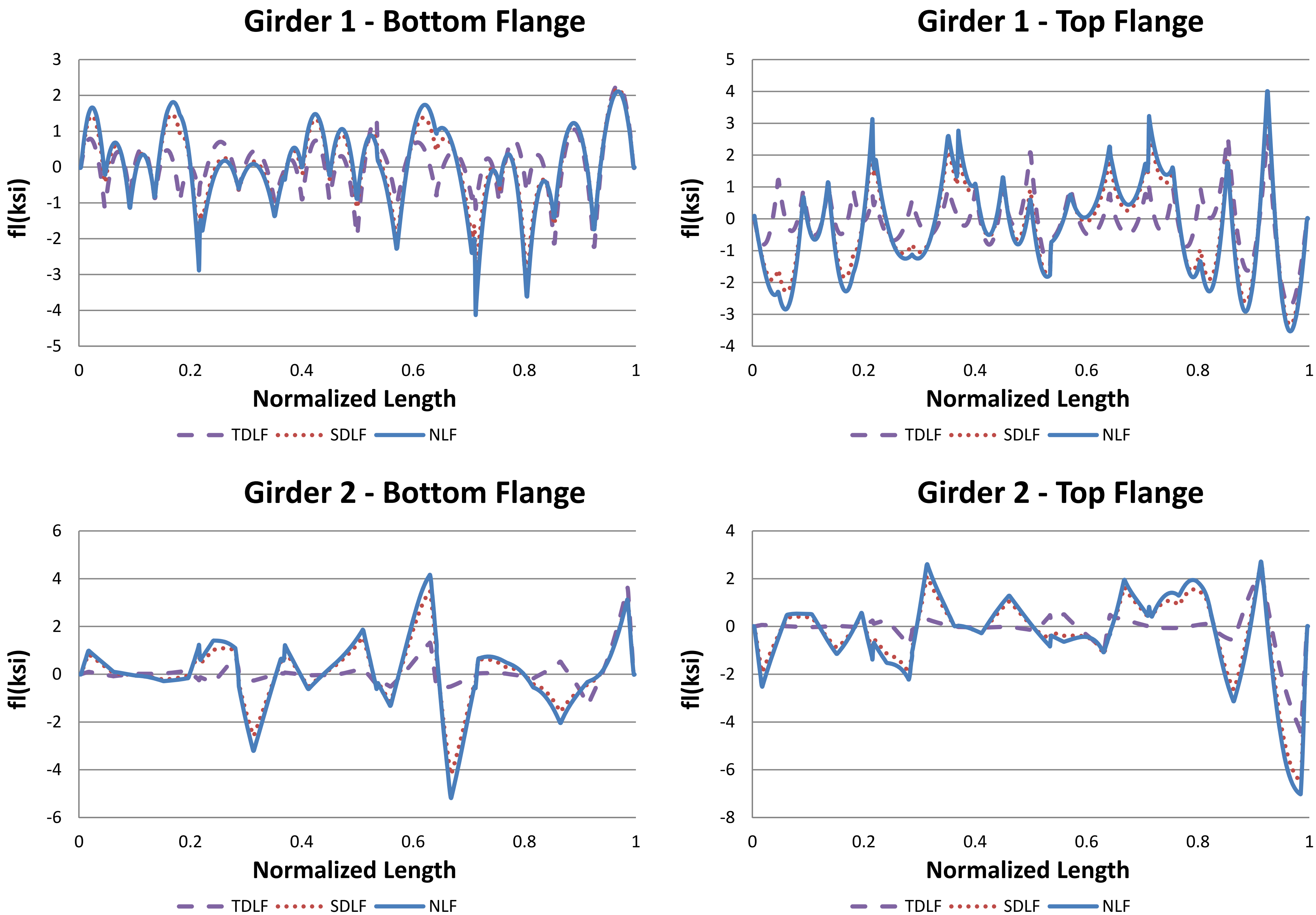


Figure L4-22. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

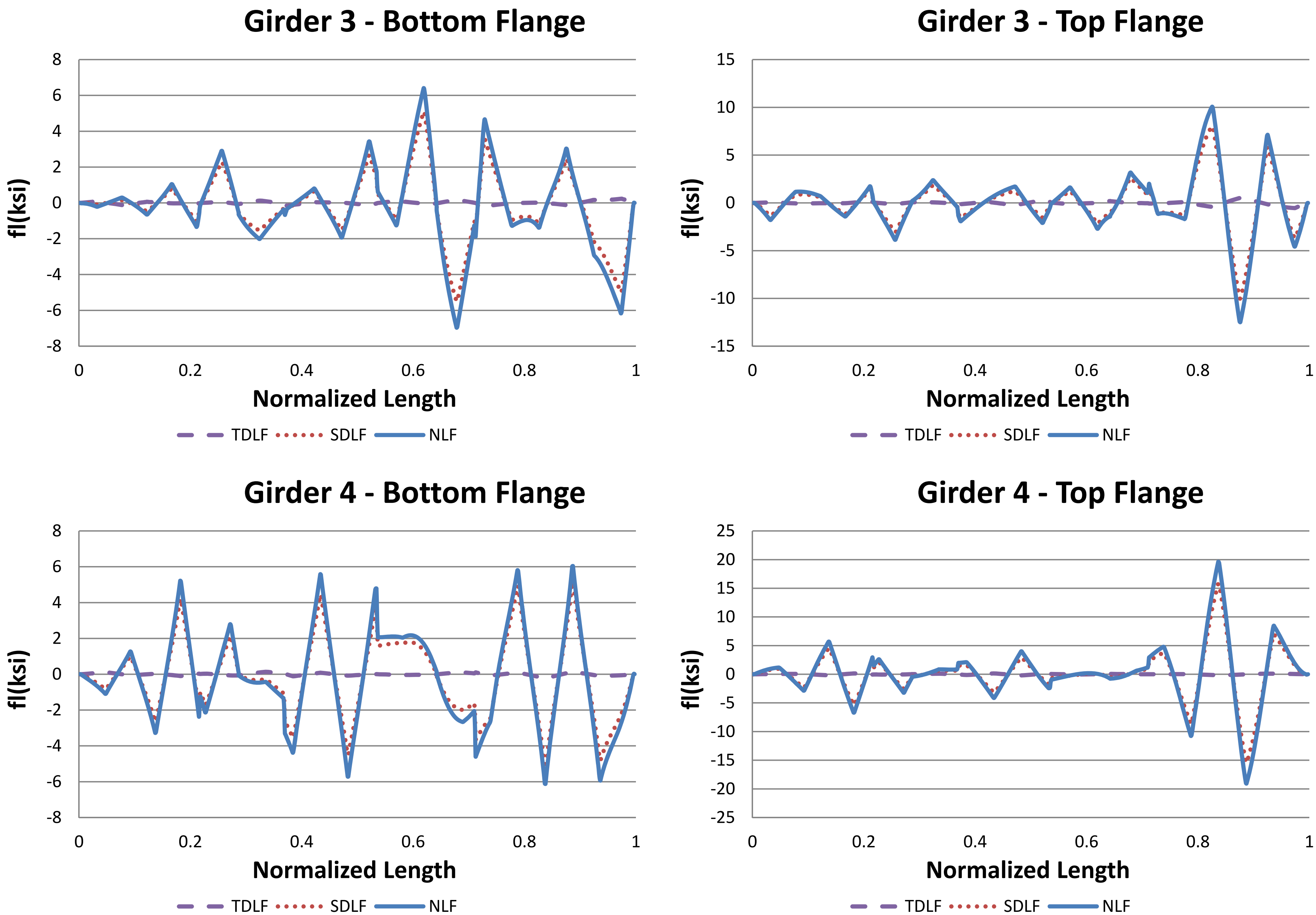


Figure L4-22 (continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

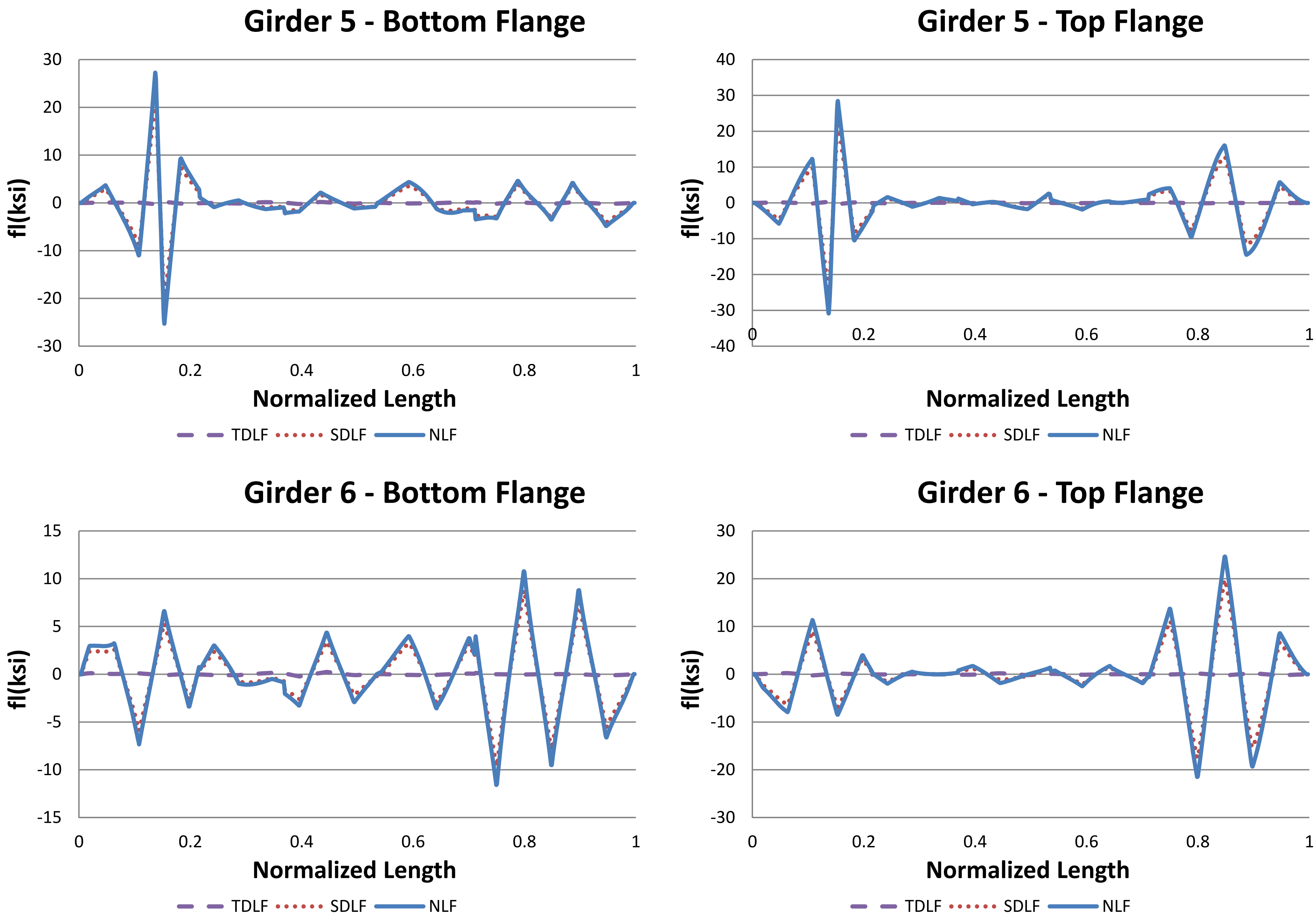


Figure L4-22 (continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

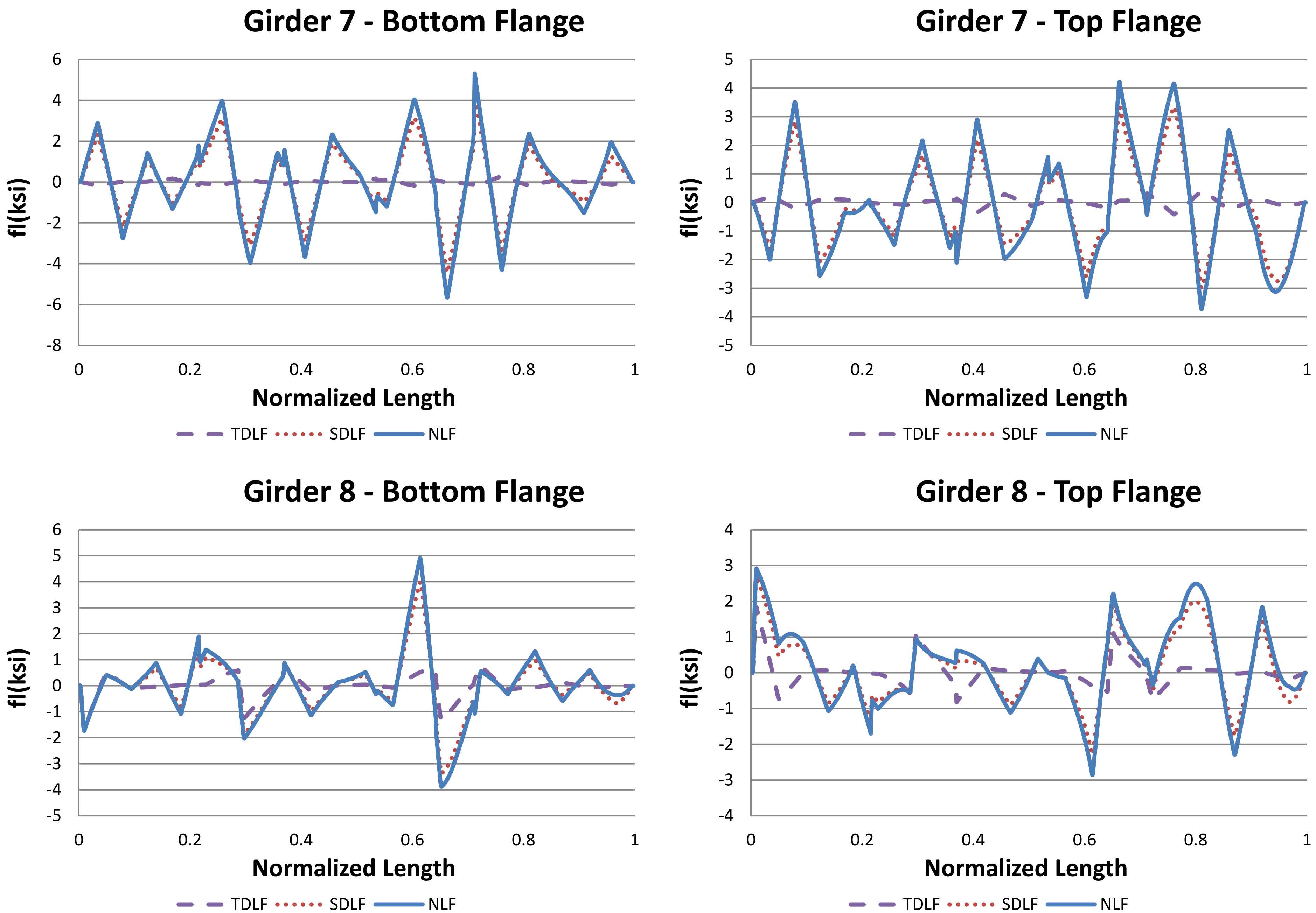
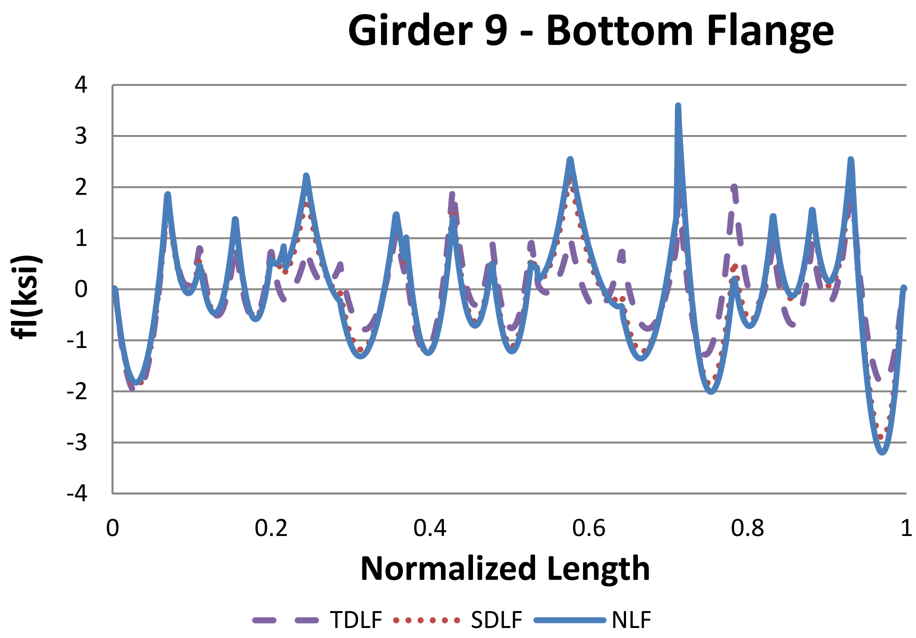


Figure L4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.



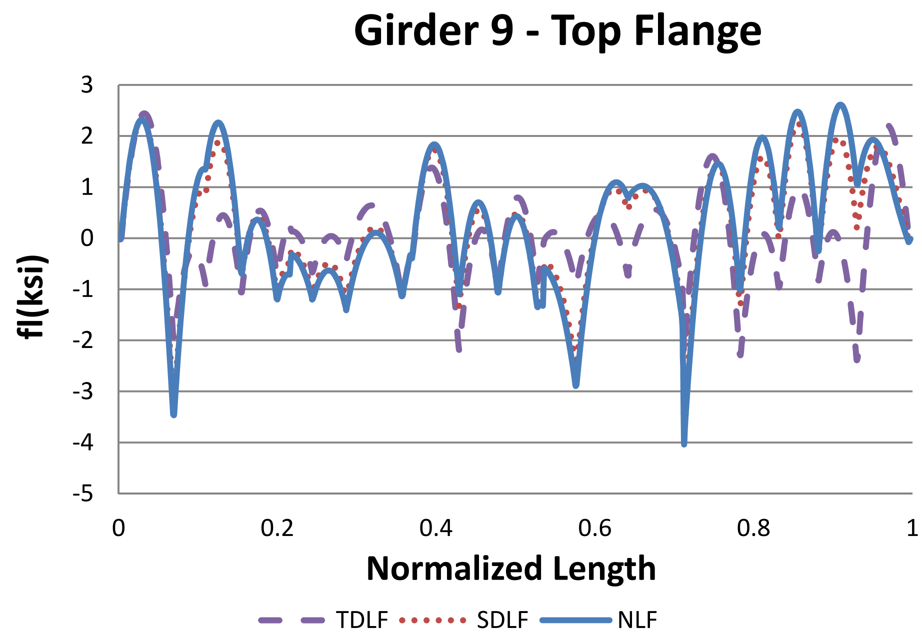


Figure L4-22 (continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

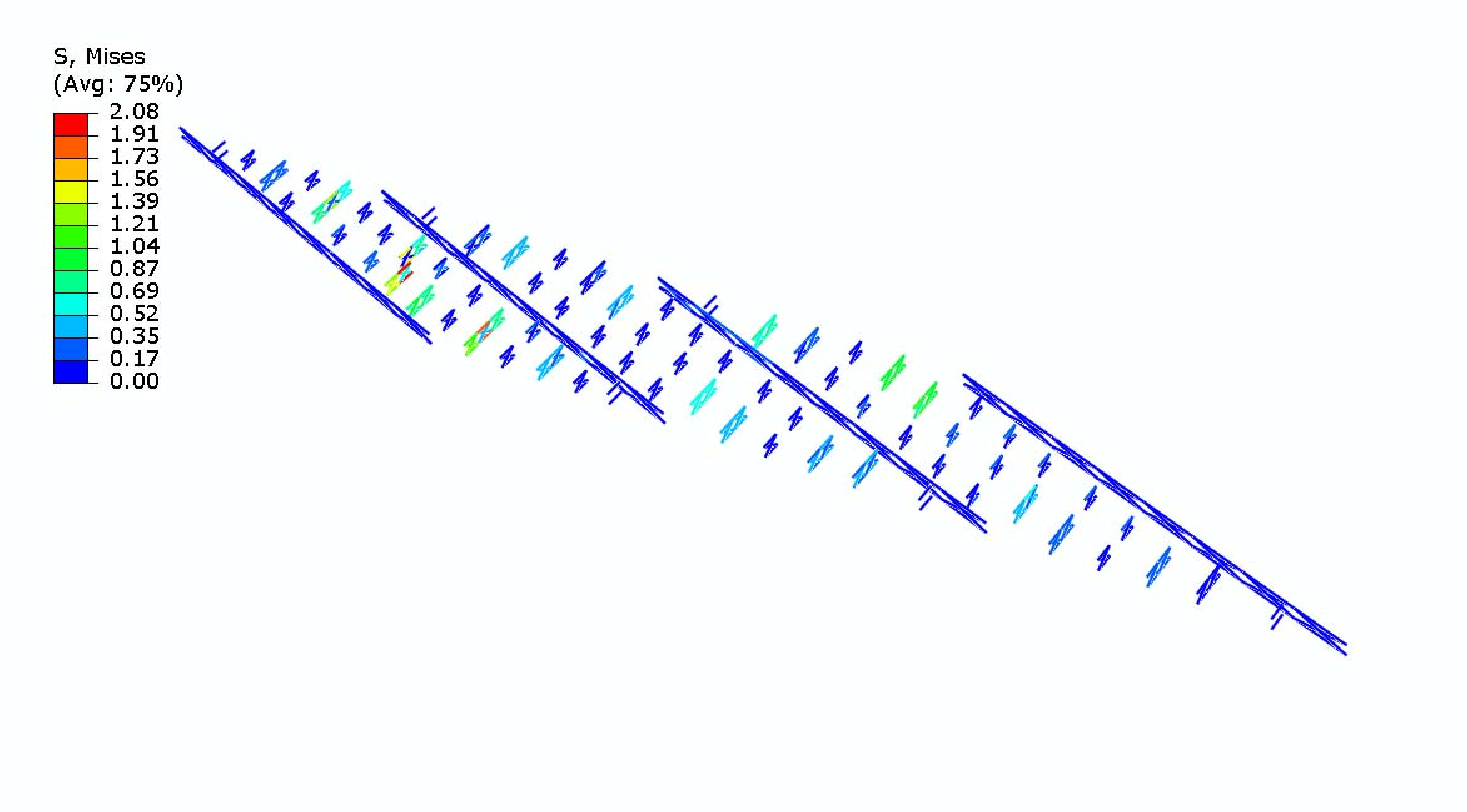


Figure L4-23. **Cross-frame stress contours (ksi) under SDL, NLF detailing (all cross-frame member areas = 5.77 in^2).**

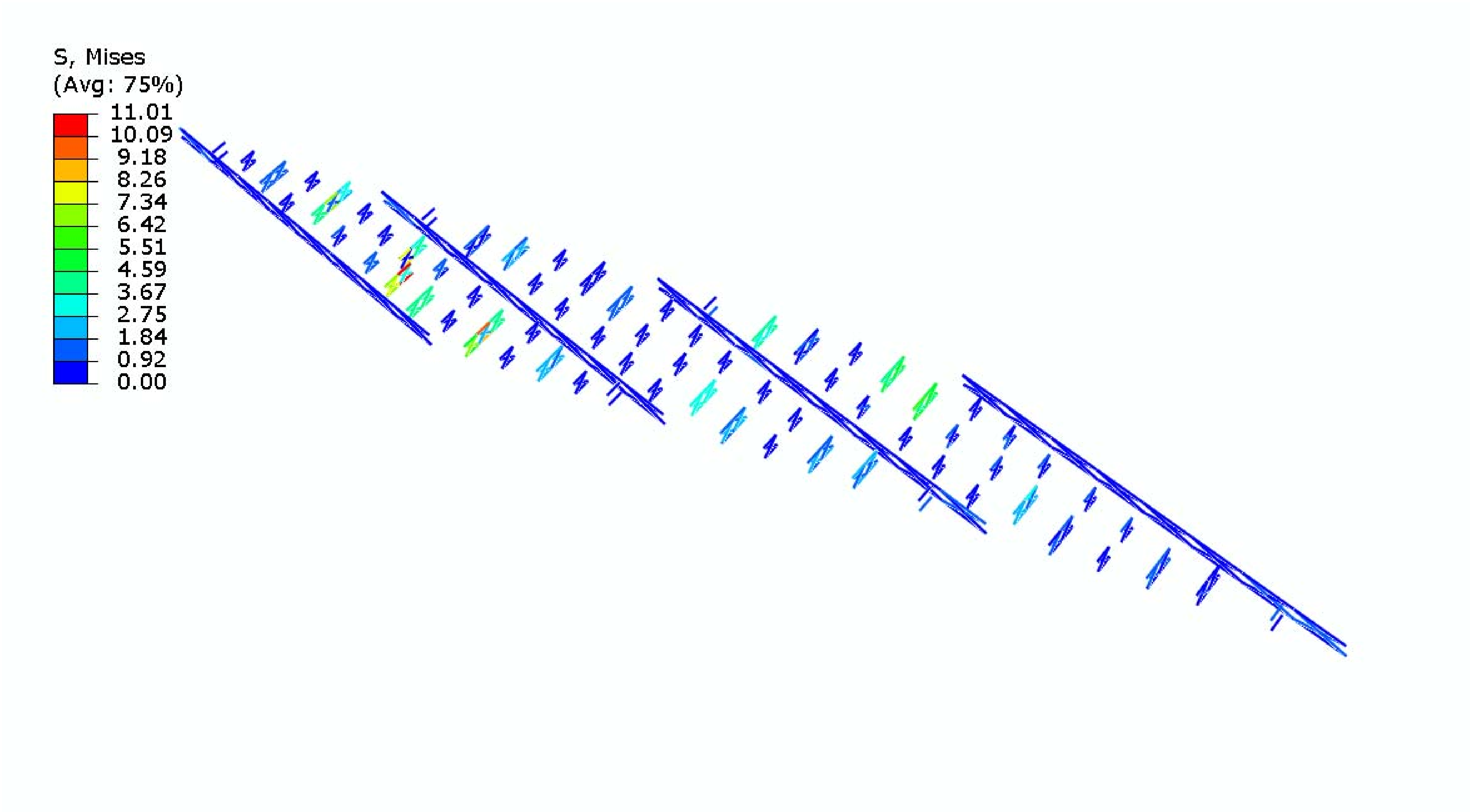


Figure L4-24. Cross-frame stress contours under TDL, NLF detailing (all cross-frame member areas = 5.77 in^2).

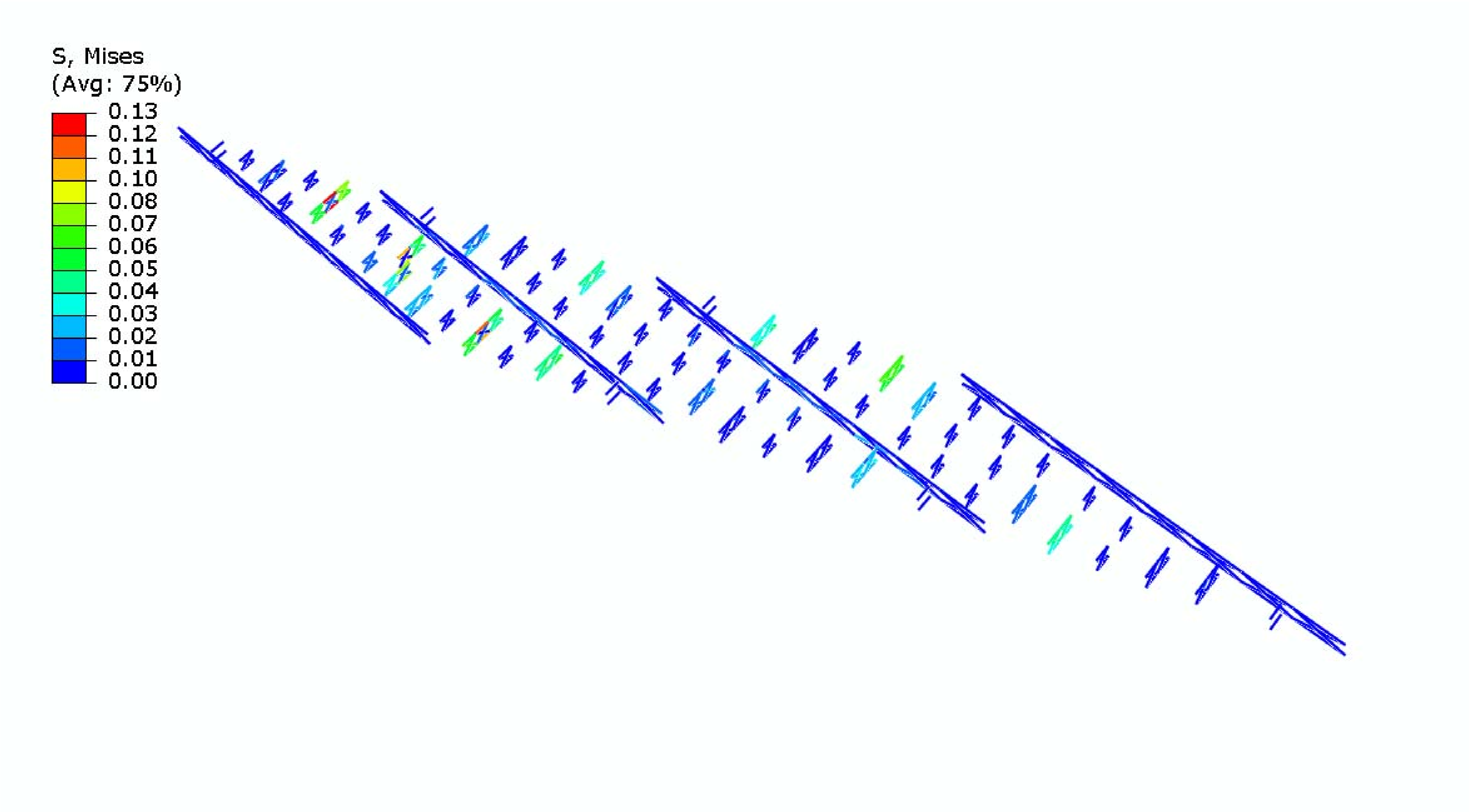


Figure L4-25. Cross-frame stress contours under SDL, SDLF detailing (all cross-frame member areas = 5.77 in^2).

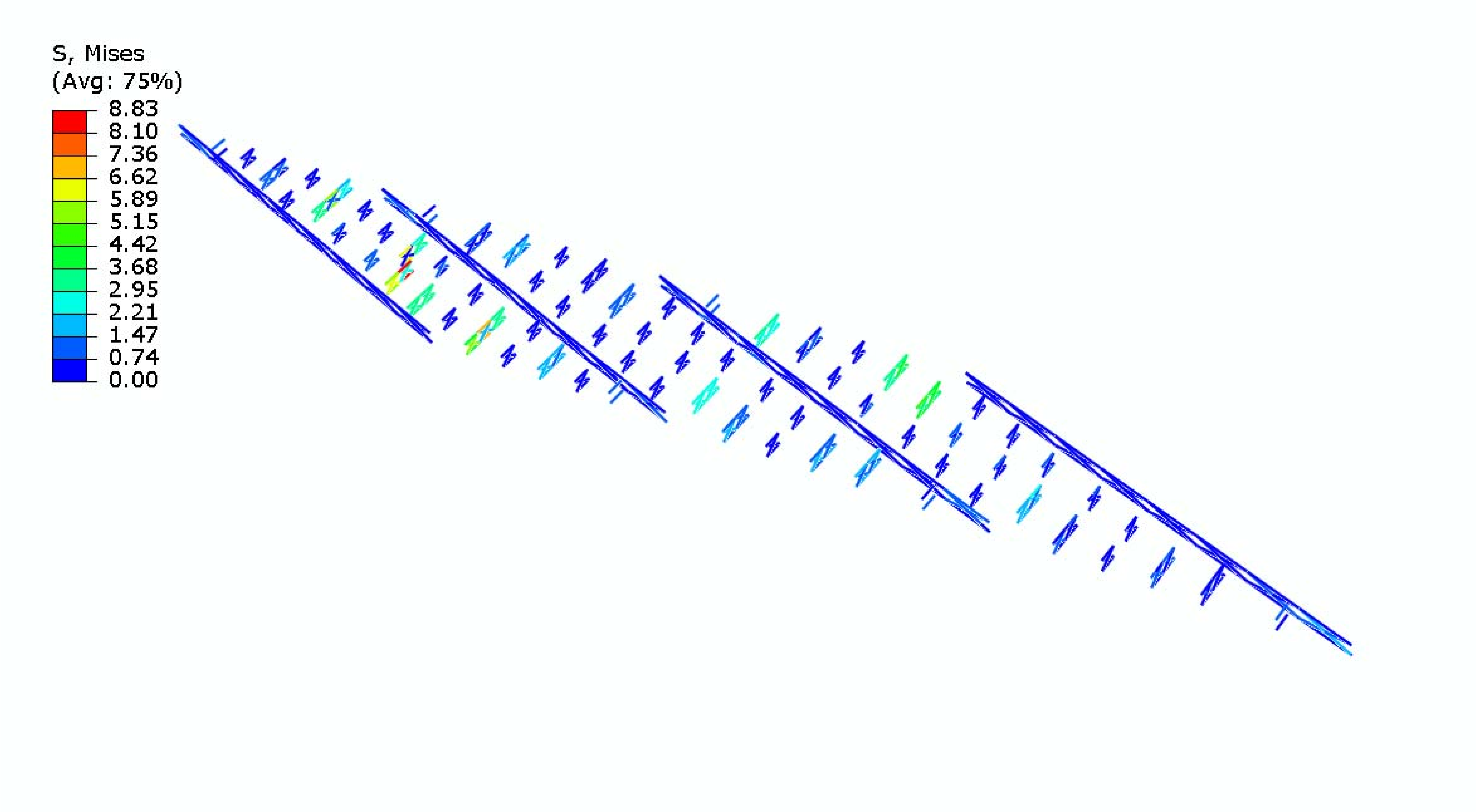


Figure L4-26. Cross-frame stress contours under TDL, SDLF detailing (all cross-frame member areas = 5.77 in^2).

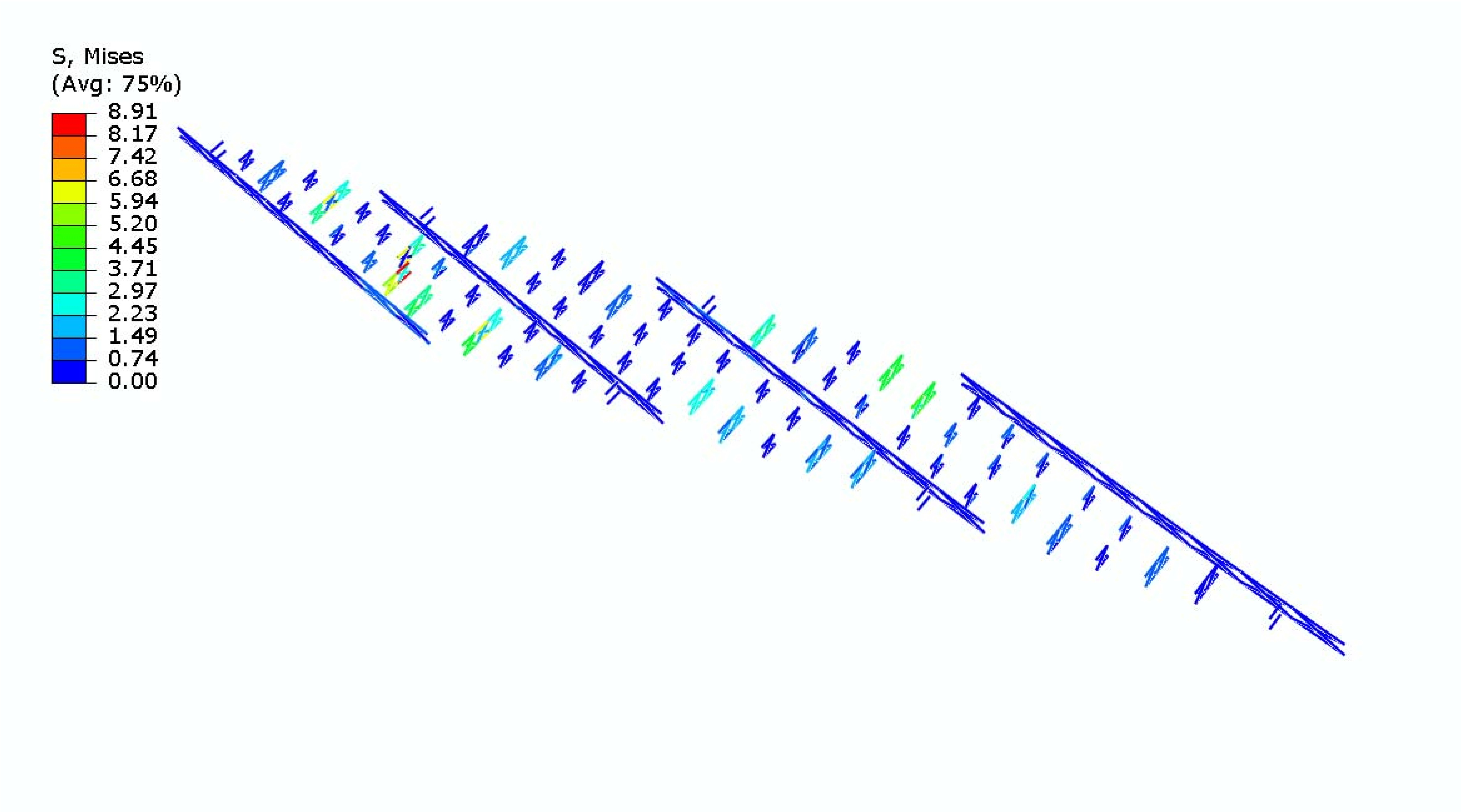


Figure L4-27. Cross-frame stress contours under SDL, TDLF detailing (all cross-frame member areas = 5.77 in^2).

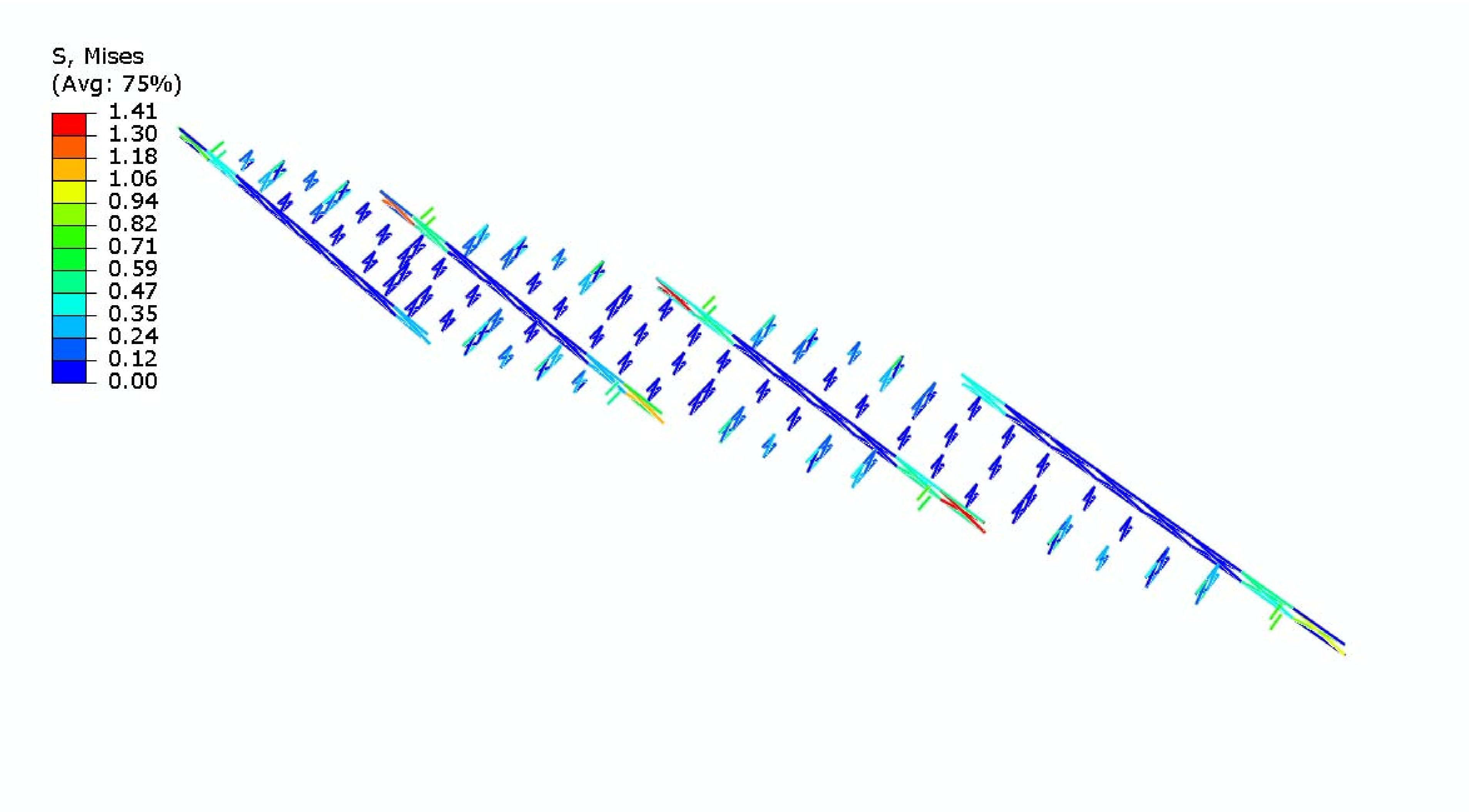


Figure L4-28. Cross-frame stress contours under TDL, TDLF (all cross-frame member areas = 5.77 in^2).

Table L4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.8	0.3	0.1	0.3	0.5	0.3	0.2	0.2
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	3.9	6.3	1.1	1.6	2.7	1.7	0.8	0.7
2	NLF	7.1	5.1	8.3	1.8	0.4	0.1	1.5	NA
	SDLF	0.4	0.1	0.2	0.1	0.0	0.0	0.1	NA
	TDLF	25.1	22.4	35.2	8.0	1.7	0.7	7.5	NA
3	NLF	0.0	0.1	4.9	3.6	0.7	4.6	1.4	0.1
	SDLF	0.0	0.0	0.1	0.1	0.0	0.4	0.1	0.0
	TDLF	0.1	0.4	20.8	14.5	2.5	20.2	5.9	0.5
4	NLF	2.3	2.7	4.2	0.3	2.0	0.6	0.1	1.7
	SDLF	0.3	0.1	0.3	0.0	0.1	0.0	0.0	0.1
	TDLF	7.6	9.4	14.2	0.8	8.6	2.5	0.3	8.4
5	NLF	0.4	1.9	0.6	0.5	0.3	4.7	0.2	0.0
	SDLF	0.1	0.4	0.0	0.1	0.1	0.3	0.1	0.0
	TDLF	1.7	6.0	2.3	1.7	1.6	20.7	0.5	0.3
6	NLF	NA	0.4	1.1	0.1	0.4	0.3	0.5	4.0
	SDLF	NA	0.0	0.1	0.0	0.1	0.1	0.1	0.5
	TDLF	NA	1.6	4.3	0.3	1.6	1.3	1.1	17.2
7	NLF	0.6	0.4	0.6	0.5	0.2	0.2	2.1	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	3.1	1.5	2.6	2.1	0.6	1.2	9.3	0.5
8	NLF	2.8	3.7	3.5	0.7	0.3	2.1	0.7	NA
	SDLF	0.0	0.1	0.1	0.0	0.0	0.1	0.3	NA
	TDLF	10.3	14.0	13.2	2.8	1.5	6.8	1.0	NA
9	NLF	0.0	2.4	0.3	0.2	0.9	0.5	2.2	1.1
	SDLF	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1
	TDLF	0.1	8.8	1.3	1.3	4.6	2.0	7.1	3.3
10	NLF	2.1	1.7	0.1	0.5	1.1	0.3	0.4	2.5
	SDLF	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0
	TDLF	8.8	7.3	0.4	2.2	4.8	2.1	1.7	10.9

Table L4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	2.4	1.6	1.1	0.2	0.9	0.2	0.3	0.1
	SDLF	0.2	0.2	0.0	0.0	0.0	0.1	0.0	0.0
	TDLF	9.4	6.3	4.8	1.0	4.0	1.1	1.5	0.2
12	NLF	NA	0.4	2.2	0.7	0.3	4.8	3.4	1.1
	SDLF	NA	0.1	0.1	0.0	0.0	0.2	0.2	0.3
	TDLF	NA	2.1	9.0	3.0	1.3	20.2	13.6	2.8
13	NLF	0.4	0.4	0.1	0.4	0.6	1.3	0.8	1.2
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
	TDLF	1.3	1.3	0.3	2.0	3.0	5.9	3.9	5.2
14	NLF	1.8	2.8	0.2	NA	NA	0.5	5.6	NA
	SDLF	0.3	0.1	0.0	NA	NA	0.0	0.4	NA
	TDLF	7.0	12.0	1.1	NA	NA	2.1	23.5	NA
15	NLF	0.1	1.2	NA	NA	NA	NA	5.9	4.6
	SDLF	0.0	0.3	NA	NA	NA	NA	0.2	0.3
	TDLF	0.4	4.4	NA	NA	NA	NA	25.2	17.9
16	NLF	1.6	1.2	NA	NA	NA	NA	0.1	1.2
	SDLF	0.0	0.1	NA	NA	NA	NA	0.0	0.0
	TDLF	6.2	4.5	NA	NA	NA	NA	0.4	5.8
17	NLF	0.3	0.5	NA	NA	NA	NA	0.2	0.1
	SDLF	0.1	0.1	NA	NA	NA	NA	0.0	0.0
	TDLF	3.5	4.1	NA	NA	NA	NA	1.2	0.2
18	NLF	NA	0.2	NA	NA	NA	NA	NA	5.9
	SDLF	NA	0.0	NA	NA	NA	NA	NA	0.4
	TDLF	NA	1.0	NA	NA	NA	NA	NA	24.8
19	NLF	0.1	NA	NA	NA	NA	NA	NA	0.5
	SDLF	0.0	NA	NA	NA	NA	NA	NA	0.0
	TDLF	0.7	NA	NA	NA	NA	NA	NA	1.8

Table L4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	4.1	1.1	0.6	0.7	2.4	1.4	4.1	5.6
	SDLF	3.5	0.8	0.5	0.6	2.0	1.2	3.7	5.4
	TDLF	1.6	0.1	0.1	0.1	0.1	0.2	2.4	4.7
2	NLF	37.9	25.8	43.4	9.6	1.9	0.5	7.0	NA
	SDLF	30.5	20.7	35.1	7.8	1.6	0.5	5.5	NA
	TDLF	0.1	0.2	0.3	0.2	0.1	0.1	1.7	NA
3	NLF	1.7	0.5	24.6	18.2	3.1	24.4	8.1	1.4
	SDLF	1.6	0.4	19.7	14.8	2.5	19.5	6.9	1.5
	TDLF	1.4	0.1	0.2	0.1	0.1	0.8	0.8	1.7
4	NLF	11.4	12.7	21.8	1.1	10.4	2.9	0.3	9.8
	SDLF	8.7	10.0	17.5	0.9	8.3	2.3	0.2	8.1
	TDLF	0.3	0.6	1.0	0.1	0.2	0.1	0.1	0.4
5	NLF	0.3	11.0	2.7	1.8	2.0	25.3	3.3	1.4
	SDLF	0.2	8.7	2.1	1.3	1.6	20.3	3.0	1.4
	TDLF	1.8	1.5	0.1	0.1	0.1	0.4	3.1	1.3
6	NLF	NA	4.0	5.2	0.5	2.0	1.6	2.8	21.1
	SDLF	NA	3.5	4.0	0.4	1.5	1.3	2.2	16.8
	TDLF	NA	1.8	0.3	0.1	0.0	0.2	1.2	0.1
7	NLF	3.9	2.1	2.9	2.6	0.8	1.2	10.4	7.8
	SDLF	4.4	1.7	2.3	2.1	0.5	1.0	8.3	7.6
	TDLF	6.6	0.3	0.1	0.1	0.1	0.2	1.1	7.1
8	NLF	14.6	17.8	17.0	3.0	1.5	8.6	0.4	NA
	SDLF	11.8	14.1	13.5	2.4	1.2	6.4	1.3	NA
	TDLF	0.8	0.6	0.4	0.1	0.1	0.5	1.9	NA
9	NLF	1.3	10.8	1.3	0.9	4.2	2.0	8.9	2.9
	SDLF	1.4	8.4	1.0	0.7	3.6	1.4	6.6	1.7
	TDLF	1.5	1.3	0.1	0.2	0.2	0.2	0.6	1.4
10	NLF	11.1	7.9	1.4	2.1	5.6	1.6	1.8	13.5
	SDLF	8.9	6.2	1.1	1.7	4.5	1.1	1.5	11.1
	TDLF	0.3	1.0	0.3	0.1	0.1	0.3	0.2	0.3

Table L4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	10.4	9.5	5.0	1.2	4.0	2.2	5.3	1.2
	SDLF	7.9	7.6	4.1	1.0	3.3	1.8	4.8	1.3
	TDLF	1.6	1.0	0.1	0.1	0.2	0.2	3.1	1.5
12	NLF	NA	1.5	11.3	2.3	0.8	24.2	19.0	4.0
	SDLF	NA	1.5	9.0	2.1	0.7	19.5	15.3	2.6
	TDLF	NA	3.0	0.6	0.1	0.1	0.9	1.4	0.1
13	NLF	6.9	1.4	1.4	1.0	1.6	6.0	3.3	4.5
	SDLF	6.7	1.1	1.3	0.7	1.1	4.9	2.6	5.2
	TDLF	8.2	0.2	0.2	0.1	0.1	0.1	1.2	8.1
14	NLF	8.1	13.6	1.9	NA	NA	1.1	26.7	NA
	SDLF	6.3	10.8	1.5	NA	NA	0.9	21.0	NA
	TDLF	0.6	0.7	0.3	NA	NA	0.1	1.7	NA
15	NLF	1.4	4.2	NA	NA	NA	NA	29.5	21.4
	SDLF	1.5	2.9	NA	NA	NA	NA	23.9	16.5
	TDLF	1.7	1.4	NA	NA	NA	NA	0.9	1.1
16	NLF	8.9	5.4	NA	NA	NA	NA	0.6	7.4
	SDLF	7.4	4.4	NA	NA	NA	NA	0.5	6.0
	TDLF	0.4	0.7	NA	NA	NA	NA	0.1	0.2
17	NLF	5.6	3.1	NA	NA	NA	NA	2.2	2.3
	SDLF	5.0	2.5	NA	NA	NA	NA	1.8	1.9
	TDLF	1.0	1.9	NA	NA	NA	NA	0.1	1.5
18	NLF	NA	6.2	NA	NA	NA	NA	NA	30.4
	SDLF	NA	5.5	NA	NA	NA	NA	NA	24.5
	TDLF	NA	3.1	NA	NA	NA	NA	NA	0.5
19	NLF	9.2	NA	NA	NA	NA	NA	NA	1.1
	SDLF	8.5	NA	NA	NA	NA	NA	NA	1.2
	TDLF	5.5	NA	NA	NA	NA	NA	NA	2.4

Table L4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.4	0.1	0.1	0.3	0.2	0.3	0.0	0.5
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	5.3	4.5	0.5	1.7	1.1	1.0	0.2	2.0
2	NLF	6.3	4.6	7.1	1.4	0.9	0.3	1.7	0.1
	SDLF	0.3	0.1	0.2	0.1	0.0	0.0	0.0	0.0
	TDLF	22.1	19.3	30.5	6.0	4.1	1.4	8.1	0.4
3	NLF	0.1	0.0	4.9	11.7	8.4	4.7	7.9	0.0
	SDLF	0.0	0.0	0.1	0.4	0.5	0.3	0.7	0.0
	TDLF	0.2	0.2	20.6	50.2	37.2	20.5	34.4	0.1
4	NLF	2.1	10.3	4.6	0.6	0.9	0.7	0.3	1.4
	SDLF	0.3	0.6	0.3	0.0	0.1	0.0	0.0	0.0
	TDLF	7.0	35.7	16.2	2.9	4.0	2.8	1.1	7.0
5	NLF	0.0	2.7	1.0	1.0	0.5	3.0	0.0	0.1
	SDLF	0.0	0.3	0.0	0.0	0.0	0.2	0.0	0.0
	TDLF	0.0	9.3	4.1	4.5	1.8	13.8	0.3	0.5
6	NLF	0.4	0.2	0.2	0.1	0.1	0.3	1.5	3.0
	SDLF	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.4
	TDLF	1.4	0.6	0.7	0.2	0.0	0.7	4.7	13.6
7	NLF	0.4	0.5	0.0	0.4	0.3	0.3	2.5	0.1
	SDLF	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	1.7	2.2	0.1	1.5	0.9	1.2	11.0	0.0
8	NLF	2.2	3.6	3.9	0.1	0.5	2.3	0.9	0.1
	SDLF	0.1	0.1	0.1	0.0	0.0	0.1	0.2	0.0
	TDLF	7.8	13.3	14.4	0.6	2.4	7.5	2.1	0.4
9	NLF	0.1	2.4	0.3	0.3	0.4	0.5	2.2	0.9
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
	TDLF	0.2	8.7	0.8	1.2	1.5	2.3	7.3	2.6
10	NLF	1.8	2.3	0.1	0.0	0.7	1.3	0.9	2.1
	SDLF	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0
	TDLF	7.4	9.4	0.1	0.0	3.5	5.7	3.5	9.3

Table L4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
		CF Location							
11	NLF	2.0	2.9	0.6	1.1	1.5	0.8	1.1	0.1
	SDLF	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0
	TDLF	7.6	11.2	2.6	5.0	6.6	3.7	3.6	0.4
12	NLF	0.3	0.8	3.4	1.0	1.0	6.3	4.8	0.6
	SDLF	0.0	0.1	0.1	0.0	0.0	0.1	0.3	0.2
	TDLF	1.1	2.7	14.5	4.5	4.5	27.0	18.9	0.7
13	NLF	0.4	1.1	0.9	0.1	0.1	0.7	1.5	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	1.8	4.4	4.0	0.4	0.5	2.9	7.0	0.1
14	NLF	1.1	2.7	0.1	NA	NA	0.7	5.3	0.2
	SDLF	0.2	0.1	0.0	NA	NA	0.0	0.4	0.0
	TDLF	4.2	11.6	0.5	NA	NA	3.3	22.4	0.8
15	NLF	0.1	1.6	NA	NA	NA	NA	5.2	3.8
	SDLF	0.0	0.2	NA	NA	NA	NA	0.1	0.2
	TDLF	0.5	6.5	NA	NA	NA	NA	22.2	14.8
16	NLF	1.2	1.6	NA	NA	NA	NA	0.2	1.0
	SDLF	0.0	0.0	NA	NA	NA	NA	0.0	0.0
	TDLF	5.0	6.4	NA	NA	NA	NA	1.0	4.8
17	NLF	0.3	0.3	NA	NA	NA	NA	0.1	0.0
	SDLF	0.1	0.0	NA	NA	NA	NA	0.0	0.0
	TDLF	3.3	3.4	NA	NA	NA	NA	0.6	0.0
18	NLF	0.0	0.1	NA	NA	NA	NA	NA	5.0
	SDLF	0.0	0.0	NA	NA	NA	NA	NA	0.3
	TDLF	0.1	1.2	NA	NA	NA	NA	NA	21.6
19	NLF	0.4	NA	NA	NA	NA	NA	NA	0.4
	SDLF	0.0	NA	NA	NA	NA	NA	NA	0.0
	TDLF	1.5	NA	NA	NA	NA	NA	NA	1.8

Table L4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.3	0.7	0.0	1.6	1.3	0.9	2.0	1.3
	SDLF	2.1	0.5	0.0	1.3	1.1	0.7	2.0	0.9
	TDLF	1.5	0.2	0.1	0.0	0.0	0.1	2.0	0.3
2	NLF	30.4	23.4	37.7	7.5	4.9	1.9	8.2	3.5
	SDLF	24.1	18.9	30.6	6.1	4.0	1.6	6.6	3.5
	TDLF	2.6	0.0	0.1	0.0	0.0	0.1	1.5	3.4
3	NLF	1.5	0.2	24.7	62.1	45.8	24.1	40.0	0.5
	SDLF	1.3	0.1	19.7	50.0	36.8	19.3	31.6	0.5
	TDLF	1.1	0.0	0.1	0.4	0.4	0.6	2.0	0.6
4	NLF	12.7	52.5	23.7	3.8	5.1	3.5	1.1	5.5
	SDLF	10.3	41.8	19.0	3.1	4.2	2.8	0.8	4.1
	TDLF	2.6	2.1	0.8	0.0	0.0	0.0	0.2	2.8
5	NLF	0.6	13.9	4.6	5.1	2.1	17.1	2.9	0.5
	SDLF	0.6	11.0	3.5	3.9	1.6	13.9	2.9	0.6
	TDLF	0.7	1.4	0.0	0.0	0.1	0.1	2.9	1.0
6	NLF	4.8	1.1	0.3	0.5	0.4	1.1	6.9	13.9
	SDLF	4.4	1.1	0.2	0.4	0.3	0.7	5.3	10.6
	TDLF	2.9	1.4	0.1	0.2	0.2	0.2	0.8	2.6
7	NLF	0.7	2.5	0.3	2.1	1.4	1.7	12.7	0.8
	SDLF	1.3	2.0	0.3	1.7	1.1	1.4	10.2	1.0
	TDLF	3.5	0.1	0.2	0.1	0.2	0.1	0.9	1.3
8	NLF	8.1	17.3	18.7	0.4	3.0	9.9	1.3	4.9
	SDLF	6.0	13.8	14.9	0.4	2.5	7.4	0.2	4.7
	TDLF	2.8	0.2	0.3	0.1	0.1	0.2	1.6	4.2
9	NLF	0.9	10.9	1.4	1.6	1.9	2.8	9.9	5.7
	SDLF	0.9	8.5	1.0	1.2	1.6	2.3	7.5	4.7
	TDLF	1.1	1.1	0.0	0.1	0.0	0.2	0.1	2.3
10	NLF	7.1	11.1	1.0	1.0	5.2	6.8	4.6	9.3
	SDLF	5.2	8.7	0.8	1.1	4.4	5.5	3.6	7.2
	TDLF	2.3	0.9	0.1	0.2	0.1	0.3	0.1	2.2

Table L4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	12.0	15.4	2.3	5.3	7.4	5.0	1.4	0.7
	SDLF	9.8	12.3	1.6	4.6	6.3	4.2	0.5	0.8
	TDLF	2.1	0.7	0.2	0.2	0.1	0.0	2.6	1.1
12	NLF	5.7	1.9	16.2	5.1	5.4	30.9	24.4	1.8
	SDLF	5.3	0.9	13.1	4.4	4.6	25.1	19.5	2.6
	TDLF	4.0	2.6	0.3	0.2	0.2	0.6	1.2	3.2
13	NLF	3.5	5.2	4.1	1.0	0.7	3.8	7.5	2.7
	SDLF	3.3	4.1	3.5	0.8	0.5	3.4	6.0	2.7
	TDLF	2.8	0.1	0.0	0.0	0.0	0.1	1.1	2.6
14	NLF	1.8	13.8	0.2	NA	NA	3.2	25.2	5.3
	SDLF	0.8	11.2	0.2	NA	NA	2.4	19.9	5.1
	TDLF	2.8	0.2	0.2	NA	NA	0.0	1.5	4.0
15	NLF	0.8	5.5	NA	NA	NA	NA	25.2	21.3
	SDLF	0.8	4.0	NA	NA	NA	NA	20.4	17.1
	TDLF	1.1	1.1	NA	NA	NA	NA	0.5	2.6
16	NLF	3.2	6.2	NA	NA	NA	NA	0.5	3.4
	SDLF	2.3	5.0	NA	NA	NA	NA	0.2	2.4
	TDLF	2.0	0.6	NA	NA	NA	NA	0.1	2.3
17	NLF	1.3	3.5	NA	NA	NA	NA	0.2	1.3
	SDLF	1.0	3.0	NA	NA	NA	NA	0.1	1.2
	TDLF	2.9	1.7	NA	NA	NA	NA	0.1	1.2
18	NLF	3.8	4.1	NA	NA	NA	NA	NA	21.7
	SDLF	3.8	3.8	NA	NA	NA	NA	NA	17.1
	TDLF	4.1	2.4	NA	NA	NA	NA	NA	3.3
19	NLF	0.0	NA	NA	NA	NA	NA	NA	2.5
	SDLF	0.1	NA	NA	NA	NA	NA	NA	2.5
	TDLF	0.0	NA	NA	NA	NA	NA	NA	2.4

Table L4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.1	0.2	0.2	0.1	0.1	0.3	0.3	0.2
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	5.4	5.9	1.3	0.1	0.0	1.4	1.4	0.8
2	NLF	6.5	4.9	7.5	1.5	1.1	0.4	1.7	0.2
	SDLF	0.4	0.2	0.2	0.1	0.1	0.0	0.1	0.0
	TDLF	22.6	20.4	31.4	6.3	4.6	1.5	8.2	0.6
3	NLF	0.1	0.0	5.0	12.0	8.6	4.8	8.0	0.1
	SDLF	0.0	0.0	0.2	0.5	0.6	0.4	0.7	0.0
	TDLF	0.2	0.1	21.2	51.4	38.1	21.1	35.0	0.3
4	NLF	2.1	10.4	4.7	0.7	1.0	0.7	0.2	1.5
	SDLF	0.3	0.6	0.3	0.1	0.1	0.0	0.0	0.1
	TDLF	7.1	36.2	16.5	3.2	4.5	3.0	0.7	7.2
5	NLF	0.0	2.7	1.1	0.8	0.6	3.2	0.0	0.1
	SDLF	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0
	TDLF	0.2	9.5	4.1	3.2	2.6	14.8	0.1	0.4
6	NLF	0.4	0.4	0.5	0.0	0.0	0.2	1.4	3.3
	SDLF	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.4
	TDLF	2.0	1.8	2.1	0.3	0.2	0.3	4.2	14.4
7	NLF	0.4	0.6	0.1	0.3	0.2	0.3	2.5	0.2
	SDLF	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	2.4	2.5	0.6	1.0	0.4	1.2	10.9	0.8
8	NLF	2.1	3.5	3.8	0.1	0.6	2.3	0.9	0.0
	SDLF	0.0	0.1	0.1	0.1	0.1	0.1	0.3	0.0
	TDLF	7.4	13.1	14.0	0.7	2.8	7.1	2.0	0.2
9	NLF	0.1	2.4	0.2	0.3	0.4	0.6	2.2	0.9
	SDLF	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1
	TDLF	0.5	8.7	0.8	1.4	2.3	2.9	7.2	2.5
10	NLF	1.8	2.2	0.3	0.1	0.8	1.1	1.0	2.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	7.5	9.1	0.5	0.9	3.6	4.0	3.8	9.4

Table L4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	2.0	2.7	0.3	1.5	1.8	0.7	1.3	0.1
	SDLF	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	7.6	10.2	1.4	6.6	8.1	3.3	5.0	0.5
12	NLF	0.1	0.3	3.7	1.2	1.4	6.5	4.9	0.5
	SDLF	0.0	0.1	0.1	0.0	0.0	0.1	0.3	0.3
	TDLF	0.2	1.0	15.8	5.5	6.0	28.0	18.9	0.4
13	NLF	0.8	0.8	1.0	0.2	0.3	1.1	1.4	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	3.0	3.1	4.6	0.7	1.5	4.5	6.7	0.4
14	NLF	1.4	2.8	0.3	NA	NA	0.1	5.4	0.2
	SDLF	0.2	0.1	0.0	NA	NA	0.0	0.4	0.0
	TDLF	5.4	11.7	0.8	NA	NA	0.3	22.9	0.9
15	NLF	0.1	1.8	NA	NA	NA	NA	5.2	3.8
	SDLF	0.0	0.3	NA	NA	NA	NA	0.1	0.2
	TDLF	0.2	7.4	NA	NA	NA	NA	22.2	15.0
16	NLF	1.4	1.8	NA	NA	NA	NA	0.2	1.0
	SDLF	0.0	0.0	NA	NA	NA	NA	0.0	0.0
	TDLF	5.4	7.0	NA	NA	NA	NA	0.5	4.9
17	NLF	0.3	0.2	NA	NA	NA	NA	0.2	0.1
	SDLF	0.0	0.0	NA	NA	NA	NA	0.0	0.0
	TDLF	3.3	2.9	NA	NA	NA	NA	0.9	0.1
18	NLF	0.1	0.2	NA	NA	NA	NA	NA	5.4
	SDLF	0.0	0.0	NA	NA	NA	NA	NA	0.4
	TDLF	0.3	0.6	NA	NA	NA	NA	NA	22.3
19	NLF	0.1	NA	NA	NA	NA	NA	NA	0.2
	SDLF	0.0	NA	NA	NA	NA	NA	NA	0.0
	TDLF	0.7	NA	NA	NA	NA	NA	NA	1.1

Table L4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	1.2	0.9	1.0	0.4	0.0	1.9	4.3	0.3
	SDLF	1.4	0.8	0.8	0.3	0.0	1.6	3.9	0.2
	TDLF	1.6	0.0	0.1	0.0	0.0	0.1	2.2	0.4
2	NLF	31.6	24.7	39.0	7.6	5.6	1.7	8.2	4.9
	SDLF	24.5	19.4	31.1	6.0	4.4	1.3	6.4	4.6
	TDLF	2.8	0.2	0.3	0.2	0.2	0.1	1.6	3.5
3	NLF	1.8	0.1	25.1	63.5	46.8	25.2	41.0	0.3
	SDLF	1.7	0.1	20.0	51.0	37.5	19.9	32.2	0.4
	TDLF	1.2	0.1	0.2	0.6	0.7	0.8	2.2	0.7
4	NLF	13.1	53.2	24.5	3.9	5.3	3.5	0.9	5.6
	SDLF	10.7	42.2	19.4	3.1	4.2	2.8	0.8	4.1
	TDLF	2.8	2.3	1.0	0.2	0.2	0.1	0.0	2.9
5	NLF	0.7	15.0	5.2	3.7	3.4	18.1	3.2	0.6
	SDLF	0.7	11.9	4.1	2.9	2.7	14.4	3.2	0.8
	TDLF	0.8	1.6	0.2	0.0	0.0	0.4	2.9	1.2
6	NLF	5.3	0.9	2.1	0.6	0.4	0.7	6.5	15.1
	SDLF	4.8	0.4	1.6	0.5	0.4	0.5	5.0	11.3
	TDLF	3.1	1.5	0.2	0.1	0.1	0.2	1.1	2.9
7	NLF	0.4	3.3	0.7	1.2	0.3	1.3	12.3	2.6
	SDLF	1.0	2.7	0.6	0.8	0.1	0.9	9.7	2.4
	TDLF	3.7	0.4	0.1	0.1	0.1	0.1	1.1	1.3
8	NLF	7.1	16.8	17.8	0.9	3.5	8.7	0.9	3.9
	SDLF	5.0	13.3	14.0	0.9	3.1	6.4	0.2	4.0
	TDLF	3.0	0.4	0.5	0.2	0.2	0.5	1.8	4.2
9	NLF	0.7	10.4	0.9	1.8	2.3	3.4	8.8	5.8
	SDLF	0.8	8.0	0.6	1.5	1.9	2.9	6.5	4.8
	TDLF	1.3	1.3	0.2	0.1	0.1	0.1	0.3	2.5
10	NLF	6.8	10.2	1.0	1.0	4.6	5.4	4.6	9.2
	SDLF	5.0	7.9	0.7	0.8	3.7	4.4	3.7	7.0
	TDLF	2.4	1.1	0.2	0.0	0.0	0.4	0.2	2.4

Table L4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	11.9	13.6	1.7	7.4	9.5	3.5	3.8	0.6
	SDLF	9.8	10.9	1.5	5.9	7.6	2.9	2.4	0.8
	TDLF	2.3	1.0	0.0	0.0	0.1	0.2	2.5	1.3
12	NLF	3.4	1.9	17.8	6.5	6.7	33.2	25.4	2.8
	SDLF	3.5	1.9	14.2	5.2	5.3	26.5	20.1	3.5
	TDLF	4.1	2.5	0.5	0.0	0.1	0.8	1.4	3.5
13	NLF	7.5	3.8	5.6	1.2	1.5	4.8	6.5	1.9
	SDLF	6.4	3.1	4.4	0.9	1.1	3.7	5.1	1.9
	TDLF	2.9	0.2	0.2	0.0	0.0	0.1	1.2	2.7
14	NLF	2.9	13.5	2.4	NA	NA	0.6	25.7	5.3
	SDLF	1.3	10.6	1.9	NA	NA	0.6	20.0	5.1
	TDLF	3.0	0.4	0.3	NA	NA	0.0	1.7	4.2
15	NLF	0.8	6.9	NA	NA	NA	NA	26.8	21.7
	SDLF	1.0	5.0	NA	NA	NA	NA	21.3	17.8
	TDLF	1.3	1.4	NA	NA	NA	NA	0.7	2.8
16	NLF	4.9	8.9	NA	NA	NA	NA	0.3	3.0
	SDLF	3.3	6.9	NA	NA	NA	NA	0.4	2.1
	TDLF	2.1	0.7	NA	NA	NA	NA	0.1	2.5
17	NLF	0.3	0.3	NA	NA	NA	NA	0.9	1.8
	SDLF	0.0	0.2	NA	NA	NA	NA	0.6	1.7
	TDLF	2.9	1.9	NA	NA	NA	NA	0.0	1.3
18	NLF	6.2	3.7	NA	NA	NA	NA	NA	23.7
	SDLF	5.8	3.5	NA	NA	NA	NA	NA	17.8
	TDLF	4.5	2.7	NA	NA	NA	NA	NA	3.5
19	NLF	0.7	NA	NA	NA	NA	NA	NA	2.0
	SDLF	0.6	NA	NA	NA	NA	NA	NA	2.2
	TDLF	0.1	NA	NA	NA	NA	NA	NA	2.4

Table L4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	-0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.02	-0.13	-0.14	-0.17	-0.14	-0.13	-0.13	-0.26
	SDLF	-0.15	-0.23	-0.17	-0.15	-0.13	-0.22	-0.19	-0.22
	TDLF	-0.89	-0.62	-0.36	0.00	-0.12	-0.58	-0.41	-0.04
3	NLF	0.09	-0.05	-0.08	-0.07	0.12	0.02	0.05	-0.22
	SDLF	-0.02	-0.11	-0.03	-0.02	0.12	-0.10	0.08	-0.11
	TDLF	-0.62	-0.37	0.11	0.29	0.09	-0.57	0.21	0.33
4	NLF	0.16	0.04	0.07	0.13	0.16	0.17	0.11	-0.12
	SDLF	0.10	0.03	0.18	0.16	0.17	0.14	0.16	0.03
	TDLF	-0.25	-0.03	0.54	0.33	0.18	0.01	0.37	0.64
5	NLF	0.17	0.14	0.09	0.00	0.00	0.15	0.00	0.00
	SDLF	0.16	0.16	0.16	0.00	0.00	0.16	0.00	0.14
	TDLF	0.01	0.25	0.42	0.00	0.00	0.21	0.00	0.73
6	NLF	0.13	0.00	0.00	-0.09	-0.11	0.00	-0.08	0.08
	SDLF	0.13	0.00	0.00	-0.08	-0.10	0.00	-0.08	0.18
	TDLF	0.10	0.00	0.00	-0.10	-0.01	0.00	-0.10	0.60
7	NLF	0.00	-0.09	-0.12	0.06	0.02	-0.10	-0.06	0.00
	SDLF	0.00	-0.07	-0.10	0.04	0.02	-0.09	-0.09	0.00
	TDLF	0.00	-0.05	0.01	-0.13	0.04	-0.04	-0.22	0.00
8	NLF	-0.06	-0.08	-0.05	0.13	0.10	0.07	0.07	-0.05
	SDLF	-0.09	-0.07	-0.01	0.10	0.09	0.04	0.05	-0.07
	TDLF	-0.15	-0.05	0.21	-0.07	0.05	-0.03	0.02	-0.11
9	NLF	-0.01	-0.04	0.10	0.00	0.00	0.08	0.09	-0.08
	SDLF	-0.03	-0.01	0.09	0.00	0.00	0.08	0.10	-0.08
	TDLF	-0.08	0.14	0.06	0.00	0.00	0.08	0.12	-0.06
10	NLF	0.05	0.07	0.00	-0.35	-0.37	0.00	0.06	-0.04
	SDLF	0.06	0.10	0.00	-0.34	-0.33	0.00	0.06	0.00
	TDLF	0.11	0.26	0.00	-0.28	-0.21	0.00	0.06	0.12

Table L4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.07	0.05	-0.35	-0.13	-0.15	-0.25	0.00	0.03
	SDLF	0.11	0.05	-0.32	-0.13	-0.11	-0.35	0.00	0.08
	TDLF	0.30	0.07	-0.24	-0.08	0.01	-0.79	0.00	0.19
12	NLF	0.00	0.00	-0.26	0.35	0.34	0.14	-0.28	0.08
	SDLF	0.03	0.00	-0.14	0.34	0.35	-0.09	-0.32	0.10
	TDLF	0.19	0.00	0.31	0.33	0.36	-1.02	-0.53	0.13
13	NLF	0.00	-0.27	0.23	0.00	0.00	0.48	-0.28	0.00
	SDLF	0.00	-0.32	0.32	0.00	0.00	0.38	-0.36	0.00
	TDLF	0.00	-0.56	0.65	0.00	0.00	-0.02	-0.73	0.00
14	NLF	-0.22	-0.28	0.00	NA	NA	0.00	0.03	-0.25
	SDLF	-0.38	-0.32	0.00	NA	NA	0.00	-0.04	-0.28
	TDLF	-1.05	-0.53	0.00	NA	NA	0.01	-0.31	-0.32
15	NLF	-0.06	-0.20	NA	NA	NA	NA	0.18	-0.32
	SDLF	-0.30	-0.19	NA	NA	NA	NA	0.21	-0.30
	TDLF	-1.30	-0.16	NA	NA	NA	NA	0.36	-0.06
16	NLF	0.16	0.17	NA	NA	NA	NA	0.34	-0.27
	SDLF	-0.10	0.28	NA	NA	NA	NA	0.43	-0.14
	TDLF	-1.24	0.74	NA	NA	NA	NA	0.82	0.52
17	NLF	0.36	0.37	NA	NA	NA	NA	0.00	-0.13
	SDLF	0.15	0.47	NA	NA	NA	NA	0.00	0.09
	TDLF	-0.85	0.93	NA	NA	NA	NA	0.00	1.12
18	NLF	0.53	0.00	NA	NA	NA	NA	NA	0.08
	SDLF	0.46	0.00	NA	NA	NA	NA	NA	0.32
	TDLF	0.08	0.00	NA	NA	NA	NA	NA	1.40
19	NLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	SDLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	TDLF	0.00	NA	NA	NA	NA	NA	NA	0.00

Table L4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.09	-0.67	-0.73	-0.94	-0.77	-0.68	-0.68	-1.36
	SDLF	-0.23	-0.78	-0.76	-0.91	-0.76	-0.76	-0.73	-1.31
	TDLF	-0.84	-1.16	-0.95	-0.75	-0.73	-1.13	-0.96	-1.12
3	NLF	0.48	-0.27	-0.47	-0.40	0.65	0.09	0.28	-1.12
	SDLF	0.37	-0.33	-0.41	-0.34	0.65	-0.03	0.31	-1.02
	TDLF	-0.18	-0.53	-0.25	-0.03	0.61	-0.50	0.43	-0.57
4	NLF	0.82	0.18	0.35	0.68	0.88	0.91	0.60	-0.62
	SDLF	0.77	0.17	0.46	0.71	0.88	0.88	0.64	-0.47
	TDLF	0.45	0.19	0.86	0.87	0.88	0.74	0.85	0.15
5	NLF	0.91	0.72	0.46	0.00	0.00	0.82	0.00	-0.01
	SDLF	0.90	0.74	0.54	0.00	0.00	0.83	0.00	0.14
	TDLF	0.77	0.88	0.82	0.00	0.00	0.87	0.00	0.73
6	NLF	0.70	0.00	0.00	-0.36	-0.48	0.00	-0.28	0.41
	SDLF	0.70	0.00	0.00	-0.35	-0.46	0.00	-0.28	0.52
	TDLF	0.69	0.00	0.00	-0.38	-0.38	0.00	-0.31	0.93
7	NLF	0.00	-0.35	-0.49	0.37	0.13	-0.42	-0.21	0.00
	SDLF	0.00	-0.34	-0.47	0.34	0.12	-0.42	-0.25	0.00
	TDLF	0.00	-0.32	-0.38	0.15	0.14	-0.37	-0.38	0.00
8	NLF	-0.28	-0.36	-0.21	0.58	0.40	0.34	0.35	-0.16
	SDLF	-0.30	-0.35	-0.18	0.55	0.39	0.31	0.33	-0.17
	TDLF	-0.37	-0.34	0.03	0.37	0.36	0.24	0.30	-0.22
9	NLF	-0.05	-0.19	0.44	0.00	0.00	0.29	0.42	-0.31
	SDLF	-0.07	-0.15	0.43	0.00	0.00	0.29	0.42	-0.31
	TDLF	-0.13	-0.02	0.39	0.00	0.00	0.30	0.46	-0.29
10	NLF	0.20	0.28	0.00	-1.96	-2.02	0.00	0.20	-0.12
	SDLF	0.21	0.31	0.00	-1.94	-1.98	0.00	0.20	-0.08
	TDLF	0.25	0.46	0.00	-1.83	-1.82	0.00	0.21	0.04

Table L4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.23	0.13	-1.92	-0.71	-0.79	-1.31	0.00	0.22
	SDLF	0.27	0.13	-1.88	-0.70	-0.74	-1.41	0.00	0.26
	TDLF	0.45	0.15	-1.78	-0.62	-0.60	-1.84	0.00	0.37
12	NLF	-0.16	0.00	-1.45	1.91	1.91	0.82	-1.49	0.35
	SDLF	-0.13	0.00	-1.32	1.89	1.90	0.59	-1.53	0.38
	TDLF	0.03	0.00	-0.84	1.86	1.87	-0.38	-1.73	0.41
13	NLF	0.00	-1.47	1.21	0.00	0.00	2.66	-1.43	0.00
	SDLF	0.00	-1.52	1.29	0.00	0.00	2.54	-1.50	0.00
	TDLF	0.00	-1.73	1.62	0.00	0.00	2.09	-1.87	0.00
14	NLF	-1.18	-1.56	0.00	NA	NA	0.01	0.23	-1.38
	SDLF	-1.34	-1.59	0.00	NA	NA	0.01	0.15	-1.40
	TDLF	-1.98	-1.77	0.00	NA	NA	0.00	-0.12	-1.43
15	NLF	-0.37	-1.14	NA	NA	NA	NA	1.05	-1.67
	SDLF	-0.60	-1.11	NA	NA	NA	NA	1.07	-1.65
	TDLF	-1.58	-1.06	NA	NA	NA	NA	1.20	-1.40
16	NLF	0.80	0.85	NA	NA	NA	NA	1.87	-1.38
	SDLF	0.54	0.96	NA	NA	NA	NA	1.95	-1.25
	TDLF	-0.60	1.43	NA	NA	NA	NA	2.31	-0.57
17	NLF	1.90	1.92	NA	NA	NA	NA	0.00	-0.65
	SDLF	1.68	2.02	NA	NA	NA	NA	0.00	-0.43
	TDLF	0.67	2.47	NA	NA	NA	NA	0.00	0.61
18	NLF	2.81	0.00	NA	NA	NA	NA	NA	0.45
	SDLF	2.73	0.00	NA	NA	NA	NA	NA	0.70
	TDLF	2.34	0.00	NA	NA	NA	NA	NA	1.78
19	NLF	0.01	NA	NA	NA	NA	NA	NA	-0.01
	SDLF	0.01	NA	NA	NA	NA	NA	NA	-0.01
	TDLF	0.00	NA	NA	NA	NA	NA	NA	0.00

Table L4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	-0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.01	-0.07	-0.08	-0.10	-0.08	-0.07	-0.07	-0.14
	SDLF	-0.09	-0.13	-0.09	-0.08	-0.07	-0.12	-0.10	-0.12
	TDLF	-0.50	-0.35	-0.20	0.00	-0.07	-0.32	-0.23	-0.02
3	NLF	0.05	-0.03	-0.05	-0.04	0.07	0.01	0.03	-0.12
	SDLF	-0.01	-0.06	-0.02	-0.01	0.07	-0.06	0.04	-0.06
	TDLF	-0.35	-0.21	0.06	0.16	0.05	-0.32	0.11	0.18
4	NLF	0.09	0.02	0.04	0.07	0.09	0.10	0.06	-0.07
	SDLF	0.06	0.02	0.10	0.09	0.10	0.08	0.09	0.02
	TDLF	-0.14	-0.02	0.30	0.18	0.10	0.01	0.21	0.36
5	NLF	0.09	0.08	0.05	0.00	0.00	0.09	0.00	0.00
	SDLF	0.09	0.09	0.09	0.00	0.00	0.09	0.00	0.08
	TDLF	0.00	0.14	0.24	0.00	0.00	0.12	0.00	0.41
6	NLF	0.07	0.00	0.00	-0.05	-0.06	0.00	-0.04	0.04
	SDLF	0.07	0.00	0.00	-0.05	-0.05	0.00	-0.05	0.10
	TDLF	0.05	0.00	0.00	-0.05	-0.01	0.00	-0.06	0.33
7	NLF	0.00	-0.05	-0.06	0.04	0.01	-0.05	-0.03	0.00
	SDLF	0.00	-0.04	-0.06	0.02	0.01	-0.05	-0.05	0.00
	TDLF	0.00	-0.03	0.01	-0.07	0.02	-0.02	-0.12	0.00
8	NLF	-0.04	-0.05	-0.03	0.07	0.06	0.04	0.04	-0.03
	SDLF	-0.05	-0.04	-0.01	0.06	0.05	0.02	0.03	-0.04
	TDLF	-0.08	-0.03	0.12	-0.04	0.03	-0.02	0.01	-0.06
9	NLF	0.00	-0.02	0.06	0.00	0.00	0.05	0.05	-0.05
	SDLF	-0.01	0.00	0.05	0.00	0.00	0.05	0.05	-0.04
	TDLF	-0.04	0.08	0.03	0.00	0.00	0.04	0.07	-0.03
10	NLF	0.03	0.04	0.00	-0.20	-0.21	0.00	0.03	-0.02
	SDLF	0.04	0.06	0.00	-0.19	-0.19	0.00	0.03	0.00
	TDLF	0.06	0.14	0.00	-0.15	-0.12	0.00	0.03	0.07

Table L4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.04	0.03	-0.19	-0.07	-0.08	-0.14	0.00	0.02
	SDLF	0.06	0.03	-0.18	-0.07	-0.06	-0.20	0.00	0.04
	TDLF	0.16	0.04	-0.14	-0.04	0.01	-0.44	0.00	0.11
12	NLF	0.00	0.00	-0.14	0.20	0.19	0.08	-0.16	0.04
	SDLF	0.02	0.00	-0.08	0.19	0.19	-0.05	-0.18	0.06
	TDLF	0.10	0.00	0.17	0.18	0.20	-0.57	-0.30	0.07
13	NLF	0.00	-0.15	0.13	0.00	0.00	0.27	-0.15	0.00
	SDLF	0.00	-0.18	0.18	0.00	0.00	0.21	-0.20	0.00
	TDLF	0.00	-0.31	0.36	0.00	0.00	-0.01	-0.41	0.00
14	NLF	-0.12	-0.16	0.00	NA	NA	0.00	0.02	-0.14
	SDLF	-0.21	-0.18	0.00	NA	NA	0.00	-0.02	-0.15
	TDLF	-0.59	-0.29	0.00	NA	NA	0.00	-0.17	-0.18
15	NLF	-0.04	-0.11	NA	NA	NA	NA	0.10	-0.18
	SDLF	-0.17	-0.10	NA	NA	NA	NA	0.12	-0.16
	TDLF	-0.73	-0.09	NA	NA	NA	NA	0.20	-0.04
16	NLF	0.09	0.09	NA	NA	NA	NA	0.19	-0.15
	SDLF	-0.06	0.16	NA	NA	NA	NA	0.24	-0.08
	TDLF	-0.70	0.42	NA	NA	NA	NA	0.46	0.29
17	NLF	0.20	0.20	NA	NA	NA	NA	0.00	-0.07
	SDLF	0.08	0.26	NA	NA	NA	NA	0.00	0.05
	TDLF	-0.48	0.52	NA	NA	NA	NA	0.00	0.63
18	NLF	0.30	0.00	NA	NA	NA	NA	NA	0.04
	SDLF	0.26	0.00	NA	NA	NA	NA	NA	0.18
	TDLF	0.05	0.00	NA	NA	NA	NA	NA	0.78
19	NLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	SDLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	TDLF	0.00	NA	NA	NA	NA	NA	NA	0.00

Table L4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.05	-0.38	-0.41	-0.53	-0.43	-0.38	-0.38	-0.76
	SDLF	-0.13	-0.43	-0.43	-0.51	-0.42	-0.43	-0.41	-0.73
	TDLF	-0.47	-0.65	-0.53	-0.42	-0.41	-0.63	-0.54	-0.63
3	NLF	0.27	-0.15	-0.26	-0.23	0.36	0.05	0.16	-0.63
	SDLF	0.21	-0.19	-0.23	-0.19	0.36	-0.02	0.17	-0.57
	TDLF	-0.10	-0.30	-0.14	-0.02	0.34	-0.28	0.24	-0.32
4	NLF	0.46	0.10	0.19	0.38	0.49	0.51	0.33	-0.34
	SDLF	0.43	0.10	0.26	0.39	0.49	0.49	0.36	-0.26
	TDLF	0.25	0.11	0.48	0.48	0.49	0.41	0.47	0.09
5	NLF	0.51	0.40	0.26	0.00	0.00	0.46	0.00	0.00
	SDLF	0.50	0.41	0.30	0.00	0.00	0.46	0.00	0.08
	TDLF	0.43	0.49	0.46	0.00	0.00	0.48	0.00	0.41
6	NLF	0.39	0.00	0.00	-0.20	-0.27	0.00	-0.15	0.23
	SDLF	0.39	0.00	0.00	-0.20	-0.26	0.00	-0.16	0.29
	TDLF	0.39	0.00	0.00	-0.21	-0.21	0.00	-0.17	0.52
7	NLF	0.00	-0.19	-0.27	0.20	0.07	-0.24	-0.12	0.00
	SDLF	0.00	-0.19	-0.26	0.19	0.07	-0.23	-0.14	0.00
	TDLF	0.00	-0.18	-0.21	0.09	0.08	-0.20	-0.21	0.00
8	NLF	-0.16	-0.20	-0.12	0.32	0.22	0.19	0.19	-0.09
	SDLF	-0.17	-0.20	-0.10	0.31	0.22	0.18	0.19	-0.09
	TDLF	-0.21	-0.19	0.02	0.21	0.20	0.14	0.17	-0.12
9	NLF	-0.03	-0.10	0.25	0.00	0.00	0.16	0.23	-0.17
	SDLF	-0.04	-0.08	0.24	0.00	0.00	0.16	0.24	-0.17
	TDLF	-0.07	-0.01	0.22	0.00	0.00	0.17	0.26	-0.16
10	NLF	0.11	0.16	0.00	-1.09	-1.13	0.00	0.11	-0.07
	SDLF	0.12	0.17	0.00	-1.08	-1.10	0.00	0.11	-0.04
	TDLF	0.14	0.26	0.00	-1.02	-1.02	0.00	0.12	0.02

Table L4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.13	0.07	-1.07	-0.40	-0.44	-0.73	0.00	0.12
	SDLF	0.15	0.07	-1.05	-0.39	-0.42	-0.79	0.00	0.15
	TDLF	0.25	0.08	-0.99	-0.35	-0.33	-1.03	0.00	0.21
12	NLF	-0.09	0.00	-0.81	1.07	1.07	0.46	-0.83	0.20
	SDLF	-0.07	0.00	-0.74	1.06	1.06	0.33	-0.85	0.21
	TDLF	0.02	0.00	-0.47	1.04	1.05	-0.21	-0.96	0.23
13	NLF	0.00	-0.82	0.67	0.00	0.00	1.48	-0.80	0.00
	SDLF	0.00	-0.85	0.72	0.00	0.00	1.42	-0.84	0.00
	TDLF	0.00	-0.97	0.91	0.00	0.00	1.16	-1.04	0.00
14	NLF	-0.66	-0.87	0.00	NA	NA	0.01	0.13	-0.77
	SDLF	-0.75	-0.89	0.00	NA	NA	0.00	0.09	-0.78
	TDLF	-1.11	-0.99	0.00	NA	NA	0.00	-0.07	-0.80
15	NLF	-0.21	-0.63	NA	NA	NA	NA	0.59	-0.93
	SDLF	-0.34	-0.62	NA	NA	NA	NA	0.60	-0.92
	TDLF	-0.89	-0.59	NA	NA	NA	NA	0.67	-0.78
16	NLF	0.44	0.47	NA	NA	NA	NA	1.05	-0.77
	SDLF	0.30	0.54	NA	NA	NA	NA	1.09	-0.70
	TDLF	-0.33	0.80	NA	NA	NA	NA	1.29	-0.32
17	NLF	1.06	1.07	NA	NA	NA	NA	0.00	-0.37
	SDLF	0.94	1.13	NA	NA	NA	NA	0.00	-0.24
	TDLF	0.38	1.38	NA	NA	NA	NA	0.00	0.34
18	NLF	1.57	0.00	NA	NA	NA	NA	NA	0.25
	SDLF	1.53	0.00	NA	NA	NA	NA	NA	0.39
	TDLF	1.30	0.00	NA	NA	NA	NA	NA	0.99
19	NLF	0.01	NA	NA	NA	NA	NA	NA	-0.01
	SDLF	0.00	NA	NA	NA	NA	NA	NA	0.00
	TDLF	0.00	NA	NA	NA	NA	NA	NA	0.00

Table L4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	18.6	51.9	61.6	17.4	90.1	224.1	272.7	88.1
	SDLF	13.8	50.5	58.6	16.7	85.3	222.7	269.6	87.0
	TDLF	0.0	43.3	46.0	12.4	65.4	215.5	257.4	82.0
G2	NLF	16.2	52.0	60.9	16.7	73.3	221.1	267.6	75.3
	SDLF	15.6	52.7	62.2	18.7	72.6	221.7	269.0	77.3
	TDLF	5.8	57.1	68.9	29.3	70.7	228.4	274.6	88.2
G3	NLF	15.7	43.9	58.4	18.8	73.1	183.5	257.9	88.6
	SDLF	15.6	53.2	61.6	18.6	73.0	192.8	261.0	88.4
	TDLF	16.3	85.5	73.7	15.8	71.2	228.9	272.8	86.0
G4	NLF	12.2	55.2	62.8	18.3	54.9	244.3	286.8	89.3
	SDLF	15.1	52.1	60.6	18.0	57.8	241.3	284.5	89.0
	TDLF	27.9	43.7	51.5	17.2	70.8	229.5	274.8	88.3
G5	NLF	15.0	52.1	62.9	18.6	70.1	229.8	287.6	90.9
	SDLF	15.2	52.2	60.4	18.1	70.3	229.9	285.1	90.4
	TDLF	15.6	52.6	50.6	16.2	70.8	230.3	275.0	88.7
G6	NLF	17.7	52.2	62.6	18.4	82.7	228.6	285.8	89.4
	SDLF	15.2	52.2	60.4	18.2	80.3	228.8	283.5	89.2
	TDLF	5.5	53.3	52.3	17.1	70.6	230.1	274.6	88.7
G7	NLF	14.0	54.2	55.4	16.5	62.4	238.2	243.0	79.0
	SDLF	15.4	52.4	61.5	18.5	63.8	236.4	249.2	80.9
	TDLF	20.7	42.7	84.4	26.7	69.0	226.7	272.1	89.2
G8	NLF	13.5	47.4	64.4	17.2	56.9	198.6	285.0	80.6
	SDLF	15.7	53.3	62.3	18.9	59.2	204.5	282.8	82.2
	TDLF	25.6	78.5	56.7	25.4	69.3	230.0	276.5	88.4
G9	NLF	14.3	56.1	58.4	20.6	69.6	247.3	256.6	100.3
	SDLF	13.6	49.7	58.7	16.7	68.8	240.9	256.7	96.7
	TDLF	10.5	23.3	59.2	0.9	65.4	214.6	256.4	82.3

Table L4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing	Load Type & Support Number							
		SDL	SDL	SDL	SDL	TDL	TDL	TDL	TDL
	Method	1	2	3	4	1	2	3	4
G1	NLF	-0.1	NA	NA	NA	-0.4	NA	NA	NA
	SDLF	0.0	NA	NA	NA	-0.3	NA	NA	NA
	TDLF	0.3	NA	NA	NA	0.0	NA	NA	NA
G2	NLF	0.0	NA	NA	NA	0.0	NA	NA	NA
	SDLF	0.0	NA	NA	NA	0.0	NA	NA	NA
	TDLF	0.0	NA	NA	NA	-0.1	NA	NA	NA
G3	NLF	0.0	NA	NA	NA	0.1	NA	NA	NA
	SDLF	0.0	NA	NA	NA	0.0	NA	NA	NA
	TDLF	-0.1	NA	NA	NA	0.0	NA	NA	NA
G4	NLF	0.0	NA	NA	NA	0.1	NA	NA	NA
	SDLF	0.0	NA	NA	NA	0.1	NA	NA	NA
	TDLF	-0.1	NA	NA	NA	0.0	NA	NA	NA
G5	NLF	0.0	NA	NA	NA	-0.1	NA	NA	NA
	SDLF	0.0	NA	NA	NA	-0.1	NA	NA	NA
	TDLF	0.1	NA	NA	NA	0.0	NA	NA	NA
G6	NLF	0.0	NA	NA	NA	-0.1	NA	NA	NA
	SDLF	0.0	NA	NA	NA	-0.1	NA	NA	NA
	TDLF	0.2	NA	NA	NA	0.0	NA	NA	NA
G7	NLF	0.1	NA	NA	NA	0.5	NA	NA	NA
	SDLF	0.0	NA	NA	NA	0.3	NA	NA	NA
	TDLF	-0.4	NA	NA	NA	0.0	NA	NA	NA
G8	NLF	0.1	NA	NA	NA	0.3	NA	NA	NA
	SDLF	0.0	NA	NA	NA	0.2	NA	NA	NA
	TDLF	-0.3	NA	NA	NA	0.0	NA	NA	NA
G9	NLF	-0.1	NA	NA	NA	-0.3	NA	NA	NA
	SDLF	0.0	NA	NA	NA	-0.2	NA	NA	NA
	TDLF	0.2	NA	NA	NA	0.1	NA	NA	NA

Table L4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.3	0.1	-0.4	0.2	-1.4	1.4	-1.8	-1.4
	SDLF	0.0	0.0	0.0	0.0	-1.0	1.3	-1.2	-1.0
	TDLF	0.4	-0.3	1.9	-0.5	0.0	0.4	0.4	0.0
G2	NLF	-0.1	0.0	-0.3	-0.2	-0.4	0.7	-1.7	-0.4
	SDLF	0.0	0.0	0.0	0.0	-0.3	0.6	-1.3	-0.3
	TDLF	0.3	-0.3	1.4	0.8	0.0	0.1	0.2	0.0
G3	NLF	-0.1	0.0	-0.2	0.0	-0.4	0.2	-1.4	-0.4
	SDLF	0.0	0.0	0.0	0.0	-0.3	0.2	-1.1	-0.3
	TDLF	0.4	-0.2	0.9	0.0	0.1	0.0	-0.1	0.1
G4	NLF	-0.1	0.1	-0.2	0.1	-0.2	1.0	-1.4	-0.2
	SDLF	0.0	0.0	0.0	0.0	-0.1	0.9	-1.1	-0.1
	TDLF	0.5	-0.5	1.1	-0.7	0.1	0.0	0.0	0.1
G5	NLF	-0.1	0.2	-0.1	0.2	-0.7	1.1	-1.1	-0.7
	SDLF	0.0	0.0	0.0	0.0	-0.5	0.9	-0.9	-0.5
	TDLF	0.7	-0.7	0.7	-1.2	0.1	0.0	0.0	0.1
G6	NLF	-0.2	0.2	-0.1	0.3	-0.7	1.5	-0.6	-0.7
	SDLF	0.0	0.0	0.0	0.0	-0.5	1.2	-0.5	-0.5
	TDLF	0.8	-1.0	0.4	-1.5	0.1	0.0	0.0	0.1
G7	NLF	0.2	0.2	-0.1	0.1	0.9	1.5	-0.5	0.9
	SDLF	0.0	0.0	0.0	0.0	0.7	1.2	-0.4	0.7
	TDLF	-0.5	-1.0	0.3	-0.3	0.1	0.1	0.0	0.1
G8	NLF	0.1	0.2	0.0	0.0	0.1	0.7	-0.9	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.5	-0.8	0.0
	TDLF	-0.2	-0.7	0.2	0.0	0.0	-0.2	-0.2	0.0
G9	NLF	-0.2	0.3	-0.1	0.3	-1.3	1.2	-1.3	-1.3
	SDLF	0.0	0.0	0.0	0.0	-1.0	0.9	-1.1	-1.0
	TDLF	0.8	-1.2	0.3	-1.1	-0.1	-0.2	-0.5	-0.1

Table L4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	-0.01	0.03	0.01	0.10	-0.04	0.17	0.03	0.53
	SDLF	0.00	0.04	0.02	0.10	-0.03	0.17	0.03	0.48
	TDLF	0.03	0.07	0.07	0.10	0.00	0.19	0.07	0.51
G2	NLF	0.00	0.03	0.01	0.09	0.00	0.15	0.04	0.45
	SDLF	0.00	0.04	0.02	0.10	0.00	0.15	0.04	0.42
	TDLF	0.00	0.08	0.04	0.20	-0.01	0.20	0.07	0.55
G3	NLF	0.00	0.03	0.01	0.09	0.01	0.14	0.05	0.47
	SDLF	0.00	0.04	0.02	0.10	0.00	0.15	0.05	0.44
	TDLF	-0.01	0.10	0.04	0.17	0.00	0.21	0.08	0.55
G4	NLF	0.00	0.03	0.01	0.10	0.01	0.16	0.05	0.52
	SDLF	0.00	0.04	0.02	0.10	0.01	0.16	0.05	0.47
	TDLF	-0.01	0.08	0.04	0.14	0.00	0.21	0.08	0.55
G5	NLF	0.00	0.03	0.01	0.10	-0.01	0.18	0.06	0.54
	SDLF	0.00	0.04	0.02	0.10	-0.01	0.18	0.05	0.49
	TDLF	0.01	0.06	0.04	0.12	0.00	0.21	0.08	0.55
G6	NLF	0.00	0.03	0.02	0.11	-0.01	0.19	0.07	0.55
	SDLF	0.00	0.04	0.02	0.10	-0.01	0.19	0.06	0.49
	TDLF	0.02	0.06	0.03	0.11	0.00	0.21	0.08	0.55
G7	NLF	0.01	0.04	0.02	0.10	0.05	0.19	0.10	0.49
	SDLF	0.00	0.04	0.02	0.10	0.03	0.19	0.09	0.45
	TDLF	-0.04	0.06	0.00	0.17	0.00	0.21	0.08	0.56
G8	NLF	0.01	0.03	0.02	0.09	0.03	0.18	0.08	0.47
	SDLF	0.00	0.04	0.02	0.10	0.02	0.17	0.07	0.44
	TDLF	-0.03	0.06	0.01	0.18	0.00	0.21	0.08	0.56
G9	NLF	-0.01	0.04	0.02	0.11	-0.03	0.20	0.07	0.53
	SDLF	0.00	0.04	0.02	0.09	-0.02	0.19	0.07	0.48
	TDLF	0.02	0.03	0.02	0.08	0.01	0.20	0.08	0.51

Table L4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	0.03	-0.01	0.04	-0.02	0.14	-0.14	0.18	-0.13
	SDLF	0.00	0.00	0.00	0.00	0.10	-0.13	0.12	-0.10
	TDLF	-0.04	0.03	-0.19	0.05	0.00	-0.04	-0.04	-0.01
G2	NLF	0.01	0.00	0.03	0.02	0.04	-0.07	0.17	0.09
	SDLF	0.00	0.00	0.00	0.00	0.03	-0.06	0.13	0.06
	TDLF	-0.03	0.03	-0.14	-0.08	0.00	-0.01	-0.02	-0.01
G3	NLF	0.01	0.00	0.02	0.00	0.04	-0.02	0.14	0.06
	SDLF	0.00	0.00	0.00	0.00	0.03	-0.02	0.11	0.05
	TDLF	-0.04	0.02	-0.09	0.00	-0.01	0.00	0.01	0.03
G4	NLF	0.01	-0.01	0.02	-0.01	0.02	-0.10	0.14	-0.08
	SDLF	0.00	0.00	0.00	0.00	0.01	-0.09	0.11	-0.06
	TDLF	-0.05	0.05	-0.11	0.07	-0.01	0.00	0.00	0.01
G5	NLF	0.01	-0.02	0.01	-0.02	0.07	-0.11	0.11	-0.14
	SDLF	0.00	0.00	0.00	0.00	0.05	-0.09	0.09	-0.11
	TDLF	-0.07	0.07	-0.07	0.12	-0.01	0.00	0.00	0.00
G6	NLF	0.02	-0.02	0.01	-0.03	0.07	-0.15	0.06	-0.18
	SDLF	0.00	0.00	0.00	0.00	0.05	-0.12	0.05	-0.13
	TDLF	-0.08	0.10	-0.04	0.15	-0.01	0.00	0.00	0.01
G7	NLF	-0.02	-0.02	0.01	-0.01	-0.09	-0.15	0.05	-0.04
	SDLF	0.00	0.00	0.00	0.00	-0.07	-0.12	0.04	-0.03
	TDLF	0.05	0.10	-0.03	0.03	-0.01	-0.01	0.00	0.01
G8	NLF	-0.01	-0.02	0.00	0.00	-0.01	-0.07	0.09	0.02
	SDLF	0.00	0.00	0.00	0.00	0.00	-0.05	0.08	0.02
	TDLF	0.02	0.07	-0.02	0.00	0.00	0.02	0.02	0.00
G9	NLF	0.02	-0.03	0.01	-0.03	0.13	-0.12	0.13	-0.14
	SDLF	0.00	0.00	0.00	0.00	0.10	-0.09	0.11	-0.10
	TDLF	-0.08	0.12	-0.03	0.11	0.01	0.02	0.05	0.00

Appendix L-5. NICSS16 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NICSS16 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table L-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
3	3-2	SDLF	0.0	-0.1	0.1	0.0	0.1	0.1
		TDLF	0.0	0.3	0.3	0.0	-0.3	0.3
	3-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.3	0.1	0.4	0.3	0.0	0.3
	3-4	SDLF	-0.3	-0.5	0.5	-0.3	0.4	0.5
		TDLF	0.4	1.2	1.2	0.3	-1.2	1.2
	3-5	SDLF	-0.3	-0.7	0.8	-0.3	0.6	0.7
		TDLF	-1.6	-4.2	4.4	-1.2	3.5	3.7

Table L-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	SDLF	0.0	-0.1	0.1	0.0	0.0	0.0
		TDLF	0.0	0.3	0.3	0.0	-0.3	0.3
	9-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.5	0.1	0.5	0.4	-0.1	0.4
	9-4	SDLF	-0.2	-0.2	0.3	-0.2	0.3	0.4
		TDLF	0.3	0.8	0.9	0.4	-1.2	1.2
	9-5	SDLF	-0.1	-0.8	0.8	-0.1	0.8	0.8
		TDLF	-0.4	-2.8	2.9	-0.3	2.9	2.9

Table L-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
18	18-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.1	-0.1	0.1	0.1	-0.1	0.1
	18-3	SDLF	-0.1	-0.2	0.2	-0.1	0.2	0.2
		TDLF	0.0	0.2	0.2	-0.1	-0.2	0.2
	18-4	SDLF	-0.2	-0.5	0.5	-0.2	0.5	0.5
		TDLF	-0.8	-2.6	2.7	-0.7	2.2	2.3

Table L-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
27	27-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.3	0.1	0.4	0.2	0.1	0.3
	27-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.5	0.7	0.9	0.4	-0.6	0.8
	27-4	SDLF	0.0	0.0	0.0	0.0	0.1	0.1
		TDLF	0.0	-0.5	0.5	0.0	1.4	1.4

Table L-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
29	29-1	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.5	-1.0	1.2	-0.5	0.5	0.7
	29-2	SDLF	-0.1	-0.7	0.7	-0.1	0.7	0.7
		TDLF	1.5	-37.9	37.9	1.7	36.9	36.9

Table L-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
36	36-1	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	0.2	0.2	0.0	0.0	0.0
	36-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	3.8	0.1	3.9	3.7	0.1	3.7
	36-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.2	0.0	0.2	0.0	0.5	0.5

Table L-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
45	45-1	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	0.0	0.0	0.0	-0.3	0.3
	45-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	5.3	-0.3	5.3	5.3	0.2	5.3
	45-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	-0.1	-0.7	0.7	-0.1	0.4	0.4

Table L-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
54	54-1	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.0	0.8	0.8	0.0	-0.8	0.8
	54-2	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	2.9	0.4	2.9	2.8	-0.1	2.8
	54-3	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
		TDLF	0.1	0.4	0.4	0.0	0.0	0.0

Table L-5-2: Erection Critical Sub-Stages

Stage	Detailing Method	Critical Sub-Stage
3	SDLF	3-5
	TDLF	3-5
9	SDLF	9-5
	TDLF	9-5
18	SDLF	18-4
	TDLF	18-4
27	SDLF	27-4
	TDLF	27-4
29	SDLF	29-2
	TDLF	29-2
36	SDLF	36-2
	TDLF	36-2
45	SDLF	45-2
	TDLF	45-2
54	SDLF	54-2
	TDLF	54-2

Table L-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
3	A	SDLF	-0.1	-0.4	0.4	NA	NA	NA
3	A	TDLF	-0.5	-2.3	2.3	NA	NA	NA
3	B	SDLF	-0.3	-0.7	0.8	-0.3	0.6	0.7
3	B	TDLF	-1.6	-4.2	4.4	-1.2	3.5	3.7
9	A	SDLF	-0.1	-0.5	0.5	NA	NA	NA
9	A	TDLF	-0.3	-1.7	1.7	NA	NA	NA
9	B	SDLF	-0.1	-0.8	0.8	-0.1	0.8	0.8
9	B	TDLF	-0.4	-2.8	2.9	-0.3	2.9	2.9
18	A	SDLF	-0.2	-0.4	0.4	NA	NA	NA
18	A	TDLF	-0.9	-2.2	2.3	NA	NA	NA
18	B	SDLF	-0.2	-0.5	0.5	-0.2	0.5	0.5
18	B	TDLF	-0.8	-2.6	2.7	-0.7	2.2	2.3
27	A	SDLF	0.0	0.0	0.0	NA	NA	NA
27	A	TDLF	0.1	-0.4	0.4	NA	NA	NA
27	B	SDLF	0.0	0.0	0.0	0.0	0.1	0.1
27	B	TDLF	0.0	-0.5	0.5	0.0	1.4	1.4
29	A	SDLF	0.0	-0.1	0.1	NA	NA	NA
29	A	TDLF	3.6	-1.6	4.0	NA	NA	NA
29	B	SDLF	-0.1	-0.7	0.7	-0.1	0.7	0.7
29	B	TDLF	1.5	-37.9	37.9	1.7	36.9	36.9
36	A	SDLF	0.0	0.0	0.0	NA	NA	NA
36	A	TDLF	2.7	1.7	3.2	NA	NA	NA
36	B	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
36	B	TDLF	3.8	0.1	3.9	3.7	0.1	3.7
45	A	SDLF	0.0	0.0	0.0	NA	NA	NA
45	A	TDLF	3.6	1.8	4.0	NA	NA	NA
45	B	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
45	B	TDLF	5.3	-0.3	5.3	5.3	0.2	5.3
54	A	SDLF	0.0	0.0	0.0	NA	NA	NA
54	A	TDLF	5.0	0.4	5.0	NA	NA	NA
54	B	SDLF	0.0	0.0	0.0	0.0	0.0	0.0
54	B	TDLF	2.9	0.4	2.9	2.8	-0.1	2.8

Table L-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
3	A	G1	SDLF	18	32
			TDLF	17	32
		G2	SDLF	18	32
			TDLF	19	33
		G3	SDLF	17	32
			TDLF	17	31
	B	G1	SDLF	18	32
			TDLF	17	32
		G2	SDLF	18	33
			TDLF	19	33
		G3	SDLF	17	33
			TDLF	17	32

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
9	A	G1	SDLF	18	32
			TDLF	17	32
		G2	SDLF	19	33
			TDLF	19	33
		G3	SDLF	19	34
			TDLF	19	33
		G4	SDLF	19	33
			TDLF	19	34
		G5	SDLF	19	34
			TDLF	19	33
		G6	SDLF	19	33
			TDLF	19	33
		G7	SDLF	19	33
			TDLF	18	33
		G8	SDLF	19	33
			TDLF	20	33
		G9	SDLF	17	32
			TDLF	17	31

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number	
				1	2
9	B	G1	SDLF	18	32
			TDLF	17	32
		G2	SDLF	19	33
			TDLF	19	33
		G3	SDLF	19	34
			TDLF	19	33
		G4	SDLF	19	33
			TDLF	19	34
		G5	SDLF	19	34
			TDLF	19	33
		G6	SDLF	19	33
			TDLF	19	33
		G7	SDLF	19	33
			TDLF	19	33
		G8	SDLF	19	33
			TDLF	20	33
		G9	SDLF	17	32
			TDLF	17	32

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
18	A	G1	SDLF	12	57	33
			TDLF	11	58	33
		G2	SDLF	13	59	33
			TDLF	13	60	33
		G3	SDLF	13	59	34
			TDLF	13	59	33
		G4	SDLF	13	59	34
			TDLF	13	60	34
		G5	SDLF	13	59	34
			TDLF	13	59	34
		G6	SDLF	13	59	34
			TDLF	13	59	34
		G7	SDLF	13	59	33
			TDLF	13	58	32
		G8	SDLF	13	59	33
			TDLF	14	60	33
		G9	SDLF	12	57	32
			TDLF	11	56	32

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
18	B	G1	SDLF	12	57	33
			TDLF	11	58	33
		G2	SDLF	13	59	33
			TDLF	13	60	33
		G3	SDLF	13	59	34
			TDLF	13	59	33
		G4	SDLF	13	59	34
			TDLF	13	60	34
		G5	SDLF	13	59	34
			TDLF	13	59	34
		G6	SDLF	13	59	34
			TDLF	13	59	34
		G7	SDLF	13	59	33
			TDLF	13	58	33
		G8	SDLF	13	59	33
			TDLF	15	60	33
		G9	SDLF	12	57	32
			TDLF	11	56	33

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
27	A	G1	SDLF	14	49	57	16
			TDLF	13	51	51	13
		G2	SDLF	15	51	60	18
			TDLF	15	50	68	26
		G3	SDLF	15	51	60	18
			TDLF	15	51	57	13
		G4	SDLF	15	51	60	18
			TDLF	15	52	59	17
		G5	SDLF	15	51	60	18
			TDLF	15	51	61	17
		G6	SDLF	15	51	60	18
			TDLF	15	51	59	18
		G7	SDLF	15	51	60	18
			TDLF	15	50	59	19
		G8	SDLF	15	51	60	17
			TDLF	16	51	61	18
		G9	SDLF	13	49	58	16
			TDLF	13	48	58	15

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
27	B	G1	SDLF	14	49	57	16
			TDLF	13	51	51	13
		G2	SDLF	15	51	60	18
			TDLF	15	50	68	26
		G3	SDLF	15	51	60	18
			TDLF	15	51	57	13
		G4	SDLF	15	51	60	18
			TDLF	15	52	59	17
		G5	SDLF	15	51	60	18
			TDLF	15	51	61	17
		G6	SDLF	15	51	60	18
			TDLF	15	51	59	18
		G7	SDLF	15	51	60	18
			TDLF	15	50	59	18
		G8	SDLF	15	51	60	18
			TDLF	16	51	61	18
		G9	SDLF	13	49	58	17
			TDLF	13	48	58	16

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
29	A	G1	SDLF	14	50	57	16
			TDLF	7	52	51	13
		G2	SDLF	15	52	60	18
			TDLF	23	54	67	26
		G3	SDLF	15	52	60	18
			TDLF	14	51	57	14
		G4	SDLF	15	51	60	18
			TDLF	15	50	60	17
		G5	SDLF	15	51	60	18
			TDLF	15	51	61	17
		G6	SDLF	15	51	60	18
			TDLF	15	51	59	18
		G7	SDLF	15	51	60	18
			TDLF	15	50	59	18
		G8	SDLF	15	51	60	18
			TDLF	16	51	61	18
		G9	SDLF	13	49	58	17
			TDLF	13	48	58	16

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
29	B	G1	SDLF	14	50	57	16
			TDLF	0	52	51	13
		G2	SDLF	16	52	60	18
			TDLF	25	48	67	26
		G3	SDLF	15	52	59	18
			TDLF	20	75	55	14
		G4	SDLF	15	51	60	18
			TDLF	14	35	60	18
		G5	SDLF	15	51	60	18
			TDLF	14	49	61	17
		G6	SDLF	15	51	60	18
			TDLF	15	51	59	18
		G7	SDLF	15	51	60	18
			TDLF	15	50	59	18
		G8	SDLF	15	51	60	18
			TDLF	16	51	61	18
		G9	SDLF	13	49	58	17
			TDLF	13	48	58	16

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
36	A	G1	SDLF	14	50	57	16
			TDLF	0	54	51	13
		G2	SDLF	16	52	60	18
			TDLF	9	48	67	26
		G3	SDLF	16	53	59	18
			TDLF	15	75	54	14
		G4	SDLF	15	52	59	18
			TDLF	28	48	58	18
		G5	SDLF	15	52	60	18
			TDLF	16	54	60	17
		G6	SDLF	15	52	60	18
			TDLF	6	56	58	18
		G7	SDLF	15	52	59	18
			TDLF	22	45	58	19
		G8	SDLF	16	52	60	18
			TDLF	24	65	59	19
		G9	SDLF	14	49	58	17
			TDLF	10	30	59	16

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
36	B	G1	SDLF	14	50	57	16
			TDLF	0	54	51	13
		G2	SDLF	16	52	60	18
			TDLF	9	48	67	26
		G3	SDLF	16	53	59	18
			TDLF	15	75	54	14
		G4	SDLF	15	52	59	18
			TDLF	28	48	58	18
		G5	SDLF	15	52	60	18
			TDLF	16	54	60	17
		G6	SDLF	15	52	60	18
			TDLF	6	56	58	18
		G7	SDLF	15	52	59	18
			TDLF	21	45	58	19
		G8	SDLF	16	52	60	18
			TDLF	25	64	59	19
		G9	SDLF	14	49	57	17
			TDLF	10	31	59	16

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
45	A	G1	SDLF	14	51	58	16
			TDLF	0	43	53	13
		G2	SDLF	16	53	61	18
			TDLF	5	60	66	26
		G3	SDLF	16	53	61	18
			TDLF	16	85	60	13
		G4	SDLF	15	52	60	18
			TDLF	28	44	55	18
		G5	SDLF	15	52	60	18
			TDLF	15	52	58	18
		G6	SDLF	15	53	60	18
			TDLF	5	55	58	18
		G7	SDLF	15	52	60	18
			TDLF	21	43	61	18
		G8	SDLF	16	53	61	18
			TDLF	25	80	61	18
		G9	SDLF	14	50	58	17
			TDLF	10	23	56	16

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
45	B	G1	SDLF	14	51	58	16
			TDLF	0	43	53	13
		G2	SDLF	16	53	61	18
			TDLF	5	60	66	26
		G3	SDLF	16	53	61	18
			TDLF	16	85	60	13
		G4	SDLF	15	52	60	18
			TDLF	28	44	55	18
		G5	SDLF	15	52	60	18
			TDLF	15	52	58	18
		G6	SDLF	15	53	60	18
			TDLF	5	55	58	18
		G7	SDLF	15	52	60	18
			TDLF	21	43	61	18
		G8	SDLF	16	53	61	18
			TDLF	25	80	61	18
		G9	SDLF	14	50	58	16
			TDLF	10	24	56	16

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
54	A	G1	SDLF	14	50	59	17
			TDLF	0	43	46	12
		G2	SDLF	16	53	62	19
			TDLF	6	57	69	29
		G3	SDLF	16	53	62	19
			TDLF	16	86	74	16
		G4	SDLF	15	52	61	18
			TDLF	28	44	52	17
		G5	SDLF	15	52	60	18
			TDLF	16	53	51	16
		G6	SDLF	15	52	60	18
			TDLF	6	53	52	17
		G7	SDLF	15	52	62	18
			TDLF	21	43	84	27
		G8	SDLF	16	53	62	19
			TDLF	26	79	56	25
		G9	SDLF	14	50	58	16
			TDLF	11	23	59	0

Table L-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
54	B	G1	SDLF	14	50	59	17
			TDLF	0	43	46	12
		G2	SDLF	16	53	62	19
			TDLF	6	57	69	29
		G3	SDLF	16	53	62	19
			TDLF	16	86	74	16
		G4	SDLF	15	52	61	18
			TDLF	28	44	52	17
		G5	SDLF	15	52	60	18
			TDLF	16	53	51	16
		G6	SDLF	15	52	60	18
			TDLF	6	53	52	17
		G7	SDLF	15	52	62	18
			TDLF	21	43	84	27
		G8	SDLF	16	53	62	19
			TDLF	26	79	56	25
		G9	SDLF	14	50	59	16
			TDLF	11	23	59	1

Appendix M1-1. EICSS2 Bridge Description

The key characteristics of EICSS2 are as follows:

- Span length along the centerline of the bridge, L_s = 259, 257, 220 ft.
- Width between the fascia girders, w_g = 66.6ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 0.48,0.49,0.23
- Number of girders in the completed bridge cross-section, n_g = 8
- Parallel skew
- Skew angle, θ = 58,62,38,38^o
- Skew index, I_s = 0.41,0.48,0.24

This appendix presents the bridge description of the bridge EICSS2 in its final condition as well as during erection. The following figures and tables are provided:

Figure M1-1-1. Framing plan

Figure M1-1-2. Bridge cross-section and cross-frames

Figure M1-1-3. Girder Elevation

Figure M1-1-4. Cross-section dimension

Figure M1-1-5. Cross-frame details

Figure M1-1-6. Erection scheme

Table M1-1-1. Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

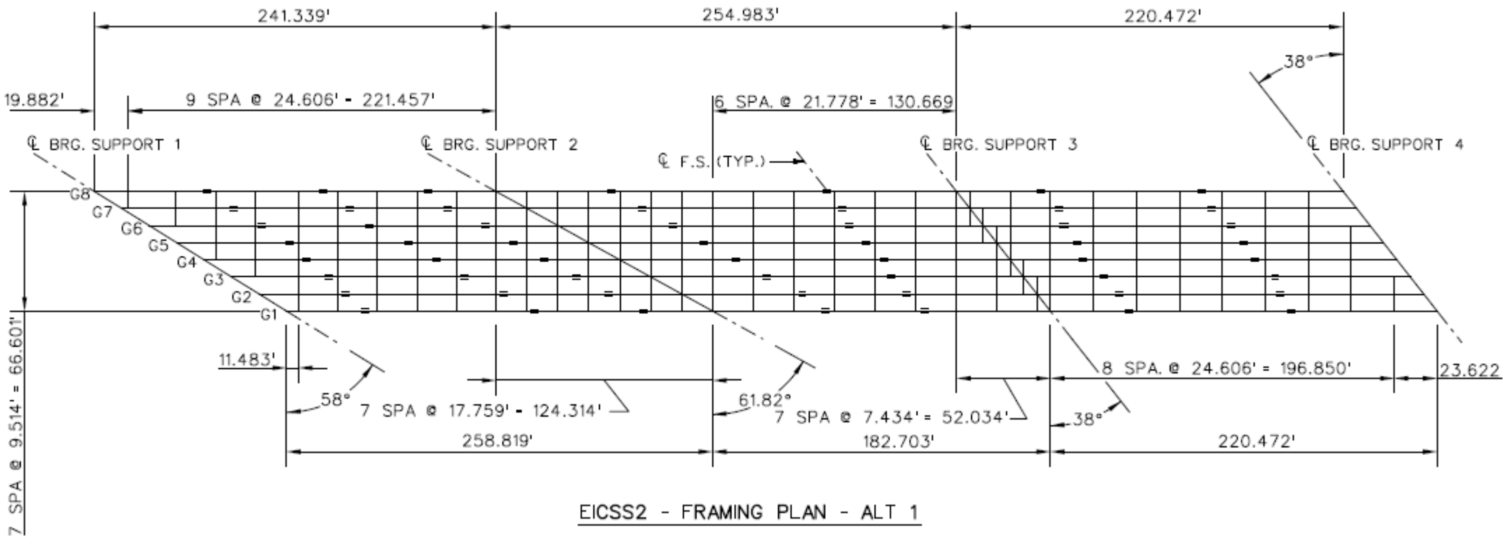


Figure M1-1-1. Framing plan.

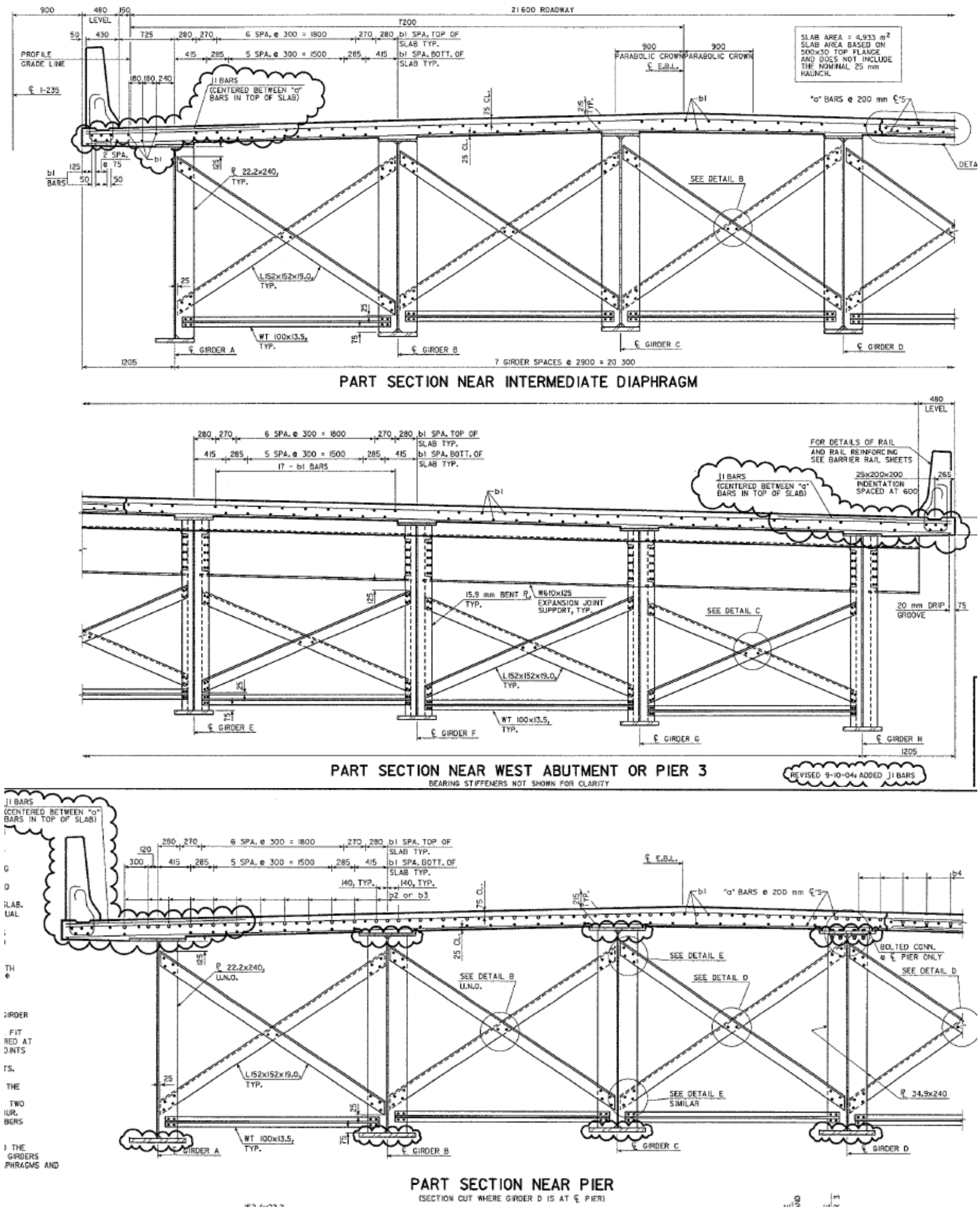
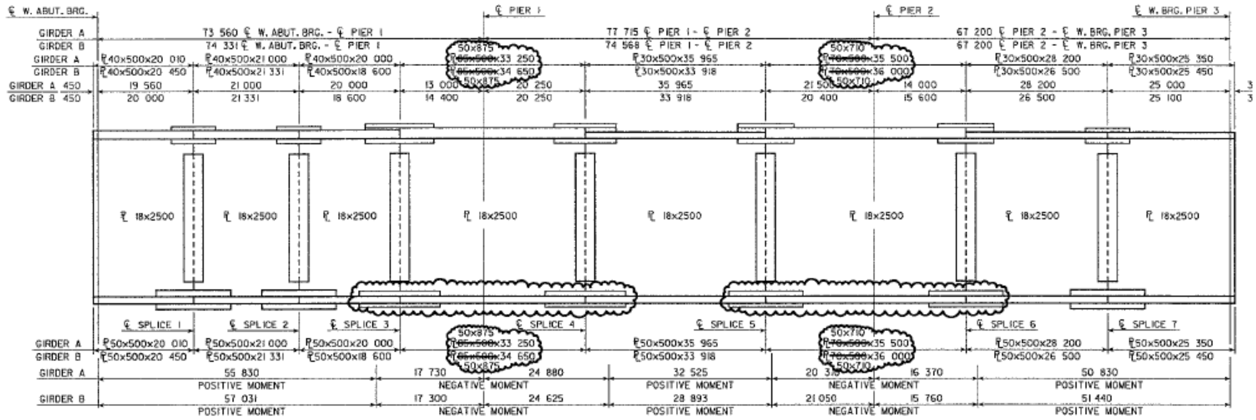
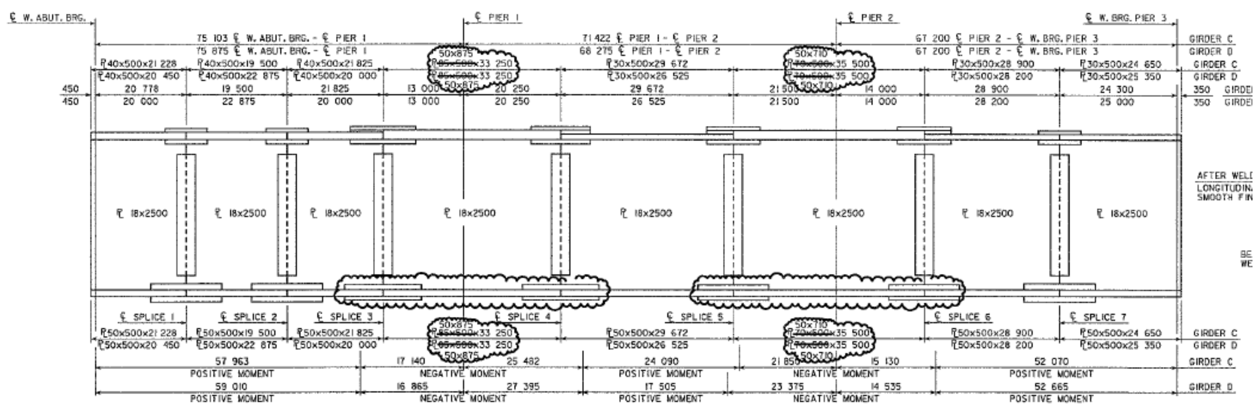


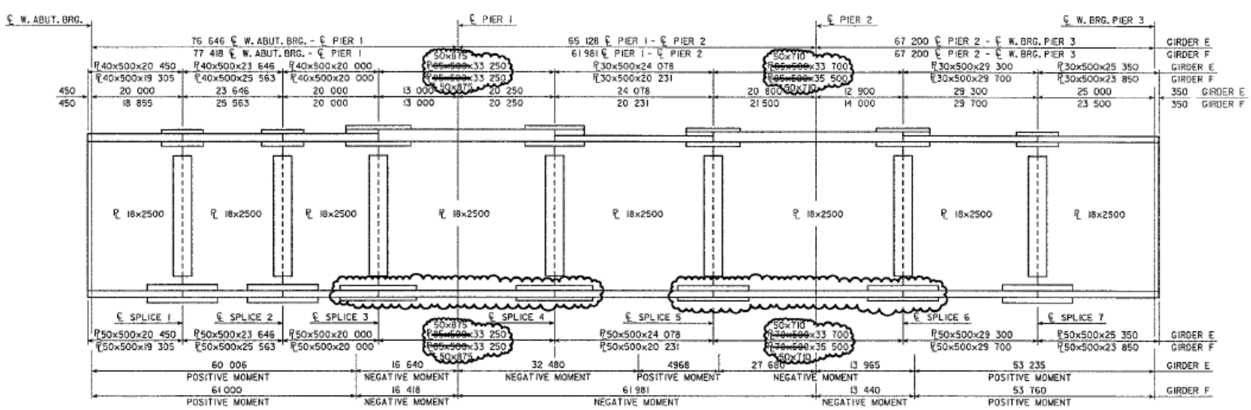
Figure M1-1-2. Bridge cross-section and cross-frames.



GIRDER A & B DETAILS



GIRDER C & D DETAILS



GIRDER E & F DETAILS

Figure M1-1-3. Girder elevations

PHASE 1: THE ERECTION FROM STAGE 1 TO STAGE 3
IS SIMILAR TO STAGE 4

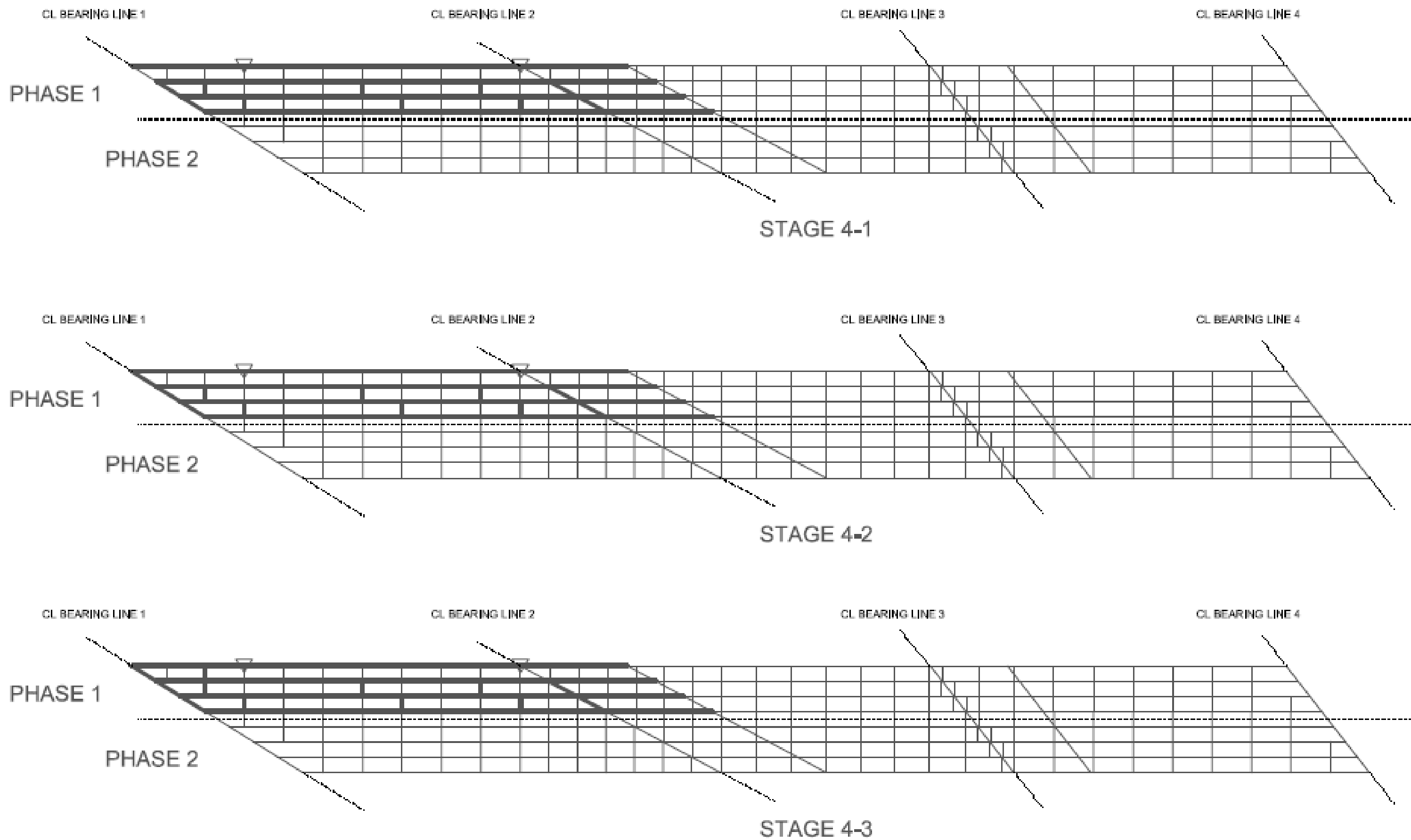


Figure M1-1-6. Erection scheme.

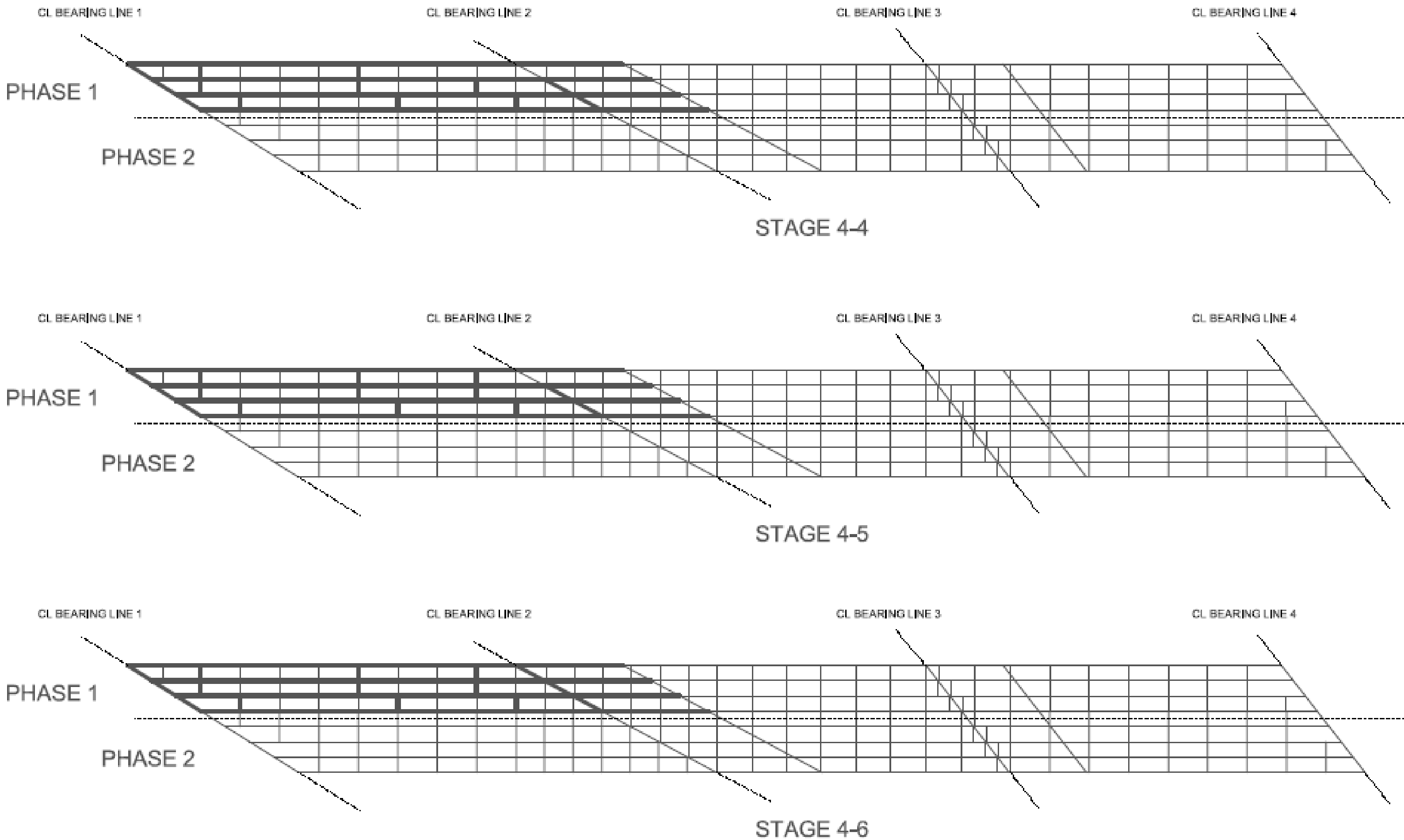
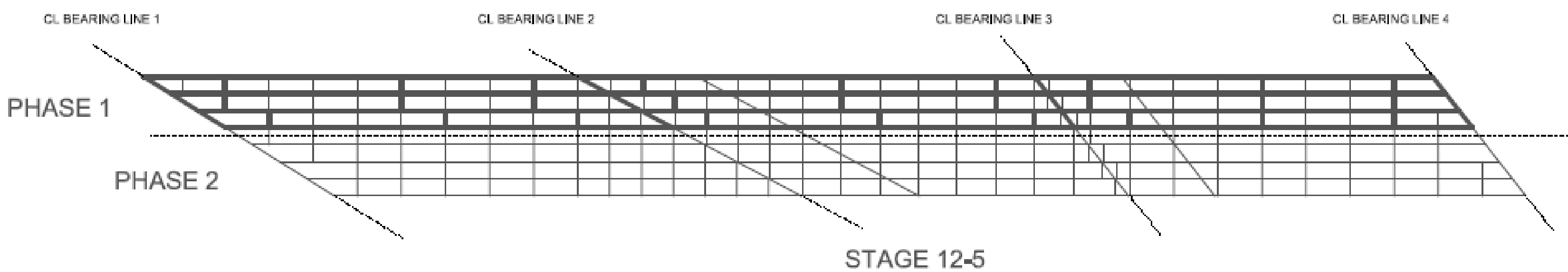


Figure M1-1-6(Continued). Erection scheme.

STAGE 5 TO STAGE 12:
REPEAT THIS SEQUENCE FOR SPAN 2 AND SPAN 3
FOR ALL GIRDERS IN PHASE 1



INSTALL THE REMAINING XFs SEQUENTIALLY
GIRDER BY GIRDER, SPAN BY SPAN
POUR THE DECK FOR PHASE 1

THEN, REPEAT THE SEQUENCE FOR PHASE 2
FINALLY, INSTALL THE CLOSURE CROSS-FRAMES AFTER
THE SECOND PHASE'S DECK IS POURED

Figure M1-1-6(Continued). Erection scheme.

Table M1-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

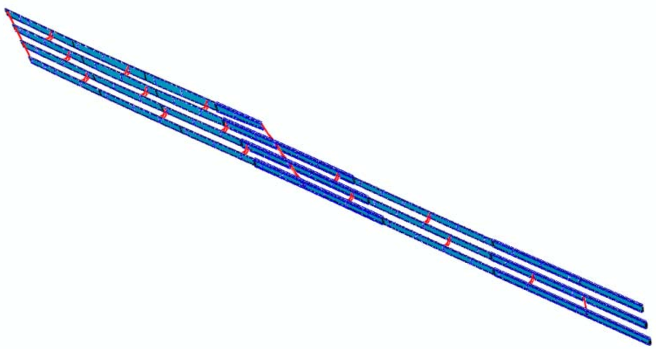
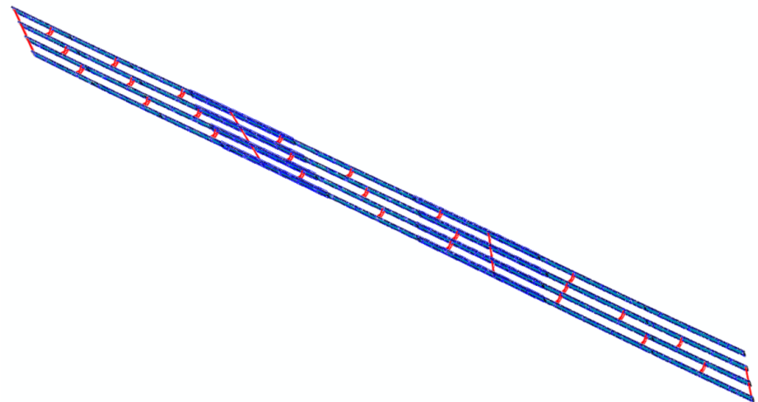
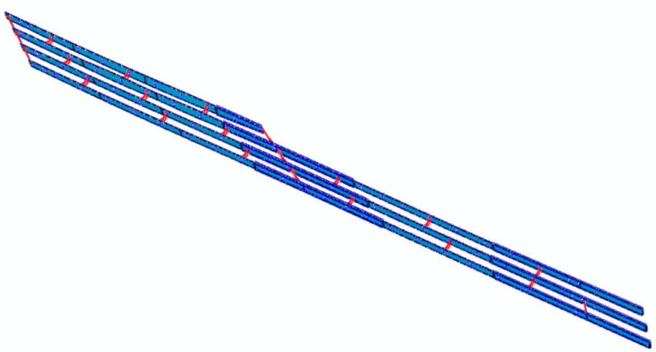
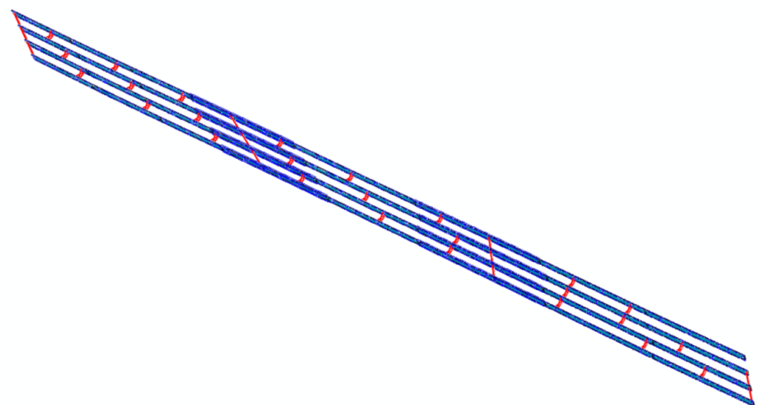
Sub-Stage	Stage	
	7	12
1		
2		

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

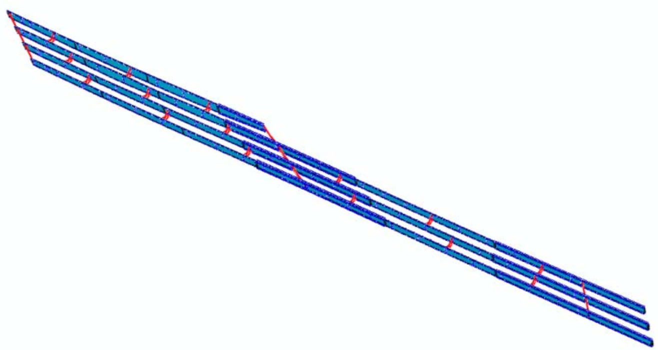
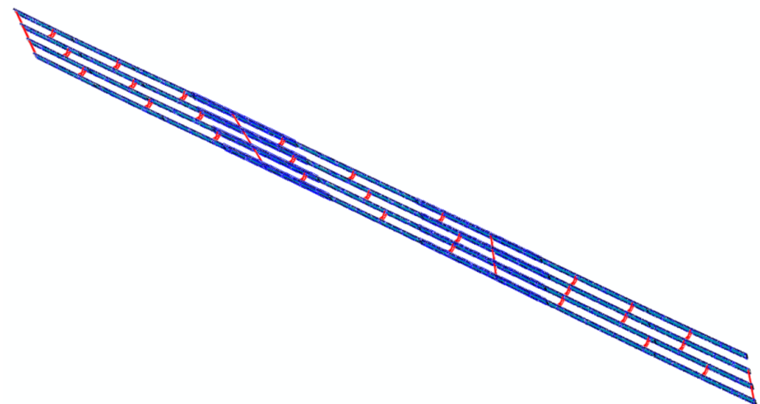
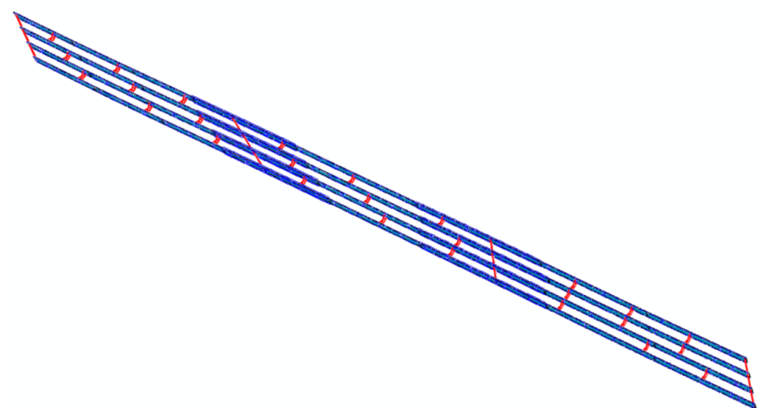
Sub-Stage	Stage	
	7	12
3		
4		

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

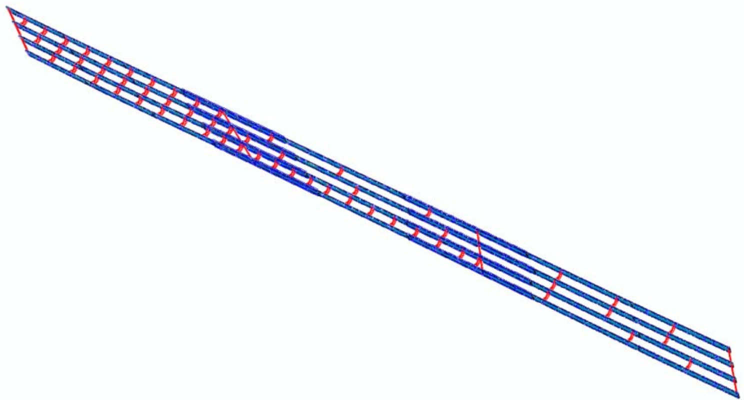
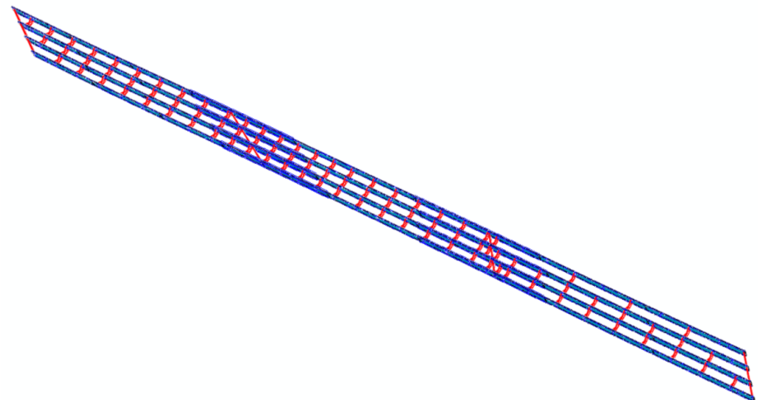
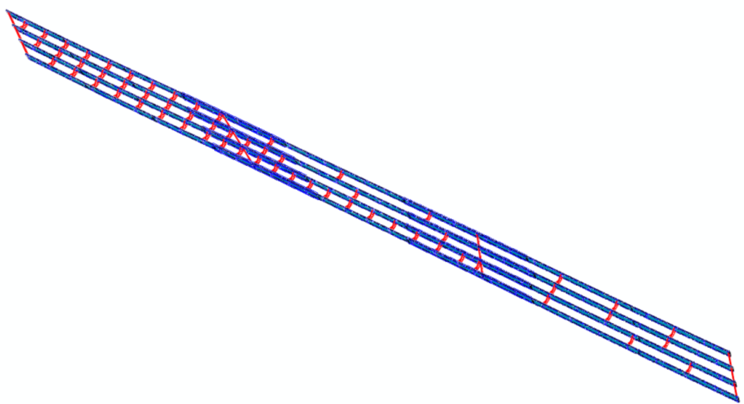
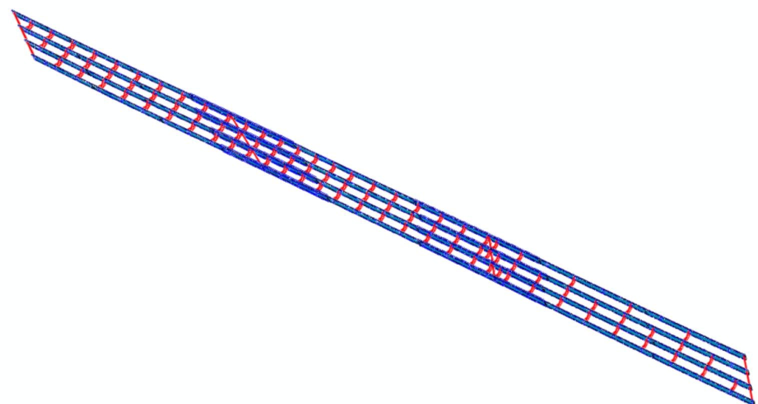
Sub-Stage	Stage	
	17	21
1		
2		

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

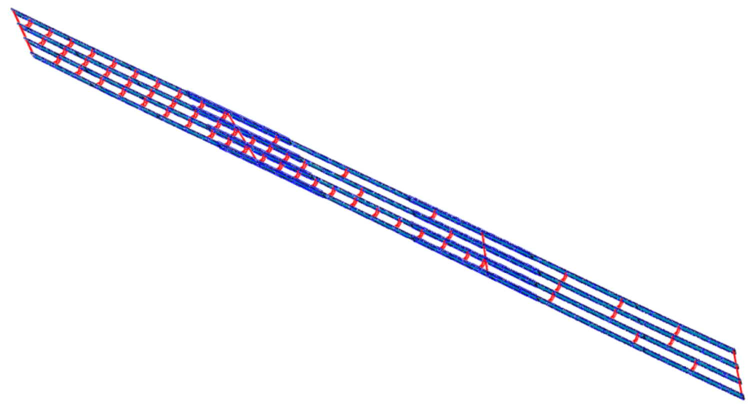
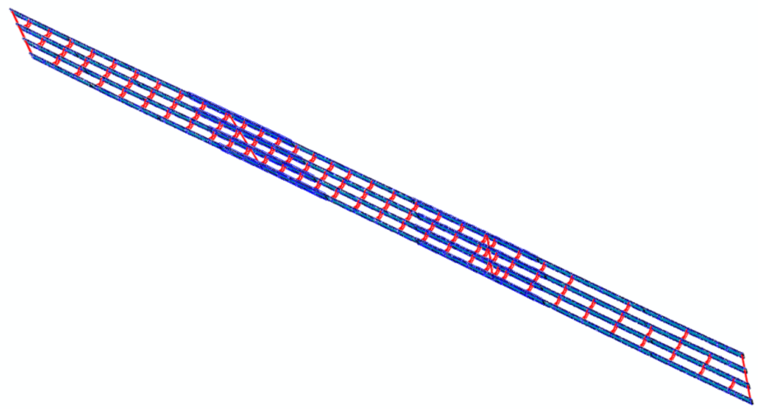
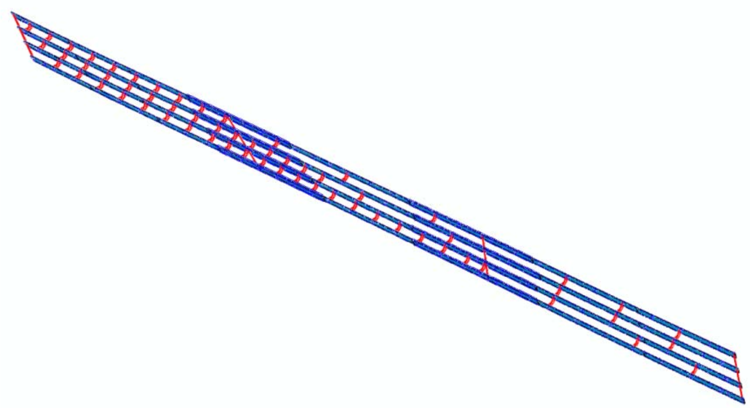
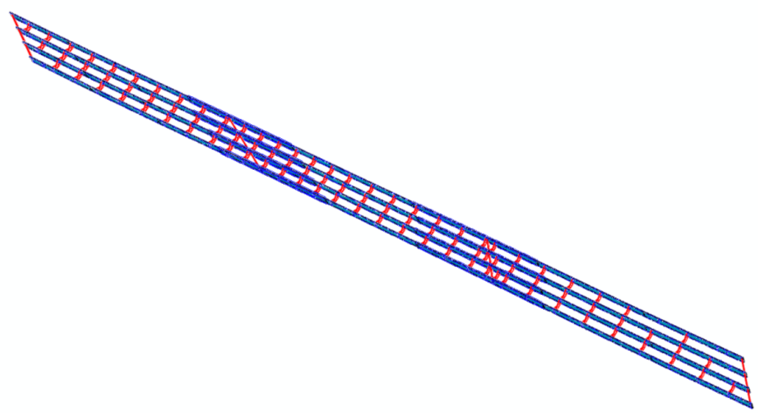
Sub-Stage	Stage	
	17	21
3		
4		

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

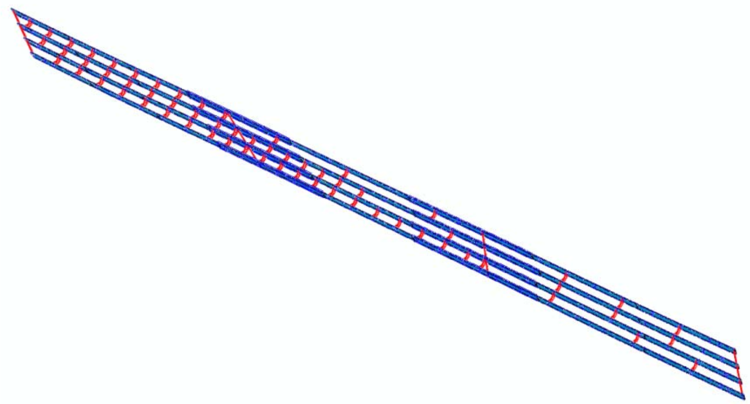
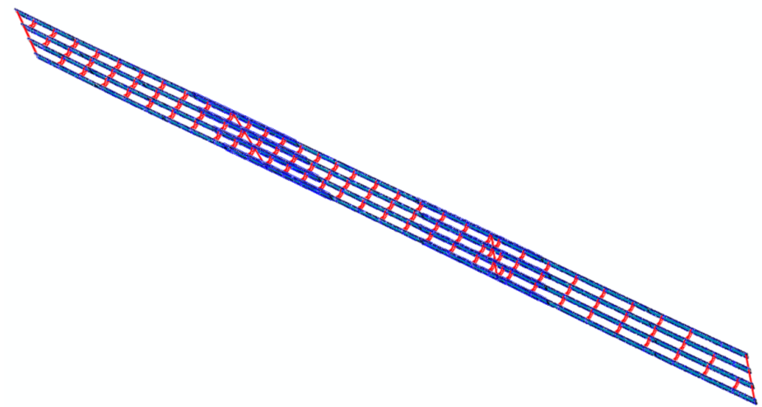
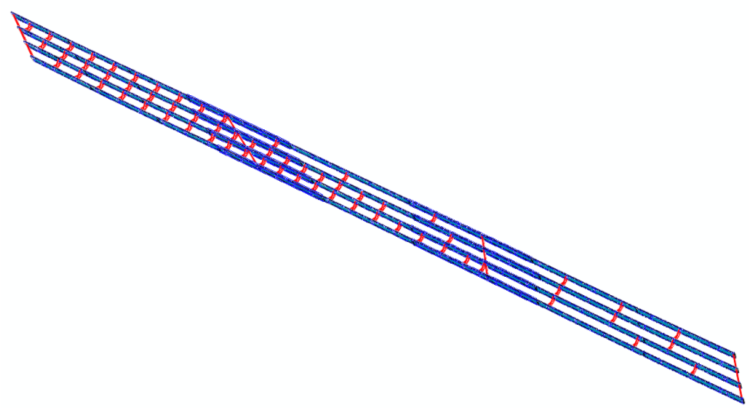
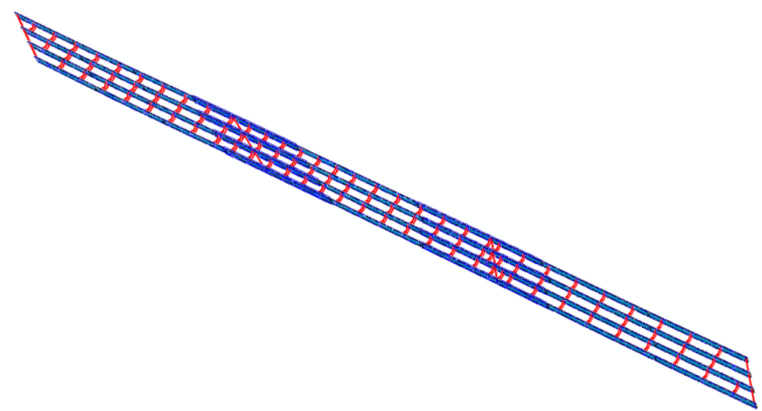
Sub-Stage	Stage	
	17	21
5		
6		

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

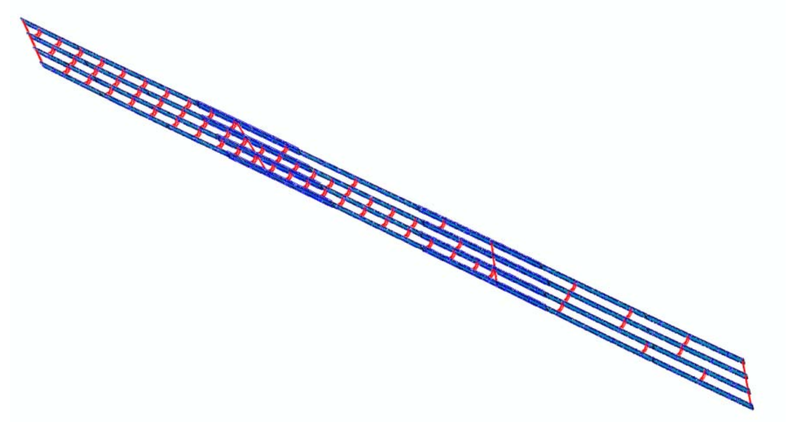
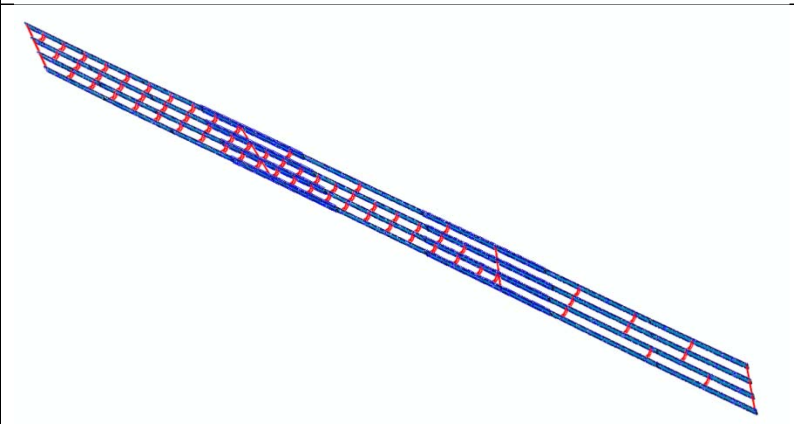
Sub-Stage	Stage	
	17	21
7		
8		

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

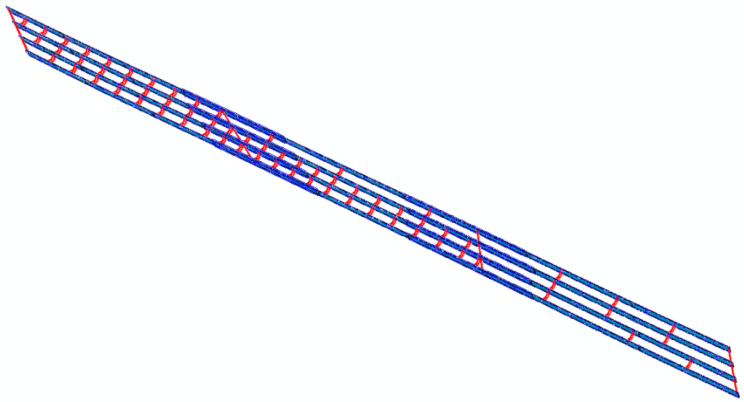
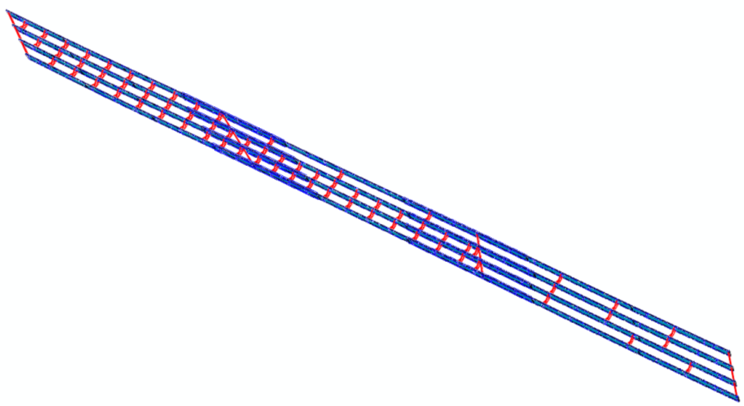
Sub-Stage	Stage	
	17	21
9		
10		

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

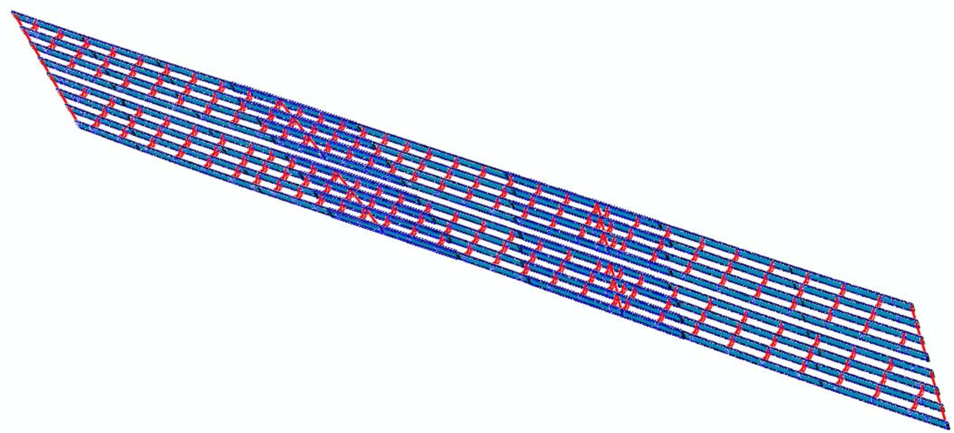
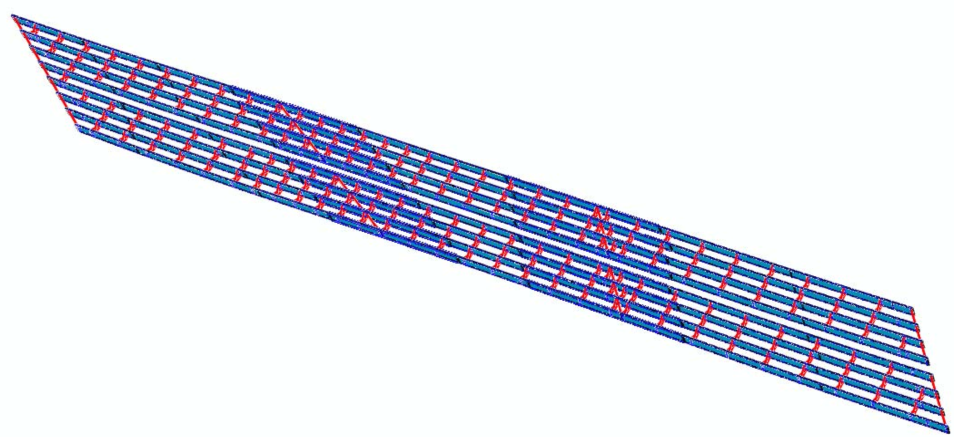
Sub-Stage	Stage 23
1	
2	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

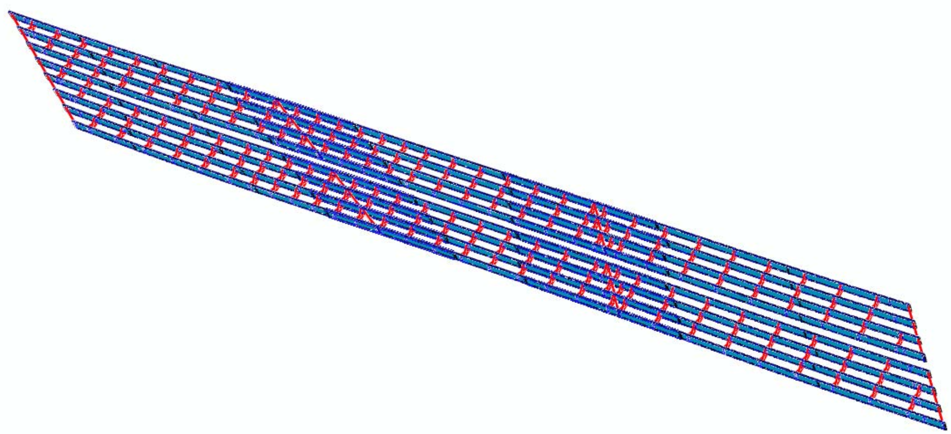
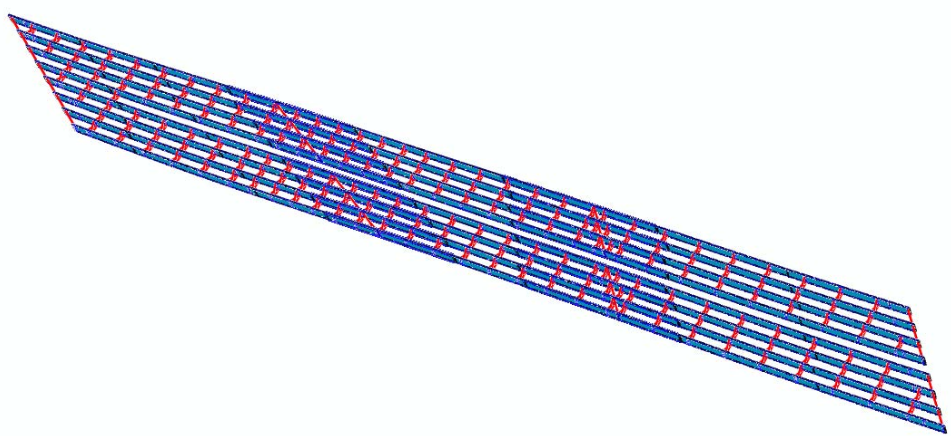
Sub-Stage	Stage 23
3	
4	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

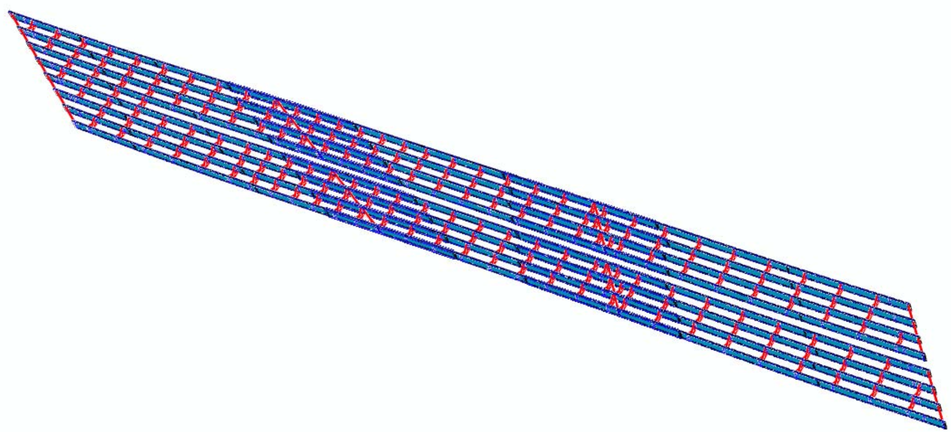
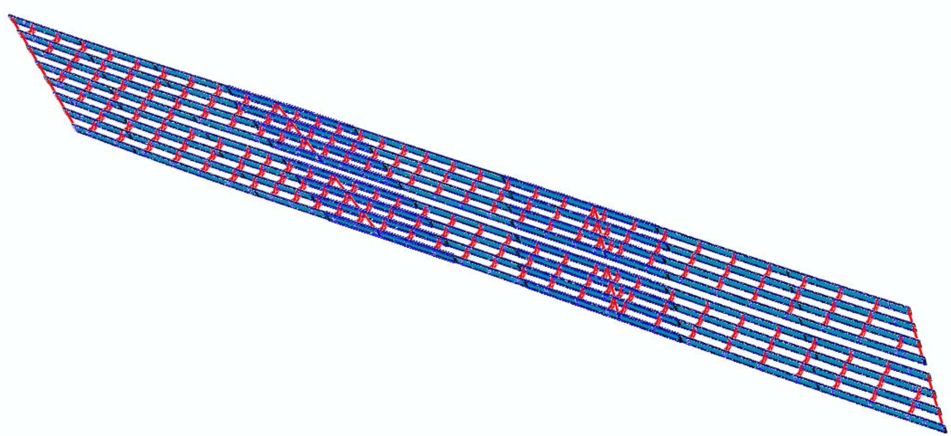
Sub-Stage	Stage 23
5	
6	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

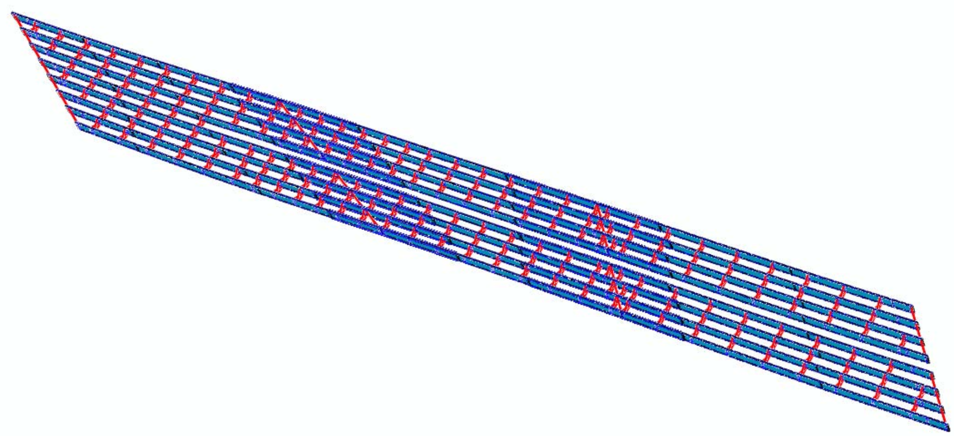
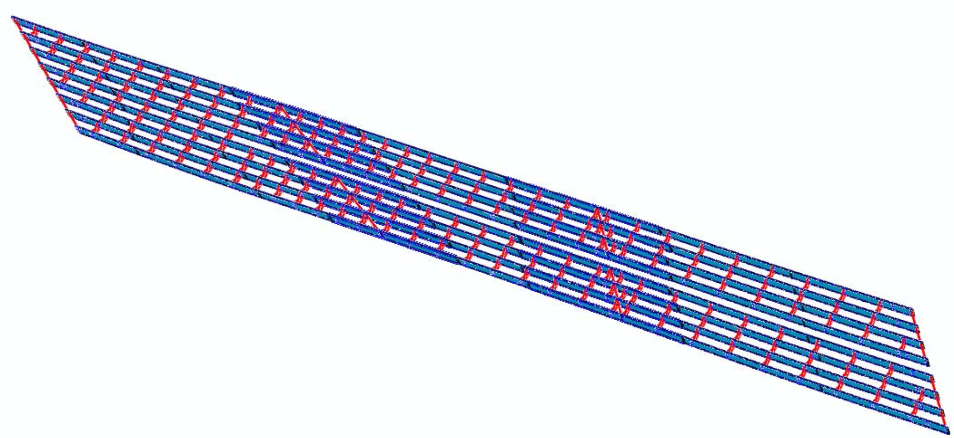
Sub-Stage	Stage 23
7	
8	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

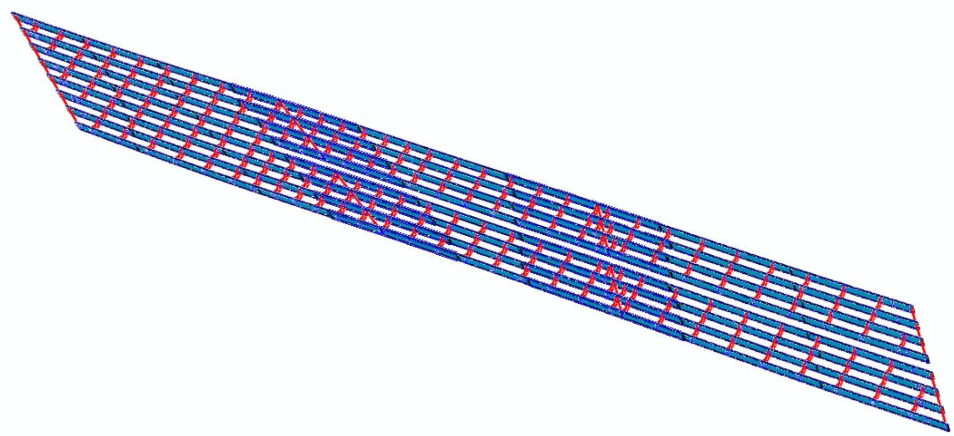
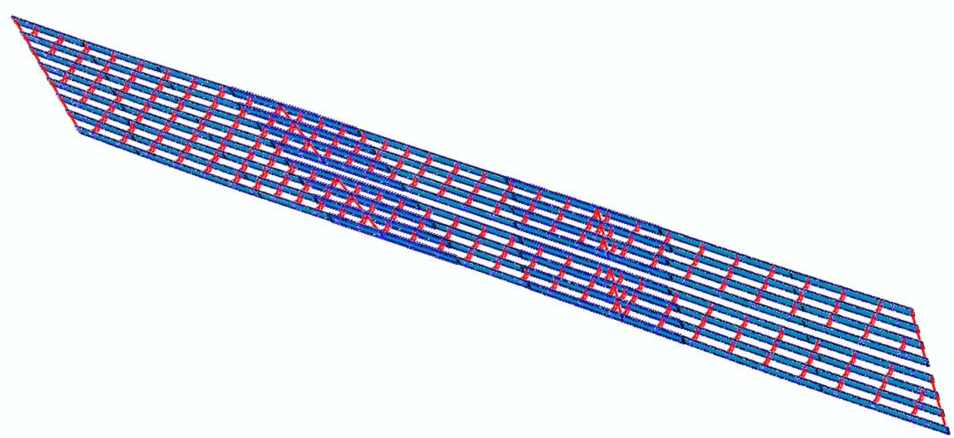
Sub-Stage	Stage
	23
9	
10	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

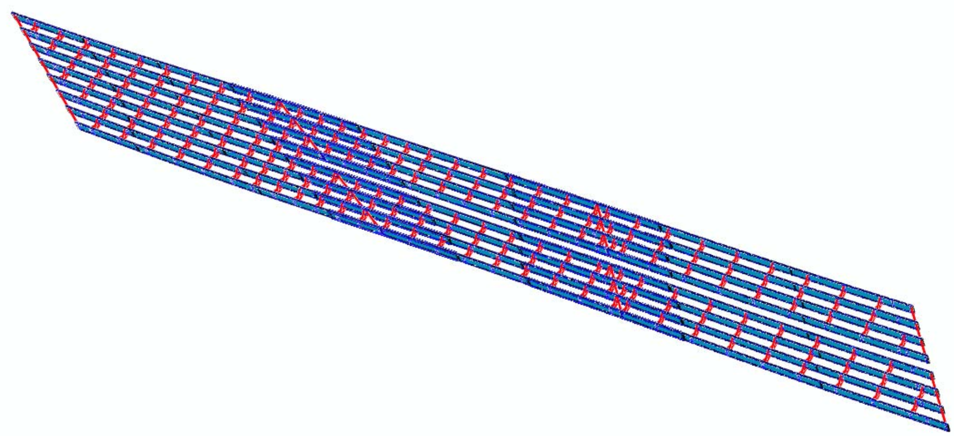
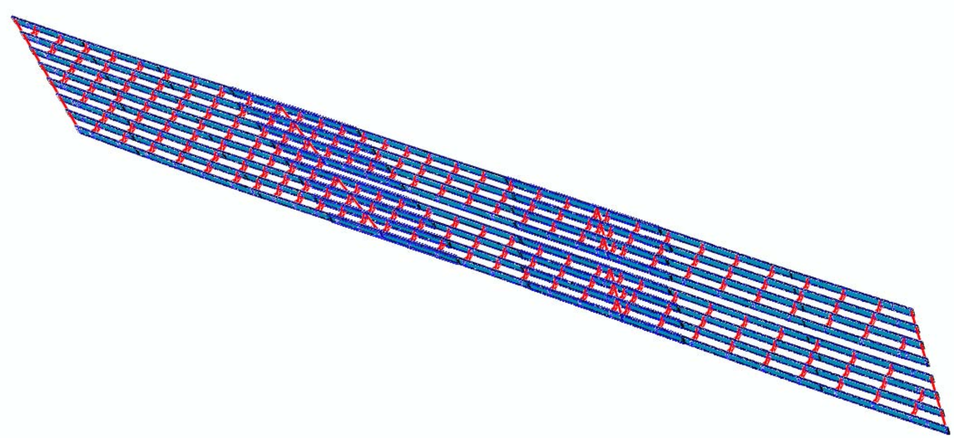
Sub-Stage	Stage
	23
11	
12	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

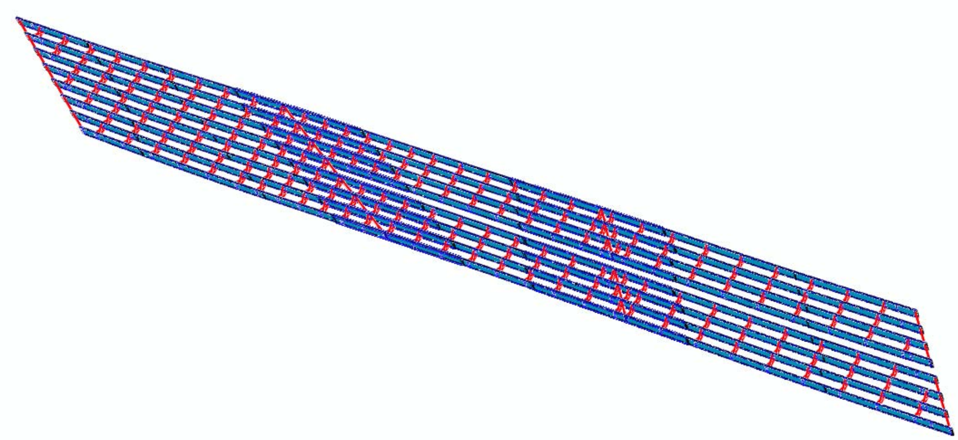
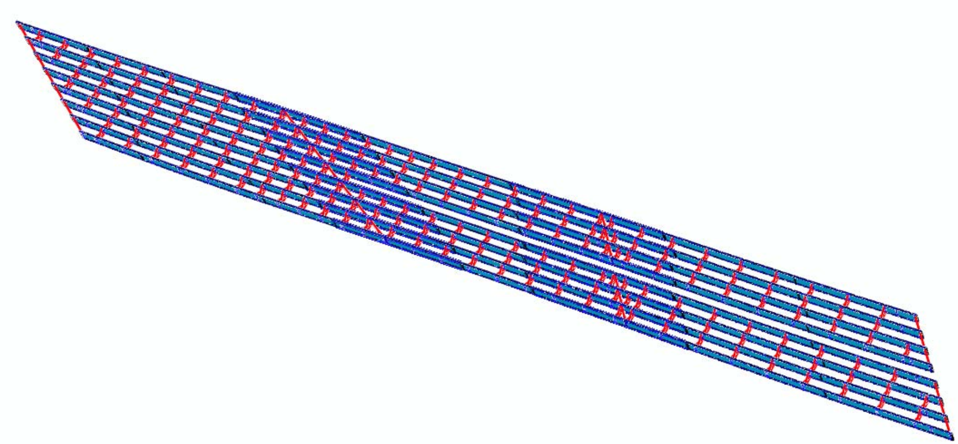
Sub-Stage	Stage 23
13	
14	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

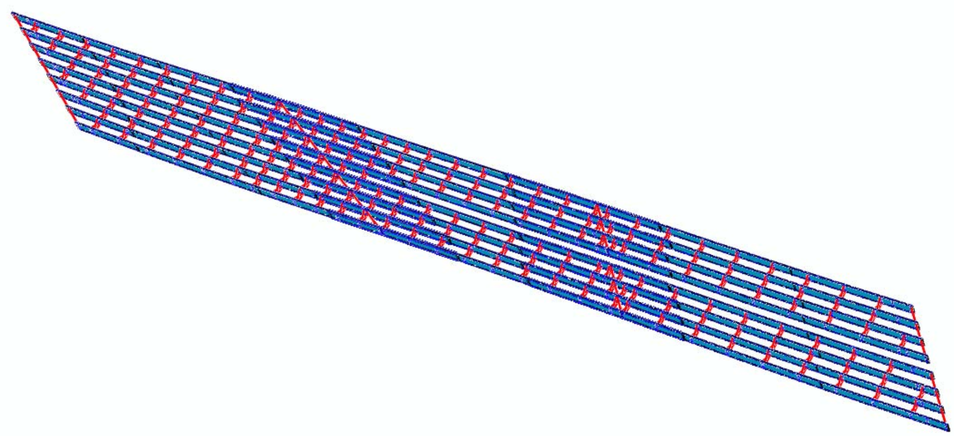
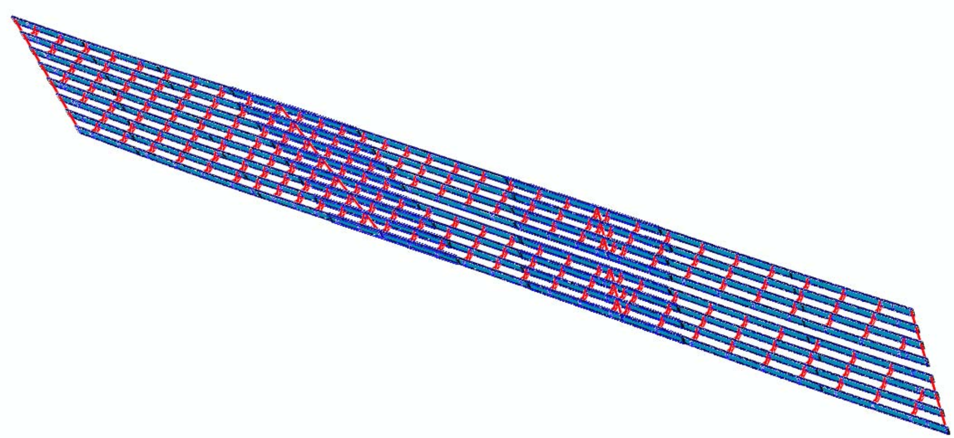
Sub-Stage	Stage
	23
15	
16	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

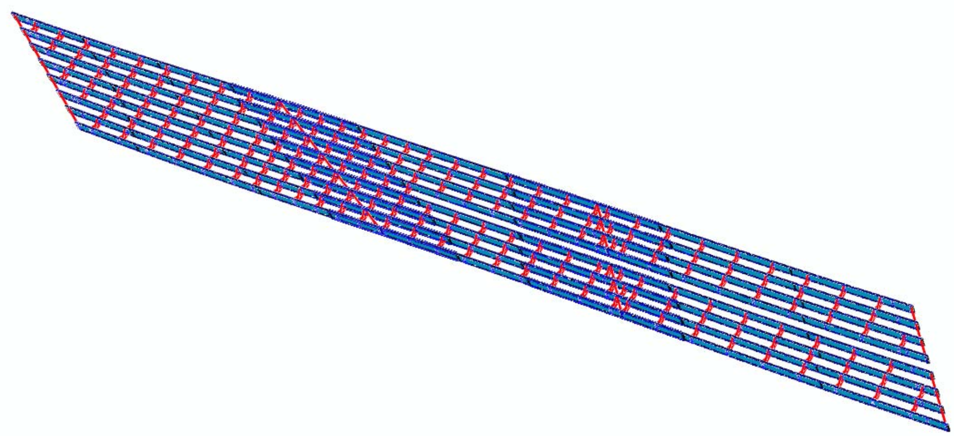
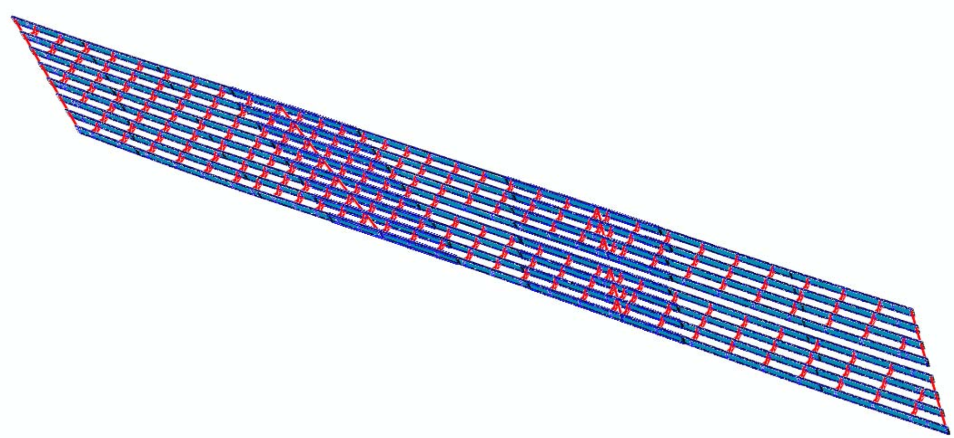
Sub-Stage	Stage
	23
17	
18	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

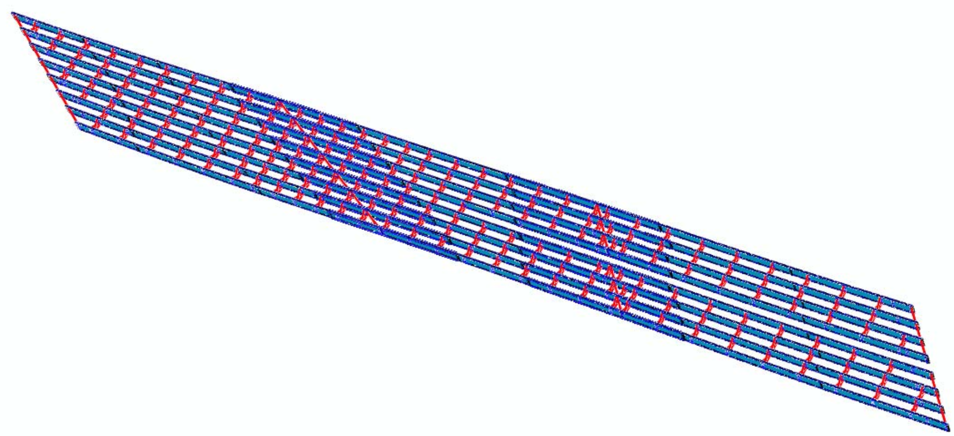
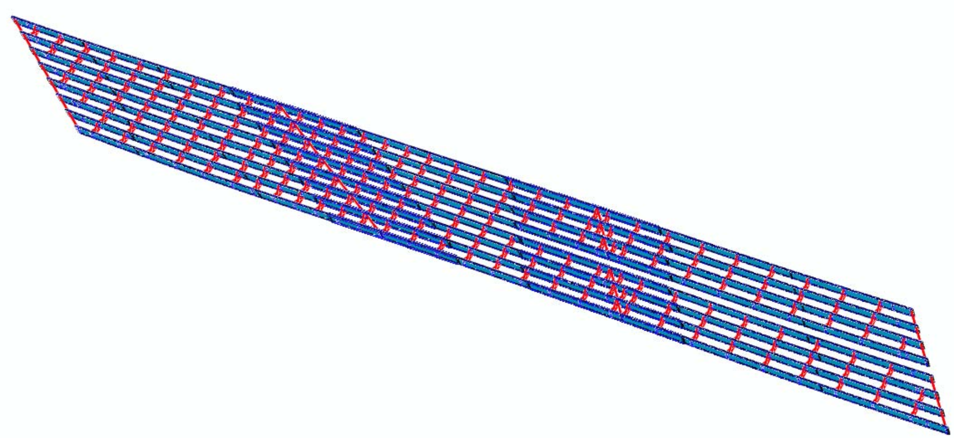
Sub-Stage	Stage 23
19	
20	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

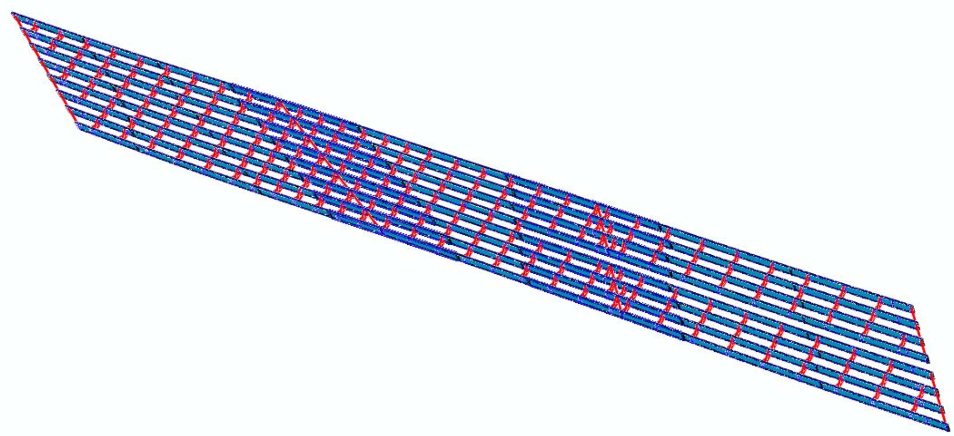
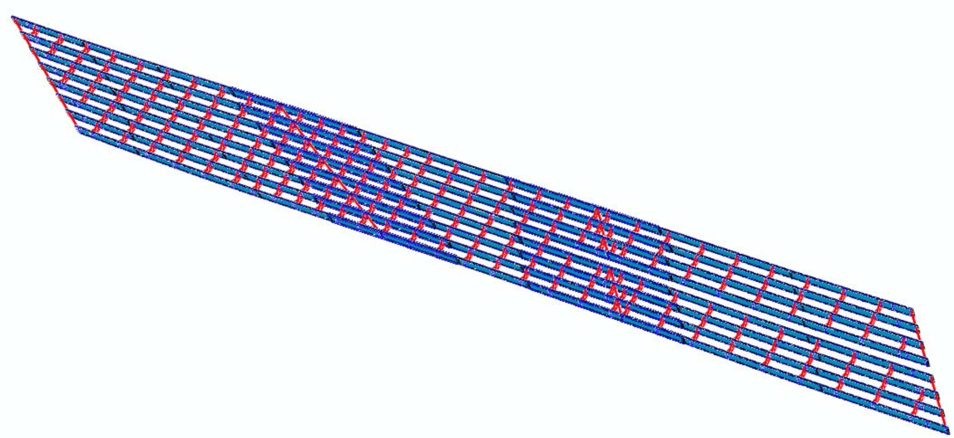
Sub-Stage	Stage
	23
21	
22	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

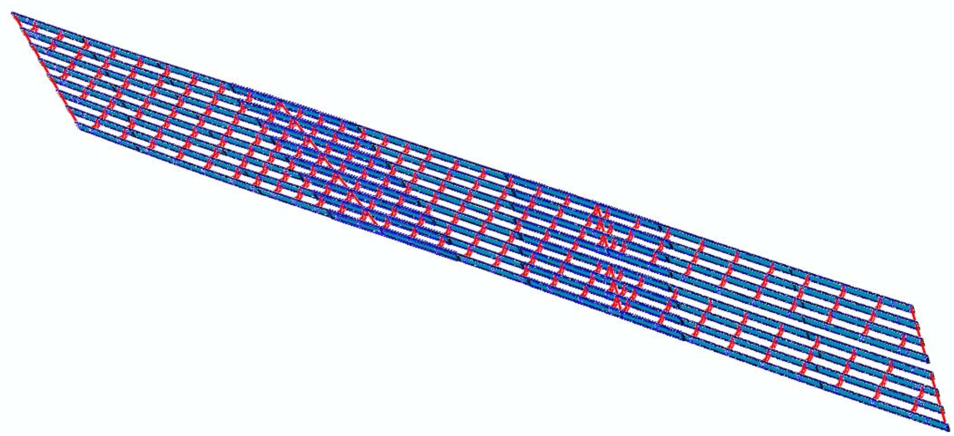
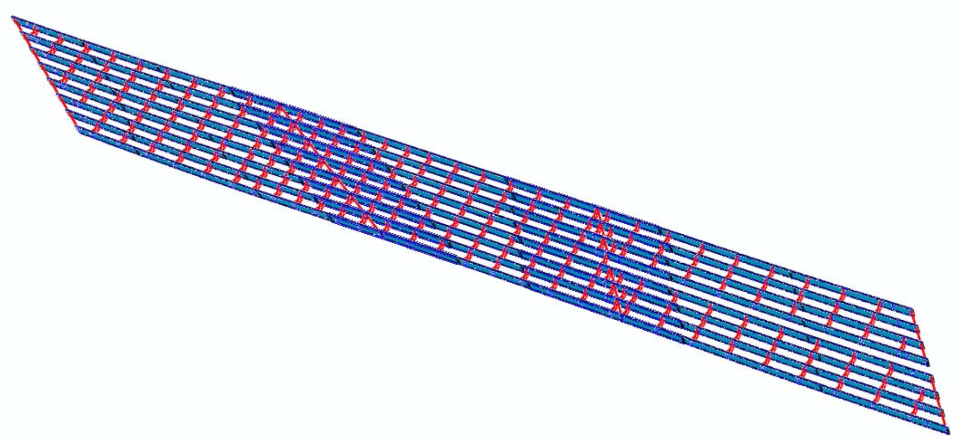
Sub-Stage	Stage
	23
23	
24	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

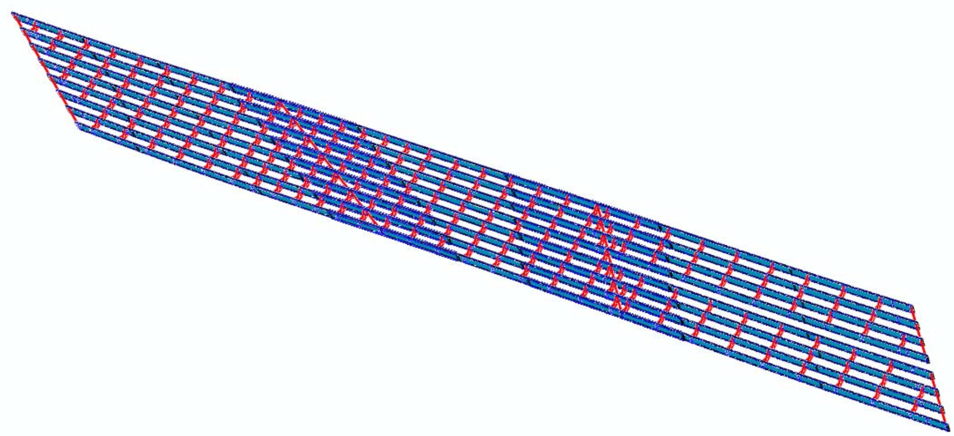
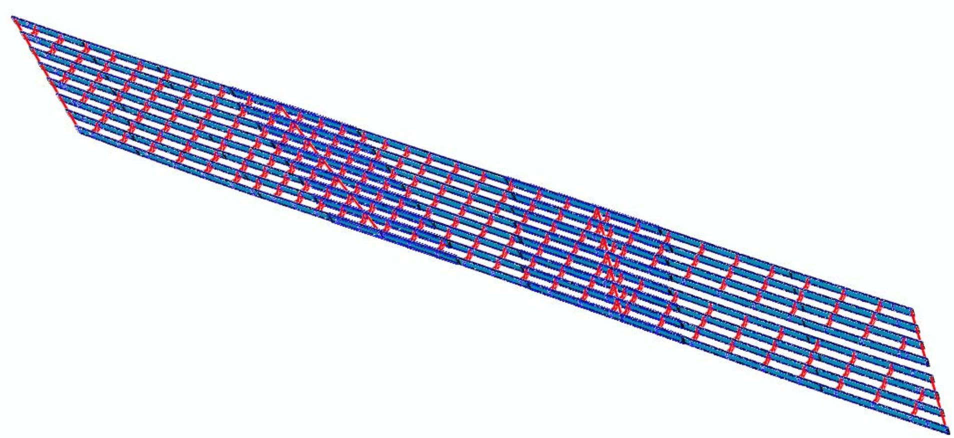
Sub-Stage	Stage 23
25	
26	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

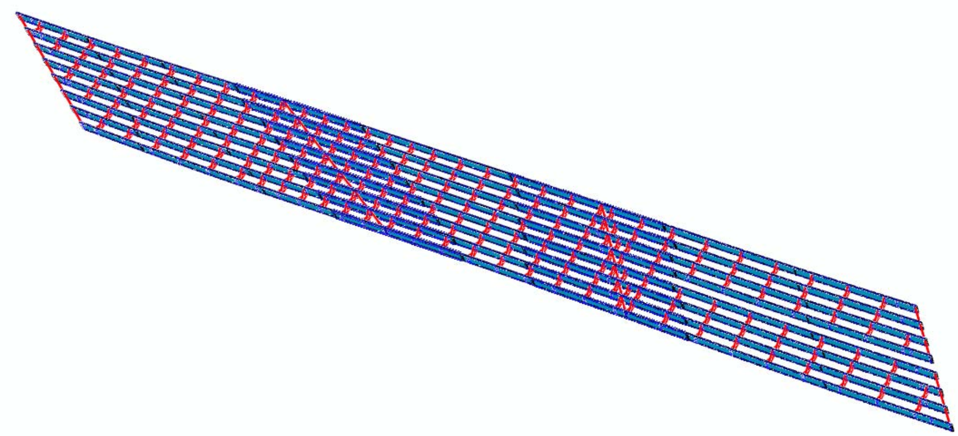
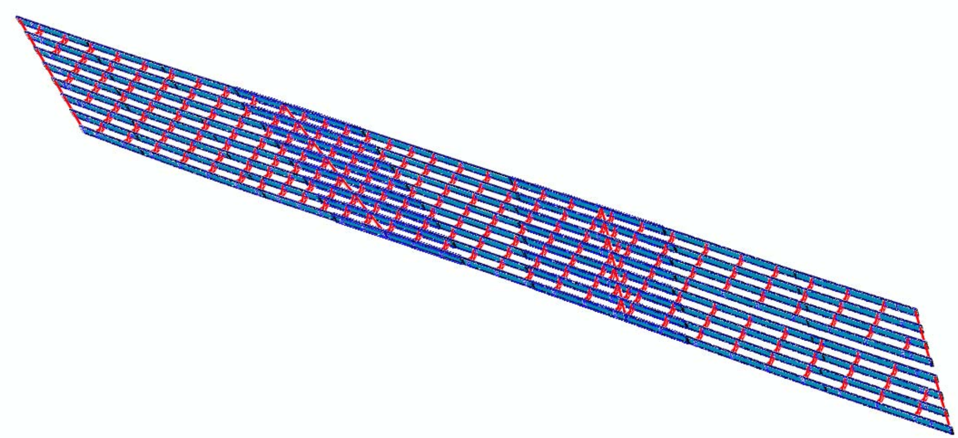
Sub-Stage	Stage 23
27	
28	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

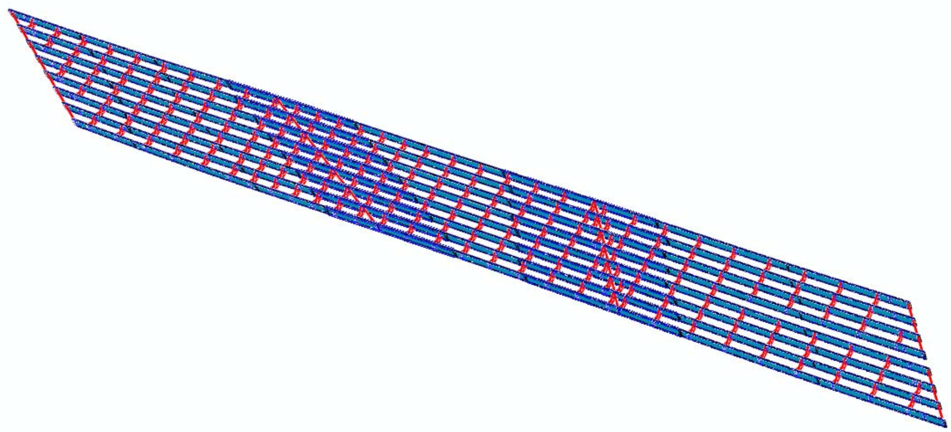
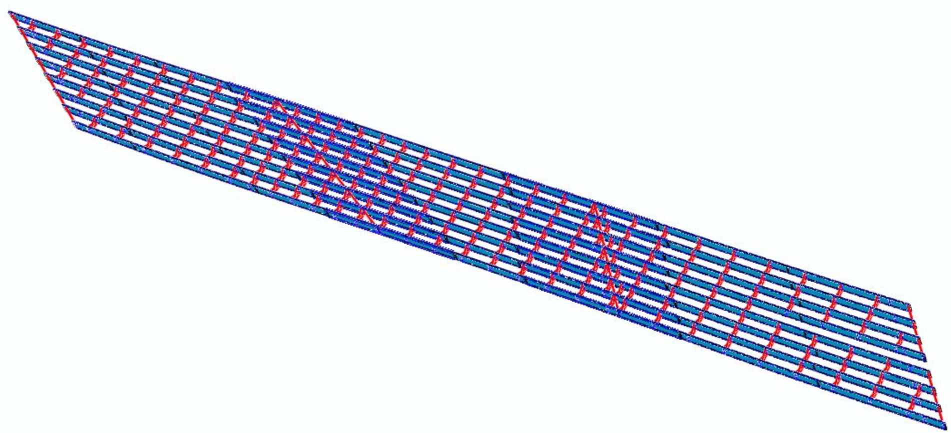
Sub-Stage	Stage 23
29	
30	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

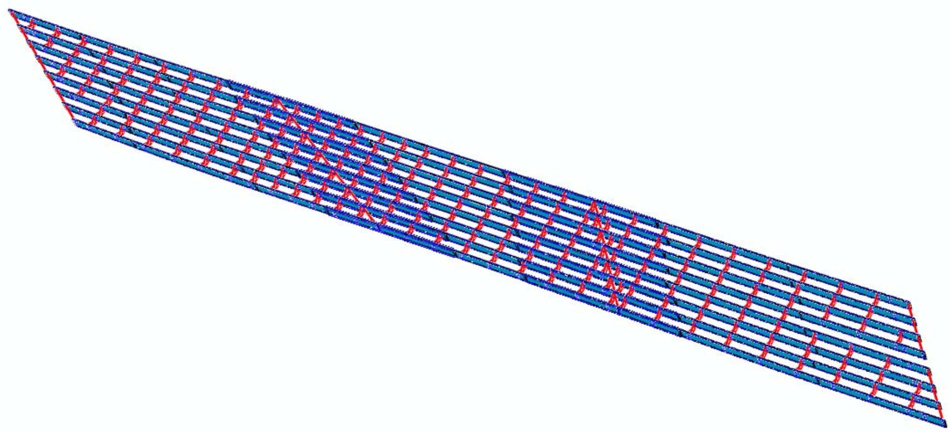
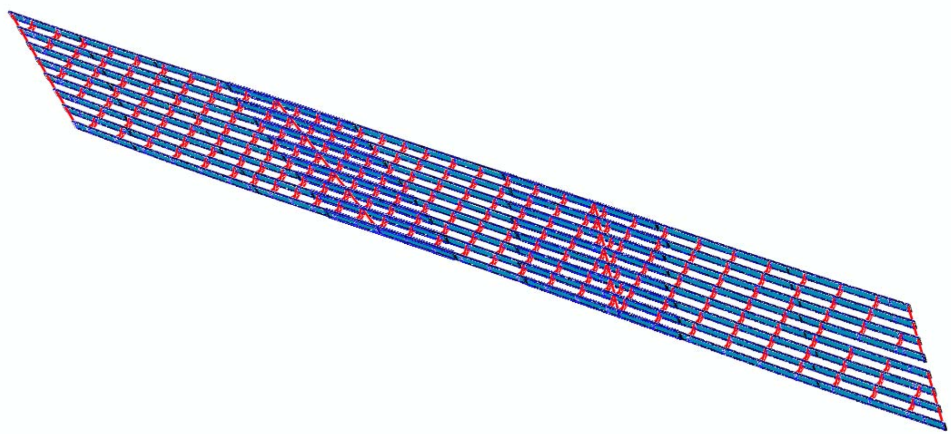
Sub-Stage	Stage
	23
31	
32	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

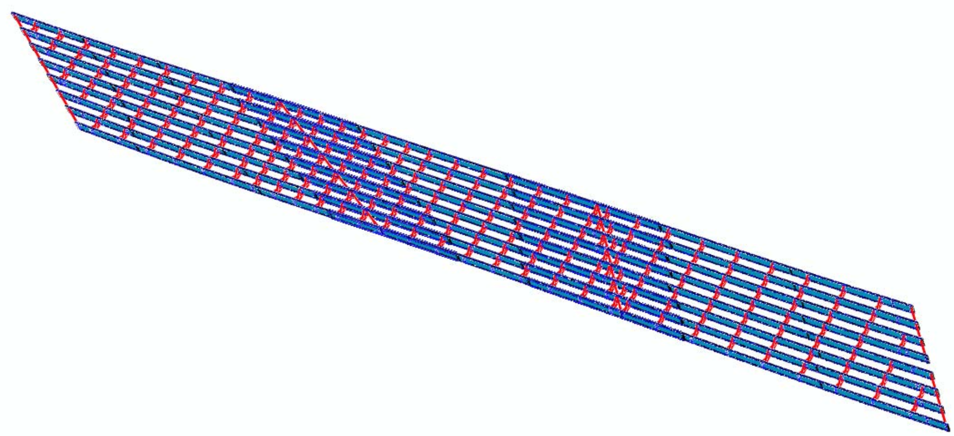
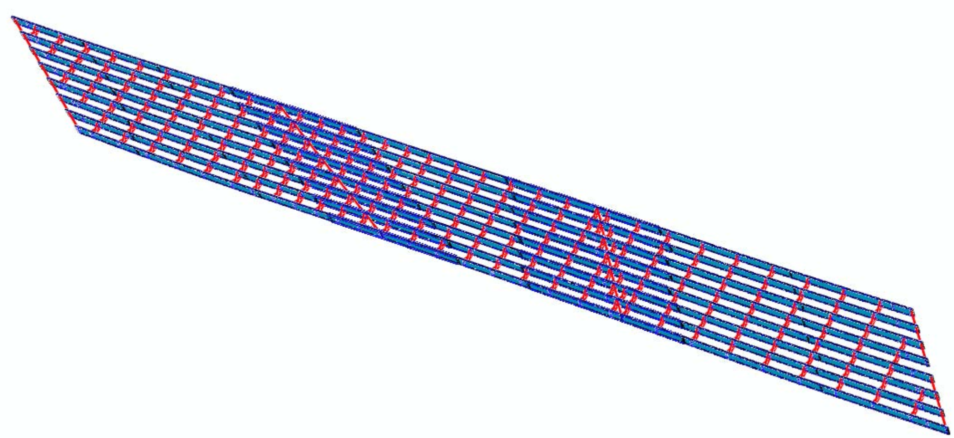
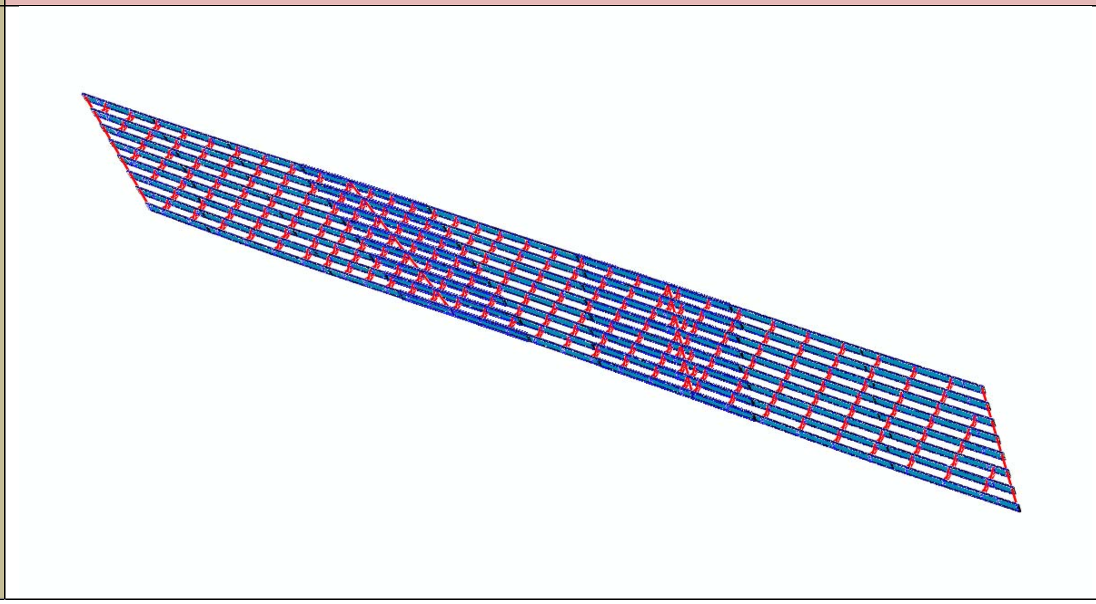
Sub-Stage	Stage
	23
33	
34	

Table M1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed SDLF

Sub-Stage	Stage
	23
35	

Appendix M1-2. EICSS2 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EICSS2 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table M1-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	3.9	12.2
	SDLF	4.1	12.4
	TDLF	4.6	12.8
G2	NLF	3.6	11.0
	SDLF	4.1	11.5
	TDLF	5.1	12.5
G3	NLF	3.3	10.2
	SDLF	3.9	10.7
	TDLF	4.9	11.8
G4	NLF	3.1	9.7
	SDLF	3.6	10.1
	TDLF	4.6	11.1
G5	NLF	3.1	9.4
	SDLF	3.4	9.7
	TDLF	4.0	10.3
G6	NLF	3.1	9.5
	SDLF	3.1	9.5
	TDLF	3.2	9.6
G7	NLF	3.2	9.8
	SDLF	2.9	9.5
	TDLF	2.2	8.9
G8	NLF	3.4	10.6
	SDLF	2.5	9.7
	TDLF	2.2	7.9
All Girders	NLF	3.9	12.2
	SDLF	4.1	12.4
	TDLF	5.1	12.8

Table M1-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.8	2.5
	SDLF	0.0	1.7
	TDLF	1.6	0.1
G2	NLF	0.7	2.1
	SDLF	0.0	1.4
	TDLF	1.4	0.0
G3	NLF	0.6	2.0
	SDLF	0.0	1.3
	TDLF	1.3	0.0
G4	NLF	0.6	1.9
	SDLF	0.0	1.2
	TDLF	1.3	0.0
G5	NLF	0.6	1.8
	SDLF	0.0	1.2
	TDLF	1.2	0.0
G6	NLF	0.6	2.0
	SDLF	0.0	1.3
	TDLF	1.3	0.0
G7	NLF	0.7	2.1
	SDLF	0.0	1.4
	TDLF	1.4	0.0
G8	NLF	0.7	2.1
	SDLF	0.0	1.4
	TDLF	1.4	0.1
All Girders	NLF	0.8	2.5
	SDLF	0.0	1.7
	TDLF	1.6	0.1

Table M1-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	6.9	21.2	7.7	23.7	0.3	0.8	0.9	2.6
	SDLF	6.6	20.9	7.4	23.3	0.0	0.7	0.0	1.7
	TDLF	7.8	20.6	7.6	22.9	0.6	0.6	1.9	1.0
G2	NLF	6.2	19.0	6.9	21.2	0.4	1.2	0.5	1.5
	SDLF	6.8	19.6	7.6	21.9	0.0	0.8	0.0	1.0
	TDLF	7.9	20.7	8.8	23.2	0.8	0.1	1.0	0.1
G3	NLF	5.6	17.2	6.3	19.4	0.4	1.3	0.6	1.7
	SDLF	6.6	18.2	7.3	20.3	0.0	0.8	0.0	1.1
	TDLF	8.4	20.0	9.5	22.3	0.8	0.1	1.1	0.1
G4	NLF	5.5	16.7	6.1	18.9	0.4	1.3	0.6	1.8
	SDLF	6.3	17.6	7.1	19.6	0.0	0.8	0.0	1.2
	TDLF	8.0	19.3	9.1	21.5	0.8	0.1	1.2	0.1
G5	NLF	5.6	17.0	6.1	18.8	0.4	1.2	0.7	1.9
	SDLF	6.1	17.5	6.8	19.4	0.0	0.8	0.0	1.3
	TDLF	7.3	18.6	8.3	20.8	0.8	0.1	1.3	0.1
G6	NLF	5.7	17.2	6.3	19.2	0.4	1.1	0.7	2.1
	SDLF	6.1	17.4	6.5	19.4	0.0	0.7	0.0	1.3
	TDLF	6.9	17.9	7.1	20.0	0.7	0.1	1.4	0.1
G7	NLF	6.0	18.3	6.6	20.4	0.6	2.0	0.8	2.6
	SDLF	6.3	17.9	6.2	20.0	0.0	1.4	0.0	1.8
	TDLF	6.8	18.0	6.6	19.2	1.3	0.1	1.6	0.2
G8	NLF	6.5	20.0	7.2	22.3	0.3	1.2	0.8	2.2
	SDLF	6.0	18.6	5.8	20.7	0.0	0.8	0.0	1.5
	TDLF	6.6	17.9	6.4	17.7	0.6	0.5	1.5	0.9
All Girders	NLF	6.9	21.2	7.7	23.7	0.6	2.0	0.9	2.6
	SDLF	6.8	20.9	7.6	23.3	0.0	1.4	0.0	1.8
	TDLF	8.4	20.7	9.5	23.2	1.3	0.6	1.9	1.0

Table M1-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	42.1	4.5	17.0	42.1
	SDLF	0.5	0.6	0.1	0.6
	TDLF	80.0	9.2	33.0	80.0
TDL	NLF	122.7	16.5	50.1	122.7
	SDLF	80.5	12.1	33.2	80.5
	TDLF	4.7	5.4	2.1	5.4

Table M1-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	5.4	1.7	2.6	4.4
	SDLF	0.0	0.1	0.0	0.0
	TDLF	10.6	3.3	5.2	8.7
TDL	NLF	16.0	6.0	7.7	13.1
	SDLF	10.7	4.6	5.1	8.8
	TDLF	1.9	1.7	0.9	1.6

Table M1-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	All Girders
NLF	0.68	0.66	0.62	0.66	0.64	0.72	0.77	0.77
SDLF	0.85	0.80	0.78	0.76	0.73	0.66	0.75	0.85
TDLF	1.38	1.03	1.06	1.11	1.17	1.25	1.78	1.78

Table M1-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	All Girders
NLF	2.12	2.05	1.92	2.04	1.98	2.23	2.39	2.39
SDLF	2.17	2.19	2.08	2.09	1.91	2.11	2.18	2.19
TDLF	2.55	2.43	2.36	2.30	2.20	2.04	2.14	2.55

Table M1-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	All Girders
NLF	0.52	0.51	0.48	0.51	0.49	0.55	0.59	0.59
SDLF	0.66	0.62	0.60	0.59	0.56	0.51	0.58	0.66
TDLF	1.07	0.80	0.82	0.86	0.91	0.97	1.37	1.37

Table M1-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	All Girders
NLF	1.64	1.58	1.48	1.57	1.53	1.72	1.85	1.85
SDLF	1.67	1.69	1.61	1.61	1.47	1.63	1.68	1.69
TDLF	1.97	1.87	1.82	1.77	1.70	1.58	1.65	1.97

Table M1-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	3318.4	9325.8
SDLF	3318.4	9325.8
TDLF	3318.4	9325.8

Table M1-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	217.9	594.9	0.3	1.1	0.6	1.1
SDLF	180.4	549.6	0.1	0.8	0.0	0.8
TDLF	297.5	482.3	0.7	0.2	1.2	0.2

Table M1-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.32	1.01	0.06	0.18
SDLF	0.35	1.04	0.00	0.12
TDLF	0.42	1.10	0.12	0.01

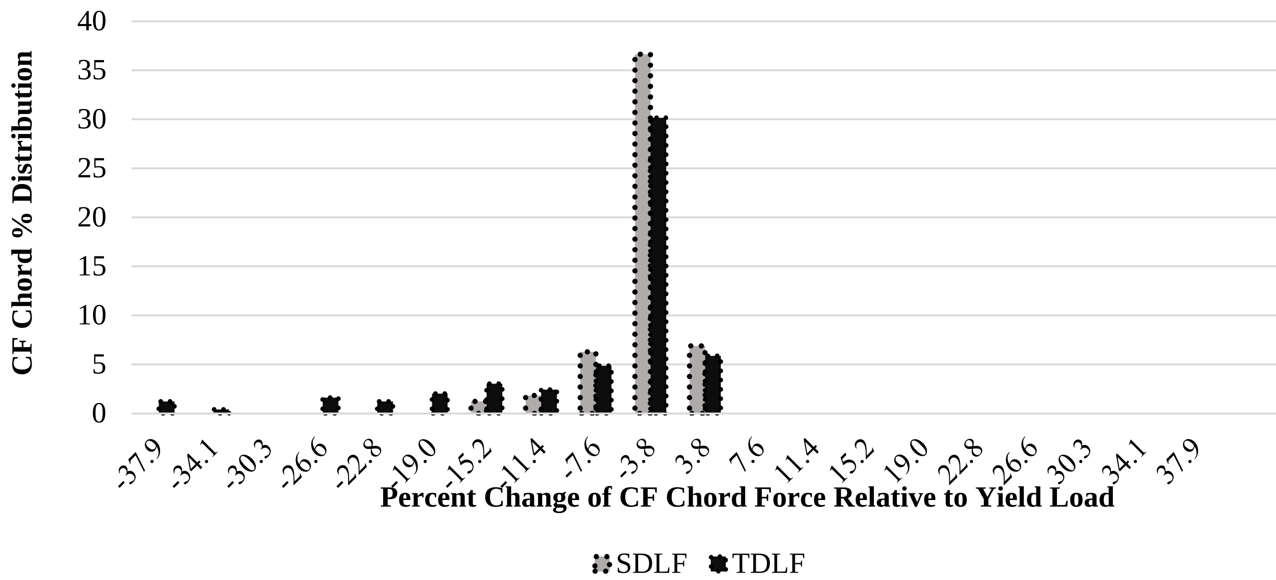


Figure M1-2-1. **Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.**

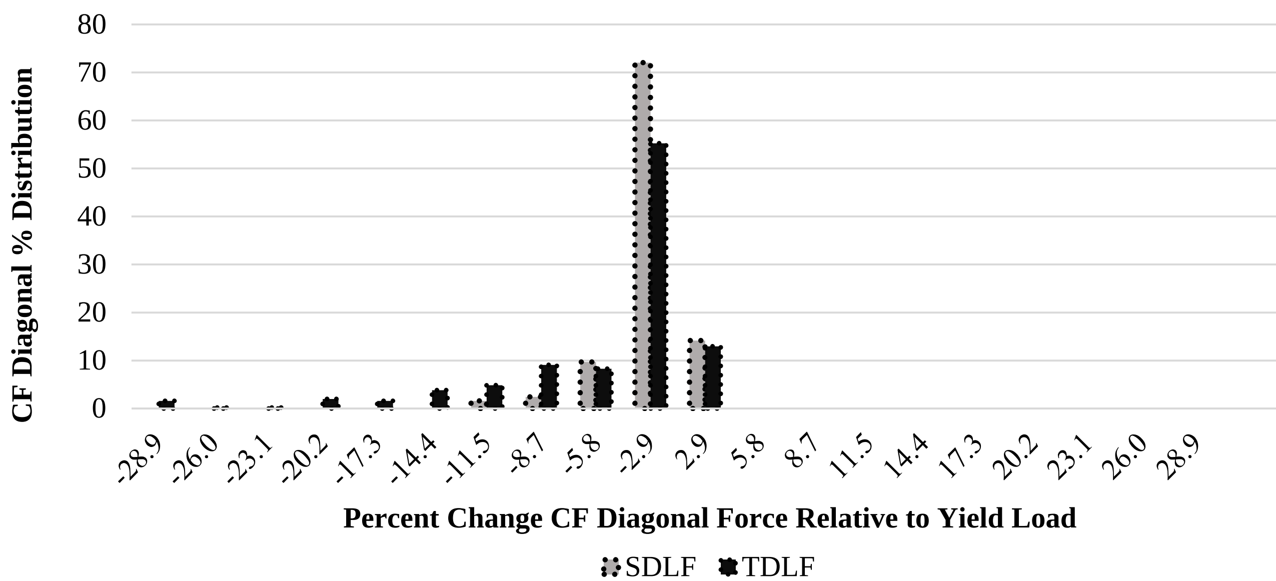
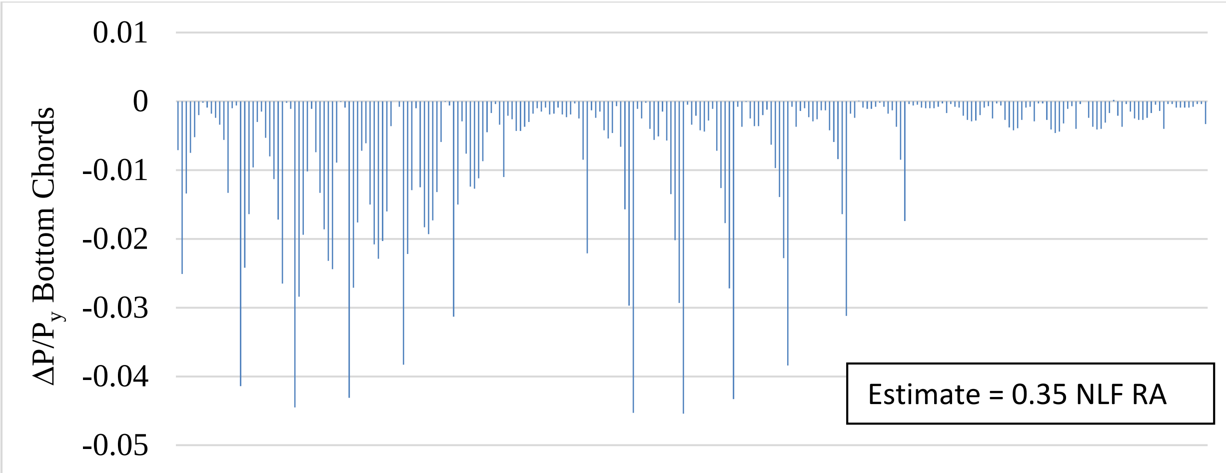


Figure M1-2-2. **Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.**



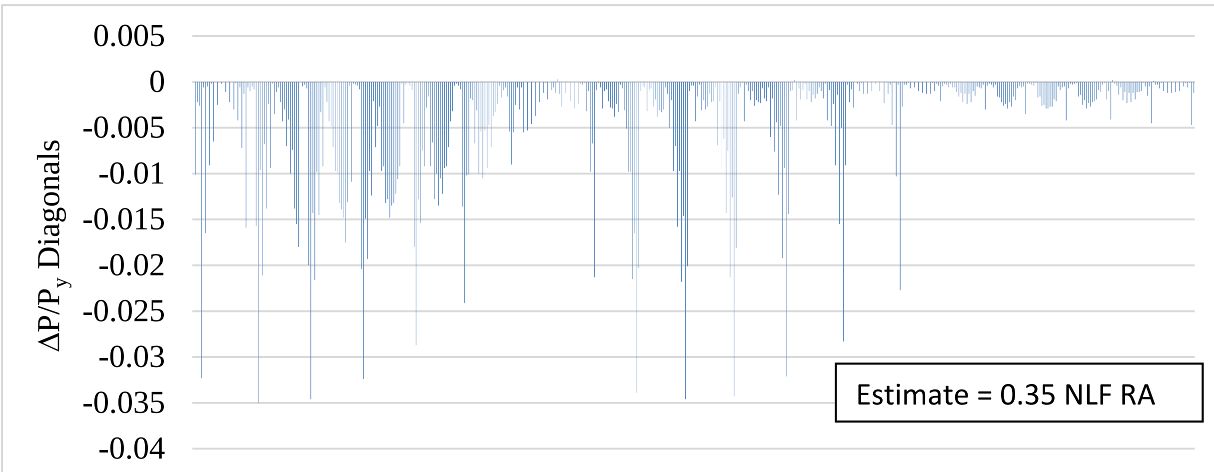


Figure M1-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

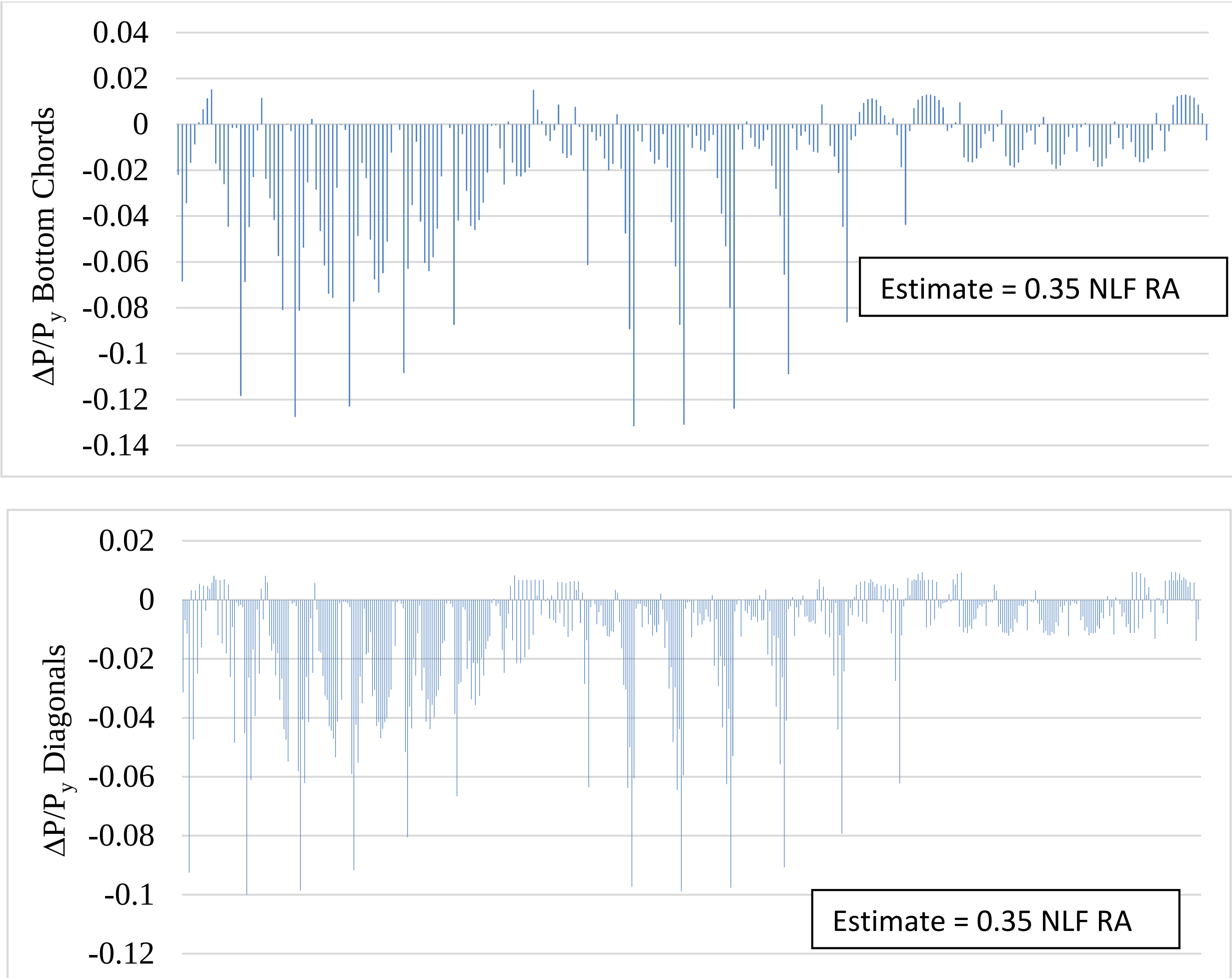


Figure M1-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix M1-3. EICSS2 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EICSS2 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table M1-3-1A. Maximums of the fit-up force resultants (kips) (main-bridge fit-up)

Detailing Method	F1	F2	F_{max}
SDLF	0.1	4.9	4.9
TDLF	2.2	46.9	46.9

Table M1-3-1B. Maximums of the fit-up force resultants (kips) (closure fit-up)

Detailing Method	F1	F2	F_{max}
SDLF	18.3	86.1	86.1
TDLF	0.5	6.2	6.2

Table M1-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G5	SDLF	178	43
	TDLF	261	44
G6	SDLF	176	44
	TDLF	166	44
G7	SDLF	204	42
	TDLF	210	42
G8	SDLF	173	39
	TDLF	243	39
All Girders	SDLF	204	39
	TDLF	261	39

Table M3-2-3. Total Vertical Reactions (kips)

Stage	Detailing Method	Sub-Stage									
		1	2	3	4	5	6	7	8	9	10
7	SDLF	1074	1075	1076	NA	NA	NA	NA	NA	NA	NA
	TDLF	1074	1075	1076	NA	NA	NA	NA	NA	NA	NA
12	SDLF	1605	1606	1606	1608	NA	NA	NA	NA	NA	NA
	TDLF	1605	1606	1606	1608	NA	NA	NA	NA	NA	NA
17	SDLF	1638	1638	1639	1640	1641	1642	1643	1644	1645	1646
	TDLF	1638	1638	1639	1640	1641	1642	1643	1644	1645	1646
21	SDLF	1669	1670	1671	1672	1673	1674	NA	NA	NA	NA
	TDLF	1669	1670	1671	1672	1673	1674	NA	NA	NA	NA

Appendix M1-4. EICSS2 Detailed Results, Completed Bridge Responses

This appendix presents the SDL and TDL responses of the bridge EICSS2 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

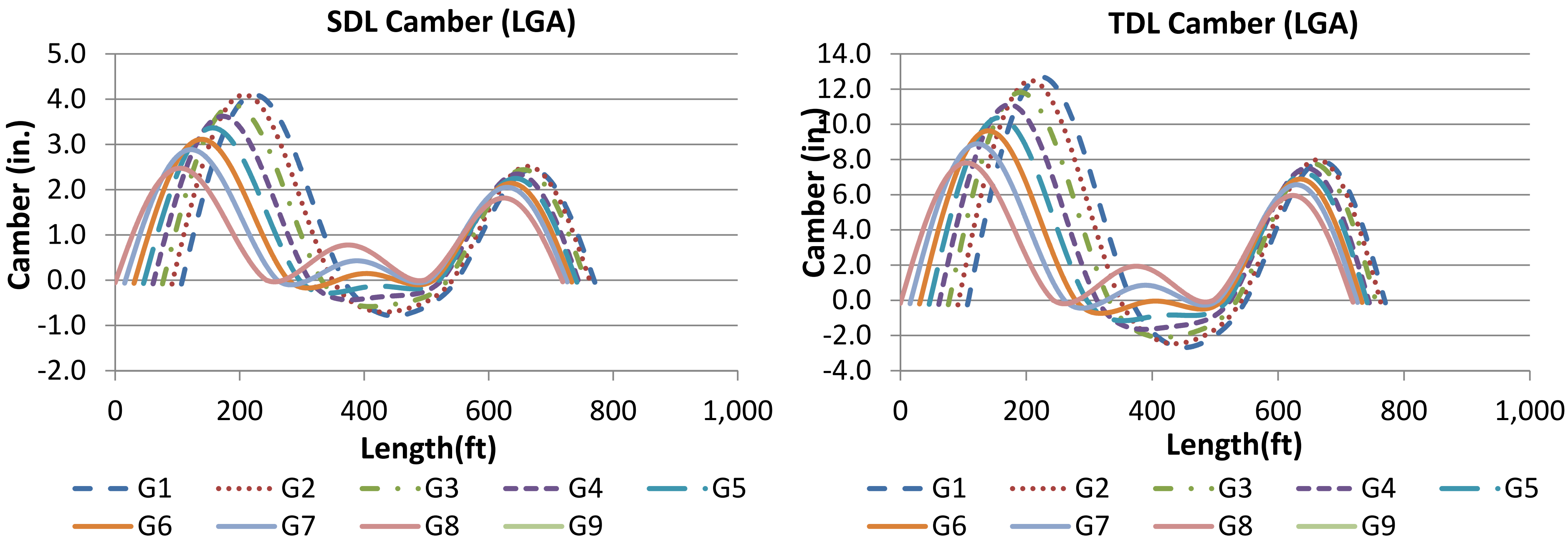


Figure M1-4-1. SDL and TDL Line Girder Analysis cambers.

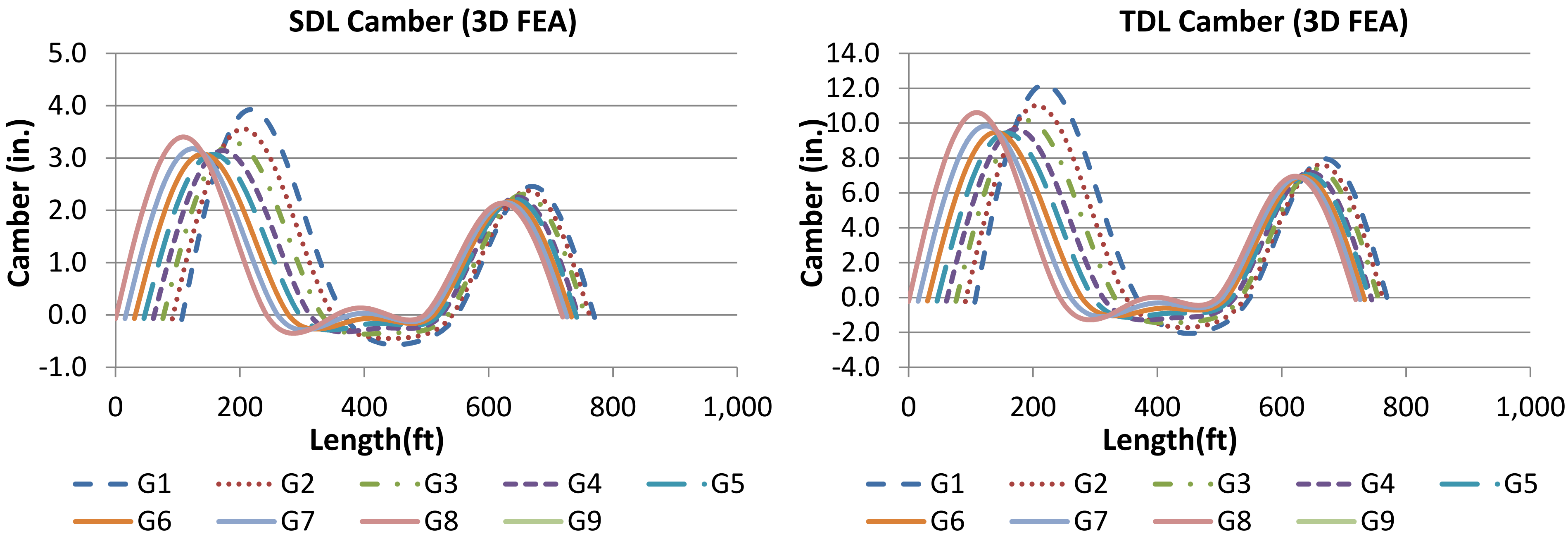


Figure M1-4-2. SDL and TDL 3D FEA cambers.

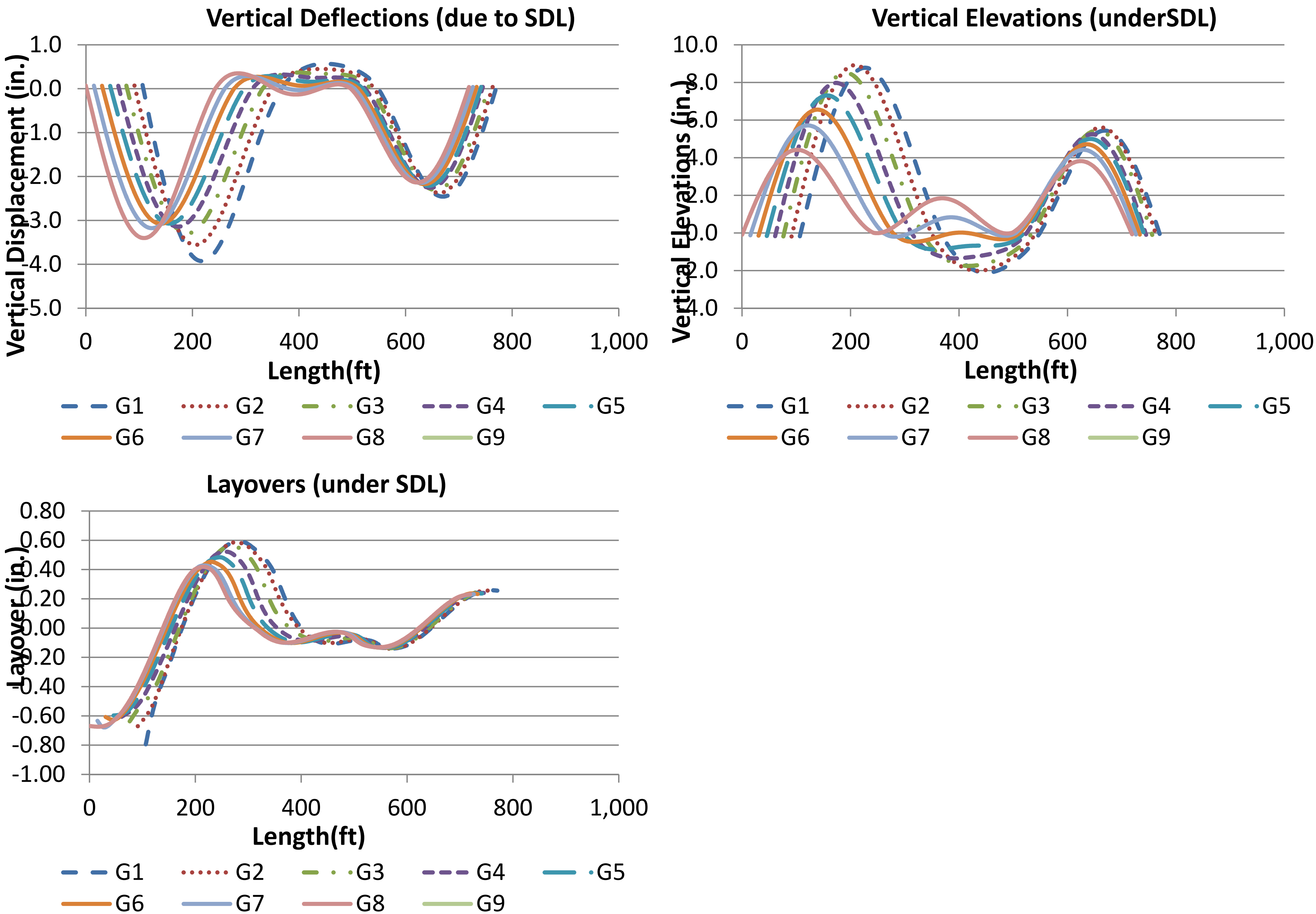


Figure M1-4-3. **Bridge displacements and elevation profiles (in) under SDL, NLF detailing.**

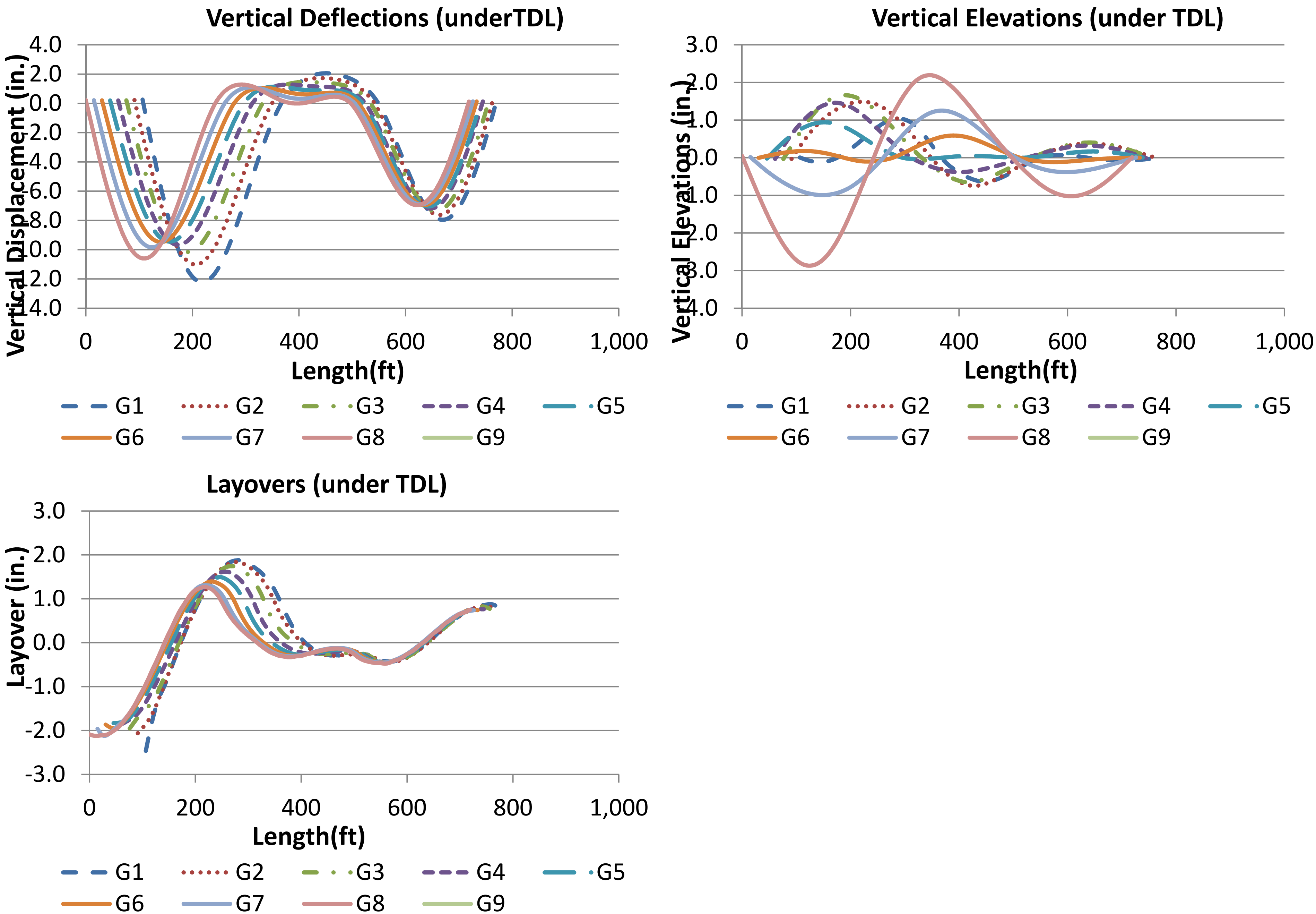


Figure M1-4-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

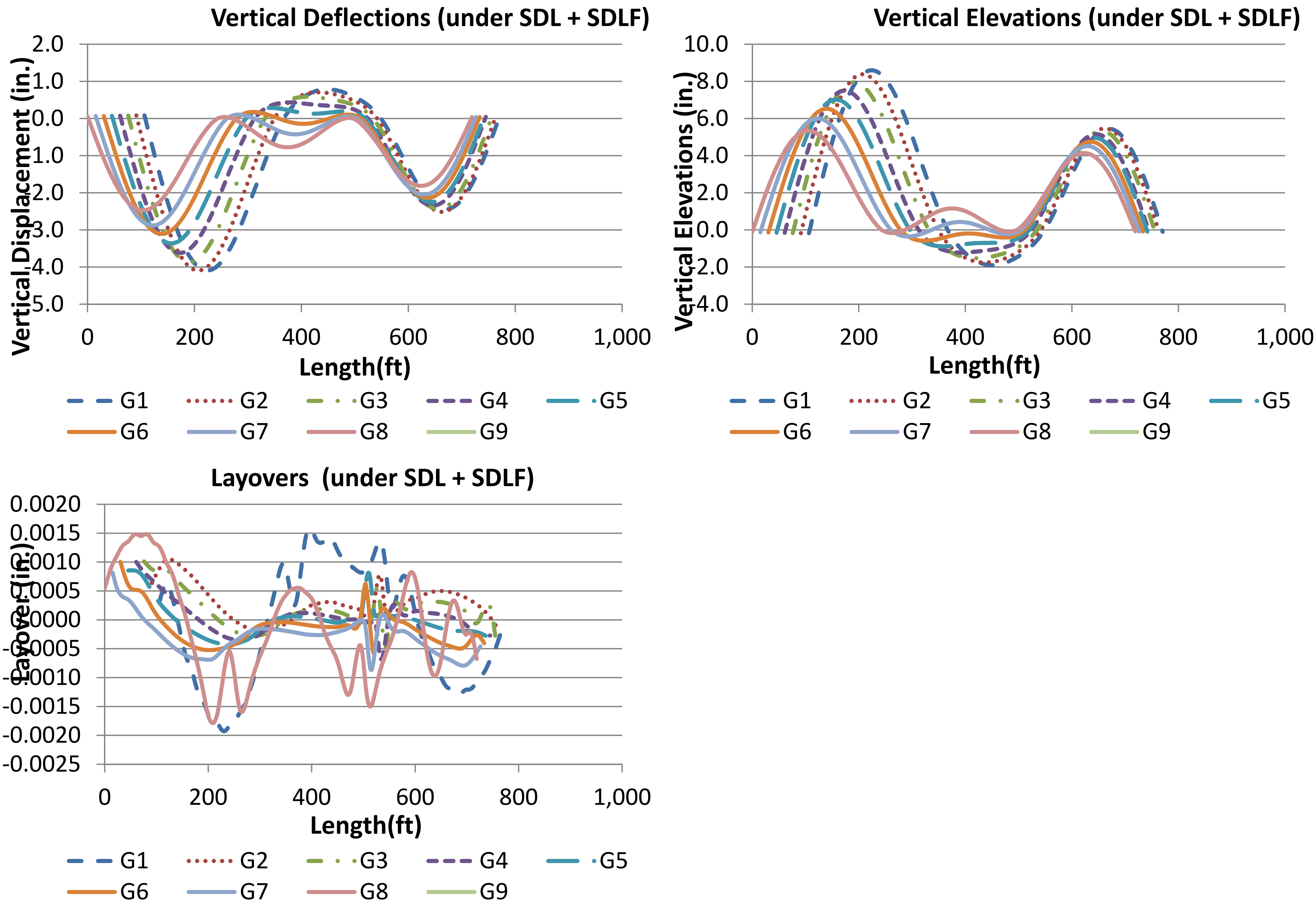


Figure M1-4-5. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

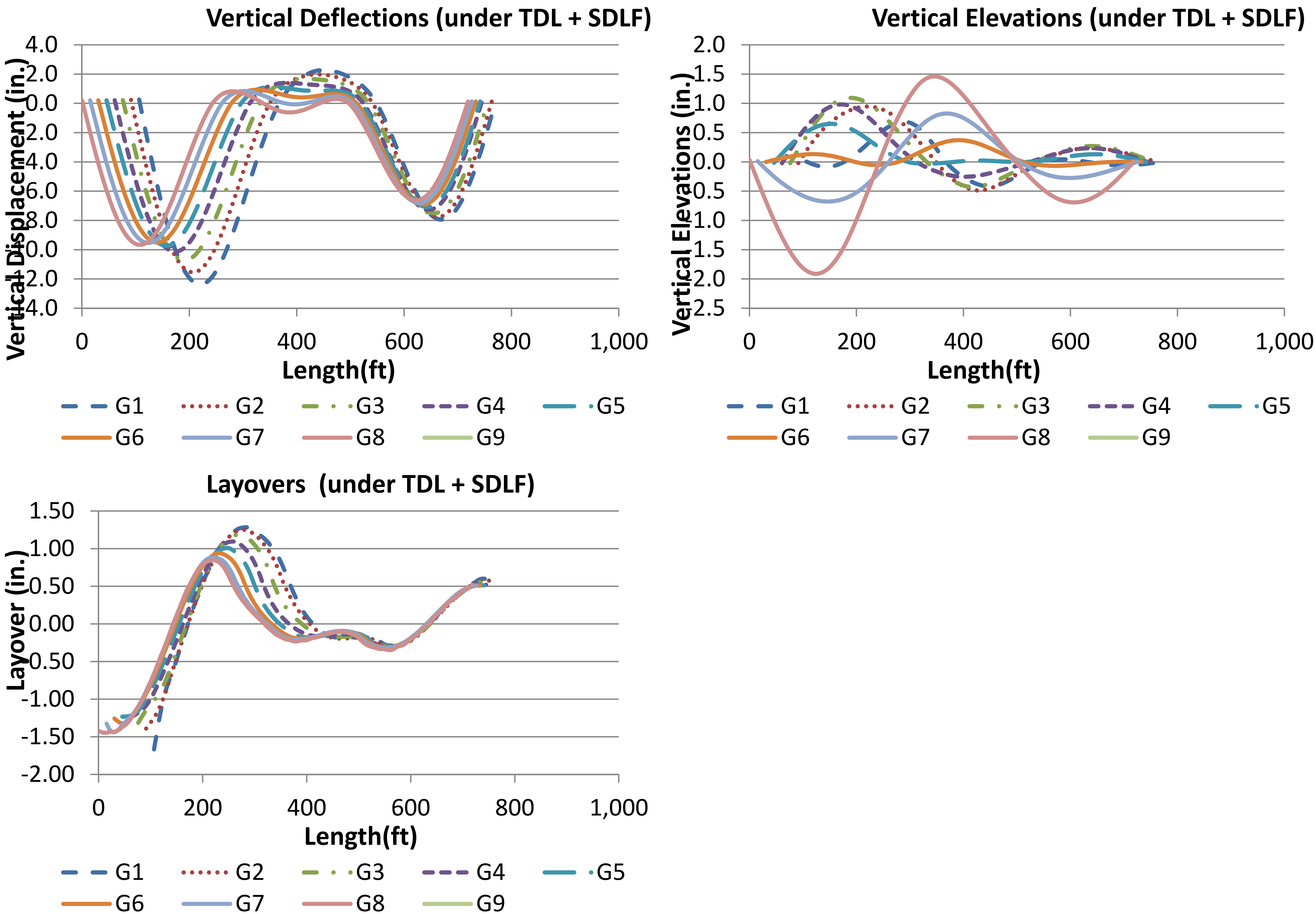
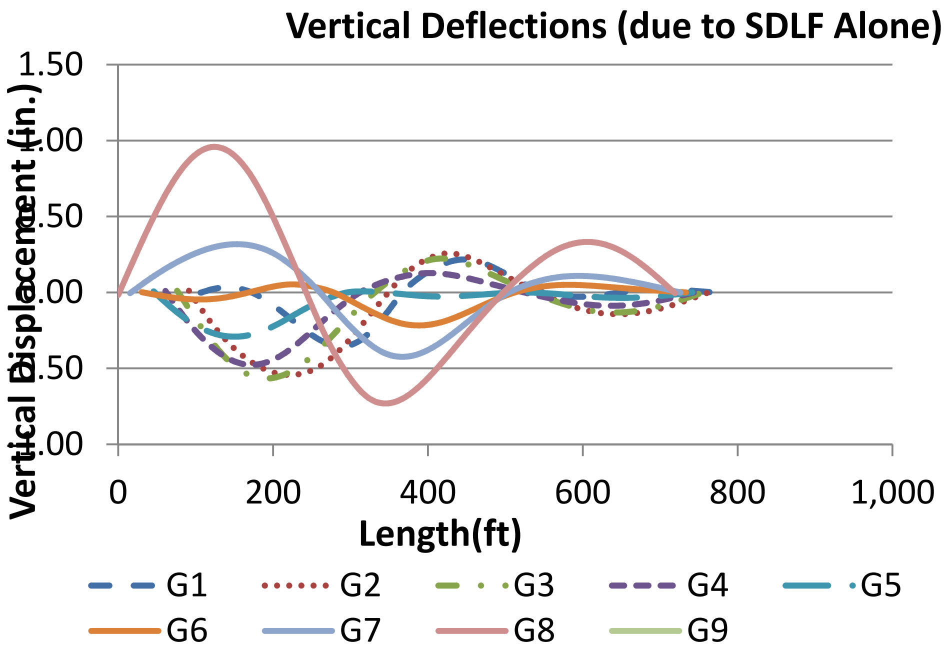


Figure M1-4-6. **Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.**



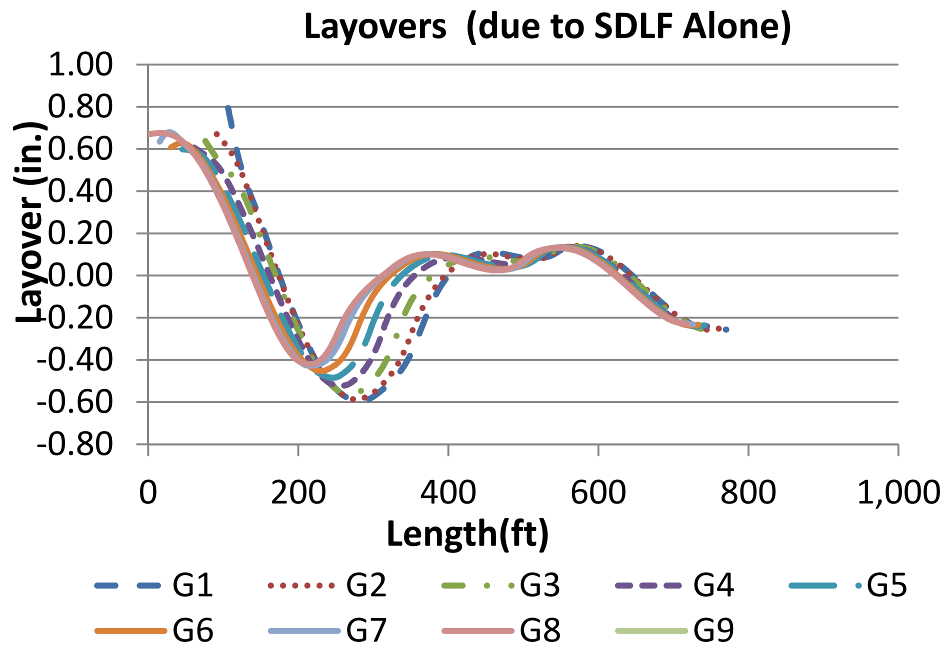
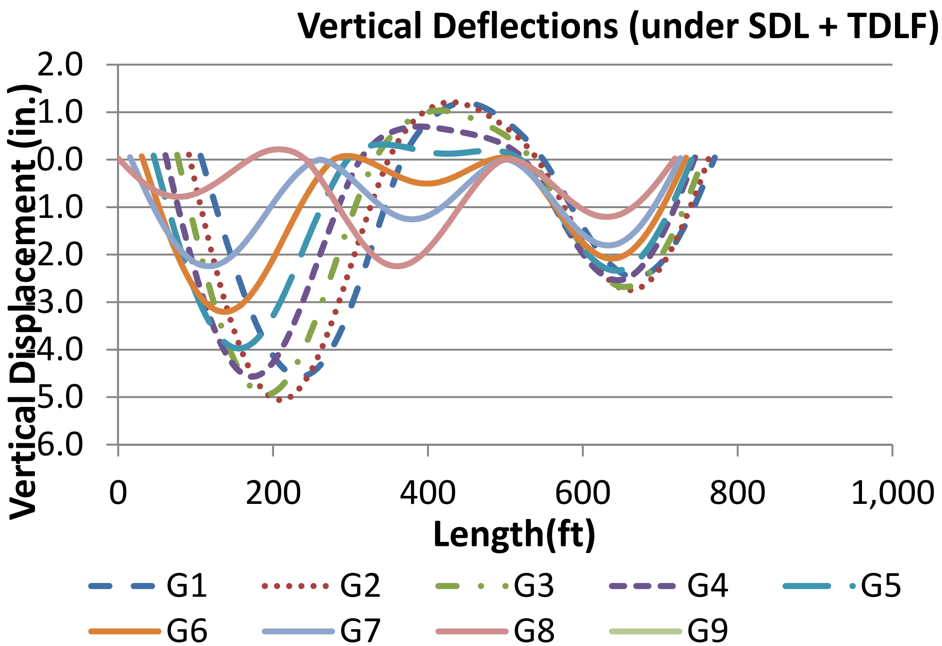
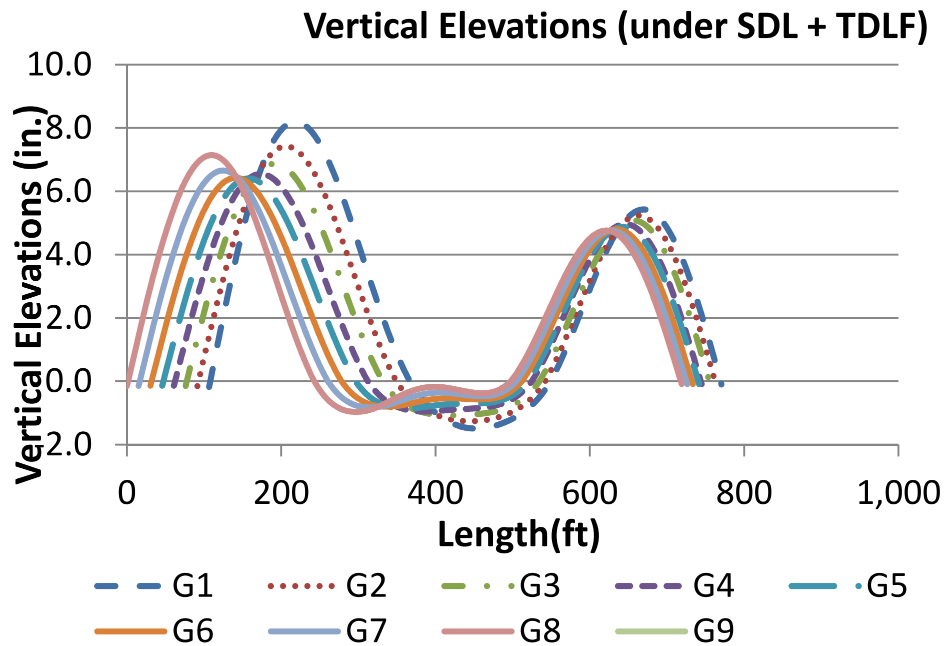


Figure M1-4-7. Bridge displacements due to SDLF detailing effects alone under NL(in).





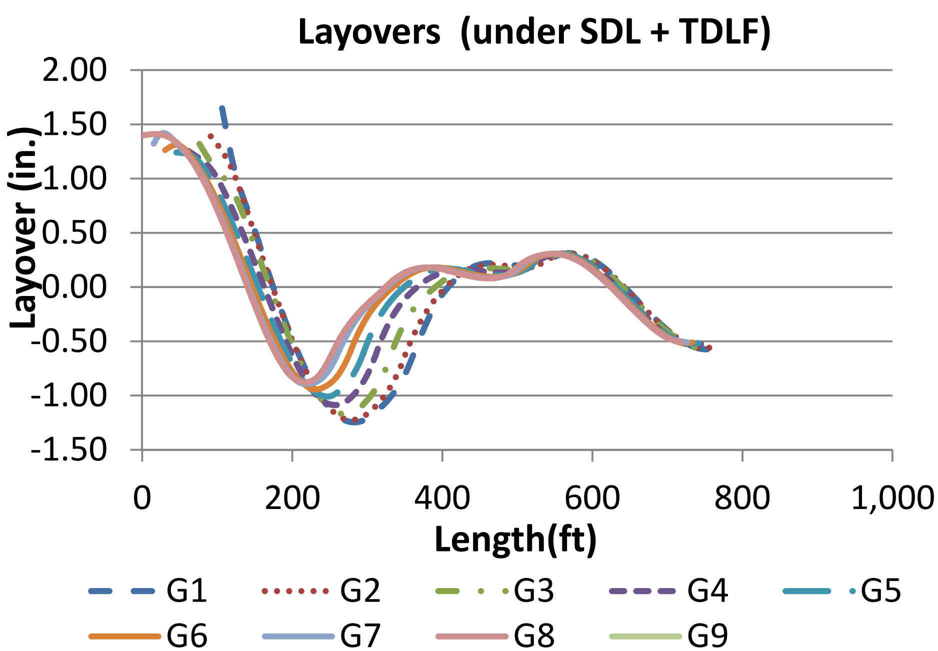


Figure M1-4-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

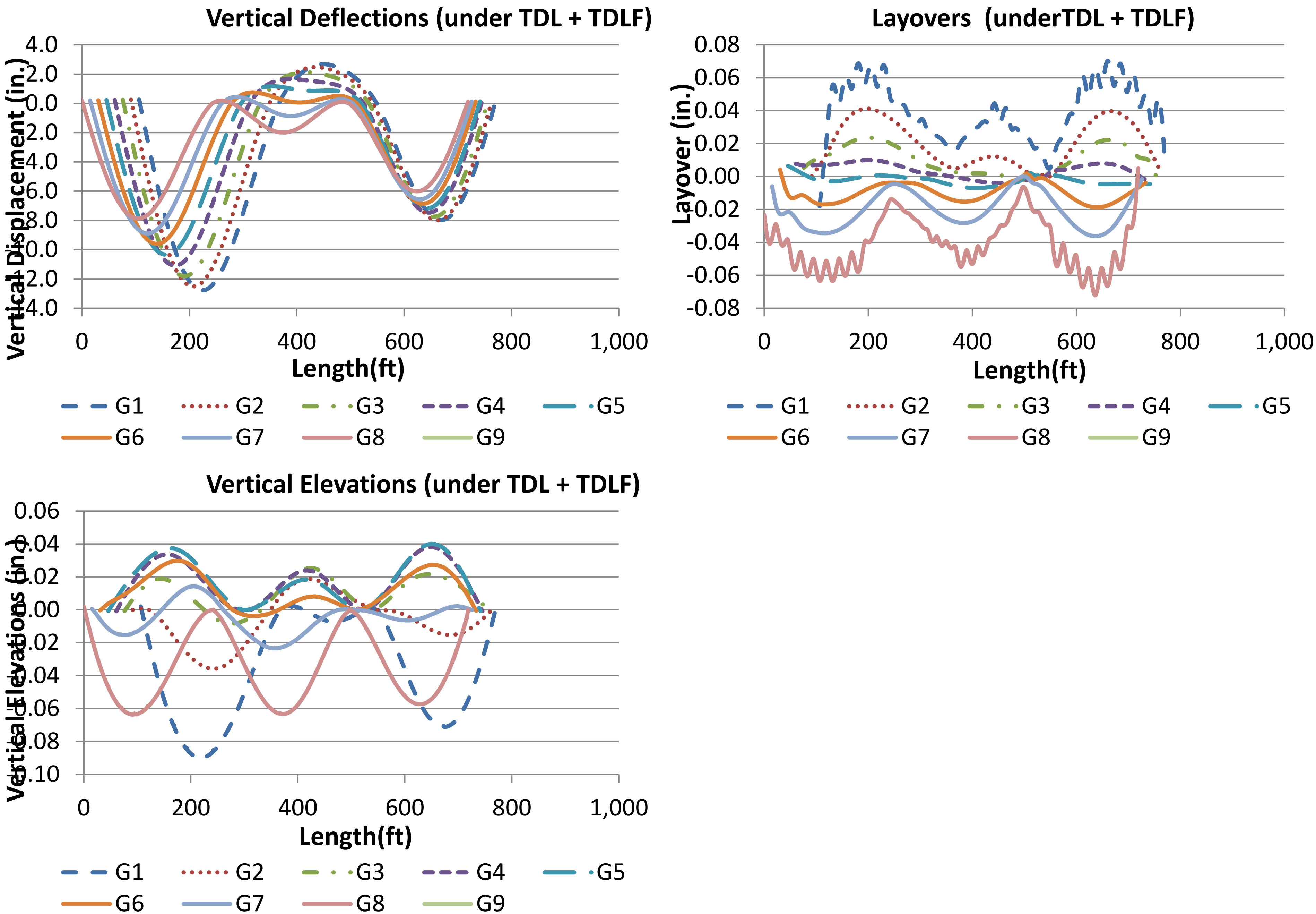


Figure M1-4-9. **Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.**

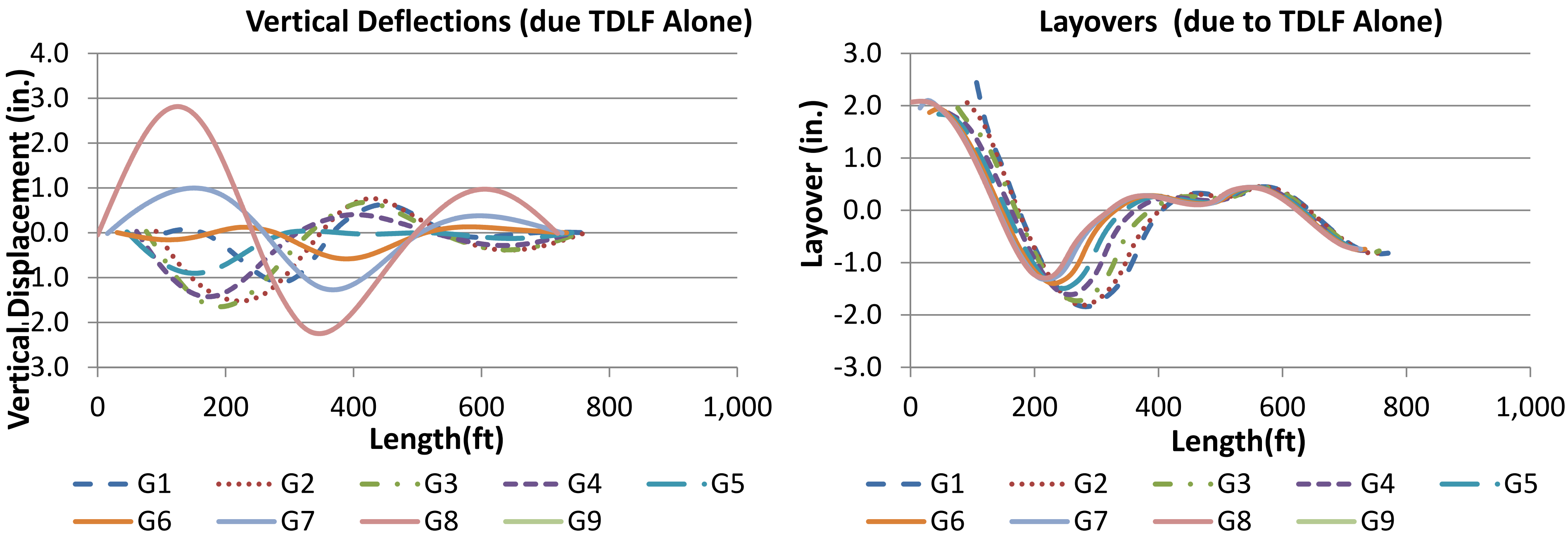


Figure M1-4-10. Bridge displacements due to TDLF detailing effects alone under NL (in).

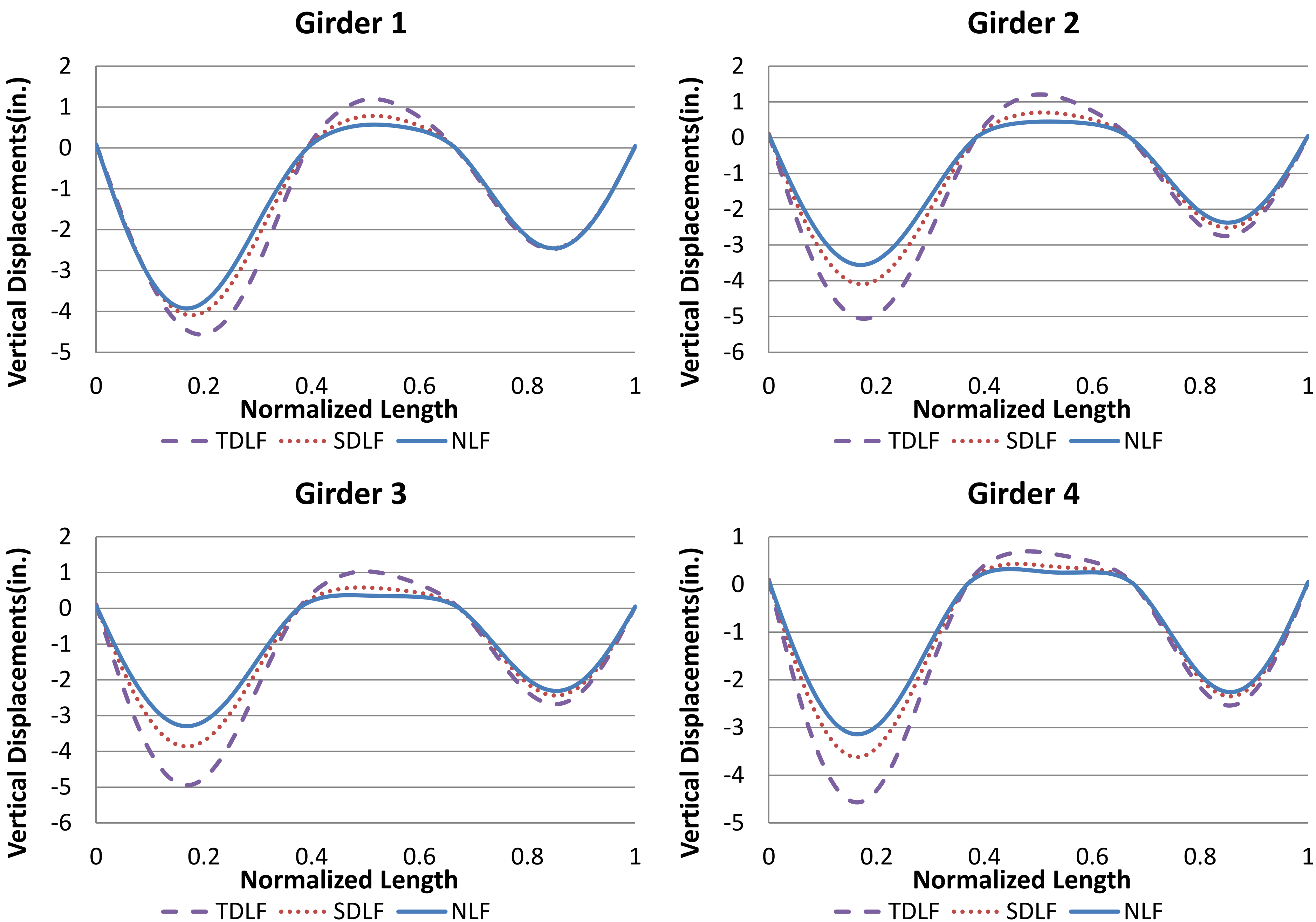


Figure M1-4-11. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

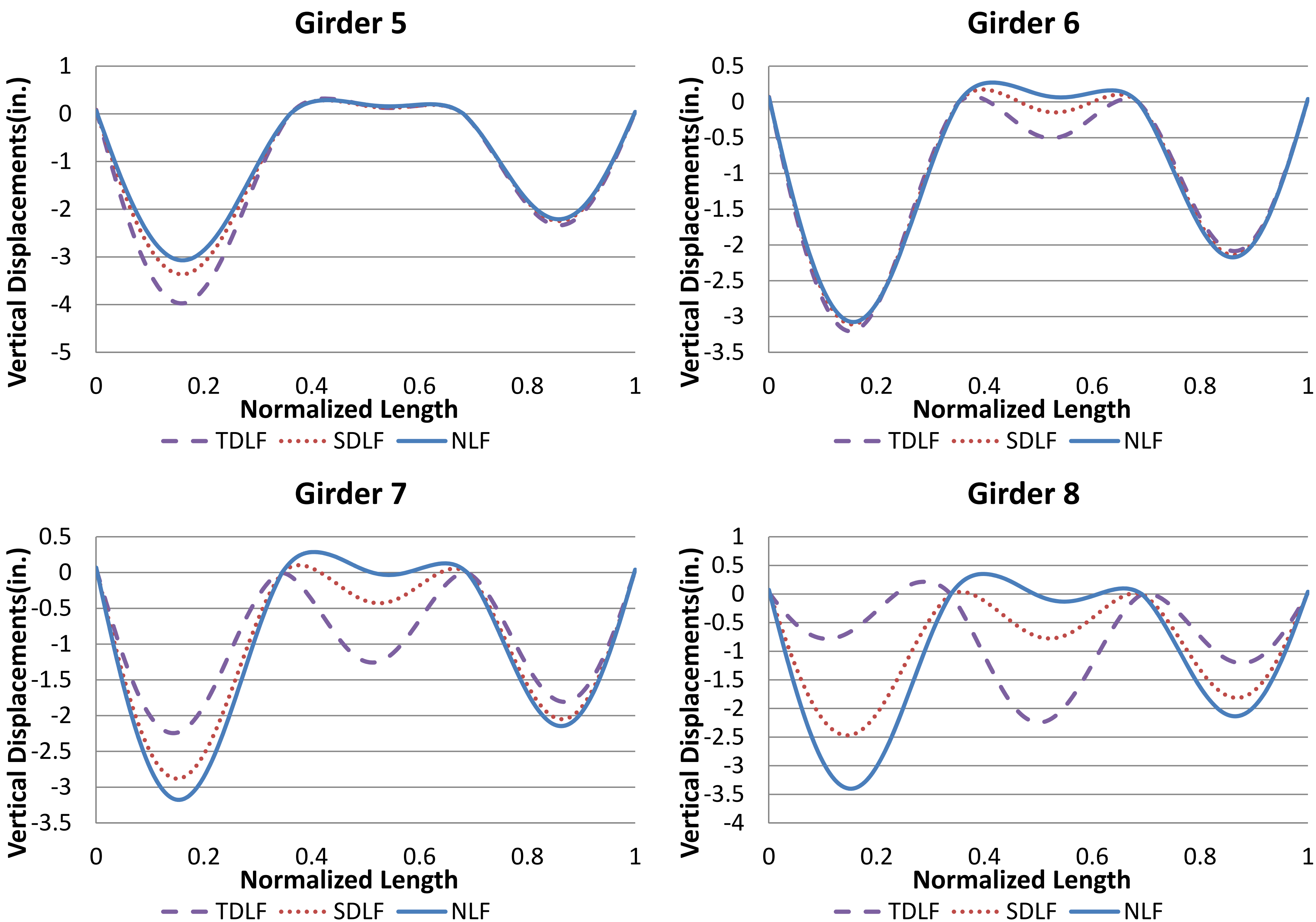


Figure M1-4-11 (Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

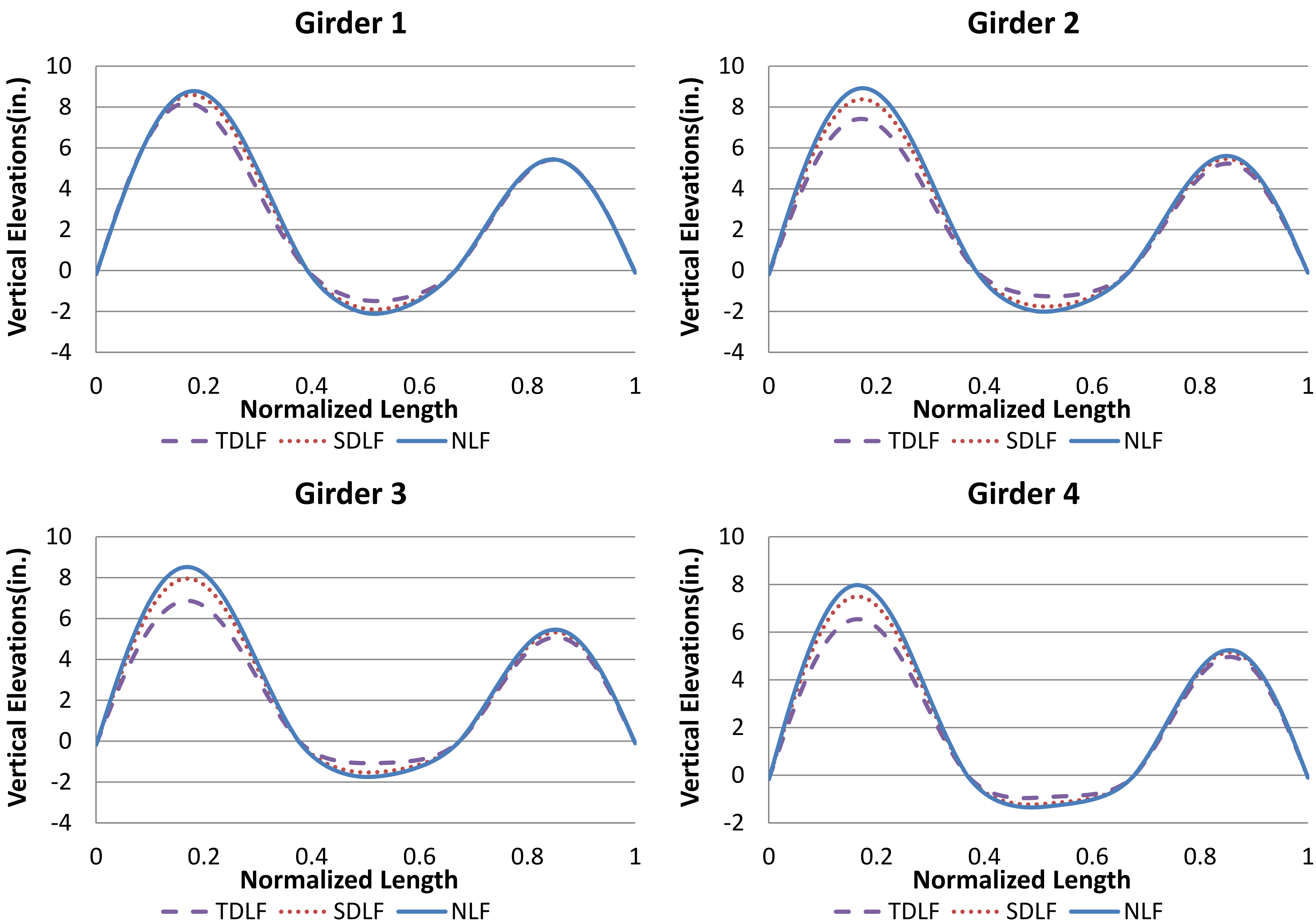


Figure M1-4-12. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

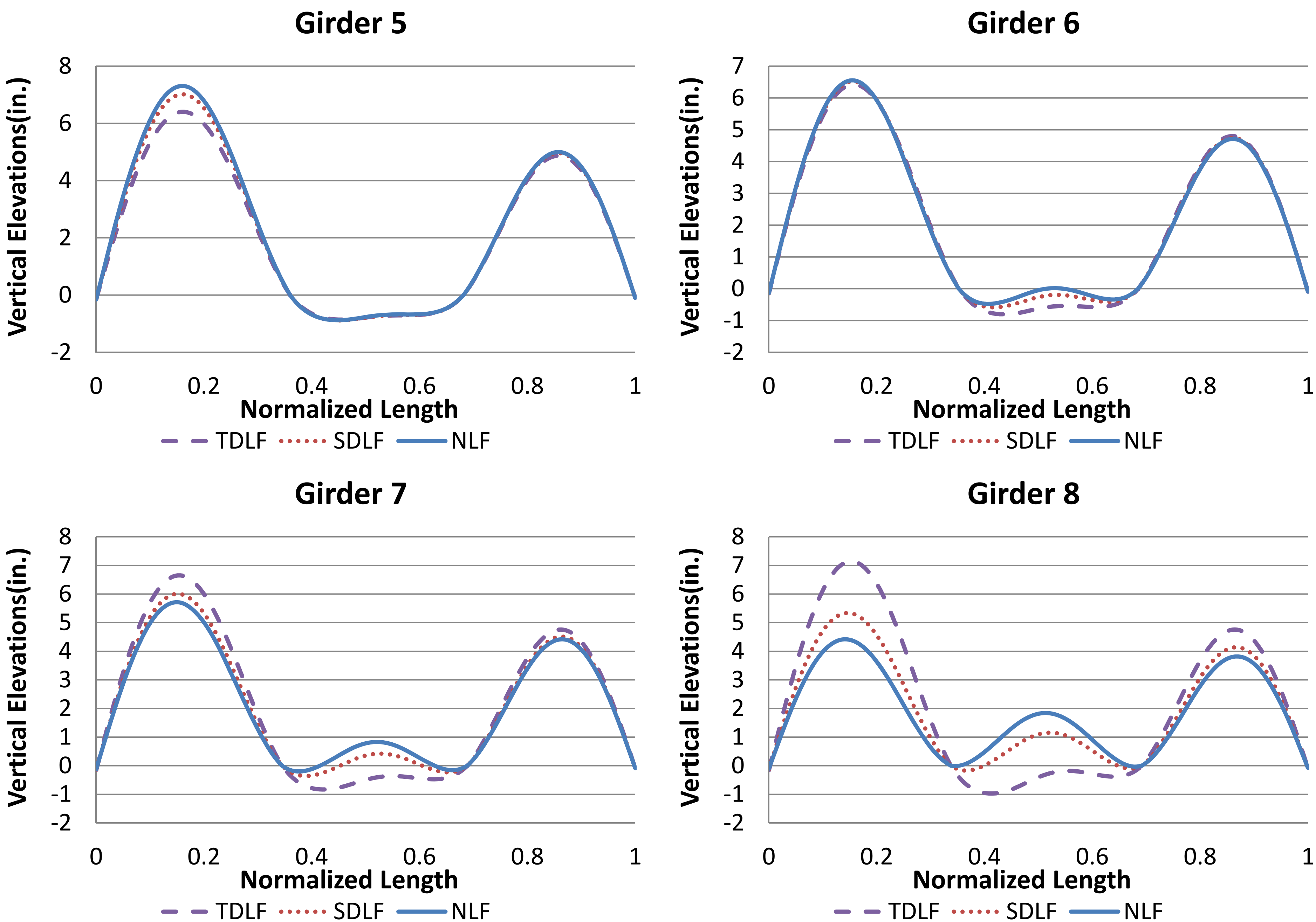


Figure M1-4-12. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

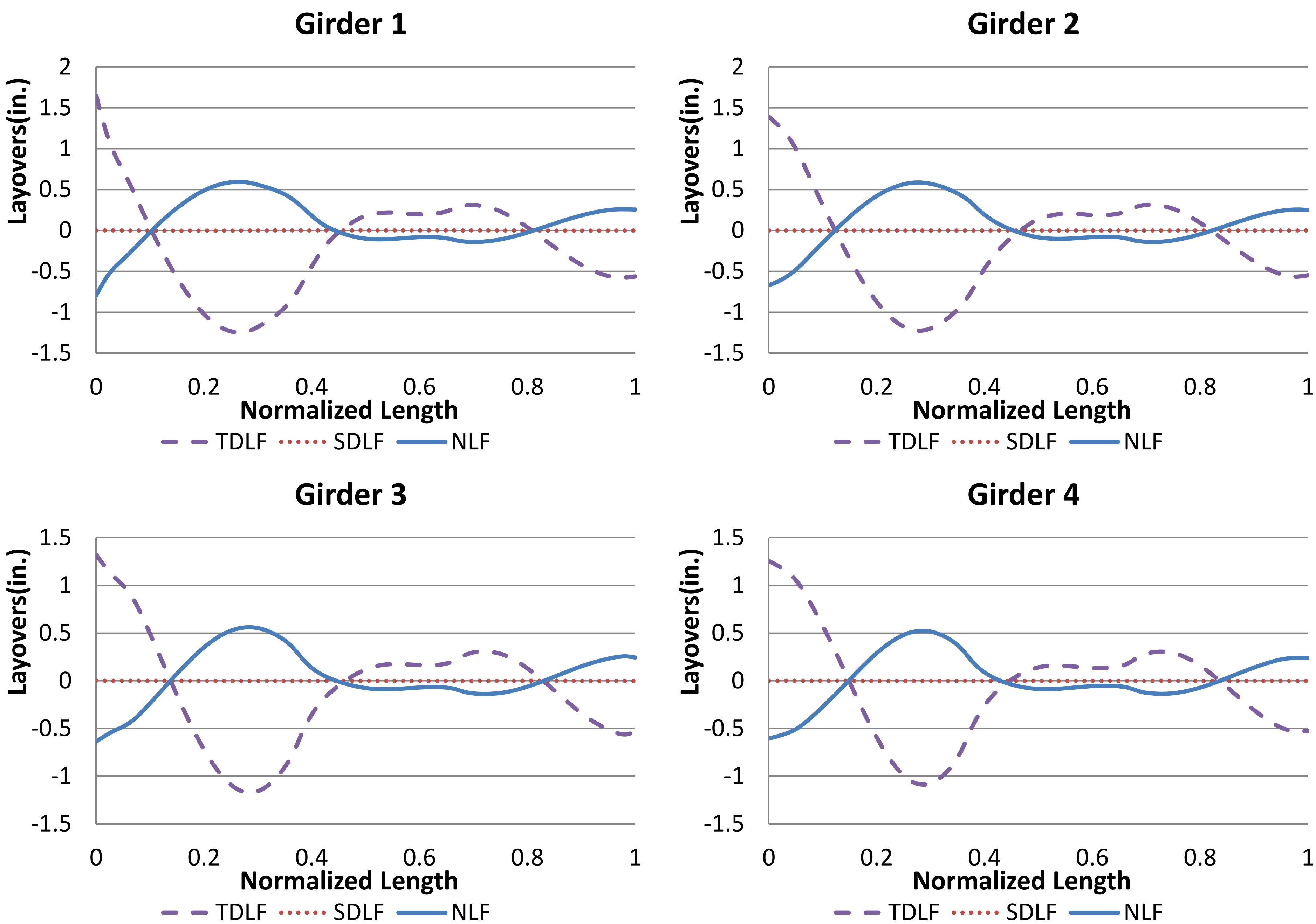


Figure M1-4-13. **Comparison of individual girder layovers (in) under SDL for different detailing methods.**

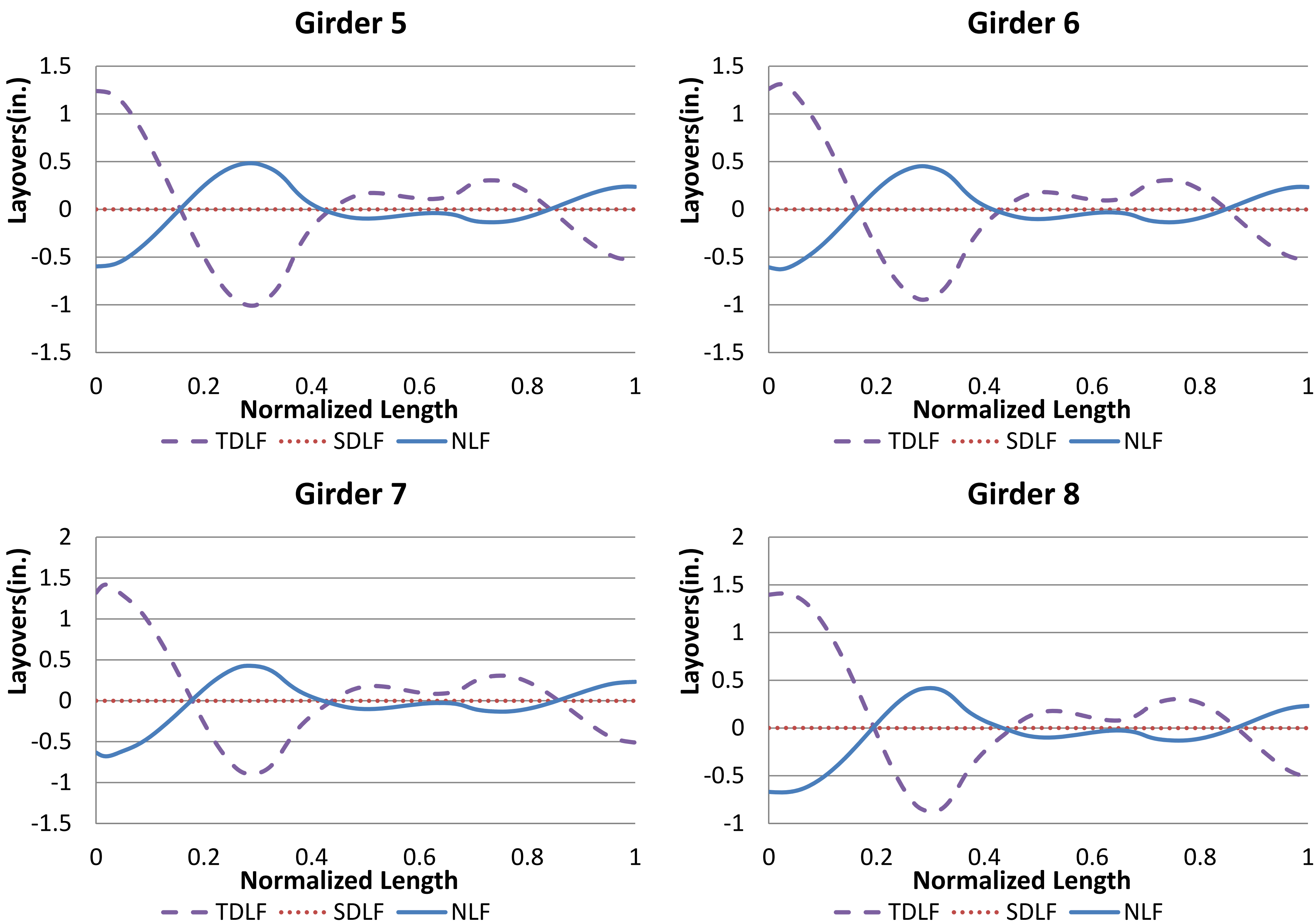


Figure M1-4-13 (Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

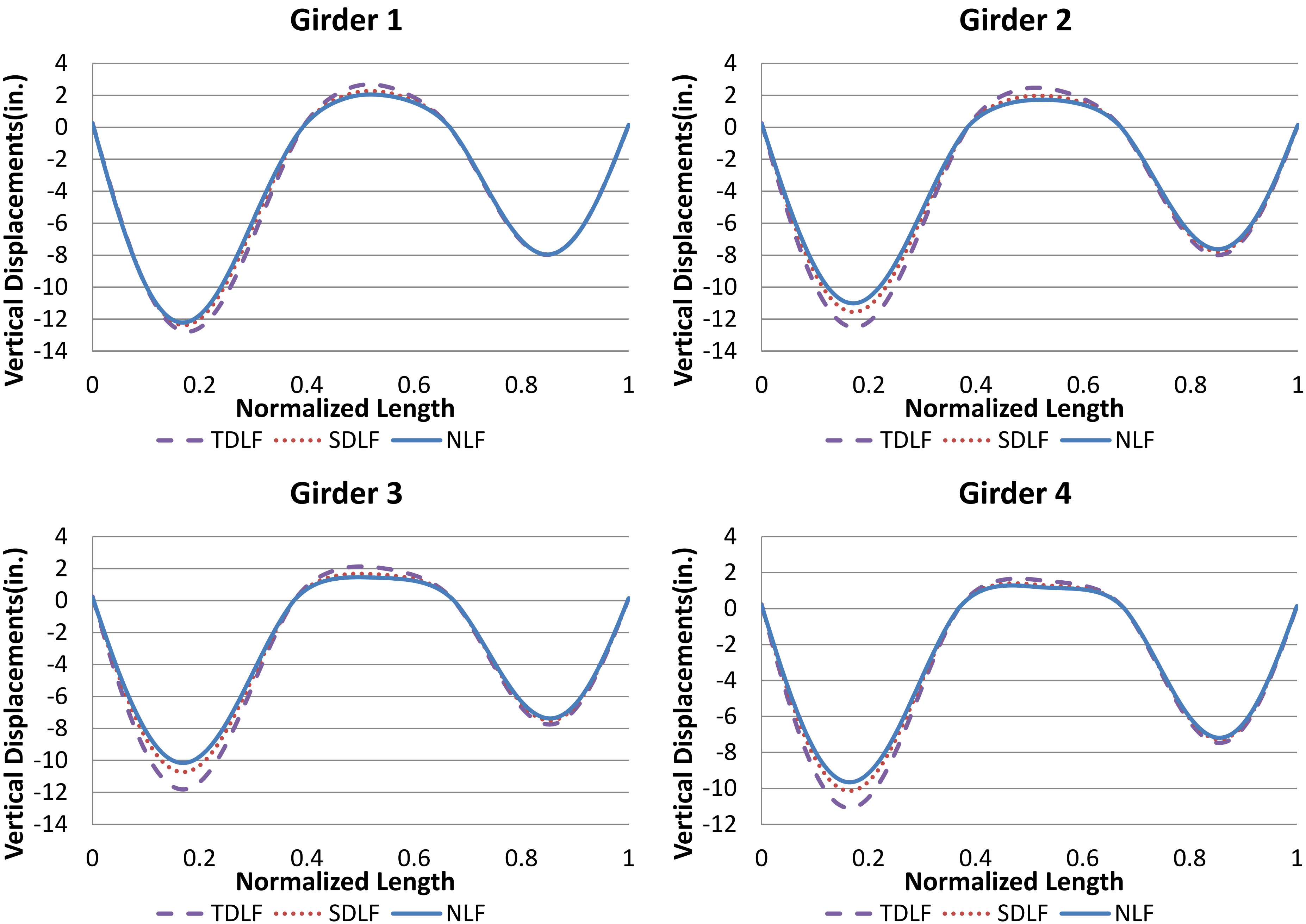


Figure M1-4-14. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

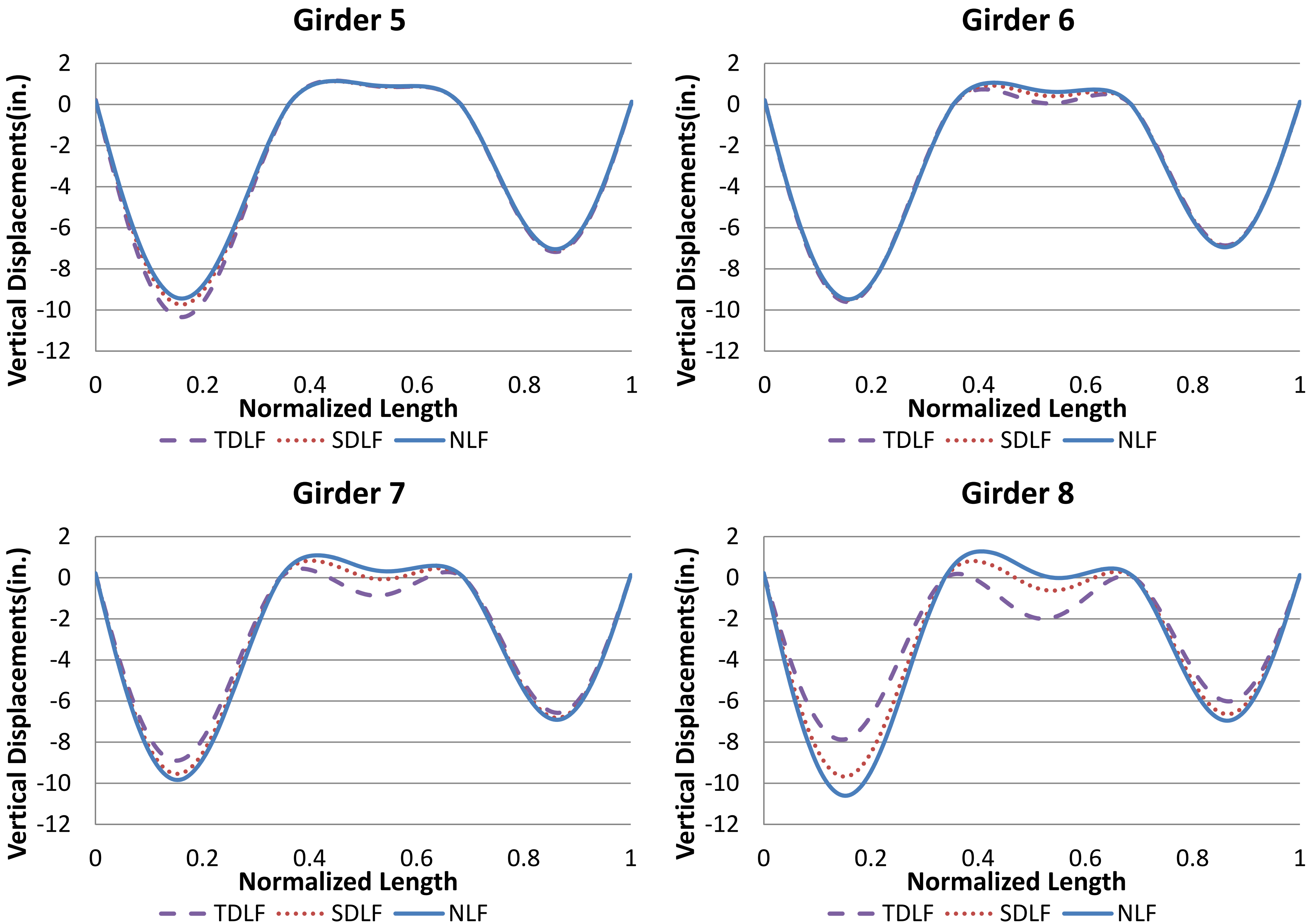


Figure M1-4-14(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

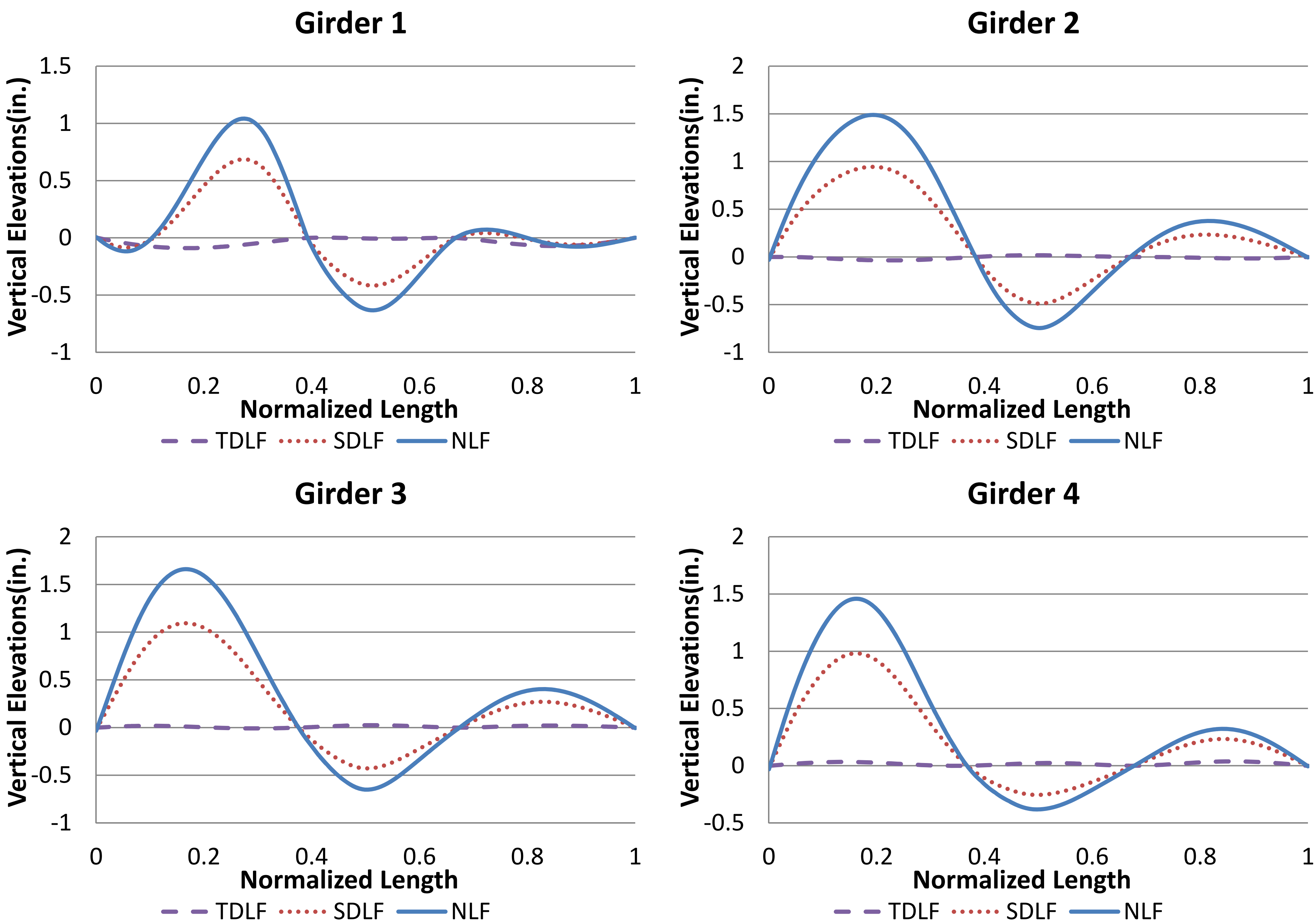


Figure M1-4-15. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

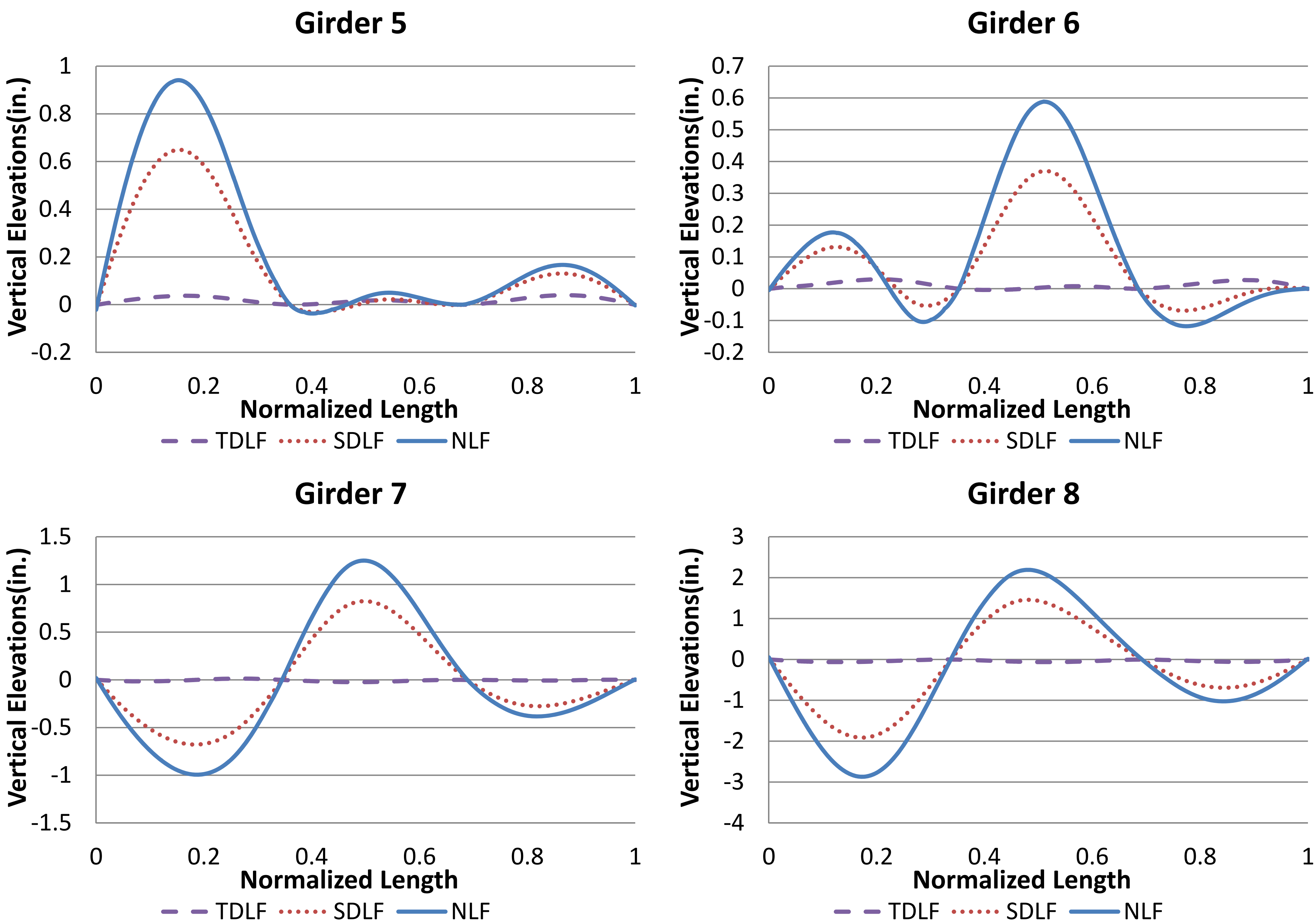


Figure M1-4-15(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

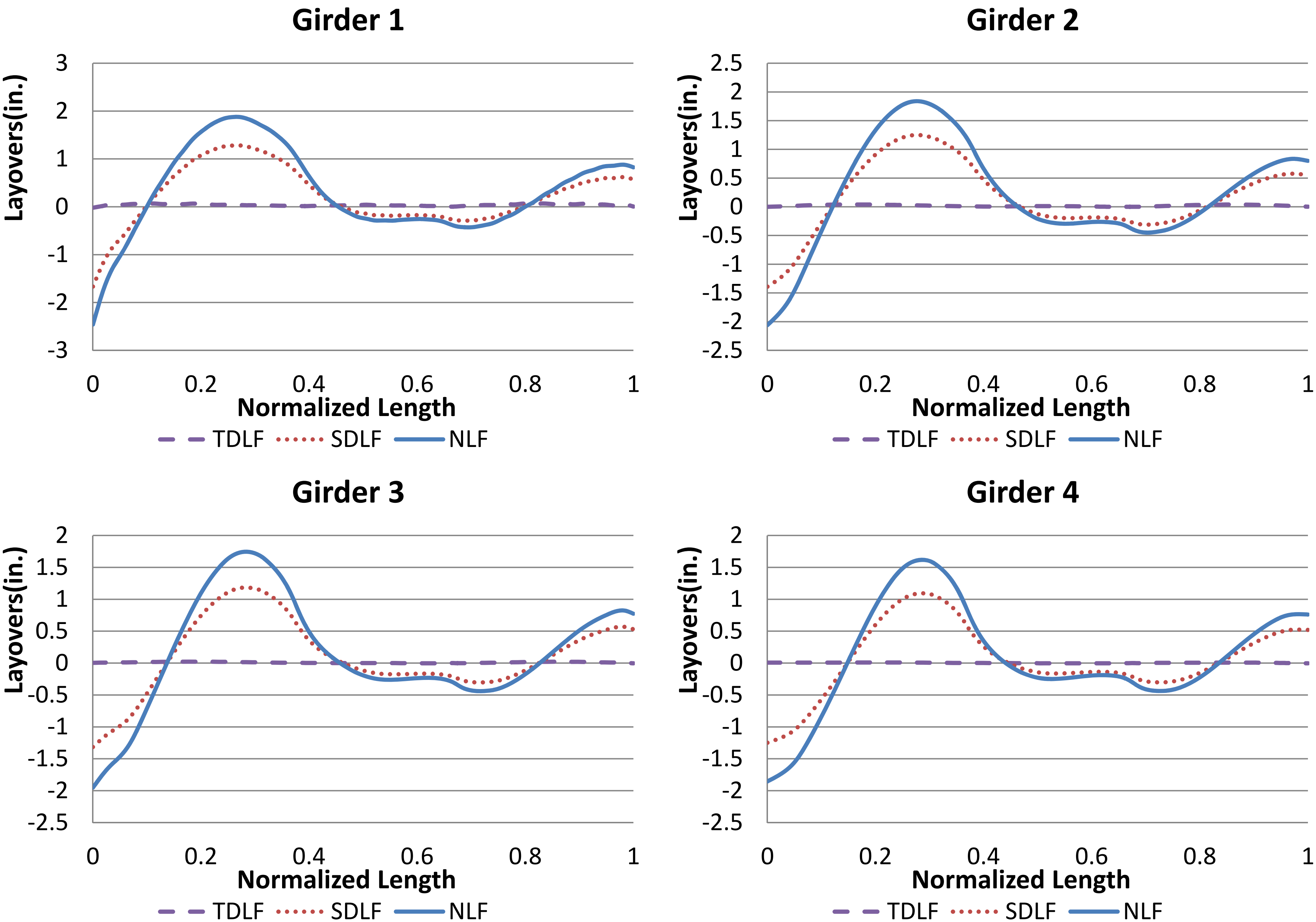


Figure M1-4-16. Comparison of individual girder layovers (in) under TDL for different detailing methods.

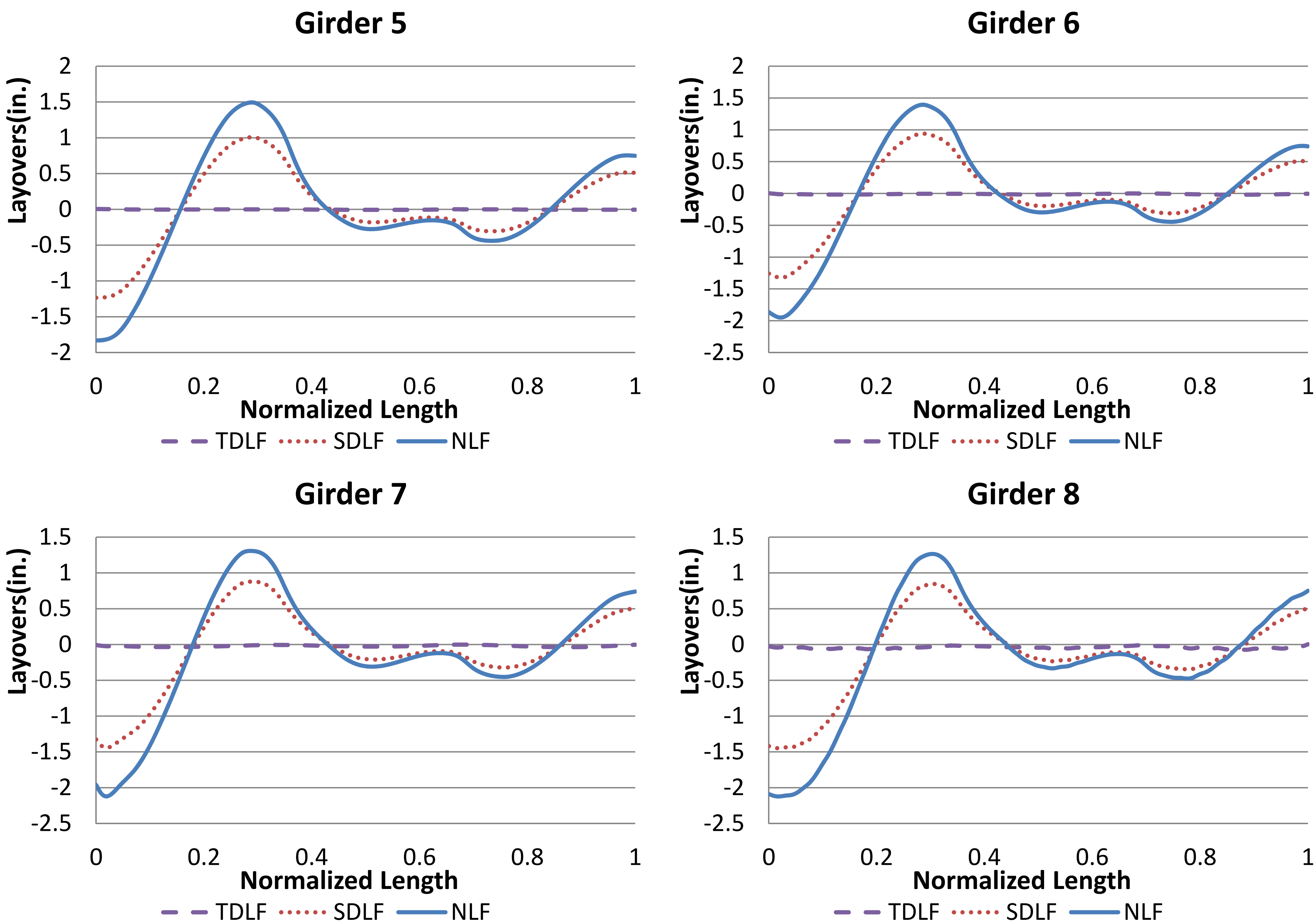


Figure M1-4-16(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

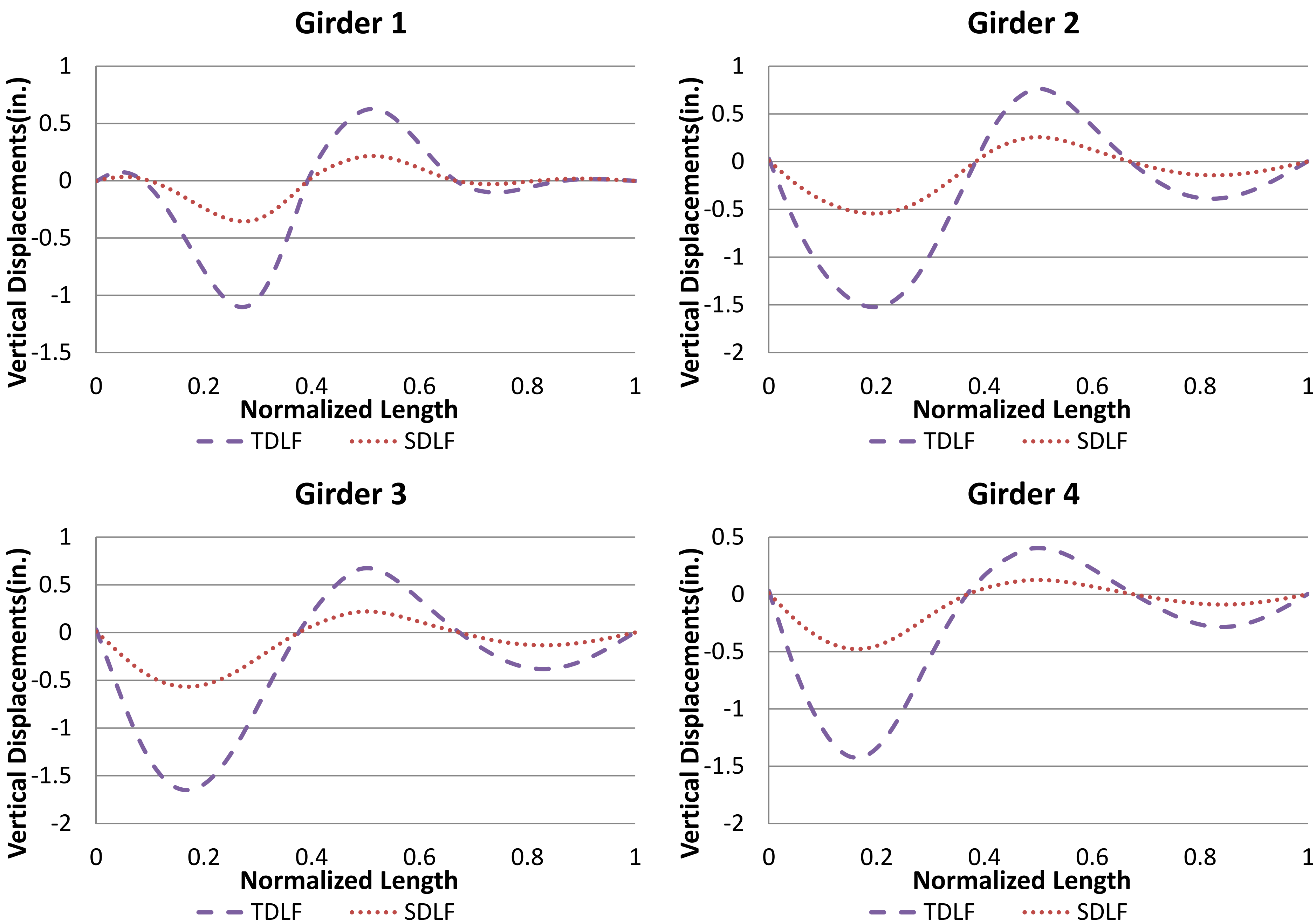


Figure M1-4-17. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

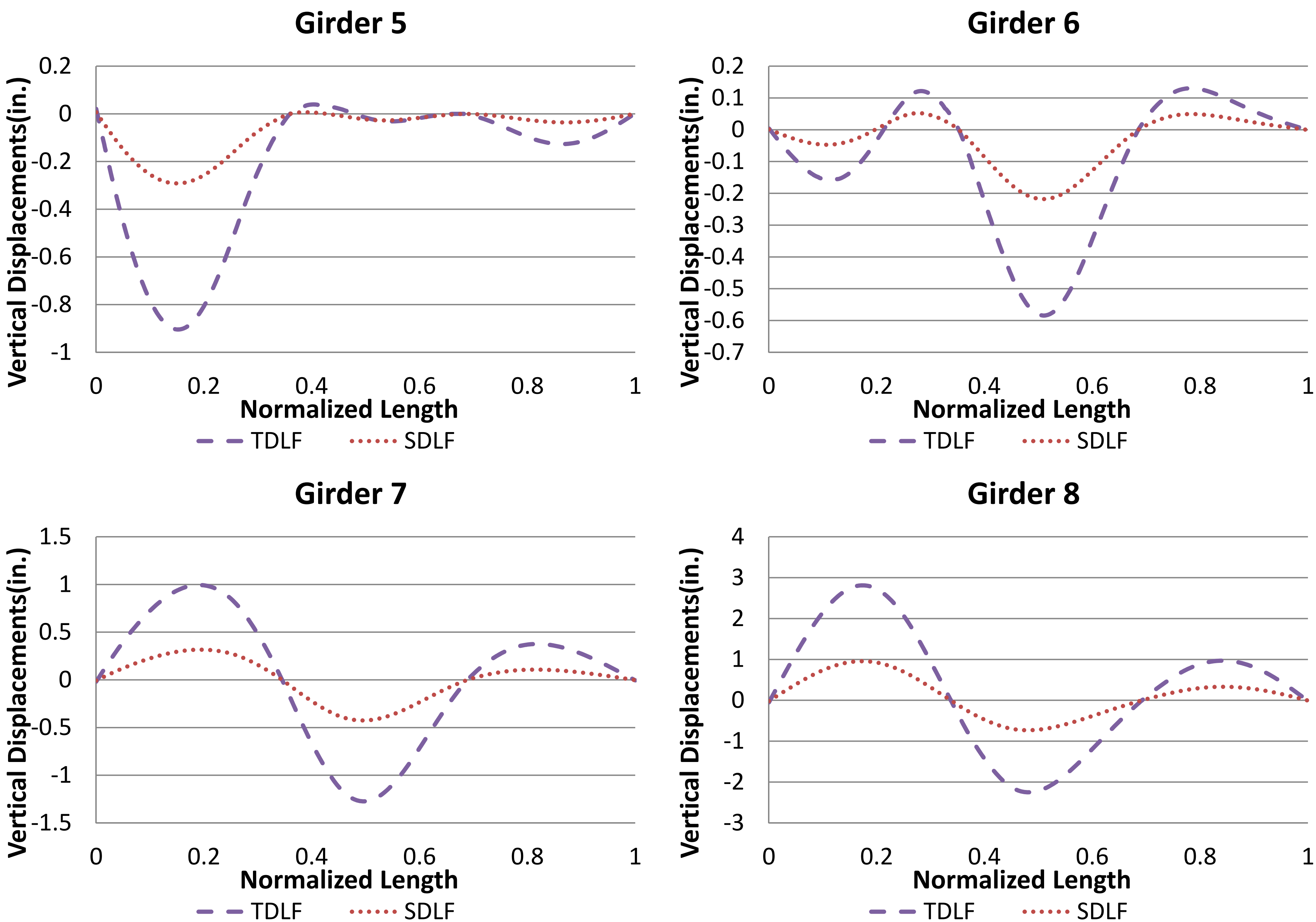


Figure M1-4-17(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing.

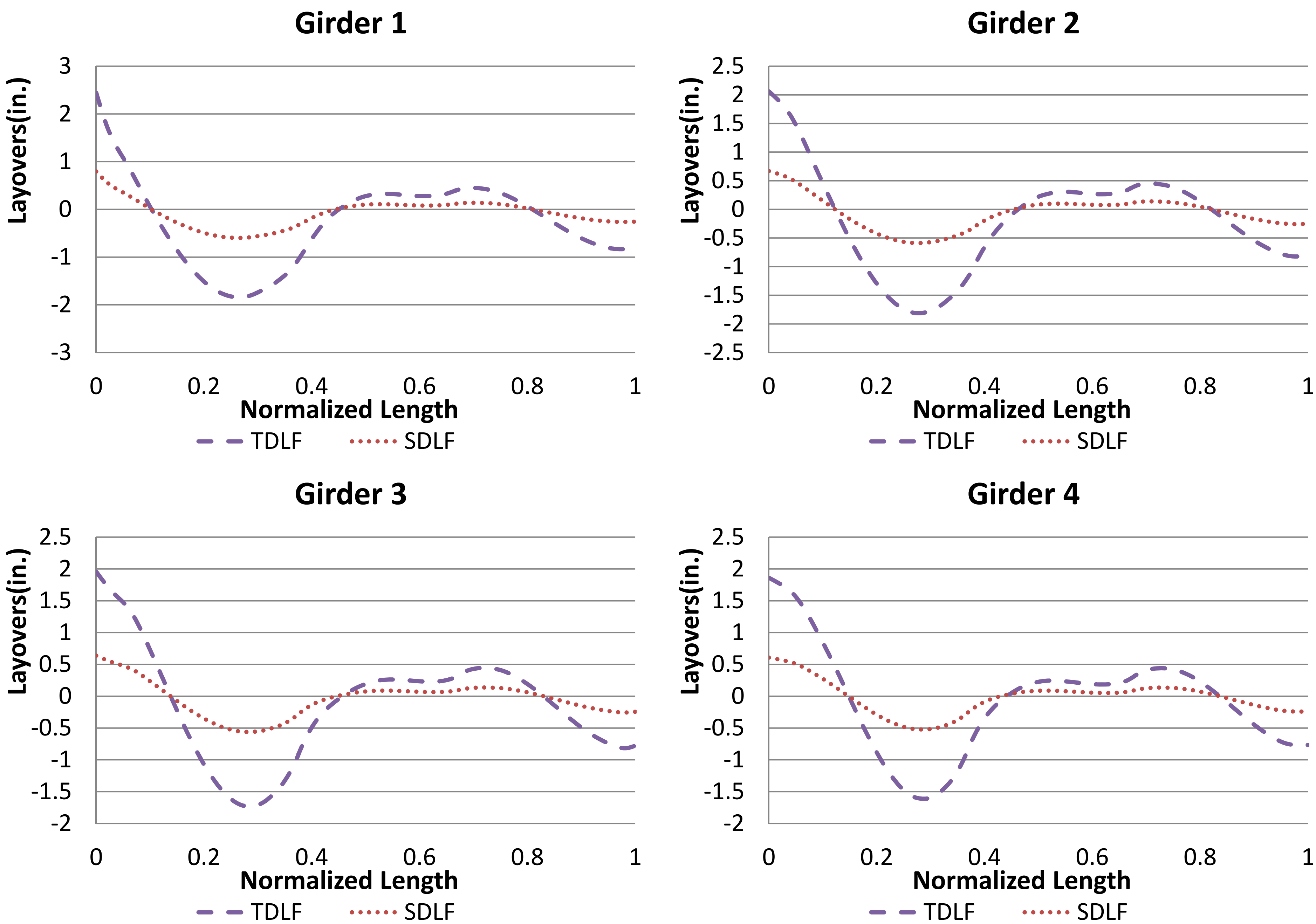


Figure M1-4-18. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

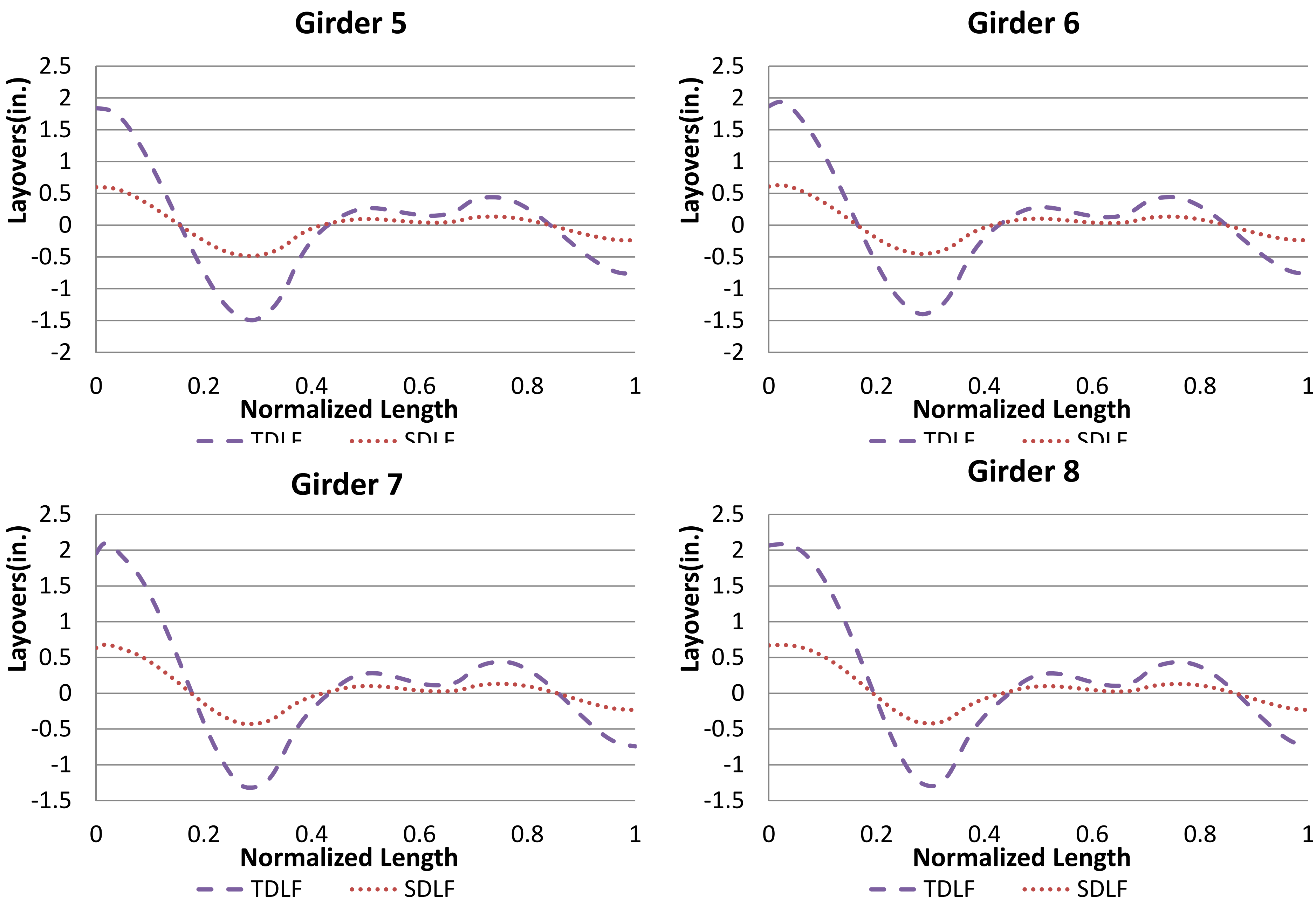


Figure M1-4-18(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing.

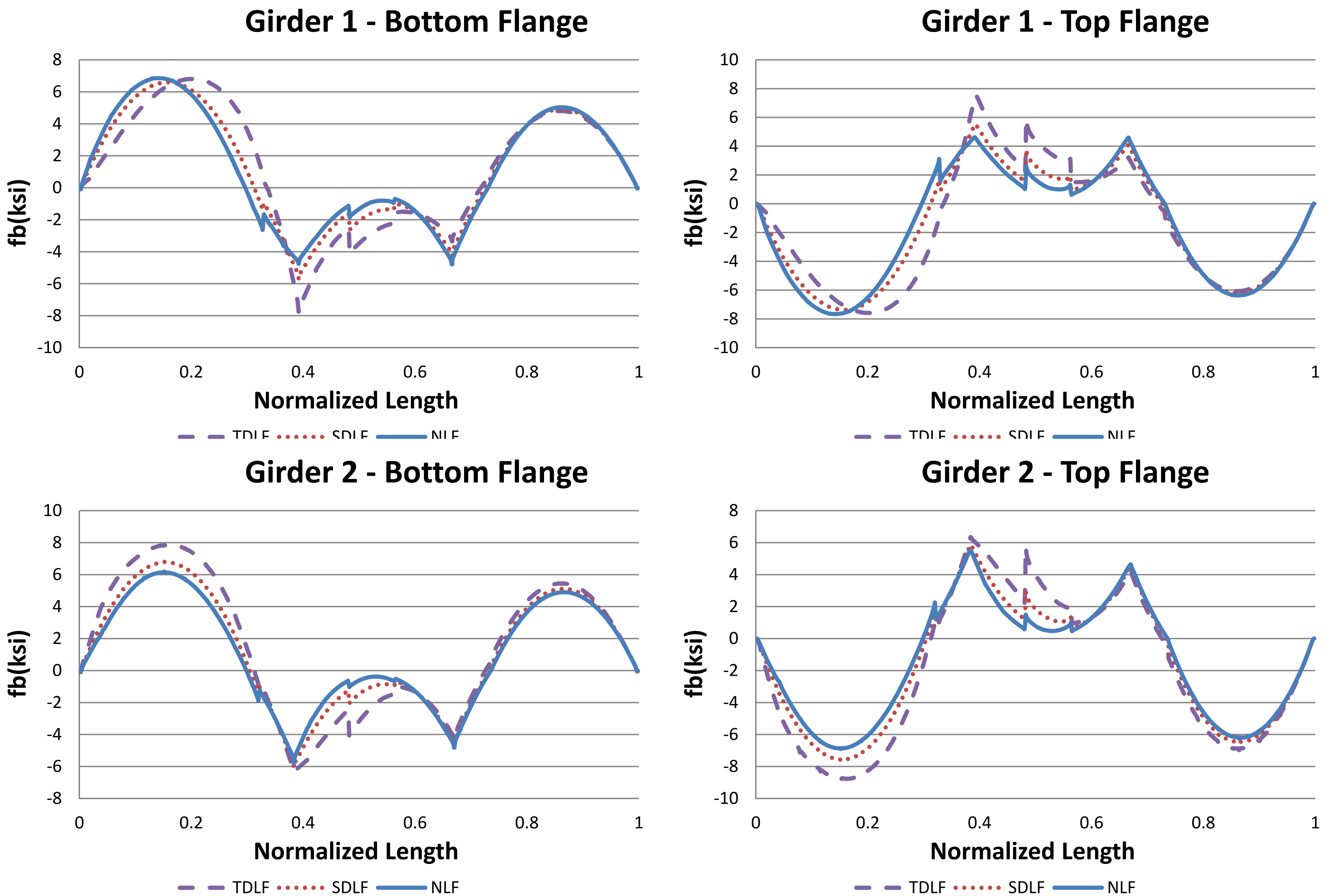


Figure M1-4-19. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

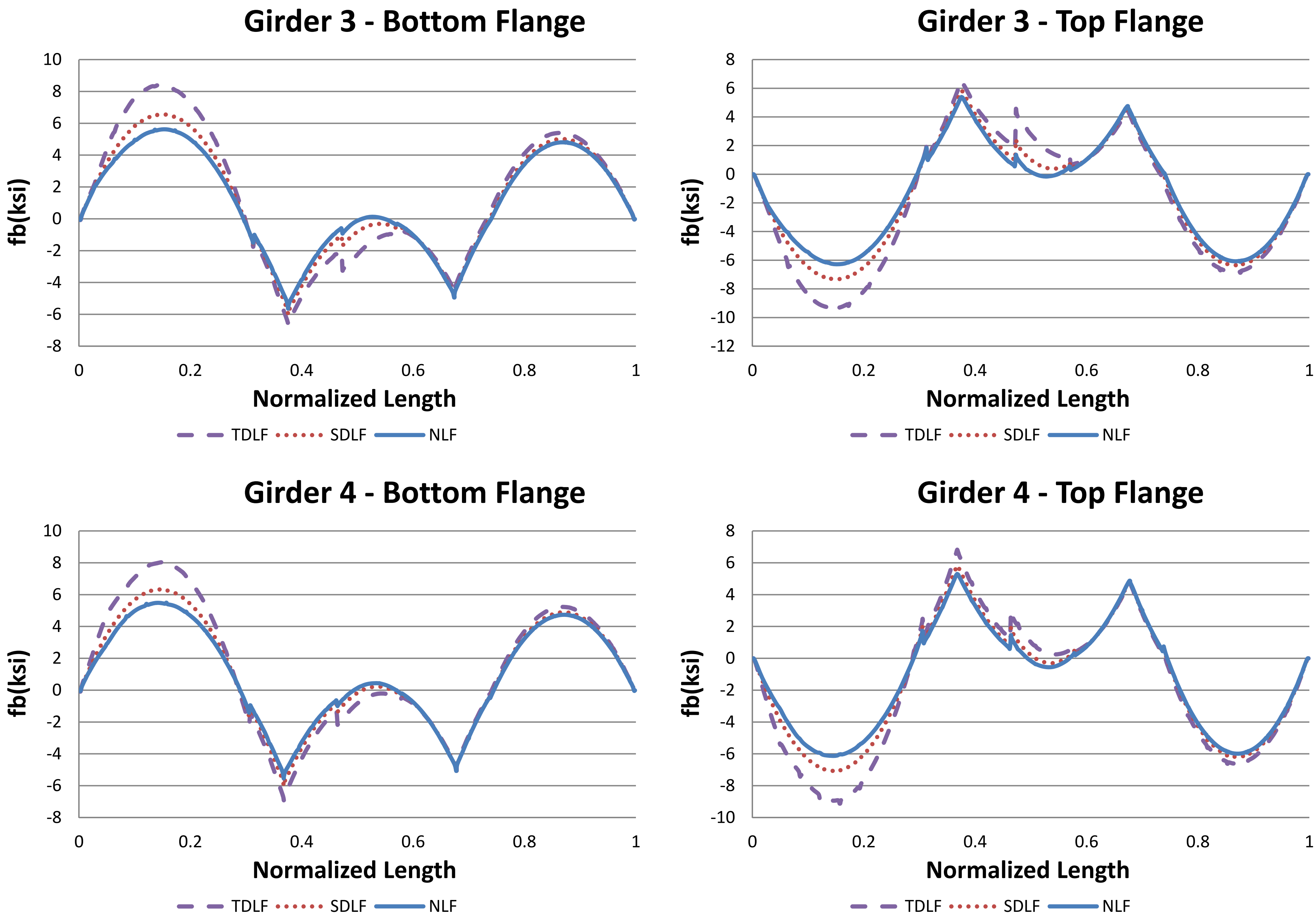


Figure M1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

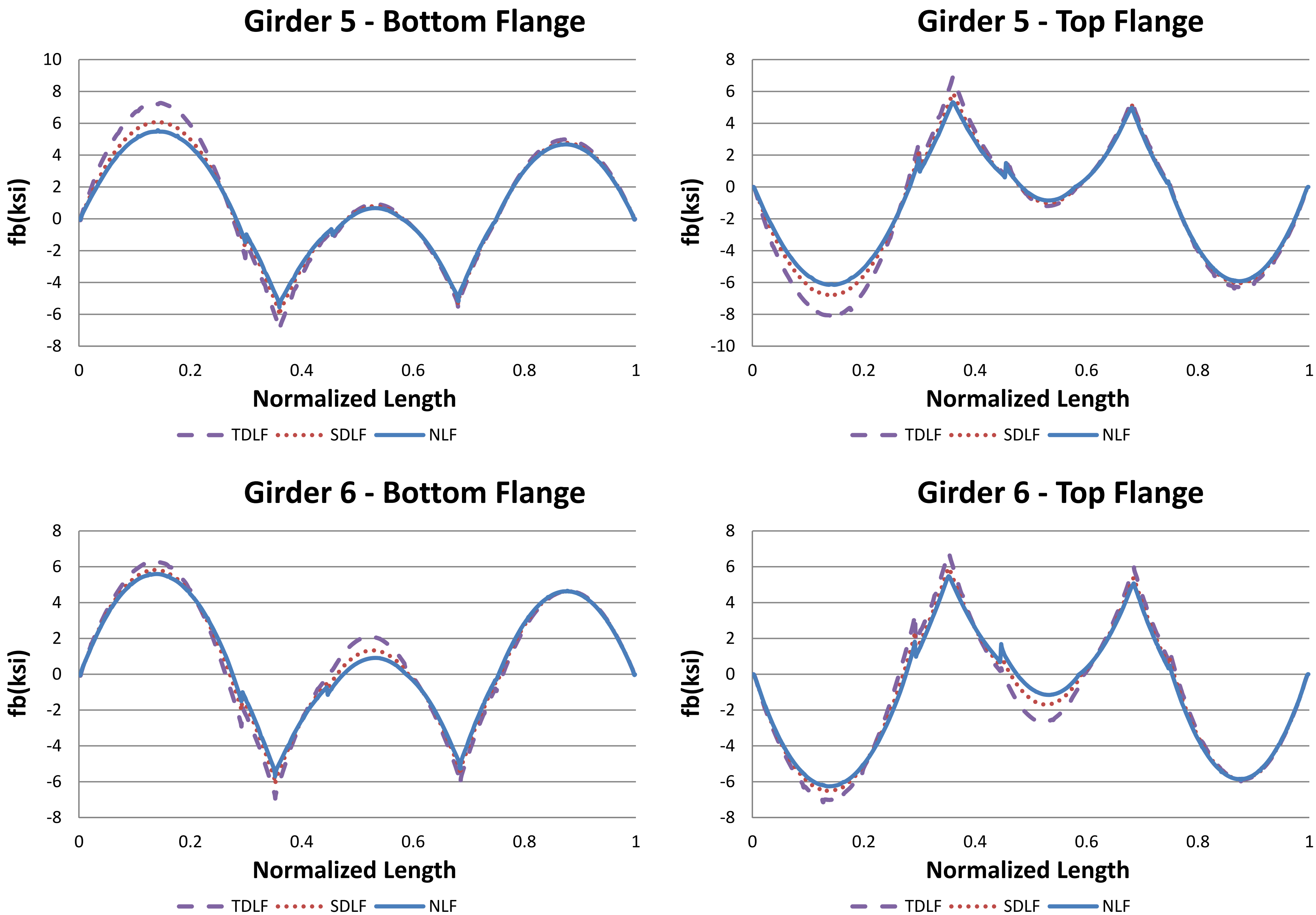


Figure M1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

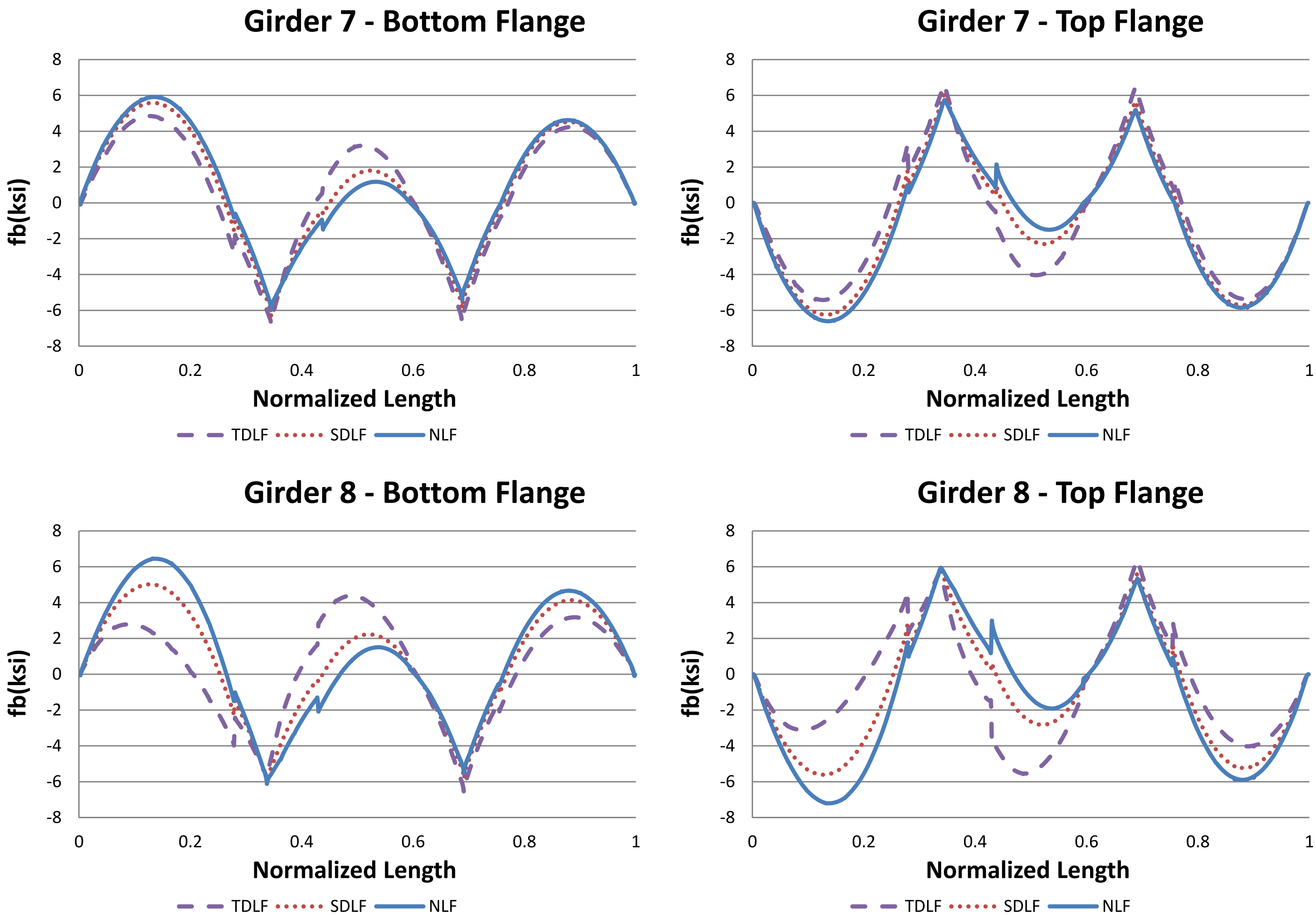


Figure M1-4-19 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

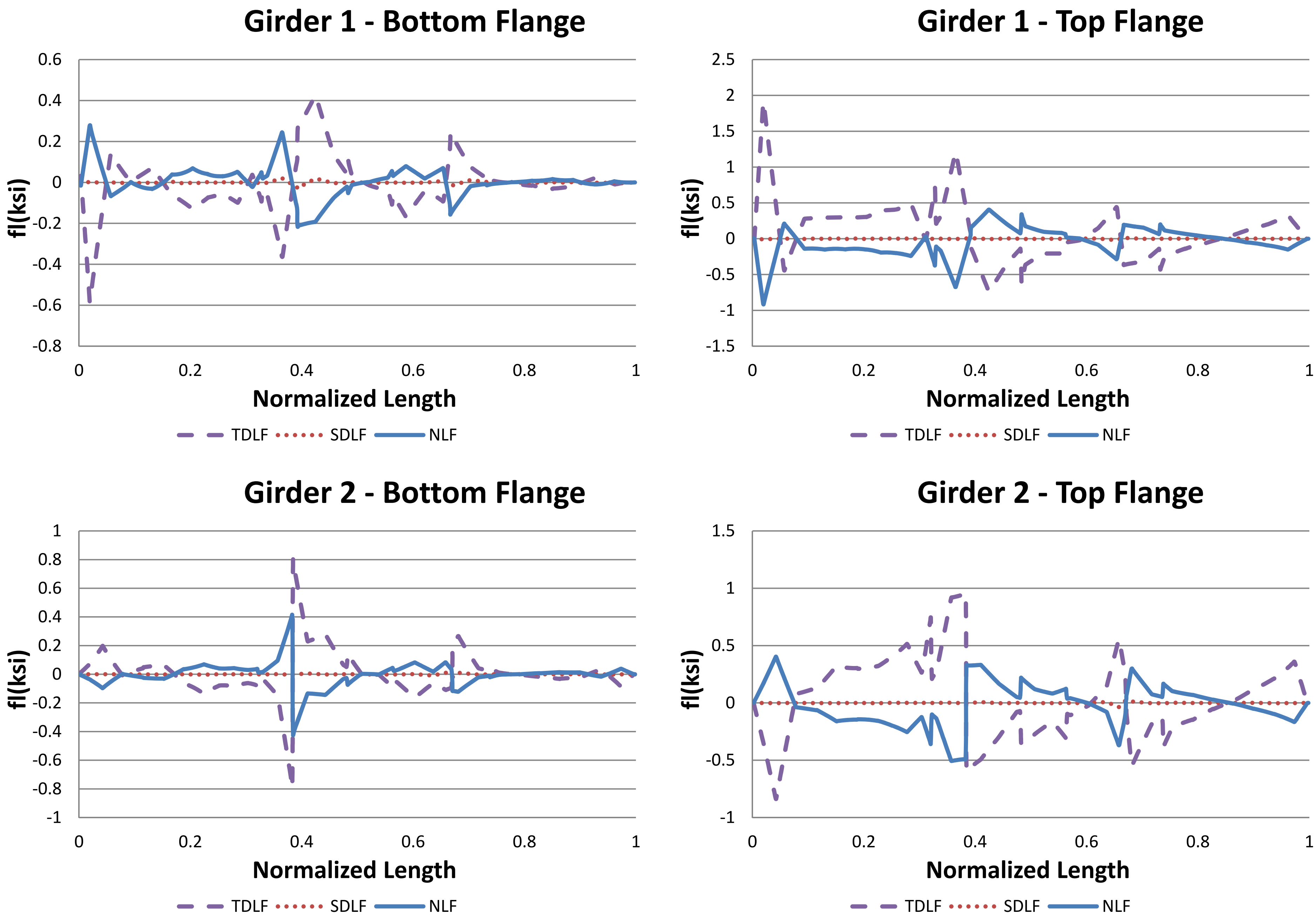


Figure M1-4-20. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

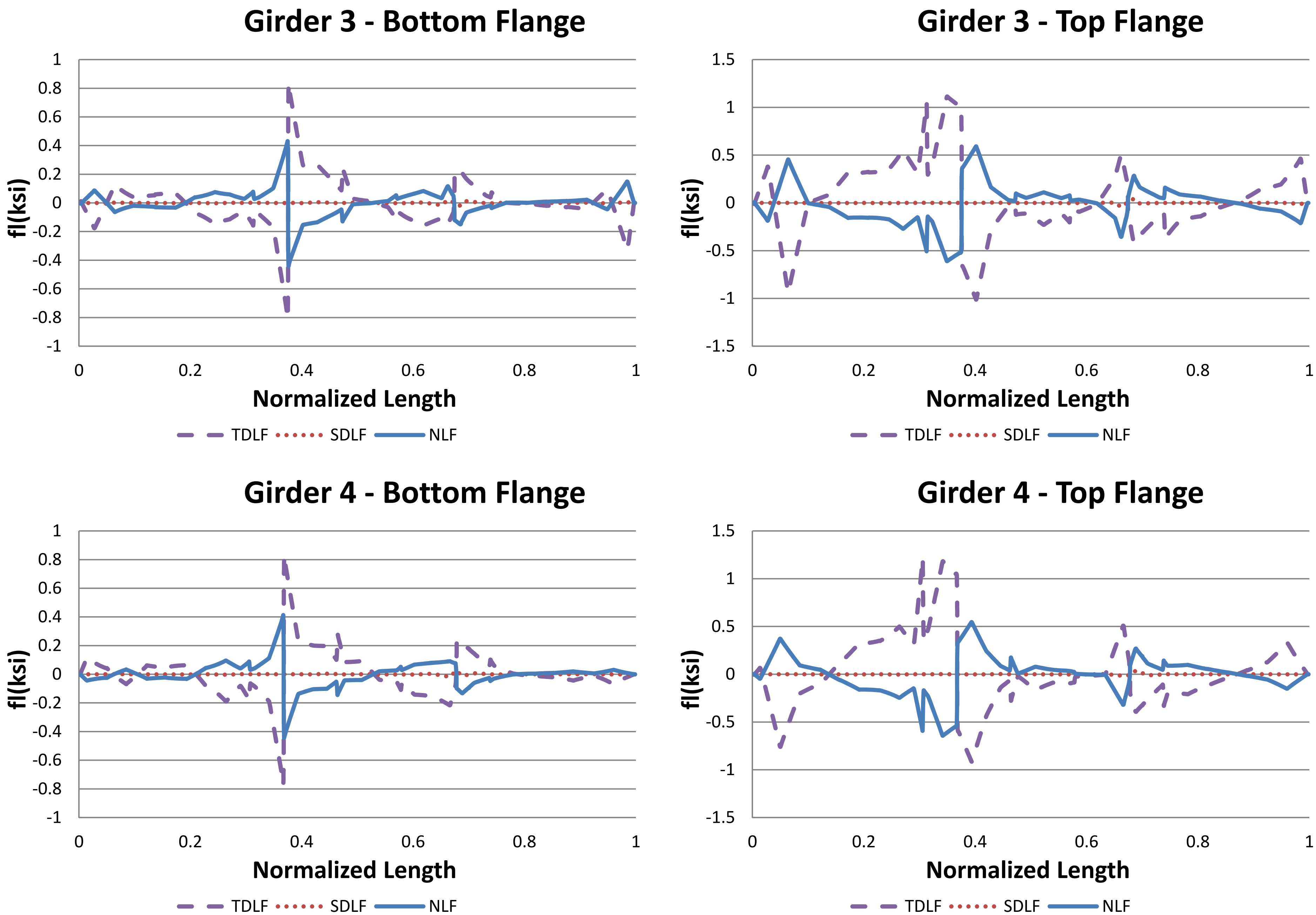


Figure M1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

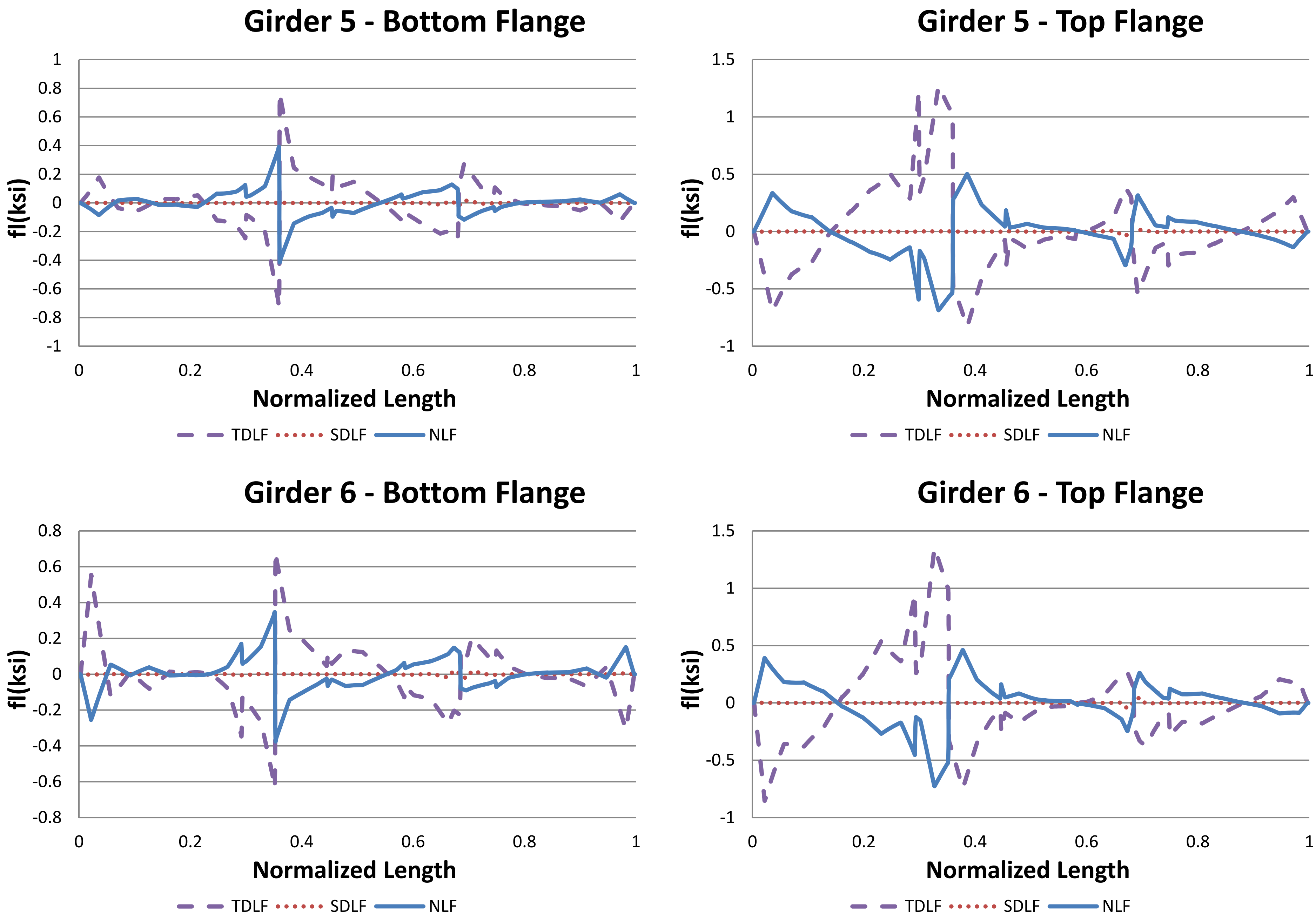


Figure M1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

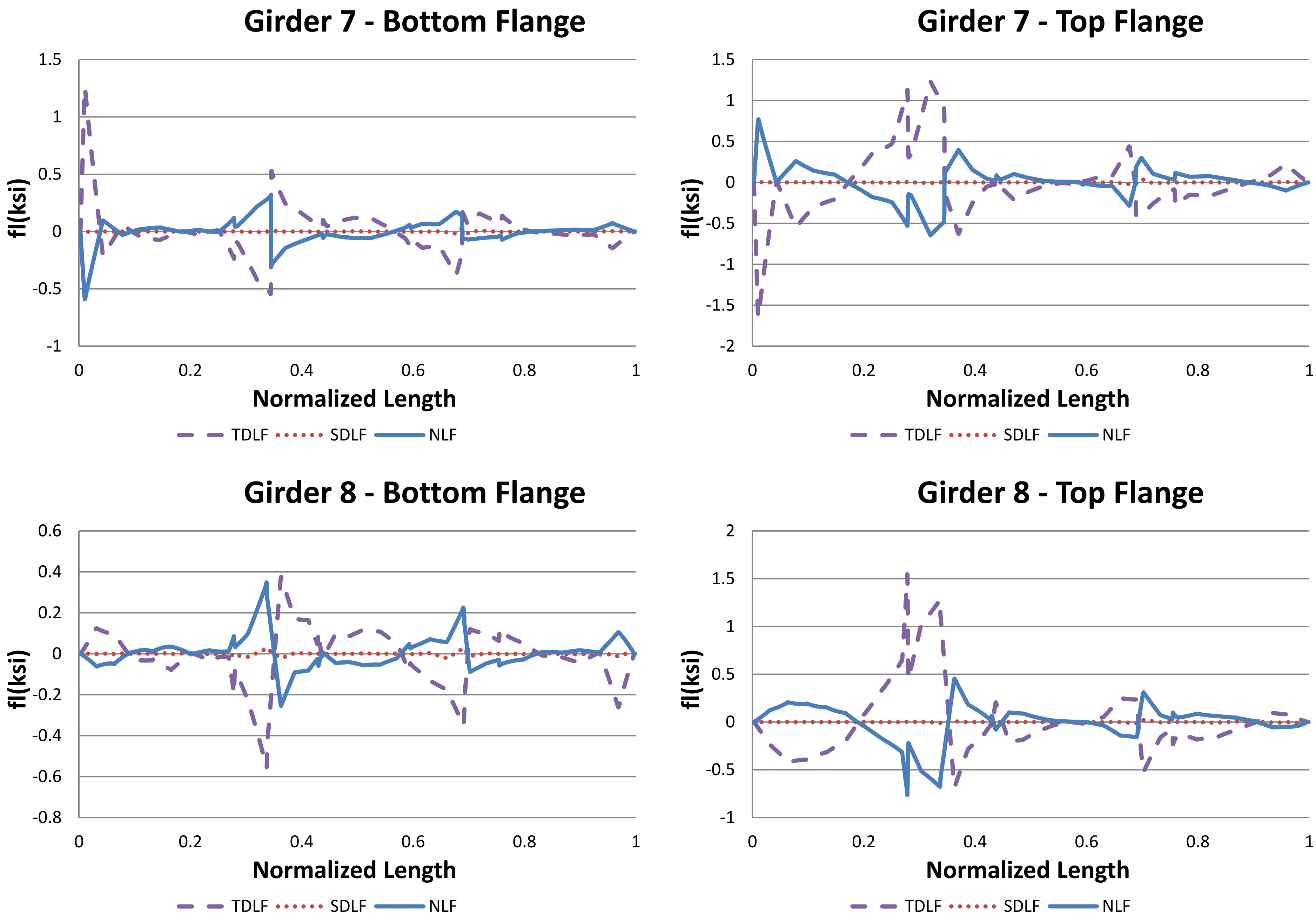


Figure M1-4-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

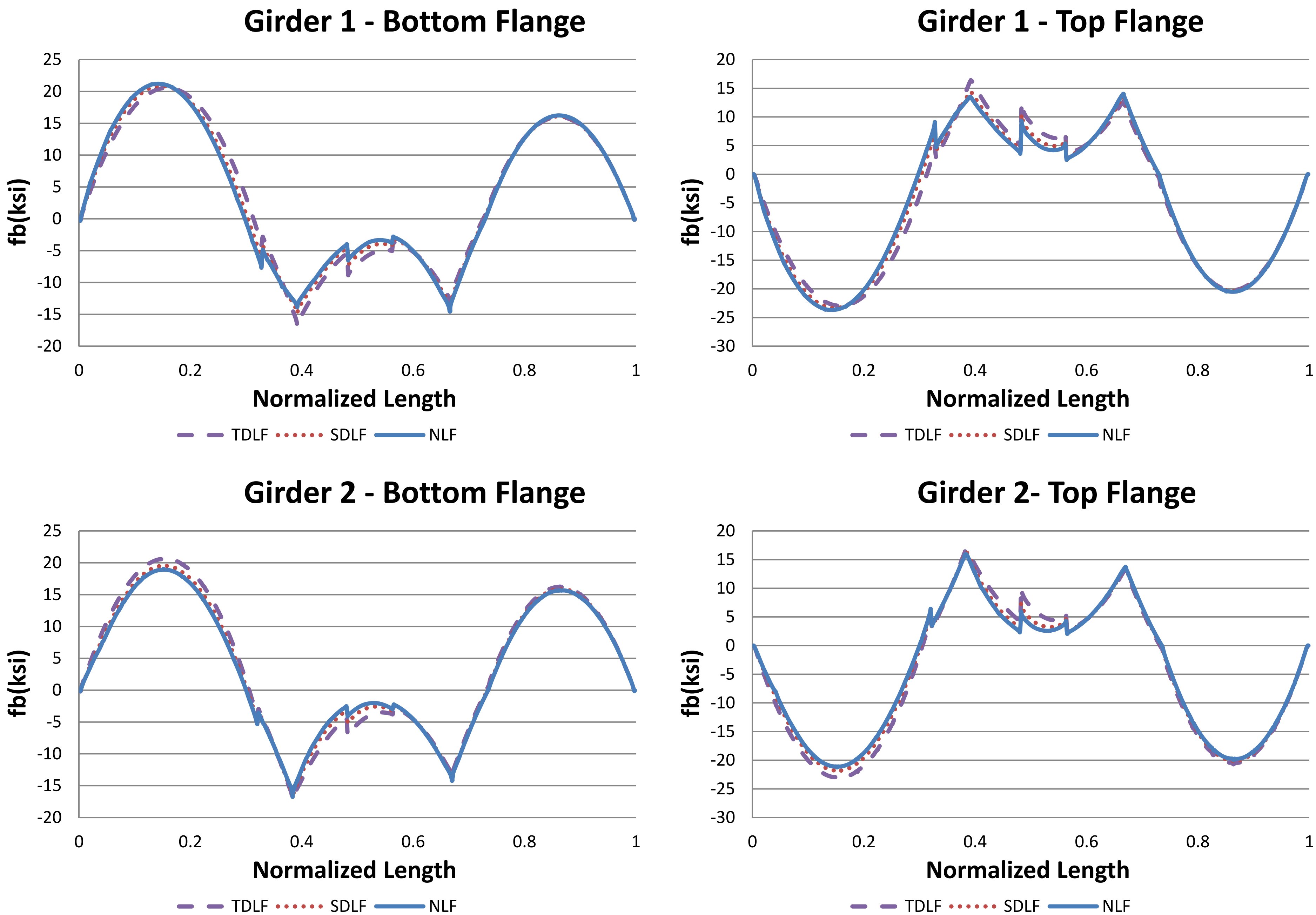


Figure M1-4-21. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

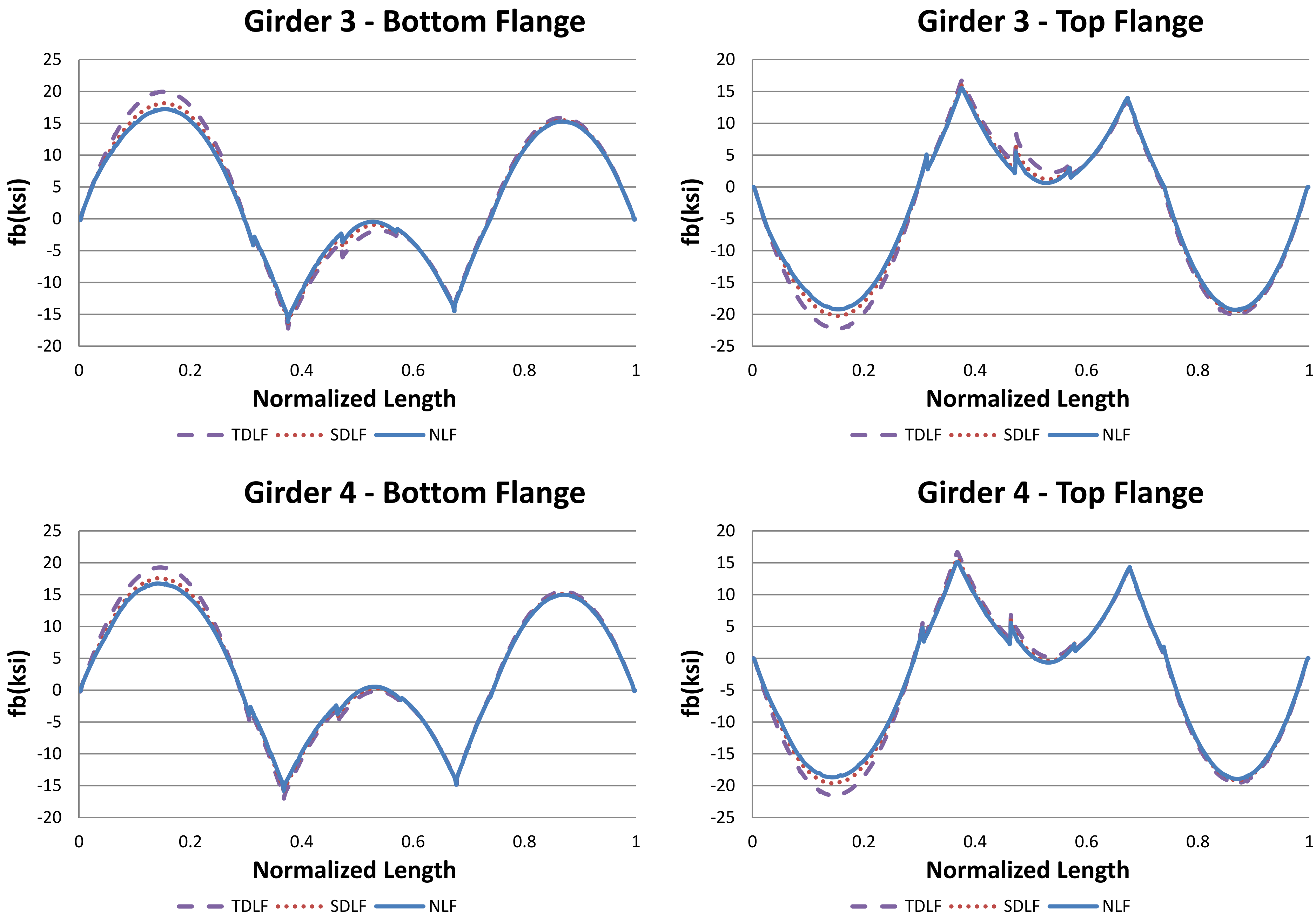


Figure M1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

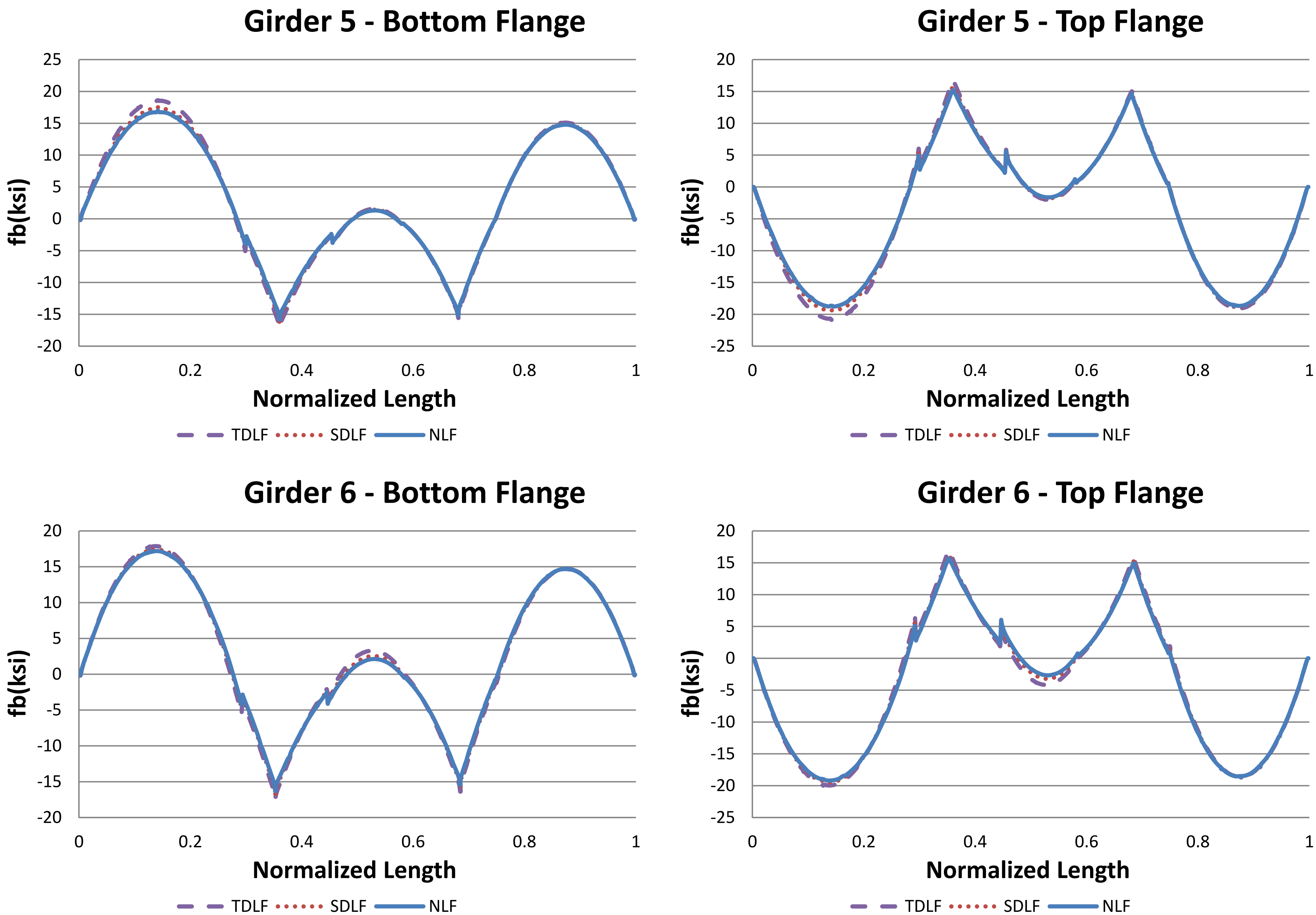


Figure M1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

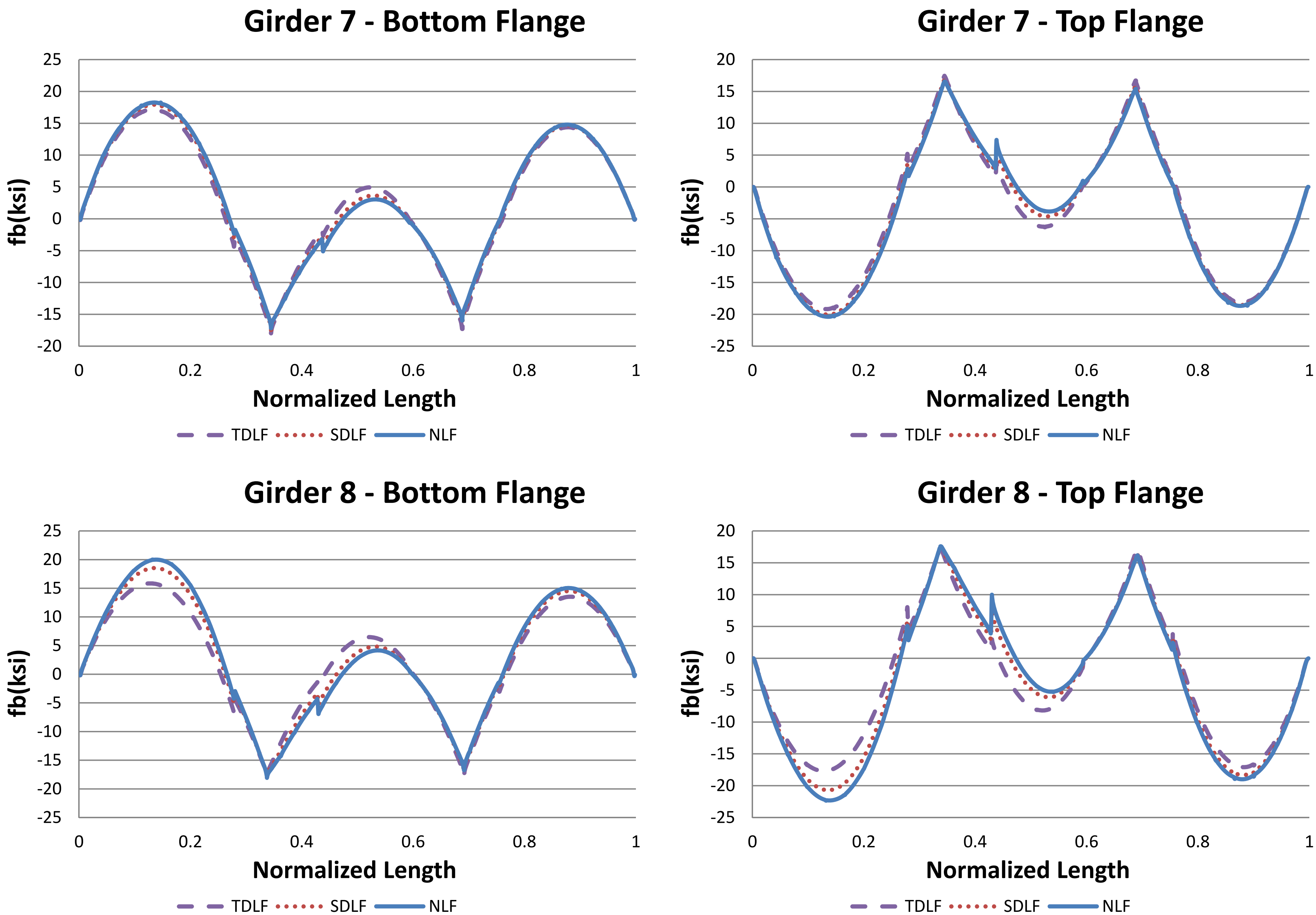


Figure M1-4-21 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

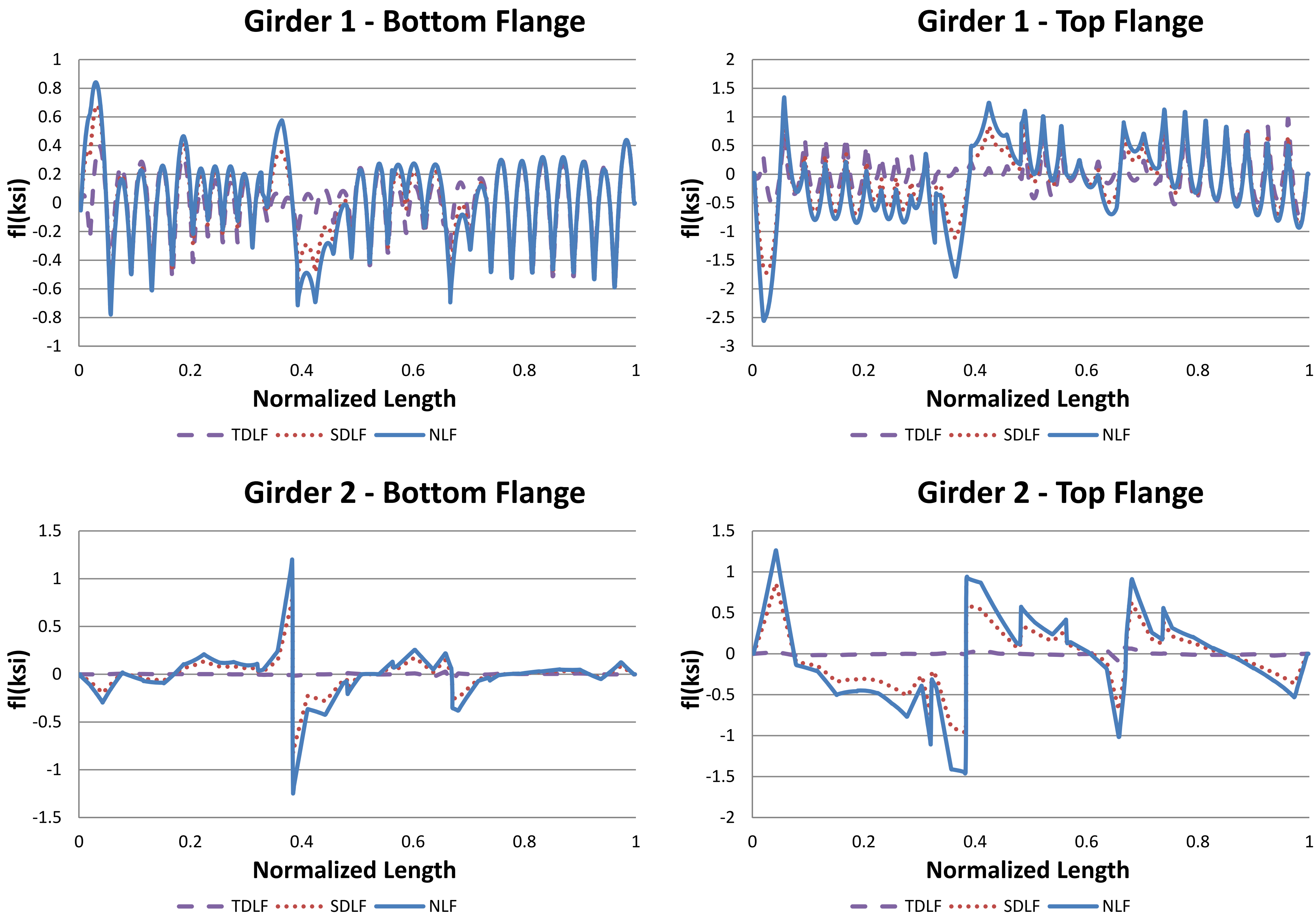


Figure M1-4-22. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

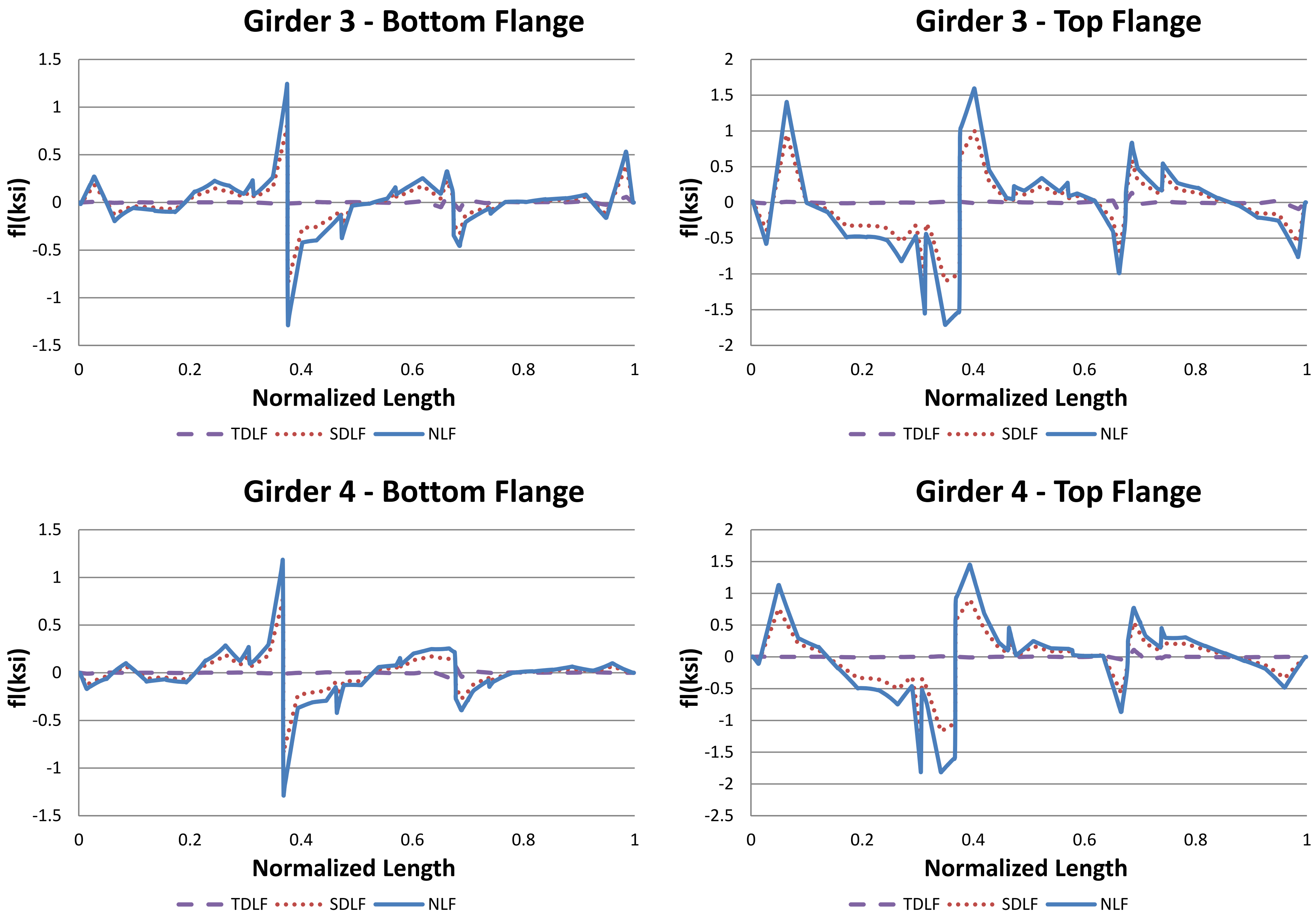


Figure M1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

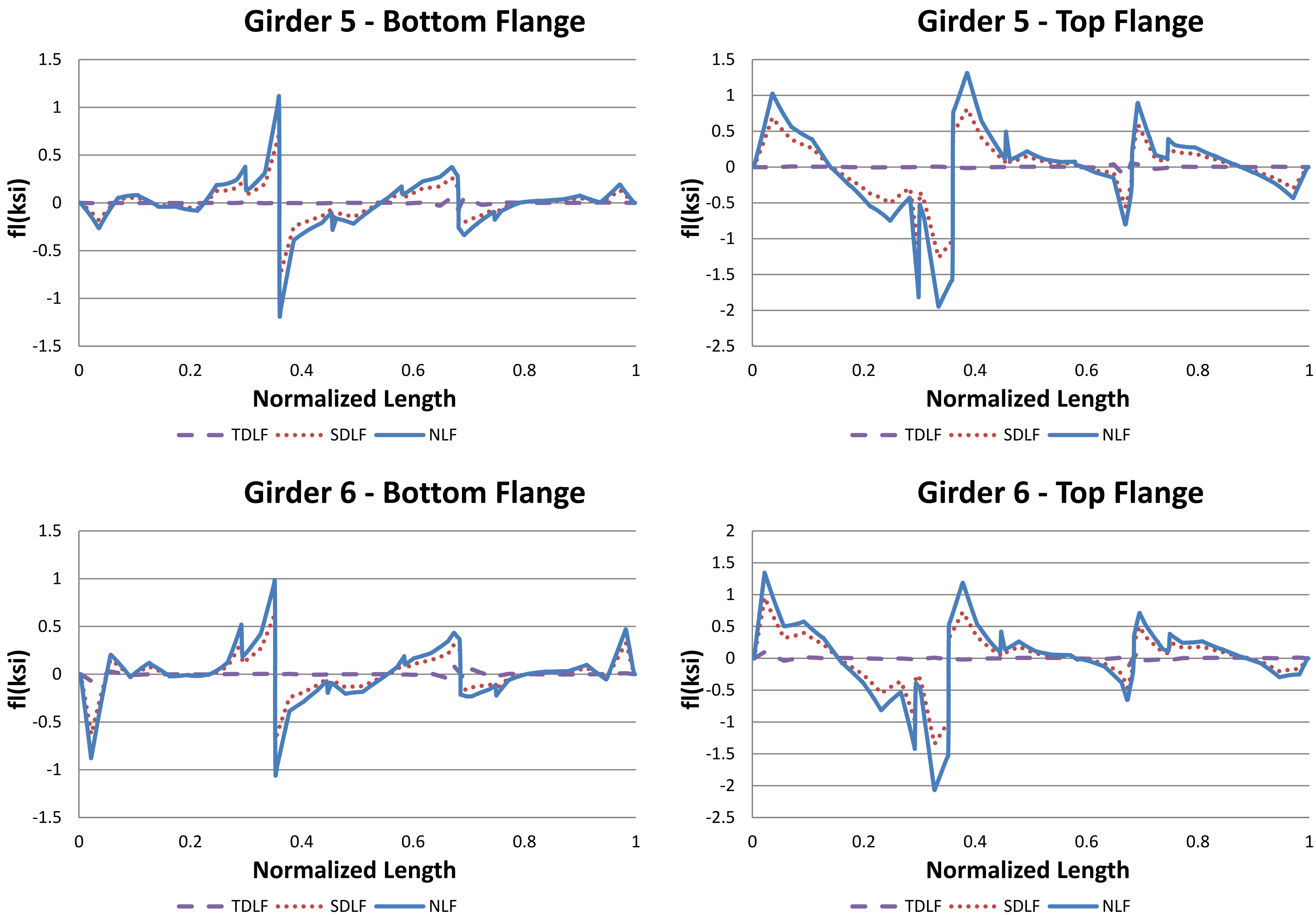


Figure M1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

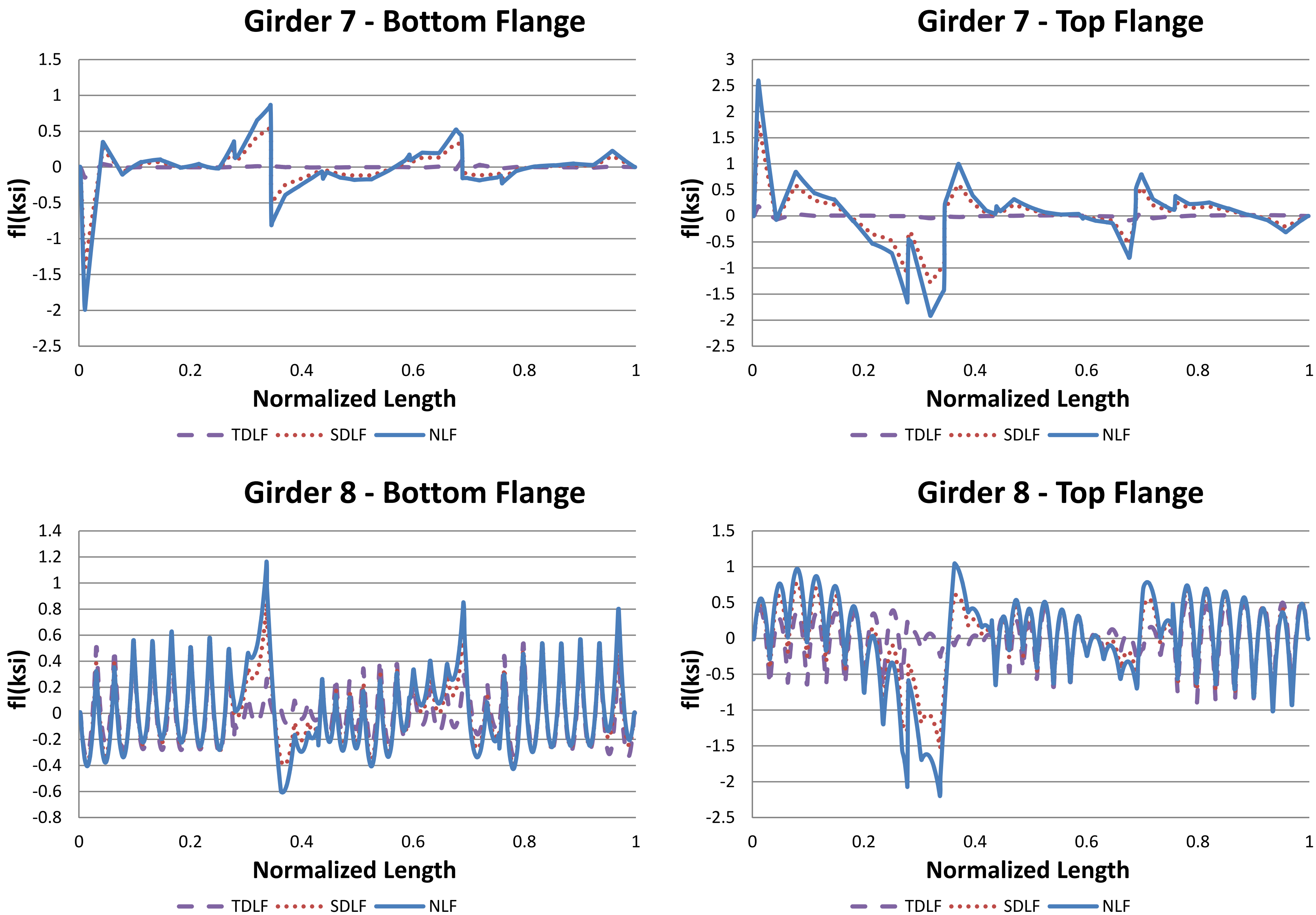


Figure M1-4-22 (continued). Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.

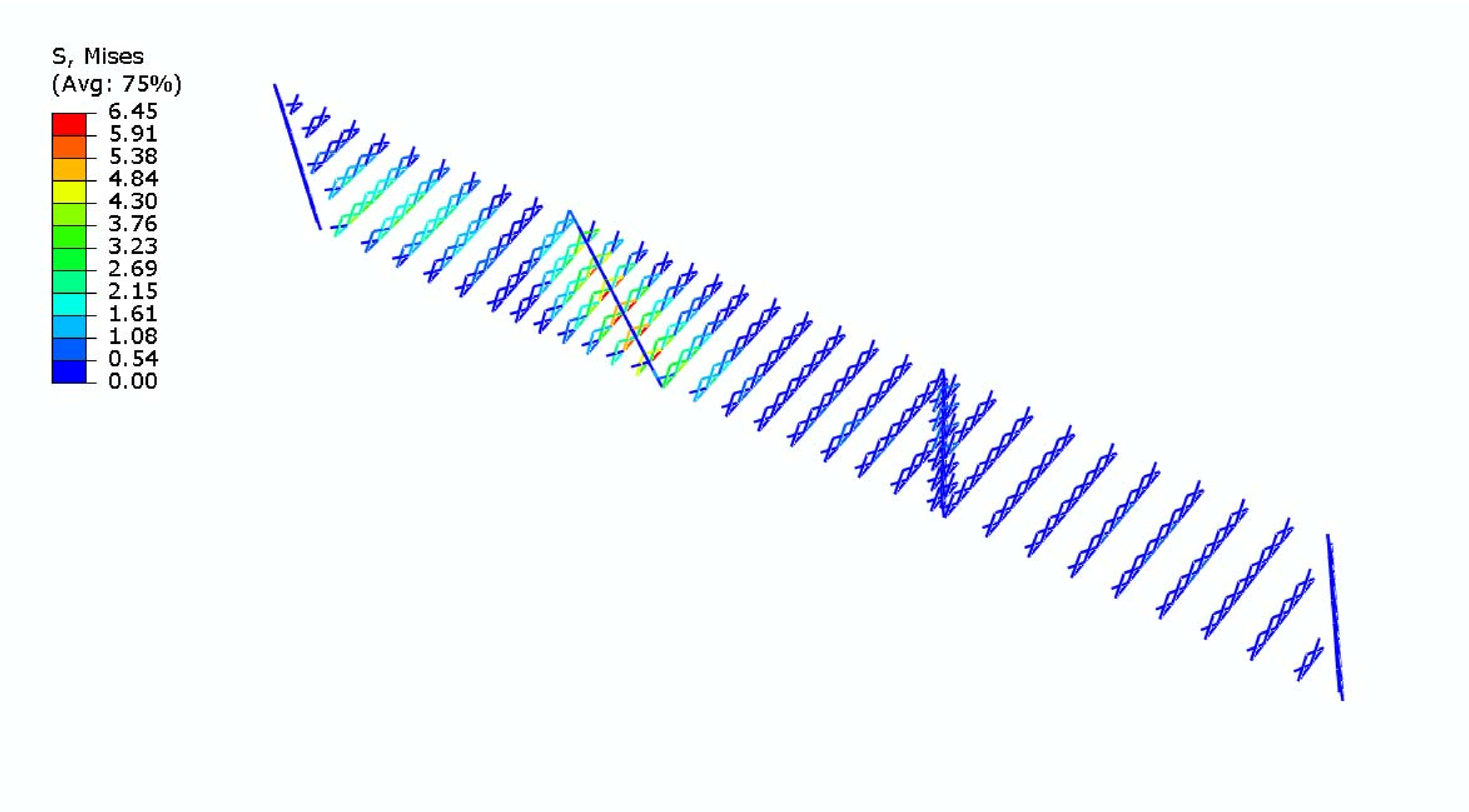


Figure M1-4-23. Cross-frame stress contours (ksi) under SDL, NLF detailing

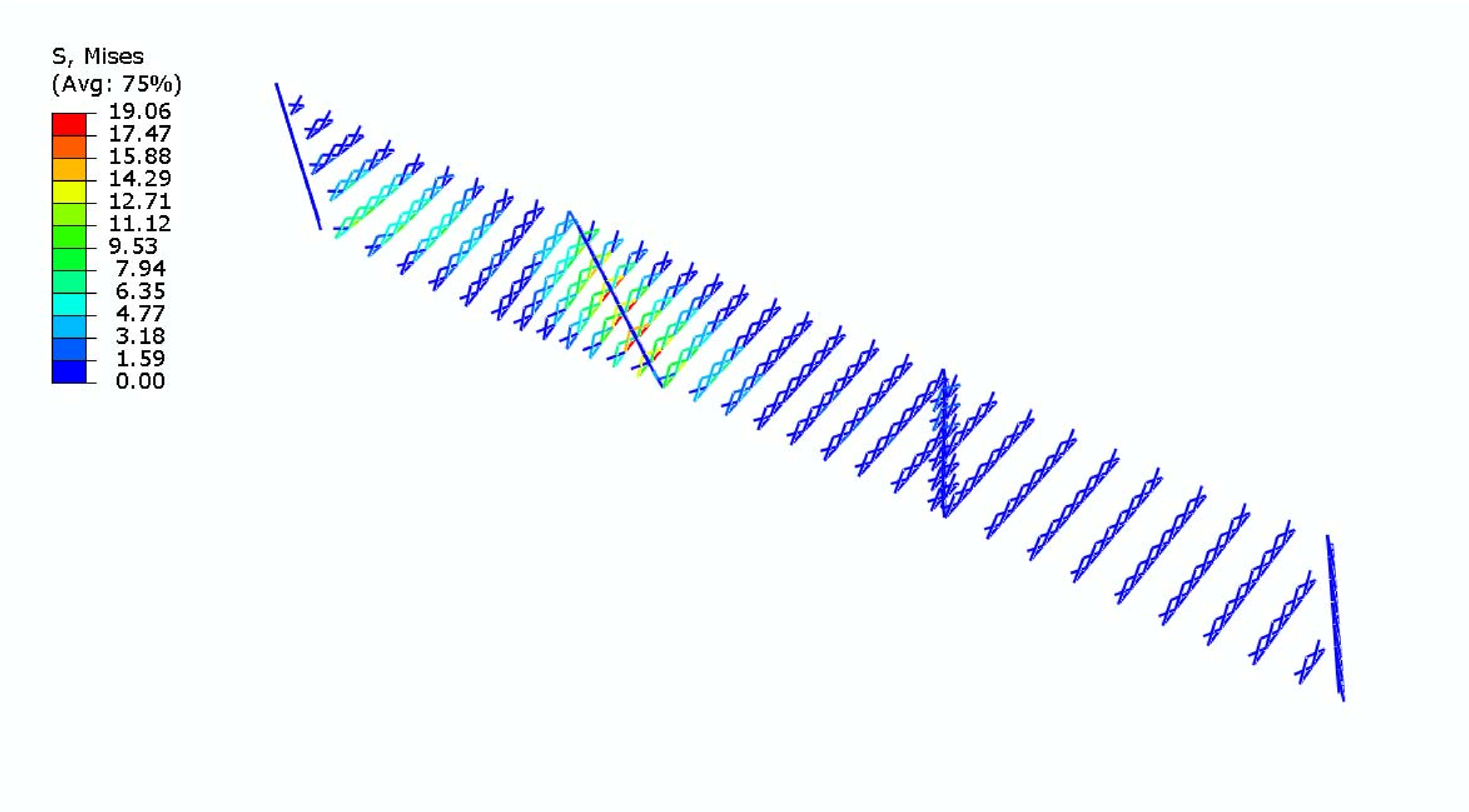


Figure M1-4-24. **Cross-frame stress contours under TDL, NLF detailing**

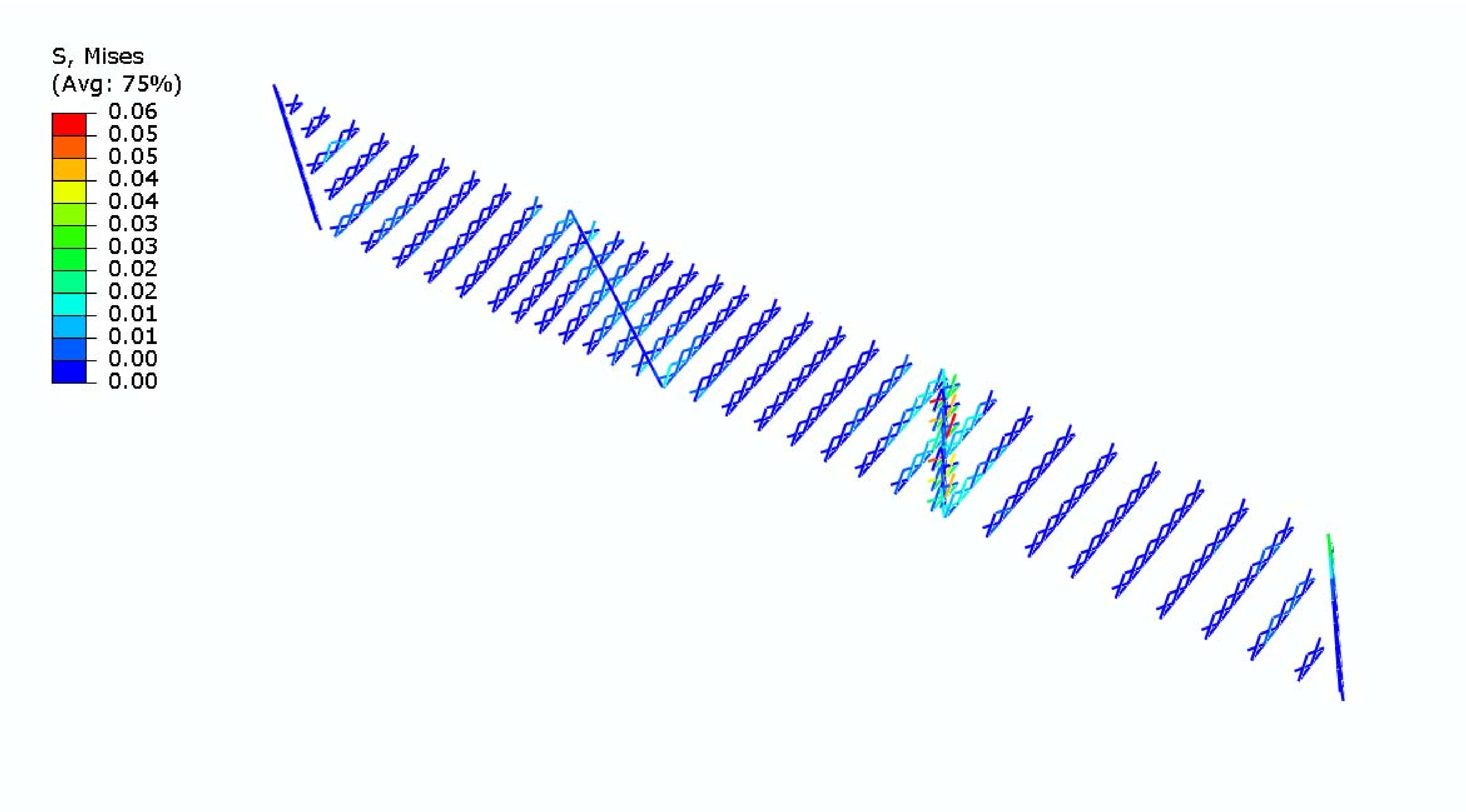


Figure M1-4-25. Cross-frame stress contours under SDL, SDLF detailing

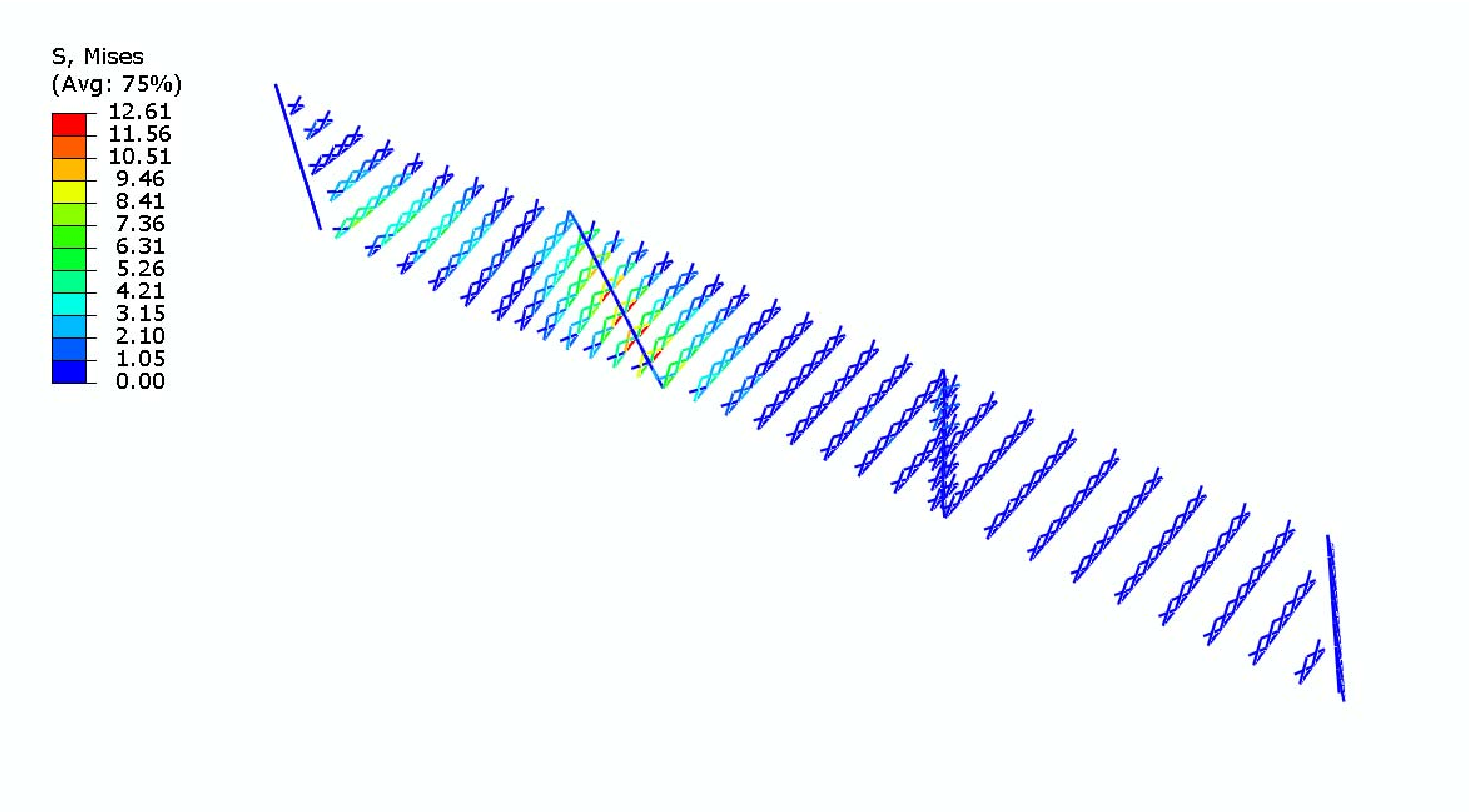


Figure M1-4-26. Cross-frame stress contours under TDL, SDLF detailing

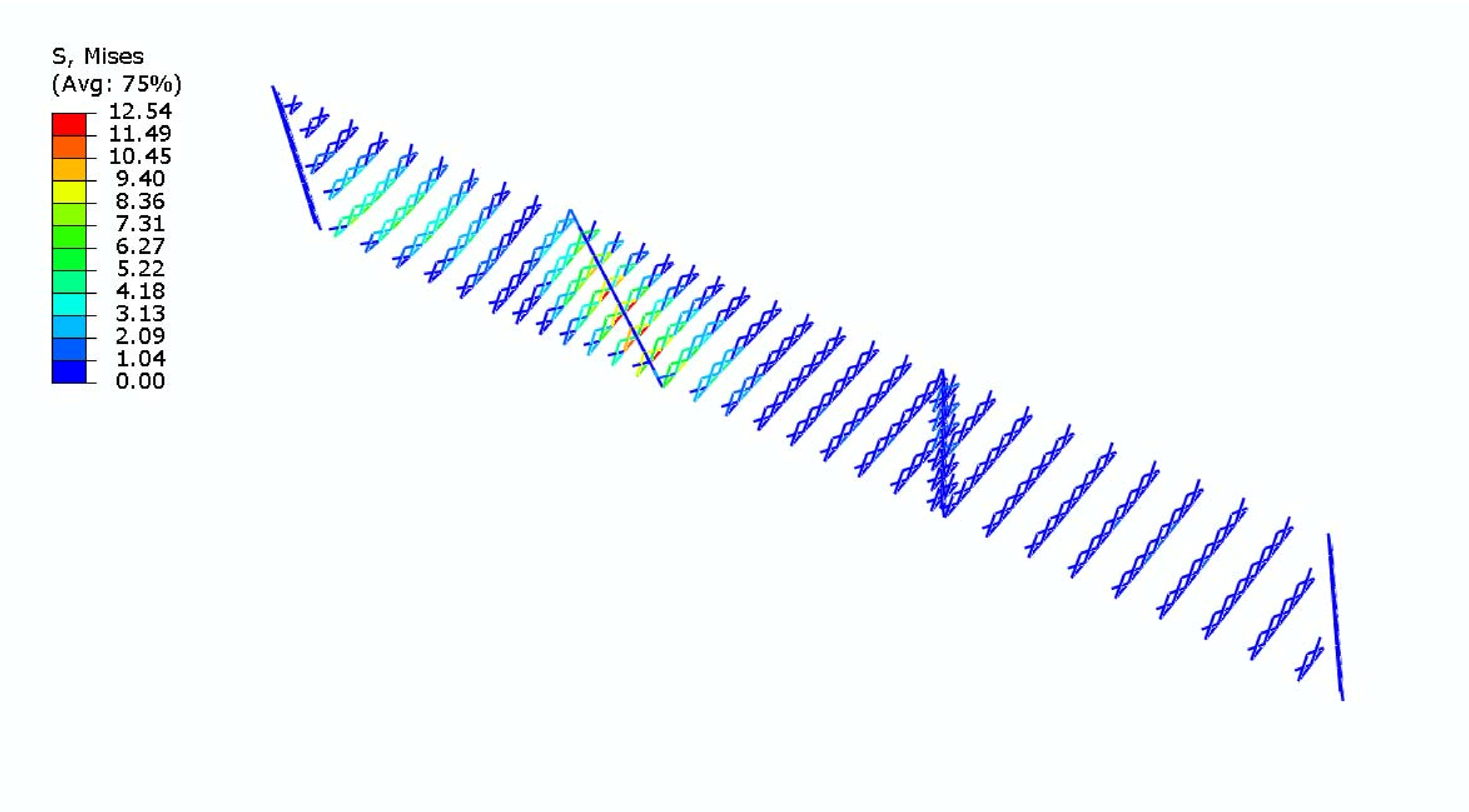


Figure M1-4-27. Cross-frame stress contours under SDL, TDLF detailing

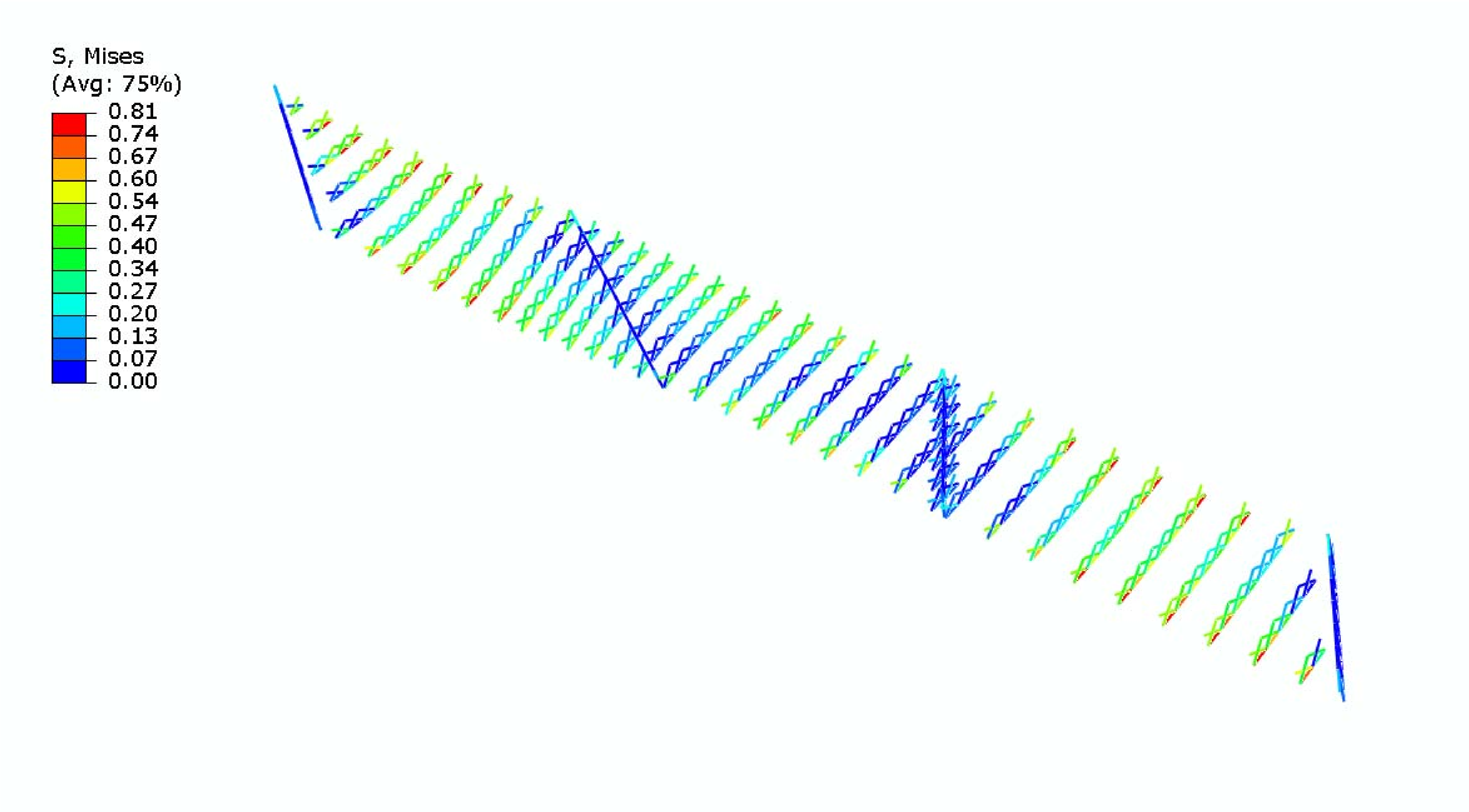


Figure M1-4-28. Cross-frame stress contours under TDL, TDLF

Table M1-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	1.3	0.6	0.4	0.4	0.6	1.1	1.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	2.7	1.2	0.7	0.7	1.1	2.2	2.2
2	NLF	19.4	21.5	13.2	5.6	5.3	2.1	2.3
	SDLF	0.1	0.1	0.0	0.0	0.1	0.0	0.0
	TDLF	40.0	43.8	26.0	10.0	9.4	5.4	5.0
3	NLF	8.7	16.5	20.9	12.8	11.1	3.7	1.6
	SDLF	0.0	0.0	0.1	0.0	0.0	0.1	0.0
	TDLF	17.4	33.2	42.6	25.2	21.5	6.0	4.2
4	NLF	4.9	12.0	17.8	15.8	14.7	8.5	2.6
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	9.5	23.7	35.6	31.4	28.8	16.0	4.5
5	NLF	3.6	8.4	15.9	17.8	16.3	11.3	4.4
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	6.6	16.4	31.8	35.5	32.3	21.9	8.2
6	NLF	2.6	5.1	11.6	15.9	15.4	12.6	5.5
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	4.7	9.8	23.3	31.8	30.8	24.7	10.5
7	NLF	1.3	1.3	5.8	11.7	11.1	12.1	6.4
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	2.0	2.1	11.6	23.4	22.8	24.1	12.4
8	NLF	0.3	4.2	2.7	5.8	3.4	8.1	6.6
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	1.2	8.8	5.2	11.6	7.7	16.9	12.9
9	NLF	3.1	11.3	11.1	8.5	11.0	2.4	3.7
	SDLF	0.0	0.0	0.0	0.0	0.1	0.0	0.0
	TDLF	6.7	23.0	22.0	15.9	20.8	4.5	7.5
10	NLF	7.9	16.6	17.4	14.8	18.4	12.1	3.0
	SDLF	0.0	0.0	0.0	0.0	0.1	0.1	0.0
	TDLF	16.2	34.3	35.4	29.4	34.9	22.9	5.6

Table M1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	11.0	25.4	25.9	23.2	34.5	29.0	10.5
	SDLF	0.0	0.1	0.1	0.1	0.1	0.0	0.1
	TDLF	23.2	50.8	51.1	44.9	63.3	51.3	18.9
12	NLF	19.8	42.1	41.7	39.0	1.1	1.0	6.4
	SDLF	0.1	0.1	0.1	0.1	0.0	0.0	0.1
	TDLF	40.1	80.0	78.5	72.6	2.3	2.2	10.8
13	NLF	39.1	0.9	0.9	1.0	38.6	34.1	27.5
	SDLF	0.1	0.0	0.0	0.0	0.1	0.1	0.1
	TDLF	74.5	2.0	1.8	2.0	71.7	62.3	48.3
14	NLF	12.0	40.9	41.7	41.3	23.1	18.6	12.3
	SDLF	0.1	0.0	0.1	0.1	0.1	0.0	0.0
	TDLF	23.2	77.8	78.9	77.5	45.7	36.2	22.9
15	NLF	25.3	25.7	26.2	25.5	14.7	10.9	5.7
	SDLF	0.1	0.1	0.1	0.1	0.0	0.0	0.0
	TDLF	51.8	52.0	52.6	50.9	31.1	22.9	11.6
16	NLF	11.8	11.8	19.0	17.2	9.1	5.8	1.6
	SDLF	0.1	0.0	0.1	0.0	0.0	0.0	0.0
	TDLF	25.4	26.1	39.9	36.3	20.4	13.3	3.9
17	NLF	3.8	6.1	11.6	11.4	7.2	5.1	2.8
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	9.8	15.7	25.7	25.2	17.8	13.1	7.4
18	NLF	0.3	0.8	6.0	8.2	2.6	2.2	1.2
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	1.5	1.6	15.7	20.2	8.0	6.9	4.0
19	NLF	2.9	4.0	1.7	2.5	2.2	1.2	0.3
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	4.4	6.4	1.3	7.7	2.8	1.5	0.6
20	NLF	3.6	4.7	4.1	2.7	2.8	2.2	1.2
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	6.5	8.3	6.5	3.5	4.2	2.8	1.5

Table M1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	2.6	3.4	4.6	3.7	3.2	2.7	1.6
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	4.6	6.1	8.1	5.8	5.2	4.1	2.5
22	NLF	1.5	1.3	3.2	3.9	2.5	2.4	1.6
	SDLF	0.0	0.1	0.1	0.1	0.0	0.0	0.0
	TDLF	2.7	2.1	5.8	6.7	3.9	3.8	2.5
23	NLF	3.1	3.4	0.6	2.1	0.9	1.1	1.3
	SDLF	0.2	0.3	0.1	0.1	0.1	0.0	0.0
	TDLF	5.4	6.0	1.5	3.6	2.6	1.5	2.1
24	NLF	1.3	1.1	3.9	4.7	5.0	2.1	0.1
	SDLF	0.2	0.1	0.4	0.2	0.4	0.1	0.0
	TDLF	2.3	2.2	7.0	9.3	9.6	4.5	0.4
25	NLF	2.9	3.7	1.4	1.4	1.6	5.1	3.6
	SDLF	0.1	0.4	0.1	0.1	0.0	0.5	0.1
	TDLF	4.9	6.4	2.6	2.7	3.2	9.7	6.6
26	NLF	0.5	0.8	4.2	4.7	5.1	1.4	2.2
	SDLF	0.0	0.1	0.3	0.1	0.5	0.1	0.2
	TDLF	0.9	1.1	7.7	9.1	9.4	2.7	4.6
27	NLF	1.2	0.8	0.8	0.6	2.0	5.5	5.5
	SDLF	0.0	0.1	0.1	0.0	0.1	0.4	0.2
	TDLF	2.0	1.2	1.4	1.4	4.1	10.6	11.2
28	NLF	1.5	1.9	0.8	1.2	0.2	1.4	0.5
	SDLF	0.0	0.0	0.0	0.0	0.1	0.1	0.0
	TDLF	2.6	3.5	1.3	1.9	0.8	3.7	2.1
29	NLF	1.5	2.6	2.4	2.5	1.4	0.6	0.6
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	2.6	4.8	4.5	4.6	2.1	0.5	0.2
30	NLF	1.4	2.8	3.2	3.2	2.5	1.4	1.2
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	2.3	5.0	6.1	6.0	4.6	2.2	1.6

Table M1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	1.2	2.6	3.5	3.5	3.2	2.3	1.3
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	1.9	4.4	6.3	6.3	6.0	3.9	2.2
32	NLF	0.7	1.9	3.1	3.1	3.4	2.6	1.4
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.9	3.0	5.5	5.5	6.3	4.7	2.4
33	NLF	0.9	0.7	2.1	2.1	3.0	2.7	1.4
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	2.7	0.9	3.5	3.5	5.5	4.9	2.5
34	NLF	0.4	0.7	0.5	0.6	2.0	2.3	1.3
	SDLF	0.0	0.0	0.1	0.0	0.1	0.0	0.0
	TDLF	0.9	2.4	0.3	0.6	3.5	4.4	2.3
35	NLF	NA	0.5	0.5	0.4	0.4	1.5	0.8
	SDLF	NA	0.0	0.0	0.0	0.0	0.1	0.0
	TDLF	NA	0.9	0.9	0.8	0.5	3.1	2.0
36	NLF	NA	NA	NA	NA	0.4	0.5	0.9
	SDLF	NA	NA	NA	NA	0.0	0.1	0.2
	TDLF	NA	NA	NA	NA	0.9	0.8	1.3

Table M1-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	4.8	2.0	1.1	1.2	1.8	3.7	4.7
	SDLF	3.5	1.4	0.7	0.8	1.3	2.7	3.6
	TDLF	0.8	0.2	0.0	0.1	0.1	0.4	1.4
2	NLF	59.8	64.8	38.1	13.8	12.9	11.7	7.9
	SDLF	40.5	43.2	25.0	8.3	7.7	9.6	5.6
	TDLF	3.2	0.5	1.0	1.7	4.0	4.2	4.3
3	NLF	23.2	47.8	63.0	37.0	30.2	5.8	9.9
	SDLF	14.4	31.3	42.0	24.2	19.1	2.0	8.3
	TDLF	4.6	3.0	1.6	2.4	3.6	3.9	4.2
4	NLF	10.4	32.7	51.6	45.7	40.9	20.8	4.3
	SDLF	5.4	20.7	33.7	29.8	26.2	12.3	4.3
	TDLF	4.3	4.1	1.9	2.5	3.4	4.1	4.4
5	NLF	6.0	21.5	45.4	51.4	46.1	29.8	8.5
	SDLF	4.3	13.0	29.5	33.6	29.8	18.5	4.3
	TDLF	4.3	4.2	2.9	2.4	3.1	4.1	4.3
6	NLF	4.4	11.7	32.6	45.4	44.1	34.3	12.0
	SDLF	4.4	6.5	21.0	29.5	28.7	21.6	6.4
	TDLF	4.4	3.9	3.3	2.2	2.6	3.9	4.3
7	NLF	3.8	1.3	15.1	32.8	32.3	33.6	14.9
	SDLF	3.8	2.0	9.3	21.1	21.1	21.5	8.5
	TDLF	3.8	3.5	3.3	2.3	1.7	3.5	4.3
8	NLF	4.6	15.6	9.9	15.1	9.7	23.4	15.9
	SDLF	4.3	11.5	7.3	9.3	6.3	15.2	9.4
	TDLF	3.2	3.2	2.9	2.3	1.4	2.8	4.4
9	NLF	12.6	36.5	34.9	25.5	32.2	8.3	8.4
	SDLF	9.5	25.2	23.8	17.0	21.2	6.0	4.7
	TDLF	3.1	2.8	2.6	2.1	1.1	1.5	4.3
10	NLF	26.6	52.7	54.3	45.2	53.7	35.4	10.2
	SDLF	18.7	36.1	36.9	30.4	35.2	23.2	7.2
	TDLF	3.1	2.5	2.2	1.8	1.0	0.3	4.1

Table M1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	36.3	77.4	78.0	68.8	98.1	80.3	29.1
	SDLF	25.3	52.0	52.1	45.6	63.5	51.2	18.5
	TDLF	3.0	2.1	1.8	1.4	0.8	0.5	3.5
12	NLF	61.3	122.7	120.6	111.9	3.3	3.2	15.5
	SDLF	41.4	80.5	78.9	72.9	2.2	2.3	9.0
	TDLF	3.3	1.5	1.3	1.1	0.1	0.1	1.8
13	NLF	114.4	2.9	2.7	3.1	110.7	96.6	76.1
	SDLF	75.4	2.0	1.8	2.1	72.0	62.5	48.6
	TDLF	2.7	0.0	0.1	0.0	1.0	1.1	2.7
14	NLF	33.7	119.2	121.2	119.3	69.6	55.8	36.2
	SDLF	21.7	78.3	79.4	78.0	46.4	37.1	23.8
	TDLF	1.5	0.6	0.6	0.8	1.4	1.9	3.2
15	NLF	77.3	78.0	79.2	77.0	46.8	35.2	19.1
	SDLF	51.9	52.2	52.9	51.4	32.1	24.3	13.4
	TDLF	3.4	0.3	0.6	1.0	1.9	2.4	3.2
16	NLF	38.7	38.7	59.2	54.1	30.7	21.0	7.9
	SDLF	26.8	26.9	40.2	36.8	21.6	15.2	6.3
	TDLF	3.5	1.3	0.6	1.3	2.2	2.7	3.1
17	NLF	15.8	22.9	37.8	37.2	26.4	20.4	12.8
	SDLF	11.9	16.8	26.2	25.8	19.2	15.3	10.0
	TDLF	4.0	2.2	0.7	1.4	2.3	2.9	3.3
18	NLF	4.1	4.1	22.8	29.2	11.8	11.4	8.1
	SDLF	4.4	4.4	16.8	20.9	9.2	9.1	6.9
	TDLF	3.7	2.9	1.1	1.3	2.2	3.1	3.1
19	NLF	4.3	8.9	2.4	10.8	3.2	1.9	3.5
	SDLF	4.0	4.9	2.3	8.3	1.5	2.6	3.7
	TDLF	4.0	3.0	1.4	0.9	1.8	3.2	3.5
20	NLF	7.3	11.9	9.2	5.7	5.8	3.2	4.0
	SDLF	3.8	7.2	5.5	3.0	3.0	1.0	4.0
	TDLF	3.7	2.8	1.5	0.5	1.2	3.0	4.0

Table M1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	5.0	8.9	11.6	9.1	8.5	5.7	3.7
	SDLF	4.1	5.6	7.0	5.4	5.3	3.0	3.8
	TDLF	4.0	2.0	1.1	0.3	0.4	2.6	3.7
22	NLF	4.4	3.8	8.5	10.6	6.8	5.9	3.9
	SDLF	4.3	2.6	5.3	6.8	4.4	3.5	3.9
	TDLF	4.1	1.1	0.5	0.4	0.4	1.8	4.0
23	NLF	7.9	8.9	1.8	5.8	3.0	2.9	3.6
	SDLF	4.8	5.5	1.1	3.8	1.9	1.8	3.7
	TDLF	1.6	1.1	0.5	0.5	0.6	0.6	3.8
24	NLF	1.4	3.4	10.7	13.3	14.5	6.2	4.0
	SDLF	0.6	2.3	6.8	8.4	9.4	4.0	3.9
	TDLF	2.2	0.1	1.4	0.7	1.3	0.3	3.6
25	NLF	10.0	9.8	4.1	4.3	4.9	14.8	12.3
	SDLF	7.3	6.2	2.8	3.0	3.3	9.7	8.7
	TDLF	2.3	1.3	0.2	0.2	0.1	1.5	2.1
26	NLF	4.6	2.0	11.6	13.1	14.7	4.3	4.7
	SDLF	4.4	1.4	7.4	8.3	9.7	3.0	2.4
	TDLF	4.2	0.7	1.1	0.7	1.2	0.2	2.1
27	NLF	3.9	1.7	2.5	2.1	5.8	16.2	16.7
	SDLF	4.0	1.0	1.7	1.6	3.9	10.7	11.0
	TDLF	4.3	0.9	0.6	0.5	0.8	1.0	1.6
28	NLF	4.4	4.1	1.9	1.9	2.0	5.1	4.6
	SDLF	4.4	2.2	1.1	0.9	2.0	3.8	4.4
	TDLF	4.4	2.5	0.4	1.2	1.3	1.6	4.1
29	NLF	4.3	5.0	5.7	5.6	2.0	2.2	4.3
	SDLF	4.3	2.4	3.3	3.2	0.8	2.7	4.2
	TDLF	4.3	3.5	1.3	2.0	2.2	2.6	4.1
30	NLF	4.3	4.7	7.2	7.2	5.1	1.3	4.3
	SDLF	4.3	1.8	4.0	3.9	2.6	2.0	4.4
	TDLF	4.3	3.9	2.4	2.5	3.0	3.5	4.4

Table M1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	4.3	3.6	7.2	7.2	6.7	3.2	4.3
	SDLF	4.3	1.7	3.7	3.7	3.5	1.7	4.3
	TDLF	4.3	4.0	3.1	2.6	3.4	3.9	4.3
32	NLF	4.2	1.5	5.8	6.2	7.1	4.0	4.3
	SDLF	4.2	2.1	2.8	3.2	3.6	1.7	4.3
	TDLF	4.3	4.0	3.4	2.7	3.2	4.1	4.3
33	NLF	6.4	2.0	3.2	3.9	6.2	4.3	4.3
	SDLF	5.6	2.7	1.1	2.0	3.2	1.6	4.3
	TDLF	4.7	3.6	3.3	2.4	2.4	4.0	4.3
34	NLF	2.3	6.0	2.2	0.4	3.9	4.2	4.4
	SDLF	1.9	5.3	2.7	0.9	2.0	1.9	4.4
	TDLF	1.0	2.9	2.9	1.5	1.5	3.4	4.4
35	NLF	NA	1.6	1.6	1.3	0.4	3.5	4.4
	SDLF	NA	1.2	1.1	0.9	0.2	1.9	4.3
	TDLF	NA	0.3	0.2	0.1	0.5	1.5	4.3
36	NLF	NA	NA	NA	NA	1.2	1.9	2.2
	SDLF	NA	NA	NA	NA	0.8	1.5	1.6
	TDLF	NA	NA	NA	NA	0.2	0.6	0.9

Table M1-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	0.4	0.0	0.0	0.0	0.0	0.1	0.4
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.8	0.1	0.1	0.0	0.0	0.3	0.7
2	NLF	5.0	10.0	3.3	1.4	2.2	0.7	0.6
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	10.4	20.4	6.6	2.4	3.7	1.6	1.2
3	NLF	2.1	6.4	9.1	6.0	4.9	1.6	0.4
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	4.2	12.9	18.3	11.7	9.4	2.7	1.0
4	NLF	1.3	4.2	8.7	7.6	6.4	3.2	0.6
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	2.4	8.2	17.4	14.9	12.6	6.0	1.1
5	NLF	0.9	3.0	6.9	8.5	7.2	4.2	1.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	1.6	5.7	13.8	17.0	14.3	8.0	2.1
6	NLF	0.7	2.0	5.0	7.8	6.8	4.8	1.4
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	1.2	3.7	9.8	15.6	13.7	9.3	2.6
7	NLF	0.3	0.5	2.8	5.6	4.7	4.6	1.6
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.5	0.8	5.4	11.4	9.7	9.2	3.1
8	NLF	0.1	1.1	0.4	2.3	0.4	2.9	1.6
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.3	2.5	1.0	4.8	1.4	5.9	3.2
9	NLF	0.8	3.6	3.8	2.7	4.8	1.1	1.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	1.7	7.4	7.7	5.1	9.1	1.7	2.0
10	NLF	1.9	6.1	7.2	6.6	8.3	5.6	0.7
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	4.0	12.7	14.7	13.0	16.0	10.3	1.4

Table M1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	2.8	9.0	10.6	10.1	14.3	11.7	4.2
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	5.9	18.3	21.3	19.9	26.9	21.3	7.3
12	NLF	5.1	15.5	16.6	16.1	0.3	0.3	1.3
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	10.1	30.0	32.2	30.8	0.6	0.4	2.0
13	NLF	9.3	0.3	0.4	0.3	14.4	11.7	6.4
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	18.0	0.5	0.8	0.6	27.2	21.4	11.4
14	NLF	2.7	16.9	17.0	16.2	8.5	6.1	3.2
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	5.1	33.0	32.8	31.0	17.1	12.0	5.9
15	NLF	8.4	11.1	10.9	10.2	5.2	3.1	1.4
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	16.6	22.8	22.4	20.6	11.2	6.7	2.8
16	NLF	3.1	5.8	7.6	6.6	3.6	2.2	0.5
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	6.7	12.9	16.2	14.2	8.5	5.3	1.1
17	NLF	1.0	2.5	5.0	4.7	2.3	1.6	0.7
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	2.4	6.4	11.6	10.9	6.2	4.3	1.8
18	NLF	0.1	0.3	2.1	2.7	0.4	0.5	0.3
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.3	0.6	5.8	7.0	2.1	1.9	1.0
19	NLF	0.7	1.7	0.6	0.4	0.8	0.5	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	1.1	2.7	0.1	2.1	0.6	0.3	0.1
20	NLF	0.9	2.0	1.9	1.1	1.4	1.0	0.3
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	1.6	3.7	3.0	1.2	1.9	1.4	0.4

Table M1-4-3(Continued).   Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	0.7	1.6	2.1	1.7	1.4	1.1	0.4
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	1.2	2.9	3.8	2.7	2.2	1.7	0.7
22	NLF	0.3	0.6	1.6	1.6	1.0	0.9	0.4
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.6	1.1	2.9	2.7	1.5	1.4	0.6
23	NLF	0.5	0.7	0.1	0.9	0.1	0.4	0.3
	SDLF	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	TDLF	1.0	1.4	0.2	1.5	0.1	0.5	0.5
24	NLF	0.7	0.5	0.8	1.2	1.2	0.4	0.1
	SDLF	0.0	0.0	0.1	0.0	0.1	0.0	0.0
	TDLF	1.2	0.9	1.6	2.3	2.5	1.1	0.0
25	NLF	0.6	0.8	0.5	0.4	0.4	1.2	0.9
	SDLF	0.0	0.1	0.0	0.1	0.0	0.1	0.0
	TDLF	1.0	1.5	0.7	0.4	0.6	2.5	1.8
26	NLF	0.2	0.2	0.9	1.4	1.2	0.4	0.7
	SDLF	0.0	0.0	0.1	0.0	0.1	0.0	0.0
	TDLF	0.2	0.3	1.9	2.8	2.5	0.5	1.3
27	NLF	0.3	0.4	0.2	0.1	0.7	1.3	1.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.1	0.1
	TDLF	0.5	0.6	0.4	0.5	1.6	2.8	2.3
28	NLF	0.4	0.8	0.3	0.4	0.0	0.4	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.6	1.3	0.6	0.8	0.3	1.3	0.5
29	NLF	0.4	1.0	1.0	1.2	0.6	0.2	0.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.6	1.8	2.0	2.2	1.0	0.1	0.0
30	NLF	0.4	1.1	1.5	1.6	1.2	0.6	0.3
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.6	1.9	2.7	3.0	2.1	0.9	0.4

Table M1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	0.3	1.0	1.6	1.7	1.5	0.9	0.3
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.5	1.7	2.8	3.2	2.7	1.5	0.5
32	NLF	0.2	0.8	1.4	1.5	1.5	1.0	0.4
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.2	1.2	2.5	2.8	2.8	1.8	0.6
33	NLF	0.2	0.3	1.0	1.0	1.3	1.0	0.3
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.6	0.3	1.6	1.8	2.5	1.8	0.6
34	NLF	0.2	0.3	0.2	0.2	0.9	0.9	0.3
	SDLF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	0.3	0.8	0.1	0.1	1.6	1.7	0.6
35	NLF	NA	0.2	0.1	0.1	0.0	0.5	0.2
	SDLF	NA	0.0	0.0	0.0	0.0	0.0	0.0
	TDLF	NA	0.4	0.2	0.3	0.0	1.1	0.4
36	NLF	NA	NA	NA	NA	0.1	0.0	0.1
	SDLF	NA	NA	NA	NA	0.0	0.0	0.0
	TDLF	NA	NA	NA	NA	0.3	0.2	0.3

Table M1-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	1.4	0.2	0.1	0.0	0.0	0.5	0.7
	SDLF	1.1	0.2	0.1	0.0	0.0	0.4	0.3
	TDLF	0.3	0.0	0.0	0.0	0.0	0.1	0.4
2	NLF	14.7	30.3	9.7	3.4	4.4	3.4	3.0
	SDLF	9.7	20.4	6.4	2.0	2.2	2.7	2.4
	TDLF	0.7	0.0	0.2	0.4	1.4	1.1	1.2
3	NLF	4.4	18.1	26.9	16.8	12.8	2.3	3.5
	SDLF	2.3	11.7	17.8	10.8	7.9	0.7	3.1
	TDLF	1.9	1.2	0.5	0.8	1.5	1.9	2.1
4	NLF	1.6	10.7	25.1	21.5	17.5	7.3	0.3
	SDLF	0.3	6.5	16.4	13.9	11.1	4.1	1.0
	TDLF	2.1	1.7	0.9	1.0	1.5	1.9	2.1
5	NLF	0.4	6.8	19.5	24.5	20.1	10.4	1.1
	SDLF	0.5	3.8	12.5	15.9	12.9	6.2	0.0
	TDLF	2.1	1.9	1.3	1.1	1.4	1.9	2.1
6	NLF	0.2	3.8	13.4	22.3	19.4	12.3	1.9
	SDLF	0.9	1.9	8.4	14.5	12.5	7.5	0.5
	TDLF	2.1	1.8	1.4	1.1	1.2	1.7	2.1
7	NLF	0.9	0.3	6.8	16.0	13.5	12.3	2.7
	SDLF	1.3	0.8	4.0	10.4	8.8	7.7	1.1
	TDLF	1.8	1.6	1.4	1.0	0.9	1.5	2.0
8	NLF	1.9	5.1	2.7	6.2	1.2	7.6	2.9
	SDLF	1.8	4.0	2.2	3.9	0.8	4.8	1.2
	TDLF	1.5	1.4	1.2	0.9	0.6	1.1	2.0
9	NLF	3.9	12.2	12.6	8.6	14.3	3.3	1.2
	SDLF	3.2	8.6	8.8	5.9	9.5	2.2	0.2
	TDLF	1.5	1.3	1.1	0.8	0.4	0.6	1.8
10	NLF	7.3	19.9	22.9	20.2	24.6	16.0	3.5
	SDLF	5.4	13.8	15.6	13.7	16.3	10.3	2.8
	TDLF	1.4	1.1	0.9	0.7	0.3	0.1	1.4

Table M1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	10.0	28.2	32.5	30.6	41.5	33.0	12.3
	SDLF	7.2	19.2	21.9	20.5	27.1	21.3	8.1
	TDLF	1.3	0.8	0.7	0.5	0.3	0.1	0.9
12	NLF	16.4	46.1	49.3	47.3	0.9	0.7	2.9
	SDLF	11.4	30.6	32.6	31.1	0.6	0.5	1.7
	TDLF	1.2	0.6	0.5	0.4	0.0	0.0	0.4
13	NLF	28.1	0.8	1.2	0.9	41.9	33.5	18.4
	SDLF	18.8	0.5	0.8	0.6	27.5	21.8	12.0
	TDLF	0.8	0.1	0.0	0.0	0.3	0.4	0.7
14	NLF	7.6	50.1	50.1	47.5	26.2	18.8	10.2
	SDLF	4.9	33.2	33.1	31.3	17.7	12.7	7.0
	TDLF	0.2	0.2	0.3	0.3	0.5	0.7	1.1
15	NLF	25.9	34.2	33.6	31.2	17.1	10.8	5.4
	SDLF	17.6	23.0	22.6	21.0	11.9	7.7	4.1
	TDLF	1.0	0.2	0.3	0.4	0.7	1.0	1.3
16	NLF	11.0	19.2	24.1	21.3	13.0	8.6	3.0
	SDLF	7.9	13.3	16.5	14.7	9.4	6.4	2.5
	TDLF	1.2	0.5	0.3	0.5	0.9	1.2	1.4
17	NLF	4.9	9.7	16.9	16.1	9.4	7.2	4.0
	SDLF	4.0	7.2	11.9	11.4	7.1	5.6	3.3
	TDLF	1.6	0.8	0.3	0.5	0.9	1.3	1.5
18	NLF	1.9	1.4	8.4	10.2	3.4	3.7	2.8
	SDLF	2.0	1.7	6.3	7.5	2.9	3.2	2.5
	TDLF	1.7	1.1	0.4	0.5	0.9	1.3	1.5
19	NLF	0.1	3.3	0.2	2.9	0.7	0.6	1.7
	SDLF	0.7	1.5	0.4	2.4	0.1	1.1	1.8
	TDLF	1.8	1.1	0.5	0.4	0.7	1.3	1.7
20	NLF	0.8	4.7	4.4	2.0	2.9	1.1	1.1
	SDLF	0.1	2.7	2.5	0.9	1.5	0.1	1.4
	TDLF	1.6	1.0	0.5	0.2	0.4	1.2	1.8

Table M1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	0.4	3.8	5.6	4.3	3.5	1.8	0.7
	SDLF	0.3	2.2	3.5	2.6	2.1	0.7	1.1
	TDLF	1.5	0.6	0.3	0.1	0.1	0.9	1.7
22	NLF	0.3	1.6	4.4	4.4	2.6	1.7	0.6
	SDLF	0.6	1.0	2.9	2.8	1.6	0.8	1.0
	TDLF	1.2	0.1	0.0	0.1	0.1	0.6	1.7
23	NLF	1.9	1.8	0.4	2.7	0.4	0.8	0.6
	SDLF	1.3	1.0	0.3	1.8	0.3	0.4	0.9
	TDLF	0.3	0.3	0.1	0.3	0.3	0.1	1.4
24	NLF	1.5	1.5	2.0	3.2	3.4	1.3	1.0
	SDLF	0.8	1.0	1.2	2.0	2.1	0.9	1.1
	TDLF	0.4	0.1	0.3	0.2	0.3	0.2	1.1
25	NLF	1.9	2.0	1.2	1.0	1.0	3.4	3.1
	SDLF	1.3	1.1	0.8	0.7	0.6	2.2	2.2
	TDLF	0.3	0.3	0.0	0.2	0.1	0.3	0.4
26	NLF	0.9	0.2	2.5	4.1	3.5	1.0	1.7
	SDLF	1.0	0.0	1.5	2.6	2.3	0.6	1.0
	TDLF	1.3	0.3	0.3	0.1	0.2	0.1	0.3
27	NLF	0.9	0.8	0.4	0.6	2.4	4.0	3.8
	SDLF	1.2	0.4	0.2	0.4	1.7	2.6	2.7
	TDLF	1.7	0.3	0.2	0.0	0.1	0.2	0.4
28	NLF	0.9	1.1	0.8	0.8	0.6	2.1	2.0
	SDLF	1.3	0.4	0.5	0.4	0.6	1.6	1.8
	TDLF	2.0	1.0	0.2	0.4	0.4	0.4	1.3
29	NLF	1.0	1.4	2.4	2.6	0.8	0.8	1.5
	SDLF	1.4	0.4	1.3	1.4	0.2	1.0	1.7
	TDLF	2.0	1.5	0.6	0.8	0.9	1.0	1.7
30	NLF	1.1	1.2	3.0	3.5	2.0	0.1	1.3
	SDLF	1.5	0.1	1.6	1.9	0.9	0.5	1.6
	TDLF	2.1	1.8	1.1	1.1	1.2	1.4	2.0

Table M1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	1.3	0.8	3.0	3.6	2.7	0.7	1.2
	SDLF	1.6	0.2	1.4	1.8	1.2	0.2	1.5
	TDLF	2.1	1.9	1.4	1.3	1.5	1.7	2.1
32	NLF	1.6	0.2	2.4	3.0	2.8	0.9	1.1
	SDLF	1.8	0.6	0.9	1.5	1.3	0.1	1.5
	TDLF	2.0	1.8	1.5	1.2	1.5	1.9	2.1
33	NLF	2.8	1.0	1.2	1.8	2.6	1.0	1.1
	SDLF	2.5	1.4	0.2	0.8	1.3	0.0	1.5
	TDLF	1.9	1.6	1.4	1.0	1.2	1.8	2.1
34	NLF	0.1	1.9	0.8	0.3	1.8	1.2	1.0
	SDLF	0.0	1.6	1.1	0.4	1.0	0.2	1.4
	TDLF	0.3	0.8	1.1	0.5	0.7	1.5	2.0
35	NLF	NA	0.5	0.4	0.4	0.2	1.0	0.9
	SDLF	NA	0.3	0.2	0.3	0.2	0.5	1.0
	TDLF	NA	0.0	0.0	0.0	0.1	0.7	1.4
36	NLF	NA	NA	NA	NA	0.4	0.0	0.0
	SDLF	NA	NA	NA	NA	0.3	0.1	0.1
	TDLF	NA	NA	NA	NA	0.0	0.2	0.4

Table M1-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	4.5	0.5	0.6	1.1	1.5	3.0	1.5
	SDLF	0.1	0.1	0.1	0.1	0.1	0.1	0.0
	TDLF	9.2	1.0	1.2	2.0	3.0	6.1	3.4
2	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
3	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
4	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
5	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
6	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
7	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
8	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
9	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
10	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA

Table M1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
12	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
13	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
14	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
15	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
16	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
17	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
18	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
19	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
20	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA

Table M1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
22	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
23	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
24	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
25	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
26	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
27	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
28	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
29	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
30	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA

Table M1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
32	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
33	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
34	NLF	1.2	NA	NA	NA	NA	NA	NA
	SDLF	0.1	NA	NA	NA	NA	NA	NA
	TDLF	2.3	NA	NA	NA	NA	NA	NA
35	NLF	NA	1.2	1.6	1.4	NA	NA	NA
	SDLF	NA	0.1	0.1	0.1	NA	NA	NA
	TDLF	NA	2.3	3.2	2.8	NA	NA	NA
36	NLF	NA	NA	NA	NA	1.5	2.1	2.4
	SDLF	NA	NA	NA	NA	0.1	0.4	0.6
	TDLF	NA	NA	NA	NA	2.7	3.2	3.2

Table M1-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	16.5	2.0	2.0	3.3	5.0	10.5	0.6
	SDLF	12.1	1.5	1.5	2.3	3.6	7.6	0.9
	TDLF	2.8	0.5	0.2	0.2	0.6	1.5	4.3
2	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
3	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
4	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
5	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
6	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
7	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
8	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
9	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
10	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA

Table M1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
12	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
13	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
14	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
15	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
16	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
17	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
18	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
19	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
20	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA

Table M1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
22	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
23	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
24	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
25	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
26	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
27	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
28	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
29	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
30	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA

Table M1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
32	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
33	NLF	NA	NA	NA	NA	NA	NA	NA
	SDLF	NA	NA	NA	NA	NA	NA	NA
	TDLF	NA	NA	NA	NA	NA	NA	NA
34	NLF	7.3	NA	NA	NA	NA	NA	NA
	SDLF	6.2	NA	NA	NA	NA	NA	NA
	TDLF	3.8	NA	NA	NA	NA	NA	NA
35	NLF	NA	4.3	5.3	4.5	NA	NA	NA
	SDLF	NA	3.2	3.8	3.2	NA	NA	NA
	TDLF	NA	0.8	0.5	0.3	NA	NA	NA
36	NLF	NA	NA	NA	NA	4.7	7.4	11.0
	SDLF	NA	NA	NA	NA	3.4	5.7	9.2
	TDLF	NA	NA	NA	NA	0.5	2.1	5.4

Table M1-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location						
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.64	-0.55	-0.61	-0.66	-0.64	-0.72	-0.77
	SDLF	-0.85	-0.67	-0.70	-0.71	-0.57	-0.60	-0.55
	TDLF	-1.24	-0.91	-0.89	-0.82	-0.42	-0.33	-0.14
3	NLF	-0.36	-0.31	-0.44	-0.55	-0.49	-0.62	-0.72
	SDLF	-0.73	-0.43	-0.48	-0.53	-0.34	-0.40	-0.34
	TDLF	-1.39	-0.69	-0.58	-0.50	-0.03	0.07	0.37
4	NLF	-0.07	-0.04	-0.23	-0.36	-0.29	-0.45	-0.61
	SDLF	-0.52	-0.14	-0.21	-0.27	-0.07	-0.16	-0.07
	TDLF	-1.29	-0.37	-0.21	-0.12	0.37	0.49	0.91
5	NLF	0.19	0.21	0.02	-0.14	-0.05	-0.23	-0.43
	SDLF	-0.26	0.16	0.08	0.01	0.21	0.11	0.21
	TDLF	-1.01	0.00	0.17	0.28	0.73	0.86	1.37
6	NLF	0.41	0.43	0.26	0.10	0.18	0.01	-0.20
	SDLF	0.02	0.44	0.36	0.29	0.46	0.36	0.47
	TDLF	-0.58	0.40	0.53	0.64	1.01	1.12	1.68
7	NLF	0.58	0.58	0.45	0.31	0.37	0.24	0.05
	SDLF	0.30	0.65	0.60	0.53	0.64	0.55	0.66
	TDLF	-0.09	0.74	0.83	0.93	1.17	1.25	1.78
8	NLF	0.65	0.64	0.58	0.48	0.50	0.41	0.27
	SDLF	0.47	0.76	0.74	0.70	0.73	0.66	0.75
	TDLF	0.27	0.93	1.02	1.10	1.17	1.22	1.64
9	NLF	0.68	0.66	0.62	0.57	0.53	0.49	0.43
	SDLF	0.60	0.80	0.78	0.76	0.68	0.64	0.73
	TDLF	0.58	1.03	1.06	1.11	0.98	0.99	1.27
10	NLF	0.66	0.62	0.60	0.56	0.48	0.47	0.48
	SDLF	0.68	0.77	0.74	0.71	0.57	0.52	0.57
	TDLF	0.82	1.02	1.00	1.00	0.76	0.65	0.74

Table M1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	0.60	0.54	0.53	0.51	0.39	0.39	0.41
	SDLF	0.70	0.68	0.65	0.62	0.41	0.36	0.32
	TDLF	0.93	0.92	0.87	0.83	0.48	0.33	0.14
12	NLF	0.53	0.43	0.41	0.40	0.00	0.00	0.00
	SDLF	0.65	0.54	0.50	0.46	0.00	0.00	0.00
	TDLF	0.92	0.74	0.67	0.59	0.00	0.00	0.00
13	NLF	0.42	0.00	0.00	0.00	0.19	0.20	0.24
	SDLF	0.54	0.00	0.00	0.00	0.14	0.10	0.03
	TDLF	0.79	0.00	0.00	0.00	0.07	-0.11	-0.39
14	NLF	0.00	0.22	0.20	0.19	0.07	0.09	0.14
	SDLF	0.00	0.29	0.25	0.20	-0.03	-0.07	-0.15
	TDLF	0.01	0.43	0.34	0.22	-0.21	-0.41	-0.74
15	NLF	0.22	0.10	0.08	0.07	-0.01	0.01	0.06
	SDLF	0.32	0.13	0.08	0.03	-0.15	-0.19	-0.28
	TDLF	0.52	0.20	0.10	-0.03	-0.42	-0.63	-0.98
16	NLF	0.06	0.00	0.00	-0.01	-0.06	-0.05	0.00
	SDLF	0.15	0.00	-0.03	-0.10	-0.24	-0.27	-0.36
	TDLF	0.33	0.01	-0.08	-0.23	-0.57	-0.77	-1.13
17	NLF	-0.04	-0.06	-0.06	-0.06	-0.10	-0.09	-0.06
	SDLF	0.03	-0.09	-0.13	-0.18	-0.30	-0.32	-0.41
	TDLF	0.19	-0.11	-0.24	-0.37	-0.67	-0.85	-1.17
18	NLF	-0.10	-0.10	-0.09	-0.10	-0.12	-0.11	-0.10
	SDLF	-0.06	-0.14	-0.19	-0.25	-0.31	-0.33	-0.42
	TDLF	0.06	-0.21	-0.36	-0.50	-0.69	-0.84	-1.12
19	NLF	-0.12	-0.11	-0.10	-0.10	-0.10	-0.11	-0.11
	SDLF	-0.11	-0.16	-0.20	-0.26	-0.28	-0.30	-0.39
	TDLF	-0.06	-0.24	-0.38	-0.54	-0.63	-0.75	-1.00
20	NLF	-0.11	-0.10	-0.09	-0.09	-0.08	-0.09	-0.11
	SDLF	-0.12	-0.14	-0.18	-0.23	-0.22	-0.24	-0.32
	TDLF	-0.12	-0.22	-0.34	-0.49	-0.51	-0.60	-0.81

Table M1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	-0.10	-0.08	-0.07	-0.07	-0.05	-0.06	-0.08
	SDLF	-0.11	-0.12	-0.14	-0.18	-0.16	-0.16	-0.24
	TDLF	-0.13	-0.18	-0.27	-0.39	-0.36	-0.43	-0.60
22	NLF	-0.09	-0.09	-0.07	-0.05	-0.04	-0.04	-0.05
	SDLF	-0.11	-0.11	-0.11	-0.13	-0.10	-0.10	-0.16
	TDLF	-0.13	-0.16	-0.20	-0.28	-0.23	-0.27	-0.40
23	NLF	-0.12	-0.11	-0.08	-0.05	-0.05	-0.03	-0.03
	SDLF	-0.13	-0.12	-0.10	-0.10	-0.07	-0.06	-0.10
	TDLF	-0.16	-0.16	-0.15	-0.18	-0.13	-0.14	-0.23
24	NLF	0.00	0.00	-0.10	-0.09	-0.08	-0.05	-0.03
	SDLF	0.00	0.00	-0.11	-0.10	-0.08	-0.05	-0.05
	TDLF	0.00	0.00	-0.14	-0.12	-0.08	-0.05	-0.09
25	NLF	-0.14	-0.13	0.00	0.00	0.00	-0.07	-0.06
	SDLF	-0.16	-0.15	0.00	0.00	0.00	-0.06	-0.04
	TDLF	-0.20	-0.18	0.00	0.00	0.00	-0.04	0.00
26	NLF	-0.16	-0.15	-0.13	-0.12	-0.11	0.00	0.00
	SDLF	-0.21	-0.16	-0.13	-0.12	-0.10	0.00	0.00
	TDLF	-0.28	-0.18	-0.16	-0.12	-0.08	0.00	0.00
27	NLF	-0.13	-0.16	-0.15	-0.15	-0.13	-0.11	-0.10
	SDLF	-0.22	-0.16	-0.14	-0.13	-0.11	-0.09	-0.06
	TDLF	-0.34	-0.18	-0.15	-0.09	-0.07	-0.05	0.01
28	NLF	-0.07	-0.13	-0.15	-0.15	-0.15	-0.14	-0.14
	SDLF	-0.19	-0.13	-0.13	-0.11	-0.11	-0.11	-0.05
	TDLF	-0.36	-0.13	-0.11	-0.03	-0.02	-0.02	0.12
29	NLF	0.01	-0.07	-0.12	-0.11	-0.14	-0.15	-0.15
	SDLF	-0.13	-0.06	-0.08	-0.06	-0.08	-0.11	0.00
	TDLF	-0.33	-0.06	-0.04	0.04	0.05	0.02	0.25
30	NLF	0.11	0.02	-0.05	-0.03	-0.09	-0.14	-0.13
	SDLF	-0.04	0.03	-0.01	0.02	-0.02	-0.08	0.07
	TDLF	-0.24	0.03	0.04	0.13	0.12	0.09	0.40

Table M1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	0.19	0.11	0.04	0.05	-0.02	-0.08	-0.07
	SDLF	0.06	0.13	0.08	0.11	0.05	-0.02	0.15
	TDLF	-0.11	0.13	0.13	0.21	0.20	0.17	0.52
32	NLF	0.26	0.20	0.13	0.14	0.07	0.00	0.00
	SDLF	0.17	0.21	0.17	0.19	0.14	0.06	0.23
	TDLF	0.05	0.22	0.22	0.28	0.27	0.25	0.59
33	NLF	0.29	0.26	0.21	0.22	0.16	0.09	0.09
	SDLF	0.26	0.28	0.24	0.25	0.21	0.14	0.29
	TDLF	0.21	0.29	0.29	0.32	0.32	0.31	0.60
34	NLF	0.00	0.29	0.27	0.27	0.23	0.17	0.18
	SDLF	0.00	0.31	0.29	0.29	0.26	0.21	0.31
	TDLF	0.00	0.32	0.33	0.33	0.34	0.34	0.54
35	NLF	NA	0.00	0.00	0.00	0.27	0.24	0.24
	SDLF	NA	0.00	0.00	0.00	0.28	0.26	0.30
	TDLF	NA	0.00	0.00	0.00	0.32	0.33	0.40
36	NLF	NA	NA	NA	NA	0.00	0.00	0.00
	SDLF	NA	NA	NA	NA	0.00	0.00	0.00
	TDLF	NA	NA	NA	NA	0.00	0.00	0.00

Table M1-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-1.95	-1.68	-1.86	-2.04	-1.98	-2.23	-2.39
	SDLF	-2.16	-1.79	-1.95	-2.09	-1.91	-2.11	-2.18
	TDLF	-2.55	-2.04	-2.14	-2.20	-1.76	-1.85	-1.77
3	NLF	-1.05	-0.93	-1.36	-1.69	-1.54	-1.95	-2.28
	SDLF	-1.42	-1.05	-1.40	-1.67	-1.38	-1.73	-1.89
	TDLF	-2.08	-1.30	-1.49	-1.64	-1.07	-1.25	-1.19
4	NLF	-0.16	-0.10	-0.69	-1.12	-0.91	-1.43	-1.93
	SDLF	-0.61	-0.20	-0.67	-1.03	-0.69	-1.14	-1.39
	TDLF	-1.38	-0.43	-0.67	-0.88	-0.26	-0.49	-0.41
5	NLF	0.65	0.69	0.07	-0.43	-0.19	-0.76	-1.38
	SDLF	0.20	0.64	0.13	-0.28	0.07	-0.42	-0.75
	TDLF	-0.55	0.48	0.22	-0.01	0.59	0.33	0.42
6	NLF	1.33	1.35	0.80	0.29	0.52	-0.02	-0.69
	SDLF	0.94	1.36	0.91	0.49	0.80	0.33	-0.03
	TDLF	0.33	1.32	1.07	0.84	1.35	1.09	1.19
7	NLF	1.82	1.82	1.41	0.96	1.12	0.69	0.06
	SDLF	1.54	1.89	1.55	1.18	1.39	1.00	0.67
	TDLF	1.16	1.98	1.78	1.58	1.92	1.70	1.79
8	NLF	2.04	2.01	1.81	1.48	1.53	1.24	0.77
	SDLF	1.86	2.12	1.97	1.70	1.75	1.48	1.25
	TDLF	1.66	2.29	2.24	2.10	2.20	2.04	2.14
9	NLF	2.12	2.05	1.92	1.75	1.62	1.51	1.28
	SDLF	2.05	2.19	2.08	1.94	1.77	1.66	1.58
	TDLF	2.03	2.43	2.36	2.30	2.07	2.01	2.13
10	NLF	2.08	1.94	1.86	1.74	1.51	1.46	1.46
	SDLF	2.10	2.08	2.01	1.89	1.60	1.51	1.56
	TDLF	2.24	2.34	2.27	2.18	1.78	1.63	1.73

Table M1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	1.91	1.71	1.66	1.58	1.22	1.22	1.29
	SDLF	2.00	1.85	1.78	1.69	1.25	1.20	1.20
	TDLF	2.23	2.09	2.00	1.90	1.31	1.16	1.02
12	NLF	1.67	1.36	1.31	1.26	0.00	0.00	0.00
	SDLF	1.79	1.47	1.40	1.32	0.00	0.00	0.00
	TDLF	2.06	1.67	1.57	1.45	0.00	0.00	0.00
13	NLF	1.34	0.00	0.00	0.00	0.66	0.70	0.82
	SDLF	1.47	0.00	0.00	0.00	0.61	0.60	0.61
	TDLF	1.71	0.00	0.00	0.00	0.54	0.39	0.19
14	NLF	-0.01	0.75	0.70	0.67	0.30	0.36	0.50
	SDLF	-0.01	0.82	0.75	0.67	0.20	0.20	0.21
	TDLF	0.00	0.96	0.84	0.70	0.02	-0.14	-0.38
15	NLF	0.76	0.39	0.33	0.30	0.04	0.11	0.24
	SDLF	0.86	0.42	0.33	0.25	-0.10	-0.09	-0.09
	TDLF	1.06	0.49	0.35	0.19	-0.36	-0.53	-0.79
16	NLF	0.27	0.08	0.08	0.04	-0.13	-0.08	0.05
	SDLF	0.36	0.08	0.05	-0.04	-0.30	-0.30	-0.31
	TDLF	0.54	0.09	0.00	-0.18	-0.63	-0.80	-1.07
17	NLF	-0.05	-0.13	-0.11	-0.12	-0.26	-0.24	-0.15
	SDLF	0.02	-0.15	-0.18	-0.24	-0.46	-0.47	-0.50
	TDLF	0.19	-0.18	-0.30	-0.44	-0.83	-0.99	-1.26
18	NLF	-0.26	-0.28	-0.24	-0.26	-0.33	-0.33	-0.28
	SDLF	-0.21	-0.32	-0.34	-0.41	-0.52	-0.55	-0.60
	TDLF	-0.10	-0.38	-0.51	-0.66	-0.90	-1.05	-1.30
19	NLF	-0.34	-0.32	-0.28	-0.30	-0.31	-0.34	-0.35
	SDLF	-0.32	-0.37	-0.38	-0.45	-0.48	-0.53	-0.62
	TDLF	-0.28	-0.45	-0.57	-0.73	-0.83	-0.98	-1.24
20	NLF	-0.34	-0.31	-0.27	-0.27	-0.24	-0.29	-0.35
	SDLF	-0.35	-0.35	-0.36	-0.41	-0.39	-0.44	-0.56
	TDLF	-0.35	-0.43	-0.53	-0.67	-0.67	-0.80	-1.05

Table M1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	-0.31	-0.28	-0.25	-0.23	-0.18	-0.22	-0.29
	SDLF	-0.32	-0.32	-0.32	-0.34	-0.29	-0.32	-0.45
	TDLF	-0.34	-0.38	-0.44	-0.55	-0.50	-0.58	-0.80
22	NLF	-0.31	-0.30	-0.24	-0.19	-0.16	-0.16	-0.21
	SDLF	-0.33	-0.33	-0.28	-0.27	-0.22	-0.22	-0.32
	TDLF	-0.35	-0.38	-0.37	-0.42	-0.35	-0.39	-0.55
23	NLF	-0.39	-0.36	-0.29	-0.21	-0.20	-0.14	-0.15
	SDLF	-0.41	-0.38	-0.31	-0.25	-0.22	-0.17	-0.21
	TDLF	-0.43	-0.41	-0.36	-0.33	-0.27	-0.25	-0.35
24	NLF	0.00	0.00	-0.33	-0.30	-0.28	-0.21	-0.14
	SDLF	0.00	0.00	-0.35	-0.31	-0.28	-0.20	-0.16
	TDLF	0.00	0.00	-0.38	-0.33	-0.28	-0.21	-0.21
25	NLF	-0.47	-0.44	0.00	0.00	0.00	-0.26	-0.24
	SDLF	-0.49	-0.46	0.00	0.00	0.00	-0.25	-0.22
	TDLF	-0.52	-0.49	0.00	0.00	0.00	-0.23	-0.17
26	NLF	-0.50	-0.48	-0.42	-0.40	-0.38	0.00	0.00
	SDLF	-0.54	-0.49	-0.43	-0.40	-0.37	0.00	0.00
	TDLF	-0.62	-0.52	-0.45	-0.40	-0.35	0.00	0.00
27	NLF	-0.39	-0.49	-0.48	-0.49	-0.43	-0.36	-0.34
	SDLF	-0.48	-0.50	-0.48	-0.47	-0.41	-0.34	-0.31
	TDLF	-0.60	-0.51	-0.48	-0.43	-0.37	-0.30	-0.23
28	NLF	-0.18	-0.39	-0.49	-0.48	-0.50	-0.46	-0.48
	SDLF	-0.30	-0.39	-0.46	-0.44	-0.46	-0.43	-0.38
	TDLF	-0.47	-0.40	-0.44	-0.36	-0.37	-0.34	-0.22
29	NLF	0.11	-0.17	-0.37	-0.34	-0.47	-0.51	-0.52
	SDLF	-0.04	-0.16	-0.33	-0.29	-0.41	-0.47	-0.37
	TDLF	-0.24	-0.17	-0.29	-0.19	-0.28	-0.33	-0.12
30	NLF	0.41	0.11	-0.15	-0.11	-0.32	-0.46	-0.47
	SDLF	0.26	0.12	-0.10	-0.06	-0.24	-0.41	-0.27
	TDLF	0.06	0.12	-0.05	0.05	-0.10	-0.24	0.06

Table M1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	0.68	0.41	0.13	0.17	-0.08	-0.30	-0.30
	SDLF	0.55	0.42	0.18	0.22	0.00	-0.24	-0.08
	TDLF	0.38	0.42	0.23	0.33	0.15	-0.05	0.29
32	NLF	0.87	0.67	0.43	0.46	0.21	-0.05	-0.05
	SDLF	0.78	0.69	0.47	0.50	0.27	0.01	0.17
	TDLF	0.67	0.70	0.52	0.59	0.41	0.20	0.53
33	NLF	0.97	0.86	0.68	0.70	0.49	0.23	0.23
	SDLF	0.93	0.88	0.72	0.73	0.54	0.29	0.42
	TDLF	0.88	0.89	0.76	0.80	0.65	0.45	0.74
34	NLF	0.00	0.94	0.86	0.85	0.72	0.51	0.51
	SDLF	0.00	0.95	0.88	0.87	0.76	0.55	0.65
	TDLF	0.00	0.97	0.92	0.92	0.83	0.68	0.87
35	NLF	NA	0.00	0.00	0.00	0.85	0.74	0.74
	SDLF	NA	0.00	0.00	0.00	0.87	0.76	0.80
	TDLF	NA	0.00	0.00	0.00	0.90	0.83	0.90
36	NLF	NA	NA	NA	NA	0.00	0.00	-0.01
	SDLF	NA	NA	NA	NA	0.00	0.00	-0.01
	TDLF	NA	NA	NA	NA	0.00	0.00	-0.01

Table M1-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.49	-0.42	-0.47	-0.51	-0.49	-0.55	-0.59
	SDLF	-0.66	-0.52	-0.54	-0.55	-0.44	-0.46	-0.42
	TDLF	-0.96	-0.71	-0.69	-0.64	-0.32	-0.26	-0.11
3	NLF	-0.27	-0.24	-0.34	-0.42	-0.38	-0.48	-0.56
	SDLF	-0.56	-0.33	-0.37	-0.41	-0.26	-0.31	-0.26
	TDLF	-1.07	-0.53	-0.44	-0.38	-0.02	0.06	0.28
4	NLF	-0.05	-0.03	-0.18	-0.28	-0.22	-0.35	-0.47
	SDLF	-0.40	-0.11	-0.16	-0.21	-0.05	-0.12	-0.05
	TDLF	-1.00	-0.29	-0.16	-0.09	0.28	0.38	0.70
5	NLF	0.15	0.16	0.01	-0.11	-0.04	-0.18	-0.33
	SDLF	-0.20	0.12	0.06	0.01	0.16	0.08	0.16
	TDLF	-0.78	0.00	0.13	0.21	0.56	0.66	1.06
6	NLF	0.32	0.33	0.20	0.08	0.14	0.01	-0.15
	SDLF	0.02	0.34	0.28	0.23	0.35	0.27	0.36
	TDLF	-0.45	0.31	0.41	0.50	0.78	0.87	1.30
7	NLF	0.44	0.45	0.35	0.24	0.29	0.18	0.03
	SDLF	0.23	0.51	0.46	0.41	0.49	0.42	0.51
	TDLF	-0.07	0.57	0.64	0.72	0.91	0.97	1.37
8	NLF	0.50	0.50	0.45	0.37	0.38	0.32	0.21
	SDLF	0.36	0.58	0.57	0.54	0.56	0.51	0.58
	TDLF	0.21	0.72	0.79	0.85	0.90	0.94	1.27
9	NLF	0.52	0.51	0.48	0.44	0.41	0.38	0.33
	SDLF	0.47	0.62	0.60	0.59	0.52	0.50	0.56
	TDLF	0.45	0.80	0.82	0.86	0.75	0.77	0.98
10	NLF	0.51	0.48	0.46	0.43	0.37	0.36	0.37
	SDLF	0.53	0.59	0.57	0.55	0.44	0.40	0.44
	TDLF	0.63	0.79	0.77	0.77	0.58	0.50	0.57

Table M1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	0.47	0.42	0.41	0.39	0.30	0.30	0.32
	SDLF	0.54	0.53	0.50	0.48	0.32	0.28	0.25
	TDLF	0.72	0.71	0.67	0.64	0.37	0.25	0.11
12	NLF	0.41	0.33	0.32	0.31	0.00	0.00	0.00
	SDLF	0.50	0.41	0.39	0.36	0.00	0.00	0.00
	TDLF	0.71	0.57	0.51	0.45	0.00	0.00	0.00
13	NLF	0.32	0.00	0.00	0.00	0.15	0.16	0.19
	SDLF	0.42	0.00	0.00	0.00	0.11	0.08	0.02
	TDLF	0.61	0.00	0.00	0.00	0.06	-0.09	-0.30
14	NLF	0.00	0.17	0.16	0.15	0.05	0.07	0.10
	SDLF	0.00	0.22	0.19	0.15	-0.02	-0.06	-0.12
	TDLF	0.01	0.33	0.26	0.17	-0.16	-0.32	-0.57
15	NLF	0.17	0.08	0.06	0.05	-0.01	0.01	0.04
	SDLF	0.25	0.10	0.06	0.02	-0.12	-0.15	-0.22
	TDLF	0.40	0.15	0.08	-0.03	-0.32	-0.48	-0.75
16	NLF	0.04	0.00	0.00	-0.01	-0.05	-0.04	0.00
	SDLF	0.12	0.00	-0.03	-0.07	-0.18	-0.21	-0.28
	TDLF	0.26	0.01	-0.06	-0.18	-0.44	-0.59	-0.87
17	NLF	-0.03	-0.05	-0.04	-0.05	-0.08	-0.07	-0.05
	SDLF	0.03	-0.07	-0.10	-0.14	-0.23	-0.25	-0.32
	TDLF	0.15	-0.09	-0.19	-0.29	-0.51	-0.65	-0.91
18	NLF	-0.08	-0.08	-0.07	-0.08	-0.09	-0.09	-0.08
	SDLF	-0.04	-0.11	-0.14	-0.19	-0.24	-0.26	-0.32
	TDLF	0.04	-0.16	-0.28	-0.39	-0.53	-0.65	-0.86
19	NLF	-0.09	-0.08	-0.08	-0.08	-0.08	-0.09	-0.09
	SDLF	-0.08	-0.12	-0.15	-0.20	-0.22	-0.23	-0.30
	TDLF	-0.05	-0.18	-0.30	-0.41	-0.48	-0.58	-0.77
20	NLF	-0.09	-0.07	-0.07	-0.07	-0.06	-0.07	-0.08
	SDLF	-0.09	-0.11	-0.14	-0.18	-0.17	-0.18	-0.25
	TDLF	-0.09	-0.17	-0.26	-0.38	-0.39	-0.46	-0.62

Table M1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	-0.07	-0.06	-0.06	-0.05	-0.04	-0.05	-0.06
	SDLF	-0.09	-0.09	-0.11	-0.14	-0.12	-0.13	-0.19
	TDLF	-0.10	-0.14	-0.21	-0.30	-0.28	-0.33	-0.46
22	NLF	-0.07	-0.07	-0.05	-0.04	-0.03	-0.03	-0.04
	SDLF	-0.08	-0.09	-0.09	-0.10	-0.08	-0.08	-0.12
	TDLF	-0.10	-0.12	-0.15	-0.22	-0.18	-0.21	-0.31
23	NLF	-0.09	-0.08	-0.06	-0.04	-0.04	-0.03	-0.03
	SDLF	-0.10	-0.10	-0.08	-0.07	-0.06	-0.04	-0.07
	TDLF	-0.12	-0.12	-0.11	-0.14	-0.10	-0.11	-0.18
24	NLF	0.00	0.00	-0.07	-0.07	-0.06	-0.04	-0.02
	SDLF	0.00	0.00	-0.09	-0.07	-0.06	-0.04	-0.04
	TDLF	0.00	0.00	-0.11	-0.09	-0.06	-0.04	-0.07
25	NLF	-0.11	-0.10	0.00	0.00	0.00	-0.06	-0.05
	SDLF	-0.12	-0.12	0.00	0.00	0.00	-0.05	-0.03
	TDLF	-0.15	-0.14	0.00	0.00	0.00	-0.03	0.00
26	NLF	-0.12	-0.11	-0.10	-0.09	-0.09	0.00	0.00
	SDLF	-0.16	-0.12	-0.10	-0.09	-0.08	0.00	0.00
	TDLF	-0.22	-0.14	-0.12	-0.09	-0.06	0.00	0.00
27	NLF	-0.10	-0.12	-0.11	-0.12	-0.10	-0.08	-0.08
	SDLF	-0.17	-0.12	-0.11	-0.10	-0.08	-0.07	-0.05
	TDLF	-0.27	-0.14	-0.11	-0.07	-0.06	-0.04	0.01
28	NLF	-0.06	-0.10	-0.12	-0.11	-0.12	-0.11	-0.11
	SDLF	-0.15	-0.10	-0.10	-0.08	-0.08	-0.08	-0.04
	TDLF	-0.28	-0.10	-0.08	-0.03	-0.02	-0.02	0.09
29	NLF	0.01	-0.05	-0.09	-0.08	-0.11	-0.12	-0.12
	SDLF	-0.10	-0.04	-0.06	-0.04	-0.06	-0.08	0.00
	TDLF	-0.26	-0.05	-0.03	0.03	0.04	0.02	0.20
30	NLF	0.08	0.02	-0.04	-0.03	-0.07	-0.10	-0.10
	SDLF	-0.03	0.02	-0.01	0.01	-0.02	-0.06	0.05
	TDLF	-0.19	0.02	0.03	0.10	0.10	0.07	0.31

Table M1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
31	NLF	0.15	0.09	0.03	0.04	-0.01	-0.06	-0.06
	SDLF	0.05	0.10	0.06	0.08	0.04	-0.02	0.11
	TDLF	-0.08	0.10	0.10	0.16	0.16	0.13	0.40
32	NLF	0.20	0.15	0.10	0.11	0.06	0.00	0.00
	SDLF	0.13	0.17	0.13	0.14	0.11	0.04	0.17
	TDLF	0.04	0.17	0.17	0.21	0.21	0.19	0.46
33	NLF	0.23	0.20	0.16	0.17	0.12	0.07	0.07
	SDLF	0.20	0.21	0.19	0.20	0.16	0.11	0.22
	TDLF	0.16	0.23	0.22	0.25	0.25	0.24	0.46
34	NLF	0.00	0.22	0.20	0.21	0.18	0.13	0.14
	SDLF	0.00	0.24	0.22	0.22	0.20	0.16	0.24
	TDLF	0.00	0.25	0.25	0.26	0.26	0.26	0.41
35	NLF	NA	0.00	0.00	0.00	0.21	0.18	0.19
	SDLF	NA	0.00	0.00	0.00	0.22	0.20	0.23
	TDLF	NA	0.00	0.00	0.00	0.24	0.25	0.31
36	NLF	NA	NA	NA	NA	0.00	0.00	0.00
	SDLF	NA	NA	NA	NA	0.00	0.00	0.00
	TDLF	NA	NA	NA	NA	0.00	0.00	0.00

Table M1-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-1.51	-1.29	-1.44	-1.57	-1.53	-1.72	-1.85
	SDLF	-1.67	-1.39	-1.51	-1.61	-1.47	-1.63	-1.68
	TDLF	-1.97	-1.57	-1.65	-1.69	-1.36	-1.43	-1.37
3	NLF	-0.81	-0.72	-1.05	-1.31	-1.19	-1.50	-1.76
	SDLF	-1.10	-0.81	-1.08	-1.29	-1.07	-1.34	-1.46
	TDLF	-1.61	-1.01	-1.15	-1.26	-0.83	-0.97	-0.92
4	NLF	-0.12	-0.08	-0.53	-0.86	-0.70	-1.10	-1.49
	SDLF	-0.47	-0.15	-0.52	-0.79	-0.53	-0.88	-1.07
	TDLF	-1.07	-0.33	-0.52	-0.68	-0.20	-0.38	-0.32
5	NLF	0.51	0.53	0.05	-0.33	-0.15	-0.58	-1.07
	SDLF	0.15	0.49	0.10	-0.22	0.05	-0.32	-0.58
	TDLF	-0.42	0.37	0.17	-0.01	0.45	0.25	0.32
6	NLF	1.03	1.04	0.62	0.23	0.40	-0.01	-0.53
	SDLF	0.73	1.05	0.70	0.38	0.62	0.25	-0.02
	TDLF	0.26	1.02	0.83	0.65	1.04	0.84	0.92
7	NLF	1.41	1.40	1.09	0.74	0.87	0.53	0.05
	SDLF	1.19	1.46	1.20	0.91	1.07	0.77	0.52
	TDLF	0.89	1.53	1.38	1.22	1.49	1.31	1.38
8	NLF	1.57	1.55	1.39	1.14	1.18	0.96	0.59
	SDLF	1.44	1.64	1.52	1.31	1.35	1.15	0.96
	TDLF	1.28	1.77	1.73	1.62	1.70	1.58	1.65
9	NLF	1.64	1.58	1.48	1.35	1.25	1.16	0.99
	SDLF	1.58	1.69	1.61	1.50	1.37	1.28	1.22
	TDLF	1.57	1.87	1.82	1.77	1.60	1.55	1.64
10	NLF	1.60	1.50	1.44	1.34	1.16	1.12	1.13
	SDLF	1.62	1.61	1.55	1.46	1.23	1.16	1.20
	TDLF	1.73	1.81	1.75	1.68	1.37	1.26	1.33

Table M1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	1.47	1.32	1.28	1.22	0.94	0.95	1.00
	SDLF	1.54	1.43	1.37	1.30	0.96	0.93	0.93
	TDLF	1.73	1.61	1.54	1.47	1.01	0.90	0.79
12	NLF	1.29	1.05	1.01	0.97	0.00	0.00	0.00
	SDLF	1.39	1.13	1.08	1.02	0.00	0.00	0.00
	TDLF	1.59	1.29	1.21	1.12	0.00	0.00	0.00
13	NLF	1.04	0.00	0.00	0.00	0.51	0.54	0.64
	SDLF	1.13	0.00	0.00	0.00	0.47	0.46	0.47
	TDLF	1.32	0.00	0.00	0.00	0.42	0.30	0.14
14	NLF	-0.01	0.58	0.54	0.52	0.23	0.28	0.38
	SDLF	0.00	0.63	0.58	0.52	0.15	0.15	0.16
	TDLF	0.00	0.74	0.65	0.54	0.02	-0.11	-0.29
15	NLF	0.59	0.30	0.25	0.23	0.03	0.08	0.19
	SDLF	0.67	0.32	0.26	0.20	-0.08	-0.07	-0.07
	TDLF	0.82	0.38	0.27	0.15	-0.28	-0.41	-0.61
16	NLF	0.21	0.06	0.06	0.03	-0.10	-0.06	0.04
	SDLF	0.28	0.06	0.04	-0.03	-0.23	-0.23	-0.24
	TDLF	0.42	0.07	0.00	-0.14	-0.49	-0.62	-0.83
17	NLF	-0.04	-0.10	-0.09	-0.10	-0.20	-0.18	-0.11
	SDLF	0.02	-0.12	-0.14	-0.18	-0.35	-0.36	-0.38
	TDLF	0.14	-0.14	-0.23	-0.34	-0.64	-0.76	-0.97
18	NLF	-0.20	-0.21	-0.19	-0.20	-0.25	-0.25	-0.22
	SDLF	-0.16	-0.24	-0.26	-0.31	-0.40	-0.42	-0.47
	TDLF	-0.07	-0.30	-0.39	-0.51	-0.70	-0.81	-1.01
19	NLF	-0.26	-0.25	-0.22	-0.23	-0.24	-0.27	-0.27
	SDLF	-0.25	-0.28	-0.30	-0.35	-0.37	-0.41	-0.48
	TDLF	-0.21	-0.35	-0.44	-0.56	-0.64	-0.75	-0.95
20	NLF	-0.26	-0.24	-0.21	-0.21	-0.19	-0.23	-0.27
	SDLF	-0.27	-0.27	-0.28	-0.32	-0.30	-0.34	-0.43
	TDLF	-0.27	-0.33	-0.41	-0.52	-0.52	-0.62	-0.81

Table M1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	-0.24	-0.22	-0.19	-0.18	-0.14	-0.17	-0.22
	SDLF	-0.25	-0.25	-0.24	-0.26	-0.22	-0.24	-0.34
	TDLF	-0.26	-0.30	-0.34	-0.43	-0.38	-0.45	-0.62
22	NLF	-0.24	-0.23	-0.19	-0.15	-0.12	-0.12	-0.16
	SDLF	-0.25	-0.25	-0.22	-0.21	-0.17	-0.17	-0.24
	TDLF	-0.27	-0.29	-0.28	-0.32	-0.27	-0.30	-0.43
23	NLF	-0.30	-0.28	-0.22	-0.16	-0.15	-0.11	-0.11
	SDLF	-0.31	-0.29	-0.24	-0.19	-0.17	-0.13	-0.16
	TDLF	-0.34	-0.32	-0.28	-0.26	-0.21	-0.19	-0.27
24	NLF	0.00	0.00	-0.26	-0.23	-0.22	-0.16	-0.11
	SDLF	0.00	0.00	-0.27	-0.24	-0.22	-0.16	-0.13
	TDLF	0.00	0.00	-0.29	-0.26	-0.22	-0.16	-0.16
25	NLF	-0.36	-0.34	0.00	0.00	0.00	-0.20	-0.18
	SDLF	-0.38	-0.35	0.00	0.00	0.00	-0.19	-0.17
	TDLF	-0.40	-0.38	0.00	0.00	0.00	-0.17	-0.13
26	NLF	-0.38	-0.37	-0.32	-0.31	-0.29	0.00	0.00
	SDLF	-0.42	-0.38	-0.33	-0.31	-0.28	0.00	0.00
	TDLF	-0.48	-0.40	-0.35	-0.31	-0.27	0.00	0.00
27	NLF	-0.30	-0.38	-0.37	-0.38	-0.33	-0.28	-0.27
	SDLF	-0.37	-0.38	-0.37	-0.36	-0.32	-0.27	-0.24
	TDLF	-0.47	-0.40	-0.37	-0.33	-0.29	-0.23	-0.18
28	NLF	-0.14	-0.30	-0.37	-0.37	-0.39	-0.35	-0.37
	SDLF	-0.23	-0.30	-0.36	-0.34	-0.35	-0.33	-0.30
	TDLF	-0.36	-0.31	-0.34	-0.28	-0.29	-0.27	-0.17
29	NLF	0.08	-0.13	-0.29	-0.26	-0.36	-0.39	-0.40
	SDLF	-0.03	-0.13	-0.26	-0.23	-0.31	-0.36	-0.29
	TDLF	-0.18	-0.13	-0.23	-0.15	-0.22	-0.26	-0.09
30	NLF	0.31	0.08	-0.11	-0.08	-0.24	-0.36	-0.36
	SDLF	0.20	0.09	-0.08	-0.04	-0.19	-0.31	-0.21
	TDLF	0.05	0.09	-0.04	0.04	-0.08	-0.18	0.05

Table M1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
31	NLF	0.52	0.31	0.10	0.13	-0.06	-0.23	-0.23
	SDLF	0.42	0.32	0.14	0.17	0.00	-0.18	-0.06
	TDLF	0.29	0.33	0.18	0.25	0.11	-0.04	0.22
32	NLF	0.68	0.52	0.33	0.35	0.16	-0.04	-0.04
	SDLF	0.61	0.53	0.36	0.39	0.21	0.01	0.13
	TDLF	0.52	0.54	0.40	0.46	0.32	0.15	0.41
33	NLF	0.75	0.67	0.53	0.54	0.38	0.18	0.18
	SDLF	0.72	0.68	0.55	0.57	0.42	0.22	0.33
	TDLF	0.68	0.69	0.59	0.62	0.50	0.35	0.57
34	NLF	0.00	0.73	0.66	0.66	0.56	0.39	0.40
	SDLF	0.00	0.74	0.68	0.67	0.58	0.43	0.50
	TDLF	0.00	0.75	0.71	0.71	0.64	0.52	0.67
35	NLF	NA	0.00	0.00	0.00	0.66	0.57	0.57
	SDLF	NA	0.00	0.00	0.00	0.67	0.59	0.62
	TDLF	NA	0.00	0.00	0.00	0.69	0.64	0.69
36	NLF	NA	NA	NA	NA	0.00	0.00	-0.01
	SDLF	NA	NA	NA	NA	0.00	0.00	-0.01
	TDLF	NA	NA	NA	NA	0.00	0.00	-0.01

Table M1-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	71.5	92.9	130.5	45.8	218.9	241.1	382.6	144.9
	SDLF	55.4	159.8	120.1	45.3	202.8	307.9	372.3	144.5
	TDLF	23.1	297.5	101.7	45.6	170.5	445.6	353.8	144.7
G2	NLF	48.0	217.9	135.0	47.7	139.1	594.9	368.9	146.9
	SDLF	57.7	172.5	132.9	48.3	148.9	549.6	366.8	147.6
	TDLF	77.4	78.2	128.0	48.1	168.6	455.2	361.8	147.4
G3	NLF	55.2	187.6	137.3	46.5	161.5	505.3	378.9	140.6
	SDLF	57.1	173.5	137.6	47.7	163.4	491.2	379.3	141.9
	TDLF	61.0	143.6	136.5	50.2	167.4	461.4	378.1	144.4
G4	NLF	50.9	182.2	141.2	45.8	147.1	486.9	391.4	140.3
	SDLF	56.6	174.7	140.3	46.8	152.9	479.5	390.5	141.3
	TDLF	68.6	159.9	139.4	48.8	164.8	464.6	389.6	143.3
G5	NLF	48.7	180.0	144.2	45.9	143.4	480.5	400.4	139.6
	SDLF	55.1	176.2	145.3	46.6	149.8	476.7	401.5	140.2
	TDLF	67.7	168.7	147.0	48.1	162.4	469.1	403.2	141.7
G6	NLF	51.8	181.4	146.1	45.9	151.3	486.6	406.1	139.0
	SDLF	54.2	177.8	149.9	46.0	153.7	483.0	409.9	139.1
	TDLF	59.0	170.0	156.0	46.4	158.4	475.2	416.0	139.5
G7	NLF	57.1	195.4	150.7	45.8	167.9	519.2	419.7	139.7
	SDLF	53.7	180.4	153.4	45.2	164.4	504.2	422.5	139.0
	TDLF	45.1	154.9	155.9	43.7	155.9	478.8	424.9	137.6
G8	NLF	54.1	148.1	142.7	44.4	165.6	417.6	417.2	142.6
	SDLF	48.4	170.7	147.7	41.2	159.9	440.1	422.1	139.4
	TDLF	38.4	212.9	162.0	35.2	149.8	482.3	436.4	133.4

Table M1-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number							
		SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.3	NA	NA	NA	-1.1	NA	NA	NA
	SDLF	0.0	NA	NA	NA	-0.8	NA	NA	NA
	TDLF	0.7	NA	NA	NA	-0.1	NA	NA	NA
G2	NLF	-0.1	NA	NA	NA	-0.1	NA	NA	NA
	SDLF	0.0	NA	NA	NA	-0.1	NA	NA	NA
	TDLF	0.0	NA	NA	NA	-0.1	NA	NA	NA
G3	NLF	0.0	NA	NA	NA	0.1	NA	NA	NA
	SDLF	0.0	NA	NA	NA	0.1	NA	NA	NA
	TDLF	-0.1	NA	NA	NA	0.0	NA	NA	NA
G4	NLF	0.1	NA	NA	NA	0.4	NA	NA	NA
	SDLF	0.0	NA	NA	NA	0.2	NA	NA	NA
	TDLF	-0.3	NA	NA	NA	0.0	NA	NA	NA
G5	NLF	0.1	NA	NA	NA	0.4	NA	NA	NA
	SDLF	0.0	NA	NA	NA	0.3	NA	NA	NA
	TDLF	-0.3	NA	NA	NA	0.0	NA	NA	NA
G6	NLF	0.1	NA	NA	NA	0.4	NA	NA	NA
	SDLF	0.0	NA	NA	NA	0.3	NA	NA	NA
	TDLF	-0.2	NA	NA	NA	0.0	NA	NA	NA
G7	NLF	0.0	NA	NA	NA	0.1	NA	NA	NA
	SDLF	0.0	NA	NA	NA	0.1	NA	NA	NA
	TDLF	-0.1	NA	NA	NA	0.0	NA	NA	NA
G8	NLF	0.0	NA	NA	NA	-0.2	NA	NA	NA
	SDLF	0.1	NA	NA	NA	-0.1	NA	NA	NA
	TDLF	0.3	NA	NA	NA	0.2	NA	NA	NA

Table M1-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.6	-0.1	-0.1	0.1	-1.8	-0.1	-0.4	0.3
	SDLF	0.0	0.0	0.0	0.0	-1.2	-0.1	-0.3	0.2
	TDLF	1.2	0.1	0.3	-0.2	-0.1	0.0	0.0	0.0
G2	NLF	-0.1	0.0	-0.1	0.1	-0.3	0.2	-0.3	0.2
	SDLF	0.0	0.0	0.0	0.0	-0.2	0.1	-0.2	0.1
	TDLF	0.2	-0.1	0.2	-0.1	0.0	0.0	0.0	0.0
G3	NLF	0.0	0.0	-0.1	0.0	0.1	0.0	-0.2	0.0
	SDLF	0.0	0.0	0.0	0.0	0.1	0.0	-0.2	0.0
	TDLF	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
G4	NLF	0.1	-0.1	0.0	0.0	0.4	-0.2	-0.1	-0.1
	SDLF	0.0	0.0	0.0	0.0	0.3	-0.1	-0.1	-0.1
	TDLF	-0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0
G5	NLF	0.2	-0.1	0.0	0.0	0.6	-0.2	0.0	-0.1
	SDLF	0.0	0.0	0.0	0.0	0.4	-0.1	0.0	-0.1
	TDLF	-0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0
G6	NLF	0.1	0.0	0.1	0.0	0.5	0.0	0.1	-0.1
	SDLF	0.0	0.0	0.0	0.0	0.3	0.0	0.1	-0.1
	TDLF	-0.3	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
G7	NLF	0.0	0.1	0.1	0.0	0.0	0.3	0.3	-0.1
	SDLF	0.0	0.0	0.0	0.0	0.0	0.2	0.2	-0.1
	TDLF	0.0	-0.2	-0.1	0.1	0.0	0.0	0.0	0.0
G8	NLF	-0.1	0.4	0.1	0.0	-0.4	1.1	0.4	0.0
	SDLF	0.0	0.0	0.0	0.0	-0.3	0.7	0.2	0.0
	TDLF	0.2	-0.8	-0.2	0.1	-0.1	0.0	0.0	0.1

Table M1-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number							
		SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.03	0.27	0.11	0.32	-0.11	0.84	0.34	1.01
	SDLF	0.00	0.32	0.14	0.35	-0.08	0.89	0.36	1.04
	TDLF	0.07	0.42	0.19	0.41	-0.01	0.99	0.41	1.10
G2	NLF	-0.01	0.26	0.12	0.31	-0.01	0.82	0.34	0.99
	SDLF	0.00	0.31	0.14	0.35	-0.01	0.87	0.36	1.03
	TDLF	0.00	0.42	0.18	0.42	-0.01	0.97	0.41	1.10
G3	NLF	0.00	0.26	0.12	0.31	0.01	0.80	0.35	0.97
	SDLF	0.00	0.30	0.14	0.34	0.01	0.85	0.37	1.00
	TDLF	-0.01	0.38	0.17	0.40	0.00	0.93	0.40	1.06
G4	NLF	0.01	0.25	0.12	0.31	0.04	0.79	0.36	0.96
	SDLF	0.00	0.28	0.13	0.33	0.02	0.82	0.38	0.98
	TDLF	-0.03	0.33	0.15	0.36	0.00	0.87	0.39	1.02
G5	NLF	0.01	0.25	0.13	0.30	0.04	0.79	0.38	0.95
	SDLF	0.00	0.26	0.13	0.31	0.03	0.79	0.38	0.96
	TDLF	-0.03	0.28	0.13	0.32	0.00	0.81	0.39	0.97
G6	NLF	0.01	0.25	0.13	0.30	0.04	0.79	0.39	0.95
	SDLF	0.00	0.24	0.13	0.29	0.03	0.77	0.39	0.94
	TDLF	-0.02	0.21	0.12	0.27	0.00	0.75	0.38	0.92
G7	NLF	0.00	0.26	0.13	0.30	0.01	0.81	0.40	0.95
	SDLF	0.00	0.22	0.12	0.27	0.01	0.77	0.39	0.92
	TDLF	-0.01	0.13	0.10	0.22	0.00	0.68	0.37	0.87
G8	NLF	0.00	0.27	0.14	0.30	-0.02	0.84	0.41	0.95
	SDLF	0.01	0.19	0.12	0.25	-0.01	0.76	0.39	0.90
	TDLF	0.03	0.03	0.10	0.15	0.02	0.61	0.37	0.80

Table M1-4-15. Transverse displacements at supports (in).

		Load Type & Support Number							
Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	0.06	0.01	0.01	-0.01	0.18	0.01	0.04	-0.03
	SDLF	0.00	0.00	0.00	0.00	0.12	0.01	0.03	-0.02
	TDLF	-0.12	-0.01	-0.03	0.02	0.01	0.00	0.00	0.00
G2	NLF	0.01	0.00	0.01	-0.01	0.03	-0.02	0.03	-0.02
	SDLF	0.00	0.00	0.00	0.00	0.02	-0.01	0.02	-0.01
	TDLF	-0.02	0.01	-0.02	0.01	0.00	0.00	0.00	0.00
G3	NLF	0.00	0.00	0.01	0.00	-0.01	0.00	0.02	0.00
	SDLF	0.00	0.00	0.00	0.00	-0.01	0.00	0.02	0.00
	TDLF	0.00	0.00	-0.02	0.00	0.00	0.00	0.00	0.00
G4	NLF	-0.01	0.01	0.00	0.00	-0.04	0.02	0.01	0.01
	SDLF	0.00	0.00	0.00	0.00	-0.03	0.01	0.01	0.01
	TDLF	0.03	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00
G5	NLF	-0.02	0.01	0.00	0.00	-0.06	0.02	0.00	0.01
	SDLF	0.00	0.00	0.00	0.00	-0.04	0.01	0.00	0.01
	TDLF	0.04	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
G6	NLF	-0.01	0.00	-0.01	0.00	-0.05	0.00	-0.01	0.01
	SDLF	0.00	0.00	0.00	0.00	-0.03	0.00	-0.01	0.01
	TDLF	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00
G7	NLF	0.00	-0.01	-0.01	0.00	0.00	-0.03	-0.03	0.01
	SDLF	0.00	0.00	0.00	0.00	0.00	-0.02	-0.02	0.01
	TDLF	0.00	0.02	0.01	-0.01	0.00	0.00	0.00	0.00
G8	NLF	0.01	-0.04	-0.01	0.00	0.04	-0.11	-0.04	0.00
	SDLF	0.00	0.00	0.00	0.00	0.03	-0.07	-0.02	0.00
	TDLF	-0.02	0.08	0.02	-0.01	0.01	0.00	0.00	-0.01

Appendix M1-5. EICSS2 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge EICSS2 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table M1-5-1. Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
7	7-2	SDLF	0.0	0.0	0.0	-0.5	0.4	0.6
		TDLF	-0.1	-0.1	0.1	-0.3	0.3	0.5
	7-3	SDLF	-0.3	-0.4	0.5	-0.2	0.3	0.4
		TDLF	-0.4	-0.5	0.7	2.5	-2.1	3.2
	7-4	SDLF	-0.1	-0.2	0.2	0.1	-0.1	0.2
		TDLF	-0.2	-0.4	0.5	0.8	-1.4	1.6

Table M1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
12	12-2	SDLF	0.0	0.0	0.0	0.2	0.0	0.2
		TDLF	0.0	0.0	0.0	1.9	0.0	1.9
	12-3	SDLF	0.0	0.0	0.0	0.1	0.0	0.1
		TDLF	0.1	0.2	0.2	0.7	-0.1	0.7
	12-4	SDLF	0.0	0.0	0.0	-0.1	0.0	0.1
		TDLF	0.3	0.4	0.5	-0.3	-0.3	0.4
	12-5	SDLF	0.1	0.0	0.1	0.0	0.1	0.1
		TDLF	-0.4	-0.1	0.5	0.3	0.3	0.4

Table M1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
17	17-1	SDLF	0.2	0.3	0.4	-1.6	-0.4	1.7
		TDLF	6.0	7.7	9.8	-45.2	-12.3	46.9
	17-2	SDLF	0.7	0.9	1.1	-1.0	-1.1	1.5
		TDLF	19.3	25.1	31.7	-21.8	-27.9	35.4
	17-3	SDLF	-0.1	-0.1	0.2	-0.3	0.1	0.4
		TDLF	-1.0	-1.3	1.7	-1.6	0.7	1.7
	17-4	SDLF	-0.1	-0.1	0.1	-0.1	0.1	0.1
		TDLF	-0.7	-0.9	1.1	0.4	0.9	1.0
	17-5	SDLF	-1.6	-2.1	2.6	1.5	2.2	2.6
		TDLF	0.0	0.0	0.1	-0.2	0.0	0.2
	17-6	SDLF	-0.4	-0.5	0.6	0.7	0.5	0.8
		TDLF	-0.1	-0.1	0.1	-0.2	0.1	0.2
	17-7	SDLF	-0.9	-1.1	1.4	0.5	1.2	1.3
		TDLF	-0.1	-0.1	0.1	-0.1	0.1	0.1
	17-8	SDLF	-3.5	-4.5	5.7	1.0	4.8	4.9
		TDLF	-0.1	-0.1	0.1	0.2	0.1	0.3
	17-9	SDLF	1.8	2.4	3.0	-0.1	-2.5	2.5
		TDLF	-0.2	-0.3	0.4	-0.1	0.4	0.4
	17-10	SDLF	2.4	3.2	4.0	0.5	-4.0	4.0
		TDLF	0.2	0.3	0.4	-1.6	-0.4	1.7

Table M1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
21	21-1	SDLF	0.1	0.1	0.2	-0.4	-0.2	0.4
		TDLF	-1.5	-1.9	2.5	-6.6	1.5	6.8
	21-2	SDLF	0.0	0.0	0.0	-0.2	0.0	0.2
		TDLF	0.3	0.4	0.5	-0.7	0.0	0.7
	21-3	SDLF	0.0	0.0	0.0	-0.1	0.0	0.1
		TDLF	0.1	0.1	0.1	0.3	-0.1	0.3
	21-4	SDLF	0.0	0.0	0.0	-0.1	0.0	0.1
		TDLF	0.0	0.0	0.0	0.7	0.0	0.7
	21-5	SDLF	0.0	0.0	0.0	0.4	0.1	0.4
		TDLF	0.0	0.0	0.0	-0.3	0.0	0.3
	21-6	SDLF	0.1	0.1	0.2	-0.9	-0.3	1.0
		TDLF	0.1	0.1	0.2	-0.4	-0.2	0.4

Table M1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
23	23-1	SDLF	0.3	-0.1	0.3	-0.3	-0.2	0.4
		TDLF	-0.1	-0.3	0.3	-0.1	0.1	0.1
	23-2	SDLF	10.8	14.0	17.7	-11.1	-13.1	17.2
		TDLF	-4.4	-5.7	7.2	0.4	5.8	5.8
	23-3	SDLF	20.8	27.0	34.1	-48.1	-28.1	55.7
		TDLF	-3.8	-4.9	6.2	3.6	5.0	6.2
	23-4	SDLF	20.1	26.1	32.9	-44.0	-27.2	51.7
		TDLF	-3.0	-3.9	5.0	4.1	4.1	5.8
	23-5	SDLF	16.5	21.4	27.0	-39.1	-22.6	45.2
		TDLF	-2.3	-3.0	3.8	4.2	3.2	5.3
	23-6	SDLF	8.6	11.2	14.1	-29.3	-12.0	31.7
		TDLF	-1.7	-2.2	2.8	3.9	2.3	4.6
	23-7	SDLF	-3.2	-4.2	5.3	-18.4	3.5	18.7
		TDLF	-1.1	-1.5	1.9	3.4	1.6	3.7
	12-8	SDLF	-16.7	-21.7	27.4	-7.3	20.9	22.1
		TDLF	-0.7	-0.9	1.2	2.7	1.0	2.8
	23-9	SDLF	-30.5	-39.5	49.9	5.3	39.5	39.9
		TDLF	-0.4	-0.5	0.6	2.0	0.5	2.1
	23-10	SDLF	-35.7	-46.2	58.4	15.7	47.1	49.6
		TDLF	-0.2	-0.2	0.3	1.4	0.2	1.4
	23-11	SDLF	-44.8	-58.0	73.3	23.1	59.7	64.1
		TDLF	0.0	0.0	0.0	1.0	0.0	1.0
	23-12	SDLF	-59.6	-77.2	97.6	31.9	80.0	86.1
		TDLF	-0.4	-0.5	0.7	0.5	0.6	0.7
	23-13	SDLF	4.0	5.2	6.5	10.3	-5.8	11.8
		TDLF	-0.4	-0.5	0.6	0.0	0.3	0.3
	23-14	SDLF	-34.3	-44.4	56.1	60.0	47.2	76.3
		TDLF	-1.9	-2.4	3.1	-0.5	2.6	2.7
	23-15	SDLF	-20.9	-27.1	34.3	49.4	28.3	56.9
		TDLF	-1.8	-2.3	3.0	0.2	2.6	2.6

Table M1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
23	23-16	SDLF	-13.9	-18.0	22.8	35.7	-26.0	44.2
		TDLF	-1.5	-2.0	2.5	0.6	0.1	0.6
	23-17	SDLF	-10.5	-13.6	17.2	24.2	-17.2	29.7
		TDLF	-1.0	-1.3	1.7	0.8	-0.2	0.8
	23-18	SDLF	-4.3	-5.6	7.1	15.0	-11.5	18.9
		TDLF	-0.5	-0.6	0.8	0.7	-0.4	0.8
	23-19	SDLF	-0.3	-0.3	0.4	4.0	-3.4	5.2
		TDLF	0.2	0.2	0.3	0.4	-0.4	0.6
	23-20	SDLF	2.0	2.6	3.2	-2.5	1.4	2.9
		TDLF	0.7	1.0	1.2	0.0	-0.3	0.3
	23-21	SDLF	2.7	3.6	4.5	-4.9	3.1	5.8
		TDLF	1.2	1.5	1.9	-0.4	-0.1	0.5
	23-22	SDLF	2.0	2.6	3.2	-4.9	3.4	6.0
		TDLF	1.3	1.7	2.2	-0.8	0.1	0.8
	12-23	SDLF	0.6	0.7	0.9	-3.0	2.6	4.0
		TDLF	1.3	1.7	2.1	-0.8	0.2	0.9
	23-24	SDLF	-4.8	-6.3	7.9	-0.7	3.3	3.3
		TDLF	0.3	0.3	0.4	-1.0	0.7	1.2
	23-25	SDLF	1.0	1.3	1.7	-0.3	0.2	0.4
		TDLF	-0.4	-0.6	0.7	-0.5	0.6	0.8
	23-26	SDLF	-0.7	-0.9	1.1	5.3	-4.6	7.0
		TDLF	-1.4	-1.8	2.3	-1.2	1.6	2.0
	23-27	SDLF	0.0	0.0	0.1	0.1	-0.2	0.2
		TDLF	-2.7	-3.5	4.5	0.7	0.5	0.8
	23-28	SDLF	1.8	2.3	3.0	-1.8	0.9	2.0
		TDLF	-3.2	-4.1	5.2	2.5	-0.9	2.6
	23-29	SDLF	3.0	3.9	4.9	-3.0	1.5	3.4
		TDLF	-3.3	-4.3	5.4	3.5	-1.7	3.9
	23-30	SDLF	3.3	4.2	5.3	-2.9	-4.3	5.2
		TDLF	-3.0	-3.9	4.9	3.8	4.0	5.5

Table M1-5-1(Continued). Fit-up forces (kips) applied to the girder being installed

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
23	23-31	SDLF	2.9	3.8	4.8	-2.2	-3.9	4.5
		TDLF	-2.4	-3.2	4.0	3.4	3.3	4.8
	23-32	SDLF	2.2	2.9	3.7	-1.4	-2.9	3.2
		TDLF	-1.7	-2.2	2.8	2.7	2.3	3.6
	23-33	SDLF	1.2	1.6	2.0	-0.4	-1.4	1.5
		TDLF	-1.0	-1.3	1.6	1.8	1.3	2.2
	23-34	SDLF	-0.2	-0.2	0.3	0.6	0.4	0.7
		TDLF	-0.3	-0.4	0.5	0.9	0.5	1.0
	23-35	SDLF	0.6	0.7	0.9	-0.4	-0.4	0.6
		TDLF	0.0	0.1	0.1	0.0	0.0	0.1

Table M1-5-2: Erection Critical Sub-Stages

Stage	Detailing Method	Critical Sub-Stage
7	SDLF	7-2
	TDLF	7-3
12	SDLF	12-2
	TDLF	12-2
17	SDLF	17-8
	TDLF	17-1
21	SDLF	21-6
	TDLF	21-1
23	SDLF	23-12
	TDLF	23-3

Table M1-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
7	A	SDLF	0.0	-0.1	0.1	NA	NA	NA
		TDLF	-0.2	-0.2	0.3	NA	NA	NA
	B	SDLF	0.0	0.0	0.0	-0.5	0.4	0.6
		TDLF	-0.4	-0.5	0.7	2.5	-2.1	3.2
12	A	SDLF	0.0	0.0	0.0	NA	NA	NA
		TDLF	0.1	0.1	0.1	NA	NA	NA
	B	SDLF	0.0	0.0	0.0	0.2	0.0	0.2
		TDLF	0.0	0.0	0.0	1.9	0.0	1.9
17	A	SDLF	-0.1	-0.1	0.1	NA	NA	NA
		TDLF	-1.0	-1.3	1.7	NA	NA	NA
	B	SDLF	-3.5	-4.5	5.7	1.0	4.8	4.9
		TDLF	6.0	7.7	9.8	-45.2	-12.3	46.9
21	A	SDLF	0.0	0.0	0.0	NA	NA	NA
		TDLF	-1.3	-1.7	2.2	NA	NA	NA
	B	SDLF	0.1	0.1	0.2	-0.9	-0.3	1.0
		TDLF	-1.5	-1.9	2.5	-6.6	1.5	6.8
23 (Closure)	A	SDLF	-11.2	-14.5	18.3	NA	NA	NA
		TDLF	-0.3	-0.4	0.5	NA	NA	NA
	B	SDLF	-59.6	-77.2	97.6	31.9	80.0	86.1
		TDLF	-3.8	-4.9	6.2	3.6	5.0	6.2

Table M1-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number		
				1	2	3
7	A	G5	SDLF	45	178	80
			TDLF	44	183	80
		G6	SDLF	49	176	82
			TDLF	49	166	81
		G7	SDLF	59	203	81
			TDLF	61	209	82
		G8	SDLF	56	63	
			TDLF	54	62	
	B	G5	SDLF	45	178	80
			TDLF	44	183	79
		G6	SDLF	49	176	82
			TDLF	49	166	85
		G7	SDLF	59	204	82
			TDLF	61	210	81
		G8	SDLF	56	63	
			TDLF	54	62	

Table M1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
12	A	G5	SDLF	51	165	135	44
			TDLF	50	171	130	44
		G6	SDLF	52	168	141	44
			TDLF	53	161	148	44
		G7	SDLF	52	172	144	42
			TDLF	53	168	142	42
		G8	SDLF	47	166	142	39
			TDLF	46	170	142	39
	B	G5	SDLF	51	165	135	44
			TDLF	50	171	128	44
		G6	SDLF	52	168	141	44
			TDLF	53	161	150	44
		G7	SDLF	52	172	145	42
			TDLF	53	169	145	43
		G8	SDLF	47	166	142	39
			TDLF	46	170	140	39

Table M1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
17	A	G5	SDLF	52	176	136	43
			TDLF	47	231	128	44
		G6	SDLF	54	170	143	44
			TDLF	63	103	145	45
		G7	SDLF	54	176	146	44
			TDLF	57	146	149	44
		G8	SDLF	48	172	143	40
			TDLF	43	210	144	39
	B	G5	SDLF	52	176	137	43
			TDLF	48	257	128	44
		G6	SDLF	54	170	144	44
			TDLF	63	49	144	45
		G7	SDLF	54	176	147	44
			TDLF	56	177	149	44
		G8	SDLF	48	172	143	40
			TDLF	43	207	145	39

Table M1-5-4 (Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Stage	Conn-ection	Girder	Detailing Method	Support Number			
				1	2	3	4
21	A	G5	SDLF	53	171	140	45
			TDLF	50	260	138	46
		G6	SDLF	54	176	149	45
			TDLF	62	78	136	46
		G7	SDLF	54	178	153	45
			TDLF	54	117	161	45
		G8	SDLF	48	173	148	41
			TDLF	43	243	152	39
	B	G5	SDLF	53	171	140	45
			TDLF	50	261	137	46
		G6	SDLF	54	176	149	45
			TDLF	62	78	141	46
		G7	SDLF	54	178	153	45
			TDLF	54	117	153	45
		G8	SDLF	48	173	148	42
			TDLF	43	243	157	39

Appendix N-1. NISCS14 Bridge Description

The key characteristics of NISCS14 are as follows:

- Span length along the centerline of the bridge, L_s = 150 ft.
- Width between the fascia girders, w_g = 74 ft.
- Radius of curvature to the centerline of the bridge, R =280 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 2.0
- Subtended angle between the supports, L_s/R = 0.54
- Number of girders in the completed bridge cross-section, n_g =9.
- Skew angle, θ = 53.7,0^o

This appendix presents the bridge description of the bridge NISCS14 in its final condition as well as during erection. The following figures and tables are provided:

Figure N-1-1. Framing plan

Figure N-1-2. Bridge cross-section

Figure N-1-3. Girder Elevation

Figure N-1-4. Cross-section dimension

Figure N-1-5. Cross-frame details

Figure N-1-6. Erection scheme

Table N-1-1. Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed NLF

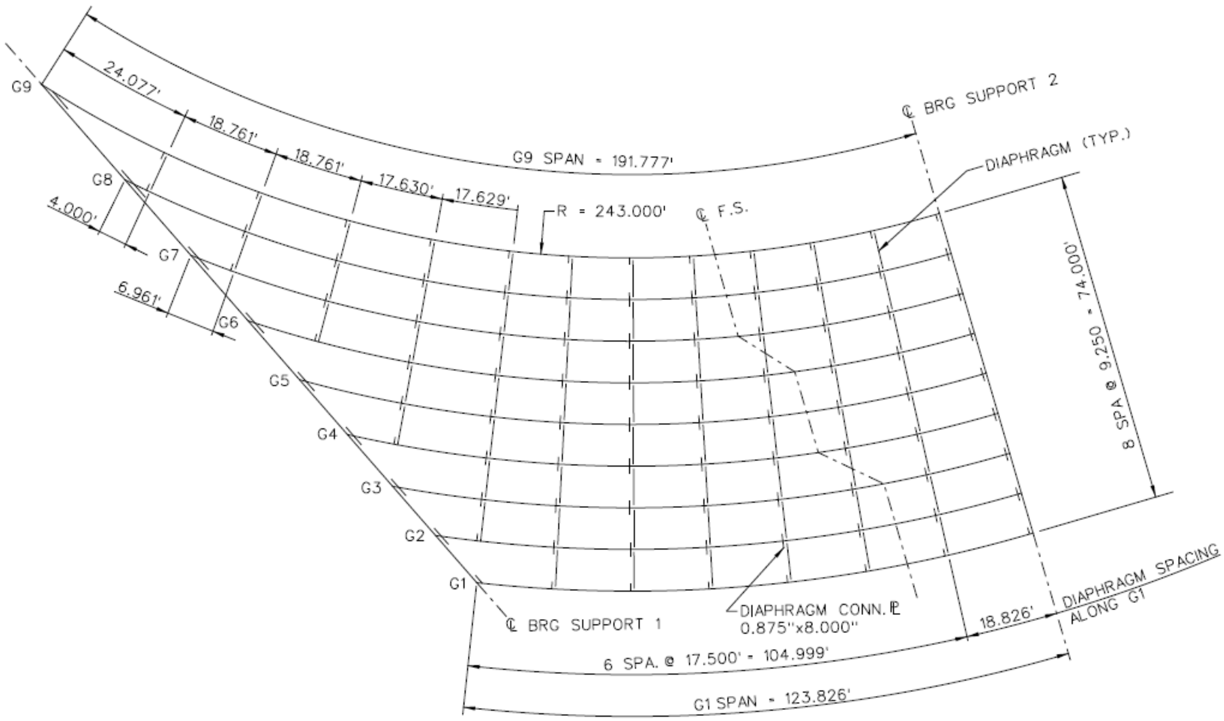


Figure N-1-1. Framing plan.

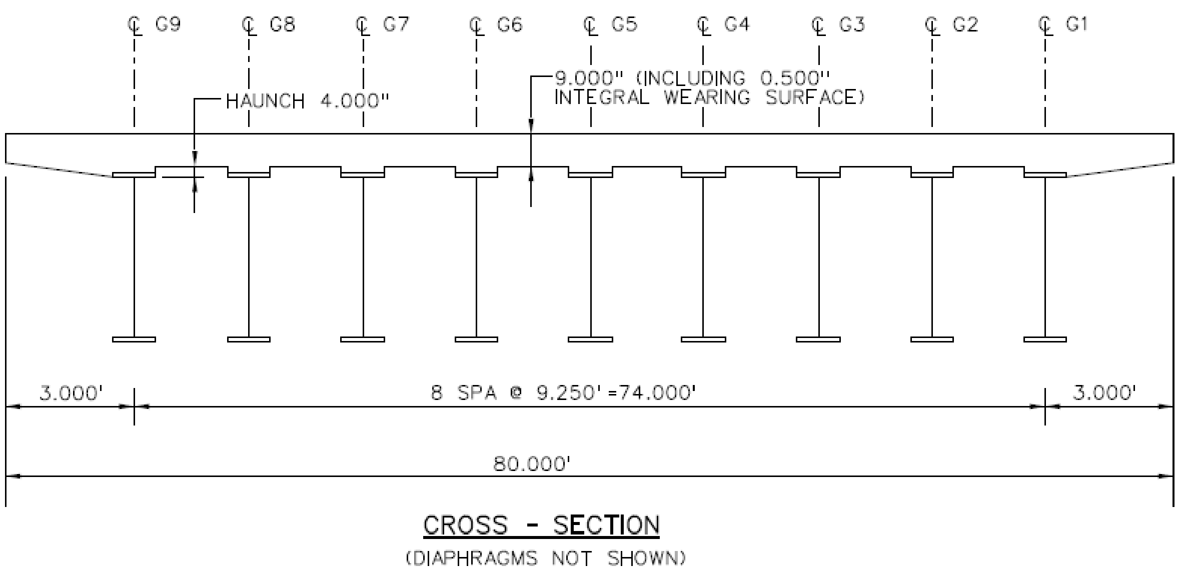


Figure N-1-2. Bridge cross-section.

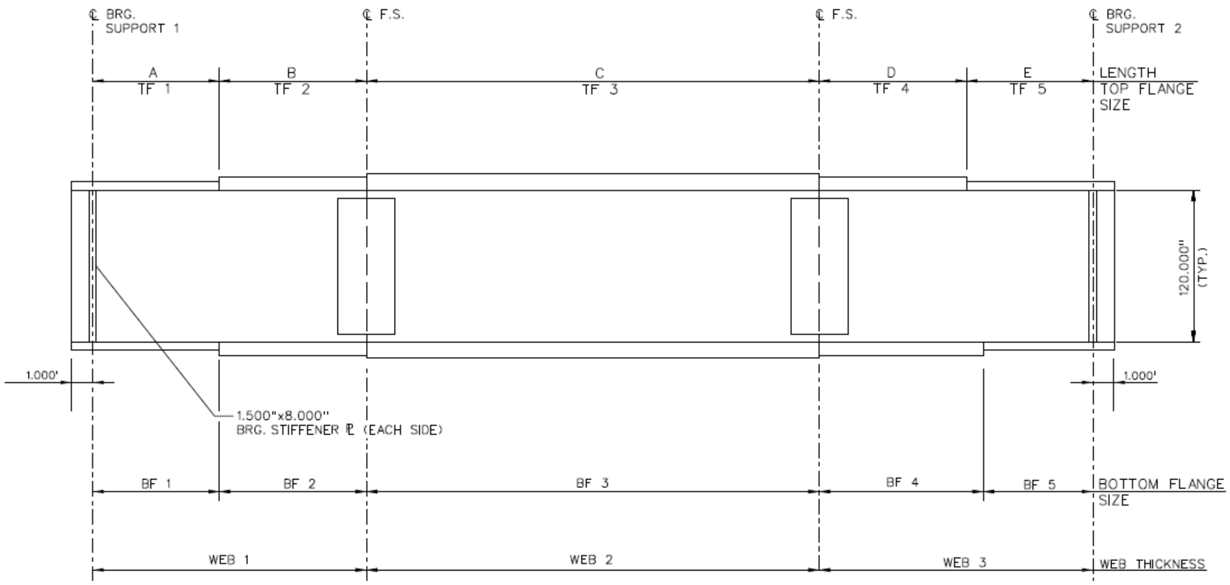


Figure N-1-3. Girder elevations

	GIRDER PLATE LENGTHS ⁎								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	15.000	16.000	15.000	17.500	17.500	20.000	20.000	27.500	35.000
B	15.000	16.000	15.000	17.500	17.500	20.000	20.000	27.500	35.000
C	65.826	69.740	78.003	67.712	75.000	78.068	77.240	73.084	71.777
D	14.000	14.000	14.000	20.000	20.000	20.000	25.000	25.000	25.000
E	14.000	14.000	14.000	20.000	20.000	20.000	25.000	25.000	25.000

⁎ ALL DIMENSIONS ARE IN FEET.

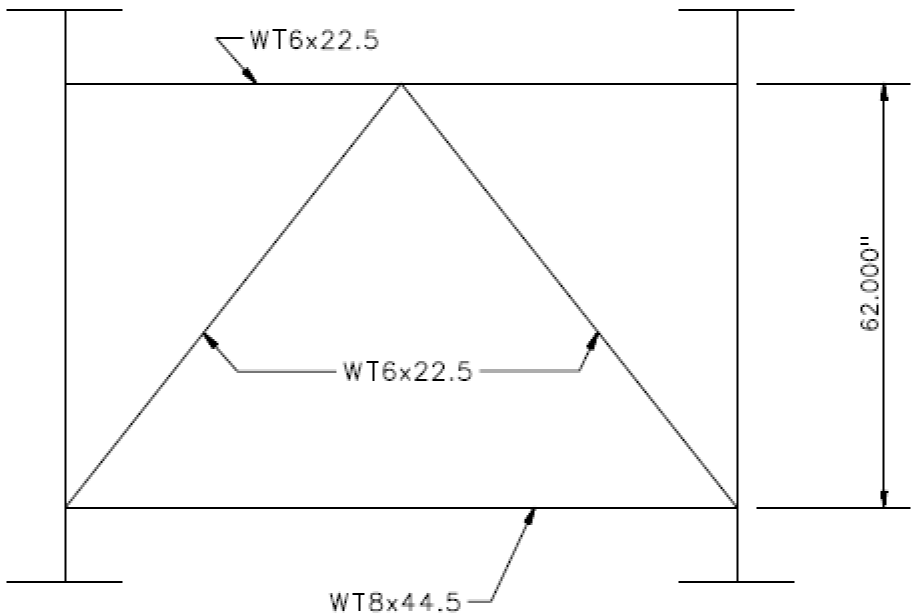
	GIRDER FLANGE DIMENSIONS ⁎⁎					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	20.000	1.000	24.000	1.000	28.000	1.500
TF2	20.000	1.000	24.000	1.000	28.000	1.500
TF3	20.000	2.000	24.000	1.000	28.000	1.500
TF4	20.000	1.000	24.000	1.000	28.000	1.500
TF5	20.000	1.000	24.000	1.000	28.000	1.500

⁎⁎ ALL DIMENSIONS ARE IN INCHES.

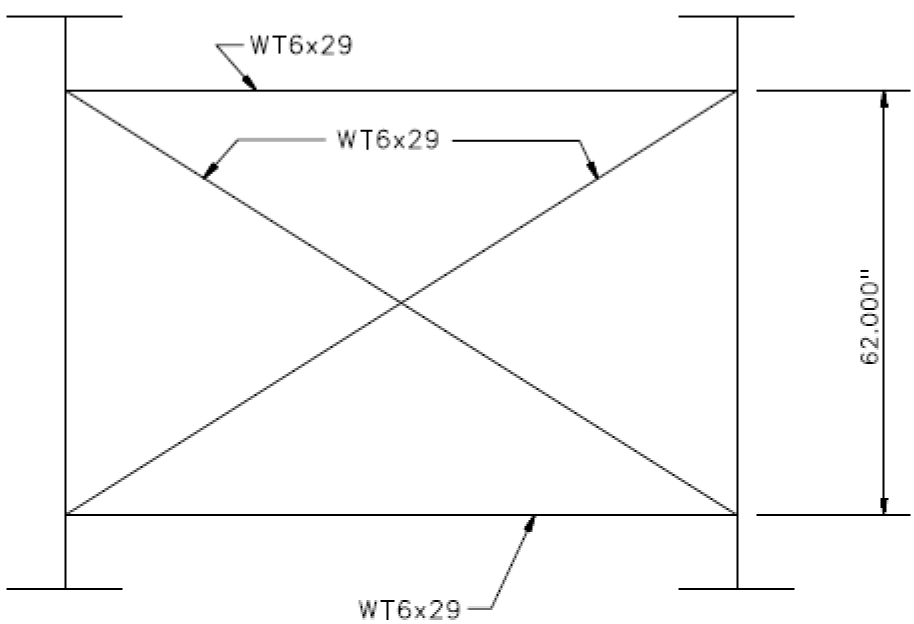
	GIRDER FLANGE DIMENSIONS ⁎⁎					
BOTTOM FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
BF1	28.000	1.500	28.000	1.500	30.000	1.750
BF2	28.000	1.500	28.000	1.500	30.000	1.750
BF3	28.000	2.250	28.000	2.250	30.000	1.750
BF4	28.000	1.500	28.000	1.500	30.000	1.750
BF5	28.000	1.500	28.000	1.500	30.000	1.750

⁎⁎ ALL DIMENSIONS ARE IN INCHES.

Figure N-1-4. Cross-section dimensions.



TYPICAL END DIAPHRAGM



TYPICAL INTERMEDIATE DIAPHRAGM

Figure N-1-4. Cross-frame details

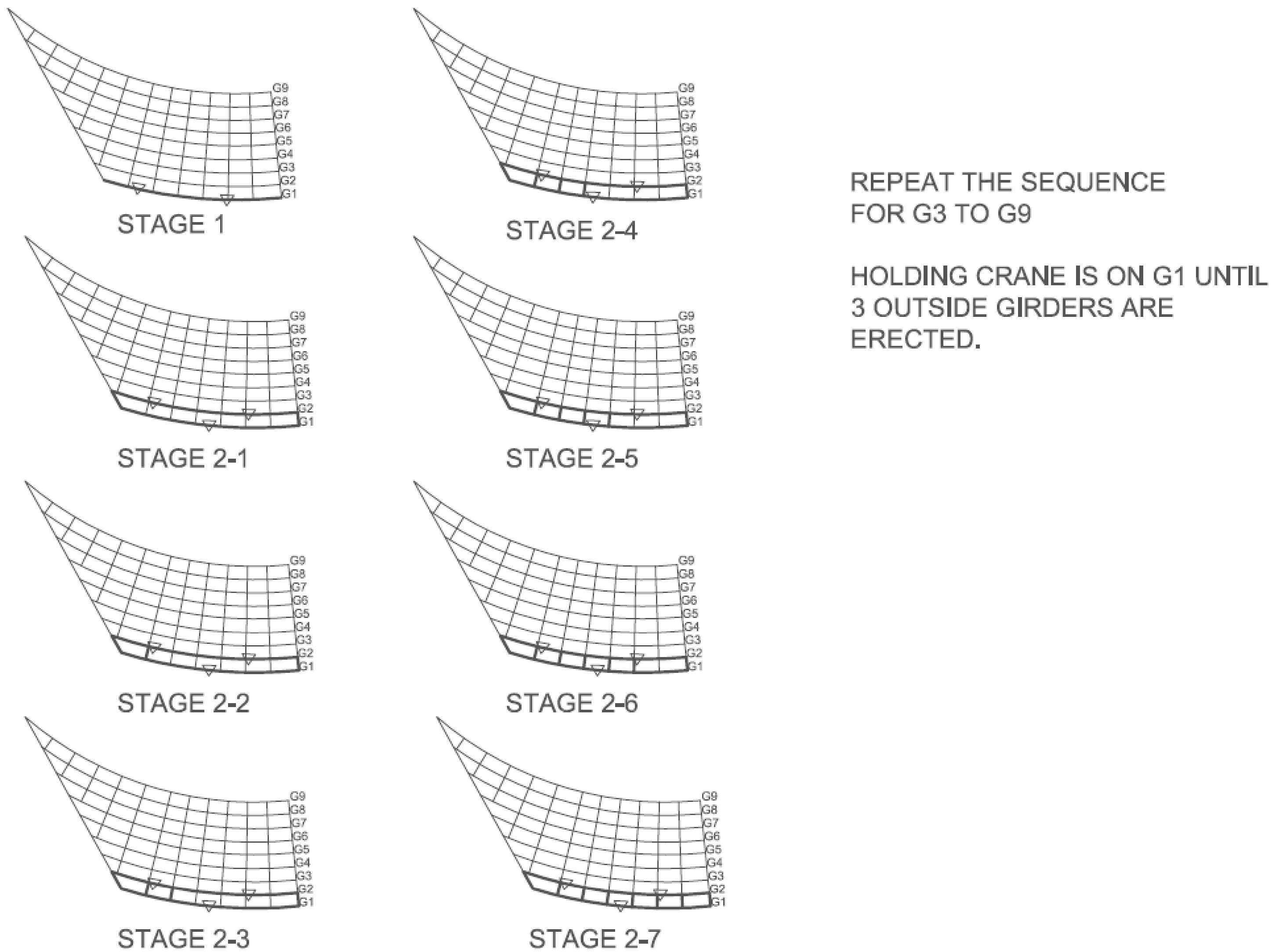


Figure N-1-6. Erection scheme.

Table N-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

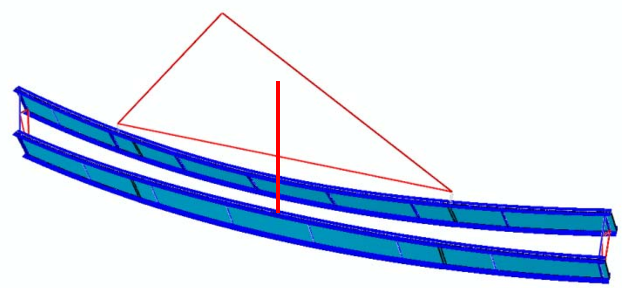
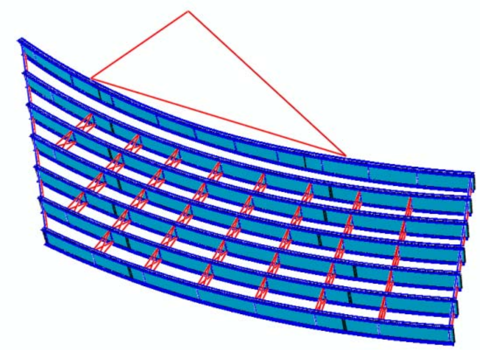
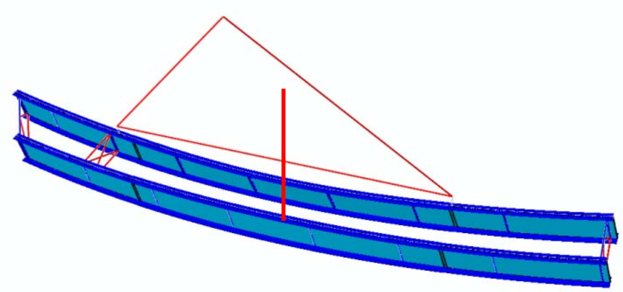
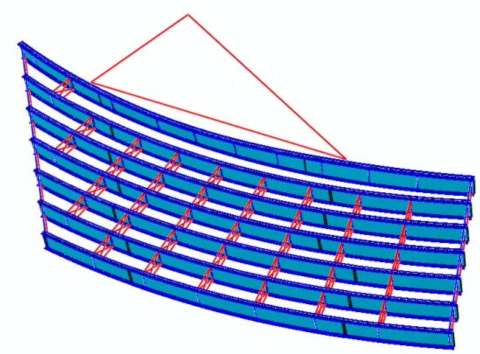
Sub-Stage	Stage	
	2	7
1		
2		

Table N-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

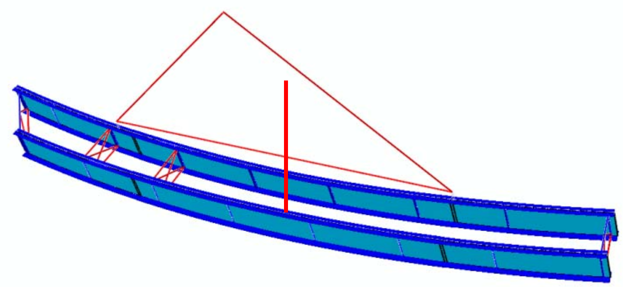
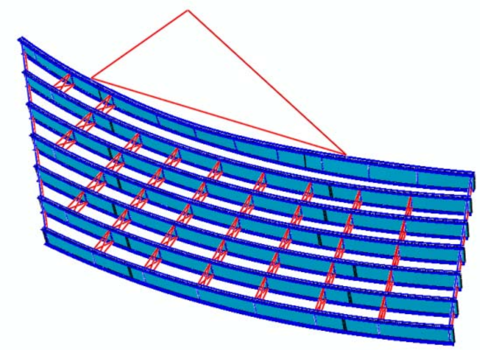
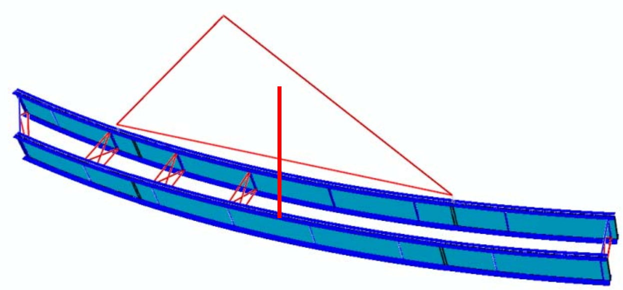
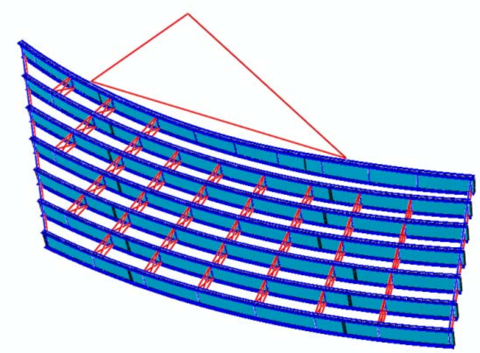
3		
4		

Table N-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

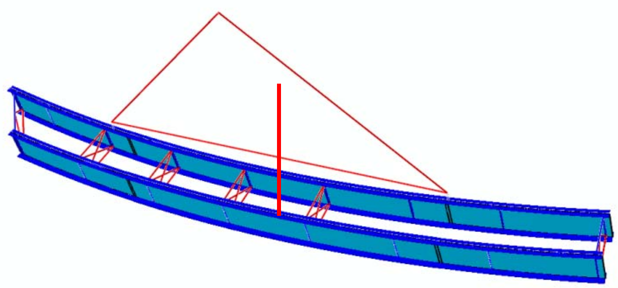
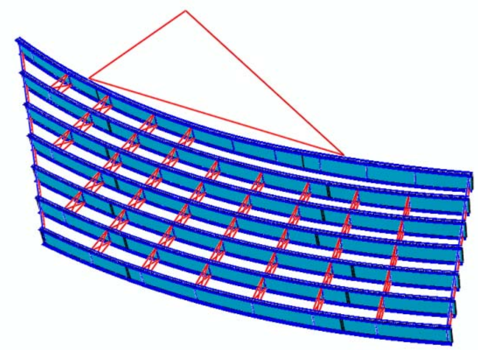
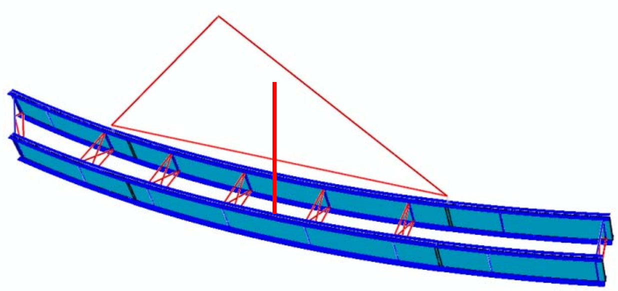
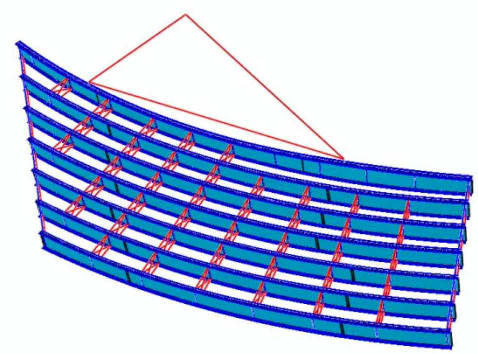
5		
6		

Table N-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

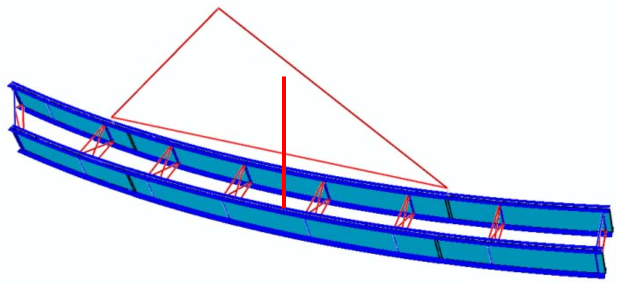
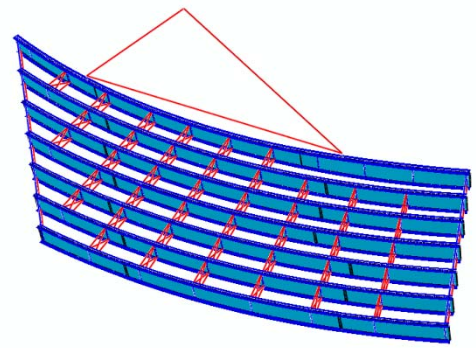
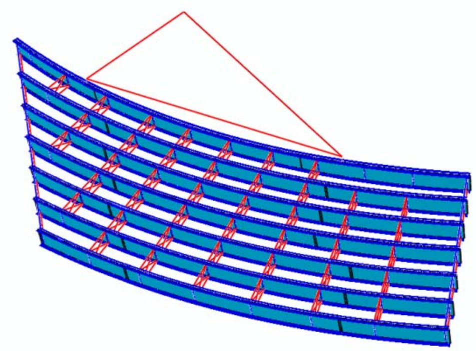
7		
8		

Table N-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

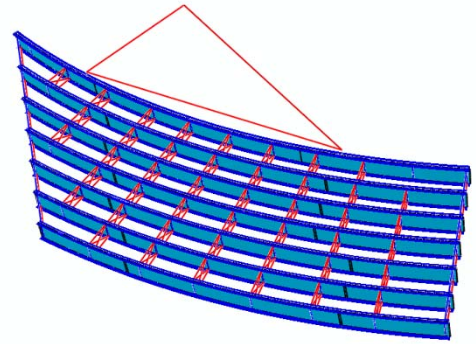
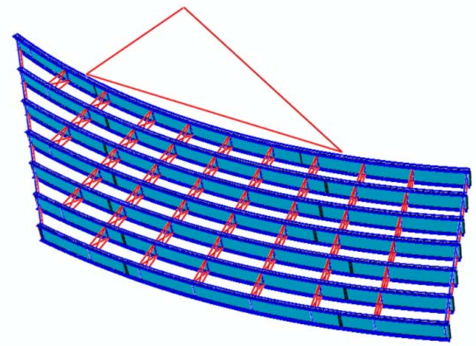
7		
8		

Table N-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

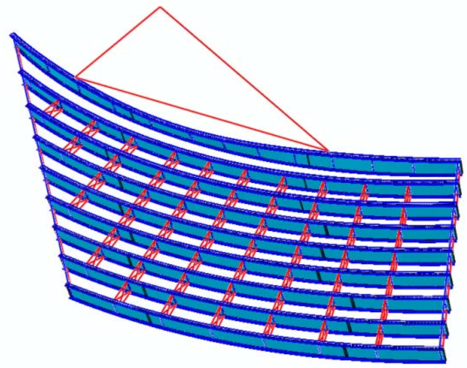
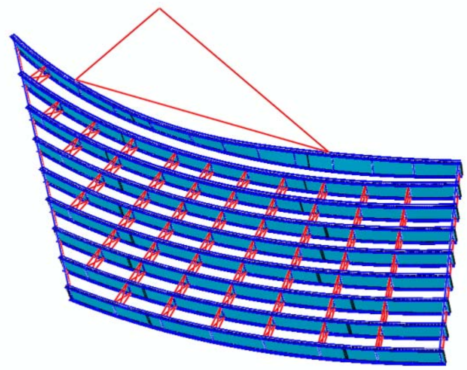
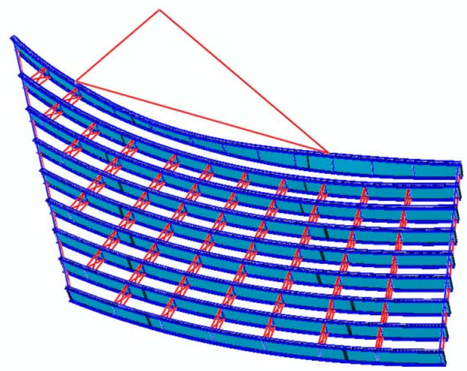
Sub-Stage	Stage 9
1	
2	
3	

Table N-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

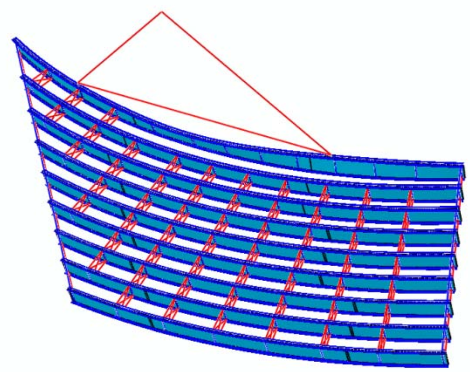
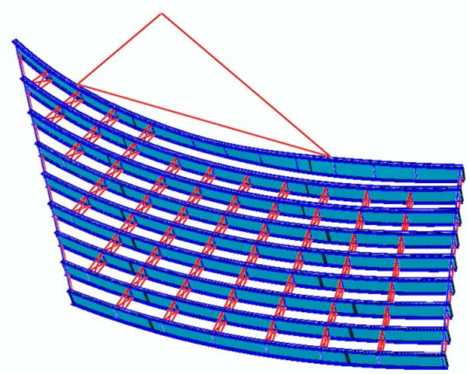
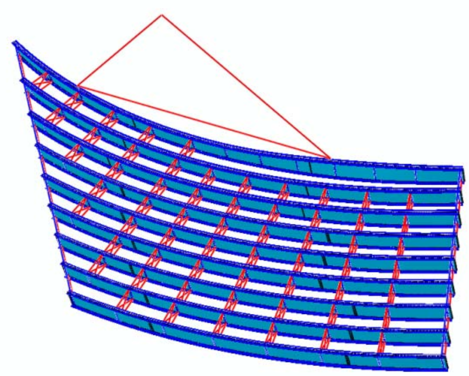
Sub-Stage	Stage 9
4	
5	
6	

Table N-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

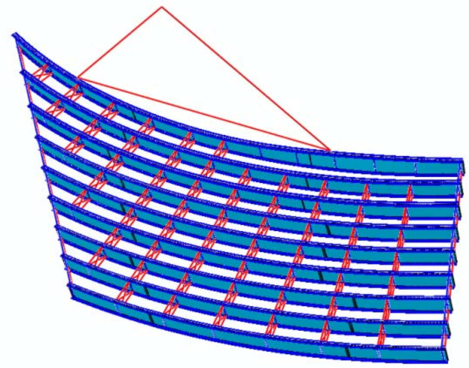
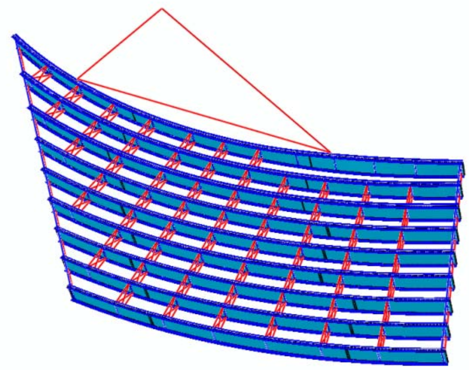
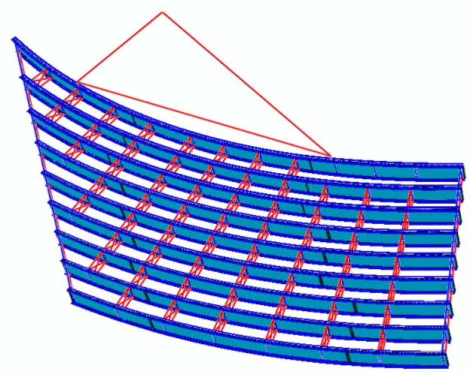
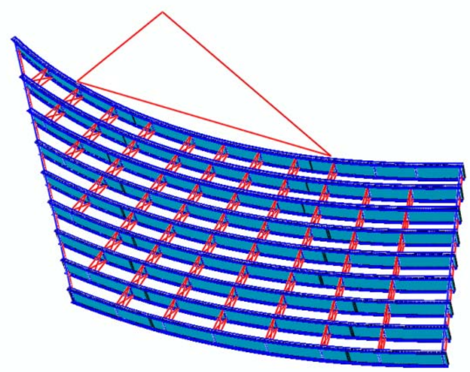
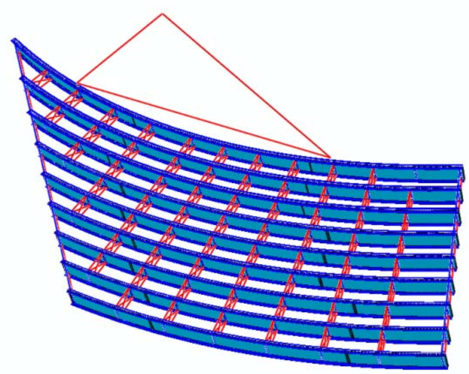
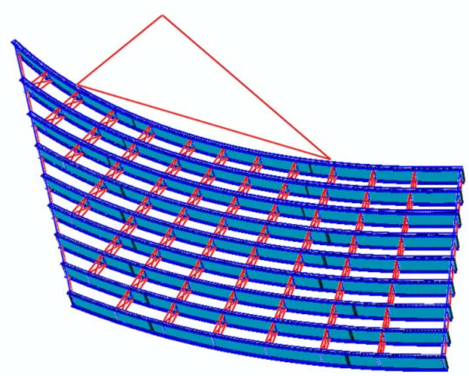
Sub-Stage	Stage 9
7	
8	
9	

Table N-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

Sub-Stage	Stage 9
10	
11	
12	

Appendix N-2. NISCS14 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISCS14 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table N-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.1	3.4
	SDLF	1.2	3.5
	TDLF	1.2	3.5
G2	NLF	1.2	3.6
	SDLF	1.2	3.6
	TDLF	1.3	3.7
G3	NLF	1.2	3.8
	SDLF	1.3	3.9
	TDLF	1.5	4.0
G4	NLF	1.3	4.1
	SDLF	1.5	4.3
	TDLF	1.7	4.5
G5	NLF	1.5	4.5
	SDLF	1.6	4.7
	TDLF	2.0	5.1
G6	NLF	1.6	4.9
	SDLF	1.8	5.1
	TDLF	2.2	5.5
G7	NLF	1.7	5.2
	SDLF	1.9	5.5
	TDLF	2.4	5.9
G8	NLF	1.8	5.5
	SDLF	2.0	5.7
	TDLF	2.5	6.2
G9	NLF	1.9	5.8
	SDLF	2.1	6.0
	TDLF	2.5	6.4
All Girders	NLF	1.9	5.8
	SDLF	2.1	6.0
	TDLF	2.5	6.4

Table N-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.18	0.56
	SDLF	0.04	0.39
	TDLF	0.34	0.11
G2	NLF	0.19	0.58
	SDLF	0.02	0.41
	TDLF	0.34	0.07
G3	NLF	0.20	0.64
	SDLF	0.03	0.46
	TDLF	0.36	0.09
G4	NLF	0.23	0.70
	SDLF	0.04	0.52
	TDLF	0.36	0.13
G5	NLF	0.25	0.77
	SDLF	0.05	0.57
	TDLF	0.37	0.15
G6	NLF	0.28	0.86
	SDLF	0.06	0.65
	TDLF	0.39	0.20
G7	NLF	0.30	0.92
	SDLF	0.08	0.70
	TDLF	0.42	0.23
G8	NLF	0.32	1.01
	SDLF	0.09	0.77
	TDLF	0.43	0.28
G9	NLF	0.34	1.07
	SDLF	0.10	0.83
	TDLF	0.44	0.32
All Girders	NLF	0.34	1.07
	SDLF	0.10	0.83
	TDLF	0.44	0.32

Table N-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	4.6	14.1	7.4	22.5	0.8	2.4	2.0	7.2
	SDLF	4.6	14.1	7.3	22.4	0.8	2.4	2.0	7.1
	TDLF	4.4	13.9	7.0	22.1	0.9	2.5	2.2	7.0
G2	NLF	4.4	13.6	7.0	21.6	0.8	2.3	2.1	6.5
	SDLF	4.4	13.6	7.0	21.7	0.8	2.3	2.1	6.5
	TDLF	4.5	13.7	7.2	21.8	0.8	2.4	2.1	6.6
G3	NLF	4.3	13.4	6.8	21.4	0.7	2.2	2.3	7.6
	SDLF	4.4	13.5	7.0	21.5	0.8	2.3	2.1	7.4
	TDLF	4.6	13.7	7.3	21.8	0.9	2.4	1.9	6.8
G4	NLF	4.1	12.7	6.3	19.3	0.9	2.9	1.9	6.1
	SDLF	4.2	12.9	6.4	19.5	0.9	3.0	2.0	6.2
	TDLF	4.6	13.2	6.8	19.9	1.0	3.0	2.1	6.3
G5	NLF	3.9	12.2	6.3	19.5	1.0	2.5	2.2	7.4
	SDLF	4.1	12.4	6.6	19.7	1.0	2.7	2.3	7.1
	TDLF	4.5	12.8	7.1	20.3	1.1	3.1	2.6	7.3
G6	NLF	3.8	11.8	6.3	19.3	1.2	3.9	2.5	7.9
	SDLF	4.0	12.0	6.5	19.5	1.2	3.9	2.5	7.9
	TDLF	4.4	12.4	6.9	20.0	1.2	3.9	2.6	8.1
G7	NLF	4.2	13.0	4.9	15.1	1.1	3.2	1.5	4.8
	SDLF	4.3	13.1	5.0	15.1	1.1	3.3	1.5	4.7
	TDLF	4.5	13.2	5.2	15.4	1.2	3.5	1.3	4.5
G8	NLF	4.0	12.5	4.7	14.5	1.1	3.1	1.5	4.7
	SDLF	4.0	12.4	4.6	14.4	1.1	3.2	1.4	4.5
	TDLF	3.8	12.2	4.4	14.1	1.1	3.3	1.2	4.3
G9	NLF	3.9	11.9	4.5	13.8	1.0	2.9	1.4	4.3
	SDLF	3.5	11.6	4.1	13.4	1.0	2.9	1.2	4.1
	TDLF	2.8	10.8	3.2	12.5	0.9	2.8	0.9	3.7
All Girders	NLF	4.6	14.1	7.4	22.5	1.2	3.9	2.5	7.9
	SDLF	4.6	14.1	7.3	22.4	1.2	3.9	2.5	7.9
	TDLF	4.6	13.9	7.3	22.1	1.2	3.9	2.6	8.1

Table N-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	17.0	24.3	23.9	24.3
	SDLF	15.6	17.9	17.8	17.9
	TDLF	18.7	23.6	23.1	23.6
TDL	NLF	54.4	77.0	76.6	77.0
	SDLF	52.4	70.5	69.8	70.5
	TDLF	49.6	57.6	57.3	57.6

Table N-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	7.1	7.1	8.2	7.3
	SDLF	7.1	6.1	7.1	6.8
	TDLF	7.4	5.5	6.1	6.5
TDL	NLF	21.7	22.4	26.1	23.0
	SDLF	21.7	21.2	24.9	22.3
	TDLF	21.7	19.3	22.5	21.2

Table N-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.20	0.28	0.27	0.35	0.34	0.38	0.44	0.49	0.49
SDLF	0.23	0.32	0.32	0.41	0.41	0.46	0.54	0.62	0.62
TDLF	0.27	0.40	0.43	0.56	0.55	0.61	0.74	0.90	0.90

Table N-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.64	0.87	0.86	1.08	1.05	1.17	1.36	1.52	1.52
SDLF	0.66	0.91	0.91	1.14	1.12	1.25	1.45	1.65	1.65
TDLF	0.71	0.99	1.01	1.29	1.26	1.40	1.65	1.93	1.93

Table N-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.11	0.16	0.15	0.19	0.19	0.21	0.24	0.27	0.27
SDLF	0.13	0.18	0.18	0.23	0.23	0.25	0.30	0.35	0.35
TDLF	0.15	0.22	0.24	0.31	0.31	0.34	0.41	0.50	0.50

Table N-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.36	0.49	0.48	0.60	0.58	0.65	0.76	0.85	0.85
SDLF	0.37	0.51	0.51	0.64	0.62	0.70	0.81	0.92	0.92
TDLF	0.40	0.55	0.57	0.72	0.70	0.78	0.92	1.08	1.08

Table N-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	802	2487
SDLF	802	2487
TDLF	802	2487

Table N-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	56	172	0.0	0.2	0.0	0.7
SDLF	53	170	0.1	0.2	0.0	0.5
TDLF	57	165	0.2	0.1	0.2	0.1

Table N-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.24	0.73	0.01	0.13
SDLF	0.20	0.65	0.00	0.10
TDLF	0.17	0.64	0.03	0.01

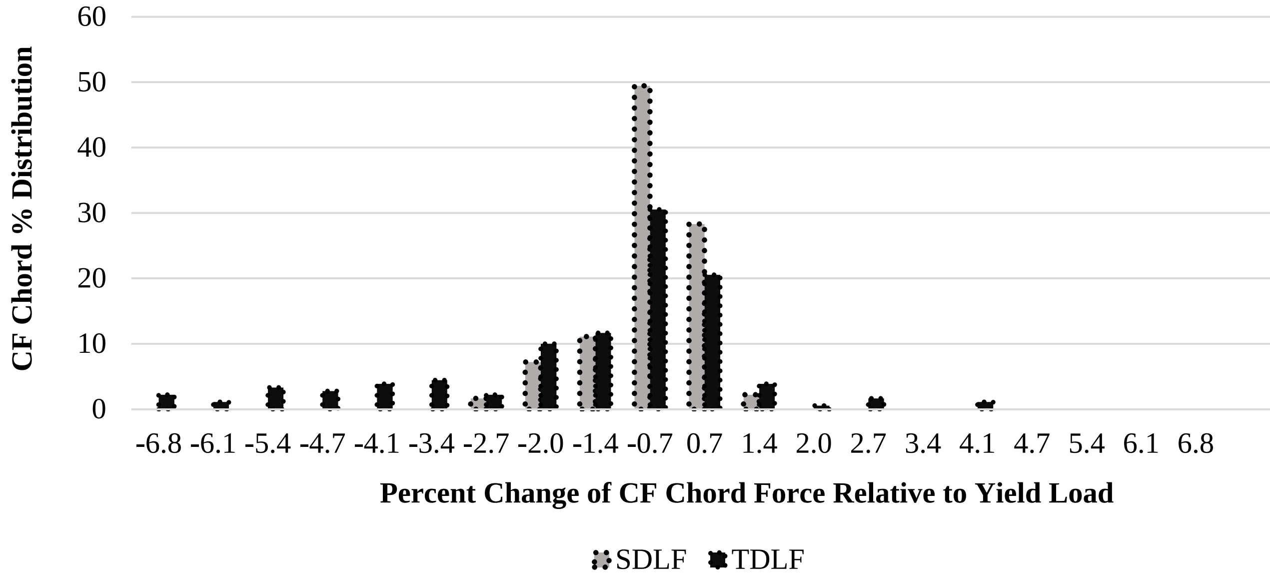


Figure N-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

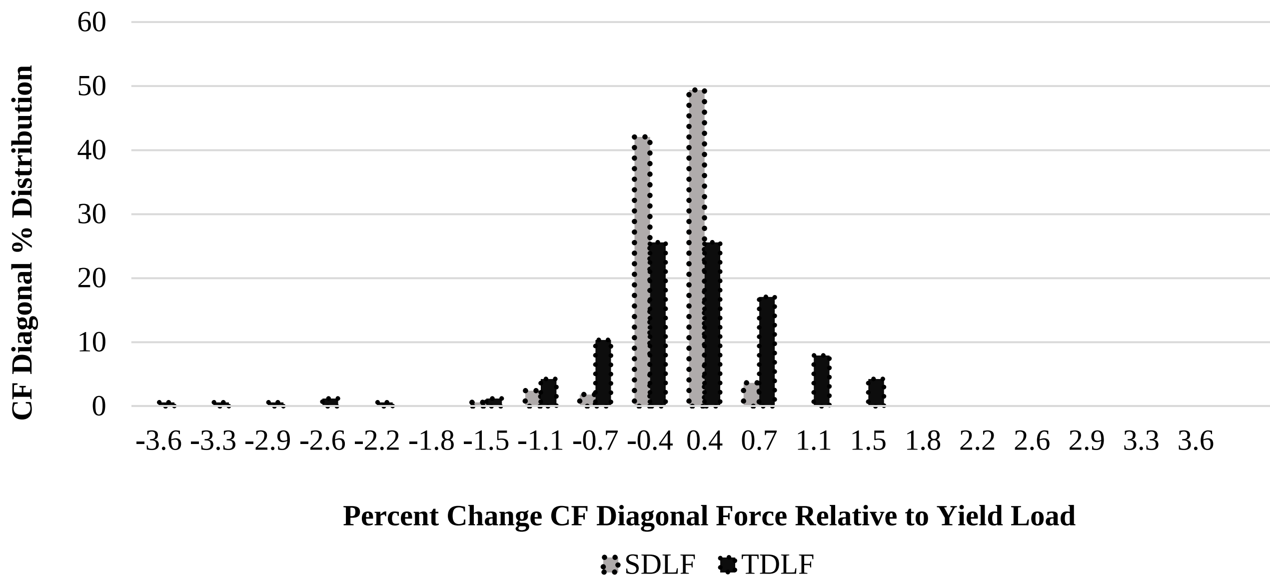


Figure N-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

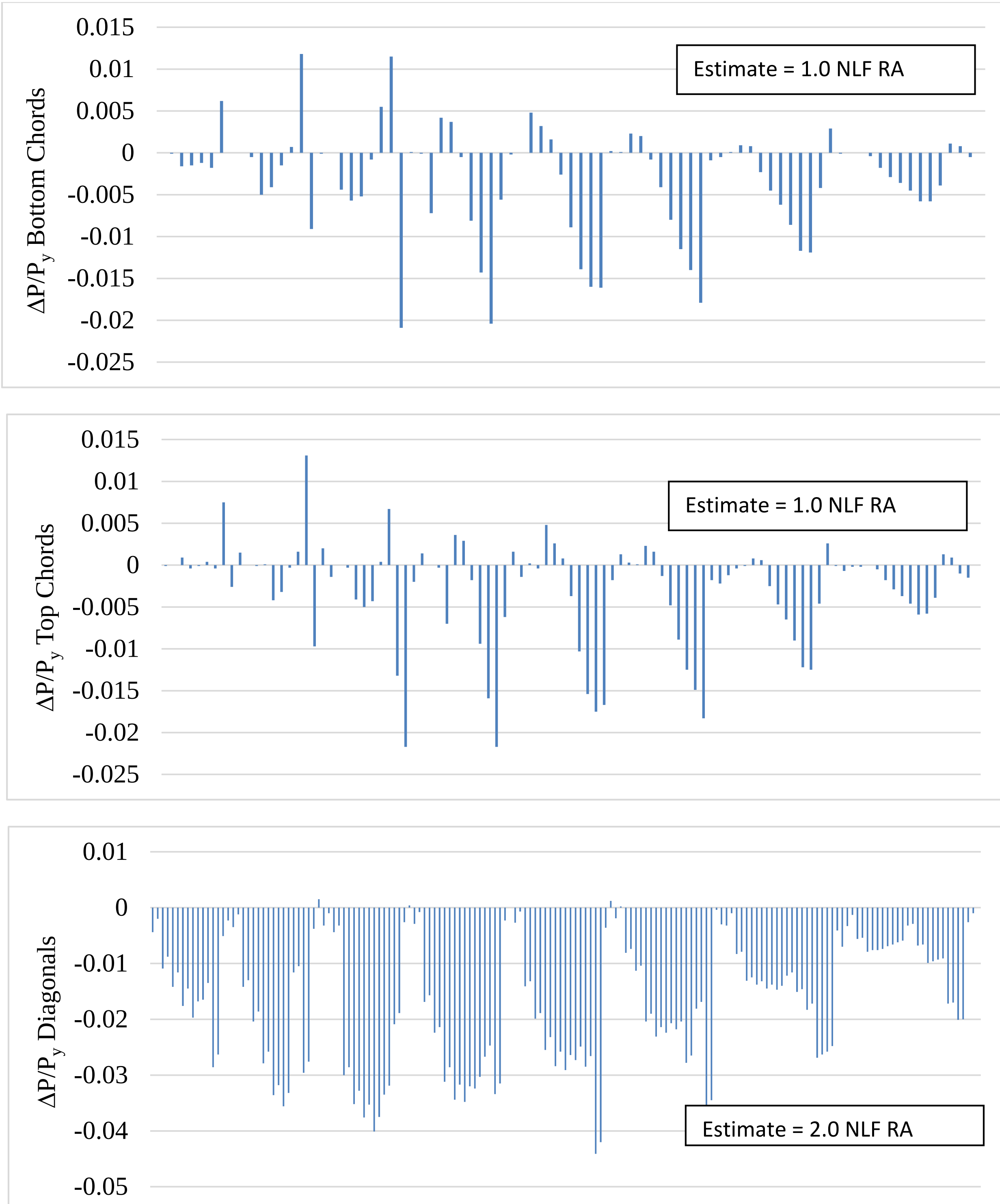


Figure N-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

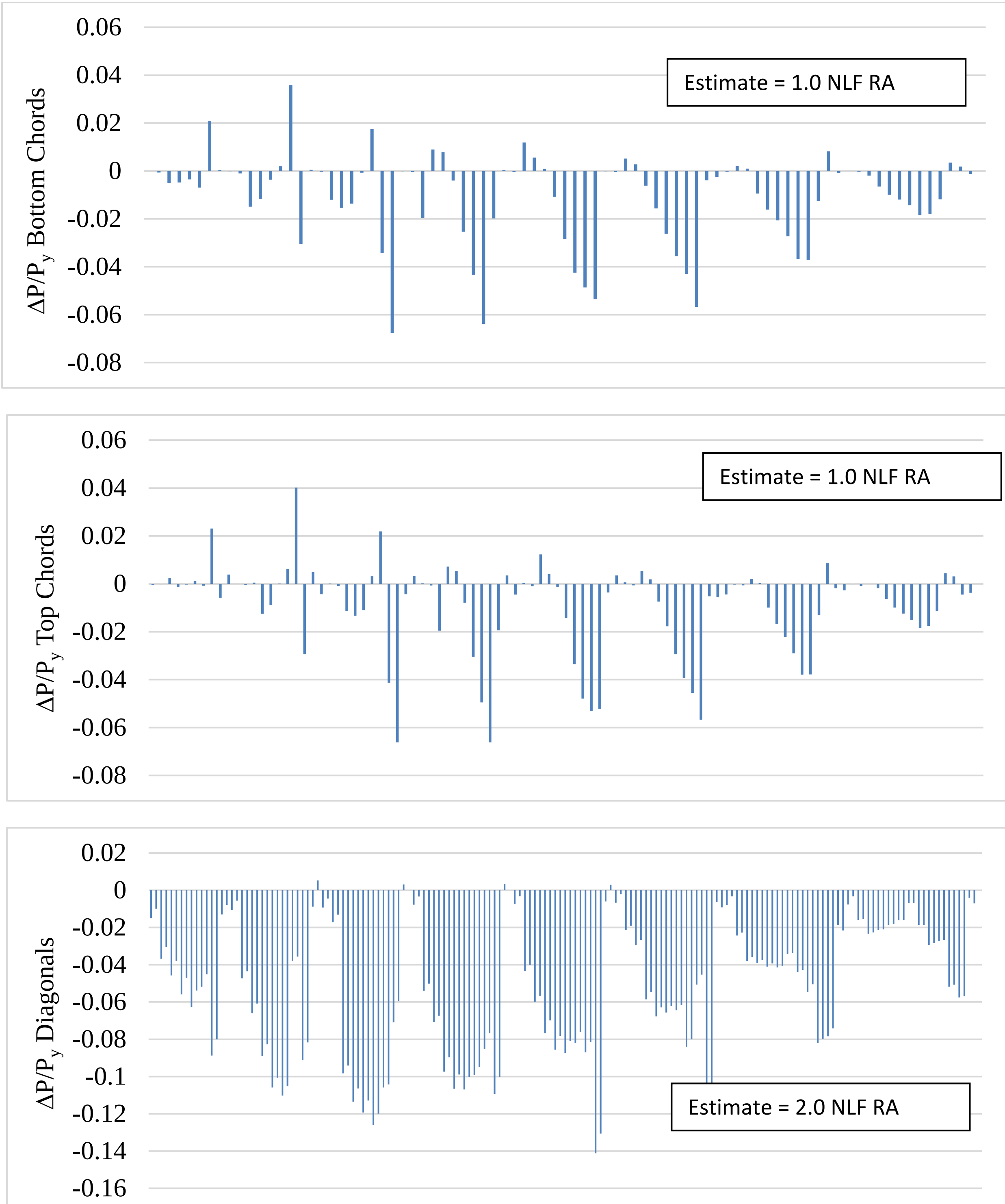


Figure N-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix N-3. NISCS14 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISCS14 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table N-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	19.9	35.3	35.3
SDLF	22.1	34.9	34.9
TDLF	34.6	34.8	34.8

Table N-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	67.3	11.3
	SDLF	67.2	11
	TDLF	74.1	10.2
G2	NLF	55.2	0
	SDLF	54.3	0
	TDLF	54.8	0
G3	NLF	45.3	34
	SDLF	47.4	35.5
	TDLF	51.9	34.1
G4	NLF	53	31.3
	SDLF	53	29.7
	TDLF	53.2	25.3
G5	NLF	36.7	10.9
	SDLF	38	9.2
	TDLF	40.8	0
G6	NLF	45.5	9.6
	SDLF	46.9	8.4
	TDLF	50.1	0
G7	NLF	38.2	0
	SDLF	38.3	0
	TDLF	37.8	0
G8	NLF	25.1	6.3
	SDLF	22.7	4
	TDLF	17.4	0
G9	NLF	12.3	0
	SDLF	11.9	0
	TDLF	10.9	0
All Girders	NLF	67.3	0
	SDLF	67.2	0
	TDLF	74.1	0

Table N-3-3. Summary of crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	145.9	66.3	43.2	42.7
SDLF	150.7	66.7	43.6	43
TDLF	196.3	67.5	44.4	43.8

Table N-3-4. Erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage											
		1	2	3	4	5	6	7	8	9	10	11	12
2	NLF	132	133	134	135	137	138	139					
	SDLF	132	133	134	135	137	138	139					
	TDLF	132	133	134	135	137	138	139					
7	NLF	565	566	568	569	570	571	572	573	574	576		
	SDLF	565	566	568	569	570	571	572	573	574	576		
	TDLF	565	566	568	569	570	571	572	573	574	576		
9	NLF	790	791	792	793	794	795	797	798	799	800	801	802
	SDLF	790	791	792	793	794	795	797	798	799	800	801	802
	TDLF	790	791	792	793	794	795	797	798	799	800	801	802

Appendix N-4. NISCS14 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge NISCS14 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

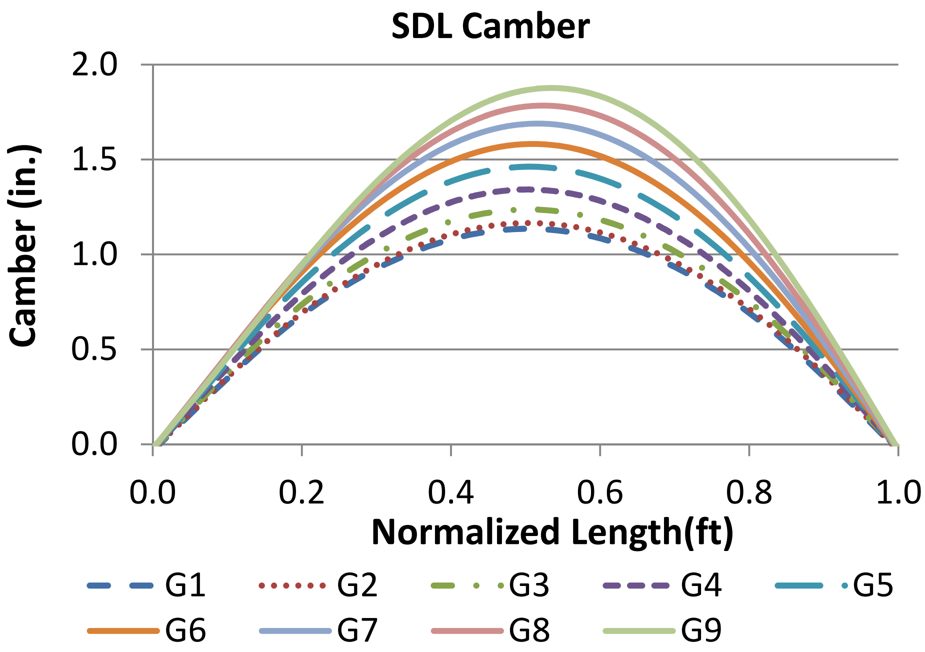
Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements



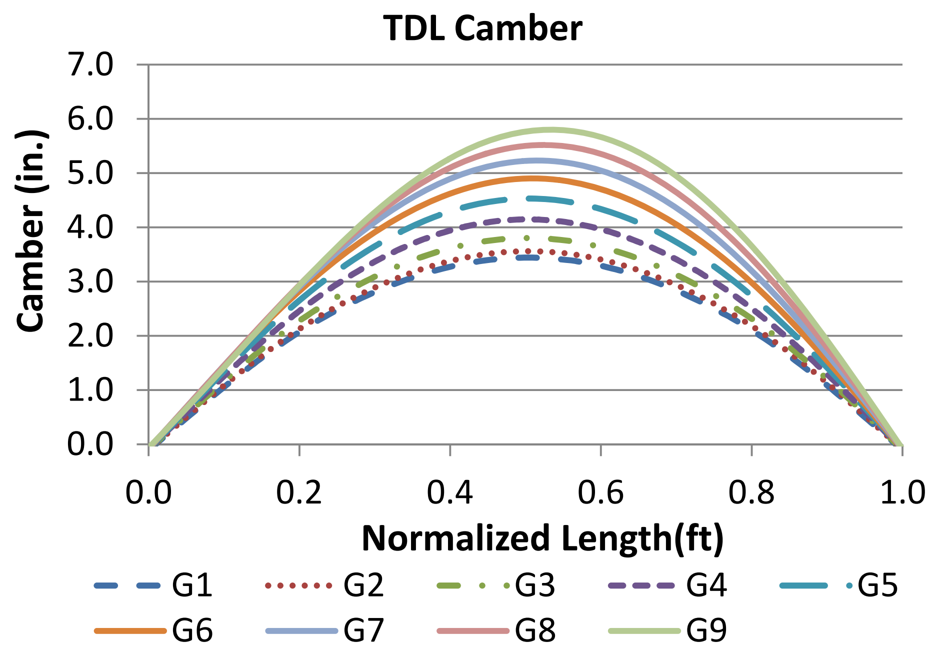


Figure N-4-1. SDL and TDL 3D FEA cambers.

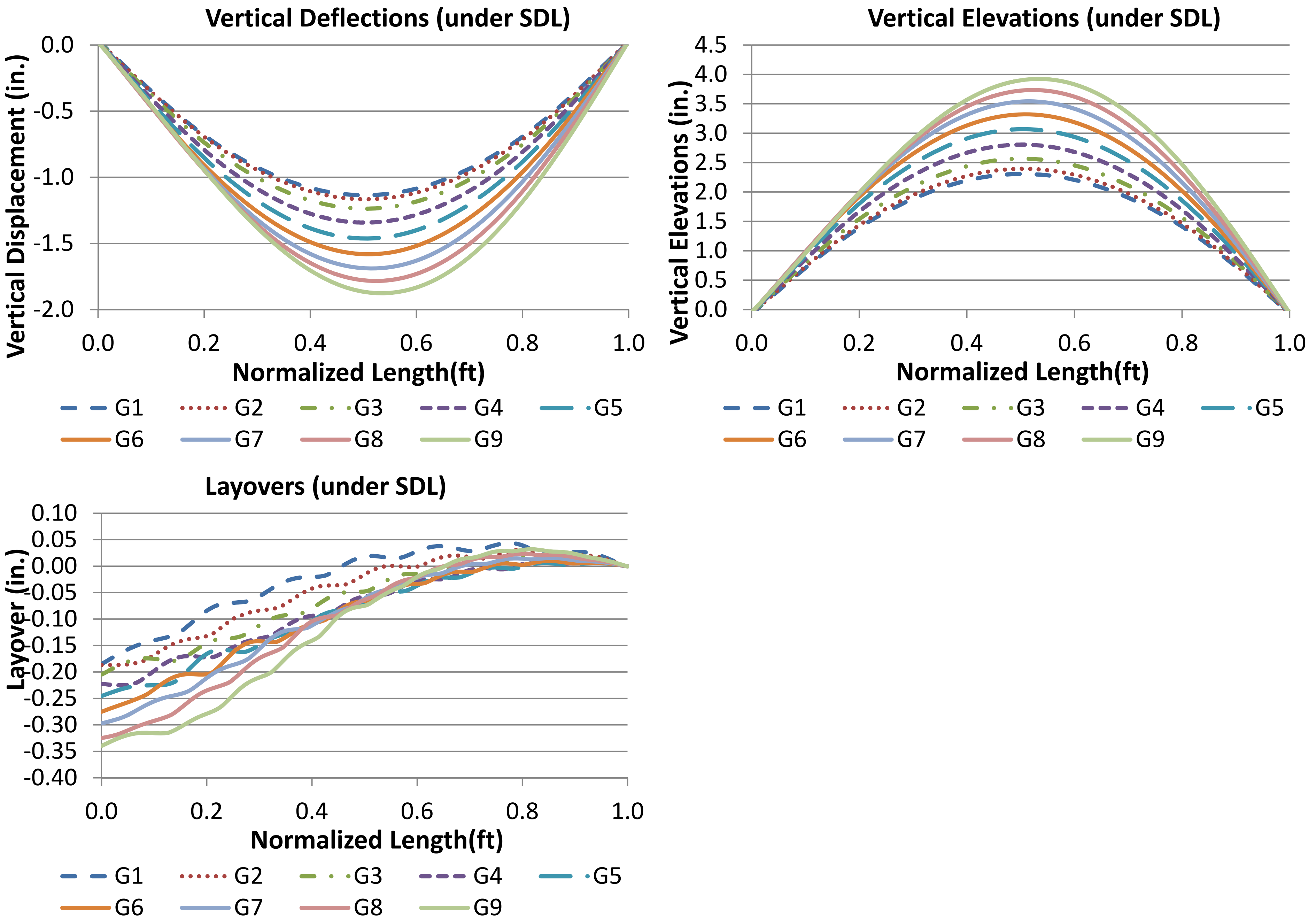


Figure N-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

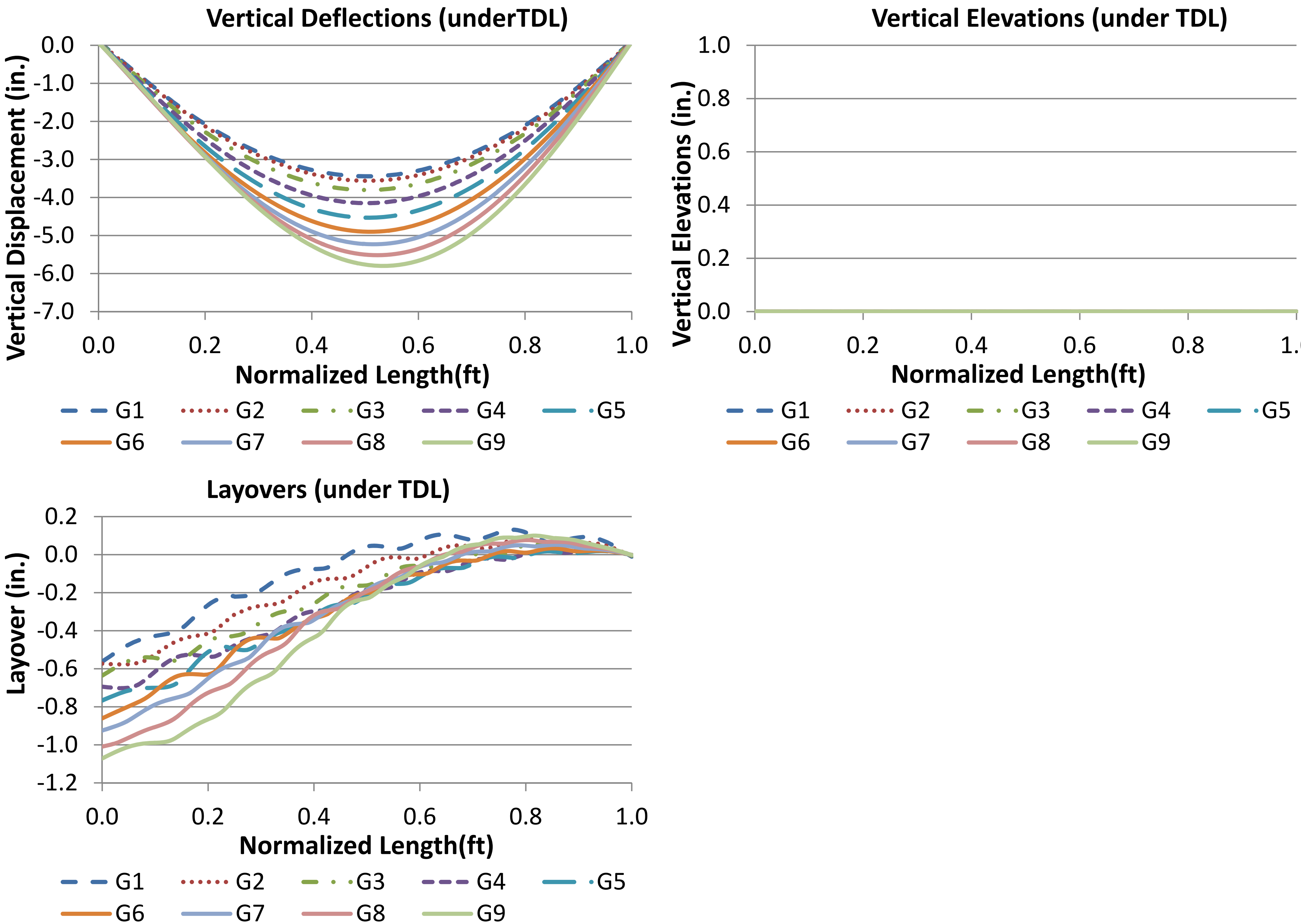


Figure N-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

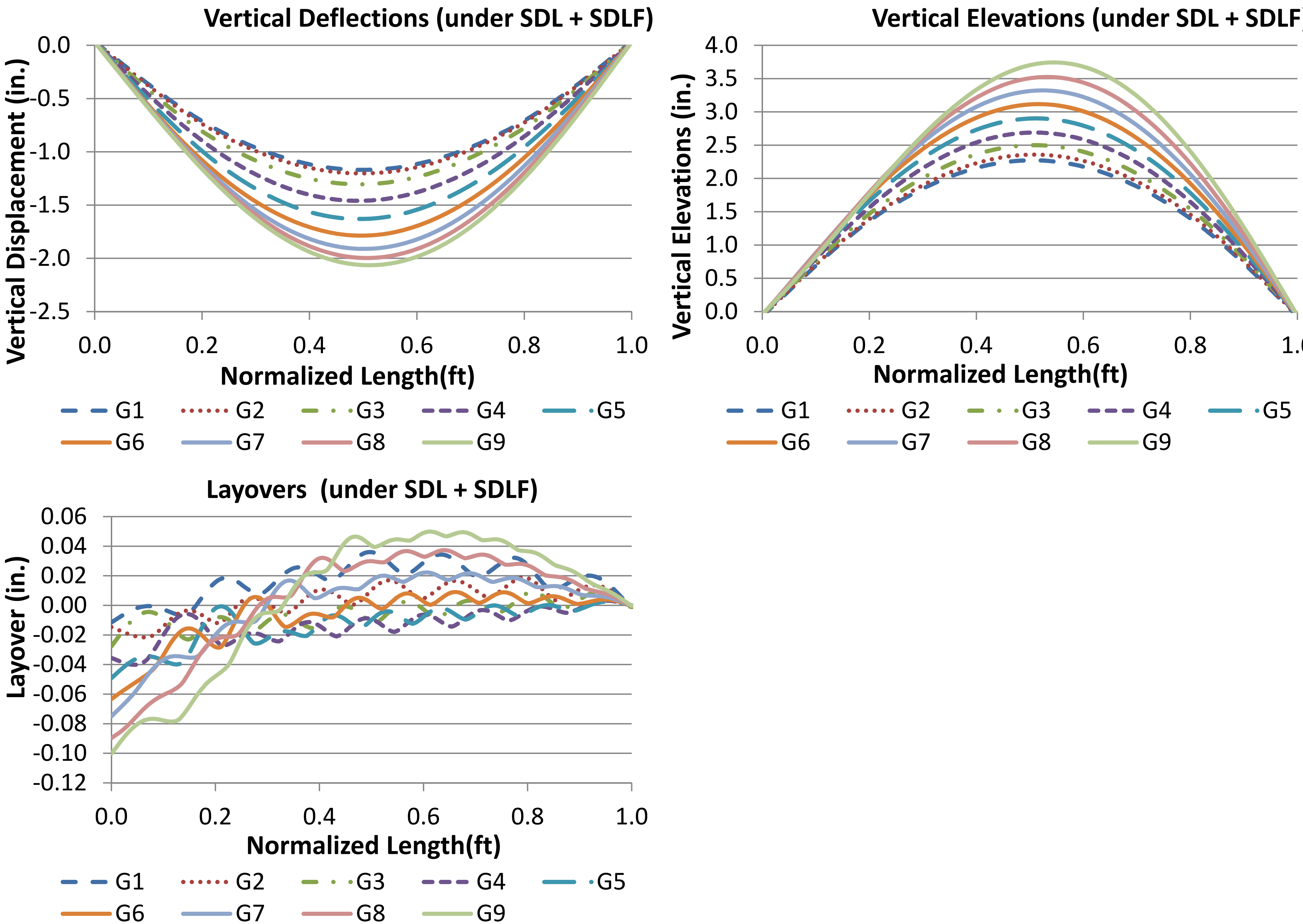


Figure N-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

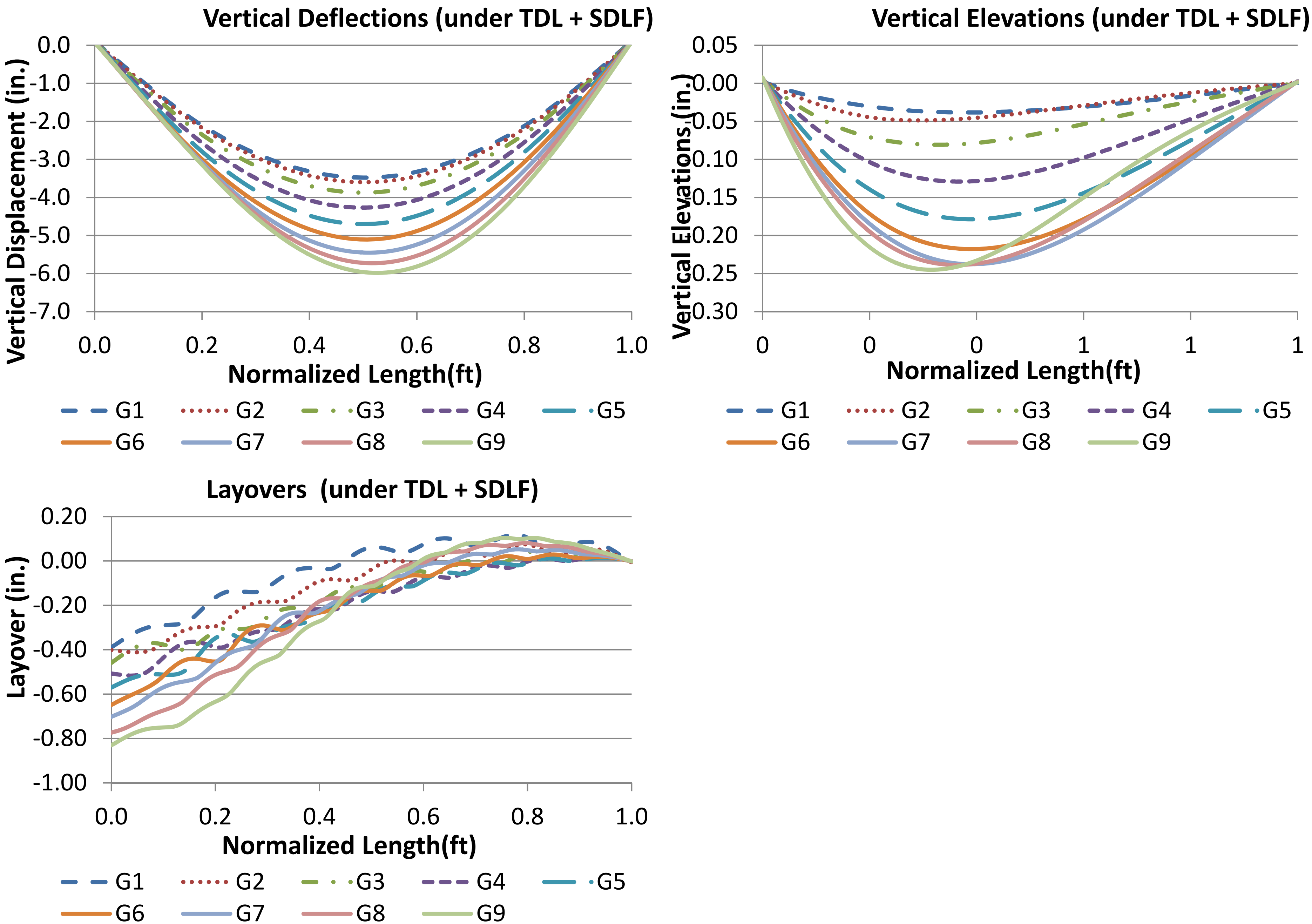


Figure N-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

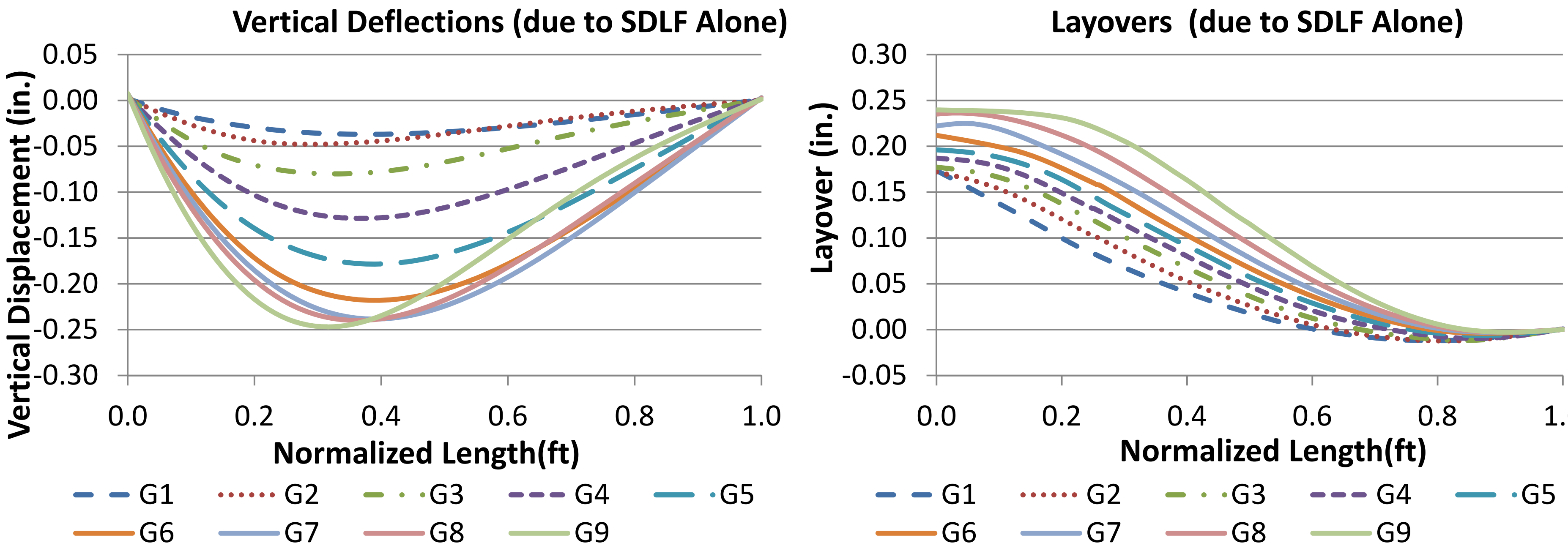


Figure N-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

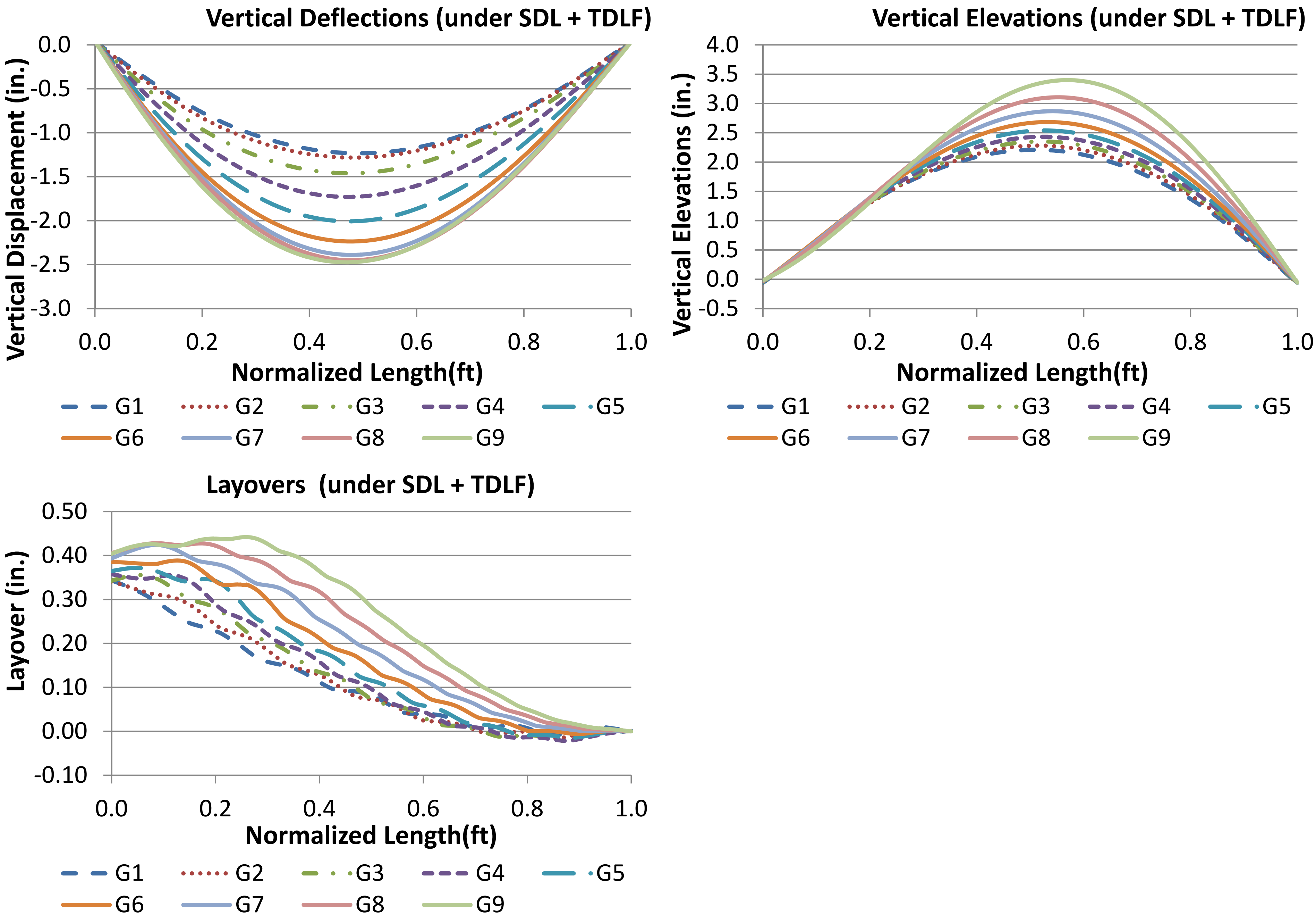


Figure N-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

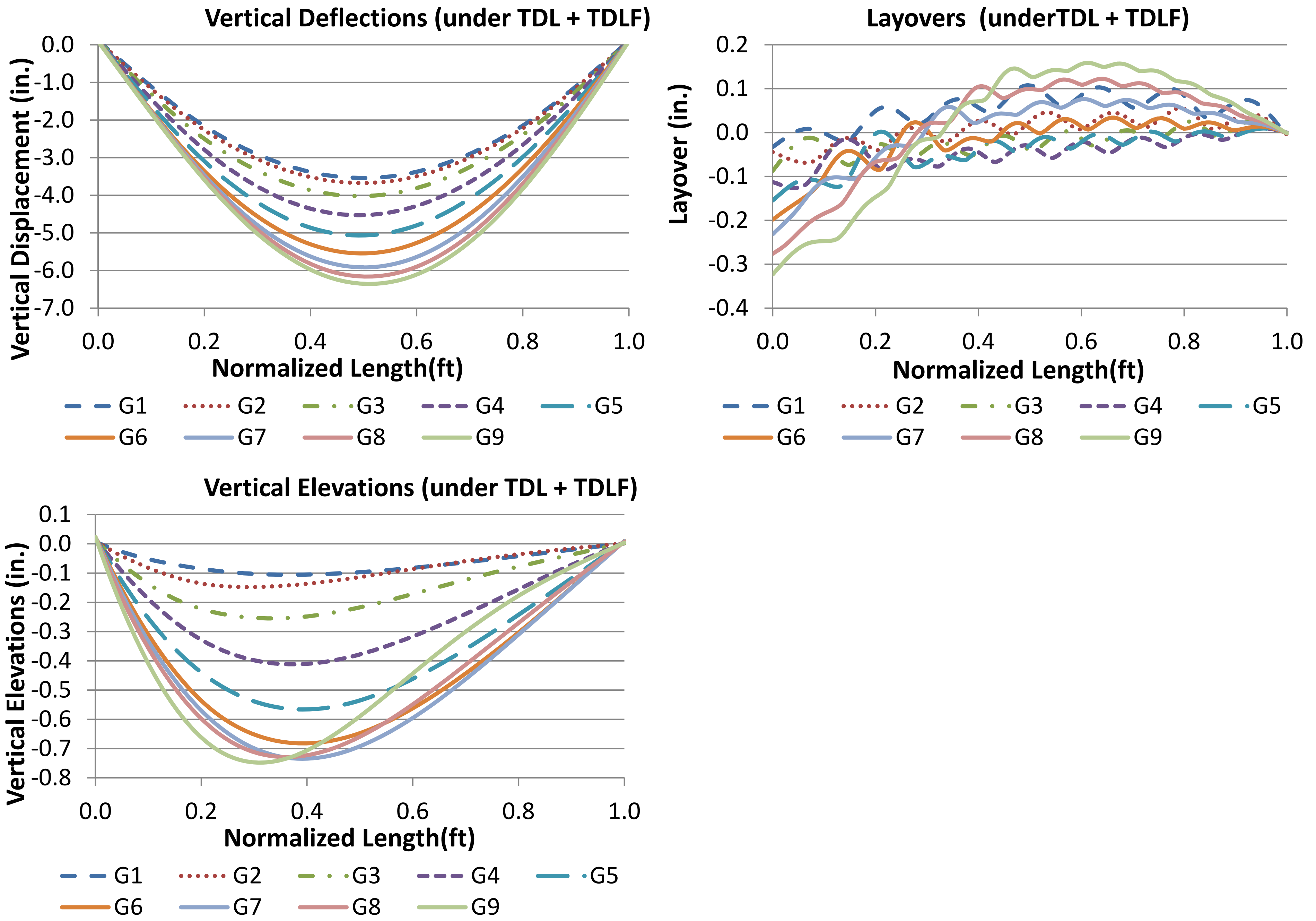


Figure N-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

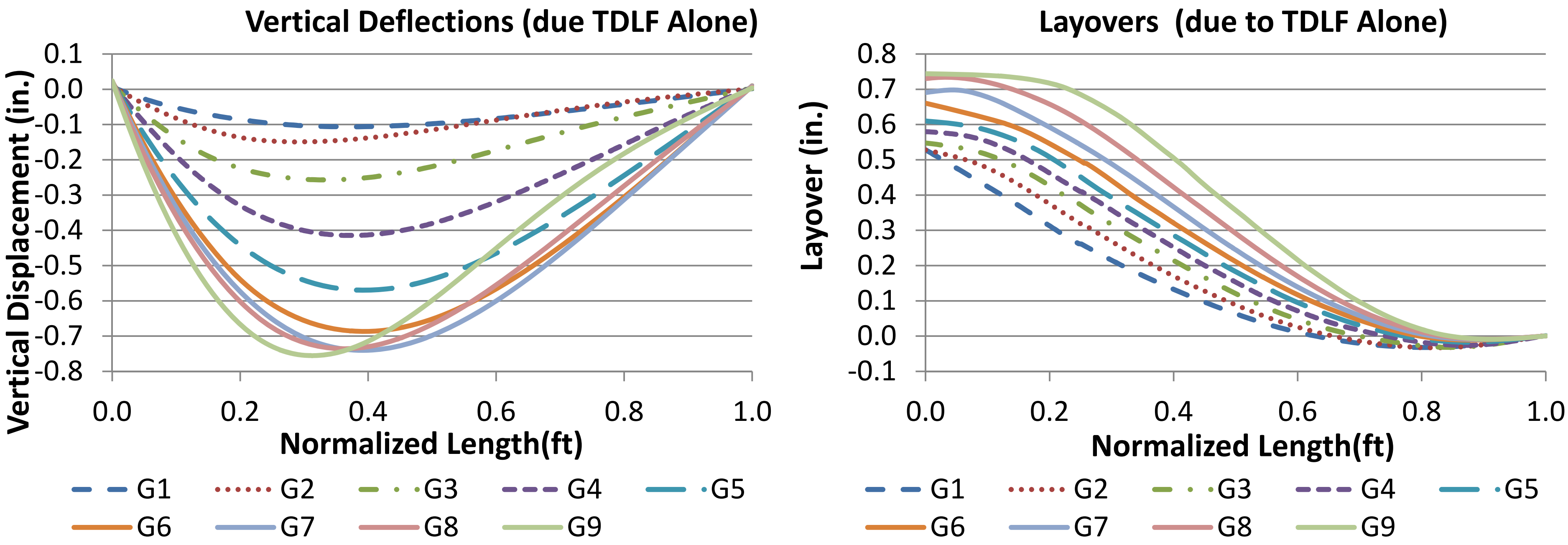


Figure N-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

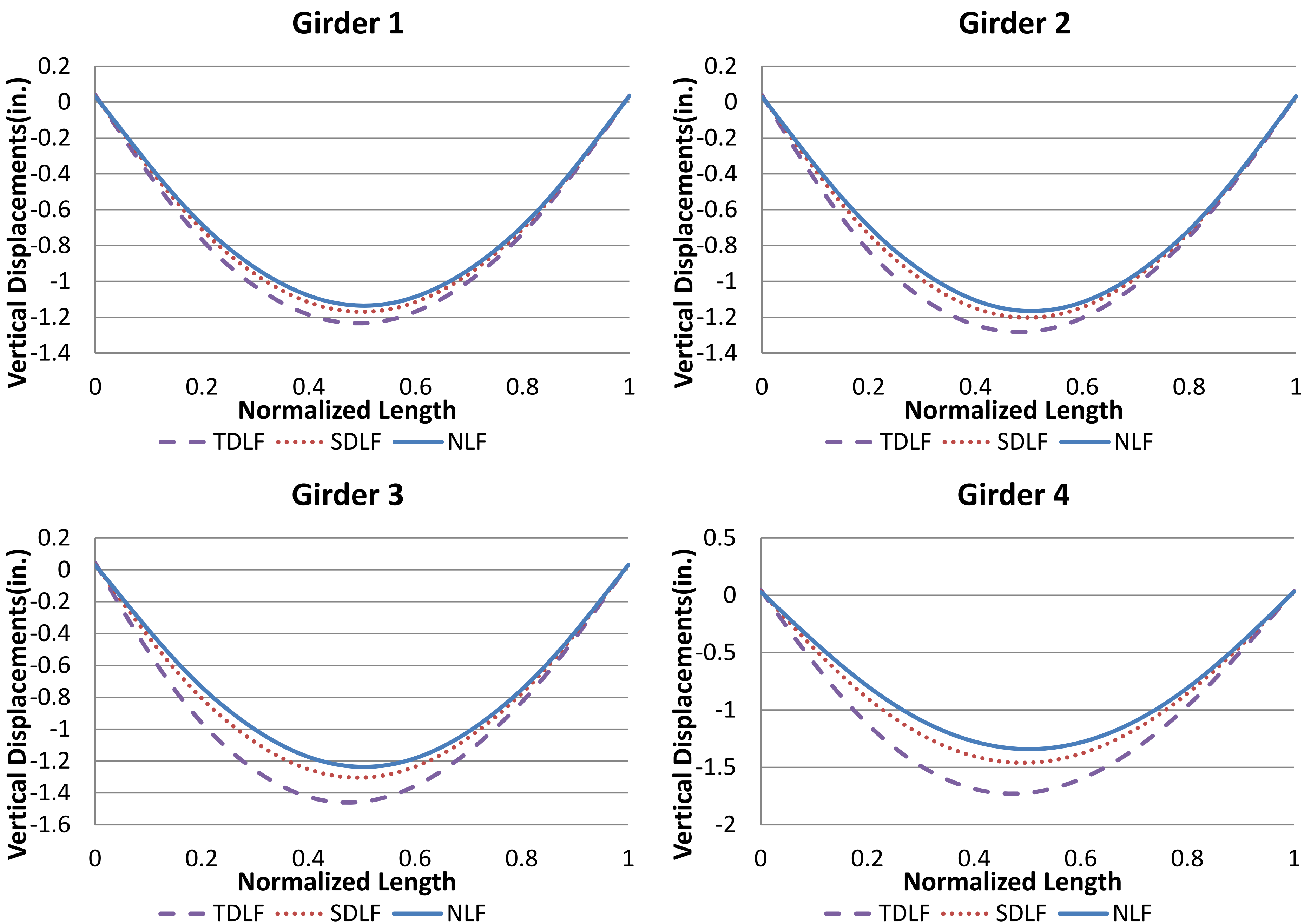


Figure N-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

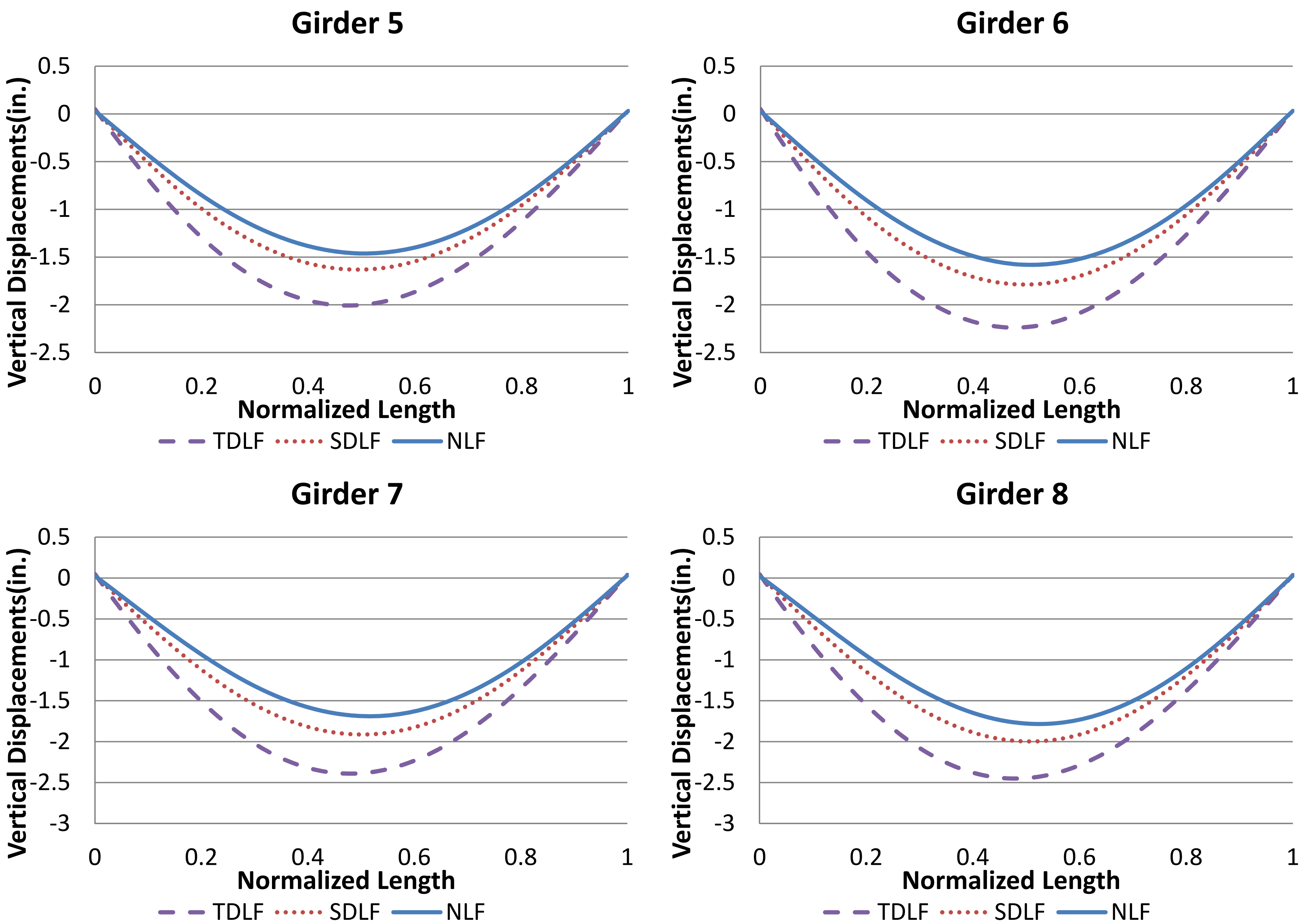


Figure N-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

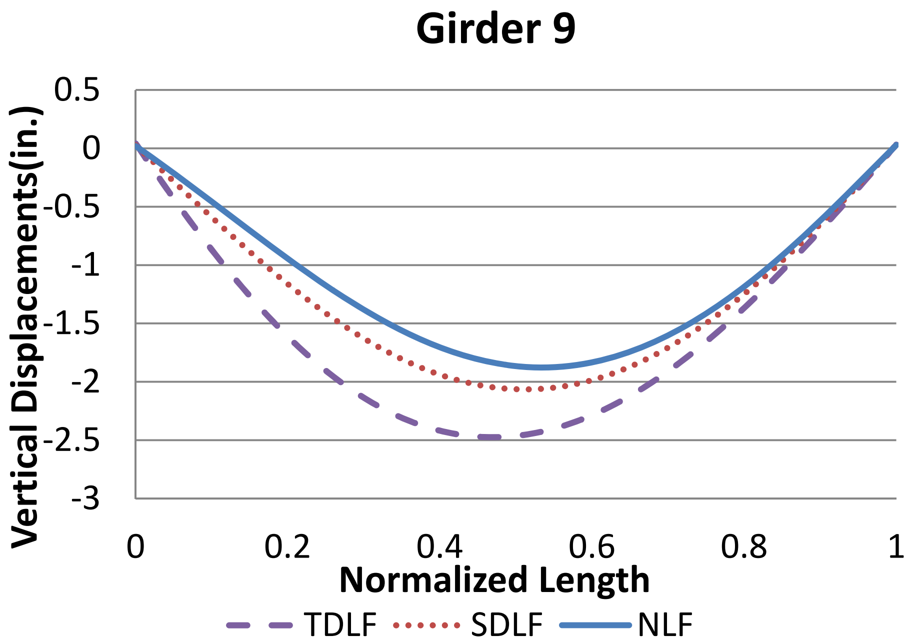


Figure N-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

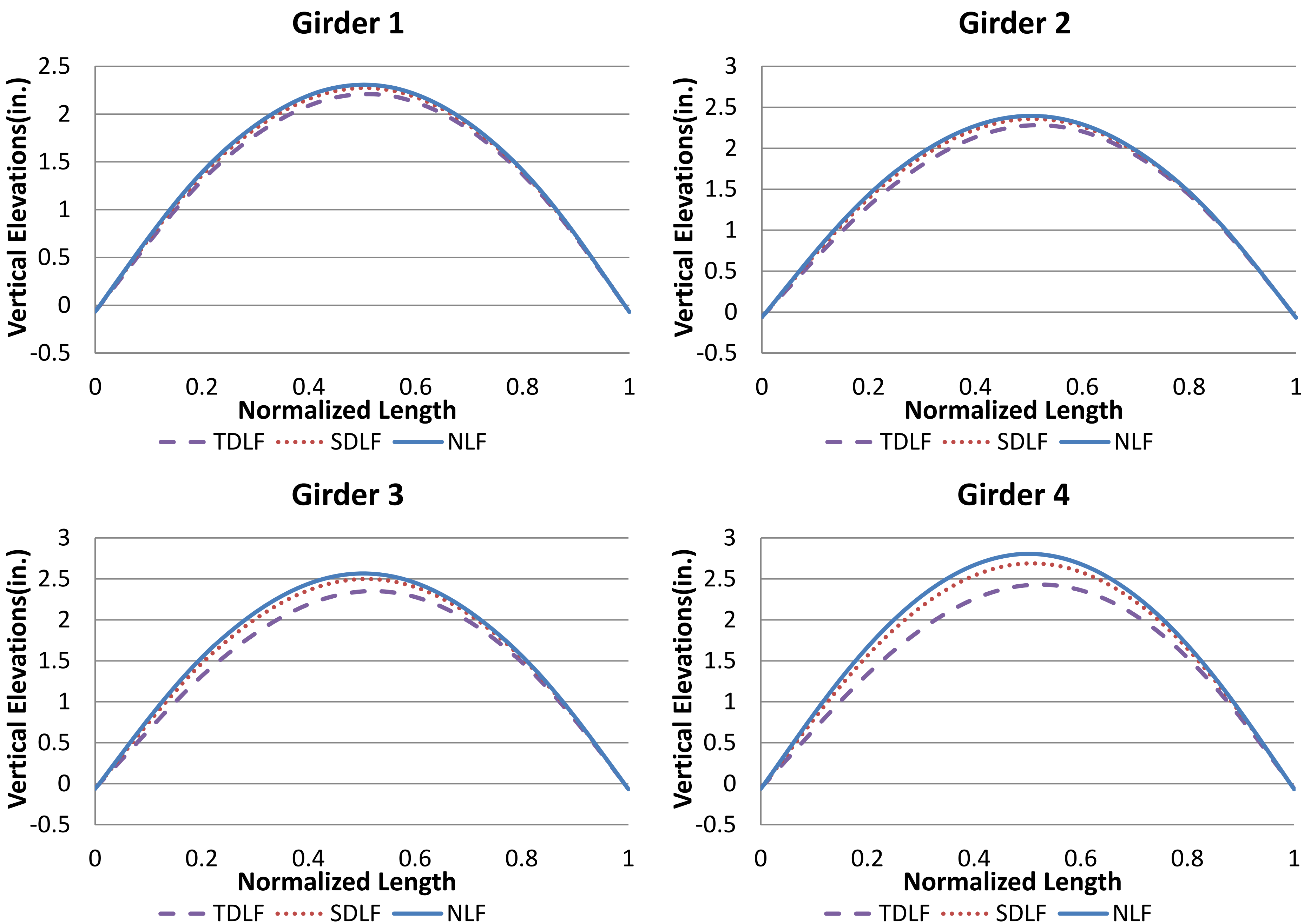


Figure N-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

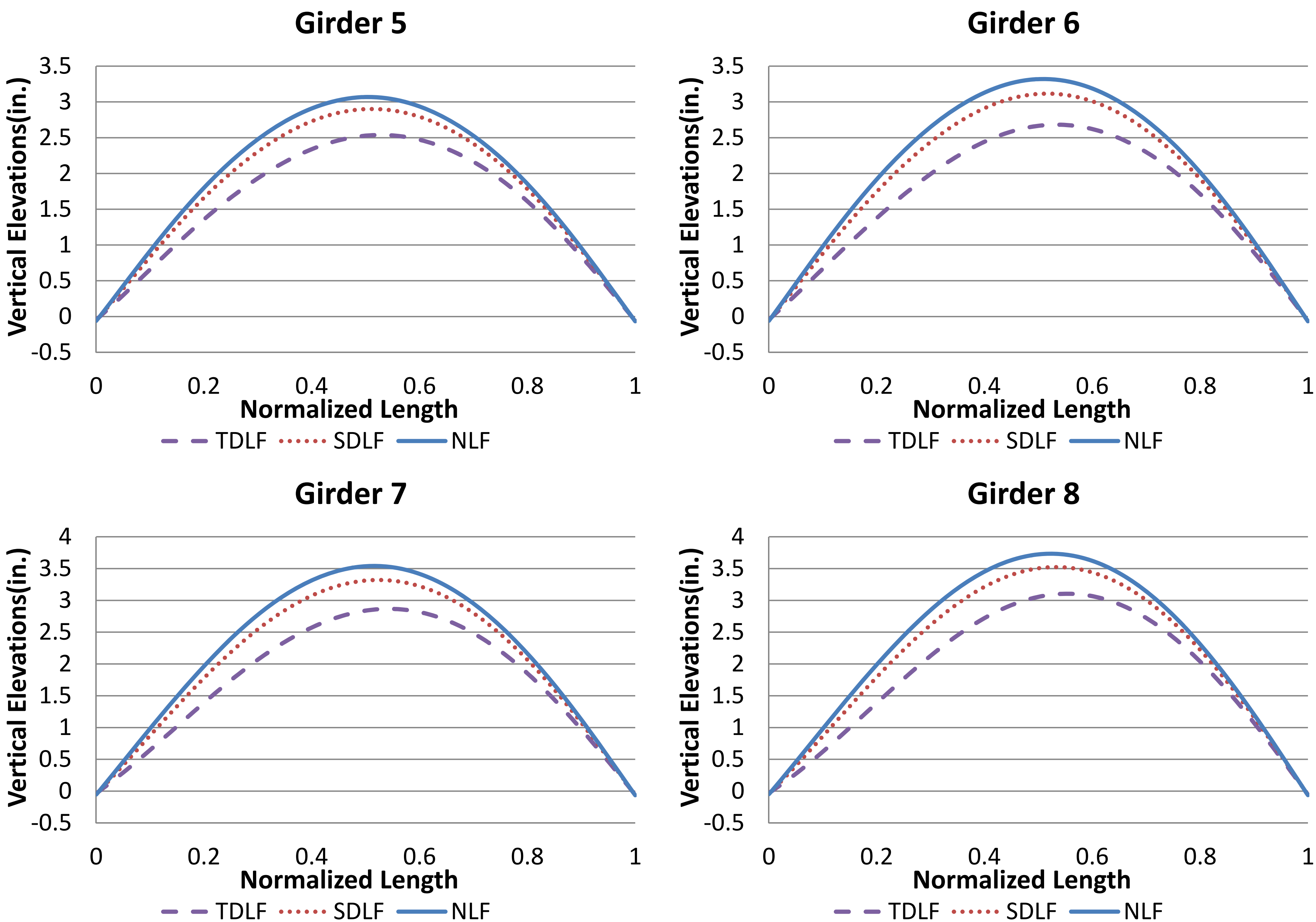


Figure N-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

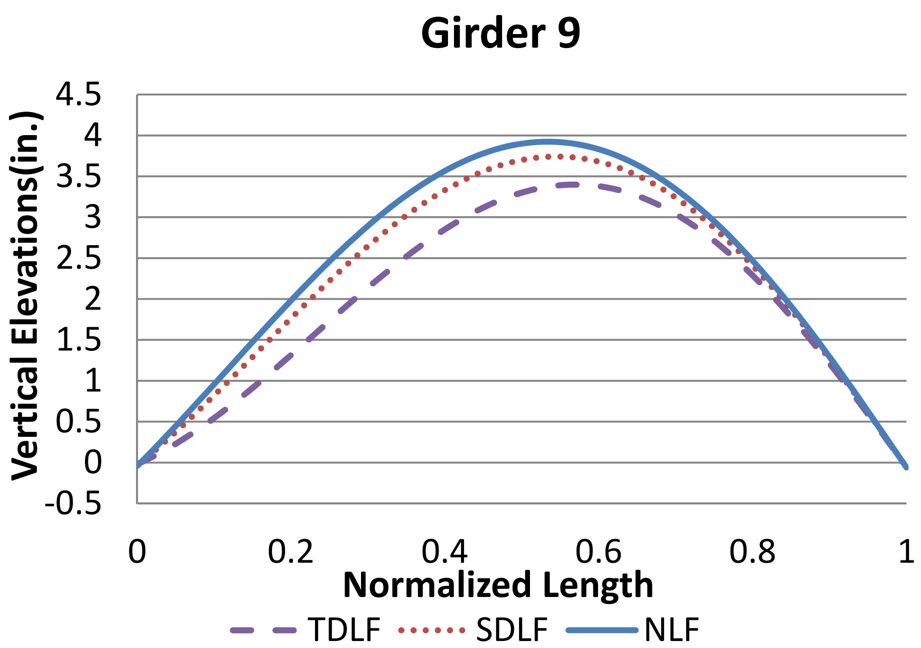


Figure N-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

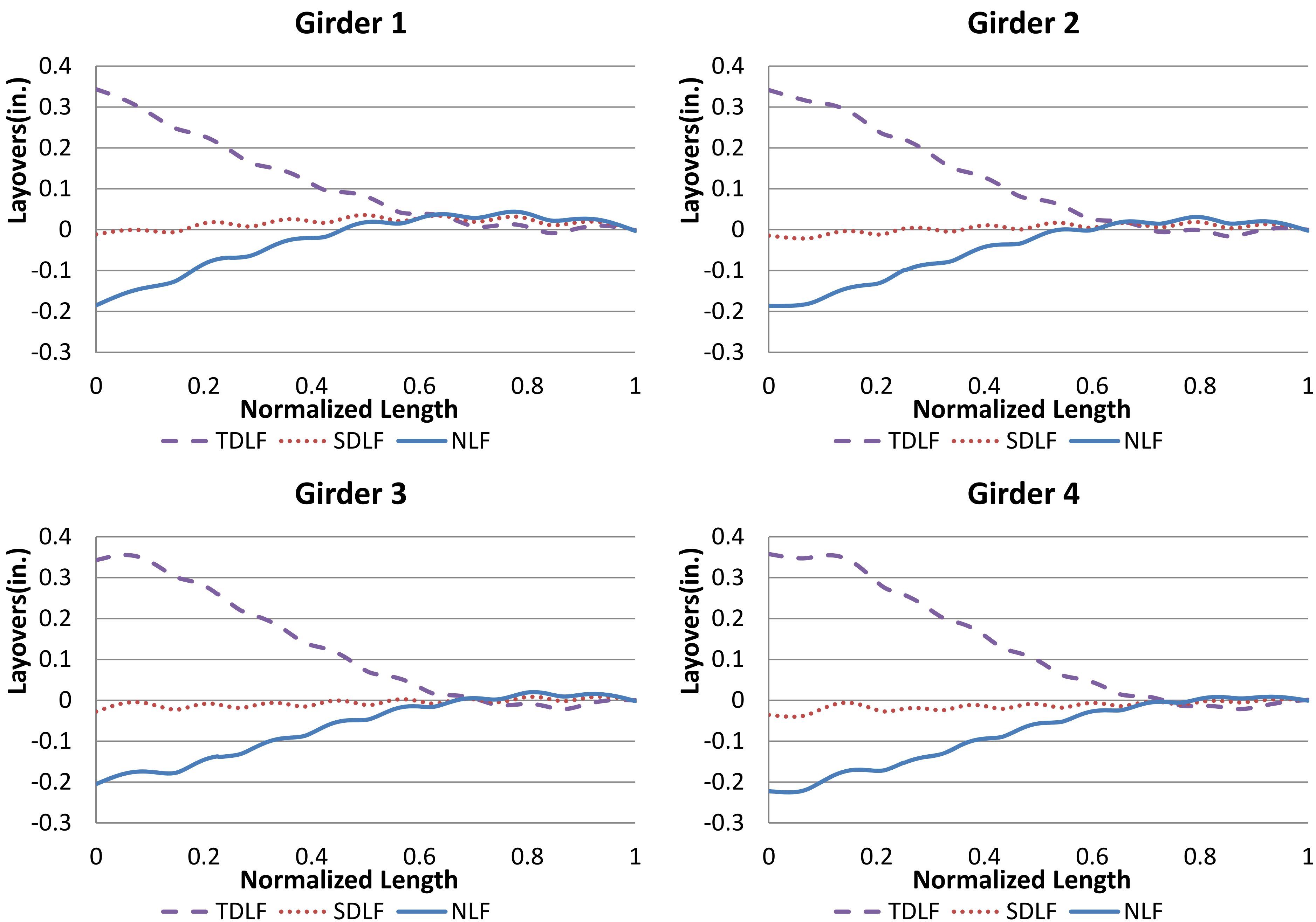


Figure N-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

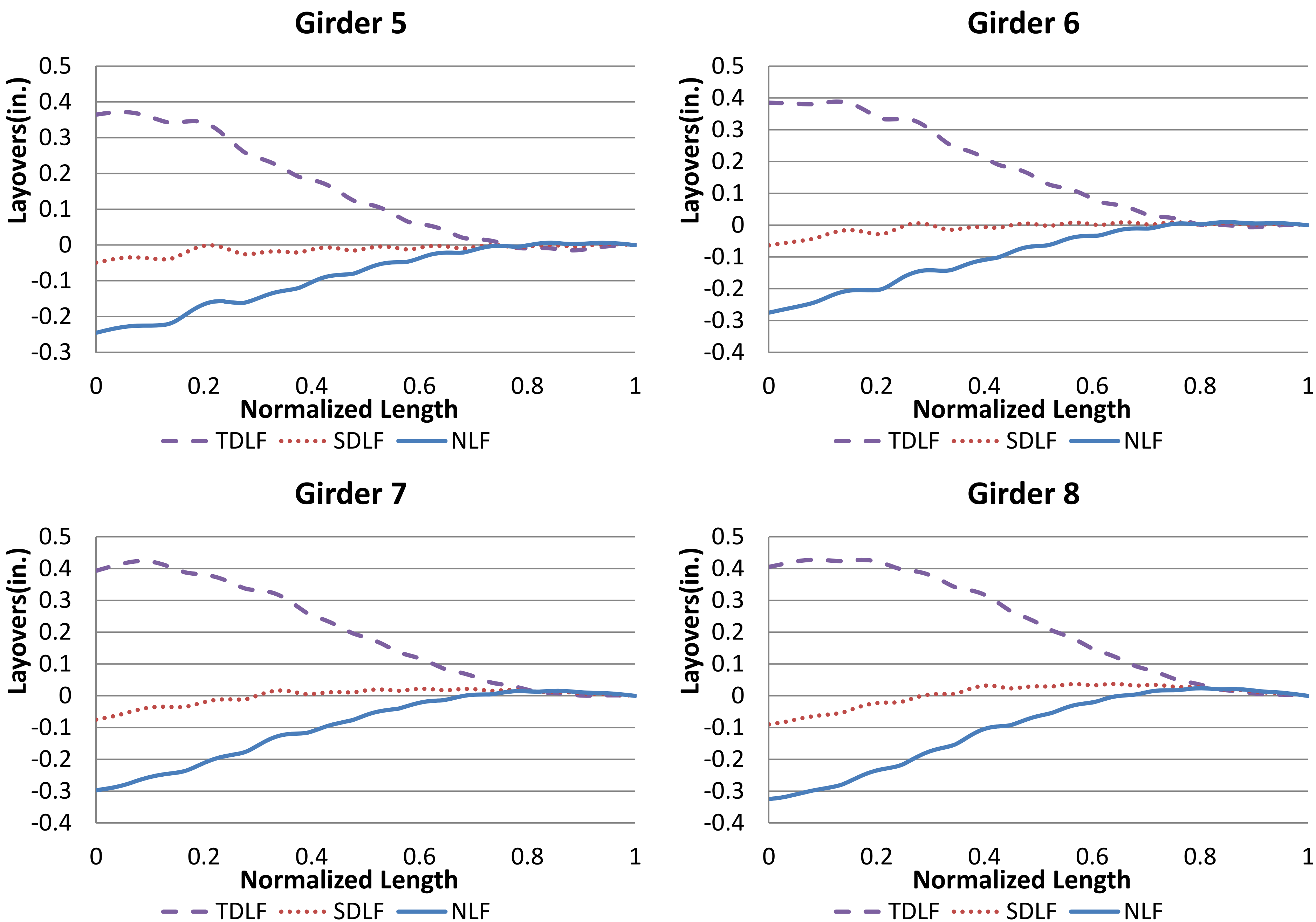


Figure N-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

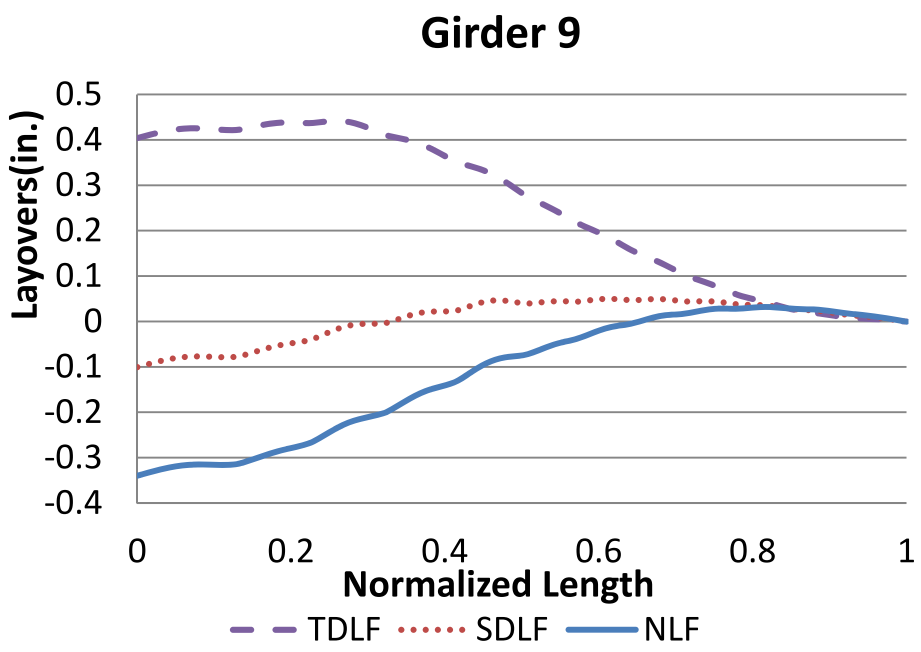


Figure N-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

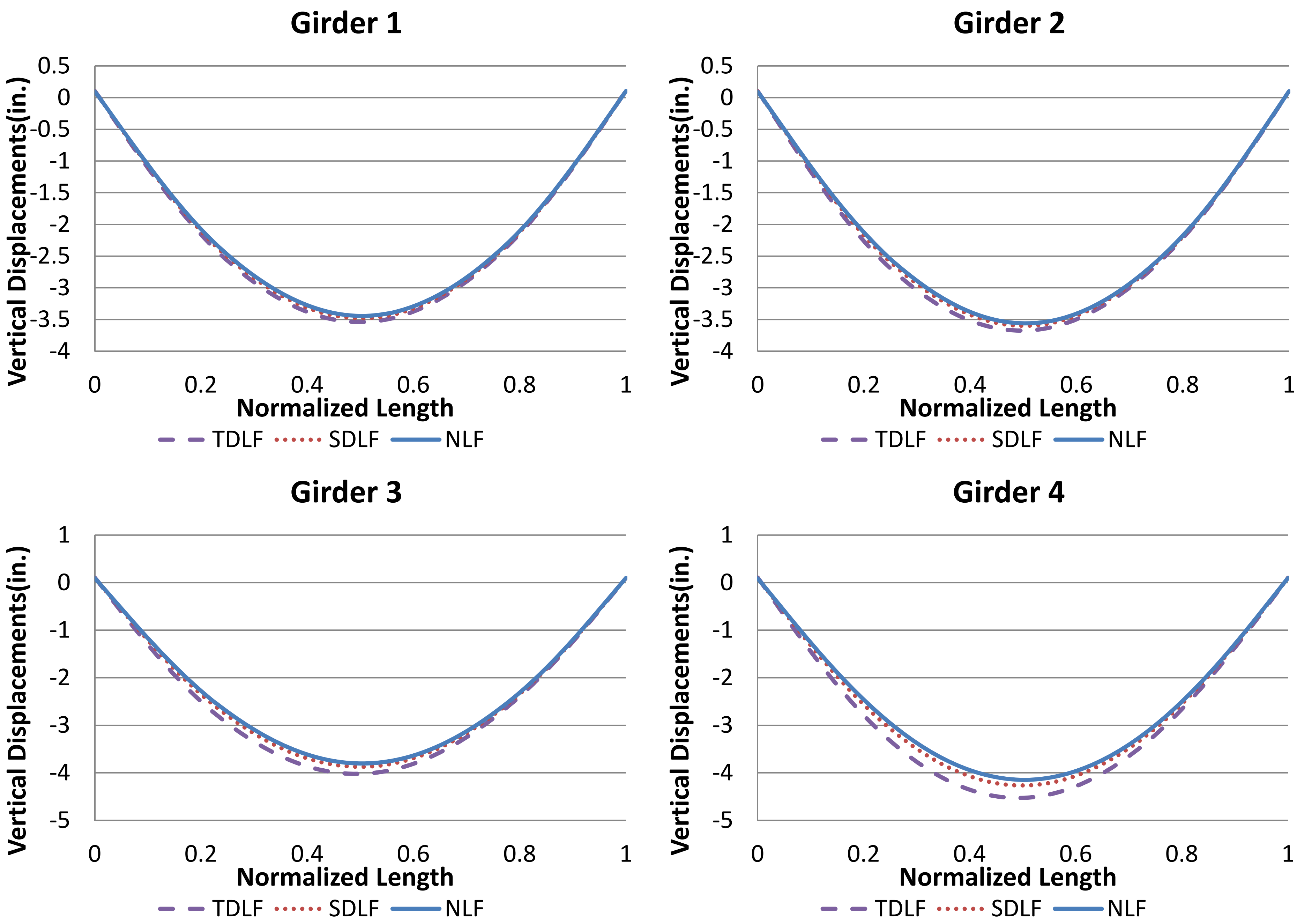


Figure N-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

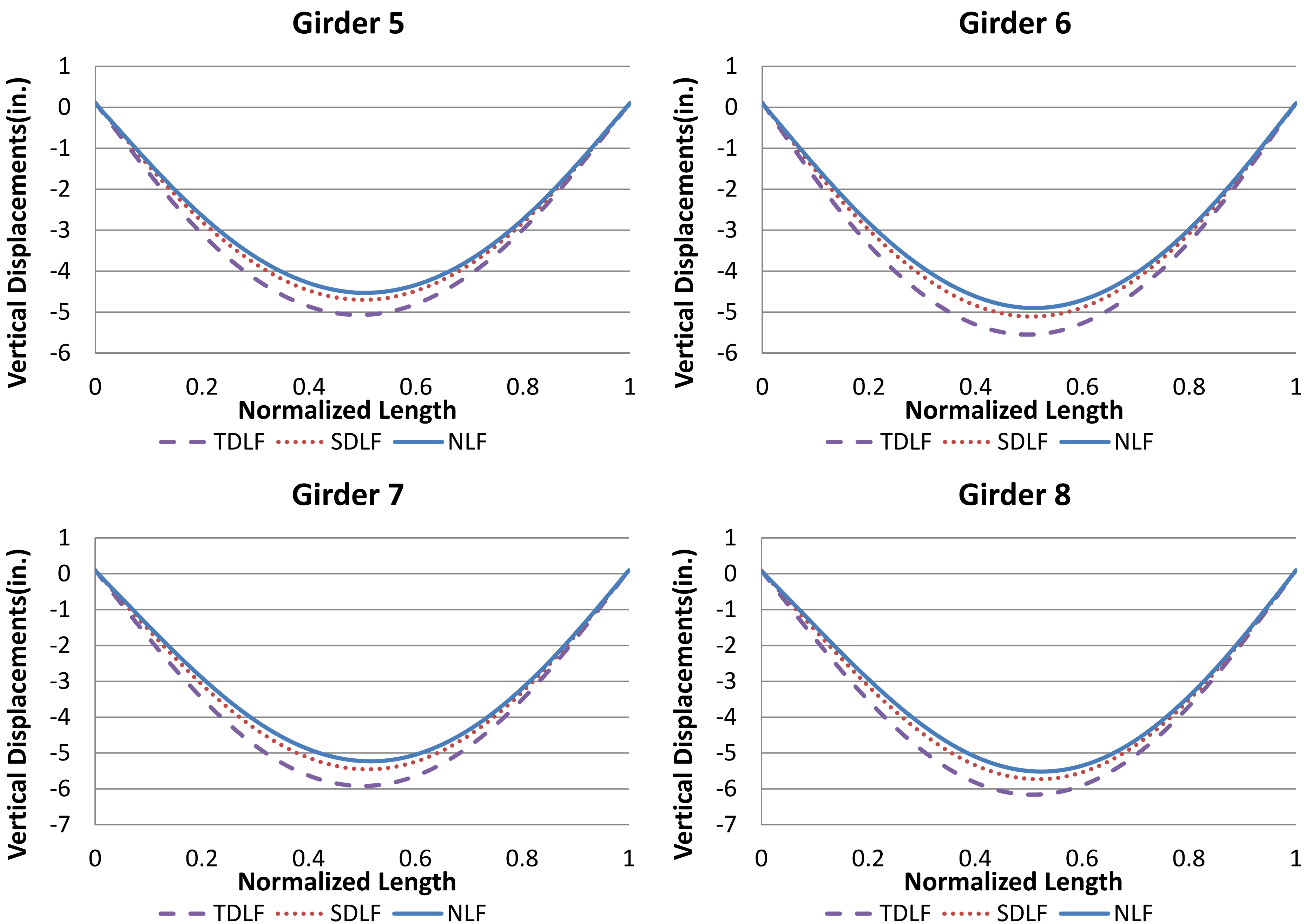


Figure N-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

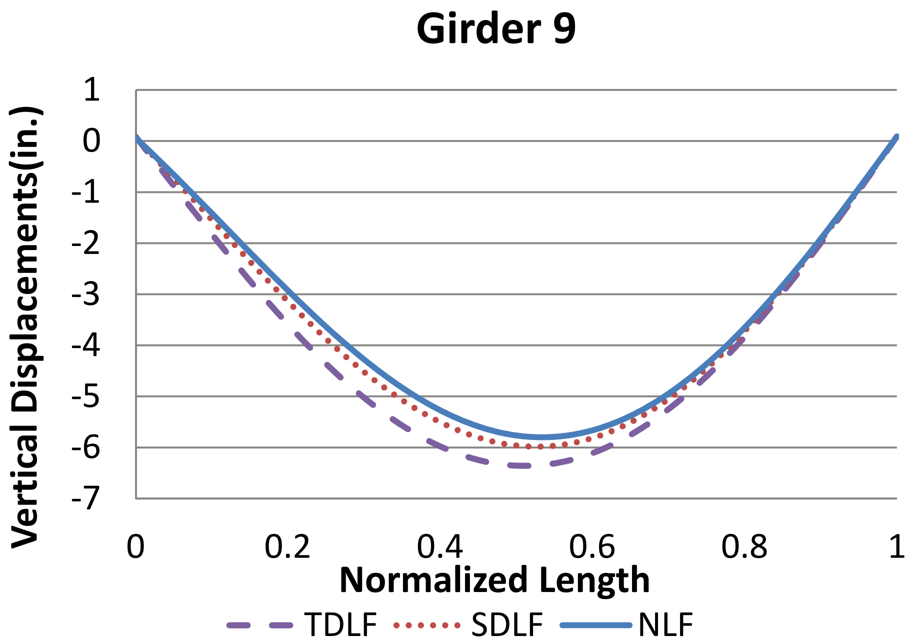


Figure N-4-13(Continued). **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

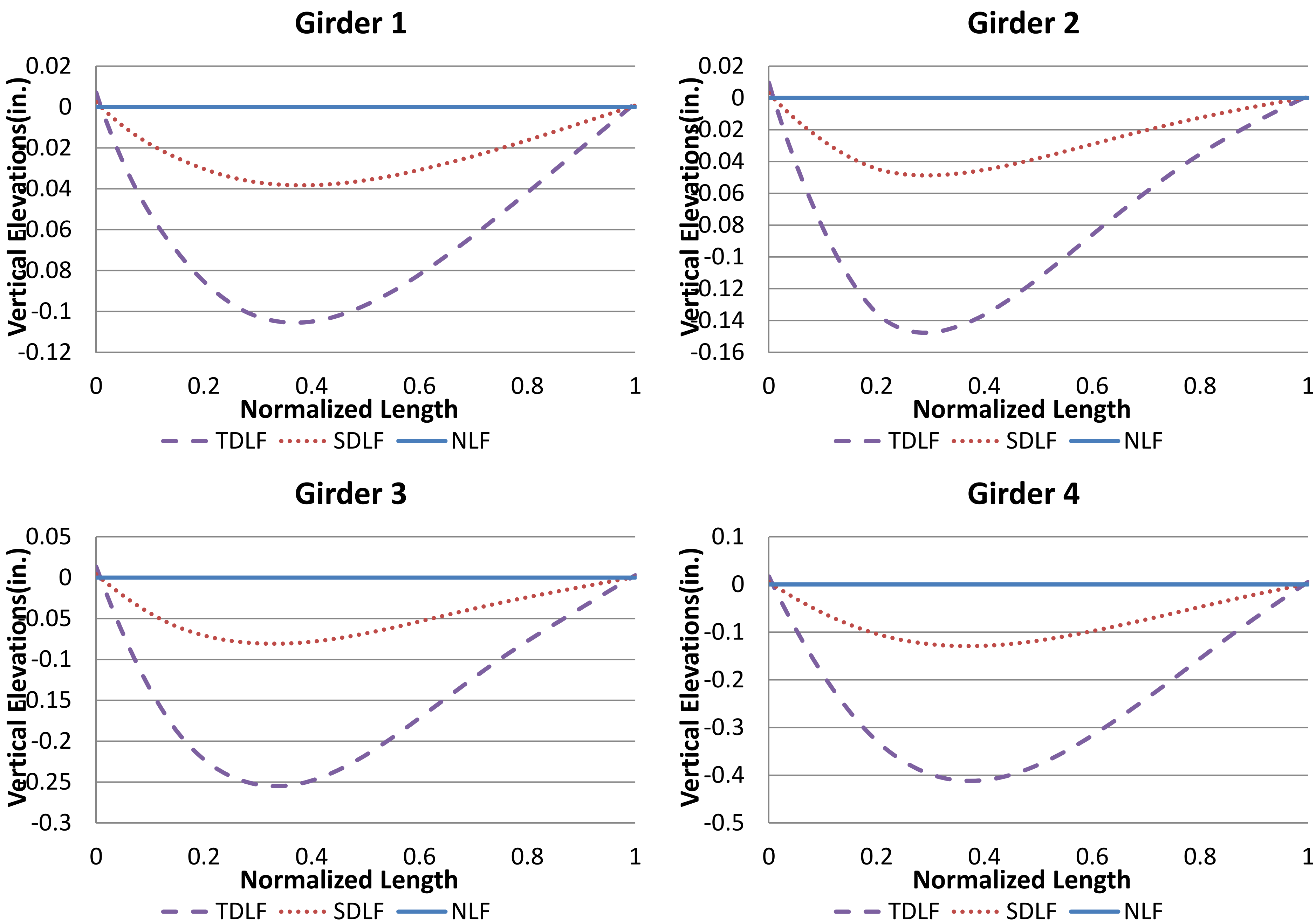


Figure N-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

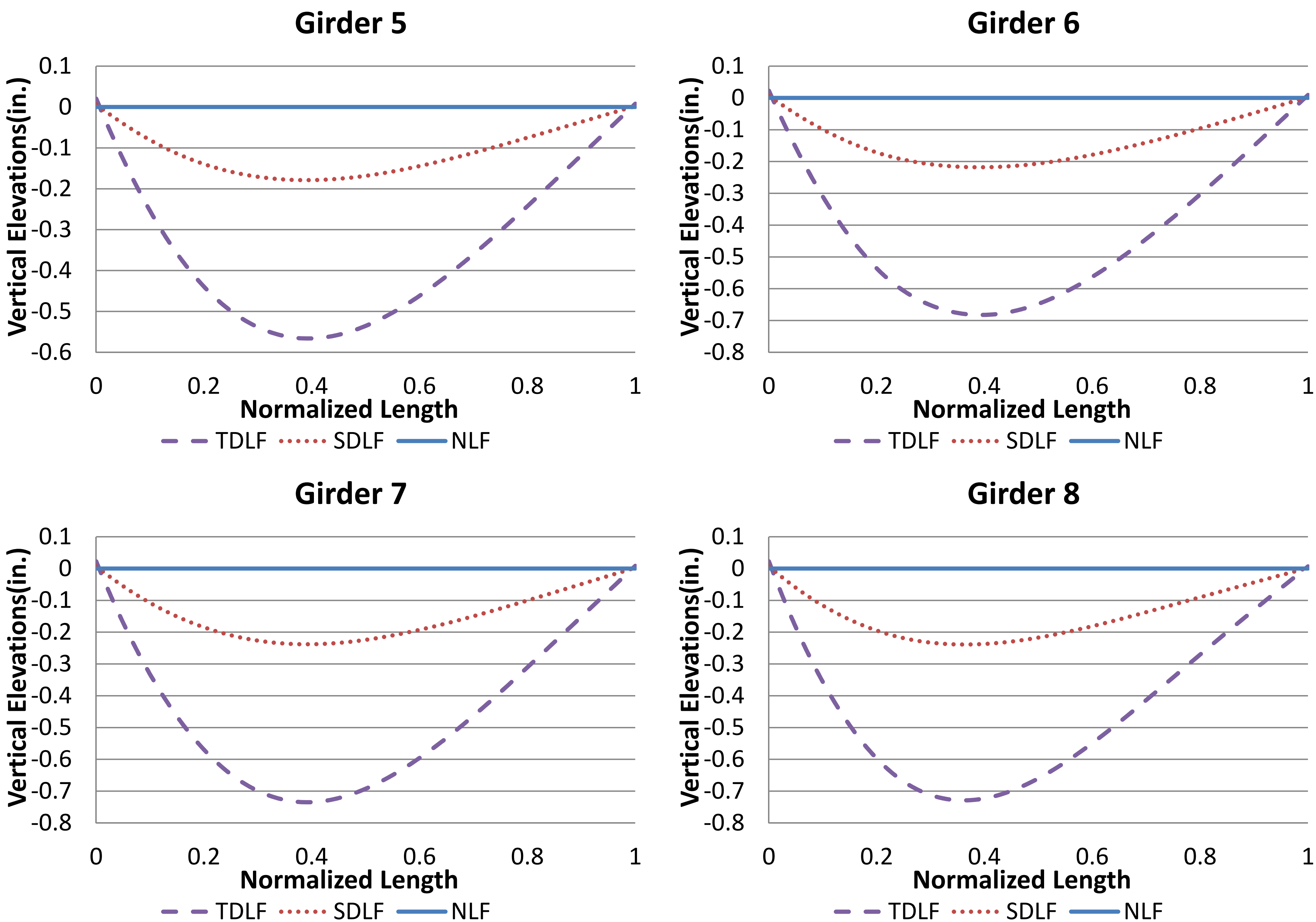


Figure N-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

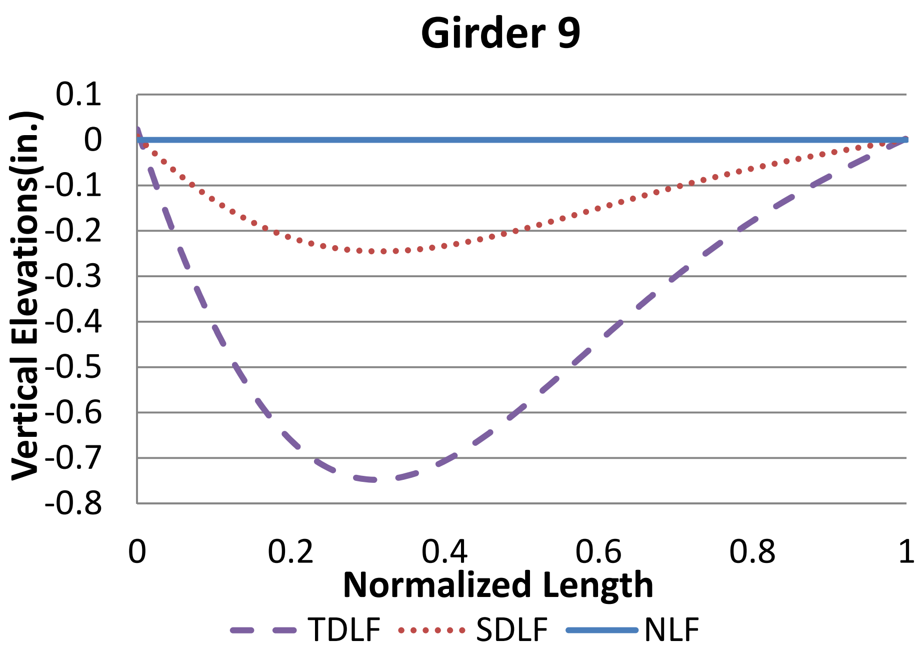


Figure N-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

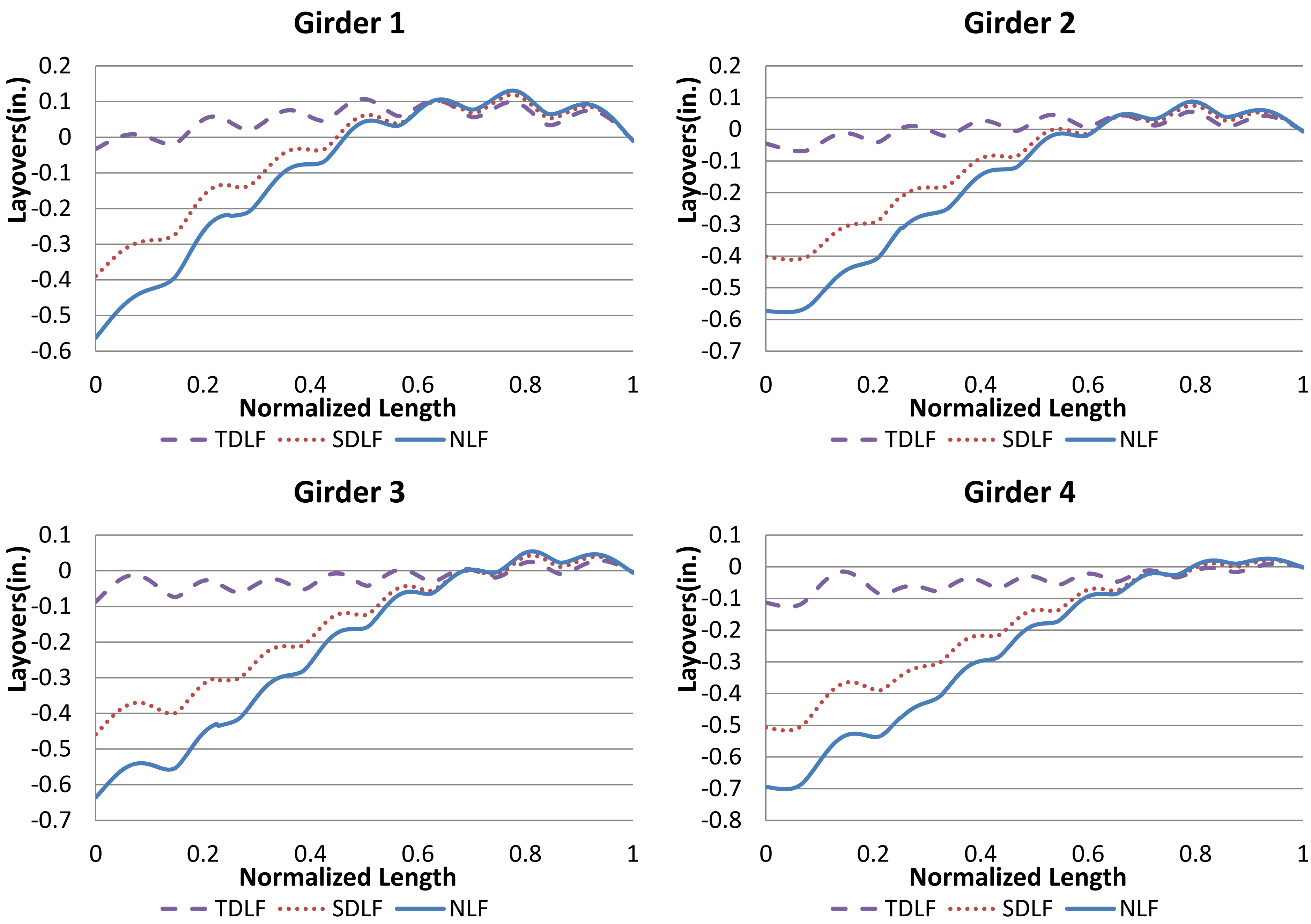


Figure N-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

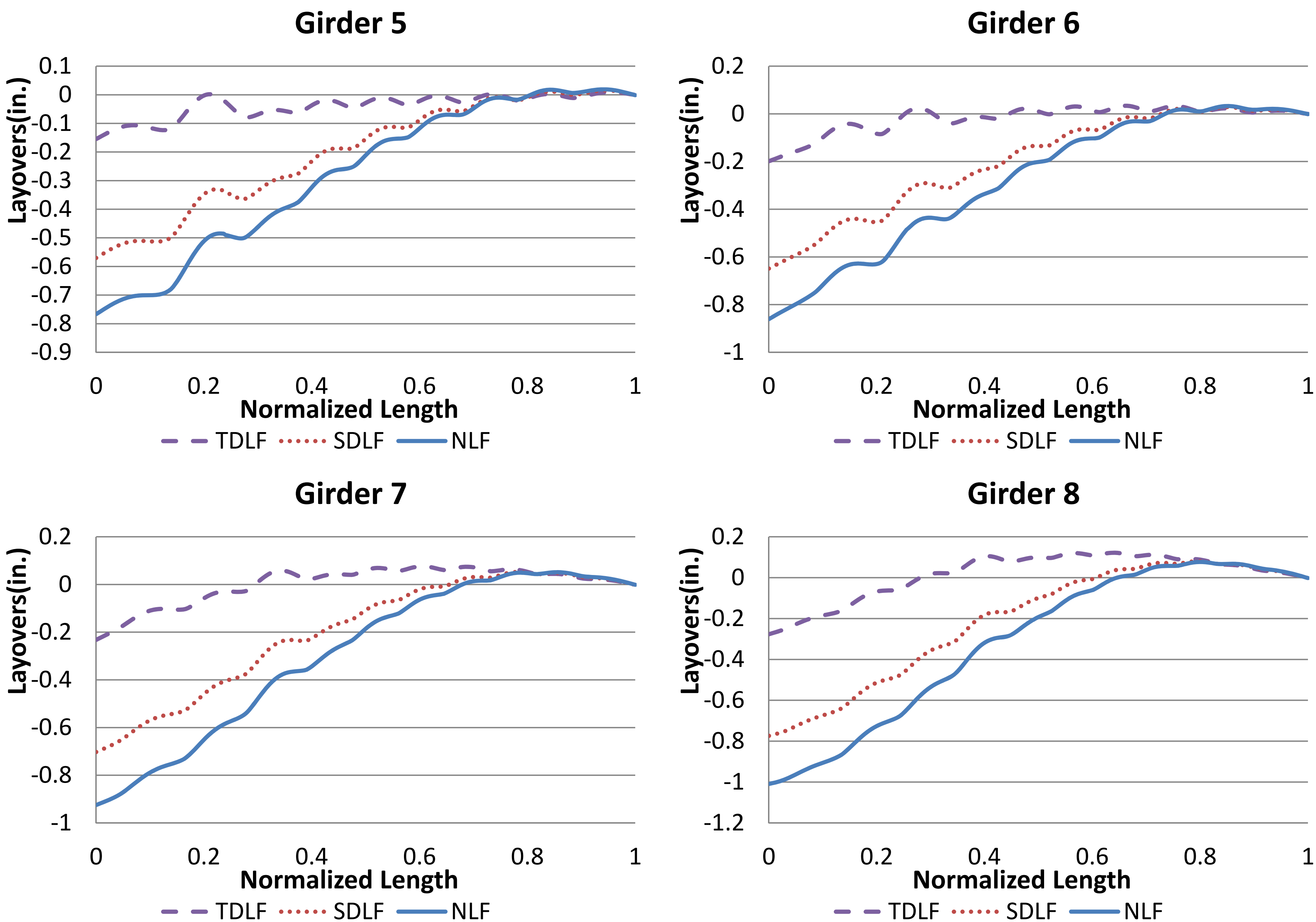


Figure N-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

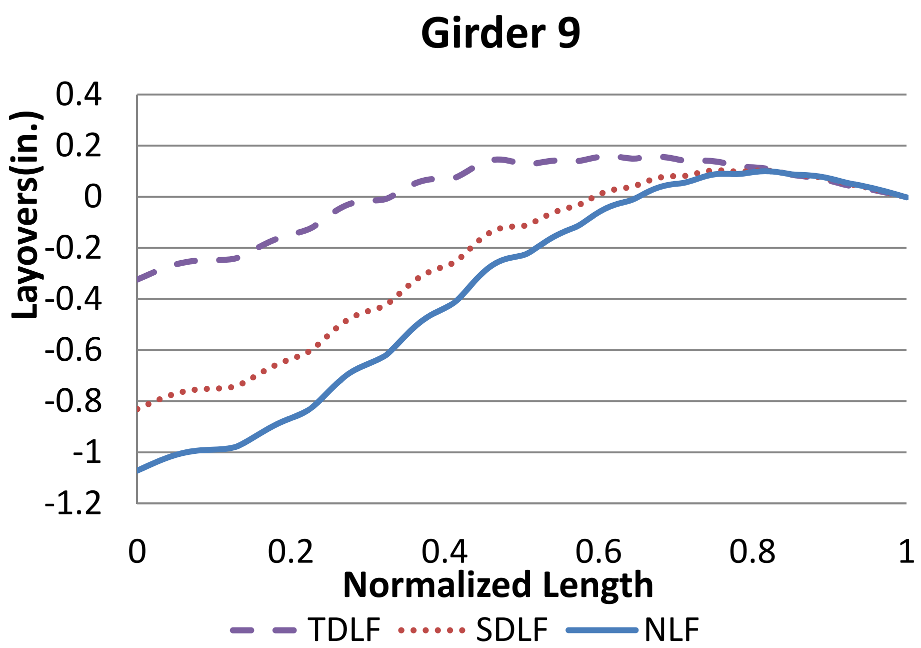


Figure N-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

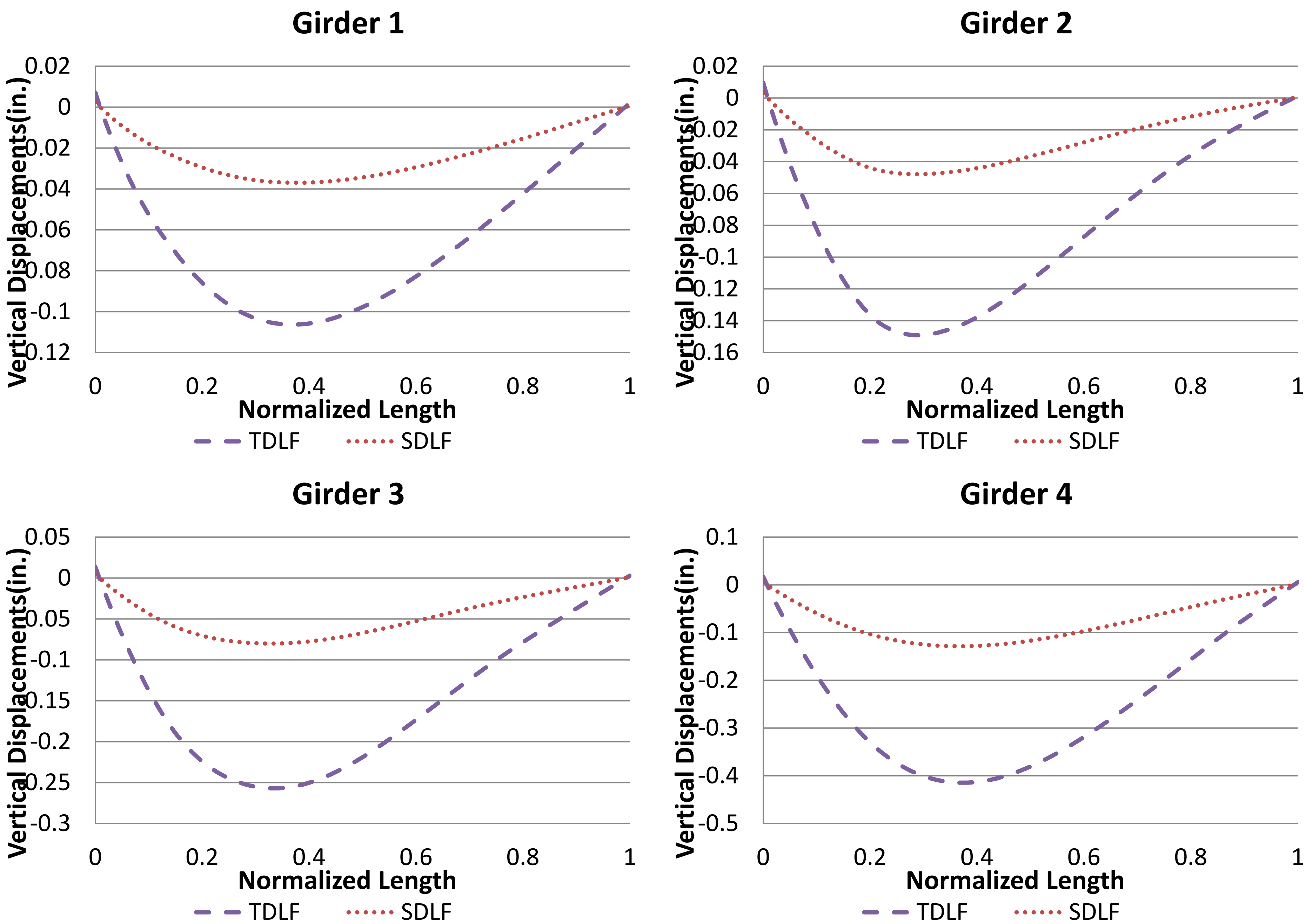


Figure N-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

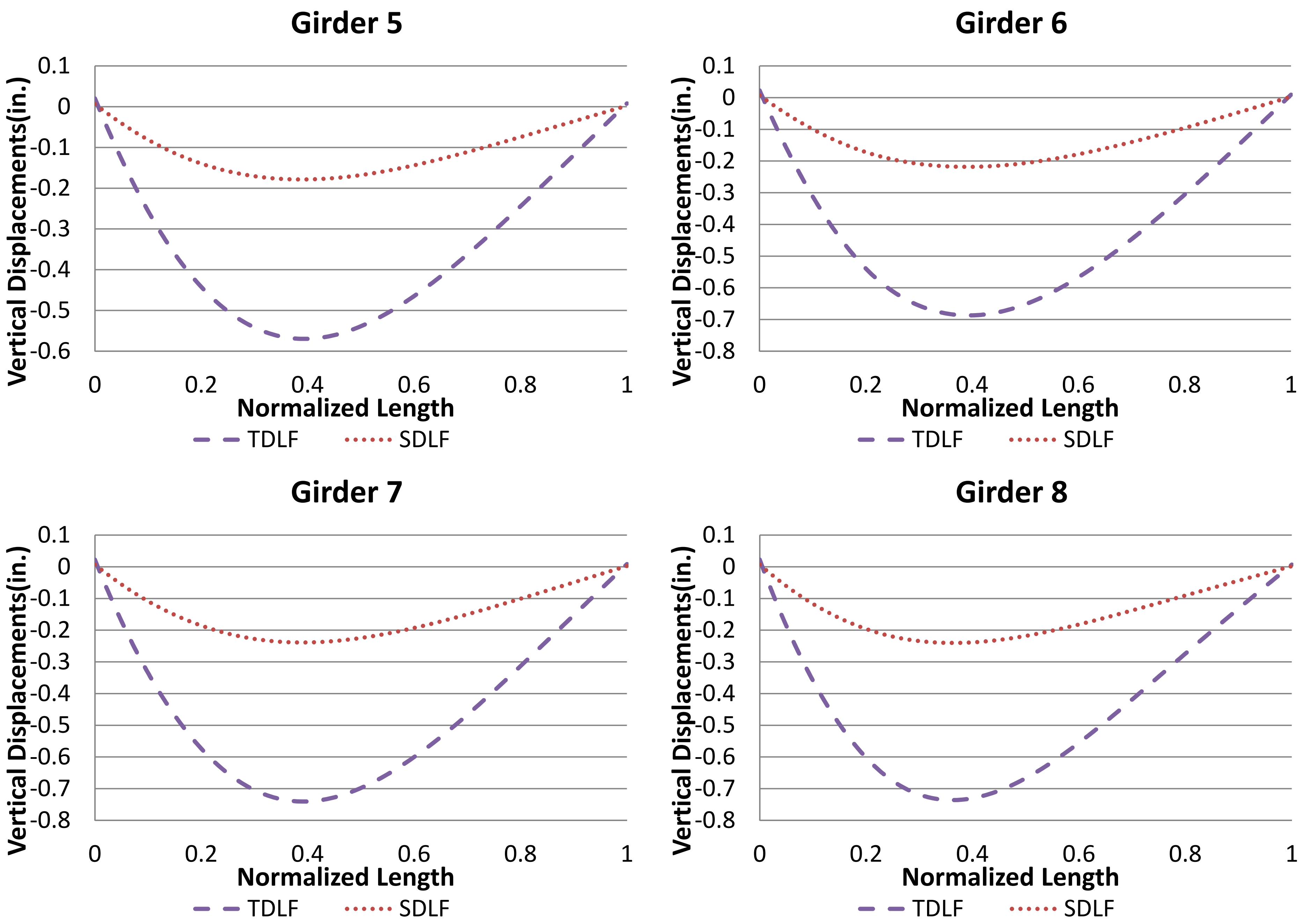


Figure N-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

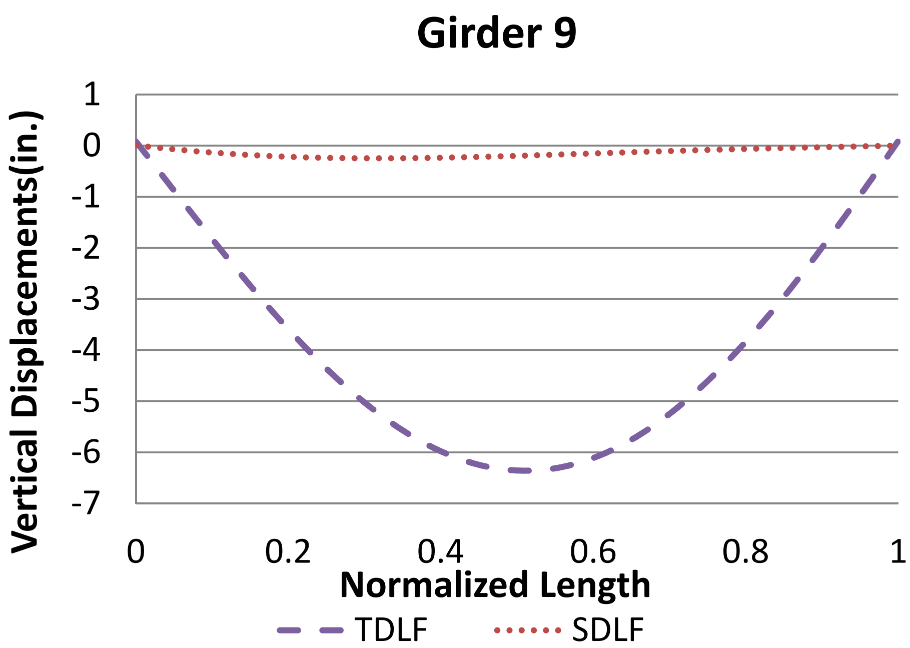


Figure N-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

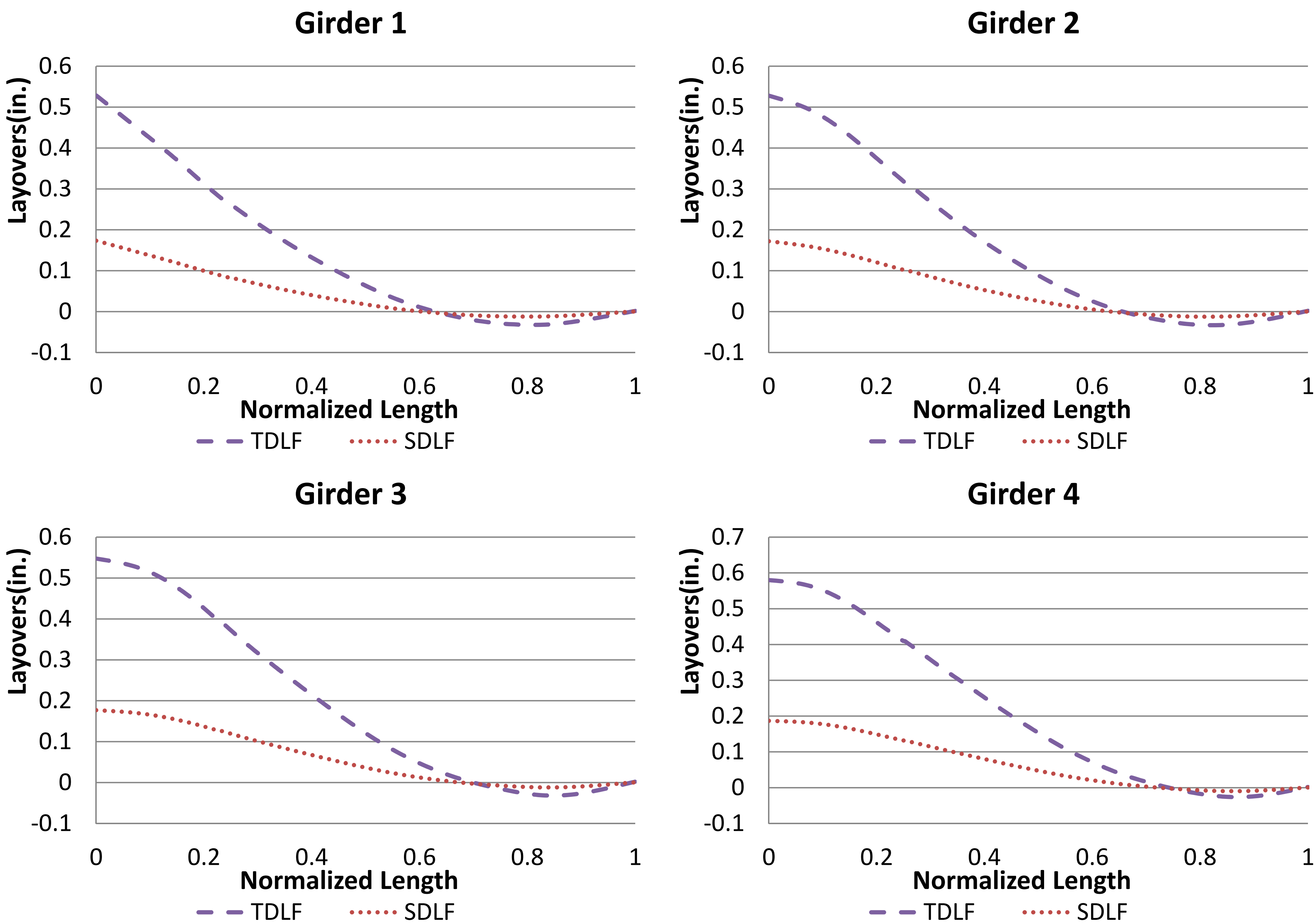


Figure N-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

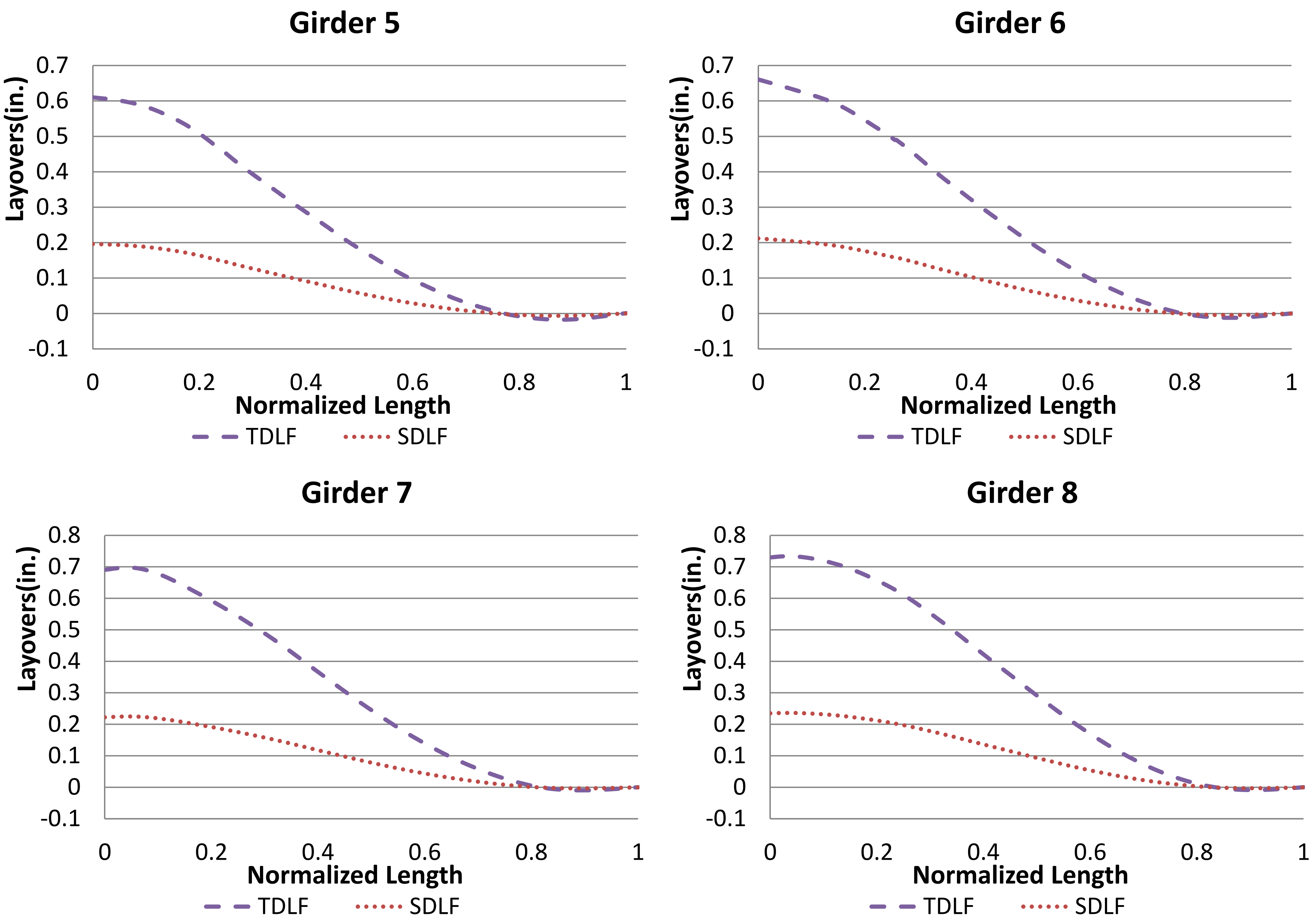


Figure N-4-17(Continued). **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.**

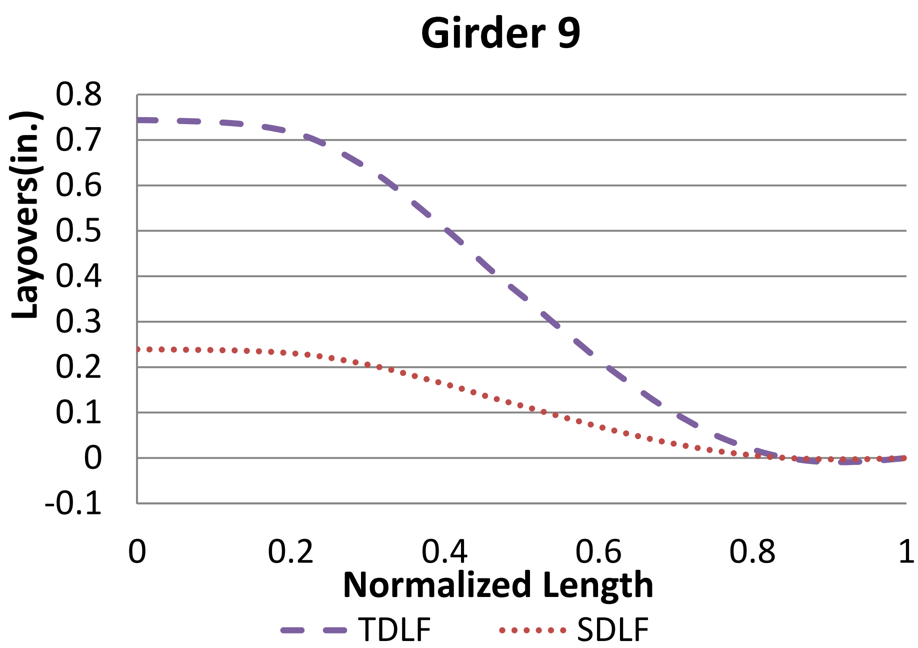


Figure N-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

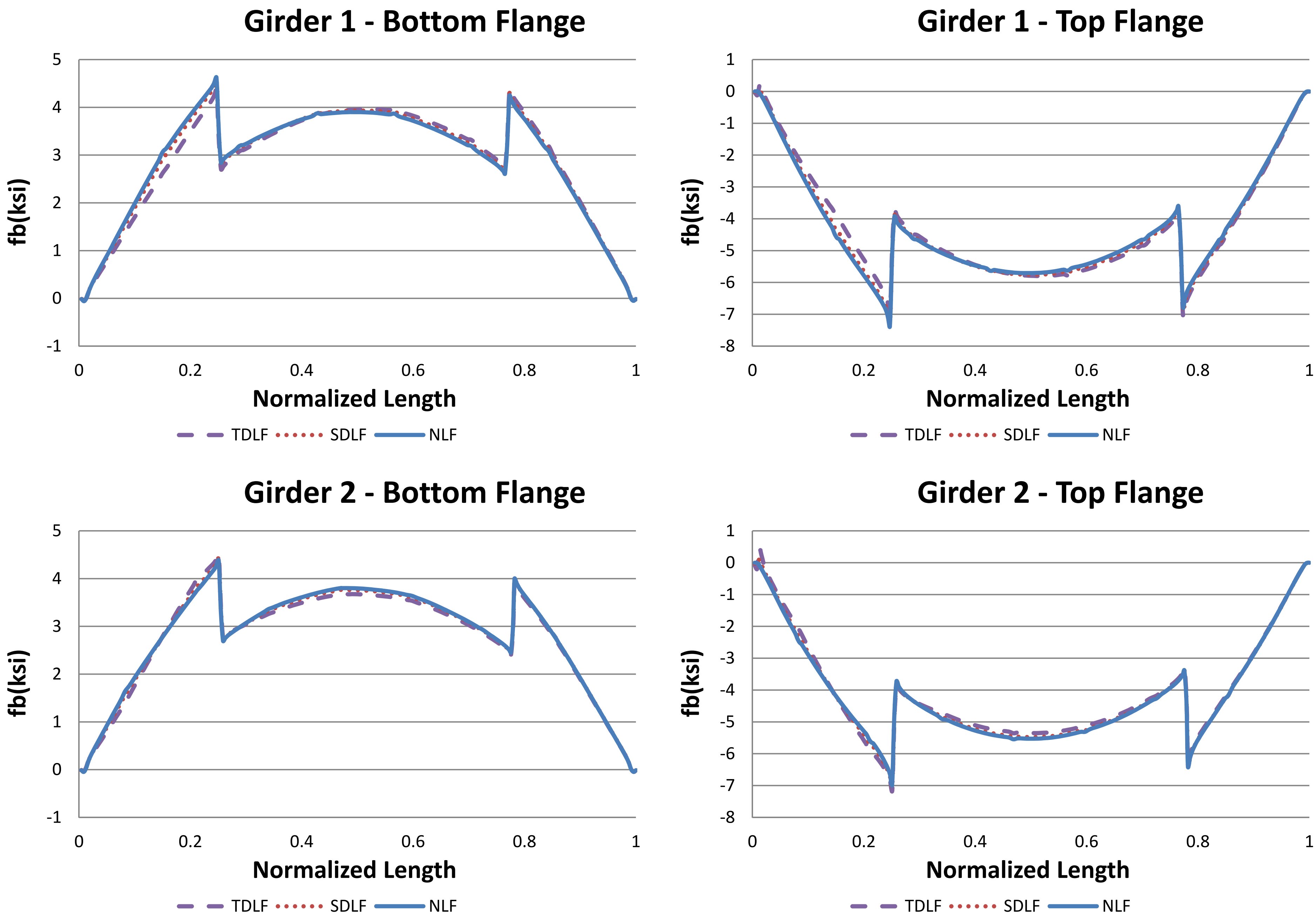


Figure N-4-18. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

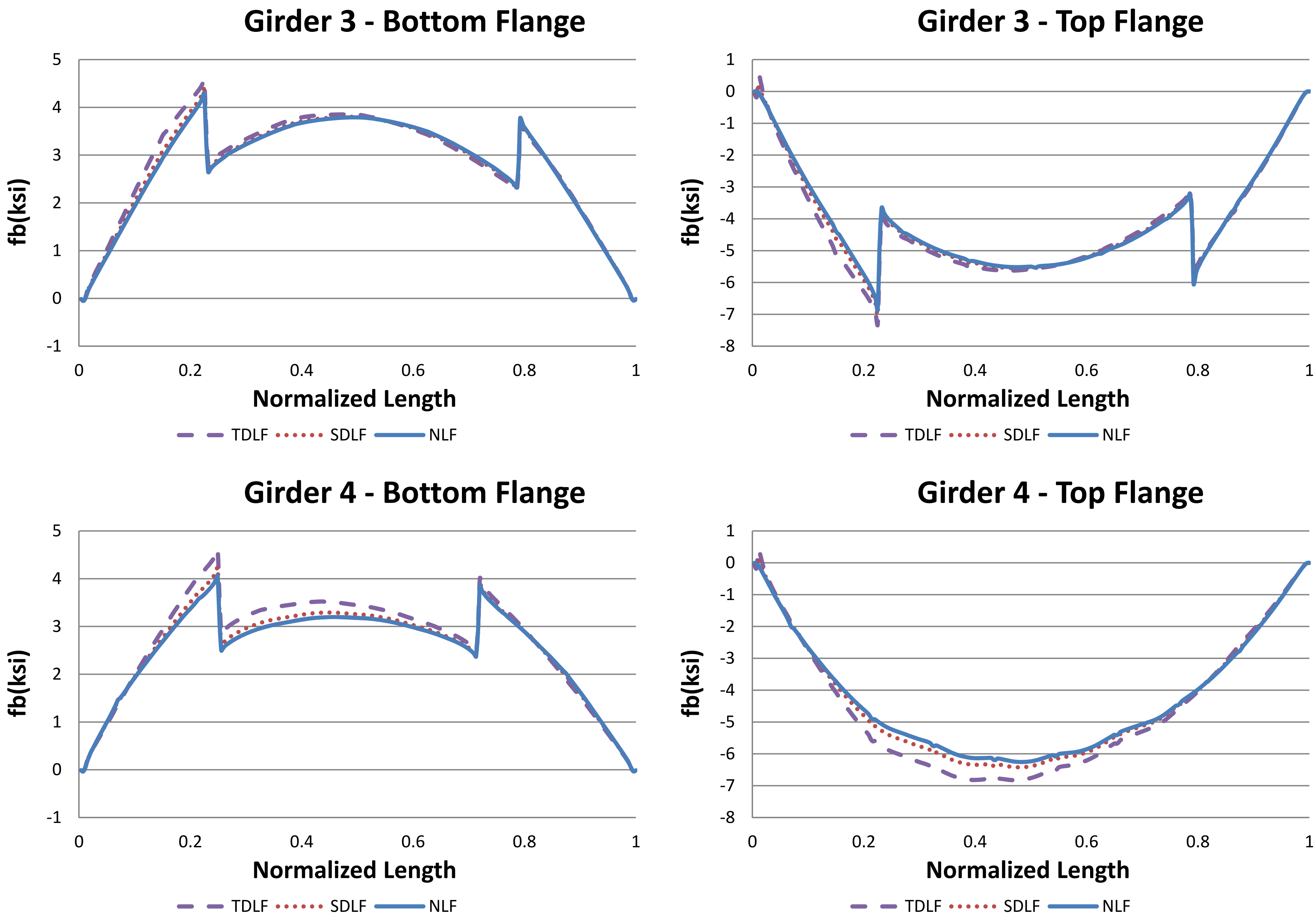


Figure N-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

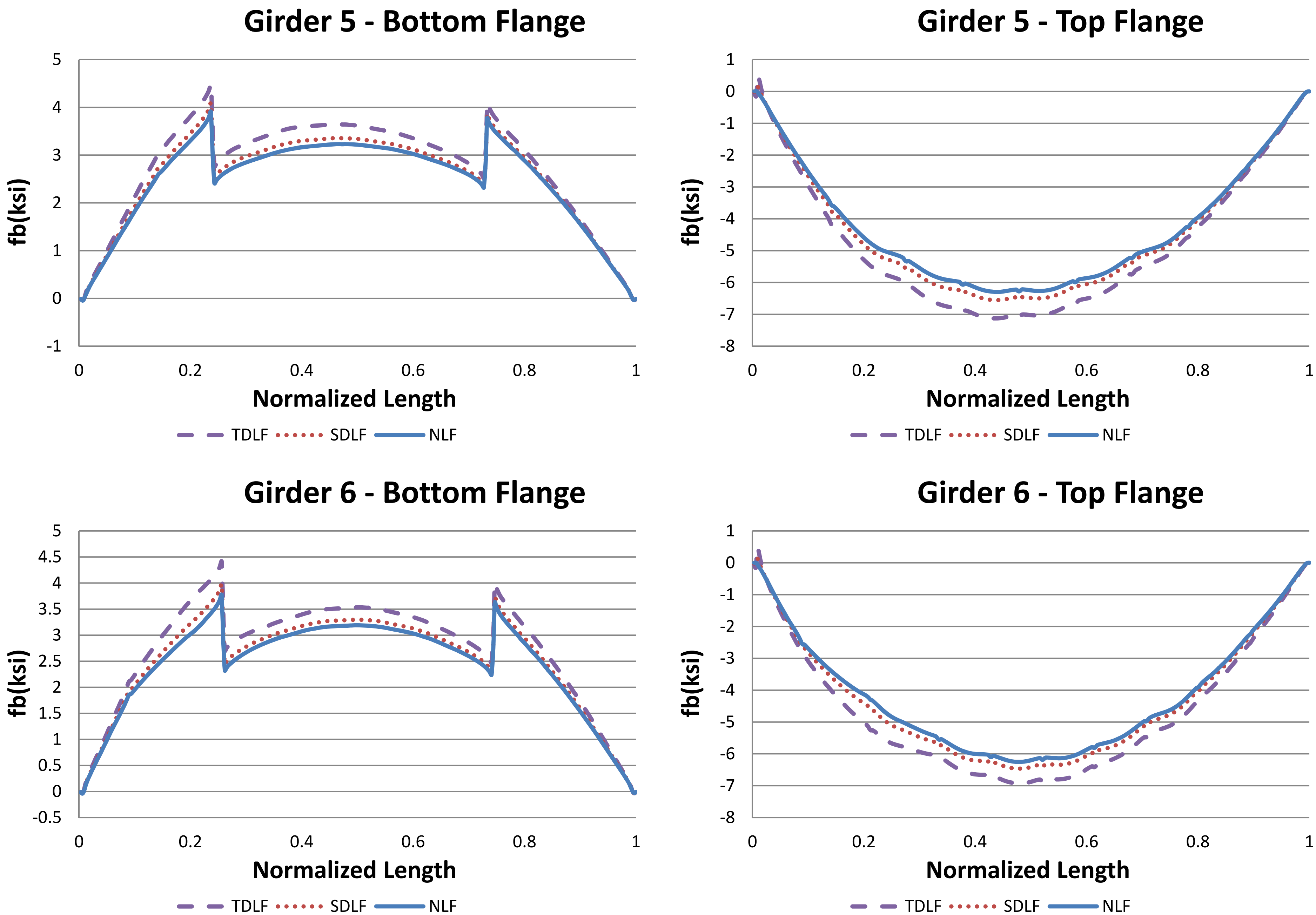


Figure N-4-18(Continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

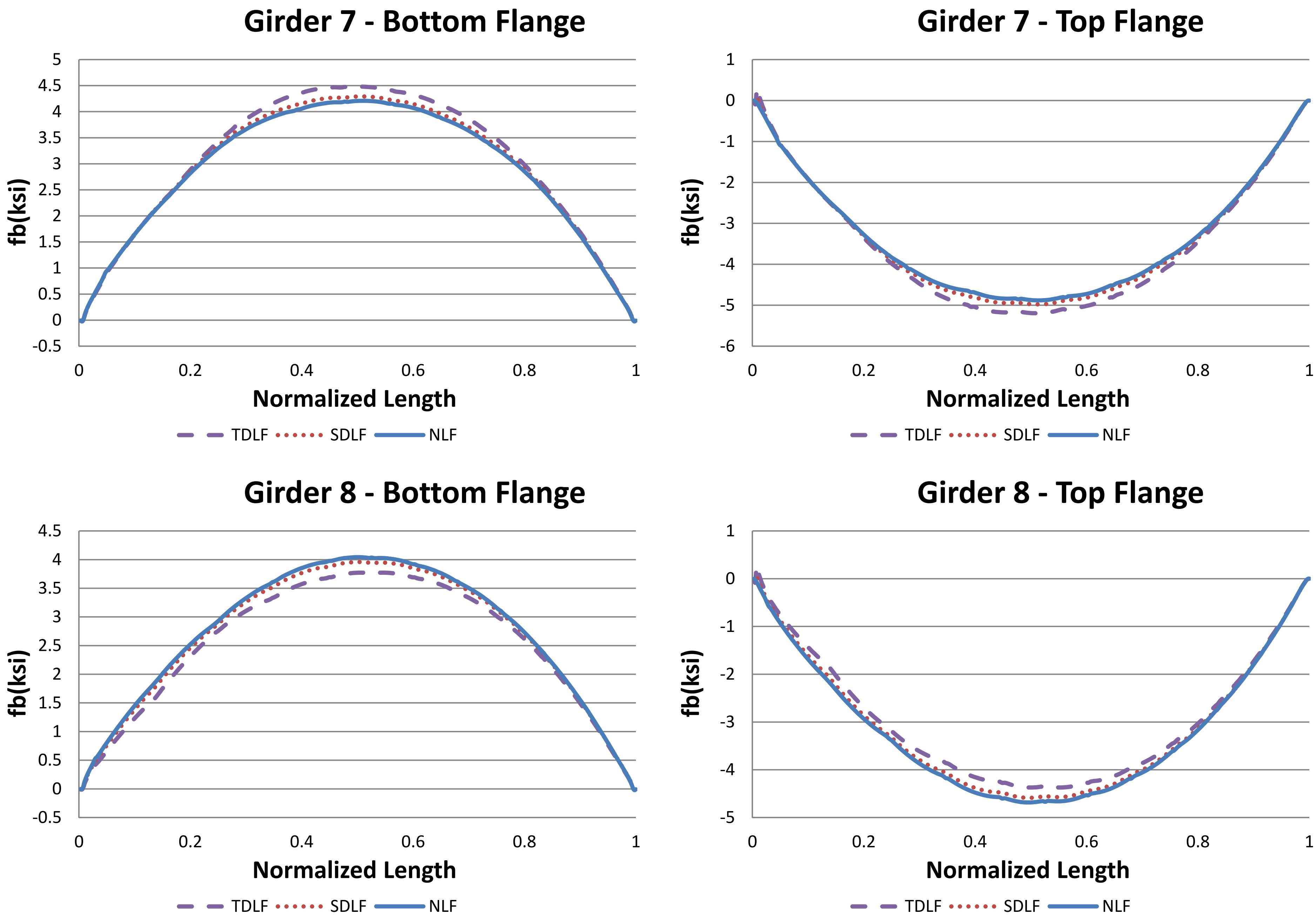
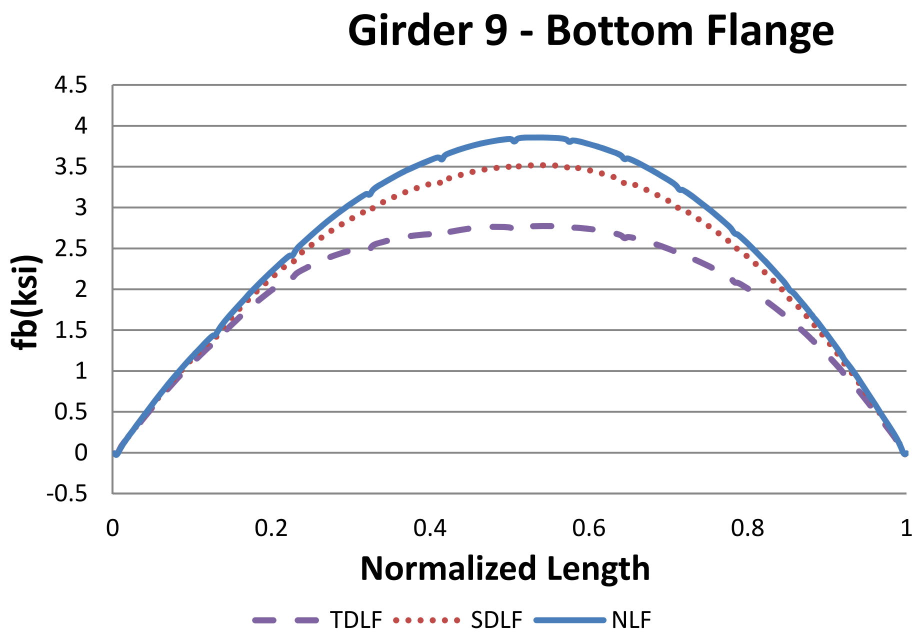


Figure N-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.



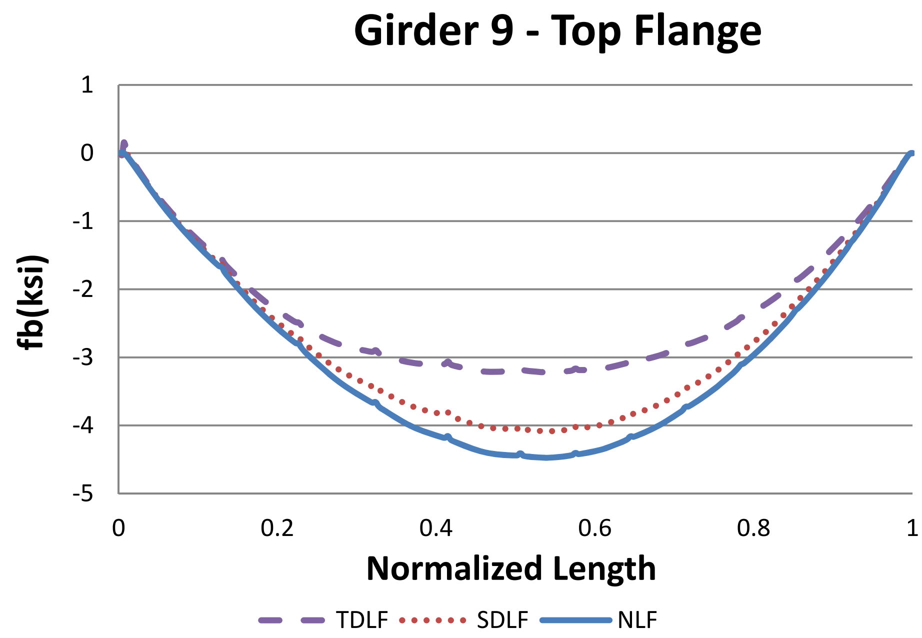


Figure N-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

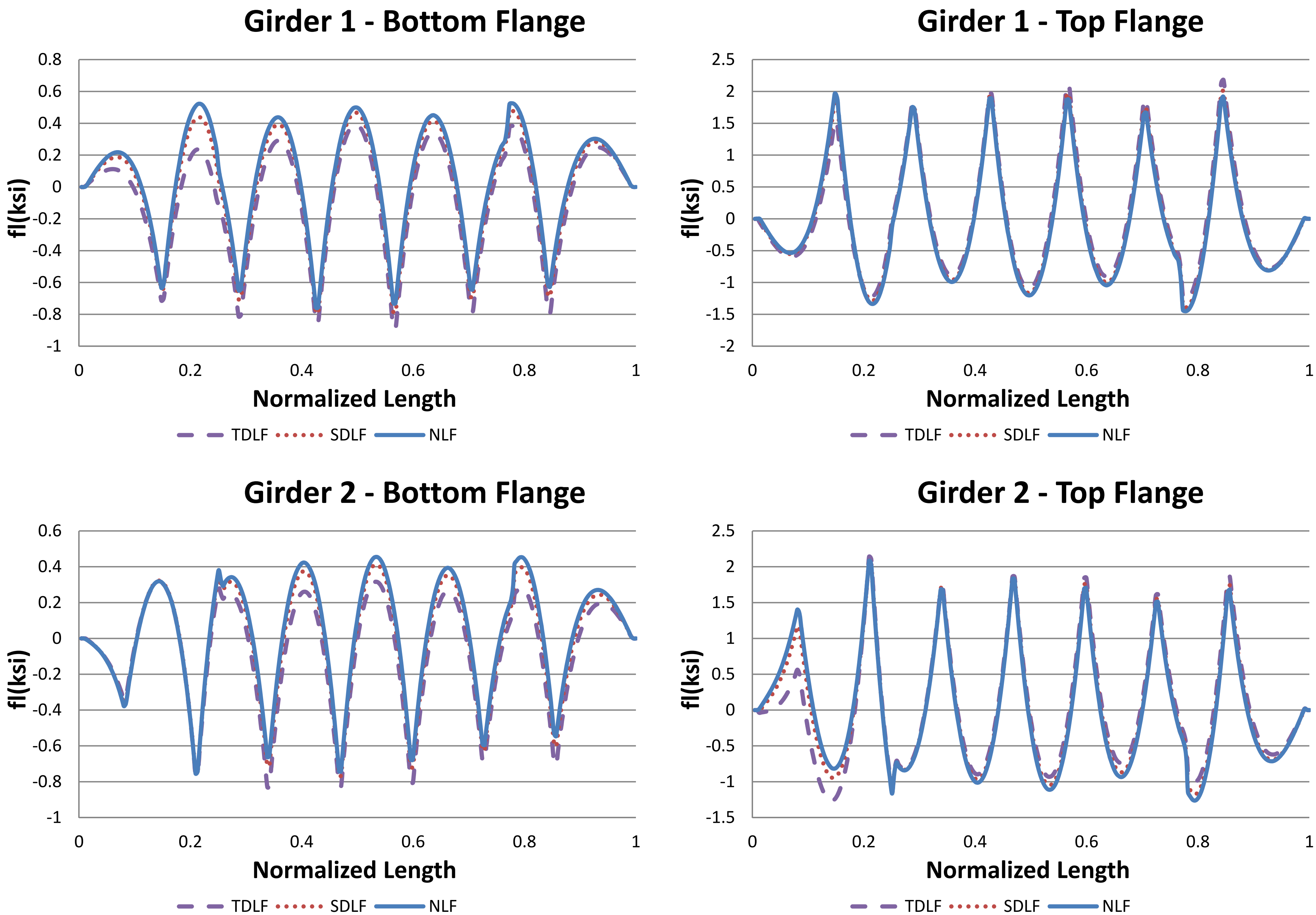


Figure N-4-19. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

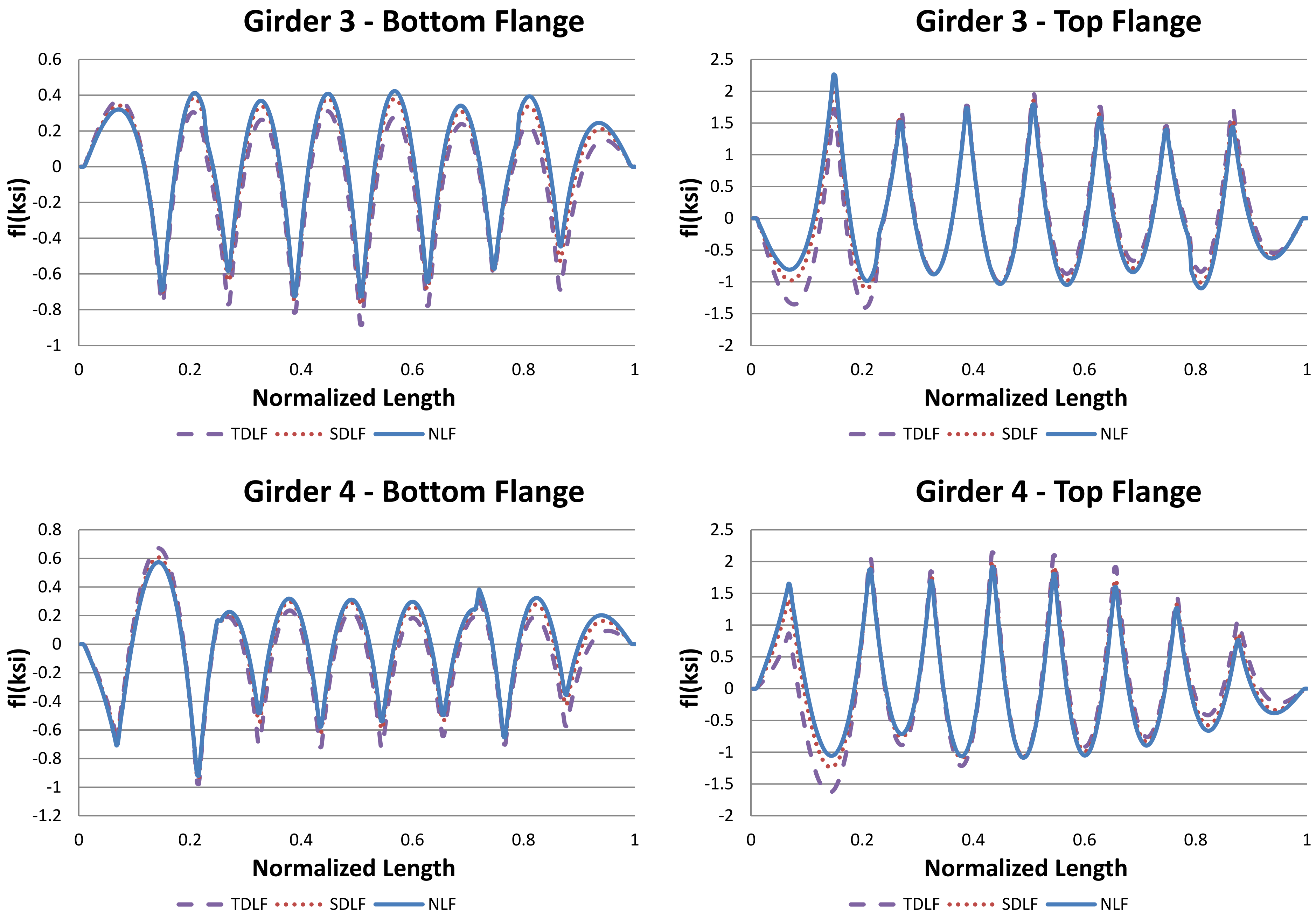


Figure N-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

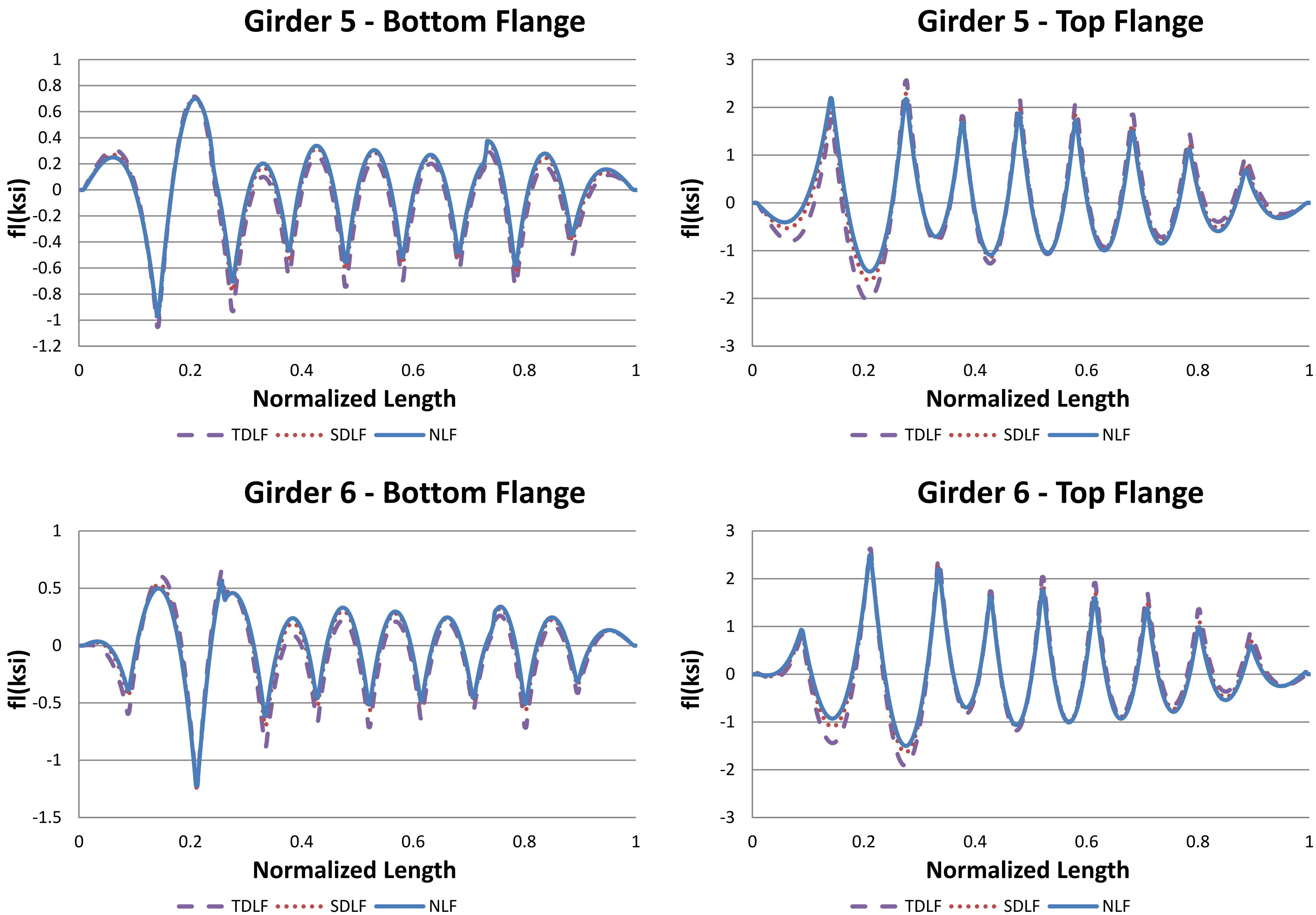


Figure N-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

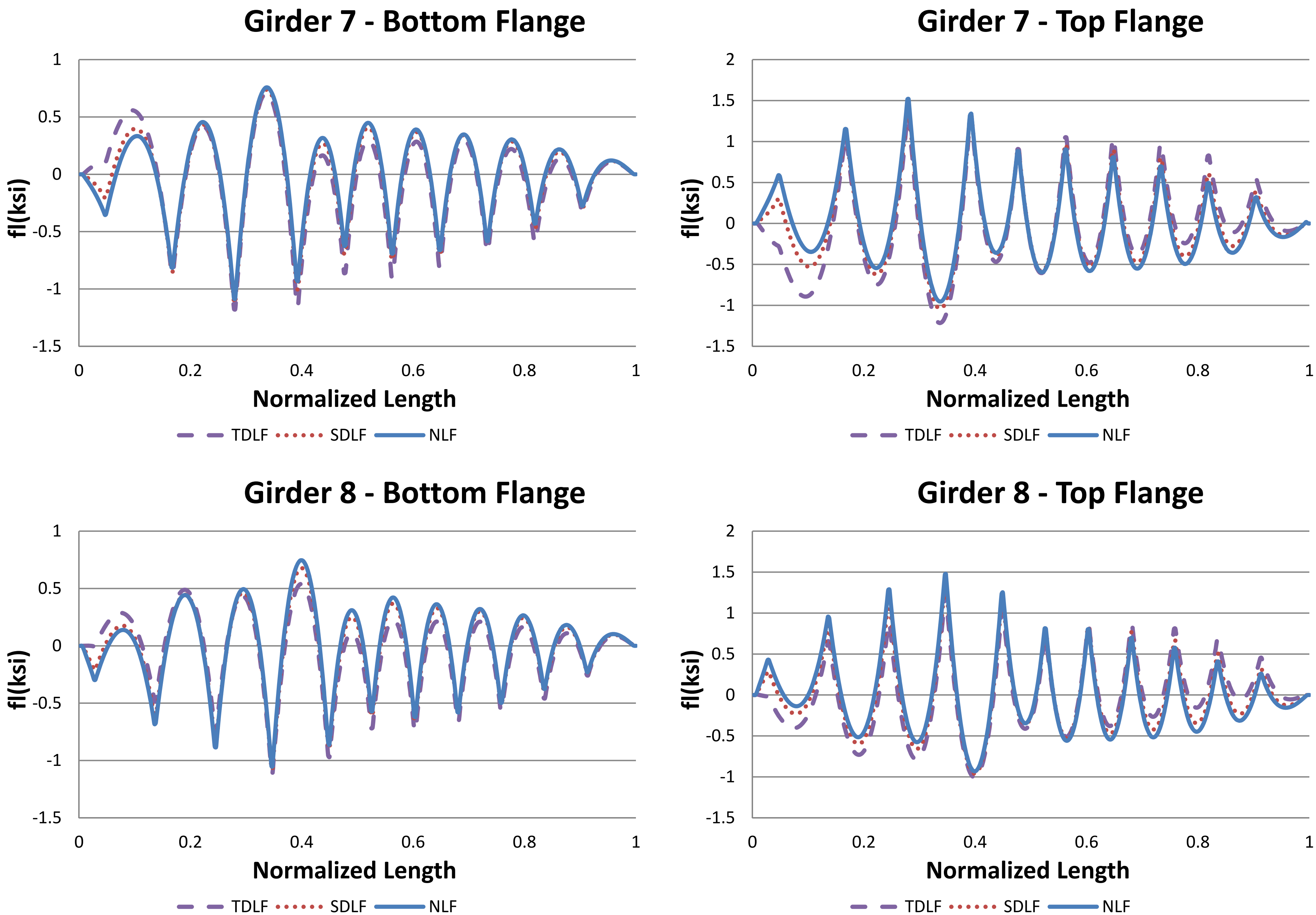


Figure N-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

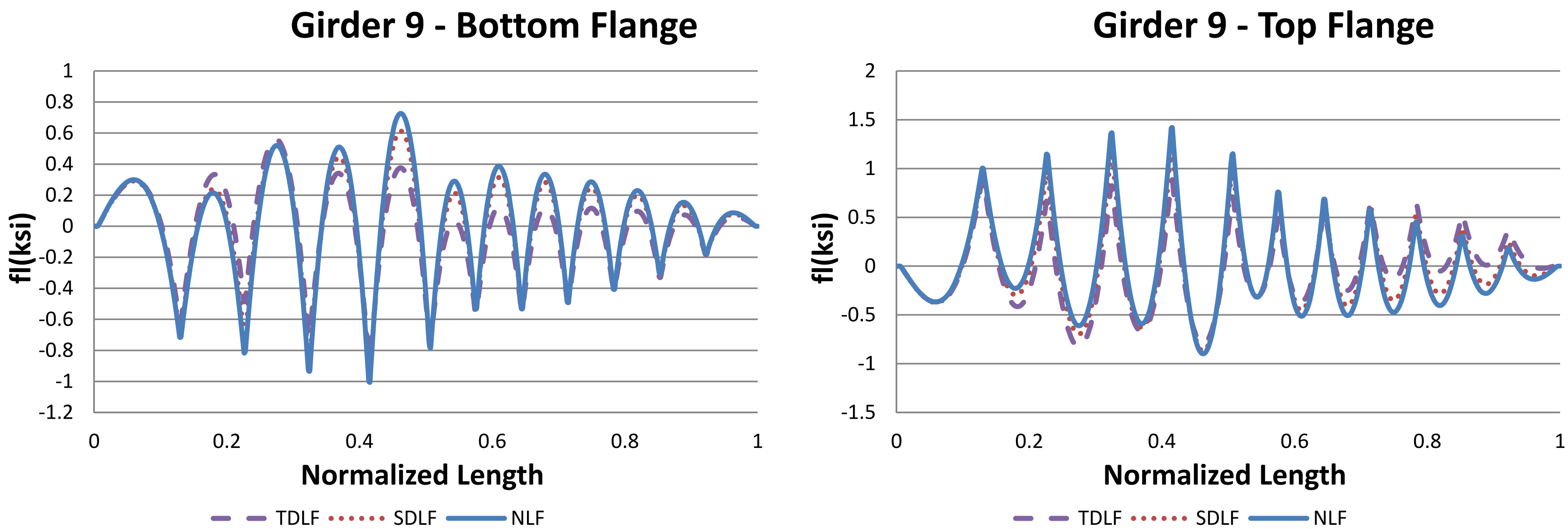


Figure N-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

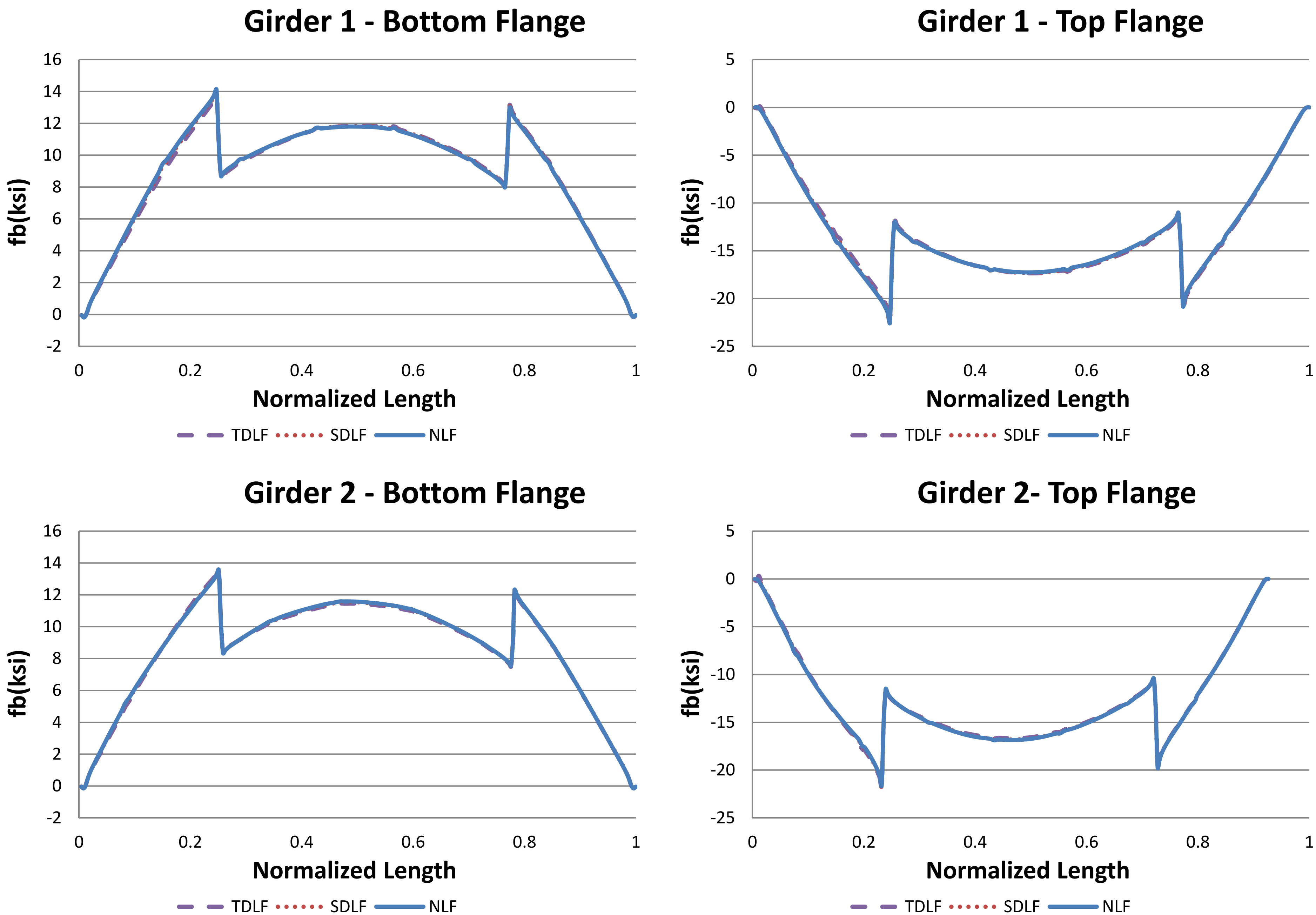


Figure N-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

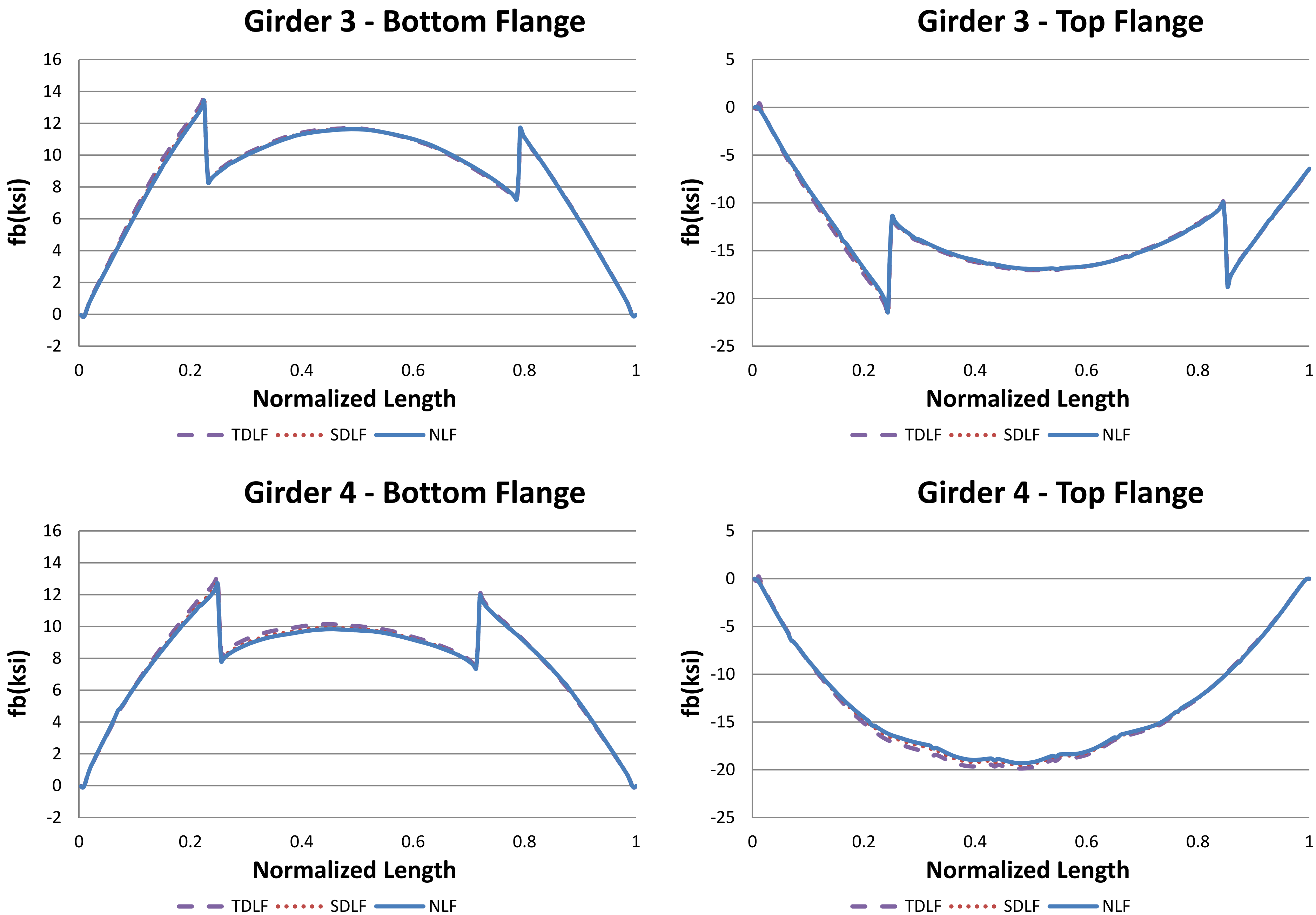


Figure N-4-20(Continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

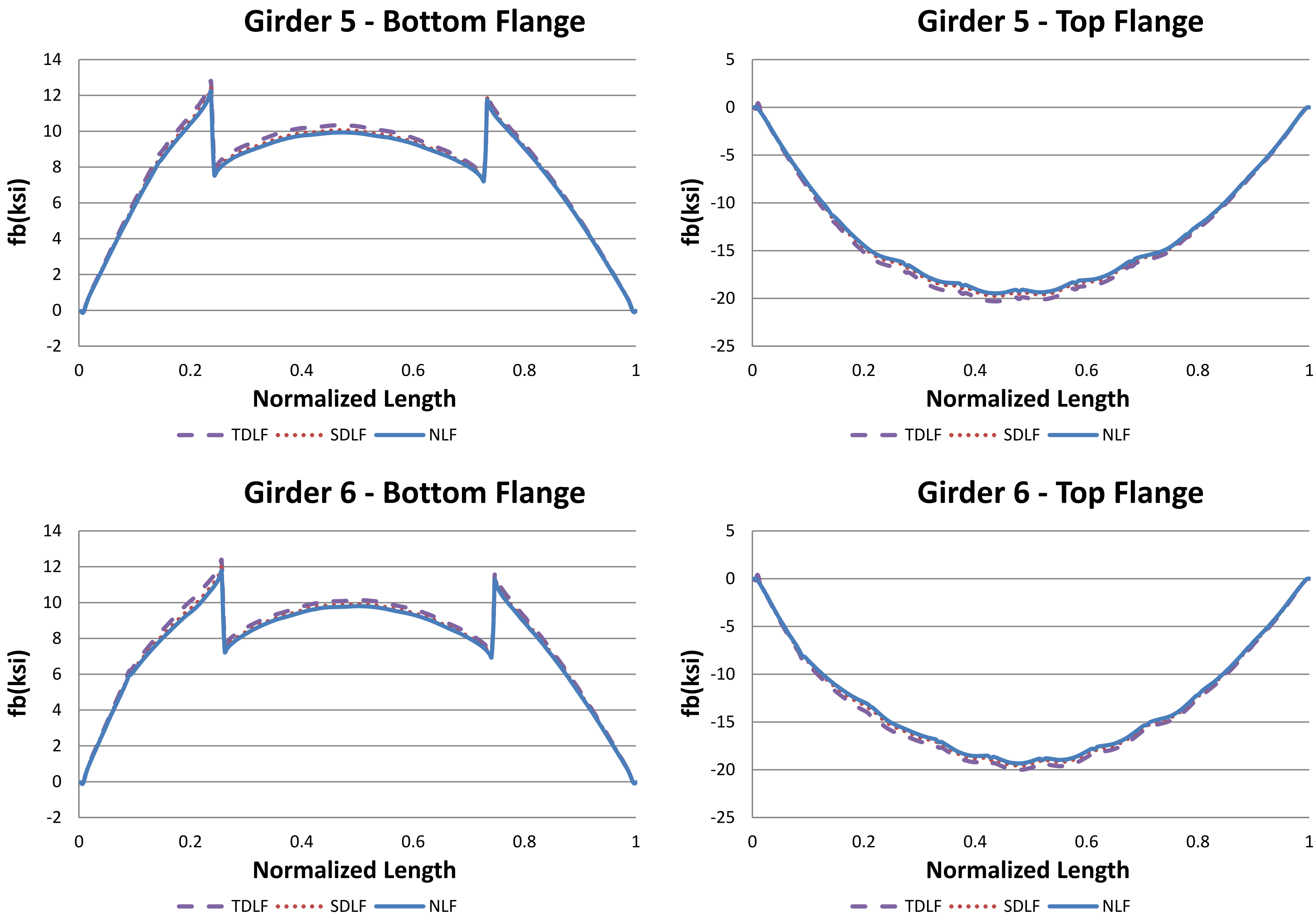


Figure N-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

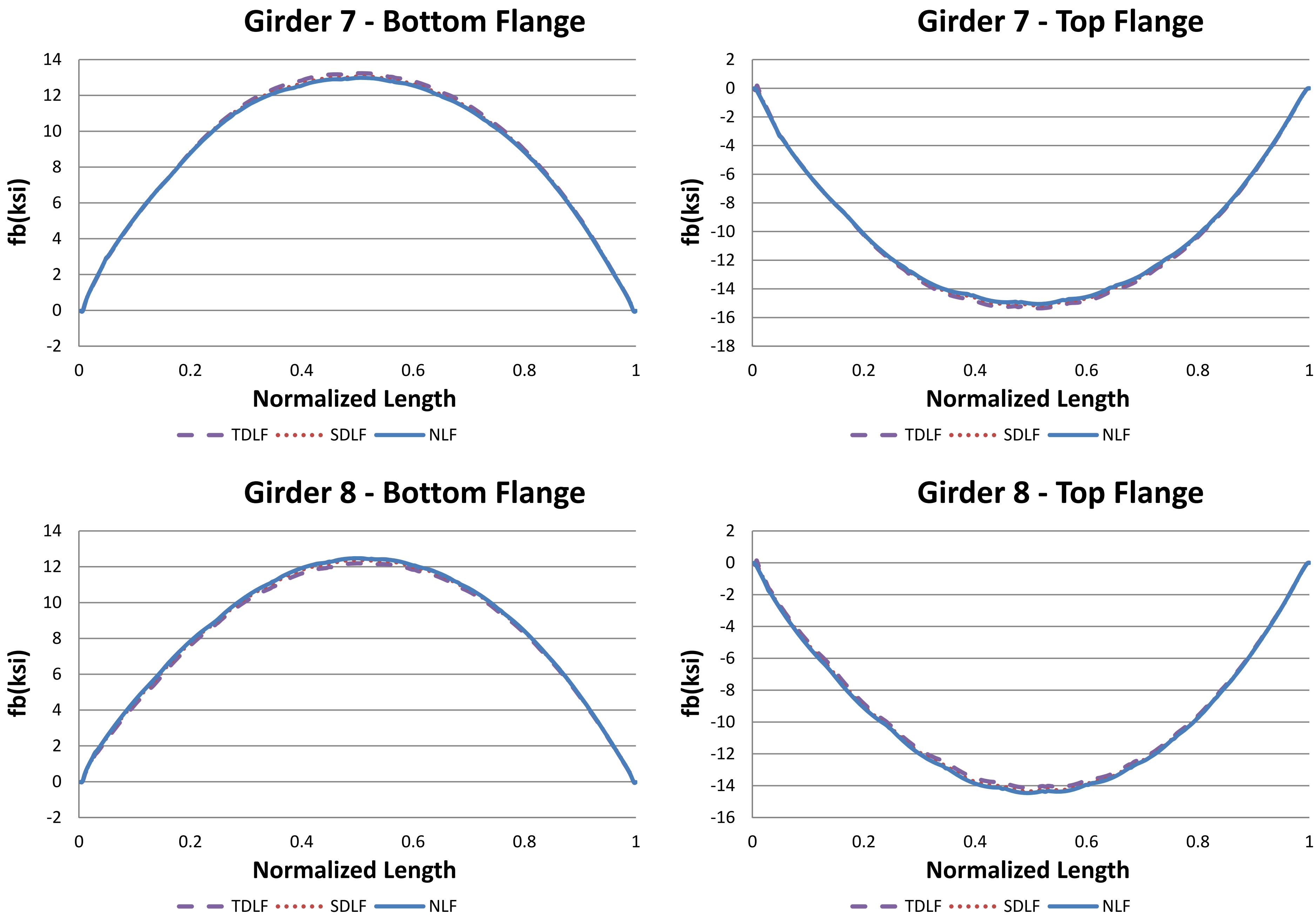
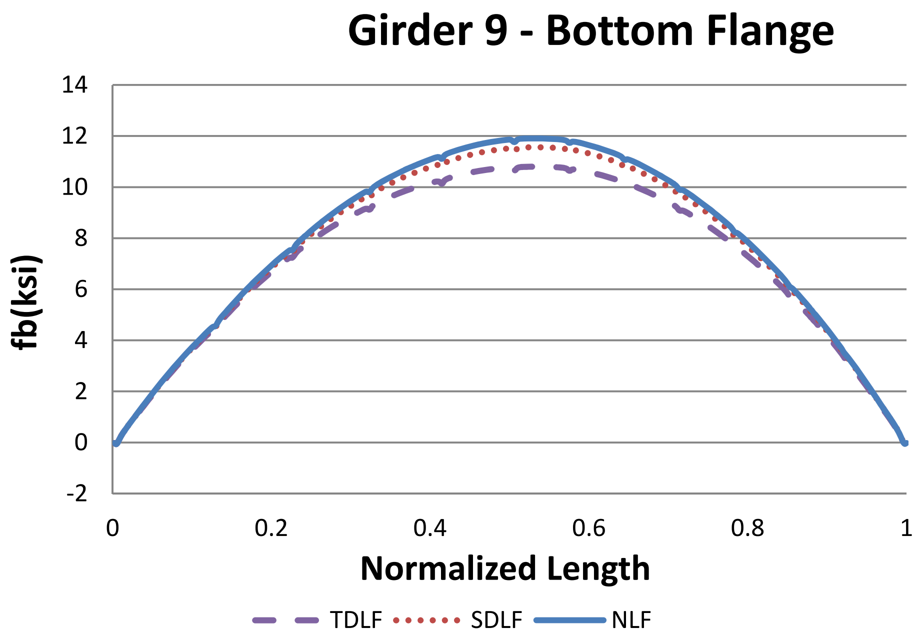


Figure N-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



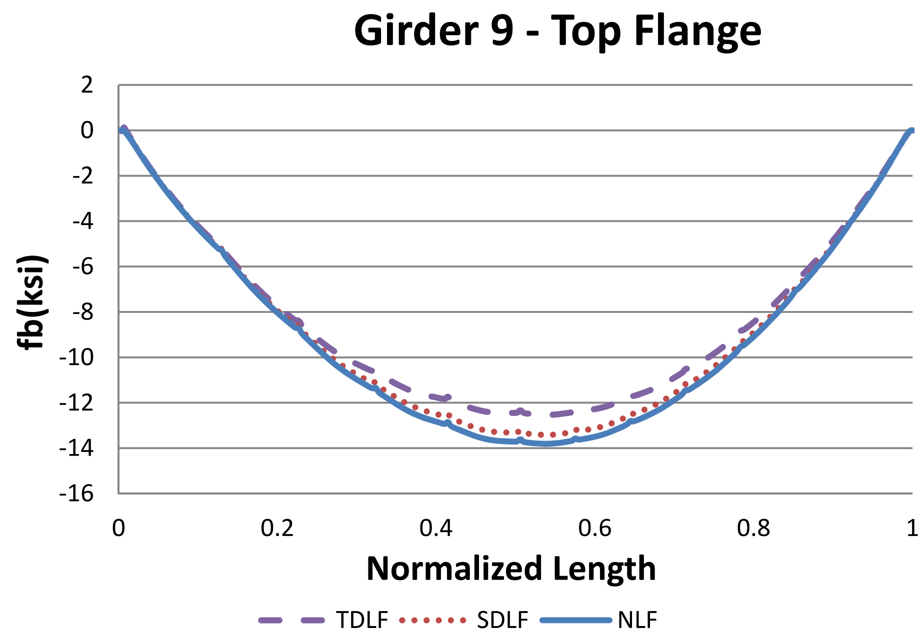


Figure N-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

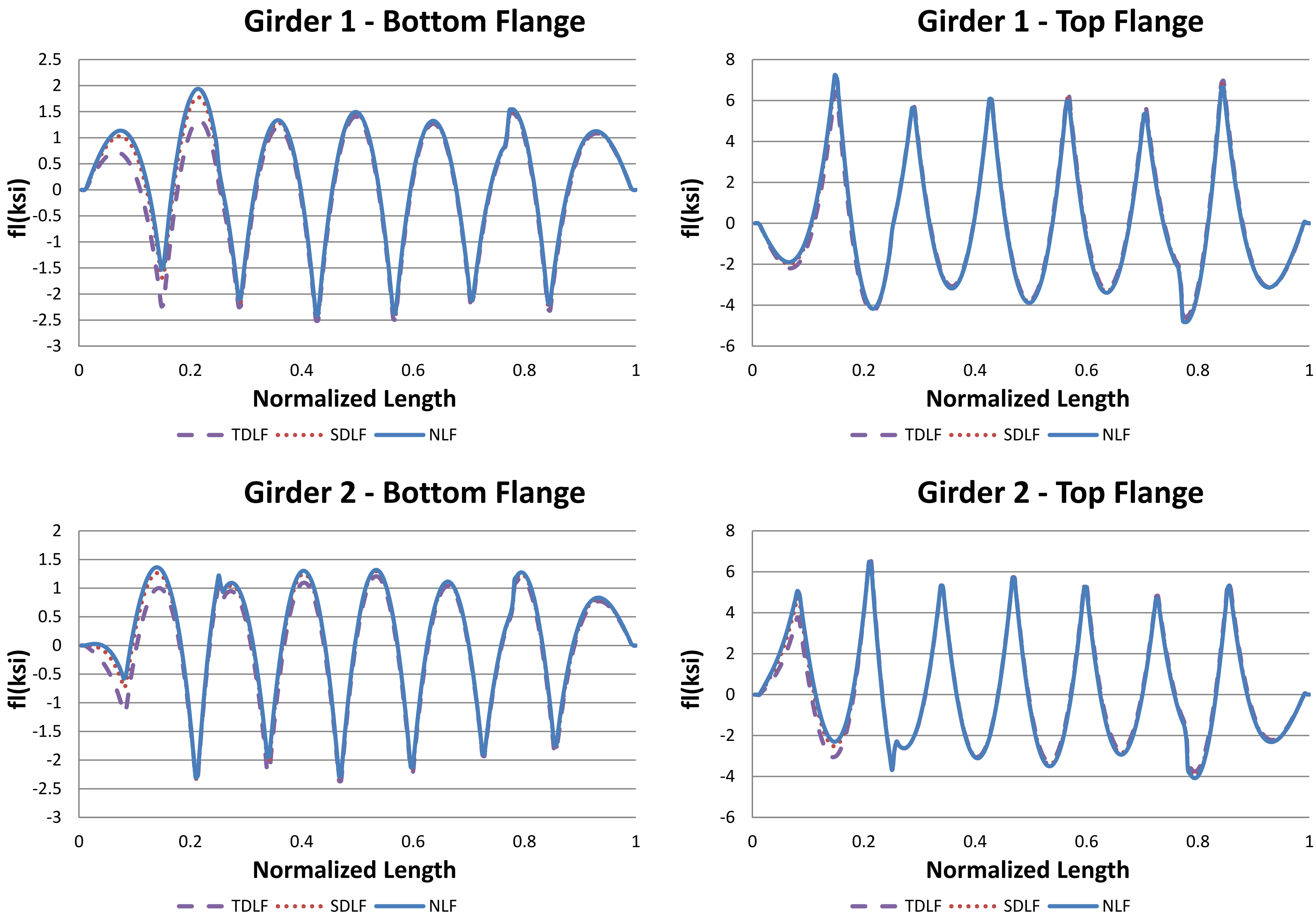


Figure N-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

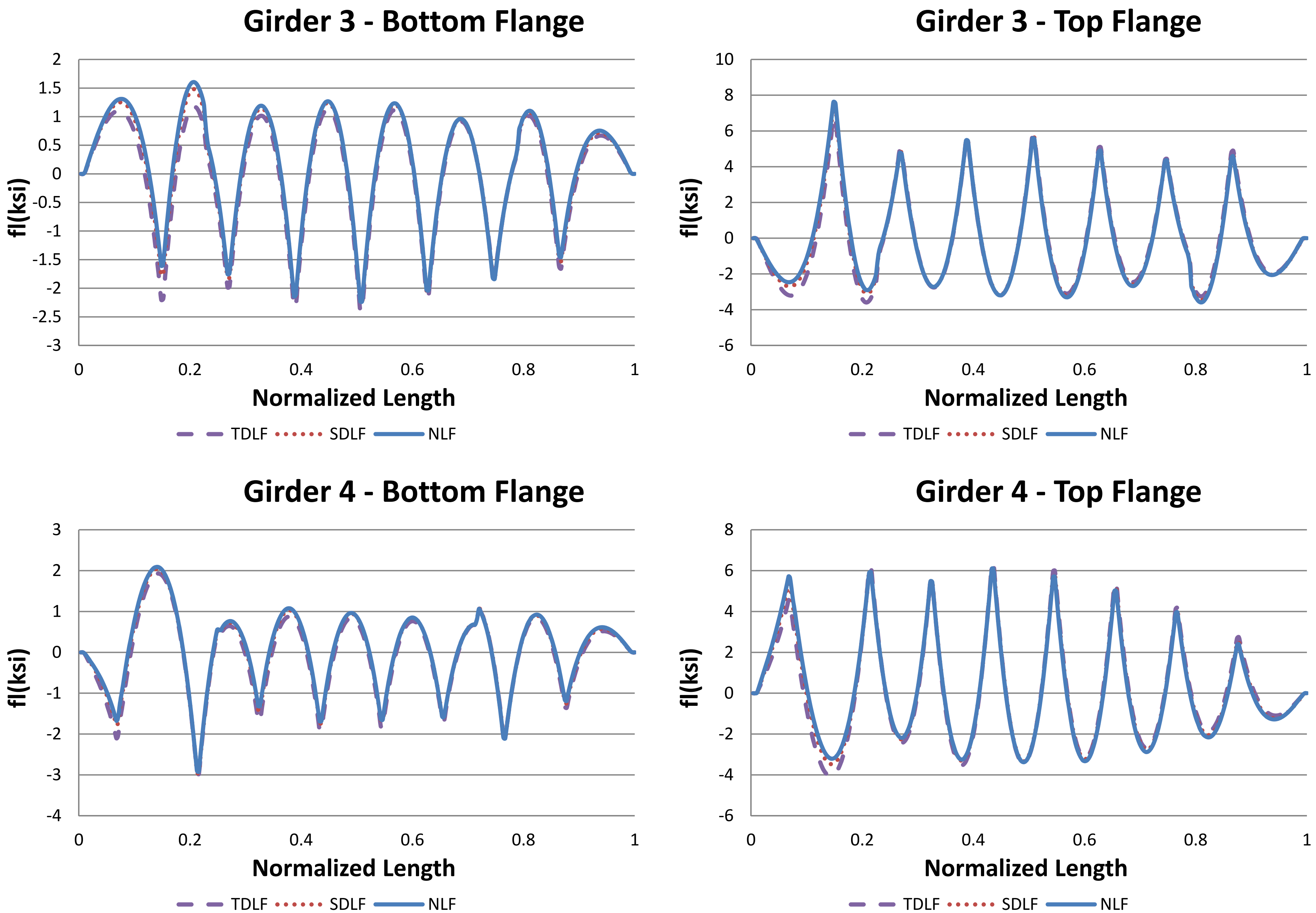


Figure N-4-21(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

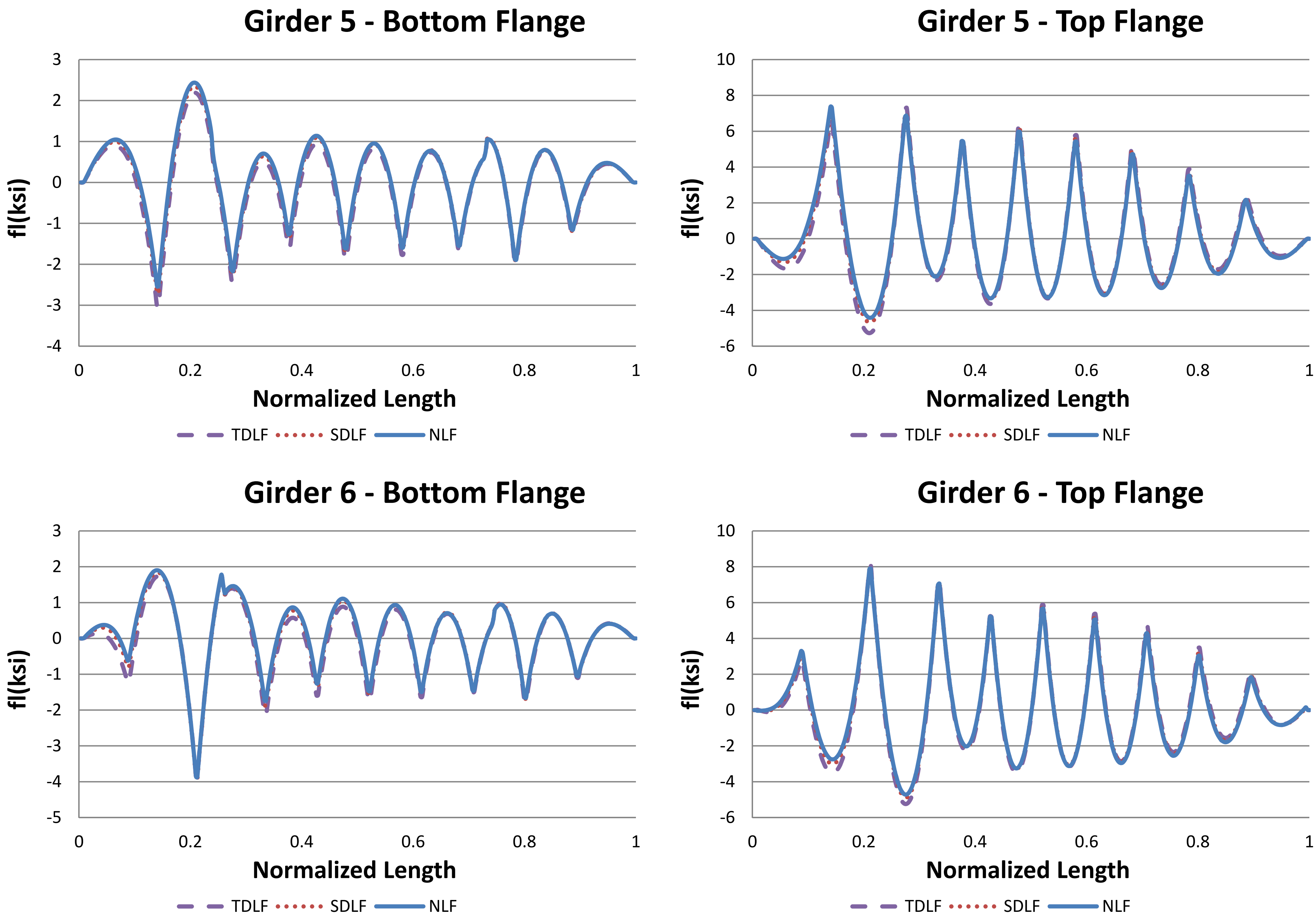


Figure N-4-21(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

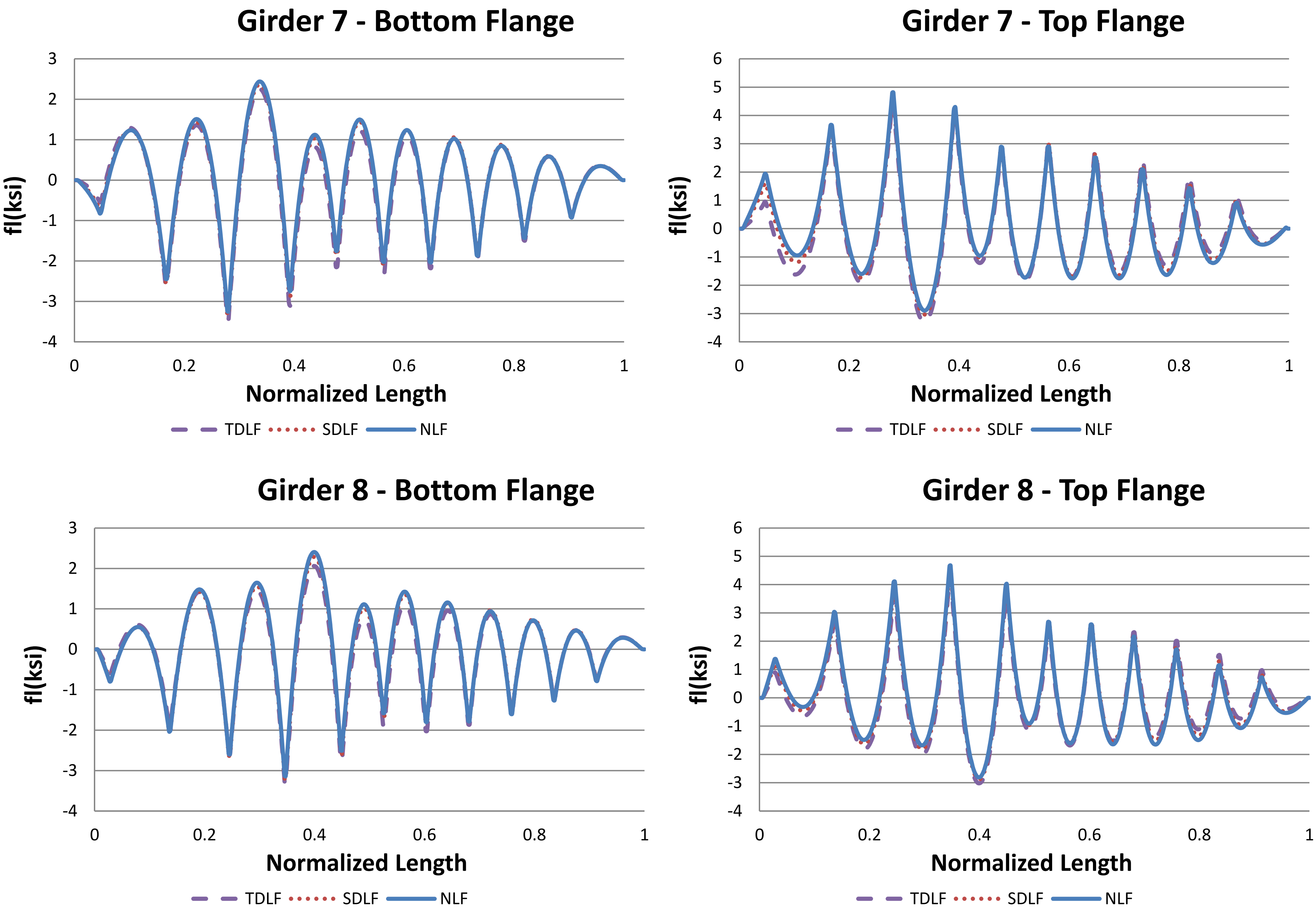
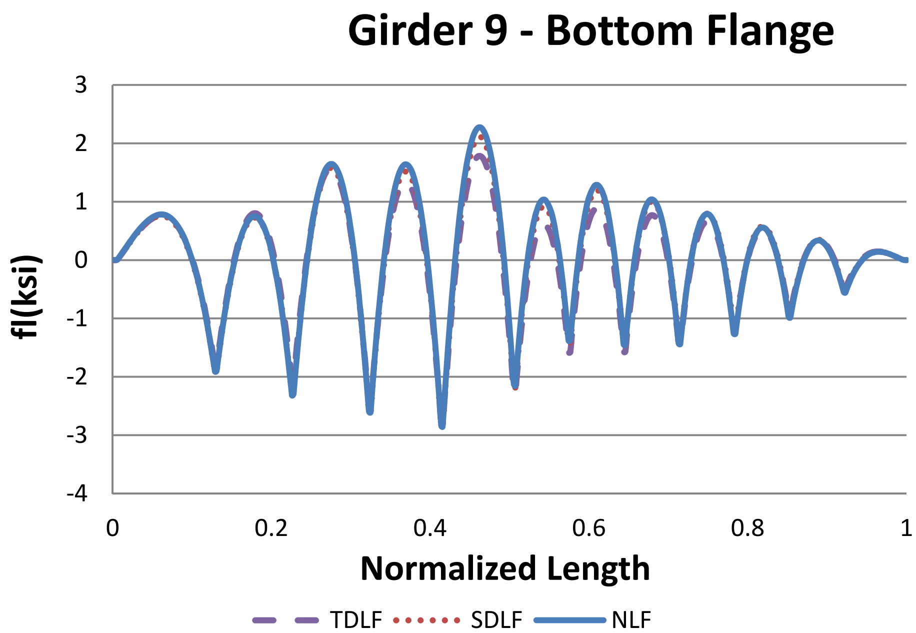


Figure N-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.



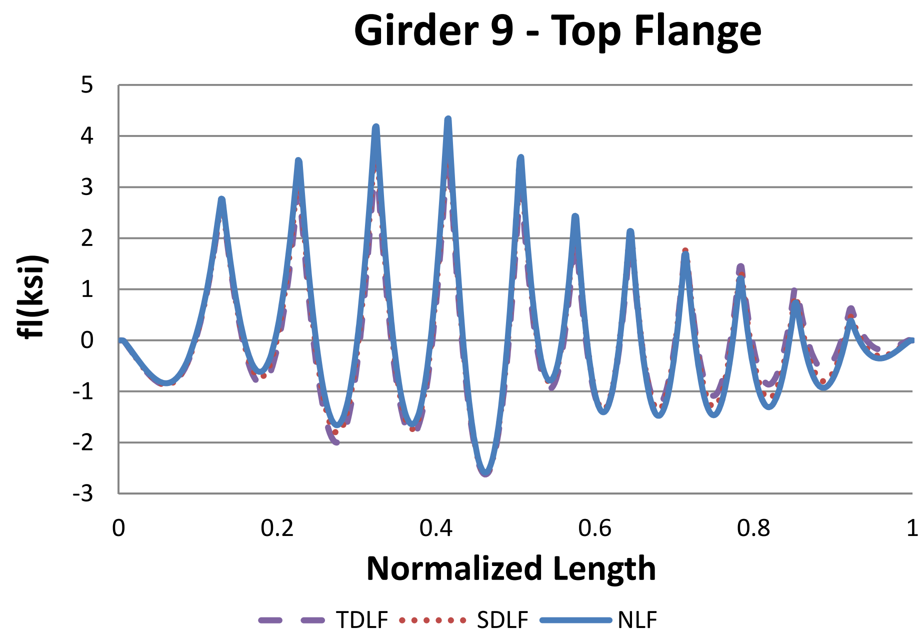


Figure N-4-21(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

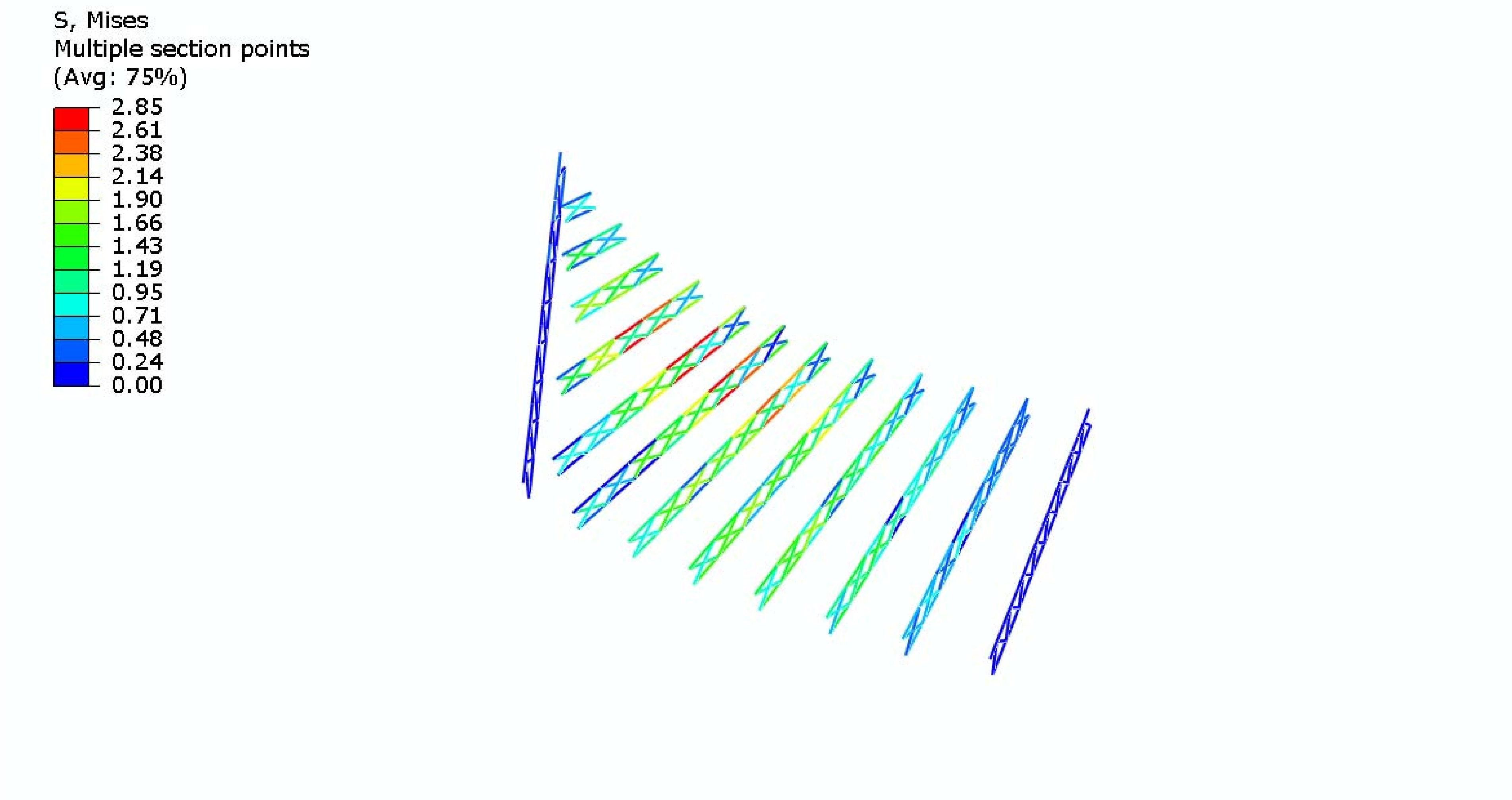


Figure N-4-22. **Cross-frame stress contours (ksi) under SDL, NLF detailing**

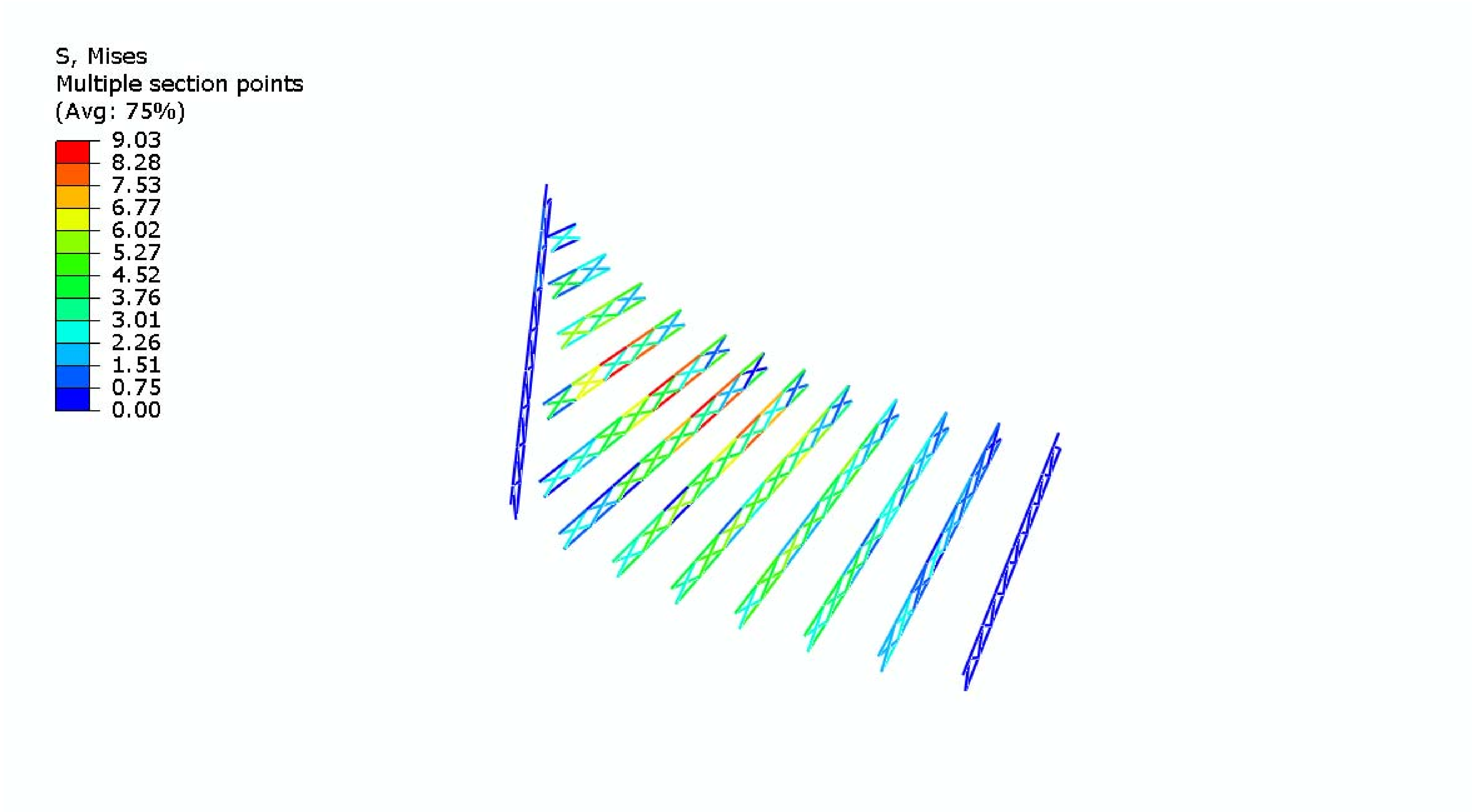


Figure N-4-23. Cross-frame stress contours under TDL, NLF detailing

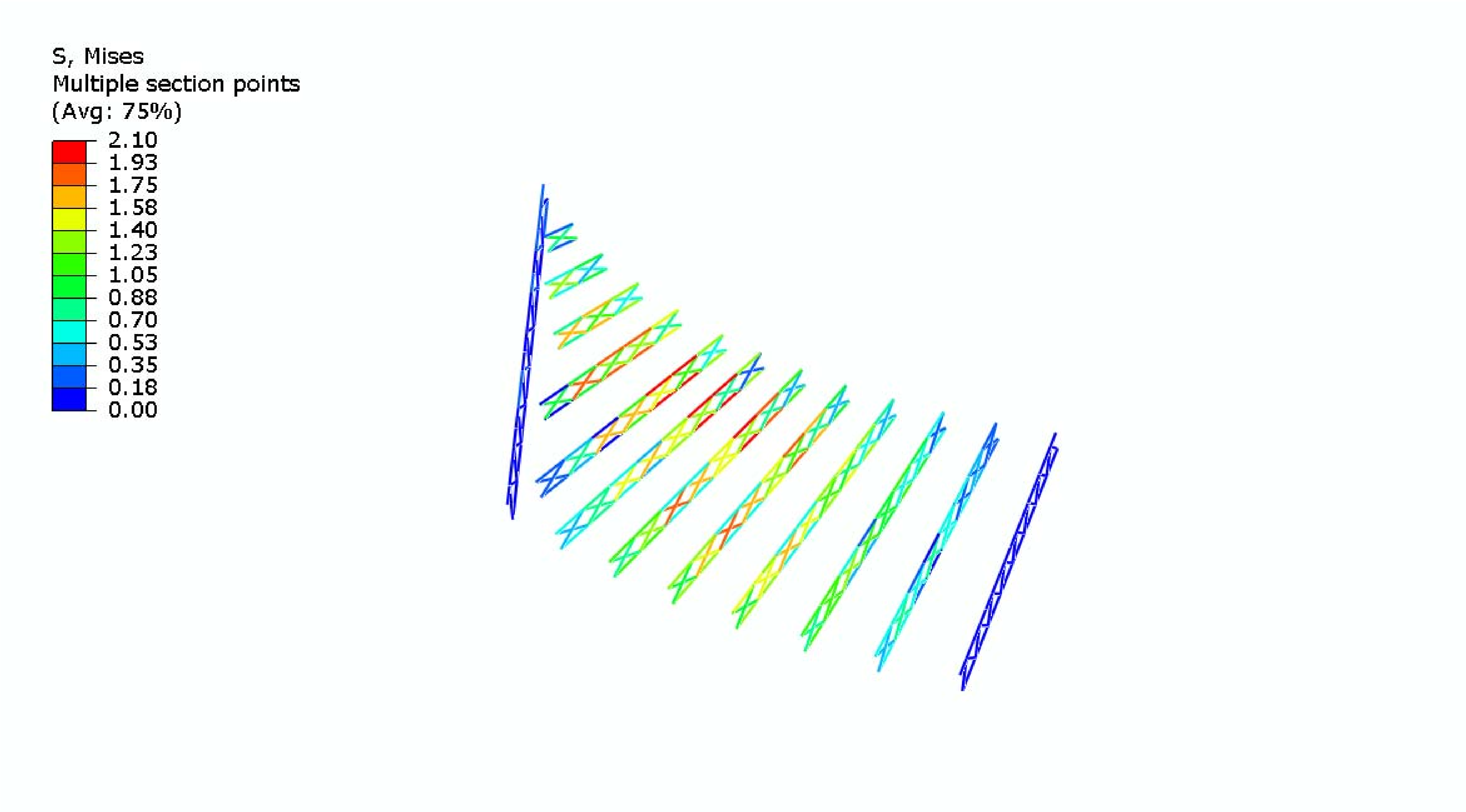


Figure N-4-24. Cross-frame stress contours under SDL, SDLF detailing

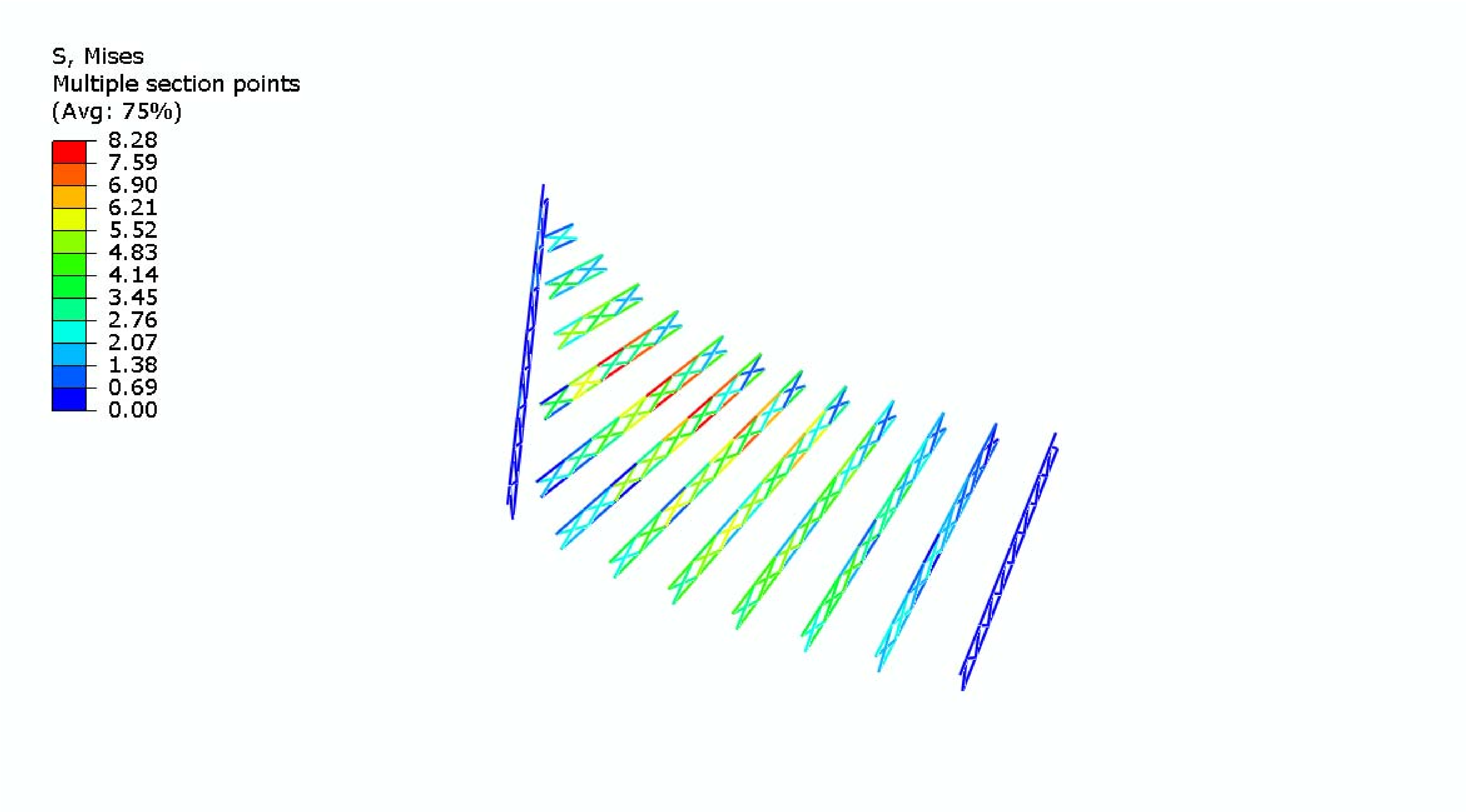


Figure N-4-25. Cross-frame stress contours under TDL, SDLF detailing

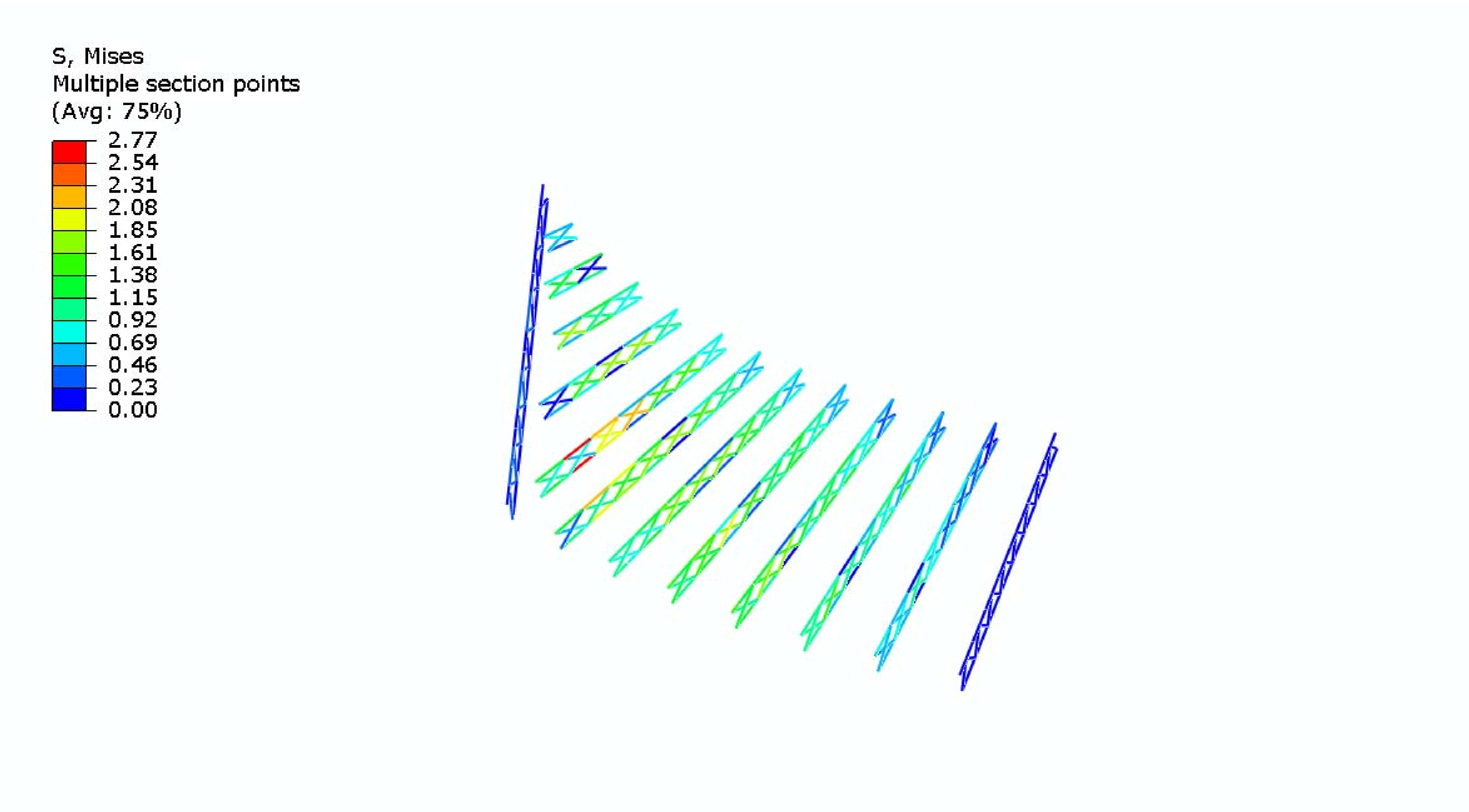


Figure N-4-26. **Cross-frame stress contours under SDL, TDLF detailing**

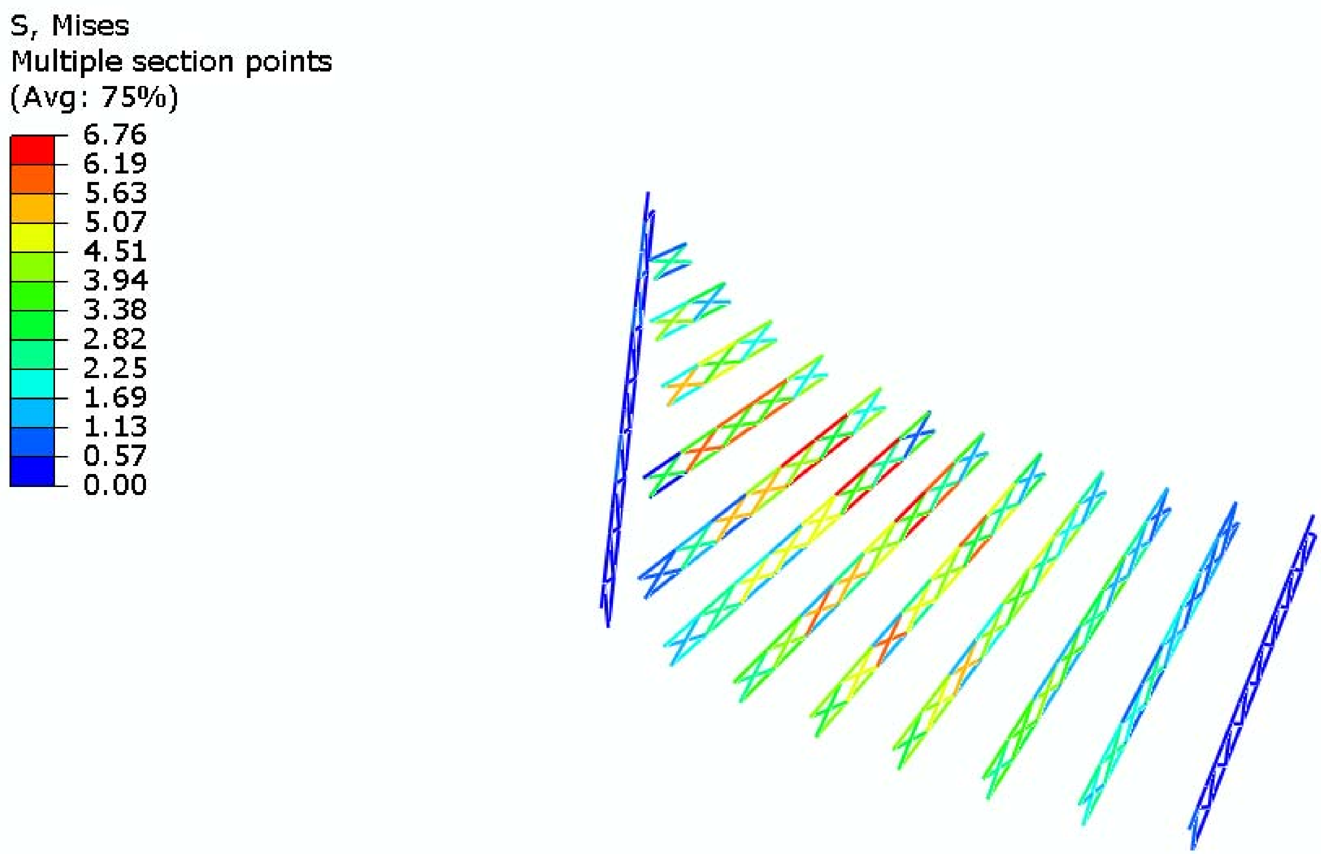


Figure N-4-27. **Cross-frame stress contours under TDL, TDLF detailing**

Table N-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.7	0.5	0.5	0.6	0.6	1.2	2.2	0.8
	SDLF	0.6	0.8	1.1	1.2	0.8	1.4	2.0	0.8
	TDLF	2.3	2.1	2.5	2.3	2.1	1.8	1.7	0.9
2	NLF	8.1	7.6	8.0	10.9	17.0	14.9	11.1	8.0
	SDLF	4.2	2.6	7.0	7.7	15.2	14.5	11.3	7.5
	TDLF	4.3	8.1	5.9	1.3	11.9	14.5	11.8	6.4
3	NLF	7.1	5.9	13.3	12.5	13.5	9.1	10.6	6.0
	SDLF	7.4	7.1	12.5	13.7	14.9	10.6	9.7	4.6
	TDLF	8.8	9.7	11.3	17.2	18.7	14.1	7.9	1.7
4	NLF	8.3	13.3	16.0	13.6	12.2	12.0	9.4	4.6
	SDLF	8.4	11.5	15.1	13.5	12.7	12.3	10.9	5.2
	TDLF	9.4	8.6	14.2	14.2	14.9	12.9	14.5	6.4
5	NLF	7.8	13.8	15.7	14.5	12.4	10.1	7.8	5.3
	SDLF	8.4	13.5	15.6	14.1	12.6	11.0	9.1	6.4
	TDLF	10.4	13.2	16.1	14.5	13.8	13.2	12.1	8.6
6	NLF	6.5	12.2	14.6	14.1	11.7	10.2	6.1	4.0
	SDLF	7.2	12.7	14.4	13.6	11.3	10.8	7.0	5.1
	TDLF	9.4	14.1	14.5	13.6	11.6	12.9	9.1	7.5
7	NLF	4.4	9.4	11.8	12.6	10.3	9.7	6.7	2.1
	SDLF	4.3	10.2	11.0	12.1	9.9	9.5	7.3	2.9
	TDLF	4.8	12.2	9.2	11.8	10.0	9.9	8.7	4.6
8	NLF	1.3	6.2	3.5	9.5	8.1	8.1	6.4	3.1
	SDLF	1.1	6.5	5.3	9.4	7.7	7.6	6.6	3.5
	TDLF	0.9	7.1	9.2	9.4	7.5	7.2	7.6	4.7
9	NLF	NA	1.0	0.9	6.7	5.3	4.8	5.8	3.2
	SDLF	NA	0.9	0.7	6.3	4.6	4.8	5.9	3.5
	TDLF	NA	0.7	0.5	5.7	3.7	5.7	6.5	4.4
10	NLF	NA	NA	NA	0.8	0.7	3.0	5.2	3.3
	SDLF	NA	NA	NA	0.6	0.6	2.6	4.8	3.4
	TDLF	NA	NA	NA	0.4	0.4	2.5	4.5	3.7

Table N-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	NA	NA	NA	NA	NA	0.6	3.2	3.1
	SDLF	NA	NA	NA	NA	NA	0.6	3.0	2.8
	TDLF	NA	NA	NA	NA	NA	0.5	2.8	2.3
12	NLF	NA	NA	NA	NA	NA	NA	0.9	2.2
	SDLF	NA	NA	NA	NA	NA	NA	0.7	1.9
	TDLF	NA	NA	NA	NA	NA	NA	0.4	1.5
13	NLF	NA	NA	NA	NA	NA	NA	NA	0.9
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.7
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.4

Table N-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	1.8	0.9	1.4	1.4	0.5	3.2	6.3	2.4
	SDLF	1.0	0.5	2.0	1.9	0.8	3.3	6.1	2.4
	TDLF	0.6	1.7	2.9	2.9	1.7	3.4	5.5	2.5
2	NLF	25.4	23.3	26.9	36.0	54.4	46.5	34.0	23.0
	SDLF	21.4	18.4	25.9	32.6	52.4	46.0	34.1	22.4
	TDLF	13.7	7.9	23.8	25.6	48.6	45.5	34.6	21.4
3	NLF	22.3	19.2	42.5	39.9	41.4	26.2	32.1	17.7
	SDLF	22.5	20.3	41.9	40.9	42.7	27.5	31.2	16.3
	TDLF	23.1	22.8	40.5	43.5	46.2	30.8	29.4	13.4
4	NLF	26.0	41.3	50.8	42.1	36.8	36.1	28.1	13.3
	SDLF	25.8	39.4	49.8	41.9	37.3	36.2	29.5	13.9
	TDLF	26.2	36.2	48.3	42.4	38.9	36.6	32.8	15.1
5	NLF	24.6	43.3	50.0	44.6	37.4	30.1	22.8	15.7
	SDLF	24.9	42.8	49.7	44.2	37.5	30.9	24.2	16.7
	TDLF	26.1	42.3	49.6	44.0	38.1	32.9	27.2	18.9
6	NLF	20.8	38.5	46.9	43.6	35.2	30.1	17.4	11.4
	SDLF	21.2	38.8	46.5	43.0	34.7	30.7	18.5	12.5
	TDLF	22.7	39.7	45.9	42.2	34.2	32.4	20.5	14.9
7	NLF	14.9	29.9	38.4	39.3	31.1	28.3	19.4	5.5
	SDLF	14.6	30.5	37.5	38.6	30.6	28.1	20.0	6.3
	TDLF	14.6	32.1	35.2	37.5	30.0	28.0	21.4	8.1
8	NLF	4.4	20.3	12.1	29.6	24.5	23.3	18.4	8.5
	SDLF	4.3	20.4	13.7	29.5	24.1	22.6	18.6	9.0
	TDLF	3.9	20.8	17.3	29.2	23.5	22.0	19.5	10.2
9	NLF	NA	3.1	2.6	21.2	16.2	13.0	16.8	9.1
	SDLF	NA	2.9	2.4	20.6	15.5	13.0	16.8	9.4
	TDLF	NA	2.6	2.0	19.8	14.2	13.5	17.4	10.3
10	NLF	NA	NA	NA	2.2	2.0	8.1	15.1	9.5
	SDLF	NA	NA	NA	1.9	1.9	7.7	14.7	9.6
	TDLF	NA	NA	NA	1.8	1.6	7.3	14.2	9.9

Table N-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	NA	NA	NA	NA	NA	1.9	9.5	9.1
	SDLF	NA	NA	NA	NA	NA	2.2	9.1	8.8
	TDLF	NA	NA	NA	NA	NA	1.6	9.0	8.3
12	NLF	NA	NA	NA	NA	NA	NA	2.1	6.0
	SDLF	NA	NA	NA	NA	NA	NA	1.8	5.8
	TDLF	NA	NA	NA	NA	NA	NA	1.6	5.4
13	NLF	NA	NA	NA	NA	NA	NA	NA	1.9
	SDLF	NA	NA	NA	NA	NA	NA	NA	1.7
	TDLF	NA	NA	NA	NA	NA	NA	NA	1.4

Table N-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.5	0.6	0.8	1.1	0.1	0.7	0.3	3.2
	SDLF	0.6	0.6	0.9	1.0	0.2	0.4	0.2	2.8
	TDLF	0.6	0.5	1.1	0.8	0.4	0.4	0.0	2.0
2	NLF	2.5	1.2	4.8	2.4	15.4	6.4	4.0	2.4
	SDLF	5.2	2.6	4.1	0.0	8.5	6.1	5.2	2.7
	TDLF	10.7	10.8	23.1	5.5	6.9	5.0	7.5	3.3
3	NLF	10.1	1.9	0.2	9.8	17.1	23.9	15.4	8.3
	SDLF	9.3	6.9	5.1	1.1	10.3	16.3	13.6	8.8
	TDLF	7.7	17.3	15.4	17.2	3.9	0.3	10.0	9.7
4	NLF	12.3	9.4	2.5	9.4	17.6	23.8	21.1	13.1
	SDLF	11.8	9.7	4.9	3.4	11.7	17.8	16.0	11.4
	TDLF	10.7	10.6	10.2	9.4	0.7	5.3	5.2	8.0
5	NLF	12.6	12.1	5.5	8.5	16.2	22.7	22.3	14.6
	SDLF	11.9	11.5	5.2	5.0	12.4	17.8	17.3	12.1
	TDLF	10.6	10.6	5.3	2.6	3.8	7.3	6.6	6.9
6	NLF	10.5	13.2	7.3	5.5	13.1	20.6	20.9	14.2
	SDLF	9.8	11.5	5.1	5.2	12.0	17.1	17.2	11.7
	TDLF	8.3	8.3	1.5	3.7	8.5	9.2	9.1	6.3
7	NLF	5.9	11.5	6.9	3.0	9.9	17.5	18.7	12.7
	SDLF	5.9	9.3	4.5	4.5	10.6	15.7	16.1	10.8
	TDLF	5.7	5.1	0.4	6.3	10.3	10.8	9.8	6.5
8	NLF	0.3	5.3	4.5	1.2	6.8	13.6	16.0	11.6
	SDLF	0.3	5.1	2.6	3.0	8.2	13.3	14.1	10.1
	TDLF	0.3	4.9	0.6	5.1	9.3	11.0	9.1	6.5
9	NLF	NA	0.1	0.1	1.9	2.7	9.2	12.1	10.0
	SDLF	NA	0.1	0.0	1.1	4.7	10.0	11.2	8.8
	TDLF	NA	0.1	0.0	6.5	7.8	10.5	8.2	5.8
10	NLF	NA	NA	NA	0.0	0.0	4.6	7.4	7.8
	SDLF	NA	NA	NA	0.0	0.1	5.6	7.7	7.0
	TDLF	NA	NA	NA	0.2	0.2	6.9	7.9	5.1

Table N-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	NA	NA	NA	NA	NA	0.1	3.6	5.2
	SDLF	NA	NA	NA	NA	NA	0.1	4.0	5.1
	TDLF	NA	NA	NA	NA	NA	0.2	4.6	4.5
12	NLF	NA	NA	NA	NA	NA	NA	0.0	2.8
	SDLF	NA	NA	NA	NA	NA	NA	0.1	2.7
	TDLF	NA	NA	NA	NA	NA	NA	0.1	2.7
13	NLF	NA	NA	NA	NA	NA	NA	NA	0.2
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.2
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.1

Table N-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.8	1.2	3.3	2.6	1.2	3.2	2.0	6.5
	SDLF	3.0	1.2	3.3	2.5	1.3	2.8	1.9	6.3
	TDLF	3.0	1.5	3.2	2.8	1.1	1.6	1.4	5.7
2	NLF	9.1	4.4	16.8	9.5	52.4	20.7	12.7	6.4
	SDLF	11.8	0.4	7.7	7.1	45.6	20.4	14.0	6.8
	TDLF	17.9	8.6	12.1	1.1	29.6	19.0	16.1	7.2
3	NLF	32.7	6.8	0.2	33.3	55.8	76.6	47.4	24.6
	SDLF	31.8	11.7	4.4	24.8	49.2	69.1	45.8	25.1
	TDLF	29.8	22.0	14.3	6.2	35.1	52.5	42.1	26.1
4	NLF	38.4	28.8	5.2	32.3	57.8	75.6	65.1	38.9
	SDLF	37.9	29.0	7.4	26.5	52.1	69.8	60.1	37.4
	TDLF	36.9	29.7	12.6	13.9	39.8	57.3	49.3	33.9
5	NLF	39.4	36.2	13.5	30.4	53.9	72.2	69.2	43.5
	SDLF	38.7	35.5	13.1	27.1	50.2	67.4	64.3	41.1
	TDLF	37.3	34.6	13.2	19.6	41.8	57.1	53.6	35.8
6	NLF	33.2	39.6	18.8	22.1	45.3	66.2	65.0	42.4
	SDLF	32.5	37.9	16.6	21.9	44.3	62.8	61.4	40.0
	TDLF	31.0	34.7	13.0	20.4	40.8	55.0	53.4	34.6
7	NLF	19.7	34.5	18.1	14.7	35.6	57.0	58.5	38.2
	SDLF	19.7	32.4	15.6	16.3	36.3	55.2	55.9	36.3
	TDLF	19.5	28.1	11.5	18.1	36.0	50.3	49.7	32.1
8	NLF	1.9	16.0	11.9	8.9	25.7	44.8	50.0	34.8
	SDLF	1.8	15.8	10.0	10.6	27.0	44.5	48.1	33.3
	TDLF	1.9	15.6	6.8	12.7	28.1	42.2	43.1	29.7
9	NLF	NA	0.7	0.6	3.0	11.1	30.6	37.8	29.8
	SDLF	NA	0.7	0.6	0.0	13.1	31.4	36.8	28.6
	TDLF	NA	0.7	0.4	5.4	16.2	31.8	33.8	25.6
10	NLF	NA	NA	NA	0.5	0.4	15.4	22.5	22.9
	SDLF	NA	NA	NA	0.5	0.4	16.4	22.9	22.1
	TDLF	NA	NA	NA	0.2	0.0	17.6	22.9	20.1

Table N-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	NA	NA	NA	NA	NA	0.1	10.8	14.8
	SDLF	NA	NA	NA	NA	NA	0.0	11.2	14.6
	TDLF	NA	NA	NA	NA	NA	0.1	11.7	14.0
12	NLF	NA	NA	NA	NA	NA	NA	0.2	7.1
	SDLF	NA	NA	NA	NA	NA	NA	0.0	7.1
	TDLF	NA	NA	NA	NA	NA	NA	0.0	7.0
13	NLF	NA	NA	NA	NA	NA	NA	NA	0.0
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.1

Table N-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	1.2	0.5	1.3	1.0	0.6	1.8	2.1	2.8
	SDLF	1.1	0.9	1.7	1.6	0.7	1.5	1.9	2.3
	TDLF	2.1	2.2	2.7	2.6	1.7	1.8	1.3	1.3
2	NLF	2.0	1.4	4.9	2.5	15.5	6.8	4.1	2.5
	SDLF	5.2	2.8	4.3	0.2	8.4	6.0	5.2	2.9
	TDLF	11.6	11.2	23.6	5.8	6.9	4.7	7.8	4.0
3	NLF	9.7	1.3	0.4	10.2	17.8	24.0	15.7	8.4
	SDLF	9.5	6.9	5.2	0.9	10.3	16.2	13.7	8.9
	TDLF	9.2	18.3	16.7	18.3	4.9	0.5	10.1	10.2
4	NLF	11.7	9.2	2.1	10.2	18.2	24.3	21.2	13.3
	SDLF	11.9	9.9	4.9	3.4	11.7	17.9	15.8	11.6
	TDLF	12.3	11.5	11.1	10.6	1.9	4.9	4.9	8.4
5	NLF	12.1	11.7	5.1	9.0	16.7	23.1	22.6	14.7
	SDLF	12.1	11.6	5.2	5.0	12.3	17.8	17.4	12.2
	TDLF	12.0	11.7	6.4	3.7	2.6	6.5	6.4	7.1
6	NLF	10.1	13.0	7.1	6.0	13.6	20.9	21.1	14.3
	SDLF	10.0	11.7	5.2	5.2	12.0	17.1	17.2	11.8
	TDLF	9.6	9.3	2.4	2.7	7.5	8.5	8.8	6.4
7	NLF	5.5	11.3	6.8	3.3	10.2	17.7	18.8	12.8
	SDLF	5.9	9.5	4.6	4.5	10.6	15.7	16.0	10.9
	TDLF	6.6	6.0	1.2	5.5	9.6	10.2	9.5	6.5
8	NLF	1.1	5.1	4.4	1.4	7.0	13.9	16.0	11.7
	SDLF	1.0	5.2	2.7	2.9	8.1	13.3	14.0	10.1
	TDLF	0.9	5.4	0.3	4.4	8.6	10.7	8.9	6.5
9	NLF	NA	0.7	0.5	1.9	2.7	9.2	12.2	10.1
	SDLF	NA	0.7	0.5	1.1	4.7	9.9	11.2	8.8
	TDLF	NA	0.6	0.5	6.3	7.8	10.0	8.0	5.8
10	NLF	NA	NA	NA	0.4	0.4	4.6	7.4	7.9
	SDLF	NA	NA	NA	0.4	0.3	5.6	7.6	7.1
	TDLF	NA	NA	NA	0.4	0.4	6.9	7.5	5.2

Table N-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	NA	NA	NA	NA	NA	0.3	3.6	5.2
	SDLF	NA	NA	NA	NA	NA	0.3	4.0	5.0
	TDLF	NA	NA	NA	NA	NA	0.4	4.5	4.5
12	NLF	NA	NA	NA	NA	NA	NA	0.5	2.8
	SDLF	NA	NA	NA	NA	NA	NA	0.4	2.8
	TDLF	NA	NA	NA	NA	NA	NA	0.3	2.7
13	NLF	NA	NA	NA	NA	NA	NA	NA	0.6
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.5
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.3

Table N-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	4.5	1.7	4.2	3.9	1.0	5.8	6.9	7.9
	SDLF	3.8	1.6	4.5	4.3	1.3	5.2	6.5	7.4
	TDLF	3.5	2.6	5.3	5.1	2.1	4.4	6.0	6.4
2	NLF	8.3	3.5	15.4	8.6	51.1	20.7	12.1	6.3
	SDLF	11.6	0.6	6.2	5.9	43.9	19.8	13.1	6.5
	TDLF	18.1	9.0	12.8	0.4	28.8	18.5	15.8	7.6
3	NLF	31.0	5.0	3.0	33.5	57.6	76.2	47.7	24.4
	SDLF	30.9	10.7	2.9	24.2	50.1	68.4	45.7	24.9
	TDLF	30.6	22.2	14.6	5.3	35.0	52.1	42.2	26.3
4	NLF	37.0	27.8	3.7	34.9	59.8	77.0	64.8	39.1
	SDLF	37.2	28.7	6.7	27.9	53.1	70.5	59.4	37.5
	TDLF	37.5	30.4	13.0	13.8	39.4	57.6	48.7	34.3
5	NLF	38.3	35.1	12.3	32.3	55.7	73.7	69.8	43.4
	SDLF	38.3	35.1	12.5	28.1	51.3	68.3	64.6	40.9
	TDLF	38.2	35.2	13.6	19.3	41.5	57.0	53.7	36.0
6	NLF	32.3	39.2	18.2	23.4	46.5	67.4	65.7	42.8
	SDLF	32.2	37.9	16.4	22.6	44.9	63.5	61.8	40.3
	TDLF	31.7	35.4	13.5	20.1	40.4	54.8	53.4	34.9
7	NLF	18.8	34.2	17.8	15.5	36.4	57.6	58.9	38.6
	SDLF	19.2	32.4	15.7	16.7	36.7	55.6	56.1	36.6
	TDLF	19.9	28.9	12.2	17.7	35.8	50.1	49.5	32.2
8	NLF	4.5	15.6	11.8	9.1	25.8	45.5	50.1	35.1
	SDLF	4.5	15.6	10.1	10.6	26.9	44.9	48.1	33.5
	TDLF	4.4	15.8	7.0	12.2	27.5	42.3	42.9	29.8
9	NLF	NA	2.3	1.6	3.2	10.8	30.4	37.9	29.9
	SDLF	NA	2.3	1.7	0.3	12.8	31.1	36.9	28.7
	TDLF	NA	2.3	1.7	5.1	16.0	31.2	33.7	25.7
10	NLF	NA	NA	NA	1.2	1.2	15.2	22.2	22.9
	SDLF	NA	NA	NA	1.2	1.1	16.2	22.5	22.2
	TDLF	NA	NA	NA	1.2	1.0	17.5	22.4	20.2

Table N-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	NA	NA	NA	NA	NA	1.2	10.6	14.6
	SDLF	NA	NA	NA	NA	NA	1.5	11.0	14.5
	TDLF	NA	NA	NA	NA	NA	1.0	11.4	13.9
12	NLF	NA	NA	NA	NA	NA	NA	1.2	7.0
	SDLF	NA	NA	NA	NA	NA	NA	1.0	7.0
	TDLF	NA	NA	NA	NA	NA	NA	1.1	6.9
13	NLF	NA	NA	NA	NA	NA	NA	NA	1.1
	SDLF	NA	NA	NA	NA	NA	NA	NA	1.0
	TDLF	NA	NA	NA	NA	NA	NA	NA	1.0

Table N-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.20	-0.28	-0.27	-0.35	-0.34	-0.38	-0.44	-0.49
	SDLF	-0.22	-0.32	-0.32	-0.41	-0.41	-0.45	-0.54	-0.62
	TDLF	-0.27	-0.40	-0.43	-0.56	-0.55	-0.61	-0.74	-0.90
3	NLF	-0.12	-0.20	-0.21	-0.27	-0.25	-0.30	-0.36	-0.42
	SDLF	-0.13	-0.24	-0.26	-0.33	-0.30	-0.34	-0.41	-0.50
	TDLF	-0.16	-0.31	-0.37	-0.45	-0.40	-0.43	-0.52	-0.67
4	NLF	-0.05	-0.14	-0.15	-0.21	-0.18	-0.21	-0.26	-0.33
	SDLF	-0.06	-0.17	-0.20	-0.26	-0.22	-0.24	-0.28	-0.36
	TDLF	-0.07	-0.25	-0.31	-0.37	-0.30	-0.28	-0.31	-0.41
5	NLF	0.00	-0.08	-0.09	-0.15	-0.12	-0.15	-0.17	-0.23
	SDLF	0.00	-0.11	-0.14	-0.19	-0.15	-0.16	-0.16	-0.22
	TDLF	0.00	-0.17	-0.23	-0.29	-0.21	-0.18	-0.14	-0.20
6	NLF	0.02	-0.03	-0.05	-0.09	-0.07	-0.09	-0.11	-0.14
	SDLF	0.03	-0.05	-0.08	-0.13	-0.10	-0.10	-0.09	-0.10
	TDLF	0.03	-0.10	-0.17	-0.22	-0.14	-0.10	-0.04	-0.02
7	NLF	0.02	0.00	-0.02	-0.05	-0.04	-0.05	-0.06	-0.08
	SDLF	0.03	-0.01	-0.04	-0.08	-0.06	-0.05	-0.03	-0.03
	TDLF	0.03	-0.05	-0.10	-0.16	-0.09	-0.04	0.03	0.08
8	NLF	0.00	0.01	0.01	-0.02	-0.01	-0.02	-0.02	-0.03
	SDLF	0.00	0.00	-0.01	-0.04	-0.03	-0.01	0.01	0.02
	TDLF	0.00	-0.02	-0.04	-0.10	-0.05	0.00	0.08	0.14
9	NLF	NA	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	SDLF	NA	0.00	0.00	-0.02	-0.01	0.01	0.03	0.06
	TDLF	NA	0.00	0.00	-0.05	-0.02	0.02	0.09	0.17
10	NLF	NA	NA	NA	0.00	0.00	0.01	0.02	0.03
	SDLF	NA	NA	NA	0.00	0.00	0.01	0.03	0.07
	TDLF	NA	NA	NA	0.00	0.00	0.02	0.08	0.16

Table N-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	NA	NA	NA	NA	NA	0.00	0.01	0.03
	SDLF	NA	NA	NA	NA	NA	0.00	0.02	0.06
	TDLF	NA	NA	NA	NA	NA	0.00	0.05	0.13
12	NLF	NA	NA	NA	NA	NA	NA	0.00	0.02
	SDLF	NA	NA	NA	NA	NA	NA	0.00	0.04
	TDLF	NA	NA	NA	NA	NA	NA	0.00	0.07
13	NLF	NA	NA	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.00

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Table N-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.64	-0.87	-0.86	-1.08	-1.05	-1.17	-1.36	-1.52
	SDLF	-0.66	-0.91	-0.91	-1.14	-1.12	-1.25	-1.45	-1.65
	TDLF	-0.71	-0.99	-1.01	-1.29	-1.26	-1.40	-1.65	-1.92
3	NLF	-0.38	-0.65	-0.67	-0.83	-0.76	-0.91	-1.10	-1.31
	SDLF	-0.40	-0.68	-0.72	-0.89	-0.81	-0.96	-1.15	-1.39
	TDLF	-0.43	-0.75	-0.83	-1.01	-0.91	-1.04	-1.26	-1.55
4	NLF	-0.19	-0.45	-0.49	-0.64	-0.56	-0.65	-0.80	-1.01
	SDLF	-0.19	-0.48	-0.54	-0.70	-0.60	-0.67	-0.82	-1.04
	TDLF	-0.21	-0.56	-0.64	-0.80	-0.68	-0.71	-0.85	-1.10
5	NLF	-0.04	-0.27	-0.31	-0.46	-0.38	-0.45	-0.52	-0.70
	SDLF	-0.03	-0.29	-0.35	-0.51	-0.41	-0.46	-0.51	-0.69
	TDLF	-0.04	-0.36	-0.45	-0.60	-0.47	-0.48	-0.48	-0.67
6	NLF	0.04	-0.12	-0.17	-0.30	-0.23	-0.28	-0.33	-0.42
	SDLF	0.05	-0.14	-0.21	-0.34	-0.26	-0.28	-0.31	-0.38
	TDLF	0.05	-0.19	-0.29	-0.42	-0.30	-0.28	-0.25	-0.30
7	NLF	0.06	-0.02	-0.07	-0.17	-0.12	-0.14	-0.17	-0.23
	SDLF	0.06	-0.03	-0.10	-0.20	-0.14	-0.14	-0.14	-0.18
	TDLF	0.06	-0.07	-0.16	-0.27	-0.17	-0.13	-0.08	-0.08
8	NLF	0.00	0.02	0.01	-0.07	-0.04	-0.04	-0.05	-0.08
	SDLF	0.00	0.01	0.00	-0.10	-0.05	-0.04	-0.02	-0.03
	TDLF	0.00	-0.01	-0.03	-0.15	-0.08	-0.02	0.05	0.09
9	NLF	NA	0.00	0.00	-0.01	0.00	0.02	0.03	0.03
	SDLF	NA	0.00	0.00	-0.03	-0.01	0.02	0.05	0.08
	TDLF	NA	0.00	0.00	-0.06	-0.02	0.04	0.11	0.19
10	NLF	NA	NA	NA	0.00	0.00	0.03	0.06	0.09
	SDLF	NA	NA	NA	0.00	0.00	0.03	0.08	0.13
	TDLF	NA	NA	NA	0.00	0.00	0.04	0.12	0.22

Table N-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	NA	NA	NA	NA	NA	0.00	0.05	0.10
	SDLF	NA	NA	NA	NA	NA	0.00	0.06	0.13
	TDLF	NA	NA	NA	NA	NA	0.00	0.08	0.19
12	NLF	NA	NA	NA	NA	NA	NA	0.00	0.06
	SDLF	NA	NA	NA	NA	NA	NA	0.00	0.08
	TDLF	NA	NA	NA	NA	NA	NA	0.00	0.12
13	NLF	NA	NA	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.00

Table N-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.11	-0.16	-0.15	-0.19	-0.19	-0.21	-0.24	-0.27
	SDLF	-0.13	-0.18	-0.18	-0.23	-0.23	-0.25	-0.30	-0.35
	TDLF	-0.15	-0.22	-0.24	-0.31	-0.31	-0.34	-0.41	-0.50
3	NLF	-0.07	-0.11	-0.12	-0.15	-0.14	-0.17	-0.20	-0.24
	SDLF	-0.07	-0.13	-0.15	-0.18	-0.17	-0.19	-0.23	-0.28
	TDLF	-0.09	-0.18	-0.21	-0.25	-0.22	-0.24	-0.29	-0.37
4	NLF	-0.03	-0.08	-0.09	-0.12	-0.10	-0.12	-0.15	-0.18
	SDLF	-0.03	-0.10	-0.11	-0.14	-0.12	-0.13	-0.16	-0.20
	TDLF	-0.04	-0.14	-0.17	-0.20	-0.17	-0.16	-0.17	-0.23
5	NLF	0.00	-0.04	-0.05	-0.08	-0.07	-0.08	-0.10	-0.13
	SDLF	0.00	-0.06	-0.08	-0.11	-0.09	-0.09	-0.09	-0.12
	TDLF	0.00	-0.10	-0.13	-0.16	-0.12	-0.10	-0.08	-0.11
6	NLF	0.01	-0.02	-0.03	-0.05	-0.04	-0.05	-0.06	-0.08
	SDLF	0.01	-0.03	-0.05	-0.07	-0.06	-0.05	-0.05	-0.06
	TDLF	0.02	-0.06	-0.09	-0.12	-0.08	-0.05	-0.02	-0.01
7	NLF	0.01	0.00	-0.01	-0.03	-0.02	-0.03	-0.03	-0.04
	SDLF	0.01	-0.01	-0.02	-0.05	-0.03	-0.03	-0.02	-0.02
	TDLF	0.02	-0.03	-0.06	-0.09	-0.05	-0.02	0.02	0.04
8	NLF	0.00	0.01	0.00	-0.01	-0.01	-0.01	-0.01	-0.02
	SDLF	0.00	0.00	0.00	-0.03	-0.01	-0.01	0.01	0.01
	TDLF	0.00	-0.01	-0.02	-0.05	-0.03	0.00	0.04	0.08
9	NLF	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	NA	0.00	0.00	-0.01	-0.01	0.00	0.02	0.03
	TDLF	NA	0.00	0.00	-0.03	-0.01	0.01	0.05	0.09
10	NLF	NA	NA	NA	0.00	0.00	0.00	0.01	0.01
	SDLF	NA	NA	NA	0.00	0.00	0.01	0.02	0.04
	TDLF	NA	NA	NA	0.00	0.00	0.01	0.04	0.09

Table N-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	NA	NA	NA	NA	NA	0.00	0.01	0.02
	SDLF	NA	NA	NA	NA	NA	0.00	0.01	0.03
	TDLF	NA	NA	NA	NA	NA	0.00	0.03	0.07
12	NLF	NA	NA	NA	NA	NA	NA	0.00	0.01
	SDLF	NA	NA	NA	NA	NA	NA	0.00	0.02
	TDLF	NA	NA	NA	NA	NA	NA	0.00	0.04
13	NLF	NA	NA	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.00

Table N-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.36	-0.49	-0.48	-0.60	-0.58	-0.65	-0.76	-0.85
	SDLF	-0.37	-0.51	-0.51	-0.64	-0.62	-0.70	-0.81	-0.92
	TDLF	-0.40	-0.55	-0.57	-0.72	-0.70	-0.78	-0.92	-1.08
3	NLF	-0.21	-0.36	-0.38	-0.47	-0.43	-0.51	-0.61	-0.73
	SDLF	-0.22	-0.38	-0.40	-0.50	-0.45	-0.54	-0.64	-0.78
	TDLF	-0.24	-0.42	-0.46	-0.57	-0.51	-0.58	-0.70	-0.87
4	NLF	-0.10	-0.25	-0.27	-0.36	-0.32	-0.36	-0.45	-0.56
	SDLF	-0.11	-0.27	-0.30	-0.39	-0.34	-0.38	-0.46	-0.58
	TDLF	-0.11	-0.31	-0.36	-0.45	-0.38	-0.40	-0.48	-0.61
5	NLF	-0.02	-0.15	-0.17	-0.26	-0.21	-0.25	-0.29	-0.39
	SDLF	-0.02	-0.16	-0.20	-0.28	-0.23	-0.26	-0.29	-0.39
	TDLF	-0.02	-0.20	-0.25	-0.34	-0.26	-0.27	-0.27	-0.37
6	NLF	0.02	-0.06	-0.10	-0.17	-0.13	-0.16	-0.18	-0.23
	SDLF	0.03	-0.08	-0.12	-0.19	-0.14	-0.16	-0.17	-0.21
	TDLF	0.03	-0.10	-0.16	-0.24	-0.17	-0.16	-0.14	-0.17
7	NLF	0.03	-0.01	-0.04	-0.09	-0.06	-0.08	-0.09	-0.13
	SDLF	0.03	-0.02	-0.05	-0.11	-0.08	-0.08	-0.08	-0.10
	TDLF	0.04	-0.04	-0.09	-0.15	-0.09	-0.07	-0.04	-0.04
8	NLF	0.00	0.01	0.00	-0.04	-0.02	-0.02	-0.03	-0.04
	SDLF	0.00	0.01	0.00	-0.05	-0.03	-0.02	-0.01	-0.02
	TDLF	0.00	0.00	-0.02	-0.08	-0.04	-0.01	0.03	0.05
9	NLF	NA	0.00	0.00	-0.01	0.00	0.01	0.02	0.02
	SDLF	NA	0.00	0.00	-0.02	-0.01	0.01	0.03	0.04
	TDLF	NA	0.00	0.00	-0.03	-0.01	0.02	0.06	0.10
10	NLF	NA	NA	NA	0.00	0.00	0.01	0.03	0.05
	SDLF	NA	NA	NA	0.00	0.00	0.02	0.04	0.07
	TDLF	NA	NA	NA	0.00	0.00	0.02	0.07	0.12

Table N-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	NA	NA	NA	NA	NA	0.00	0.03	0.05
	SDLF	NA	NA	NA	NA	NA	0.00	0.03	0.07
	TDLF	NA	NA	NA	NA	NA	0.00	0.04	0.11
12	NLF	NA	NA	NA	NA	NA	NA	0.00	0.04
	SDLF	NA	NA	NA	NA	NA	NA	0.00	0.04
	TDLF	NA	NA	NA	NA	NA	NA	0.00	0.07
13	NLF	NA	NA	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.00

Table N-4-11. Individual support vertical reactions under SDL and TDL (kips).

		Load Type & Support Number			
Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	56	53	172	164
	SDLF	53	53	170	165
	TDLF	49	54	165	165
G2	NLF	53	49	165	153
	SDLF	51	49	163	152
	TDLF	46	49	158	152
G3	NLF	50	45	157	142
	SDLF	52	45	159	142
	TDLF	57	46	164	143
G4	NLF	51	40	162	125
	SDLF	51	39	162	124
	TDLF	50	37	161	123
G5	NLF	44	37	140	116
	SDLF	46	37	142	116
	TDLF	51	39	147	118
G6	NLF	46	35	144	109
	SDLF	48	36	146	111
	TDLF	52	38	151	113
G7	NLF	51	44	154	133
	SDLF	52	44	154	133
	TDLF	53	45	156	134
G8	NLF	45	40	134	120
	SDLF	44	39	132	120
	TDLF	40	38	128	119
G9	NLF	31	34	95	103
	SDLF	30	33	94	102
	TDLF	29	30	93	98

Table N-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.0	NA	0.1	NA
	SDLF	0.0	NA	0.1	NA
	TDLF	0.1	NA	0.1	NA
G2	NLF	0.0	NA	0.2	NA
	SDLF	0.0	NA	0.2	NA
	TDLF	0.1	NA	0.1	NA
G3	NLF	0.0	NA	0.0	NA
	SDLF	0.0	NA	0.0	NA
	TDLF	0.1	NA	0.0	NA
G4	NLF	0.0	NA	0.2	NA
	SDLF	0.0	NA	0.2	NA
	TDLF	0.0	NA	0.1	NA
G5	NLF	0.0	NA	0.0	NA
	SDLF	0.0	NA	0.0	NA
	TDLF	0.1	NA	0.0	NA
G6	NLF	0.0	NA	0.0	NA
	SDLF	0.0	NA	0.0	NA
	TDLF	0.0	NA	0.0	NA
G7	NLF	0.0	NA	-0.1	NA
	SDLF	-0.1	NA	-0.1	NA
	TDLF	-0.2	NA	-0.2	NA
G8	NLF	0.0	NA	-0.2	NA
	SDLF	-0.1	NA	-0.2	NA
	TDLF	-0.1	NA	-0.2	NA
G9	NLF	0.0	NA	-0.4	NA
	SDLF	0.0	NA	-0.3	NA
	TDLF	-0.1	NA	-0.2	NA

Table N-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	0.0	0.0	-0.3	0.1
	SDLF	0.0	0.0	-0.2	0.1
	TDLF	0.1	0.0	0.0	0.0
G2	NLF	0.0	0.0	-0.4	0.1
	SDLF	0.0	0.0	-0.3	0.1
	TDLF	0.1	0.0	0.1	0.0
G3	NLF	0.0	0.0	-0.2	0.1
	SDLF	0.0	0.0	-0.1	0.1
	TDLF	0.1	0.0	0.1	0.0
G4	NLF	0.0	0.0	-0.4	0.1
	SDLF	0.0	0.0	-0.3	0.1
	TDLF	0.1	0.0	0.0	0.0
G5	NLF	0.0	0.0	-0.1	0.1
	SDLF	0.0	0.0	0.0	0.1
	TDLF	0.0	0.0	0.0	0.0
G6	NLF	0.0	0.0	-0.2	0.0
	SDLF	0.0	0.0	-0.1	0.0
	TDLF	0.0	0.0	-0.1	0.0
G7	NLF	0.0	0.0	0.0	0.0
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.0	0.0	-0.1	0.0
G8	NLF	0.0	0.0	0.3	0.1
	SDLF	0.0	0.0	0.2	0.1
	TDLF	-0.1	0.0	-0.1	0.0
G9	NLF	0.0	0.0	0.7	0.1
	SDLF	0.0	0.0	0.5	0.1
	TDLF	-0.2	0.0	0.0	0.0

Table N-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.00	0.17	0.02	0.55
	SDLF	0.01	0.17	0.03	0.52
	TDLF	0.02	0.17	0.03	0.51
G2	NLF	0.00	0.18	0.04	0.57
	SDLF	0.01	0.16	0.04	0.53
	TDLF	0.01	0.15	0.02	0.50
G3	NLF	0.00	0.18	0.00	0.55
	SDLF	0.00	0.16	0.01	0.51
	TDLF	0.01	0.16	0.01	0.51
G4	NLF	0.00	0.18	0.04	0.57
	SDLF	0.01	0.16	0.03	0.52
	TDLF	0.01	0.16	0.02	0.51
G5	NLF	0.00	0.18	-0.01	0.55
	SDLF	0.00	0.16	-0.01	0.50
	TDLF	0.01	0.17	0.01	0.52
G6	NLF	0.00	0.19	0.00	0.60
	SDLF	0.00	0.17	0.00	0.53
	TDLF	0.00	0.17	0.01	0.55
G7	NLF	0.00	0.24	-0.01	0.73
	SDLF	-0.01	0.20	-0.02	0.65
	TDLF	-0.04	0.17	-0.04	0.64
G8	NLF	0.00	0.24	-0.04	0.72
	SDLF	-0.01	0.20	-0.04	0.64
	TDLF	-0.03	0.16	-0.03	0.64
G9	NLF	-0.01	0.24	-0.07	0.70
	SDLF	-0.01	0.20	-0.06	0.61
	TDLF	-0.01	0.15	-0.03	0.62

Table N-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.00	0.00	-0.05	0.02
	SDLF	0.00	0.00	-0.04	0.01
	TDLF	0.02	0.00	0.01	0.00
G2	NLF	0.00	0.00	-0.07	0.02
	SDLF	0.00	0.00	-0.06	0.01
	TDLF	0.03	0.00	0.01	0.00
G3	NLF	0.00	0.00	-0.03	0.02
	SDLF	0.00	0.00	-0.02	0.01
	TDLF	0.01	0.00	0.01	0.00
G4	NLF	-0.01	0.00	-0.07	0.02
	SDLF	0.00	0.00	-0.05	0.02
	TDLF	0.03	0.00	0.01	0.00
G5	NLF	0.00	0.00	-0.02	0.02
	SDLF	0.00	0.00	-0.01	0.02
	TDLF	0.01	0.00	0.01	0.00
G6	NLF	-0.01	0.00	-0.03	0.02
	SDLF	0.00	0.00	-0.02	0.02
	TDLF	0.00	0.00	-0.01	0.00
G7	NLF	0.00	0.00	-0.01	0.02
	SDLF	0.00	0.00	-0.01	0.02
	TDLF	-0.01	0.00	-0.02	0.00
G8	NLF	0.01	0.00	0.05	0.02
	SDLF	0.00	0.00	0.04	0.02
	TDLF	-0.02	0.00	-0.01	0.00
G9	NLF	0.01	0.00	0.13	0.02
	SDLF	0.00	0.00	0.10	0.02
	TDLF	-0.03	0.00	0.01	0.00

Appendix N-5. NISCS14 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISCS14 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table N-5-1. Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	0.1	0.5	0.5	0.0	-0.2	0.2
		SDLF	-0.7	1.2	1.4	0.0	-1.0	1.0
		TDLF	-2.4	2.7	3.6	0.0	-2.8	2.8
	2-3	NLF	0.9	1.5	1.7	1.0	-1.5	1.8
		SDLF	0.9	1.4	1.7	0.7	-1.5	1.7
		TDLF	1.0	1.3	1.6	0.2	-1.5	1.5
	2-4	NLF	1.2	4.3	4.4	1.2	-4.2	4.4
		SDLF	1.3	4.5	4.7	1.0	-4.5	4.6
		TDLF	1.6	5.1	5.3	0.5	-5.0	5.0
	2-5	NLF	0.7	4.3	4.4	0.7	-4.3	4.3
		SDLF	0.4	3.4	3.4	0.0	-3.4	3.4
		TDLF	0.3	3.5	3.5	-0.9	-3.5	3.6
	2-6	NLF	0.3	1.1	1.2	0.3	-1.2	1.3
		SDLF	-0.1	0.0	0.1	-0.4	-0.1	0.4
		TDLF	-0.2	0.3	0.3	-1.3	-0.4	1.3
	2-7	NLF	0.1	-1.8	1.8	0.1	1.7	1.7
		SDLF	-0.1	-2.2	2.2	-0.3	2.1	2.1
		TDLF	-0.1	-2.1	2.1	-1.0	2.0	2.3
	2-8	NLF	0.1	-1.0	1.0	0.1	1.0	1.0
		SDLF	0.1	-1.2	1.2	-0.1	1.2	1.2
		TDLF	0.3	-1.2	1.2	-0.5	1.2	1.3

Table N-5-1(Continued). Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
7	7-2	NLF	-0.9	3.6	3.7	0.0	-3.8	3.8
		SDLF	-1.7	4.5	4.8	0.0	-4.8	4.8
		TDLF	-3.2	6.4	7.1	0.0	-6.9	6.9
	7-3	NLF	-2.3	-2.0	3.0	-2.3	2.0	3.0
		SDLF	-2.7	-2.6	3.8	-2.8	2.5	3.8
		TDLF	-3.6	-4.0	5.4	-3.9	3.8	5.5
	7-4	NLF	-14.5	16.3	21.8	-14.7	-16.2	21.8
		SDLF	-15.8	15.9	22.4	-16.0	-15.7	22.4
		TDLF	-18.4	14.7	23.5	-18.6	-14.5	23.6
	7-5	NLF	-10.3	20.2	22.7	-10.3	-20.4	22.9
		SDLF	-12.6	19.2	23.0	-12.7	-19.4	23.2
		TDLF	-17.4	16.9	24.3	-17.7	-17.3	24.8
	7-6	NLF	-11.0	12.7	16.8	-10.9	-13.3	17.2
		SDLF	-13.6	10.3	17.1	-13.7	-10.8	17.4
		TDLF	-19.1	4.9	19.7	-19.4	-5.7	20.2
	7-7	NLF	-13.1	0.6	13.1	-13.0	-1.3	13.0
		SDLF	-16.4	-3.5	16.7	-16.4	3.0	16.7
		TDLF	-21.0	-10.1	23.3	-21.4	9.5	23.4
	7-8	NLF	-14.4	-12.3	18.9	-14.3	11.9	18.6
		SDLF	-16.7	-15.5	22.7	-16.8	15.2	22.6
		TDLF	-18.5	-18.3	26.0	-19.0	18.1	26.2
	7-9	NLF	-12.2	-14.7	19.1	-12.2	14.4	18.9
		SDLF	-13.2	-15.7	20.5	-13.3	15.5	20.4
		TDLF	-14.2	-17.1	22.2	-14.7	17.0	22.5
	7-10	NLF	-7.4	-7.8	10.7	-7.4	7.8	10.8
		SDLF	-7.8	-8.0	11.1	-7.9	8.0	11.3
		TDLF	-8.3	-8.4	11.8	-8.7	8.6	12.2
	7-11	NLF	-2.9	-1.4	3.2	-2.9	1.7	3.4
		SDLF	-3.2	-1.4	3.5	-3.4	1.8	3.8
		TDLF	-3.8	-1.4	4.1	-4.2	2.1	4.7

Table N-5-1(Continued). Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	NLF	-2.7	6.7	7.3	0.0	-7.5	7.5
		SDLF	-3.2	7.4	8.1	0.0	-8.3	8.3
		TDLF	-4.3	8.9	9.9	0.0	-10.1	10.1
	9-3	NLF	-5.3	0.3	5.4	-5.4	-0.3	5.4
		SDLF	-6.5	0.6	6.6	-6.5	-0.5	6.5
		TDLF	-9.0	1.1	9.0	-8.7	-0.9	8.7
	9-4	NLF	-8.9	14.5	17.0	-8.4	-14.3	16.6
		SDLF	-10.3	15.0	18.2	-9.6	-14.7	17.6
		TDLF	-12.8	14.9	19.6	-11.9	-14.6	18.9
	9-5	NLF	-6.9	29.8	30.6	-7.1	-29.3	30.1
		SDLF	-8.0	29.9	30.9	-8.1	-29.3	30.4
		TDLF	-10.5	29.5	31.3	-10.4	-29.1	30.9
	9-6	NLF	-10.6	34.0	35.6	-10.7	-33.6	35.3
		SDLF	-12.4	33.0	35.3	-12.4	-32.6	34.9
		TDLF	-15.9	30.6	34.5	-15.8	-30.7	34.8
	9-7	NLF	-17.3	25.7	31.0	-17.3	-25.7	31.0
		SDLF	-20.1	23.3	30.7	-20.1	-23.2	30.7
		TDLF	-25.6	17.7	31.1	-25.5	-18.0	31.2
	9-8	NLF	-21.9	8.2	23.4	-21.8	-8.5	23.4
		SDLF	-25.6	3.5	25.9	-25.6	-3.7	25.8
		TDLF	-30.7	-4.9	31.1	-30.6	4.5	30.9
	9-9	NLF	-24.5	-9.7	26.4	-24.3	9.2	26.0
		SDLF	-26.4	-13.7	29.7	-26.3	13.4	29.5
		TDLF	-28.6	-20.4	35.1	-28.2	20.0	34.4
	9-10	NLF	-20.9	-18.1	27.6	-20.8	17.7	27.3
		SDLF	-21.9	-20.9	30.3	-21.8	20.6	30.0
		TDLF	-22.6	-25.0	33.7	-22.5	24.9	33.5
	9-11	NLF	-15.2	-13.6	20.4	-14.3	13.2	19.4
		SDLF	-15.5	-14.7	21.4	-14.6	14.4	20.5
		TDLF	-16.0	-17.3	23.6	-15.2	17.2	22.9

Table N-5-1(Continued). Fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-12	NLF	-6.3	-3.7	7.3	-6.3	4.0	7.5
		SDLF	-6.6	-4.1	7.8	-6.7	4.5	8.0
		TDLF	-7.2	-5.1	8.9	-7.4	5.7	9.3
	9-13	NLF	-2.1	-0.7	2.2	-2.1	0.6	2.2
		SDLF	-2.2	-0.8	2.4	-2.2	0.8	2.4
		TDLF	-2.9	-1.0	3.0	-3.0	1.2	3.2

Table N-5-2: Erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
2	NLF	2-4
	SDLF	2-4
	TDLF	2-4
7	NLF	7-5
	SDLF	7-5
	TDLF	7-8
9	NLF	9-6
	SDLF	9-6
	TDLF	9-6

Table N-5-3. Erection critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	1.4	2.4	2.7	NA	NA	NA
		SDLF	1.2	2.5	2.8	NA	NA	NA
		TDLF	0.9	2.8	3.0	NA	NA	NA
	B	NLF	1.2	4.3	4.4	1.2	-4.2	4.4
		SDLF	1.3	4.5	4.7	1.0	-4.5	4.6
		TDLF	1.6	5.1	5.3	0.5	-5.0	5.0
7	A	NLF	-16.5	6.0	17.5	NA	NA	NA
		SDLF	-20.5	5.6	21.3	NA	NA	NA
		TDLF	-32.7	-11.2	34.6	NA	NA	NA
	B	NLF	-10.3	20.2	22.7	-10.3	-20.4	22.9
		SDLF	-12.6	19.2	23.0	-12.7	-19.4	23.2
		TDLF	-18.5	-18.3	26.0	-19.0	18.1	26.2
9	A	NLF	-15.5	12.4	19.9	NA	NA	NA
		SDLF	-18.6	12.1	22.1	NA	NA	NA
		TDLF	-24.7	11.0	27.0	NA	NA	NA
	B	NLF	-10.6	34.0	35.6	-10.7	-33.6	35.3
		SDLF	-12.4	33.0	35.3	-12.4	-32.6	34.9
		TDLF	-15.9	30.6	34.5	-15.8	-30.7	34.8

Table N-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	12.5	42.7	11.3		
			SDLF	12.1	43.0	11.0		
			TDLF	11.2	43.8	10.3		
		G2	NLF	0.7	33.1	66.4	33.3	0.0
			SDLF	0.8	33.3	66.8	33.5	0.0
			TDLF	0.8	33.7	67.6	33.9	0.0
	B	G1	NLF	12.4	43.2	11.3		
			SDLF	12.0	43.6	11.0		
			TDLF	11.1	44.4	10.2		
		G2	NLF	1.0	33.1	66.3	33.3	0.0
			SDLF	1.1	33.3	66.7	33.4	0.0
			TDLF	1.1	33.7	67.5	33.8	0.0

Table N-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
7	A	G1	NLF	66.0	52.4			
			SDLF	65.9	53.5			
			TDLF	74.1	58.9			
		G2	NLF	54.0	45.8			
			SDLF	53.3	45.7			
			TDLF	54.2	46.2			
		G3	NLF	34.5	39.2			
			SDLF	36.0	38.9			
			TDLF	34.1	37.0			
		G4	NLF	44.0	32.0			
			SDLF	44.1	30.4			
			TDLF	35.6	25.3			
		G5	NLF	15.1	28.3			
			SDLF	13.4	28.2			
			TDLF	0.0	12.2			
		G6	NLF	10.2	11.4			
			SDLF	8.8	10.0			
			TDLF	0.0	0.0			
		G7	NLF	7.7	63.9	127.6	63.8	0.0
			SDLF	7.0	66.6	133.1	66.5	0.0
			TDLF	0.0	97.0	193.8	96.9	0.0

Table N-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
7	B	G1	NLF	67.3	52.6			
			SDLF	67.2	53.7			
			TDLF	73.9	58.6			
		G2	NLF	55.0	45.6			
			SDLF	54.3	45.5			
			TDLF	54.8	46.2			
		G3	NLF	34.0	38.8			
			SDLF	35.5	38.4			
			TDLF	36.2	37.5			
		G4	NLF	44.1	31.3			
			SDLF	44.1	29.7			
			TDLF	32.1	26.9			
		G5	NLF	10.9	27.2			
			SDLF	9.2	27.2			
			TDLF	0.0	9.6			
		G6	NLF	9.6	12.4			
			SDLF	8.4	10.7			
			TDLF	0.0	0.0			
		G7	NLF	9.6	65.1	130.1	65.0	0.0
			SDLF	8.7	68.0	135.8	67.9	0.0
			TDLF	0.0	98.1	196.3	98.1	0.0

Table N-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	A	G1	NLF	60.5	53.2			
			SDLF	59.2	54.1			
			TDLF	56.2	55.7			
		G2	NLF	54.5	48.1			
			SDLF	53.0	48.2			
			TDLF	49.7	47.9			
		G3	NLF	45.3	43.1			
			SDLF	47.4	43.1			
			TDLF	51.9	43.3			
		G4	NLF	51.6	36.5			
			SDLF	51.7	35.3			
			TDLF	51.9	33.4			
		G5	NLF	36.7	32.8			
			SDLF	38.0	32.9			
			TDLF	40.8	33.3			
		G6	NLF	45.2	31.0			
			SDLF	46.7	31.3			
			TDLF	49.9	33.2			
		G7	NLF	35.5	38.2			
			SDLF	33.4	38.3			
			TDLF	28.5	37.8			
		G8	NLF	6.7	25.1			
			SDLF	4.3	22.7			
			TDLF	0.0	17.4			
		G9	NLF	11.1	69.3	138.6	69.3	0.0
			SDLF	10.8	71.7	143.3	71.7	0.0
			TDLF	10.1	76.5	152.9	76.4	0.0

Table N-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	B	G1	NLF	61.6	53.5			
			SDLF	60.3	54.5			
			TDLF	57.2	56.0			
		G2	NLF	55.2	48.1			
			SDLF	53.6	48.2			
			TDLF	50.3	47.9			
		G3	NLF	45.0	42.7			
			SDLF	47.1	42.7			
			TDLF	51.7	43.0			
		G4	NLF	53.0	35.9			
			SDLF	53.0	34.8			
			TDLF	53.2	32.8			
		G5	NLF	36.2	32.2			
			SDLF	37.5	32.2			
			TDLF	40.3	32.7			
		G6	NLF	45.5	30.1			
			SDLF	46.9	30.6			
			TDLF	50.1	32.4			
		G7	NLF	28.5	37.5			
			SDLF	26.5	37.5			
			TDLF	21.7	37.2			
		G8	NLF	6.3	24.7			
			SDLF	4.0	22.3			
			TDLF	0.0	16.8			
		G9	NLF	12.3	72.9	145.9	73.0	0.0
			SDLF	11.9	75.3	150.7	75.3	0.0
			TDLF	10.9	80.2	160.3	80.1	0.0

Appendix O1-1. NISCS15 Bridge Description

The key characteristics of NISCS15 are as follows:

- Span length along the centerline of the bridge, L_s = 150 ft.
- Width between the fascia girders, w_g = 74 ft.
- Radius of curvature to the centerline of the bridge, R =280 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 2.0
- Subtended angle between the supports, L_s/R = 0.54
- Number of girders in the completed bridge cross-section, n_g =9.
- Skew angle, θ = -35,0^o

This appendix presents the bridge description of the bridge NISCS15 in its final condition as well as during erection. The following figures and tables are provided:

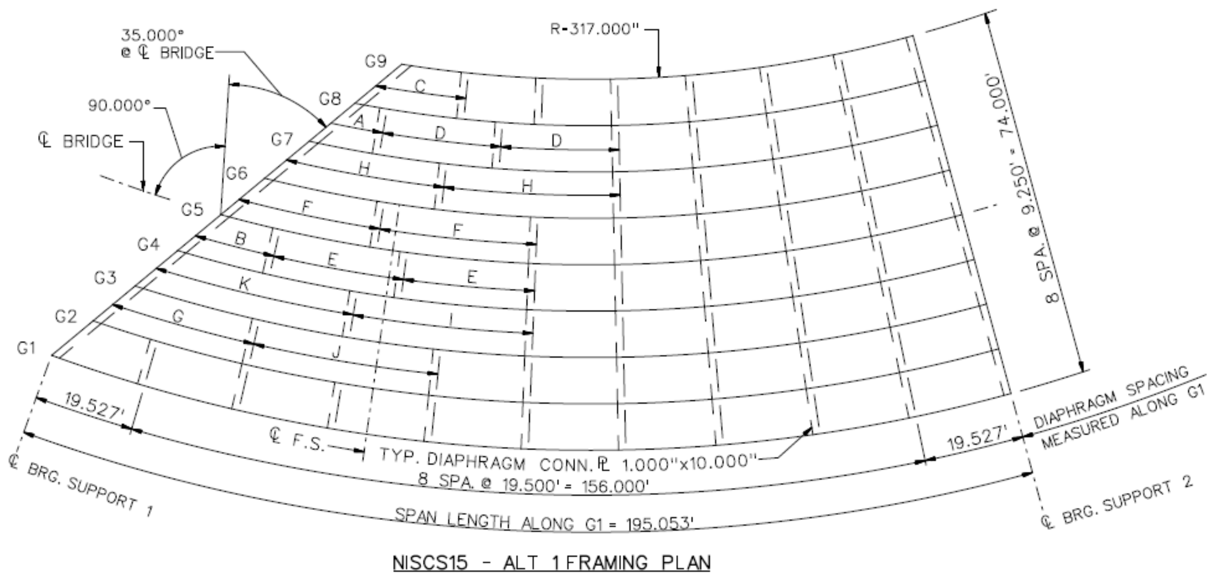


Figure O1-1-1. Framing plan.

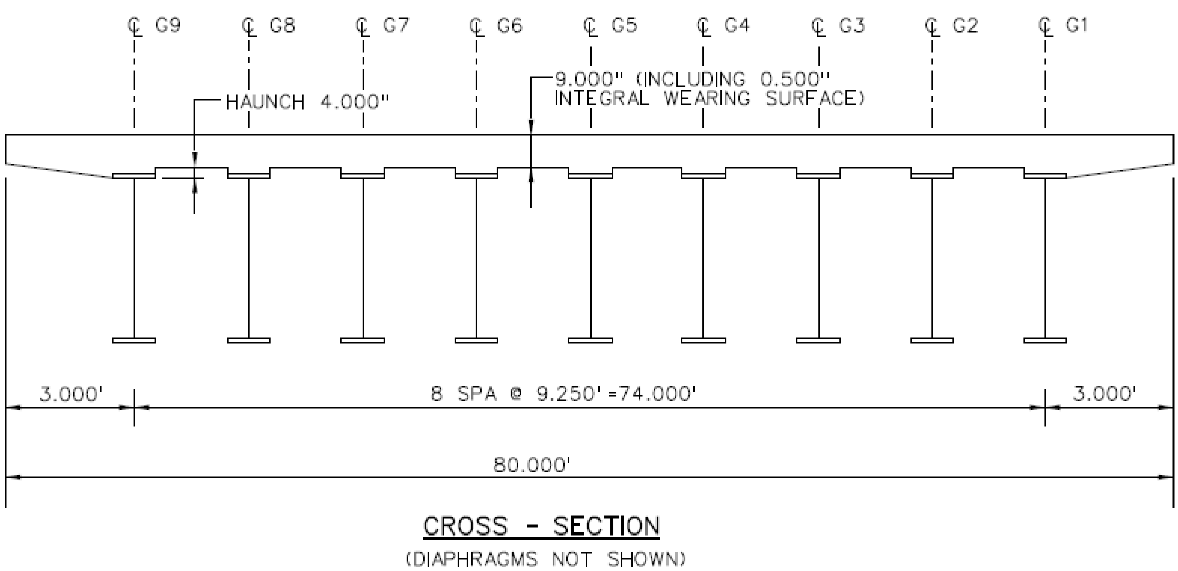


Figure O1-1-2. Bridge cross-section.

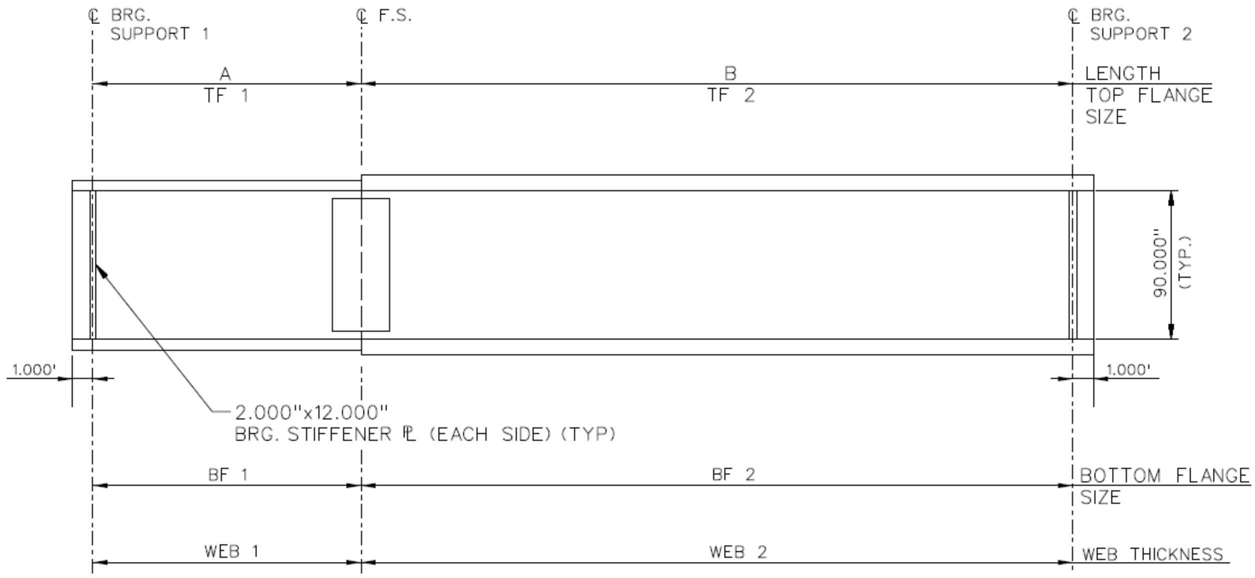


Figure O1-1-3. Girder elevations

	GIRDER PLATE LENGTHS ⚹								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	65.053	57.691	50.264	42.763	35.174	27.479	126.897	115.124	103.165
B	130.000	126.206	122.413	118.620	114.826	111.033	000.000	000.000	000.000

ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS ⚹⚹					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	30.000	2.750	26.000	2.750	24.000	1.500
TF2	30.000	2.750	26.000	2.750		

⚹⚹ ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS ⚹⚹							
TOP FLANGE	G1		G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF	BF	TF
BF1	32.000	3.250	32.000	3.000	28.000	2.000	24.000	1.500
BF2	32.000	3.250	32.000	3.000	28.000	2.000		

⚹⚹ ALL DIMENSIONS ARE IN INCHES.

Figure O1-1-4. Cross-section dimensions.

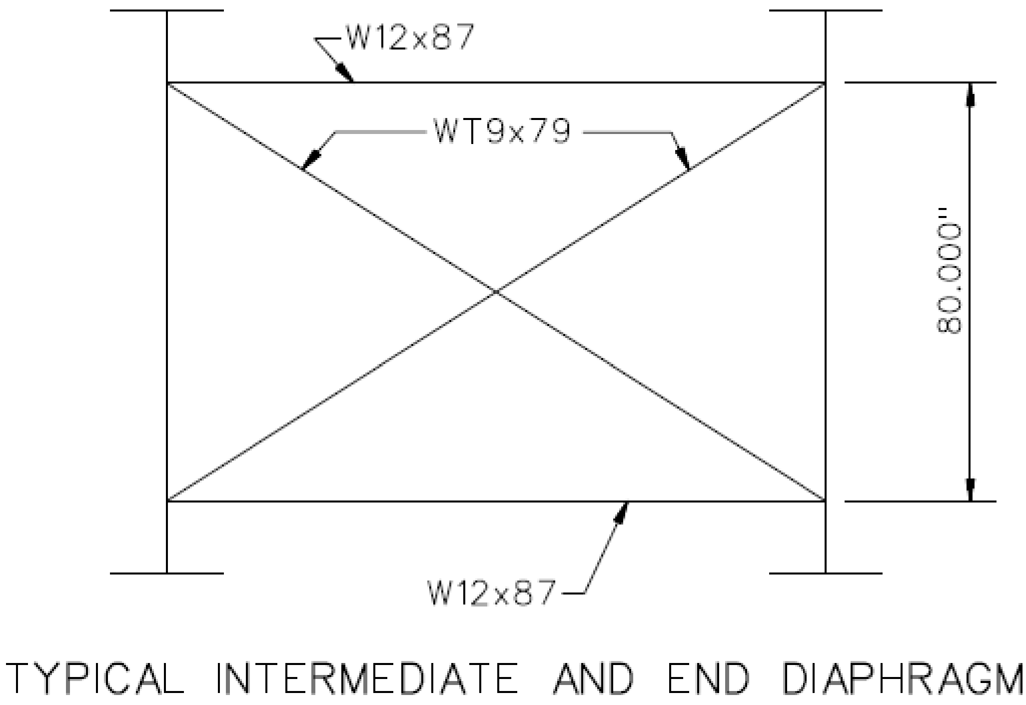


Figure O1-1-5. Cross-frame details

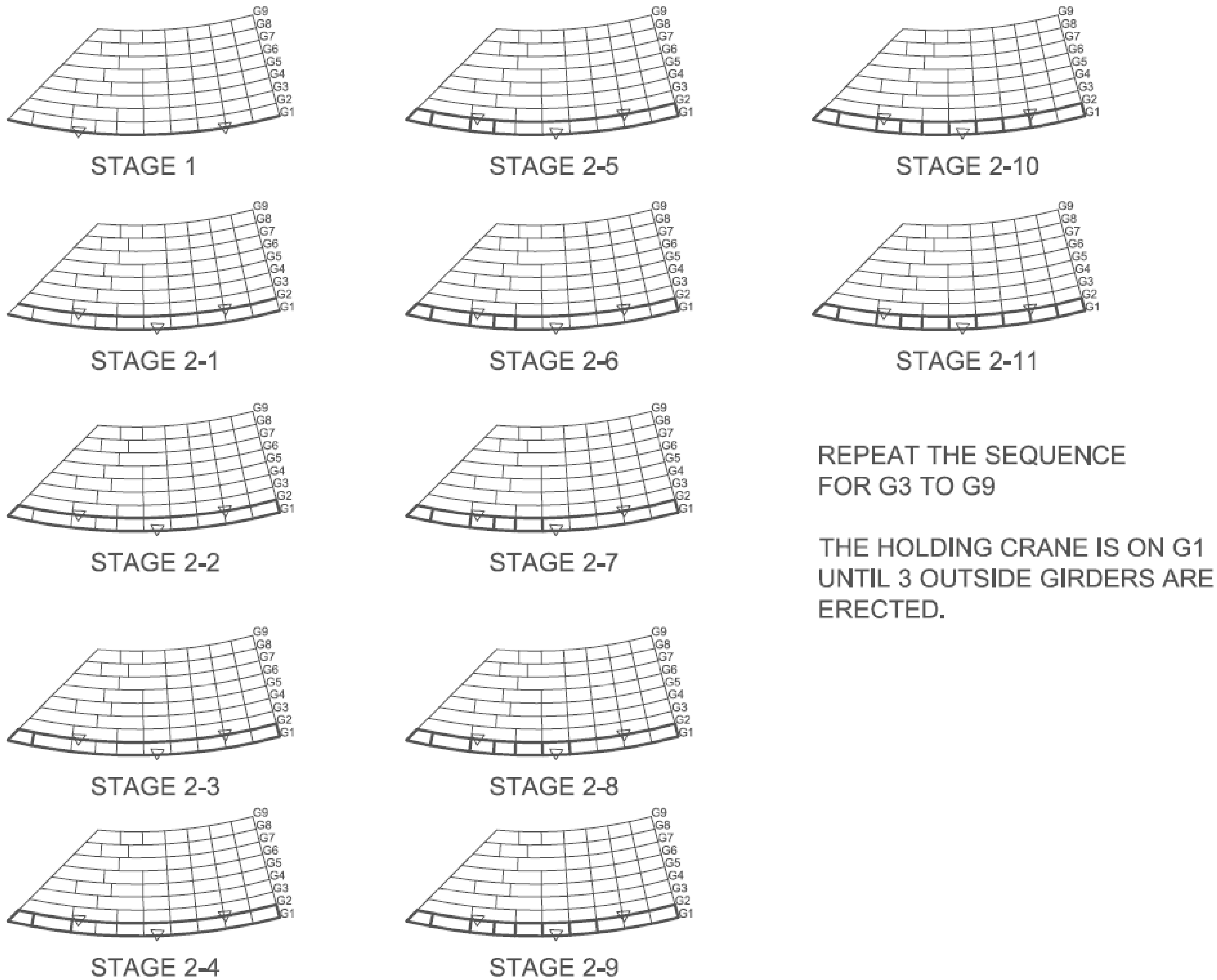


Figure O1-1-6. Erection scheme 1.

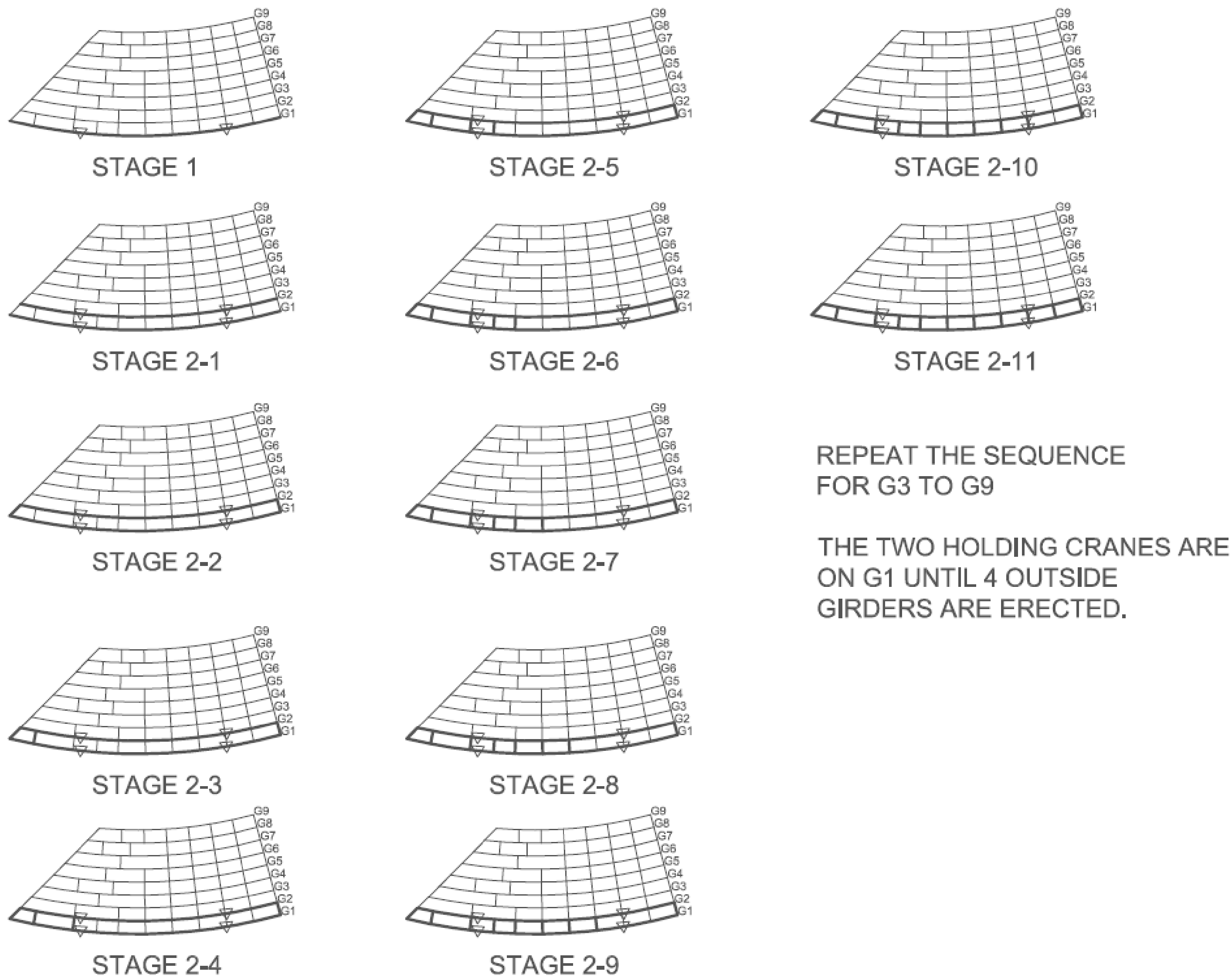
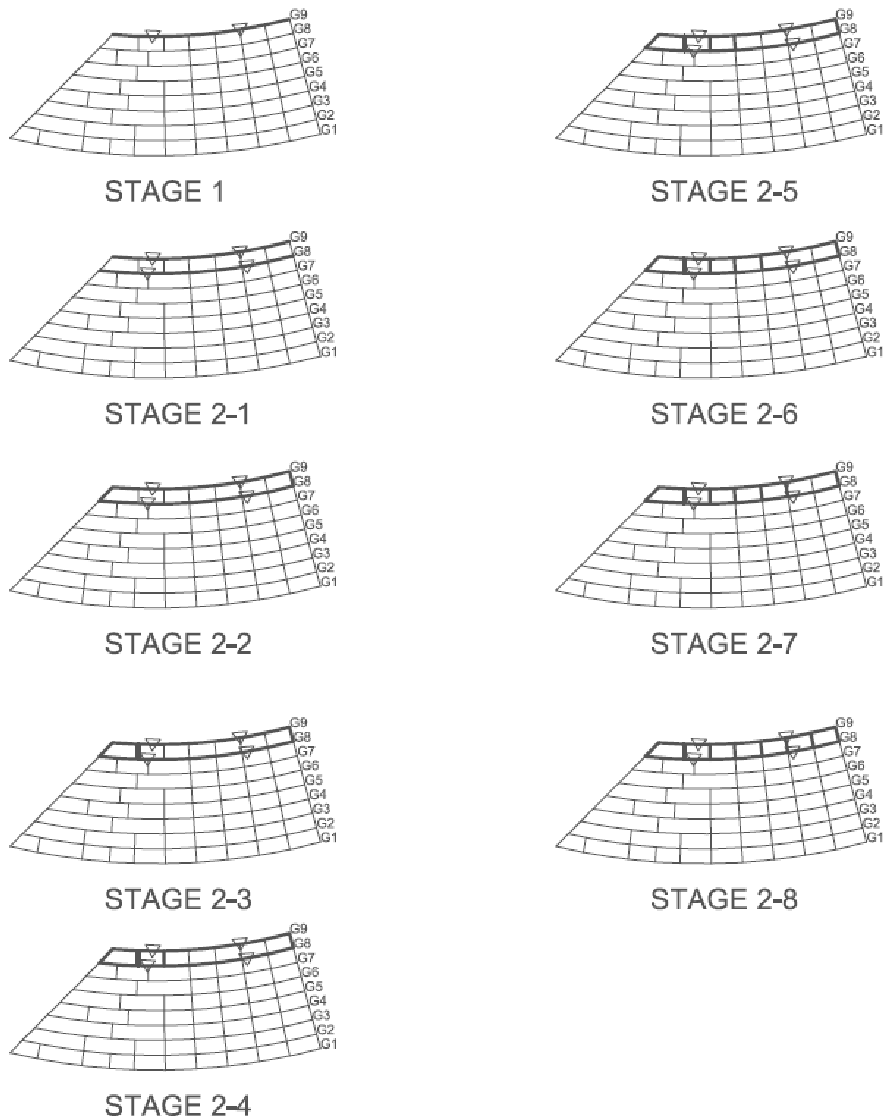


Figure O1-1-6(Continued). Erection scheme 2A.



REPEAT THE SEQUENCE FOR G3 TO G9

FOR G3 TO G9, THE TWO HOLDING CRANES ARE ON THE INSIDE GIRDER ADJACENT TO THE GIRDER BEING INSTALLED

Figure O1-1-6(Continued). Erection scheme 3.

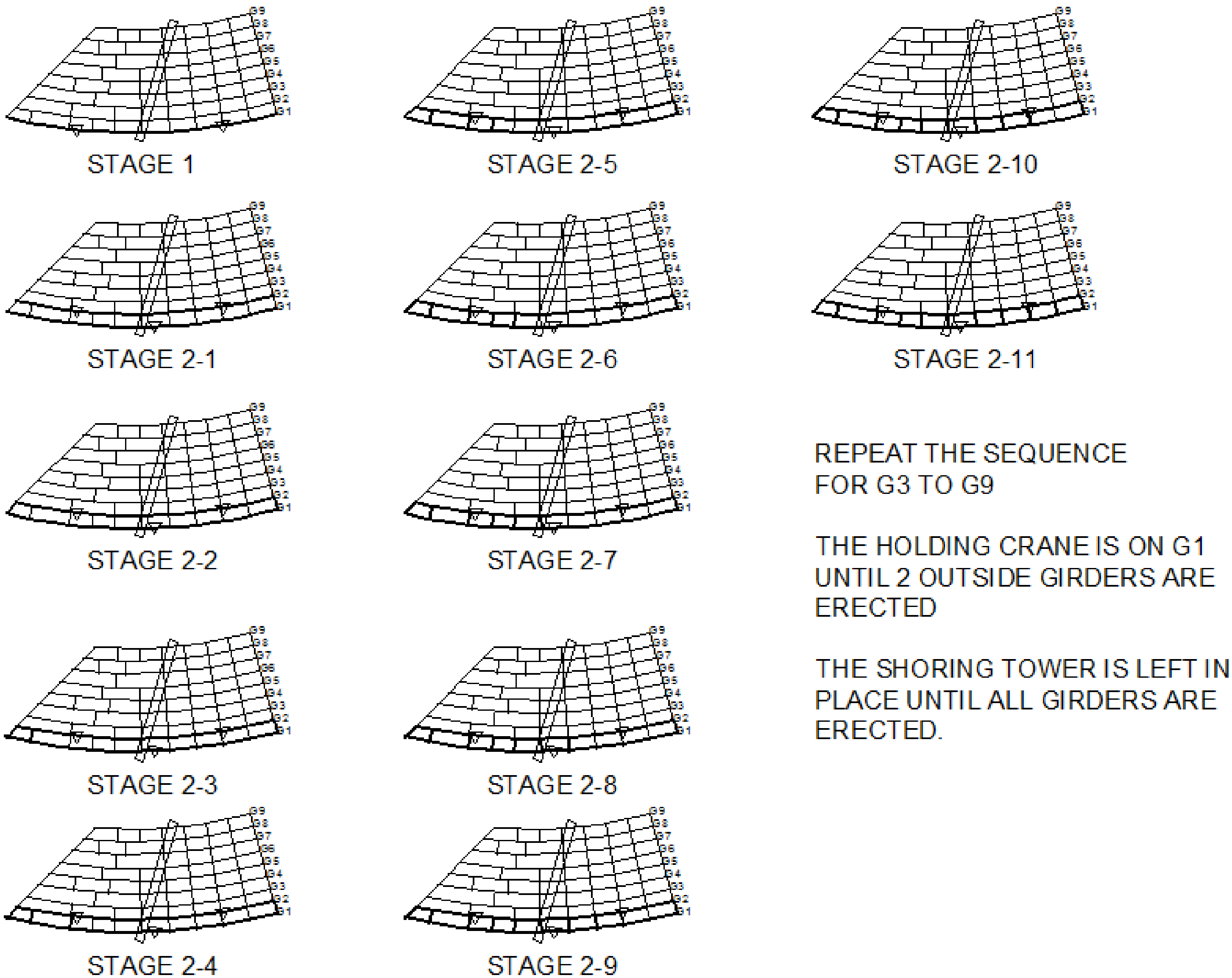


Figure O1-1-6(Continued). Erection scheme 4.

Table O1-1-1. Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

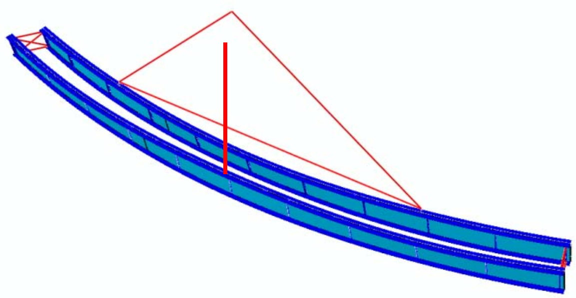
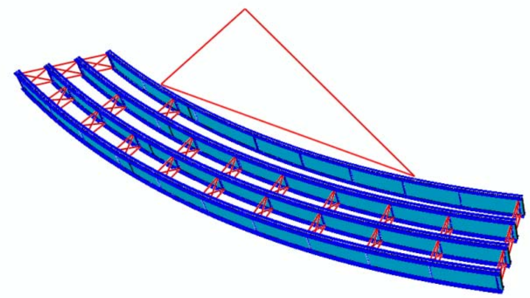
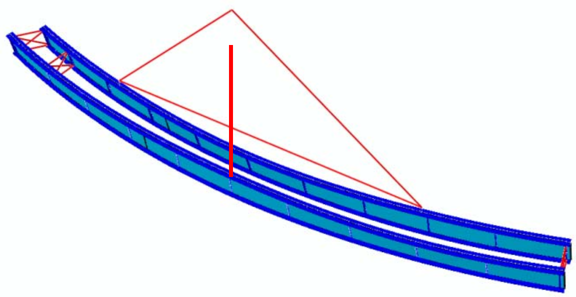
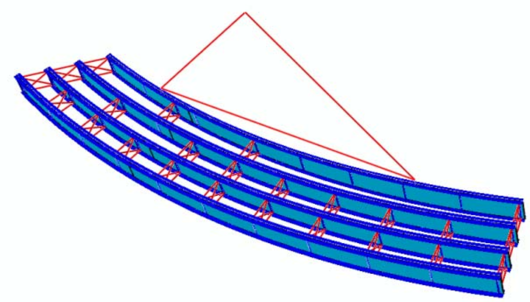
Sub-Stage	Stage	
	2	4
1		
2		

Table O1-1-1(Continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

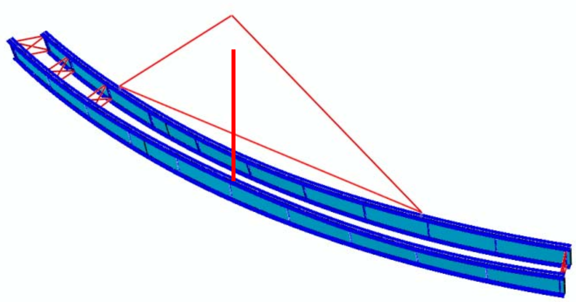
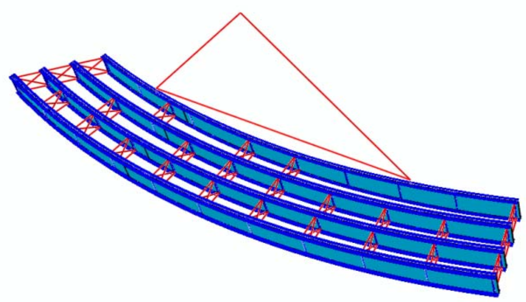
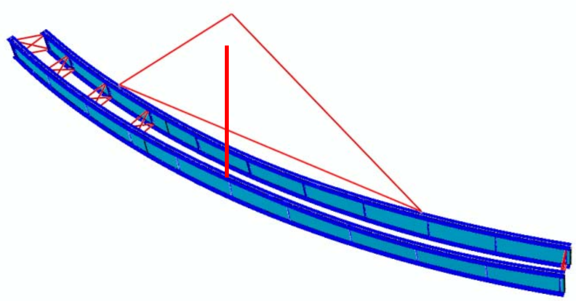
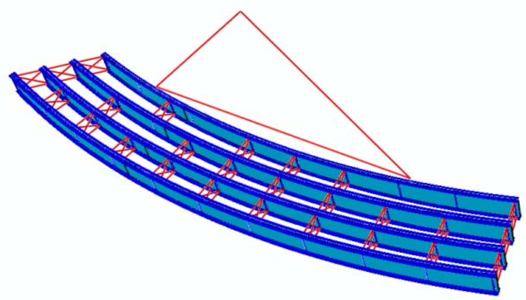
3		
4		

Table O1-1-1(Continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

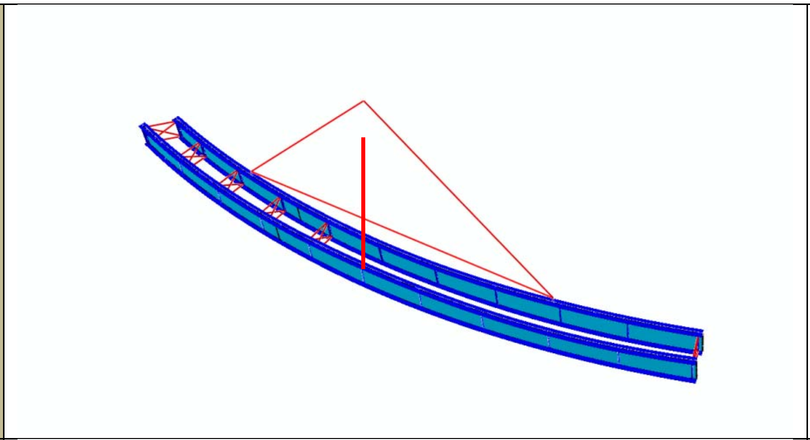
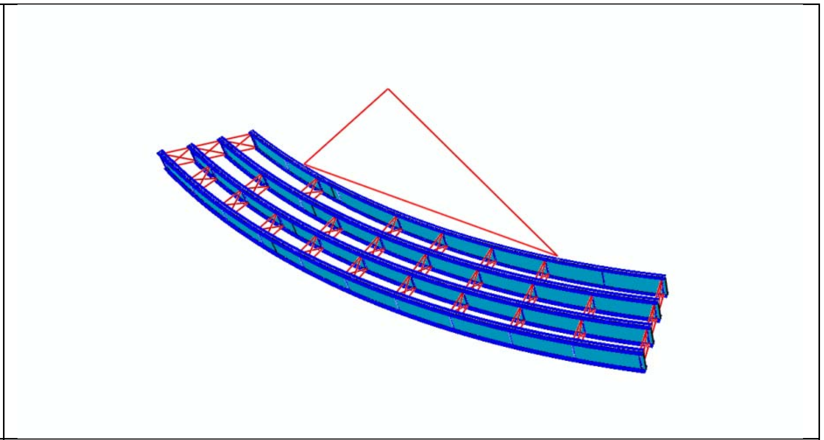
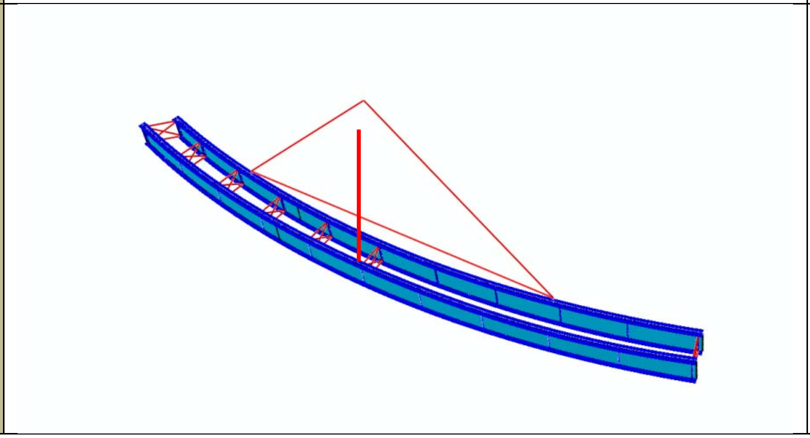
5		
6		

Table O1-1-1 (continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

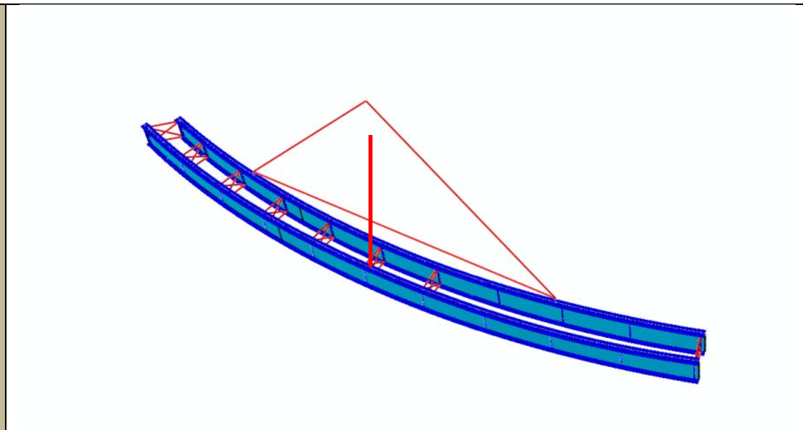
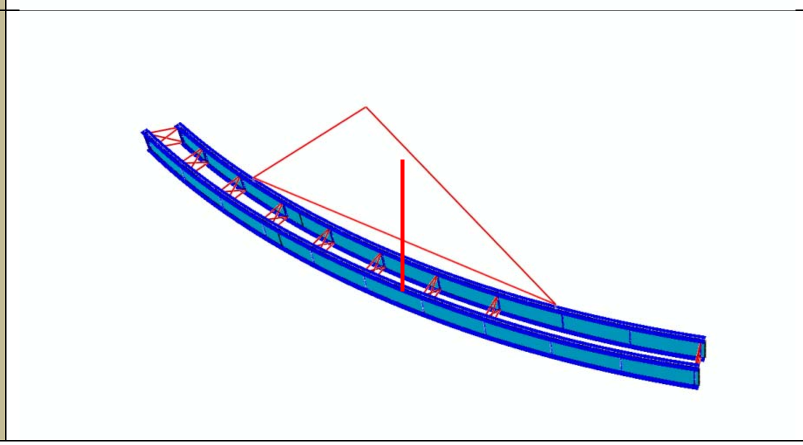
7		
8		

Table O1-1-1 (continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

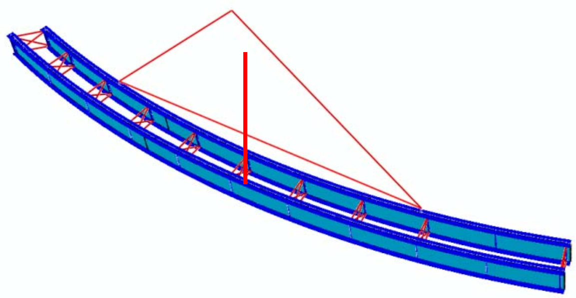
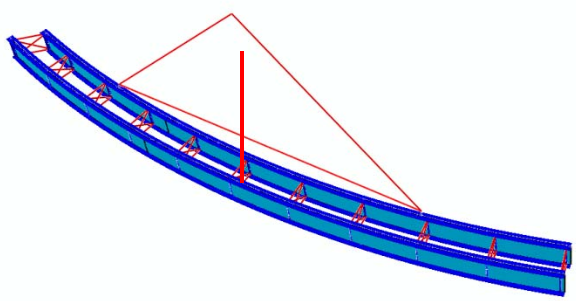
9		
10		

Table O1-1-1 (continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

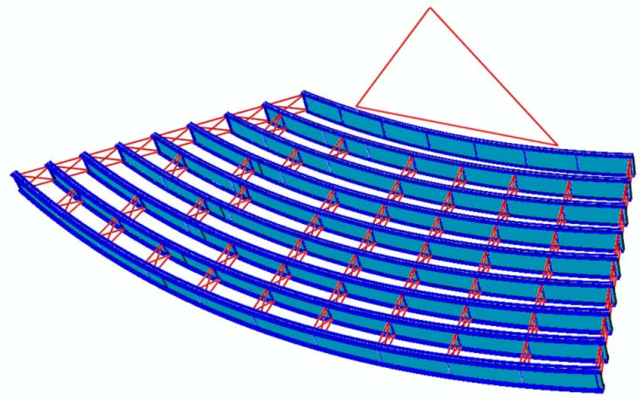
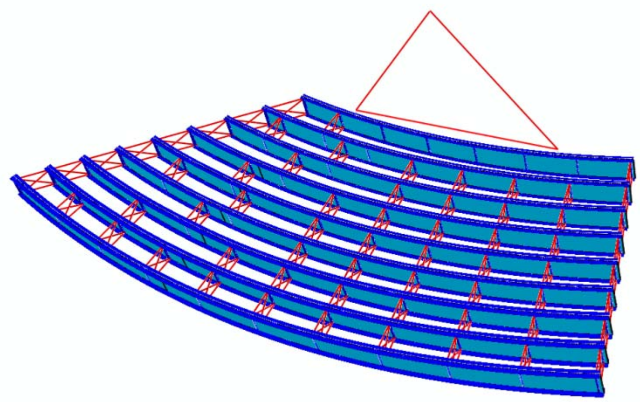
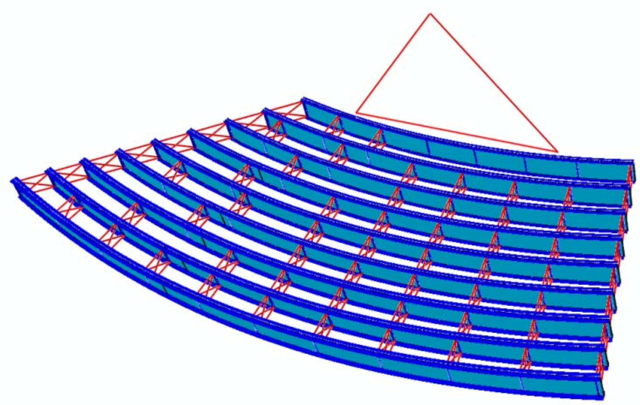
Sub-Stage	Stage 9
1	
2	
3	

Table O1-1-1 (continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

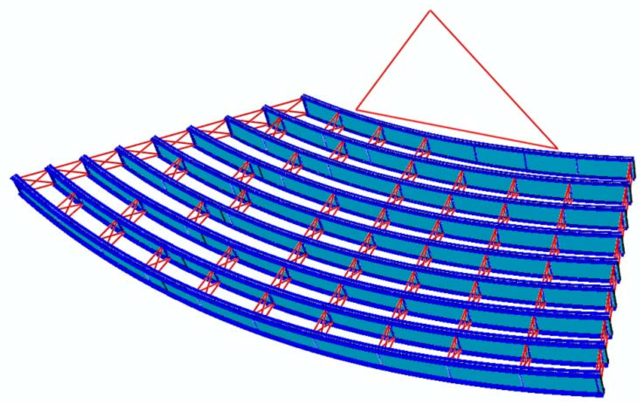
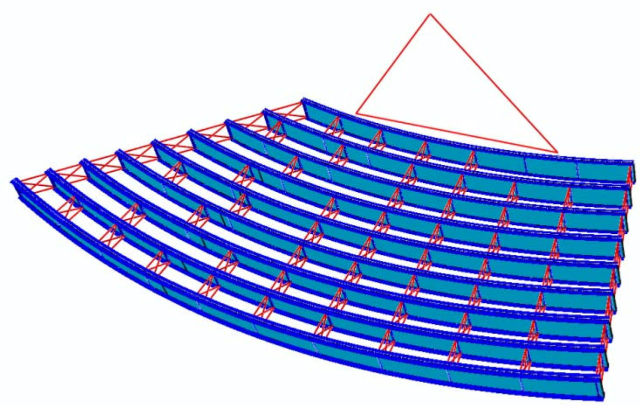
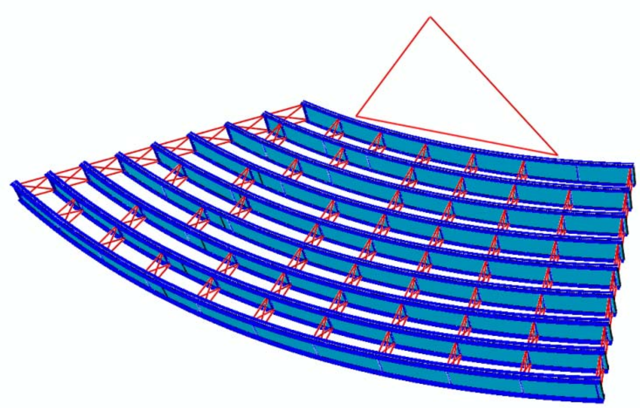
Sub-Stage	Stage 9
4	
5	
6	

Table O1-1-1 (continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

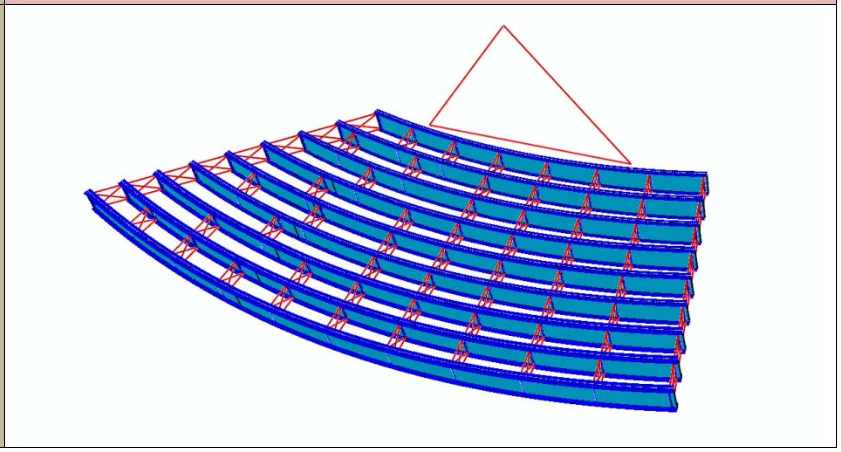
Sub-Stage	Stage
	9
7	

Table O1-1-2. Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

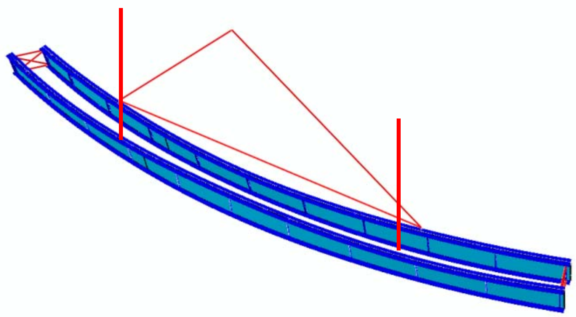
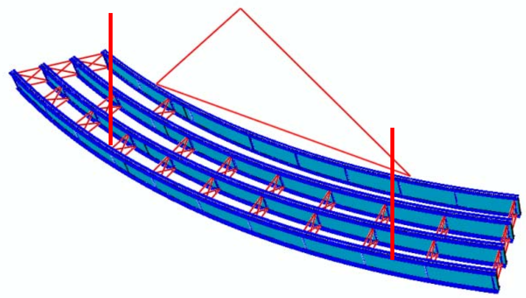
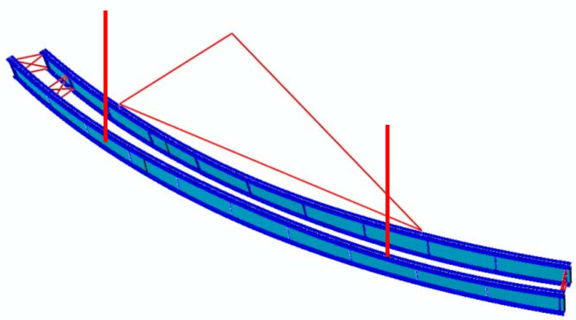
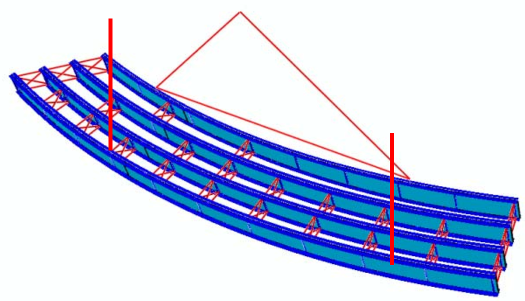
Sub-Stage	Stage	
	2	4
1		
2		

Table O1-1-2(Continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

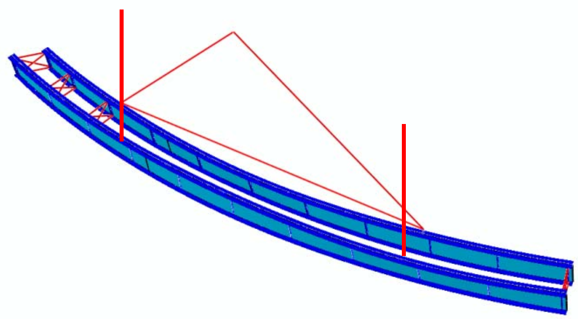
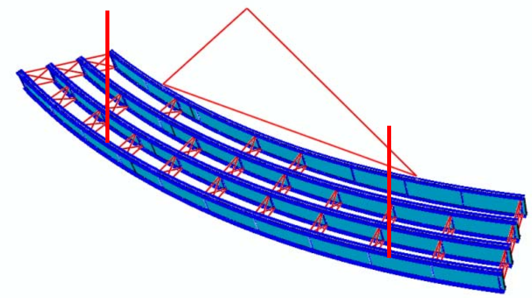
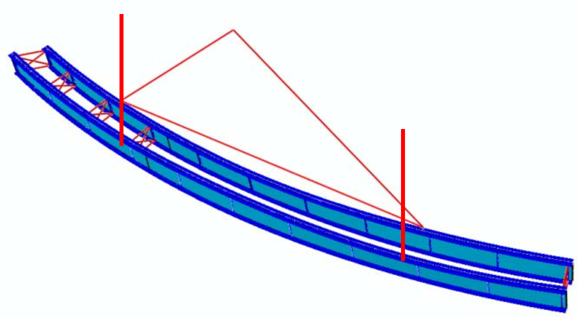
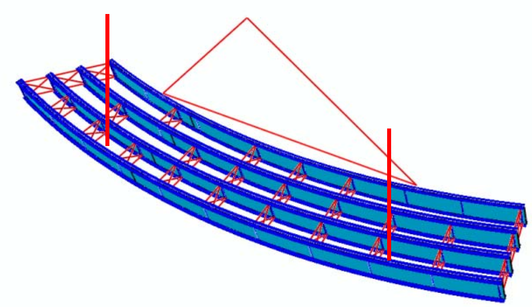
3		
4		

Table O1-1-2(Continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

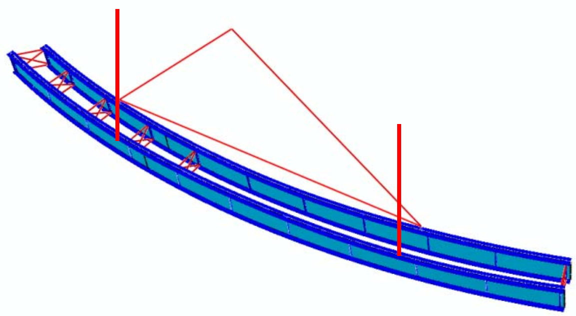
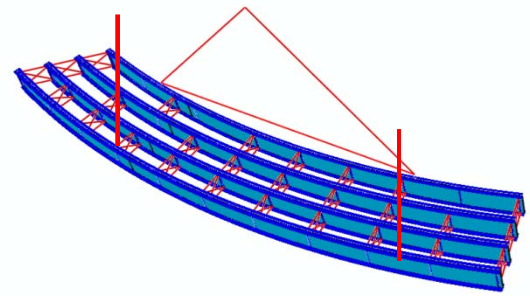
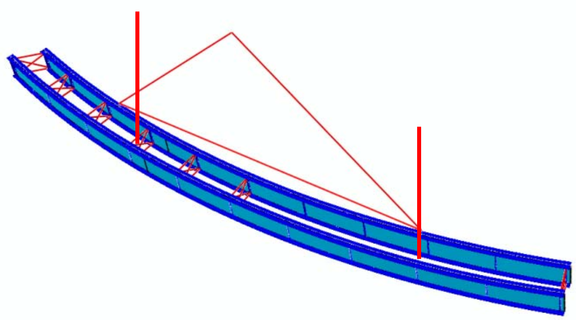
5		
6		

Table O1-1-2(Continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

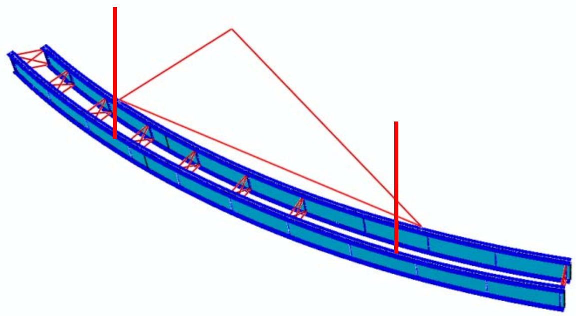
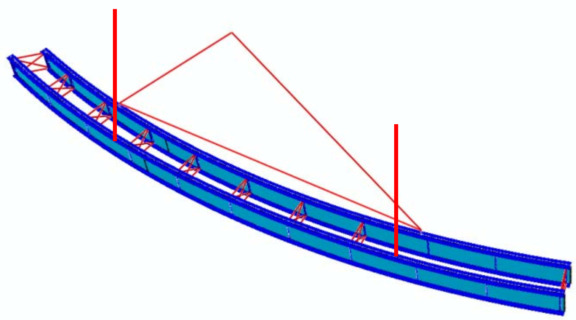
7		
8		

Table O1-1-2(Continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

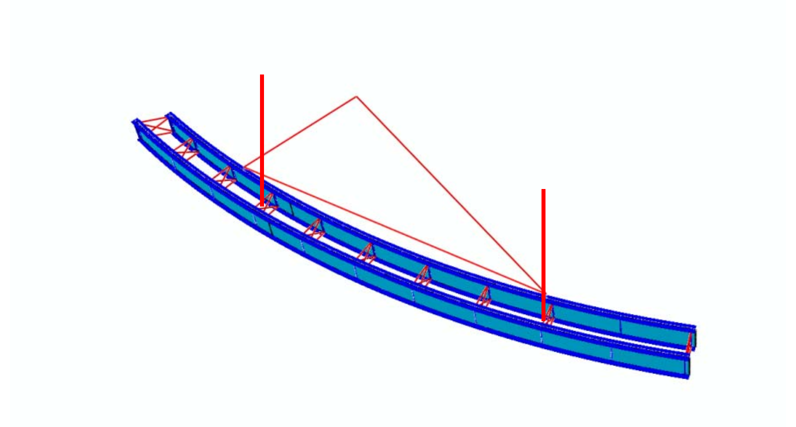
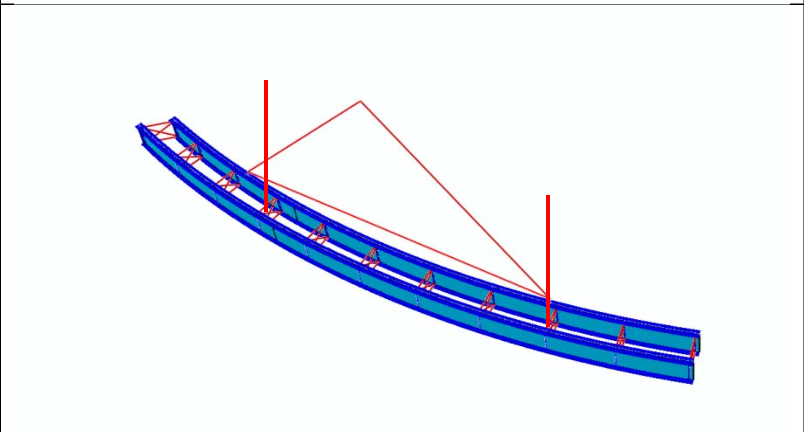
9		
10		

Table O1-1-2(Continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

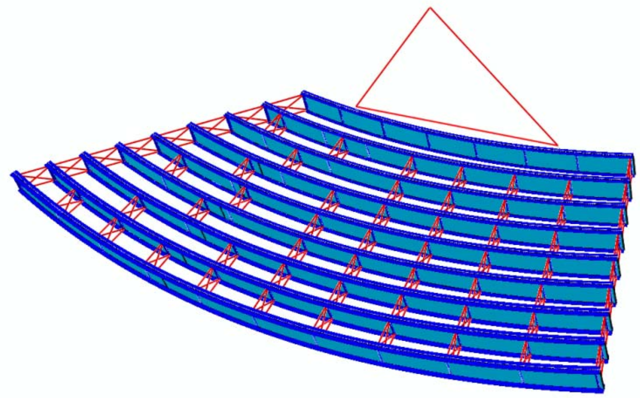
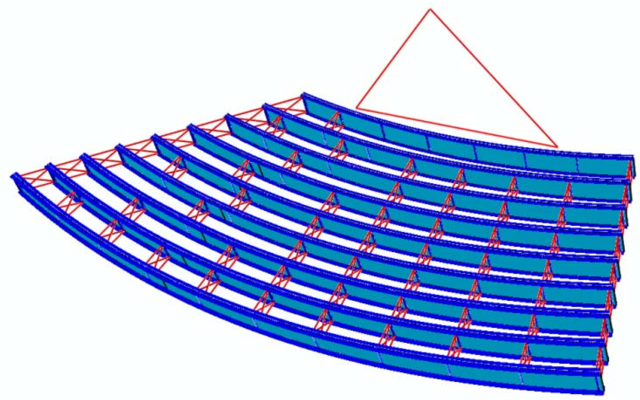
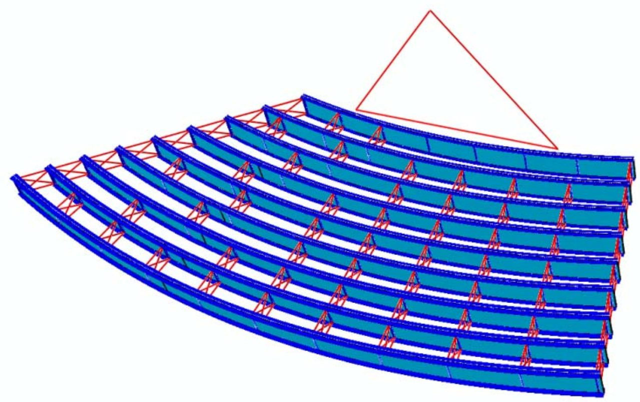
Sub-Stage	Stage 9
1	
2	
3	

Table O1-1-2(Continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

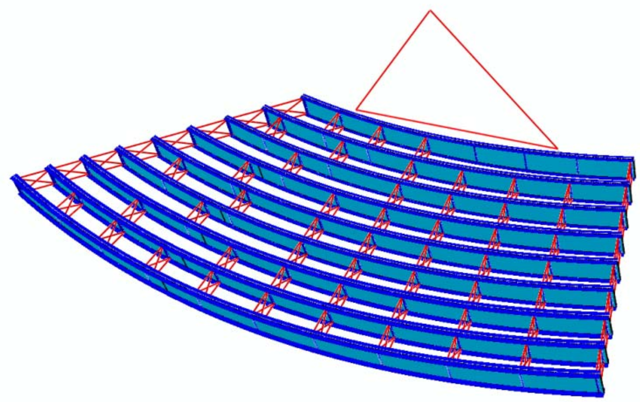
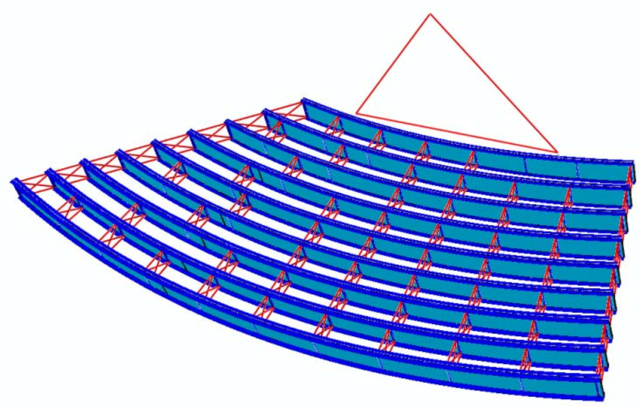
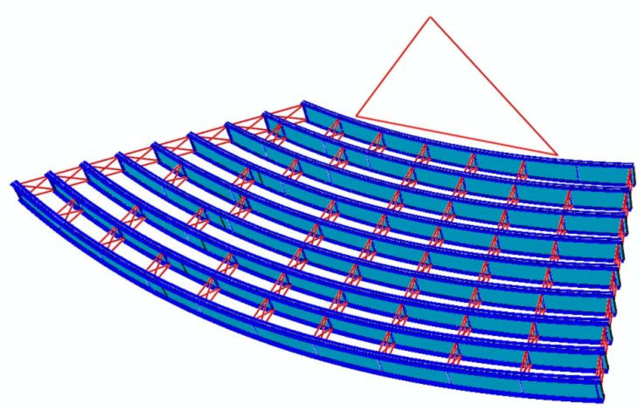
Sub-Stage	Stage 9
4	
5	
6	

Table O1-1-2(Continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

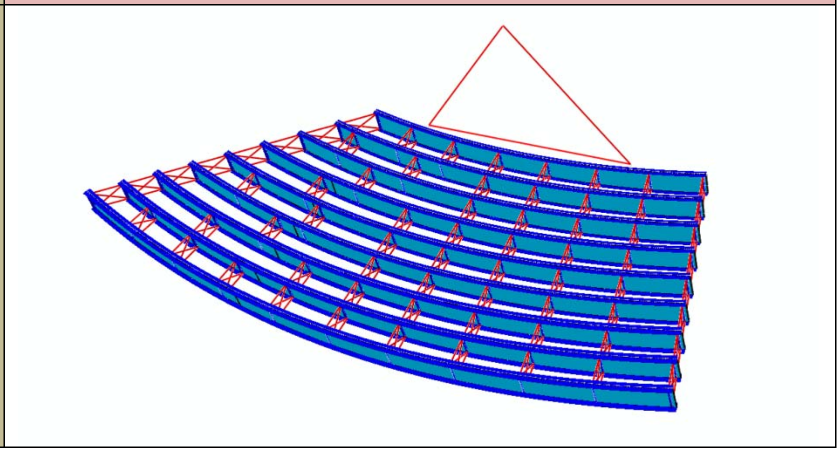
Sub-Stage	Stage
	9
7	

Table O1-1-3. Three-dimensional view of erection method 3 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

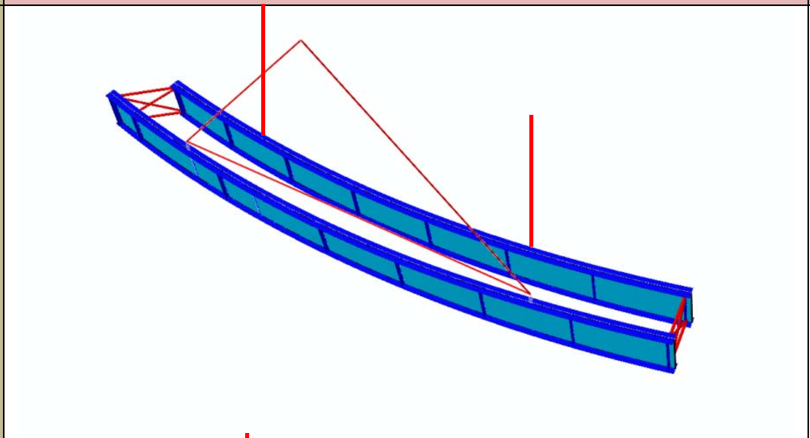
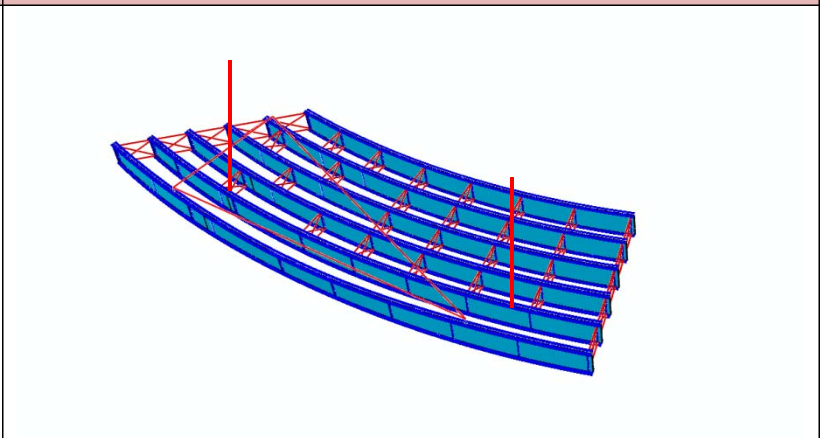
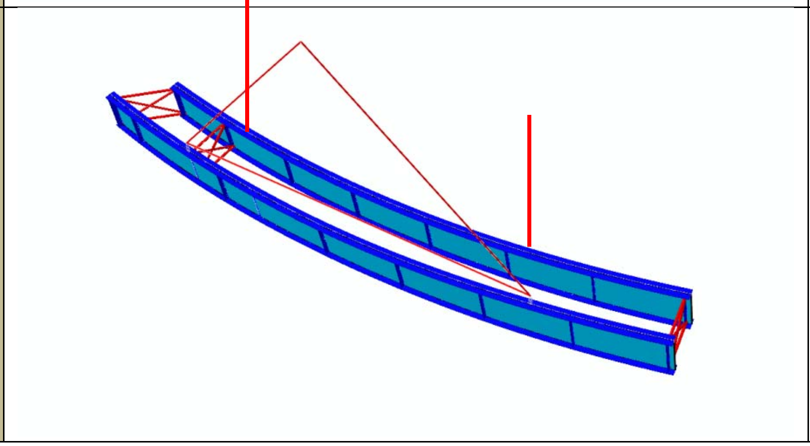
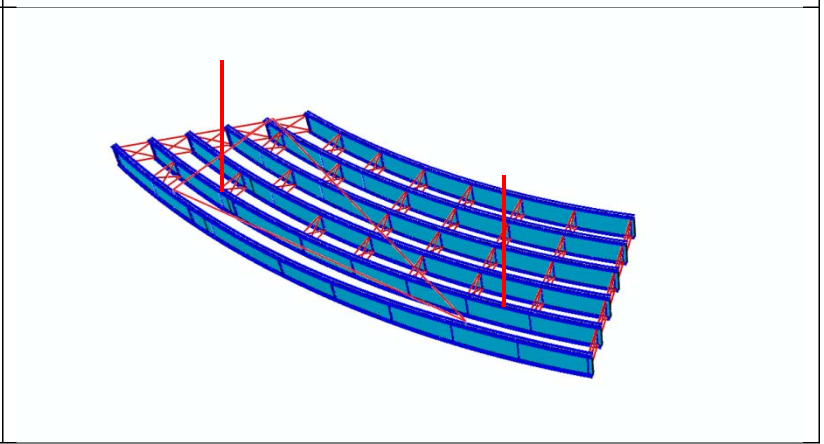
Sub-Stage	Stage	
	2	4
1		
2		

Table O1-1-3(Continued). Three-dimensional view of erection method 3 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

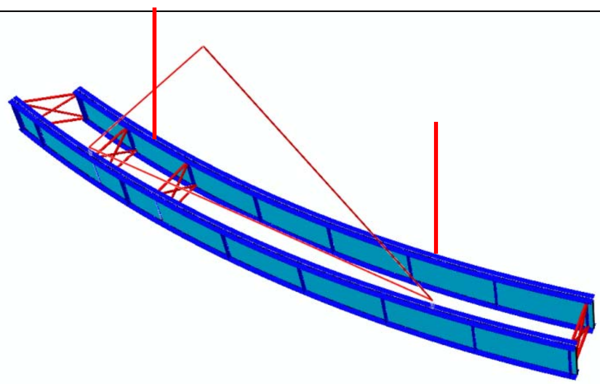
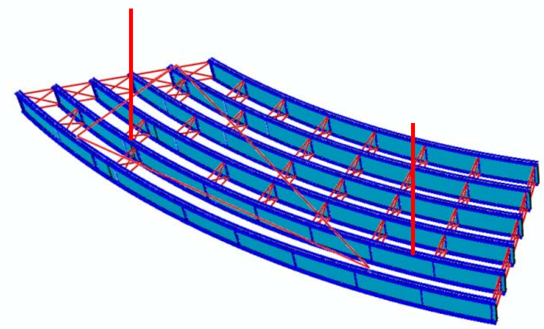
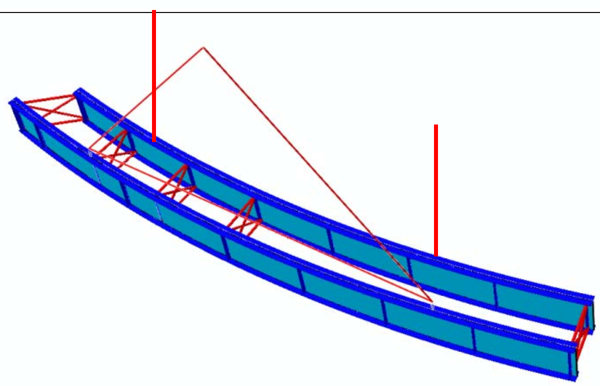
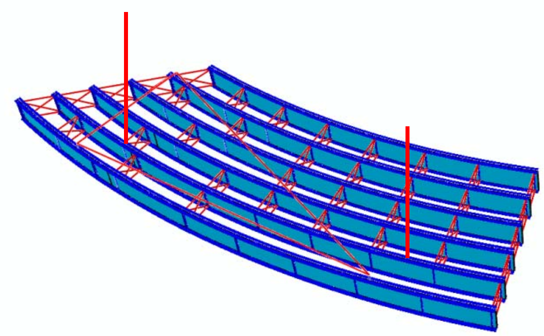
3		
4		

Table O1-1-3(Continued). Three-dimensional view of erection method 3 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

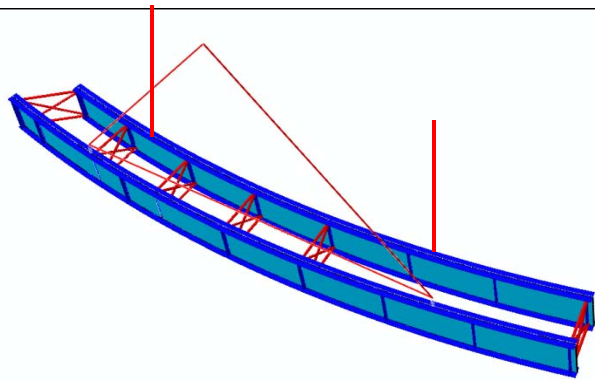
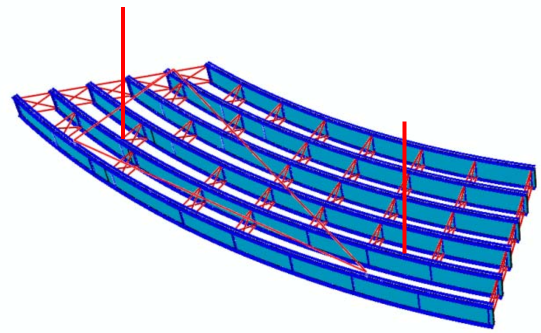
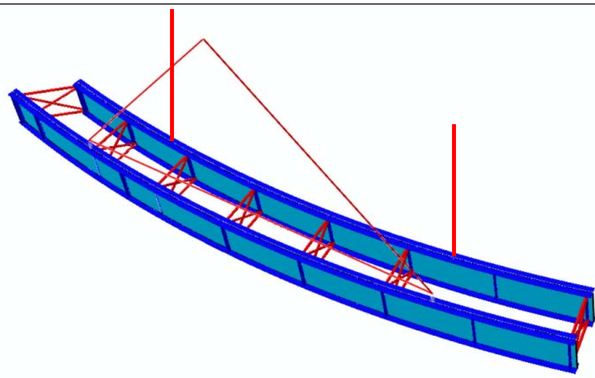
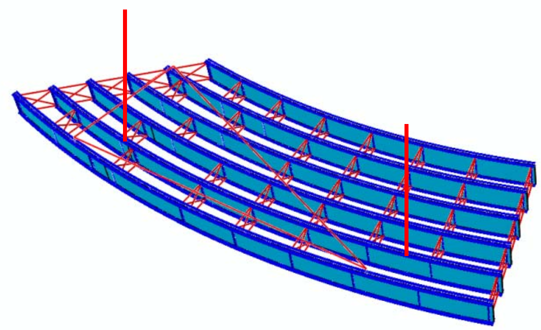
5		
6		

Table O1-1-3(Continued). Three-dimensional view of erection method 3 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

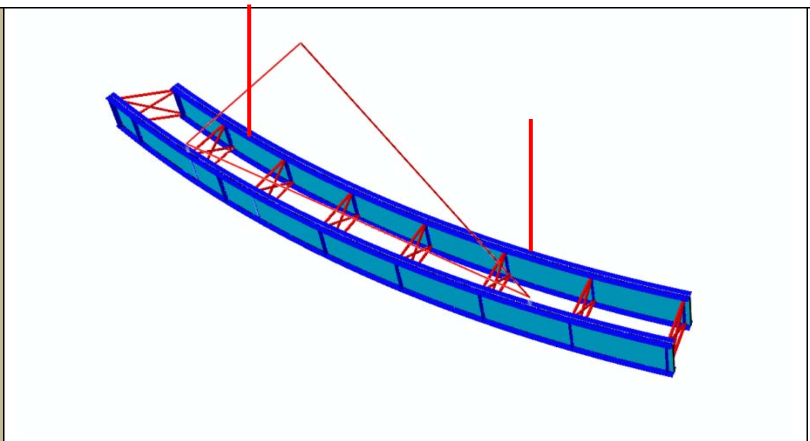
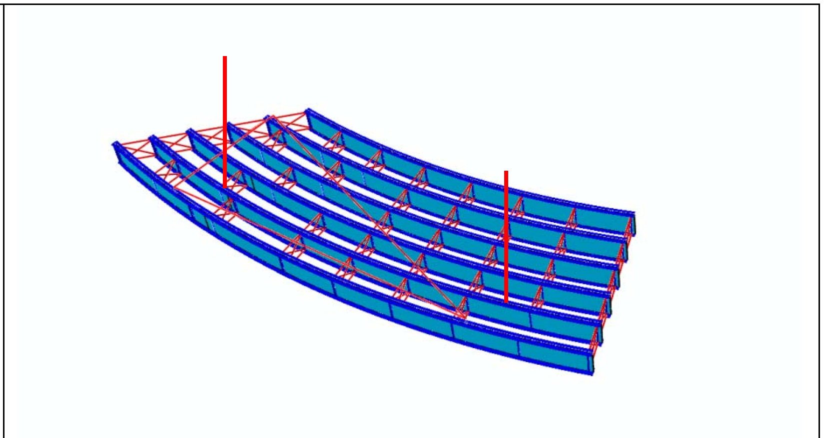
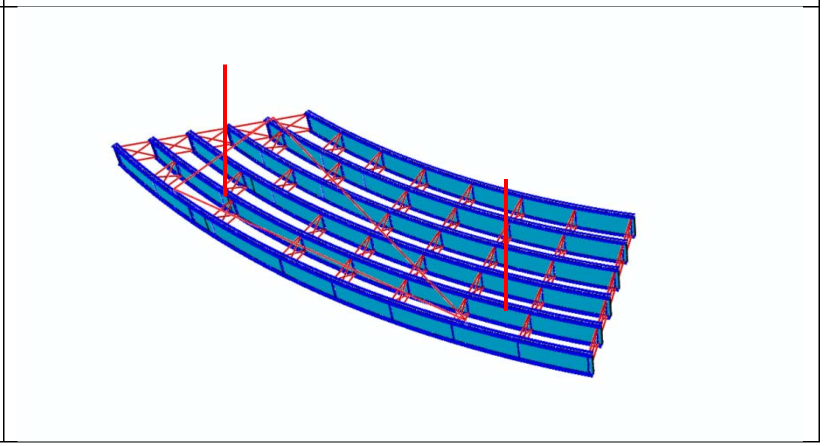
7		
8		

Table O1-1-3(Continued). Three-dimensional view of erection method 3 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

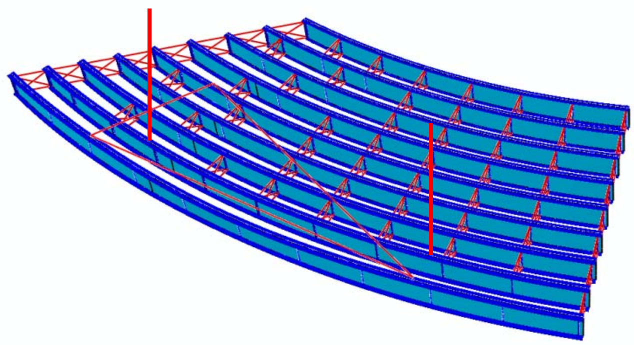
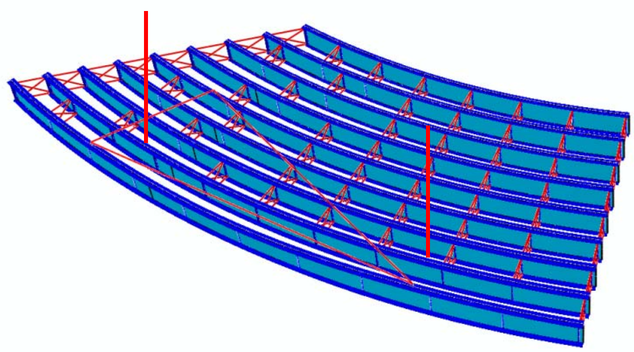
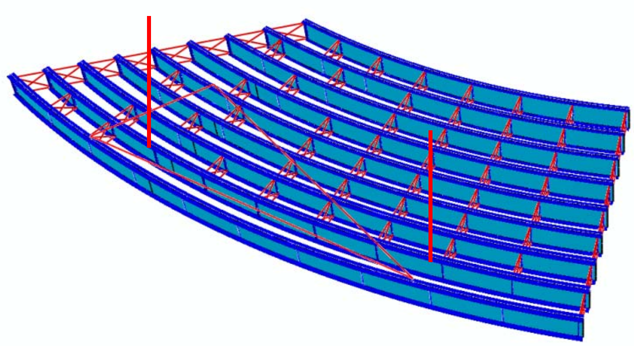
Sub-Stage	Stage
	9
1	
2	
3	

Table O1-1-3(Continued). Three-dimensional view of erection method 3 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

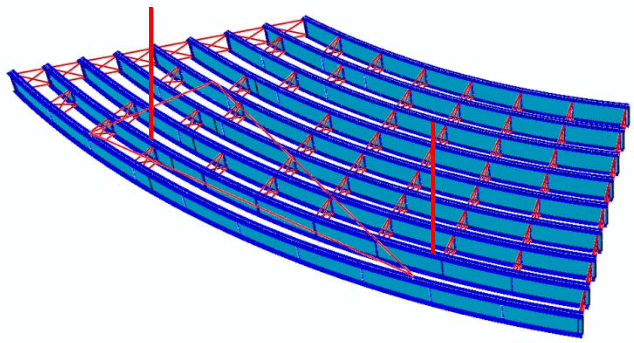
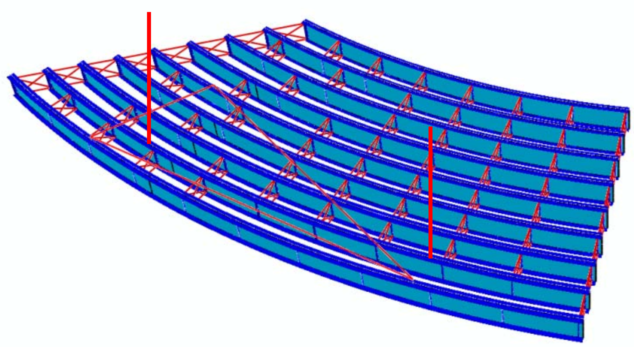
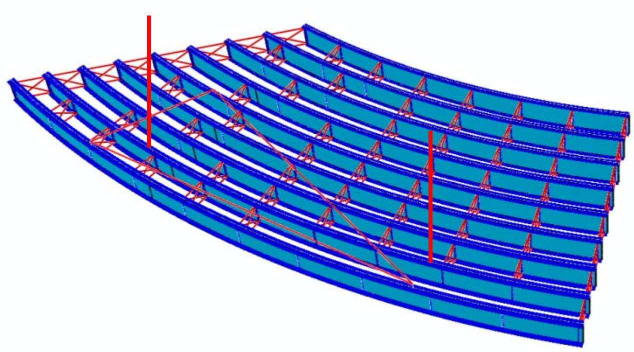
Sub-Stage	Stage 9
4	
5	
6	

Table O1-1-3(Continued). Three-dimensional view of erection method 3 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

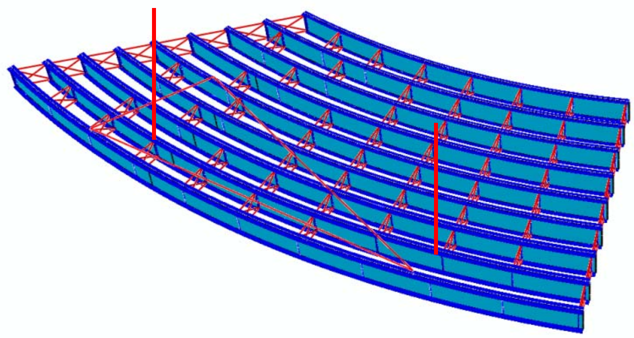
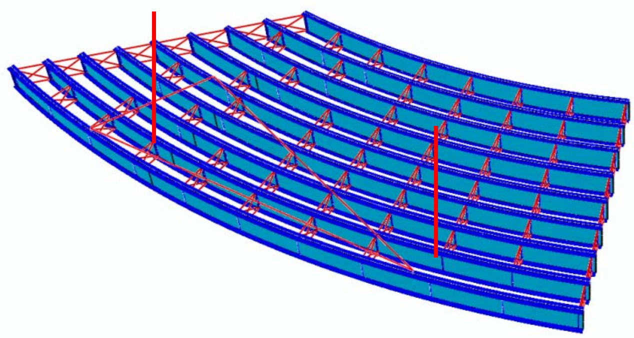
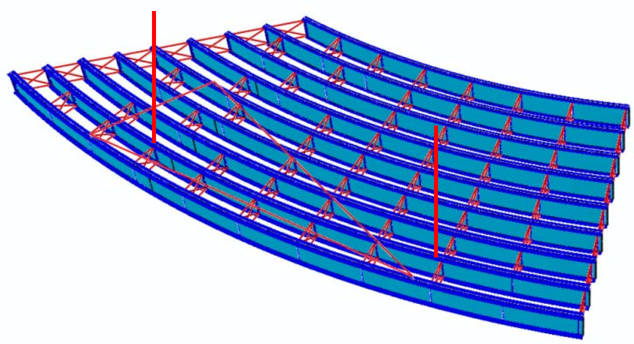
Sub-Stage	Stage
	9
7	
8	
9	

Table O1-1-3(Continued). Three-dimensional view of erection method 3 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

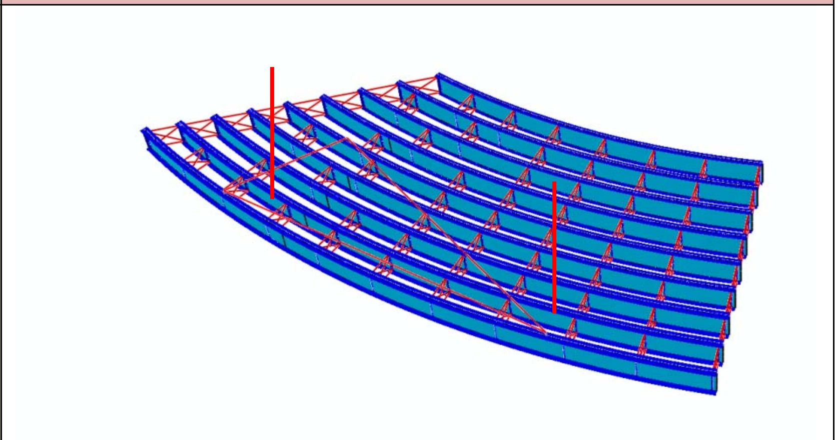
Sub-Stage	Stage
	9
10	

Table O1-1-4. Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

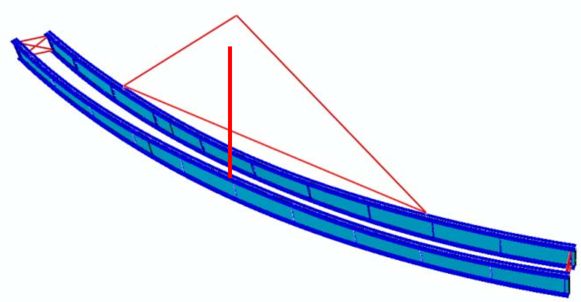
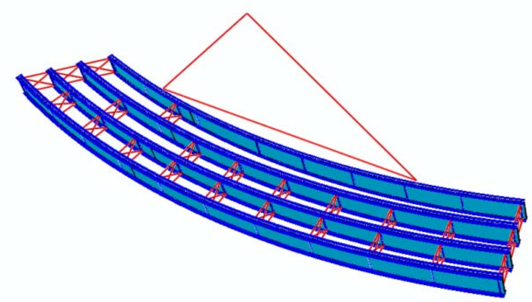
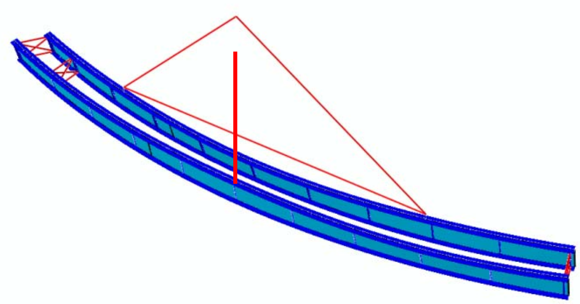
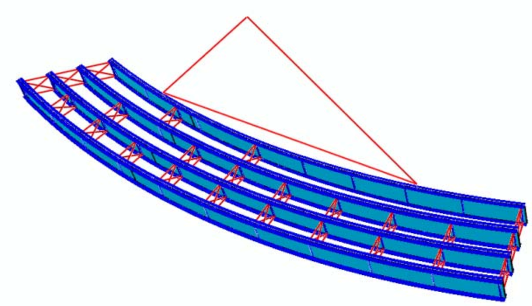
Sub-Stage	**Stage**	
	2	**4**
1		
2		

Table O1-1-4(Continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

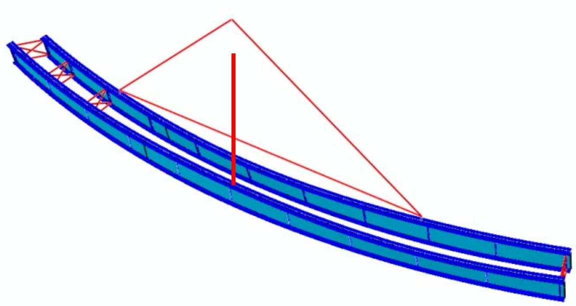
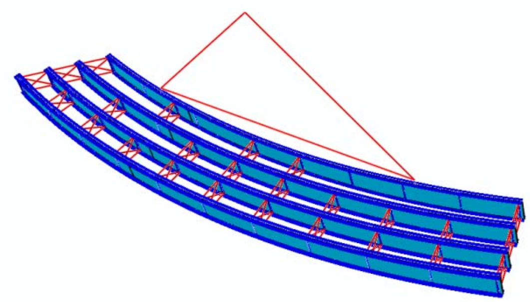
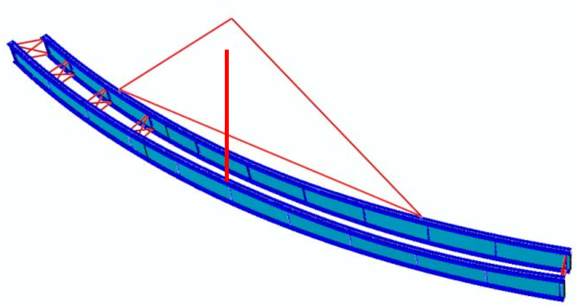
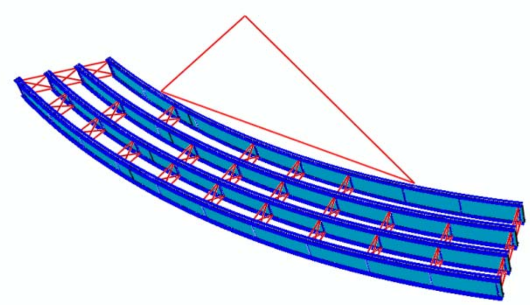
3		
4		

Table O1-1-4(Continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

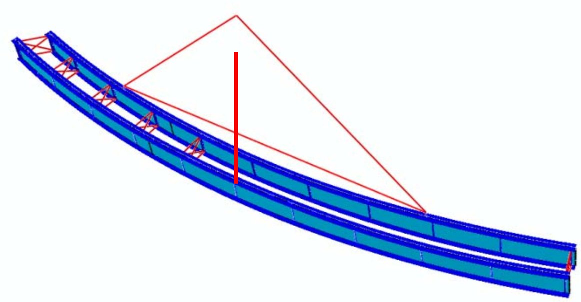
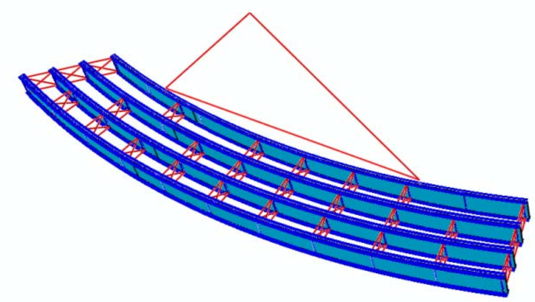
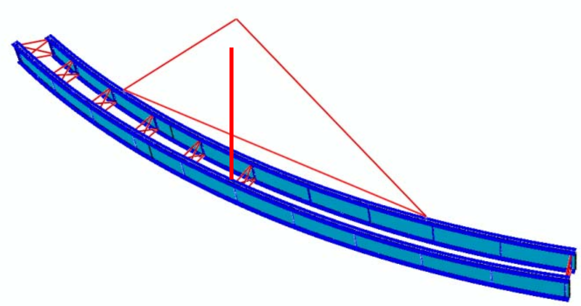
5		
6		

Table O1-1-4 (continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

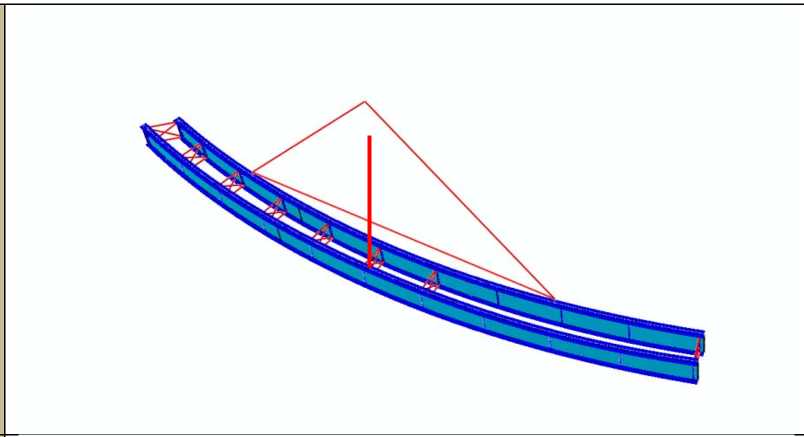
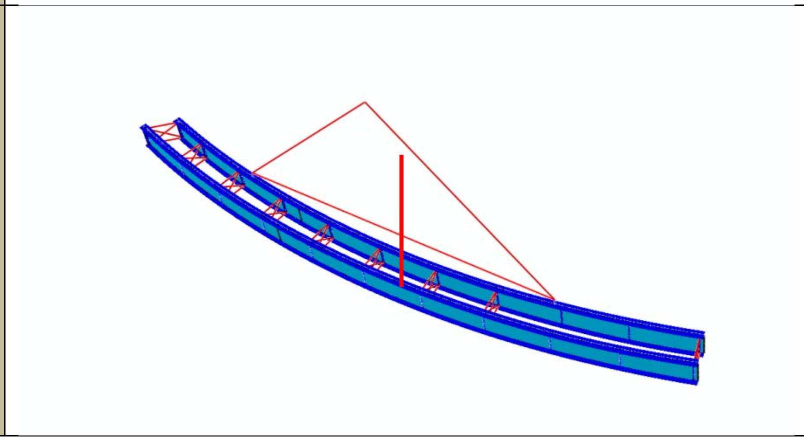
7		
8		

Table O1-1-4 (continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

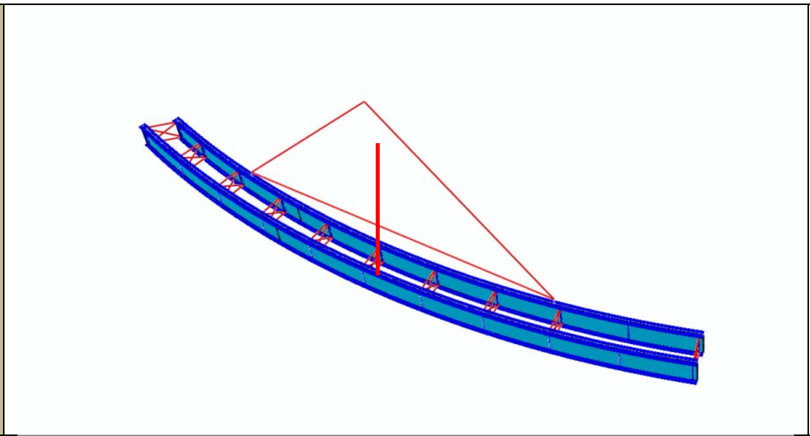
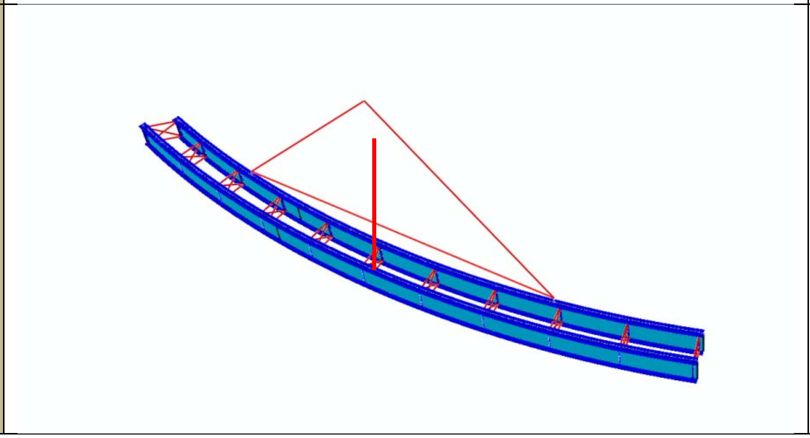
9		
10		

Table O1-1-4 (continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

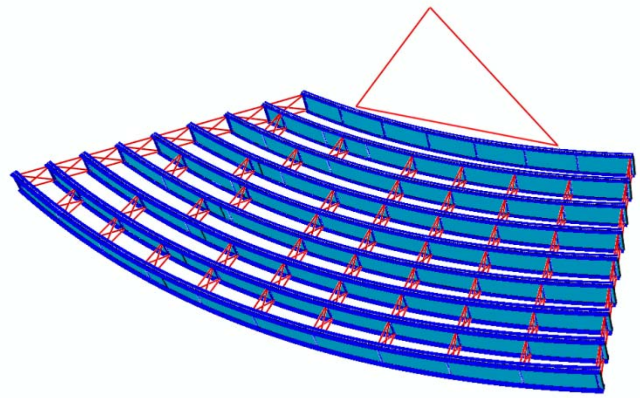
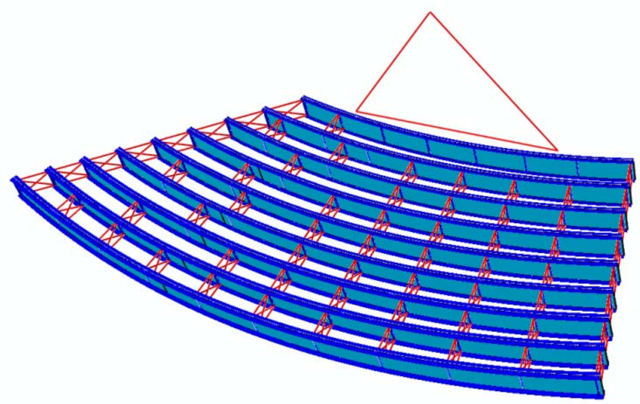
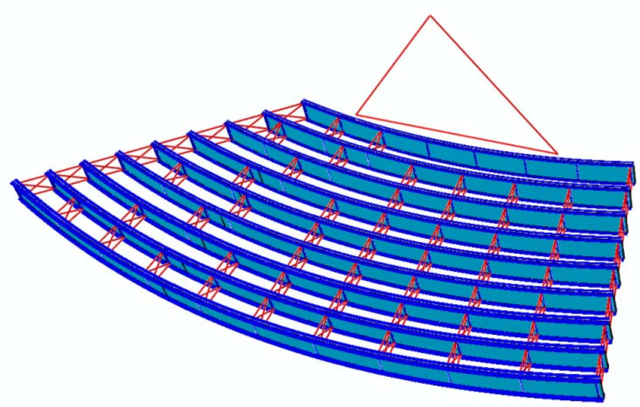
Sub-Stage	Stage 9
1	
2	
3	

Table O1-1-4 (continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

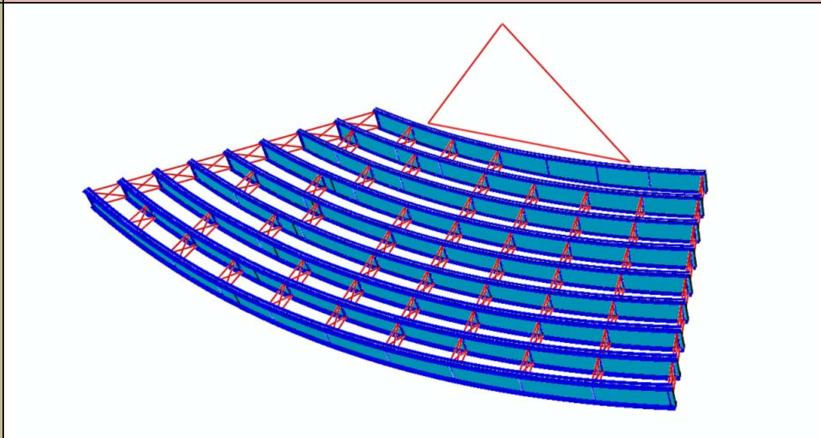
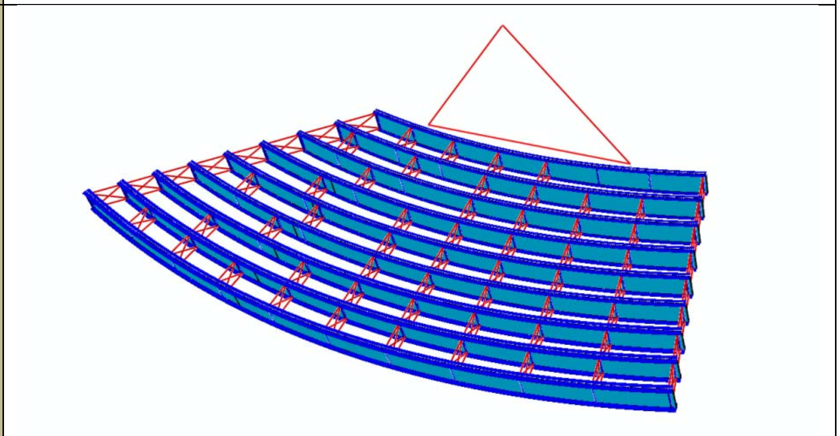
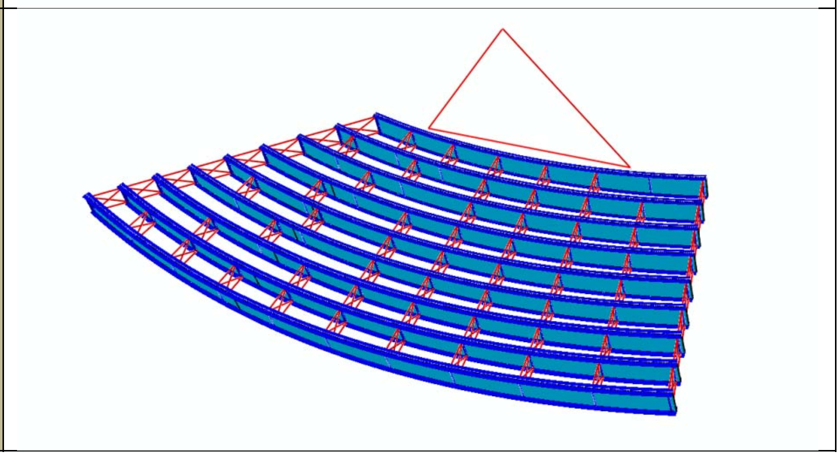
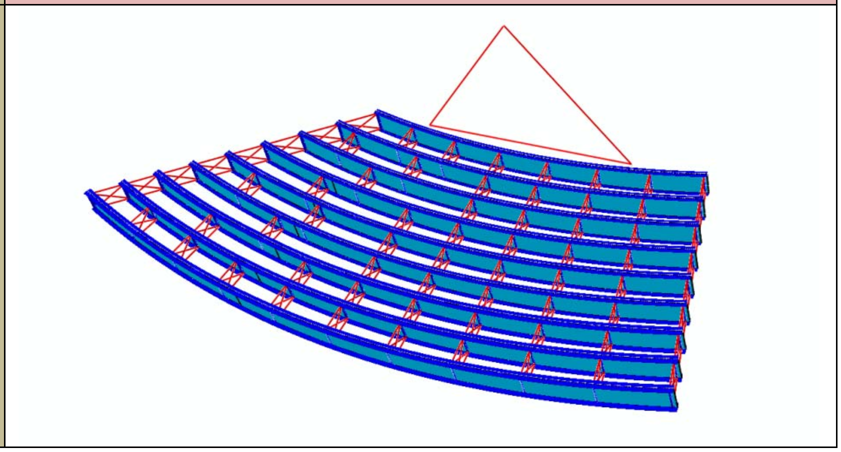
Sub-Stage	Stage 9
4	
5	
6	

Table O1-1-4 (continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

Sub-Stage	Stage
	9
7	

Appendix O1-2. NISCS15 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISCS15 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table O1-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	5.1	11.1
	SDLF	4.2	10.2
	TDLF	3.2	9.1
G2	NLF	4.1	9.1
	SDLF	3.2	8.1
	TDLF	2.0	6.9
G3	NLF	3.3	7.3
	SDLF	2.3	6.2
	TDLF	1.1	5.0
G4	NLF	2.5	5.7
	SDLF	1.5	4.7
	TDLF	0.5	3.6
G5	NLF	1.8	4.3
	SDLF	1.0	3.4
	TDLF	0.1	2.4
G6	NLF	1.3	3.0
	SDLF	0.5	2.3
	TDLF	0.4	1.4
G7	NLF	0.8	2.0
	SDLF	0.2	1.4
	TDLF	0.4	0.8
G8	NLF	0.4	1.1
	SDLF	0.0	0.7
	TDLF	0.4	0.3
G9	NLF	0.0	0.2
	SDLF	0.2	0.1
	TDLF	0.4	0.2
All Girders	NLF	5.1	11.1
	SDLF	4.2	10.2
	TDLF	3.2	9.1

Table O1-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.94	2.01
	SDLF	0.13	1.19
	TDLF	0.85	0.26
G2	NLF	0.92	1.96
	SDLF	0.10	1.14
	TDLF	0.87	0.23
G3	NLF	0.85	1.82
	SDLF	0.12	1.03
	TDLF	0.91	0.27
G4	NLF	0.69	1.49
	SDLF	0.12	0.81
	TDLF	0.90	0.28
G5	NLF	0.68	1.47
	SDLF	0.14	0.75
	TDLF	0.86	0.30
G6	NLF	0.55	1.18
	SDLF	0.17	0.51
	TDLF	0.86	0.36
G7	NLF	0.38	0.87
	SDLF	0.17	0.37
	TDLF	0.75	0.36
G8	NLF	0.35	0.76
	SDLF	0.17	0.25
	TDLF	0.75	0.34
G9	NLF	0.34	0.74
	SDLF	0.17	0.23
	TDLF	0.75	0.35
All Girders	NLF	0.94	2.01
	SDLF	0.17	1.19
	TDLF	0.91	0.36

Table O1-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	8.1	17.8	9.5	21.0	1.9	4.7	2.2	5.3
	SDLF	8.9	18.5	10.4	21.8	2.0	4.5	2.8	5.5
	TDLF	9.7	19.3	11.4	22.7	2.3	4.5	3.5	6.3
G2	NLF	7.2	16.0	8.0	17.8	1.8	4.8	2.1	4.7
	SDLF	7.5	16.3	8.4	18.2	1.8	4.2	2.3	4.4
	TDLF	7.9	16.6	8.8	18.5	2.0	4.1	2.8	5.1
G3	NLF	7.1	16.2	8.0	18.0	4.3	9.4	5.7	12.8
	SDLF	7.0	16.0	7.8	17.8	2.8	7.9	3.7	10.8
	TDLF	7.0	15.8	7.9	17.6	1.7	6.1	2.4	8.2
G4	NLF	5.8	13.3	6.1	14.0	3.3	7.3	3.8	8.1
	SDLF	5.3	12.7	5.5	13.3	2.3	5.9	2.7	6.9
	TDLF	4.7	12.1	5.0	12.7	2.3	5.5	3.3	6.5
G5	NLF	4.6	11.0	4.9	11.6	2.9	6.3	3.5	7.9
	SDLF	3.9	10.3	4.1	10.8	1.9	5.5	2.2	6.1
	TDLF	3.2	9.5	3.4	10.0	1.7	4.7	2.4	5.3
G6	NLF	4.3	10.5	4.5	11.1	3.8	8.1	4.8	10.3
	SDLF	3.4	9.4	3.5	9.9	1.1	5.3	1.3	6.7
	TDLF	2.7	8.5	2.8	9.0	2.1	2.6	3.1	3.1
G7	NLF	2.5	6.9	2.5	6.9	2.6	6.5	3.4	8.5
	SDLF	1.9	6.2	1.9	6.1	1.4	4.0	1.2	3.5
	TDLF	1.6	5.5	1.6	5.5	4.1	3.7	5.7	3.6
G8	NLF	1.1	4.0	1.1	4.0	2.1	5.3	2.6	7.0
	SDLF	0.9	3.9	0.9	3.9	0.8	2.8	0.7	3.5
	TDLF	0.8	3.8	0.8	3.8	3.4	1.7	3.9	1.6
G9	NLF	2.2	2.5	2.2	2.6	0.6	2.1	2.0	5.9
	SDLF	1.1	1.2	1.1	1.2	0.7	1.3	0.4	2.6
	TDLF	0.8	1.0	0.8	1.0	1.8	1.4	3.2	1.0
All Girders	NLF	8.1	17.8	9.5	21.0	4.3	9.4	5.7	12.8
	SDLF	8.9	18.5	10.4	21.8	2.8	7.9	3.7	10.8
	TDLF	9.7	19.3	11.4	22.7	4.1	6.1	5.7	8.2

Table O1-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	74.6	222.7	219.7	222.7
	SDLF	74.2	195.0	190.7	195.0
	TDLF	87.3	163.6	156.7	163.6
TDL	NLF	158.7	471.8	462.3	471.8
	SDLF	154.1	440.3	432.2	440.3
	TDLF	165.6	405.3	395.4	405.3

Table O1-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	15.8	48.8	48.6	32.3
	SDLF	15.0	44.7	44.3	29.7
	TDLF	16.0	44.0	42.9	29.7
TDL	NLF	35.7	100.3	98.9	67.6
	SDLF	34.7	95.3	94.1	64.7
	TDLF	34.0	90.7	89.7	62.1

Table O1-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.04	0.99	0.77	0.69	0.65	0.48	0.42	0.40	1.04
SDLF	1.12	1.04	0.72	0.58	0.49	0.29	0.22	0.20	1.12
TDLF	1.21	1.08	0.67	0.47	0.32	0.13	0.07	0.09	1.21

Table O1-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	2.23	2.11	1.63	1.47	1.37	1.01	0.92	0.89	2.23
SDLF	2.29	2.14	1.57	1.35	1.21	0.83	0.71	0.68	2.29
TDLF	2.34	2.17	1.49	1.21	1.03	0.62	0.50	0.46	2.34

Table O1-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.75	0.71	0.56	0.50	0.47	0.34	0.30	0.29	0.75
SDLF	0.80	0.75	0.52	0.42	0.36	0.21	0.16	0.14	0.80
TDLF	0.87	0.78	0.48	0.34	0.23	0.09	0.05	0.06	0.87

Table O1-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.61	1.52	1.17	1.06	0.99	0.73	0.66	0.64	1.61
SDLF	1.65	1.55	1.13	0.97	0.88	0.60	0.51	0.49	1.65
TDLF	1.68	1.57	1.07	0.87	0.74	0.45	0.36	0.33	1.68

Table O1-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	1206	2828
SDLF	1206	2828
TDLF	1206	2828

Table O1-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	170	369	0.8	3.0	0.7	2.9
SDLF	183	381	0.4	1.9	0.3	1.2
TDLF	199	395	0.4	0.9	1.1	0.6

Table O1-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.45	0.60	0.14	0.57
SDLF	0.45	0.59	0.05	0.25
TDLF	0.60	1.05	0.23	0.12

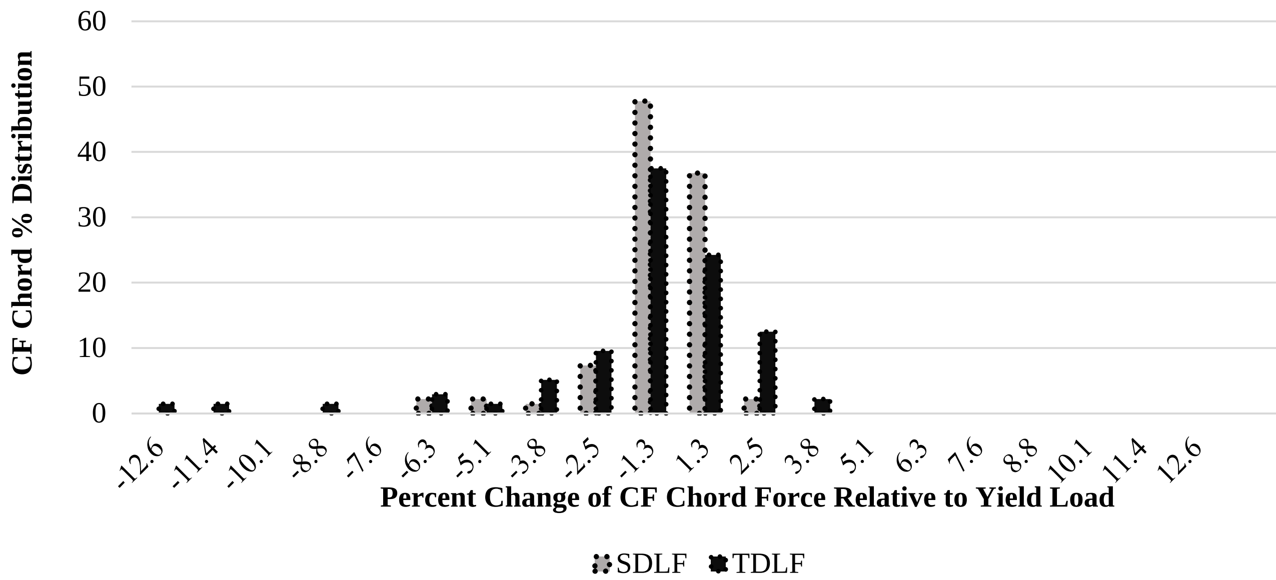


Figure O1-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

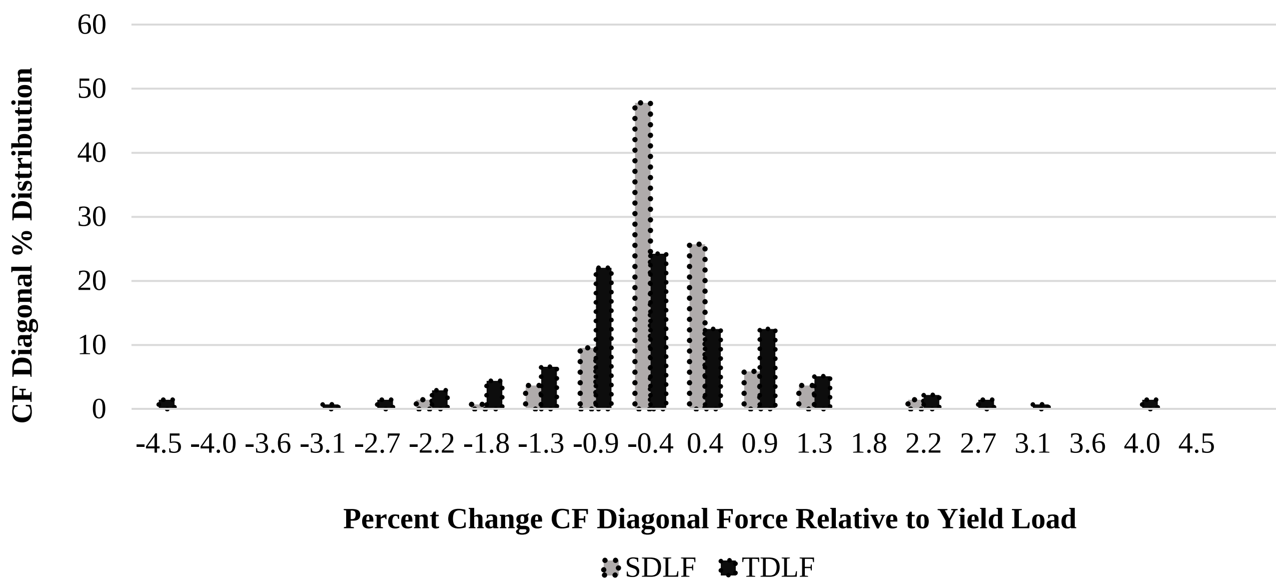


Figure O1-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

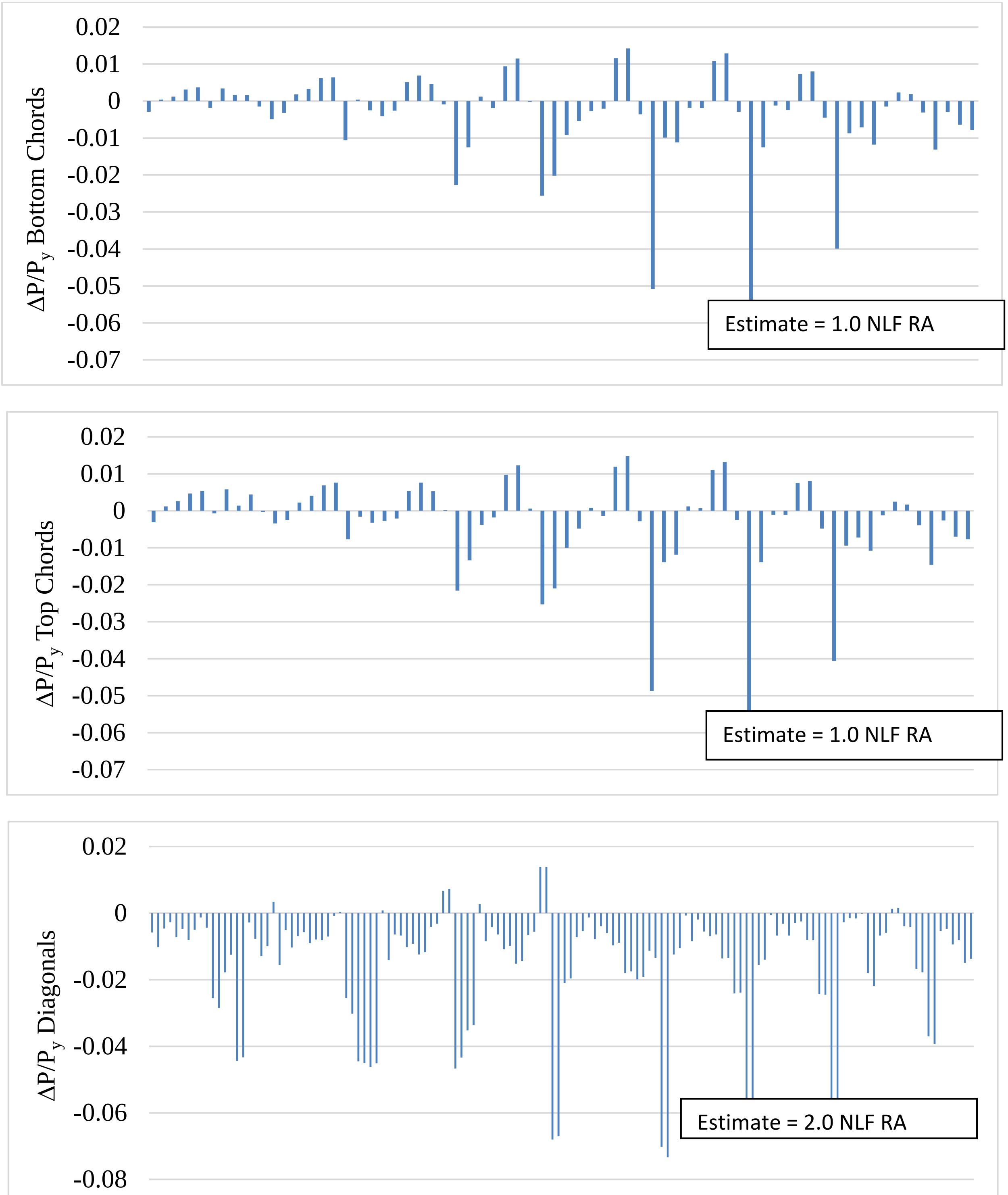


Figure O1-2-3. **Difference between magnitude of estimated and DLF RA forces, divided by the member yield load ((ΔP/P_y), under SDL, SDLF detailing.**

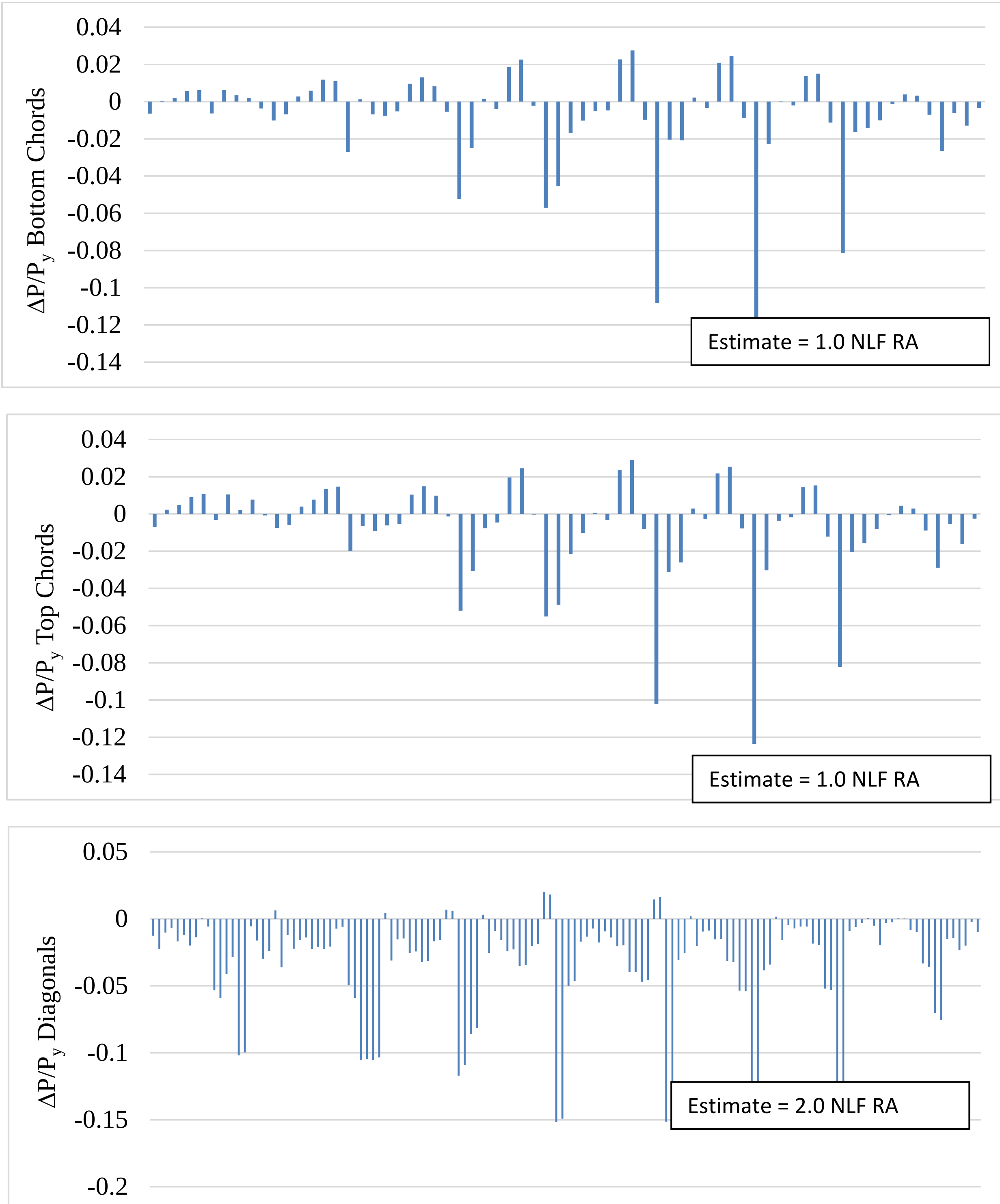


Figure O1-2-4. **Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.**

Appendix O1-3. NISCS15 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISCS15 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table O1-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	Erection Method 1			Erection Method 2A			Erection Method 3			Erection Method 4		
	F1	F2	F_{max}	F1	F2	F_{max}	F1	F2	F_{max}	F1	F2	F_{max}
NLF	70.1	79.3	79.3	40.8	33.3	40.8	5.1	82.0	82.0	9.9	6.4	9.9
SDLF	67.9	81.0	81.0	38.4	39.2	39.2	14.1	32.6	32.6	34.7	38.5	38.5
TDLF	76.5	81.8	81.8	64.5	45.5	64.5	32.0	93.8	93.8	71.2	58.7	71.2

Table O1-3-2. Summary of erection method 1 vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	319.5	37.8
	SDLF	318.1	66
	TDLF	310.2	72
G2	NLF	132	0
	SDLF	132.2	0
	TDLF	130.9	12.9
G3	NLF	121.5	0
	SDLF	121.5	0
	TDLF	117	0
G4	NLF	76.8	0
	SDLF	74.2	0
	TDLF	73.9	0
G5	NLF	72.7	50
	SDLF	69.2	44.2
	TDLF	66.8	37.7
G6	NLF	64.1	34.7
	SDLF	60.4	32.7
	TDLF	56.4	33
G7	NLF	38.6	24.3
	SDLF	33.1	24.3
	TDLF	31.6	20.6
G8	NLF	12.6	3.4
	SDLF	24.8	1.3
	TDLF	22.2	0
G9	NLF	8.4	0
	SDLF	10.6	0
	TDLF	28.4	3.3
All Girders	NLF	319.5	8.4
	SDLF	318.1	10.6
	TDLF	310.2	22.2

Table O1-3-3. Summary of erection method 1 crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	174.1	0	124.2	120
SDLF	51.5	0	167.1	154.9
TDLF	42.8	0	165.8	151.3

Table O1-3-4. Summary of erection method 2A vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	171.6	0
	SDLF	184.2	14.3
	TDLF	199.2	4.6
G2	NLF	132	0
	SDLF	132.2	25.1
	TDLF	130.9	10.6
G3	NLF	121.5	43
	SDLF	121.5	53.5
	TDLF	117	36.4
G4	NLF	76.8	0
	SDLF	74.2	15
	TDLF	73.9	0
G5	NLF	72.7	50
	SDLF	69.2	44.2
	TDLF	66.8	37.7
G6	NLF	64.1	34.7
	SDLF	60.4	32.7
	TDLF	56.4	33
G7	NLF	38.6	24.3
	SDLF	33.1	24.3
	TDLF	31.6	20.6
G8	NLF	12.6	3.4
	SDLF	24.8	1.3
	TDLF	22.2	0
G9	NLF	8.4	0
	SDLF	10.6	0
	TDLF	28.4	3.3
All Girders	NLF	171.6	8.4
	SDLF	184.2	10.6
	TDLF	199.2	22.2

Table O1-3-5. Summary of erection method 2A crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	183.5	0	191.7	93.7
SDLF	51	0	192.8	110.1
TDLF	74.7	0	199.4	62.4

Table O1-3-6. Summary of erection method 3 vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	21.3	0
	SDLF	15.1	0
	TDLF	39.2	0
G2	NLF	0	0
	SDLF	38.3	16.8
	TDLF	69.4	30.6
G3	NLF	20.6	15.3
	SDLF	60.4	37
	TDLF	74.9	57.3
G4	NLF	48	0
	SDLF	45.6	0
	TDLF	50.3	0
G5	NLF	42.4	0
	SDLF	43.3	19.7
	TDLF	49	5.6
G6	NLF	46.9	0
	SDLF	48.3	33.2
	TDLF	59.5	30.6
G7	NLF	40.1	24.7
	SDLF	38.6	30.6
	TDLF	41.2	26.3
G8	NLF	44.4	0
	SDLF	40.6	4.1
	TDLF	35	11.3
G9	NLF	48.7	0.8
	SDLF	49.2	1.6
	TDLF	56.3	6.7
All Girders	NLF	48.7	0
	SDLF	60.4	15.1
	TDLF	74.9	35

Table O1-3-7. Summary of erection method 3 crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	136.4	63.3	299.2	23.1
SDLF	207.2	63.6	226.1	0
TDLF	249.7	57.5	176.8	0

Table O1-3-8. Summary of erection method 4 vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	129.6	36.1
	SDLF	276.7	65.7
	TDLF	203.2	71.9
G2	NLF	122.2	13.3
	SDLF	77.2	0
	TDLF	92.7	0
G3	NLF	118.1	30
	SDLF	66	0
	TDLF	76.9	0
G4	NLF	75.4	9.5
	SDLF	41.2	0
	TDLF	49.6	0
G5	NLF	64.7	24.3
	SDLF	37.9	0
	TDLF	44.6	0
G6	NLF	87	23
	SDLF	44.1	0
	TDLF	44.6	0
G7	NLF	40.7	17.8
	SDLF	30.5	0
	TDLF	32.8	0
G8	NLF	36.5	15
	SDLF	41.1	24.1
	TDLF	25.5	0
G9	NLF	20.1	5.8
	SDLF	45.4	7.1
	TDLF	37.1	0
All Girders	NLF	129.6	5.8
	SDLF	276.7	0
	TDLF	203.2	0

Table O1-3-9. Summary of erection method 4 crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	92.1	27.2	52.2	48.9
SDLF	78.6	21.2	58.3	53.7
TDLF	51.8	0	31.8	22.4

Table O1-3-10. Erection total vertical reactions at each sub-stage

Erection Method	Stage	Detailing Method	Sub-Stage									
			1	2	3	4	5	6	7	8	9	10
1	2	NLF	363	367	370	374	377	380	384	387	391	394
		SDLF	363	367	370	374	377	380	384	387	391	394
		TDLF	363	367	370	374	377	380	384	387	391	394
	4	NLF	698	701	704	708	711	715				
		SDLF	698	701	704	708	711	715				
		TDLF	698	701	704	708	711	715				
	9	NLF	1185	1189	1192	1195	1199	1202	1206			
		SDLF	1185	1189	1192	1195	1199	1202	1206			
		TDLF	1185	1189	1192	1195	1199	1202	1206			
2A	2	NLF	363	367	370	374	377	380	384	387	391	394
		SDLF	363	367	370	374	377	380	384	387	391	394
		TDLF	363	367	370	374	377	380	384	387	391	394
	4	NLF	698	701	704	708	711	715				
		SDLF	698	701	704	708	711	715				
		TDLF	698	701	704	708	711	715				
	9	NLF	1185	1189	1192	1195	1199	1202	1206			
		SDLF	1185	1189	1192	1195	1199	1202	1206			
		TDLF	1185	1189	1192	1195	1199	1202	1206			
3	2	NLF	115	118	122	125	129	132	135			
		SDLF	115	118	122	125	129	132	135			
		TDLF	115	118	122	125	129	132	135			
	6	NLF	568	572	575	578	582	585	589	592		
		SDLF	568	572	575	578	582	585	589	592		
		TDLF	568	572	575	578	582	585	589	592		
	9	NLF	1175	1178	1182	1185	1189	1192	1195	1199	1202	1206
		SDLF	1175	1178	1182	1185	1189	1192	1195	1199	1202	1206
		TDLF	1175	1178	1182	1185	1189	1192	1195	1199	1202	1206

Table O1-3-10(Continued). Erection total vertical reactions at each sub-stage

Erection Method	Stage	Detailing Method	Sub-Stage									
			1	2	3	4	5	6	7	8	9	10
4	2	NLF	363	367	370	374	377	380	384	387	391	394
		SDLF	363	367	370	374	377	380	384	387	391	394
		TDLF	363	367	370	374	377	380	384	387	391	394
	4	NLF	698	701	704	708	711	715				
		SDLF	698	701	704	708	711	715				
		TDLF	698	701	704	708	711	715				
	9	NLF	1185	1189	1192	1195	1199	1202	1206			
		SDLF	1185	1189	1192	1195	1199	1202	1206			
		TDLF	1185	1189	1192	1195	1199	1202	1206			

Appendix O1-4. NISCS15 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge NISCS15 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

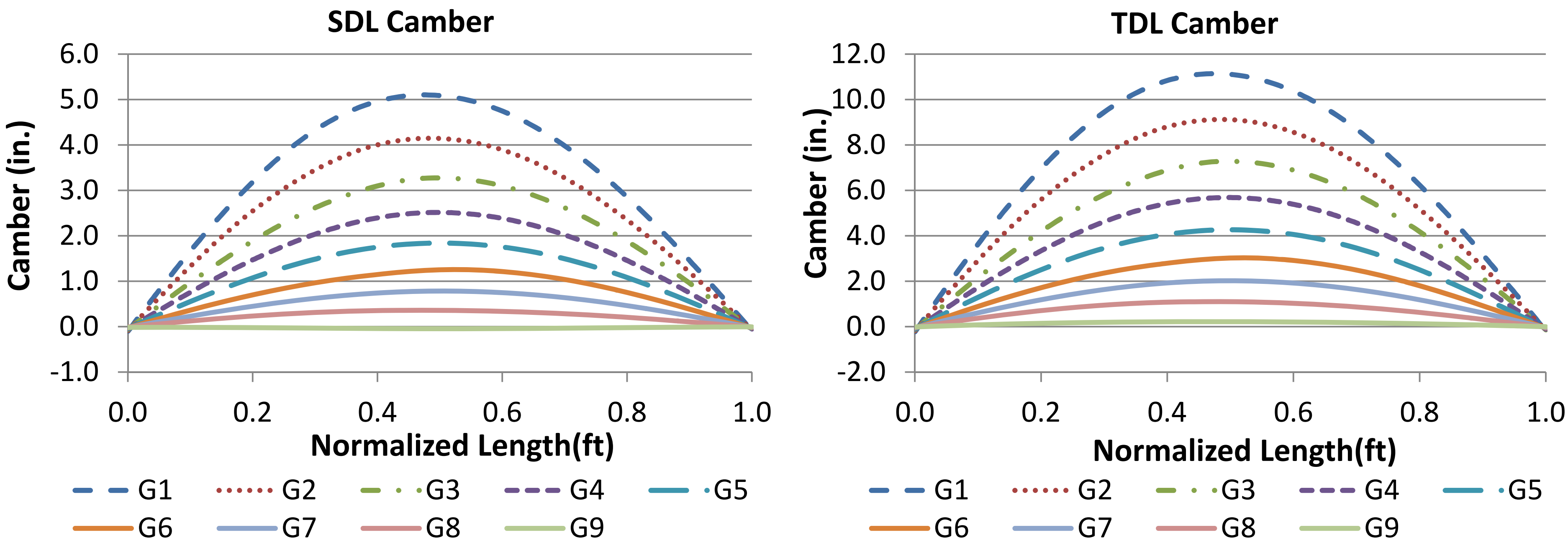


Figure O1-4-1. SDL and TDL 3D FEA cambers.

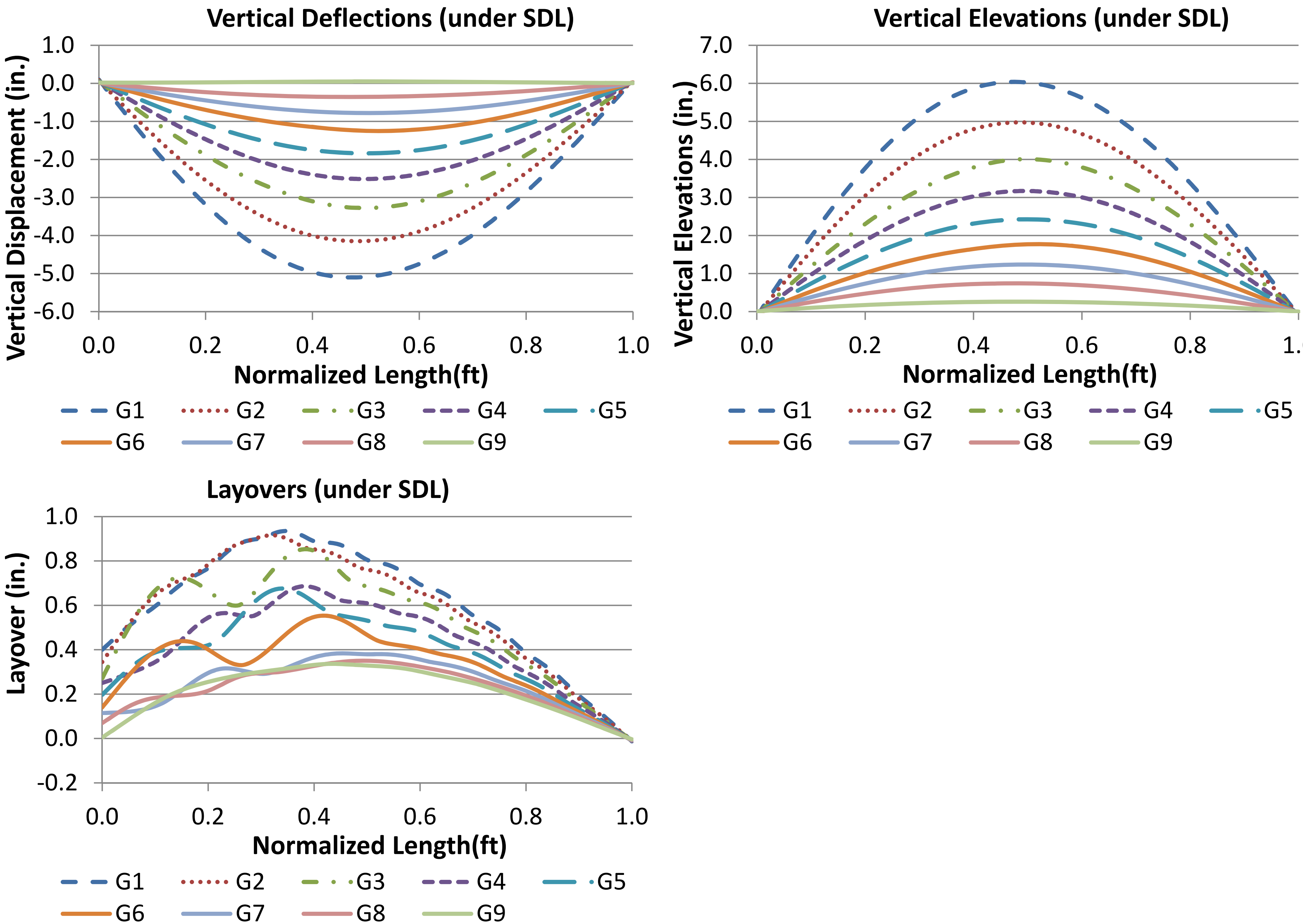


Figure O1-4-2. **Bridge displacements and elevation profiles (in) under SDL, NLF detailing.**

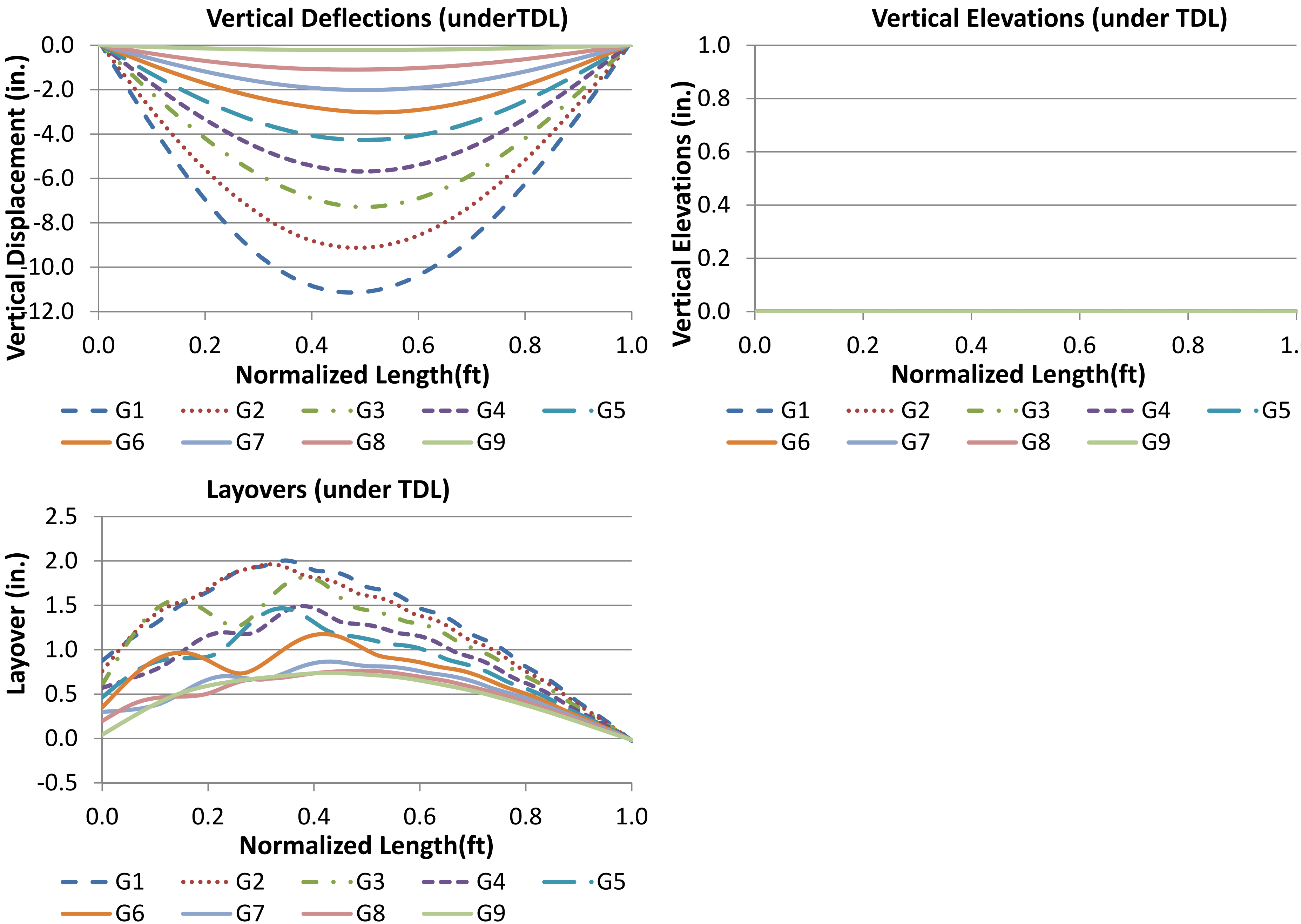


Figure O1-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

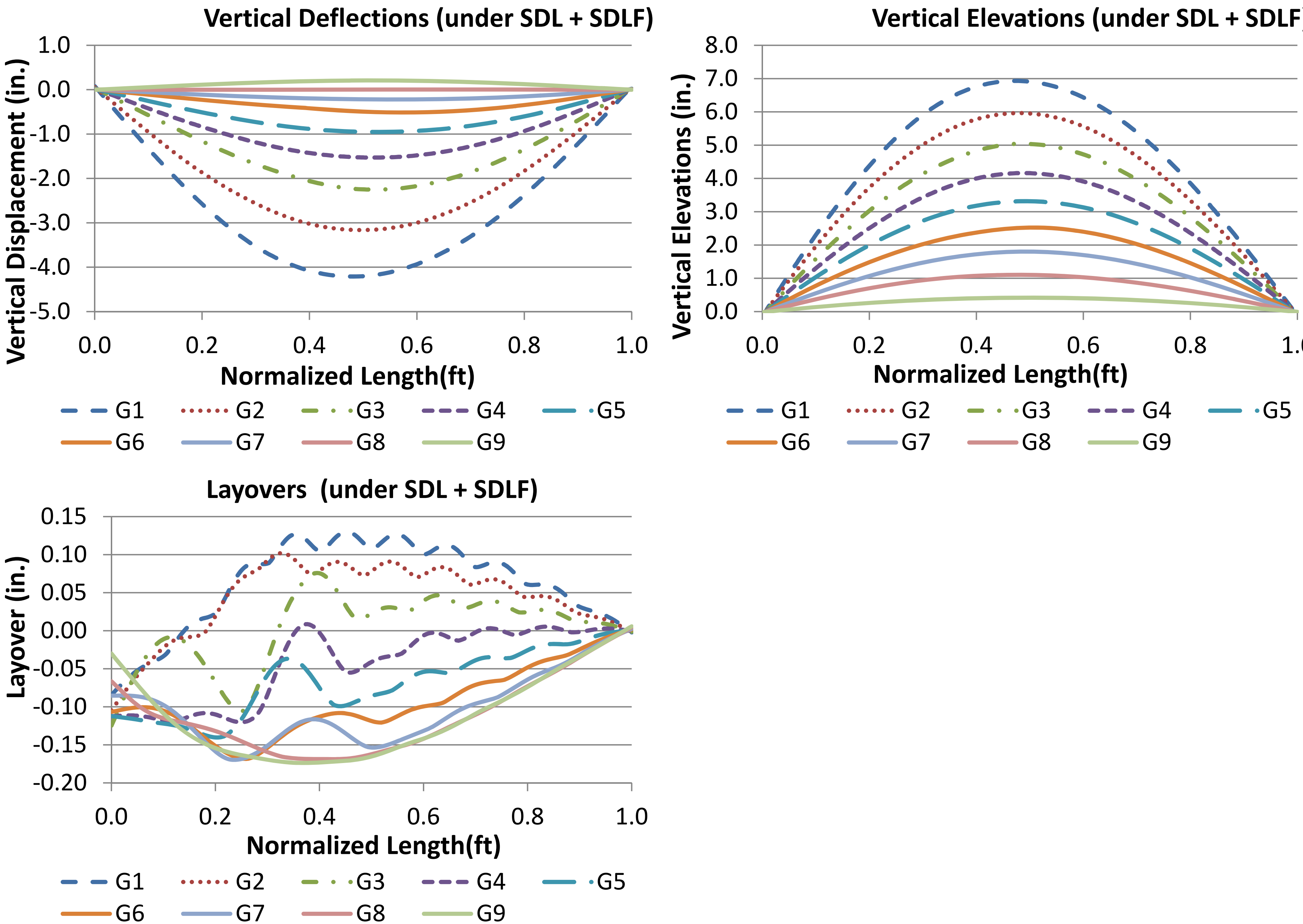


Figure O1-4-4. **Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.**

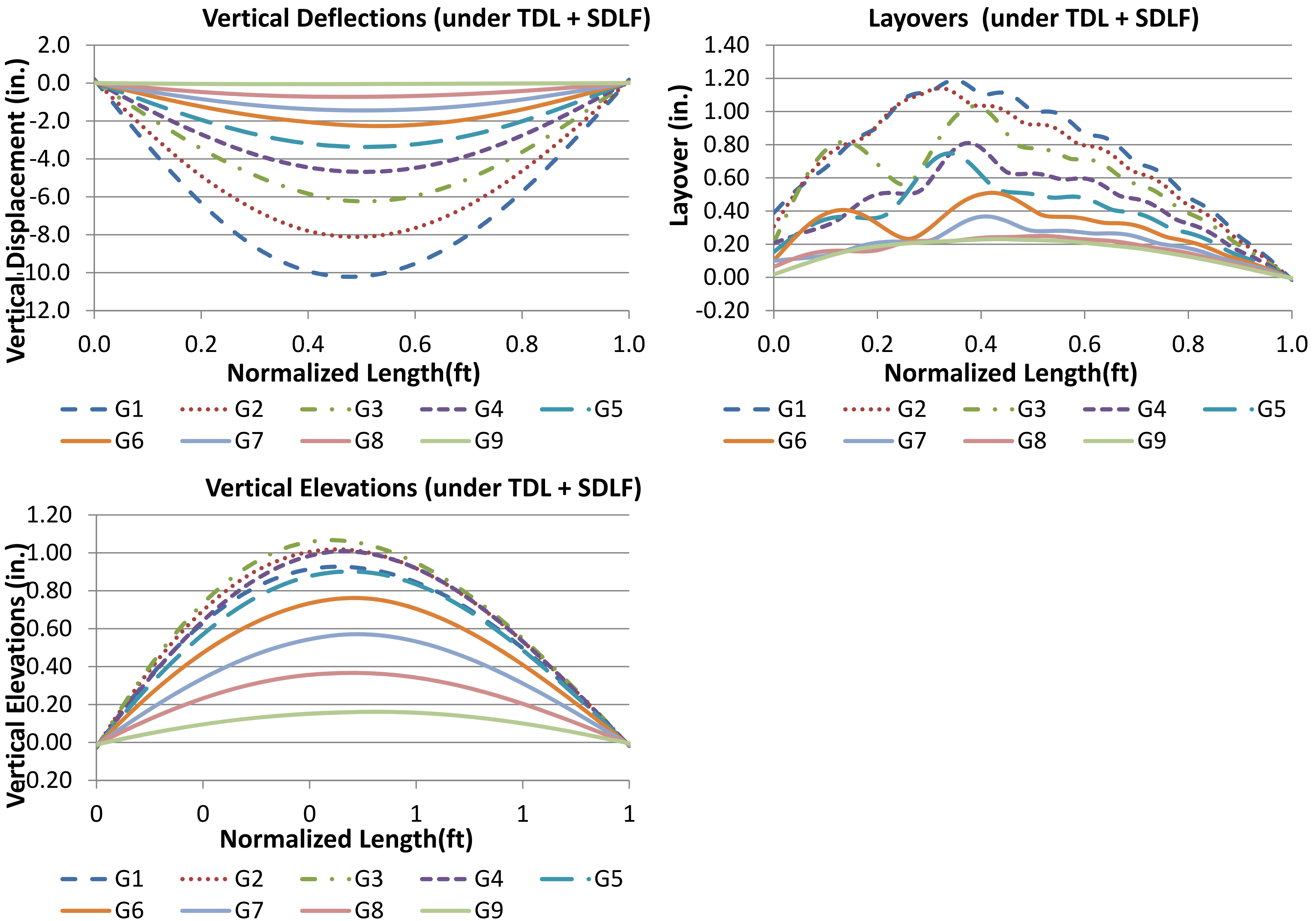


Figure O1-4-5. **Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.**

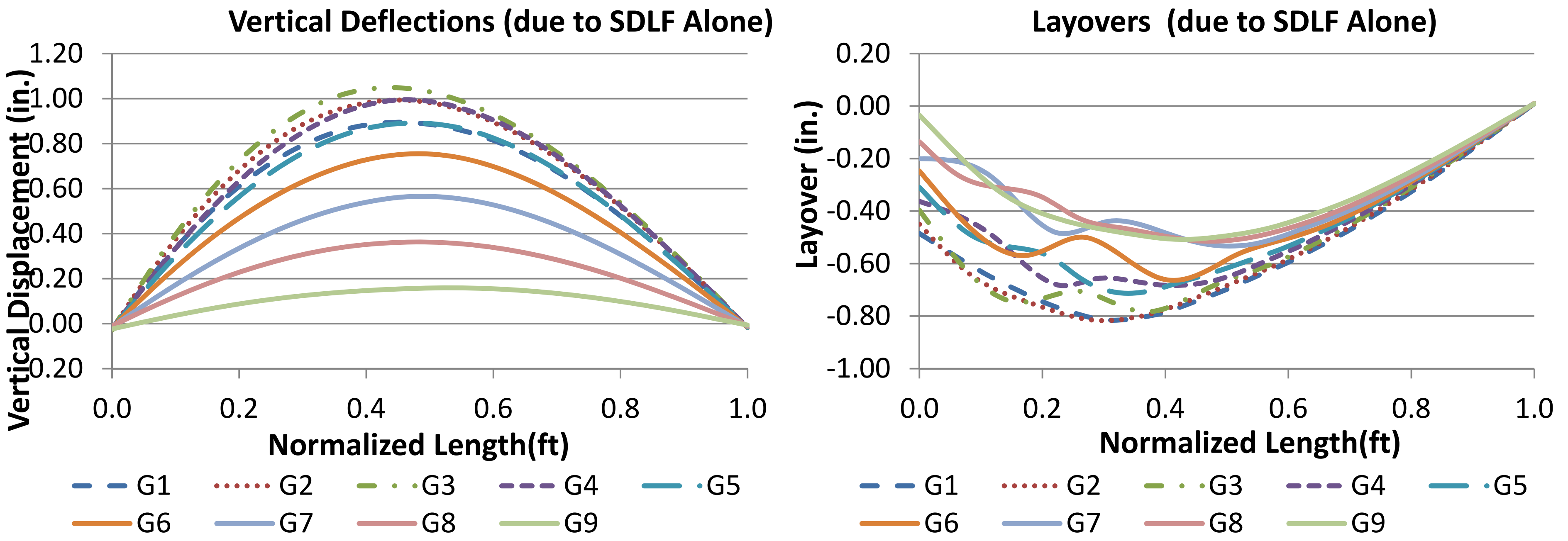


Figure O1-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

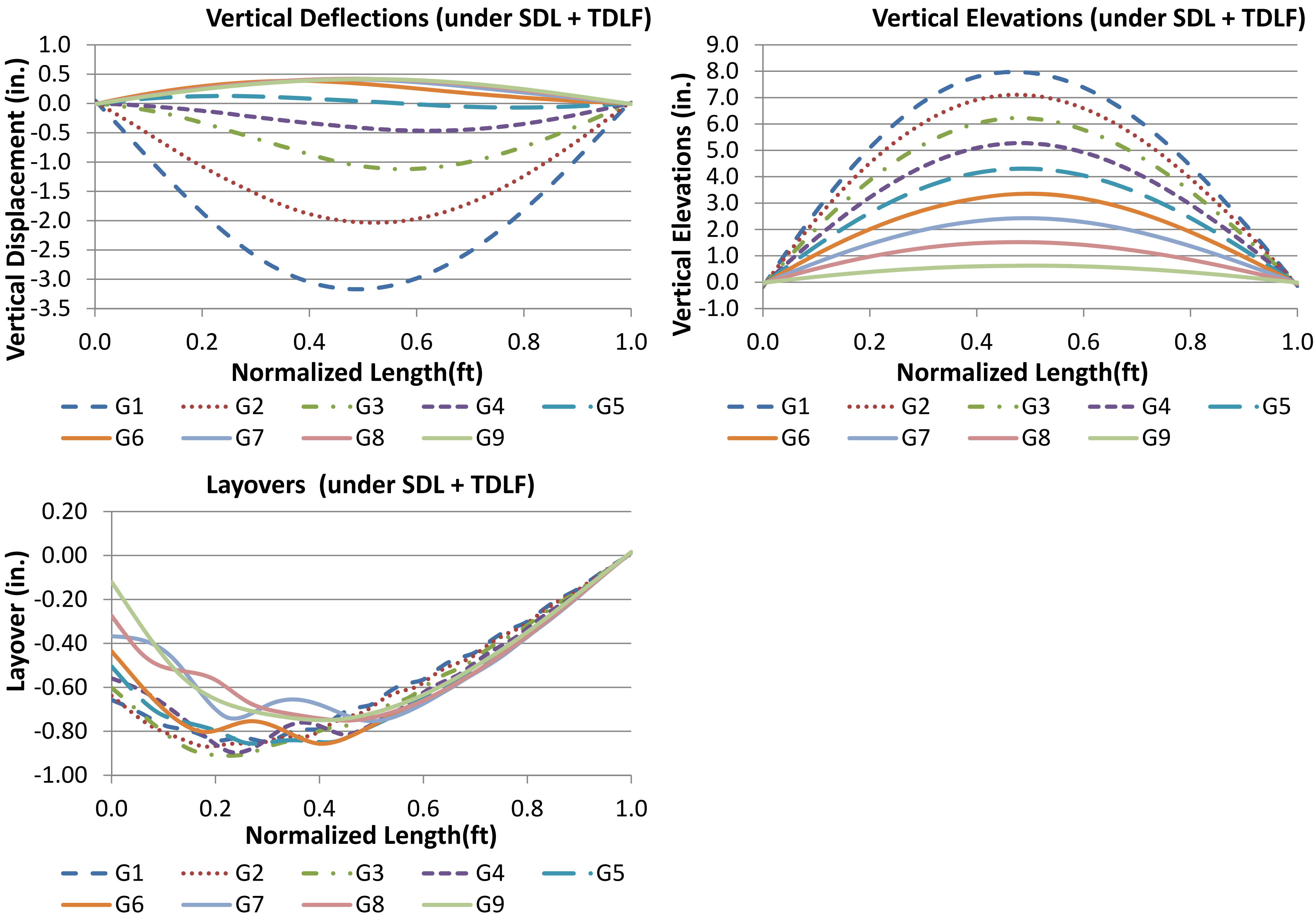


Figure O1-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

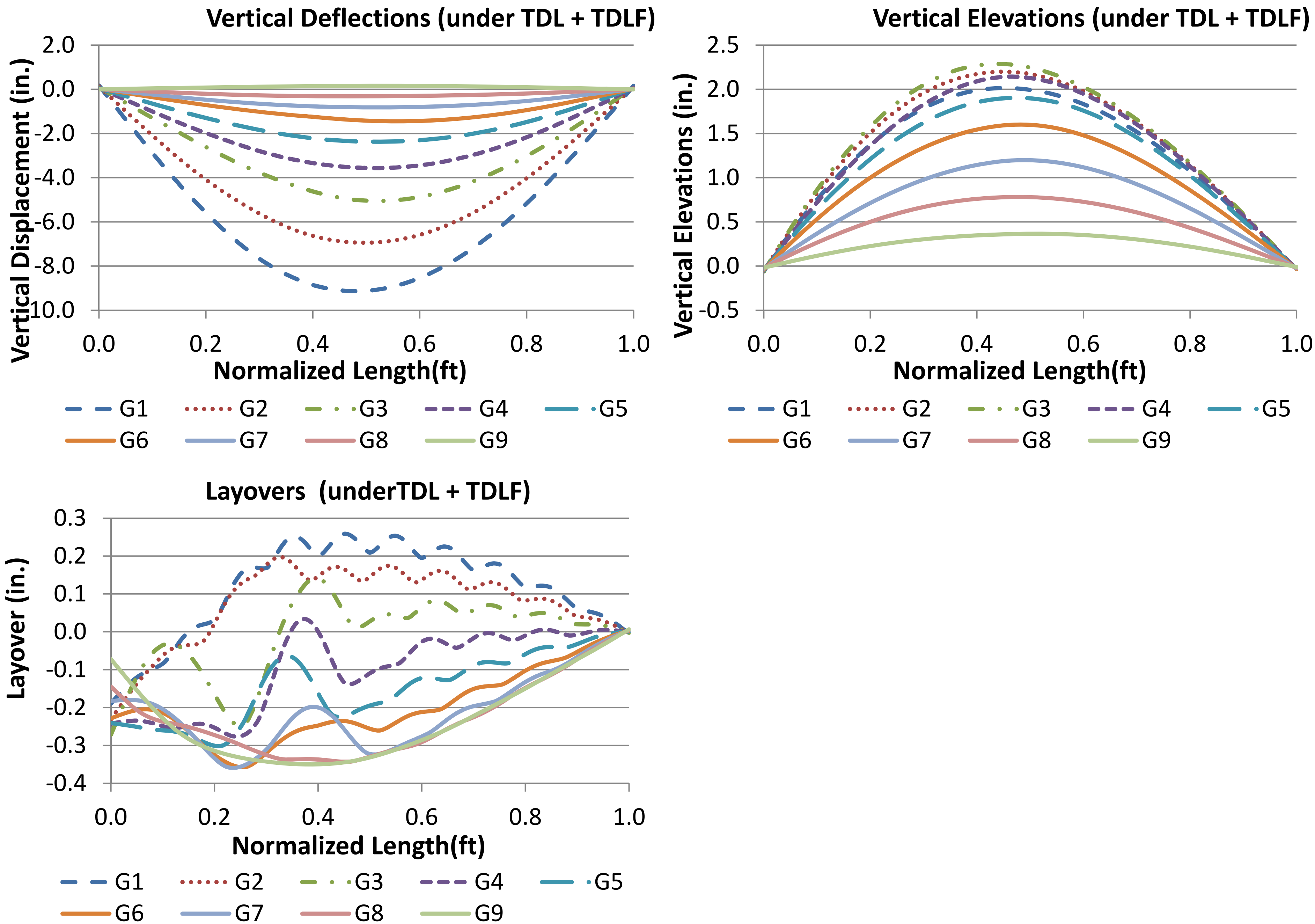


Figure O1-4-8. **Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.**

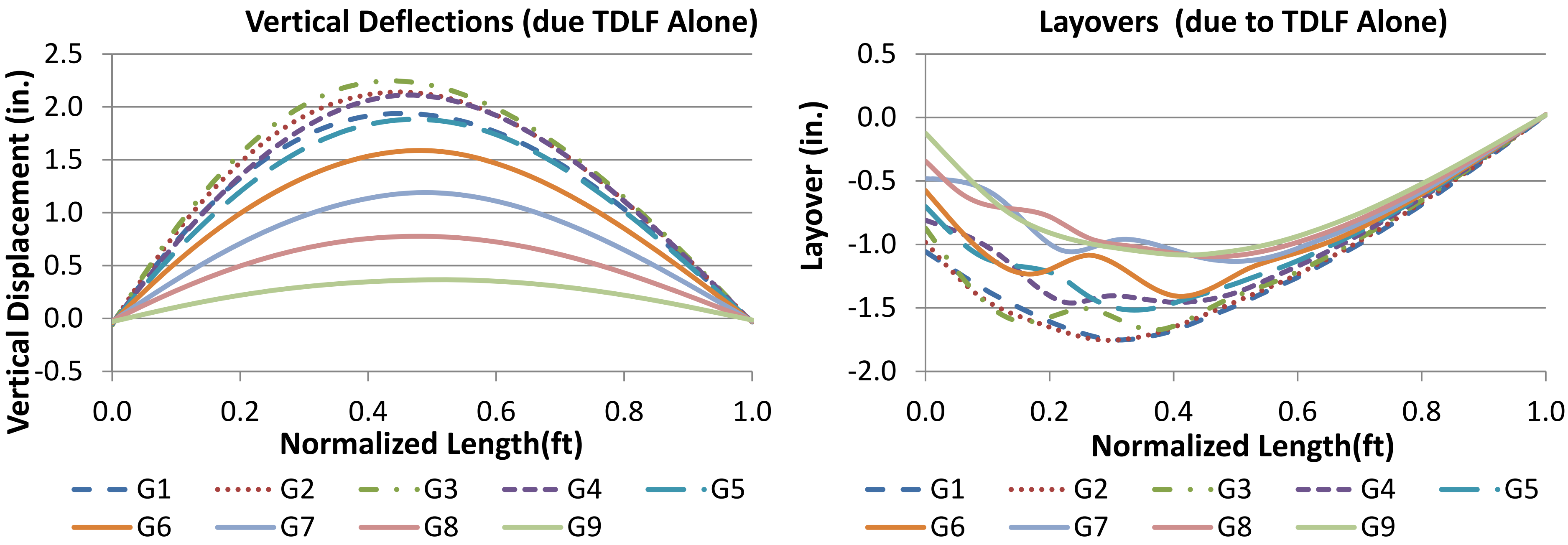


Figure O1-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

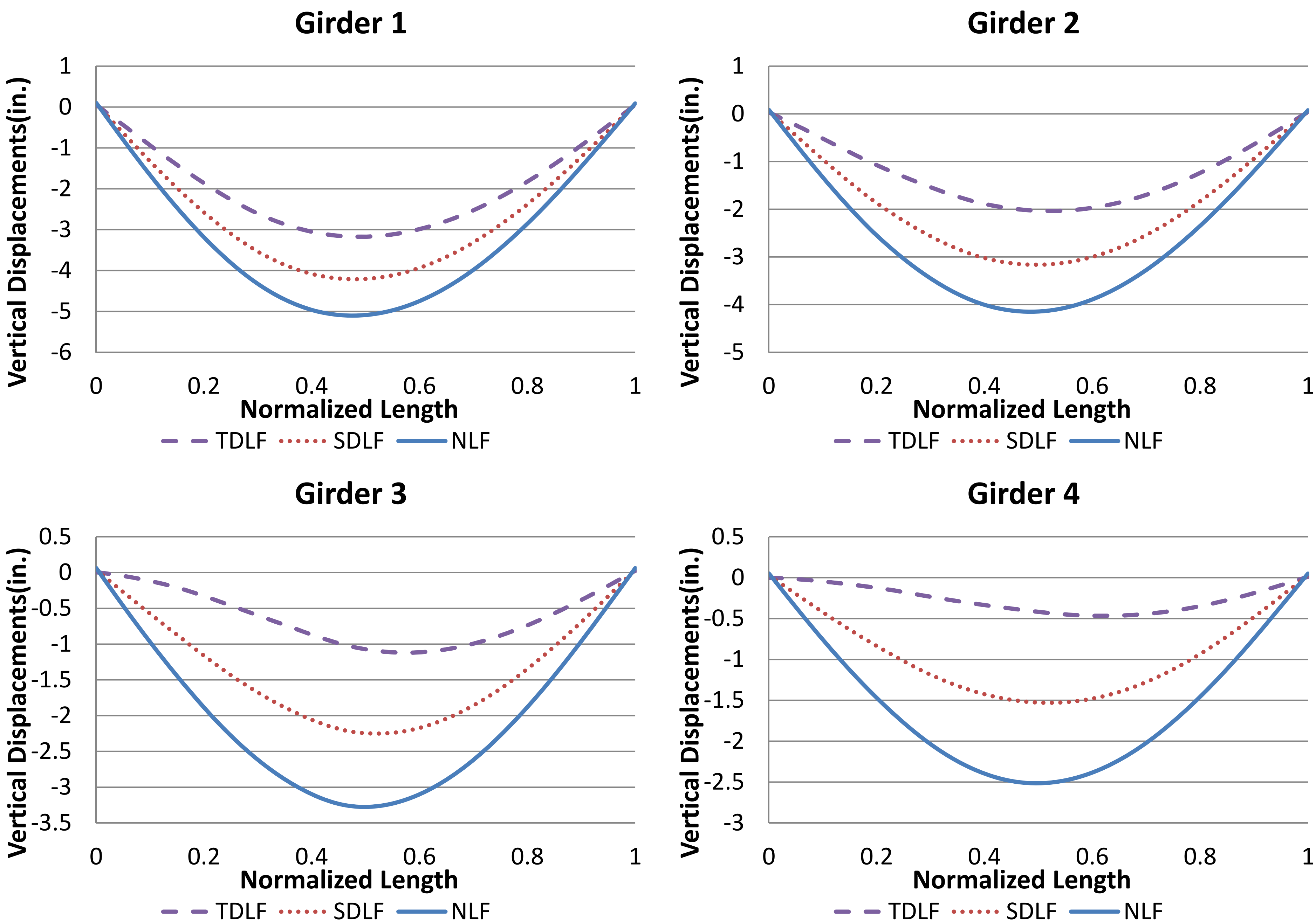


Figure O1-4-10. **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

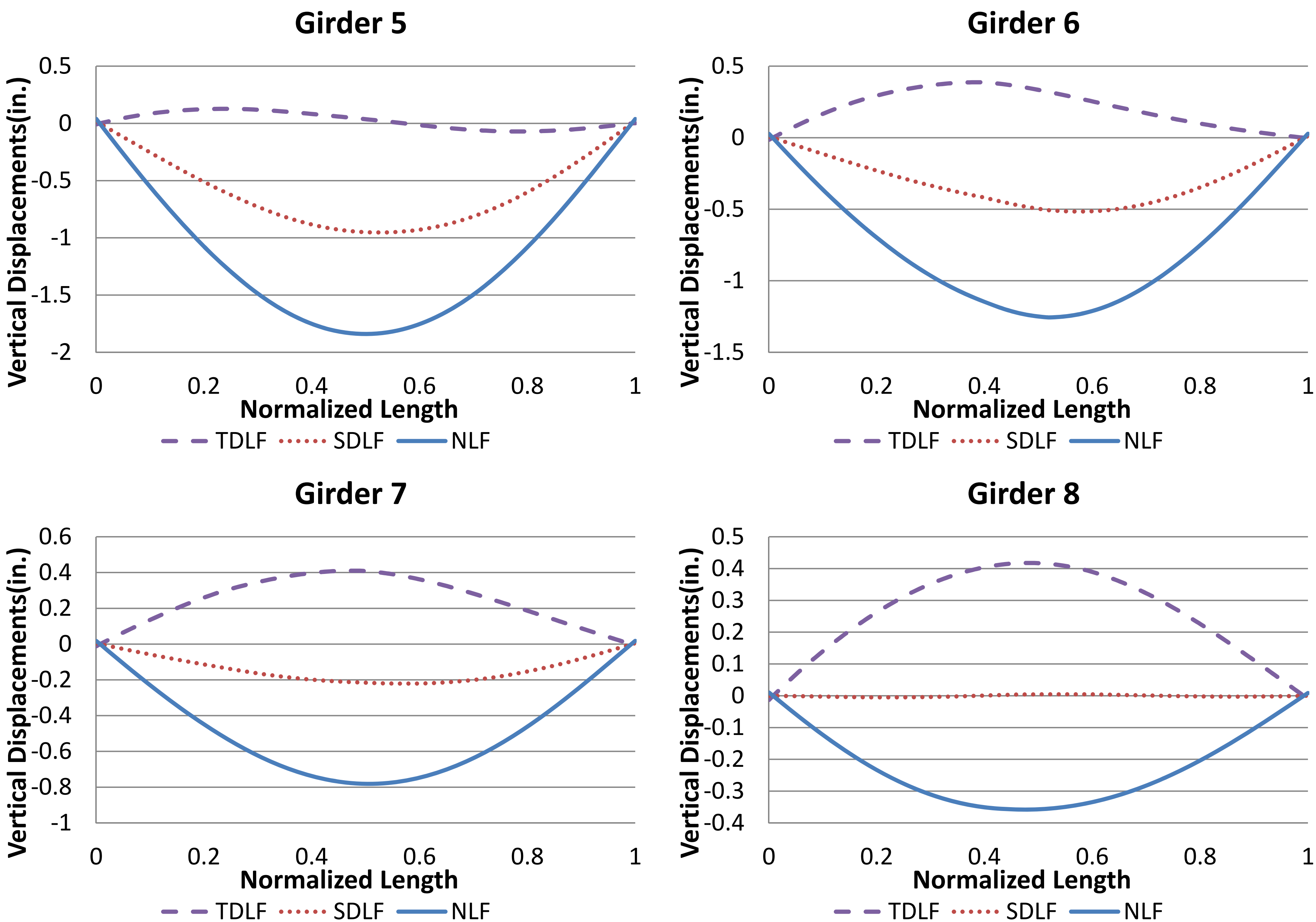


Figure O1-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

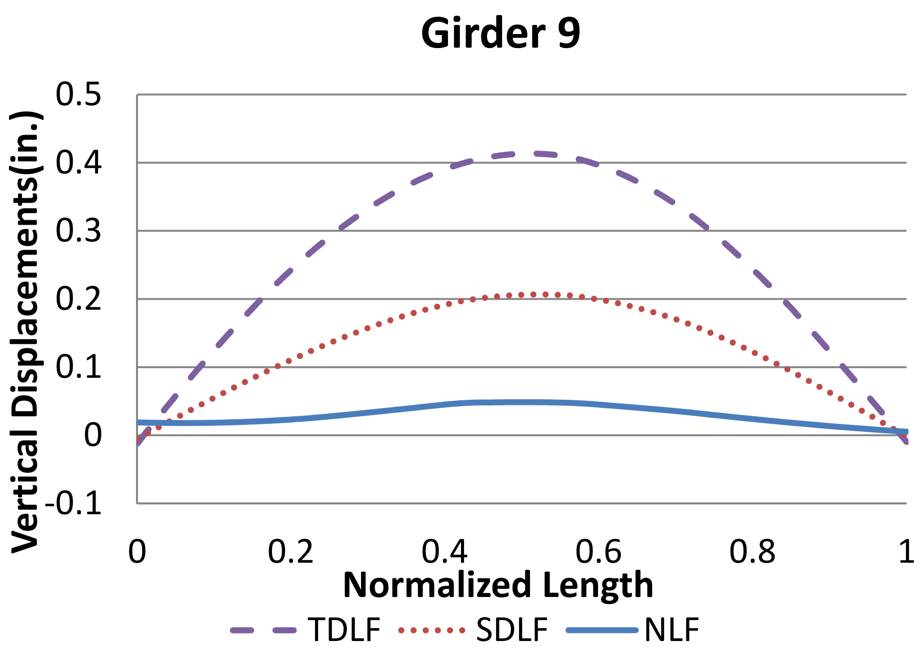


Figure O1-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

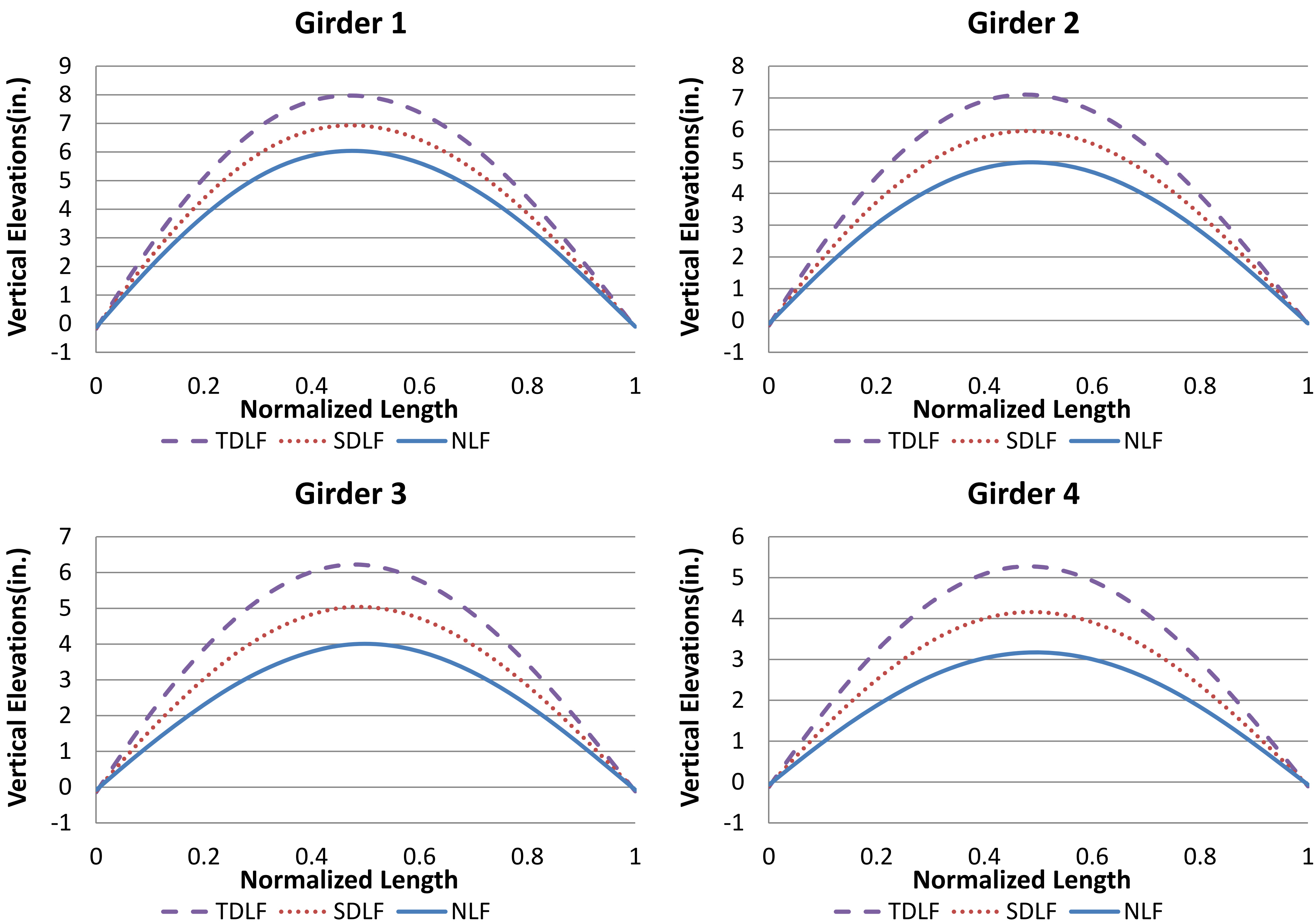


Figure O1-4-11. **Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.**

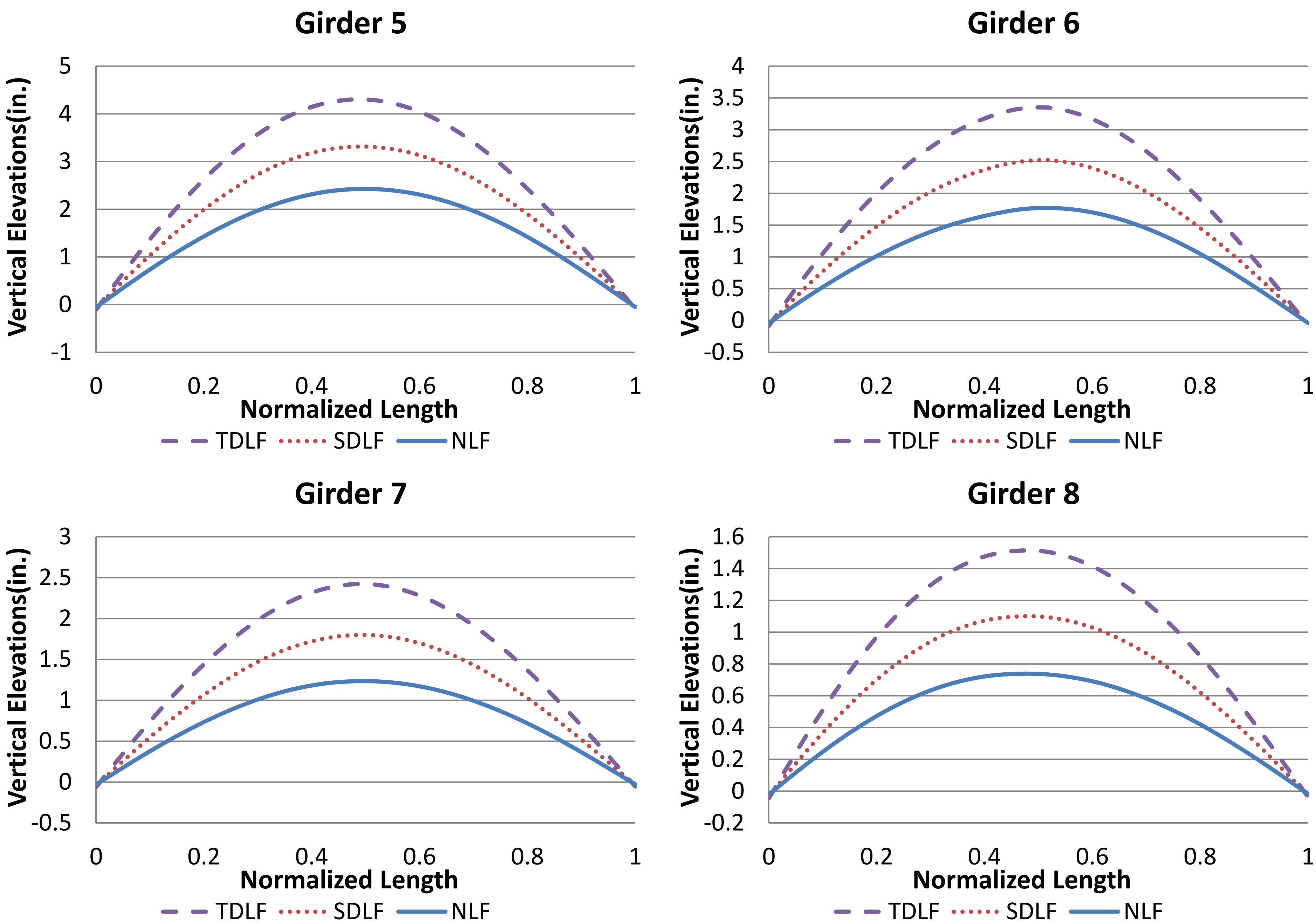


Figure O1-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

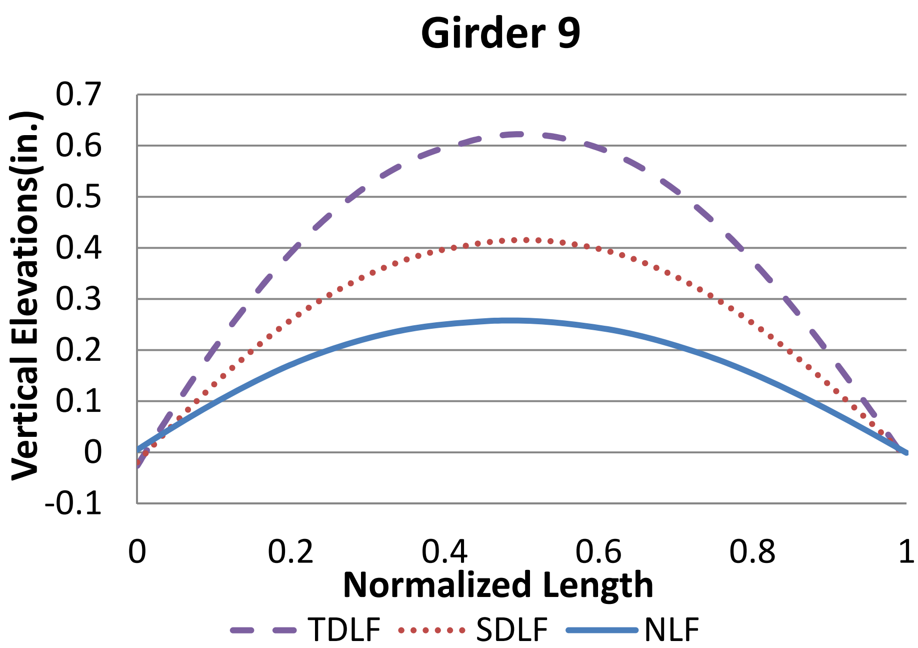


Figure O1-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

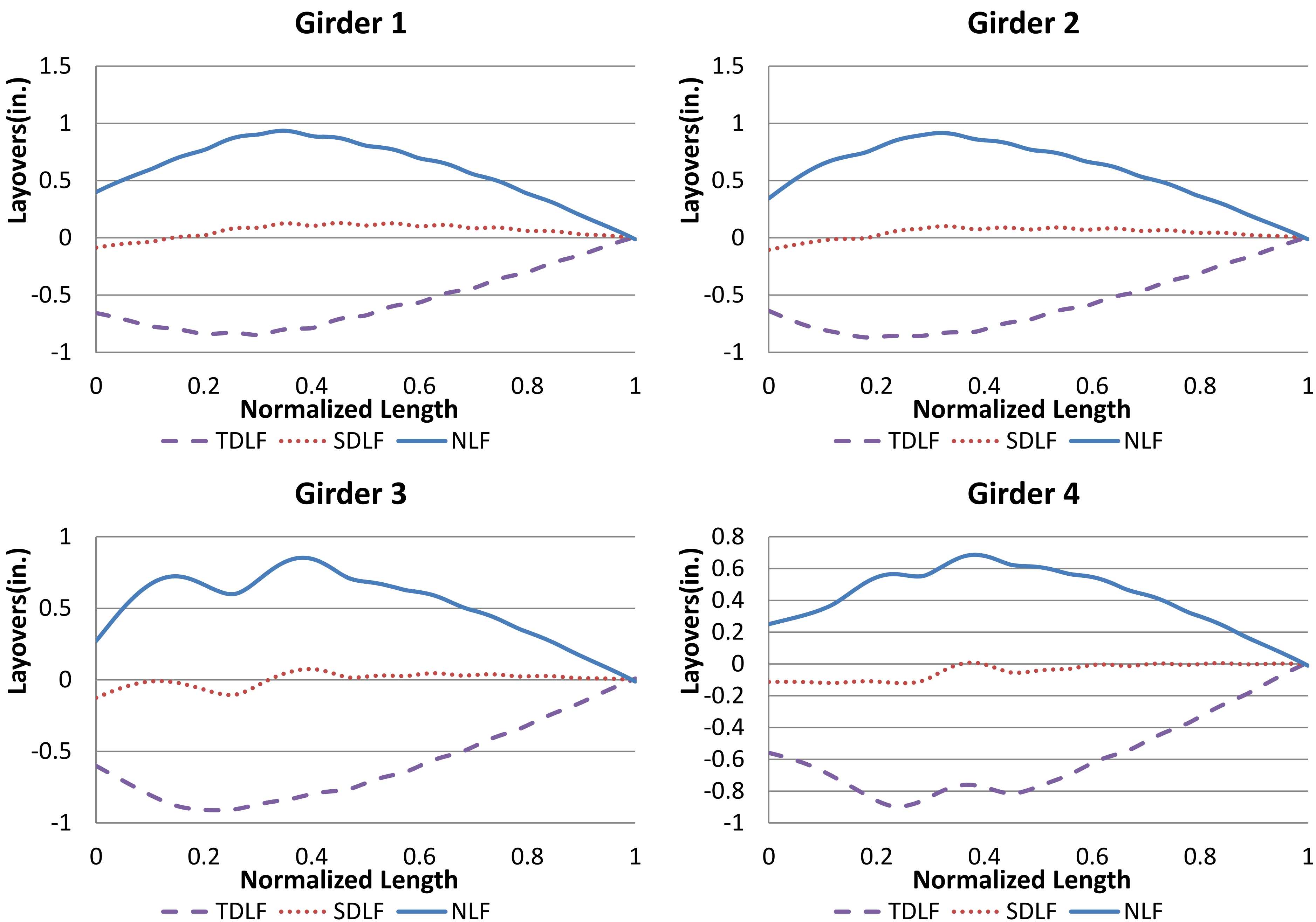


Figure O1-4-12. **Comparison of individual girder layovers (in) under SDL for different detailing methods.**

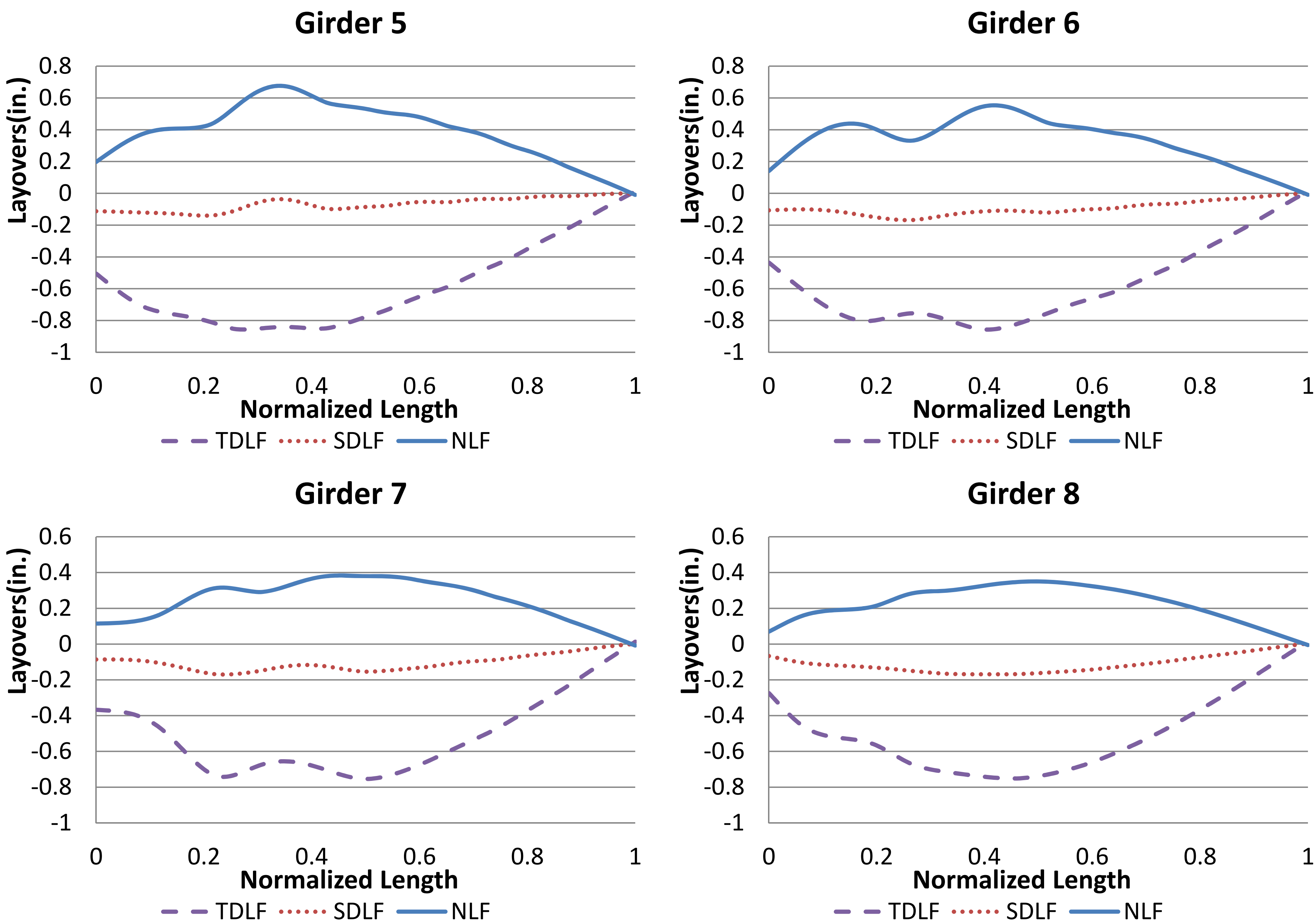


Figure O1-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

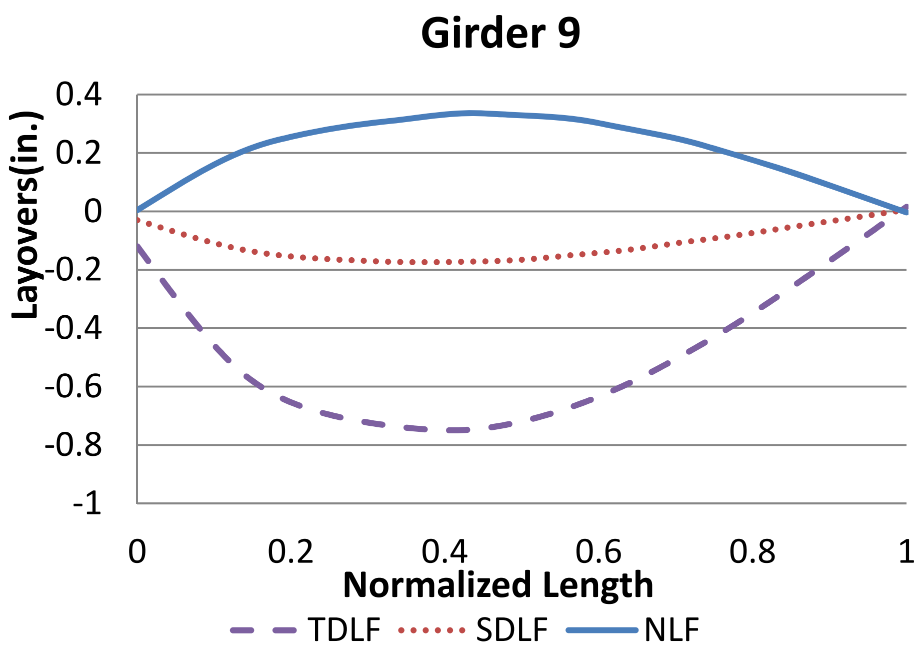


Figure O1-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

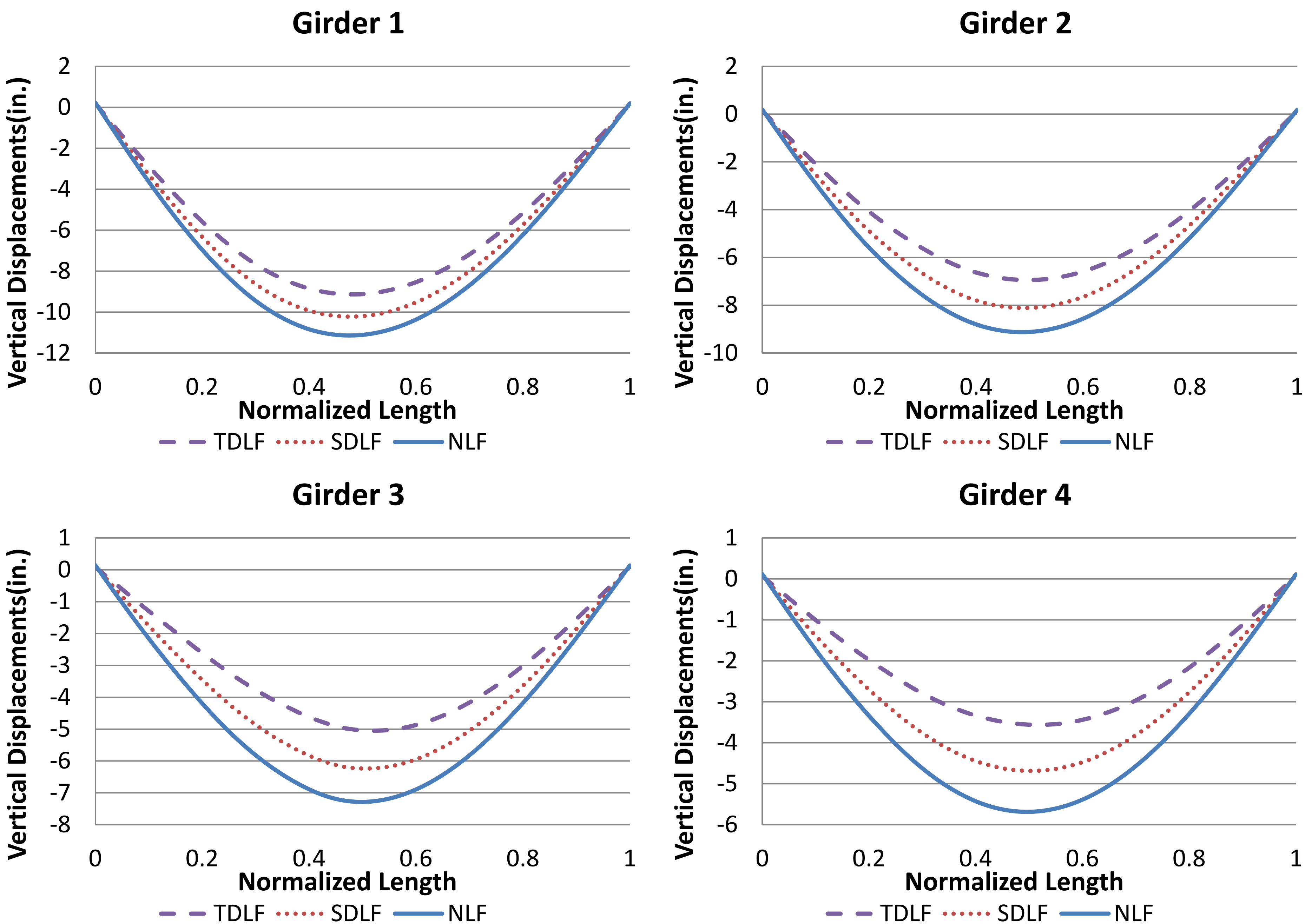


Figure O1-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

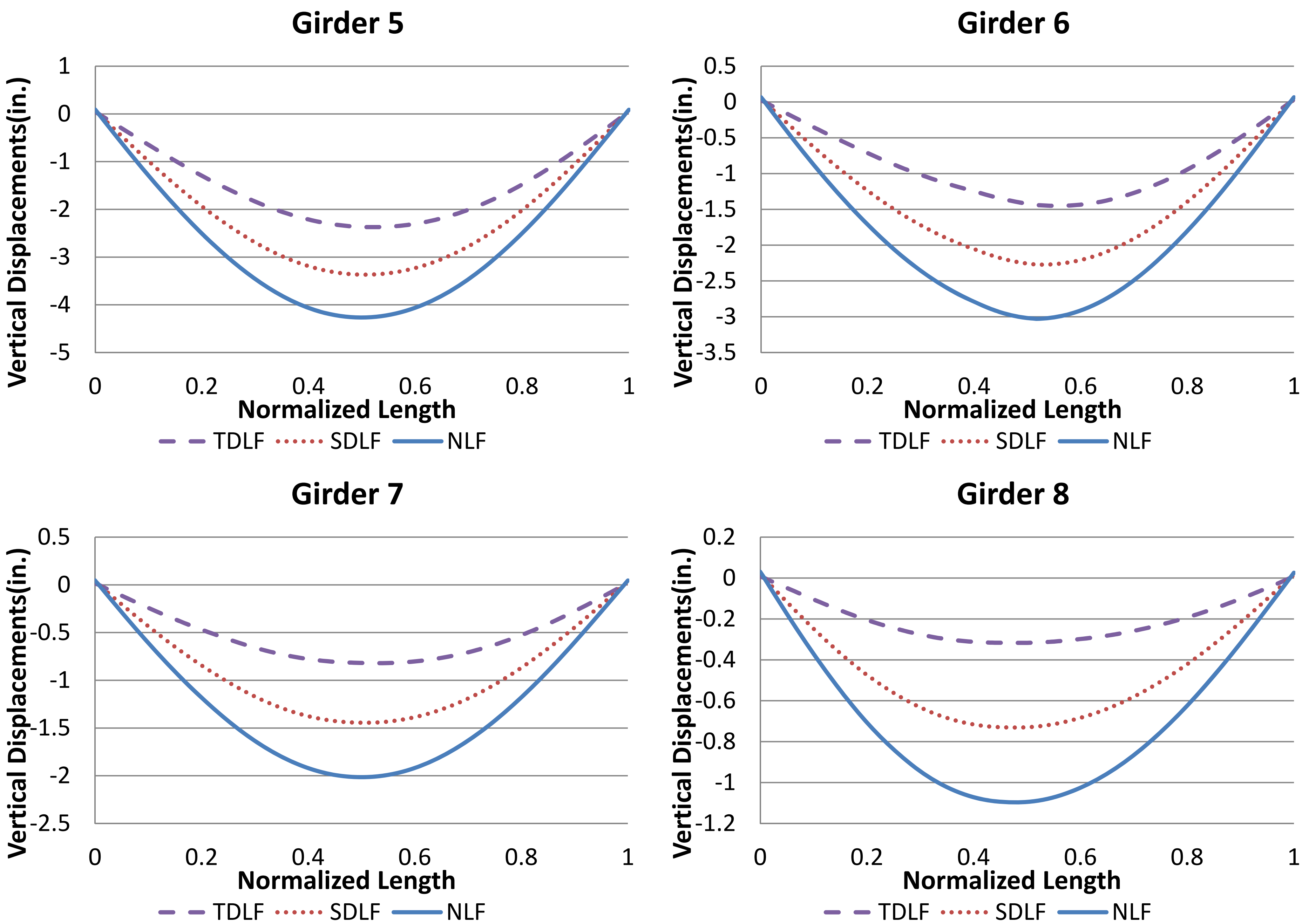


Figure O1-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

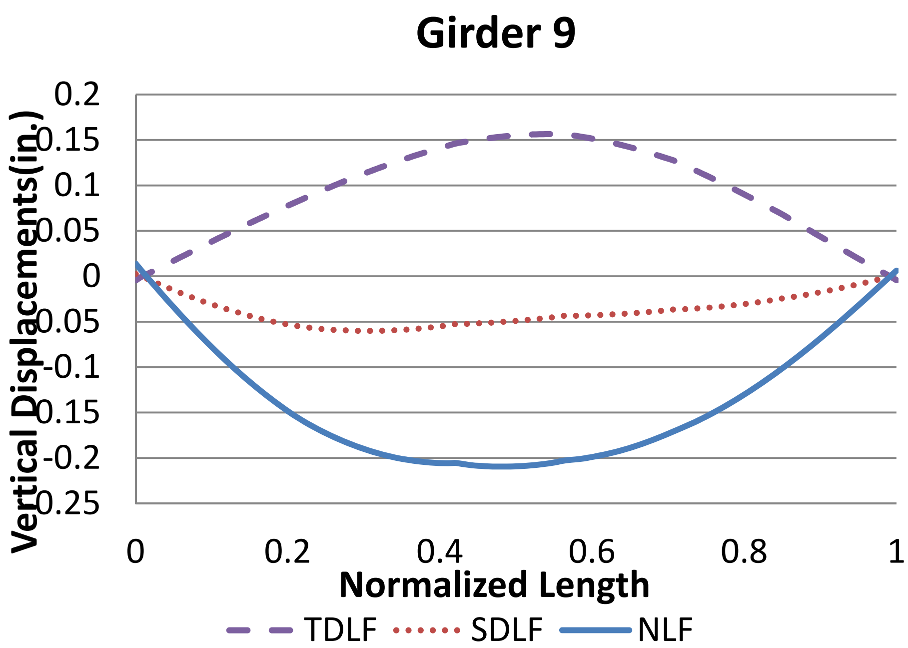


Figure O1-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

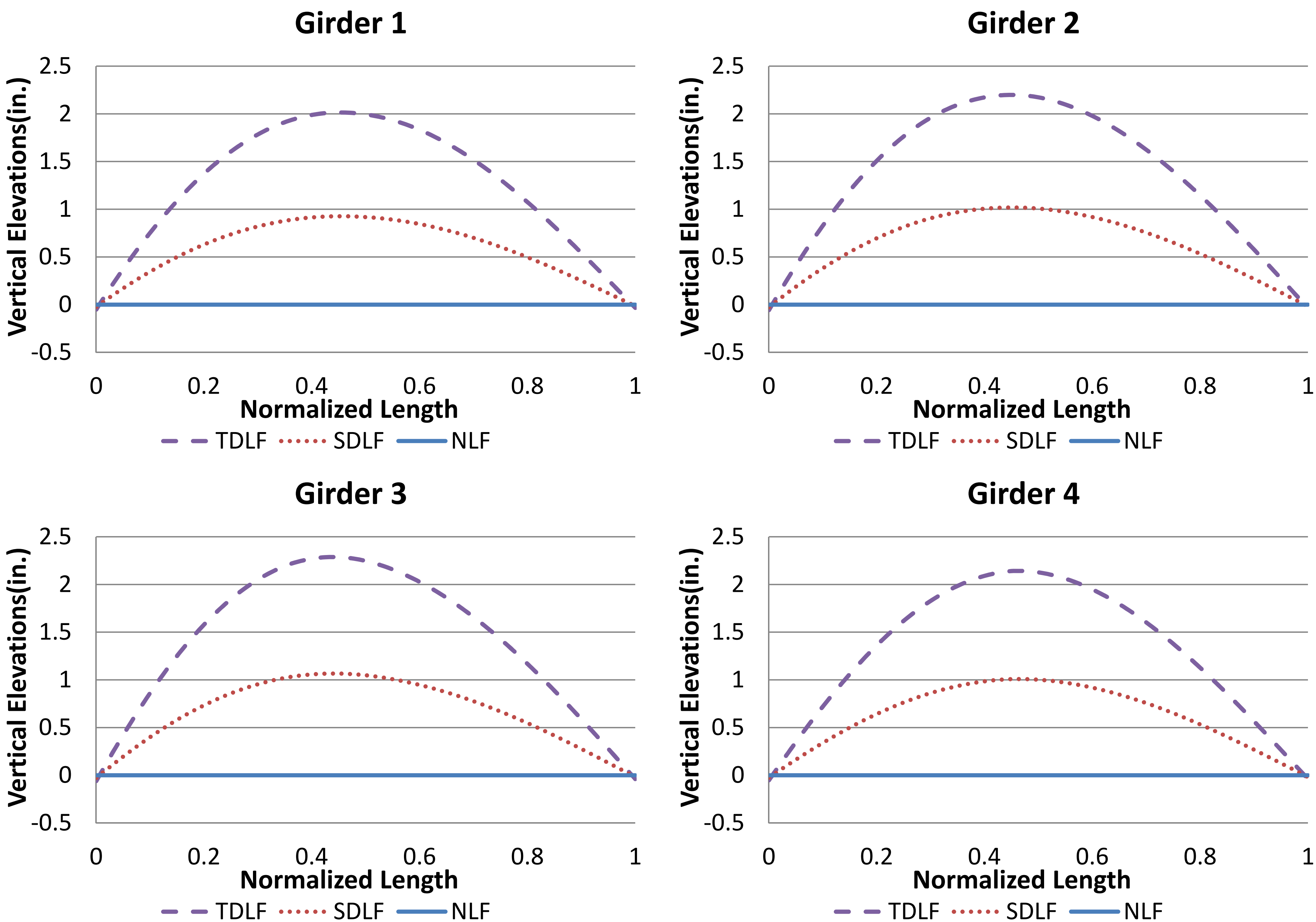


Figure O1-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

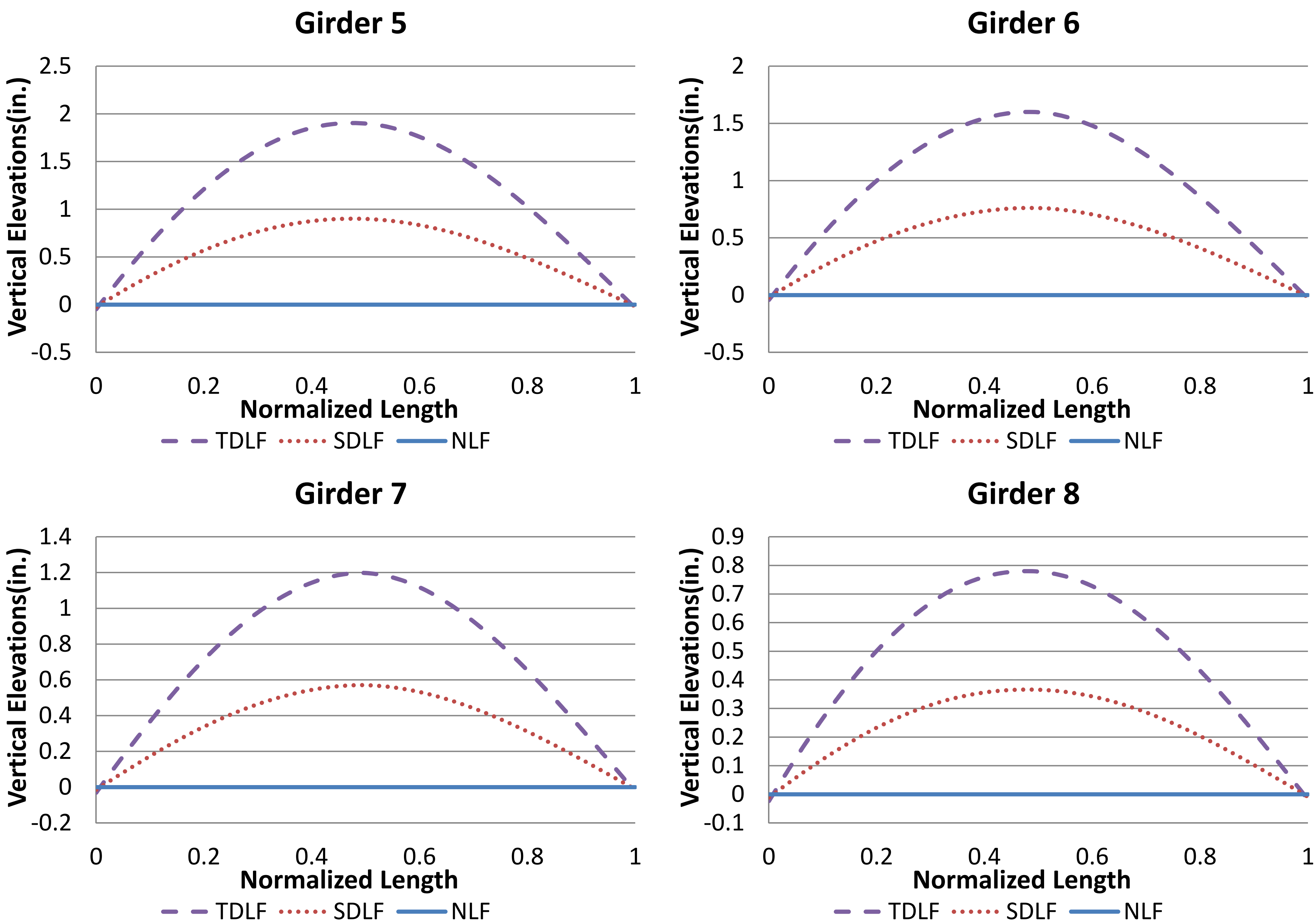


Figure O1-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

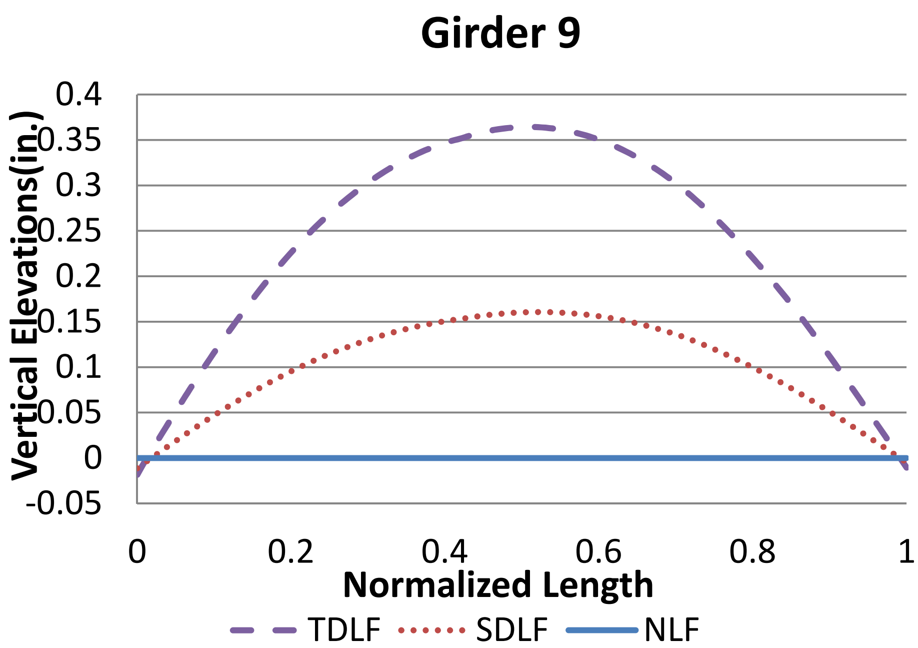


Figure O1-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

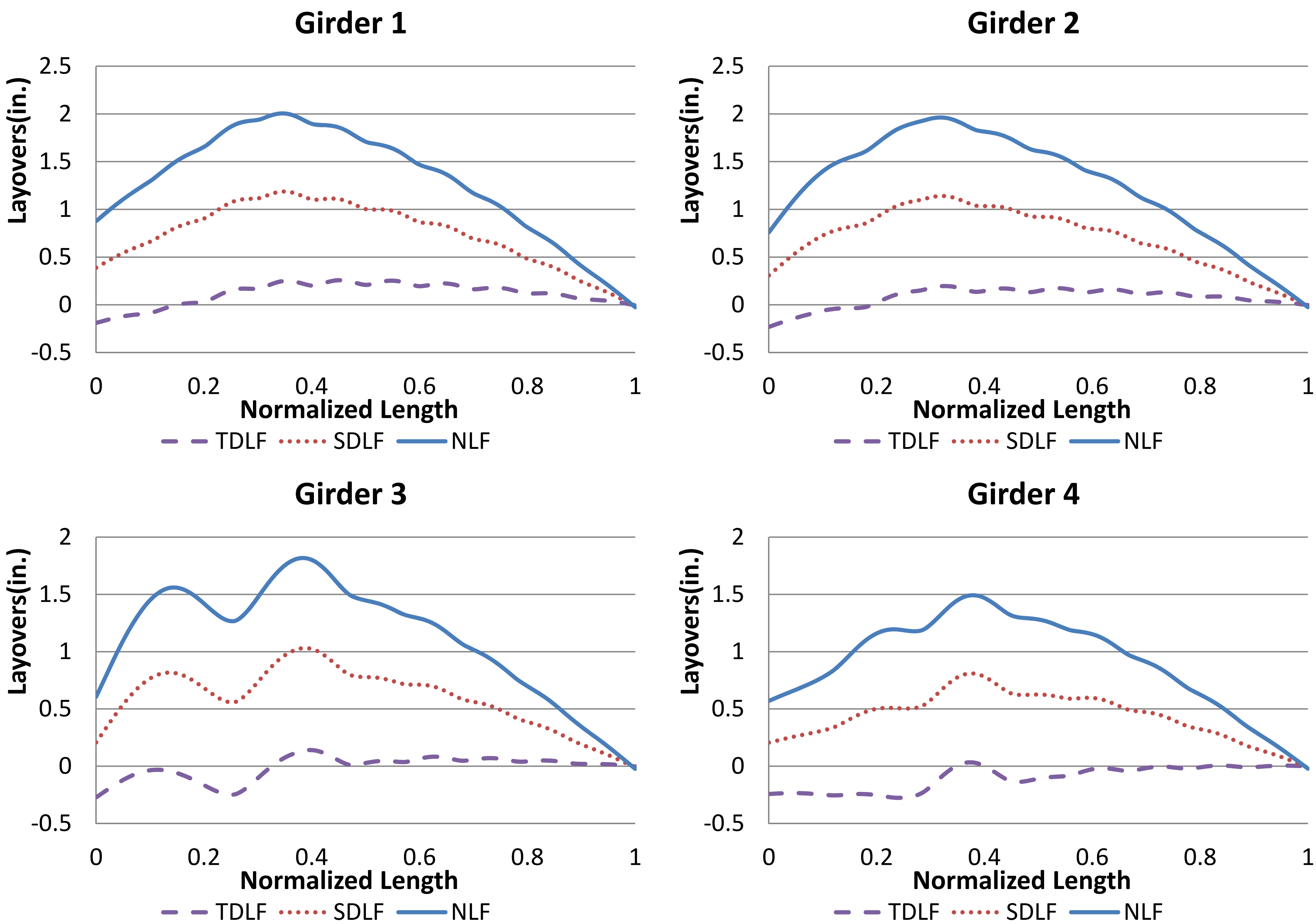


Figure O1-4-15. **Comparison of individual girder layovers (in) under TDL for different detailing methods.**

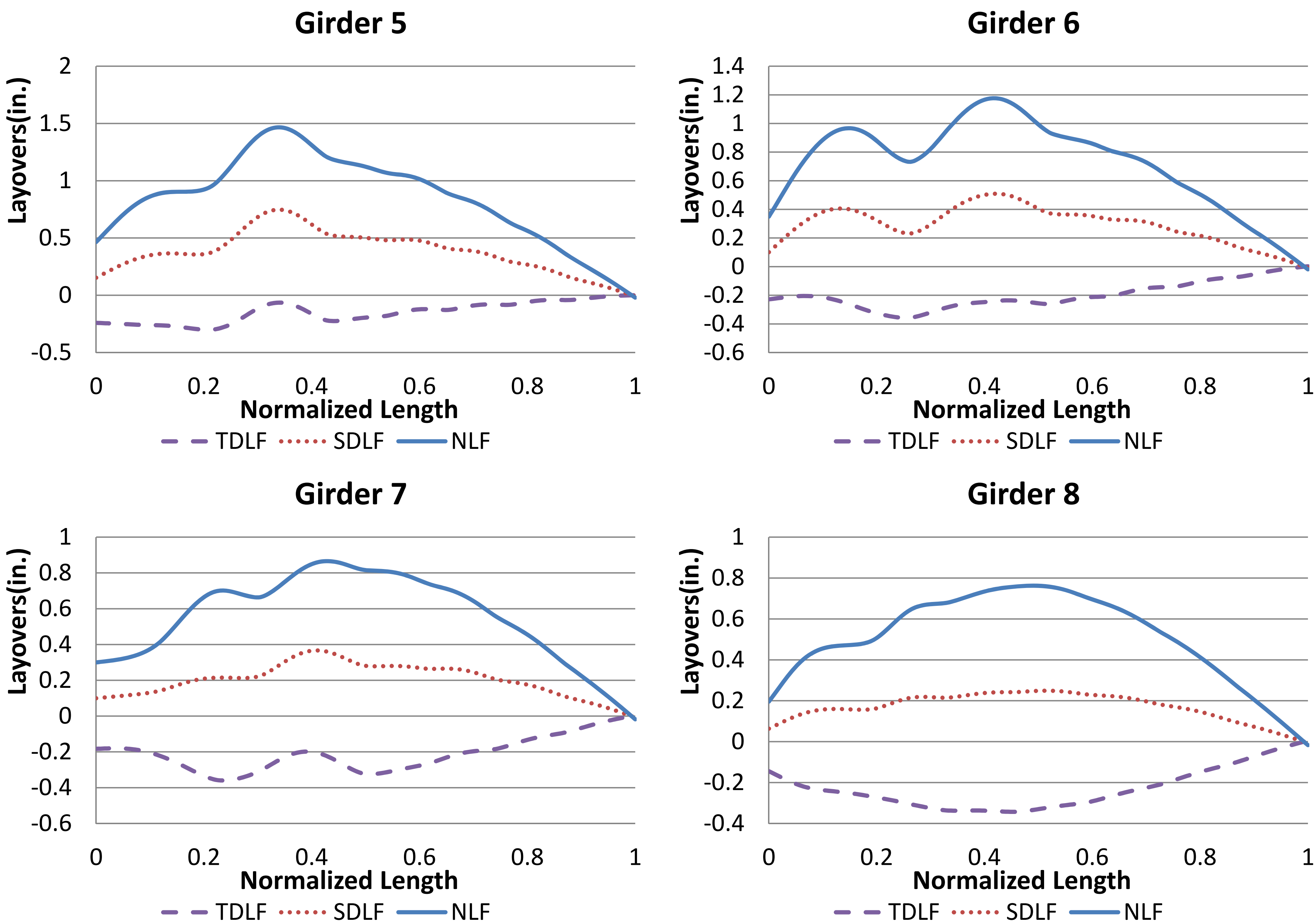


Figure O1-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

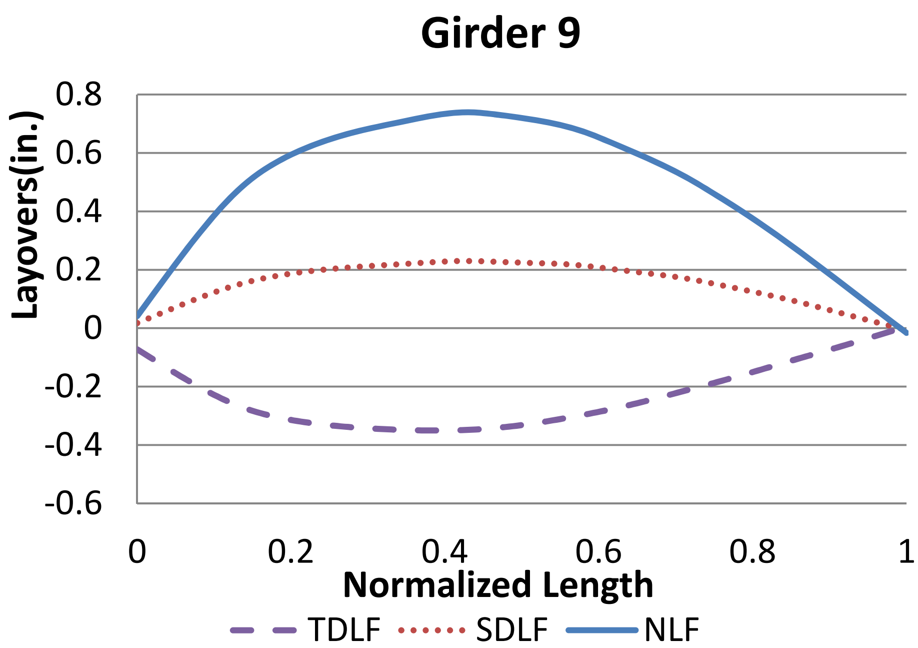


Figure O1-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

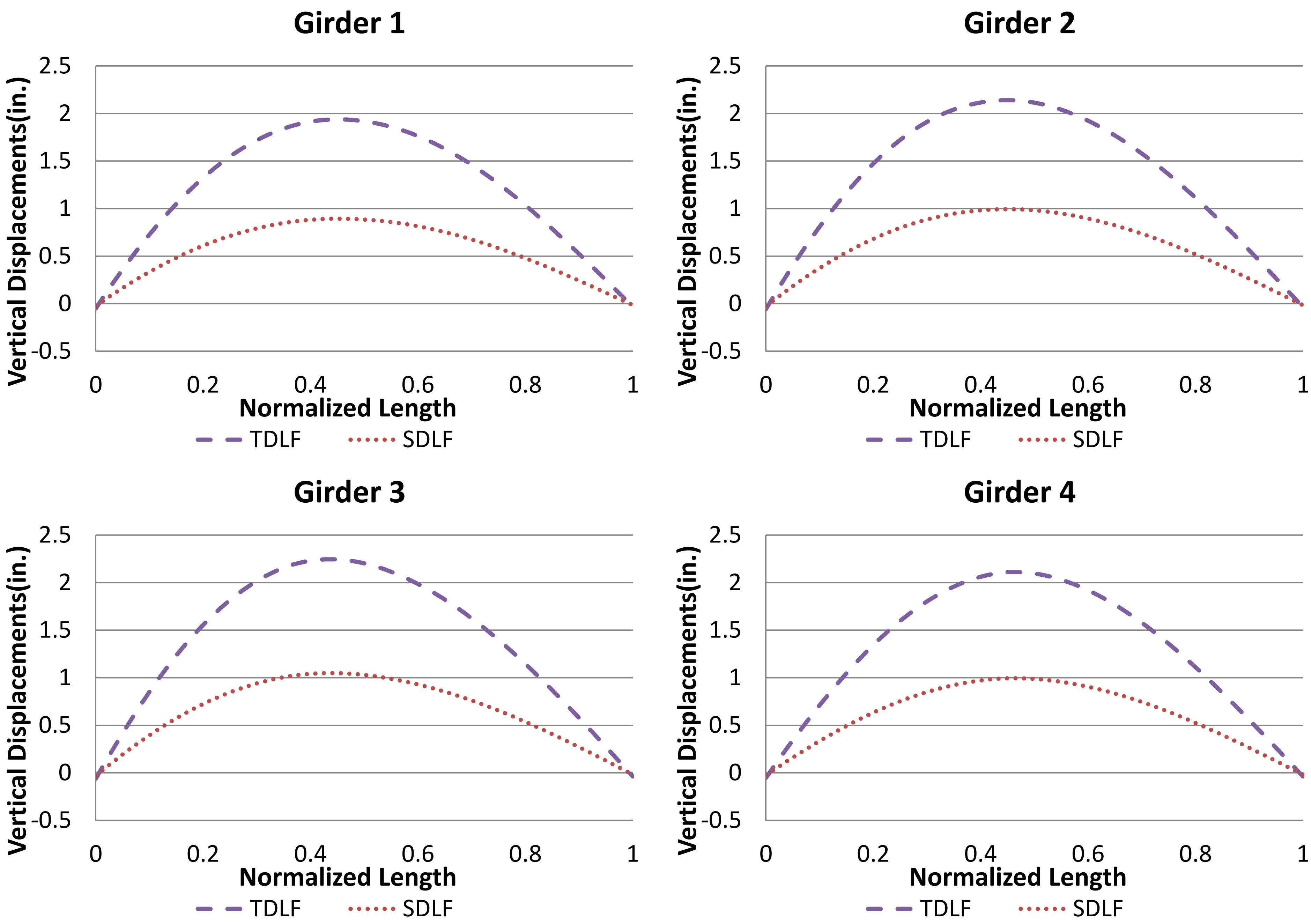


Figure O1-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

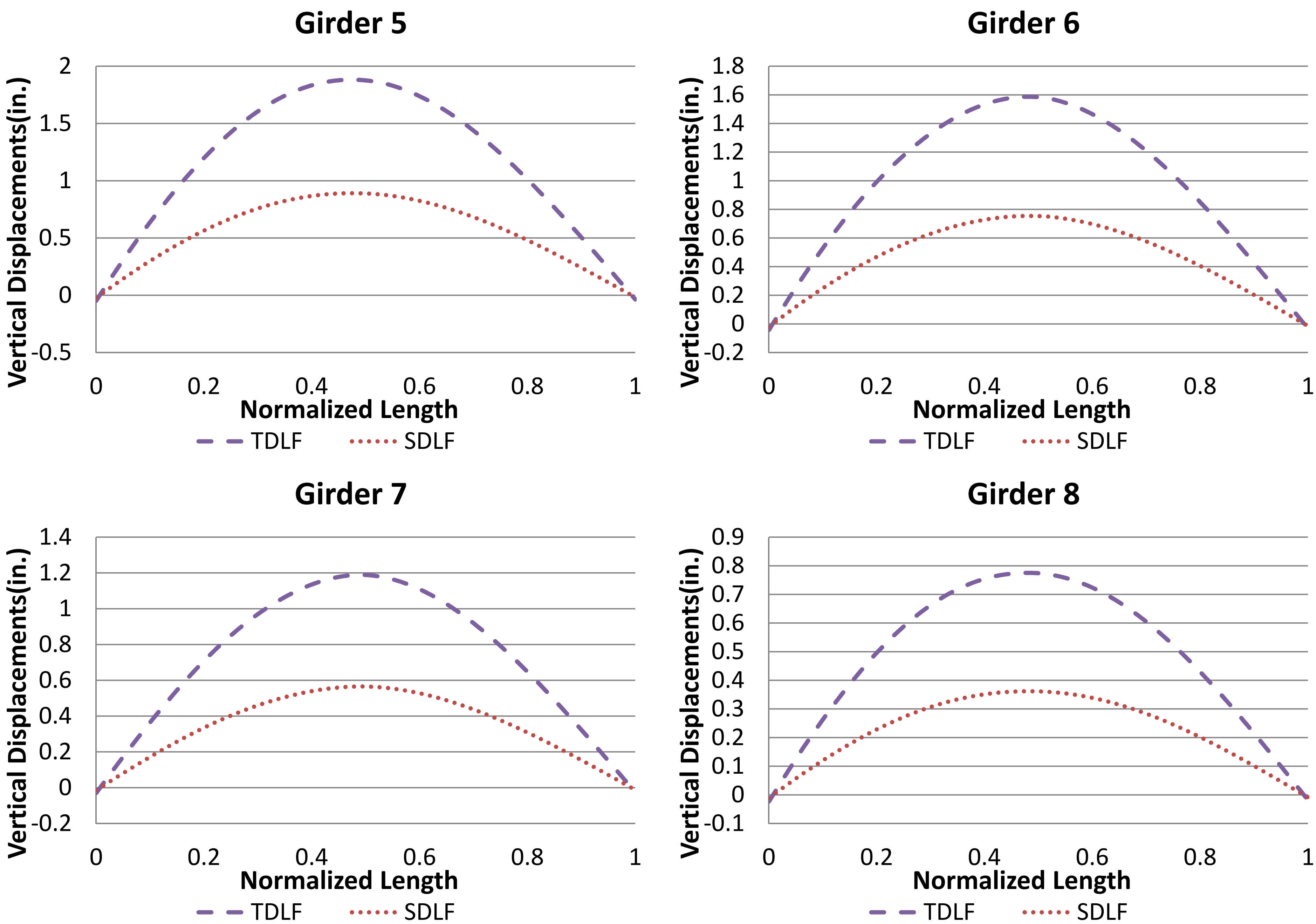


Figure O1-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

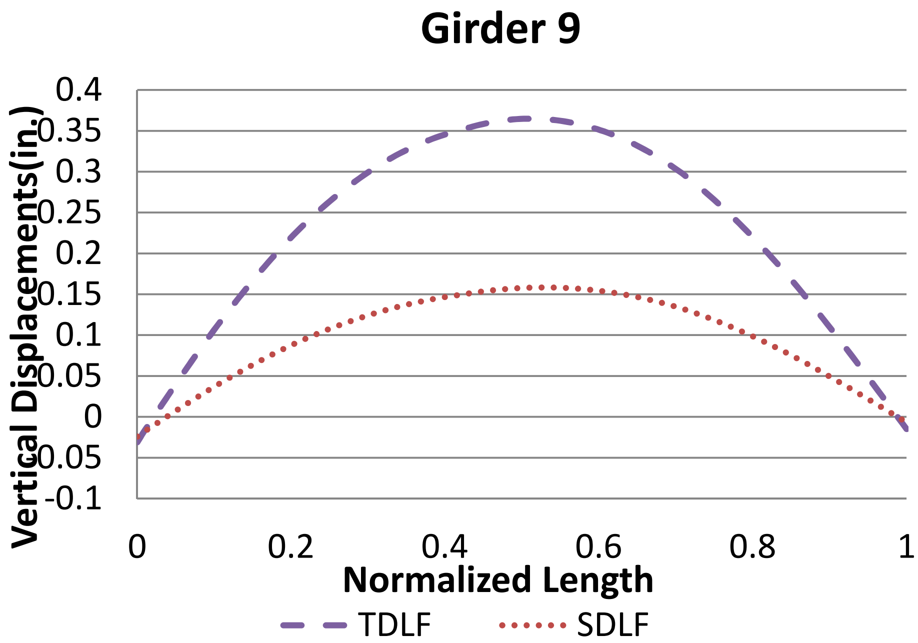


Figure O1-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

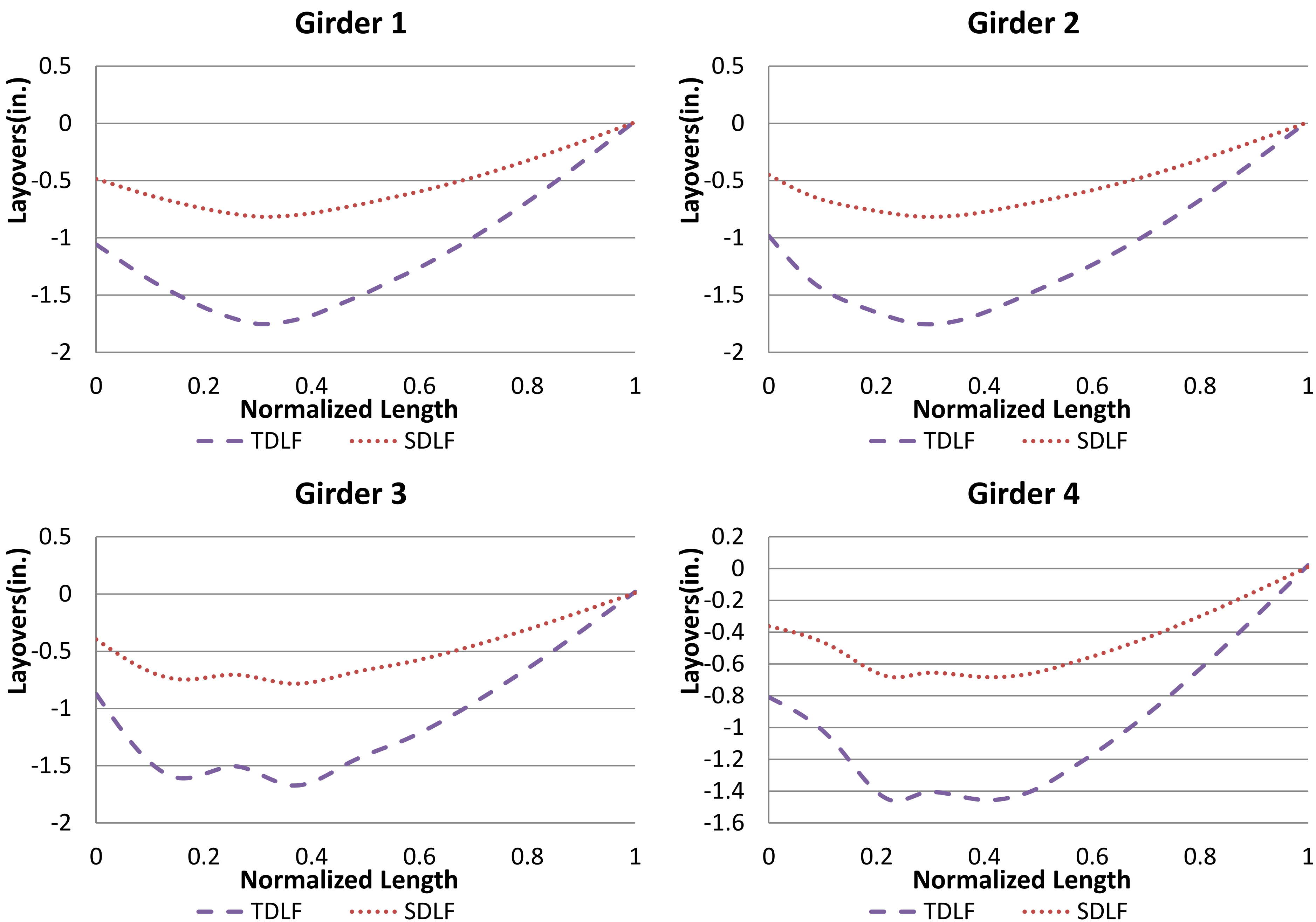


Figure O1-4-17. **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.**

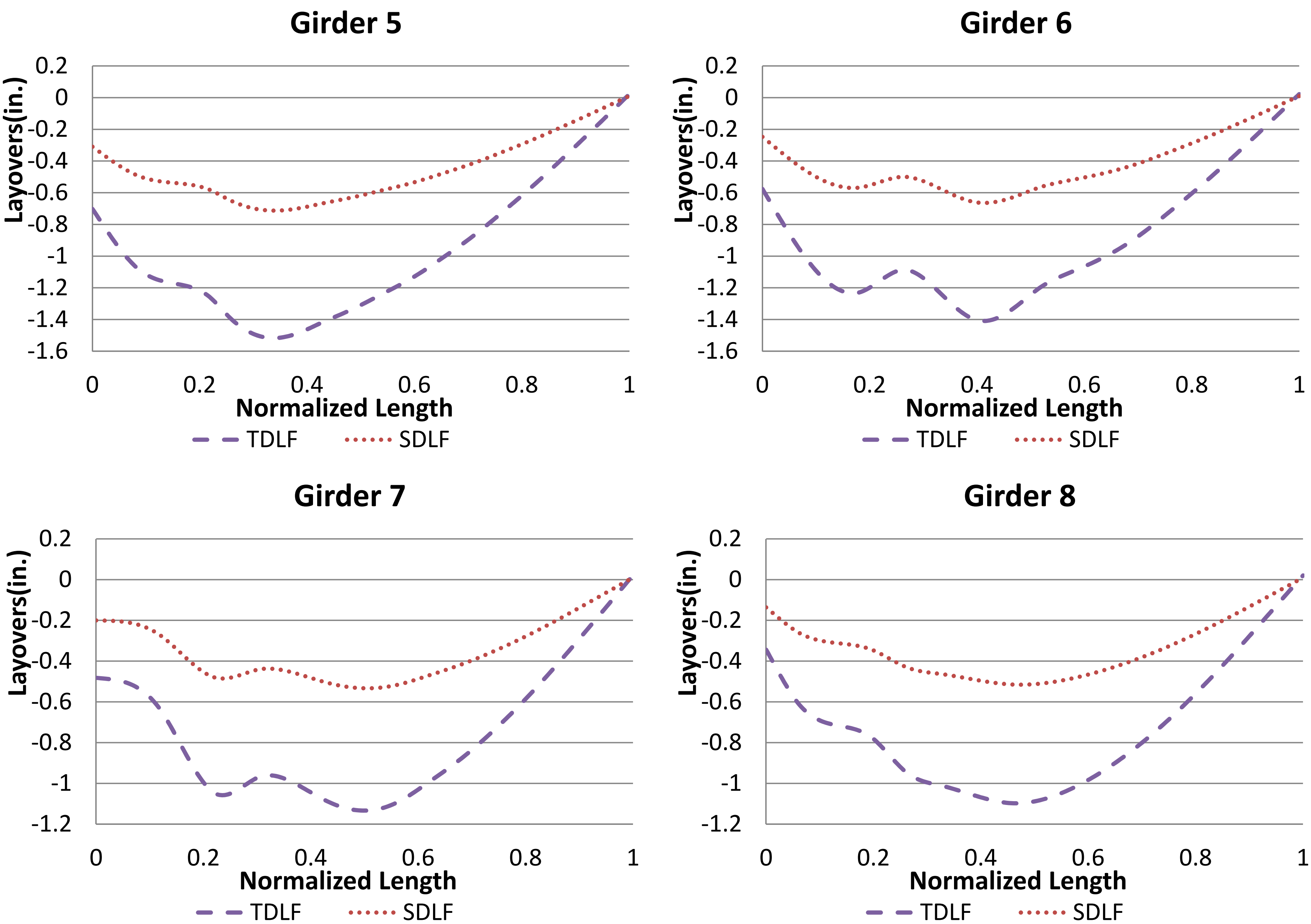


Figure O1-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

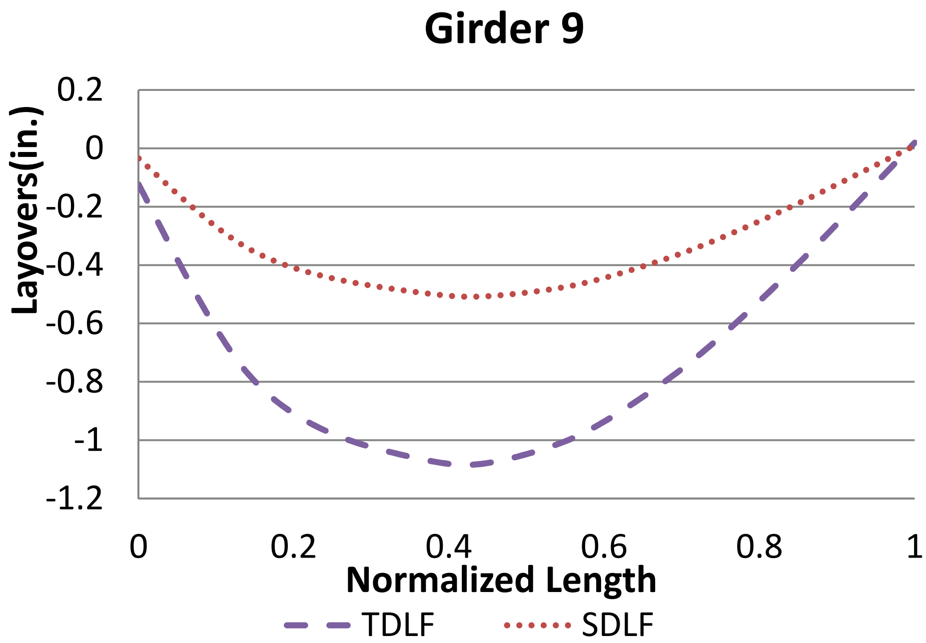


Figure O1-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

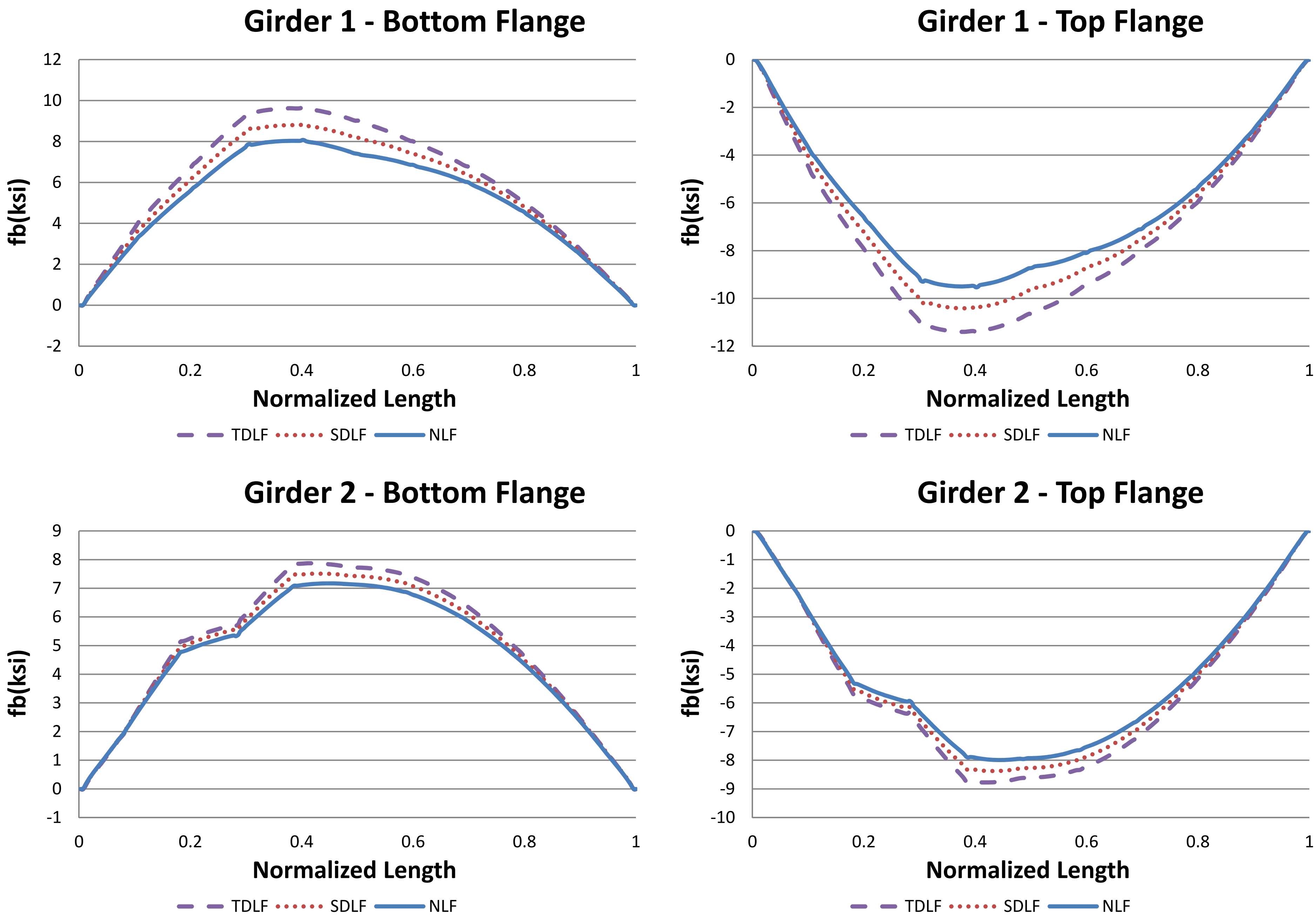


Figure O1-4-18. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

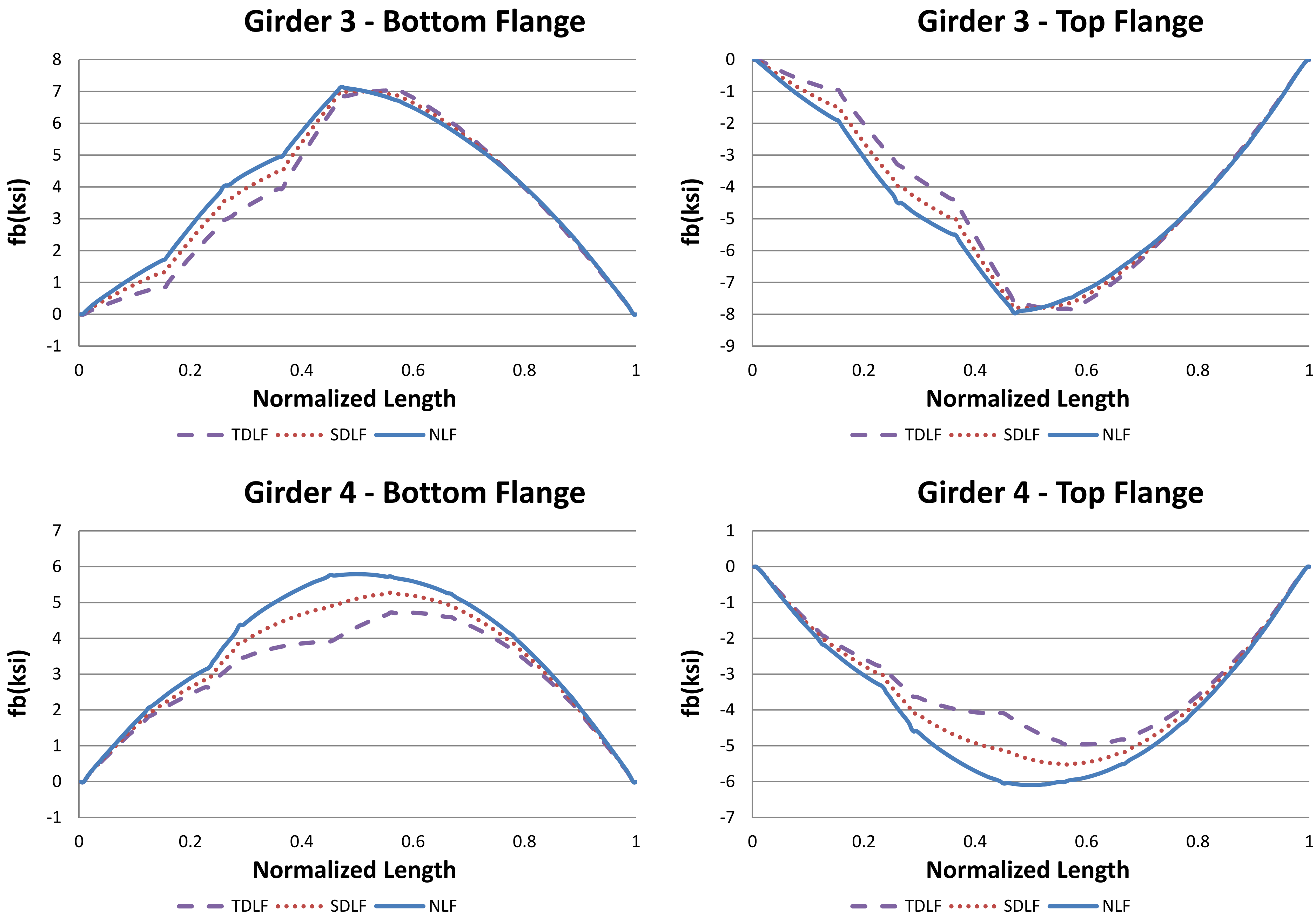


Figure O1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

Figure O1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

Figure O1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

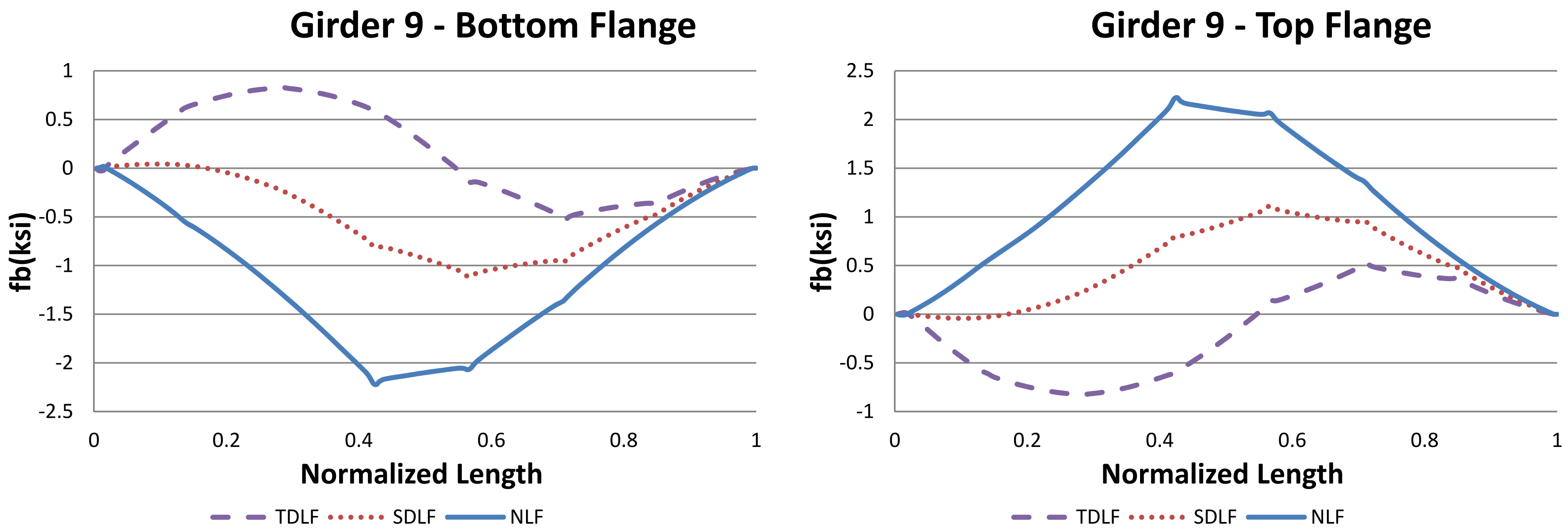


Figure O1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

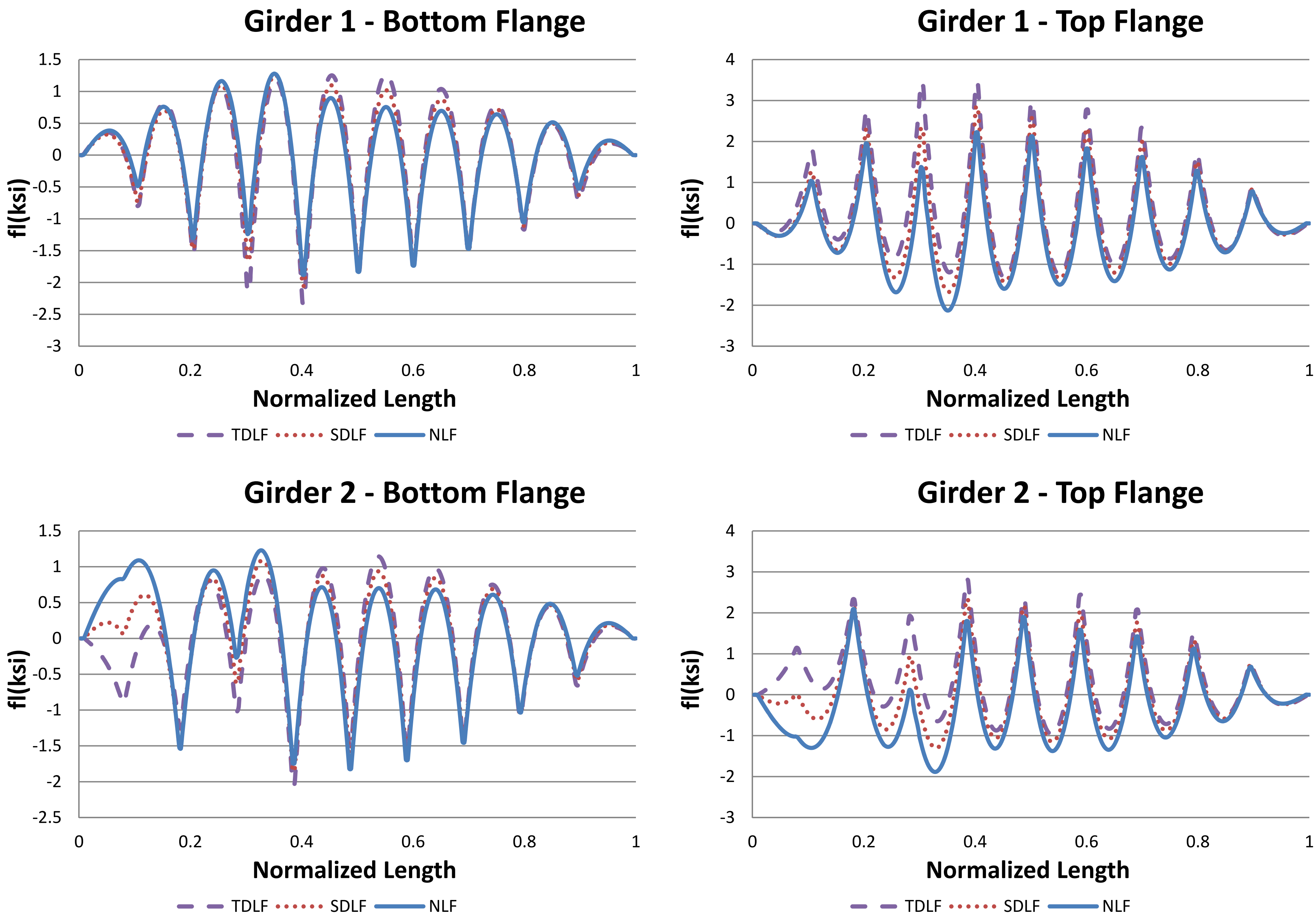


Figure O1-4-19. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

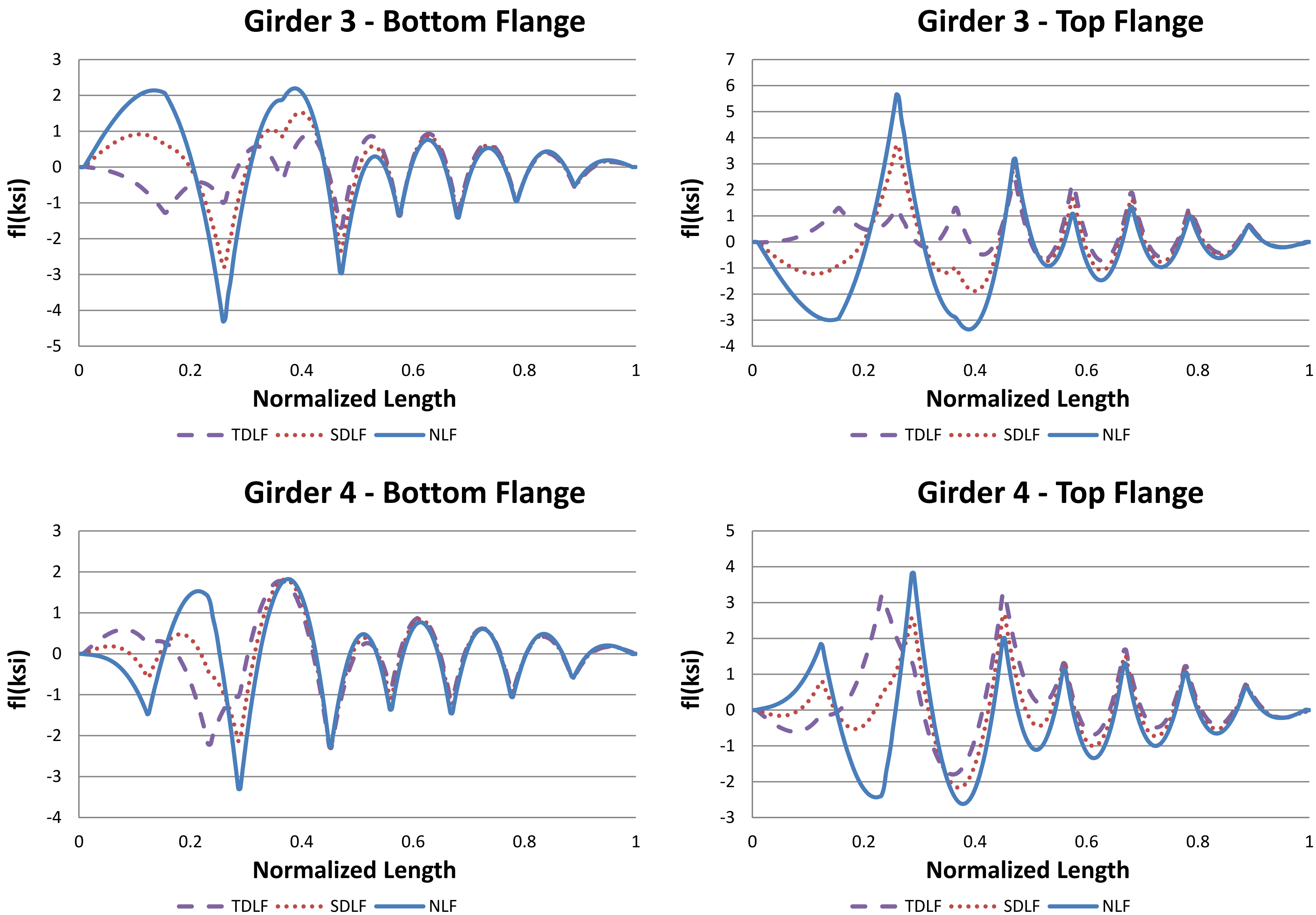


Figure O1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

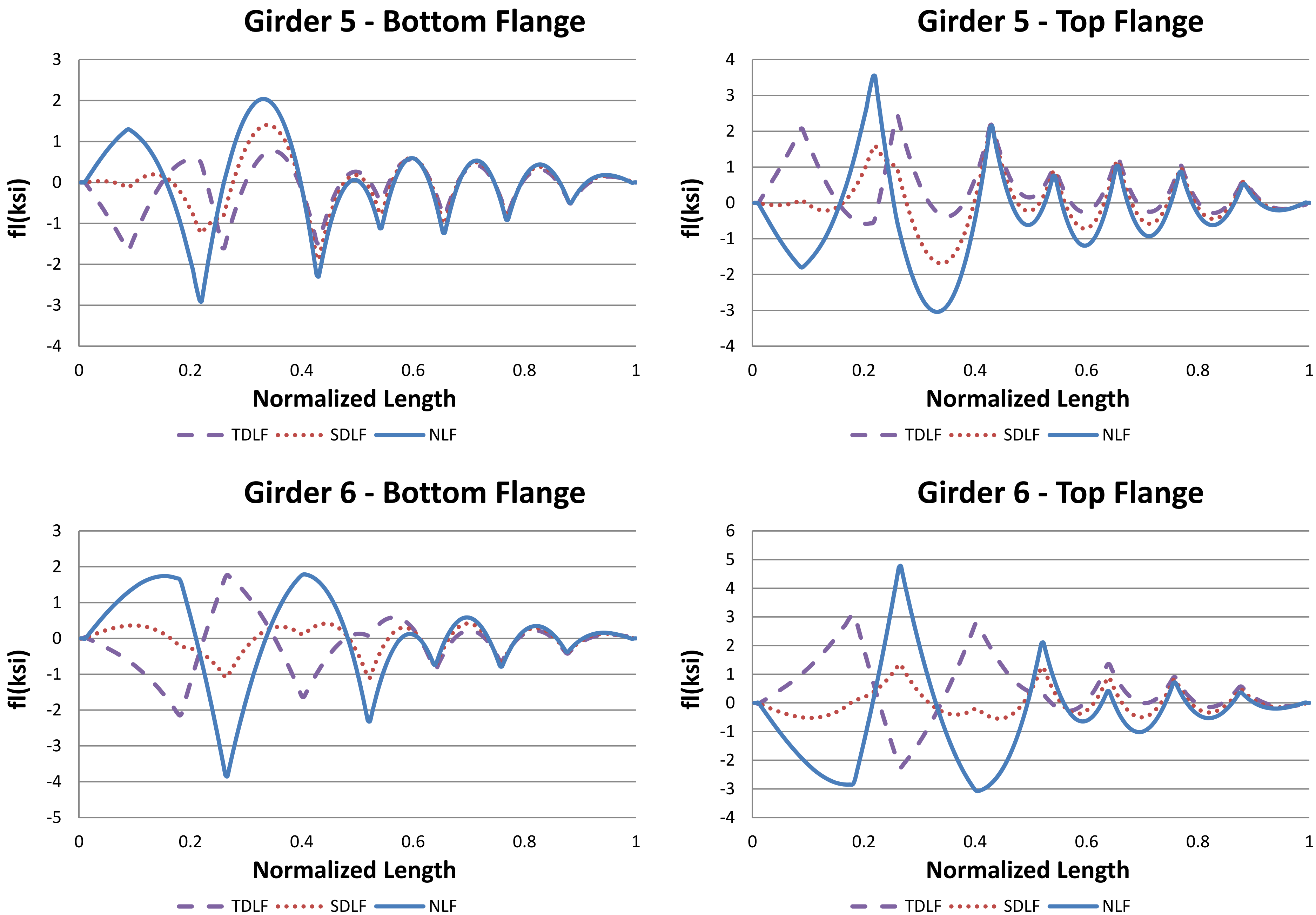


Figure O1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

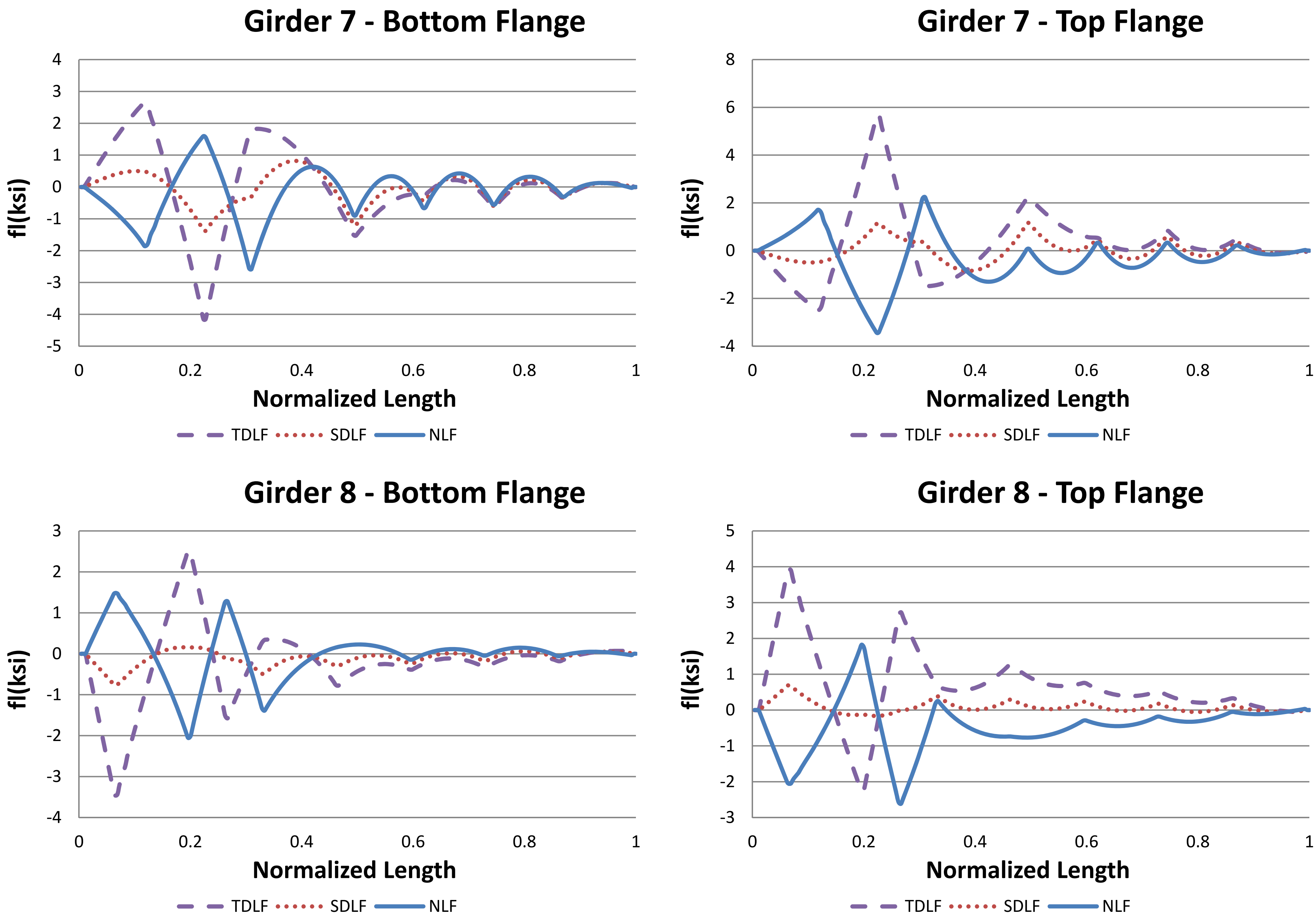
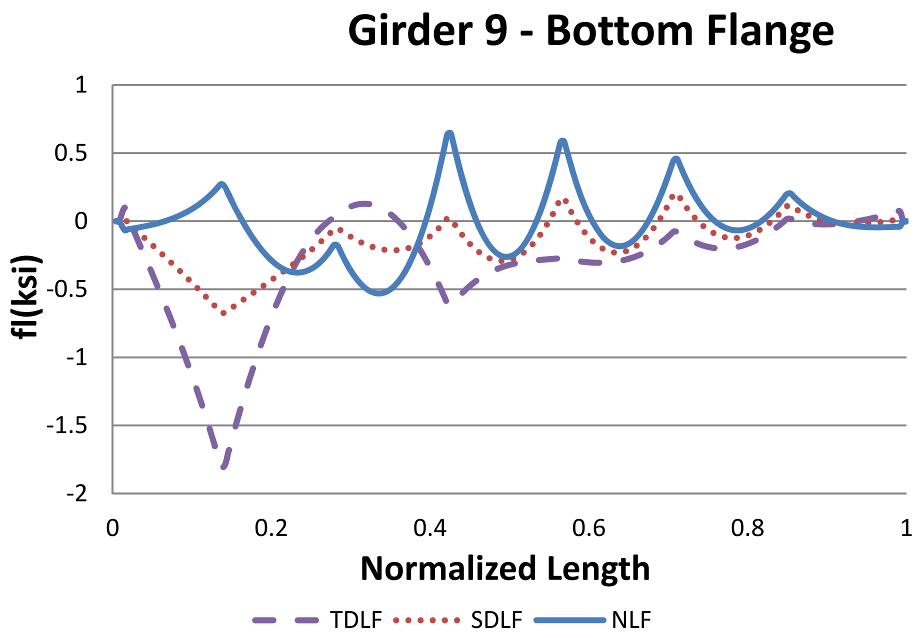


Figure O1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.



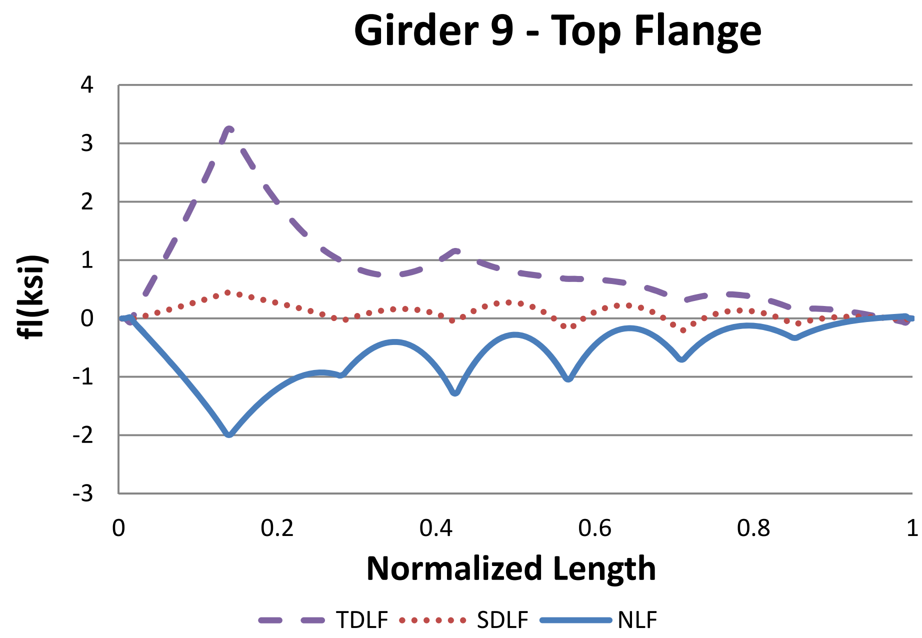


Figure O1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

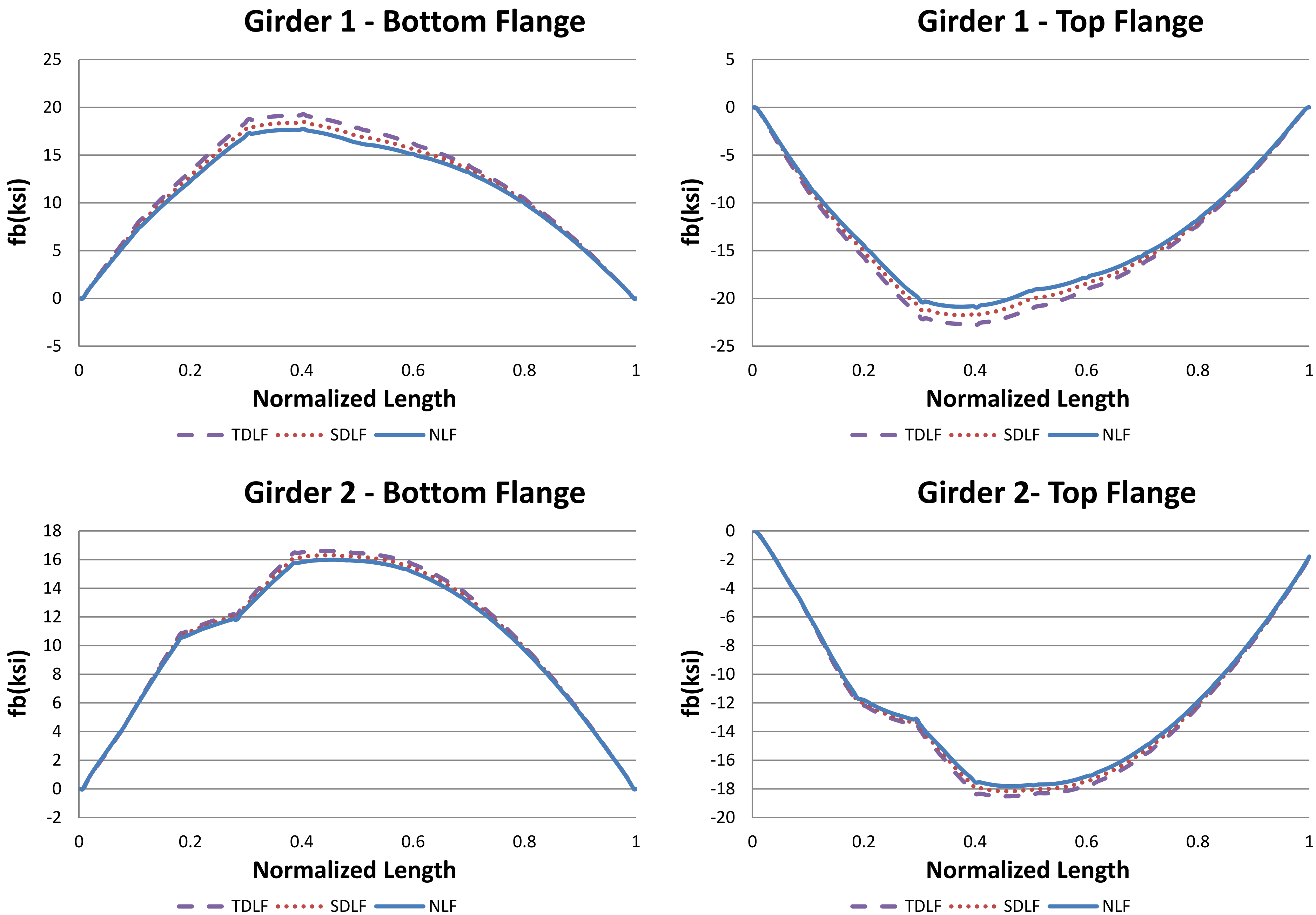


Figure O1-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

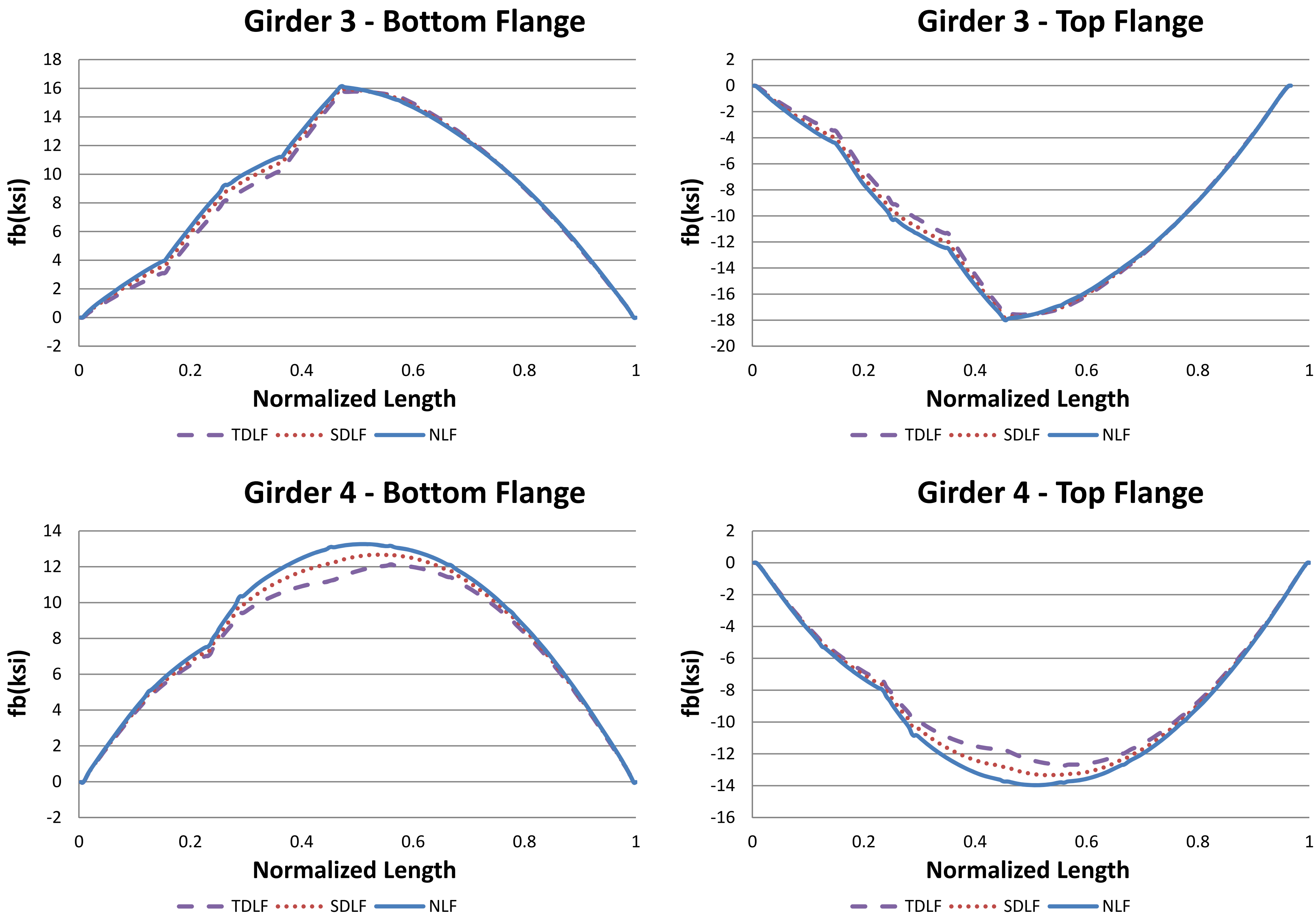


Figure O1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

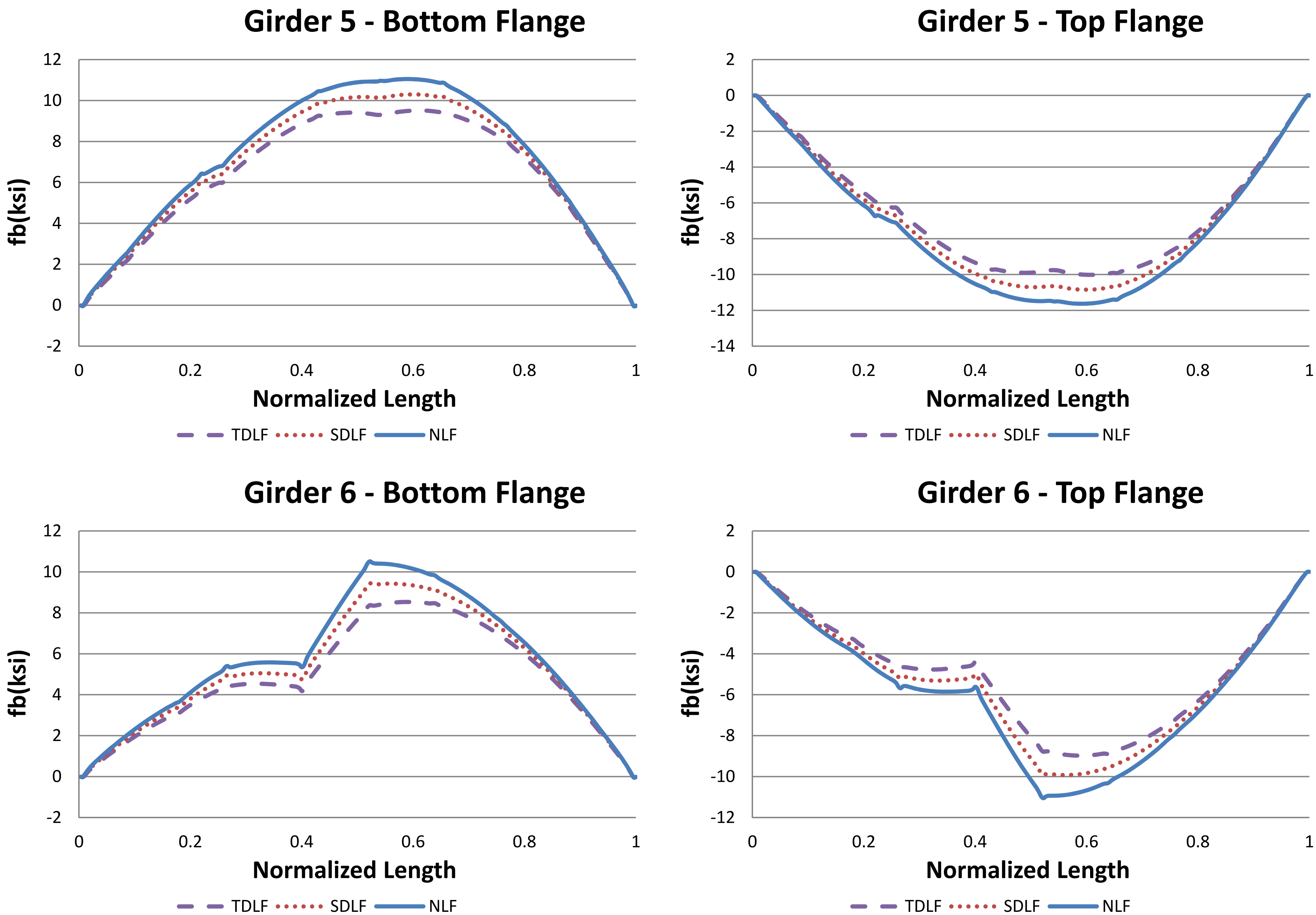


Figure O1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

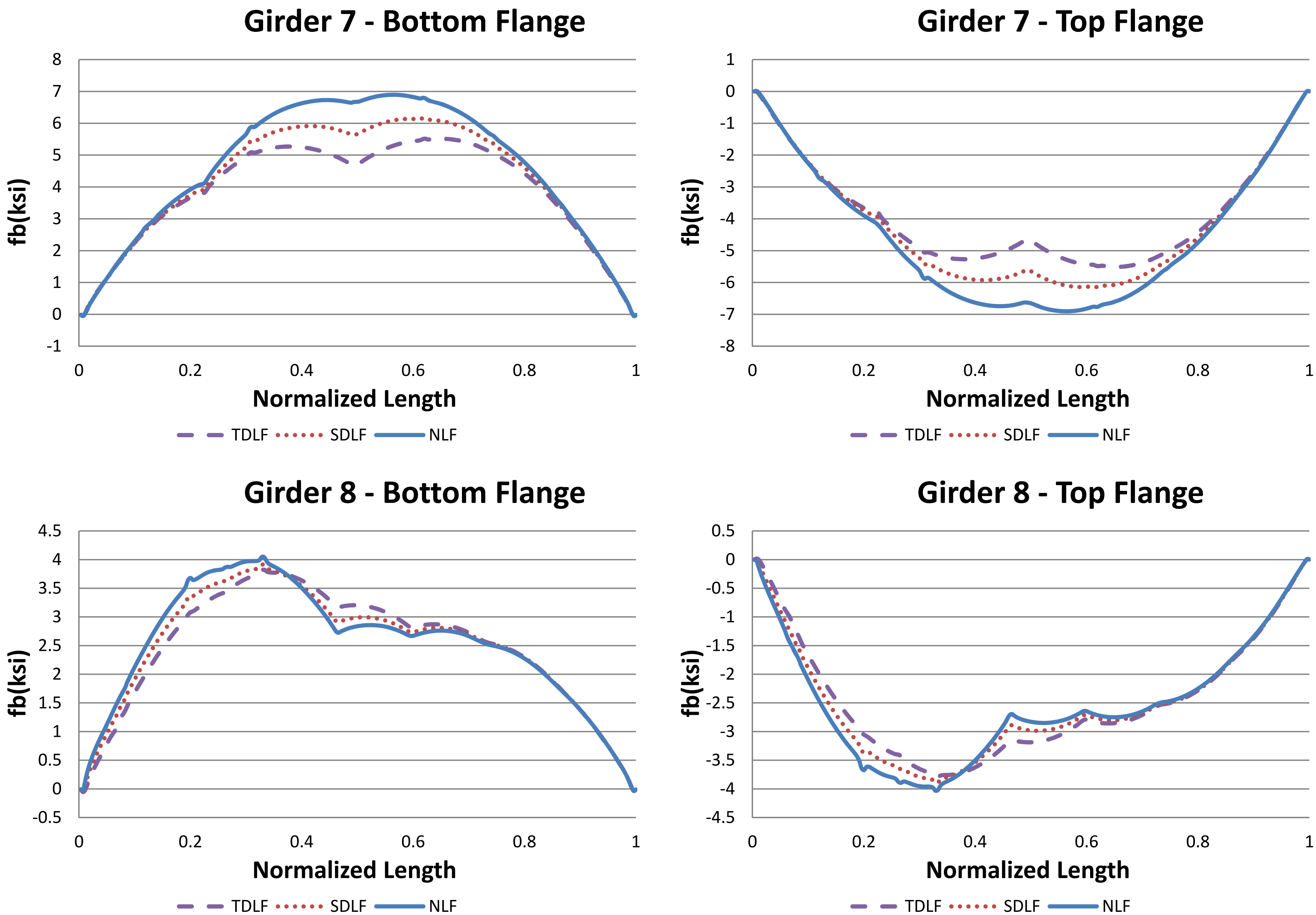
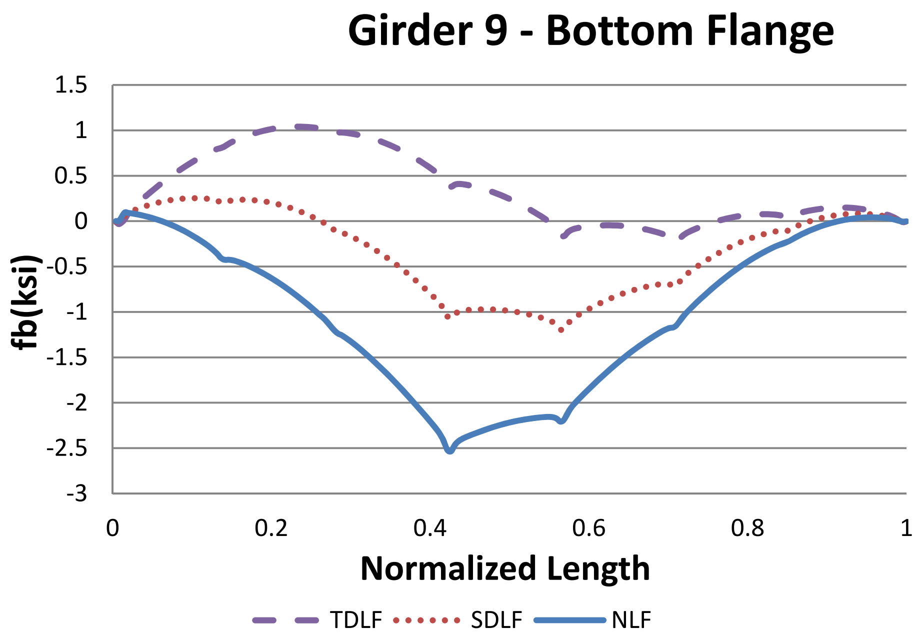


Figure O1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



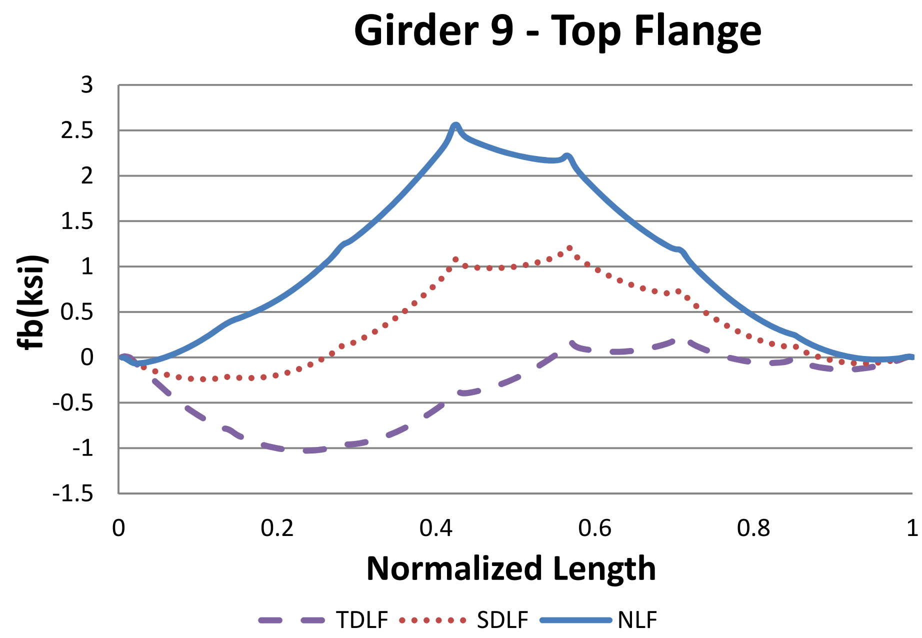


Figure O1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

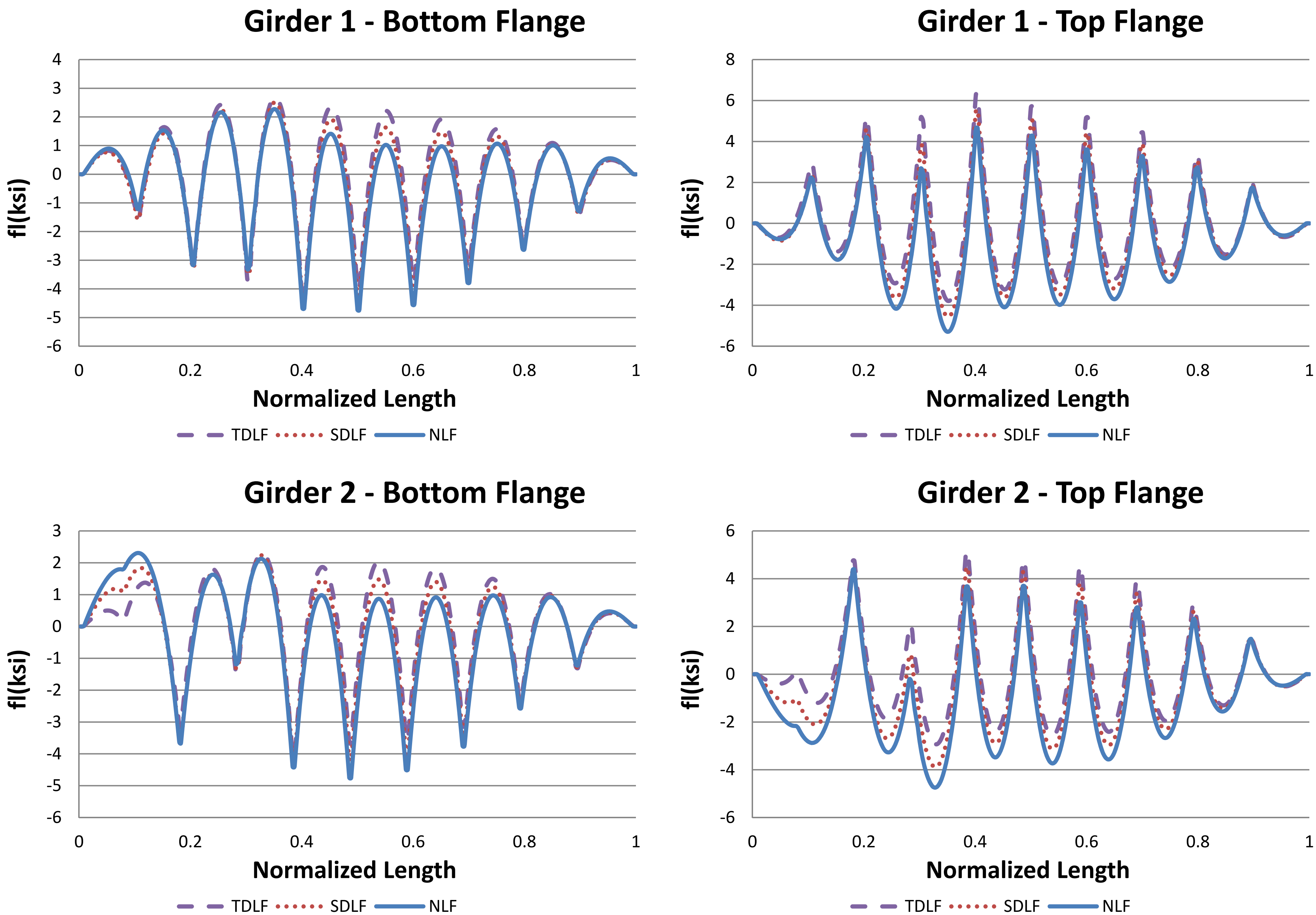


Figure O1-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

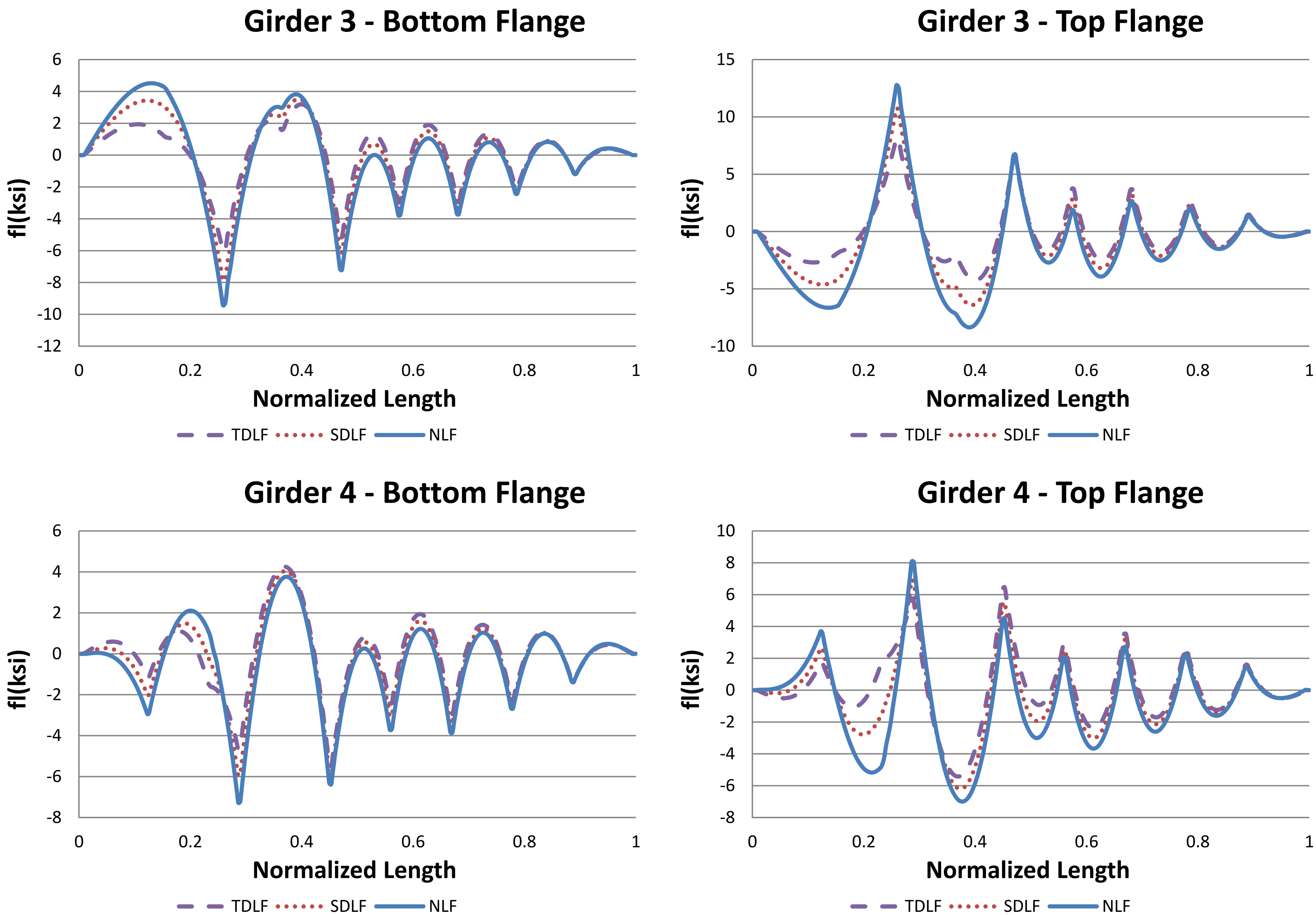


Figure O1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

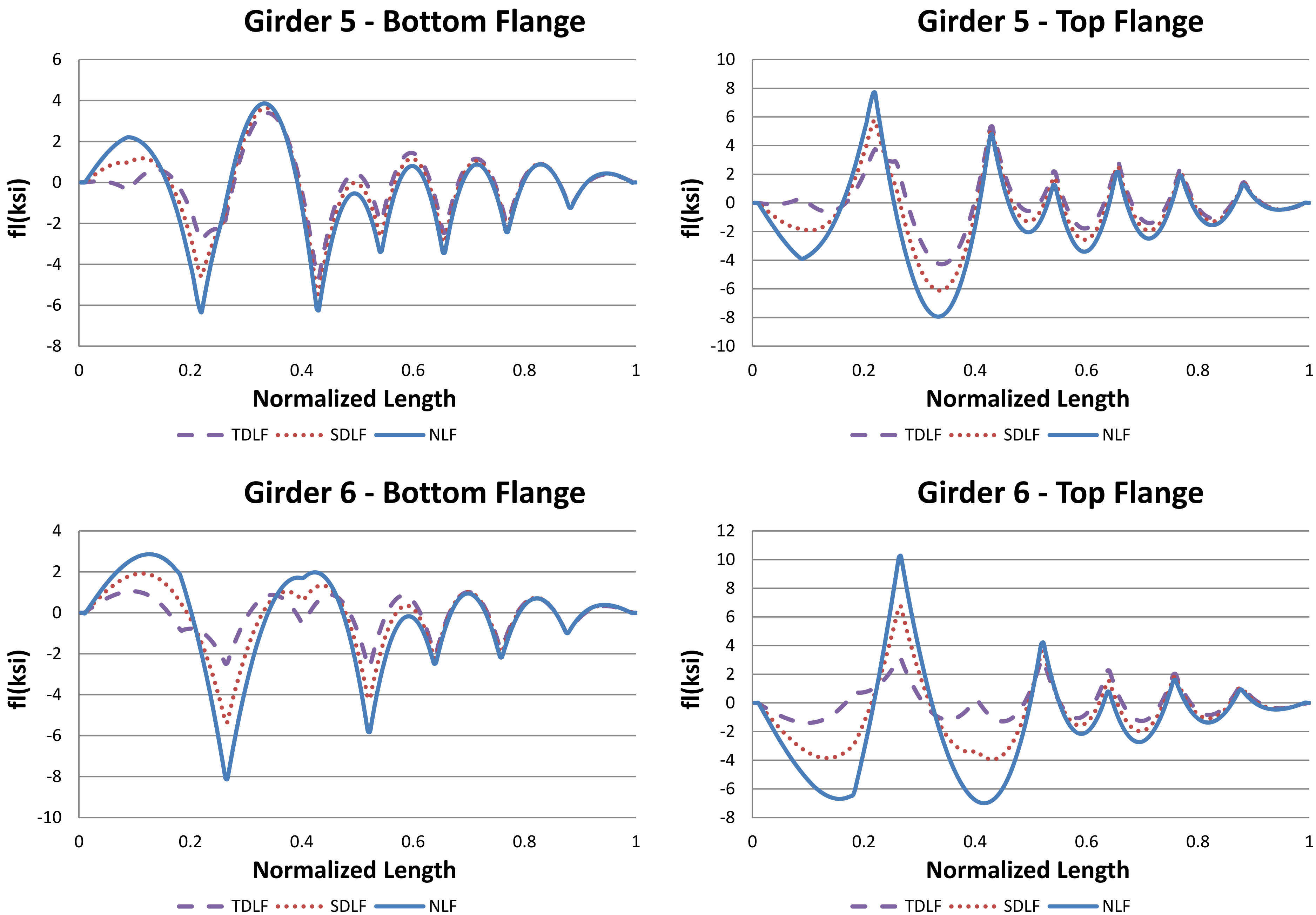


Figure O1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

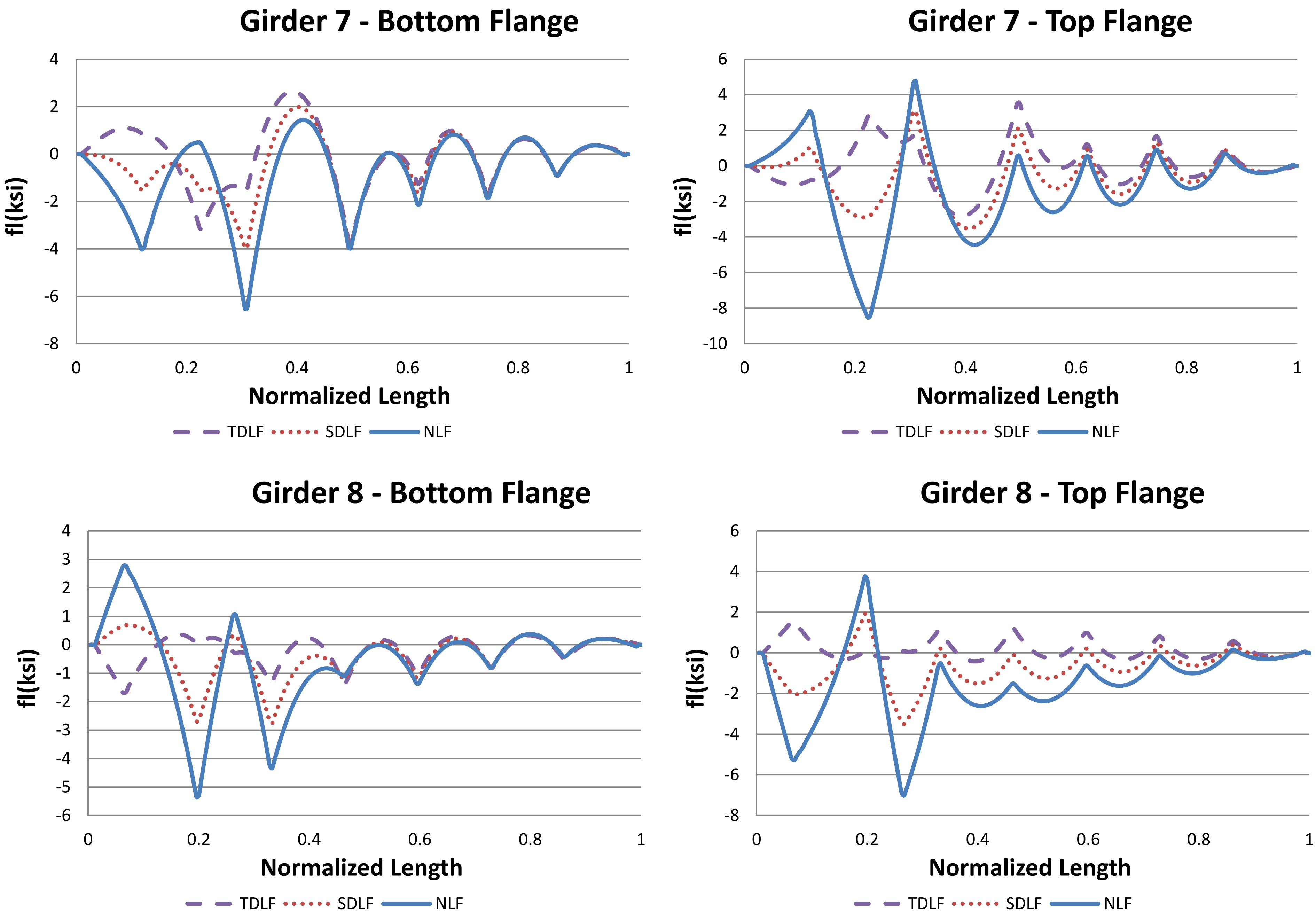
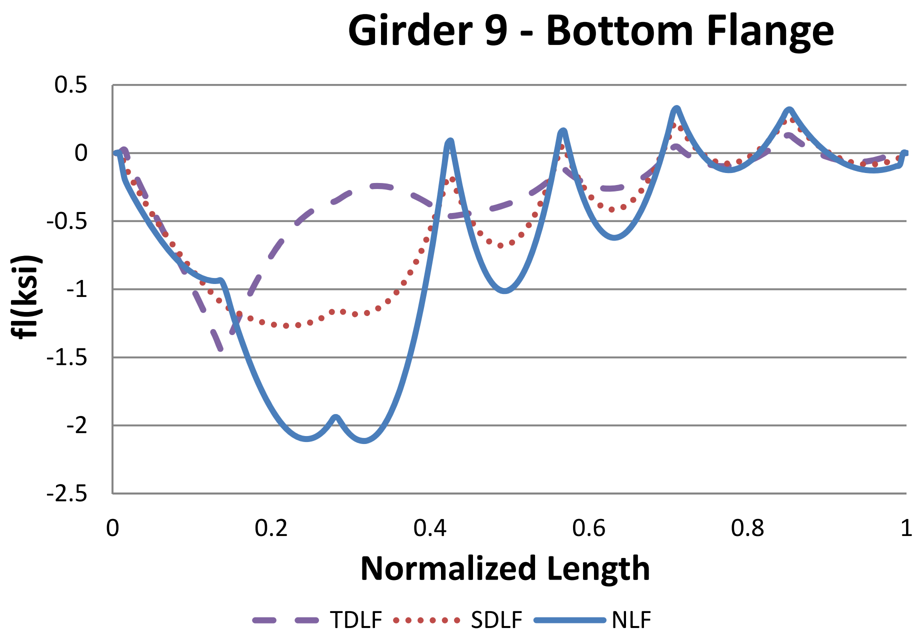


Figure O1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.



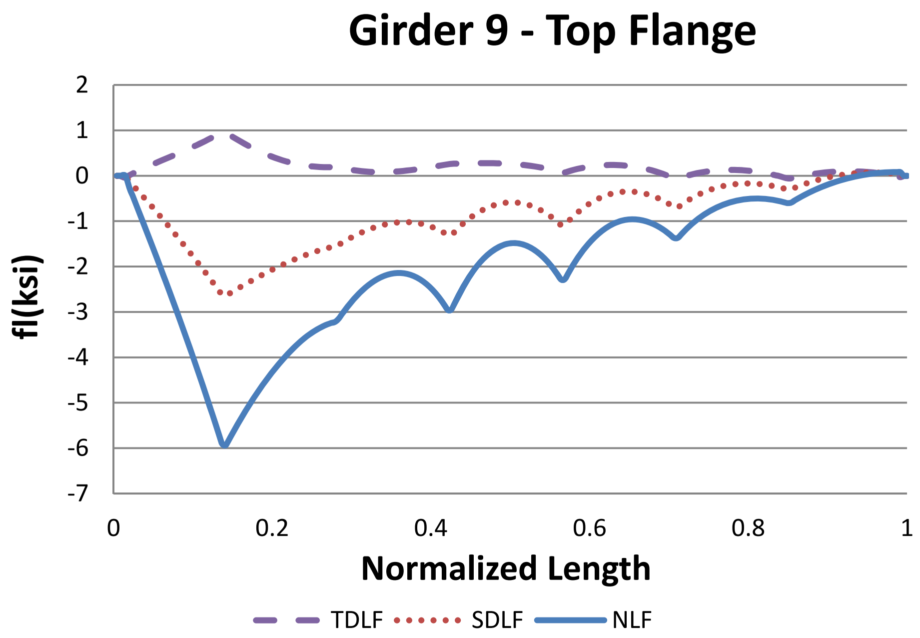


Figure O1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

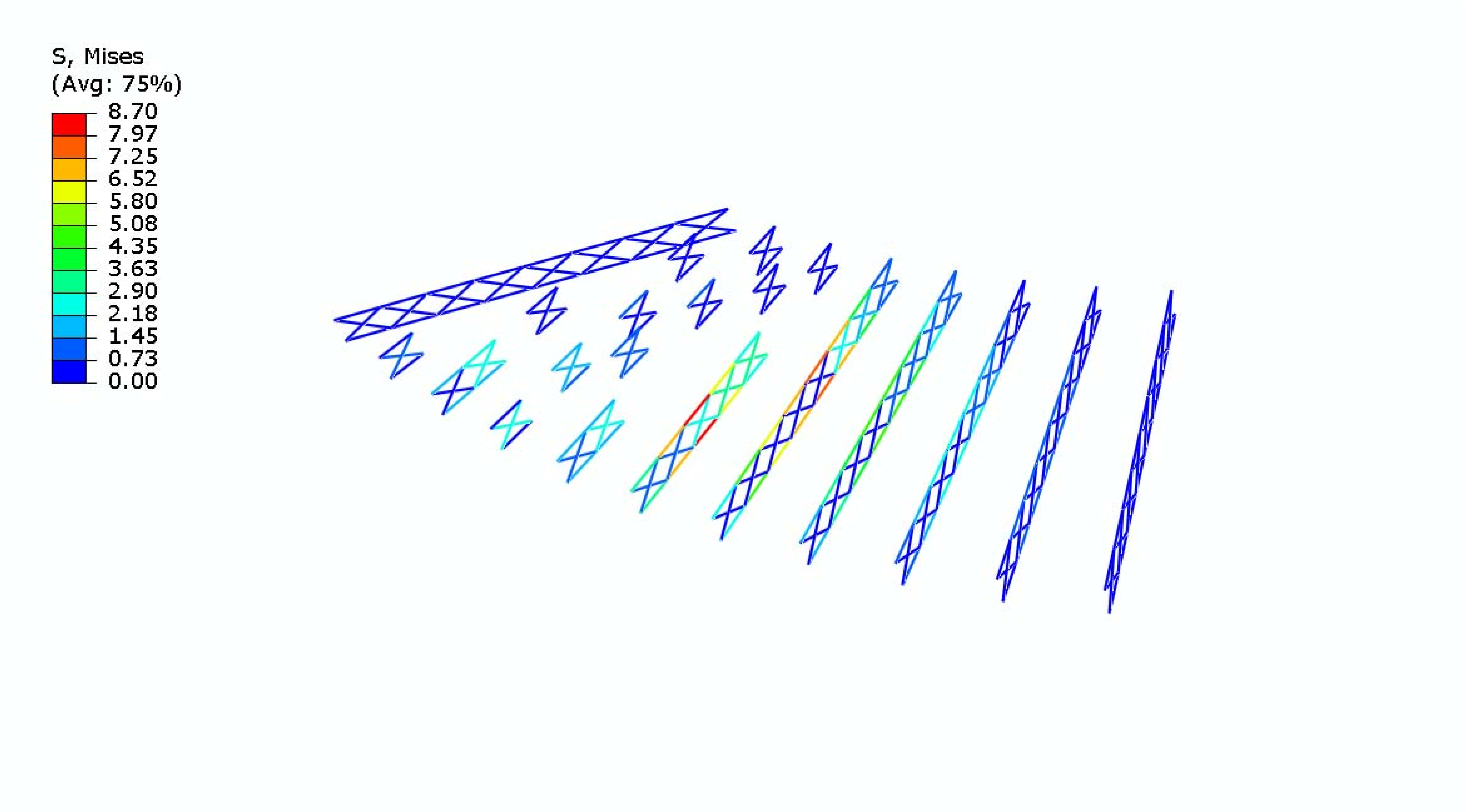


Figure O1-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing

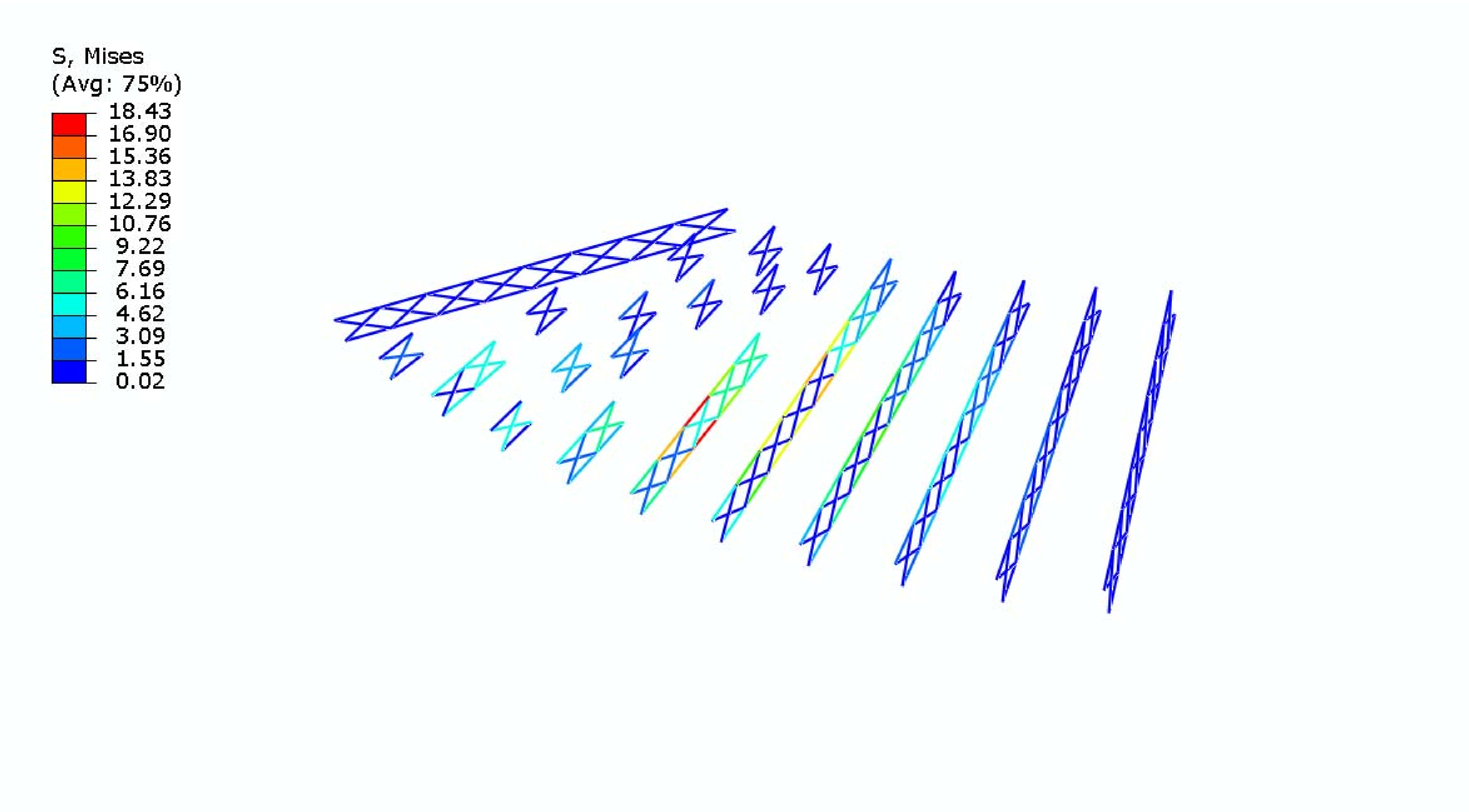


Figure O1-4-23. **Cross-frame stress contours under TDL, NLF detailing**

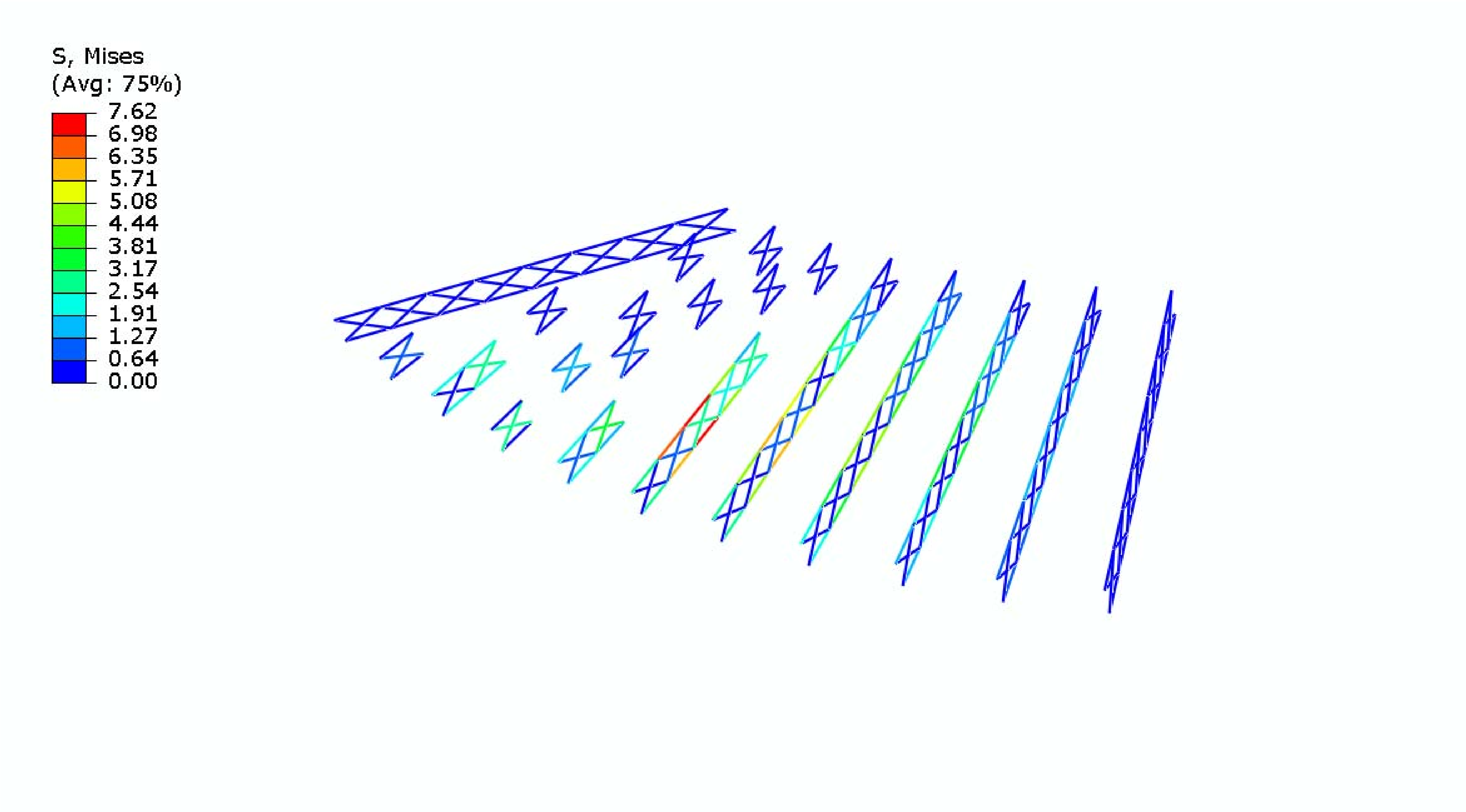


Figure O1-4-24. Cross-frame stress contours under SDL, SDLF detailing

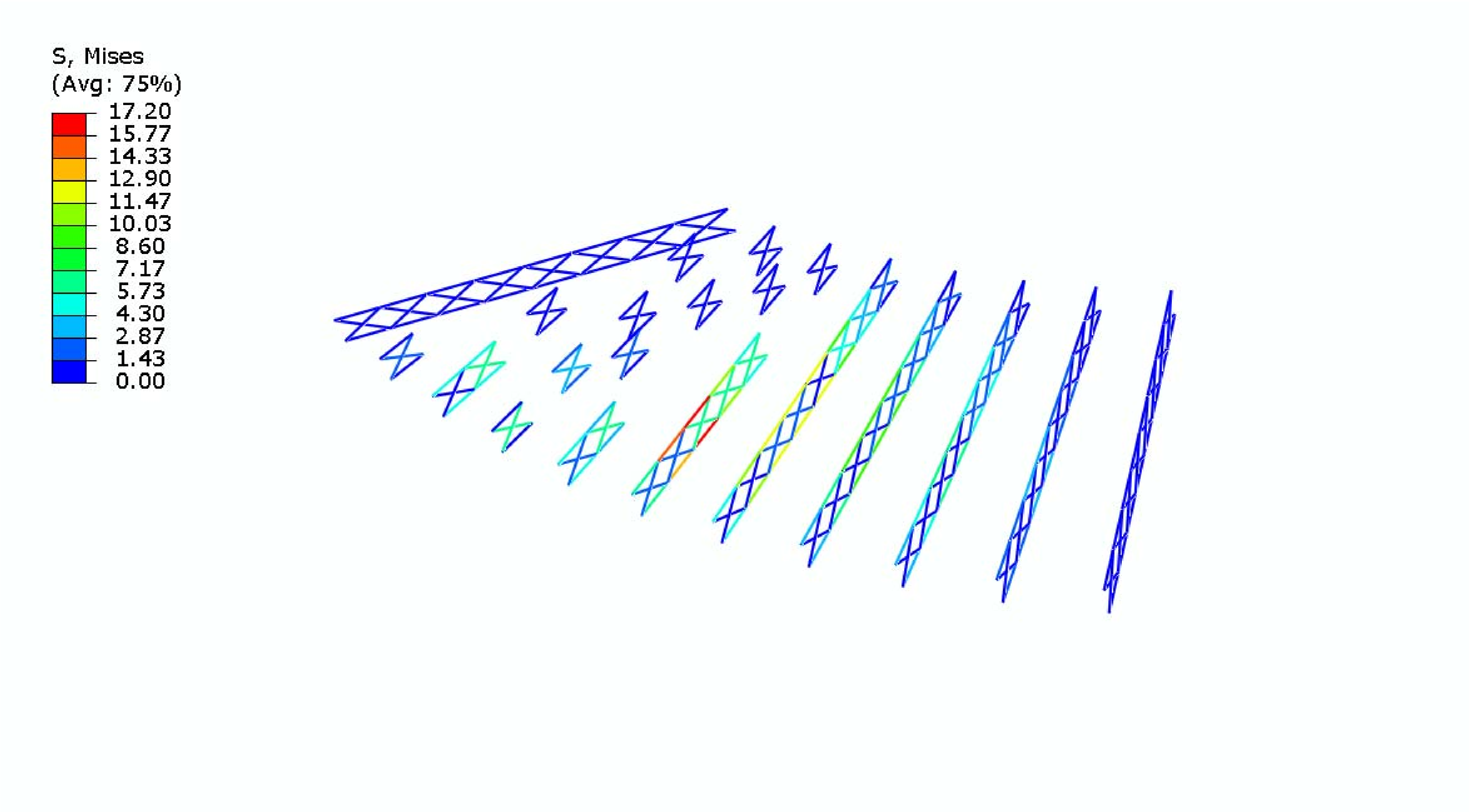


Figure O1-4-25. **Cross-frame stress contours under TDL, SDLF detailing**

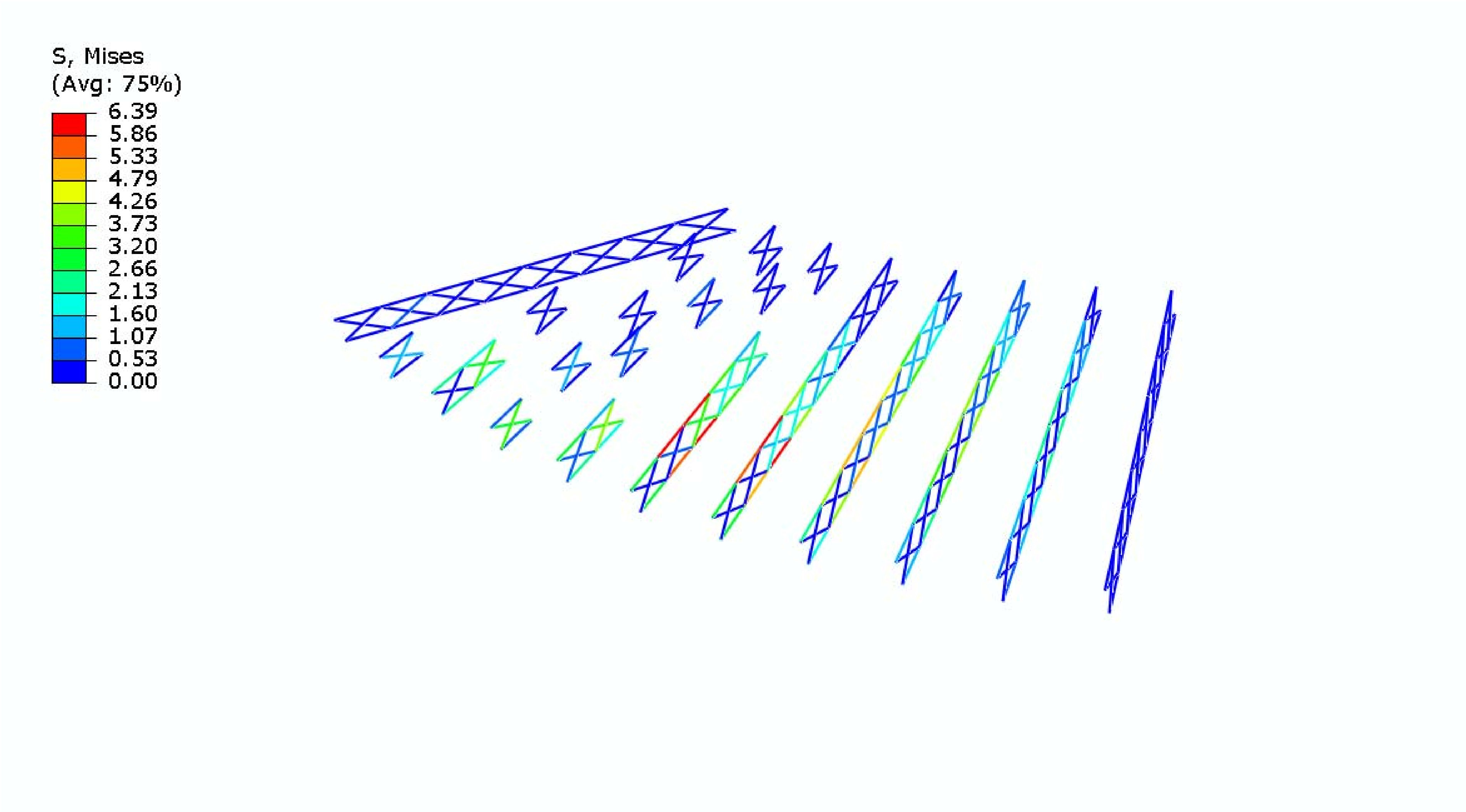


Figure O1-4-26. **Cross-frame stress contours under SDL, TDLF detailing**

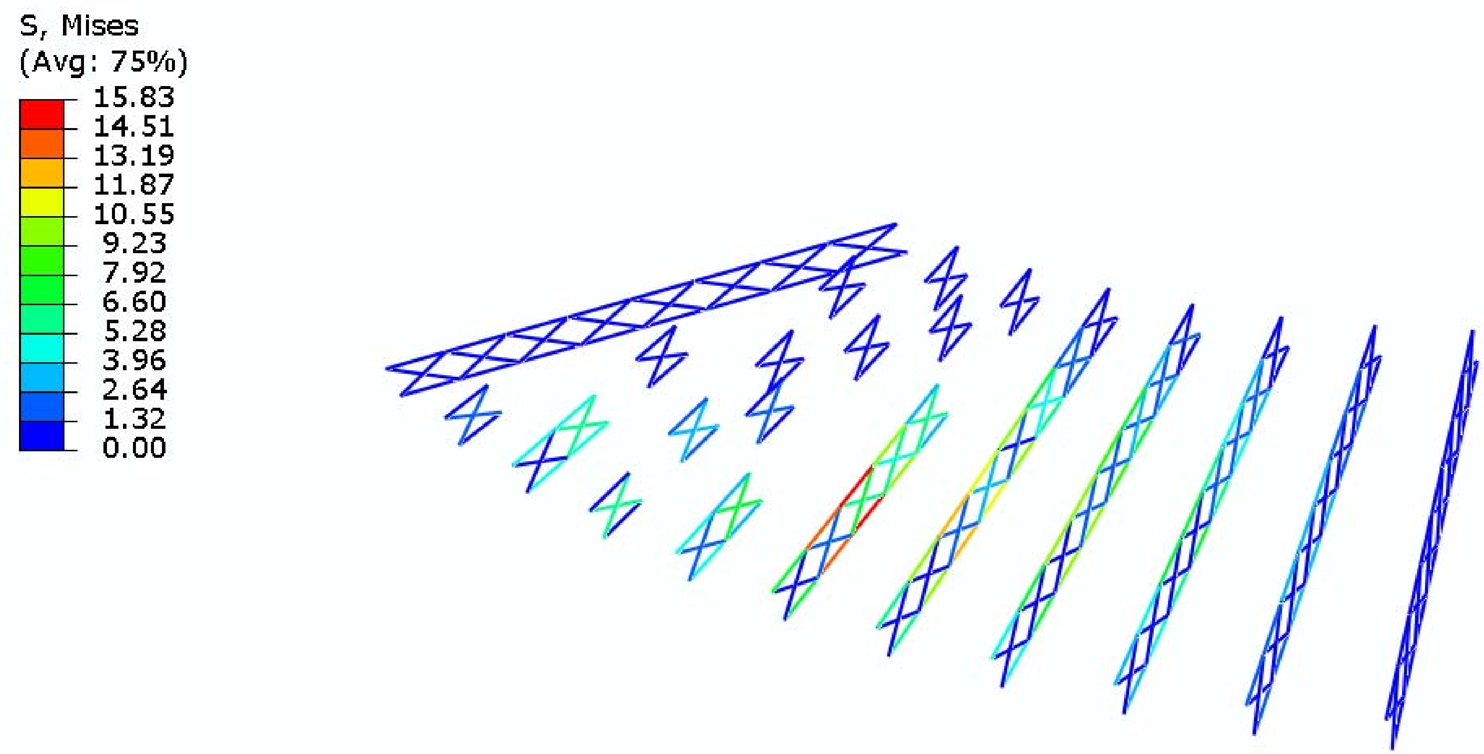


Figure O1-4-27. Cross-frame stress contours under TDL, TDLF detailing

Table O1-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	9.0	7.6	5.3	4.0	4.4	4.0	12.1	9.0
	SDLF	5.0	4.4	4.9	1.2	1.4	1.8	1.2	1.0
	TDLF	10.9	13.8	11.5	7.8	7.9	5.5	7.3	6.1
2	NLF	19.2	59.9	35.9	7.8	10.8	13.6	1.6	5.8
	SDLF	25.5	67.3	32.1	8.6	8.2	9.9	2.4	1.5
	TDLF	33.5	75.1	26.0	10.5	6.3	6.0	5.1	5.0
3	NLF	6.8	63.2	58.1	22.1	74.6	56.2	2.7	3.4
	SDLF	8.0	74.2	66.0	20.7	67.4	47.8	3.0	1.3
	TDLF	10.6	87.3	75.4	20.3	59.5	38.4	4.3	2.1
4	NLF	58.2	27.5	6.5	67.5	1.6	27.7	49.9	28.6
	SDLF	66.0	23.4	21.6	57.2	12.6	27.7	26.6	13.7
	TDLF	75.7	20.5	38.9	44.8	26.1	28.8	3.1	4.6
5	NLF	18.6	1.0	6.9	5.2	21.0	17.5	28.3	18.2
	SDLF	20.3	2.2	9.7	26.5	19.8	19.3	28.2	16.9
	TDLF	24.3	3.6	12.7	48.5	19.3	21.5	27.9	14.9
6	NLF	23.3	9.3	9.8	10.4	18.7	9.3	14.8	9.3
	SDLF	13.7	9.9	5.8	14.2	17.2	10.9	20.3	14.1
	TDLF	4.3	10.7	1.3	18.9	16.3	12.4	25.9	18.6
7	NLF	5.3	8.8	7.6	12.9	10.1	3.6	7.0	2.7
	SDLF	6.5	8.0	4.0	8.9	9.6	1.4	10.8	7.0
	TDLF	10.1	7.2	2.2	5.1	9.5	4.0	15.1	11.6
8	NLF	6.0	6.1	4.0	8.7	3.5	NA	5.1	5.5
	SDLF	3.9	4.9	1.6	5.6	1.0	NA	3.2	3.8
	TDLF	2.7	4.4	5.9	2.6	4.8	NA	3.8	3.2
9	NLF	7.0	6.1	NA	3.6	NA	NA	NA	NA
	SDLF	6.8	1.7	NA	1.0	NA	NA	NA	NA
	TDLF	7.7	8.3	NA	4.9	NA	NA	NA	NA
10	NLF	4.7	NA	NA	NA	NA	NA	NA	NA
	SDLF	5.1	NA	NA	NA	NA	NA	NA	NA
	TDLF	6.4	NA	NA	NA	NA	NA	NA	NA

Table O1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	6.4	NA	NA	NA	NA	NA	NA	NA
	SDLF	2.2	NA	NA	NA	NA	NA	NA	NA
	TDLF	7.4	NA	NA	NA	NA	NA	NA	NA

Table O1-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	21.3	16.6	15.9	9.0	10.7	9.6	10.1	4.4
	SDLF	11.6	7.2	10.7	3.9	5.3	5.6	3.0	3.3
	TDLF	11.2	9.0	11.3	2.7	3.3	4.4	2.6	2.7
2	NLF	43.4	133.9	85.6	18.9	27.4	34.5	4.2	15.4
	SDLF	49.6	140.6	80.9	19.7	24.0	30.1	5.3	10.4
	TDLF	57.2	147.8	74.5	21.6	22.1	26.3	8.0	6.1
3	NLF	13.7	143.4	142.2	53.0	158.7	127.2	10.3	12.3
	SDLF	13.7	154.1	148.9	50.8	150.9	118.0	10.6	10.0
	TDLF	16.3	165.6	157.7	50.3	141.6	107.6	12.1	8.0
4	NLF	131.0	52.2	24.6	148.7	7.8	62.7	102.9	53.8
	SDLF	137.5	47.8	39.2	136.9	21.6	62.1	77.6	37.8
	TDLF	146.3	44.3	56.1	123.6	34.6	62.7	53.6	23.9
5	NLF	42.3	9.0	23.9	21.6	50.8	40.5	59.9	35.7
	SDLF	42.2	10.1	26.8	42.5	49.3	42.0	59.3	33.7
	TDLF	46.1	11.2	29.6	64.2	48.5	43.8	58.4	31.5
6	NLF	47.5	25.4	28.2	30.3	43.1	21.0	32.9	19.5
	SDLF	37.7	26.2	24.3	34.0	41.2	22.7	38.0	23.9
	TDLF	26.4	26.7	19.7	38.5	40.2	24.4	43.2	28.1
7	NLF	7.6	22.7	20.5	32.2	22.5	5.1	14.9	7.8
	SDLF	8.0	22.2	17.1	28.2	22.1	2.6	18.9	11.9
	TDLF	11.4	21.3	12.8	24.3	22.0	1.8	23.0	15.9
8	NLF	15.5	14.8	8.7	20.6	8.0	NA	4.0	1.6
	SDLF	12.6	14.1	4.1	17.7	4.6	NA	2.7	1.1
	TDLF	11.3	13.2	3.1	14.6	2.1	NA	0.9	0.7
9	NLF	16.7	13.6	NA	9.1	NA	NA	NA	NA
	SDLF	16.2	8.5	NA	5.7	NA	NA	NA	NA
	TDLF	16.9	4.2	NA	2.3	NA	NA	NA	NA
10	NLF	11.0	NA	NA	NA	NA	NA	NA	NA
	SDLF	11.4	NA	NA	NA	NA	NA	NA	NA
	TDLF	12.5	NA	NA	NA	NA	NA	NA	NA

Table O1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	14.5	NA	NA	NA	NA	NA	NA	NA
	SDLF	9.0	NA	NA	NA	NA	NA	NA	NA
	TDLF	5.2	NA	NA	NA	NA	NA	NA	NA

Table O1-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.6	2.1	2.4	1.8	0.7	0.1	13.3	9.4
	SDLF	3.7	3.2	3.9	1.6	1.7	1.4	1.8	0.7
	TDLF	10.9	10.5	6.9	5.6	5.0	2.0	6.8	1.9
2	NLF	10.6	54.9	36.4	9.4	17.6	17.4	6.8	7.4
	SDLF	8.6	51.6	20.4	2.6	3.2	1.4	2.4	0.8
	TDLF	5.3	45.6	2.0	4.4	11.6	14.6	12.1	9.8
3	NLF	55.1	42.6	219.7	18.9	63.1	170.3	11.9	5.7
	SDLF	57.2	43.1	190.7	7.1	50.4	92.3	0.7	1.8
	TDLF	58.7	42.6	156.7	4.8	36.3	13.0	10.2	2.0
4	NLF	12.0	175.8	156.2	150.6	188.1	94.3	93.5	30.2
	SDLF	14.1	162.2	155.1	124.7	123.1	90.6	42.4	13.4
	TDLF	15.5	146.4	154.2	94.7	55.5	85.6	7.9	2.7
5	NLF	52.9	116.1	111.2	171.8	117.9	49.5	56.8	21.0
	SDLF	57.2	124.3	117.1	139.1	113.3	66.1	51.1	17.0
	TDLF	61.2	133.8	124.6	104.0	108.5	82.6	43.5	12.3
6	NLF	80.5	79.2	71.9	121.9	63.9	19.9	30.0	11.9
	SDLF	78.2	87.2	80.7	121.6	82.2	33.7	40.3	14.3
	TDLF	75.1	96.2	90.3	122.3	101.1	48.1	50.1	16.4
7	NLF	61.0	54.5	35.3	72.5	27.6	2.7	10.6	4.0
	SDLF	65.7	58.7	41.8	87.3	42.4	0.3	20.0	7.0
	TDLF	70.8	63.1	48.0	103.4	57.8	2.9	29.9	10.0
8	NLF	45.4	28.1	2.5	33.0	2.2	NA	6.1	4.3
	SDLF	49.4	30.4	0.8	45.0	0.5	NA	3.1	2.4
	TDLF	53.5	31.9	3.5	57.8	3.6	NA	1.0	0.5
9	NLF	32.6	3.2	NA	2.0	NA	NA	NA	NA
	SDLF	34.1	0.9	NA	0.5	NA	NA	NA	NA
	TDLF	35.4	4.7	NA	3.4	NA	NA	NA	NA
10	NLF	17.5	NA	NA	NA	NA	NA	NA	NA
	SDLF	18.0	NA	NA	NA	NA	NA	NA	NA
	TDLF	18.2	NA	NA	NA	NA	NA	NA	NA

Table O1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	2.5	NA	NA	NA	NA	NA	NA	NA
	SDLF	1.2	NA	NA	NA	NA	NA	NA	NA
	TDLF	5.7	NA	NA	NA	NA	NA	NA	NA

Table O1-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	4.2	2.3	6.6	2.7	0.6	3.6	8.6	2.3
	SDLF	1.4	2.3	7.9	0.2	1.8	3.4	1.0	0.9
	TDLF	8.7	7.4	8.5	3.7	3.4	3.4	4.2	1.9
2	NLF	24.1	119.3	74.6	18.0	31.7	33.1	13.4	15.9
	SDLF	22.7	117.1	60.1	11.6	18.7	18.6	4.4	7.9
	TDLF	19.3	110.6	42.7	5.0	5.1	4.0	4.7	0.6
3	NLF	122.0	91.3	462.3	34.9	122.5	329.5	24.9	12.2
	SDLF	123.5	93.0	432.2	24.5	110.7	249.4	14.1	8.1
	TDLF	124.3	93.0	395.4	13.6	96.4	167.7	4.1	4.3
4	NLF	26.8	380.8	330.7	304.8	375.8	182.1	171.7	52.9
	SDLF	30.0	364.9	327.3	278.4	308.0	177.4	119.2	35.5
	TDLF	31.3	346.2	323.7	246.6	237.4	171.1	67.5	18.9
5	NLF	117.2	250.7	233.2	351.7	233.3	95.1	103.8	36.2
	SDLF	121.5	257.3	237.9	316.7	227.2	111.0	97.7	32.1
	TDLF	125.1	264.9	243.9	278.8	220.9	126.6	89.5	27.2
6	NLF	177.6	170.7	150.4	247.4	125.7	39.3	54.5	20.5
	SDLF	174.0	177.9	158.3	245.5	143.0	52.6	64.4	22.7
	TDLF	169.5	185.9	167.2	244.6	160.9	66.1	73.7	24.6
7	NLF	134.6	117.8	73.9	145.9	54.5	3.3	21.3	8.7
	SDLF	138.4	121.5	80.0	159.6	68.9	1.3	30.0	11.2
	TDLF	142.5	125.3	86.2	174.8	83.6	1.0	38.8	13.7
8	NLF	100.4	61.5	5.1	65.9	4.9	NA	1.8	0.5
	SDLF	104.0	63.5	2.1	77.5	2.3	NA	0.6	0.2
	TDLF	107.5	65.1	1.5	89.9	1.2	NA	0.7	1.0
9	NLF	72.4	7.0	NA	4.1	NA	NA	NA	NA
	SDLF	73.6	3.3	NA	1.5	NA	NA	NA	NA
	TDLF	74.7	1.8	NA	1.1	NA	NA	NA	NA
10	NLF	39.7	NA	NA	NA	NA	NA	NA	NA
	SDLF	40.1	NA	NA	NA	NA	NA	NA	NA
	TDLF	40.2	NA	NA	NA	NA	NA	NA	NA

Table O1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	5.0	NA	NA	NA	NA	NA	NA	NA
	SDLF	1.3	NA	NA	NA	NA	NA	NA	NA
	TDLF	3.2	NA	NA	NA	NA	NA	NA	NA

Table O1-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	3.0	0.6	4.0	0.8	0.2	0.4	13.5	10.1
	SDLF	1.3	2.8	0.9	1.8	1.8	0.9	0.2	0.2
	TDLF	7.6	6.7	5.9	4.0	4.0	4.6	2.1	0.7
2	NLF	10.8	57.0	39.2	10.2	19.8	20.3	7.9	9.1
	SDLF	10.4	52.9	22.0	4.0	4.6	2.6	1.3	0.2
	TDLF	10.5	48.2	3.0	2.0	11.2	15.5	10.8	9.6
3	NLF	54.5	44.5	222.7	20.9	65.5	171.3	13.6	5.6
	SDLF	60.1	42.4	195.0	8.1	47.7	94.8	1.6	2.3
	TDLF	65.7	39.9	163.6	4.5	28.9	17.6	10.4	0.7
4	NLF	12.7	175.6	155.6	152.4	187.6	94.5	93.5	30.2
	SDLF	14.5	165.7	155.9	125.5	125.3	91.3	41.5	11.5
	TDLF	17.6	154.3	157.3	95.2	60.8	87.1	9.6	6.1
5	NLF	52.7	115.4	111.0	171.3	117.9	49.6	57.1	21.1
	SDLF	60.1	125.1	117.7	138.9	114.3	66.5	50.9	16.1
	TDLF	68.7	136.9	126.4	104.6	110.9	83.5	43.1	10.4
6	NLF	79.1	78.9	71.6	121.6	63.8	19.8	29.9	11.8
	SDLF	78.3	87.7	81.3	122.4	82.8	34.0	40.2	14.0
	TDLF	76.9	98.2	92.2	124.5	102.7	48.7	50.2	15.9
7	NLF	59.5	54.1	35.3	72.2	27.5	0.1	10.5	3.9
	SDLF	66.4	59.3	42.2	87.9	42.7	0.9	20.1	7.0
	TDLF	74.5	65.0	48.8	105.2	58.5	2.7	30.2	10.3
8	NLF	44.4	27.9	2.4	32.9	1.4	NA	5.2	4.5
	SDLF	50.4	30.8	0.3	45.3	0.4	NA	3.7	3.0
	TDLF	57.3	33.0	5.4	58.5	3.5	NA	2.9	2.1
9	NLF	31.7	2.9	NA	1.9	NA	NA	NA	NA
	SDLF	35.0	0.3	NA	0.4	NA	NA	NA	NA
	TDLF	38.6	5.6	NA	4.0	NA	NA	NA	NA
10	NLF	17.1	NA	NA	NA	NA	NA	NA	NA
	SDLF	18.7	NA	NA	NA	NA	NA	NA	NA
	TDLF	20.1	NA	NA	NA	NA	NA	NA	NA

Table O1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	4.2	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.2	NA	NA	NA	NA	NA	NA	NA
	TDLF	4.5	NA	NA	NA	NA	NA	NA	NA

Table O1-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	7.1	1.6	7.8	3.2	0.5	2.9	9.9	3.6
	SDLF	3.2	0.8	4.1	3.0	1.7	1.1	2.6	0.0
	TDLF	2.5	6.2	2.0	4.0	4.2	1.9	0.5	0.3
2	NLF	24.5	125.1	85.2	21.6	41.4	45.5	18.4	22.9
	SDLF	23.6	119.1	66.4	15.0	25.1	26.2	8.4	12.7
	TDLF	23.5	113.2	46.0	8.6	8.0	6.7	1.7	2.1
3	NLF	121.5	99.0	471.8	43.4	130.7	331.4	32.6	12.9
	SDLF	126.6	94.9	440.3	29.4	111.0	252.2	19.2	9.1
	TDLF	131.4	90.8	405.3	15.7	90.8	173.2	6.2	5.8
4	NLF	29.1	380.9	328.1	311.0	373.4	182.8	171.0	52.7
	SDLF	29.3	369.2	326.7	281.4	309.1	178.2	117.5	33.5
	TDLF	31.9	355.4	326.4	248.5	242.8	172.8	65.7	15.7
5	NLF	119.0	248.8	233.1	349.6	233.7	95.2	104.8	37.0
	SDLF	125.0	257.3	238.4	315.3	228.3	111.4	97.8	31.7
	TDLF	132.4	267.6	245.7	279.1	223.3	127.7	89.2	25.6
6	NLF	174.9	170.2	149.9	247.0	125.2	38.9	54.3	20.6
	SDLF	173.3	178.0	158.8	246.2	143.4	52.7	64.4	22.7
	TDLF	170.8	187.4	168.9	246.6	162.5	66.8	73.9	24.4
7	NLF	131.5	117.0	73.8	145.0	54.0	3.0	20.9	8.5
	SDLF	137.8	121.7	80.3	159.9	68.9	2.1	30.0	11.4
	TDLF	145.1	126.9	87.1	176.4	84.3	0.6	39.3	14.2
8	NLF	98.7	61.0	6.1	65.4	3.5	NA	2.0	1.1
	SDLF	104.1	63.6	3.3	77.5	1.9	NA	1.8	1.2
	TDLF	110.3	66.0	0.8	90.4	0.8	NA	0.3	0.2
9	NLF	70.9	6.6	NA	4.9	NA	NA	NA	NA
	SDLF	73.9	3.2	NA	3.1	NA	NA	NA	NA
	TDLF	77.1	0.8	NA	0.9	NA	NA	NA	NA
10	NLF	38.9	NA	NA	NA	NA	NA	NA	NA
	SDLF	40.5	NA	NA	NA	NA	NA	NA	NA
	TDLF	41.8	NA	NA	NA	NA	NA	NA	NA

Table O1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	9.8	NA	NA	NA	NA	NA	NA	NA
	SDLF	6.0	NA	NA	NA	NA	NA	NA	NA
	TDLF	1.0	NA	NA	NA	NA	NA	NA	NA

Table O1-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.71	0.86	0.68	0.45	0.52	0.38	0.20	0.25
	SDLF	0.65	0.81	0.53	0.30	0.34	0.17	0.07	0.08
	TDLF	0.59	0.76	0.33	0.14	0.15	-0.06	-0.07	-0.09
3	NLF	0.90	0.99	0.77	0.65	0.65	0.48	0.35	0.36
	SDLF	0.91	1.04	0.72	0.51	0.49	0.29	0.16	0.15
	TDLF	0.92	1.08	0.65	0.35	0.32	0.09	-0.03	-0.05
4	NLF	1.04	0.89	0.71	0.69	0.57	0.43	0.42	0.40
	SDLF	1.10	0.94	0.70	0.58	0.45	0.28	0.22	0.19
	TDLF	1.17	0.99	0.67	0.45	0.30	0.13	0.01	-0.02
5	NLF	1.03	0.77	0.58	0.64	0.48	0.32	0.40	0.38
	SDLF	1.12	0.82	0.58	0.57	0.38	0.22	0.22	0.20
	TDLF	1.21	0.87	0.57	0.47	0.26	0.11	0.04	0.02
6	NLF	0.94	0.62	0.41	0.53	0.34	0.17	0.31	0.30
	SDLF	1.04	0.66	0.41	0.48	0.28	0.12	0.18	0.17
	TDLF	1.15	0.71	0.41	0.42	0.20	0.07	0.06	0.03
7	NLF	0.81	0.43	0.21	0.37	0.18	0.00	0.17	0.16
	SDLF	0.90	0.47	0.21	0.35	0.15	0.00	0.10	0.10
	TDLF	1.00	0.50	0.21	0.31	0.11	0.00	0.04	0.03
8	NLF	0.64	0.22	0.00	0.19	0.00	NA	0.00	0.01
	SDLF	0.72	0.24	0.00	0.18	0.00	NA	0.00	0.00
	TDLF	0.80	0.26	0.00	0.16	0.00	NA	0.00	0.00
9	NLF	0.45	0.00	NA	0.00	NA	NA	NA	NA
	SDLF	0.51	0.00	NA	0.00	NA	NA	NA	NA
	TDLF	0.56	0.00	NA	0.00	NA	NA	NA	NA
10	NLF	0.23	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.26	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.29	NA	NA	NA	NA	NA	NA	NA

Table O1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

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Table O1-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	1.53	1.84	1.43	1.00	1.13	0.85	0.49	0.59
	SDLF	1.48	1.79	1.27	0.85	0.95	0.63	0.36	0.43
	TDLF	1.40	1.73	1.07	0.68	0.75	0.40	0.22	0.26
3	NLF	1.94	2.11	1.63	1.39	1.37	1.01	0.79	0.81
	SDLF	1.95	2.14	1.57	1.24	1.21	0.83	0.61	0.61
	TDLF	1.94	2.17	1.49	1.08	1.03	0.62	0.41	0.40
4	NLF	2.23	1.87	1.49	1.47	1.20	0.91	0.92	0.89
	SDLF	2.29	1.92	1.47	1.35	1.08	0.76	0.71	0.68
	TDLF	2.34	1.96	1.43	1.21	0.93	0.60	0.50	0.46
5	NLF	2.19	1.61	1.21	1.35	1.00	0.68	0.85	0.83
	SDLF	2.27	1.66	1.21	1.27	0.90	0.58	0.67	0.64
	TDLF	2.35	1.70	1.19	1.17	0.78	0.47	0.49	0.46
6	NLF	1.99	1.29	0.85	1.11	0.72	0.36	0.65	0.64
	SDLF	2.08	1.33	0.85	1.06	0.65	0.31	0.53	0.51
	TDLF	2.18	1.37	0.84	0.99	0.57	0.25	0.40	0.37
7	NLF	1.70	0.90	0.43	0.78	0.38	0.00	0.35	0.35
	SDLF	1.79	0.94	0.44	0.75	0.34	0.00	0.29	0.28
	TDLF	1.88	0.96	0.43	0.71	0.30	0.00	0.22	0.21
8	NLF	1.35	0.46	0.00	0.41	0.00	NA	0.00	0.00
	SDLF	1.42	0.48	0.00	0.39	0.00	NA	0.00	0.00
	TDLF	1.49	0.50	0.00	0.37	0.00	NA	0.00	0.00
9	NLF	0.94	0.00	NA	0.00	NA	NA	NA	NA
	SDLF	1.00	0.00	NA	0.00	NA	NA	NA	NA
	TDLF	1.05	0.00	NA	0.00	NA	NA	NA	NA
10	NLF	0.49	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.51	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.54	NA	NA	NA	NA	NA	NA	NA

Table O1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table O1-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.51	0.62	0.49	0.33	0.37	0.28	0.14	0.18
	SDLF	0.47	0.59	0.38	0.22	0.25	0.12	0.05	0.06
	TDLF	0.42	0.55	0.24	0.10	0.11	-0.04	-0.05	-0.06
3	NLF	0.65	0.71	0.56	0.47	0.47	0.34	0.25	0.26
	SDLF	0.66	0.75	0.52	0.36	0.36	0.21	0.12	0.11
	TDLF	0.66	0.78	0.47	0.25	0.23	0.06	-0.02	-0.04
4	NLF	0.75	0.64	0.51	0.50	0.41	0.31	0.30	0.29
	SDLF	0.80	0.68	0.50	0.42	0.32	0.20	0.16	0.14
	TDLF	0.84	0.72	0.48	0.32	0.22	0.09	0.01	-0.01
5	NLF	0.74	0.55	0.42	0.46	0.34	0.23	0.29	0.28
	SDLF	0.80	0.59	0.42	0.41	0.27	0.16	0.16	0.14
	TDLF	0.87	0.63	0.41	0.34	0.19	0.08	0.03	0.01
6	NLF	0.68	0.44	0.29	0.38	0.25	0.12	0.22	0.22
	SDLF	0.75	0.48	0.30	0.35	0.20	0.09	0.13	0.12
	TDLF	0.83	0.51	0.29	0.30	0.14	0.05	0.04	0.03
7	NLF	0.58	0.31	0.15	0.27	0.13	0.00	0.12	0.12
	SDLF	0.65	0.34	0.15	0.25	0.11	0.00	0.07	0.07
	TDLF	0.72	0.36	0.15	0.22	0.08	0.00	0.03	0.02
8	NLF	0.46	0.16	0.00	0.14	0.00	NA	0.00	0.00
	SDLF	0.52	0.17	0.00	0.13	0.00	NA	0.00	0.00
	TDLF	0.58	0.19	0.00	0.12	0.00	NA	0.00	0.00
9	NLF	0.33	0.00	NA	0.00	NA	NA	NA	NA
	SDLF	0.36	0.00	NA	0.00	NA	NA	NA	NA
	TDLF	0.40	0.00	NA	0.00	NA	NA	NA	NA
10	NLF	0.17	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.19	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.21	NA	NA	NA	NA	NA	NA	NA

Table O1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table O1-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	1.11	1.33	1.03	0.72	0.81	0.61	0.35	0.42
	SDLF	1.06	1.29	0.92	0.61	0.69	0.46	0.26	0.31
	TDLF	1.01	1.25	0.77	0.49	0.54	0.29	0.16	0.18
3	NLF	1.40	1.52	1.17	1.00	0.99	0.73	0.57	0.58
	SDLF	1.40	1.55	1.13	0.90	0.88	0.60	0.44	0.44
	TDLF	1.40	1.57	1.07	0.78	0.74	0.45	0.30	0.29
4	NLF	1.61	1.35	1.07	1.06	0.87	0.65	0.66	0.64
	SDLF	1.65	1.38	1.06	0.97	0.78	0.55	0.51	0.49
	TDLF	1.68	1.42	1.03	0.87	0.67	0.43	0.36	0.33
5	NLF	1.58	1.16	0.87	0.97	0.72	0.49	0.61	0.60
	SDLF	1.63	1.20	0.87	0.91	0.65	0.42	0.49	0.46
	TDLF	1.69	1.23	0.86	0.84	0.56	0.34	0.35	0.33
6	NLF	1.43	0.93	0.61	0.80	0.52	0.26	0.47	0.46
	SDLF	1.50	0.96	0.61	0.76	0.47	0.22	0.38	0.36
	TDLF	1.57	0.99	0.61	0.71	0.41	0.18	0.29	0.27
7	NLF	1.22	0.65	0.31	0.56	0.27	0.00	0.25	0.25
	SDLF	1.29	0.67	0.31	0.54	0.25	0.00	0.21	0.20
	TDLF	1.35	0.69	0.31	0.51	0.22	0.00	0.16	0.15
8	NLF	0.97	0.33	0.00	0.29	0.00	NA	0.00	0.00
	SDLF	1.03	0.35	0.00	0.28	0.00	NA	0.00	0.00
	TDLF	1.08	0.36	0.00	0.27	0.00	NA	0.00	0.00
9	NLF	0.68	0.00	NA	0.00	NA	NA	NA	NA
	SDLF	0.72	0.00	NA	0.00	NA	NA	NA	NA
	TDLF	0.75	0.00	NA	0.00	NA	NA	NA	NA
10	NLF	0.35	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.37	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.39	NA	NA	NA	NA	NA	NA	NA

Table O1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table O1-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	170	133	369	287
	SDLF	183	138	381	292
	TDLF	199	143	395	297
G2	NLF	131	124	280	271
	SDLF	132	126	280	274
	TDLF	128	130	281	275
G3	NLF	71	120	162	265
	SDLF	62	120	153	263
	TDLF	55	115	140	264
G4	NLF	64	77	150	177
	SDLF	59	73	145	174
	TDLF	53	72	143	169
G5	NLF	51	73	126	168
	SDLF	45	69	120	164
	TDLF	38	65	112	161
G6	NLF	39	64	104	150
	SDLF	35	60	100	147
	TDLF	33	56	96	145
G7	NLF	39	38	86	92
	SDLF	26	36	80	91
	TDLF	21	34	78	88
G8	NLF	7	5	74	57
	SDLF	23	10	75	57
	TDLF	19	14	70	58
G9	NLF	0	0	0	11
	SDLF	9	0	18	14
	TDLF	29	0	39	17

Table O1-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.6	NA	-2.7	NA
	SDLF	-0.3	NA	-1.9	NA
	TDLF	0.1	NA	-0.7	NA
G2	NLF	-0.4	NA	-1.7	NA
	SDLF	-0.2	NA	-1.2	NA
	TDLF	0.0	NA	-0.5	NA
G3	NLF	-0.2	NA	-0.3	NA
	SDLF	-0.1	NA	0.0	NA
	TDLF	-0.4	NA	-0.4	NA
G4	NLF	-0.2	NA	-0.8	NA
	SDLF	-0.1	NA	-0.4	NA
	TDLF	-0.1	NA	-0.2	NA
G5	NLF	0.1	NA	0.4	NA
	SDLF	0.0	NA	0.3	NA
	TDLF	-0.1	NA	0.1	NA
G6	NLF	0.3	NA	1.1	NA
	SDLF	0.1	NA	0.7	NA
	TDLF	0.0	NA	0.3	NA
G7	NLF	0.0	NA	0.1	NA
	SDLF	0.1	NA	0.2	NA
	TDLF	0.3	NA	0.4	NA
G8	NLF	0.5	NA	2.0	NA
	SDLF	0.3	NA	1.3	NA
	TDLF	0.1	NA	0.6	NA
G9	NLF	0.8	NA	3.0	NA
	SDLF	0.4	NA	1.9	NA
	TDLF	0.1	NA	0.9	NA

Table O1-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.3	-0.1	-1.4	-0.4
	SDLF	0.3	0.0	-0.6	-0.2
	TDLF	1.1	0.1	0.6	-0.1
G2	NLF	-0.2	-0.1	-0.9	-0.4
	SDLF	0.2	0.0	-0.3	-0.2
	TDLF	0.8	0.1	0.5	-0.1
G3	NLF	-0.1	-0.1	0.0	-0.4
	SDLF	0.1	0.0	0.3	-0.2
	TDLF	0.1	0.1	0.2	-0.1
G4	NLF	-0.1	-0.1	-0.3	-0.4
	SDLF	0.1	0.0	0.0	-0.2
	TDLF	0.2	0.1	0.2	0.0
G5	NLF	0.1	-0.1	0.5	-0.4
	SDLF	0.0	0.0	0.3	-0.2
	TDLF	-0.1	0.1	0.1	0.0
G6	NLF	0.3	-0.1	1.0	0.0
	SDLF	0.0	-0.1	0.5	0.1
	TDLF	-0.3	0.0	-0.1	0.1
G7	NLF	0.1	-0.1	0.3	0.0
	SDLF	-0.1	-0.1	0.0	0.1
	TDLF	-0.3	0.0	-0.2	0.1
G8	NLF	0.5	-0.1	1.9	-0.4
	SDLF	-0.1	0.0	0.8	-0.2
	TDLF	-0.7	0.1	-0.2	0.0
G9	NLF	0.7	-0.1	2.9	-0.4
	SDLF	-0.2	0.0	1.2	-0.2
	TDLF	-1.1	0.1	-0.4	0.0

Table O1-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.11	0.45	-0.53	0.43
	SDLF	-0.07	0.45	-0.38	0.59
	TDLF	0.03	0.60	-0.15	1.05
G2	NLF	-0.08	0.38	-0.35	0.44
	SDLF	-0.05	0.38	-0.24	0.57
	TDLF	0.00	0.43	-0.10	0.87
G3	NLF	-0.04	0.31	-0.06	0.50
	SDLF	-0.02	0.28	0.00	0.59
	TDLF	-0.08	0.20	-0.08	0.63
G4	NLF	-0.05	0.24	-0.16	0.28
	SDLF	-0.02	0.22	-0.08	0.40
	TDLF	-0.02	0.19	-0.03	0.54
G5	NLF	0.02	0.22	0.09	0.36
	SDLF	0.01	0.17	0.06	0.39
	TDLF	-0.01	0.11	0.02	0.43
G6	NLF	0.06	0.18	0.22	0.35
	SDLF	0.03	0.12	0.14	0.33
	TDLF	0.00	0.06	0.06	0.32
G7	NLF	0.01	0.07	0.02	0.04
	SDLF	0.03	0.08	0.03	0.14
	TDLF	0.06	0.10	0.07	0.26
G8	NLF	0.11	0.10	0.41	0.29
	SDLF	0.05	0.07	0.26	0.25
	TDLF	0.01	0.04	0.13	0.22
G9	NLF	0.16	0.08	0.60	0.33
	SDLF	0.08	0.04	0.37	0.23
	TDLF	0.01	0.02	0.17	0.15

Table O1-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.06	-0.02	-0.27	-0.08
	SDLF	0.05	0.00	-0.11	-0.04
	TDLF	0.21	0.01	0.12	-0.01
G2	NLF	-0.04	-0.02	-0.18	-0.08
	SDLF	0.05	0.00	-0.05	-0.04
	TDLF	0.15	0.01	0.10	-0.01
G3	NLF	-0.02	-0.02	0.00	-0.08
	SDLF	0.03	0.00	0.06	-0.05
	TDLF	0.03	0.01	0.03	-0.01
G4	NLF	-0.02	-0.02	-0.06	-0.08
	SDLF	0.01	0.00	-0.01	-0.05
	TDLF	0.03	0.01	0.03	-0.01
G5	NLF	0.02	-0.02	0.10	-0.08
	SDLF	0.01	0.00	0.07	-0.05
	TDLF	-0.02	0.01	0.02	-0.01
G6	NLF	0.05	-0.02	0.21	-0.08
	SDLF	-0.01	0.00	0.10	-0.05
	TDLF	-0.07	0.01	-0.01	-0.01
G7	NLF	0.02	-0.02	0.06	-0.08
	SDLF	-0.03	0.00	0.00	-0.05
	TDLF	-0.07	0.01	-0.04	-0.01
G8	NLF	0.10	-0.02	0.38	-0.08
	SDLF	-0.02	0.00	0.16	-0.05
	TDLF	-0.14	0.01	-0.04	-0.01
G9	NLF	0.14	-0.02	0.57	-0.08
	SDLF	-0.04	0.00	0.25	-0.05
	TDLF	-0.23	0.01	-0.08	-0.01

Appendix O1-5. NISCS15 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISCS15 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table O1-5-1. Erection method 1 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	0.8	-4.7	4.8	0.4	4.7	4.7
		SDLF	-2.5	-4.4	5.1	3.9	4.4	5.9
		TDLF	-6.3	-4.2	7.5	7.9	4.0	8.9
	2-3	NLF	2.2	-3.8	4.4	2.1	3.8	4.4
		SDLF	7.8	1.1	7.9	6.3	-1.0	6.4
		TDLF	14.9	8.1	17.0	11.5	-8.1	14.1
	2-4	NLF	2.6	1.4	3.0	2.5	-1.5	2.8
		SDLF	8.9	3.1	9.4	6.3	-3.1	7.0
		TDLF	17.3	7.3	18.7	11.4	-7.1	13.5
	2-5	NLF	2.3	10.4	10.7	2.2	-10.5	10.7
		SDLF	12.3	18.8	22.5	11.1	-19.2	22.1
		TDLF	23.6	28.0	36.6	20.8	-29.0	35.7
	2-6	NLF	1.4	16.6	16.7	1.3	-16.7	16.7
		SDLF	13.6	25.5	28.9	10.7	-26.0	28.1
		TDLF	27.2	35.0	44.3	20.7	-36.2	41.7
	2-7	NLF	-1.2	12.9	13.0	3.1	-13.1	13.5
		SDLF	15.4	29.5	33.3	19.6	-30.0	35.8
		TDLF	34.0	47.5	58.4	37.7	-48.5	61.5
	2-8	NLF	1.0	-0.6	1.2	1.0	0.6	1.1
		SDLF	25.8	29.0	38.8	24.6	-29.1	38.1
		TDLF	32.0	23.6	39.7	28.9	-24.1	37.6
	2-9	NLF	0.8	-10.0	10.0	0.8	9.7	9.7
		SDLF	22.5	17.1	28.2	21.3	-17.6	27.6
		TDLF	25.1	8.4	26.5	22.1	-9.2	23.9
	2-10	NLF	-0.2	-8.9	8.9	0.6	8.8	8.8
		SDLF	13.3	7.9	15.5	12.3	-8.0	14.7
		TDLF	15.1	3.6	15.5	12.5	-3.7	13.0
	2-11	NLF	1.2	-1.9	2.2	1.3	1.9	2.3
		SDLF	5.8	3.2	6.6	5.0	-3.3	6.0
		TDLF	6.6	1.7	6.9	4.9	-1.7	5.2

Table O1-5-1(Continued). Erection method 1 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
4	4-2	NLF	47.4	-37.9	60.7	47.0	33.8	57.9
		SDLF	45.3	-34.0	56.6	44.5	31.4	54.5
		TDLF	49.6	-30.0	58.0	48.2	27.9	55.7
	4-3	NLF	46.0	-65.3	79.9	44.5	65.6	79.3
		SDLF	51.2	-64.4	82.3	47.6	65.5	81.0
		TDLF	56.5	-63.9	85.3	49.8	64.8	81.8
	4-4	NLF	-3.7	-55.4	55.6	-4.0	57.9	58.0
		SDLF	8.0	-53.2	53.8	7.0	54.9	55.3
		TDLF	12.5	-56.1	57.5	10.8	56.7	57.7
	4-5	NLF	1.9	-45.1	45.1	1.2	48.3	48.3
		SDLF	6.9	-41.5	42.1	5.7	44.0	44.3
		TDLF	6.7	-43.0	43.6	5.1	44.6	44.8
	4-6	NLF	3.4	-22.2	22.5	2.8	24.7	24.8
		SDLF	4.3	-21.3	21.7	3.1	23.1	23.3
		TDLF	5.3	-19.9	20.6	3.7	21.1	21.4
	4-7	NLF	-0.9	-6.9	7.0	-1.5	8.8	9.0
		SDLF	-0.4	-6.7	6.7	-1.5	8.2	8.3
		TDLF	0.3	-6.1	6.1	-1.0	7.1	7.2

Table O1-5-1(Continued). Erection method 1 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	NLF	0.6	-0.8	1.0	0.6	0.7	1.0
		SDLF	-0.4	-0.8	0.9	0.0	1.2	1.2
		TDLF	-1.3	-0.7	1.5	0.0	1.6	1.6
	9-3	NLF	10.6	-4.0	11.3	10.7	2.2	10.9
		SDLF	7.6	1.9	7.8	7.1	-2.1	7.4
		TDLF	5.2	8.8	10.2	3.9	-7.5	8.5
	9-4	NLF	12.2	-3.0	12.5	12.0	3.5	12.5
		SDLF	11.6	2.0	11.7	11.1	-1.9	11.3
		TDLF	12.2	7.8	14.5	11.3	-8.2	14.0
	9-5	NLF	24.8	-14.0	28.5	24.6	14.2	28.4
		SDLF	20.7	-4.9	21.2	21.9	5.0	22.5
		TDLF	16.6	4.0	17.0	19.3	-4.3	19.7
	9-6	NLF	12.4	-11.4	16.9	12.3	11.5	16.9
		SDLF	15.2	-5.8	16.3	15.8	5.9	16.9
		TDLF	17.4	-0.1	17.4	18.8	0.1	18.8
	9-7	NLF	5.7	-5.9	8.2	5.7	6.1	8.3
		SDLF	9.7	-4.0	10.5	9.9	4.0	10.7
		TDLF	13.4	-1.8	13.5	13.9	1.8	14.0
	9-8	NLF	1.5	-1.8	2.4	1.6	1.9	2.4
		SDLF	4.1	-1.4	4.3	4.0	1.4	4.2
		TDLF	6.8	-0.9	6.8	6.5	1.0	6.6

Table O1-5-2. Erection method 2A fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	-1.9	-3.6	4.1	-1.9	3.6	4.1
		SDLF	-5.3	-3.4	6.3	1.7	3.3	3.7
		TDLF	-9.2	-3.1	9.7	5.9	3.0	6.6
	2-3	NLF	-4.0	-5.7	6.9	-3.8	5.6	6.8
		SDLF	2.1	2.0	2.9	0.6	-2.0	2.1
		TDLF	9.8	9.0	13.3	6.4	-9.1	11.2
	2-4	NLF	0.0	-0.1	0.1	0.9	0.1	0.9
		SDLF	6.7	2.7	7.2	5.0	-2.8	5.7
		TDLF	16.8	4.4	17.3	11.9	-4.4	12.7
	2-5	NLF	6.8	5.1	8.5	6.8	-5.4	8.6
		SDLF	17.7	11.3	21.0	16.6	-11.6	20.2
		TDLF	31.7	15.2	35.2	29.3	-16.2	33.4
	2-6	NLF	9.9	8.3	12.9	9.8	-8.6	13.1
		SDLF	24.0	13.3	27.4	21.3	-13.7	25.3
		TDLF	40.7	16.8	44.1	34.5	-18.1	39.0
	2-7	NLF	7.4	5.0	8.9	7.3	-5.2	9.0
		SDLF	24.4	21.4	32.4	23.8	-21.6	32.1
		TDLF	37.0	28.2	46.5	35.3	-28.8	45.5
	2-8	NLF	0.8	-0.5	1.0	0.9	0.6	1.0
		SDLF	23.5	32.2	39.9	22.3	-32.2	39.2
		TDLF	23.5	22.2	32.3	20.2	-22.4	30.2
	2-9	NLF	-5.5	-5.3	7.6	-5.4	5.4	7.7
		SDLF	11.6	24.1	26.7	10.1	-24.1	26.2
		TDLF	12.1	18.0	21.7	8.7	-18.2	20.2
	2-10	NLF	-5.3	-5.1	7.4	-4.6	5.2	6.9
		SDLF	4.7	14.6	15.3	3.6	-14.7	15.1
		TDLF	5.3	11.8	12.9	2.5	-11.9	12.2
	2-11	NLF	-1.3	-1.0	1.6	-1.3	1.0	1.6
		SDLF	1.8	5.1	5.4	1.0	-5.0	5.1
		TDLF	2.2	4.1	4.6	0.3	-3.9	3.9

Table O1-5-2(Continued). Erection method 2A fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
4	4-2	NLF	-11.3	3.8	11.9	-11.1	-3.4	11.6
		SDLF	2.2	1.9	2.9	1.4	-1.6	2.1
		TDLF	16.4	-0.1	16.4	14.6	0.3	14.6
	4-3	NLF	-24.9	23.4	34.2	-24.4	-22.6	33.3
		SDLF	13.2	12.6	18.2	10.6	-12.7	16.5
		TDLF	39.2	1.0	39.2	33.3	-1.4	33.3
	4-4	NLF	-25.1	8.3	26.5	-24.6	-7.5	25.8
		SDLF	11.7	15.9	19.8	11.1	-15.9	19.4
		TDLF	20.4	8.0	21.9	18.9	-8.3	20.6
	4-5	NLF	-31.4	-0.5	31.4	-30.9	1.5	30.9
		SDLF	0.0	21.7	21.7	-0.5	-21.5	21.5
		TDLF	-0.1	13.7	13.7	-1.3	-13.8	13.9
	4-6	NLF	-30.2	-4.5	30.5	-29.6	5.2	30.0
		SDLF	-5.6	16.0	16.9	-6.0	-15.9	17.0
		TDLF	-6.5	11.6	13.3	-7.6	-11.6	13.9
	4-7	NLF	-12.7	-1.1	12.8	-12.6	1.3	12.6
		SDLF	-2.4	6.9	7.3	-2.8	-6.8	7.4
		TDLF	-2.9	5.6	6.3	-3.8	-5.4	6.6

Table O1-5-2(Continued). Erection method 2A fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	NLF	0.6	-0.8	1.0	0.6	0.7	1.0
		SDLF	-0.4	-0.8	0.9	0.0	1.2	1.2
		TDLF	-1.3	-0.7	1.5	0.0	1.6	1.6
	9-3	NLF	10.6	-4.0	11.3	10.7	2.2	10.9
		SDLF	7.6	1.9	7.8	7.1	-2.1	7.4
		TDLF	5.2	8.8	10.2	3.9	-7.5	8.5
	9-4	NLF	12.2	-3.0	12.5	12.0	3.5	12.5
		SDLF	11.6	2.0	11.7	11.1	-1.9	11.3
		TDLF	12.2	7.8	14.5	11.3	-8.2	14.0
	9-5	NLF	24.8	-14.0	28.5	24.6	14.2	28.4
		SDLF	20.7	-4.9	21.2	21.9	5.0	22.5
		TDLF	16.6	4.0	17.0	19.3	-4.3	19.7
	9-6	NLF	12.4	-11.4	16.9	12.3	11.5	16.9
		SDLF	15.2	-5.8	16.3	15.8	5.9	16.9
		TDLF	17.4	-0.1	17.4	18.8	0.1	18.8
	9-7	NLF	5.7	-5.9	8.2	5.7	6.1	8.3
		SDLF	9.7	-4.0	10.5	9.9	4.0	10.7
		TDLF	13.4	-1.8	13.5	13.9	1.8	14.0
	9-8	NLF	1.5	-1.8	2.4	1.6	1.9	2.4
		SDLF	4.1	-1.4	4.3	4.0	1.4	4.2
		TDLF	6.8	-0.9	6.8	6.5	1.0	6.6

Table O1-5-3. Erection method 3 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	-0.5	-0.8	1.0	-0.4	0.8	1.0
		SDLF	-0.8	-0.9	1.2	-0.1	1.0	1.0
		TDLF	-1.5	-0.7	1.7	0.7	1.0	1.2
	2-3	NLF	-1.1	-1.3	1.7	0.7	1.3	1.5
		SDLF	1.6	3.4	3.7	3.0	-3.3	4.5
		TDLF	5.3	9.9	11.3	6.1	-9.9	11.7
	2-4	NLF	1.3	0.0	1.3	1.3	0.0	1.3
		SDLF	5.1	5.7	7.7	4.7	-5.8	7.5
		TDLF	7.1	6.1	9.4	6.2	-6.2	8.8
	2-5	NLF	1.7	1.3	2.1	1.7	-1.3	2.1
		SDLF	5.0	6.2	7.9	6.3	-6.2	8.8
		TDLF	8.0	9.4	12.3	10.7	-9.4	14.3
	2-6	NLF	0.6	0.7	0.9	0.6	-0.7	0.9
		SDLF	4.8	6.4	8.0	5.5	-6.4	8.4
		TDLF	6.6	5.4	8.5	8.0	-5.5	9.7
	2-7	NLF	-0.5	-0.4	0.6	-0.5	0.4	0.7
		SDLF	2.7	4.4	5.2	2.9	-4.4	5.3
		TDLF	3.7	2.9	4.7	4.2	-3.0	5.1
	2-8	NLF	-0.7	-0.8	1.0	-0.7	0.8	1.0
		SDLF	1.1	2.0	2.3	1.0	-2.0	2.2
		TDLF	1.6	1.4	2.2	1.4	-1.5	2.0

Table O1-5-3(Continued). Erection method 3 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-2	NLF	1.3	7.4	7.6	1.3	-7.4	7.5
		SDLF	-0.1	7.1	7.1	2.7	-6.9	7.4
		TDLF	-1.9	6.7	7.0	4.4	-6.2	7.6
	6-3	NLF	-4.2	-6.9	8.1	-4.2	7.0	8.1
		SDLF	1.8	3.8	4.2	0.9	-3.8	3.9
		TDLF	9.2	16.6	18.9	7.1	-16.7	18.2
	6-4	NLF	-4.7	-12.9	13.8	-4.7	13.0	13.9
		SDLF	13.1	20.0	23.9	12.5	-20.2	23.7
		TDLF	23.8	37.7	44.5	22.5	-38.1	44.2
	6-5	NLF	1.1	-5.6	5.7	1.1	5.5	5.6
		SDLF	15.3	14.0	20.7	14.5	-14.3	20.4
		TDLF	19.9	14.1	24.4	18.6	-14.8	23.7
	6-6	NLF	0.7	-4.4	4.5	0.7	4.4	4.4
		SDLF	15.3	21.8	26.7	15.3	-22.2	26.9
		TDLF	20.3	21.5	29.5	20.3	-22.4	30.2
	6-7	NLF	-6.2	-17.7	18.7	-6.2	17.7	18.8
		SDLF	6.7	7.8	10.3	6.1	-8.1	10.1
		TDLF	8.1	-3.9	9.0	6.8	3.2	7.5
	6-8	NLF	-16.3	-40.1	43.3	-16.2	40.3	43.4
		SDLF	2.7	6.5	7.0	2.2	-6.6	7.0
		TDLF	6.6	7.0	9.6	5.6	-7.2	9.1
	6-9	NLF	-7.8	-19.0	20.5	-7.8	19.1	20.6
		SDLF	1.2	3.4	3.6	0.7	-3.3	3.4
		TDLF	3.7	5.8	6.9	2.8	-5.6	6.3

Table O1-5-3(Continued). Erection method 3 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	NLF	-1.2	0.7	1.4	-1.2	-0.7	1.4
		SDLF	-4.3	-0.2	4.3	1.9	0.4	2.0
		TDLF	-6.6	3.3	7.4	6.8	-2.6	7.3
	9-3	NLF	-8.5	-12.5	15.1	-8.3	12.7	15.2
		SDLF	5.1	9.3	10.7	3.6	-9.4	10.1
		TDLF	21.1	35.0	40.9	17.7	-35.7	39.8
	9-4	NLF	-22.9	-47.6	52.8	-22.0	48.1	52.9
		SDLF	18.7	27.4	33.2	17.2	-27.7	32.6
		TDLF	50.5	80.8	95.3	46.3	-81.7	93.8
	9-5	NLF	-1.5	-5.0	5.2	-1.4	4.8	5.0
		SDLF	24.7	18.8	31.1	24.0	-20.2	31.3
		TDLF	37.7	27.6	46.7	35.7	-30.4	46.9
	9-6	NLF	4.8	-2.5	5.4	5.0	2.0	5.3
		SDLF	28.3	16.4	32.7	25.9	-17.7	31.4
		TDLF	36.0	10.0	37.4	30.1	-12.8	32.7
	9-7	NLF	5.6	-3.0	6.4	5.7	2.7	6.3
		SDLF	25.6	17.2	30.8	25.4	-18.4	31.3
		TDLF	32.4	5.3	32.8	31.5	-8.8	32.7
	9-8	NLF	-7.9	-33.7	34.6	-7.6	33.7	34.5
		SDLF	16.2	9.2	18.6	15.3	-10.1	18.3
		TDLF	22.5	-10.0	24.7	20.2	7.1	21.5
	9-9	NLF	-27.7	-76.8	81.7	-27.4	77.3	82.0
		SDLF	11.4	18.0	21.3	10.1	-18.4	21.0
		TDLF	27.8	27.1	38.8	25.0	-28.5	37.9
	9-10	NLF	-46.7	-	125.	-43.5	117.	124.
		SDLF	4.8	12.0	12.9	4.7	-12.1	13.0
		TDLF	24.0	38.6	45.5	21.5	-39.0	44.5
	9-11	NLF	-9.6	-23.8	25.7	-9.7	24.2	26.1
		SDLF	4.5	9.9	10.9	3.6	-9.6	10.2
		TDLF	9.8	14.6	17.6	7.9	-14.1	16.2

Table O1-5-4. Erection method 4 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	2.7	0.8	2.8	2.1	-0.7	2.2
		SDLF	-0.2	1.9	1.9	6.0	-1.9	6.3
		TDLF	-3.7	3.1	4.8	10.7	-3.2	11.2
	2-3	NLF	3.5	-1.5	3.8	3.6	1.7	3.9
		SDLF	10.6	6.8	12.5	9.1	-6.6	11.2
		TDLF	18.5	15.8	24.3	15.1	-15.9	21.9
	2-4	NLF	1.8	0.2	1.8	1.6	0.4	1.7
		SDLF	9.0	3.6	9.7	6.4	-3.0	7.0
		TDLF	17.1	7.2	18.5	11.2	-6.6	13.0
	2-5	NLF	-1.4	2.4	2.8	-1.5	-1.7	2.2
		SDLF	8.5	10.1	13.2	7.2	-9.7	12.0
		TDLF	19.6	19.0	27.3	16.8	-19.1	25.4
	2-6	NLF	-4.8	2.6	5.5	-4.8	-2.2	5.3
		SDLF	10.5	18.4	21.2	7.4	-18.2	19.7
		TDLF	27.2	35.2	44.5	20.5	-35.6	41.0
	2-7	NLF	-5.0	-1.5	5.2	-6.2	1.6	6.4
		SDLF	19.8	30.0	35.9	14.9	-30.2	33.7
		TDLF	38.4	48.2	61.6	32.5	-49.0	58.7
	2-8	NLF	-1.6	-4.5	4.8	-1.6	4.3	4.6
		SDLF	25.7	29.3	38.9	24.5	-29.7	38.5
		TDLF	31.9	23.9	39.8	28.8	-24.7	38.0
	2-9	NLF	1.9	-5.3	5.6	1.9	5.1	5.4
		SDLF	22.4	17.4	28.4	21.2	-17.7	27.6
		TDLF	25.1	8.8	26.6	22.0	-9.3	23.9
	2-10	NLF	1.6	-4.2	4.4	2.1	4.0	4.5
		SDLF	13.3	8.0	15.5	12.2	-8.1	14.7
		TDLF	15.0	3.7	15.5	12.5	-3.8	13.1
	2-11	NLF	1.6	-0.4	1.7	1.7	0.4	1.8
		SDLF	5.8	3.3	6.6	5.0	-3.3	6.0
		TDLF	6.6	1.8	6.9	4.9	-1.7	5.2

Table O1-5-4(Continued). Erection method 4 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
4	4-2	NLF	0.8	0.7	1.0	0.8	-0.7	1.1
		SDLF	0.0	6.3	6.3	-0.8	-5.4	5.5
		TDLF	12.7	5.1	13.7	10.9	-3.8	11.6
	4-3	NLF	-1.9	0.9	2.2	-1.8	-0.9	2.0
		SDLF	8.0	16.0	17.9	5.3	-15.6	16.5
		TDLF	38.4	3.7	38.6	32.5	-3.7	32.7
	4-4	NLF	-0.9	-1.8	2.0	-0.8	1.7	1.9
		SDLF	19.4	15.5	24.8	18.7	-15.5	24.3
		TDLF	30.8	6.4	31.5	29.1	-6.6	29.8
	4-5	NLF	-1.5	-0.7	1.6	-1.5	0.8	1.6
		SDLF	14.4	17.1	22.3	13.8	-17.0	21.8
		TDLF	14.4	7.1	16.1	13.1	-7.2	14.9
	4-6	NLF	-2.6	-0.9	2.7	-2.5	0.9	2.7
		SDLF	7.5	9.8	12.4	7.0	-9.9	12.1
		TDLF	6.3	4.3	7.7	5.1	-4.5	6.8
	4-7	NLF	-1.0	0.0	1.0	-0.9	-0.1	0.9
		SDLF	3.2	3.9	5.1	2.7	-3.9	4.8
		TDLF	2.4	2.2	3.3	1.5	-2.1	2.6

Table O1-5-4(Continued). Erection method 4 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	NLF	0.1	0.0	0.1	-0.2	0.0	0.2
		SDLF	-0.5	0.0	0.5	-0.5	0.4	0.7
		TDLF	-1.5	0.2	1.5	-0.4	0.8	0.9
	9-3	NLF	0.1	0.0	0.1	0.0	0.0	0.0
		SDLF	-2.2	4.4	4.9	-2.8	-2.8	4.0
		TDLF	-6.0	11.1	12.6	-7.4	-7.7	10.7
	9-4	NLF	-0.2	0.5	0.5	-0.2	-0.4	0.5
		SDLF	-1.4	4.2	4.4	-1.9	-3.3	3.8
		TDLF	-2.7	10.0	10.4	-3.7	-8.5	9.3
	9-5	NLF	-1.6	0.1	1.6	-1.6	-0.2	1.6
		SDLF	-23.7	9.7	25.6	-22.4	-9.3	24.3
		TDLF	-11.7	23.9	26.6	-9.1	-23.2	25.0
	9-6	NLF	-0.4	-0.5	0.6	-0.3	0.5	0.6
		SDLF	-13.9	8.8	16.5	-13.2	-8.7	15.8
		TDLF	7.9	22.6	24.0	9.2	-22.3	24.1
	9-7	NLF	-1.1	-0.1	1.1	-1.1	0.2	1.1
		SDLF	-4.4	6.1	7.5	-4.2	-6.1	7.4
		TDLF	8.3	11.6	14.3	8.6	-11.3	14.2
	9-8	NLF	-1.3	-0.1	1.3	-1.3	0.1	1.3
		SDLF	-1.5	2.2	2.7	-1.6	-2.1	2.7
		TDLF	4.9	4.2	6.5	4.6	-3.8	5.9

Table O1-5-5: Erection Critical Sub-Stages with cranes at the NL elevations

Erection Method	Stage	Detailing Method	Critical Sub-Stage
1A	**2**	NLF	2-6
		SDLF	2-8
		TDLF	2-7
	4	NLF	4-3
		SDLF	4-3
		TDLF	4-3
	9	NLF	9-5
		SDLF	9-5
		TDLF	9-5
1B	2	NLF	2-6
		SDLF	2-8
		TDLF	2-7
	4	NLF	4-3
		SDLF	4-5
		TDLF	4-3
	9	NLF	9-5
		SDLF	9-5
		TDLF	9-5
2	2	NLF	2-5
		SDLF	2-5
		TDLF	2-5
	6	NLF	6-8
		SDLF	6-6
		TDLF	6-4
	9	NLF	9-9
		SDLF	9-4
		TDLF	9-4
4	2	NLF	2-7
		SDLF	2-8
		TDLF	2-7
	6	NLF	4-3
		SDLF	4-4
		TDLF	4-4
	9	NLF	9-5
		SDLF	9-5
		TDLF	9-5

Table O1-5-6. Erection method 1A critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	-5.2	5.7	7.7	NA	NA	NA
		SDLF	33.8	9.5	35.1	NA	NA	NA
		TDLF	46.9	14.5	49.1	NA	NA	NA
	B	NLF	1.4	16.6	16.7	1.3	-16.7	16.7
		SDLF	25.8	29.0	38.8	24.6	-29.1	38.1
		TDLF	34.0	47.5	58.4	37.7	-48.5	61.5
4	A	NLF	69.7	-7.0	70.1	NA	NA	NA
		SDLF	67.7	-5.4	67.9	NA	NA	NA
		TDLF	76.3	-4.7	76.5	NA	NA	NA
	B	NLF	46.0	-65.3	79.9	44.5	65.6	79.3
		SDLF	51.2	-64.4	82.3	47.6	65.5	81.0
		TDLF	56.5	-63.9	85.3	49.8	64.8	81.8
9	A	NLF	40.5	-4.9	40.8	NA	NA	NA
		SDLF	38.3	-1.6	38.4	NA	NA	NA
		TDLF	35.9	1.4	35.9	NA	NA	NA
	B	NLF	24.8	-14.0	28.5	24.6	14.2	28.4
		SDLF	20.7	-4.9	21.2	21.9	5.0	22.5
		TDLF	16.6	4.0	17.0	19.3	-4.3	19.7

Table O1-5-7. Erection method 1B critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	14.5	2.7	14.7	NA	NA	NA
		SDLF	28.8	10.8	30.8	NA	NA	NA
		TDLF	63.4	11.8	64.5	NA	NA	NA
	B	NLF	9.9	8.3	12.9	9.8	-8.6	13.1
		SDLF	23.5	32.2	39.9	22.3	-32.2	39.2
		TDLF	37.0	28.2	46.5	35.3	-28.8	45.5
4	A	NLF	-19.4	0.8	19.4	NA	NA	NA
		SDLF	25.1	6.5	25.9	NA	NA	NA
		TDLF	30.1	0.2	30.1	NA	NA	NA
	B	NLF	-24.9	23.4	34.2	-24.4	-22.6	33.3
		SDLF	0.0	21.7	21.7	-0.5	-21.5	21.5
		TDLF	39.2	1.0	39.2	33.3	-1.4	33.3
9	A	NLF	40.5	-4.9	40.8	NA	NA	NA
		SDLF	38.3	-1.6	38.4	NA	NA	NA
		TDLF	35.9	1.4	35.9	NA	NA	NA
	B	NLF	24.8	-14.0	28.5	24.6	14.2	28.4
		SDLF	20.7	-4.9	21.2	21.9	5.0	22.5
		TDLF	16.6	4.0	17.0	19.3	-4.3	19.7

Table O1-5-8. Erection method 2 critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	2.2	0.3	2.2	NA	NA	NA
		SDLF	7.6	1.8	7.8	NA	NA	NA
		TDLF	13.1	2.7	13.4	NA	NA	NA
	B	NLF	1.7	1.3	2.1	1.7	-1.3	2.1
		SDLF	5.0	6.2	7.9	6.3	-6.2	8.8
		TDLF	8.0	9.4	12.3	10.7	-9.4	14.3
6	A	NLF	-3.2	-2.1	3.8	NA	NA	NA
		SDLF	14.1	0.6	14.1	NA	NA	NA
		TDLF	7.9	0.5	7.9	NA	NA	NA
	B	NLF	-16.3	-40.1	43.3	-16.2	40.3	43.4
		SDLF	15.3	21.8	26.7	15.3	-22.2	26.9
		TDLF	23.8	37.7	44.5	22.5	-38.1	44.2
9	A	NLF	-0.6	-5.1	5.1	NA	NA	NA
		SDLF	12.0	0.7	12.1	NA	NA	NA
		TDLF	31.8	3.7	32.0	NA	NA	NA
	B	NLF	-27.7	-76.8	81.7	-27.4	77.3	82.0
		SDLF	18.7	27.4	33.2	17.2	-27.7	32.6
		TDLF	50.5	80.8	95.3	46.3	-81.7	93.8

Table O1-5-9. Erection method 4 critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	-9.9	-0.3	9.9	NA	NA	NA
		SDLF	33.4	9.4	34.7	NA	NA	NA
		TDLF	46.8	16.2	49.5	NA	NA	NA
	B	NLF	-5.0	-1.5	5.2	-6.2	1.6	6.4
		SDLF	25.7	29.3	38.9	24.5	-29.7	38.5
		TDLF	38.4	48.2	61.6	32.5	-49.0	58.7
6	A	NLF	-1.8	-4.8	5.2	NA	NA	NA
		SDLF	10.6	3.6	11.1	NA	NA	NA
		TDLF	71.2	1.3	71.2	NA	NA	NA
	B	NLF	-1.9	0.9	2.2	-1.8	-0.9	2.0
		SDLF	19.4	15.5	24.8	18.7	-15.5	24.3
		TDLF	30.8	6.4	31.5	29.1	-6.6	29.8
9	A	NLF	-2.5	0.0	2.5	NA	NA	NA
		SDLF	-39.0	3.6	39.2	NA	NA	NA
		TDLF	-24.2	8.9	25.8	NA	NA	NA
	B	NLF	-1.6	0.1	1.6	-1.6	-0.2	1.6
		SDLF	-23.7	9.7	25.6	-22.4	-9.3	24.3
		TDLF	-11.7	23.9	26.6	-9.1	-23.2	25.0

Table O1-5-10. Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	42.1	120.0	37.8		
			SDLF	69.0	154.9	66.0		
			TDLF	75.5	151.3	72.0		
		G2	NLF	0.9	87.0	174.1	87.1	0.3
			SDLF	20.3	25.7	51.5	25.8	20.3
			TDLF	18.3	21.3	42.8	21.5	18.7
	B	G1	NLF	42.4	124.2	37.9		
			SDLF	70.0	167.1	68.1		
			TDLF	76.0	165.8	73.5		
		G2	NLF	3.3	83.1	166.3	83.2	2.7
			SDLF	28.9	10.7	21.4	10.7	28.3
			TDLF	28.6	4.1	8.2	4.1	28.3

Table O1-5-10(Continued). Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
4	A	G1	NLF	319.5	281.6			
			SDLF	318.1	281.3			
			TDLF	310.2	273.5			
		G2	NLF	0.0	63.5			
			SDLF	0.0	62.1			
			TDLF	12.9	75.0			
		G3	NLF	0.0	0.0			
			SDLF	0.0	0.0			
			TDLF	0.0	0.0			
		G4	NLF	0.0	15.6	31.3	15.8	0.0
			SDLF	0.0	17.1	34.3	17.2	0.0
			TDLF	0.0	12.1	24.2	12.2	0.0

Table O1-5-10(Continued). Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
4	B	G1	NLF	304.1	262.5			
			SDLF	298.7	259.3			
			TDLF	295.1	258.4			
		G2	NLF	31.4	98.7			
			SDLF	39.1	104.0			
			TDLF	42.9	104.7			
		G3	NLF	0.0	0.0			
			SDLF	0.0	0.0			
			TDLF	0.0	0.0			
		G4	NLF	0.0	2.2	4.4	2.2	0.0
			SDLF	0.0	0.0	0.0	0.0	0.0
			TDLF	0.0	0.0	0.0	0.0	0.0

Table O1-5-10(Continued). Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	A	G1	NLF	171.6	135.9			
			SDLF	184.2	139.6			
			TDLF	199.1	143.4			
		G2	NLF	132.0	126.9			
			SDLF	132.2	127.8			
			TDLF	128.2	130.9			
		G3	NLF	70.5	121.5			
			SDLF	61.6	121.5			
			TDLF	54.9	117.0			
		G4	NLF	63.8	76.8			
			SDLF	58.2	74.2			
			TDLF	52.0	73.9			
		G5	NLF	50.0	70.5			
			SDLF	44.2	68.5			
			TDLF	37.7	66.8			
		G6	NLF	34.7	57.6			
			SDLF	32.7	56.0			
			TDLF	33.0	53.9			
		G7	NLF	33.2	24.3			
			SDLF	24.9	24.3			
			TDLF	22.1	24.0			
		G8	NLF	12.6	3.5			
			SDLF	24.8	1.3			
			TDLF	22.2	0.0			
		G9	NLF	0.0	0.0	0.0	0.0	8.4
			SDLF	7.0	0.0	0.0	0.0	10.6
			TDLF	22.2	0.0	0.0	0.0	12.3

Table O1-5-10(Continued). Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	B	G1	NLF	170.0	132.8			
			SDLF	183.5	138.0			
			TDLF	199.2	143.2			
		G2	NLF	130.9	124.6			
			SDLF	131.7	126.3			
			TDLF	128.3	130.2			
		G3	NLF	71.0	119.9			
			SDLF	62.1	120.1			
			TDLF	55.3	115.6			
		G4	NLF	64.5	76.8			
			SDLF	58.8	73.5			
			TDLF	52.5	72.6			
		G5	NLF	51.3	72.7			
			SDLF	45.1	69.2			
			TDLF	38.2	66.1			
		G6	NLF	38.6	64.1			
			SDLF	34.5	60.4			
			TDLF	33.1	56.4			
		G7	NLF	38.6	36.8			
			SDLF	25.5	33.1			
			TDLF	20.6	31.6			
		G8	NLF	6.4	3.4			
			SDLF	23.4	8.7			
			TDLF	19.2	8.3			
		G9	NLF	0.0	0.0	0.0	0.0	0.0
			SDLF	8.4	0.0	0.0	0.0	0.0
			TDLF	28.4	0.0	0.0	0.0	3.3

Table O1-5-11. Erection method 2A vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	0.0	98.6	93.7	1.2	
			SDLF	35.2	110.1	131.7	16.9	
			TDLF	92.3	62.4	172.1	4.7	
		G2	NLF	10.5	81.4	162.9	81.5	8.4
			SDLF	25.1	16.4	32.8	16.4	30.2
			TDLF	10.6	0.0	0.0	0.0	36.4
	B	G1	NLF	0.0	100.4	96.0	0.5	
			SDLF	33.3	118.9	143.2	14.3	
			TDLF	37.7	94.9	134.5	4.6	
		G2	NLF	11.7	79.2	158.6	79.4	9.8
			SDLF	34.5	0.0	0.0	0.0	39.6
			TDLF	15.0	0.0	0.0	0.0	38.5

Table O1-5-11(Continued). Erection method 2A vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
4	A	G1	NLF	0.0	186.1	175.4	10.9	
			SDLF	45.3	142.5	182.1	26.3	
			TDLF	97.7	70.9	199.4	35.2	
		G2	NLF	25.4	40.0			
			SDLF	46.3	46.0			
			TDLF	69.6	45.7			
		G3	NLF	62.5	58.1			
			SDLF	53.5	72.0			
			TDLF	36.4	56.3			
		G4	NLF	4.0	66.7	133.5	66.8	0.0
			SDLF	22.8	25.5	51.0	25.6	15.0
			TDLF	0.0	37.3	74.7	37.4	10.0

Table O1-5-11(Continued). Erection method 2A vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
4	B	G1	NLF	0.0	191.7	190.1	0.0	
			SDLF	45.7	140.8	192.8	24.7	
			TDLF	106.3	78.5	185.3	48.1	
		G2	NLF	0.0	29.4			
			SDLF	48.3	43.4			
			TDLF	68.0	56.9			
		G3	NLF	61.9	43.0			
			SDLF	58.4	71.7			
			TDLF	41.4	68.1			
		G4	NLF	1.4	91.7	183.5	91.8	0.0
			SDLF	33.1	8.3	16.6	8.3	32.2
			TDLF	24.5	0.0	0.0	0.0	23.8

Table O1-5-11(Continued). Erection method 2A vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	A	G1	NLF	171.6	135.9			
			SDLF	184.2	139.6			
			TDLF	199.1	143.4			
		G2	NLF	132.0	126.9			
			SDLF	132.2	127.8			
			TDLF	128.2	130.9			
		G3	NLF	70.5	121.5			
			SDLF	61.6	121.5			
			TDLF	54.9	117.0			
		G4	NLF	63.8	76.8			
			SDLF	58.2	74.2			
			TDLF	52.0	73.9			
		G5	NLF	50.0	70.5			
			SDLF	44.2	68.5			
			TDLF	37.7	66.8			
		G6	NLF	34.7	57.6			
			SDLF	32.7	56.0			
			TDLF	33.0	53.9			
		G7	NLF	33.2	24.3			
			SDLF	24.9	24.3			
			TDLF	22.1	24.0			
		G8	NLF	12.6	3.5			
			SDLF	24.8	1.3			
			TDLF	22.2	0.0			
		G9	NLF	0.0	0.0	0.0	0.0	8.4
			SDLF	7.0	0.0	0.0	0.0	10.6
			TDLF	22.2	0.0	0.0	0.0	12.3

Table O1-5-11(Continued). Erection method 2A vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	B	G1	NLF	170.0	132.8			
			SDLF	183.5	138.0			
			TDLF	199.2	143.2			
		G2	NLF	130.9	124.6			
			SDLF	131.7	126.3			
			TDLF	128.3	130.2			
		G3	NLF	71.0	119.9			
			SDLF	62.1	120.1			
			TDLF	55.3	115.6			
		G4	NLF	64.5	76.8			
			SDLF	58.8	73.5			
			TDLF	52.5	72.6			
		G5	NLF	51.3	72.7			
			SDLF	45.1	69.2			
			TDLF	38.2	66.1			
		G6	NLF	38.6	64.1			
			SDLF	34.5	60.4			
			TDLF	33.1	56.4			
		G7	NLF	38.6	36.8			
			SDLF	25.5	33.1			
			TDLF	20.6	31.6			
		G8	NLF	6.4	3.4			
			SDLF	23.4	8.7			
			TDLF	19.2	8.3			
		G9	NLF	0.0	0.0	0.0	0.0	0.0
			SDLF	8.4	0.0	0.0	0.0	0.0
			TDLF	28.4	0.0	0.0	0.0	3.3

Table O1-5-12. Erection method 3 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G8	NLF	2.1	31.6	63.3	31.7	0.0
			SDLF	8.8	31.7	63.6	31.9	4.7
			TDLF	15.1	28.7	57.5	28.8	12.1
		G9	NLF	0.8	30.7	24.1	2.4	
			SDLF	17.7	0.0	27.0	1.6	
			TDLF	16.4	0.0	15.6	6.7	
	B	G8	NLF	2.1	32.5	65.0	32.6	0.0
			SDLF	7.5	34.0	68.1	34.1	4.1
			TDLF	13.4	31.7	63.4	31.8	11.3
		G9	NLF	1.2	30.6	23.1	3.2	
			SDLF	18.9	0.0	20.4	6.2	
			TDLF	18.1	0.0	5.1	13.8	

Table O1-5-12(Continued). Erection method 3 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	A	G4	NLF	0.0	45.5	91.2	45.6	0.2
			SDLF	17.3	80.0	160.3	80.2	0.0
			TDLF	1.5	57.8	115.8	58.0	0.0
		G5	NLF	0.0	115.5	147.9	0.0	
			SDLF	32.3	0.0	77.0	19.7	
			TDLF	18.7	63.7	104.8	5.6	
		G6	NLF	14.3	7.5			
			SDLF	40.4	33.2			
			TDLF	35.6	30.6			
		G7	NLF	37.1	24.7			
			SDLF	30.8	31.5			
			TDLF	29.8	31.2			
		G8	NLF	33.9	35.3			
			SDLF	29.7	34.6			
			TDLF	29.1	35.0			
		G9	NLF	35.9	43.5			
			SDLF	39.6	33.7			
			TDLF	37.5	34.4			

Table O1-5-12(Continued). Erection method 3 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	B	G4	NLF	0.0	35.3	70.7	35.4	0.0
			SDLF	12.8	86.6	173.5	86.8	0.0
			TDLF	13.7	79.5	159.1	79.7	0.0
		G5	NLF	0.0	125.9	168.4	0.0	
			SDLF	32.2	0.0	65.5	19.9	
			TDLF	37.0	0.0	52.1	15.2	
		G6	NLF	18.7	0.0			
			SDLF	40.7	35.6			
			TDLF	47.0	59.5			
		G7	NLF	32.3	25.9			
			SDLF	30.6	32.1			
			TDLF	30.6	41.2			
		G8	NLF	32.8	35.7			
			SDLF	29.8	34.7			
			TDLF	25.9	33.6			
		G9	NLF	35.5	42.7			
			SDLF	40.5	33.8			
			TDLF	38.4	21.7			

Table O1-5-12(Continued). Erection method 3 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	A	G1	NLF	0.0	68.2	136.4	68.3	21.3
			SDLF	8.8	95.0	190.1	95.1	0.1
			TDLF	32.0	102.9	206.0	103.1	0.0
		G2	NLF	0.0	240.0	260.5	0.0	
			SDLF	38.0	116.2	222.2	26.1	
			TDLF	69.4	42.9	176.8	49.0	
		G3	NLF	17.1	18.7			
			SDLF	54.9	37.0			
			TDLF	68.9	57.3			
		G4	NLF	48.0	29.2			
			SDLF	44.6	34.3			
			TDLF	47.9	44.0			
		G5	NLF	42.4	38.2			
			SDLF	38.4	43.2			
			TDLF	35.3	49.0			
		G6	NLF	46.9	45.0			
			SDLF	42.0	48.2			
			TDLF	37.9	50.7			
		G7	NLF	40.1	39.5			
			SDLF	33.5	38.6			
			TDLF	26.3	38.8			
		G8	NLF	40.2	44.4			
			SDLF	33.8	40.5			
			TDLF	27.2	34.6			
		G9	NLF	40.4	48.7			
			SDLF	49.2	40.4			
			TDLF	55.9	29.9			

Table O1-5-12(Continued). Erection method 3 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	B	G1	NLF	0.0	41.1	82.2	41.1	18.6
			SDLF	15.1	103.5	207.2	103.7	0.0
			TDLF	39.2	124.8	249.7	124.9	0.0
		G2	NLF	0.0	274.3	299.2	0.0	
			SDLF	38.3	88.9	226.1	16.8	
			TDLF	66.6	0.0	164.1	30.6	
		G3	NLF	20.6	15.3			
			SDLF	60.4	39.9			
			TDLF	74.9	72.9			
		G4	NLF	40.0	29.0			
			SDLF	45.6	34.8			
			TDLF	50.3	46.3			
		G5	NLF	40.9	37.8			
			SDLF	38.6	43.3			
			TDLF	36.5	48.6			
		G6	NLF	46.6	44.2			
			SDLF	42.0	48.3			
			TDLF	38.7	49.9			
		G7	NLF	39.8	38.7			
			SDLF	33.5	38.6			
			TDLF	27.1	38.0			
		G8	NLF	39.8	43.7			
			SDLF	33.9	40.6			
			TDLF	27.4	34.6			
		G9	NLF	40.1	48.1			
			SDLF	49.2	40.6			
			TDLF	56.3	30.4			

Table O1-5-13. Erection method 4 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
2	A	G1	NLF	42.0	67.0	52.2	36.2		
			SDLF	69.6	96.2	58.3	65.7		
			TDLF	76.7	128.2	22.4	71.9		
		G2	NLF	14.4	61.5	46.0	92.1	46.1	13.3
			SDLF	20.1	0.0	25.9	51.8	26.0	20.4
			TDLF	18.3	0.0	21.0	42.1	21.1	19.2
	B	G1	NLF	42.0	70.4	48.9	36.1		
			SDLF	70.7	113.1	53.7	67.7		
			TDLF	77.1	132.8	31.8	73.2		
		G2	NLF	14.5	64.4	45.3	90.7	45.4	13.3
			SDLF	28.8	0.0	10.6	21.2	10.6	28.6
			TDLF	28.3	0.0	4.3	8.7	4.4	28.5

Table O1-5-13(Continued). Erection method 4 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
4	A	G1	NLF	48.1	127.7	47.5			
			SDLF	88.8	203.6	89.5			
			TDLF	121.9	168.1	120.7			
		G2	NLF	38.9	121.4	39.3			
			SDLF	60.2	0.0	67.9			
			TDLF	73.1	0.0	83.5			
		G3	NLF	31.6	108.0	30.0			
			SDLF	41.6	0.0	45.9			
			TDLF	38.5	0.0	45.2			
		G4	NLF	9.5	32.0	26.2	52.4	26.2	9.6
			SDLF	17.6	28.0	21.3	42.7	21.4	13.4
			TDLF	25.2	0.0	0.0	0.0	0.0	23.1

Table O1-5-13(Continued). Erection method 4 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
4	B	G1	NLF	48.2	129.6	47.4			
			SDLF	88.9	206.7	89.0			
			TDLF	122.0	169.2	120.3			
		G2	NLF	38.9	122.2	39.3			
			SDLF	59.8	0.0	67.5			
			TDLF	72.9	0.0	83.2			
		G3	NLF	31.7	104.2	30.0			
			SDLF	39.5	0.0	46.6			
			TDLF	37.5	0.0	46.1			
		G4	NLF	10.6	36.5	26.4	52.8	26.4	9.7
			SDLF	14.8	0.3	39.3	78.6	39.4	9.3
			TDLF	26.7	0.0	0.0	0.0	0.0	23.1

Table O1-5-13(Continued). Erection method 4 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
9	A	G1	NLF	48.3	125.3	43.9			
			SDLF	87.9	275.9	91.5			
			TDLF	128.0	202.4	106.9			
		G2	NLF	39.2	121.2	41.1			
			SDLF	60.3	0.0	76.9			
			TDLF	75.4	0.0	92.5			
		G3	NLF	33.3	118.1	38.3			
			SDLF	46.3	0.0	65.8			
			TDLF	44.6	0.0	76.9			
		G4	NLF	26.8	75.4	26.6			
			SDLF	41.0	0.0	38.2			
			TDLF	39.3	0.0	49.6			
		G5	NLF	24.3	64.7	25.2			
			SDLF	37.8	0.0	35.5			
			TDLF	34.6	0.0	44.6			
		G6	NLF	23.0	86.7	23.9			
			SDLF	44.1	0.0	35.3			
			TDLF	44.6	0.0	42.1			
		G7	NLF	19.7	40.5	17.8			
			SDLF	30.5	0.0	28.8			
			TDLF	28.9	0.0	32.8			
		G8	NLF	17.7	36.5	15.0			
			SDLF	24.1	41.1	29.6			
			TDLF	25.2	0.0	23.8			
		G9	NLF	8.7	19.1	13.6	27.2	13.6	5.9
			SDLF	21.1	45.4	14.6	29.3	14.7	7.2
			TDLF	35.7	29.0	12.2	24.5	12.3	12.1

Table O1-5-13(Continued). Erection method 4 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
9	B	G1	NLF	48.3	125.3	43.9			
			SDLF	87.9	276.7	91.8			
			TDLF	128.0	203.2	107.1			
		G2	NLF	39.2	121.2	41.1			
			SDLF	60.4	0.0	77.2			
			TDLF	75.4	0.0	92.7			
		G3	NLF	33.3	118.1	38.3			
			SDLF	46.4	0.0	66.0			
			TDLF	44.7	0.0	76.9			
		G4	NLF	26.8	75.4	26.6			
			SDLF	41.2	0.0	38.3			
			TDLF	39.4	0.0	49.6			
		G5	NLF	24.3	64.7	25.2			
			SDLF	37.9	0.0	35.4			
			TDLF	34.7	0.0	44.4			
		G6	NLF	23.0	87.0	23.9			
			SDLF	44.1	0.0	35.4			
			TDLF	44.1	0.0	42.3			
		G7	NLF	19.7	40.7	17.8			
			SDLF	30.3	0.0	28.9			
			TDLF	28.9	0.0	32.2			
		G8	NLF	17.8	36.3	15.0			
			SDLF	24.6	32.1	30.1			
			TDLF	25.5	0.0	24.7			
		G9	NLF	8.8	20.1	13.8	27.5	13.8	5.8
			SDLF	21.7	40.1	20.9	41.8	20.9	7.1
			TDLF	37.1	0.0	25.9	51.8	25.9	12.7

Appendix O2-1. NISCS15 Bridge Description

The key characteristics of NISCS15 are as follows:

- Span length along the centerline of the bridge, L_s = 150 ft.
- Width between the fascia girders, w_g = 74 ft.
- Radius of curvature to the centerline of the bridge, R =280 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 2.0
- Subtended angle between the supports, L_s/R = 0.54
- Number of girders in the completed bridge cross-section, n_g =9.
- Skew angle, θ = -35,0^o

This appendix presents the bridge description of the bridge NISCS15 in its final condition as well as during erection. The following figures and tables are provided:

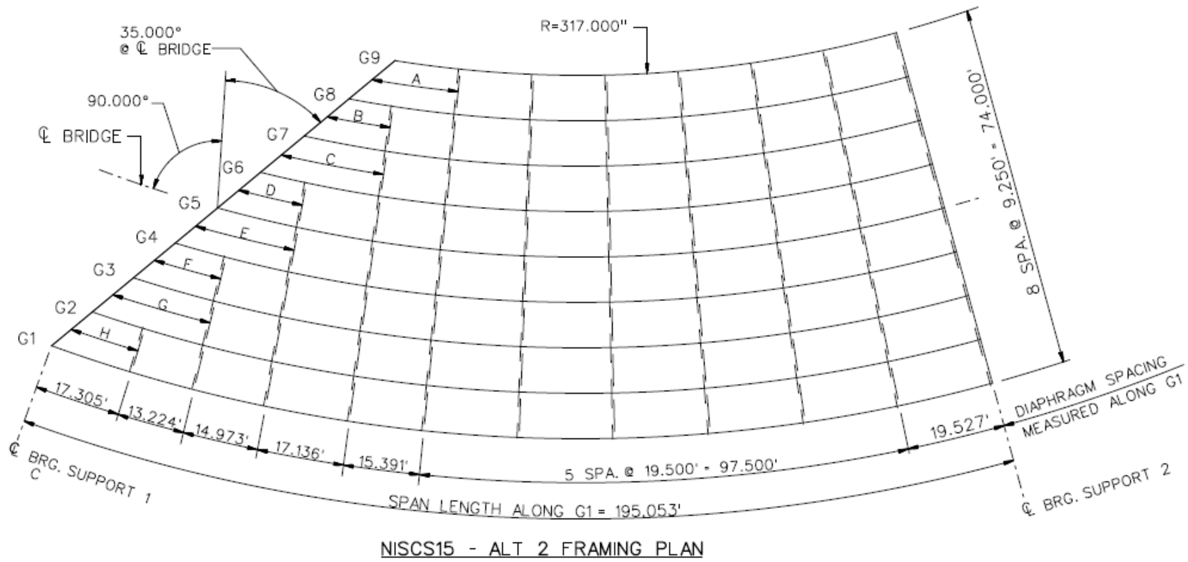


Figure O2-1-1. Framing plan.

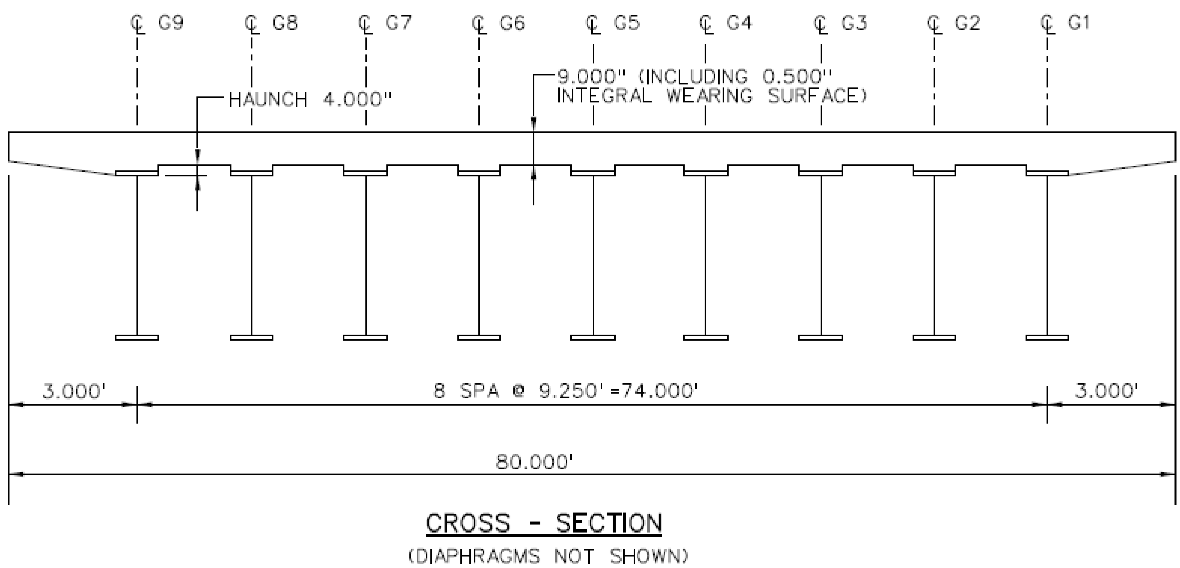


Figure O2-1-2. Bridge cross-section.

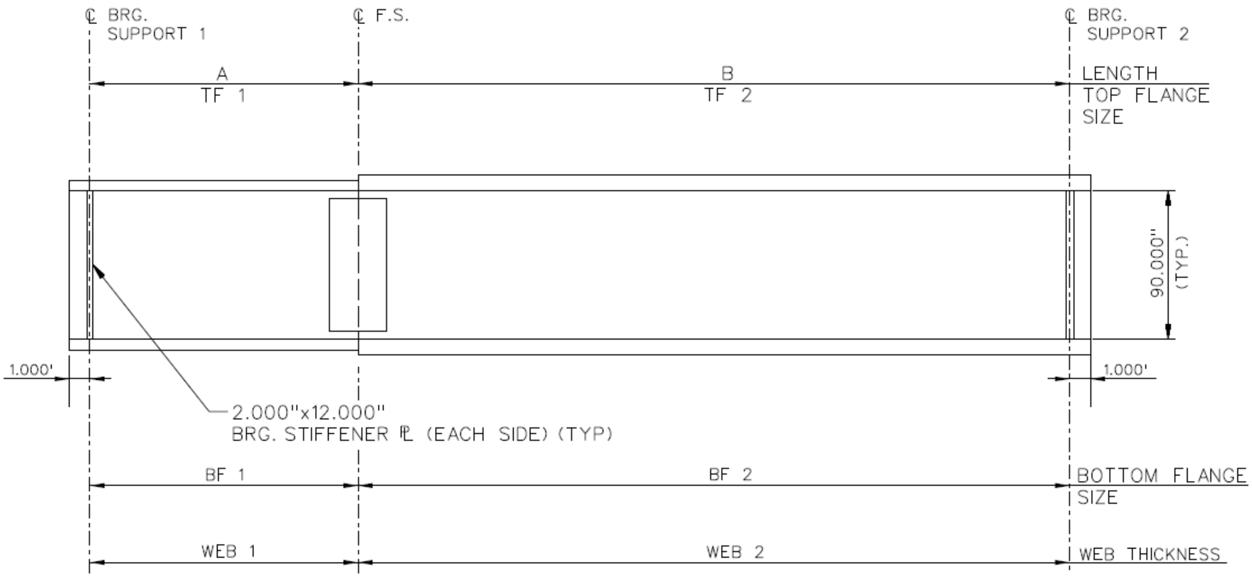


Figure O2-1-3. Girder elevations

	GIRDER PLATE LENGTHS *								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	65.053	57.691	50.264	42.763	35.174	27.479	126.897	115.124	103.165
B	130.000	126.206	122.413	118.620	114.826	111.033	000.000	000.000	000.000

ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS **					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	30.000	2.750	26.000	2.750	24.000	1.500
TF2	30.000	2.750	26.000	2.750		

** ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS **							
TOP FLANGE	G1		G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF	BF	TF
BF1	32.000	3.250	32.000	3.000	28.000	2.000	24.000	1.500
BF2	32.000	3.250	32.000	3.000	28.000	2.000		

** ALL DIMENSIONS ARE IN INCHES.

Figure O2-1-4. Cross-section dimensions.

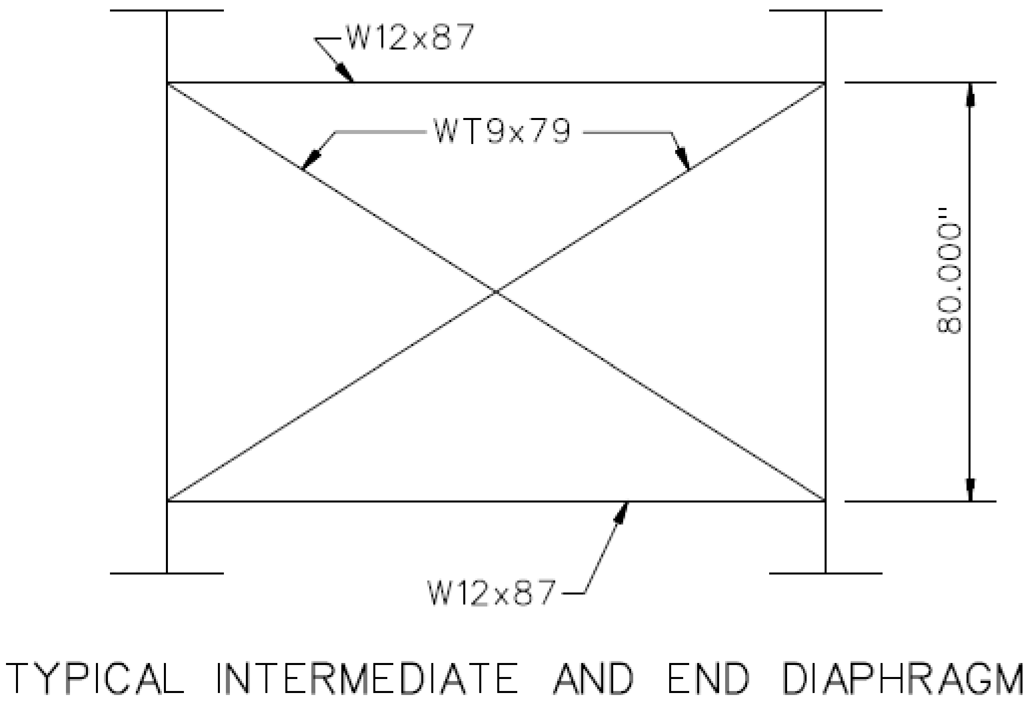


Figure O2-1-5. Cross-frame details

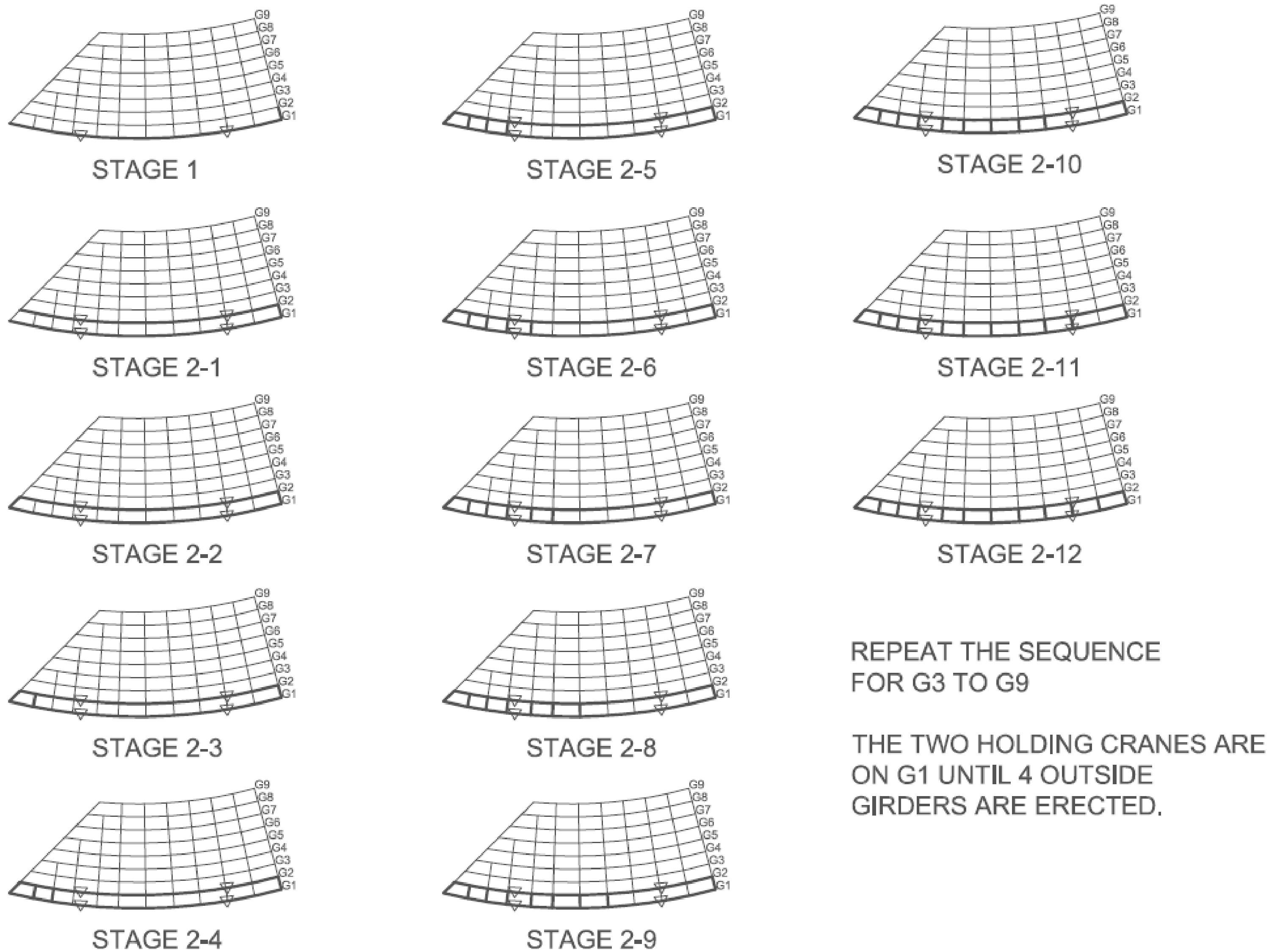


Figure O2-1-6. Erection scheme 2A

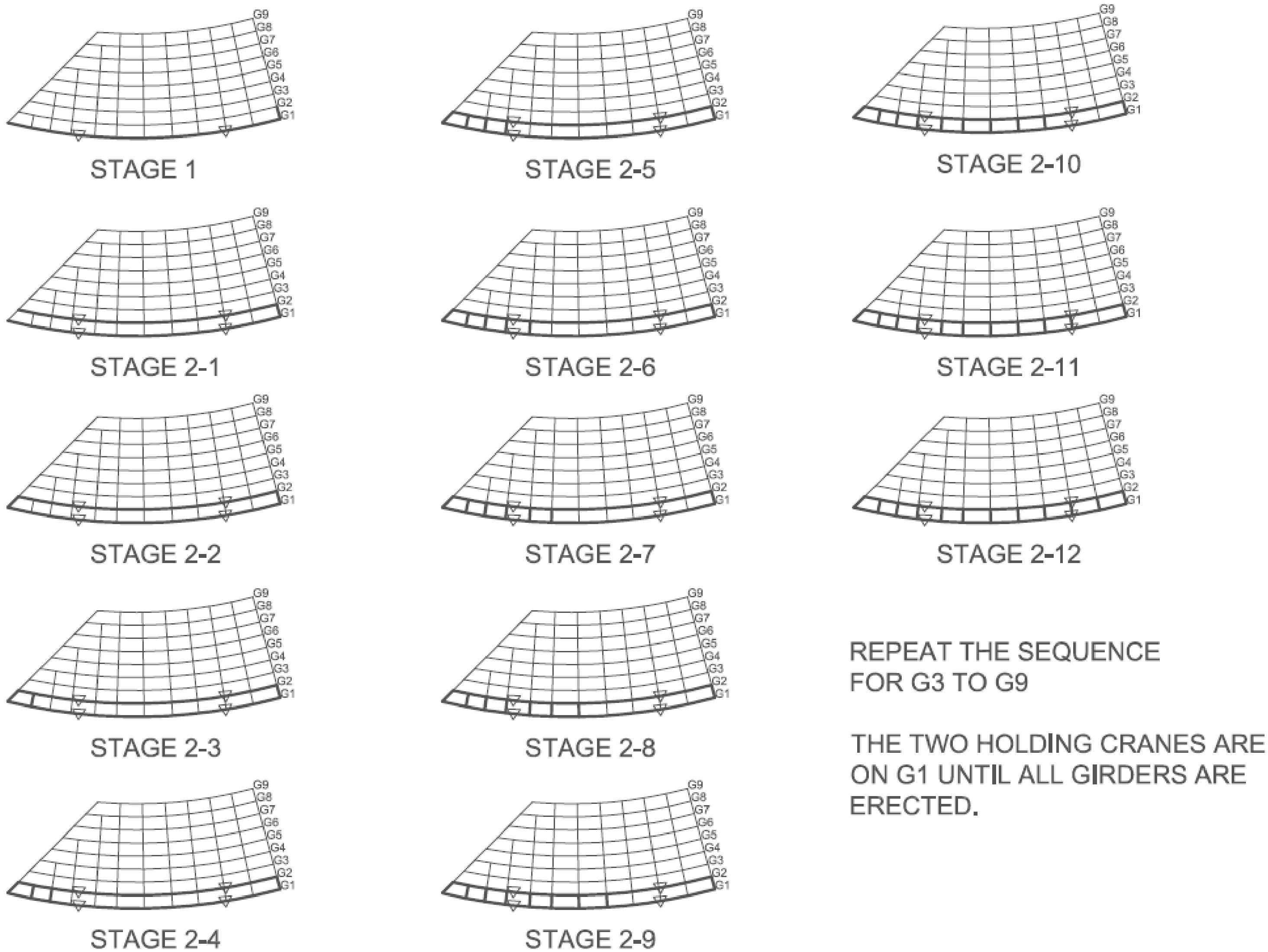


Figure O2-1-6(Continued). Erection scheme 2B (Cross-frames are installed from the left skewed bearing line to the right radial bearing line)

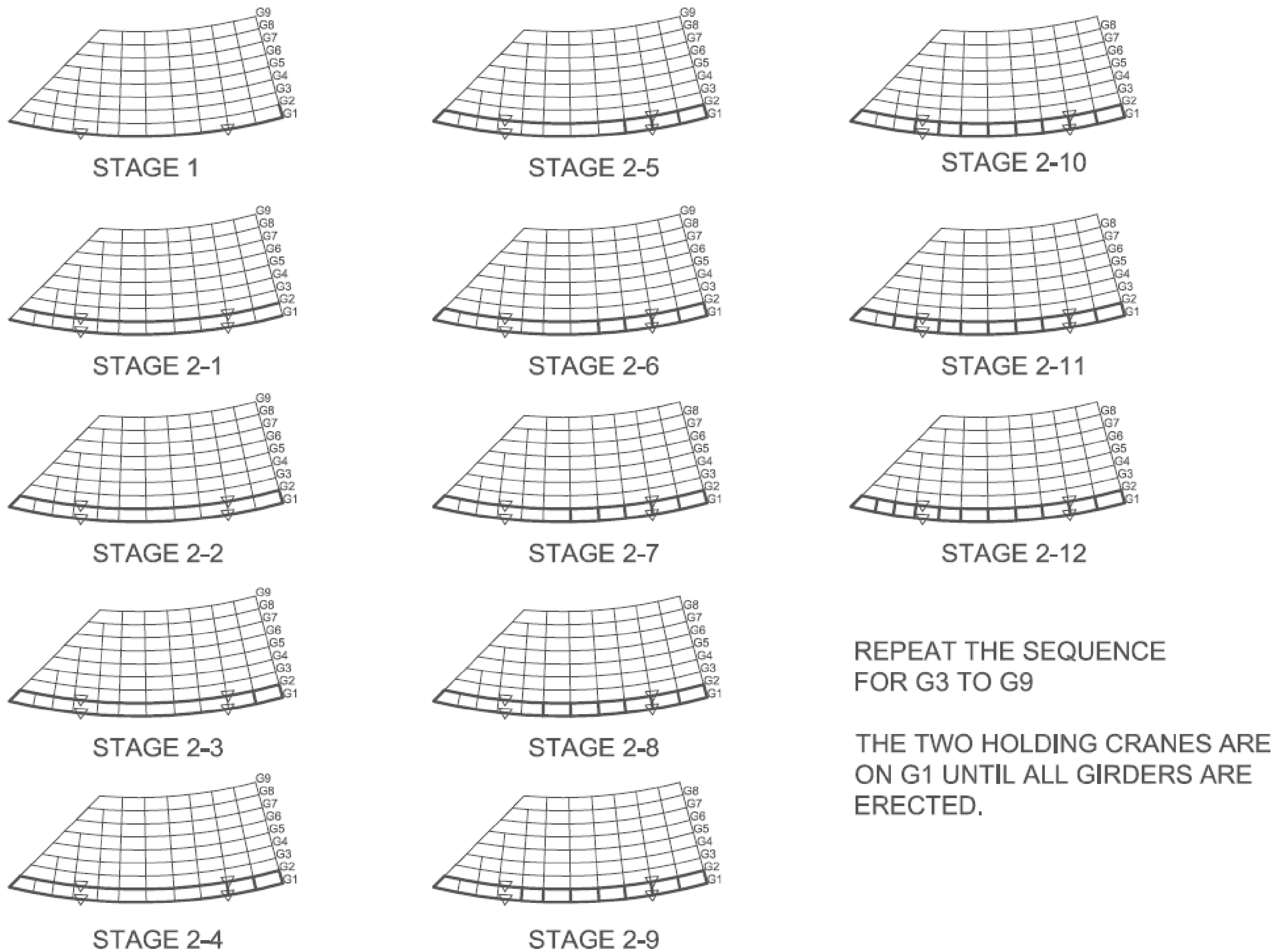
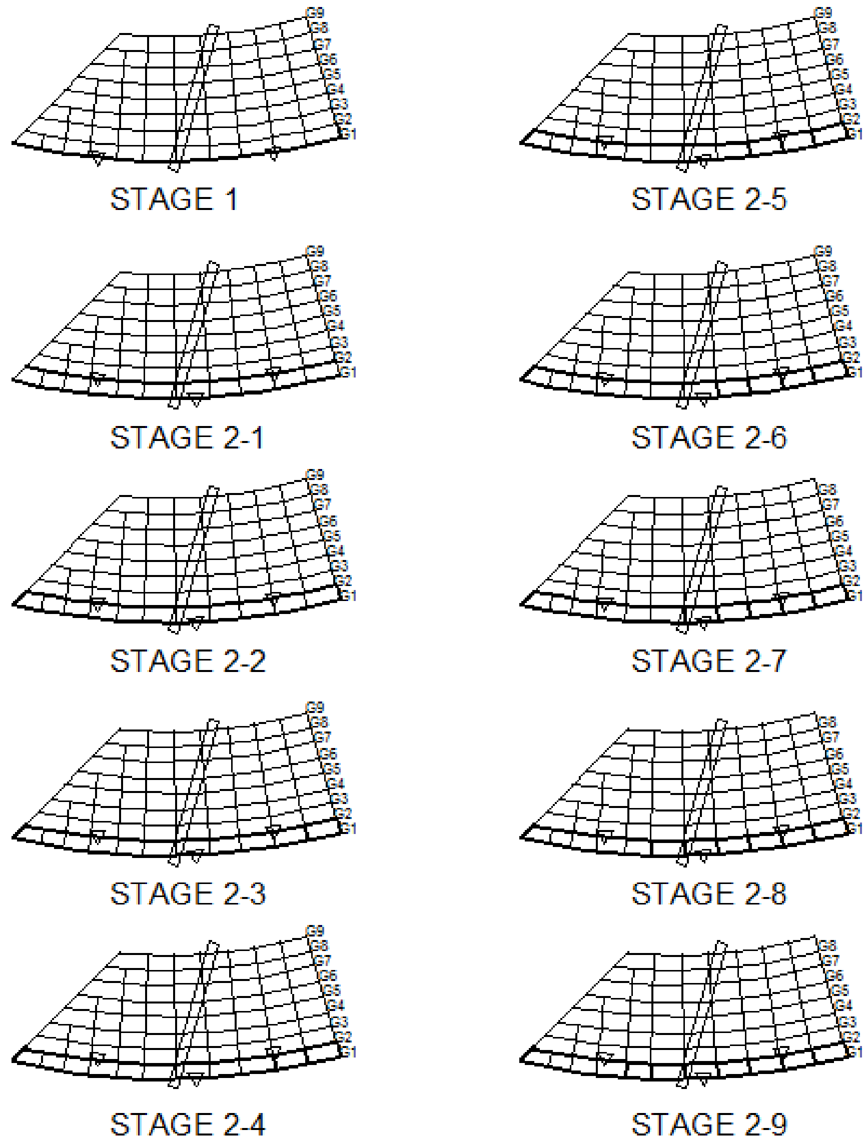
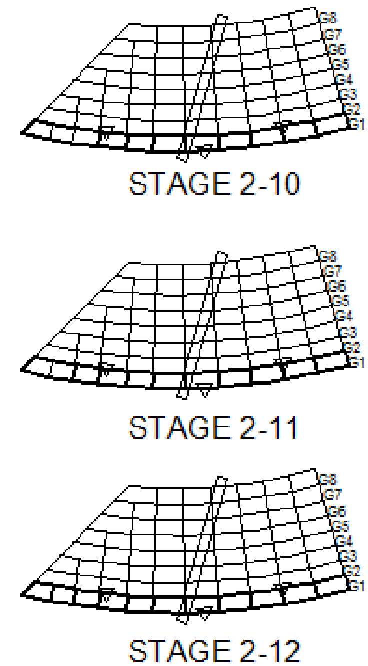


Figure O2-1-6(Continued). Erection scheme 2C (Cross-frames are installed from the right radial bearing line to the left skewed bearing line)





REPEAT THE SEQUENCE FOR G3 TO G9

THE HOLDING CRANE IS ON G1 UNTIL 2 OUTSIDE GIRDERS ARE ERECTED

THE SHORING TOWER IS LEFT IN PLACE UNTIL ALL GIRDERS ARE ERECTED.

Figure O2-1-6(Continued). Erection scheme 4

Table O2-1-1. Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

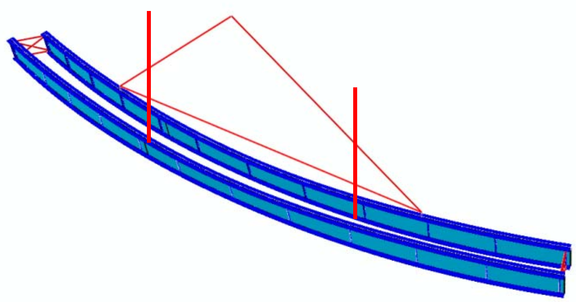
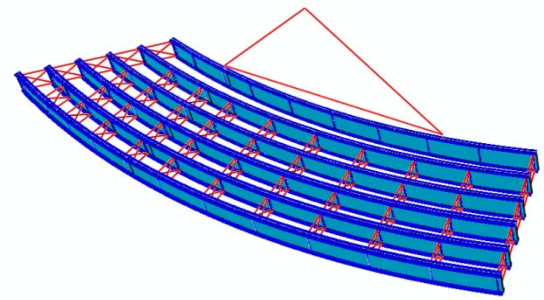
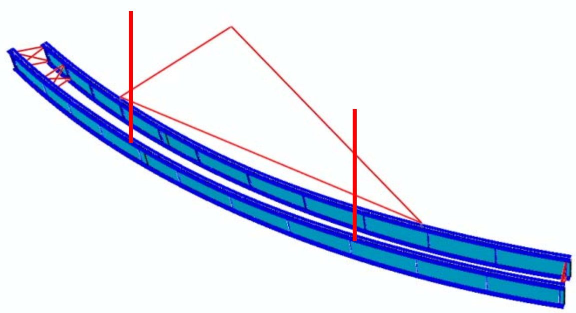
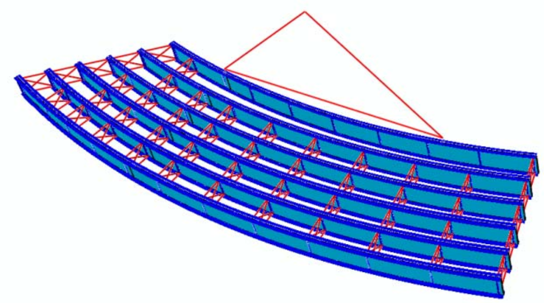
Sub-Stage	Stage	
	2	6
1		
2		

Table O2-1-1(Continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

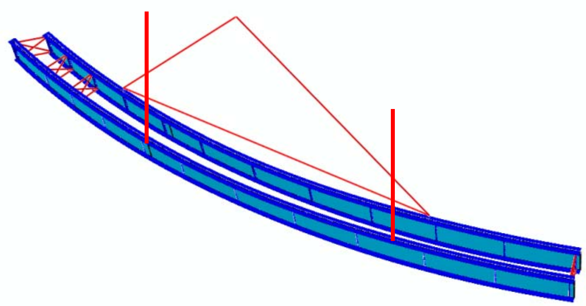
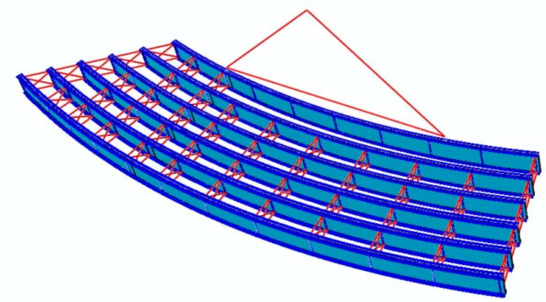
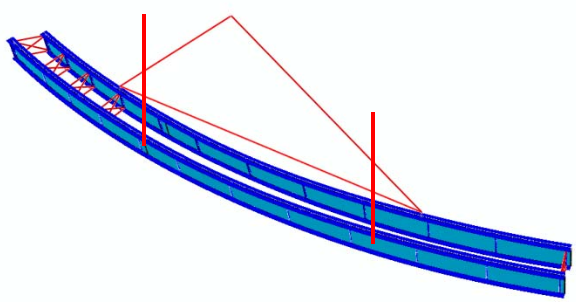
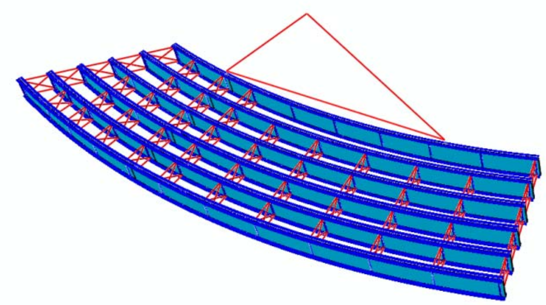
3		
4		

Table O2-1-1(Continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

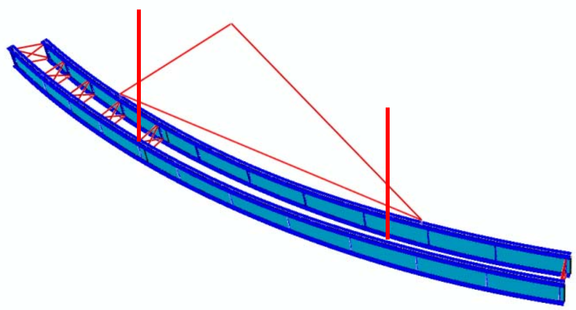
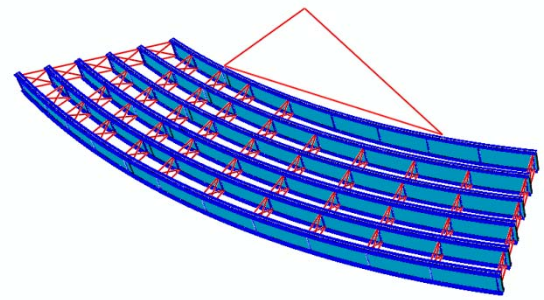
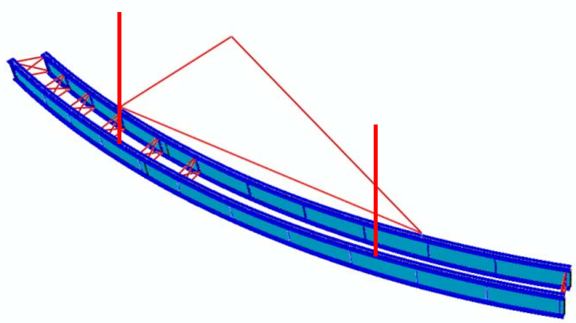
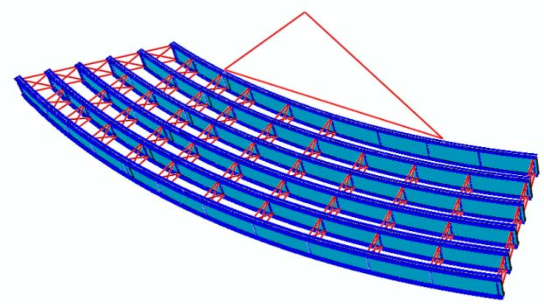
5		
6		

Table O2-1-1 (continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

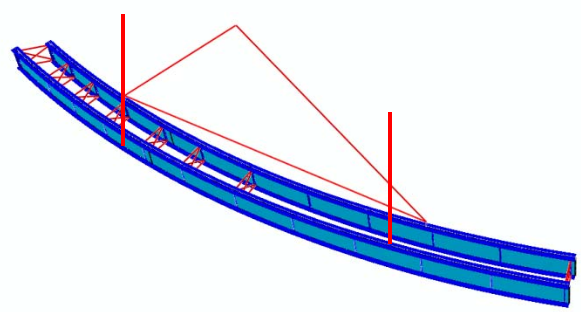
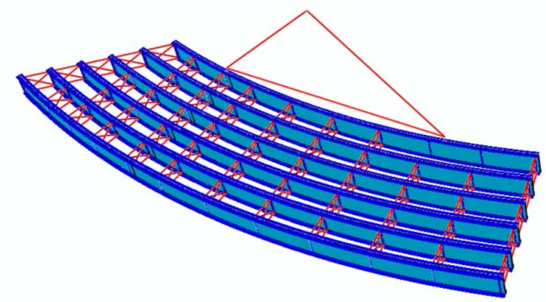
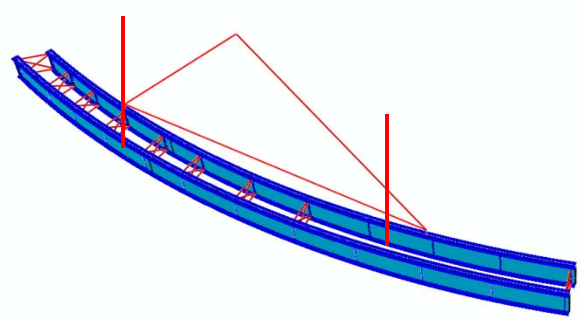
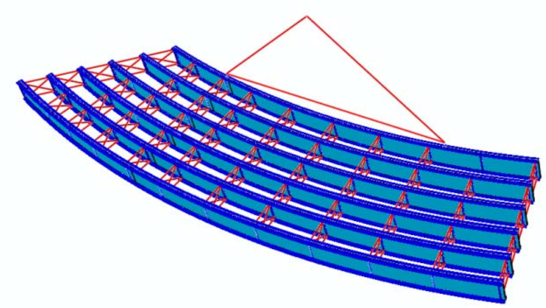
7		
8		

Table O2-1-1 (continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

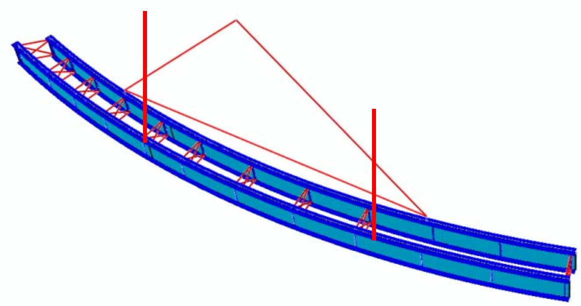
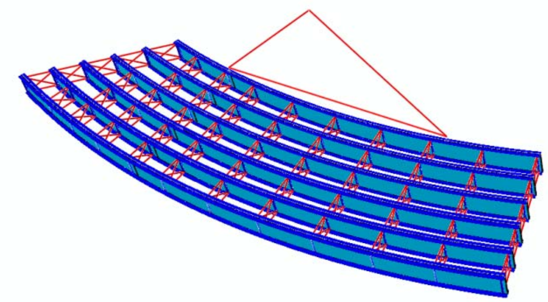
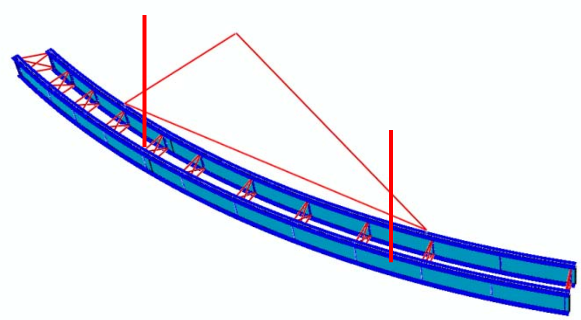
9		
10		

Table O2-1-1 (continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

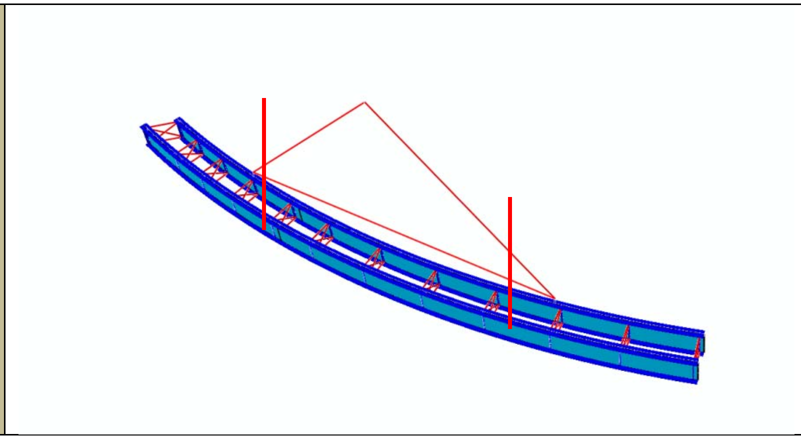
11		

Table O2-1-1(Continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

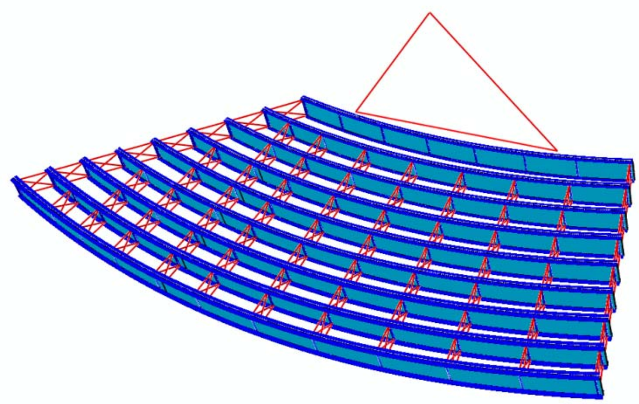
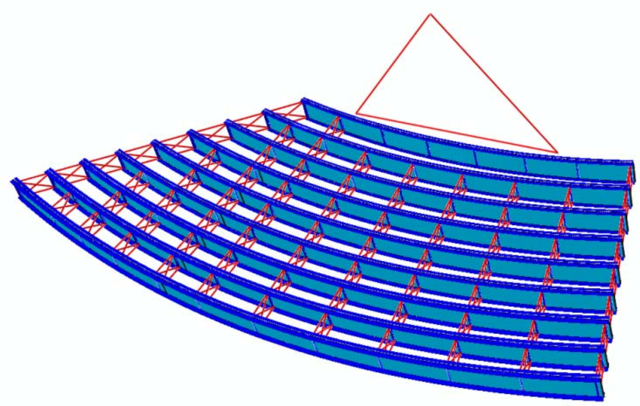
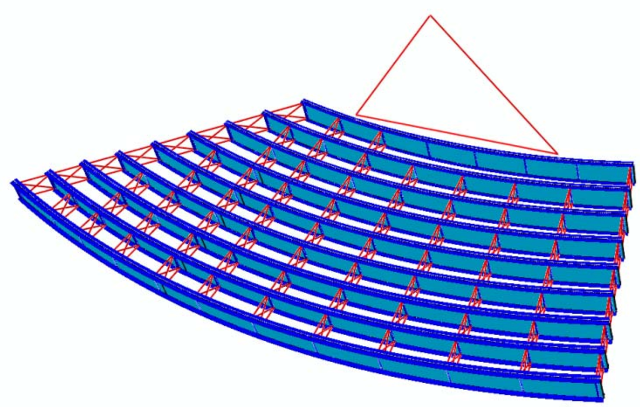
Sub-Stage	Stage 9
1	
2	
3	

Table O2-1-1 (continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

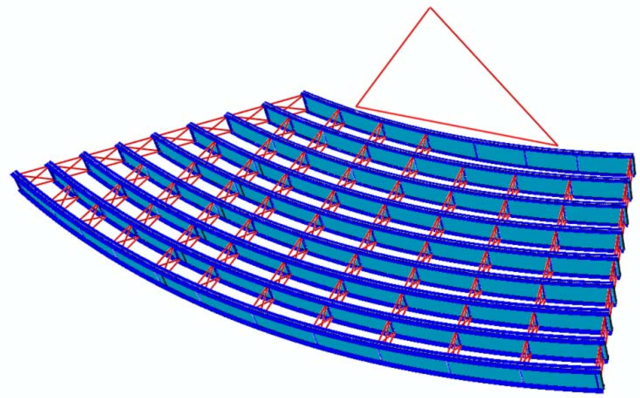
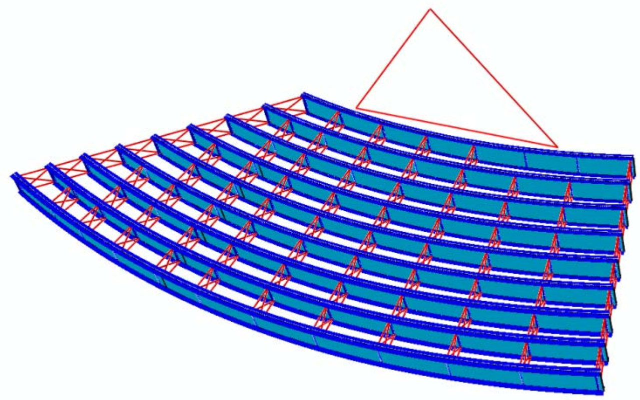
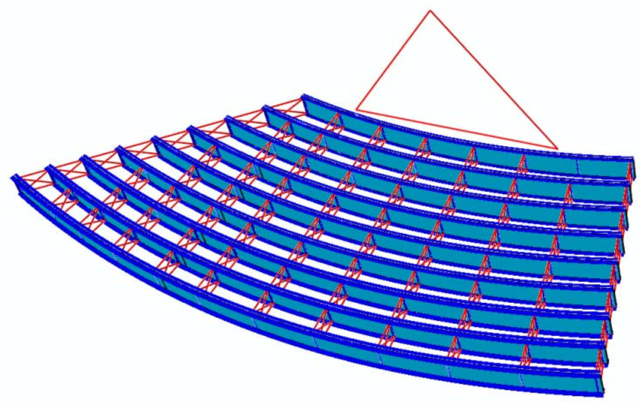
Sub-Stage	Stage 9
4	
5	
6	

Table O2-1-1 (continued). Three-dimensional view of erection method 2A sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

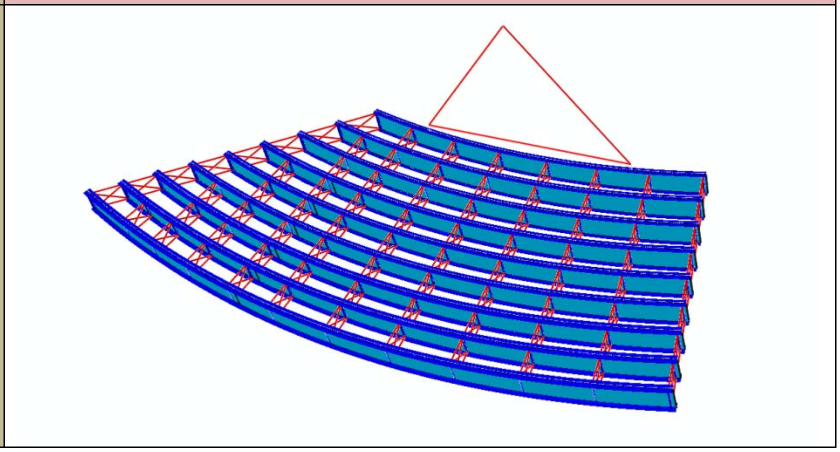
Sub-Stage	Stage 9
7	

Table O2-1-2. Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

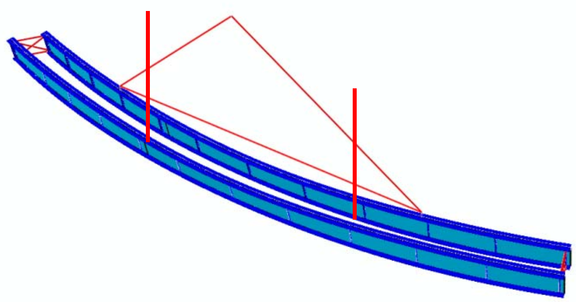
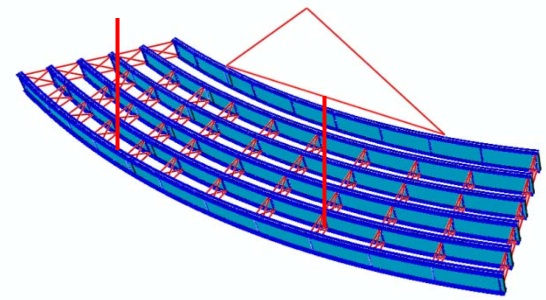
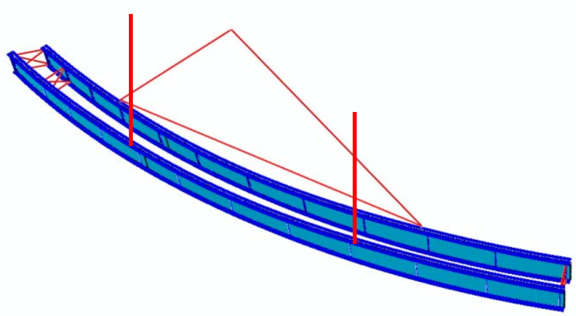
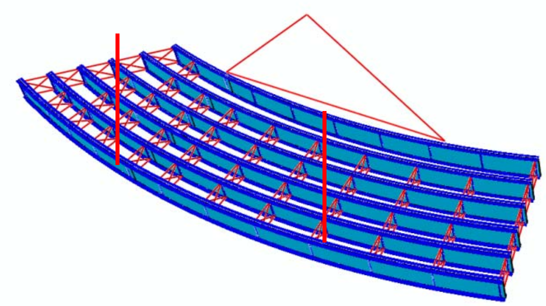
Sub-Stage	Stage	
	2	6
1		
2		

Table O2-1-2(Continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

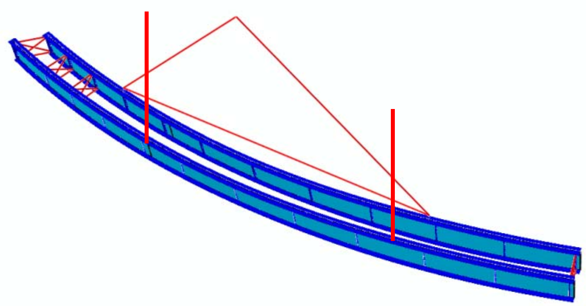
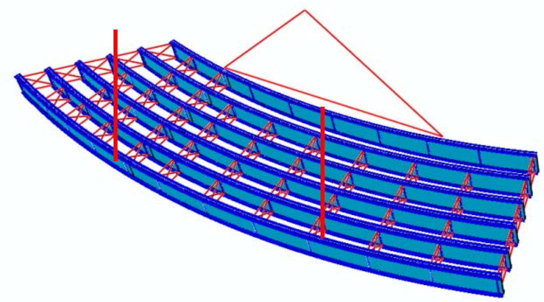
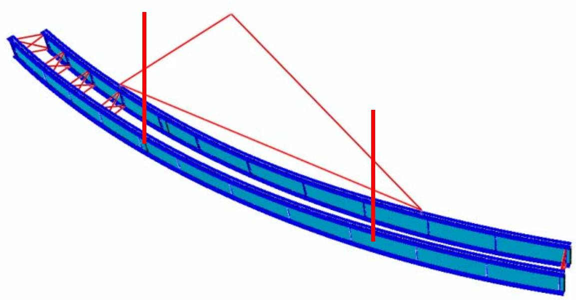
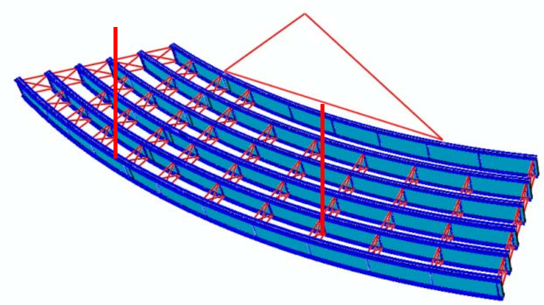
3		
4		

Table O2-1-2(Continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

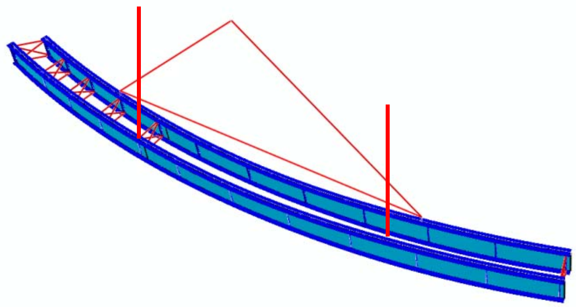
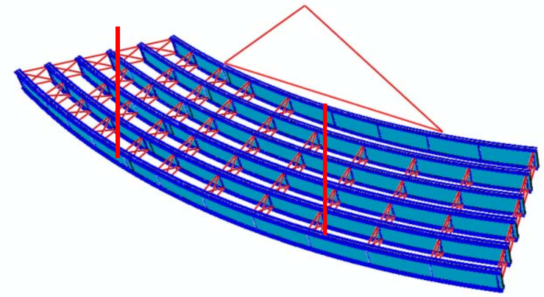
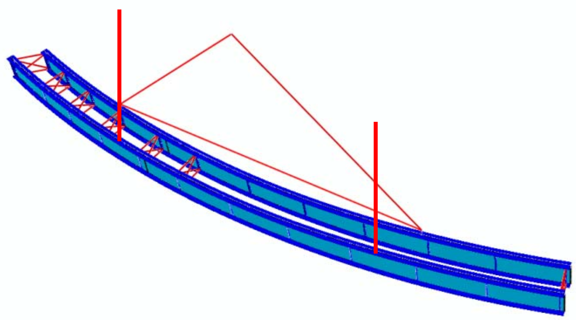
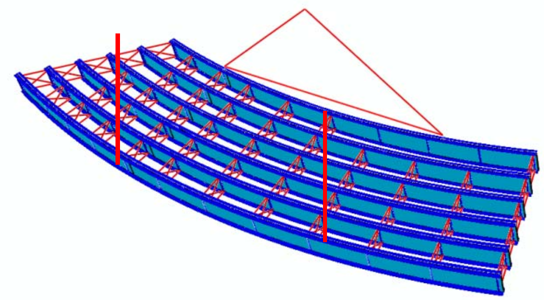
5		
6		

Table O2-1-2 (continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

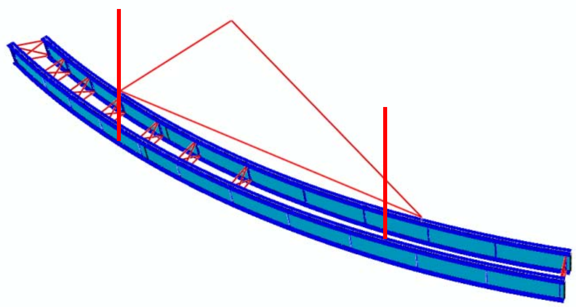
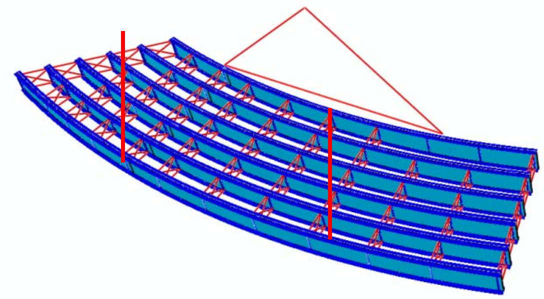
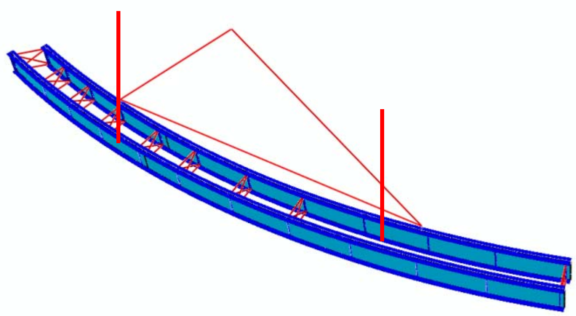
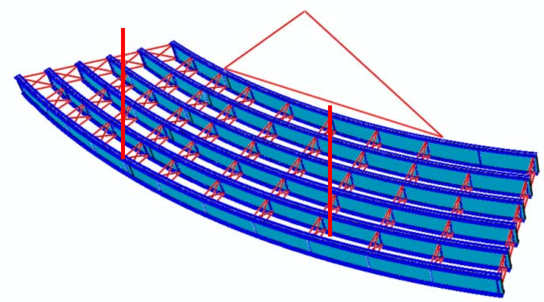
7		
8		

Table O2-1-2 (continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

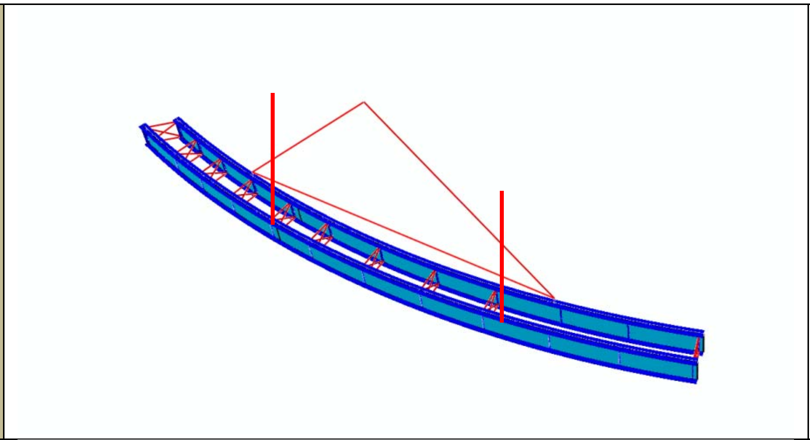
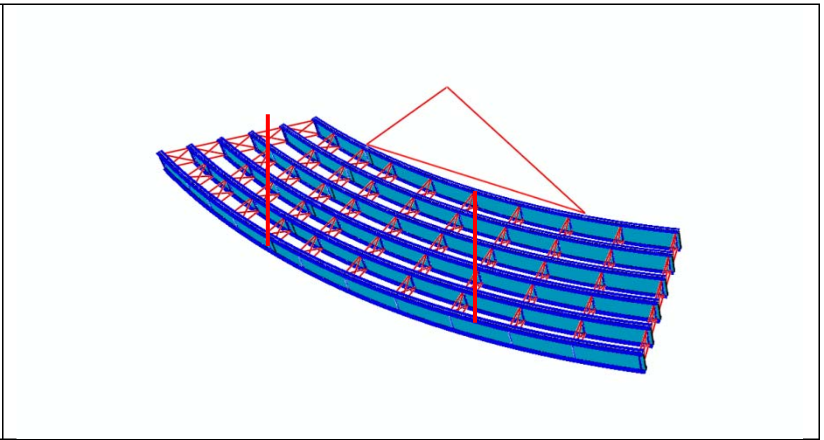
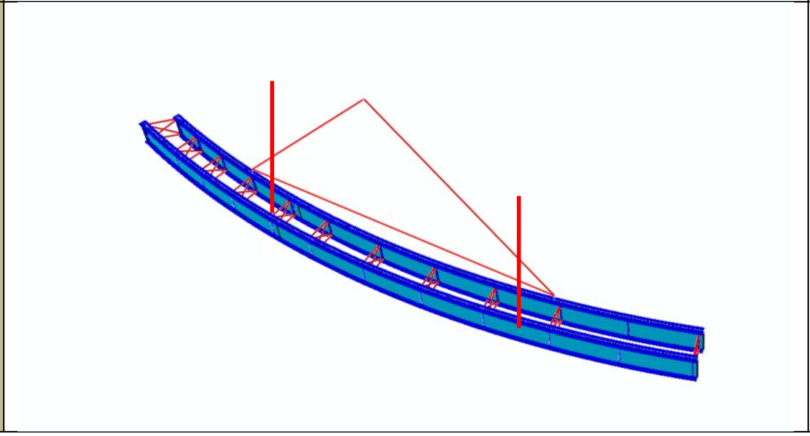
9		
10		

Table O2-1-2 (continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

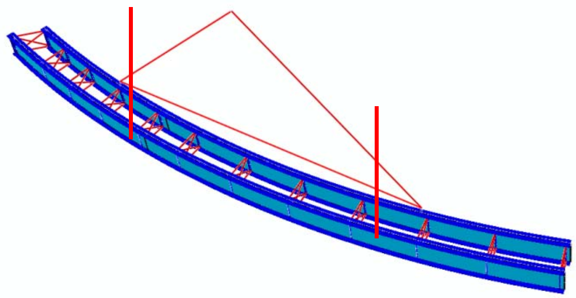
11		

Table O2-1-2 (continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

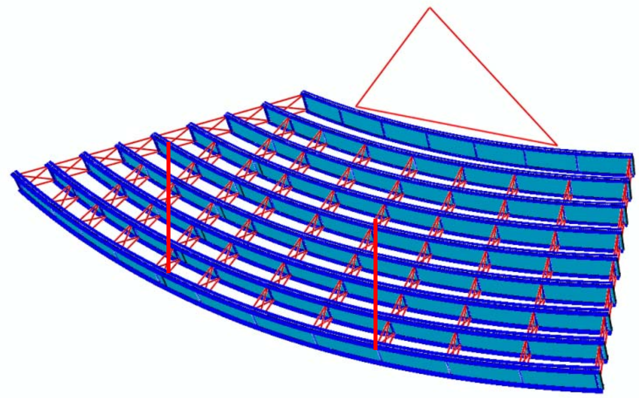
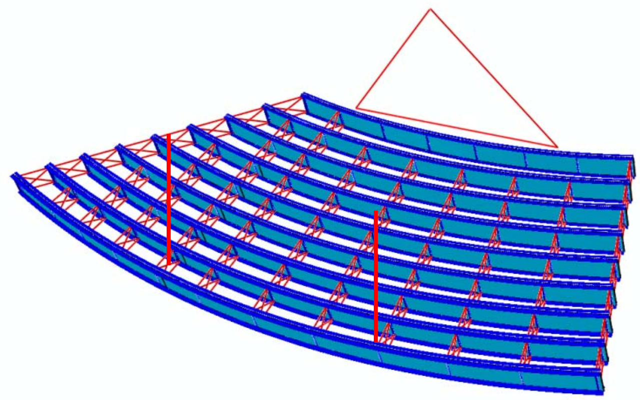
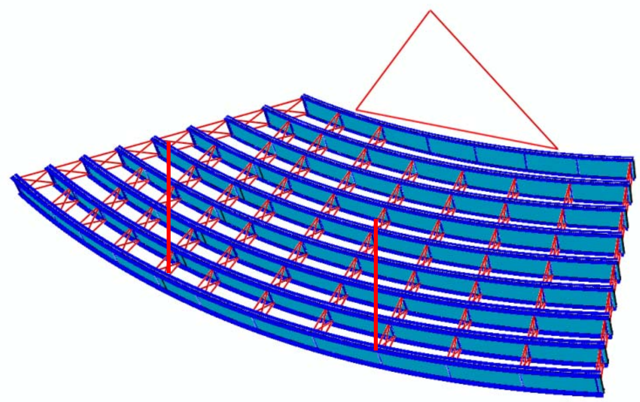
Sub-Stage	Stage 9
1	
2	
3	

Table O2-1-2 (continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

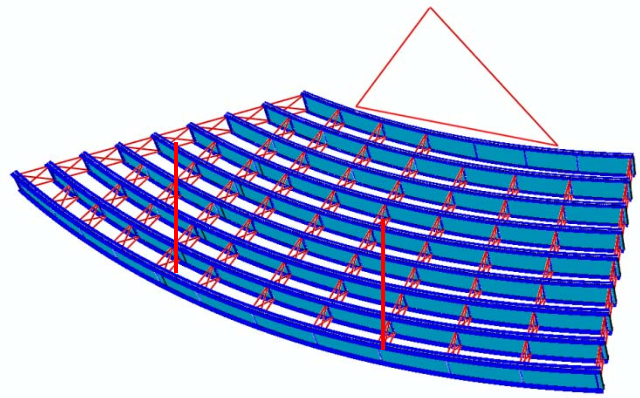
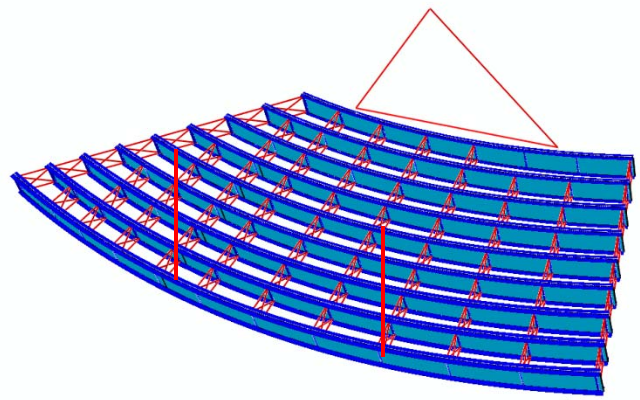
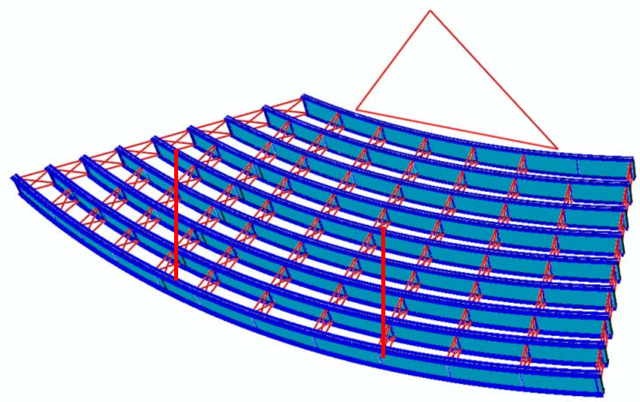
Sub-Stage	Stage 9
4	
5	
6	

Table O2-1-2 (continued). Three-dimensional view of erection method 2B sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

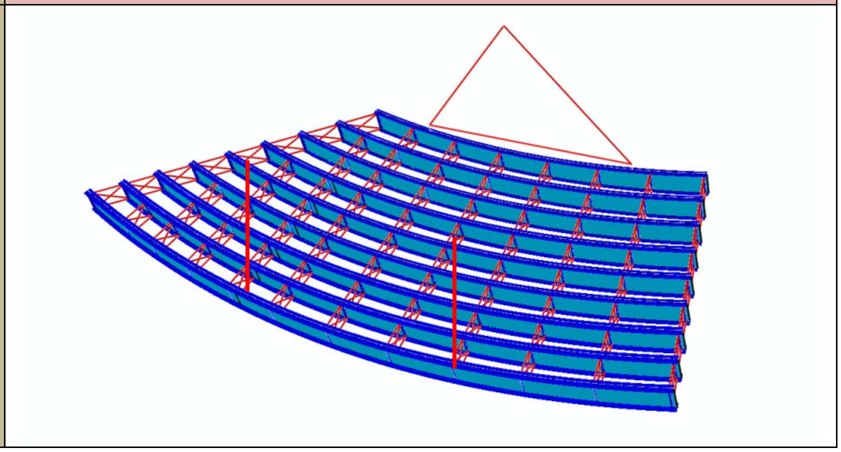
Sub-Stage	Stage
	9
7	

Table O2-1-3. Three-dimensional view of erection method 2C sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

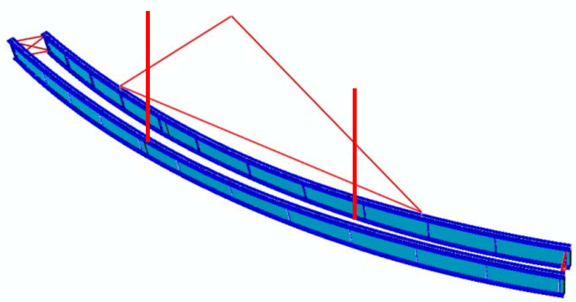
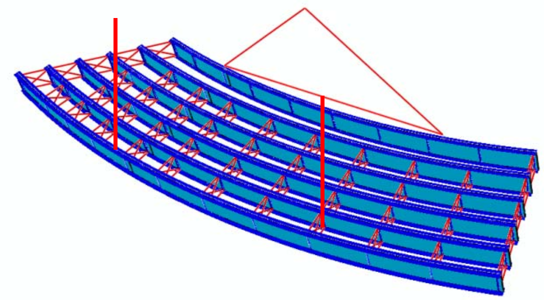
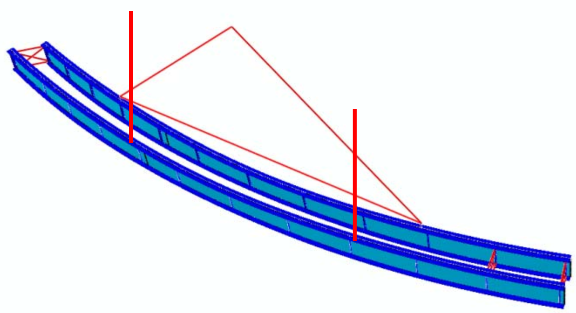
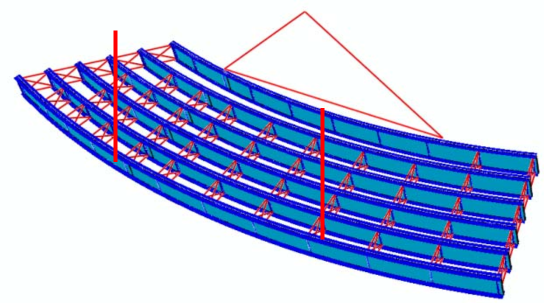
Sub-Stage	Stage	
	2	6
1		
2		

Table O2-1-3(Continued). Three-dimensional view of erection method 2C sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

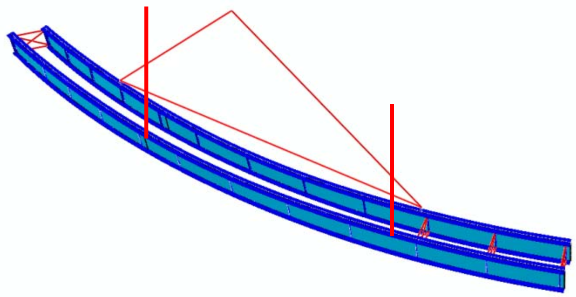
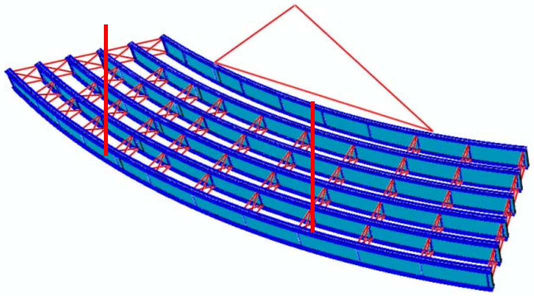
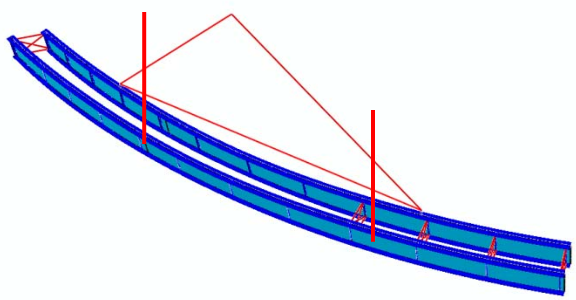
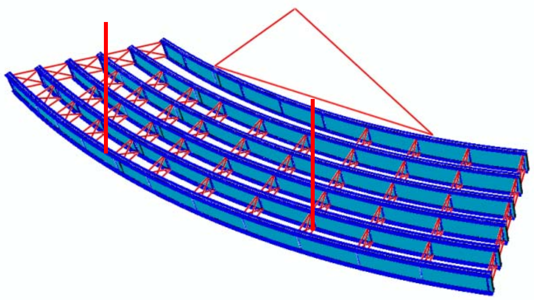
3		
4		

Table O2-1-3(Continued). Three-dimensional view of erection method 2C sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

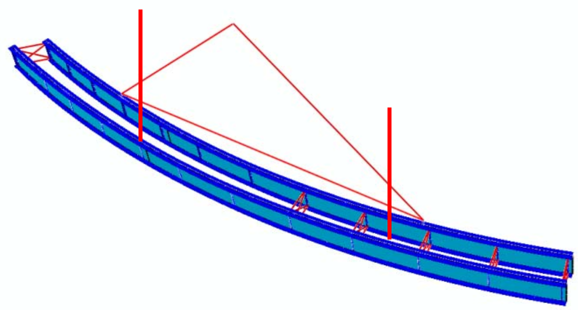
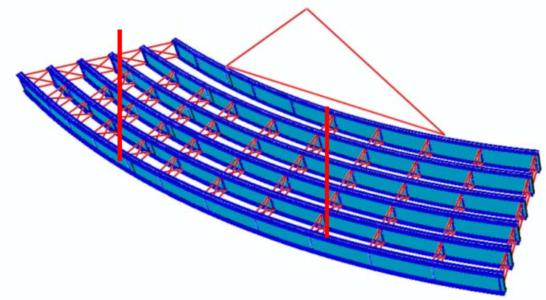
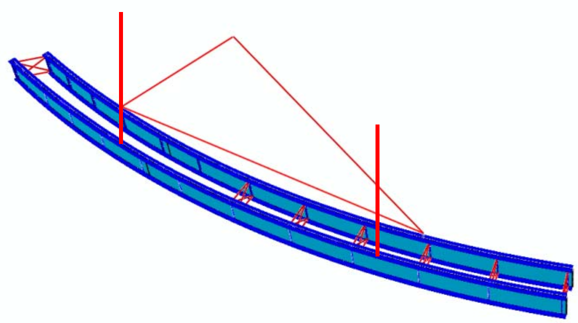
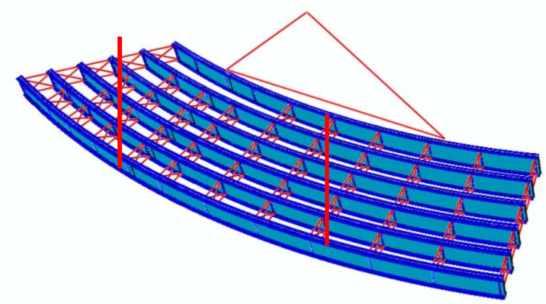
5		
6		

Table O2-1-3 (continued). Three-dimensional view of erection method 2C sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

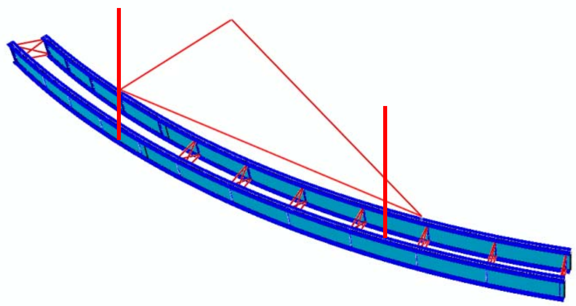
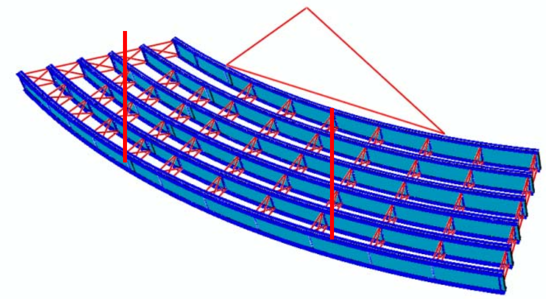
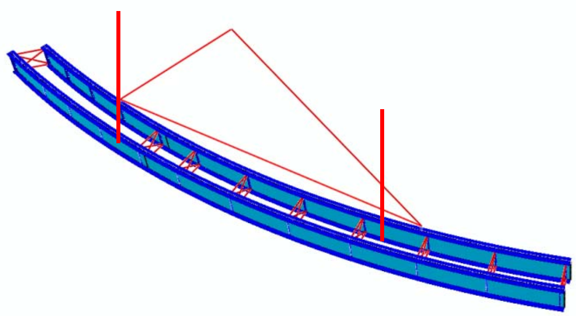
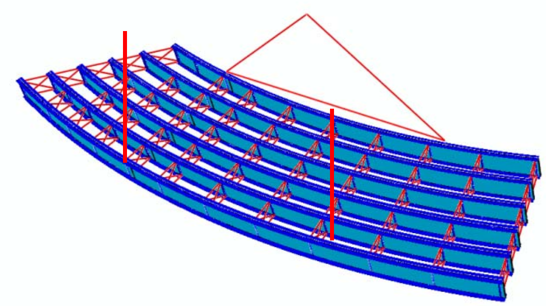
7		
8		

Table O2-1-3 (continued). Three-dimensional view of erection method 2C sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

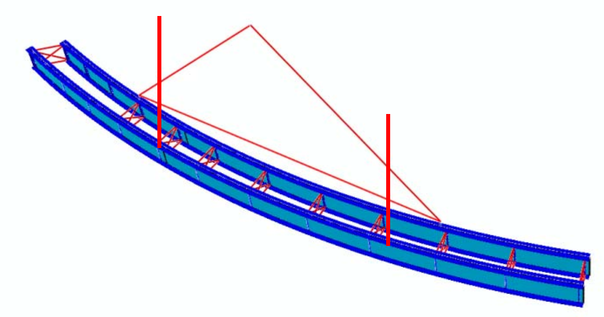
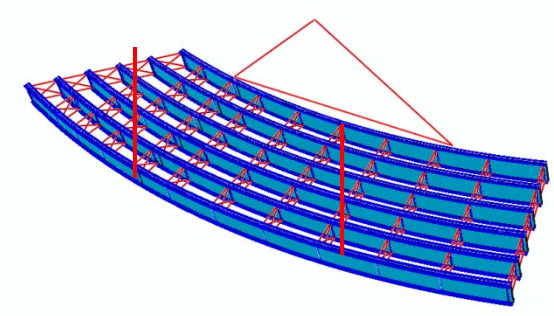
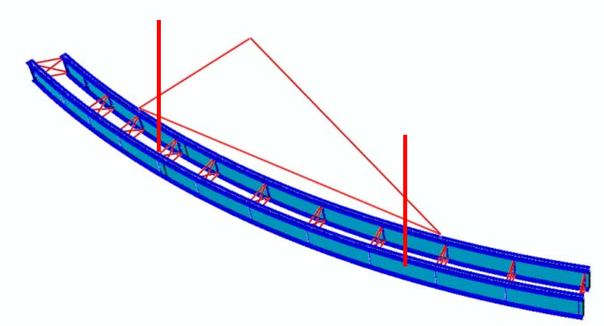
9		
10		

Table O2-1-3 (continued). Three-dimensional view of erection method 2C sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

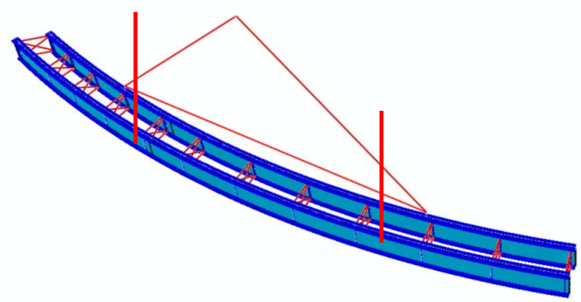
11		

Table O2-1-3 (continued). Three-dimensional view of erection method 2C sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

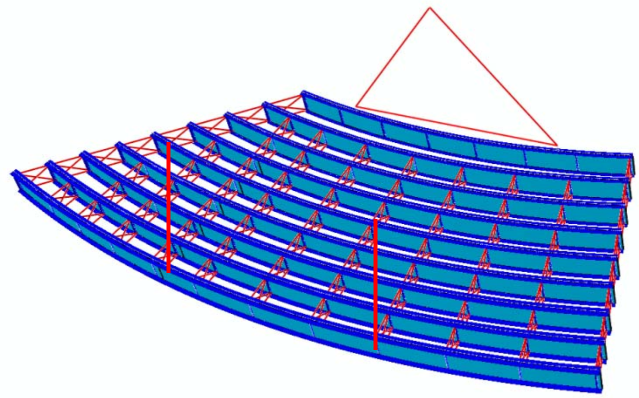
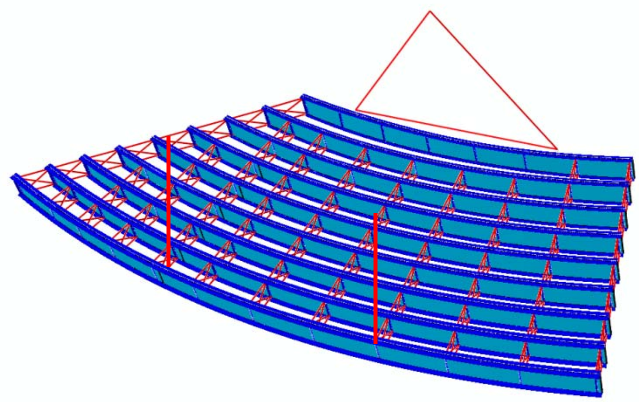
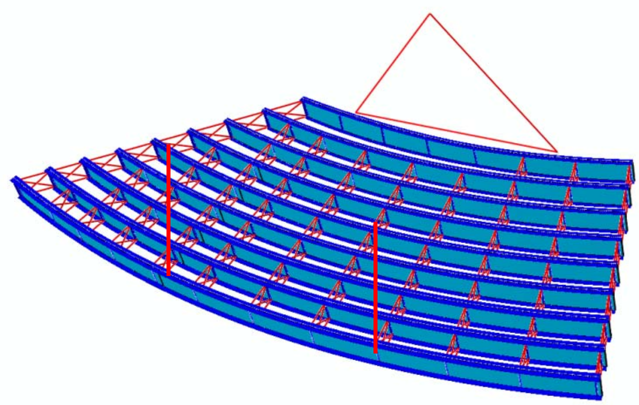
Sub-Stage	Stage 9
1	
2	
3	

Table O2-1-3 (continued). Three-dimensional view of erection method 2C sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

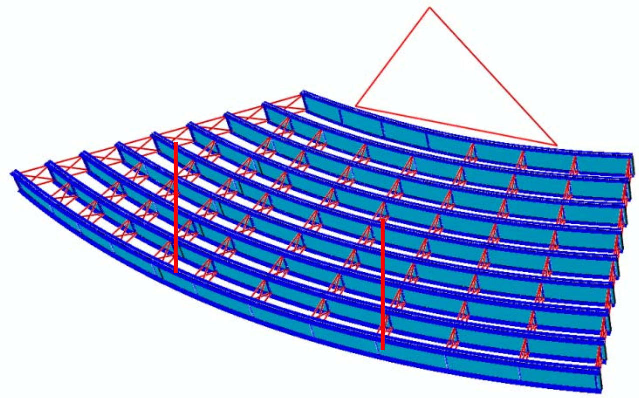
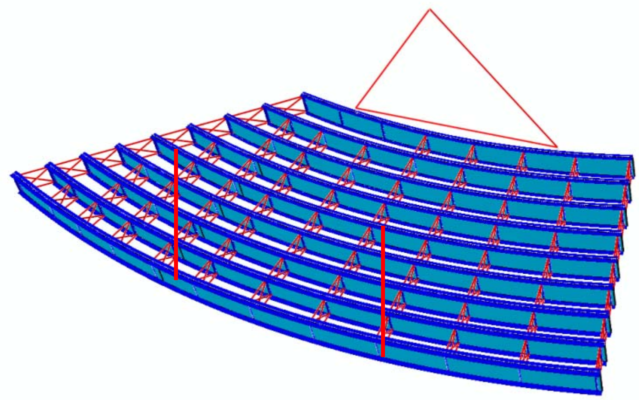
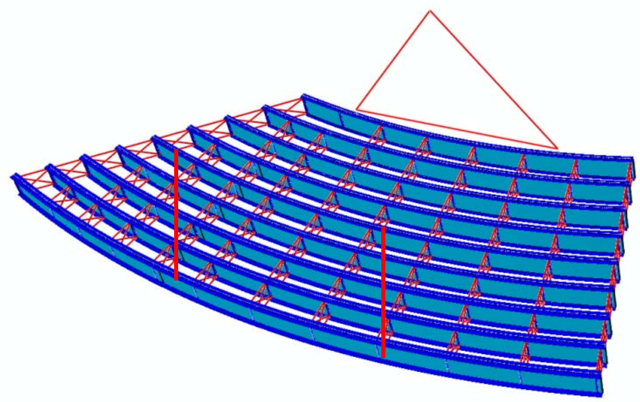
Sub-Stage	Stage 9
4	
5	
6	

Table O2-1-3 (continued). Three-dimensional view of erection method 2C sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

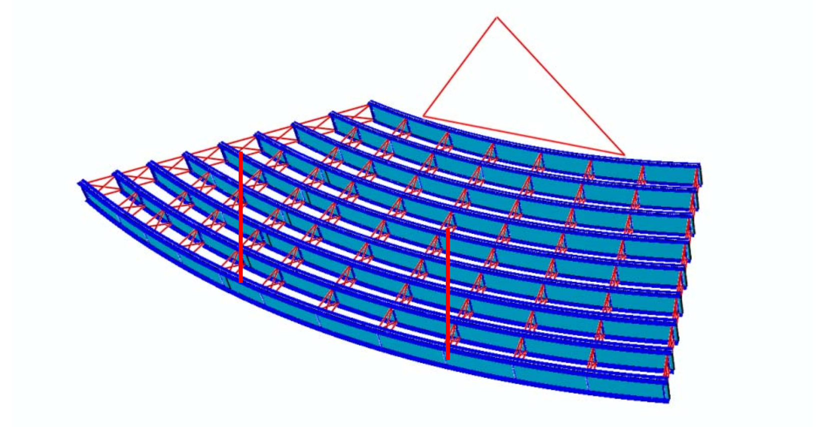
Sub-Stage	Stage 9
7	

Table O1-1-4. Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

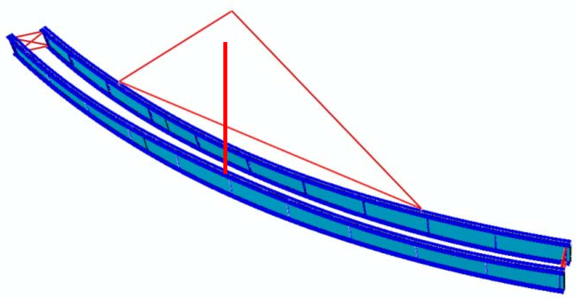
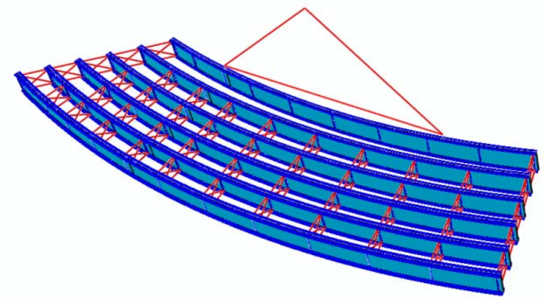
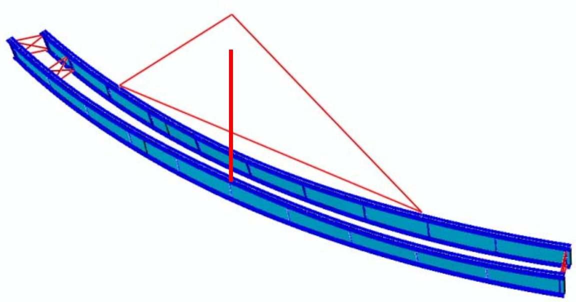
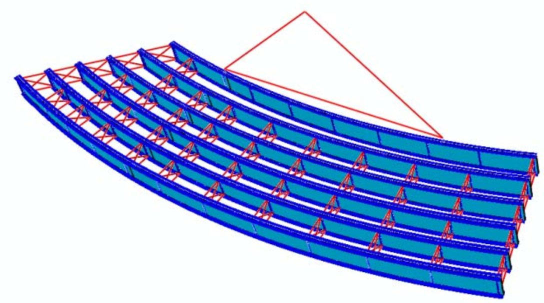
Sub-Stage	Stage	
	2	6
1		
2		

Table O1-1-4(Continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

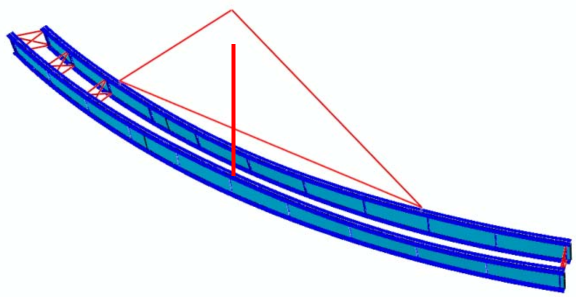
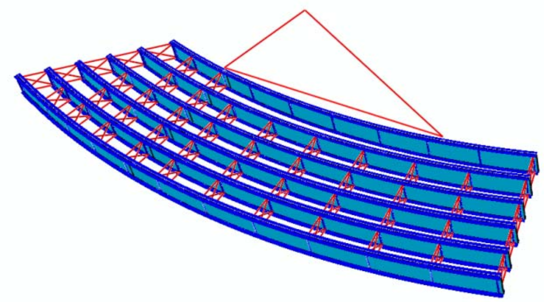
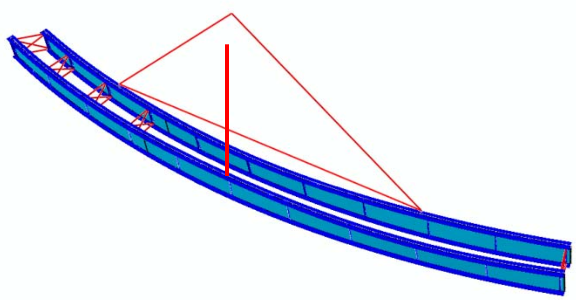
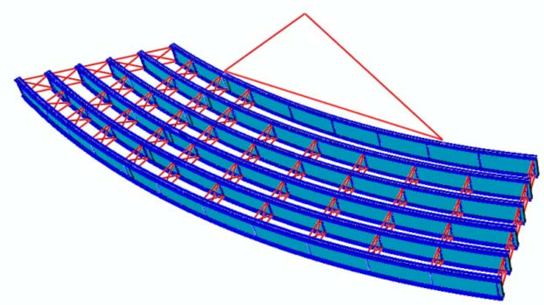
3		
4		

Table O1-1-4(Continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

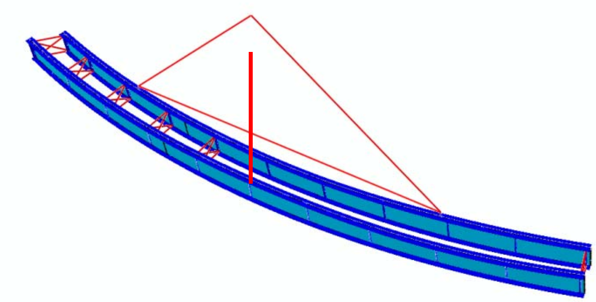
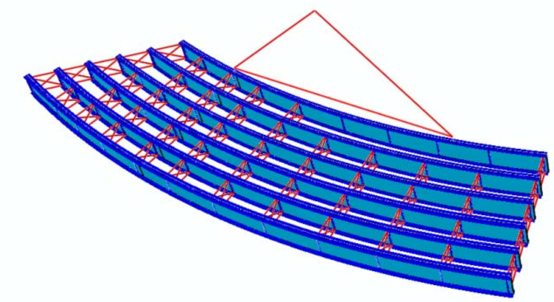
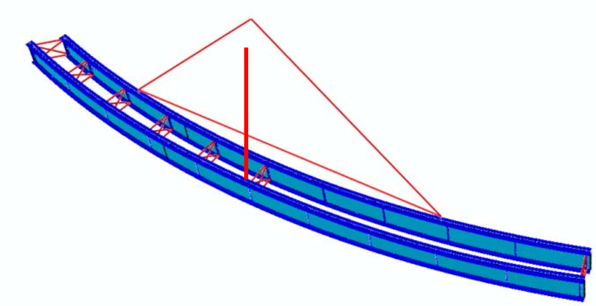
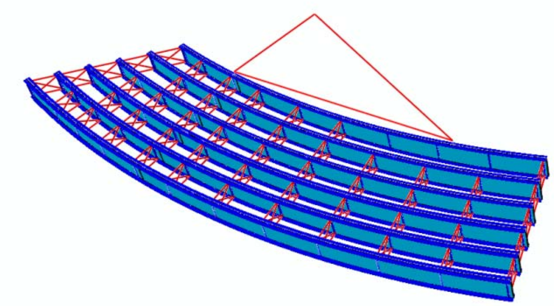
5		
6		

Table O1-1-4 (continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

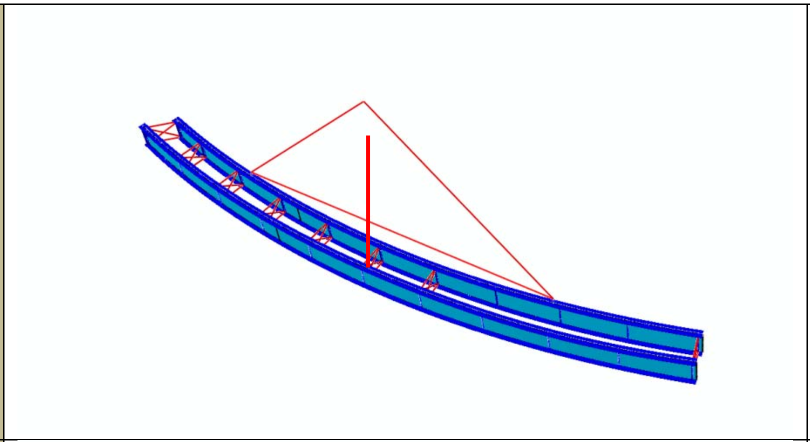
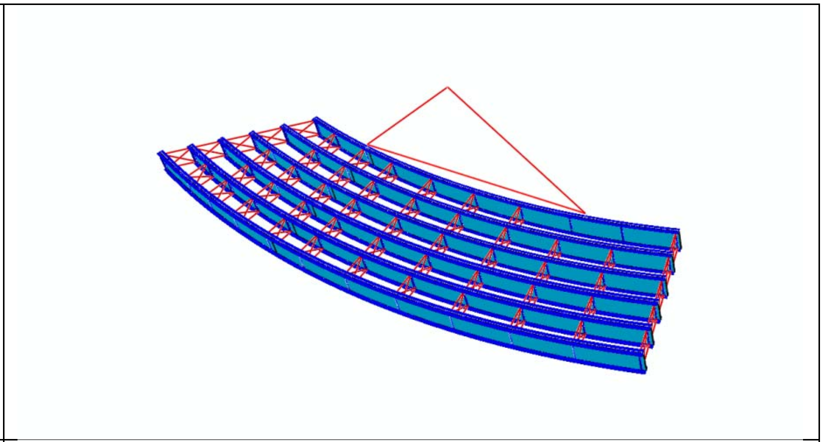
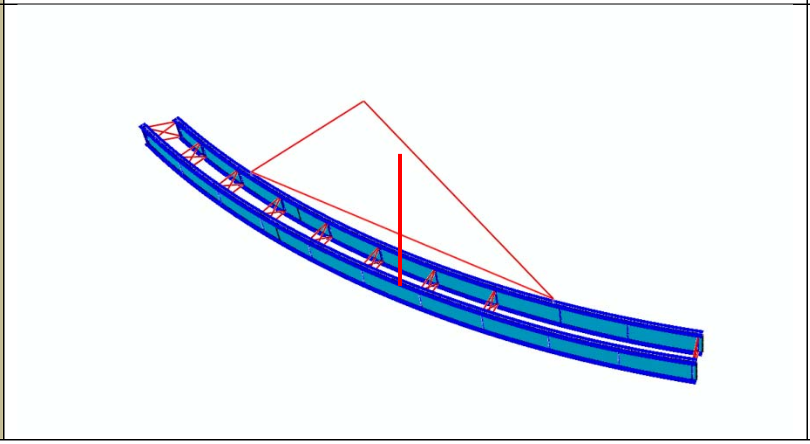
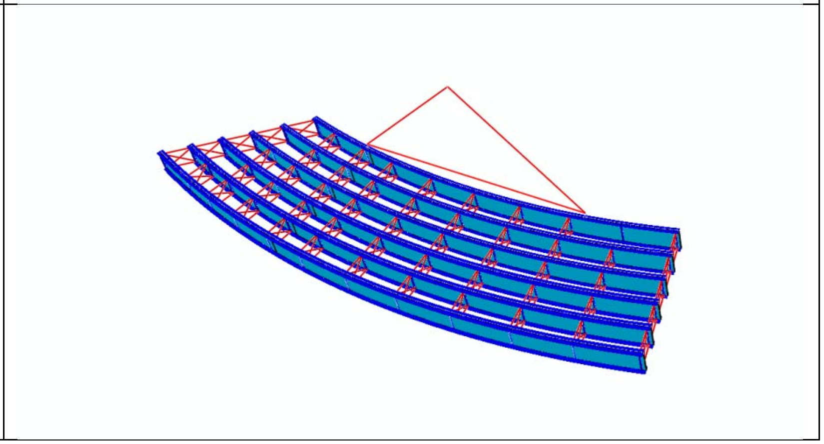
7		
8		

Table O1-1-4 (continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

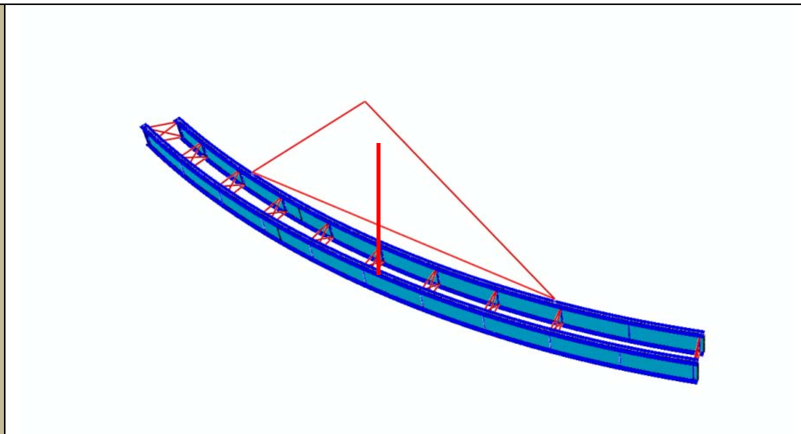
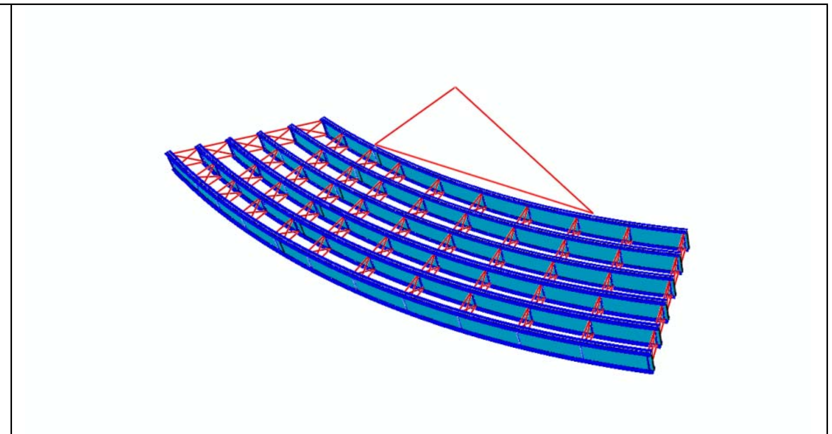
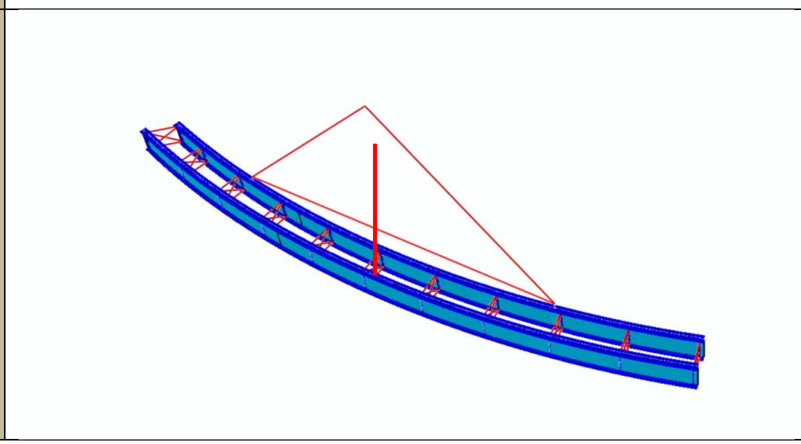
9		
10		

Table O1-1-4 (continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

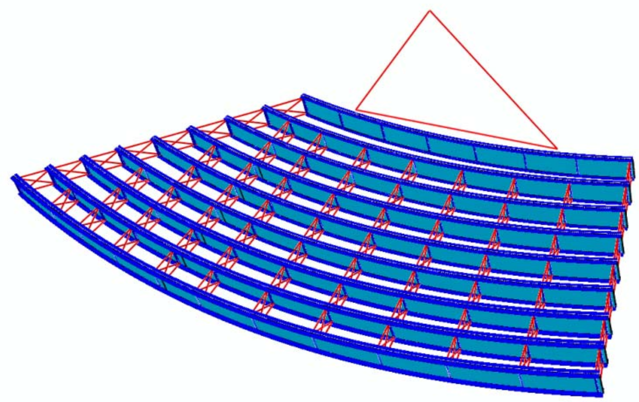
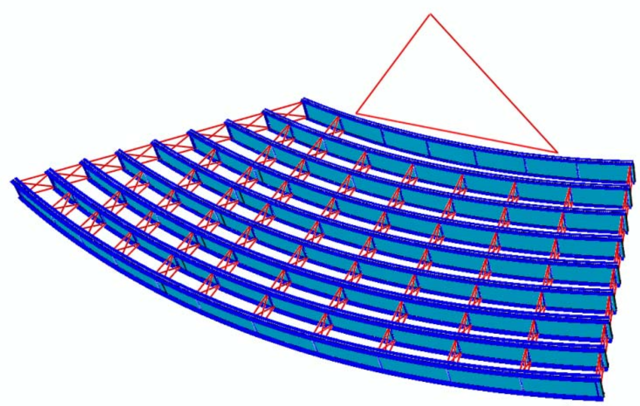
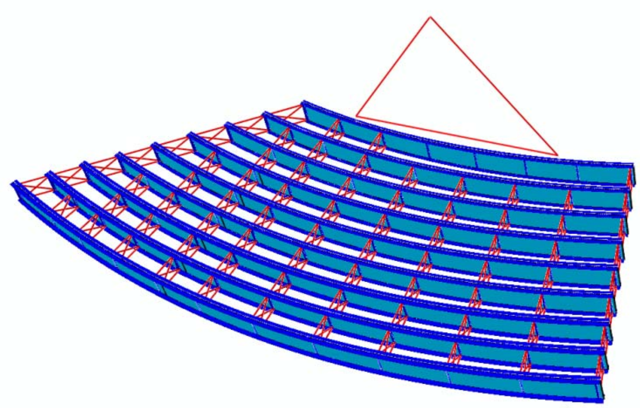
Sub-Stage	Stage 9
1	
2	
3	

Table O1-1-4 (continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

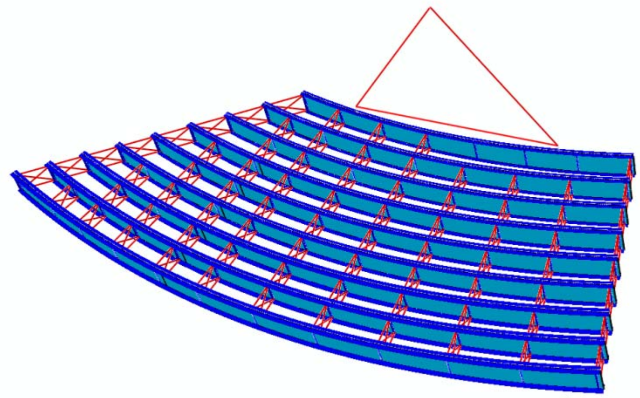
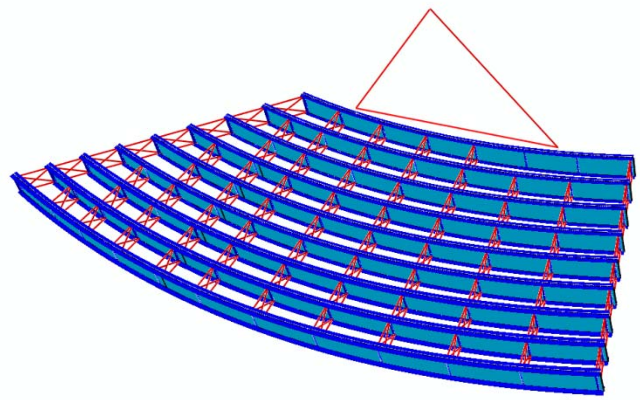
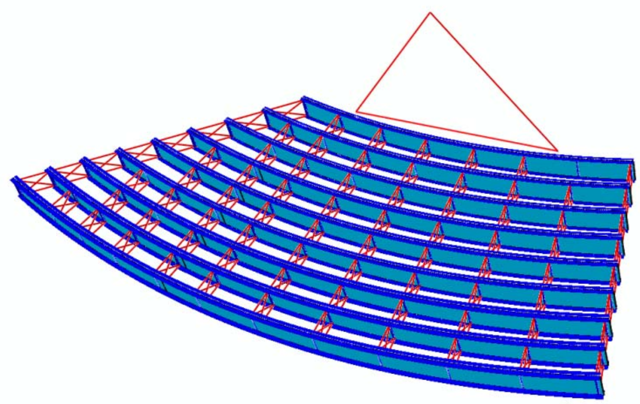
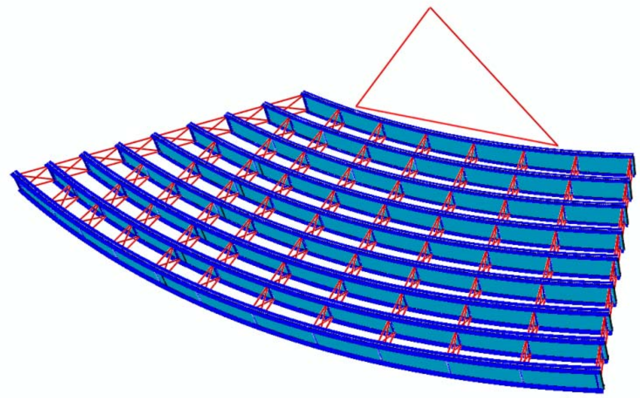
Sub-Stage	Stage 9
4	
5	
6	

Table O1-1-4 (continued). Three-dimensional view of erection method 4 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

Sub-Stage	Stage
	9
7	

Appendix O2-2. NISCS15 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISCS15 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table O2-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	4.3	9.4
	SDLF	3.8	8.8
	TDLF	3.1	8.2
G2	NLF	3.7	8.0
	SDLF	3.0	7.4
	TDLF	2.3	6.6
G3	NLF	3.0	6.7
	SDLF	2.4	6.0
	TDLF	1.6	5.2
G4	NLF	2.5	5.5
	SDLF	1.8	4.8
	TDLF	1.0	4.0
G5	NLF	1.9	4.3
	SDLF	1.3	3.7
	TDLF	0.6	2.9
G6	NLF	1.4	3.3
	SDLF	0.8	2.7
	TDLF	0.2	2.1
G7	NLF	1.0	2.3
	SDLF	0.5	1.8
	TDLF	0.1	1.3
G8	NLF	0.5	1.4
	SDLF	0.1	1.0
	TDLF	0.3	0.6
G9	NLF	0.1	0.5
	SDLF	0.2	0.2
	TDLF	0.5	0.2
All Girders	NLF	4.3	9.4
	SDLF	3.8	8.8
	TDLF	3.1	8.2

Table O2-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.60	1.28
	SDLF	0.12	0.79
	TDLF	0.52	0.24
G2	NLF	0.58	1.22
	SDLF	0.09	0.73
	TDLF	0.53	0.17
G3	NLF	0.54	1.15
	SDLF	0.07	0.66
	TDLF	0.55	0.16
G4	NLF	0.50	1.06
	SDLF	0.09	0.57
	TDLF	0.57	0.18
G5	NLF	0.46	0.98
	SDLF	0.09	0.50
	TDLF	0.59	0.20
G6	NLF	0.42	0.90
	SDLF	0.10	0.42
	TDLF	0.61	0.20
G7	NLF	0.39	0.84
	SDLF	0.11	0.37
	TDLF	0.63	0.22
G8	NLF	0.38	0.82
	SDLF	0.12	0.34
	TDLF	0.65	0.25
G9	NLF	0.37	0.79
	SDLF	0.13	0.32
	TDLF	0.67	0.27
All Girders	NLF	0.60	1.28
	SDLF	0.13	0.79
	TDLF	0.67	0.27

Table O2-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	7.2	15.8	8.6	18.7	1.8	4.4	2.0	4.2
	SDLF	7.9	16.4	9.3	19.4	1.8	4.2	2.5	4.8
	TDLF	8.5	17.0	10.0	20.1	1.9	4.0	3.0	5.5
G2	NLF	6.9	15.2	7.7	16.9	1.7	4.3	1.7	3.8
	SDLF	7.2	15.4	8.0	17.2	1.7	3.9	2.1	3.9
	TDLF	7.5	15.7	8.3	17.5	1.7	3.6	2.5	4.6
G3	NLF	6.3	14.1	7.0	15.7	1.5	4.0	1.4	3.5
	SDLF	6.3	14.1	7.0	15.7	1.4	3.5	1.8	3.3
	TDLF	6.3	14.0	7.0	15.6	1.3	3.2	2.1	3.9
G4	NLF	5.9	13.4	6.2	14.1	1.6	4.3	1.5	3.5
	SDLF	5.6	13.1	5.9	13.8	1.5	3.8	1.7	3.5
	TDLF	5.4	12.8	5.7	13.5	1.3	3.4	2.0	3.9
G5	NLF	5.3	12.2	5.6	12.8	1.5	4.0	1.3	3.4
	SDLF	4.8	11.7	5.1	12.3	1.2	3.5	1.5	2.9
	TDLF	4.4	11.3	4.7	11.9	1.1	3.0	1.6	3.4
G6	NLF	4.5	10.7	4.8	11.2	1.6	3.6	2.1	4.5
	SDLF	4.0	10.1	4.2	10.6	1.0	3.0	1.2	2.4
	TDLF	3.6	9.6	3.8	10.1	1.7	2.5	2.1	2.8
G7	NLF	3.5	8.6	3.5	8.6	1.0	3.2	1.0	2.9
	SDLF	2.9	8.0	2.9	8.1	0.9	2.7	0.9	2.0
	TDLF	2.6	7.6	2.6	7.6	1.1	2.3	1.2	2.2
G8	NLF	2.1	5.3	2.1	5.3	2.1	3.6	3.1	6.9
	SDLF	1.3	4.8	1.3	4.8	0.6	1.9	0.5	3.0
	TDLF	1.1	4.5	1.1	4.5	3.4	1.5	4.2	1.3
G9	NLF	2.4	3.7	2.3	3.7	1.6	2.0	3.1	7.3
	SDLF	1.6	2.5	1.6	2.5	0.8	0.7	0.5	3.3
	TDLF	1.5	1.5	1.5	1.5	2.9	1.6	3.7	0.8
All Girders	NLF	7.2	15.8	8.6	18.7	2.1	4.4	3.1	7.3
	SDLF	7.9	16.4	9.3	19.4	1.8	4.2	2.5	4.8
	TDLF	8.5	17.0	10.0	20.1	3.4	4.0	4.2	5.5

Table O2-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	73.0	159.7	158.0	159.7
	SDLF	46.2	103.9	103.1	103.9
	TDLF	42.5	105.5	103.4	105.5
TDL	NLF	145.8	317.9	310.4	317.9
	SDLF	110.1	241.6	234.9	241.6
	TDLF	92.4	215.1	212.6	215.1

Table O2-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	13.7	47.5	47.4	30.6
	SDLF	12.4	43.1	42.6	27.6
	TDLF	14.7	41.9	41.2	28.1
TDL	NLF	30.5	96.4	95.6	63.3
	SDLF	28.5	91.2	90.2	59.6
	TDLF	28.1	86.6	85.4	57.0

Table O2-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.66	0.63	0.59	0.55	0.51	0.47	0.45	0.44	0.66
SDLF	0.74	0.68	0.60	0.52	0.44	0.37	0.34	0.33	0.74
TDLF	0.82	0.73	0.60	0.47	0.36	0.27	0.22	0.22	0.82

Table O2-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.40	1.33	1.24	1.16	1.06	1.00	0.96	0.94	1.40
SDLF	1.47	1.38	1.25	1.12	0.98	0.90	0.83	0.83	1.47
TDLF	1.55	1.41	1.24	1.06	0.88	0.78	0.69	0.71	1.55

Table O2-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.48	0.46	0.43	0.39	0.36	0.34	0.32	0.32	0.48
SDLF	0.54	0.49	0.43	0.37	0.32	0.26	0.24	0.24	0.54
TDLF	0.59	0.52	0.43	0.34	0.26	0.19	0.16	0.16	0.59

Table O2-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.01	0.96	0.89	0.84	0.76	0.72	0.69	0.68	1.01
SDLF	1.06	0.99	0.90	0.81	0.70	0.65	0.60	0.60	1.06
TDLF	1.11	1.02	0.90	0.77	0.64	0.56	0.50	0.51	1.11

Table O2-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	1251	2874
SDLF	1251	2873
TDLF	1251	2874

Table O2-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	144	307	0.7	2.6	0.7	2.4
SDLF	148	310	0.4	1.7	0.2	1.1
TDLF	150	314	0.2	0.9	0.9	0.3

Table O2-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.38	0.53	0.13	0.49
SDLF	0.42	0.68	0.03	0.21
TDLF	0.50	0.93	0.19	0.05

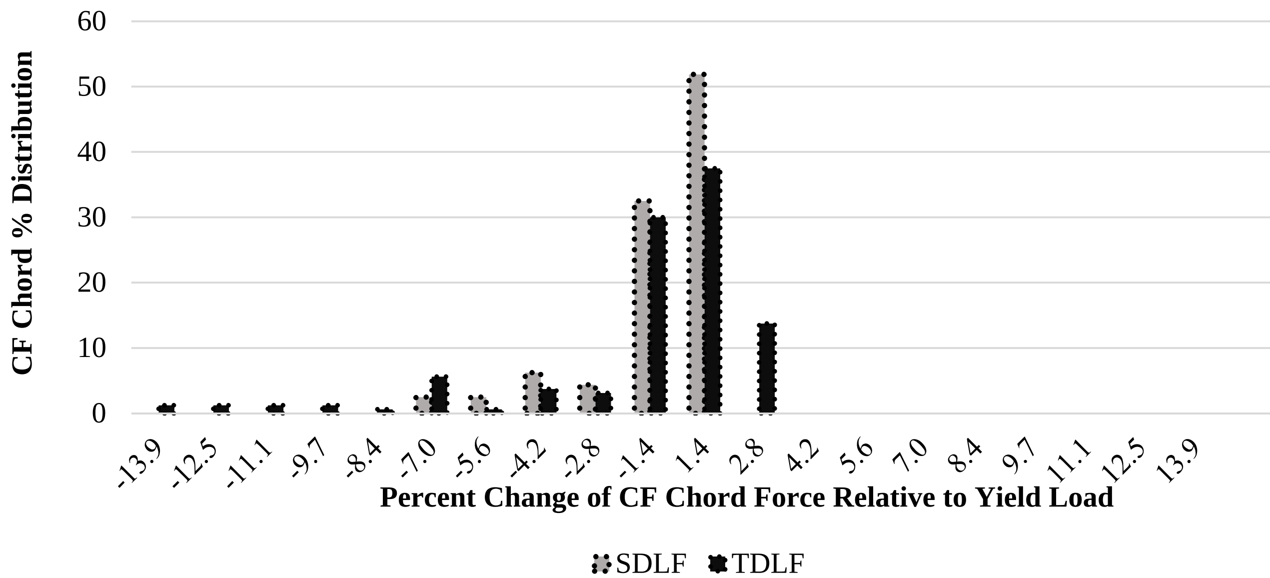


Figure O2-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

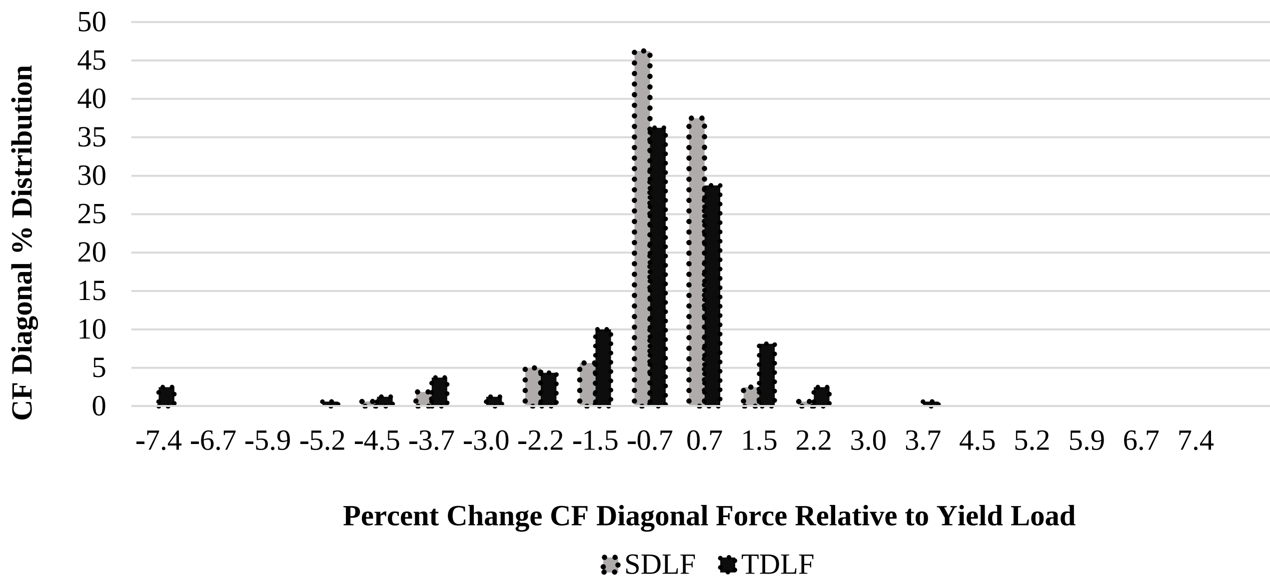


Figure O2-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

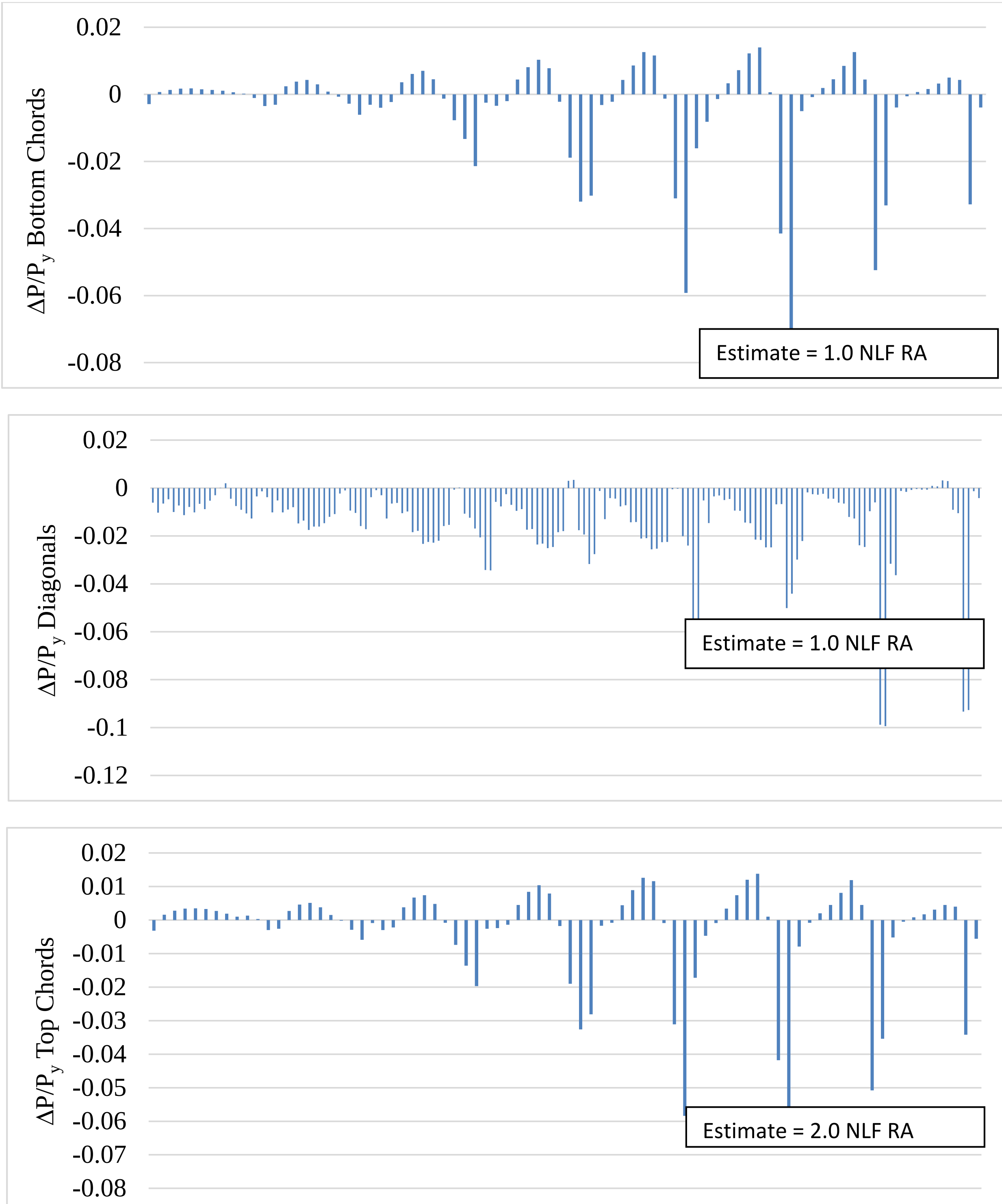


Figure O2-2-3. **Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.**

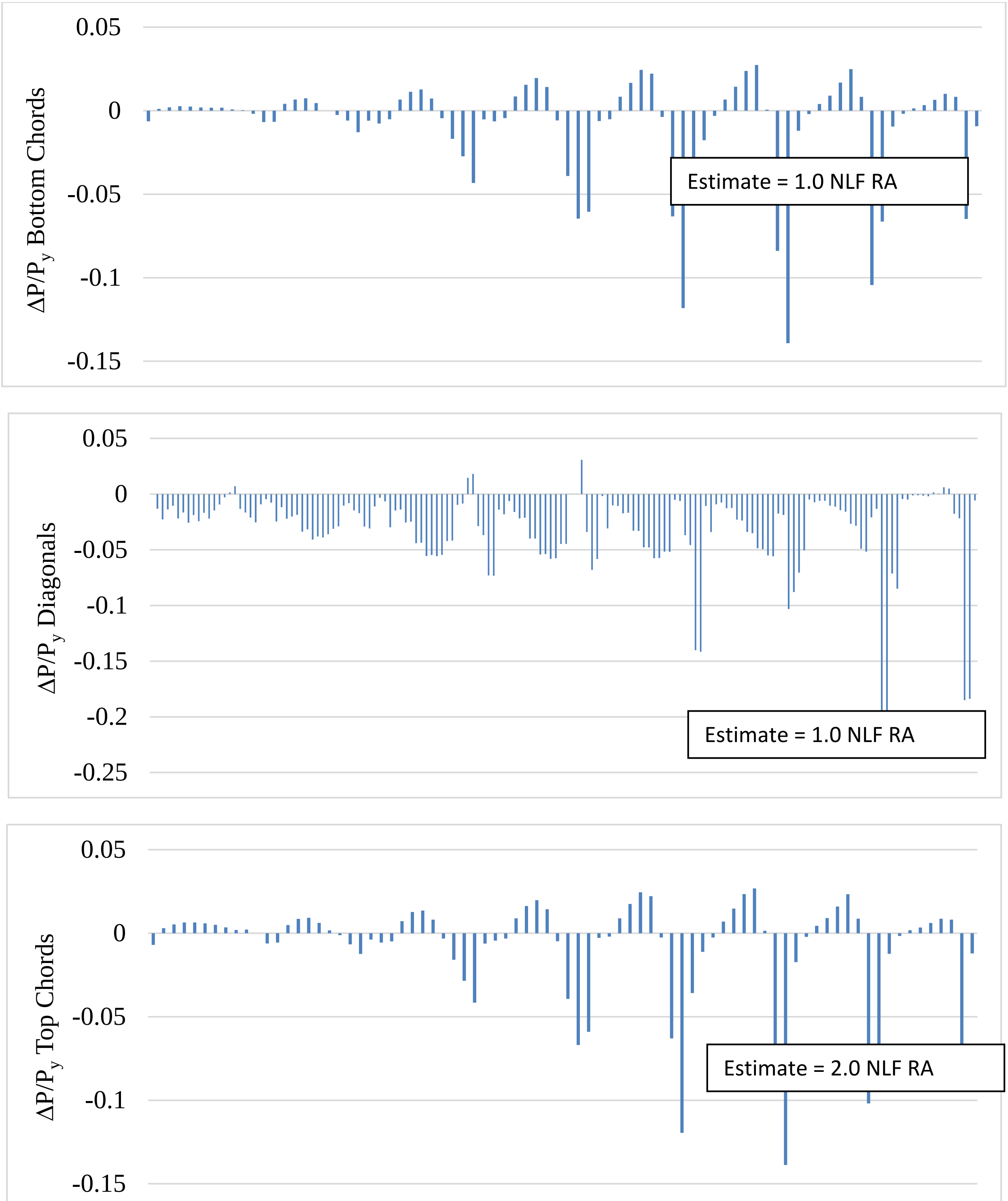


Figure O2-2-4. **Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.**

Appendix O2-3. NISCS15 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISCS15 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table O2-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	Erection Method 2A			Erection Method 2B			Erection Method 2C			Erection Method 4		
	F1	F2	F_{max}	F1	F2	F_{max}	F1	F2	F_{max}	F1	F2	F_{max}
NLF	141.0	100.0	141.0	88.1	55.4	88.1	69.1	48.7	61.1	6.1	6.5	6.5
SDLF	147.4	98.3	147.4	58.7	40.1	58.7	51.0	31.9	51.0	40.0	31.5	40.0
TDLF	155.8	97.0	155.8	50.1	42.8	50.1	78.4	50.0	78.4	50.3	44.5	50.3

Table O2-3-2. Summary of erection method 2A vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	188.7	-5.6
	SDLF	189.4	13.2
	TDLF	190.5	5.7
G2	NLF	154	8.4
	SDLF	150.6	24.1
	TDLF	147.1	14.1
G3	NLF	188.1	100.1
	SDLF	181.7	101.1
	TDLF	173.6	102.8
G4	NLF	73.3	36.2
	SDLF	70.7	33.7
	TDLF	67.2	27
G5	NLF	103.7	-2.4
	SDLF	110.8	1.3
	TDLF	114.8	5.8
G6	NLF	53.3	-152
	SDLF	52.1	-146.1
	TDLF	60.1	-138.4
G7	NLF	94.1	28.9
	SDLF	28.6	25.8
	TDLF	23.6	-49
G8	NLF	18	-40.6
	SDLF	29.4	13.5
	TDLF	90.1	10.6
G9	NLF	15.1	-56.6
	SDLF	13.8	-44.1
	TDLF	14.4	-34.1
All Girders	NLF	188.7	-152
	SDLF	189.4	-146.1
	TDLF	190.5	-138.4

Table O2-3-3. Summary of erection method 2A crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	165.4	0.1	107.7	89.7
SDLF	69.3	4.6	126.4	114.8
TDLF	48.7	4	149.5	82.9

Table O2-3-4. Summary of erection method 2B vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	10.9	-10.4
	SDLF	33.7	13.2
	TDLF	72.4	5.7
G2	NLF	29.2	-2
	SDLF	38.9	24.1
	TDLF	58.5	14.1
G3	NLF	51.4	16.8
	SDLF	57.4	39
	TDLF	71	61.8
G4	NLF	56.8	39.7
	SDLF	47.5	41
	TDLF	50.5	28.5
G5	NLF	59.9	-3.2
	SDLF	56.7	16.7
	TDLF	62.2	16.5
G6	NLF	81.8	-8.2
	SDLF	62.9	-3.7
	TDLF	77.5	23.4
G7	NLF	50.5	43.3
	SDLF	39.6	-12.2
	TDLF	33.6	-81.4
G8	NLF	44.2	18.3
	SDLF	77.5	37.2
	TDLF	132.6	31
G9	NLF	50	-12.6
	SDLF	48.8	-10.1
	TDLF	41.8	-6.6
All Girders	NLF	81.8	-12.6
	SDLF	77.5	-12.2
	TDLF	132.6	-81.4

Table O2-3-5. Summary of erection method 2B crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	165.4	102.2	307.3	89.7
SDLF	112.8	45	254.2	114.8
TDLF	80.1	0	229.3	82.9

Table O2-3-6. Summary of erection method 2C vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	17.5	-9.1
	SDLF	36	14.3
	TDLF	74.7	12.4
G2	NLF	33.5	-1.1
	SDLF	41.3	23.6
	TDLF	60.2	25.4
G3	NLF	52.2	17.1
	SDLF	58.1	38.5
	TDLF	68.2	62.5
G4	NLF	66	32.6
	SDLF	49	39.7
	TDLF	44.6	29.6
G5	NLF	81	-8.8
	SDLF	69.8	23.9
	TDLF	64	17.1
G6	NLF	56.7	-9.5
	SDLF	61.7	-3.7
	TDLF	78.5	17.9
G7	NLF	61.6	32.4
	SDLF	32.6	-13.2
	TDLF	37.4	-82.2
G8	NLF	63.7	-10
	SDLF	72.7	25.1
	TDLF	118.9	37.1
G9	NLF	40.4	-7.8
	SDLF	47.4	9.8
	TDLF	89.9	28.5
All Girders	NLF	81	-10
	SDLF	72.7	-13.2
	TDLF	118.9	-82.2

Table O2-3-7. Summary of erection method 2C crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	163.8	97.8	298.6	89.9
SDLF	114.9	31.2	261.2	111.5
TDLF	39.9	0	226.7	104.9

Table O2-3-8. Summary of erection method 4 vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	131.3	35.8
	SDLF	265	72.5
	TDLF	269.7	61.2
G2	NLF	128.7	13.4
	SDLF	71.9	0
	TDLF	83.1	0
G3	NLF	124	38
	SDLF	60.4	0
	TDLF	80.8	0
G4	NLF	79.6	23.9
	SDLF	36.6	0
	TDLF	45.9	0
G5	NLF	68.4	19.2
	SDLF	60.3	0
	TDLF	48.9	0
G6	NLF	89.5	6.5
	SDLF	53.3	0
	TDLF	79.4	0
G7	NLF	40.5	17.8
	SDLF	30.6	-16.4
	TDLF	30.5	-81.3
G8	NLF	39.8	14.9
	SDLF	80.6	29.9
	TDLF	135.1	0
G9	NLF	17.7	5.4
	SDLF	48.7	-0.1
	TDLF	57.7	-0.2
All Girders	NLF	131.3	5.4
	SDLF	265	-16.4
	TDLF	269.7	-81.3

Table O2-3-9. Summary of erection method 4 crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	92.3	28	50.6	49.1
SDLF	52.1	0	85.6	79.4
TDLF	57.2	0	82	29.4

Table O2-3-10. Erection total vertical reactions at each sub-stage

Erection Method	Stage	Detailing Method	Sub-Stage										
			1	2	3	4	5	6	7	8	9	10	11
2A, 2B, 2C, and 4	2	NLF	365	368	372	375	378	382	385	389	392	395	398
		SDLF	365	368	372	375	378	382	385	389	392	395	398
		TDLF	365	368	372	375	378	382	385	389	392	395	398
	6	NLF	964	968	971	974	978	981	985	988	992		
		SDLF	964	968	971	974	978	981	985	988	992		
		TDLF	964	968	971	974	978	981	985	988	992		
	9	NLF	1231	1234	1238	1241	1244	1248	1251				
		SDLF	1231	1234	1238	1241	1244	1248	1251				
		TDLF	1231	1234	1238	1241	1244	1248	1251				

Appendix O2-4. NISCS15 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge NISCS15 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

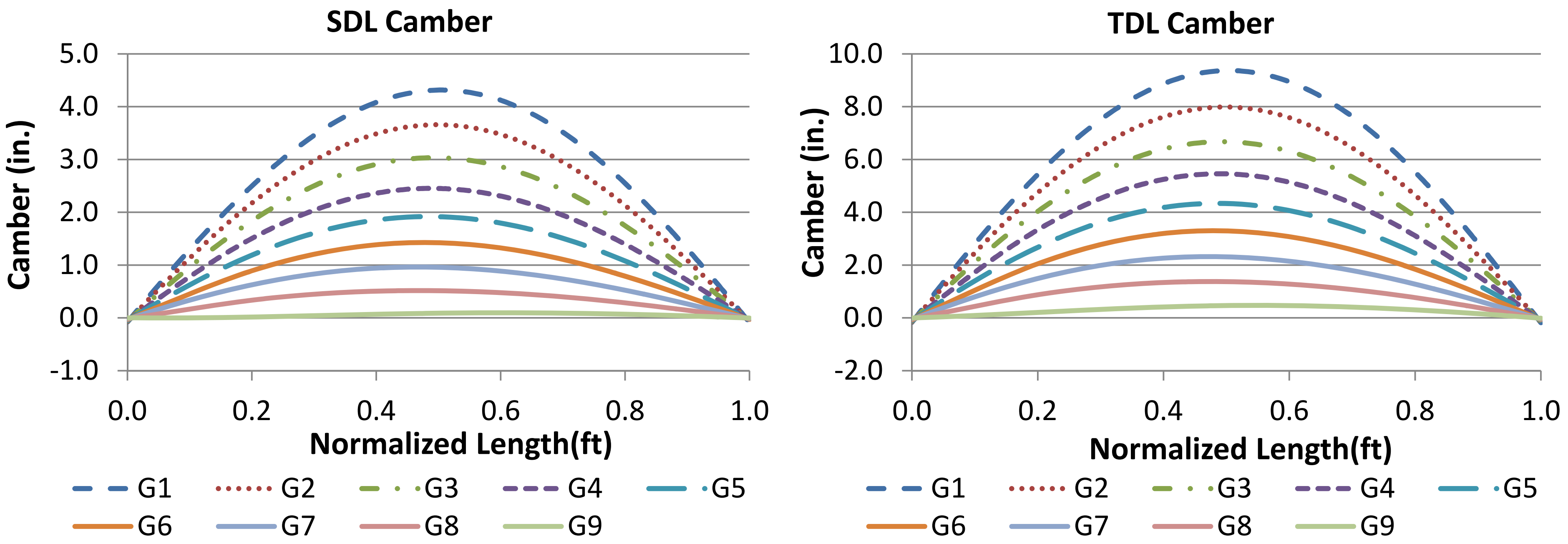


Figure O2-4-1. SDL and TDL 3D FEA cambers.

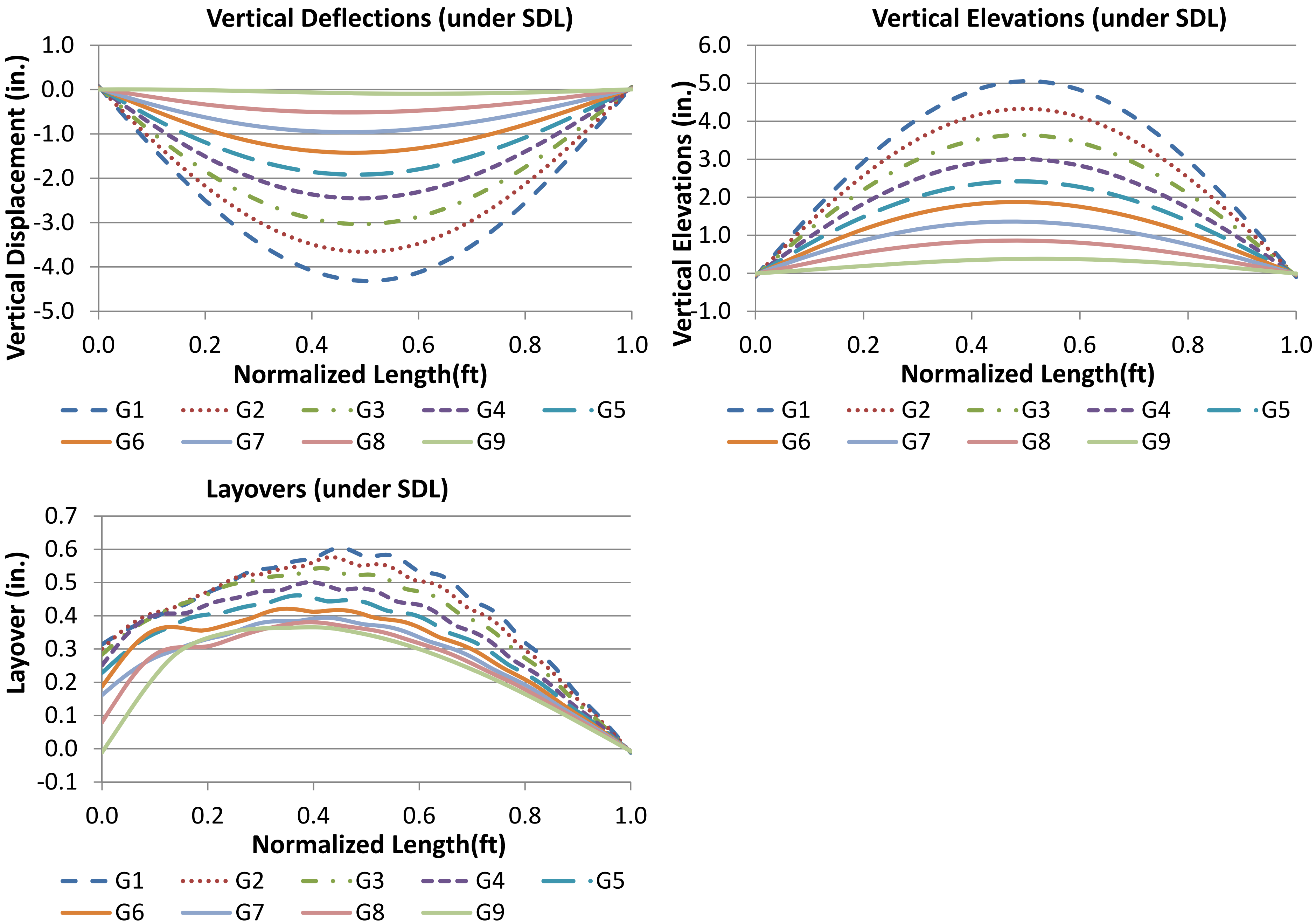


Figure O2-4-2. **Bridge displacements and elevation profiles (in) under SDL, NLF detailing.**

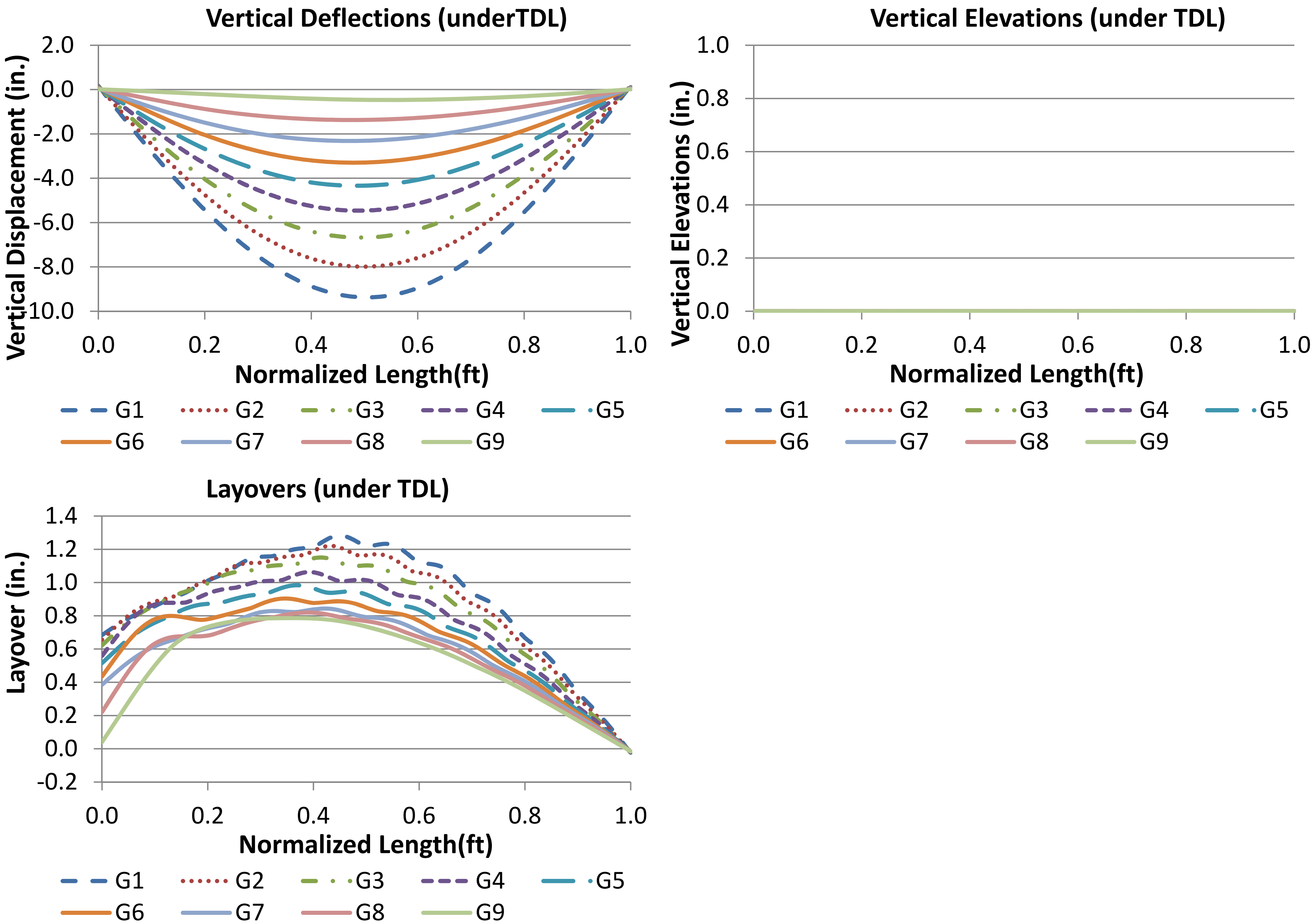


Figure O2-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

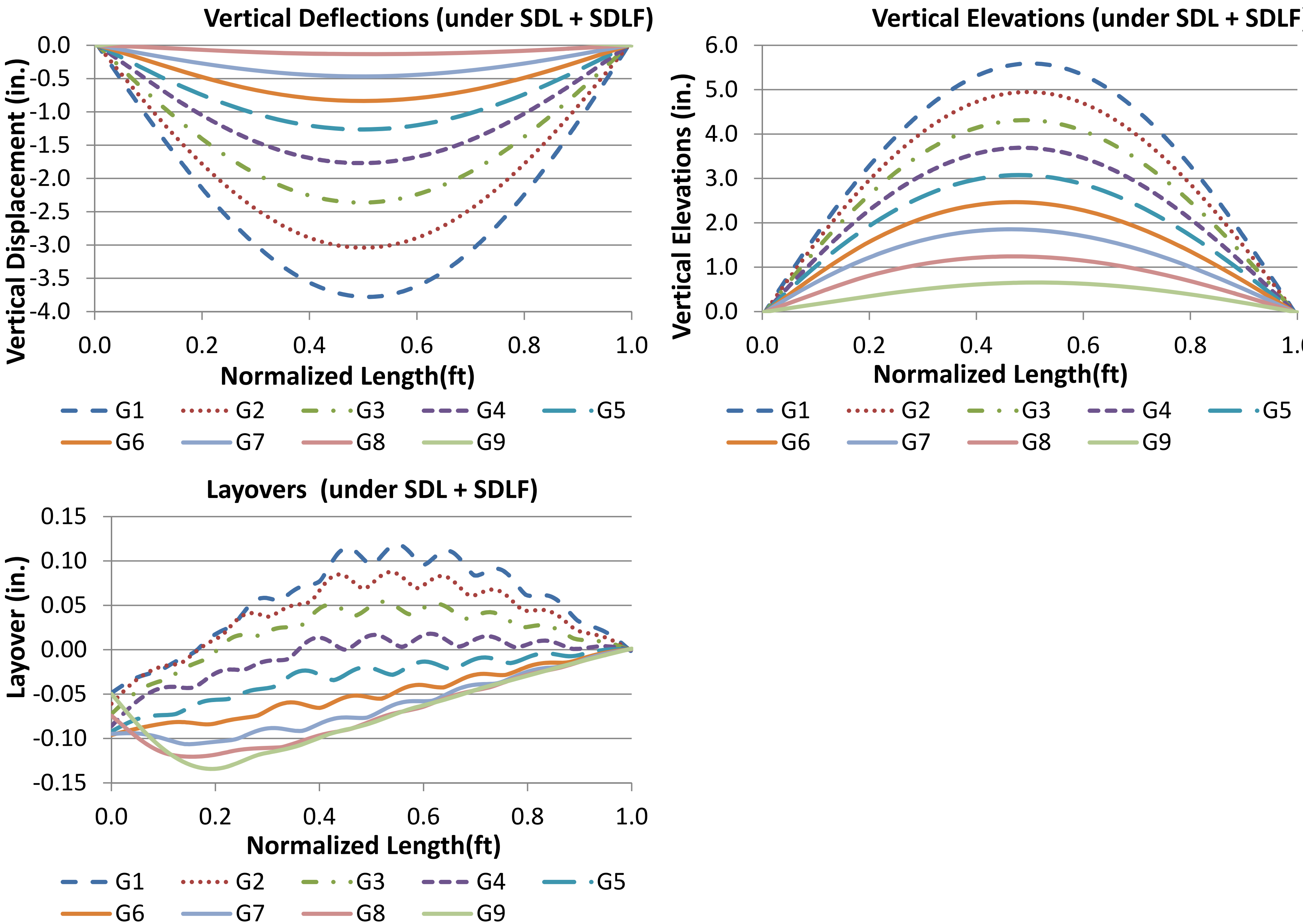


Figure O2-4-4. **Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.**

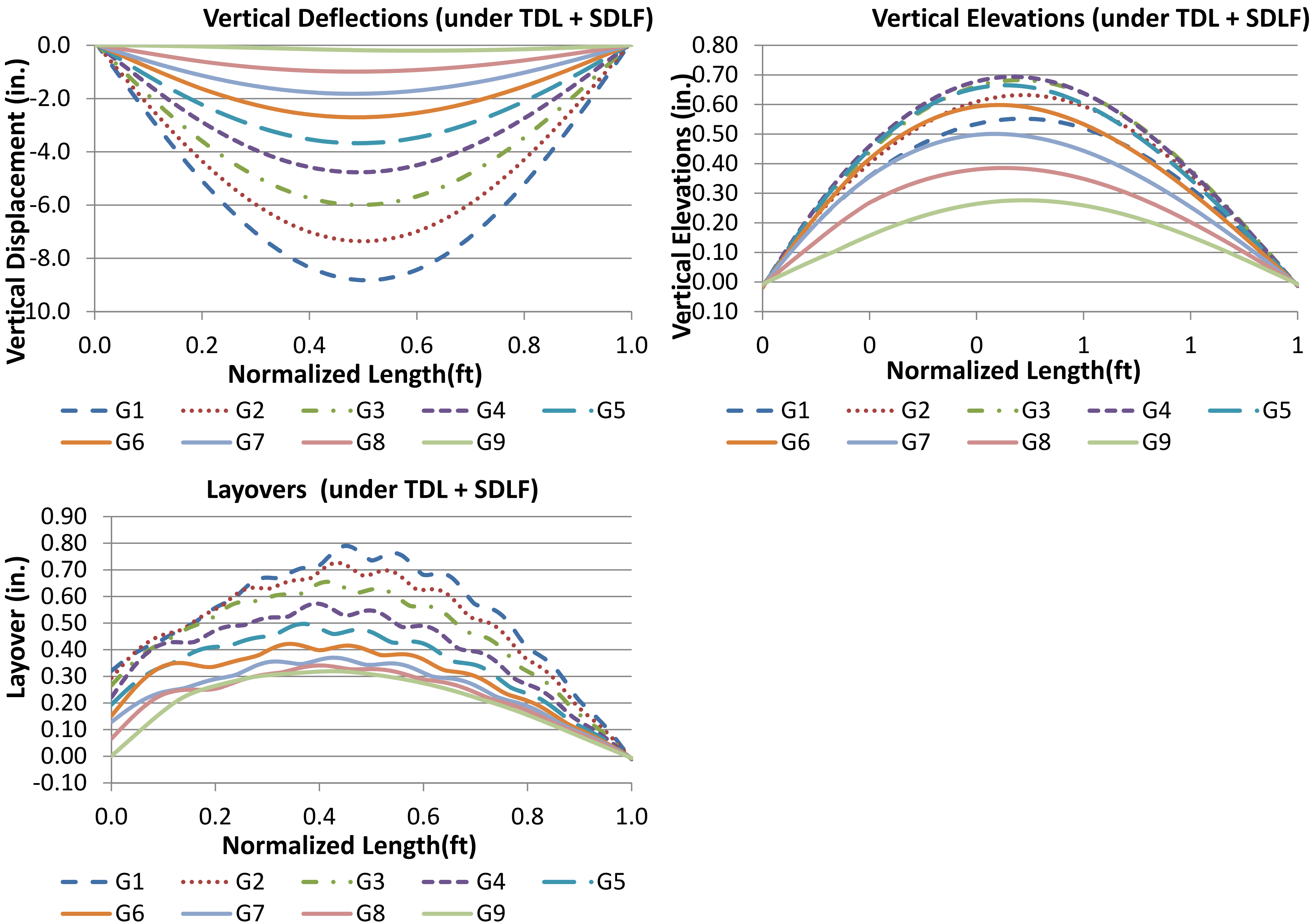


Figure O2-4-5. **Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.**

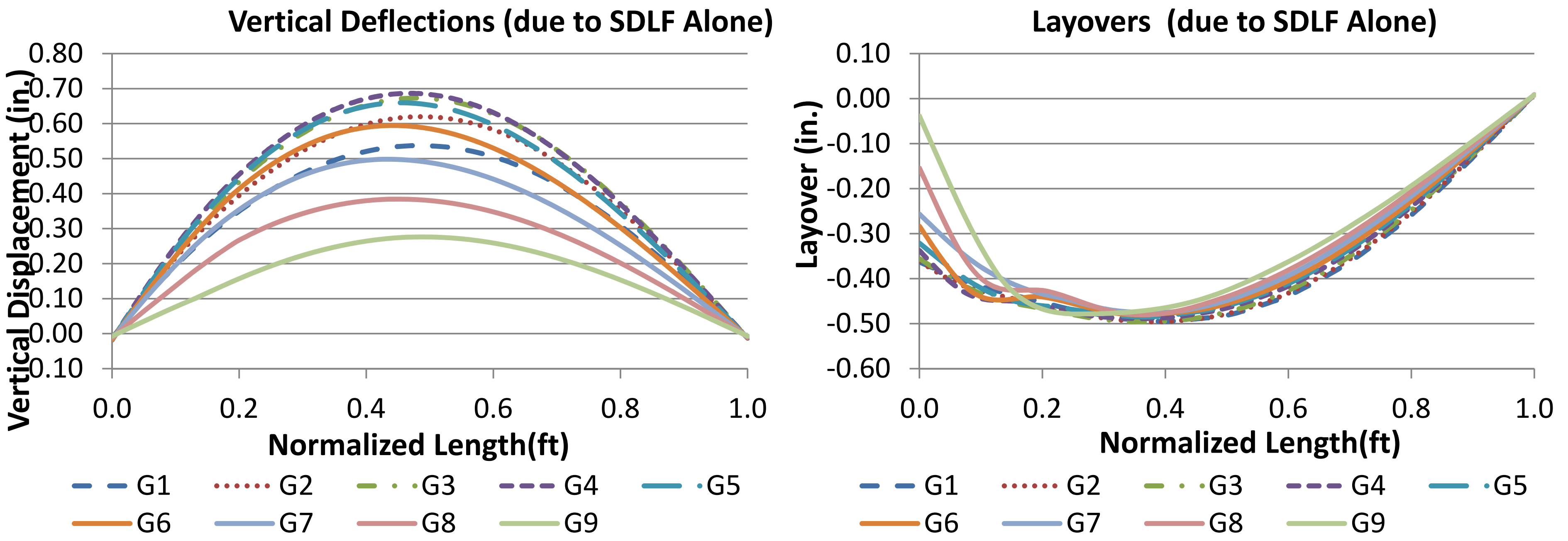


Figure O2-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

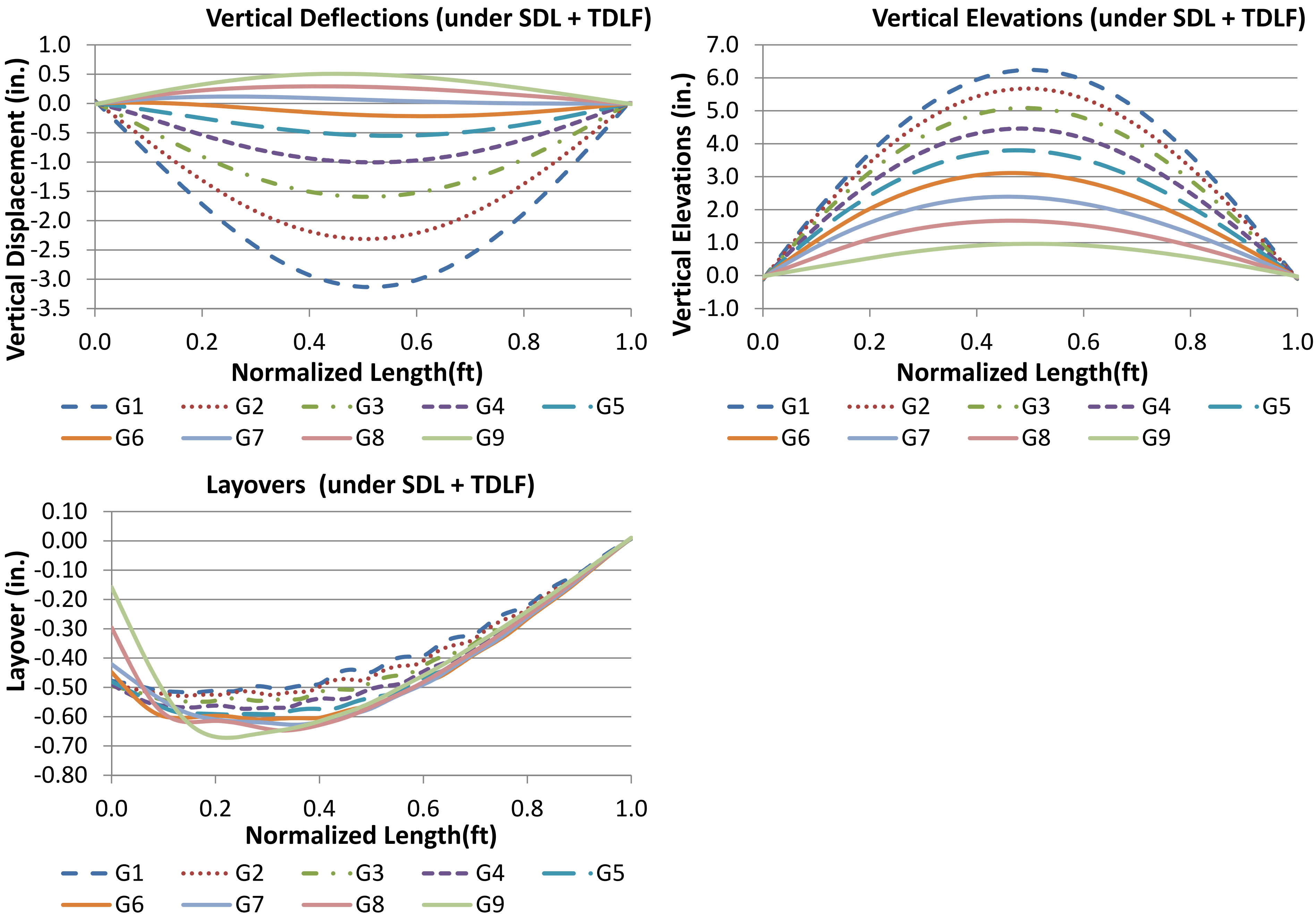


Figure O2-4-7. **Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.**

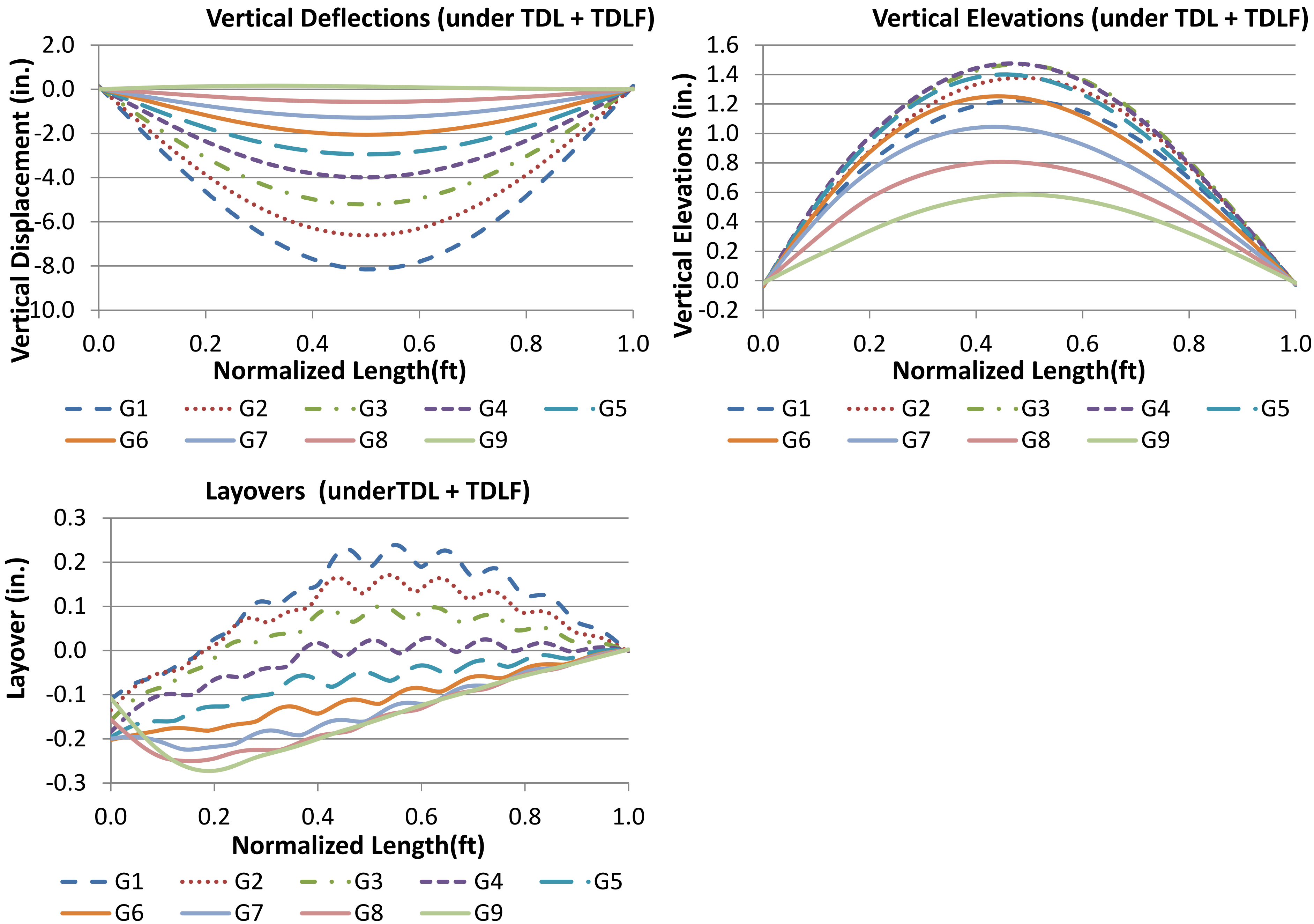
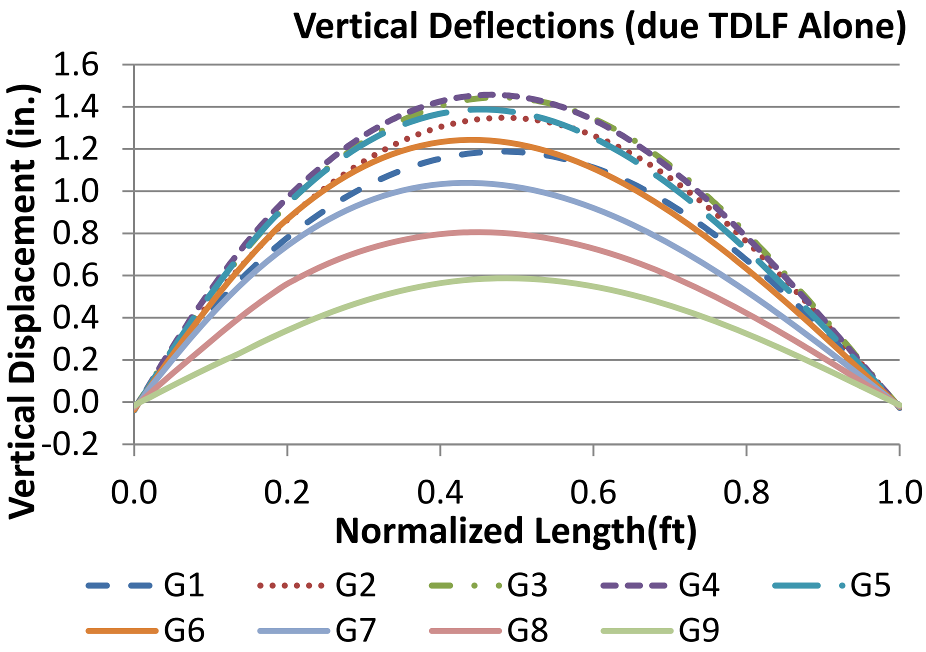


Figure O2-4-8. **Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.**



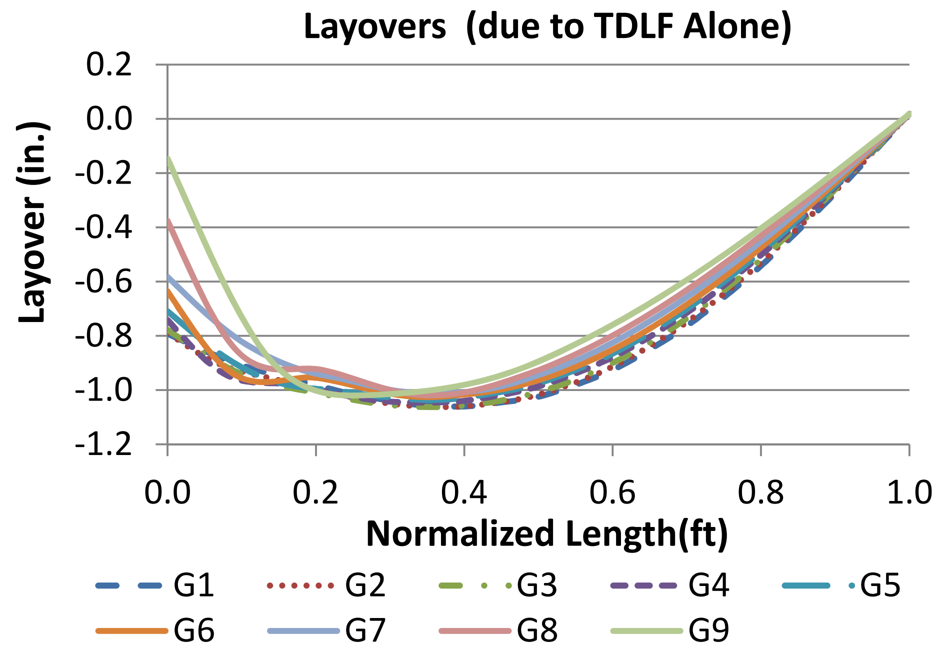


Figure O2-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

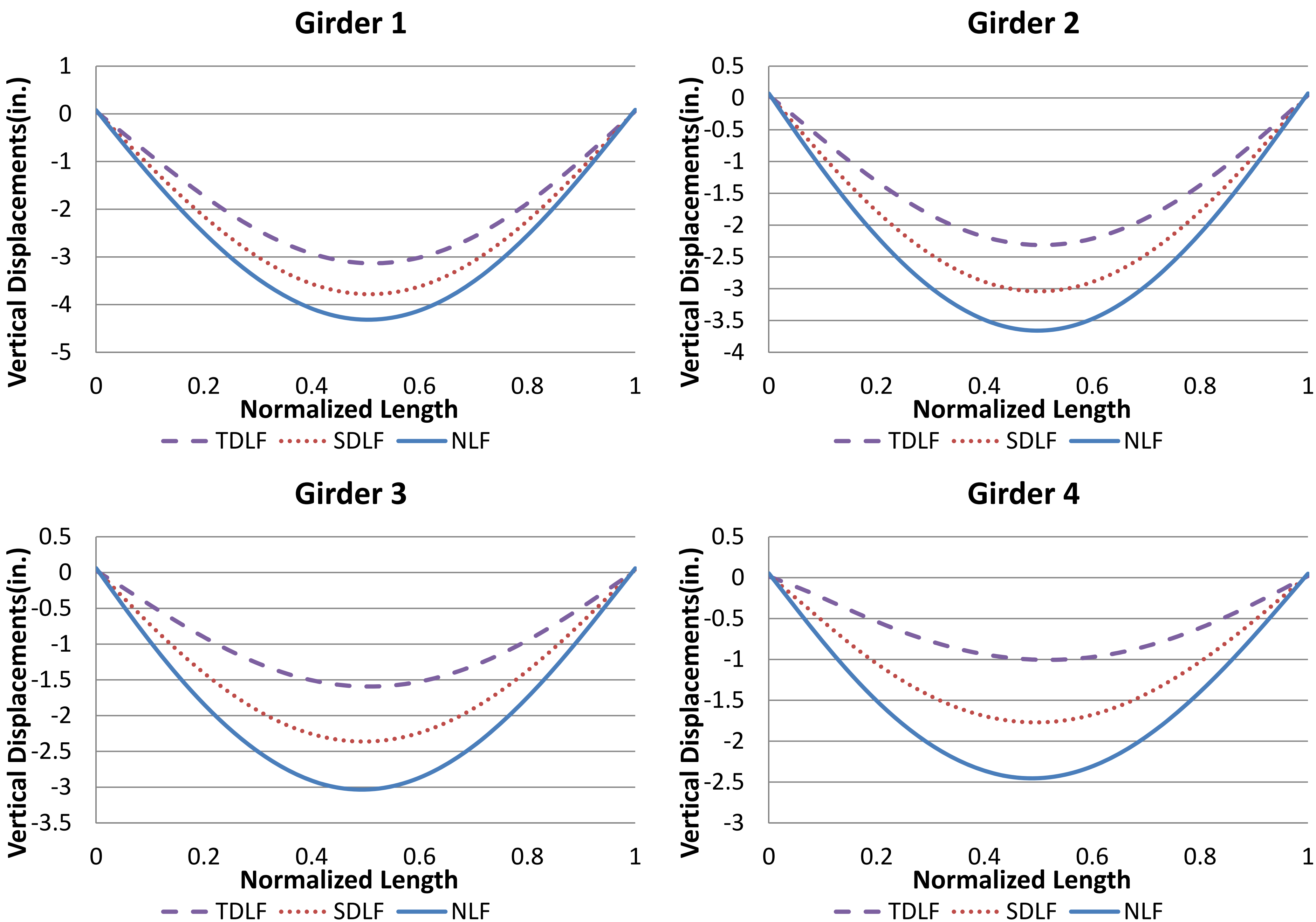


Figure O2-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

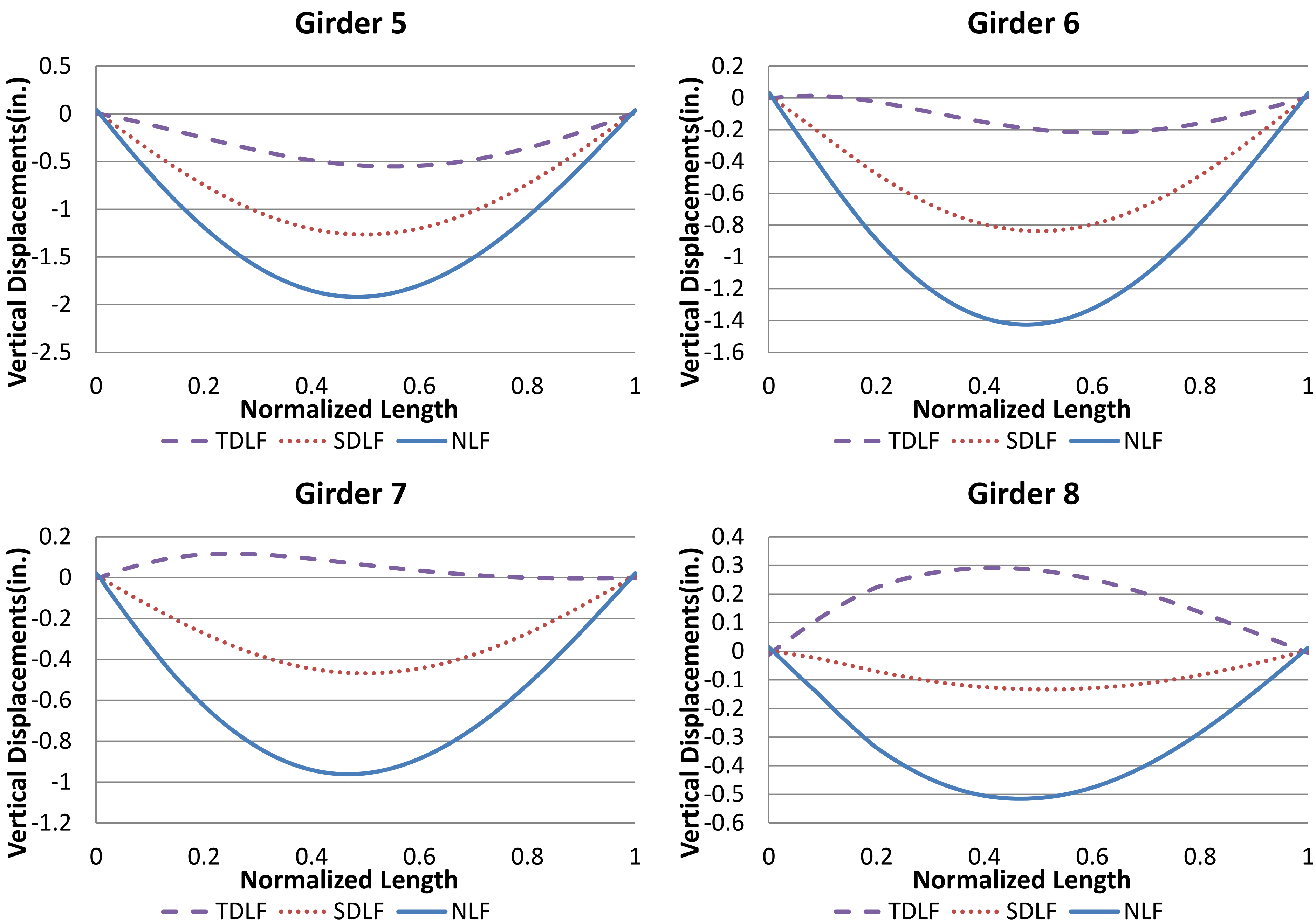


Figure O2-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

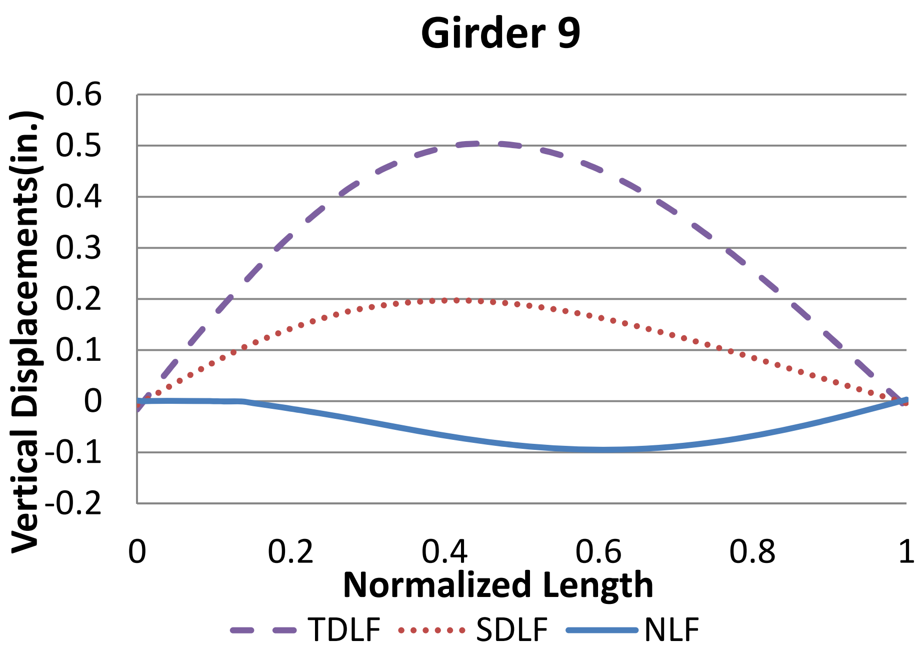


Figure O2-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

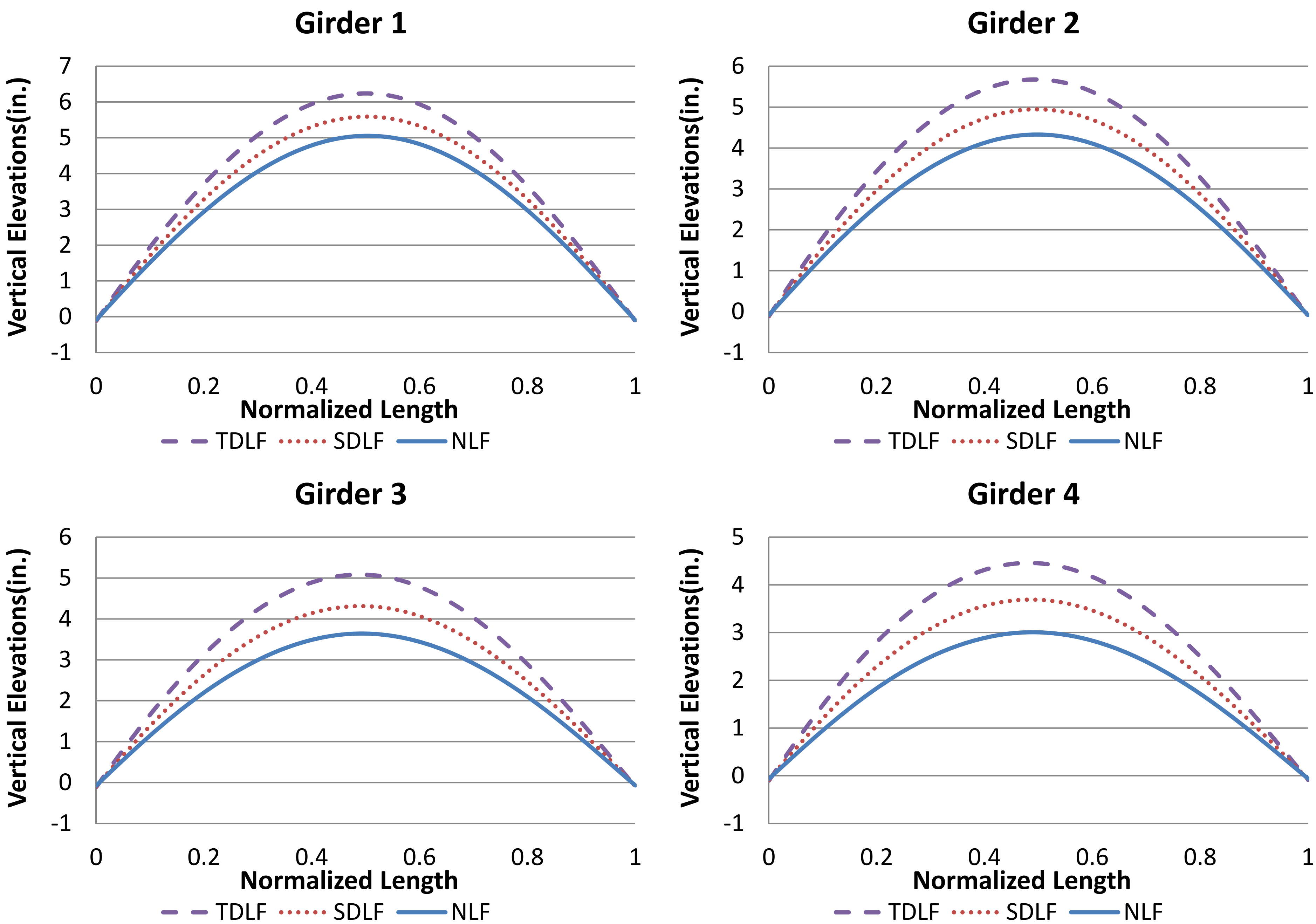


Figure O2-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

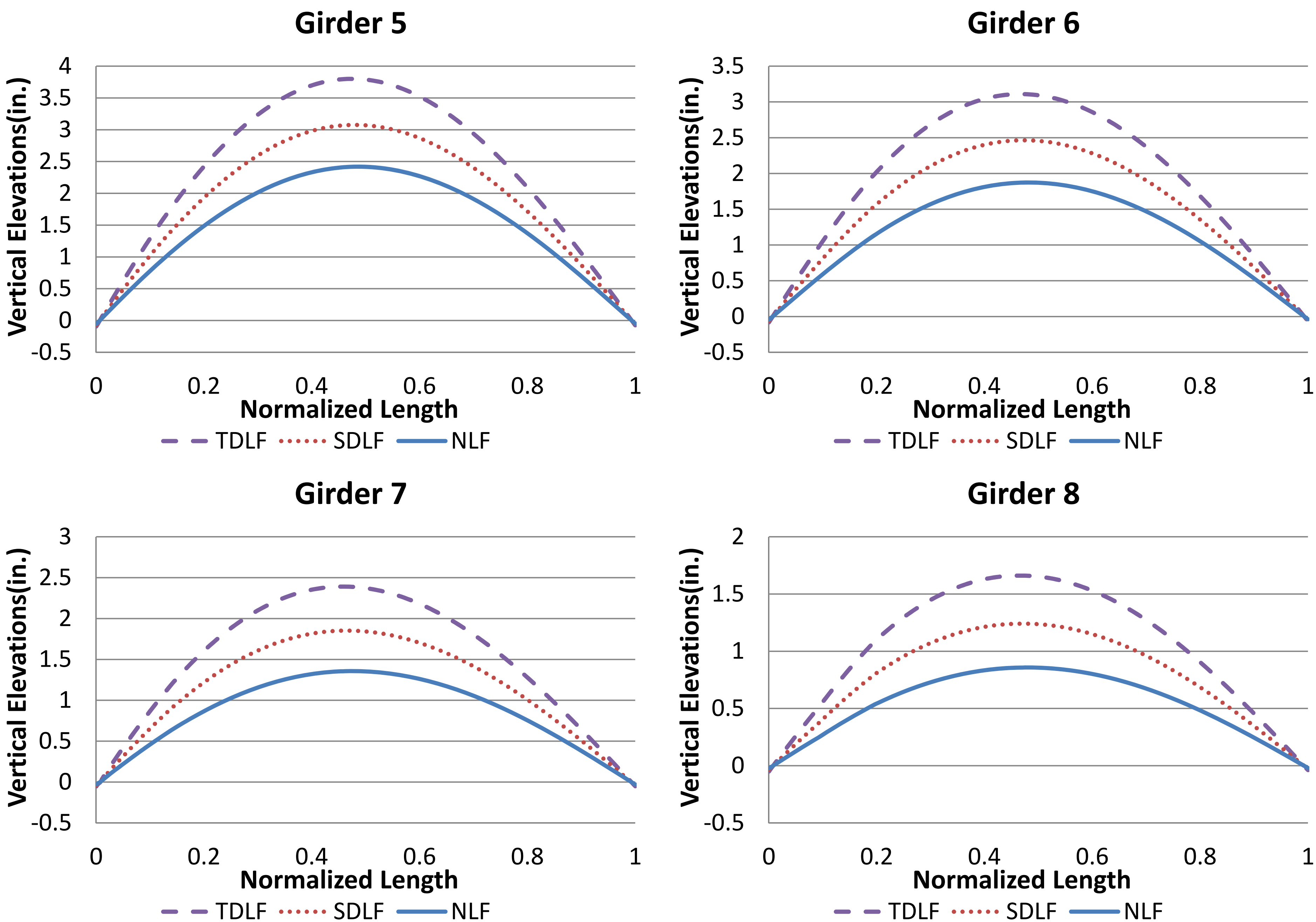


Figure O2-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

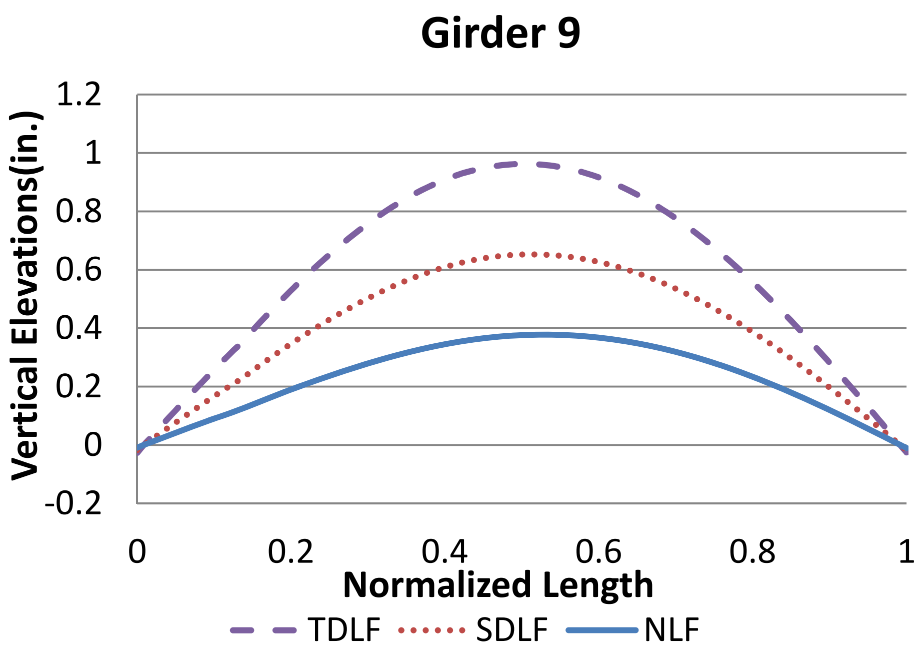


Figure O2-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

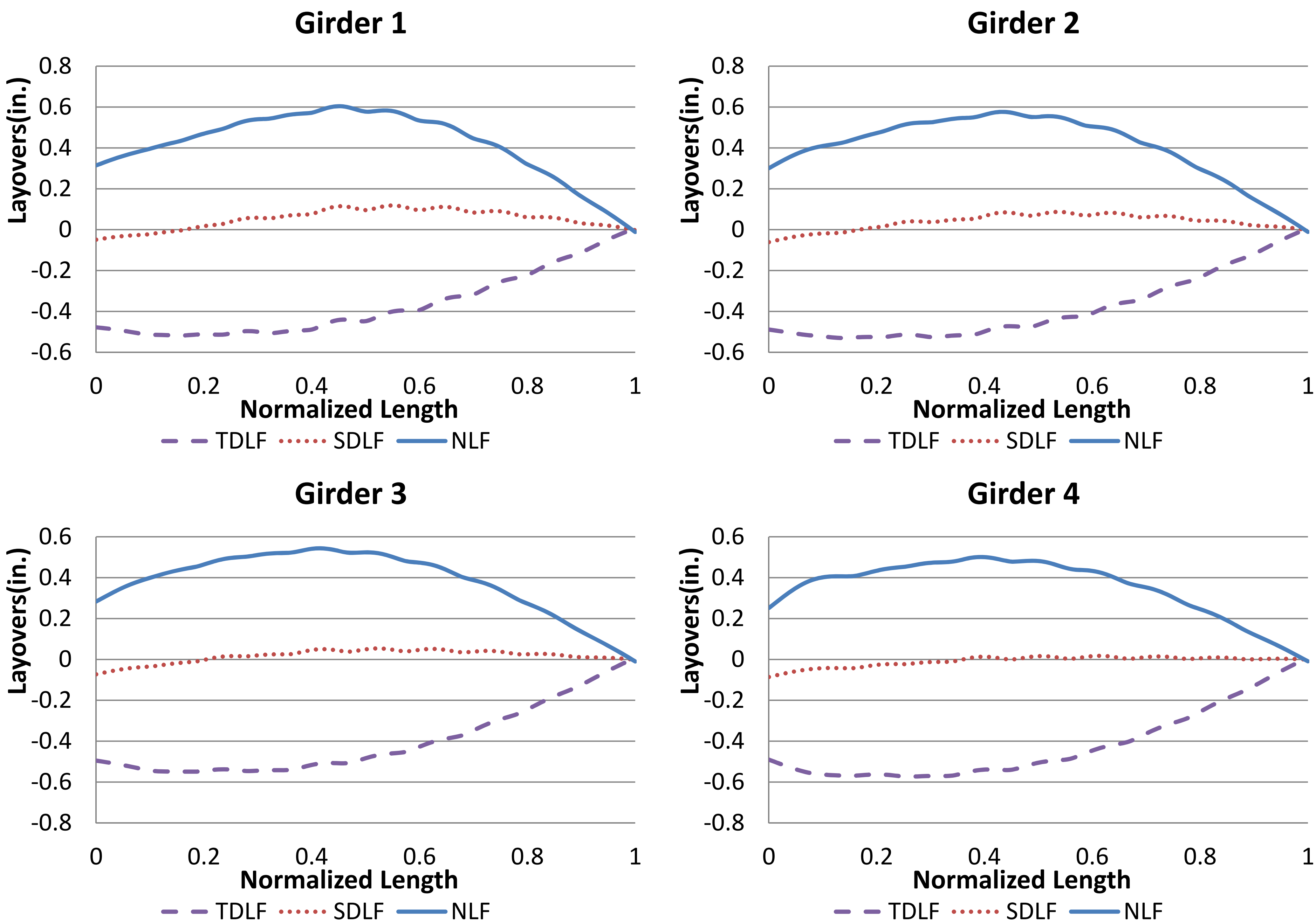


Figure O2-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

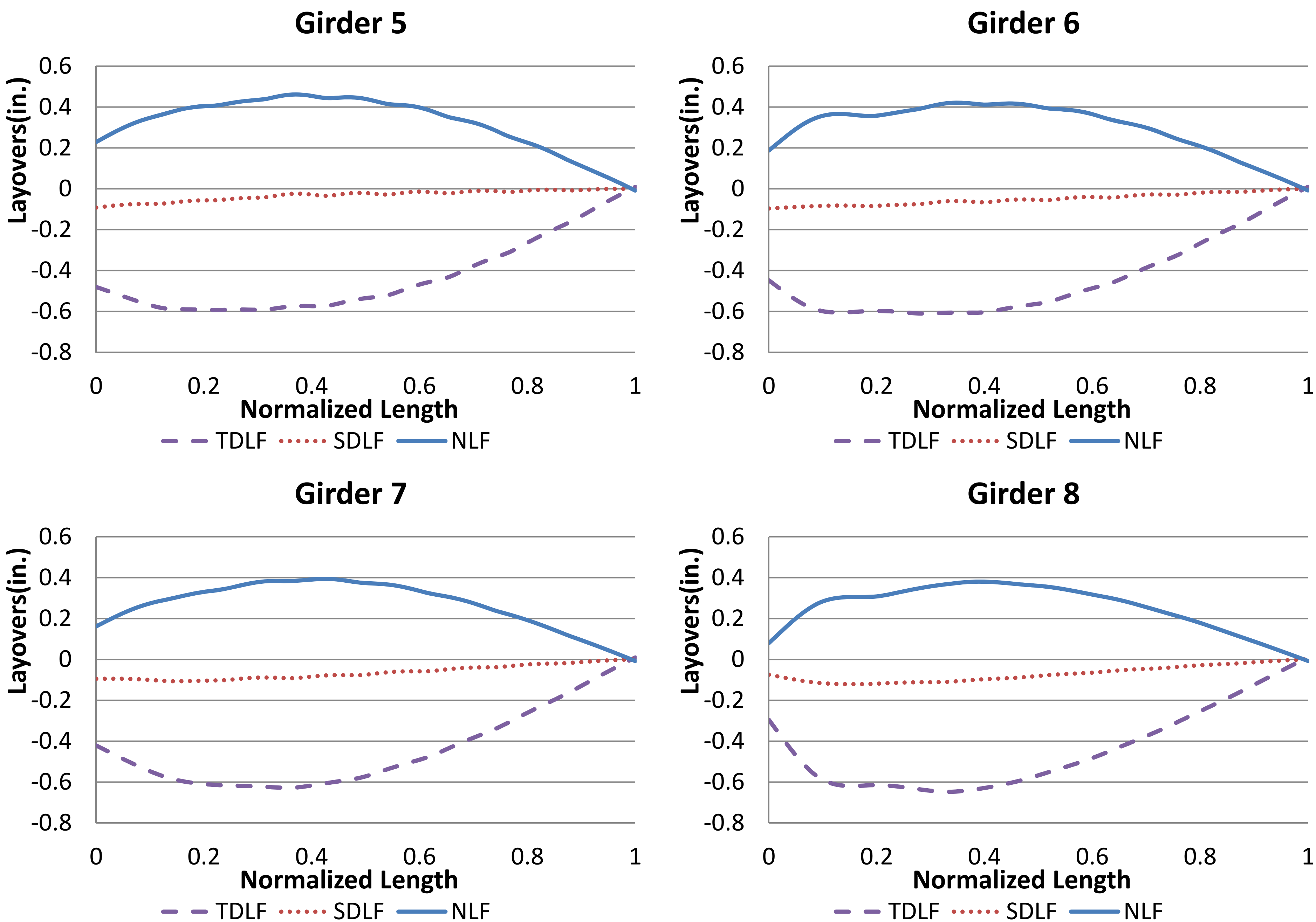


Figure O2-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

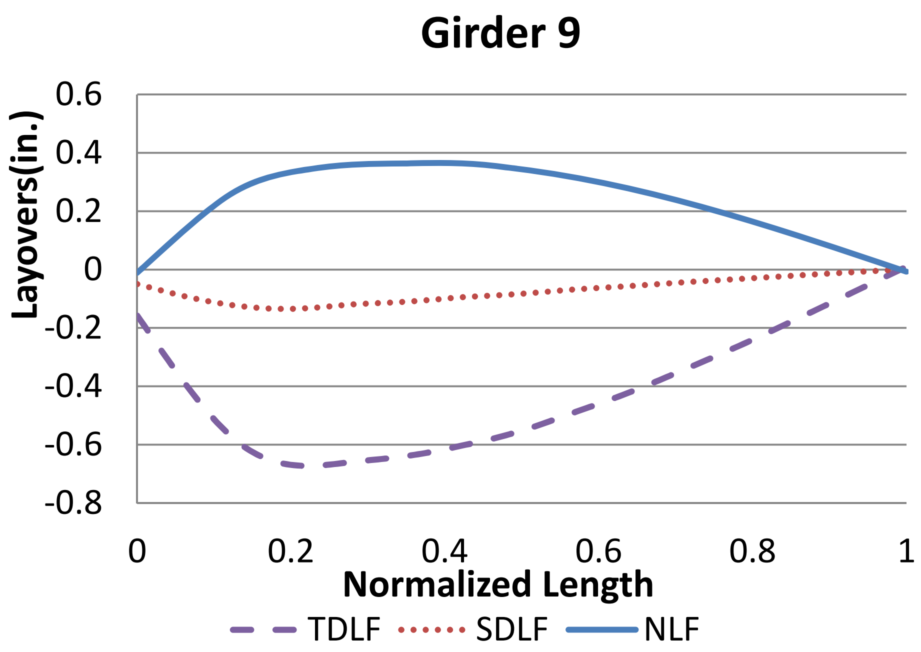


Figure O2-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

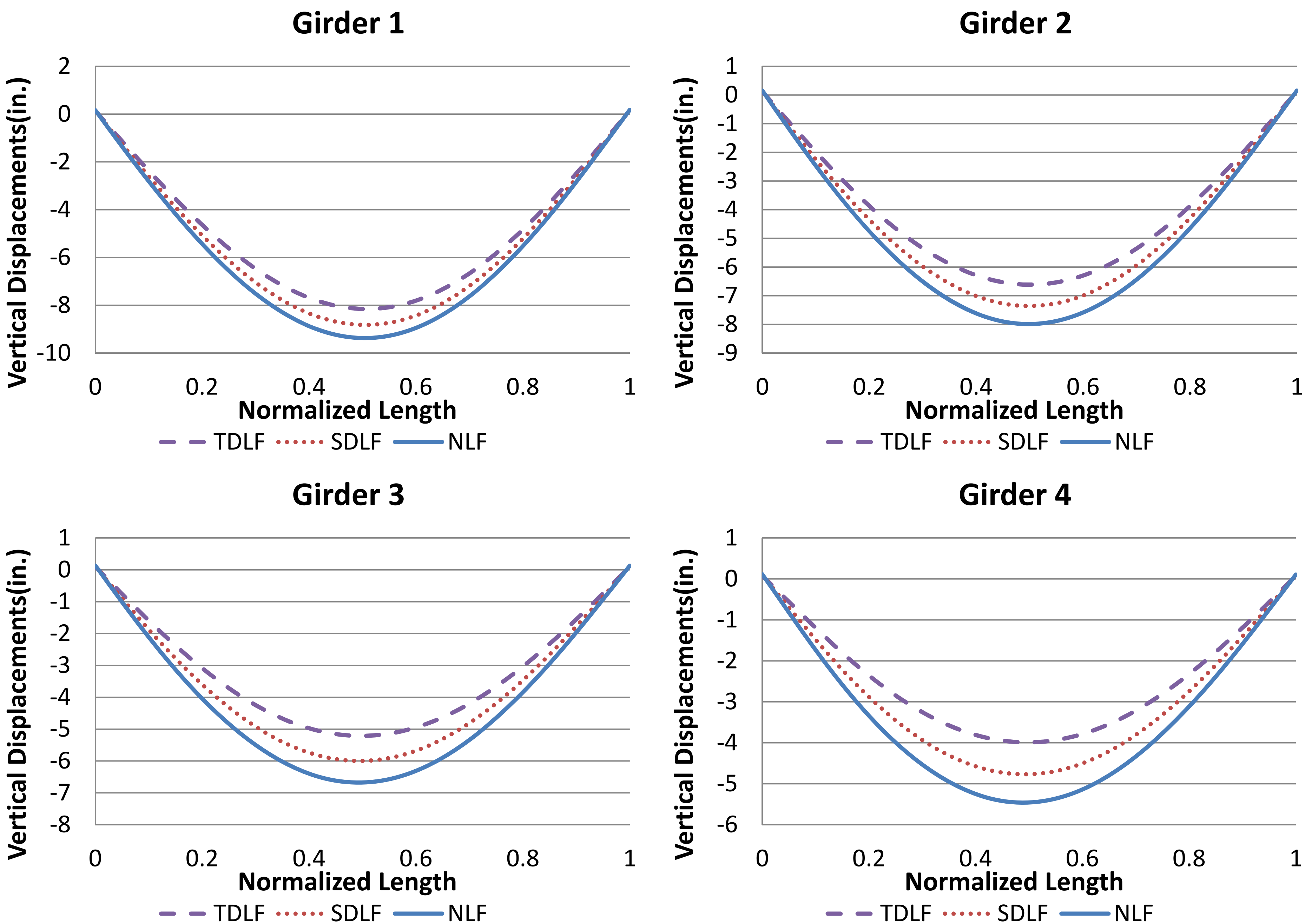


Figure O2-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

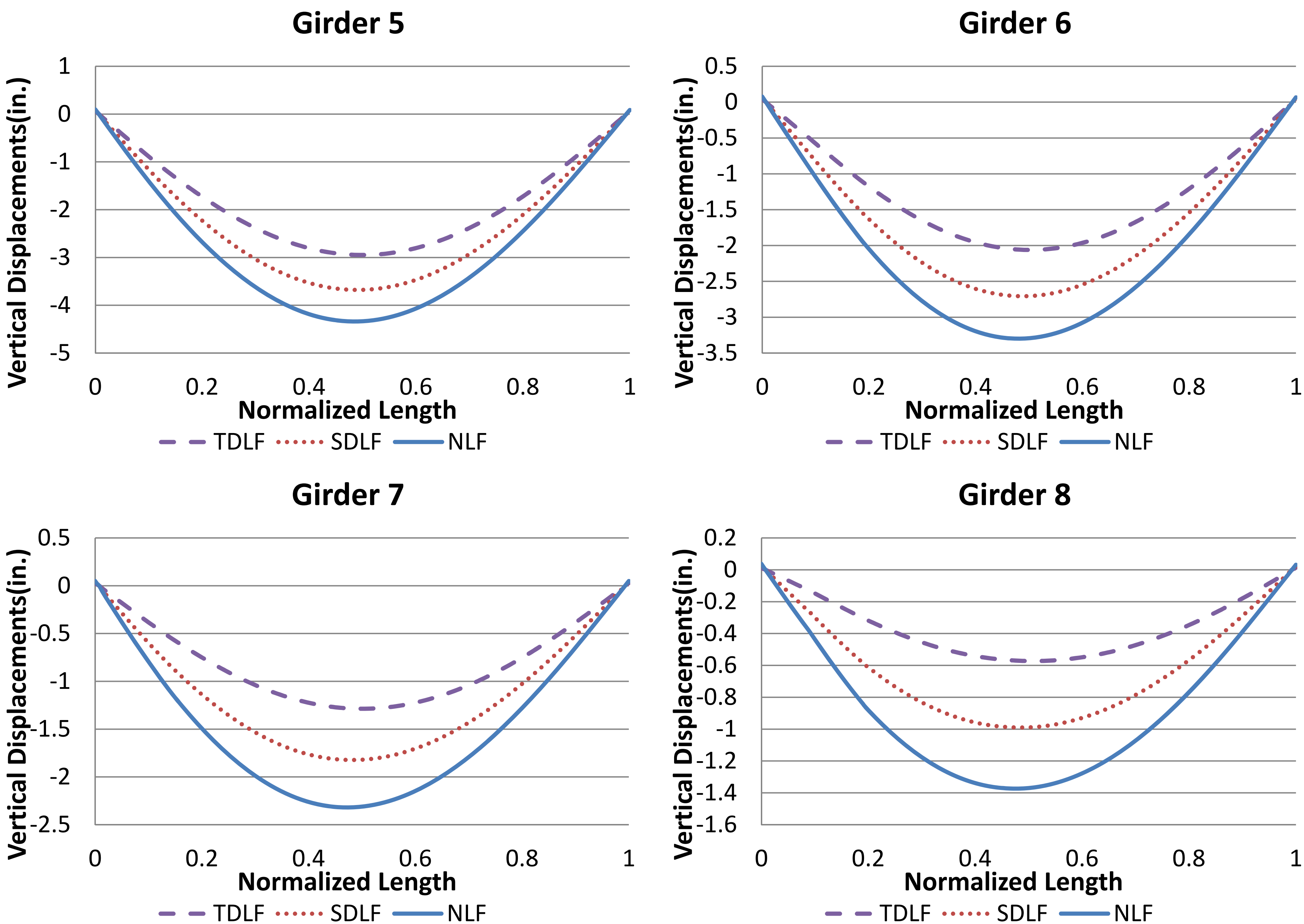


Figure O2-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

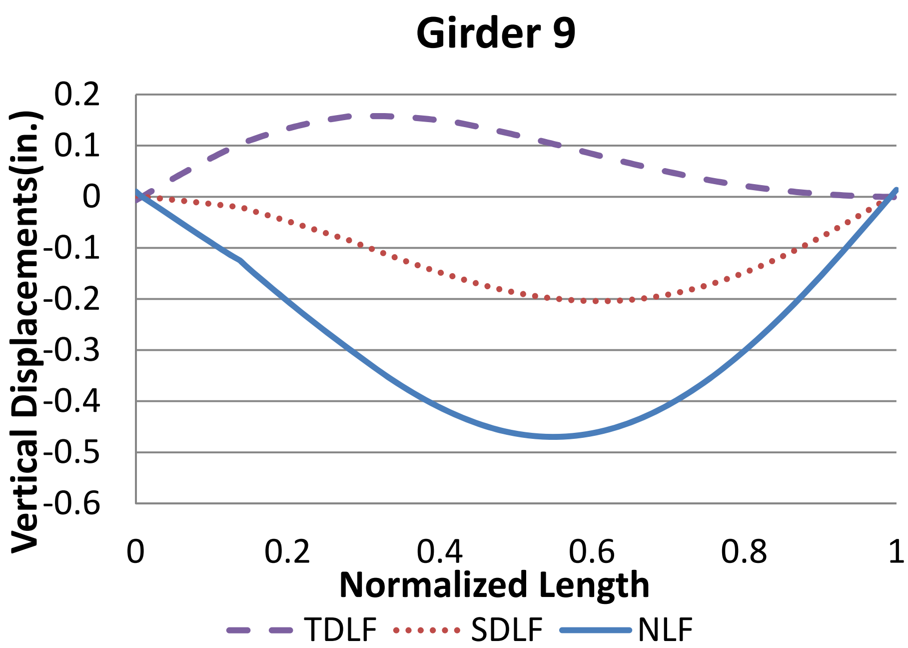


Figure O2-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

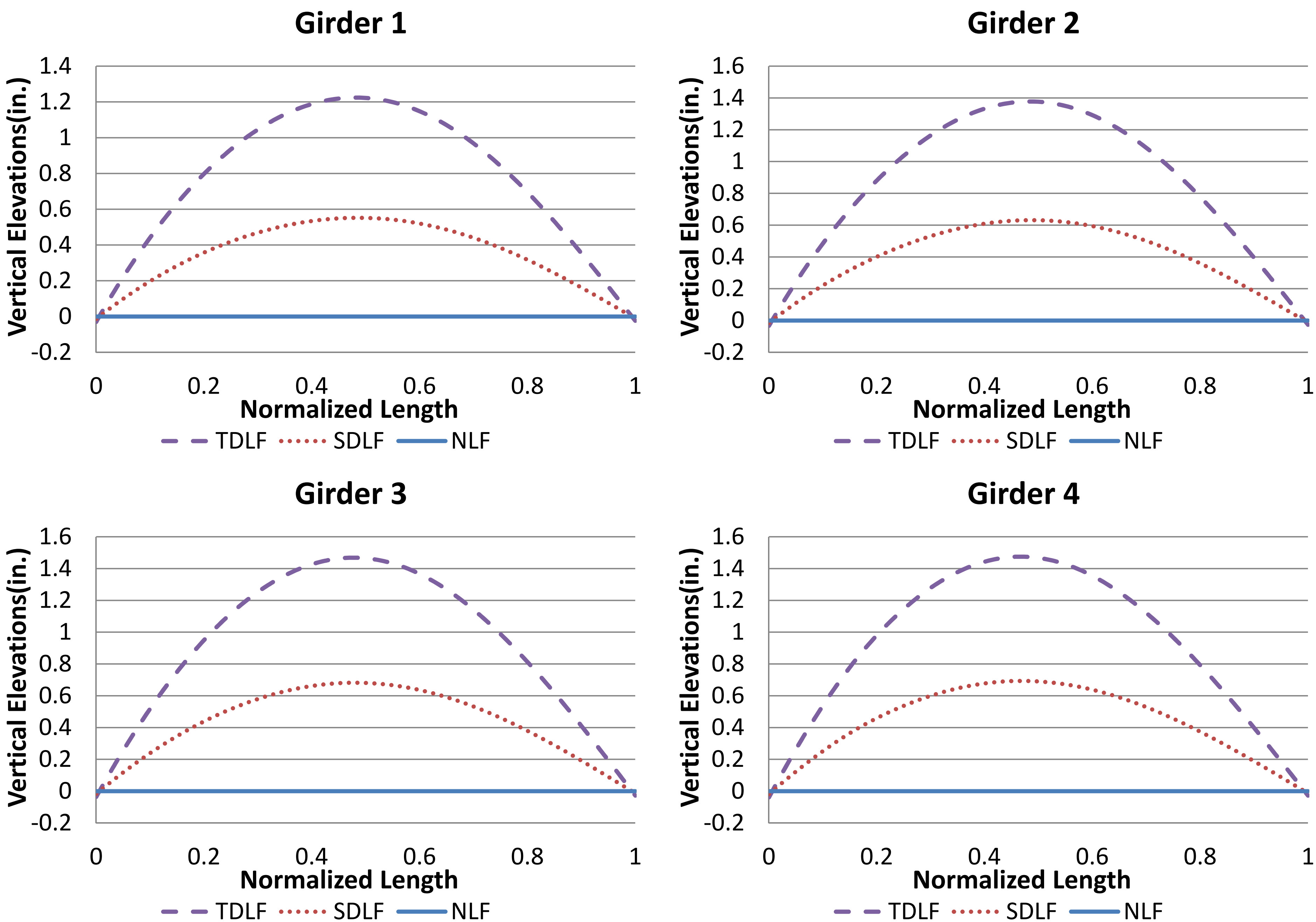


Figure O2-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

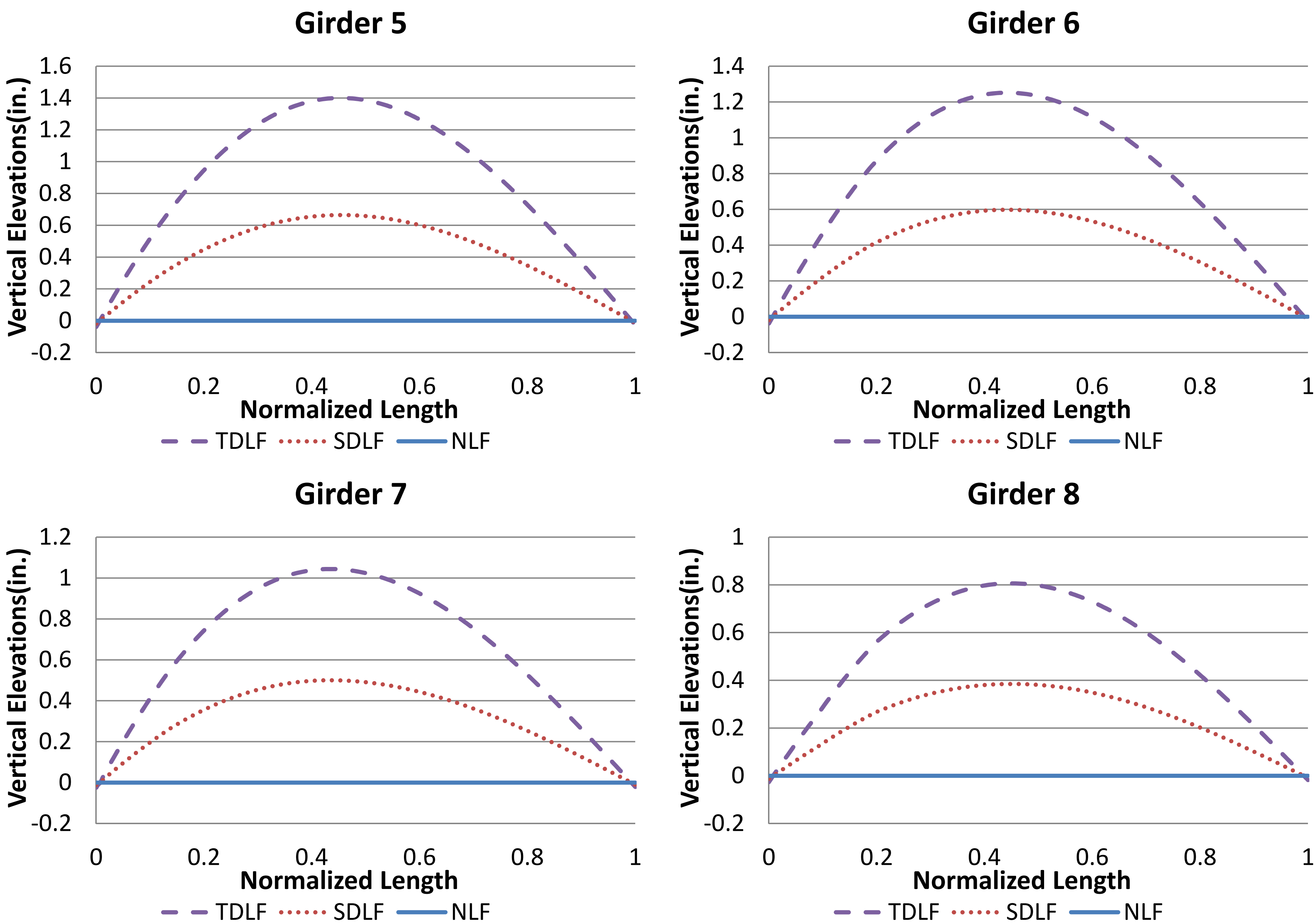


Figure O2-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

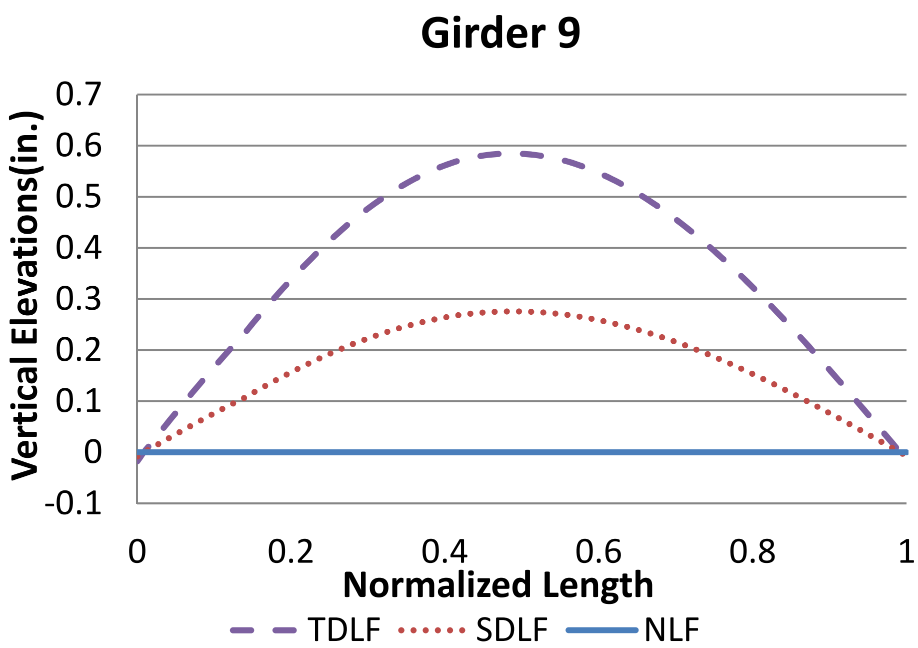


Figure O2-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

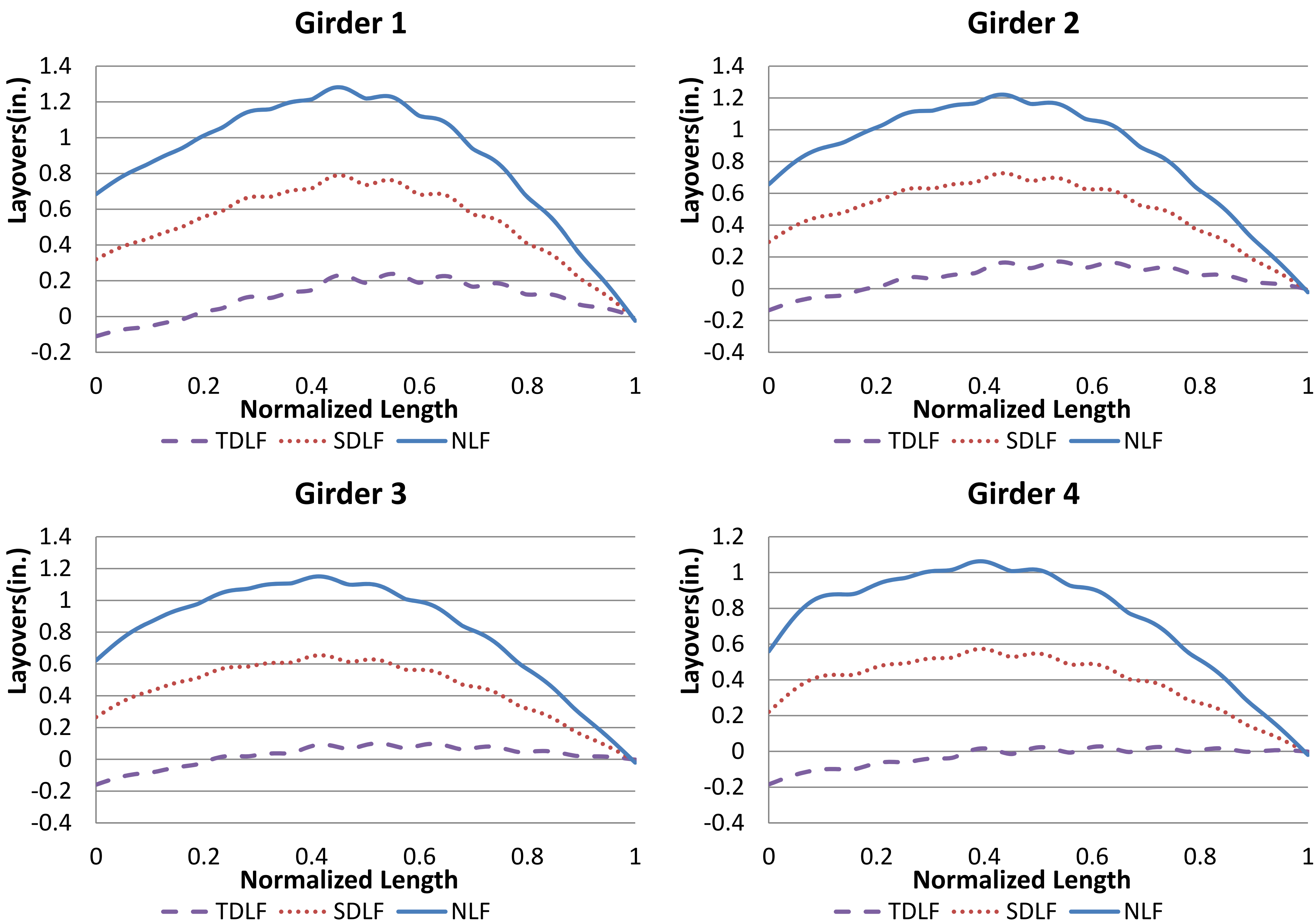


Figure O2-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

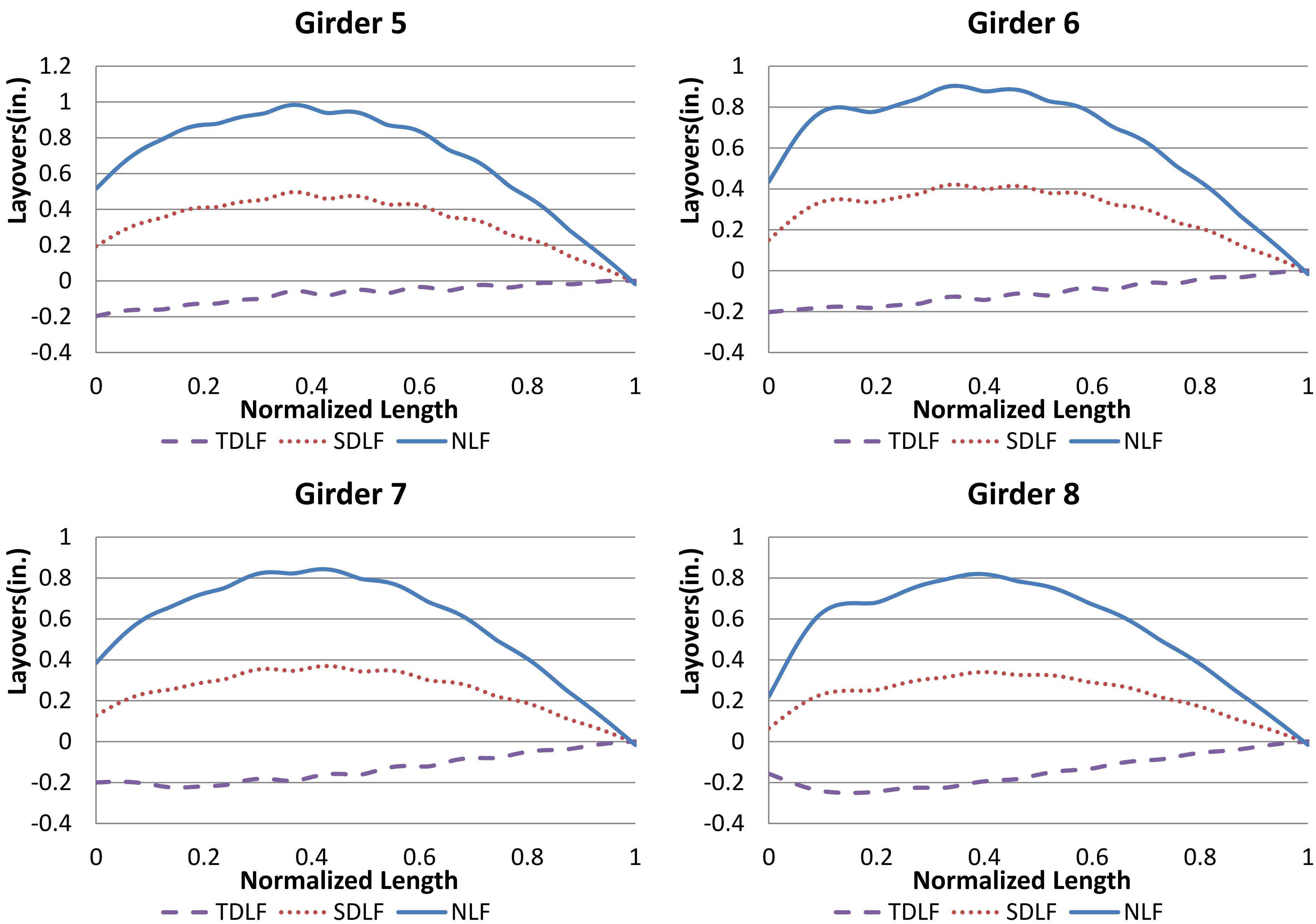


Figure O2-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

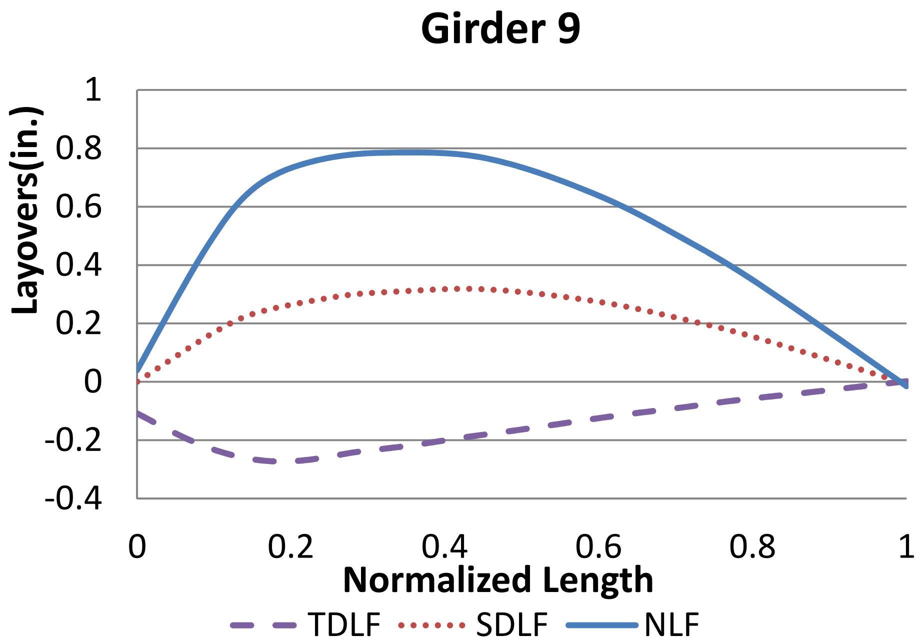


Figure O2-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

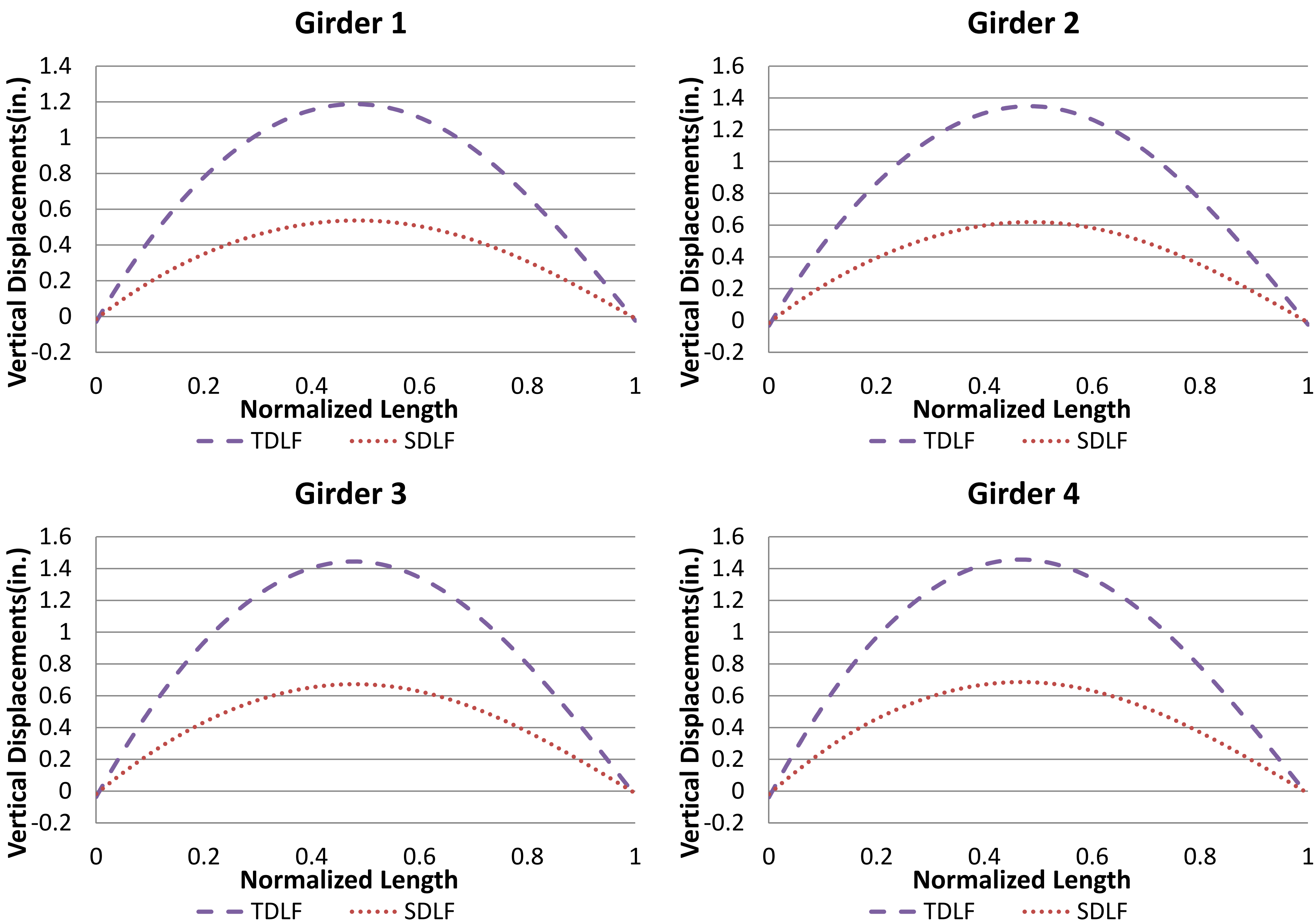


Figure O2-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

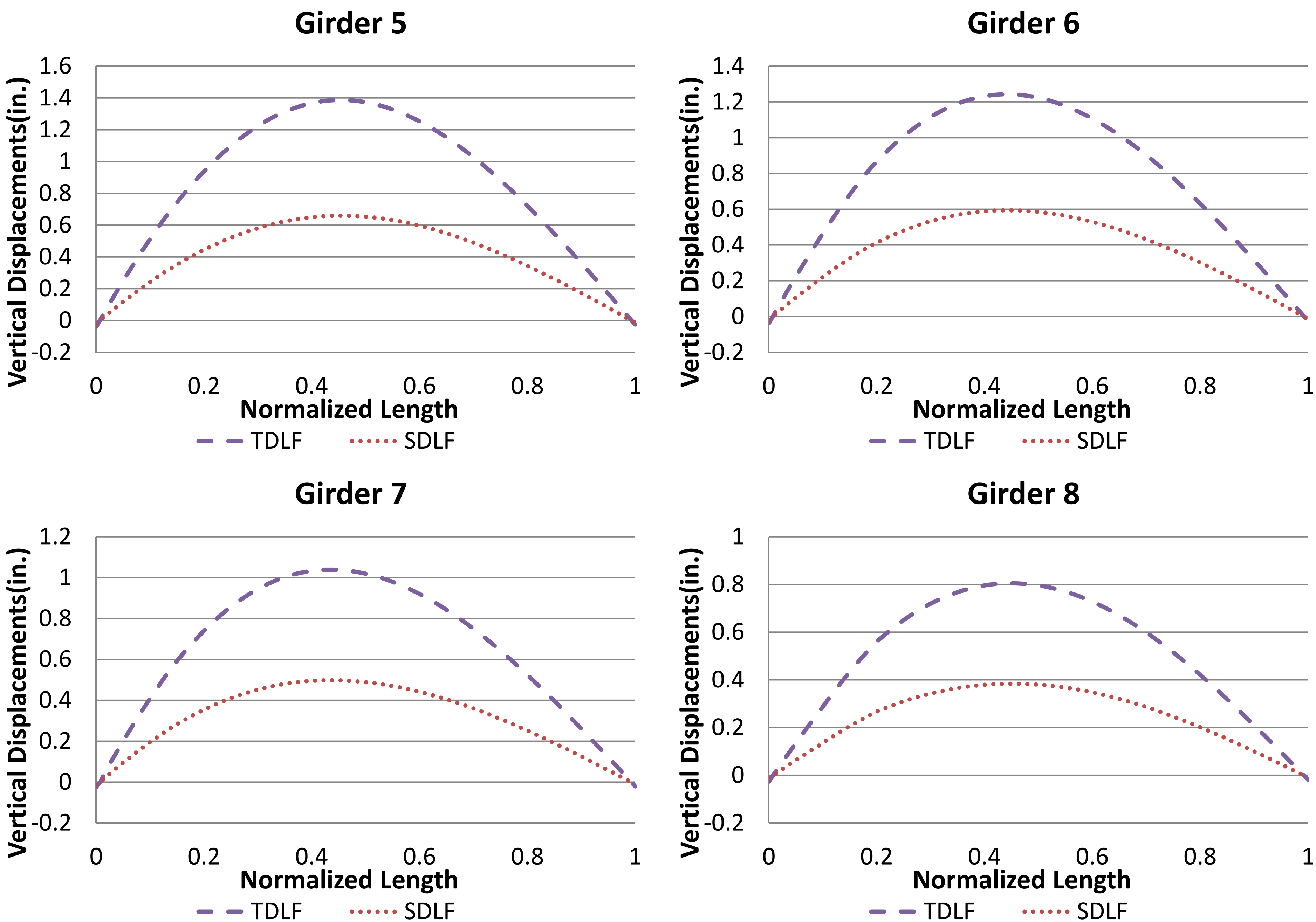


Figure O2-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

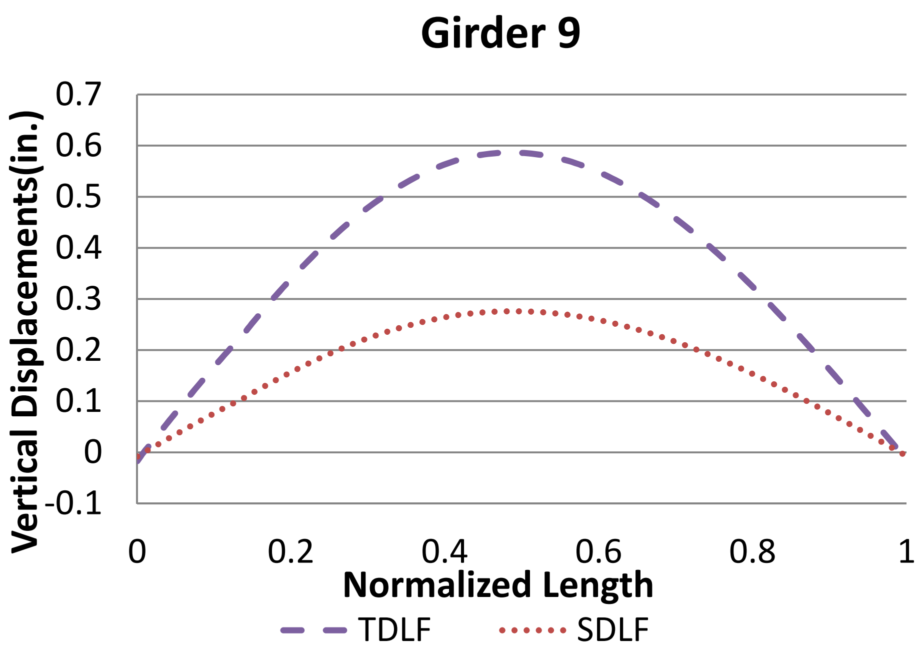


Figure O2-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

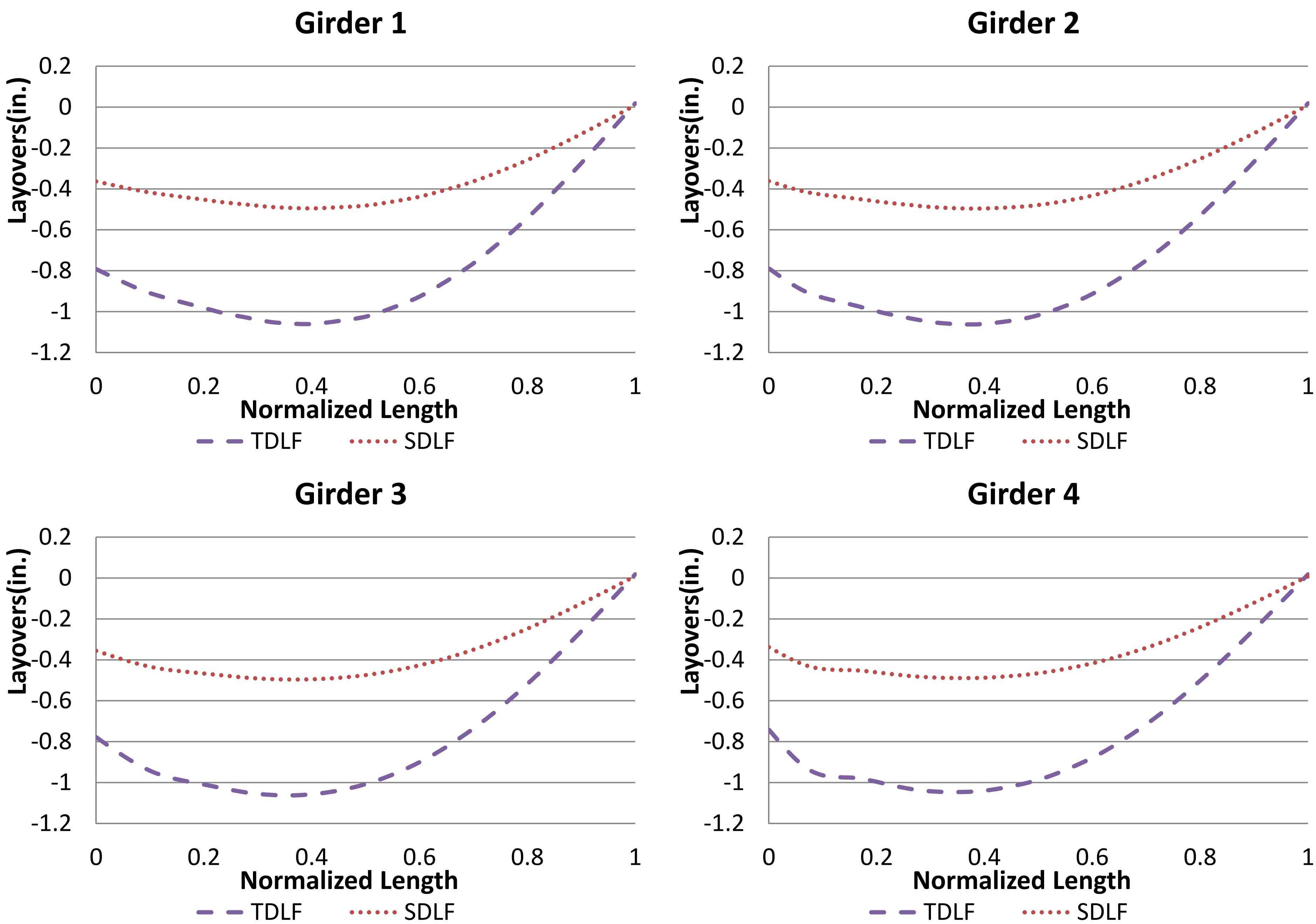


Figure O2-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

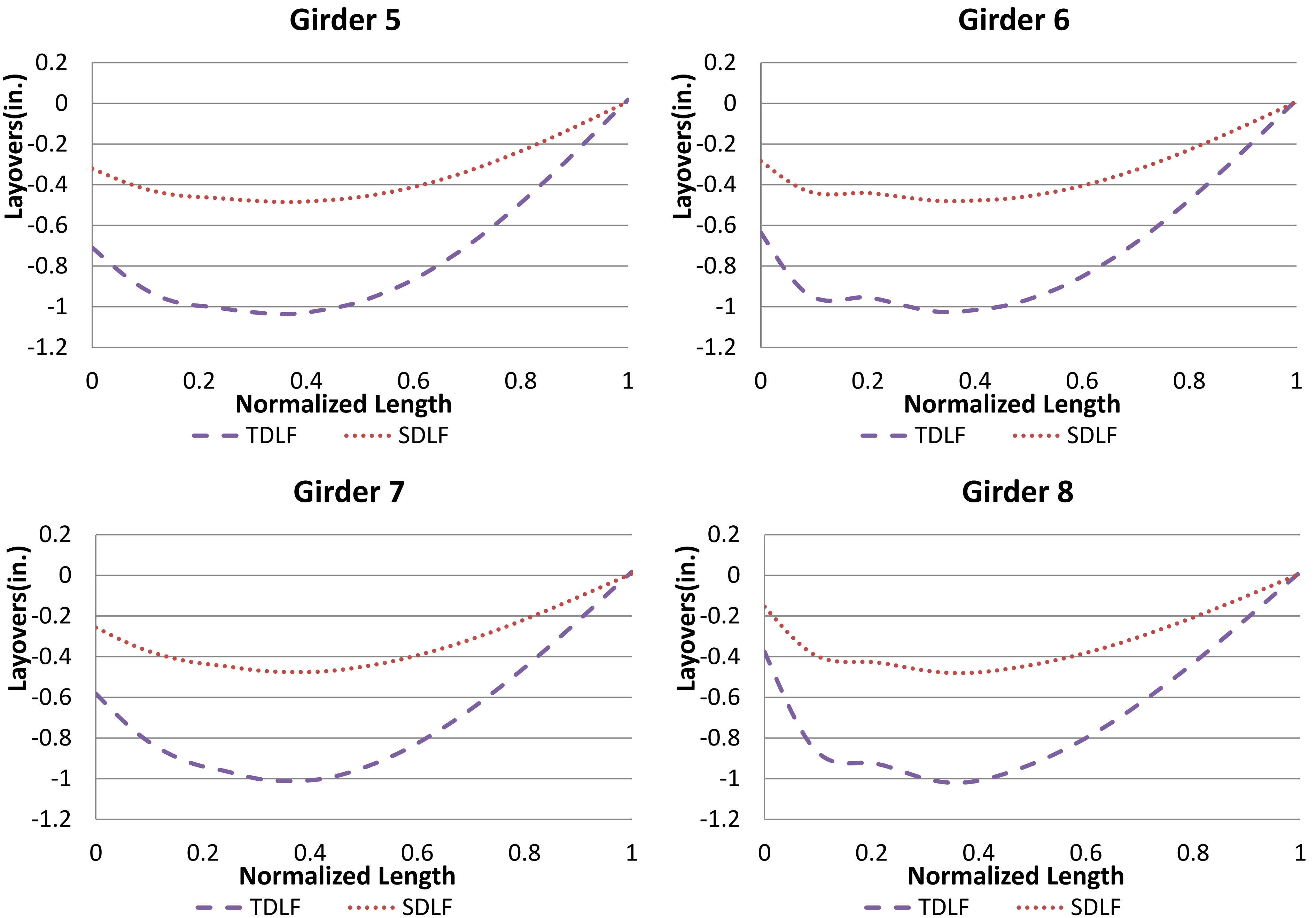


Figure O2-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

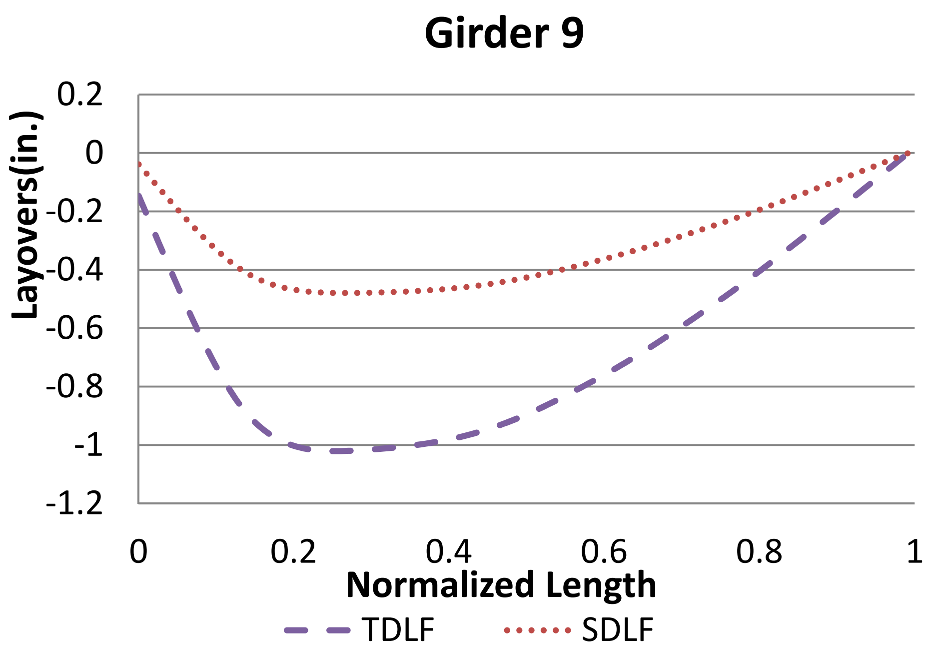


Figure O2-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

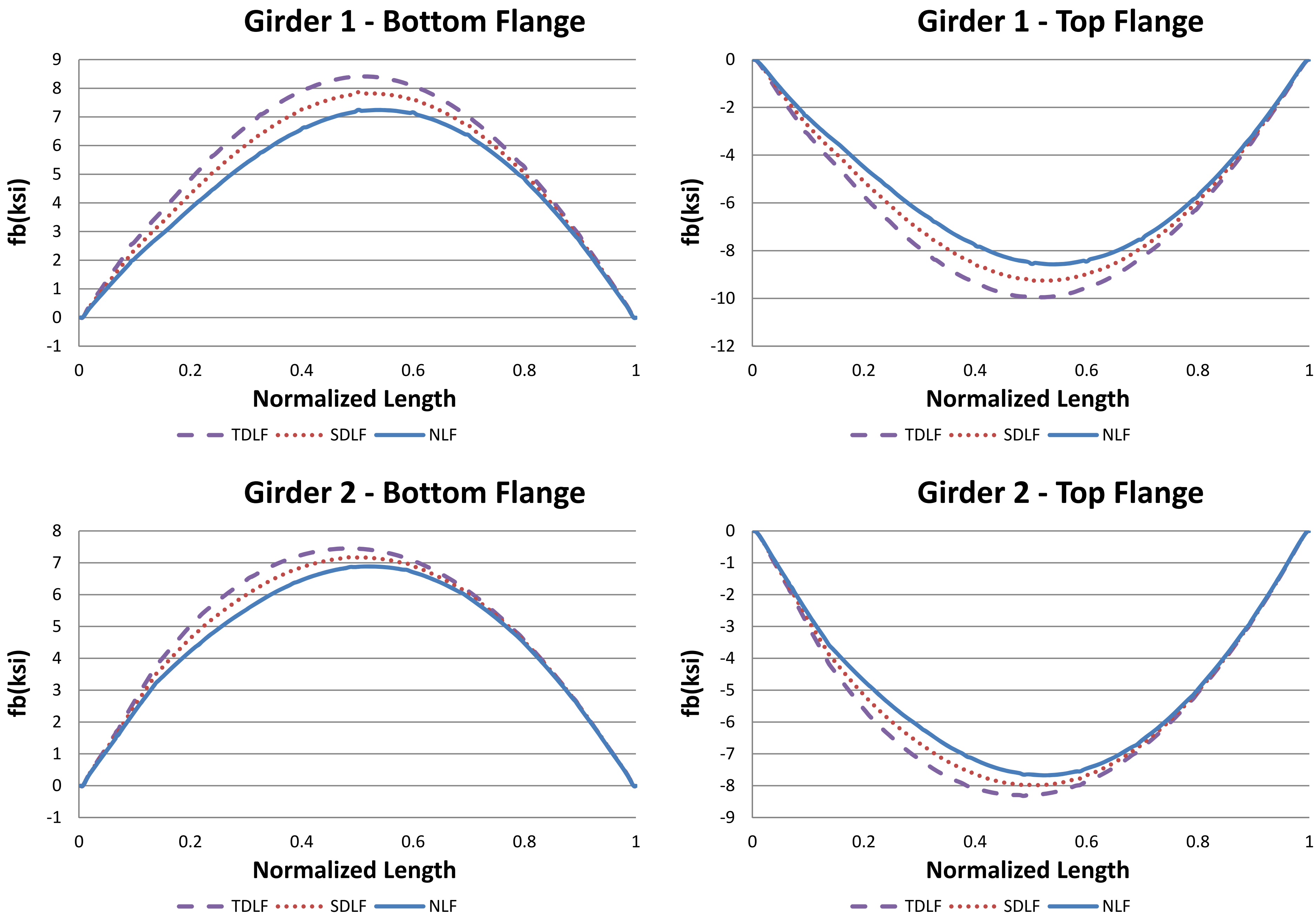


Figure O2-4-18. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

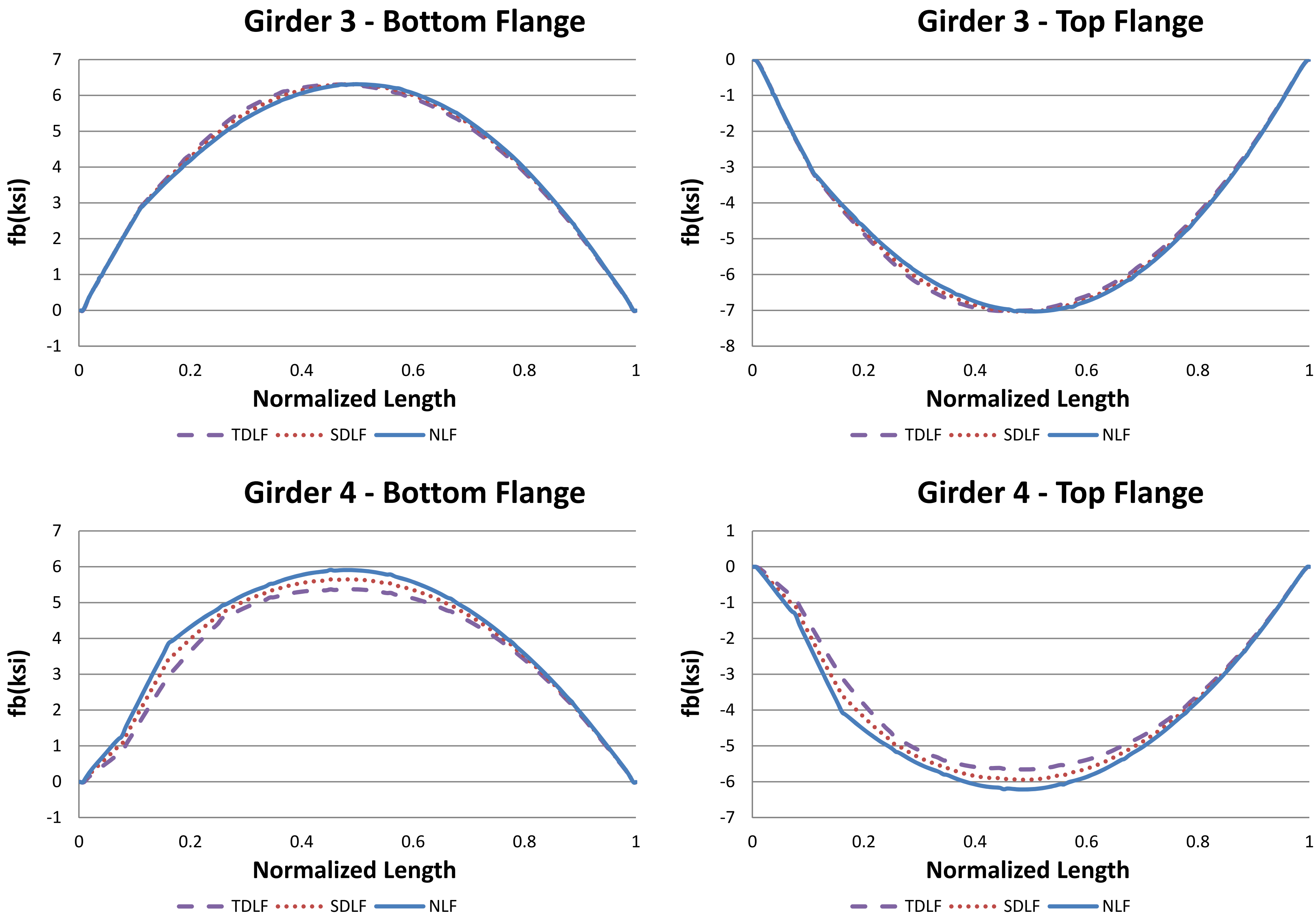


Figure O2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

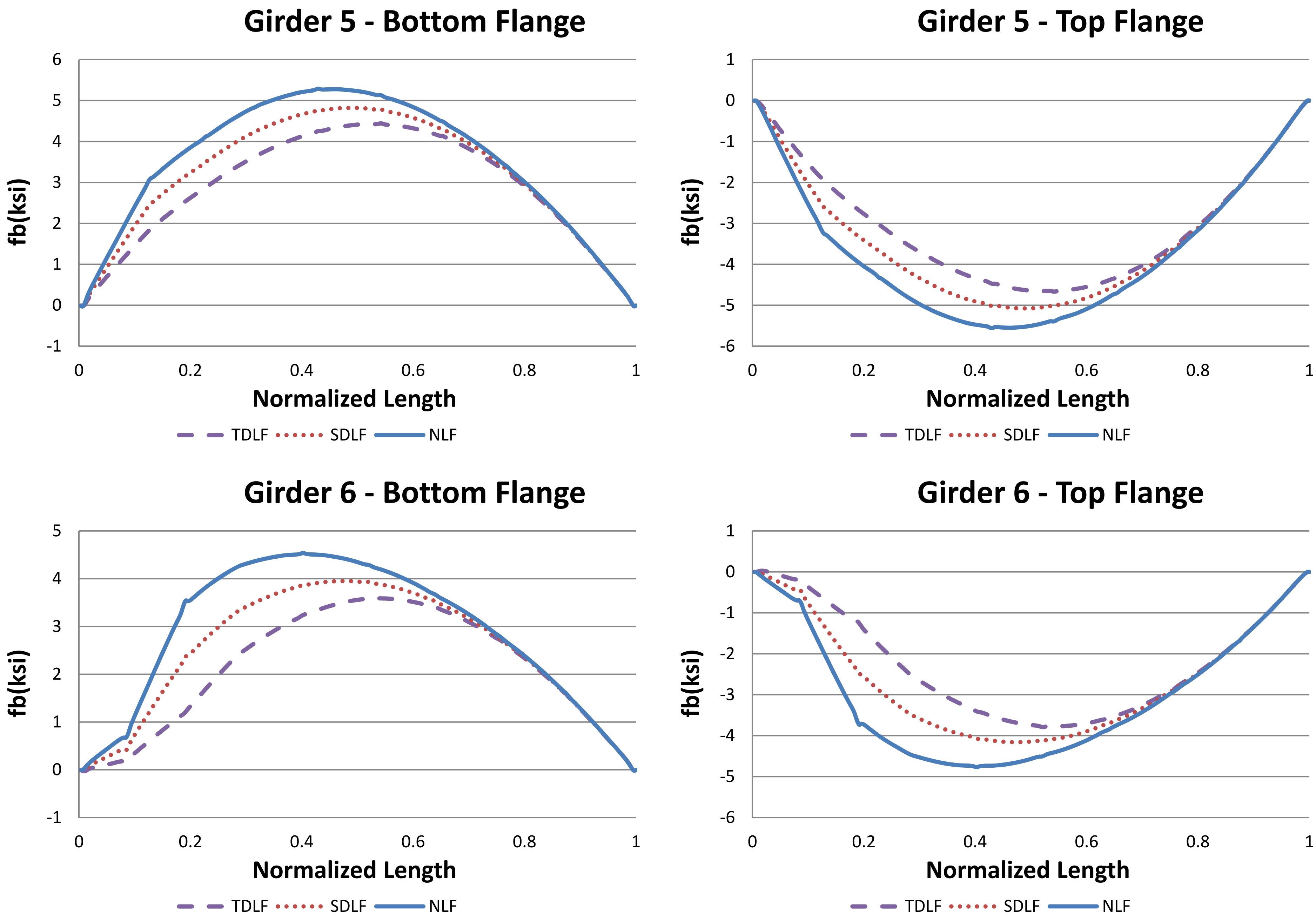


Figure O2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

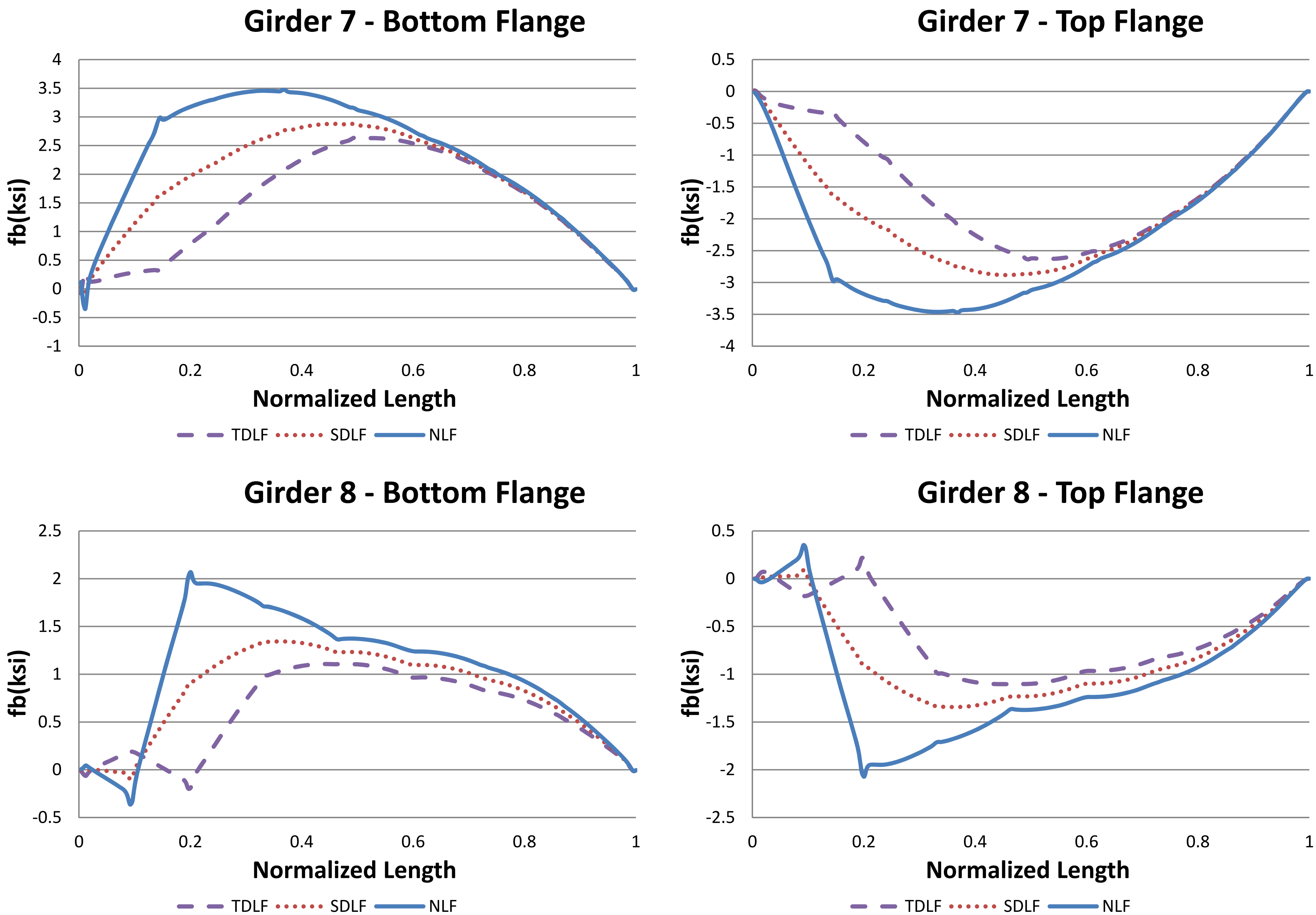


Figure O2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

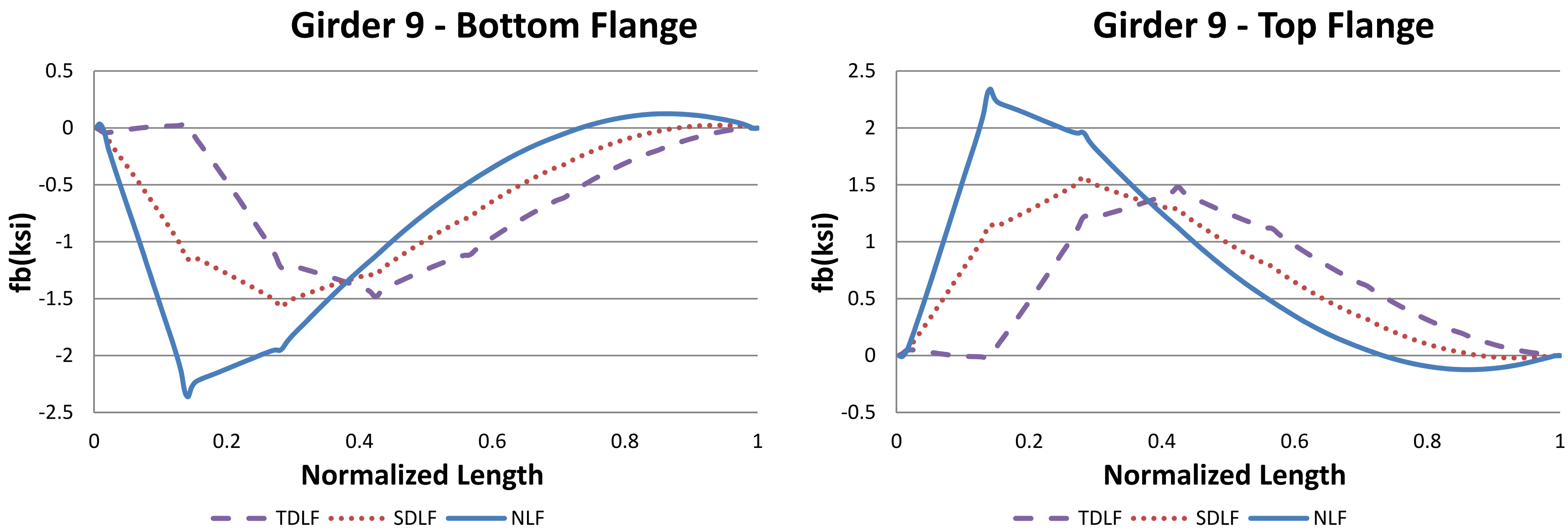


Figure O2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

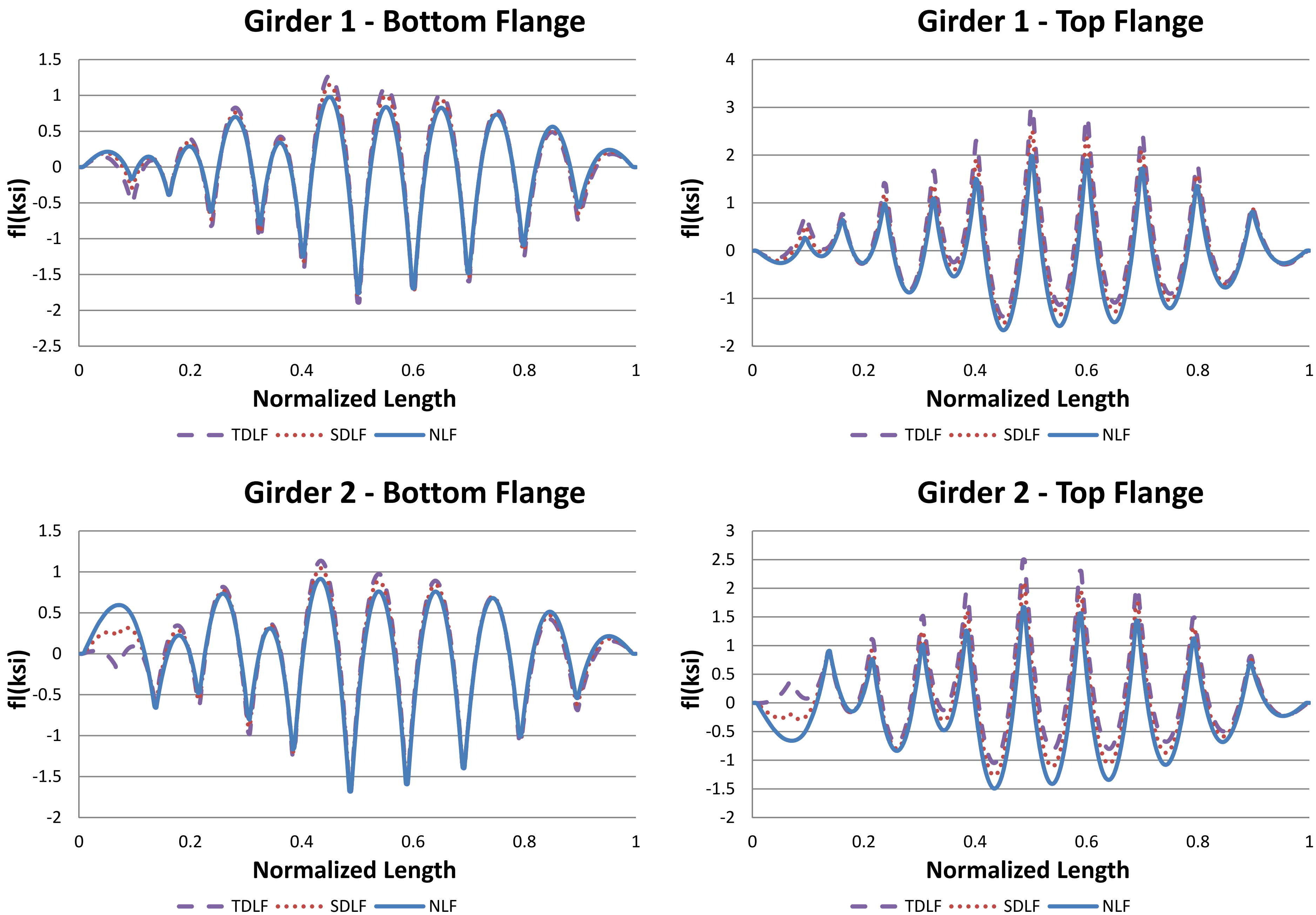


Figure O2-4-19. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

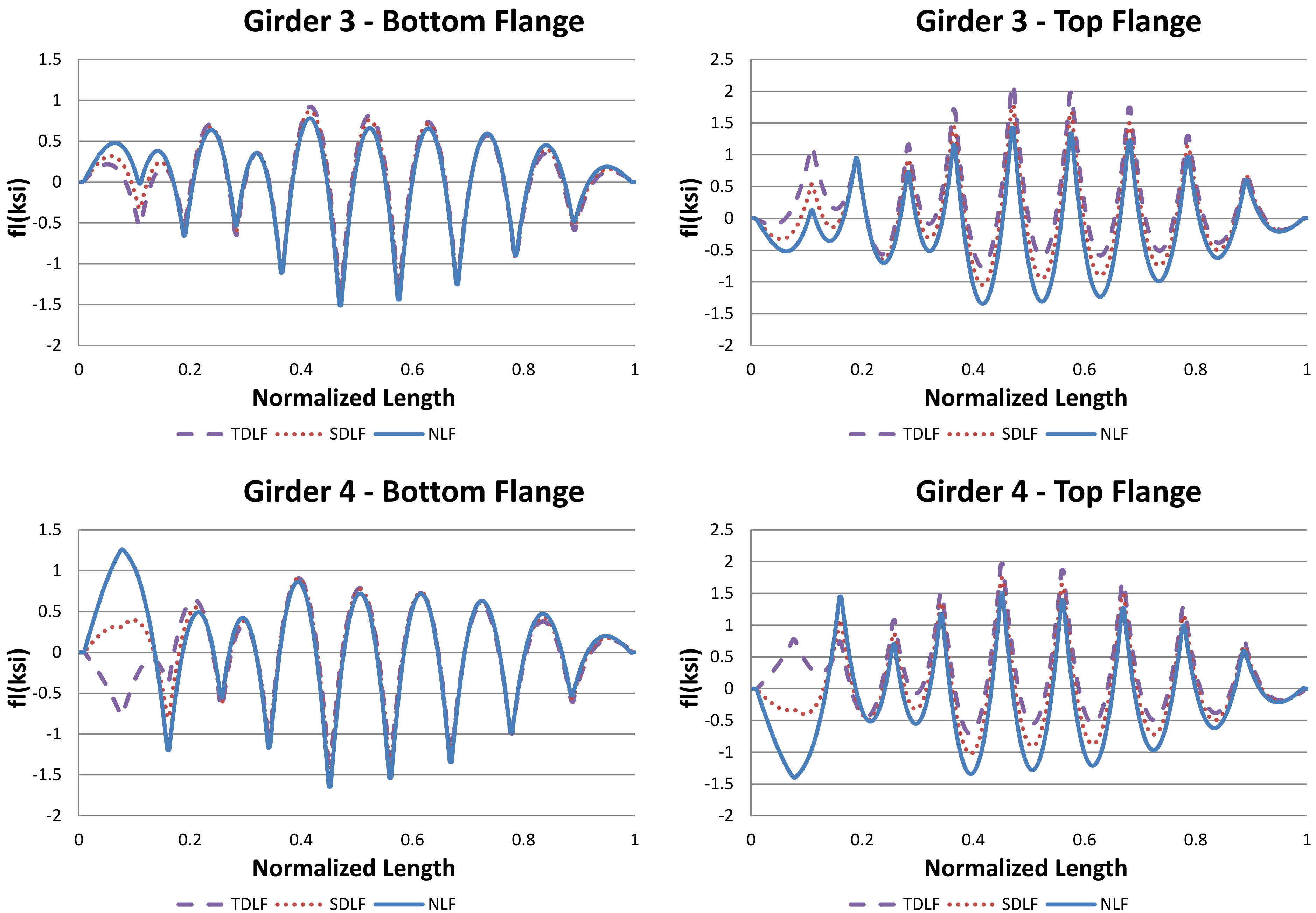


Figure O2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

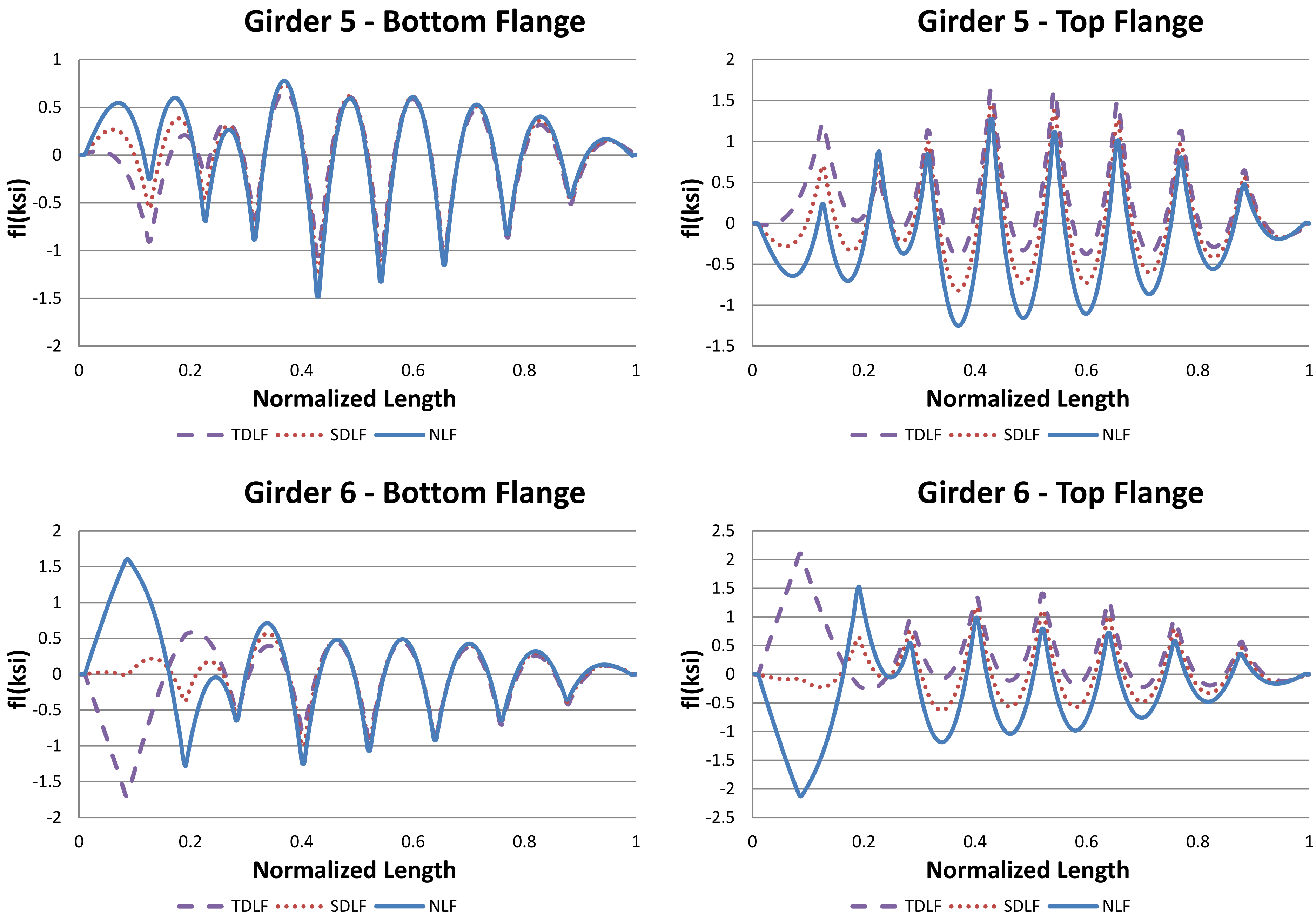


Figure O2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

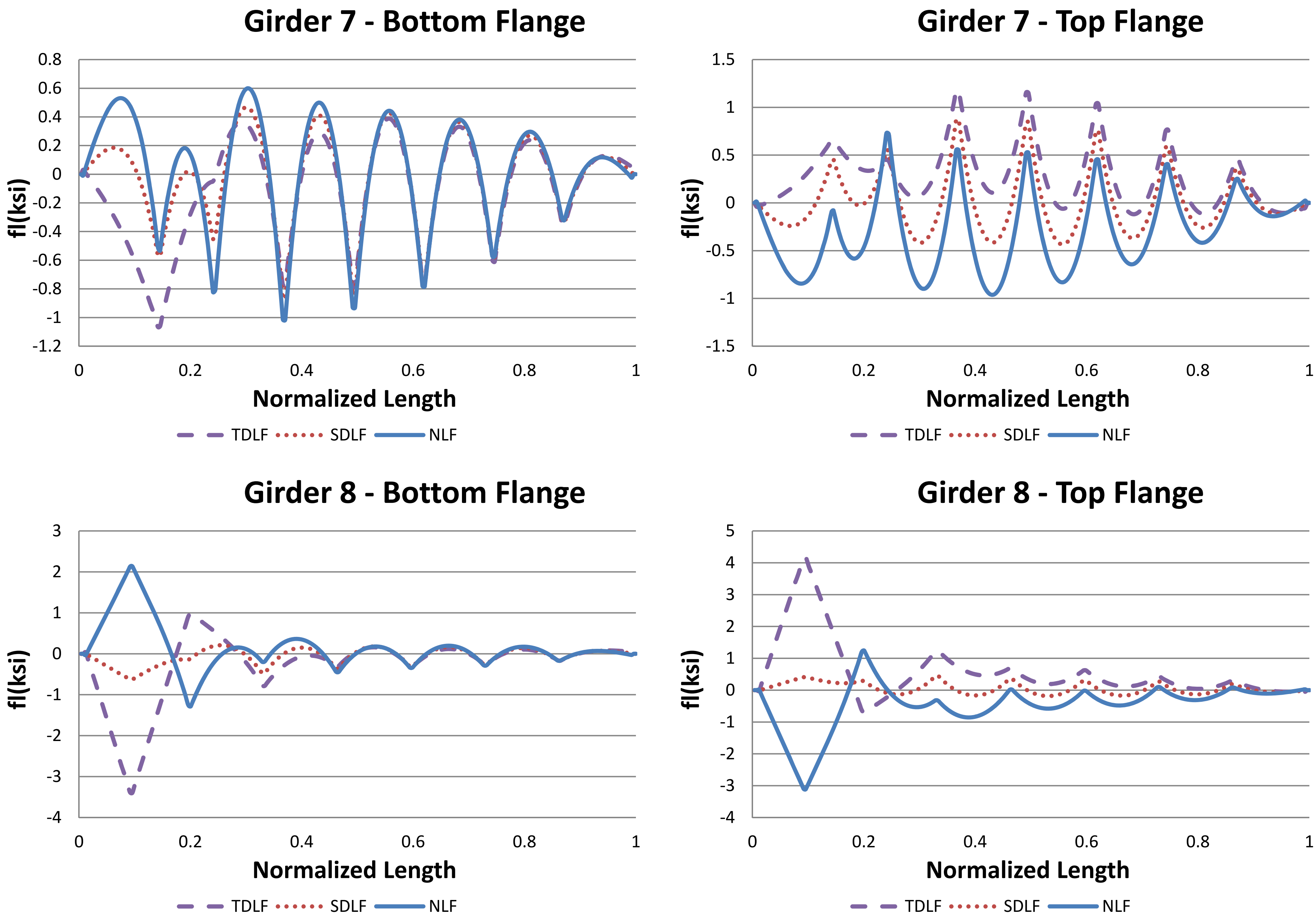


Figure O2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

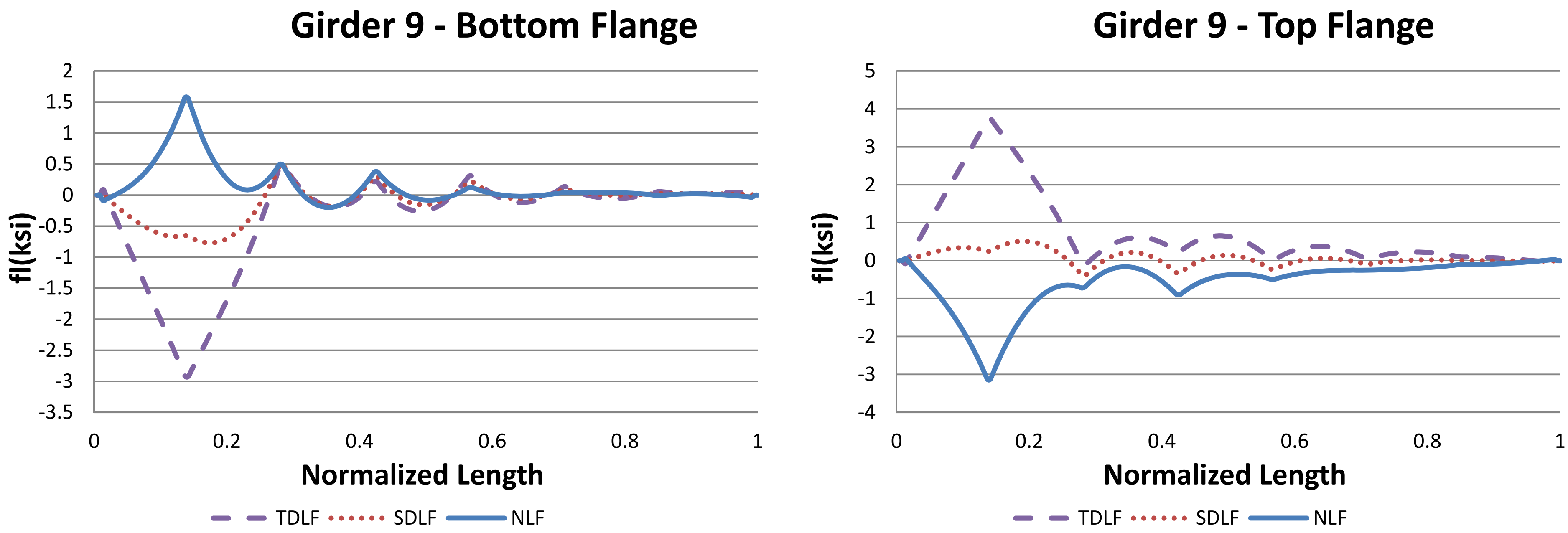


Figure O2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

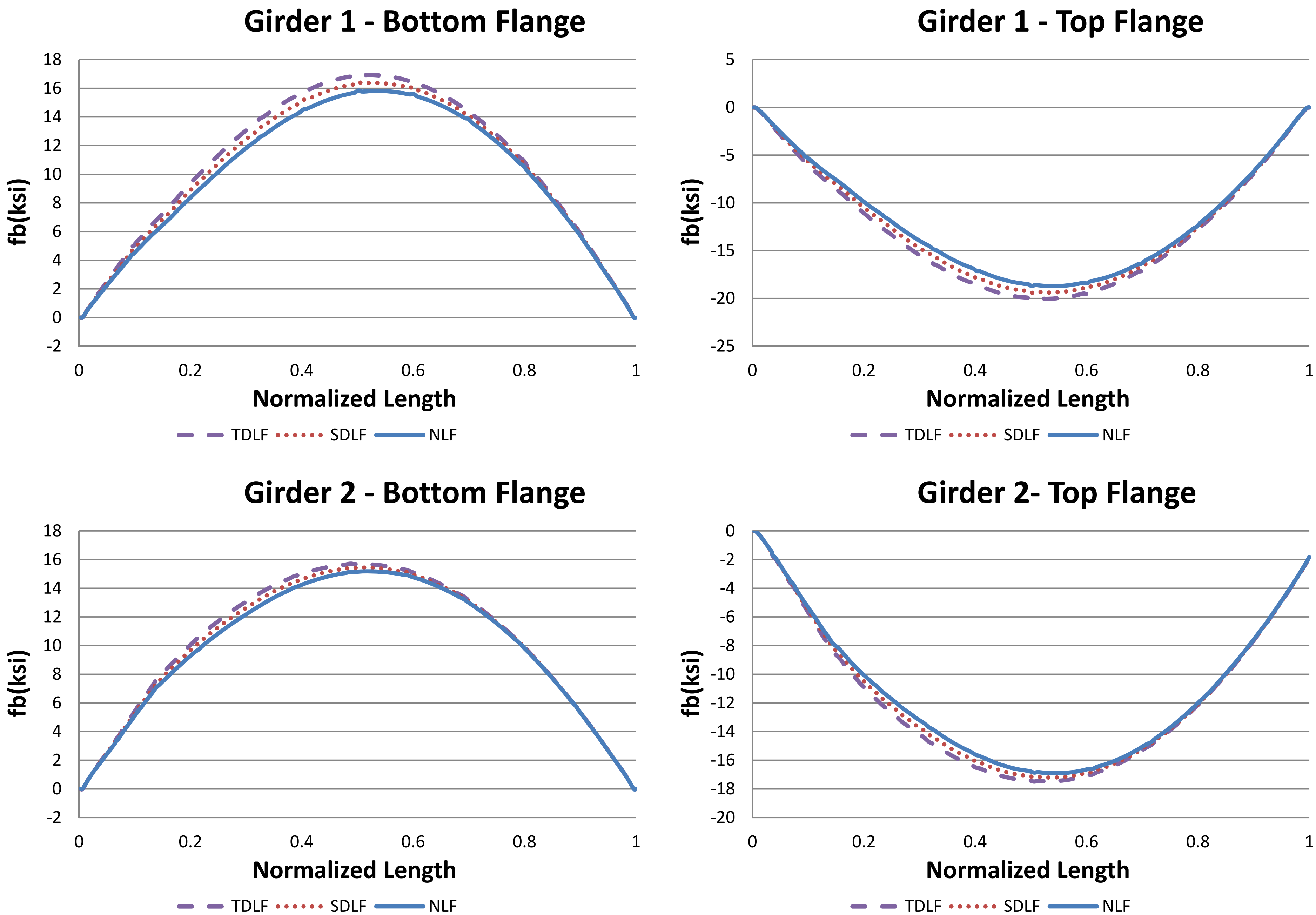


Figure O2-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

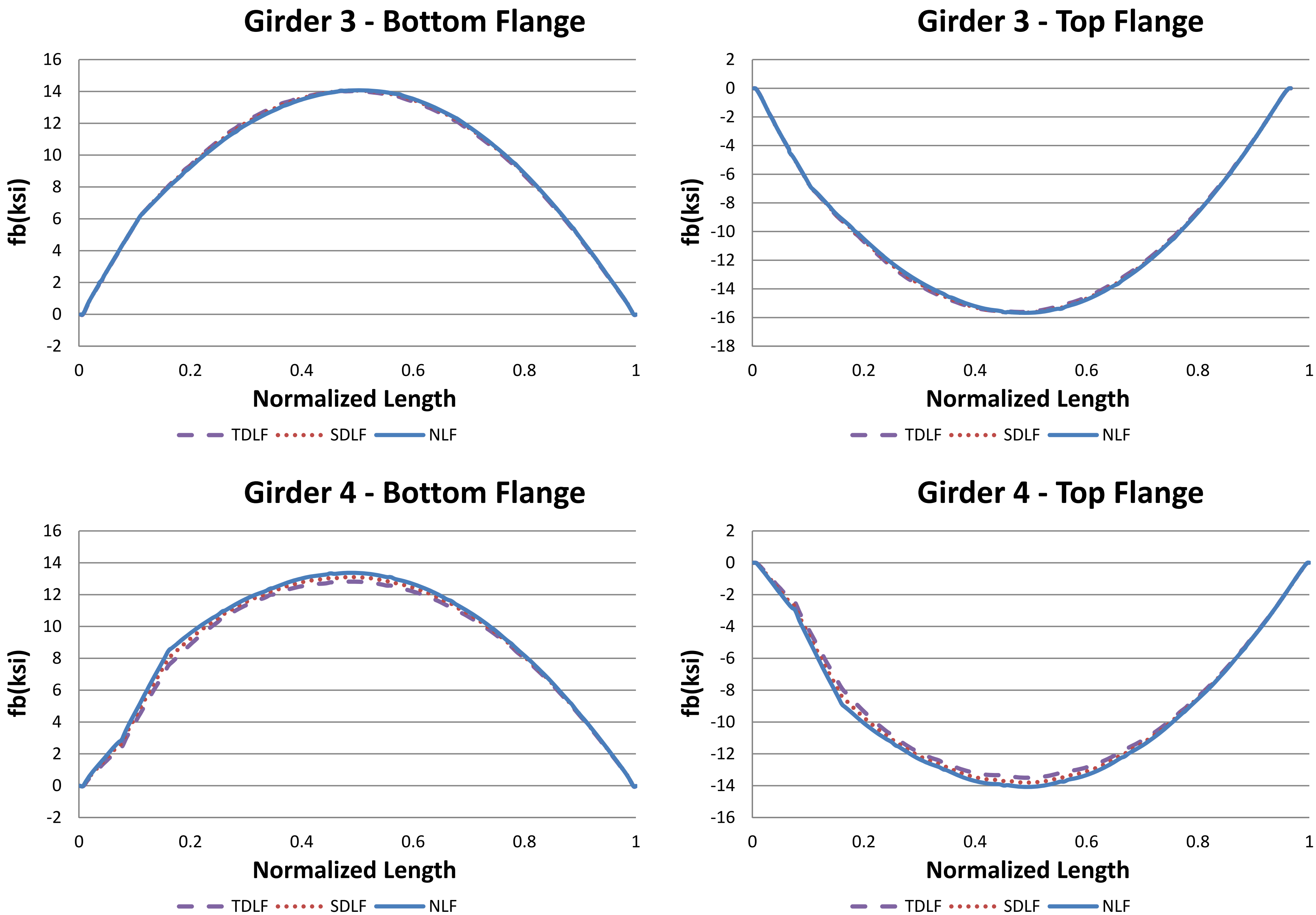


Figure O2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

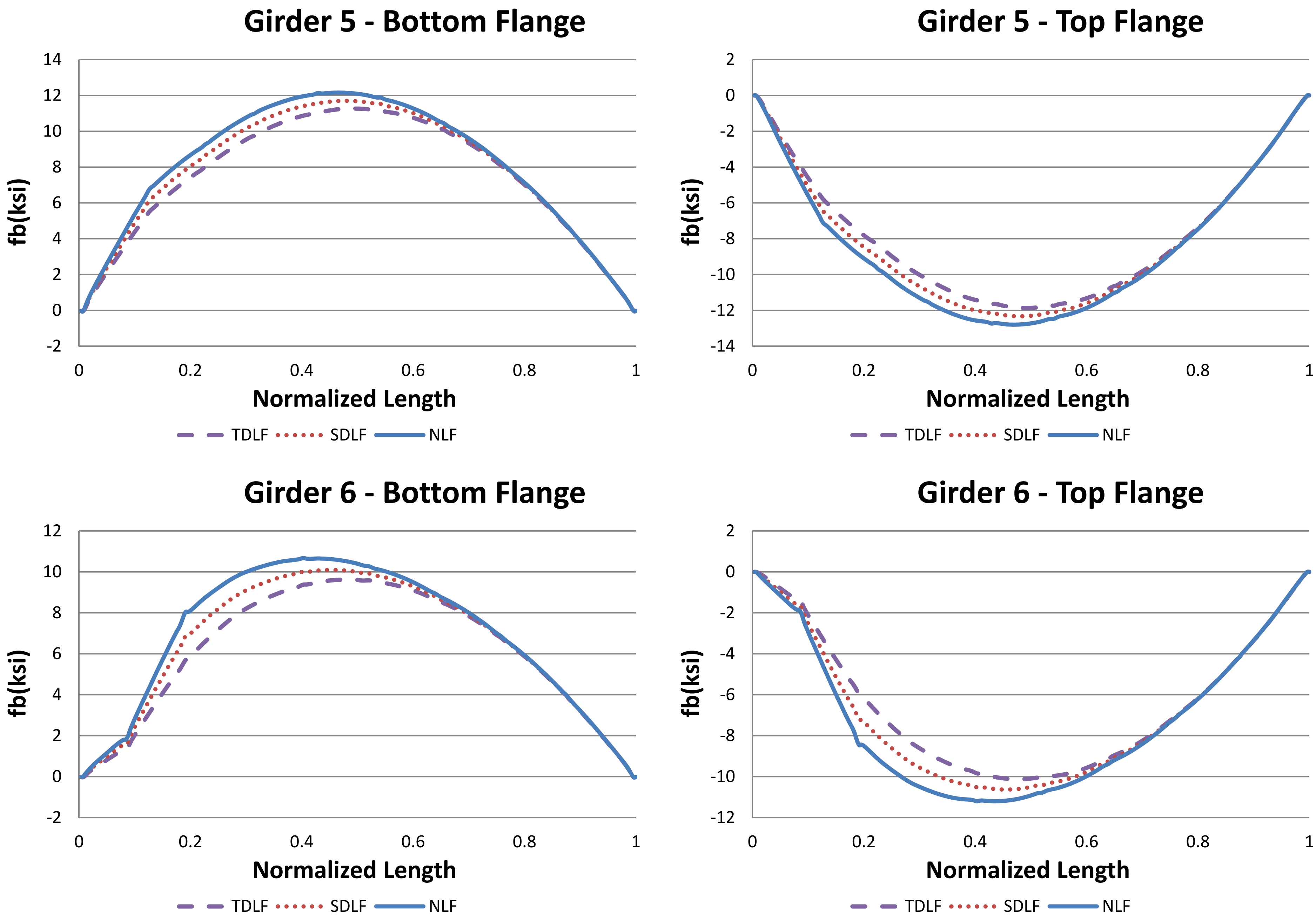


Figure O2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

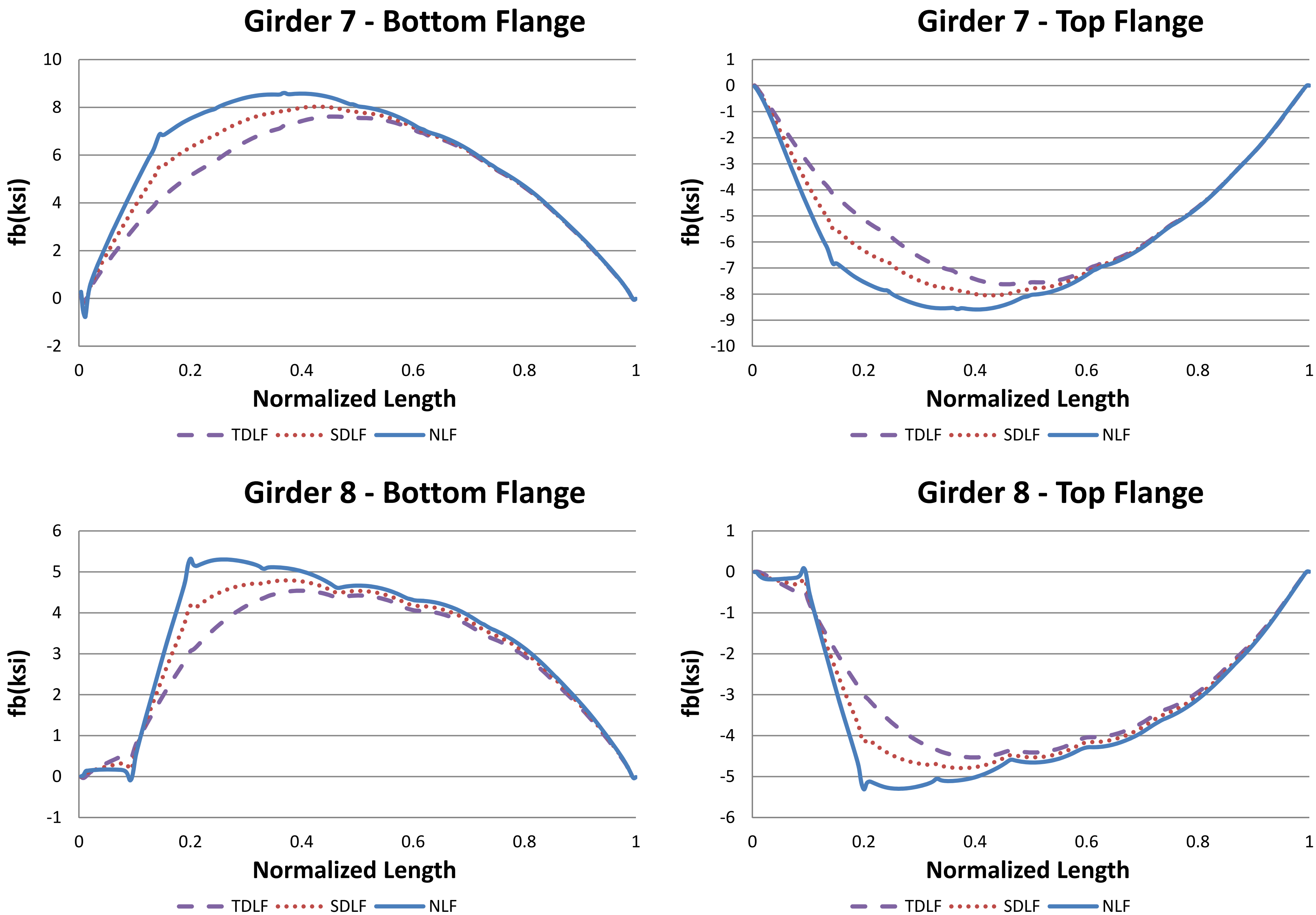
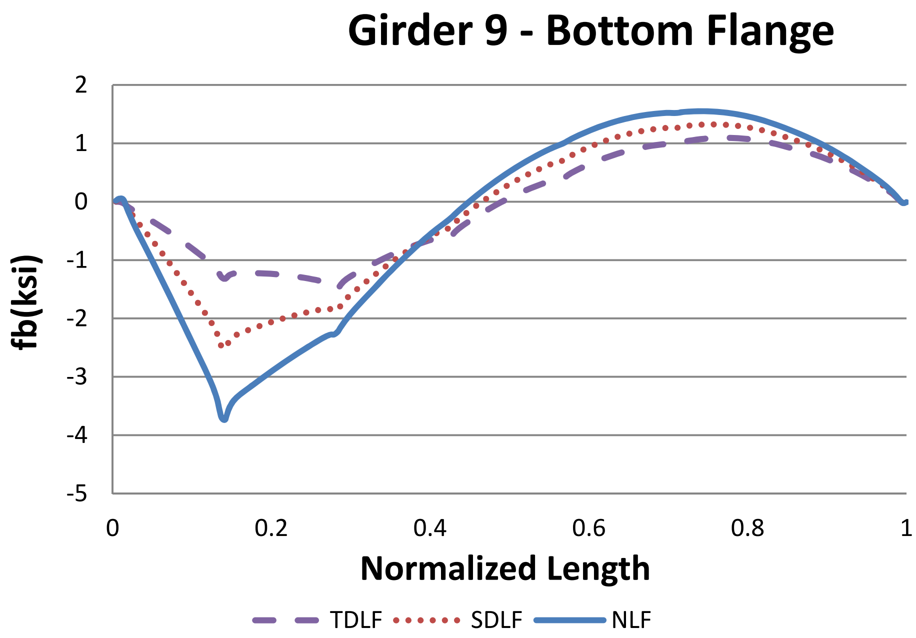


Figure O2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



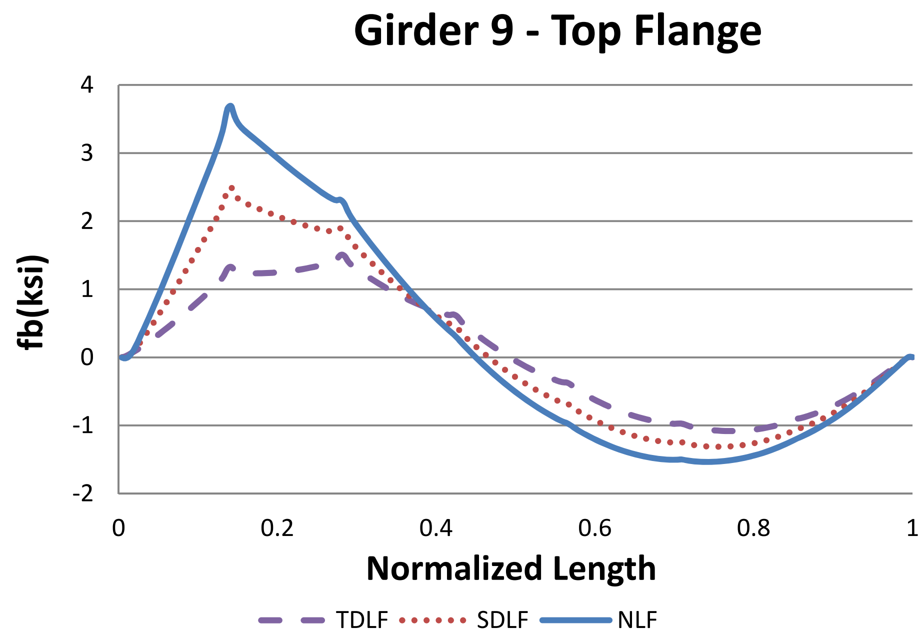


Figure O2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

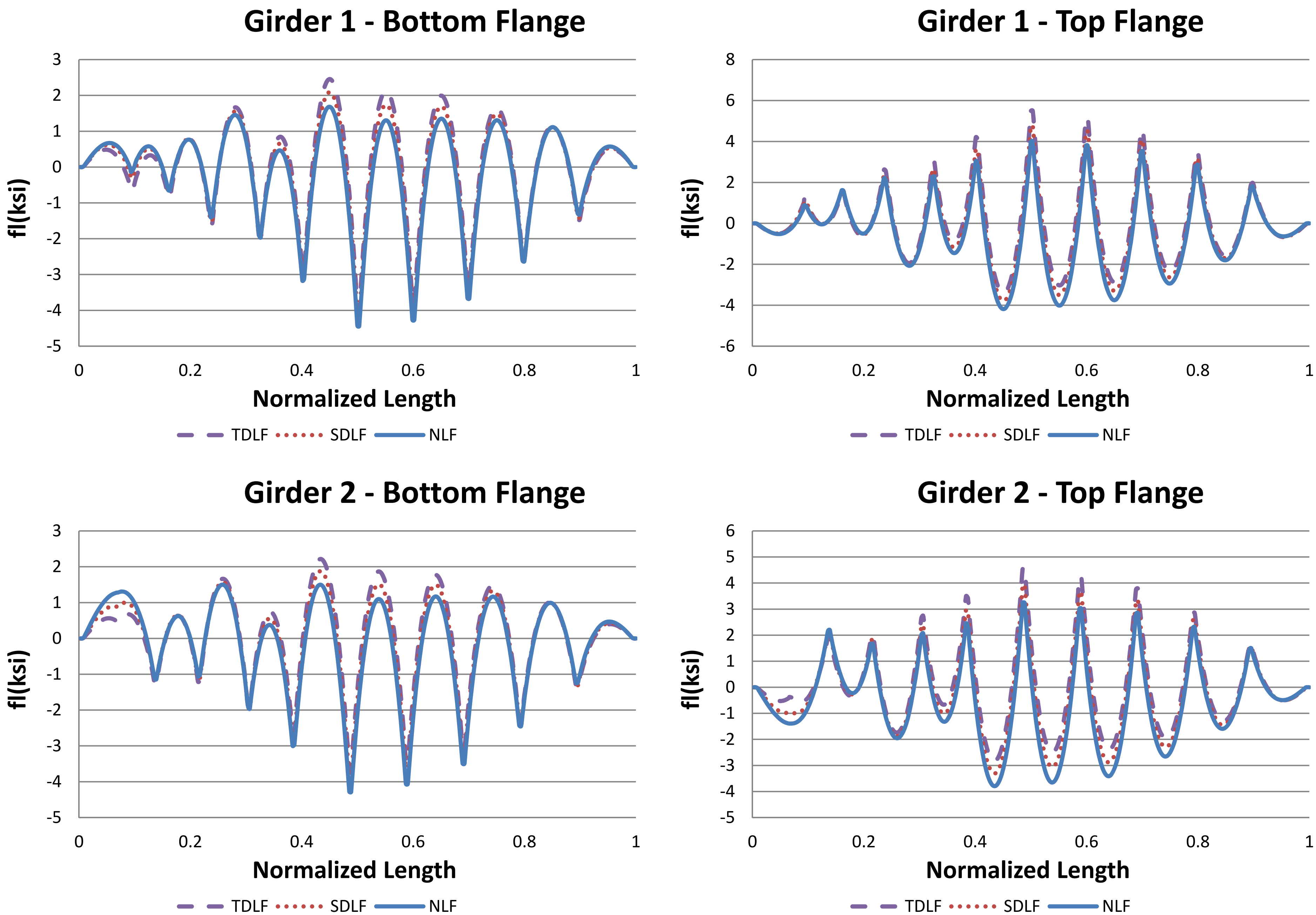


Figure O2-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

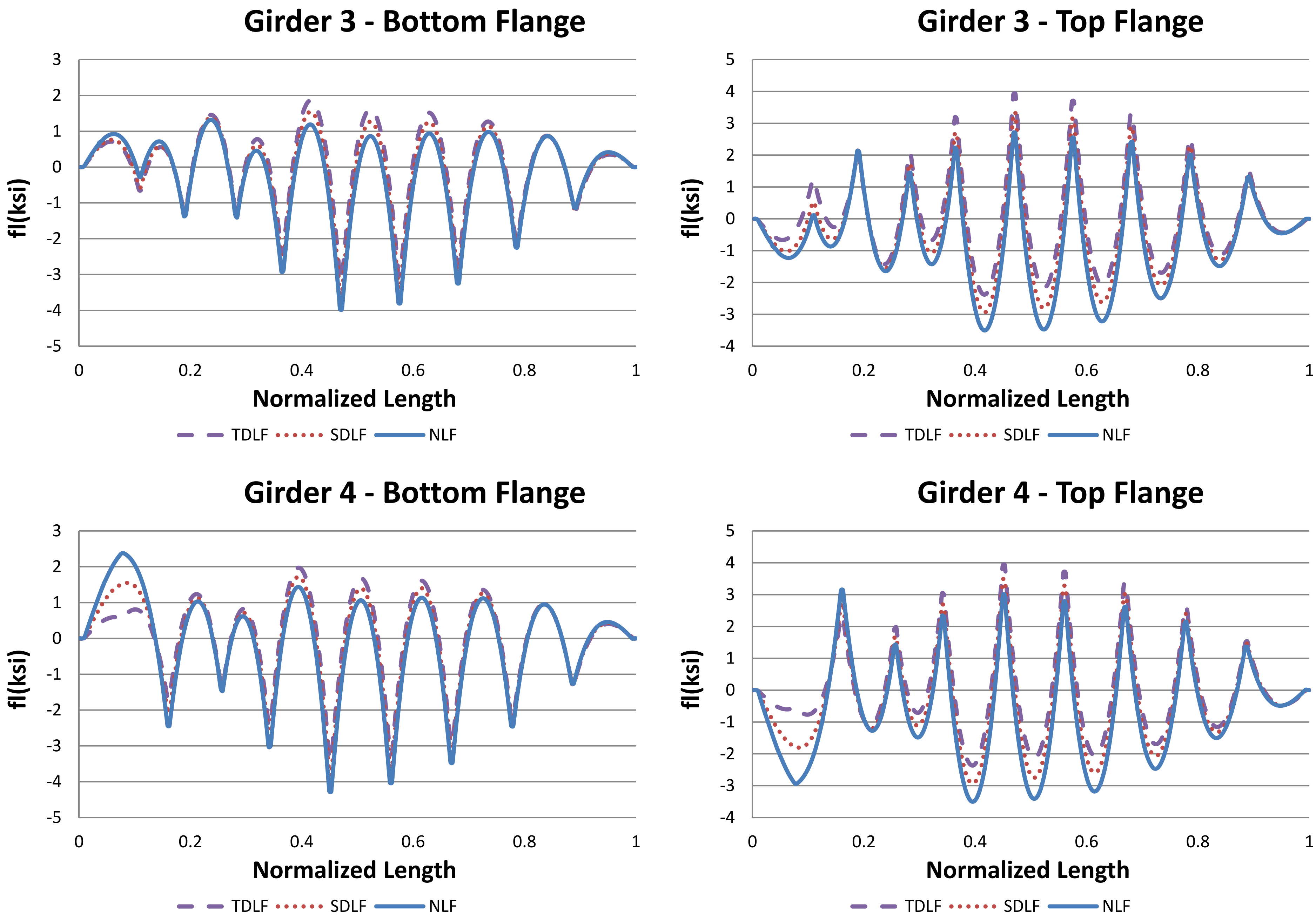


Figure O2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

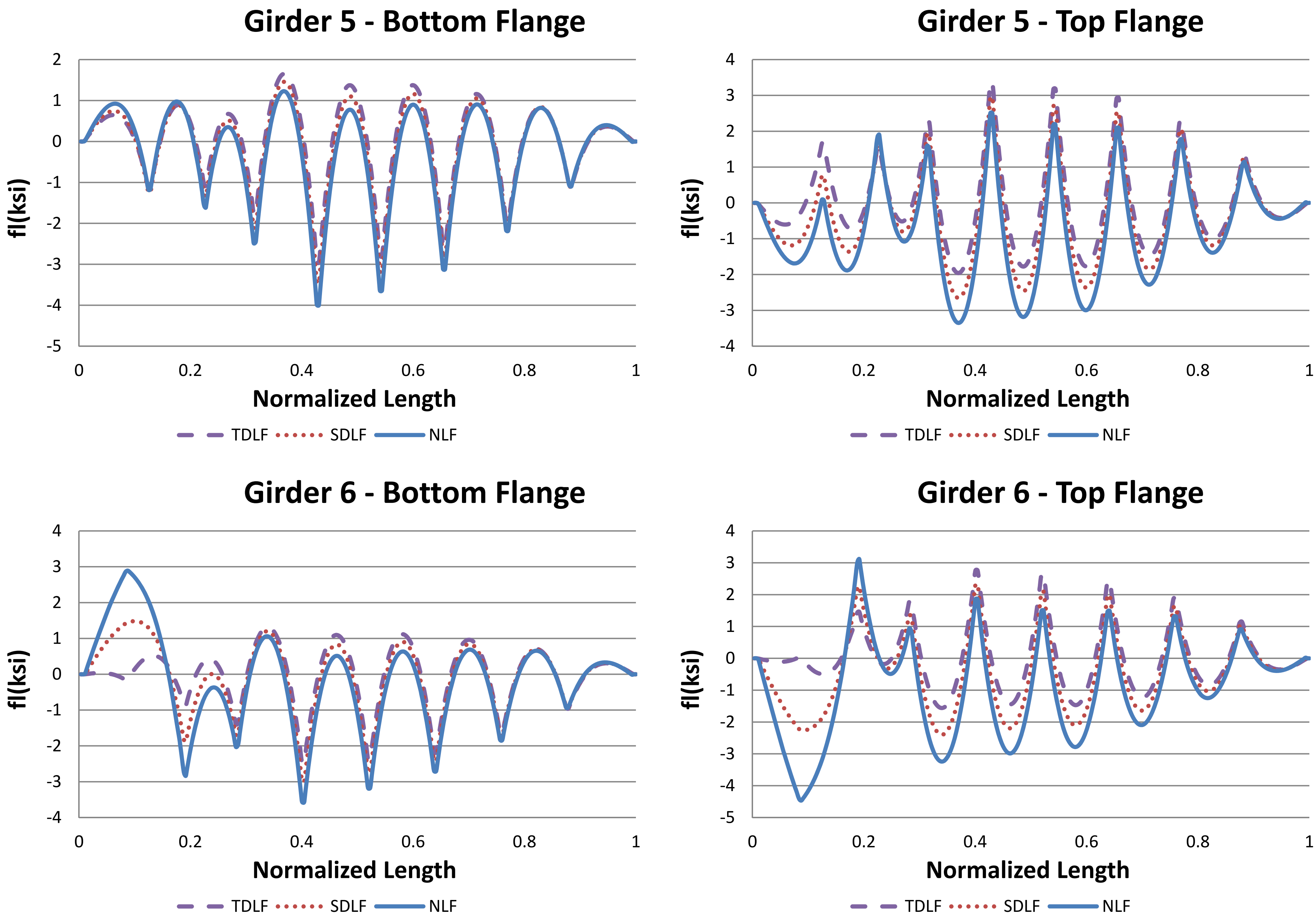


Figure O2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

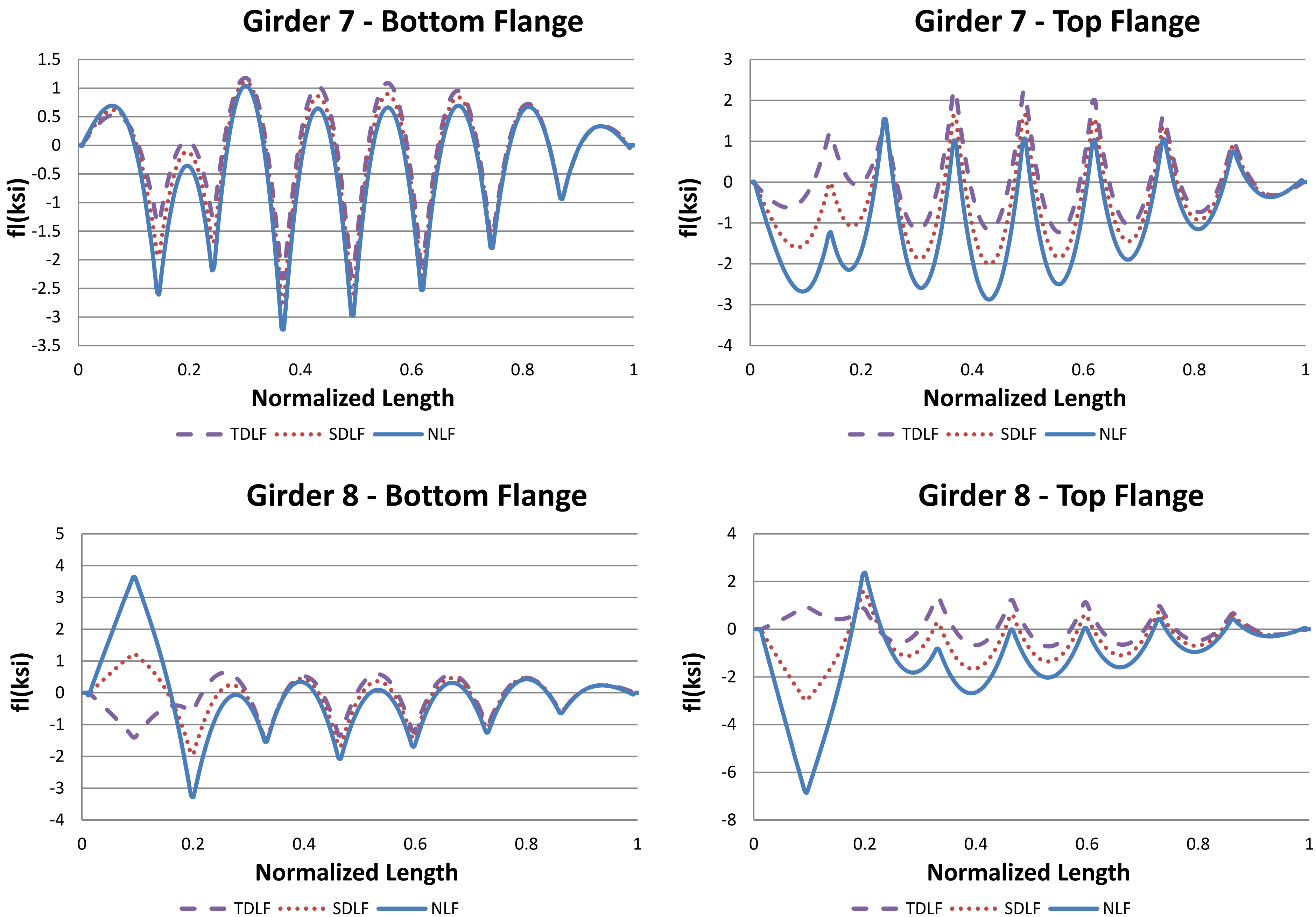


Figure O2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

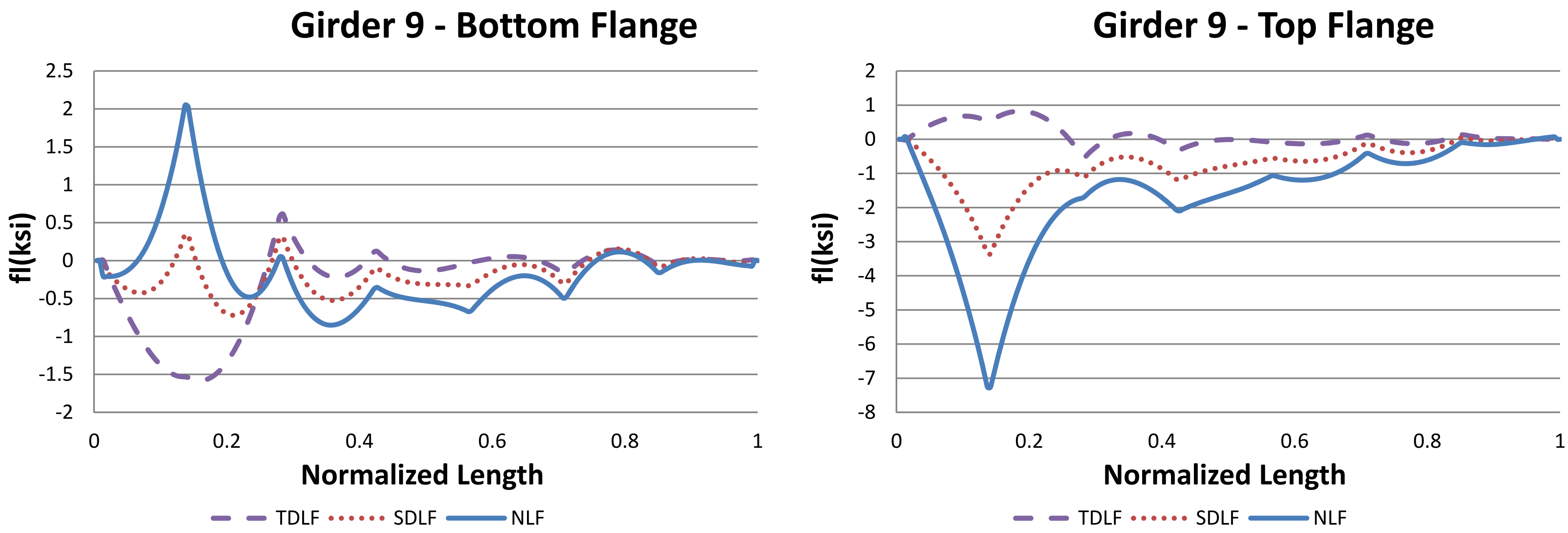


Figure O2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

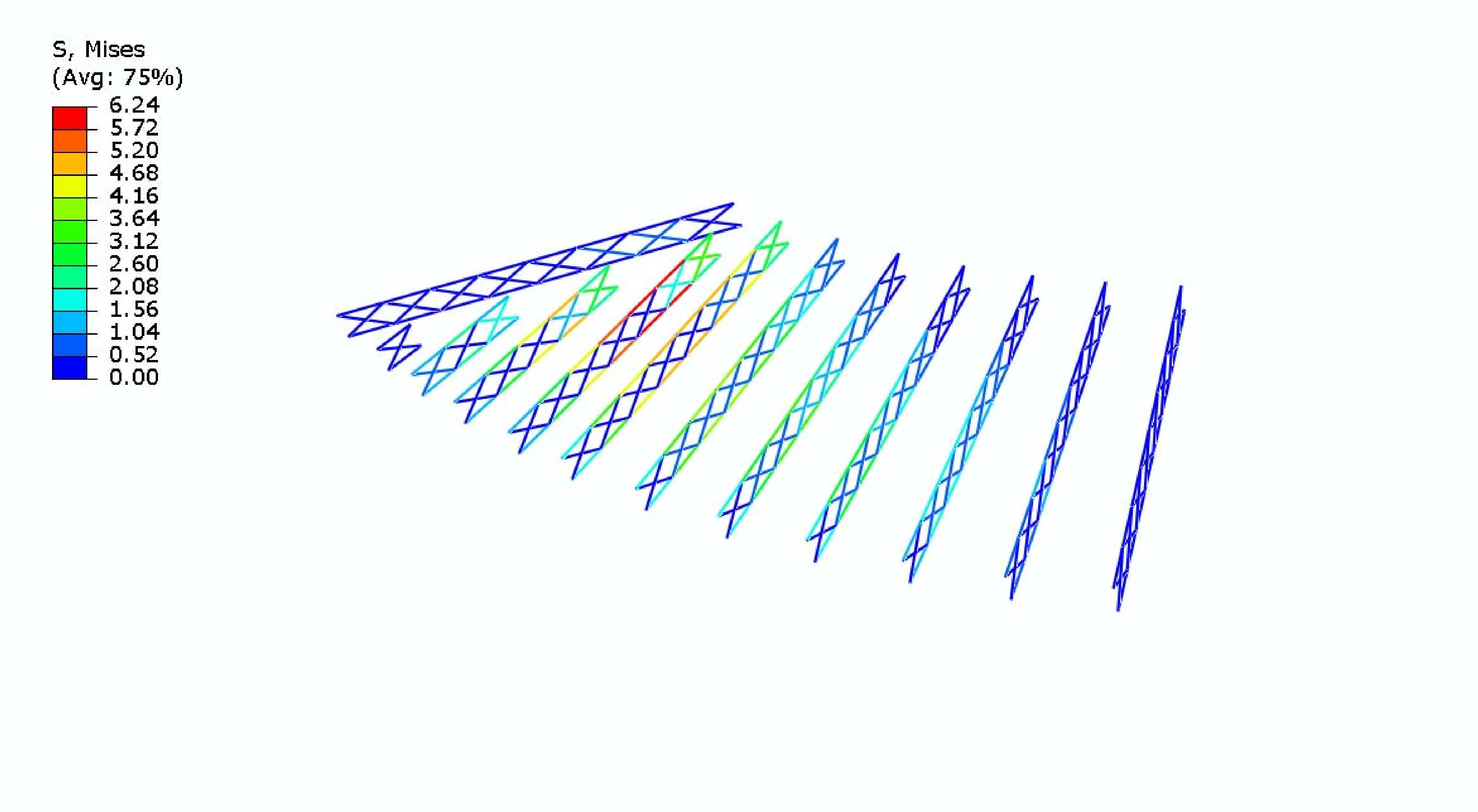


Figure O2-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing

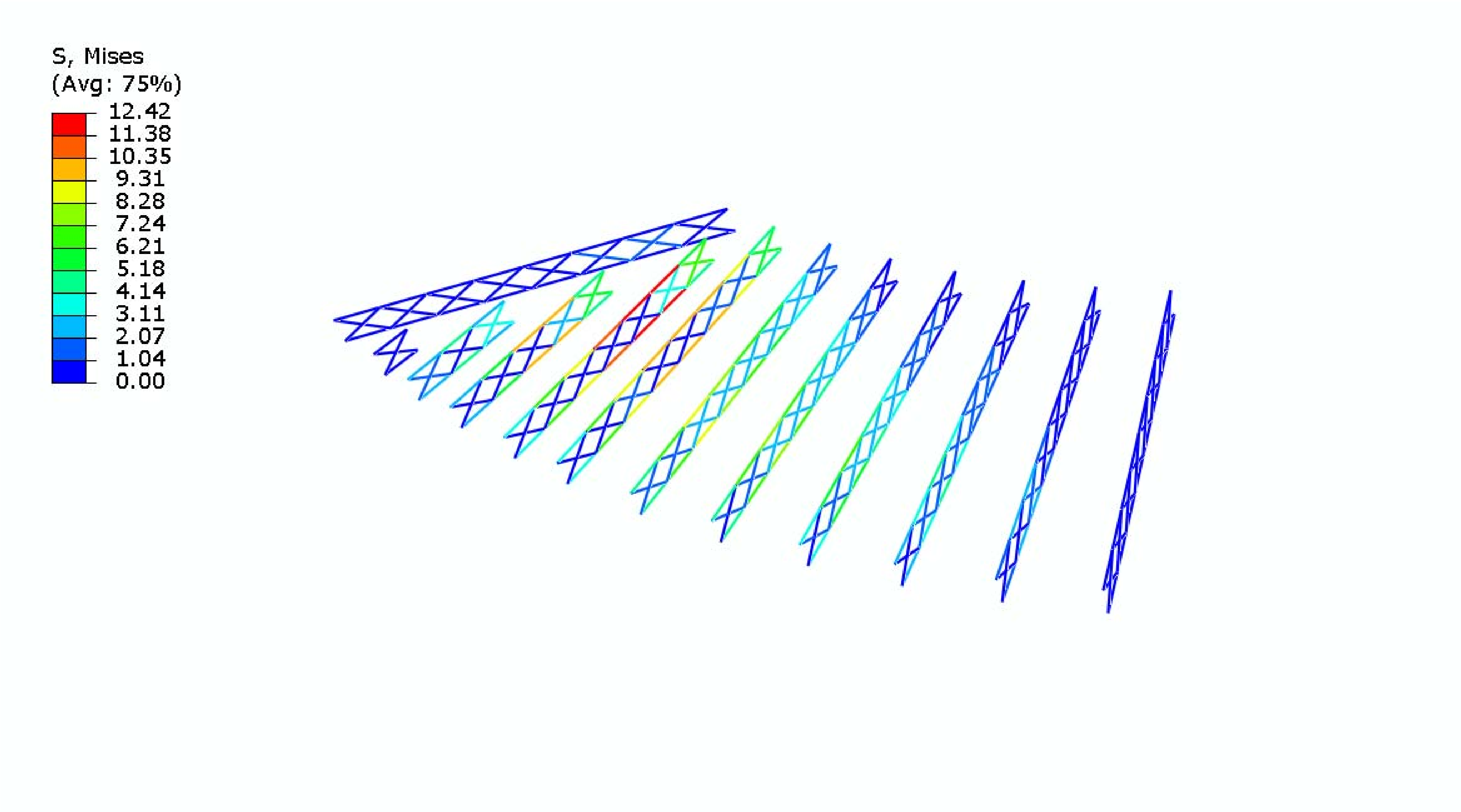


Figure O2-4-23. Cross-frame stress contours under TDL, NLF detailing

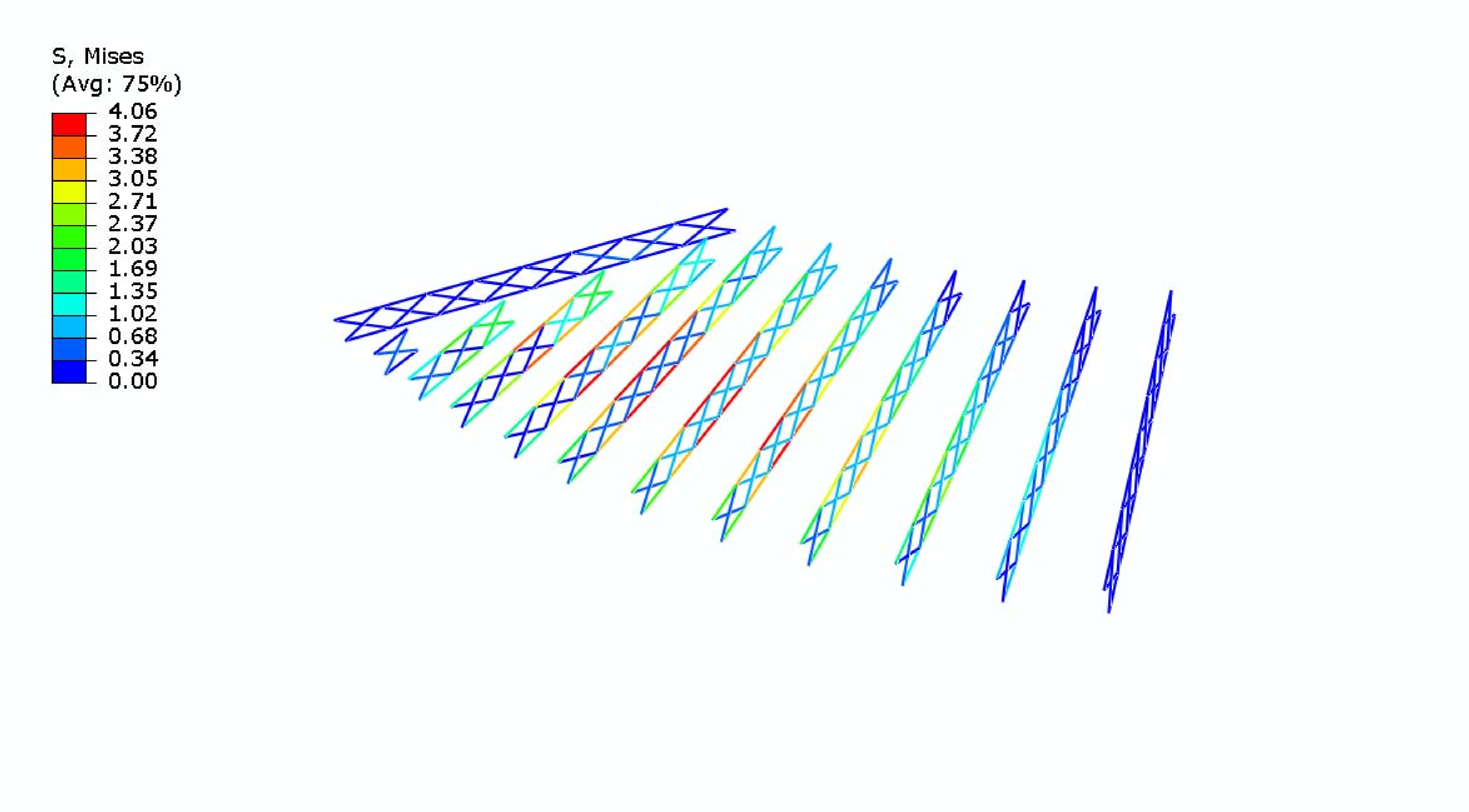


Figure O2-4-24. Cross-frame stress contours under SDL, SDLF detailing

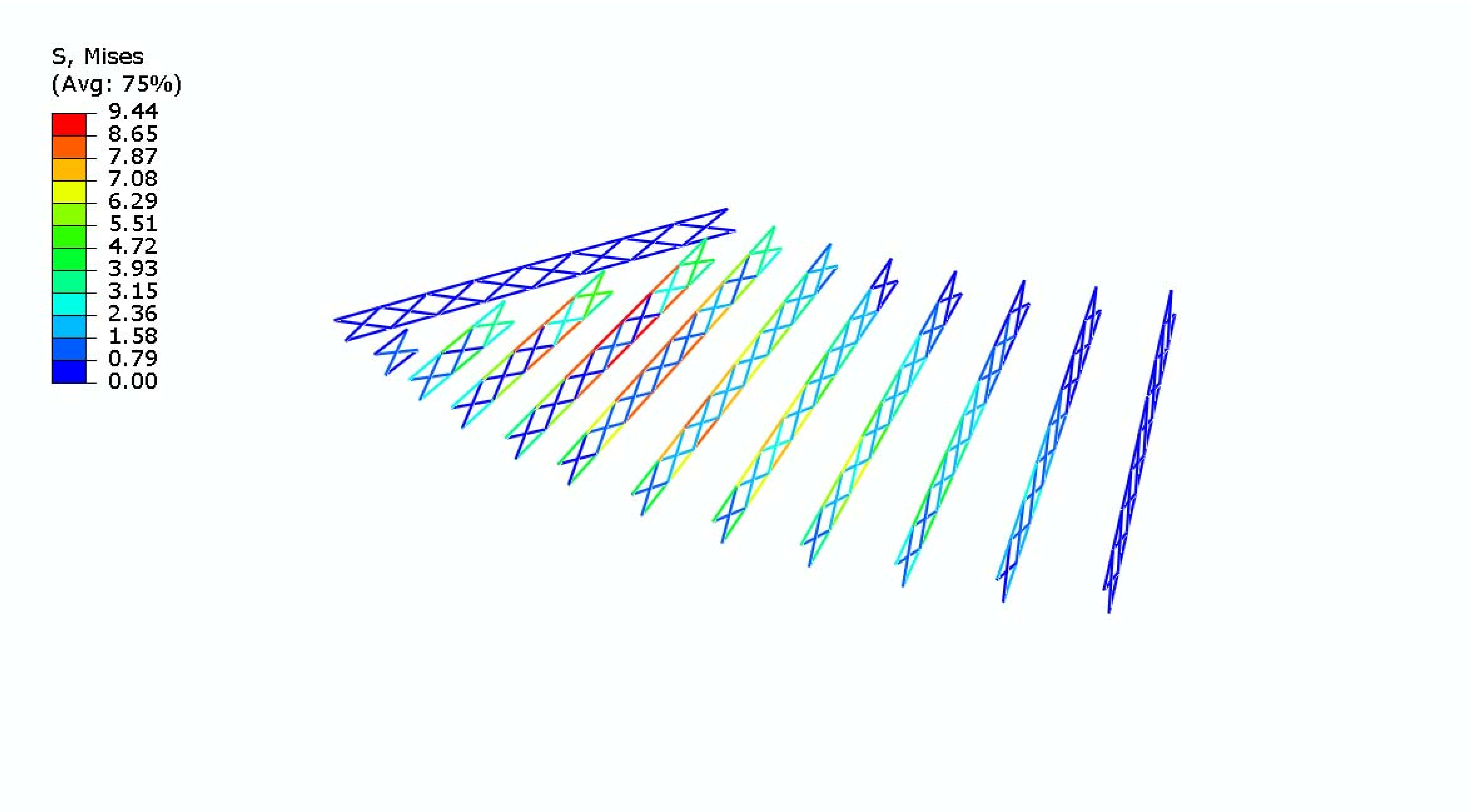


Figure O2-4-25. **Cross-frame stress contours under TDL, SDLF detailing**

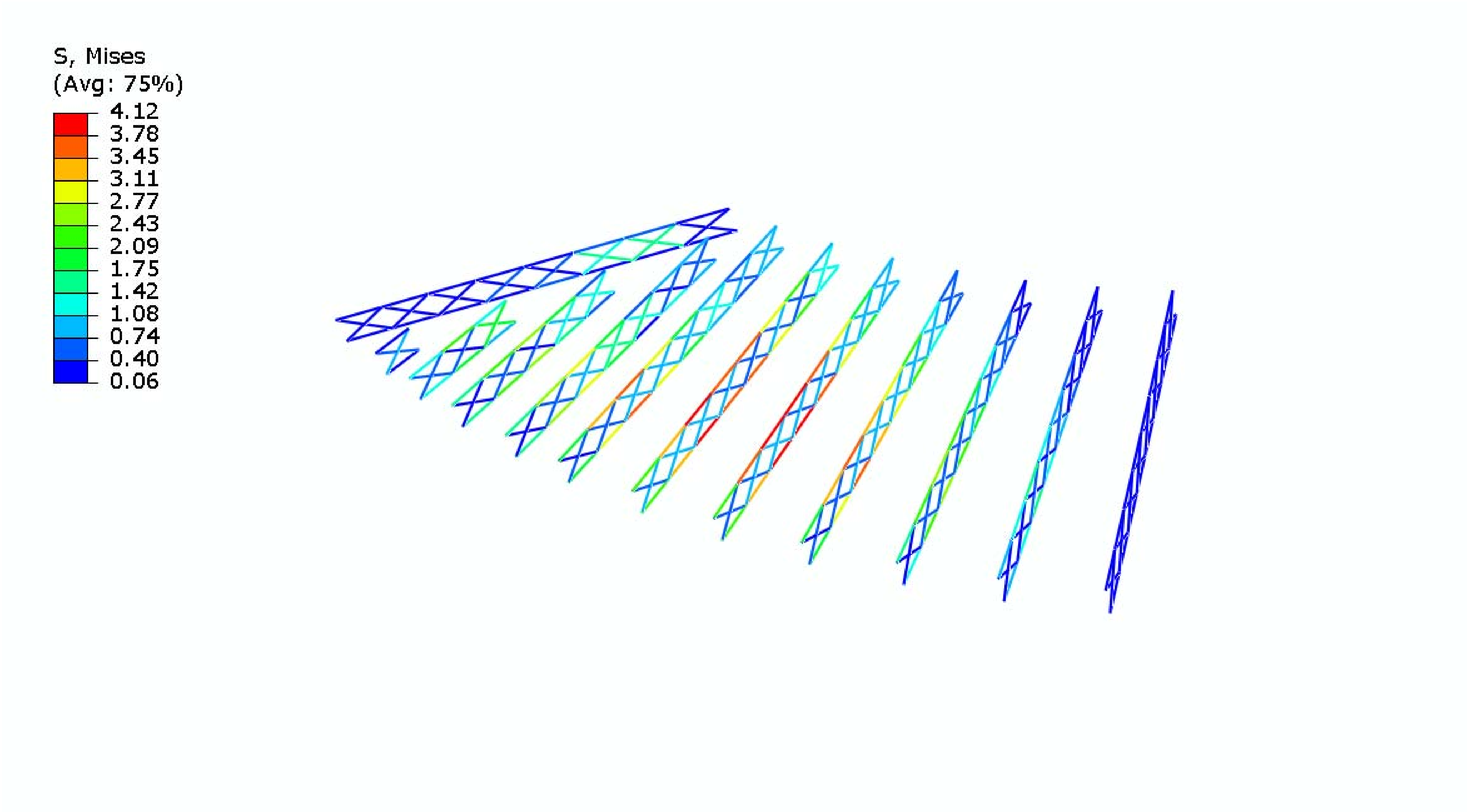


Figure O2-4-26. **Cross-frame stress contours under SDL, TDLF detailing**

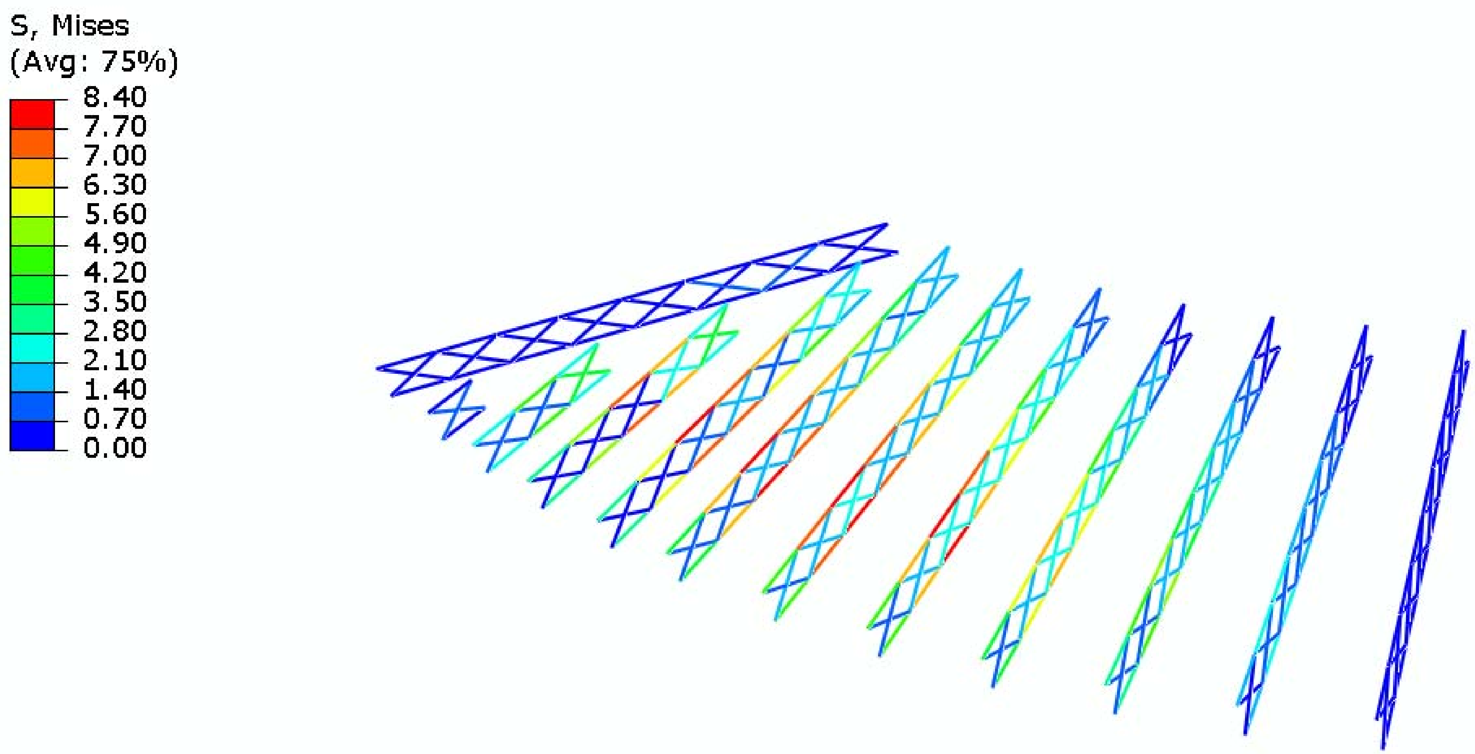


Figure O2-4-27. Cross-frame stress contours under TDL, TDLF detailing

Table O2-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	6.1	7.3	4.4	7.0	7.3	12.9	17.1	1.9
	SDLF	3.5	3.3	3.0	1.8	2.5	8.9	8.1	1.2
	TDLF	8.0	8.5	8.5	10.5	14.4	37.1	39.8	4.9
2	NLF	7.1	5.7	40.9	31.4	63.2	40.1	73.0	65.4
	SDLF	11.8	10.2	41.9	29.8	46.2	27.4	31.3	22.6
	TDLF	17.5	15.2	42.5	28.5	28.9	15.8	13.3	19.5
3	NLF	13.0	9.1	11.1	3.2	7.5	15.0	12.9	16.6
	SDLF	12.2	1.7	1.7	16.1	12.9	22.2	17.9	21.8
	TDLF	12.1	12.7	14.6	35.4	33.2	28.9	23.1	27.5
4	NLF	6.1	4.3	2.8	5.8	7.7	25.0	24.2	4.2
	SDLF	1.7	3.4	8.9	15.0	15.0	21.2	20.0	12.1
	TDLF	2.8	11.2	20.4	24.4	22.3	17.5	16.3	20.0
5	NLF	1.1	6.7	7.9	19.9	23.0	23.5	17.4	2.7
	SDLF	3.0	11.4	15.7	19.0	19.9	21.9	20.7	6.6
	TDLF	7.3	16.7	23.9	17.9	16.9	20.5	24.0	10.4
6	NLF	5.2	15.9	19.4	24.9	25.6	18.5	11.3	2.4
	SDLF	8.0	18.8	21.0	21.1	21.8	20.0	15.5	4.0
	TDLF	12.5	22.2	22.6	17.4	18.2	21.7	19.8	5.8
7	NLF	11.4	17.9	23.7	24.2	22.8	12.8	7.5	1.5
	SDLF	14.2	18.3	21.8	21.3	21.4	14.7	10.0	2.2
	TDLF	18.8	19.3	20.0	18.5	20.0	16.6	12.6	3.1
8	NLF	11.2	18.0	23.7	18.7	16.7	6.7	4.1	0.8
	SDLF	12.2	16.9	21.2	17.5	17.0	7.9	5.3	0.4
	TDLF	15.0	16.2	18.9	16.2	17.3	9.1	6.6	2.6
9	NLF	11.2	14.8	19.1	10.4	9.2	1.8	1.4	NA
	SDLF	11.0	13.4	17.4	10.1	9.7	0.7	0.4	NA
	TDLF	12.2	12.4	15.7	9.8	10.5	4.7	3.2	NA
10	NLF	9.5	8.9	10.9	4.1	2.6	NA	NA	NA
	SDLF	8.8	8.1	10.3	0.7	0.8	NA	NA	NA
	TDLF	9.3	7.3	9.6	5.3	4.5	NA	NA	NA

Table O2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	6.1	6.1	3.8	NA	NA	NA	NA	NA
	SDLF	5.6	1.5	1.3	NA	NA	NA	NA	NA
	TDLF	6.0	6.4	7.0	NA	NA	NA	NA	NA
12	NLF	6.6	NA	NA	NA	NA	NA	NA	NA
	SDLF	2.1	NA	NA	NA	NA	NA	NA	NA
	TDLF	7.7	NA	NA	NA	NA	NA	NA	NA

Table O2-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	14.7	17.1	10.4	16.6	17.2	31.6	40.8	3.5
	SDLF	8.7	9.3	5.3	7.9	7.0	9.9	15.4	1.3
	TDLF	7.9	7.1	6.4	3.8	5.3	18.6	16.8	2.1
2	NLF	16.7	14.8	86.5	67.0	127.9	82.2	145.8	129.0
	SDLF	21.1	18.6	87.3	64.4	110.1	67.4	103.8	86.0
	TDLF	26.9	23.8	87.9	63.2	92.4	56.1	61.1	44.0
3	NLF	25.6	13.9	16.6	0.9	11.9	35.0	27.0	33.4
	SDLF	24.1	3.3	5.2	18.8	8.7	41.8	31.5	37.6
	TDLF	23.9	8.0	9.6	37.8	29.2	48.2	36.9	42.9
4	NLF	10.1	4.0	3.8	18.4	21.0	56.7	50.9	8.8
	SDLF	5.6	3.8	14.1	27.6	28.1	52.5	46.4	16.2
	TDLF	1.7	11.7	25.7	36.7	34.9	48.6	41.9	24.1
5	NLF	2.5	19.5	25.4	49.1	53.3	53.7	37.7	6.4
	SDLF	4.9	24.2	33.1	47.7	49.9	51.8	40.4	9.9
	TDLF	8.8	29.2	41.0	46.3	46.5	50.0	43.6	13.4
6	NLF	13.7	39.5	50.8	58.7	58.5	43.3	25.6	5.5
	SDLF	15.5	42.2	51.9	54.6	54.4	44.5	29.2	7.0
	TDLF	19.8	45.3	53.2	50.7	50.5	45.9	33.4	8.5
7	NLF	27.2	43.0	59.0	56.4	52.3	31.0	17.5	3.0
	SDLF	28.8	43.2	56.7	53.3	50.6	32.7	19.7	3.9
	TDLF	33.3	43.9	54.7	50.3	49.0	34.4	21.9	4.7
8	NLF	26.1	42.2	58.1	43.6	38.5	16.8	9.5	2.5
	SDLF	26.0	41.0	55.3	42.3	38.7	18.0	10.7	1.4
	TDLF	28.7	40.2	52.7	40.8	38.8	19.0	12.0	0.8
9	NLF	25.6	34.2	46.9	24.1	20.7	4.6	4.2	NA
	SDLF	24.4	32.9	45.1	24.0	21.4	2.7	2.8	NA
	TDLF	25.5	31.8	43.2	23.5	22.1	1.6	0.9	NA
10	NLF	21.0	20.2	27.3	9.4	6.4	NA	NA	NA
	SDLF	19.9	19.6	26.8	5.1	4.2	NA	NA	NA
	TDLF	20.3	18.8	25.9	1.5	1.9	NA	NA	NA

Table O2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	13.3	13.3	8.6	NA	NA	NA	NA	NA
	SDLF	12.8	7.4	5.6	NA	NA	NA	NA	NA
	TDLF	13.2	3.4	3.0	NA	NA	NA	NA	NA
12	NLF	14.6	NA	NA	NA	NA	NA	NA	NA
	SDLF	9.3	NA	NA	NA	NA	NA	NA	NA
	TDLF	5.0	NA	NA	NA	NA	NA	NA	NA

Table O2-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.5	3.1	1.8	1.6	6.0	5.6	4.0	2.4
	SDLF	2.0	2.0	2.5	2.5	4.6	0.9	1.0	2.6
	TDLF	7.0	7.5	7.5	7.5	17.7	8.9	7.4	9.8
2	NLF	5.6	58.8	35.1	121.3	56.1	150.0	66.0	61.6
	SDLF	4.1	54.8	31.9	82.6	35.5	60.7	23.7	19.6
	TDLF	2.6	50.0	27.6	42.9	14.1	29.7	19.3	22.1
3	NLF	29.9	73.9	118.6	134.0	158.0	127.9	115.3	18.0
	SDLF	30.1	66.1	91.1	93.0	82.2	74.8	48.1	23.4
	TDLF	30.1	58.1	63.3	52.0	6.2	22.8	17.7	29.1
4	NLF	35.7	77.5	113.2	122.3	131.0	75.0	46.5	7.2
	SDLF	36.4	74.0	96.2	98.1	91.3	75.8	52.1	13.6
	TDLF	36.9	70.5	79.1	74.1	52.1	76.8	58.0	20.1
5	NLF	38.7	80.0	109.8	101.1	91.7	42.6	19.7	3.6
	SDLF	40.1	79.0	99.9	98.3	90.0	60.6	35.8	7.8
	TDLF	41.3	78.0	90.1	95.3	88.3	78.4	51.9	12.1
6	NLF	45.6	84.1	104.8	80.1	62.8	26.6	11.0	2.1
	SDLF	47.4	85.1	103.1	90.1	77.7	42.1	21.9	4.2
	TDLF	48.8	85.5	100.9	99.5	92.1	57.6	32.8	6.5
7	NLF	52.1	78.9	92.6	60.2	42.9	16.6	6.7	0.9
	SDLF	54.1	82.8	98.3	73.4	59.1	25.8	12.4	1.7
	TDLF	55.5	86.1	103.4	86.3	74.9	35.4	18.4	2.7
8	NLF	50.4	66.8	75.1	40.7	27.7	8.0	3.1	0.5
	SDLF	52.7	72.3	84.1	51.0	38.7	12.3	5.6	0.3
	TDLF	54.4	77.4	92.6	61.3	49.8	16.8	8.4	2.0
9	NLF	44.0	48.6	53.1	20.5	13.5	1.4	0.8	NA
	SDLF	46.2	53.4	61.0	26.1	19.0	0.4	0.2	NA
	TDLF	48.1	57.9	68.5	31.8	24.7	2.7	1.6	NA
10	NLF	32.9	25.5	27.4	2.0	2.3	NA	NA	NA
	SDLF	34.6	28.5	32.1	0.5	0.5	NA	NA	NA
	TDLF	35.9	31.0	36.5	3.6	4.3	NA	NA	NA

Table O2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	17.6	3.2	2.3	NA	NA	NA	NA	NA
	SDLF	18.6	0.8	0.7	NA	NA	NA	NA	NA
	TDLF	19.3	5.5	4.3	NA	NA	NA	NA	NA
12	NLF	2.6	NA	NA	NA	NA	NA	NA	NA
	SDLF	1.2	NA	NA	NA	NA	NA	NA	NA
	TDLF	5.5	NA	NA	NA	NA	NA	NA	NA

Table O2-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	3.7	5.5	2.6	2.7	12.9	13.5	10.3	6.0
	SDLF	0.6	0.9	1.0	0.8	3.0	6.7	5.0	1.2
	TDLF	5.0	4.4	5.5	5.2	9.8	1.8	1.8	5.9
2	NLF	12.0	121.6	72.0	241.0	110.4	294.2	129.6	119.2
	SDLF	10.6	117.8	69.2	202.8	90.4	205.9	87.9	77.9
	TDLF	9.6	114.0	65.3	163.6	69.0	116.0	44.6	36.3
3	NLF	63.9	154.7	240.5	266.4	310.4	249.9	222.9	32.0
	SDLF	64.2	146.8	213.1	225.2	234.9	195.9	155.6	37.2
	TDLF	64.3	138.1	185.1	183.7	159.1	142.5	89.3	42.6
4	NLF	77.5	163.4	231.4	244.4	257.9	142.6	84.9	9.4
	SDLF	78.2	159.6	214.1	219.5	217.4	143.1	90.1	15.8
	TDLF	78.5	155.8	196.5	194.4	176.9	143.5	95.6	22.3
5	NLF	84.3	170.4	226.8	202.3	178.7	78.0	30.7	2.8
	SDLF	85.6	168.9	216.2	198.9	176.5	95.8	46.8	6.9
	TDLF	86.7	167.0	205.2	194.9	174.0	113.1	62.6	11.1
6	NLF	100.1	180.6	218.3	160.4	120.9	46.6	14.3	0.7
	SDLF	101.5	181.0	215.9	169.9	135.4	61.9	25.1	2.7
	TDLF	102.4	180.5	212.6	178.5	149.2	77.1	35.7	4.9
7	NLF	114.6	170.0	194.0	120.3	81.5	27.9	7.0	0.1
	SDLF	116.2	173.4	199.1	133.1	97.4	37.0	12.6	0.9
	TDLF	117.0	175.9	203.3	145.3	112.7	46.3	18.5	1.9
8	NLF	110.9	144.5	158.0	80.9	52.0	13.1	2.6	1.4
	SDLF	112.8	149.6	166.5	90.9	62.8	17.3	5.0	0.7
	TDLF	114.0	154.1	174.2	100.7	73.4	21.7	7.7	1.0
9	NLF	96.8	105.9	112.1	40.3	25.2	3.3	2.0	NA
	SDLF	98.8	110.5	119.6	45.8	30.5	1.5	1.0	NA
	TDLF	100.3	114.4	126.5	51.2	35.9	0.7	0.5	NA
10	NLF	72.9	56.4	58.2	4.7	5.4	NA	NA	NA
	SDLF	74.4	59.4	62.8	2.1	2.5	NA	NA	NA
	TDLF	75.5	61.6	66.8	1.0	1.1	NA	NA	NA

Table O2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	39.9	6.8	5.0	NA	NA	NA	NA	NA
	SDLF	40.9	2.6	1.9	NA	NA	NA	NA	NA
	TDLF	41.4	1.8	1.5	NA	NA	NA	NA	NA
12	NLF	5.1	NA	NA	NA	NA	NA	NA	NA
	SDLF	1.4	NA	NA	NA	NA	NA	NA	NA
	TDLF	3.0	NA	NA	NA	NA	NA	NA	NA

Table O2-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.8	2.2	1.8	0.9	4.9	6.2	3.6	5.0
	SDLF	1.0	1.7	1.3	1.4	1.1	4.0	3.1	2.2
	TDLF	5.4	6.4	5.4	4.1	8.1	17.4	12.6	10.1
2	NLF	5.2	58.6	36.0	122.3	57.4	152.9	68.2	64.2
	SDLF	5.5	57.4	32.7	86.3	35.4	66.0	22.9	20.4
	TDLF	5.6	55.2	29.1	49.5	13.0	20.9	22.8	22.5
3	NLF	29.2	74.2	118.8	134.9	159.7	128.3	116.1	17.1
	SDLF	30.9	66.6	93.5	93.2	85.0	74.8	51.1	22.2
	TDLF	32.5	59.2	67.5	51.7	10.3	21.7	12.7	27.5
4	NLF	35.1	77.8	113.9	122.4	131.3	74.9	46.0	7.5
	SDLF	36.5	74.1	96.6	98.1	91.6	76.2	51.7	13.3
	TDLF	38.0	70.6	79.5	73.5	51.7	78.1	57.8	19.0
5	NLF	38.1	80.0	110.0	101.0	91.6	43.2	20.1	3.6
	SDLF	40.5	79.7	100.5	98.7	90.5	60.8	35.3	7.6
	TDLF	43.3	79.7	91.2	96.6	89.8	78.5	50.6	11.5
6	NLF	44.8	84.0	105.0	80.4	63.2	26.8	11.1	2.0
	SDLF	48.3	86.0	103.9	90.5	78.0	42.2	21.5	4.1
	TDLF	52.1	88.0	103.0	100.5	93.0	57.6	32.0	6.4
7	NLF	51.2	79.0	93.1	60.3	43.1	16.5	6.5	0.8
	SDLF	55.5	83.8	99.3	73.7	59.2	26.0	12.3	1.8
	TDLF	60.1	88.8	105.5	87.0	75.5	35.7	18.3	3.0
8	NLF	49.6	66.8	75.5	40.5	27.6	8.0	3.0	0.3
	SDLF	54.1	73.2	85.0	51.3	38.9	12.4	5.6	0.3
	TDLF	59.0	79.9	94.6	62.2	50.6	17.1	8.6	1.8
9	NLF	43.2	48.3	53.2	20.4	13.5	1.1	0.7	NA
	SDLF	47.5	54.2	61.8	26.2	19.1	0.1	0.2	NA
	TDLF	52.3	60.2	70.3	32.1	25.1	2.4	2.4	NA
10	NLF	32.1	25.4	27.6	1.6	0.9	NA	NA	NA
	SDLF	35.7	28.8	32.4	0.1	0.0	NA	NA	NA
	TDLF	39.4	31.9	37.1	2.8	1.6	NA	NA	NA

Table O2-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	17.3	3.1	2.7	NA	NA	NA	NA	NA
	SDLF	19.3	0.1	0.1	NA	NA	NA	NA	NA
	TDLF	21.2	4.2	3.8	NA	NA	NA	NA	NA
12	NLF	4.5	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.4	NA	NA	NA	NA	NA	NA	NA
	TDLF	4.6	NA	NA	NA	NA	NA	NA	NA

Table O2-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	6.2	3.6	2.8	0.4	12.2	13.4	9.1	10.9
	SDLF	2.5	0.1	0.4	1.0	5.5	4.2	3.0	3.4
	TDLF	1.6	3.6	2.8	3.1	2.2	8.7	6.6	4.6
2	NLF	12.8	124.3	75.2	246.3	114.7	304.6	135.9	127.1
	SDLF	13.0	122.6	71.3	209.1	91.8	216.0	89.7	82.2
	TDLF	12.8	119.4	67.3	170.8	68.9	127.1	43.6	38.5
3	NLF	63.4	155.4	243.4	270.3	317.9	250.2	226.2	30.0
	SDLF	65.0	147.4	217.2	227.4	241.6	196.3	160.5	35.1
	TDLF	66.3	139.6	190.2	184.7	164.9	143.0	95.7	40.3
4	NLF	76.7	165.1	234.5	244.9	258.6	142.7	83.9	10.8
	SDLF	77.8	160.7	216.1	219.8	218.2	143.4	89.3	16.4
	TDLF	79.2	156.4	198.0	194.6	177.9	144.7	95.1	22.0
5	NLF	83.7	170.7	227.4	202.3	178.7	79.7	32.2	3.1
	SDLF	85.8	169.7	217.1	199.1	176.8	96.6	47.0	7.0
	TDLF	88.2	169.1	207.1	196.1	175.4	113.9	62.0	10.9
6	NLF	98.7	180.8	219.2	161.5	122.1	47.4	14.7	0.8
	SDLF	101.7	181.7	217.1	170.5	136.2	62.3	24.9	2.9
	TDLF	105.1	182.9	215.1	179.7	150.5	77.4	35.2	5.1
7	NLF	113.2	170.6	195.6	120.9	82.2	28.0	6.9	0.1
	SDLF	116.7	174.4	200.7	133.5	97.7	37.2	12.6	1.2
	TDLF	120.8	178.6	206.0	146.2	113.5	46.8	18.5	2.4
8	NLF	109.6	144.8	159.3	80.5	51.7	13.0	2.5	1.8
	SDLF	113.4	150.5	167.9	91.0	62.8	17.4	5.1	1.3
	TDLF	117.7	156.6	176.7	101.4	74.1	22.1	8.1	0.3
9	NLF	95.5	105.4	112.3	40.0	24.9	3.0	2.4	NA
	SDLF	99.4	111.0	120.5	45.7	30.5	2.0	1.7	NA
	TDLF	103.7	116.5	128.5	51.4	36.3	0.3	0.4	NA
10	NLF	71.5	56.1	58.3	3.9	2.4	NA	NA	NA
	SDLF	74.8	59.5	63.1	2.4	1.7	NA	NA	NA
	TDLF	78.3	62.3	67.5	0.3	0.1	NA	NA	NA

Table O2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	39.3	7.0	6.1	NA	NA	NA	NA	NA
	SDLF	41.3	4.1	3.7	NA	NA	NA	NA	NA
	TDLF	43.1	0.2	0.2	NA	NA	NA	NA	NA
12	NLF	10.2	NA	NA	NA	NA	NA	NA	NA
	SDLF	6.1	NA	NA	NA	NA	NA	NA	NA
	TDLF	1.3	NA	NA	NA	NA	NA	NA	NA

Table O2-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.46	0.49	0.46	0.45	0.40	0.38	0.32	0.33
	SDLF	0.42	0.46	0.39	0.37	0.29	0.25	0.17	0.17
	TDLF	0.38	0.41	0.31	0.27	0.16	0.12	0.02	0.01
3	NLF	0.52	0.56	0.52	0.52	0.46	0.44	0.39	0.44
	SDLF	0.51	0.55	0.48	0.46	0.37	0.32	0.25	0.29
	TDLF	0.49	0.54	0.43	0.39	0.27	0.19	0.10	0.14
4	NLF	0.58	0.61	0.57	0.55	0.49	0.47	0.45	0.44
	SDLF	0.60	0.63	0.56	0.51	0.42	0.37	0.32	0.33
	TDLF	0.61	0.65	0.53	0.45	0.32	0.25	0.18	0.21
5	NLF	0.63	0.63	0.59	0.55	0.51	0.45	0.44	0.39
	SDLF	0.68	0.68	0.60	0.52	0.44	0.37	0.34	0.30
	TDLF	0.72	0.71	0.58	0.47	0.36	0.27	0.22	0.22
6	NLF	0.66	0.63	0.59	0.51	0.48	0.39	0.39	0.28
	SDLF	0.73	0.68	0.60	0.48	0.42	0.32	0.31	0.23
	TDLF	0.79	0.73	0.60	0.44	0.35	0.25	0.22	0.18
7	NLF	0.66	0.58	0.54	0.43	0.40	0.29	0.28	0.15
	SDLF	0.74	0.63	0.56	0.41	0.36	0.24	0.23	0.12
	TDLF	0.82	0.68	0.56	0.37	0.30	0.19	0.18	0.10
8	NLF	0.61	0.49	0.45	0.31	0.29	0.15	0.15	0.00
	SDLF	0.69	0.53	0.47	0.29	0.26	0.13	0.12	0.00
	TDLF	0.78	0.57	0.47	0.27	0.22	0.10	0.10	0.00
9	NLF	0.51	0.35	0.33	0.16	0.15	0.00	0.00	NA
	SDLF	0.59	0.38	0.34	0.15	0.14	0.00	0.00	NA
	TDLF	0.66	0.41	0.34	0.14	0.12	0.00	0.00	NA
10	NLF	0.37	0.18	0.17	0.00	0.00	NA	NA	NA
	SDLF	0.42	0.20	0.18	0.00	0.00	NA	NA	NA
	TDLF	0.48	0.22	0.18	0.00	0.00	NA	NA	NA

Table O2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.19	0.00	0.00	NA	NA	NA	NA	NA
	SDLF	0.22	0.00	0.00	NA	NA	NA	NA	NA
	TDLF	0.25	0.00	0.00	NA	NA	NA	NA	NA
12	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

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Table O2-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.02	-0.02	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.02	-0.02	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00
2	NLF	1.00	1.06	0.99	0.98	0.88	0.83	0.72	0.74
	SDLF	0.96	1.02	0.93	0.90	0.77	0.71	0.57	0.58
	TDLF	0.91	0.98	0.84	0.80	0.64	0.57	0.41	0.42
3	NLF	1.11	1.19	1.11	1.11	0.99	0.95	0.85	0.94
	SDLF	1.10	1.19	1.07	1.05	0.90	0.83	0.71	0.79
	TDLF	1.08	1.17	1.02	0.98	0.80	0.70	0.56	0.64
4	NLF	1.24	1.30	1.21	1.16	1.06	1.00	0.96	0.94
	SDLF	1.26	1.32	1.20	1.12	0.98	0.90	0.83	0.83
	TDLF	1.26	1.33	1.17	1.06	0.88	0.78	0.69	0.71
5	NLF	1.35	1.34	1.26	1.15	1.07	0.96	0.94	0.82
	SDLF	1.39	1.38	1.26	1.12	1.00	0.87	0.83	0.73
	TDLF	1.43	1.41	1.24	1.07	0.92	0.77	0.72	0.65
6	NLF	1.40	1.32	1.24	1.06	1.00	0.82	0.81	0.60
	SDLF	1.47	1.38	1.25	1.03	0.94	0.75	0.73	0.54
	TDLF	1.53	1.41	1.24	0.99	0.87	0.67	0.65	0.49
7	NLF	1.39	1.21	1.13	0.89	0.84	0.60	0.59	0.32
	SDLF	1.47	1.27	1.15	0.86	0.80	0.55	0.54	0.29
	TDLF	1.55	1.31	1.15	0.83	0.74	0.50	0.49	0.26
8	NLF	1.28	1.01	0.94	0.64	0.61	0.31	0.31	0.00
	SDLF	1.36	1.06	0.95	0.62	0.58	0.29	0.29	0.00
	TDLF	1.44	1.09	0.95	0.60	0.54	0.26	0.26	0.00
9	NLF	1.07	0.73	0.68	0.33	0.32	0.00	0.00	NA
	SDLF	1.14	0.76	0.68	0.33	0.30	0.00	0.00	NA
	TDLF	1.21	0.79	0.68	0.31	0.28	0.00	0.00	NA
10	NLF	0.77	0.38	0.35	0.00	0.00	NA	NA	NA
	SDLF	0.82	0.40	0.36	0.00	0.00	NA	NA	NA
	TDLF	0.87	0.41	0.36	0.00	0.00	NA	NA	NA

Table O2-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.40	0.00	0.00	NA	NA	NA	NA	NA
	SDLF	0.43	0.00	0.00	NA	NA	NA	NA	NA
	TDLF	0.46	0.00	0.00	NA	NA	NA	NA	NA
12	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table O2-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.33	0.35	0.33	0.33	0.29	0.27	0.23	0.24
	SDLF	0.31	0.33	0.28	0.27	0.21	0.18	0.13	0.13
	TDLF	0.27	0.30	0.23	0.20	0.12	0.08	0.01	0.01
3	NLF	0.37	0.40	0.37	0.37	0.33	0.32	0.28	0.31
	SDLF	0.37	0.40	0.35	0.33	0.27	0.23	0.18	0.21
	TDLF	0.35	0.39	0.31	0.28	0.19	0.14	0.07	0.10
4	NLF	0.42	0.44	0.41	0.39	0.36	0.34	0.32	0.32
	SDLF	0.43	0.46	0.40	0.37	0.30	0.26	0.23	0.24
	TDLF	0.44	0.47	0.38	0.33	0.23	0.18	0.13	0.15
5	NLF	0.46	0.46	0.43	0.39	0.36	0.33	0.32	0.28
	SDLF	0.49	0.49	0.43	0.37	0.32	0.26	0.24	0.22
	TDLF	0.52	0.51	0.42	0.34	0.26	0.19	0.16	0.16
6	NLF	0.48	0.45	0.42	0.36	0.34	0.28	0.28	0.20
	SDLF	0.53	0.49	0.43	0.35	0.30	0.23	0.22	0.17
	TDLF	0.57	0.52	0.43	0.32	0.25	0.18	0.16	0.13
7	NLF	0.48	0.42	0.39	0.31	0.29	0.21	0.20	0.11
	SDLF	0.54	0.46	0.40	0.29	0.26	0.17	0.17	0.09
	TDLF	0.59	0.49	0.40	0.27	0.22	0.14	0.13	0.07
8	NLF	0.44	0.35	0.33	0.22	0.21	0.11	0.11	0.00
	SDLF	0.50	0.38	0.34	0.21	0.19	0.09	0.09	0.00
	TDLF	0.56	0.41	0.34	0.20	0.16	0.07	0.07	0.00
9	NLF	0.37	0.25	0.24	0.12	0.11	0.00	0.00	NA
	SDLF	0.42	0.28	0.24	0.11	0.10	0.00	0.00	NA
	TDLF	0.47	0.30	0.24	0.10	0.09	0.00	0.00	NA
10	NLF	0.27	0.13	0.12	0.00	0.00	NA	NA	NA
	SDLF	0.30	0.15	0.13	0.00	0.00	NA	NA	NA
	TDLF	0.34	0.16	0.13	0.00	0.00	NA	NA	NA

Table O2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	0.14	0.00	0.00	NA	NA	NA	NA	NA
	SDLF	0.16	0.00	0.00	NA	NA	NA	NA	NA
	TDLF	0.18	0.00	0.00	NA	NA	NA	NA	NA
12	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table O2-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.02	-0.02	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00
2	NLF	0.72	0.76	0.72	0.71	0.64	0.60	0.52	0.54
	SDLF	0.69	0.74	0.67	0.65	0.55	0.51	0.41	0.42
	TDLF	0.66	0.70	0.61	0.58	0.46	0.41	0.30	0.30
3	NLF	0.80	0.86	0.80	0.80	0.72	0.68	0.61	0.68
	SDLF	0.79	0.86	0.77	0.76	0.65	0.60	0.51	0.57
	TDLF	0.78	0.84	0.73	0.71	0.57	0.50	0.41	0.46
4	NLF	0.89	0.93	0.87	0.84	0.76	0.72	0.69	0.68
	SDLF	0.90	0.95	0.86	0.81	0.70	0.65	0.60	0.60
	TDLF	0.91	0.96	0.84	0.77	0.64	0.56	0.50	0.51
5	NLF	0.97	0.97	0.91	0.83	0.77	0.69	0.68	0.59
	SDLF	1.00	1.00	0.91	0.81	0.72	0.63	0.60	0.53
	TDLF	1.03	1.01	0.89	0.77	0.66	0.56	0.52	0.47
6	NLF	1.01	0.95	0.89	0.76	0.72	0.59	0.59	0.43
	SDLF	1.06	0.99	0.90	0.75	0.68	0.54	0.53	0.39
	TDLF	1.10	1.02	0.90	0.72	0.62	0.49	0.47	0.35
7	NLF	1.00	0.88	0.82	0.64	0.61	0.43	0.43	0.23
	SDLF	1.06	0.91	0.83	0.62	0.57	0.40	0.39	0.21
	TDLF	1.11	0.94	0.83	0.60	0.53	0.36	0.35	0.19
8	NLF	0.92	0.73	0.68	0.46	0.44	0.23	0.23	0.00
	SDLF	0.98	0.76	0.69	0.45	0.42	0.21	0.21	0.00
	TDLF	1.04	0.79	0.69	0.43	0.39	0.19	0.19	0.00
9	NLF	0.77	0.52	0.49	0.24	0.23	0.00	0.00	NA
	SDLF	0.82	0.55	0.49	0.24	0.22	0.00	0.00	NA
	TDLF	0.87	0.57	0.49	0.23	0.20	0.00	0.00	NA
10	NLF	0.55	0.27	0.25	0.00	0.00	NA	NA	NA
	SDLF	0.59	0.29	0.26	0.00	0.00	NA	NA	NA
	TDLF	0.63	0.30	0.26	0.00	0.00	NA	NA	NA

Table O2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.29	0.00	0.00	NA	NA	NA	NA	NA
	SDLF	0.31	0.00	0.00	NA	NA	NA	NA	NA
	TDLF	0.33	0.00	0.00	NA	NA	NA	NA	NA
12	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table O2-4-11. Individual support vertical reactions under SDL and TDL (kips).

		Load Type & Support Number			
Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	117	140	253	300
	SDLF	131	144	266	304
	TDLF	144	149	280	308
G2	NLF	125	129	266	276
	SDLF	131	129	272	276
	TDLF	137	128	277	276
G3	NLF	144	119	307	262
	SDLF	148	120	310	263
	TDLF	150	121	314	262
G4	NLF	69	74	153	168
	SDLF	55	71	140	164
	TDLF	42	68	125	162
G5	NLF	98	65	214	152
	SDLF	78	66	195	153
	TDLF	58	68	175	154
G6	NLF	24	58	62	139
	SDLF	39	58	77	139
	TDLF	62	59	100	140
G7	NLF	96	35	222	91
	SDLF	27	34	154	91
	TDLF	-54	32	73	89
G8	NLF	-22	24	-29	70
	SDLF	15	23	7	69
	TDLF	59	22	52	68
G9	NLF	-52	9	-77	44
	SDLF	-23	6	-47	41
	TDLF	5	2	-18	37

Table O2-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.4	NA	-1.6	NA
	SDLF	-0.2	NA	-1.0	NA
	TDLF	-0.1	NA	-0.5	NA
G2	NLF	-0.4	NA	-1.3	NA
	SDLF	-0.2	NA	-0.9	NA
	TDLF	-0.1	NA	-0.5	NA
G3	NLF	-0.3	NA	-1.1	NA
	SDLF	-0.2	NA	-0.8	NA
	TDLF	0.0	NA	-0.4	NA
G4	NLF	-0.1	NA	-0.5	NA
	SDLF	-0.1	NA	-0.3	NA
	TDLF	0.0	NA	-0.2	NA
G5	NLF	0.0	NA	-0.2	NA
	SDLF	0.0	NA	-0.2	NA
	TDLF	0.0	NA	0.0	NA
G6	NLF	0.1	NA	0.6	NA
	SDLF	0.1	NA	0.4	NA
	TDLF	0.1	NA	0.2	NA
G7	NLF	0.2	NA	0.6	NA
	SDLF	0.1	NA	0.4	NA
	TDLF	-0.1	NA	0.3	NA
G8	NLF	0.5	NA	2.0	NA
	SDLF	0.3	NA	1.3	NA
	TDLF	0.1	NA	0.6	NA
G9	NLF	0.7	NA	2.6	NA
	SDLF	0.4	NA	1.7	NA
	TDLF	0.2	NA	0.9	NA

Table O2-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number: SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.2	-0.1	-0.8	-0.3
	SDLF	0.1	0.0	-0.2	-0.2
	TDLF	0.5	0.0	0.3	-0.1
G2	NLF	-0.2	-0.1	-0.6	-0.3
	SDLF	0.1	0.0	-0.2	-0.2
	TDLF	0.4	0.0	0.2	-0.1
G3	NLF	-0.1	-0.1	-0.5	-0.3
	SDLF	0.1	0.0	-0.2	-0.2
	TDLF	0.4	0.0	0.2	-0.1
G4	NLF	-0.1	-0.1	-0.2	-0.3
	SDLF	0.1	0.0	0.0	-0.2
	TDLF	0.2	0.0	0.2	-0.1
G5	NLF	0.0	-0.1	0.0	-0.3
	SDLF	0.1	0.0	0.0	-0.2
	TDLF	0.1	0.0	0.1	-0.1
G6	NLF	0.1	-0.1	0.6	0.0
	SDLF	0.0	-0.1	0.3	0.0
	TDLF	0.0	0.0	0.1	0.0
G7	NLF	0.2	-0.1	0.7	0.0
	SDLF	0.0	-0.1	0.3	0.0
	TDLF	-0.4	0.0	0.0	0.0
G8	NLF	0.5	-0.1	1.8	-0.4
	SDLF	-0.1	0.0	0.9	-0.2
	TDLF	-0.5	0.1	-0.1	-0.1
G9	NLF	0.7	-0.1	2.4	-0.4
	SDLF	-0.2	0.0	1.1	-0.2
	TDLF	-0.9	0.1	-0.3	-0.1

Table O2-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.09	0.38	-0.32	0.53
	SDLF	-0.04	0.42	-0.19	0.68
	TDLF	-0.01	0.50	-0.10	0.93
G2	NLF	-0.07	0.35	-0.26	0.50
	SDLF	-0.04	0.36	-0.17	0.61
	TDLF	-0.02	0.42	-0.10	0.81
G3	NLF	-0.05	0.31	-0.21	0.43
	SDLF	-0.03	0.31	-0.15	0.51
	TDLF	0.00	0.34	-0.07	0.69
G4	NLF	-0.03	0.28	-0.10	0.44
	SDLF	-0.02	0.26	-0.07	0.49
	TDLF	-0.01	0.26	-0.04	0.59
G5	NLF	-0.01	0.24	-0.04	0.37
	SDLF	0.00	0.21	-0.03	0.41
	TDLF	0.00	0.19	0.00	0.50
G6	NLF	0.03	0.21	0.13	0.41
	SDLF	0.02	0.17	0.08	0.40
	TDLF	0.02	0.14	0.04	0.41
G7	NLF	0.04	0.17	0.12	0.30
	SDLF	0.02	0.12	0.08	0.31
	TDLF	-0.03	0.05	0.05	0.32
G8	NLF	0.10	0.15	0.39	0.42
	SDLF	0.06	0.09	0.25	0.33
	TDLF	0.03	0.05	0.12	0.25
G9	NLF	0.14	0.10	0.51	0.37
	SDLF	0.08	0.05	0.34	0.26
	TDLF	0.04	0.01	0.18	0.16

Table O2-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.04	-0.02	-0.15	-0.07
	SDLF	0.03	-0.01	-0.04	-0.04
	TDLF	0.10	0.01	0.05	-0.01
G2	NLF	-0.03	-0.02	-0.13	-0.07
	SDLF	0.02	0.00	-0.04	-0.04
	TDLF	0.08	0.01	0.04	-0.01
G3	NLF	-0.02	-0.02	-0.10	-0.07
	SDLF	0.02	0.00	-0.04	-0.04
	TDLF	0.07	0.01	0.04	-0.01
G4	NLF	-0.01	-0.02	-0.03	-0.07
	SDLF	0.02	0.00	0.00	-0.04
	TDLF	0.04	0.01	0.03	-0.01
G5	NLF	0.01	-0.02	0.00	-0.07
	SDLF	0.01	0.00	0.01	-0.04
	TDLF	0.02	0.01	0.03	-0.01
G6	NLF	0.03	-0.02	0.12	-0.07
	SDLF	0.01	0.00	0.07	-0.04
	TDLF	-0.01	0.01	0.02	-0.01
G7	NLF	0.04	-0.02	0.13	-0.07
	SDLF	0.00	0.00	0.06	-0.04
	TDLF	-0.07	0.01	0.00	-0.01
G8	NLF	0.09	-0.02	0.36	-0.07
	SDLF	-0.01	0.00	0.17	-0.04
	TDLF	-0.11	0.01	-0.01	-0.01
G9	NLF	0.13	-0.02	0.49	-0.07
	SDLF	-0.03	0.00	0.21	-0.04
	TDLF	-0.19	0.01	-0.06	-0.01

Appendix O2-5. NISCS15 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISCS15 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table O2-5-1. Erection method 2A fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	-2.7	-4.4	5.2	-2.7	4.5	5.3
		SDLF	-4.8	-4.0	6.3	0.4	3.9	3.9
		TDLF	-7.4	-3.4	8.1	4.0	3.2	5.1
	2-3	NLF	-5.5	-3.4	6.4	-5.5	3.5	6.5
		SDLF	-1.0	-0.8	1.3	-2.3	0.8	2.4
		TDLF	4.1	2.1	4.6	1.5	-2.2	2.7
	2-4	NLF	-3.8	-0.4	3.8	-3.8	0.5	3.8
		SDLF	1.4	-0.2	1.4	0.3	0.2	0.4
		TDLF	7.1	0.0	7.1	4.9	0.2	4.9
	2-5	NLF	-0.9	5.5	5.5	2.9	-5.5	6.2
		SDLF	6.5	6.8	9.4	9.6	-7.1	11.9
		TDLF	14.9	8.2	17.0	17.0	-8.8	19.2
	2-6	NLF	7.3	10.2	12.5	7.2	-10.1	12.4
		SDLF	16.0	11.6	19.8	15.1	-11.7	19.1
		TDLF	25.9	13.0	29.0	23.8	-13.5	27.3
	2-7	NLF	9.8	10.2	14.1	9.8	-10.6	14.4
		SDLF	20.5	15.1	25.5	19.3	-15.5	24.8
		TDLF	32.6	20.2	38.3	29.6	-21.0	36.3
	2-8	NLF	7.3	6.0	9.5	7.3	-6.1	9.5
		SDLF	20.3	17.3	26.7	18.6	-17.4	25.5
		TDLF	34.7	29.5	45.6	30.8	-29.8	42.8
	2-9	NLF	1.1	-0.2	1.2	1.2	0.2	1.2
		SDLF	17.8	22.7	28.9	16.1	-22.7	27.9
		TDLF	25.7	28.5	38.4	21.7	-28.6	35.8
	2-10	NLF	-5.1	-5.4	7.4	-5.1	5.5	7.5
		SDLF	12.4	25.5	28.3	10.8	-25.5	27.7
		TDLF	13.7	20.8	24.9	9.9	-20.9	23.2
	2-11	NLF	-5.5	-4.9	7.3	-4.8	4.9	6.9
		SDLF	5.3	15.1	16.0	4.0	-15.2	15.7
		TDLF	6.4	12.7	14.3	3.4	-12.9	13.3
	2-12	NLF	-1.3	-0.9	1.6	-1.3	0.9	1.6
		SDLF	2.1	5.3	5.7	1.2	-5.2	5.4
		TDLF	2.6	4.5	5.2	0.8	-4.3	4.4

Table O2-5-1(Continued). Erection method 2A fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-2	NLF	-0.2	-2.0	2.0	1.2	2.0	2.3
		SDLF	-1.3	-1.8	2.2	3.0	1.9	3.6
		TDLF	-3.2	-1.5	3.5	4.7	1.9	5.0
	6-3	NLF	91.1	-46.2	102.	90.8	41.8	100.0
		SDLF	91.5	-36.8	98.6	91.8	35.0	98.3
		TDLF	92.5	-27.9	96.7	93.4	26.3	97.0
	6-4	NLF	20.0	-25.5	32.4	19.6	26.4	32.9
		SDLF	36.7	-26.7	45.4	34.4	27.9	44.3
		TDLF	46.4	-27.6	54.0	41.9	29.8	51.4
	6-5	NLF	3.9	-28.5	28.8	4.1	26.8	27.1
		SDLF	21.6	-24.6	32.8	21.6	23.5	31.9
		TDLF	26.4	-22.9	35.0	26.4	21.7	34.2
	6-6	NLF	2.2	-22.1	22.2	2.3	21.8	21.9
		SDLF	17.5	-17.7	24.9	17.1	17.6	24.5
		TDLF	20.3	-17.8	27.0	19.4	17.5	26.1
	6-7	NLF	-0.2	-23.1	23.1	-0.2	23.3	23.3
		SDLF	14.6	-13.0	19.5	14.3	13.1	19.4
		TDLF	15.7	-13.4	20.7	15.1	13.3	20.1
	6-8	NLF	-3.0	-24.9	25.0	-3.0	25.3	25.5
		SDLF	11.3	-8.5	14.2	11.1	8.8	14.2
		TDLF	11.6	-9.0	14.7	11.2	8.9	14.3
	6-9	NLF	-4.2	-17.7	18.2	-4.2	18.1	18.6
		SDLF	7.4	-4.0	8.4	7.1	4.4	8.3
		TDLF	7.5	-4.3	8.6	7.1	4.3	8.3
	6-10	NLF	-2.0	-6.6	6.9	-2.1	7.0	7.3
		SDLF	3.5	-1.1	3.7	3.3	1.4	3.5
		TDLF	3.8	-1.2	3.9	3.3	1.4	3.5

Table O2-5-1(Continued). Erection method 2A fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	NLF	-0.8	-0.7	1.1	0.4	0.7	0.8
		SDLF	1.6	-0.8	1.8	1.7	1.2	2.1
		TDLF	4.8	-0.9	4.9	4.1	1.8	4.5
	9-3	NLF	47.5	-15.4	50.0	48.4	13.9	50.3
		SDLF	39.6	-6.9	40.2	40.1	6.7	40.6
		TDLF	33.3	1.5	33.4	33.1	-0.9	33.2
	9-4	NLF	9.6	-9.7	13.6	9.3	10.3	13.9
		SDLF	20.1	-9.6	22.3	20.6	10.1	22.9
		TDLF	30.5	-9.8	32.1	31.8	10.1	33.3
	9-5	NLF	1.4	-6.6	6.7	1.4	6.9	7.0
		SDLF	9.4	-6.8	11.6	9.7	6.8	11.8
		TDLF	15.2	-8.1	17.3	15.9	7.8	17.8
	9-6	NLF	-0.2	-4.5	4.5	-0.2	4.5	4.5
		SDLF	5.0	-3.8	6.3	5.2	3.8	6.4
		TDLF	7.5	-5.7	9.4	7.8	5.7	9.7
	9-7	NLF	-0.7	-2.5	2.6	-0.7	2.6	2.6
		SDLF	2.8	-1.2	3.0	2.8	1.2	3.0
		TDLF	3.8	-2.4	4.5	4.0	2.3	4.6
	9-8	NLF	-0.9	-0.9	1.3	-0.8	1.0	1.3
		SDLF	1.3	-0.1	1.3	1.2	0.1	1.2
		TDLF	1.8	-0.5	1.9	1.5	0.5	1.6

Table O2-5-2. Erection method 2B fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	-2.7	-4.4	5.2	-2.7	4.5	5.3
		SDLF	-4.8	-4.0	6.3	0.4	3.9	3.9
		TDLF	-7.4	-3.4	8.1	4.0	3.2	5.1
	2-3	NLF	-5.5	-3.4	6.4	-5.5	3.5	6.5
		SDLF	-1.0	-0.8	1.3	-2.3	0.8	2.4
		TDLF	4.1	2.1	4.6	1.5	-2.2	2.7
	2-4	NLF	-3.8	-0.4	3.8	-3.8	0.5	3.8
		SDLF	1.4	-0.2	1.4	0.3	0.2	0.4
		TDLF	7.1	0.0	7.1	4.9	0.2	4.9
	2-5	NLF	-0.9	5.5	5.5	2.9	-5.5	6.2
		SDLF	6.5	6.8	9.4	9.6	-7.1	11.9
		TDLF	14.9	8.2	17.0	17.0	-8.8	19.2
	2-6	NLF	7.3	10.2	12.5	7.2	-10.1	12.4
		SDLF	16.0	11.6	19.8	15.1	-11.7	19.1
		TDLF	25.9	13.0	29.0	23.8	-13.5	27.3
	2-7	NLF	9.8	10.2	14.1	9.8	-10.6	14.4
		SDLF	20.5	15.1	25.5	19.3	-15.5	24.8
		TDLF	32.6	20.2	38.3	29.6	-21.0	36.3
	2-8	NLF	7.3	6.0	9.5	7.3	-6.1	9.5
		SDLF	20.3	17.3	26.7	18.6	-17.4	25.5
		TDLF	34.7	29.5	45.6	30.8	-29.8	42.8
	2-9	NLF	1.1	-0.2	1.2	1.2	0.2	1.2
		SDLF	17.8	22.7	28.9	16.1	-22.7	27.9
		TDLF	25.7	28.5	38.4	21.7	-28.6	35.8
	2-10	NLF	-5.1	-5.4	7.4	-5.1	5.5	7.5
		SDLF	12.4	25.5	28.3	10.8	-25.5	27.7
		TDLF	13.7	20.8	24.9	9.9	-20.9	23.2
	2-11	NLF	-5.5	-4.9	7.3	-4.8	4.9	6.9
		SDLF	5.3	15.1	16.0	4.0	-15.2	15.7
		TDLF	6.4	12.7	14.3	3.4	-12.9	13.3
	2-12	NLF	-1.3	-0.9	1.6	-1.3	0.9	1.6
		SDLF	2.1	5.3	5.7	1.2	-5.2	5.4
		TDLF	2.6	4.5	5.2	0.8	-4.3	4.4

Table O2-5-2(Continued). Erection method 2B fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-2	NLF	-0.3	-2.0	2.0	-1.5	2.0	2.5
		SDLF	-1.7	-1.8	2.5	0.4	2.0	2.0
		TDLF	-3.2	-1.5	3.5	3.0	1.9	3.5
	6-3	NLF	-54.3	13.2	55.9	-54.1	-12.1	55.4
		SDLF	-31.6	12.9	34.1	-31.3	-12.2	33.6
		TDLF	-5.2	12.3	13.3	-4.7	-11.0	11.9
	6-4	NLF	-39.9	20.4	44.8	-38.5	-20.3	43.5
		SDLF	-13.8	12.0	18.3	-15.0	-12.0	19.2
		TDLF	14.5	2.5	14.7	11.1	-2.3	11.3
	6-5	NLF	-29.3	24.6	38.3	-29.2	-23.8	37.7
		SDLF	-4.3	20.6	21.1	-4.6	-20.0	20.5
		TDLF	22.4	16.0	27.6	22.0	-15.2	26.8
	6-6	NLF	-29.4	20.3	35.7	-29.2	-19.7	35.2
		SDLF	-4.1	20.2	20.6	-4.6	-19.8	20.4
		TDLF	23.0	20.2	30.6	21.9	-19.6	29.4
	6-7	NLF	-33.7	8.4	34.8	-33.5	-7.9	34.4
		SDLF	-8.4	18.2	20.0	-8.7	-17.9	19.9
		TDLF	17.6	28.2	33.2	16.9	-27.7	32.4
	6-8	NLF	-35.8	-5.6	36.2	-35.6	6.1	36.1
		SDLF	-12.2	13.1	17.9	-12.4	-12.9	17.9
		TDLF	4.9	25.1	25.6	4.4	-24.8	25.2
	6-9	NLF	-31.8	-9.8	33.3	-31.8	10.1	33.3
		SDLF	-13.0	6.6	14.6	-13.3	-6.4	14.7
		TDLF	-0.9	15.6	15.6	-1.3	-15.4	15.5
	6-10	NLF	-16.3	-3.9	16.8	-16.3	3.9	16.7
		SDLF	-7.2	2.8	7.7	-7.4	-2.7	7.9
		TDLF	-1.0	6.6	6.7	-1.6	-6.3	6.5

Table O2-5-2(Continued). Erection method 2B fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	NLF	-1.7	-0.7	1.8	-2.5	0.7	2.6
		SDLF	0.7	-0.8	1.1	-0.9	1.2	1.5
		TDLF	4.0	-0.9	4.1	2.1	1.7	2.7
	9-3	NLF	-41.0	6.8	41.5	-41.4	-6.6	42.0
		SDLF	-37.3	12.2	39.2	-38.4	-11.7	40.1
		TDLF	-29.7	17.3	34.3	-31.3	-16.1	35.2
	9-4	NLF	-36.1	11.1	37.8	-36.0	-10.8	37.6
		SDLF	-9.4	10.5	14.1	-8.8	-10.6	13.8
		TDLF	19.9	9.3	22.0	21.3	-9.9	23.5
	9-5	NLF	-30.1	7.8	31.0	-29.9	-7.4	30.8
		SDLF	-6.7	11.1	12.9	-6.3	-11.3	12.9
		TDLF	19.0	15.0	24.2	19.7	-15.2	24.9
	9-6	NLF	-26.4	-1.3	26.4	-26.2	1.5	26.2
		SDLF	-7.8	7.5	10.8	-7.7	-7.3	10.6
		TDLF	7.5	13.0	15.0	7.8	-12.7	14.9
	9-7	NLF	-22.2	-6.7	23.2	-22.2	6.8	23.2
		SDLF	-8.1	2.6	8.6	-8.2	-2.5	8.5
		TDLF	2.0	7.8	8.0	2.0	-7.7	7.9
	9-8	NLF	-14.8	-4.8	15.5	-14.7	4.7	15.4
		SDLF	-5.8	0.3	5.8	-5.9	-0.3	5.9
		TDLF	0.7	3.3	3.4	0.3	-3.1	3.1

Table O2-5-3. Erection method 2C fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	-2.5	-3.4	4.2	-2.6	3.4	4.3
		SDLF	-5.5	-3.2	6.4	0.4	3.2	3.3
		TDLF	-9.0	-3.0	9.5	3.8	3.1	4.9
	2-3	NLF	-4.5	-1.8	4.8	-4.5	1.9	4.9
		SDLF	-1.3	0.7	1.5	-2.2	-0.6	2.3
		TDLF	2.1	3.4	4.0	0.3	-3.4	3.4
	2-4	NLF	-1.6	4.6	4.9	-0.9	-4.5	4.6
		SDLF	3.9	7.7	8.6	3.3	-7.7	8.4
		TDLF	10.0	11.1	15.0	7.7	-11.3	13.7
	2-5	NLF	5.6	10.5	11.9	5.6	-10.6	12.0
		SDLF	13.5	13.9	19.4	11.9	-14.1	18.4
		TDLF	22.2	17.8	28.4	18.6	-18.1	25.9
	2-6	NLF	9.0	9.5	13.1	9.0	-9.7	13.2
		SDLF	19.5	16.0	25.2	17.8	-16.1	24.1
		TDLF	31.2	23.1	38.8	27.3	-23.4	36.0
	2-7	NLF	6.7	4.3	8.0	6.8	-4.5	8.1
		SDLF	20.9	18.4	27.9	19.3	-18.5	26.8
		TDLF	36.8	33.8	50.0	32.9	-34.0	47.3
	2-8	NLF	0.4	-2.7	2.7	0.5	2.7	2.7
		SDLF	19.1	22.4	29.4	17.8	-22.5	28.7
		TDLF	25.8	23.4	34.8	22.6	-23.7	32.7
	2-9	NLF	-5.4	-7.1	8.9	-5.4	7.2	9.0
		SDLF	13.7	22.9	26.6	12.8	-22.9	26.3
		TDLF	16.6	15.8	22.9	14.4	-16.3	21.8
	2-10	NLF	-7.7	-5.1	9.2	-3.8	5.1	6.4
		SDLF	6.4	14.1	15.4	6.2	-14.2	15.5
		TDLF	9.2	9.0	12.9	8.2	-9.6	12.7
	2-11	NLF	-2.2	-0.6	2.3	-2.4	0.9	2.5
		SDLF	3.1	6.8	7.5	2.1	-6.8	7.1
		TDLF	5.2	4.1	6.7	3.2	-4.7	5.7
	2-12	NLF	-0.7	0.0	0.7	-0.7	-0.2	0.7
		SDLF	3.1	5.4	6.2	1.8	-5.3	5.6
		TDLF	5.5	4.1	6.9	3.0	-4.8	5.6

Table O2-5-3(Continued). Erection method 2C fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-2	NLF	0.2	-1.4	1.4	-1.1	1.4	1.8
		SDLF	-1.4	-1.3	1.9	0.4	1.3	1.3
		TDLF	-3.2	-1.2	3.4	2.9	1.2	3.1
	6-3	NLF	-46.7	14.8	49.0	-46.6	-14.3	48.7
		SDLF	-21.5	8.9	23.3	-21.9	-8.4	23.4
		TDLF	6.1	2.4	6.6	5.4	-1.5	5.6
	6-4	NLF	-41.3	23.6	47.6	-41.2	-22.8	47.1
		SDLF	-16.4	17.2	23.7	-16.7	-16.6	23.5
		TDLF	10.9	10.3	15.0	10.2	-9.2	13.8
	6-5	NLF	-34.6	24.7	42.5	-34.3	-24.2	42.0
		SDLF	-9.3	21.7	23.6	-9.6	-21.2	23.2
		TDLF	18.5	18.6	26.2	17.8	-17.3	24.8
	6-6	NLF	-33.8	14.2	36.6	-33.4	-13.9	36.2
		SDLF	-7.6	19.9	21.3	-7.9	-19.4	21.0
		TDLF	21.4	26.3	34.0	20.5	-24.9	32.3
	6-7	NLF	-35.3	-1.7	35.3	-34.9	2.0	34.9
		SDLF	-10.1	14.9	18.0	-10.6	-14.4	17.9
		TDLF	12.8	27.4	30.2	11.6	-26.2	28.6
	6-8	NLF	-34.2	-10.7	35.9	-33.9	10.8	35.6
		SDLF	-15.0	9.1	17.6	-15.2	-8.6	17.5
		TDLF	0.2	20.0	20.0	-0.1	-18.9	18.9
	6-9	NLF	-28.1	-8.0	29.2	-25.8	8.1	27.0
		SDLF	-16.1	6.5	17.4	-17.4	-5.7	18.3
		TDLF	-5.7	14.9	16.0	-10.0	-13.1	16.4
	6-10	NLF	-10.3	-2.0	10.5	-10.2	1.8	10.4
		SDLF	-14.7	10.3	17.9	-14.4	-9.6	17.3
		TDLF	-15.0	19.9	25.0	-14.6	-17.5	22.8

Table O2-5-3(Continued). Erection method 2C fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	NLF	0.1	-0.5	0.6	-0.9	0.5	1.0
		SDLF	-0.5	-0.5	0.7	-0.3	0.5	0.6
		TDLF	-1.6	-0.5	1.7	0.9	0.4	1.0
	9-3	NLF	-38.4	7.7	39.1	-38.2	-7.6	39.0
		SDLF	-18.6	5.6	19.5	-18.8	-5.3	19.5
		TDLF	4.1	3.2	5.2	3.7	-2.5	4.4
	9-4	NLF	-36.5	10.9	38.0	-36.3	-10.7	37.8
		SDLF	-16.9	10.3	19.8	-16.9	-10.0	19.6
		TDLF	5.6	9.6	11.1	5.5	-8.7	10.3
	9-5	NLF	-33.9	7.7	34.8	-33.7	-7.7	34.5
		SDLF	-15.5	12.2	19.7	-15.4	-11.8	19.4
		TDLF	5.9	17.2	18.2	6.1	-16.0	17.2
	9-6	NLF	-31.4	-1.0	31.4	-31.1	1.0	31.2
		SDLF	-16.7	10.7	19.8	-16.4	-10.1	19.3
		TDLF	-2.9	19.7	19.9	-2.4	-18.3	18.5
	9-7	NLF	-26.0	-6.1	26.7	-25.9	6.0	26.6
		SDLF	-20.6	7.9	22.0	-20.1	-7.1	21.4
		TDLF	-16.4	17.6	24.1	-15.4	-15.7	22.0
	9-8	NLF	-13.2	-4.3	13.8	-13.3	4.5	14.0
		SDLF	-30.4	7.2	31.2	-31.2	-6.9	31.9
		TDLF	-46.0	16.7	48.9	-47.7	-15.1	50.0

Table O2-5-4. Erection method 4 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	2.8	0.8	2.9	2.1	-0.8	2.2
		SDLF	0.6	1.8	1.9	5.1	-1.8	5.4
		TDLF	-2.0	2.8	3.5	8.7	-3.0	9.2
	2-3	NLF	3.7	-1.7	4.0	3.7	1.9	4.1
		SDLF	8.0	3.4	8.7	6.9	-3.3	7.6
		TDLF	13.0	9.1	15.9	10.4	-9.1	13.8
	2-4	NLF	2.8	-0.2	2.8	2.7	0.8	2.8
		SDLF	6.7	2.2	7.1	5.7	-1.5	5.9
		TDLF	11.1	4.6	12.0	8.9	-3.9	9.7
	2-5	NLF	-0.6	0.7	0.9	1.1	0.0	1.1
		SDLF	4.9	5.0	7.0	5.7	-4.4	7.3
		TDLF	11.1	9.6	14.7	10.7	-9.4	14.3
	2-6	NLF	-2.1	3.4	4.0	-2.3	-2.5	3.4
		SDLF	4.9	9.1	10.3	3.8	-8.4	9.2
		TDLF	12.7	15.4	20.0	10.3	-15.1	18.3
	2-7	NLF	-5.4	2.3	5.9	-5.5	-1.9	5.8
		SDLF	6.6	16.3	17.6	5.1	-16.0	16.8
		TDLF	20.1	31.8	37.6	16.7	-31.9	36.0
	2-8	NLF	-5.1	-1.6	5.4	-6.2	1.7	6.5
		SDLF	15.2	25.3	29.5	10.1	-25.4	27.4
		TDLF	29.5	38.5	48.5	21.6	-38.9	44.5
	2-9	NLF	-1.7	-4.5	4.8	-1.7	4.3	4.6
		SDLF	18.5	20.2	27.4	16.9	-20.5	26.6
		TDLF	31.7	31.2	44.5	27.8	-31.7	42.2
	2-10	NLF	1.8	-5.1	5.5	1.9	5.0	5.3
		SDLF	22.0	19.5	29.4	20.5	-19.8	28.5
		TDLF	24.6	14.0	28.3	21.0	-14.4	25.5
	2-11	NLF	1.6	-4.0	4.3	2.1	3.9	4.4
		SDLF	13.2	9.3	16.1	12.0	-9.5	15.3
		TDLF	14.7	6.3	16.1	11.9	-6.5	13.5
	2-12	NLF	1.7	-0.3	1.7	1.7	0.3	1.8
		SDLF	5.7	3.8	6.9	5.0	-3.8	6.3
		TDLF	6.5	2.8	7.0	4.8	-2.7	5.5

Table O2-5-4(Continued). Erection method 4 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-2	NLF	0.3	0.3	0.5	-0.1	-0.3	0.4
		SDLF	-0.9	0.8	1.3	1.3	-0.6	1.4
		TDLF	-2.4	1.4	2.8	3.6	-1.1	3.7
	6-3	NLF	-1.0	1.0	1.4	-1.0	-1.0	1.4
		SDLF	-18.3	14.2	23.1	-18.1	-13.1	22.3
		TDLF	-9.2	19.8	21.9	-8.8	-17.8	19.8
	6-4	NLF	-2.6	2.5	3.6	-2.3	-2.5	3.4
		SDLF	-9.8	10.8	14.6	-11.8	-9.9	15.4
		TDLF	8.4	6.7	10.7	4.0	-4.7	6.2
	6-5	NLF	-1.4	2.6	3.0	-1.4	-2.7	3.0
		SDLF	-8.4	15.3	17.4	-8.8	-13.5	16.1
		TDLF	14.4	15.7	21.3	13.6	-12.1	18.2
	6-6	NLF	-0.6	1.0	1.2	-0.6	-1.1	1.2
		SDLF	-10.6	14.1	17.6	-11.3	-13.0	17.2
		TDLF	22.1	21.9	31.1	20.7	-19.7	28.5
	6-7	NLF	-0.1	-1.8	1.8	-1.5	1.7	2.3
		SDLF	-9.0	13.3	16.1	-10.9	-13.1	17.0
		TDLF	21.5	28.9	36.0	20.8	-28.4	35.2
	6-8	NLF	-2.7	-1.6	3.1	-2.6	1.7	3.1
		SDLF	-3.8	12.2	12.7	-4.0	-12.0	12.7
		TDLF	10.9	23.3	25.7	10.4	-22.9	25.2
	6-9	NLF	-3.6	-1.2	3.8	-3.6	1.3	3.8
		SDLF	-1.8	7.3	7.5	-2.0	-7.2	7.5
		TDLF	5.0	13.1	14.0	4.5	-12.9	13.7
	6-10	NLF	-2.0	-0.2	2.0	-2.0	0.2	2.0
		SDLF	-0.6	3.0	3.0	-0.8	-2.9	3.0
		TDLF	2.3	5.2	5.7	1.8	-4.9	5.3

Table O2-5-4(Continued). Erection method 4 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
9	9-2	NLF	0.2	0.0	0.2	-0.1	0.0	0.1
		SDLF	1.6	0.0	1.6	0.0	0.4	0.4
		TDLF	4.3	0.0	4.3	2.3	0.9	2.4
	9-3	NLF	-1.7	0.5	1.8	-1.7	-0.4	1.8
		SDLF	-28.6	11.7	30.9	-29.7	-10.6	31.5
		TDLF	-31.9	19.3	37.3	-33.8	-16.9	37.8
	9-4	NLF	-1.8	1.0	2.0	-1.8	-1.0	2.0
		SDLF	-2.9	7.6	8.2	-2.4	-7.0	7.4
		TDLF	18.4	9.7	20.9	19.6	-8.6	21.4
	9-5	NLF	-1.1	0.1	1.2	-1.1	-0.1	1.1
		SDLF	0.8	8.6	8.7	1.2	-8.6	8.6
		TDLF	18.7	15.2	24.1	19.4	-15.0	24.5
	9-6	NLF	-0.8	-0.7	1.0	-0.7	0.7	1.0
		SDLF	-1.8	7.3	7.5	-1.6	-7.1	7.3
		TDLF	7.6	13.4	15.4	7.9	-13.1	15.3
	9-7	NLF	-1.5	-0.4	1.5	-1.5	0.4	1.6
		SDLF	-4.1	4.1	5.8	-4.1	-4.0	5.7
		TDLF	2.0	8.0	8.2	2.0	-7.8	8.1
	9-8	NLF	-1.5	-0.2	1.6	-1.5	0.2	1.5
		SDLF	-3.1	1.4	3.5	-3.3	-1.4	3.5
		TDLF	0.7	3.4	3.5	0.3	-3.2	3.2

Table O2-5-5: Erection Critical Sub-Stages with cranes at the NL elevations

Erection Method	Stage	Detailing Method	Critical Sub-Stage
2A	**2**	NLF	2-7
		SDLF	2-9
		TDLF	2-8
	6	NLF	6-3
		SDLF	6-3
		TDLF	6-3
	9	NLF	9-3
		SDLF	9-3
		TDLF	9-3
2B	**2**	NLF	2-7
		SDLF	2-9
		TDLF	2-8
	6	NLF	6-3
		SDLF	6-3
		TDLF	6-7
	9	NLF	9-3
		SDLF	9-3
		TDLF	9-3
2C	**2**	NLF	2-6
		SDLF	2-8
		TDLF	2-7
	6	NLF	6-3
		SDLF	6-3
		TDLF	6-6
	9	NLF	9-3
		SDLF	9-8
		TDLF	9-8
4	2	NLF	2-8
		SDLF	2-10
		TDLF	2-8
	6	NLF	6-9
		SDLF	6-3
		TDLF	6-7
	9	NLF	9-4
		SDLF	9-3
		TDLF	9-3

Table O2-5-6. Erection method 2A critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	13.9	3.6	14.3	NA	NA	NA
		SDLF	21.6	7.4	22.9	NA	NA	NA
		TDLF	49.1	9.7	50.1	NA	NA	NA
	B	NLF	9.8	10.2	14.1	9.8	-10.6	14.4
		SDLF	17.8	22.7	28.9	16.1	-22.7	27.9
		TDLF	34.7	29.5	45.6	30.8	-29.8	42.8
6	A	NLF	140.8	-8.8	141.0	NA	NA	NA
		SDLF	147.3	-5.6	147.4	NA	NA	NA
		TDLF	155.7	-4.3	155.8	NA	NA	NA
	B	NLF	91.1	-46.2	102.1	90.8	41.8	100.0
		SDLF	91.5	-36.8	98.6	91.8	35.0	98.3
		TDLF	92.5	-27.9	96.7	93.4	26.3	97.0
9	A	NLF	76.8	-3.4	76.9	NA	NA	NA
		SDLF	68.2	-1.0	68.2	NA	NA	NA
		TDLF	62.3	0.8	62.3	NA	NA	NA
	B	NLF	47.5	-15.4	50.0	48.4	13.9	50.3
		SDLF	39.6	-6.9	40.2	40.1	6.7	40.6
		TDLF	33.3	1.5	33.4	33.1	-0.9	33.2

Table O2-5-7. Erection method 2B critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	13.9	3.6	14.3	NA	NA	NA
		SDLF	21.6	7.4	22.9	NA	NA	NA
		TDLF	49.1	9.7	50.1	NA	NA	NA
	B	NLF	9.8	10.2	14.1	9.8	-10.6	14.4
		SDLF	17.8	22.7	28.9	16.1	-22.7	27.9
		TDLF	34.7	29.5	45.6	30.8	-29.8	42.8
6	A	NLF	-88.1	2.1	88.1	NA	NA	NA
		SDLF	-47.4	1.9	47.4	NA	NA	NA
		TDLF	36.3	13.4	38.7	NA	NA	NA
	B	NLF	-54.3	13.2	55.9	-54.1	-12.1	55.4
		SDLF	-31.6	12.9	34.1	-31.3	-12.2	33.6
		TDLF	17.6	28.2	33.2	16.9	-27.7	32.4
9	A	NLF	-69.0	1.0	69.0	NA	NA	NA
		SDLF	-58.7	2.1	58.7	NA	NA	NA
		TDLF	-41.6	3.5	41.8	NA	NA	NA
	B	NLF	-41.0	6.8	41.5	-41.4	-6.6	42.0
		SDLF	-37.3	12.2	39.2	-38.4	-11.7	40.1
		TDLF	-29.7	17.3	34.3	-31.3	-16.1	35.2

Table O2-5-8. Erection method 2C critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	12.7	3.0	13.1	NA	NA	NA
		SDLF	24.4	7.2	25.5	NA	NA	NA
		TDLF	50.7	10.7	51.8	NA	NA	NA
	B	NLF	9.0	9.5	13.1	9.0	-9.7	13.2
		SDLF	19.1	22.4	29.4	17.8	-22.5	28.7
		TDLF	36.8	33.8	50.0	32.9	-34.0	47.3
6	A	NLF	-69.1	2.9	69.1	NA	NA	NA
		SDLF	-30.2	1.9	30.2	NA	NA	NA
		TDLF	39.6	12.3	41.4	NA	NA	NA
	B	NLF	-46.7	14.8	49.0	-46.6	-14.3	48.7
		SDLF	-21.5	8.9	23.3	-21.9	-8.4	23.4
		TDLF	21.4	26.3	34.0	20.5	-24.9	32.3
9	A	NLF	-60.3	1.4	60.3	NA	NA	NA
		SDLF	-50.9	3.3	51.0	NA	NA	NA
		TDLF	-78.0	8.2	78.4	NA	NA	NA
	B	NLF	-38.4	7.7	39.1	-38.2	-7.6	39.0
		SDLF	-30.4	7.2	31.2	-31.2	-6.9	31.9
		TDLF	-46.0	16.7	48.9	-47.7	-15.1	50.0

Table O2-5-9. Erection method 4 critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	-1.1	-1.6	1.9	NA	NA	NA
		SDLF	20.5	5.1	21.1	NA	NA	NA
		TDLF	48.4	13.8	50.3	NA	NA	NA
	B	NLF	-5.1	-1.6	5.4	-6.2	1.7	6.5
		SDLF	22.0	19.5	29.4	20.5	-19.8	28.5
		TDLF	29.5	38.5	48.5	21.6	-38.9	44.5
6	A	NLF	-6.1	-0.9	6.1	NA	NA	NA
		SDLF	-21.9	2.9	22.0	NA	NA	NA
		TDLF	40.6	14.1	43.0	NA	NA	NA
	B	NLF	-3.6	-1.2	3.8	-3.6	1.3	3.8
		SDLF	-18.3	14.2	23.1	-18.1	-13.1	22.3
		TDLF	21.5	28.9	36.0	20.8	-28.4	35.2
9	A	NLF	-2.7	0.3	2.7	NA	NA	NA
		SDLF	-39.8	3.4	40.0	NA	NA	NA
		TDLF	-45.9	6.4	46.3	NA	NA	NA
	B	NLF	-1.8	1.0	2.0	-1.8	-1.0	2.0
		SDLF	-28.6	11.7	30.9	-29.7	-10.6	31.5
		TDLF	-31.9	19.3	37.3	-33.8	-16.9	37.8

Table O2-5-10. Erection method 2A vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	-3.8	104.4	89.7	2.9	
			SDLF	21.5	114.8	117.8	15.0	
			TDLF	59.0	82.9	143.9	6.6	
		G2	NLF	13.1	82.7	165.4	82.7	8.4
			SDLF	24.1	34.6	69.3	34.6	24.5
			TDLF	14.1	24.3	48.7	24.3	28.4
	B	G1	NLF	-5.6	107.7	90.4	2.8	
			SDLF	20.3	121.4	126.4	13.2	
			TDLF	55.1	91.8	149.5	5.7	
		G2	NLF	14.8	81.2	162.3	81.1	9.4
			SDLF	30.9	22.5	45.0	22.5	31.4
			TDLF	21.1	13.8	27.6	13.8	34.4

Table O2-5-10(Continued). Erection method 2A vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	A	G1	NLF	120.6	188.7			
			SDLF	127.1	189.4			
			TDLF	133.5	190.5			
		G2	NLF	154.0	143.7			
			SDLF	150.6	142.8			
			TDLF	147.1	141.0			
		G3	NLF	188.1	100.1			
			SDLF	181.7	101.1			
			TDLF	173.6	102.8			
		G4	NLF	41.5	36.2			
			SDLF	33.7	33.7			
			TDLF	27.0	30.1			
		G5	NLF	44.0	-2.4			
			SDLF	58.3	1.3			
			TDLF	76.2	5.8			
		G6	NLF	-99.7	17.7	35.4	17.7	15.9
			SDLF	-101.0	15.8	31.7	15.9	15.5
			TDLF	-104.7	13.6	27.3	13.7	15.7

Table O2-5-10(Continued). Erection method 2A vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	B	G1	NLF	116.1	185.9			
			SDLF	123.3	187.0			
			TDLF	130.4	188.6			
		G2	NLF	146.9	142.7			
			SDLF	144.4	141.9			
			TDLF	142.1	140.4			
		G3	NLF	180.7	100.8			
			SDLF	175.3	101.9			
			TDLF	168.7	103.4			
		G4	NLF	52.3	37.4			
			SDLF	43.0	35.2			
			TDLF	36.2	30.6			
		G5	NLF	103.7	2.4			
			SDLF	110.8	4.4			
			TDLF	114.8	10.3			
		G6	NLF	-152.0	19.2	38.4	19.2	12.3
			SDLF	-146.1	16.5	33.0	16.5	13.5
			TDLF	-138.4	13.4	26.9	13.5	13.5

Table O2-5-10(Continued). Erection method 2A vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	A	G1	NLF	117.0	144.6			
			SDLF	129.9	147.8			
			TDLF	142.9	151.3			
		G2	NLF	126.3	130.8			
			SDLF	131.3	131.1			
			TDLF	136.2	130.5			
		G3	NLF	146.0	119.8			
			SDLF	148.4	120.8			
			TDLF	149.9	122.1			
		G4	NLF	68.3	72.7			
			SDLF	54.3	70.3			
			TDLF	40.2	67.1			
		G5	NLF	98.1	61.7			
			SDLF	78.3	62.6			
			TDLF	57.3	64.4			
		G6	NLF	21.5	51.7			
			SDLF	36.7	51.2			
			TDLF	59.8	51.6			
		G7	NLF	89.4	28.9			
			SDLF	25.8	26.4			
			TDLF	-49.0	23.2			
		G8	NLF	-40.6	16.9			
			SDLF	18.6	13.5			
			TDLF	86.8	10.6			
		G9	NLF	-35.8	0.1	0.1	0.1	15.1
			SDLF	-33.2	2.4	4.9	2.5	13.8
			TDLF	-33.3	3.8	7.5	3.8	13.3

Table O2-5-10(Continued). Erection method 2A vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	B	G1	NLF	116.4	142.9			
			SDLF	129.6	146.8			
			TDLF	142.8	151.0			
		G2	NLF	125.3	130.0			
			SDLF	130.7	130.6			
			TDLF	136.0	130.4			
		G3	NLF	144.7	119.7			
			SDLF	147.6	120.8			
			TDLF	149.6	122.2			
		G4	NLF	68.0	73.3			
			SDLF	54.2	70.7			
			TDLF	40.2	67.2			
		G5	NLF	97.5	62.6			
			SDLF	77.9	63.2			
			TDLF	57.2	64.7			
		G6	NLF	22.2	53.3			
			SDLF	37.2	52.1			
			TDLF	60.1	51.9			
		G7	NLF	94.1	29.8			
			SDLF	28.6	27.1			
			TDLF	-48.2	23.6			
		G8	NLF	-22.0	18.0			
			SDLF	29.4	14.2			
			TDLF	90.1	11.0			
		G9	NLF	-56.6	1.4	2.7	1.4	12.3
			SDLF	-44.1	2.3	4.6	2.3	13.0
			TDLF	-34.1	2.0	4.0	2.0	14.4

Table O2-5-11. Erection method 2B vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	-3.8	104.4	89.7	2.9	
			SDLF	21.5	114.8	117.8	15.0	
			TDLF	59.0	82.9	143.9	6.6	
		G2	NLF	13.1	82.7	165.4	82.7	8.4
			SDLF	24.1	34.6	69.3	34.6	24.5
			TDLF	14.1	24.3	48.7	24.3	28.4
	B	G1	NLF	-5.6	107.7	90.4	2.8	
			SDLF	20.3	121.4	126.4	13.2	
			TDLF	55.1	91.8	149.5	5.7	
		G2	NLF	14.8	81.2	162.3	81.1	9.4
			SDLF	30.9	22.5	45.0	22.5	31.4
			TDLF	21.1	13.8	27.6	13.8	34.4

Table O2-5-11(Continued). Erection method 2B vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	A	G1	NLF	0.5	271.0	211.4	10.9	
			SDLF	33.7	206.9	204.9	28.1	
			TDLF	72.4	149.6	187.8	49.1	
		G2	NLF	4.9	29.2			
			SDLF	30.1	38.9			
			TDLF	58.5	53.6			
		G3	NLF	20.3	51.4			
			SDLF	41.8	57.4			
			TDLF	65.6	71.0			
		G4	NLF	56.3	50.9			
			SDLF	43.9	47.5			
			TDLF	28.5	50.5			
		G5	NLF	17.6	59.9			
			SDLF	34.1	56.7			
			TDLF	25.5	61.2			
		G6	NLF	60.1	64.9	129.8	65.0	-8.2
			SDLF	33.9	55.8	111.7	55.9	-3.7
			TDLF	72.0	5.4	10.8	5.4	23.4

Table O2-5-11(Continued). Erection method 2B vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	B	G1	NLF	-0.8	277.9	212.4	10.0	
			SDLF	32.7	212.6	205.7	27.4	
			TDLF	71.9	148.9	192.4	48.4	
		G2	NLF	4.3	28.3			
			SDLF	29.7	38.2			
			TDLF	58.4	52.4			
		G3	NLF	19.8	50.6			
			SDLF	41.5	56.7			
			TDLF	66.0	69.5			
		G4	NLF	52.8	50.6			
			SDLF	41.2	47.1			
			TDLF	28.9	49.2			
		G5	NLF	-3.2	58.5			
			SDLF	16.7	56.0			
			TDLF	27.3	62.2			
		G6	NLF	81.8	66.3	132.7	66.4	-8.0
			SDLF	52.6	56.3	112.8	56.5	-3.3
			TDLF	75.8	0.0	0.0	0.0	30.1

Table O2-5-11(Continued). Erection method 2B vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	A	G1	NLF	-9.9	305.6	274.5	3.7	
			SDLF	25.1	250.2	250.3	22.1	
			TDLF	65.4	181.4	224.8	42.3	
		G2	NLF	-1.7	20.2			
			SDLF	24.5	32.6			
			TDLF	54.7	46.0			
		G3	NLF	17.0	40.9			
			SDLF	39.2	51.1			
			TDLF	65.8	62.6			
		G4	NLF	56.7	40.4			
			SDLF	43.2	41.8			
			TDLF	28.5	44.3			
		G5	NLF	39.4	46.3			
			SDLF	27.4	49.6			
			TDLF	17.1	52.9			
		G6	NLF	53.7	52.4			
			SDLF	62.9	52.3			
			TDLF	77.5	54.5			
		G7	NLF	50.5	43.8			
			SDLF	-8.1	39.6			
			TDLF	-75.7	33.6			
		G8	NLF	28.1	44.2			
			SDLF	77.5	37.6			
			TDLF	132.6	32.0			
		G9	NLF	37.2	51.1	102.2	51.1	-12.6
			SDLF	29.8	46.8	93.6	46.8	-10.1
			TDLF	18.6	40.0	80.1	40.0	-6.6

Table O2-5-11(Continued). Erection method 2B vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	B	G1	NLF	-10.4	307.3	277.4	3.3	
			SDLF	24.5	252.6	254.2	21.6	
			TDLF	64.7	184.3	229.3	41.8	
		G2	NLF	-2.0	19.7			
			SDLF	24.2	31.9			
			TDLF	54.4	45.1			
		G3	NLF	16.8	40.3			
			SDLF	39.0	50.3			
			TDLF	65.4	61.8			
		G4	NLF	56.8	39.7			
			SDLF	43.4	41.0			
			TDLF	28.9	43.2			
		G5	NLF	39.3	45.7			
			SDLF	27.2	48.7			
			TDLF	16.5	52.1			
		G6	NLF	53.6	51.5			
			SDLF	62.8	51.1			
			TDLF	77.4	53.0			
		G7	NLF	47.5	43.3			
			SDLF	-12.2	39.1			
			TDLF	-81.4	33.4			
		G8	NLF	18.3	43.6			
			SDLF	63.8	37.2			
			TDLF	117.6	31.0			
		G9	NLF	50.0	52.3	104.6	52.3	-12.3
			SDLF	48.8	46.6	93.3	46.7	-8.3
			TDLF	41.8	38.3	76.7	38.4	-3.0

Table O2-5-12. Erection method 2C vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	1.1	89.9	102.8	-1.9	
			SDLF	18.3	111.5	126.2	15.0	
			TDLF	13.5	129.2	104.9	40.4	
		G2	NLF	8.1	81.9	163.8	81.9	12.9
			SDLF	24.5	28.7	57.4	28.7	30.5
			TDLF	27.0	19.9	39.9	19.9	25.4
	B	G1	NLF	1.2	90.6	106.8	-4.0	
			SDLF	16.4	120.3	133.5	14.3	
			TDLF	12.4	136.0	115.8	36.5	
		G2	NLF	9.4	79.8	159.6	79.8	14.8
			SDLF	32.0	15.6	31.2	15.6	37.5
			TDLF	34.8	6.2	12.3	6.2	33.9

Table O2-5-12(Continued). Erection method 2C vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	A	G1	NLF	4.7	241.5	224.6	16.5	
			SDLF	36.0	191.6	210.3	31.0	
			TDLF	74.7	129.5	197.0	51.4	
		G2	NLF	7.7	33.1			
			SDLF	31.5	41.0			
			TDLF	60.2	53.9			
		G3	NLF	23.5	52.2			
			SDLF	43.4	58.1			
			TDLF	67.8	68.2			
		G4	NLF	66.0	38.9			
			SDLF	49.0	42.9			
			TDLF	34.9	42.7			
		G5	NLF	81.0	12.8			
			SDLF	69.8	36.3			
			TDLF	61.7	47.8			
		G6	NLF	-8.1	67.0	134.3	67.3	37.2
			SDLF	-2.9	55.0	110.3	55.2	17.6
			TDLF	17.9	15.9	31.8	15.9	36.4

Table O2-5-12(Continued). Erection method 2C vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	B	G1	NLF	4.4	239.2	231.4	17.5	
			SDLF	35.8	190.4	214.0	31.5	
			TDLF	74.1	130.7	199.2	50.7	
		G2	NLF	7.8	33.5			
			SDLF	31.6	41.3			
			TDLF	59.9	53.1			
		G3	NLF	23.7	51.6			
			SDLF	43.5	57.9			
			TDLF	67.4	67.8			
		G4	NLF	65.3	32.6			
			SDLF	48.6	39.7			
			TDLF	34.4	43.1			
		G5	NLF	79.5	-8.8			
			SDLF	69.1	23.9			
			TDLF	64.0	49.7			
		G6	NLF	-9.5	71.2	142.7	71.5	56.7
			SDLF	-3.7	57.4	114.9	57.5	29.1
			TDLF	23.2	9.5	19.0	9.5	41.6

Table O2-5-12(Continued). Erection method 2C vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	A	G1	NLF	-8.8	298.4	269.1	4.8	
			SDLF	23.6	253.3	260.6	21.4	
			TDLF	65.3	185.3	225.4	42.0	
		G2	NLF	-1.0	22.6			
			SDLF	23.6	31.9			
			TDLF	54.6	45.8			
		G3	NLF	17.2	44.7			
			SDLF	38.5	50.5			
			TDLF	65.7	62.7			
		G4	NLF	56.3	44.3			
			SDLF	42.4	41.0			
			TDLF	29.6	44.6			
		G5	NLF	39.9	51.3			
			SDLF	26.5	47.7			
			TDLF	17.2	54.3			
		G6	NLF	55.0	55.4			
			SDLF	61.5	47.7			
			TDLF	78.2	57.0			
		G7	NLF	61.6	35.6			
			SDLF	-12.0	32.4			
			TDLF	-79.3	36.8			
		G8	NLF	63.7	4.3			
			SDLF	72.7	25.1			
			TDLF	118.9	38.8			
		G9	NLF	-7.2	48.8	97.8	49.0	27.4
			SDLF	39.1	56.0	112.1	56.1	9.8
			TDLF	78.1	0.0	0.0	0.0	28.5

Table O2-5-12(Continued). Erection method 2C vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
9	B	G1	NLF	-9.1	298.6	271.3	4.7	
			SDLF	23.5	254.0	261.2	21.3	
			TDLF	65.1	186.6	226.7	41.8	
		G2	NLF	-1.1	22.6			
			SDLF	23.6	31.8			
			TDLF	54.5	45.4			
		G3	NLF	17.1	45.0			
			SDLF	38.5	50.4			
			TDLF	65.6	62.5			
		G4	NLF	56.1	44.7			
			SDLF	42.6	40.9			
			TDLF	30.0	44.3			
		G5	NLF	39.7	52.0			
			SDLF	26.6	47.7			
			TDLF	17.1	54.3			
		G6	NLF	54.8	55.5			
			SDLF	61.7	47.8			
			TDLF	78.5	56.8			
		G7	NLF	61.0	32.4			
			SDLF	-13.2	32.6			
			TDLF	-82.2	37.4			
		G8	NLF	63.0	-10.0			
			SDLF	67.3	25.1			
			TDLF	110.5	37.1			
		G9	NLF	-7.8	51.6	103.3	51.7	40.4
			SDLF	47.4	55.0	110.1	55.1	10.4
			TDLF	89.9	0.0	0.0	0.0	29.3

Table O1-5-13. Erection method 4 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
2	A	G1	NLF	43.2	71.6	49.1	35.8		
			SDLF	77.8	90.1	85.6	75.6		
			TDLF	83.6	83.9	82.0	78.5		
		G2	NLF	14.8	66.7	46.2	92.3	46.1	13.4
			SDLF	32.3	0.0	0.0	0.0	0.0	32.4
			TDLF	26.8	0.0	2.4	4.8	2.4	27.2
	B	G1	NLF	43.7	69.9	50.6	36.0		
			SDLF	75.5	96.3	79.4	72.5		
			TDLF	67.7	125.9	29.4	61.2		
		G2	NLF	15.1	65.1	45.5	91.0	45.5	13.7
			SDLF	33.1	0.0	1.2	2.4	1.2	32.9
			TDLF	21.8	0.0	28.6	57.2	28.6	22.1

Table O1-5-13(Continued). Erection method 4 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
6	A	G1	NLF	48.6	131.0	45.4			
			SDLF	80.3	238.4	75.9			
			TDLF	109.1	217.0	96.1			
		G2	NLF	43.6	128.7	41.9			
			SDLF	61.6	27.8	65.2			
			TDLF	81.1	0.0	83.1			
		G3	NLF	41.2	122.2	38.0			
			SDLF	54.5	0.0	59.5			
			TDLF	72.3	0.0	80.8			
		G4	NLF	24.3	74.0	23.9			
			SDLF	24.1	0.0	35.3			
			TDLF	14.7	0.0	45.9			
		G5	NLF	23.0	57.8	19.2			
			SDLF	31.9	60.3	36.3			
			TDLF	19.9	0.0	47.6			
		G6	NLF	12.0	39.7	32.3	64.8	32.4	7.0
			SDLF	27.4	28.3	26.0	52.1	26.0	6.9
			TDLF	73.7	0.0	7.8	15.7	7.9	22.5

Table O1-5-13(Continued). Erection method 4 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
6	B	G1	NLF	48.6	131.3	45.4			
			SDLF	81.8	243.9	75.4			
			TDLF	108.5	219.0	96.6			
		G2	NLF	43.6	128.7	42.0			
			SDLF	62.8	25.0	65.0			
			TDLF	80.8	0.0	83.0			
		G3	NLF	41.1	122.1	38.1			
			SDLF	55.0	0.0	59.7			
			TDLF	72.3	0.0	80.2			
		G4	NLF	24.1	73.7	23.9			
			SDLF	21.4	0.0	36.0			
			TDLF	15.4	0.0	45.1			
		G5	NLF	22.8	57.4	19.2			
			SDLF	16.7	55.2	36.6			
			TDLF	21.8	0.0	48.9			
		G6	NLF	11.3	39.3	34.3	68.8	34.4	6.5
			SDLF	49.6	41.0	15.5	31.1	15.6	11.4
			TDLF	79.4	0.0	0.0	0.0	0.0	30.0

Table O1-5-13(Continued). Erection method 4 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
9	A	G1	NLF	48.3	126.1	43.6			
			SDLF	86.1	265.0	77.0			
			TDLF	110.7	264.9	94.8			
		G2	NLF	43.7	126.7	41.0			
			SDLF	65.1	70.5	66.2			
			TDLF	82.9	0.0	78.9			
		G3	NLF	41.9	124.0	38.6			
			SDLF	54.9	4.9	60.4			
			TDLF	73.8	0.0	74.3			
		G4	NLF	25.8	79.5	26.4			
			SDLF	18.4	0.0	36.6			
			TDLF	11.1	0.0	42.5			
		G5	NLF	26.6	68.3	25.1			
			SDLF	16.1	0.0	38.6			
			TDLF	8.7	0.0	47.8			
		G6	NLF	25.6	89.3	23.8			
			SDLF	53.3	0.0	39.0			
			TDLF	75.3	0.0	48.8			
		G7	NLF	19.9	40.5	17.8			
			SDLF	-13.3	18.1	29.8			
			TDLF	-75.6	0.0	30.5			
		G8	NLF	18.5	38.8	14.9			
			SDLF	80.6	41.8	29.9			
			TDLF	135.1	0.0	32.4			
		G9	NLF	10.0	17.5	14.0	28.0	14.0	5.6
			SDLF	27.4	15.2	25.5	51.0	25.5	-0.1
			TDLF	30.1	16.6	24.6	49.3	24.7	-0.2

Table O1-5-13(Continued). Erection method 4 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
9	B	G1	NLF	48.4	126.1	43.5			
			SDLF	86.4	264.4	76.8			
			TDLF	110.8	269.7	95.3			
		G2	NLF	43.7	126.7	41.0			
			SDLF	65.4	71.9	66.0			
			TDLF	82.9	0.0	78.7			
		G3	NLF	41.9	124.0	38.6			
			SDLF	55.1	9.4	60.3			
			TDLF	73.6	0.0	73.6			
		G4	NLF	25.8	79.6	26.4			
			SDLF	18.7	0.0	36.5			
			TDLF	11.1	0.0	41.5			
		G5	NLF	26.6	68.4	25.1			
			SDLF	16.0	0.0	38.7			
			TDLF	8.1	0.0	46.8			
		G6	NLF	25.6	89.5	23.8			
			SDLF	53.2	0.0	39.3			
			TDLF	75.1	0.0	47.3			
		G7	NLF	19.9	40.5	17.8			
			SDLF	-16.4	12.7	30.6			
			TDLF	-81.3	0.0	30.4			
		G8	NLF	18.1	39.8	14.9			
			SDLF	69.5	34.1	31.0			
			TDLF	120.8	0.0	30.9			
		G9	NLF	10.5	17.7	14.5	29.1	14.6	5.4
			SDLF	48.7	25.9	18.0	36.0	18.0	4.0
			TDLF	57.7	33.0	9.8	19.6	9.8	8.5

Appendix P-1. EISCS3 Bridge Description

The key characteristics of EISCS3 are as follows:

- Span length along the centerline of the bridge, L_s = 153 ft.
- Width between the fascia girders, w_g = 74 ft.
- Radius of curvature to the centerline of the bridge, R =279 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 5.0
- Subtended angle between the supports, L_s/R = 0.55
- Number of girders in the completed bridge cross-section, n_g =6.
- Skew angle, θ = 52.4,0°

This appendix presents the bridge description of the bridge EISCS3 in its final condition as well as during erection. The following figures and tables are provided:

Figure P-1-1.	Framing plan
Figure P-1-2.	Bridge cross-section
Figure P-1-3.	Girder Elevation
Figure P-1-4.	Cross-section dimension
Figure P-1-5.	Cross-frame details
Figure P-1-6.	Erection scheme
Table P-1-1.	Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed NLF

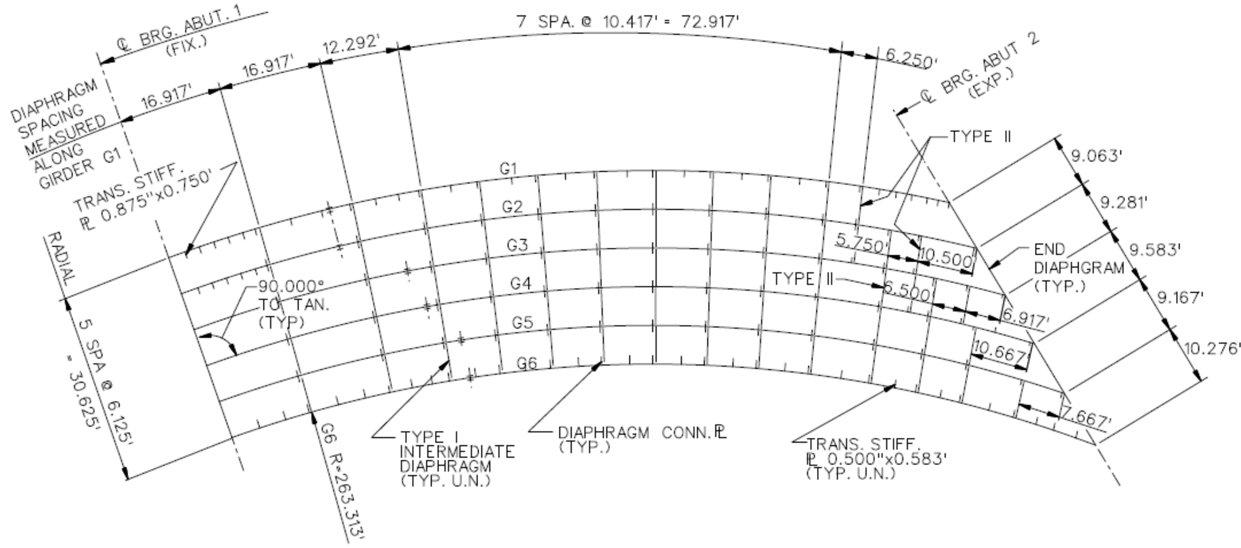


Figure P-1-1. Framing plan.

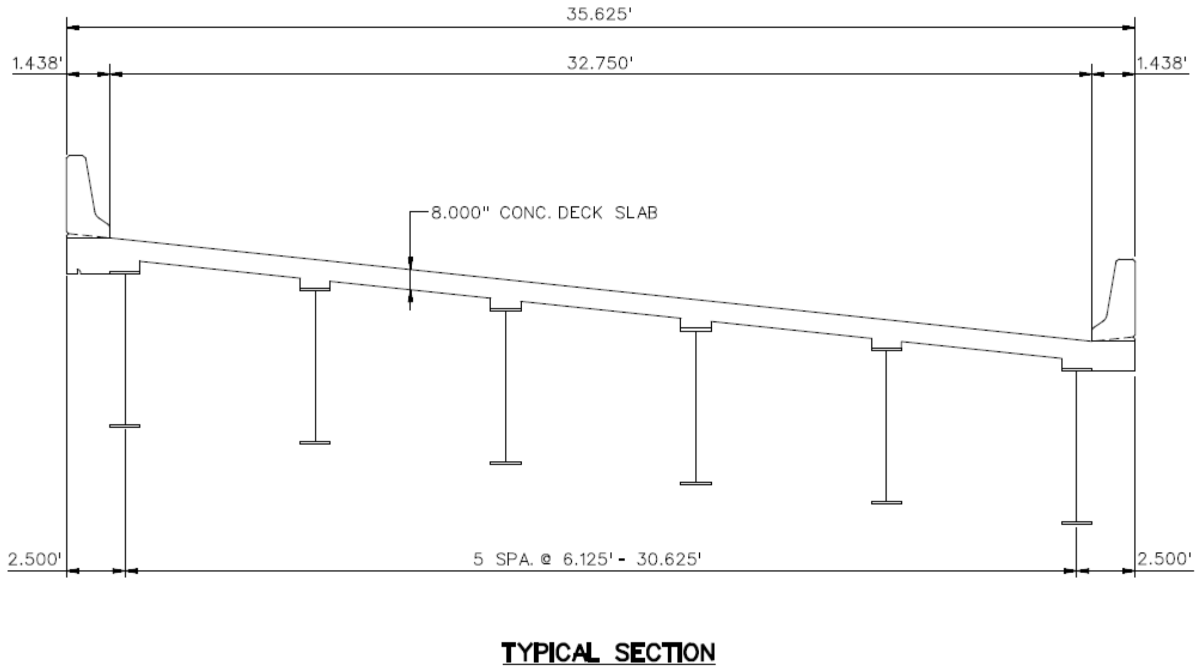


Figure P-1-2. Bridge cross-section.

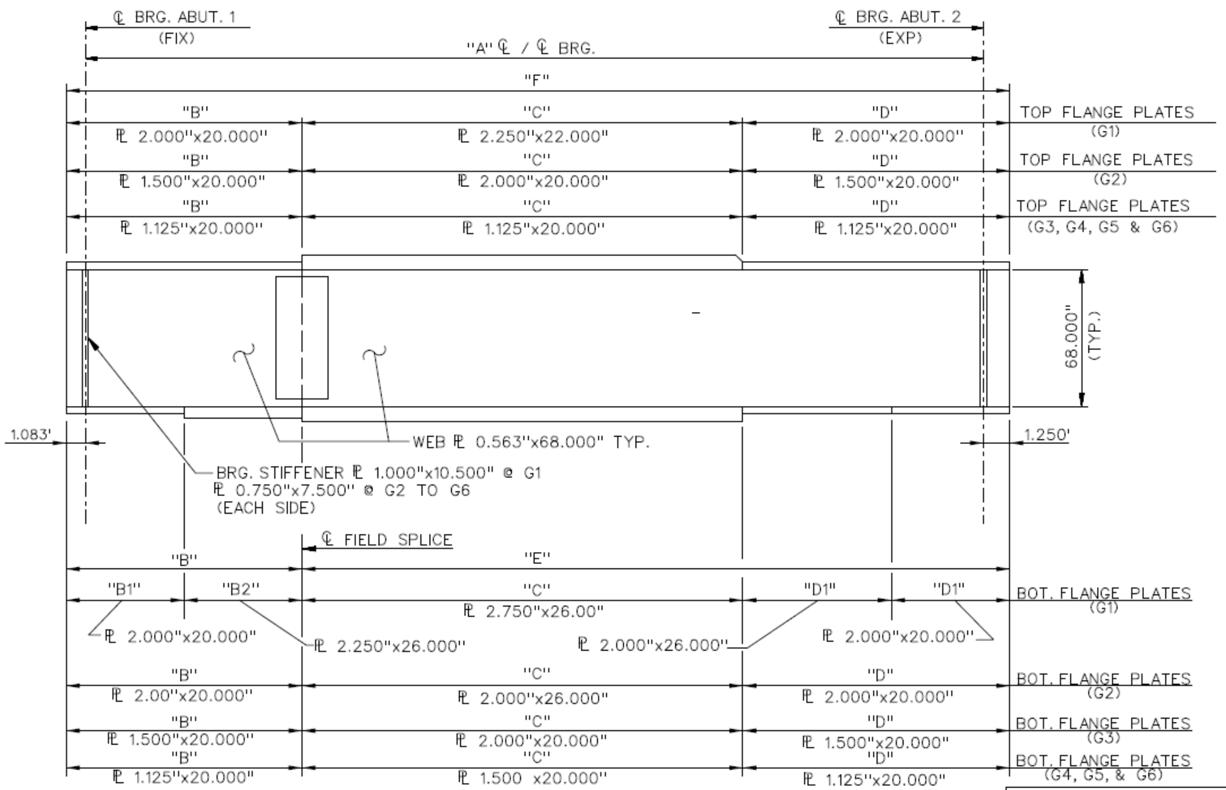
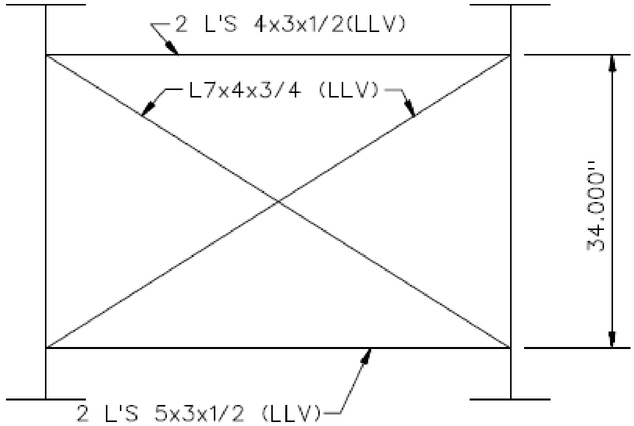


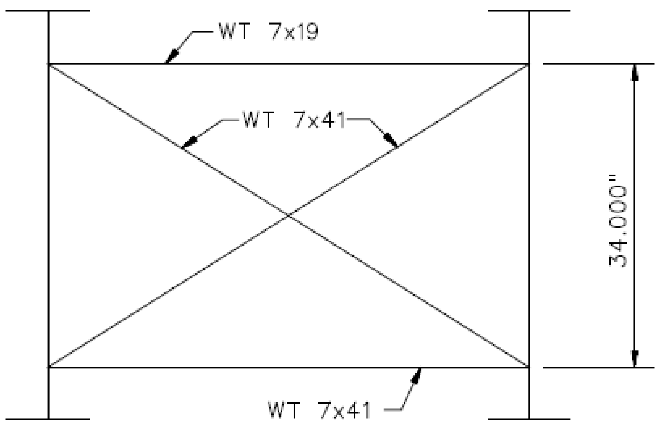
Figure P-1-3. Girder elevations

	TABLE OF GIRDER DIMENSIONS									
GIRDER	DIM. "A"	DIM. "B"	DIM. "B1"	DIM. "B2"	DIM. "C"	DIM. "D"	DIM. "D1"	DIM. "D1"	DIM. "E"	DIM. "F"
G1	141.208'	30.917'	11.000'	19.917'	84.167'	28.458'	18.458'	10.000'	112.625'	143.542'
G2	144.865'	30.250'	———	———	83.417'	33.531'	———	———	116.948'	147.198'
G3	148.698'	39.333'	———	———	73.333'	38.365'	———	———	111.698'	151.031'
G4	152.760'	40.833'	———	———	74.333'	39.927'	———	———	114.260'	155.094'
G5	157.073'	46.917'	———	———	68.333'	44.156'	———	———	112.490'	159.406'
G6	161.708'	46.417'	———	———	69.250'	48.375'	———	———	117.625'	164.042'

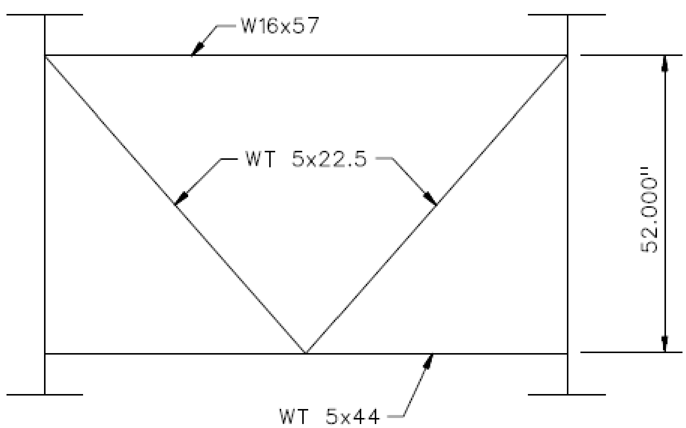
Figure P-1-4. Cross-section dimensions.



INTERMEDIATE DIAPHRAGM - TYPE I



INTERMEDIATE DIAPHRAGM - TYPE II



END DIAPHGRAM

Figure P-1-4. Cross-frame details

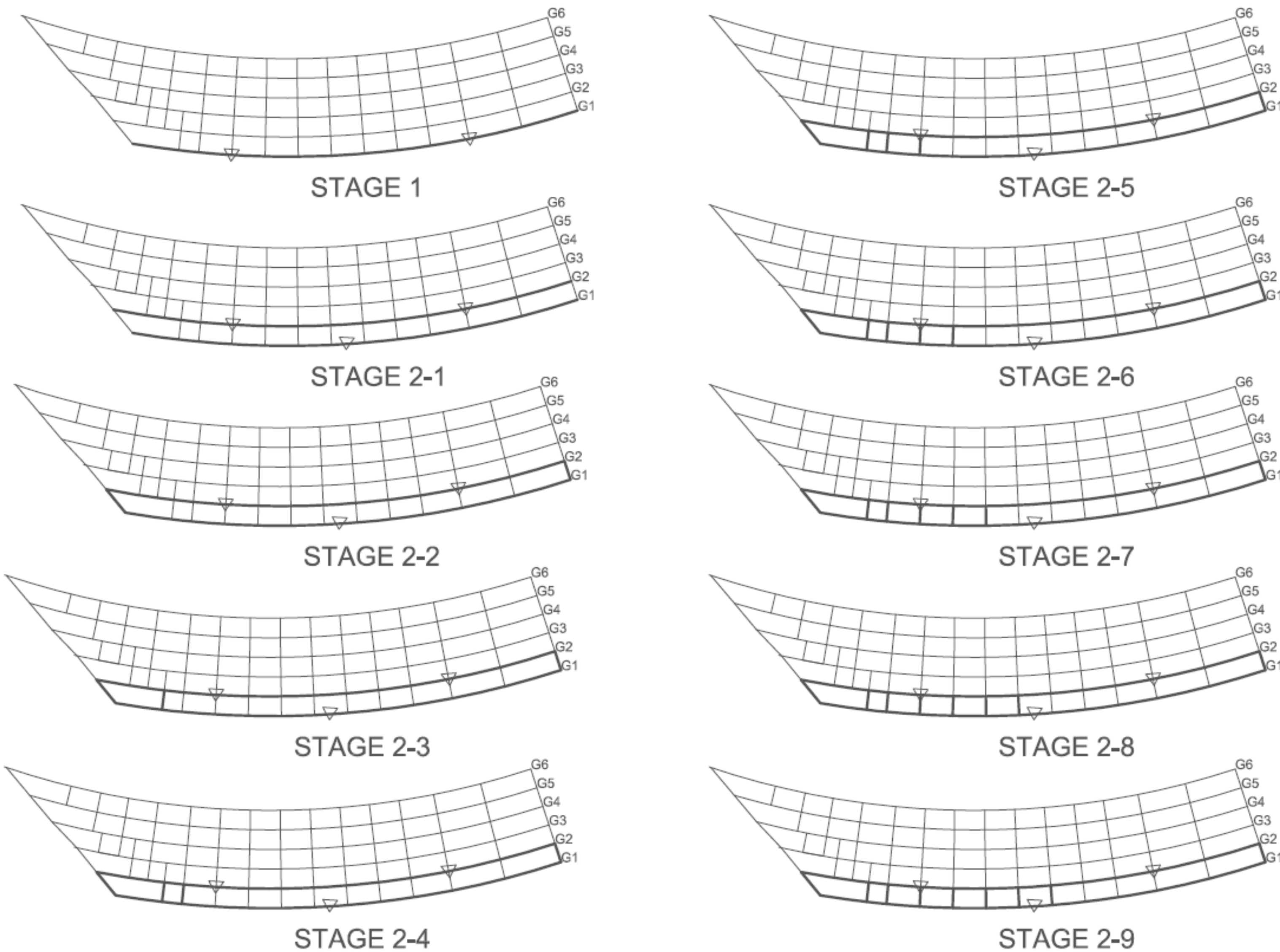
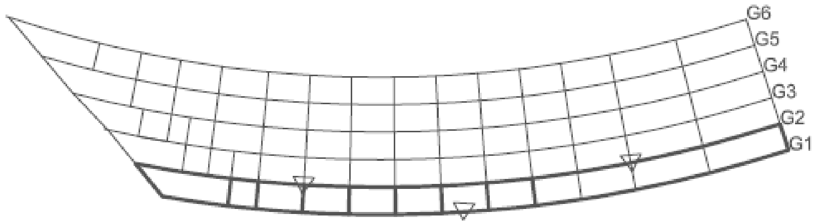
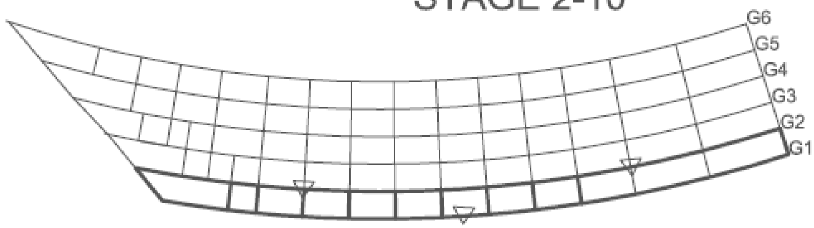


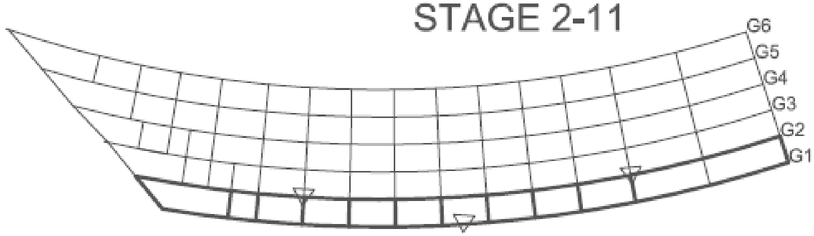
Figure P-1-6. Erection scheme 1.



STAGE 2-10



STAGE 2-11



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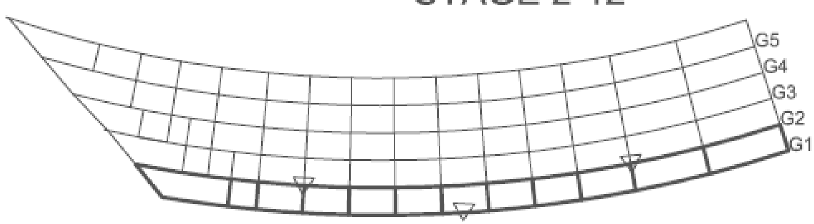


STAGE 2-13

REPEAT THE SEQUENCE FOR G3 TO G6

THE HOLDING CRANE IS ON G1 UNTIL 4 OUTSIDE GIRDERS ARE ERECTED.

Figure P-1-6(Continued). Erection scheme 1.

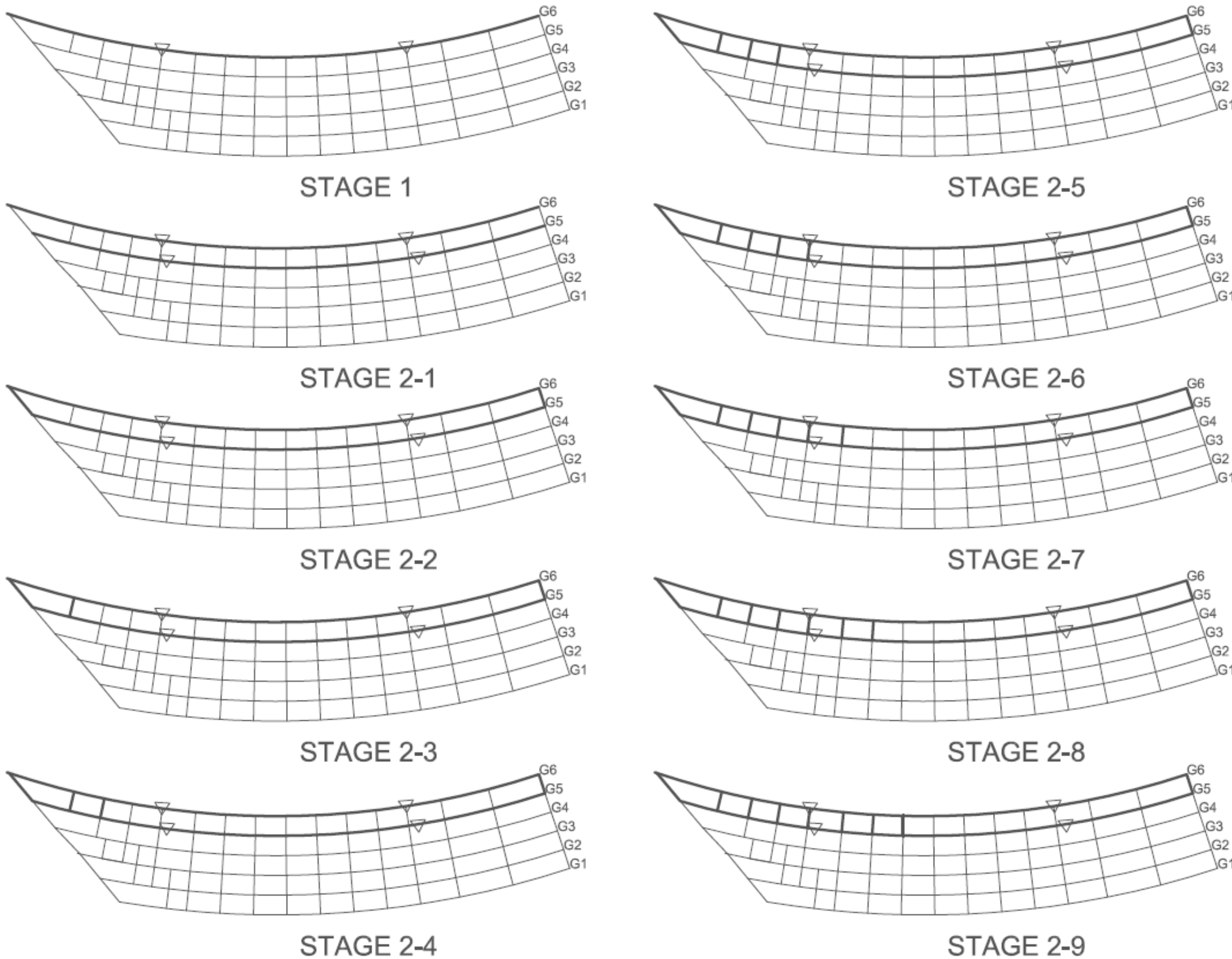
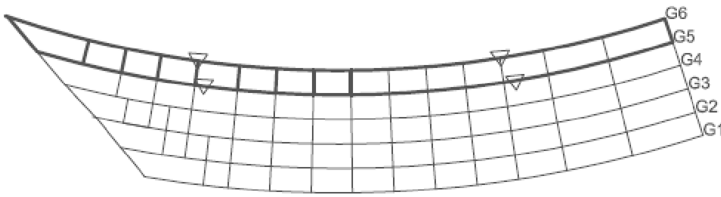
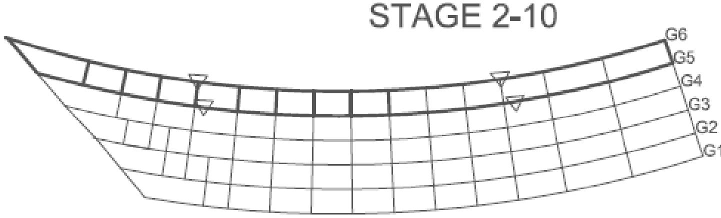


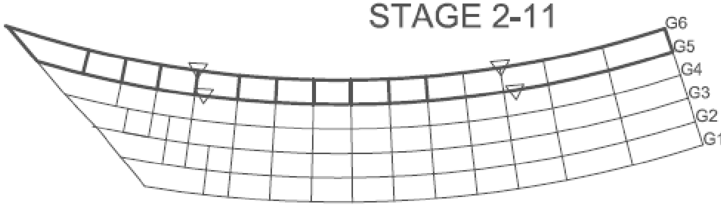
Figure P-1-6(Continued). Erection scheme 2.



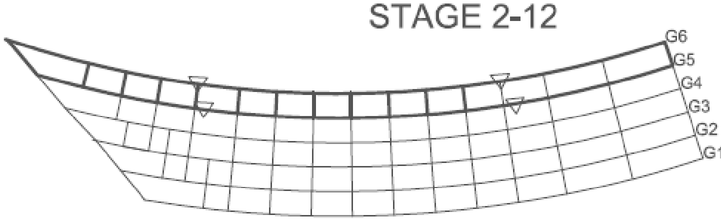
STAGE 2-10



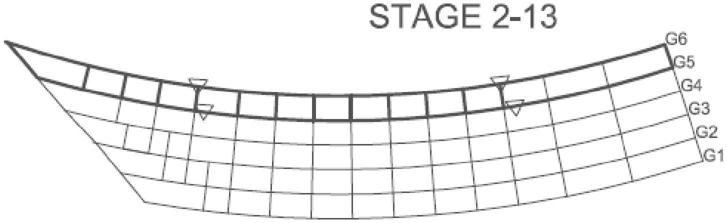
STAGE 2-11



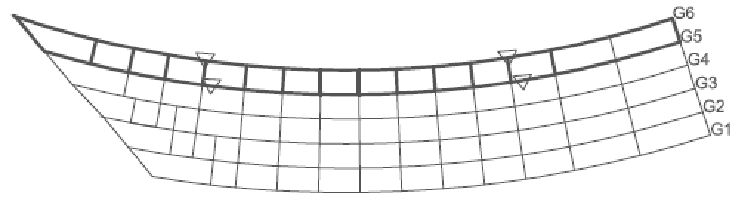
STAGE 2-12



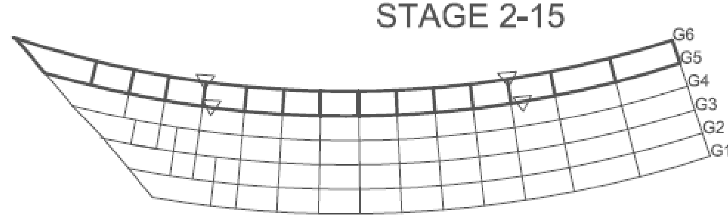
STAGE 2-13



STAGE 2-14



STAGE 2-15



STAGE 2-16

REPEAT THE SEQUENCE
FOR G4 TO G1

THE TWO HOLDING CRANES
ARE ON THE INSIDE GIRDER
ADJACENT TO THE GIRDER
BEING INSTALLED

Figure P-1-6(Continued). Erection scheme 2.

Table P-1-1. Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

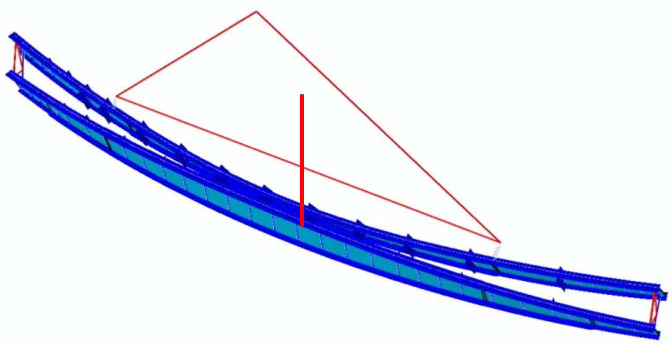
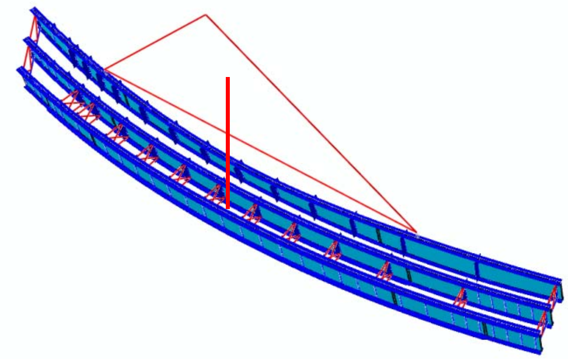
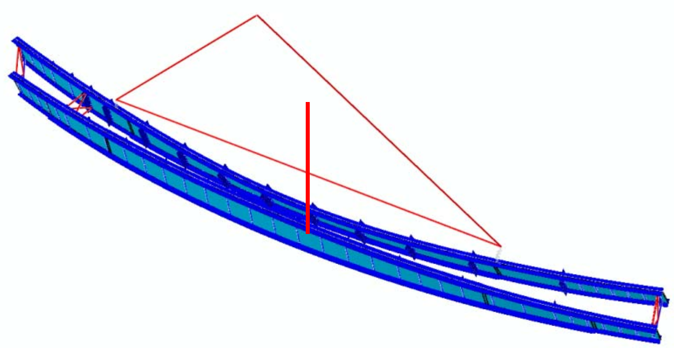
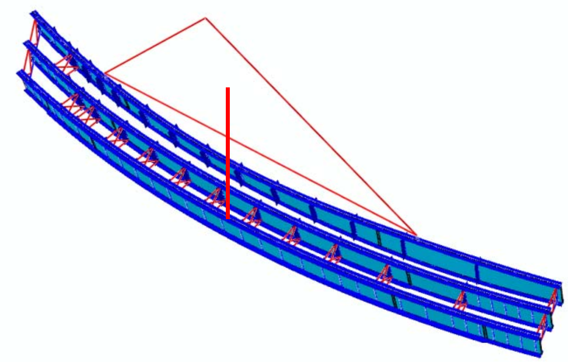
Sub-Stage	Stage	
	2	3
1		
2		

Table P-1-1(Continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

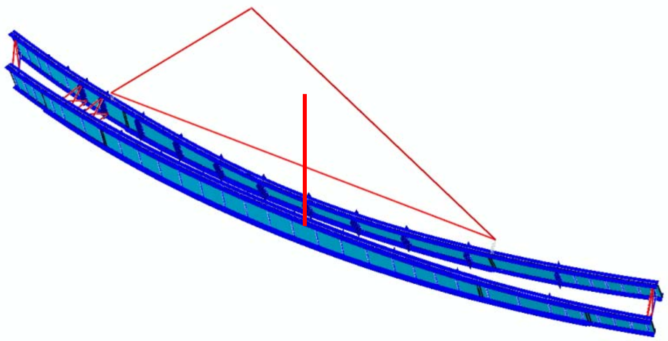
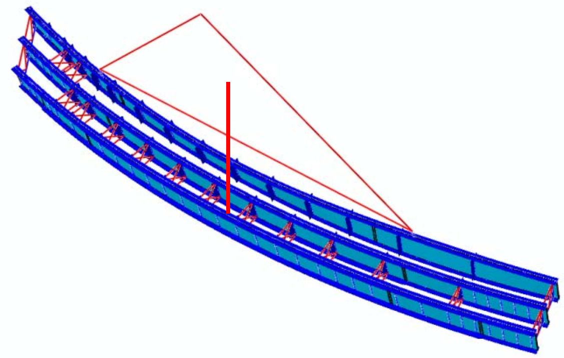
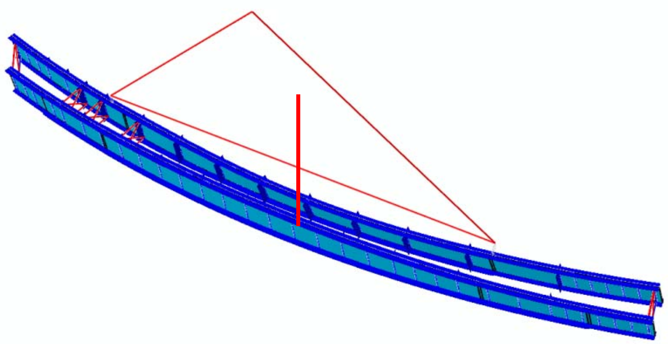
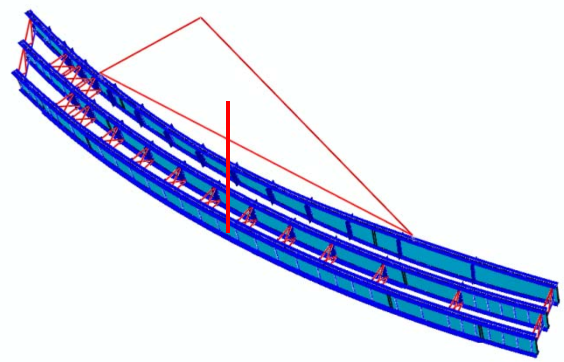
3		
4		

Table P-1-1(Continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

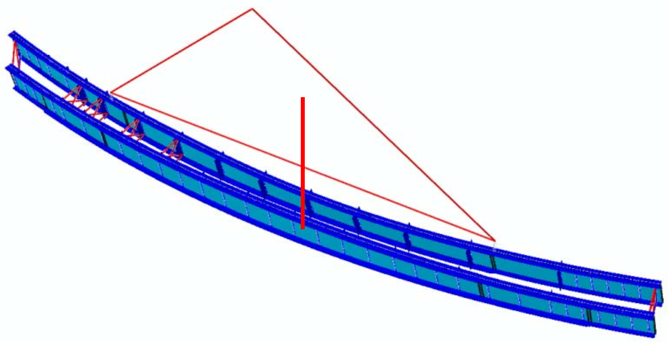
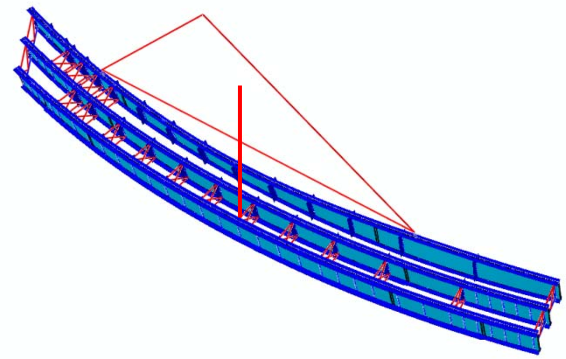
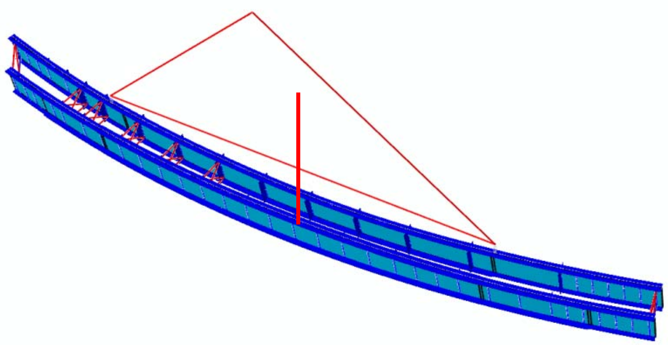
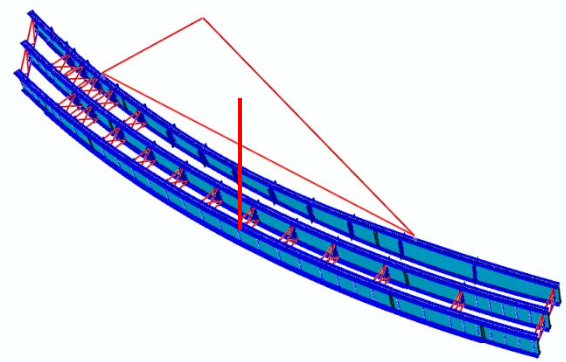
5		
6		

Table P-1-1 (continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

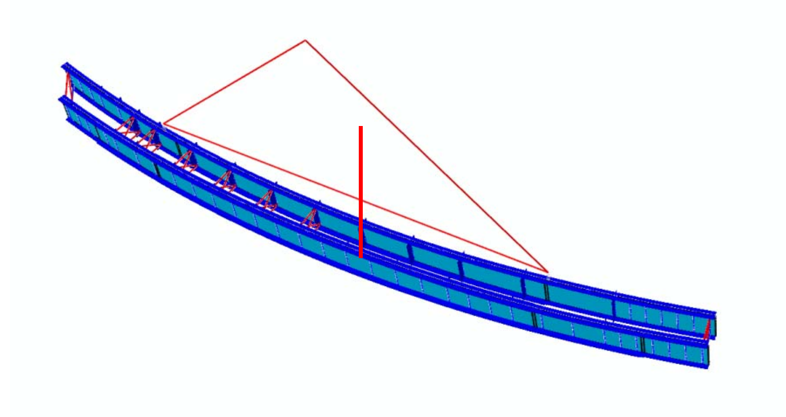
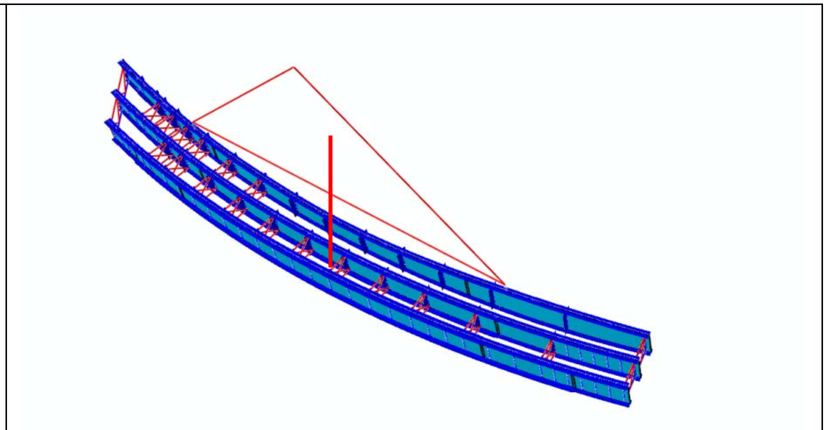
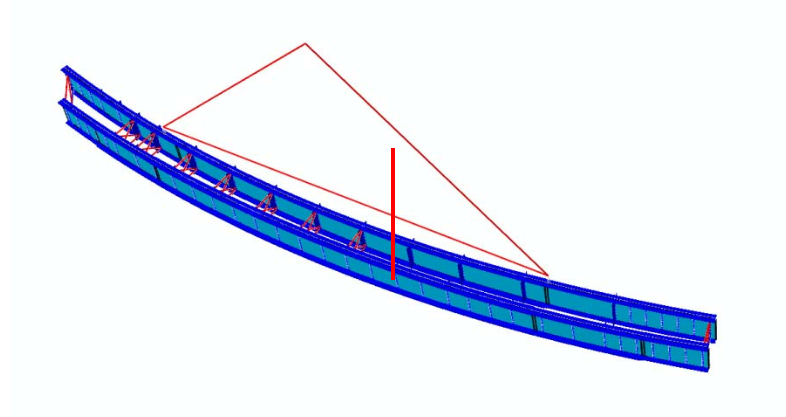
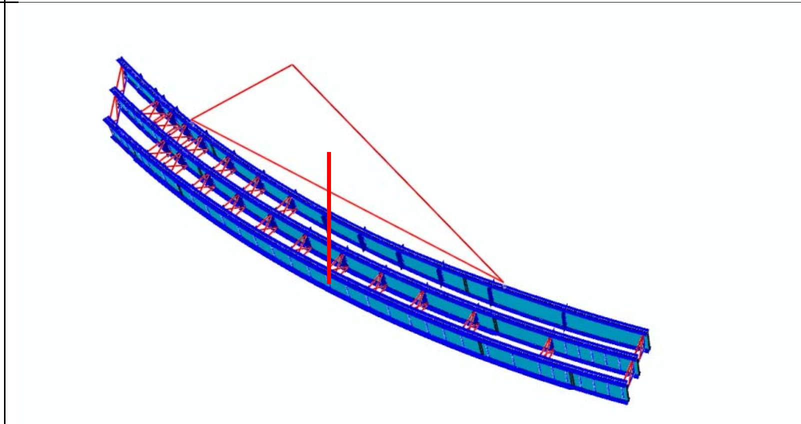
7		
8		

Table P-1-1 (continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

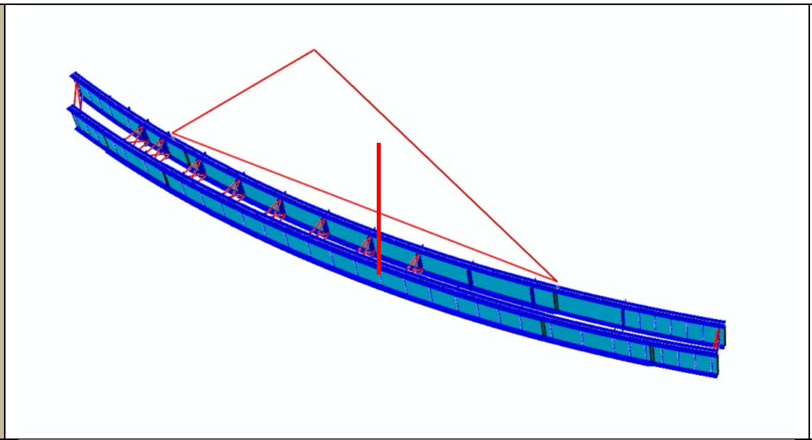
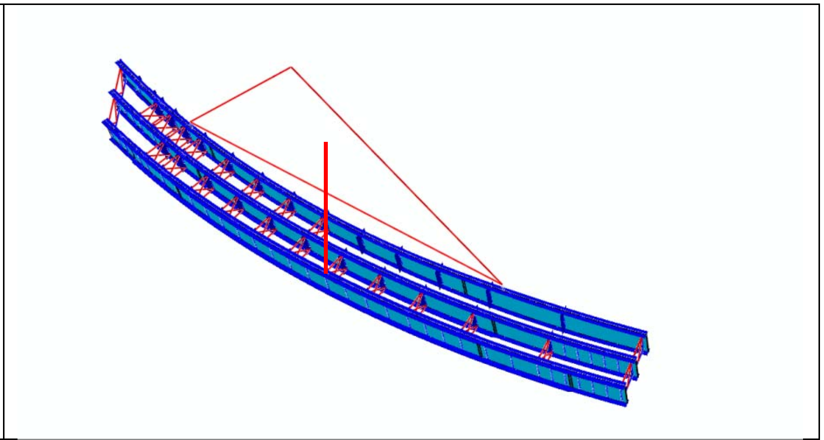
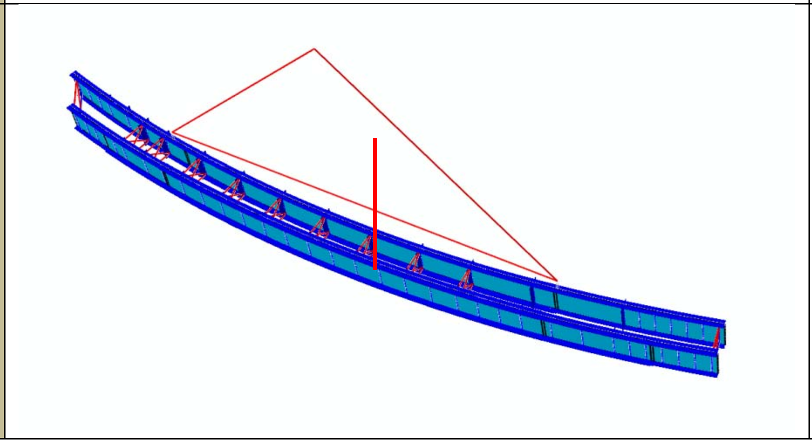
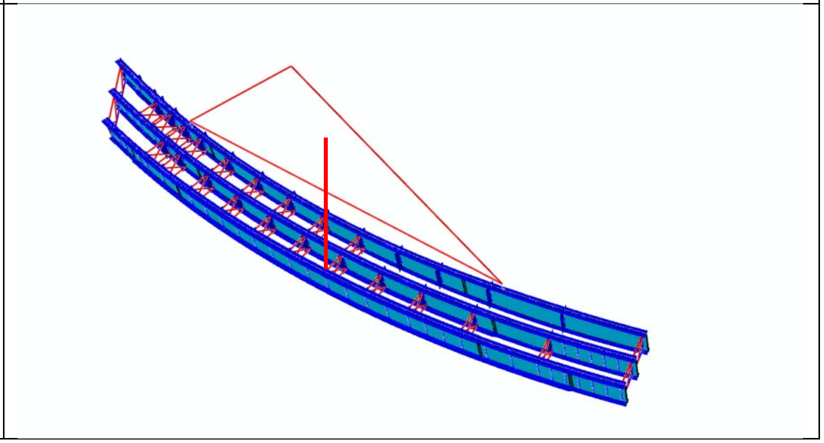
9		
10		

Table P-1-1 (continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

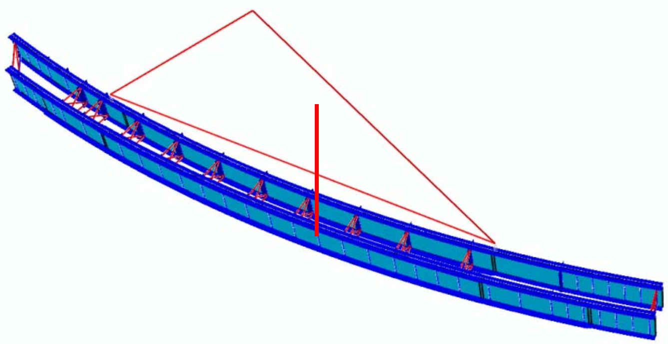
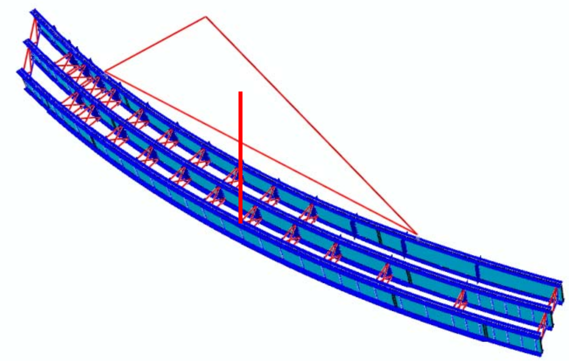
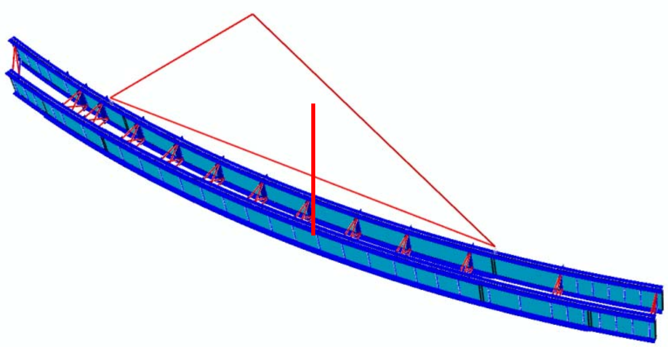
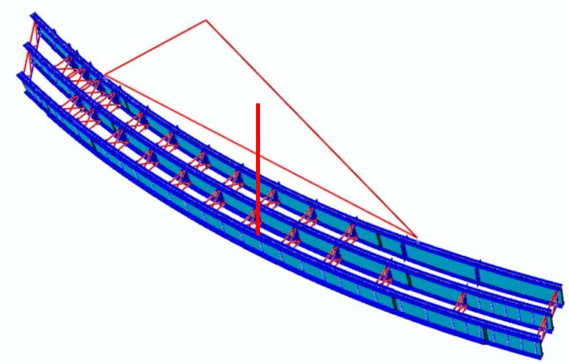
11		
12		

Table P-1-1 (continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

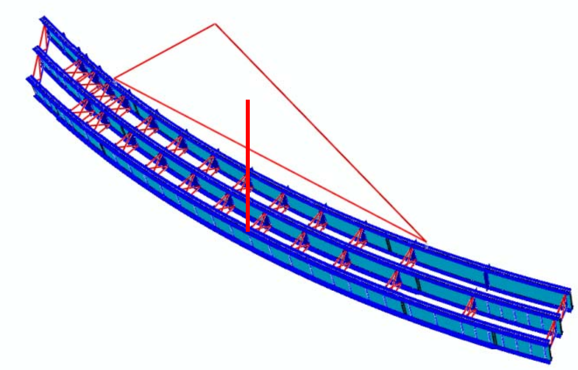
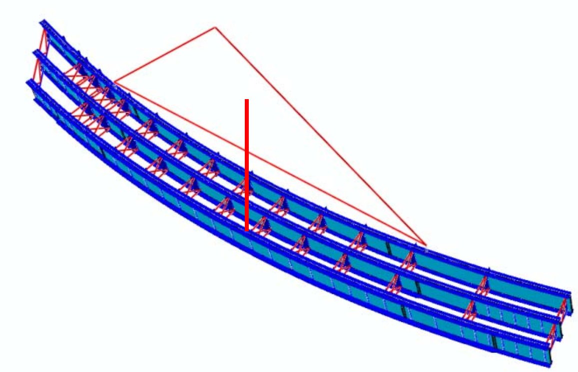
13		
14		

Table P-1-1 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

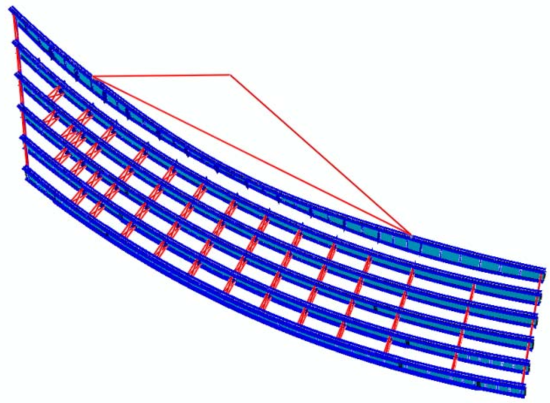
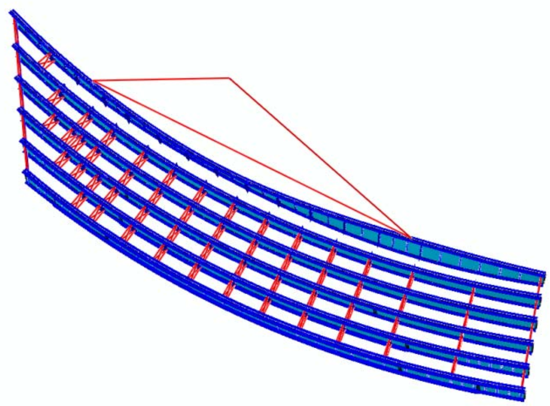
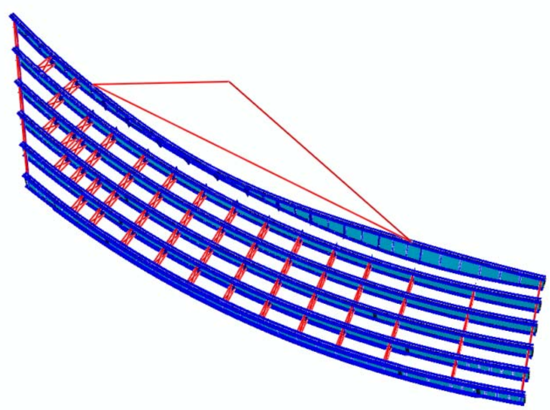
Sub-Stage	Stage 6
1	
2	
3	

Table P-1-1 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

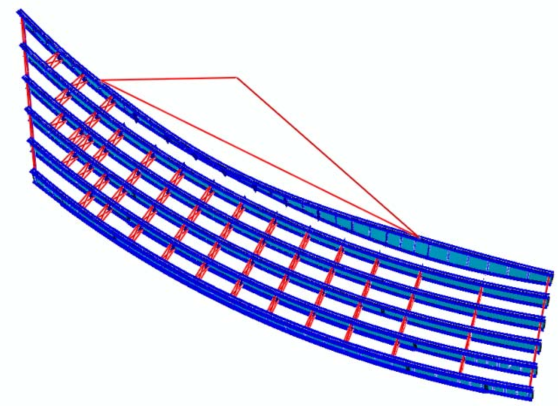
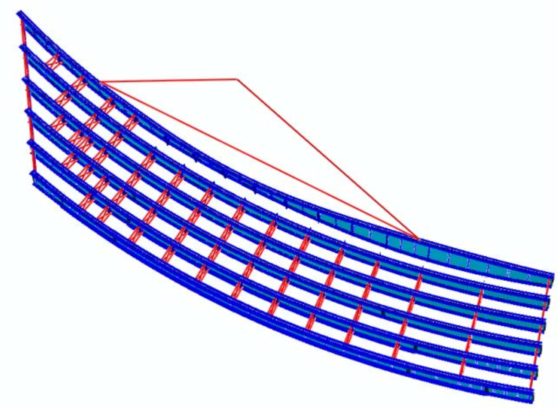
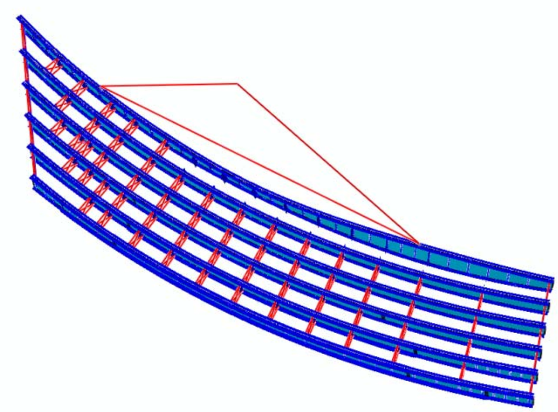
Sub-Stage	Stage
	6
4	
5	
6	

Table P-1-1 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

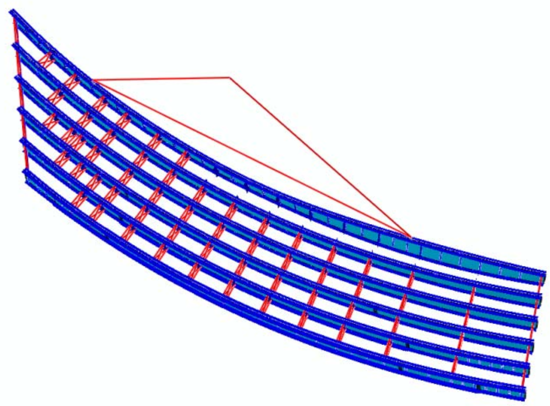
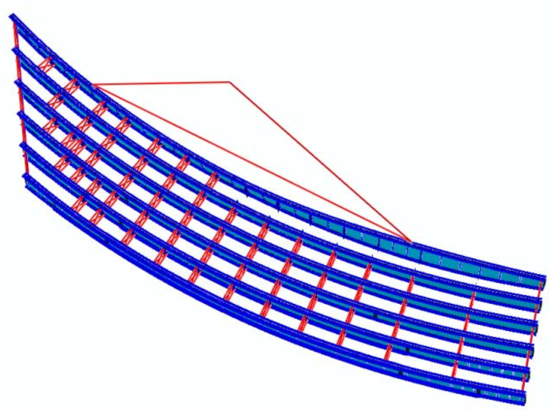
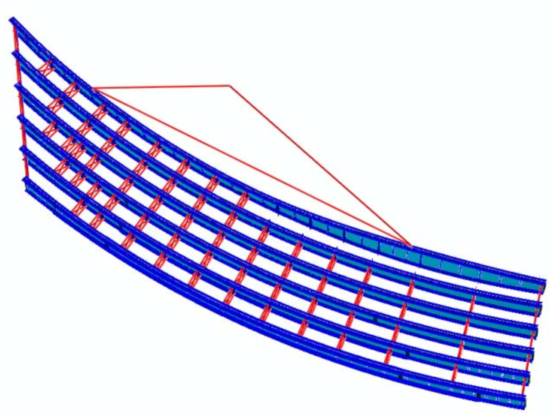
Sub-Stage	Stage 6
7	
8	
9	

Table P-1-1 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

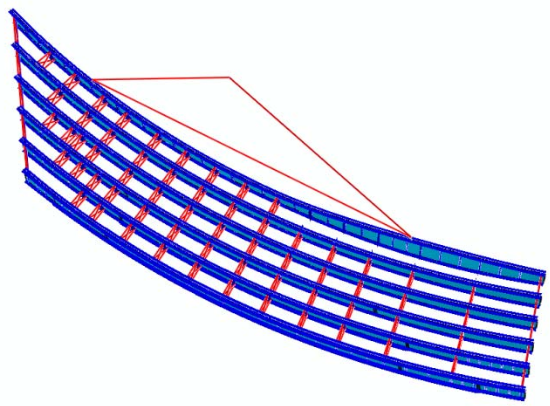
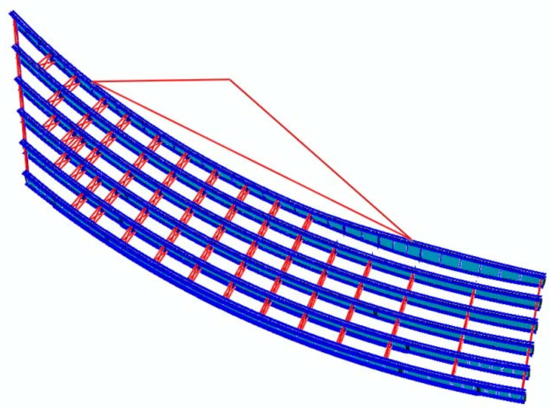
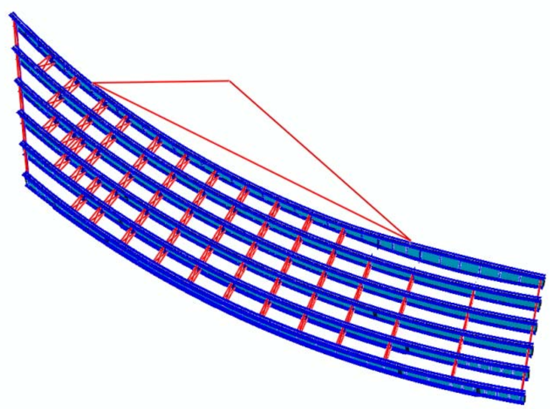
Sub-Stage	Stage 6
10	
11	
12	

Table P-1-1 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

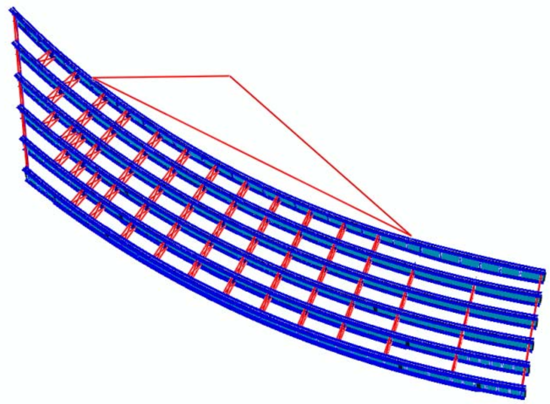
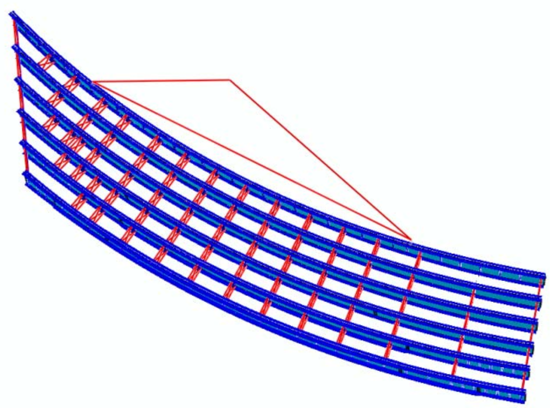
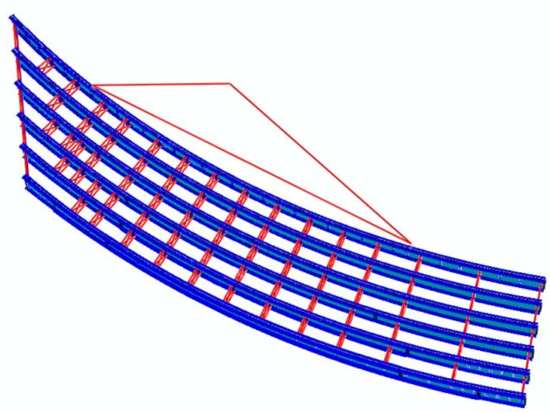
Sub-Stage	Stage 6
13	
14	
15	

Table P-1-2. Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

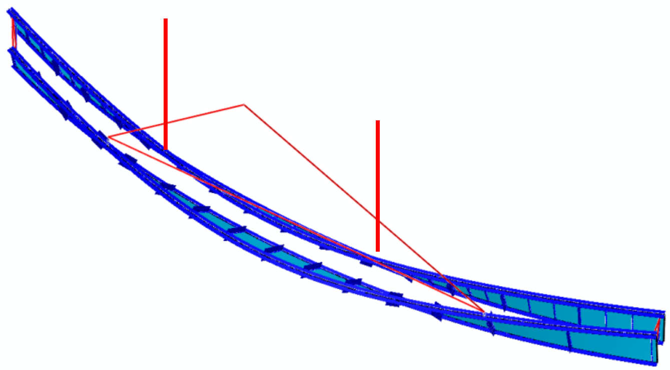
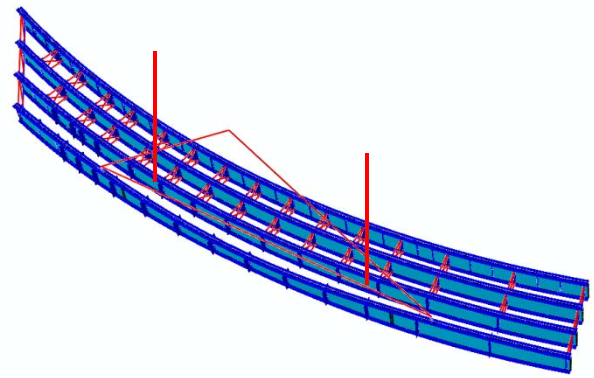
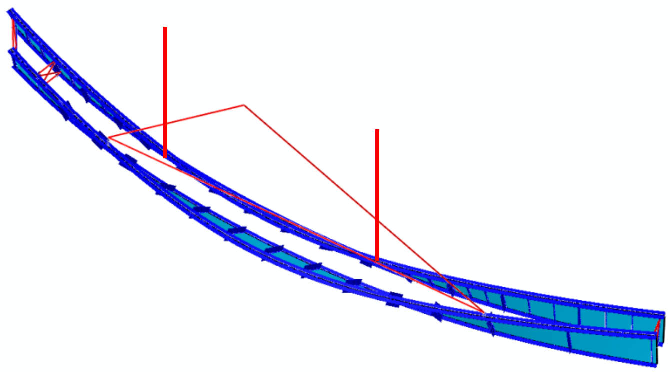
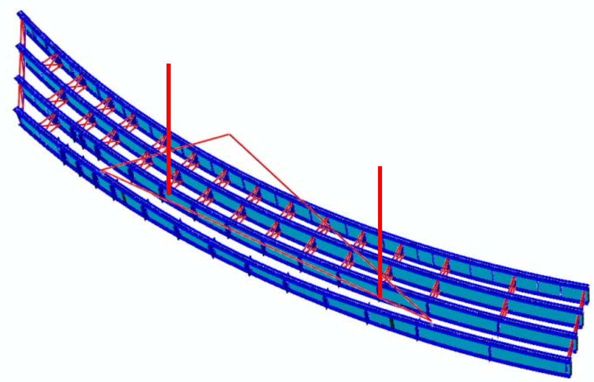
Sub-Stage	Stage	
	2	4
1		
2		

Table P-1-2 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

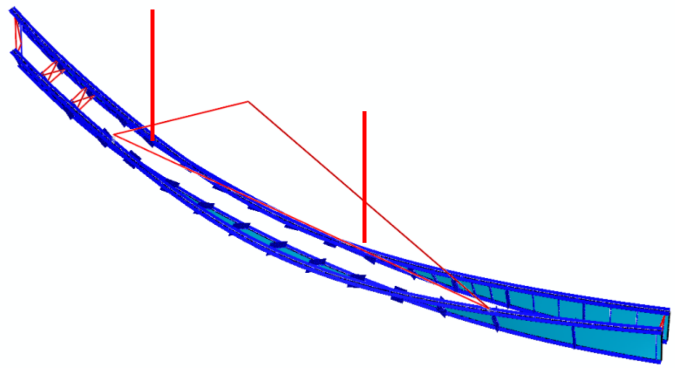
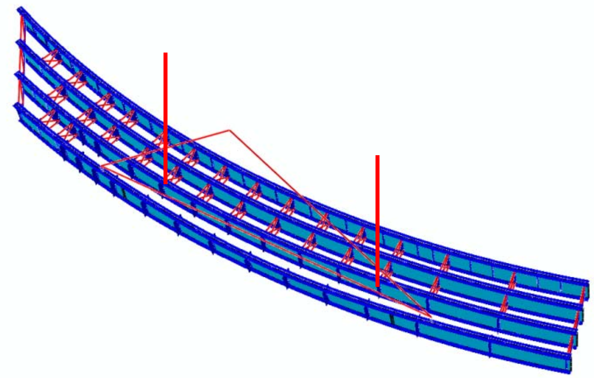
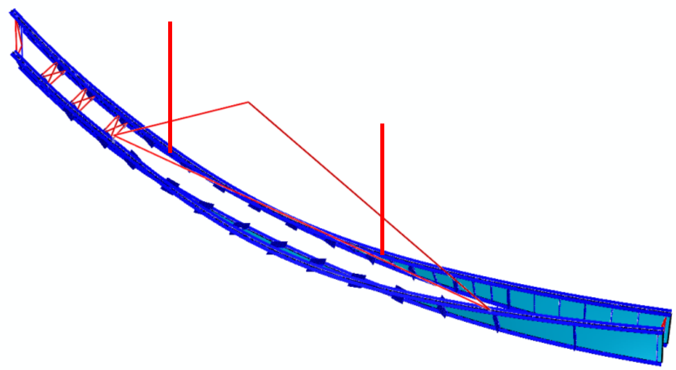
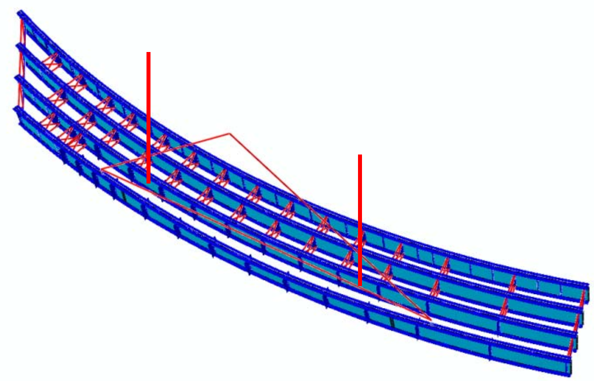
3		
4		

Table P-1-2 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

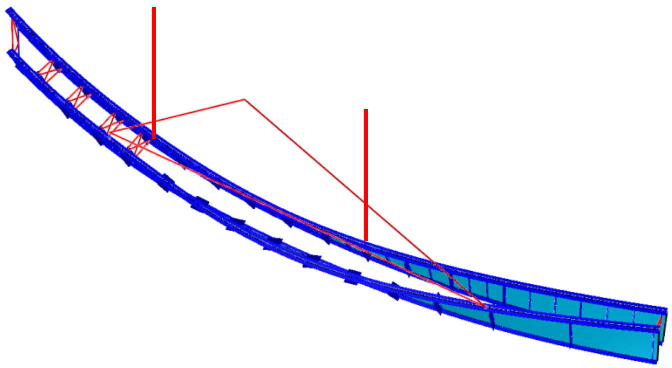
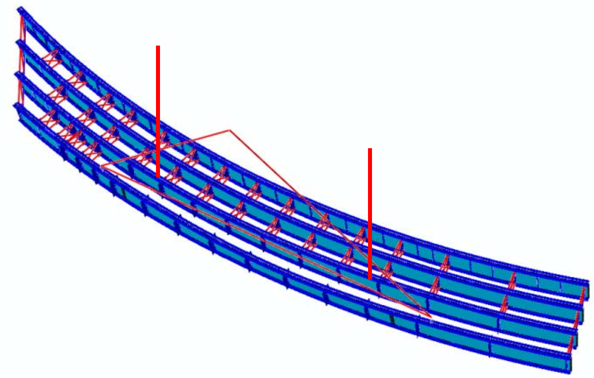
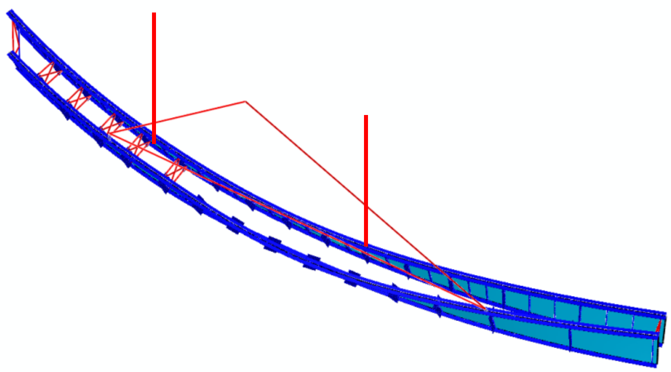
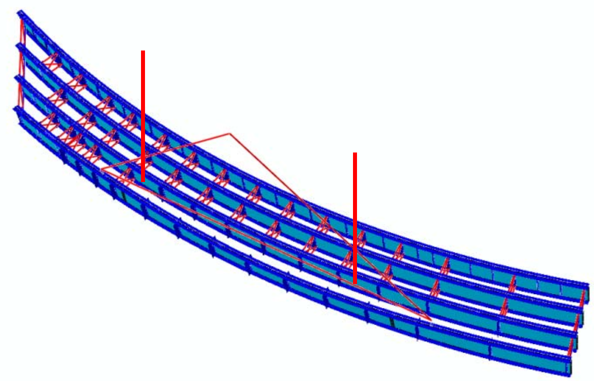
5		
6		

Table P-1-2 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

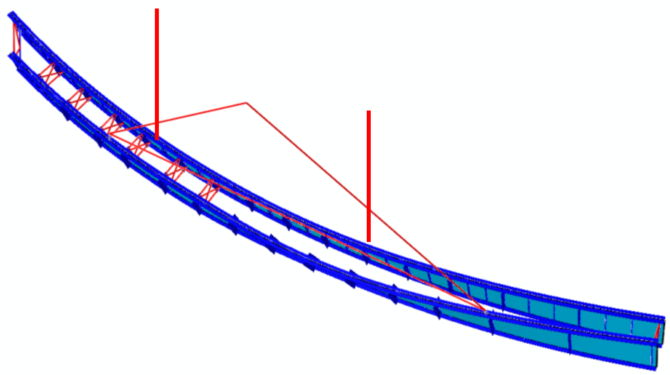
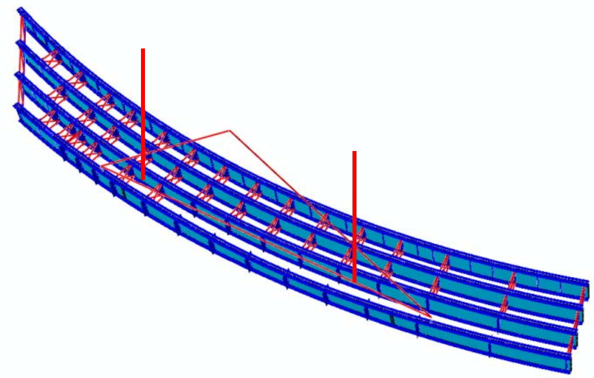
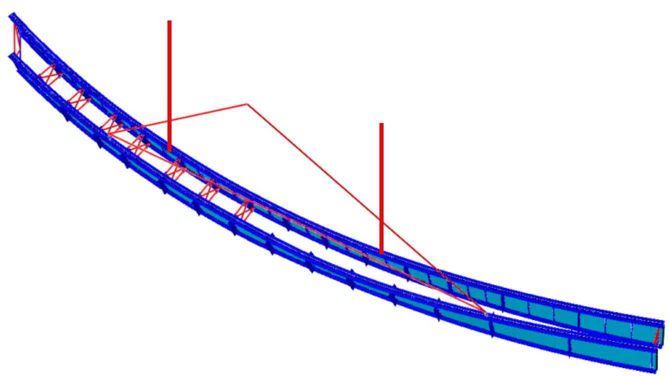
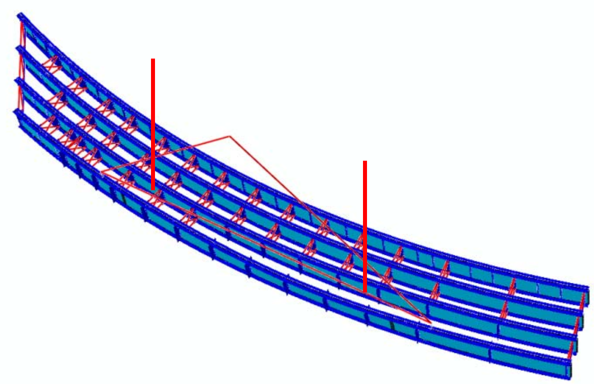
7		
8		

Table P-1-2 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

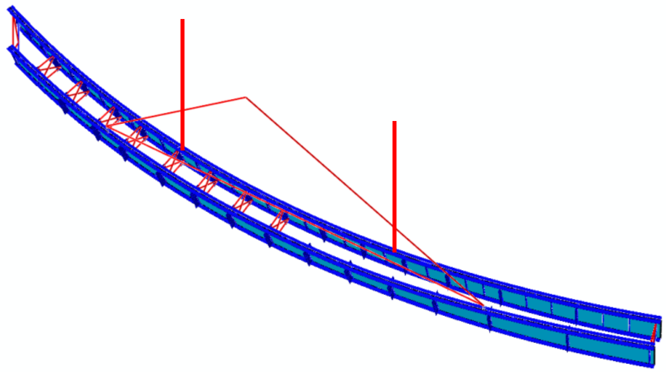
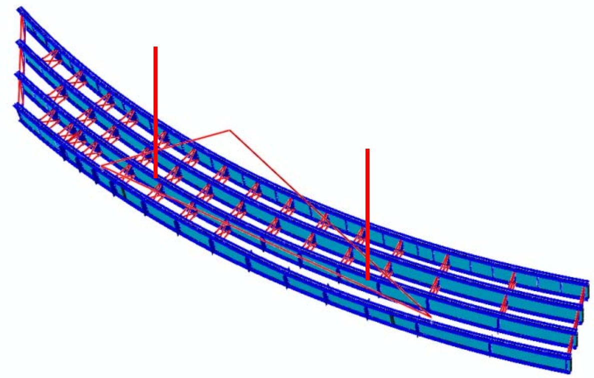
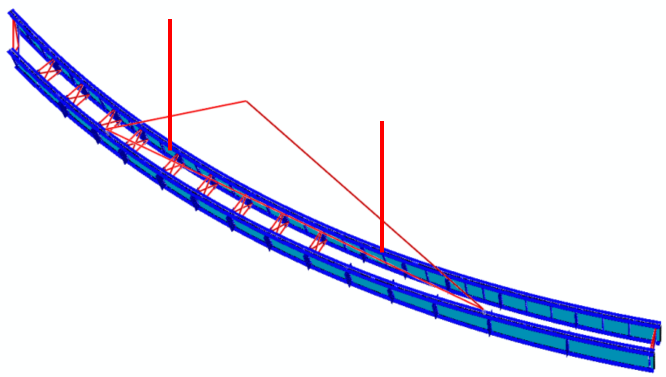
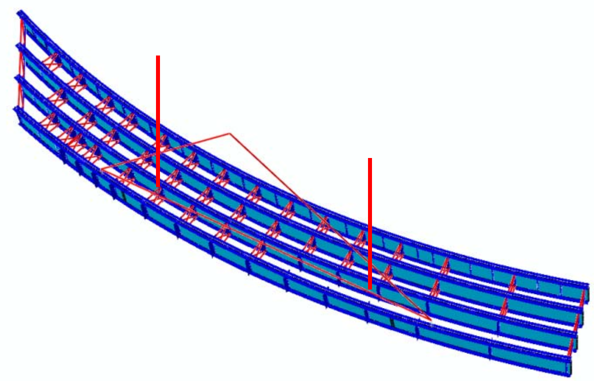
9		
10		

Table P-1-2 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

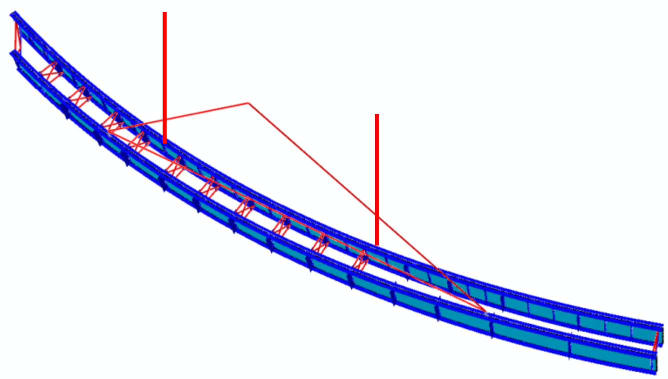
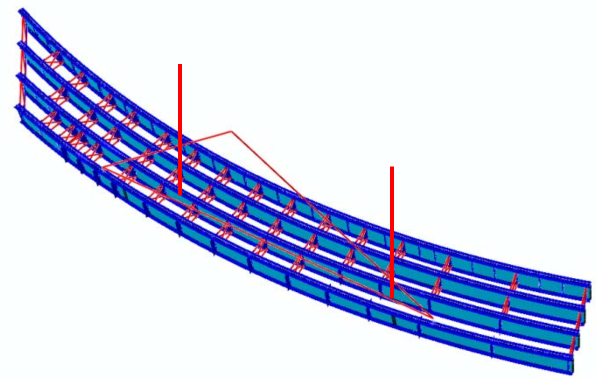
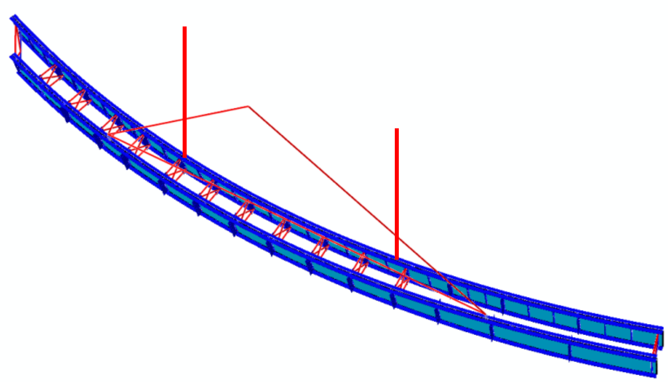
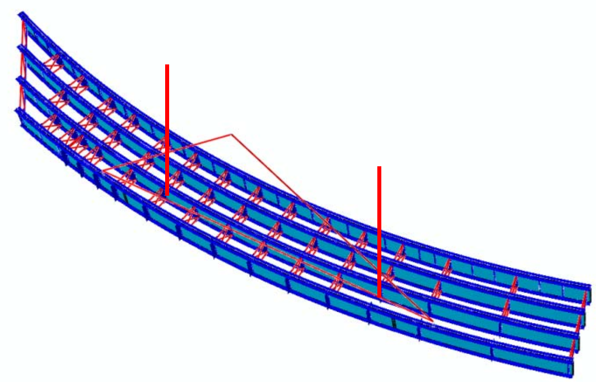
11		
12		

Table P-1-2 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

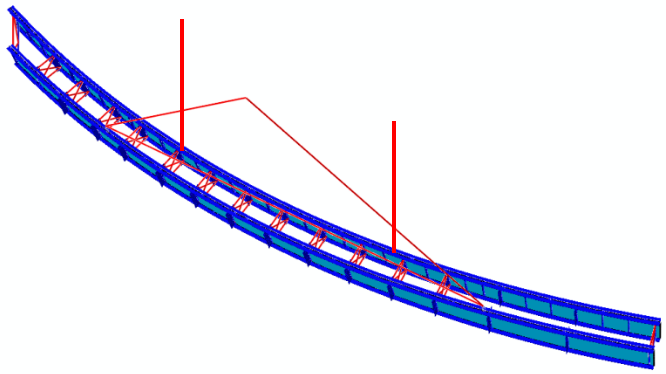
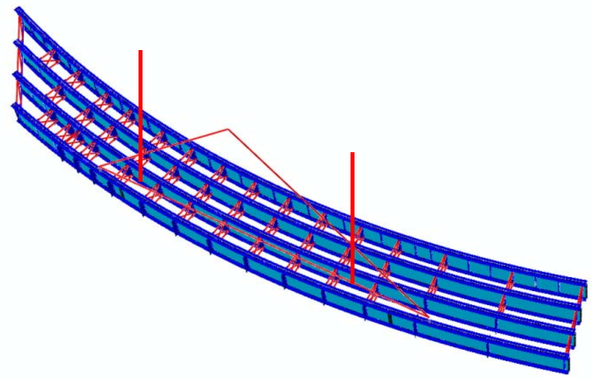
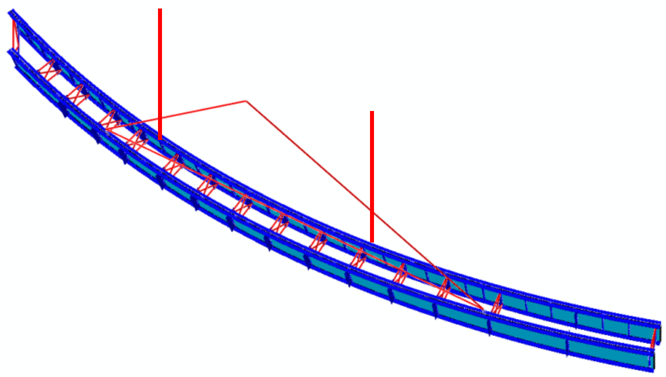
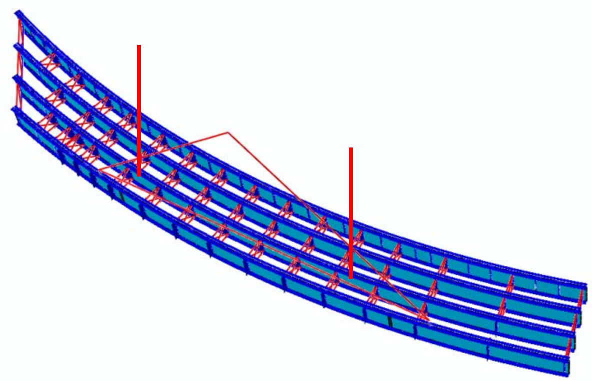
13		
14		

Table P-1-2 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

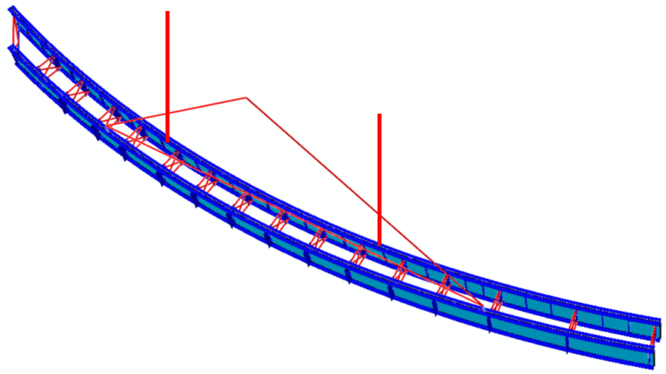
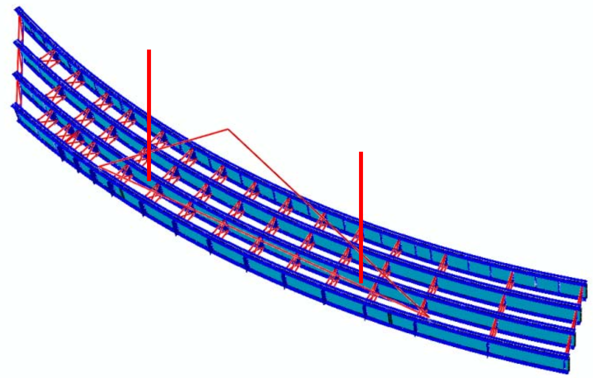
15		

Table P-1-2 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

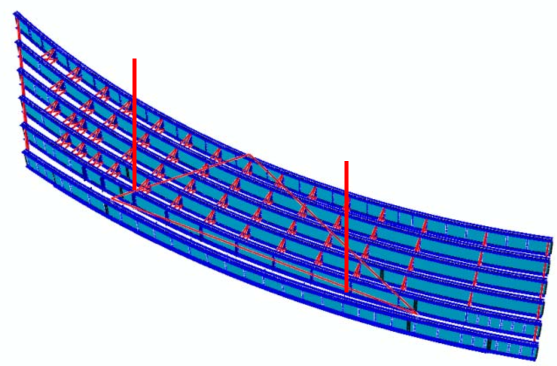
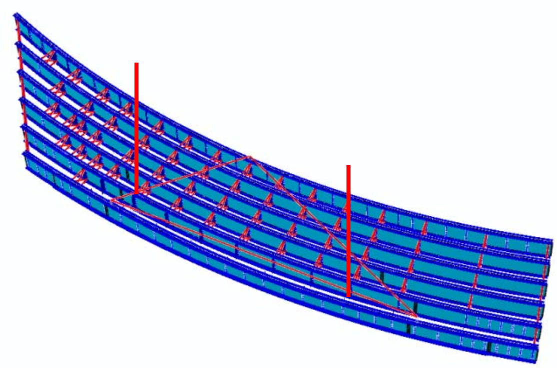
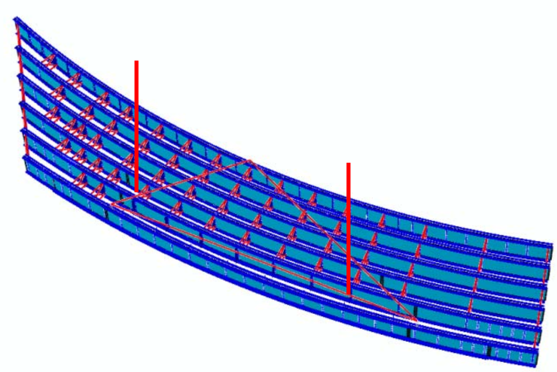
Sub-Stage	Stage 6
1	
2	
3	

Table P-1-2 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

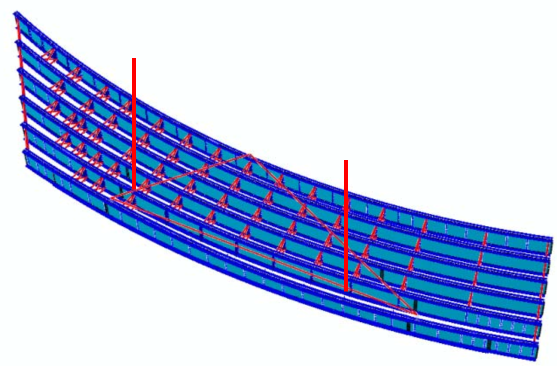
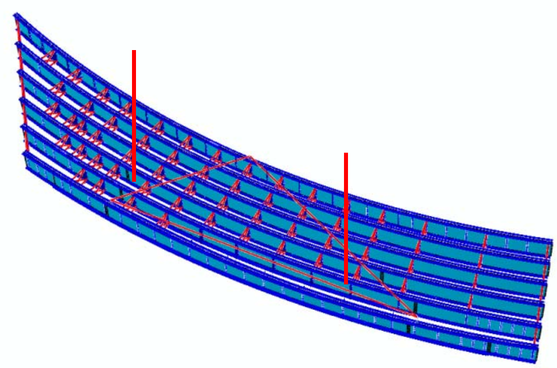
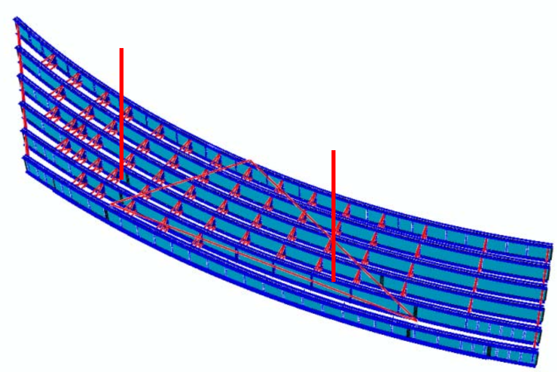
Sub-Stage	Stage 6
4	
5	
6	

Table P-1-2 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

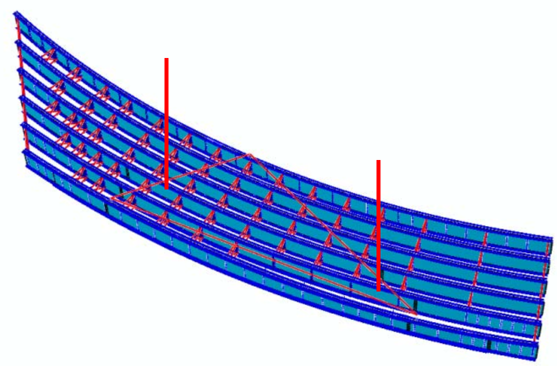
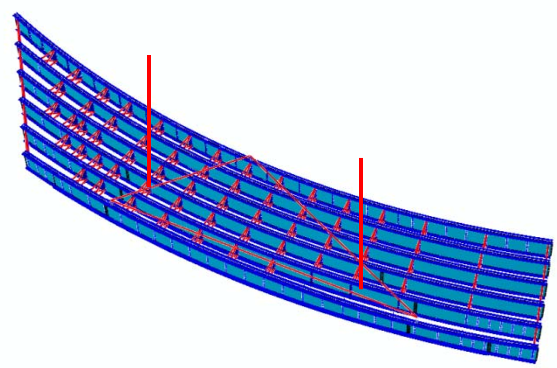
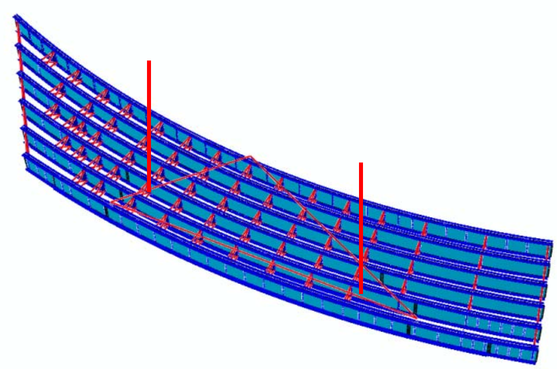
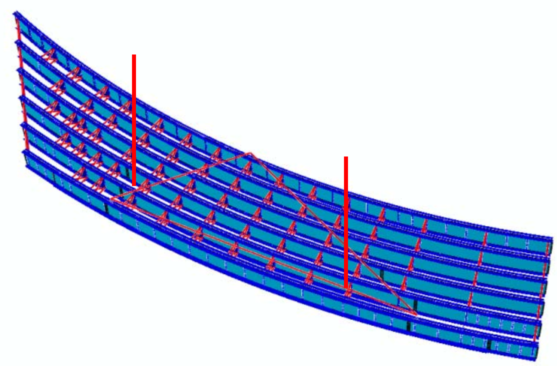
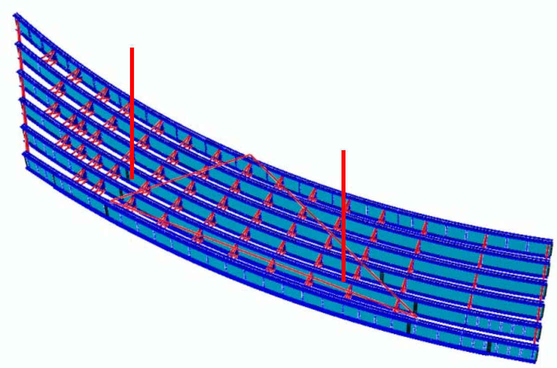
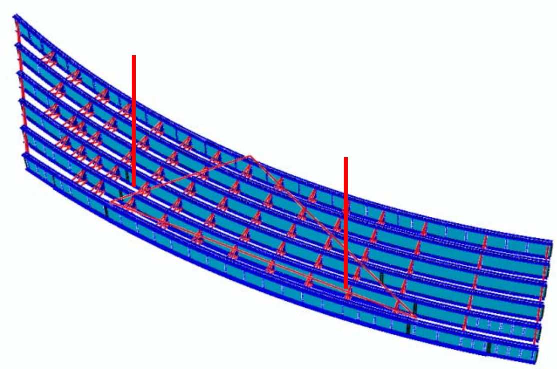
Sub-Stage	Stage
	6
7	
8	
9	

Table P-1-2 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

Sub-Stage	Stage 6
10	
11	
12	

Appendix P-2. EISCS3 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EISCS3 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table P-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	2.9	6.6
	SDLF	2.6	6.3
	TDLF	2.3	6.0
G2	NLF	2.5	5.8
	SDLF	2.1	5.5
	TDLF	1.8	5.1
G3	NLF	2.1	5.1
	SDLF	1.7	4.7
	TDLF	1.3	4.3
G4	NLF	1.7	4.4
	SDLF	1.3	4.0
	TDLF	1.0	3.6
G5	NLF	1.4	3.7
	SDLF	1.0	3.3
	TDLF	0.7	3.0
G6	NLF	1.2	3.2
	SDLF	0.8	2.8
	TDLF	0.5	2.5
All Girders	NLF	2.9	6.6
	SDLF	2.6	6.3
	TDLF	2.3	6.0

Table P-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.44	1.02
	SDLF	0.08	0.55
	TDLF	0.62	0.16
G2	NLF	0.38	0.82
	SDLF	0.06	0.46
	TDLF	0.50	0.11
G3	NLF	0.36	0.74
	SDLF	0.04	0.41
	TDLF	0.42	0.07
G4	NLF	0.34	0.71
	SDLF	0.05	0.37
	TDLF	0.38	0.09
G5	NLF	0.34	0.69
	SDLF	0.05	0.36
	TDLF	0.38	0.10
G6	NLF	0.33	0.68
	SDLF	0.06	0.35
	TDLF	0.40	0.11
All Girders	NLF	0.44	1.02
	SDLF	0.08	0.55
	TDLF	0.62	0.16

Table P-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	6.7	15.9	8.9	21.0	1.3	3.2	1.7	4.1
	SDLF	7.0	16.1	9.2	21.3	0.8	2.2	1.5	3.7
	TDLF	7.2	16.3	9.5	21.6	2.0	2.1	2.3	3.8
G2	NLF	5.9	14.3	7.2	17.3	1.2	2.6	2.2	4.9
	SDLF	6.0	14.3	7.2	17.3	0.9	2.4	1.3	3.2
	TDLF	6.0	14.3	7.2	17.3	1.4	2.2	2.2	3.0
G3	NLF	4.3	10.7	6.2	15.4	1.1	2.6	2.2	5.0
	SDLF	4.2	10.6	6.0	15.2	0.9	2.4	1.1	3.2
	TDLF	4.1	10.4	5.8	15.0	0.9	2.2	1.4	2.7
G4	NLF	3.5	9.2	4.2	11.0	1.5	2.8	2.8	6.3
	SDLF	3.3	9.1	4.0	10.8	0.8	2.0	1.2	4.4
	TDLF	3.1	8.9	3.7	10.6	0.6	1.6	1.1	2.5
G5	NLF	2.5	7.1	3.0	8.4	0.4	1.6	0.9	2.6
	SDLF	2.4	7.0	2.8	8.3	0.4	1.3	0.4	1.8
	TDLF	2.2	6.9	2.6	8.2	0.4	1.1	0.8	1.2
G6	NLF	3.1	8.0	3.6	9.5	0.4	1.5	1.0	2.7
	SDLF	2.5	7.4	2.9	8.8	0.4	1.1	0.5	1.9
	TDLF	1.8	6.8	2.1	8.0	0.4	0.8	0.8	1.1
All Girders	NLF	6.7	15.9	8.9	21.0	1.5	3.2	2.8	6.3
	SDLF	7.0	16.1	9.2	21.3	0.9	2.4	1.5	4.4
	TDLF	7.2	16.3	9.5	21.6	2.0	2.2	2.3	3.8

Table P-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	25.5	22.6	34.8	34.8
	SDLF	13.0	23.2	36.5	36.5
	TDLF	13.6	24.5	38.0	38.0
TDL	NLF	55.0	51.6	80.2	80.2
	SDLF	42.0	51.3	81.2	81.2
	TDLF	27.9	52.0	81.9	81.9

Table P-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	5.7	9.8	10.5	8.0
	SDLF	5.1	8.0	8.6	6.8
	TDLF	5.1	7.2	7.7	6.3
TDL	NLF	13.8	21.5	22.9	18.1
	SDLF	12.9	19.5	20.9	16.7
	TDLF	12.3	17.5	18.7	15.3

Table P-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.40	0.40	0.38	0.35	0.35	0.40
SDLF	0.47	0.47	0.42	0.36	0.35	0.47
TDLF	0.54	0.54	0.46	0.36	0.35	0.54

Table P-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.83	0.83	0.78	0.72	0.71	0.83
SDLF	0.89	0.89	0.82	0.72	0.71	0.89
TDLF	0.95	0.95	0.85	0.71	0.70	0.95

Table P-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.19	0.19	0.18	0.16	0.16	0.19
SDLF	0.22	0.22	0.20	0.17	0.16	0.22
TDLF	0.25	0.25	0.21	0.17	0.16	0.25

Table P-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	All Girders
NLF	0.38	0.38	0.36	0.33	0.33	0.38
SDLF	0.41	0.41	0.38	0.33	0.33	0.41
TDLF	0.44	0.44	0.39	0.33	0.32	0.44

Table P-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	427	1074
SDLF	427	1073
TDLF	427	1074

Table P-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	104	239	0.2	0.3	0.3	0.8
SDLF	98	233	0.2	0.3	0.1	0.3
TDLF	91	226	0.2	0.3	0.5	0.1

Table P-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.29	0.46	0.05	0.16
SDLF	0.26	0.50	0.02	0.06
TDLF	0.27	0.62	0.10	0.01

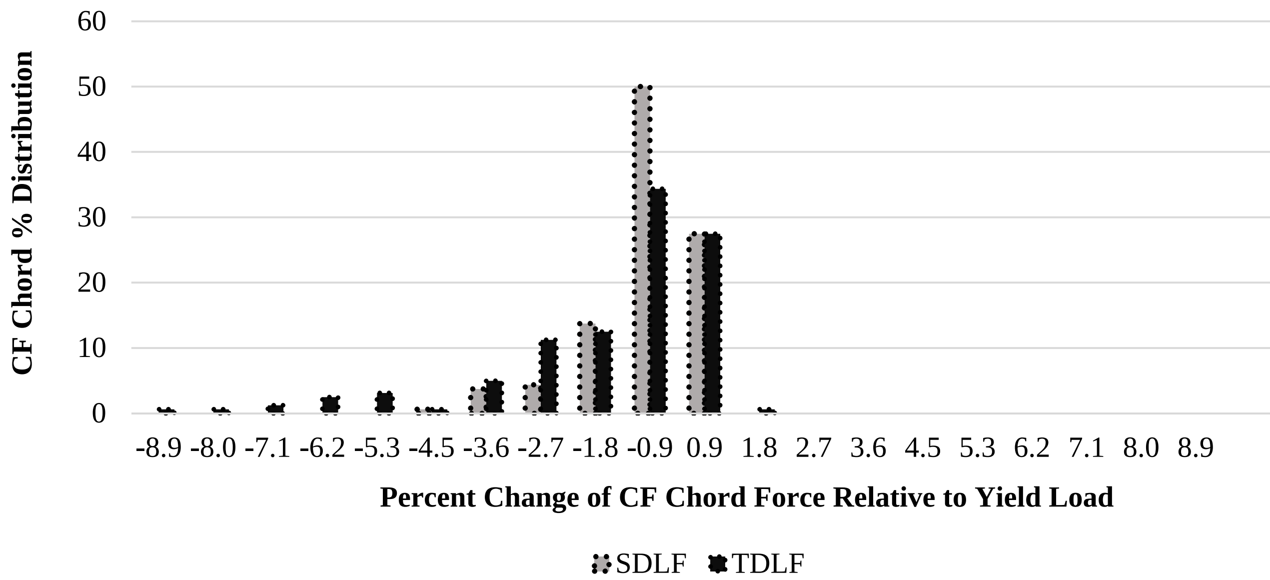


Figure O2-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

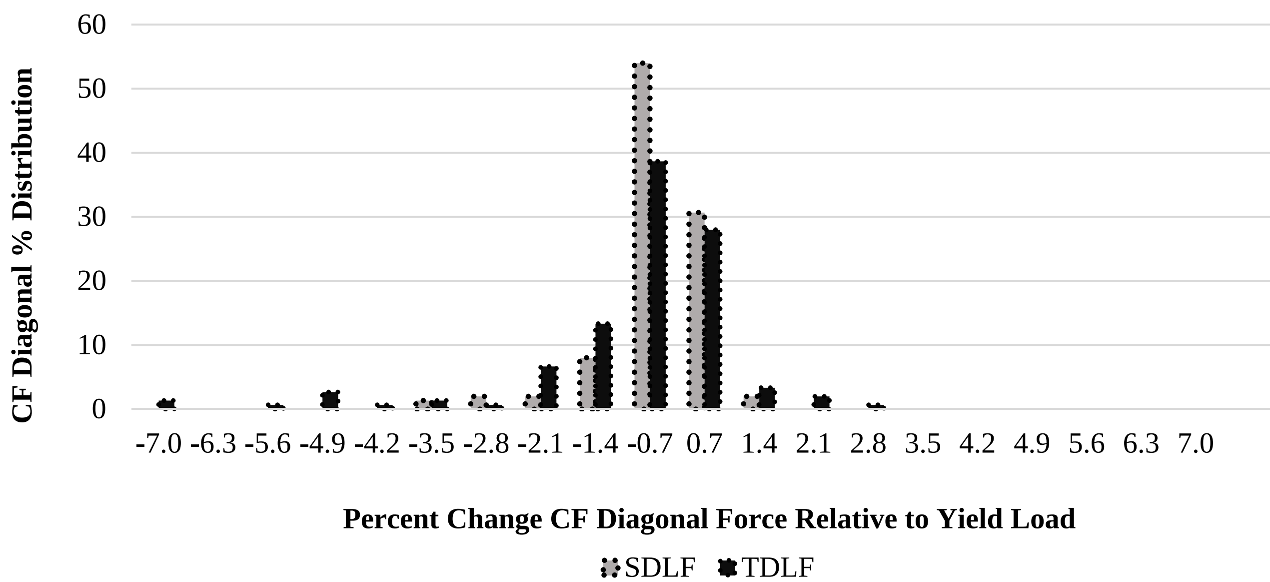


Figure O2-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

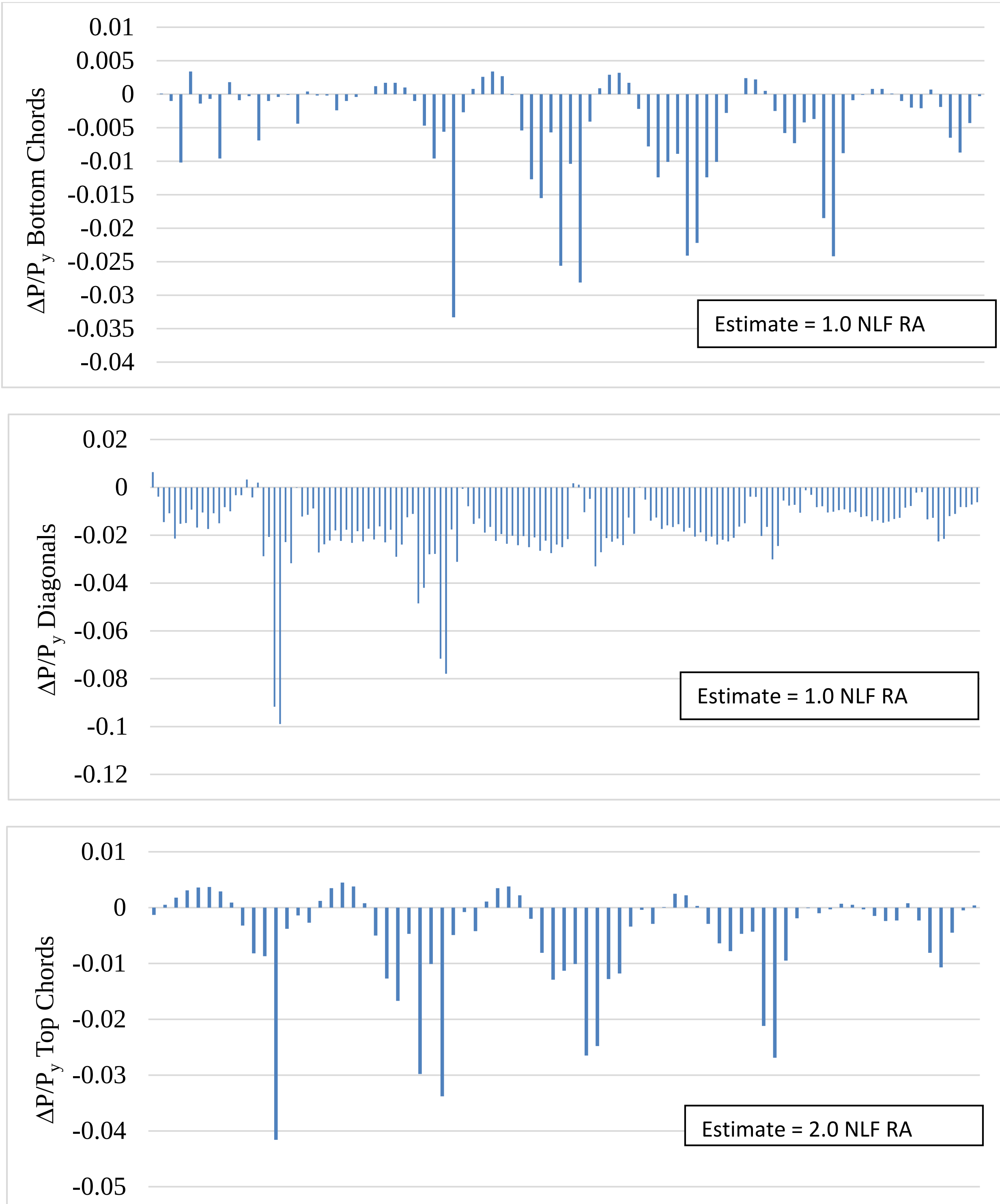


Figure P-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

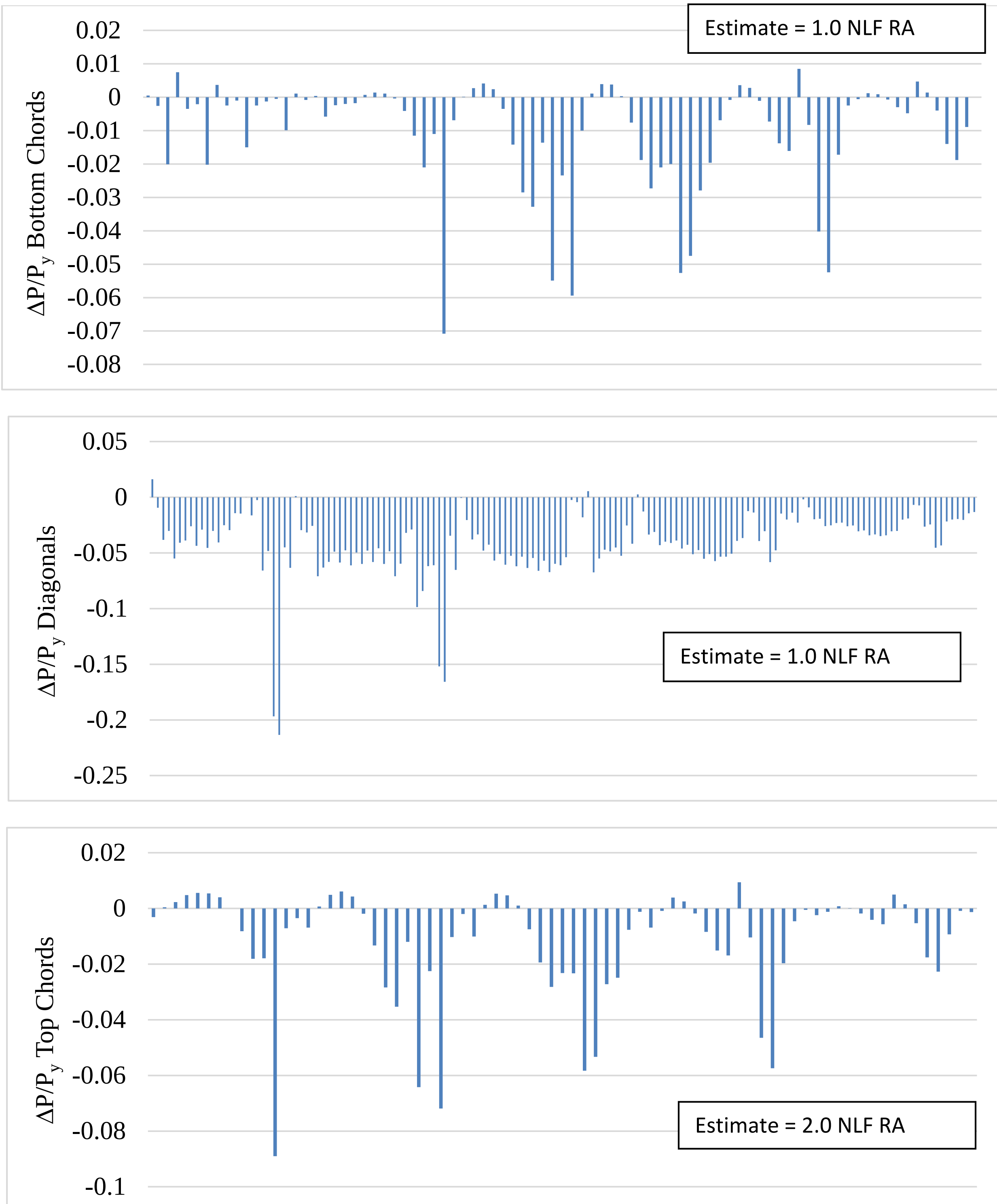


Figure P-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix P1-3. EISCS3 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EISCS3 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table P1-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	Erection Method 1			Erection Method 2		
	F1	F2	F_{max}	F1	F2	F_{max}
NLF	21.1	23.4	23.4	8.4	45.7	45.7
SDLF	11.4	14.9	14.9	9.0	33.0	33.0
TDLF	14.5	16.8	16.8	13.9	20.5	20.5

Table P1-3-2. Summary of erection method 1 vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	114.5	12.3
	SDLF	105.2	12.9
	TDLF	94.6	13.3
G2	NLF	53.2	0
	SDLF	49	0
	TDLF	47	0
G3	NLF	14.9	0
	SDLF	25.9	0
	TDLF	25.7	7.5
G4	NLF	0	0
	SDLF	10.7	6.2
	TDLF	17.9	13.4
G5	NLF	0	0
	SDLF	5.2	0
	TDLF	6	2.8
G6	NLF	12.1	0
	SDLF	12.2	0
	TDLF	9	1.4
All Girders	NLF	114.5	0
	SDLF	105.2	5.2
	TDLF	94.6	6

Table P1-3-3. Summary of erection method 1 crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	107.6	66.2	75	53.2
SDLF	76.1	54	71	53.4
TDLF	64.4	7.4	72.3	53.7

Table P1-3-4. Summary of erection method 2 vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	1	0
	SDLF	1.2	0
	TDLF	13.9	0
G2	NLF	0	0
	SDLF	7.4	0
	TDLF	23.2	0
G3	NLF	6.4	0
	SDLF	11.1	0
	TDLF	26.6	0
G4	NLF	40.4	0
	SDLF	43.9	0
	TDLF	42.8	0
G5	NLF	31.6	0
	SDLF	29.6	0
	TDLF	25	0
G6	NLF	26.5	0
	SDLF	24.1	0
	TDLF		0.7
All Girders	NLF	40.4	0
	SDLF	43.9	1.2
	TDLF	42.8	13.9

Table P1-3-5. Summary of erection method 2 crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	70.3	0	115.3	26.2
SDLF	71.7	5.1	116.5	26
TDLF	84.7	57.1	92.4	0

Table P1-3-6. Erection total vertical reactions at each sub-stage

Erection Method	Stage	Detailing Method	Sub-Stage														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	2	NLF	147	147	148	149	149	150	151	152	152	153	154	154			
		SDLF	147	147	148	149	149	150	151	152	152	153	154	154			
		TDLF	147	147	148	149	149	150	151	152	152	153	154	154			
	3	NLF	213	214	214	215	216	217	217	218	219	219	220	221	221	222	
		SDLF	213	214	214	215	216	217	217	218	219	219	220	221	221	222	
		TDLF	213	214	214	215	216	217	217	218	219	219	220	221	221	222	
	6	NLF	417	418	418	419	420	420	421	422	422	423	424	425	425	426	427
		SDLF	417	418	418	419	420	420	421	422	422	423	424	425	425	426	427
		TDLF	417	418	418	419	420	420	421	422	422	423	424	425	425	426	427
2	2	NLF	116	117	117	118	119	119	120	121	122	122	123	124	124	125	126
		SDLF	116	117	117	118	119	119	120	121	122	122	123	124	124	125	126
		TDLF	116	117	117	118	119	119	120	121	122	122	123	124	124	125	126
	4	NLF	251	252	253	254	254	255	256	256	257	258	258	259	260	260	261
		SDLF	251	252	253	254	254	255	256	256	257	258	258	259	260	260	261
		TDLF	251	252	253	254	254	255	256	256	257	258	258	259	260	260	261
	6	NLF	419	420	420	421	422	422	423	424	425	425	426	427			
		SDLF	419	420	420	421	422	422	423	424	425	425	426	427			
		TDLF	419	420	420	421	422	422	423	424	425	425	426	427			

Appendix P-4. EISCS3 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge EISCS3 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

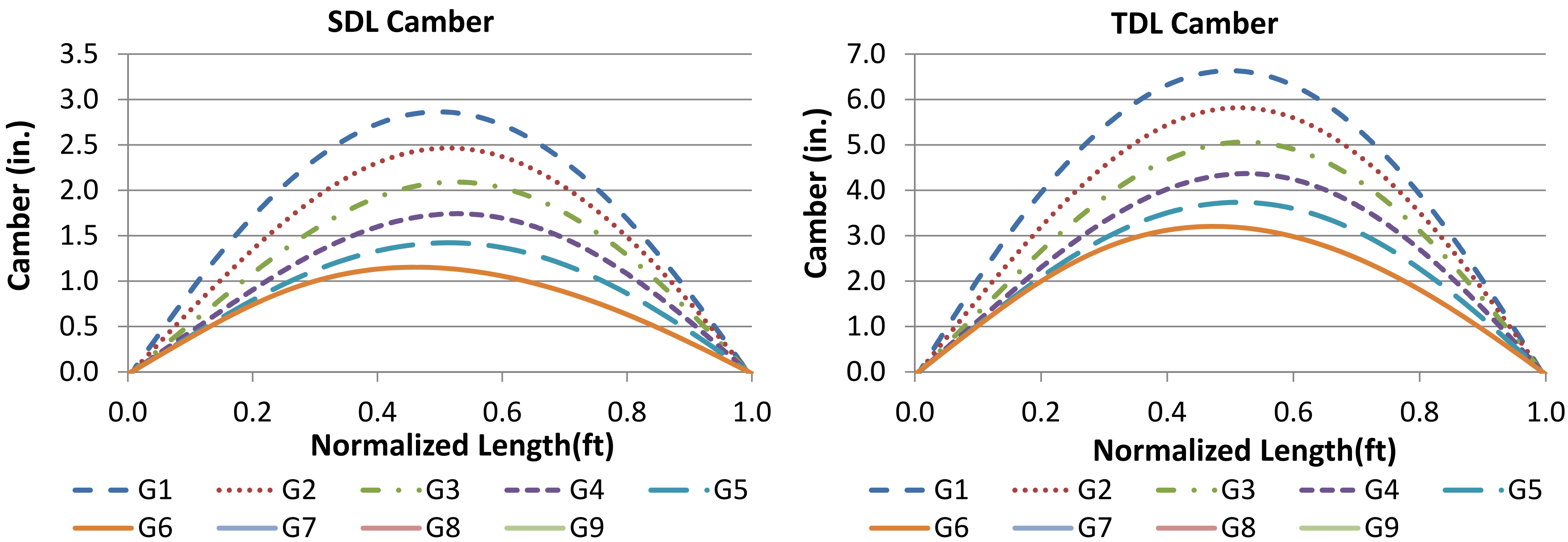


Figure P-4-1. SDL and TDL 3D FEA cambers.

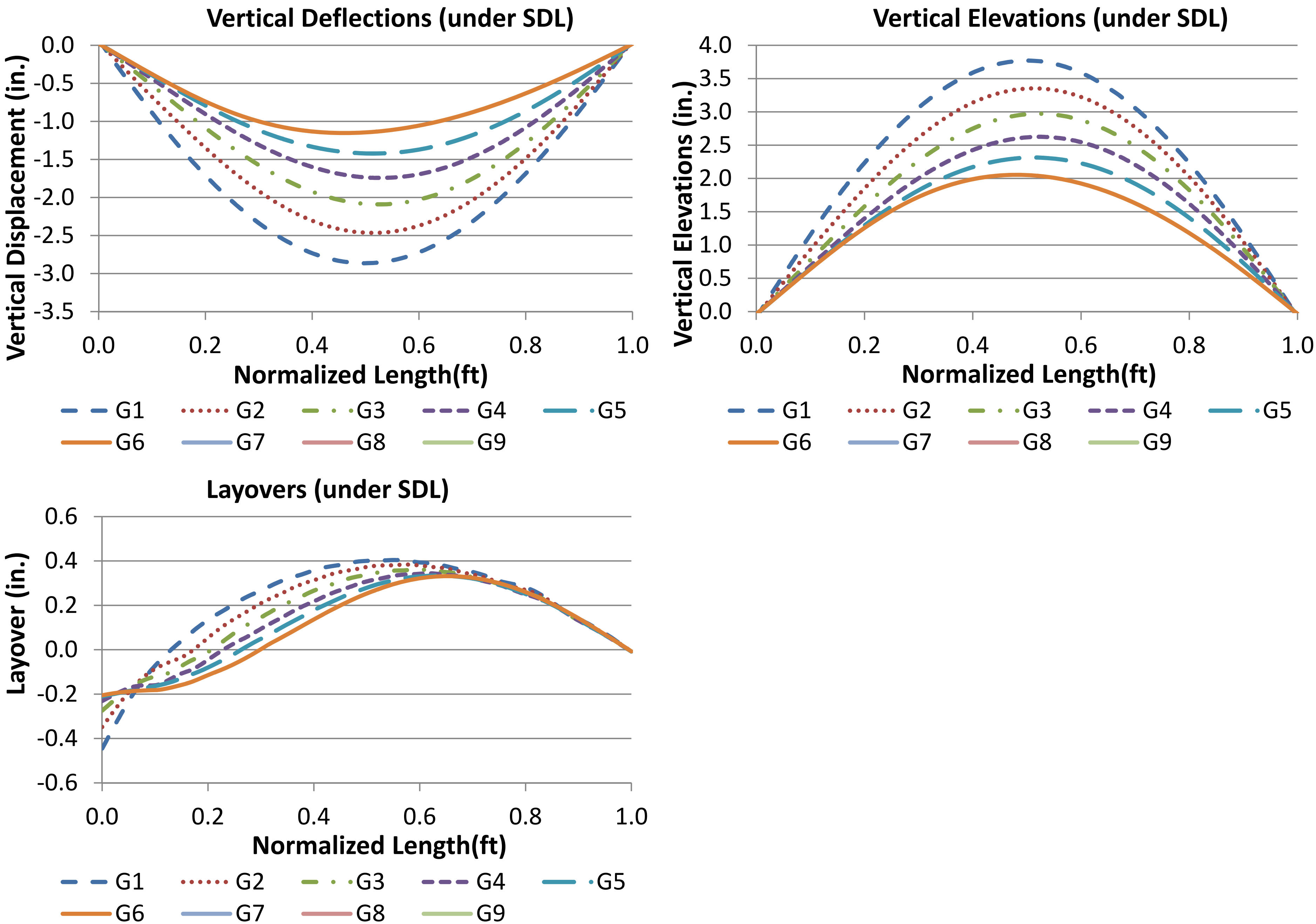


Figure P-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

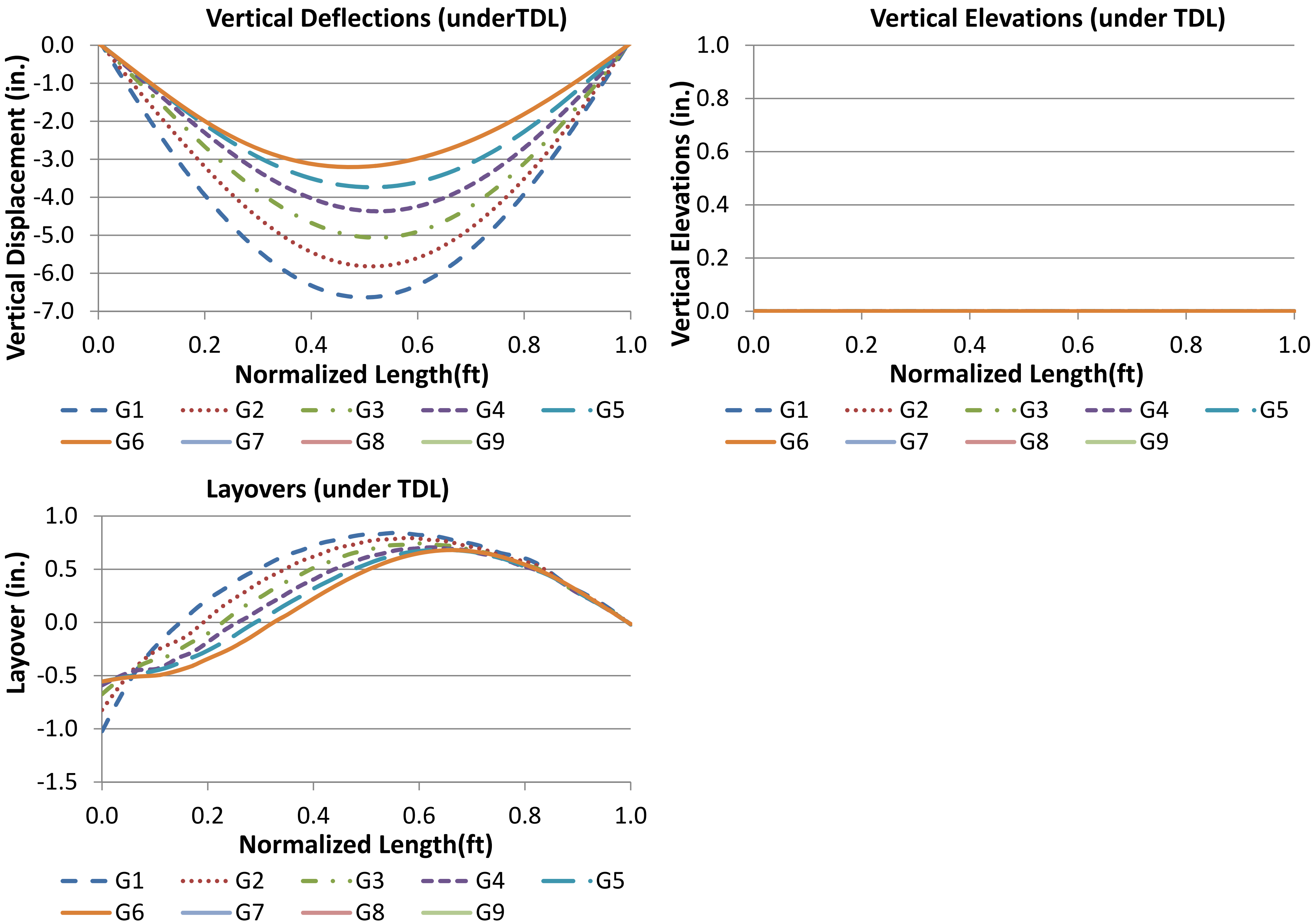


Figure P-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

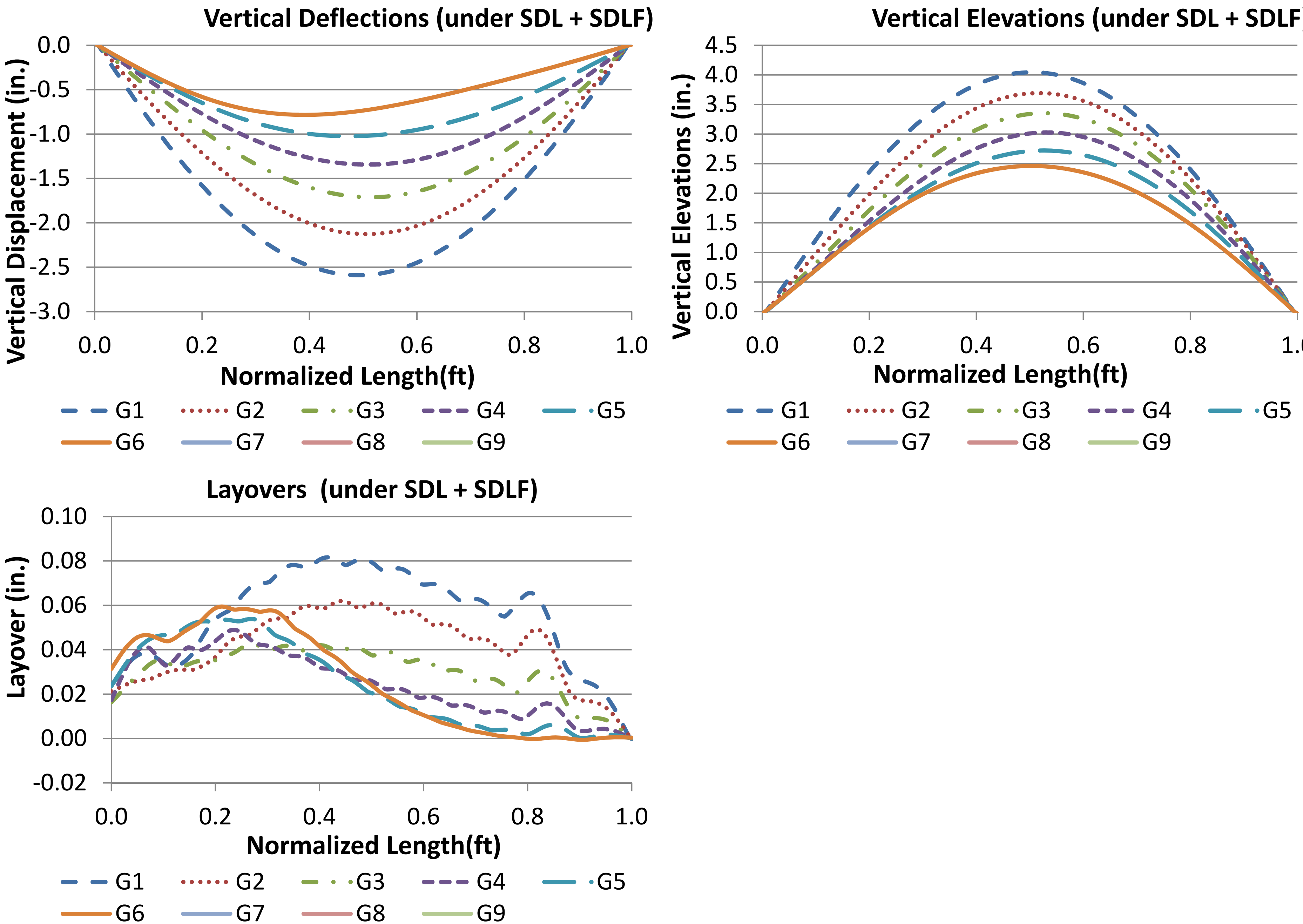


Figure P-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

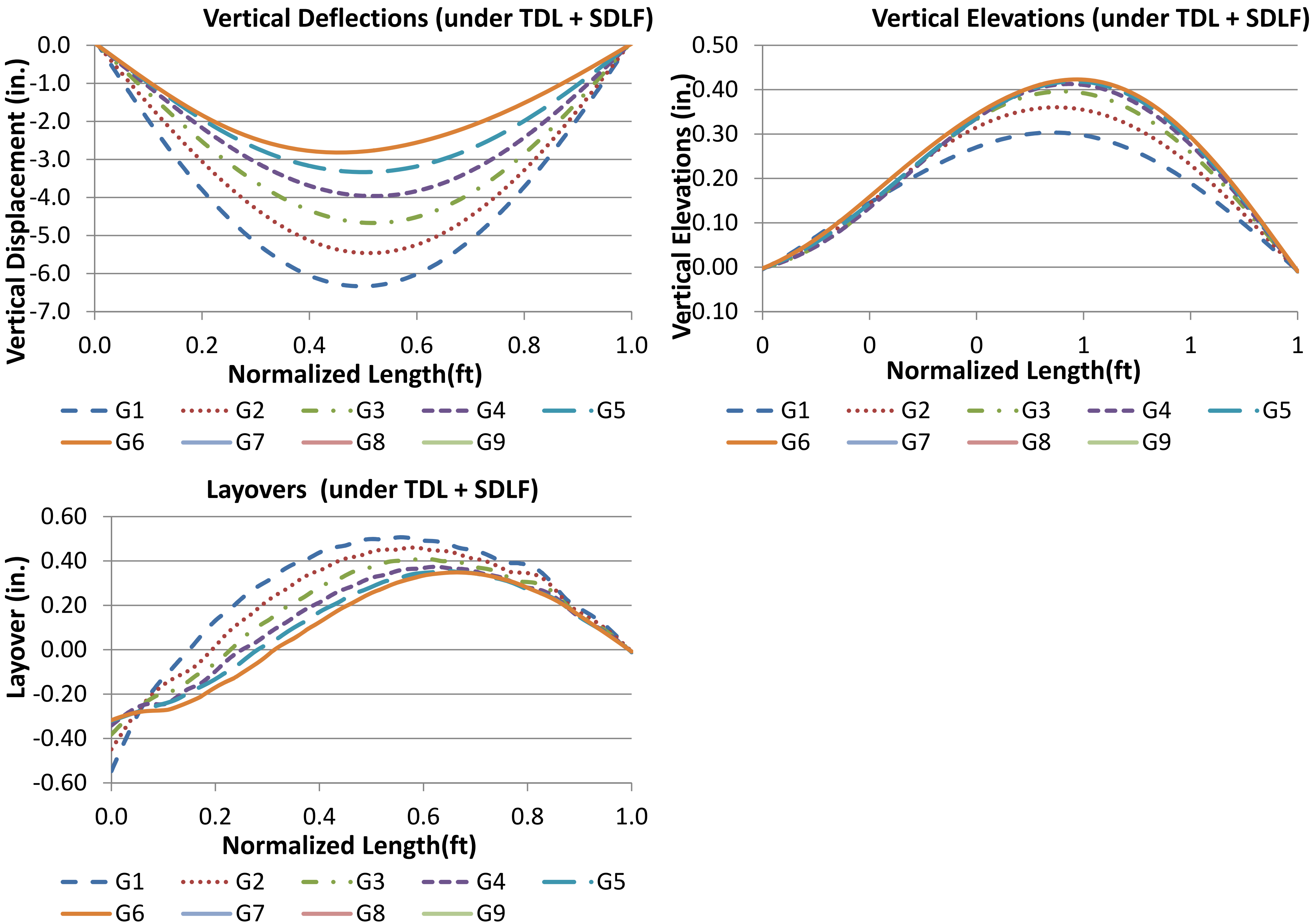


Figure P-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

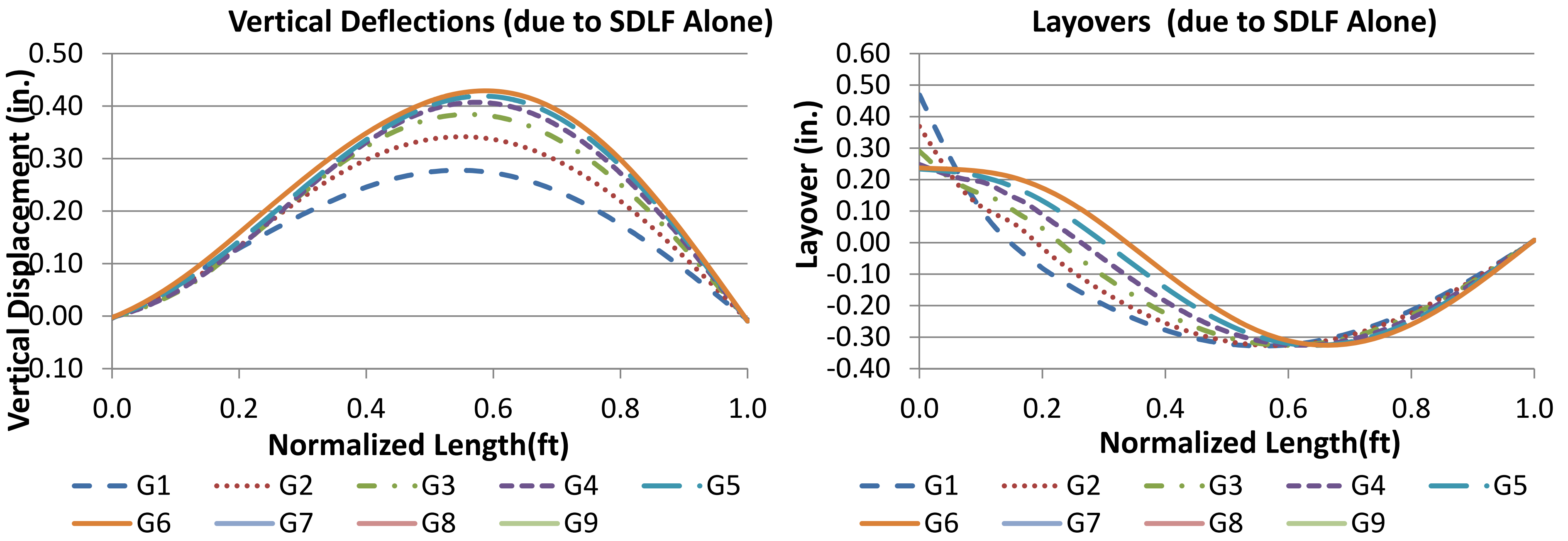


Figure P-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

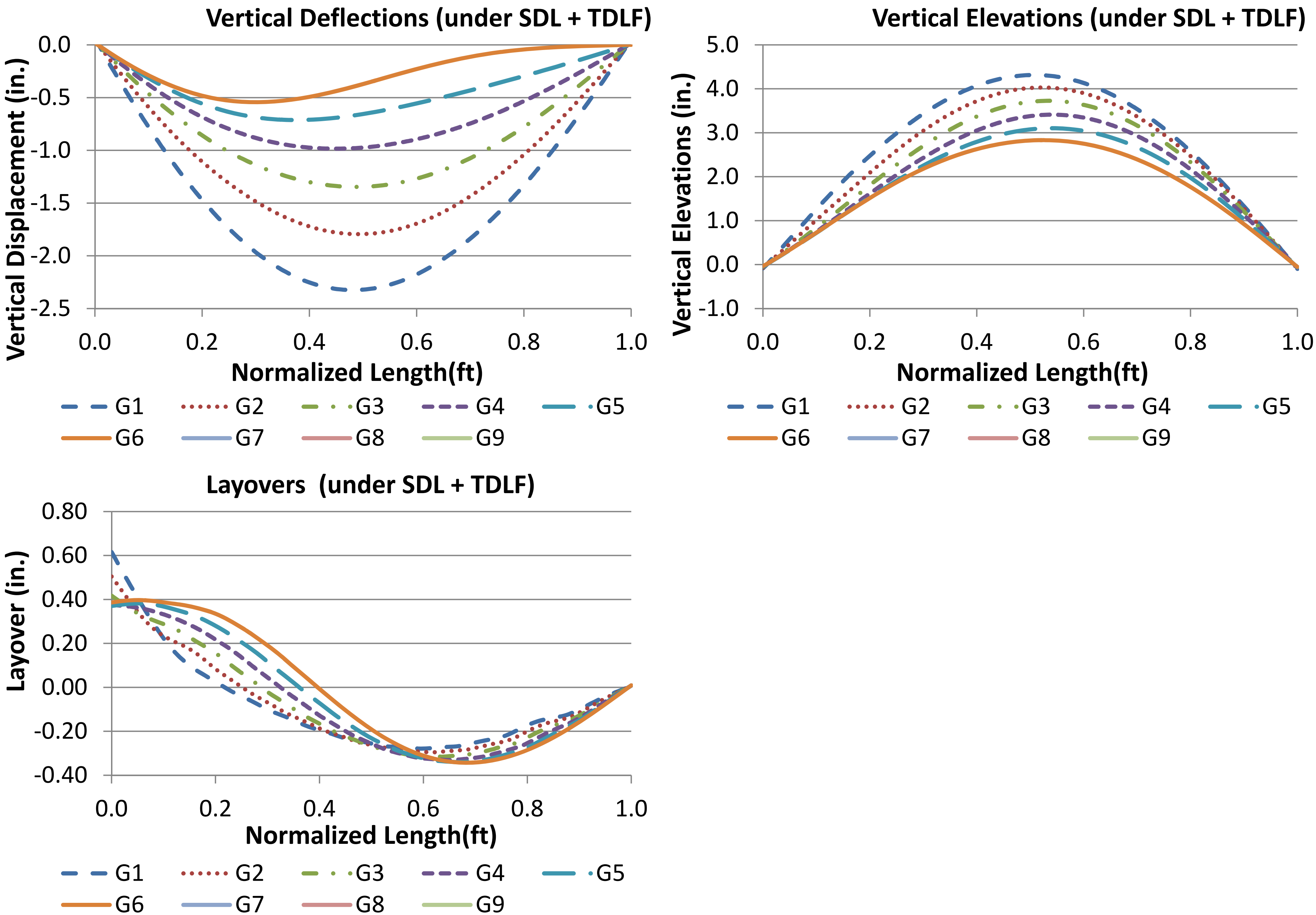


Figure P-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

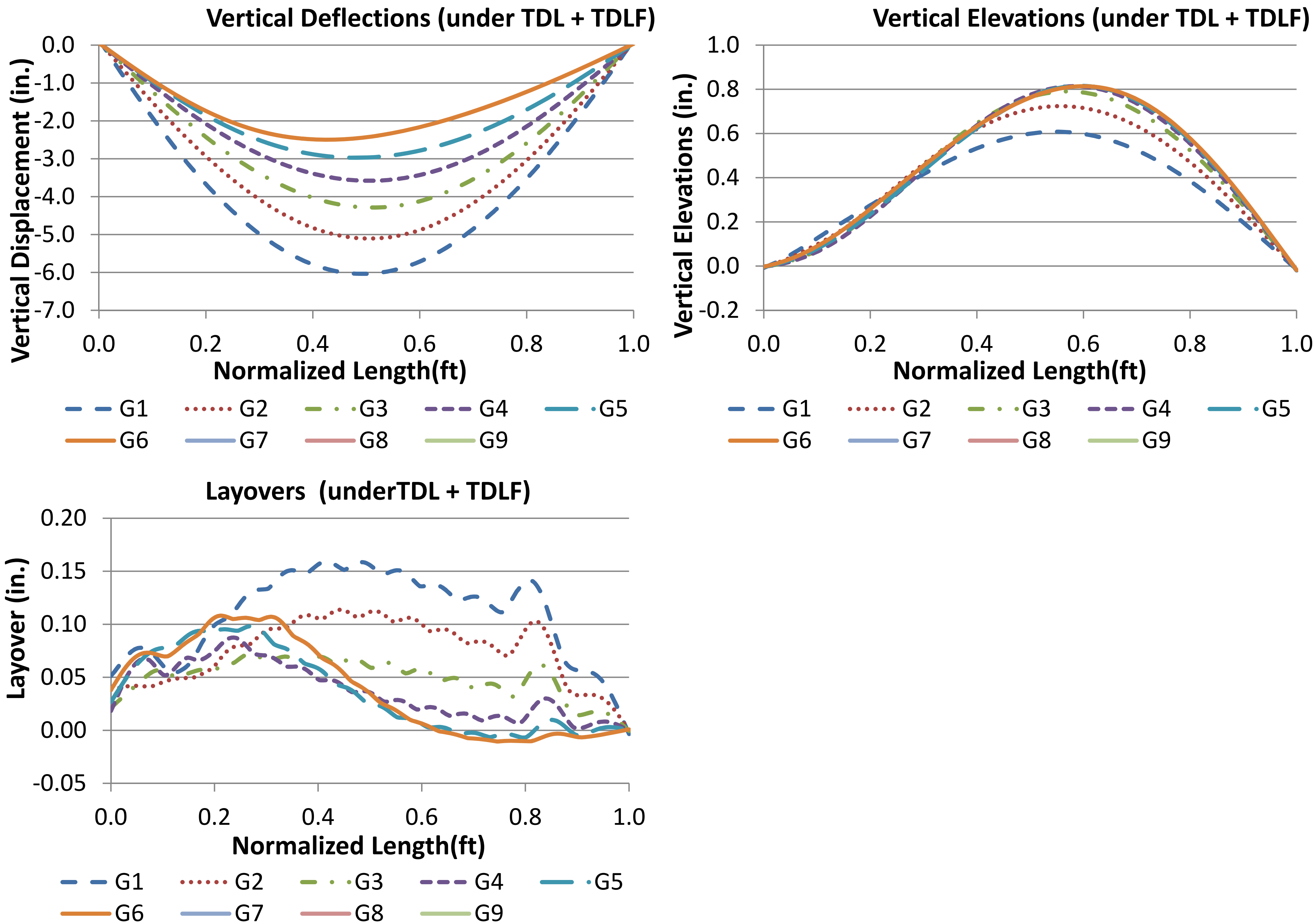


Figure P-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

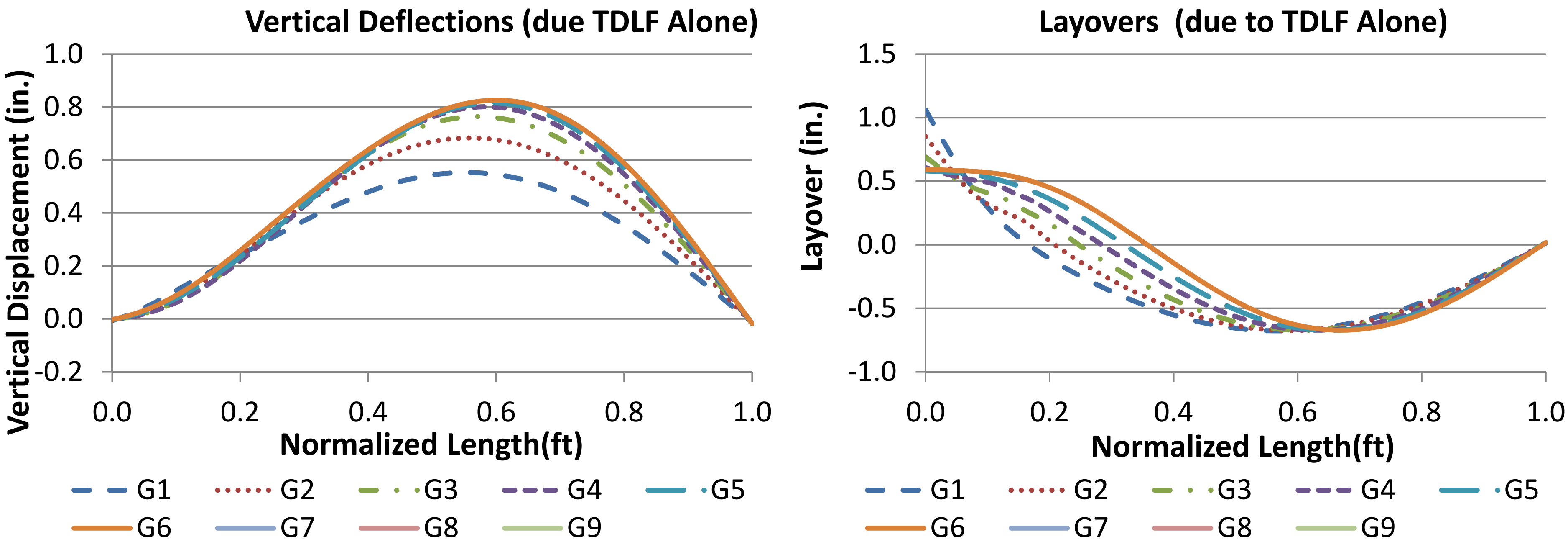


Figure P-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

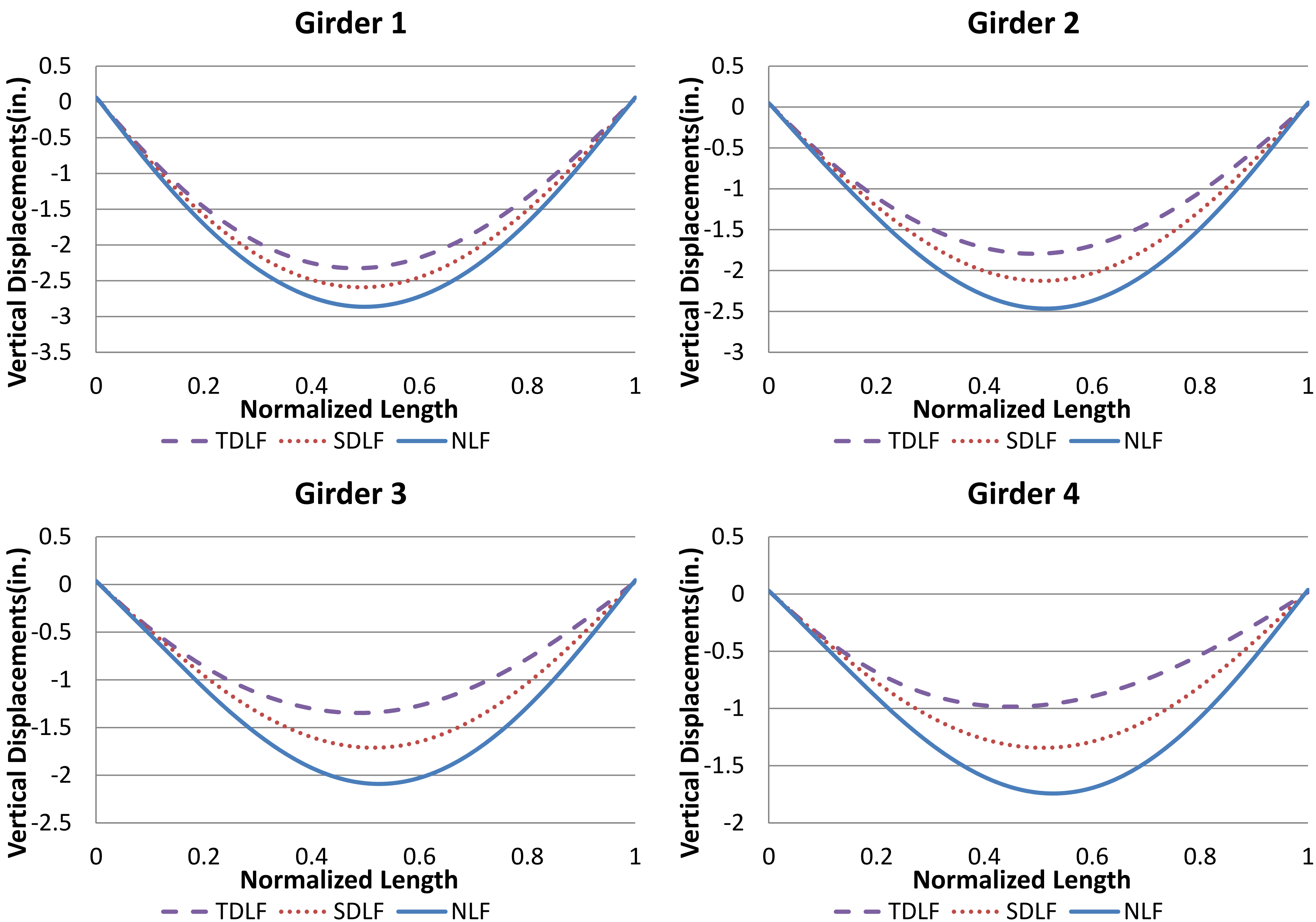


Figure P-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

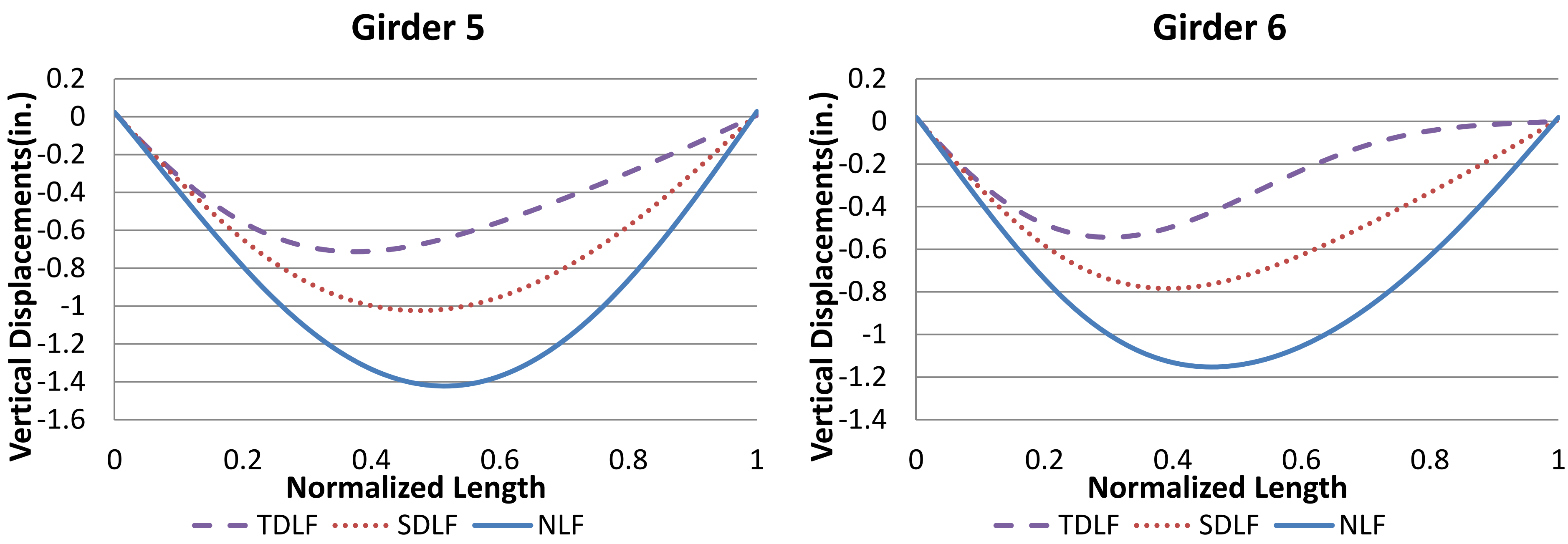


Figure P-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

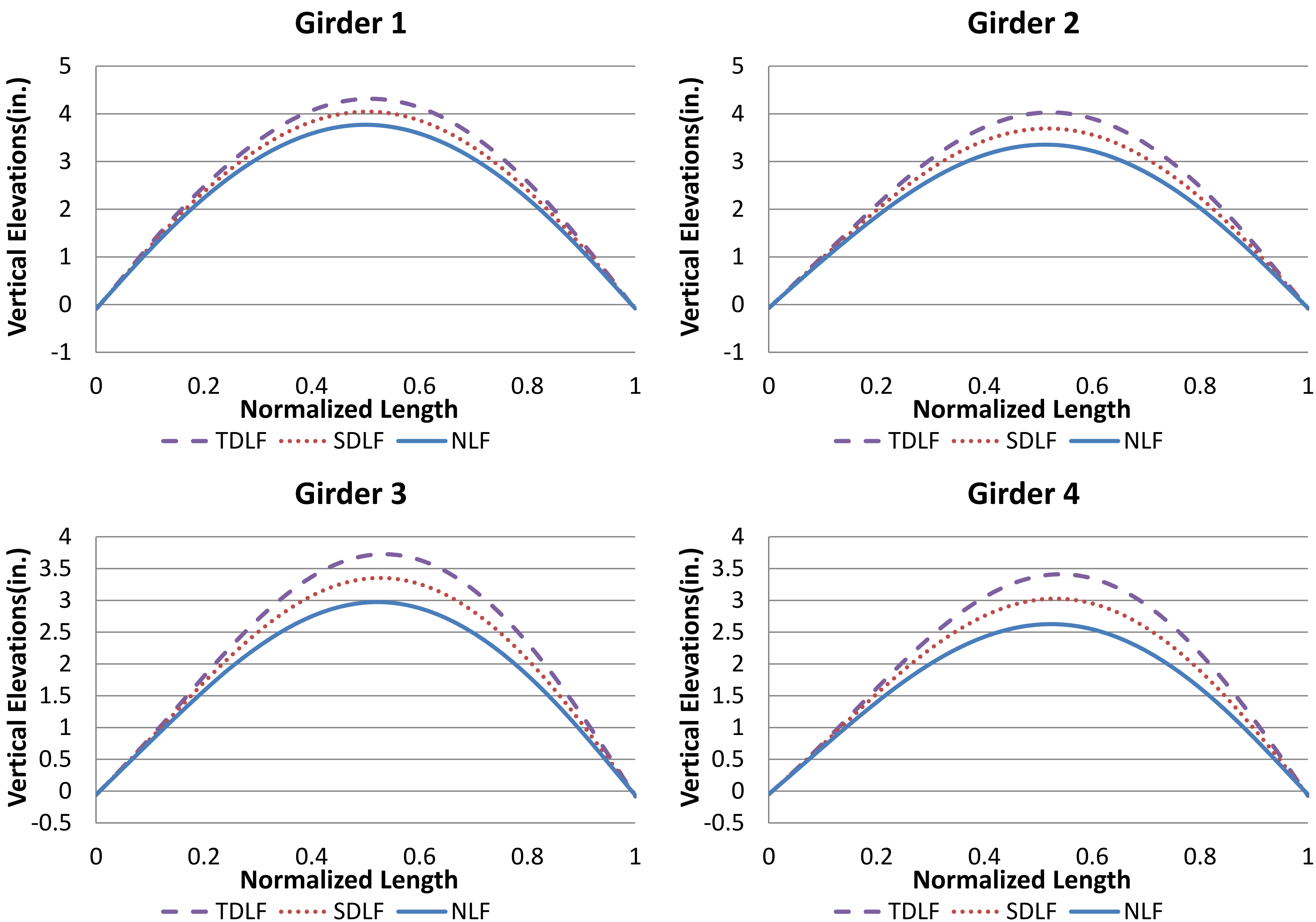


Figure P-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

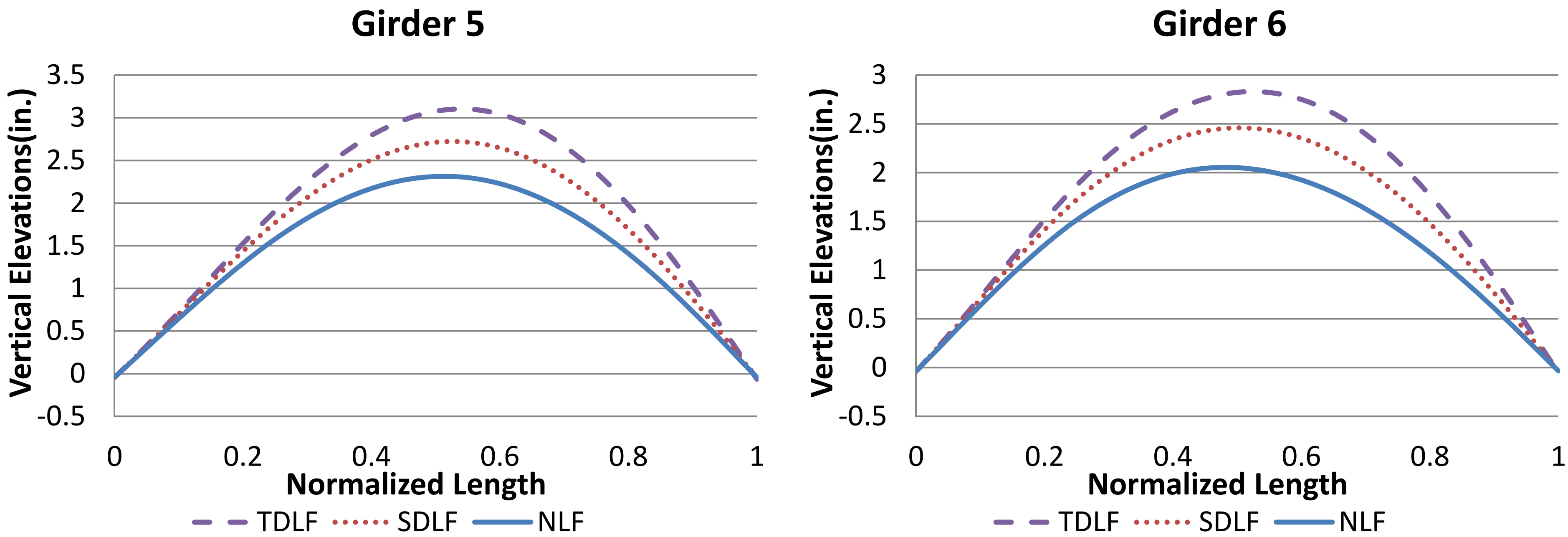


Figure P-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

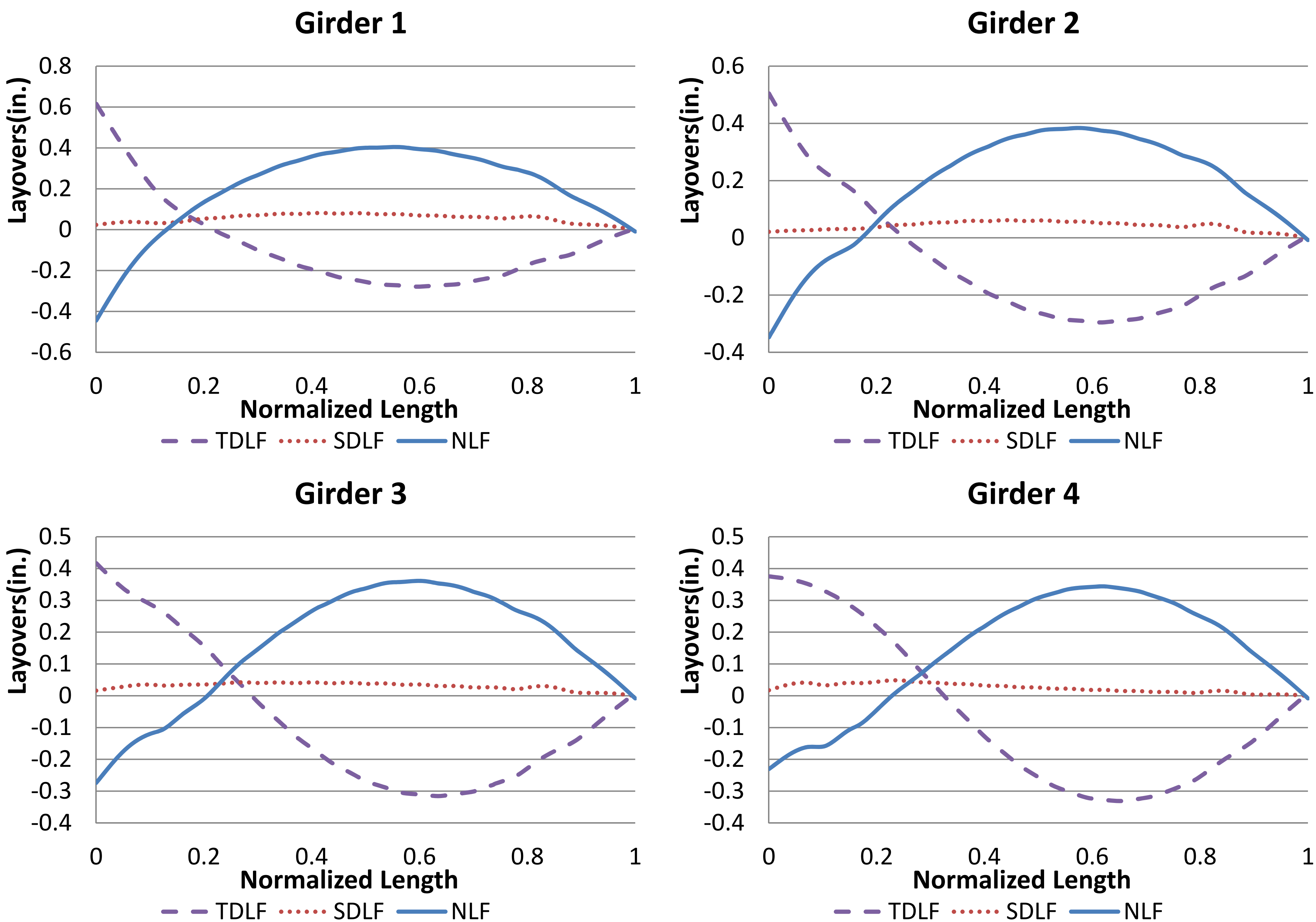
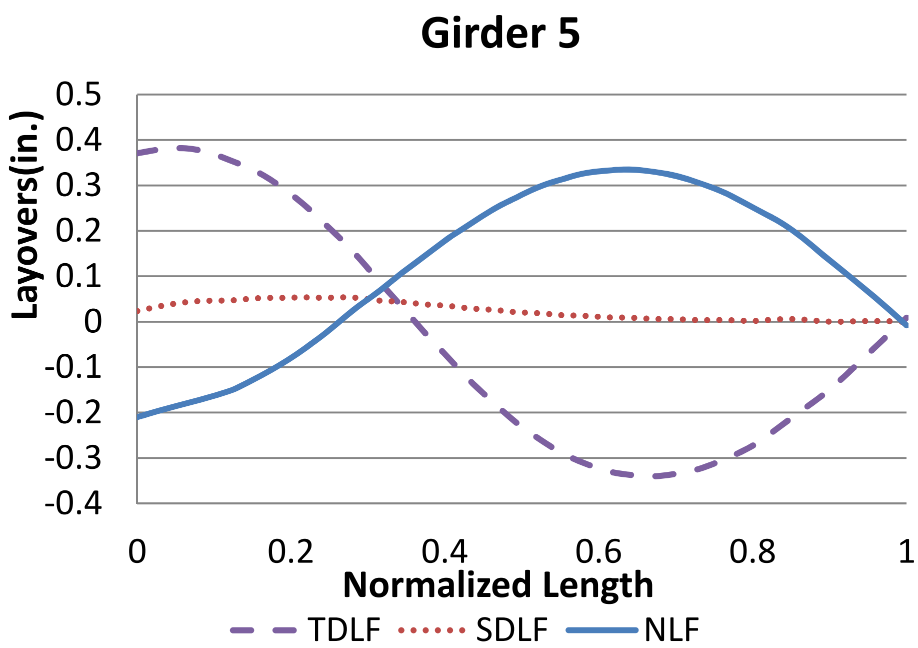


Figure P-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.



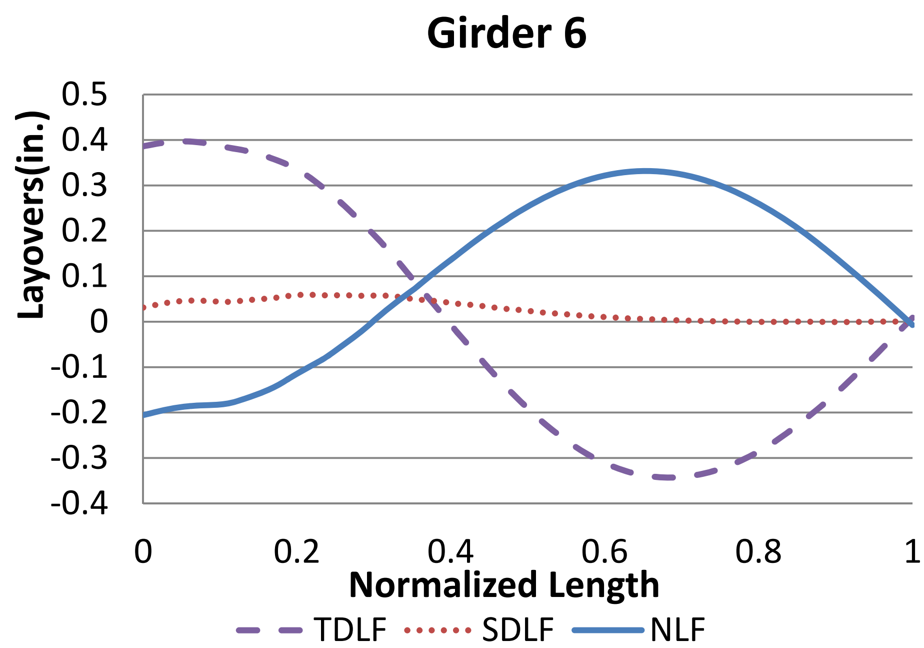


Figure P-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

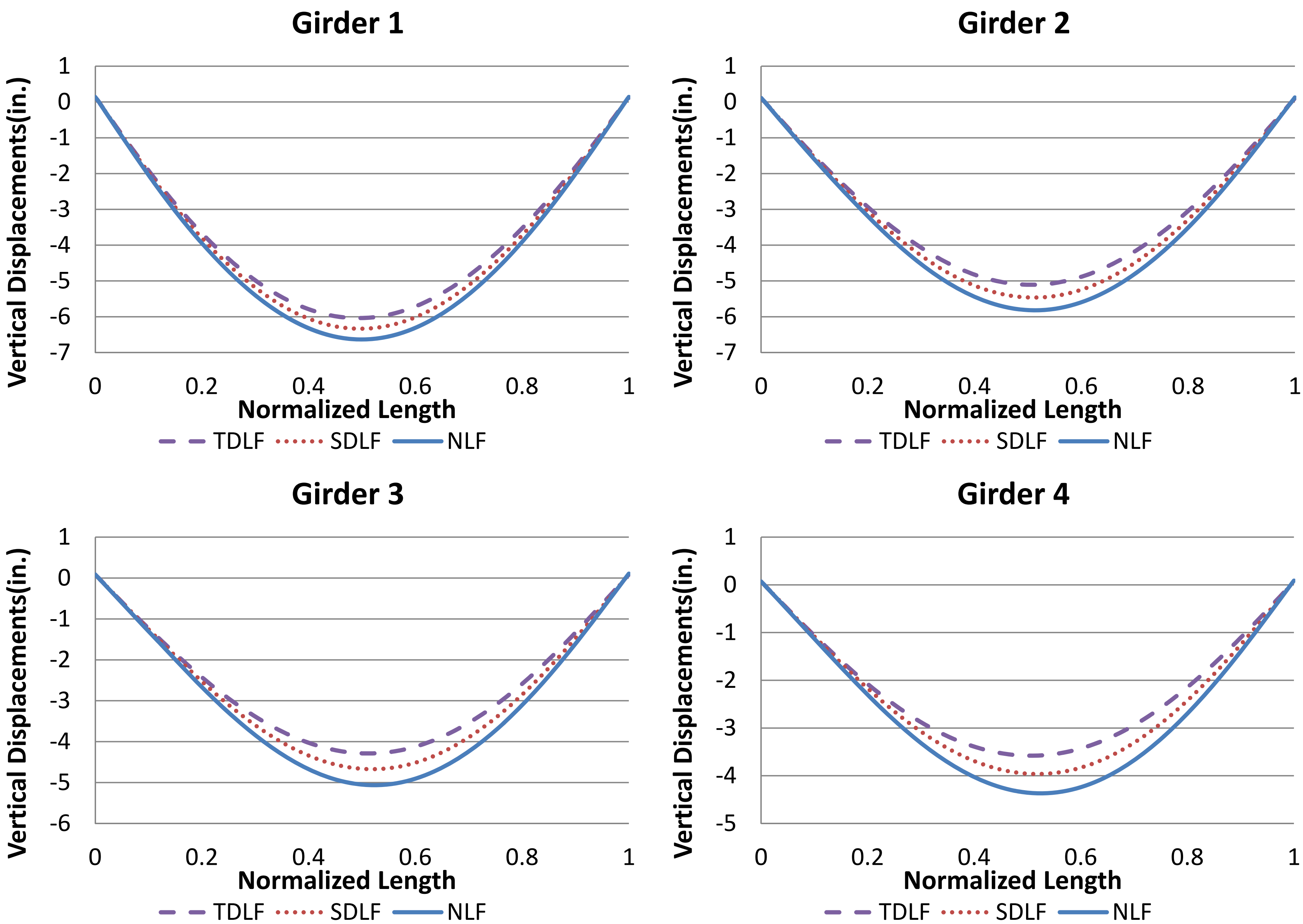
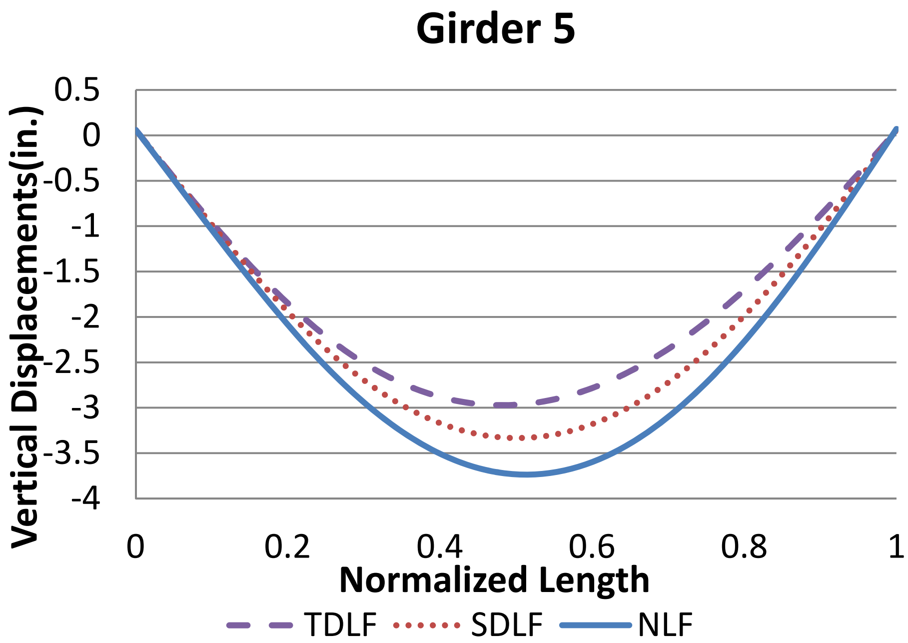


Figure P-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.



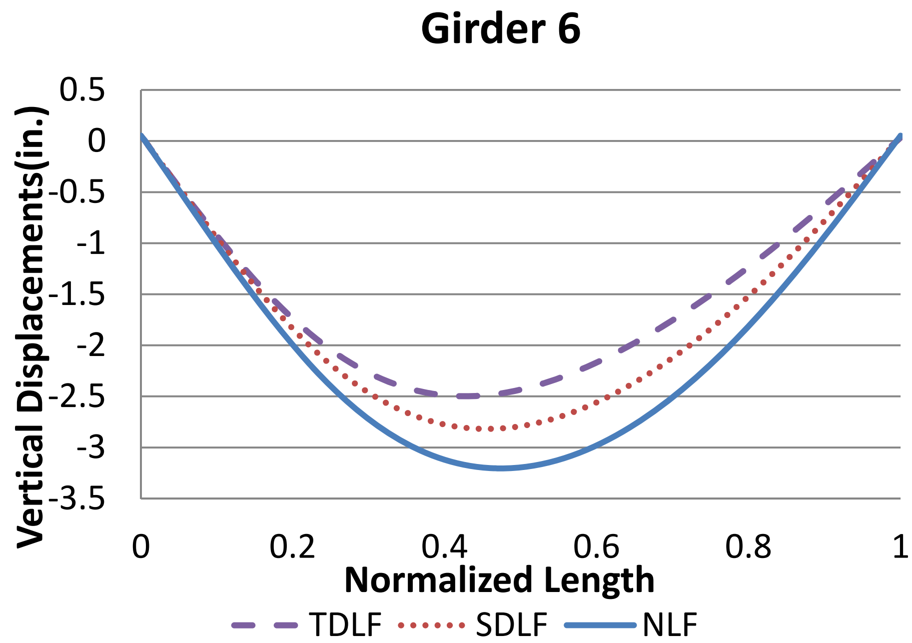


Figure P-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

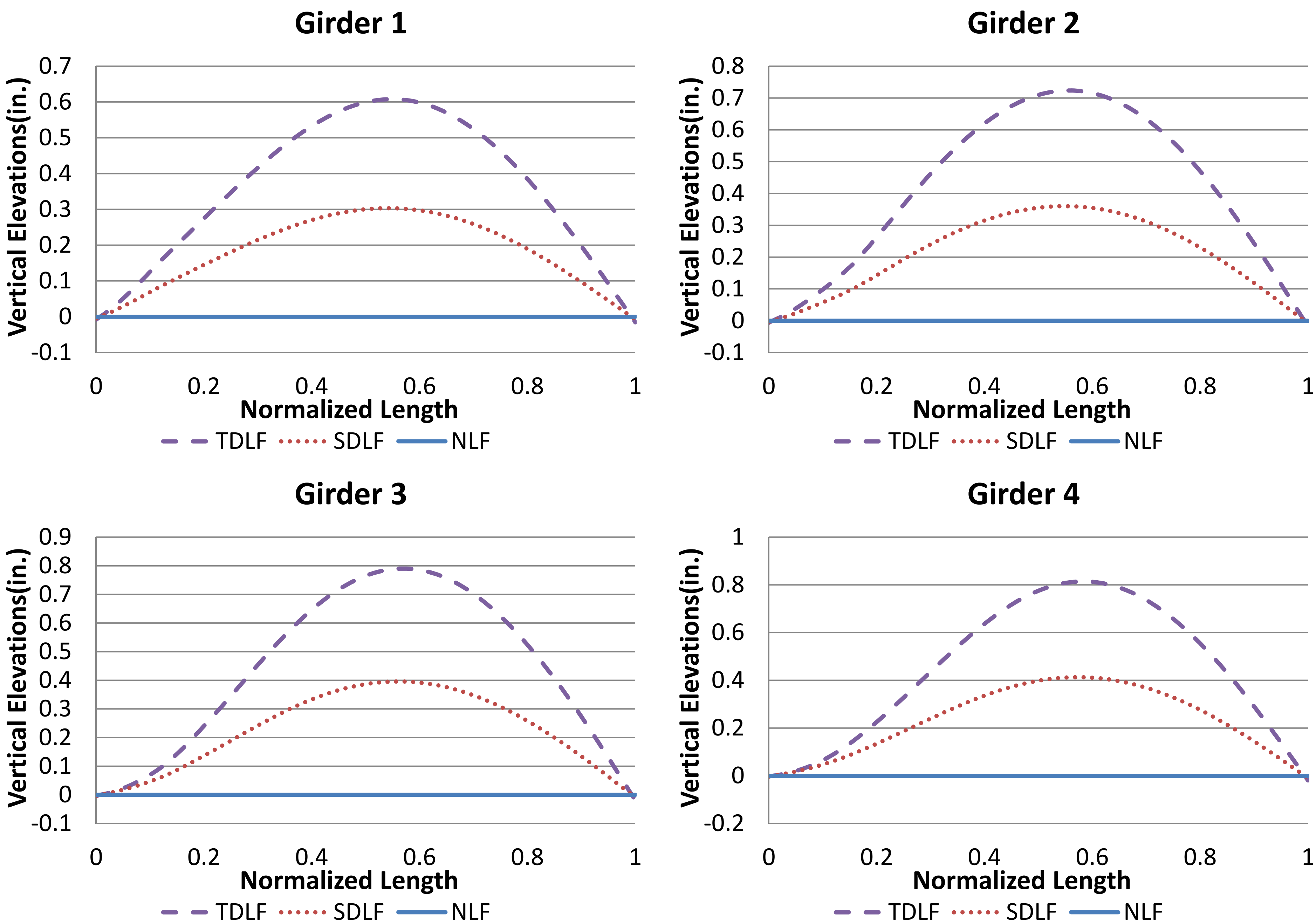


Figure P-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

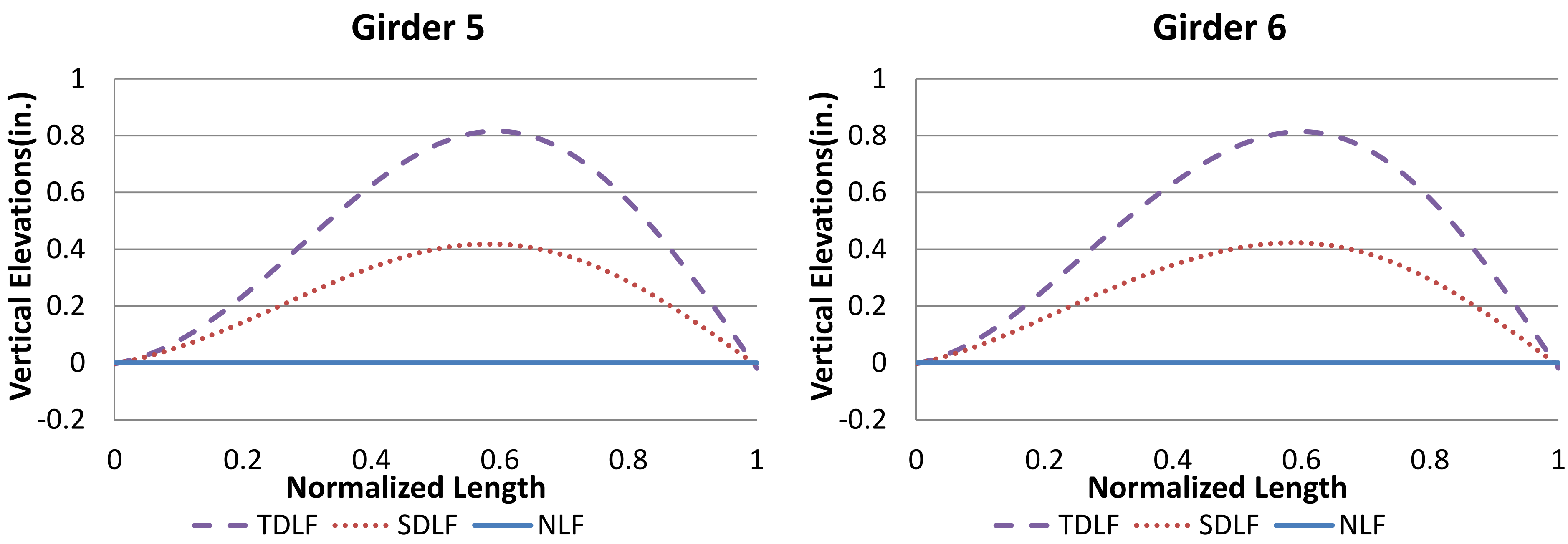


Figure P-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

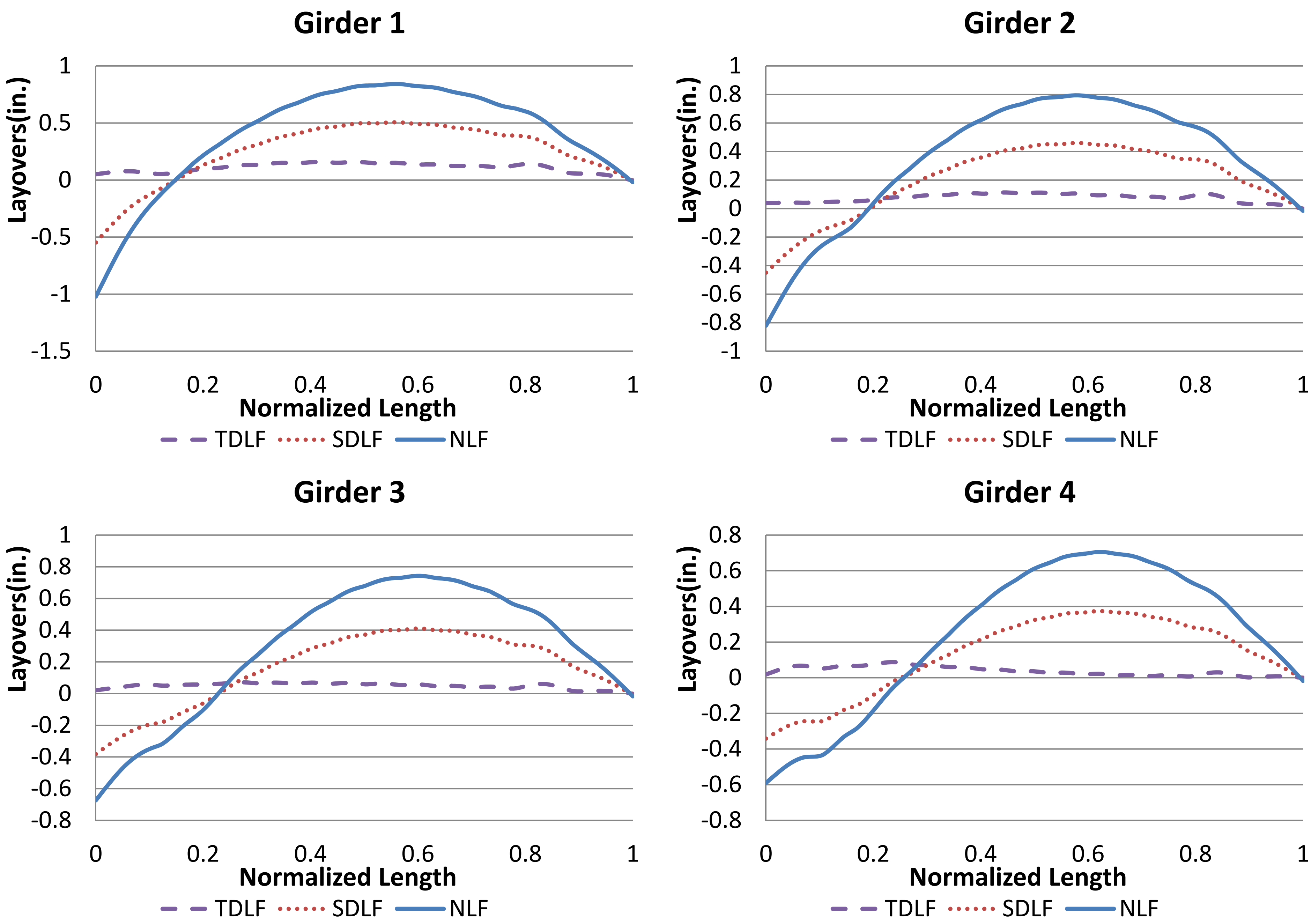
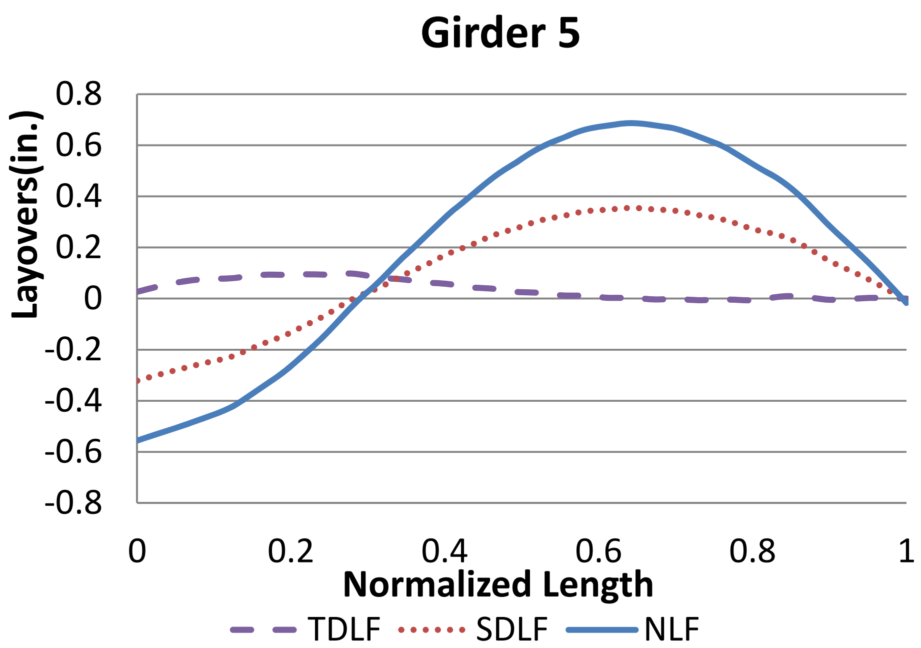


Figure P-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.



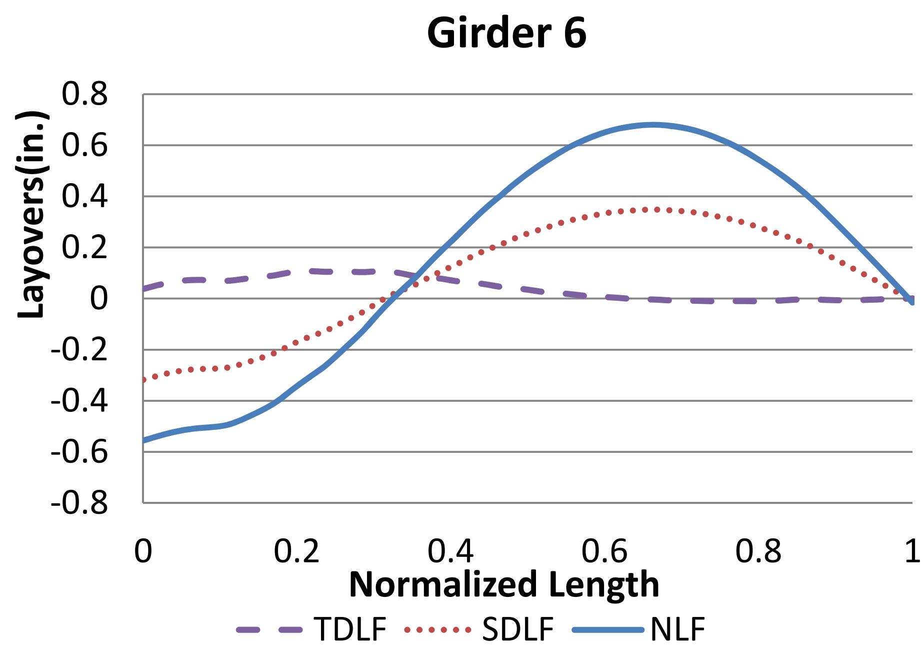


Figure P-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

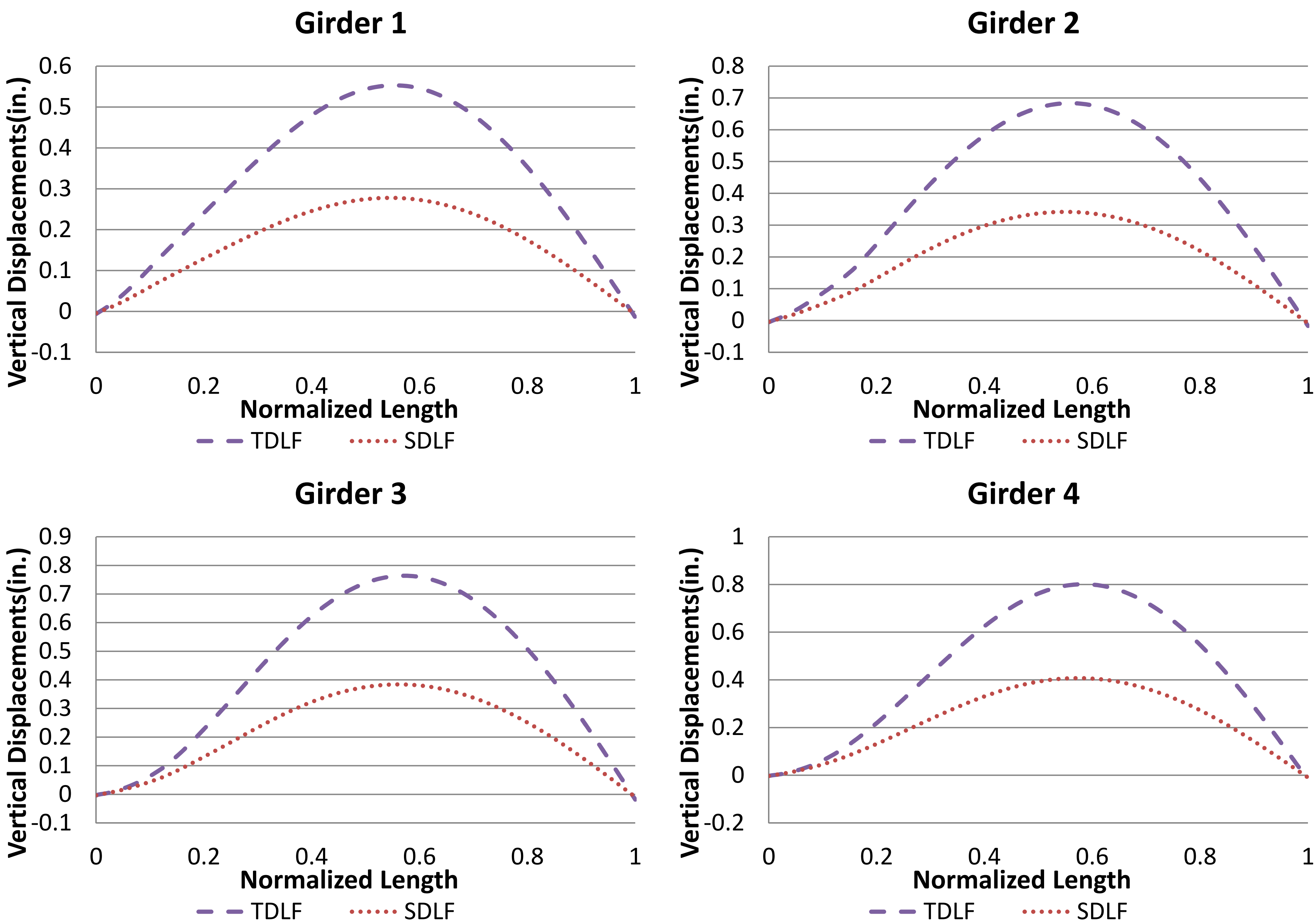


Figure P-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

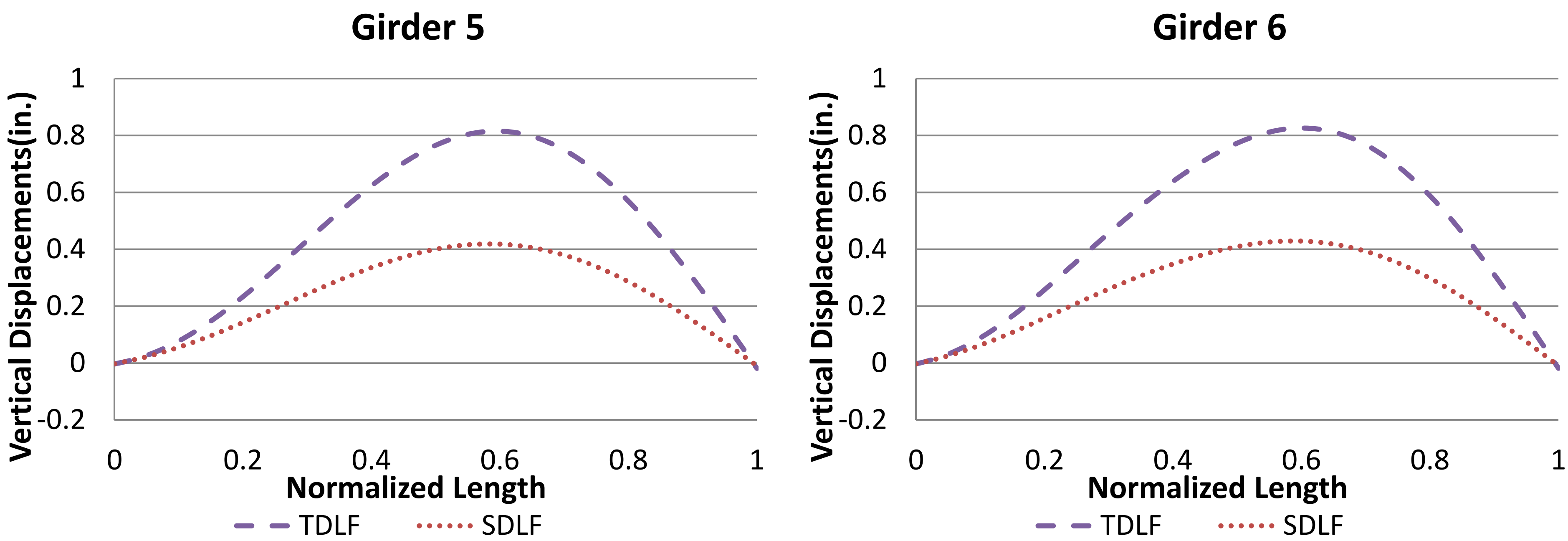


Figure P-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

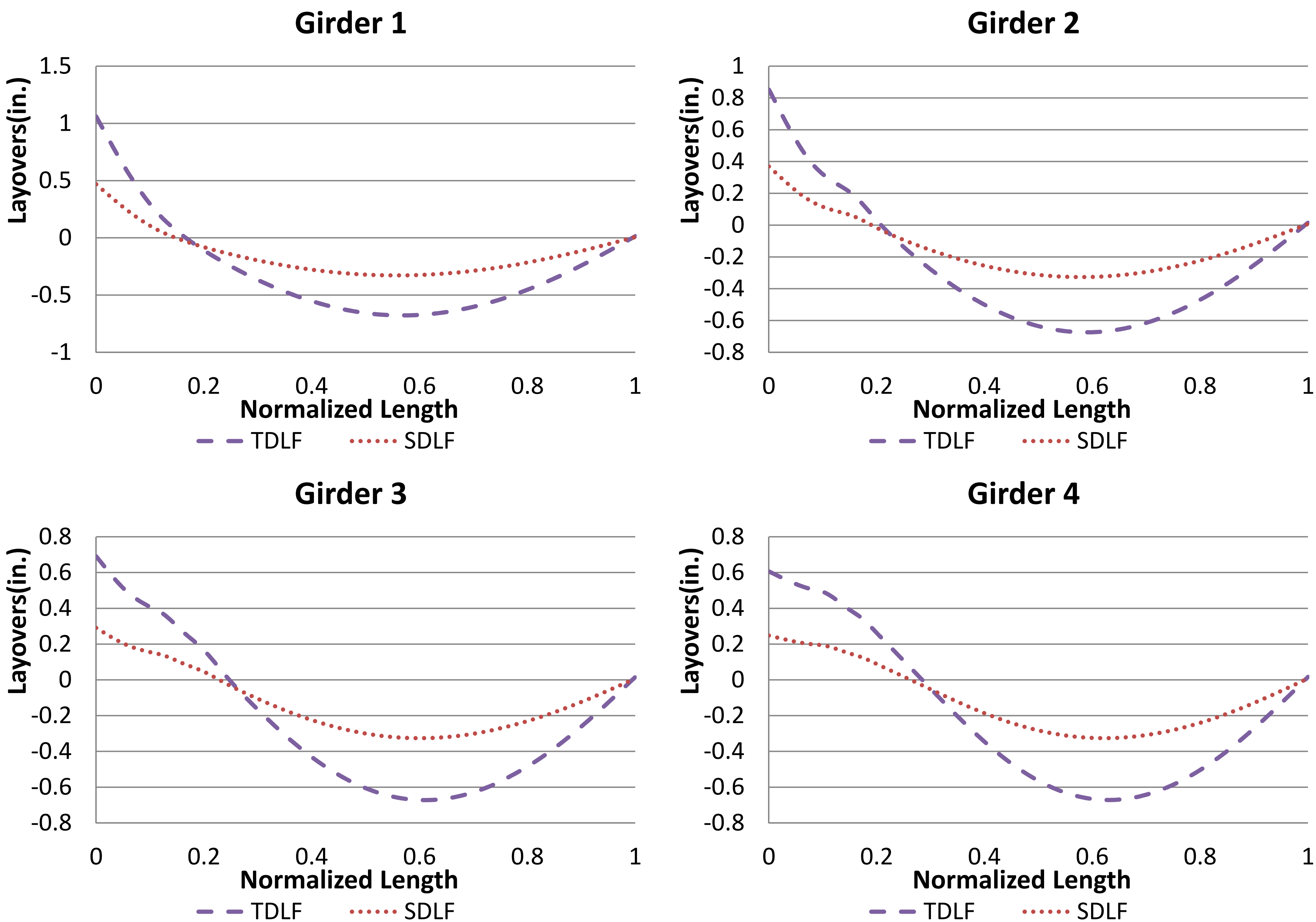


Figure P-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

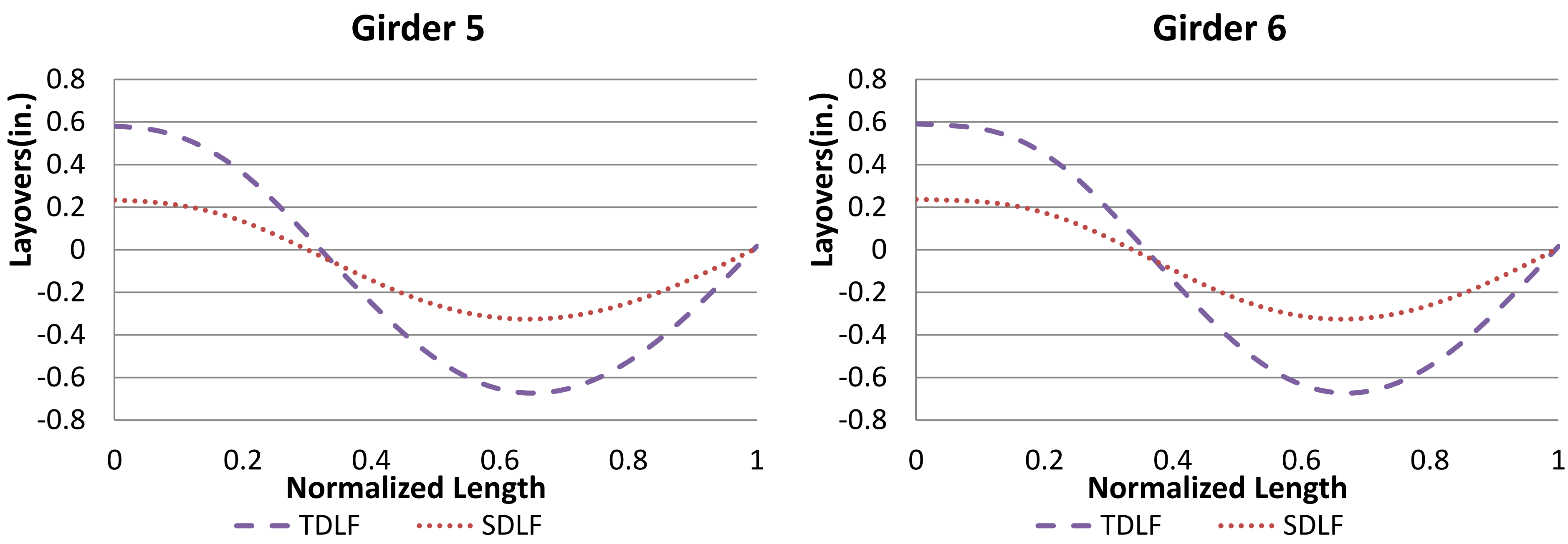


Figure P-4-17(Continued). **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.**

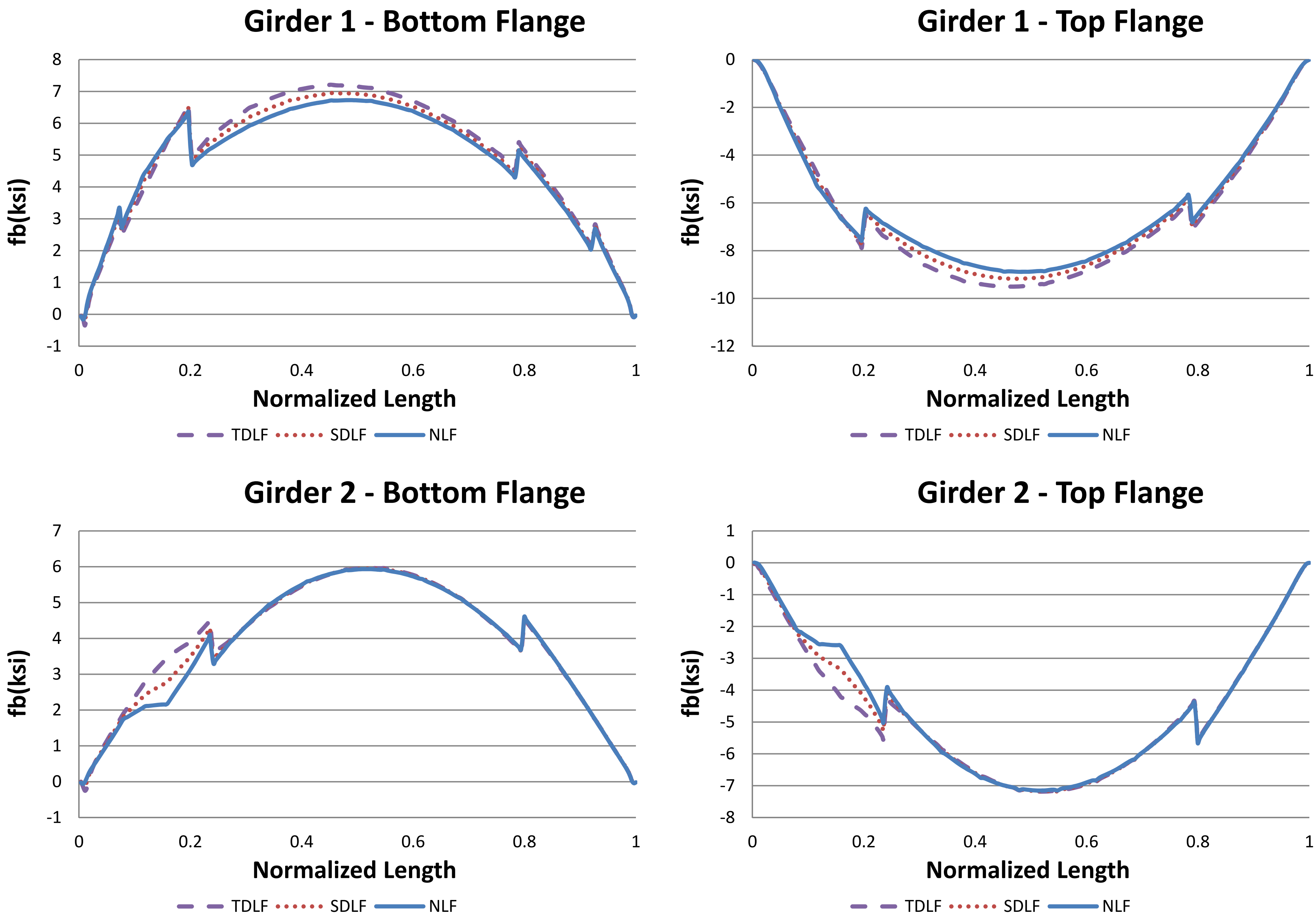


Figure P-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

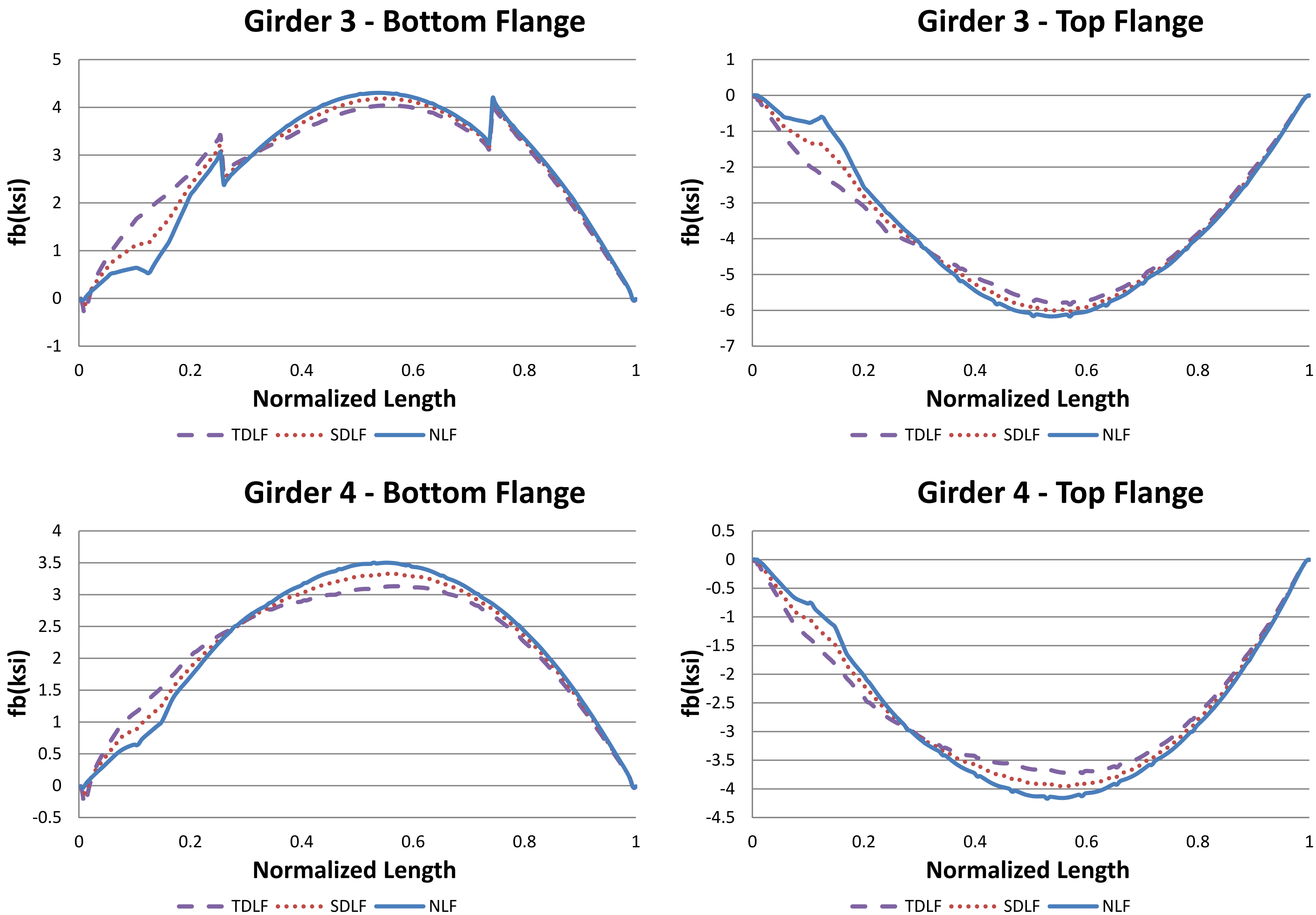


Figure P-4-18(Continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

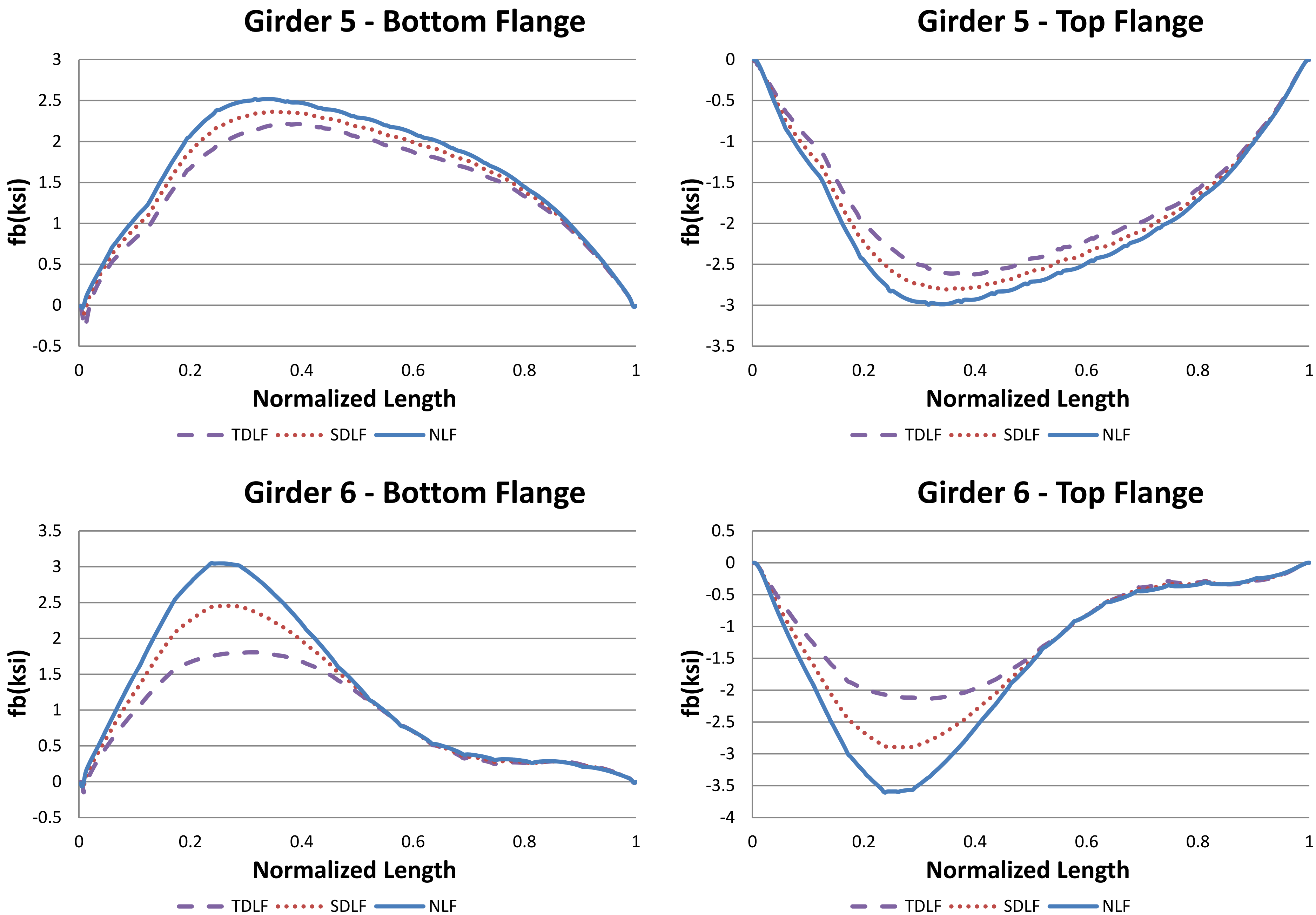


Figure P-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

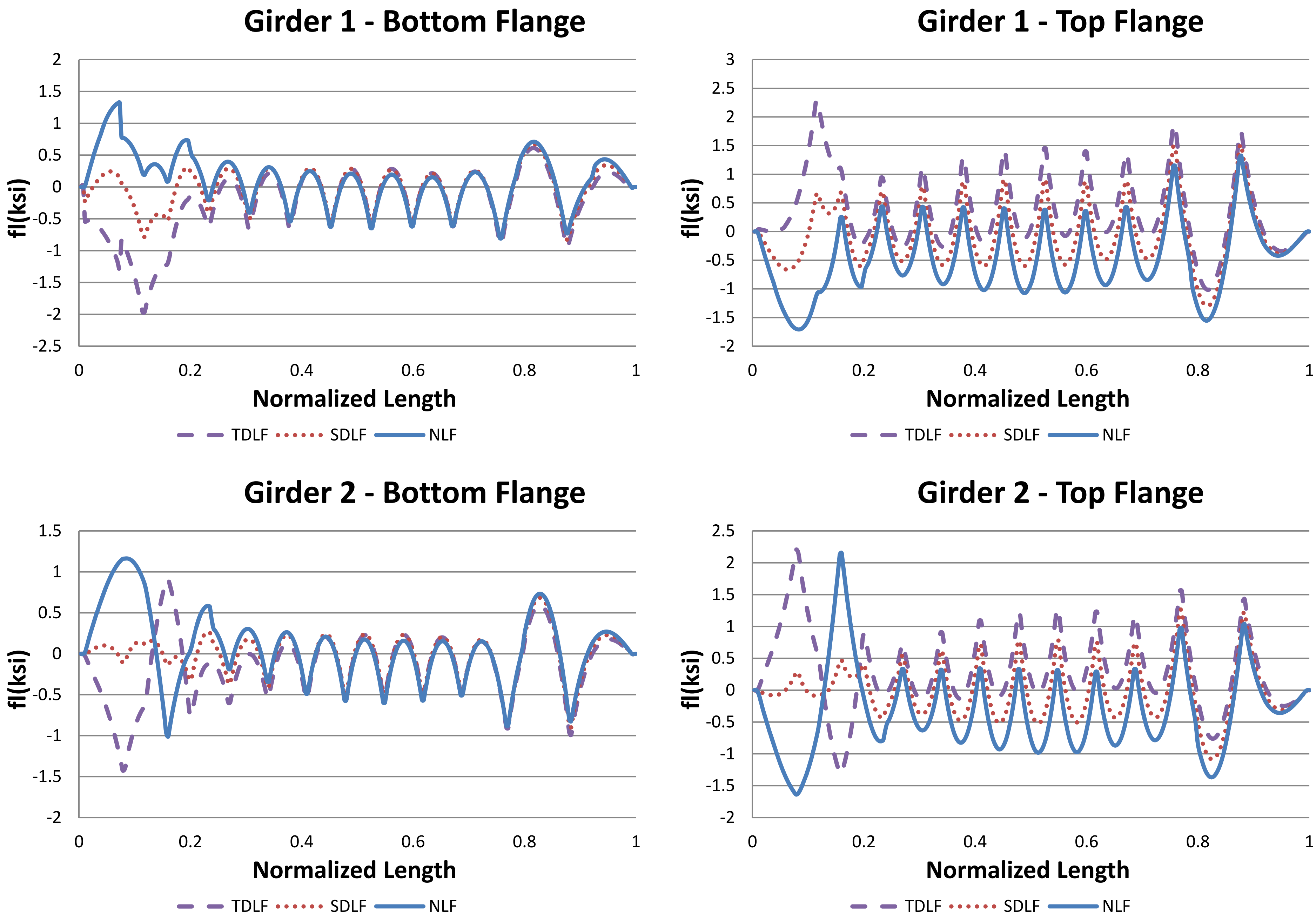


Figure P-4-19. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

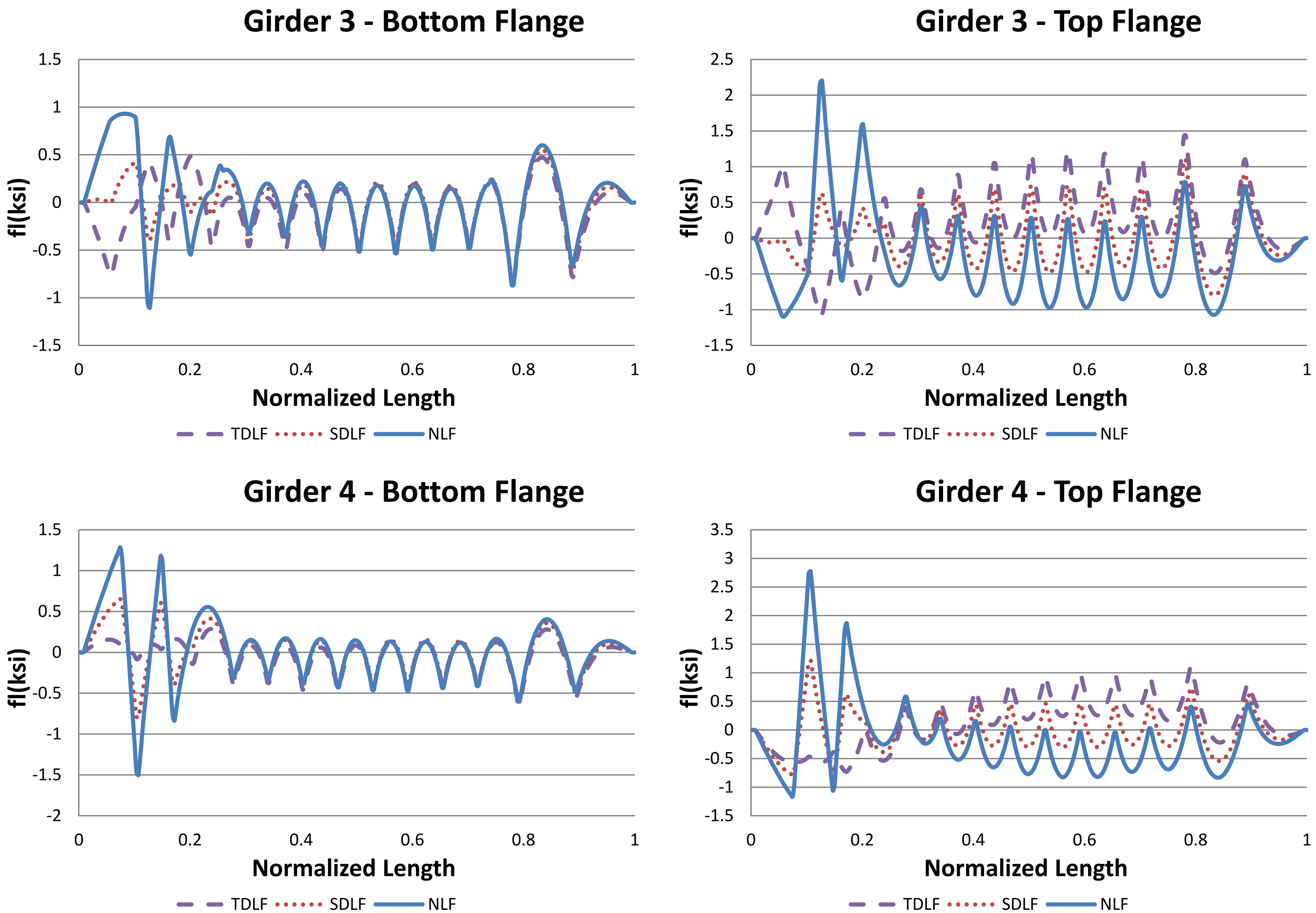


Figure P-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

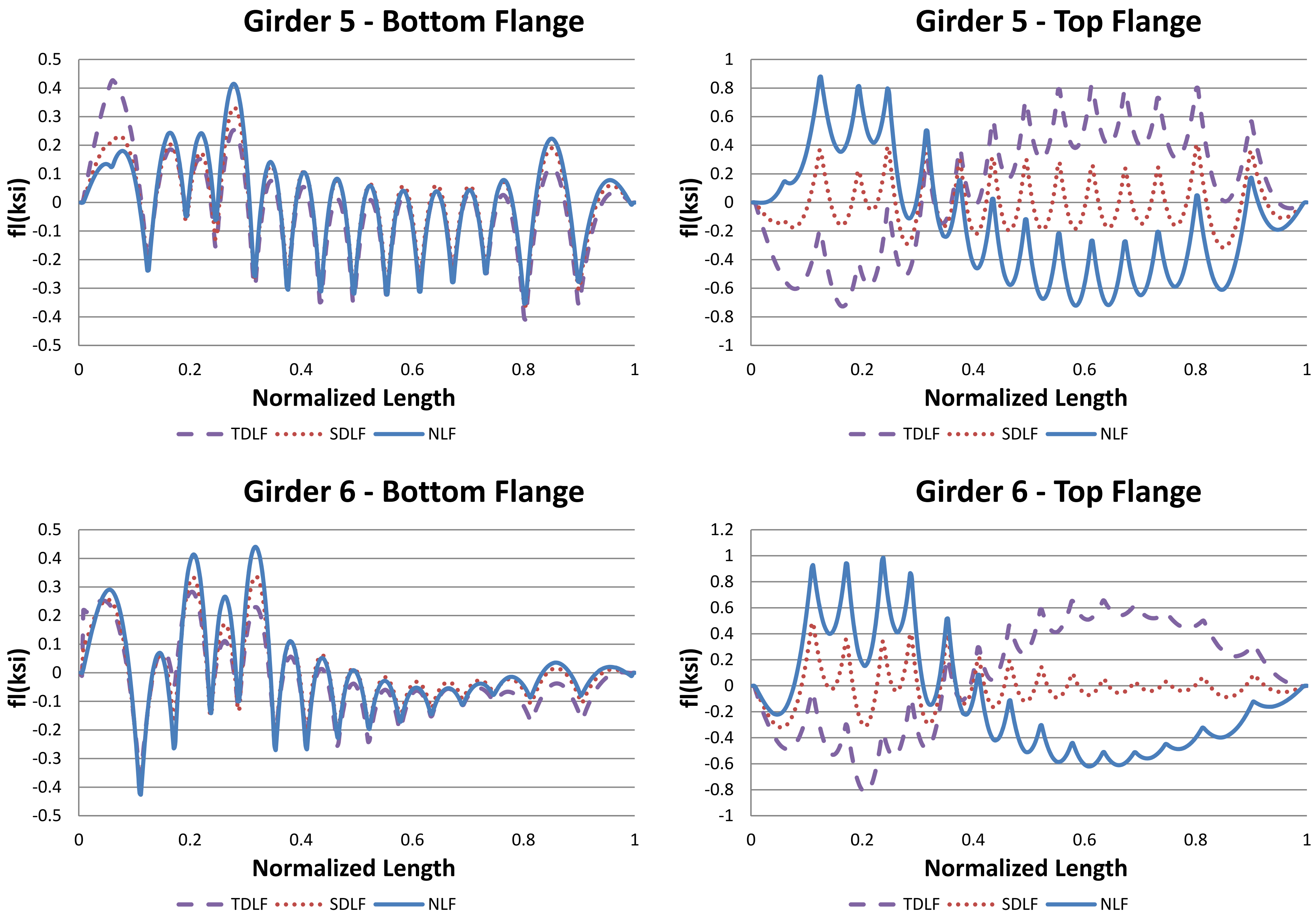


Figure P-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

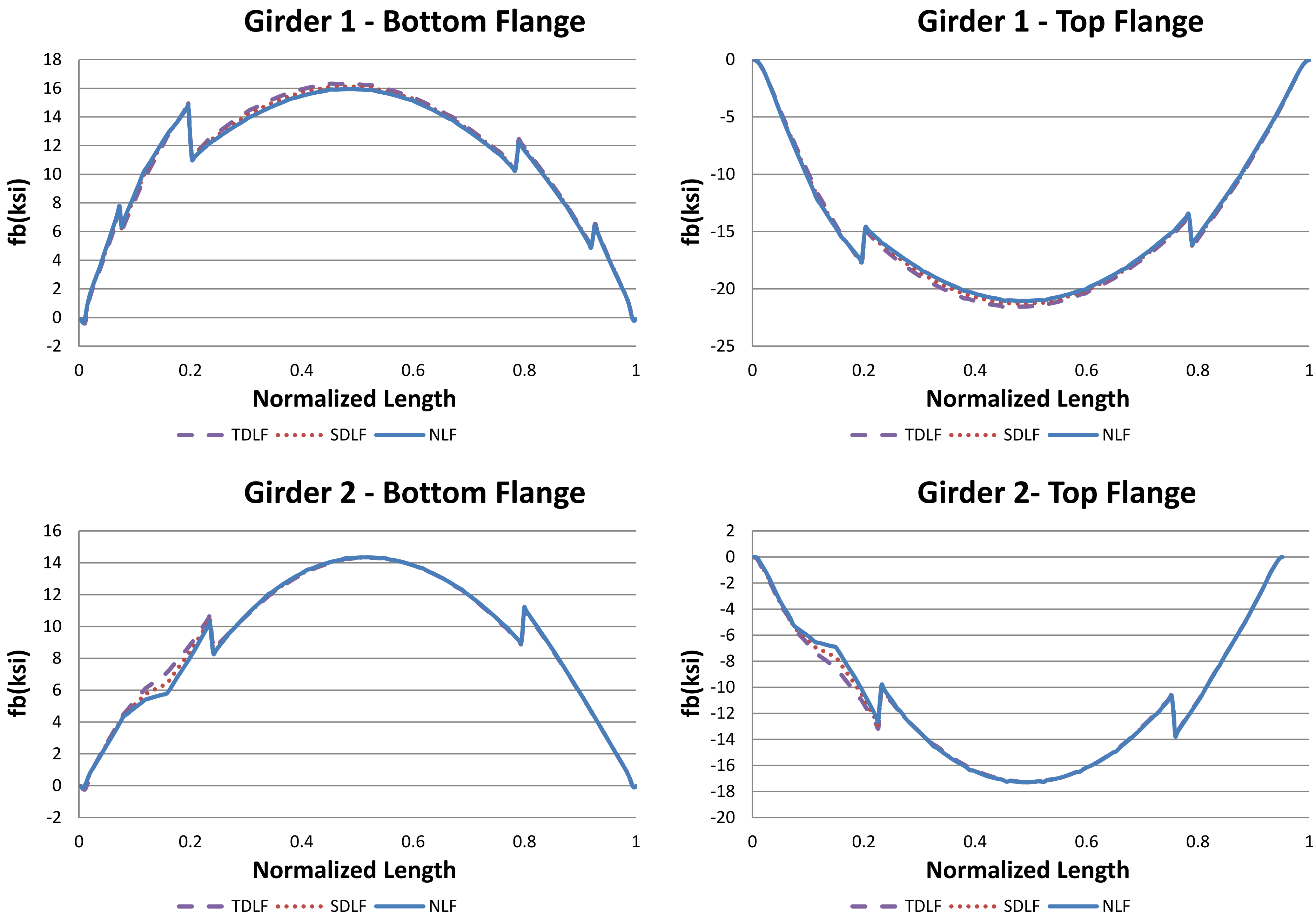


Figure P-4-20. Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

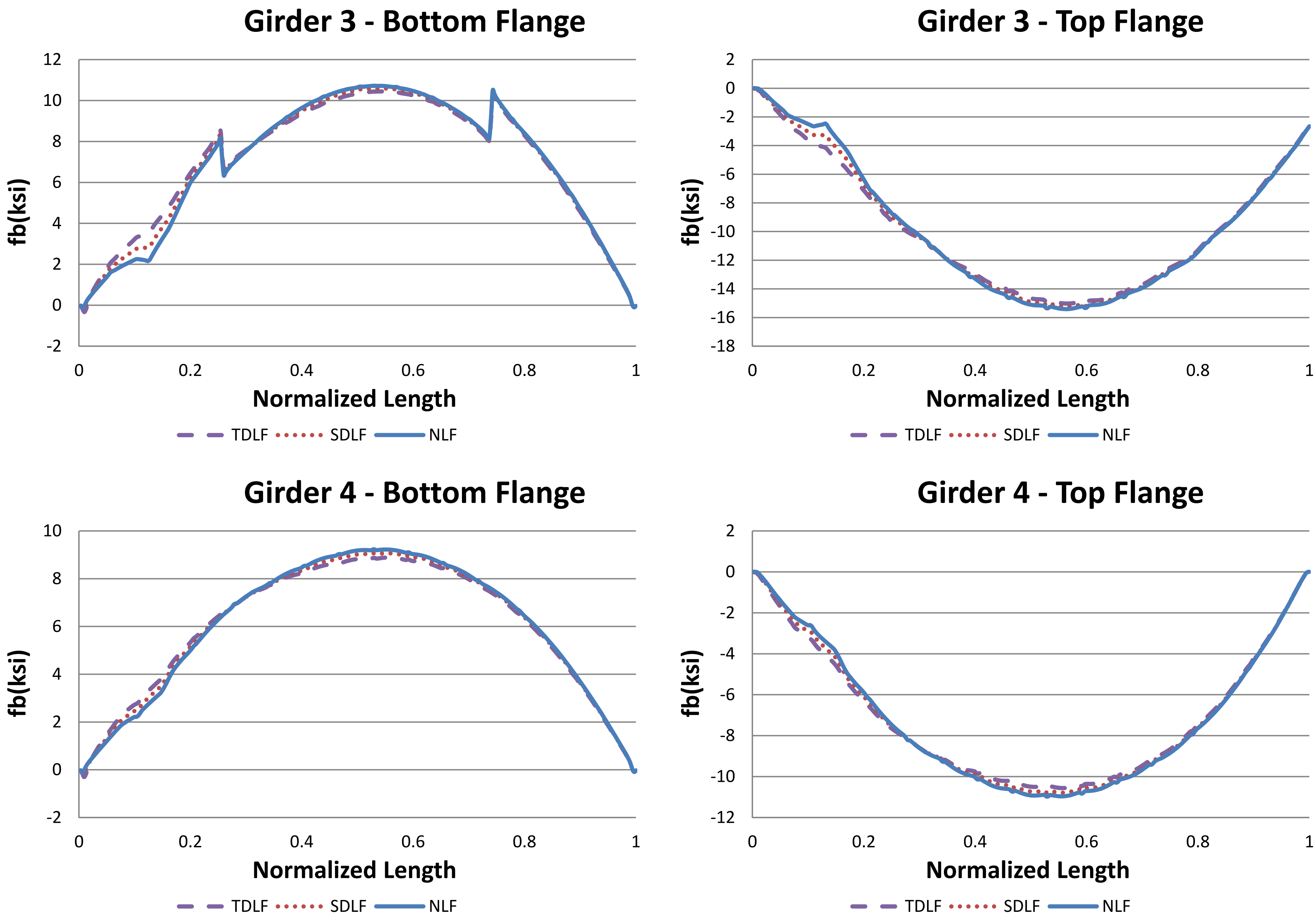


Figure P-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

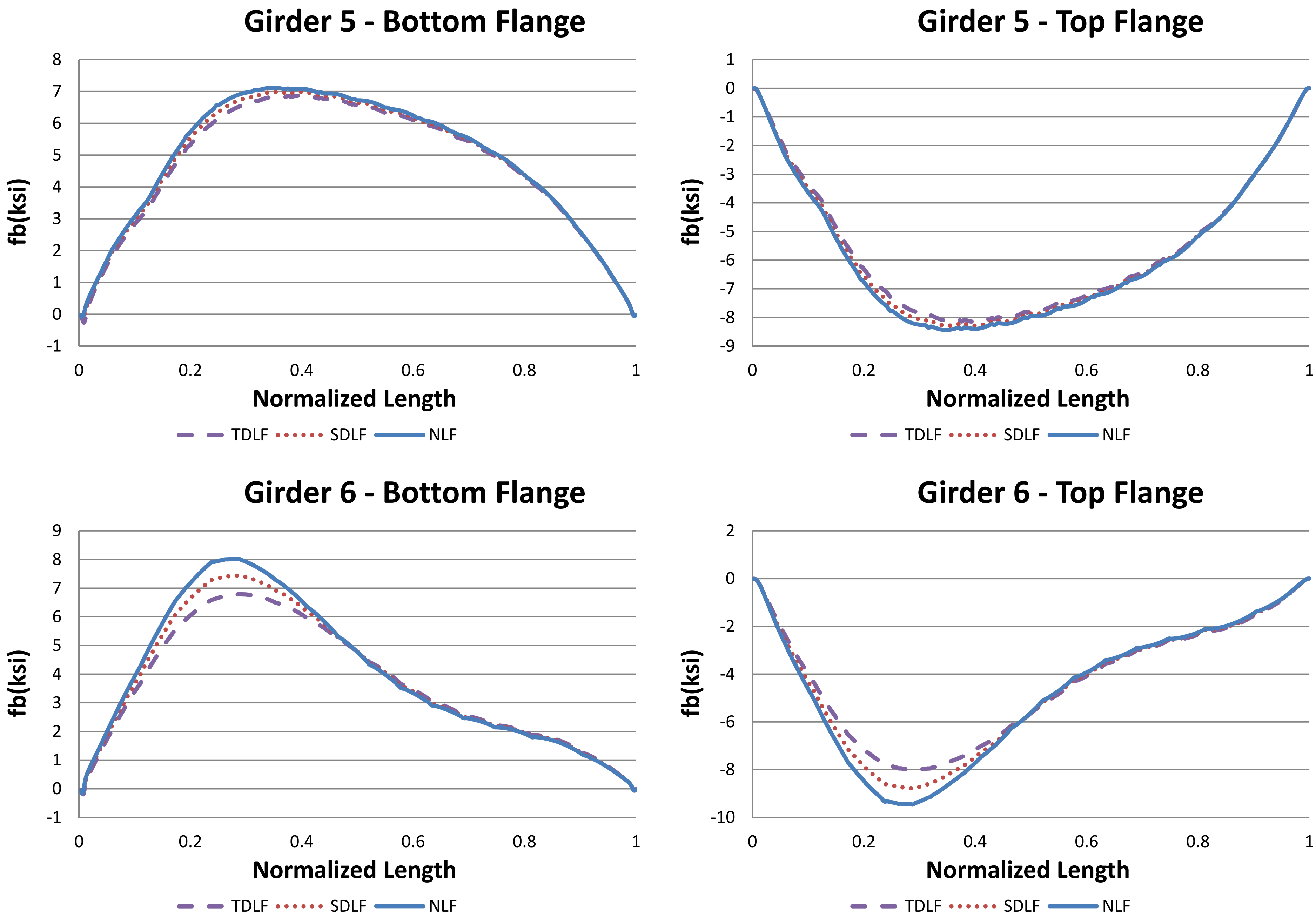


Figure P-4-20(Continued). **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

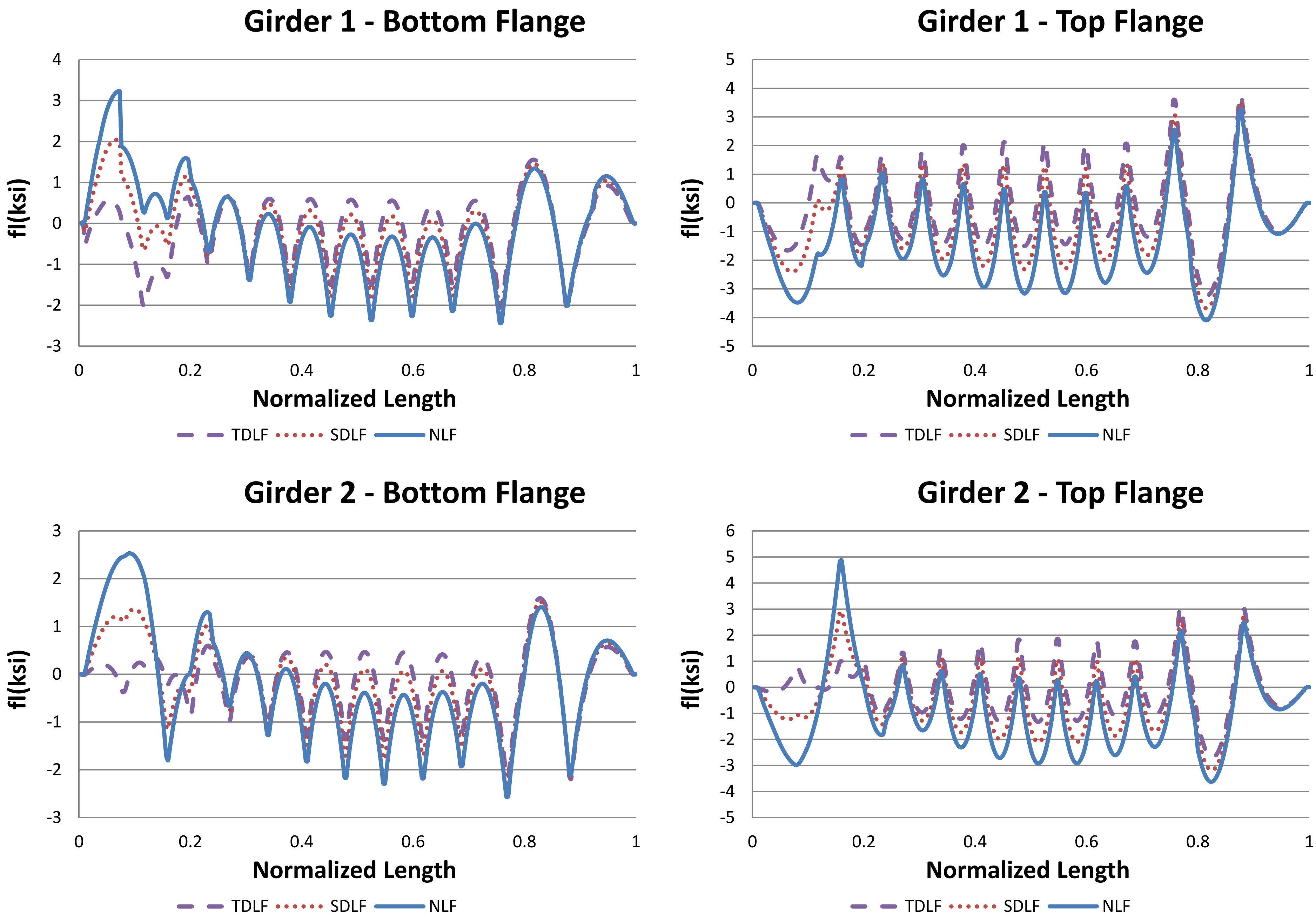


Figure P-4-21. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

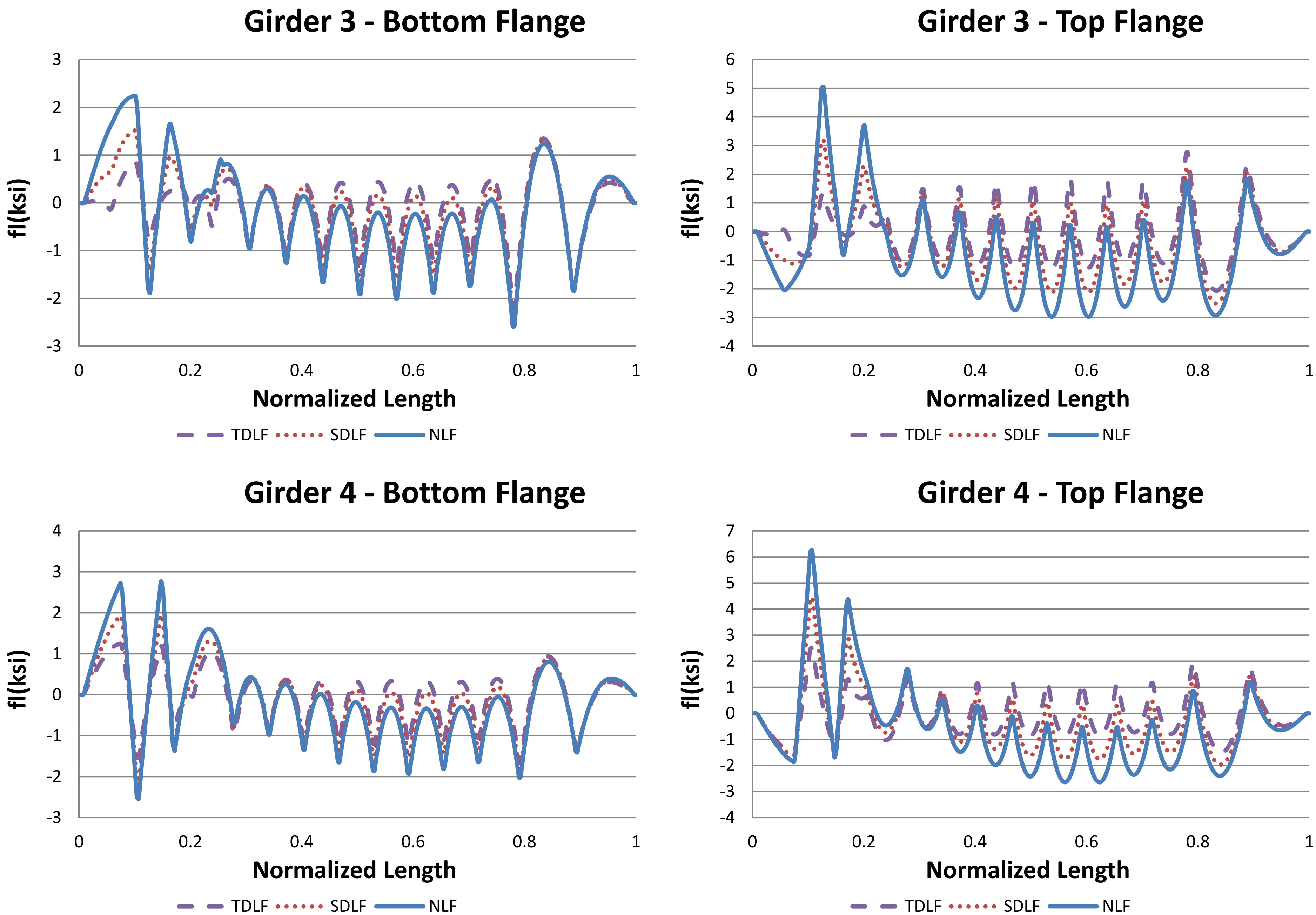


Figure P-4-21(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

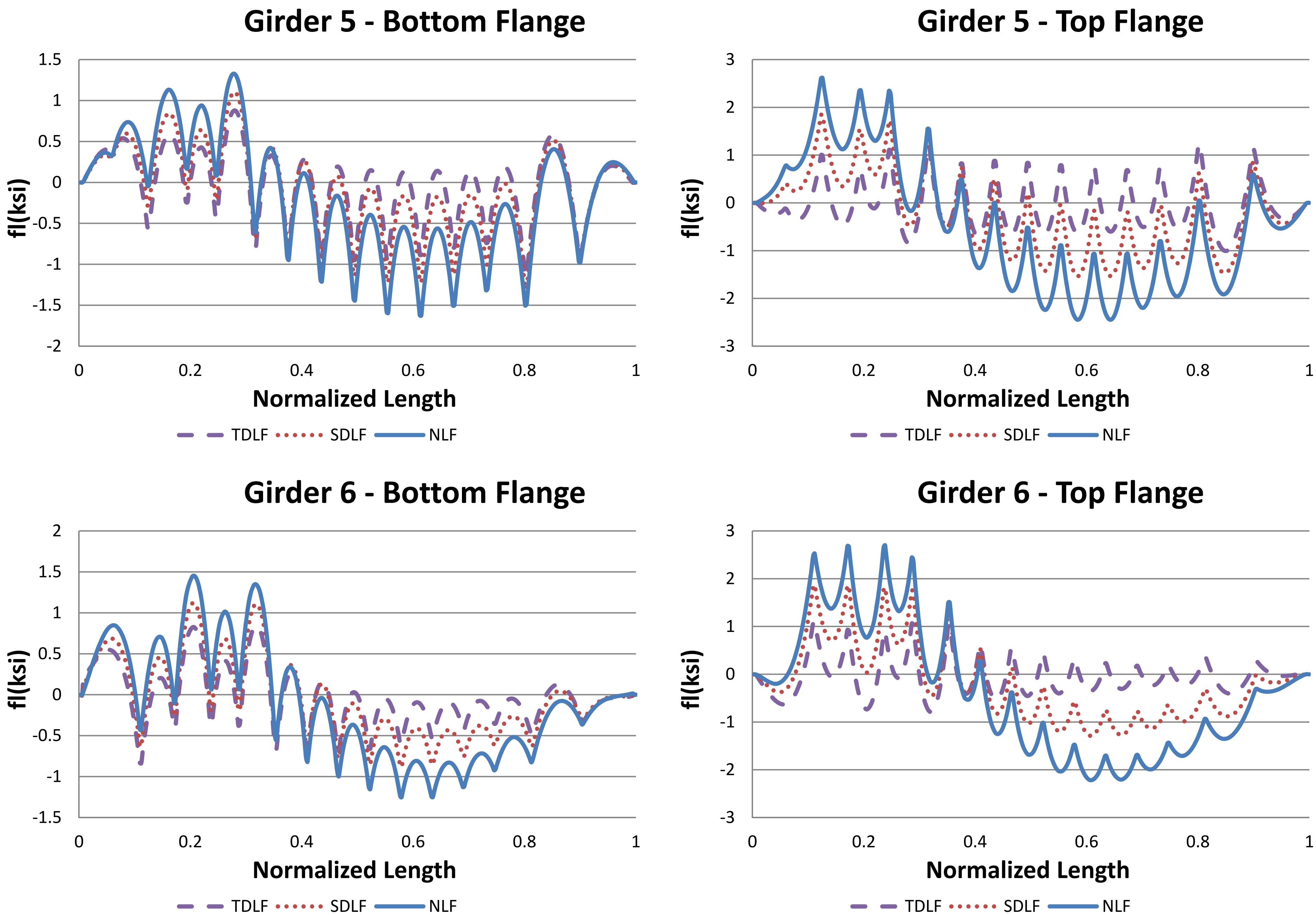


Figure P-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

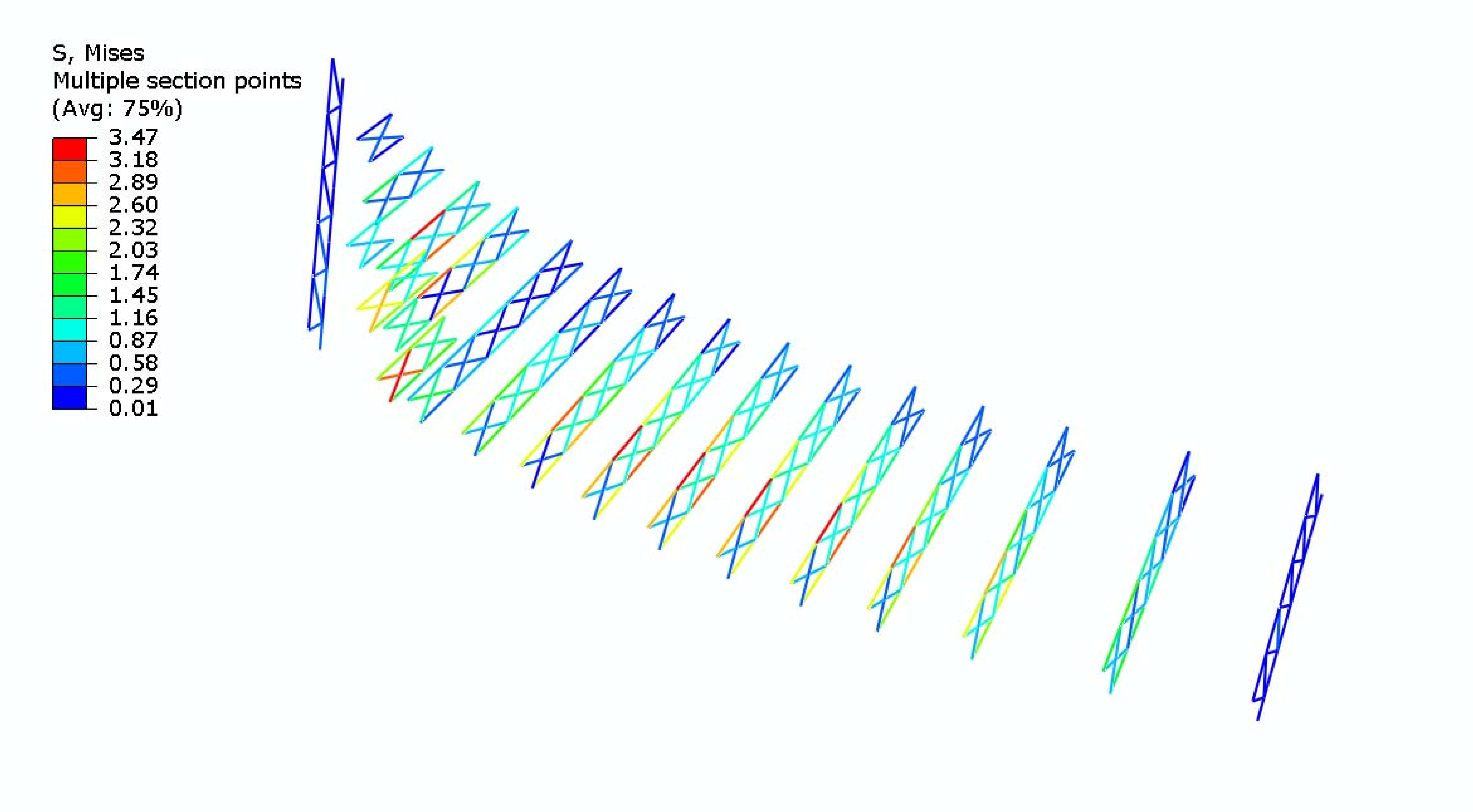


Figure P-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing

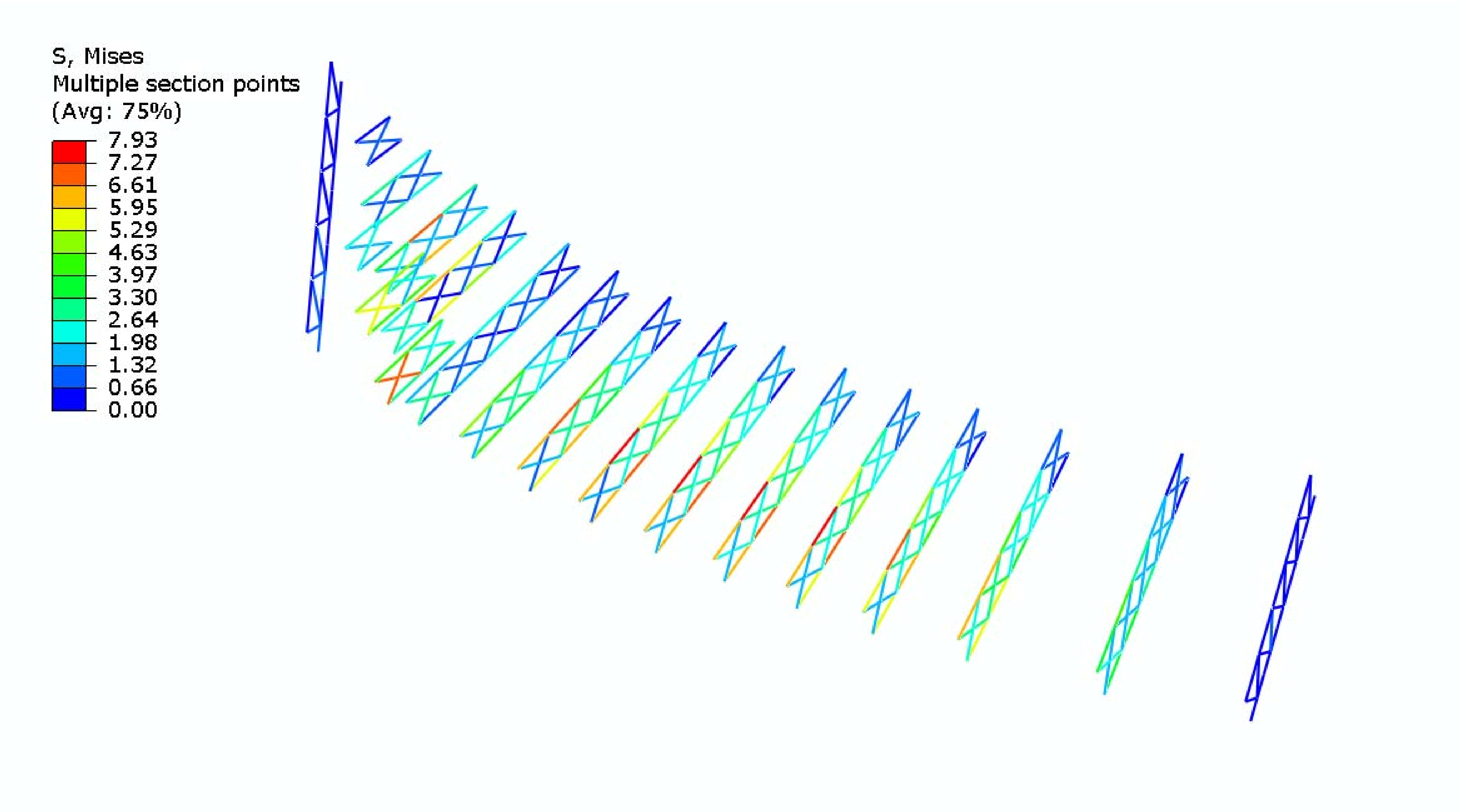


Figure P-4-23. Cross-frame stress contours under TDL, NLF detailing

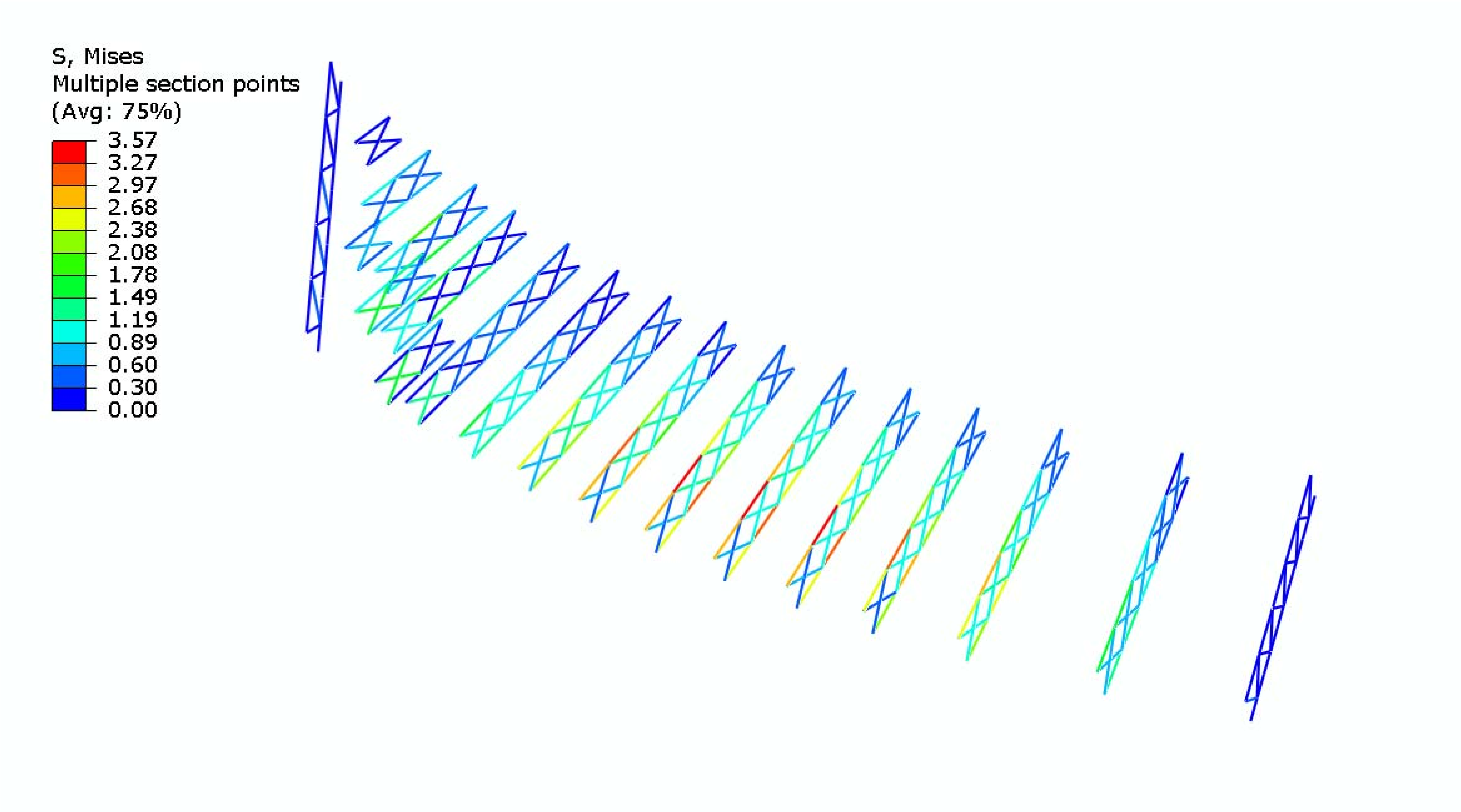


Figure P-4-24. Cross-frame stress contours under SDL, SDLF detailing

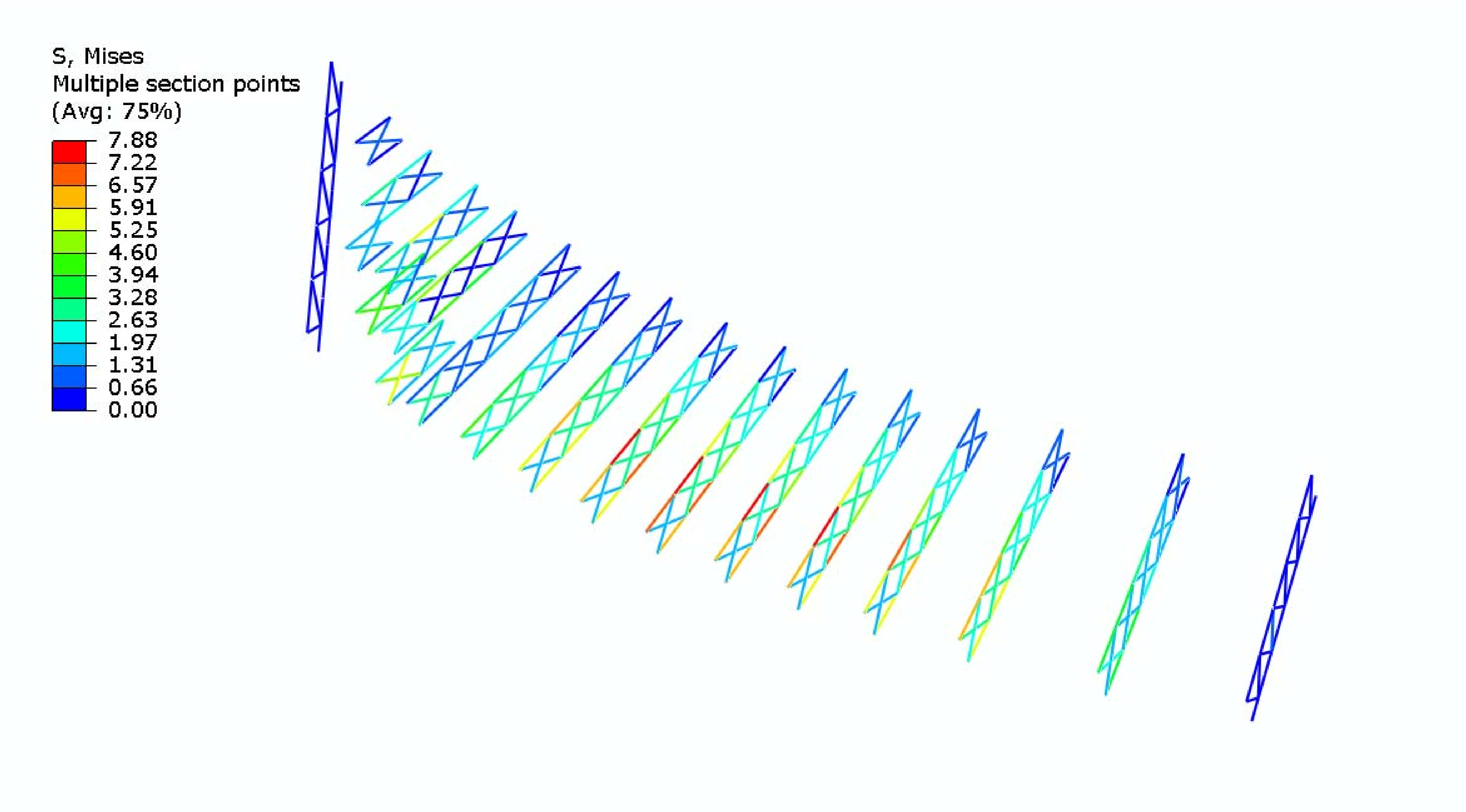


Figure P-4-25. Cross-frame stress contours under TDL, SDLF detailing

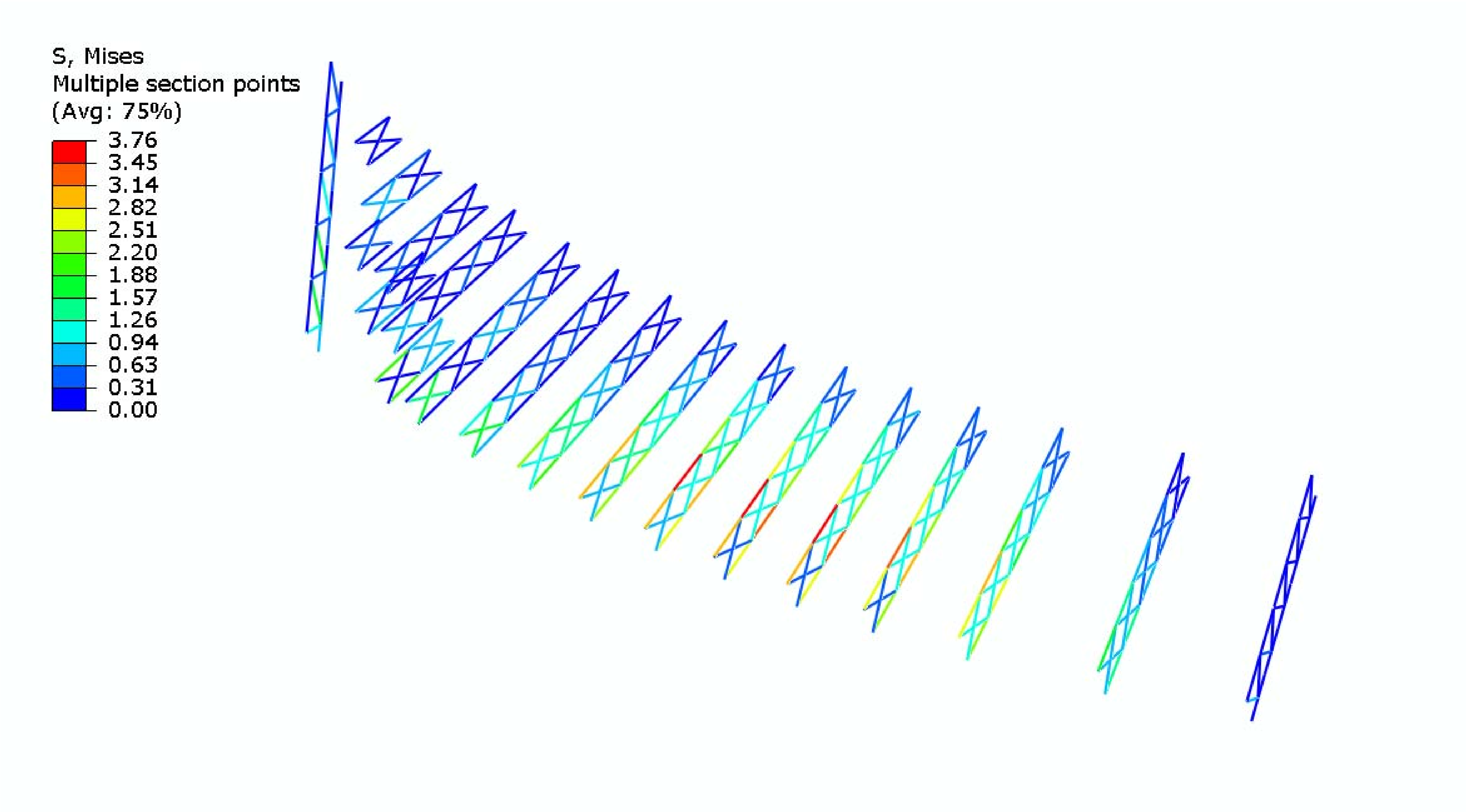


Figure P-4-26. Cross-frame stress contours under SDL, TDLF detailing

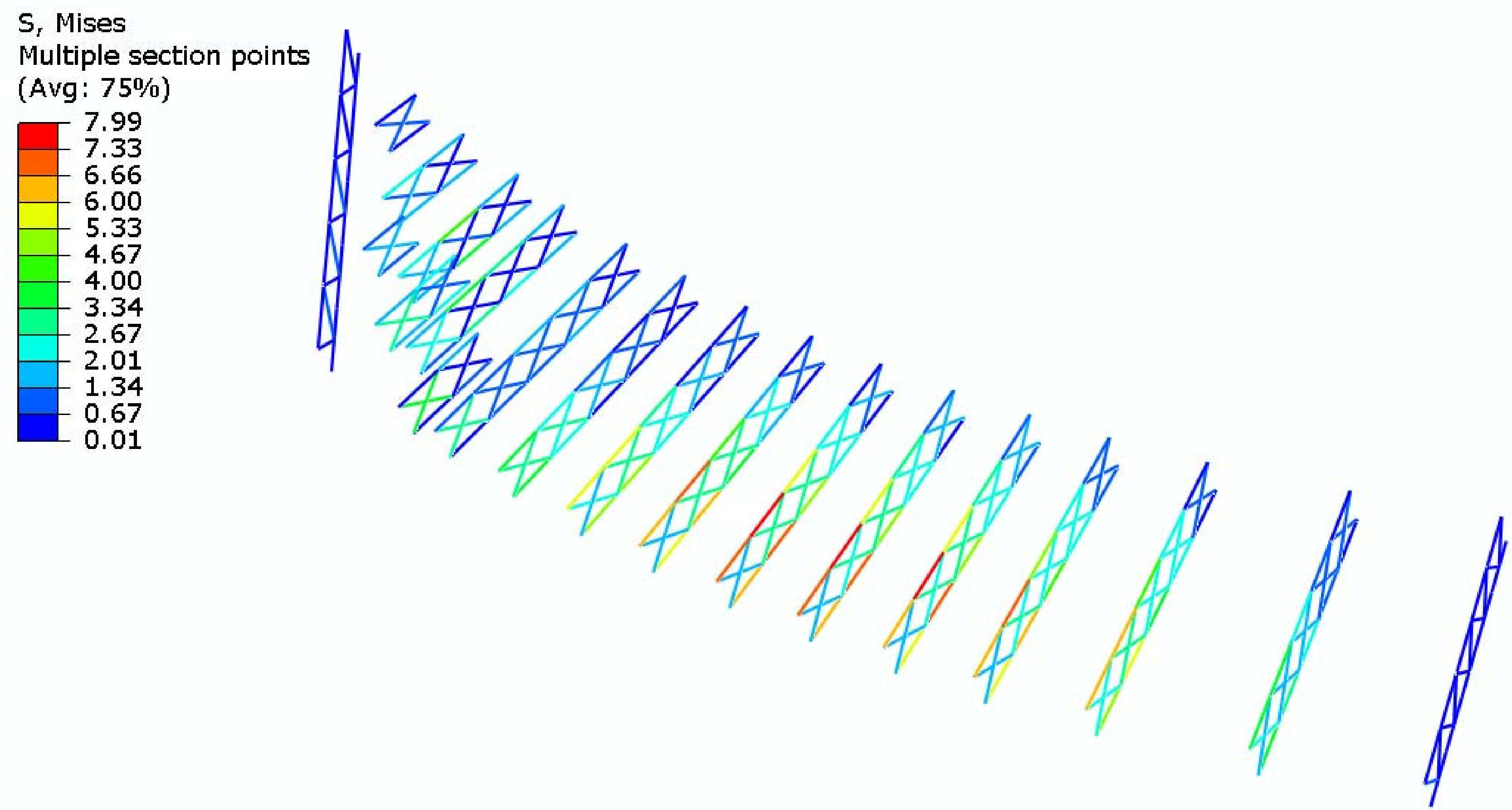


Figure P-4-27. Cross-frame stress contours under TDL, TDLF detailing

Table P-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	3.5	3.4	2.1	1.1	1.1
	SDLF	3.5	3.5	2.6	1.7	0.7
	TDLF	11.7	11.6	8.2	5.2	2.8
2	NLF	25.5	20.9	7.1	3.7	2.7
	SDLF	13.0	11.9	5.1	4.5	2.2
	TDLF	0.9	2.7	3.4	5.3	1.6
3	NLF	11.2	9.3	7.1	7.8	3.8
	SDLF	11.4	7.9	5.5	4.0	3.0
	TDLF	12.3	6.2	3.8	0.1	2.3
4	NLF	5.4	10.4	8.1	4.6	5.6
	SDLF	9.1	2.2	3.5	1.4	2.6
	TDLF	13.6	6.9	1.5	2.7	1.3
5	NLF	3.7	3.6	2.1	2.0	3.0
	SDLF	6.2	2.3	0.5	2.5	0.9
	TDLF	9.4	1.2	1.8	3.2	2.1
6	NLF	4.6	9.7	1.4	5.0	0.9
	SDLF	5.4	8.2	3.3	3.7	1.1
	TDLF	6.6	7.0	5.5	2.7	1.4
7	NLF	5.6	9.3	7.7	7.1	2.5
	SDLF	5.4	9.8	5.8	5.6	1.7
	TDLF	5.4	10.5	4.0	4.0	1.1
8	NLF	6.0	9.1	9.3	8.1	3.9
	SDLF	5.3	9.8	8.1	7.1	2.8
	TDLF	4.8	10.5	6.9	5.8	1.7
9	NLF	5.7	9.0	9.8	8.3	4.7
	SDLF	4.8	9.2	9.4	7.9	3.8
	TDLF	4.1	9.5	8.9	7.3	2.7
10	NLF	5.1	8.8	9.7	8.0	5.0
	SDLF	4.5	8.7	9.7	8.1	4.5
	TDLF	4.2	8.6	9.7	8.0	3.8

Table P-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	8.1	8.4	9.4	7.4	4.8
	SDLF	8.0	8.1	9.6	7.6	4.8
	TDLF	8.1	7.9	9.6	7.8	4.6
12	NLF	5.9	8.2	9.1	6.7	4.4
	SDLF	6.2	8.0	9.0	7.0	4.7
	TDLF	6.8	7.6	8.9	7.3	4.9
13	NLF	0.3	10.0	8.4	6.7	4.0
	SDLF	2.3	9.5	8.2	6.7	4.3
	TDLF	5.6	8.6	7.8	6.7	4.7
14	NLF	NA	5.0	7.5	4.8	4.0
	SDLF	NA	5.6	7.7	4.2	4.0
	TDLF	NA	6.3	8.0	3.5	4.0
15	NLF	NA	2.6	5.6	0.9	2.8
	SDLF	NA	1.5	5.2	0.6	2.4
	TDLF	NA	2.5	4.9	1.3	2.0
16	NLF	NA	NA	1.6	NA	0.5
	SDLF	NA	NA	1.0	NA	0.6
	TDLF	NA	NA	1.6	NA	1.3

Table P-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location				
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	7.0	7.1	4.0	1.7	1.4
	SDLF	1.1	3.3	1.8	0.8	0.2
	TDLF	7.0	7.4	5.9	4.1	2.0
2	NLF	55.0	44.2	15.7	9.3	6.6
	SDLF	42.0	34.9	13.6	10.2	6.2
	TDLF	27.9	24.7	11.1	11.0	5.6
3	NLF	25.2	20.3	15.4	14.3	6.7
	SDLF	25.0	19.0	13.8	10.4	5.8
	TDLF	25.0	17.2	12.1	6.2	5.0
4	NLF	14.0	20.1	16.1	7.9	10.9
	SDLF	17.7	11.5	11.3	4.5	7.8
	TDLF	21.7	2.3	6.2	1.0	4.3
5	NLF	10.8	9.7	2.8	6.5	5.4
	SDLF	13.3	8.4	1.7	7.0	3.2
	TDLF	15.9	7.2	3.1	7.7	0.7
6	NLF	12.9	23.9	5.8	12.4	3.3
	SDLF	13.7	22.4	7.8	11.1	3.5
	TDLF	14.4	20.6	10.0	9.8	3.8
7	NLF	14.9	23.7	19.3	17.1	6.2
	SDLF	14.7	24.2	17.3	15.5	5.3
	TDLF	14.3	24.5	15.2	13.7	4.7
8	NLF	15.8	23.5	23.0	19.5	9.4
	SDLF	15.0	24.2	21.7	18.3	8.3
	TDLF	14.1	24.8	20.2	17.0	7.1
9	NLF	14.8	23.4	24.3	20.0	11.3
	SDLF	13.9	23.5	23.8	19.5	10.2
	TDLF	12.8	23.7	23.2	18.8	9.1
10	NLF	13.4	23.0	24.2	19.4	11.8
	SDLF	12.8	22.8	24.1	19.4	11.3
	TDLF	12.0	22.4	24.0	19.1	10.6

Table P-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	20.7	21.8	23.8	17.9	11.5
	SDLF	20.6	21.5	23.8	18.1	11.4
	TDLF	20.2	21.1	23.6	18.1	11.1
12	NLF	15.3	21.5	22.8	16.2	10.4
	SDLF	15.7	21.1	22.7	16.4	10.7
	TDLF	15.9	20.6	22.3	16.6	10.8
13	NLF	1.0	25.8	21.0	16.4	9.5
	SDLF	2.5	25.2	20.7	16.4	9.8
	TDLF	5.6	24.3	20.2	16.3	10.1
14	NLF	NA	13.4	18.7	11.6	9.9
	SDLF	NA	14.0	18.9	11.0	9.8
	TDLF	NA	14.6	19.1	10.3	9.8
15	NLF	NA	6.3	13.8	2.4	6.7
	SDLF	NA	4.7	13.4	1.7	6.3
	TDLF	NA	3.5	13.0	1.2	5.9
16	NLF	NA	NA	4.1	NA	1.4
	SDLF	NA	NA	3.1	NA	1.0
	TDLF	NA	NA	2.2	NA	1.2

Table P-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	2.1	21.0	31.0	9.7	12.5
	SDLF	0.7	18.9	31.5	5.0	9.7
	TDLF	4.2	24.9	31.8	3.9	6.9
2	NLF	0.5	3.7	16.6	8.5	9.1
	SDLF	0.4	1.6	17.8	6.3	5.8
	TDLF	0.1	0.8	18.7	3.7	2.1
3	NLF	0.1	14.4	15.1	9.7	6.9
	SDLF	0.2	10.8	16.2	8.7	4.4
	TDLF	1.0	6.8	17.2	7.4	1.5
4	NLF	1.7	18.0	13.2	9.7	3.7
	SDLF	0.9	16.3	13.6	9.9	3.0
	TDLF	4.0	14.2	14.1	9.7	2.1
5	NLF	0.3	19.1	9.5	9.1	1.3
	SDLF	0.2	18.8	7.9	9.9	1.5
	TDLF	0.0	18.2	6.0	10.5	1.7
6	NLF	1.1	19.3	16.9	8.3	0.7
	SDLF	0.7	19.7	6.4	9.2	0.1
	TDLF	0.2	19.9	5.1	10.1	0.9
7	NLF	0.3	18.8	8.8	7.8	2.0
	SDLF	1.0	19.5	4.9	7.8	1.2
	TDLF	1.8	20.0	0.3	7.8	0.4
8	NLF	3.2	17.8	13.9	5.3	2.7
	SDLF	0.4	18.5	4.3	4.3	2.3
	TDLF	4.7	19.0	6.5	3.0	1.8
9	NLF	0.7	17.2	5.6	6.4	2.9
	SDLF	0.5	17.6	3.4	2.6	3.0
	TDLF	0.1	18.0	0.7	1.1	2.8
10	NLF	1.9	17.0	13.2	11.5	2.8
	SDLF	1.4	17.0	7.3	6.8	3.1
	TDLF	0.6	16.8	1.1	1.5	3.3

Table P-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.7	11.0	20.8	16.4	2.7
	SDLF	2.0	10.8	16.1	8.1	3.0
	TDLF	3.6	10.5	10.8	1.0	3.3
12	NLF	3.6	0.4	23.3	20.3	2.6
	SDLF	0.2	0.0	21.3	11.3	2.6
	TDLF	5.0	0.7	18.8	0.8	2.5
13	NLF	2.5	0.4	23.7	7.8	1.7
	SDLF	2.6	0.5	23.7	4.5	1.3
	TDLF	2.8	1.8	23.3	0.3	0.9
14	NLF	NA	0.1	23.0	6.2	10.3
	SDLF	NA	0.0	24.1	2.4	7.0
	TDLF	NA	0.2	24.8	1.4	3.8
15	NLF	NA	0.6	21.9	29.3	22.2
	SDLF	NA	0.8	23.1	24.2	13.1
	TDLF	NA	1.7	24.2	18.3	3.1
16	NLF	NA	NA	34.8	NA	27.8
	SDLF	NA	NA	36.5	NA	15.9
	TDLF	NA	NA	38.0	NA	4.4

Table P-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	4.3	46.9	67.1	17.5	26.4
	SDLF	1.4	45.1	66.9	12.5	23.5
	TDLF	2.1	42.5	66.5	7.1	20.7
2	NLF	1.5	9.0	36.3	16.5	19.7
	SDLF	1.3	7.2	37.2	14.1	16.4
	TDLF	1.0	4.8	37.7	11.3	12.7
3	NLF	0.2	33.2	32.9	19.3	15.4
	SDLF	0.2	29.5	33.7	18.2	13.0
	TDLF	0.8	25.3	34.3	16.6	10.1
4	NLF	3.3	41.9	28.2	19.6	9.1
	SDLF	0.8	39.9	28.3	19.6	8.5
	TDLF	2.3	37.5	28.6	19.2	7.6
5	NLF	0.9	44.9	20.5	18.3	4.1
	SDLF	0.8	44.2	18.8	18.9	4.4
	TDLF	0.6	43.3	16.7	19.3	4.7
6	NLF	2.8	45.6	34.2	16.7	0.0
	SDLF	2.5	45.7	23.7	17.4	0.9
	TDLF	1.8	45.5	11.9	18.0	1.8
7	NLF	1.0	44.8	18.2	15.7	2.9
	SDLF	1.8	45.1	14.2	15.5	2.0
	TDLF	2.4	45.2	9.4	15.4	1.1
8	NLF	6.8	42.5	28.3	11.1	4.5
	SDLF	3.4	42.8	18.8	10.0	4.1
	TDLF	0.8	43.0	7.7	8.5	3.4
9	NLF	2.0	40.9	10.6	12.4	5.1
	SDLF	1.7	41.1	8.3	8.7	5.1
	TDLF	1.2	41.2	5.6	5.1	4.8
10	NLF	4.7	40.7	29.5	24.3	5.0
	SDLF	4.2	40.5	23.6	19.4	5.3
	TDLF	3.4	40.0	17.1	13.8	5.4

Table P-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	2.0	26.7	46.6	34.0	4.8
	SDLF	3.4	26.5	41.5	25.5	5.0
	TDLF	4.8	26.0	35.8	16.1	5.2
12	NLF	7.4	0.3	52.7	42.9	4.7
	SDLF	4.1	0.1	50.2	33.8	4.6
	TDLF	0.1	0.6	47.3	23.2	4.5
13	NLF	6.3	0.9	54.0	17.0	3.6
	SDLF	6.5	0.0	53.6	13.6	3.1
	TDLF	6.7	1.3	52.7	9.5	2.6
14	NLF	NA	0.2	52.9	12.6	20.9
	SDLF	NA	0.3	53.5	8.7	17.6
	TDLF	NA	0.4	53.8	4.7	14.4
15	NLF	NA	1.8	50.3	62.5	47.1
	SDLF	NA	1.9	51.2	56.9	37.7
	TDLF	NA	2.5	51.9	50.4	27.4
16	NLF	NA	NA	80.2	NA	60.1
	SDLF	NA	NA	81.2	NA	48.1
	TDLF	NA	NA	81.9	NA	34.1

Table P-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location				
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	4.4	3.5	1.7	1.3	0.2
	SDLF	1.2	0.6	1.2	0.3	0.6
	TDLF	2.2	5.0	4.3	2.1	0.9
2	NLF	14.2	16.9	6.6	9.9	1.5
	SDLF	0.6	5.9	2.8	6.8	1.4
	TDLF	13.8	5.8	1.0	3.8	1.3
3	NLF	4.8	8.1	10.7	21.3	7.0
	SDLF	1.9	4.8	6.5	12.5	5.5
	TDLF	0.6	0.9	1.8	2.8	4.0
4	NLF	13.4	14.5	16.1	15.9	8.8
	SDLF	10.7	4.8	8.0	8.9	5.3
	TDLF	7.9	5.8	0.9	1.0	1.4
5	NLF	16.7	4.8	19.9	5.6	6.8
	SDLF	15.6	3.2	11.3	4.2	4.2
	TDLF	14.5	0.9	1.4	2.2	1.2
6	NLF	17.8	12.8	7.5	0.8	3.7
	SDLF	18.1	7.4	4.3	0.7	2.9
	TDLF	18.5	1.8	0.1	2.0	2.0
7	NLF	18.0	19.7	6.2	5.3	1.2
	SDLF	18.9	15.6	2.5	2.8	1.5
	TDLF	20.1	11.2	1.0	0.2	1.6
8	NLF	17.6	22.2	12.7	8.1	0.5
	SDLF	18.7	20.6	8.5	6.0	0.2
	TDLF	20.2	18.8	4.1	3.7	0.9
9	NLF	16.6	22.6	16.2	9.3	1.9
	SDLF	17.8	22.8	13.6	8.3	1.1
	TDLF	19.3	23.1	10.6	7.1	0.2
10	NLF	15.8	22.0	17.2	9.3	2.6
	SDLF	16.8	23.2	16.5	9.4	2.1
	TDLF	18.0	24.5	15.6	9.4	1.5

Table P-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location				
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**
11	NLF	16.1	20.9	16.9	8.7	2.8
	SDLF	16.7	22.3	17.6	9.4	2.7
	TDLF	17.5	23.9	18.1	10.1	2.5
12	NLF	10.2	19.3	15.8	7.9	2.7
	SDLF	10.3	20.4	17.1	8.7	2.9
	TDLF	10.6	21.8	18.3	9.7	3.1
13	NLF	2.3	17.7	14.3	7.4	2.5
	SDLF	1.1	18.1	15.5	7.5	2.8
	TDLF	0.5	18.7	16.8	7.6	3.0
14	NLF	NA	11.5	12.6	5.1	2.5
	SDLF	NA	10.6	13.0	4.1	2.4
	TDLF	NA	9.5	13.6	3.0	2.3
15	NLF	NA	2.6	9.0	0.6	1.6
	SDLF	NA	1.4	7.6	0.2	1.2
	TDLF	NA	0.5	6.0	0.6	0.8
16	NLF	NA	NA	1.2	NA	0.1
	SDLF	NA	NA	0.6	NA	0.0
	TDLF	NA	NA	0.6	NA	0.4

Table P-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	9.8	8.1	4.3	3.7	0.7
	SDLF	6.8	4.0	1.3	1.9	0.2
	TDLF	3.8	0.5	2.2	0.2	0.4
2	NLF	27.6	34.3	13.5	20.4	2.9
	SDLF	13.3	22.7	9.5	17.1	2.7
	TDLF	1.4	10.9	5.4	13.9	2.6
3	NLF	11.6	16.7	21.9	44.9	14.7
	SDLF	8.4	13.3	17.7	36.0	13.3
	TDLF	5.8	9.3	13.1	26.2	11.7
4	NLF	31.2	29.9	33.2	34.4	19.1
	SDLF	28.4	19.8	24.9	27.3	15.6
	TDLF	25.3	9.0	15.8	19.3	11.7
5	NLF	38.9	9.0	42.2	13.4	15.4
	SDLF	37.6	7.5	33.3	12.0	12.7
	TDLF	36.2	5.1	23.3	10.0	9.7
6	NLF	41.8	28.9	16.6	0.0	9.1
	SDLF	41.8	23.2	13.3	1.7	8.3
	TDLF	41.8	17.4	9.0	3.1	7.4
7	NLF	42.6	44.2	12.5	9.5	3.9
	SDLF	43.1	39.7	8.7	6.7	4.2
	TDLF	43.9	34.9	5.0	4.0	4.4
8	NLF	41.9	50.3	26.6	15.8	0.2
	SDLF	42.6	48.1	22.1	13.4	1.1
	TDLF	43.7	45.9	17.4	10.9	1.9
9	NLF	39.8	51.6	34.6	18.6	2.7
	SDLF	40.5	51.3	31.5	17.3	1.8
	TDLF	41.6	51.0	28.3	15.9	0.8
10	NLF	37.7	50.6	37.2	18.9	4.4
	SDLF	38.4	51.2	36.1	18.7	3.7
	TDLF	39.3	52.0	34.8	18.3	3.0

Table P-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	38.8	48.2	36.9	17.7	5.0
	SDLF	39.0	49.0	37.1	18.0	4.7
	TDLF	39.5	50.1	37.2	18.5	4.4
12	NLF	24.8	44.4	34.7	15.8	4.9
	SDLF	24.8	45.1	35.4	16.4	4.9
	TDLF	24.9	46.0	36.2	17.1	4.9
13	NLF	5.8	40.7	31.0	15.1	4.5
	SDLF	4.7	40.7	31.8	14.9	4.6
	TDLF	3.2	40.9	32.7	14.8	4.8
14	NLF	NA	26.1	27.0	10.4	4.6
	SDLF	NA	25.1	27.1	9.4	4.4
	TDLF	NA	23.9	27.4	8.2	4.2
15	NLF	NA	6.5	19.4	1.9	3.3
	SDLF	NA	5.4	17.9	1.7	2.9
	TDLF	NA	3.6	16.1	0.9	2.5
16	NLF	NA	NA	3.4	NA	0.9
	SDLF	NA	NA	2.9	NA	0.8
	TDLF	NA	NA	1.6	NA	0.5

Table P-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.01	0.00	0.00	0.00	0.00
	SDLF	0.01	0.00	0.00	0.00	0.00
	TDLF	0.01	0.00	0.00	0.00	0.00
2	NLF	-0.05	-0.14	-0.18	-0.17	-0.19
	SDLF	-0.03	-0.11	-0.15	-0.12	-0.15
	TDLF	-0.02	-0.11	-0.14	-0.10	-0.13
3	NLF	0.05	-0.07	-0.13	-0.10	-0.15
	SDLF	0.08	-0.04	-0.09	-0.05	-0.10
	TDLF	0.10	-0.03	-0.07	-0.01	-0.06
4	NLF	0.17	-0.01	-0.10	-0.03	-0.09
	SDLF	0.22	0.02	-0.06	0.02	-0.03
	TDLF	0.27	0.05	-0.03	0.06	0.02
5	NLF	0.27	0.05	-0.05	0.07	-0.02
	SDLF	0.33	0.09	-0.01	0.11	0.04
	TDLF	0.39	0.12	0.02	0.15	0.09
6	NLF	0.34	0.16	0.06	0.15	0.07
	SDLF	0.41	0.20	0.10	0.19	0.12
	TDLF	0.47	0.23	0.13	0.22	0.17
7	NLF	0.38	0.25	0.15	0.23	0.15
	SDLF	0.45	0.29	0.19	0.26	0.19
	TDLF	0.52	0.33	0.22	0.28	0.23
8	NLF	0.40	0.32	0.23	0.29	0.23
	SDLF	0.47	0.36	0.27	0.31	0.26
	TDLF	0.54	0.40	0.29	0.32	0.28
9	NLF	0.40	0.36	0.30	0.33	0.29
	SDLF	0.46	0.41	0.33	0.35	0.31
	TDLF	0.52	0.45	0.35	0.35	0.32
10	NLF	0.37	0.38	0.34	0.35	0.33
	SDLF	0.42	0.43	0.37	0.36	0.34
	TDLF	0.48	0.46	0.39	0.36	0.35

Table P-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location				
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**
11	NLF	0.30	0.38	0.36	0.35	0.35
	SDLF	0.35	0.42	0.39	0.36	0.35
	TDLF	0.39	0.45	0.40	0.36	0.35
12	NLF	0.17	0.35	0.36	0.32	0.35
	SDLF	0.19	0.38	0.38	0.33	0.35
	TDLF	0.22	0.41	0.39	0.32	0.34
13	NLF	0.00	0.29	0.33	0.26	0.32
	SDLF	0.00	0.31	0.35	0.27	0.32
	TDLF	0.00	0.33	0.36	0.26	0.31
14	NLF	NA	0.16	0.27	0.15	0.26
	SDLF	NA	0.18	0.28	0.15	0.26
	TDLF	NA	0.19	0.29	0.14	0.25
15	NLF	NA	0.00	0.15	0.00	0.14
	SDLF	NA	0.00	0.16	0.00	0.14
	TDLF	NA	0.00	0.16	0.00	0.14
16	NLF	NA	NA	0.00	NA	0.00
	SDLF	NA	NA	0.00	NA	0.00
	TDLF	NA	NA	0.00	NA	0.00

Table P-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.01	0.00	0.00	0.00	0.00
	SDLF	0.01	0.00	0.00	0.00	0.00
	TDLF	0.01	0.00	0.00	0.00	0.00
2	NLF	-0.19	-0.38	-0.48	-0.47	-0.53
	SDLF	-0.17	-0.36	-0.45	-0.42	-0.49
	TDLF	-0.16	-0.36	-0.44	-0.40	-0.46
3	NLF	0.02	-0.24	-0.37	-0.31	-0.44
	SDLF	0.05	-0.22	-0.33	-0.26	-0.38
	TDLF	0.07	-0.20	-0.31	-0.22	-0.35
4	NLF	0.30	-0.12	-0.31	-0.16	-0.29
	SDLF	0.34	-0.08	-0.27	-0.11	-0.23
	TDLF	0.38	-0.06	-0.25	-0.07	-0.18
5	NLF	0.51	0.03	-0.20	0.06	-0.14
	SDLF	0.57	0.07	-0.16	0.10	-0.08
	TDLF	0.62	0.09	-0.13	0.14	-0.03
6	NLF	0.67	0.26	0.05	0.25	0.07
	SDLF	0.73	0.30	0.08	0.28	0.12
	TDLF	0.79	0.33	0.11	0.30	0.16
7	NLF	0.78	0.47	0.25	0.42	0.25
	SDLF	0.84	0.50	0.28	0.44	0.29
	TDLF	0.90	0.53	0.30	0.46	0.32
8	NLF	0.83	0.62	0.43	0.56	0.42
	SDLF	0.89	0.66	0.46	0.57	0.44
	TDLF	0.95	0.69	0.48	0.58	0.46
9	NLF	0.82	0.73	0.58	0.66	0.56
	SDLF	0.88	0.77	0.60	0.67	0.57
	TDLF	0.93	0.80	0.62	0.67	0.58
10	NLF	0.77	0.78	0.68	0.71	0.65
	SDLF	0.81	0.82	0.70	0.72	0.66
	TDLF	0.86	0.85	0.71	0.71	0.66

Table P-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.64	0.78	0.74	0.72	0.71
	SDLF	0.68	0.81	0.75	0.72	0.71
	TDLF	0.72	0.84	0.76	0.71	0.70
12	NLF	0.36	0.72	0.74	0.67	0.71
	SDLF	0.38	0.75	0.75	0.67	0.71
	TDLF	0.41	0.77	0.75	0.66	0.70
13	NLF	0.01	0.60	0.69	0.55	0.66
	SDLF	0.01	0.62	0.70	0.55	0.66
	TDLF	0.01	0.63	0.70	0.54	0.65
14	NLF	NA	0.34	0.57	0.30	0.55
	SDLF	NA	0.35	0.58	0.30	0.54
	TDLF	NA	0.36	0.58	0.30	0.53
15	NLF	NA	0.00	0.32	0.00	0.30
	SDLF	NA	0.00	0.32	0.00	0.30
	TDLF	NA	0.00	0.32	0.00	0.29
16	NLF	NA	NA	0.00	NA	0.00
	SDLF	NA	NA	0.00	NA	0.00
	TDLF	NA	NA	0.00	NA	0.00

Table P-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.02	-0.06	-0.08	-0.08	-0.09
	SDLF	-0.01	-0.05	-0.07	-0.06	-0.07
	TDLF	-0.01	-0.05	-0.06	-0.04	-0.06
3	NLF	0.02	-0.03	-0.06	-0.05	-0.07
	SDLF	0.04	-0.02	-0.04	-0.02	-0.05
	TDLF	0.05	-0.01	-0.03	0.00	-0.03
4	NLF	0.08	-0.01	-0.05	-0.01	-0.04
	SDLF	0.10	0.01	-0.03	0.01	-0.01
	TDLF	0.12	0.02	-0.01	0.03	0.01
5	NLF	0.13	0.02	-0.02	0.03	-0.01
	SDLF	0.15	0.04	0.00	0.05	0.02
	TDLF	0.18	0.06	0.01	0.07	0.04
6	NLF	0.16	0.07	0.03	0.07	0.03
	SDLF	0.19	0.09	0.05	0.09	0.06
	TDLF	0.22	0.11	0.06	0.10	0.08
7	NLF	0.18	0.12	0.07	0.10	0.07
	SDLF	0.21	0.14	0.09	0.12	0.09
	TDLF	0.24	0.15	0.10	0.13	0.11
8	NLF	0.19	0.15	0.11	0.13	0.10
	SDLF	0.22	0.17	0.12	0.14	0.12
	TDLF	0.25	0.19	0.13	0.15	0.13
9	NLF	0.18	0.17	0.14	0.15	0.13
	SDLF	0.21	0.19	0.15	0.16	0.14
	TDLF	0.24	0.21	0.16	0.16	0.15
10	NLF	0.17	0.18	0.16	0.16	0.15
	SDLF	0.19	0.20	0.17	0.17	0.16
	TDLF	0.22	0.21	0.18	0.17	0.16

Table P-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
11	NLF	0.14	0.17	0.17	0.16	0.16
	SDLF	0.16	0.19	0.18	0.16	0.16
	TDLF	0.18	0.21	0.19	0.16	0.16
12	NLF	0.08	0.16	0.17	0.15	0.16
	SDLF	0.09	0.18	0.17	0.15	0.16
	TDLF	0.10	0.19	0.18	0.15	0.16
13	NLF	0.00	0.13	0.15	0.12	0.15
	SDLF	0.00	0.14	0.16	0.12	0.15
	TDLF	0.00	0.15	0.16	0.12	0.15
14	NLF	NA	0.07	0.13	0.07	0.12
	SDLF	NA	0.08	0.13	0.07	0.12
	TDLF	NA	0.09	0.13	0.07	0.12
15	NLF	NA	0.00	0.07	0.00	0.07
	SDLF	NA	0.00	0.07	0.00	0.07
	TDLF	NA	0.00	0.07	0.00	0.06
16	NLF	NA	NA	0.00	NA	0.00
	SDLF	NA	NA	0.00	NA	0.00
	TDLF	NA	NA	0.00	NA	0.00

Table P-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6
1	NLF	0.01	0.00	0.00	0.00	0.00
	SDLF	0.01	0.00	0.00	0.00	0.00
	TDLF	0.01	0.00	0.00	0.00	0.00
2	NLF	-0.09	-0.18	-0.22	-0.22	-0.25
	SDLF	-0.08	-0.17	-0.21	-0.20	-0.23
	TDLF	-0.08	-0.16	-0.20	-0.18	-0.21
3	NLF	0.01	-0.11	-0.17	-0.15	-0.20
	SDLF	0.02	-0.10	-0.15	-0.12	-0.18
	TDLF	0.03	-0.09	-0.14	-0.10	-0.16
4	NLF	0.14	-0.05	-0.14	-0.07	-0.13
	SDLF	0.16	-0.04	-0.13	-0.05	-0.10
	TDLF	0.18	-0.03	-0.11	-0.03	-0.08
5	NLF	0.24	0.01	-0.09	0.03	-0.06
	SDLF	0.26	0.03	-0.07	0.05	-0.04
	TDLF	0.29	0.04	-0.06	0.06	-0.02
6	NLF	0.31	0.12	0.02	0.11	0.03
	SDLF	0.34	0.14	0.04	0.13	0.06
	TDLF	0.37	0.15	0.05	0.14	0.07
7	NLF	0.36	0.22	0.11	0.19	0.12
	SDLF	0.39	0.23	0.13	0.20	0.13
	TDLF	0.42	0.25	0.14	0.21	0.15
8	NLF	0.38	0.29	0.20	0.26	0.19
	SDLF	0.41	0.31	0.21	0.27	0.20
	TDLF	0.44	0.32	0.22	0.27	0.21
9	NLF	0.38	0.34	0.27	0.31	0.26
	SDLF	0.41	0.35	0.28	0.31	0.26
	TDLF	0.43	0.37	0.29	0.31	0.27
10	NLF	0.36	0.36	0.32	0.33	0.30
	SDLF	0.38	0.38	0.33	0.33	0.31
	TDLF	0.40	0.39	0.33	0.33	0.31

Table P-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location				
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**
11	NLF	0.30	0.36	0.34	0.33	0.33
	SDLF	0.31	0.37	0.35	0.33	0.33
	TDLF	0.33	0.39	0.35	0.33	0.32
12	NLF	0.17	0.33	0.34	0.31	0.33
	SDLF	0.18	0.35	0.35	0.31	0.33
	TDLF	0.19	0.36	0.35	0.30	0.32
13	NLF	0.00	0.28	0.32	0.25	0.31
	SDLF	0.00	0.29	0.32	0.25	0.30
	TDLF	0.00	0.29	0.32	0.25	0.30
14	NLF	NA	0.16	0.26	0.14	0.25
	SDLF	NA	0.16	0.27	0.14	0.25
	TDLF	NA	0.17	0.27	0.14	0.25
15	NLF	NA	0.00	0.15	0.00	0.14
	SDLF	NA	0.00	0.15	0.00	0.14
	TDLF	NA	0.00	0.15	0.00	0.13
16	NLF	NA	NA	0.00	NA	0.00
	SDLF	NA	NA	0.00	NA	0.00
	TDLF	NA	NA	0.00	NA	0.00

Table P-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	104	75	239	178
	SDLF	98	77	233	180
	TDLF	91	80	226	183
G2	NLF	49	51	120	124
	SDLF	49	50	120	123
	TDLF	50	49	120	122
G3	NLF	17	29	50	75
	SDLF	23	29	56	75
	TDLF	30	28	63	73
G4	NLF	14	22	44	59
	SDLF	19	22	48	59
	TDLF	23	21	53	58
G5	NLF	20	15	56	44
	SDLF	19	15	54	44
	TDLF	17	14	53	44
G6	NLF	23	6	60	24
	SDLF	20	6	57	24
	TDLF	17	7	54	25

Table P-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number: SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.2	NA	-0.6	NA
	SDLF	-0.2	NA	-0.5	NA
	TDLF	-0.2	NA	-0.5	NA
G2	NLF	-0.1	NA	-0.3	NA
	SDLF	-0.1	NA	-0.2	NA
	TDLF	-0.2	NA	-0.3	NA
G3	NLF	0.0	NA	0.1	NA
	SDLF	0.0	NA	0.1	NA
	TDLF	0.1	NA	0.1	NA
G4	NLF	0.1	NA	0.3	NA
	SDLF	0.1	NA	0.2	NA
	TDLF	0.1	NA	0.2	NA
G5	NLF	0.1	NA	0.3	NA
	SDLF	0.1	NA	0.3	NA
	TDLF	0.1	NA	0.3	NA
G6	NLF	0.1	NA	0.2	NA
	SDLF	0.1	NA	0.2	NA
	TDLF	0.2	NA	0.3	NA

Table P-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.3	0.0	0.8	0.0
	SDLF	-0.1	0.0	0.3	0.0
	TDLF	-0.5	0.0	-0.2	0.0
G2	NLF	0.1	0.0	0.4	-0.1
	SDLF	0.0	0.0	0.2	0.0
	TDLF	-0.1	0.0	0.0	0.0
G3	NLF	0.0	0.0	-0.1	-0.1
	SDLF	0.0	0.0	-0.1	0.0
	TDLF	0.1	0.0	0.0	0.0
G4	NLF	-0.1	0.0	-0.3	-0.1
	SDLF	0.0	0.0	-0.2	0.0
	TDLF	0.1	0.0	0.0	0.0
G5	NLF	-0.1	0.0	-0.4	-0.1
	SDLF	0.0	0.0	-0.1	0.0
	TDLF	0.2	0.0	0.1	0.0
G6	NLF	-0.1	0.0	-0.2	-0.1
	SDLF	0.0	0.0	0.0	0.0
	TDLF	0.1	0.0	0.0	0.0

Table P-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.04	0.29	-0.12	0.46
	SDLF	-0.04	0.26	-0.11	0.50
	TDLF	-0.05	0.27	-0.10	0.62
G2	NLF	-0.02	0.24	-0.06	0.41
	SDLF	-0.03	0.22	-0.05	0.45
	TDLF	-0.04	0.20	-0.06	0.53
G3	NLF	0.01	0.20	0.03	0.34
	SDLF	0.01	0.18	0.03	0.39
	TDLF	0.01	0.17	0.02	0.45
G4	NLF	0.02	0.18	0.06	0.32
	SDLF	0.02	0.16	0.05	0.35
	TDLF	0.02	0.13	0.04	0.41
G5	NLF	0.02	0.15	0.06	0.26
	SDLF	0.02	0.12	0.05	0.29
	TDLF	0.03	0.10	0.05	0.34
G6	NLF	0.02	0.12	0.04	0.18
	SDLF	0.03	0.10	0.04	0.22
	TDLF	0.04	0.07	0.06	0.29

Load Type & Support Number spans the SDL 1, SDL 2, TDL 1, TDL 2 columns.

Table P-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number: SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.05	0.00	0.16	-0.01
	SDLF	-0.02	0.00	0.06	0.00
	TDLF	-0.10	0.00	-0.04	0.00
G2	NLF	0.03	-0.01	0.08	-0.01
	SDLF	0.00	0.00	0.03	-0.01
	TDLF	-0.02	0.00	0.01	-0.01
G3	NLF	0.00	0.00	-0.02	-0.01
	SDLF	0.00	0.00	-0.02	-0.01
	TDLF	0.01	0.00	0.01	0.00
G4	NLF	-0.02	0.00	-0.06	-0.01
	SDLF	0.00	0.00	-0.03	-0.01
	TDLF	0.03	0.00	0.01	0.00
G5	NLF	-0.02	0.00	-0.07	-0.01
	SDLF	0.01	0.00	-0.03	-0.01
	TDLF	0.04	0.00	0.01	0.00
G6	NLF	-0.02	0.00	-0.04	-0.01
	SDLF	0.01	0.00	0.00	-0.01
	TDLF	0.02	0.00	0.00	0.00

Appendix P-5. EISCS3 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge EISCS3 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Table P-5-1. Erection method 1 fit-up forces (kips) applied to the girder being installed

Table P-5-2. Erection method 2 fit-up forces (kips) applied to the girder being installed

Table P-5-3. Erection critical sub-stages

Table P-5-4. Erection method 1 critical fit-up forces (kips) applied to the girder being installed

Table P-5-5. Erection method 2 critical fit-up forces (kips) applied to the girder being installed

Reactions

Table P-5-6. Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Table P-5-7. Erection method 2 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Table P-5-1. Erection method 1 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	-1.0	-1.6	1.9	0.0	1.3	1.3
		SDLF	-5.8	-5.7	8.2	0.0	5.7	5.7
		TDLF	-12.0	-11.4	16.6	0.0	11.5	11.5
	2-3	NLF	2.3	2.1	3.1	2.1	-1.4	2.5
		SDLF	2.8	1.7	3.3	2.7	-1.2	3.0
		TDLF	3.6	1.5	3.9	3.3	-0.9	3.4
	2-4	NLF	4.6	13.4	14.2	4.2	-12.3	13.1
		SDLF	5.6	14.7	15.7	5.2	-14.0	14.9
		TDLF	6.7	16.3	17.6	6.1	-15.7	16.8
	2-5	NLF	4.1	12.2	12.9	3.9	-11.8	12.4
		SDLF	5.1	11.7	12.8	4.7	-11.6	12.5
		TDLF	6.1	11.3	12.8	5.4	-11.4	12.7
	2-6	NLF	3.4	12.5	12.9	3.2	-12.1	12.5
		SDLF	4.7	11.9	12.8	4.3	-11.7	12.5
		TDLF	6.1	11.6	13.1	5.3	-11.5	12.7
	2-7	NLF	2.1	10.4	10.6	1.9	-10.2	10.3
		SDLF	4.0	10.6	11.3	3.6	-10.6	11.2
		TDLF	6.7	13.2	14.8	5.8	-13.3	14.6
	2-8	NLF	1.1	7.0	7.0	0.9	-6.9	6.9
		SDLF	4.2	10.3	11.2	3.8	-10.4	11.1
		TDLF	7.5	13.9	15.8	6.7	-14.2	15.7
	2-9	NLF	0.6	3.3	3.3	0.6	-3.3	3.4
		SDLF	4.6	8.8	9.9	4.4	-9.0	10.0
		TDLF	8.6	13.9	16.3	7.9	-14.3	16.4
	2-10	NLF	0.3	-1.0	1.0	0.3	0.9	1.0
		SDLF	4.9	6.6	8.2	4.7	-6.9	8.3
		TDLF	8.8	12.4	15.2	8.2	-12.8	15.2
	2-11	NLF	0.3	-2.7	2.7	0.4	2.5	2.6
		SDLF	4.9	5.6	7.4	4.7	-6.0	7.7
		TDLF	7.0	7.6	10.4	6.5	-8.1	10.4

Table P-5-1(Continued). Erection method 1 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-12	NLF	0.2	-2.7	2.7	0.3	2.5	2.6
		SDLF	3.5	3.8	5.2	3.3	-3.9	5.2
		TDLF	4.6	4.1	6.1	3.9	-4.1	5.6
	2-13	NLF	0.3	-0.9	1.0	0.3	0.8	0.9
		SDLF	1.6	1.7	2.4	1.5	-1.6	2.2
		TDLF	2.0	1.8	2.7	1.6	-1.6	2.3

Table P-5-1(Continued). Erection method 1 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
3	3-2	NLF	-0.9	-2.2	2.4	0.0	2.3	2.3
		SDLF	-5.0	-5.3	7.3	0.0	5.3	5.3
		TDLF	-10.9	-9.6	14.6	0.0	9.7	9.7
	3-3	NLF	-0.7	-1.7	1.9	-0.7	1.8	1.9
		SDLF	1.2	-2.6	2.9	1.4	2.6	3.0
		TDLF	3.1	-3.6	4.8	3.3	3.6	4.9
	3-4	NLF	-0.7	1.1	1.3	-0.9	-0.6	1.0
		SDLF	2.0	0.4	2.0	1.9	0.4	1.9
		TDLF	4.6	-0.2	4.6	4.5	1.6	4.8
	3-5	NLF	-0.3	4.3	4.3	-0.5	-3.7	3.8
		SDLF	1.8	1.3	2.2	1.9	-0.9	2.1
		TDLF	3.8	-1.6	4.1	4.2	2.2	4.7
	3-6	NLF	0.7	7.0	7.1	0.5	-6.5	6.5
		SDLF	1.7	5.8	6.0	1.5	-5.1	5.3
		TDLF	2.6	4.6	5.3	2.3	-3.6	4.3
	3-7	NLF	0.5	8.0	8.0	0.3	-7.5	7.5
		SDLF	3.1	6.8	7.5	2.9	-6.6	7.2
		TDLF	5.5	5.7	7.9	5.2	-5.5	7.5
	3-8	NLF	-0.7	9.0	9.0	-1.0	-8.5	8.6
		SDLF	3.5	8.3	9.0	3.1	-8.0	8.6
		TDLF	7.4	7.7	10.7	7.0	-7.5	10.2
	3-9	NLF	-2.3	8.5	8.9	-2.7	-8.0	8.4
		SDLF	2.5	8.7	9.0	2.2	-8.4	8.6
		TDLF	7.2	8.8	11.4	6.8	-8.5	10.9
	3-10	NLF	-3.6	6.6	7.5	-4.0	-6.1	7.3
		SDLF	1.5	8.1	8.3	1.1	-7.9	7.9
		TDLF	6.4	9.5	11.5	5.9	-9.4	11.1
	3-11	NLF	-3.9	3.1	5.0	-4.2	-2.7	5.0
		SDLF	1.3	6.8	6.9	1.0	-6.7	6.7
		TDLF	6.3	10.3	12.1	5.8	-10.2	11.7

Table P-5-1(Continued). Erection method 1 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
3	3-12	NLF	-3.3	-1.3	3.6	-3.4	1.7	3.8
		SDLF	1.8	4.9	5.2	1.6	-4.8	5.0
		TDLF	6.7	10.7	12.6	6.2	-10.7	12.4
	3-13	NLF	-3.3	-4.9	5.9	-3.3	5.2	6.1
		SDLF	1.4	2.7	3.0	1.2	-2.6	2.9
		TDLF	5.4	9.1	10.6	4.9	-9.0	10.3
	3-14	NLF	-2.8	-4.7	5.4	-2.8	4.7	5.4
		SDLF	0.5	1.0	1.1	0.4	-0.9	1.0
		TDLF	3.0	5.1	5.9	2.7	-5.0	5.7
	3-15	NLF	-1.0	-1.7	2.0	-1.0	1.7	2.0
		SDLF	0.5	0.5	0.7	0.4	-0.5	0.7
		TDLF	1.5	2.2	2.6	1.3	-2.2	2.5

Table P-5-1(Continued). Erection method 1 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-2	NLF	-1.7	-3.6	3.9	0.0	3.7	3.7
		SDLF	-2.5	-4.4	5.1	0.0	4.5	4.5
		TDLF	-3.9	-5.9	7.1	0.0	6.0	6.0
	6-3	NLF	-2.6	-1.4	2.9	-2.8	1.8	3.3
		SDLF	-1.5	-2.4	2.8	-1.5	2.6	3.0
		TDLF	-0.6	-3.5	3.6	-0.4	3.4	3.4
	6-4	NLF	-3.4	3.7	5.0	-3.7	-3.8	5.3
		SDLF	-0.9	0.8	1.2	-1.0	-0.8	1.3
		TDLF	1.4	-1.9	2.3	1.4	2.1	2.5
	6-5	NLF	1.1	8.6	8.7	1.1	-9.2	9.3
		SDLF	3.4	5.1	6.1	3.4	-5.5	6.5
		TDLF	5.6	1.5	5.8	5.5	-1.7	5.8
	6-6	NLF	5.5	13.4	14.5	5.6	-14.3	15.3
		SDLF	6.7	9.6	11.7	6.8	-9.9	12.0
		TDLF	7.6	5.8	9.6	7.6	-5.5	9.3
	6-7	NLF	6.3	11.5	13.1	6.5	-12.4	14.0
		SDLF	7.2	8.7	11.3	7.4	-9.1	11.7
		TDLF	7.6	5.9	9.6	7.8	-5.7	9.7
	6-8	NLF	4.6	8.5	9.6	4.7	-9.2	10.3
		SDLF	6.0	7.1	9.3	6.2	-7.4	9.6
		TDLF	6.9	5.6	8.9	7.0	-5.4	8.9
	6-9	NLF	1.8	3.6	4.0	1.9	-4.0	4.5
		SDLF	4.1	3.9	5.7	4.3	-4.1	5.9
		TDLF	5.8	4.1	7.1	6.0	-3.9	7.2
	6-10	NLF	-1.6	-2.6	3.0	-1.5	2.1	2.6
		SDLF	1.8	-0.2	1.8	2.0	0.0	2.0
		TDLF	4.5	1.9	4.9	4.8	-1.7	5.0
	6-11	NLF	-5.1	-9.5	10.7	-5.0	9.2	10.5
		SDLF	-0.7	-4.9	5.0	-0.5	4.8	4.9
		TDLF	3.0	-0.8	3.1	3.2	1.0	3.4

Table P-5-1(Continued). Erection method 1 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-12	NLF	-8.0	-16.6	18.4	-7.9	16.6	18.4
		SDLF	-3.1	-10.0	10.4	-2.9	10.0	10.4
		TDLF	1.3	-3.8	4.0	1.5	3.9	4.2
	6-13	NLF	-9.5	-21.4	23.4	-9.3	21.5	23.4
		SDLF	-4.7	-13.8	14.6	-4.6	13.8	14.7
		TDLF	-0.3	-6.3	6.3	-0.1	6.4	6.4
	6-14	NLF	-8.7	-20.4	22.2	-8.6	20.3	22.1
		SDLF	-5.0	-13.9	14.7	-4.9	13.8	14.6
		TDLF	-1.1	-6.8	6.9	-1.0	6.8	6.9
	6-15	NLF	-6.0	-12.1	13.6	-6.0	12.0	13.4
		SDLF	-3.6	-8.5	9.2	-3.6	8.4	9.1
		TDLF	-1.1	-4.3	4.4	-1.0	4.2	4.3
	6-16	NLF	-2.6	-3.7	4.5	-2.6	3.8	4.6
		SDLF	-1.5	-2.6	3.0	-1.6	2.6	3.1
		TDLF	-0.4	-1.3	1.3	-0.4	1.2	1.2

Table P-5-2. Erection method 2 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	-1.4	-2.5	2.9	0.0	2.8	2.8
		SDLF	-2.0	-3.4	3.9	0.0	3.7	3.7
		TDLF	-2.9	-4.8	5.6	0.0	5.2	5.2
	2-3	NLF	-0.2	-1.1	1.1	-0.2	0.9	1.0
		SDLF	-0.3	-1.2	1.2	-0.3	0.9	1.0
		TDLF	-0.3	-1.1	1.2	-0.3	0.9	1.0
	2-4	NLF	1.7	1.0	2.0	1.8	-1.3	2.2
		SDLF	1.8	1.1	2.1	1.9	-1.4	2.3
		TDLF	2.0	1.3	2.4	2.1	-1.6	2.6
	2-5	NLF	2.8	3.4	4.4	3.0	-4.0	5.0
		SDLF	3.0	3.7	4.8	3.0	-4.3	5.3
		TDLF	3.3	4.1	5.3	3.2	-4.7	5.7
	2-6	NLF	4.7	4.9	6.8	4.9	-5.7	7.5
		SDLF	5.0	5.4	7.4	5.2	-6.2	8.1
		TDLF	5.5	6.0	8.1	5.5	-6.7	8.7
	2-7	NLF	4.8	4.0	6.2	5.1	-4.7	6.9
		SDLF	5.2	4.5	6.9	5.4	-5.2	7.5
		TDLF	5.6	5.0	7.5	5.8	-5.7	8.1
	2-8	NLF	5.3	3.7	6.5	5.6	-4.3	7.1
		SDLF	5.7	4.5	7.3	6.0	-5.0	7.8
		TDLF	6.2	5.1	8.0	6.5	-5.7	8.6
	2-9	NLF	4.7	2.9	5.5	4.9	-3.3	5.9
		SDLF	5.2	3.8	6.4	5.4	-4.1	6.8
		TDLF	5.7	4.6	7.3	6.0	-5.0	7.8
	2-10	NLF	3.6	1.9	4.1	3.7	-2.1	4.3
		SDLF	4.1	3.0	5.1	4.3	-3.2	5.4
		TDLF	4.8	4.5	6.6	5.0	-4.7	6.9
	2-11	NLF	2.1	0.8	2.3	2.2	-0.8	2.4
		SDLF	3.0	3.1	4.3	3.2	-3.1	4.4
		TDLF	4.2	5.3	6.8	4.4	-5.4	7.0

Table P-5-2(Continued). Erection method 2 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-12	NLF	0.7	-0.4	0.8	0.7	0.4	0.8
		SDLF	1.9	3.2	3.7	2.0	-3.2	3.8
		TDLF	4.0	6.9	8.0	4.1	-7.0	8.1
	2-13	NLF	-0.5	-1.4	1.5	-0.5	1.4	1.5
		SDLF	1.0	3.3	3.5	1.0	-3.3	3.5
		TDLF	3.6	8.6	9.3	3.6	-8.6	9.3
	2-14	NLF	-1.0	-1.7	2.0	-1.0	1.7	2.0
		SDLF	0.3	3.0	3.0	0.3	-3.0	3.1
		TDLF	2.0	6.3	6.6	2.0	-6.4	6.7
	2-15	NLF	-0.9	-1.1	1.4	-0.7	1.1	1.3
		SDLF	0.0	2.0	2.0	0.1	-2.1	2.1
		TDLF	0.9	3.8	3.9	1.1	-3.9	4.0
	2-16	NLF	-0.3	-0.3	0.5	-0.3	0.3	0.4
		SDLF	0.0	0.8	0.8	0.0	-0.8	0.8
		TDLF	0.4	1.4	1.5	0.4	-1.4	1.4

Table P-5-2(Continued). Erection method 2 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
4	4-2	NLF	0.6	3.8	3.9	0.0	-4.0	4.0
		SDLF	-0.9	2.6	2.7	0.0	-2.7	2.7
		TDLF	-2.9	0.7	3.0	0.0	-0.7	0.7
	4-3	NLF	-5.5	-16.4	17.3	-5.4	16.2	17.1
		SDLF	-5.5	-17.1	18.0	-5.3	16.9	17.7
		TDLF	-6.2	-19.9	20.8	-5.9	19.7	20.5
	4-4	NLF	-6.7	-18.1	19.3	-6.6	17.9	19.1
		SDLF	-6.2	-15.3	16.5	-6.1	15.4	16.5
		TDLF	-5.6	-13.0	14.2	-5.6	13.2	14.3
	4-5	NLF	-4.7	-10.3	11.3	-4.7	10.1	11.1
		SDLF	-4.2	-9.3	10.2	-3.9	8.7	9.6
		TDLF	-3.8	-8.8	9.6	-3.3	7.7	8.4
	4-6	NLF	-5.0	-13.8	14.7	-4.8	13.6	14.4
		SDLF	-3.5	-9.9	10.5	-3.2	9.5	10.0
		TDLF	-2.2	-6.7	7.1	-1.9	6.1	6.4
	4-7	NLF	-1.3	-3.8	4.0	-1.2	3.6	3.8
		SDLF	0.6	1.3	1.4	0.6	-1.5	1.6
		TDLF	2.3	5.8	6.2	2.2	-6.2	6.6
	4-8	NLF	-0.3	-4.5	4.5	-0.2	4.2	4.2
		SDLF	1.5	-0.2	1.5	1.6	-0.2	1.6
		TDLF	3.2	3.4	4.7	3.2	-4.1	5.2
	4-9	NLF	-1.0	-10.0	10.0	-0.7	9.6	9.6
		SDLF	1.1	-5.7	5.8	1.3	5.2	5.3
		TDLF	3.1	-1.5	3.4	3.1	0.8	3.2
	4-10	NLF	-2.3	-16.1	16.3	-1.9	15.7	15.8
		SDLF	0.2	-10.8	10.8	0.5	10.2	10.3
		TDLF	2.5	-5.9	6.4	2.6	5.1	5.8
	4-11	NLF	-4.0	-22.1	22.5	-3.5	21.8	22.1
		SDLF	-0.9	-14.9	14.9	-0.6	14.4	14.4
		TDLF	2.0	-8.5	8.7	2.1	7.8	8.1

Table P-5-2(Continued). Erection method 2 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
4	4-12	NLF	-6.1	-28.8	29.5	-5.6	28.6	29.1
		SDLF	-2.2	-18.7	18.8	-1.9	18.3	18.4
		TDLF	1.4	-9.9	10.0	1.5	9.4	9.6
	4-13	NLF	-8.8	-37.1	38.2	-8.2	37.0	37.9
		SDLF	-3.9	-23.0	23.3	-3.6	22.8	23.1
		TDLF	0.6	-10.8	10.8	0.7	10.5	10.6
	4-14	NLF	-11.5	-44.5	46.0	-10.9	44.4	45.7
		SDLF	-5.9	-27.8	28.4	-5.6	27.7	28.2
		TDLF	-0.2	-10.9	10.9	-0.1	10.7	10.7
	4-15	NLF	-11.1	-40.0	41.6	-10.3	39.9	41.3
		SDLF	-8.1	-32.3	33.3	-7.5	32.1	33.0
		TDLF	-0.9	-9.0	9.1	-0.7	8.8	8.9
	4-16	NLF	-3.3	-11.7	12.1	-3.2	11.7	12.1
		SDLF	-2.5	-10.3	10.7	-2.5	10.4	10.7
		TDLF	0.3	-1.2	1.3	0.2	1.3	1.3

Table P-5-2(Continued). Erection method 2 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-2	NLF	-1.0	-1.6	1.9	0.0	1.3	1.3
		SDLF	-5.8	-5.7	8.2	0.0	5.7	5.7
		TDLF	-12.0	-11.4	16.6	0.0	11.5	11.5
	6-3	NLF	2.3	2.1	3.1	2.1	-1.4	2.5
		SDLF	2.8	1.7	3.3	2.7	-1.2	3.0
		TDLF	3.6	1.5	3.9	3.3	-0.9	3.4
	6-4	NLF	4.6	13.4	14.2	4.2	-12.3	13.1
		SDLF	5.6	14.7	15.7	5.2	-14.0	14.9
		TDLF	6.7	16.3	17.6	6.1	-15.7	16.8
	6-5	NLF	4.1	12.2	12.9	3.9	-11.8	12.4
		SDLF	5.1	11.7	12.8	4.7	-11.6	12.5
		TDLF	6.1	11.3	12.8	5.4	-11.4	12.7
	6-6	NLF	3.4	12.5	12.9	3.2	-12.1	12.5
		SDLF	4.7	11.9	12.8	4.3	-11.7	12.5
		TDLF	6.1	11.6	13.1	5.3	-11.5	12.7
	6-7	NLF	2.1	10.4	10.6	1.9	-10.2	10.3
		SDLF	4.0	10.6	11.3	3.6	-10.6	11.2
		TDLF	6.7	13.2	14.8	5.8	-13.3	14.6
	6-8	NLF	1.1	7.0	7.0	0.9	-6.9	6.9
		SDLF	4.2	10.3	11.2	3.8	-10.4	11.1
		TDLF	7.5	13.9	15.8	6.7	-14.2	15.7
	6-9	NLF	0.6	3.3	3.3	0.6	-3.3	3.4
		SDLF	4.6	8.8	9.9	4.4	-9.0	10.0
		TDLF	8.6	13.9	16.3	7.9	-14.3	16.4
	6-10	NLF	0.3	-1.0	1.0	0.3	0.9	1.0
		SDLF	4.9	6.6	8.2	4.7	-6.9	8.3
		TDLF	8.8	12.4	15.2	8.2	-12.8	15.2
	6-11	NLF	0.3	-2.7	2.7	0.4	2.5	2.6
		SDLF	4.9	5.6	7.4	4.7	-6.0	7.7
		TDLF	7.0	7.6	10.4	6.5	-8.1	10.4

Table P-5-2(Continued). Erection method 2 fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
6	6-12	NLF	0.2	-2.7	2.7	0.3	2.5	2.6
		SDLF	3.5	3.8	5.2	3.3	-3.9	5.2
		TDLF	4.6	4.1	6.1	3.9	-4.1	5.6
	6-13	NLF	0.3	-0.9	1.0	0.3	0.8	0.9
		SDLF	1.6	1.7	2.4	1.5	-1.6	2.2
		TDLF	2.0	1.8	2.7	1.6	-1.6	2.3

Table P-5-3: Erection Critical Sub-Stages with cranes at the NL elevations

Erection Method	Stage	Detailing Method	Critical Sub-Stage
1	2	NLF	2-4
		SDLF	2-4
		TDLF	2-4
	3	NLF	3-8
		SDLF	3-8
		TDLF	3-12
	6	NLF	6-13
		SDLF	6-13
		TDLF	6-7
2	2	NLF	2-6
		SDLF	2-6
		TDLF	2-13
	4	NLF	4-14
		SDLF	4-15
		TDLF	4-3
	6	NLF	6-4
		SDLF	6-4
		TDLF	6-9

Table P-5-4. Erection method 1 critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	4.9	7.5	8.9	NA	NA	NA
		SDLF	6.3	7.9	10.1	NA	NA	NA
		TDLF	7.7	8.7	11.6	NA	NA	NA
	B	NLF	4.6	13.4	14.2	4.2	-12.3	13.1
		SDLF	5.6	14.7	15.7	5.2	-14.0	14.9
		TDLF	6.7	16.3	17.6	6.1	-15.7	16.8
3	A	NLF	-1.8	4.7	5.0	NA	NA	NA
		SDLF	5.4	5.7	7.8	NA	NA	NA
		TDLF	10.2	7.9	12.9	NA	NA	NA
	B	NLF	-0.7	9.0	9.0	-1.0	-8.5	8.6
		SDLF	3.5	8.3	9.0	3.1	-8.0	8.6
		TDLF	6.7	10.7	12.6	6.2	-10.7	12.4
6	A	NLF	-15.0	-14.8	21.1	NA	NA	NA
		SDLF	-7.1	-8.9	11.4	NA	NA	NA
		TDLF	13.3	5.7	14.5	NA	NA	NA
	B	NLF	-9.5	-21.4	23.4	-9.3	21.5	23.4
		SDLF	-4.7	-13.8	14.6	-4.6	13.8	14.7
		TDLF	7.6	5.9	9.6	7.8	-5.7	9.7

Table P-5-5. Erection method 2critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	7.6	3.5	8.4	NA	NA	NA
		SDLF	8.1	3.8	9.0	NA	NA	NA
		TDLF	3.8	4.3	5.8	NA	NA	NA
	B	NLF	4.7	4.9	6.8	4.9	-5.7	7.5
		SDLF	5.0	5.4	7.4	5.2	-6.2	8.1
		TDLF	3.6	8.6	9.3	3.6	-8.6	9.3
4	A	NLF	-0.9	-4.7	4.8	NA	NA	NA
		SDLF	0.3	-2.4	2.5	NA	NA	NA
		TDLF	-2.2	-1.5	2.7	NA	NA	NA
	B	NLF	-11.5	-44.5	46.0	-10.9	44.4	45.7
		SDLF	-8.1	-32.3	33.3	-7.5	32.1	33.0
		TDLF	-6.2	-19.9	20.8	-5.9	19.7	20.5
6	A	NLF	-3.4	-3.8	5.1	NA	NA	NA
		SDLF	-1.1	-1.4	1.8	NA	NA	NA
		TDLF	13.7	-2.0	13.9	NA	NA	NA
	B	NLF	4.6	13.4	14.2	4.2	-12.3	13.1
		SDLF	5.6	14.7	15.7	5.2	-14.0	14.9
		TDLF	8.6	13.9	16.3	7.9	-14.3	16.4

Table P-5-6. Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	15.3	53.2	12.3		
			SDLF	15.6	53.4	12.9		
			TDLF	15.6	53.7	13.3		
		G2	NLF	0.0	33.4	66.9	33.4	0.0
			SDLF	0.3	32.8	65.6	32.8	0.0
			TDLF	0.7	32.2	64.4	32.2	0.0
	B	G1	NLF	15.6	53.4	12.6		
			SDLF	15.9	53.7	13.2		
			TDLF	15.9	54.1	13.7		
		G2	NLF	0.2	33.1	66.2	33.1	0.0
			SDLF	0.6	32.3	64.6	32.3	0.0
			TDLF	1.1	31.6	63.3	31.7	0.0

Table P-5-6(Continued). Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
3	A	G1	NLF	28.9	74.2	25.5		
			SDLF	31.5	70.4	30.0		
			TDLF	35.7	71.2	39.0		
		G2	NLF	10.7	8.3			
			SDLF	17.3	11.7			
			TDLF	30.1	14.2			
		G3	NLF	2.3	33.5	66.9	33.4	0.0
			SDLF	1.7	27.1	54.2	27.1	0.0
			TDLF	7.5	6.0	11.9	6.0	9.9

Table P-5-6(Continued). Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
3	B	G1	NLF	28.5	75.0	24.7		
			SDLF	31.4	71.0	29.4		
			TDLF	35.5	72.3	39.2		
		G2	NLF	10.6	8.7			
			SDLF	17.0	12.2			
			TDLF	31.3	14.4			
		G3	NLF	2.6	33.6	67.1	33.5	0.0
			SDLF	2.1	27.0	54.0	27.0	0.0
			TDLF	8.4	3.7	7.4	3.7	11.4

Table P-5-6(Continued). Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	A	G1	NLF	114.0	83.0			
			SDLF	105.0	79.5			
			TDLF	94.2	82.5			
		G2	NLF	45.3	51.6			
			SDLF	46.6	48.6			
			TDLF	45.8	47.0			
		G3	NLF	3.3	14.9			
			SDLF	14.5	24.9			
			TDLF	25.7	23.6			
		G4	NLF	0.0	0.0			
			SDLF	7.0	10.7			
			TDLF	17.9	13.5			
		G5	NLF	0.0	0.0			
			SDLF	5.2	0.0			
			TDLF	6.0	2.8			
		6	NLF	12.1	49.9	99.9	50.0	0.0
			SDLF	12.2	35.1	70.2	35.1	0.0
			TDLF	8.5	25.6	51.2	25.6	1.4

Table P-5-6(Continued). Erection method 1 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	B	G1	NLF	114.5	85.4			
			SDLF	105.2	79.6			
			TDLF	94.6	82.5			
		G2	NLF	45.5	53.2			
			SDLF	46.6	49.0			
			TDLF	46.1	47.0			
		G3	NLF	0.8	7.5			
			SDLF	14.1	25.9			
			TDLF	25.5	23.6			
		G4	NLF	0.0	0.0			
			SDLF	6.2	6.6			
			TDLF	17.2	13.4			
		G5	NLF	0.0	0.0			
			SDLF	4.0	0.0			
			TDLF	5.9	2.9			
		6	NLF	10.0	53.8	107.6	53.8	0.0
			SDLF	11.4	38.0	76.1	38.1	0.0
			TDLF	9.0	25.7	51.5	25.7	1.4

Table P-5-7. Erection method 2 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G5	NLF	0.0	29.5	58.9	29.4	0.0
			SDLF	0.0	29.5	59.0	29.4	0.0
			TDLF	0.0	37.8	75.7	37.9	3.5
		G6	NLF	0.0	32.7	26.5	0.2	
			SDLF	0.0	32.7	26.4	0.3	
			TDLF	0.0	32.0	3.3	8.8	
	B	G5	NLF	0.0	29.7	59.3	29.6	0.0
			SDLF	0.0	29.8	59.4	29.6	0.0
			TDLF	0.0	39.3	78.7	39.4	3.9
		G6	NLF	0.0	32.9	26.2	0.4	
			SDLF	0.0	32.9	26.0	0.5	
			TDLF	0.7	30.3	0.0	10.1	

Table P-5-7(Continued). Erection method 2 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
4	A	G3	NLF	0.0	7.9	15.8	7.9	3.7
			SDLF	0.0	10.6	21.2	10.6	9.8
			TDLF	0.0	30.3	60.6	30.3	0.0
		G4	NLF	0.0	107.1	87.6	0.0	
			SDLF	0.0	108.1	69.3	2.0	
			TDLF	0.0	72.6	47.6	4.5	
		G5	NLF	3.4	0.0			
			SDLF	6.0	8.5			
			TDLF	11.5	13.7			
		G6	NLF	21.8	20.0			
			SDLF	19.8	15.4			
			TDLF	22.6	18.7			

Table P-5-7(Continued). Erection method 2 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
4	B	G3	NLF	0.0	0.0	0.0	0.0	1.7
			SDLF	0.0	2.5	5.1	2.5	6.7
			TDLF	0.0	28.5	57.1	28.5	0.0
		G4	NLF	0.0	115.3	102.5	0.0	
			SDLF	0.0	116.5	84.8	3.5	
			TDLF	0.0	81.2	46.9	6.4	
		G5	NLF	3.4	0.0			
			SDLF	5.6	8.1			
			TDLF	0.0	13.2			
		G6	NLF	20.0	16.8			
			SDLF	18.3	12.0			
			TDLF	29.3	17.9			

Table P-5-7(Continued). Erection method 2 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	A	G1	NLF	0.0	35.1	70.3	35.2	0.0
			SDLF	0.0	35.8	71.7	35.9	0.8
			TDLF	0.0	42.3	84.7	42.4	12.7
		G2	NLF	0.0	100.9	87.3	0.0	
			SDLF	0.0	100.2	73.7	7.4	
			TDLF	0.0	88.4	30.3	23.2	
		G3	NLF	0.0	6.2			
			SDLF	2.4	11.1			
			TDLF	26.2	18.6			
		G4	NLF	40.4	16.5			
			SDLF	43.7	17.4			
			TDLF	42.8	19.5			
		G5	NLF	30.9	23.9			
			SDLF	29.5	22.6			
			TDLF	25.0	20.5			
		G6	NLF	16.9	26.6			
			SDLF	15.3	24.1			
			TDLF	11.4	20.3			

Table P-5-7(Continued). Erection method 2 vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
6	B	G1	NLF	0.0	32.7	65.5	32.8	1.0
			SDLF	0.0	35.2	70.5	35.3	1.2
			TDLF	0.0	38.9	77.8	39.0	13.9
		G2	NLF	0.0	106.0	88.3	0.0	
			SDLF	0.0	102.1	73.8	7.4	
			TDLF	0.0	92.4	34.8	22.2	
		G3	NLF	0.0	6.4			
			SDLF	1.5	11.0			
			TDLF	26.6	18.1			
		G4	NLF	37.7	16.3			
			SDLF	43.9	17.4			
			TDLF	42.2	19.3			
		G5	NLF	31.6	23.8			
			SDLF	29.6	22.6			
			TDLF	24.7	20.4			
		G6	NLF	17.4	26.5			
			SDLF	15.3	24.1			
			TDLF	11.2	20.1			

Appendix Q1-2. NISCS38 Bridge Description

The key characteristics of NISCS38 are as follows:

- Span length along the centerline of the bridge, L_s = 300 ft.
- Width between the fascia girders, w_g = 74 ft.
- Radius of curvature to the centerline of the bridge, R =730 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 4.1
- Subtended angle between the supports, L_s/R = 0.41
- Number of girders in the completed bridge cross-section, n_g =9.
- Skew angle, θ = 62.6,0^o

This appendix presents the bridge description of the bridge NISCS38 in its final condition as well as during erection. The following figures and tables are provided:

Figure Q1-2-1. Framing plan

Figure Q1-2-2. Bridge cross-section

Figure Q1-2-3. Girder Elevation

Figure Q1-2-4. Cross-section dimension

Figure Q1-2-5. Cross-frame details

Figure Q1-2-6. Erection scheme

Table Q1-2-1. Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed NLF

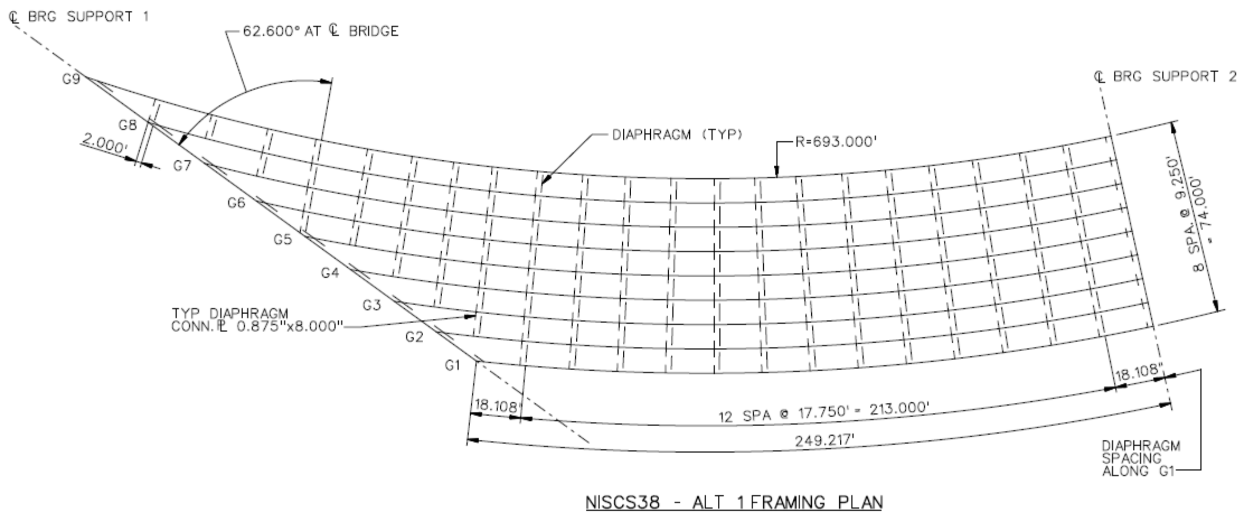


Figure Q1-2-1. Framing plan.

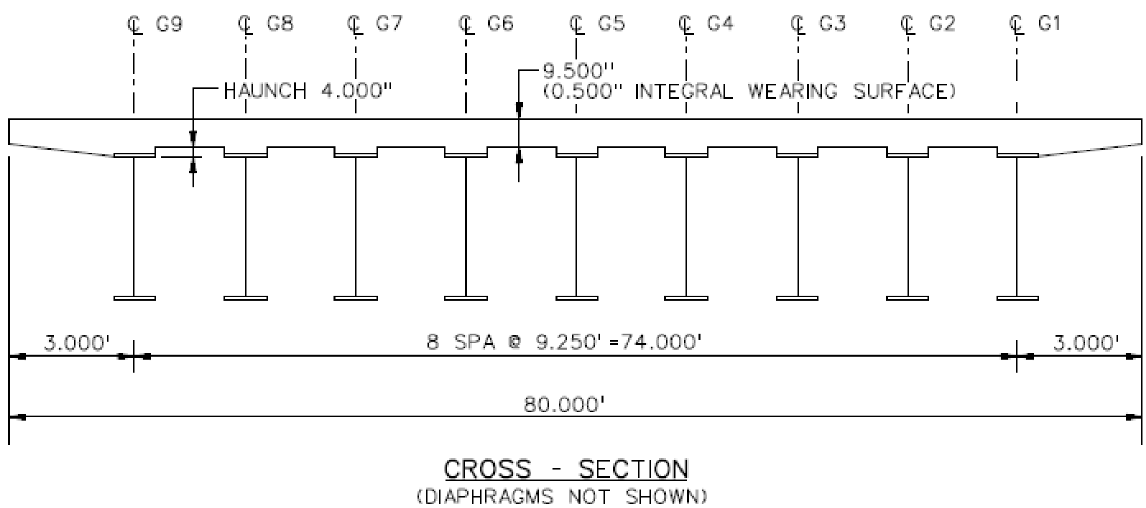


Figure Q1-2-2. Bridge cross-section.

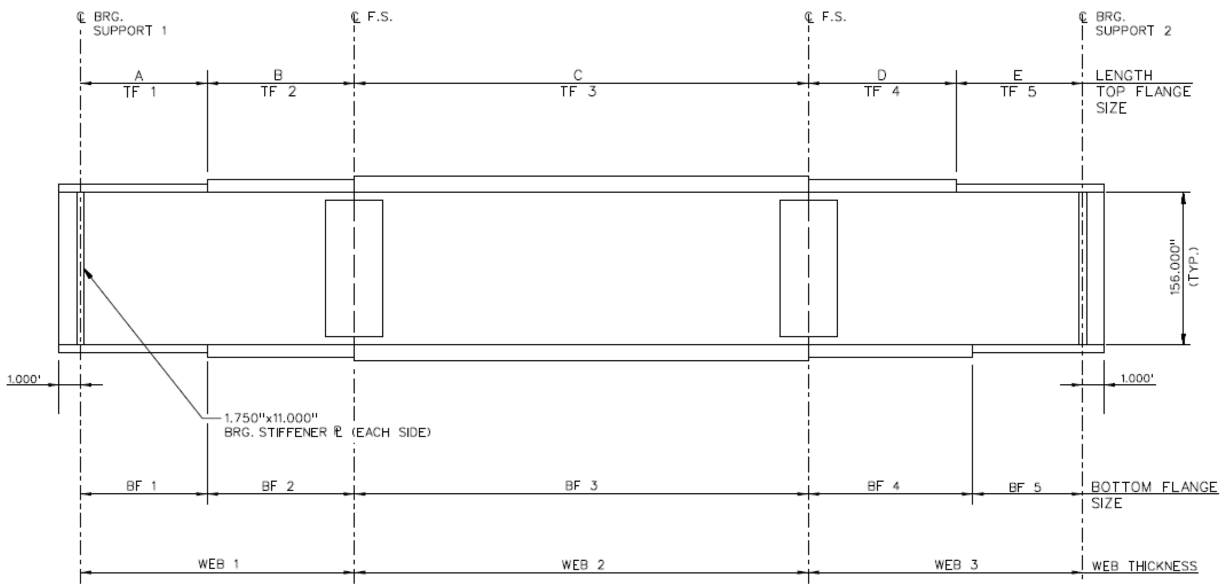


Figure Q1-2-3. Girder elevations

	GIRDER PLATE LENGTHS ⋇								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	60.000	75.000	75.000	75.000	85.000	92.246	104.000	110.000	118.000
B	0	0	0	0	0	0	0	0	0
C	129.216	126.057	123.408	130.000	125.000	130.000	122.025	126.857	129.387
D	0	0	0	0	0	0	0	0	0
E	60.000	60.000	75.000	81.352	90.000	92.246	104.000	110.000	118.000

⋇ ALL DIMENSIONS ARE IN FEET.

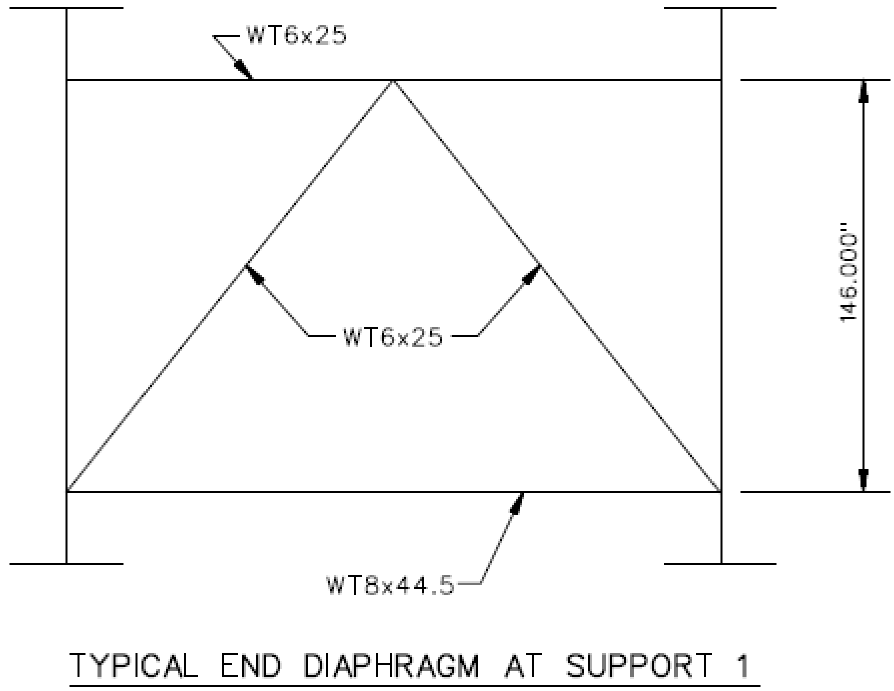
	GIRDER FLANGE DIMENSIONS ⋇⋇					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	36.000	1.750	30.000	1.250	36.000	1.500
TF2	N/A	N/A	N/A	N/A	N/A	N/A
TF3	36.000	2.250	30.000	2.000	36.000	1.500
TF4	N/A	N/A	N/A	N/A	N/A	N/A
TF5	36.000	1.750	30.000	1.250	36.000	1.500

⋇⋇ ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS ⋇⋇					
BOTTOM FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
BF1	36.000	2.000	30.000	1.250	36.000	1.500
BF2	N/A	N/A	N/A	N/A	N/A	N/A
BF3	36.000	2.500	30.000	2.000	36.000	1.500
BF4	N/A	N/A	N/A	N/A	N/A	N/A
BF5	36.000	2.000	30.000	1.250	36.000	1.500

⋇⋇ ALL DIMENSIONS ARE IN INCHES.

Figure Q1-2-4. Cross-section dimensions.



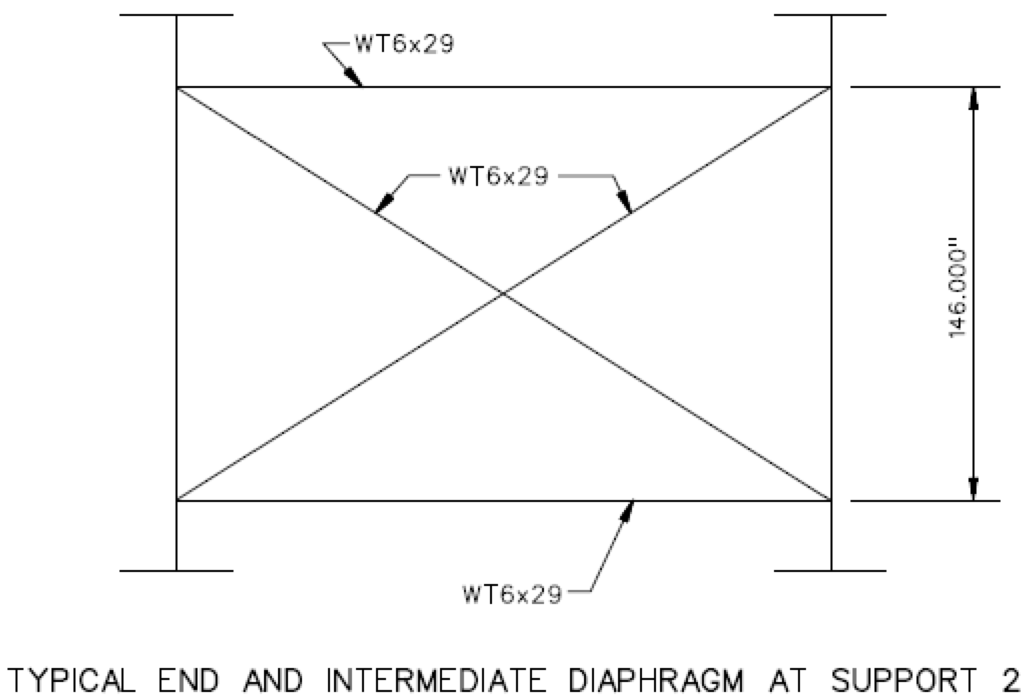


Figure Q1-2-5. Cross-frame details

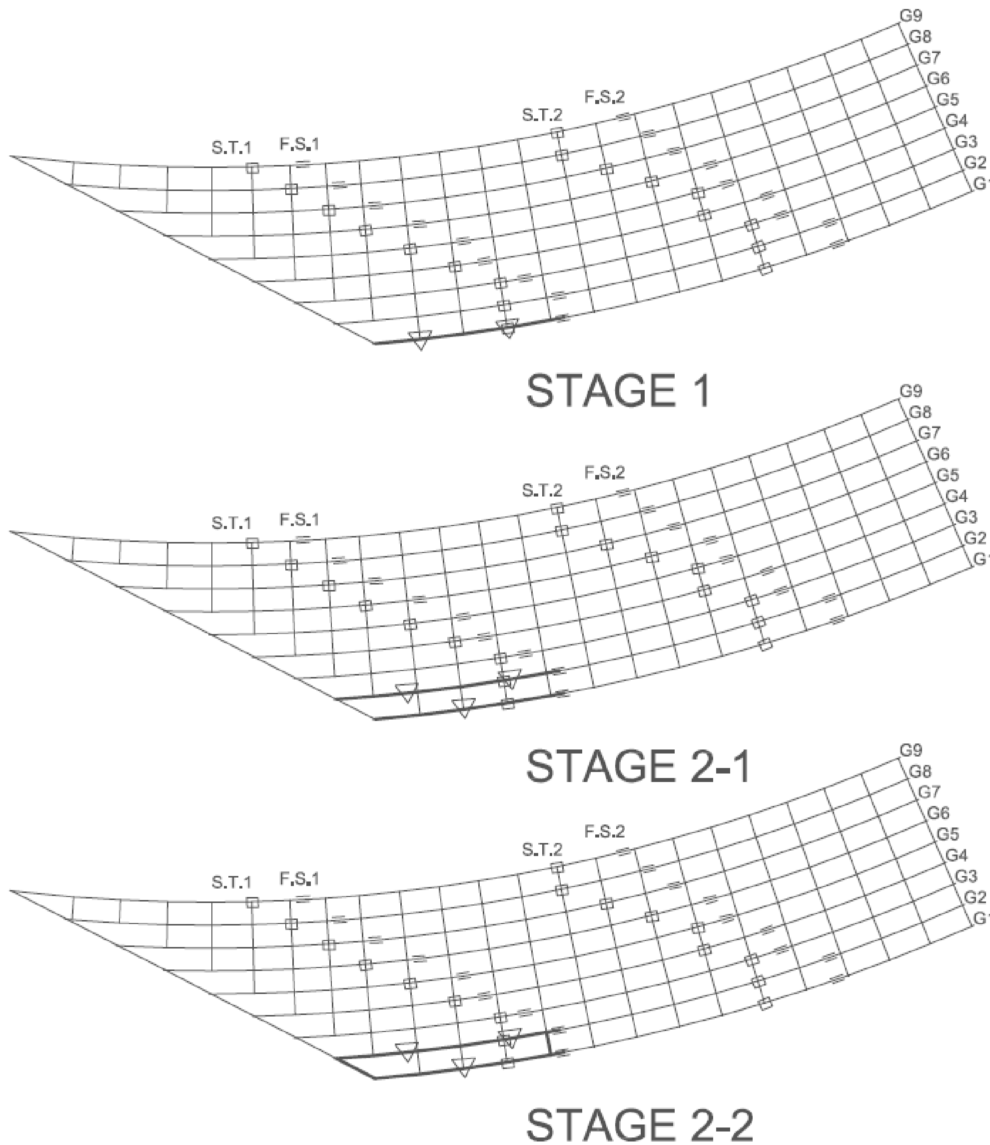
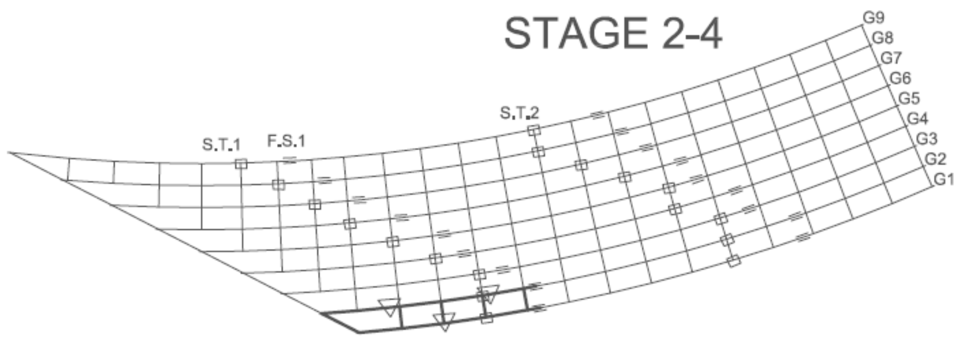


Figure Q1-2-6. Erection scheme.

STAGE 2-3

STAGE 2-4

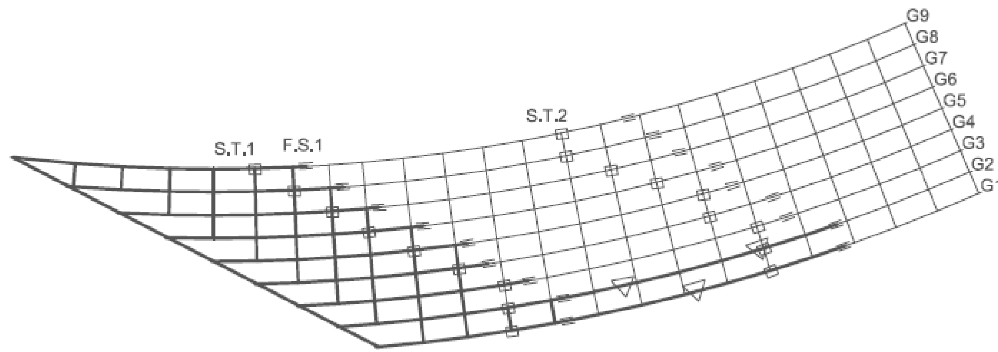


STAGE 2-5

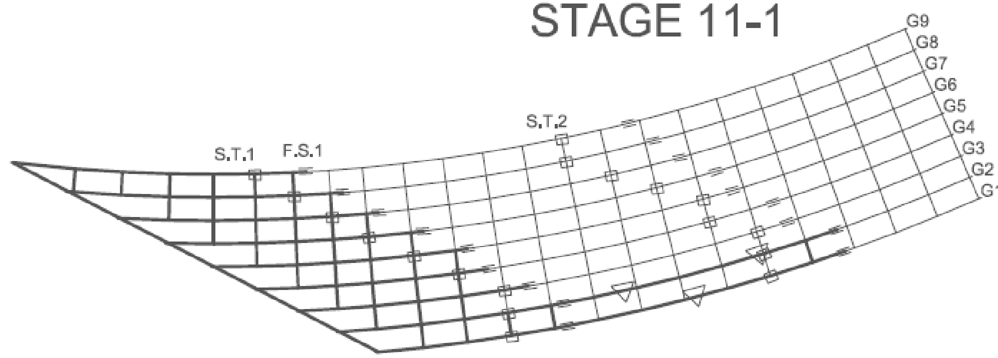
Figure Q1-2-6(Continued). Erection scheme.

REPEAT THE SEQUENCE FOR G3 TO G9
FOR THE FIRST FIELD SEGMENT
ACROSS THE BRIDGE WIDTH. THE
SHORING TOWERS REMAIN IN PLACE
UNTIL THE WHOLE BRIDGE IS ERECTED.
THE HOLDING CRANE IS ON G1 UNTIL
THE FIELD SEGMENTS OF G1-G3 ARE
ERECTED

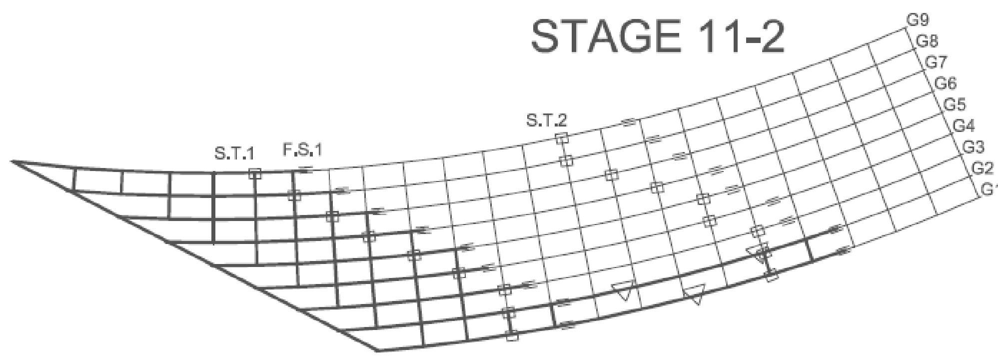
Figure Q1-2-6(Continued). Erection scheme.



STAGE 11-1

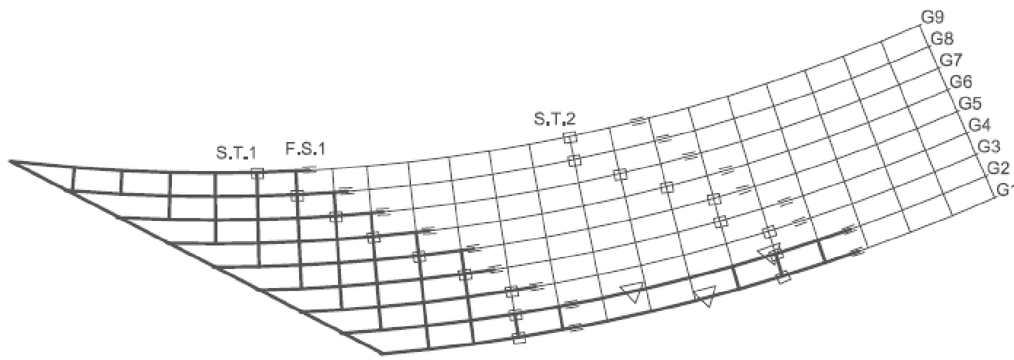


STAGE 11-2

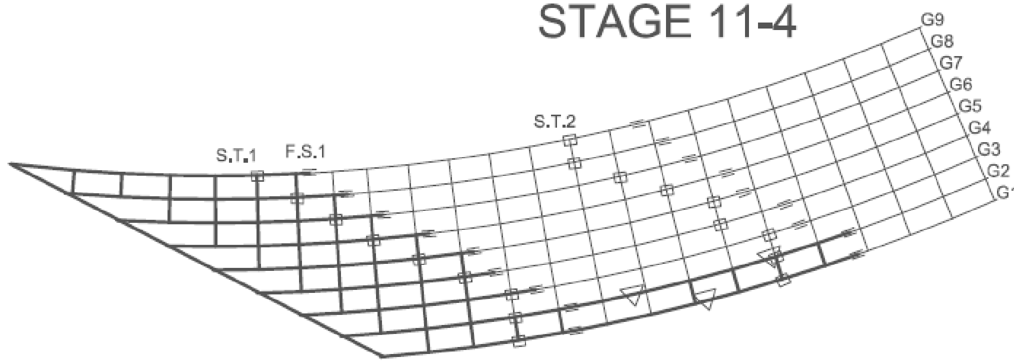


STAGE 11-3

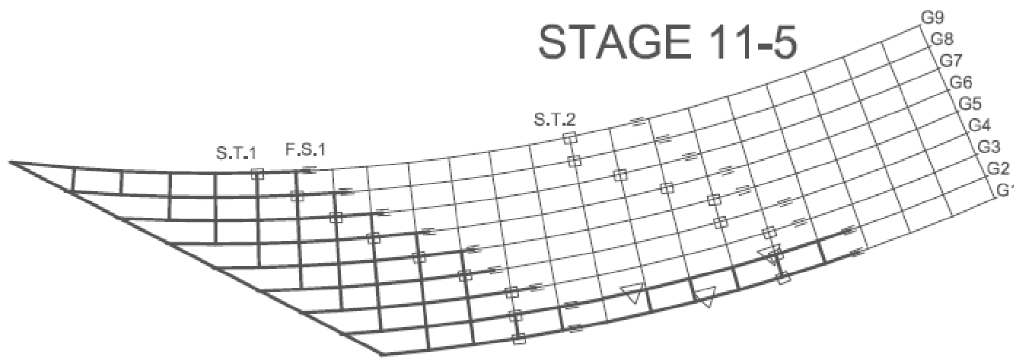
Figure Q1-2-6(Continued). Erection scheme.



STAGE 11-4

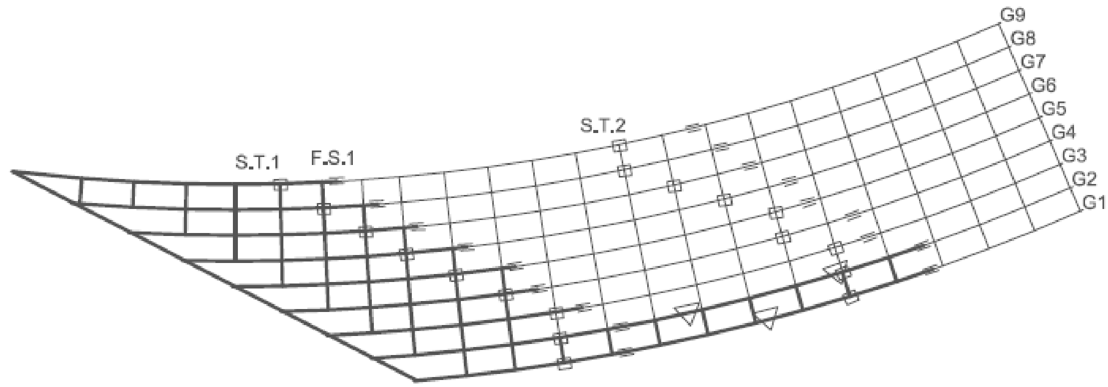


STAGE 11-5



STAGE 11-6

Figure Q1-2-6(Continued). Erection scheme.



STAGE 11-7

REPEAT THE SEQUENCE FOR G3 TO G9 FOR THE SECOND FIELD SEGMENT ACROSS THE BRIDGE WIDTH. THE SHORING TOWERS REMAIN IN PLACE UNTIL THE WHOLE BRIDGE IS ERECTED. THE HOLDING CRANE IS ON G1 UNTIL THE FIELD SEGMENTS OF G1-G3 ARE ERECTED. COUNTERWEIGHTS ARE INSTALLED DURING STAGES 17 & 18 ON G8 AND G9.

REPEAT THE SEQUENCE FOR THE THIRD FIELD SEGMENT ACROSS THE BRIDGE WIDTH

Figure Q1-2-6(Continued). Erection scheme.

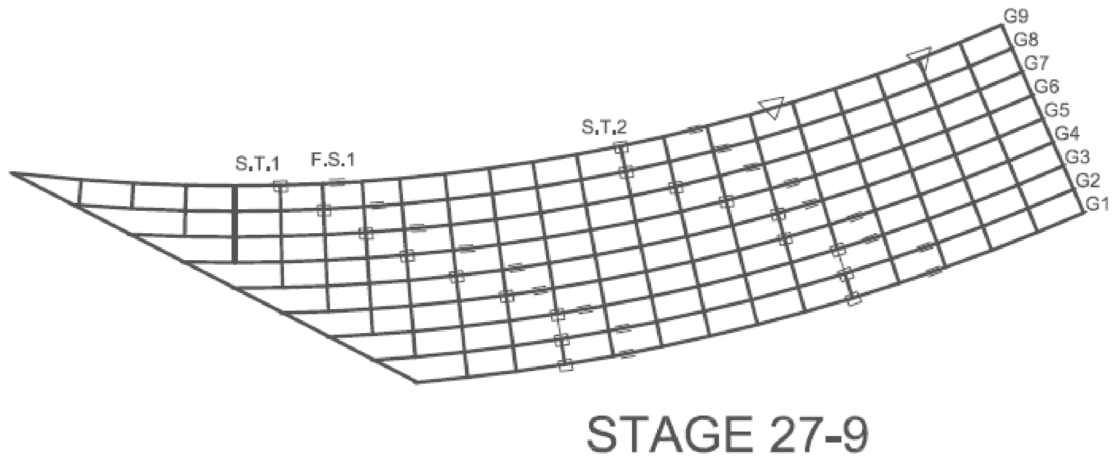


Figure Q1-2-6(Continued). Erection scheme.

Table Q1-2-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

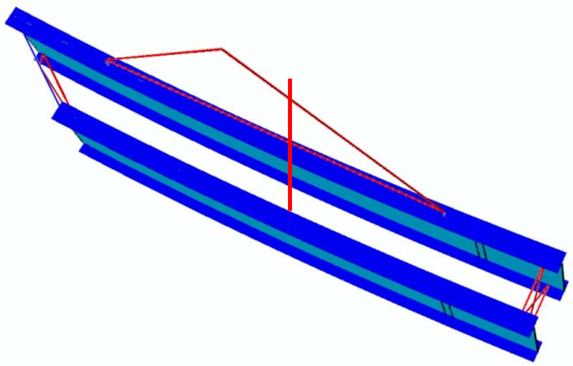
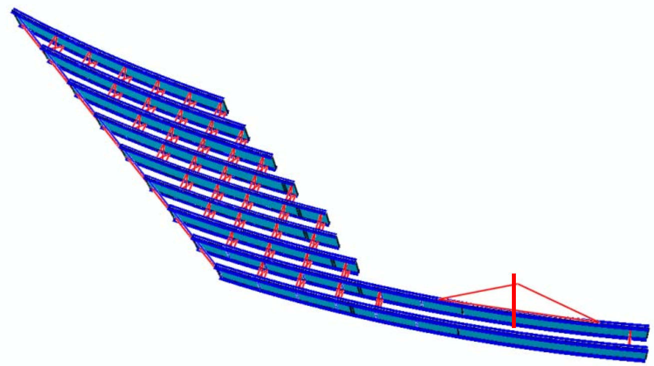
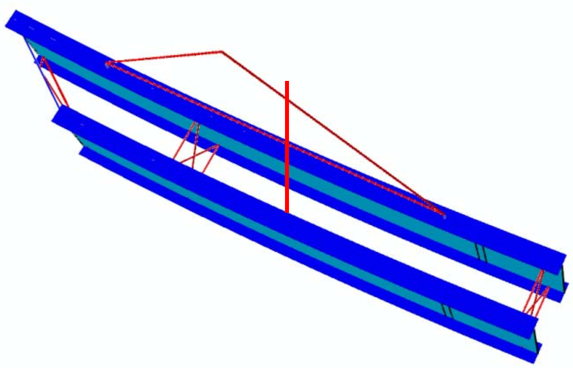
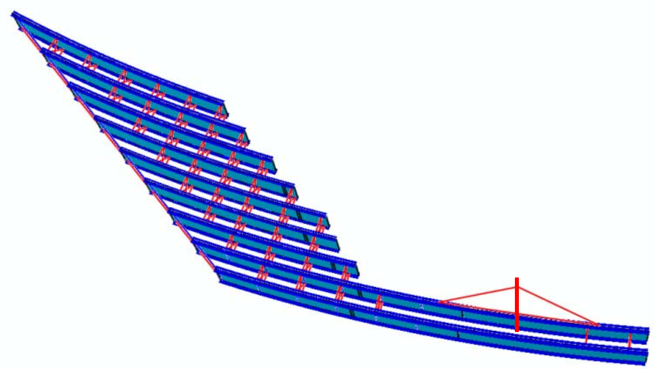
Sub-Stage	Stage	
	2	11
1		
2		

Table Q1-2-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

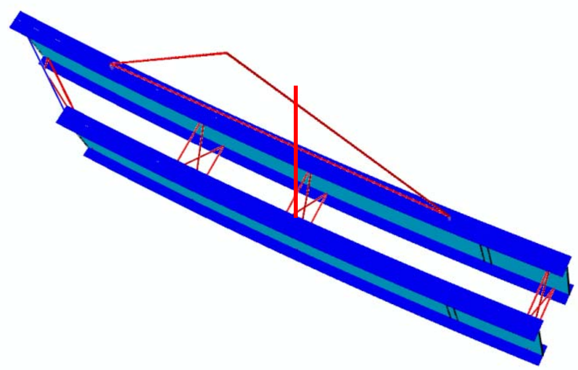
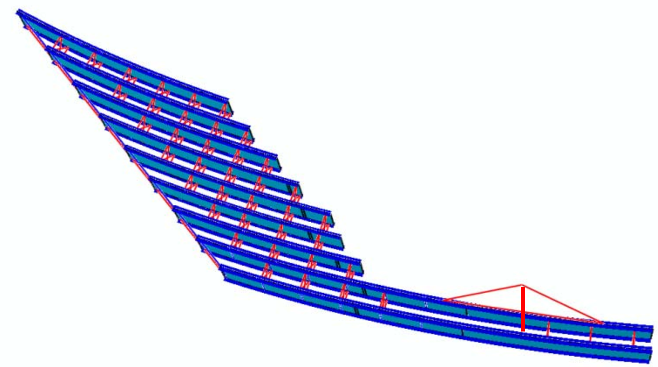
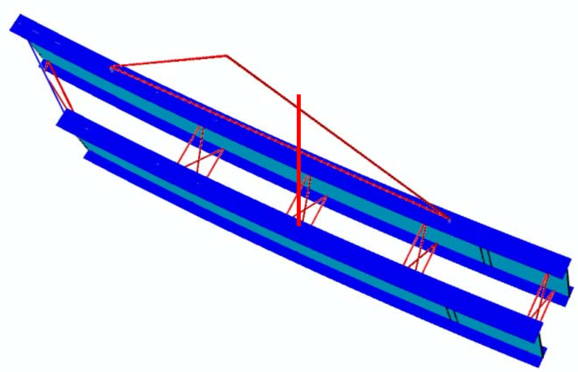
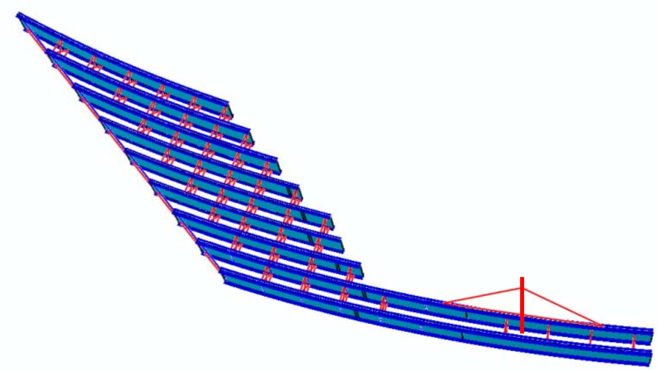
3		
4		

Table Q1-2-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

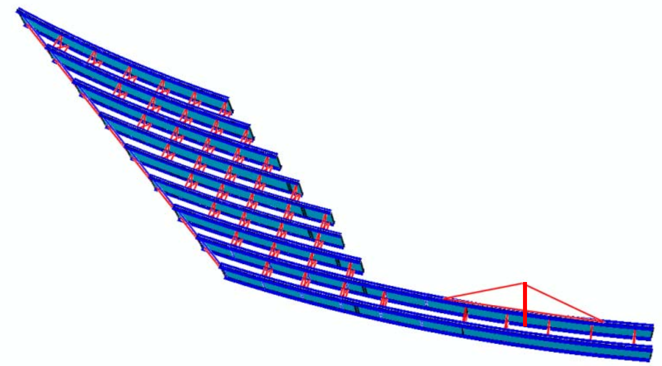
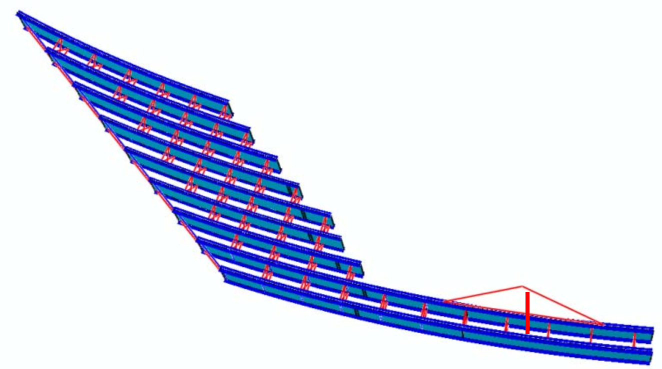
5		
6		

Table Q1-2-1 (continued).. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

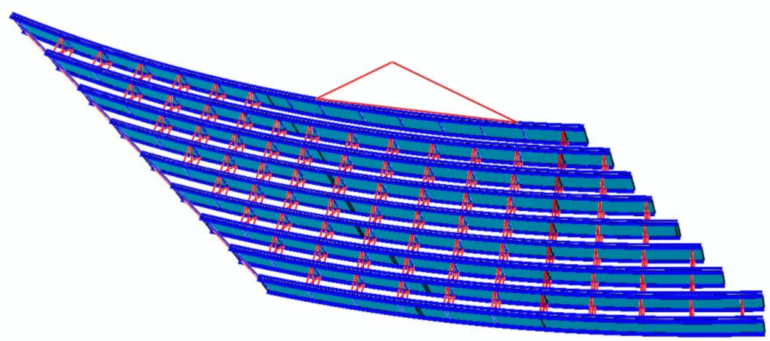
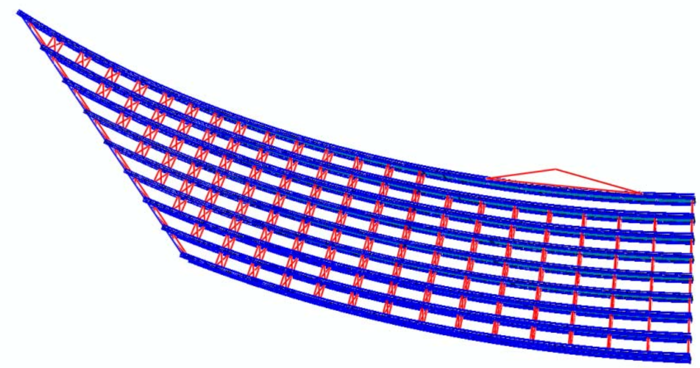
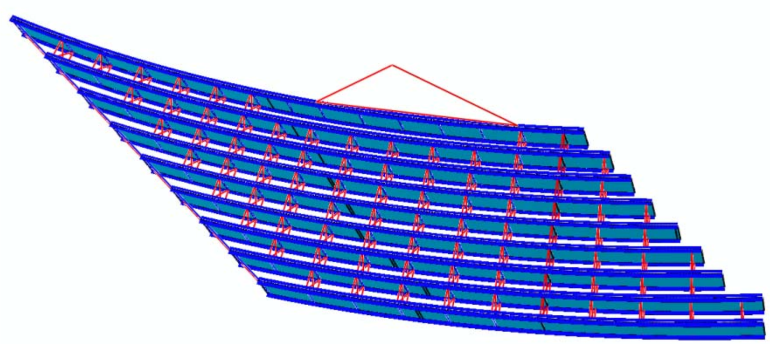
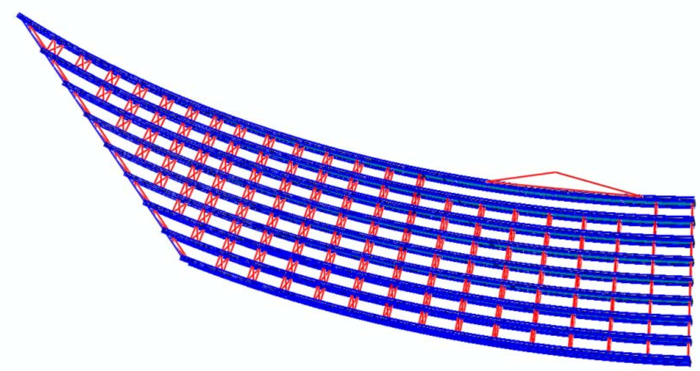
Sub-Stage	Stage	
	18	27
1		
2		

Table Q1-2-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

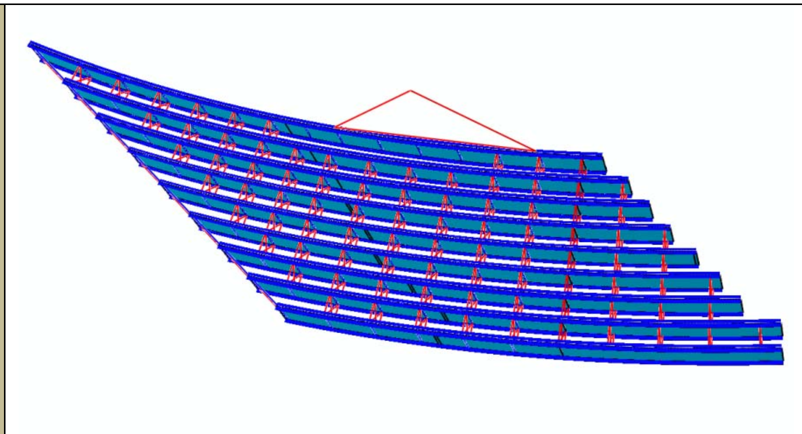
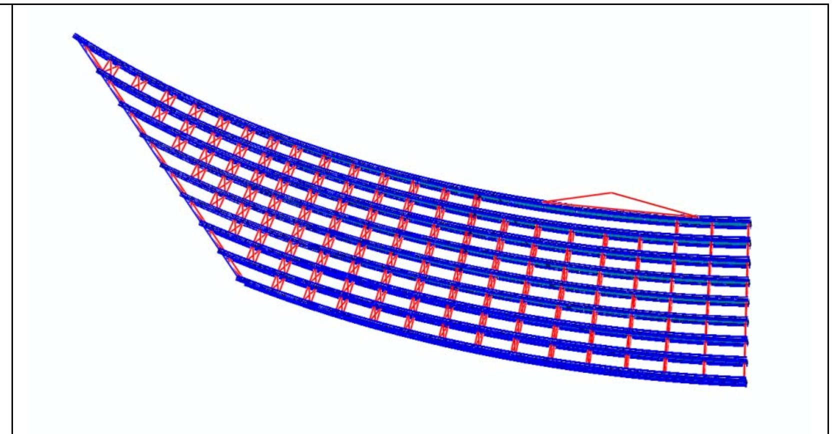
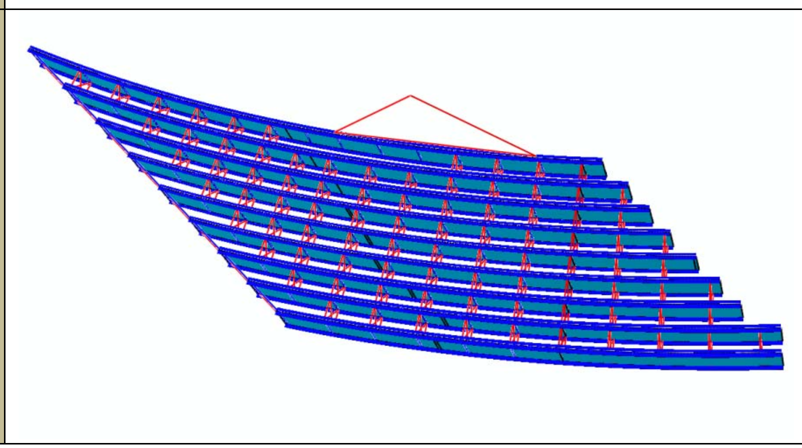
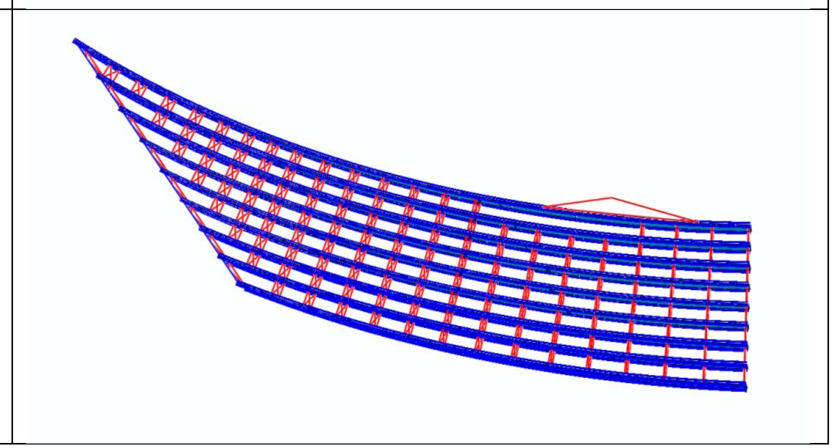
3		
4		

Table Q1-2-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

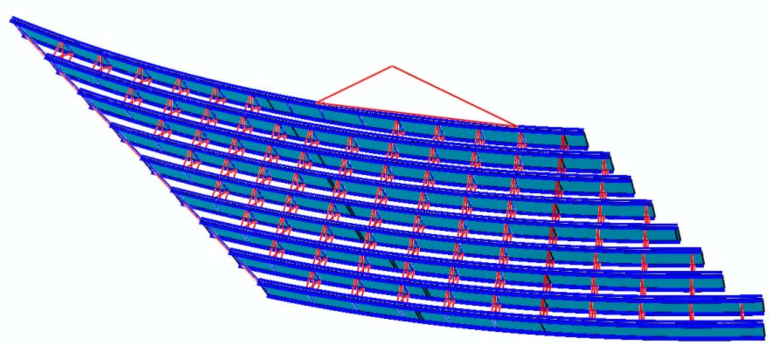
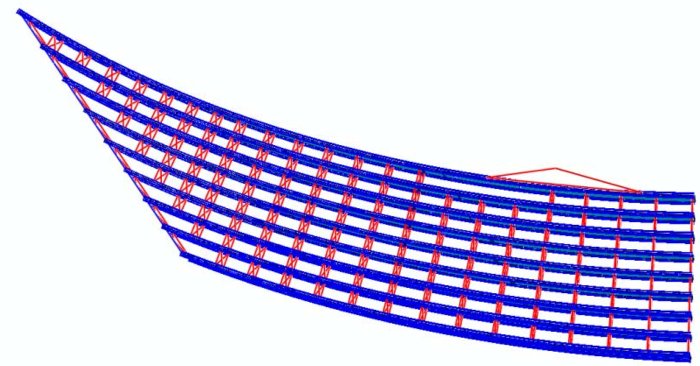
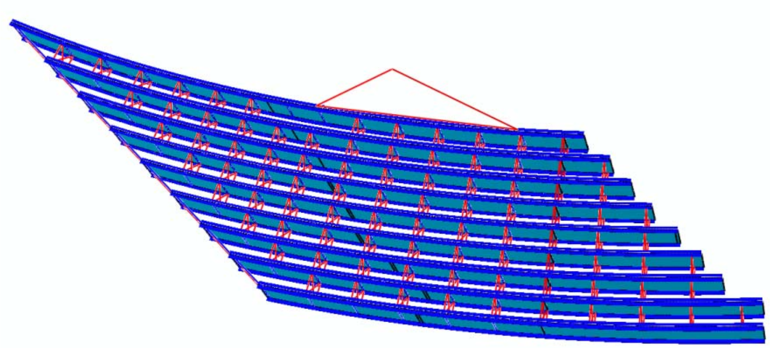
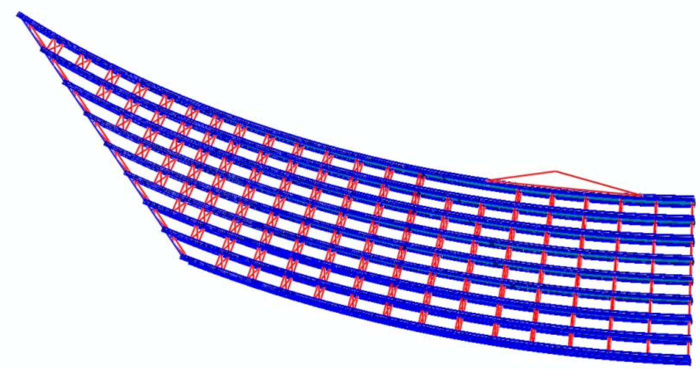
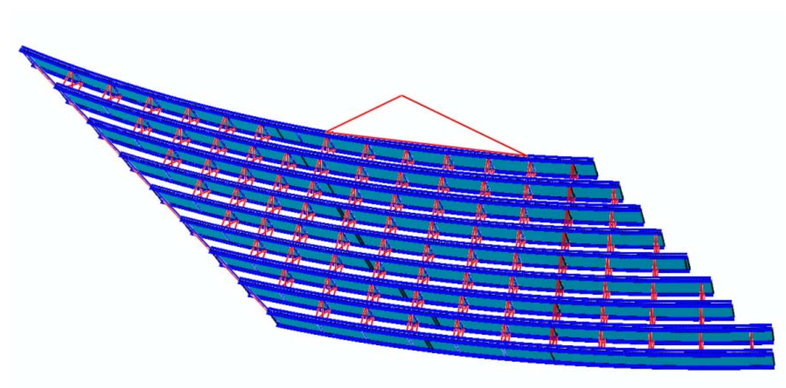
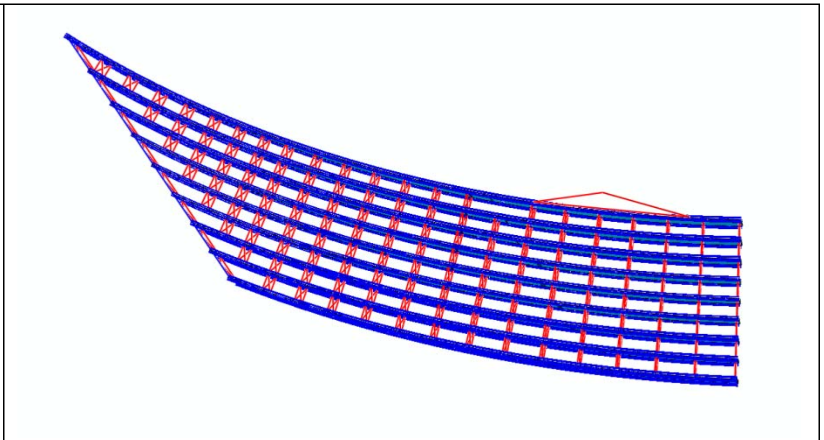
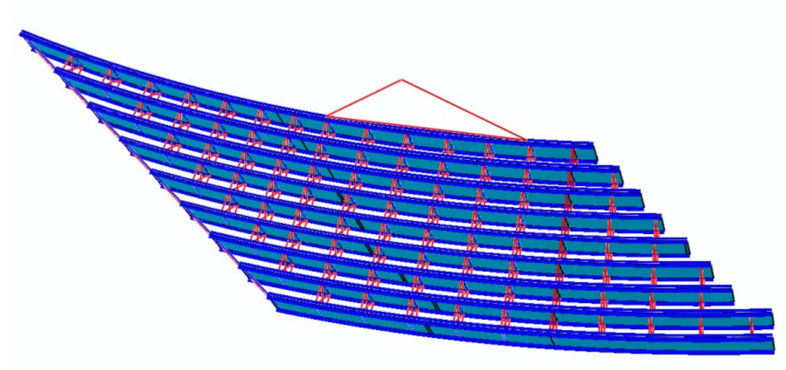
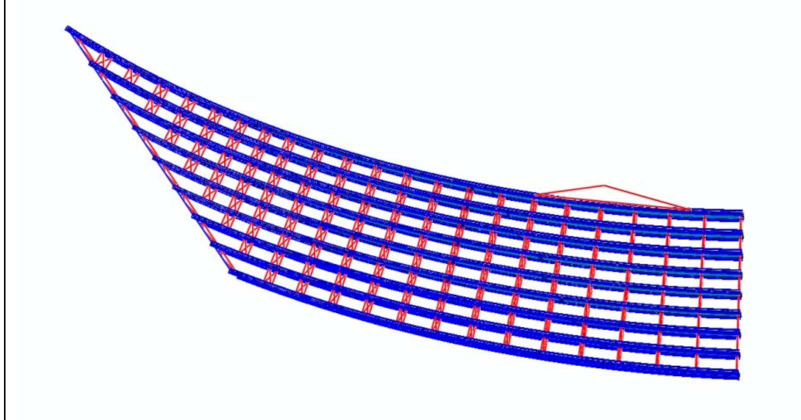
5		
6		

Table Q1-2-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

7		
8		

Appendix Q1-2. NISCS38 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISCS38 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table Q1-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	5.0	10.0
	SDLF	5.2	10.2
	TDLF	5.5	10.4
G2	NLF	4.9	10.0
	SDLF	5.1	10.2
	TDLF	5.4	10.4
G3	NLF	4.9	10.1
	SDLF	5.1	10.3
	TDLF	5.4	10.6
G4	NLF	5.0	10.4
	SDLF	5.2	10.6
	TDLF	5.6	10.9
G5	NLF	5.1	10.7
	SDLF	5.4	11.0
	TDLF	5.9	11.4
G6	NLF	5.3	11.2
	SDLF	5.7	11.5
	TDLF	6.2	12.1
G7	NLF	5.5	11.7
	SDLF	6.0	12.1
	TDLF	6.6	12.8
G8	NLF	5.8	12.3
	SDLF	6.3	12.8
	TDLF	7.0	13.5
G9	NLF	6.1	13.0
	SDLF	6.6	13.6
	TDLF	7.4	14.3
All Girders	NLF	6.1	13.0
	SDLF	6.6	13.6
	TDLF	7.4	14.3

Table Q1-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.31	2.64
	SDLF	0.11	1.40
	TDLF	1.11	0.22
G2	NLF	1.21	2.49
	SDLF	0.13	1.38
	TDLF	1.01	0.28
G3	NLF	1.19	2.49
	SDLF	0.15	1.44
	TDLF	0.96	0.34
G4	NLF	1.22	2.59
	SDLF	0.19	1.54
	TDLF	0.95	0.40
G5	NLF	1.27	2.69
	SDLF	0.22	1.64
	TDLF	0.98	0.47
G6	NLF	1.32	2.82
	SDLF	0.25	1.74
	TDLF	1.02	0.54
G7	NLF	1.39	2.97
	SDLF	0.27	1.85
	TDLF	1.04	0.60
G8	NLF	1.49	3.19
	SDLF	0.34	2.03
	TDLF	1.05	0.74
G9	NLF	1.53	3.29
	SDLF	0.37	2.11
	TDLF	1.06	0.81
All Girders	NLF	1.53	3.29
	SDLF	0.37	2.11
	TDLF	1.11	0.81

Table Q1-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	11.4	23.1	12.0	24.4	1.3	3.8	1.0	2.8
	SDLF	11.8	23.5	12.5	24.9	0.9	1.9	0.9	2.7
	TDLF	12.2	23.8	12.9	25.2	2.0	1.9	1.2	1.9
G2	NLF	10.5	21.4	11.1	22.7	0.9	2.3	1.6	3.2
	SDLF	10.7	21.6	11.3	22.8	0.8	1.8	0.8	2.5
	TDLF	10.8	21.7	11.4	23.0	1.3	1.7	1.1	1.8
G3	NLF	9.7	19.9	10.2	21.1	0.9	2.4	1.2	3.1
	SDLF	9.6	19.8	10.2	21.0	0.8	1.9	0.7	2.6
	TDLF	9.6	19.8	10.1	20.9	1.1	1.6	1.0	1.7
G4	NLF	10.4	21.6	10.5	21.8	1.1	2.7	1.4	4.3
	SDLF	10.3	21.5	10.3	21.6	1.0	2.3	1.0	2.9
	TDLF	10.3	21.3	10.3	21.4	1.2	2.1	1.2	2.3
G5	NLF	9.9	20.7	9.9	20.8	1.1	2.8	1.3	4.1
	SDLF	9.8	20.6	9.8	20.7	1.0	2.4	1.0	2.8
	TDLF	10.2	20.9	10.2	21.0	1.2	2.1	1.1	2.3
G6	NLF	9.5	20.4	9.6	20.5	1.0	2.5	1.3	3.7
	SDLF	9.6	20.5	9.7	20.6	0.9	2.2	0.9	2.3
	TDLF	9.8	20.6	9.8	20.7	1.1	2.0	1.1	1.9
G7	NLF	8.1	17.3	8.1	17.4	0.8	2.2	1.1	2.9
	SDLF	8.0	17.2	8.0	17.3	0.7	1.6	0.7	2.3
	TDLF	7.9	17.1	7.9	17.2	1.0	1.5	0.8	1.5
G8	NLF	8.2	17.5	8.2	17.6	0.8	2.2	1.1	2.9
	SDLF	7.8	17.1	7.9	17.2	0.6	1.6	0.7	2.3
	TDLF	7.6	16.8	7.6	16.9	1.0	1.4	0.8	1.5
G9	NLF	8.2	17.6	8.3	17.8	0.8	2.3	1.1	2.9
	SDLF	7.6	17.0	7.6	17.1	0.7	1.6	0.7	2.2
	TDLF	7.1	16.4	7.1	16.5	0.9	1.5	0.8	1.5
All Girders	NLF	11.4	23.1	12.0	24.4	1.3	3.8	1.6	4.3
	SDLF	11.8	23.5	12.5	24.9	1.0	2.4	1.0	2.9
	TDLF	12.2	23.8	12.9	25.2	2.0	2.1	1.2	2.3

Table Q1-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	34.9	45.5	45.6	45.6
	SDLF	29.0	38.5	35.9	38.5
	TDLF	33.3	37.9	33.7	37.9
TDL	NLF	57.9	87.5	89.9	89.9
	SDLF	57.7	75.5	71.8	75.5
	TDLF	60.9	74.8	69.4	74.8

Table Q1-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	13.3	14.3	15.0	14.0
	SDLF	13.0	11.3	11.6	12.2
	TDLF	13.6	10.8	11.1	12.3
TDL	NLF	28.0	27.8	29.4	28.3
	SDLF	27.6	24.6	25.8	26.4
	TDLF	27.3	22.5	23.3	25.1

Table Q1-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.68	0.76	0.80	0.84	0.88	0.93	0.98	1.06	1.06
SDLF	0.76	0.87	0.93	0.98	1.02	1.08	1.16	1.30	1.30
TDLF	0.86	0.99	1.08	1.15	1.21	1.28	1.38	1.61	1.61

Table Q1-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.44	1.61	1.71	1.79	1.88	1.98	2.09	2.26	2.26
SDLF	1.52	1.71	1.83	1.93	2.02	2.13	2.27	2.50	2.50
TDLF	1.62	1.83	1.98	2.09	2.20	2.33	2.49	2.80	2.80

Table Q1-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.83	0.93	0.99	1.03	1.08	1.14	1.20	1.29	1.29
SDLF	0.94	1.06	1.14	1.20	1.26	1.33	1.42	1.60	1.60
TDLF	1.06	1.21	1.32	1.40	1.48	1.57	1.69	1.97	1.97

Table Q1-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.76	1.97	2.10	2.20	2.31	2.43	2.57	2.77	2.77
SDLF	1.86	2.10	2.24	2.36	2.48	2.61	2.78	3.07	3.07
TDLF	1.98	2.24	2.43	2.56	2.70	2.85	3.05	3.43	3.43

Table Q1-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	3054	6388
SDLF	3054	6388
TDLF	3054	6388

Table Q1-2-11. **Summary of maximum reactions under SDL and TDL (kips).**

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	324	622	0.3	1.5	0.7	3.7
SDLF	299	600	0.2	1.0	0.2	2.3
TDLF	281	587	0.7	0.2	0.8	0.6

Table Q1-2-12. **Summary of maximum support displacements under SDL and TDL (kips).**

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.95	2.15	0.15	0.74
SDLF	0.82	1.95	0.03	0.47
TDLF	0.79	1.73	0.15	0.13

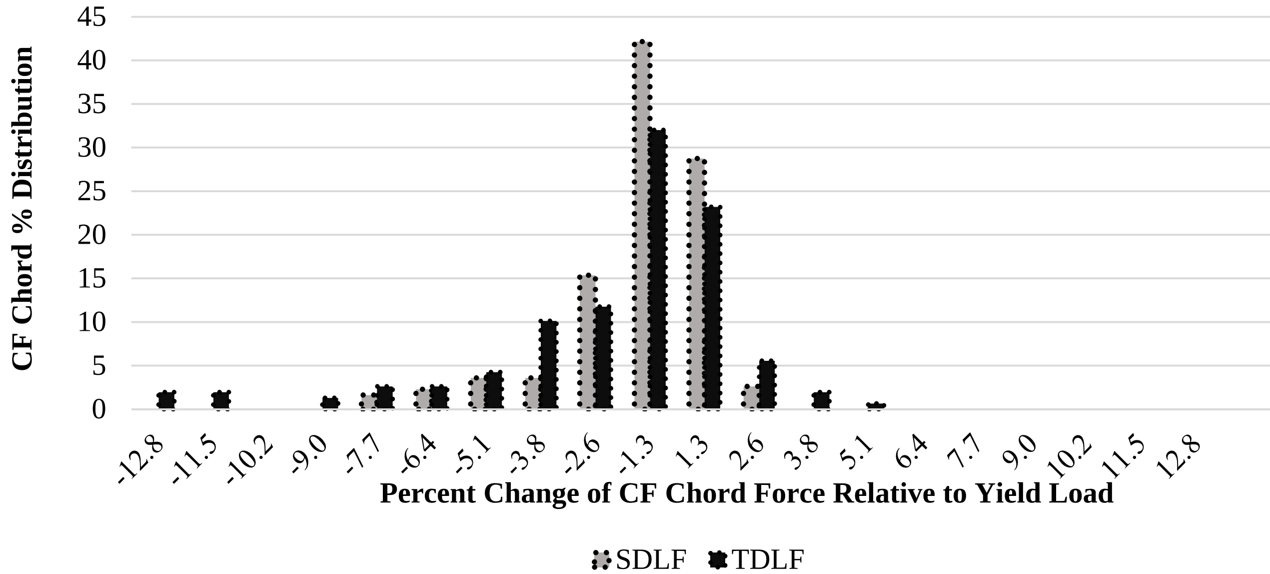


Figure Q1-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

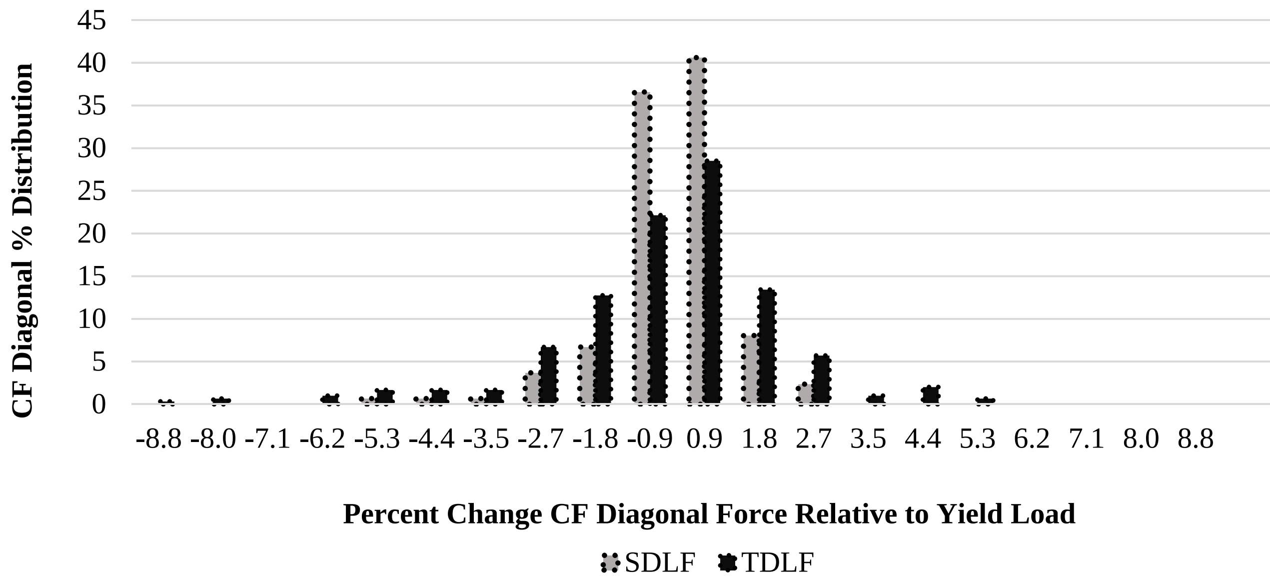


Figure Q1-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

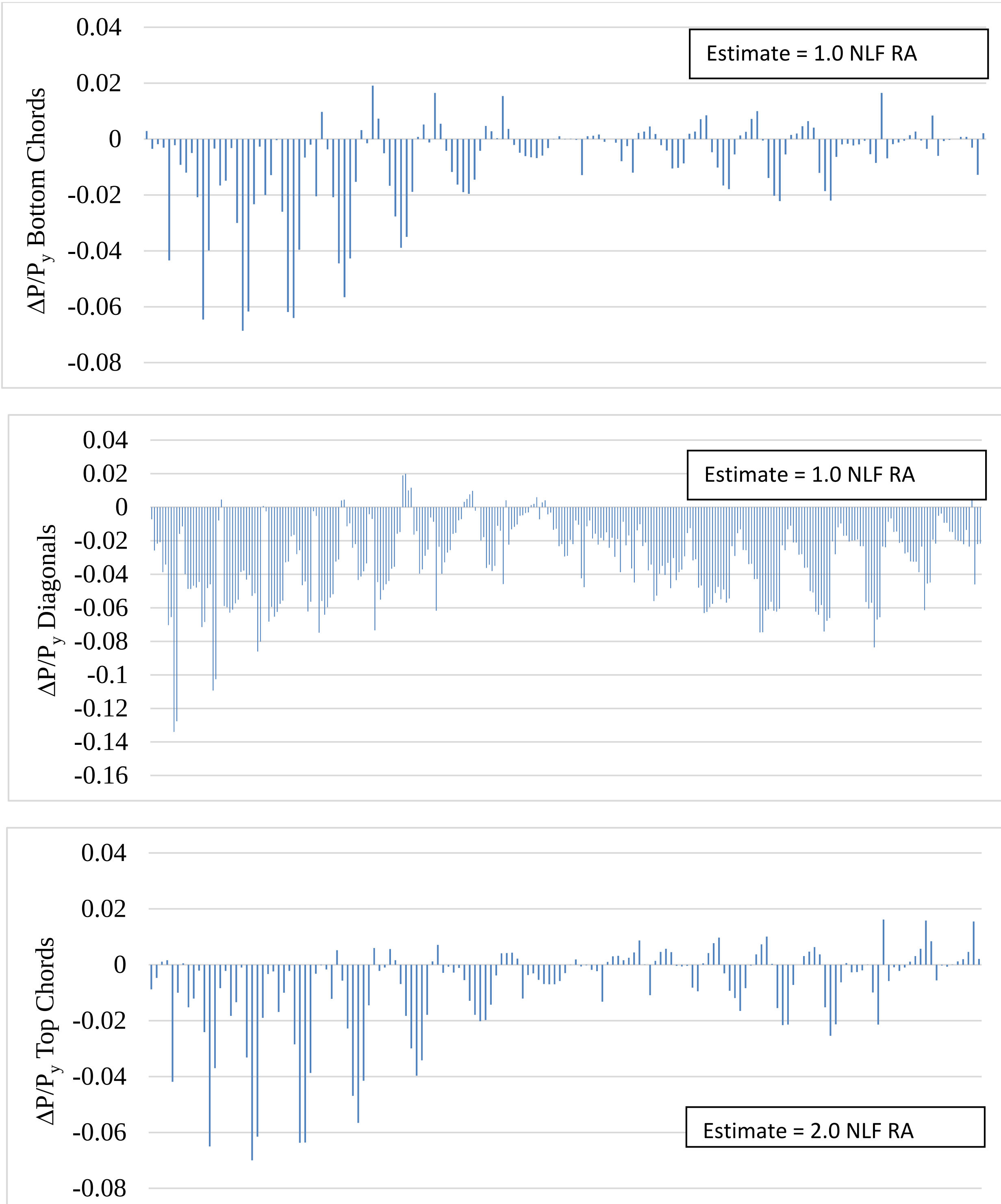


Figure Q1-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

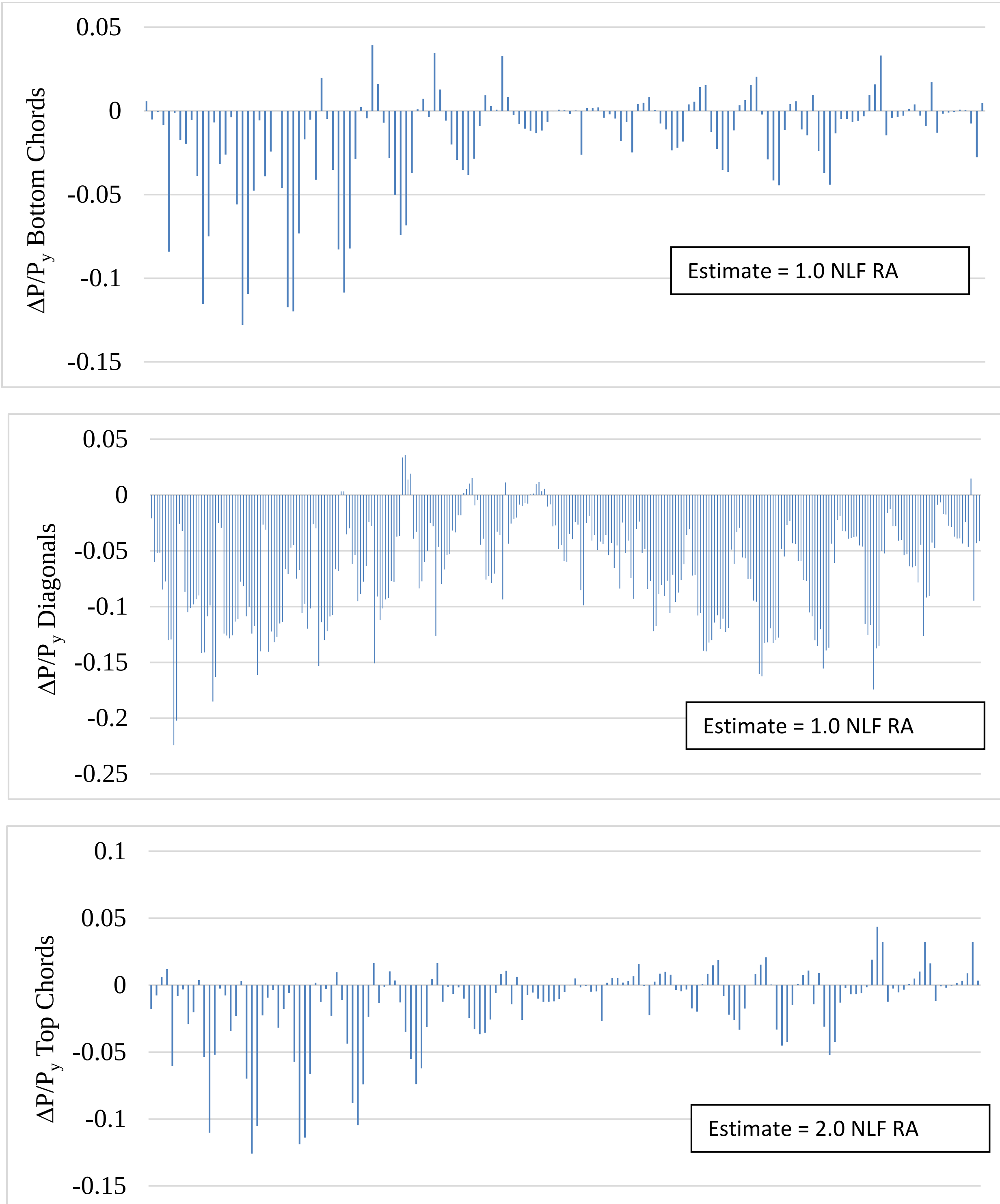


Figure Q1-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix Q1-3. NISCS38 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISCS38 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Table Q1-3-1. Maximums of the fit-up force resultants (kips)

Reactions

Table Q1-3-2. Summary of erection vertical reactions (kips)

Table Q1-3-3. Summary of erection crane loads (kips)

Table Q1-3-4. Total vertical reactions (kips)

Table Q1-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	22.4	14.7	22.4
SDLF	21.6	14.2	21.6
TDLF	26.2	18.5	26.2

Table Q1-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	122.2	13
	SDLF	210.5	0
	TDLF	325.4	0
G2	NLF	138.9	15.7
	SDLF	158.4	0
	TDLF	195.2	0
G3	NLF	169.1	30.6
	SDLF	125.7	0
	TDLF	157.8	0
G4	NLF	129.5	28.2
	SDLF	167.3	0
	TDLF	165.2	0
G5	NLF	156.1	22
	SDLF	195.2	2.4
	TDLF	223.5	0
G6	NLF	156.2	30.6
	SDLF	210.1	7.4
	TDLF	224.2	0
G7	NLF	153.2	35.4
	SDLF	190.8	1.1
	TDLF	224.5	0
G8	NLF	134	24.6
	SDLF	176.5	6.3
	TDLF	210.7	0
G9	NLF	115.5	0
	SDLF	188.1	0
	TDLF	235	0
All Girders	NLF	169.1	0
	SDLF	210.5	0
	TDLF	325.4	0

Table Q1-3-3. Summary of erection crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	157.8	50.7	66.4	27.9
SDLF	153.2	3.9	78.4	22.1
TDLF	131.3	7.9	76.9	14.4

Table Q1-3-6. Erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage							
		1	2	3	4	5	6	7	8
2	NLF	180	182	183	184				
	SDLF	180	182	183	184				
	TDLF	180	182	183	184				
11	NLF	1185	1186	1188	1189	1190	1192		
	SDLF	1185	1186	1188	1189	1190	1192		
	TDLF	1185	1186	1188	1189	1190	1192		
18	NLF	2143	2144	2146	2147	2149	2150	2152	2153
	SDLF	2143	2144	2146	2147	2149	2150	2152	2153
	TDLF	2143	2144	2146	2147	2149	2150	2152	2153
27	NLF	3044	3045	3047	3048	3049	3051	3052	3054
	SDLF	3044	3045	3047	3048	3049	3051	3052	3054
	TDLF	3044	3045	3047	3048	3049	3051	3052	3054

Appendix Q1-4. NISCS38 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge NISCS38 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

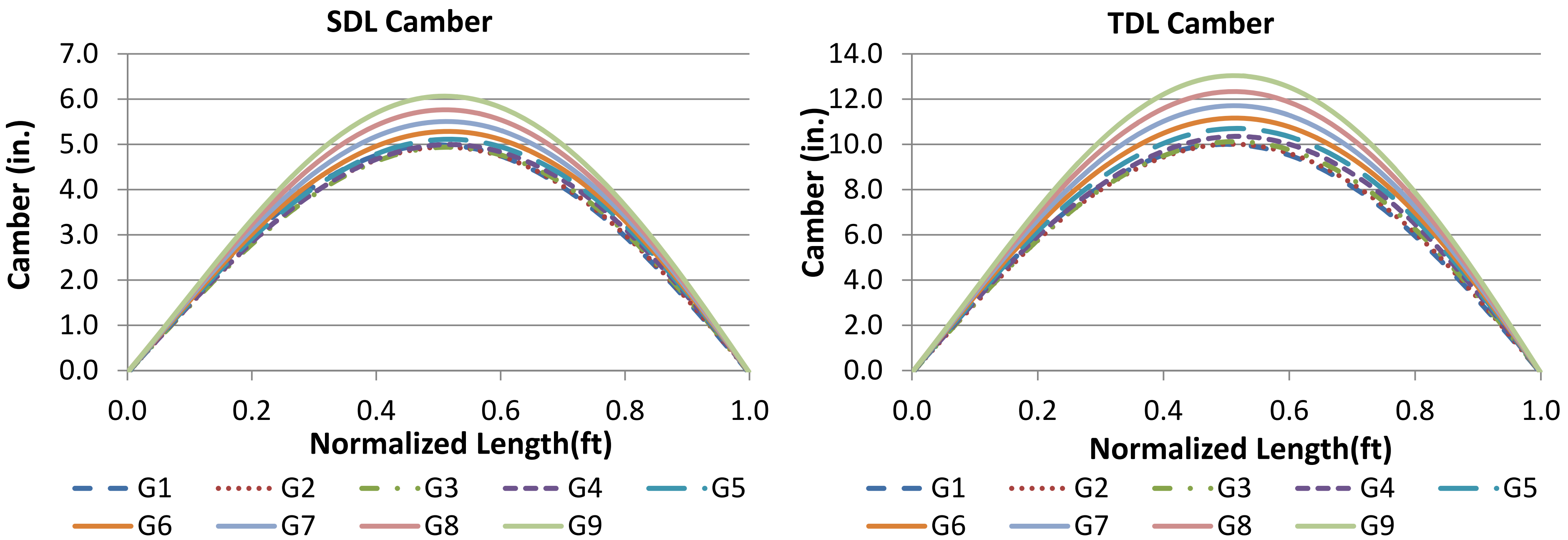


Figure Q1-4-1. SDL and TDL 3D FEA cambers.

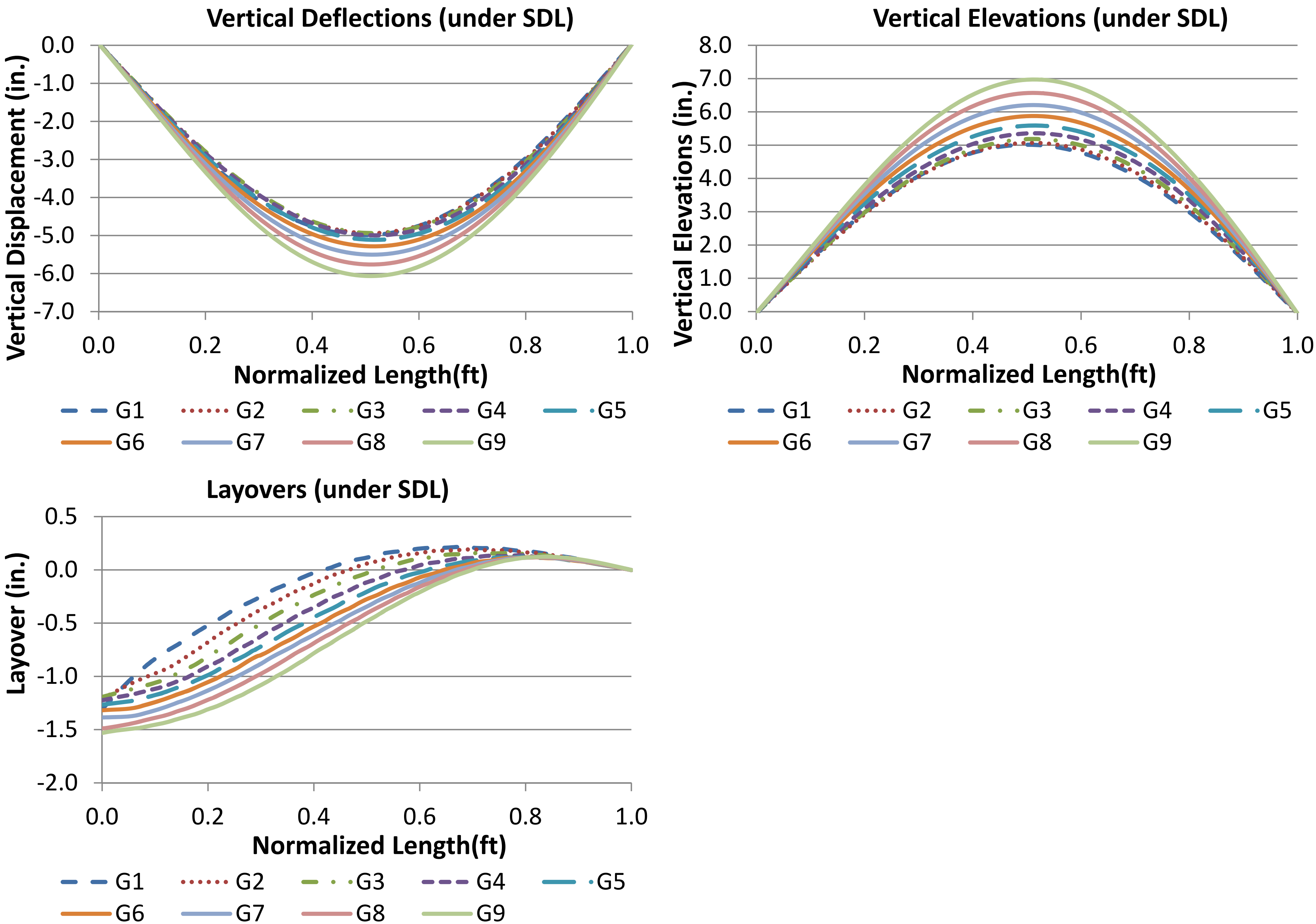


Figure Q1-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

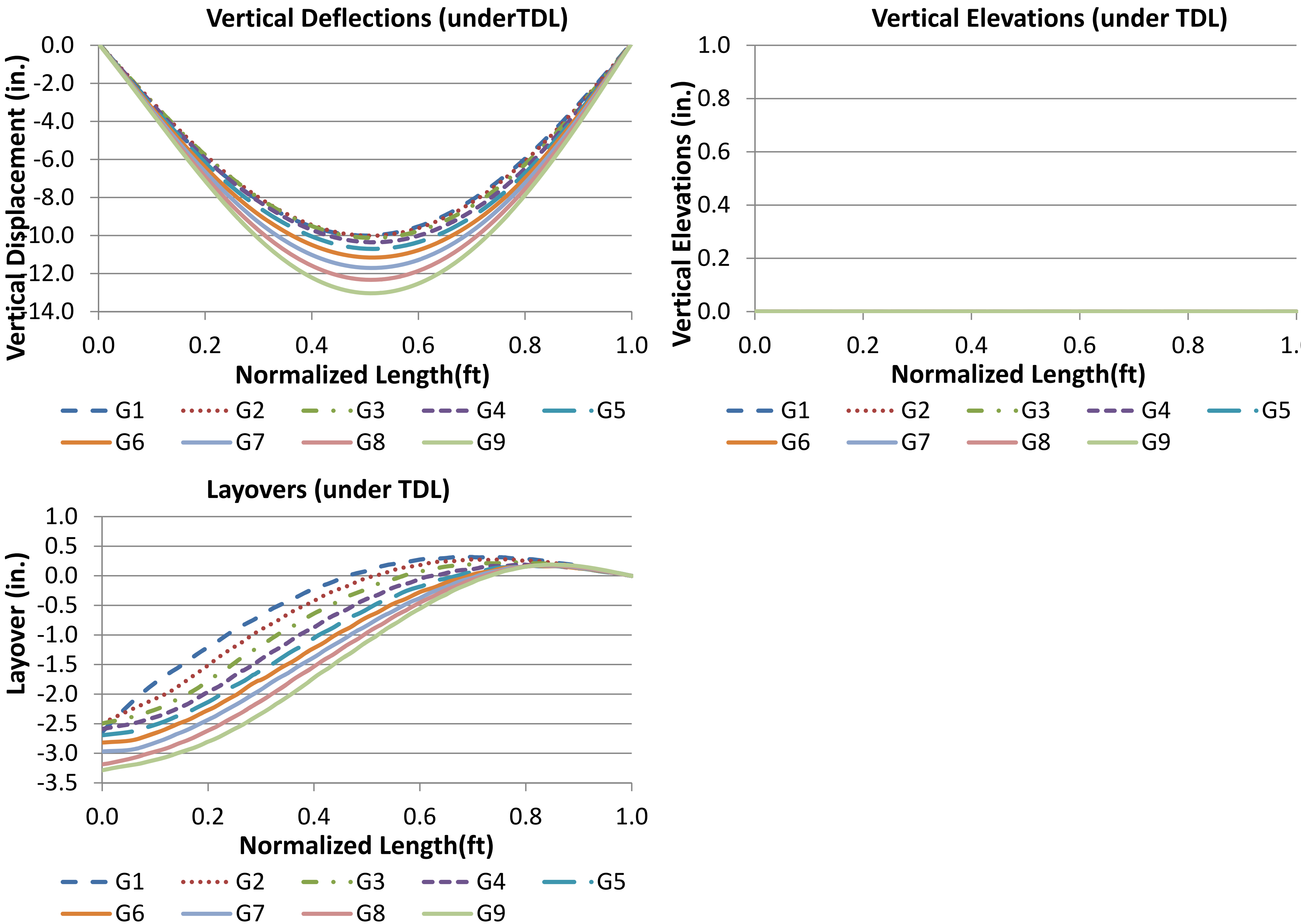


Figure Q1-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

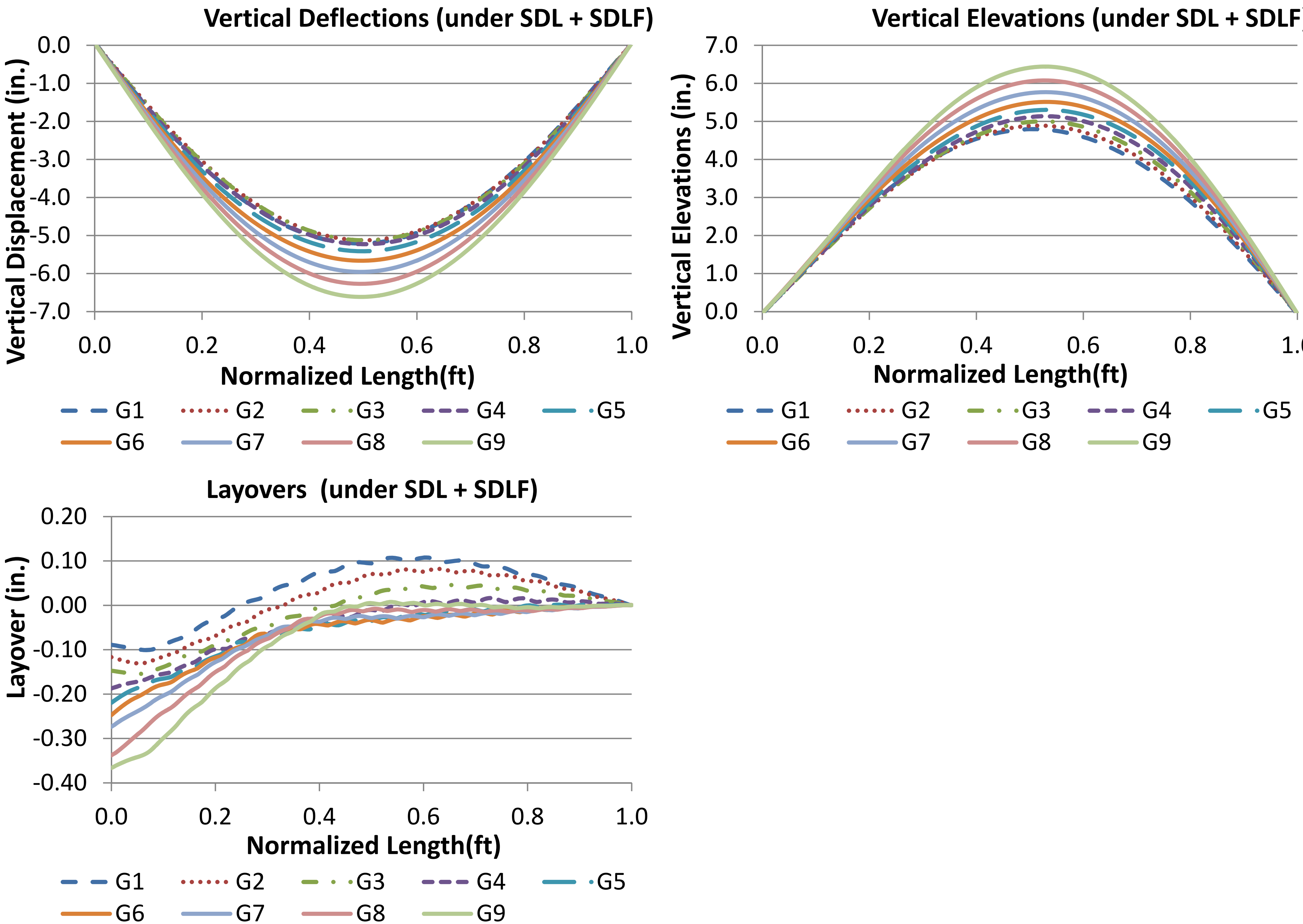


Figure Q1-4-4. **Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.**

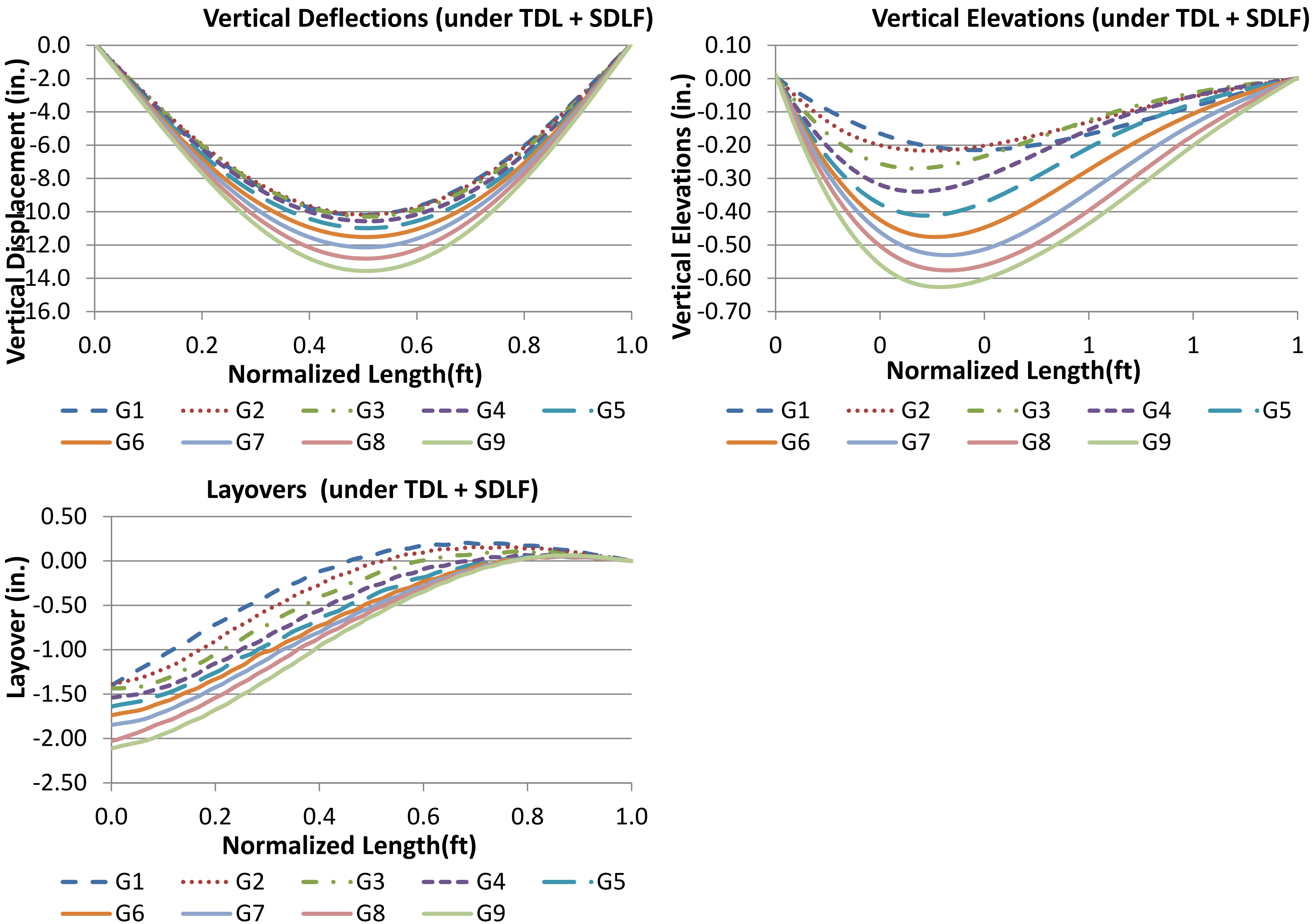


Figure Q1-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

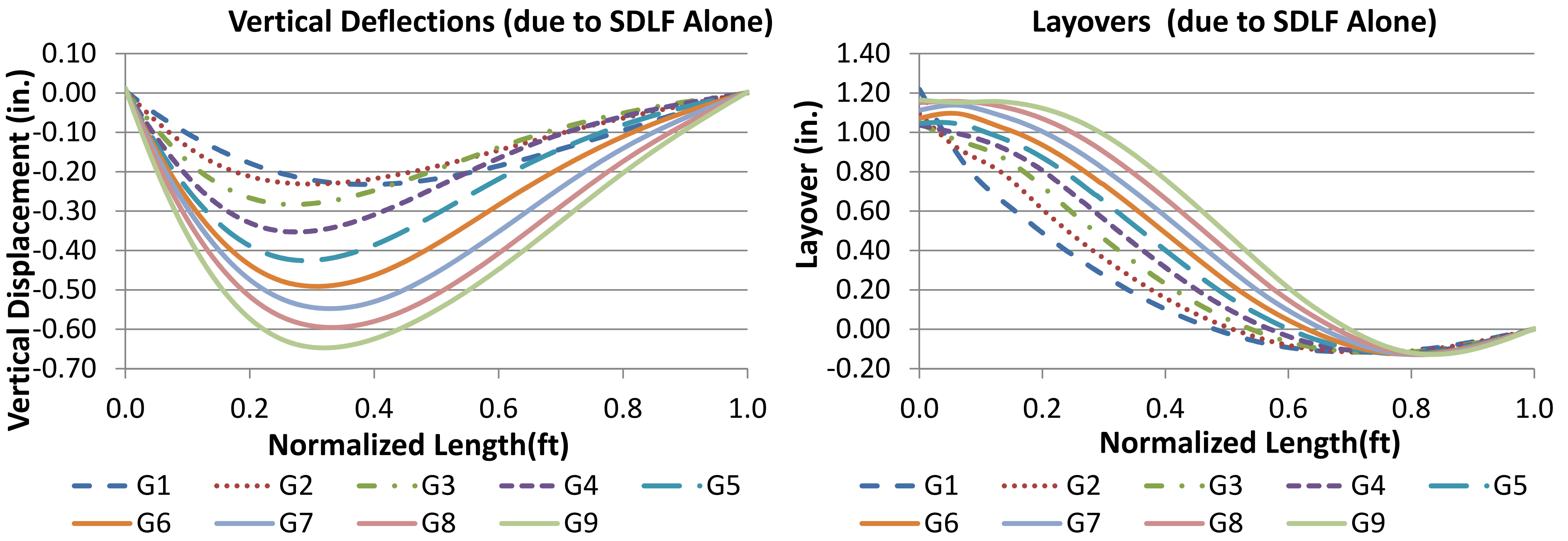


Figure Q1-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

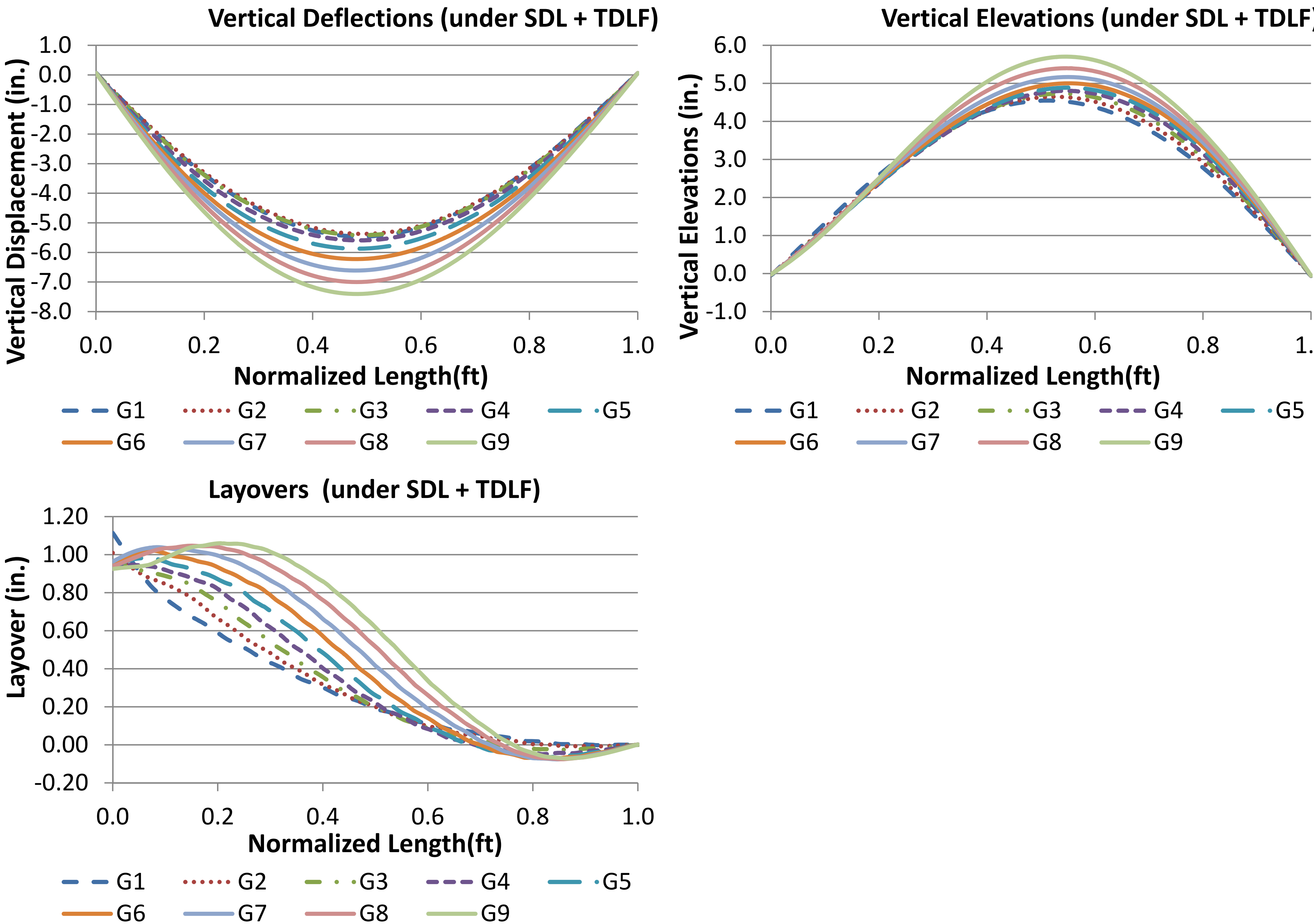
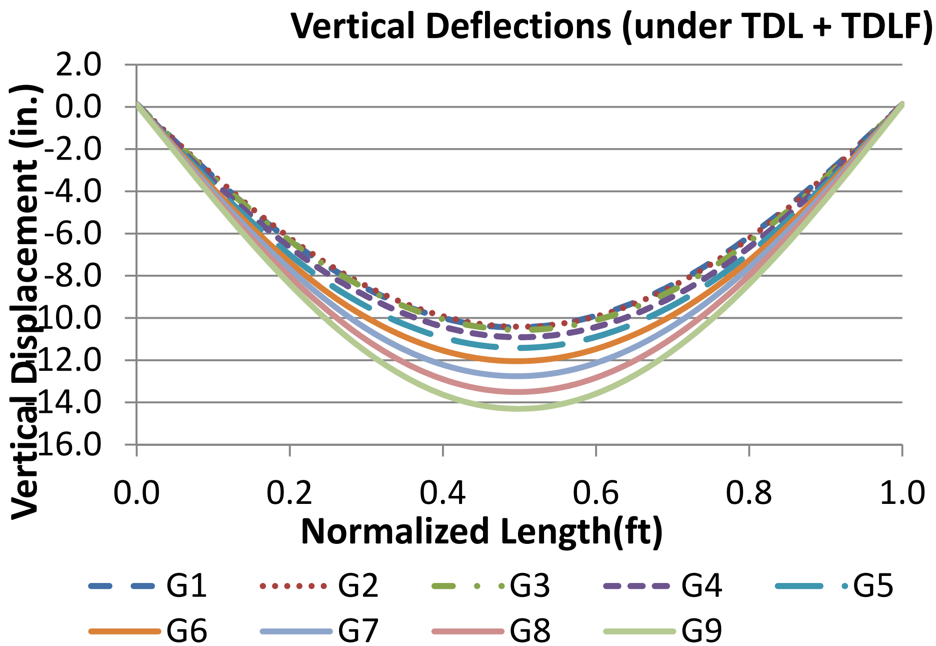
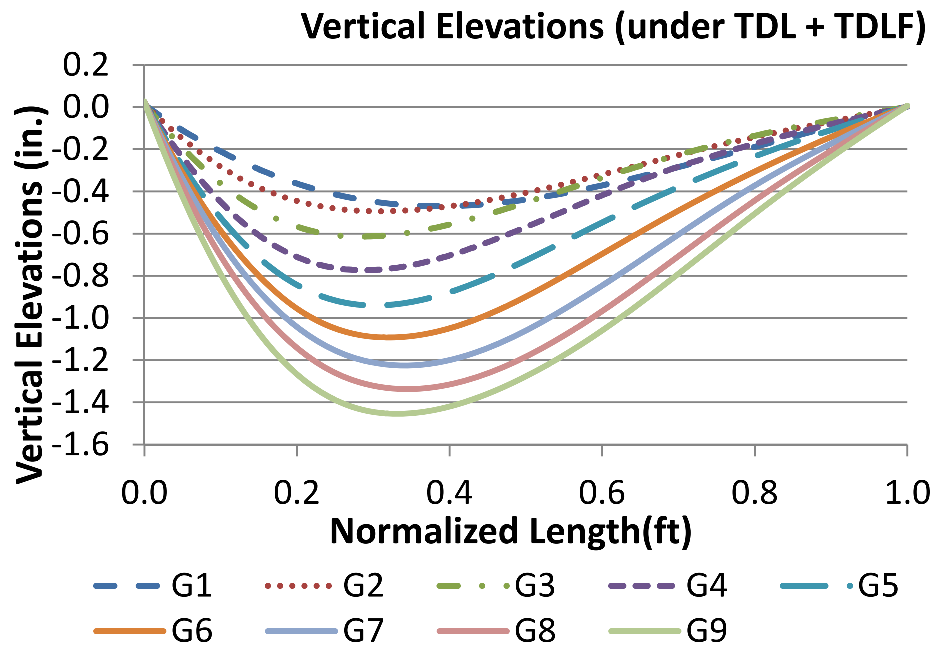


Figure Q1-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.





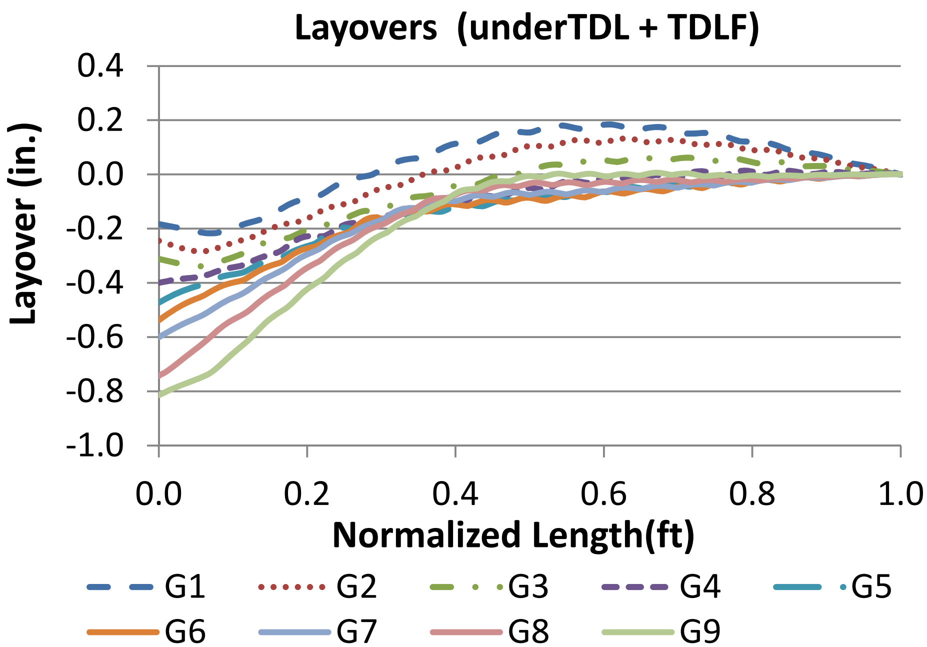


Figure Q1-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

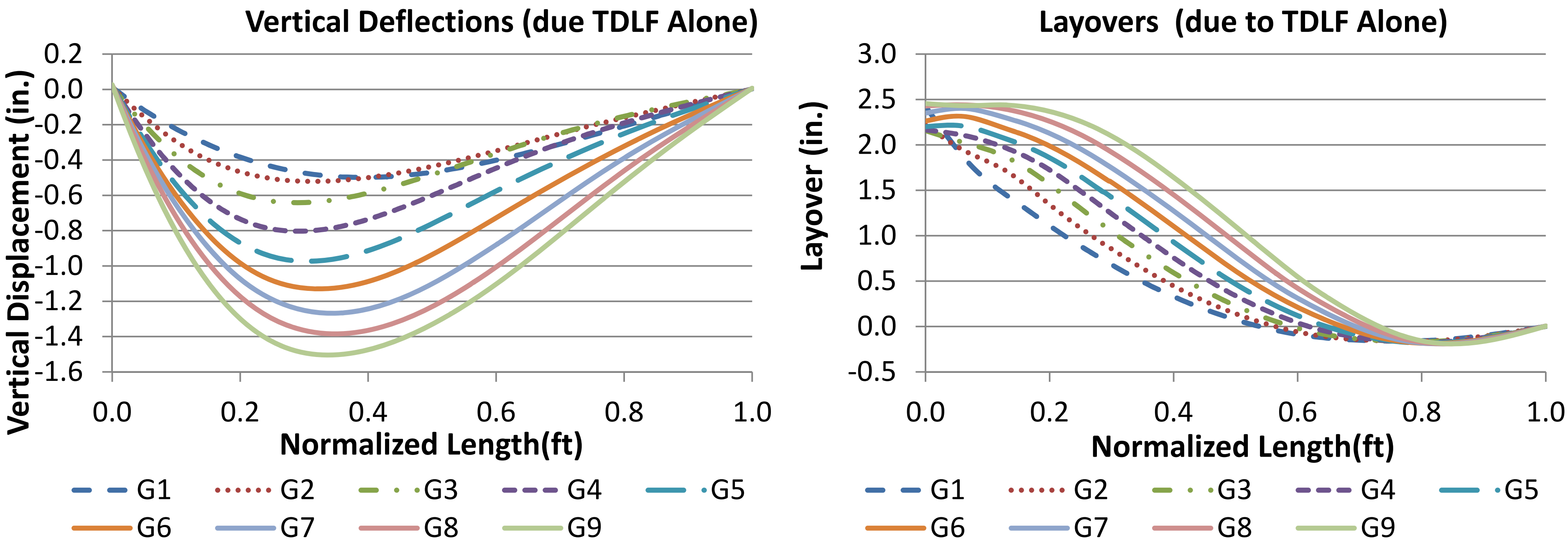


Figure Q1-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

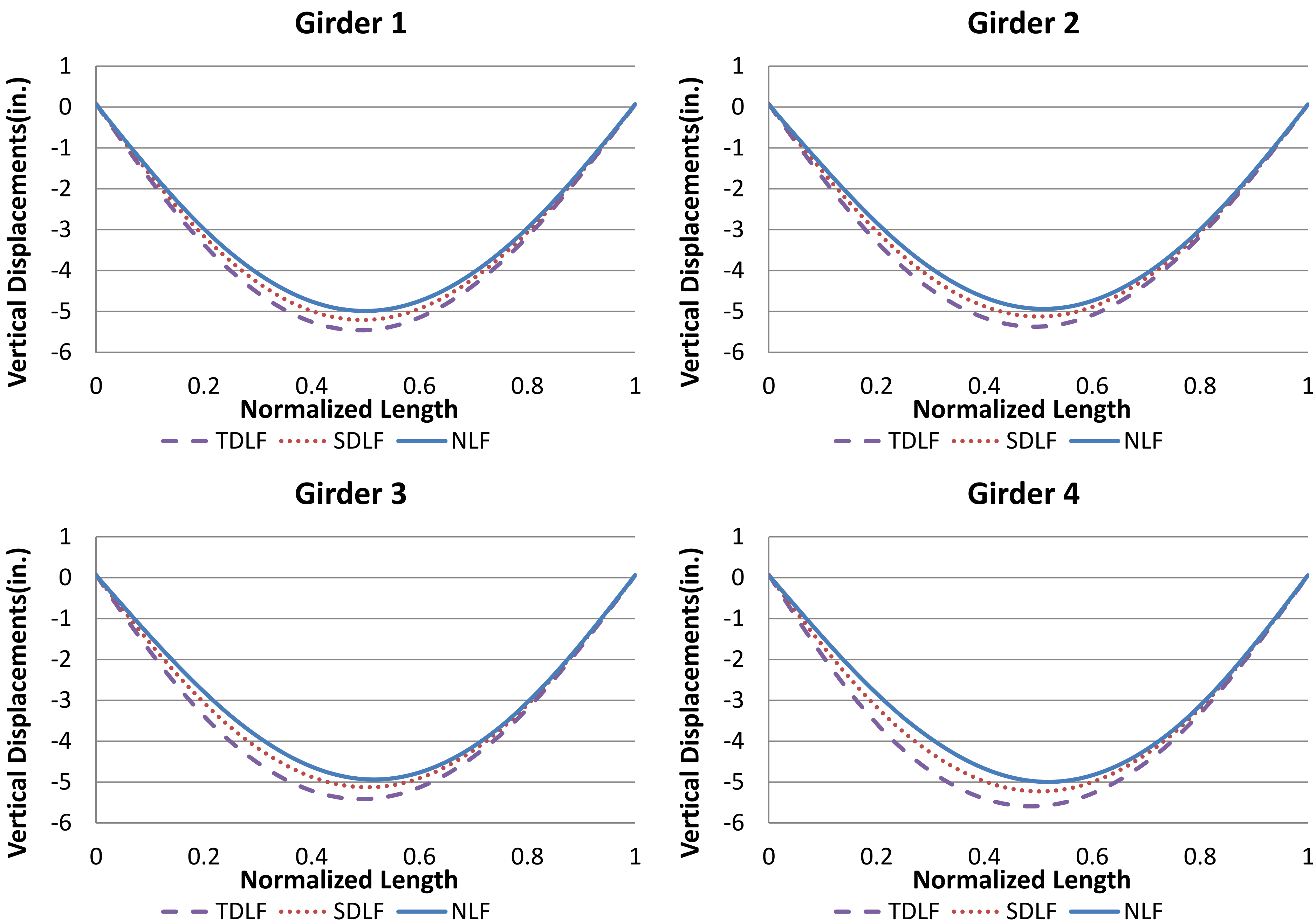


Figure Q1-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

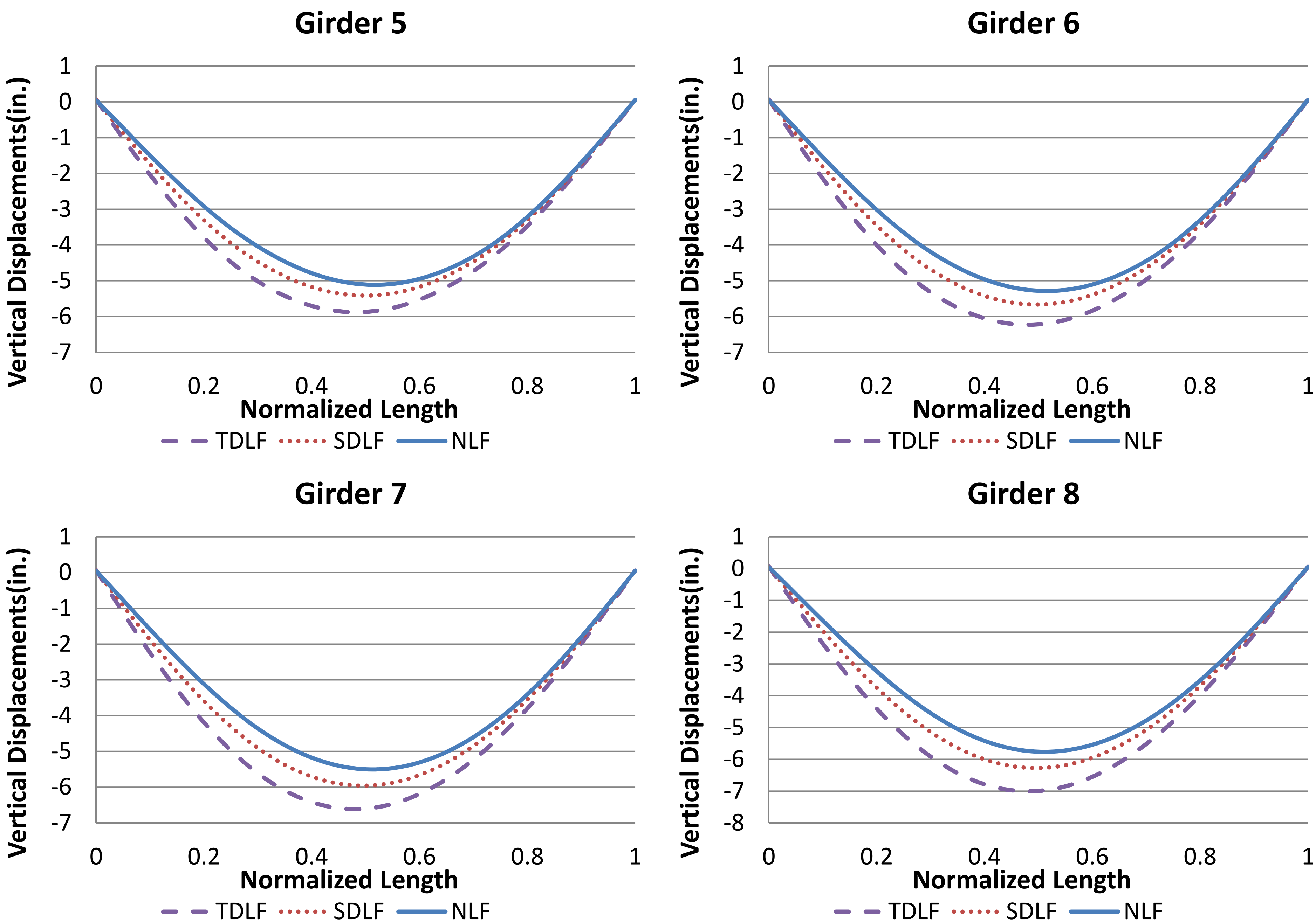


Figure Q1-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

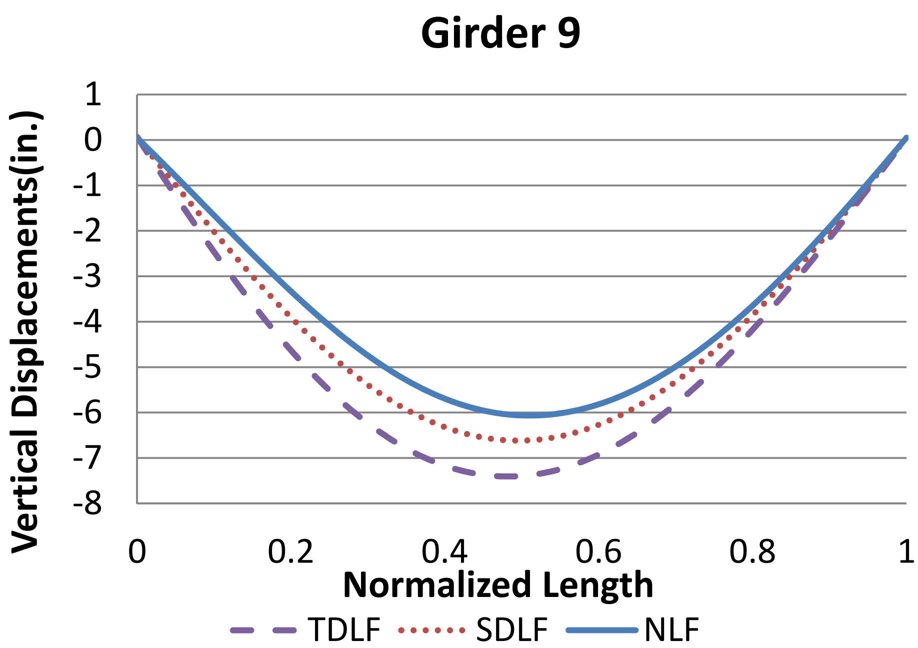


Figure Q1-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

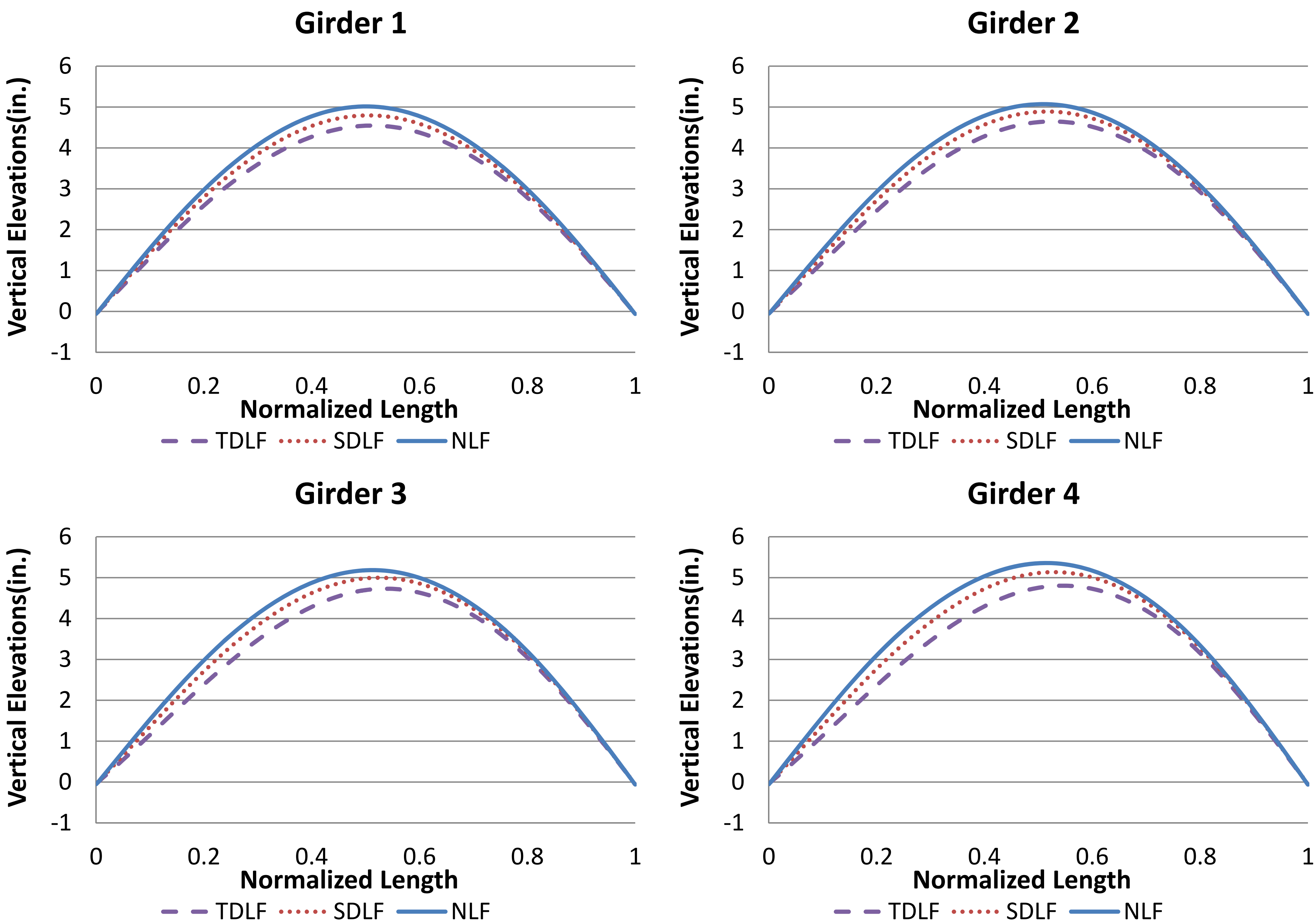


Figure Q1-4-11. **Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.**

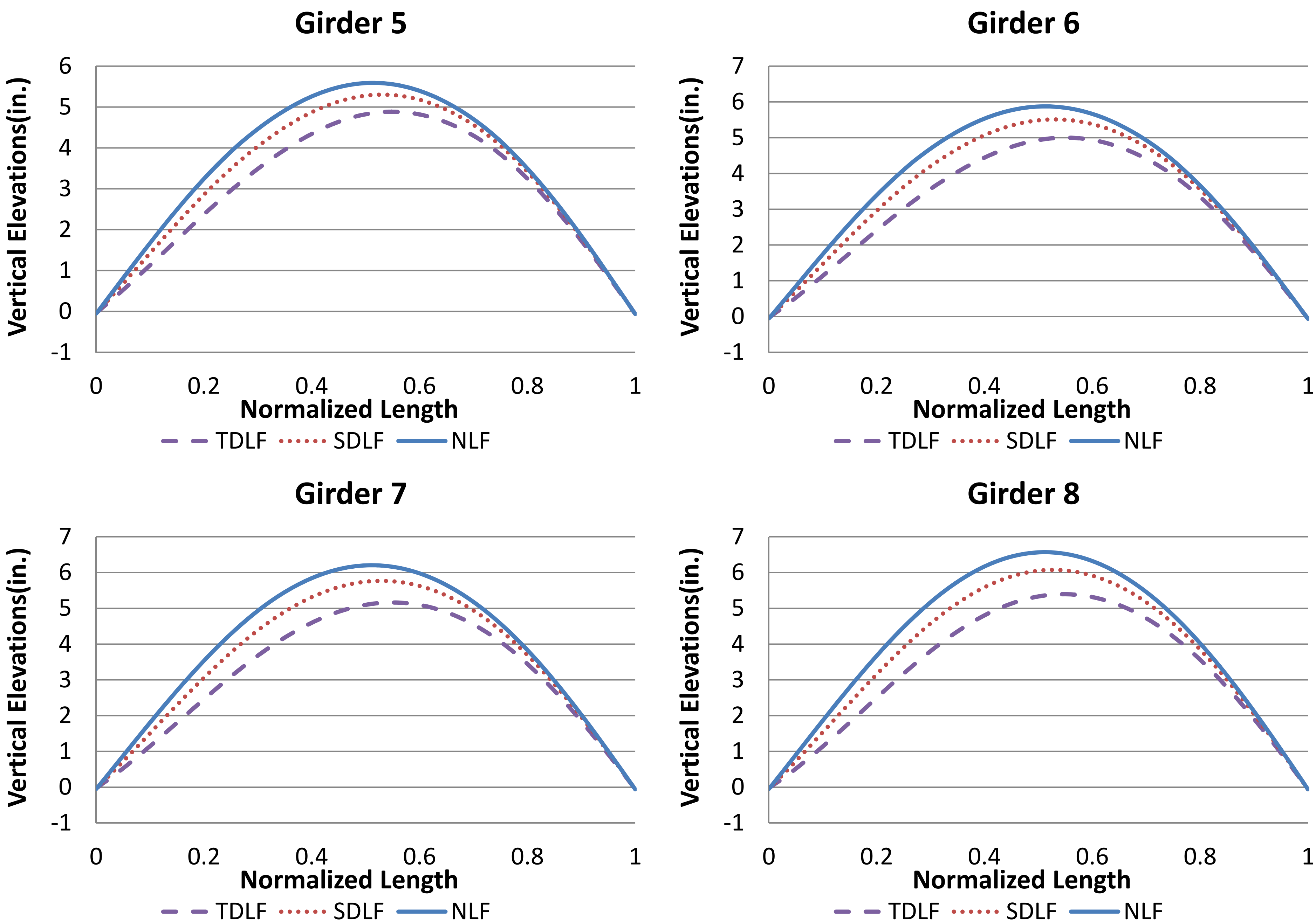


Figure Q1-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

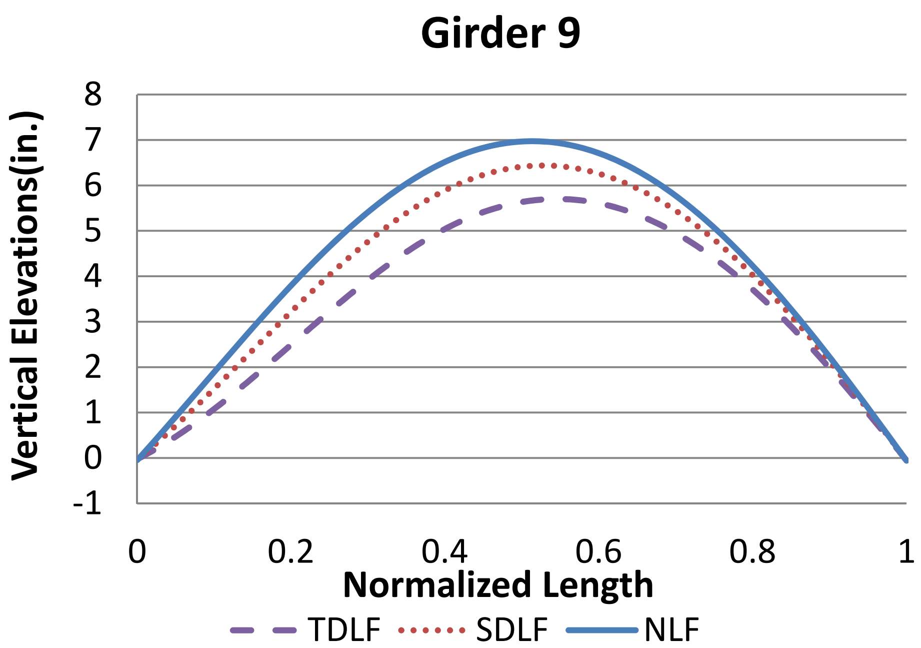


Figure Q1-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

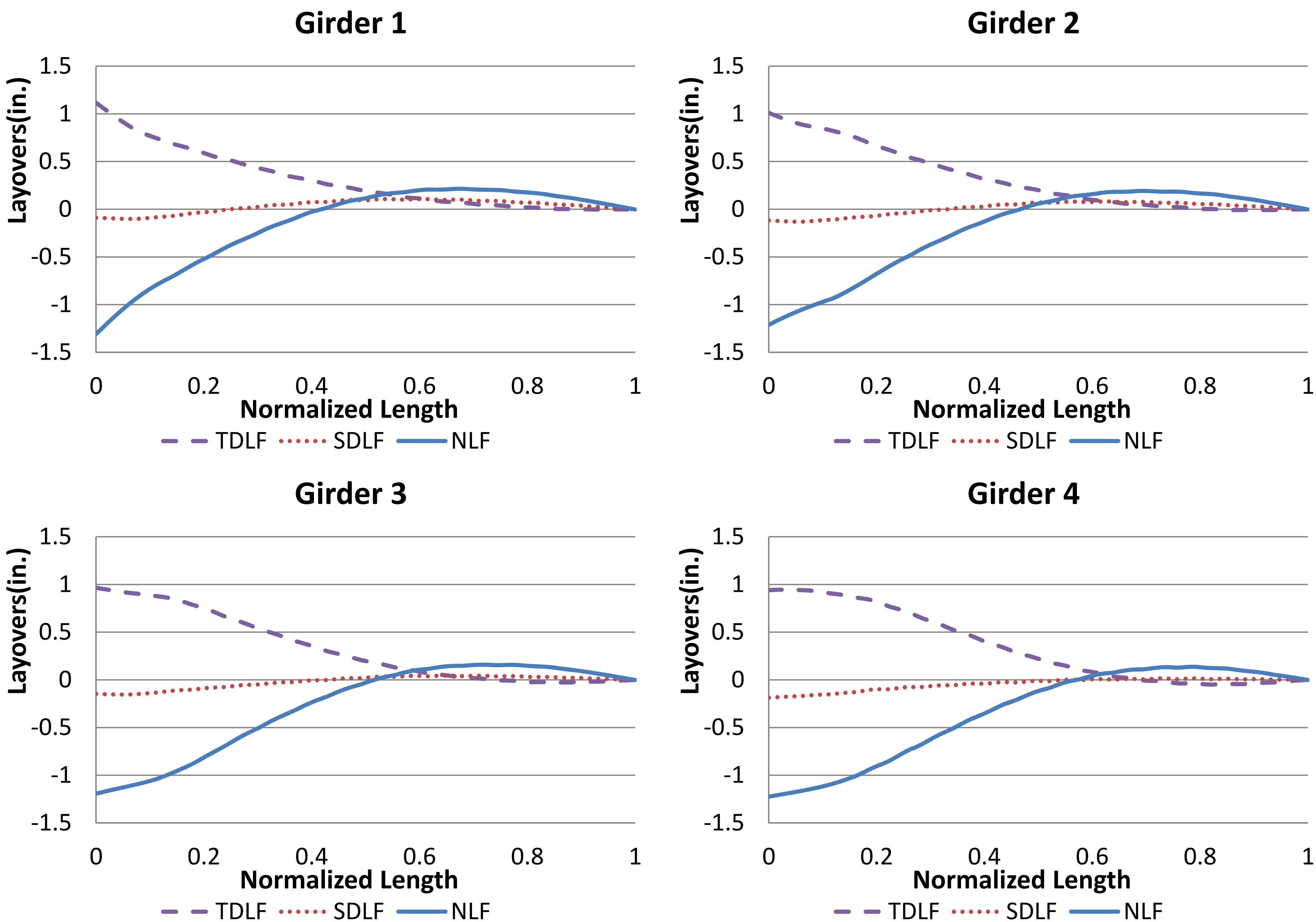


Figure Q1-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

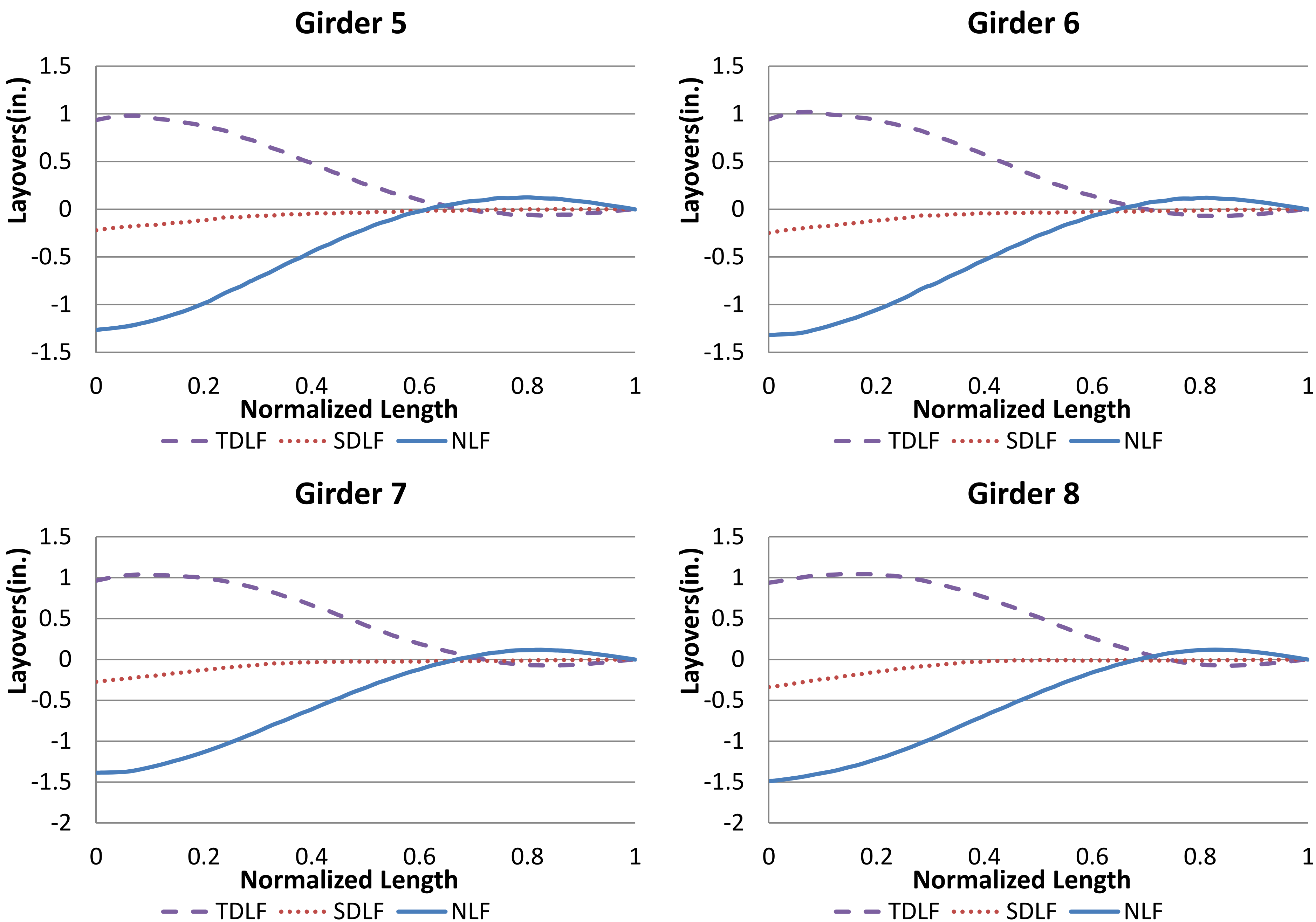


Figure Q1-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

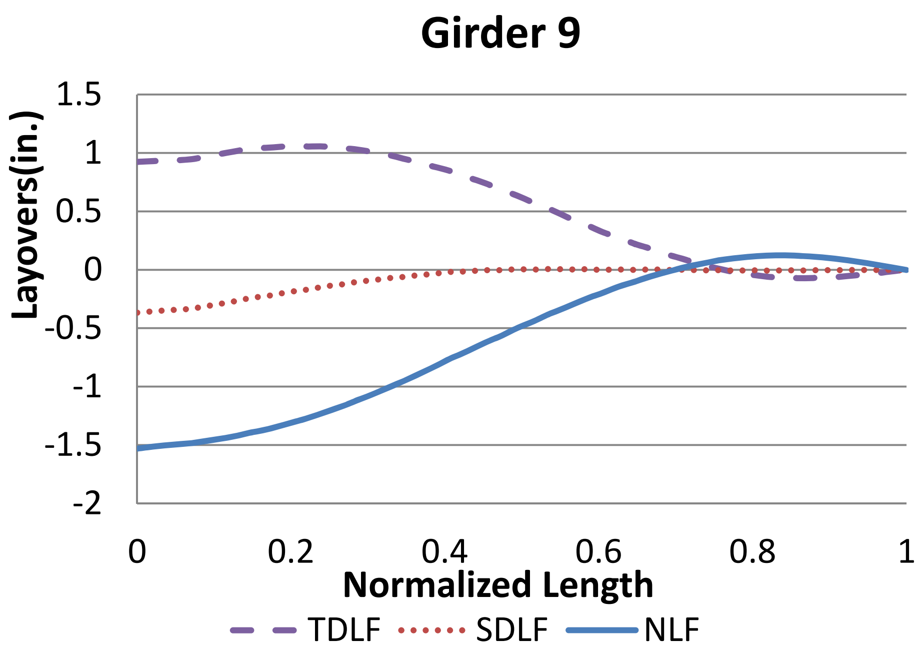


Figure Q1-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

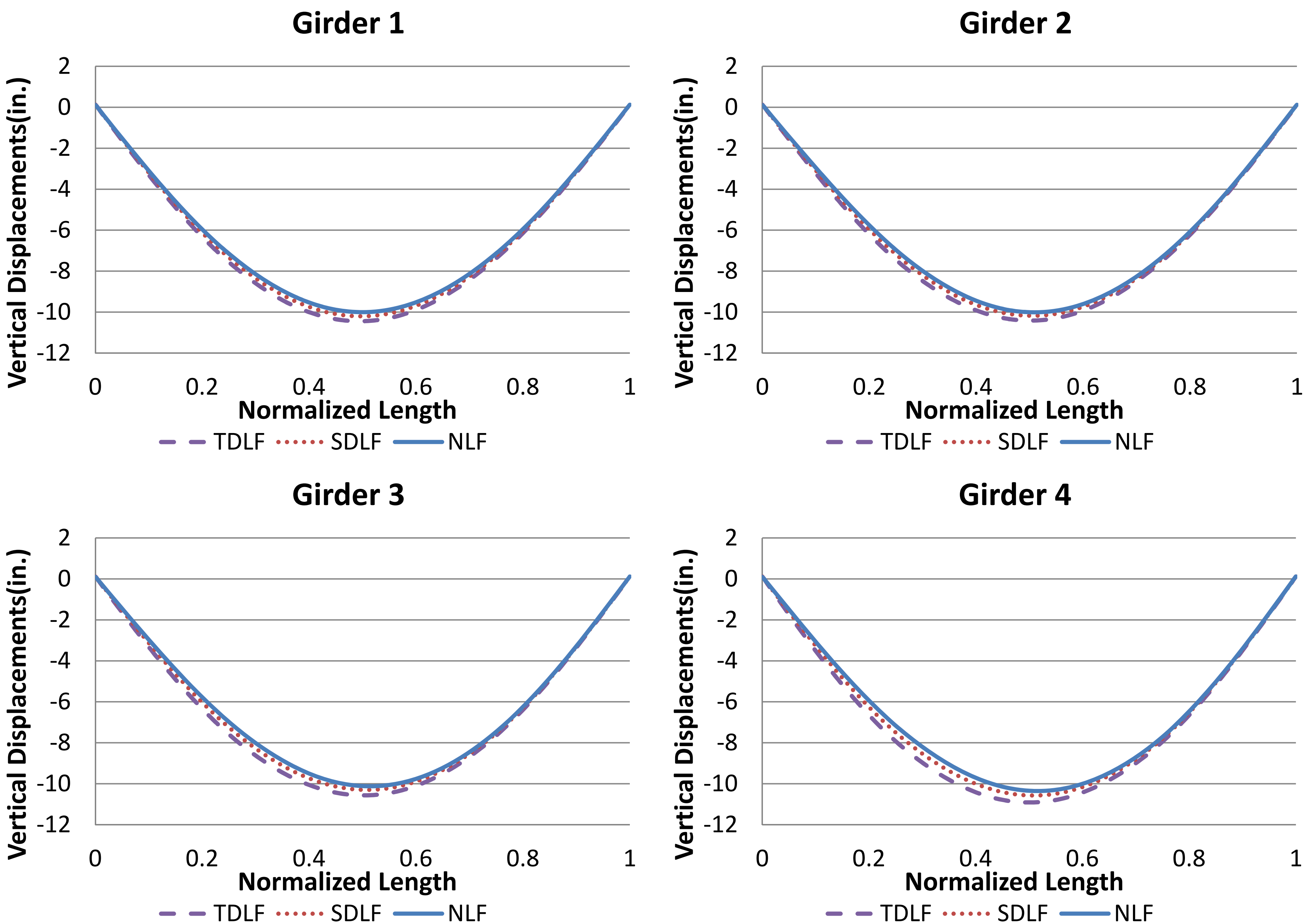


Figure Q1-4-13. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

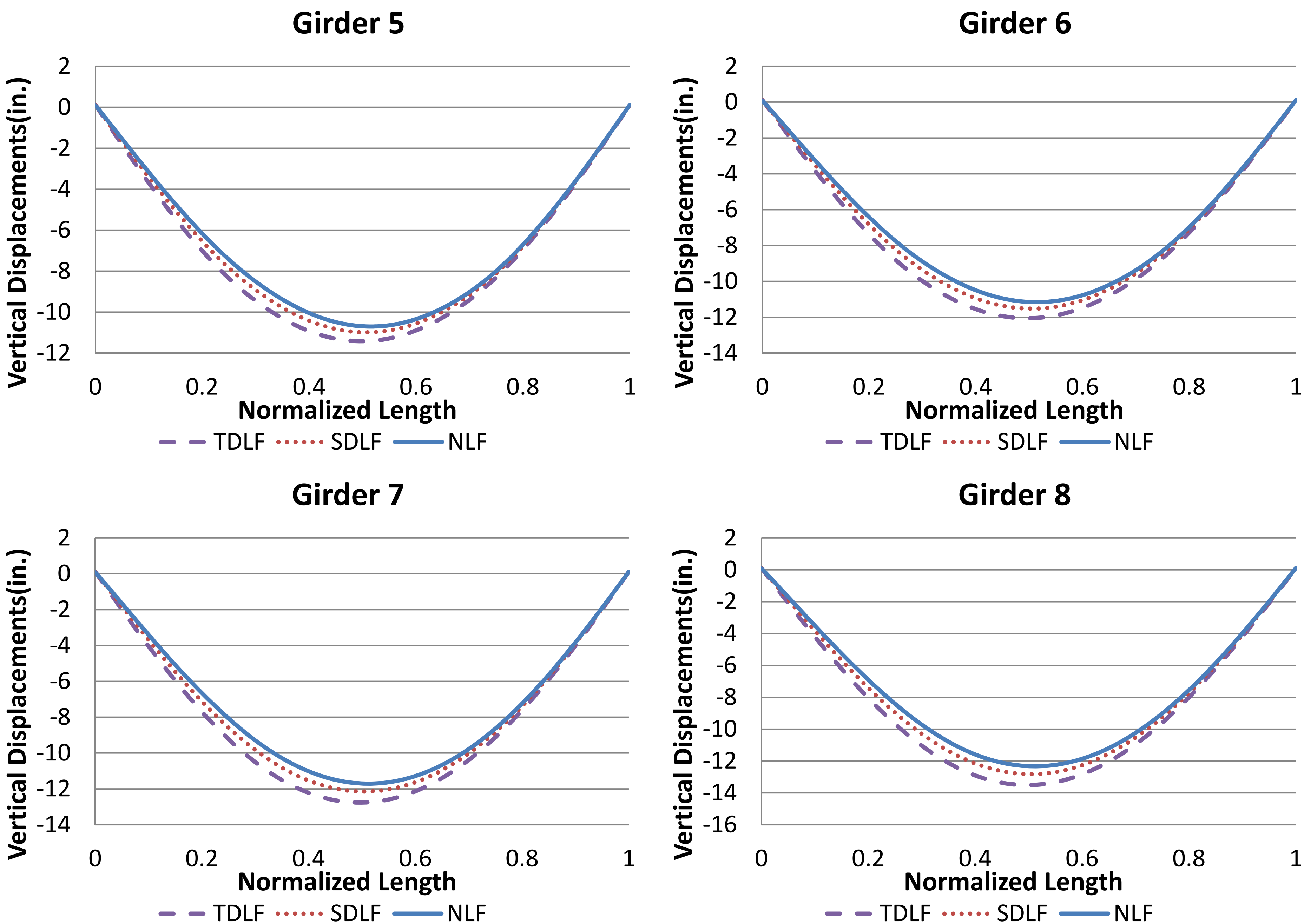


Figure Q1-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

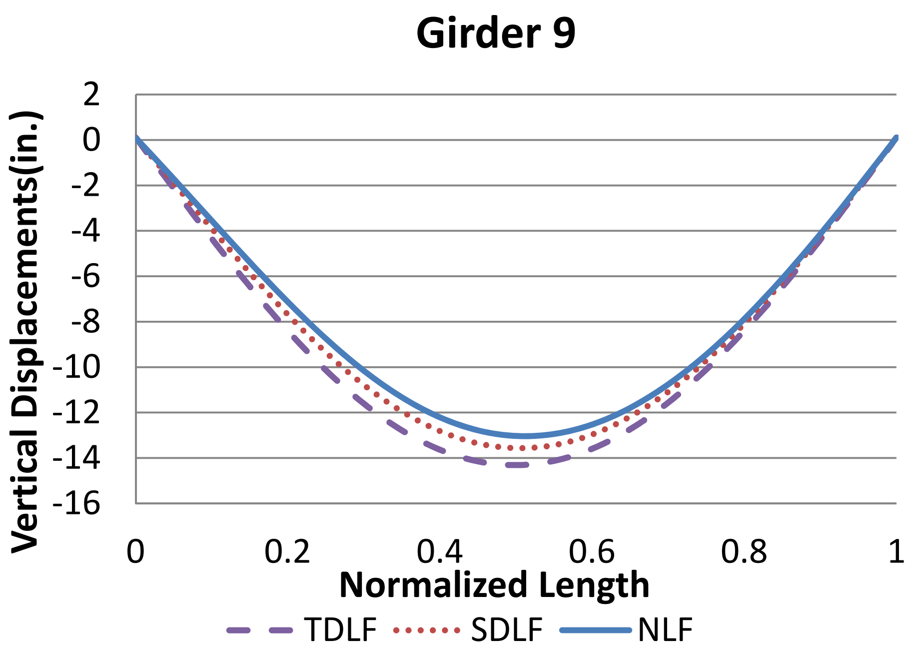


Figure Q1-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

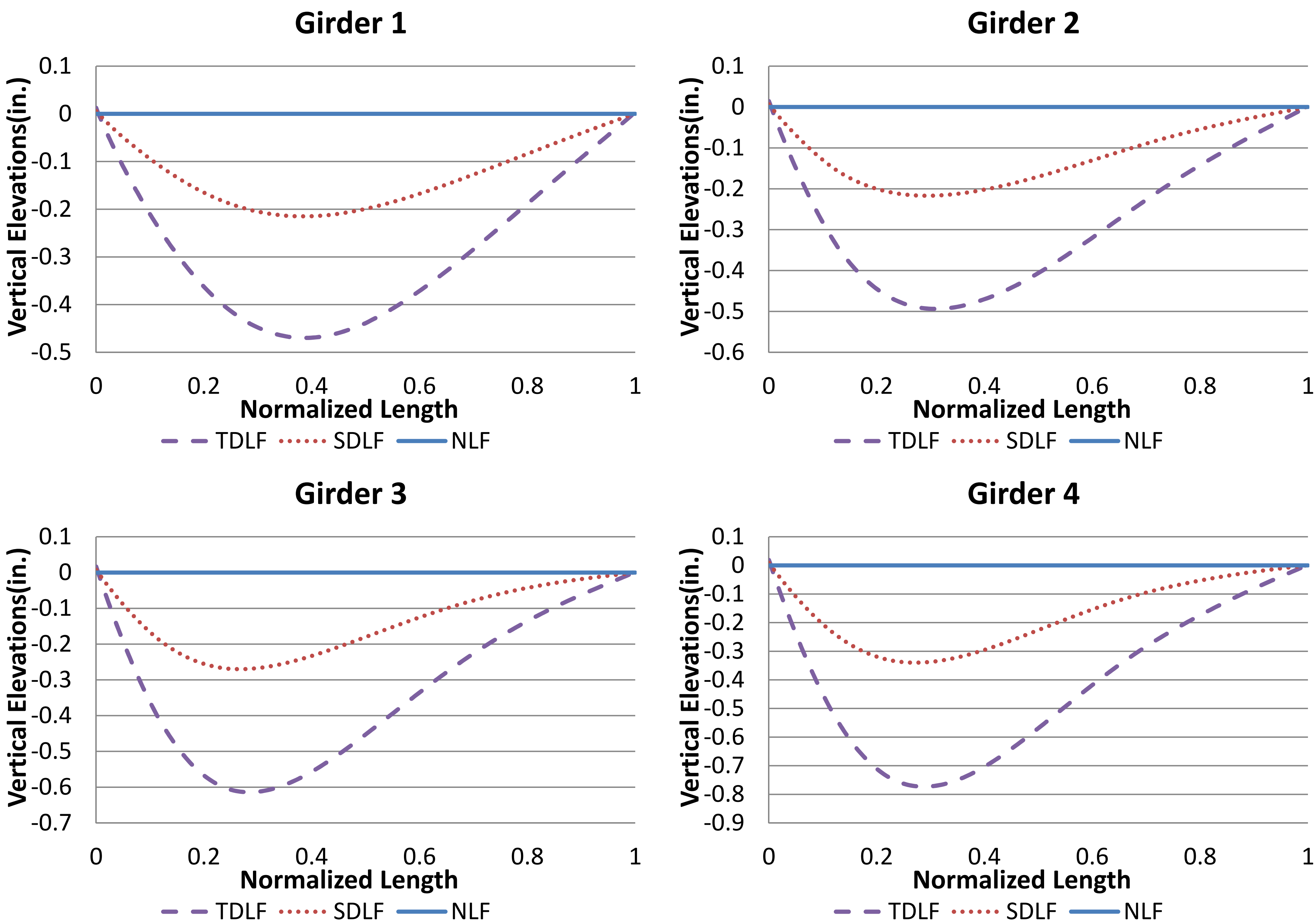


Figure Q1-4-14. **Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.**

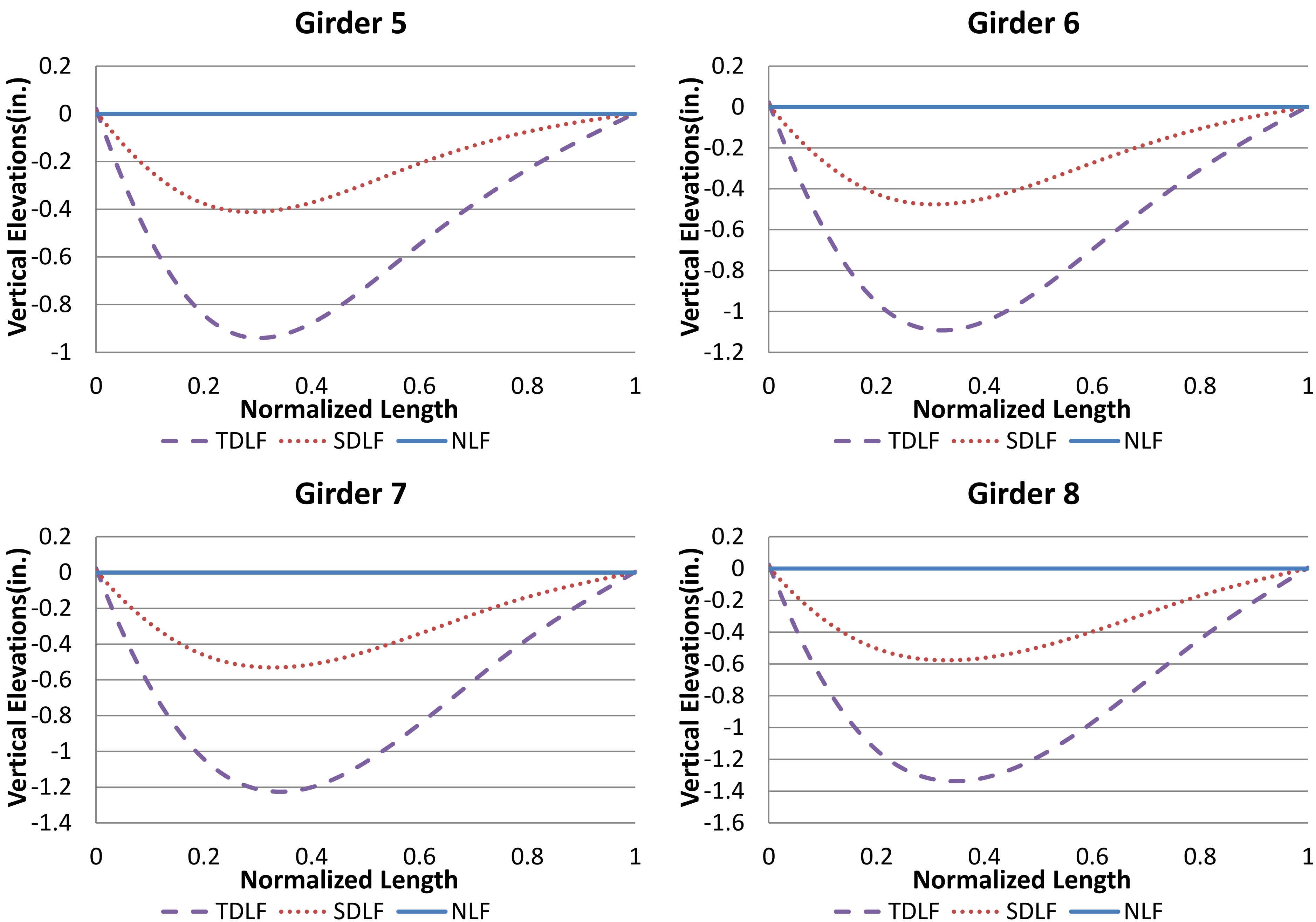


Figure Q1-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

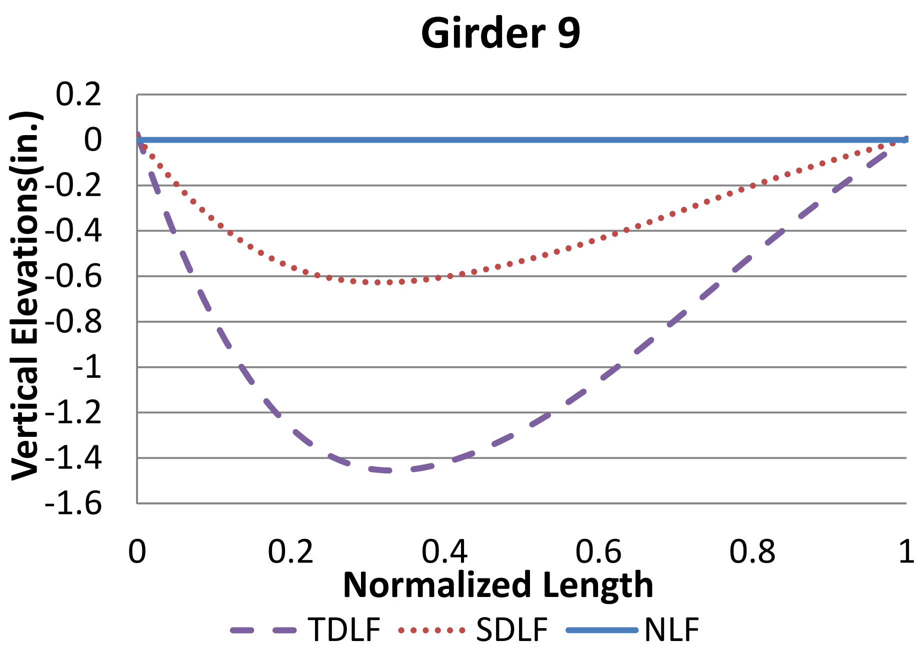


Figure Q1-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

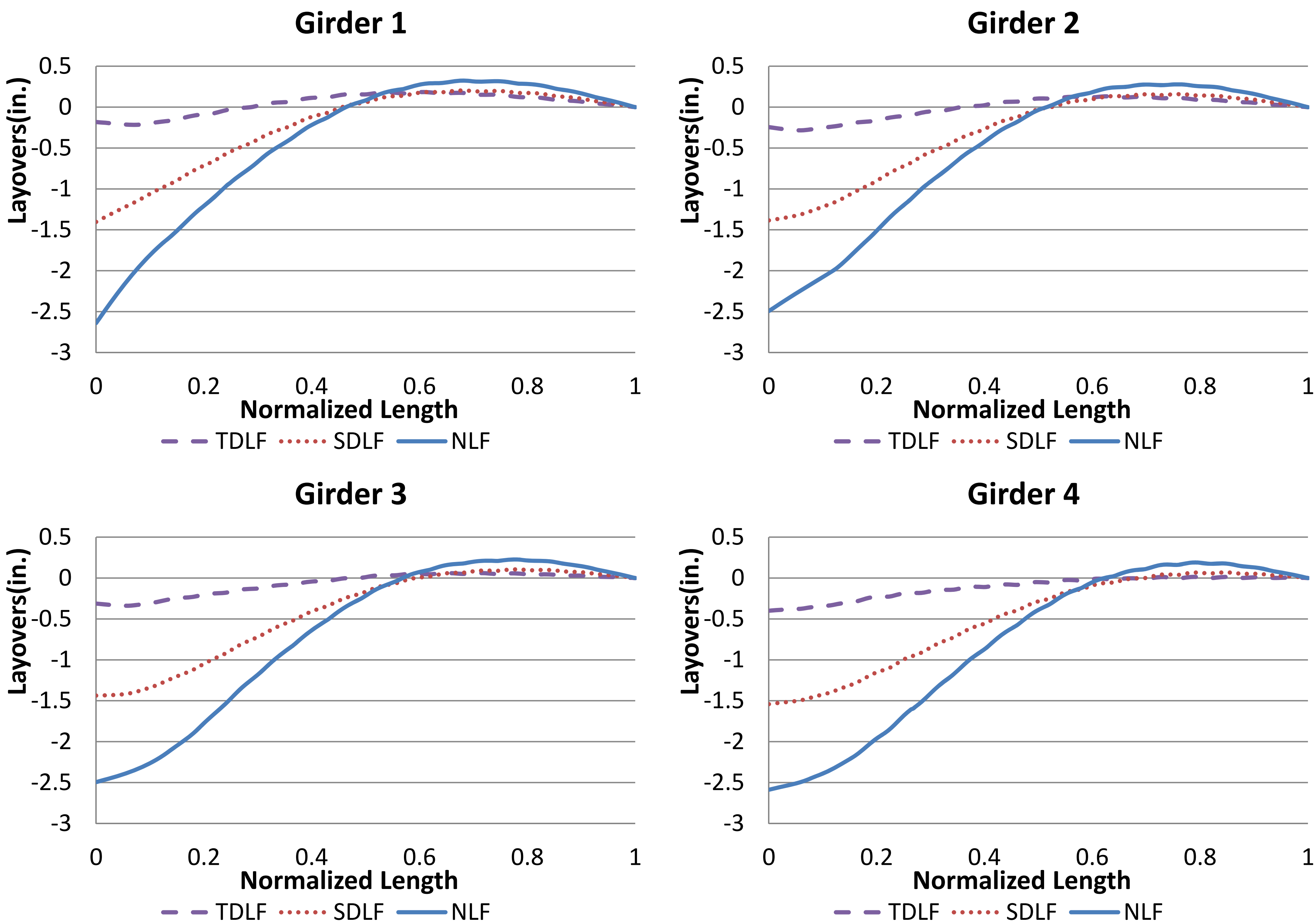


Figure Q1-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

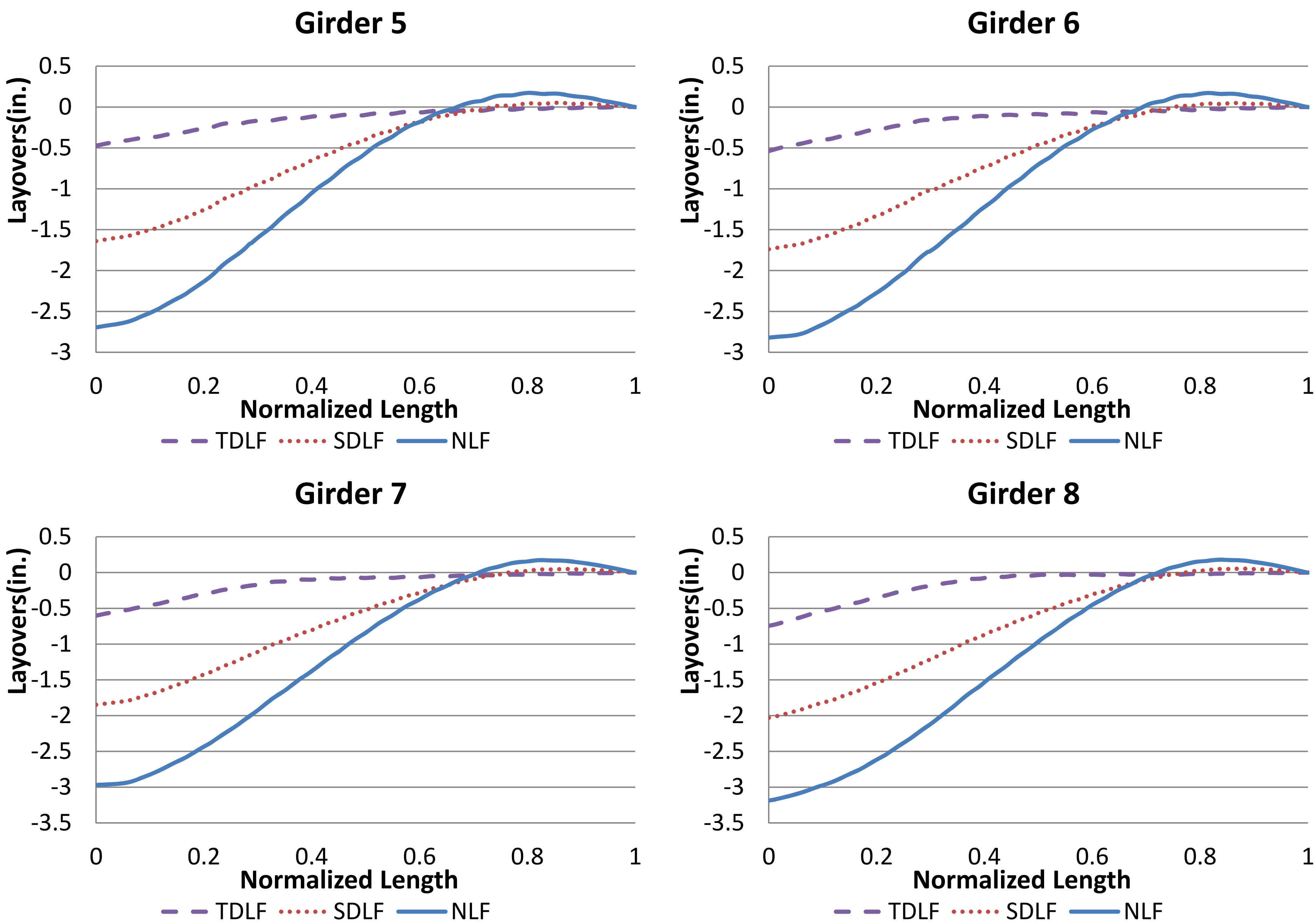


Figure Q1-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

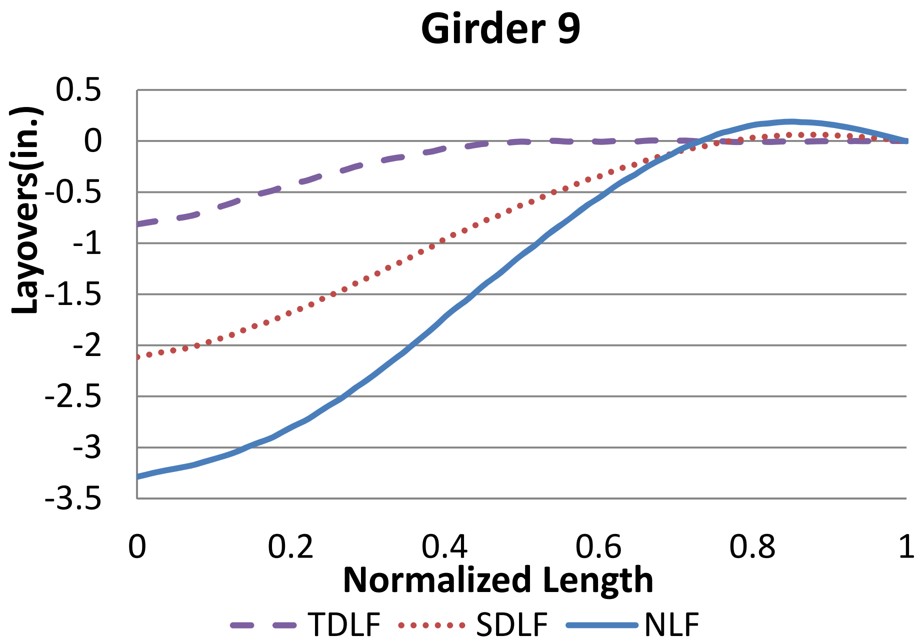


Figure Q1-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

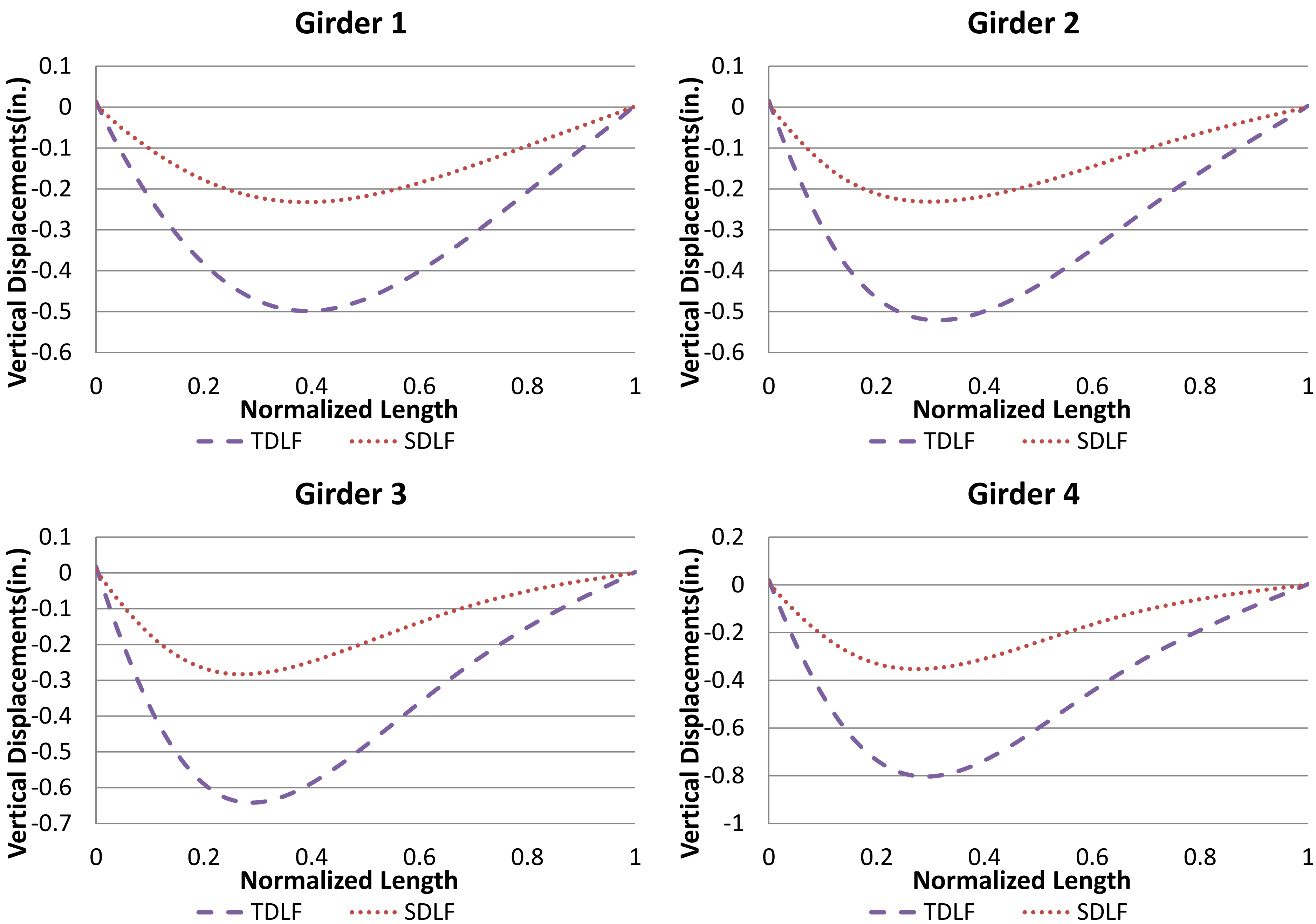


Figure Q1-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

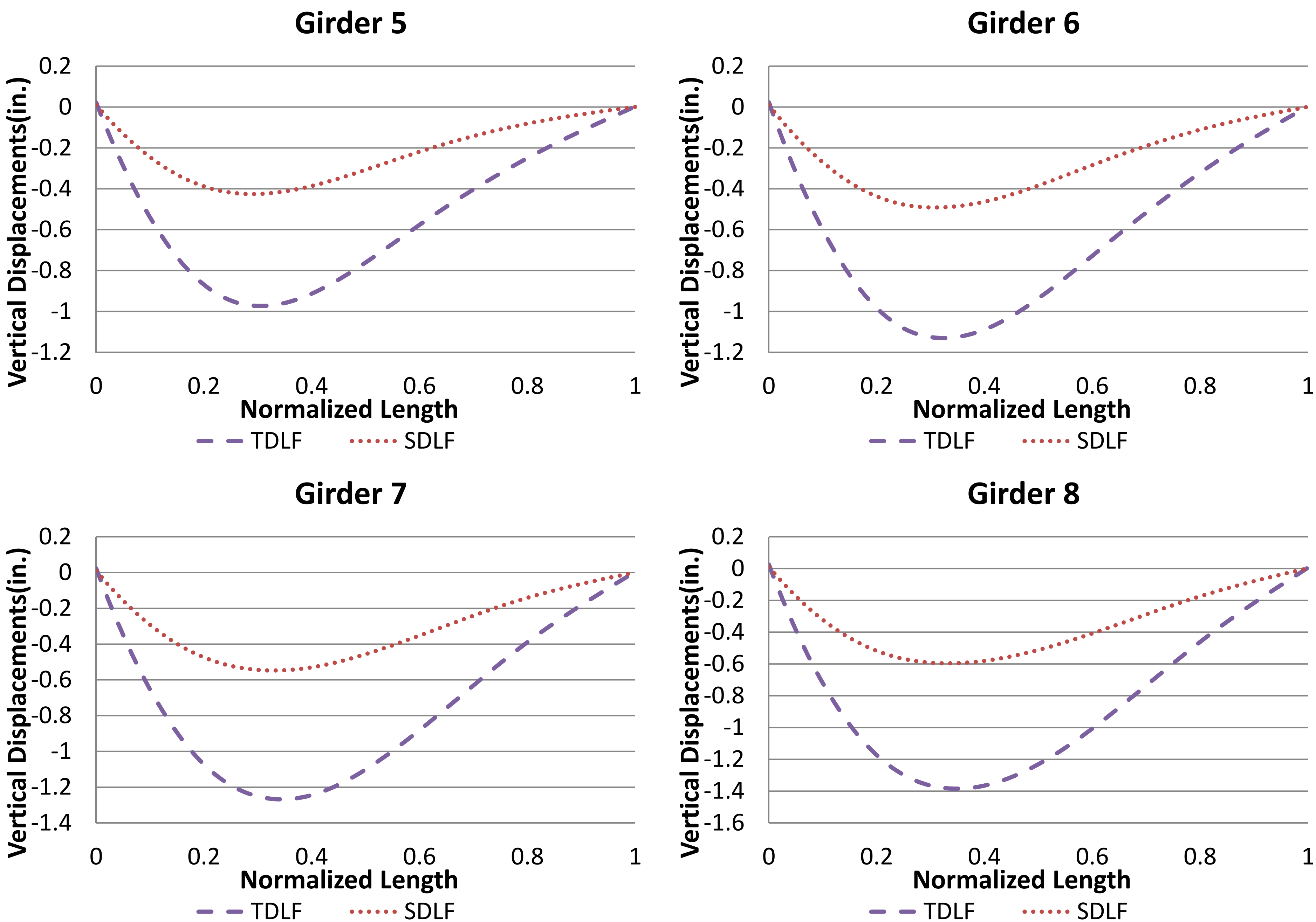


Figure Q1-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

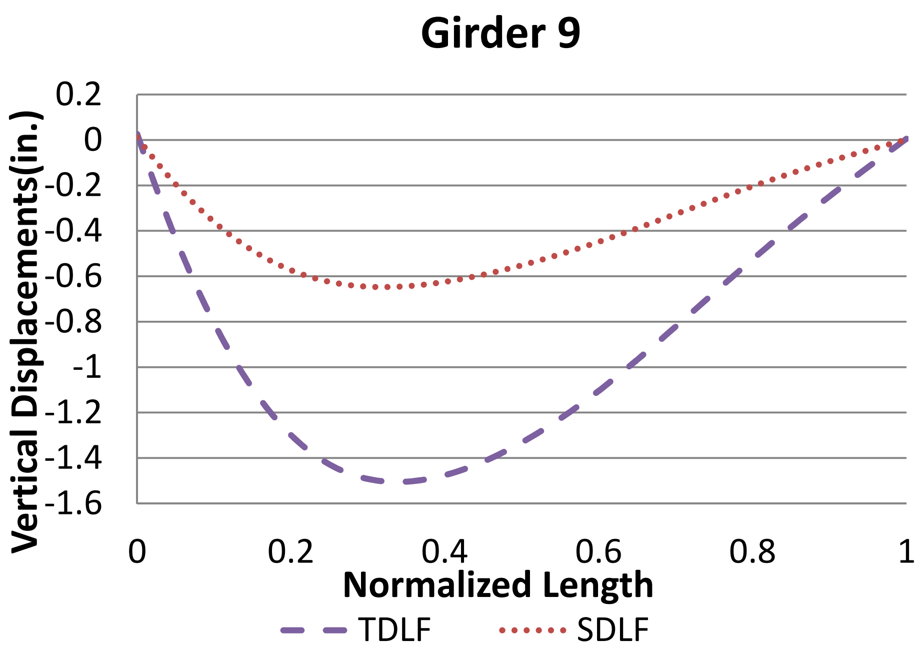


Figure Q1-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

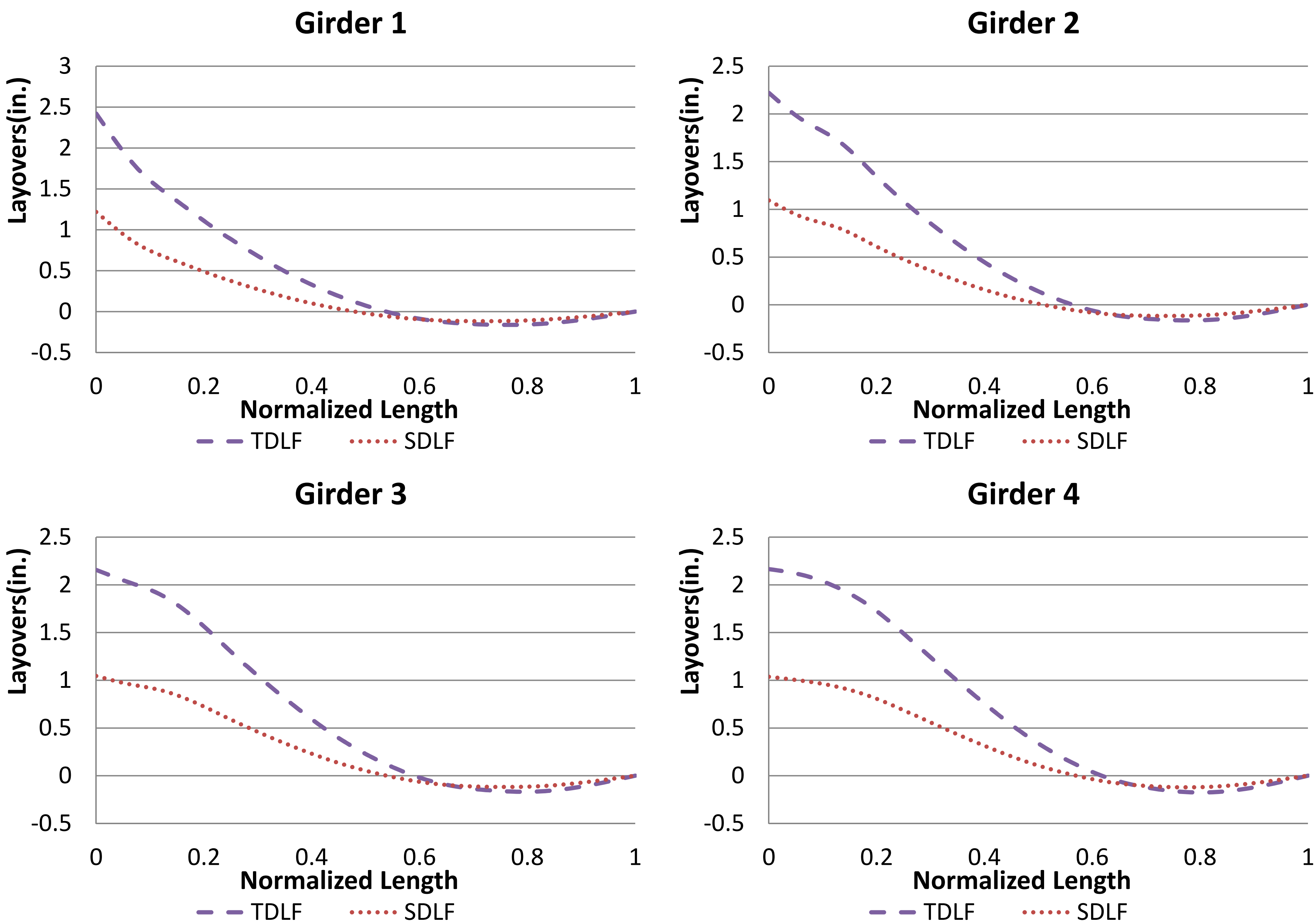


Figure Q1-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

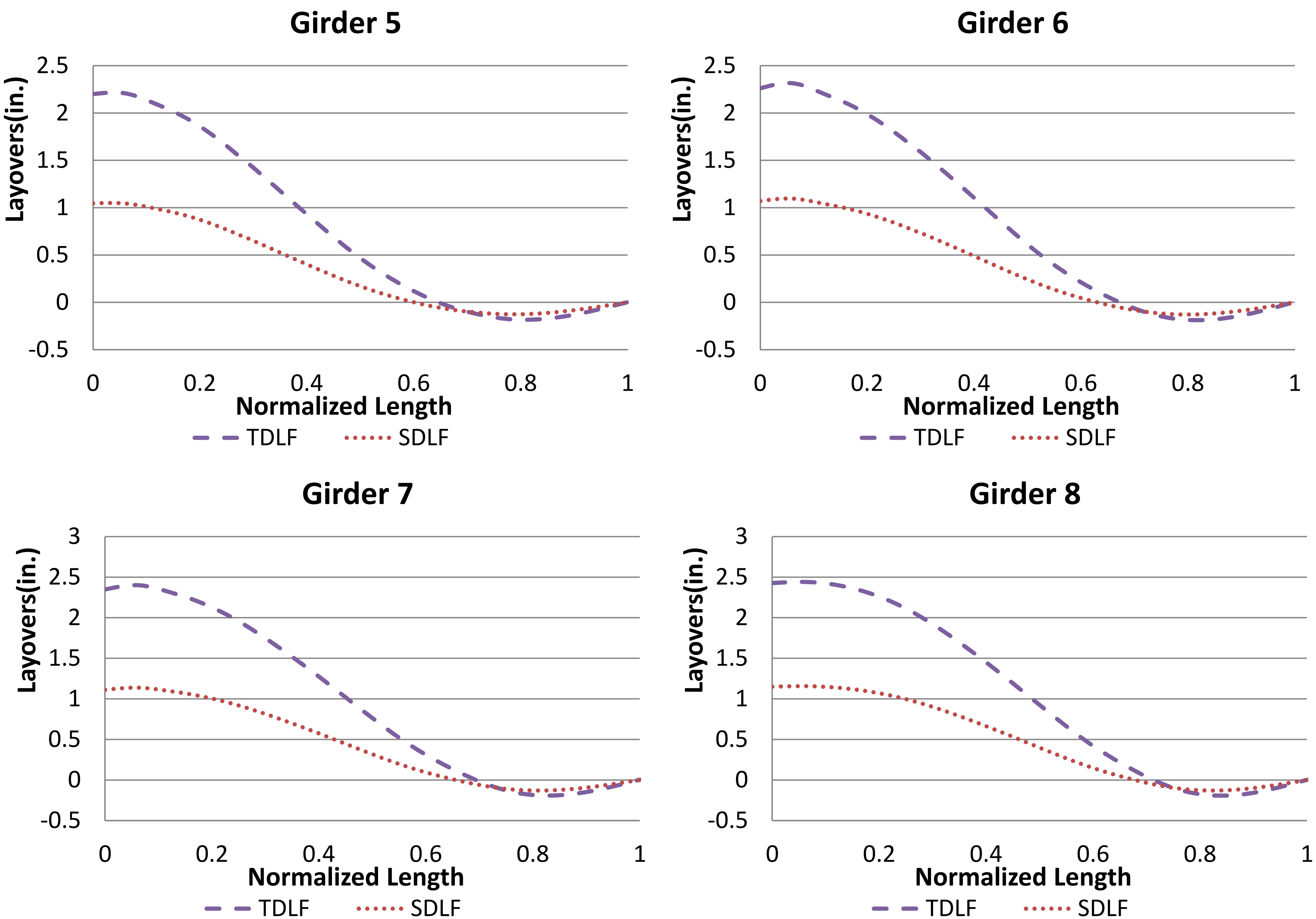


Figure Q1-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

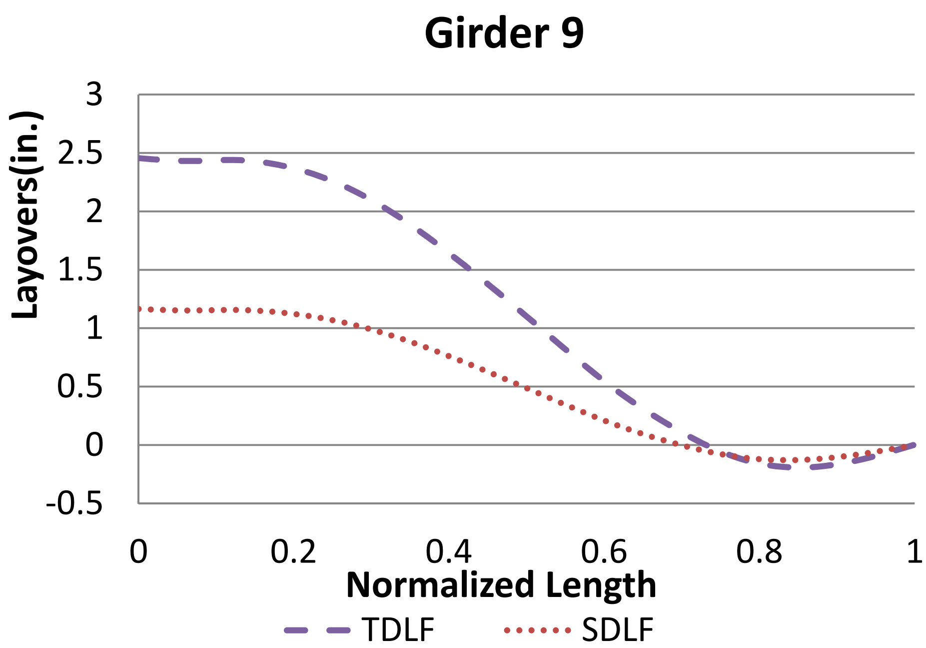


Figure Q1-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

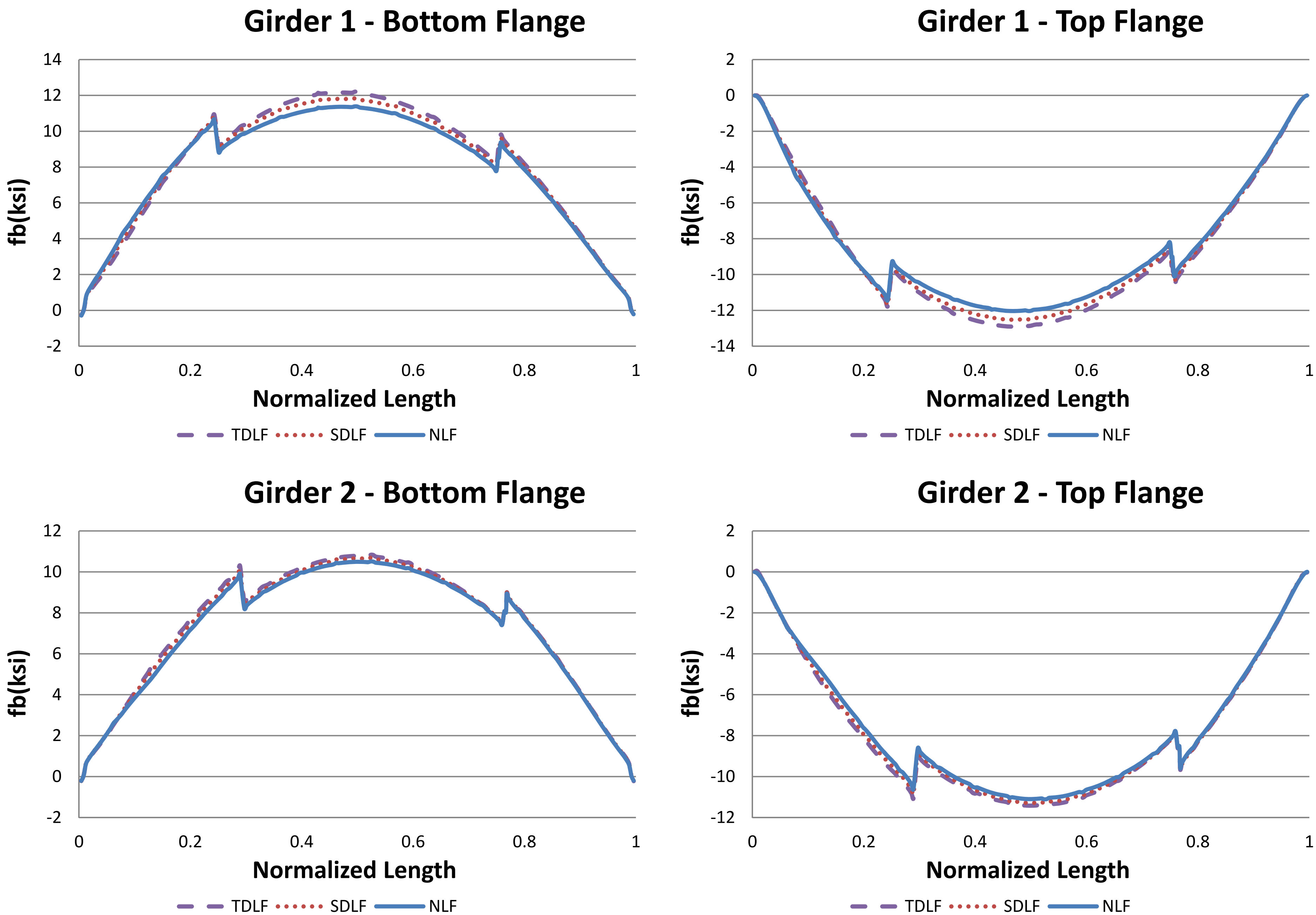


Figure Q1-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

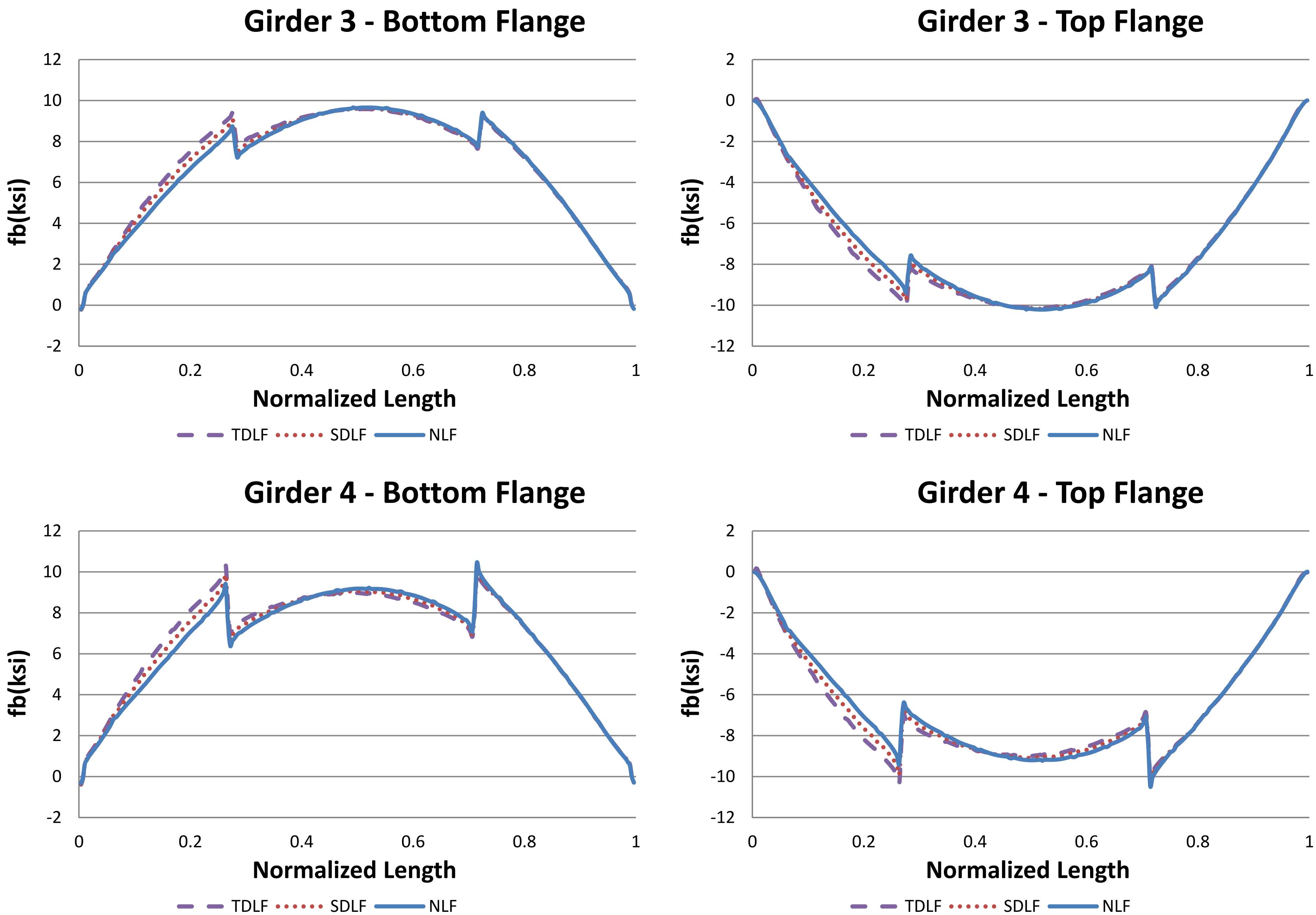


Figure Q1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

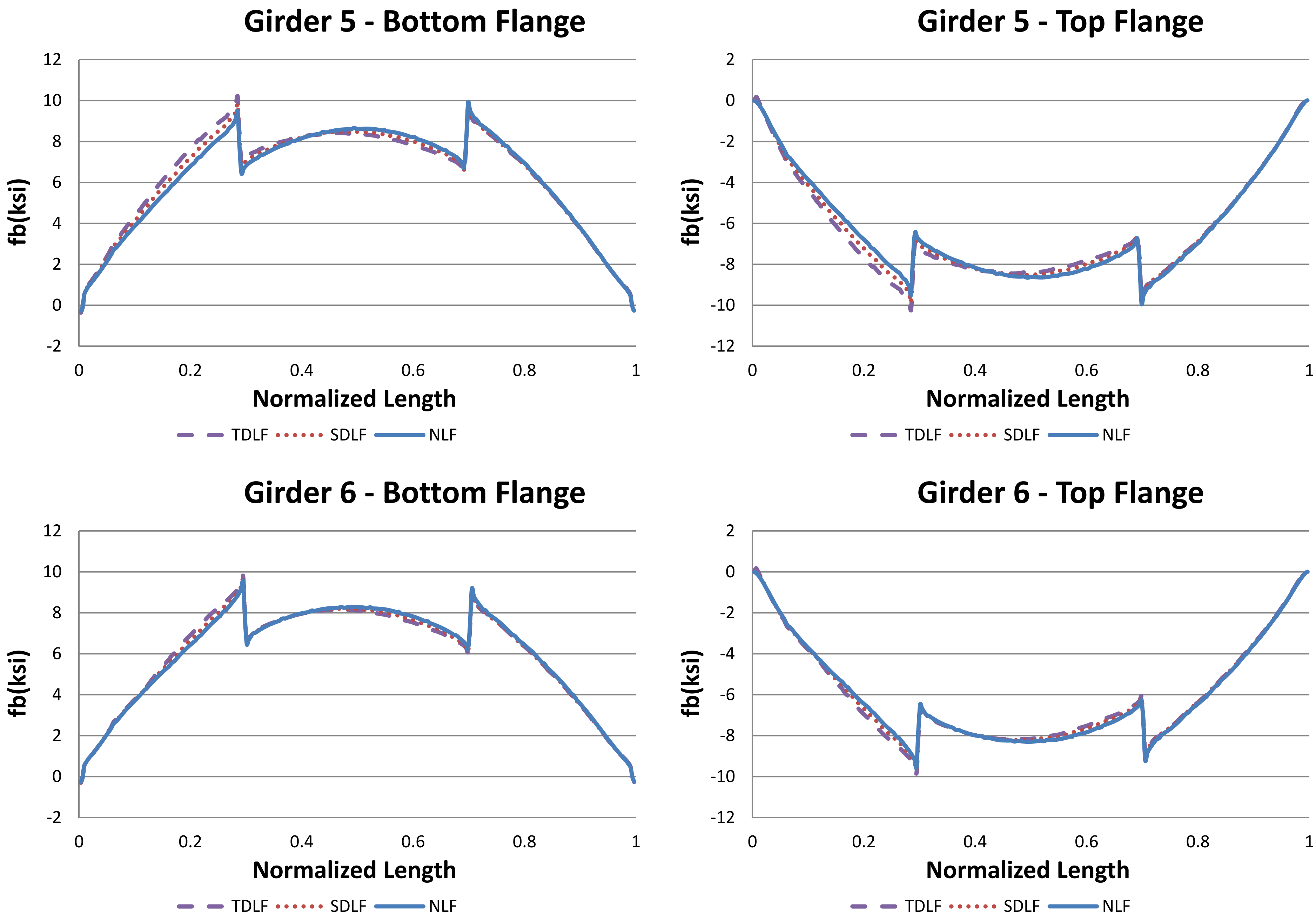


Figure Q1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

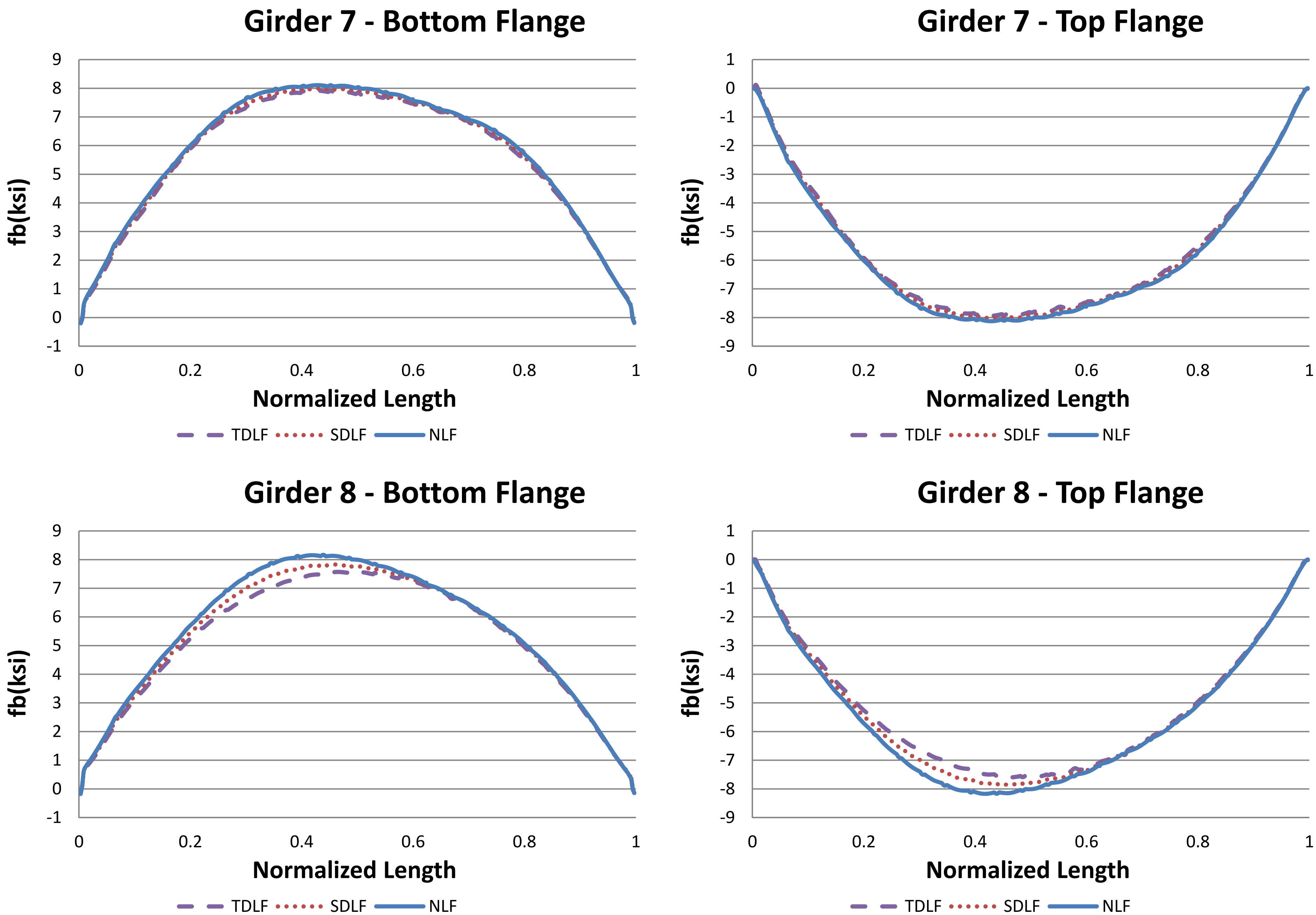


Figure Q1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

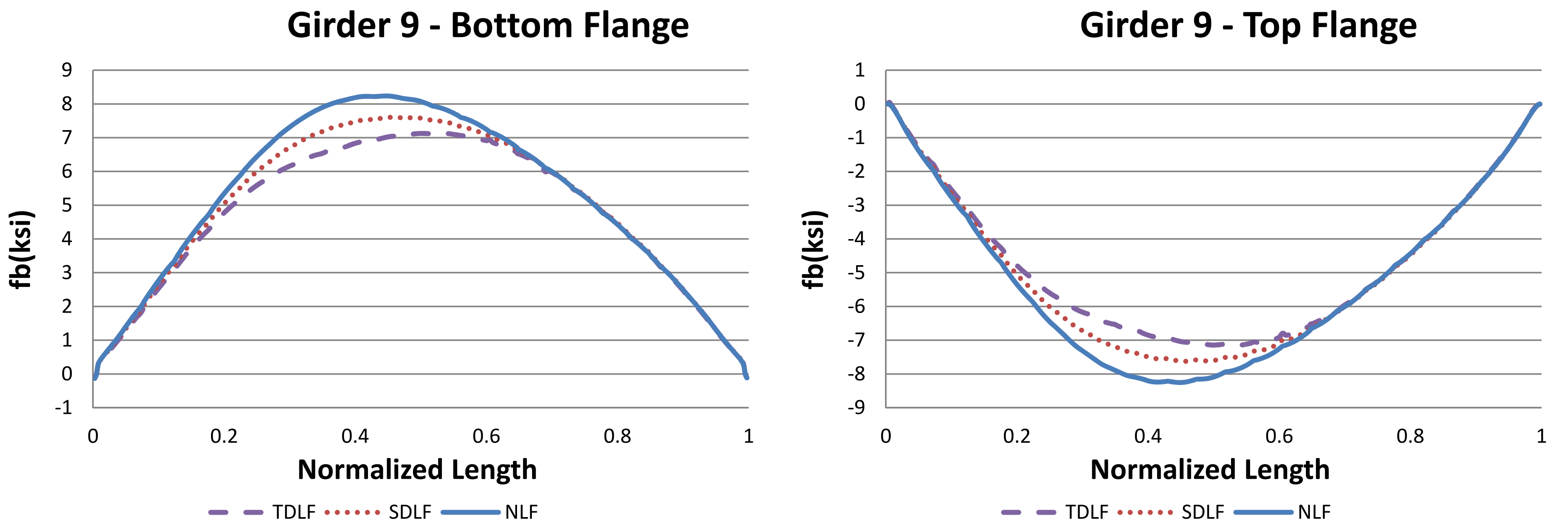


Figure Q1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

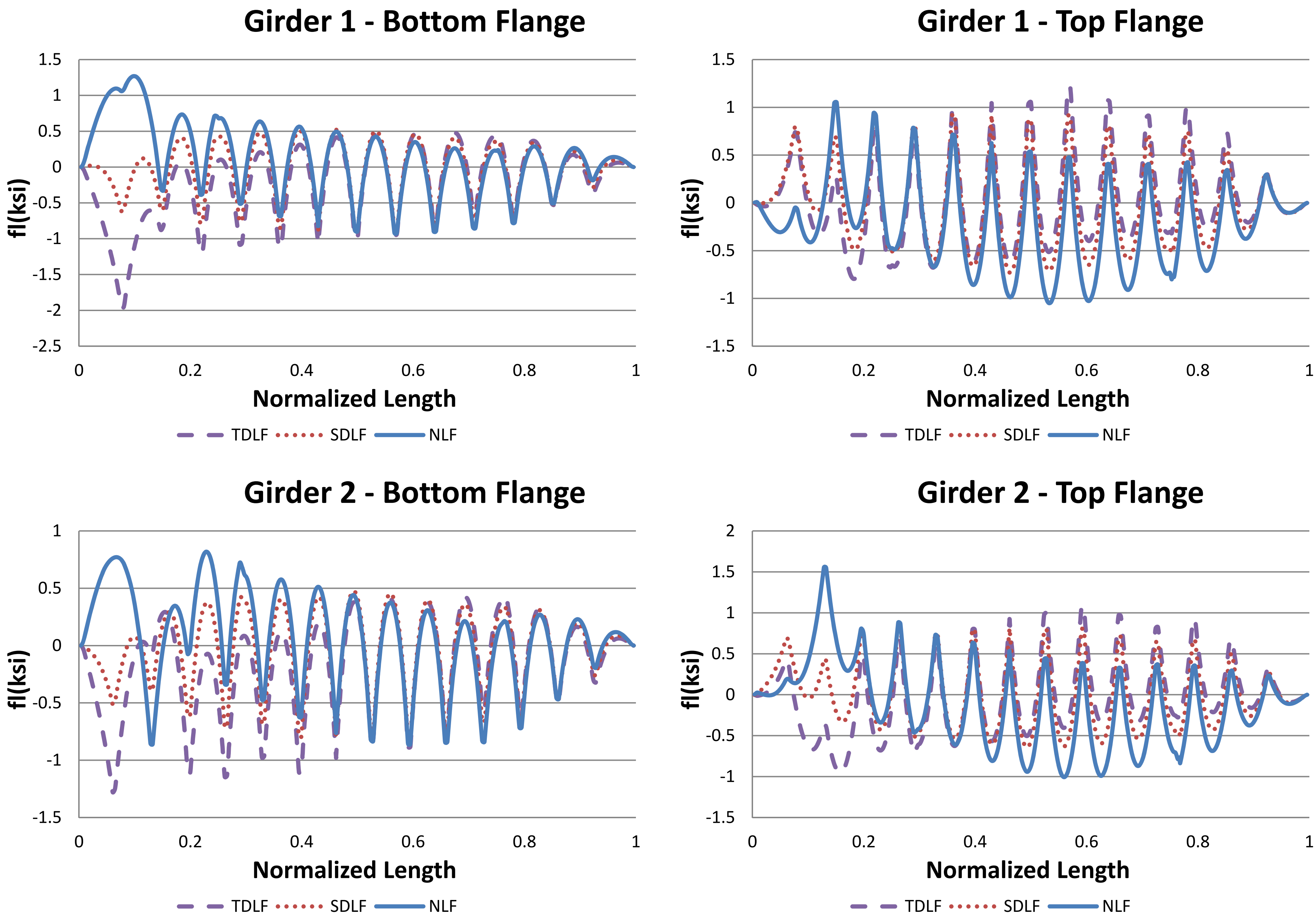


Figure Q1-4-19. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

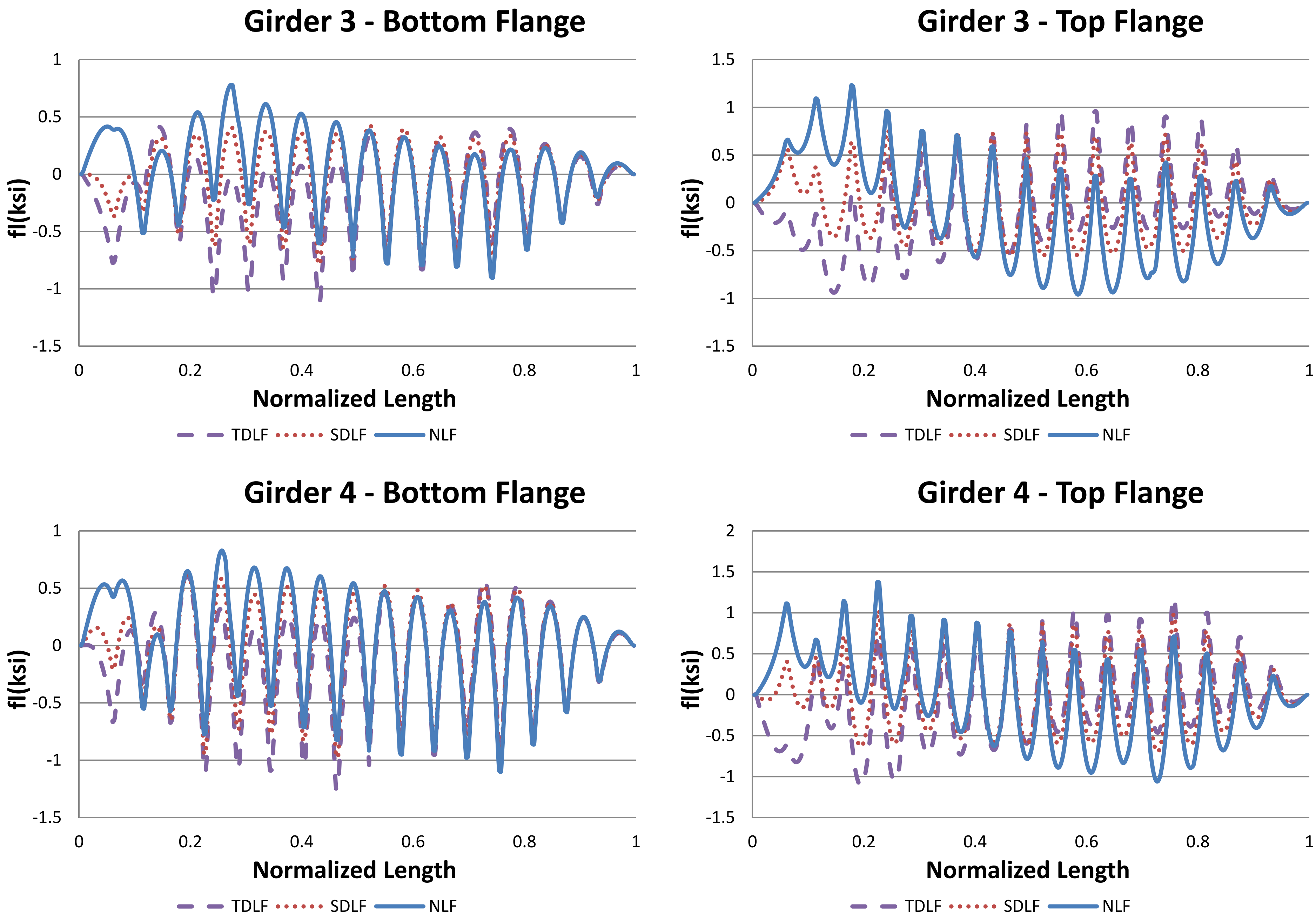


Figure Q1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under SDL for different detailing methods.

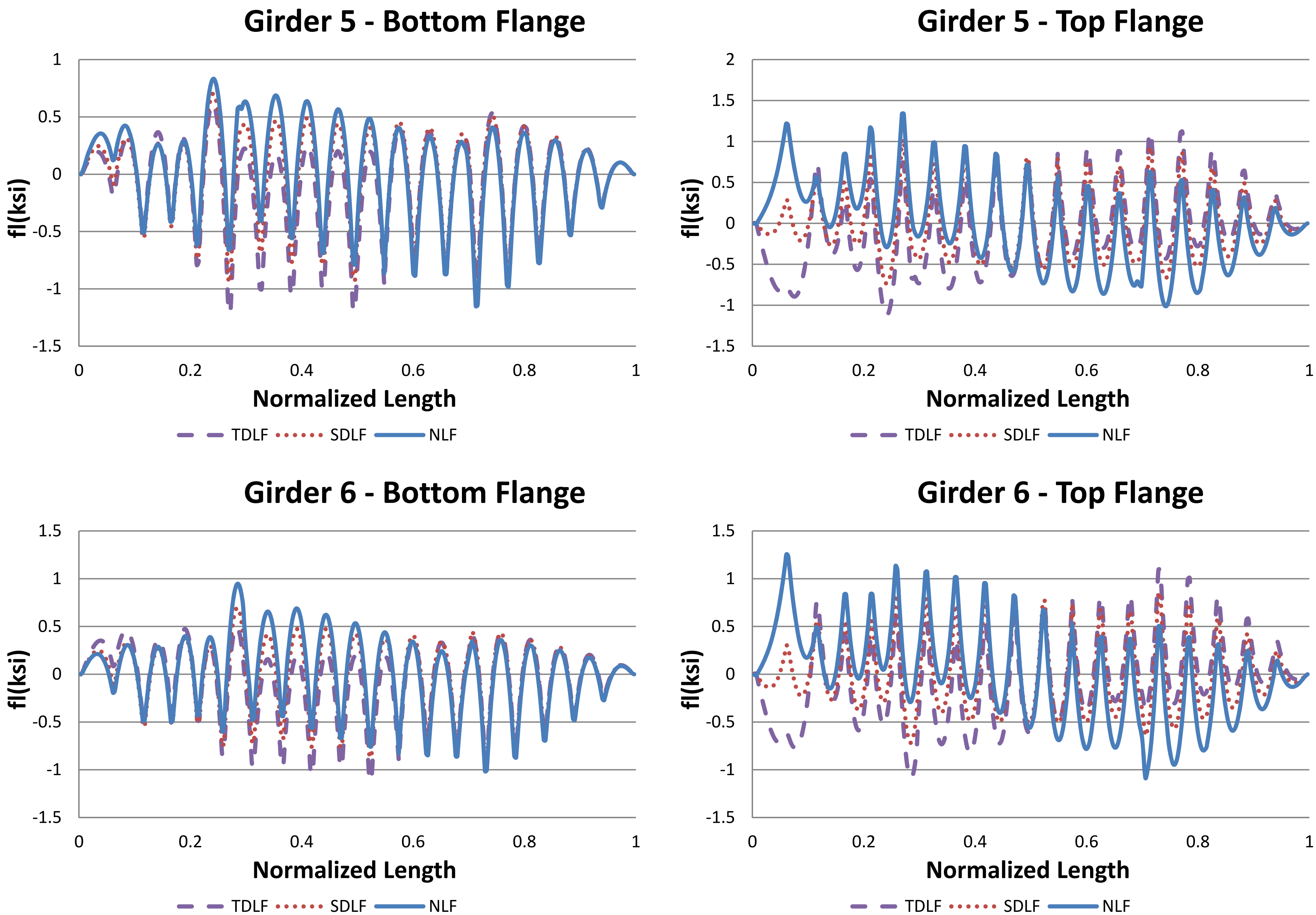


Figure Q1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

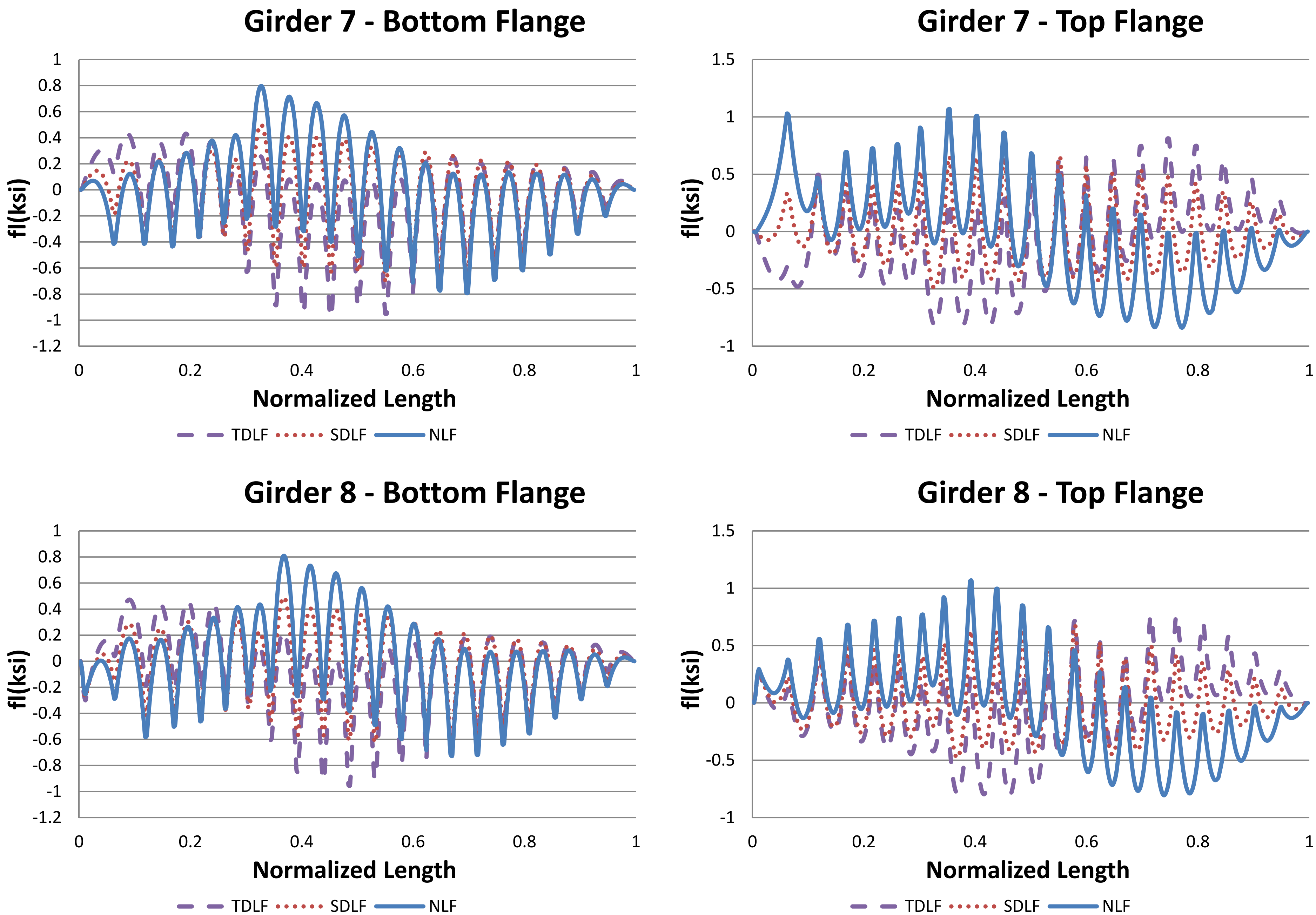
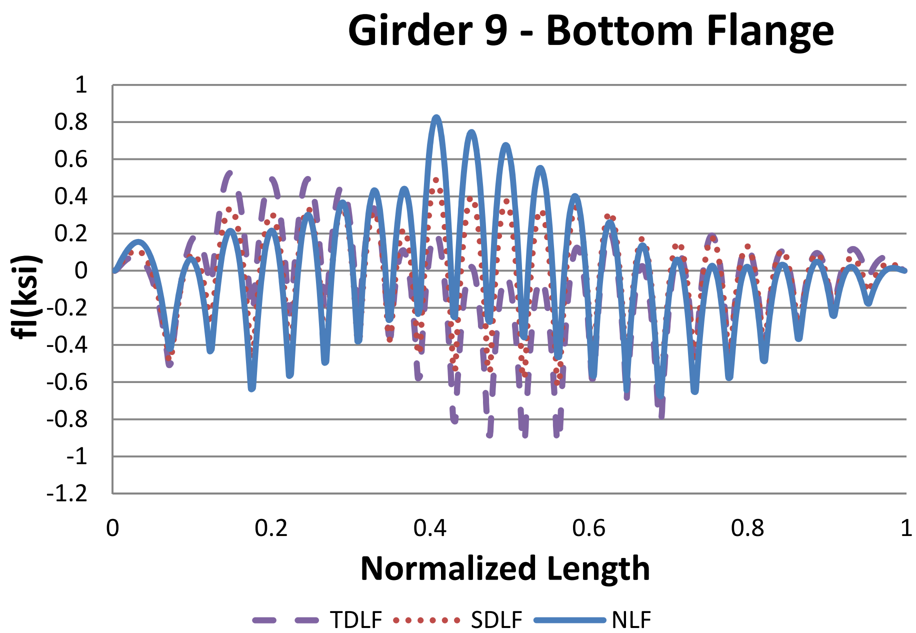


Figure Q1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.



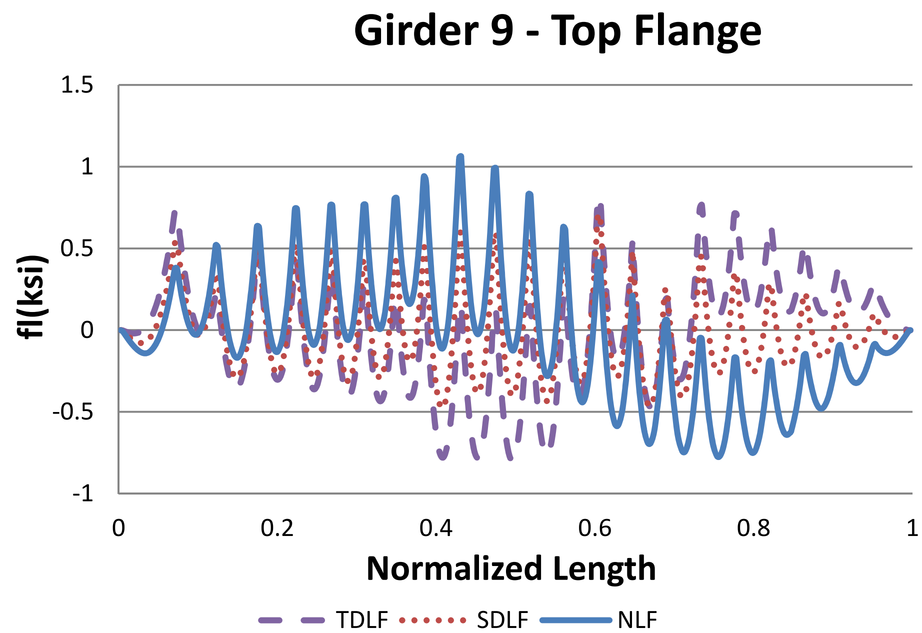


Figure Q1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

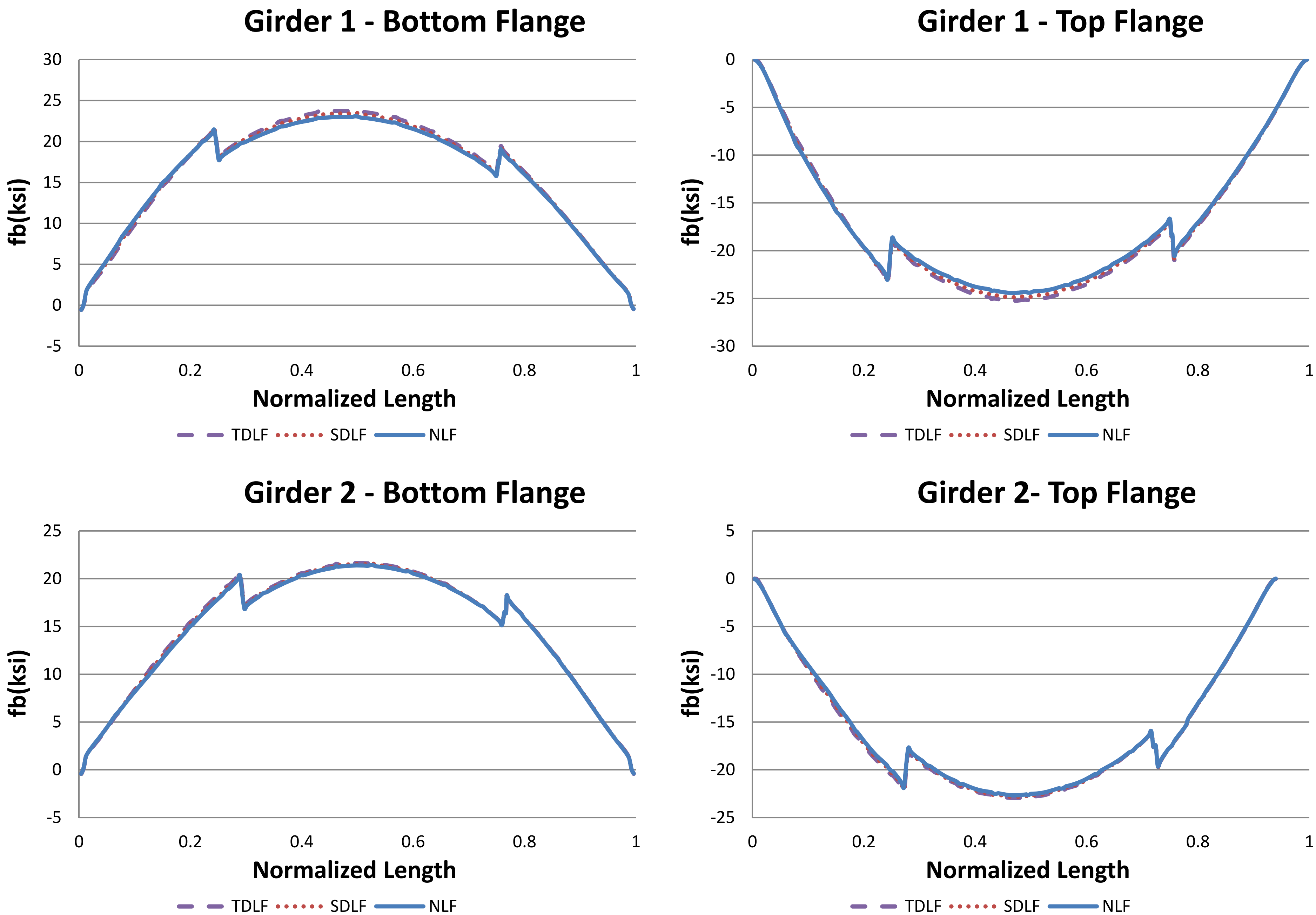


Figure Q1-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

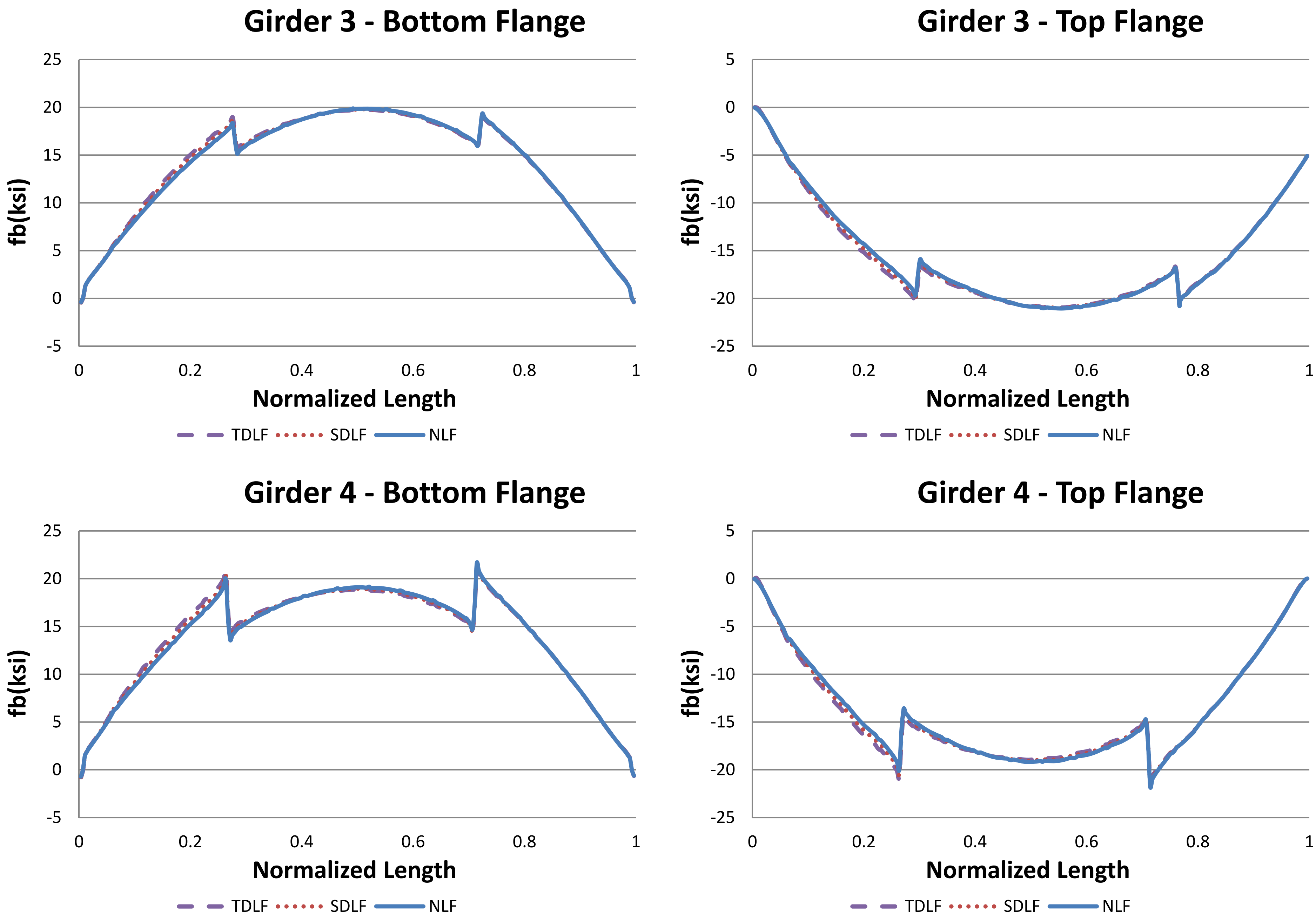


Figure Q1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

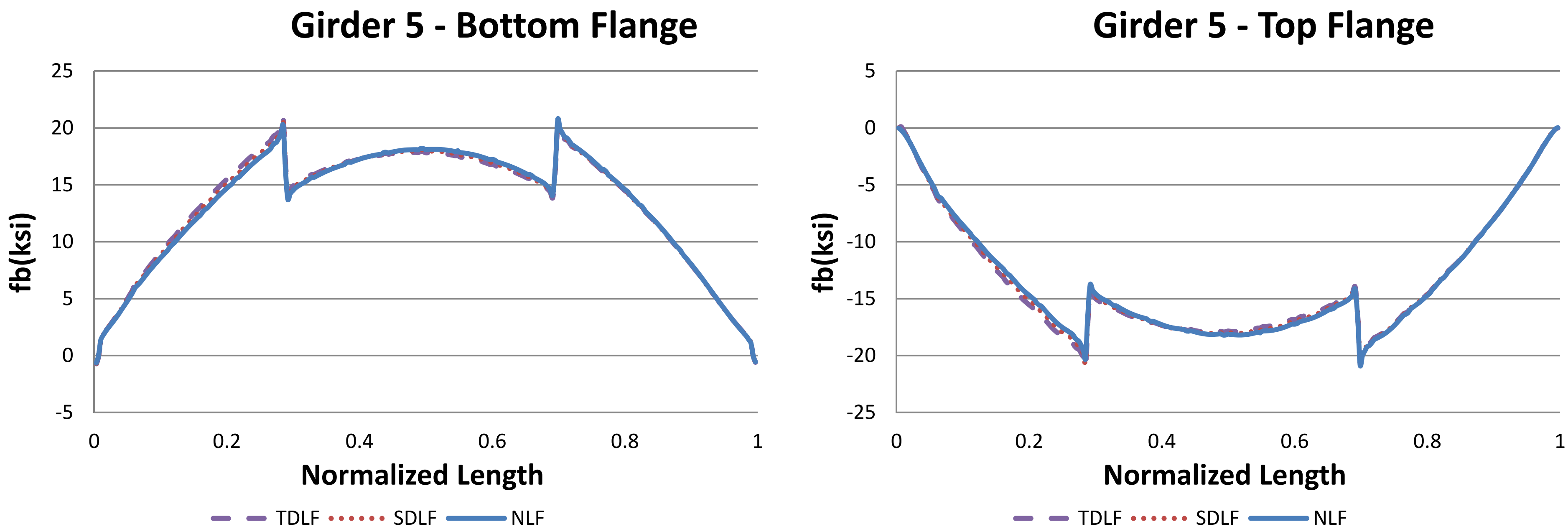


Figure Q1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

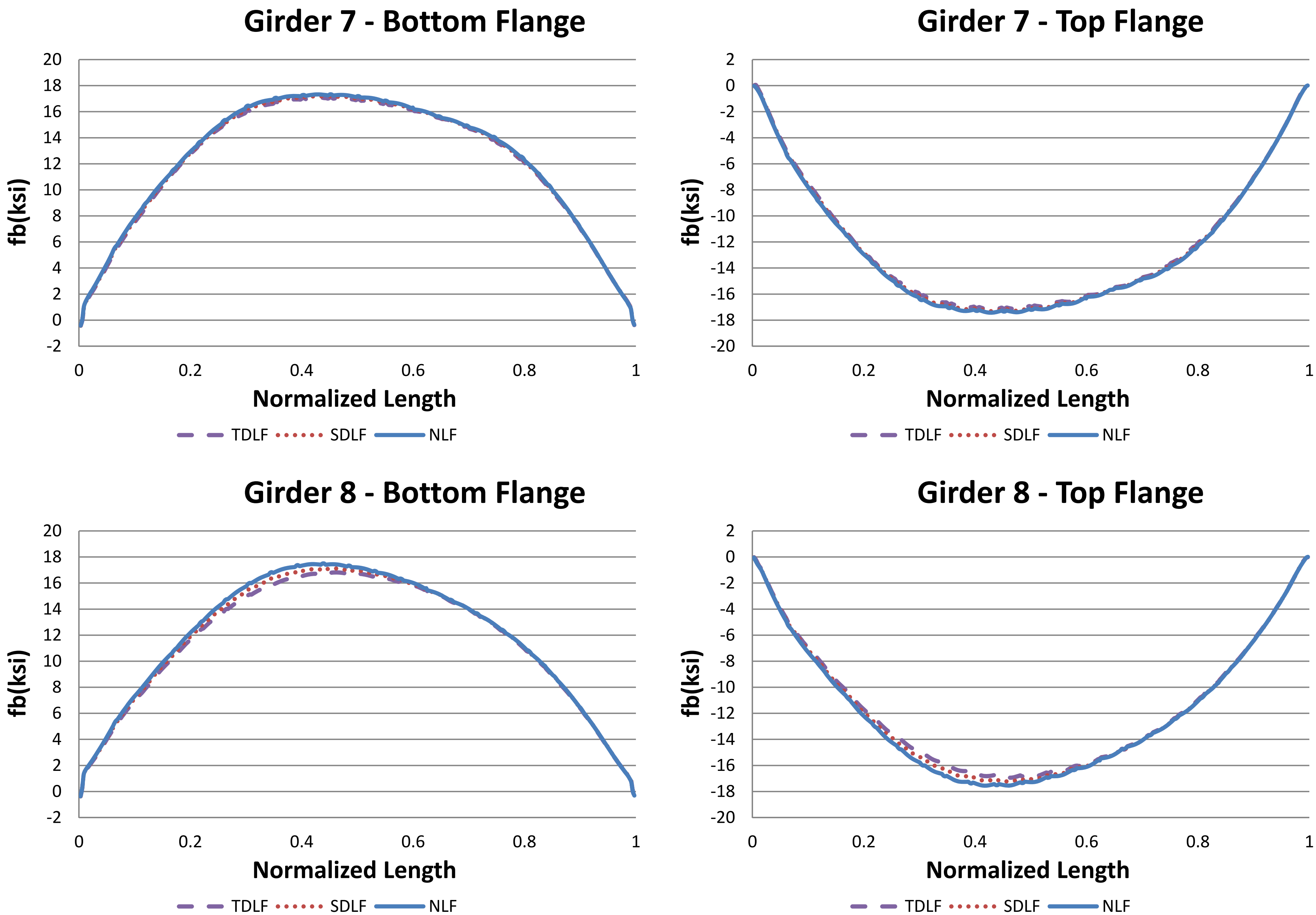
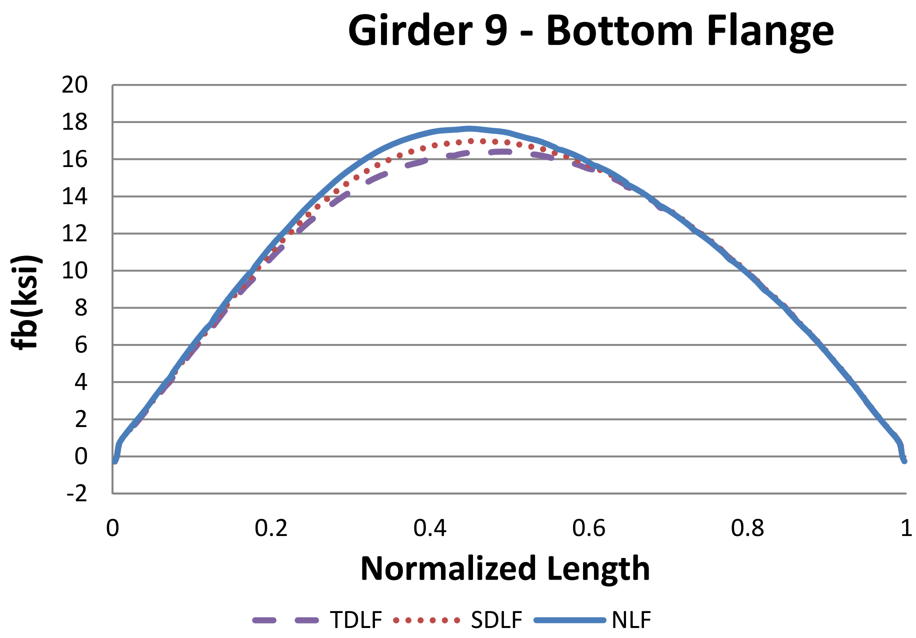


Figure Q1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



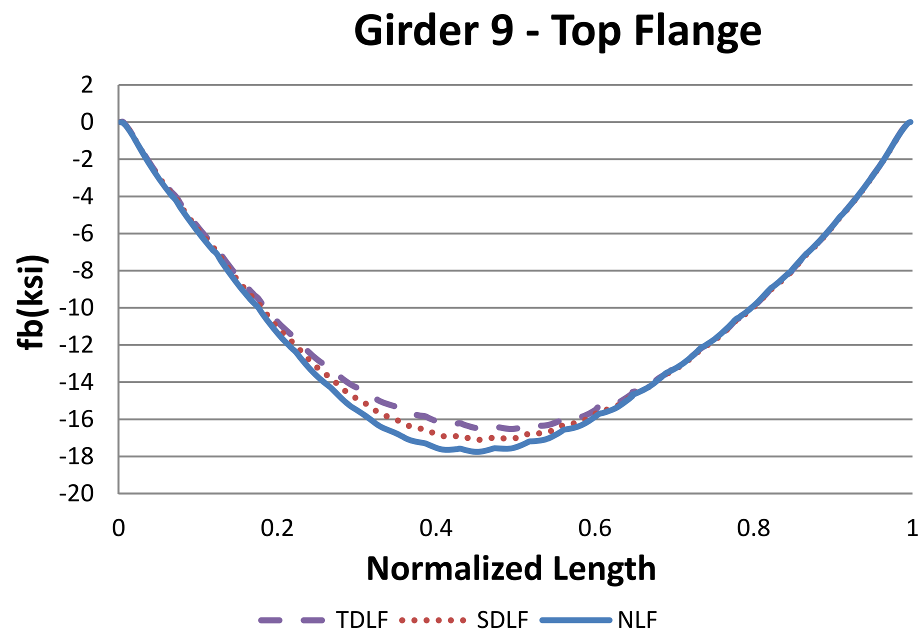


Figure Q1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

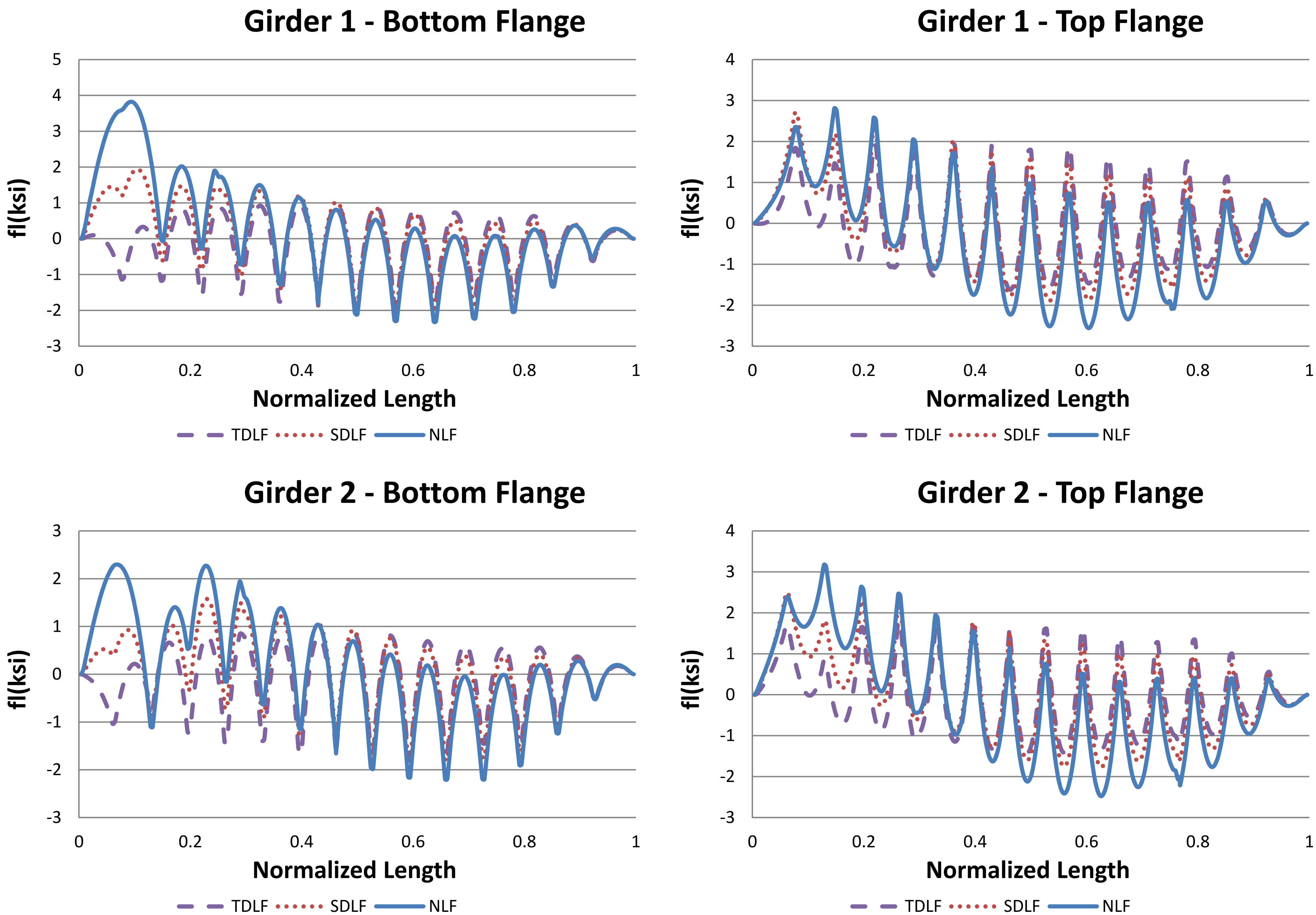


Figure Q1-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

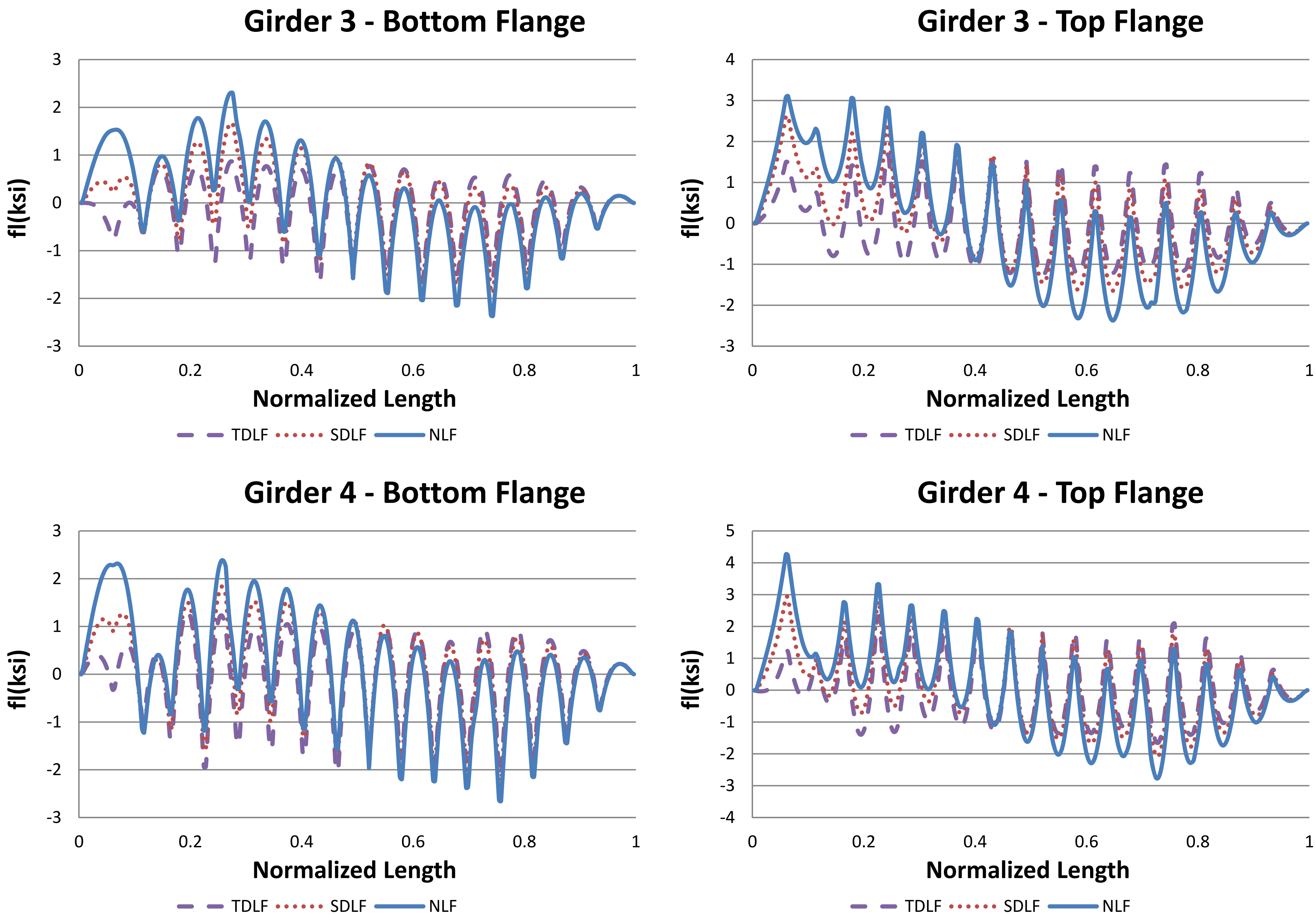


Figure Q1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

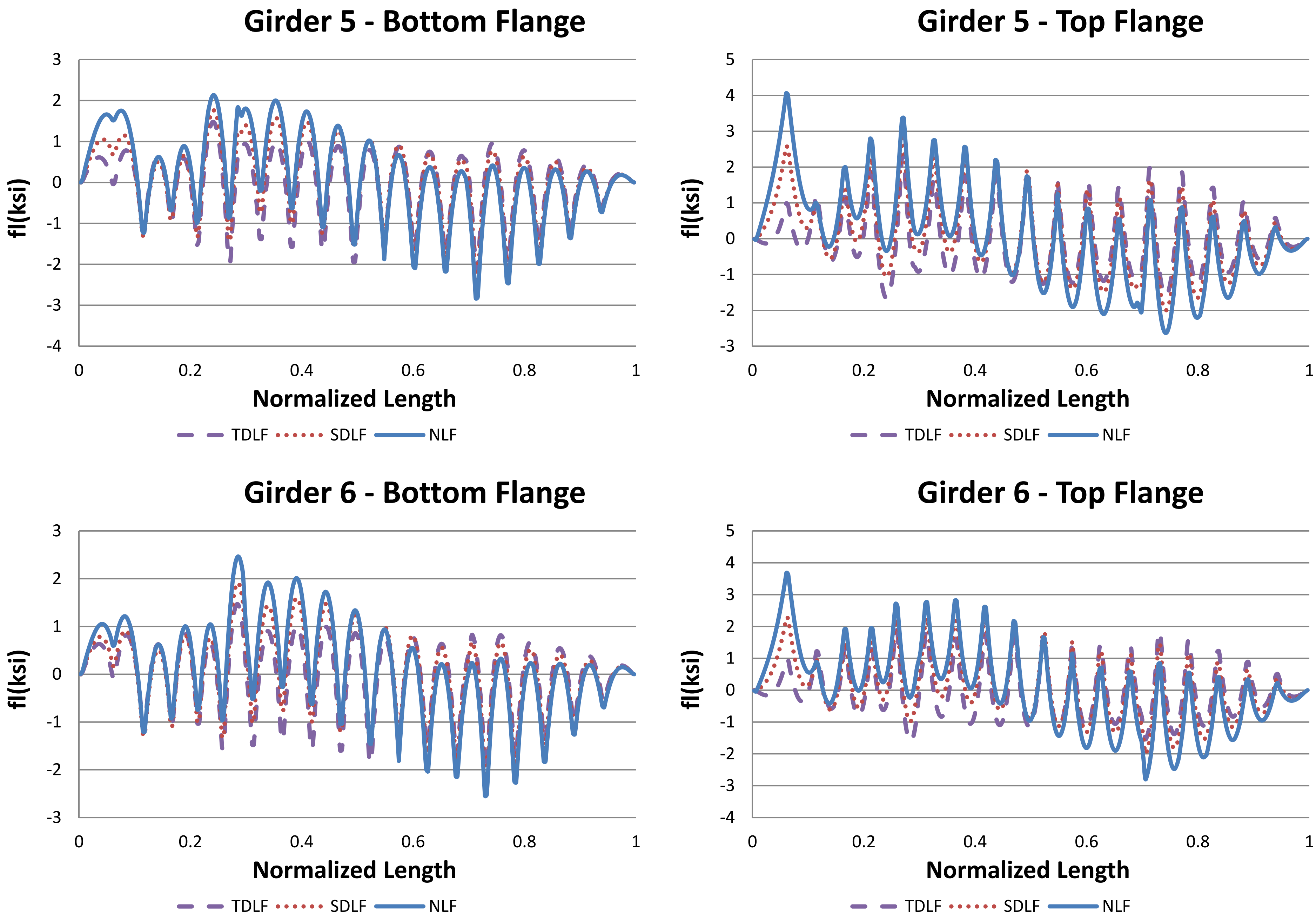


Figure Q1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

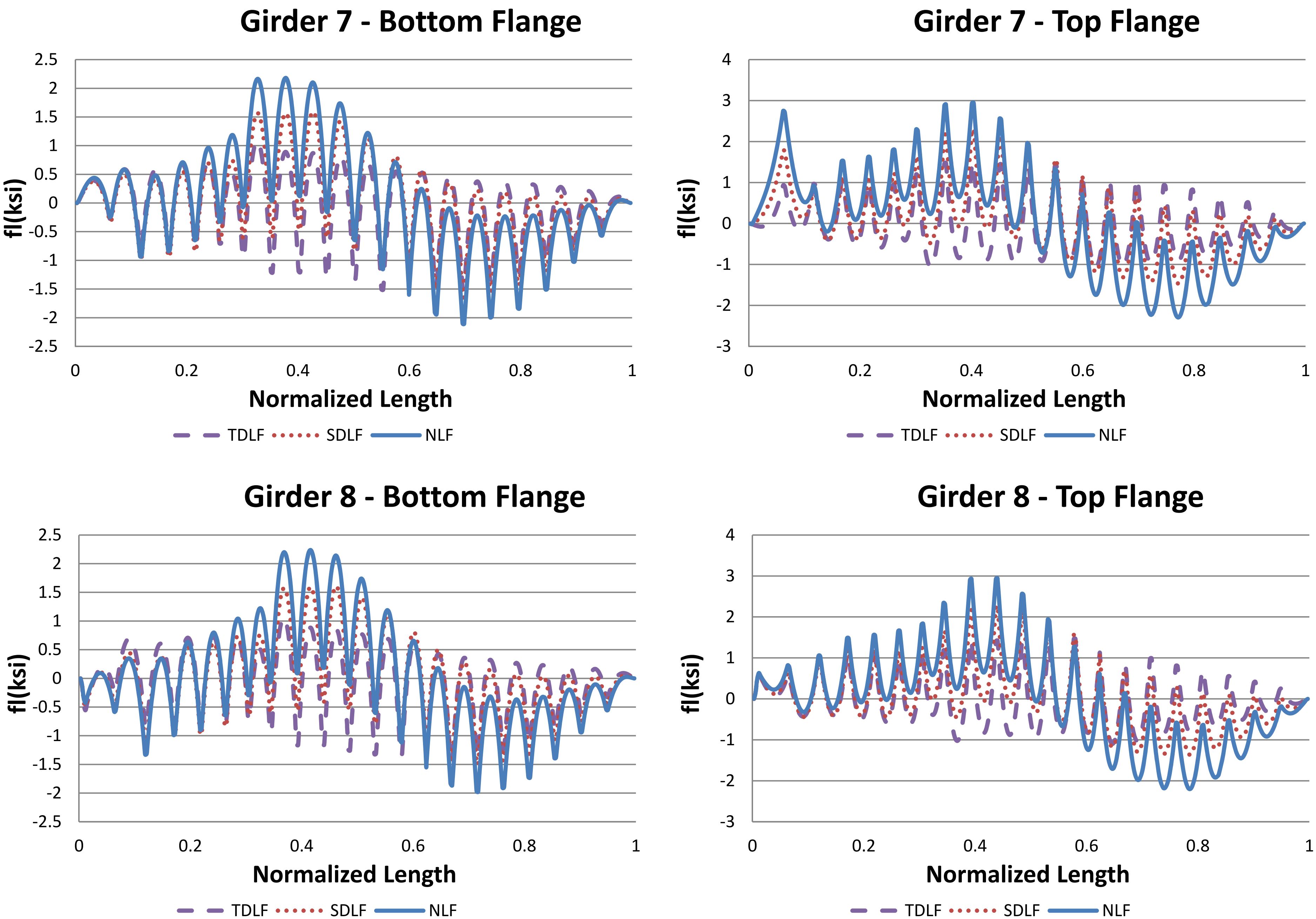
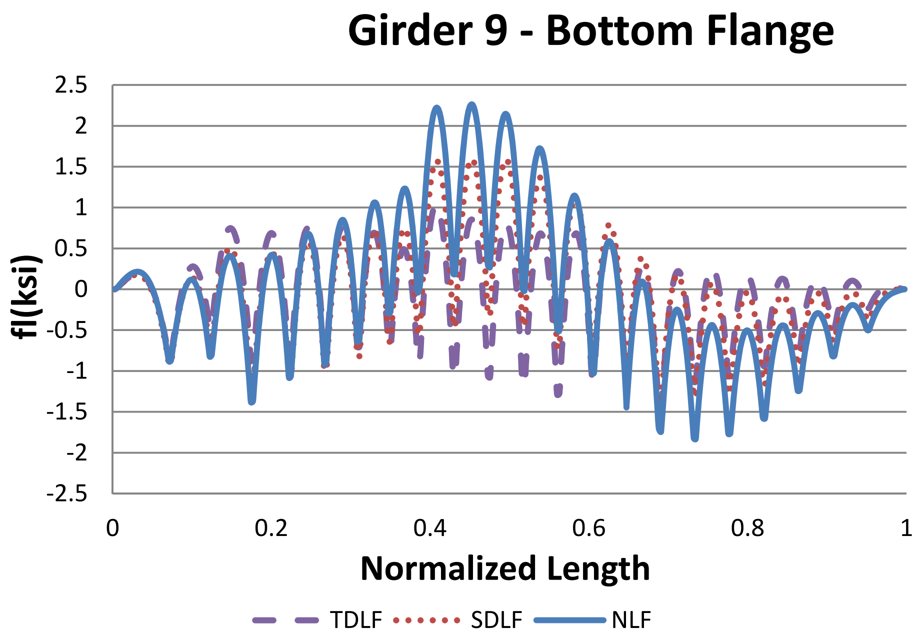


Figure Q1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.



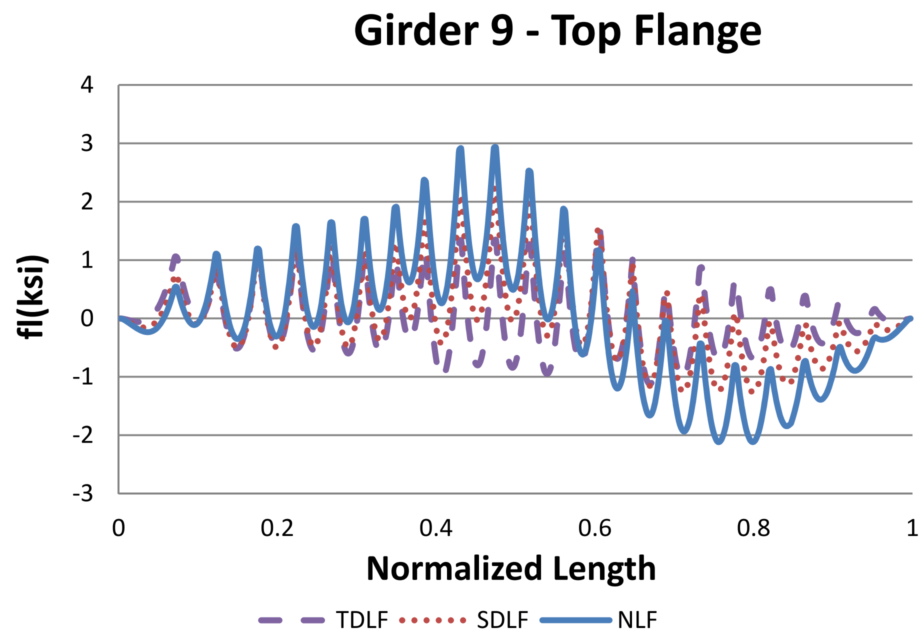


Figure Q1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

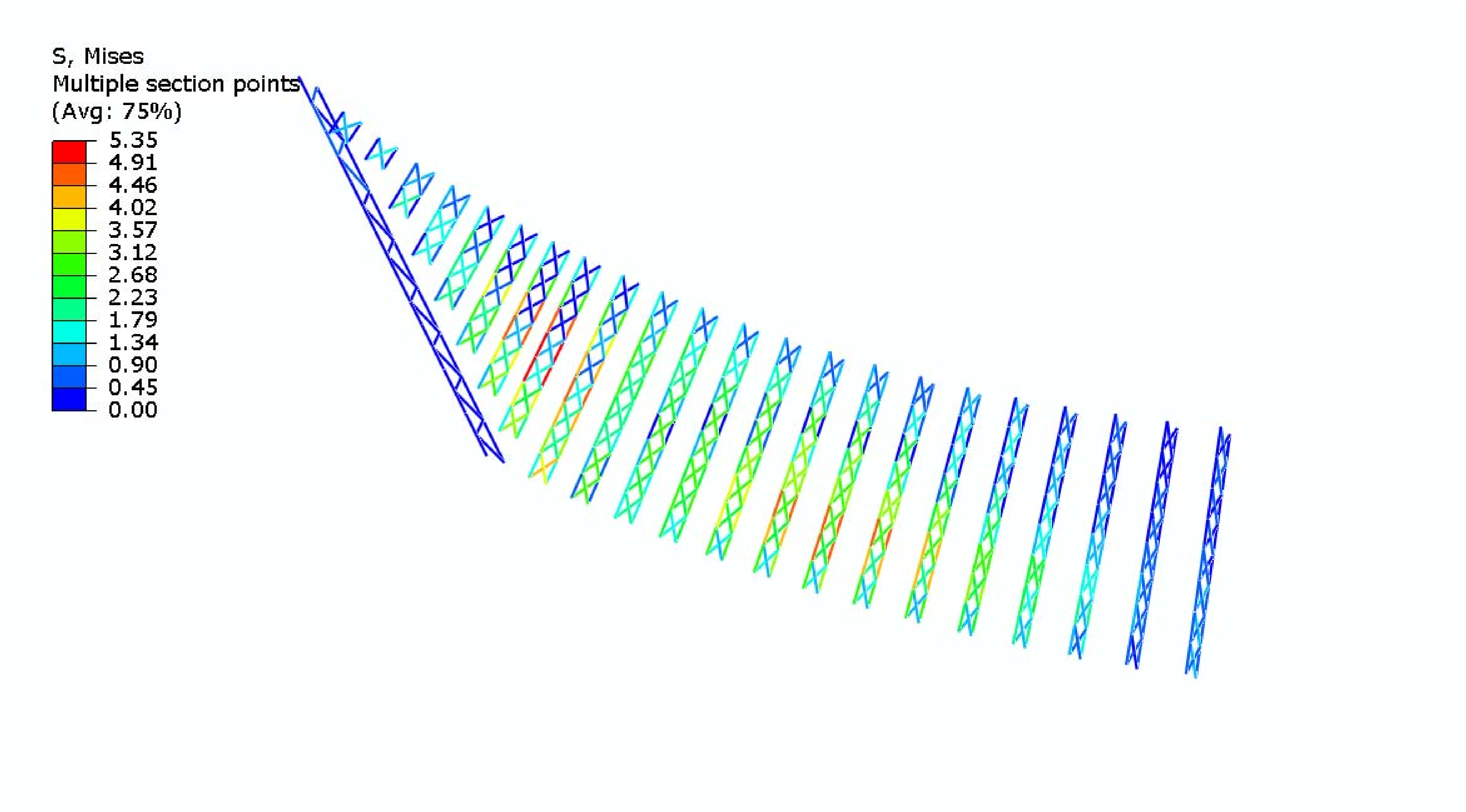


Figure Q1-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing

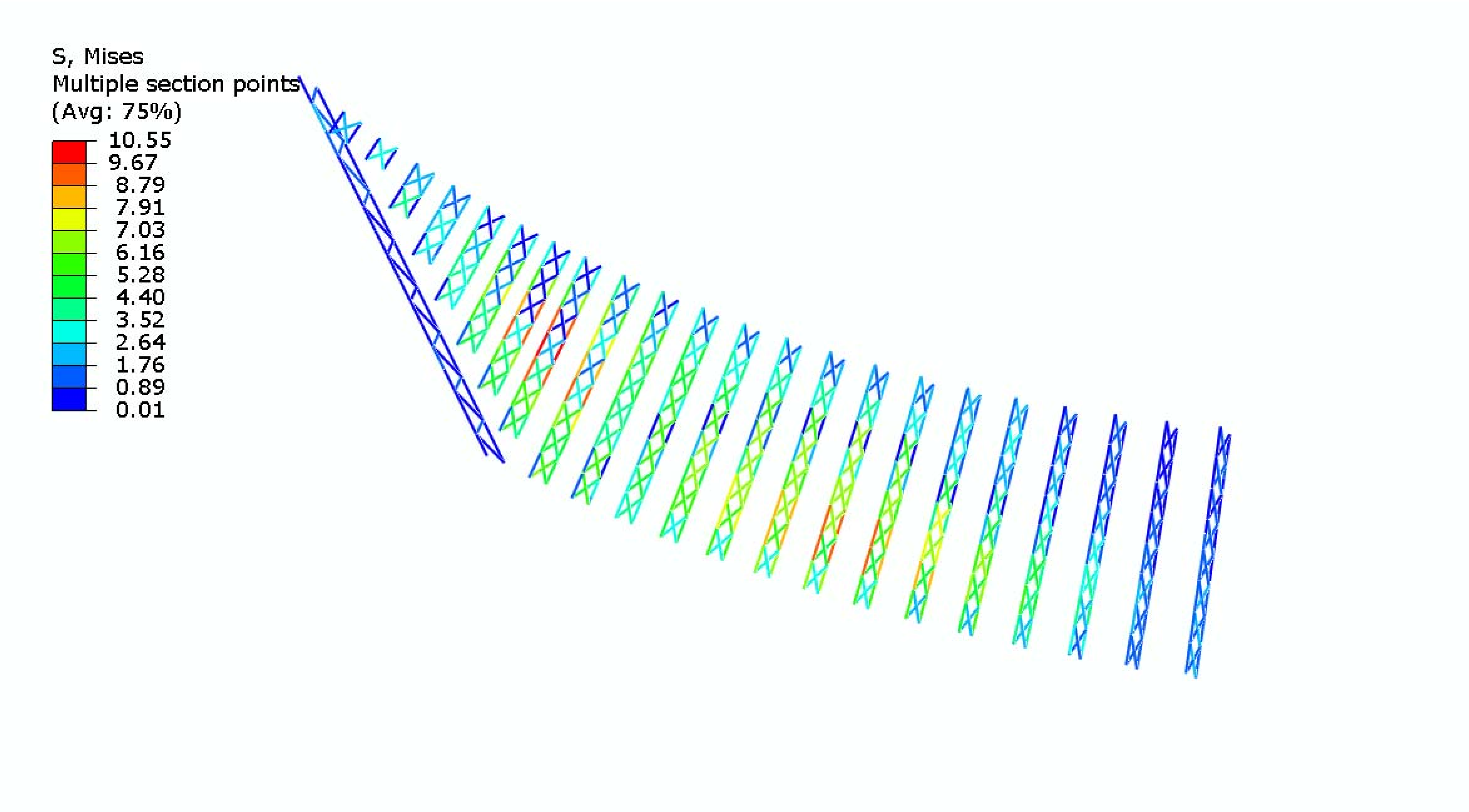


Figure Q1-4-23. Cross-frame stress contours under TDL, NLF detailing

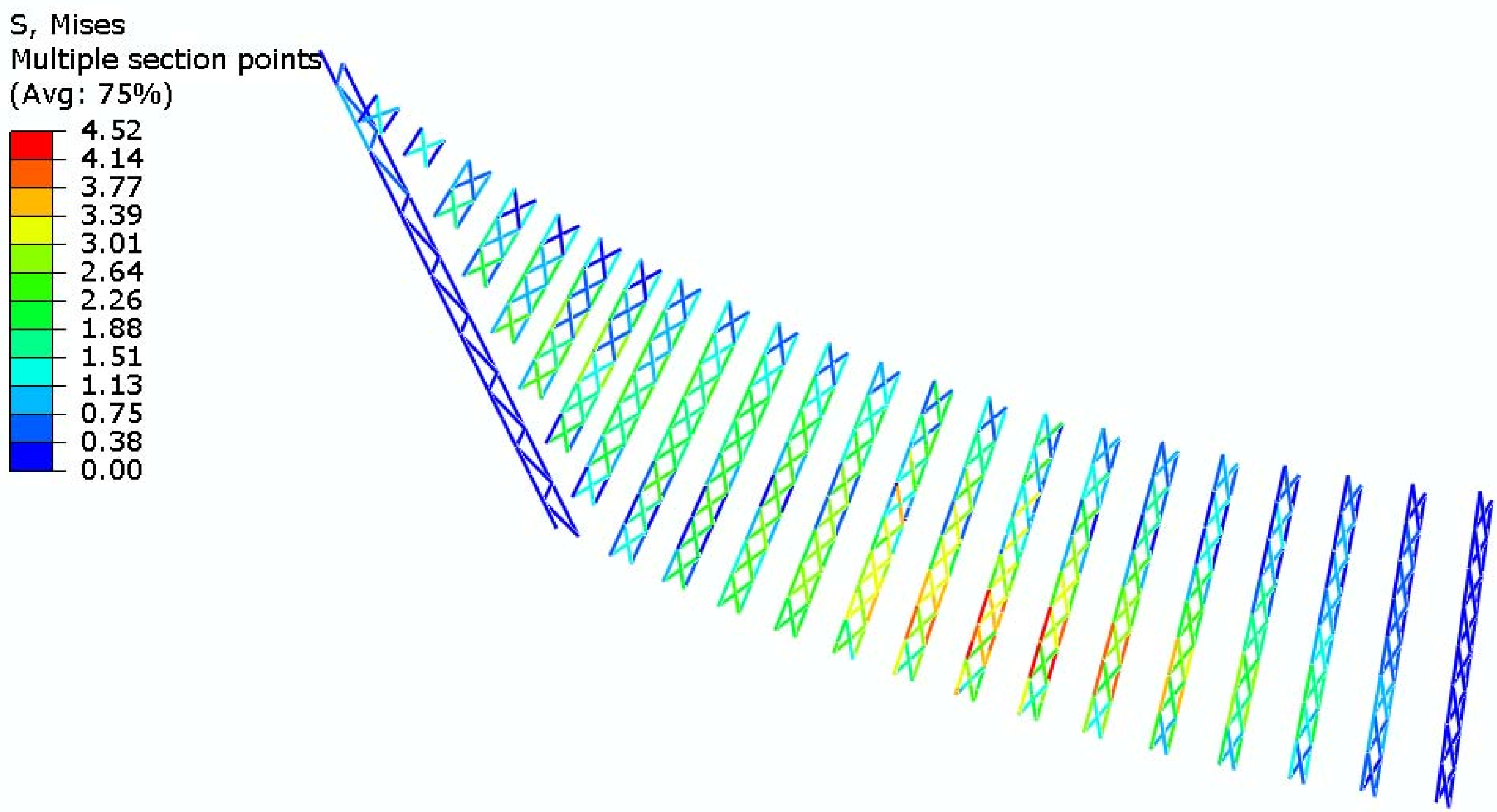


Figure Q1-4-24. Cross-frame stress contours under SDL, SDLF detailing

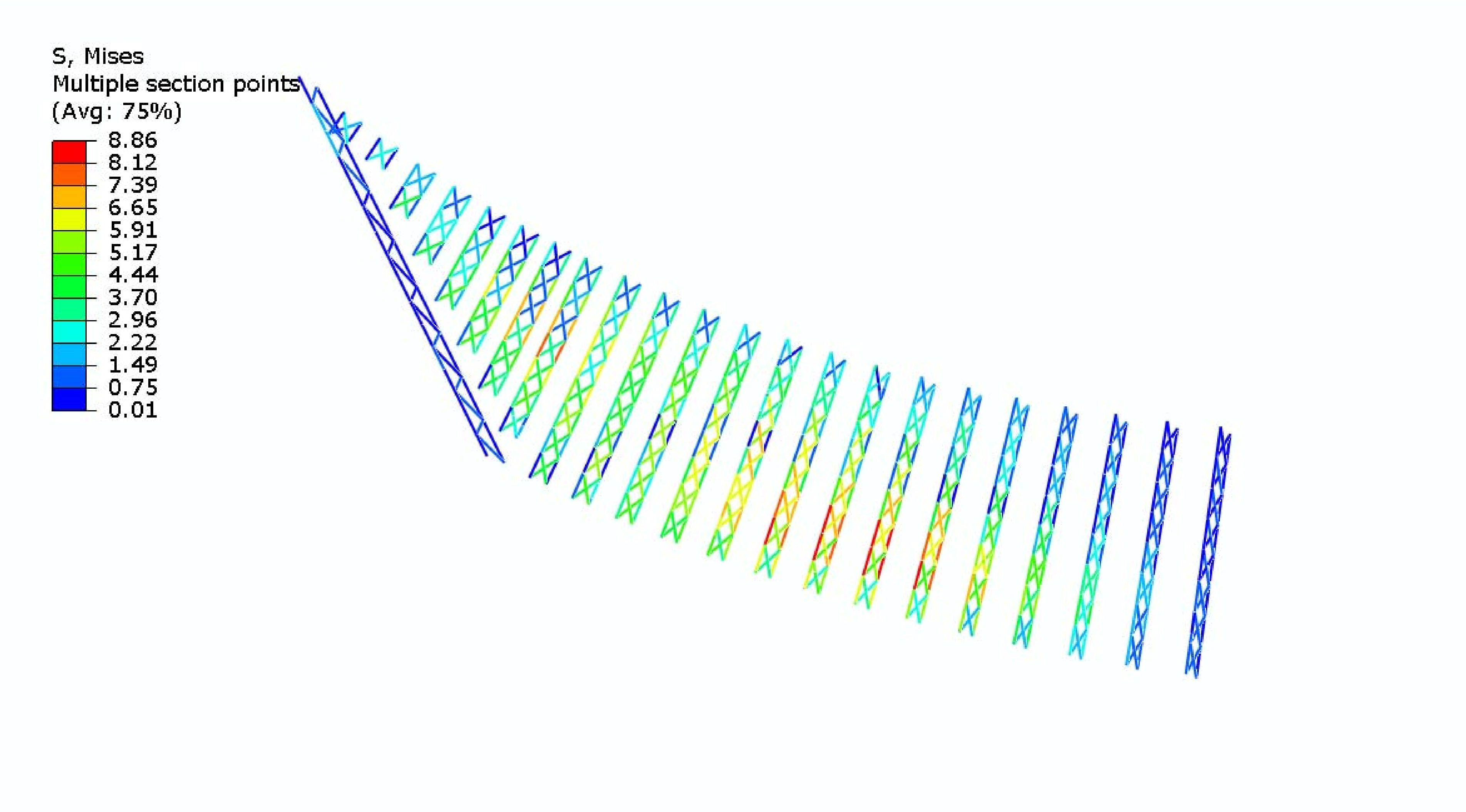


Figure Q1-4-25. Cross-frame stress contours under TDL, SDLF detailing

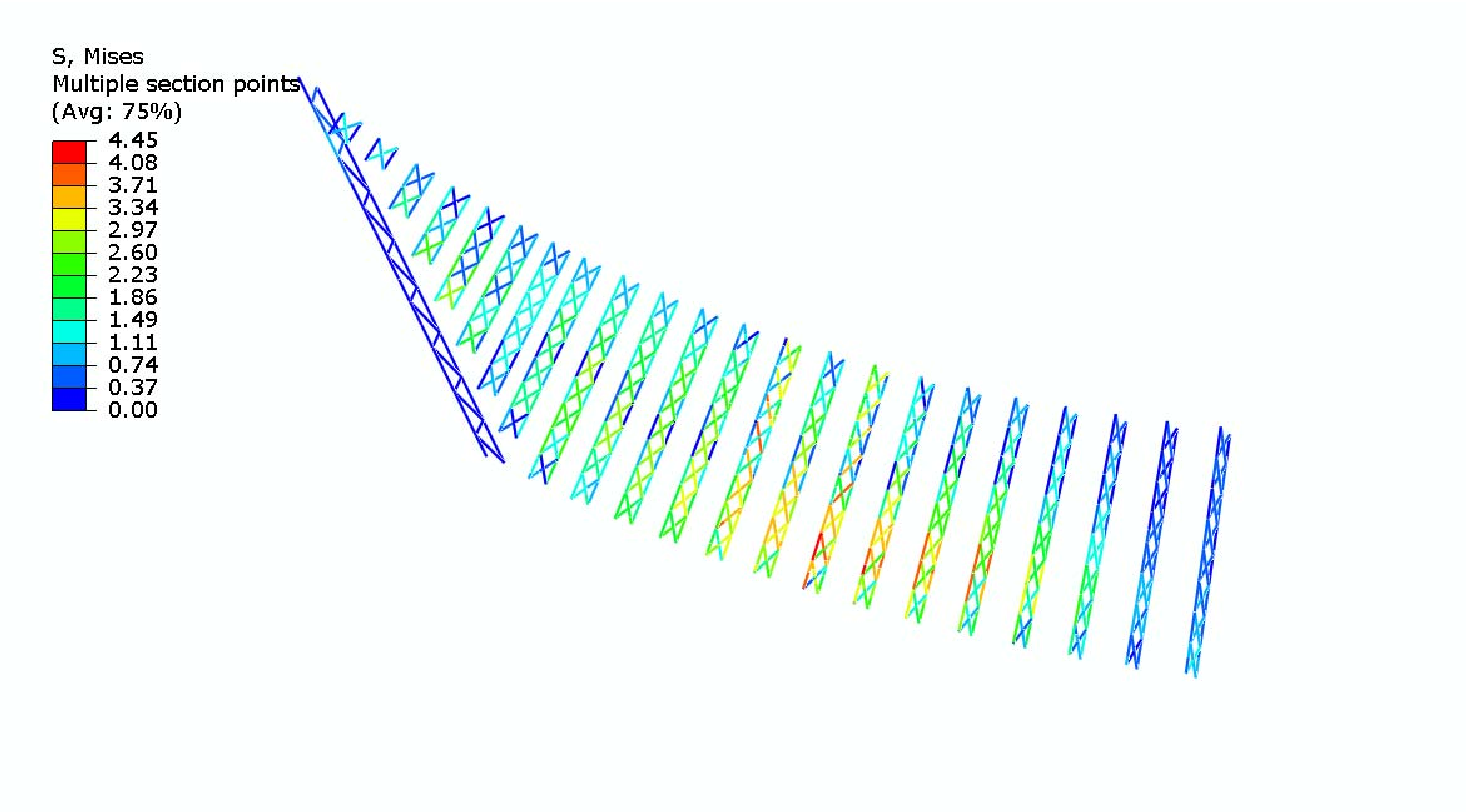


Figure Q1-4-26. Cross-frame stress contours under SDL, TDLF detailing

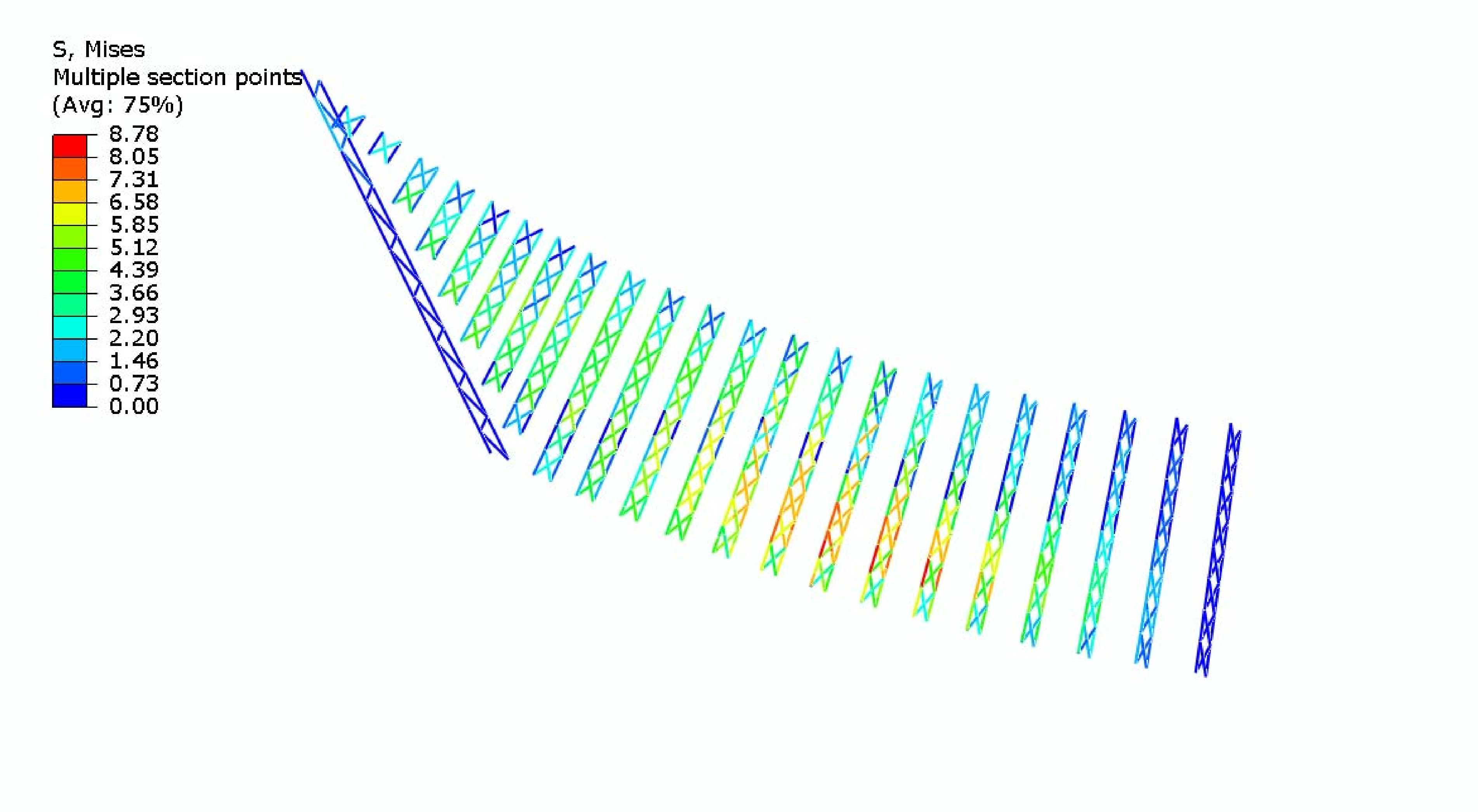


Figure Q1-4-27. **Cross-frame stress contours under TDL, TDLF detailing**

Table Q1-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.3	0.9	1.1	1.3	1.6	2.2	4.6	4.0
	SDLF	1.9	1.9	1.3	0.8	0.7	1.3	4.1	4.3
	TDLF	1.7	1.3	0.6	1.2	1.3	0.7	3.8	4.7
2	NLF	34.9	29.1	26.8	23.1	18.2	14.6	15.7	10.1
	SDLF	12.7	11.7	16.8	19.8	20.1	16.8	15.1	10.8
	TDLF	2.8	0.9	9.6	18.3	22.7	19.3	14.7	11.4
3	NLF	23.9	17.8	20.3	17.3	15.9	13.2	12.5	11.5
	SDLF	18.8	15.1	18.0	14.7	13.3	9.5	9.6	10.4
	TDLF	13.3	10.6	13.8	11.0	10.4	6.2	7.1	9.5
4	NLF	17.7	24.7	18.9	13.5	11.0	6.6	7.5	8.1
	SDLF	19.5	19.2	20.0	15.3	11.6	6.4	6.7	6.2
	TDLF	19.5	14.1	19.2	15.4	11.4	6.1	6.2	4.6
5	NLF	13.6	21.2	18.1	12.3	8.9	0.6	3.3	4.4
	SDLF	17.9	22.3	20.1	17.4	13.1	5.6	6.1	3.1
	TDLF	20.9	24.1	22.8	21.6	16.3	10.4	8.8	2.0
6	NLF	11.8	22.7	23.4	16.6	6.5	0.2	1.3	2.1
	SDLF	20.5	24.5	23.0	19.4	14.9	8.9	6.5	2.5
	TDLF	28.9	26.1	23.9	22.6	23.0	17.3	11.4	3.1
7	NLF	11.7	22.3	26.0	23.2	15.5	10.6	3.5	0.7
	SDLF	15.0	27.7	25.6	22.2	17.6	15.0	9.0	2.9
	TDLF	19.1	32.5	25.7	22.2	19.6	18.6	14.0	5.0
8	NLF	12.0	21.2	26.4	25.9	21.7	16.5	7.0	0.1
	SDLF	18.9	24.8	27.7	24.8	20.9	17.7	10.9	3.0
	TDLF	26.8	28.7	28.8	24.4	20.5	18.4	14.4	5.7
9	NLF	11.7	19.9	25.8	26.9	24.9	19.4	8.9	2.1
	SDLF	13.9	26.0	28.3	28.2	24.0	19.7	11.2	4.8
	TDLF	17.1	32.4	30.6	30.2	23.7	20.2	13.2	7.2
10	NLF	10.1	18.7	24.7	26.9	26.6	21.6	11.7	3.8
	SDLF	11.2	22.2	28.3	27.7	29.0	21.6	12.4	6.3
	TDLF	13.0	26.4	31.6	28.7	32.5	22.3	13.0	8.4

Table Q1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	8.2	17.8	23.7	26.4	27.1	23.7	14.2	3.9
	SDLF	9.0	19.9	26.8	28.9	25.9	27.8	14.2	5.7
	TDLF	10.4	22.4	30.0	31.7	25.0	33.3	14.5	7.4
12	NLF	8.1	20.3	24.8	26.8	26.6	25.4	15.9	5.1
	SDLF	7.5	17.8	25.1	27.3	28.4	22.6	21.6	5.8
	TDLF	7.2	15.1	25.1	27.7	30.9	20.1	28.5	6.5
13	NLF	6.6	14.7	24.6	28.5	25.3	25.8	16.4	6.5
	SDLF	5.9	14.2	22.7	25.2	24.0	27.4	13.5	7.3
	TDLF	5.4	13.8	20.4	21.4	22.7	29.7	11.1	8.3
14	NLF	4.0	9.5	19.5	19.5	21.2	21.9	15.6	7.5
	SDLF	3.6	9.9	19.1	20.7	21.1	19.8	21.2	16.6
	TDLF	3.7	10.1	18.4	21.7	20.9	17.8	28.0	27.1
15	NLF	10.7	5.3	13.5	15.2	16.6	12.4	14.2	7.6
	SDLF	1.1	5.3	13.8	15.9	17.8	14.8	14.6	6.0
	TDLF	10.2	5.6	13.8	16.6	19.1	17.8	15.4	5.0
16	NLF	NA	10.0	6.7	11.1	12.9	10.0	13.5	7.4
	SDLF	NA	0.8	7.3	11.2	13.9	11.8	13.1	17.0
	TDLF	NA	8.8	8.0	11.2	14.9	13.9	13.1	28.0
17	NLF	NA	NA	7.8	6.2	9.3	9.0	11.8	7.5
	SDLF	NA	NA	0.6	6.1	9.5	9.5	12.0	9.3
	TDLF	NA	NA	8.7	6.3	9.9	10.3	12.7	11.5
18	NLF	NA	NA	NA	6.5	5.2	7.2	9.3	8.2
	SDLF	NA	NA	NA	0.5	5.0	7.1	9.9	7.9
	TDLF	NA	NA	NA	5.9	5.3	7.3	10.8	7.7
19	NLF	NA	NA	NA	NA	5.7	4.5	6.6	7.8
	SDLF	NA	NA	NA	NA	0.4	4.1	7.1	7.4
	TDLF	NA	NA	NA	NA	5.7	4.3	7.8	7.2
20	NLF	NA	NA	NA	NA	NA	6.2	3.6	6.3
	SDLF	NA	NA	NA	NA	NA	0.5	3.9	6.4
	TDLF	NA	NA	NA	NA	NA	6.0	4.6	6.7

Table Q1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	NA	NA	NA	NA	NA	NA	5.3	4.4
	SDLF	NA	NA	NA	NA	NA	NA	0.4	4.8
	TDLF	NA	NA	NA	NA	NA	NA	6.0	5.4
22	NLF	NA	NA	NA	NA	NA	NA	NA	2.4
	SDLF	NA	NA	NA	NA	NA	NA	NA	2.7
	TDLF	NA	NA	NA	NA	NA	NA	NA	3.4
23	NLF	NA	NA	NA	NA	NA	NA	NA	4.8
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.4
	TDLF	NA	NA	NA	NA	NA	NA	NA	5.2

Table Q1-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	7.7	7.5	7.2	6.4	5.9	6.6	10.9	9.8
	SDLF	7.6	7.3	6.0	4.6	3.9	4.7	9.8	9.6
	TDLF	3.7	4.3	3.1	1.9	1.7	2.9	8.8	9.9
2	NLF	57.9	48.6	50.2	44.9	36.9	29.9	32.6	19.2
	SDLF	35.6	30.9	39.9	41.4	38.6	32.1	32.0	20.5
	TDLF	20.3	18.3	31.7	38.9	40.6	34.2	31.6	21.5
3	NLF	45.1	38.5	46.0	38.7	34.9	28.1	26.5	23.3
	SDLF	40.7	35.8	43.7	36.2	32.2	24.3	23.8	22.1
	TDLF	35.0	31.1	39.8	32.3	29.3	20.9	21.3	21.3
4	NLF	36.6	50.4	45.2	33.1	26.3	15.4	16.8	16.8
	SDLF	38.8	45.7	46.3	34.7	26.9	15.0	15.8	14.7
	TDLF	39.0	40.6	45.8	35.1	26.5	14.7	15.4	13.0
5	NLF	29.6	42.5	39.9	29.3	21.9	3.2	8.4	9.4
	SDLF	33.9	44.4	42.2	34.9	26.2	8.1	11.2	8.3
	TDLF	37.1	46.5	45.1	39.4	29.7	13.0	14.0	7.2
6	NLF	26.1	47.0	48.7	36.4	15.8	2.3	4.4	5.0
	SDLF	34.8	48.8	48.9	39.5	24.5	11.3	9.6	5.6
	TDLF	43.3	50.7	50.0	42.8	32.9	19.9	14.6	6.1
7	NLF	26.0	47.2	54.0	48.1	33.6	24.0	8.7	2.2
	SDLF	29.1	52.4	54.1	47.7	36.1	28.7	14.5	4.6
	TDLF	33.2	57.5	54.5	47.9	38.2	32.5	19.6	6.7
8	NLF	26.5	45.6	55.7	53.3	45.2	35.6	15.6	0.9
	SDLF	33.2	49.1	56.6	52.6	44.9	37.2	19.8	4.1
	TDLF	40.9	53.0	57.9	52.5	44.7	38.0	23.4	6.7
9	NLF	25.7	43.4	55.4	55.7	51.3	40.6	19.0	4.9
	SDLF	27.7	49.2	57.7	57.2	50.7	41.4	21.6	7.9
	TDLF	30.6	55.5	60.0	59.3	50.6	42.0	23.7	10.3
10	NLF	22.1	41.0	53.7	56.2	54.7	44.5	24.2	8.2
	SDLF	23.0	44.1	57.1	56.9	57.3	44.9	25.1	10.9
	TDLF	24.7	48.1	60.3	57.9	60.9	45.6	25.9	13.1

Table Q1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	18.0	39.0	51.8	55.8	56.0	48.6	29.0	7.9
	SDLF	18.8	41.0	54.8	57.6	54.7	53.0	29.2	10.0
	TDLF	20.0	43.3	57.8	60.4	53.8	58.5	29.5	11.7
12	NLF	17.7	44.4	55.0	56.9	55.1	52.3	32.3	10.2
	SDLF	17.0	41.7	54.9	57.2	56.4	49.4	38.0	11.1
	TDLF	16.7	38.8	54.6	57.4	58.7	47.0	44.9	11.8
13	NLF	14.4	32.4	54.8	61.4	52.7	53.1	33.1	12.9
	SDLF	13.9	31.7	52.5	57.7	50.8	54.2	30.2	13.8
	TDLF	13.3	31.1	49.9	53.6	49.3	56.4	27.7	14.8
14	NLF	8.8	21.2	43.7	42.5	44.7	45.0	31.4	14.7
	SDLF	8.3	21.6	43.1	43.4	43.9	42.2	36.4	23.8
	TDLF	8.4	21.8	42.3	44.2	43.2	40.0	43.1	34.3
15	NLF	22.4	11.7	30.6	33.1	34.8	24.3	28.5	14.9
	SDLF	12.7	11.5	30.8	33.7	35.8	26.4	28.1	13.2
	TDLF	2.6	11.8	30.7	34.2	36.9	29.0	28.8	12.2
16	NLF	NA	20.8	15.2	24.2	26.9	19.4	26.7	14.5
	SDLF	NA	11.5	15.7	24.2	27.7	20.9	26.1	23.4
	TDLF	NA	1.9	16.4	24.1	28.7	22.9	25.8	34.5
17	NLF	NA	NA	16.0	13.2	19.3	17.4	23.3	14.6
	SDLF	NA	NA	8.0	13.1	19.4	17.8	23.4	15.8
	TDLF	NA	NA	1.5	13.2	19.7	18.4	24.0	18.0
18	NLF	NA	NA	NA	13.8	10.5	13.9	18.4	16.1
	SDLF	NA	NA	NA	7.9	10.3	13.7	18.8	15.3
	TDLF	NA	NA	NA	1.4	10.5	13.8	19.6	15.1
19	NLF	NA	NA	NA	NA	12.3	8.3	13.0	15.4
	SDLF	NA	NA	NA	NA	7.0	8.0	13.4	14.6
	TDLF	NA	NA	NA	NA	1.1	8.1	14.1	14.3
20	NLF	NA	NA	NA	NA	NA	13.5	6.8	12.4
	SDLF	NA	NA	NA	NA	NA	7.7	7.0	12.3
	TDLF	NA	NA	NA	NA	NA	1.2	7.7	12.6

Table Q1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	NA	NA	NA	NA	NA	NA	11.7	8.5
	SDLF	NA	NA	NA	NA	NA	NA	6.8	8.8
	TDLF	NA	NA	NA	NA	NA	NA	1.0	9.4
22	NLF	NA	NA	NA	NA	NA	NA	NA	4.1
	SDLF	NA	NA	NA	NA	NA	NA	NA	4.6
	TDLF	NA	NA	NA	NA	NA	NA	NA	5.2
23	NLF	NA	NA	NA	NA	NA	NA	NA	10.5
	SDLF	NA	NA	NA	NA	NA	NA	NA	6.0
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.7

Table Q1-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	1.5	1.4	0.7	0.6	0.7	1.4	3.5	4.0
	SDLF	0.1	0.9	1.1	0.7	0.3	0.6	3.7	3.8
	TDLF	1.0	2.5	2.0	1.7	1.0	0.1	4.2	3.5
2	NLF	14.9	16.0	13.5	10.6	6.9	4.0	2.5	0.6
	SDLF	3.6	1.1	3.6	7.8	8.2	6.2	3.7	0.6
	TDLF	16.8	12.3	3.2	5.7	9.6	8.2	4.7	0.5
3	NLF	7.6	28.5	32.8	32.2	26.5	18.4	11.2	1.1
	SDLF	6.3	1.0	6.5	15.4	20.0	18.7	13.2	1.1
	TDLF	6.1	20.0	13.2	2.1	14.6	19.0	14.9	0.9
4	NLF	13.8	6.3	34.8	43.7	41.0	31.2	19.6	6.8
	SDLF	13.0	2.6	5.5	16.4	22.8	23.2	17.8	7.2
	TDLF	13.3	11.9	19.3	6.7	6.8	15.8	16.0	7.5
5	NLF	21.1	13.2	13.5	40.2	45.6	38.2	24.9	10.2
	SDLF	19.6	11.1	0.7	13.8	21.5	23.3	18.7	10.2
	TDLF	18.7	11.4	11.9	10.0	0.3	9.6	12.8	10.0
6	NLF	25.1	26.1	8.8	19.0	37.0	38.5	26.6	12.7
	SDLF	26.3	21.0	7.5	7.9	18.1	21.9	18.2	11.4
	TDLF	27.6	17.6	7.7	2.2	1.0	6.8	10.5	10.0
7	NLF	26.7	34.1	22.6	1.6	22.3	31.3	26.1	13.9
	SDLF	25.7	30.2	16.3	1.5	13.5	19.5	18.0	11.4
	TDLF	24.3	26.8	11.6	0.9	5.9	9.1	10.7	9.0
8	NLF	26.8	38.0	32.2	10.8	10.8	24.7	25.3	14.1
	SDLF	23.4	33.6	25.1	5.3	9.3	17.6	18.4	11.1
	TDLF	19.6	29.1	19.1	0.9	7.9	11.5	12.1	8.4
9	NLF	25.8	38.8	38.1	20.4	1.0	17.5	23.4	14.3
	SDLF	25.2	34.3	30.5	11.9	5.1	15.4	18.4	11.6
	TDLF	24.4	29.4	23.1	4.2	8.9	13.6	13.9	9.0
10	NLF	24.2	37.7	40.3	26.9	7.4	10.5	19.7	14.9
	SDLF	24.3	35.9	33.2	17.5	1.4	13.7	17.9	12.2
	TDLF	24.0	33.7	26.0	8.5	9.7	16.9	16.4	9.8

Table Q1-4-3(Continued). **Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.**

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	21.9	35.5	39.3	29.7	13.4	4.5	15.5	14.4
	SDLF	21.5	34.5	35.0	21.1	4.1	12.6	17.9	12.3
	TDLF	20.9	33.2	30.3	12.5	4.9	20.9	20.5	10.4
12	NLF	16.6	30.0	35.1	27.7	16.0	0.3	12.0	13.3
	SDLF	17.2	30.7	33.0	21.7	8.1	7.3	19.1	12.4
	TDLF	17.8	31.4	30.9	15.8	0.5	14.1	26.6	11.6
13	NLF	11.5	22.7	25.1	20.5	13.2	1.3	9.8	11.8
	SDLF	12.0	24.6	28.7	20.3	8.0	2.4	13.4	13.3
	TDLF	12.4	26.6	32.7	20.6	3.3	5.3	16.9	15.1
14	NLF	5.7	15.9	19.7	12.7	5.5	0.3	8.6	10.5
	SDLF	6.1	17.1	22.7	17.0	7.2	2.0	7.1	17.0
	TDLF	6.5	18.4	26.3	22.0	9.9	3.4	4.7	24.4
15	NLF	5.3	7.7	14.7	10.2	3.7	1.5	6.9	9.3
	SDLF	0.1	8.7	15.9	13.3	6.4	1.3	6.7	10.3
	TDLF	5.8	9.7	17.5	17.3	10.2	0.1	5.7	11.4
16	NLF	NA	5.1	7.4	8.0	3.5	1.0	3.7	8.3
	SDLF	NA	0.0	8.2	9.2	5.5	0.2	4.8	2.9
	TDLF	NA	5.4	9.4	11.1	8.4	1.6	5.4	3.5
17	NLF	NA	NA	3.6	4.2	3.1	0.6	2.1	7.0
	SDLF	NA	NA	0.1	4.8	4.0	0.4	2.7	5.6
	TDLF	NA	NA	4.1	5.9	5.8	2.3	2.7	3.8
18	NLF	NA	NA	NA	2.3	1.5	0.2	1.8	5.0
	SDLF	NA	NA	NA	0.0	2.1	0.5	1.5	5.3
	TDLF	NA	NA	NA	2.7	3.4	2.0	0.6	5.4
19	NLF	NA	NA	NA	NA	2.3	0.6	1.4	3.7
	SDLF	NA	NA	NA	NA	0.0	0.3	0.9	4.0
	TDLF	NA	NA	NA	NA	2.7	1.6	0.1	4.1
20	NLF	NA	NA	NA	NA	NA	2.8	1.3	2.9
	SDLF	NA	NA	NA	NA	NA	0.0	0.5	2.9
	TDLF	NA	NA	NA	NA	NA	3.1	0.6	2.7

Table Q1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	NA	NA	NA	NA	NA	NA	3.0	2.1
	SDLF	NA	NA	NA	NA	NA	NA	0.1	2.0
	TDLF	NA	NA	NA	NA	NA	NA	3.3	1.7
22	NLF	NA	NA	NA	NA	NA	NA	NA	1.4
	SDLF	NA	NA	NA	NA	NA	NA	NA	1.1
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.7
23	NLF	NA	NA	NA	NA	NA	NA	NA	2.7
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.1
	TDLF	NA	NA	NA	NA	NA	NA	NA	2.9

Table Q1-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	1.9	3.5	1.9	2.4	2.7	4.1	8.0	6.5
	SDLF	1.6	1.2	0.2	0.7	1.3	2.8	8.1	6.7
	TDLF	1.2	1.0	1.8	1.0	0.1	1.6	8.4	6.6
2	NLF	25.3	26.2	25.3	22.0	15.4	9.3	6.5	1.7
	SDLF	5.3	7.6	13.9	18.3	16.0	11.0	7.3	1.5
	TDLF	10.6	5.7	5.0	14.8	16.4	12.4	7.7	1.0
3	NLF	18.6	44.7	54.4	59.3	51.2	36.8	22.5	1.8
	SDLF	16.4	17.0	27.9	42.2	44.7	37.2	24.7	2.0
	TDLF	14.9	4.4	7.8	28.2	39.0	37.2	26.4	1.9
4	NLF	27.1	7.0	60.8	81.6	80.3	62.5	39.7	14.2
	SDLF	26.3	1.2	31.6	54.1	61.9	54.4	38.0	14.5
	TDLF	26.8	9.6	6.4	30.6	45.2	46.7	35.9	14.5
5	NLF	41.2	25.8	22.6	76.8	89.9	76.9	50.2	20.6
	SDLF	39.7	23.3	10.5	50.7	65.7	61.8	44.1	20.7
	TDLF	39.0	23.5	1.2	26.9	43.6	47.7	38.0	20.5
6	NLF	49.7	49.4	16.7	36.0	73.1	77.3	53.8	25.8
	SDLF	50.8	44.1	15.0	25.7	54.6	60.9	45.5	24.5
	TDLF	52.2	41.0	15.0	16.4	37.8	45.7	37.6	23.0
7	NLF	53.6	65.4	41.5	5.2	44.6	63.2	52.9	28.3
	SDLF	52.2	61.2	34.9	5.4	36.4	51.9	45.0	25.8
	TDLF	50.8	58.0	30.3	5.2	29.5	41.8	37.8	23.3
8	NLF	54.1	73.7	59.9	17.0	24.2	50.7	51.9	28.6
	SDLF	50.3	68.9	52.4	11.2	23.2	44.3	45.4	25.8
	TDLF	46.5	64.3	46.4	6.7	22.2	38.7	39.4	23.0
9	NLF	52.3	75.9	71.6	34.9	6.8	38.2	48.8	29.2
	SDLF	51.3	70.9	63.4	26.0	11.3	36.5	44.3	26.6
	TDLF	50.3	65.9	56.0	18.3	15.2	35.2	40.2	24.1
10	NLF	49.5	74.1	76.2	47.4	8.6	25.8	42.3	30.4
	SDLF	49.1	71.8	68.5	37.5	0.4	29.3	40.9	28.1
	TDLF	48.6	69.4	61.2	28.4	8.9	32.7	39.8	25.9

Table Q1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	45.1	70.3	74.4	52.6	19.9	14.7	35.0	29.7
	SDLF	44.3	68.7	69.5	43.5	10.2	23.1	37.6	28.0
	TDLF	43.4	67.1	64.6	34.8	1.1	31.5	40.5	26.4
12	NLF	34.0	59.8	66.6	48.2	24.3	7.3	28.8	27.9
	SDLF	34.5	59.8	63.8	41.8	16.1	14.5	36.0	27.2
	TDLF	34.9	60.1	61.2	35.8	8.5	21.4	43.6	26.8
13	NLF	23.7	44.6	46.3	34.0	18.1	4.8	24.9	25.5
	SDLF	24.1	46.2	49.3	33.1	12.6	8.6	28.6	27.2
	TDLF	24.4	48.1	52.9	33.0	7.9	11.6	32.2	29.1
14	NLF	12.2	31.5	35.7	17.9	1.9	7.0	22.9	23.2
	SDLF	12.5	32.4	38.4	21.8	3.3	9.5	21.4	29.8
	TDLF	12.9	33.6	41.7	26.7	5.9	11.0	19.0	37.1
15	NLF	10.6	15.4	26.8	13.8	1.3	11.1	19.5	21.2
	SDLF	5.2	16.2	27.7	16.6	1.2	10.9	19.3	22.1
	TDLF	0.6	17.2	29.1	20.4	4.9	9.7	18.3	23.2
16	NLF	NA	10.4	13.5	11.2	0.4	9.3	12.6	19.3
	SDLF	NA	5.3	14.1	12.1	1.4	8.6	13.7	13.8
	TDLF	NA	0.1	15.1	13.9	4.3	6.8	14.2	7.5
17	NLF	NA	NA	7.6	5.7	0.8	7.3	8.7	16.4
	SDLF	NA	NA	3.9	6.1	1.6	6.4	9.3	15.0
	TDLF	NA	NA	0.2	7.2	3.3	4.5	9.2	13.2
18	NLF	NA	NA	NA	5.0	0.1	4.8	7.2	12.2
	SDLF	NA	NA	NA	2.6	0.6	4.2	6.9	12.5
	TDLF	NA	NA	NA	0.0	1.8	2.7	6.0	12.5
19	NLF	NA	NA	NA	NA	5.0	3.4	5.3	9.2
	SDLF	NA	NA	NA	NA	2.7	2.7	4.9	9.5
	TDLF	NA	NA	NA	NA	0.1	1.4	3.8	9.5
20	NLF	NA	NA	NA	NA	NA	5.9	3.8	7.1
	SDLF	NA	NA	NA	NA	NA	3.2	3.1	7.1
	TDLF	NA	NA	NA	NA	NA	0.2	2.0	6.8

Table Q1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	NA	NA	NA	NA	NA	NA	6.4	4.9
	SDLF	NA	NA	NA	NA	NA	NA	3.6	4.8
	TDLF	NA	NA	NA	NA	NA	NA	0.2	4.5
22	NLF	NA	NA	NA	NA	NA	NA	NA	2.9
	SDLF	NA	NA	NA	NA	NA	NA	NA	2.6
	TDLF	NA	NA	NA	NA	NA	NA	NA	2.1
23	NLF	NA	NA	NA	NA	NA	NA	NA	5.6
	SDLF	NA	NA	NA	NA	NA	NA	NA	3.1
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.0

Table Q1-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	3.1	1.8	0.8	0.6	0.8	1.9	5.9	6.5
	SDLF	1.3	1.2	1.2	0.4	0.5	1.7	6.7	5.9
	TDLF	1.0	1.4	0.4	0.8	1.5	1.8	7.7	5.4
2	NLF	14.1	14.5	11.1	8.7	5.3	2.9	1.7	0.7
	SDLF	3.7	1.3	3.0	7.4	7.8	5.9	3.5	0.6
	TDLF	13.8	9.7	0.4	7.7	11.1	9.1	5.4	0.5
3	NLF	5.9	29.0	32.7	31.7	26.1	18.1	11.3	1.5
	SDLF	6.6	1.3	6.5	15.3	19.9	18.6	13.1	1.2
	TDLF	9.1	19.0	12.8	3.0	15.4	19.5	14.8	1.1
4	NLF	13.0	7.7	35.1	43.4	40.3	30.7	19.2	6.4
	SDLF	13.5	2.6	5.3	16.3	22.6	23.0	17.6	7.2
	TDLF	14.9	13.7	19.3	6.1	7.7	16.4	16.2	8.0
5	NLF	20.7	12.3	14.7	40.9	45.5	37.6	24.5	10.3
	SDLF	18.7	11.4	0.6	13.8	21.4	23.1	18.4	10.2
	TDLF	17.2	13.0	13.7	10.1	0.0	10.1	12.8	10.1
6	NLF	24.7	25.8	8.5	20.0	37.9	38.6	26.2	12.5
	SDLF	20.9	20.7	8.0	7.9	17.9	21.7	17.8	11.3
	TDLF	17.1	17.1	9.2	3.4	0.3	6.4	10.3	10.1
7	NLF	26.4	33.7	22.6	2.1	23.1	32.1	26.2	13.7
	SDLF	26.4	27.3	16.9	1.2	13.4	19.4	17.6	11.2
	TDLF	26.3	21.4	12.7	0.2	4.9	8.4	10.1	9.0
8	NLF	26.5	37.8	32.2	10.6	11.3	25.4	25.8	13.9
	SDLF	30.2	34.3	24.4	6.3	8.9	17.6	18.2	10.9
	TDLF	33.7	30.7	17.7	3.1	6.7	10.8	11.5	8.3
9	NLF	25.5	38.7	38.3	20.3	1.2	18.1	23.9	14.5
	SDLF	27.4	38.5	31.2	13.1	3.4	15.1	18.4	11.4
	TDLF	29.1	37.9	24.5	6.9	5.2	12.6	13.4	8.8
10	NLF	23.9	37.7	40.5	27.0	7.3	10.8	20.0	15.2
	SDLF	25.0	37.5	35.5	17.9	2.1	11.5	17.6	12.2
	TDLF	25.9	36.8	30.1	9.2	2.3	12.1	15.6	9.6

Table Q1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	21.4	35.3	39.8	29.9	13.5	4.6	15.7	14.7
	SDLF	22.1	35.2	35.9	20.7	4.4	7.0	15.2	12.4
	TDLF	22.7	34.7	31.5	11.3	4.3	8.8	14.7	10.2
12	NLF	16.4	29.4	35.0	28.0	16.2	0.3	12.1	13.4
	SDLF	17.7	31.3	33.7	21.4	5.3	7.2	10.9	12.1
	TDLF	19.1	33.2	32.1	14.7	5.6	13.8	9.2	11.0
13	NLF	11.0	22.7	25.0	20.2	13.3	1.3	9.7	11.9
	SDLF	12.3	25.1	29.2	20.3	6.8	7.8	13.3	10.3
	TDLF	13.6	27.9	33.7	20.8	0.5	17.0	16.5	8.6
14	NLF	5.9	15.5	20.0	12.9	5.4	0.2	8.5	10.5
	SDLF	6.4	17.4	23.2	17.2	7.0	4.1	15.2	5.3
	TDLF	6.8	19.6	27.1	22.4	9.5	7.9	22.1	0.6
15	NLF	NA	8.3	14.4	10.3	3.9	1.3	7.0	9.3
	SDLF	NA	8.9	16.2	13.4	6.6	1.3	9.4	10.2
	TDLF	NA	9.5	18.5	17.5	10.5	0.3	11.4	10.7
16	NLF	NA	4.9	8.3	7.7	3.6	0.8	3.5	8.3
	SDLF	NA	0.3	8.5	9.3	5.6	0.0	4.8	14.9
	TDLF	NA	4.7	8.9	11.6	8.7	1.9	5.5	22.1
17	NLF	NA	NA	4.3	5.0	2.8	0.5	2.0	7.0
	SDLF	NA	NA	0.3	4.9	4.1	0.6	2.4	8.9
	TDLF	NA	NA	4.1	5.2	6.3	2.6	2.2	10.8
18	NLF	NA	NA	NA	3.8	2.2	0.6	1.7	4.9
	SDLF	NA	NA	NA	0.2	2.2	0.6	1.3	5.8
	TDLF	NA	NA	NA	3.7	2.7	2.5	0.2	6.3
19	NLF	NA	NA	NA	NA	3.2	0.1	1.7	3.6
	SDLF	NA	NA	NA	NA	0.1	0.4	0.8	4.1
	TDLF	NA	NA	NA	NA	3.3	1.0	0.7	4.3
20	NLF	NA	NA	NA	NA	NA	2.7	0.8	2.9
	SDLF	NA	NA	NA	NA	NA	0.0	0.4	2.9
	TDLF	NA	NA	NA	NA	NA	3.0	0.2	2.7

Table Q1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
21	NLF	NA	NA	NA	NA	NA	NA	2.5	2.2
	SDLF	NA	NA	NA	NA	NA	NA	0.0	1.9
	TDLF	NA	NA	NA	NA	NA	NA	2.8	1.4
22	NLF	NA	NA	NA	NA	NA	NA	NA	1.1
	SDLF	NA	NA	NA	NA	NA	NA	NA	1.0
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.8
23	NLF	NA	NA	NA	NA	NA	NA	NA	2.3
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	NA	NA	2.9

Table Q1-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	4.5	4.3	6.6	6.1	5.3	4.3	12.5	14.4
	SDLF	4.2	5.1	6.4	4.6	3.2	3.9	13.5	13.4
	TDLF	3.4	2.9	3.2	1.5	1.1	3.9	14.8	12.6
2	NLF	13.8	14.9	12.1	12.0	7.3	3.8	1.7	2.6
	SDLF	3.6	0.3	4.6	11.2	10.4	7.2	3.8	2.6
	TDLF	11.8	7.2	2.5	12.7	14.4	10.9	6.3	2.3
3	NLF	10.3	42.5	52.0	55.3	48.5	34.6	22.3	2.7
	SDLF	11.7	14.9	25.8	38.8	42.5	35.3	24.0	2.2
	TDLF	15.4	4.4	7.1	27.1	38.4	36.5	25.8	2.0
4	NLF	25.5	13.2	59.0	78.5	75.9	59.3	37.6	11.8
	SDLF	26.4	2.2	29.1	51.6	58.5	52.0	36.2	12.8
	TDLF	28.1	9.7	5.4	30.0	44.3	45.9	35.1	14.0
5	NLF	40.9	22.8	28.2	77.2	87.5	73.3	48.0	20.3
	SDLF	39.0	22.3	13.3	49.9	63.7	59.2	42.3	20.3
	TDLF	37.6	24.4	1.6	26.6	43.0	46.9	37.1	20.2
6	NLF	49.3	49.4	15.2	40.7	74.7	76.4	51.6	24.7
	SDLF	45.4	44.3	15.0	28.1	54.6	59.7	43.5	23.6
	TDLF	41.7	40.8	16.5	16.4	37.3	44.9	36.4	22.6
7	NLF	53.3	65.0	41.9	6.9	47.9	64.7	52.3	27.0
	SDLF	53.1	58.4	36.1	5.8	38.0	51.9	43.9	24.7
	TDLF	53.0	52.7	32.0	4.3	29.3	41.2	36.7	22.6
8	NLF	53.9	73.7	60.3	16.9	26.1	53.6	52.8	27.5
	SDLF	57.3	69.9	52.3	12.5	23.6	45.7	45.3	24.7
	TDLF	60.7	66.3	45.7	9.3	21.3	38.8	38.8	22.3
9	NLF	52.4	76.2	72.3	35.0	7.1	40.0	50.5	28.9
	SDLF	53.8	75.5	64.9	27.6	9.4	37.0	45.1	26.0
	TDLF	55.3	74.8	58.1	21.5	11.2	34.5	40.1	23.6
10	NLF	49.3	74.9	77.2	47.9	8.7	26.2	43.4	30.9
	SDLF	49.9	74.0	71.6	38.4	3.4	27.0	41.0	28.0
	TDLF	50.6	73.0	66.0	29.7	1.0	27.7	39.1	25.6

Table Q1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	44.1	70.3	76.3	53.5	20.5	14.7	35.2	30.6
	SDLF	44.5	69.5	71.6	43.8	11.1	17.2	34.7	28.3
	TDLF	44.9	68.7	66.9	34.3	2.4	19.1	34.4	26.2
12	NLF	34.1	58.2	66.2	49.6	25.3	6.8	28.6	28.4
	SDLF	35.1	59.7	64.4	42.4	14.2	13.8	27.4	27.1
	TDLF	36.3	61.4	62.7	35.5	3.1	20.5	25.8	26.0
13	NLF	23.1	45.3	46.2	33.1	18.7	4.2	24.3	25.5
	SDLF	24.2	47.2	49.9	32.9	11.9	13.5	28.0	23.9
	TDLF	25.4	49.6	54.3	33.3	5.5	22.8	31.3	22.4
14	NLF	12.8	30.8	36.9	18.6	2.0	7.2	22.3	23.0
	SDLF	13.2	32.5	39.6	22.4	3.3	11.5	29.1	17.7
	TDLF	13.5	34.5	43.2	27.5	5.9	15.3	36.0	11.9
15	NLF	NA	16.6	26.5	14.5	0.4	10.0	19.4	20.7
	SDLF	NA	17.1	28.0	17.2	2.0	10.3	21.8	21.6
	TDLF	NA	17.7	30.1	21.1	5.7	9.3	23.7	22.2
16	NLF	NA	10.3	15.2	10.7	0.3	8.5	11.7	18.9
	SDLF	NA	5.6	15.3	12.0	2.0	7.8	13.1	25.5
	TDLF	NA	0.7	15.7	14.2	4.9	6.0	13.8	32.7
17	NLF	NA	NA	9.1	7.4	0.4	6.7	8.0	16.2
	SDLF	NA	NA	5.1	7.2	1.5	5.8	8.5	18.1
	TDLF	NA	NA	0.7	7.4	3.6	3.8	8.3	19.9
18	NLF	NA	NA	NA	7.9	1.6	5.3	6.7	11.7
	SDLF	NA	NA	NA	4.3	1.6	4.2	6.3	12.5
	TDLF	NA	NA	NA	0.4	2.0	2.3	5.3	13.0
19	NLF	NA	NA	NA	NA	6.7	2.0	5.6	8.7
	SDLF	NA	NA	NA	NA	3.7	1.7	4.8	9.2
	TDLF	NA	NA	NA	NA	0.3	1.1	3.3	9.3
20	NLF	NA	NA	NA	NA	NA	5.8	2.7	6.7
	SDLF	NA	NA	NA	NA	NA	3.2	2.3	6.8
	TDLF	NA	NA	NA	NA	NA	0.2	1.6	6.6

Table Q1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	NA	NA	NA	NA	NA	NA	5.5	5.0
	SDLF	NA	NA	NA	NA	NA	NA	3.0	4.7
	TDLF	NA	NA	NA	NA	NA	NA	0.2	4.2
22	NLF	NA	NA	NA	NA	NA	NA	NA	2.2
	SDLF	NA	NA	NA	NA	NA	NA	NA	2.0
	TDLF	NA	NA	NA	NA	NA	NA	NA	1.8
23	NLF	NA	NA	NA	NA	NA	NA	NA	5.3
	SDLF	NA	NA	NA	NA	NA	NA	NA	3.0
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.3

Table Q1-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.68	-0.76	-0.80	-0.84	-0.88	-0.93	-0.98	-1.06
	SDLF	-0.76	-0.87	-0.93	-0.98	-1.02	-1.08	-1.16	-1.30
	TDLF	-0.86	-0.99	-1.08	-1.15	-1.21	-1.28	-1.38	-1.61
3	NLF	-0.51	-0.65	-0.74	-0.78	-0.82	-0.87	-0.92	-1.02
	SDLF	-0.58	-0.74	-0.85	-0.90	-0.94	-0.99	-1.06	-1.23
	TDLF	-0.66	-0.85	-0.98	-1.05	-1.10	-1.16	-1.25	-1.48
4	NLF	-0.35	-0.51	-0.63	-0.71	-0.75	-0.79	-0.85	-0.97
	SDLF	-0.39	-0.58	-0.72	-0.80	-0.85	-0.89	-0.96	-1.13
	TDLF	-0.46	-0.68	-0.84	-0.94	-0.99	-1.03	-1.11	-1.35
5	NLF	-0.22	-0.37	-0.50	-0.60	-0.67	-0.71	-0.77	-0.91
	SDLF	-0.23	-0.42	-0.57	-0.68	-0.75	-0.79	-0.86	-1.03
	TDLF	-0.27	-0.49	-0.67	-0.79	-0.87	-0.90	-0.98	-1.20
6	NLF	-0.10	-0.24	-0.37	-0.48	-0.56	-0.63	-0.69	-0.83
	SDLF	-0.09	-0.27	-0.43	-0.55	-0.63	-0.70	-0.76	-0.93
	TDLF	-0.11	-0.33	-0.52	-0.65	-0.73	-0.79	-0.86	-1.07
7	NLF	-0.01	-0.13	-0.26	-0.38	-0.47	-0.54	-0.61	-0.76
	SDLF	0.02	-0.15	-0.31	-0.44	-0.53	-0.60	-0.67	-0.83
	TDLF	0.02	-0.19	-0.38	-0.52	-0.62	-0.68	-0.75	-0.93
8	NLF	0.06	-0.04	-0.16	-0.27	-0.37	-0.45	-0.52	-0.68
	SDLF	0.10	-0.04	-0.19	-0.33	-0.43	-0.50	-0.56	-0.73
	TDLF	0.12	-0.07	-0.26	-0.40	-0.51	-0.58	-0.62	-0.81
9	NLF	0.10	0.03	-0.07	-0.18	-0.28	-0.36	-0.43	-0.60
	SDLF	0.15	0.04	-0.10	-0.22	-0.33	-0.40	-0.46	-0.64
	TDLF	0.18	0.03	-0.15	-0.29	-0.40	-0.47	-0.51	-0.70
10	NLF	0.13	0.08	0.00	-0.09	-0.19	-0.27	-0.34	-0.50
	SDLF	0.17	0.09	-0.02	-0.13	-0.24	-0.31	-0.37	-0.53
	TDLF	0.20	0.09	-0.06	-0.20	-0.31	-0.38	-0.41	-0.58

Table Q1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.13	0.10	0.04	-0.03	-0.11	-0.18	-0.25	-0.41
	SDLF	0.17	0.12	0.03	-0.06	-0.15	-0.23	-0.28	-0.43
	TDLF	0.20	0.12	0.00	-0.12	-0.22	-0.29	-0.32	-0.46
12	NLF	0.11	0.10	0.07	0.02	-0.04	-0.11	-0.17	-0.32
	SDLF	0.15	0.12	0.06	-0.01	-0.09	-0.15	-0.20	-0.33
	TDLF	0.18	0.12	0.03	-0.06	-0.14	-0.21	-0.24	-0.36
13	NLF	0.09	0.09	0.08	0.04	0.01	-0.05	-0.10	-0.24
	SDLF	0.11	0.11	0.07	0.02	-0.03	-0.09	-0.13	-0.25
	TDLF	0.13	0.11	0.04	-0.03	-0.08	-0.14	-0.16	-0.27
14	NLF	0.05	0.08	0.08	0.07	0.04	0.00	-0.04	-0.16
	SDLF	0.06	0.09	0.07	0.05	0.01	-0.03	-0.06	-0.17
	TDLF	0.07	0.09	0.05	0.01	-0.03	-0.07	-0.10	-0.19
15	NLF	0.00	0.04	0.06	0.07	0.06	0.05	0.01	-0.08
	SDLF	0.00	0.05	0.06	0.06	0.04	0.02	-0.01	-0.10
	TDLF	0.00	0.05	0.04	0.03	0.01	-0.01	-0.04	-0.11
16	NLF	NA	0.00	0.04	0.06	0.07	0.07	0.05	-0.02
	SDLF	NA	0.00	0.03	0.05	0.05	0.05	0.03	-0.04
	TDLF	NA	0.00	0.03	0.03	0.02	0.02	0.00	-0.05
17	NLF	NA	NA	0.00	0.03	0.05	0.07	0.07	0.02
	SDLF	NA	NA	0.00	0.03	0.04	0.05	0.05	0.01
	TDLF	NA	NA	0.00	0.02	0.03	0.04	0.03	-0.01
18	NLF	NA	NA	NA	0.00	0.03	0.05	0.07	0.06
	SDLF	NA	NA	NA	0.00	0.02	0.04	0.05	0.04
	TDLF	NA	NA	NA	0.00	0.02	0.03	0.04	0.03
19	NLF	NA	NA	NA	NA	0.00	0.03	0.06	0.07
	SDLF	NA	NA	NA	NA	0.00	0.02	0.04	0.06
	TDLF	NA	NA	NA	NA	0.00	0.02	0.04	0.05
20	NLF	NA	NA	NA	NA	NA	0.00	0.03	0.07
	SDLF	NA	NA	NA	NA	NA	0.00	0.03	0.06
	TDLF	NA	NA	NA	NA	NA	0.00	0.02	0.05

Table Q1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	NA	NA	NA	NA	NA	NA	0.00	0.06
	SDLF	NA	NA	NA	NA	NA	NA	0.00	0.05
	TDLF	NA	NA	NA	NA	NA	NA	0.00	0.04
22	NLF	NA	NA	NA	NA	NA	NA	NA	0.03
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.03
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.03
23	NLF	NA	NA	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.00

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Table Q1-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-1.43	-1.61	-1.71	-1.79	-1.88	-1.98	-2.09	-2.26
	SDLF	-1.52	-1.71	-1.83	-1.93	-2.02	-2.13	-2.27	-2.50
	TDLF	-1.61	-1.83	-1.98	-2.09	-2.20	-2.33	-2.49	-2.80
3	NLF	-1.12	-1.40	-1.58	-1.68	-1.76	-1.86	-1.97	-2.18
	SDLF	-1.19	-1.48	-1.69	-1.79	-1.88	-1.98	-2.11	-2.39
	TDLF	-1.27	-1.59	-1.82	-1.93	-2.03	-2.14	-2.29	-2.64
4	NLF	-0.82	-1.13	-1.37	-1.53	-1.62	-1.71	-1.82	-2.07
	SDLF	-0.87	-1.20	-1.46	-1.62	-1.71	-1.80	-1.93	-2.23
	TDLF	-0.93	-1.29	-1.57	-1.75	-1.85	-1.93	-2.08	-2.44
5	NLF	-0.56	-0.85	-1.11	-1.31	-1.46	-1.54	-1.66	-1.94
	SDLF	-0.57	-0.90	-1.18	-1.39	-1.54	-1.62	-1.74	-2.06
	TDLF	-0.61	-0.97	-1.28	-1.50	-1.65	-1.73	-1.86	-2.23
6	NLF	-0.32	-0.60	-0.87	-1.08	-1.24	-1.38	-1.50	-1.79
	SDLF	-0.31	-0.64	-0.92	-1.15	-1.31	-1.44	-1.56	-1.88
	TDLF	-0.33	-0.69	-1.01	-1.25	-1.40	-1.54	-1.66	-2.01
7	NLF	-0.13	-0.38	-0.64	-0.87	-1.05	-1.20	-1.34	-1.63
	SDLF	-0.11	-0.40	-0.69	-0.93	-1.11	-1.26	-1.39	-1.70
	TDLF	-0.10	-0.44	-0.76	-1.01	-1.20	-1.34	-1.47	-1.80
8	NLF	0.01	-0.20	-0.43	-0.66	-0.86	-1.02	-1.16	-1.47
	SDLF	0.05	-0.20	-0.47	-0.71	-0.91	-1.07	-1.19	-1.52
	TDLF	0.07	-0.22	-0.53	-0.79	-0.99	-1.14	-1.25	-1.60
9	NLF	0.11	-0.05	-0.25	-0.47	-0.66	-0.83	-0.97	-1.31
	SDLF	0.16	-0.04	-0.28	-0.51	-0.71	-0.88	-1.00	-1.35
	TDLF	0.18	-0.05	-0.33	-0.58	-0.79	-0.94	-1.05	-1.41
10	NLF	0.17	0.05	-0.11	-0.30	-0.48	-0.65	-0.79	-1.12
	SDLF	0.21	0.07	-0.13	-0.34	-0.53	-0.69	-0.81	-1.14
	TDLF	0.24	0.06	-0.17	-0.40	-0.60	-0.75	-0.86	-1.19

Table Q1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	0.18	0.11	-0.01	-0.16	-0.32	-0.47	-0.61	-0.93
	SDLF	0.23	0.13	-0.02	-0.19	-0.37	-0.52	-0.64	-0.95
	TDLF	0.25	0.13	-0.06	-0.25	-0.43	-0.58	-0.68	-0.98
12	NLF	0.17	0.12	0.05	-0.06	-0.18	-0.32	-0.44	-0.75
	SDLF	0.21	0.14	0.04	-0.09	-0.23	-0.36	-0.47	-0.76
	TDLF	0.23	0.14	0.01	-0.14	-0.28	-0.42	-0.51	-0.78
13	NLF	0.14	0.13	0.08	0.01	-0.08	-0.19	-0.29	-0.57
	SDLF	0.16	0.15	0.07	-0.02	-0.11	-0.23	-0.32	-0.58
	TDLF	0.18	0.15	0.04	-0.06	-0.16	-0.28	-0.35	-0.60
14	NLF	0.08	0.11	0.09	0.07	0.01	-0.07	-0.16	-0.41
	SDLF	0.09	0.12	0.09	0.05	-0.02	-0.11	-0.19	-0.42
	TDLF	0.10	0.12	0.07	0.01	-0.06	-0.15	-0.22	-0.44
15	NLF	0.00	0.06	0.08	0.09	0.07	0.03	-0.05	-0.26
	SDLF	0.00	0.07	0.08	0.07	0.04	0.00	-0.07	-0.27
	TDLF	0.00	0.07	0.06	0.05	0.01	-0.03	-0.10	-0.29
16	NLF	NA	0.00	0.05	0.08	0.09	0.09	0.04	-0.13
	SDLF	NA	0.00	0.05	0.07	0.07	0.06	0.01	-0.14
	TDLF	NA	0.00	0.04	0.05	0.04	0.04	-0.01	-0.16
17	NLF	NA	NA	0.00	0.04	0.08	0.10	0.09	-0.02
	SDLF	NA	NA	0.00	0.04	0.06	0.08	0.07	-0.04
	TDLF	NA	NA	0.00	0.03	0.05	0.06	0.05	-0.05
18	NLF	NA	NA	NA	0.00	0.04	0.08	0.10	0.06
	SDLF	NA	NA	NA	0.00	0.04	0.07	0.08	0.04
	TDLF	NA	NA	NA	0.00	0.03	0.06	0.07	0.03
19	NLF	NA	NA	NA	NA	0.00	0.05	0.09	0.10
	SDLF	NA	NA	NA	NA	0.00	0.04	0.08	0.09
	TDLF	NA	NA	NA	NA	0.00	0.03	0.07	0.07
20	NLF	NA	NA	NA	NA	NA	0.00	0.05	0.11
	SDLF	NA	NA	NA	NA	NA	0.00	0.04	0.10
	TDLF	NA	NA	NA	NA	NA	0.00	0.04	0.09

Table Q1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	NA	NA	NA	NA	NA	NA	0.00	0.09
	SDLF	NA	NA	NA	NA	NA	NA	0.00	0.09
	TDLF	NA	NA	NA	NA	NA	NA	0.00	0.08
22	NLF	NA	NA	NA	NA	NA	NA	NA	0.05
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.05
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.05
23	NLF	NA	NA	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.00

Table Q1-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.83	-0.93	-0.99	-1.03	-1.08	-1.14	-1.20	-1.29
	SDLF	-0.94	-1.06	-1.14	-1.20	-1.26	-1.33	-1.42	-1.60
	TDLF	-1.06	-1.21	-1.32	-1.40	-1.48	-1.57	-1.69	-1.97
3	NLF	-0.62	-0.79	-0.90	-0.96	-1.01	-1.06	-1.13	-1.25
	SDLF	-0.71	-0.90	-1.04	-1.10	-1.15	-1.22	-1.30	-1.50
	TDLF	-0.81	-1.04	-1.21	-1.28	-1.35	-1.42	-1.53	-1.82
4	NLF	-0.43	-0.62	-0.77	-0.86	-0.92	-0.97	-1.04	-1.19
	SDLF	-0.48	-0.71	-0.88	-0.98	-1.04	-1.09	-1.18	-1.39
	TDLF	-0.56	-0.83	-1.03	-1.15	-1.21	-1.26	-1.36	-1.65
5	NLF	-0.27	-0.45	-0.61	-0.73	-0.82	-0.87	-0.95	-1.11
	SDLF	-0.28	-0.51	-0.70	-0.83	-0.92	-0.97	-1.05	-1.27
	TDLF	-0.33	-0.61	-0.82	-0.97	-1.07	-1.11	-1.20	-1.47
6	NLF	-0.12	-0.30	-0.46	-0.59	-0.69	-0.78	-0.85	-1.02
	SDLF	-0.11	-0.34	-0.53	-0.68	-0.77	-0.85	-0.93	-1.14
	TDLF	-0.13	-0.41	-0.64	-0.80	-0.89	-0.97	-1.05	-1.31
7	NLF	-0.01	-0.16	-0.32	-0.46	-0.57	-0.67	-0.75	-0.93
	SDLF	0.03	-0.18	-0.38	-0.54	-0.65	-0.73	-0.82	-1.01
	TDLF	0.03	-0.23	-0.47	-0.64	-0.76	-0.84	-0.92	-1.14
8	NLF	0.07	-0.05	-0.19	-0.33	-0.45	-0.56	-0.64	-0.83
	SDLF	0.12	-0.05	-0.24	-0.40	-0.52	-0.62	-0.69	-0.89
	TDLF	0.14	-0.08	-0.31	-0.50	-0.62	-0.71	-0.77	-1.00
9	NLF	0.13	0.04	-0.09	-0.22	-0.34	-0.44	-0.53	-0.73
	SDLF	0.19	0.05	-0.12	-0.27	-0.40	-0.50	-0.56	-0.78
	TDLF	0.21	0.03	-0.18	-0.36	-0.49	-0.58	-0.63	-0.86
10	NLF	0.15	0.09	0.00	-0.12	-0.23	-0.33	-0.42	-0.62
	SDLF	0.21	0.12	-0.02	-0.17	-0.29	-0.38	-0.45	-0.65
	TDLF	0.25	0.11	-0.08	-0.24	-0.38	-0.46	-0.51	-0.71

Table Q1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	0.16	0.12	0.05	-0.03	-0.13	-0.23	-0.31	-0.50
	SDLF	0.21	0.15	0.04	-0.08	-0.19	-0.28	-0.34	-0.52
	TDLF	0.25	0.14	0.00	-0.15	-0.27	-0.35	-0.39	-0.57
12	NLF	0.14	0.12	0.08	0.02	-0.05	-0.14	-0.21	-0.39
	SDLF	0.19	0.14	0.07	-0.02	-0.11	-0.19	-0.24	-0.41
	TDLF	0.22	0.14	0.04	-0.08	-0.18	-0.26	-0.29	-0.44
13	NLF	0.11	0.12	0.09	0.05	0.01	-0.06	-0.12	-0.29
	SDLF	0.14	0.14	0.09	0.02	-0.04	-0.11	-0.15	-0.30
	TDLF	0.16	0.14	0.05	-0.03	-0.10	-0.17	-0.20	-0.33
14	NLF	0.06	0.09	0.09	0.08	0.05	0.00	-0.05	-0.19
	SDLF	0.08	0.11	0.09	0.06	0.01	-0.04	-0.08	-0.20
	TDLF	0.09	0.11	0.06	0.02	-0.04	-0.09	-0.12	-0.23
15	NLF	0.00	0.05	0.07	0.08	0.08	0.06	0.02	-0.10
	SDLF	0.00	0.06	0.07	0.07	0.05	0.03	-0.01	-0.12
	TDLF	0.00	0.06	0.05	0.04	0.01	-0.01	-0.05	-0.14
16	NLF	NA	0.00	0.04	0.07	0.08	0.08	0.06	-0.03
	SDLF	NA	0.00	0.04	0.06	0.06	0.06	0.03	-0.05
	TDLF	NA	0.00	0.03	0.04	0.03	0.03	0.00	-0.07
17	NLF	NA	NA	0.00	0.04	0.07	0.08	0.08	0.03
	SDLF	NA	NA	0.00	0.03	0.05	0.06	0.06	0.01
	TDLF	NA	NA	0.00	0.02	0.03	0.04	0.03	-0.01
18	NLF	NA	NA	NA	0.00	0.04	0.07	0.09	0.07
	SDLF	NA	NA	NA	0.00	0.03	0.05	0.07	0.05
	TDLF	NA	NA	NA	0.00	0.02	0.04	0.05	0.04
19	NLF	NA	NA	NA	NA	0.00	0.04	0.07	0.09
	SDLF	NA	NA	NA	NA	0.00	0.03	0.05	0.07
	TDLF	NA	NA	NA	NA	0.00	0.02	0.04	0.06
20	NLF	NA	NA	NA	NA	NA	0.00	0.04	0.09
	SDLF	NA	NA	NA	NA	NA	0.00	0.03	0.08
	TDLF	NA	NA	NA	NA	NA	0.00	0.03	0.06

Table Q1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	NA	NA	NA	NA	NA	NA	0.00	0.07
	SDLF	NA	NA	NA	NA	NA	NA	0.00	0.06
	TDLF	NA	NA	NA	NA	NA	NA	0.00	0.05
22	NLF	NA	NA	NA	NA	NA	NA	NA	0.04
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.04
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.03
23	NLF	NA	NA	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.00

Table Q1-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-1.76	-1.97	-2.10	-2.20	-2.31	-2.43	-2.57	-2.77
	SDLF	-1.86	-2.10	-2.24	-2.36	-2.48	-2.61	-2.78	-3.07
	TDLF	-1.98	-2.24	-2.42	-2.56	-2.70	-2.85	-3.05	-3.43
3	NLF	-1.38	-1.71	-1.94	-2.05	-2.16	-2.28	-2.41	-2.68
	SDLF	-1.46	-1.82	-2.07	-2.19	-2.30	-2.43	-2.58	-2.92
	TDLF	-1.56	-1.95	-2.23	-2.37	-2.49	-2.62	-2.80	-3.23
4	NLF	-1.01	-1.39	-1.68	-1.87	-1.98	-2.09	-2.23	-2.54
	SDLF	-1.06	-1.47	-1.78	-1.99	-2.10	-2.21	-2.36	-2.74
	TDLF	-1.14	-1.59	-1.93	-2.14	-2.26	-2.37	-2.54	-2.99
5	NLF	-0.68	-1.04	-1.36	-1.60	-1.79	-1.89	-2.04	-2.38
	SDLF	-0.70	-1.10	-1.45	-1.70	-1.88	-1.98	-2.14	-2.53
	TDLF	-0.74	-1.19	-1.57	-1.83	-2.02	-2.12	-2.28	-2.73
6	NLF	-0.40	-0.74	-1.06	-1.33	-1.52	-1.69	-1.84	-2.19
	SDLF	-0.38	-0.78	-1.13	-1.41	-1.60	-1.77	-1.92	-2.31
	TDLF	-0.40	-0.85	-1.24	-1.53	-1.72	-1.88	-2.03	-2.47
7	NLF	-0.16	-0.47	-0.79	-1.07	-1.29	-1.47	-1.65	-2.00
	SDLF	-0.13	-0.49	-0.84	-1.14	-1.36	-1.54	-1.71	-2.08
	TDLF	-0.13	-0.54	-0.93	-1.24	-1.46	-1.64	-1.80	-2.21
8	NLF	0.01	-0.24	-0.53	-0.81	-1.05	-1.25	-1.42	-1.80
	SDLF	0.06	-0.24	-0.58	-0.87	-1.12	-1.31	-1.46	-1.86
	TDLF	0.08	-0.27	-0.65	-0.97	-1.21	-1.40	-1.54	-1.96
9	NLF	0.14	-0.06	-0.31	-0.57	-0.81	-1.02	-1.19	-1.61
	SDLF	0.19	-0.05	-0.34	-0.63	-0.88	-1.07	-1.22	-1.65
	TDLF	0.22	-0.07	-0.40	-0.71	-0.97	-1.15	-1.29	-1.73
10	NLF	0.20	0.06	-0.14	-0.36	-0.59	-0.79	-0.96	-1.37
	SDLF	0.26	0.08	-0.16	-0.41	-0.65	-0.84	-1.00	-1.40
	TDLF	0.29	0.08	-0.21	-0.49	-0.73	-0.92	-1.05	-1.45

Table Q1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.22	0.13	-0.01	-0.19	-0.39	-0.58	-0.75	-1.14
	SDLF	0.28	0.16	-0.03	-0.24	-0.45	-0.63	-0.78	-1.16
	TDLF	0.31	0.15	-0.07	-0.31	-0.53	-0.70	-0.83	-1.20
12	NLF	0.21	0.15	0.06	-0.07	-0.22	-0.39	-0.54	-0.92
	SDLF	0.25	0.17	0.05	-0.11	-0.28	-0.45	-0.58	-0.93
	TDLF	0.28	0.17	0.01	-0.17	-0.35	-0.51	-0.62	-0.96
13	NLF	0.17	0.16	0.09	0.01	-0.09	-0.23	-0.36	-0.70
	SDLF	0.20	0.18	0.09	-0.03	-0.14	-0.28	-0.39	-0.72
	TDLF	0.22	0.18	0.05	-0.08	-0.20	-0.34	-0.43	-0.74
14	NLF	0.09	0.14	0.11	0.08	0.01	-0.09	-0.19	-0.50
	SDLF	0.11	0.15	0.11	0.06	-0.03	-0.13	-0.23	-0.51
	TDLF	0.12	0.15	0.08	0.01	-0.08	-0.18	-0.26	-0.54
15	NLF	0.00	0.08	0.10	0.11	0.08	0.04	-0.06	-0.32
	SDLF	0.00	0.08	0.10	0.09	0.05	0.00	-0.09	-0.33
	TDLF	0.00	0.09	0.08	0.06	0.01	-0.03	-0.12	-0.35
16	NLF	NA	0.00	0.06	0.09	0.11	0.10	0.05	-0.16
	SDLF	NA	0.00	0.06	0.08	0.08	0.08	0.02	-0.18
	TDLF	NA	0.00	0.05	0.06	0.05	0.05	-0.01	-0.19
17	NLF	NA	NA	0.00	0.05	0.09	0.12	0.11	-0.03
	SDLF	NA	NA	0.00	0.05	0.08	0.10	0.08	-0.05
	TDLF	NA	NA	0.00	0.04	0.06	0.08	0.06	-0.06
18	NLF	NA	NA	NA	0.00	0.05	0.10	0.13	0.07
	SDLF	NA	NA	NA	0.00	0.05	0.09	0.10	0.05
	TDLF	NA	NA	NA	0.00	0.04	0.07	0.09	0.03
19	NLF	NA	NA	NA	NA	0.00	0.06	0.11	0.12
	SDLF	NA	NA	NA	NA	0.00	0.05	0.09	0.10
	TDLF	NA	NA	NA	NA	0.00	0.04	0.08	0.09
20	NLF	NA	NA	NA	NA	NA	0.00	0.06	0.14
	SDLF	NA	NA	NA	NA	NA	0.00	0.05	0.12
	TDLF	NA	NA	NA	NA	NA	0.00	0.05	0.11

Table Q1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
21	NLF	NA	NA	NA	NA	NA	NA	0.00	0.12
	SDLF	NA	NA	NA	NA	NA	NA	0.00	0.10
	TDLF	NA	NA	NA	NA	NA	NA	0.00	0.10
22	NLF	NA	NA	NA	NA	NA	NA	NA	0.07
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.06
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.06
23	NLF	NA	NA	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.00

Table Q1-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	324	250	622	507
	SDLF	299	254	600	510
	TDLF	281	256	587	512
G2	NLF	238	235	490	479
	SDLF	238	236	490	480
	TDLF	236	236	487	480
G3	NLF	221	214	471	441
	SDLF	233	216	483	443
	TDLF	241	218	490	445
G4	NLF	156	144	339	301
	SDLF	168	140	352	298
	TDLF	179	138	362	296
G5	NLF	145	130	316	276
	SDLF	155	129	327	275
	TDLF	165	130	337	276
G6	NLF	133	120	289	257
	SDLF	136	118	292	255
	TDLF	139	117	295	254
G7	NLF	151	131	323	282
	SDLF	146	131	319	282
	TDLF	143	132	315	283
G8	NLF	150	116	314	250
	SDLF	144	115	308	250
	TDLF	140	113	304	248
G9	NLF	104	94	223	207
	SDLF	100	94	217	208
	TDLF	96	93	212	207

(Column headers span: Load Type & Support Number)

Table Q1-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.1	NA	1.4	NA
	SDLF	-0.2	NA	0.8	NA
	TDLF	-0.7	NA	-0.3	NA
G2	NLF	0.3	NA	1.5	NA
	SDLF	0.0	NA	1.0	NA
	TDLF	-0.4	NA	0.1	NA
G3	NLF	0.3	NA	1.2	NA
	SDLF	0.1	NA	0.7	NA
	TDLF	-0.2	NA	0.2	NA
G4	NLF	0.1	NA	0.4	NA
	SDLF	0.0	NA	0.2	NA
	TDLF	0.0	NA	0.1	NA
G5	NLF	0.0	NA	-0.1	NA
	SDLF	0.0	NA	-0.1	NA
	TDLF	0.1	NA	0.0	NA
G6	NLF	-0.1	NA	-0.6	NA
	SDLF	0.0	NA	-0.4	NA
	TDLF	0.2	NA	0.0	NA
G7	NLF	-0.2	NA	-1.0	NA
	SDLF	0.0	NA	-0.6	NA
	TDLF	0.3	NA	0.0	NA
G8	NLF	-0.2	NA	-1.4	NA
	SDLF	0.0	NA	-0.8	NA
	TDLF	0.4	NA	-0.1	NA
G9	NLF	-0.3	NA	-1.8	NA
	SDLF	0.1	NA	-1.0	NA
	TDLF	0.5	NA	-0.1	NA

Table Q1-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.3	0.1	-2.9	0.5
	SDLF	-0.1	0.0	-2.1	0.3
	TDLF	0.7	-0.1	-0.3	0.0
G2	NLF	-0.6	0.1	-3.3	0.5
	SDLF	-0.1	0.0	-2.2	0.3
	TDLF	0.8	-0.1	-0.3	0.0
G3	NLF	-0.6	0.1	-2.8	0.5
	SDLF	-0.1	0.0	-1.7	0.3
	TDLF	0.6	-0.1	-0.3	0.0
G4	NLF	-0.4	0.1	-1.5	0.5
	SDLF	0.0	0.0	-0.9	0.3
	TDLF	0.3	-0.1	-0.2	0.0
G5	NLF	-0.2	0.1	-0.6	0.5
	SDLF	0.0	0.0	-0.3	0.3
	TDLF	0.0	-0.1	-0.2	0.0
G6	NLF	0.0	0.1	0.4	0.5
	SDLF	0.0	0.0	0.3	0.3
	TDLF	-0.2	-0.1	-0.1	0.0
G7	NLF	0.2	0.1	1.4	0.4
	SDLF	0.0	0.0	0.9	0.3
	TDLF	-0.4	-0.1	0.0	0.0
G8	NLF	0.5	0.1	2.4	0.4
	SDLF	0.1	0.0	1.6	0.3
	TDLF	-0.5	-0.1	0.3	0.0
G9	NLF	0.7	0.1	3.7	0.4
	SDLF	0.2	0.0	2.3	0.3
	TDLF	-0.6	-0.1	0.6	0.0

Table Q1-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.02	0.95	0.27	2.15
	SDLF	-0.05	0.82	0.15	1.95
	TDLF	-0.14	0.69	-0.05	1.71
G2	NLF	0.05	0.94	0.31	2.13
	SDLF	0.00	0.81	0.19	1.92
	TDLF	-0.08	0.69	0.02	1.70
G3	NLF	0.05	0.92	0.24	2.05
	SDLF	0.01	0.80	0.15	1.86
	TDLF	-0.03	0.70	0.05	1.70
G4	NLF	0.03	0.92	0.08	1.97
	SDLF	0.00	0.81	0.04	1.82
	TDLF	-0.01	0.74	0.01	1.73
G5	NLF	0.01	0.90	-0.02	1.89
	SDLF	0.00	0.81	-0.02	1.77
	TDLF	0.02	0.76	0.01	1.73
G6	NLF	-0.02	0.89	-0.12	1.82
	SDLF	0.01	0.81	-0.08	1.72
	TDLF	0.04	0.78	0.00	1.73
G7	NLF	-0.03	0.88	-0.20	1.76
	SDLF	0.01	0.80	-0.12	1.68
	TDLF	0.06	0.79	0.00	1.73
G8	NLF	-0.05	0.87	-0.27	1.71
	SDLF	0.01	0.80	-0.16	1.65
	TDLF	0.07	0.79	-0.02	1.72
G9	NLF	-0.07	0.86	-0.35	1.63
	SDLF	0.01	0.79	-0.20	1.59
	TDLF	0.09	0.79	-0.02	1.70

Table Q1-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.05	0.02	-0.58	0.11
	SDLF	-0.02	0.00	-0.42	0.07
	TDLF	0.13	-0.03	-0.05	0.01
G2	NLF	-0.12	0.02	-0.66	0.10
	SDLF	-0.02	0.00	-0.44	0.06
	TDLF	0.15	-0.03	-0.06	0.01
G3	NLF	-0.12	0.02	-0.56	0.10
	SDLF	-0.02	0.00	-0.35	0.06
	TDLF	0.12	-0.02	-0.06	0.01
G4	NLF	-0.07	0.02	-0.31	0.10
	SDLF	-0.01	0.00	-0.18	0.06
	TDLF	0.05	-0.02	-0.04	0.01
G5	NLF	-0.04	0.02	-0.12	0.09
	SDLF	-0.01	0.00	-0.06	0.06
	TDLF	0.00	-0.02	-0.03	0.01
G6	NLF	0.00	0.01	0.09	0.09
	SDLF	0.00	0.00	0.06	0.06
	TDLF	-0.04	-0.02	-0.02	0.01
G7	NLF	0.04	0.01	0.28	0.09
	SDLF	0.00	0.00	0.18	0.06
	TDLF	-0.08	-0.02	0.00	0.01
G8	NLF	0.10	0.01	0.49	0.09
	SDLF	0.02	0.00	0.32	0.06
	TDLF	-0.09	-0.02	0.07	0.01
G9	NLF	0.15	0.01	0.74	0.08
	SDLF	0.03	0.00	0.47	0.05
	TDLF	-0.11	-0.01	0.13	0.01

Appendix Q1-5. NISCS38 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISCS38 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Table Q1-5-1. Erection fit-up forces (kips) applied to the girder being installed

Table Q1-5-2. Erection critical sub-stages

Table Q1-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Reactions

Table Q1-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Table Q1-5-1. Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	-0.4	-0.4	0.6	-1.0	0.2	1.0
		SDLF	2.4	4.4	5.0	1.8	-2.7	3.2
		TDLF	3.3	5.8	6.7	2.7	-3.5	4.4
	2-3	NLF	0.7	1.0	1.2	0.7	-1.0	1.2
		SDLF	-0.5	-0.2	0.5	-0.7	0.1	0.7
		TDLF	-1.1	-0.8	1.4	-1.6	0.6	1.7
	2-4	NLF	-0.2	0.4	0.4	0.3	-0.4	0.5
		SDLF	0.3	2.6	2.6	0.5	-2.2	2.2
		TDLF	1.6	3.5	3.9	0.4	-2.8	2.8
	2-5	NLF	0.7	-0.2	0.7	-1.5	0.2	1.5
		SDLF	0.2	0.1	0.2	-0.4	-0.2	0.5
		TDLF	1.3	0.5	1.3	-0.4	-0.6	0.7

Table Q1-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
11	11-2	NLF	-0.3	0.3	0.4	-0.3	-0.1	0.4
		SDLF	0.0	-0.3	0.3	-1.3	0.4	1.3
		TDLF	0.0	-1.2	1.2	-2.6	1.1	2.9
	11-3	NLF	1.5	1.8	2.3	-0.3	-1.7	1.7
		SDLF	2.5	0.5	2.6	-2.1	-0.4	2.2
		TDLF	1.9	-1.5	2.4	-5.1	1.6	5.4
	11-4	NLF	1.2	1.9	2.2	1.1	-1.8	2.2
		SDLF	1.8	0.4	1.8	-1.3	-0.3	1.3
		TDLF	0.9	-1.9	2.1	-5.4	2.1	5.8
	11-5	NLF	1.1	1.1	1.6	1.2	-1.1	1.6
		SDLF	4.6	-0.2	4.6	-5.0	0.4	5.0
		TDLF	6.7	-2.5	7.1	-12.8	2.9	13.2
	11-6	NLF	0.4	0.0	0.4	0.4	0.1	0.4
		SDLF	0.0	-1.0	1.0	-1.5	1.0	1.8
		TDLF	-1.6	-3.0	3.4	-4.9	2.9	5.7
	11-7	NLF	0.1	-0.3	0.4	0.1	0.5	0.5
		SDLF	-4.6	-1.4	4.8	2.4	1.3	2.8
		TDLF	-10.3	-3.2	10.7	3.8	3.0	4.9

Table Q1-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
18	18-2	NLF	0.7	0.2	0.7	0.8	0.0	0.8
		SDLF	6.6	0.0	6.6	6.8	-0.3	6.8
		TDLF	14.7	-0.1	14.7	14.1	-0.6	14.1
	18-3	NLF	5.8	2.0	6.1	3.7	-1.9	4.2
		SDLF	22.6	-1.7	22.6	2.7	2.1	3.4
		TDLF	31.0	-5.2	31.5	-7.8	6.2	10.0
	18-4	NLF	-0.2	2.8	2.8	-0.2	-2.7	2.7
		SDLF	10.3	-4.9	11.4	7.2	4.7	8.6
		TDLF	8.7	-10.5	13.6	2.0	10.4	10.6
	18-5	NLF	-3.6	2.6	4.4	-3.6	-2.6	4.4
		SDLF	5.6	-5.7	8.0	5.1	6.5	8.2
		TDLF	3.7	-11.4	12.0	2.5	12.9	13.2
	18-6	NLF	-5.2	1.4	5.4	-5.3	-1.5	5.5
		SDLF	4.0	-6.8	7.9	3.9	7.2	8.2
		TDLF	2.6	-12.4	12.7	2.3	13.3	13.5
	18-7	NLF	-5.6	0.1	5.6	-5.7	-0.1	5.7
		SDLF	3.8	-6.7	7.7	3.7	7.0	7.9
		TDLF	2.2	-11.5	11.7	1.9	11.9	12.0
	18-8	NLF	-6.2	-1.0	6.3	-4.1	0.7	4.2
		SDLF	5.1	-5.8	7.7	4.9	6.0	7.8
		TDLF	2.5	-9.3	9.6	2.9	9.5	9.9
	18-9	NLF	-1.1	0.1	1.1	-1.2	0.4	1.2
		SDLF	6.3	-4.2	7.6	6.2	4.4	7.6
		TDLF	4.8	-5.9	7.6	4.4	6.4	7.8

Table Q1-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
27	27-2	NLF	-0.4	-0.2	0.4	-2.0	0.2	2.0
		SDLF	-3.7	-0.2	3.7	1.4	0.2	1.4
		TDLF	-6.8	0.2	6.8	6.0	-0.2	6.0
	27-3	NLF	-14.0	0.9	14.0	-13.9	-0.8	13.9
		SDLF	-13.2	1.7	13.3	-13.4	-1.2	13.5
		TDLF	-6.9	3.1	7.6	-7.5	-2.2	7.8
	27-4	NLF	-14.5	2.1	14.6	-14.5	-2.0	14.7
		SDLF	-13.8	2.9	14.1	-13.9	-2.7	14.2
		TDLF	-7.5	3.5	8.3	-7.7	-3.3	8.4
	27-5	NLF	-13.3	1.7	13.4	-13.3	-1.6	13.4
		SDLF	-12.6	2.6	12.9	-12.6	-2.3	12.8
		TDLF	-7.2	2.7	7.7	-7.2	-2.2	7.5
	27-6	NLF	-13.1	0.2	13.1	-13.1	-0.1	13.1
		SDLF	-12.3	1.0	12.4	-12.2	-0.7	12.2
		TDLF	-7.3	0.9	7.4	-7.1	-0.2	7.1
	27-7	NLF	-13.0	-1.0	13.0	-13.0	1.2	13.1
		SDLF	-12.0	-0.5	12.1	-11.5	0.8	11.5
		TDLF	-7.0	-0.9	7.1	-5.8	1.6	6.0
	27-8	NLF	-12.7	-1.5	12.8	-10.8	1.4	10.9
		SDLF	-12.4	-1.3	12.5	-7.1	1.2	7.2
		TDLF	-8.1	-2.2	8.4	0.4	2.1	2.1
	27-9	NLF	-5.6	-0.1	5.6	-5.7	0.4	5.7
		SDLF	-12.5	-0.8	12.5	4.8	0.0	4.8
		TDLF	-18.3	-2.9	18.5	18.5	0.6	18.5

Table Q1-5-2: Erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
2	NLF	2-5
	SDLF	2-2
	TDLF	2-2
11	NLF	11-4
	SDLF	11-5
	TDLF	11-5
18	NLF	18-7
	SDLF	18-4
	TDLF	18-2
27	NLF	27-4
	SDLF	27-4
	TDLF	27-9

Table Q1-5-3. Erection critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	-0.8	-0.2	0.8	NA	NA	NA
		SDLF	-1.2	-0.8	1.5	NA	NA	NA
		TDLF	-3.8	-2.7	4.6	NA	NA	NA
	B	NLF	0.7	-0.2	0.7	-1.5	0.2	1.5
		SDLF	2.4	4.4	5.0	1.8	-2.7	3.2
		TDLF	3.3	5.8	6.7	2.7	-3.5	4.4
11	A	NLF	0.8	1.1	1.4	NA	NA	NA
		SDLF	0.6	0.1	0.6	NA	NA	NA
		TDLF	-2.4	-1.1	2.6	NA	NA	NA
	B	NLF	1.2	1.9	2.2	1.1	-1.8	2.2
		SDLF	4.6	-0.2	4.6	-5.0	0.4	5.0
		TDLF	6.7	-2.5	7.1	-12.8	2.9	13.2
18	A	NLF	-8.2	0.1	8.2	NA	NA	NA
		SDLF	14.0	-3.4	14.4	NA	NA	NA
		TDLF	26.2	-0.3	26.2	NA	NA	NA
	B	NLF	-5.6	0.1	5.6	-5.7	-0.1	5.7
		SDLF	10.3	-4.9	11.4	7.2	4.7	8.6
		TDLF	14.7	-0.1	14.7	14.1	-0.6	14.1
27	A	NLF	-22.4	1.4	22.4	NA	NA	NA
		SDLF	-21.5	2.0	21.6	NA	NA	NA
		TDLF	-10.7	-3.2	11.2	NA	NA	NA
	B	NLF	-14.5	2.1	14.6	-14.5	-2.0	14.7
		SDLF	-13.8	2.9	14.1	-13.9	-2.7	14.2
		TDLF	-18.3	-2.9	18.5	18.5	0.6	18.5

Table Q1-5-6. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	19.5	28.0	37.4		
			SDLF	18.7	22.1	40.6		
			TDLF	12.8	37.8	30.0		
		G2	NLF	16.5	25.5	51.1	25.6	29.7
			SDLF	0.9	47.6	95.3	47.7	0.0
			TDLF	1.6	47.7	95.4	47.7	0.0
	B	G1	NLF	19.3	27.9	38.7		
			SDLF	0.0	78.4	1.5		
			TDLF	0.0	76.9	2.4		
		G2	NLF	16.5	25.3	50.7	25.4	31.3
			SDLF	1.1	49.5	99.1	49.6	0.0
			TDLF	1.3	49.7	99.5	49.8	0.0

Table Q1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
11	A	G1	NLF	29.2	93.5	65.5	46.1		
			SDLF	0.0	140.4	33.9	56.2		
			TDLF	0.0	201.0	14.4	53.5		
		G2	NLF	44.9	91.5	52.7	105.4	52.7	15.7
			SDLF	33.7	158.4	22.0	44.0	22.0	46.3
			TDLF	0.2	195.2	4.0	7.9	4.0	57.9
		G3	NLF	45.4	30.7				
			SDLF	41.8	13.4				
			TDLF	38.2	0.0				
		G4	NLF	37.3	47.6				
			SDLF	38.9	27.7				
			TDLF	39.5	0.0				
		G5	NLF	38.3	61.1				
			SDLF	44.2	83.3				
			TDLF	45.1	105.9				
		G6	NLF	37.7	61.7				
			SDLF	39.1	85.8				
			TDLF	34.2	103.6				
		G7	NLF	41.9	60.3				
			SDLF	31.2	27.8				
			TDLF	17.4	0.0				
		G8	NLF	48.6	55.4				
			SDLF	39.8	12.6				
			TDLF	31.3	0.0				
		G9	NLF	43.8	85.0				
			SDLF	42.6	147.0				
			TDLF	41.8	201.1				

Table Q1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
11	B	G1	NLF	29.3	93.4	66.4	45.9		
			SDLF	0.0	140.3	34.6	55.8		
			TDLF	0.0	200.7	15.2	52.9		
		G2	NLF	45.0	92.1	51.2	102.4	51.2	18.2
			SDLF	33.6	158.2	22.8	45.6	22.8	45.4
			TDLF	0.0	194.1	7.0	14.0	7.0	53.8
		G3	NLF	45.4	30.6				
			SDLF	41.8	13.5				
			TDLF	38.2	0.0				
		G4	NLF	37.3	47.6				
			SDLF	38.9	27.7				
			TDLF	39.5	0.0				
		G5	NLF	38.3	61.1				
			SDLF	44.2	83.3				
			TDLF	45.1	106.0				
		G6	NLF	37.7	61.7				
			SDLF	39.1	85.8				
			TDLF	34.2	103.6				
		G7	NLF	41.9	60.3				
			SDLF	31.2	27.8				
			TDLF	17.4	0.0				
		G8	NLF	48.6	55.4				
			SDLF	39.8	12.6				
			TDLF	31.3	0.0				
		G9	NLF	43.8	85.0				
			SDLF	42.6	147.0				
			TDLF	41.8	201.1				

Table Q1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
18	A	G1	NLF	13.0	112.3	102.6			
			SDLF	0.0	165.1	140.5			
			TDLF	0.0	164.7	206.1			
		G2	NLF	27.4	130.7	94.0			
			SDLF	0.0	118.8	55.3			
			TDLF	0.0	76.3	10.7			
		G3	NLF	32.0	169.0	36.1			
			SDLF	0.0	125.7	17.2			
			TDLF	0.0	157.8	0.0			
		G4	NLF	28.2	129.4	119.8			
			SDLF	0.0	167.3	66.6			
			TDLF	0.0	165.2	52.3			
		G5	NLF	29.6	119.5	22.0			
			SDLF	2.5	195.2	11.9			
			TDLF	0.0	223.5	0.0			
		G6	NLF	30.6	112.3	77.6			
			SDLF	7.4	209.5	68.2			
			TDLF	0.0	224.2	50.7			
		G7	NLF	35.4	120.1	84.8			
			SDLF	1.7	185.0	100.9			
			TDLF	0.0	185.2	133.6			
		G8	NLF	43.4	112.3	110.8			
			SDLF	6.4	157.2	132.7			
			TDLF	0.0	123.9	111.2			
		G9	NLF	39.4	95.7	60.5	121.2	60.7	0.0
			SDLF	15.4	188.1	1.9	3.9	1.9	2.5
			TDLF	0.0	234.7	11.1	22.3	11.2	0.0

Table Q1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
18	B	G1	NLF	13.1	112.3	102.6			
			SDLF	0.0	165.1	140.5			
			TDLF	0.0	164.7	206.0			
		G2	NLF	27.5	130.8	94.0			
			SDLF	0.0	118.7	55.3			
			TDLF	0.0	76.2	10.7			
		G3	NLF	32.0	169.1	36.1			
			SDLF	0.0	125.5	17.2			
			TDLF	0.0	157.6	0.0			
		G4	NLF	28.2	129.5	119.8			
			SDLF	0.0	166.7	66.9			
			TDLF	0.0	165.1	52.1			
		G5	NLF	29.6	119.8	22.1			
			SDLF	2.4	195.0	12.0			
			TDLF	0.0	223.3	0.0			
		G6	NLF	30.7	112.6	77.7			
			SDLF	7.4	210.1	68.0			
			TDLF	0.0	223.8	50.5			
		G7	NLF	35.5	119.2	84.7			
			SDLF	1.6	186.2	98.9			
			TDLF	0.0	184.7	135.0			
		G8	NLF	43.4	111.5	109.5			
			SDLF	6.3	157.6	136.6			
			TDLF	0.0	126.0	114.5			
		G9	NLF	39.4	96.2	61.7	123.5	61.9	0.0
			SDLF	15.4	187.1	2.7	5.4	2.7	0.0
			TDLF	0.0	235.0	8.9	17.8	8.9	0.0

Table Q1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
27	A	G1	NLF	19.5	101.9	122.0	37.1			
			SDLF	0.0	160.5	210.3	46.4			
			TDLF	0.0	158.0	325.4	46.0			
		G2	NLF	32.0	114.7	138.5	42.9			
			SDLF	0.0	111.4	73.8	45.2			
			TDLF	0.0	65.2	29.2	38.6			
		G3	NLF	34.8	132.4	156.2	48.3			
			SDLF	0.0	103.4	76.2	50.3			
			TDLF	0.0	118.7	3.0	45.3			
		G4	NLF	29.5	110.3	121.9	41.7			
			SDLF	0.0	156.7	43.2	39.7			
			TDLF	0.0	145.2	26.6	33.4			
		G5	NLF	30.7	105.0	156.1	44.4			
			SDLF	6.2	183.5	143.4	47.1			
			TDLF	0.0	203.8	141.6	45.3			
		G6	NLF	31.6	105.0	156.2	45.4			
			SDLF	7.7	200.7	148.4	47.6			
			TDLF	0.0	216.9	157.8	44.2			
		G7	NLF	35.8	122.0	153.2	46.8			
			SDLF	1.1	190.7	185.1	52.4			
			TDLF	0.0	195.5	221.8	52.8			
		G8	NLF	41.6	133.8	127.0	25.4			
			SDLF	6.9	176.4	138.0	29.1			
			TDLF	0.0	151.2	210.1	38.2			
		G9	NLF	37.7	115.5	81.6	77.4	154.5	77.1	12.8
			SDLF	16.1	163.2	20.1	75.5	150.8	75.3	14.1
			TDLF	0.0	195.1	0.0	65.7	131.3	65.5	13.1

Table Q1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
27	B	G1	NLF	19.5	101.8	122.2	37.2			
			SDLF	0.0	160.4	210.5	46.5			
			TDLF	0.0	158.1	325.2	46.0			
		G2	NLF	32.0	114.7	138.9	43.0			
			SDLF	0.0	111.4	74.2	45.3			
			TDLF	0.0	65.2	29.0	38.7			
		G3	NLF	34.8	132.4	157.0	48.4			
			SDLF	0.0	103.4	76.9	50.5			
			TDLF	0.0	118.6	3.0	45.3			
		G4	NLF	29.5	110.5	122.4	41.8			
			SDLF	0.0	156.8	43.6	39.8			
			TDLF	0.0	145.3	26.2	33.4			
		G5	NLF	30.6	105.1	155.6	44.4			
			SDLF	6.2	183.7	142.9	47.1			
			TDLF	0.0	203.8	141.8	45.4			
		G6	NLF	31.6	105.2	154.7	45.0			
			SDLF	7.6	200.8	146.9	47.2			
			TDLF	0.0	216.7	157.0	44.2			
		G7	NLF	35.8	122.1	151.8	45.4			
			SDLF	1.1	190.8	183.7	51.1			
			TDLF	0.0	195.3	224.5	52.8			
		G8	NLF	41.6	134.0	127.4	24.6			
			SDLF	6.9	176.5	138.4	28.3			
			TDLF	0.0	151.0	210.7	38.4			
		G9	NLF	37.6	115.5	81.2	79.0	157.8	78.8	13.8
			SDLF	16.1	163.2	20.0	76.7	153.2	76.5	15.6
			TDLF	0.0	195.2	0.0	64.7	129.2	64.5	13.9

Appendix Q2-1. NISCS38 Bridge Description

The key characteristics of NISCS38 are as follows:

- Span length along the centerline of the bridge, L_s = 300 ft.
- Width between the fascia girders, w_g = 74 ft.
- Radius of curvature to the centerline of the bridge, R =730 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 4.1
- Subtended angle between the supports, L_s/R = 0.41
- Number of girders in the completed bridge cross-section, n_g =9.
- Skew angle, θ = 62.6,0^o

This appendix presents the bridge description of the bridge NISCS38 in its final condition as well as during erection. The following figures and tables are provided:

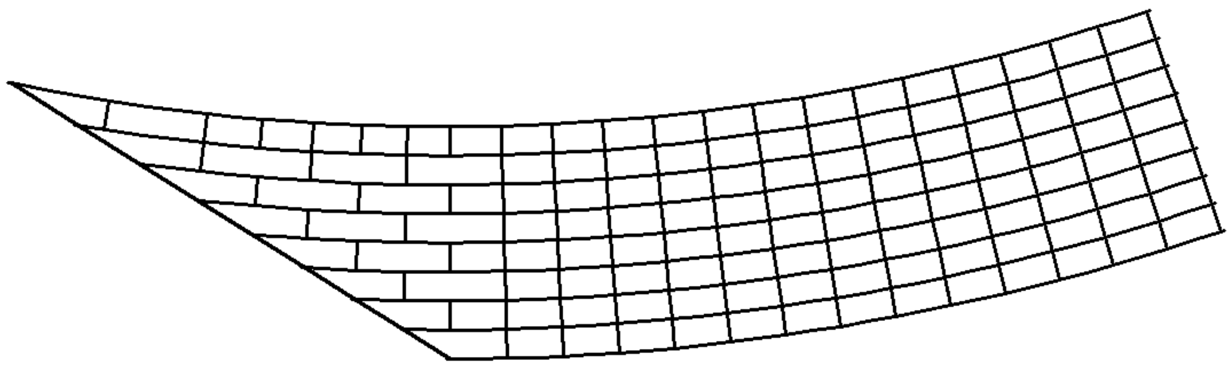


Figure Q1-2-1. Framing plan.

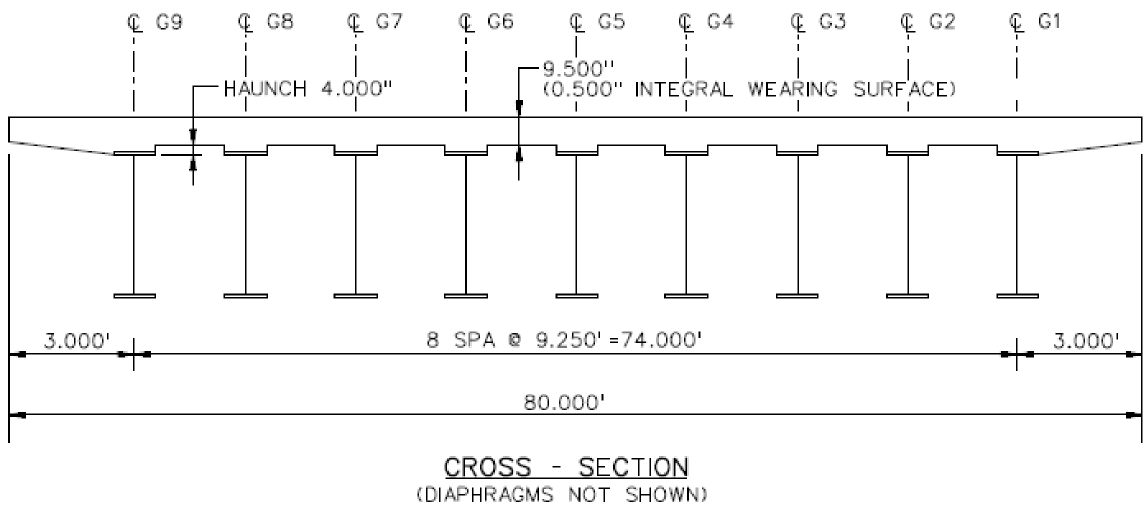


Figure Q1-2-2. Bridge cross-section.

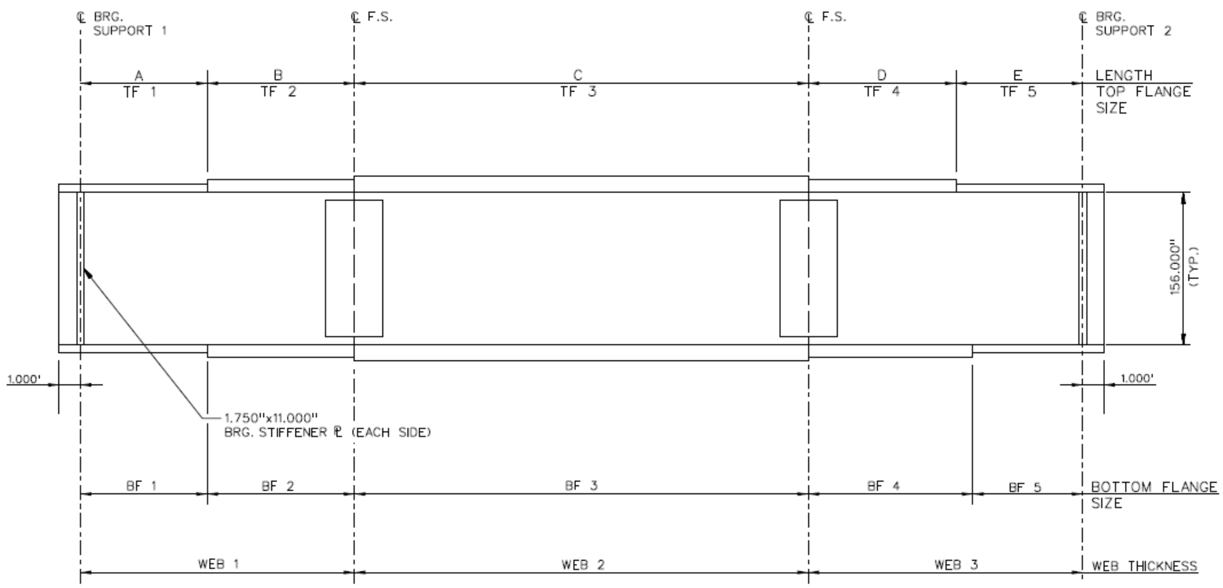


Figure Q1-2-3. Girder elevations

	GIRDER PLATE LENGTHS ⁎								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	60.000	75.000	75.000	75.000	85.000	92.246	104.000	110.000	118.000
B	0	0	0	0	0	0	0	0	0
C	129.216	126.057	123.408	130.000	125.000	130.000	122.025	126.857	129.387
D	0	0	0	0	0	0	0	0	0
E	60.000	60.000	75.000	81.352	90.000	92.246	104.000	110.000	118.000

⁎ ALL DIMENSIONS ARE IN FEET.

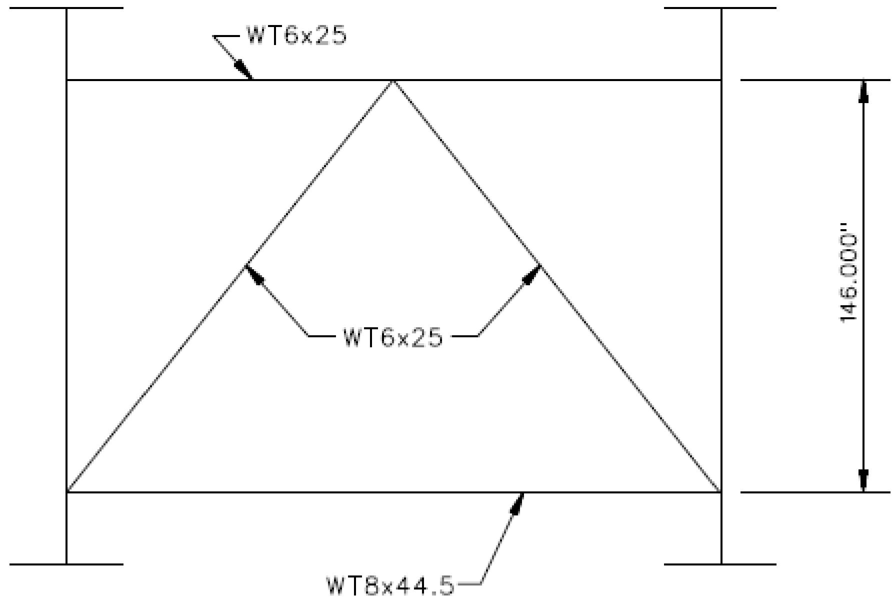
	GIRDER FLANGE DIMENSIONS ⁎⁎					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	36.000	1.750	30.000	1.250	36.000	1.500
TF2	N/A	N/A	N/A	N/A	N/A	N/A
TF3	36.000	2.250	30.000	2.000	36.000	1.500
TF4	N/A	N/A	N/A	N/A	N/A	N/A
TF5	36.000	1.750	30.000	1.250	36.000	1.500

⁎⁎ ALL DIMENSIONS ARE IN INCHES.

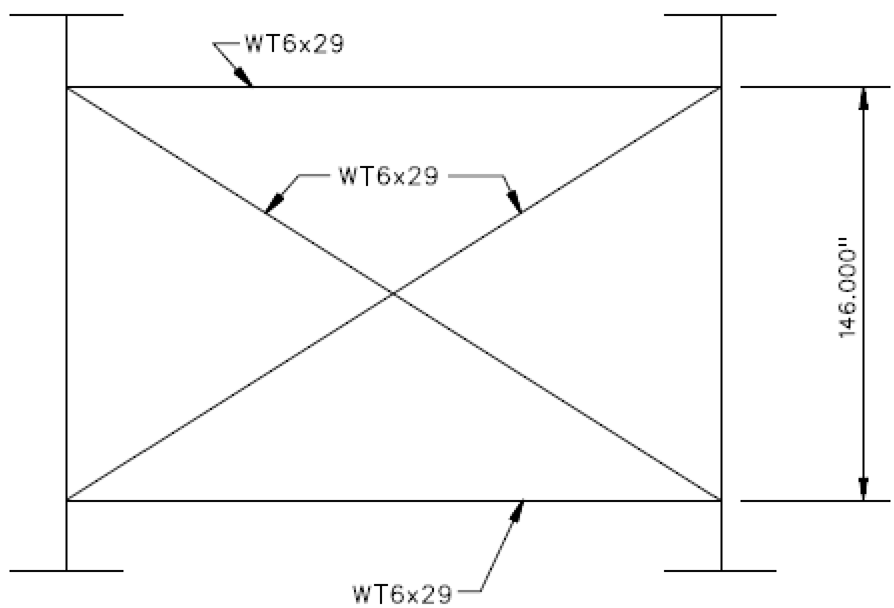
	GIRDER FLANGE DIMENSIONS ⁎⁎					
BOTTOM FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
BF1	36.000	2.000	30.000	1.250	36.000	1.500
BF2	N/A	N/A	N/A	N/A	N/A	N/A
BF3	36.000	2.500	30.000	2.000	36.000	1.500
BF4	N/A	N/A	N/A	N/A	N/A	N/A
BF5	36.000	2.000	30.000	1.250	36.000	1.500

⁎⁎ ALL DIMENSIONS ARE IN INCHES.

Figure Q1-2-4. Cross-section dimensions.



TYPICAL END DIAPHRAGM AT SUPPORT 1



TYPICAL END AND INTERMEDIATE DIAPHRAGM AT SUPPORT 2

Figure Q1-2-5. Cross-frame details

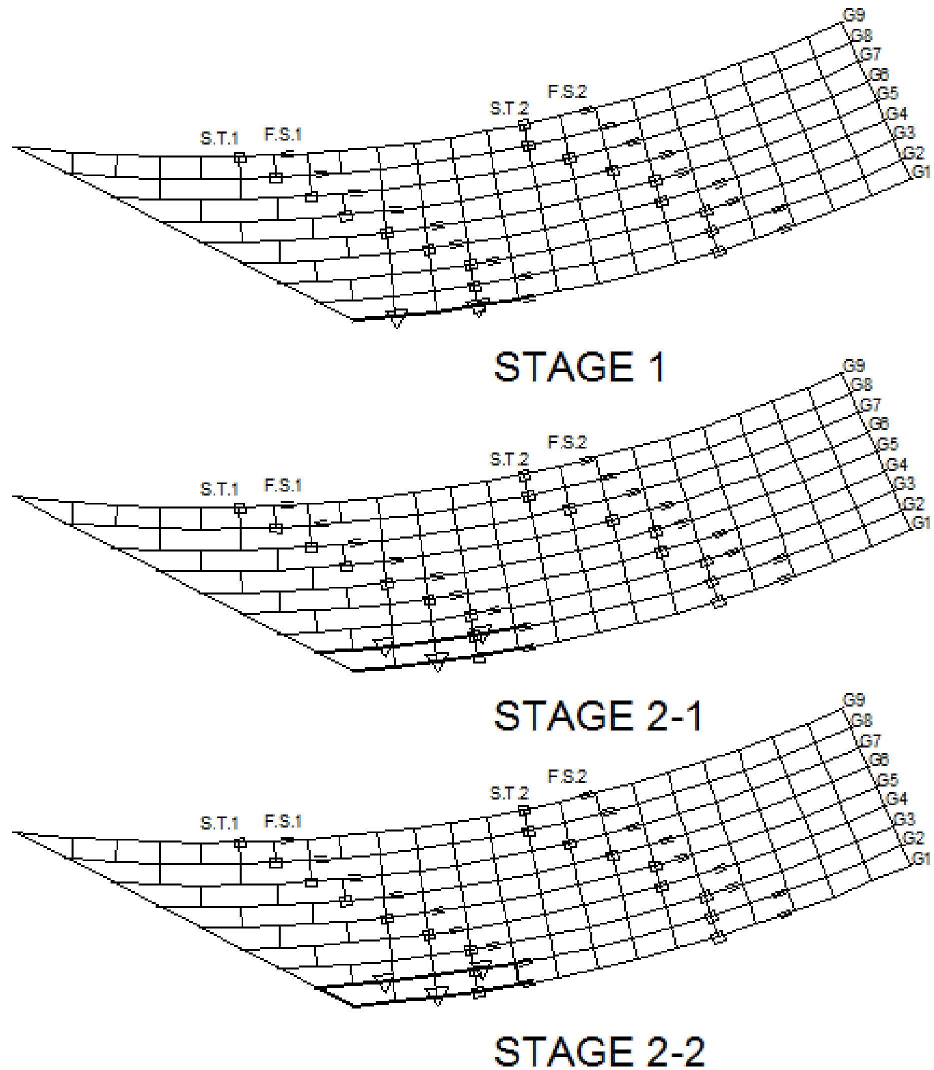
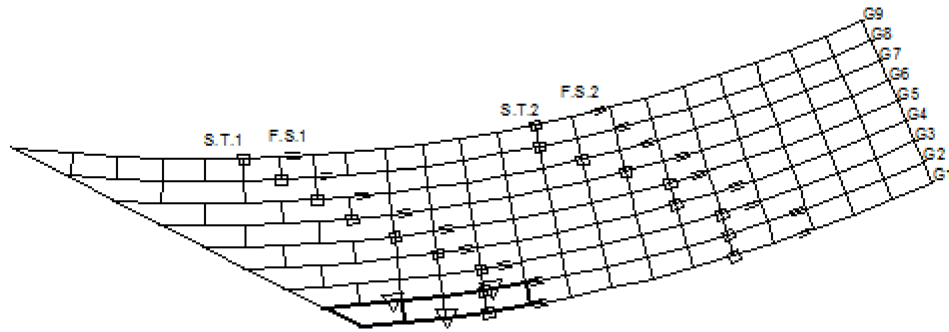
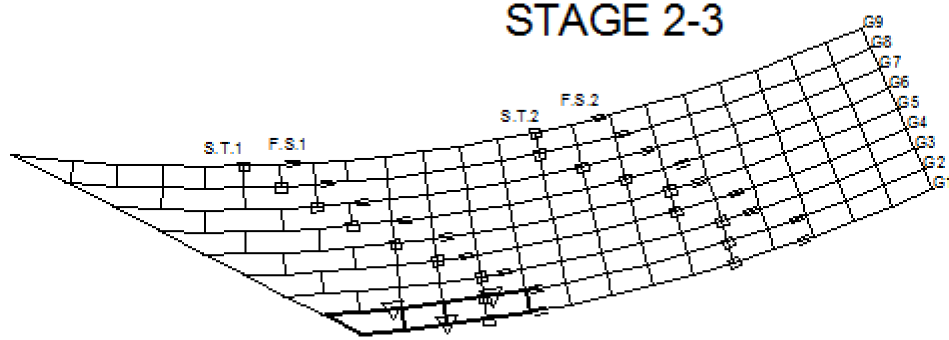


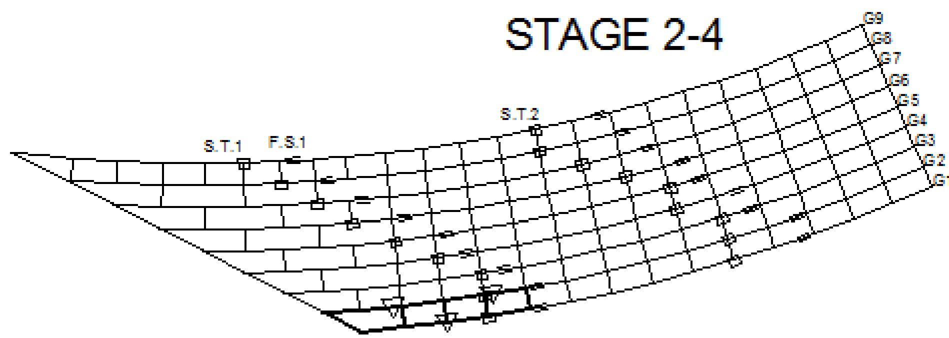
Figure Q1-2-6. Erection scheme.



STAGE 2-3



STAGE 2-4

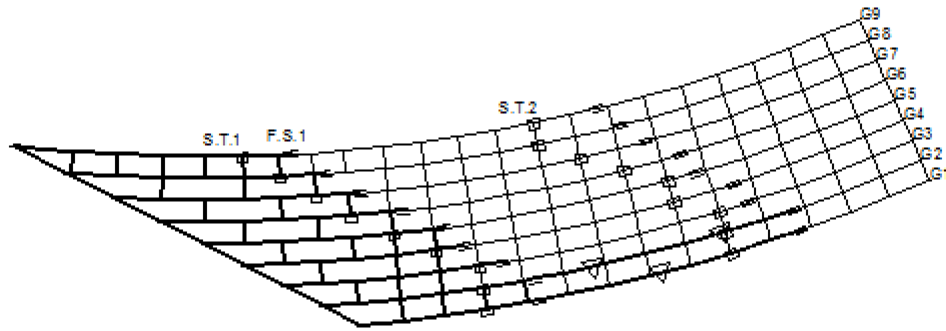


STAGE 2-5

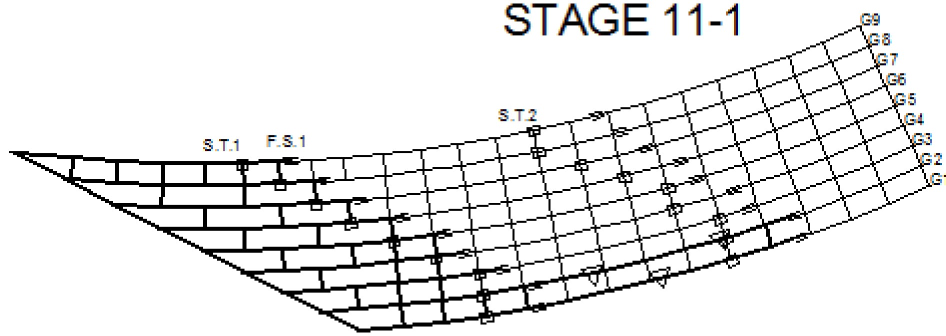
Figure Q1-2-6(Continued). Erection scheme.

REPEAT THE SEQUENCE FOR G3 TO G9
FOR THE FIRST FIELD SEGMENT
ACROSS THE BRIDGE WIDTH. THE
SHORING TOWERS REMAIN IN PLACE
UNTIL THE WHOLE BRIDGE IS ERECTED.
THE HOLDING CRANE IS ON G1 UNTIL
THE FIELD SEGMENTS OF G1-G3 ARE
ERECTED

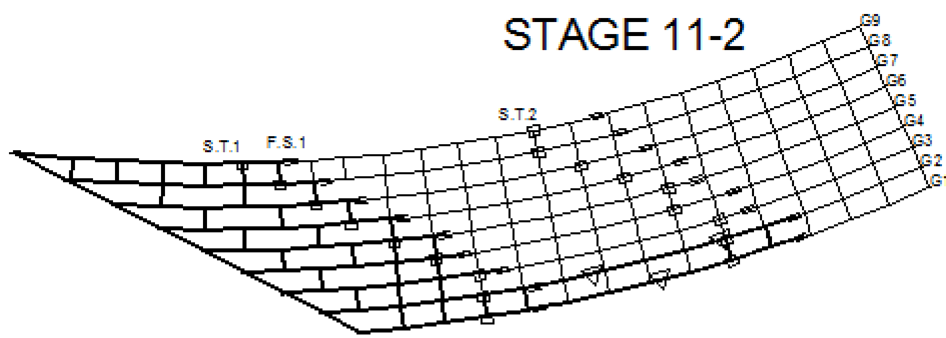
Figure Q1-2-6(Continued). Erection scheme.



STAGE 11-1

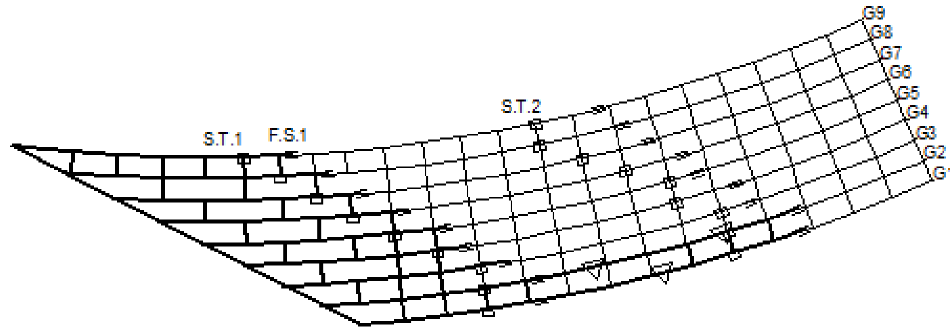


STAGE 11-2

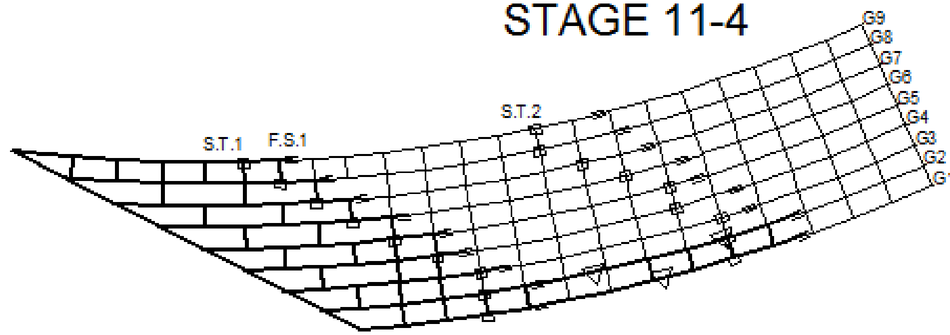


STAGE 11-3

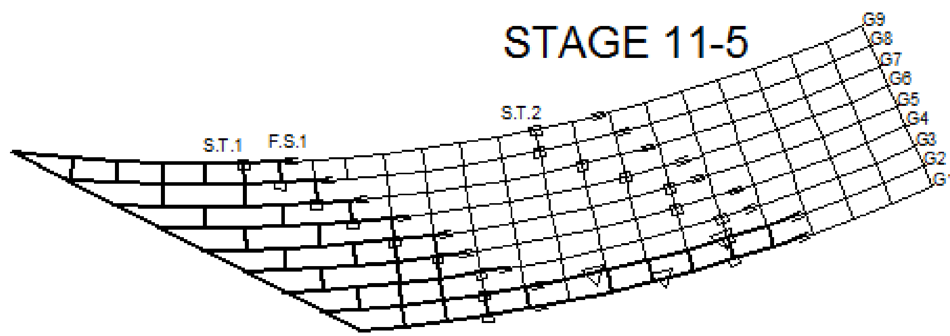
Figure Q1-2-6(Continued). Erection scheme.



STAGE 11-4

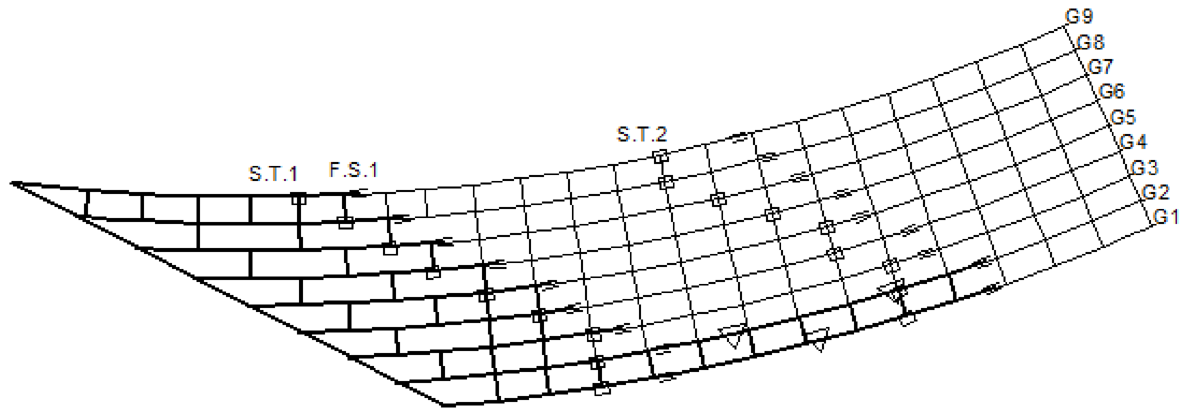


STAGE 11-5



STAGE 11-6

Figure Q1-2-6(Continued). Erection scheme.



STAGE 11-7

REPEAT THE SEQUENCE FOR G3 TO G9 FOR THE SECOND FIELD SEGMENT ACROSS THE BRIDGE WIDTH. THE SHORING TOWERS REMAIN IN PLACE UNTIL THE WHOLE BRIDGE IS ERECTED. THE HOLDING CRANE IS ON G1 UNTIL THE FIELD SEGMENTS OF G1-G3 ARE ERECTED. COUNTERWEIGHTS ARE INSTALLED DURING STAGES 17 & 18 ON G8 AND G9.

REPEAT THE SEQUENCE FOR THE THIRD FIELD SEGMENT ACROSS THE BRIDGE WIDTH

Figure Q1-2-6(Continued). Erection scheme.

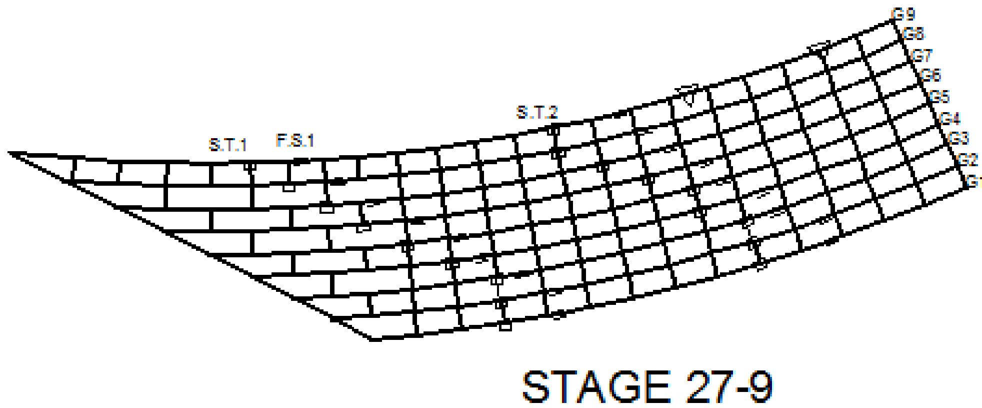


Figure Q1-2-6(Continued). Erection scheme.

Table Q1-2-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

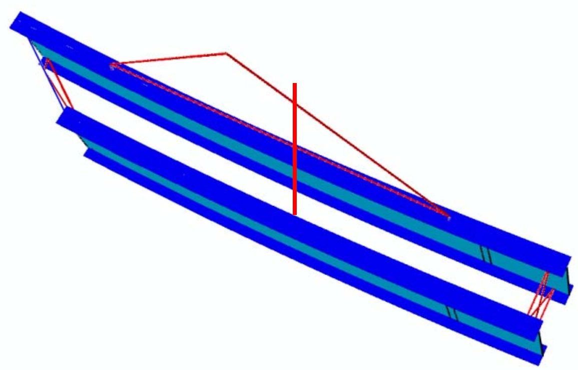
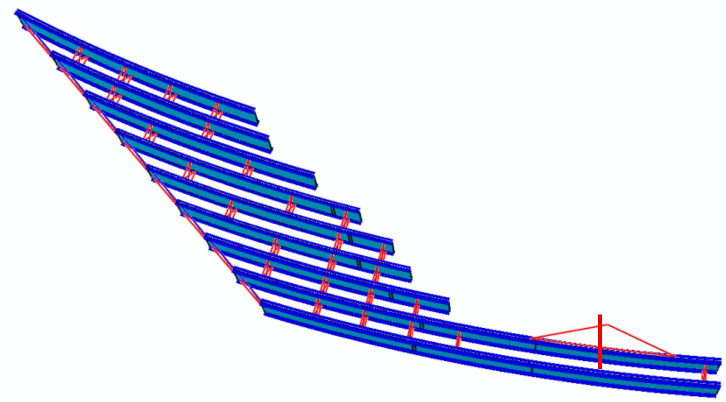
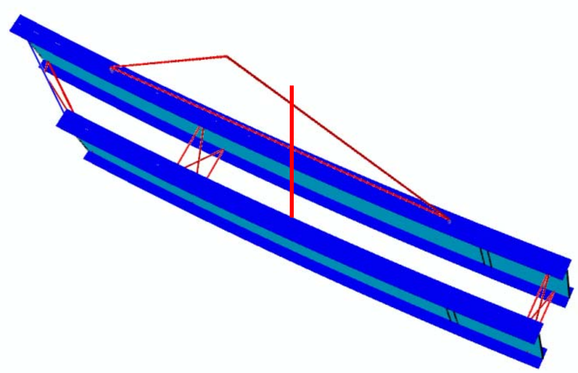
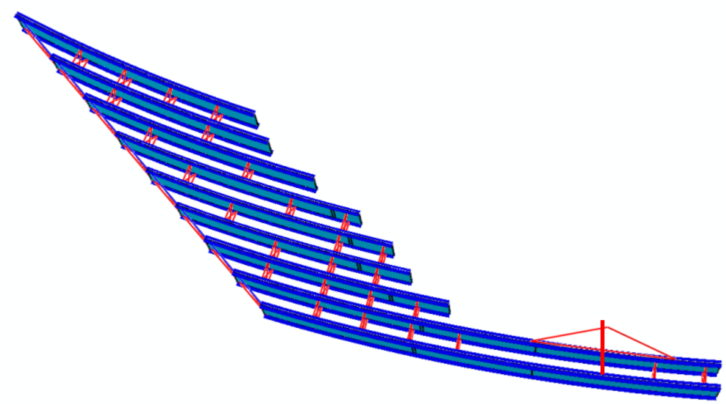
Sub-Stage	Stage	
	2	11
1		
2		

Table Q1-2-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

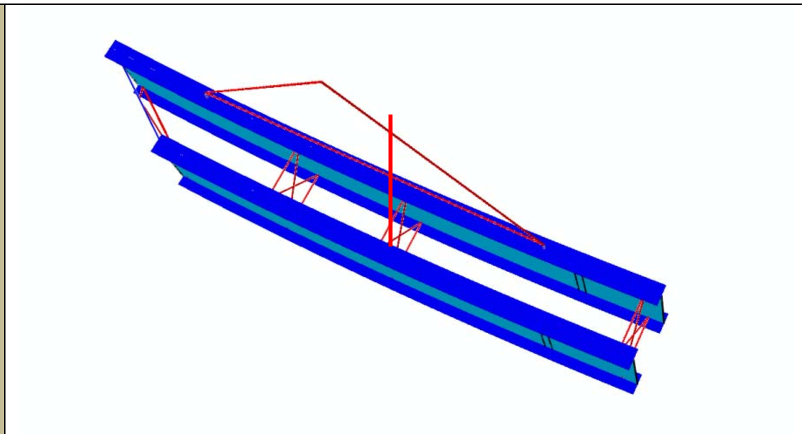
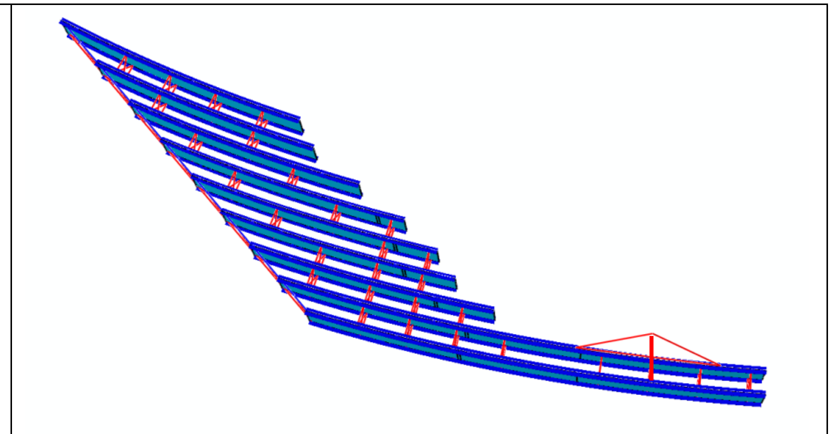
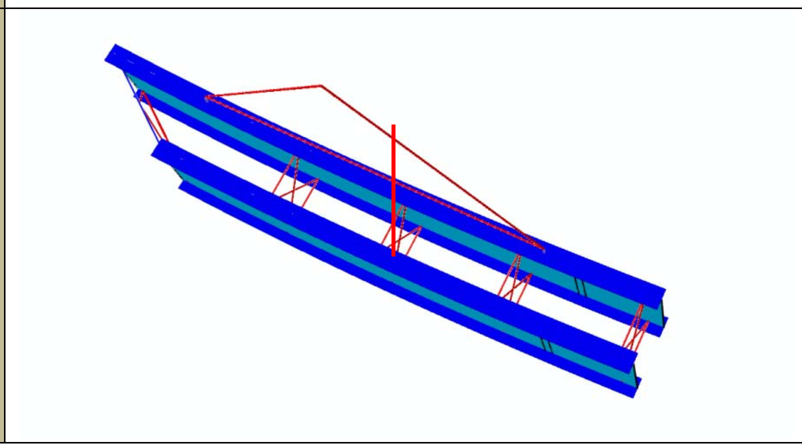
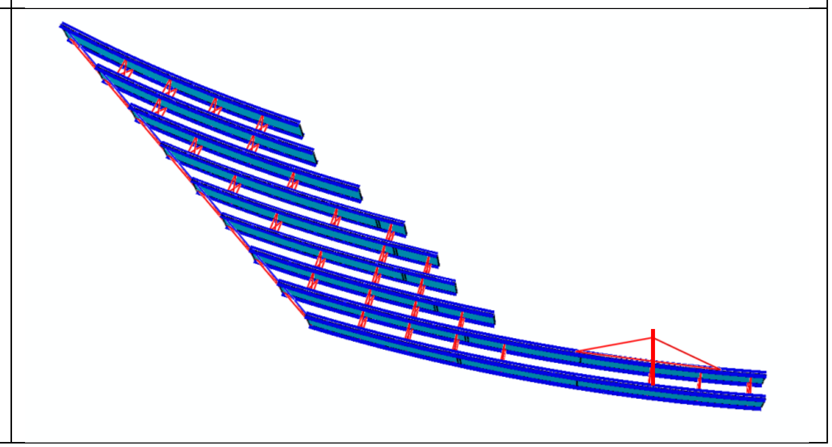
3		
4		

Table Q1-2-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

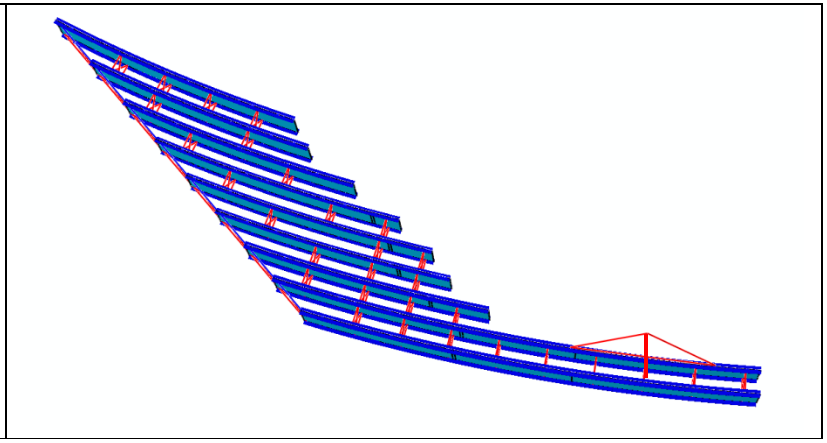
5		

Table Q1-2-1 (continued).. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

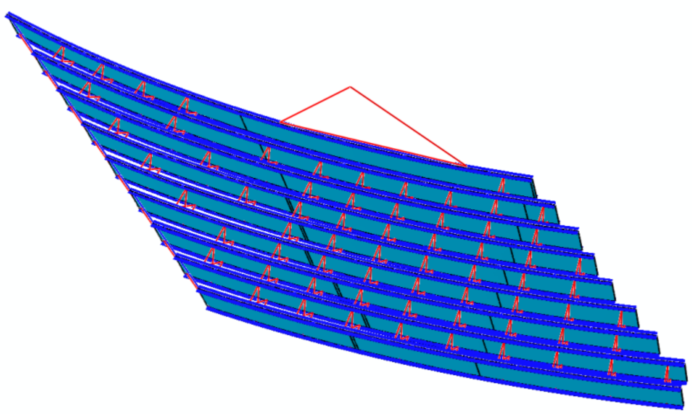
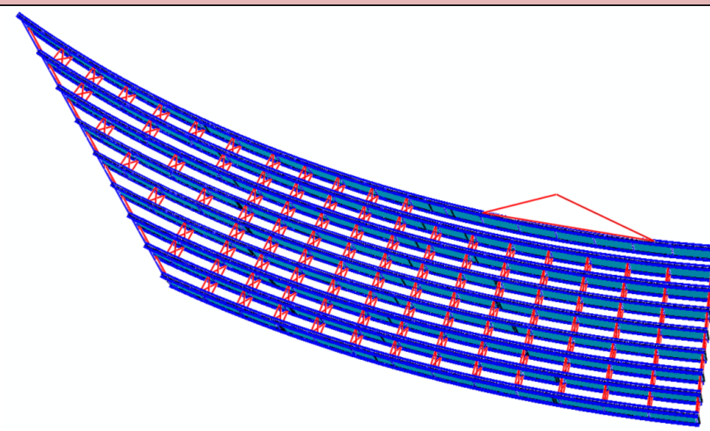
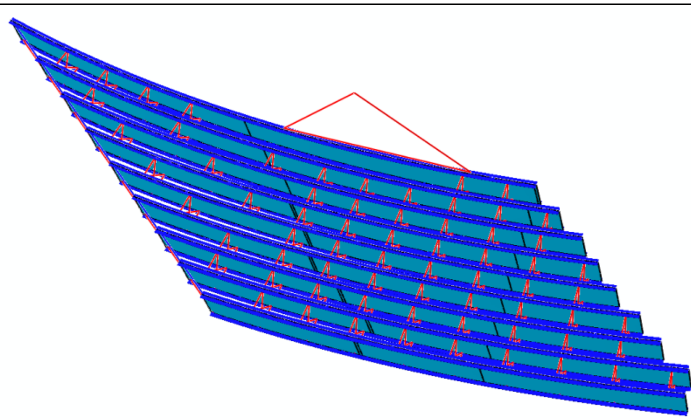
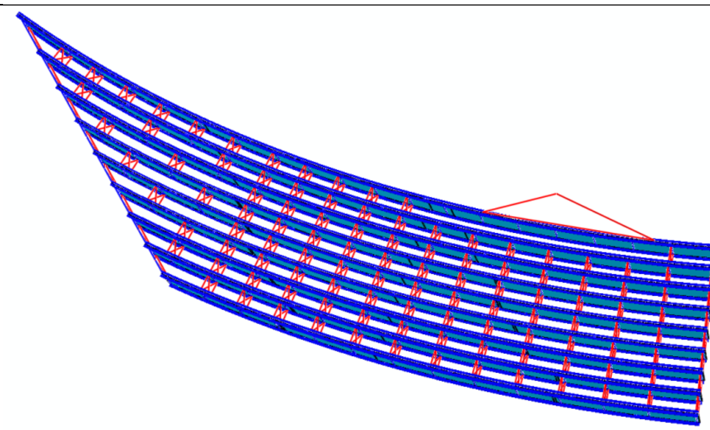
Sub-Stage	Stage	
	18	27
1		
2		

Table Q1-2-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

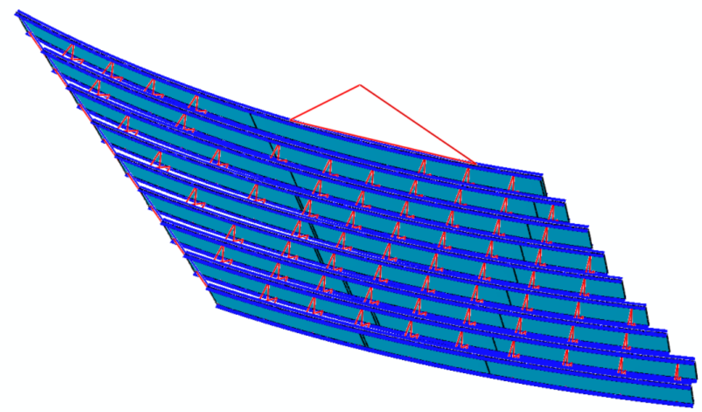
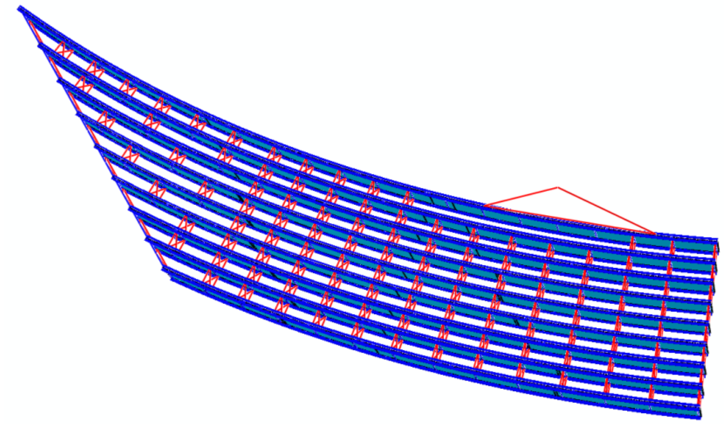
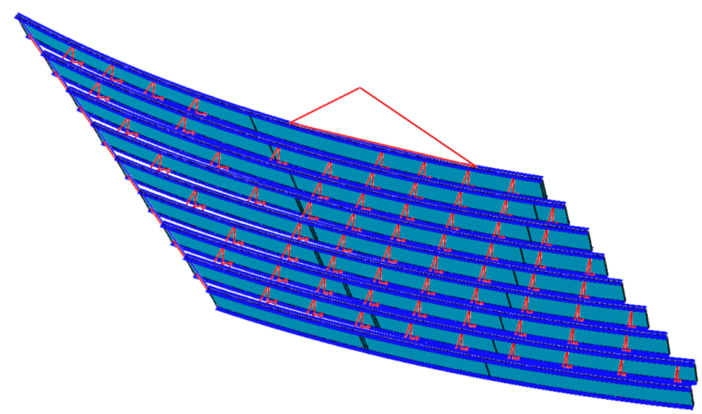
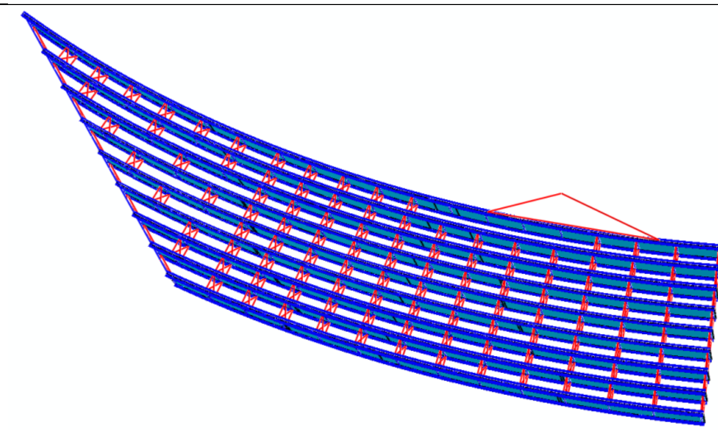
3		
4		

Table Q1-2-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

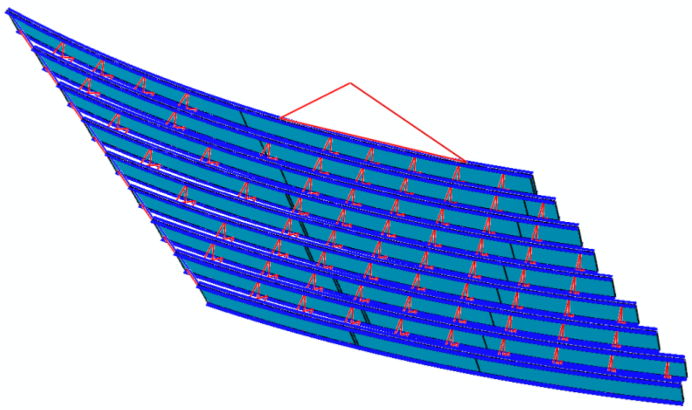
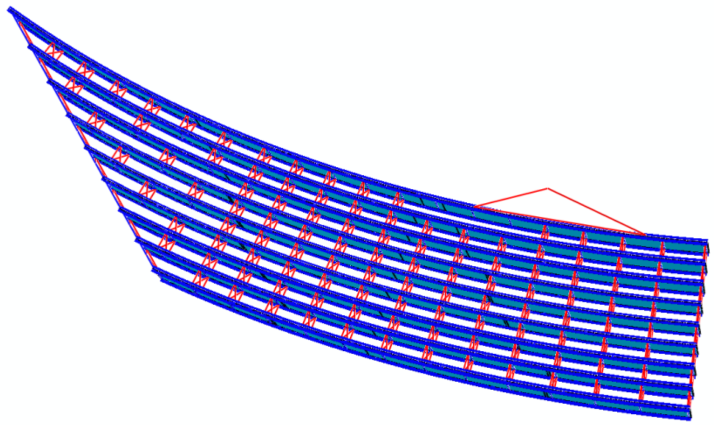
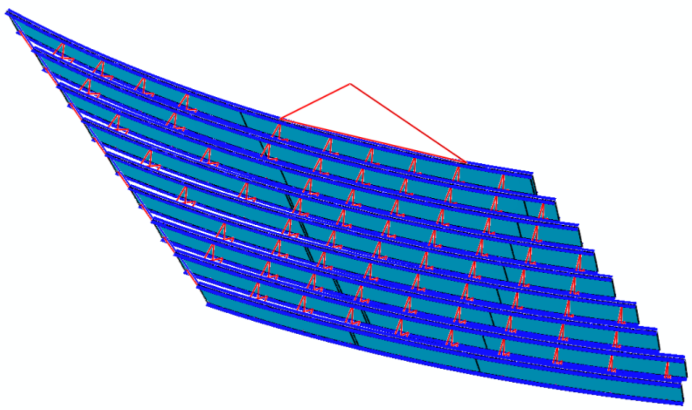
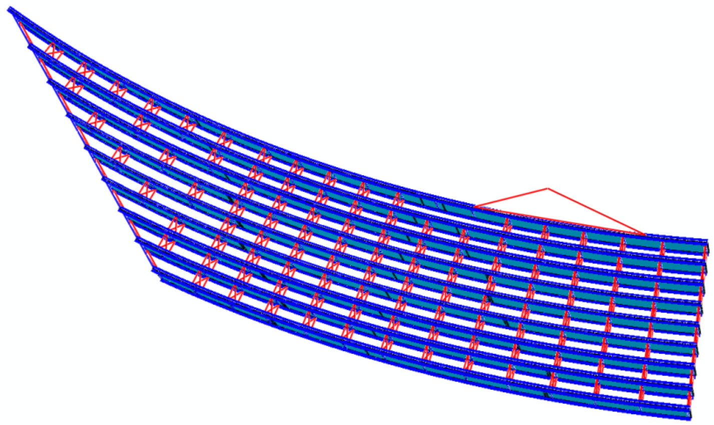
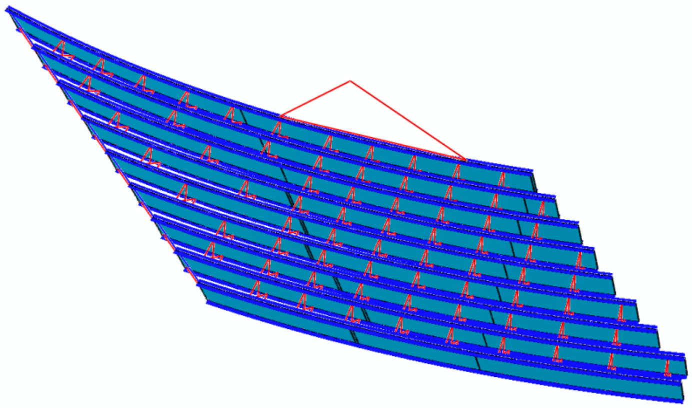
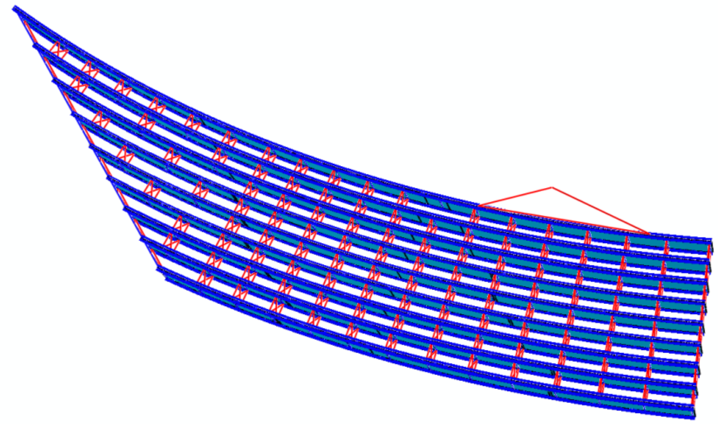
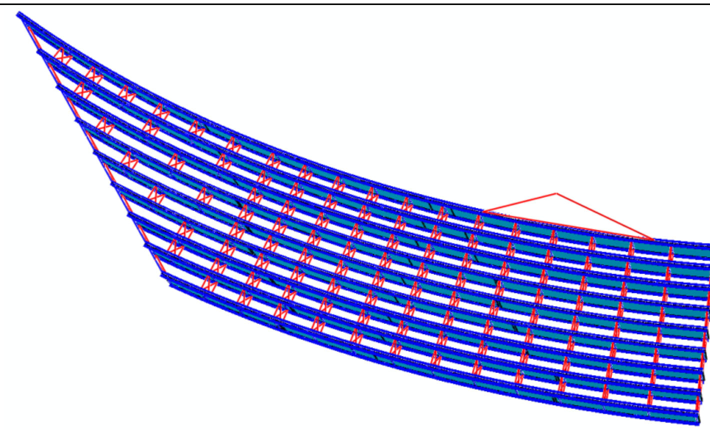
5		
6		

Table Q1-2-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

7		
8		

Appendix Q2-2. NISCS38 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISCS38 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table Q2-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	5.1	10.2
	SDLF	5.3	10.3
	TDLF	5.5	10.6
G2	NLF	5.0	10.2
	SDLF	5.1	10.3
	TDLF	5.4	10.5
G3	NLF	5.0	10.2
	SDLF	5.1	10.4
	TDLF	5.4	10.6
G4	NLF	5.0	10.4
	SDLF	5.2	10.6
	TDLF	5.6	10.9
G5	NLF	5.1	10.7
	SDLF	5.4	11.0
	TDLF	5.8	11.4
G6	NLF	5.3	11.2
	SDLF	5.6	11.5
	TDLF	6.2	12.0
G7	NLF	5.4	11.7
	SDLF	5.9	12.1
	TDLF	6.5	12.7
G8	NLF	5.7	12.2
	SDLF	6.1	12.6
	TDLF	6.8	13.3
G9	NLF	5.9	12.8
	SDLF	6.4	13.3
	TDLF	7.1	13.9
All Girders	NLF	5.9	12.8
	SDLF	6.4	13.3
	TDLF	7.1	13.9

Table Q2-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.33	2.69
	SDLF	0.12	1.41
	TDLF	1.16	0.20
G2	NLF	1.23	2.53
	SDLF	0.12	1.40
	TDLF	1.05	0.26
G3	NLF	1.20	2.51
	SDLF	0.13	1.43
	TDLF	1.00	0.29
G4	NLF	1.24	2.61
	SDLF	0.17	1.56
	TDLF	1.00	0.38
G5	NLF	1.29	2.77
	SDLF	0.21	1.68
	TDLF	1.05	0.46
G6	NLF	1.35	2.92
	SDLF	0.24	1.80
	TDLF	1.05	0.53
G7	NLF	1.38	2.99
	SDLF	0.26	1.86
	TDLF	1.03	0.59
G8	NLF	1.42	3.07
	SDLF	0.29	1.93
	TDLF	1.06	0.65
G9	NLF	1.45	3.15
	SDLF	0.31	2.00
	TDLF	1.07	0.71
All Girders	NLF	1.45	3.15
	SDLF	0.31	2.00
	TDLF	1.16	0.71

Table Q2-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	11.6	23.5	12.2	24.8	1.3	3.9	1.2	3.2
	SDLF	12.0	23.9	12.7	25.2	1.1	2.4	1.1	3.1
	TDLF	12.3	24.2	13.0	25.6	2.0	2.3	1.4	2.3
G2	NLF	10.6	21.7	11.2	22.9	1.1	2.7	1.8	4.1
	SDLF	10.8	21.8	11.4	23.0	1.0	2.2	1.0	2.7
	TDLF	10.9	21.9	11.5	23.1	1.3	2.1	1.3	2.1
G3	NLF	9.7	19.9	10.2	21.1	1.1	2.7	2.0	5.4
	SDLF	9.6	19.9	10.2	21.0	0.9	2.2	0.9	3.8
	TDLF	9.6	19.9	10.2	21.0	1.2	1.9	1.5	2.2
G4	NLF	10.3	21.5	10.3	21.6	2.2	5.2	1.9	6.0
	SDLF	10.1	21.2	10.2	21.4	1.6	4.1	1.7	5.0
	TDLF	10.6	21.6	10.6	21.8	2.2	3.2	1.6	4.0
G5	NLF	9.7	20.5	9.7	20.5	2.2	5.1	2.5	5.4
	SDLF	10.0	20.9	10.0	20.9	1.8	4.2	2.0	4.8
	TDLF	10.5	21.3	10.5	21.4	2.1	3.8	1.9	4.5
G6	NLF	9.5	20.5	9.5	20.6	2.8	6.4	3.2	6.9
	SDLF	9.7	20.6	9.7	20.8	2.0	5.1	2.0	5.7
	TDLF	9.9	20.8	10.0	21.0	2.4	4.2	1.9	4.6
G7	NLF	7.8	17.0	7.8	17.0	2.8	5.8	3.2	6.9
	SDLF	7.9	17.0	7.9	17.0	2.0	5.2	2.1	5.7
	TDLF	7.9	17.0	7.9	17.0	1.2	4.3	1.3	4.7
G8	NLF	7.8	17.0	7.9	17.1	1.4	3.0	1.8	3.9
	SDLF	7.5	16.7	7.6	16.8	1.3	2.9	1.4	3.3
	TDLF	7.3	16.4	7.3	16.5	1.3	2.7	1.1	3.0
G9	NLF	8.1	17.6	8.1	17.7	1.1	2.5	1.5	3.7
	SDLF	7.5	17.0	7.6	17.1	1.0	2.2	1.1	2.8
	TDLF	7.2	16.5	7.2	16.6	1.1	2.1	1.0	2.3
All Girders	NLF	11.6	23.5	12.2	24.8	2.8	6.4	3.2	6.9
	SDLF	12.0	23.9	12.7	25.2	2.0	5.2	2.1	5.7
	TDLF	12.3	24.2	13.0	25.6	2.4	4.3	1.9	4.7

Table Q2-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	34.6	66.5	66.1	66.5
	SDLF	34.9	39.0	38.3	39.0
	TDLF	36.1	36.4	35.0	36.4
TDL	NLF	73.2	135.1	137.8	137.8
	SDLF	74.1	103.6	106.4	106.4
	TDLF	75.6	75.3	74.9	75.6

Table Q2-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	15.4	14.8	15.5	15.3
	SDLF	14.9	11.6	12.1	13.3
	TDLF	15.3	11.7	12.0	13.6
TDL	NLF	32.6	28.7	30.5	31.1
	SDLF	32.0	25.5	26.9	29.0
	TDLF	31.4	23.5	24.5	27.7

Table Q2-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.66	0.79	0.78	0.86	0.92	0.94	0.96	1.00	1.00
SDLF	0.74	0.89	0.88	1.00	1.07	1.11	1.14	1.20	1.20
TDLF	0.83	1.00	1.01	1.17	1.26	1.33	1.37	1.46	1.46

Table Q2-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.41	1.66	1.66	1.86	1.98	2.03	2.07	2.15	2.15
SDLF	1.49	1.76	1.75	1.99	2.12	2.20	2.25	2.35	2.35
TDLF	1.58	1.87	1.88	2.15	2.31	2.41	2.48	2.61	2.61

Table Q2-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	0.81	0.97	0.95	1.06	1.12	1.15	1.17	1.22	1.22
SDLF	0.91	1.08	1.07	1.22	1.31	1.36	1.40	1.47	1.47
TDLF	1.02	1.23	1.24	1.43	1.54	1.63	1.68	1.79	1.79

Table Q2-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.73	2.04	2.03	2.27	2.42	2.49	2.54	2.64	2.64
SDLF	1.82	2.15	2.15	2.43	2.60	2.69	2.76	2.88	2.88
TDLF	1.94	2.29	2.31	2.64	2.83	2.96	3.03	3.19	3.19

Table Q2-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	3026	6360
SDLF	3026	6360
TDLF	3026	6360

Table Q2-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	322	620	0.3	1.4	0.6	3.4
SDLF	298	599	0.2	0.9	0.1	2.1
TDLF	281	587	0.7	0.1	0.7	0.4

Table Q2-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.96	2.18	0.13	0.68
SDLF	0.84	1.99	0.02	0.42
TDLF	0.75	1.74	0.15	0.09

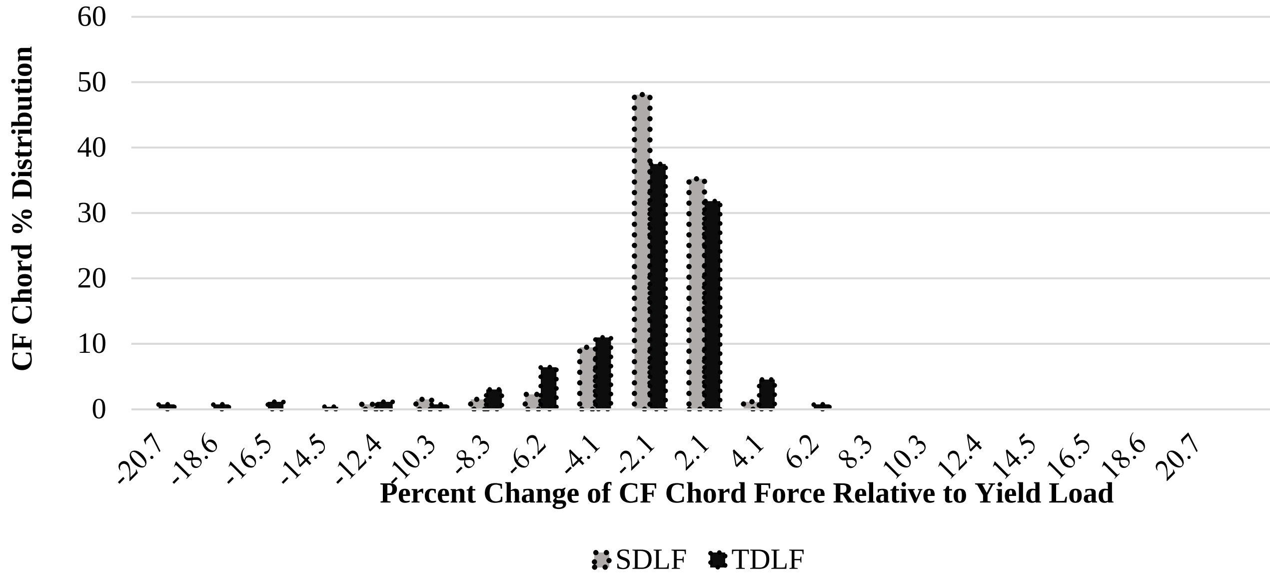


Figure Q2-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

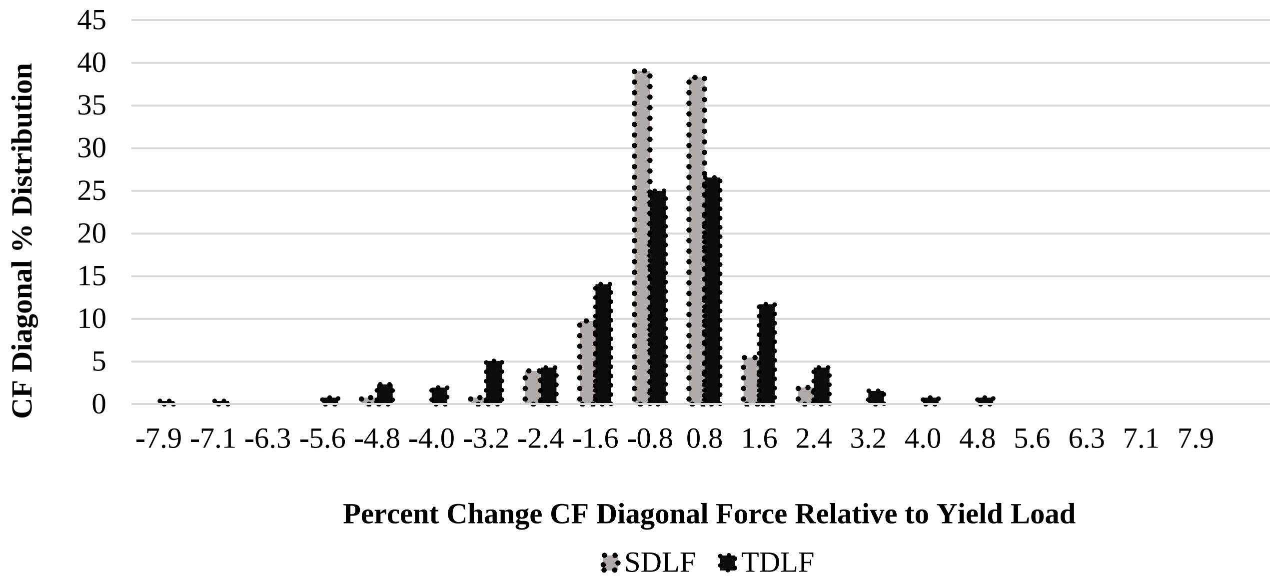


Figure Q2-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

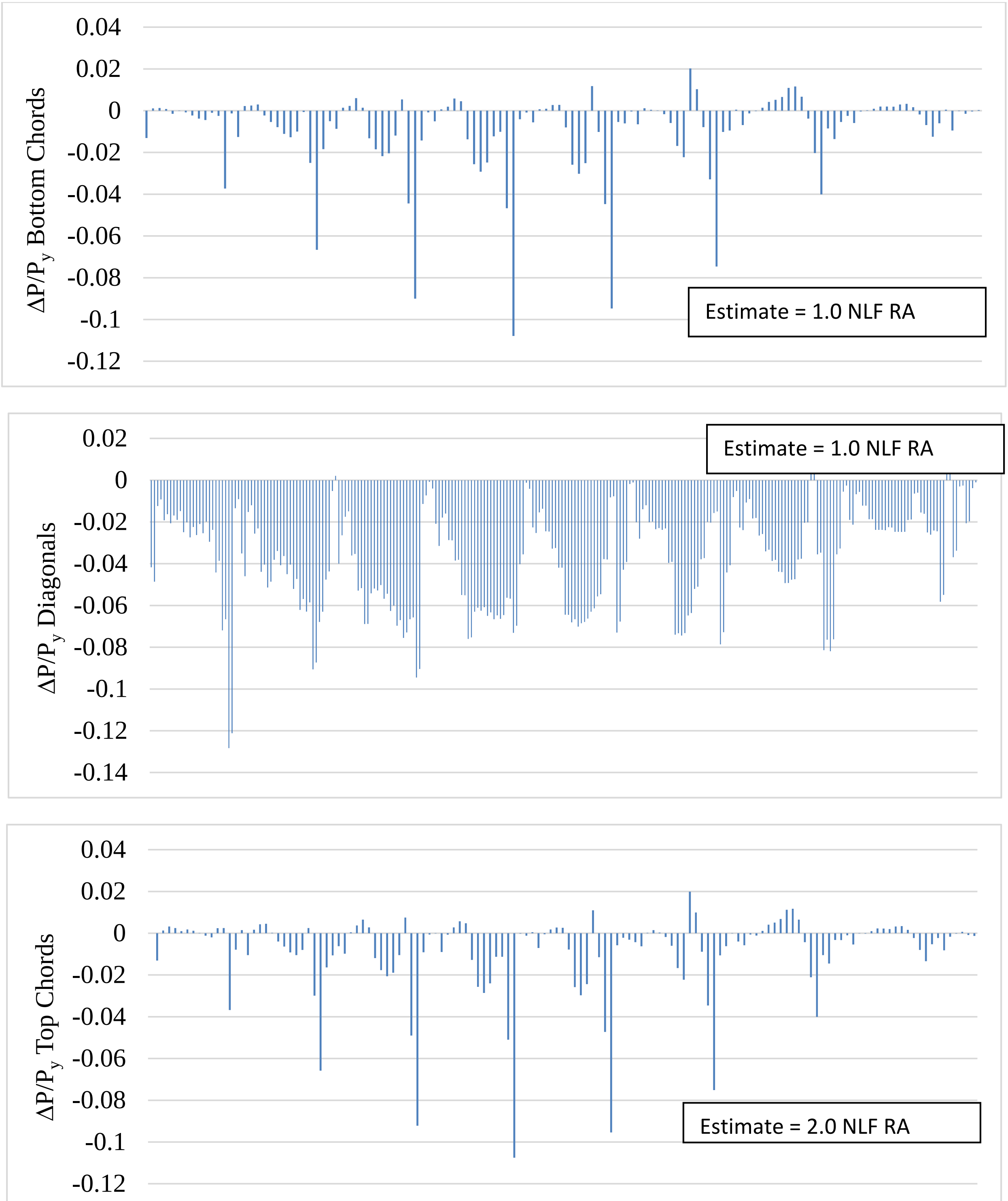


Figure Q2-2-3. **Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.**

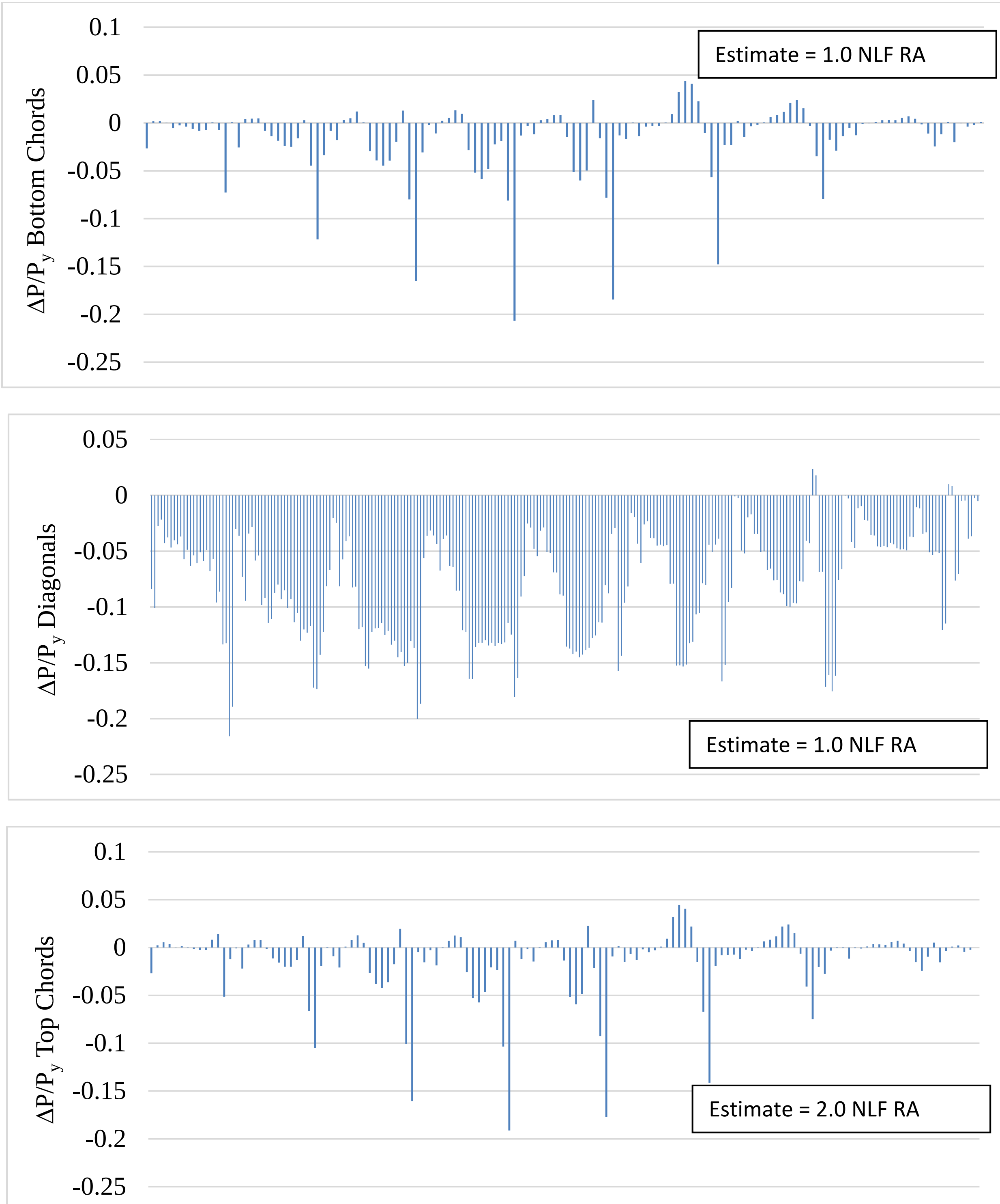


Figure Q2-2-4. **Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.**

Appendix Q2-3. NISCS38 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISCS38 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Table Q2-3-1. Maximums of the fit-up force resultants (kips)

Reactions

Table Q2-3-2. Summary of erection vertical reactions (kips)

Table Q2-3-3. Summary of erection crane loads (kips)

Table Q2-3-4. Total vertical reactions (kips)

Table Q2-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	20.1	13.8	20.1
SDLF	18.5	12.2	18.5
TDLF	11.8	15.7	15.7

Table Q2-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	123.2	19.4
	SDLF	213.8	0
	TDLF	326.5	0
G2	NLF	142.3	16.1
	SDLF	88.5	0
	TDLF	97.7	0
G3	NLF	171.8	28.1
	SDLF	167.9	0
	TDLF	176.5	0
G4	NLF	141	27.6
	SDLF	170.1	0
	TDLF	242.7	0
G5	NLF	151.3	21.6
	SDLF	244.4	0
	TDLF	312.6	0
G6	NLF	131.1	24.4
	SDLF	146.9	0
	TDLF	196.2	0
G7	NLF	171.9	11.2
	SDLF	206.5	0
	TDLF	235.4	0
G8	NLF	124.3	28.6
	SDLF	209.8	0
	TDLF	189.9	0
G9	NLF	126.8	15.3
	SDLF	149.9	0
	TDLF	202.8	0
All Girders	NLF	171.9	11.2
	SDLF	244.4	0
	TDLF	326.5	0

Table Q2-3-3. Summary of erection crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	155.5	56.2	59.7	27.9
SDLF	144.7	34.2	86.5	21.9
TDLF	112.3	16.6	85.9	9.3

Table Q2-3-6. Erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage							
		1	2	3	4	5	6	7	8
2	NLF	202	203	204	206				
	SDLF	202	203	204	206				
	TDLF	202	203	204	206				
11	NLF	1161	1163	1164	1166	1167			
	SDLF	1161	1163	1164	1166	1167			
	TDLF	1161	1163	1164	1166	1167			
18	NLF	2009	2010	2011	2013	2014	2016	2017	
	SDLF	2009	2010	2011	2013	2014	2016	2017	
	TDLF	2009	2010	2011	2013	2014	2016	2017	
27	NLF	3016	3017	3019	3020	3021	3023	3024	3026
	SDLF	3016	3017	3019	3020	3021	3023	3024	3026
	TDLF	3016	3017	3019	3020	3021	3023	3024	3026

Appendix Q2-4. NISCS38 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge NISCS38 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

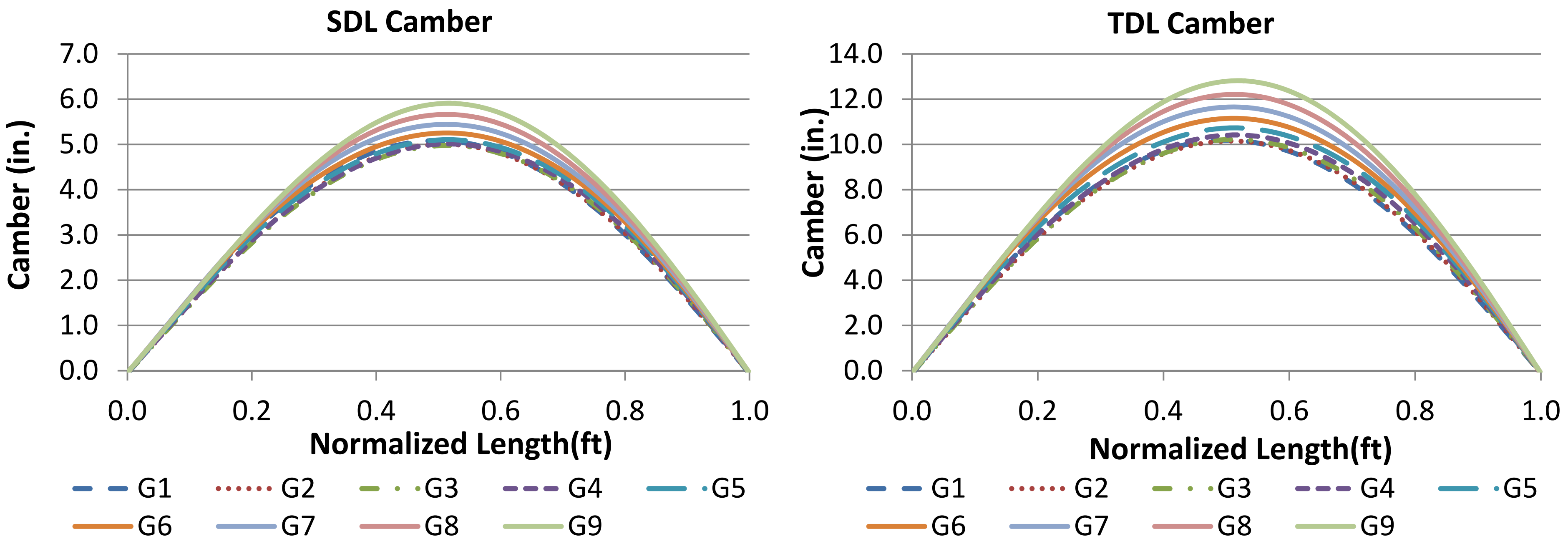


Figure Q2-4-1. SDL and TDL 3D FEA cambers.

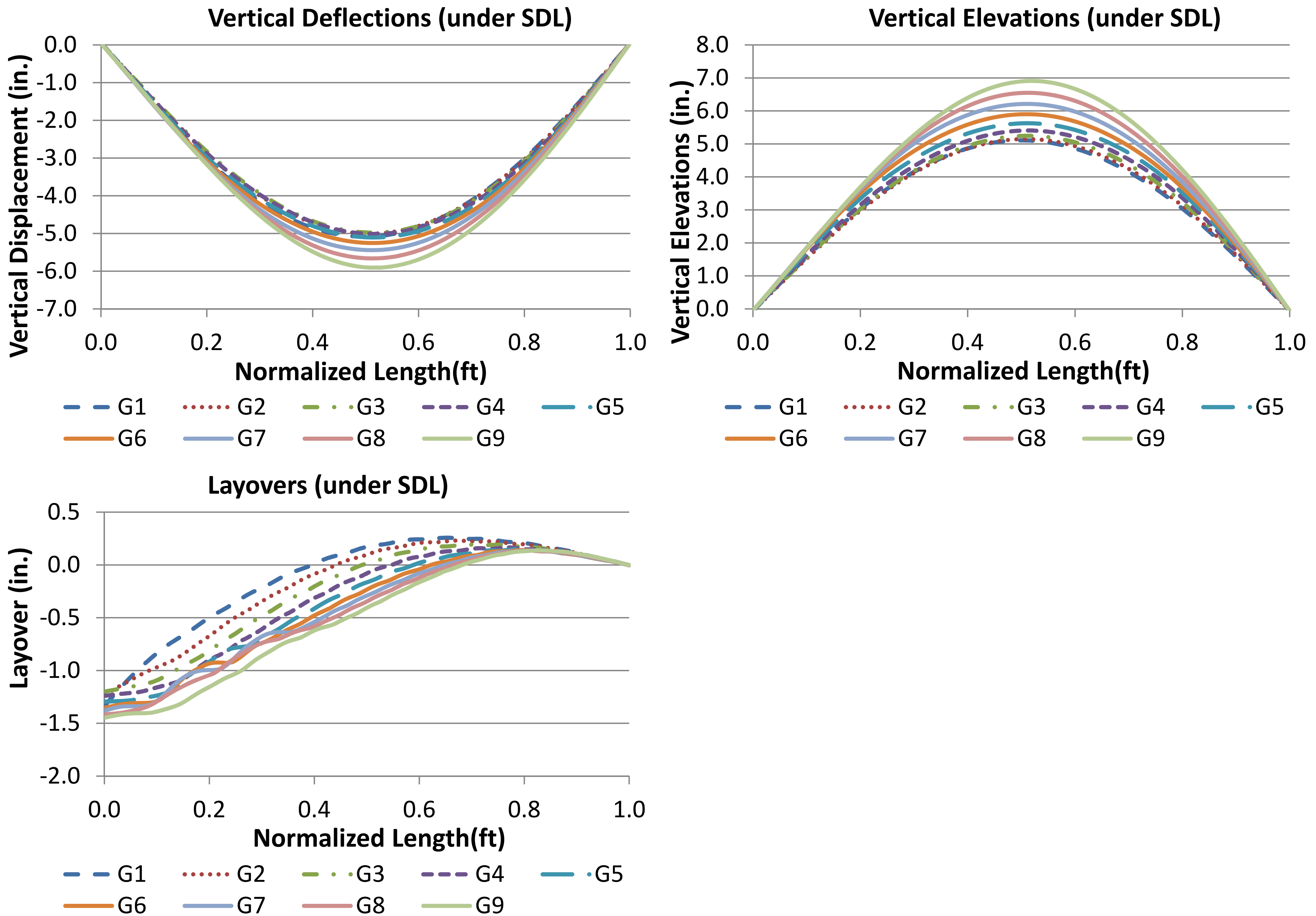


Figure Q2-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

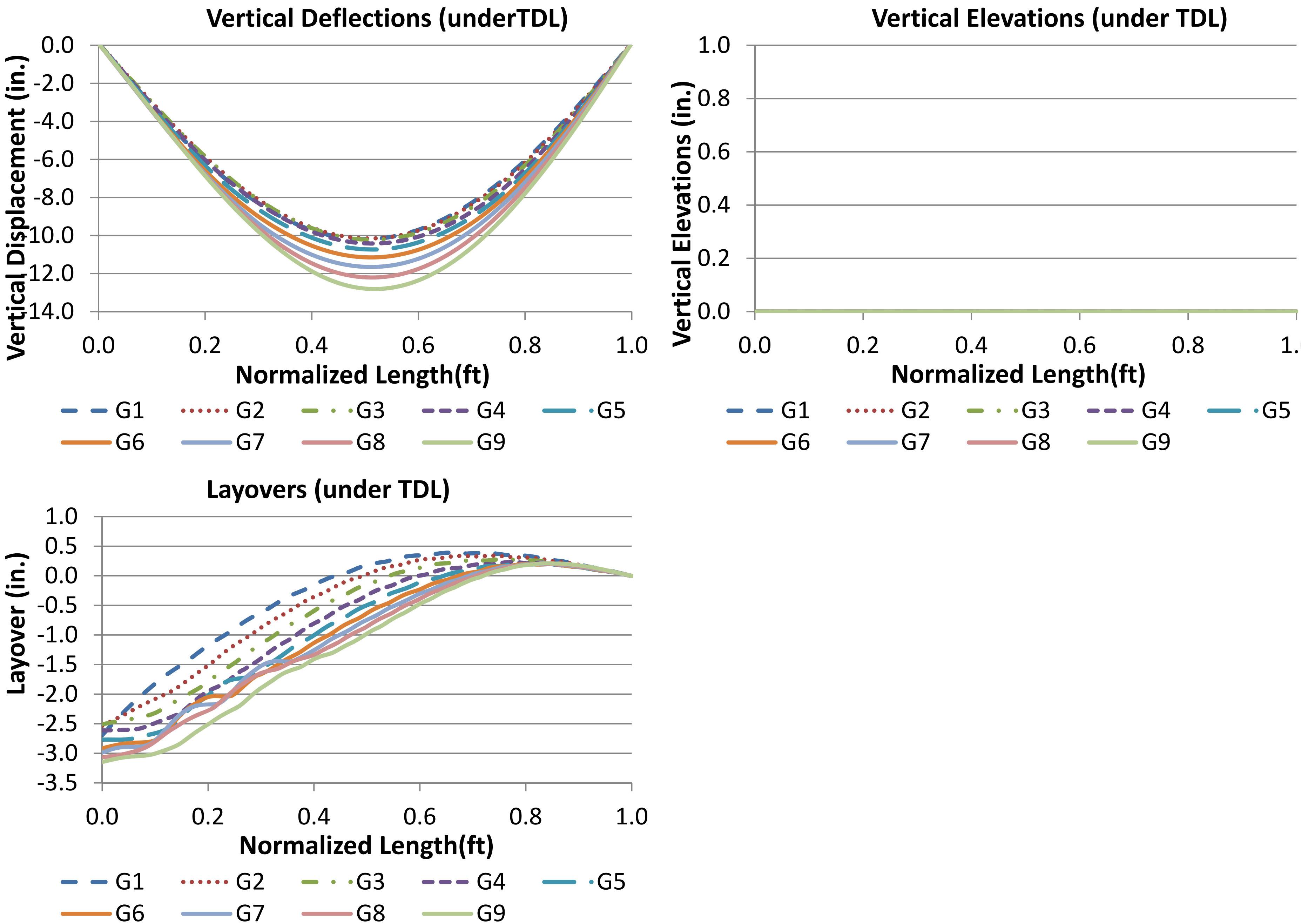


Figure Q2-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

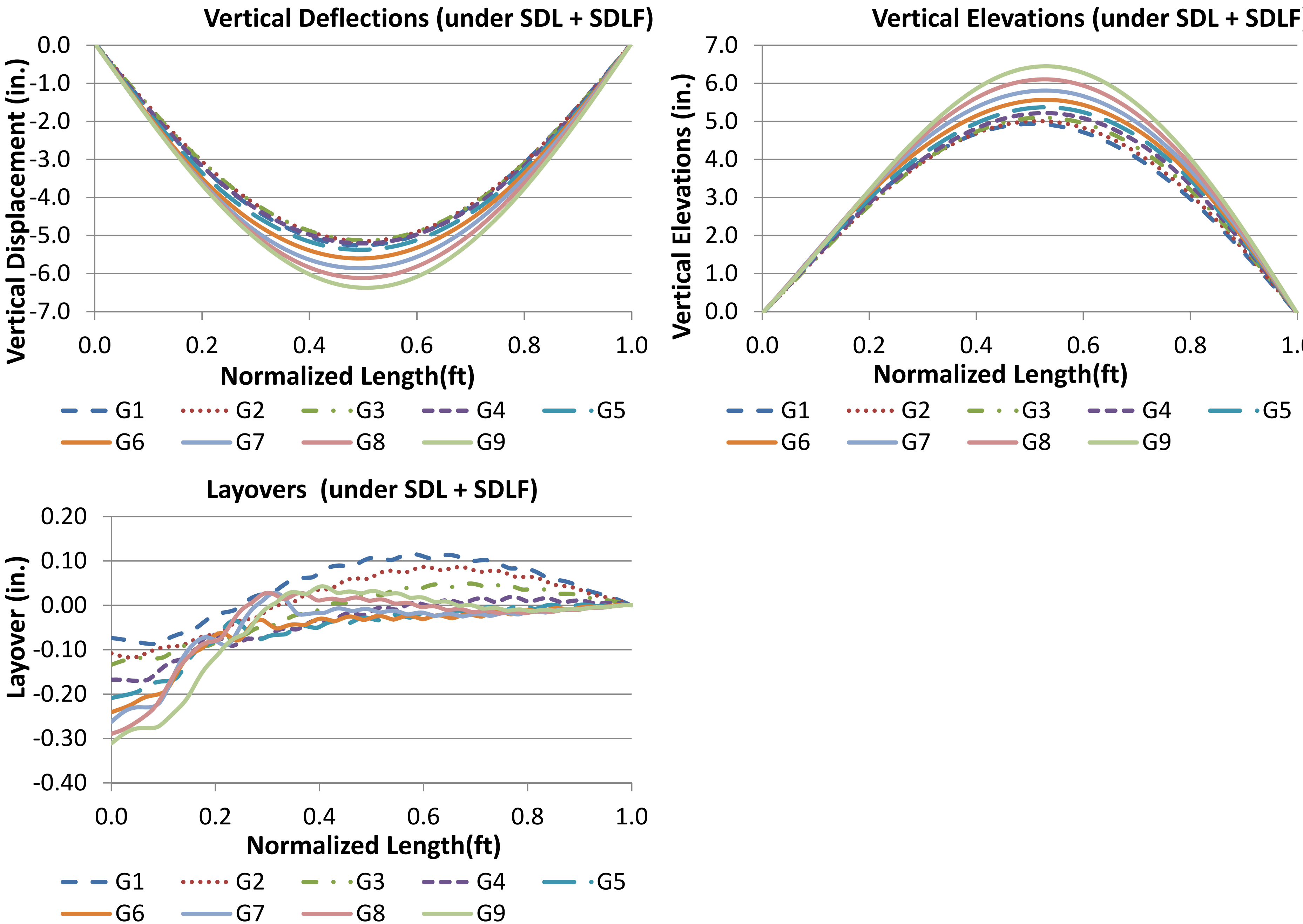


Figure Q2-4-4. **Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.**

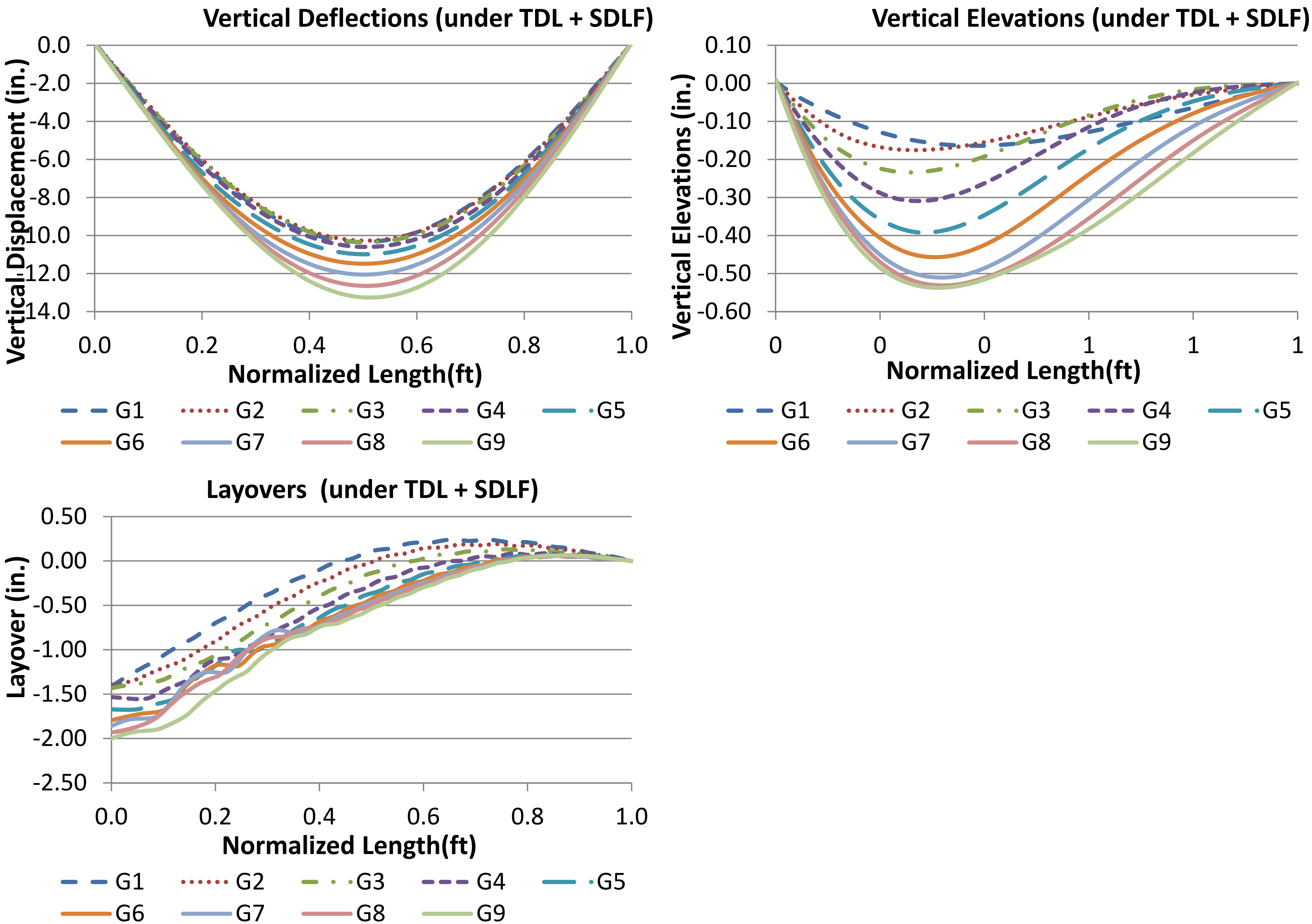


Figure Q2-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

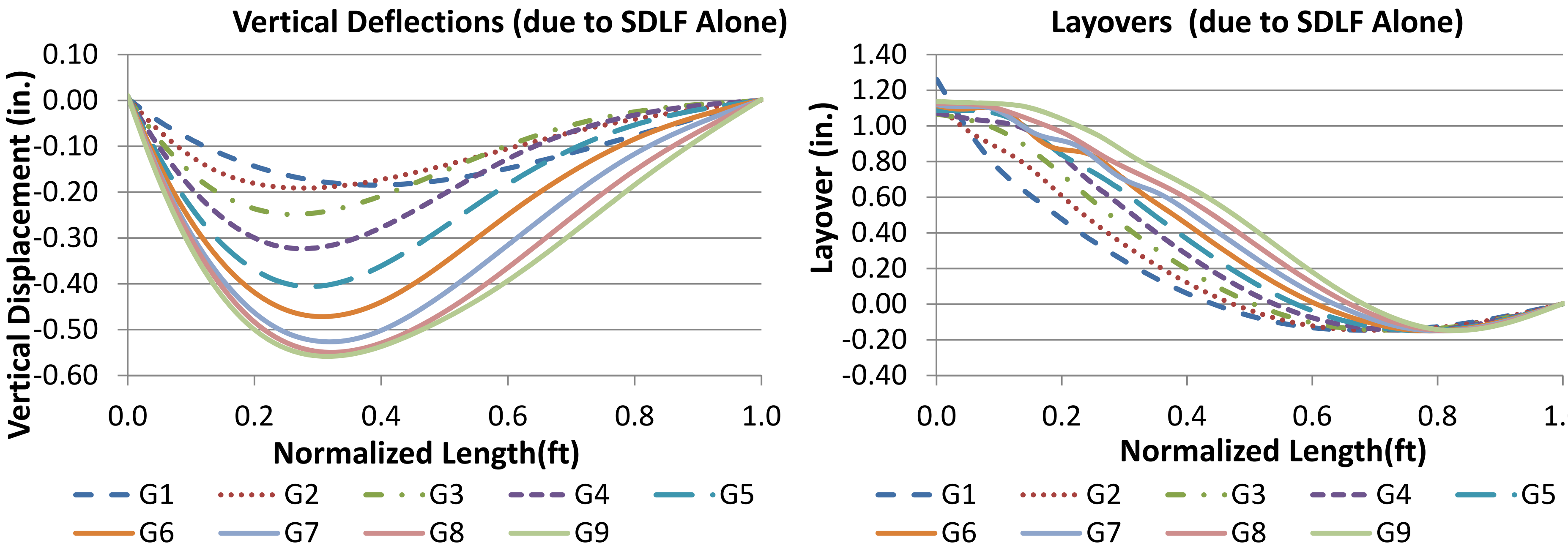


Figure Q2-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

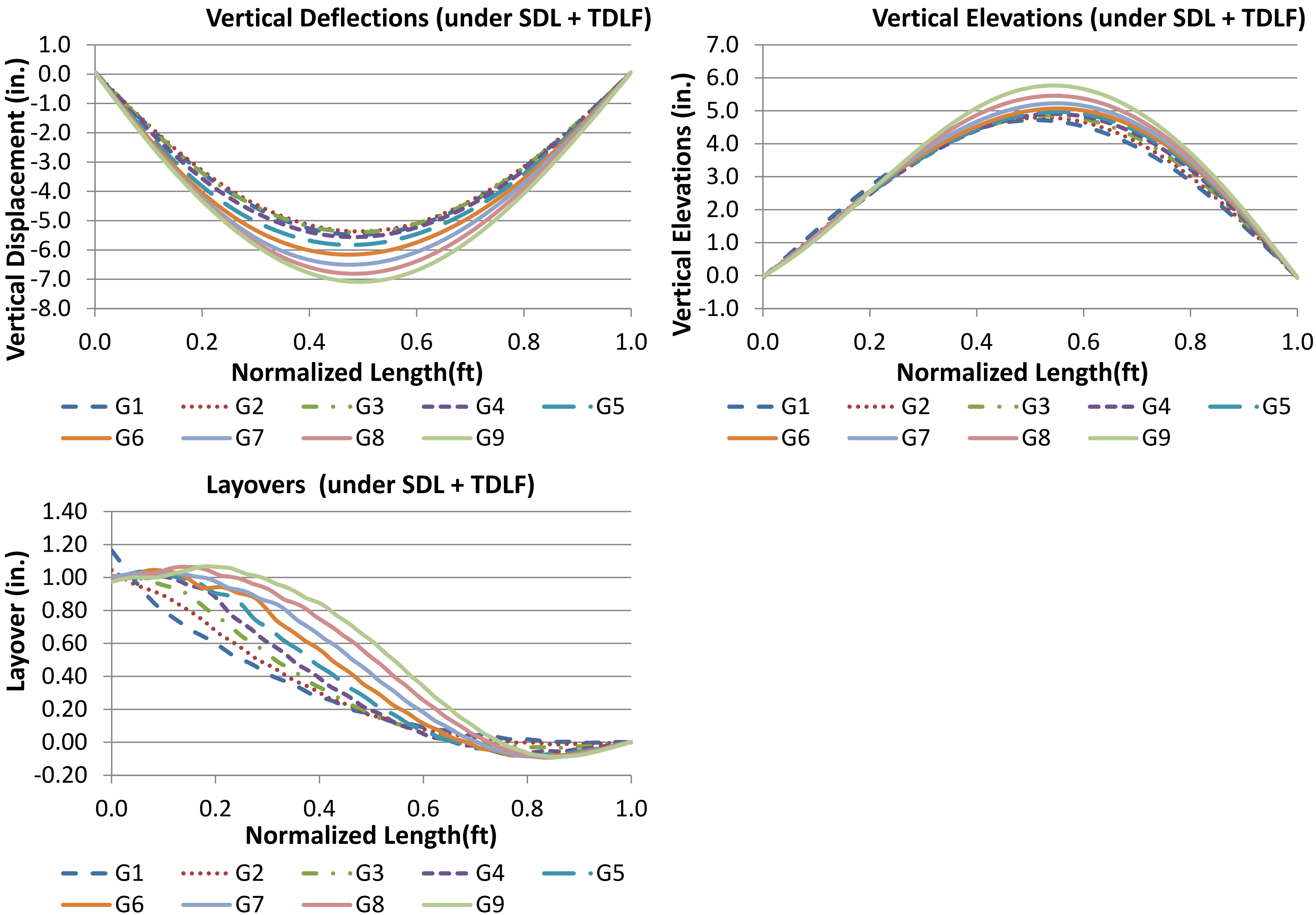


Figure Q2-4-7. **Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.**

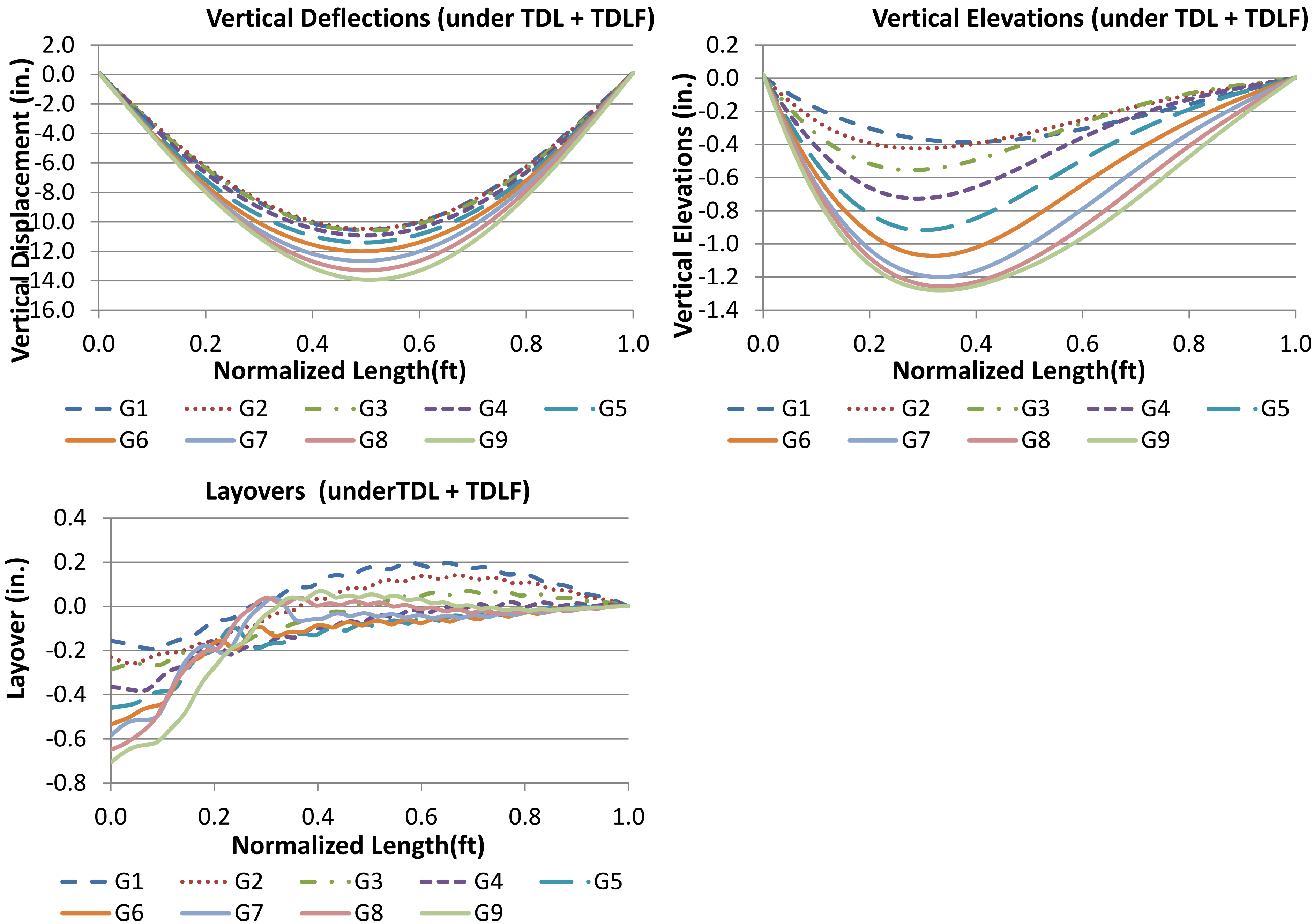


Figure Q2-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

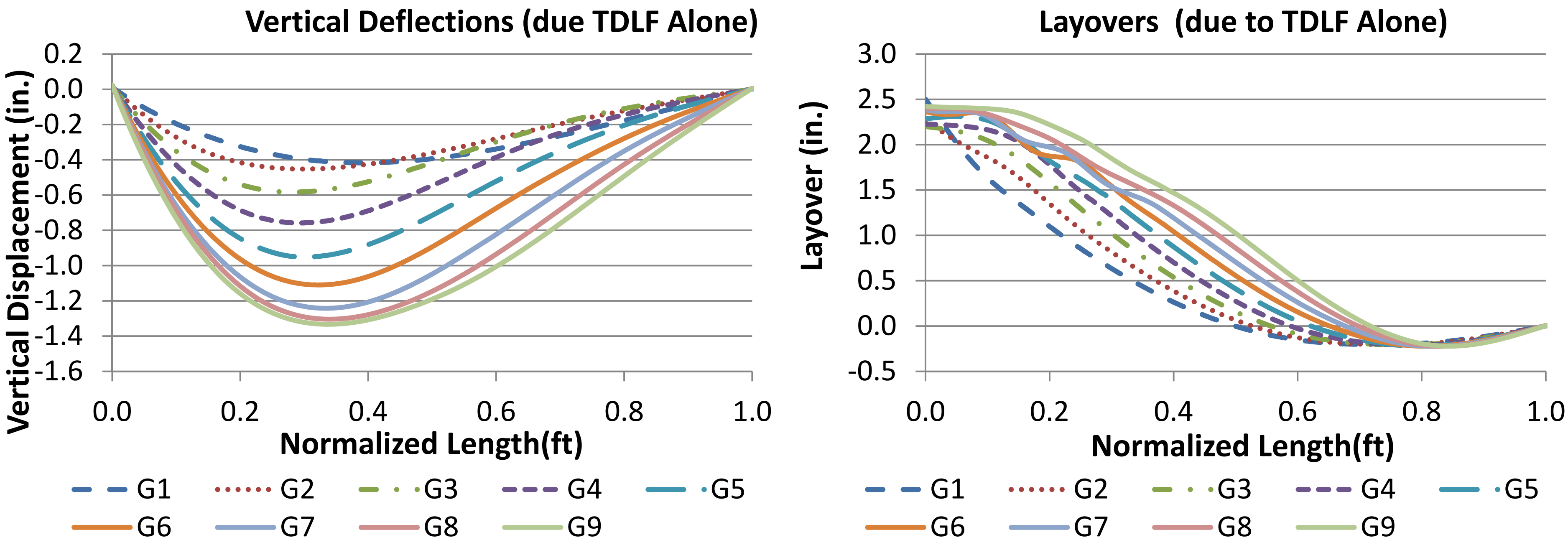


Figure Q2-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

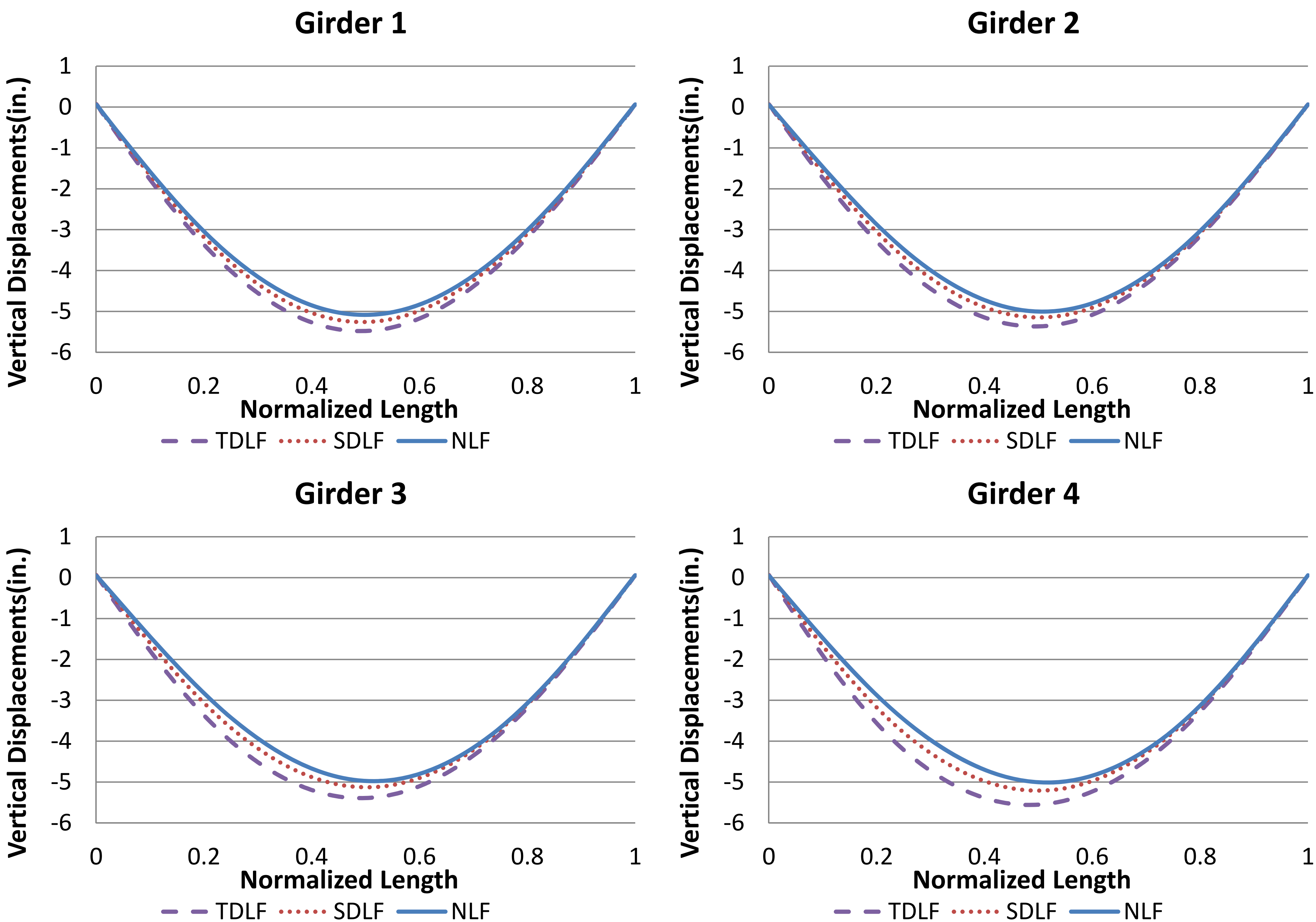


Figure Q2-4-10. **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

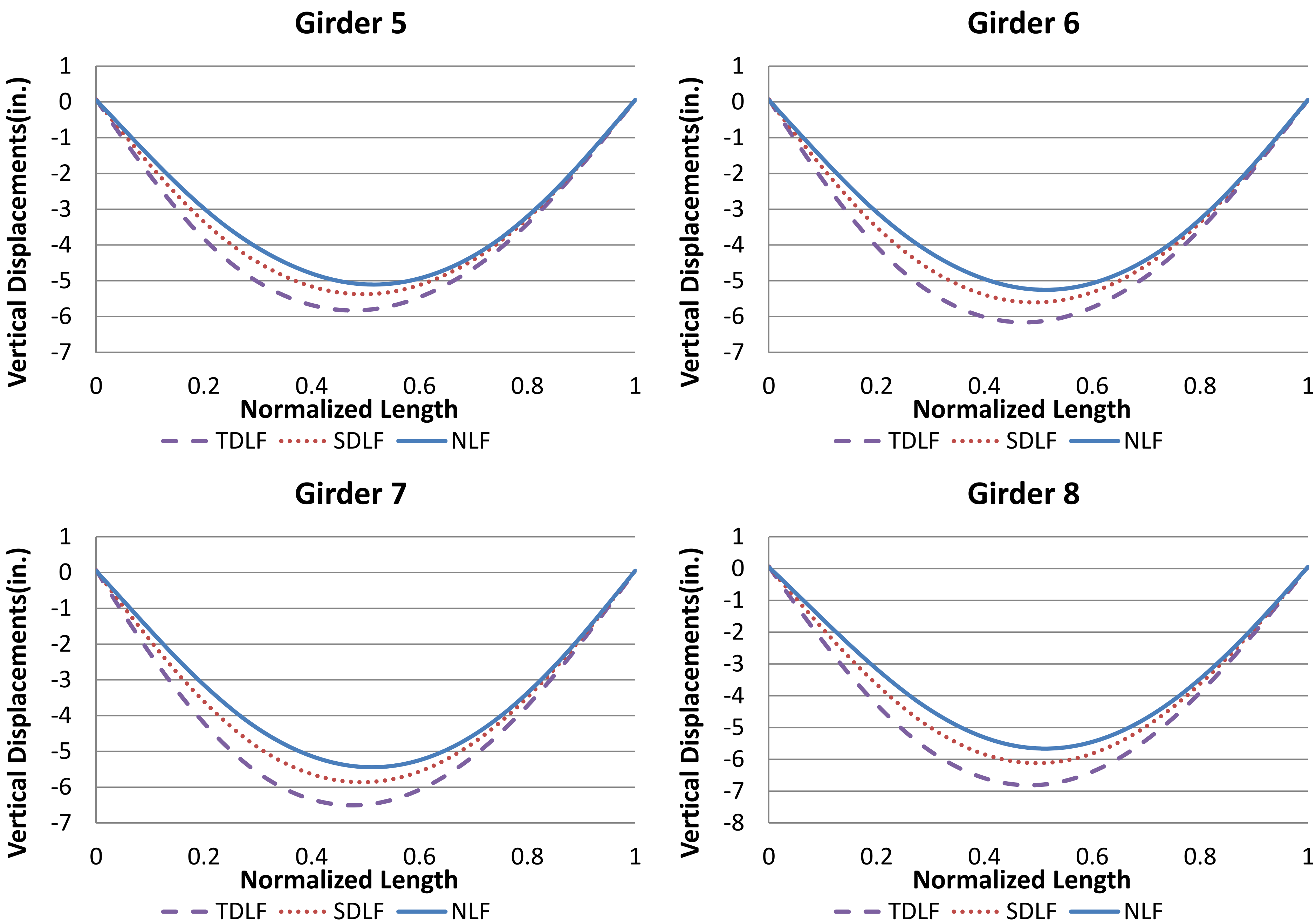


Figure Q2-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

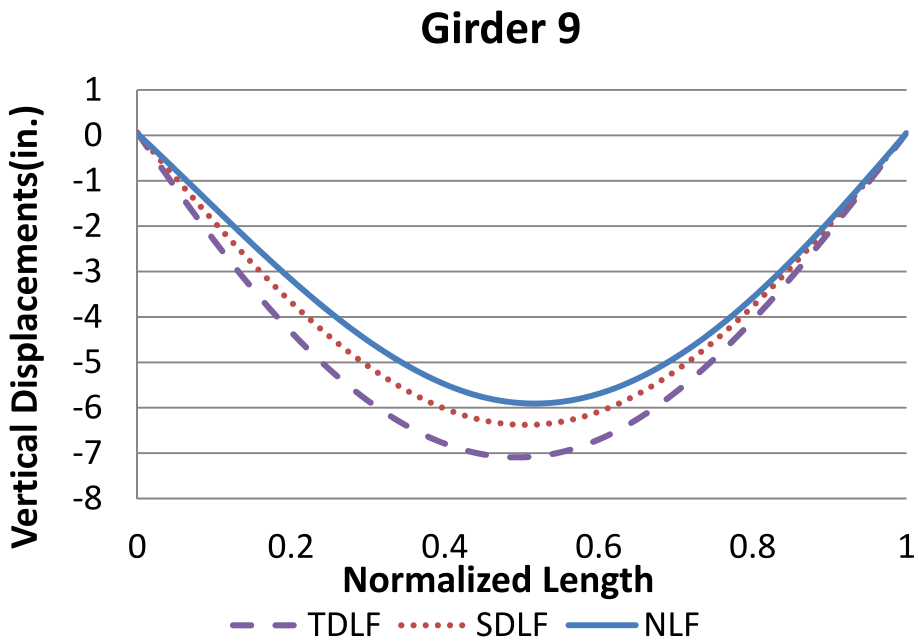


Figure Q2-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

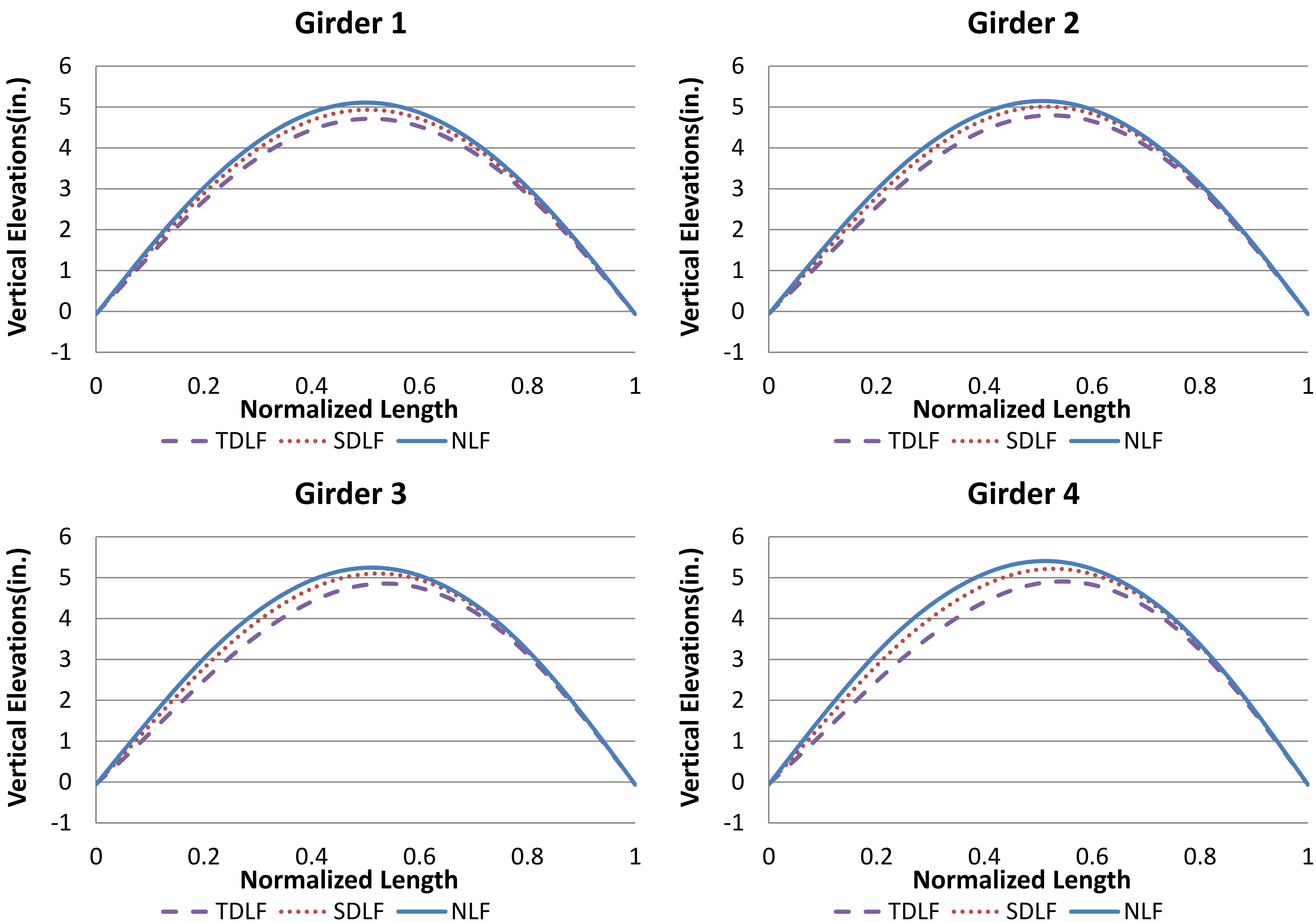


Figure Q2-4-11. **Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.**

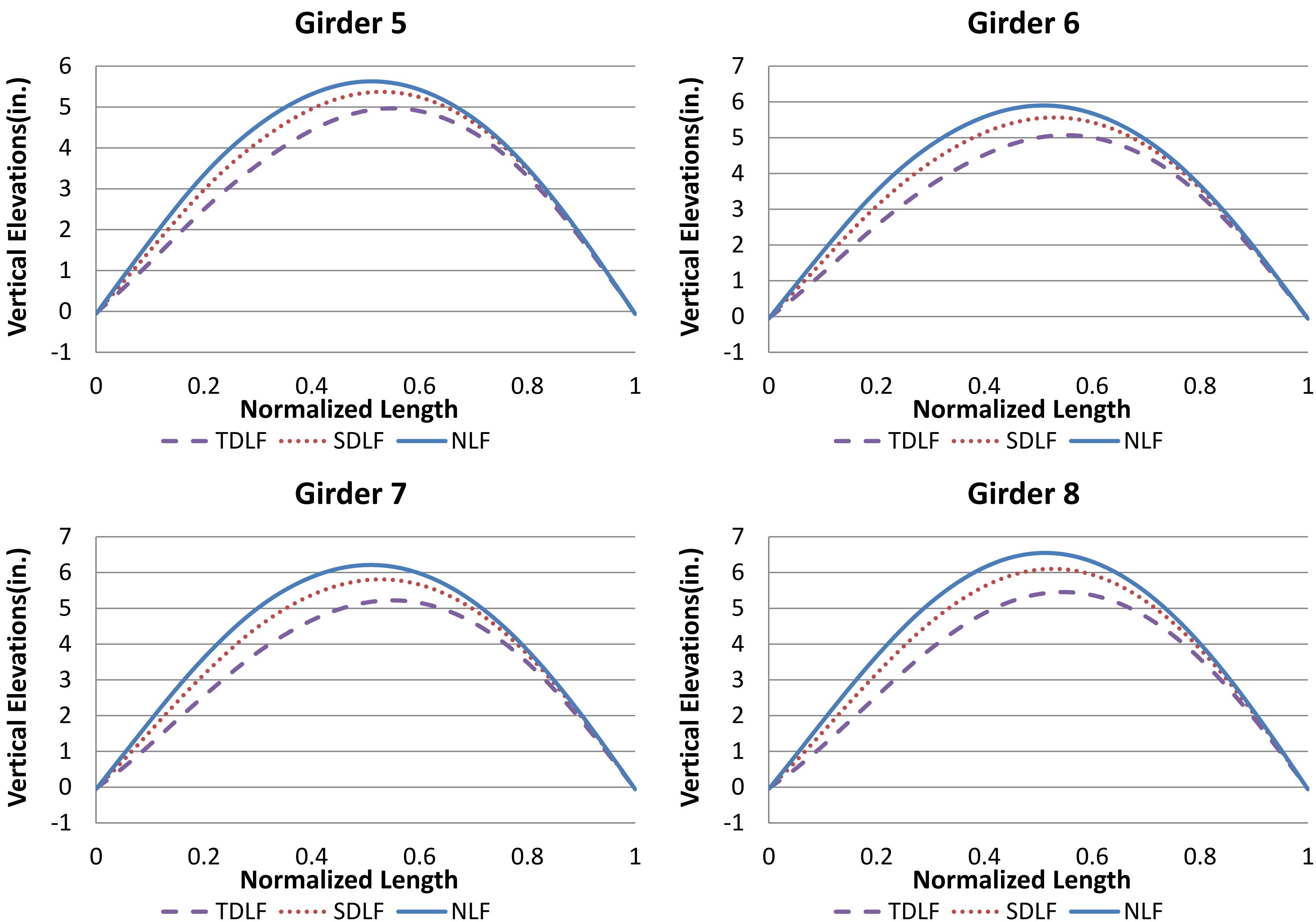


Figure Q2-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

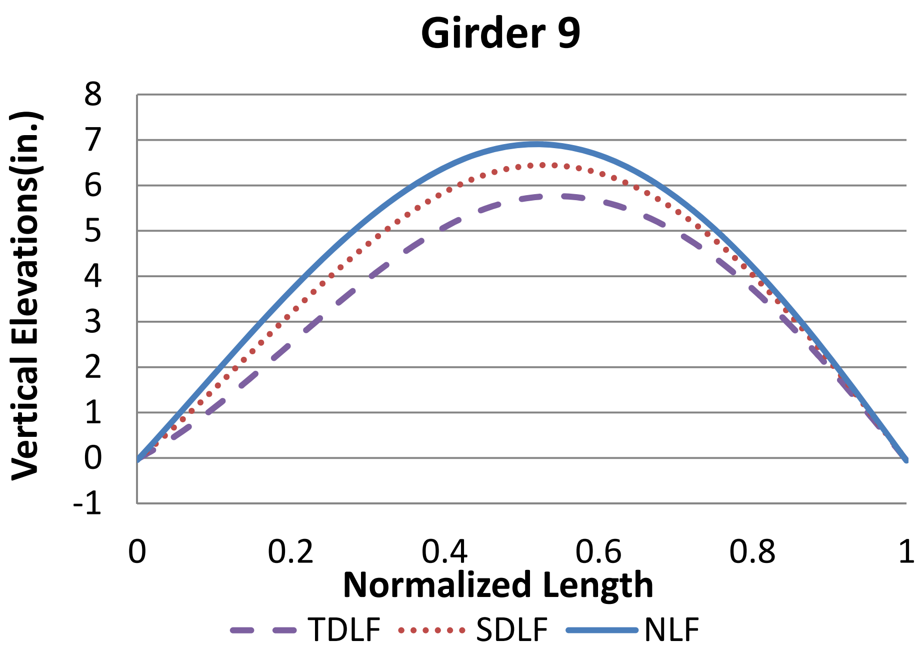


Figure Q2-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

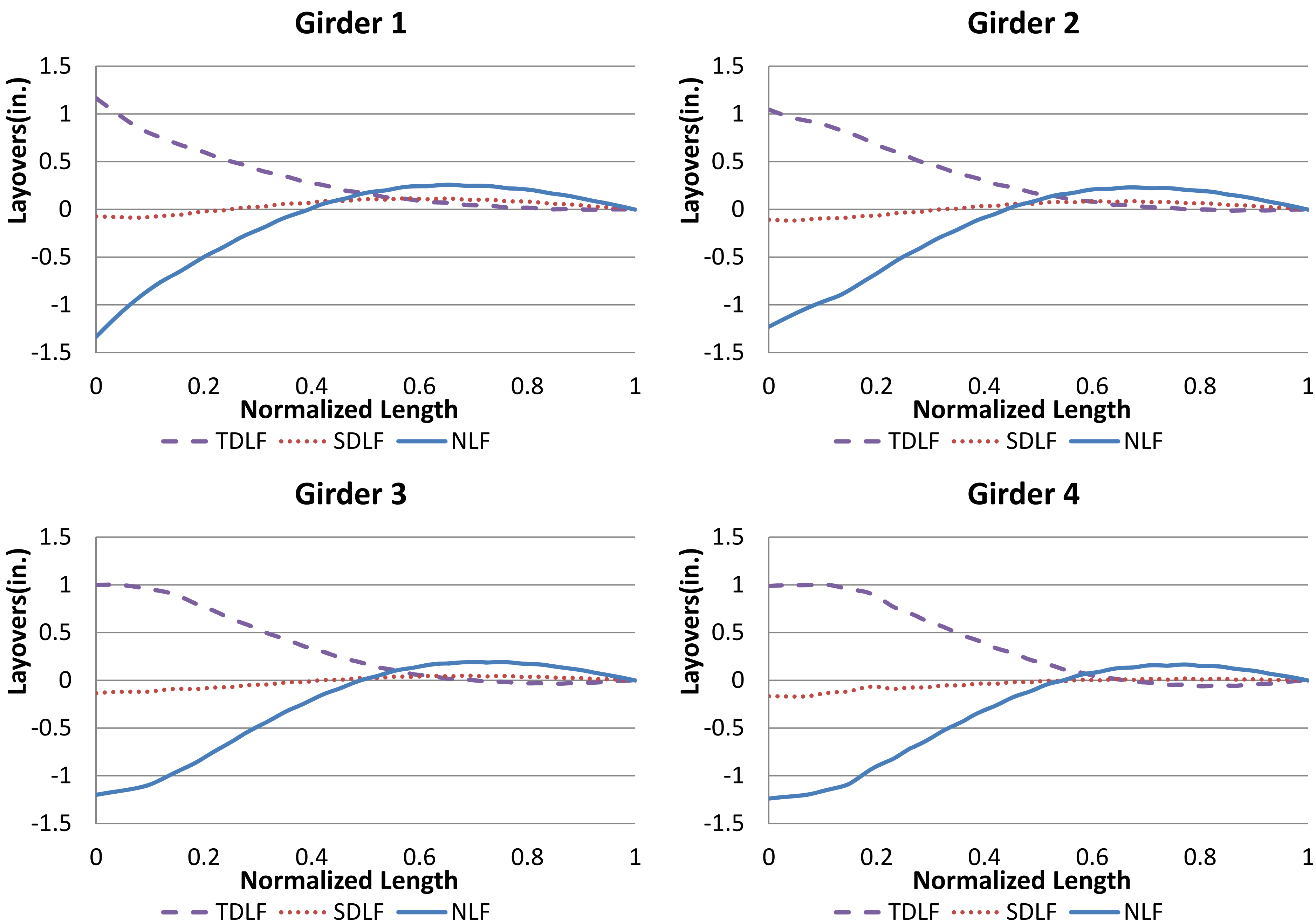


Figure Q2-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

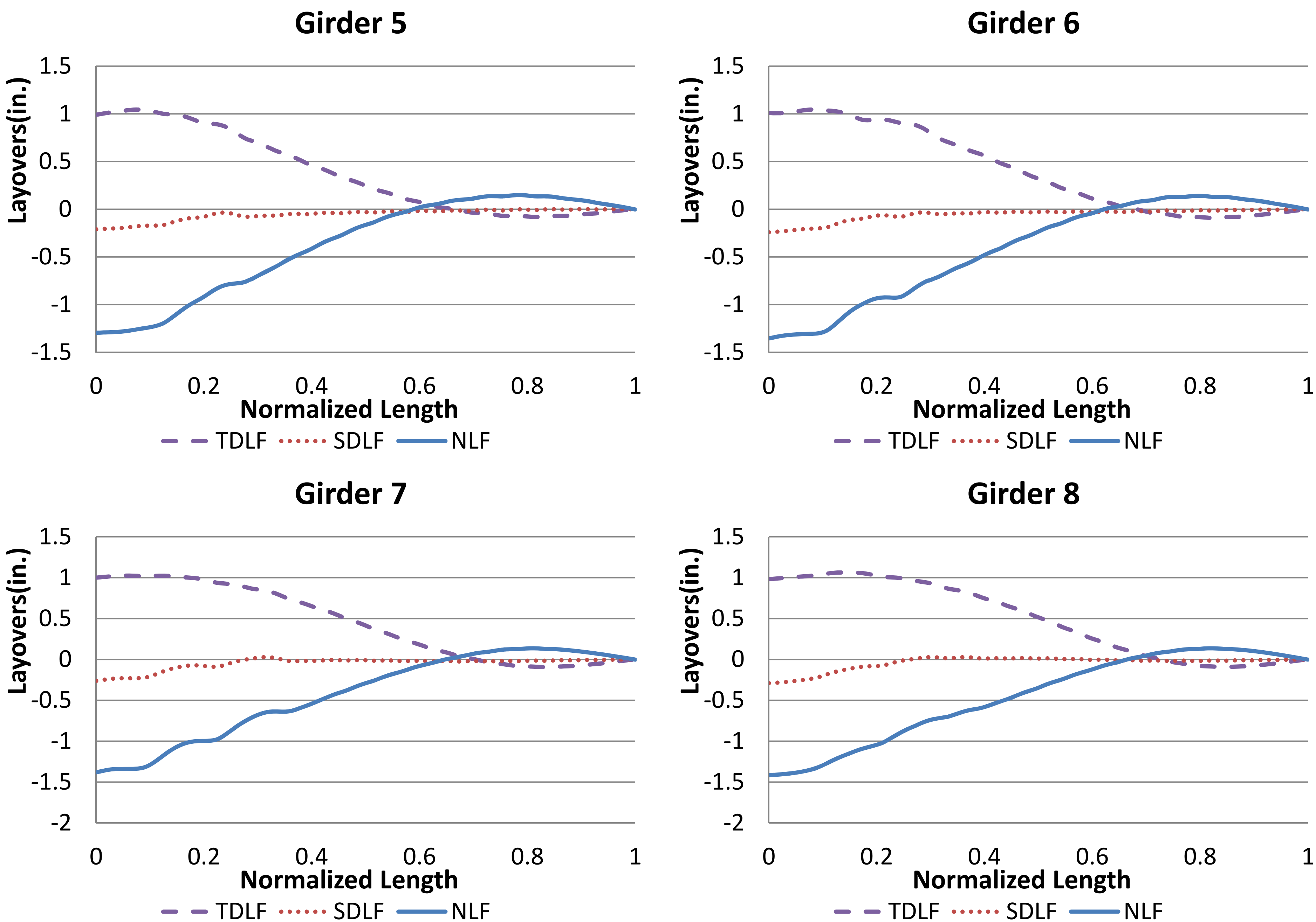


Figure Q2-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

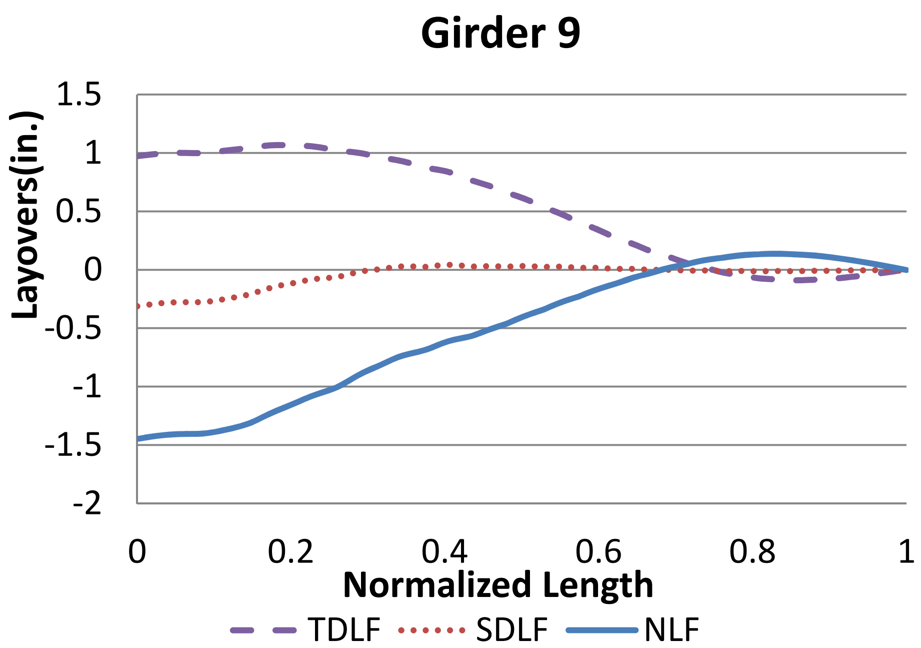


Figure Q2-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

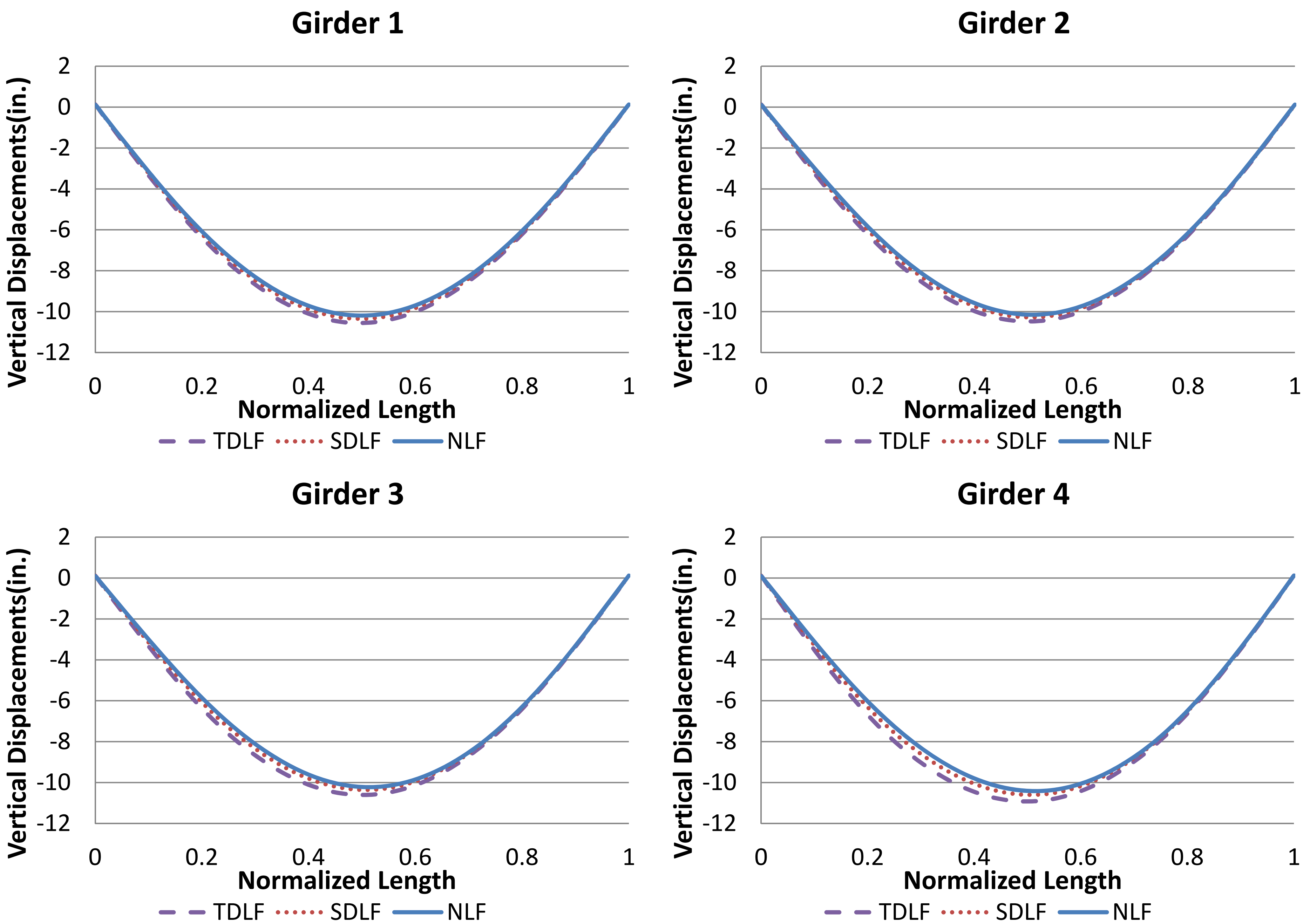


Figure Q2-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

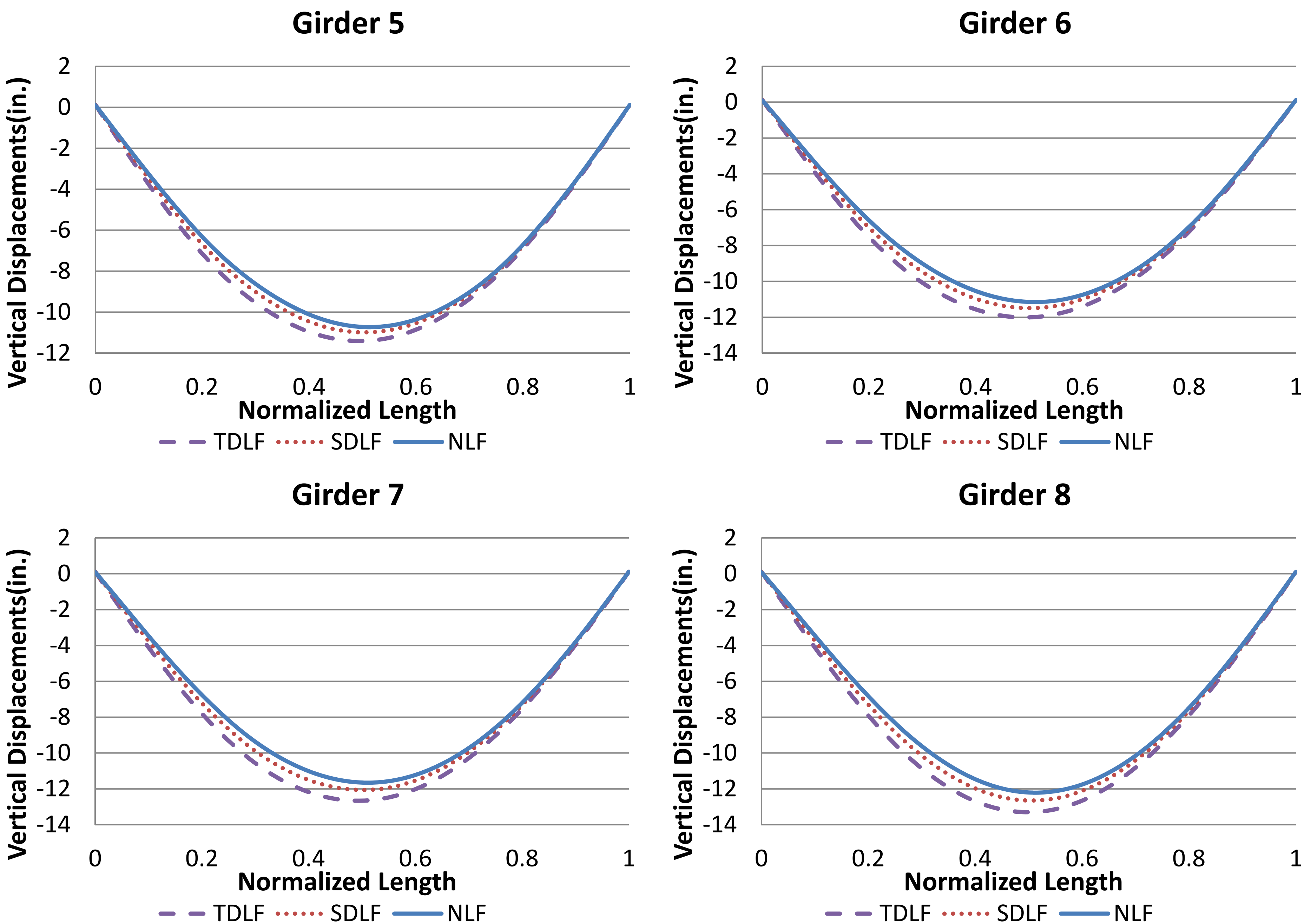


Figure Q2-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

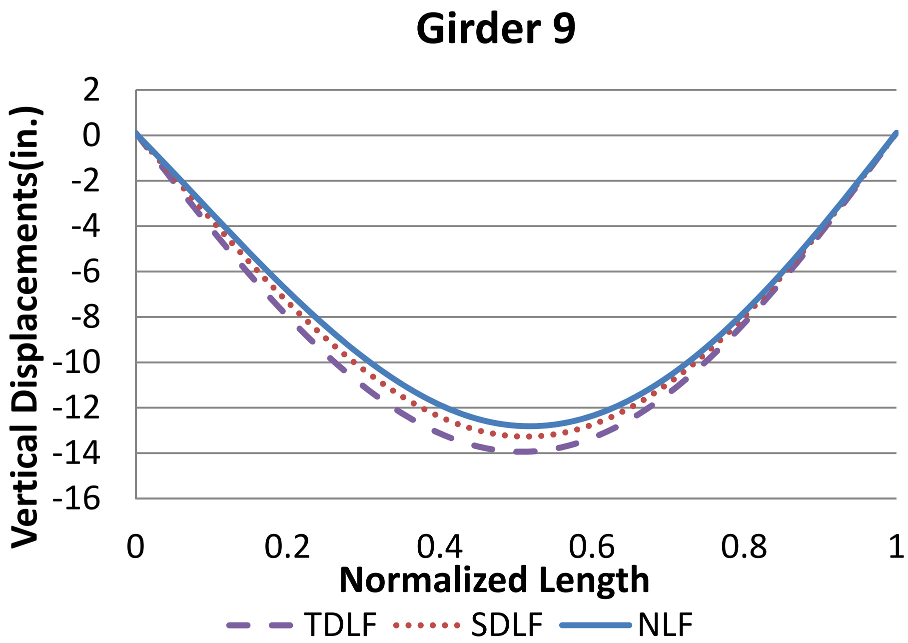


Figure Q2-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

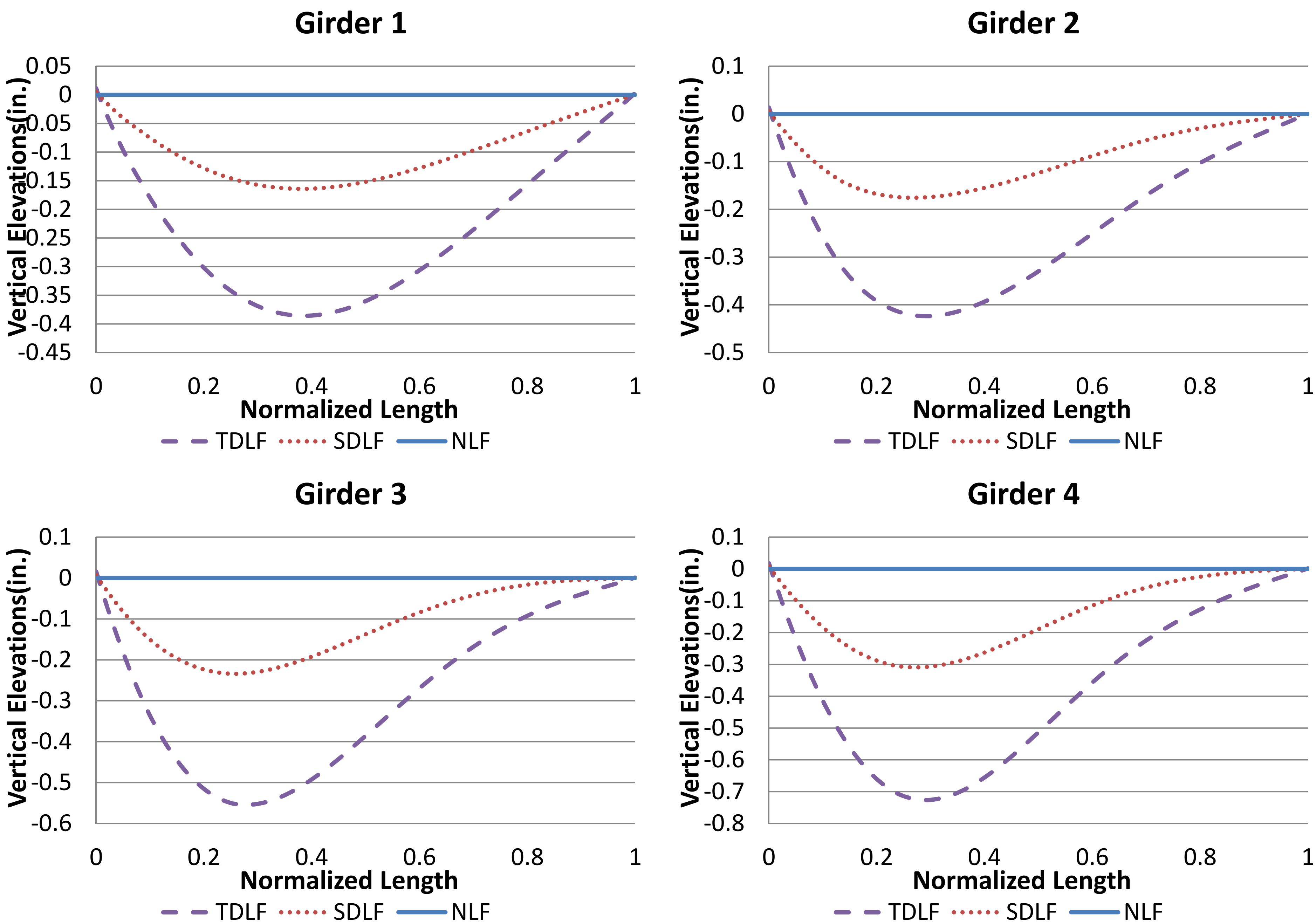


Figure Q2-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

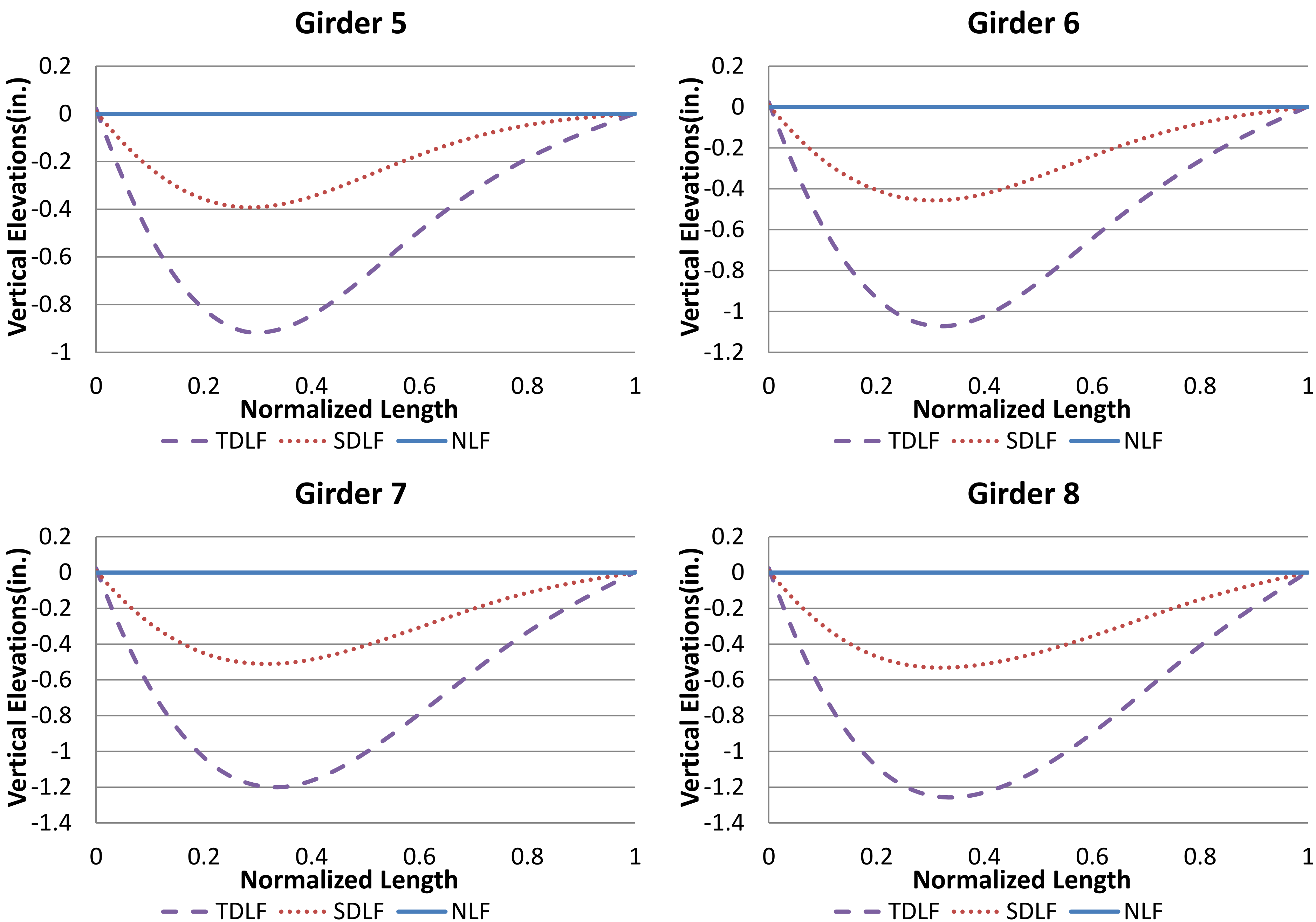


Figure Q2-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

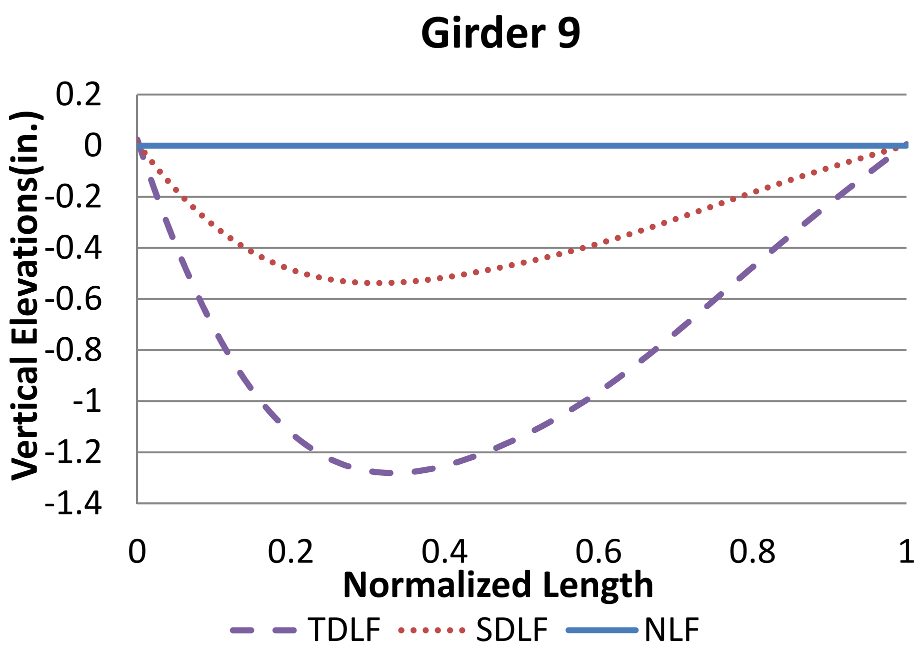


Figure Q2-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

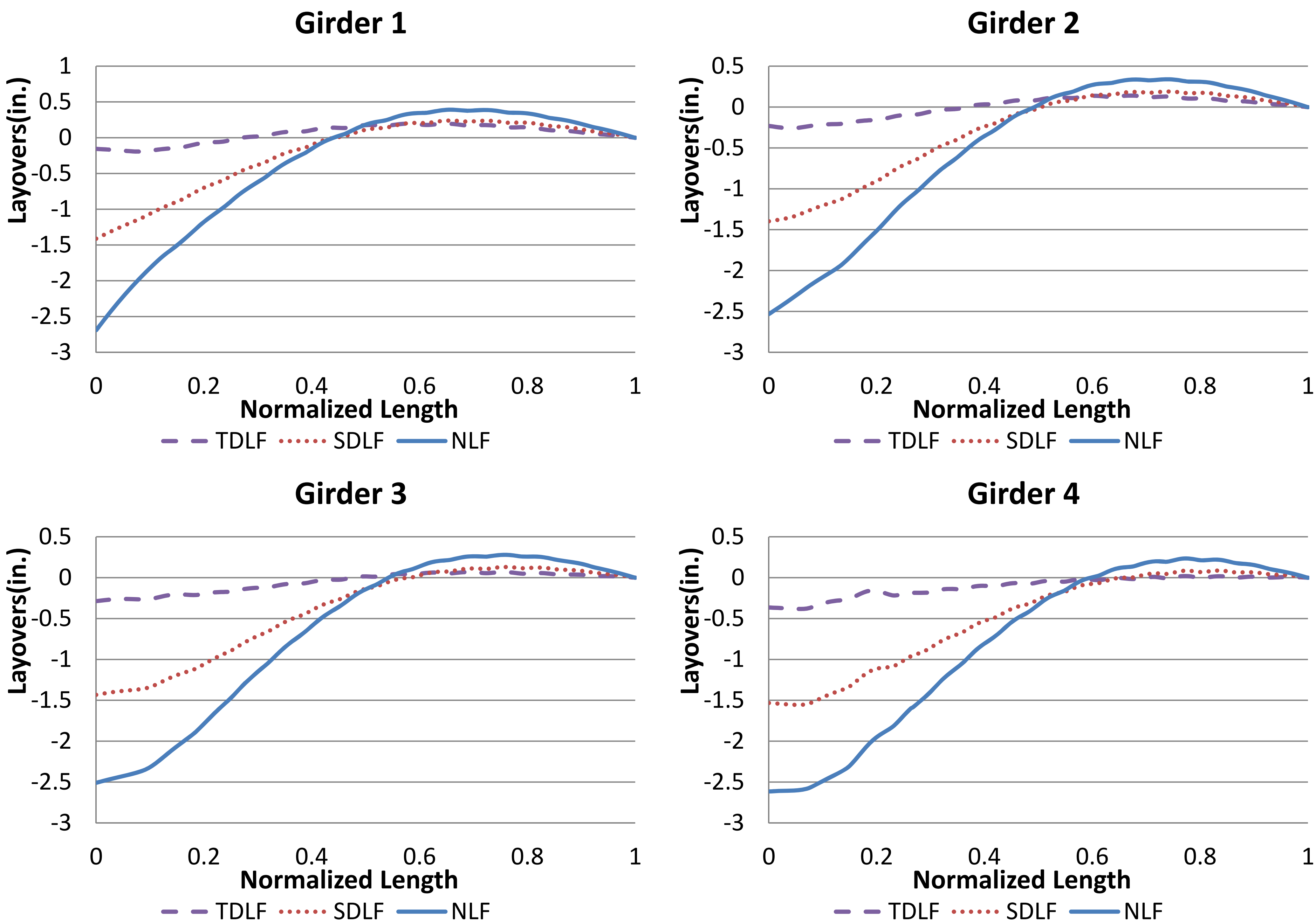


Figure Q2-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

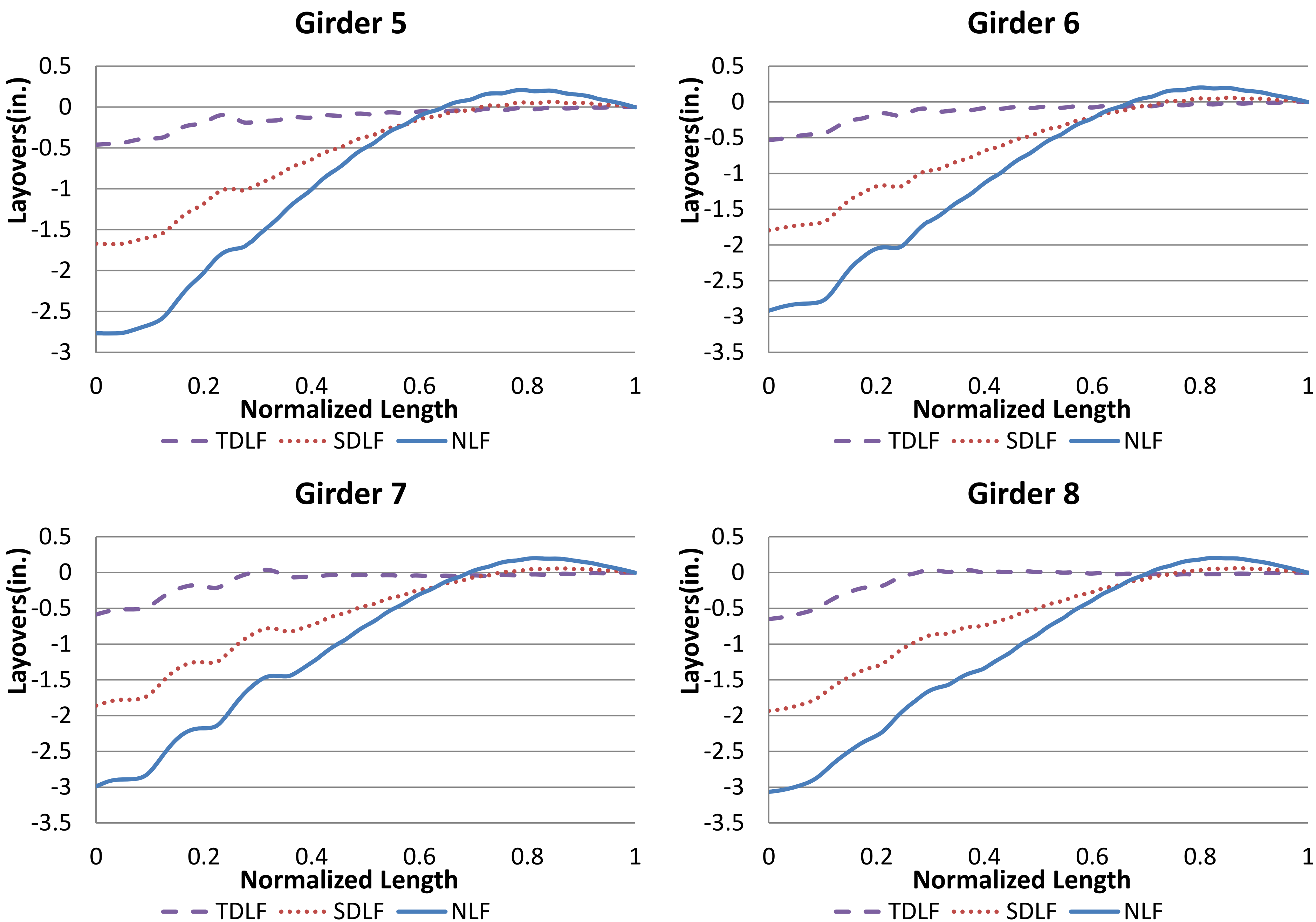


Figure Q2-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

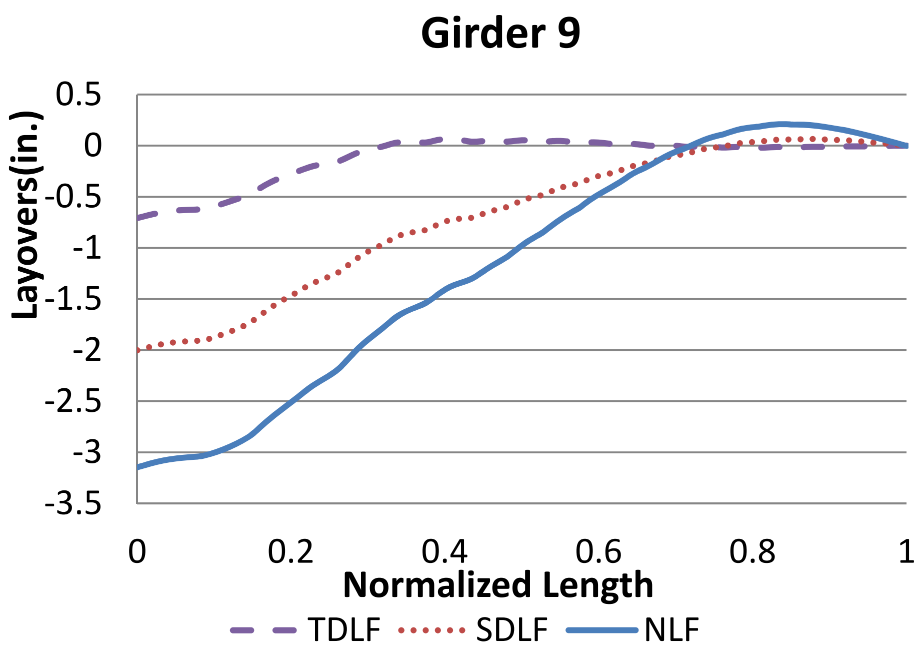


Figure Q2-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

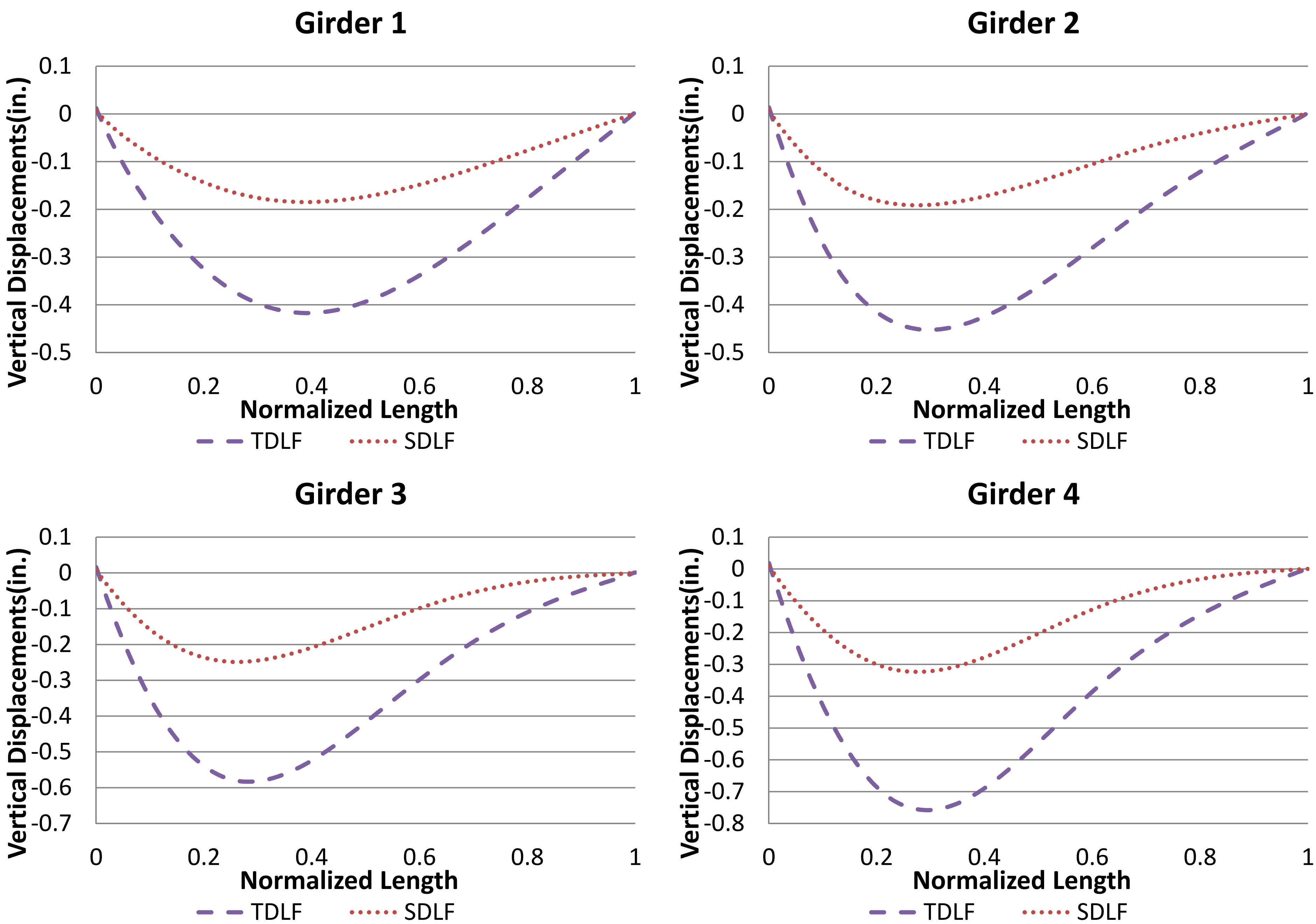


Figure Q2-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

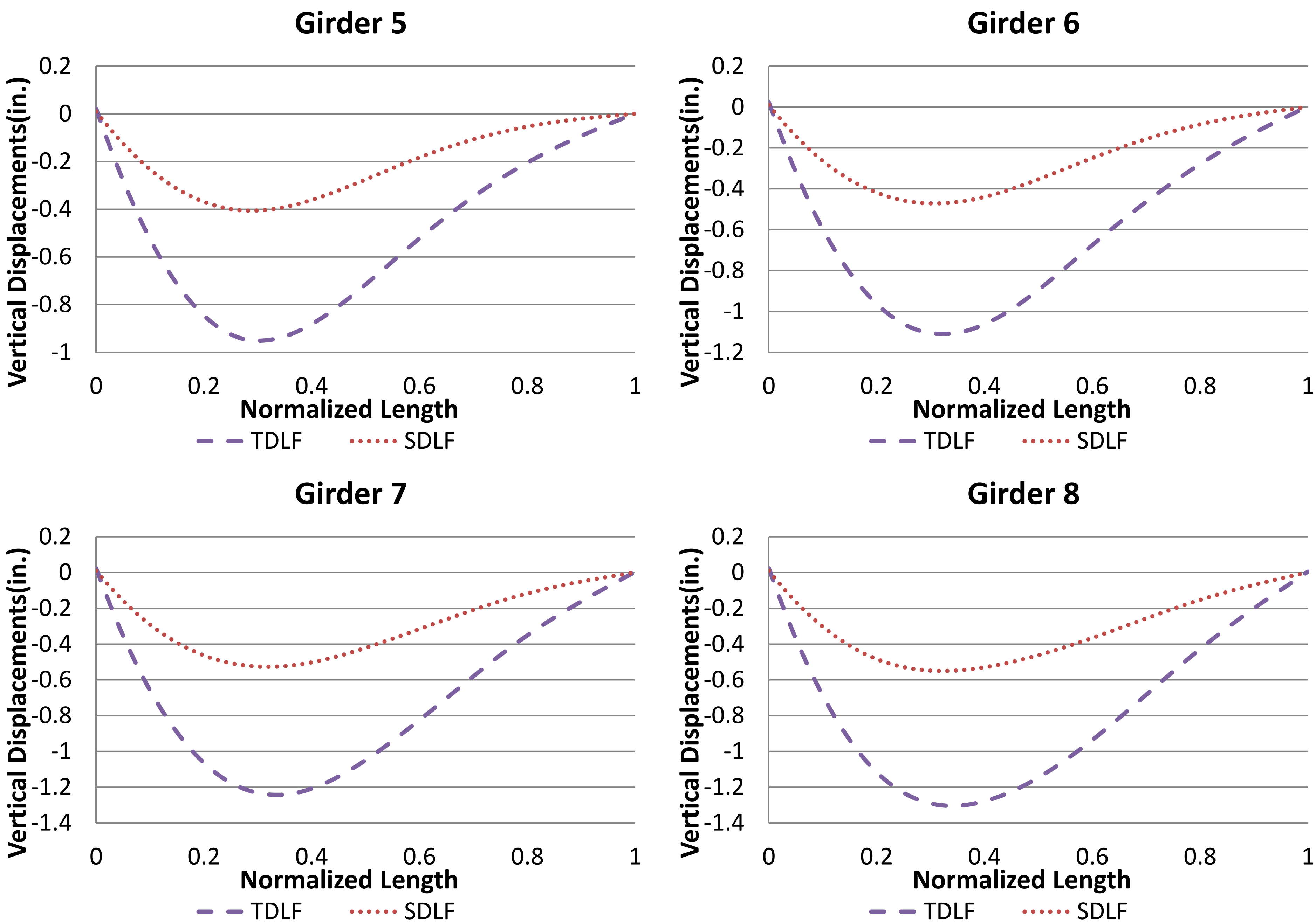


Figure Q2-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

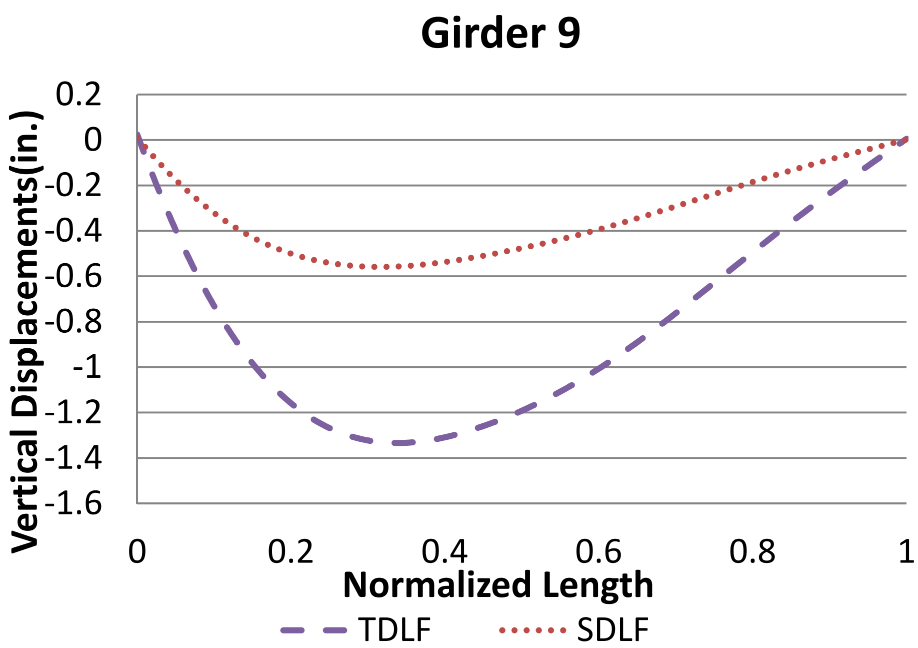


Figure Q2-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

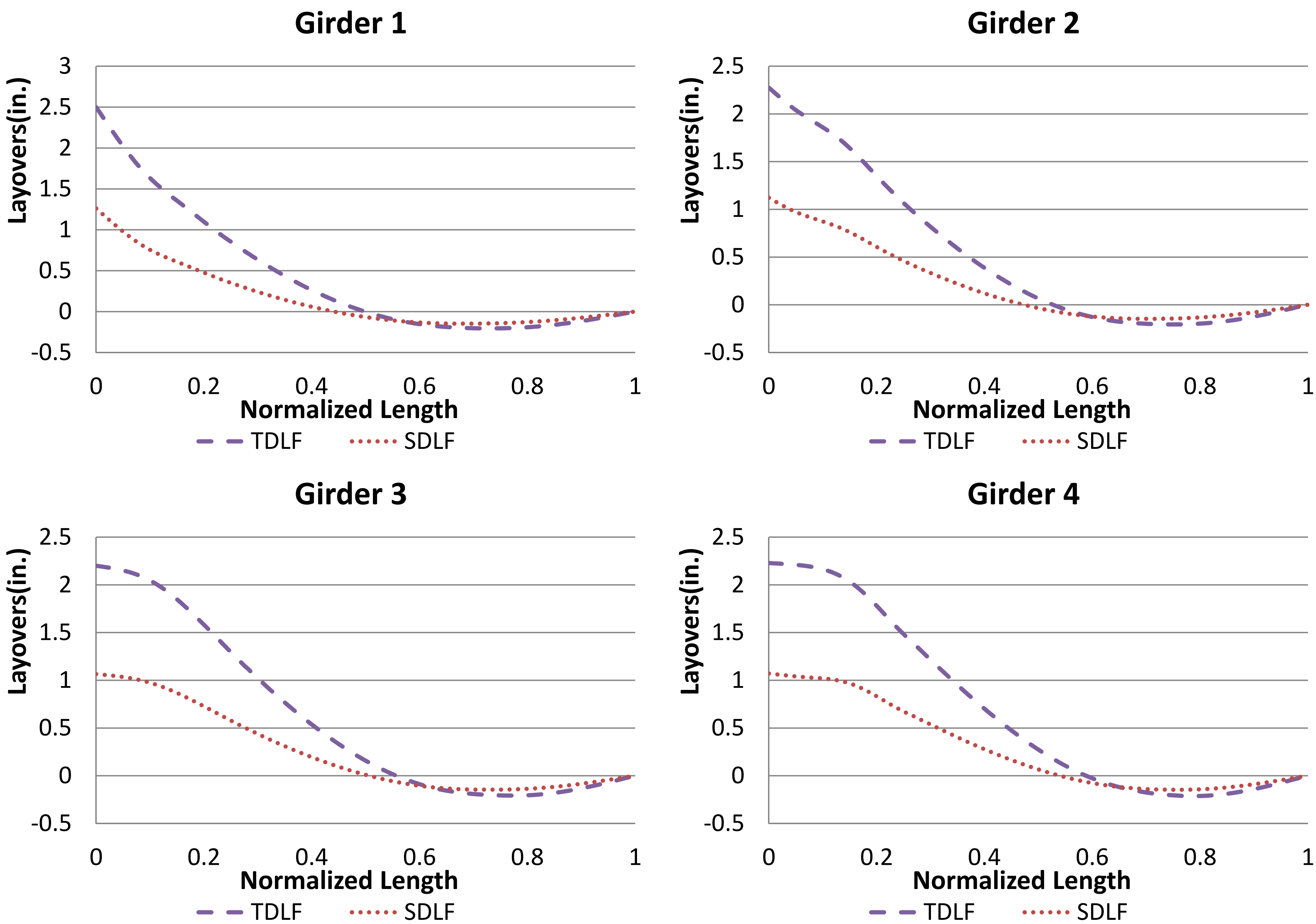


Figure Q2-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

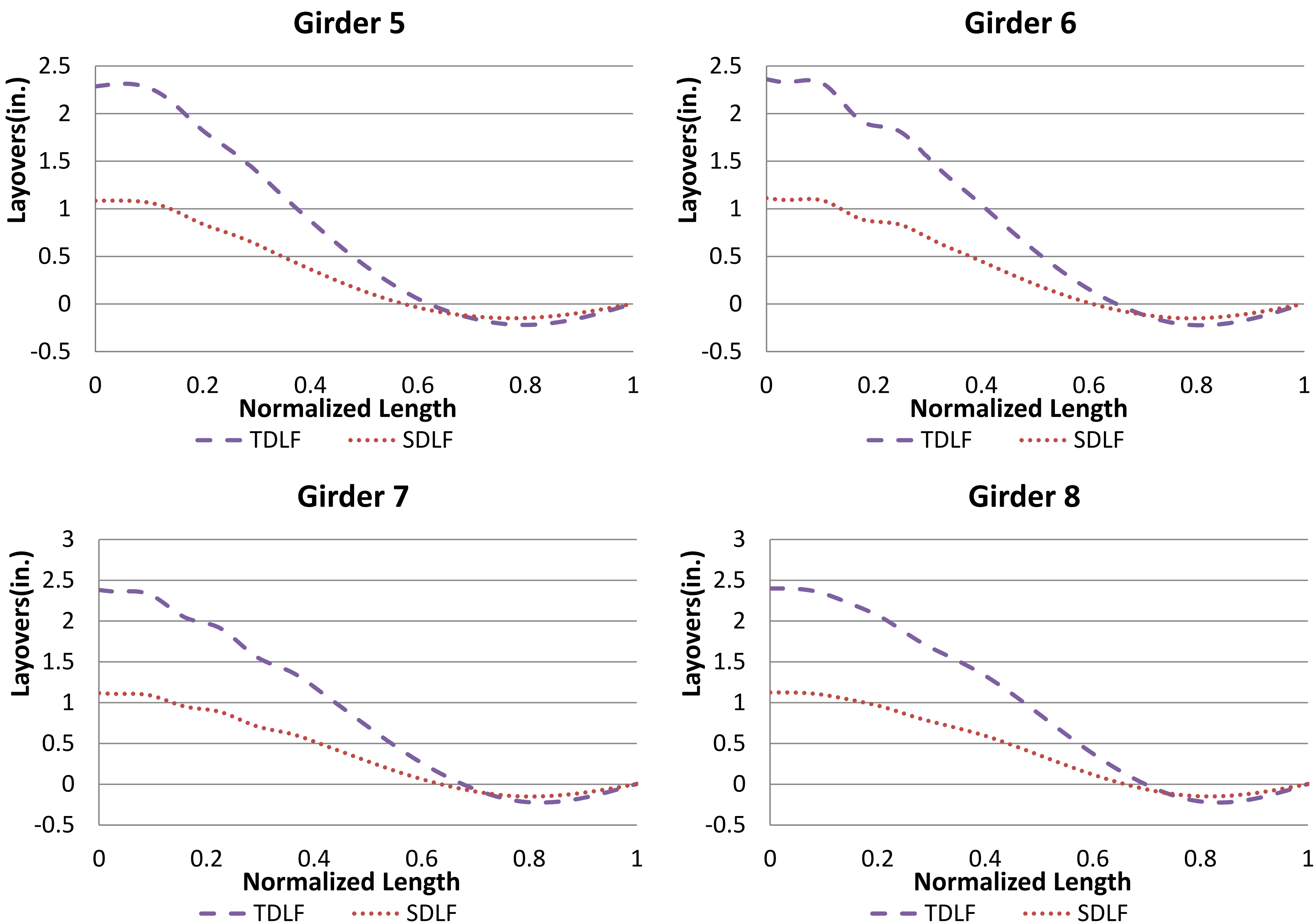


Figure Q2-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

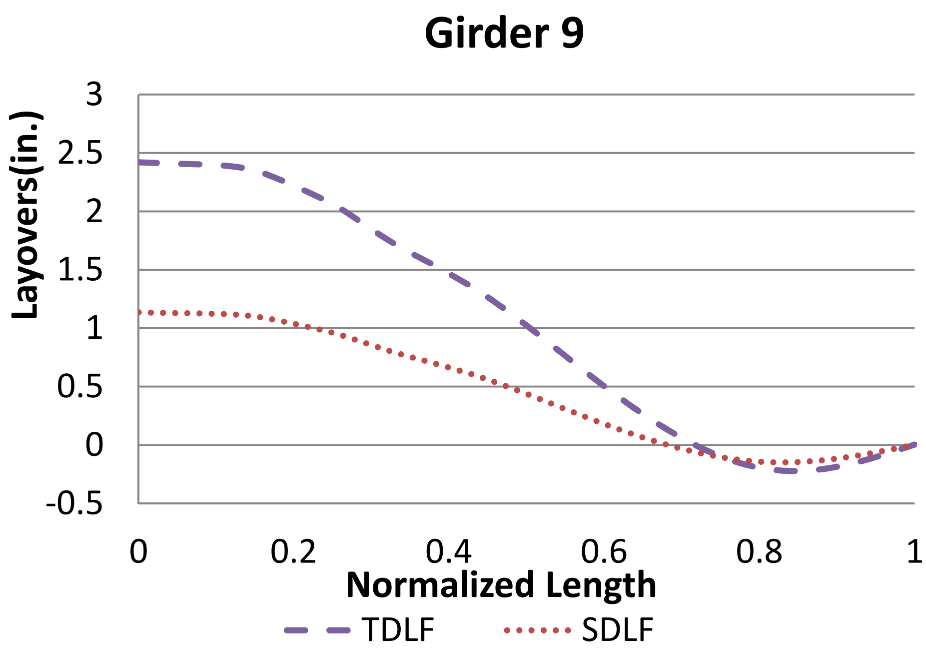


Figure Q2-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

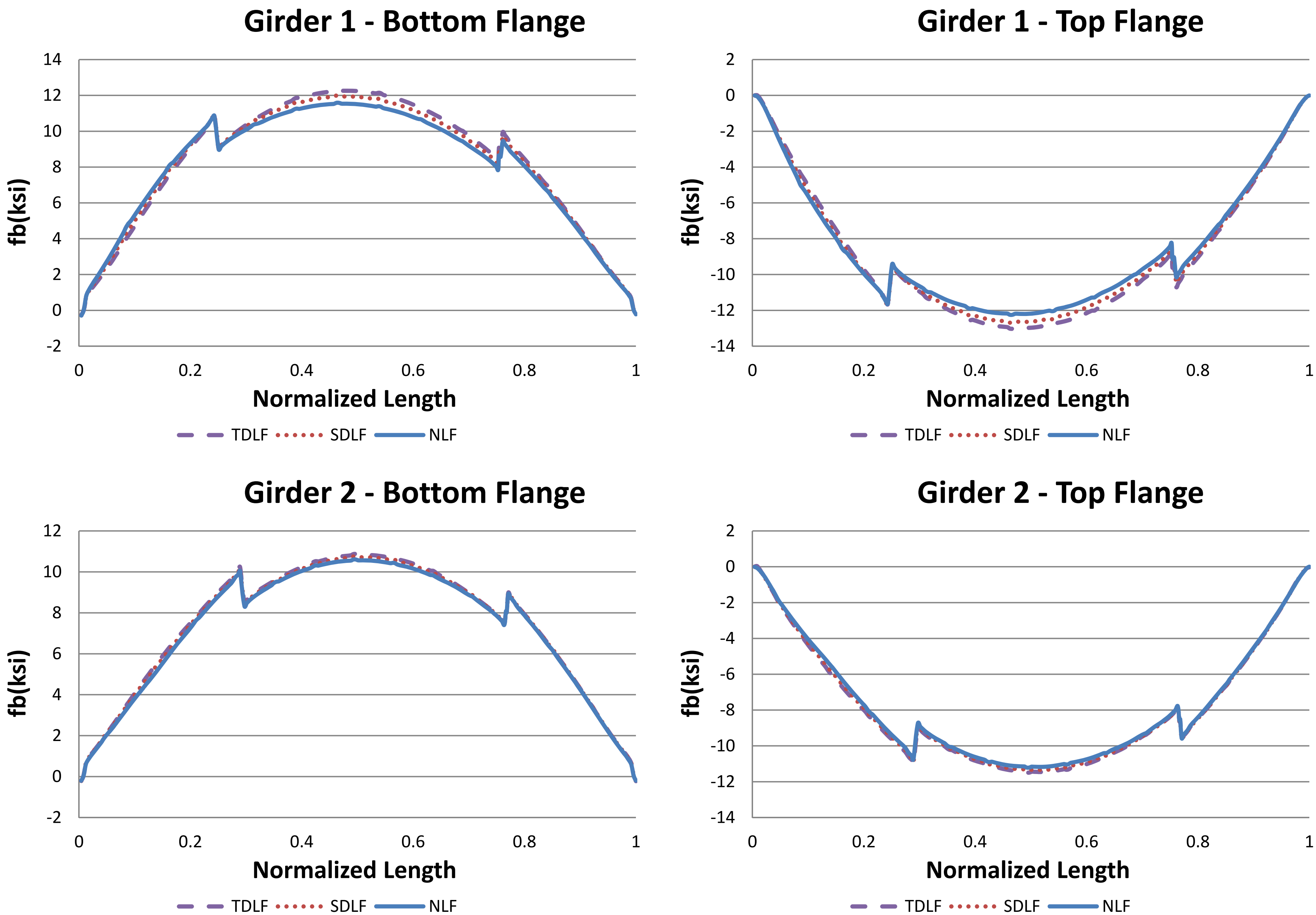


Figure Q2-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

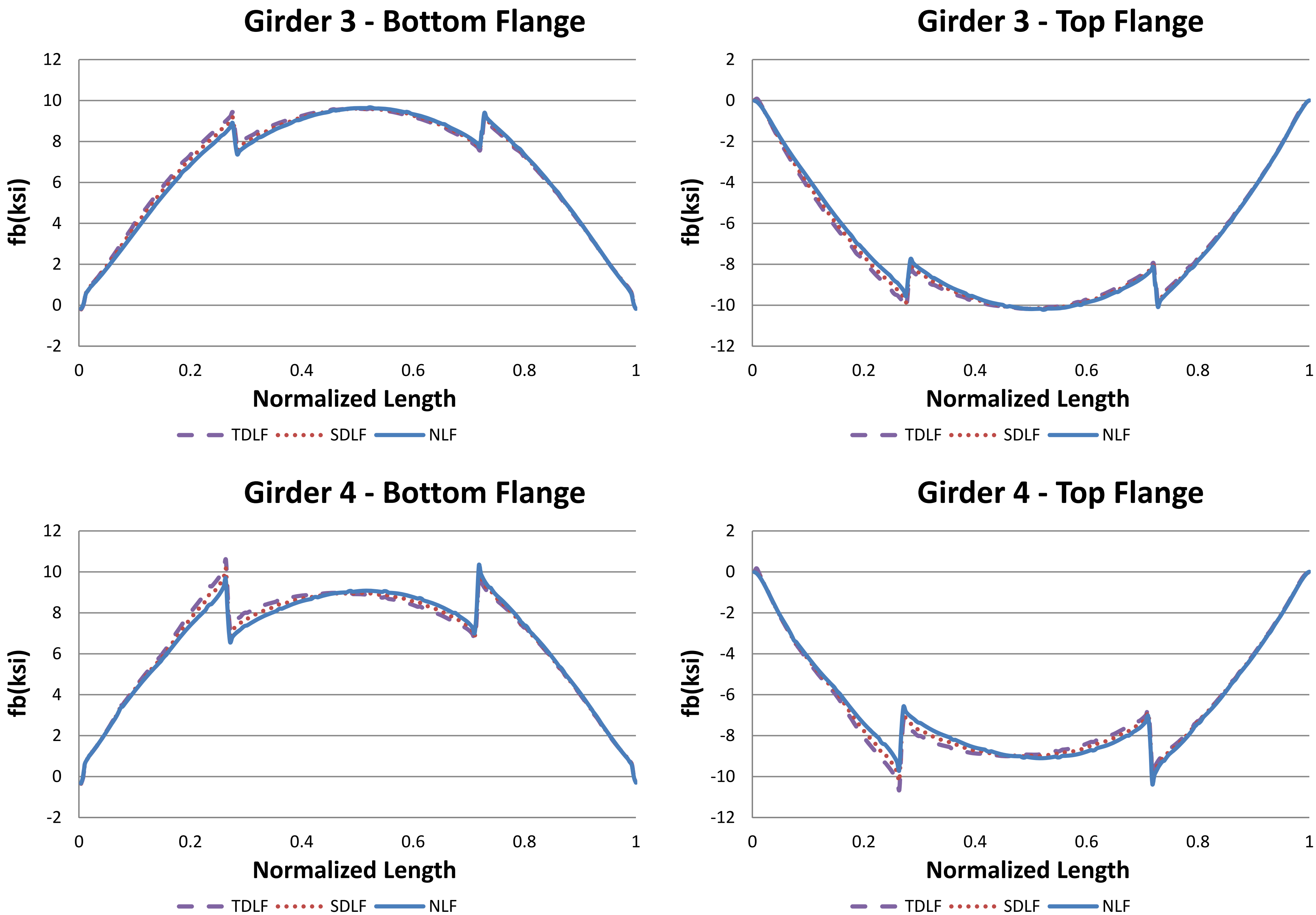


Figure Q2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

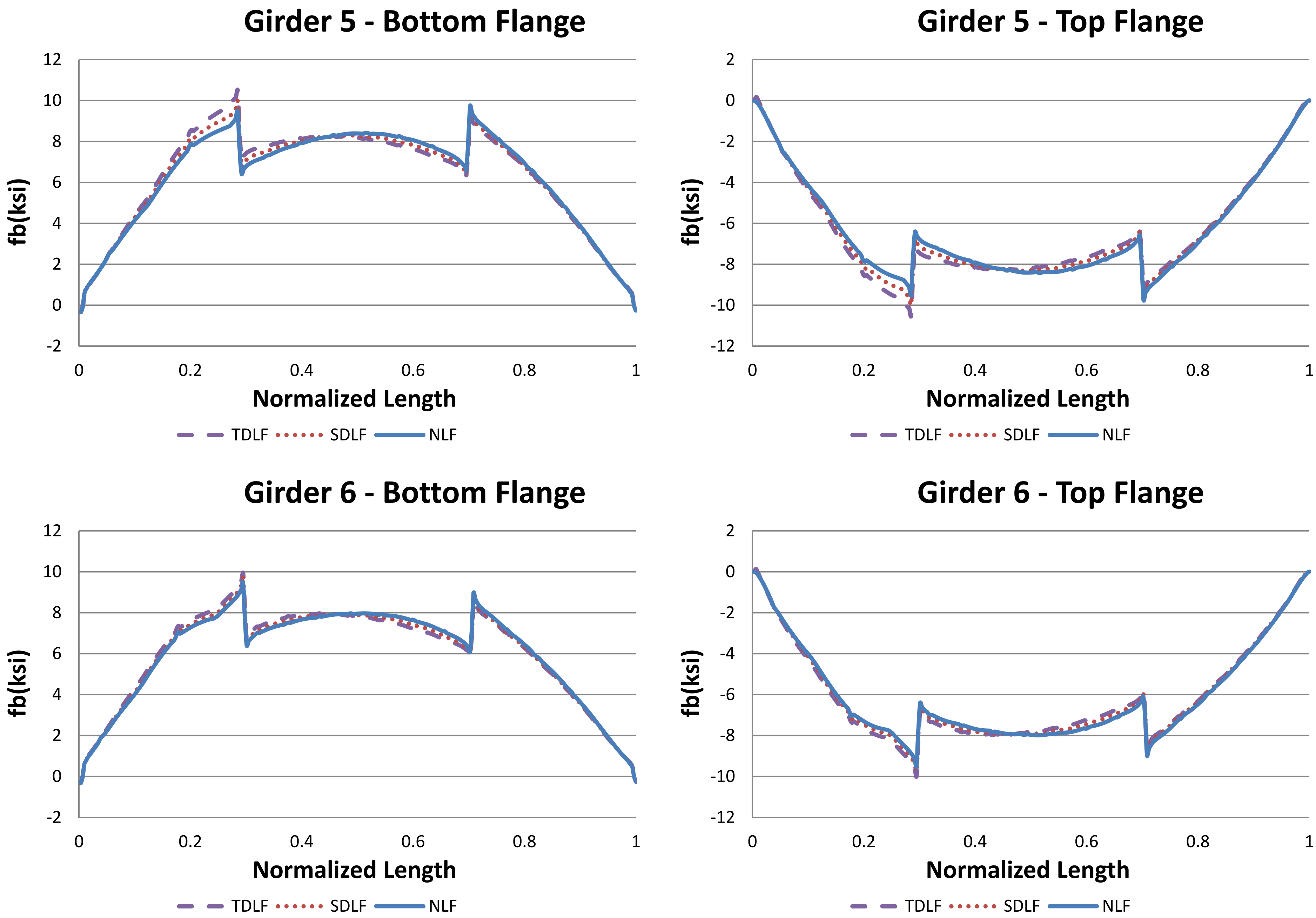


Figure Q2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

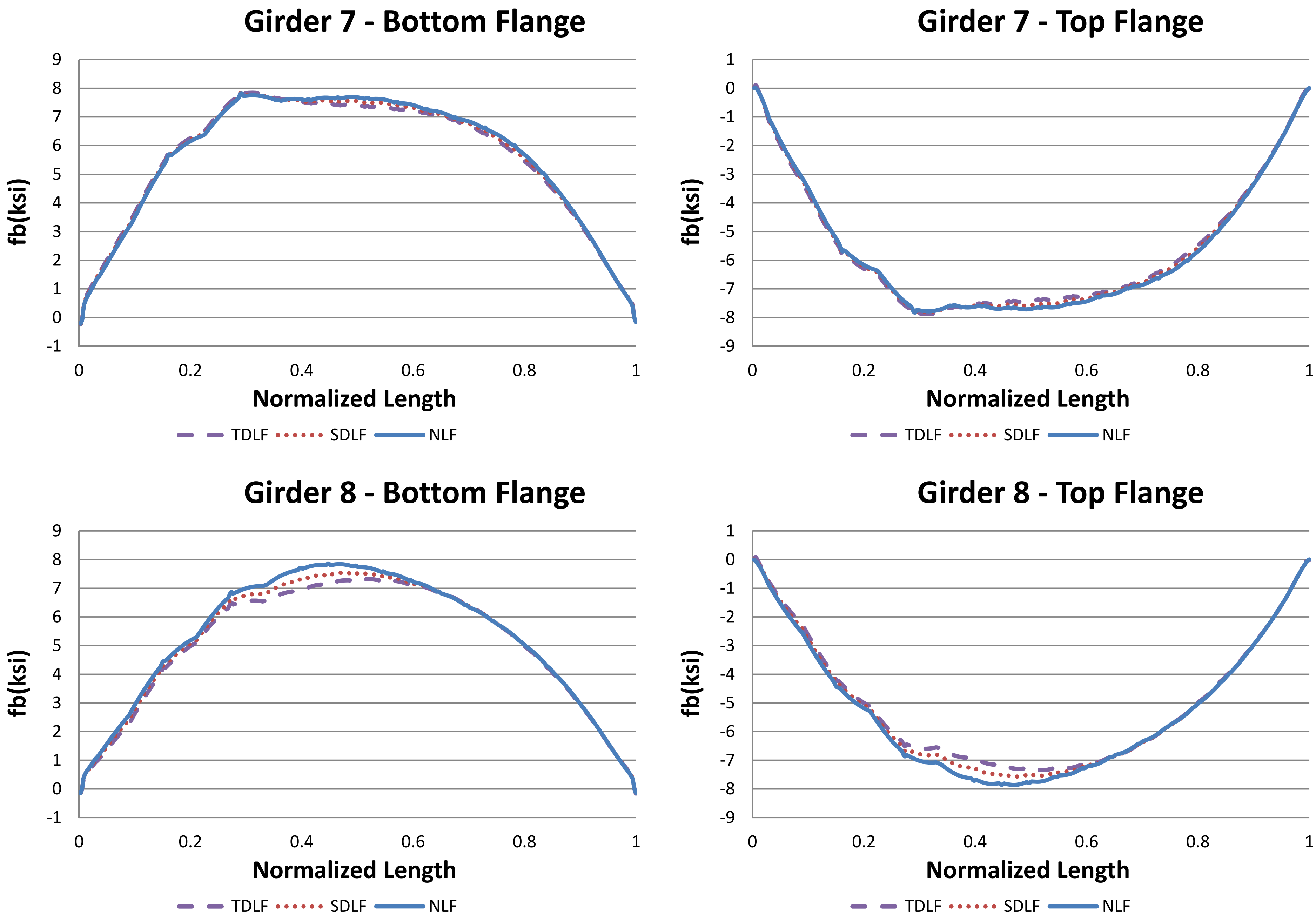
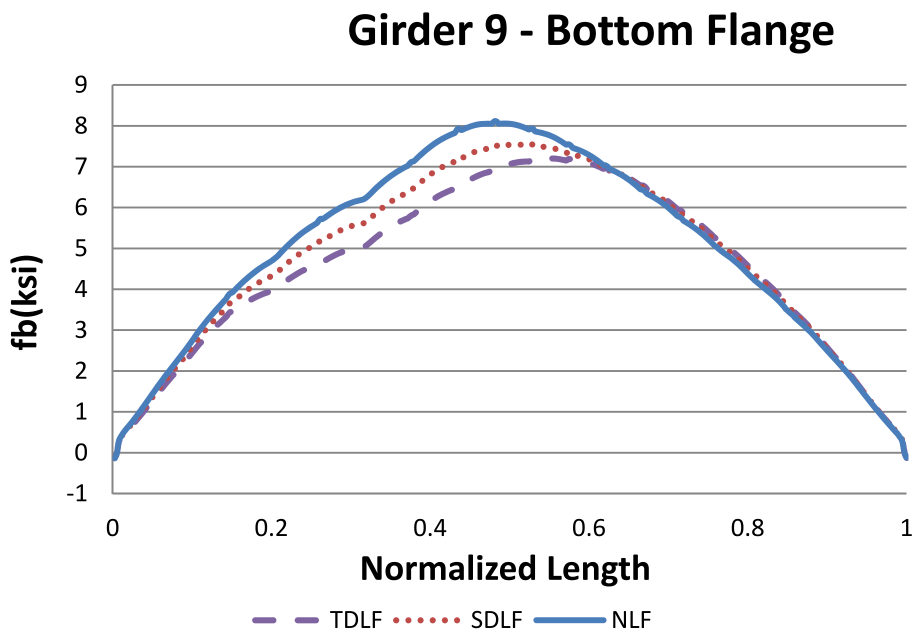


Figure Q2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.



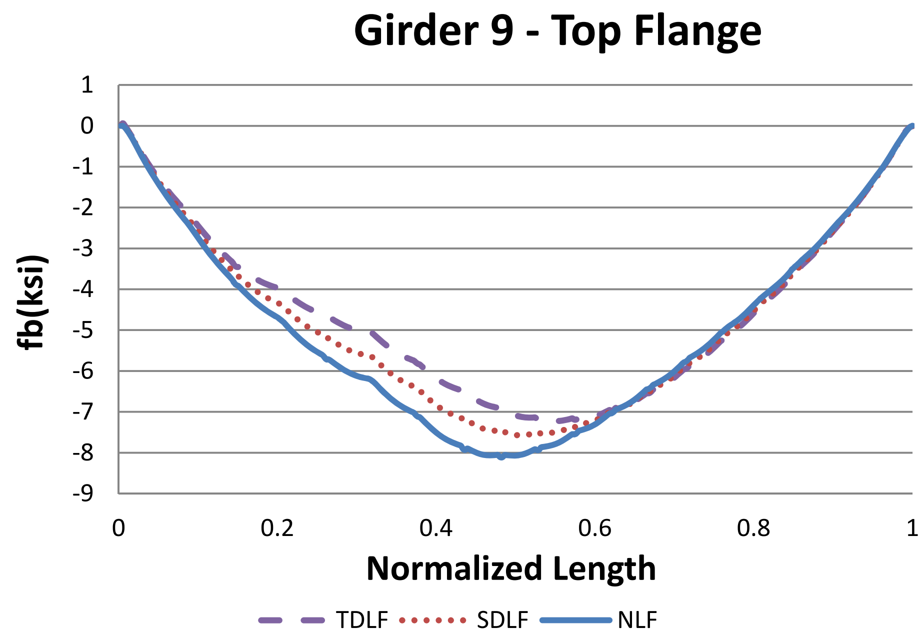


Figure Q2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

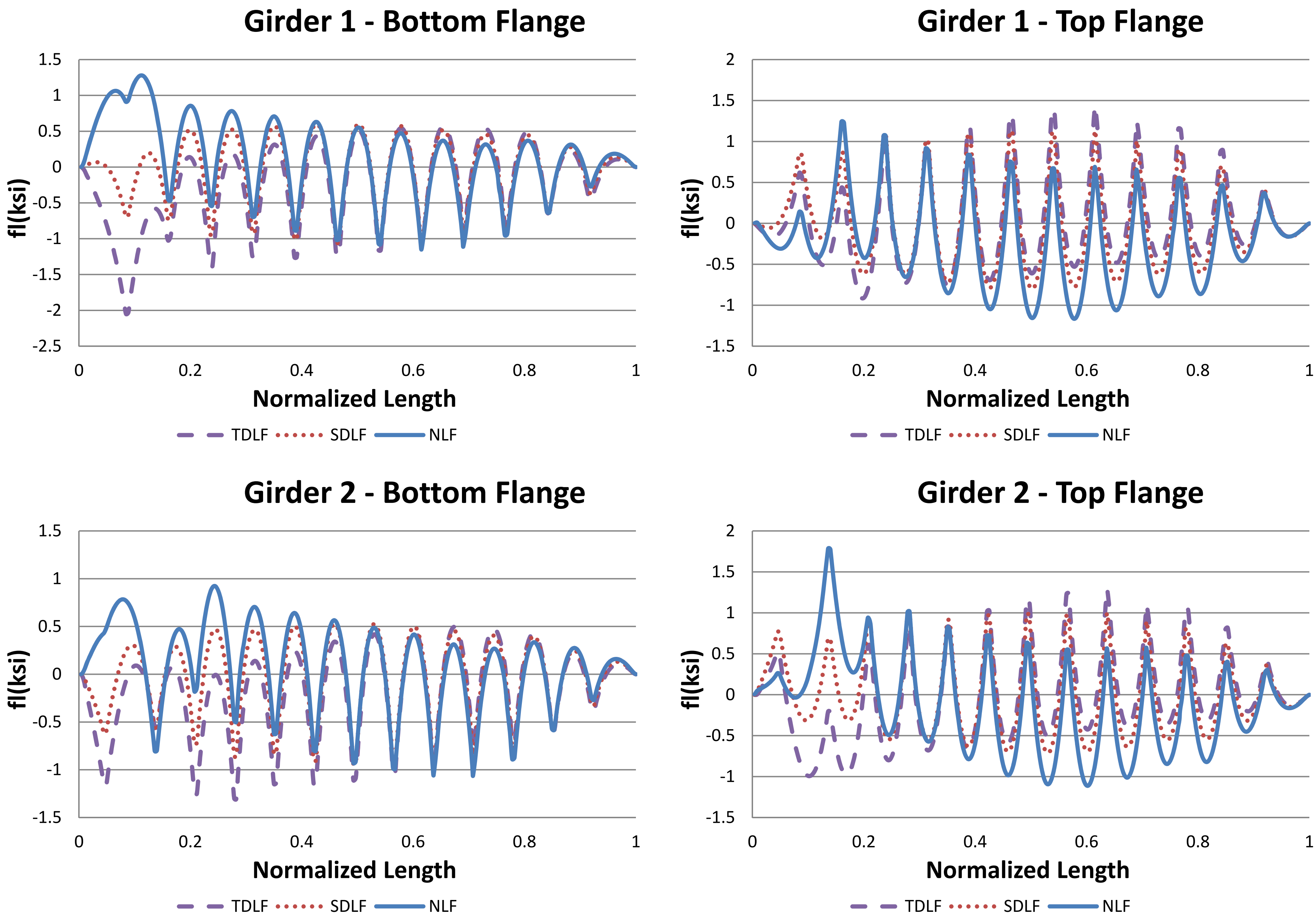


Figure Q2-4-19. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

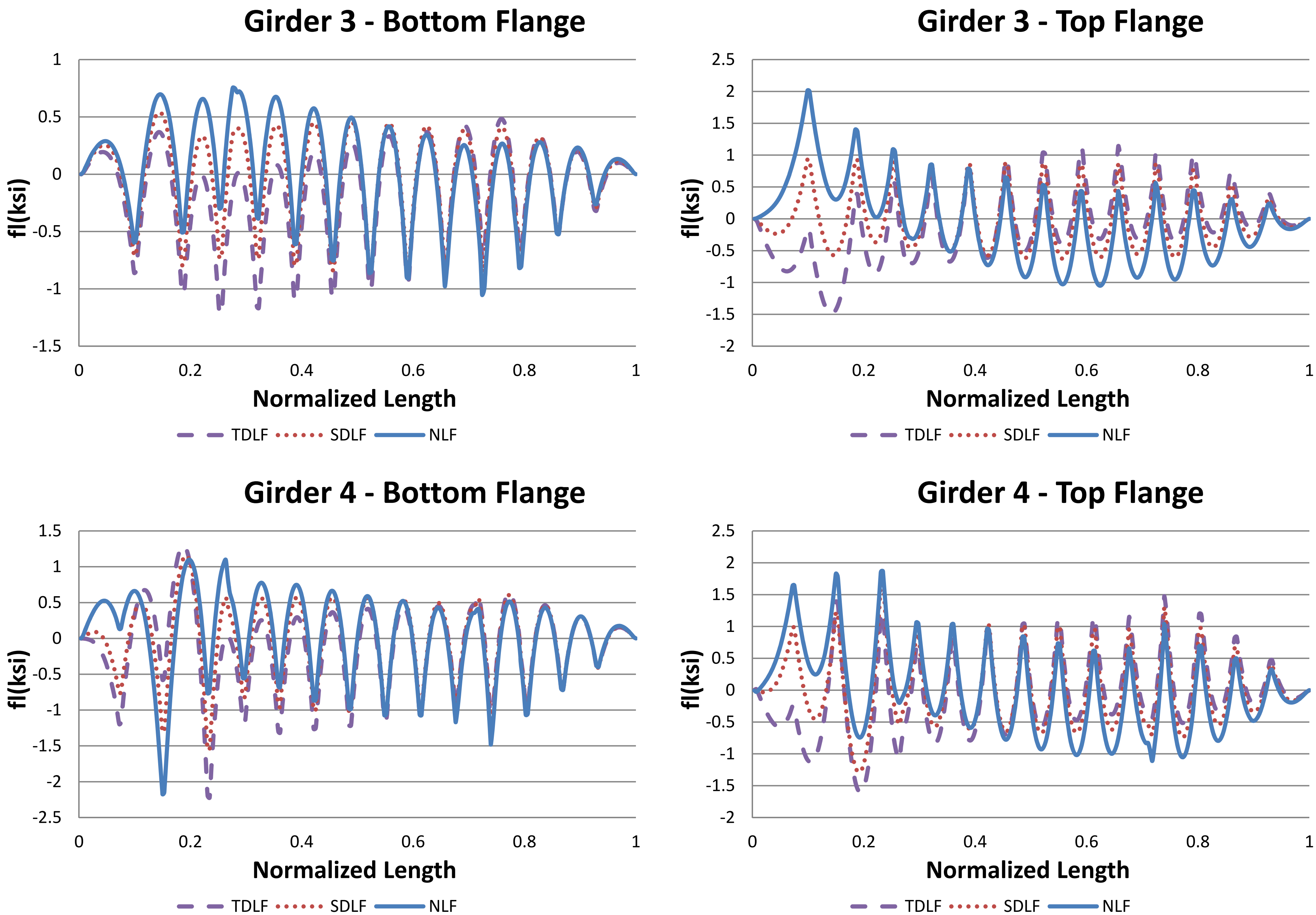


Figure Q2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

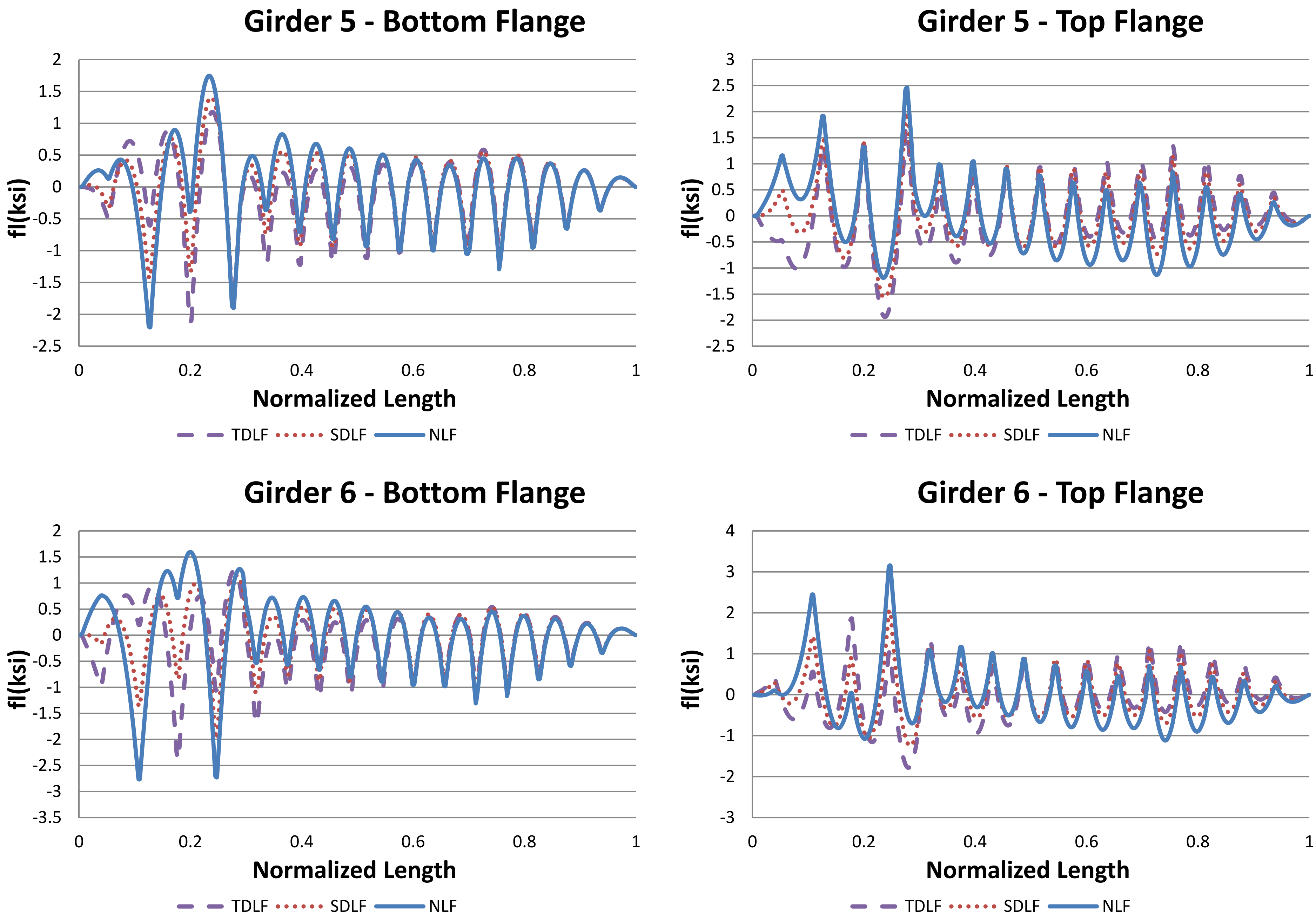


Figure Q2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

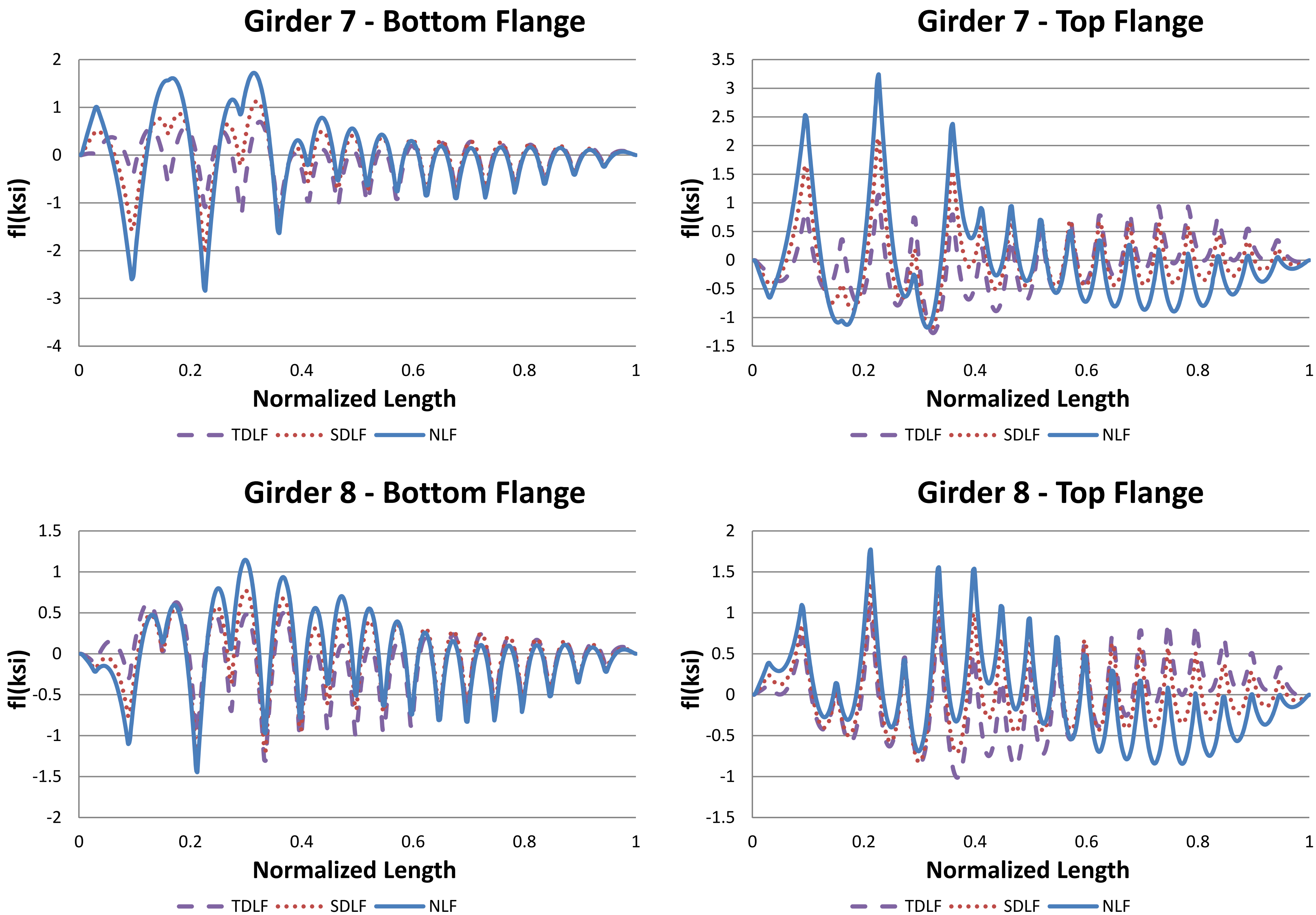


Figure Q2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

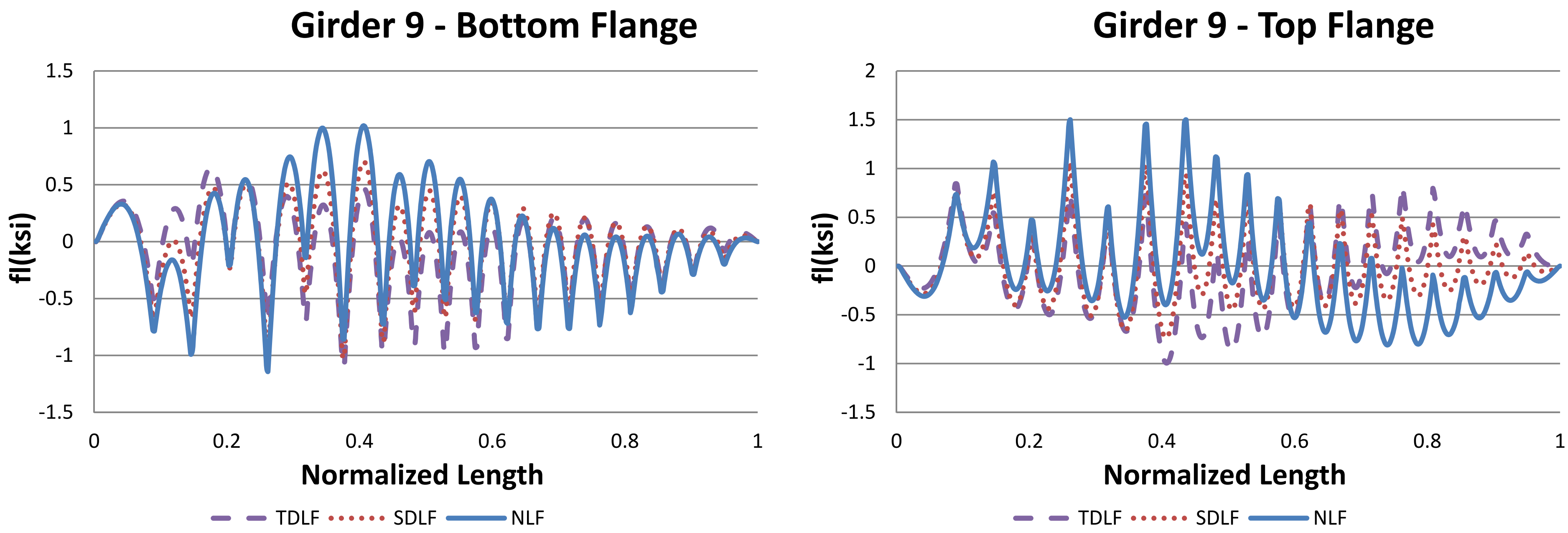


Figure Q2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

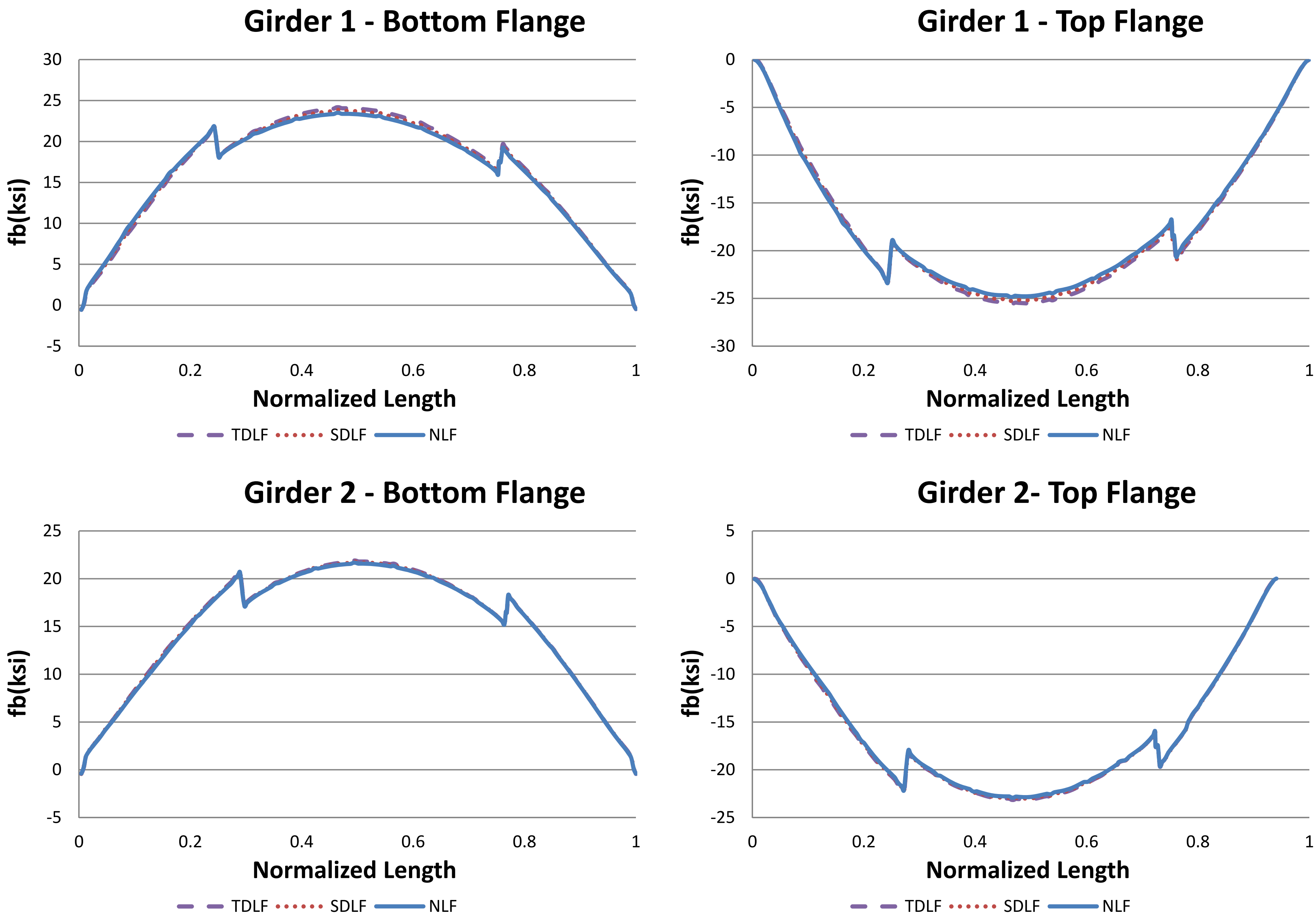


Figure Q2-4-20. Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

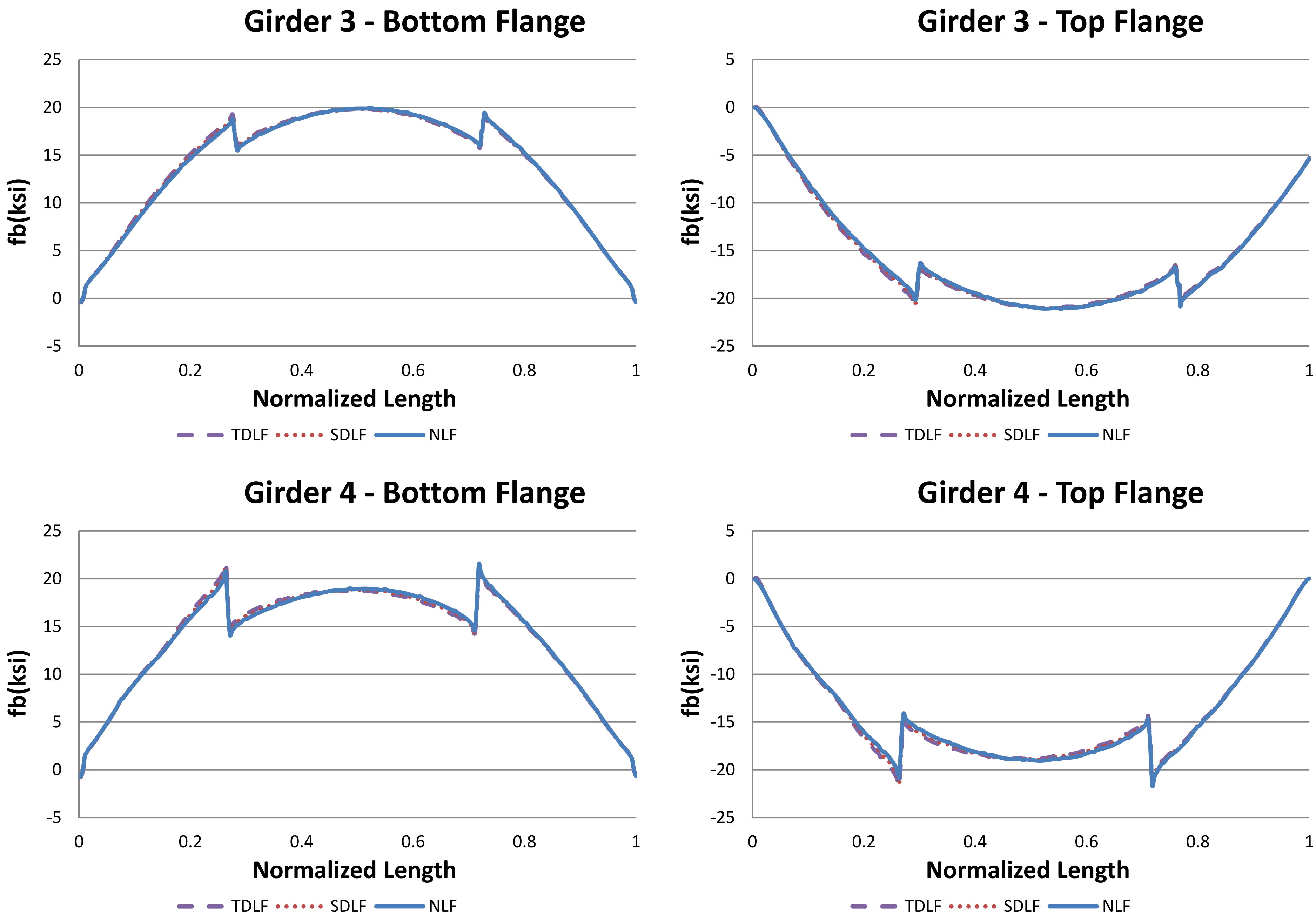


Figure Q2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

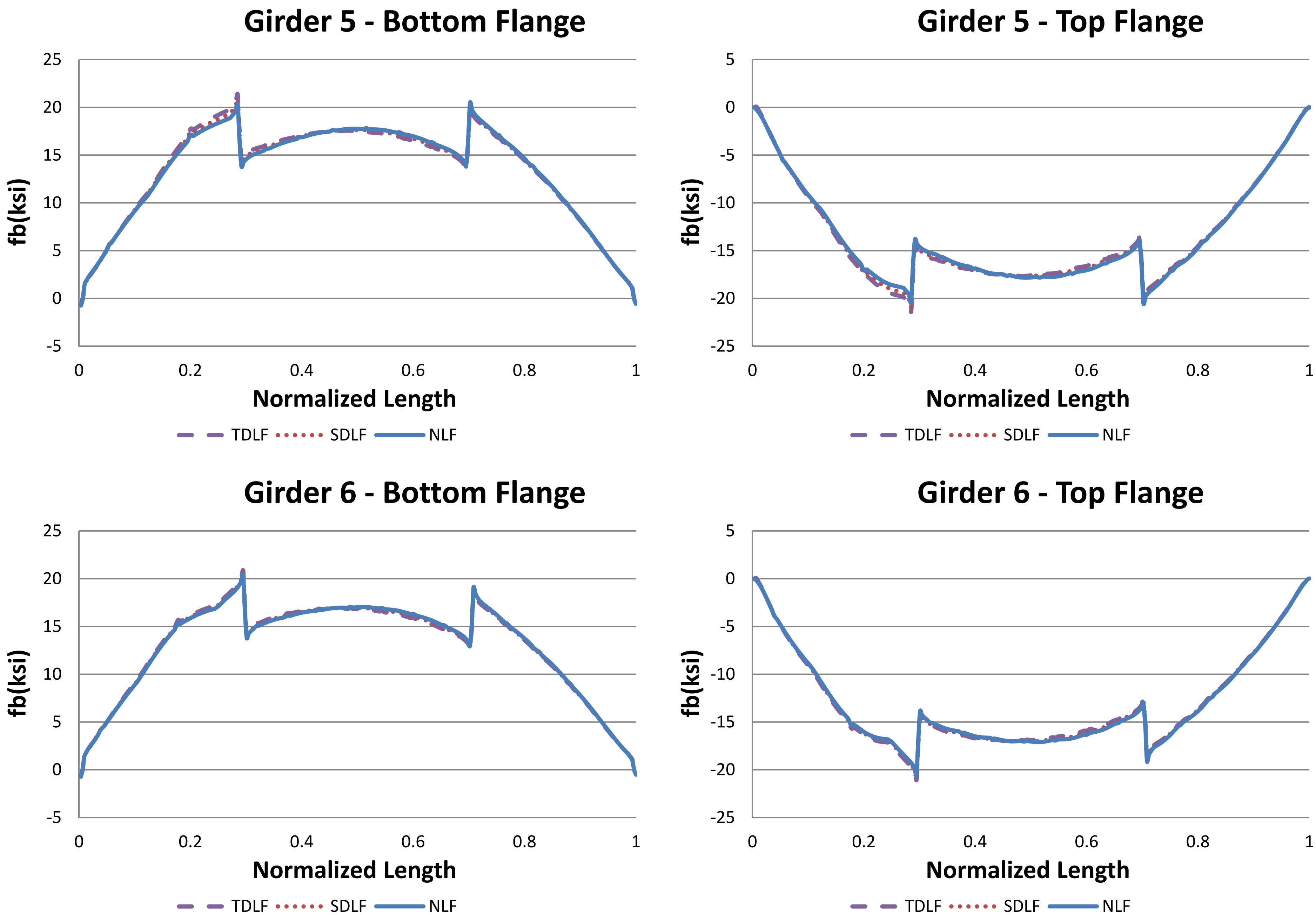


Figure Q2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

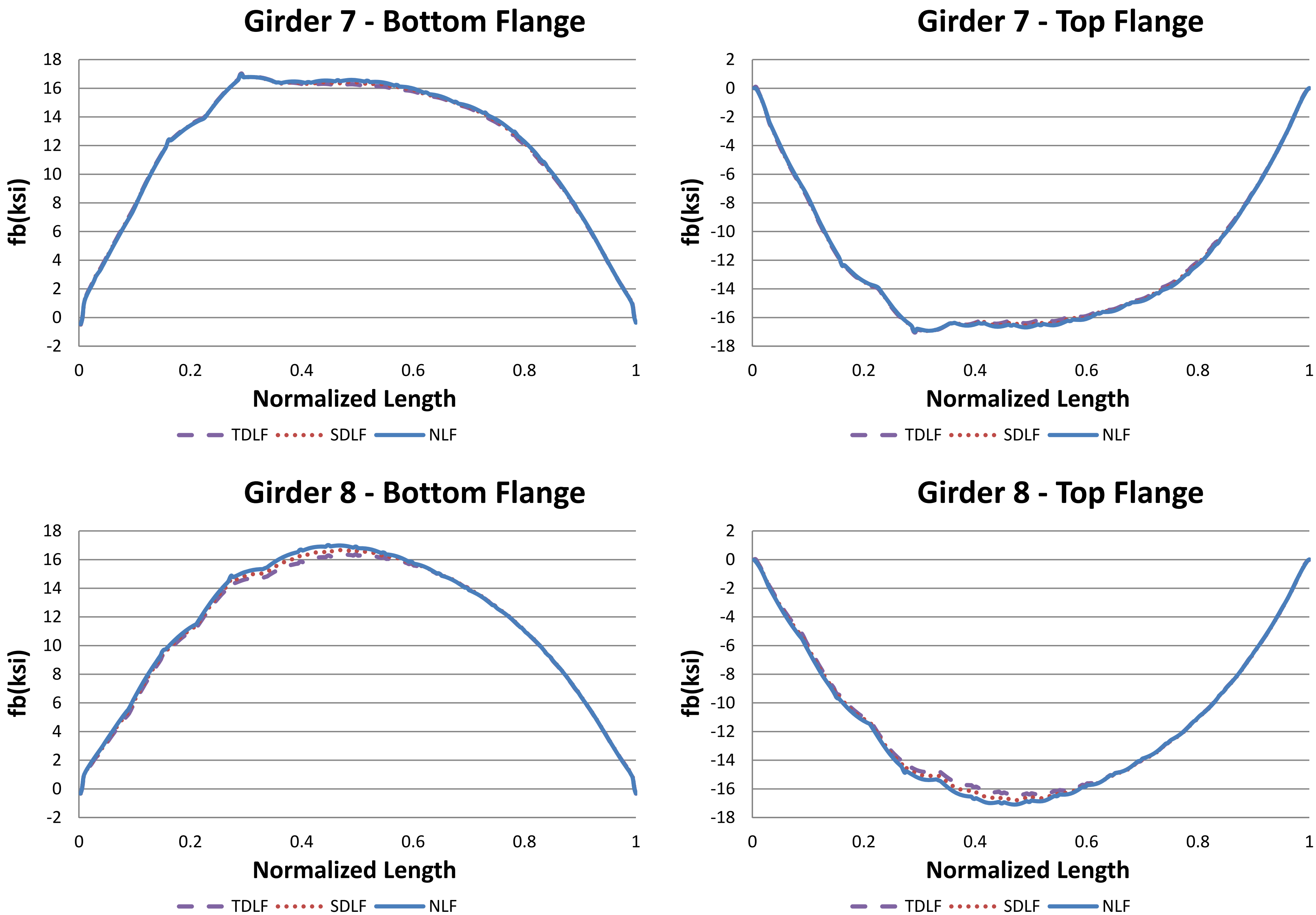
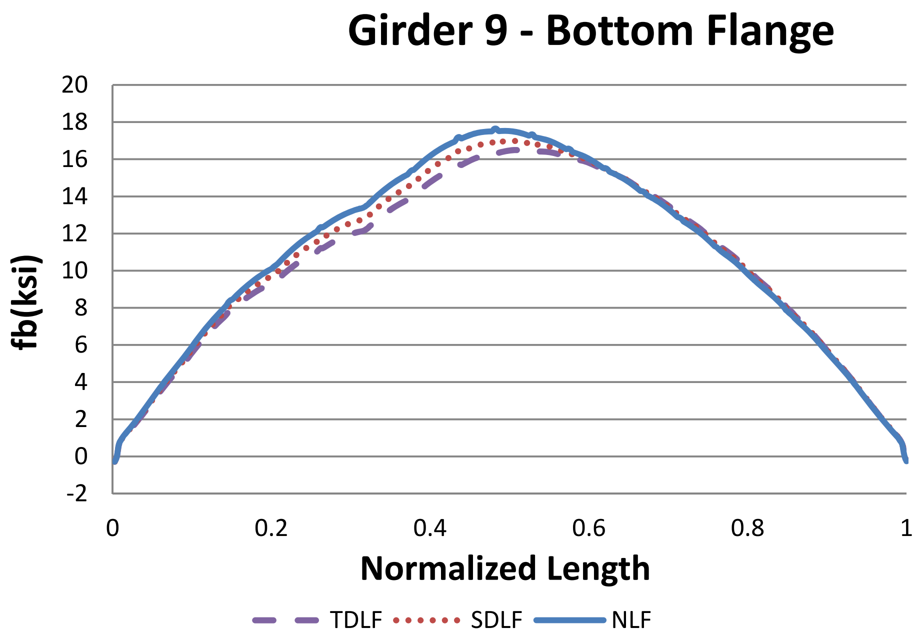


Figure Q2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



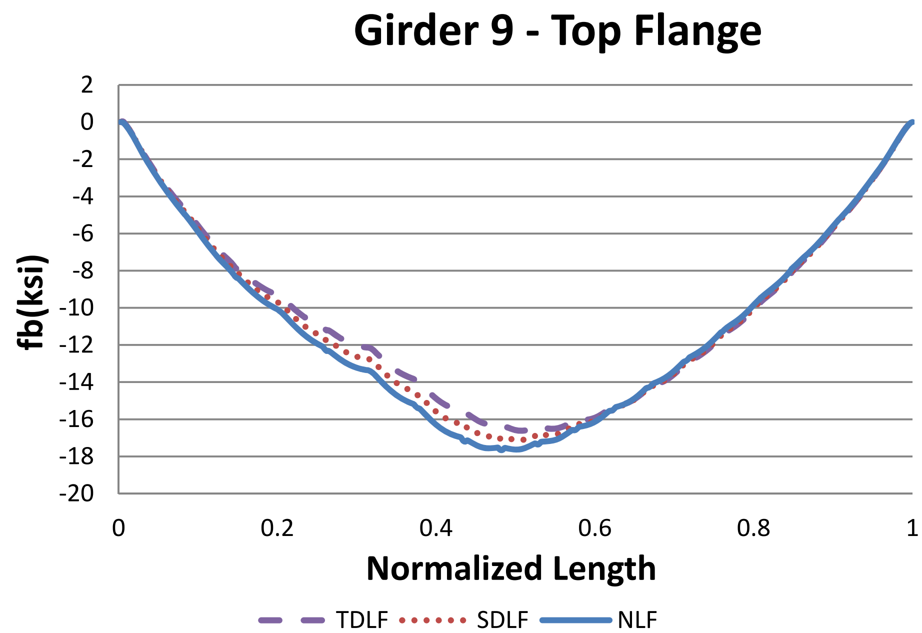


Figure Q2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

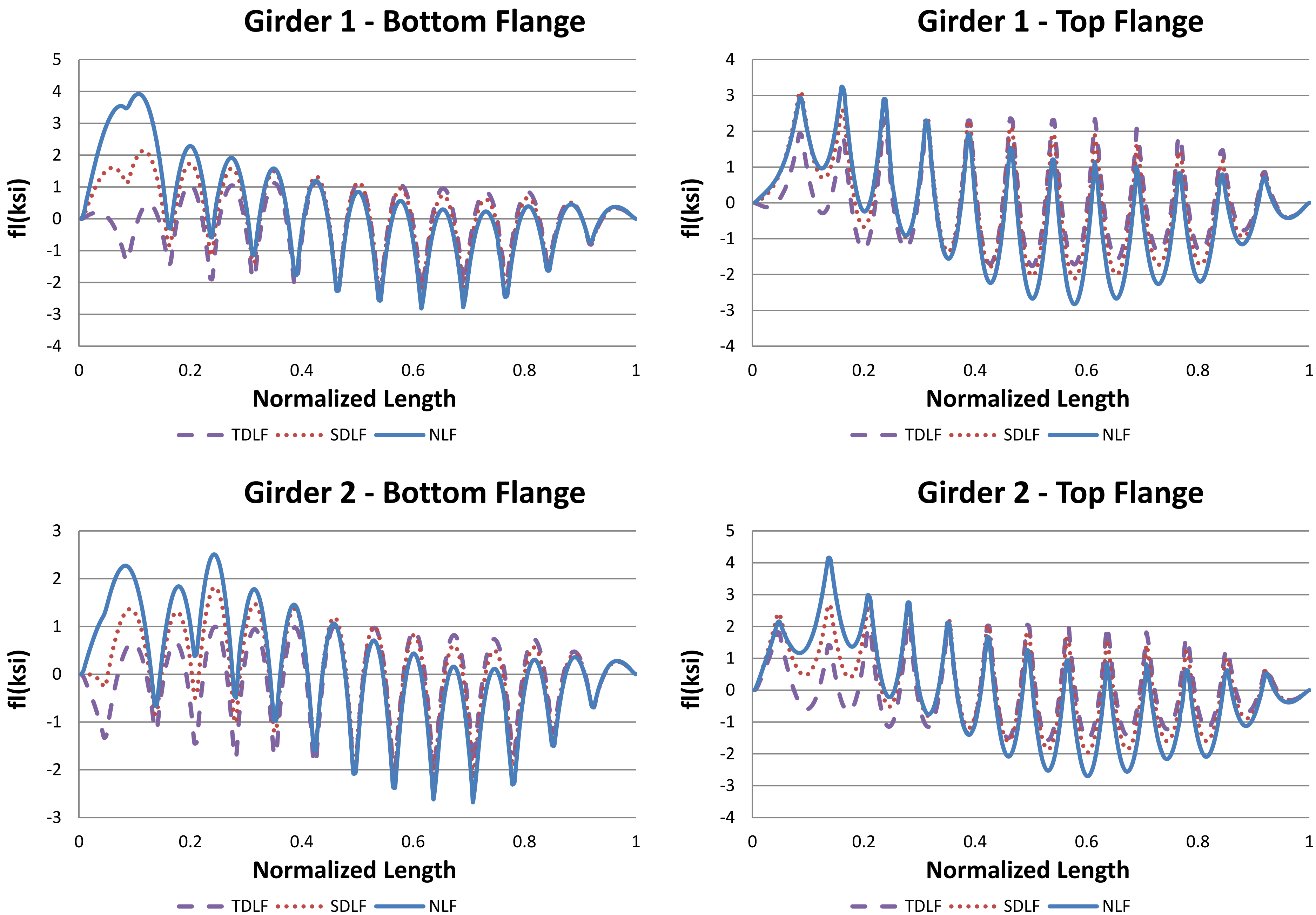


Figure Q2-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

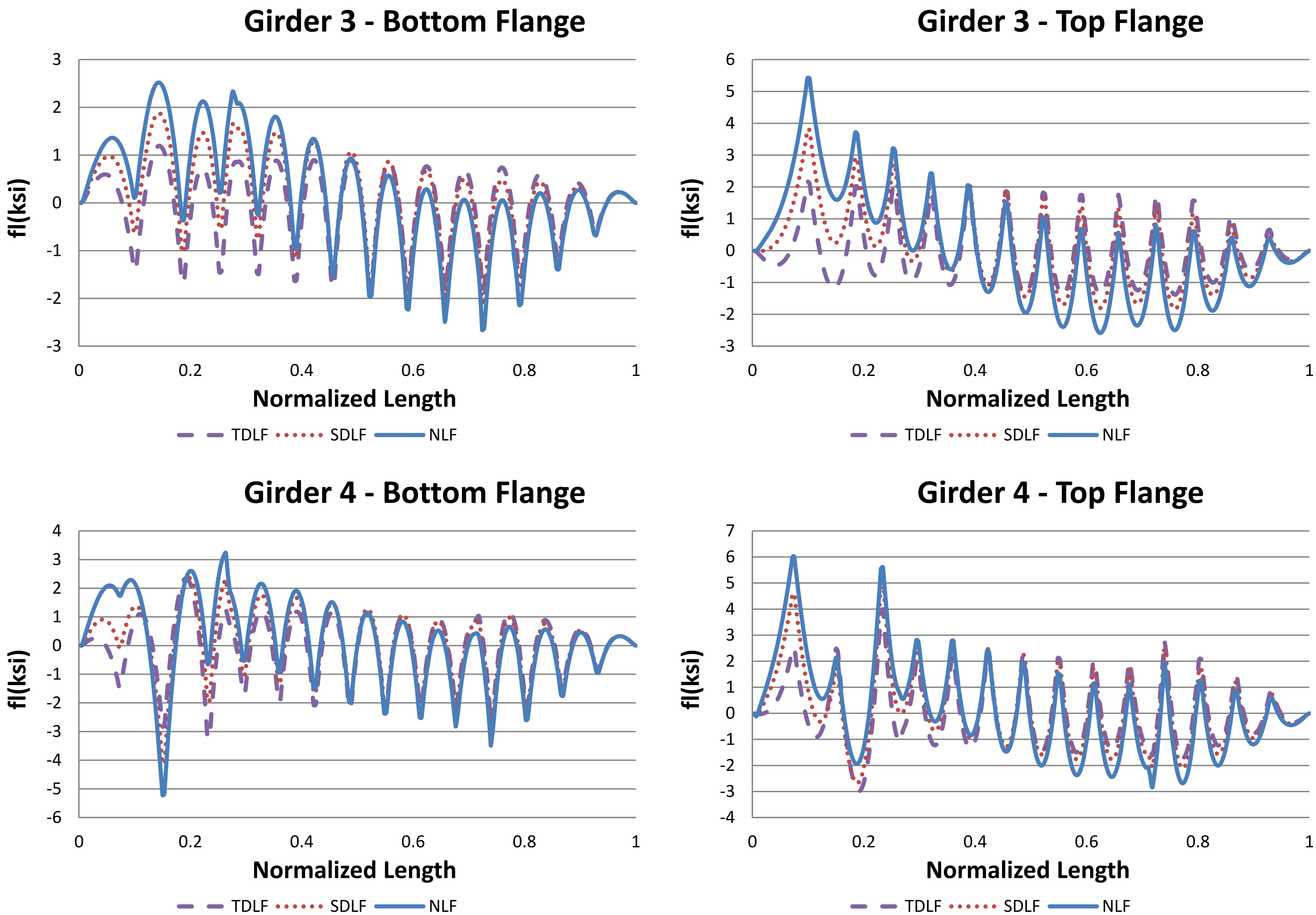


Figure Q2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

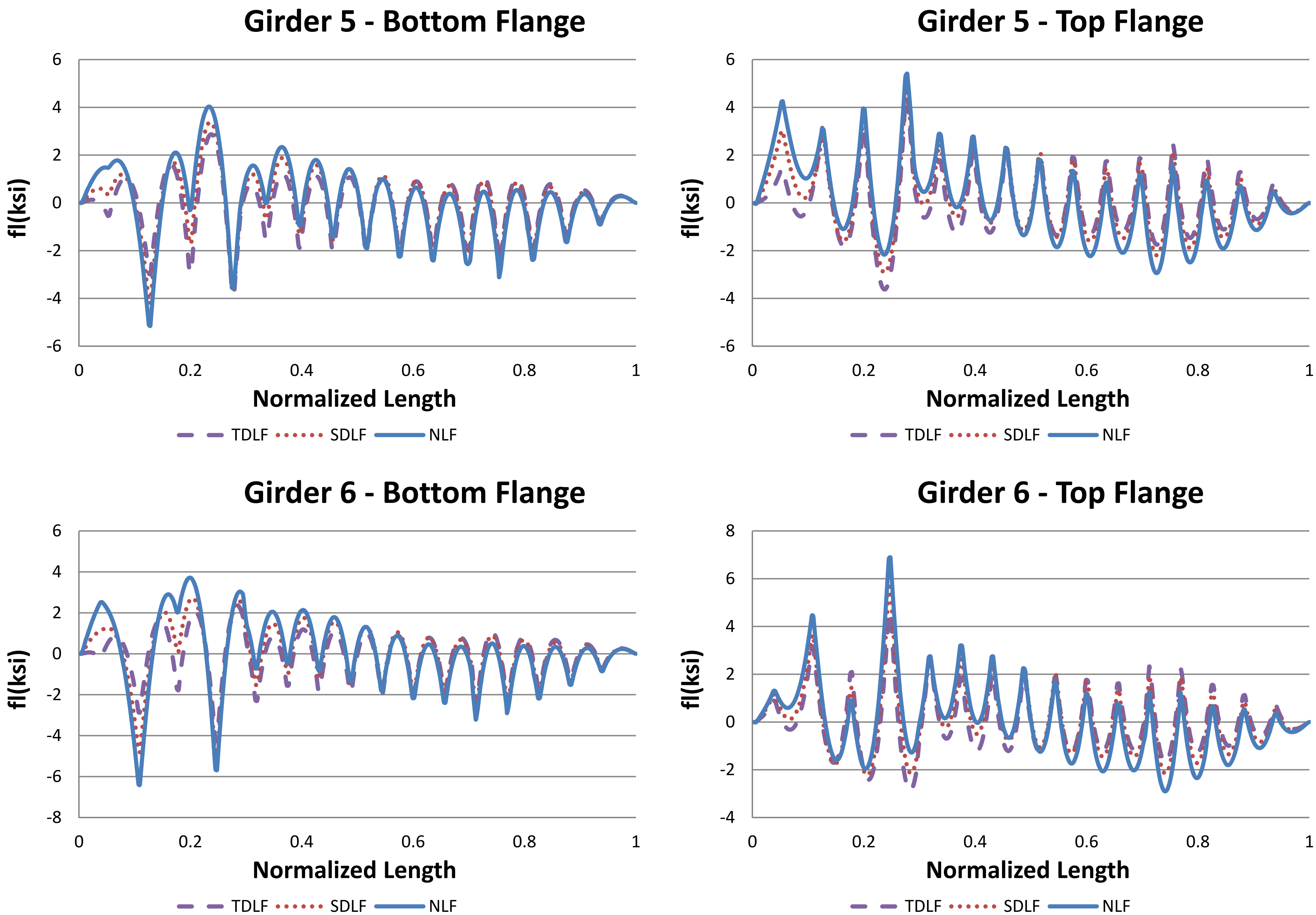


Figure Q2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

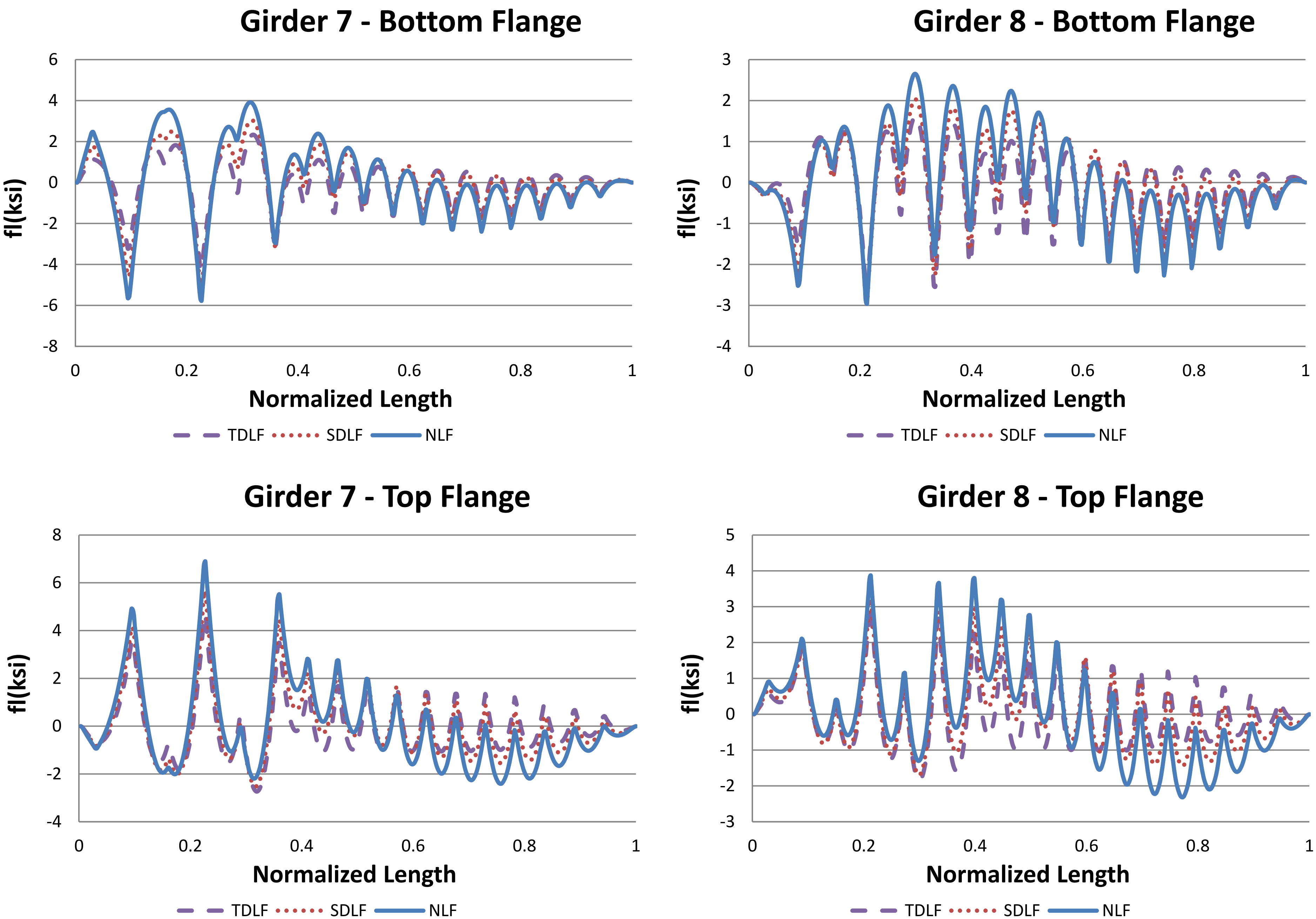


Figure Q2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

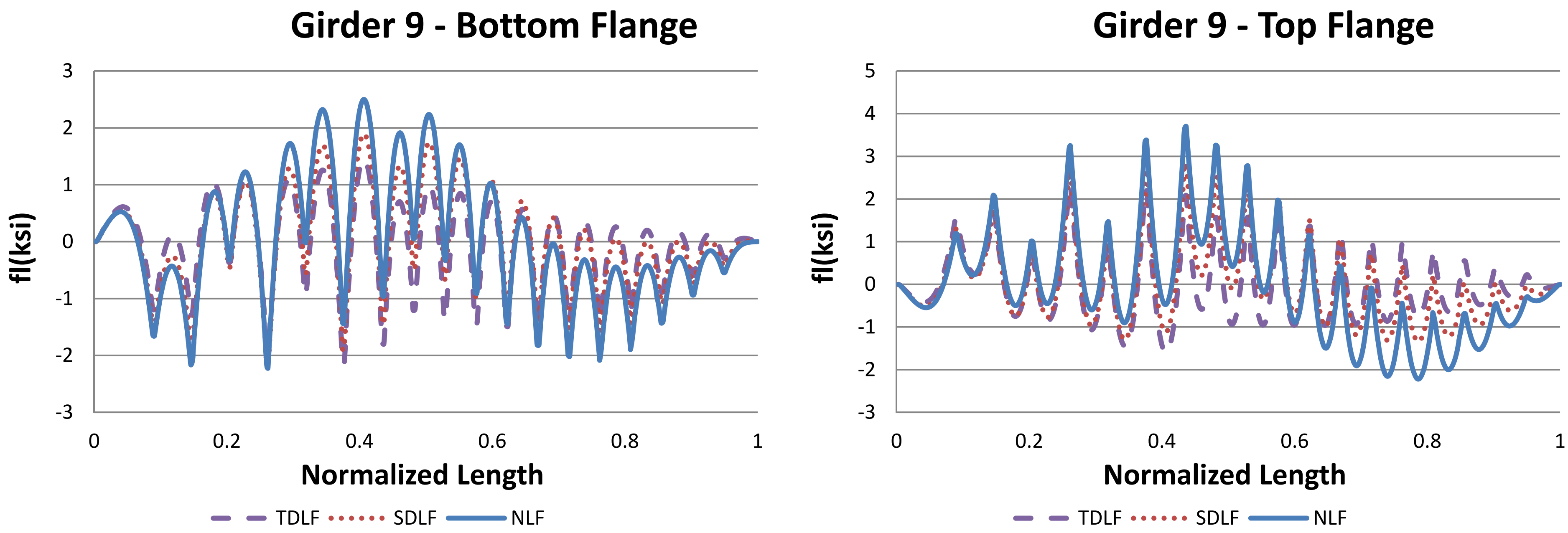


Figure Q2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

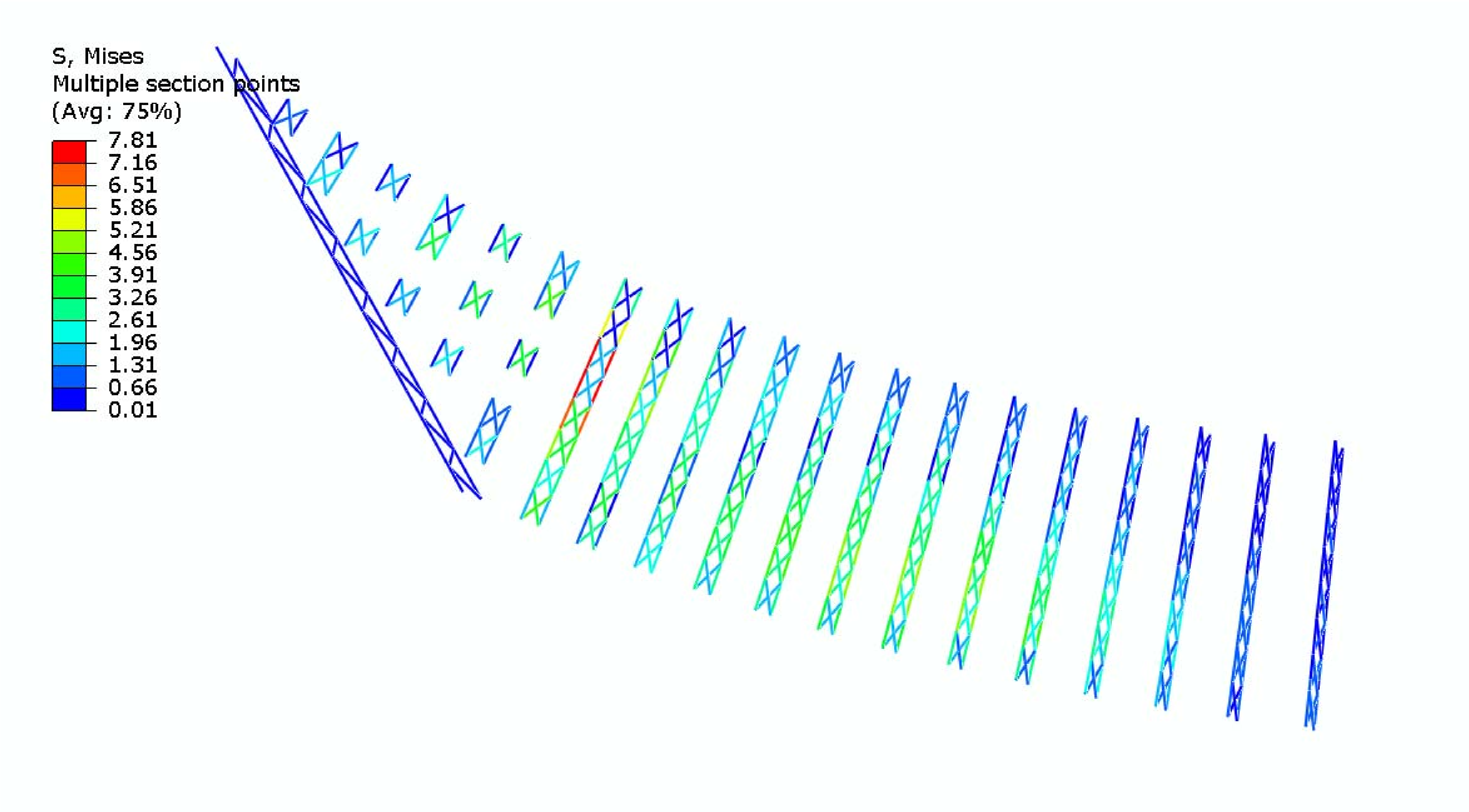


Figure Q2-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing

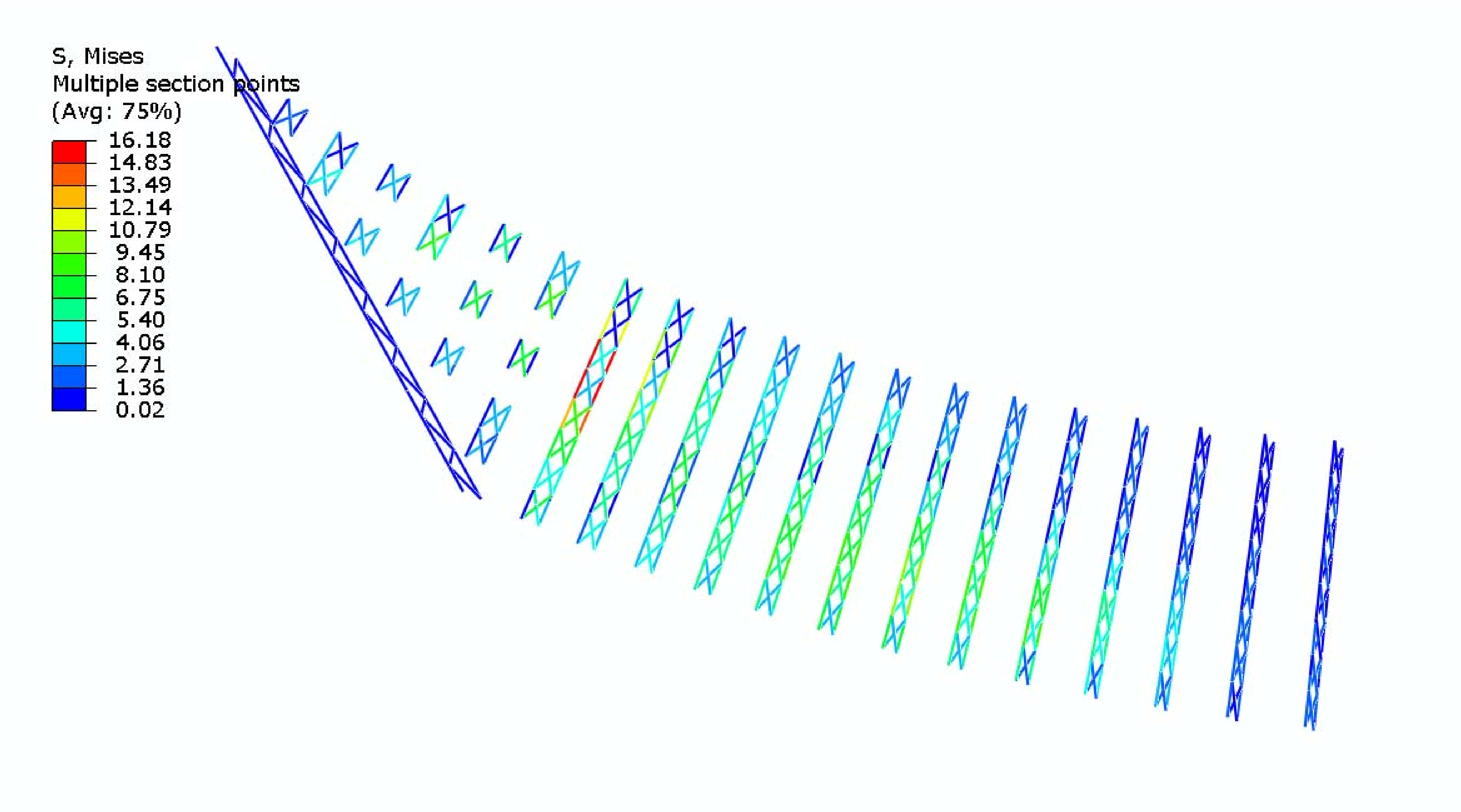


Figure Q2-4-23. Cross-frame stress contours under TDL, NLF detailing

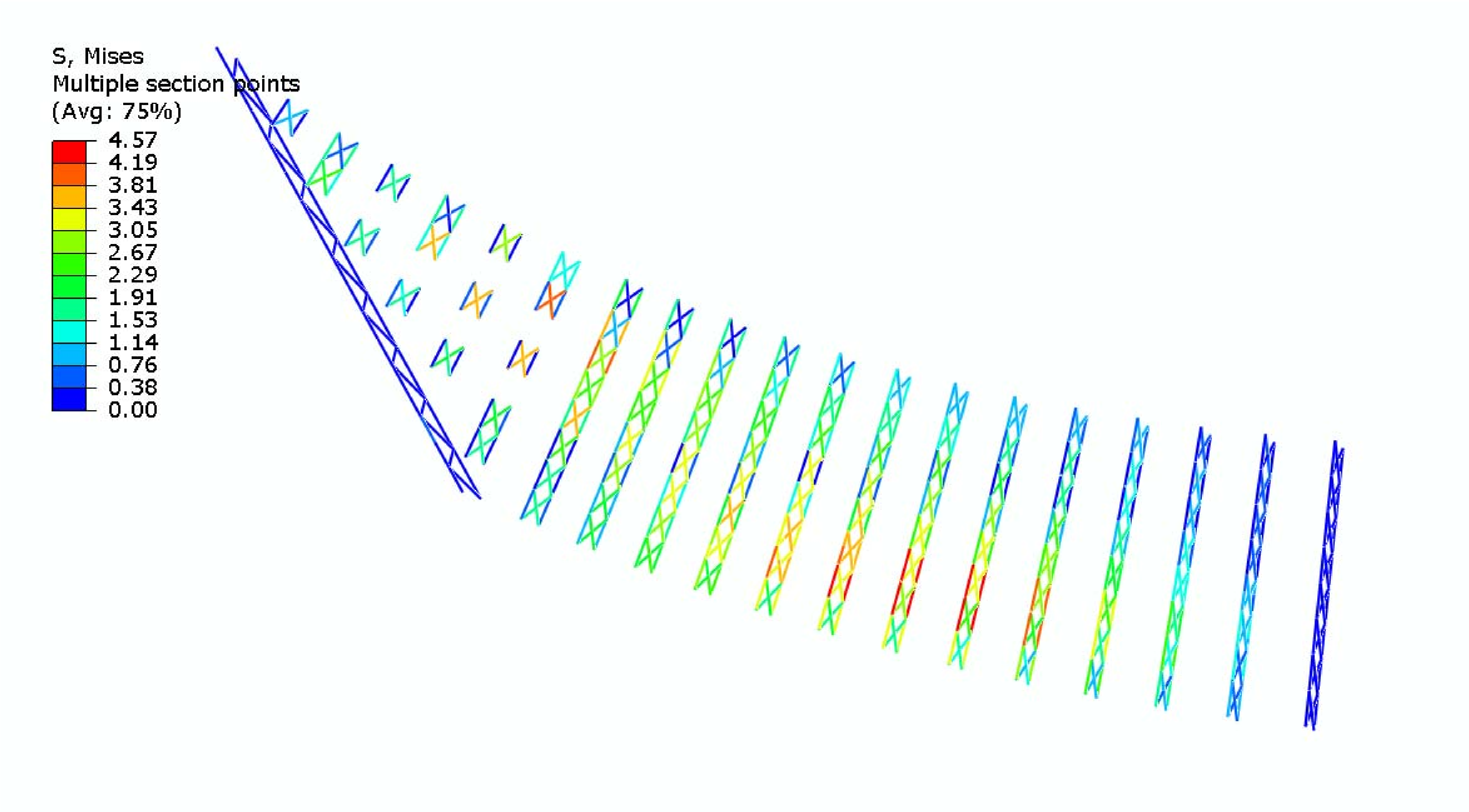


Figure Q2-4-24. Cross-frame stress contours under SDL, SDLF detailing

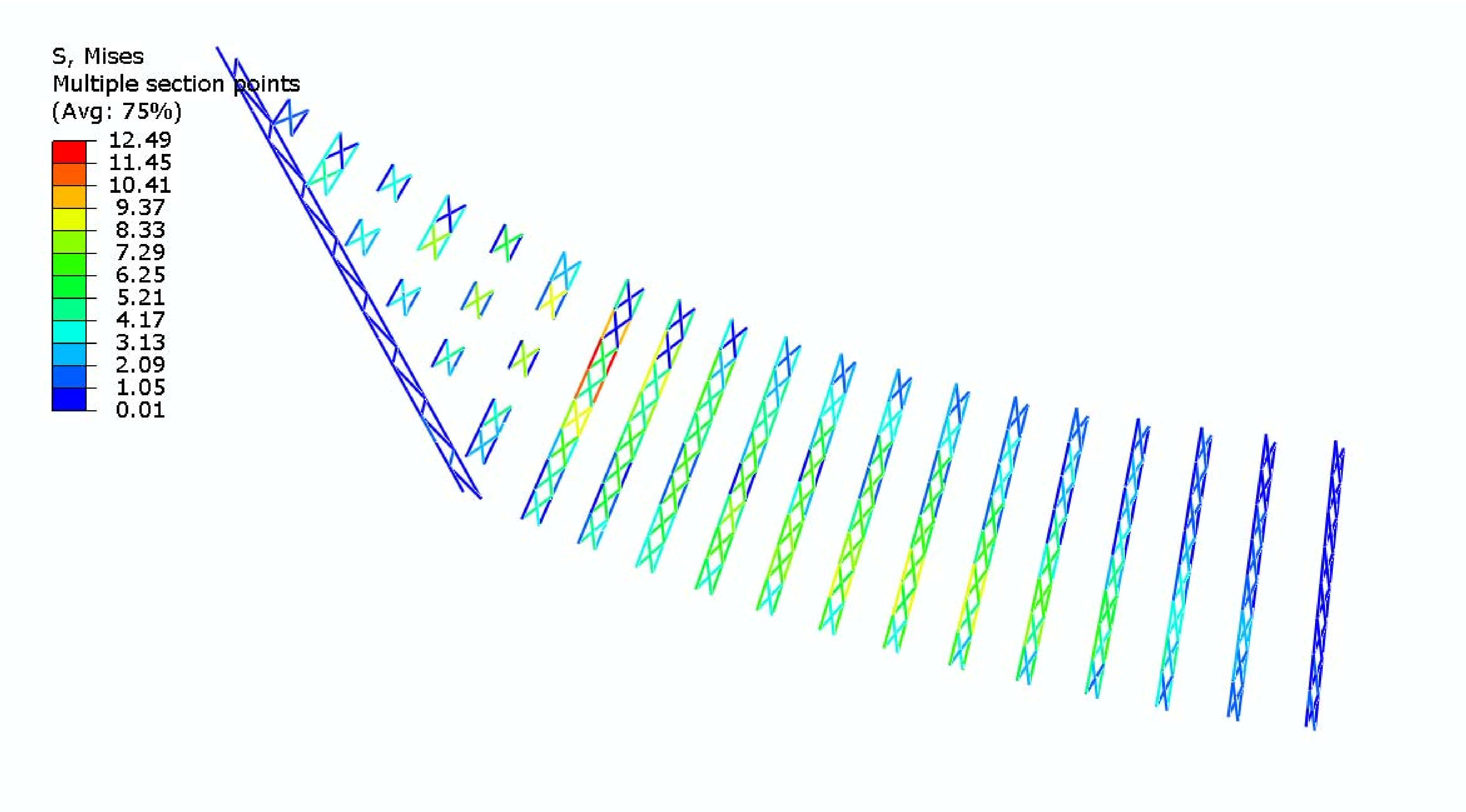


Figure Q2-4-25. Cross-frame stress contours under TDL, SDLF detailing

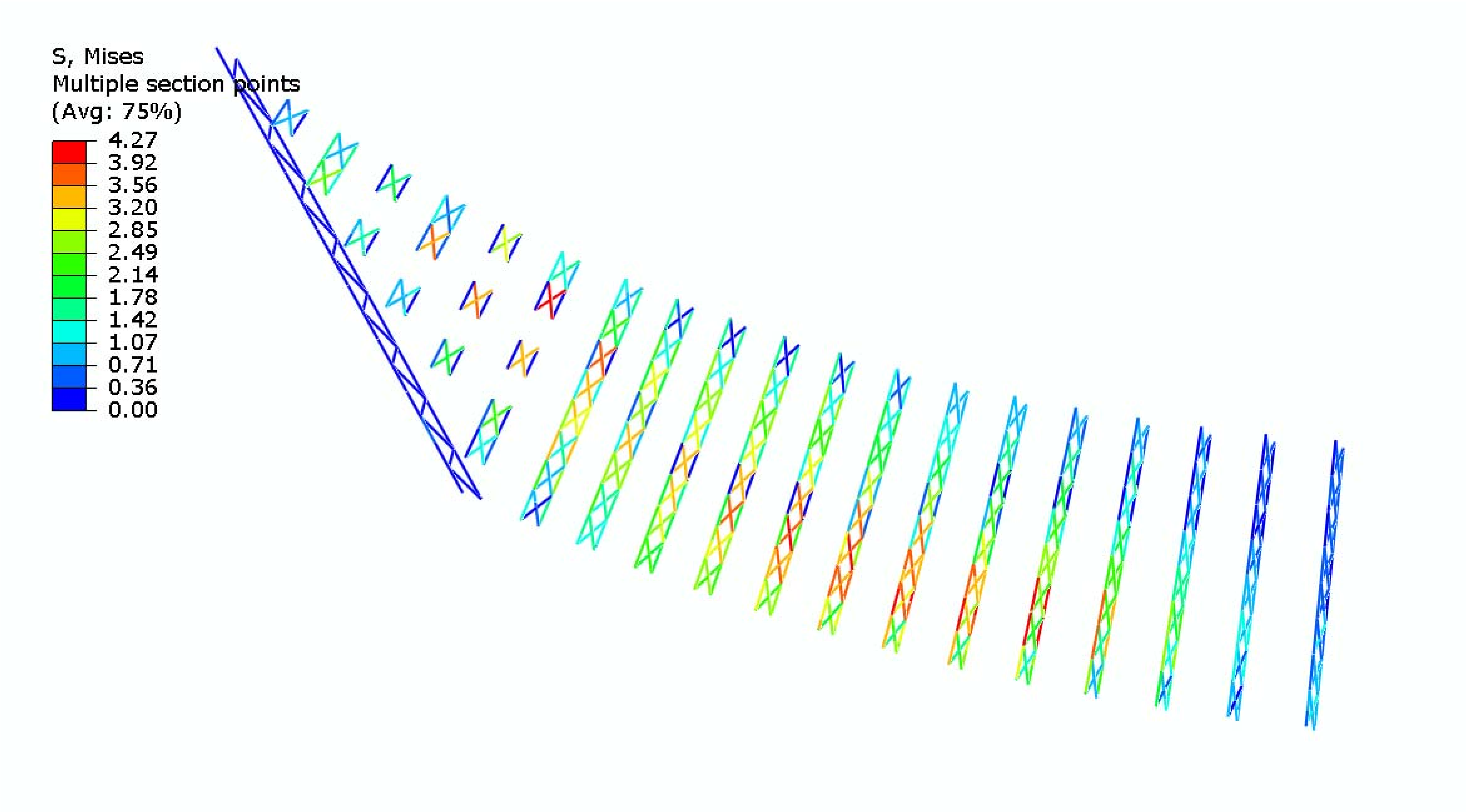


Figure Q2-4-26. Cross-frame stress contours under SDL, TDLF detailing

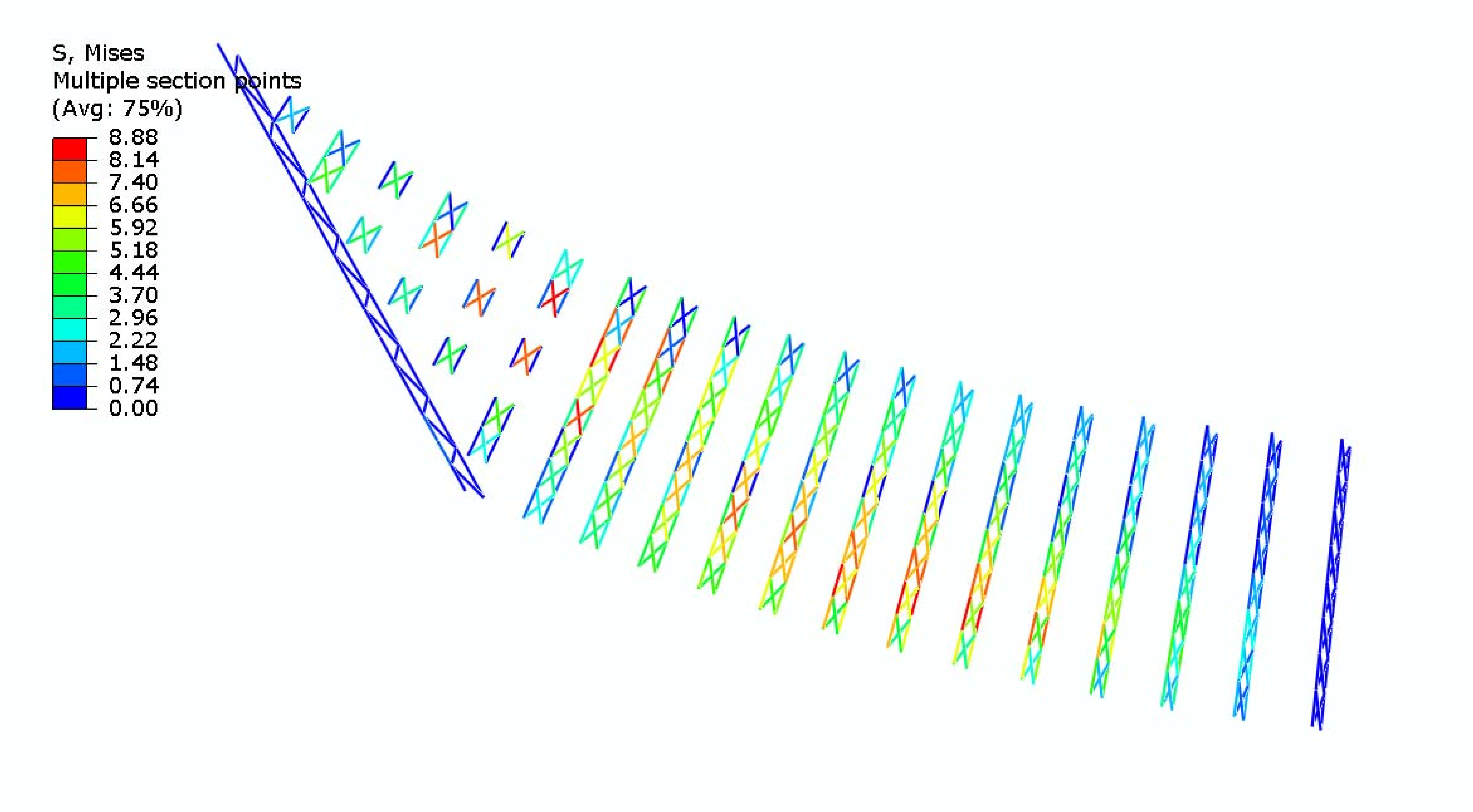


Figure Q2-4-27. Cross-frame stress contours under TDL, TDLF detailing

Table Q2-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	1.7	0.5	1.2	1.3	0.7	1.9	1.4	1.3
	SDLF	2.0	1.8	0.9	1.0	1.0	0.9	0.8	1.3
	TDLF	1.5	0.7	1.0	0.7	0.9	1.0	0.9	1.0
2	NLF	34.6	17.0	11.0	16.7	15.8	17.2	17.4	8.7
	SDLF	14.8	13.7	17.2	16.3	13.3	15.6	19.7	8.6
	TDLF	2.9	11.6	19.9	15.7	10.4	13.9	22.2	8.6
3	NLF	24.1	21.5	30.9	31.0	30.4	32.2	33.0	3.0
	SDLF	18.9	14.2	22.6	30.9	30.2	31.2	31.8	4.8
	TDLF	13.3	8.1	14.6	28.0	30.2	31.1	31.0	6.9
4	NLF	18.7	28.7	26.0	25.7	12.1	15.9	34.3	15.4
	SDLF	19.8	19.4	23.9	27.2	20.7	25.2	34.9	15.7
	TDLF	19.3	11.5	22.8	29.7	27.6	33.2	36.1	16.3
5	NLF	15.0	25.4	30.0	27.9	18.5	14.2	3.9	0.7
	SDLF	18.6	24.9	28.6	27.8	20.9	19.8	7.4	3.4
	TDLF	21.7	25.1	28.0	29.1	22.8	25.0	18.3	6.4
6	NLF	13.5	26.9	29.8	28.2	24.0	18.1	0.5	24.2
	SDLF	17.4	28.2	30.7	28.3	24.5	20.0	5.5	24.2
	TDLF	21.5	29.5	32.1	29.5	25.4	22.1	10.2	24.6
7	NLF	13.2	24.9	28.6	28.2	26.3	21.3	9.1	11.3
	SDLF	16.4	28.6	31.3	29.0	26.0	20.5	9.5	12.3
	TDLF	20.1	32.2	34.1	30.4	26.6	20.3	9.5	13.4
8	NLF	12.8	22.7	27.0	27.8	27.6	24.7	14.0	4.9
	SDLF	15.0	27.1	30.6	29.4	26.6	21.8	11.8	1.5
	TDLF	17.9	31.8	34.2	31.2	26.3	19.5	9.4	7.7
9	NLF	11.3	20.6	25.3	27.7	27.9	27.0	16.7	3.4
	SDLF	13.0	24.8	29.1	29.1	26.3	22.4	13.2	0.3
	TDLF	15.3	29.4	32.7	30.4	25.1	18.1	9.6	3.6
10	NLF	8.7	18.8	24.7	29.7	26.9	26.2	17.4	2.8
	SDLF	10.5	22.3	27.2	27.4	25.1	20.9	13.7	3.0
	TDLF	12.7	26.3	29.6	24.5	23.4	15.5	10.3	2.9

Table Q2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	8.0	20.3	27.1	23.3	25.2	17.0	16.3	6.3
	SDLF	8.3	19.7	24.9	23.1	23.0	17.1	14.0	4.5
	TDLF	8.7	19.0	22.2	22.6	20.5	17.7	12.0	2.4
12	NLF	7.0	16.9	21.6	17.2	18.9	11.8	15.3	8.1
	SDLF	6.5	15.9	21.2	18.1	19.9	13.7	14.3	5.6
	TDLF	6.1	15.0	20.3	18.9	20.9	16.1	13.7	3.0
13	NLF	4.4	10.7	15.3	12.6	14.8	10.4	13.9	8.6
	SDLF	4.2	11.2	15.5	12.8	15.8	11.0	13.6	6.6
	TDLF	4.2	11.5	15.5	13.0	16.8	11.9	13.9	4.8
14	NLF	11.0	6.1	7.7	7.3	10.8	8.4	11.2	8.6
	SDLF	1.3	6.2	8.5	7.3	11.0	8.3	11.5	7.5
	TDLF	10.4	6.4	9.4	7.4	11.4	8.4	12.2	6.8
15	NLF	NA	10.3	8.3	7.0	6.1	5.3	8.0	9.2
	SDLF	NA	0.9	0.6	0.6	6.0	4.9	8.3	8.2
	TDLF	NA	9.0	9.7	6.4	6.2	5.0	9.0	7.6
16	NLF	NA	NA	NA	NA	5.6	6.2	4.5	9.2
	SDLF	NA	NA	NA	NA	0.4	0.5	4.7	8.3
	TDLF	NA	NA	NA	NA	5.8	6.0	5.4	7.6
17	NLF	NA	NA	NA	NA	NA	NA	5.3	7.7
	SDLF	NA	NA	NA	NA	NA	NA	0.5	7.4
	TDLF	NA	NA	NA	NA	NA	NA	6.0	7.5
18	NLF	NA	NA	NA	NA	NA	NA	NA	5.4
	SDLF	NA	NA	NA	NA	NA	NA	NA	5.7
	TDLF	NA	NA	NA	NA	NA	NA	NA	6.3
19	NLF	NA	NA	NA	NA	NA	NA	NA	3.0
	SDLF	NA	NA	NA	NA	NA	NA	NA	3.4
	TDLF	NA	NA	NA	NA	NA	NA	NA	4.1
20	NLF	NA	NA	NA	NA	NA	NA	NA	4.8
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.5
	TDLF	NA	NA	NA	NA	NA	NA	NA	5.3

Table Q2-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	8.6	6.3	7.5	6.4	4.7	0.8	1.0	1.5
	SDLF	8.2	6.2	5.4	4.7	3.8	0.9	1.0	1.1
	TDLF	4.0	3.6	1.9	2.3	2.4	0.8	1.1	1.1
2	NLF	58.1	29.3	32.9	36.9	35.0	37.1	37.0	16.7
	SDLF	37.9	26.1	39.1	36.4	32.2	35.3	39.2	16.7
	TDLF	25.0	24.0	41.8	35.3	29.1	33.4	41.7	16.9
3	NLF	46.1	45.1	66.2	73.0	65.6	68.8	71.0	6.0
	SDLF	41.5	37.4	57.7	73.0	65.3	67.6	69.3	7.9
	TDLF	35.7	30.4	50.3	69.9	65.8	67.8	68.7	10.0
4	NLF	39.0	57.4	55.2	56.9	30.2	36.4	73.2	32.1
	SDLF	40.5	48.8	53.4	58.7	38.9	46.1	74.1	32.5
	TDLF	40.2	40.9	52.2	60.6	46.0	54.1	75.6	33.2
5	NLF	32.7	50.9	62.8	58.2	41.6	32.1	7.1	1.3
	SDLF	36.5	51.1	61.9	58.7	44.3	38.0	4.3	3.9
	TDLF	39.7	51.6	61.6	60.2	45.9	42.6	15.2	6.8
6	NLF	30.0	56.0	62.7	58.2	50.7	38.6	1.8	50.7
	SDLF	34.0	57.3	64.0	58.7	51.6	40.9	6.9	51.2
	TDLF	38.1	58.9	65.6	60.1	52.8	43.0	11.3	51.7
7	NLF	29.5	53.3	61.1	58.6	54.3	44.3	19.0	23.7
	SDLF	32.6	56.9	63.9	59.5	54.3	43.7	19.5	24.7
	TDLF	36.3	60.6	66.7	60.9	55.1	43.6	19.6	25.9
8	NLF	28.6	49.4	58.6	58.4	56.9	50.8	28.6	10.5
	SDLF	30.7	53.6	62.1	59.8	55.9	48.1	26.5	4.7
	TDLF	33.4	58.2	65.5	61.5	55.7	45.8	24.2	2.5
9	NLF	25.3	45.5	55.7	58.9	57.7	55.6	34.0	8.3
	SDLF	26.8	49.3	59.2	59.9	55.9	50.9	30.3	5.0
	TDLF	29.0	53.7	62.6	61.0	54.6	46.4	26.8	1.9
10	NLF	19.7	41.9	55.0	64.1	55.7	53.8	35.0	5.2
	SDLF	21.5	45.0	57.1	61.2	53.8	48.3	31.1	5.5
	TDLF	23.5	48.7	59.2	58.0	51.9	42.7	27.5	5.5

Table Q2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	18.0	45.2	60.4	50.8	53.0	34.0	32.7	12.2
	SDLF	18.2	44.3	57.8	50.2	50.4	33.8	30.0	10.5
	TDLF	18.5	43.3	54.8	49.4	47.6	34.2	27.7	8.5
12	NLF	15.5	37.4	48.6	37.7	39.7	22.9	30.4	15.8
	SDLF	15.2	36.4	47.9	38.4	40.4	24.6	29.2	13.3
	TDLF	14.8	35.2	46.9	39.0	41.1	26.8	28.5	10.7
13	NLF	9.9	23.9	34.8	27.5	31.0	20.0	27.5	16.6
	SDLF	9.6	24.5	34.9	27.7	31.8	20.5	27.0	14.5
	TDLF	9.6	24.7	34.7	27.7	32.6	21.3	27.1	12.6
14	NLF	23.0	13.3	17.7	15.7	22.4	16.1	22.0	16.6
	SDLF	13.2	13.3	18.6	15.7	22.6	15.9	22.1	15.3
	TDLF	3.0	13.7	19.3	15.7	22.8	15.9	22.8	14.5
15	NLF	NA	21.2	16.9	15.1	12.5	9.8	15.6	17.8
	SDLF	NA	11.5	8.1	8.7	12.4	9.5	15.9	16.6
	TDLF	NA	2.1	1.6	1.5	12.5	9.5	16.5	15.9
16	NLF	NA	NA	NA	NA	12.2	13.5	8.4	17.9
	SDLF	NA	NA	NA	NA	7.0	7.7	8.7	16.8
	TDLF	NA	NA	NA	NA	1.2	1.3	9.3	16.1
17	NLF	NA	NA	NA	NA	NA	NA	11.7	14.9
	SDLF	NA	NA	NA	NA	NA	NA	6.8	14.5
	TDLF	NA	NA	NA	NA	NA	NA	1.2	14.6
18	NLF	NA	NA	NA	NA	NA	NA	NA	10.4
	SDLF	NA	NA	NA	NA	NA	NA	NA	10.6
	TDLF	NA	NA	NA	NA	NA	NA	NA	11.2
19	NLF	NA	NA	NA	NA	NA	NA	NA	5.3
	SDLF	NA	NA	NA	NA	NA	NA	NA	5.8
	TDLF	NA	NA	NA	NA	NA	NA	NA	6.5
20	NLF	NA	NA	NA	NA	NA	NA	NA	10.5
	SDLF	NA	NA	NA	NA	NA	NA	NA	6.2
	TDLF	NA	NA	NA	NA	NA	NA	NA	1.0

Table Q2-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	1.8	0.7	0.3	0.4	0.8	1.5	2.6	2.1
	SDLF	0.9	2.6	0.2	0.2	0.5	1.8	1.0	2.3
	TDLF	0.1	4.2	0.6	0.5	0.1	1.9	0.4	2.3
2	NLF	12.0	7.0	9.4	4.4	5.8	10.0	15.2	2.8
	SDLF	3.9	0.8	3.3	2.7	3.2	5.9	13.0	2.7
	TDLF	15.1	4.5	0.1	1.4	0.7	1.7	10.5	2.4
3	NLF	10.0	26.7	38.7	60.4	3.6	9.8	16.7	13.7
	SDLF	8.9	1.7	0.4	14.4	1.3	5.5	10.9	13.1
	TDLF	8.9	22.6	30.2	25.5	1.2	0.6	4.5	12.4
4	NLF	16.5	3.5	15.4	29.2	66.1	65.8	8.2	1.3
	SDLF	16.0	7.2	3.5	9.3	25.8	34.0	4.6	1.2
	TDLF	16.5	17.5	20.7	8.0	11.8	3.0	0.6	1.0
5	NLF	24.1	15.9	7.9	7.6	40.3	42.2	48.0	17.8
	SDLF	22.1	15.7	10.2	3.3	21.2	28.2	31.0	13.8
	TDLF	20.7	17.5	13.8	1.0	4.9	16.1	14.0	9.5
6	NLF	27.7	29.1	23.5	9.6	19.8	26.7	37.3	0.1
	SDLF	26.1	24.8	18.4	4.3	15.5	23.3	28.6	0.3
	TDLF	24.4	22.1	15.2	0.3	12.1	21.2	21.0	0.7
7	NLF	29.0	37.3	35.0	22.4	3.5	13.1	25.8	14.1
	SDLF	28.0	31.9	26.3	11.9	8.5	17.6	24.2	11.6
	TDLF	26.7	27.1	18.7	2.3	13.3	22.4	23.5	8.9
8	NLF	28.5	41.1	41.7	30.4	8.9	3.6	17.5	23.1
	SDLF	28.2	36.4	32.4	17.9	1.8	12.2	20.4	17.7
	TDLF	27.5	31.6	23.4	6.0	11.9	20.8	23.8	12.4
9	NLF	27.1	41.6	43.7	32.4	16.5	1.7	11.9	19.1
	SDLF	27.0	38.3	35.8	21.4	3.7	7.8	16.9	16.2
	TDLF	26.6	34.5	27.8	10.7	8.8	16.9	22.0	13.6
10	NLF	25.0	40.0	41.5	27.9	17.8	3.0	8.9	15.8
	SDLF	24.4	37.7	35.9	22.1	6.8	4.2	13.5	15.0
	TDLF	23.6	35.0	30.1	16.8	3.7	10.7	17.9	14.6

Table Q2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	19.6	35.7	32.2	18.1	11.6	0.9	7.0	12.9
	SDLF	20.0	34.7	32.8	20.0	8.2	1.6	9.8	13.7
	TDLF	20.2	33.6	33.7	23.0	6.0	2.9	11.9	14.7
12	NLF	13.6	27.3	24.3	13.9	6.8	1.1	3.9	10.7
	SDLF	14.2	28.6	26.8	16.3	8.0	0.4	6.1	12.2
	TDLF	14.7	30.1	30.0	19.9	10.7	0.9	7.5	13.7
13	NLF	7.0	19.4	18.3	10.8	6.1	1.2	1.3	9.2
	SDLF	7.5	20.5	19.3	11.6	7.3	1.2	3.1	10.5
	TDLF	8.0	21.8	20.9	13.5	9.8	2.5	4.1	11.6
14	NLF	5.3	9.8	9.8	6.1	5.2	1.1	0.8	7.7
	SDLF	0.2	10.8	10.4	6.3	5.5	1.3	1.4	8.5
	TDLF	6.0	11.9	11.5	7.3	7.0	2.4	1.2	9.0
15	NLF	NA	5.2	3.5	2.1	2.8	0.2	0.7	5.7
	SDLF	NA	0.1	0.2	0.1	3.1	0.8	0.7	6.5
	TDLF	NA	5.7	4.2	2.6	4.2	2.0	0.1	7.1
16	NLF	NA	NA	NA	NA	2.3	2.8	0.9	3.9
	SDLF	NA	NA	NA	NA	0.1	0.0	0.4	4.7
	TDLF	NA	NA	NA	NA	2.8	3.2	0.7	5.3
17	NLF	NA	NA	NA	NA	NA	NA	3.0	2.9
	SDLF	NA	NA	NA	NA	NA	NA	0.1	3.3
	TDLF	NA	NA	NA	NA	NA	NA	3.4	3.4
18	NLF	NA	NA	NA	NA	NA	NA	NA	2.1
	SDLF	NA	NA	NA	NA	NA	NA	NA	2.2
	TDLF	NA	NA	NA	NA	NA	NA	NA	2.0
19	NLF	NA	NA	NA	NA	NA	NA	NA	1.4
	SDLF	NA	NA	NA	NA	NA	NA	NA	1.2
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.8
20	NLF	NA	NA	NA	NA	NA	NA	NA	2.7
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.1
	TDLF	NA	NA	NA	NA	NA	NA	NA	2.9

Table Q2-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	2.5	0.2	1.6	2.3	0.3	1.8	6.0	2.5
	SDLF	2.9	3.0	1.0	1.2	0.7	2.6	4.3	3.0
	TDLF	2.9	5.1	0.2	0.2	0.6	3.1	2.7	3.1
2	NLF	19.8	9.9	17.7	11.8	14.6	22.9	33.3	6.0
	SDLF	2.6	0.9	10.1	9.1	11.2	18.3	30.7	5.6
	TDLF	11.2	4.5	4.5	6.2	7.4	13.0	27.4	5.0
3	NLF	23.2	42.2	66.1	116.8	8.7	21.7	35.6	28.7
	SDLF	21.3	12.9	27.3	70.3	6.3	17.4	29.9	27.9
	TDLF	20.0	9.7	4.3	28.8	3.2	11.9	23.2	27.1
4	NLF	32.3	0.6	24.5	54.5	134.7	137.8	17.4	2.2
	SDLF	31.8	9.2	6.4	35.7	94.4	106.4	14.1	2.3
	TDLF	32.6	18.4	9.5	19.9	56.1	74.9	9.9	2.1
5	NLF	47.2	30.9	14.4	18.0	80.7	87.2	101.6	37.4
	SDLF	45.2	30.3	16.4	14.1	62.6	74.0	84.9	33.3
	TDLF	44.0	32.1	19.9	9.9	47.5	63.0	67.8	28.8
6	NLF	55.0	54.9	42.2	13.1	43.4	58.0	78.2	0.6
	SDLF	53.1	50.4	36.8	7.5	39.5	55.1	70.2	0.6
	TDLF	51.6	48.1	33.8	3.6	36.5	53.5	63.3	1.0
7	NLF	58.1	71.5	64.4	37.5	13.3	32.5	55.9	29.5
	SDLF	56.7	65.6	55.1	26.5	18.7	37.1	54.7	27.2
	TDLF	55.4	60.9	47.6	16.9	23.5	42.1	54.4	24.4
8	NLF	57.6	79.6	77.8	52.8	10.2	14.4	40.3	48.6
	SDLF	56.8	74.3	67.8	39.8	0.8	23.2	43.3	43.5
	TDLF	56.0	69.4	58.8	27.8	11.0	31.9	46.8	38.2
9	NLF	55.0	81.2	81.9	56.2	24.5	4.7	29.6	39.9
	SDLF	54.5	77.2	73.4	44.9	11.3	14.3	34.7	37.3
	TDLF	53.9	73.3	65.2	34.1	1.1	23.4	39.8	35.2
10	NLF	51.4	78.6	78.3	47.6	26.3	2.7	24.2	33.5
	SDLF	50.3	75.6	71.9	41.1	15.0	10.1	28.8	33.0
	TDLF	49.1	72.6	65.8	35.5	4.4	16.5	33.1	32.9

Table Q2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	40.2	71.0	59.9	27.6	13.2	7.3	20.6	28.4
	SDLF	40.3	69.1	59.6	28.9	9.3	10.0	23.5	29.2
	TDLF	40.3	67.5	60.2	31.6	7.0	11.2	25.5	30.3
12	NLF	28.1	53.7	44.0	19.8	3.4	6.6	13.9	24.3
	SDLF	28.5	54.6	46.1	21.9	4.3	7.4	16.1	25.7
	TDLF	28.9	55.7	49.1	25.4	6.9	6.8	17.5	27.2
13	NLF	15.0	38.2	33.3	15.7	3.3	5.1	8.0	21.4
	SDLF	15.4	39.0	33.9	16.2	4.3	5.2	9.8	22.6
	TDLF	15.7	40.1	35.4	17.9	6.7	3.8	10.7	23.7
14	NLF	10.6	19.6	17.8	8.7	3.6	3.3	6.1	18.4
	SDLF	5.0	20.4	18.3	8.8	3.8	3.3	6.7	19.1
	TDLF	0.8	21.3	19.1	9.7	5.3	2.0	6.4	19.6
15	NLF	NA	10.5	7.2	4.5	1.8	2.5	4.7	14.0
	SDLF	NA	5.0	3.3	2.4	1.9	2.2	4.6	14.8
	TDLF	NA	0.4	0.5	0.1	3.0	0.9	3.8	15.3
16	NLF	NA	NA	NA	NA	5.1	6.0	3.4	10.0
	SDLF	NA	NA	NA	NA	2.9	3.4	3.0	10.8
	TDLF	NA	NA	NA	NA	0.0	0.1	1.9	11.2
17	NLF	NA	NA	NA	NA	NA	NA	6.4	7.5
	SDLF	NA	NA	NA	NA	NA	NA	3.6	7.8
	TDLF	NA	NA	NA	NA	NA	NA	0.1	7.9
18	NLF	NA	NA	NA	NA	NA	NA	NA	5.2
	SDLF	NA	NA	NA	NA	NA	NA	NA	5.3
	TDLF	NA	NA	NA	NA	NA	NA	NA	5.1
19	NLF	NA	NA	NA	NA	NA	NA	NA	3.0
	SDLF	NA	NA	NA	NA	NA	NA	NA	2.8
	TDLF	NA	NA	NA	NA	NA	NA	NA	2.4
20	NLF	NA	NA	NA	NA	NA	NA	NA	5.6
	SDLF	NA	NA	NA	NA	NA	NA	NA	3.1
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.1

Table Q2-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	3.2	1.1	0.7	0.5	1.4	2.9	2.9	2.6
	SDLF	2.3	2.8	0.6	0.7	0.4	1.4	1.7	2.2
	TDLF	2.1	2.7	1.3	1.2	2.0	0.6	1.2	1.4
2	NLF	11.6	6.3	7.0	2.6	4.3	8.9	14.5	2.7
	SDLF	4.1	0.6	3.1	2.5	3.3	6.2	13.2	3.0
	TDLF	12.4	2.6	3.2	3.8	3.2	4.1	12.3	3.4
3	NLF	8.5	26.4	39.3	60.3	3.3	9.6	16.6	13.3
	SDLF	9.6	1.6	0.0	14.5	0.8	5.1	10.4	13.2
	TDLF	12.5	20.5	29.8	23.0	1.1	0.8	4.3	13.2
4	NLF	15.8	5.3	16.9	31.0	66.5	66.2	8.4	1.5
	SDLF	16.8	7.5	4.0	9.3	25.9	34.2	3.9	0.8
	TDLF	18.6	20.5	23.7	10.6	10.4	4.4	0.4	0.2
5	NLF	23.8	15.0	7.5	8.1	41.5	43.2	48.2	17.6
	SDLF	22.9	16.1	10.7	3.2	21.3	28.4	31.1	14.1
	TDLF	22.5	19.3	15.2	1.6	3.3	15.2	14.8	10.5
6	NLF	27.4	28.8	23.5	9.4	20.3	27.1	37.8	0.3
	SDLF	26.9	25.4	19.1	4.6	15.4	23.4	28.8	0.7
	TDLF	26.4	23.4	16.2	0.8	11.4	20.8	20.5	1.6
7	NLF	28.8	37.0	35.1	22.5	3.6	13.3	26.0	14.1
	SDLF	28.8	32.5	27.0	12.2	8.3	17.5	24.2	11.8
	TDLF	28.7	28.7	20.0	2.9	13.0	22.4	23.2	9.7
8	NLF	28.4	41.0	42.0	30.5	8.9	3.7	17.6	23.1
	SDLF	29.0	37.1	33.2	18.3	1.5	12.2	20.4	17.4
	TDLF	29.3	33.1	24.8	6.7	11.4	20.7	23.8	12.0
9	NLF	26.9	41.7	44.2	32.8	16.7	1.8	11.9	19.4
	SDLF	27.7	39.0	36.7	21.9	4.0	7.7	16.9	16.0
	TDLF	28.3	36.0	29.1	11.2	8.2	16.8	22.0	12.7
10	NLF	24.7	40.1	41.8	27.9	18.1	2.9	8.7	15.9
	SDLF	25.1	38.4	36.7	22.4	7.2	4.2	13.5	14.9
	TDLF	25.3	36.4	31.5	17.4	3.3	10.6	18.0	14.2

Table Q2-4-5(Continued).   Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	19.4	35.3	32.0	18.1	11.6	1.1	7.0	13.0
	SDLF	20.5	35.4	33.2	20.1	8.3	1.5	9.9	13.6
	TDLF	21.6	35.3	34.8	23.3	6.1	2.7	12.0	14.6
12	NLF	13.3	27.2	24.6	14.1	7.0	1.3	3.7	10.7
	SDLF	14.7	29.1	27.3	16.5	8.1	0.6	5.9	12.2
	TDLF	16.1	31.4	30.9	20.2	10.8	1.2	7.2	13.7
13	NLF	7.2	19.1	18.1	10.5	6.3	1.3	1.1	9.1
	SDLF	7.8	20.9	19.7	11.7	7.4	1.4	2.8	10.5
	TDLF	8.3	23.1	22.0	14.0	10.0	2.8	3.7	11.7
14	NLF	6.1	10.2	10.4	6.7	4.9	0.8	0.7	7.7
	SDLF	0.5	11.0	10.6	6.4	5.6	1.4	1.2	8.5
	TDLF	5.4	11.8	11.1	6.6	7.5	3.0	0.7	9.1
15	NLF	NA	4.8	4.5	4.0	3.3	0.7	1.0	5.6
	SDLF	NA	0.3	0.3	0.2	3.1	0.8	0.5	6.5
	TDLF	NA	4.5	4.2	4.0	3.5	1.5	0.7	7.1
16	NLF	NA	NA	NA	NA	3.1	2.7	0.5	3.8
	SDLF	NA	NA	NA	NA	0.1	0.0	0.2	4.7
	TDLF	NA	NA	NA	NA	3.3	3.0	0.4	5.3
17	NLF	NA	NA	NA	NA	NA	NA	2.5	2.8
	SDLF	NA	NA	NA	NA	NA	NA	0.0	3.3
	TDLF	NA	NA	NA	NA	NA	NA	2.8	3.3
18	NLF	NA	NA	NA	NA	NA	NA	NA	2.2
	SDLF	NA	NA	NA	NA	NA	NA	NA	2.1
	TDLF	NA	NA	NA	NA	NA	NA	NA	1.7
19	NLF	NA	NA	NA	NA	NA	NA	NA	1.2
	SDLF	NA	NA	NA	NA	NA	NA	NA	1.1
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.9
20	NLF	NA	NA	NA	NA	NA	NA	NA	2.3
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.0
	TDLF	NA	NA	NA	NA	NA	NA	NA	2.8

Table Q2-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	5.8	6.0	5.8	4.9	6.7	5.4	3.7	4.4
	SDLF	6.0	8.5	3.8	3.1	4.4	4.3	3.4	3.5
	TDLF	5.5	6.3	1.6	1.8	1.2	2.6	3.5	2.8
2	NLF	9.5	3.3	4.7	1.8	6.2	16.3	28.3	4.3
	SDLF	5.9	3.7	1.4	2.4	5.8	14.1	27.3	4.6
	TDLF	12.4	5.0	2.7	4.8	6.7	12.8	26.9	5.3
3	NLF	15.1	34.7	63.3	110.1	5.4	18.6	33.3	26.6
	SDLF	17.0	7.1	23.7	64.4	2.9	14.1	27.2	26.7
	TDLF	21.3	10.0	5.1	28.6	1.4	10.4	21.5	27.0
4	NLF	31.0	9.0	32.0	63.7	131.6	135.1	16.5	2.4
	SDLF	32.4	4.9	10.0	40.9	91.2	103.6	11.9	1.5
	TDLF	34.5	19.2	11.0	19.6	56.2	75.0	7.8	0.8
5	NLF	47.0	28.1	12.9	19.4	87.0	92.1	99.7	35.9
	SDLF	46.2	29.6	16.3	14.5	66.3	77.2	83.2	32.7
	TDLF	45.9	33.3	21.3	9.4	47.5	63.5	67.8	29.4
6	NLF	54.8	55.1	42.9	13.3	45.2	59.8	81.1	0.3
	SDLF	54.1	51.6	38.3	8.3	40.2	56.0	72.2	1.6
	TDLF	53.7	49.6	35.5	4.4	36.1	53.3	63.7	2.5
7	NLF	58.2	71.3	65.1	38.0	13.2	32.4	56.9	28.7
	SDLF	57.8	66.5	56.6	27.4	18.0	36.7	55.1	26.6
	TDLF	57.6	62.7	49.7	18.1	22.8	41.7	54.2	24.6
8	NLF	58.0	79.9	78.8	53.6	10.7	14.1	40.1	47.6
	SDLF	58.0	75.4	69.5	40.9	0.1	22.7	42.9	42.2
	TDLF	58.2	71.3	61.0	29.1	9.9	31.3	46.5	37.3
9	NLF	55.3	82.0	83.9	58.2	25.5	3.8	29.2	41.1
	SDLF	55.5	78.5	75.5	46.6	12.4	13.5	34.2	37.8
	TDLF	55.9	75.3	67.7	35.7	0.2	22.7	39.4	34.6
10	NLF	50.7	79.4	79.3	47.4	27.6	2.4	23.4	34.0
	SDLF	50.7	76.9	73.5	41.5	16.2	9.7	28.2	33.0
	TDLF	50.8	74.5	68.0	36.4	5.6	16.1	32.7	32.4

Table Q2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	40.2	69.7	59.3	27.6	13.3	6.7	20.3	28.2
	SDLF	40.9	69.3	60.0	29.2	9.7	9.4	23.1	28.9
	TDLF	41.8	69.0	61.4	32.2	7.5	10.6	25.2	29.9
12	NLF	27.8	53.9	45.3	20.8	4.2	5.5	13.3	23.9
	SDLF	28.9	55.2	47.4	22.7	4.9	6.5	15.5	25.3
	TDLF	30.1	57.2	50.6	26.1	7.5	5.9	16.8	26.9
13	NLF	15.4	37.9	33.2	15.4	4.2	4.4	7.0	20.8
	SDLF	16.0	39.4	34.4	16.3	5.0	4.5	8.9	22.2
	TDLF	16.4	41.3	36.5	18.3	7.4	3.1	9.8	23.4
14	NLF	12.9	20.4	19.2	10.1	3.3	3.6	5.5	18.1
	SDLF	7.3	21.1	19.3	9.6	3.9	3.2	6.0	18.9
	TDLF	1.4	21.8	19.6	9.8	5.7	1.5	5.6	19.3
15	NLF	NA	10.2	9.6	8.4	3.0	1.5	4.8	13.5
	SDLF	NA	5.9	5.6	4.5	2.7	1.4	4.5	14.5
	TDLF	NA	0.8	0.7	0.4	3.2	0.7	3.2	15.0
16	NLF	NA	NA	NA	NA	6.5	5.7	2.5	9.4
	SDLF	NA	NA	NA	NA	3.5	3.1	2.2	10.4
	TDLF	NA	NA	NA	NA	0.3	0.2	1.5	10.9
17	NLF	NA	NA	NA	NA	NA	NA	5.5	7.0
	SDLF	NA	NA	NA	NA	NA	NA	3.0	7.5
	TDLF	NA	NA	NA	NA	NA	NA	0.3	7.5
18	NLF	NA	NA	NA	NA	NA	NA	NA	5.2
	SDLF	NA	NA	NA	NA	NA	NA	NA	5.1
	TDLF	NA	NA	NA	NA	NA	NA	NA	4.7
19	NLF	NA	NA	NA	NA	NA	NA	NA	2.4
	SDLF	NA	NA	NA	NA	NA	NA	NA	2.3
	TDLF	NA	NA	NA	NA	NA	NA	NA	2.1
20	NLF	NA	NA	NA	NA	NA	NA	NA	5.3
	SDLF	NA	NA	NA	NA	NA	NA	NA	3.0
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.3

Table Q2-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.66	-0.79	-0.78	-0.86	-0.92	-0.94	-0.96	-1.00
	SDLF	-0.74	-0.88	-0.88	-0.99	-1.07	-1.11	-1.14	-1.20
	TDLF	-0.83	-1.00	-1.01	-1.17	-1.26	-1.33	-1.37	-1.46
3	NLF	-0.47	-0.64	-0.62	-0.59	-0.68	-0.72	-0.76	-0.93
	SDLF	-0.53	-0.71	-0.71	-0.68	-0.77	-0.82	-0.85	-1.08
	TDLF	-0.61	-0.82	-0.83	-0.81	-0.89	-0.95	-0.97	-1.27
4	NLF	-0.30	-0.48	-0.47	-0.46	-0.53	-0.49	-0.53	-0.82
	SDLF	-0.34	-0.55	-0.54	-0.53	-0.59	-0.54	-0.56	-0.92
	TDLF	-0.40	-0.64	-0.65	-0.64	-0.69	-0.62	-0.61	-1.06
5	NLF	-0.16	-0.32	-0.33	-0.33	-0.42	-0.39	-0.43	-0.72
	SDLF	-0.16	-0.37	-0.39	-0.39	-0.48	-0.43	-0.44	-0.77
	TDLF	-0.20	-0.45	-0.49	-0.49	-0.57	-0.50	-0.47	-0.85
6	NLF	-0.04	-0.19	-0.21	-0.22	-0.32	-0.30	-0.35	-0.60
	SDLF	-0.02	-0.22	-0.25	-0.27	-0.37	-0.33	-0.36	-0.61
	TDLF	-0.03	-0.28	-0.33	-0.35	-0.45	-0.39	-0.39	-0.66
7	NLF	0.05	-0.07	-0.10	-0.12	-0.22	-0.21	-0.27	-0.50
	SDLF	0.09	-0.08	-0.13	-0.16	-0.27	-0.24	-0.28	-0.50
	TDLF	0.09	-0.13	-0.20	-0.23	-0.34	-0.30	-0.31	-0.52
8	NLF	0.12	0.02	-0.01	-0.04	-0.13	-0.13	-0.19	-0.40
	SDLF	0.16	0.03	-0.03	-0.08	-0.18	-0.17	-0.20	-0.39
	TDLF	0.18	0.00	-0.09	-0.14	-0.24	-0.22	-0.23	-0.40
9	NLF	0.15	0.08	0.05	0.02	-0.05	-0.06	-0.11	-0.33
	SDLF	0.20	0.10	0.04	-0.01	-0.10	-0.10	-0.13	-0.32
	TDLF	0.23	0.08	-0.01	-0.07	-0.16	-0.15	-0.16	-0.32
10	NLF	0.15	0.12	0.08	0.06	0.01	0.00	-0.05	-0.25
	SDLF	0.20	0.14	0.07	0.03	-0.03	-0.04	-0.07	-0.24
	TDLF	0.23	0.13	0.04	-0.02	-0.09	-0.09	-0.10	-0.24

Table Q2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.14	0.12	0.09	0.08	0.05	0.05	0.01	-0.17
	SDLF	0.18	0.14	0.09	0.06	0.01	0.02	-0.02	-0.17
	TDLF	0.21	0.14	0.06	0.02	-0.04	-0.02	-0.05	-0.17
12	NLF	0.11	0.12	0.09	0.09	0.07	0.08	0.05	-0.10
	SDLF	0.14	0.13	0.09	0.07	0.05	0.05	0.03	-0.10
	TDLF	0.16	0.14	0.07	0.04	0.01	0.02	0.00	-0.11
13	NLF	0.06	0.09	0.07	0.07	0.08	0.08	0.08	-0.03
	SDLF	0.08	0.11	0.07	0.06	0.06	0.06	0.05	-0.04
	TDLF	0.09	0.11	0.06	0.04	0.03	0.04	0.03	-0.05
14	NLF	0.00	0.05	0.04	0.04	0.07	0.06	0.08	0.02
	SDLF	0.00	0.06	0.04	0.04	0.05	0.05	0.06	0.01
	TDLF	0.00	0.06	0.04	0.03	0.03	0.03	0.04	-0.01
15	NLF	NA	0.00	0.00	0.00	0.04	0.04	0.07	0.06
	SDLF	NA	0.00	0.00	0.00	0.03	0.03	0.05	0.04
	TDLF	NA	0.00	0.00	0.00	0.02	0.02	0.04	0.03
16	NLF	NA	NA	NA	NA	0.00	0.00	0.04	0.08
	SDLF	NA	NA	NA	NA	0.00	0.00	0.03	0.06
	TDLF	NA	NA	NA	NA	0.00	0.00	0.02	0.05
17	NLF	NA	NA	NA	NA	NA	NA	0.00	0.08
	SDLF	NA	NA	NA	NA	NA	NA	0.00	0.07
	TDLF	NA	NA	NA	NA	NA	NA	0.00	0.06
18	NLF	NA	NA	NA	NA	NA	NA	NA	0.07
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.06
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.05
19	NLF	NA	NA	NA	NA	NA	NA	NA	0.04
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.03
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.03
20	NLF	NA	NA	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.00

Table Q2-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-1.41	-1.66	-1.66	-1.85	-1.98	-2.03	-2.07	-2.15
	SDLF	-1.49	-1.76	-1.75	-1.99	-2.12	-2.20	-2.25	-2.35
	TDLF	-1.58	-1.87	-1.88	-2.15	-2.31	-2.41	-2.48	-2.60
3	NLF	-1.07	-1.38	-1.37	-1.32	-1.50	-1.58	-1.65	-2.01
	SDLF	-1.13	-1.46	-1.45	-1.41	-1.58	-1.67	-1.74	-2.15
	TDLF	-1.20	-1.56	-1.57	-1.53	-1.70	-1.80	-1.86	-2.35
4	NLF	-0.74	-1.08	-1.07	-1.04	-1.19	-1.10	-1.18	-1.79
	SDLF	-0.77	-1.15	-1.14	-1.12	-1.26	-1.15	-1.21	-1.88
	TDLF	-0.83	-1.24	-1.24	-1.22	-1.35	-1.23	-1.26	-2.01
5	NLF	-0.45	-0.77	-0.80	-0.79	-0.98	-0.91	-0.98	-1.56
	SDLF	-0.46	-0.82	-0.86	-0.86	-1.04	-0.95	-0.99	-1.61
	TDLF	-0.49	-0.89	-0.95	-0.95	-1.12	-1.01	-1.02	-1.69
6	NLF	-0.20	-0.50	-0.54	-0.56	-0.76	-0.72	-0.83	-1.31
	SDLF	-0.19	-0.54	-0.59	-0.62	-0.82	-0.75	-0.83	-1.33
	TDLF	-0.20	-0.59	-0.67	-0.69	-0.89	-0.81	-0.85	-1.37
7	NLF	-0.01	-0.27	-0.32	-0.36	-0.56	-0.53	-0.66	-1.12
	SDLF	0.02	-0.28	-0.36	-0.40	-0.61	-0.57	-0.67	-1.12
	TDLF	0.03	-0.32	-0.42	-0.47	-0.68	-0.62	-0.69	-1.13
8	NLF	0.12	-0.08	-0.14	-0.19	-0.37	-0.36	-0.49	-0.93
	SDLF	0.16	-0.08	-0.17	-0.23	-0.42	-0.40	-0.51	-0.91
	TDLF	0.18	-0.10	-0.22	-0.29	-0.49	-0.46	-0.53	-0.92
9	NLF	0.20	0.06	-0.01	-0.06	-0.21	-0.22	-0.33	-0.78
	SDLF	0.24	0.07	-0.03	-0.10	-0.26	-0.26	-0.35	-0.76
	TDLF	0.27	0.05	-0.07	-0.15	-0.32	-0.31	-0.38	-0.76
10	NLF	0.22	0.14	0.07	0.02	-0.09	-0.09	-0.19	-0.62
	SDLF	0.27	0.15	0.06	-0.01	-0.13	-0.13	-0.21	-0.61
	TDLF	0.30	0.15	0.02	-0.06	-0.18	-0.18	-0.24	-0.60

Table Q2-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.21	0.16	0.10	0.08	0.01	0.02	-0.06	-0.45
	SDLF	0.25	0.18	0.09	0.06	-0.03	-0.01	-0.09	-0.45
	TDLF	0.28	0.18	0.06	0.02	-0.08	-0.05	-0.12	-0.45
12	NLF	0.17	0.16	0.12	0.11	0.08	0.09	0.04	-0.30
	SDLF	0.20	0.18	0.11	0.09	0.05	0.07	0.01	-0.30
	TDLF	0.22	0.18	0.09	0.06	0.01	0.04	-0.02	-0.31
13	NLF	0.10	0.14	0.10	0.10	0.10	0.11	0.10	-0.16
	SDLF	0.11	0.15	0.10	0.09	0.08	0.09	0.07	-0.17
	TDLF	0.12	0.15	0.08	0.07	0.05	0.07	0.05	-0.18
14	NLF	0.00	0.08	0.06	0.06	0.09	0.10	0.12	-0.04
	SDLF	0.00	0.09	0.06	0.05	0.08	0.08	0.10	-0.05
	TDLF	0.00	0.09	0.05	0.04	0.06	0.07	0.08	-0.07
15	NLF	NA	0.00	0.00	0.00	0.06	0.06	0.10	0.05
	SDLF	NA	0.00	0.00	0.00	0.05	0.05	0.09	0.03
	TDLF	NA	0.00	0.00	0.00	0.04	0.04	0.08	0.02
16	NLF	NA	NA	NA	NA	0.00	0.00	0.06	0.11
	SDLF	NA	NA	NA	NA	0.00	0.00	0.06	0.09
	TDLF	NA	NA	NA	NA	0.00	0.00	0.05	0.08
17	NLF	NA	NA	NA	NA	NA	NA	0.00	0.13
	SDLF	NA	NA	NA	NA	NA	NA	0.00	0.11
	TDLF	NA	NA	NA	NA	NA	NA	0.00	0.10
18	NLF	NA	NA	NA	NA	NA	NA	NA	0.11
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.10
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.09
19	NLF	NA	NA	NA	NA	NA	NA	NA	0.06
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.06
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.05
20	NLF	NA	NA	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.00

Table Q2-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-0.81	-0.97	-0.95	-1.06	-1.12	-1.15	-1.17	-1.22
	SDLF	-0.91	-1.08	-1.07	-1.22	-1.31	-1.36	-1.40	-1.47
	TDLF	-1.02	-1.23	-1.24	-1.43	-1.54	-1.63	-1.68	-1.79
3	NLF	-0.58	-0.78	-0.76	-0.72	-0.83	-0.89	-0.93	-1.14
	SDLF	-0.65	-0.88	-0.87	-0.83	-0.94	-1.00	-1.04	-1.32
	TDLF	-0.75	-1.00	-1.02	-0.99	-1.09	-1.17	-1.19	-1.56
4	NLF	-0.37	-0.59	-0.58	-0.56	-0.65	-0.60	-0.65	-1.01
	SDLF	-0.41	-0.67	-0.67	-0.65	-0.73	-0.66	-0.68	-1.13
	TDLF	-0.49	-0.78	-0.80	-0.78	-0.85	-0.75	-0.75	-1.30
5	NLF	-0.19	-0.39	-0.41	-0.41	-0.52	-0.48	-0.53	-0.88
	SDLF	-0.20	-0.45	-0.48	-0.48	-0.59	-0.53	-0.54	-0.94
	TDLF	-0.24	-0.55	-0.60	-0.60	-0.70	-0.61	-0.58	-1.04
6	NLF	-0.04	-0.23	-0.25	-0.27	-0.39	-0.36	-0.43	-0.73
	SDLF	-0.02	-0.27	-0.31	-0.33	-0.46	-0.41	-0.44	-0.75
	TDLF	-0.04	-0.34	-0.41	-0.43	-0.55	-0.48	-0.47	-0.81
7	NLF	0.07	-0.09	-0.12	-0.14	-0.27	-0.25	-0.33	-0.61
	SDLF	0.11	-0.10	-0.16	-0.20	-0.33	-0.30	-0.34	-0.61
	TDLF	0.12	-0.15	-0.24	-0.29	-0.42	-0.37	-0.38	-0.64
8	NLF	0.14	0.03	-0.01	-0.04	-0.16	-0.15	-0.23	-0.50
	SDLF	0.20	0.03	-0.04	-0.09	-0.21	-0.20	-0.25	-0.48
	TDLF	0.22	0.00	-0.11	-0.17	-0.30	-0.27	-0.29	-0.49
9	NLF	0.18	0.10	0.06	0.03	-0.06	-0.07	-0.14	-0.40
	SDLF	0.24	0.12	0.04	-0.01	-0.12	-0.12	-0.16	-0.39
	TDLF	0.28	0.10	-0.01	-0.08	-0.19	-0.18	-0.20	-0.39
10	NLF	0.19	0.14	0.10	0.07	0.01	0.00	-0.06	-0.31
	SDLF	0.25	0.17	0.09	0.03	-0.04	-0.05	-0.09	-0.29
	TDLF	0.29	0.16	0.05	-0.03	-0.11	-0.10	-0.12	-0.30

Table Q2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.17	0.15	0.11	0.10	0.06	0.06	0.01	-0.21
	SDLF	0.22	0.18	0.11	0.07	0.01	0.02	-0.02	-0.21
	TDLF	0.26	0.17	0.07	0.02	-0.05	-0.02	-0.06	-0.21
12	NLF	0.13	0.14	0.11	0.10	0.09	0.10	0.07	-0.12
	SDLF	0.17	0.17	0.11	0.08	0.06	0.06	0.03	-0.13
	TDLF	0.20	0.17	0.08	0.05	0.01	0.03	0.00	-0.14
13	NLF	0.07	0.11	0.09	0.09	0.10	0.10	0.10	-0.04
	SDLF	0.09	0.13	0.09	0.07	0.07	0.07	0.06	-0.05
	TDLF	0.11	0.13	0.07	0.05	0.03	0.05	0.03	-0.07
14	NLF	0.00	0.07	0.05	0.05	0.08	0.08	0.10	0.03
	SDLF	0.00	0.08	0.05	0.04	0.06	0.06	0.07	0.01
	TDLF	0.00	0.08	0.04	0.03	0.04	0.04	0.05	-0.01
15	NLF	NA	0.00	0.00	0.00	0.05	0.04	0.08	0.08
	SDLF	NA	0.00	0.00	0.00	0.04	0.03	0.06	0.05
	TDLF	NA	0.00	0.00	0.00	0.02	0.02	0.05	0.04
16	NLF	NA	NA	NA	NA	0.00	0.00	0.05	0.10
	SDLF	NA	NA	NA	NA	0.00	0.00	0.04	0.08
	TDLF	NA	NA	NA	NA	0.00	0.00	0.03	0.06
17	NLF	NA	NA	NA	NA	NA	NA	0.00	0.10
	SDLF	NA	NA	NA	NA	NA	NA	0.00	0.08
	TDLF	NA	NA	NA	NA	NA	NA	0.00	0.07
18	NLF	NA	NA	NA	NA	NA	NA	NA	0.08
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.07
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.06
19	NLF	NA	NA	NA	NA	NA	NA	NA	0.05
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.04
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.04
20	NLF	NA	NA	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.00

Table Q2-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	-1.73	-2.04	-2.03	-2.27	-2.42	-2.49	-2.54	-2.64
	SDLF	-1.82	-2.15	-2.15	-2.43	-2.60	-2.69	-2.75	-2.88
	TDLF	-1.93	-2.29	-2.31	-2.64	-2.83	-2.95	-3.03	-3.19
3	NLF	-1.31	-1.69	-1.67	-1.61	-1.83	-1.94	-2.03	-2.46
	SDLF	-1.38	-1.79	-1.78	-1.72	-1.94	-2.05	-2.13	-2.64
	TDLF	-1.47	-1.91	-1.92	-1.87	-2.08	-2.21	-2.28	-2.87
4	NLF	-0.90	-1.33	-1.31	-1.28	-1.46	-1.35	-1.45	-2.19
	SDLF	-0.95	-1.41	-1.40	-1.37	-1.54	-1.41	-1.48	-2.30
	TDLF	-1.02	-1.51	-1.52	-1.50	-1.65	-1.50	-1.54	-2.47
5	NLF	-0.55	-0.94	-0.97	-0.97	-1.20	-1.11	-1.21	-1.91
	SDLF	-0.56	-1.00	-1.05	-1.05	-1.27	-1.16	-1.22	-1.97
	TDLF	-0.60	-1.10	-1.16	-1.16	-1.37	-1.24	-1.25	-2.07
6	NLF	-0.25	-0.62	-0.67	-0.69	-0.93	-0.88	-1.01	-1.61
	SDLF	-0.23	-0.66	-0.73	-0.75	-1.00	-0.92	-1.02	-1.63
	TDLF	-0.24	-0.73	-0.82	-0.85	-1.10	-0.99	-1.05	-1.68
7	NLF	-0.02	-0.33	-0.40	-0.44	-0.68	-0.65	-0.81	-1.37
	SDLF	0.02	-0.35	-0.44	-0.50	-0.75	-0.70	-0.82	-1.37
	TDLF	0.03	-0.40	-0.52	-0.58	-0.83	-0.76	-0.85	-1.39
8	NLF	0.15	-0.10	-0.17	-0.23	-0.45	-0.45	-0.60	-1.14
	SDLF	0.20	-0.10	-0.21	-0.28	-0.51	-0.50	-0.62	-1.12
	TDLF	0.22	-0.13	-0.27	-0.35	-0.59	-0.56	-0.65	-1.12
9	NLF	0.24	0.07	-0.01	-0.07	-0.26	-0.27	-0.41	-0.95
	SDLF	0.30	0.08	-0.03	-0.12	-0.32	-0.32	-0.43	-0.93
	TDLF	0.33	0.07	-0.08	-0.18	-0.39	-0.38	-0.47	-0.93
10	NLF	0.27	0.17	0.08	0.02	-0.11	-0.11	-0.23	-0.75
	SDLF	0.33	0.19	0.07	-0.01	-0.16	-0.16	-0.26	-0.74
	TDLF	0.37	0.18	0.03	-0.07	-0.22	-0.22	-0.30	-0.74

Table Q2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	0.26	0.19	0.12	0.10	0.01	0.03	-0.08	-0.56
	SDLF	0.31	0.22	0.11	0.07	-0.04	-0.02	-0.11	-0.55
	TDLF	0.34	0.22	0.08	0.02	-0.09	-0.06	-0.15	-0.56
12	NLF	0.21	0.20	0.14	0.13	0.10	0.11	0.04	-0.37
	SDLF	0.24	0.22	0.14	0.11	0.06	0.08	0.01	-0.37
	TDLF	0.27	0.22	0.11	0.08	0.01	0.05	-0.02	-0.38
13	NLF	0.12	0.17	0.13	0.12	0.13	0.14	0.12	-0.19
	SDLF	0.14	0.19	0.12	0.11	0.10	0.11	0.09	-0.21
	TDLF	0.15	0.19	0.10	0.08	0.06	0.09	0.06	-0.22
14	NLF	0.00	0.10	0.08	0.07	0.11	0.12	0.15	-0.05
	SDLF	0.00	0.11	0.07	0.07	0.09	0.10	0.12	-0.07
	TDLF	0.00	0.11	0.06	0.05	0.07	0.08	0.10	-0.08
15	NLF	NA	0.00	0.00	0.00	0.07	0.07	0.13	0.07
	SDLF	NA	0.00	0.00	0.00	0.06	0.06	0.11	0.04
	TDLF	NA	0.00	0.00	0.00	0.05	0.05	0.09	0.03
16	NLF	NA	NA	NA	NA	0.00	0.00	0.08	0.13
	SDLF	NA	NA	NA	NA	0.00	0.00	0.07	0.11
	TDLF	NA	NA	NA	NA	0.00	0.00	0.06	0.09
17	NLF	NA	NA	NA	NA	NA	NA	0.00	0.16
	SDLF	NA	NA	NA	NA	NA	NA	0.00	0.13
	TDLF	NA	NA	NA	NA	NA	NA	0.00	0.12
18	NLF	NA	NA	NA	NA	NA	NA	NA	0.13
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.12
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.11
19	NLF	NA	NA	NA	NA	NA	NA	NA	0.08
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.07
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.07
20	NLF	NA	NA	NA	NA	NA	NA	NA	0.00
	SDLF	NA	NA	NA	NA	NA	NA	NA	0.00
	TDLF	NA	NA	NA	NA	NA	NA	NA	0.00

Table Q2-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	322	251	620	510
	SDLF	298	256	599	514
	TDLF	281	259	587	517
G2	NLF	233	235	484	480
	SDLF	240	236	490	479
	TDLF	244	235	492	480
G3	NLF	197	211	429	438
	SDLF	213	214	446	441
	TDLF	223	217	457	442
G4	NLF	156	145	335	305
	SDLF	158	139	338	298
	TDLF	162	134	340	293
G5	NLF	154	128	337	272
	SDLF	156	127	339	271
	TDLF	158	128	340	272
G6	NLF	152	119	332	256
	SDLF	153	116	333	253
	TDLF	155	114	335	251
G7	NLF	161	130	347	280
	SDLF	166	130	352	280
	TDLF	171	130	357	280
G8	NLF	122	114	260	248
	SDLF	117	114	255	248
	TDLF	112	113	249	248
G9	NLF	104	93	223	205
	SDLF	99	94	217	207
	TDLF	94	94	211	207

Table Q2-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	0.1	NA	1.3	NA
	SDLF	-0.2	NA	0.8	NA
	TDLF	-0.7	NA	-0.2	NA
G2	NLF	0.2	NA	1.4	NA
	SDLF	0.0	NA	0.9	NA
	TDLF	-0.4	NA	0.1	NA
G3	NLF	0.1	NA	0.4	NA
	SDLF	0.0	NA	0.2	NA
	TDLF	0.0	NA	0.1	NA
G4	NLF	0.1	NA	0.3	NA
	SDLF	0.0	NA	0.2	NA
	TDLF	0.0	NA	0.1	NA
G5	NLF	0.1	NA	0.1	NA
	SDLF	0.0	NA	0.0	NA
	TDLF	0.0	NA	0.0	NA
G6	NLF	0.0	NA	-0.3	NA
	SDLF	0.0	NA	-0.2	NA
	TDLF	0.0	NA	-0.1	NA
G7	NLF	-0.1	NA	-0.7	NA
	SDLF	0.0	NA	-0.5	NA
	TDLF	0.2	NA	0.0	NA
G8	NLF	-0.2	NA	-1.2	NA
	SDLF	0.1	NA	-0.7	NA
	TDLF	0.4	NA	0.0	NA
G9	NLF	-0.3	NA	-1.6	NA
	SDLF	0.1	NA	-0.9	NA
	TDLF	0.5	NA	0.0	NA

Table Q2-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	-0.2	0.1	-2.7	0.5
	SDLF	-0.1	0.0	-2.0	0.3
	TDLF	0.7	-0.1	-0.2	0.0
G2	NLF	-0.5	0.1	-2.9	0.4
	SDLF	-0.1	0.0	-1.9	0.3
	TDLF	0.7	-0.1	-0.1	0.0
G3	NLF	-0.3	0.1	-1.3	0.4
	SDLF	0.0	0.0	-0.7	0.3
	TDLF	0.3	-0.1	0.0	0.0
G4	NLF	-0.3	0.1	-1.3	0.4
	SDLF	0.0	0.0	-0.8	0.3
	TDLF	0.3	-0.1	-0.2	0.0
G5	NLF	-0.2	0.1	-0.8	0.4
	SDLF	0.0	0.0	-0.4	0.3
	TDLF	0.1	-0.1	-0.1	0.0
G6	NLF	-0.1	0.1	-0.1	0.4
	SDLF	0.0	0.0	0.1	0.2
	TDLF	-0.1	-0.1	-0.1	0.0
G7	NLF	0.1	0.0	0.9	0.4
	SDLF	0.0	0.0	0.6	0.2
	TDLF	-0.3	-0.1	-0.1	0.0
G8	NLF	0.4	0.0	2.2	0.3
	SDLF	0.1	0.0	1.4	0.2
	TDLF	-0.5	-0.1	0.1	0.0
G9	NLF	0.6	0.0	3.4	0.3
	SDLF	0.1	0.0	2.1	0.2
	TDLF	-0.6	-0.1	0.4	0.0

Table Q2-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	0.01	0.96	0.27	2.18
	SDLF	-0.04	0.84	0.16	1.99
	TDLF	-0.13	0.70	-0.05	1.74
G2	NLF	0.05	0.94	0.28	2.13
	SDLF	0.00	0.81	0.17	1.93
	TDLF	-0.07	0.69	0.02	1.71
G3	NLF	0.02	0.90	0.08	1.91
	SDLF	0.01	0.80	0.04	1.77
	TDLF	0.00	0.73	0.02	1.68
G4	NLF	0.02	0.92	0.07	1.98
	SDLF	0.01	0.81	0.04	1.84
	TDLF	-0.01	0.73	0.02	1.73
G5	NLF	0.01	0.92	0.02	1.97
	SDLF	0.00	0.81	0.00	1.82
	TDLF	0.00	0.73	0.00	1.74
G6	NLF	0.00	0.91	-0.06	1.93
	SDLF	0.00	0.80	-0.05	1.79
	TDLF	0.01	0.74	-0.01	1.74
G7	NLF	-0.02	0.89	-0.14	1.85
	SDLF	0.00	0.79	-0.09	1.74
	TDLF	0.04	0.75	-0.01	1.73
G8	NLF	-0.04	0.87	-0.24	1.74
	SDLF	0.01	0.78	-0.13	1.67
	TDLF	0.08	0.75	0.01	1.71
G9	NLF	-0.06	0.85	-0.32	1.65
	SDLF	0.02	0.77	-0.17	1.60
	TDLF	0.10	0.75	0.01	1.68

Table Q2-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.04	0.02	-0.54	0.09
	SDLF	-0.02	0.00	-0.41	0.06
	TDLF	0.13	-0.03	-0.03	0.00
G2	NLF	-0.09	0.02	-0.58	0.09
	SDLF	-0.01	0.00	-0.38	0.06
	TDLF	0.15	-0.02	-0.03	0.00
G3	NLF	-0.06	0.01	-0.25	0.08
	SDLF	-0.01	0.00	-0.15	0.05
	TDLF	0.06	-0.02	-0.01	0.00
G4	NLF	-0.05	0.01	-0.25	0.08
	SDLF	-0.01	0.00	-0.16	0.05
	TDLF	0.05	-0.02	-0.03	0.00
G5	NLF	-0.04	0.01	-0.16	0.08
	SDLF	0.00	0.00	-0.08	0.05
	TDLF	0.02	-0.02	-0.02	0.01
G6	NLF	-0.02	0.01	-0.02	0.08
	SDLF	0.00	0.00	0.01	0.05
	TDLF	-0.02	-0.02	-0.01	0.01
G7	NLF	0.02	0.01	0.17	0.07
	SDLF	0.00	0.00	0.12	0.05
	TDLF	-0.07	-0.02	-0.01	0.00
G8	NLF	0.08	0.01	0.43	0.07
	SDLF	0.01	0.00	0.27	0.05
	TDLF	-0.10	-0.01	0.03	0.00
G9	NLF	0.13	0.01	0.68	0.07
	SDLF	0.02	0.00	0.42	0.04
	TDLF	-0.12	-0.01	0.09	0.00

Appendix Q2-5. NISCS38 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISCS38 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table Q2-5-1. Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	-0.5	-0.5	0.7	-1.1	0.1	1.1
		SDLF	2.8	5.3	6.0	2.2	-3.3	3.9
		TDLF	3.7	6.7	7.7	3.2	-4.1	5.1
	2-3	NLF	0.6	1.1	1.3	0.6	-1.1	1.3
		SDLF	-0.6	0.0	0.6	-1.0	-0.2	1.1
		TDLF	-0.9	-0.6	1.1	-1.9	0.4	1.9
	2-4	NLF	-0.2	0.4	0.5	0.1	-0.4	0.4
		SDLF	0.5	2.9	2.9	-0.1	-2.4	2.4
		TDLF	1.9	3.8	4.2	-0.2	-3.0	3.0
	2-5	NLF	0.9	-0.2	0.9	-1.9	0.3	1.9
		SDLF	0.6	0.2	0.6	-0.9	-0.3	0.9
		TDLF	1.8	0.5	1.9	-1.0	-0.7	1.2

Table Q2-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
11	11-2	NLF	-0.3	0.2	0.3	-0.3	-0.1	0.3
		SDLF	0.0	-0.4	0.4	-1.2	0.4	1.3
		TDLF	0.0	-1.2	1.2	-2.5	1.1	2.7
	11-3	NLF	1.2	1.2	1.7	-0.4	-1.2	1.3
		SDLF	2.2	0.2	2.2	-1.8	-0.2	1.8
		TDLF	1.5	-1.3	2.0	-4.0	1.4	4.3
	11-4	NLF	0.7	1.3	1.4	1.3	-1.3	1.8
		SDLF	0.6	-0.1	0.6	-0.5	0.0	0.5
		TDLF	-0.7	-2.0	2.1	-3.4	2.0	3.9
	11-5	NLF	0.6	0.4	0.7	0.6	-0.3	0.7
		SDLF	0.2	-0.6	0.6	-1.2	0.7	1.3
		TDLF	-1.3	-2.4	2.7	-4.2	2.5	4.9
	11-6	NLF	0.4	0.0	0.4	0.4	0.0	0.4
		SDLF	-0.3	-1.0	1.0	-1.6	1.0	1.9
		TDLF	-1.5	-2.7	3.1	-4.5	2.7	5.2

Table Q2-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
18	18-2	NLF	-1.3	-0.1	1.4	-3.3	0.3	3.3
		SDLF	8.0	0.0	8.0	6.3	-0.3	6.3
		TDLF	17.2	0.1	17.2	15.0	-0.8	15.1
	18-3	NLF	-12.7	1.0	12.7	-13.8	-1.0	13.8
		SDLF	-0.9	-2.2	2.3	-2.5	2.1	3.3
		TDLF	0.6	-6.0	6.0	0.1	6.1	6.1
	18-4	NLF	-12.3	2.8	12.6	-12.4	-2.8	12.7
		SDLF	-1.0	-3.5	3.6	-1.2	3.6	3.8
		TDLF	-1.1	-9.9	10.0	-1.6	10.4	10.6
	18-5	NLF	-11.0	2.3	11.2	-11.1	-2.3	11.4
		SDLF	-0.1	-5.9	5.9	-0.5	5.9	6.0
		TDLF	-1.2	-14.0	14.0	-2.1	14.0	14.2
	18-6	NLF	-10.5	0.5	10.5	-10.6	-0.6	10.7
		SDLF	-1.0	-8.1	8.1	-1.4	7.7	7.9
		TDLF	-3.4	-15.8	16.1	-4.3	15.1	15.7
	18-7	NLF	-9.9	-1.1	9.9	-7.1	1.0	7.1
		SDLF	-9.1	-7.4	11.8	-7.2	7.2	10.2
		TDLF	-17.2	-12.2	21.1	-14.0	11.9	18.4
	18-8	NLF	-1.2	-1.1	1.6	-1.2	1.0	1.6
		SDLF	-5.1	-4.7	6.9	-5.5	4.6	7.2
		TDLF	-7.5	-7.3	10.5	-8.6	7.2	11.2

Table Q2-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
27	27-2	NLF	0.3	-0.1	0.3	-1.4	0.1	1.4
		SDLF	-3.0	-0.1	3.0	1.8	0.1	1.8
		TDLF	-6.6	0.3	6.7	6.0	-0.3	6.0
	27-3	NLF	-12.9	1.2	13.0	-12.8	-1.2	12.9
		SDLF	-11.7	2.2	11.9	-11.9	-1.9	12.0
		TDLF	-5.2	3.4	6.2	-5.8	-2.8	6.4
	27-4	NLF	-12.8	2.5	13.0	-12.8	-2.4	13.0
		SDLF	-11.5	3.5	12.1	-11.7	-3.4	12.2
		TDLF	-5.2	3.9	6.5	-5.5	-3.8	6.6
	27-5	NLF	-11.3	2.0	11.4	-11.3	-1.9	11.4
		SDLF	-10.0	2.9	10.4	-10.0	-2.7	10.4
		TDLF	-4.4	2.7	5.2	-4.6	-2.3	5.1
	27-6	NLF	-11.1	0.0	11.1	-11.1	0.1	11.1
		SDLF	-9.4	0.8	9.4	-9.4	-0.6	9.4
		TDLF	-3.9	0.2	3.9	-4.0	0.2	4.0
	27-7	NLF	-11.3	-1.5	11.4	-11.3	1.6	11.4
		SDLF	-8.5	-1.1	8.6	-8.5	1.2	8.6
		TDLF	-2.3	-2.0	3.0	-2.3	2.3	3.2
	27-8	NLF	-10.7	-1.7	10.8	-9.7	1.7	9.8
		SDLF	-7.0	-1.6	7.2	-6.1	1.7	6.3
		TDLF	-0.1	-2.7	2.7	0.5	2.9	2.9
	27-9	NLF	-4.8	-0.2	4.8	-4.8	0.5	4.8
		SDLF	-1.3	-0.3	1.4	-1.2	0.6	1.3
		TDLF	3.7	-1.5	4.0	3.9	2.0	4.4

Table Q2-5-2: Erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
2	NLF	2-5
	SDLF	2-2
	TDLF	2-2
11	NLF	11-4
	SDLF	11-6
	TDLF	11-6
18	NLF	18-3
	SDLF	18-7
	TDLF	18-6
27	NLF	27-4
	SDLF	27-4
	TDLF	27-4

Table Q2-5-3. Erection critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	-0.5	0.0	0.5	NA	NA	NA
		SDLF	-2.3	-0.6	2.4	NA	NA	NA
		TDLF	-2.5	-0.8	2.6	NA	NA	NA
	B	NLF	0.9	-0.2	0.9	-1.9	0.3	1.9
		SDLF	2.8	5.3	6.0	2.2	-3.3	3.9
		TDLF	3.7	6.7	7.7	3.2	-4.1	5.1
11	A	NLF	0.8	0.8	1.1	NA	NA	NA
		SDLF	-0.9	-0.6	1.1	NA	NA	NA
		TDLF	-3.2	-1.6	3.6	NA	NA	NA
	B	NLF	0.7	1.3	1.4	1.3	-1.3	1.8
		SDLF	-0.3	-1.0	1.0	-1.6	1.0	1.9
		TDLF	-1.5	-2.7	3.1	-4.5	2.7	5.2
18	A	NLF	-18.8	0.6	18.8	NA	NA	NA
		SDLF	-10.9	-4.9	12.0	NA	NA	NA
		TDLF	-3.3	-11.3	11.8	NA	NA	NA
	B	NLF	-12.7	1.0	12.7	-13.8	-1.0	13.8
		SDLF	-9.1	-7.4	11.8	-7.2	7.2	10.2
		TDLF	-3.4	-15.8	16.1	-4.3	15.1	15.7
27	A	NLF	-20.0	1.6	20.1	NA	NA	NA
		SDLF	-18.3	2.2	18.5	NA	NA	NA
		TDLF	-8.7	2.5	9.1	NA	NA	NA
	B	NLF	-12.8	2.5	13.0	-12.8	-2.4	13.0
		SDLF	-11.5	3.5	12.1	-11.7	-3.4	12.2
		TDLF	-5.2	3.9	6.5	-5.5	-3.8	6.6

Table Q2-5-6. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	20.7	27.9	47.5		
			SDLF	0.0	86.5	3.5		
			TDLF	0.0	85.9	3.8		
		G2	NLF	16.1	28.4	56.8	28.4	36.4
			SDLF	0.9	53.5	107.1	53.6	3.4
			TDLF	0.1	54.8	109.8	54.9	1.9
	B	G1	NLF	20.7	27.9	47.8		
			SDLF	0.0	85.4	4.5		
			TDLF	0.0	83.5	5.8		
		G2	NLF	16.3	28.1	56.2	28.1	37.1
			SDLF	0.0	55.6	111.3	55.7	0.5
			TDLF	0.0	56.1	112.3	56.2	0.0

Table Q2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
11	A	G1	NLF	29.1	89.6	58.9	39.5	0.0	0.0
			SDLF	0.0	165.3	21.9	54.6	0.0	0.0
			TDLF	0.0	242.9	9.3	49.3	0.0	0.0
		G2	NLF	32.6	83.7	42.3	84.7	42.4	18.7
			SDLF	15.9	55.7	17.1	34.2	17.1	45.1
			TDLF	0.0	22.2	8.3	16.6	8.3	45.7
		G3	NLF	37.8	95.4				
			SDLF	33.1	167.9				
			TDLF	0.0	176.5				
		G4	NLF	35.4	31.0				
			SDLF	31.7	0.0				
			TDLF	35.1	0.0				
		G5	NLF	35.3	77.1				
			SDLF	29.5	82.7				
			TDLF	24.3	84.9				
		G6	NLF	32.4	63.7				
			SDLF	23.3	77.6				
			TDLF	19.0	113.4				
		G7	NLF	32.9	63.0				
			SDLF	22.7	38.7				
			TDLF	26.0	37.8				
		G8	NLF	44.8	86.8				
			SDLF	50.4	177.5				
			TDLF	45.8	177.5				
		G9	NLF	41.2	49.7				
			SDLF	38.3	0.0				
			TDLF	40.0	0.0				

Table Q2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
11	B	G1	NLF	29.1	89.6	59.7	39.2		
			SDLF	0.0	165.5	22.3	54.4		
			TDLF	0.0	243.0	9.8	49.1		
		G2	NLF	32.6	84.0	41.3	82.7	41.4	20.6
			SDLF	15.8	55.7	17.6	35.2	17.6	44.4
			TDLF	0.0	22.2	9.3	18.6	9.3	44.3
		G3	NLF	37.8	95.5				
			SDLF	33.1	167.9				
			TDLF	0.0	176.4				
		G4	NLF	35.4	31.0				
			SDLF	31.7	0.0				
			TDLF	35.0	0.0				
		G5	NLF	35.3	77.1				
			SDLF	29.5	82.8				
			TDLF	24.3	85.0				
		G6	NLF	32.4	63.7				
			SDLF	23.3	77.6				
			TDLF	19.0	113.4				
		G7	NLF	32.9	63.0				
			SDLF	22.7	38.7				
			TDLF	26.0	37.8				
		G8	NLF	44.8	86.8				
			SDLF	50.4	177.5				
			TDLF	45.8	177.5				
		G9	NLF	41.2	49.7				
			SDLF	38.3	0.0				
			TDLF	40.0	0.0				

Table Q2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
18	A	G1	NLF	19.4	100.1	94.9			
			SDLF	0.0	159.3	131.0			
			TDLF	0.0	167.9	191.9			
		G2	NLF	25.7	142.0	89.0			
			SDLF	0.0	88.5	45.6			
			TDLF	0.0	97.2	0.0			
		G3	NLF	28.1	99.5	40.1			
			SDLF	0.0	129.1	16.8			
			TDLF	0.0	0.0	0.0			
		G4	NLF	27.6	140.2	114.4			
			SDLF	0.0	170.1	69.2			
			TDLF	0.0	242.0	42.2			
		G5	NLF	27.3	134.6	21.7			
			SDLF	0.0	244.4	3.2			
			TDLF	0.0	312.6	0.0			
		G6	NLF	24.4	102.7	128.1			
			SDLF	0.0	146.9	132.8			
			TDLF	0.0	148.8	175.8			
		G7	NLF	21.1	118.5	11.2			
			SDLF	0.0	145.6	23.0			
			TDLF	0.0	168.9	0.0			
		G8	NLF	34.4	124.3	90.6			
			SDLF	0.0	187.3	87.5			
			TDLF	0.0	107.9	83.4			
		G9	NLF	35.8	79.6	51.2	102.4	51.2	31.7
			SDLF	11.1	141.8	34.2	68.5	34.3	13.3
			TDLF	0.0	190.8	42.0	84.1	42.1	0.0

Table Q2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
18	B	G1	NLF	19.4	100.2	95.0			
			SDLF	0.0	159.3	130.9			
			TDLF	0.0	167.7	192.0			
		G2	NLF	25.7	142.3	89.0			
			SDLF	0.0	88.5	45.5			
			TDLF	0.0	97.7	0.0			
		G3	NLF	28.1	100.0	40.0			
			SDLF	0.0	129.3	16.8			
			TDLF	0.0	0.0	0.0			
		G4	NLF	27.6	141.0	114.4			
			SDLF	0.0	170.1	69.1			
			TDLF	0.0	242.7	42.6			
		G5	NLF	27.3	134.4	21.6			
			SDLF	0.0	244.4	3.3			
			TDLF	0.0	312.6	0.0			
		G6	NLF	24.5	101.9	127.6			
			SDLF	0.0	146.9	132.6			
			TDLF	0.0	148.4	177.5			
		G7	NLF	21.4	117.3	12.8			
			SDLF	0.0	145.2	23.3			
			TDLF	0.0	169.1	0.0			
		G8	NLF	34.5	123.9	84.3			
			SDLF	0.0	185.7	86.7			
			TDLF	0.0	105.8	70.2			
		G9	NLF	35.8	80.1	50.5	101.1	50.6	38.8
			SDLF	10.6	140.3	41.7	83.4	41.7	3.7
			TDLF	0.0	186.4	50.7	101.5	50.8	0.0

Table Q2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
27	A	G1	NLF	25.4	94.1	123.1	44.0			
			SDLF	0.0	164.2	213.7	56.5			
			TDLF	0.0	174.7	326.4	59.1			
		G2	NLF	30.5	119.1	138.3	48.3			
			SDLF	0.0	71.6	65.9	51.9			
			TDLF	0.0	76.4	4.9	46.5			
		G3	NLF	32.3	97.9	171.2	52.0			
			SDLF	3.0	138.4	77.2	54.2			
			TDLF	0.0	0.0	0.0	49.2			
		G4	NLF	31.1	112.5	119.2	43.4			
			SDLF	3.8	142.6	48.8	38.6			
			TDLF	0.0	206.7	29.7	30.8			
		G5	NLF	31.2	126.9	151.3	44.8			
			SDLF	0.0	240.1	125.1	47.0			
			TDLF	0.0	304.8	114.8	46.7			
		G6	NLF	28.9	93.1	131.1	45.5			
			SDLF	0.0	139.3	132.4	46.7			
			TDLF	0.0	141.8	196.2	44.7			
		G7	NLF	28.1	105.8	171.9	47.5			
			SDLF	0.0	147.8	206.5	52.7			
			TDLF	0.0	181.5	235.4	55.4			
		G8	NLF	34.1	113.7	111.1	29.1			
			SDLF	0.0	209.8	143.0	33.7			
			TDLF	0.0	109.7	189.7	40.7			
		G9	NLF	33.9	126.7	112.4	76.5	153.3	76.8	15.3
			SDLF	10.5	149.8	41.6	71.8	143.8	72.0	17.8
			TDLF	0.0	202.8	28.8	48.2	96.6	48.4	23.7

Table Q2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
27	B	G1	NLF	25.4	94.0	123.2	44.1			
			SDLF	0.0	164.1	213.8	56.6			
			TDLF	0.0	174.7	326.5	59.1			
		G2	NLF	30.5	119.0	138.6	48.4			
			SDLF	0.0	71.5	66.2	52.0			
			TDLF	0.0	76.4	5.3	46.6			
		G3	NLF	32.3	97.9	171.8	52.1			
			SDLF	3.0	138.4	77.8	54.4			
			TDLF	0.0	0.0	0.0	49.3			
		G4	NLF	31.1	112.6	119.5	43.5			
			SDLF	3.8	142.7	49.1	38.7			
			TDLF	0.0	206.7	30.0	30.9			
		G5	NLF	31.2	127.1	150.9	44.7			
			SDLF	0.0	240.2	124.8	46.9			
			TDLF	0.0	304.9	114.7	46.7			
		G6	NLF	28.8	93.2	130.8	45.1			
			SDLF	0.0	139.4	132.2	46.3			
			TDLF	0.0	141.8	196.0	44.5			
		G7	NLF	28.0	105.8	169.7	46.3			
			SDLF	0.0	147.8	204.4	51.6			
			TDLF	0.0	181.5	234.3	54.8			
		G8	NLF	34.1	113.7	110.7	28.6			
			SDLF	0.0	209.7	142.8	33.2			
			TDLF	0.0	109.6	189.9	40.4			
		G9	NLF	33.9	126.8	112.8	77.6	155.5	77.9	16.5
			SDLF	10.4	149.9	42.5	72.2	144.7	72.5	19.6
			TDLF	0.0	202.8	30.0	47.5	95.1	47.7	25.9

Appendix R1-1. NISCS39 Bridge Description

The key characteristics of NISCS39 are as follows:

- Span length along the centerline of the bridge, L_s = 300 ft.
- Width between the fascia girders, w_g = 74 ft.
- Radius of curvature to the centerline of the bridge, R =730 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 4.1
- Subtended angle between the supports, L_s/R = 0.41
- Number of girders in the completed bridge cross-section, n_g =9.
- Skew angle, θ = -35,0^o

This appendix presents the bridge description of the bridge NISCS39 in its final condition as well as during erection. The following figures and tables are provided:

Figure R1-1-1. Framing plan

Figure R1-1-2. Bridge cross-section

Figure R1-1-3. Girder Elevation

Figure R1-1-4. Cross-section dimension

Figure R1-1-5. Cross-frame details

Figure R1-1-6. Counterweight details

Figure R1-1-7. Erection scheme

Table R1-1-1. Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed NLF

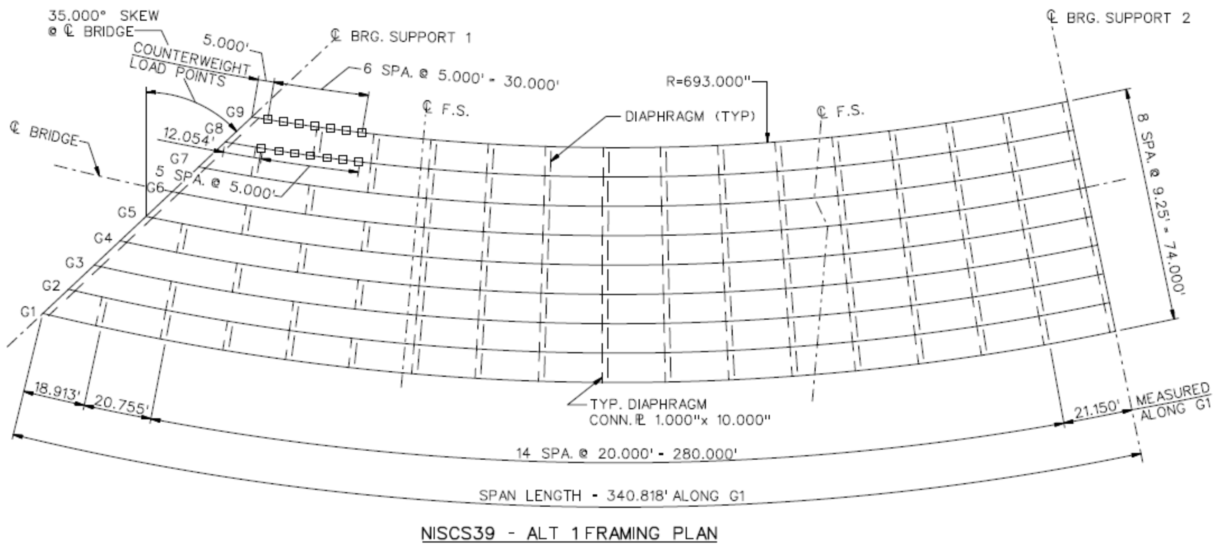


Figure R1-1-1. Framing plan.

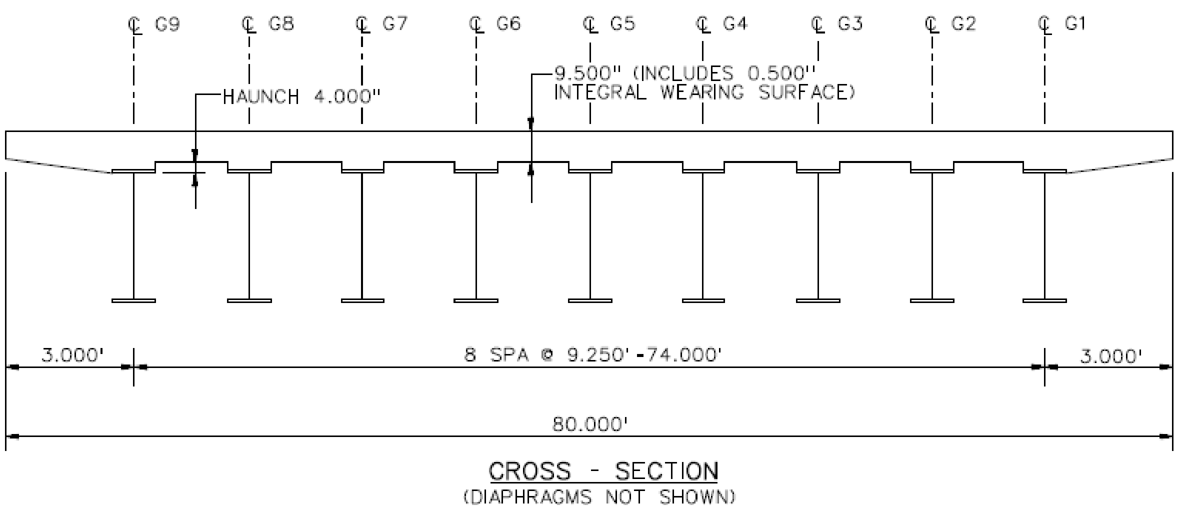


Figure R1-1-2. Bridge cross-section.

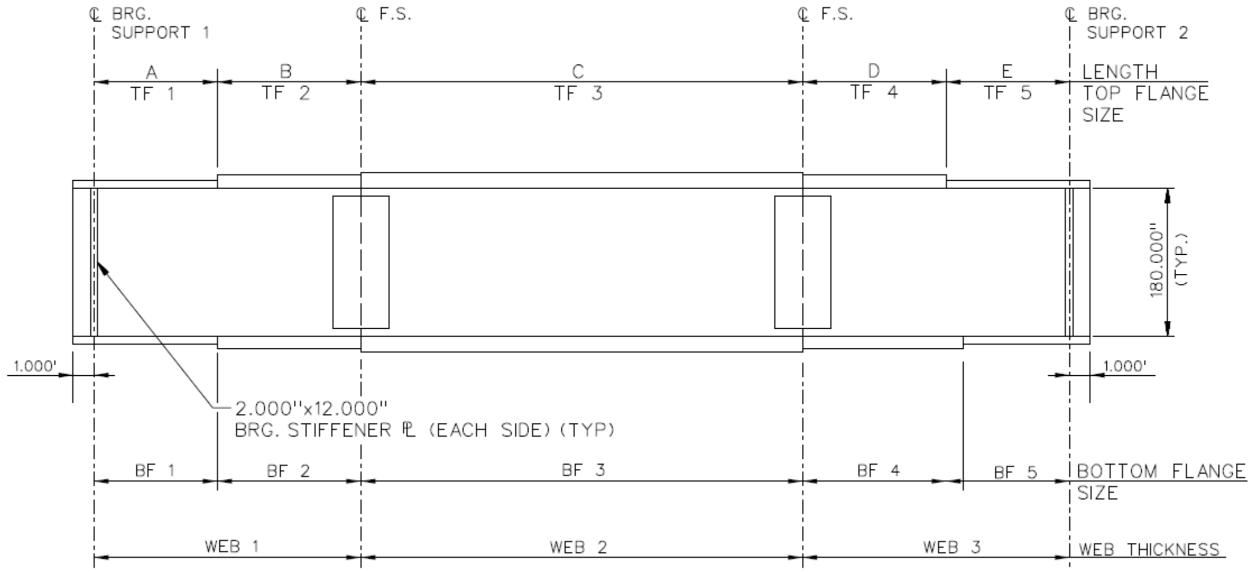


Figure R1-1-3. Girder elevations

	GIRDER PLATE LENGTHS ⁎								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	115.000	107.570	100.108	92.610	85.075	77.499	69.881	62.216	54.501
B	35.001	35.362	35.724	36.086	36.448	36.810	34.671	35.033	35.395
C	59.999	59.276	58.552	57.828	57.105	56.381	55.658	54.934	54.210
D	35.001	35.362	35.724	36.086	36.448	36.810	34.671	35.033	35.395
E	95.818	93.095	90.371	87.648	84.925	82.202	84.478	81.755	79.032

⁎ ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS ⁎⁎					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	44.000	2.500	36.000	1.750	30.000	1.500
TF2	44.000	3.000	36.000	1.750	30.000	1.500
TF3	44.000	3.000	36.000	2.000	30.000	1.500
TF4	44.000	3.000	36.000	1.750	30.000	1.500
TF5	44.000	2.500	36.000	1.750	30.000	1.500

⁎⁎ ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS ⁎⁎					
BOTTOM FLANGE	G1		G2		G3	
	BF	TF	BF	TF	BF	TF
BF1	46.000	2.500	38.000	1.750	32.000	1.500
BF2	46.000	3.500	38.000	2.500	32.000	1.500
BF3	46.000	3.500	38.000	2.500	32.000	1.500
BF4	46.000	3.500	38.000	2.500	32.000	1.500
BF5	46.000	2.500	38.000	1.750	32.000	1.500

⁎⁎ ALL DIMENSIONS ARE IN INCHES.

Figure R1-1-4. Cross-section dimensions.

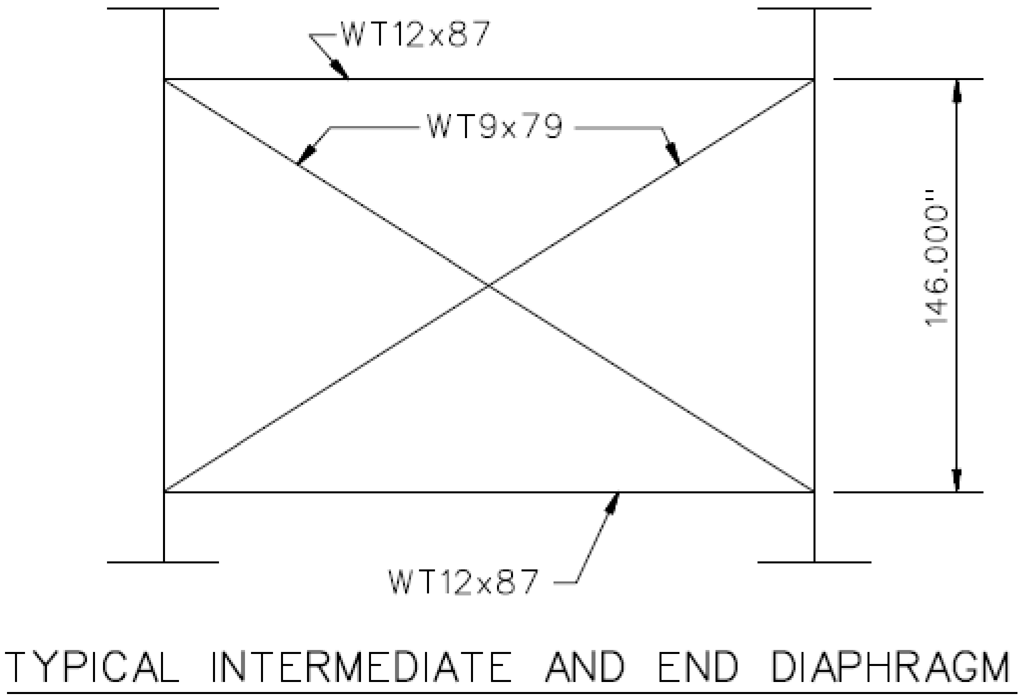


Figure R1-1-5. Cross-frame details

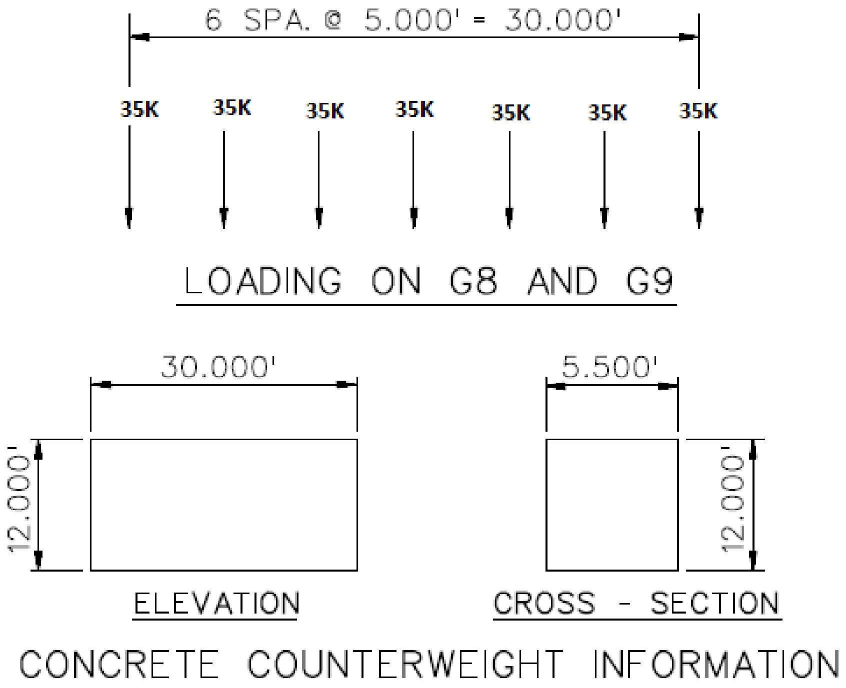
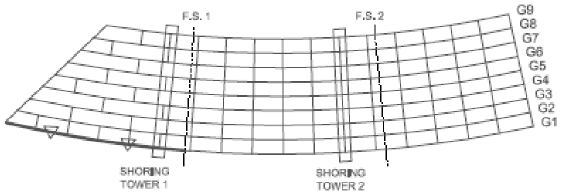
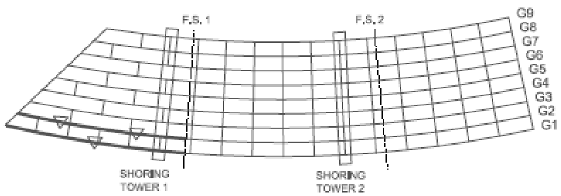


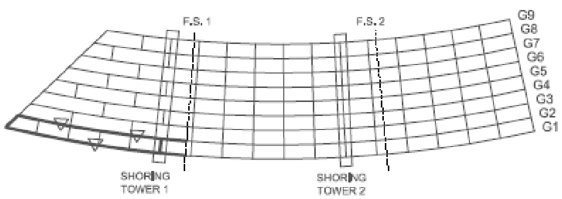
Figure R1-1-6. Counterweight details



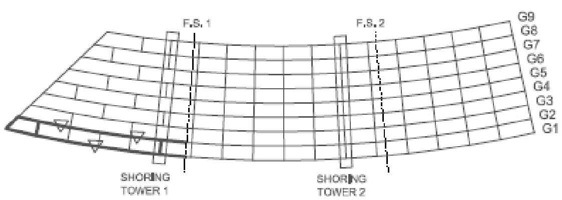
STAGE 1



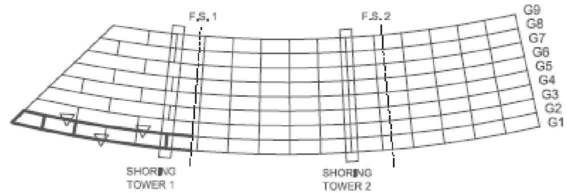
STAGE 2-1



STAGE 2-2



STAGE 2-3



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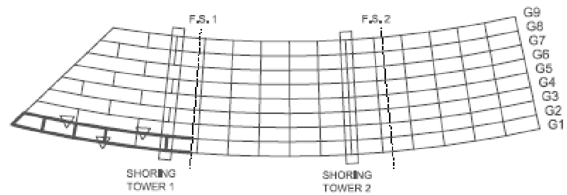

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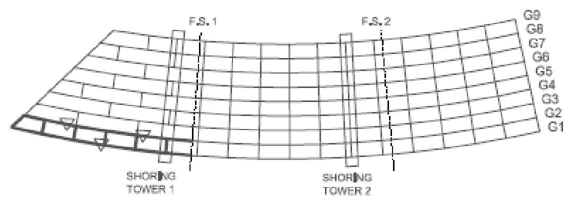
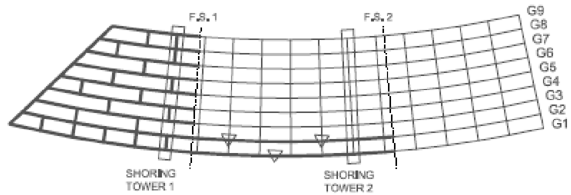


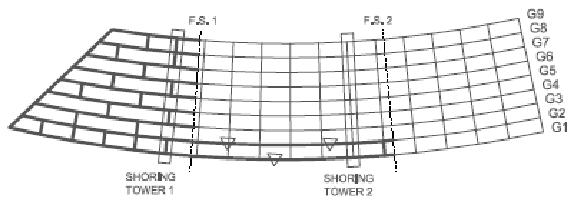
STAGE 2-6

REPEAT THE SEQUENCE FOR G3 TO G9 FOR THE FIRST FIELD SEGMENT ACROSS THE BRIDGE WIDTH. THE SHORING TOWERS REMAIN IN PLACE UNTIL THE WHOLE BRIDGE IS ERECTED. THE HOLDING CRANE IS ON G1 UNTIL THE FIELD SEGMENTS OF G1-G3 ARE ERECTED

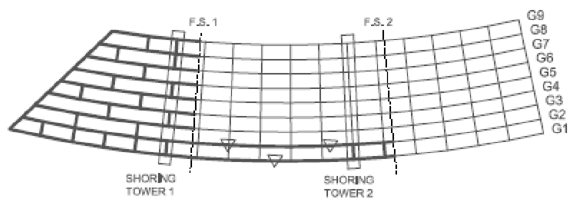
Figure R1-1-7. Erection scheme.



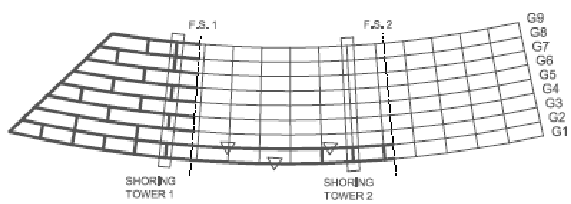
STAGE 11-1



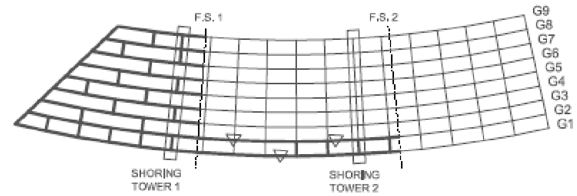
STAGE 11-2



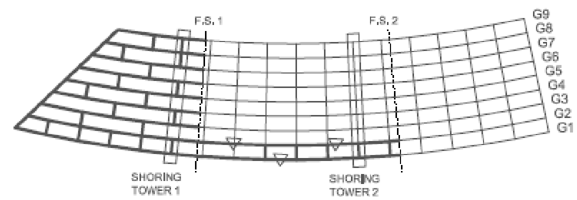
STAGE 11-3



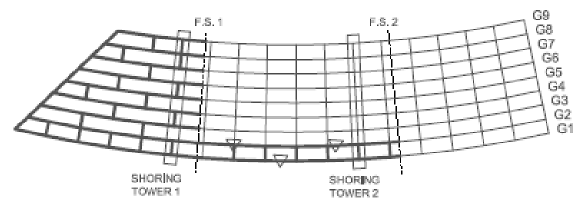
STAGE 11-4



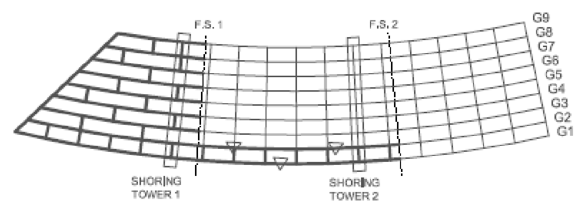
STAGE 11-5



STAGE 11-6



STAGE 11-7

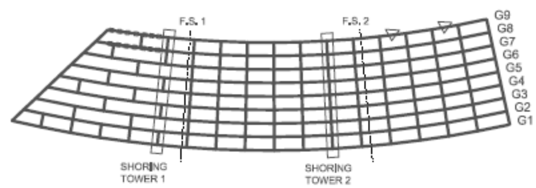


STAGE 11-8

Figure R1-1-7(Continued). Erection scheme.

REPEAT THE SEQUENCE FOR G3 TO G9 FOR THE SECOND FIELD SEGMENT ACROSS THE BRIDGE WIDTH. THE SHORING TOWERS REMAIN IN PLACE UNTIL THE WHOLE BRIDGE IS ERECTED. THE HOLDING CRANE IS ON G1 UNTIL THE FIELD SEGMENTS OF G1-G3 ARE ERECTED. COUNTERWEIGHTS ARE INSTALLED DURING STAGES 17 & 18 ON G8 AND G9.

REPEAT THE SEQUENCE FOR THE THIRD FIELD SEGMENT ACROSS THE BRIDGE WIDTH



STAGE 27-6

Figure R1-1-7(Continued). Erection scheme.

Table R1-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

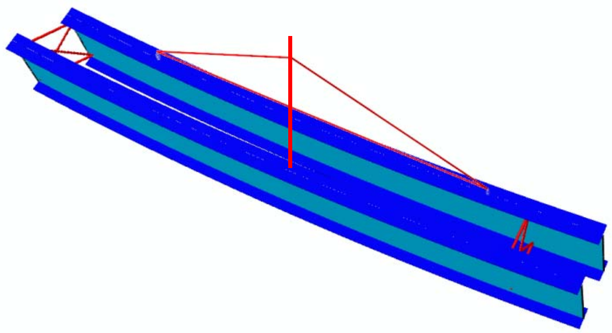
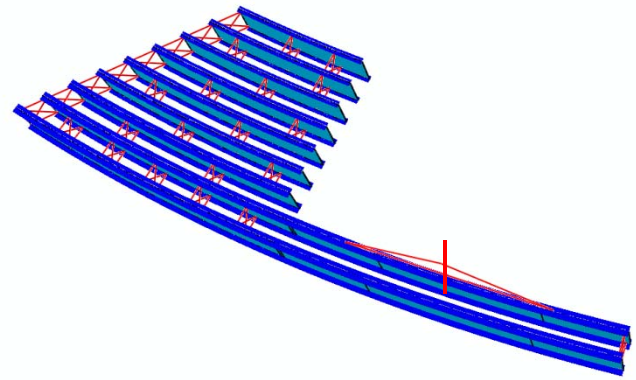
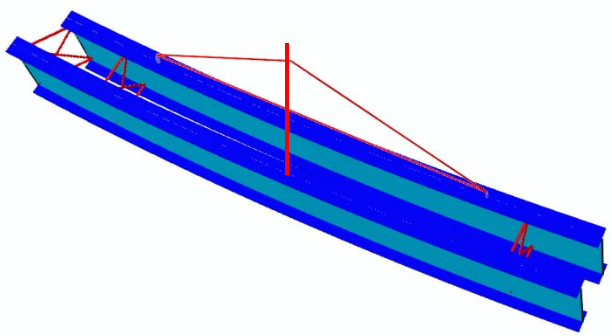
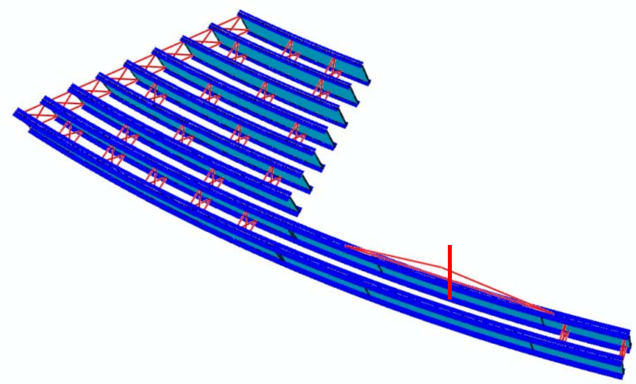
Sub-Stage	Stage	
	2	11
1		
2		

Table R1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

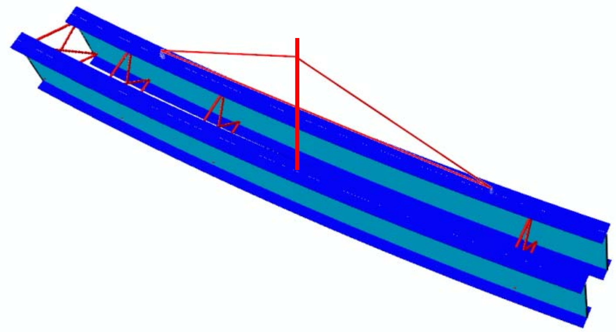
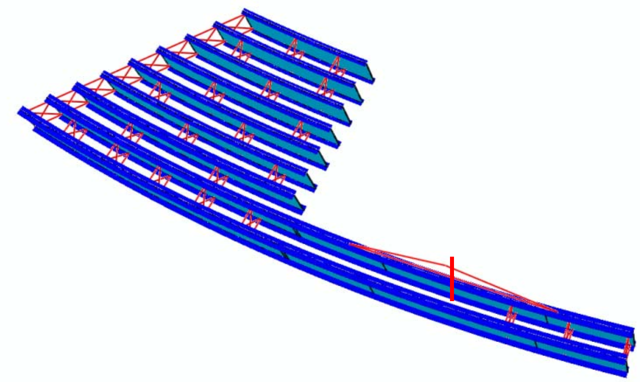
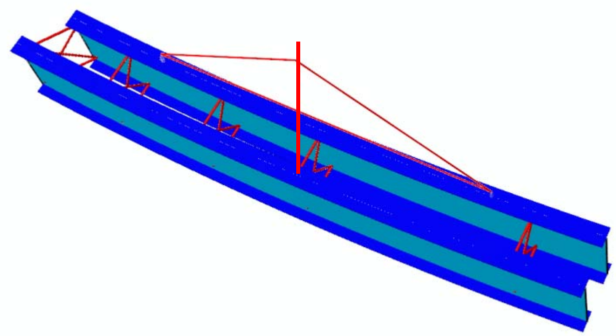
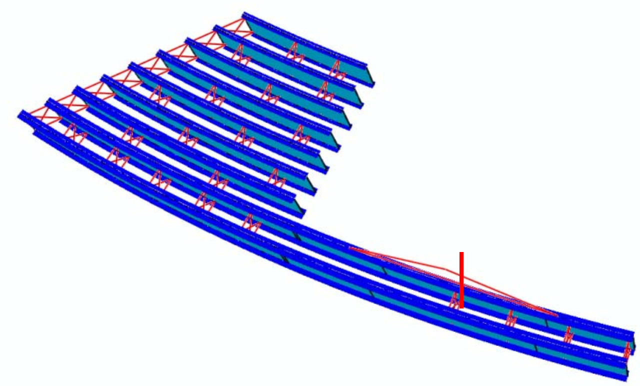
3		
4		

Table R1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

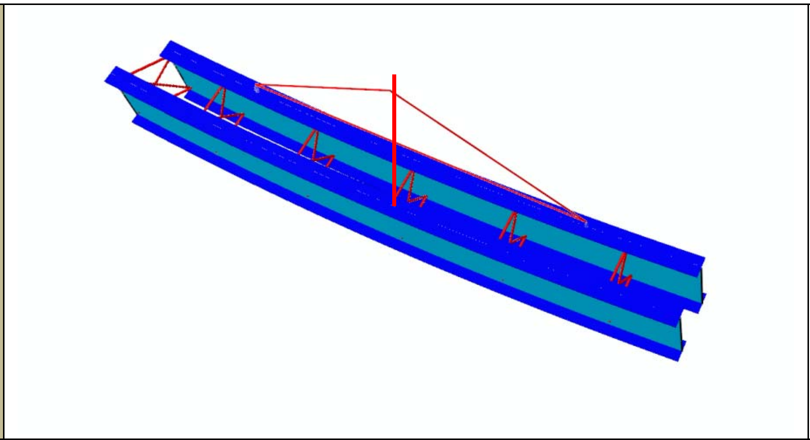
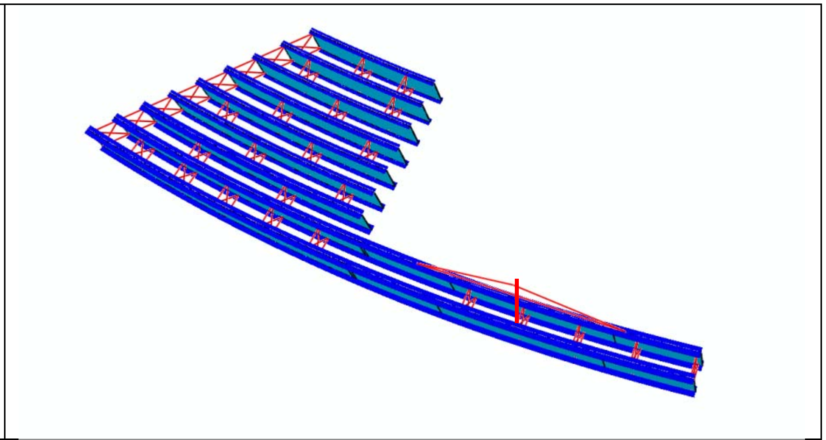
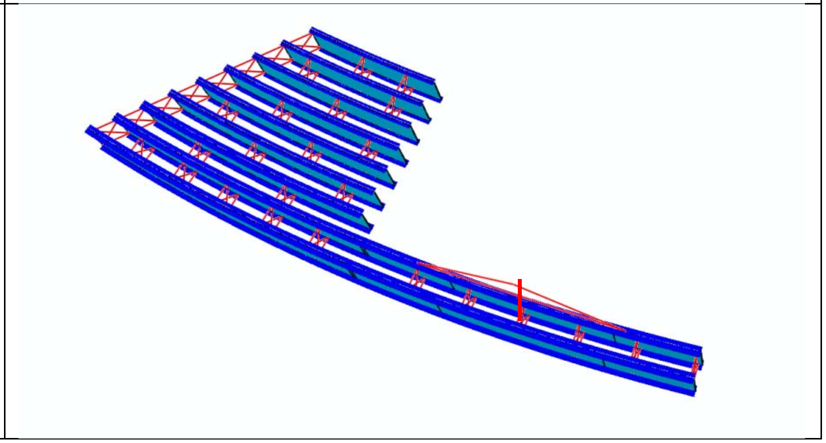
5		
6		

Table R1-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

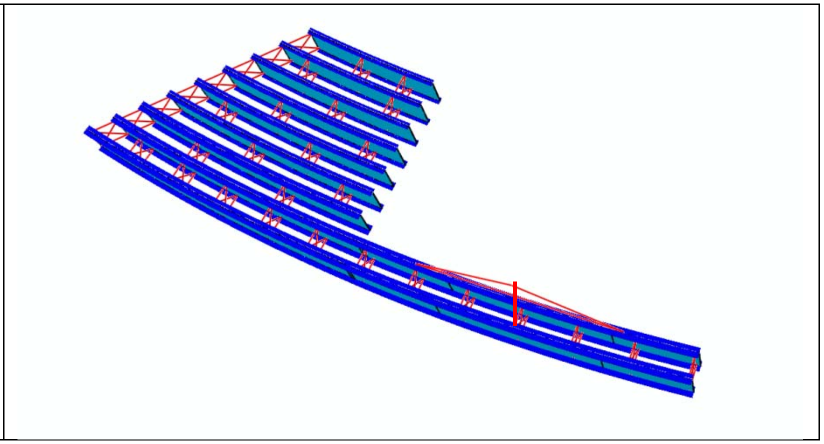
7		

Table R1-1-1 (continued).. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

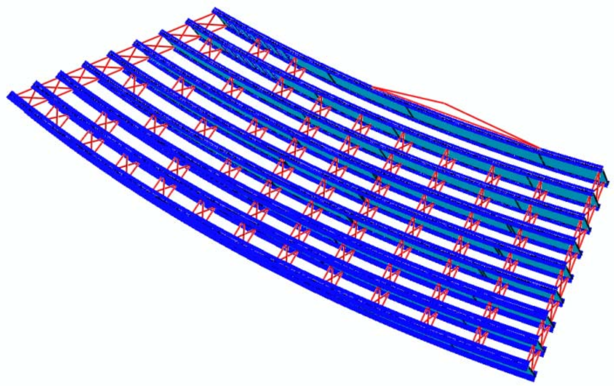
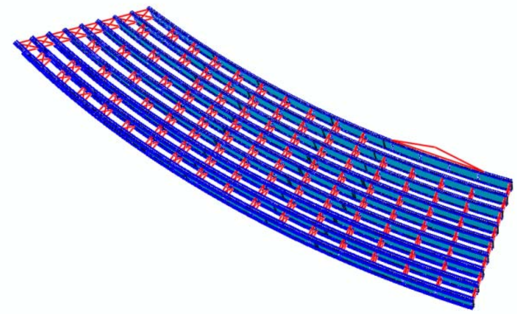
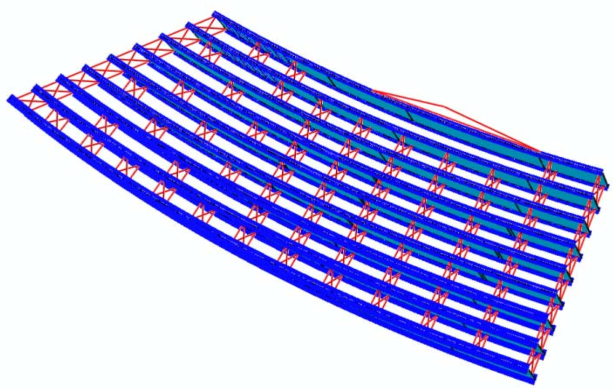
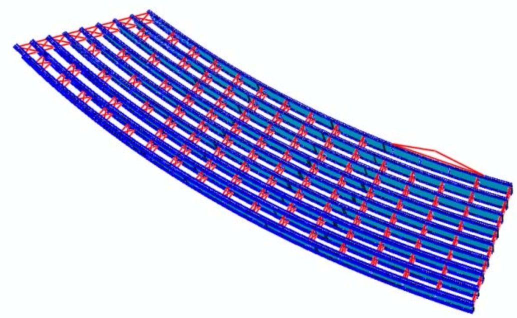
Sub-Stage	Stage	
	18	27
1		
2		

Table R1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

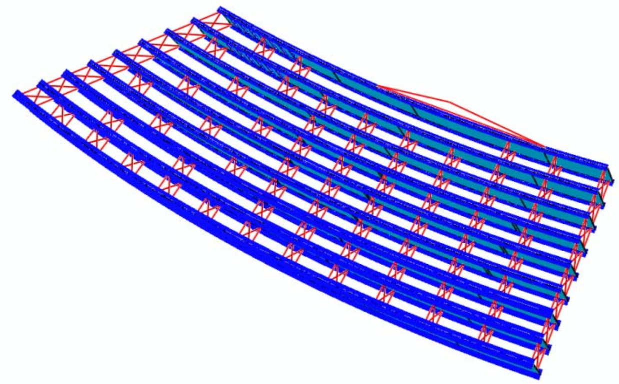
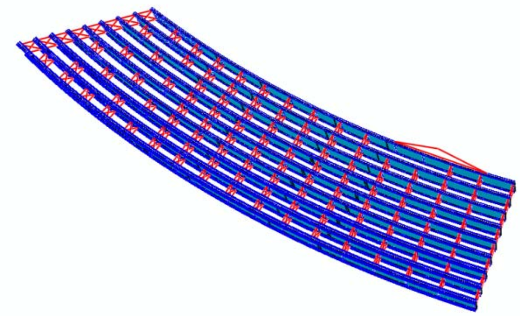
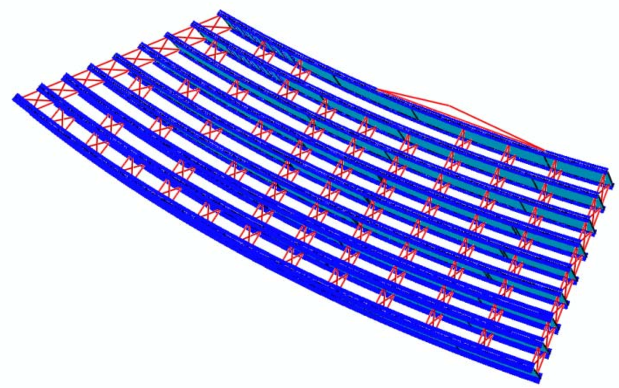
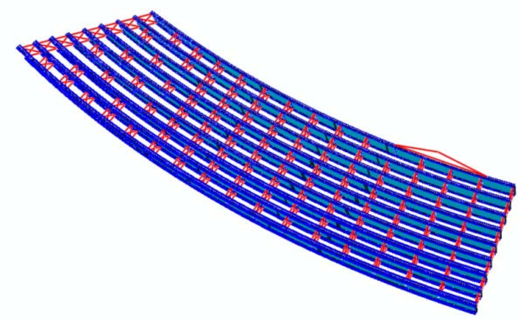
3		
4		

Table R1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

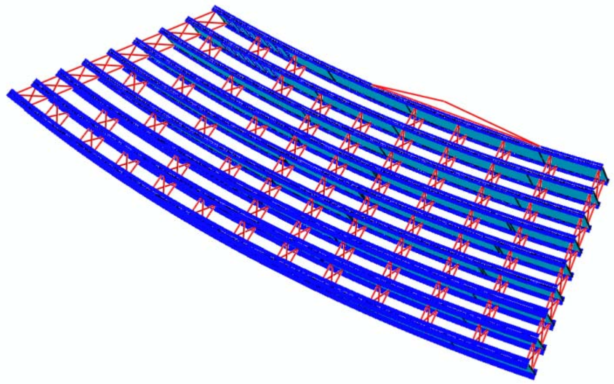
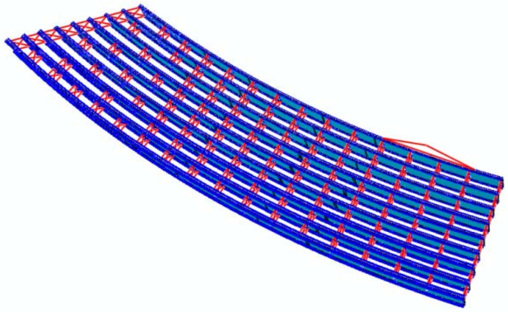
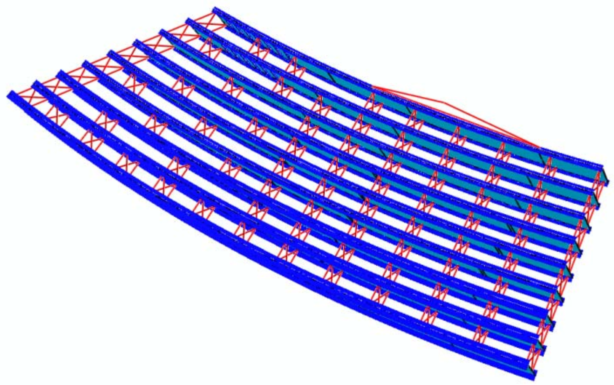
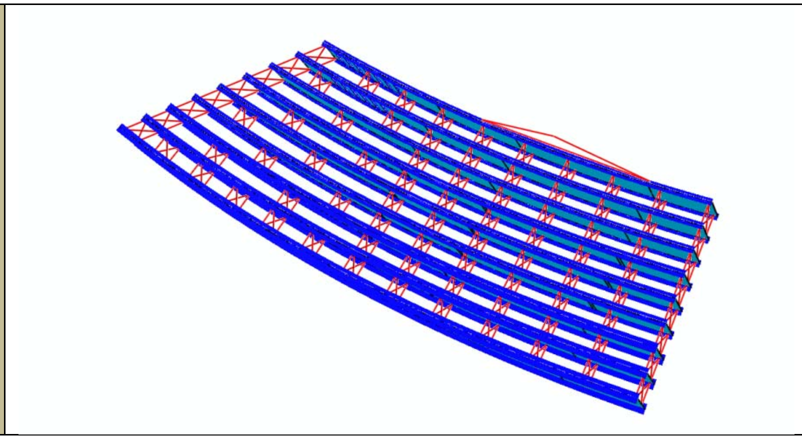
5		
6		

Table R1-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

7		

Appendix R1-2. NISCS39 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISCS39 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table R1-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	14.8	26.2
	SDLF	11.5	21.8
	TDLF	9.1	18.8
G2	NLF	13.0	23.0
	SDLF	9.7	18.9
	TDLF	7.4	16.0
G3	NLF	11.2	19.9
	SDLF	8.1	16.0
	TDLF	5.8	13.3
G4	NLF	9.5	16.9
	SDLF	6.5	13.2
	TDLF	4.3	10.7
G5	NLF	7.9	13.9
	SDLF	5.0	10.6
	TDLF	2.9	8.3
G6	NLF	6.2	11.0
	SDLF	3.6	8.0
	TDLF	1.7	6.0
G7	NLF	4.6	8.2
	SDLF	2.2	5.5
	TDLF	0.5	3.8
G8	NLF	3.0	5.3
	SDLF	0.8	3.1
	TDLF	0.7	1.6
G9	NLF	1.4	2.6
	SDLF	0.5	0.7
	TDLF	1.9	0.6
All Girders	NLF	14.8	26.2
	SDLF	11.5	21.8
	TDLF	9.1	18.8

Table R1-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	3.18	5.64
	SDLF	0.33	2.30
	TDLF	2.28	0.70
G2	NLF	3.09	5.46
	SDLF	0.36	2.22
	TDLF	2.38	0.74
G3	NLF	3.01	5.32
	SDLF	0.38	1.98
	TDLF	2.45	0.76
G4	NLF	2.88	5.09
	SDLF	0.39	1.79
	TDLF	2.55	0.83
G5	NLF	2.81	4.96
	SDLF	0.40	1.66
	TDLF	2.64	0.91
G6	NLF	2.75	4.85
	SDLF	0.44	1.55
	TDLF	2.72	1.01
G7	NLF	2.69	4.75
	SDLF	0.50	1.47
	TDLF	2.77	1.10
G8	NLF	2.67	4.70
	SDLF	0.52	1.43
	TDLF	2.81	1.16
G9	NLF	2.65	4.66
	SDLF	0.53	1.40
	TDLF	2.82	1.18
All Girders	NLF	3.18	5.64
	SDLF	0.53	2.30
	TDLF	2.82	1.18

Table R1-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	16.8	29.2	16.9	29.4	3.7	10.1	4.1	10.8
	SDLF	17.7	29.5	17.7	29.7	1.1	4.7	1.8	4.7
	TDLF	18.2	29.7	18.3	29.8	2.6	2.3	3.8	3.7
G2	NLF	15.4	26.6	15.7	27.2	3.8	10.2	4.1	10.8
	SDLF	15.6	26.4	15.6	26.7	1.9	5.1	2.5	5.1
	TDLF	15.7	26.3	15.7	26.3	2.8	3.1	3.9	4.6
G3	NLF	14.3	24.9	14.4	25.0	3.6	10.1	5.0	10.9
	SDLF	14.1	24.3	14.3	24.5	2.2	4.6	2.9	6.8
	TDLF	14.0	23.9	14.3	24.2	2.6	3.7	3.7	4.5
G4	NLF	12.3	21.1	14.0	24.4	4.5	9.1	7.3	15.8
	SDLF	11.4	20.1	13.6	23.7	2.1	5.2	2.8	6.5
	TDLF	11.1	19.3	13.4	23.2	2.3	2.9	4.5	4.4
G5	NLF	10.4	17.9	11.8	20.3	3.3	8.8	4.7	10.6
	SDLF	9.4	16.8	11.1	19.6	1.1	4.0	1.6	4.6
	TDLF	9.3	16.0	10.9	19.0	2.2	1.5	3.5	2.9
G6	NLF	8.4	14.2	9.3	15.9	3.6	9.3	5.0	12.0
	SDLF	7.4	13.3	8.9	15.6	0.9	4.3	1.6	5.1
	TDLF	7.3	12.7	8.5	15.4	2.1	1.6	4.3	3.0
G7	NLF	6.1	9.9	6.2	10.0	5.5	11.3	10.6	24.8
	SDLF	5.4	9.5	5.5	9.7	0.8	5.0	1.3	8.9
	TDLF	5.3	9.5	5.4	9.8	2.6	1.3	8.5	2.7
G8	NLF	4.2	5.8	4.3	5.8	4.9	13.3	5.2	13.8
	SDLF	4.2	6.1	4.3	6.1	1.0	5.7	1.1	4.9
	TDLF	4.1	6.2	4.2	6.3	3.0	1.6	6.4	2.8
G9	NLF	2.3	4.7	2.4	5.0	5.0	14.9	7.9	20.0
	SDLF	1.9	2.5	2.0	2.6	0.7	6.1	0.5	7.1
	TDLF	2.7	2.2	2.7	2.3	2.9	0.8	6.8	2.2
All Girders	NLF	16.8	29.2	16.9	29.4	5.5	14.9	10.6	24.8
	SDLF	17.7	29.5	17.7	29.7	2.2	6.1	2.9	8.9
	TDLF	18.2	29.7	18.3	29.8	3.0	3.7	8.5	4.6

Table R1-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	132.2	391.7	389.4	391.7
	SDLF	123.7	276.1	269.4	276.1
	TDLF	135.8	240.7	226.7	240.7
TDL	NLF	224.3	678.0	671.8	678.0
	SDLF	204.0	525.7	516.6	525.7
	TDLF	211.7	435.3	420.4	435.3

Table R1-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	33.6	72.5	71.5	52.8
	SDLF	30.7	66.0	64.8	48.1
	TDLF	32.0	64.4	61.4	47.4
TDL	NLF	60.8	130.9	127.5	95.0
	SDLF	54.3	114.8	112.4	84.0
	TDLF	52.0	104.7	102.1	77.7

Table R1-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.84	1.80	1.74	1.69	1.65	1.62	1.62	1.62	1.84
SDLF	1.81	1.72	1.61	1.50	1.43	1.38	1.36	1.36	1.81
TDLF	1.79	1.66	1.51	1.37	1.26	1.19	1.18	1.18	1.79

Table R1-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	3.25	3.16	3.07	2.98	2.90	2.86	2.85	2.85	3.25
SDLF	3.08	2.93	2.80	2.67	2.55	2.49	2.47	2.47	3.08
TDLF	2.96	2.78	2.61	2.43	2.30	2.22	2.19	2.19	2.96

Table R1-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	2.25	2.20	2.13	2.07	2.02	1.99	1.98	1.98	2.25
SDLF	2.22	2.11	1.97	1.84	1.75	1.69	1.67	1.67	2.22
TDLF	2.19	2.03	1.84	1.67	1.55	1.46	1.45	1.45	2.19

Table R1-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	3.98	3.87	3.76	3.65	3.56	3.50	3.49	3.49	3.98
SDLF	3.77	3.60	3.43	3.27	3.13	3.05	3.03	3.03	3.77
TDLF	3.63	3.40	3.19	2.98	2.82	2.72	2.69	2.69	3.63

Table R1-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	4802	8071
SDLF	4802	8070
TDLF	4802	8071

Table R1-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	518	892	5.3	14.5	4.1	12.1
SDLF	541	895	1.0	6.3	0.9	3.4
TDLF	562	908	2.1	1.0	4.5	2.1

Table R1-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	1.05	2.91	0.82	2.42
SDLF	1.66	1.27	0.19	0.69
TDLF	3.37	3.45	0.90	0.42

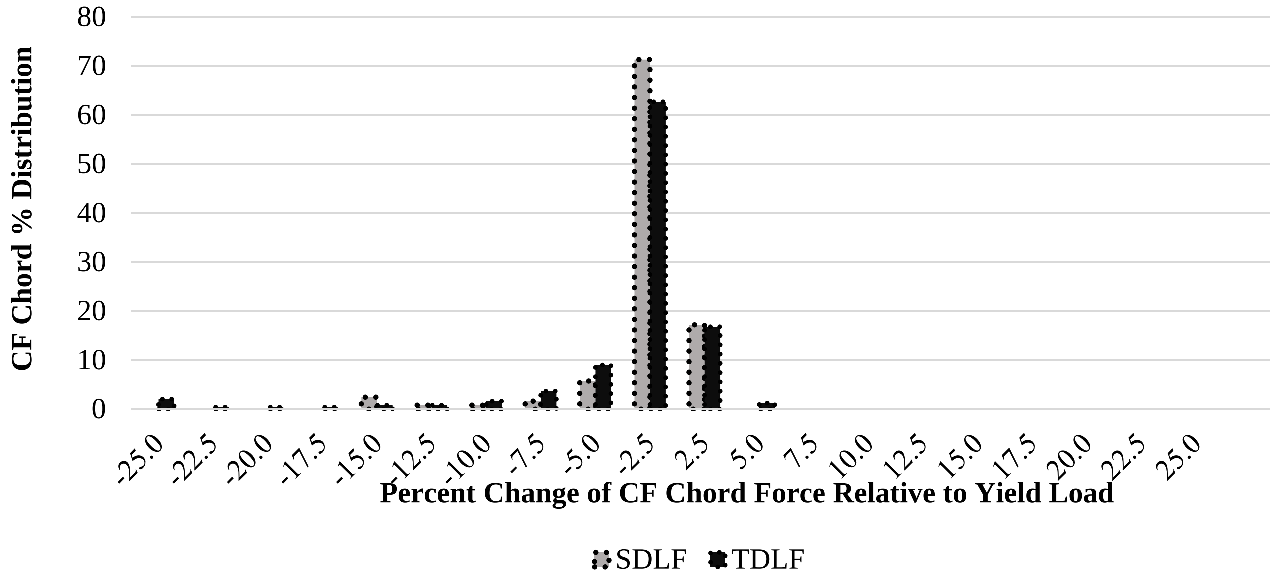


Figure R1-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

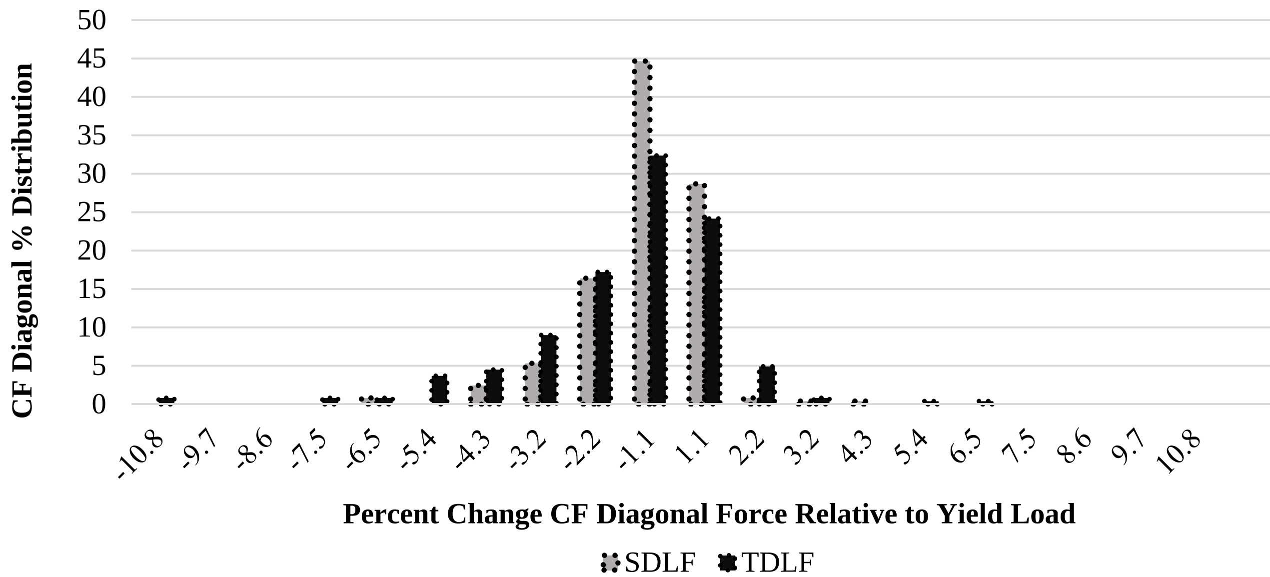


Figure R1-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

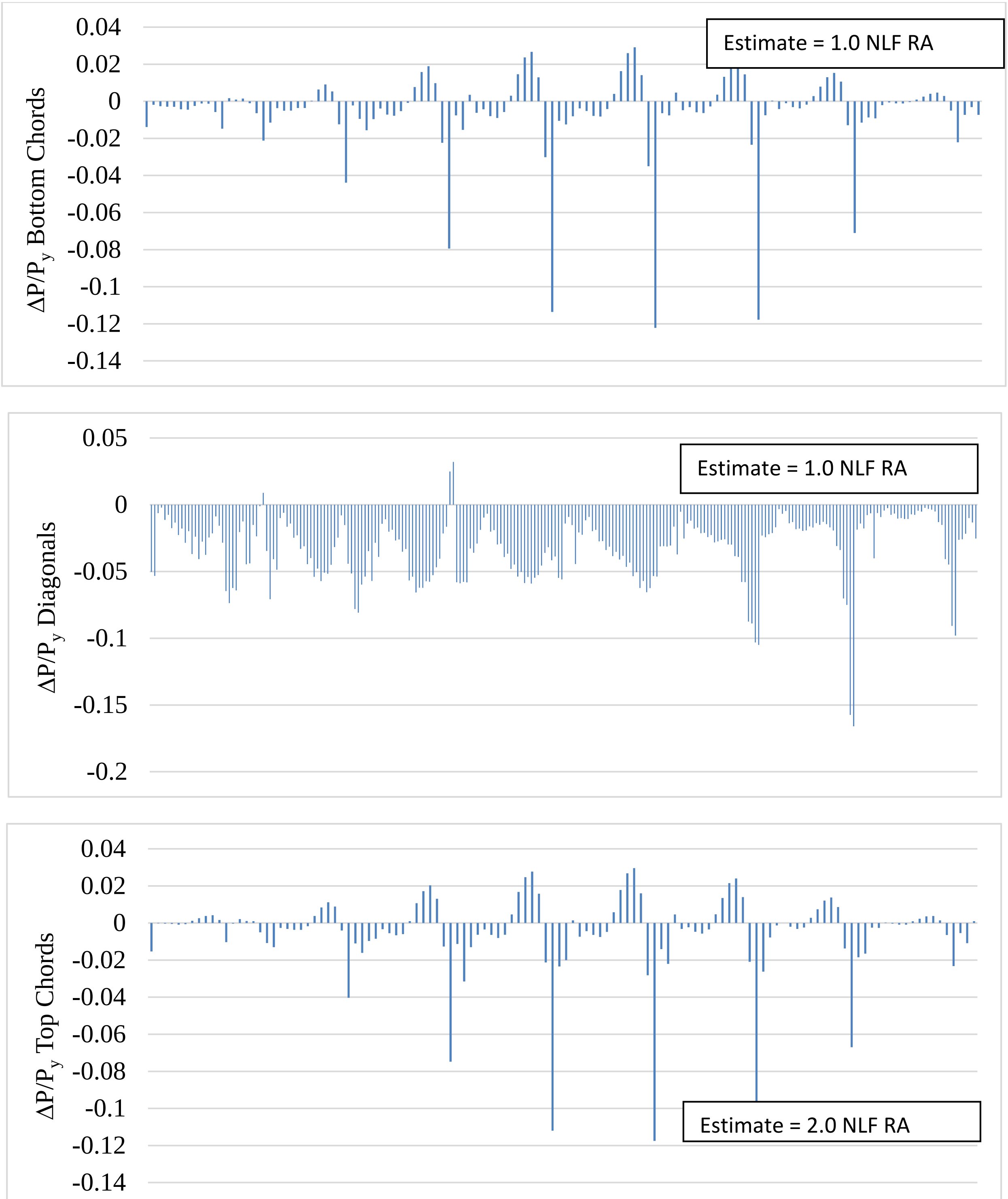


Figure R1-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

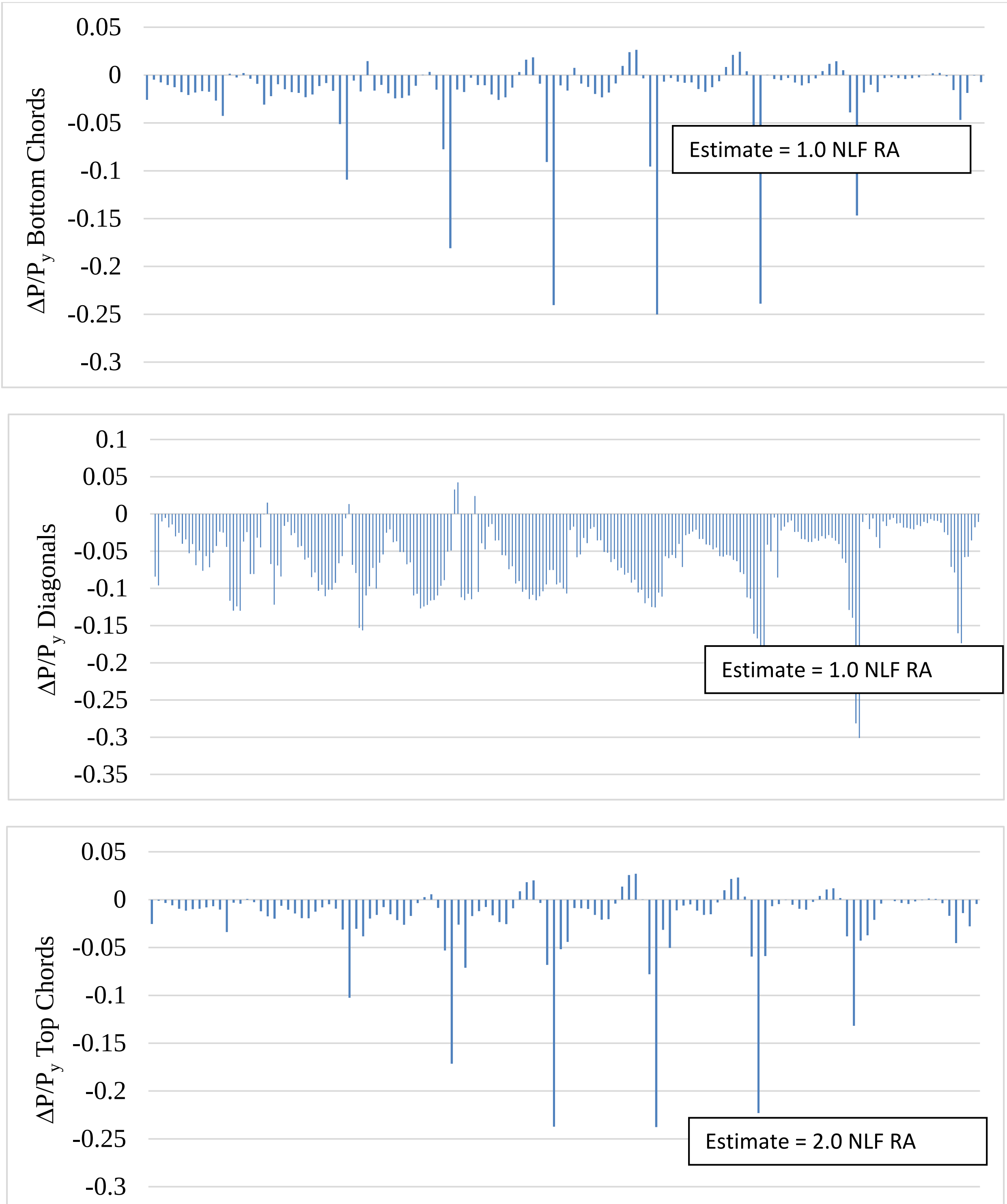


Figure R1-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix R1-3. NISCS39 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge NISCS39 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table R1-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	16.9	10.4	16.9
SDLF	61.2	46.5	61.2
TDLF	103.9	75.1	103.9

Table R1-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	247	41.5
	SDLF	579.8	40.9
	TDLF	655.9	0
G2	NLF	279.5	3.8
	SDLF	196.2	0
	TDLF	267.7	0
G3	NLF	265.6	47.9
	SDLF	185.1	0
	TDLF	242.5	0
G4	NLF	214.1	33.2
	SDLF	136.1	0
	TDLF	200.1	0
G5	NLF	206.9	28.7
	SDLF	130.6	0
	TDLF	164	0
G6	NLF	200.5	25.2
	SDLF	143.6	0
	TDLF	190.3	0
G7	NLF	166.3	34.3
	SDLF	152	0
	TDLF	193.7	0
G8	NLF	294.3	31.5
	SDLF	215.9	0
	TDLF	301.2	0
G9	NLF	232.9	7.8
	SDLF	331	25.3
	TDLF	364.9	0
All Girders	NLF	294.3	3.8
	SDLF	579.8	0
	TDLF	655.9	0

Table R1-3-3. Summary of erection crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	153.5	113.4	98.4	93.8
SDLF	161.3	0	94.6	0
TDLF	156.1	0	103.7	0

Table R1-3-6. Erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage						
		1	2	3	4	5	6	7
2	NLF	347	351	355	359	363		
	SDLF	347	351	355	359	363		
	TDLF	347	351	355	359	363		
11	NLF	1560	1564	1568	1572	1576	1580	1584
	SDLF	1560	1564	1568	1572	1576	1580	1584
	TDLF	1560	1564	1568	1572	1576	1580	1584
18	NLF	3353	3357	3361	3365	3369	3373	3377
	SDLF	3353	3357	3361	3365	3369	3373	3377
	TDLF	3353	3357	3361	3365	3369	3373	3377
27	NLF	4785	4789	4793	4798	4802		
	SDLF	4785	4789	4793	4797	4802		
	TDLF	4785	4789	4793	4798	4802		

Appendix R1-4. NISCS39 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge NISCS39 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Figure R1-4-1. SDL and TDL 3D FEA cambers.

Overview of Bridge Displacements and Elevation Profiles

Figure R1-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.
Figure R1-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.
Figure R1-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.
Figure R1-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.
Figure R1-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).
Figure R1-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.
Figure R1-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.
Figure R1-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

Girder Displacements and Elevations for Different Detailing Methods

Figure R1-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.
Figure R1-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.
Figure R1-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.
Figure R1-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.
Figure R1-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.
Figure R1-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.
Figure R1-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.
Figure R1-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

Girder Flange Stresses for Different Detailing Methods

Figure R1-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.
Figure R1-4-19. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods
Figure R1-4-20. Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.
Figure R1-4-21. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

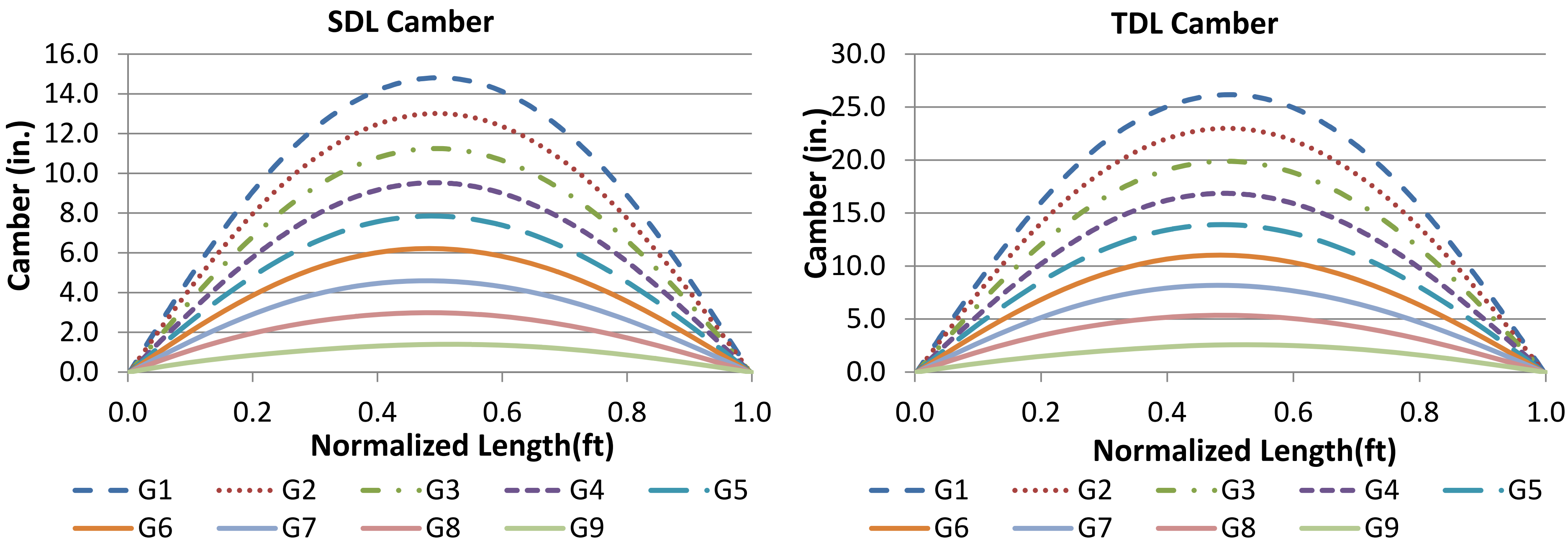


Figure R1-4-1. SDL and TDL 3D FEA cambers.

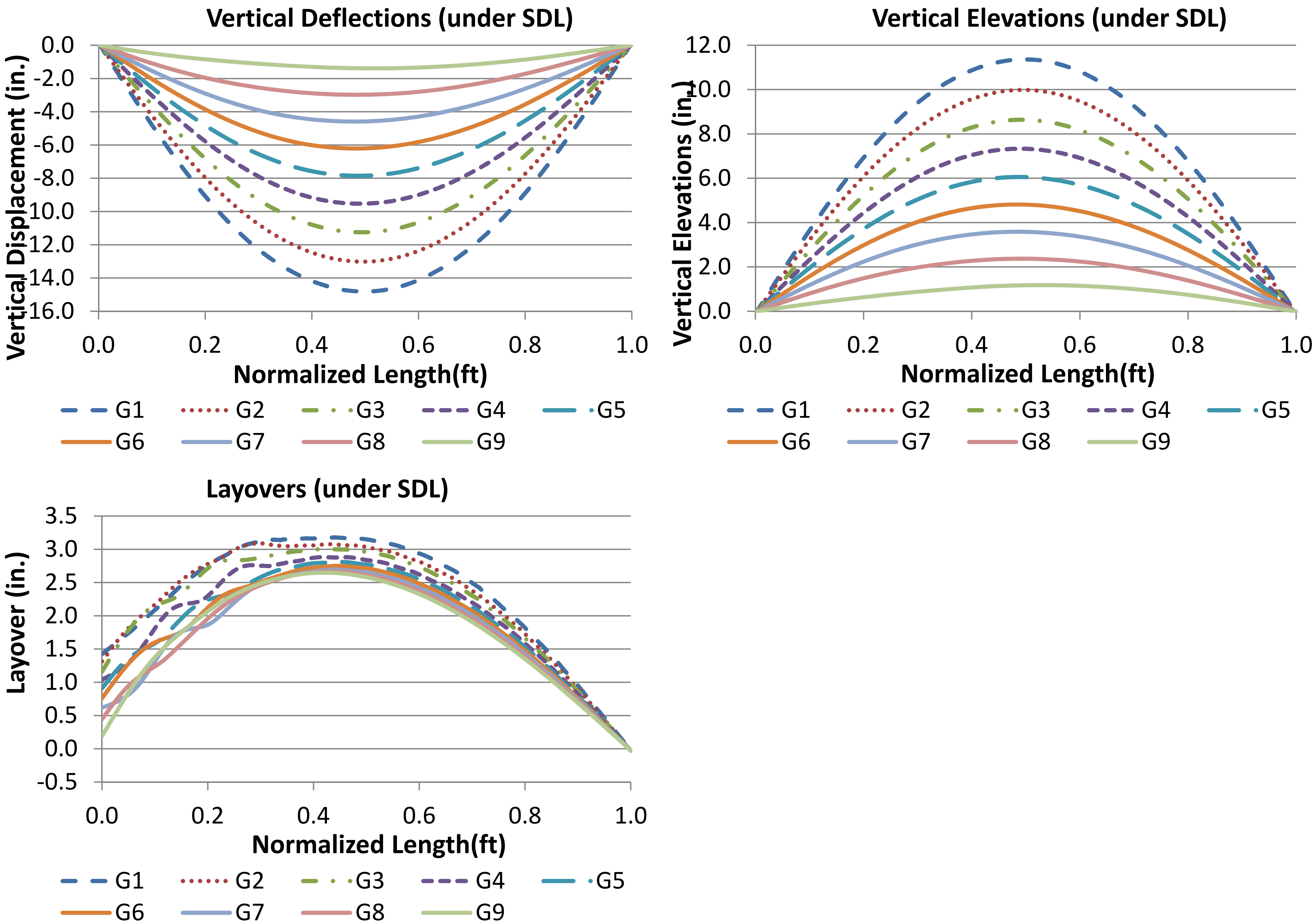


Figure R1-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

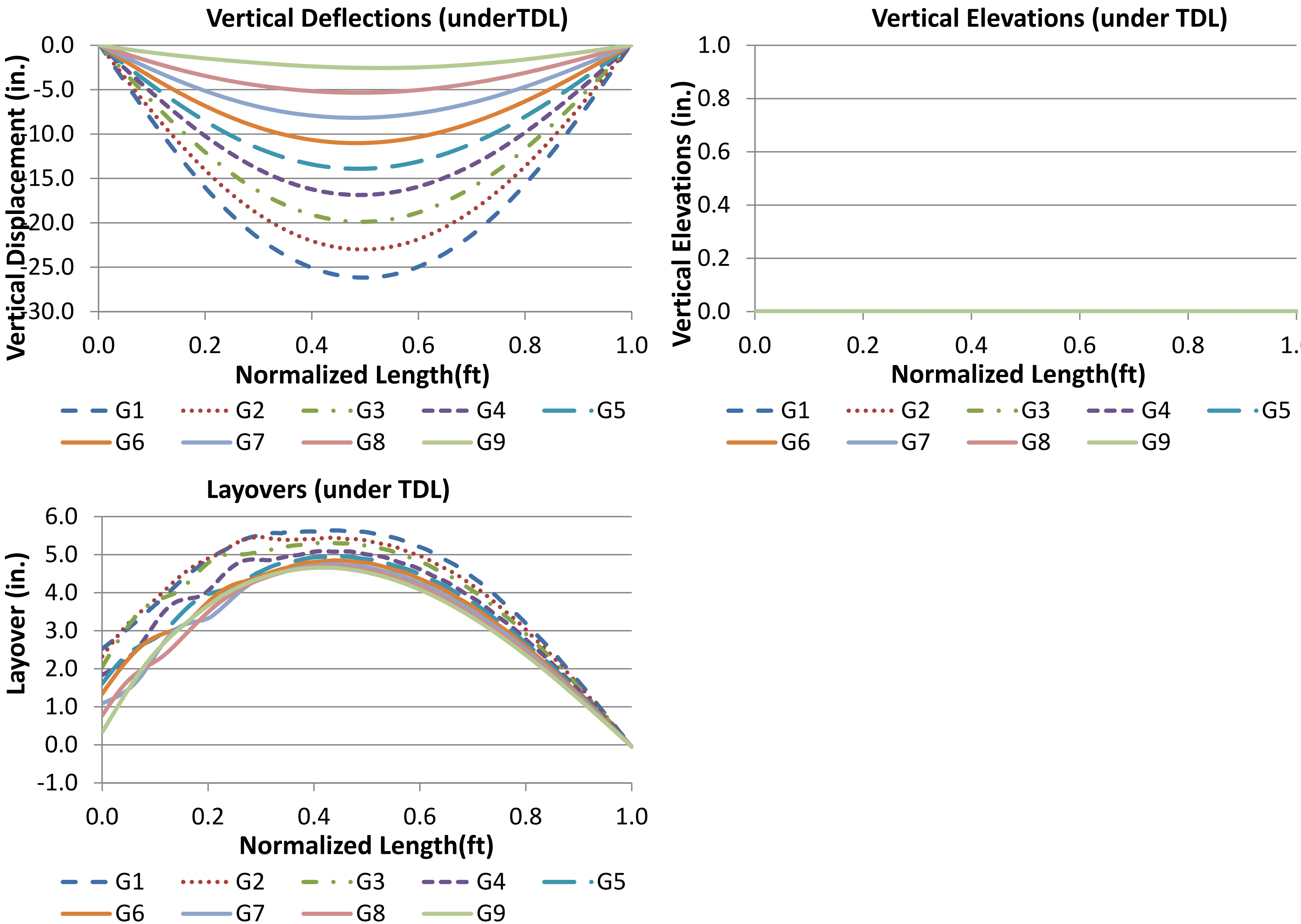


Figure R1-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

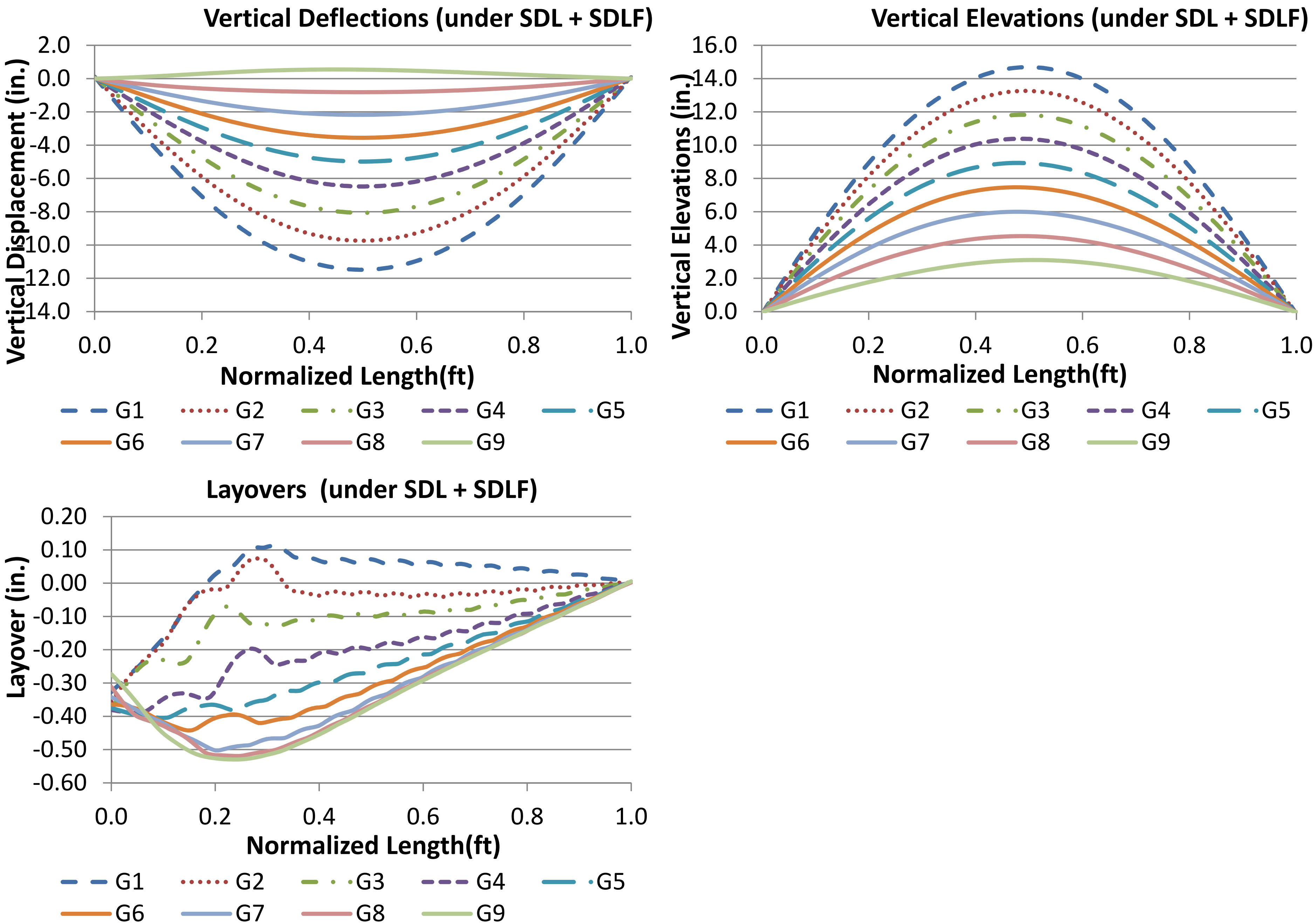


Figure R1-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

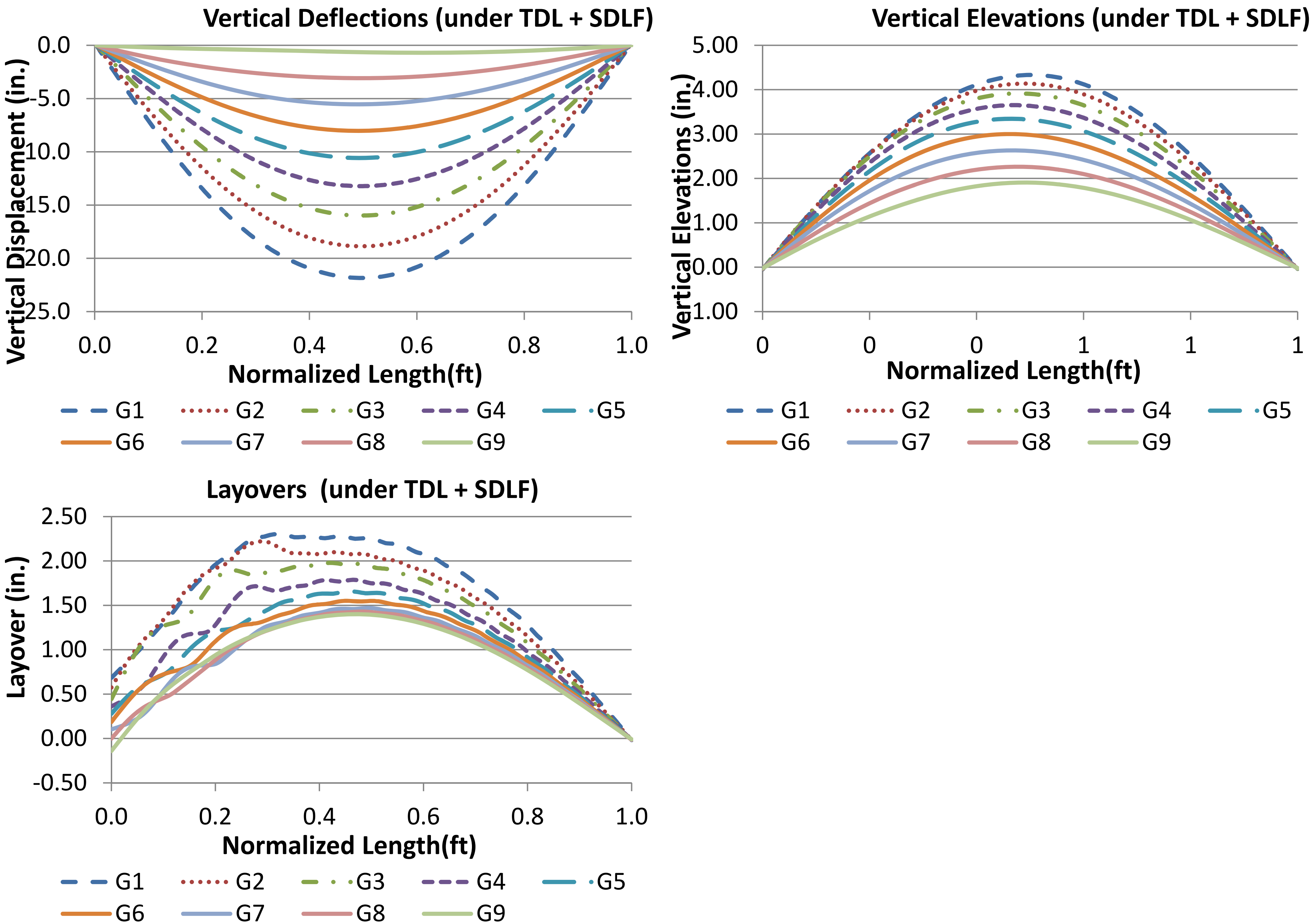


Figure R1-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

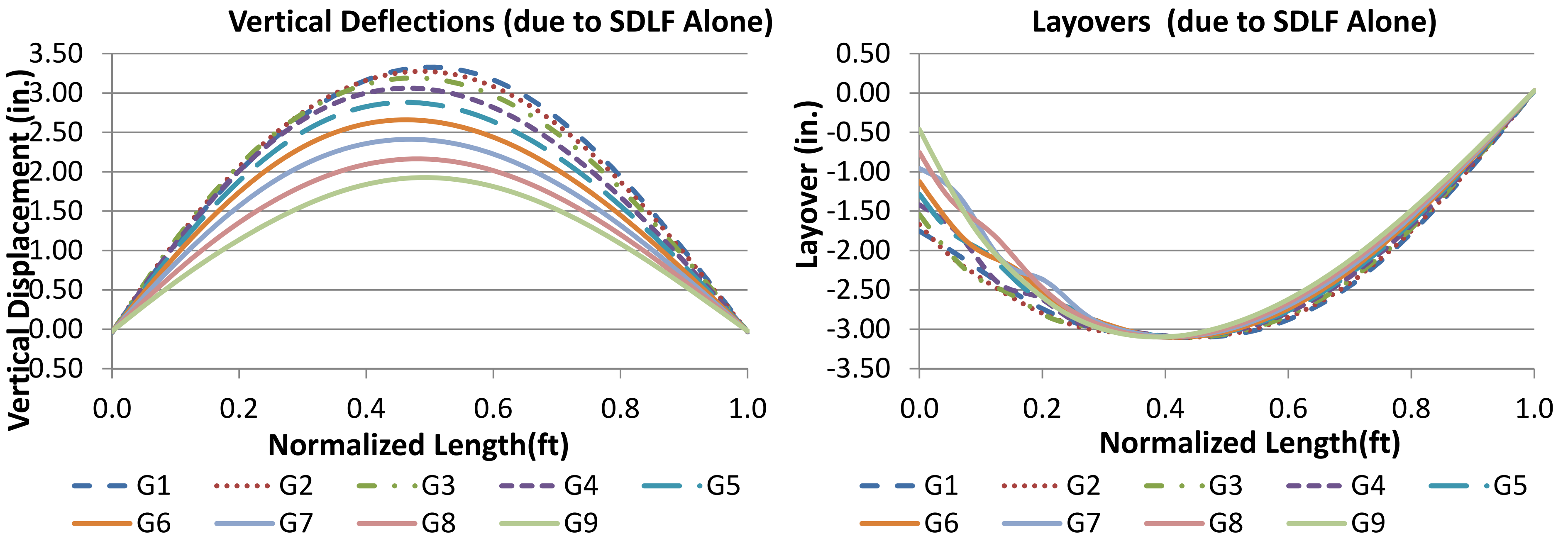


Figure R1-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

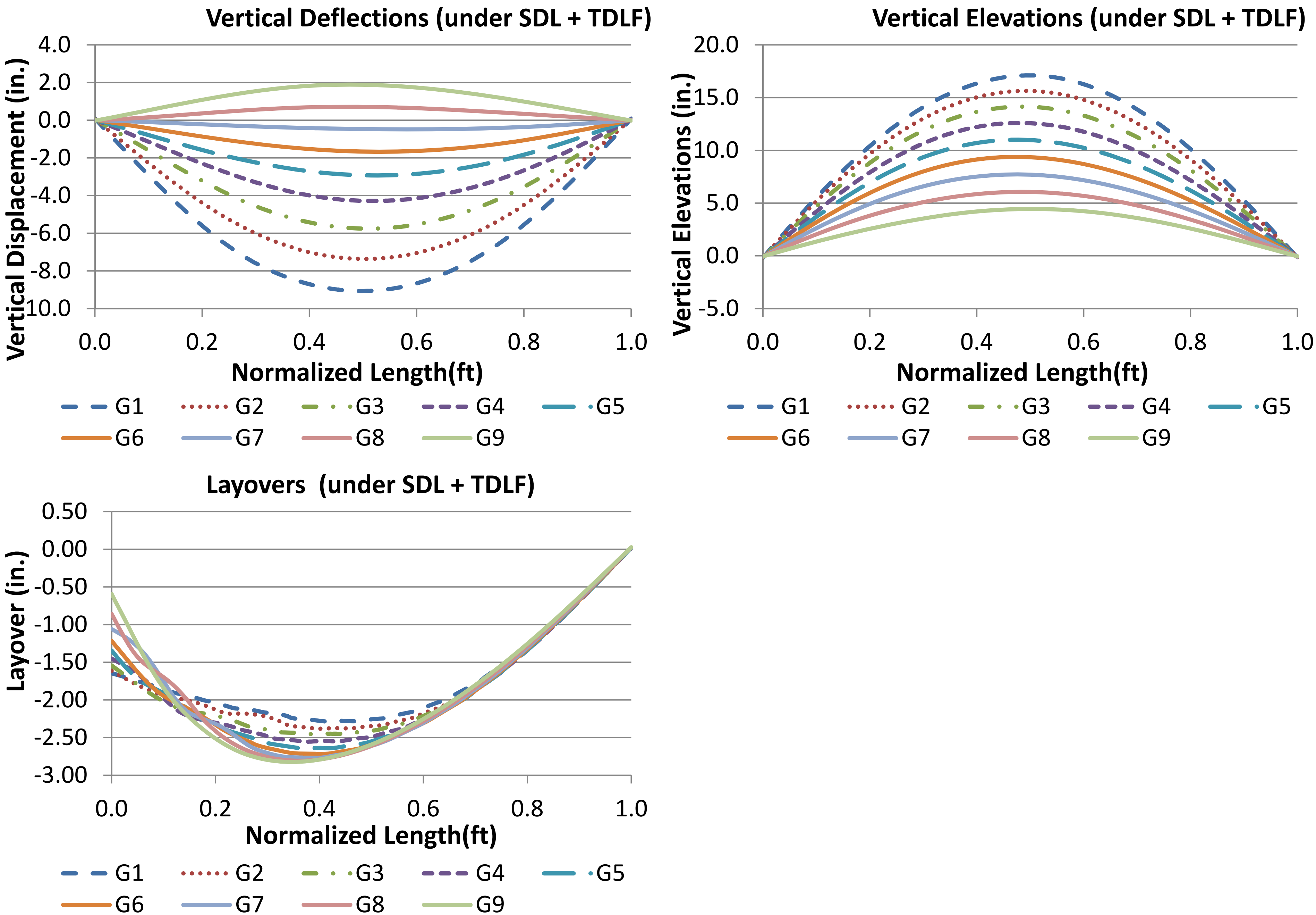


Figure R1-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

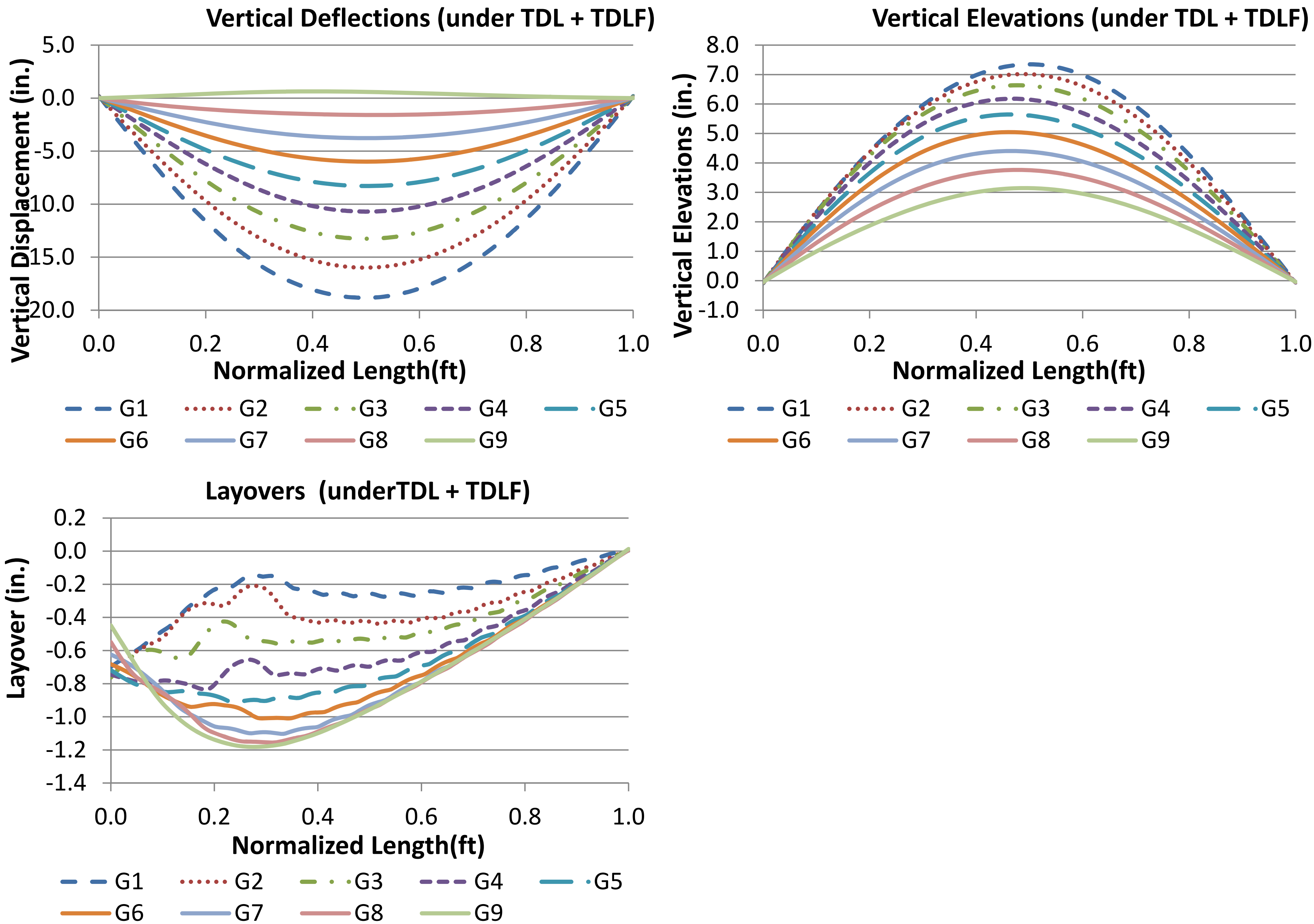


Figure R1-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

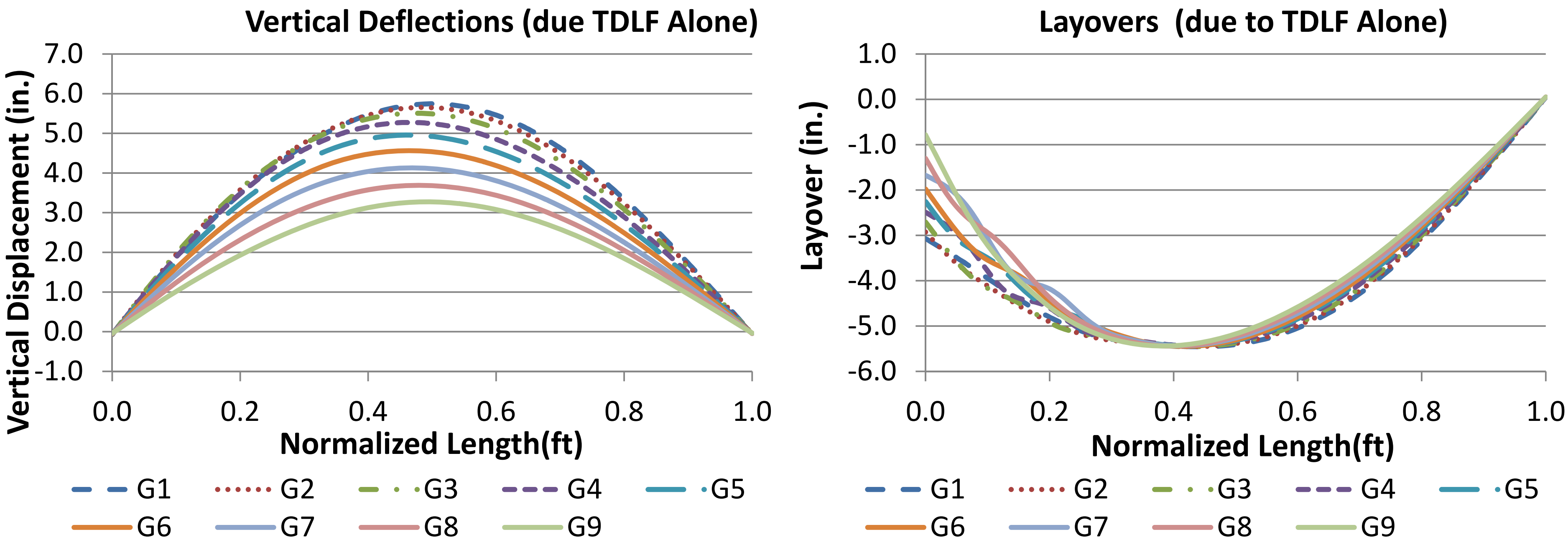


Figure R1-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

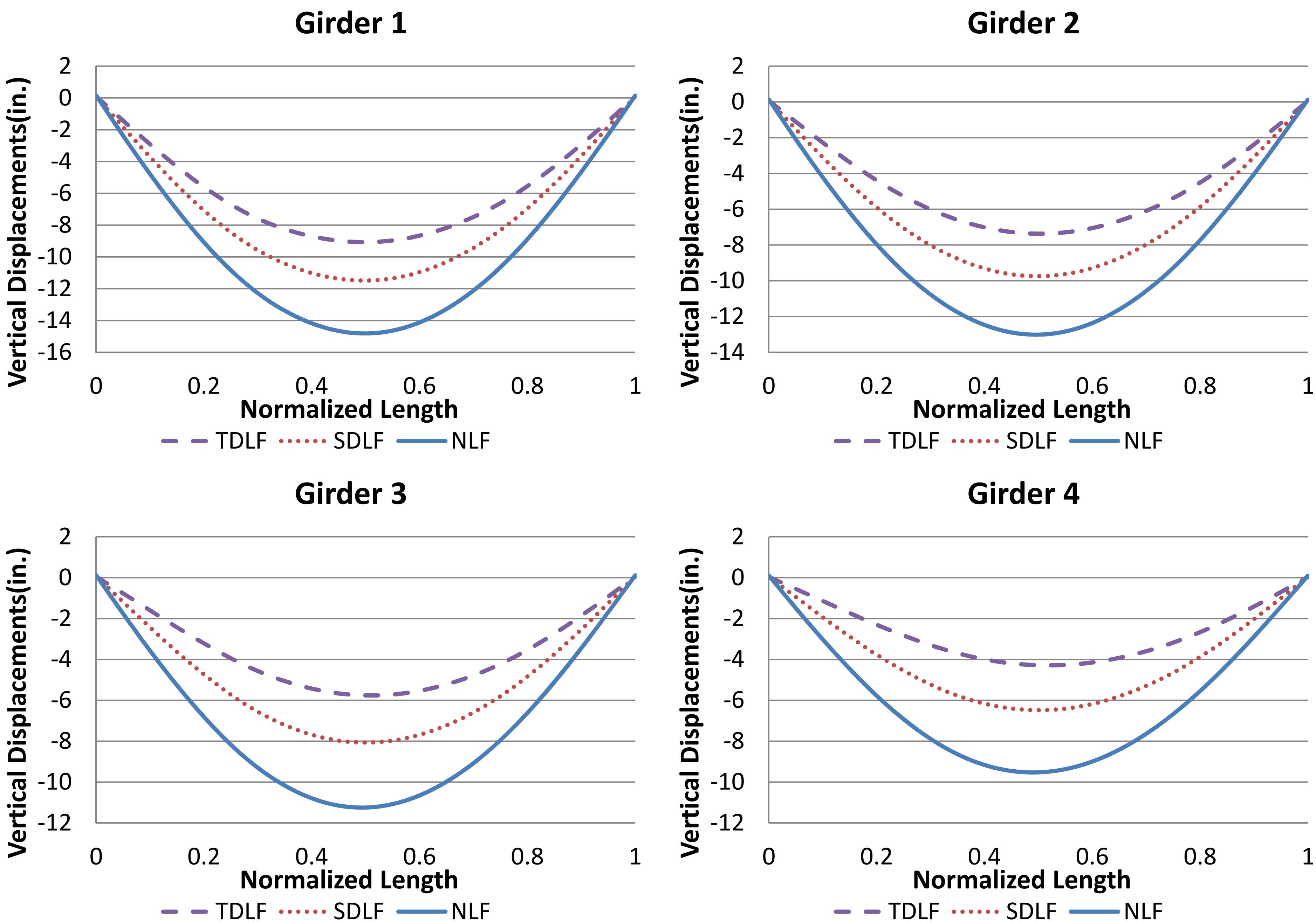


Figure R1-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

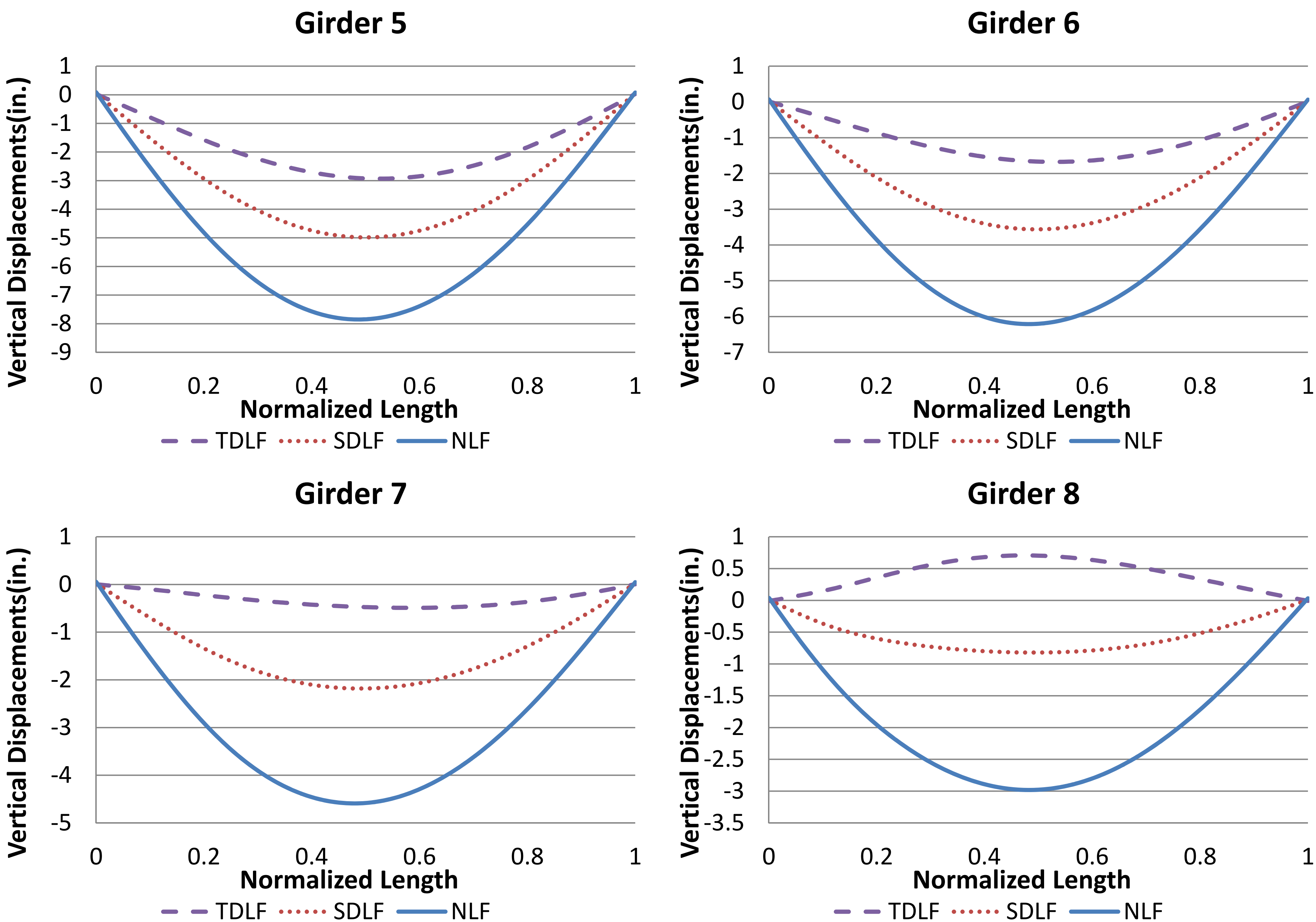


Figure R1-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

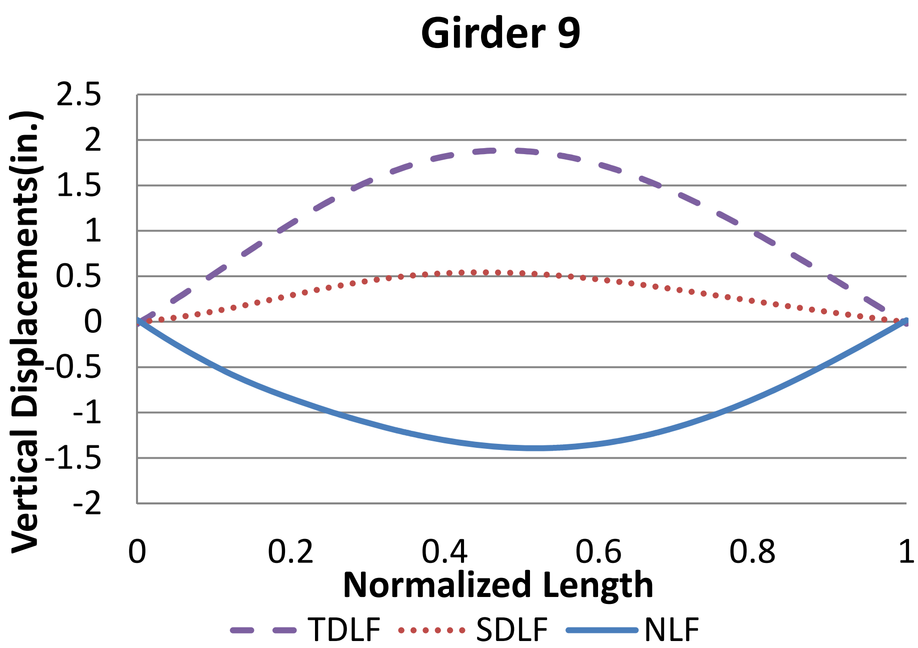


Figure R1-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

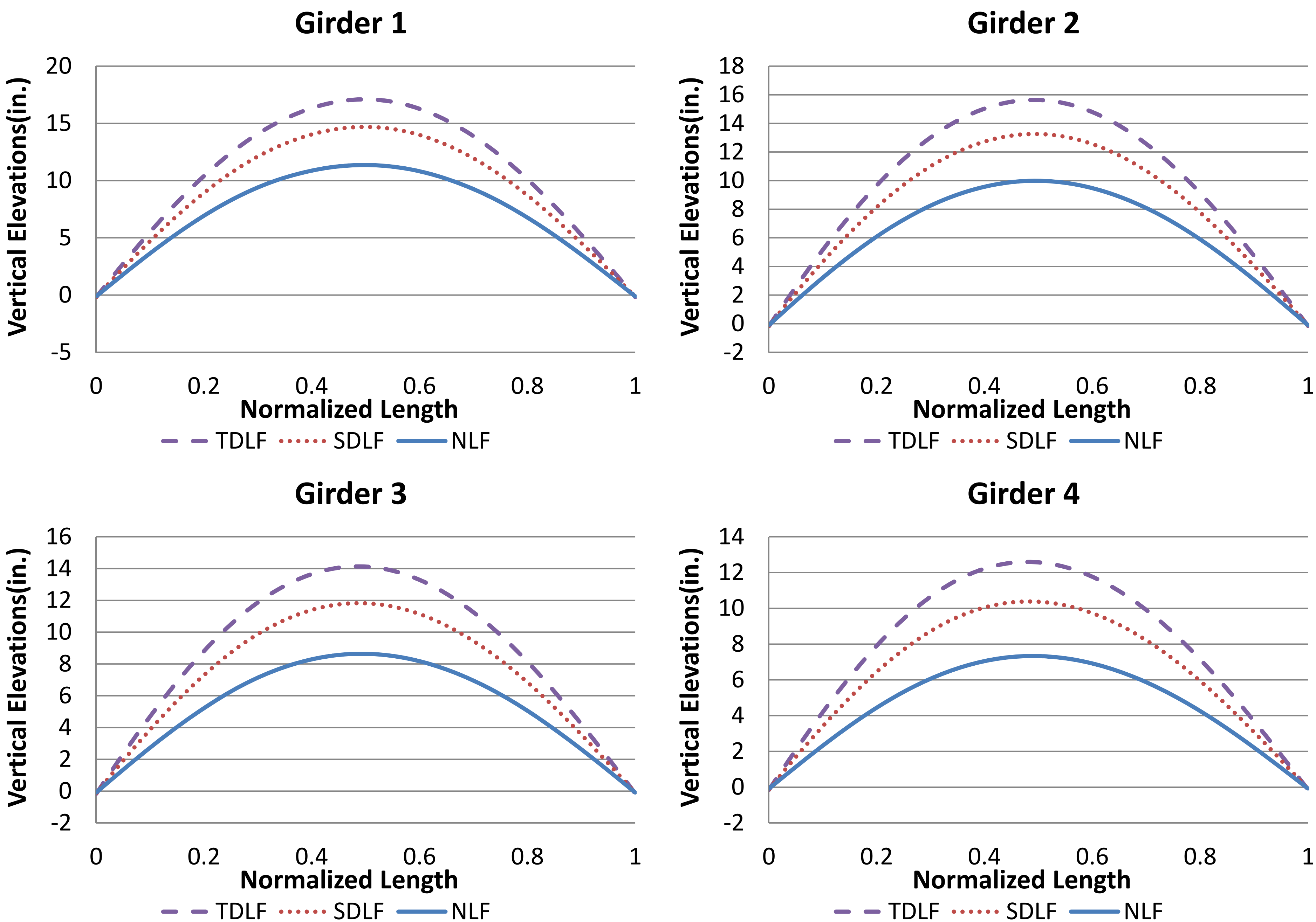


Figure R1-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

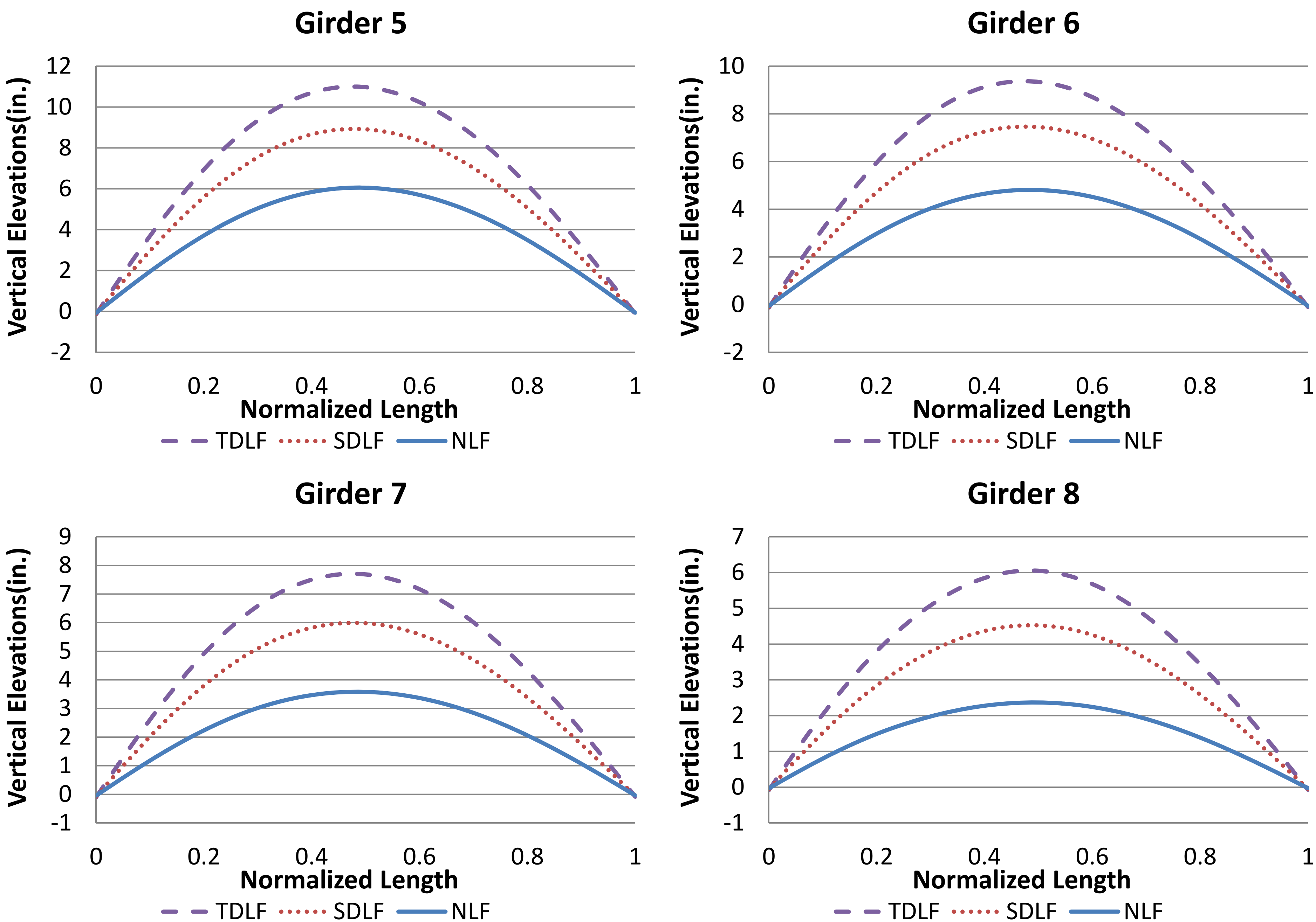


Figure R1-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

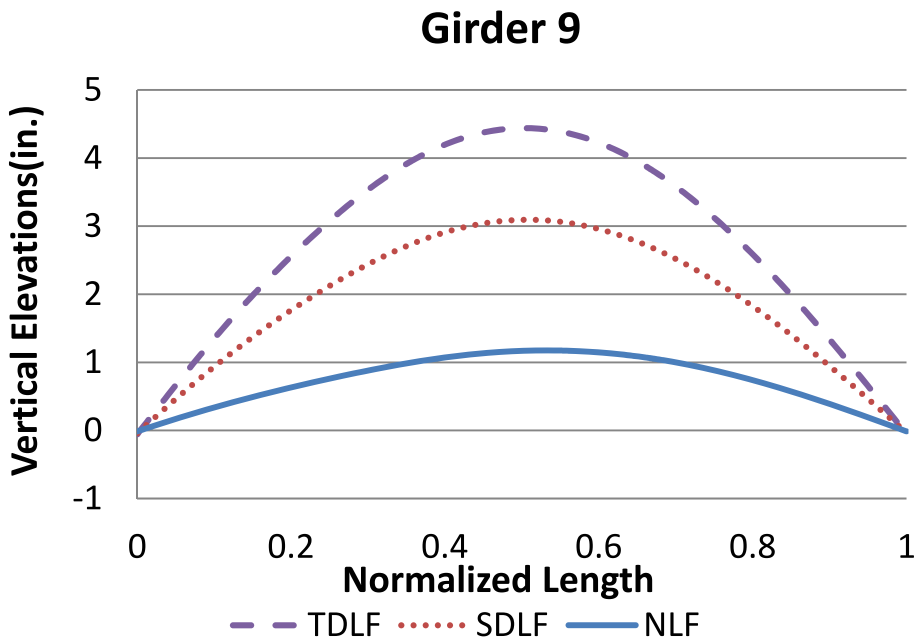


Figure R1-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

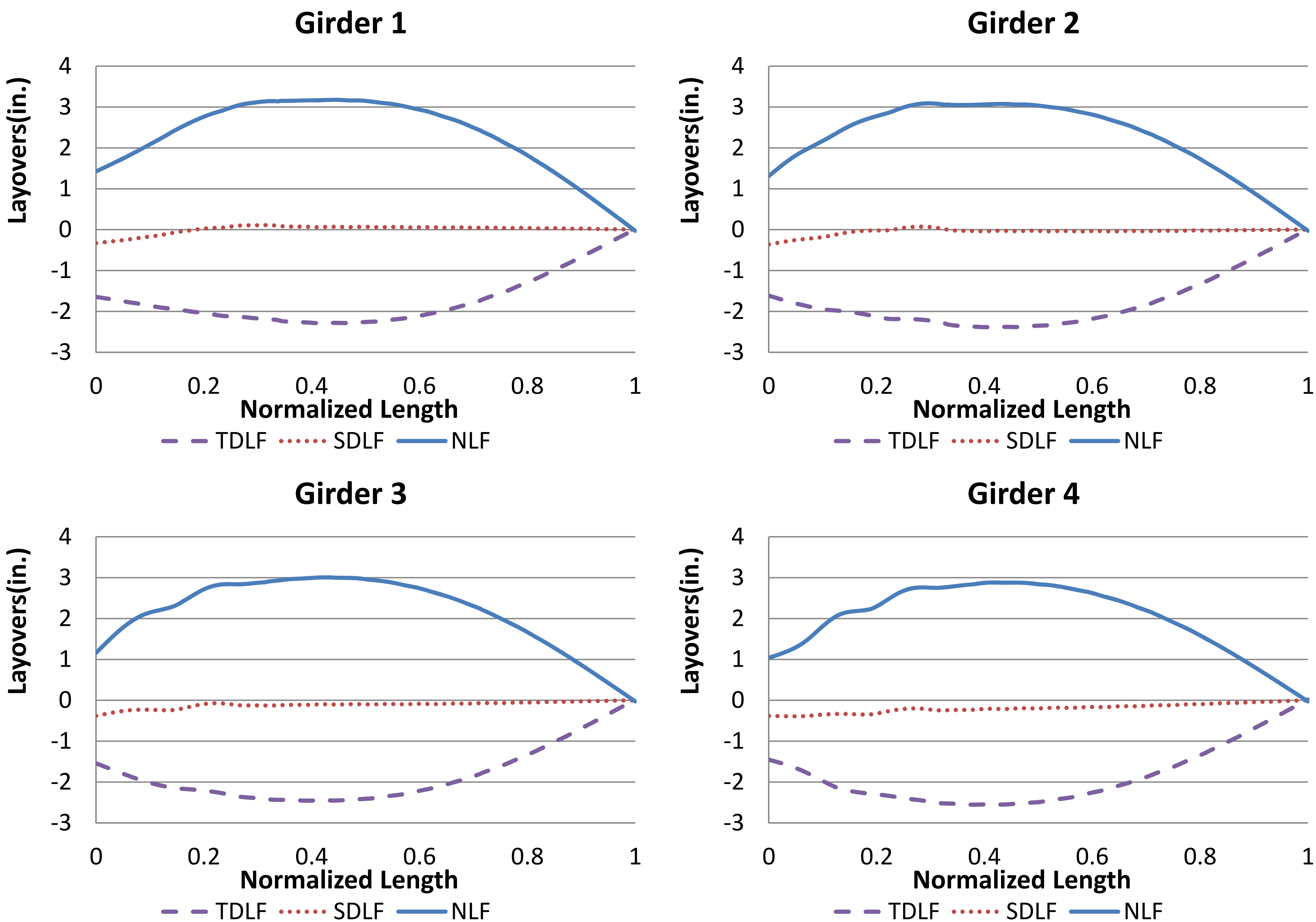


Figure R1-4-12. **Comparison of individual girder layovers (in) under SDL for different detailing methods.**

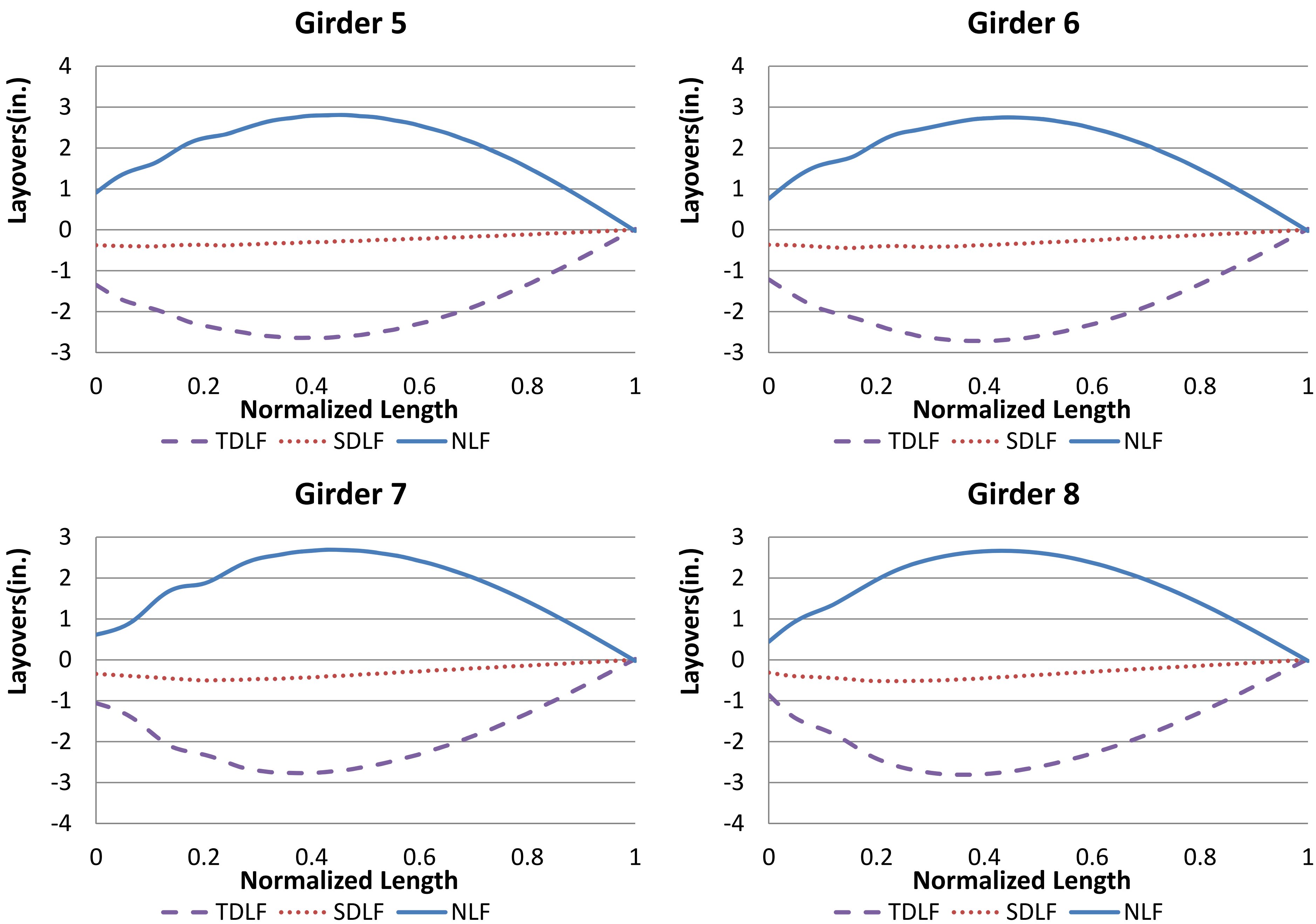


Figure R1-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

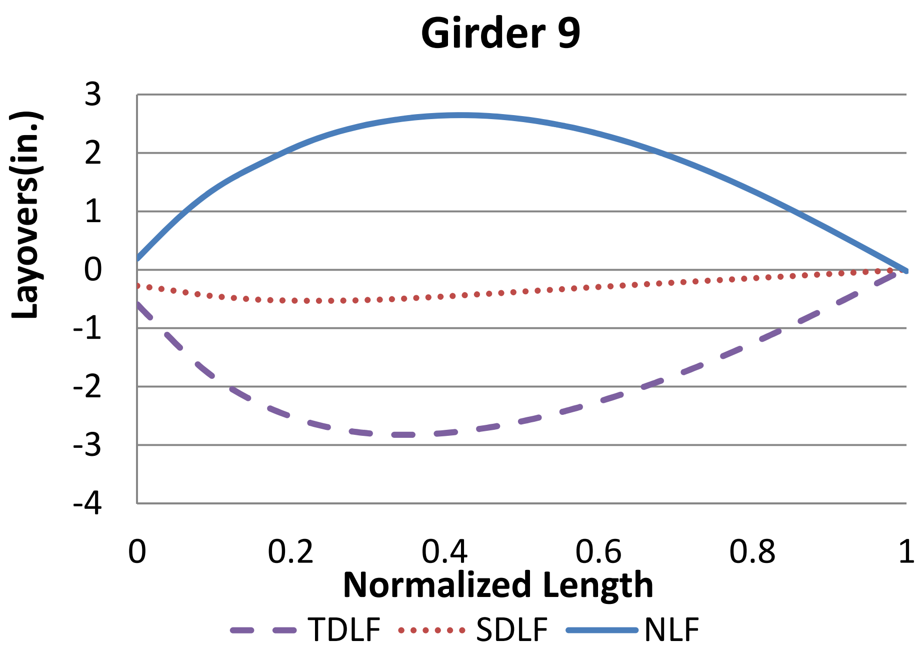


Figure R1-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

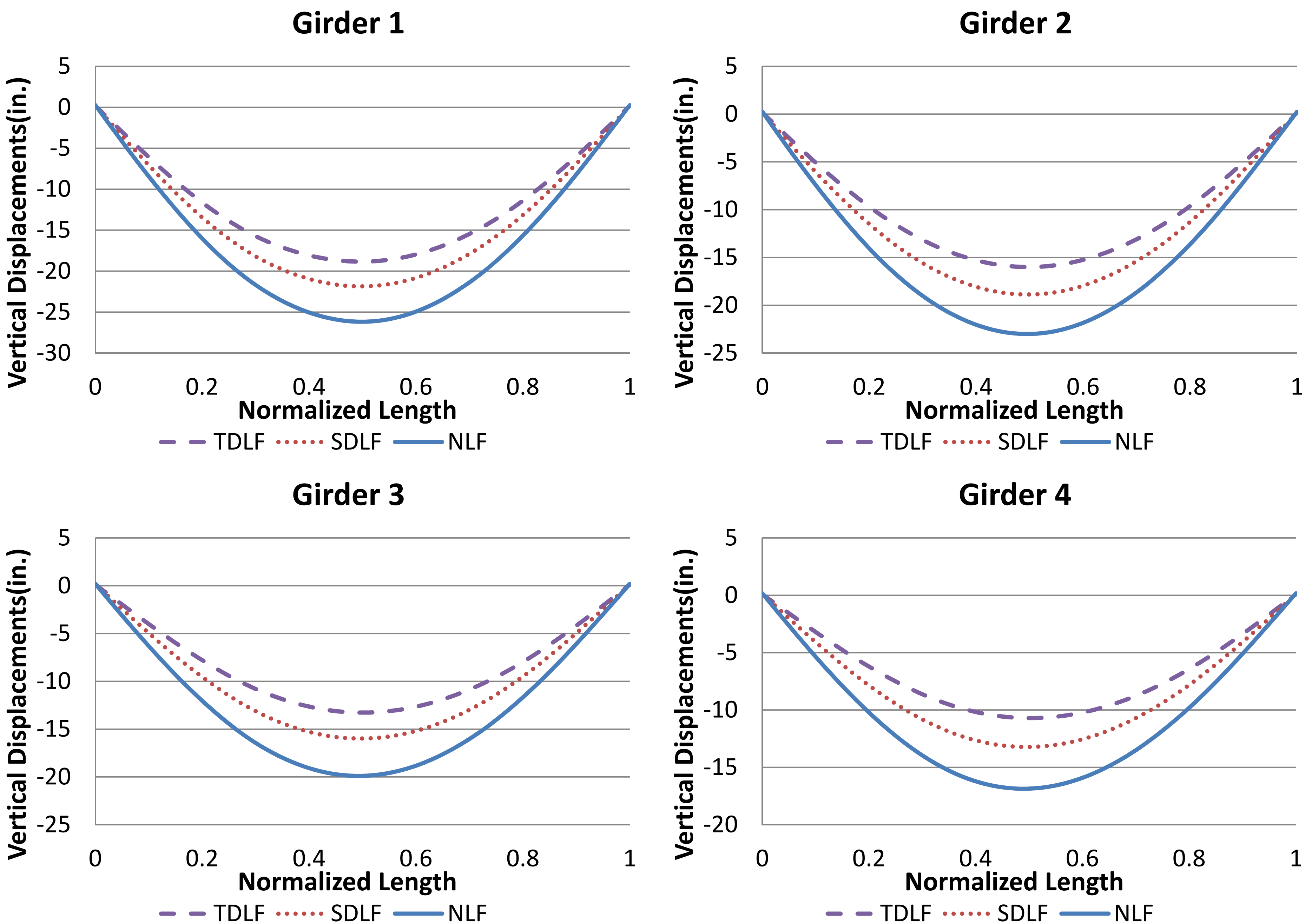


Figure R1-4-13. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

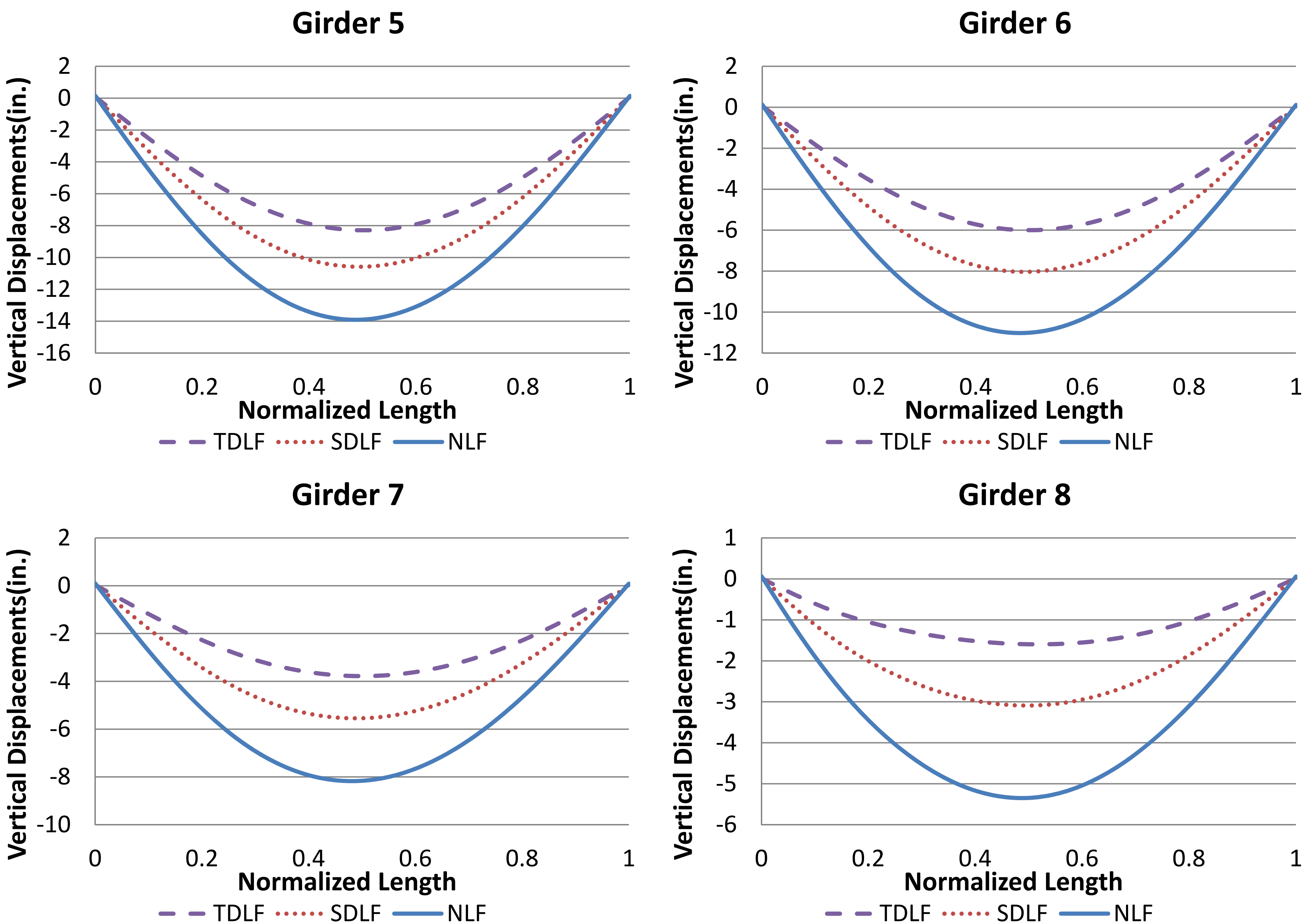


Figure R1-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

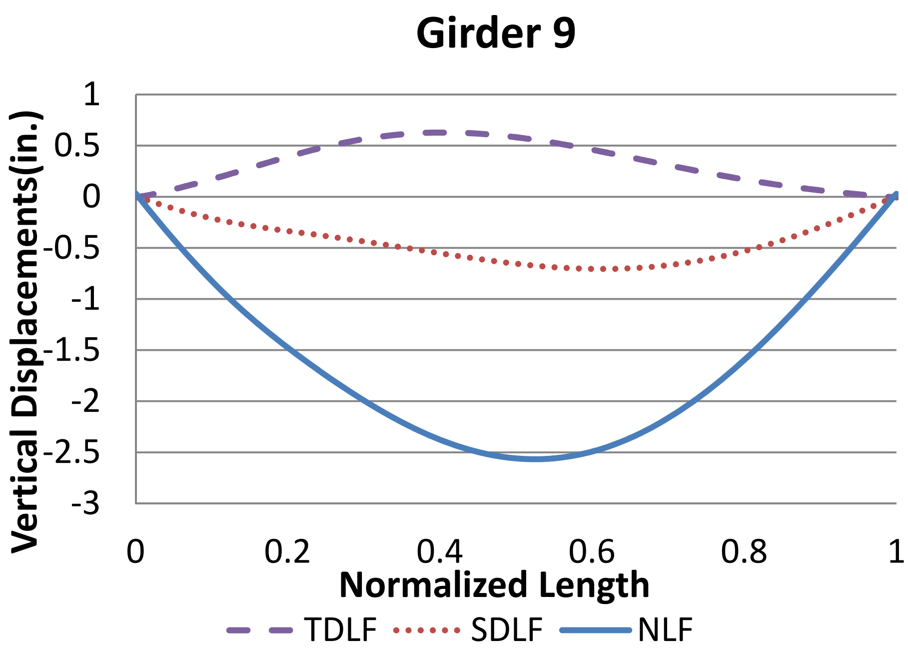


Figure R1-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

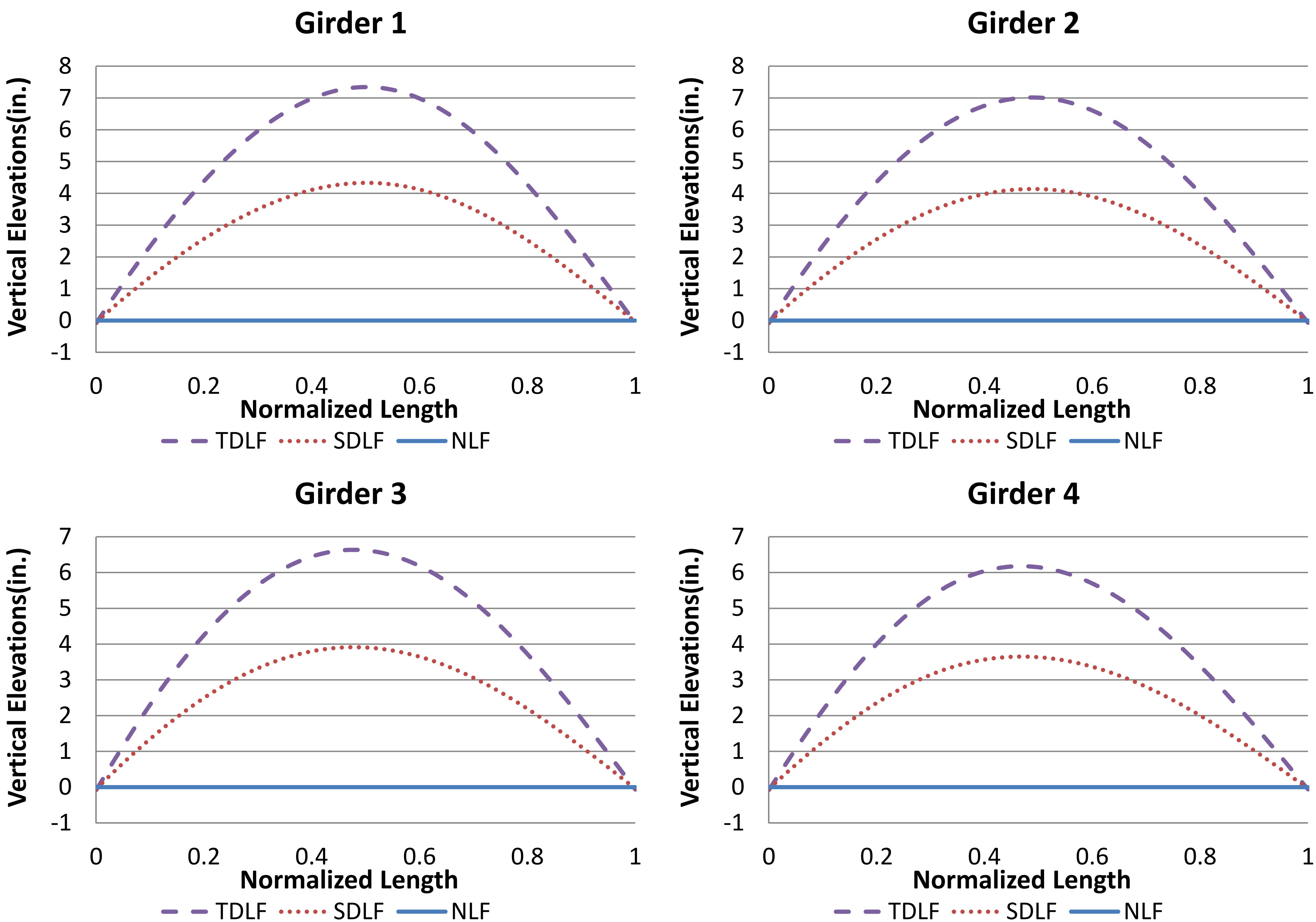


Figure R1-4-14. **Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.**

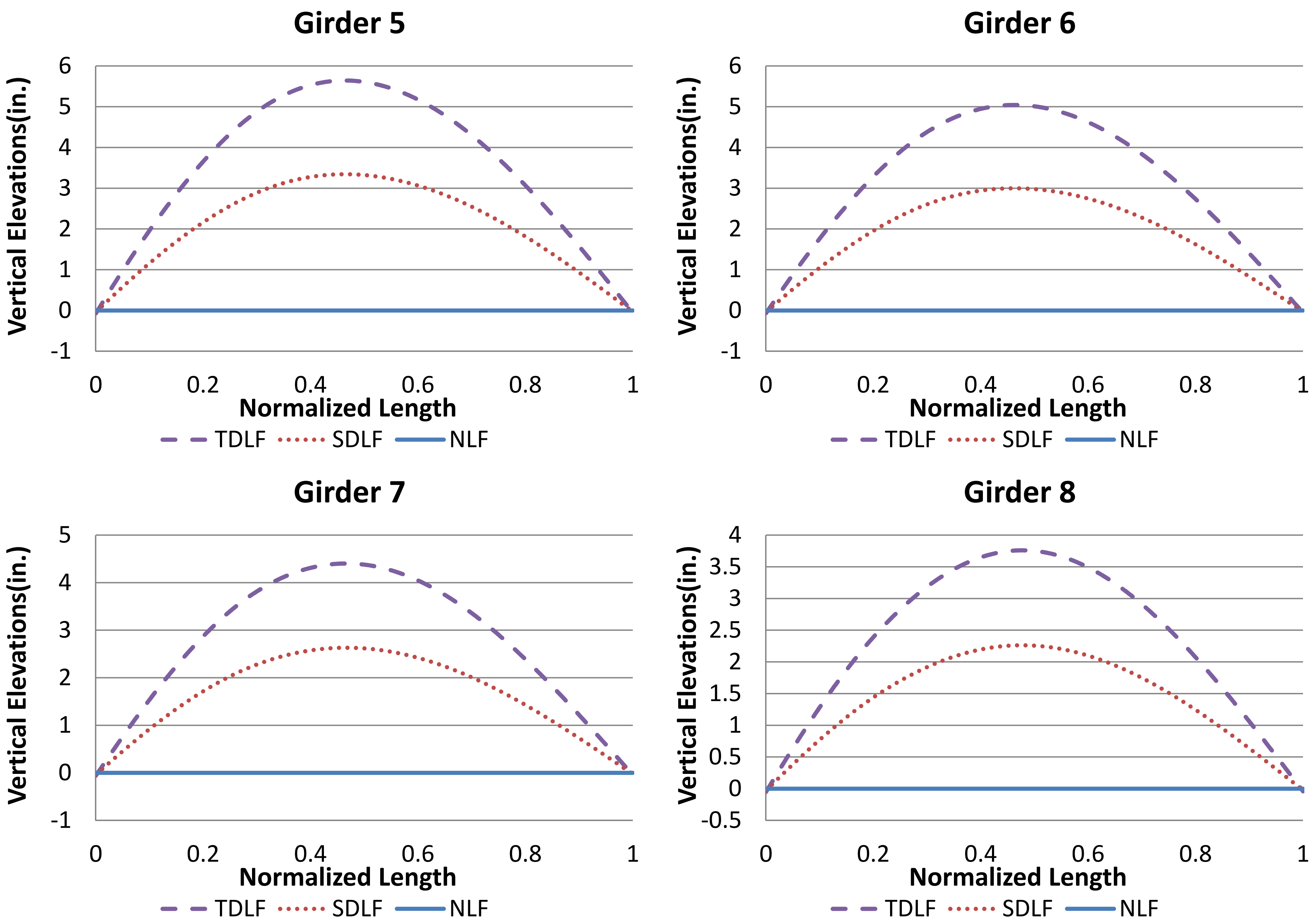


Figure R1-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

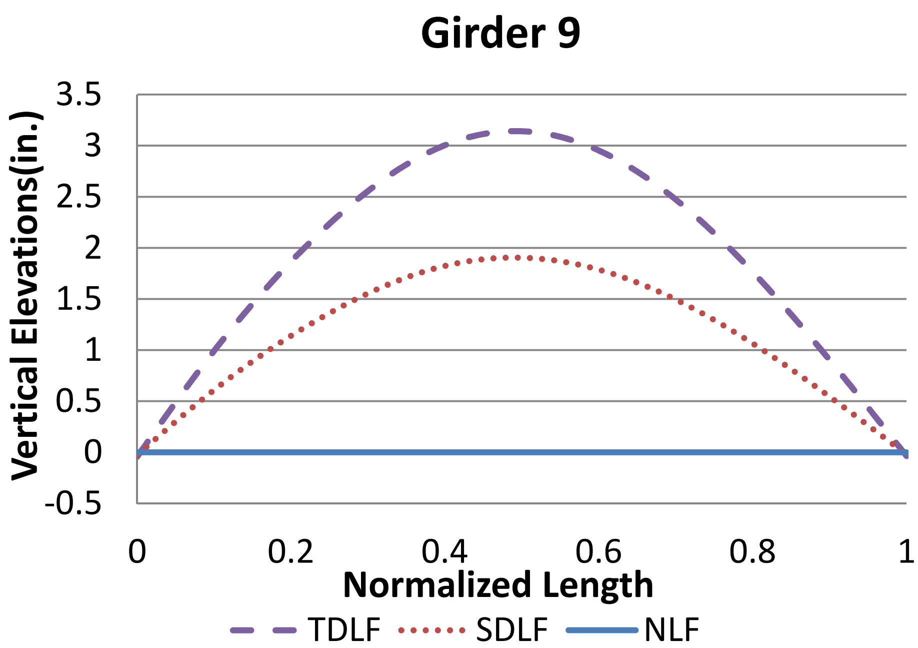


Figure R1-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

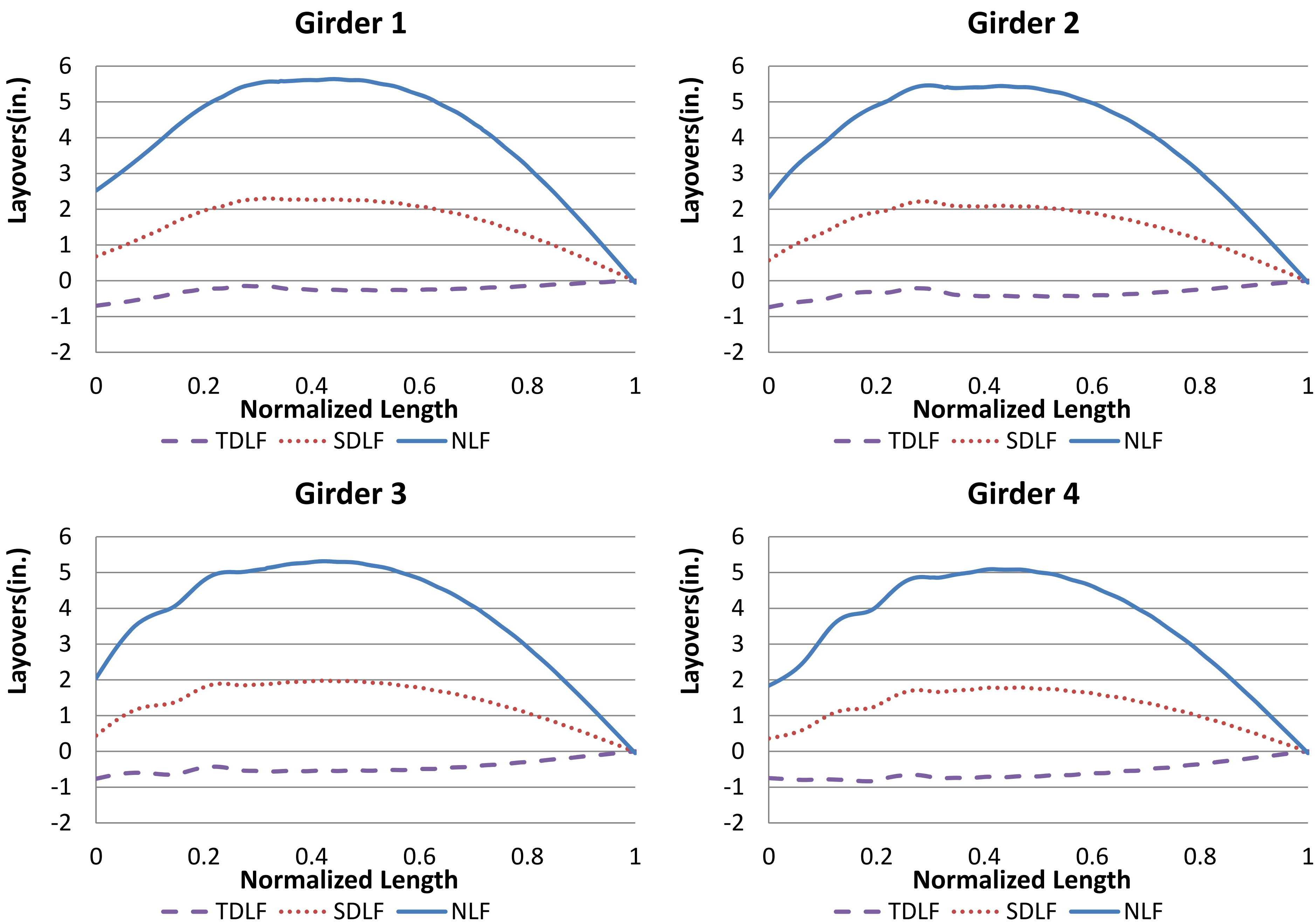


Figure R1-4-15. **Comparison of individual girder layovers (in) under TDL for different detailing methods.**

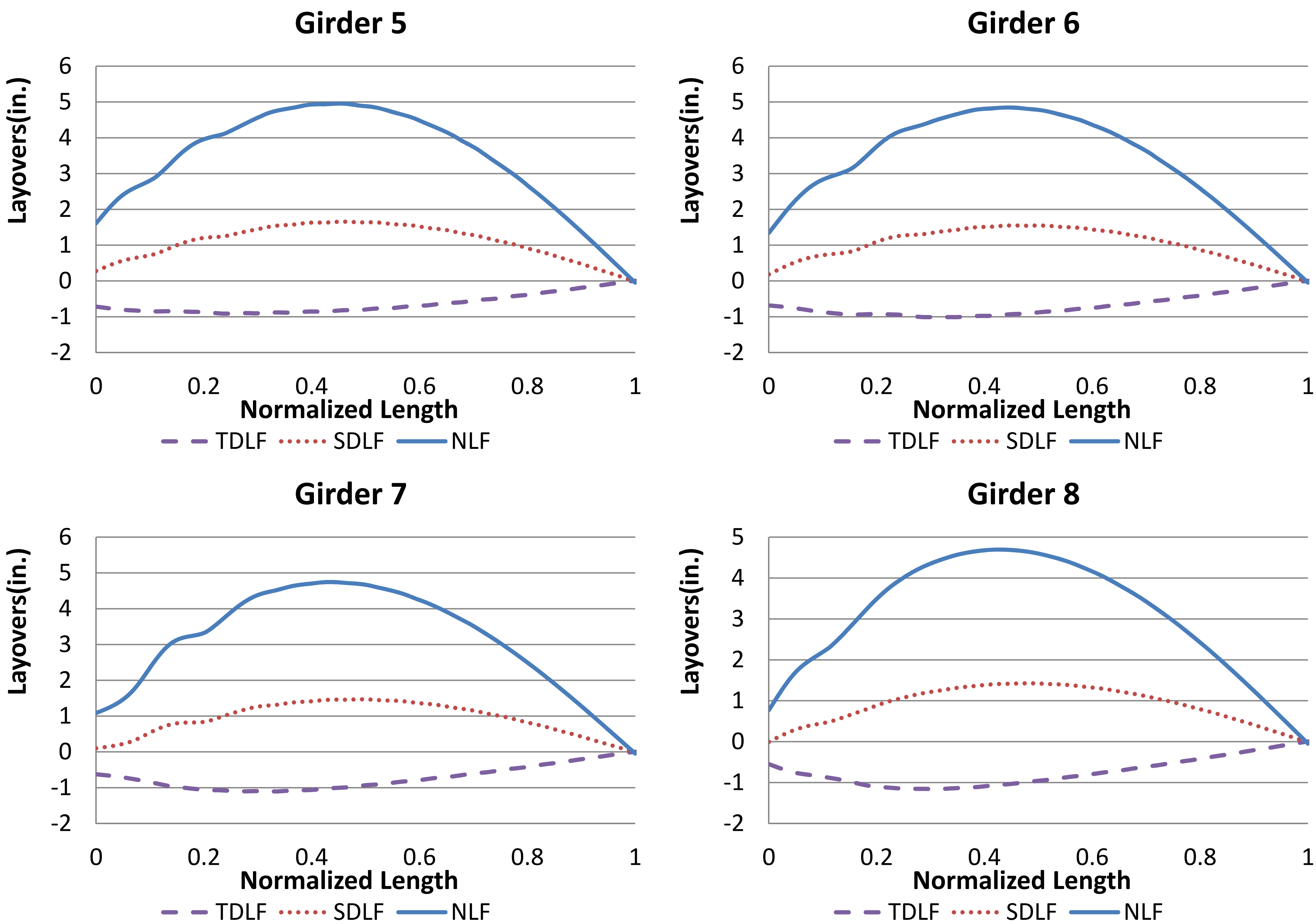


Figure R1-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

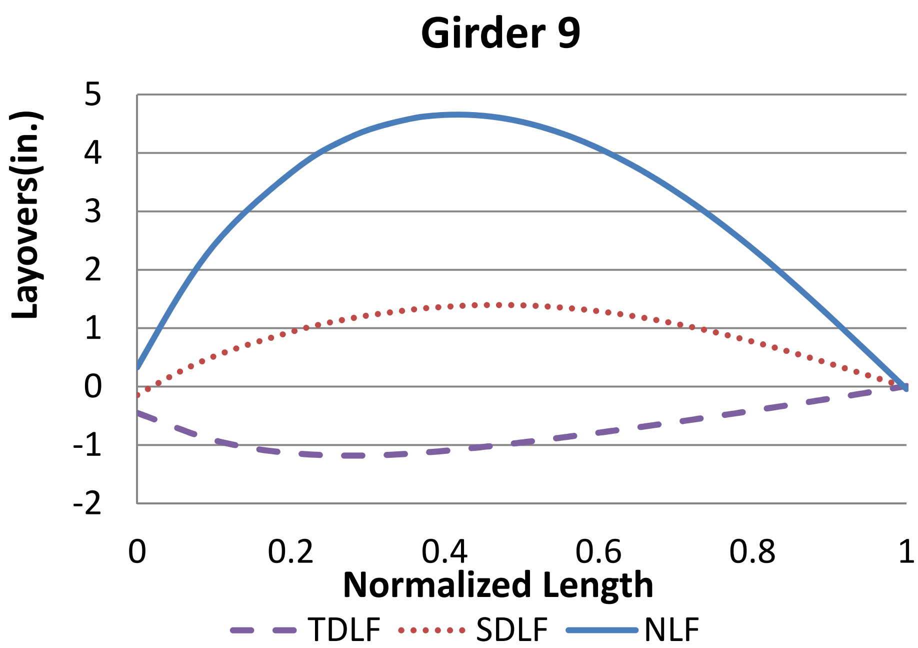


Figure R1-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

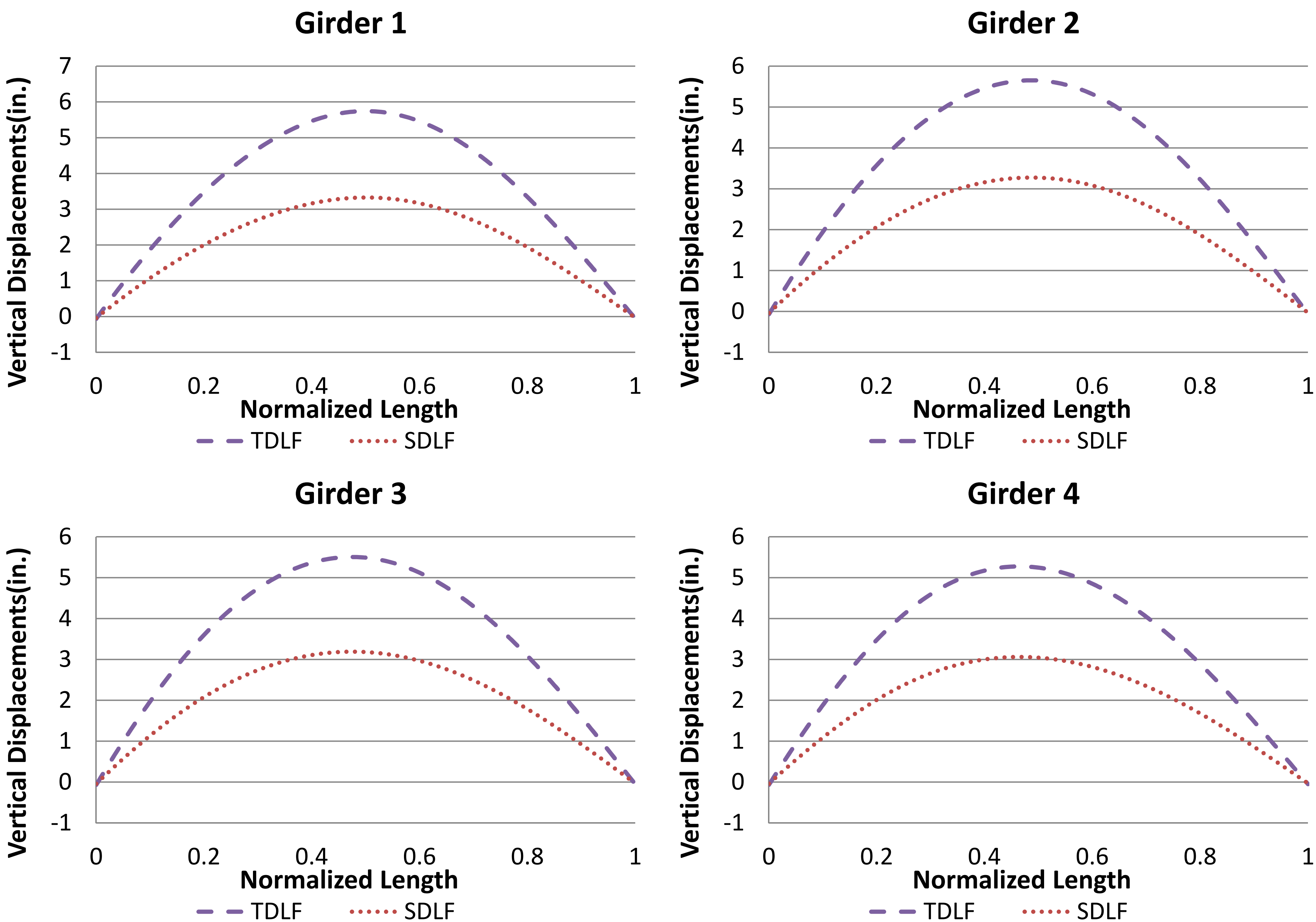


Figure R1-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

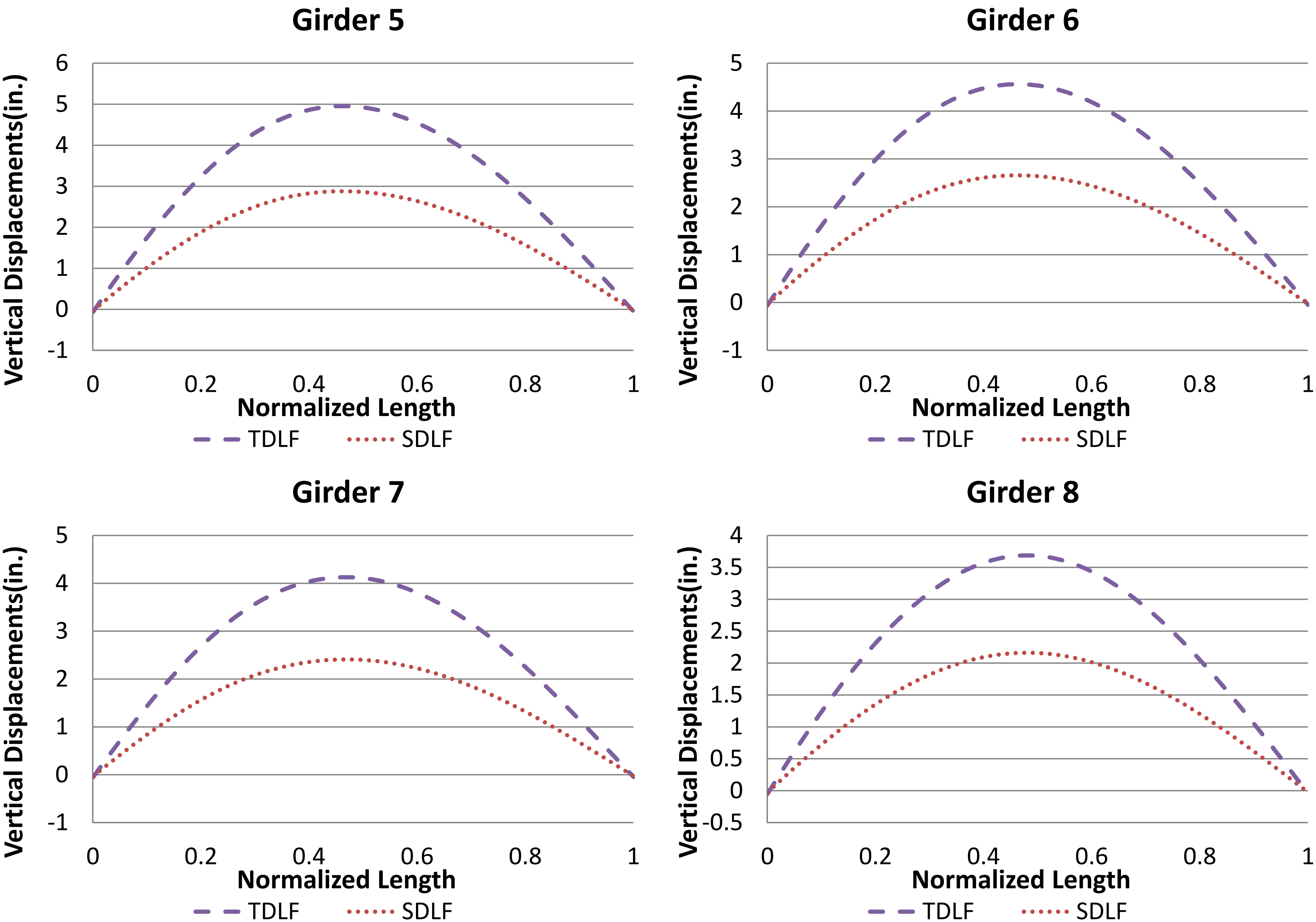


Figure R1-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

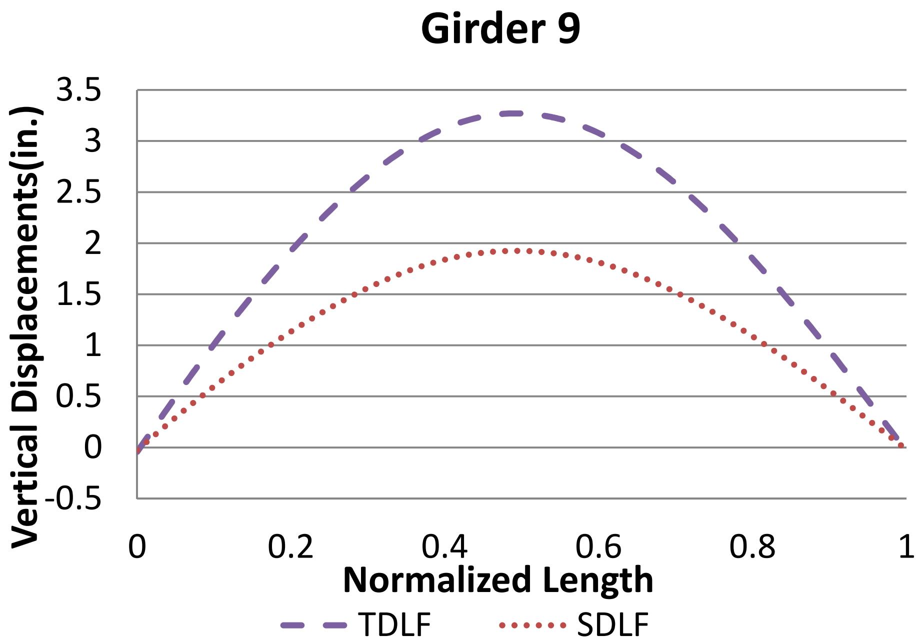


Figure R1-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

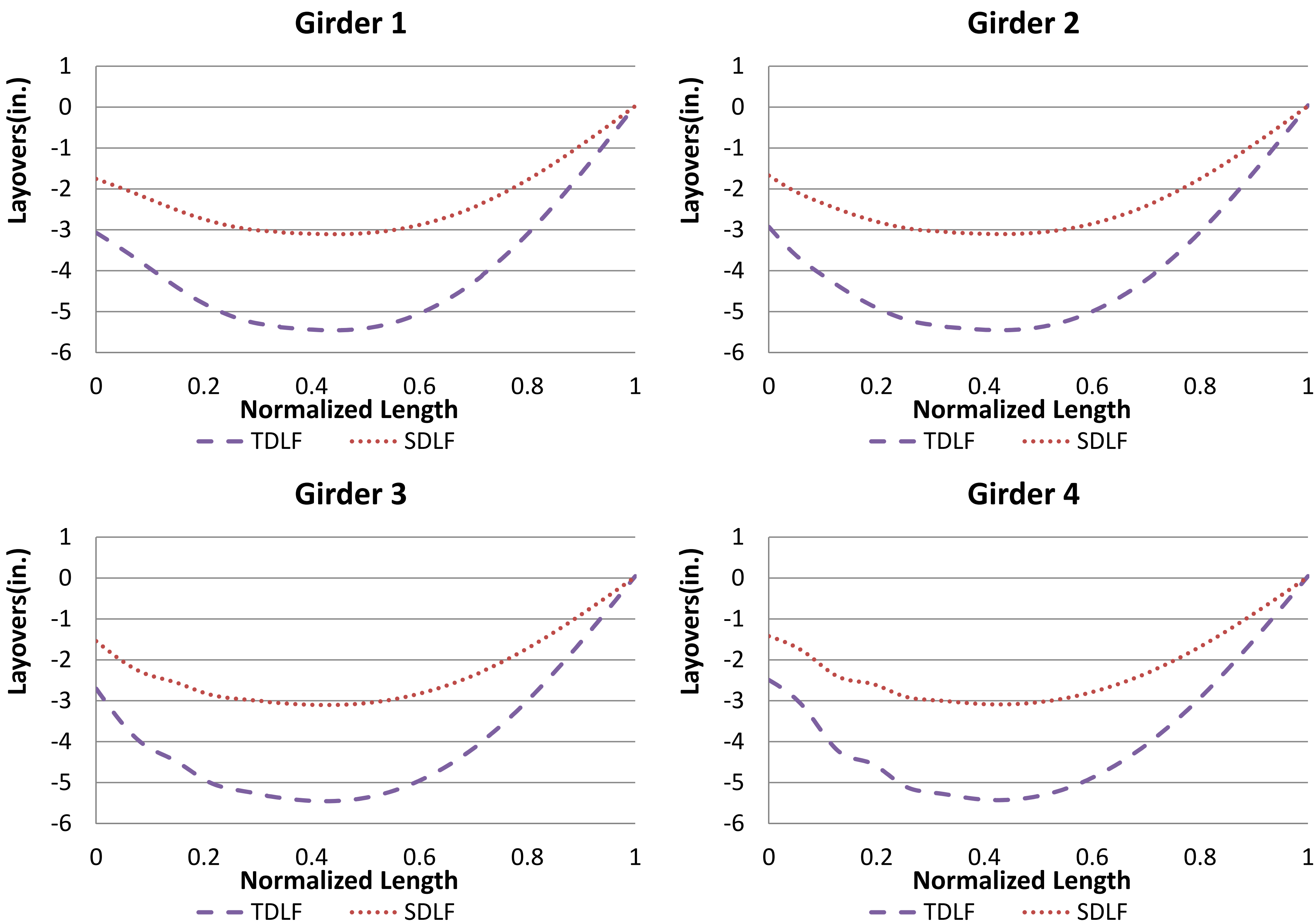


Figure R1-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

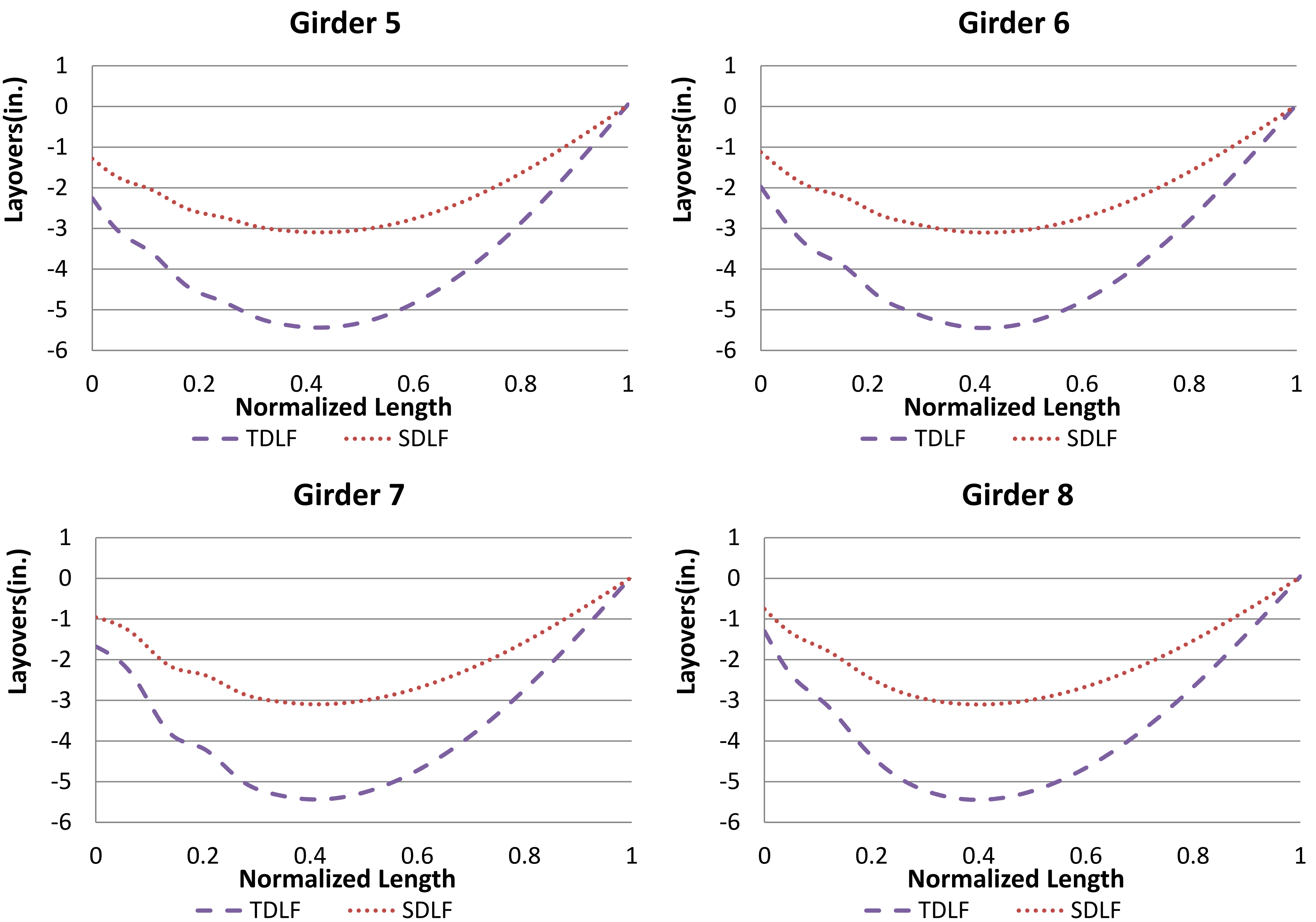


Figure R1-4-17(Continued). **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.**

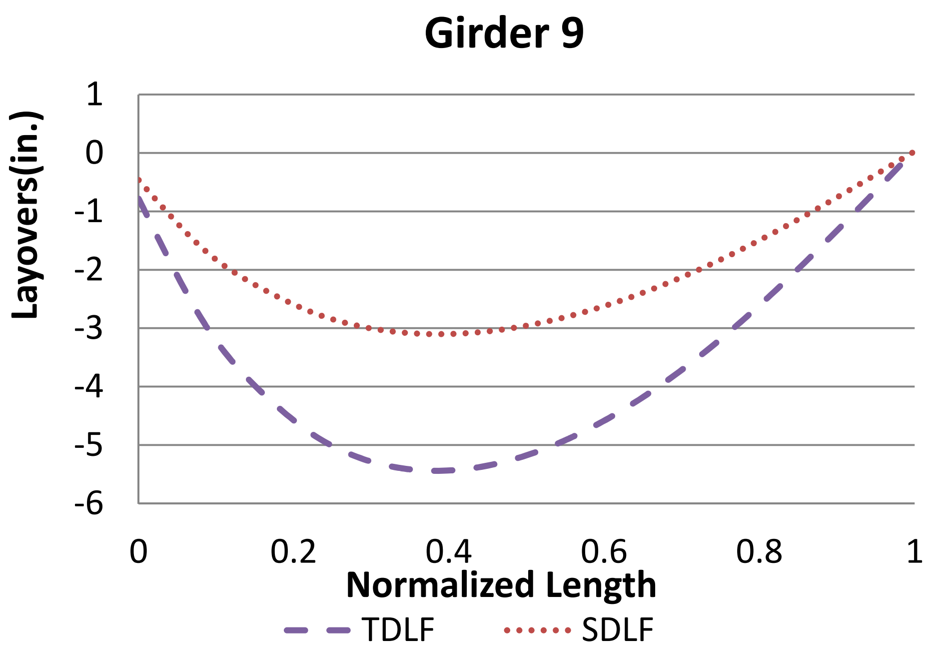


Figure R1-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

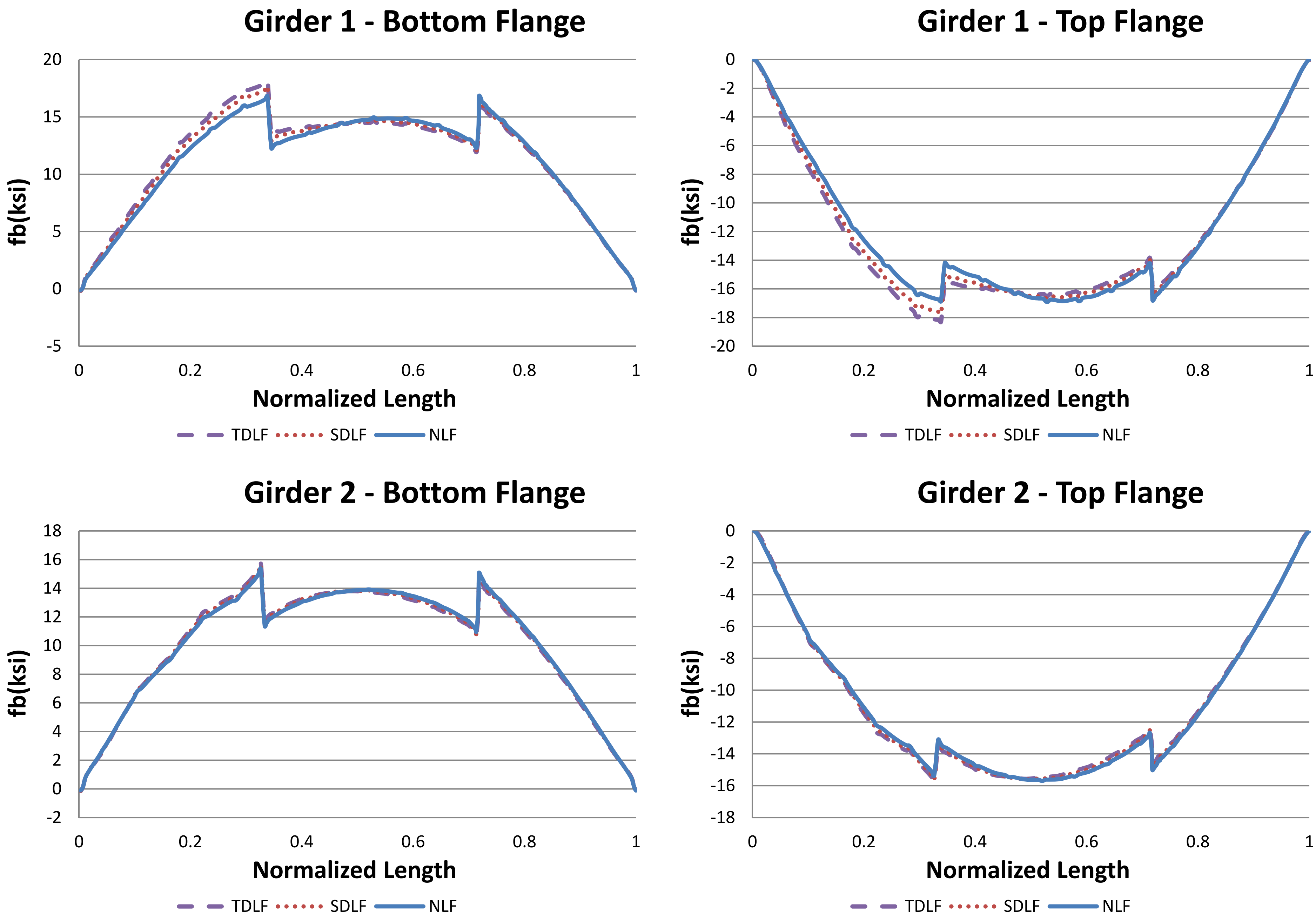


Figure R1-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

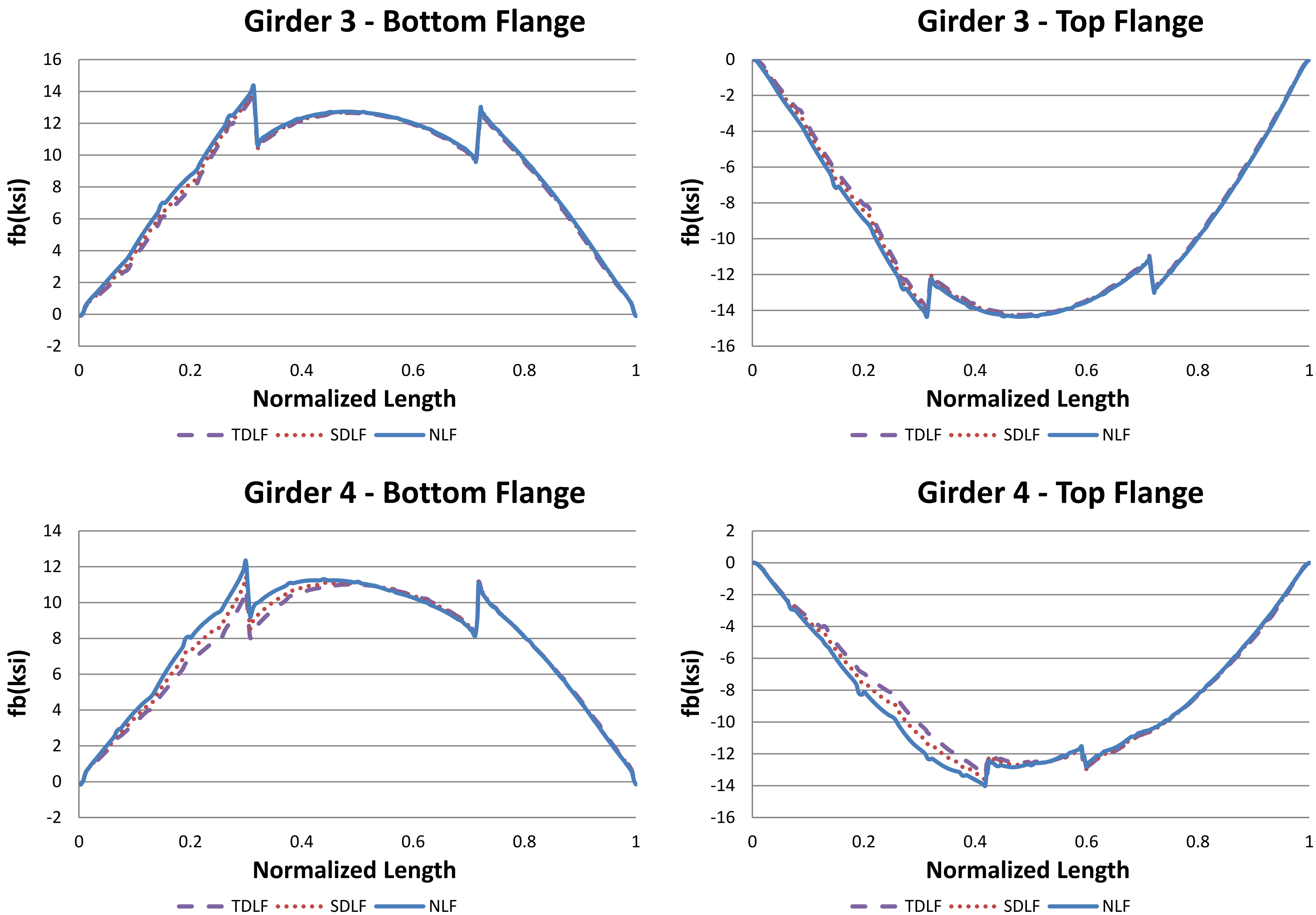


Figure R1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

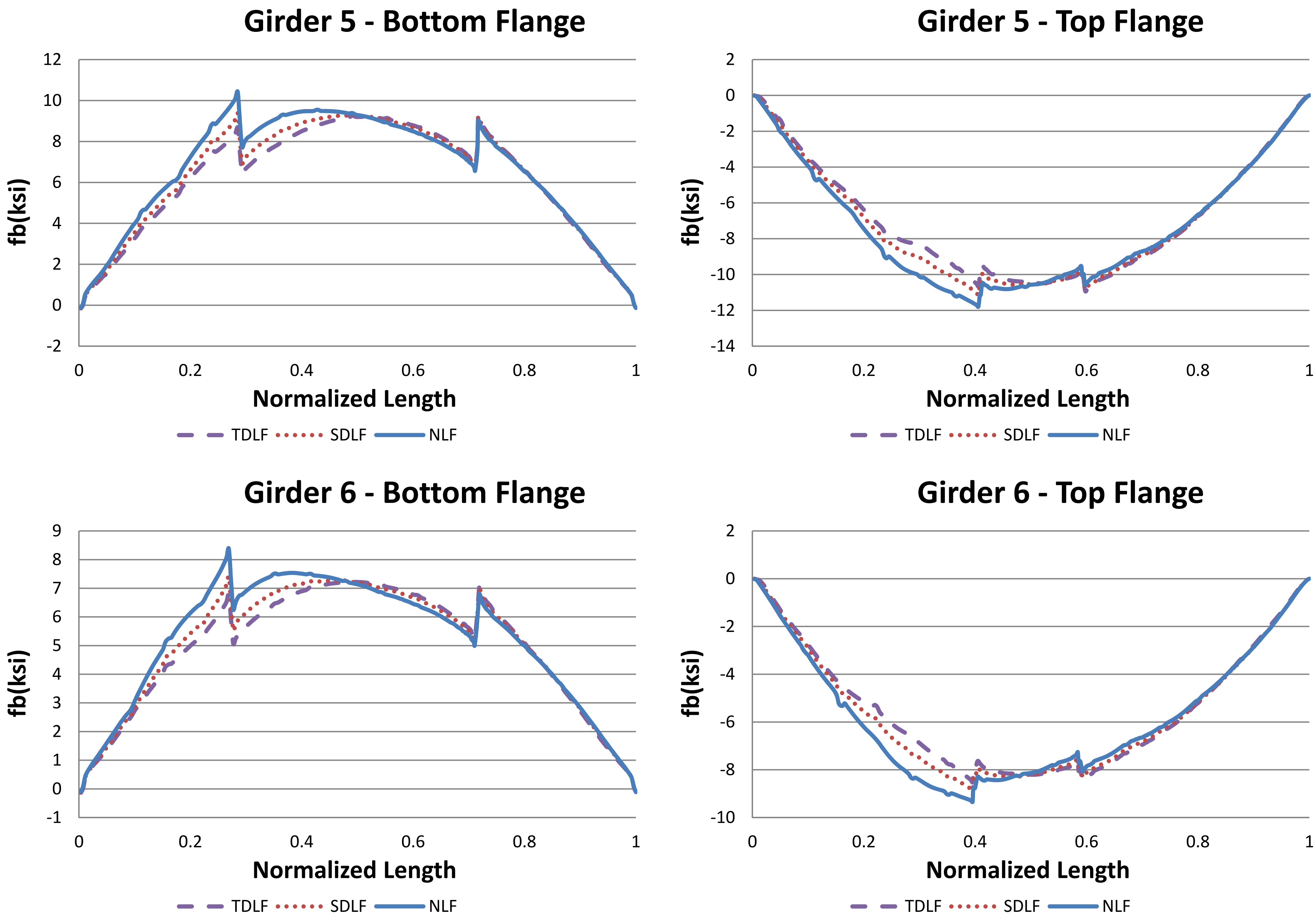


Figure R1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

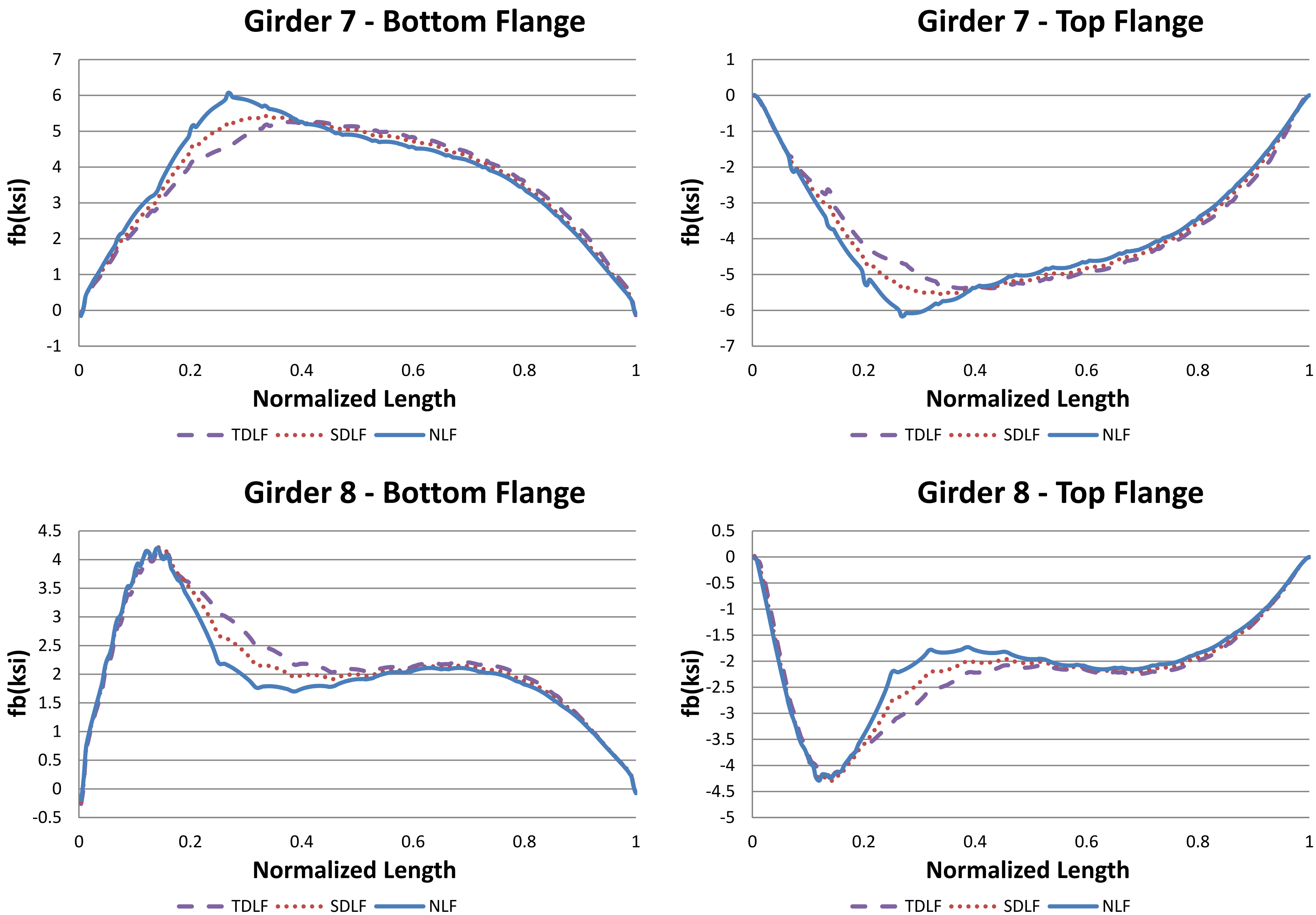
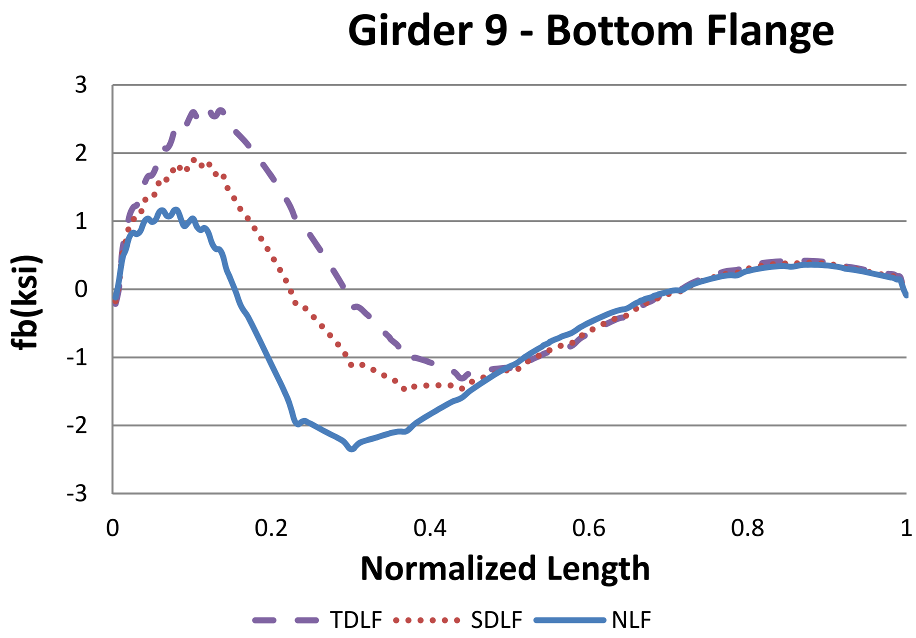


Figure R1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.



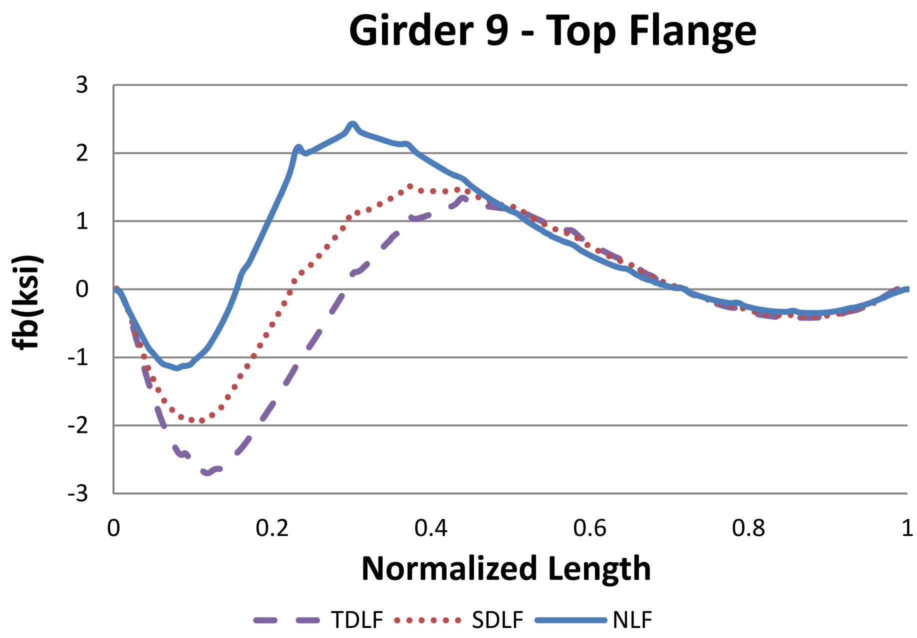


Figure R1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

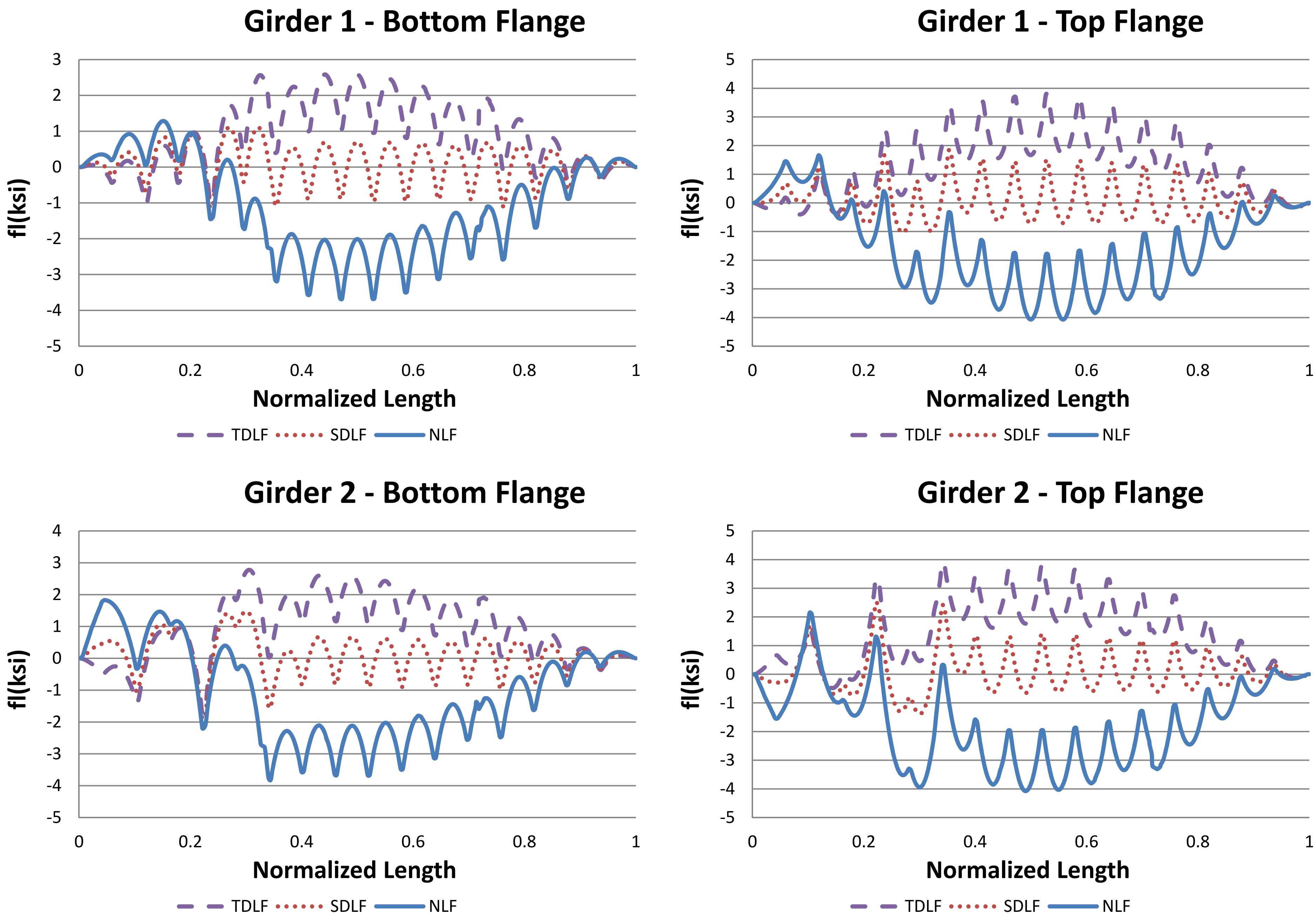
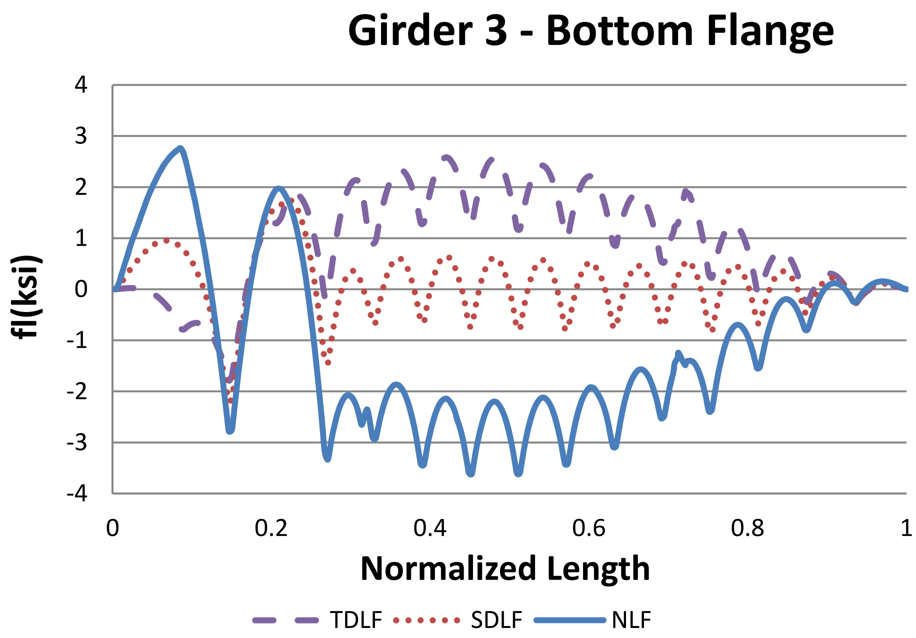
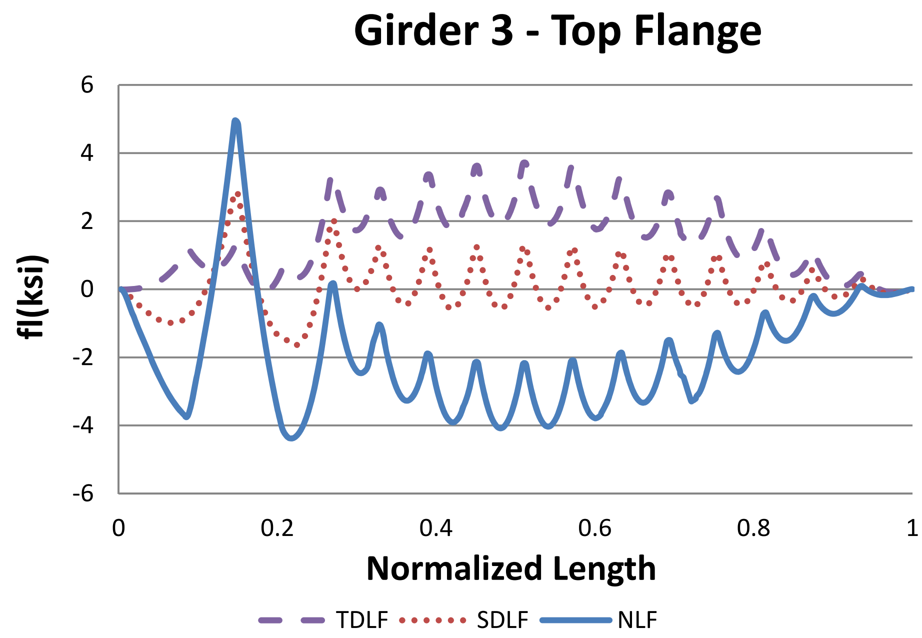
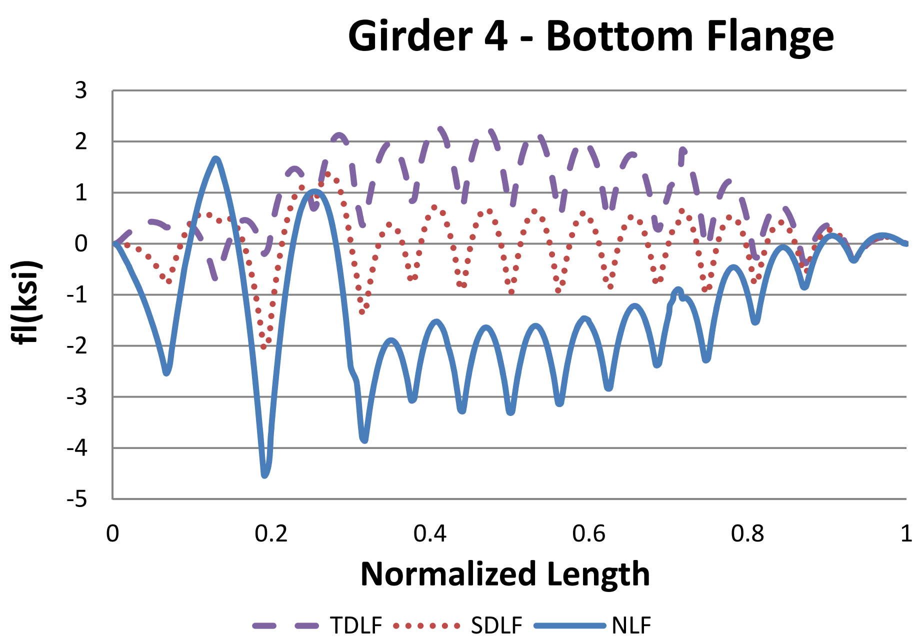


Figure R1-4-19. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**







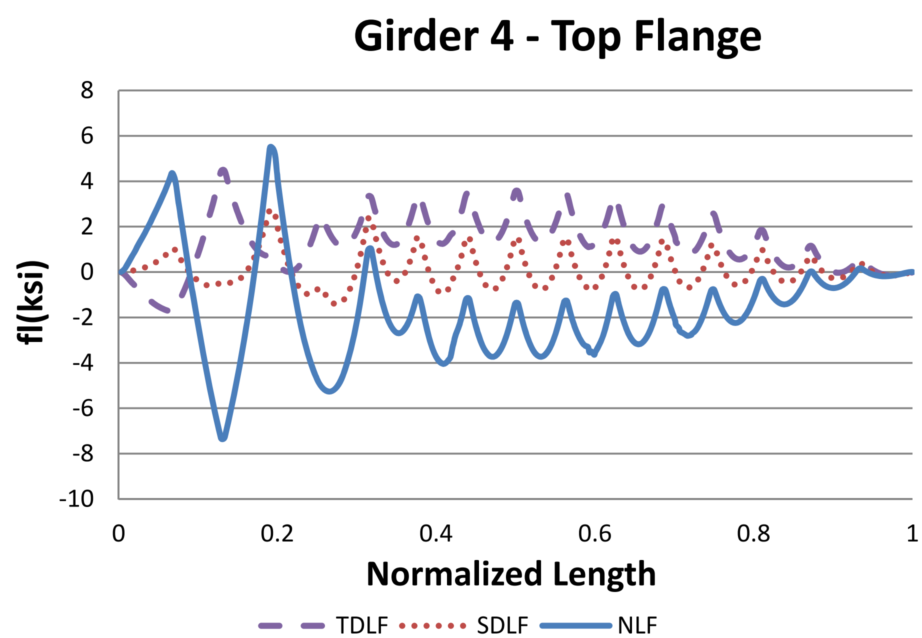


Figure R1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

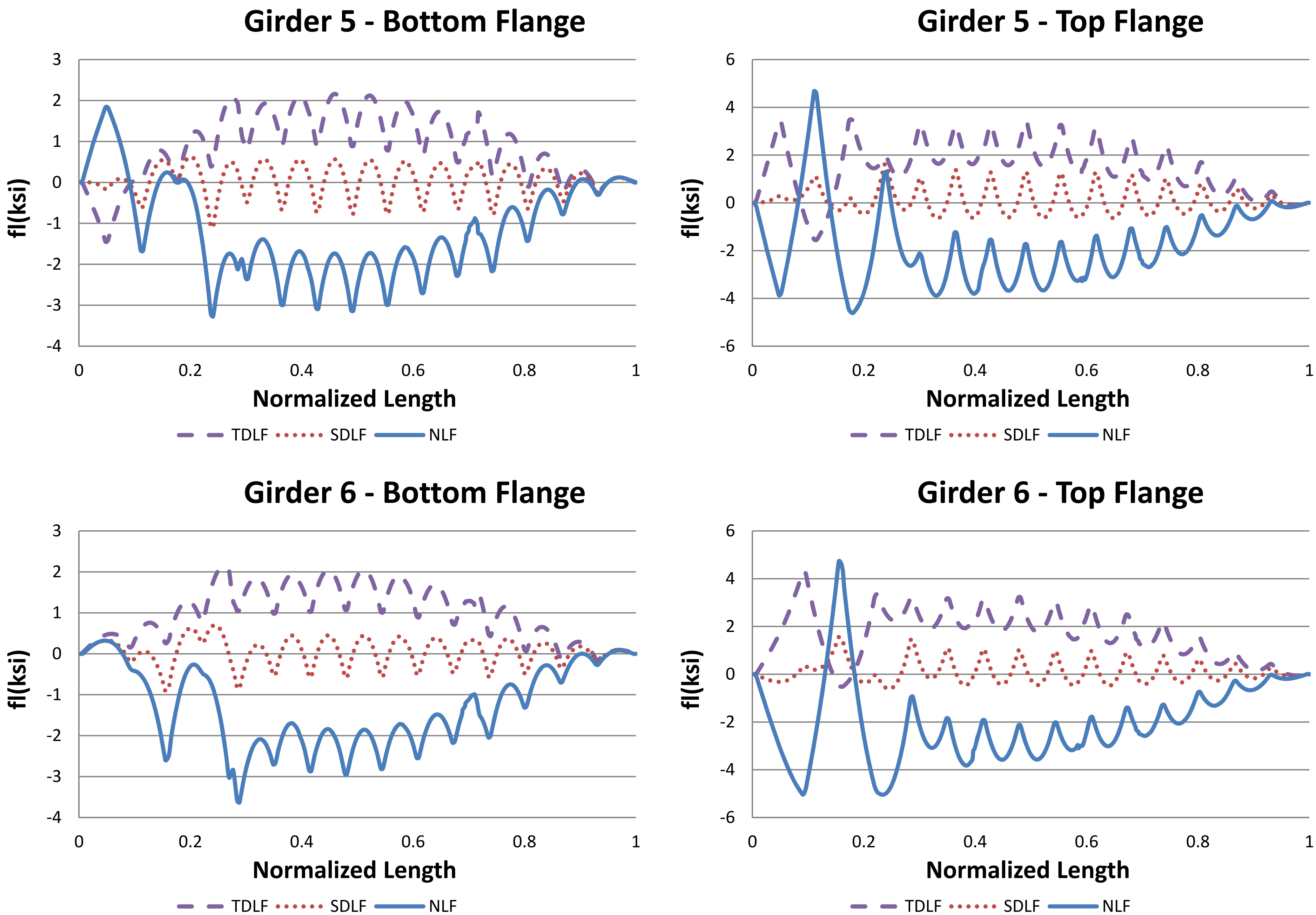


Figure R1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

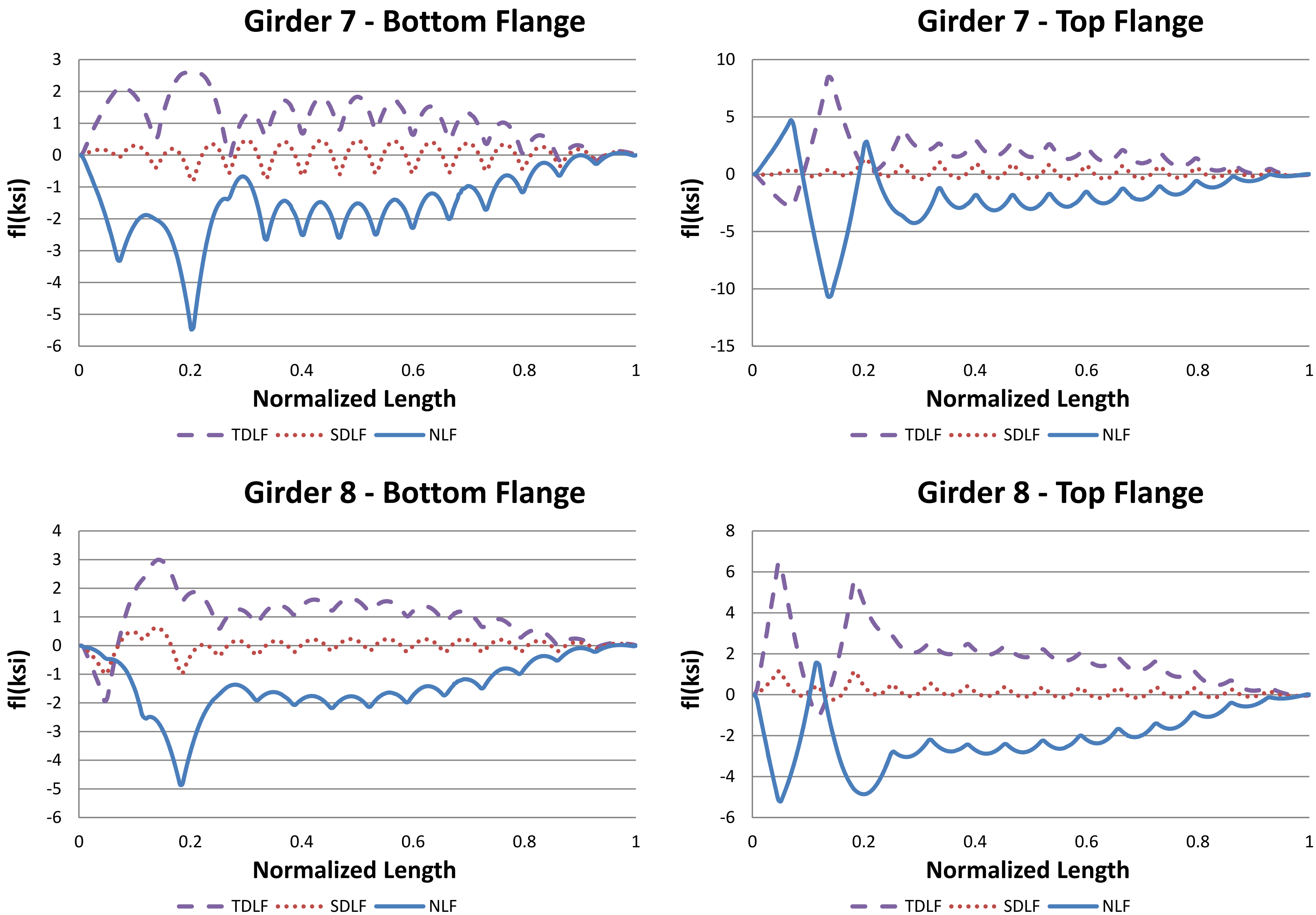
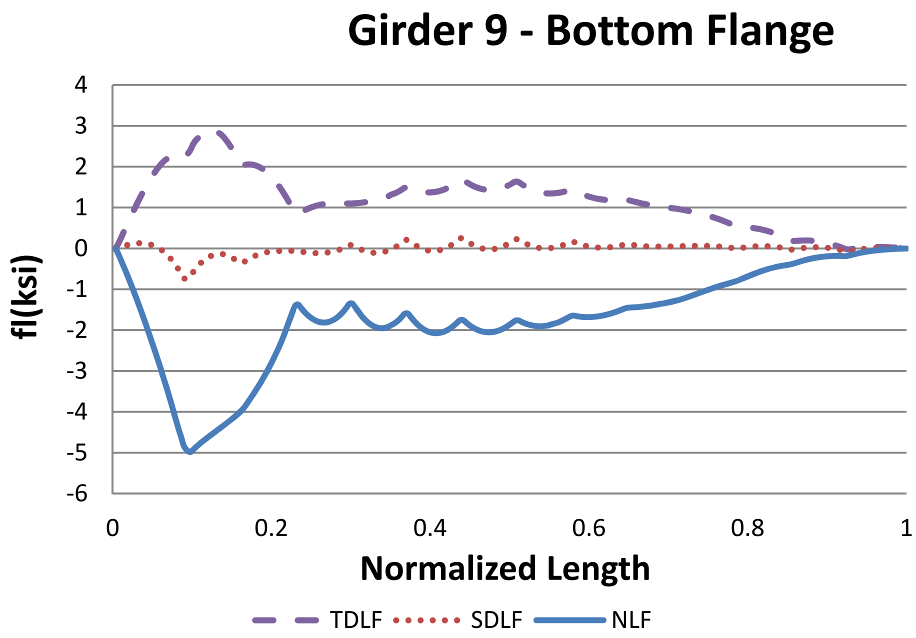


Figure R1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.



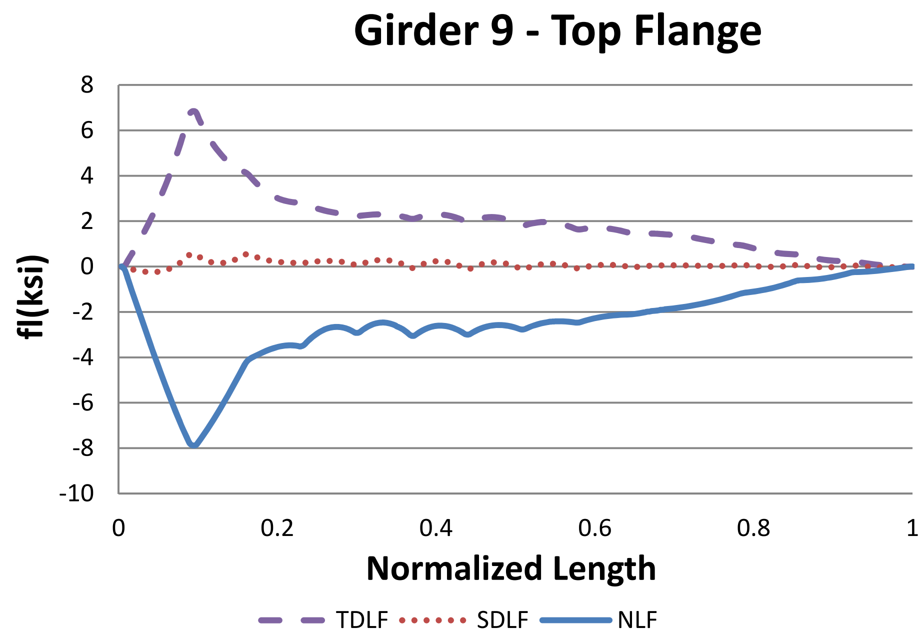


Figure R1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

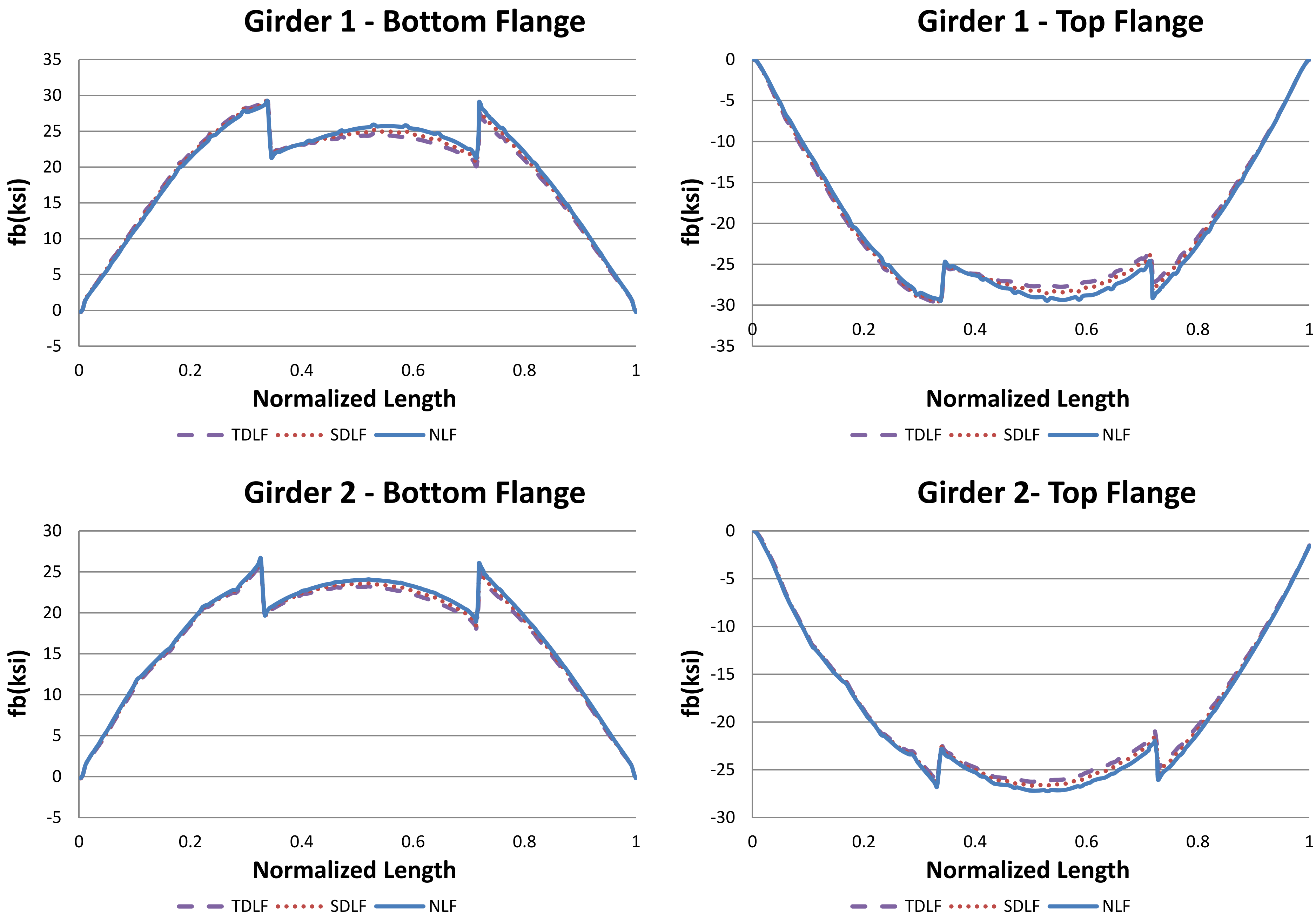


Figure R1-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

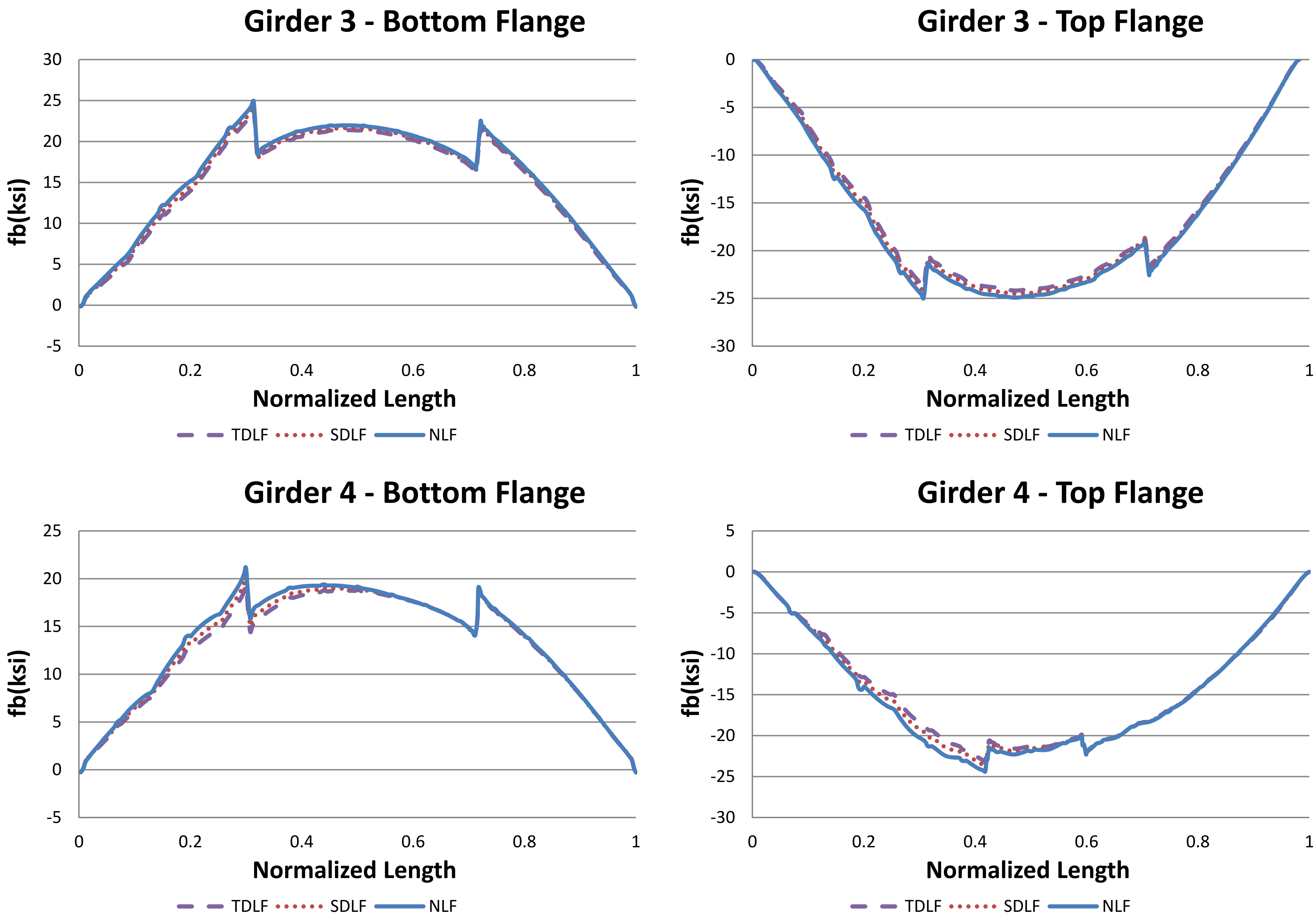


Figure R1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

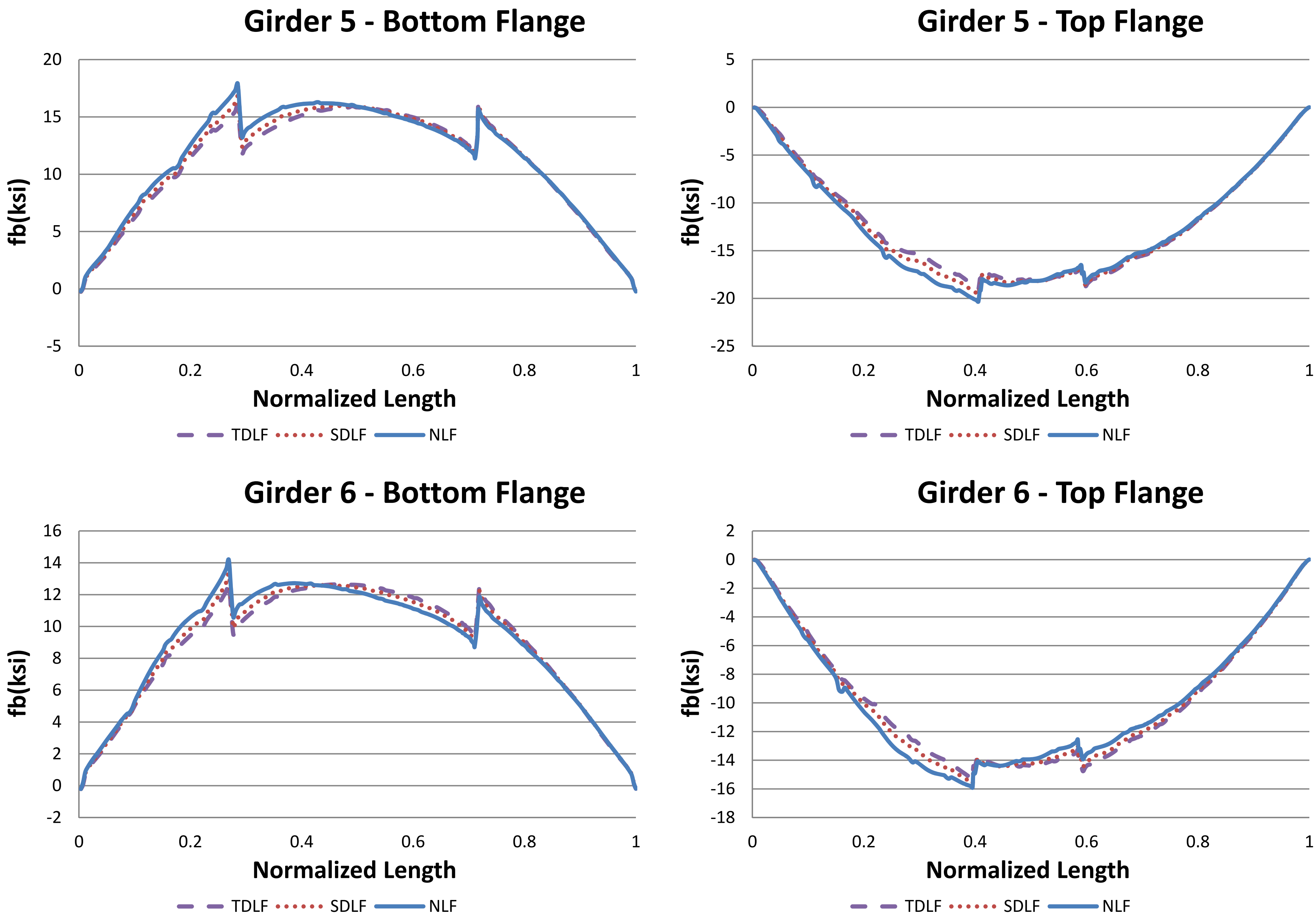


Figure R1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

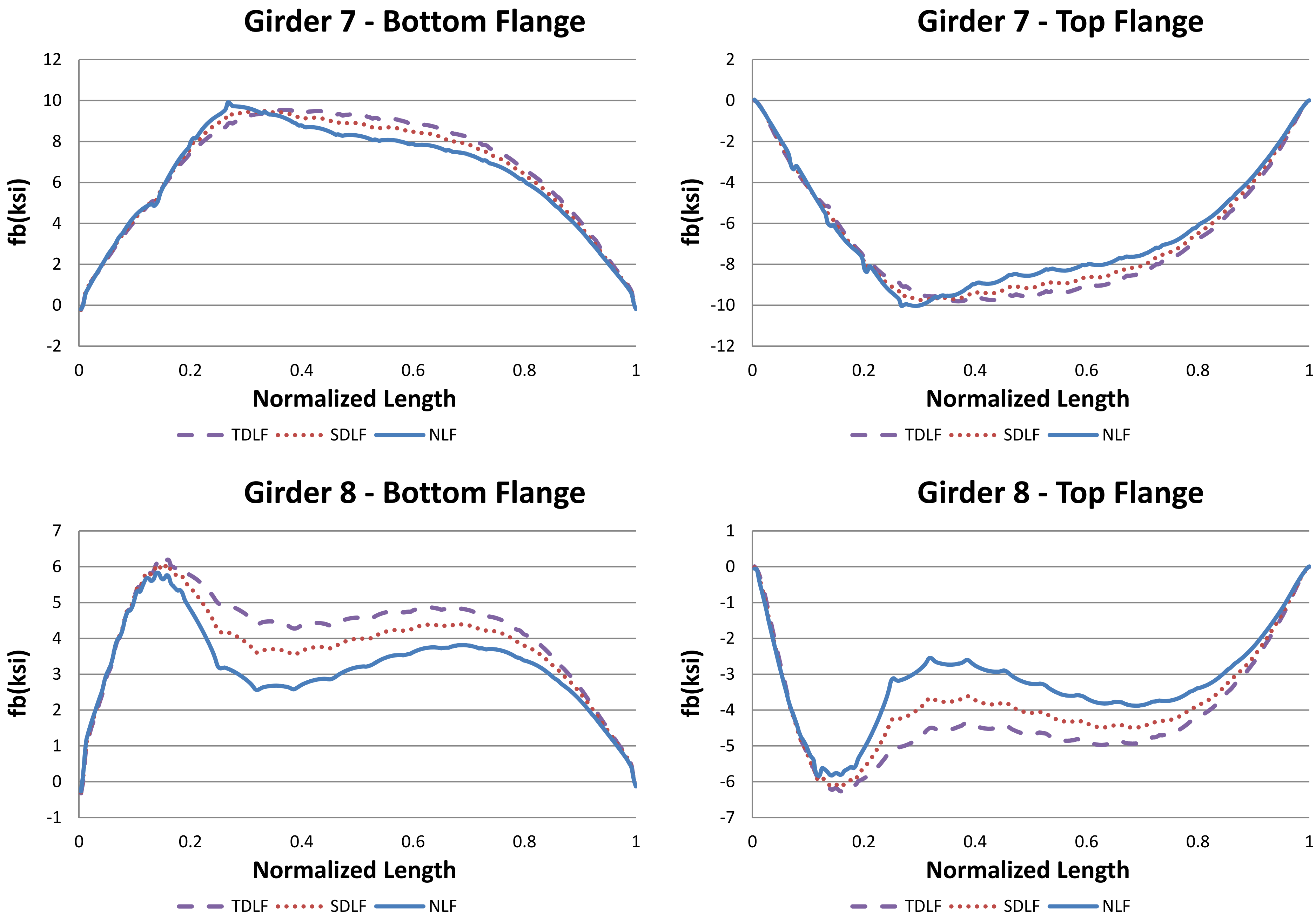
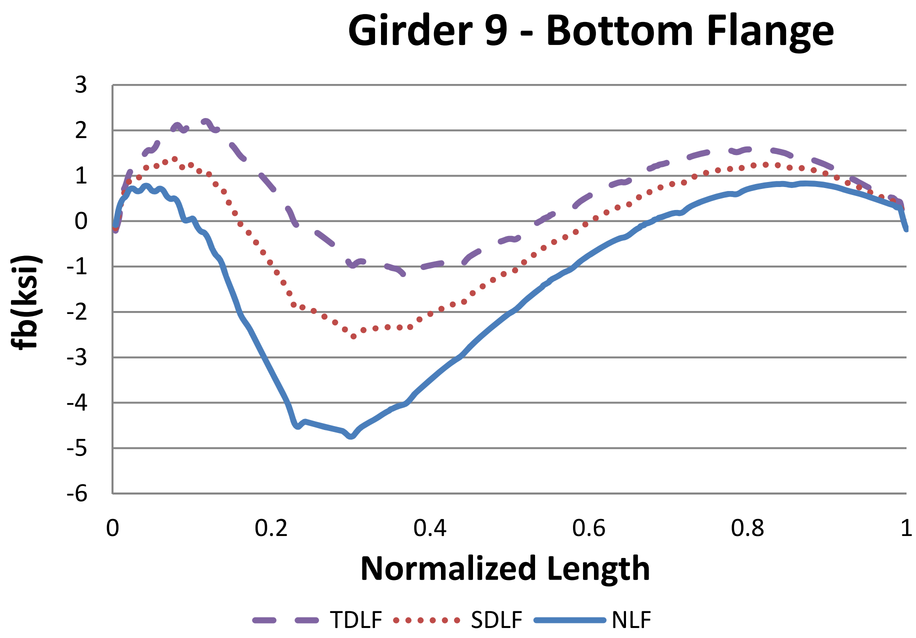


Figure R1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



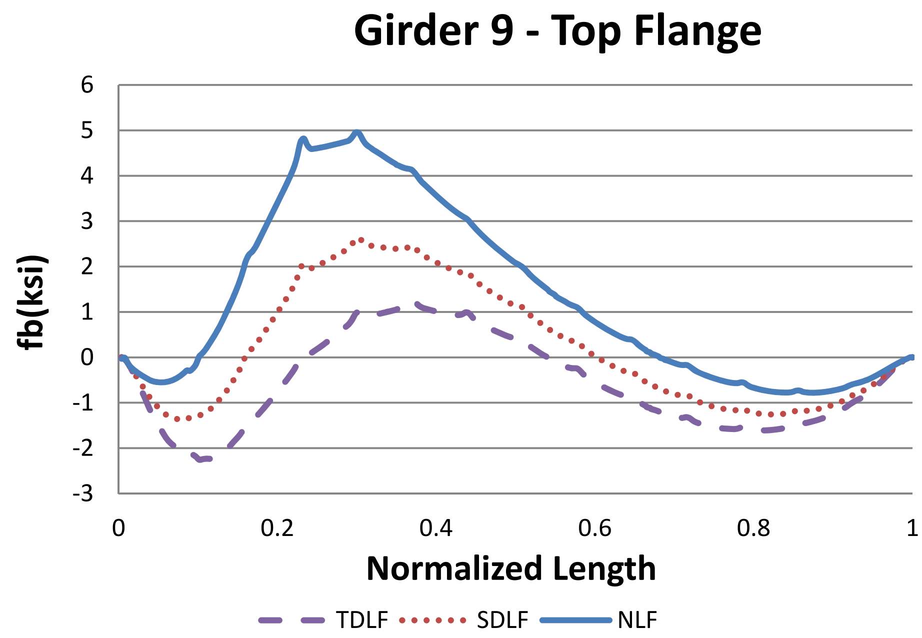


Figure R1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

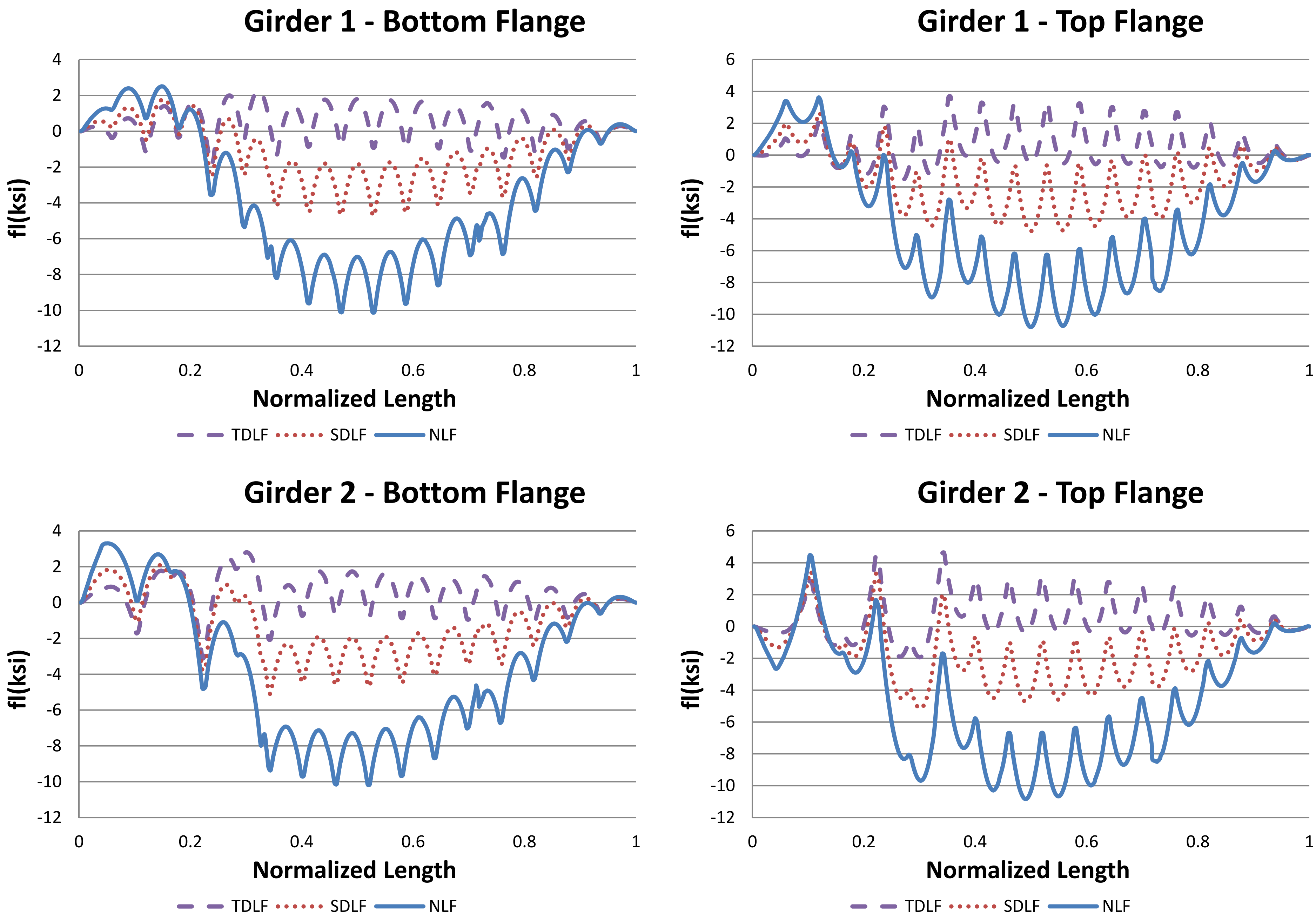


Figure R1-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

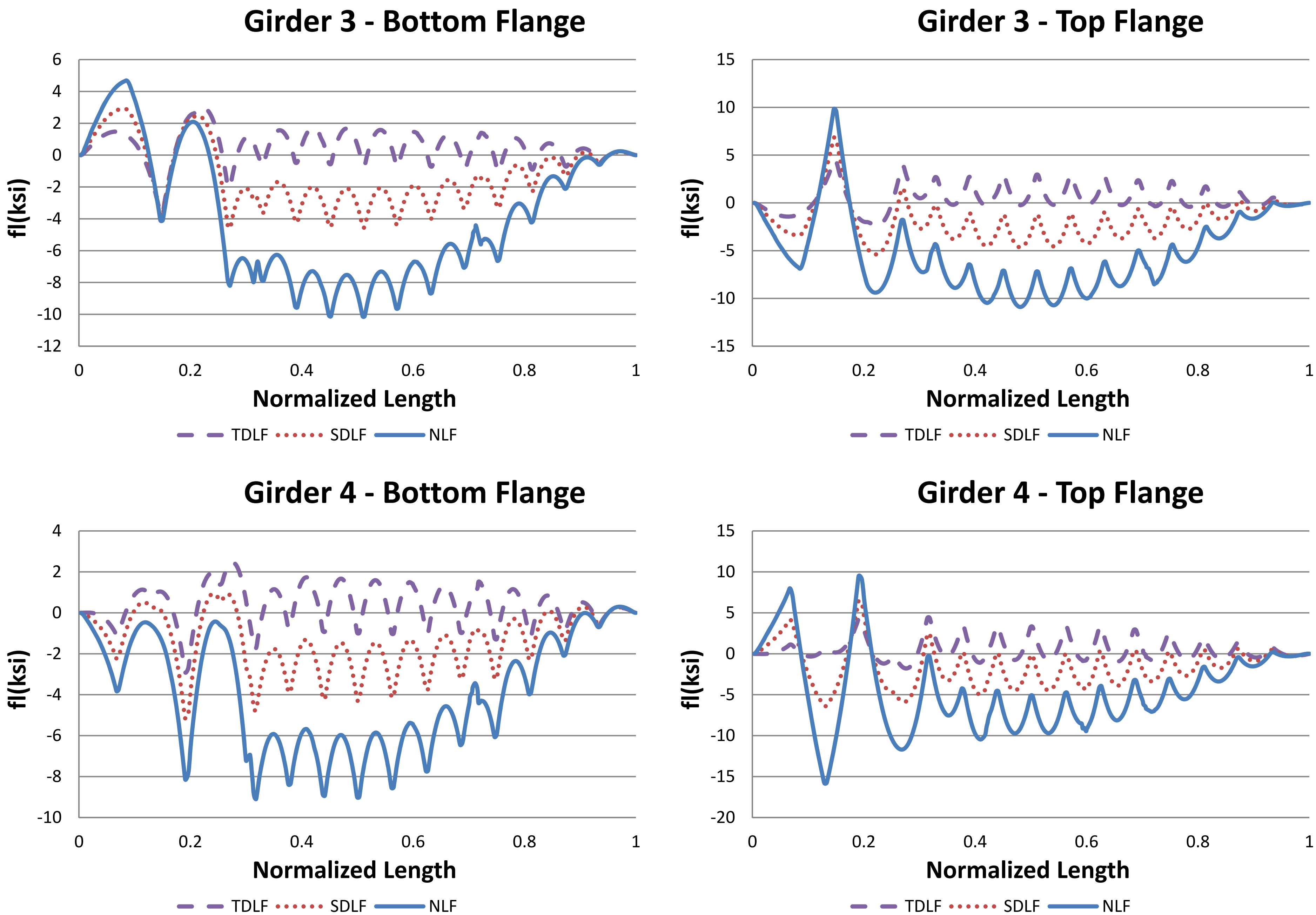


Figure R1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

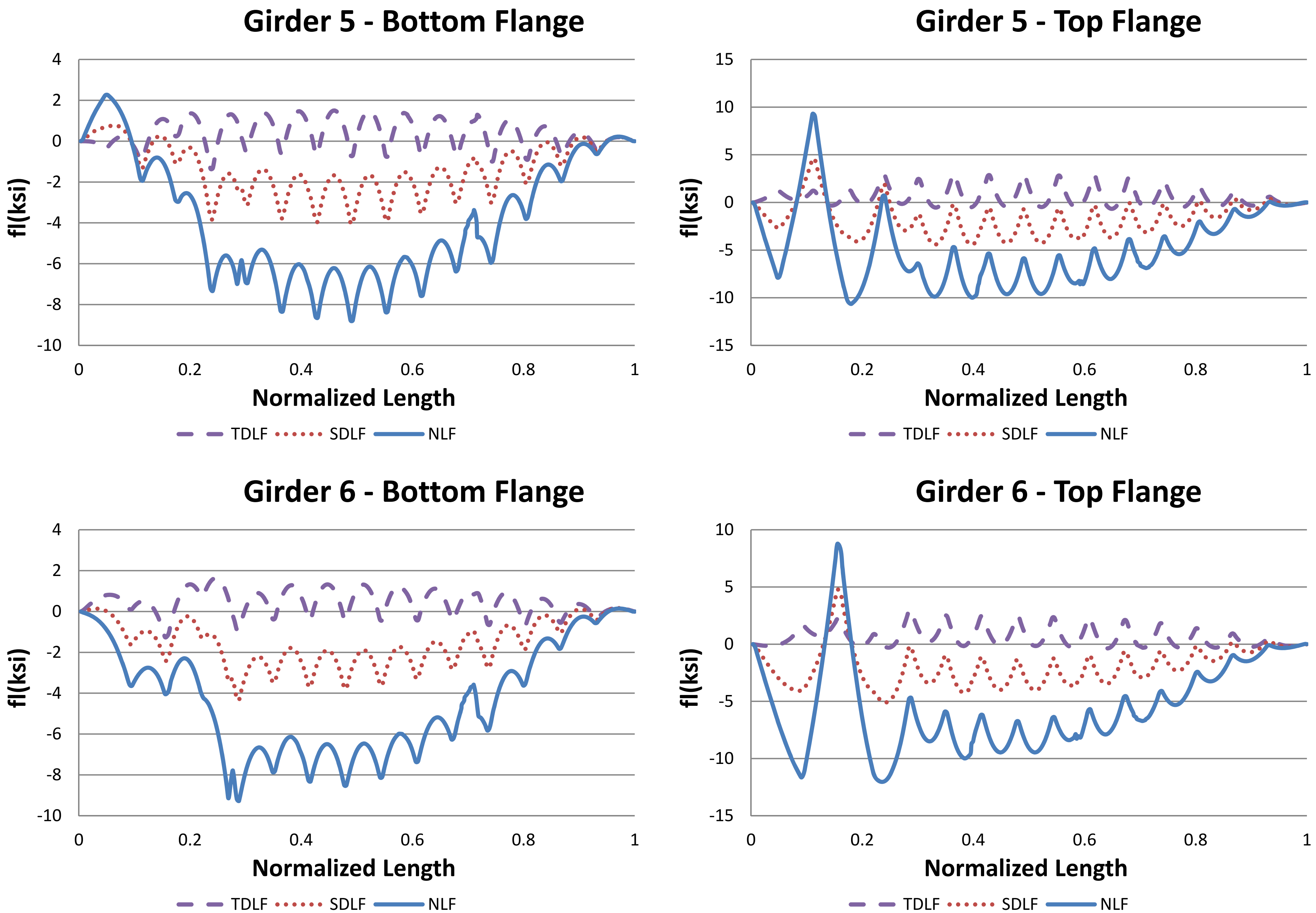


Figure R1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

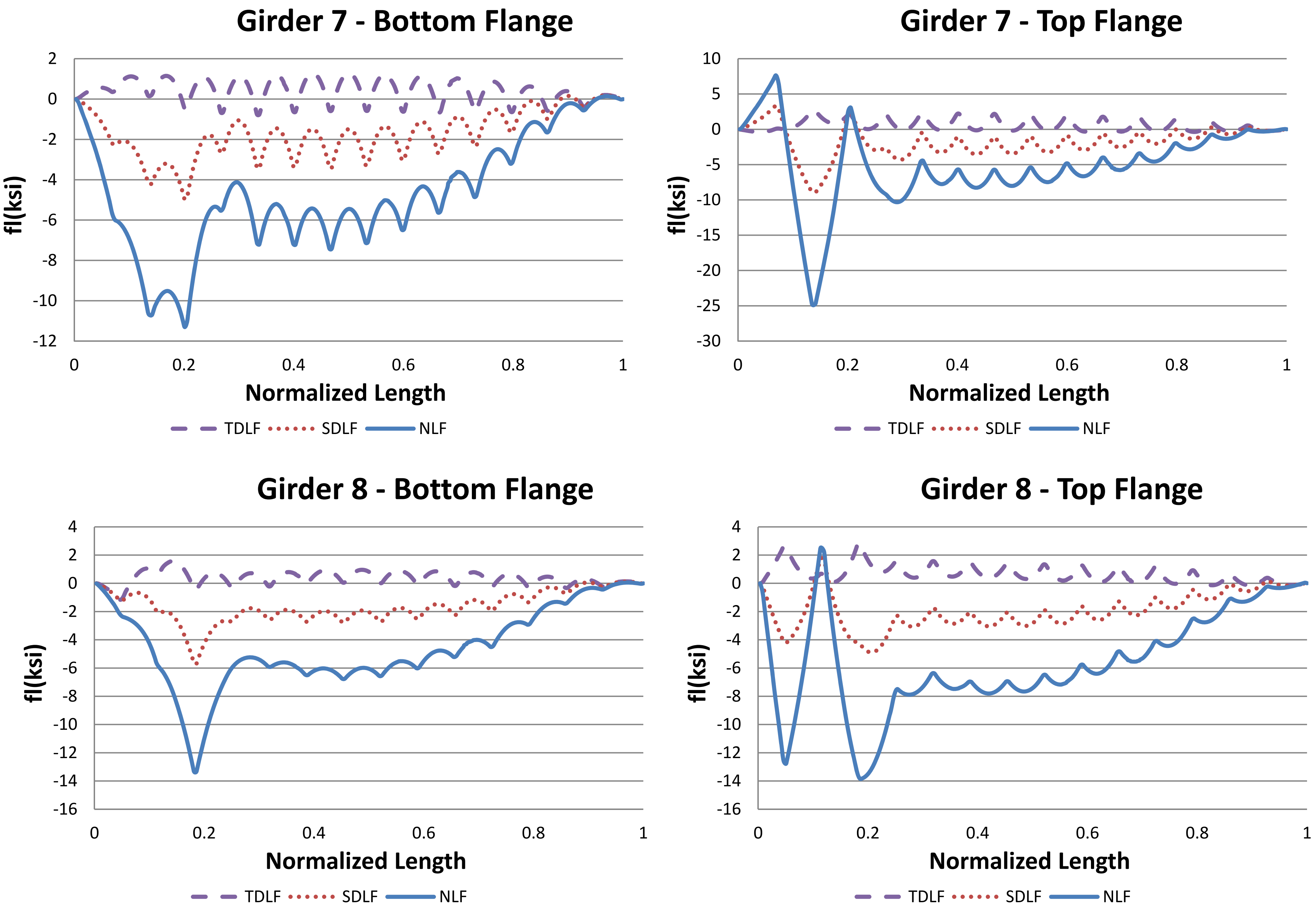


Figure R1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

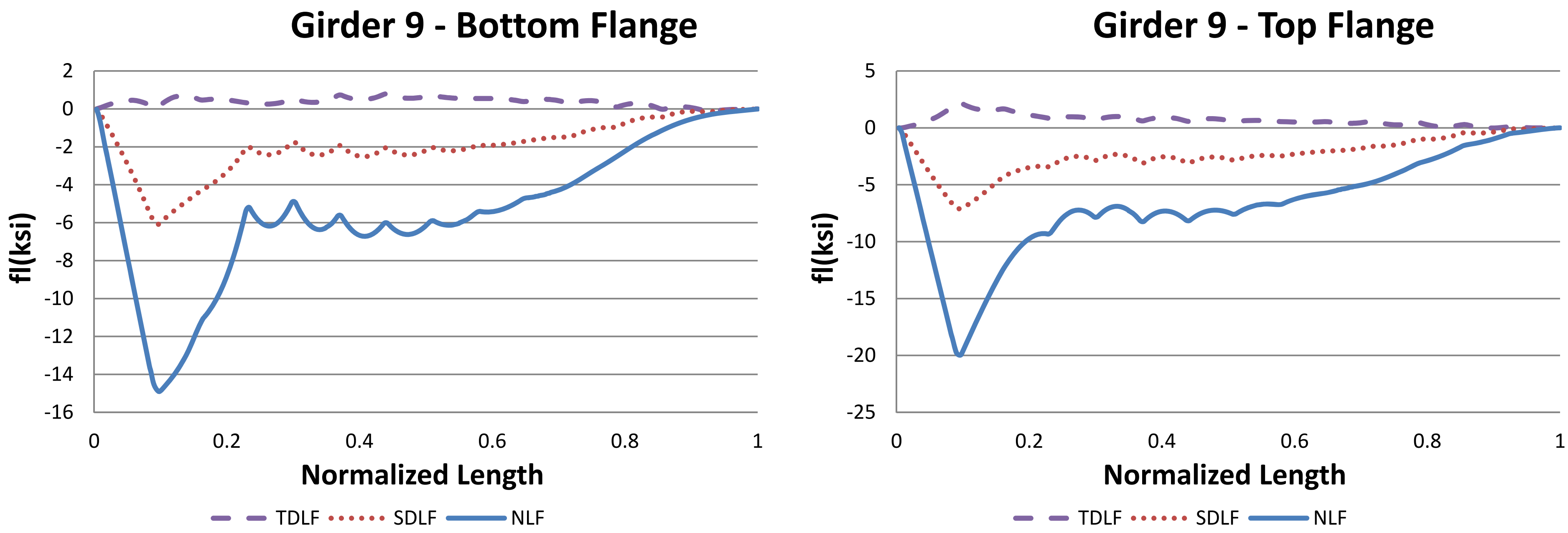


Figure R1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

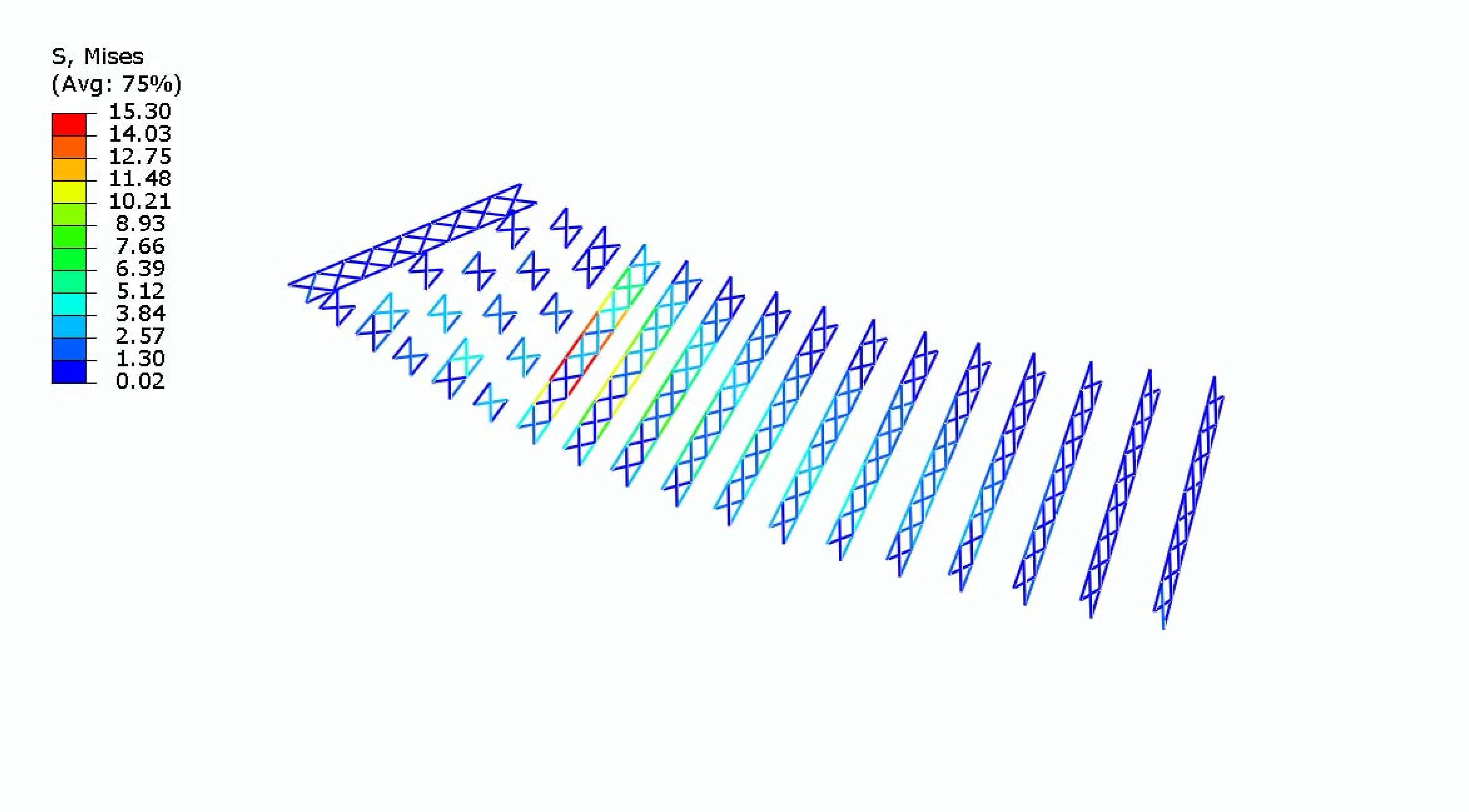


Figure R1-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing

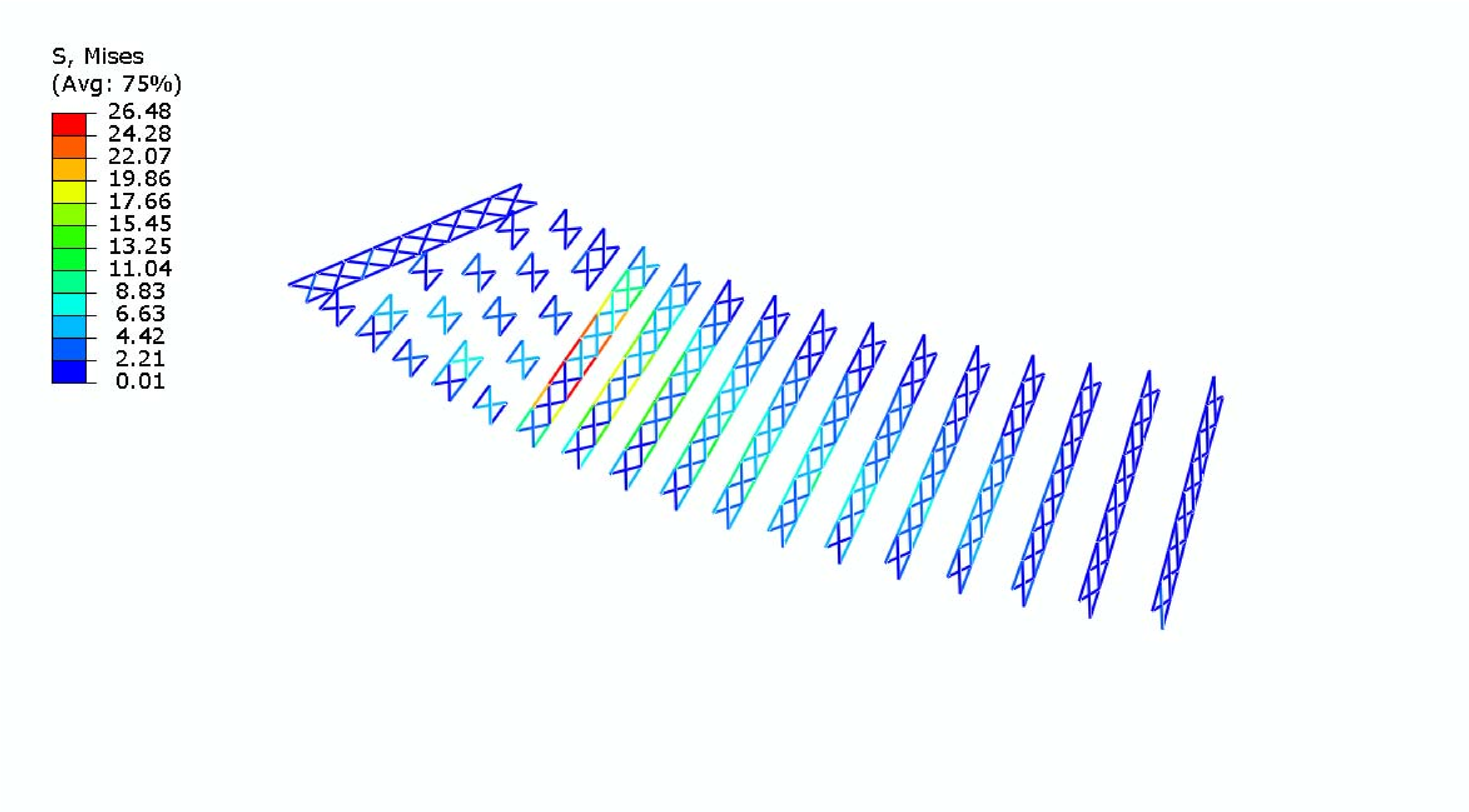


Figure R1-4-23. **Cross-frame stress contours under TDL, NLF detailing**

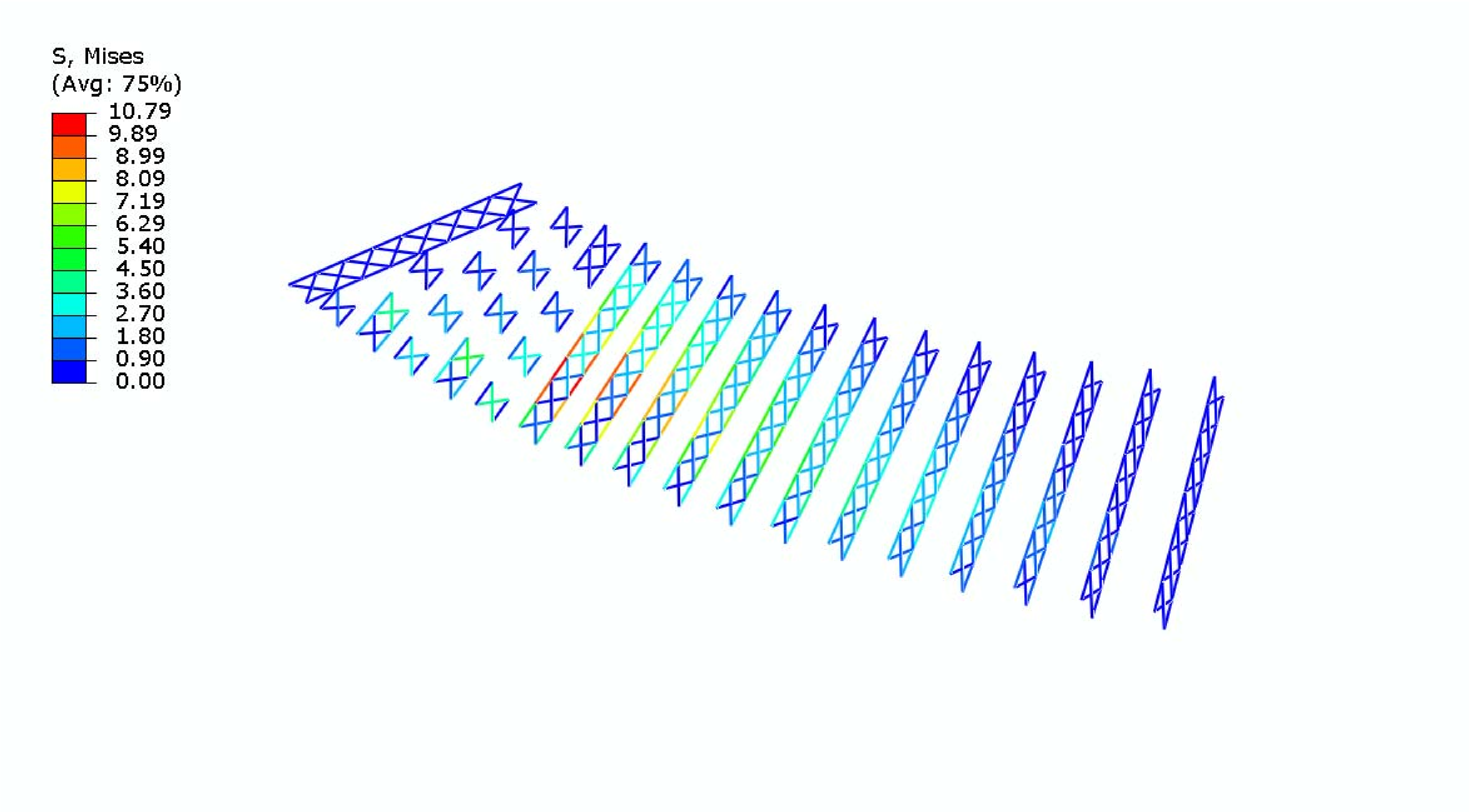


Figure R1-4-24. **Cross-frame stress contours under SDL, SDLF detailing**

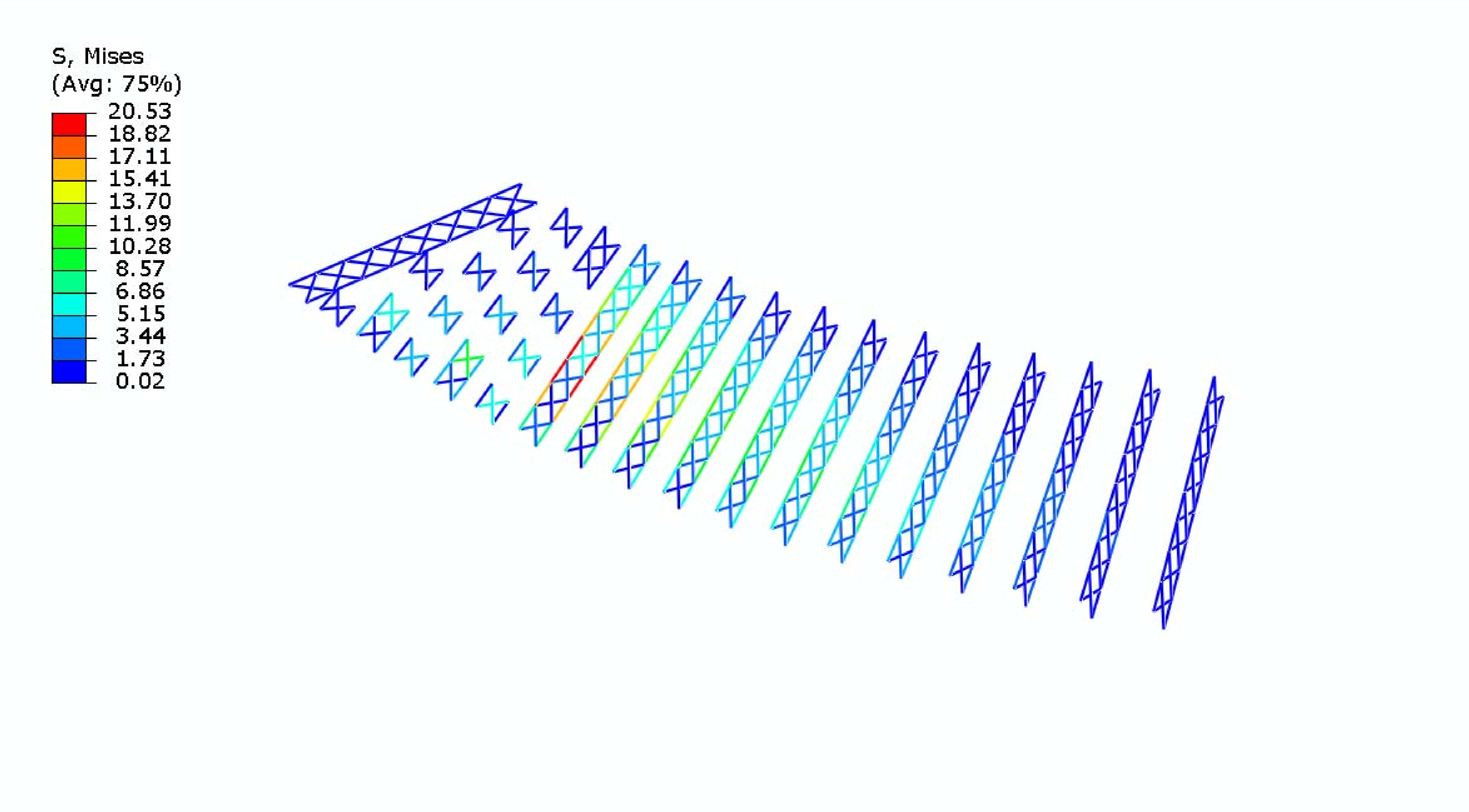


Figure R1-4-25. **Cross-frame stress contours under TDL, SDLF detailing**

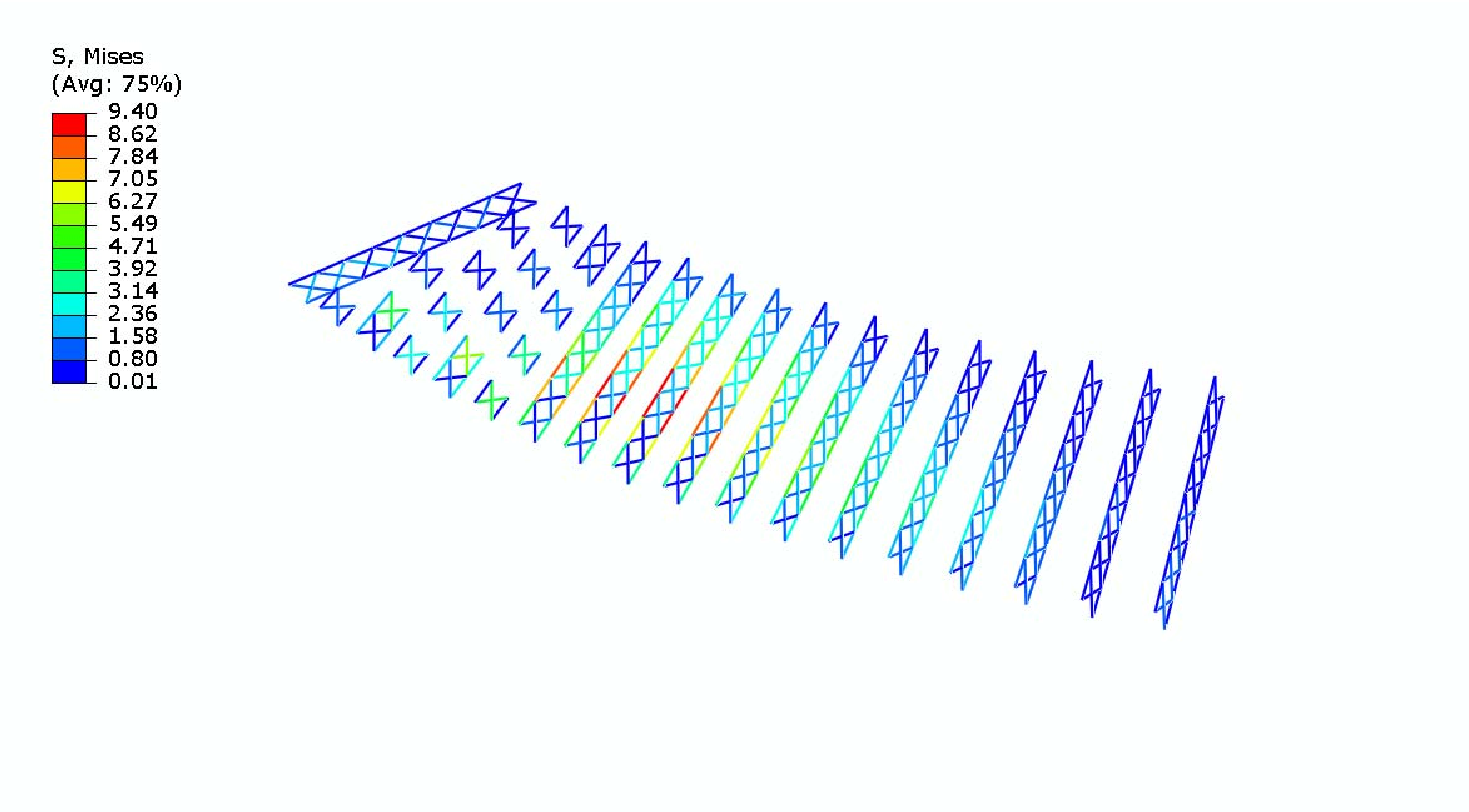


Figure R1-4-26. Cross-frame stress contours under SDL, TDLF detailing

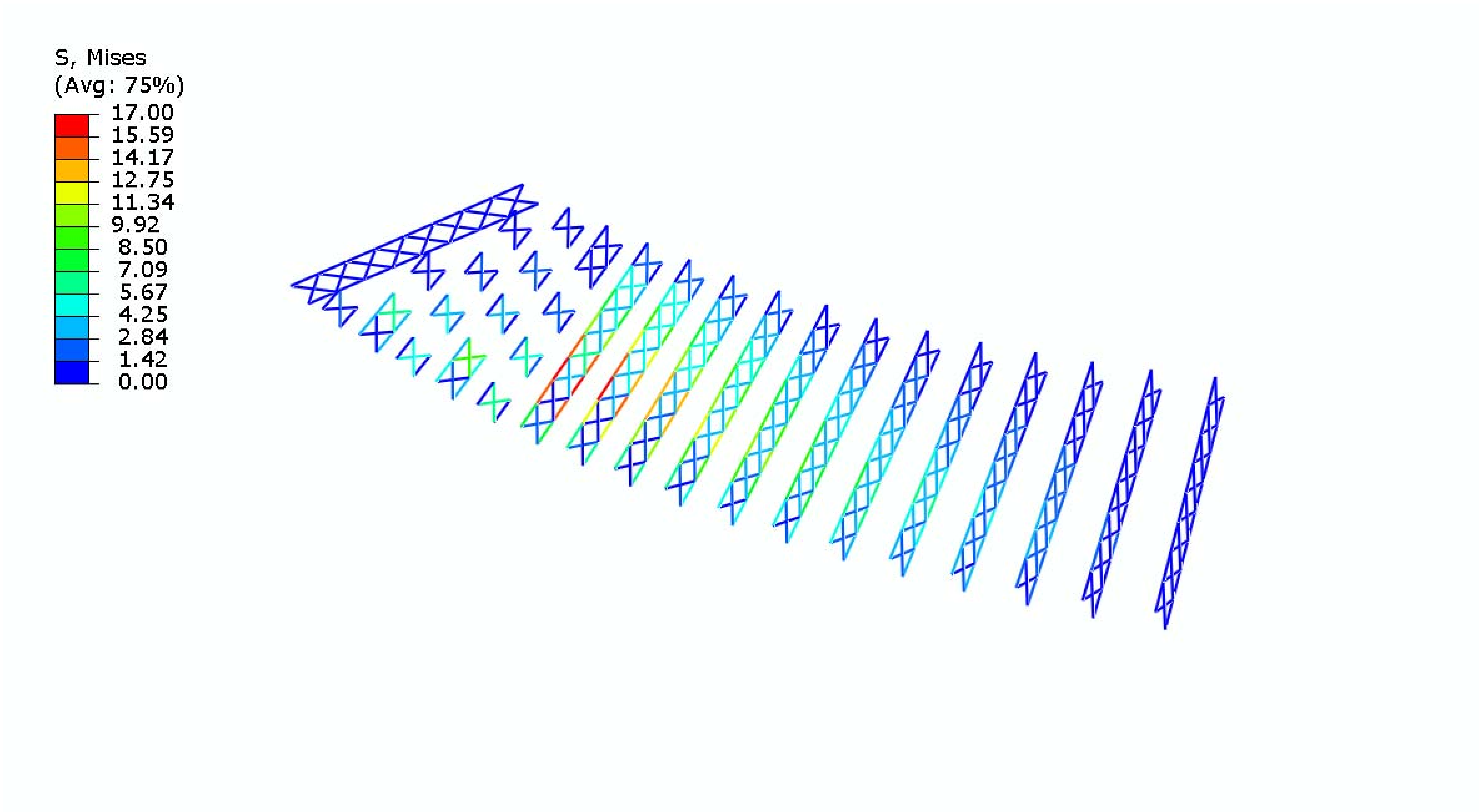


Figure R1-4-27. Cross-frame stress contours under TDL, TDLF detailing

Table R1-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	36.9	28.2	19.4	21.6	17.9	10.3	20.3	12.8
	SDLF	12.1	13.5	16.0	8.3	7.3	7.0	5.9	3.8
	TDLF	42.2	42.7	45.0	38.7	27.1	31.4	32.7	10.5
2	NLF	8.4	78.2	64.5	14.2	28.6	26.3	15.4	18.2
	SDLF	23.2	93.0	61.6	17.9	21.8	24.4	13.0	12.8
	TDLF	34.9	104.2	59.2	19.3	16.1	23.8	15.5	9.8
3	NLF	17.5	108.7	73.3	54.6	36.3	94.7	19.1	18.4
	SDLF	15.5	123.7	78.3	44.3	36.7	67.6	19.6	6.6
	TDLF	14.5	135.8	82.8	36.1	37.4	51.6	24.3	6.1
4	NLF	57.6	26.8	3.9	64.0	60.0	86.8	132.2	72.8
	SDLF	64.4	6.1	44.2	82.9	57.5	70.6	71.9	37.3
	TDLF	69.5	28.7	73.2	95.3	56.0	59.1	28.9	15.4
5	NLF	20.8	5.9	27.3	48.3	67.8	68.5	76.6	43.7
	SDLF	27.1	5.9	35.6	59.8	63.3	69.7	67.1	38.2
	TDLF	32.0	14.8	41.7	69.7	61.0	70.3	61.2	36.0
6	NLF	82.8	24.8	44.0	54.3	66.8	53.8	47.0	24.4
	SDLF	91.1	18.3	39.3	52.6	66.0	62.2	55.9	32.7
	TDLF	98.6	15.5	37.9	54.4	67.1	68.3	62.7	38.5
7	NLF	59.1	42.4	52.9	58.4	60.7	43.4	33.4	15.3
	SDLF	37.4	29.6	43.6	51.9	62.4	52.2	45.4	25.5
	TDLF	24.0	23.0	38.9	49.2	64.5	58.6	53.9	32.1
8	NLF	26.8	49.8	58.8	58.7	53.8	36.3	26.4	11.3
	SDLF	26.3	38.1	50.0	52.7	56.4	42.5	36.7	19.4
	TDLF	30.7	32.3	45.7	50.1	59.1	47.1	43.7	24.5
9	NLF	10.5	49.8	63.3	55.5	47.4	33.0	23.2	10.2
	SDLF	3.9	42.3	54.5	50.8	49.1	34.2	29.5	15.0
	TDLF	15.7	39.1	49.4	48.9	51.3	35.3	33.6	17.9
10	NLF	26.7	45.1	57.9	50.8	42.7	27.1	21.6	10.2
	SDLF	18.1	43.5	53.4	48.1	42.8	26.7	23.8	12.0
	TDLF	15.9	43.5	51.1	47.2	43.8	27.6	25.2	13.0

Table R1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	32.2	37.9	42.1	43.5	37.2	22.5	20.9	11.1
	SDLF	25.8	39.1	45.0	42.5	35.6	20.5	19.2	9.8
	TDLF	25.3	40.5	48.3	42.3	35.5	19.8	17.9	8.8
12	NLF	31.4	29.8	33.1	34.2	30.1	17.4	18.1	10.0
	SDLF	28.6	32.9	36.0	34.5	28.6	14.7	15.2	7.9
	TDLF	30.4	35.1	38.5	34.2	27.4	12.0	12.9	6.8
13	NLF	27.3	20.7	23.6	23.6	21.4	11.4	13.4	7.3
	SDLF	29.4	24.2	25.6	24.8	20.7	7.5	11.1	5.9
	TDLF	32.7	26.9	26.1	25.9	20.0	1.3	9.9	5.9
14	NLF	23.9	12.1	13.8	12.3	12.1	13.7	7.0	4.2
	SDLF	26.3	14.3	12.8	14.8	11.8	2.2	7.0	3.9
	TDLF	28.5	17.9	9.0	19.9	11.9	18.2	10.3	4.3
15	NLF	19.3	27.6	21.7	15.2	12.3	NA	8.7	4.4
	SDLF	22.8	4.9	3.7	3.4	2.6	NA	2.3	2.7
	TDLF	25.4	27.1	23.1	19.6	12.7	NA	15.1	9.0
16	NLF	13.4	NA	NA	NA	NA	NA	NA	NA
	SDLF	17.4	NA	NA	NA	NA	NA	NA	NA
	TDLF	20.9	NA	NA	NA	NA	NA	NA	NA
17	NLF	7.7	NA	NA	NA	NA	NA	NA	NA
	SDLF	10.8	NA	NA	NA	NA	NA	NA	NA
	TDLF	14.7	NA	NA	NA	NA	NA	NA	NA
18	NLF	30.3	NA	NA	NA	NA	NA	NA	NA
	SDLF	5.6	NA	NA	NA	NA	NA	NA	NA
	TDLF	29.3	NA	NA	NA	NA	NA	NA	NA

Table R1-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	62.2	47.6	59.6	30.1	33.8	48.0	18.8	22.1
	SDLF	17.0	9.8	18.9	4.4	7.1	10.2	4.7	3.2
	TDLF	20.8	21.8	31.7	18.8	15.1	16.3	15.6	7.4
2	NLF	13.9	136.9	119.0	25.0	52.4	49.8	18.8	26.6
	SDLF	28.9	148.2	110.8	29.0	43.5	44.2	16.5	19.4
	TDLF	40.7	158.0	105.1	30.3	36.2	41.3	19.4	16.1
3	NLF	31.1	196.6	134.8	99.2	66.3	161.8	14.1	42.3
	SDLF	27.6	204.0	134.1	85.1	64.4	127.4	16.0	29.3
	TDLF	24.9	211.7	135.2	74.4	63.6	106.2	22.1	17.9
4	NLF	101.9	35.5	20.0	126.6	112.8	152.9	224.3	124.3
	SDLF	106.4	8.9	60.4	138.3	102.9	128.6	152.0	81.3
	TDLF	110.1	21.1	89.4	146.3	96.6	111.9	99.2	55.2
5	NLF	37.9	1.5	63.3	97.3	125.8	123.1	132.3	72.3
	SDLF	43.1	11.0	66.5	101.7	113.4	117.8	114.8	61.9
	TDLF	47.4	18.5	69.5	107.2	106.1	114.3	103.7	57.1
6	NLF	153.5	51.1	88.0	101.4	121.2	99.2	82.6	40.8
	SDLF	153.6	41.7	78.0	95.0	114.4	102.2	86.2	45.8
	TDLF	156.0	36.3	72.8	92.8	111.2	104.8	90.2	50.0
7	NLF	98.8	80.5	102.5	109.0	111.8	81.6	60.4	26.7
	SDLF	75.1	63.7	86.9	96.8	107.3	86.0	68.2	34.5
	TDLF	58.8	53.6	78.0	89.9	105.5	89.6	74.6	39.9
8	NLF	40.1	92.4	111.5	108.3	99.2	69.3	49.0	20.7
	SDLF	39.3	76.2	96.6	97.0	96.7	71.7	55.7	27.0
	TDLF	42.9	66.8	88.1	90.6	96.0	73.8	60.9	31.0
9	NLF	21.5	91.8	119.8	102.7	88.1	63.3	43.9	19.3
	SDLF	13.1	79.9	104.5	93.1	85.3	61.1	47.1	22.4
	TDLF	9.9	73.2	95.3	87.4	84.2	60.0	49.4	24.3
10	NLF	49.5	83.2	109.0	93.8	78.8	50.3	41.0	19.3
	SDLF	38.6	77.7	99.3	87.1	75.5	48.0	40.5	19.6
	TDLF	34.2	75.0	93.6	83.0	73.7	47.4	40.1	19.6

Table R1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	58.1	67.8	77.7	78.1	67.2	42.5	38.3	20.1
	SDLF	49.2	67.5	78.6	75.3	63.5	38.8	35.3	17.8
	TDLF	46.4	67.6	80.0	73.6	61.9	36.6	33.0	16.1
12	NLF	55.8	53.4	61.8	62.2	55.1	32.1	32.8	17.5
	SDLF	50.8	55.6	63.2	61.0	52.0	28.6	29.0	15.0
	TDLF	50.4	56.9	64.3	59.7	49.7	25.3	26.0	13.4
13	NLF	49.1	35.9	43.9	42.4	38.6	17.3	23.8	12.4
	SDLF	49.7	39.8	45.3	43.2	37.3	14.6	21.2	11.2
	TDLF	51.3	42.1	45.2	43.9	36.1	9.7	19.5	10.7
14	NLF	42.6	20.3	22.7	22.8	20.8	16.6	12.5	7.1
	SDLF	44.2	22.9	22.4	25.4	21.0	8.4	12.7	7.3
	TDLF	45.6	25.7	20.1	29.0	20.8	6.1	14.7	7.3
15	NLF	34.5	48.0	36.0	27.5	21.7	NA	10.6	8.9
	SDLF	37.5	19.0	15.5	13.9	8.5	NA	4.5	4.9
	TDLF	39.6	10.4	6.5	7.9	4.0	NA	4.7	4.0
16	NLF	23.5	NA	NA	NA	NA	NA	NA	NA
	SDLF	27.7	NA	NA	NA	NA	NA	NA	NA
	TDLF	30.7	NA	NA	NA	NA	NA	NA	NA
17	NLF	13.1	NA	NA	NA	NA	NA	NA	NA
	SDLF	17.0	NA	NA	NA	NA	NA	NA	NA
	TDLF	19.8	NA	NA	NA	NA	NA	NA	NA
18	NLF	54.3	NA	NA	NA	NA	NA	NA	NA
	SDLF	21.7	NA	NA	NA	NA	NA	NA	NA
	TDLF	11.3	NA	NA	NA	NA	NA	NA	NA

Table R1-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	19.3	8.2	8.0	3.8	1.0	5.8	6.2	6.5
	SDLF	7.8	11.8	12.5	6.6	7.0	6.4	5.5	2.8
	TDLF	28.0	30.5	16.5	14.4	17.9	6.0	10.2	7.5
2	NLF	15.0	65.1	47.2	18.5	12.7	14.8	7.8	3.7
	SDLF	6.7	52.9	27.5	2.5	3.0	5.2	3.3	0.3
	TDLF	0.5	42.2	12.2	8.3	2.9	1.2	12.0	3.2
3	NLF	51.7	68.9	38.8	23.7	16.3	297.5	16.3	9.8
	SDLF	50.4	66.1	29.1	10.2	8.1	146.7	1.5	0.5
	TDLF	49.2	62.9	21.0	0.3	2.0	41.2	11.6	8.8
4	NLF	11.8	284.9	371.0	389.4	347.3	177.4	170.1	51.3
	SDLF	13.7	228.7	269.4	243.9	190.9	147.4	79.2	23.1
	TDLF	14.4	187.8	197.2	141.4	82.6	126.1	15.8	4.3
5	NLF	63.3	207.1	275.1	272.4	243.0	112.5	98.2	32.2
	SDLF	64.5	191.2	246.4	233.8	198.2	131.1	81.8	25.9
	TDLF	64.8	180.4	226.7	207.0	166.3	142.8	70.7	21.9
6	NLF	15.6	161.2	204.3	194.5	162.2	75.0	57.7	20.1
	SDLF	17.8	168.0	216.9	211.0	180.3	106.7	71.2	23.8
	TDLF	18.2	172.7	225.3	221.5	191.1	126.8	80.2	26.0
7	NLF	130.8	135.7	162.6	144.0	112.7	55.0	37.1	13.4
	SDLF	111.9	147.4	186.8	178.2	150.0	82.6	56.6	19.4
	TDLF	97.8	154.4	202.1	199.9	173.6	99.7	69.0	23.0
8	NLF	107.5	121.9	137.9	113.4	84.1	45.1	26.5	9.7
	SDLF	100.0	130.2	158.2	143.7	117.4	62.0	43.1	14.9
	TDLF	94.6	134.3	170.2	162.3	138.2	72.1	53.4	18.0
9	NLF	91.4	114.3	122.8	94.4	68.3	41.3	22.1	7.9
	SDLF	89.7	114.7	132.7	113.2	89.1	45.9	32.2	11.2
	TDLF	88.0	113.4	137.4	124.1	101.6	47.9	38.0	12.9
10	NLF	84.4	104.1	111.2	85.2	61.7	37.5	20.3	7.0
	SDLF	82.9	99.5	110.3	89.0	66.8	33.9	23.9	8.2
	TDLF	80.9	95.2	108.0	90.1	69.0	30.8	25.5	8.7

Table R1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	80.6	87.7	96.6	77.6	55.8	32.3	19.8	6.5
	SDLF	77.4	83.1	89.8	70.3	50.4	24.3	17.6	6.0
	TDLF	74.0	79.6	84.2	64.2	46.2	18.6	15.4	5.4
12	NLF	76.9	70.5	78.5	64.6	47.4	23.5	17.3	5.5
	SDLF	71.2	64.1	68.6	53.1	36.9	16.0	12.5	4.0
	TDLF	66.1	59.4	61.1	44.7	29.8	11.0	9.2	3.1
13	NLF	69.8	50.7	56.2	46.6	34.9	12.2	12.1	3.8
	SDLF	64.3	44.1	47.0	36.3	24.8	8.2	8.1	2.4
	TDLF	59.8	38.7	39.9	29.1	17.5	5.9	6.4	1.9
14	NLF	59.4	27.1	29.4	24.7	19.2	4.6	5.6	1.8
	SDLF	55.6	22.4	24.4	19.2	12.5	1.6	4.3	0.9
	TDLF	52.8	16.9	19.7	15.1	6.1	6.9	5.2	0.5
15	NLF	47.4	12.4	10.1	6.2	3.5	NA	3.9	1.1
	SDLF	43.7	2.4	2.2	1.7	1.3	NA	1.6	1.6
	TDLF	41.0	10.4	9.0	6.2	2.7	NA	6.8	3.5
16	NLF	33.9	NA	NA	NA	NA	NA	NA	NA
	SDLF	30.6	NA	NA	NA	NA	NA	NA	NA
	TDLF	28.0	NA	NA	NA	NA	NA	NA	NA
17	NLF	18.3	NA	NA	NA	NA	NA	NA	NA
	SDLF	15.9	NA	NA	NA	NA	NA	NA	NA
	TDLF	13.6	NA	NA	NA	NA	NA	NA	NA
18	NLF	14.8	NA	NA	NA	NA	NA	NA	NA
	SDLF	3.1	NA	NA	NA	NA	NA	NA	NA
	TDLF	15.5	NA	NA	NA	NA	NA	NA	NA

Table R1-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	24.9	3.2	23.0	0.1	21.3	13.6	14.6	2.8
	SDLF	2.2	12.1	22.2	6.7	12.4	11.4	1.5	3.6
	TDLF	14.7	21.8	19.5	9.8	12.5	8.4	8.1	6.7
2	NLF	22.9	109.5	67.6	23.9	9.3	9.1	8.3	1.4
	SDLF	16.2	98.6	55.3	11.6	6.5	9.1	1.3	1.1
	TDLF	11.2	87.6	44.9	3.1	5.4	9.3	4.7	0.9
3	NLF	89.7	118.2	65.9	29.0	21.1	509.0	31.0	30.1
	SDLF	87.1	114.9	55.8	21.8	16.2	329.4	18.8	17.5
	TDLF	84.8	110.7	46.6	15.3	12.3	203.2	7.6	6.2
4	NLF	20.6	506.9	652.0	671.8	593.2	307.7	296.6	93.8
	SDLF	22.7	425.7	516.6	491.9	404.8	256.9	186.3	58.0
	TDLF	23.2	366.9	420.4	364.1	273.1	220.6	108.8	33.8
5	NLF	111.8	374.9	491.1	478.7	422.3	196.9	170.6	57.9
	SDLF	110.2	336.1	432.5	410.5	351.0	200.7	141.0	45.9
	TDLF	108.5	309.4	391.7	362.5	299.9	202.0	120.6	37.9
6	NLF	27.7	294.7	368.3	345.3	285.4	135.1	100.7	36.2
	SDLF	30.0	282.2	357.0	339.1	283.8	154.4	104.7	35.3
	TDLF	29.6	273.5	348.8	333.7	281.0	166.2	107.2	34.6
7	NLF	236.4	250.9	297.7	260.7	203.3	101.5	66.6	24.8
	SDLF	204.6	245.2	301.0	275.8	224.4	118.5	78.1	26.8
	TDLF	181.9	240.3	302.0	284.5	237.0	128.5	85.1	27.8
8	NLF	197.4	227.3	256.0	209.3	155.4	84.6	49.0	18.4
	SDLF	177.3	219.5	257.4	222.7	174.7	91.9	58.6	20.1
	TDLF	163.4	212.7	256.4	229.9	186.1	95.5	64.1	20.8
9	NLF	169.0	213.7	229.4	176.5	128.1	77.4	41.3	15.1
	SDLF	156.2	199.2	222.1	179.9	136.3	73.1	45.0	15.2
	TDLF	146.8	187.7	215.1	180.5	140.3	69.1	46.6	14.8
10	NLF	156.9	192.8	206.0	157.8	114.9	66.5	37.7	13.3
	SDLF	144.9	176.0	190.8	148.7	109.0	57.0	35.5	11.6
	TDLF	135.5	163.2	178.7	141.0	103.8	50.2	33.2	10.3

Table R1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	150.0	160.8	176.2	140.7	100.9	57.5	34.5	11.3
	SDLF	136.8	146.9	158.6	123.5	87.3	44.1	28.3	8.8
	TDLF	126.5	137.0	145.7	110.9	77.6	35.0	23.6	7.1
12	NLF	143.2	128.6	142.2	116.4	85.6	41.5	30.1	9.8
	SDLF	128.0	115.2	123.9	96.7	67.8	30.2	21.8	6.5
	TDLF	116.5	105.8	110.9	83.1	55.9	22.9	16.3	4.5
13	NLF	128.5	91.4	100.4	82.9	62.2	21.9	21.1	7.0
	SDLF	115.5	80.6	86.1	67.3	47.2	16.0	14.6	4.3
	TDLF	105.8	72.5	75.9	56.9	36.9	12.1	11.1	2.9
14	NLF	108.3	48.1	52.6	44.0	33.1	7.0	11.4	4.1
	SDLF	98.9	41.6	45.3	36.2	24.5	0.9	8.5	2.4
	TDLF	92.2	35.9	39.5	30.5	17.3	3.4	7.4	1.3
15	NLF	86.0	25.0	17.0	10.1	10.4	NA	2.4	1.3
	SDLF	78.2	8.9	4.2	1.5	3.7	NA	2.1	1.2
	TDLF	72.7	3.3	3.7	3.1	1.0	NA	4.5	2.8
16	NLF	60.8	NA	NA	NA	NA	NA	NA	NA
	SDLF	55.2	NA	NA	NA	NA	NA	NA	NA
	TDLF	51.1	NA	NA	NA	NA	NA	NA	NA
17	NLF	32.7	NA	NA	NA	NA	NA	NA	NA
	SDLF	29.3	NA	NA	NA	NA	NA	NA	NA
	TDLF	26.6	NA	NA	NA	NA	NA	NA	NA
18	NLF	26.9	NA	NA	NA	NA	NA	NA	NA
	SDLF	8.1	NA	NA	NA	NA	NA	NA	NA
	TDLF	6.1	NA	NA	NA	NA	NA	NA	NA

Table R1-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	5.9	5.0	12.6	5.2	0.6	5.5	6.2	2.2
	SDLF	7.8	7.4	4.1	6.9	6.4	4.5	3.1	3.5
	TDLF	18.0	13.1	15.8	8.1	5.0	13.9	3.1	0.7
2	NLF	18.0	77.6	71.9	31.8	33.8	40.8	20.3	15.8
	SDLF	11.7	57.1	31.6	6.2	5.6	7.3	0.8	1.8
	TDLF	7.0	43.1	2.0	13.6	15.1	17.0	18.7	10.7
3	NLF	54.1	79.3	45.5	42.0	27.2	293.6	27.5	7.3
	SDLF	55.4	65.2	31.0	12.1	9.1	150.6	3.9	0.3
	TDLF	56.2	55.3	21.1	9.4	2.9	52.5	15.3	5.4
4	NLF	13.5	285.9	371.9	391.7	344.7	175.6	164.8	49.5
	SDLF	14.9	234.3	276.1	248.3	194.3	148.8	79.1	19.8
	TDLF	16.3	197.0	209.0	149.3	91.6	131.9	22.2	1.7
5	NLF	67.3	199.8	266.1	263.8	237.1	114.0	98.2	32.2
	SDLF	70.0	194.6	249.9	236.5	201.0	131.9	80.6	23.9
	TDLF	72.0	192.3	240.7	219.3	177.0	144.8	70.5	19.6
6	NLF	18.1	159.7	203.3	193.6	162.2	76.2	59.1	20.9
	SDLF	17.8	171.1	220.1	213.8	182.8	106.9	70.2	22.7
	TDLF	18.5	180.6	233.4	228.8	197.2	127.8	78.4	24.3
7	NLF	129.3	136.0	163.7	144.7	113.6	55.4	38.1	13.9
	SDLF	116.1	150.3	189.8	180.2	151.5	82.8	55.7	18.8
	TDLF	105.9	161.4	208.5	204.8	177.4	101.1	67.5	21.9
8	NLF	101.6	122.2	138.9	113.7	84.4	45.1	27.0	9.9
	SDLF	103.7	133.0	160.9	145.4	118.7	62.4	42.5	14.5
	TDLF	105.9	141.0	176.1	166.8	141.8	73.7	52.4	17.3
9	NLF	88.5	113.0	121.6	93.0	67.4	40.5	22.3	8.0
	SDLF	93.9	117.9	135.3	114.5	90.2	46.5	31.8	10.9
	TDLF	98.9	121.5	144.8	129.0	105.5	50.2	37.7	12.6
10	NLF	83.0	104.5	111.4	84.3	60.6	38.3	20.0	6.8
	SDLF	87.8	102.3	112.7	90.1	68.0	33.9	23.7	8.0
	TDLF	92.3	100.9	113.5	93.9	72.8	30.7	25.7	8.7

Table R1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	79.2	88.3	98.2	78.5	56.5	31.8	20.5	6.8
	SDLF	82.5	83.6	90.5	70.4	50.3	24.5	17.4	5.7
	TDLF	85.7	80.8	85.2	64.6	46.4	19.6	15.0	4.8
12	NLF	74.9	69.9	78.2	63.9	46.8	22.3	16.8	5.1
	SDLF	76.4	65.2	69.7	53.6	37.2	16.4	12.6	3.9
	TDLF	78.3	62.1	63.6	46.4	31.0	12.6	9.9	3.3
13	NLF	69.8	49.3	55.0	45.0	33.5	11.7	11.0	2.9
	SDLF	69.0	45.1	48.0	36.8	25.2	8.8	8.4	2.5
	TDLF	69.0	41.5	42.5	31.1	19.4	7.3	7.6	2.6
14	NLF	59.3	26.6	29.5	24.3	18.6	3.2	4.9	1.2
	SDLF	58.1	23.3	25.3	19.8	13.0	1.0	4.9	1.4
	TDLF	57.7	18.6	21.2	16.6	7.1	4.1	6.9	1.7
15	NLF	47.0	15.2	9.7	6.9	8.3	NA	0.8	2.1
	SDLF	46.4	1.5	1.2	1.2	1.2	NA	0.8	1.3
	TDLF	46.1	16.5	12.3	9.2	11.1	NA	1.9	5.2
16	NLF	33.0	NA	NA	NA	NA	NA	NA	NA
	SDLF	32.6	NA	NA	NA	NA	NA	NA	NA
	TDLF	32.0	NA	NA	NA	NA	NA	NA	NA
17	NLF	17.7	NA	NA	NA	NA	NA	NA	NA
	SDLF	17.5	NA	NA	NA	NA	NA	NA	NA
	TDLF	16.5	NA	NA	NA	NA	NA	NA	NA
18	NLF	18.3	NA	NA	NA	NA	NA	NA	NA
	SDLF	1.2	NA	NA	NA	NA	NA	NA	NA
	TDLF	15.8	NA	NA	NA	NA	NA	NA	NA

Table R1-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	9.7	14.3	14.9	21.6	5.6	0.5	31.4	9.0
	SDLF	3.1	1.1	3.6	13.6	5.7	2.6	13.1	7.5
	TDLF	12.7	10.9	7.1	10.3	8.7	8.4	4.4	3.2
2	NLF	34.8	141.6	137.1	62.3	68.8	82.3	44.5	37.8
	SDLF	25.9	112.0	84.4	30.1	31.4	38.3	18.2	18.3
	TDLF	19.1	92.5	46.1	5.7	4.3	6.8	3.3	2.1
3	NLF	96.5	146.1	83.1	80.6	52.5	497.8	64.6	25.8
	SDLF	94.7	122.9	62.9	42.0	28.4	328.3	34.1	15.7
	TDLF	93.2	107.0	49.7	14.4	12.1	212.3	9.8	7.8
4	NLF	24.8	510.9	654.7	678.0	585.9	300.2	280.0	88.0
	SDLF	24.8	434.4	525.7	498.4	405.5	253.5	178.3	51.8
	TDLF	25.7	379.7	435.3	374.4	281.8	224.0	111.3	29.9
5	NLF	123.9	357.6	468.7	457.0	406.4	199.8	168.3	56.7
	SDLF	120.7	333.1	427.1	404.0	346.2	201.2	137.4	42.7
	TDLF	118.5	317.6	400.8	369.7	306.4	203.9	119.2	35.1
6	NLF	34.5	292.5	367.1	344.4	286.0	137.4	103.5	38.0
	SDLF	31.0	284.0	359.0	340.6	285.2	154.5	103.9	34.8
	TDLF	30.4	280.5	356.1	340.1	286.3	167.2	105.6	33.3
7	NLF	235.6	253.2	301.5	263.5	205.8	102.1	68.7	26.2
	SDLF	211.1	248.3	304.5	277.8	225.7	118.2	77.5	26.7
	TDLF	192.4	247.1	308.7	289.2	240.5	129.7	84.0	27.2
8	NLF	186.3	229.2	259.0	210.7	156.2	84.3	49.9	19.0
	SDLF	177.9	222.0	260.1	223.9	175.3	91.6	57.9	19.9
	TDLF	173.0	218.9	262.4	234.0	189.2	96.9	63.4	20.5
9	NLF	165.5	210.8	225.9	173.0	125.9	74.9	41.5	15.3
	SDLF	159.3	200.5	222.4	179.1	135.8	72.5	44.5	15.0
	TDLF	156.7	194.6	221.3	184.3	143.3	71.1	46.4	14.8
10	NLF	156.8	194.0	206.0	155.8	112.3	69.8	36.6	12.8
	SDLF	149.7	178.9	192.6	148.6	108.8	58.1	34.8	11.4
	TDLF	146.6	169.2	184.2	144.3	107.0	50.4	33.5	10.5

Table R1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	149.9	163.1	180.8	144.2	103.9	56.3	37.1	12.7
	SDLF	141.7	148.2	160.8	124.6	88.0	44.0	29.1	9.3
	TDLF	137.7	138.5	147.4	111.5	77.7	35.9	23.7	6.9
12	NLF	140.6	127.0	141.1	114.6	83.8	38.8	29.1	9.2
	SDLF	132.3	115.9	124.8	96.7	67.6	29.9	21.7	6.5
	TDLF	127.8	108.4	113.7	84.7	57.0	24.1	17.0	4.9
13	NLF	130.4	88.3	97.7	79.3	58.8	20.2	18.8	5.4
	SDLF	121.2	80.8	86.3	66.8	46.7	16.3	14.3	4.2
	TDLF	115.7	74.8	78.2	58.3	38.3	13.8	12.1	3.5
14	NLF	109.8	45.8	51.4	42.0	30.8	7.5	9.6	2.8
	SDLF	102.3	41.8	45.8	36.2	24.4	4.1	8.8	2.9
	TDLF	97.6	37.6	41.4	32.2	18.4	0.3	9.3	2.8
15	NLF	85.8	21.6	17.8	13.7	8.9	NA	7.4	5.0
	SDLF	81.3	6.7	7.7	7.1	2.8	NA	5.7	3.0
	TDLF	78.2	3.9	2.6	1.7	2.6	NA	1.4	0.3
16	NLF	59.5	NA	NA	NA	NA	NA	NA	NA
	SDLF	57.2	NA	NA	NA	NA	NA	NA	NA
	TDLF	55.2	NA	NA	NA	NA	NA	NA	NA
17	NLF	31.2	NA	NA	NA	NA	NA	NA	NA
	SDLF	30.6	NA	NA	NA	NA	NA	NA	NA
	TDLF	29.6	NA	NA	NA	NA	NA	NA	NA
18	NLF	30.0	NA	NA	NA	NA	NA	NA	NA
	SDLF	11.2	NA	NA	NA	NA	NA	NA	NA
	TDLF	2.5	NA	NA	NA	NA	NA	NA	NA

Table R1-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	1.08	1.28	1.28	0.84	0.96	1.03	0.56	0.78
	SDLF	0.91	1.11	1.06	0.59	0.69	0.74	0.31	0.51
	TDLF	0.78	0.98	0.89	0.40	0.49	0.54	0.13	0.30
3	NLF	1.32	1.66	1.62	1.29	1.37	1.41	1.11	1.10
	SDLF	1.21	1.56	1.45	1.03	1.10	1.11	0.78	0.78
	TDLF	1.12	1.48	1.33	0.82	0.90	0.90	0.54	0.55
4	NLF	1.55	1.78	1.69	1.58	1.50	1.54	1.35	1.35
	SDLF	1.47	1.70	1.54	1.36	1.24	1.25	1.02	1.01
	TDLF	1.42	1.63	1.44	1.18	1.04	1.04	0.76	0.77
5	NLF	1.70	1.80	1.73	1.66	1.60	1.61	1.52	1.51
	SDLF	1.66	1.72	1.59	1.46	1.35	1.34	1.20	1.19
	TDLF	1.62	1.66	1.49	1.30	1.16	1.14	0.95	0.95
6	NLF	1.81	1.79	1.74	1.69	1.65	1.62	1.60	1.60
	SDLF	1.78	1.71	1.61	1.50	1.41	1.38	1.31	1.31
	TDLF	1.76	1.64	1.51	1.36	1.23	1.19	1.09	1.09
7	NLF	1.83	1.75	1.71	1.67	1.64	1.58	1.62	1.62
	SDLF	1.81	1.66	1.58	1.50	1.43	1.36	1.36	1.36
	TDLF	1.79	1.60	1.48	1.37	1.26	1.19	1.16	1.16
8	NLF	1.84	1.67	1.64	1.61	1.59	1.47	1.57	1.57
	SDLF	1.80	1.58	1.51	1.45	1.40	1.29	1.35	1.35
	TDLF	1.77	1.52	1.41	1.33	1.25	1.14	1.18	1.18
9	NLF	1.82	1.55	1.52	1.50	1.48	1.32	1.47	1.47
	SDLF	1.77	1.47	1.40	1.35	1.31	1.16	1.28	1.28
	TDLF	1.74	1.41	1.30	1.25	1.18	1.03	1.14	1.14
10	NLF	1.78	1.39	1.36	1.34	1.33	1.13	1.32	1.32
	SDLF	1.72	1.31	1.25	1.22	1.18	1.00	1.16	1.16
	TDLF	1.68	1.26	1.16	1.12	1.07	0.89	1.04	1.04

Table R1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	1.70	1.19	1.17	1.14	1.13	0.89	1.12	1.12
	SDLF	1.64	1.12	1.07	1.04	1.01	0.79	0.99	0.99
	TDLF	1.60	1.08	0.99	0.97	0.92	0.70	0.90	0.90
12	NLF	1.58	0.94	0.92	0.90	0.89	0.62	0.88	0.88
	SDLF	1.52	0.89	0.85	0.82	0.80	0.55	0.79	0.79
	TDLF	1.48	0.85	0.78	0.77	0.73	0.48	0.72	0.71
13	NLF	1.42	0.65	0.64	0.63	0.62	0.33	0.61	0.61
	SDLF	1.36	0.62	0.59	0.58	0.56	0.29	0.55	0.55
	TDLF	1.33	0.60	0.54	0.54	0.51	0.25	0.51	0.50
14	NLF	1.21	0.34	0.34	0.33	0.33	0.00	0.32	0.32
	SDLF	1.16	0.33	0.31	0.30	0.29	0.00	0.29	0.29
	TDLF	1.13	0.32	0.28	0.29	0.27	0.00	0.27	0.26
15	NLF	0.95	0.00	0.00	0.00	0.00	NA	0.00	0.00
	SDLF	0.92	0.00	0.00	0.00	0.00	NA	0.00	0.00
	TDLF	0.90	0.00	0.00	0.00	0.00	NA	0.00	0.00
16	NLF	0.66	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.64	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.63	NA	NA	NA	NA	NA	NA	NA
17	NLF	0.35	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.34	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.33	NA	NA	NA	NA	NA	NA	NA
18	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table R1-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
		CF Location							
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	1.89	2.24	2.25	1.49	1.69	1.84	1.01	1.38
	SDLF	1.66	2.00	1.94	1.18	1.37	1.49	0.73	1.07
	TDLF	1.49	1.82	1.72	0.96	1.13	1.24	0.53	0.83
3	NLF	2.32	2.91	2.86	2.27	2.42	2.51	1.98	1.96
	SDLF	2.13	2.70	2.57	1.92	2.06	2.11	1.58	1.57
	TDLF	1.99	2.55	2.37	1.66	1.80	1.83	1.30	1.29
4	NLF	2.72	3.13	2.98	2.79	2.65	2.73	2.40	2.39
	SDLF	2.55	2.92	2.71	2.45	2.29	2.33	1.97	1.97
	TDLF	2.43	2.77	2.52	2.20	2.02	2.04	1.66	1.66
5	NLF	3.00	3.17	3.05	2.93	2.82	2.85	2.68	2.68
	SDLF	2.83	2.95	2.78	2.61	2.45	2.46	2.26	2.25
	TDLF	2.72	2.80	2.59	2.36	2.18	2.17	1.94	1.94
6	NLF	3.20	3.15	3.07	2.98	2.90	2.86	2.83	2.83
	SDLF	3.04	2.93	2.80	2.67	2.54	2.49	2.42	2.42
	TDLF	2.93	2.78	2.61	2.43	2.28	2.22	2.12	2.12
7	NLF	3.24	3.08	3.01	2.94	2.89	2.77	2.85	2.85
	SDLF	3.07	2.86	2.75	2.64	2.55	2.43	2.47	2.47
	TDLF	2.96	2.70	2.56	2.42	2.30	2.18	2.19	2.19
8	NLF	3.25	2.94	2.88	2.83	2.79	2.58	2.76	2.76
	SDLF	3.07	2.72	2.62	2.54	2.48	2.29	2.42	2.42
	TDLF	2.94	2.56	2.44	2.33	2.24	2.06	2.17	2.17
9	NLF	3.22	2.73	2.67	2.63	2.60	2.31	2.57	2.58
	SDLF	3.03	2.52	2.43	2.37	2.32	2.05	2.28	2.28
	TDLF	2.89	2.37	2.25	2.18	2.11	1.86	2.06	2.06
10	NLF	3.14	2.44	2.39	2.35	2.33	1.96	2.30	2.31
	SDLF	2.94	2.25	2.17	2.12	2.08	1.75	2.05	2.05
	TDLF	2.80	2.12	2.01	1.96	1.90	1.59	1.86	1.86

Table R1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	3.00	2.08	2.04	2.00	1.98	1.55	1.96	1.96
	SDLF	2.80	1.92	1.85	1.81	1.77	1.38	1.75	1.75
	TDLF	2.66	1.81	1.72	1.67	1.62	1.25	1.60	1.59
12	NLF	2.78	1.64	1.61	1.58	1.56	1.07	1.54	1.54
	SDLF	2.59	1.52	1.46	1.43	1.40	0.96	1.38	1.38
	TDLF	2.47	1.43	1.35	1.33	1.28	0.86	1.27	1.26
13	NLF	2.49	1.14	1.12	1.10	1.08	0.56	1.07	1.07
	SDLF	2.32	1.06	1.02	1.00	0.98	0.50	0.96	0.96
	TDLF	2.21	1.00	0.94	0.93	0.90	0.45	0.89	0.88
14	NLF	2.12	0.60	0.59	0.58	0.57	0.00	0.56	0.56
	SDLF	1.98	0.56	0.53	0.53	0.51	0.00	0.51	0.50
	TDLF	1.88	0.53	0.49	0.49	0.47	0.00	0.47	0.46
15	NLF	1.67	0.00	0.00	0.00	0.00	NA	0.00	0.00
	SDLF	1.56	0.00	0.00	0.00	0.00	NA	0.00	0.00
	TDLF	1.49	0.00	0.00	0.00	0.00	NA	0.00	0.00
16	NLF	1.17	NA	NA	NA	NA	NA	NA	NA
	SDLF	1.09	NA	NA	NA	NA	NA	NA	NA
	TDLF	1.04	NA	NA	NA	NA	NA	NA	NA
17	NLF	0.61	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.57	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.55	NA	NA	NA	NA	NA	NA	NA
18	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table R1-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	1.32	1.56	1.57	1.03	1.17	1.27	0.69	0.96
	SDLF	1.11	1.36	1.29	0.72	0.84	0.91	0.38	0.62
	TDLF	0.95	1.20	1.09	0.49	0.60	0.66	0.16	0.37
3	NLF	1.62	2.03	1.99	1.58	1.68	1.73	1.36	1.35
	SDLF	1.48	1.91	1.78	1.26	1.35	1.37	0.96	0.96
	TDLF	1.37	1.81	1.63	1.01	1.10	1.10	0.67	0.67
4	NLF	1.90	2.18	2.07	1.94	1.84	1.89	1.66	1.65
	SDLF	1.81	2.08	1.89	1.67	1.52	1.53	1.24	1.24
	TDLF	1.74	2.00	1.76	1.45	1.28	1.27	0.94	0.94
5	NLF	2.08	2.20	2.12	2.04	1.96	1.98	1.86	1.85
	SDLF	2.03	2.11	1.95	1.79	1.65	1.64	1.47	1.46
	TDLF	1.98	2.03	1.83	1.59	1.42	1.40	1.17	1.17
6	NLF	2.22	2.19	2.13	2.07	2.02	1.99	1.96	1.96
	SDLF	2.19	2.09	1.97	1.84	1.73	1.69	1.61	1.60
	TDLF	2.16	2.01	1.84	1.66	1.51	1.46	1.33	1.33
7	NLF	2.25	2.14	2.10	2.05	2.01	1.93	1.98	1.98
	SDLF	2.22	2.04	1.94	1.84	1.75	1.67	1.67	1.67
	TDLF	2.19	1.96	1.81	1.67	1.55	1.46	1.43	1.43
8	NLF	2.25	2.05	2.01	1.97	1.94	1.81	1.93	1.93
	SDLF	2.21	1.94	1.85	1.77	1.71	1.58	1.65	1.65
	TDLF	2.17	1.86	1.73	1.62	1.53	1.40	1.45	1.45
9	NLF	2.23	1.90	1.86	1.83	1.81	1.62	1.80	1.80
	SDLF	2.17	1.80	1.71	1.66	1.61	1.43	1.57	1.57
	TDLF	2.13	1.72	1.59	1.53	1.45	1.27	1.39	1.39
10	NLF	2.18	1.70	1.67	1.64	1.63	1.38	1.61	1.61
	SDLF	2.11	1.61	1.53	1.49	1.45	1.22	1.42	1.42
	TDLF	2.06	1.54	1.42	1.38	1.32	1.09	1.28	1.27

Table R1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	2.08	1.45	1.43	1.40	1.38	1.09	1.37	1.37
	SDLF	2.01	1.37	1.31	1.27	1.24	0.97	1.22	1.22
	TDLF	1.96	1.32	1.22	1.18	1.13	0.86	1.10	1.10
12	NLF	1.93	1.15	1.13	1.10	1.09	0.76	1.08	1.08
	SDLF	1.86	1.09	1.04	1.01	0.98	0.67	0.96	0.96
	TDLF	1.81	1.05	0.96	0.94	0.90	0.59	0.88	0.87
13	NLF	1.73	0.80	0.79	0.77	0.76	0.40	0.75	0.75
	SDLF	1.67	0.76	0.72	0.71	0.69	0.35	0.67	0.67
	TDLF	1.63	0.73	0.66	0.67	0.63	0.30	0.62	0.61
14	NLF	1.48	0.42	0.42	0.40	0.40	0.00	0.39	0.39
	SDLF	1.42	0.40	0.38	0.37	0.36	0.00	0.35	0.35
	TDLF	1.39	0.39	0.34	0.36	0.33	0.00	0.33	0.32
15	NLF	1.17	0.00	0.00	0.00	0.00	NA	0.00	0.00
	SDLF	1.13	0.00	0.00	0.00	0.00	NA	0.00	0.00
	TDLF	1.10	0.00	0.00	0.00	0.00	NA	0.00	0.00
16	NLF	0.81	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.79	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.77	NA	NA	NA	NA	NA	NA	NA
17	NLF	0.43	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.41	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.41	NA	NA	NA	NA	NA	NA	NA
18	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table R1-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	2.32	2.75	2.76	1.82	2.07	2.25	1.24	1.70
	SDLF	2.03	2.45	2.38	1.45	1.67	1.82	0.89	1.30
	TDLF	1.82	2.23	2.11	1.18	1.39	1.51	0.65	1.02
3	NLF	2.85	3.57	3.50	2.78	2.97	3.08	2.42	2.40
	SDLF	2.61	3.31	3.15	2.35	2.52	2.59	1.94	1.93
	TDLF	2.43	3.12	2.90	2.04	2.20	2.24	1.59	1.58
4	NLF	3.34	3.83	3.65	3.42	3.25	3.34	2.94	2.93
	SDLF	3.12	3.58	3.32	3.01	2.80	2.85	2.42	2.41
	TDLF	2.97	3.39	3.08	2.69	2.47	2.50	2.03	2.03
5	NLF	3.67	3.88	3.74	3.59	3.46	3.49	3.29	3.28
	SDLF	3.47	3.62	3.41	3.19	3.01	3.01	2.76	2.76
	TDLF	3.33	3.43	3.17	2.89	2.67	2.66	2.38	2.37
6	NLF	3.92	3.86	3.76	3.65	3.56	3.50	3.46	3.46
	SDLF	3.73	3.59	3.43	3.27	3.12	3.05	2.96	2.96
	TDLF	3.59	3.40	3.19	2.98	2.79	2.72	2.59	2.59
7	NLF	3.97	3.78	3.69	3.61	3.54	3.39	3.49	3.49
	SDLF	3.77	3.50	3.37	3.24	3.13	2.98	3.03	3.03
	TDLF	3.63	3.31	3.13	2.97	2.82	2.68	2.69	2.69
8	NLF	3.98	3.60	3.53	3.46	3.42	3.16	3.38	3.38
	SDLF	3.76	3.33	3.21	3.12	3.03	2.80	2.97	2.97
	TDLF	3.61	3.14	2.98	2.86	2.75	2.52	2.66	2.66
9	NLF	3.94	3.34	3.27	3.22	3.18	2.83	3.15	3.16
	SDLF	3.71	3.09	2.97	2.90	2.84	2.52	2.79	2.79
	TDLF	3.54	2.91	2.76	2.67	2.58	2.28	2.52	2.52
10	NLF	3.85	2.99	2.93	2.88	2.85	2.41	2.82	2.83
	SDLF	3.60	2.76	2.66	2.60	2.55	2.15	2.51	2.51
	TDLF	3.43	2.60	2.46	2.40	2.33	1.94	2.28	2.28

Table R1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	3.67	2.55	2.50	2.45	2.42	1.90	2.40	2.40
	SDLF	3.43	2.35	2.27	2.22	2.17	1.69	2.14	2.14
	TDLF	3.26	2.22	2.10	2.05	1.99	1.53	1.96	1.95
12	NLF	3.41	2.01	1.97	1.94	1.91	1.32	1.89	1.89
	SDLF	3.18	1.86	1.79	1.75	1.72	1.18	1.69	1.69
	TDLF	3.02	1.76	1.66	1.63	1.57	1.06	1.55	1.55
13	NLF	3.05	1.40	1.37	1.35	1.33	0.69	1.31	1.31
	SDLF	2.85	1.30	1.25	1.22	1.20	0.62	1.18	1.18
	TDLF	2.71	1.23	1.15	1.14	1.10	0.55	1.09	1.08
14	NLF	2.60	0.74	0.72	0.71	0.70	0.00	0.69	0.69
	SDLF	2.42	0.68	0.65	0.64	0.63	0.00	0.62	0.62
	TDLF	2.31	0.65	0.60	0.60	0.58	0.00	0.57	0.56
15	NLF	2.05	0.00	0.00	0.00	0.00	NA	0.00	0.00
	SDLF	1.92	0.00	0.00	0.00	0.00	NA	0.00	0.00
	TDLF	1.83	0.00	0.00	0.00	0.00	NA	0.00	0.00
16	NLF	1.43	NA	NA	NA	NA	NA	NA	NA
	SDLF	1.34	NA	NA	NA	NA	NA	NA	NA
	TDLF	1.27	NA	NA	NA	NA	NA	NA	NA
17	NLF	0.75	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.70	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.67	NA	NA	NA	NA	NA	NA	NA
18	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table R1-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	511	518	874	892
	SDLF	541	517	895	874
	TDLF	562	520	908	862
G2	NLF	489	472	844	808
	SDLF	492	465	832	790
	TDLF	487	463	822	779
G3	NLF	328	419	608	702
	SDLF	310	410	554	689
	TDLF	317	385	534	680
G4	NLF	246	244	366	459
	SDLF	212	257	377	462
	TDLF	160	284	357	459
G5	NLF	227	223	420	378
	SDLF	212	214	387	373
	TDLF	214	200	375	371
G6	NLF	187	187	369	306
	SDLF	186	176	334	307
	TDLF	208	156	337	307
G7	NLF	170	98	211	210
	SDLF	140	120	242	226
	TDLF	87	158	226	242
G8	NLF	229	86	325	150
	SDLF	244	81	326	160
	TDLF	264	66	338	162
G9	NLF	137	32	86	64
	SDLF	191	35	164	77
	TDLF	232	39	223	89

Table R1-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number			
		SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-5.3	NA	-14.6	NA
	SDLF	-1.0	NA	-6.4	NA
	TDLF	2.1	NA	-0.8	NA
G2	NLF	-3.1	NA	-8.5	NA
	SDLF	-0.7	NA	-3.9	NA
	TDLF	1.1	NA	-0.7	NA
G3	NLF	-1.2	NA	-2.8	NA
	SDLF	-0.5	NA	-1.3	NA
	TDLF	-0.2	NA	-0.9	NA
G4	NLF	-1.8	NA	-5.9	NA
	SDLF	-0.2	NA	-2.4	NA
	TDLF	0.7	NA	0.1	NA
G5	NLF	1.5	NA	3.9	NA
	SDLF	0.1	NA	1.5	NA
	TDLF	-0.9	NA	0.0	NA
G6	NLF	2.7	NA	7.4	NA
	SDLF	0.3	NA	3.0	NA
	TDLF	-1.0	NA	0.2	NA
G7	NLF	-0.9	NA	-2.6	NA
	SDLF	0.4	NA	-0.5	NA
	TDLF	1.1	NA	1.0	NA
G8	NLF	3.8	NA	11.0	NA
	SDLF	0.7	NA	4.9	NA
	TDLF	-1.5	NA	0.6	NA
G9	NLF	5.0	NA	14.5	NA
	SDLF	1.0	NA	6.3	NA
	TDLF	-1.7	NA	0.7	NA

Table R1-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number: SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-3.2	-0.3	-9.2	-1.1
	SDLF	0.8	0.0	-2.6	-0.4
	TDLF	3.9	0.2	2.1	0.0
G2	NLF	-1.9	-0.4	-5.3	-1.1
	SDLF	0.7	0.0	-1.3	-0.4
	TDLF	2.6	0.2	1.6	0.0
G3	NLF	-0.6	-0.4	-1.5	-1.1
	SDLF	0.4	0.0	0.0	-0.4
	TDLF	1.1	0.2	0.7	0.0
G4	NLF	-1.0	-0.4	-3.5	-1.1
	SDLF	0.2	0.0	-1.1	-0.4
	TDLF	0.9	0.2	0.7	0.0
G5	NLF	1.3	-0.4	3.3	-1.0
	SDLF	0.1	0.0	1.3	-0.4
	TDLF	-0.7	0.2	0.0	0.0
G6	NLF	2.1	-0.4	6.0	-1.0
	SDLF	-0.1	0.0	2.0	-0.4
	TDLF	-1.5	0.2	-0.5	0.0
G7	NLF	-0.4	-0.4	-1.1	-0.9
	SDLF	-0.4	0.0	-0.8	-0.4
	TDLF	-0.6	0.2	-0.6	0.0
G8	NLF	3.1	-0.3	9.2	-0.8
	SDLF	-0.5	0.0	2.9	-0.4
	TDLF	-3.2	0.2	-1.6	0.1
G9	NLF	4.1	-0.4	12.1	-0.8
	SDLF	-0.9	0.0	3.4	-0.4
	TDLF	-4.5	0.2	-2.6	0.0

Table R1-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-1.05	-0.43	-2.92	-4.09
	SDLF	-0.20	1.66	-1.29	0.14
	TDLF	0.42	3.37	-0.16	3.45
G2	NLF	-0.62	-0.26	-1.71	-3.31
	SDLF	-0.14	1.47	-0.78	0.26
	TDLF	0.22	2.86	-0.14	3.02
G3	NLF	-0.24	-0.16	-0.56	-2.63
	SDLF	-0.10	1.24	-0.27	0.36
	TDLF	-0.04	2.29	-0.18	2.51
G4	NLF	-0.37	-0.55	-1.17	-3.66
	SDLF	-0.04	1.06	-0.48	-0.22
	TDLF	0.13	2.20	0.02	2.29
G5	NLF	0.31	-0.11	0.78	-2.08
	SDLF	0.02	0.91	0.30	0.23
	TDLF	-0.17	1.67	-0.01	1.91
G6	NLF	0.54	-0.11	1.49	-1.75
	SDLF	0.07	0.75	0.59	0.18
	TDLF	-0.20	1.43	0.04	1.60
G7	NLF	-0.17	-1.02	-0.53	-4.11
	SDLF	0.08	0.57	-0.11	-0.82
	TDLF	0.22	1.65	0.20	1.43
G8	NLF	0.76	-0.32	2.20	-1.77
	SDLF	0.14	0.43	0.98	-0.09
	TDLF	-0.29	0.93	0.12	1.00
G9	NLF	1.01	-0.35	2.91	-1.54
	SDLF	0.19	0.22	1.27	-0.25
	TDLF	-0.34	0.64	0.14	0.59

Table R1-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.64	-0.07	-1.83	-0.22
	SDLF	0.16	-0.01	-0.52	-0.08
	TDLF	0.77	0.04	0.42	0.00
G2	NLF	-0.37	-0.07	-1.06	-0.22
	SDLF	0.13	0.00	-0.26	-0.08
	TDLF	0.52	0.04	0.31	0.01
G3	NLF	-0.12	-0.07	-0.30	-0.22
	SDLF	0.08	0.00	0.00	-0.08
	TDLF	0.21	0.04	0.14	0.01
G4	NLF	-0.21	-0.07	-0.70	-0.22
	SDLF	0.05	0.00	-0.21	-0.08
	TDLF	0.19	0.04	0.14	0.01
G5	NLF	0.26	-0.07	0.66	-0.21
	SDLF	0.02	0.00	0.26	-0.08
	TDLF	-0.14	0.05	0.00	0.01
G6	NLF	0.43	-0.07	1.19	-0.21
	SDLF	-0.02	0.00	0.41	-0.08
	TDLF	-0.29	0.05	-0.10	0.01
G7	NLF	-0.07	-0.07	-0.22	-0.19
	SDLF	-0.08	0.00	-0.16	-0.08
	TDLF	-0.12	0.05	-0.11	0.01
G8	NLF	0.62	-0.07	1.84	-0.16
	SDLF	-0.10	0.00	0.58	-0.07
	TDLF	-0.64	0.05	-0.32	0.01
G9	NLF	0.82	-0.07	2.42	-0.16
	SDLF	-0.19	-0.01	0.69	-0.08
	TDLF	-0.90	0.04	-0.52	0.00

Load Type & Support Number spans columns SDL 1 – TDL 2.

Appendix R1-5. NISCS39 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge NISCS39 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table R1-5-1. Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	2.2	0.8	2.4	-0.3	-0.9	0.9
		SDLF	-14.6	6.3	15.9	29.1	-3.9	29.4
		TDLF	-34.4	6.6	35.0	47.0	-2.0	47.1
	2-3	NLF	1.9	2.2	2.9	2.1	-2.3	3.1
		SDLF	17.3	10.3	20.1	10.4	-10.1	14.5
		TDLF	21.4	12.8	24.9	9.4	-12.4	15.6
	2-4	NLF	2.3	2.7	3.5	2.1	-2.6	3.3
		SDLF	13.4	5.5	14.5	6.8	-5.1	8.5
		TDLF	16.7	5.9	17.7	5.4	-5.1	7.4
	2-5	NLF	1.3	2.2	2.5	2.0	-2.2	3.0
		SDLF	8.9	4.4	9.9	6.6	-4.2	7.9
		TDLF	11.2	5.3	12.4	7.3	-4.9	8.8
	2-6	NLF	0.6	0.8	1.0	0.6	-0.8	1.0
		SDLF	7.5	2.4	7.8	0.4	-2.2	2.2
		TDLF	11.1	3.0	11.6	-1.8	-2.5	3.0

Table R1-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
11	11-2	NLF	-0.2	0.3	0.4	-0.2	-0.3	0.3
		SDLF	11.0	8.3	13.8	3.1	-7.8	8.4
		TDLF	20.7	15.0	25.6	5.5	-14.5	15.5
	11-3	NLF	3.1	2.2	3.8	-1.1	-2.0	2.3
		SDLF	49.1	31.7	58.5	26.4	-31.4	41.0
		TDLF	75.5	43.7	87.2	39.2	-44.4	59.2
	11-4	NLF	1.8	2.7	3.2	1.7	-2.7	3.2
		SDLF	46.8	29.8	55.4	35.7	-29.9	46.5
		TDLF	69.2	35.6	77.9	48.0	-36.2	60.1
	11-5	NLF	-0.2	2.4	2.5	3.9	-2.6	4.7
		SDLF	46.5	26.8	53.7	37.9	-26.9	46.5
		TDLF	68.8	30.0	75.1	49.3	-29.9	57.6
	11-6	NLF	0.4	0.6	0.7	0.4	-0.6	0.7
		SDLF	43.1	22.9	48.8	33.5	-22.6	40.4
		TDLF	62.4	25.1	67.3	43.7	-24.6	50.2
	11-7	NLF	-2.4	-1.1	2.7	0.6	0.9	1.1
		SDLF	34.7	18.9	39.5	26.7	-18.6	32.5
		TDLF	50.8	20.9	54.9	34.9	-20.3	40.4
	11-8	NLF	-1.4	-1.2	1.8	-1.1	1.2	1.6
		SDLF	24.6	15.1	28.9	19.5	-15.0	24.6
		TDLF	36.7	17.5	40.7	26.1	-17.0	31.2

Table R1-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
18	18-2	NLF	0.7	0.1	0.7	0.7	0.0	0.7
		SDLF	-33.1	-2.6	33.2	-32.7	3.4	32.9
		TDLF	-74.9	-7.3	75.2	-74.6	8.6	75.1
	18-3	NLF	-2.9	0.9	3.0	-4.7	-0.7	4.7
		SDLF	0.3	7.0	7.0	-5.8	-6.0	8.4
		TDLF	13.3	8.6	15.8	3.0	-6.0	6.7
	18-4	NLF	-6.8	1.3	6.9	-6.5	-1.3	6.7
		SDLF	7.5	12.7	14.7	7.9	-12.8	15.1
		TDLF	44.3	17.3	47.6	44.7	-17.8	48.1
	18-5	NLF	-6.9	1.2	7.0	-6.7	-1.1	6.8
		SDLF	3.6	17.4	17.8	4.1	-17.8	18.3
		TDLF	30.6	21.5	37.4	31.3	-22.8	38.7
	18-6	NLF	-7.4	0.0	7.4	-7.2	0.1	7.2
		SDLF	-7.6	18.0	19.5	-6.6	-18.6	19.7
		TDLF	11.9	21.7	24.8	13.6	-23.6	27.3
	18-7	NLF	-8.4	-1.1	8.5	-6.0	1.1	6.1
		SDLF	-22.1	15.0	26.7	-19.8	-15.5	25.2
		TDLF	-10.9	18.4	21.4	-7.0	-20.6	21.8
	18-8	NLF	-3.4	-1.1	3.5	-3.1	1.1	3.3
		SDLF	-40.1	10.1	41.4	-36.0	-9.9	37.3
		TDLF	-38.9	13.4	41.1	-32.0	-14.8	35.2

Table R1-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
27	27-2	NLF	0.4	0.1	0.4	-2.1	0.0	2.1
		SDLF	-8.5	1.2	8.6	-3.5	-1.8	3.9
		TDLF	-3.0	5.9	6.6	4.5	-7.5	8.8
	27-3	NLF	-11.5	0.9	11.6	-10.4	-0.8	10.4
		SDLF	-13.4	12.0	18.0	-12.7	-11.5	17.1
		TDLF	18.5	26.5	32.3	16.8	-25.3	30.3
	27-4	NLF	-9.1	1.2	9.1	-9.0	-1.0	9.0
		SDLF	-10.9	14.9	18.4	-11.2	-14.3	18.2
		TDLF	8.3	26.9	28.2	7.4	-25.9	26.9
	27-5	NLF	-8.1	0.2	8.1	-8.0	0.0	8.0
		SDLF	-10.7	12.1	16.1	-10.7	-11.8	15.9
		TDLF	3.2	21.3	21.5	2.9	-21.0	21.2
	27-6	NLF	-9.3	-1.2	9.4	-6.1	0.9	6.2
		SDLF	-11.6	7.3	13.7	-8.3	-7.4	11.1
		TDLF	1.5	14.0	14.1	1.6	-14.1	14.2

Table R1-5-2: Erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
2	NLF	2-4
	SDLF	2-2
	TDLF	2-2
11	NLF	11-5
	SDLF	11-4
	TDLF	11-4
18	NLF	18-6
	SDLF	18-8
	TDLF	18-2
27	NLF	27-3
	SDLF	27-4
	TDLF	27-3

Table R1-5-3. Erection critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	1.2	2.3	2.6	NA	NA	NA
		SDLF	1.6	1.9	2.5	NA	NA	NA
		TDLF	2.2	2.7	3.5	NA	NA	NA
	B	NLF	2.3	2.7	3.5	2.1	-2.6	3.3
		SDLF	-14.6	6.3	15.9	29.1	-3.9	29.4
		TDLF	-34.4	6.6	35.0	47.0	-2.0	47.1
11	A	NLF	0.7	1.6	1.8	NA	NA	NA
		SDLF	58.9	16.4	61.2	NA	NA	NA
		TDLF	89.7	20.0	91.9	NA	NA	NA
	B	NLF	-0.2	2.4	2.5	3.9	-2.6	4.7
		SDLF	46.8	29.8	55.4	35.7	-29.9	46.5
		TDLF	69.2	35.6	77.9	48.0	-36.2	60.1
18	A	NLF	-11.3	-0.1	11.3	NA	NA	NA
		SDLF	-60.8	6.3	61.1	NA	NA	NA
		TDLF	-103.8	-5.8	103.9	NA	NA	NA
	B	NLF	-7.4	0.0	7.4	-7.2	0.1	7.2
		SDLF	-40.1	10.1	41.4	-36.0	-9.9	37.3
		TDLF	-74.9	-7.3	75.2	-74.6	8.6	75.1
27	A	NLF	-16.9	0.1	16.9	NA	NA	NA
		SDLF	-17.9	9.4	20.2	NA	NA	NA
		TDLF	49.5	16.3	52.1	NA	NA	NA
	B	NLF	-11.5	0.9	11.6	-10.4	-0.8	10.4
		SDLF	-10.9	14.9	18.4	-11.2	-14.3	18.2
		TDLF	18.5	26.5	32.3	16.8	-25.3	30.3

Table R1-5-6. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number				
				1	2	3	4	5
2	A	G1	NLF	41.5	93.8	48.5		
			SDLF	40.9	89.0	49.1		
			TDLF	43.2	86.2	50.7		
		G2	NLF	8.1	76.7	153.5	76.8	3.8
			SDLF	0.6	80.6	161.3	80.7	0.0
			TDLF	1.6	78.0	156.1	78.1	3.1
	B	G1	NLF	43.2	94.0	52.3		
			SDLF	93.1	0.0	114.0		
			TDLF	91.7	0.0	112.5		
		G2	NLF	20.5	61.5	123.1	61.6	22.1
			SDLF	59.6	0.0	0.0	0.0	80.5
			TDLF	61.2	0.0	0.0	0.0	81.7

Table R1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
11	A	G1	NLF	75.3	175.6	96.2	79.5		
			SDLF	177.5	165.1	78.6	204.4		
			TDLF	235.8	60.7	84.4	271.0		
		G2	NLF	70.1	169.2	68.0	136.3	68.3	50.7
			SDLF	133.5	0.0	0.0	0.0	0.0	153.1
			TDLF	174.8	0.0	0.0	0.0	0.0	159.6
		G3	NLF	69.3	87.4				
			SDLF	71.5	28.9				
			TDLF	84.7	0.0				
		G4	NLF	52.7	67.8				
			SDLF	39.2	66.3				
			TDLF	15.1	14.2				
		G5	NLF	49.6	62.7				
			SDLF	52.0	64.5				
			TDLF	53.5	74.8				
		G6	NLF	44.1	58.1				
			SDLF	48.8	59.7				
			TDLF	57.6	62.9				
		G7	NLF	36.2	48.1				
			SDLF	25.8	44.1				
			TDLF	14.4	49.3				
		G8	NLF	31.5	45.7				
			SDLF	40.1	44.8				
			TDLF	47.2	26.5				
		G9	NLF	24.4	39.3				
			SDLF	25.3	42.5				
			TDLF	25.7	53.6				

Table R1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
11	B	G1	NLF	75.4	176.0	98.4	79.1		
			SDLF	180.2	155.8	94.6	195.3		
			TDLF	237.5	48.9	103.7	258.9		
		G2	NLF	70.2	169.9	65.3	130.9	65.6	54.7
			SDLF	137.0	0.0	0.0	0.0	0.0	159.1
			TDLF	178.1	0.0	0.0	0.0	0.0	165.5
		G3	NLF	69.4	87.6				
			SDLF	72.5	20.2				
			TDLF	86.4	0.0				
		G4	NLF	52.7	67.8				
			SDLF	39.2	66.2				
			TDLF	14.3	7.8				
		G5	NLF	49.6	62.7				
			SDLF	52.0	64.5				
			TDLF	53.4	75.8				
		G6	NLF	44.1	58.1				
			SDLF	48.8	59.7				
			TDLF	57.7	63.0				
		G7	NLF	36.2	48.1				
			SDLF	25.7	44.1				
			TDLF	14.3	49.3				
		G8	NLF	31.5	45.7				
			SDLF	40.1	44.8				
			TDLF	47.2	26.5				
		G9	NLF	24.4	39.3				
			SDLF	25.3	42.5				
			TDLF	25.7	53.7				

Table R1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
18	A	G1	NLF	63.0	237.3	147.9			
			SDLF	203.6	228.6	462.0			
			TDLF	296.4	0.0	655.9			
		G2	NLF	55.5	239.6	146.8			
			SDLF	172.7	0.0	188.9			
			TDLF	222.3	0.0	189.6			
		G3	NLF	48.0	221.6	143.6			
			SDLF	141.5	0.0	88.8			
			TDLF	145.0	0.0	3.9			
		G4	NLF	33.3	170.2	112.0			
			SDLF	94.7	0.0	98.5			
			TDLF	84.0	0.0	95.9			
		G5	NLF	28.7	158.3	110.3			
			SDLF	107.3	0.0	110.3			
			TDLF	108.5	0.0	90.0			
		G6	NLF	25.2	150.8	108.5			
			SDLF	113.1	0.0	143.6			
			TDLF	122.8	0.0	129.0			
		G7	NLF	34.3	137.2	79.6			
			SDLF	113.0	0.0	151.6			
			TDLF	111.2	0.0	170.5			
		G8	NLF	101.0	250.6	65.8			
			SDLF	215.5	0.0	160.5			
			TDLF	252.7	0.0	110.4			
		G9	NLF	138.1	214.5	59.3	118.7	59.4	26.7
			SDLF	257.5	156.5	0.0	0.0	0.0	166.7
			TDLF	278.6	0.0	49.0	97.9	49.0	186.3

Table R1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number					
				1	2	3	4	5	6
18	B	G1	NLF	63.0	237.3	147.9			
			SDLF	203.5	229.4	462.2			
			TDLF	295.5	0.0	655.3			
		G2	NLF	55.5	239.6	146.8			
			SDLF	172.7	0.0	188.9			
			TDLF	221.7	0.0	190.9			
		G3	NLF	47.9	221.7	143.7			
			SDLF	141.8	0.0	88.5			
			TDLF	145.4	0.0	7.9			
		G4	NLF	33.2	170.3	112.1			
			SDLF	94.6	0.0	98.3			
			TDLF	84.4	0.0	102.3			
		G5	NLF	28.7	158.4	110.2			
			SDLF	107.3	0.0	109.9			
			TDLF	109.5	0.0	97.2			
		G6	NLF	25.3	150.7	108.4			
			SDLF	112.7	0.0	143.5			
			TDLF	124.2	0.0	130.3			
		G7	NLF	34.4	136.8	79.5			
			SDLF	111.8	0.0	152.0			
			TDLF	112.6	0.0	154.4			
		G8	NLF	101.1	250.1	65.7			
			SDLF	215.9	0.0	161.3			
			TDLF	253.8	0.0	54.6			
		G9	NLF	138.0	215.0	60.9	121.8	60.9	25.8
			SDLF	260.8	154.8	0.0	0.0	0.0	167.2
			TDLF	285.4	0.0	26.1	52.2	26.1	275.1

Table R1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
27	A	G1	NLF	73.4	206.3	246.8	91.5			
			SDLF	211.4	489.2	579.5	215.3			
			TDLF	311.8	418.2	514.0	289.0			
		G2	NLF	66.1	209.1	279.4	91.7			
			SDLF	171.7	0.0	168.9	195.9			
			TDLF	238.1	0.0	0.0	266.7			
		G3	NLF	55.6	189.8	265.5	89.1			
			SDLF	158.2	0.0	0.0	184.8			
			TDLF	198.4	0.0	0.0	241.0			
		G4	NLF	42.9	149.7	214.1	71.5			
			SDLF	112.4	0.0	0.0	135.9			
			TDLF	113.3	0.0	0.0	198.5			
		G5	NLF	37.4	138.8	206.9	69.5			
			SDLF	130.6	0.0	0.0	125.9			
			TDLF	161.5	0.0	0.0	162.2			
		G6	NLF	30.2	134.5	200.5	67.9			
			SDLF	140.4	0.0	34.1	124.4			
			TDLF	190.1	0.0	0.0	158.8			
		G7	NLF	35.4	113.0	166.3	56.3			
			SDLF	101.9	0.0	101.6	114.8			
			TDLF	108.0	0.0	0.0	193.7			
		G8	NLF	107.3	294.2	153.4	43.3			
			SDLF	214.1	93.4	103.4	89.4			
			TDLF	301.2	0.0	0.0	164.1			
		G9	NLF	132.7	232.8	103.5	56.6	113.5	56.8	7.8
			SDLF	218.7	330.7	39.7	80.3	160.9	80.6	44.0
			TDLF	364.9	96.2	0.0	20.3	40.7	20.4	57.1

Table R1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
27	B	G1	NLF	73.4	206.3	247.0	91.7			
			SDLF	211.4	489.0	579.8	215.6			
			TDLF	312.0	418.4	513.7	289.6			
		G2	NLF	66.1	209.1	279.5	91.9			
			SDLF	171.8	0.0	169.5	196.2			
			TDLF	238.3	0.0	0.0	267.7			
		G3	NLF	55.7	189.8	265.6	89.3			
			SDLF	158.3	0.0	0.0	185.1			
			TDLF	198.7	0.0	0.0	242.5			
		G4	NLF	42.9	149.7	214.1	71.7			
			SDLF	112.4	0.0	0.0	136.1			
			TDLF	113.5	0.0	0.0	200.1			
		G5	NLF	37.4	138.8	206.7	69.7			
			SDLF	130.6	0.0	0.0	125.7			
			TDLF	161.8	0.0	0.0	164.0			
		G6	NLF	30.2	134.5	200.2	67.9			
			SDLF	140.3	0.0	33.1	123.2			
			TDLF	190.3	0.0	0.0	159.4			
		G7	NLF	35.3	113.1	165.9	55.4			
			SDLF	101.9	0.0	100.7	112.9			
			TDLF	107.8	0.0	0.0	188.9			
		G8	NLF	107.2	294.3	153.5	40.8			
			SDLF	213.9	94.0	105.0	92.8			
			TDLF	299.1	0.0	0.0	152.4			
		G9	NLF	132.7	232.9	104.0	56.6	113.4	56.8	12.1
			SDLF	218.6	331.0	46.0	71.6	143.5	71.9	54.9
			TDLF	360.3	111.0	0.0	0.0	0.0	0.0	100.0

Appendix R2-1. NISCS39 Bridge Description

The key characteristics of NISCS39 are as follows:

- Span length along the centerline of the bridge, L_s = 300 ft.
- Width between the fascia girders, w_g = 74 ft.
- Radius of curvature to the centerline of the bridge, R =730 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 4.1
- Subtended angle between the supports, L_s/R = 0.41
- Number of girders in the completed bridge cross-section, n_g =9.
- Skew angle, θ = -35,0^o

This appendix presents the bridge description of the bridge NISCS39 in its final condition as well as during erection. The following figures and tables are provided:

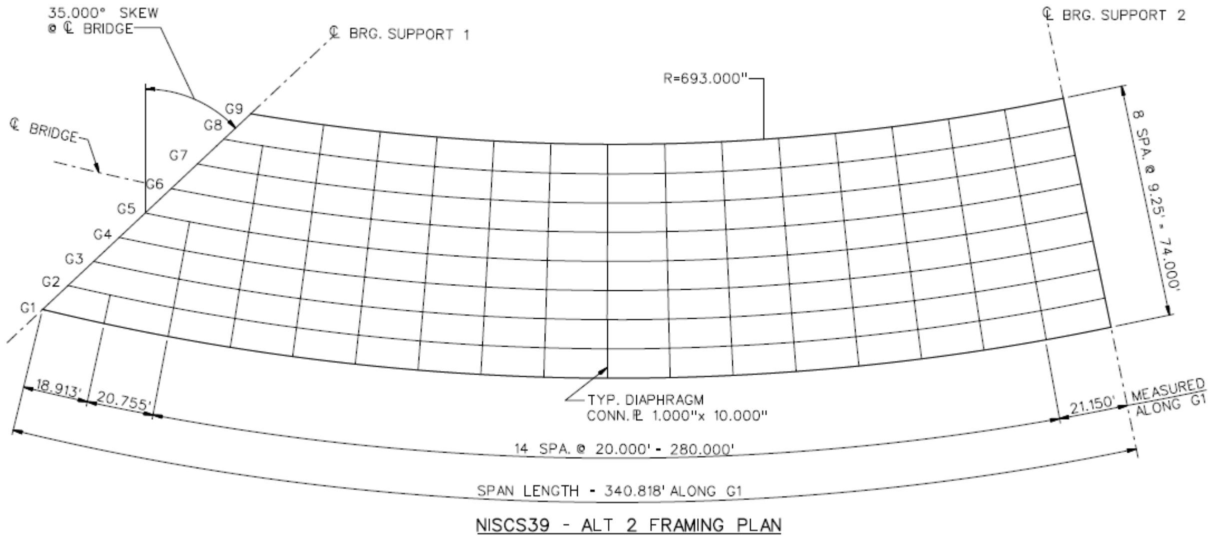


Figure R2-1-1. Framing plan.

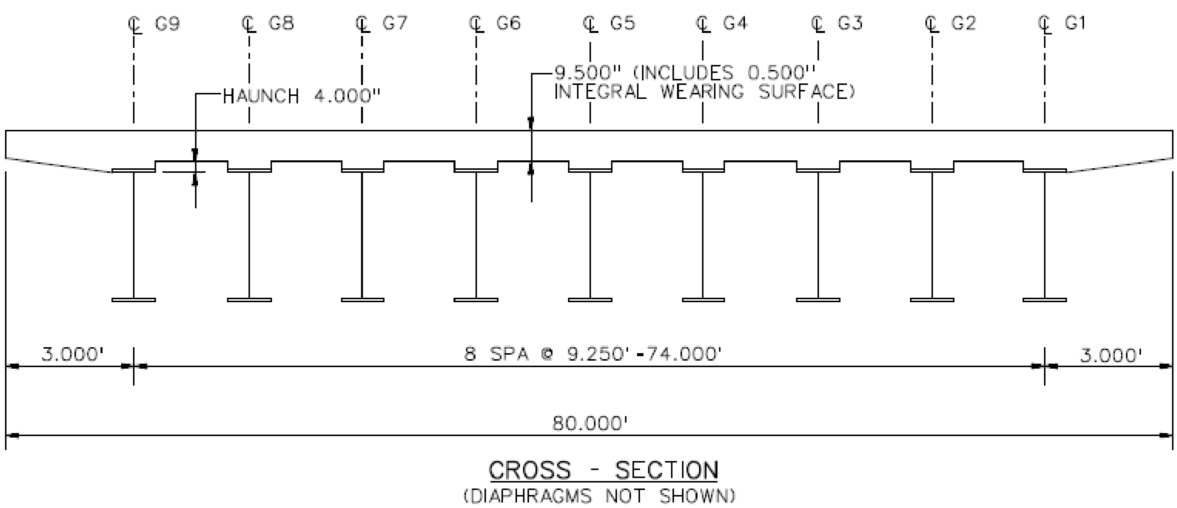


Figure R2-1-2. Bridge cross-section.

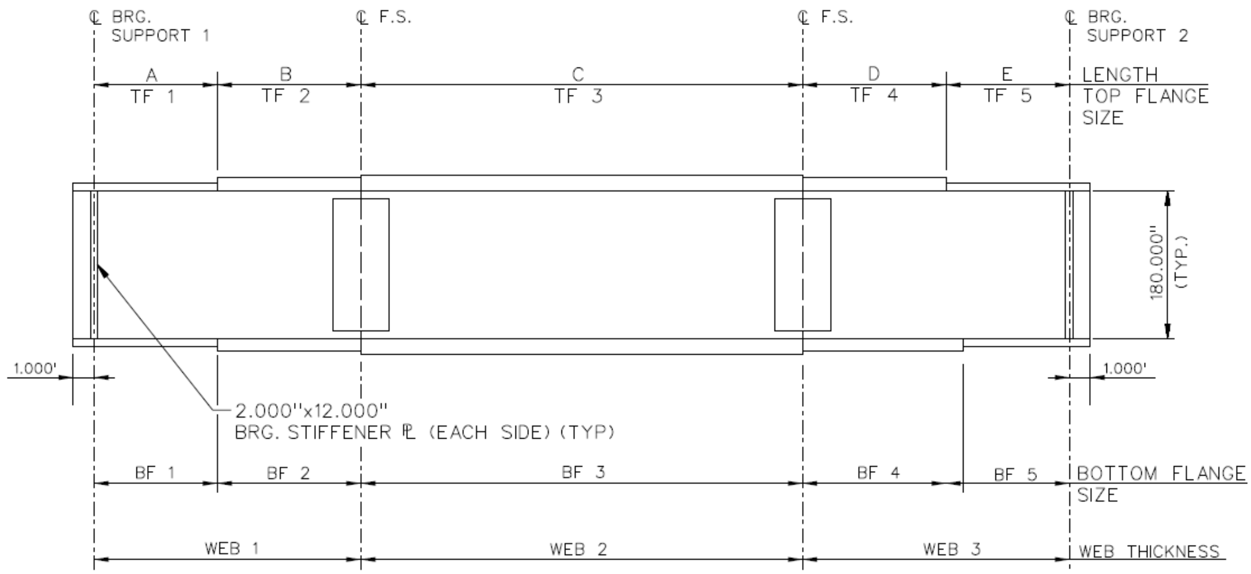


Figure R2-1-3. Girder elevations

	GIRDER PLATE LENGTHS ⚹								
LENGTH	G1	G2	G3	G4	G5	G6	G7	G8	G9
A	115.000	107.570	100.108	92.610	85.075	77.499	69.881	62.216	54.501
B	35.001	35.362	35.724	36.086	36.448	36.810	34.671	35.033	35.395
C	59.999	59.276	58.552	57.828	57.105	56.381	55.658	54.934	54.210
D	35.001	35.362	35.724	36.086	36.448	36.810	34.671	35.033	35.395
E	95.818	93.095	90.371	87.648	84.925	82.202	84.478	81.755	79.032

⚹ ALL DIMENSIONS ARE IN FEET.

	GIRDER FLANGE DIMENSIONS ⚹⚹					
TOP FLANGE	G1, G2, G3		G4, G5, G6		G7, G8, G9	
	BF	TF	BF	TF	BF	TF
TF1	44.000	2.500	36.000	1.750	30.000	1.500
TF2	44.000	3.000	36.000	1.750	30.000	1.500
TF3	44.000	3.000	36.000	2.000	30.000	1.500
TF4	44.000	3.000	36.000	1.750	30.000	1.500
TF5	44.000	2.500	36.000	1.750	30.000	1.500

⚹⚹ ALL DIMENSIONS ARE IN INCHES.

	GIRDER FLANGE DIMENSIONS ⚹⚹					
BOTTOM FLANGE	G1		G2		G3	
	BF	TF	BF	TF	BF	TF
BF1	46.000	2.500	38.000	1.750	32.000	1.500
BF2	46.000	3.500	38.000	2.500	32.000	1.500
BF3	46.000	3.500	38.000	2.500	32.000	1.500
BF4	46.000	3.500	38.000	2.500	32.000	1.500
BF5	46.000	2.500	38.000	1.750	32.000	1.500

⚹⚹ ALL DIMENSIONS ARE IN INCHES.

Figure R2-1-4. Cross-section dimensions.

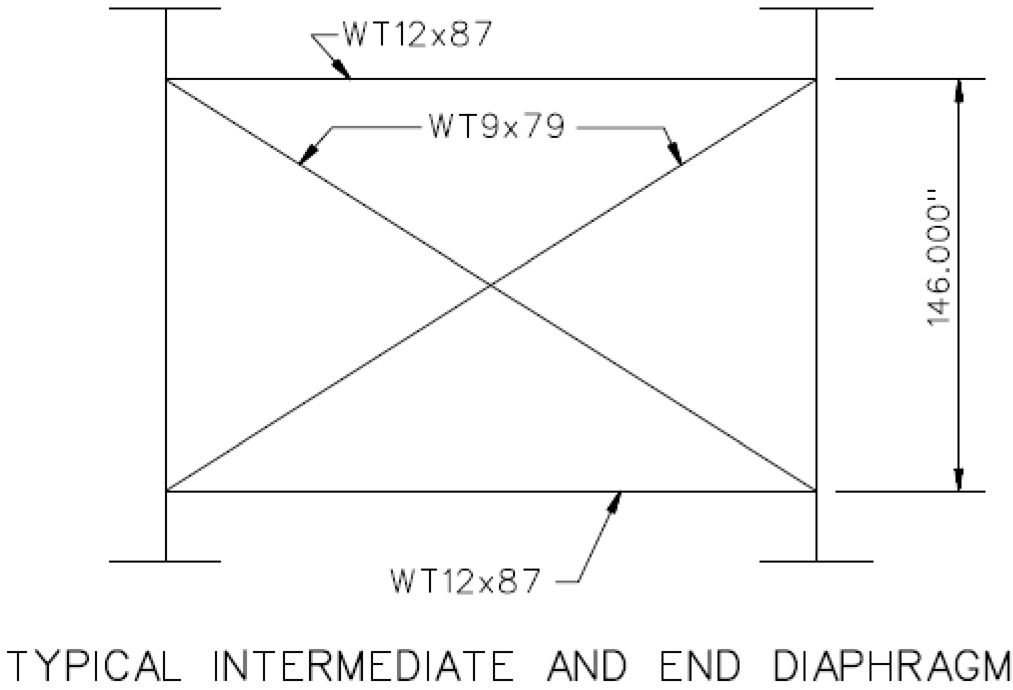


Figure R2-1-5. Cross-frame details

Appendix R2-2. NISCS39 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge NISCS39 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table R2-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	14.0	24.3
	SDLF	11.3	20.9
	TDLF	9.5	18.7
G2	NLF	12.4	21.5
	SDLF	9.6	18.2
	TDLF	7.8	16.0
G3	NLF	10.7	18.7
	SDLF	8.0	15.5
	TDLF	6.2	13.4
G4	NLF	9.1	16.0
	SDLF	6.5	12.9
	TDLF	4.7	10.9
G5	NLF	7.5	13.3
	SDLF	5.0	10.4
	TDLF	3.3	8.6
G6	NLF	6.0	10.6
	SDLF	3.6	8.0
	TDLF	1.9	6.3
G7	NLF	4.4	8.0
	SDLF	2.1	5.6
	TDLF	0.6	4.0
G8	NLF	2.9	5.4
	SDLF	0.7	3.2
	TDLF	0.7	1.8
G9	NLF	1.4	2.9
	SDLF	0.8	0.9
	TDLF	2.1	0.7
All Girders	NLF	14.0	24.3
	SDLF	11.3	20.9
	TDLF	9.5	18.7

Table R2-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	2.95	5.05
	SDLF	0.25	2.09
	TDLF	1.78	0.50
G2	NLF	2.84	4.85
	SDLF	0.27	1.91
	TDLF	1.88	0.54
G3	NLF	2.79	4.75
	SDLF	0.30	1.81
	TDLF	1.93	0.57
G4	NLF	2.70	4.59
	SDLF	0.33	1.67
	TDLF	2.01	0.61
G5	NLF	2.65	4.51
	SDLF	0.35	1.58
	TDLF	2.07	0.63
G6	NLF	2.62	4.45
	SDLF	0.35	1.52
	TDLF	2.12	0.64
G7	NLF	2.59	4.39
	SDLF	0.36	1.47
	TDLF	2.17	0.70
G8	NLF	2.57	4.37
	SDLF	0.40	1.44
	TDLF	2.20	0.78
G9	NLF	2.56	4.34
	SDLF	0.43	1.42
	TDLF	2.23	0.85
All Girders	NLF	2.95	5.05
	SDLF	0.43	2.09
	TDLF	2.23	0.85

Table R2-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	16.7	28.6	17.3	29.7	3.1	8.5	3.8	9.5
	SDLF	16.9	28.3	17.3	29.2	1.1	4.2	1.4	4.4
	TDLF	16.9	28.0	17.3	28.8	1.9	1.8	3.2	2.8
G2	NLF	14.8	25.5	15.5	26.7	3.1	8.5	3.7	9.4
	SDLF	15.1	25.5	15.5	26.3	1.1	4.1	1.7	4.2
	TDLF	15.3	25.5	15.4	26.0	2.0	1.8	3.1	3.0
G3	NLF	13.6	23.5	13.7	23.6	3.0	8.4	3.6	9.3
	SDLF	13.7	23.4	13.7	23.4	0.9	4.0	1.3	4.1
	TDLF	13.7	23.2	13.7	23.3	1.8	1.7	3.0	2.4
G4	NLF	12.3	21.2	12.9	22.5	2.8	7.6	3.3	8.5
	SDLF	12.0	20.8	12.9	22.3	1.0	3.8	1.8	4.1
	TDLF	11.8	20.5	12.9	22.2	1.7	1.6	2.9	3.3
G5	NLF	10.9	18.9	10.8	19.1	3.5	7.4	4.7	8.7
	SDLF	10.4	18.4	10.9	19.1	0.8	3.6	1.3	4.0
	TDLF	10.1	18.0	10.9	19.1	1.6	1.4	2.7	2.6
G6	NLF	8.8	15.5	8.4	15.0	2.5	7.2	3.2	8.1
	SDLF	8.2	14.9	8.5	15.2	0.7	3.3	1.2	3.7
	TDLF	7.8	14.5	8.5	15.3	1.6	1.1	2.5	2.4
G7	NLF	5.6	10.0	5.7	10.2	2.2	7.7	3.8	10.2
	SDLF	5.0	9.4	5.1	9.7	0.6	3.1	0.9	3.2
	TDLF	4.9	9.4	5.0	9.6	1.4	0.9	3.2	1.8
G8	NLF	2.8	5.3	2.9	5.4	2.7	5.9	10.7	20.6
	SDLF	2.1	4.9	2.1	5.0	0.8	2.5	0.6	7.4
	TDLF	2.1	5.1	2.1	5.2	3.1	1.5	7.3	1.1
G9	NLF	4.7	7.6	4.8	7.7	2.4	8.7	10.2	22.1
	SDLF	3.6	5.3	3.7	5.7	1.2	4.4	0.6	8.8
	TDLF	3.7	4.6	3.8	4.7	1.4	1.8	5.9	0.9
All Girders	NLF	16.7	28.6	17.3	29.7	3.5	8.7	10.7	22.1
	SDLF	16.9	28.3	17.3	29.2	1.2	4.4	1.8	8.8
	TDLF	16.9	28.0	17.3	28.8	3.1	1.8	7.3	3.3

Table R2-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	235.2	450.2	410.4	450.2
	SDLF	89.5	185.6	182.5	185.6
	TDLF	70.0	193.8	189.5	193.8
TDL	NLF	392.7	769.5	657.5	769.5
	SDLF	230.5	445.6	396.9	445.6
	TDLF	141.3	287.7	282.5	287.7

Table R2-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	34.1	80.5	79.6	57.1
	SDLF	27.4	69.9	68.8	48.4
	TDLF	28.8	66.2	64.0	46.9
TDL	NLF	61.2	140.3	136.9	99.9
	SDLF	50.7	122.3	119.7	85.9
	TDLF	47.0	111.1	108.7	78.4

Table R2-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	1.67	1.64	1.61	1.58	1.57	1.56	1.56	1.57	1.67
SDLF	1.67	1.61	1.54	1.48	1.45	1.43	1.43	1.43	1.67
TDLF	1.67	1.59	1.49	1.41	1.36	1.33	1.33	1.34	1.67

Table R2-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	2.85	2.79	2.73	2.68	2.66	2.64	2.65	2.66	2.85
SDLF	2.75	2.67	2.57	2.50	2.45	2.42	2.42	2.43	2.75
TDLF	2.69	2.59	2.47	2.37	2.30	2.27	2.27	2.28	2.69

Table R2-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	2.05	2.01	1.97	1.94	1.92	1.91	1.91	1.92	2.05
SDLF	2.04	1.97	1.89	1.82	1.77	1.75	1.75	1.75	2.04
TDLF	2.05	1.95	1.83	1.73	1.67	1.63	1.63	1.64	2.05

Table R2-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9	All Girders
NLF	3.49	3.42	3.35	3.29	3.25	3.24	3.24	3.25	3.49
SDLF	3.37	3.27	3.15	3.06	3.00	2.96	2.96	2.98	3.37
TDLF	3.30	3.17	3.02	2.90	2.82	2.78	2.78	2.80	3.30

Table R2-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	4352	7621
SDLF	4352	7620
TDLF	4352	7621

Table R2-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	512	871	5.7	15.9	4.5	12.8
SDLF	518	865	1.2	7.0	0.8	4.5
TDLF	522	862	1.9	1.2	4.3	1.1

Table R2-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	1.15	3.18	0.91	2.55
SDLF	1.52	1.40	0.17	0.89
TDLF	2.80	2.89	0.85	0.22

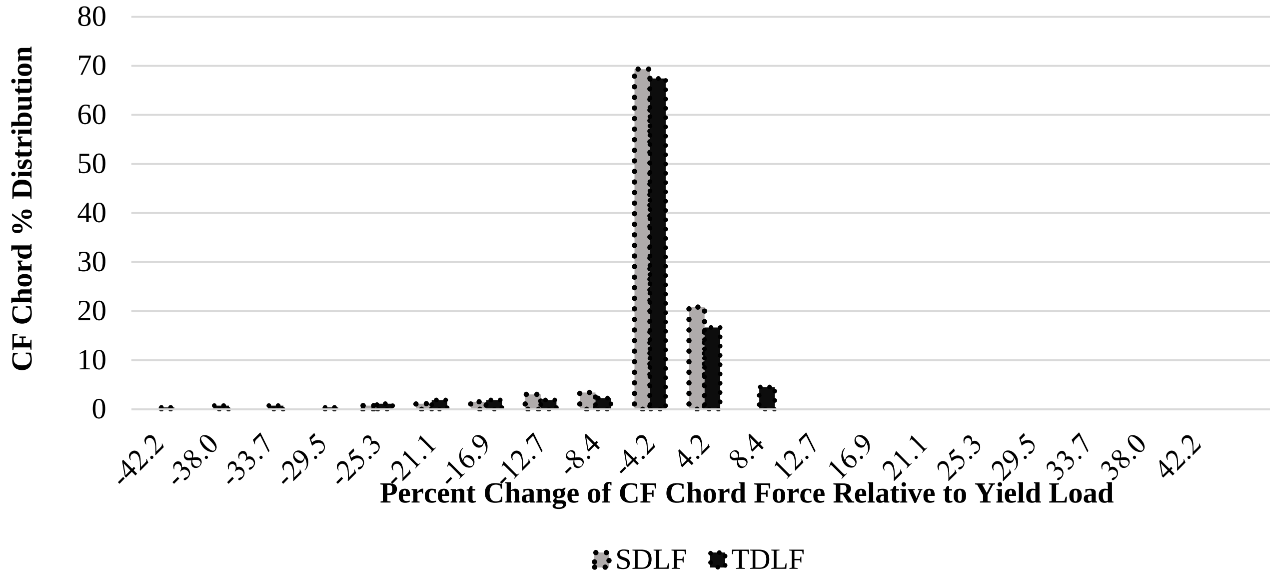


Figure R2-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

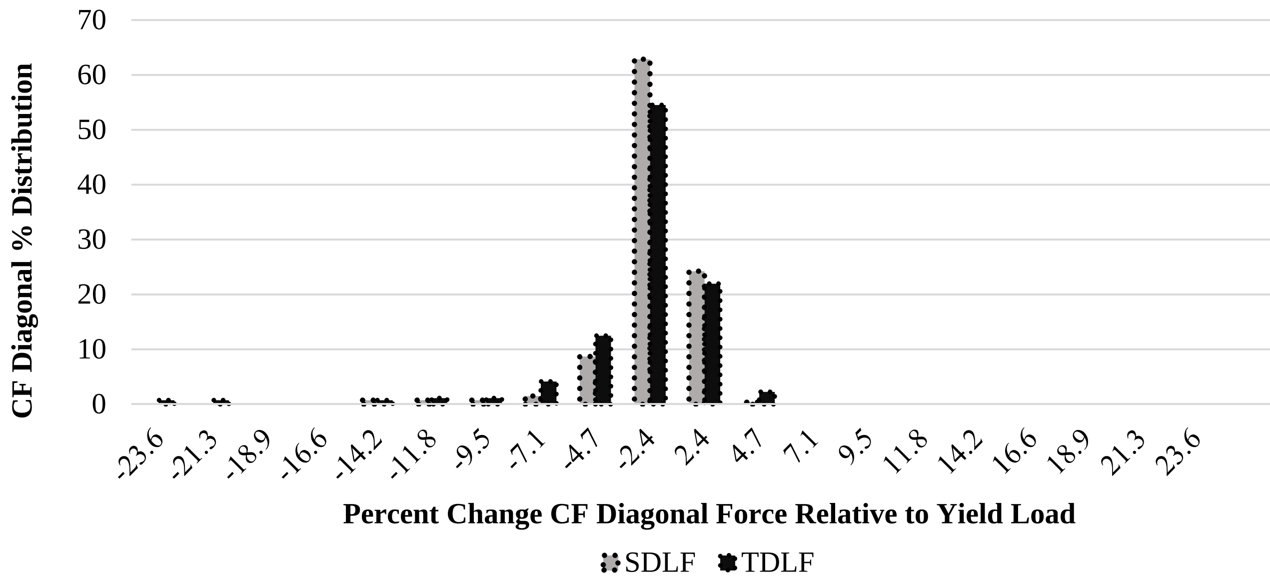


Figure R2-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

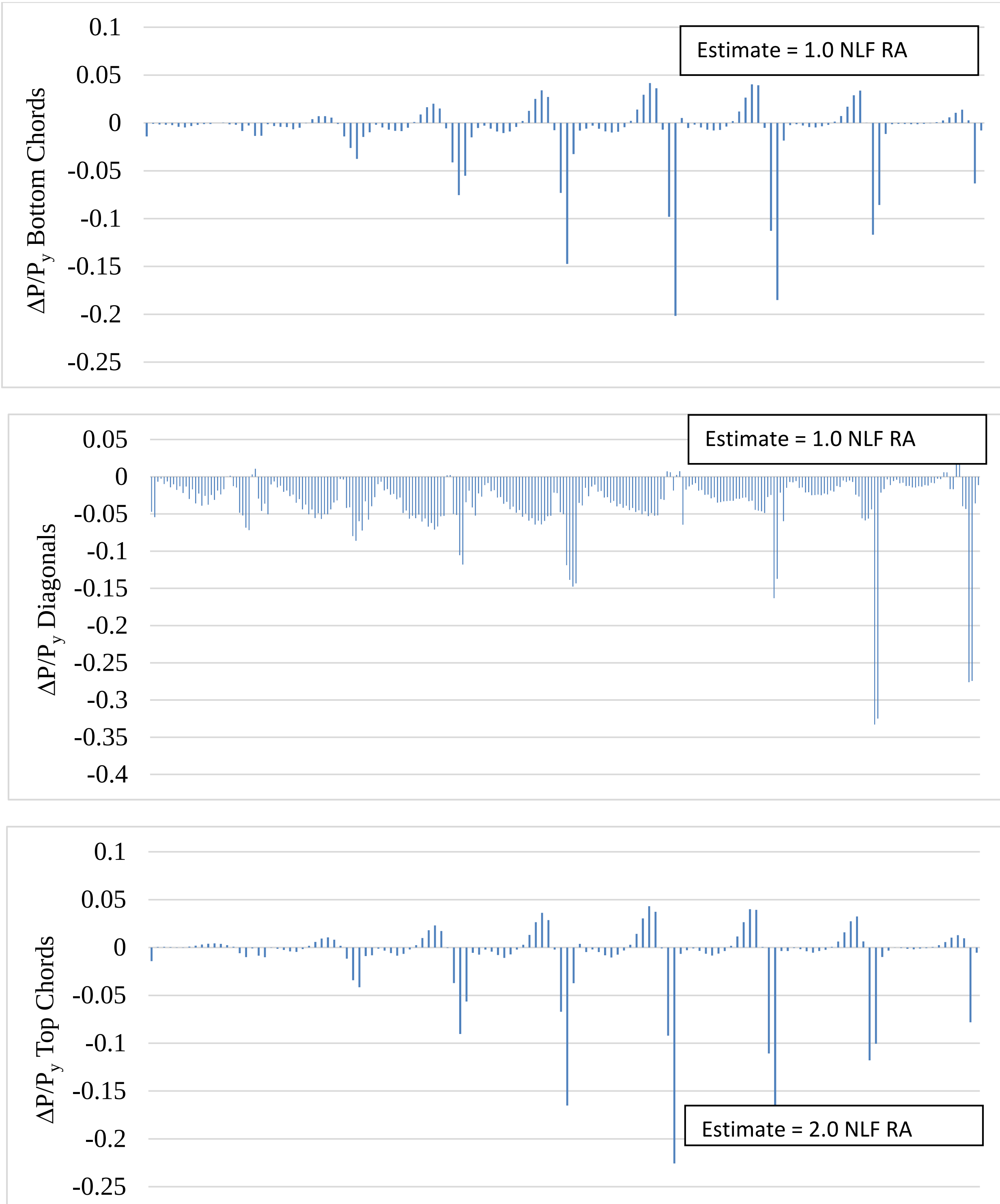


Figure R2-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load ((ΔP/P_y), under SDL, SDLF detailing.

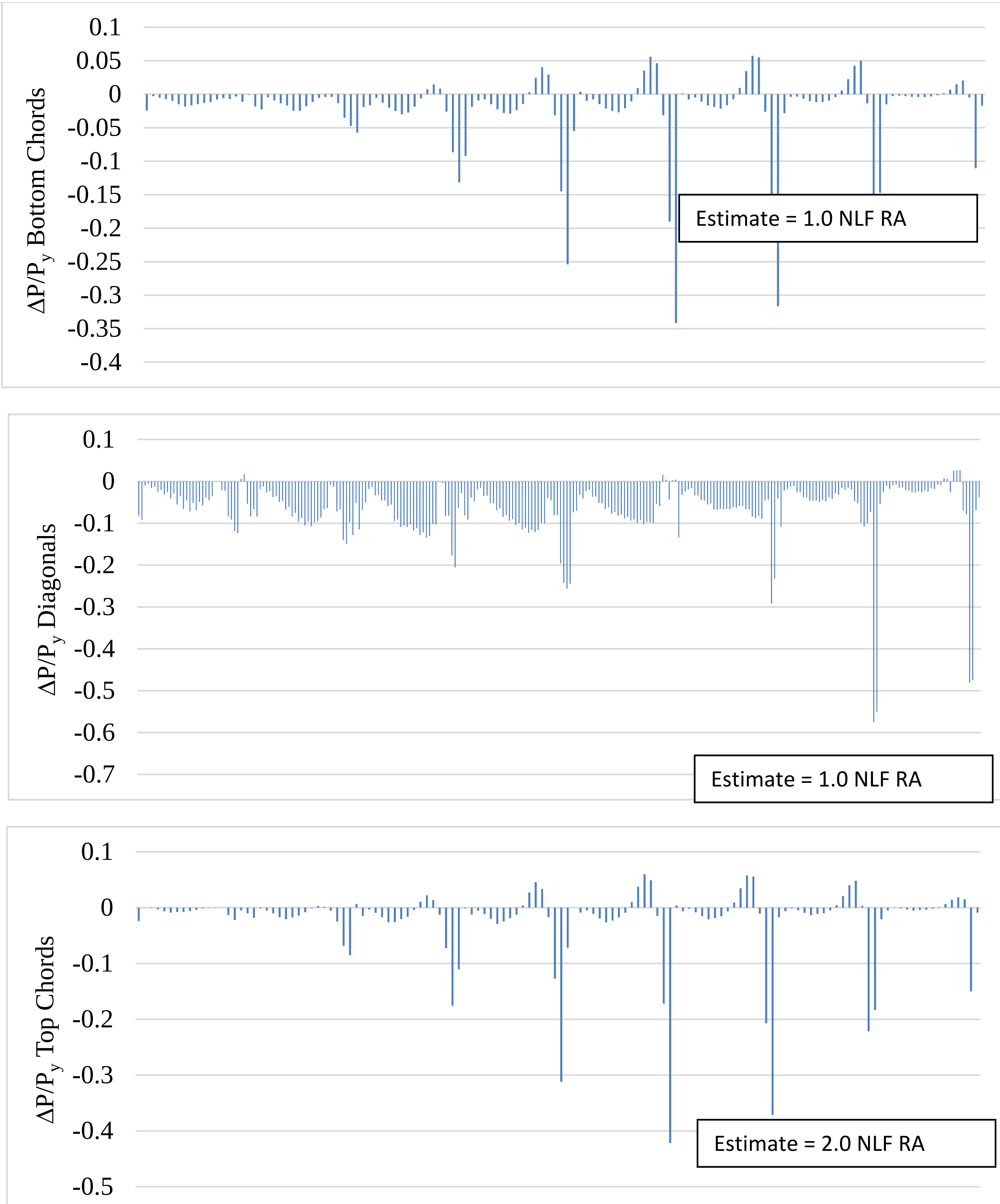


Figure R2-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix R2-4. NISCS39 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge NISCS39 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Figure R2-4-1. SDL and TDL 3D FEA cambers.

Overview of Bridge Displacements and Elevation Profiles

Figure R2-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.
Figure R2-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.
Figure R2-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.
Figure R2-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.
Figure R2-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).
Figure R2-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.
Figure R2-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.
Figure R2-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

Girder Displacements and Elevations for Different Detailing Methods

Figure R2-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.
Figure R2-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.
Figure R2-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.
Figure R2-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.
Figure R2-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.
Figure R2-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.
Figure R2-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.
Figure R2-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

Girder Flange Stresses for Different Detailing Methods

Figure R2-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.
Figure R2-4-19. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods
Figure R2-4-20. Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.
Figure R2-4-21. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

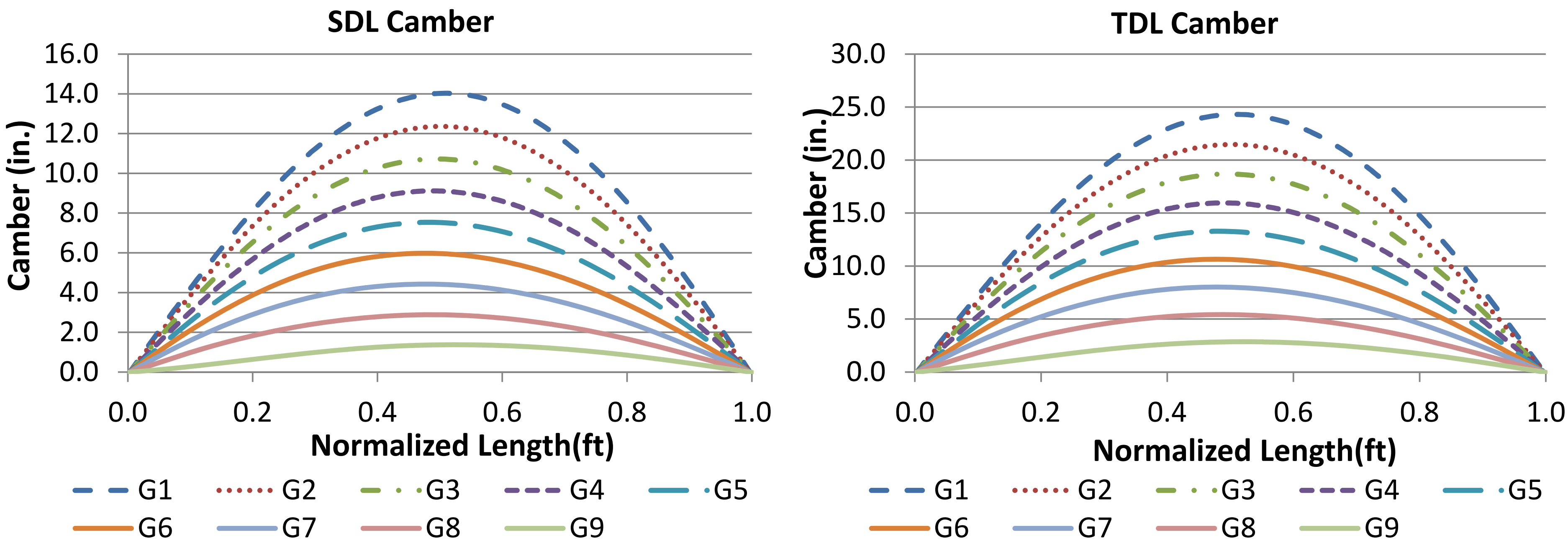


Figure R2-4-1. SDL and TDL 3D FEA cambers.

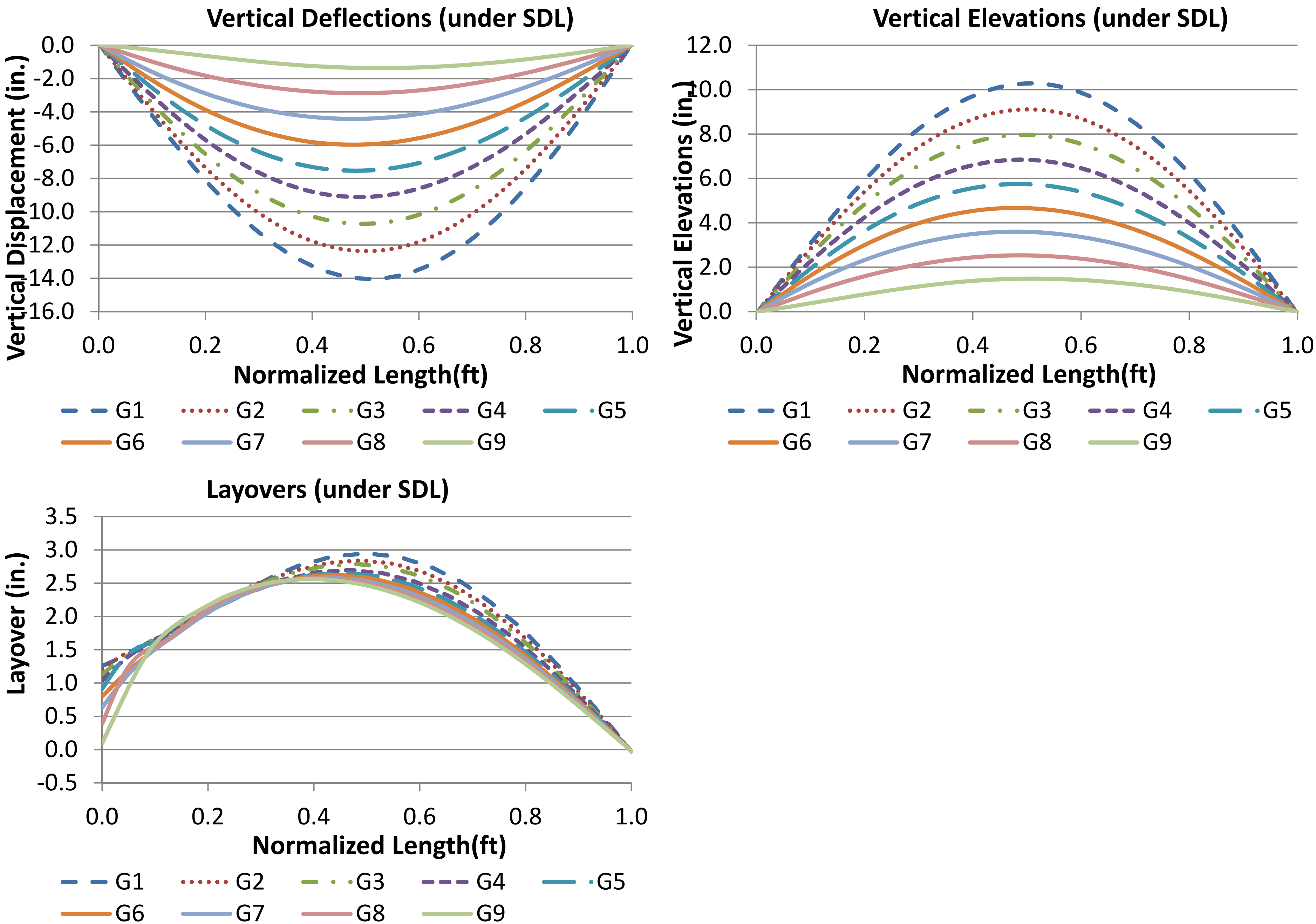


Figure R2-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

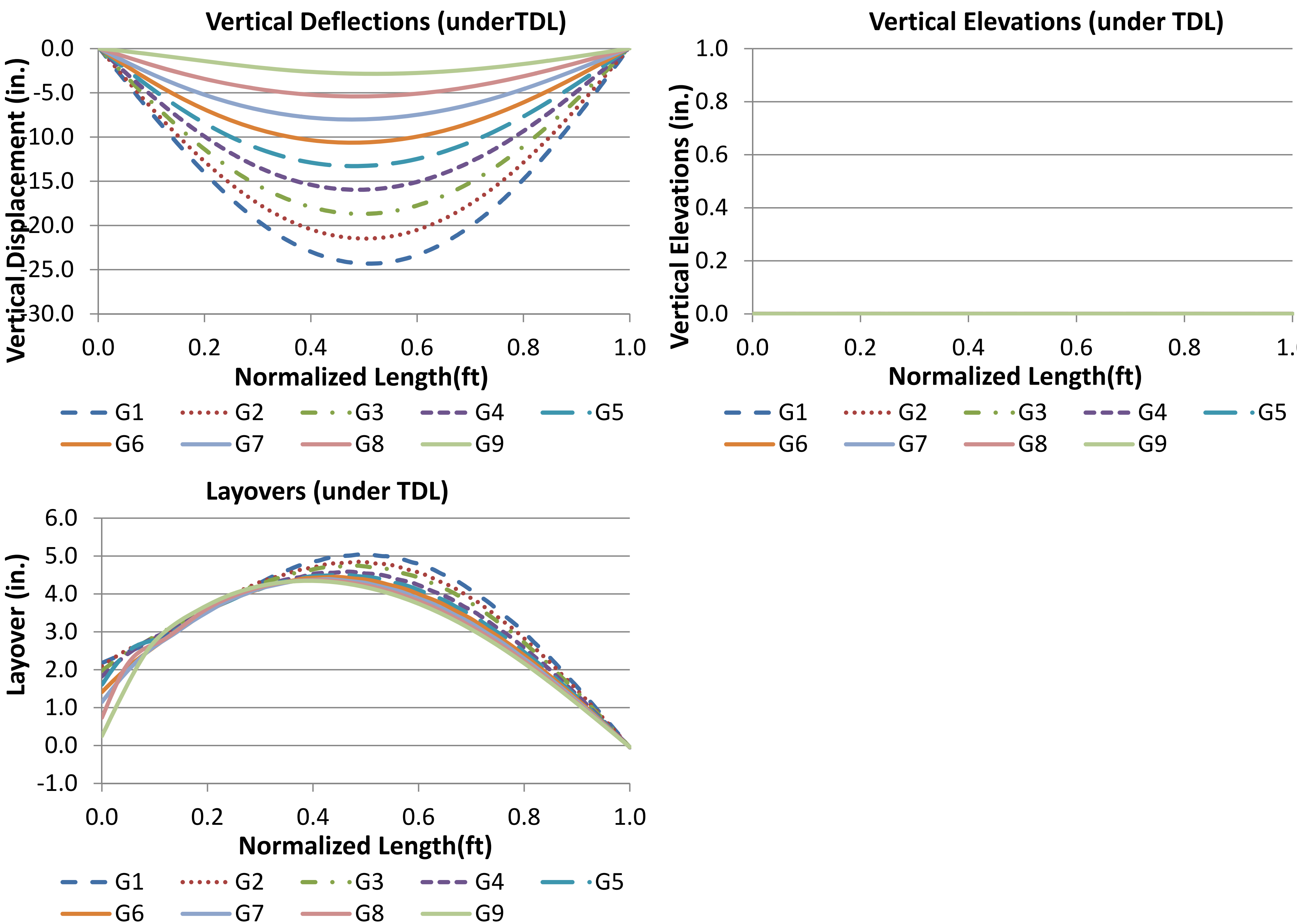


Figure R2-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

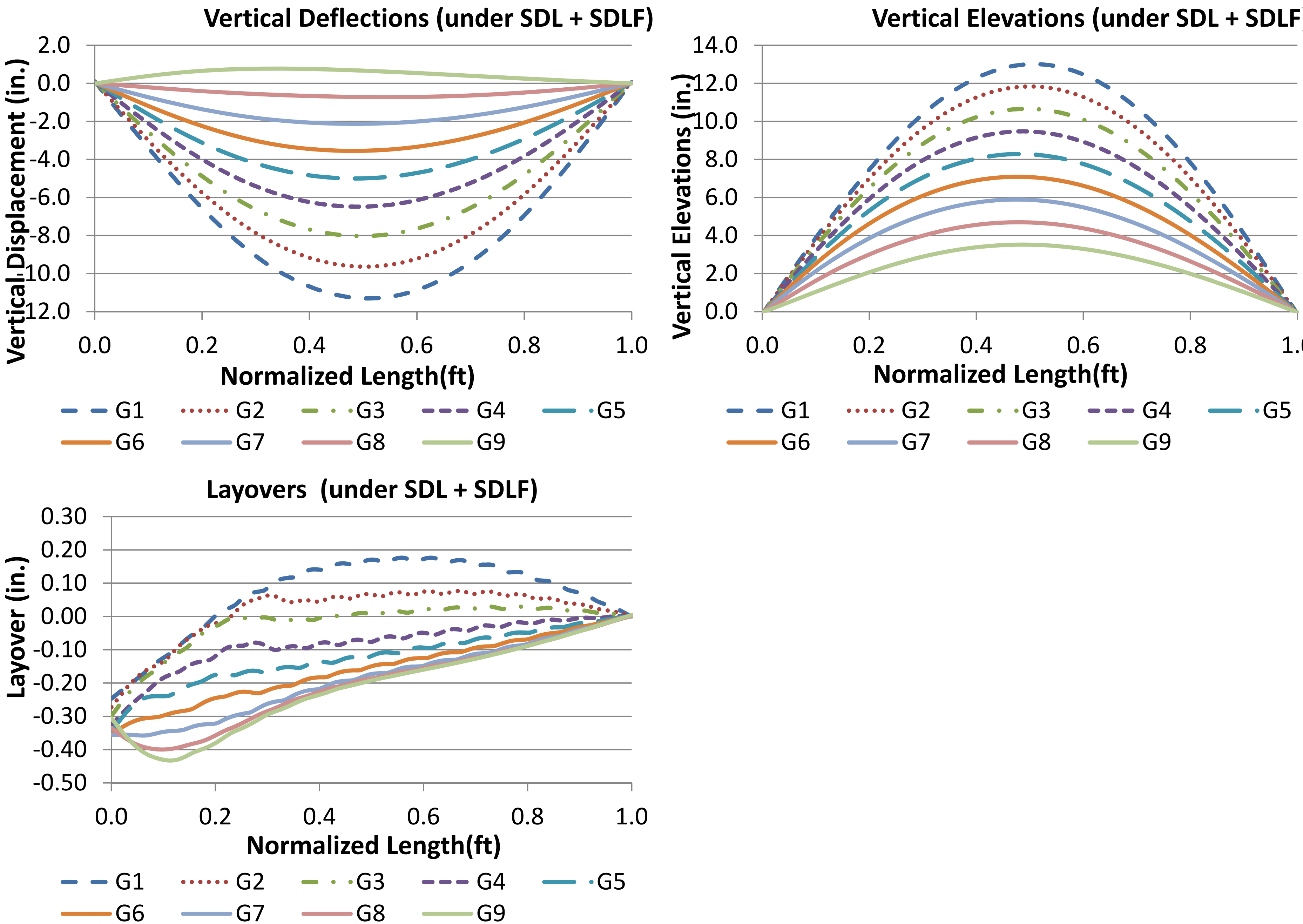


Figure R2-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

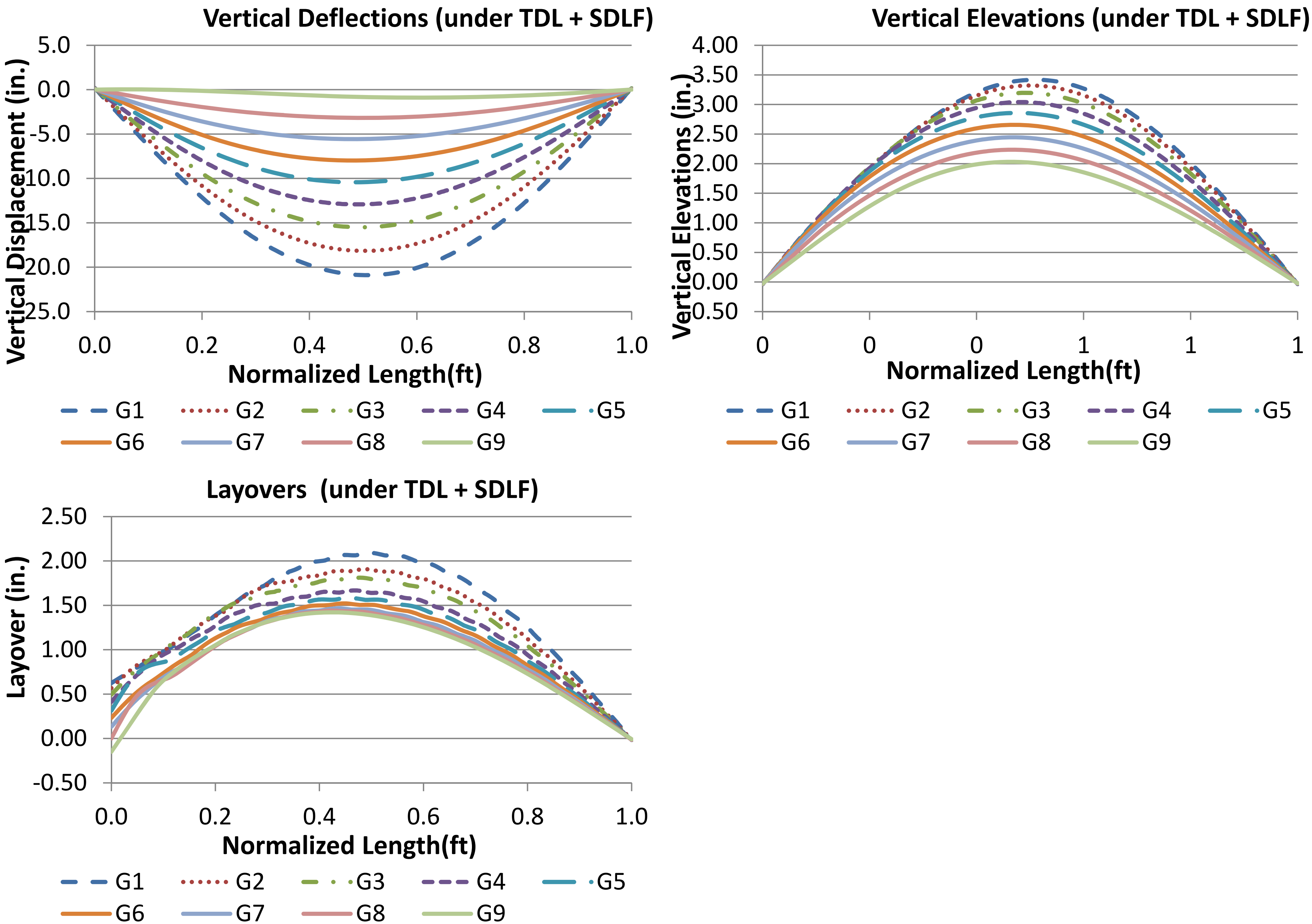


Figure R2-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

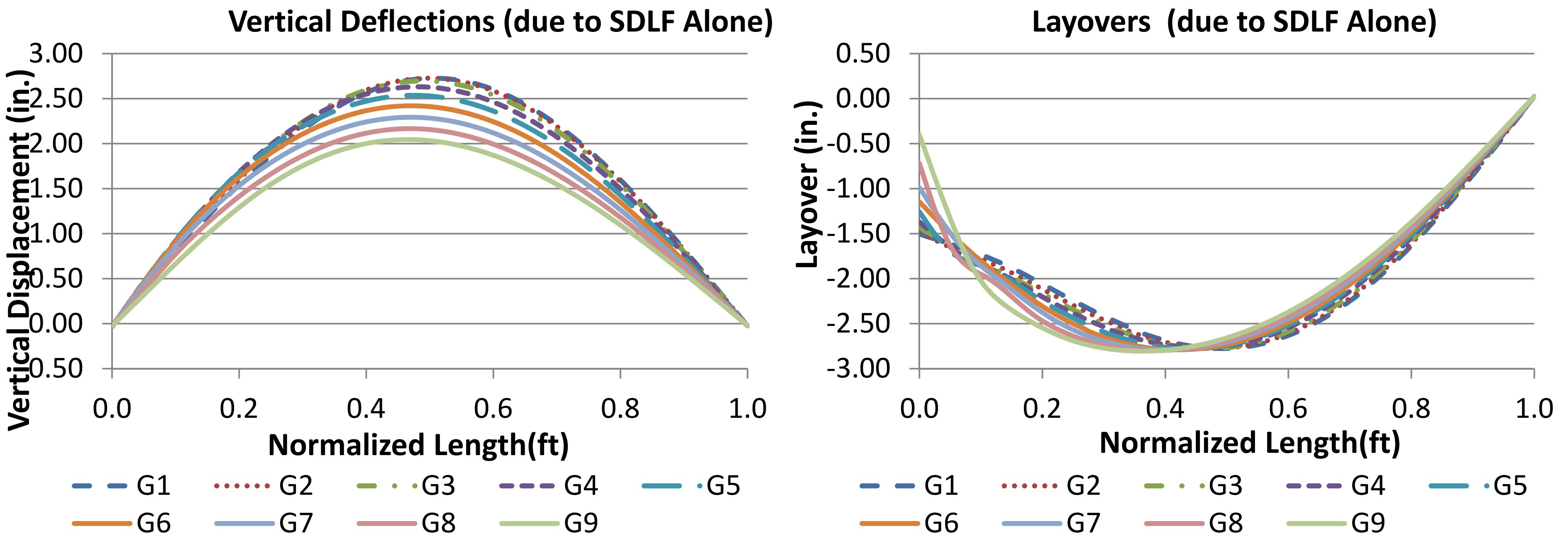


Figure R2-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

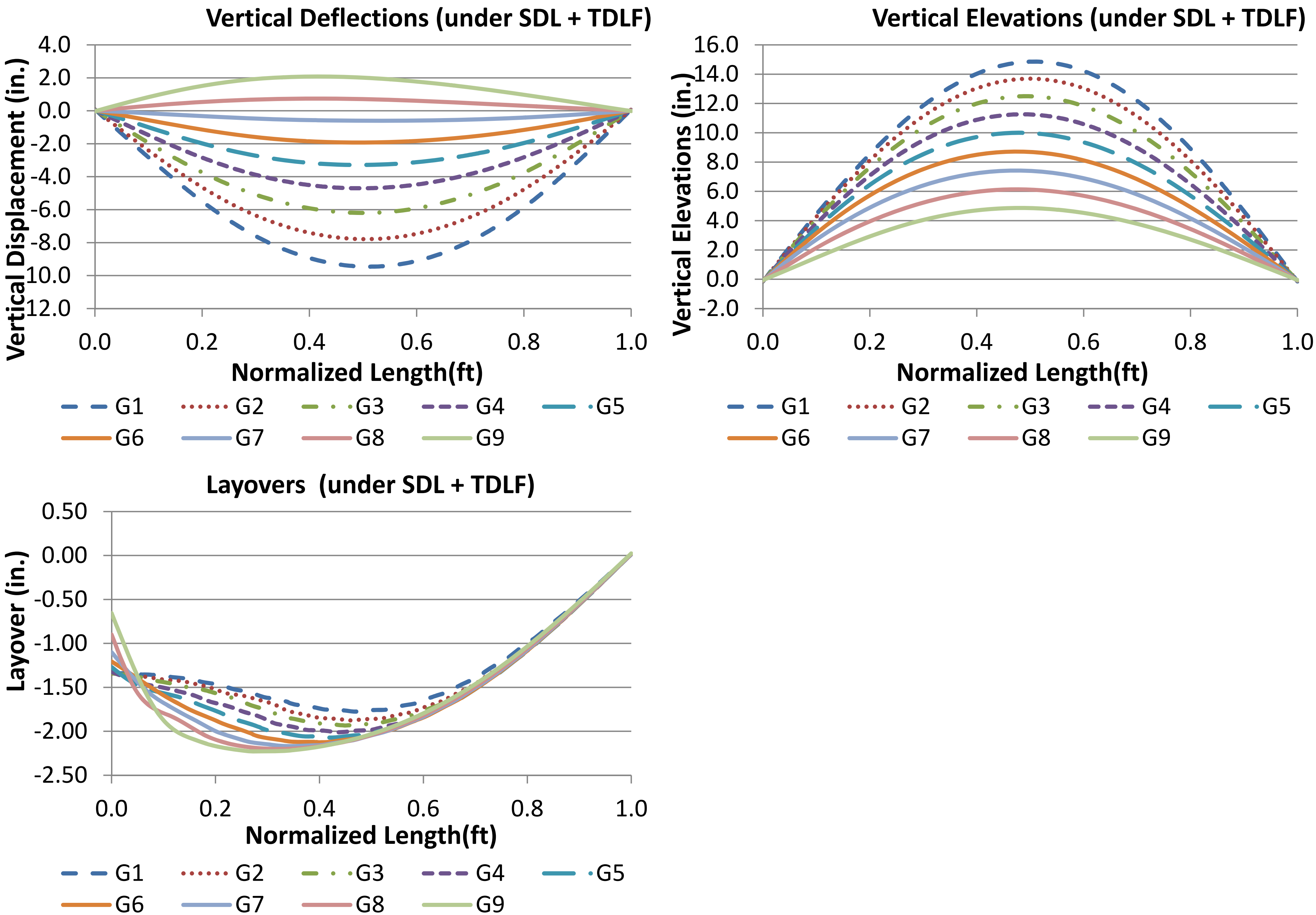


Figure R2-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

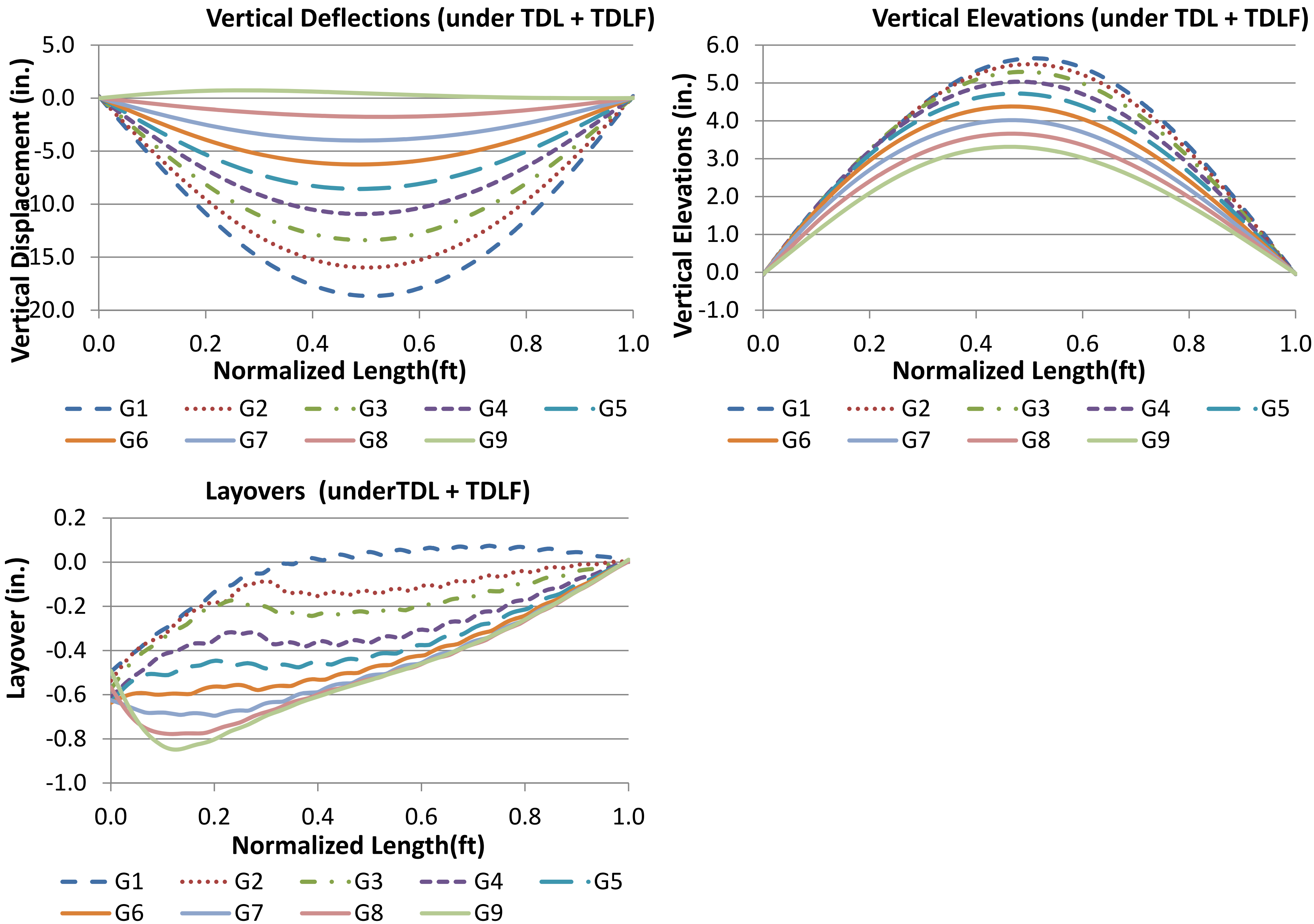


Figure R2-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

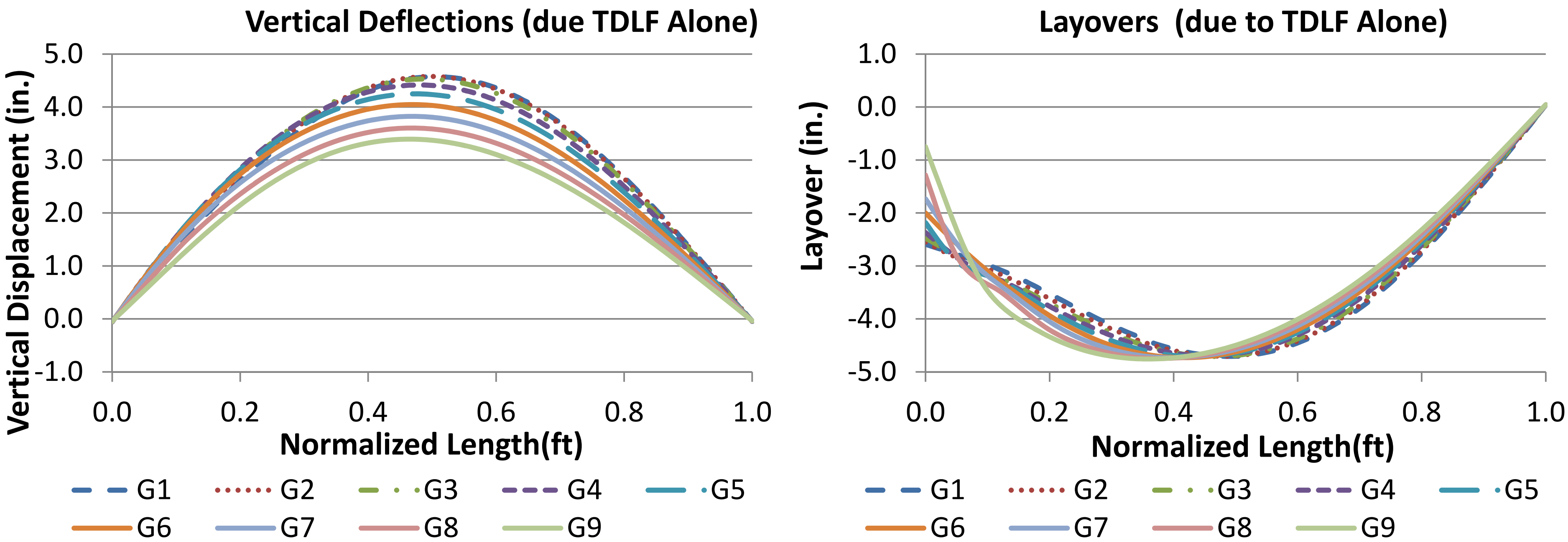


Figure R2-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

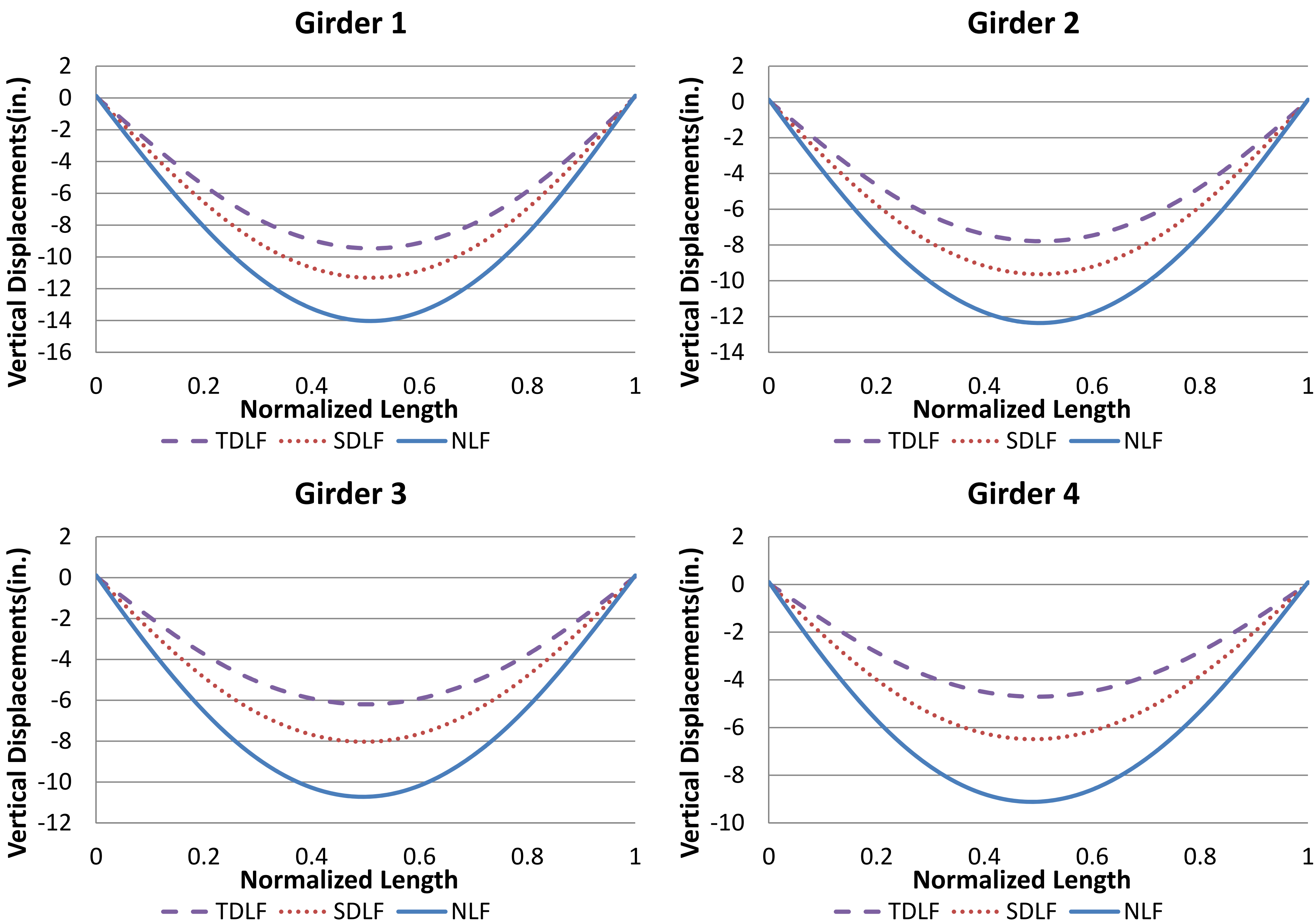


Figure R2-4-10. **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

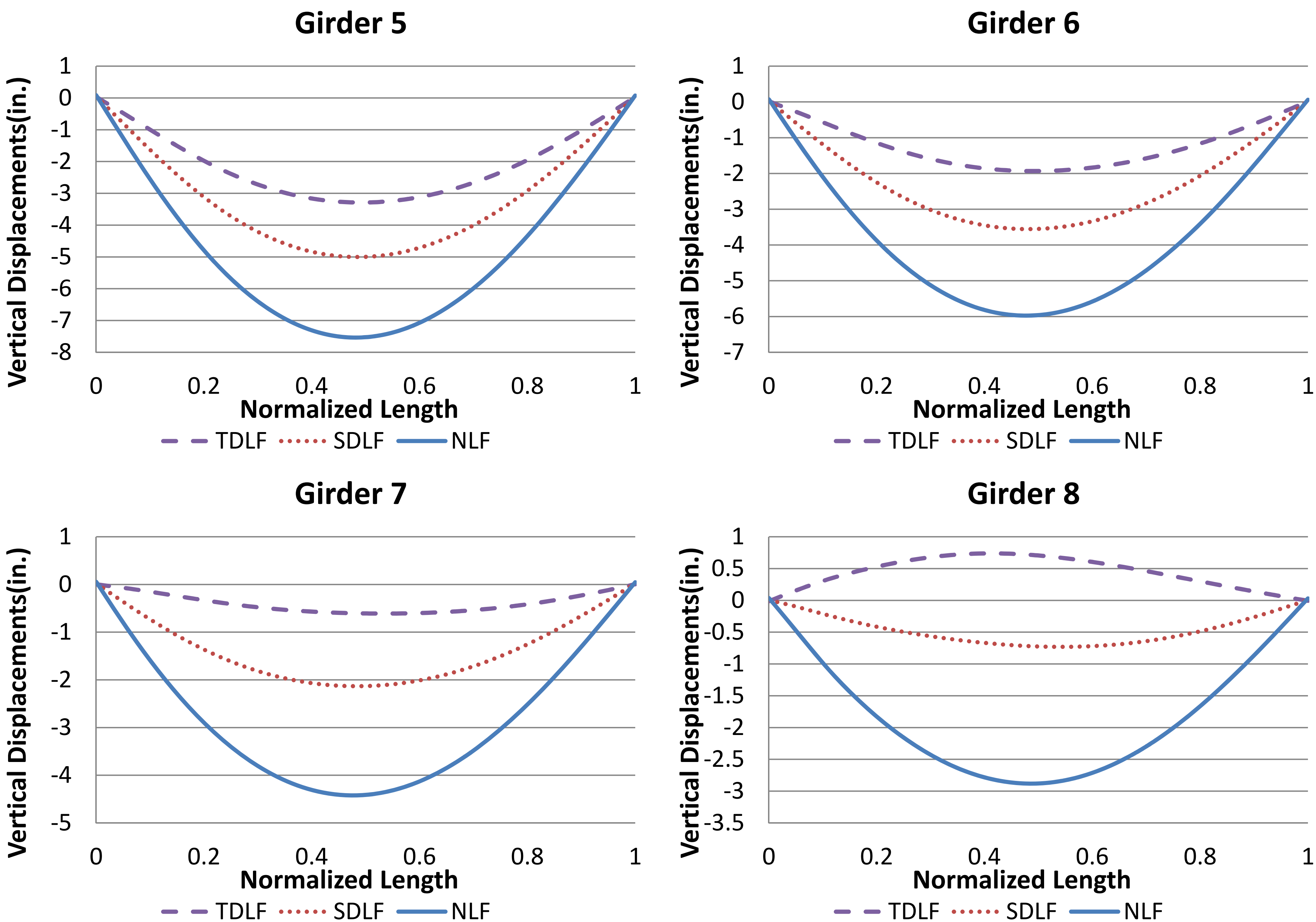


Figure R2-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

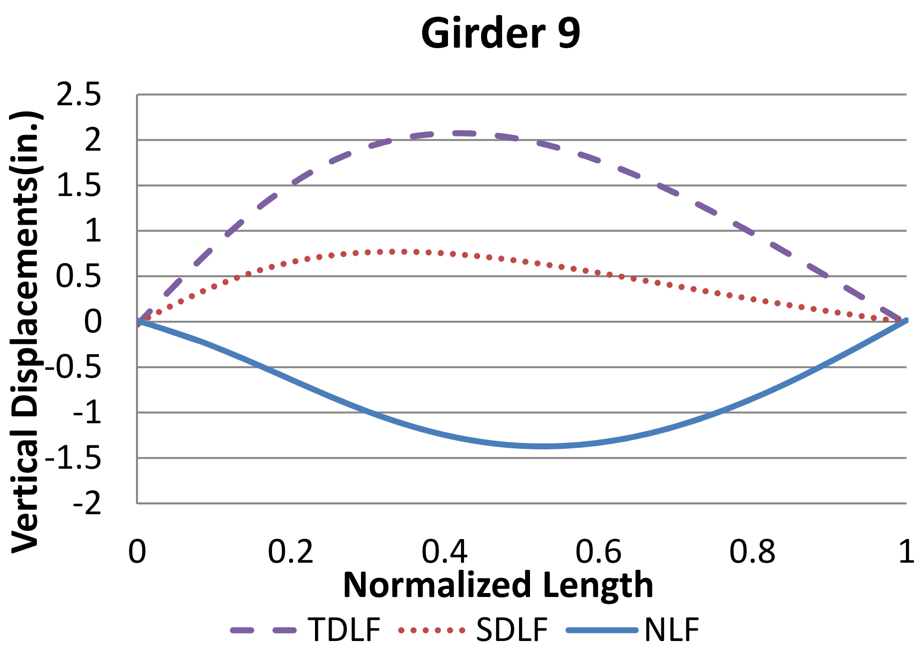


Figure R2-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

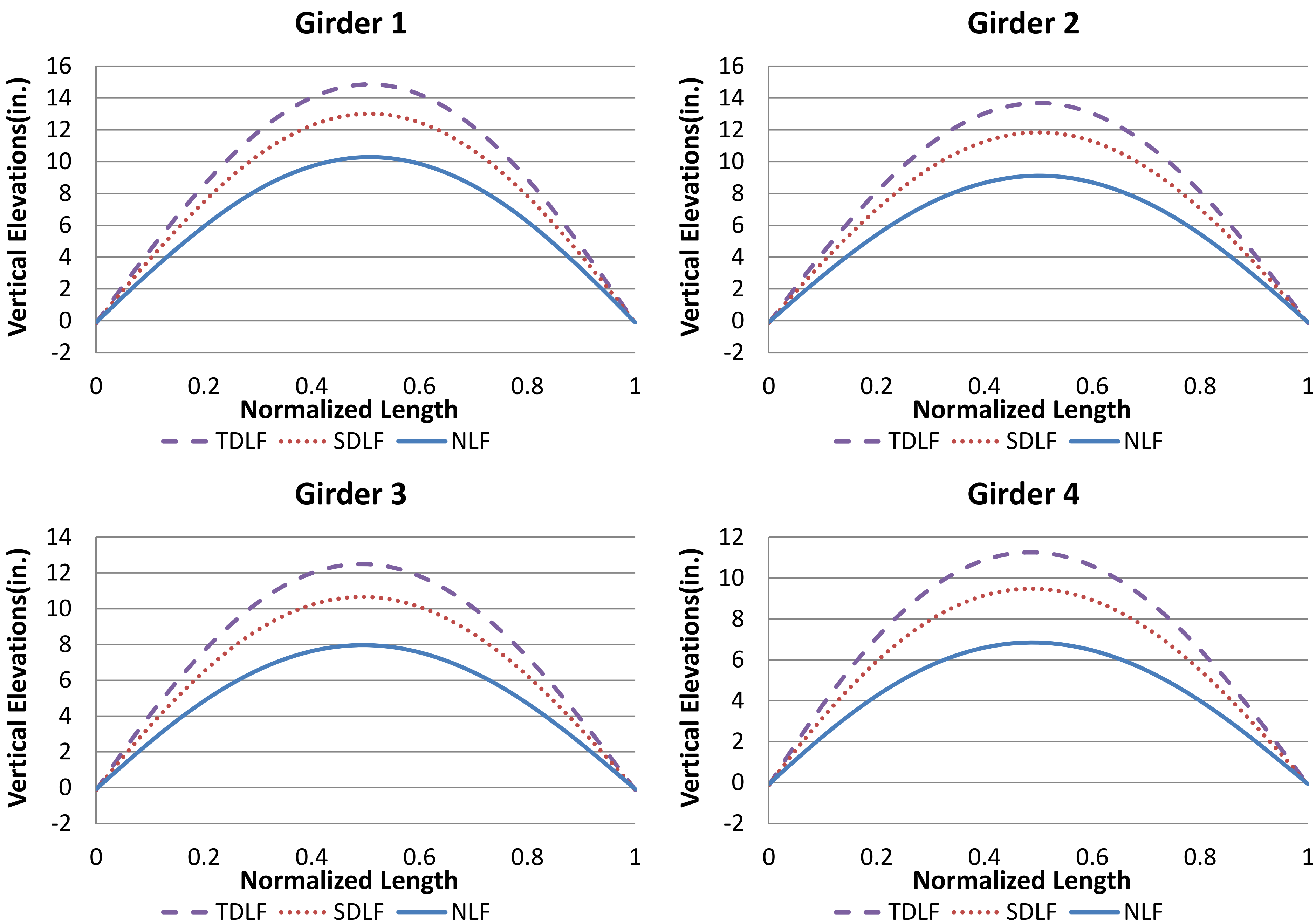


Figure R2-4-11. **Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.**

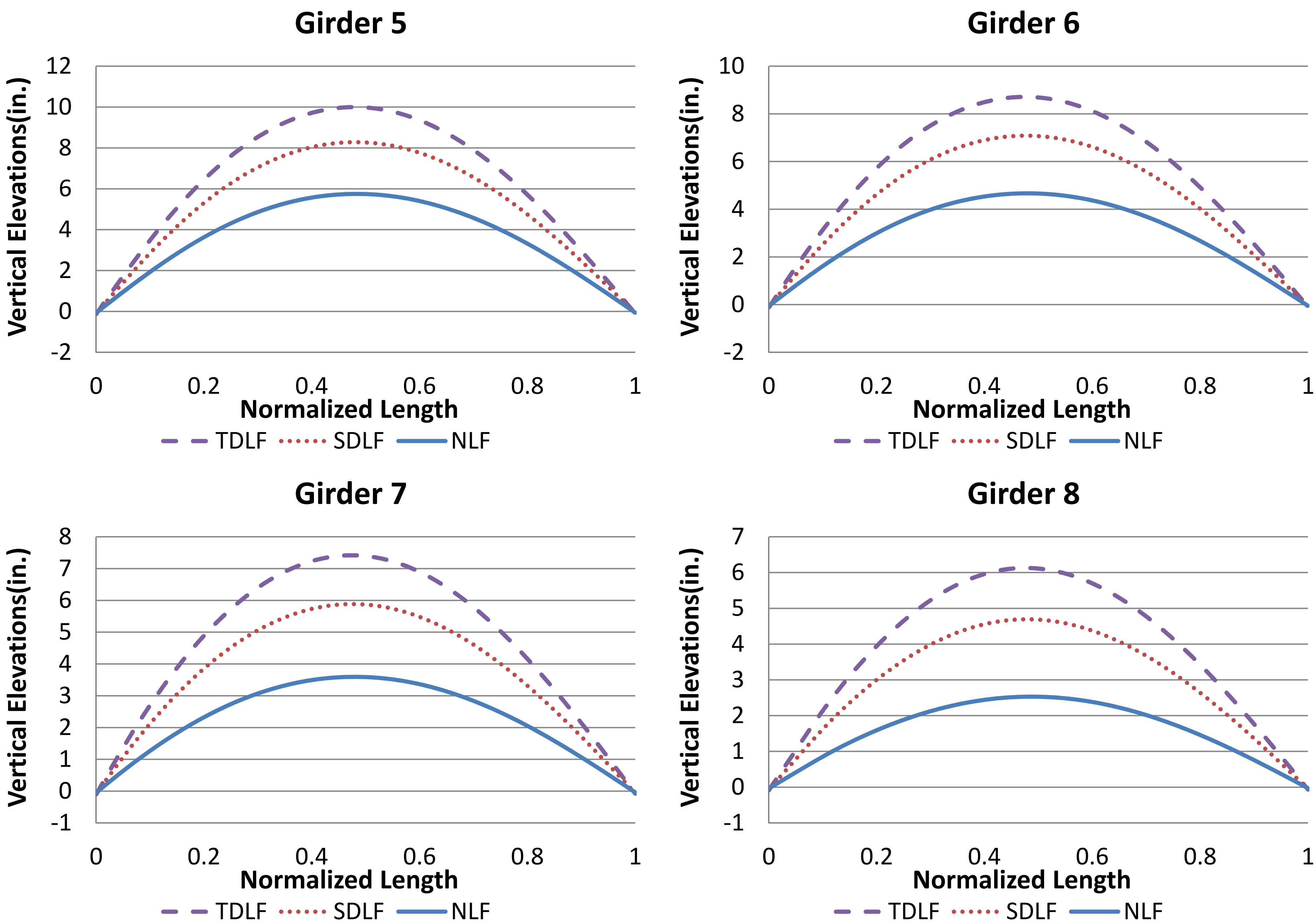


Figure R2-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

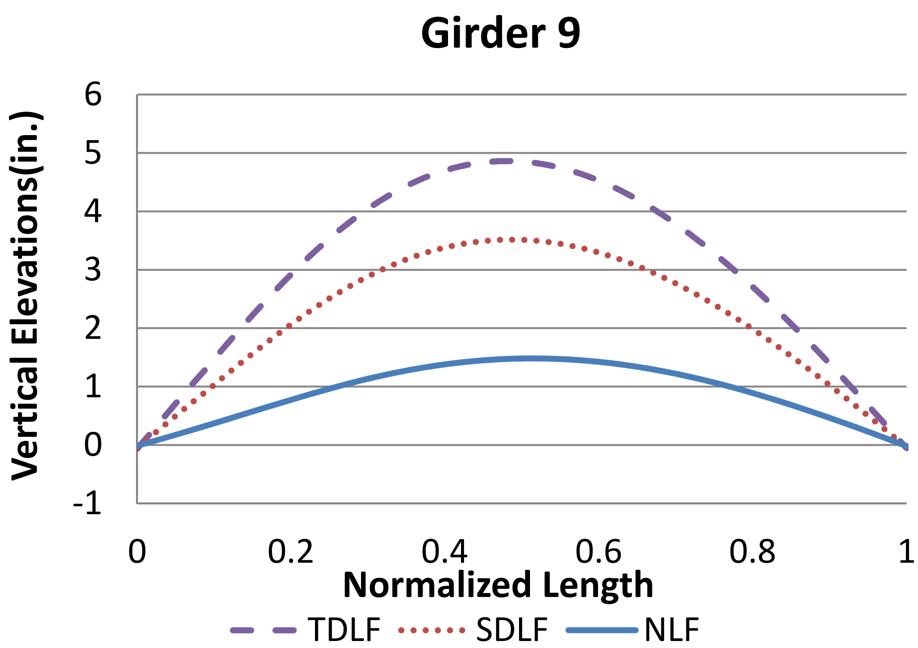


Figure R2-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

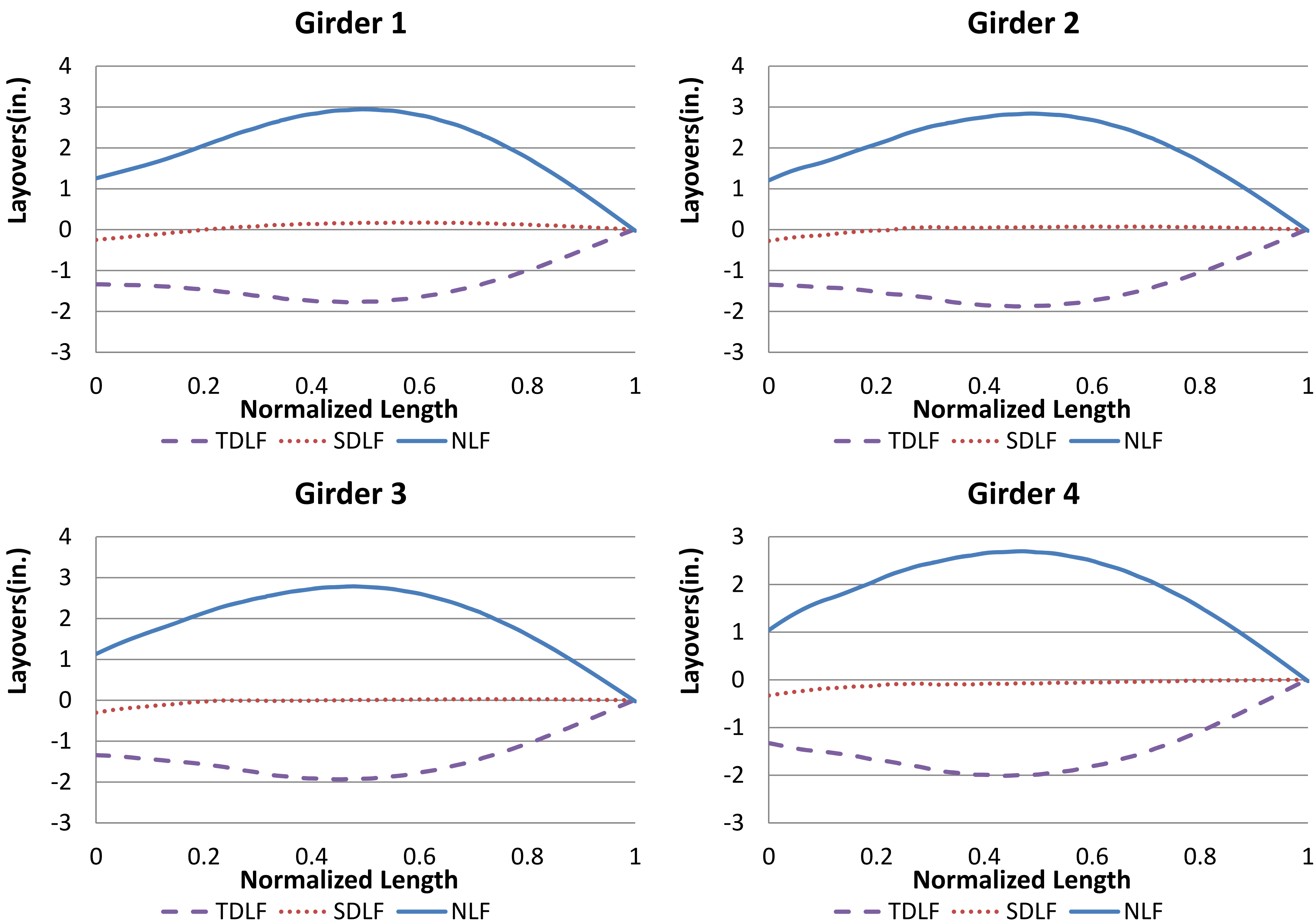


Figure R2-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

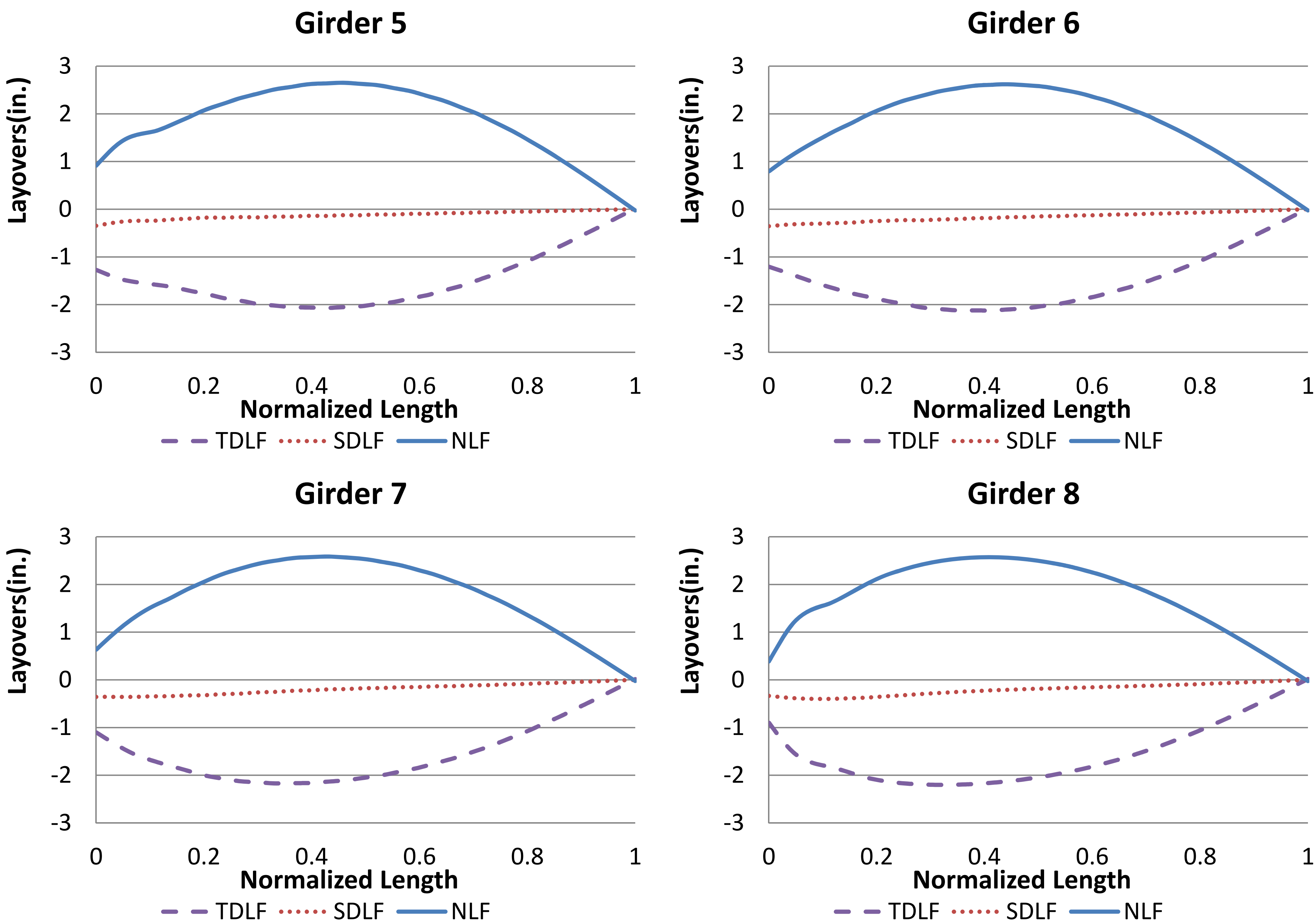


Figure R2-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

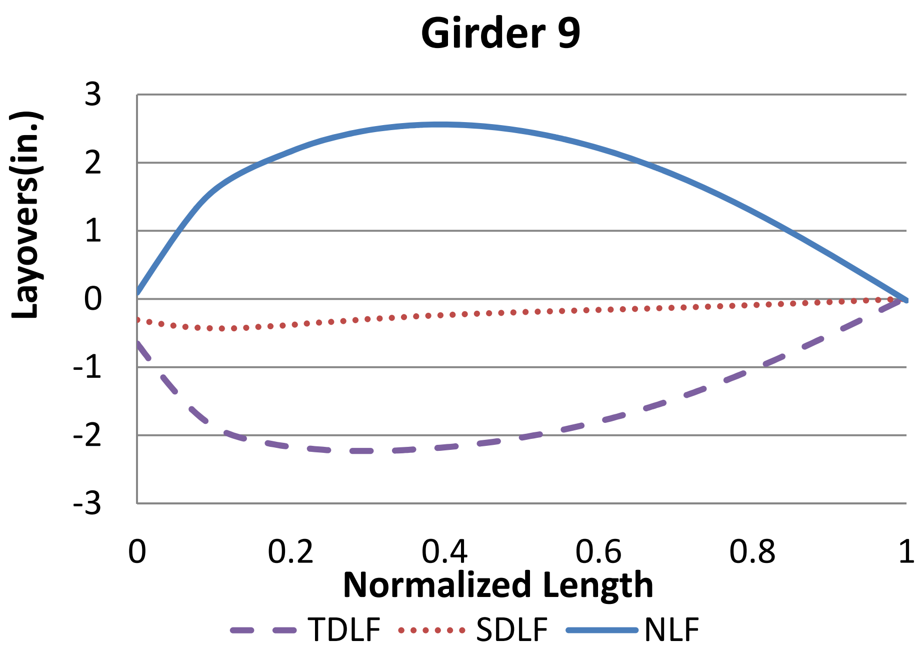


Figure R2-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

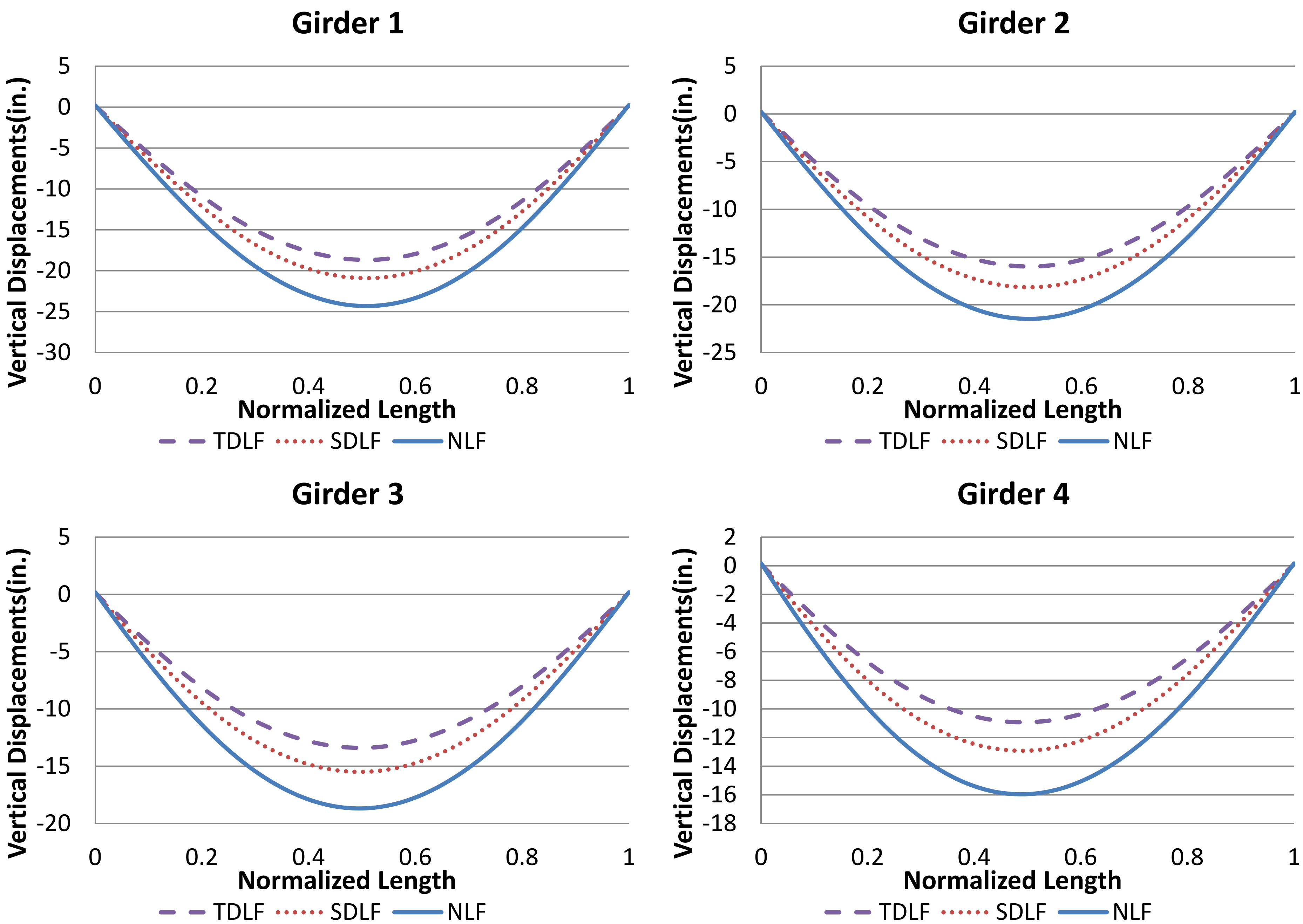


Figure R2-4-13. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

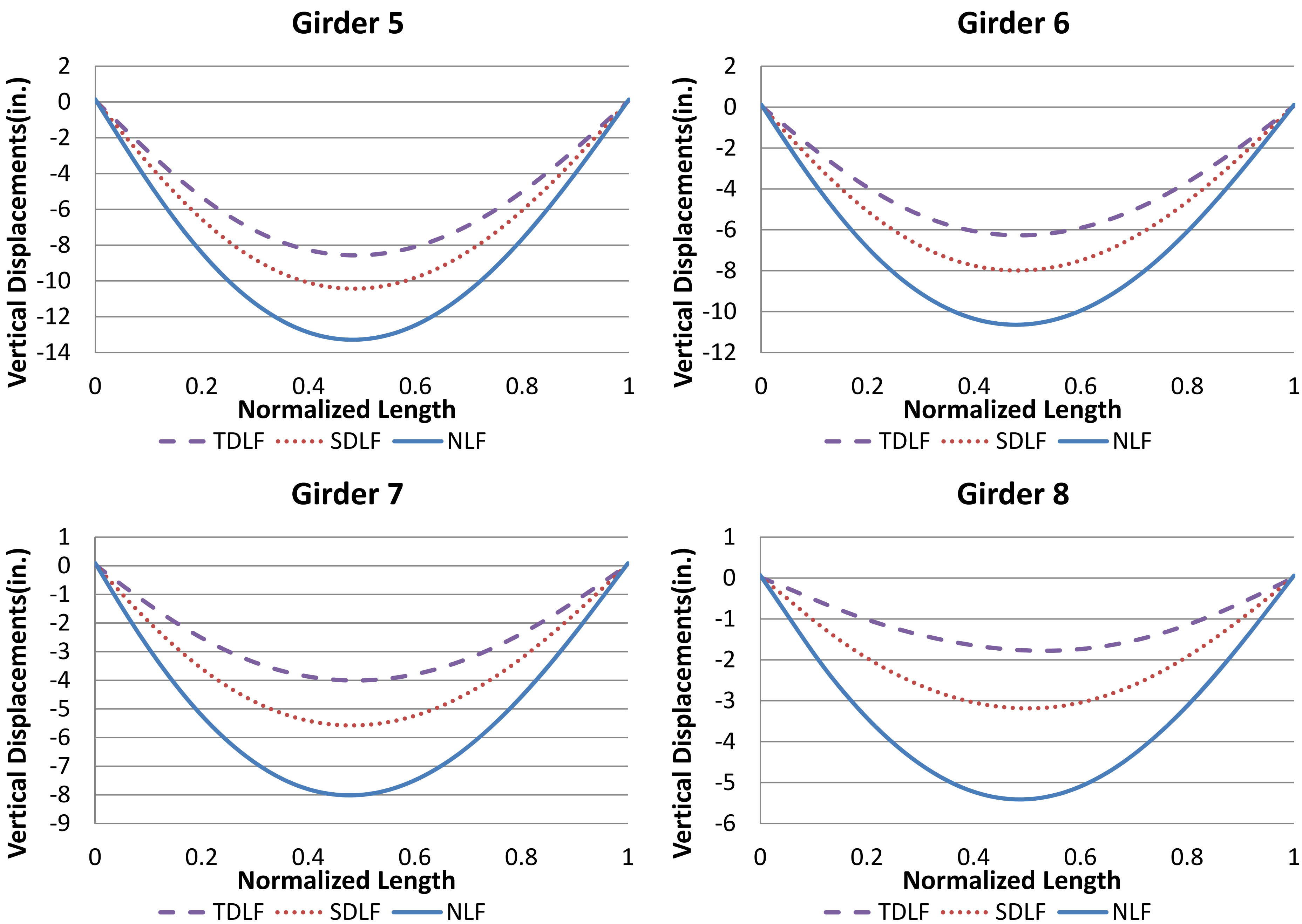


Figure R2-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

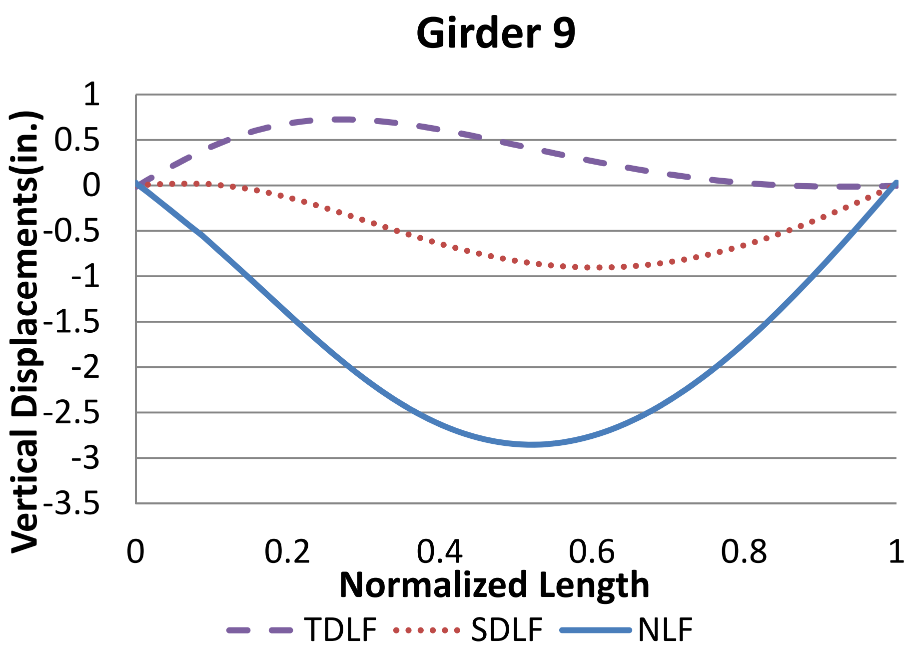


Figure R2-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

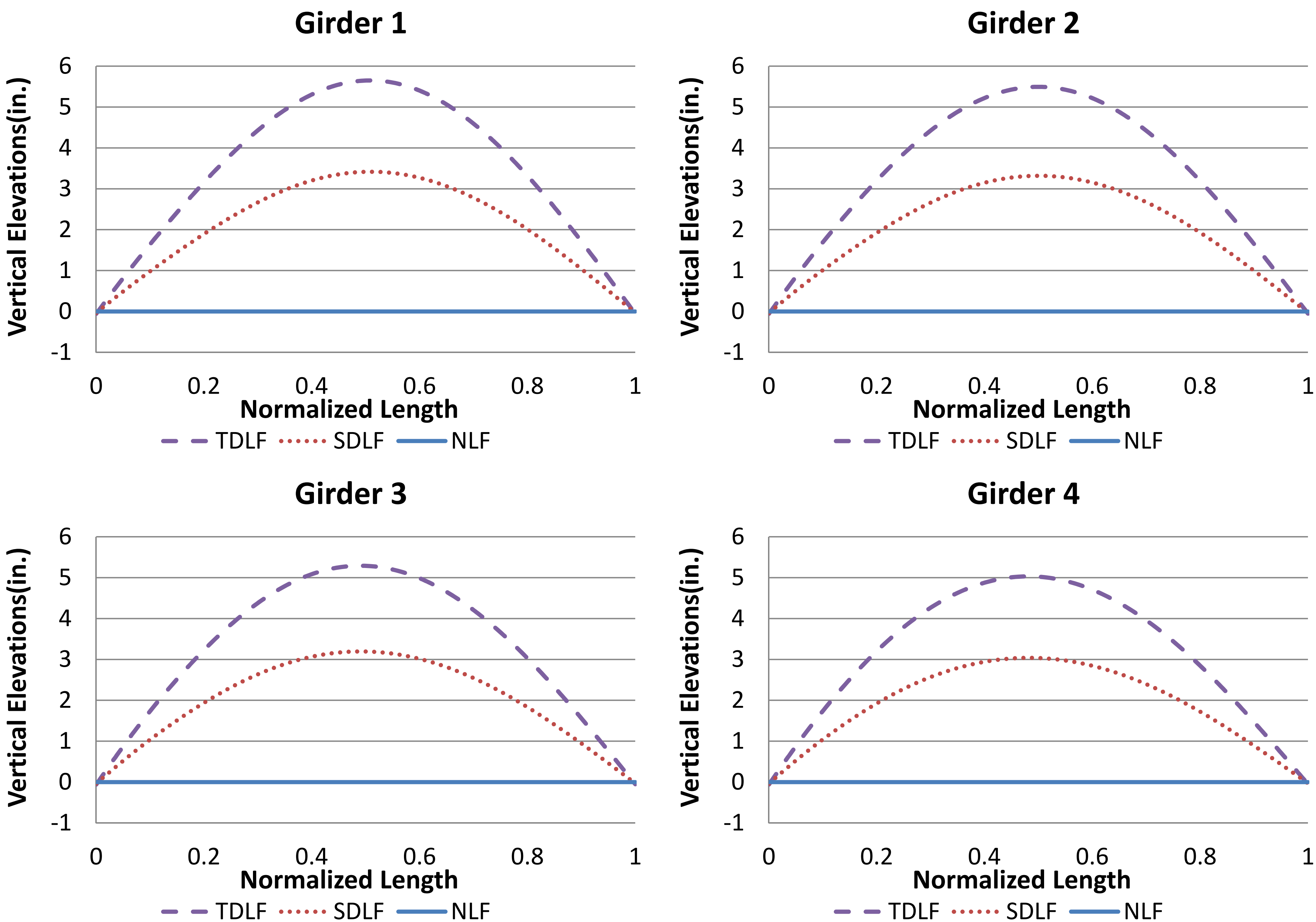


Figure R2-4-14. **Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.**

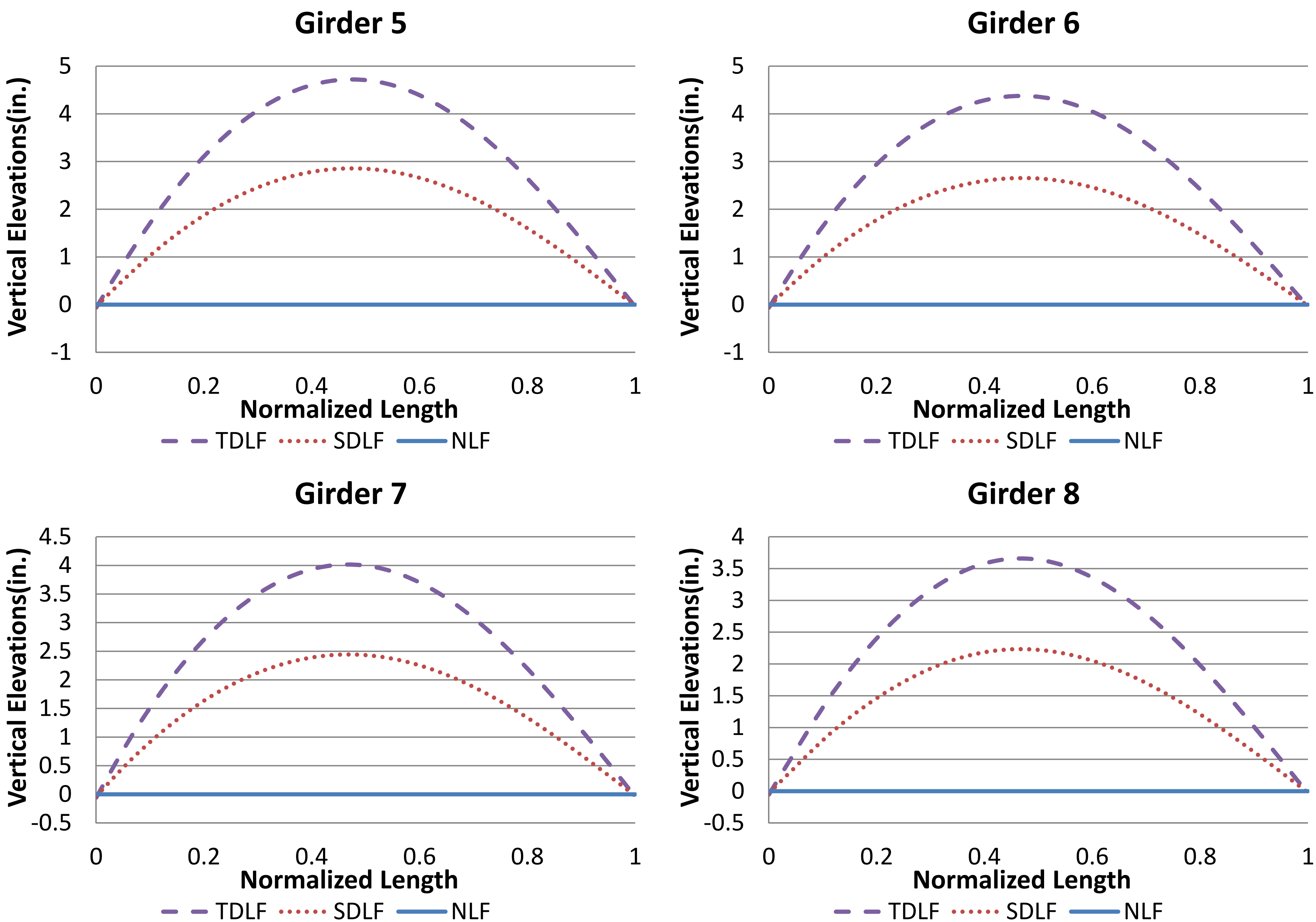


Figure R2-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

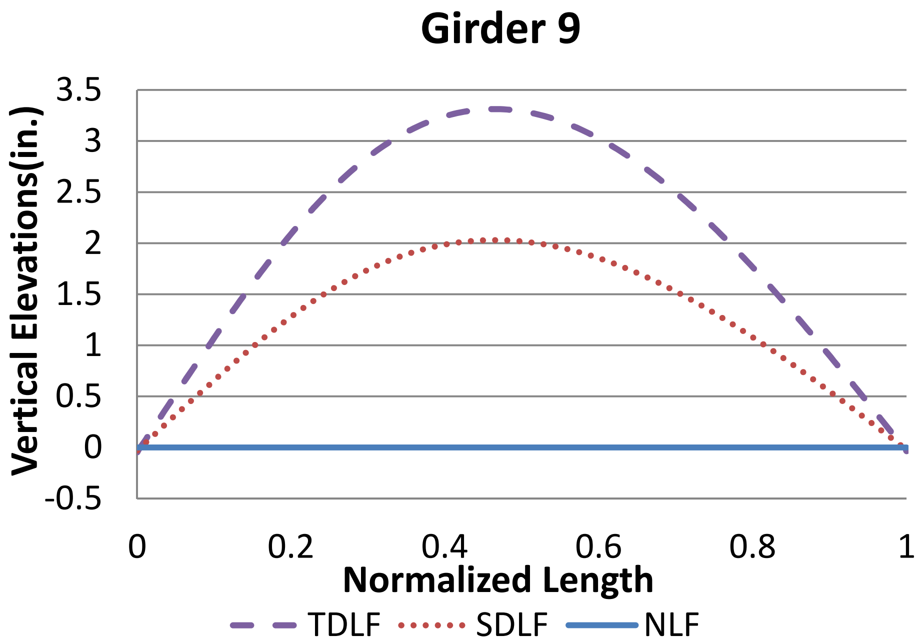


Figure R2-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

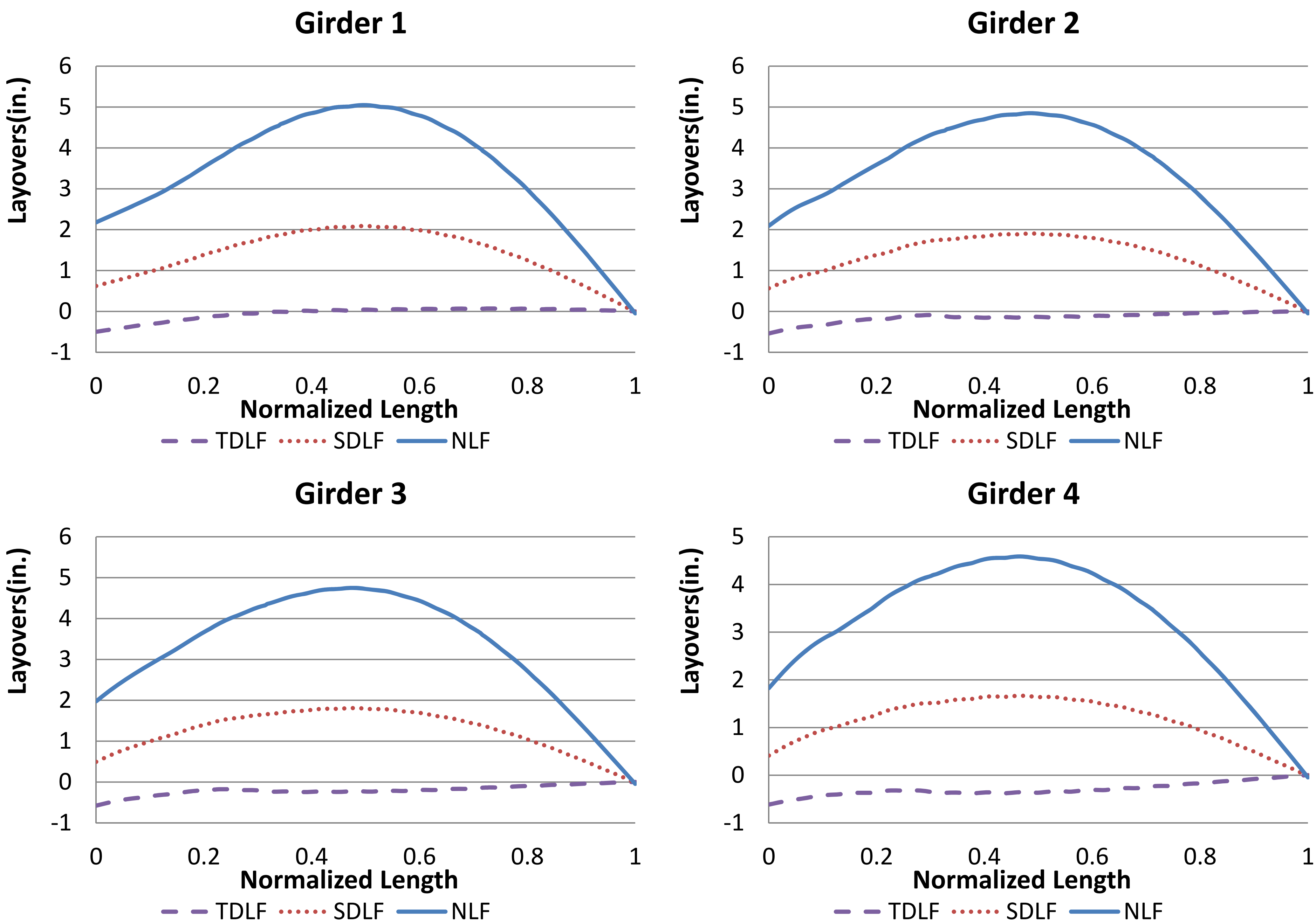


Figure R2-4-15. **Comparison of individual girder layovers (in) under TDL for different detailing methods.**

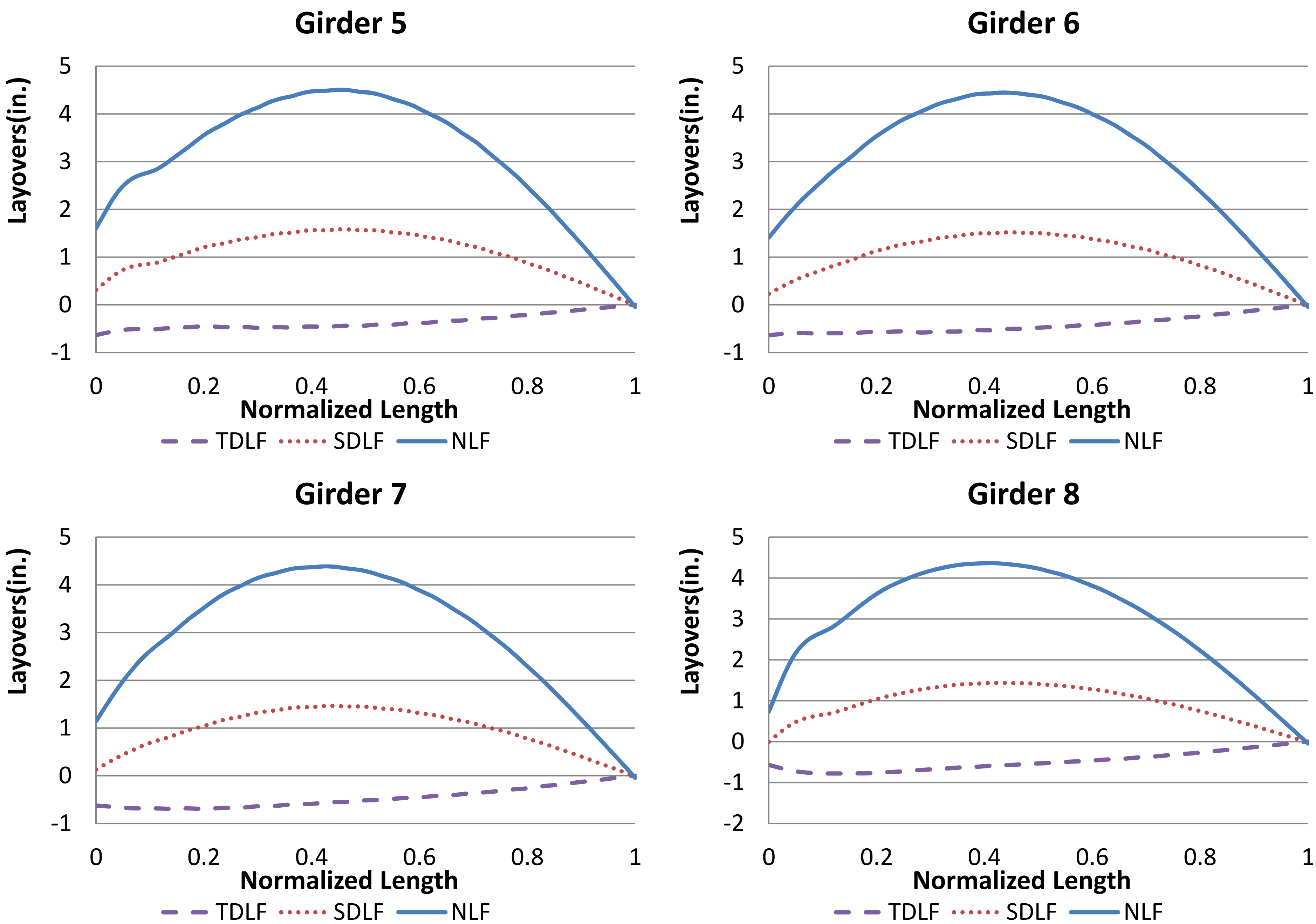


Figure R2-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

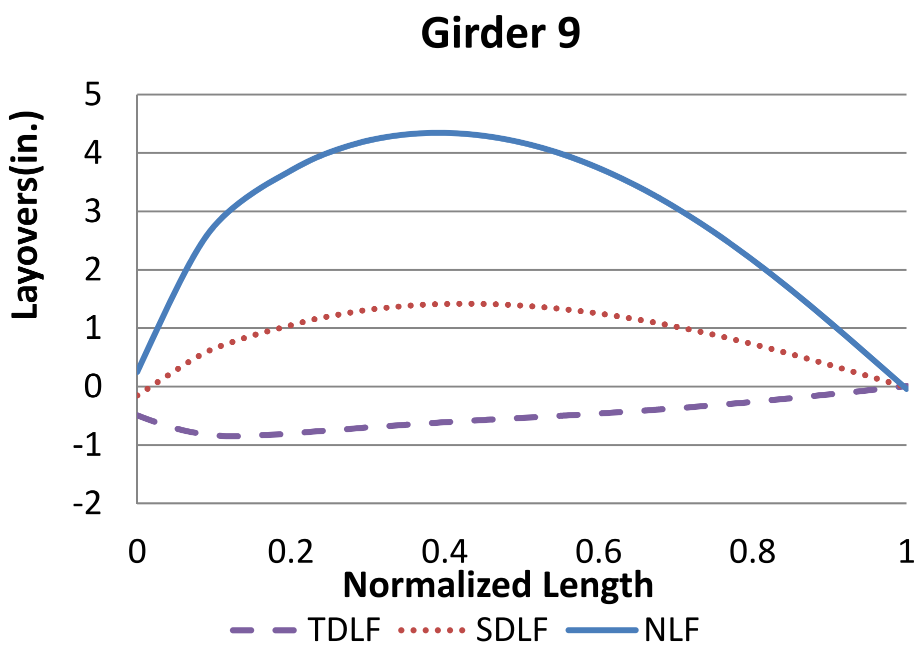


Figure R2-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

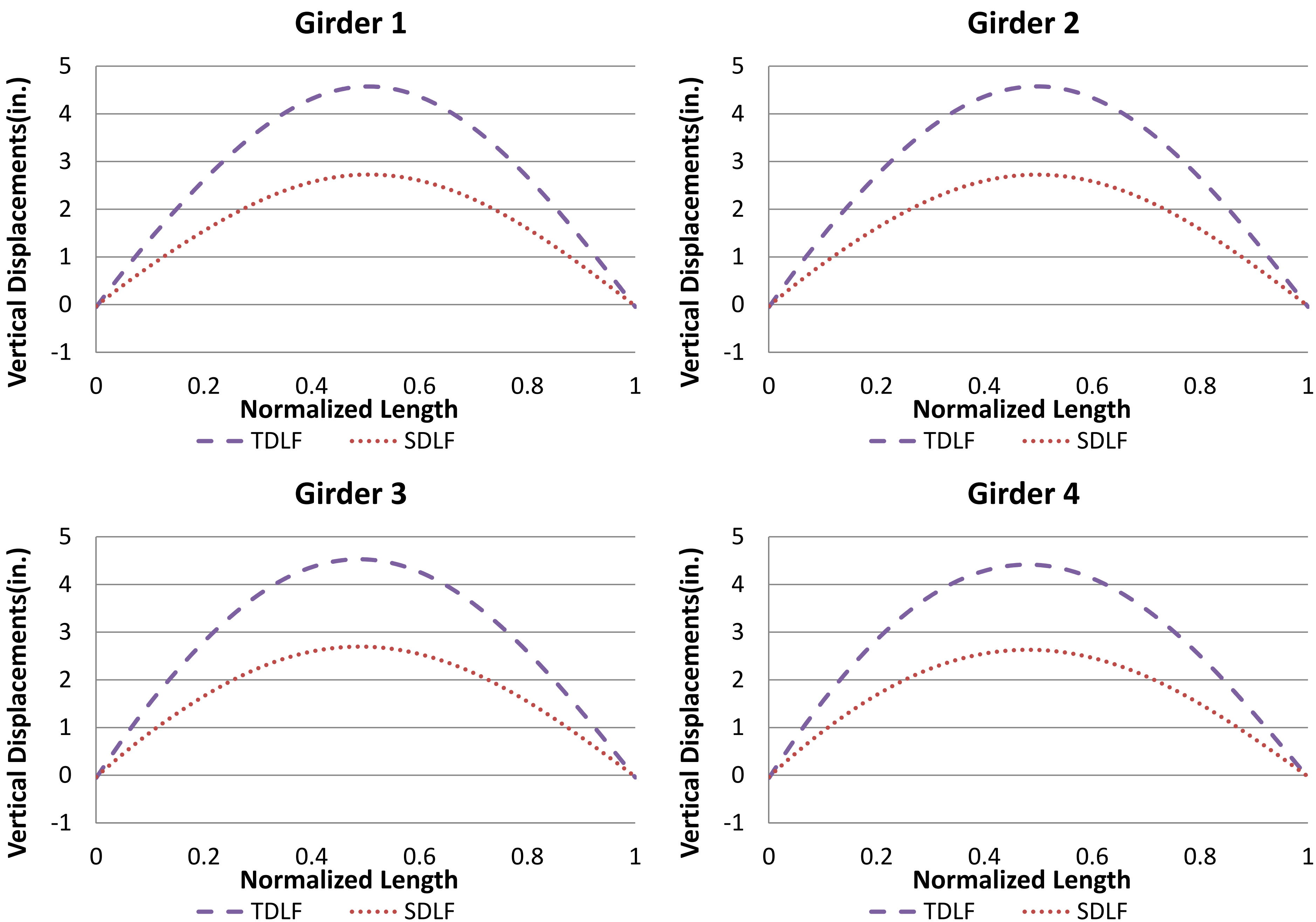


Figure R2-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

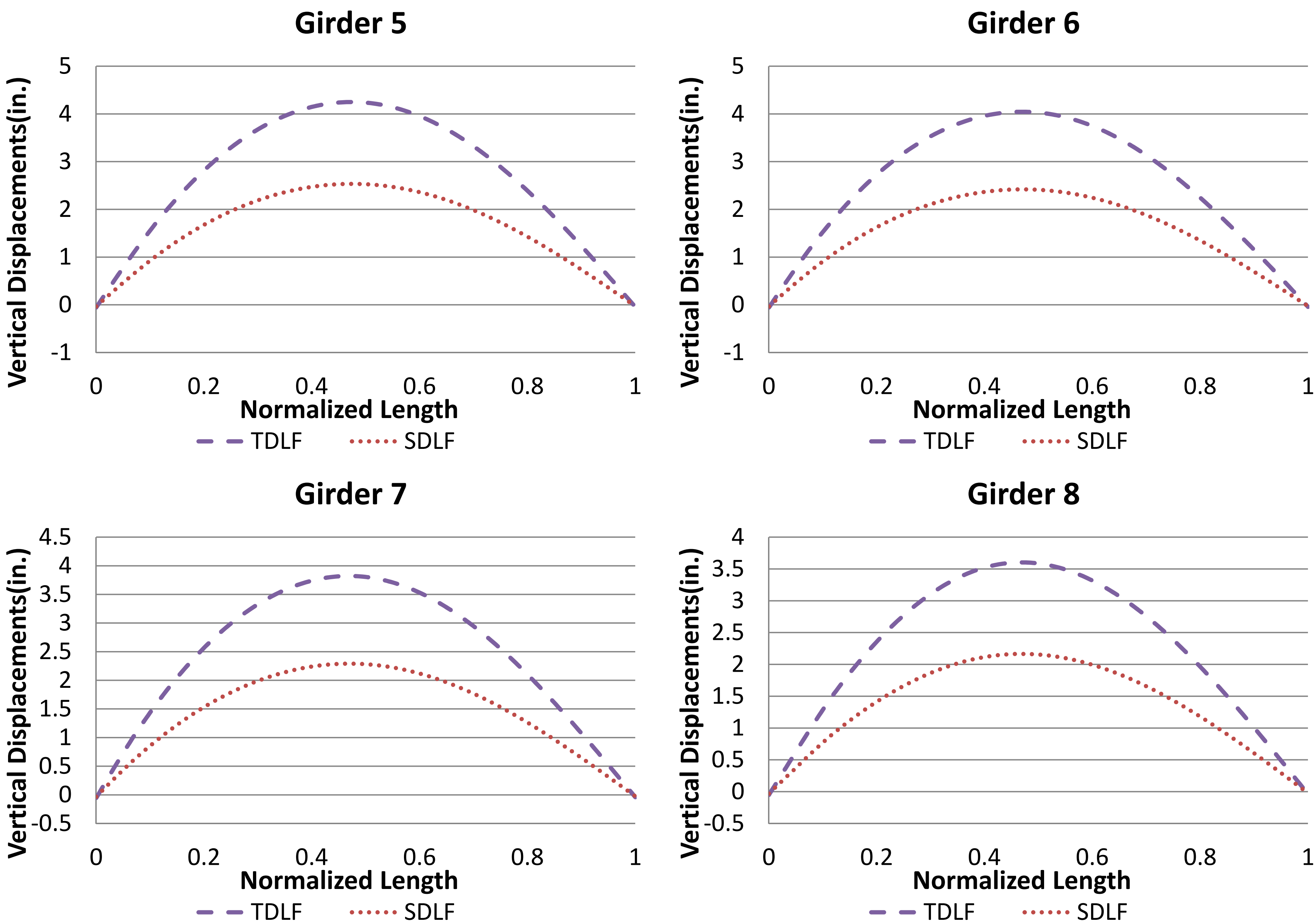


Figure R2-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

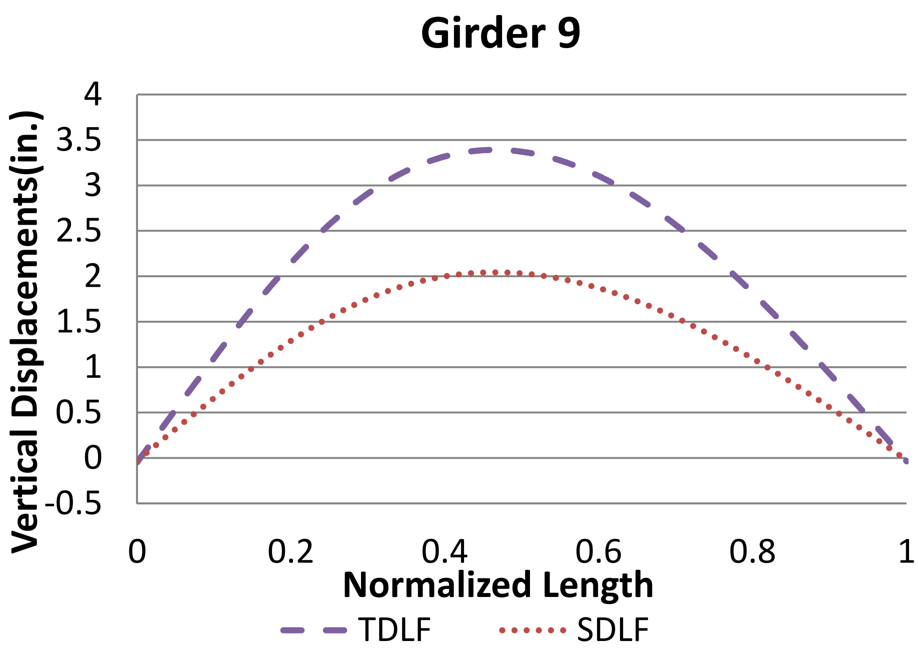


Figure R2-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

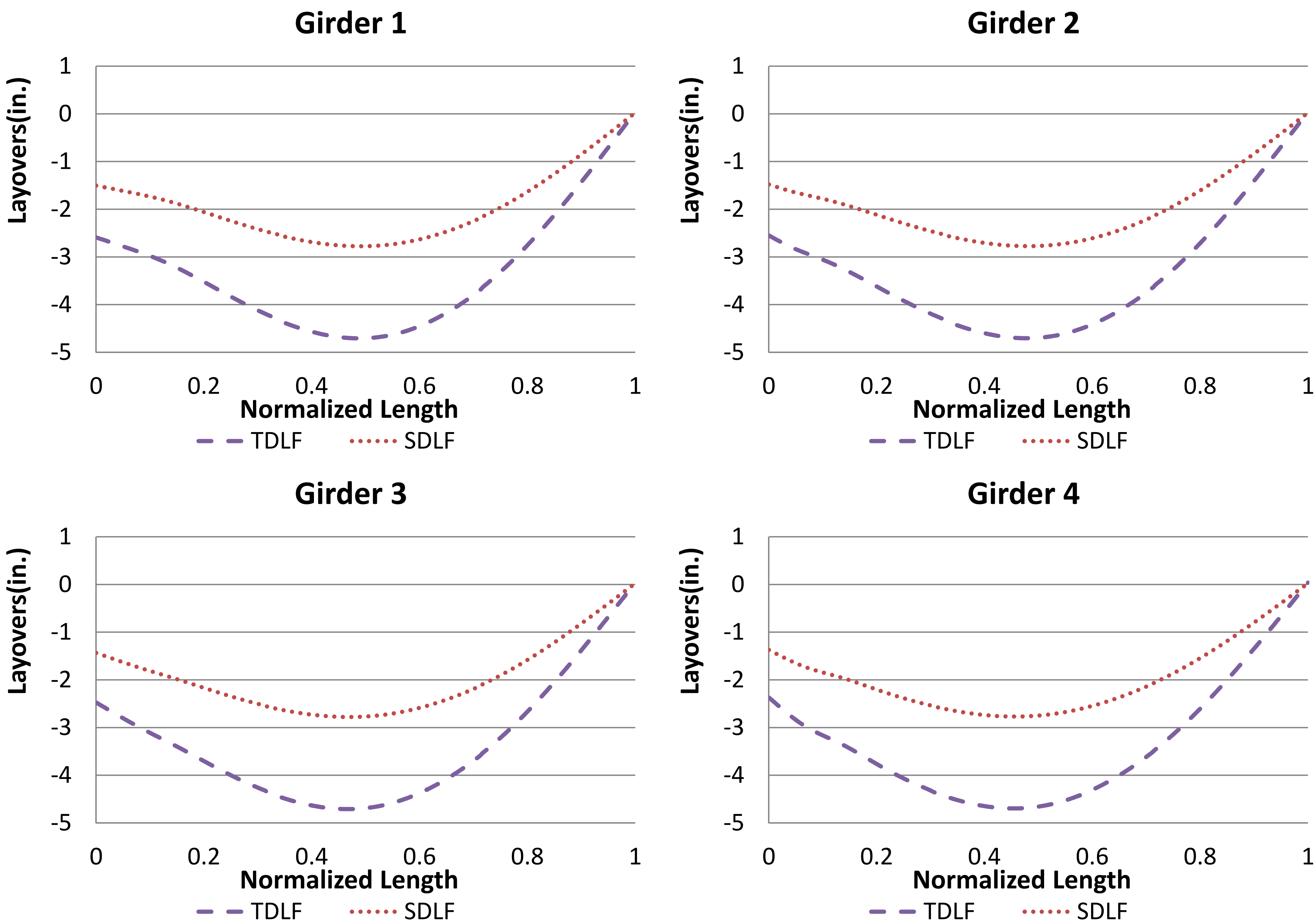


Figure R2-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

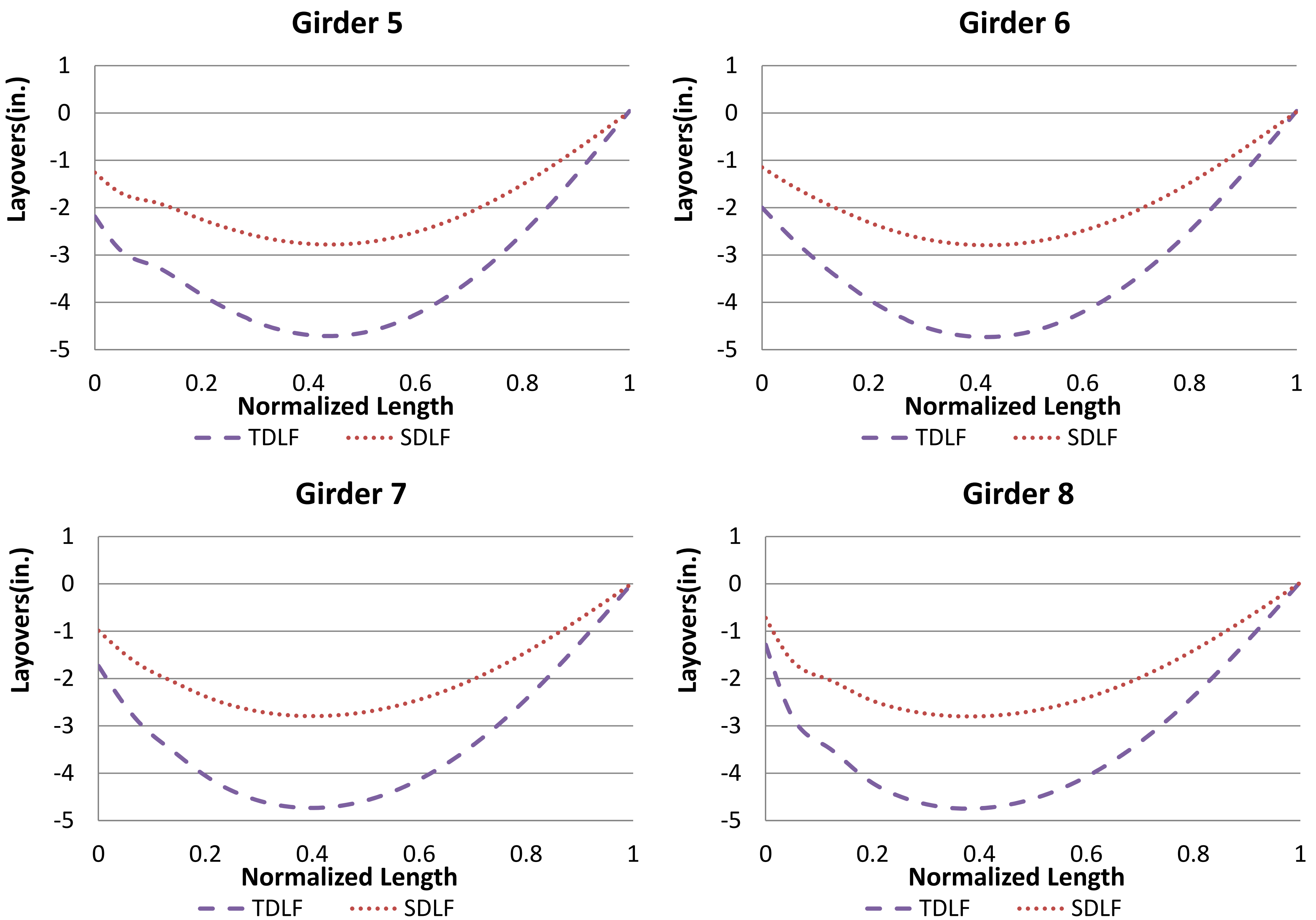


Figure R2-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

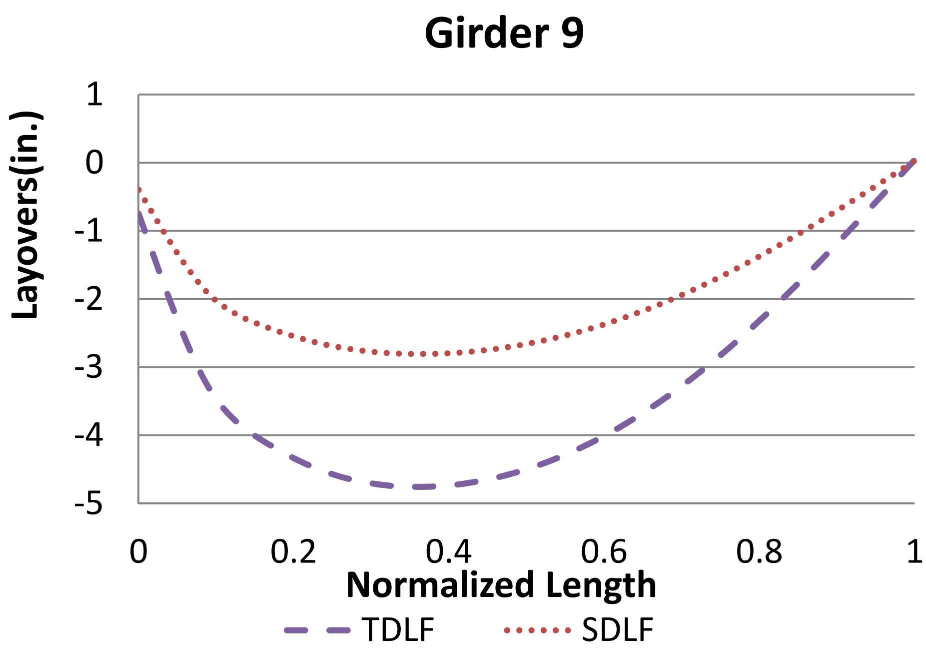


Figure R2-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

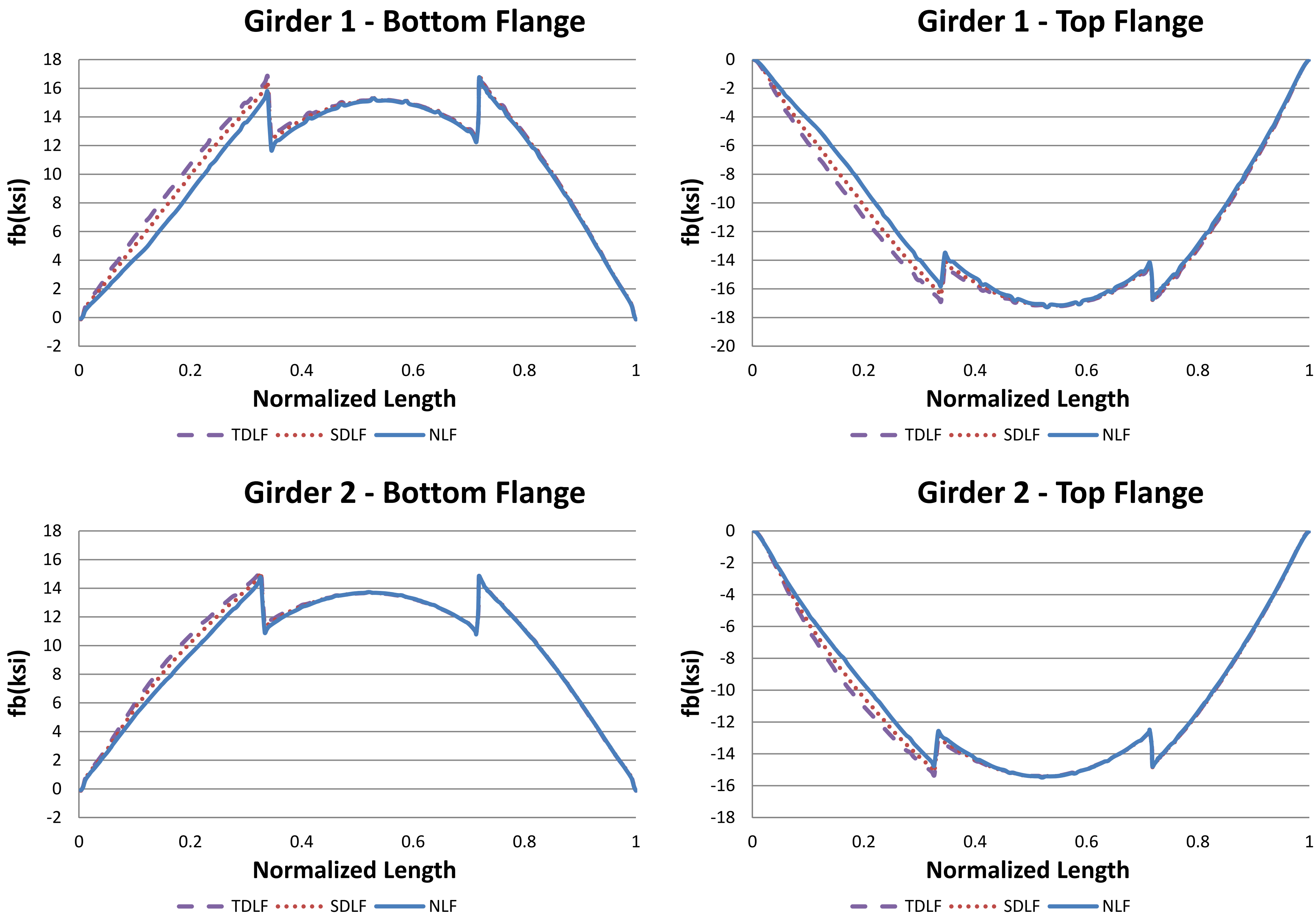


Figure R2-4-18. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

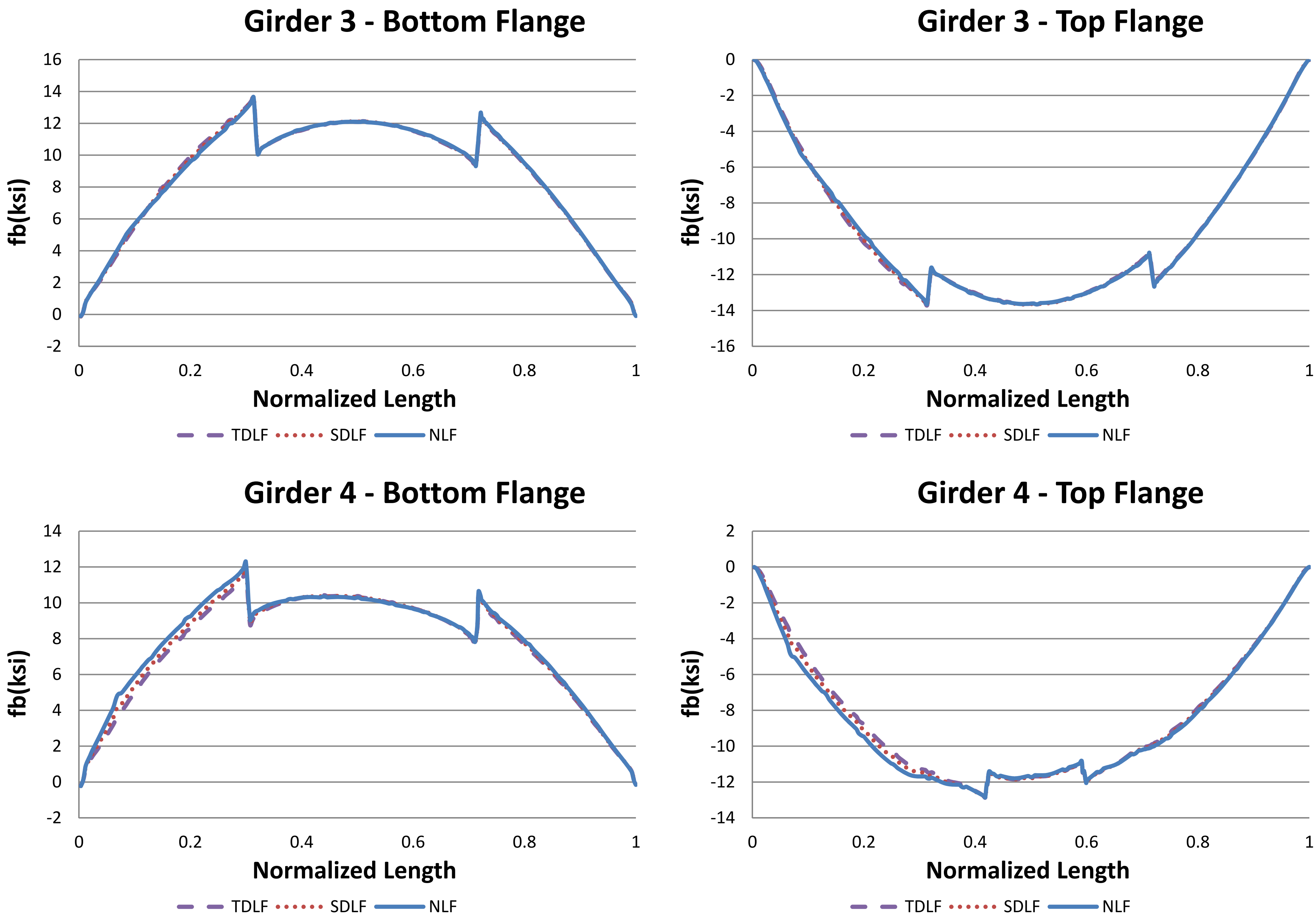


Figure R2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

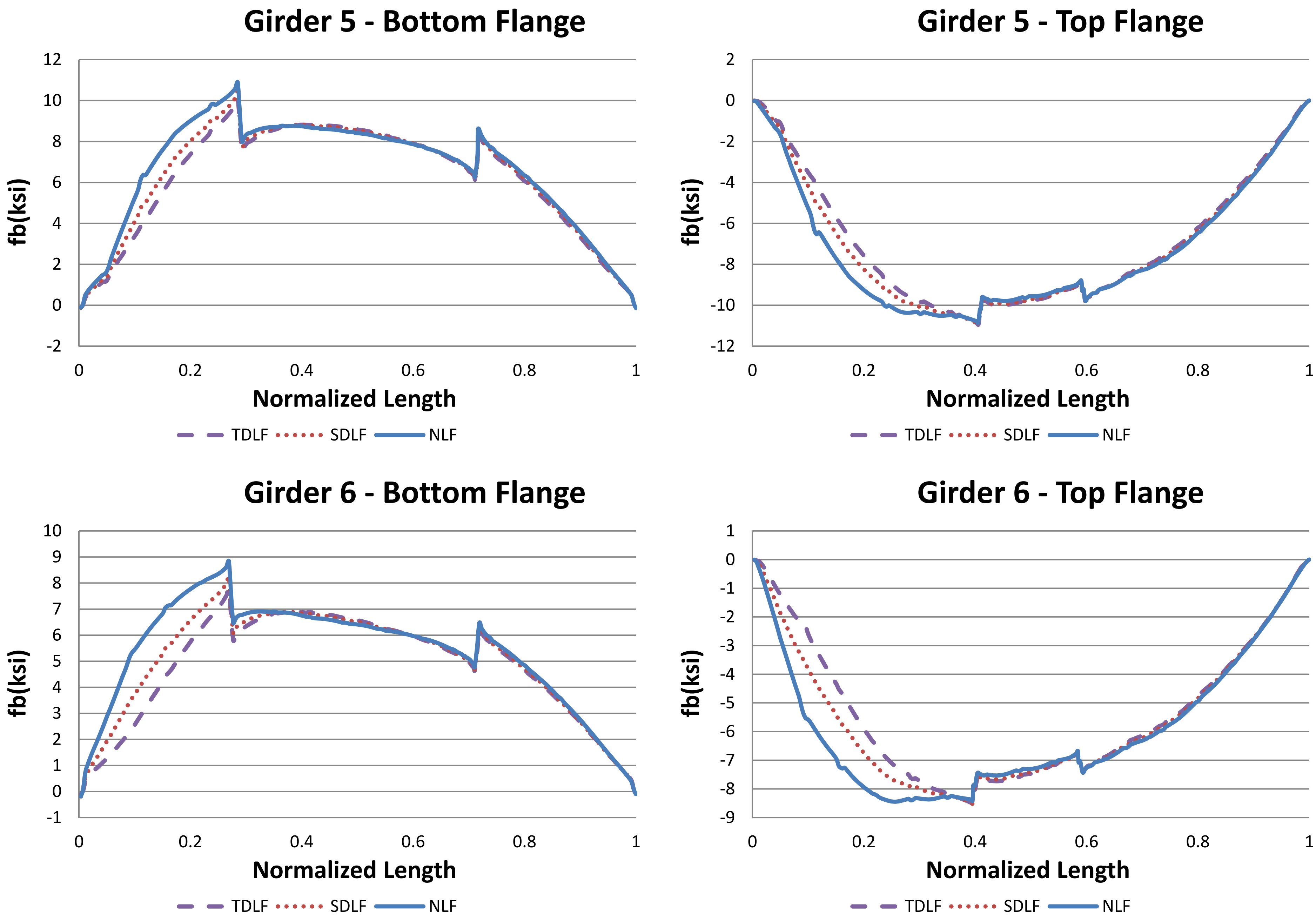


Figure R2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

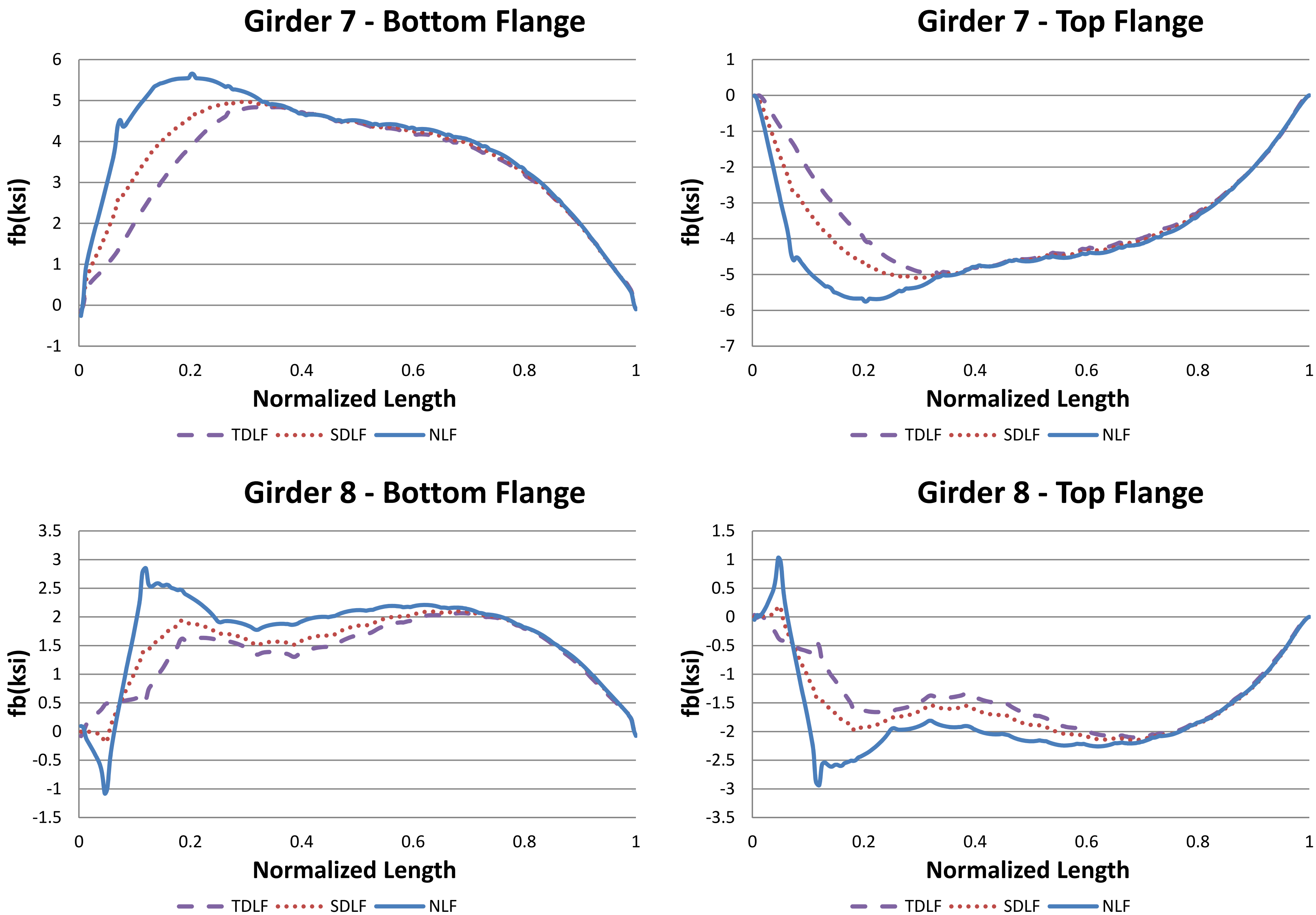
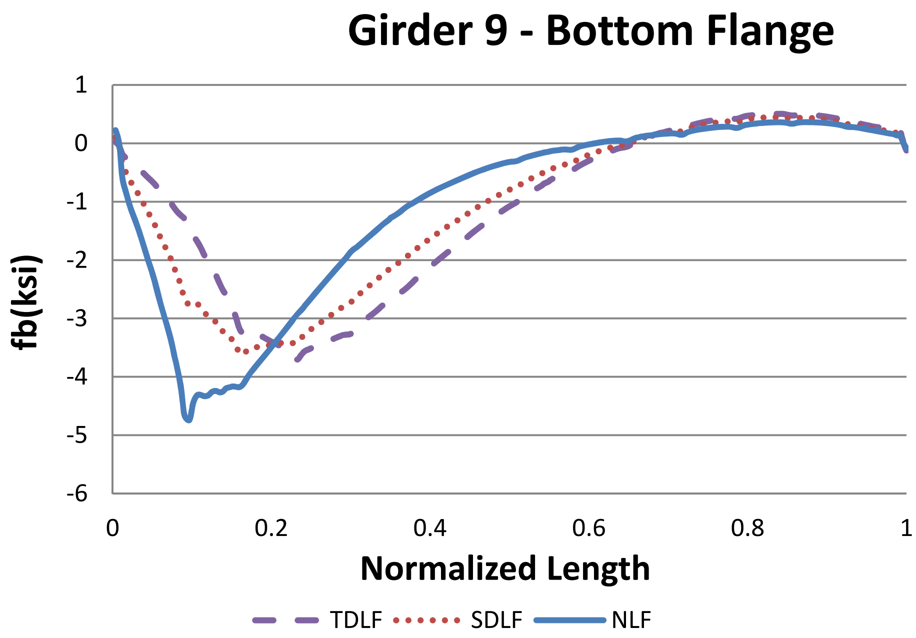


Figure R2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.



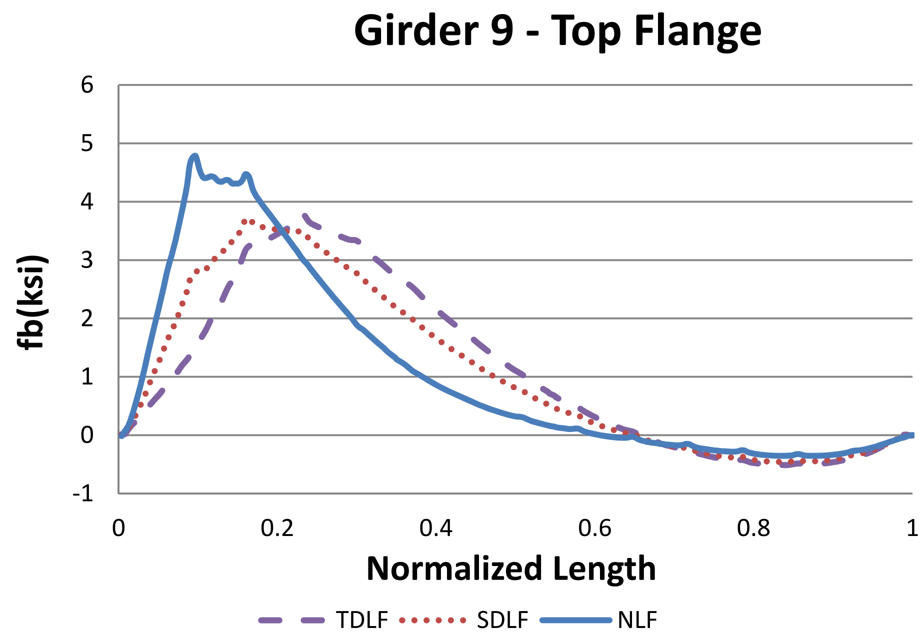


Figure R2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

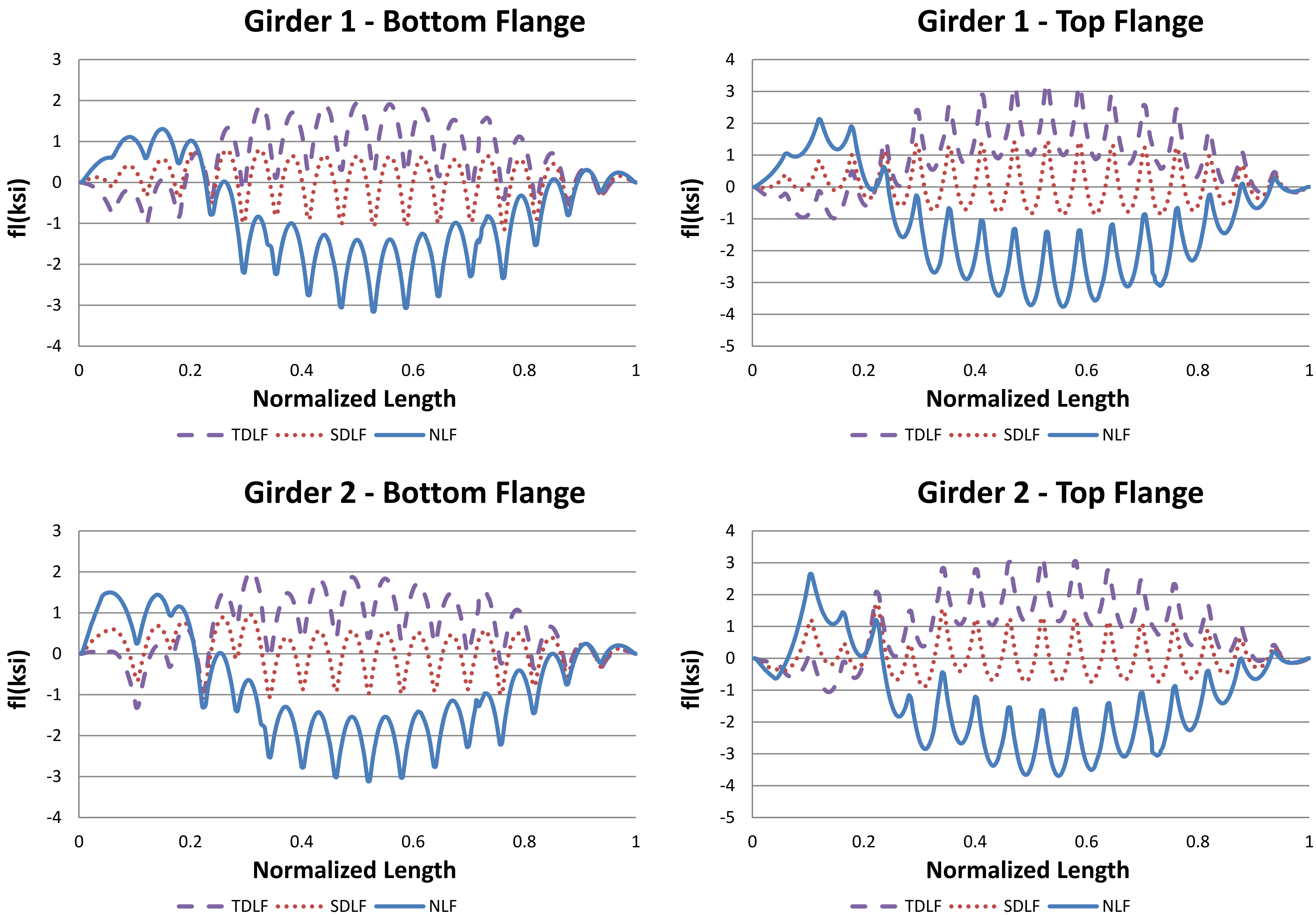


Figure R2-4-19. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

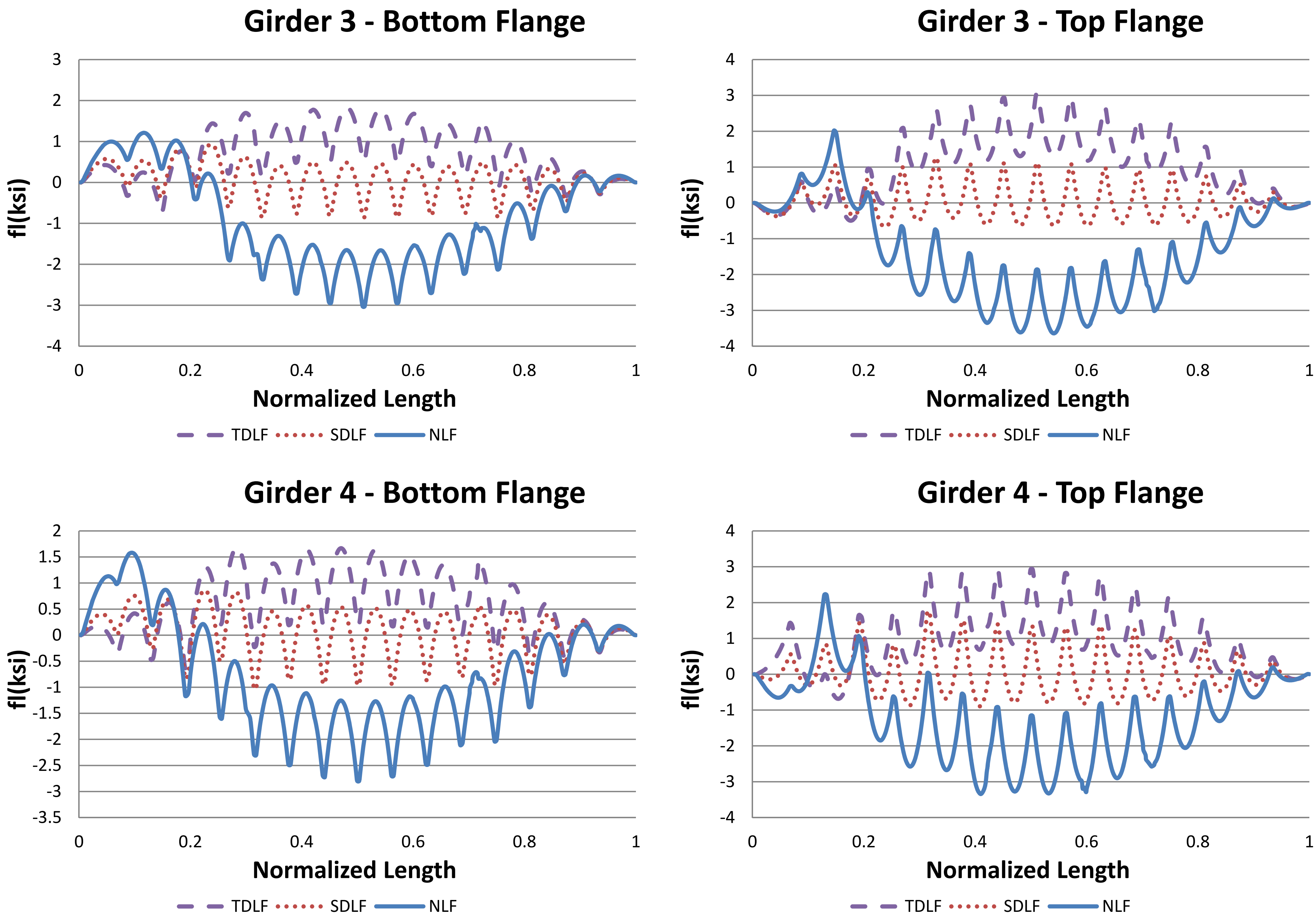


Figure R2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

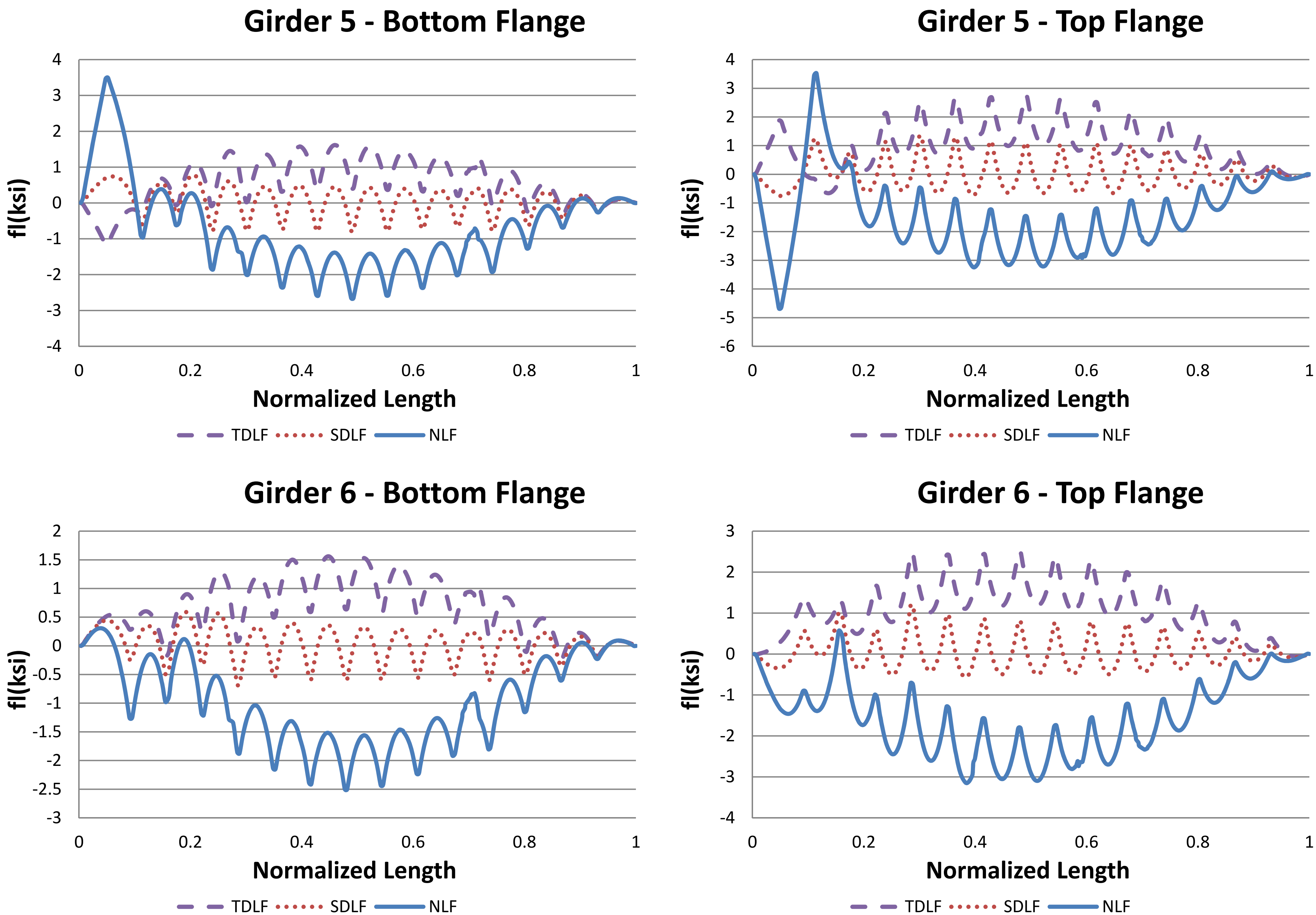


Figure R2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

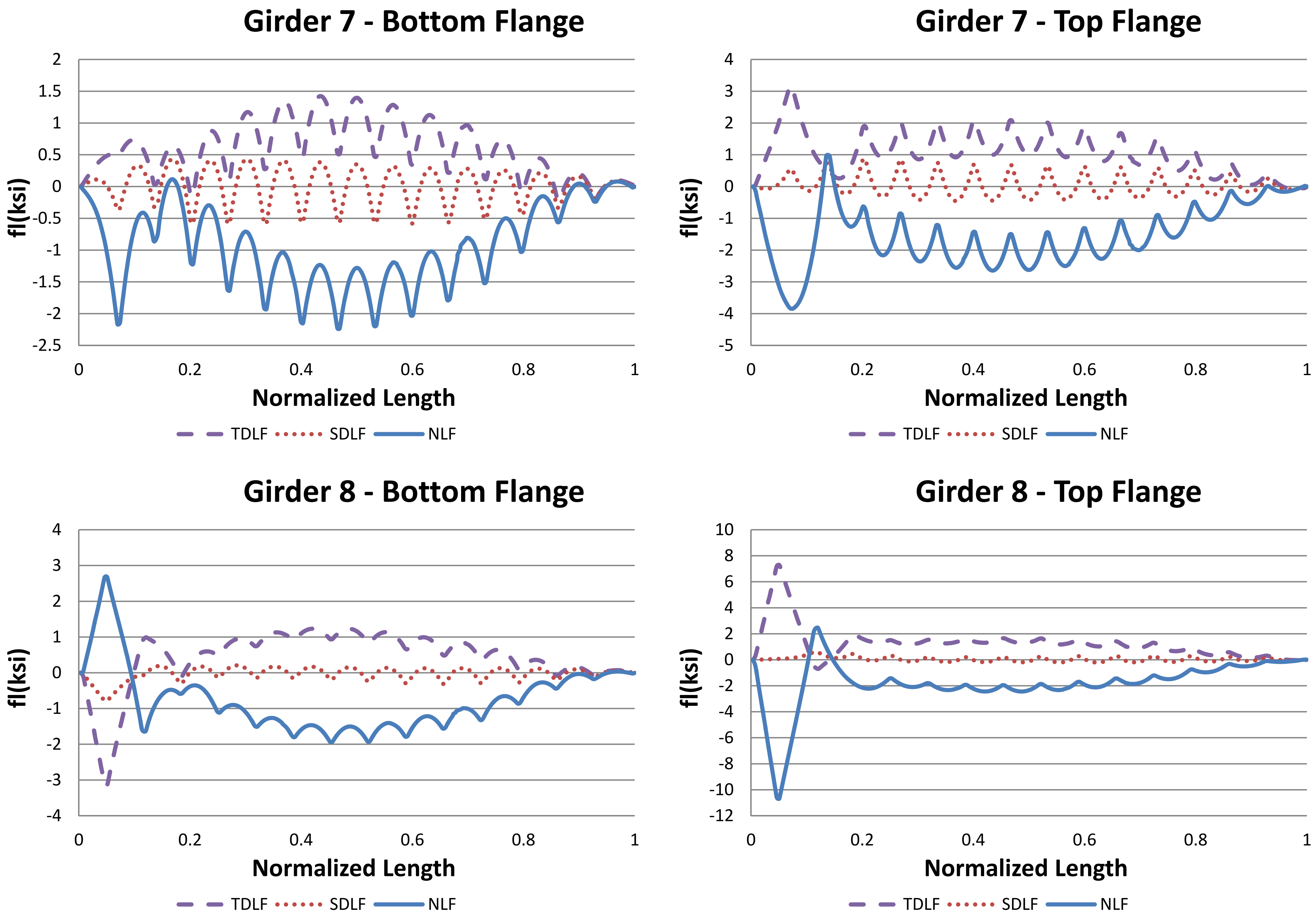


Figure R2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

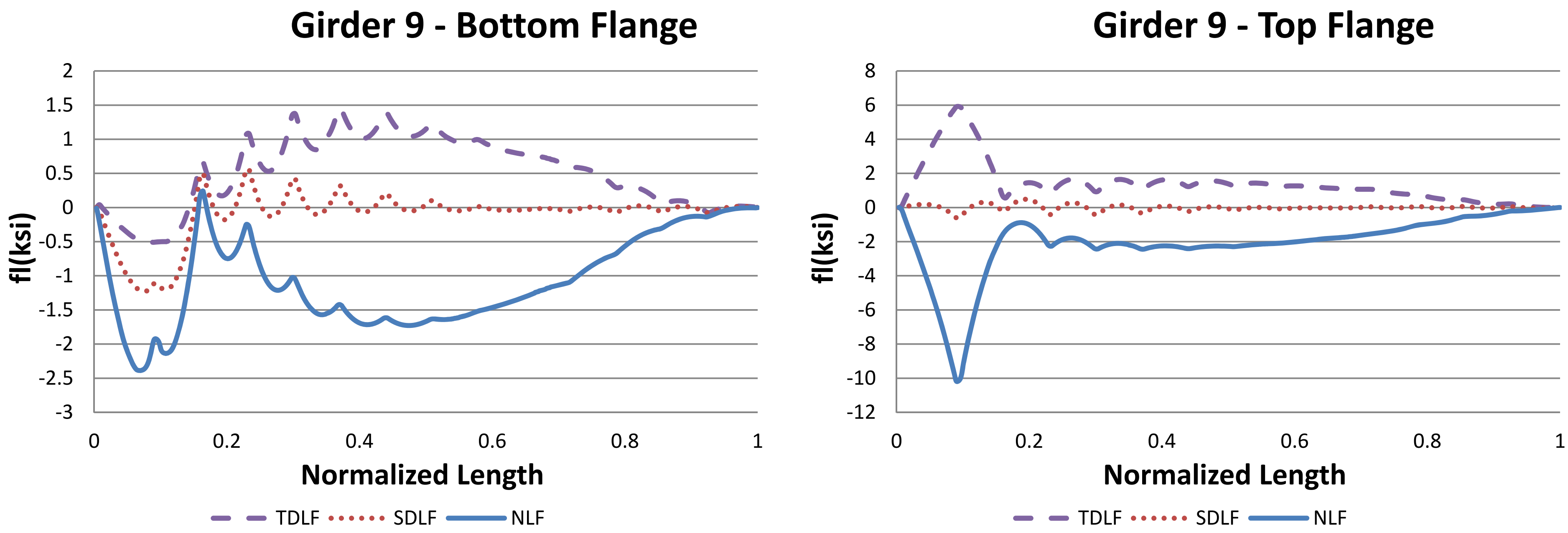


Figure R2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under SDL for different detailing methods.

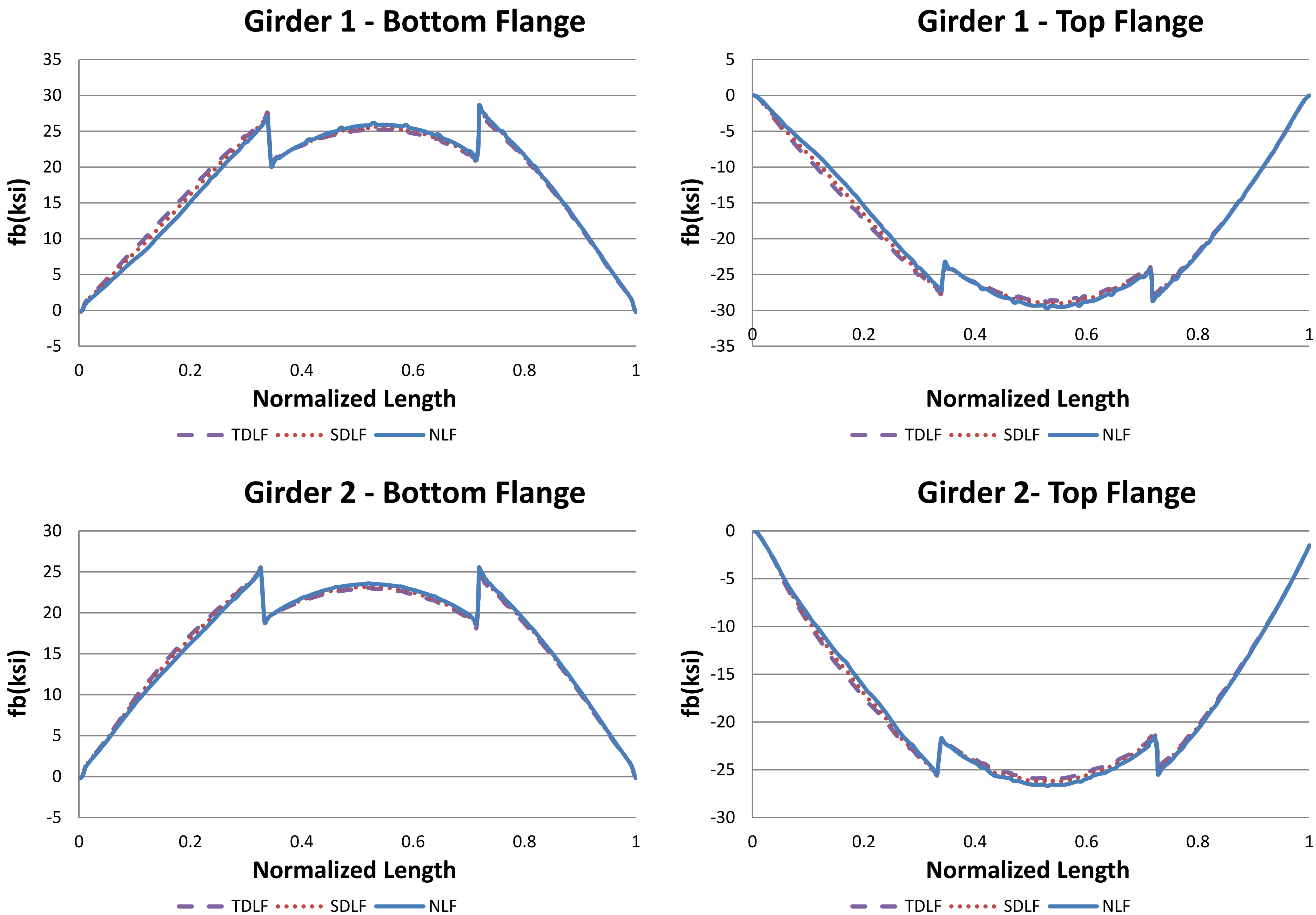


Figure R2-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

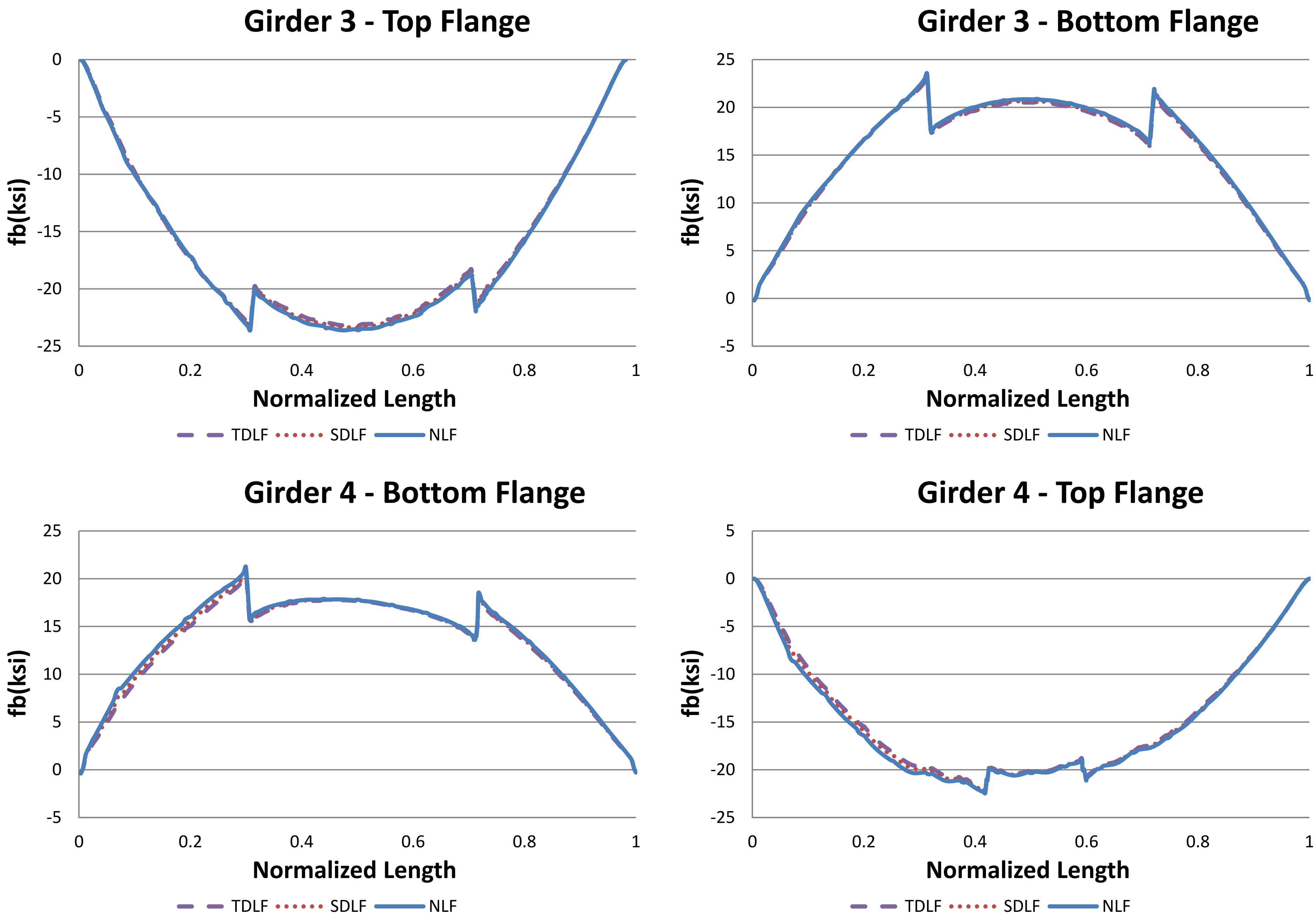


Figure R2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

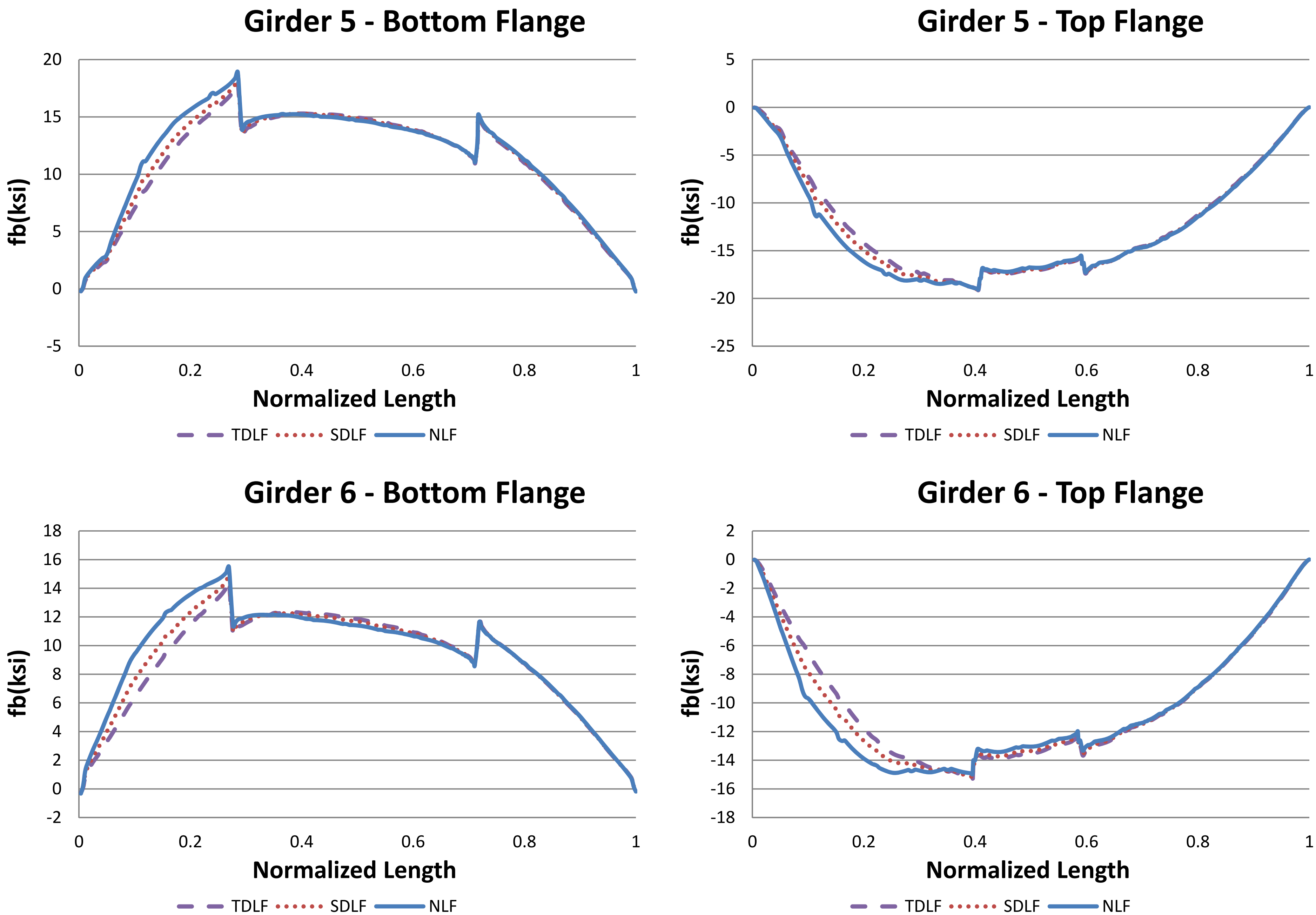


Figure R2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

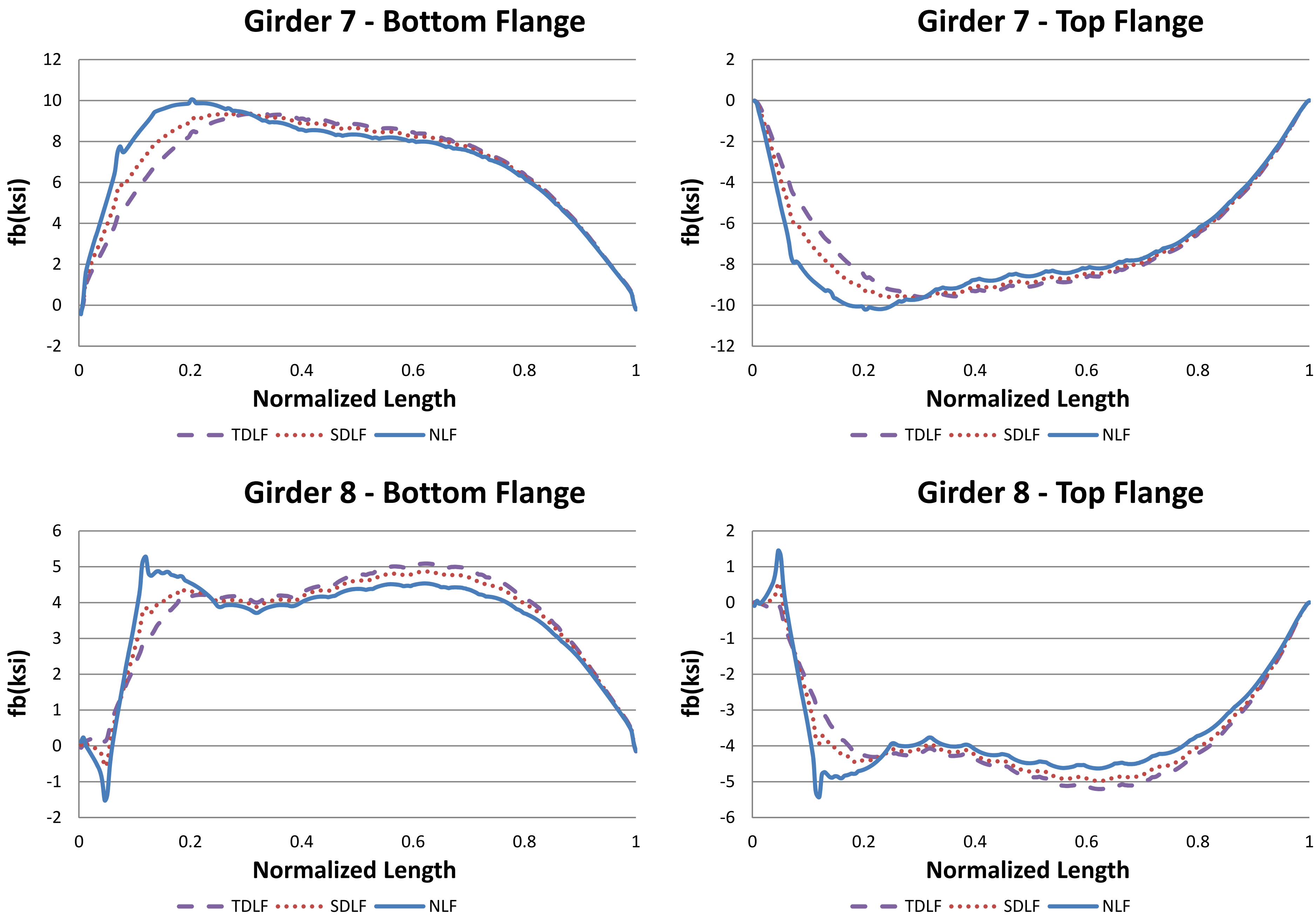
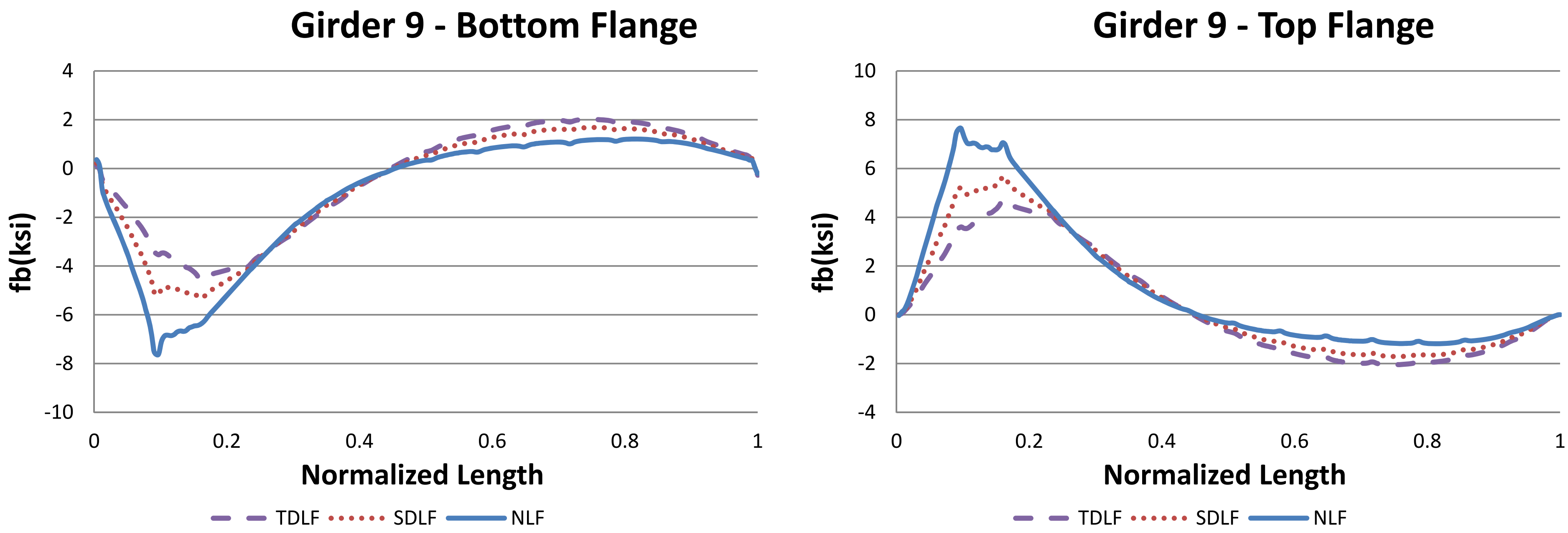


Figure R2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



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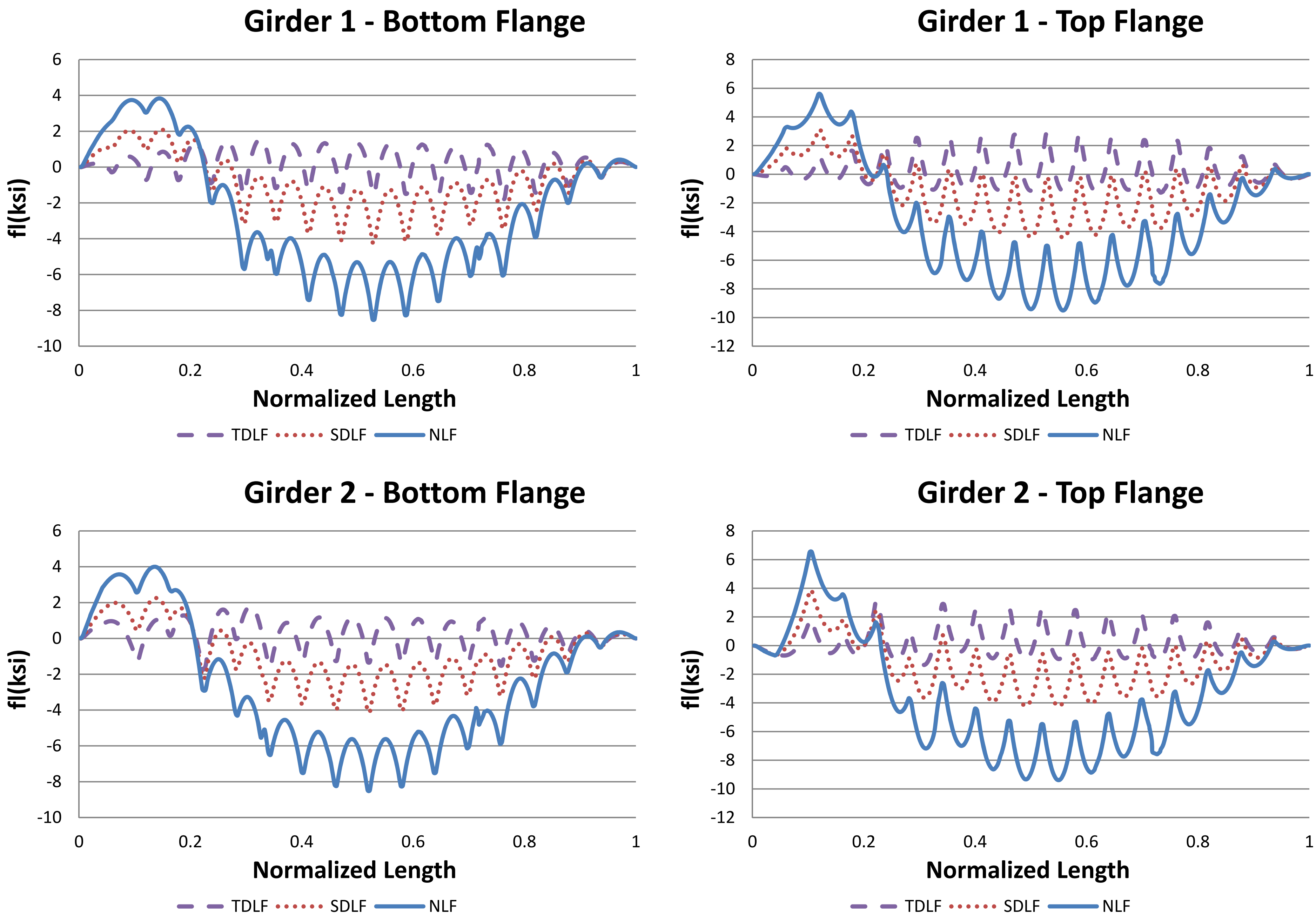


Figure R2-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

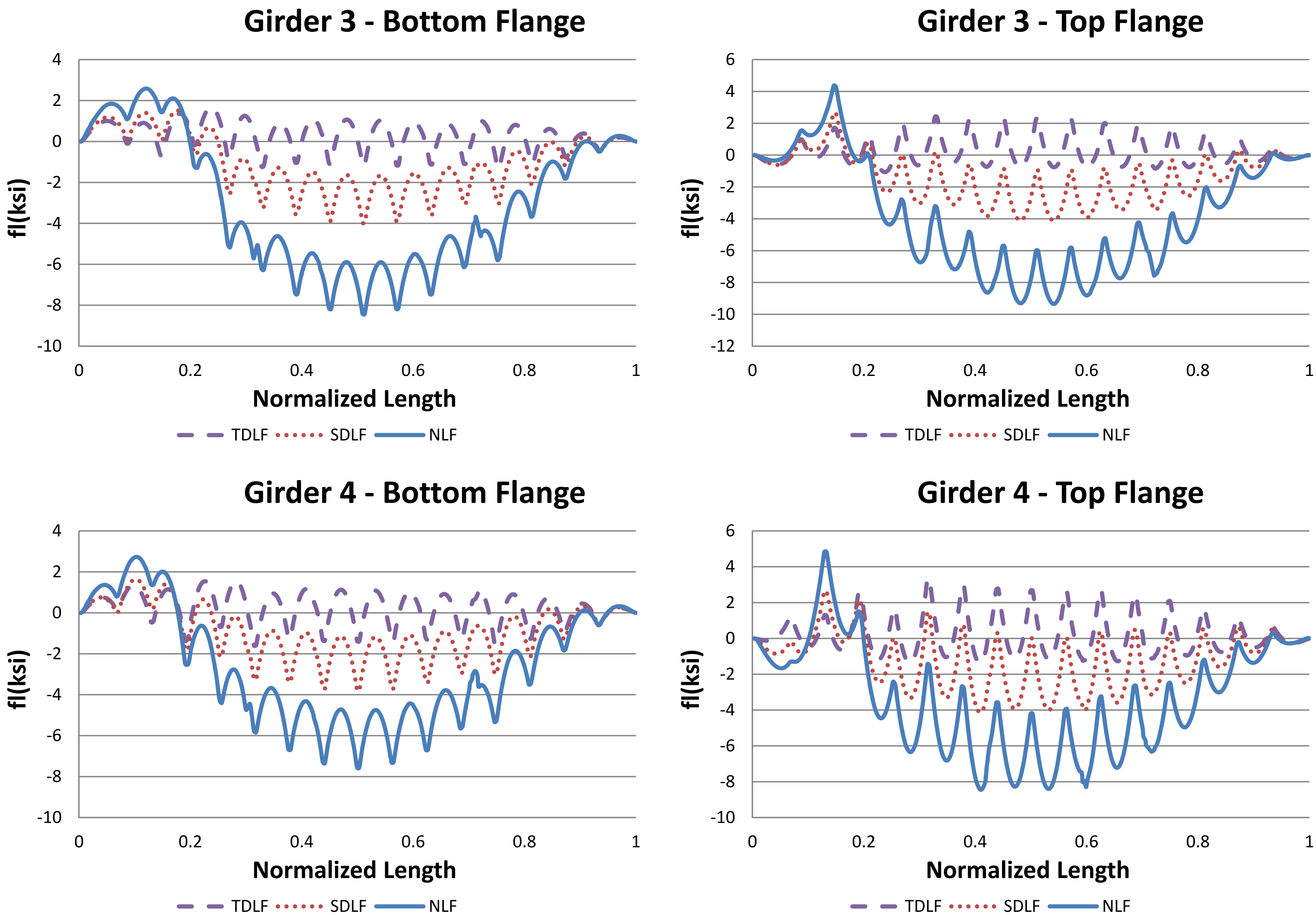


Figure R2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

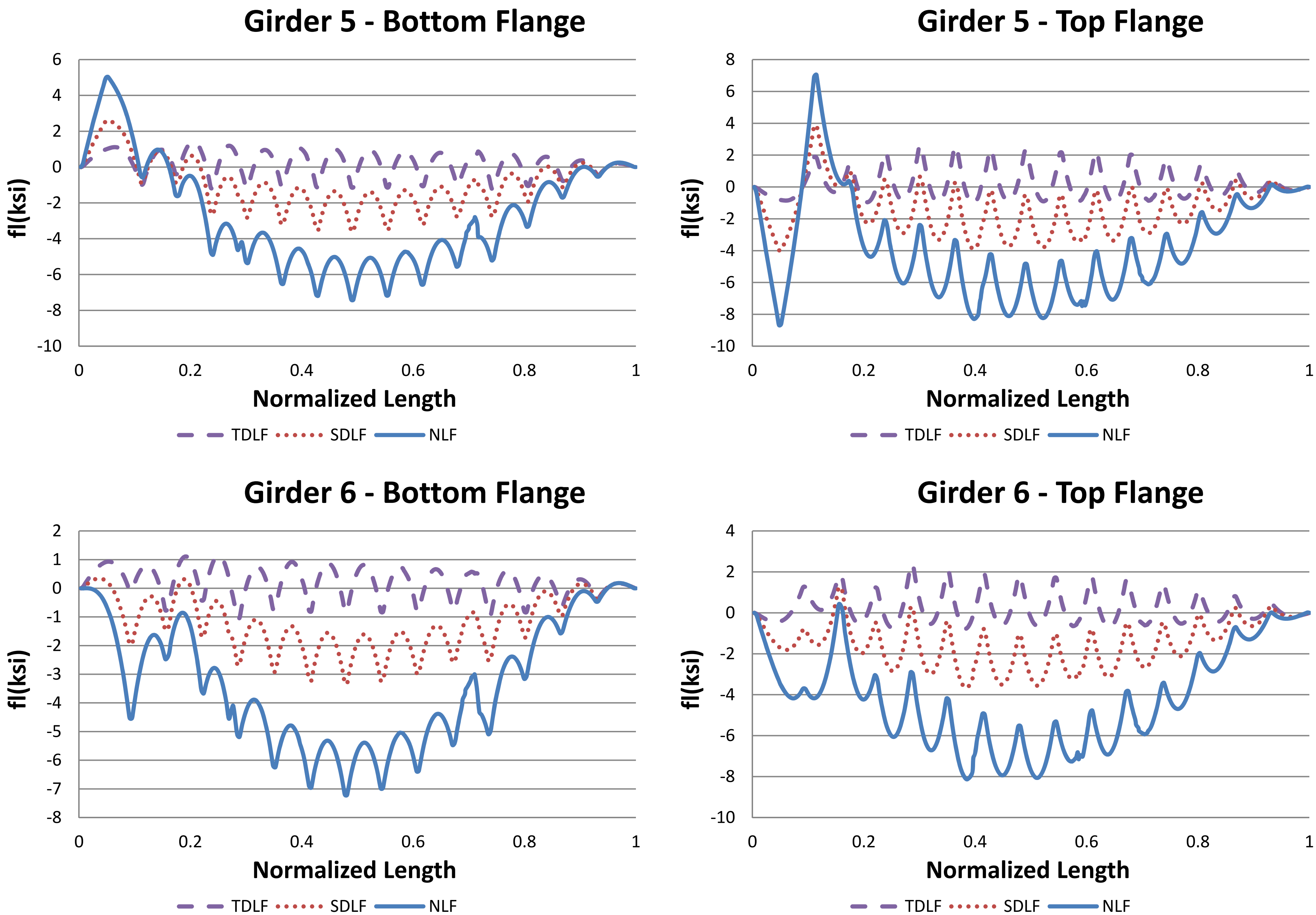


Figure R2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

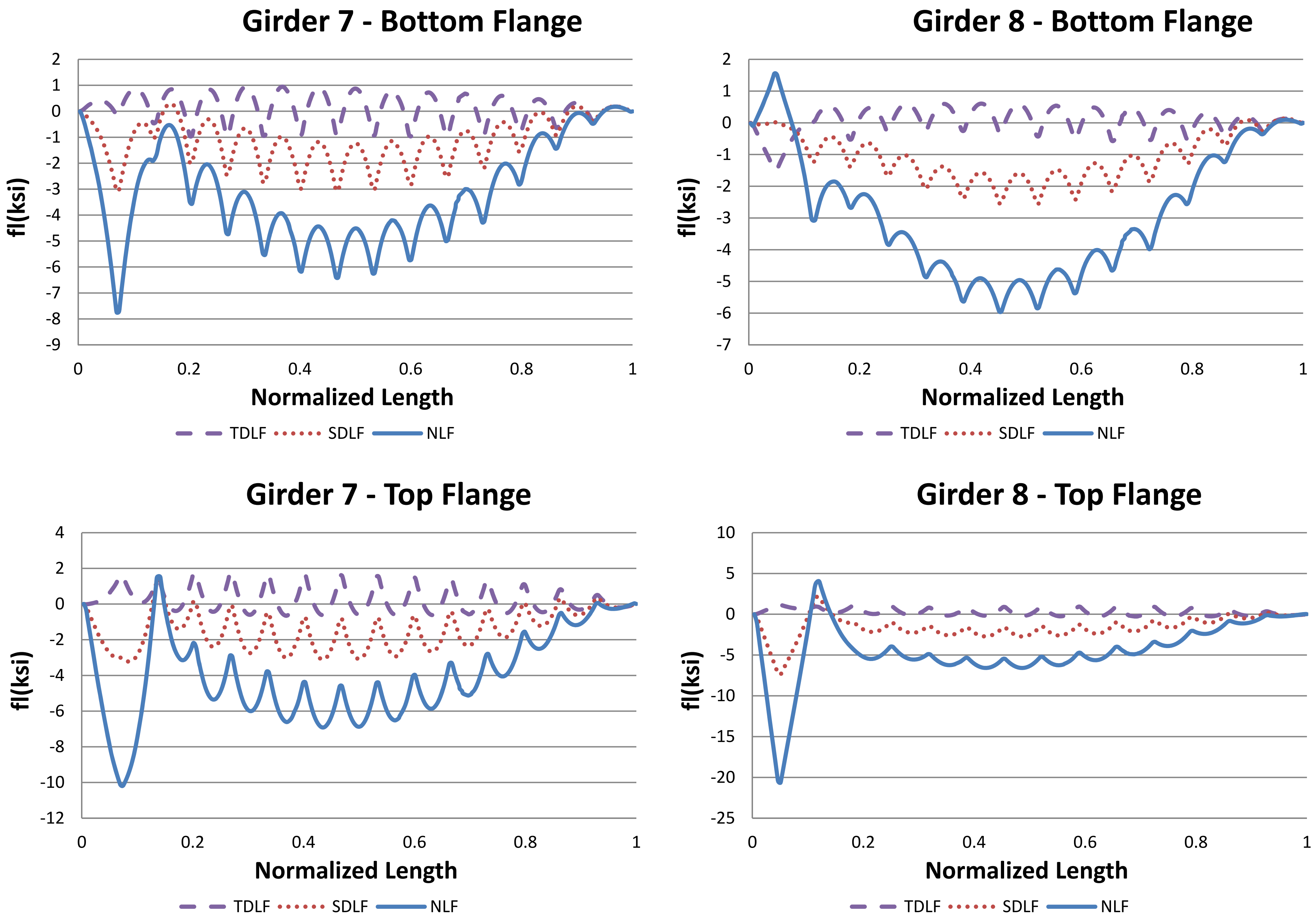
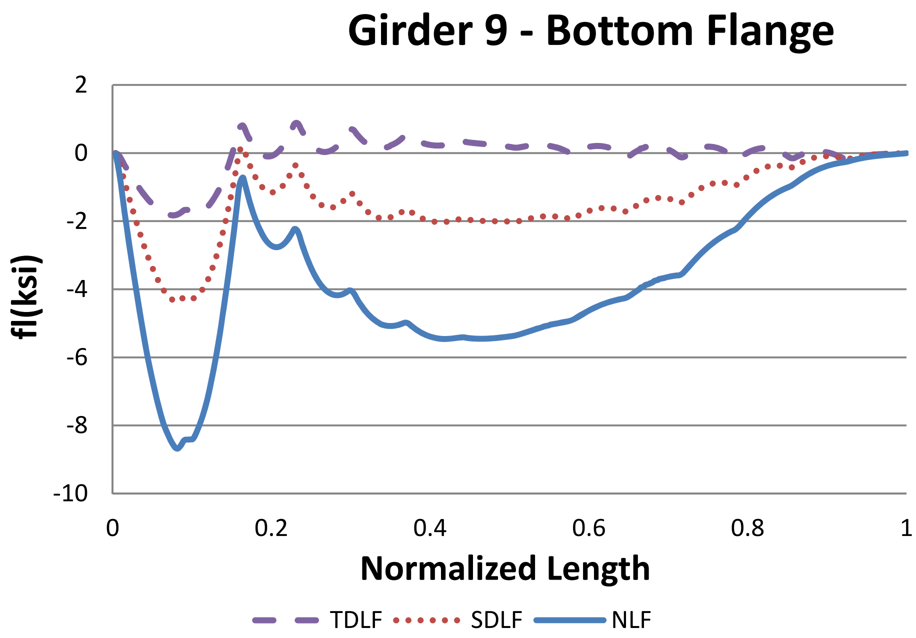


Figure R2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.



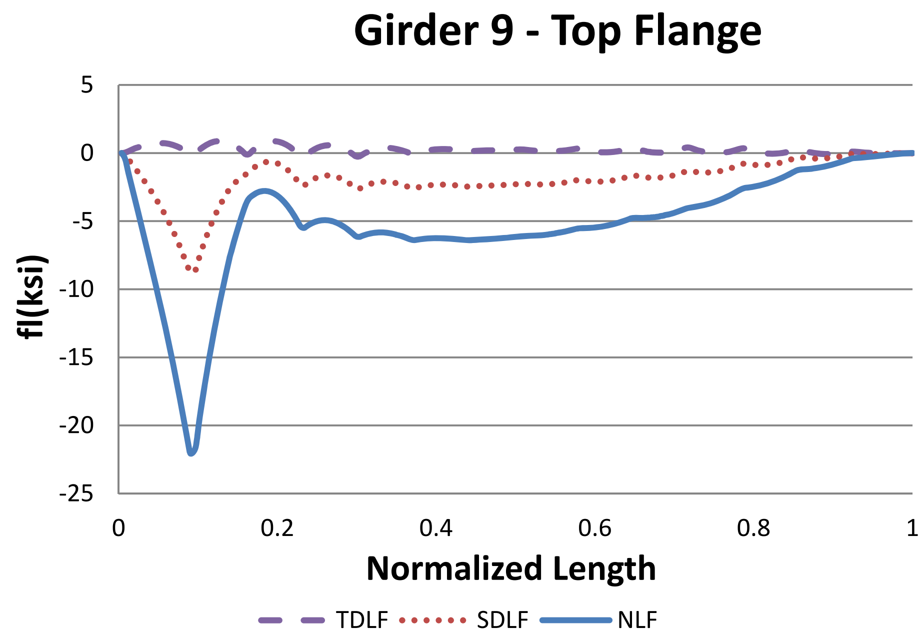


Figure R2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

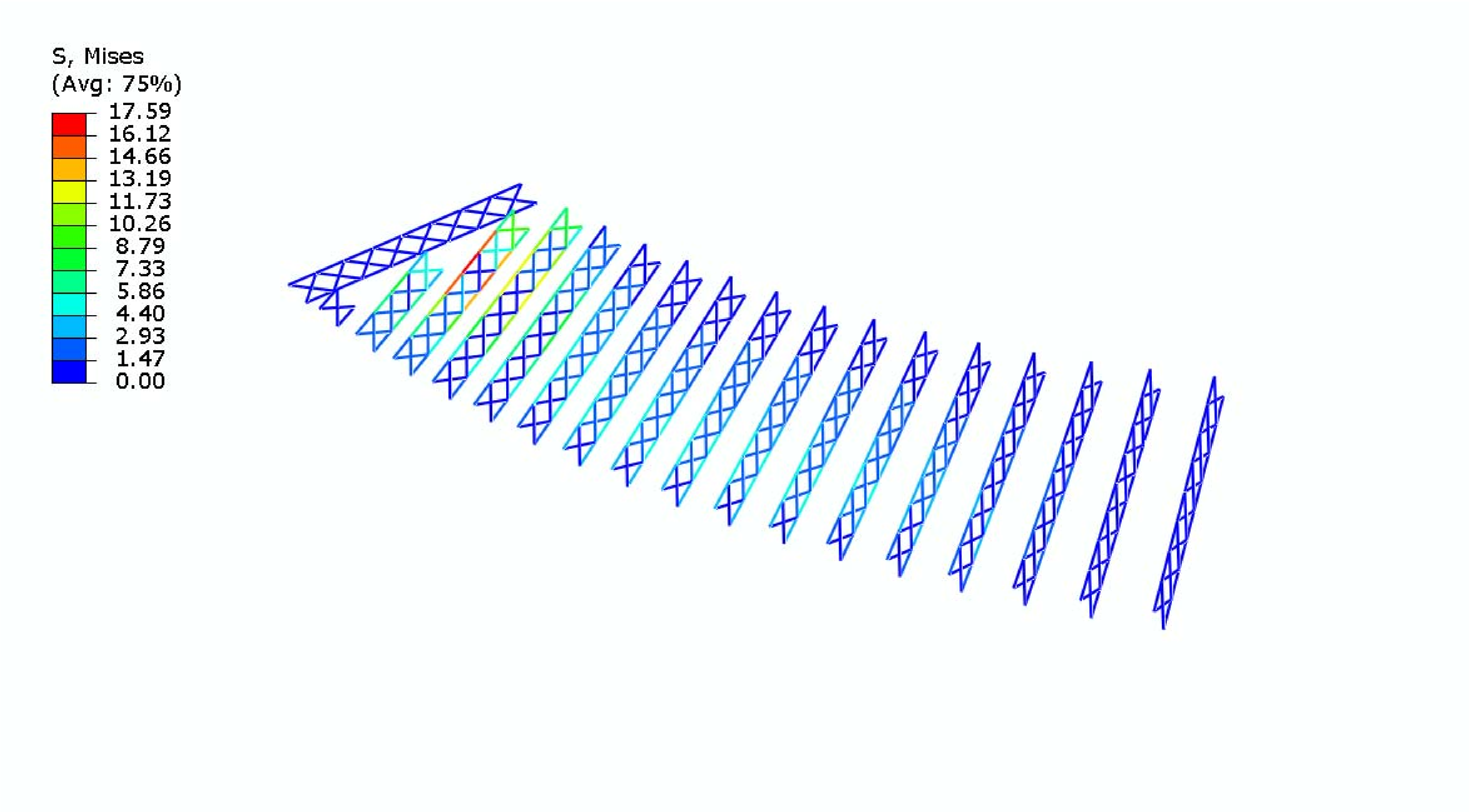


Figure R2-4-22. **Cross-frame stress contours (ksi) under SDL, NLF detailing**

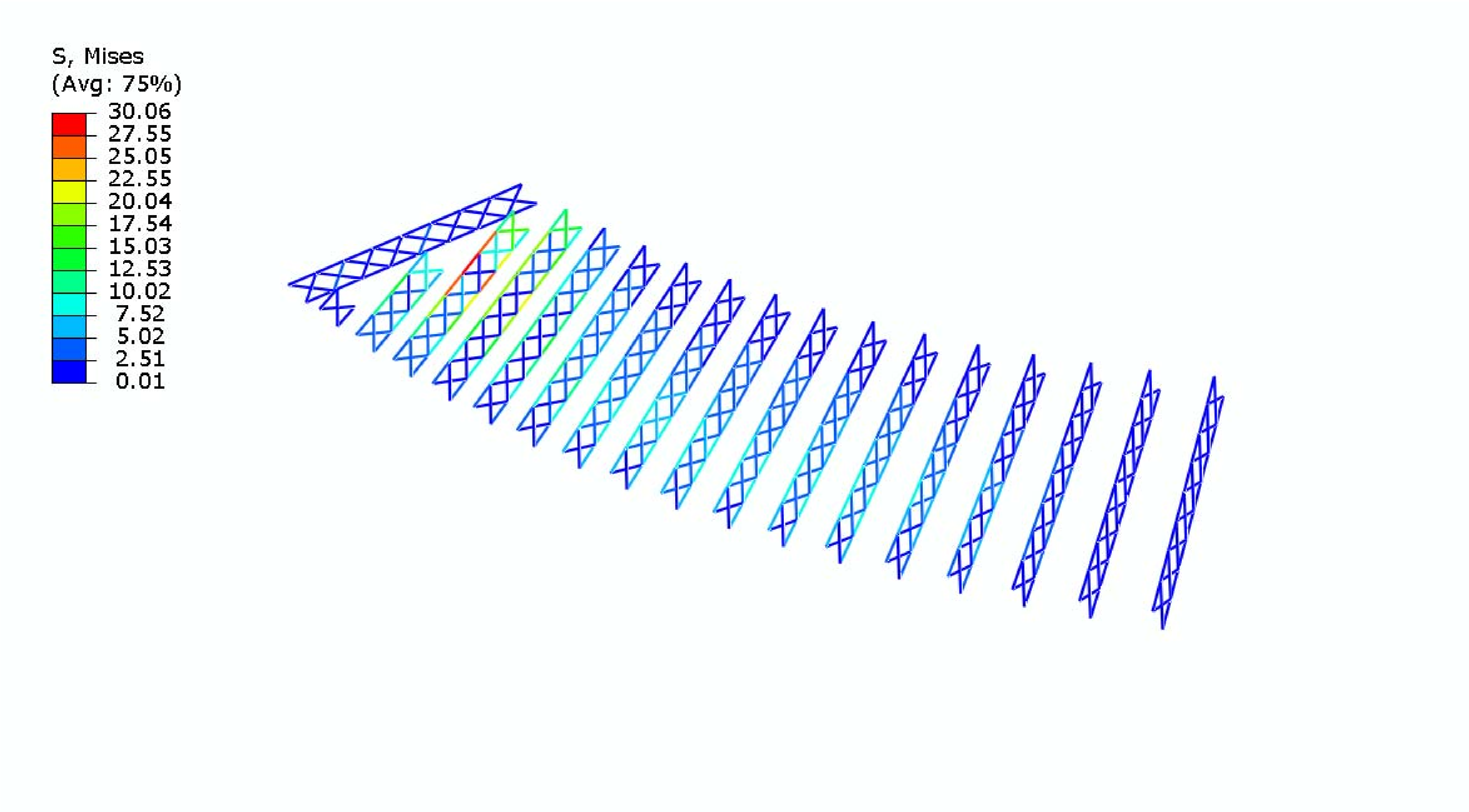


Figure R2-4-23. Cross-frame stress contours under TDL, NLF detailing

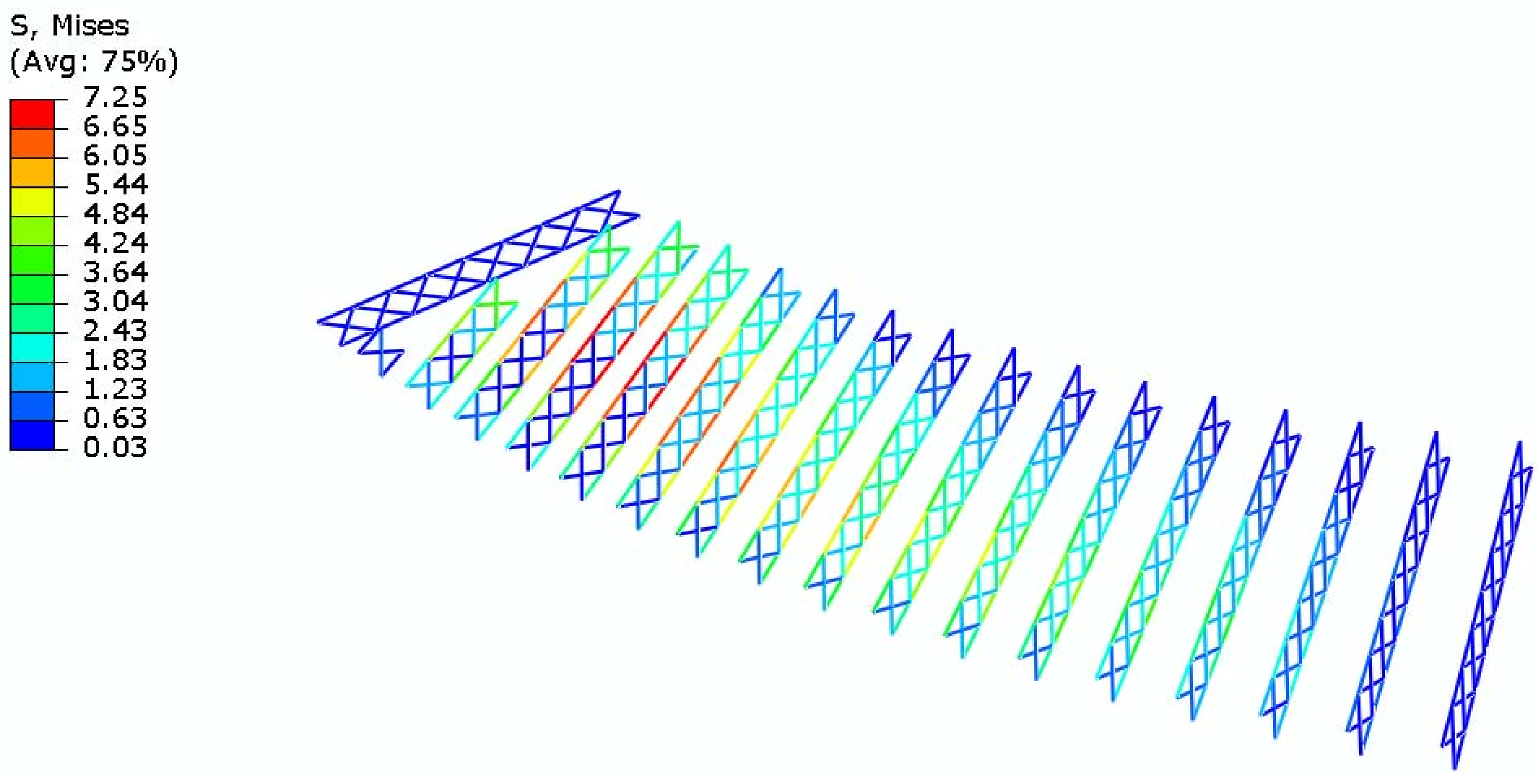


Figure R2-4-24. **Cross-frame stress contours under SDL, SDLF detailing**

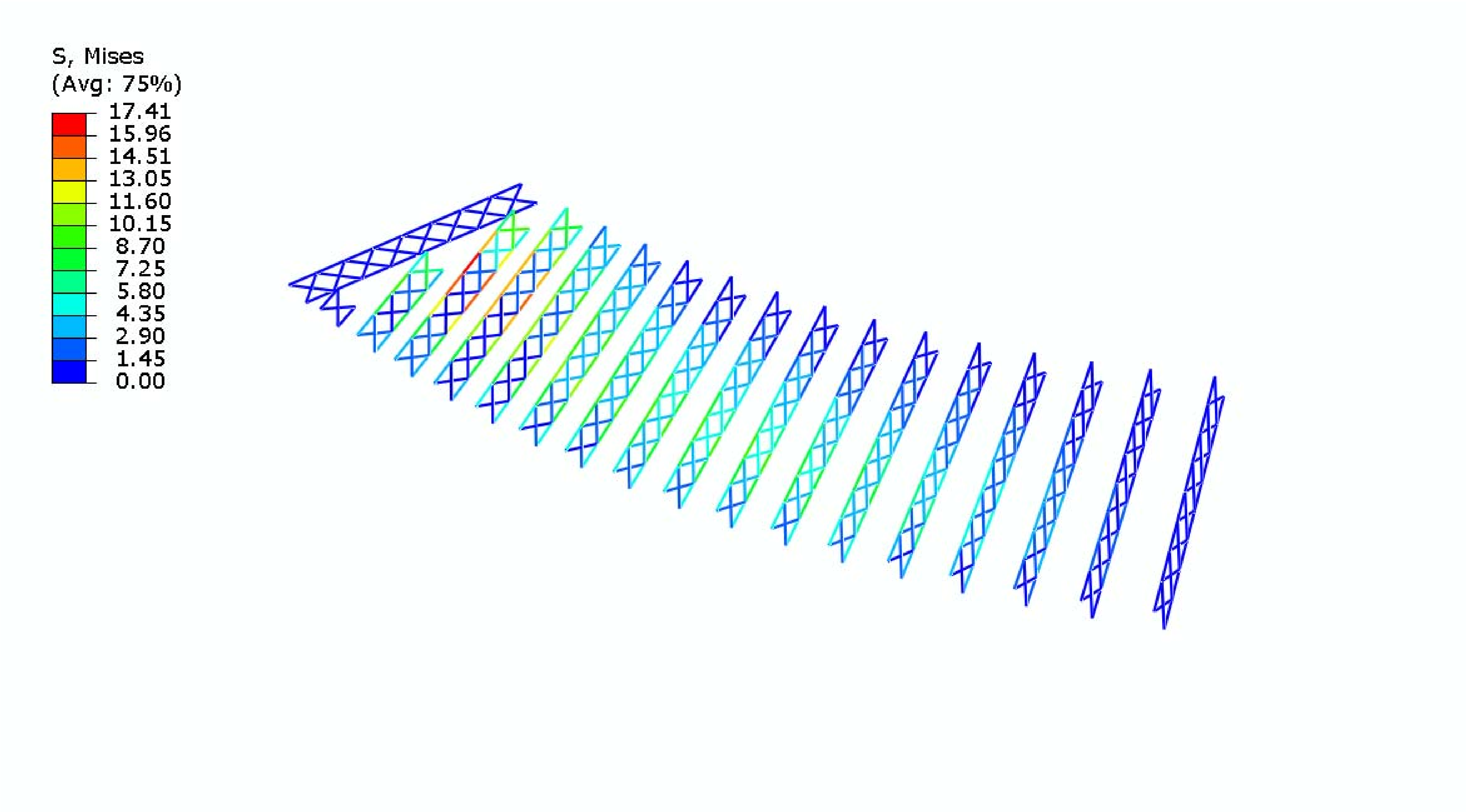


Figure R2-4-25. Cross-frame stress contours under TDL, SDLF detailing

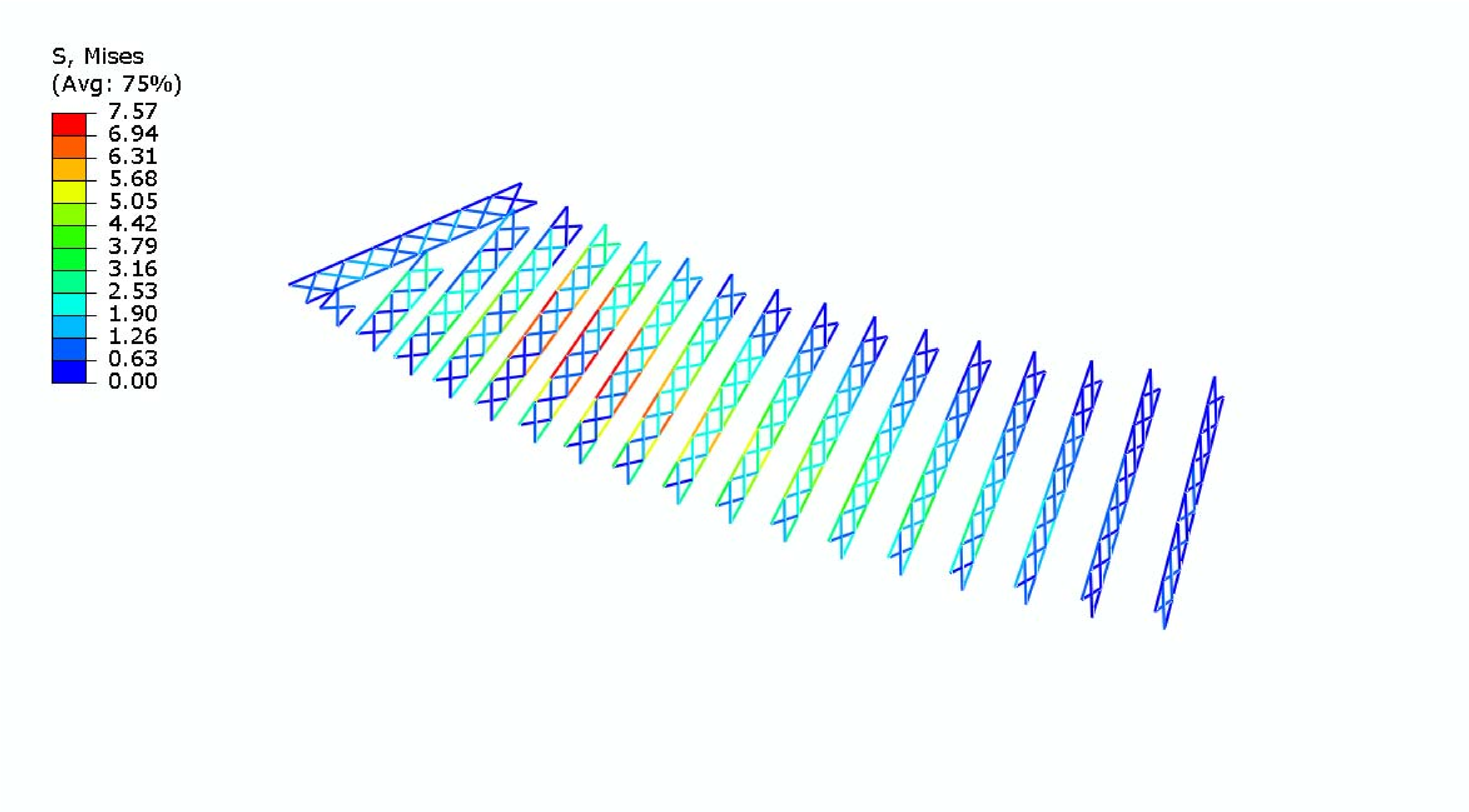


Figure R2-4-26. Cross-frame stress contours under SDL, TDLF detailing

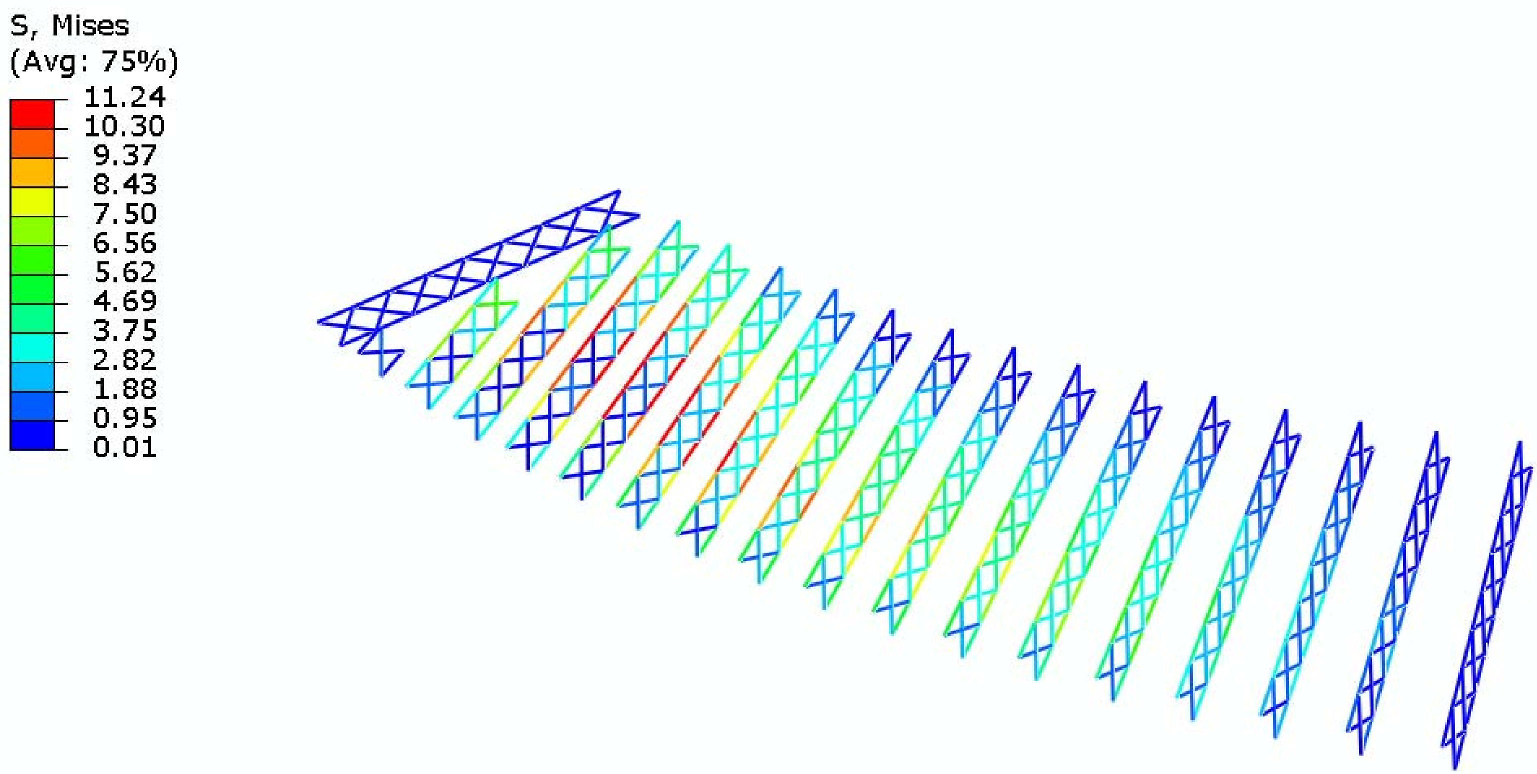


Figure R2-4-27. **Cross-frame stress contours under TDL, TDLF detailing**

Table R2-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	24.6	31.0	27.7	19.5	32.4	29.2	8.7	19.7
	SDLF	8.8	11.2	12.1	10.8	9.9	10.9	10.2	3.8
	TDLF	25.5	31.3	32.8	27.5	35.9	39.3	19.0	12.3
2	NLF	3.8	42.9	34.3	128.4	26.5	114.2	235.2	195.5
	SDLF	17.3	8.6	41.3	89.5	41.3	52.1	84.1	70.9
	TDLF	27.1	26.1	48.1	63.8	57.4	17.1	19.3	12.9
3	NLF	55.8	54.7	66.7	73.9	13.3	35.1	54.4	57.1
	SDLF	29.1	9.9	3.6	13.0	33.6	41.4	52.5	64.4
	TDLF	12.2	19.8	49.0	70.0	47.9	45.7	52.1	70.0
4	NLF	40.2	24.1	25.7	26.0	34.3	51.2	59.0	8.2
	SDLF	20.2	0.8	8.2	6.2	32.4	45.7	49.8	36.5
	TDLF	7.4	16.8	30.9	27.9	31.5	42.7	43.9	55.5
5	NLF	6.1	6.6	3.6	22.6	52.1	52.3	40.8	1.1
	SDLF	4.6	8.9	9.7	19.5	43.9	51.8	51.9	17.5
	TDLF	11.9	10.2	14.3	18.1	38.7	51.7	59.8	29.7
6	NLF	1.6	31.0	47.4	48.4	54.5	44.7	24.9	1.5
	SDLF	4.5	25.1	33.9	36.0	50.3	52.0	43.0	9.9
	TDLF	7.0	21.8	25.7	28.6	48.9	57.2	55.1	15.3
7	NLF	20.7	42.2	61.6	58.9	55.6	40.6	19.7	5.8
	SDLF	20.8	31.4	45.6	46.5	55.1	48.8	32.4	8.1
	TDLF	22.1	26.2	36.1	40.1	56.1	54.6	40.8	9.5
8	NLF	24.5	51.0	64.0	63.9	53.8	39.1	20.4	9.2
	SDLF	20.9	41.3	54.9	56.6	54.7	43.7	25.6	8.7
	TDLF	22.2	37.2	50.7	53.6	56.1	46.8	28.7	8.2
9	NLF	30.6	53.3	62.1	63.0	50.8	38.3	22.6	11.6
	SDLF	26.2	47.2	58.8	60.2	51.7	39.2	22.7	9.8
	TDLF	27.2	45.8	58.3	59.7	53.3	39.9	22.6	8.5
10	NLF	33.2	51.3	60.5	59.3	46.7	36.7	24.4	12.8
	SDLF	29.8	49.1	60.9	59.1	46.9	35.5	21.9	10.7
	TDLF	31.7	50.0	63.0	60.5	48.1	35.0	20.1	9.3

Table R2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	32.1	46.4	60.5	54.0	43.0	35.7	25.0	13.6
	SDLF	31.2	47.3	59.9	54.1	42.2	32.0	21.4	10.7
	TDLF	34.6	49.7	60.4	55.6	42.9	29.8	19.2	9.0
12	NLF	28.3	39.7	53.5	48.6	38.0	30.4	24.5	12.0
	SDLF	30.2	43.8	54.3	48.9	36.1	27.6	20.1	9.6
	TDLF	35.1	47.4	55.1	50.1	36.3	26.8	17.5	8.6
13	NLF	23.1	32.5	38.1	41.4	30.7	25.3	21.0	8.8
	SDLF	28.5	36.4	43.2	41.9	29.5	22.7	17.7	7.4
	TDLF	33.7	39.4	46.9	42.9	29.2	21.5	15.8	7.0
14	NLF	19.8	25.5	29.9	32.5	21.8	19.1	15.3	5.4
	SDLF	23.9	29.2	33.2	33.4	21.3	17.2	13.5	4.7
	TDLF	26.8	31.5	35.1	34.0	20.9	16.3	13.1	3.6
15	NLF	16.1	17.8	21.4	22.5	12.8	10.7	8.1	5.6
	SDLF	19.8	20.8	23.5	23.7	11.6	10.0	8.2	2.6
	TDLF	21.9	22.1	24.7	24.8	9.7	10.5	10.3	10.8
16	NLF	11.4	10.8	11.3	12.6	14.1	8.7	7.6	NA
	SDLF	14.7	11.6	12.9	13.6	2.5	2.8	2.0	NA
	TDLF	16.4	11.1	14.9	16.4	15.9	12.5	11.5	NA
17	NLF	7.1	28.4	20.9	14.9	NA	NA	NA	NA
	SDLF	9.1	4.1	4.3	3.3	NA	NA	NA	NA
	TDLF	10.9	24.8	23.1	16.2	NA	NA	NA	NA
18	NLF	31.2	NA	NA	NA	NA	NA	NA	NA
	SDLF	5.1	NA	NA	NA	NA	NA	NA	NA
	TDLF	26.8	NA	NA	NA	NA	NA	NA	NA

Table R2-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	44.9	62.1	47.7	34.4	69.3	52.5	23.0	37.4
	SDLF	15.2	20.4	13.7	8.2	15.7	9.8	5.2	9.7
	TDLF	14.5	20.1	20.6	17.4	17.1	20.3	16.1	7.1
2	NLF	6.5	72.2	61.1	214.7	51.9	197.3	392.7	328.9
	SDLF	20.8	29.2	63.0	169.2	55.2	118.0	230.5	192.1
	TDLF	30.9	8.0	71.3	141.3	71.4	80.5	118.9	101.4
3	NLF	92.6	90.1	110.9	124.5	27.7	59.7	91.0	96.7
	SDLF	62.3	39.8	33.6	30.2	46.9	65.4	84.6	100.0
	TDLF	43.2	7.9	16.4	31.9	60.2	69.1	83.7	102.3
4	NLF	67.1	37.9	37.3	40.5	62.9	90.2	102.0	14.8
	SDLF	43.1	10.5	1.7	8.6	59.1	81.3	88.4	42.1
	TDLF	28.2	7.6	23.7	18.3	56.9	76.2	79.8	60.7
5	NLF	8.5	17.4	14.3	45.6	95.3	94.3	72.4	0.2
	SDLF	4.9	19.3	19.8	40.9	83.1	89.7	79.2	18.3
	TDLF	12.7	20.5	24.2	38.5	75.5	87.2	85.2	30.2
6	NLF	6.1	60.2	91.7	90.8	99.2	83.1	46.7	4.9
	SDLF	9.1	51.4	74.2	74.6	91.0	86.3	61.4	12.6
	TDLF	11.5	46.6	63.7	64.8	86.5	89.1	72.2	17.5
7	NLF	39.5	78.1	116.6	107.9	101.5	77.1	38.6	12.3
	SDLF	38.2	64.1	95.1	91.4	97.0	81.6	48.3	13.4
	TDLF	38.4	56.4	82.3	81.7	95.0	85.2	55.4	14.0
8	NLF	43.8	93.1	119.5	116.4	100.1	75.1	40.1	18.0
	SDLF	38.5	79.6	105.0	104.6	96.3	76.1	42.2	16.0
	TDLF	38.2	72.7	97.3	98.3	94.7	77.2	44.1	14.5
9	NLF	54.2	97.0	116.6	116.3	94.2	73.6	43.7	22.0
	SDLF	47.8	86.9	107.5	108.2	91.1	71.0	40.8	18.4
	TDLF	47.0	82.4	103.5	104.3	90.0	69.8	39.3	16.2
10	NLF	58.6	93.2	113.0	109.0	86.9	70.2	46.5	23.8
	SDLF	53.1	87.3	108.4	104.4	83.4	65.7	41.1	19.9
	TDLF	53.1	85.4	107.2	102.7	82.0	63.4	37.7	17.7

Table R2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	56.5	84.6	113.9	99.7	79.4	67.7	46.7	24.5
	SDLF	53.6	82.2	108.2	95.9	75.6	60.9	40.6	20.2
	TDLF	55.2	82.1	105.6	94.5	74.2	57.0	36.8	17.7
12	NLF	49.7	73.3	101.0	89.8	68.8	55.4	44.4	21.1
	SDLF	49.9	74.6	97.6	86.9	65.0	51.0	38.6	18.0
	TDLF	53.1	76.2	96.1	85.8	63.9	49.0	35.1	16.2
13	NLF	41.4	58.9	70.9	75.1	56.5	46.6	37.7	14.9
	SDLF	46.1	61.9	74.5	74.0	53.7	42.6	33.4	13.6
	TDLF	50.1	64.0	77.2	73.9	52.3	40.3	30.7	12.8
14	NLF	35.8	46.4	56.3	59.8	39.6	34.8	27.2	8.5
	SDLF	39.5	49.6	58.4	59.4	38.4	32.2	25.0	8.5
	TDLF	41.9	51.4	59.8	59.1	37.3	30.6	24.0	7.7
15	NLF	29.2	31.4	40.2	40.9	21.2	18.6	14.3	10.0
	SDLF	32.7	34.8	42.0	41.8	20.6	18.4	14.6	5.3
	TDLF	34.5	36.2	43.1	42.5	18.9	18.2	15.7	3.7
16	NLF	20.0	18.0	20.9	22.0	21.5	16.7	11.3	NA
	SDLF	23.7	19.0	22.9	23.7	6.7	5.2	4.0	NA
	TDLF	25.5	19.3	24.6	25.7	4.6	4.1	2.9	NA
17	NLF	11.3	46.8	35.4	27.0	NA	NA	NA	NA
	SDLF	14.3	16.2	11.8	11.3	NA	NA	NA	NA
	TDLF	16.2	6.9	7.9	6.3	NA	NA	NA	NA
18	NLF	53.0	NA	NA	NA	NA	NA	NA	NA
	SDLF	21.0	NA	NA	NA	NA	NA	NA	NA
	TDLF	9.7	NA	NA	NA	NA	NA	NA	NA

Table R2-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	12.6	11.0	9.5	2.1	4.3	9.1	5.3	12.7
	SDLF	4.8	7.8	9.9	8.1	10.9	14.5	9.5	2.5
	TDLF	15.7	18.7	20.5	16.5	16.7	29.8	22.5	0.1
2	NLF	8.0	153.8	181.8	94.0	410.4	351.1	157.5	127.5
	SDLF	4.6	105.7	111.1	52.2	152.3	114.1	47.9	46.6
	TDLF	3.4	75.0	63.2	22.6	21.6	47.3	28.0	7.8
3	NLF	58.9	139.2	247.2	350.6	307.8	302.9	263.2	47.0
	SDLF	48.2	105.7	150.7	162.1	182.2	158.6	113.6	50.5
	TDLF	42.0	82.7	85.5	36.3	99.2	62.1	13.8	52.1
4	NLF	58.2	137.1	212.6	276.2	188.7	162.0	111.9	13.7
	SDLF	55.7	119.1	159.9	182.5	179.7	155.5	112.2	31.5
	TDLF	53.8	107.5	125.5	121.1	173.2	150.3	111.3	43.4
5	NLF	56.2	117.2	171.2	189.0	108.9	77.4	36.8	4.4
	SDLF	54.3	115.8	163.9	179.3	155.2	127.7	80.1	17.9
	TDLF	53.0	114.9	159.2	172.5	185.1	160.6	108.5	26.8
6	NLF	68.9	120.3	145.9	132.6	72.5	41.3	13.2	3.9
	SDLF	69.4	127.5	165.2	167.3	125.6	92.8	50.2	11.3
	TDLF	69.4	131.6	177.1	189.5	159.5	126.1	74.3	15.9
7	NLF	68.6	120.6	133.0	103.4	63.3	34.0	11.0	5.1
	SDLF	68.7	129.7	158.7	146.9	100.9	67.9	32.7	8.4
	TDLF	68.1	134.5	174.2	174.2	123.7	88.9	46.3	10.3
8	NLF	78.2	120.3	129.9	97.7	65.7	37.6	14.8	6.2
	SDLF	76.8	129.4	150.9	129.9	83.7	52.8	24.0	7.3
	TDLF	74.9	133.9	162.7	148.9	93.2	61.1	29.2	7.6
9	NLF	80.8	120.6	130.5	99.5	70.2	43.1	19.1	7.2
	SDLF	79.3	125.6	141.7	115.7	73.0	45.5	20.9	6.8
	TDLF	77.3	127.3	146.9	123.7	72.7	45.5	21.2	6.3
10	NLF	81.9	120.3	130.6	101.4	72.3	47.2	22.5	7.6
	SDLF	79.3	120.1	132.0	103.9	66.6	42.3	20.0	6.4
	TDLF	76.5	118.4	130.8	103.3	61.6	38.1	17.8	5.6

Table R2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	81.4	118.7	128.0	99.8	73.1	49.3	24.2	7.6
	SDLF	77.3	112.3	121.7	94.4	61.4	40.0	19.7	5.8
	TDLF	73.6	106.8	116.0	89.5	53.2	33.5	16.7	4.8
12	NLF	78.9	110.7	121.4	97.5	68.6	46.8	24.6	6.6
	SDLF	72.8	102.1	110.4	86.1	55.7	36.7	18.5	4.7
	TDLF	67.9	95.7	102.4	78.2	47.8	30.5	14.7	3.9
13	NLF	71.9	94.1	107.2	90.7	57.8	40.1	21.3	4.7
	SDLF	66.7	88.5	96.7	77.1	46.6	31.0	15.8	3.3
	TDLF	62.7	85.0	90.0	68.8	40.5	26.1	12.9	2.5
14	NLF	61.2	75.4	86.8	75.0	41.9	28.8	15.0	2.5
	SDLF	58.3	70.3	77.8	63.7	34.0	22.8	11.5	1.4
	TDLF	56.1	67.5	73.1	57.7	30.1	20.1	10.0	0.1
15	NLF	48.6	53.6	61.5	53.5	22.0	14.8	7.8	0.2
	SDLF	46.1	49.5	55.3	45.9	18.4	12.5	6.2	1.6
	TDLF	44.5	47.6	52.7	42.3	16.2	12.0	5.0	2.5
16	NLF	34.5	27.8	32.0	28.4	5.8	4.9	1.4	NA
	SDLF	32.5	26.0	29.5	24.7	1.8	1.9	1.5	NA
	TDLF	31.3	25.4	29.4	22.7	6.9	6.8	2.6	NA
17	NLF	18.3	14.5	9.8	5.1	NA	NA	NA	NA
	SDLF	17.1	2.7	2.6	1.7	NA	NA	NA	NA
	TDLF	16.1	15.2	12.4	6.4	NA	NA	NA	NA
18	NLF	15.4	NA	NA	NA	NA	NA	NA	NA
	SDLF	2.7	NA	NA	NA	NA	NA	NA	NA
	TDLF	15.2	NA	NA	NA	NA	NA	NA	NA

Table R2-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	15.0	11.9	8.5	8.6	16.0	12.7	3.0	26.4
	SDLF	0.0	3.9	6.6	10.3	16.1	9.3	6.4	10.3
	TDLF	8.3	12.7	15.5	13.6	17.4	23.6	16.4	4.3
2	NLF	9.5	243.0	291.5	150.0	657.5	564.4	252.9	207.0
	SDLF	7.8	196.4	220.1	109.0	396.9	324.9	143.1	123.0
	TDLF	8.5	169.7	173.5	79.7	220.3	159.1	64.6	65.6
3	NLF	94.0	229.9	402.9	567.9	518.1	507.0	437.6	84.4
	SDLF	84.2	194.3	302.5	373.0	372.1	343.7	273.1	81.0
	TDLF	79.7	169.2	234.4	242.9	274.6	234.3	163.3	78.2
4	NLF	97.0	237.8	362.8	466.6	320.5	274.2	190.4	22.5
	SDLF	94.7	210.8	296.1	354.8	296.6	254.5	180.5	38.2
	TDLF	92.5	192.9	252.0	280.7	280.3	240.7	173.1	48.8
5	NLF	99.0	206.2	296.6	322.8	186.7	131.8	61.5	7.0
	SDLF	93.7	195.9	276.5	298.8	222.9	174.4	100.4	18.6
	TDLF	89.8	189.1	263.3	282.5	246.1	202.1	125.8	26.3
6	NLF	123.0	214.7	257.4	229.8	128.6	73.3	22.7	6.2
	SDLF	118.5	212.1	264.4	253.0	172.5	117.9	55.7	11.5
	TDLF	115.2	209.7	268.1	267.3	200.3	146.8	77.3	14.8
7	NLF	123.6	218.9	239.7	184.5	115.0	61.8	19.1	7.9
	SDLF	118.1	216.6	252.3	216.4	143.4	89.1	36.7	9.2
	TDLF	113.7	213.8	258.9	236.0	160.2	105.9	47.7	9.7
8	NLF	142.0	220.1	237.0	177.4	119.9	68.3	25.5	9.8
	SDLF	133.5	216.8	243.9	197.7	128.3	76.5	30.4	8.7
	TDLF	126.9	213.2	246.4	208.9	131.7	80.4	32.7	7.7
9	NLF	147.4	221.2	239.1	181.6	127.1	77.2	32.5	11.3
	SDLF	138.0	213.3	235.6	185.4	120.1	72.5	29.7	8.8
	TDLF	130.8	206.6	231.3	185.5	113.6	67.9	27.1	7.0
10	NLF	149.6	220.4	238.9	184.3	129.7	83.5	38.1	12.1
	SDLF	138.8	207.3	225.6	174.4	114.1	71.3	31.0	8.9
	TDLF	130.6	197.5	215.0	165.8	102.7	62.4	25.8	6.8

Table R2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	148.5	216.7	233.0	180.2	128.9	86.2	40.7	11.6
	SDLF	136.2	198.1	212.7	162.5	108.1	69.7	31.7	8.4
	TDLF	127.2	184.8	198.0	149.8	94.1	58.6	25.7	6.4
12	NLF	143.5	199.6	218.0	173.2	117.6	78.4	39.8	10.4
	SDLF	129.7	180.9	195.1	151.0	97.8	63.4	30.6	7.1
	TDLF	119.9	168.1	179.5	136.2	85.4	54.0	24.7	5.4
13	NLF	129.5	167.8	189.6	158.0	99.0	67.4	34.8	7.5
	SDLF	118.1	154.6	169.9	136.1	81.7	53.8	26.4	5.1
	TDLF	110.1	146.1	157.5	122.3	71.5	45.8	21.5	3.7
14	NLF	109.2	133.8	152.6	130.1	71.2	48.3	24.5	4.5
	SDLF	101.7	122.9	136.6	111.9	59.4	39.2	18.9	2.8
	TDLF	96.6	116.4	127.1	101.2	52.4	34.2	16.0	1.3
15	NLF	86.3	94.6	107.3	92.1	37.8	25.6	13.4	1.2
	SDLF	80.6	87.1	96.8	80.0	32.3	21.8	10.7	0.8
	TDLF	76.9	82.6	90.9	73.0	28.2	19.5	8.8	2.6
16	NLF	60.9	49.7	56.2	48.8	9.6	6.1	1.8	NA
	SDLF	57.1	46.4	52.0	43.1	1.8	0.3	1.5	NA
	TDLF	54.6	43.9	49.2	38.9	2.8	3.9	3.1	NA
17	NLF	32.7	24.0	16.1	9.4	NA	NA	NA	NA
	SDLF	30.6	6.2	2.8	1.9	NA	NA	NA	NA
	TDLF	28.9	5.1	5.0	2.5	NA	NA	NA	NA
18	NLF	26.2	NA	NA	NA	NA	NA	NA	NA
	SDLF	7.6	NA	NA	NA	NA	NA	NA	NA
	TDLF	5.2	NA	NA	NA	NA	NA	NA	NA

Table R2-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	5.9	5.8	1.2	3.3	1.8	9.1	16.3	8.2
	SDLF	5.1	5.7	5.8	8.2	6.8	4.4	3.6	1.2
	TDLF	12.3	14.9	14.0	12.9	14.4	6.1	3.3	3.1
2	NLF	9.6	162.7	191.1	102.9	450.2	383.5	178.2	150.6
	SDLF	8.3	109.7	118.9	55.2	161.4	125.1	49.5	50.5
	TDLF	6.5	72.6	69.6	24.0	30.4	47.6	35.6	14.8
3	NLF	61.6	151.1	268.8	378.8	303.5	303.7	271.8	35.0
	SDLF	48.7	107.3	153.1	167.5	185.6	162.0	120.9	47.2
	TDLF	39.5	78.6	76.6	27.6	106.0	66.6	20.5	56.0
4	NLF	63.2	133.8	208.6	271.3	181.0	154.4	103.2	14.3
	SDLF	55.6	118.8	161.0	185.3	179.8	155.0	111.4	30.8
	TDLF	50.9	108.7	128.8	127.2	179.0	155.6	117.1	41.7
5	NLF	54.6	112.8	164.8	182.1	109.0	77.8	37.3	4.8
	SDLF	55.7	115.1	164.0	179.2	156.7	128.2	78.9	17.9
	TDLF	56.3	116.9	163.8	177.3	188.8	162.3	106.9	26.3
6	NLF	65.9	120.4	146.1	132.3	72.1	42.2	14.4	4.0
	SDLF	69.2	130.7	168.1	169.0	127.4	93.5	49.4	11.2
	TDLF	71.5	138.1	183.3	193.8	164.2	127.8	72.6	15.7
7	NLF	68.4	119.4	132.0	102.2	63.2	34.4	11.5	5.2
	SDLF	73.3	133.0	161.6	148.6	102.1	68.1	31.9	8.2
	TDLF	77.2	142.5	181.7	179.6	127.5	90.1	44.9	10.0
8	NLF	76.2	120.3	130.5	97.7	66.2	38.1	15.3	6.4
	SDLF	81.8	132.3	153.7	131.5	84.5	52.8	23.4	7.0
	TDLF	86.3	140.8	169.1	153.6	95.8	61.8	28.2	7.2
9	NLF	79.2	121.0	131.8	100.2	70.4	43.4	19.5	7.3
	SDLF	84.3	128.5	144.5	117.1	74.0	45.8	20.4	6.4
	TDLF	88.7	133.9	152.7	127.4	75.7	46.7	20.6	5.8
10	NLF	80.6	120.6	131.6	101.8	71.6	47.3	22.9	7.5
	SDLF	84.5	122.9	134.7	105.4	67.7	42.8	19.7	6.1
	TDLF	88.1	124.8	136.5	107.1	65.2	39.7	17.6	5.3

Table R2-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	80.0	117.5	127.0	98.5	72.2	48.8	24.2	7.9
	SDLF	82.4	115.5	124.4	95.7	62.7	40.6	19.5	5.4
	TDLF	84.9	114.5	123.0	94.0	57.0	35.8	16.8	4.1
12	NLF	76.8	110.8	121.5	96.6	69.1	47.7	25.4	6.2
	SDLF	77.9	105.0	112.9	87.3	55.8	36.9	18.4	4.5
	TDLF	79.4	101.5	107.9	82.0	48.5	30.7	14.4	3.8
13	NLF	71.7	94.4	108.4	91.3	57.2	39.7	21.0	3.9
	SDLF	71.3	89.1	97.6	77.5	46.9	31.3	15.9	3.2
	TDLF	71.5	86.5	91.6	69.9	41.9	27.1	13.6	3.0
14	NLF	60.9	74.7	86.4	74.4	40.5	27.8	14.1	2.0
	SDLF	60.6	71.4	79.1	64.3	34.5	23.2	11.7	1.9
	TDLF	60.9	70.2	75.7	59.6	32.0	21.7	11.1	1.2
15	NLF	48.1	52.2	60.3	52.0	21.5	14.3	7.3	2.9
	SDLF	48.7	50.5	56.3	46.5	18.9	13.1	6.7	1.1
	TDLF	49.4	50.4	55.4	44.5	17.5	13.5	6.2	6.4
16	NLF	33.6	27.3	32.0	28.0	4.9	2.7	3.9	NA
	SDLF	34.4	26.9	30.4	25.2	1.1	0.9	0.7	NA
	TDLF	35.2	27.4	31.0	23.8	7.2	4.8	6.6	NA
17	NLF	17.7	12.1	9.7	8.4	NA	NA	NA	NA
	SDLF	18.5	1.0	0.9	1.2	NA	NA	NA	NA
	TDLF	18.7	10.7	8.3	9.2	NA	NA	NA	NA
18	NLF	17.3	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.8	NA	NA	NA	NA	NA	NA	NA
	TDLF	14.1	NA	NA	NA	NA	NA	NA	NA

Table R2-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	6.1	0.4	11.1	12.2	5.9	29.3	31.9	12.4
	SDLF	2.3	5.8	9.2	11.5	7.0	11.9	13.4	5.0
	TDLF	7.1	8.7	9.3	12.6	11.0	7.4	5.0	1.1
2	NLF	20.4	282.8	326.3	176.0	769.5	649.5	301.5	262.8
	SDLF	17.5	219.2	242.2	120.1	445.6	364.8	159.9	145.8
	TDLF	14.0	173.6	184.7	84.1	229.6	174.1	66.9	70.7
3	NLF	108.2	258.6	460.9	647.3	502.2	506.5	459.5	54.5
	SDLF	92.0	205.1	325.3	407.3	370.7	347.9	288.9	65.8
	TDLF	79.8	170.8	236.0	247.9	282.2	241.2	175.5	74.0
4	NLF	109.5	226.2	349.4	450.3	301.2	255.2	168.9	24.4
	SDLF	98.9	207.1	293.6	353.1	289.6	246.6	171.2	38.5
	TDLF	92.5	194.3	256.2	287.7	282.0	241.3	173.1	47.9
5	NLF	93.9	196.0	281.3	305.9	187.0	132.5	62.7	8.2
	SDLF	93.7	191.8	271.6	292.7	224.2	174.5	99.2	19.3
	TDLF	93.7	189.1	265.2	284.0	249.9	203.8	124.4	26.6
6	NLF	117.0	215.0	257.4	229.2	127.8	74.7	24.8	6.6
	SDLF	116.7	215.5	267.2	254.3	173.0	118.4	55.4	11.8
	TDLF	116.5	216.8	274.9	272.0	204.2	148.5	76.2	15.1
7	NLF	124.2	216.6	237.2	182.0	115.3	62.5	20.1	8.5
	SDLF	123.3	218.3	253.2	216.3	143.7	88.9	36.1	9.3
	TDLF	123.5	220.7	265.3	240.4	163.3	106.9	46.7	9.8
8	NLF	139.9	221.2	238.9	178.0	121.4	69.4	26.5	10.3
	SDLF	137.8	219.3	246.3	198.4	128.7	76.3	29.8	8.6
	TDLF	137.7	219.6	252.5	212.9	133.9	81.0	32.0	7.6
9	NLF	146.7	223.4	242.7	183.8	127.8	77.6	33.2	11.7
	SDLF	142.8	216.2	238.8	186.5	120.5	72.2	29.2	8.7
	TDLF	141.7	213.0	237.4	188.9	116.1	68.9	26.7	6.8
10	NLF	149.7	222.1	241.7	185.8	128.0	83.5	38.6	12.0
	SDLF	144.0	210.0	228.4	175.4	113.8	71.2	30.6	8.6
	TDLF	141.9	203.6	220.8	169.2	105.5	63.7	25.7	6.7

Table R2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location							
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**	**G8-G9**
11	NLF	148.1	214.1	230.1	177.2	126.8	84.4	40.1	13.0
	SDLF	141.2	199.6	213.4	162.0	108.2	69.4	31.1	8.6
	TDLF	138.2	191.4	203.9	153.2	97.3	60.5	25.9	6.1
12	NLF	140.9	200.5	218.0	171.5	120.1	81.5	42.3	10.0
	SDLF	134.0	183.9	197.2	151.3	98.5	64.6	31.3	7.1
	TDLF	130.7	174.1	185.0	139.6	86.2	54.7	24.9	5.5
13	NLF	130.9	169.6	193.4	160.8	97.6	66.5	34.1	6.2
	SDLF	123.6	155.8	172.0	137.2	81.6	53.9	26.4	4.9
	TDLF	119.7	147.9	159.7	123.5	72.7	46.8	22.2	4.1
14	NLF	110.2	132.2	151.6	128.6	68.3	46.1	22.6	3.4
	SDLF	104.8	123.7	137.6	112.0	59.0	39.0	18.7	3.3
	TDLF	101.9	119.1	129.9	103.0	53.8	35.4	16.8	2.7
15	NLF	86.1	91.8	104.9	89.0	36.0	24.3	12.0	5.8
	SDLF	83.5	87.3	97.1	79.6	32.4	22.2	11.0	3.3
	TDLF	82.2	84.9	93.1	74.5	29.5	21.2	10.1	0.5
16	NLF	59.7	47.8	55.3	47.1	9.5	8.2	8.2	NA
	SDLF	59.0	46.7	52.6	43.2	4.6	5.2	5.2	NA
	TDLF	58.5	45.7	51.1	40.1	1.7	0.3	0.3	NA
17	NLF	31.4	21.6	17.8	13.8	NA	NA	NA	NA
	SDLF	31.8	9.5	8.8	6.0	NA	NA	NA	NA
	TDLF	31.5	1.8	1.1	2.1	NA	NA	NA	NA
18	NLF	29.5	NA	NA	NA	NA	NA	NA	NA
	SDLF	11.7	NA	NA	NA	NA	NA	NA	NA
	TDLF	1.5	NA	NA	NA	NA	NA	NA	NA

Table R2-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.88	0.99	0.92	0.86	0.91	0.79	0.69	0.88
	SDLF	0.76	0.88	0.78	0.67	0.72	0.57	0.42	0.60
	TDLF	0.67	0.81	0.68	0.54	0.60	0.41	0.24	0.41
3	NLF	1.02	1.15	1.10	1.04	1.12	1.05	0.98	1.20
	SDLF	0.94	1.08	1.00	0.89	0.95	0.83	0.73	0.95
	TDLF	0.88	1.03	0.92	0.79	0.84	0.68	0.56	0.78
4	NLF	1.16	1.30	1.26	1.20	1.30	1.26	1.22	1.41
	SDLF	1.11	1.25	1.18	1.08	1.15	1.06	0.99	1.20
	TDLF	1.08	1.22	1.11	0.99	1.04	0.92	0.82	1.05
5	NLF	1.31	1.42	1.39	1.35	1.43	1.41	1.40	1.52
	SDLF	1.28	1.39	1.32	1.23	1.29	1.23	1.20	1.35
	TDLF	1.26	1.37	1.27	1.15	1.19	1.10	1.05	1.23
6	NLF	1.45	1.53	1.49	1.46	1.52	1.51	1.51	1.57
	SDLF	1.43	1.50	1.43	1.35	1.39	1.35	1.34	1.42
	TDLF	1.42	1.48	1.37	1.27	1.29	1.23	1.21	1.32
7	NLF	1.55	1.60	1.57	1.54	1.57	1.56	1.56	1.56
	SDLF	1.55	1.57	1.50	1.44	1.44	1.42	1.41	1.43
	TDLF	1.54	1.56	1.45	1.36	1.35	1.31	1.30	1.34
8	NLF	1.63	1.64	1.61	1.58	1.56	1.55	1.55	1.50
	SDLF	1.63	1.61	1.54	1.48	1.45	1.43	1.43	1.39
	TDLF	1.63	1.59	1.49	1.41	1.36	1.33	1.33	1.30
9	NLF	1.67	1.63	1.60	1.58	1.51	1.50	1.50	1.40
	SDLF	1.67	1.61	1.54	1.48	1.40	1.39	1.38	1.29
	TDLF	1.67	1.59	1.49	1.41	1.33	1.30	1.30	1.22
10	NLF	1.67	1.58	1.55	1.52	1.41	1.40	1.39	1.25
	SDLF	1.66	1.56	1.49	1.44	1.32	1.30	1.29	1.16
	TDLF	1.67	1.54	1.45	1.38	1.25	1.22	1.22	1.09

Table R2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	1.61	1.48	1.45	1.43	1.26	1.25	1.25	1.06
	SDLF	1.61	1.46	1.40	1.35	1.18	1.17	1.16	0.98
	TDLF	1.62	1.44	1.36	1.30	1.12	1.10	1.10	0.93
12	NLF	1.51	1.34	1.30	1.28	1.08	1.07	1.06	0.84
	SDLF	1.52	1.32	1.26	1.22	1.01	0.99	0.98	0.78
	TDLF	1.52	1.31	1.23	1.17	0.96	0.94	0.93	0.73
13	NLF	1.36	1.14	1.12	1.09	0.85	0.84	0.84	0.58
	SDLF	1.37	1.13	1.09	1.04	0.80	0.79	0.78	0.54
	TDLF	1.38	1.12	1.06	1.01	0.75	0.74	0.74	0.51
14	NLF	1.17	0.91	0.89	0.87	0.59	0.59	0.58	0.31
	SDLF	1.18	0.90	0.86	0.83	0.56	0.55	0.54	0.28
	TDLF	1.18	0.89	0.85	0.80	0.52	0.52	0.52	0.26
15	NLF	0.92	0.63	0.62	0.60	0.31	0.31	0.30	0.00
	SDLF	0.93	0.63	0.60	0.58	0.29	0.29	0.28	0.00
	TDLF	0.94	0.62	0.59	0.56	0.27	0.27	0.27	0.00
16	NLF	0.64	0.33	0.32	0.32	0.00	0.00	0.00	NA
	SDLF	0.65	0.33	0.32	0.30	0.00	0.00	0.00	NA
	TDLF	0.66	0.33	0.31	0.30	0.00	0.00	0.00	NA
17	NLF	0.34	0.00	0.00	0.00	NA	NA	NA	NA
	SDLF	0.34	0.00	0.00	0.00	NA	NA	NA	NA
	TDLF	0.35	0.00	0.00	0.00	NA	NA	NA	NA
18	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table R2-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	1.52	1.70	1.59	1.48	1.57	1.37	1.21	1.52
	SDLF	1.36	1.56	1.41	1.26	1.35	1.12	0.91	1.20
	TDLF	1.25	1.46	1.28	1.11	1.20	0.94	0.71	0.99
3	NLF	1.75	1.97	1.89	1.78	1.93	1.80	1.68	2.06
	SDLF	1.63	1.85	1.73	1.59	1.71	1.54	1.39	1.75
	TDLF	1.55	1.77	1.63	1.46	1.56	1.36	1.19	1.54
4	NLF	1.99	2.22	2.15	2.06	2.22	2.14	2.09	2.40
	SDLF	1.89	2.11	2.01	1.88	2.00	1.89	1.80	2.12
	TDLF	1.83	2.04	1.91	1.76	1.86	1.71	1.60	1.93
5	NLF	2.24	2.43	2.38	2.30	2.44	2.40	2.39	2.58
	SDLF	2.15	2.33	2.24	2.12	2.22	2.15	2.11	2.33
	TDLF	2.09	2.26	2.14	1.99	2.08	1.98	1.92	2.16
6	NLF	2.47	2.61	2.54	2.49	2.59	2.57	2.57	2.66
	SDLF	2.38	2.50	2.40	2.31	2.37	2.33	2.32	2.43
	TDLF	2.33	2.43	2.30	2.18	2.22	2.16	2.14	2.27
7	NLF	2.65	2.73	2.66	2.62	2.65	2.64	2.65	2.64
	SDLF	2.56	2.61	2.51	2.43	2.45	2.42	2.42	2.43
	TDLF	2.51	2.54	2.41	2.30	2.30	2.26	2.25	2.28
8	NLF	2.78	2.79	2.73	2.68	2.64	2.63	2.63	2.54
	SDLF	2.69	2.67	2.57	2.50	2.44	2.42	2.42	2.34
	TDLF	2.63	2.59	2.47	2.37	2.30	2.27	2.27	2.21
9	NLF	2.85	2.78	2.72	2.67	2.55	2.53	2.53	2.36
	SDLF	2.75	2.65	2.56	2.49	2.36	2.34	2.34	2.18
	TDLF	2.69	2.58	2.46	2.36	2.23	2.20	2.20	2.06
10	NLF	2.83	2.69	2.63	2.58	2.38	2.36	2.36	2.11
	SDLF	2.74	2.57	2.48	2.41	2.21	2.18	2.18	1.95
	TDLF	2.68	2.49	2.38	2.29	2.09	2.06	2.05	1.84

Table R2-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location							
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	2.74	2.51	2.45	2.41	2.13	2.11	2.11	1.79
	SDLF	2.65	2.40	2.31	2.25	1.98	1.96	1.95	1.66
	TDLF	2.59	2.33	2.22	2.15	1.87	1.85	1.84	1.56
12	NLF	2.57	2.26	2.20	2.16	1.82	1.80	1.79	1.41
	SDLF	2.48	2.17	2.09	2.03	1.69	1.67	1.66	1.31
	TDLF	2.43	2.10	2.00	1.93	1.60	1.58	1.57	1.23
13	NLF	2.31	1.93	1.89	1.85	1.44	1.42	1.41	0.98
	SDLF	2.24	1.85	1.79	1.73	1.33	1.32	1.31	0.91
	TDLF	2.19	1.80	1.72	1.66	1.26	1.24	1.24	0.85
14	NLF	1.97	1.53	1.49	1.46	1.00	0.99	0.98	0.52
	SDLF	1.91	1.47	1.42	1.37	0.93	0.92	0.91	0.48
	TDLF	1.88	1.43	1.37	1.31	0.88	0.86	0.86	0.45
15	NLF	1.56	1.07	1.04	1.02	0.52	0.52	0.52	0.00
	SDLF	1.52	1.02	0.99	0.96	0.49	0.48	0.48	0.00
	TDLF	1.49	1.00	0.96	0.92	0.46	0.45	0.45	0.00
16	NLF	1.09	0.56	0.55	0.53	0.00	0.00	0.00	NA
	SDLF	1.06	0.54	0.52	0.50	0.00	0.00	0.00	NA
	TDLF	1.04	0.52	0.50	0.48	0.00	0.00	0.00	NA
17	NLF	0.57	0.00	0.00	0.00	NA	NA	NA	NA
	SDLF	0.56	0.00	0.00	0.00	NA	NA	NA	NA
	TDLF	0.55	0.00	0.00	0.00	NA	NA	NA	NA
18	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table R2-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	1.08	1.21	1.13	1.05	1.12	0.97	0.85	1.08
	SDLF	0.93	1.08	0.95	0.82	0.89	0.70	0.52	0.73
	TDLF	0.82	1.00	0.83	0.66	0.73	0.51	0.30	0.50
3	NLF	1.25	1.40	1.35	1.27	1.38	1.28	1.20	1.48
	SDLF	1.15	1.32	1.22	1.09	1.17	1.02	0.90	1.16
	TDLF	1.08	1.26	1.12	0.97	1.03	0.84	0.68	0.95
4	NLF	1.43	1.59	1.54	1.47	1.59	1.54	1.50	1.72
	SDLF	1.37	1.53	1.44	1.33	1.40	1.29	1.21	1.47
	TDLF	1.32	1.50	1.37	1.21	1.27	1.12	1.01	1.29
5	NLF	1.61	1.74	1.71	1.65	1.75	1.73	1.72	1.86
	SDLF	1.57	1.70	1.62	1.51	1.58	1.51	1.47	1.65
	TDLF	1.55	1.68	1.56	1.41	1.45	1.35	1.28	1.50
6	NLF	1.77	1.87	1.83	1.79	1.87	1.85	1.86	1.92
	SDLF	1.75	1.84	1.75	1.66	1.70	1.66	1.64	1.74
	TDLF	1.74	1.82	1.68	1.56	1.58	1.51	1.48	1.61
7	NLF	1.90	1.96	1.92	1.89	1.92	1.91	1.91	1.91
	SDLF	1.90	1.93	1.84	1.76	1.76	1.74	1.73	1.75
	TDLF	1.89	1.91	1.77	1.67	1.65	1.60	1.60	1.64
8	NLF	2.00	2.01	1.97	1.94	1.91	1.90	1.90	1.84
	SDLF	1.99	1.97	1.89	1.81	1.77	1.75	1.75	1.70
	TDLF	2.00	1.95	1.83	1.72	1.67	1.63	1.63	1.60
9	NLF	2.05	2.00	1.96	1.93	1.85	1.84	1.83	1.71
	SDLF	2.04	1.97	1.89	1.82	1.72	1.70	1.70	1.59
	TDLF	2.05	1.94	1.83	1.73	1.62	1.59	1.59	1.49
10	NLF	2.04	1.94	1.90	1.87	1.73	1.71	1.71	1.53
	SDLF	2.04	1.91	1.83	1.76	1.61	1.59	1.58	1.42
	TDLF	2.04	1.88	1.77	1.69	1.53	1.50	1.49	1.34

Table R2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	1.98	1.82	1.77	1.75	1.55	1.53	1.53	1.30
	SDLF	1.98	1.79	1.71	1.65	1.45	1.43	1.42	1.21
	TDLF	1.98	1.77	1.66	1.59	1.37	1.35	1.34	1.14
12	NLF	1.85	1.64	1.60	1.57	1.32	1.31	1.30	1.03
	SDLF	1.86	1.62	1.54	1.49	1.24	1.22	1.21	0.95
	TDLF	1.87	1.60	1.51	1.44	1.17	1.15	1.14	0.89
13	NLF	1.67	1.40	1.37	1.34	1.04	1.03	1.02	0.71
	SDLF	1.68	1.39	1.33	1.28	0.98	0.96	0.95	0.66
	TDLF	1.69	1.37	1.30	1.23	0.92	0.91	0.90	0.62
14	NLF	1.43	1.11	1.08	1.06	0.73	0.72	0.71	0.37
	SDLF	1.44	1.10	1.06	1.01	0.68	0.67	0.66	0.35
	TDLF	1.45	1.09	1.04	0.98	0.64	0.63	0.63	0.32
15	NLF	1.13	0.77	0.76	0.74	0.38	0.38	0.37	0.00
	SDLF	1.14	0.77	0.74	0.71	0.36	0.35	0.35	0.00
	TDLF	1.15	0.76	0.72	0.69	0.33	0.33	0.33	0.00
16	NLF	0.79	0.41	0.40	0.39	0.00	0.00	0.00	NA
	SDLF	0.80	0.40	0.39	0.37	0.00	0.00	0.00	NA
	TDLF	0.81	0.40	0.38	0.36	0.00	0.00	0.00	NA
17	NLF	0.41	0.00	0.00	0.00	NA	NA	NA	NA
	SDLF	0.42	0.00	0.00	0.00	NA	NA	NA	NA
	TDLF	0.43	0.00	0.00	0.00	NA	NA	NA	NA
18	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table R2-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	1.86	2.08	1.95	1.82	1.93	1.68	1.48	1.86
	SDLF	1.67	1.91	1.72	1.54	1.65	1.37	1.12	1.47
	TDLF	1.53	1.79	1.57	1.35	1.46	1.16	0.87	1.21
3	NLF	2.14	2.41	2.32	2.18	2.36	2.20	2.06	2.53
	SDLF	1.99	2.26	2.13	1.95	2.09	1.88	1.71	2.15
	TDLF	1.89	2.17	1.99	1.79	1.91	1.66	1.46	1.89
4	NLF	2.44	2.72	2.63	2.52	2.72	2.63	2.56	2.94
	SDLF	2.32	2.59	2.46	2.30	2.45	2.31	2.21	2.60
	TDLF	2.24	2.50	2.34	2.15	2.27	2.09	1.96	2.36
5	NLF	2.75	2.98	2.91	2.81	2.99	2.94	2.93	3.17
	SDLF	2.64	2.85	2.74	2.60	2.72	2.64	2.59	2.86
	TDLF	2.57	2.77	2.62	2.44	2.54	2.42	2.35	2.65
6	NLF	3.03	3.19	3.12	3.05	3.17	3.15	3.15	3.25
	SDLF	2.92	3.06	2.94	2.83	2.91	2.85	2.84	2.98
	TDLF	2.85	2.98	2.81	2.67	2.72	2.65	2.62	2.78
7	NLF	3.25	3.34	3.26	3.21	3.25	3.24	3.24	3.23
	SDLF	3.14	3.20	3.08	2.98	3.00	2.96	2.96	2.97
	TDLF	3.07	3.11	2.95	2.82	2.82	2.77	2.76	2.80
8	NLF	3.41	3.42	3.34	3.29	3.24	3.22	3.22	3.11
	SDLF	3.29	3.27	3.15	3.06	2.99	2.96	2.96	2.87
	TDLF	3.22	3.17	3.02	2.90	2.82	2.78	2.78	2.70
9	NLF	3.49	3.40	3.33	3.27	3.12	3.11	3.10	2.89
	SDLF	3.37	3.25	3.14	3.05	2.89	2.87	2.86	2.67
	TDLF	3.30	3.16	3.01	2.90	2.73	2.70	2.70	2.52
10	NLF	3.47	3.29	3.22	3.16	2.92	2.89	2.89	2.58
	SDLF	3.35	3.14	3.04	2.95	2.71	2.68	2.67	2.39
	TDLF	3.28	3.05	2.91	2.81	2.56	2.52	2.52	2.26

Table R2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location							
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	G8-G9
11	NLF	3.36	3.08	3.00	2.95	2.61	2.59	2.58	2.19
	SDLF	3.24	2.94	2.84	2.76	2.43	2.40	2.39	2.03
	TDLF	3.17	2.86	2.72	2.63	2.30	2.26	2.26	1.91
12	NLF	3.14	2.77	2.70	2.65	2.23	2.21	2.19	1.73
	SDLF	3.04	2.65	2.55	2.48	2.07	2.04	2.03	1.60
	TDLF	2.98	2.58	2.46	2.37	1.96	1.93	1.92	1.51
13	NLF	2.83	2.37	2.31	2.26	1.76	1.74	1.73	1.20
	SDLF	2.74	2.27	2.19	2.12	1.64	1.61	1.60	1.11
	TDLF	2.69	2.21	2.11	2.03	1.54	1.52	1.51	1.05
14	NLF	2.42	1.87	1.83	1.79	1.22	1.21	1.20	0.63
	SDLF	2.35	1.80	1.74	1.68	1.14	1.12	1.11	0.58
	TDLF	2.30	1.75	1.68	1.61	1.07	1.06	1.05	0.55
15	NLF	1.91	1.31	1.27	1.25	0.64	0.63	0.63	0.00
	SDLF	1.86	1.26	1.21	1.17	0.60	0.59	0.58	0.00
	TDLF	1.83	1.22	1.17	1.13	0.56	0.56	0.56	0.00
16	NLF	1.33	0.69	0.67	0.65	0.00	0.00	0.00	NA
	SDLF	1.30	0.66	0.64	0.62	0.00	0.00	0.00	NA
	TDLF	1.28	0.64	0.62	0.59	0.00	0.00	0.00	NA
17	NLF	0.70	0.00	0.00	0.00	NA	NA	NA	NA
	SDLF	0.68	0.00	0.00	0.00	NA	NA	NA	NA
	TDLF	0.67	0.00	0.00	0.00	NA	NA	NA	NA
18	NLF	0.00	NA	NA	NA	NA	NA	NA	NA
	SDLF	0.00	NA	NA	NA	NA	NA	NA	NA
	TDLF	0.00	NA	NA	NA	NA	NA	NA	NA

Table R2-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	334	512	573	871
	SDLF	403	518	642	865
	TDLF	447	522	686	862
G2	NLF	405	464	703	791
	SDLF	431	461	716	778
	TDLF	454	453	729	770
G3	NLF	470	398	790	693
	SDLF	464	409	783	698
	TDLF	453	422	777	699
G4	NLF	383	259	656	452
	SDLF	337	247	603	439
	TDLF	302	243	564	431
G5	NLF	222	217	417	376
	SDLF	173	206	347	366
	TDLF	154	190	314	359
G6	NLF	334	167	562	309
	SDLF	237	172	473	315
	TDLF	164	180	403	319
G7	NLF	295	112	493	213
	SDLF	200	112	410	216
	TDLF	127	116	341	219
G8	NLF	-77	86	-82	158
	SDLF	-6	79	-20	163
	TDLF	55	64	37	162
G9	NLF	-258	29	-427	73
	SDLF	-126	36	-259	86
	TDLF	-40	45	-148	97

Table R2-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-5.4	NA	-13.8	NA
	SDLF	-1.0	NA	-5.7	NA
	TDLF	1.5	NA	-1.3	NA
G2	NLF	-4.0	NA	-10.5	NA
	SDLF	-0.9	NA	-4.6	NA
	TDLF	1.1	NA	-1.1	NA
G3	NLF	-3.0	NA	-8.8	NA
	SDLF	-0.6	NA	-4.1	NA
	TDLF	1.1	NA	-0.7	NA
G4	NLF	-1.3	NA	-4.1	NA
	SDLF	-0.3	NA	-2.1	NA
	TDLF	0.6	NA	-0.2	NA
G5	NLF	0.4	NA	1.2	NA
	SDLF	0.0	NA	0.3	NA
	TDLF	-0.3	NA	-0.1	NA
G6	NLF	0.7	NA	1.3	NA
	SDLF	0.2	NA	0.6	NA
	TDLF	-0.2	NA	0.4	NA
G7	NLF	2.4	NA	6.2	NA
	SDLF	0.6	NA	2.9	NA
	TDLF	-0.8	NA	0.8	NA
G8	NLF	5.7	NA	15.9	NA
	SDLF	1.1	NA	7.0	NA
	TDLF	-1.9	NA	1.1	NA
G9	NLF	5.5	NA	15.5	NA
	SDLF	1.2	NA	6.9	NA
	TDLF	-1.4	NA	1.2	NA

Table R2-4-13. Individual support transverse reactions under SDL and TDL (kips).

		Load Type & Support Number			
Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-3.2	-0.4	-8.3	-1.2
	SDLF	0.4	0.0	-2.4	-0.5
	TDLF	2.7	0.2	1.1	0.0
G2	NLF	-2.4	-0.4	-6.3	-1.2
	SDLF	0.4	0.0	-1.8	-0.5
	TDLF	2.2	0.2	0.9	0.0
G3	NLF	-1.8	-0.4	-5.3	-1.3
	SDLF	0.3	0.0	-1.8	-0.5
	TDLF	1.9	0.2	0.8	0.0
G4	NLF	-0.6	-0.5	-2.1	-1.3
	SDLF	0.3	0.0	-0.6	-0.5
	TDLF	1.1	0.2	0.7	0.0
G5	NLF	0.6	-0.5	1.6	-1.2
	SDLF	0.2	0.0	0.7	-0.5
	TDLF	-0.1	0.2	0.2	0.0
G6	NLF	0.8	-0.5	1.7	-1.3
	SDLF	0.0	0.0	0.6	-0.5
	TDLF	-0.6	0.2	0.0	0.0
G7	NLF	2.0	-0.5	5.4	-1.2
	SDLF	-0.1	0.0	2.0	-0.5
	TDLF	-1.6	0.2	-0.3	0.0
G8	NLF	4.5	-0.5	12.7	-1.2
	SDLF	-0.2	0.0	4.5	-0.5
	TDLF	-3.4	0.2	-1.0	0.0
G9	NLF	4.5	-0.5	12.8	-1.2
	SDLF	-0.8	-0.1	3.8	-0.5
	TDLF	-4.3	0.2	-2.1	-0.1

Table R2-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	-1.07	-0.25	-2.76	-3.04
	SDLF	-0.20	1.52	-1.15	0.46
	TDLF	0.29	2.80	-0.26	2.89
G2	NLF	-0.80	-0.18	-2.10	-2.70
	SDLF	-0.17	1.35	-0.91	0.40
	TDLF	0.22	2.47	-0.22	2.58
G3	NLF	-0.61	-0.20	-1.77	-2.71
	SDLF	-0.13	1.18	-0.82	0.18
	TDLF	0.22	2.22	-0.13	2.30
G4	NLF	-0.25	-0.07	-0.82	-2.13
	SDLF	-0.06	1.03	-0.41	0.25
	TDLF	0.12	1.87	-0.04	2.02
G5	NLF	0.09	0.04	0.24	-1.44
	SDLF	-0.01	0.86	0.07	0.39
	TDLF	-0.06	1.44	-0.02	1.66
G6	NLF	0.15	-0.12	0.26	-1.76
	SDLF	0.05	0.70	0.13	0.13
	TDLF	-0.04	1.23	0.09	1.41
G7	NLF	0.47	-0.01	1.24	-1.12
	SDLF	0.11	0.56	0.58	0.26
	TDLF	-0.15	0.90	0.16	1.15
G8	NLF	1.15	0.38	3.18	0.37
	SDLF	0.21	0.40	1.40	0.65
	TDLF	-0.38	0.41	0.22	0.79
G9	NLF	1.10	0.03	3.11	-0.20
	SDLF	0.24	0.14	1.38	0.17
	TDLF	-0.29	0.22	0.25	0.35

Table R2-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number SDL 1	SDL 2	TDL 1	TDL 2
G1	NLF	-0.64	-0.09	-1.66	-0.24
	SDLF	0.09	-0.01	-0.47	-0.10
	TDLF	0.55	0.04	0.22	-0.01
G2	NLF	-0.48	-0.09	-1.25	-0.25
	SDLF	0.08	-0.01	-0.36	-0.10
	TDLF	0.44	0.04	0.18	0.00
G3	NLF	-0.35	-0.09	-1.05	-0.25
	SDLF	0.06	-0.01	-0.35	-0.10
	TDLF	0.37	0.04	0.16	0.00
G4	NLF	-0.12	-0.09	-0.42	-0.25
	SDLF	0.06	-0.01	-0.13	-0.10
	TDLF	0.21	0.05	0.14	0.00
G5	NLF	0.11	-0.09	0.32	-0.25
	SDLF	0.03	-0.01	0.14	-0.10
	TDLF	-0.02	0.05	0.04	0.00
G6	NLF	0.17	-0.09	0.35	-0.25
	SDLF	0.01	-0.01	0.12	-0.10
	TDLF	-0.12	0.05	0.00	0.00
G7	NLF	0.40	-0.09	1.07	-0.25
	SDLF	-0.01	-0.01	0.39	-0.10
	TDLF	-0.31	0.05	-0.06	0.00
G8	NLF	0.91	-0.09	2.55	-0.24
	SDLF	-0.05	-0.01	0.89	-0.10
	TDLF	-0.68	0.05	-0.20	0.00
G9	NLF	0.89	-0.09	2.55	-0.24
	SDLF	-0.17	-0.01	0.76	-0.10
	TDLF	-0.85	0.04	-0.42	-0.01

Appendix S-1. XICCS7 Bridge Description

The key characteristics of XICCS7 are as follows:

- Span length along the centerline of the bridge, L_s = 160, 210, 160 ft.
- Width between the fascia girders, w_g = 33 ft.
- Radius of curvature to the centerline of the bridge, R =700 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 4.8, 6.4, 4.8
- Subtended angle between the supports, L_s/R = 0.23, 0.30, 0.23
- Number of girders in the completed bridge cross-section, n_g =4.
- Skew angle, θ = 0, 60, 60, 0°

This appendix presents the bridge description of the bridge XICCS7 in its final condition as well as during erection. The following figures and tables are provided:

Figure S-1-1.	Framing plan
Figure S-1-2.	Bridge cross-section and Cross-frame details
Figure S-1-3.	Girder Elevation
Figure S-1-4.	Erection scheme
Table S-1-1.	Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed NLF

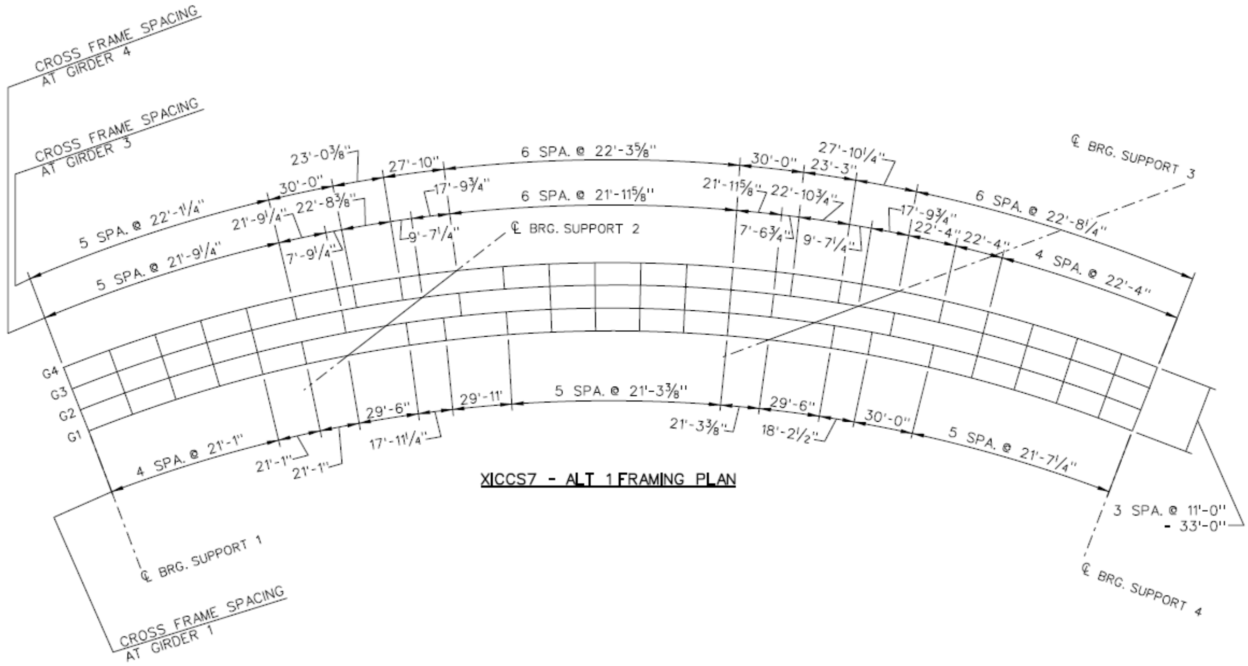


Figure S-1-1. Framing plan.

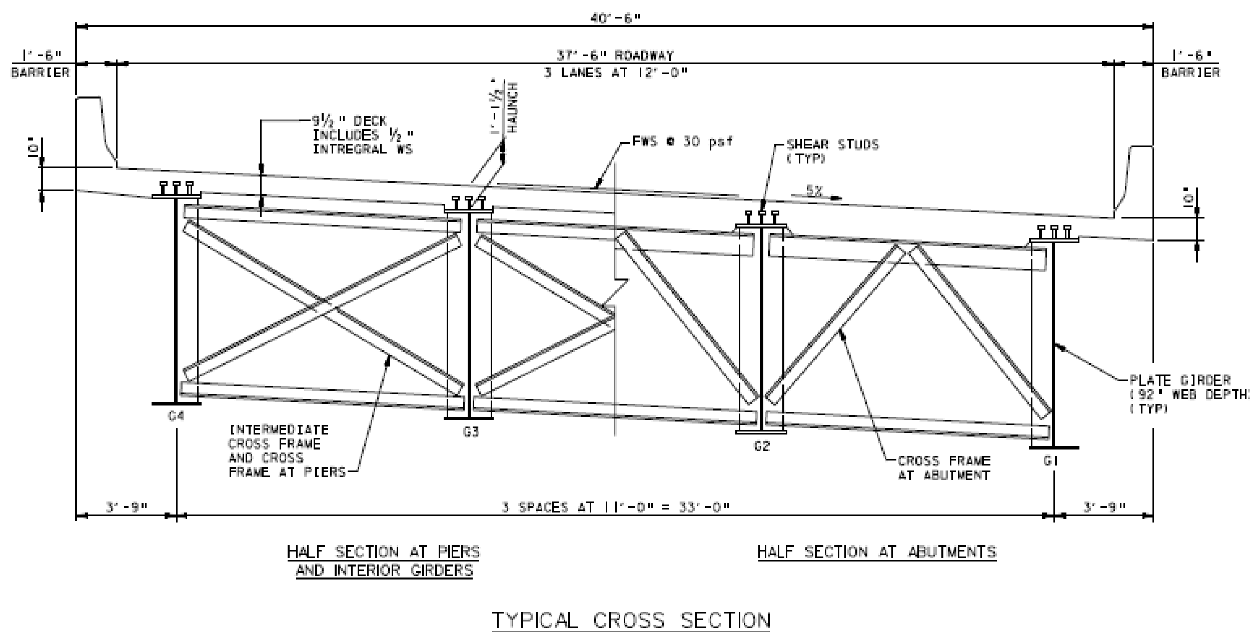


Figure S-1-2. Bridge cross-section and cross-frame details.

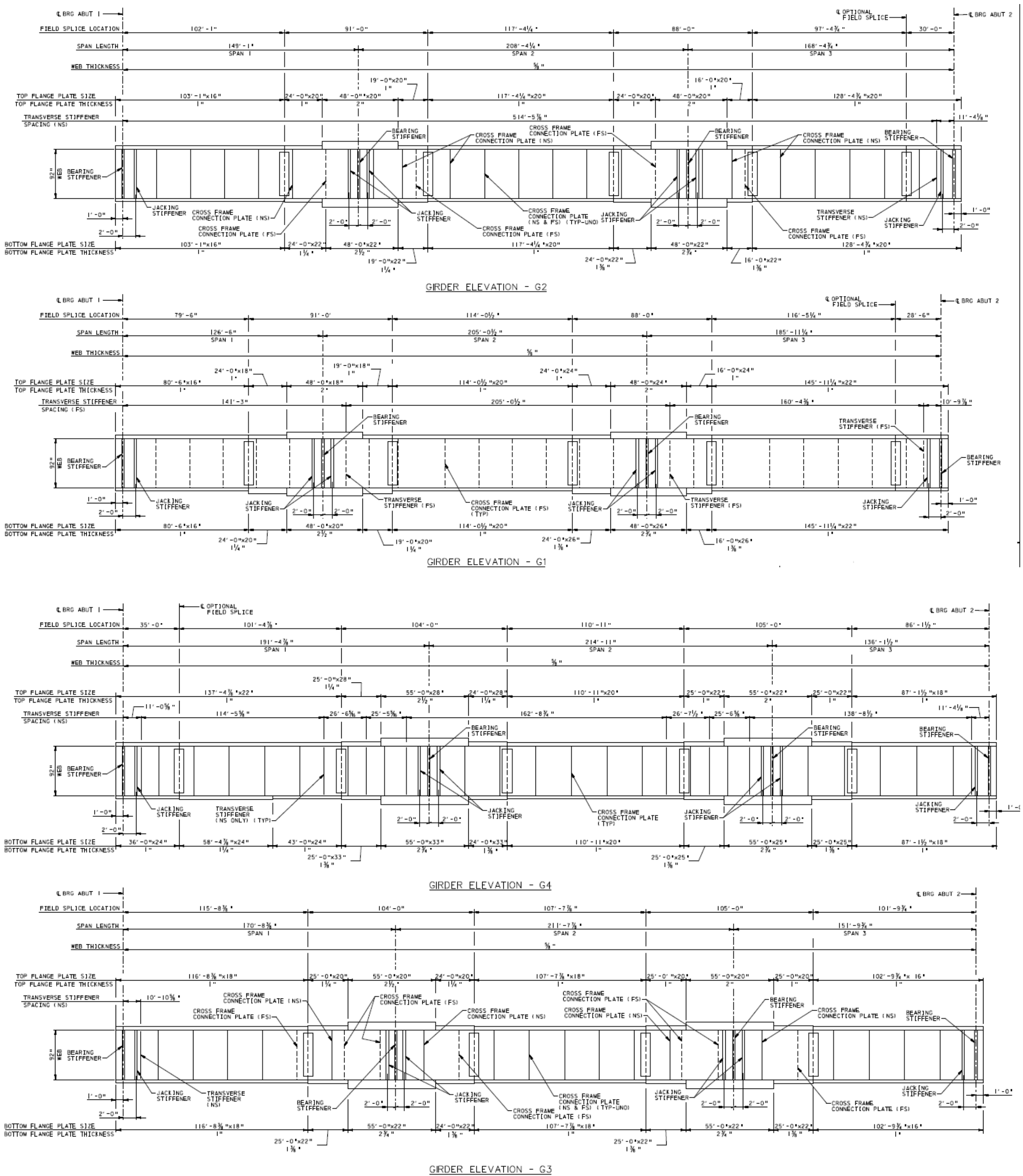
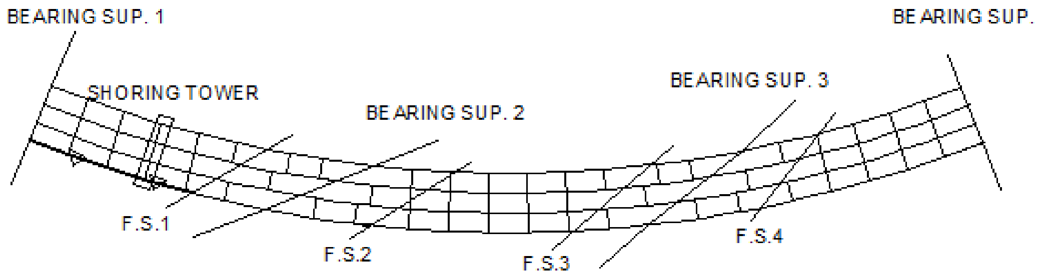
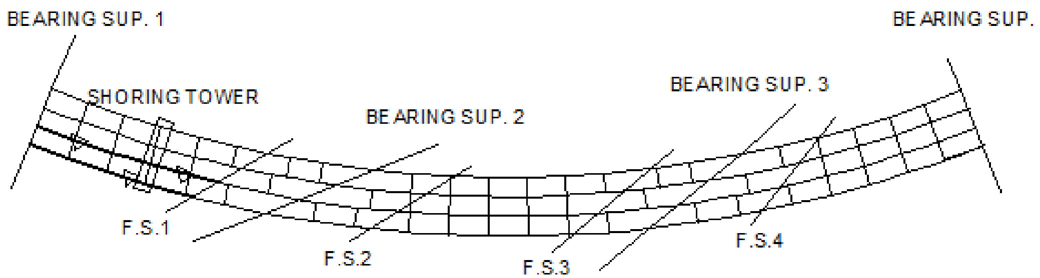


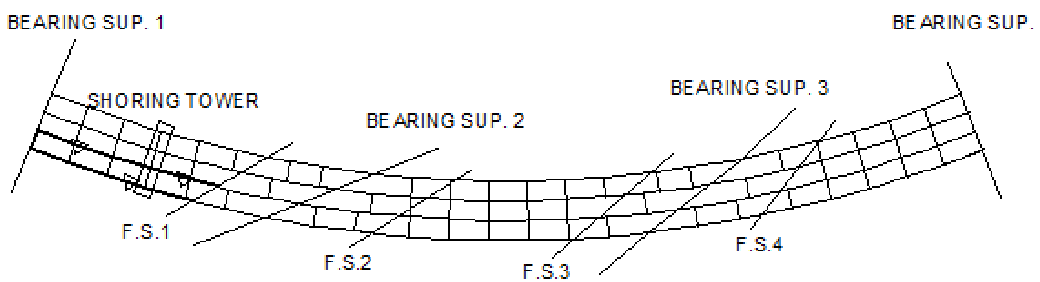
Figure S-1-3. Girder elevations



STAGE 1

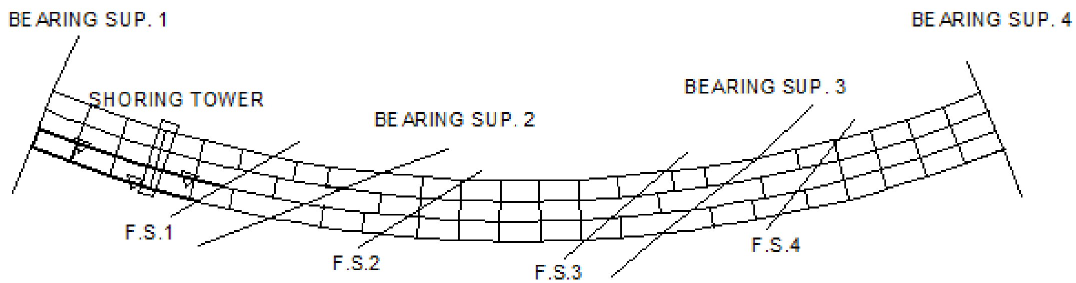


STAGE 2-1

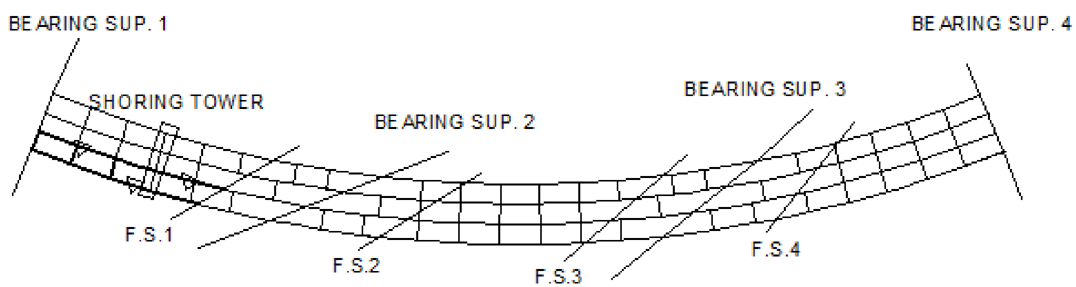


STAGE 2-2

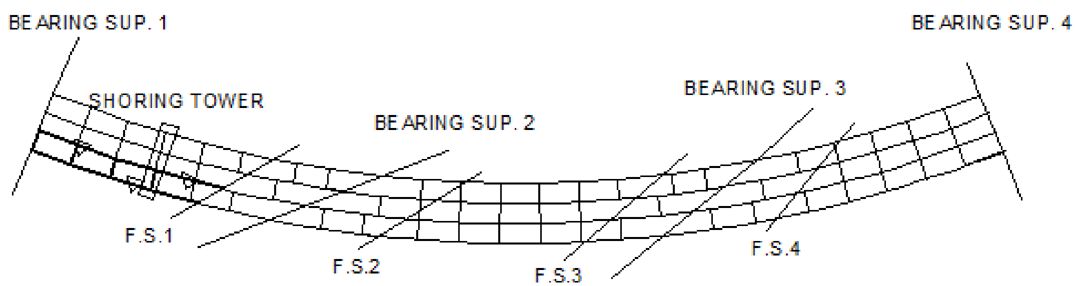
Figure S-1-4. Erection scheme



STAGE 2-3

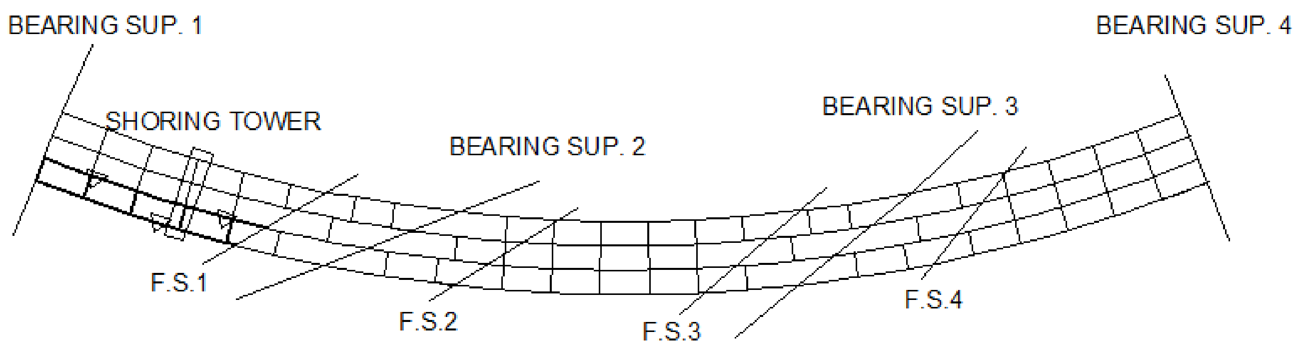


STAGE 2-4



STAGE 2-5

Figure S-1-6(Continued). Erection scheme

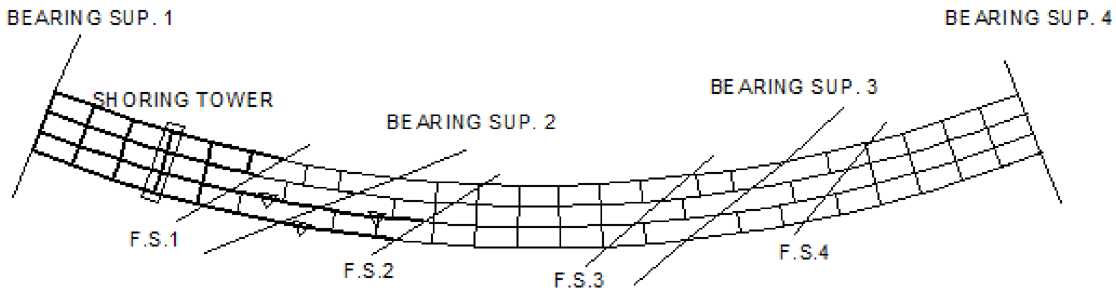


STAGE 2-6

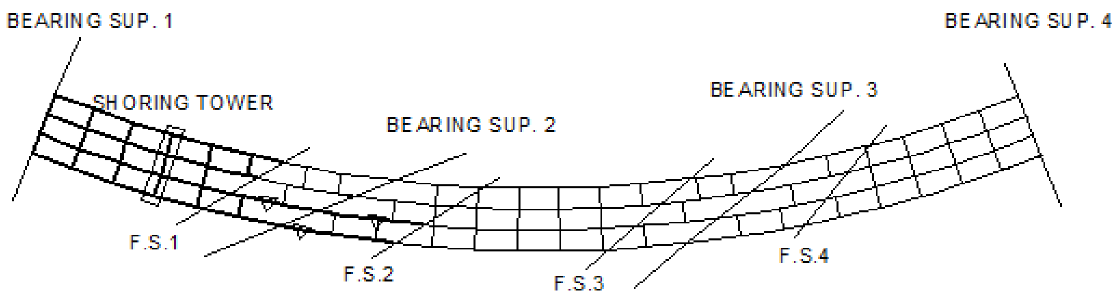
REPEAT THE SEQUENCE
FOR G3 TO G4

THE HOLDING CRANE IS ON G1
UNTIL ALL GIRDERS ARE
ERECTED

Figure S-1-6(Continued). Erection scheme



STAGE 6-1



STAGE 6-2

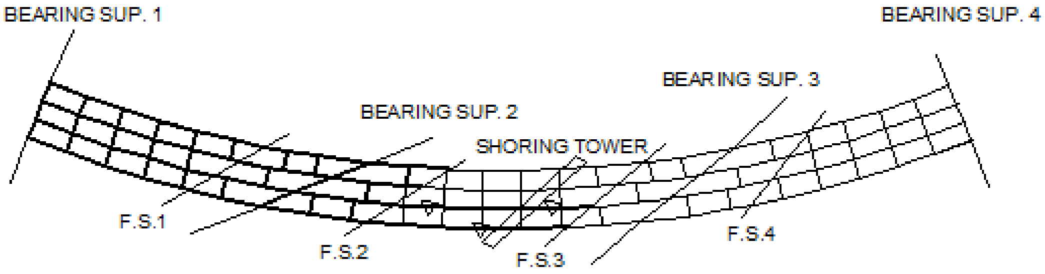
INSTALL THE REMAINING CFS FOR STAGE 6

REPEAT THE SEQUENCE FOR G3 TO G4

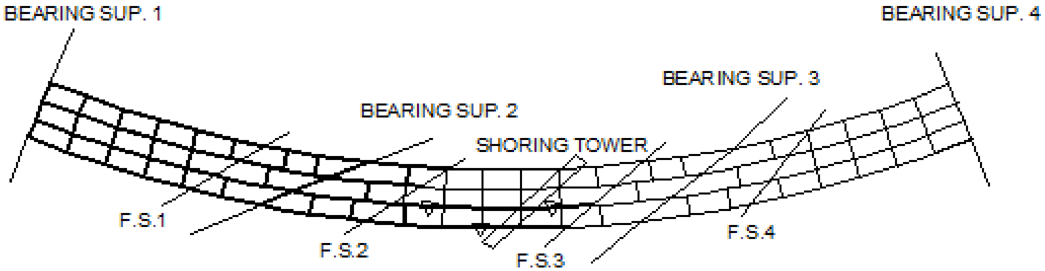
THE HOLDING CRANE IS ON G1 UNTIL ALL GIRDERS ARE ERECTED

REMOVE THE SHORING TOWER AFTER STAGE 8

Figure S-1-6(Continued). Erection scheme



STAGE 10-1



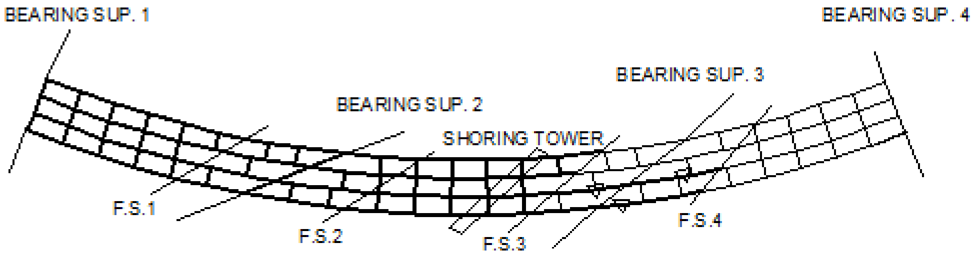
STAGE 10-2

INSTALL THE REMAINING CFS FOR STAGE 10

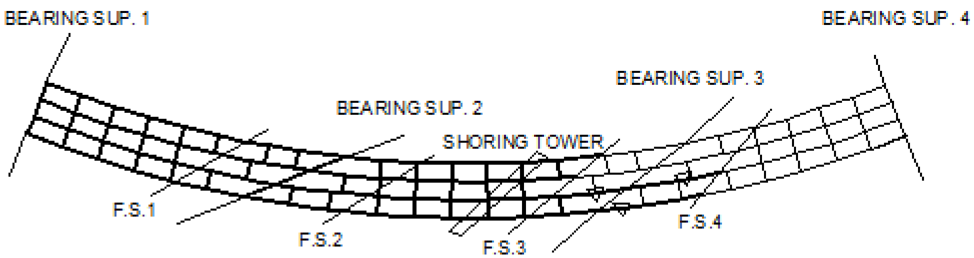
REPEAT THE SEQUENCE FOR G3 TO G4

THE HOLDING CRANE IS ON G1 UNTIL ALL GIRDERS ARE ERECTED

Figure S-1-6(Continued). Erection scheme



STAGE 14-1



STAGE 14-2

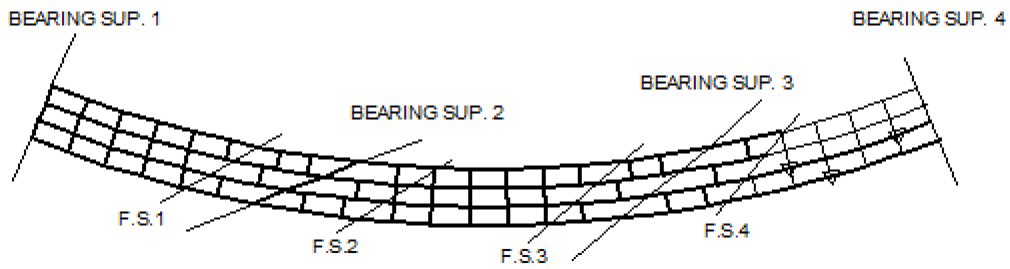
INSTALL THE REMAINING CFS FOR STAGE 14

REPEAT THE SEQUENCE FOR G3 TO G4

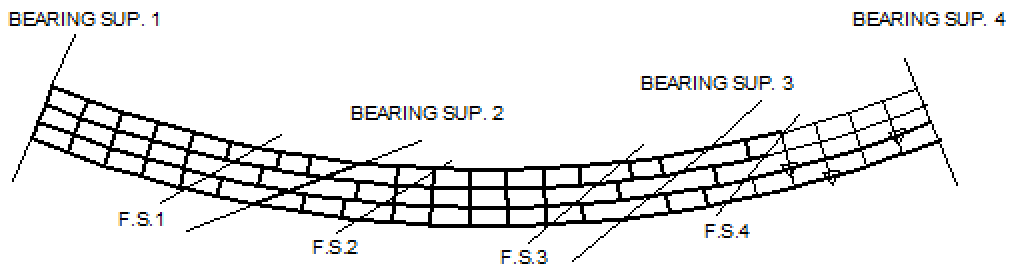
THE HOLDING CRANE IS ON G1 UNTIL ALL GIRDERS ARE ERECTED

REMOVE THE SHORING TOWER AFTER STAGE 16

Figure S-1-6(Continued). Erection scheme



STAGE 18-1



STAGE 18-2

INSTALL THE REMAINING CFS FOR STAGE 18

REPEAT THE SEQUENCE FOR G3 TO G4

THE HOLDING CRANE IS ON G1 UNTIL ALL GIRDERS ARE ERECTED

Figure S-1-6(Continued). Erection scheme

Table S-1-1. Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

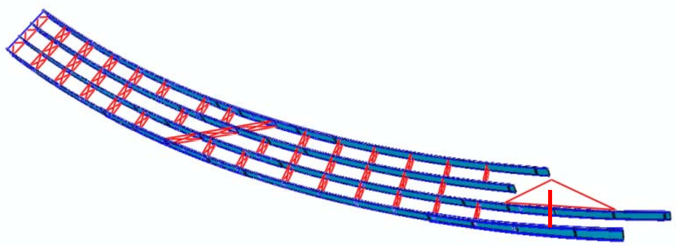
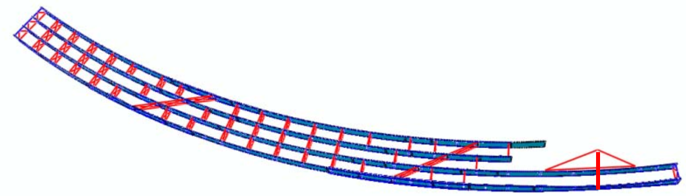
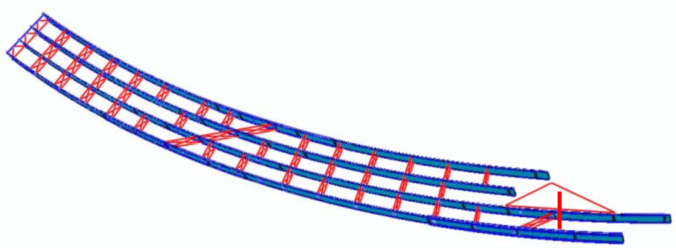
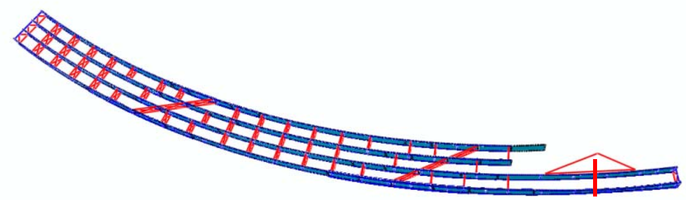
Sub-Stage	Stage	
	14	18
1		
2		

Table S-1-1(Continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

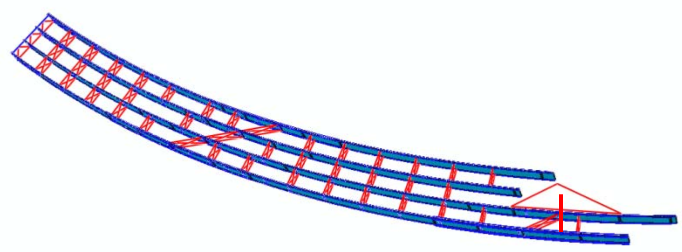
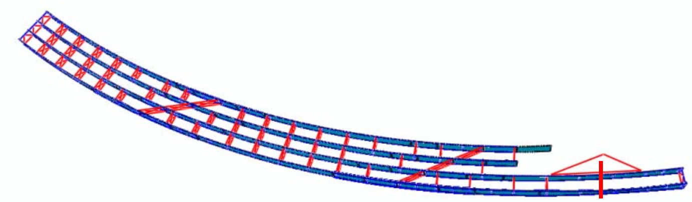
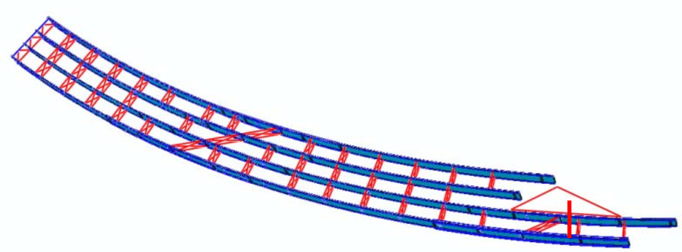
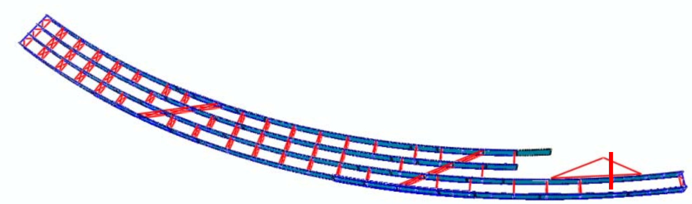
3		
4		

Table S-1-1(Continued). Three-dimensional view of erection method 1 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

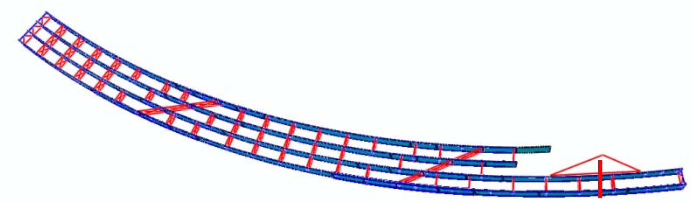
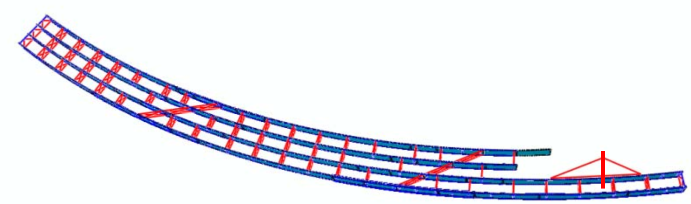
5		
6		

Table S-1-1 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

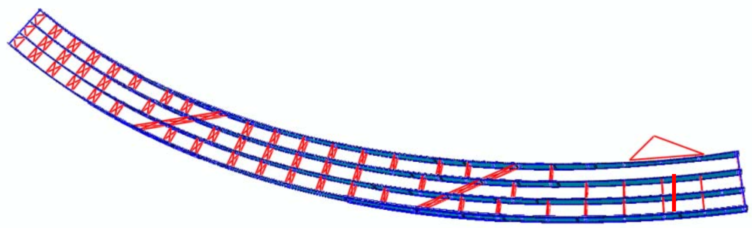
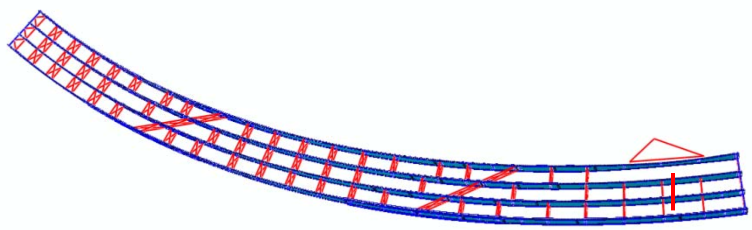
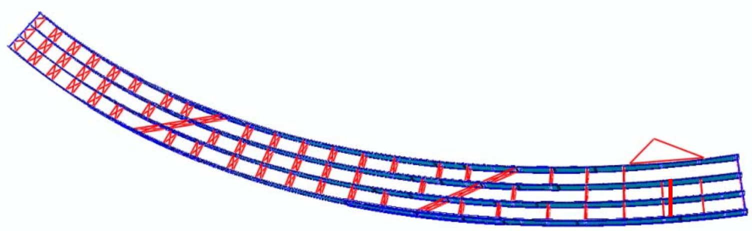
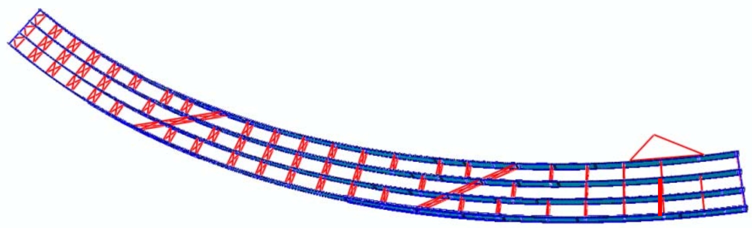
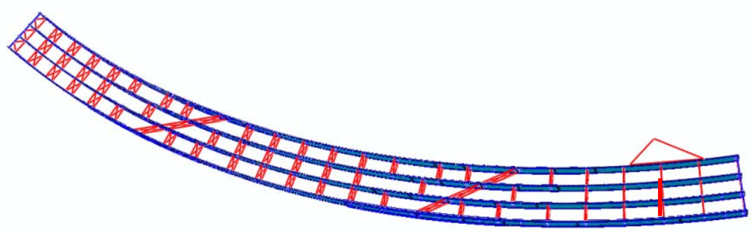
Sub-Stage	Stage 20
1	
2	
3	

Table S-1-1 (continued). Three-dimensional view of erection method 2 sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

Sub-Stage	Stage 20
4	
5	

Appendix S-2. XICCS7 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge XICCS7 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table S-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.2	4.9
	SDLF	1.1	4.8
	TDLF	0.9	4.5
G2	NLF	0.8	3.4
	SDLF	0.7	3.3
	TDLF	0.7	3.0
G3	NLF	0.6	2.7
	SDLF	0.7	2.8
	TDLF	0.9	3.0
G4	NLF	0.8	3.6
	SDLF	0.9	3.6
	TDLF	1.2	3.9
All Girders	NLF	1.2	4.9
	SDLF	1.1	4.8
	TDLF	1.2	4.5

Table S-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	0.29	1.20
	SDLF	0.05	0.93
	TDLF	0.81	0.24
G2	NLF	0.29	1.21
	SDLF	0.03	0.94
	TDLF	0.82	0.14
G3	NLF	0.28	1.19
	SDLF	0.05	0.92
	TDLF	0.83	0.21
G4	NLF	0.25	1.02
	SDLF	0.14	0.77
	TDLF	0.83	0.65
All Girders	NLF	0.29	1.21
	SDLF	0.14	0.94
	TDLF	0.83	0.65

Table S-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	3.4	14.6	3.9	16.9	0.8	5.1	0.9	5.1
	SDLF	3.5	14.7	4.1	17.1	0.7	4.6	1.1	4.9
	TDLF	4.2	15.0	4.6	17.5	1.3	4.3	1.8	5.4
G2	NLF	3.5	14.6	3.8	16.0	0.9	5.2	1.1	5.1
	SDLF	3.3	14.4	3.6	15.8	1.0	4.9	1.0	4.8
	TDLF	3.6	14.0	3.6	15.7	2.1	4.2	2.6	4.7
G3	NLF	3.0	12.9	3.8	16.4	1.3	7.0	1.6	6.0
	SDLF	3.0	13.0	3.8	16.4	0.8	5.8	0.9	4.8
	TDLF	3.1	13.0	3.9	16.5	2.9	3.5	4.1	3.8
G4	NLF	3.6	15.7	4.5	20.0	1.3	6.7	1.9	8.3
	SDLF	3.8	15.9	4.7	20.2	0.9	6.2	1.4	7.7
	TDLF	4.4	16.5	5.5	20.8	1.1	4.5	1.5	6.4
All Girders	NLF	3.6	15.7	4.5	20.0	1.3	7.0	1.9	8.3
	SDLF	3.8	15.9	4.7	20.2	1.0	6.2	1.4	7.7
	TDLF	4.4	16.5	5.5	20.8	2.9	4.5	4.1	6.4

Table S-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	13.0	9.5	9.9	13.0
	SDLF	12.8	7.0	7.4	12.8
	TDLF	12.9	11.5	13.9	13.9
TDL	NLF	52.2	42.6	43.8	52.2
	SDLF	52.1	39.1	40.1	52.1
	TDLF	50.2	29.1	30.5	50.2

Table S-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	2.6	1.8	2.0	2.2
	SDLF	2.2	1.7	1.9	2.0
	TDLF	2.4	2.6	2.9	2.6
TDL	NLF	11.0	7.7	8.5	9.6
	SDLF	10.6	7.5	8.3	9.2
	TDLF	9.7	7.1	8.0	8.6

Table S-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	All Girders
NLF	0.39	0.37	0.35	0.39
SDLF	0.40	0.37	0.35	0.40
TDLF	0.44	0.38	0.43	0.44

Table S-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	All Girders
NLF	1.60	1.54	1.45	1.60
SDLF	1.60	1.54	1.44	1.60
TDLF	1.62	1.52	1.43	1.62

Table S-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	All Girders
NLF	0.26	0.25	0.24	0.26
SDLF	0.27	0.25	0.24	0.27
TDLF	0.30	0.25	0.29	0.30

Table S-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	All Girders
NLF	1.08	1.04	0.98	1.08
SDLF	1.09	1.04	0.98	1.09
TDLF	1.10	1.03	0.97	1.10

Table S-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	932.7	3718.4
SDLF	932.7	3718.3
TDLF	932.7	3718.4

Table S-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	113.6	442.1	0.1	0.3	0.1	0.9
SDLF	110.8	439.2	0.1	0.3	0.1	0.8
TDLF	121.9	432.4	0.2	0.5	0.2	0.6

Table S-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.18	0.68	0.02	0.18
SDLF	0.17	0.65	0.02	0.17
TDLF	0.22	0.79	0.03	0.13

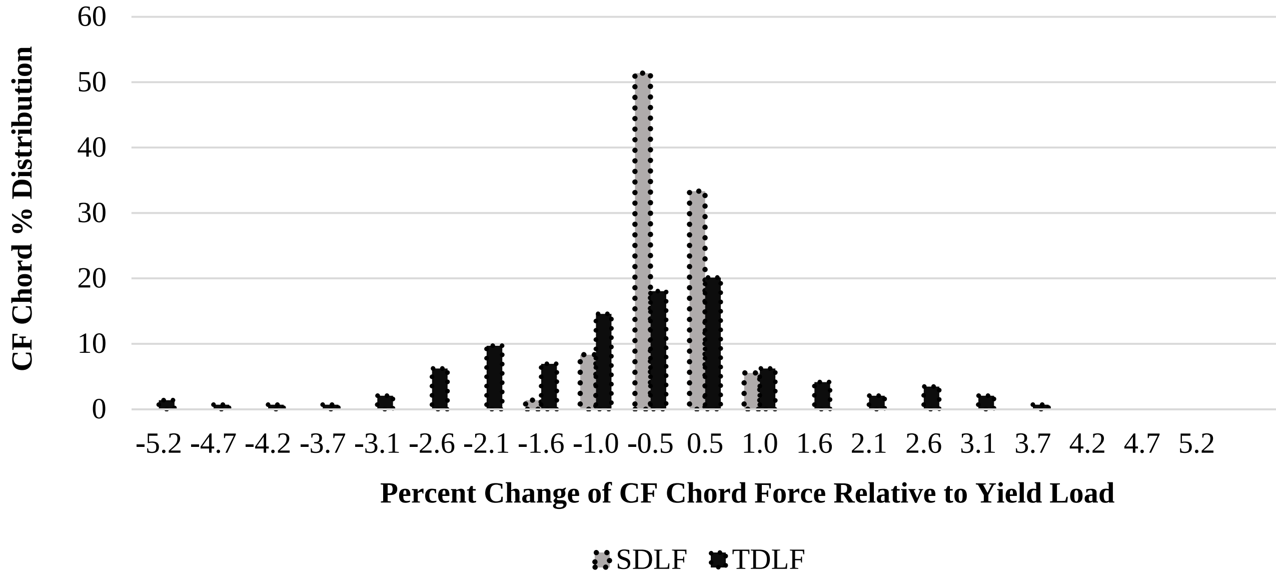


Figure S-2-1. **Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.**

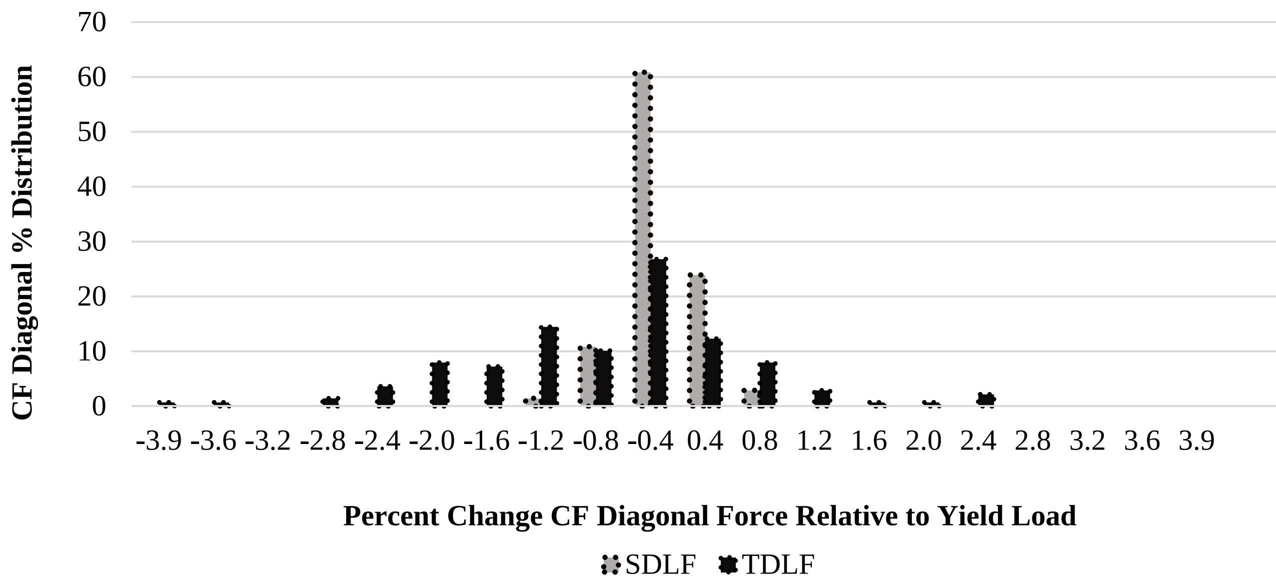


Figure S-2-2. **Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.**

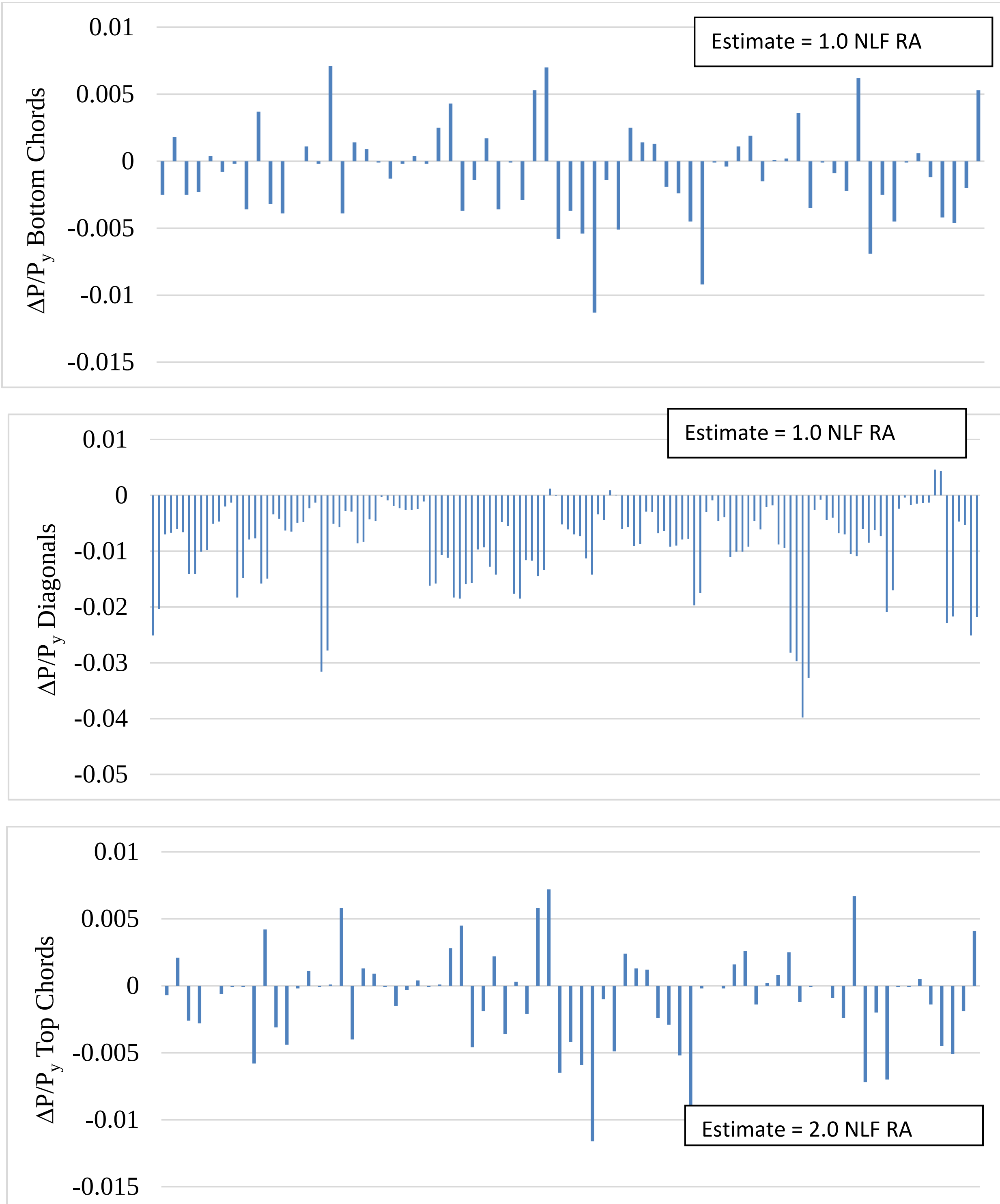


Figure S-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

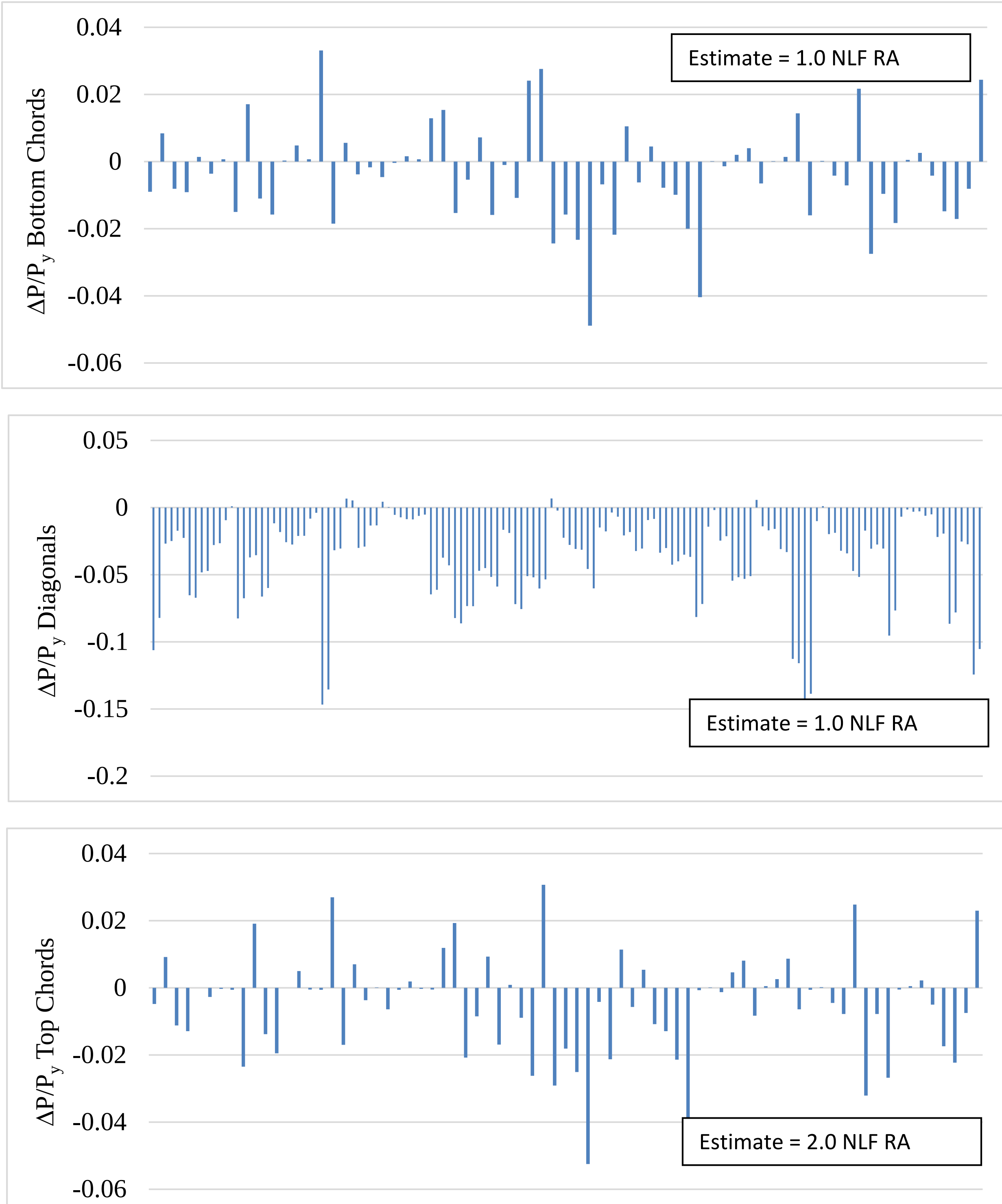


Figure S-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix S-3. XICCS7 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge XICCS7 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table S-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	5.7	3.4	5.7
SDLF	5.0	3.4	5.0
TDLF	4.6	5.5	5.5

Table S-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	96.1	15.8
	SDLF	99.7	18.7
	TDLF	110.9	18.1
G2	NLF	106.7	0.3
	SDLF	104.5	0.3
	TDLF	99.6	1.1
G3	NLF	101.8	16.1
	SDLF	98	16.5
	TDLF	85.1	16.5
G4	NLF	108	10.3
	SDLF	112.7	12.6
	TDLF	126.2	12.2
All Girders	NLF	108	96.1
	SDLF	112.7	98
	TDLF	126.2	85.1

Table S-3-3. Summary of erection crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	51.8	4.5	34.8	25.2
SDLF	51.2	1.8	33.5	22.9
TDLF	49.7	0	26.2	21.4

Table S-3-4. Erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage					
		1	2	3	4	5	6
14	NLF	664	666	667	668		
	SDLF	664	666	667	668		
	TDLF	664	666	667	668		
18	NLF	851	852	853	854	855	856
	SDLF	851	852	853	854	855	856
	TDLF	851	852	853	854	855	856
20	NLF	928	930	931	932	933	
	SDLF	928	930	931	932	933	
	TDLF	928	930	931	932	933	

Appendix S-4. XICCS7 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge XICCS7 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

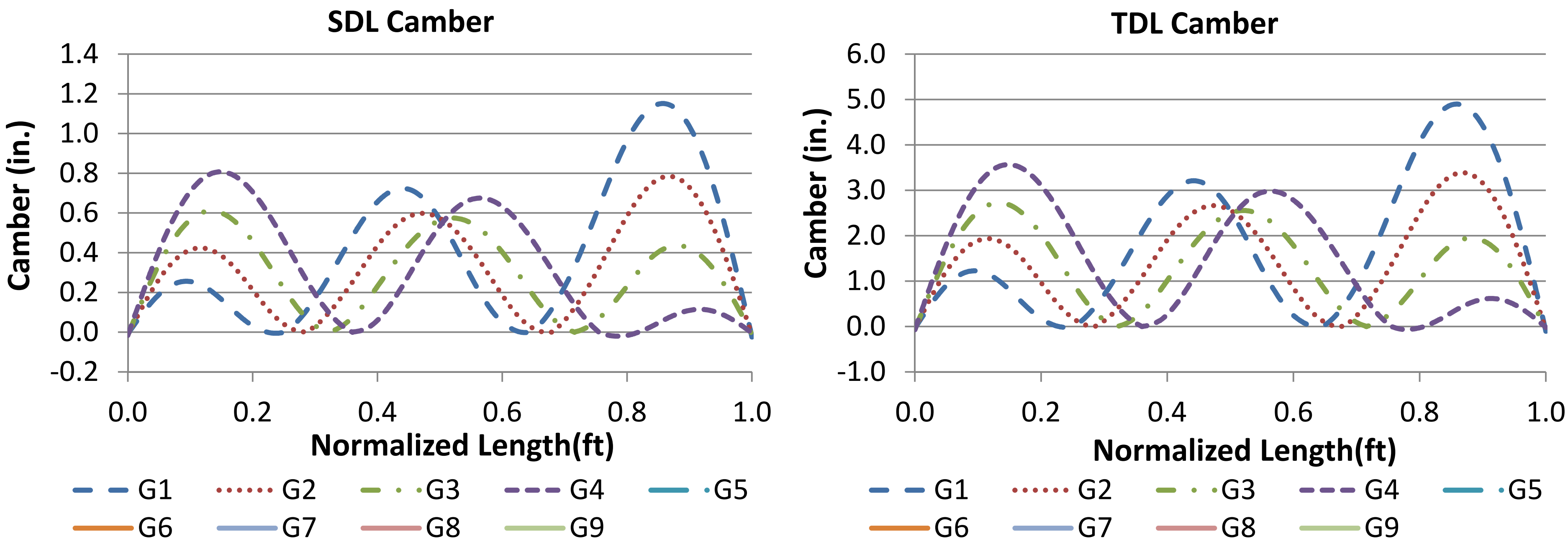


Figure S-4-1. SDL and TDL 3D FEA cambers.

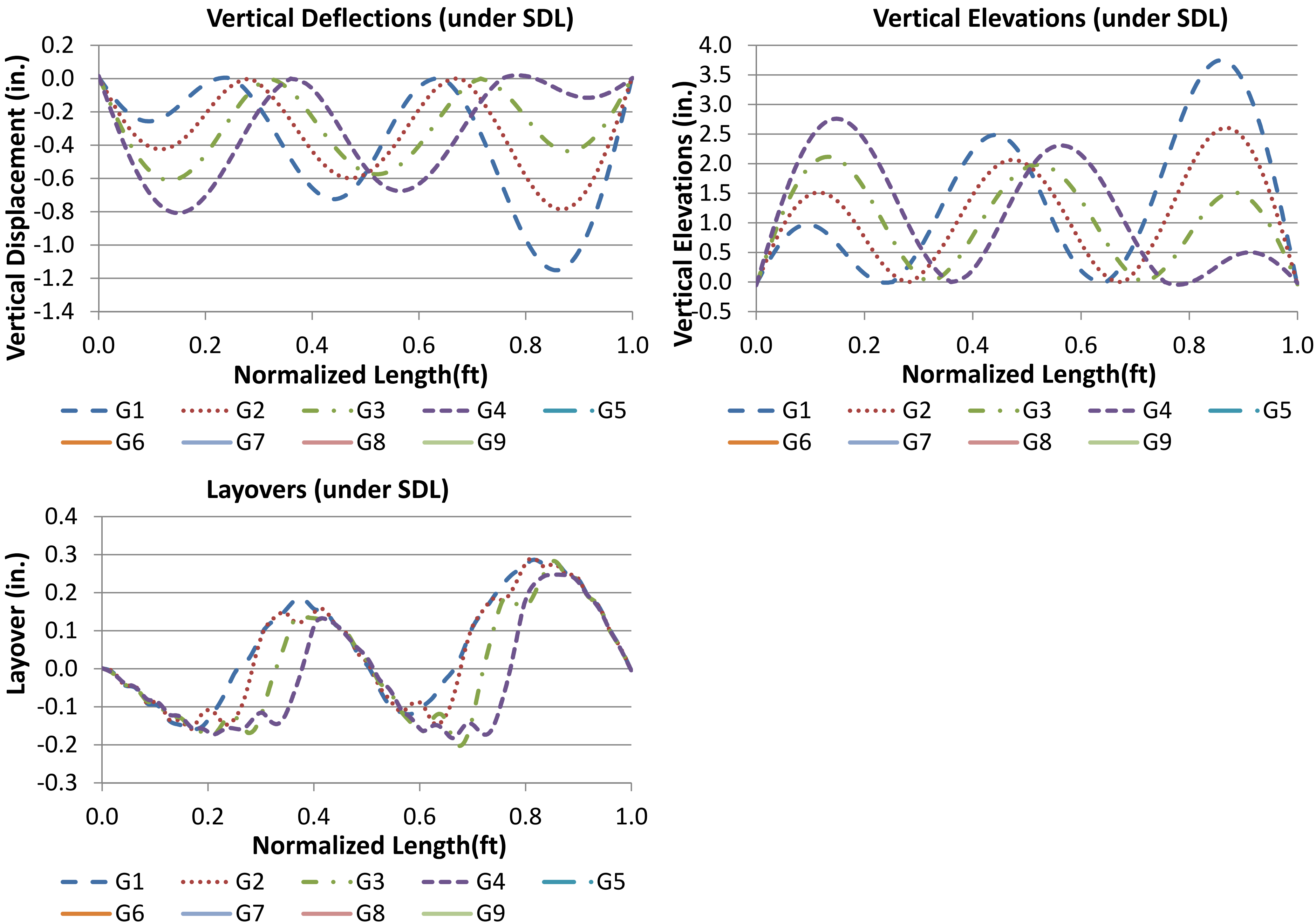


Figure S-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

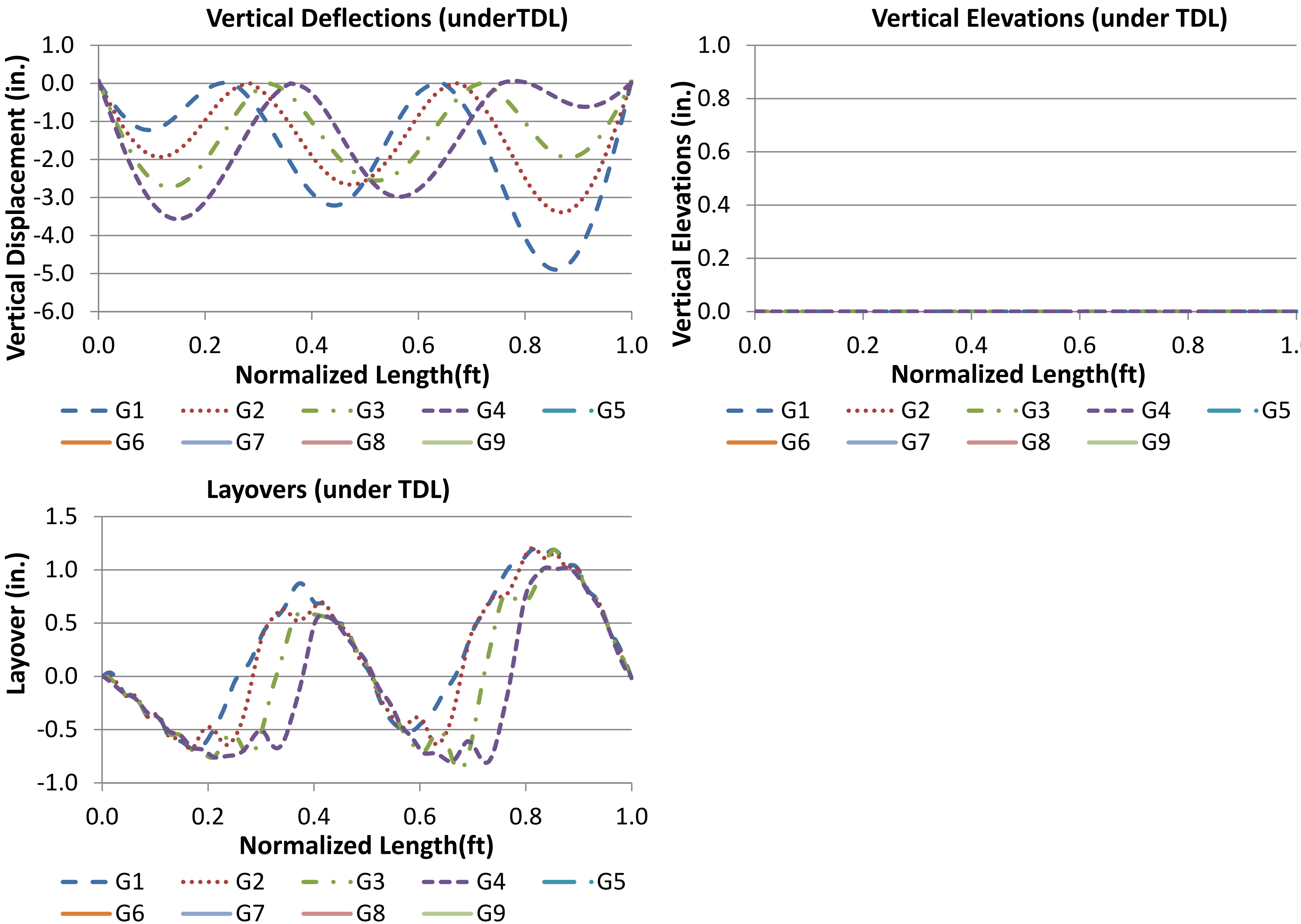


Figure S-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

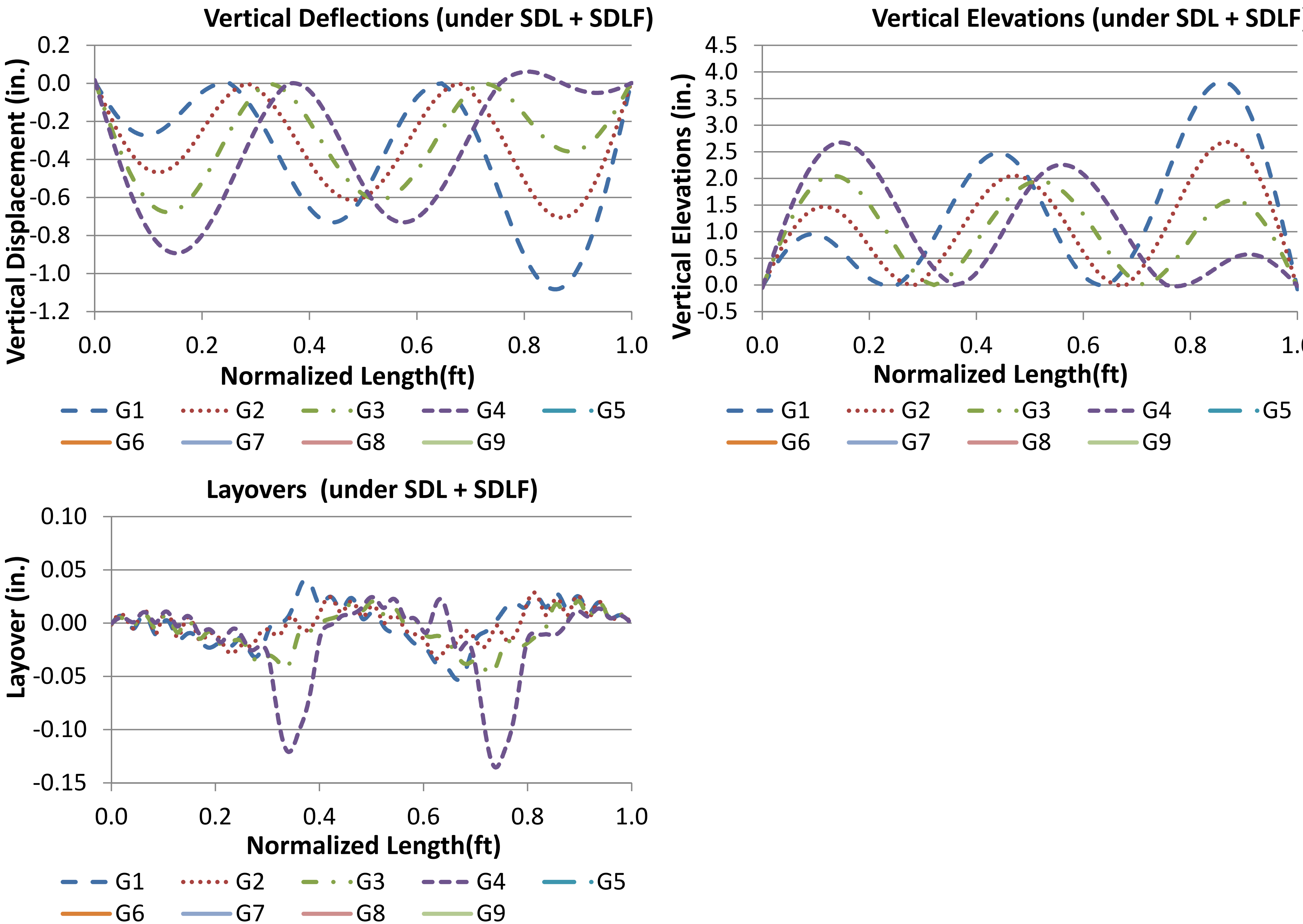


Figure S-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

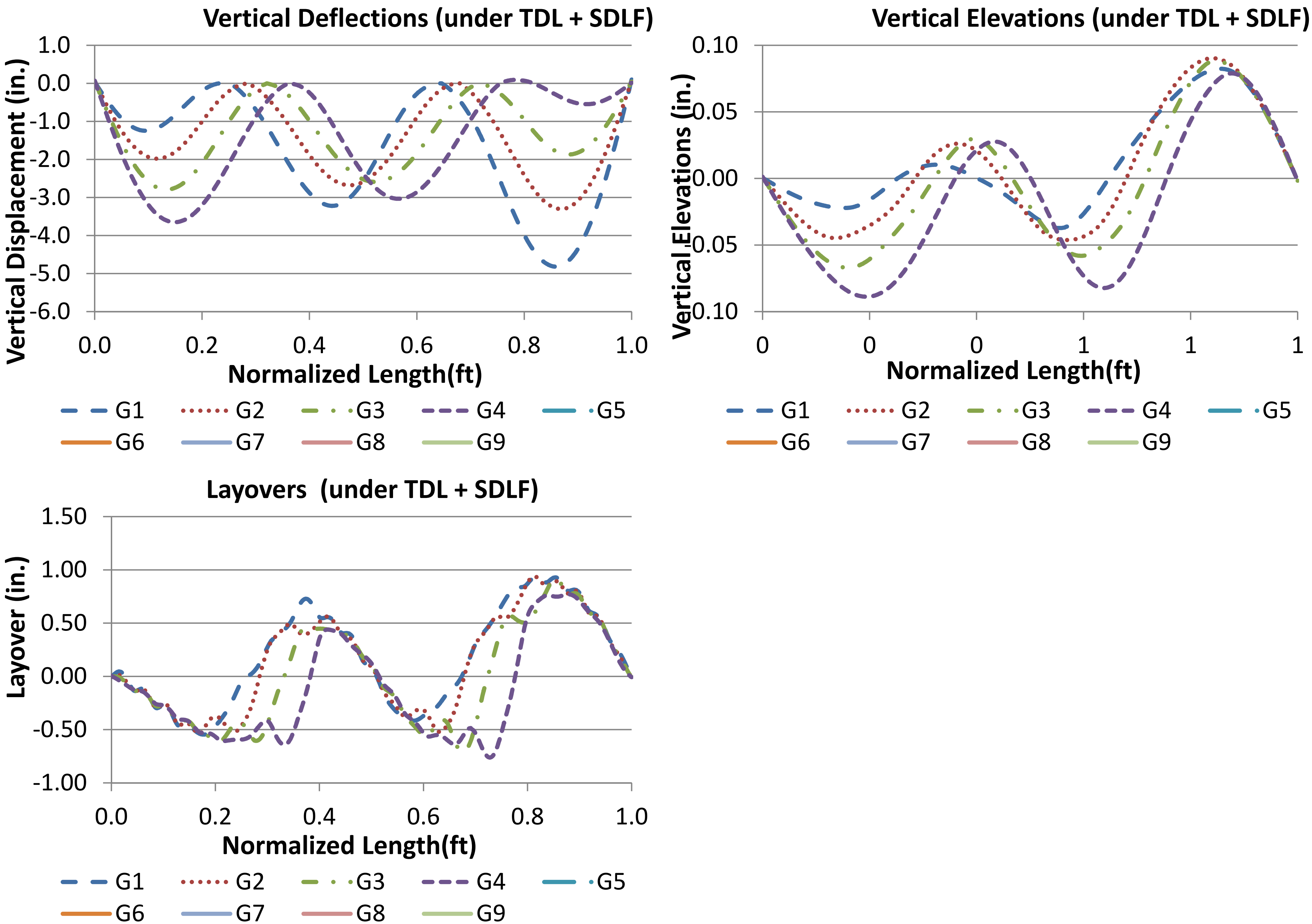


Figure S-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

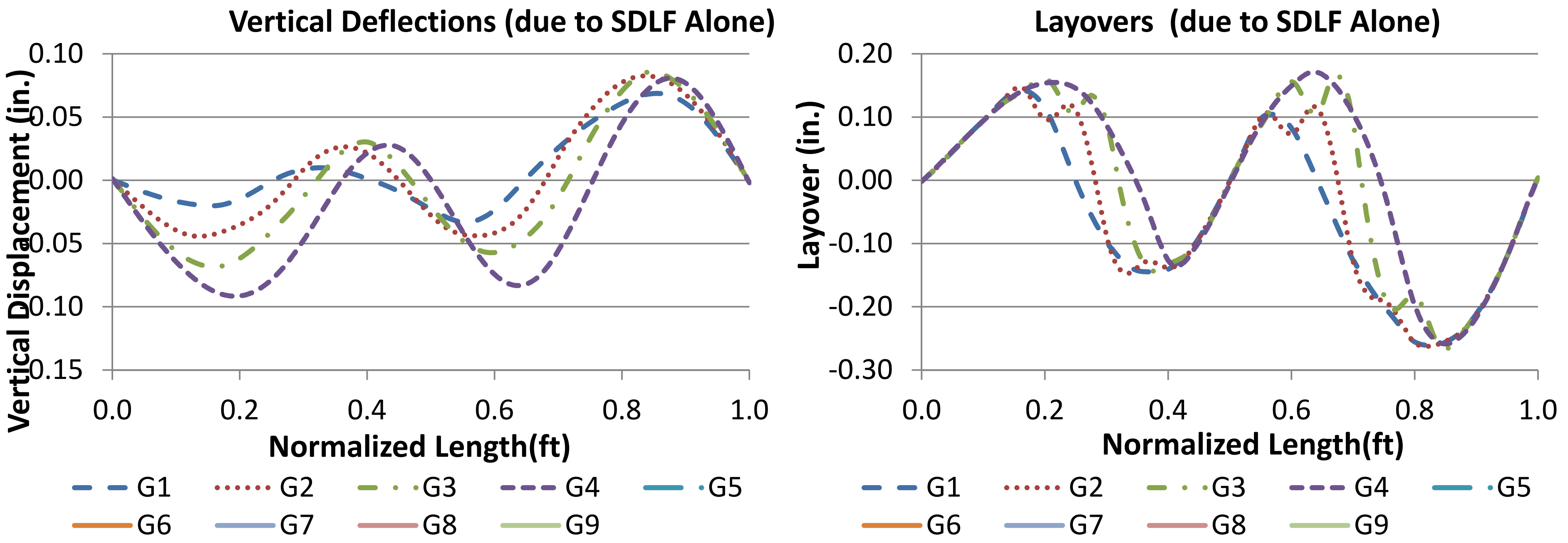


Figure S-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

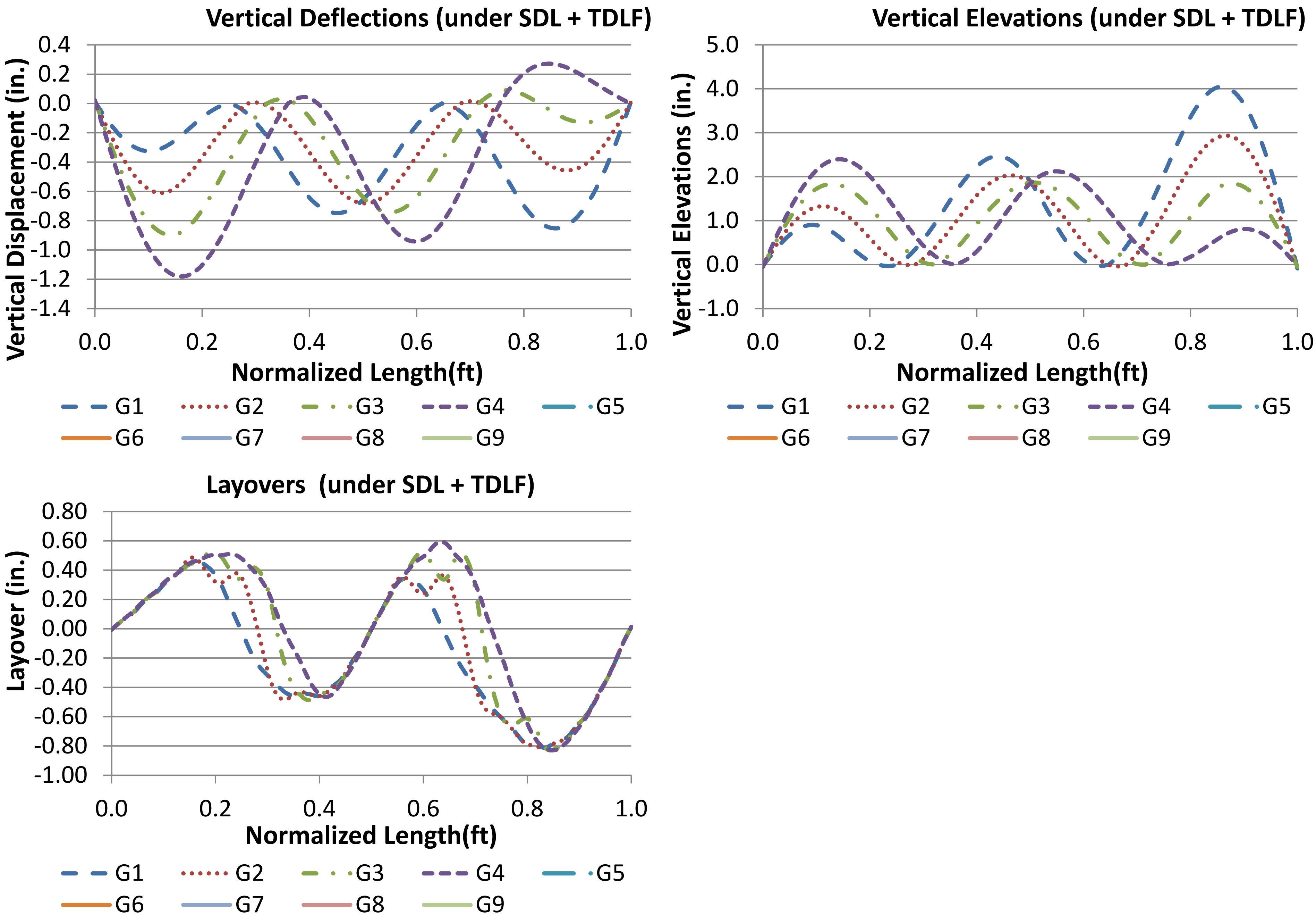


Figure S-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

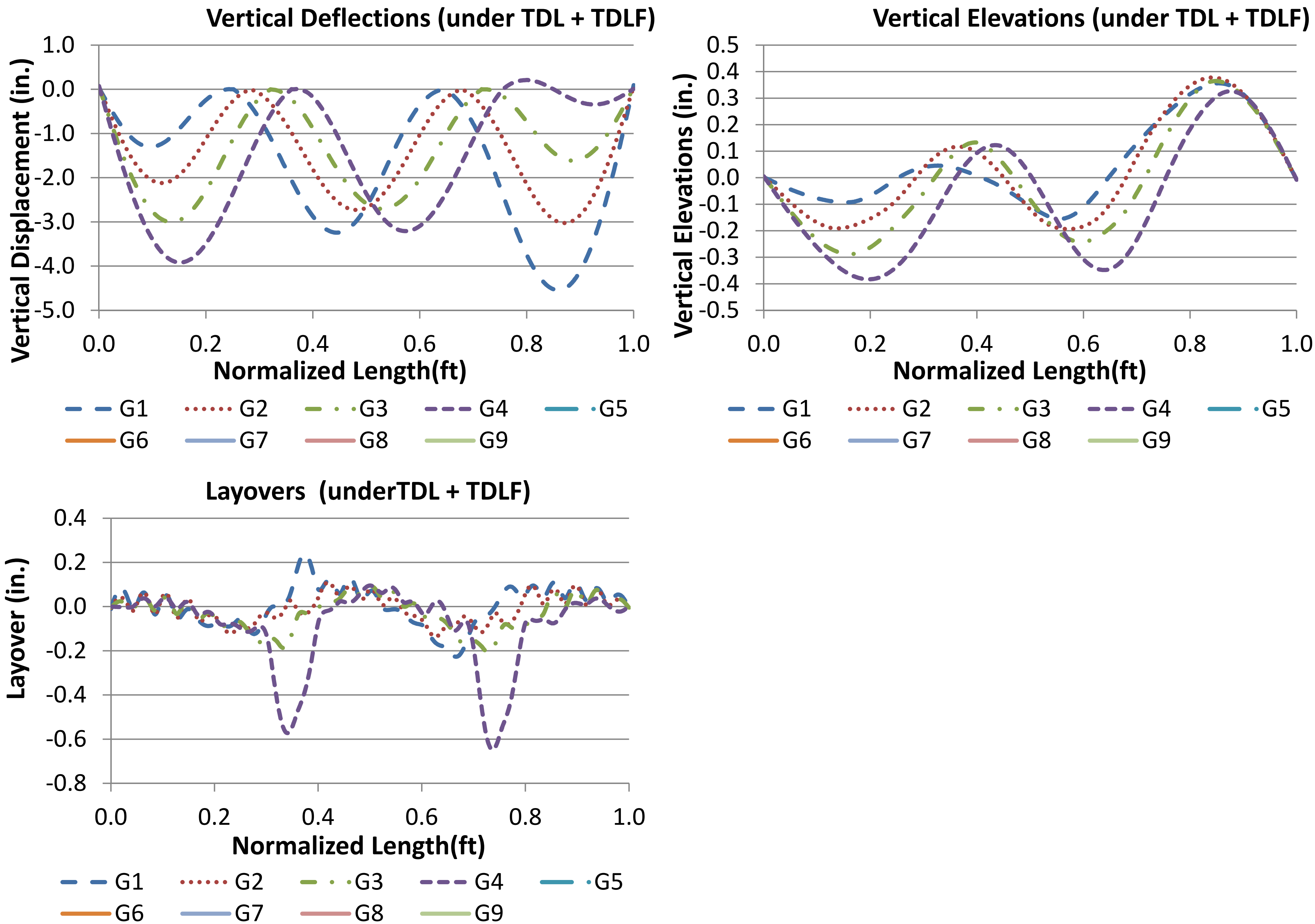


Figure S-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

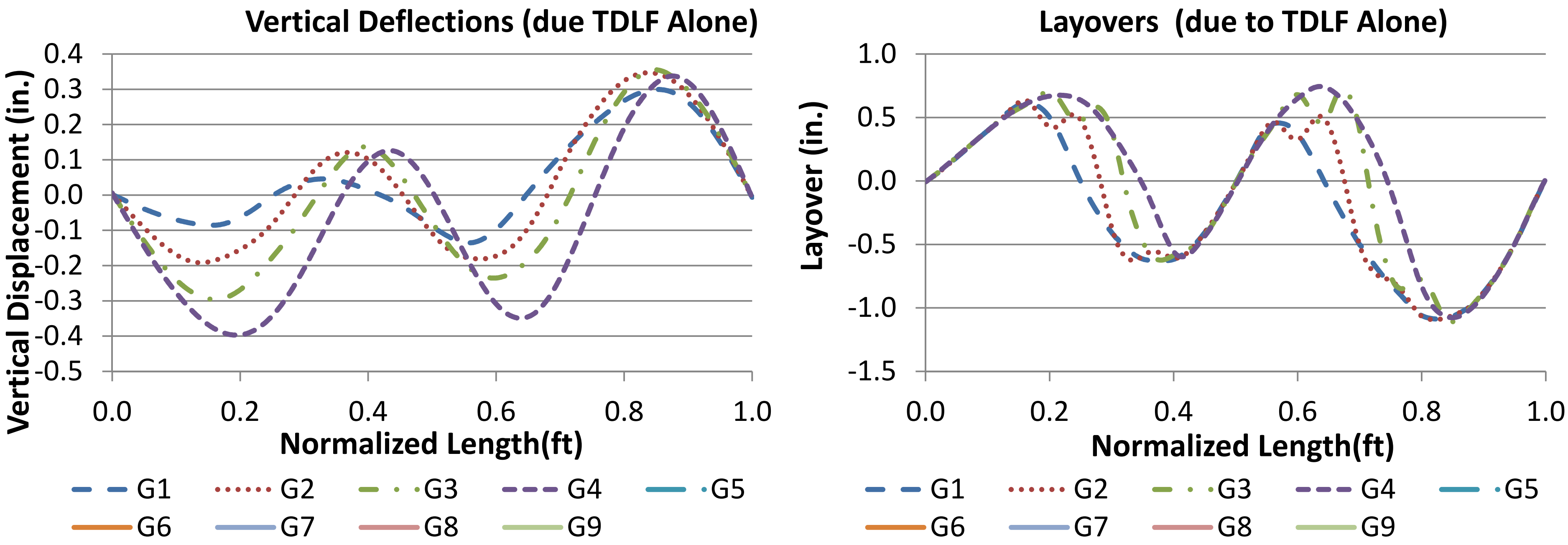


Figure S-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

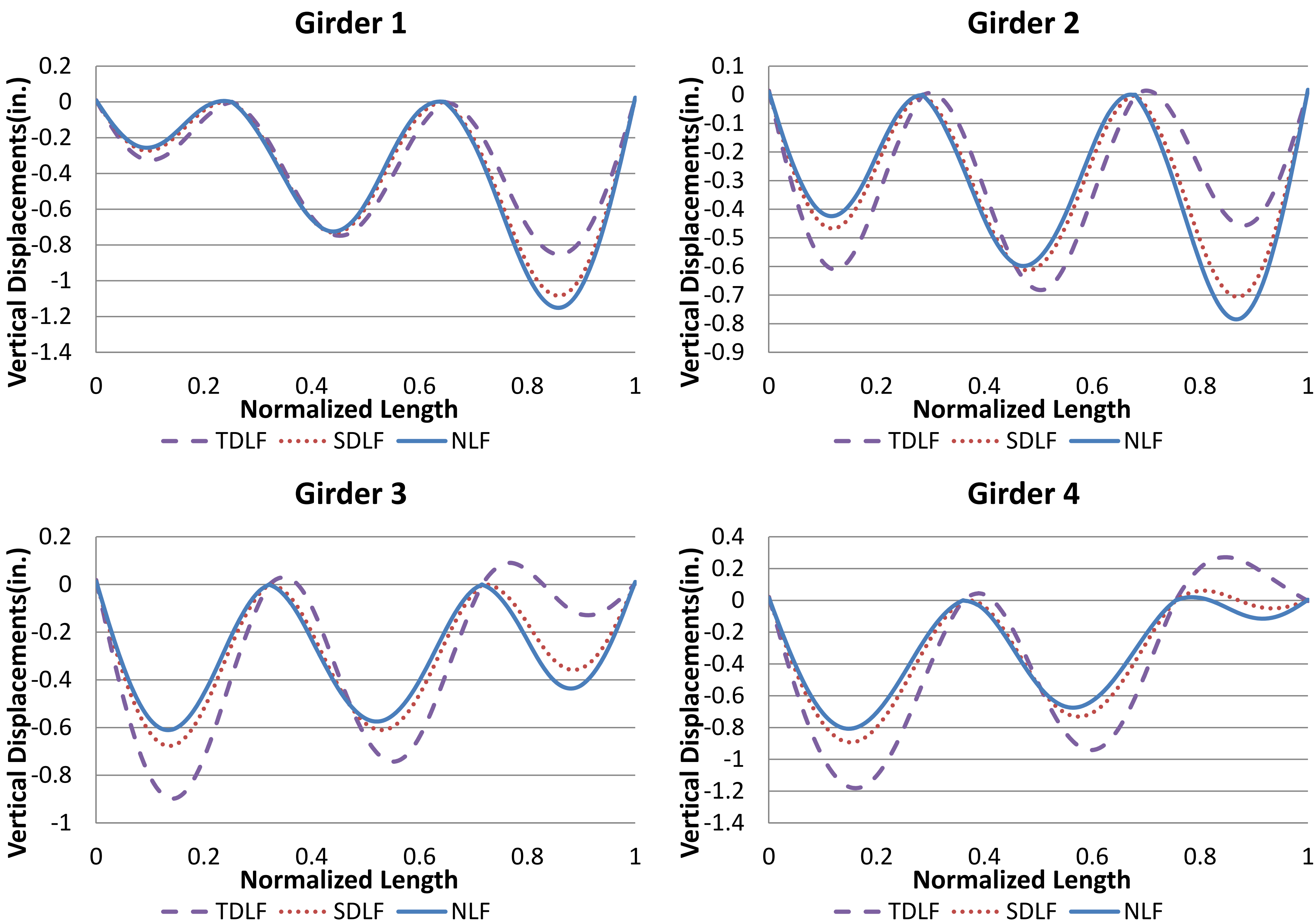


Figure S-4-10. Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

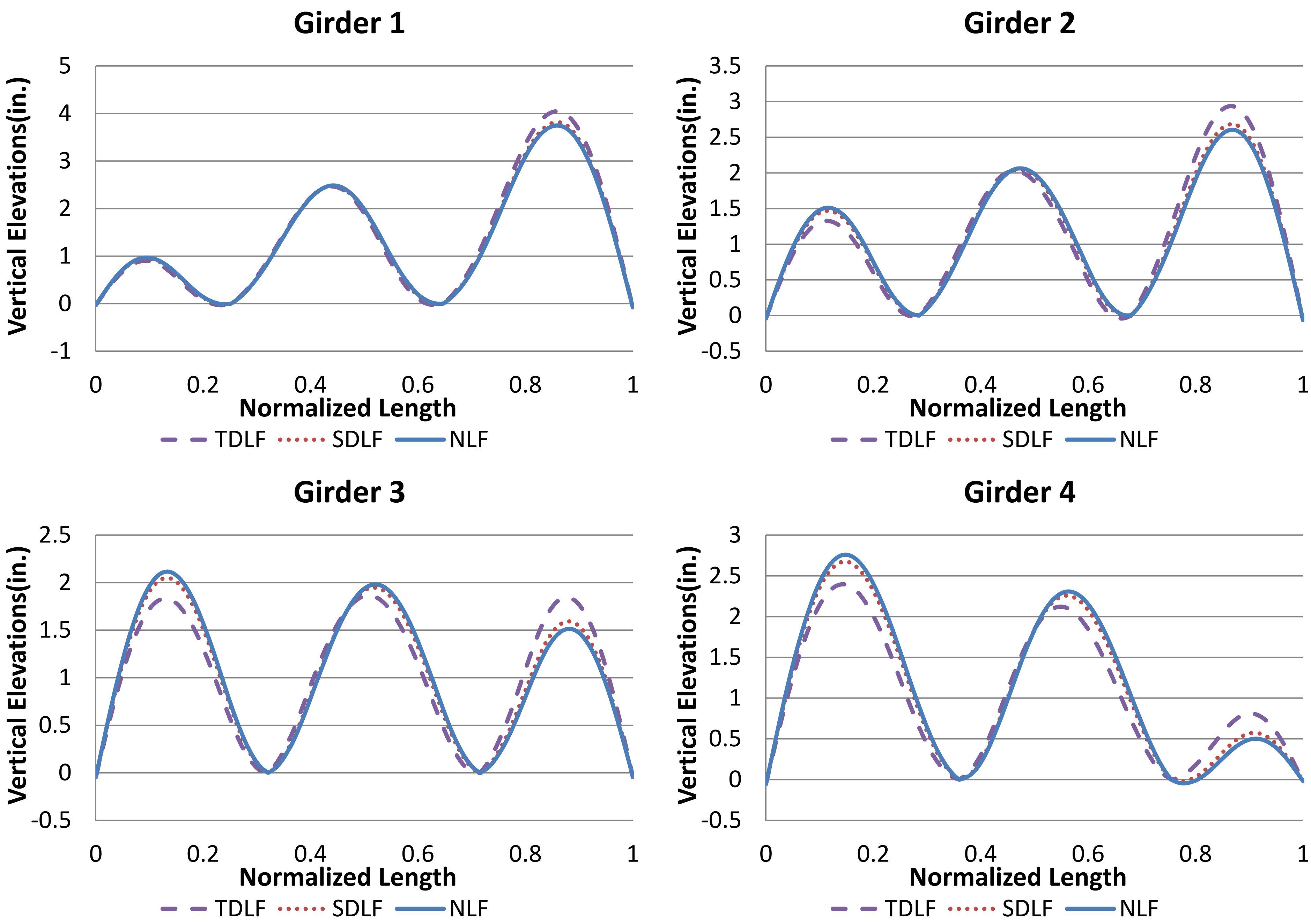


Figure S-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

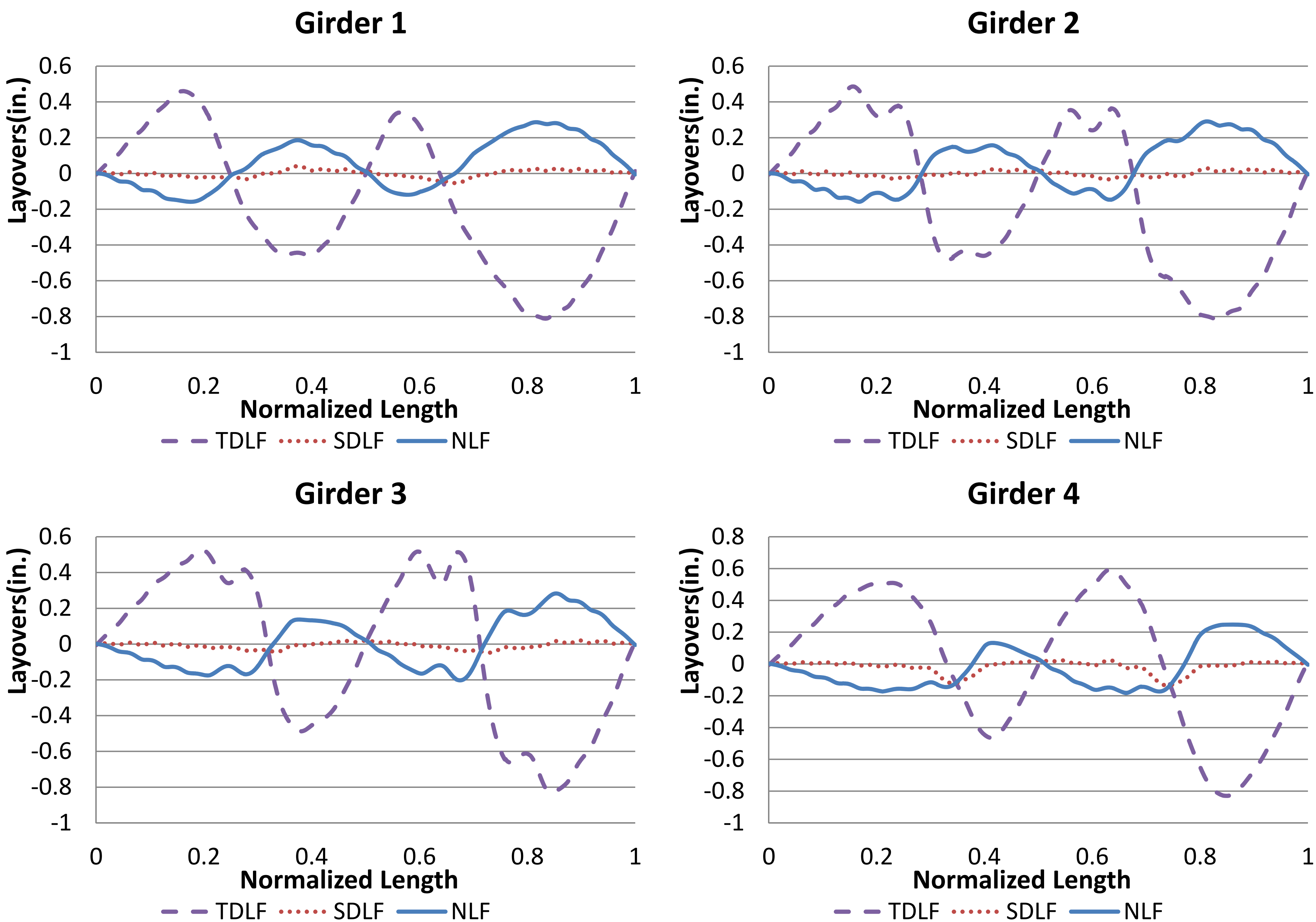


Figure S-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

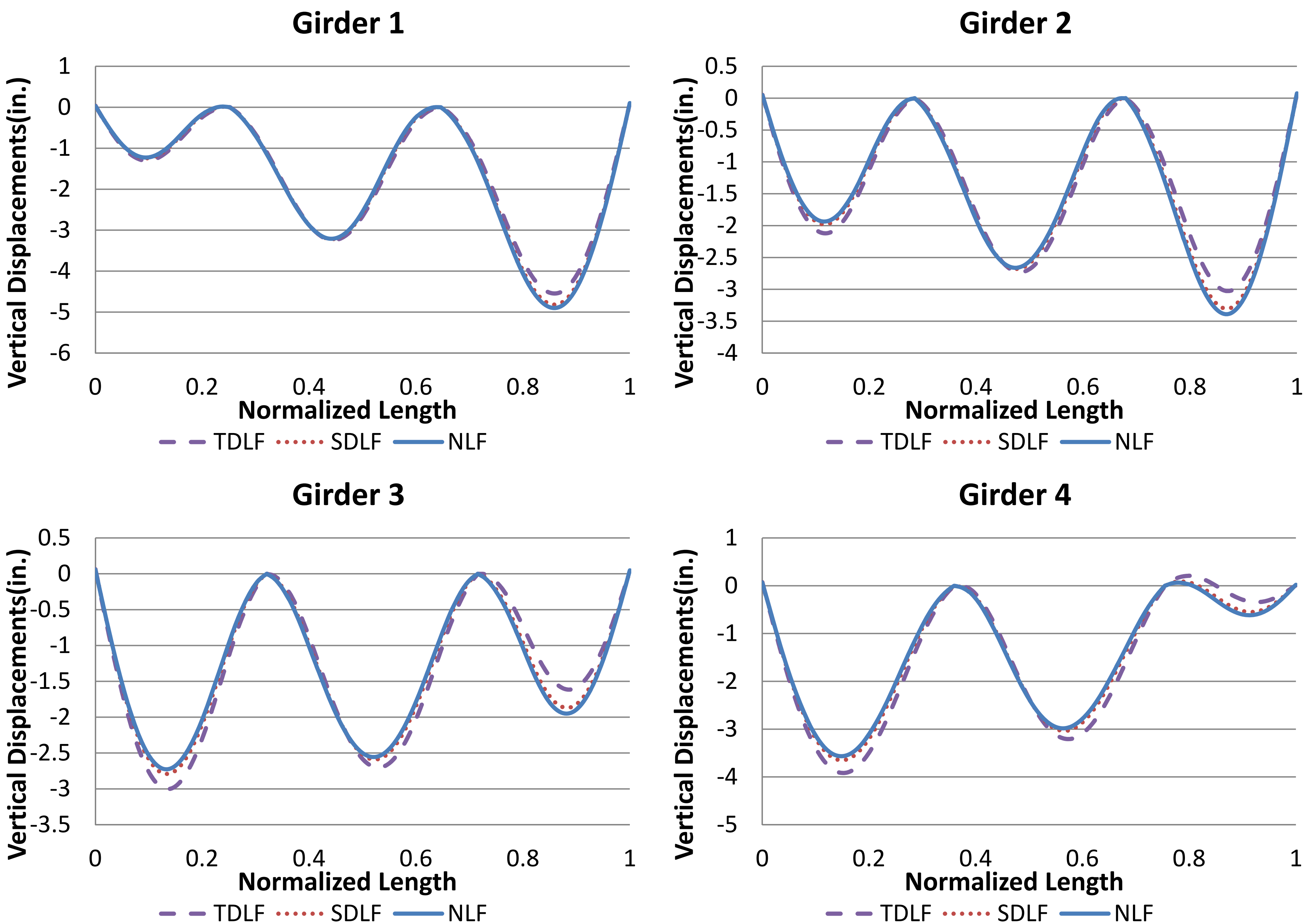


Figure S-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

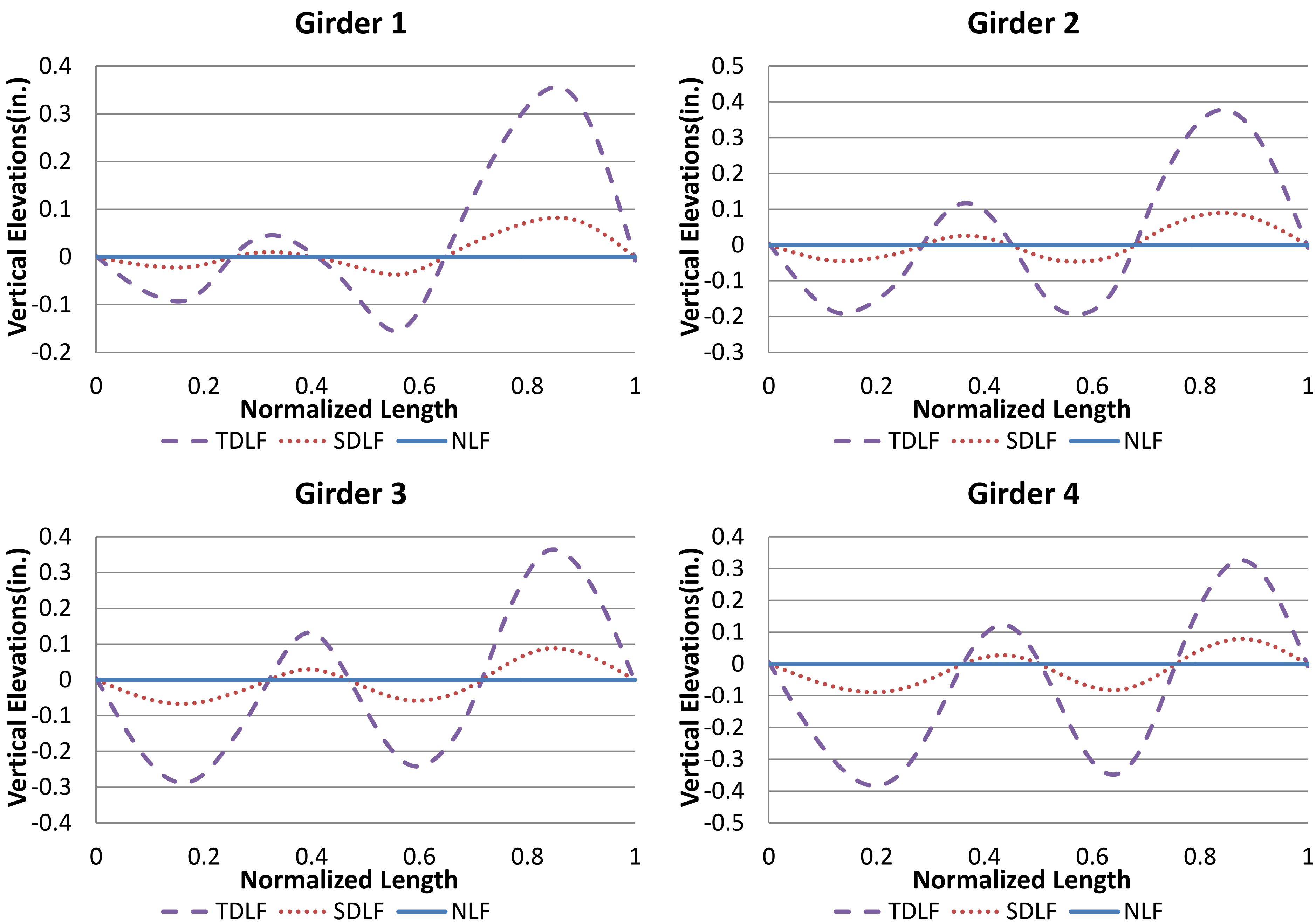


Figure S-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

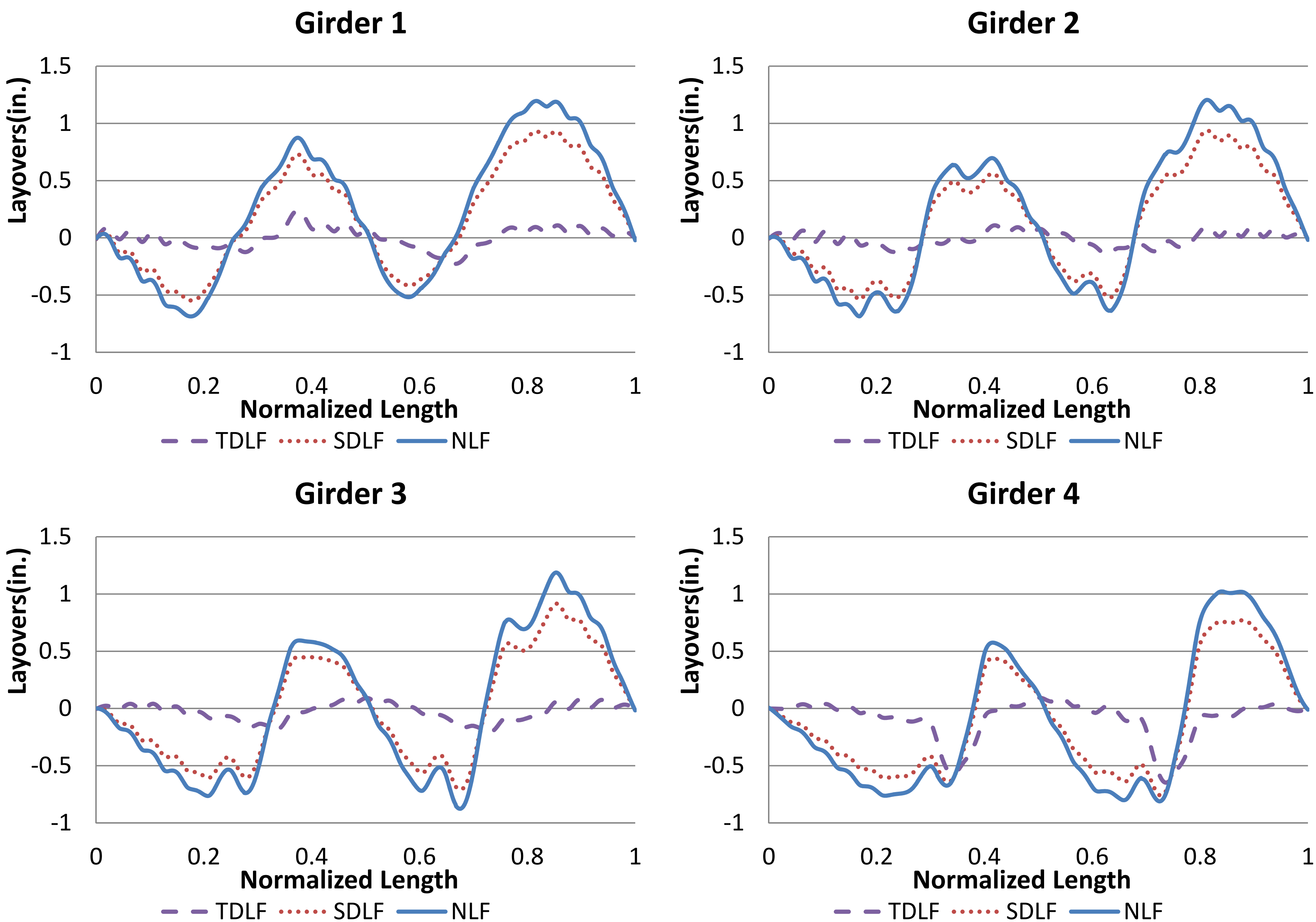


Figure S-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

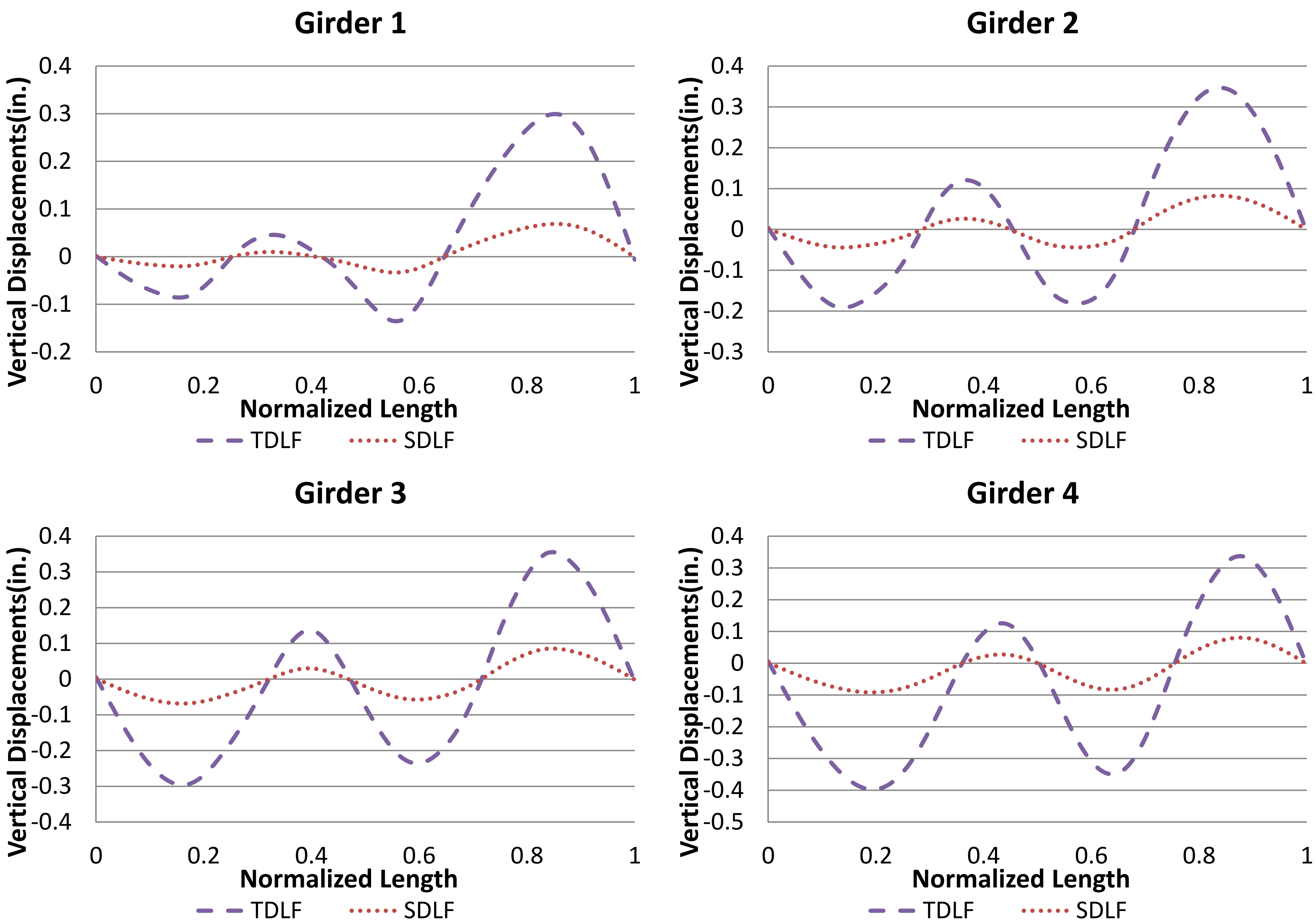


Figure S-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

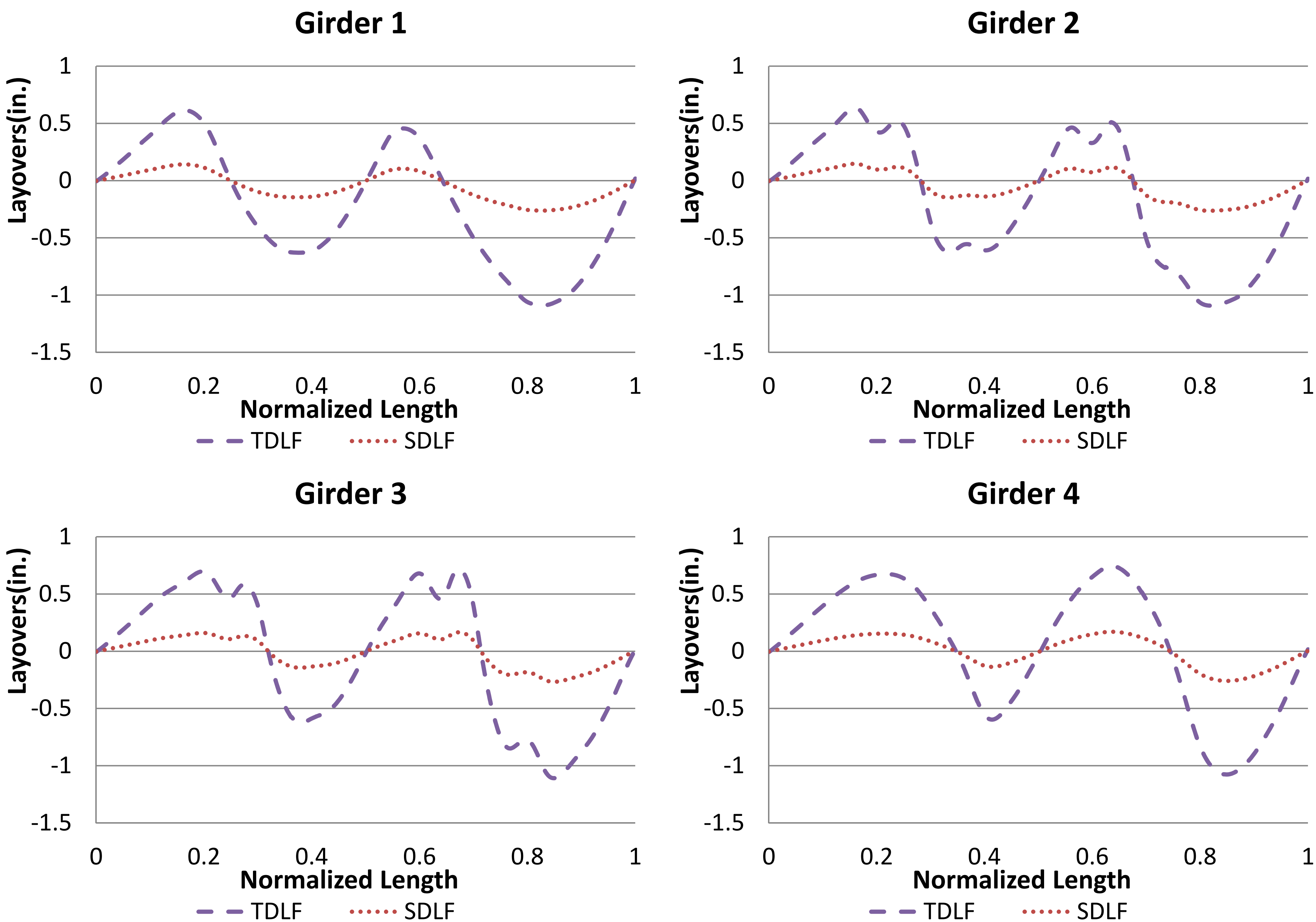


Figure S-4-17. Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

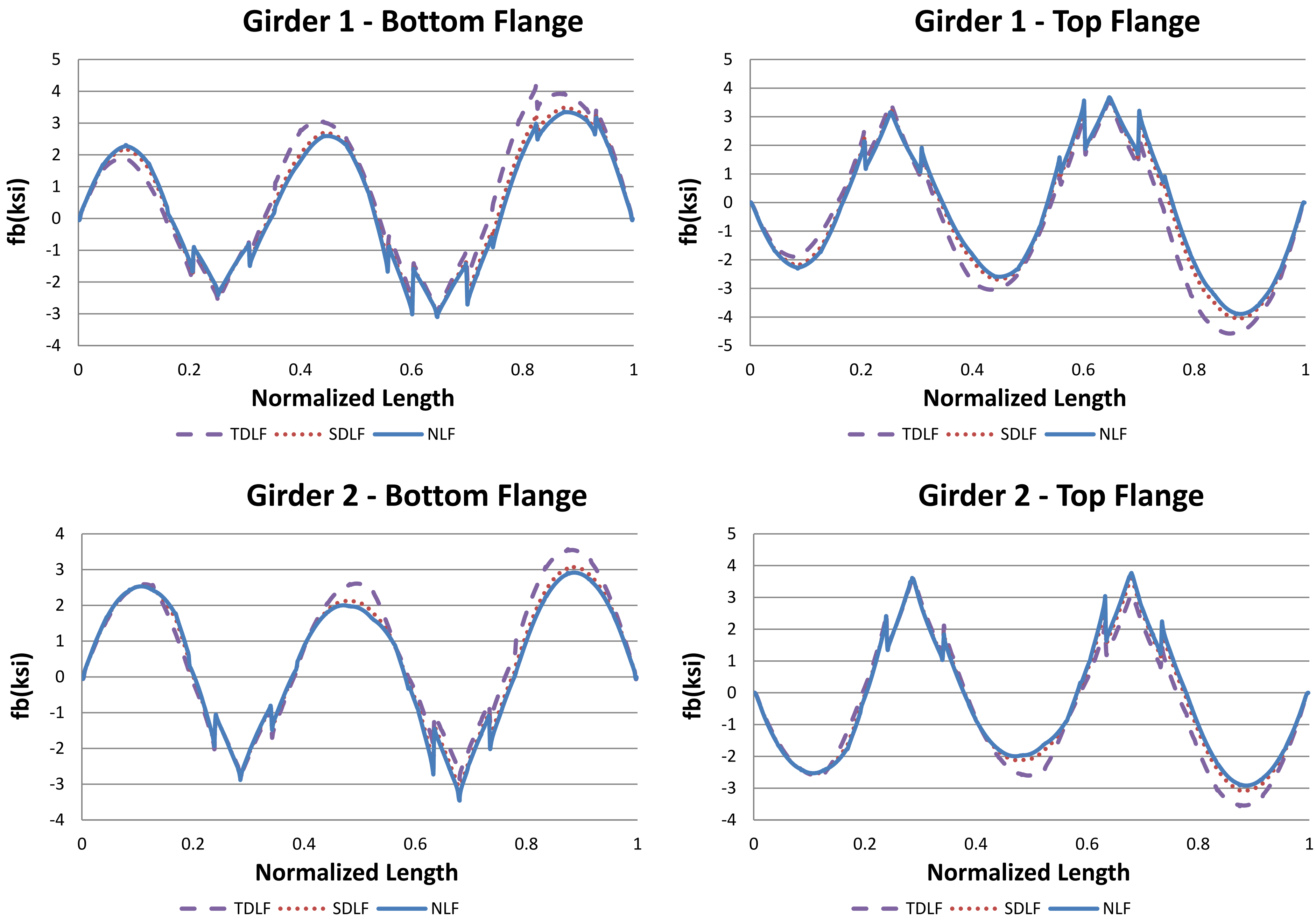


Figure S-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

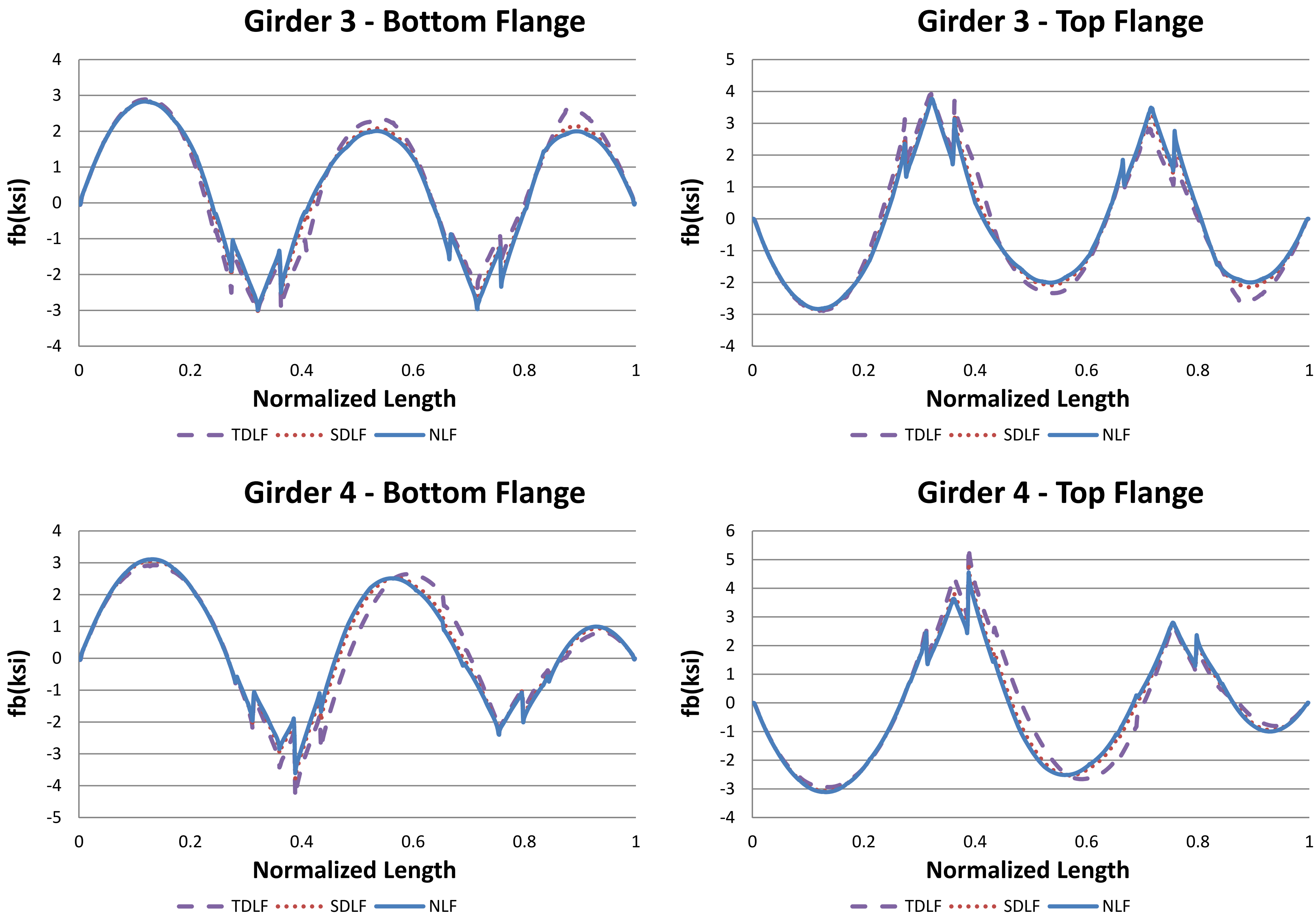


Figure S-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

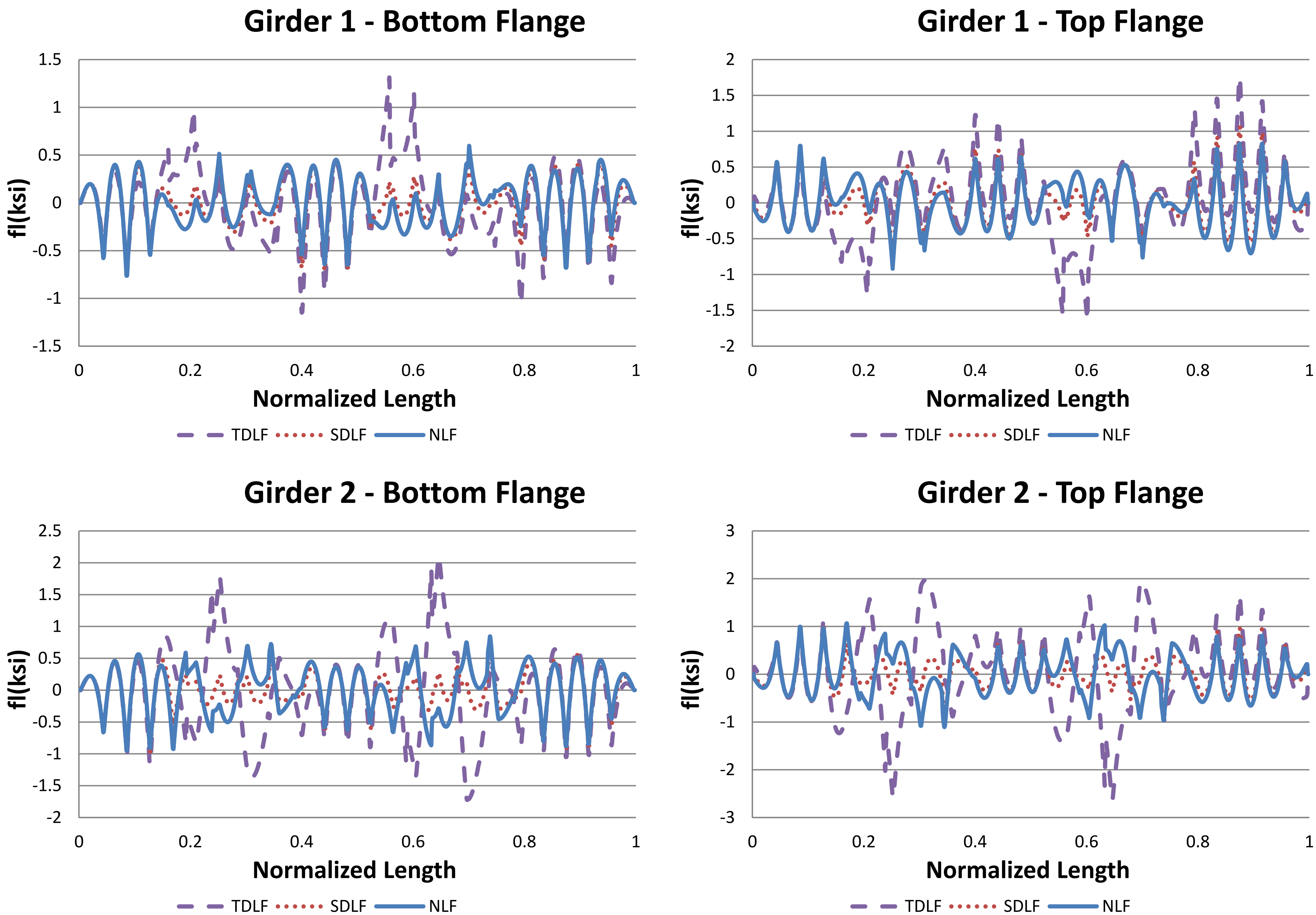


Figure S-4-19. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

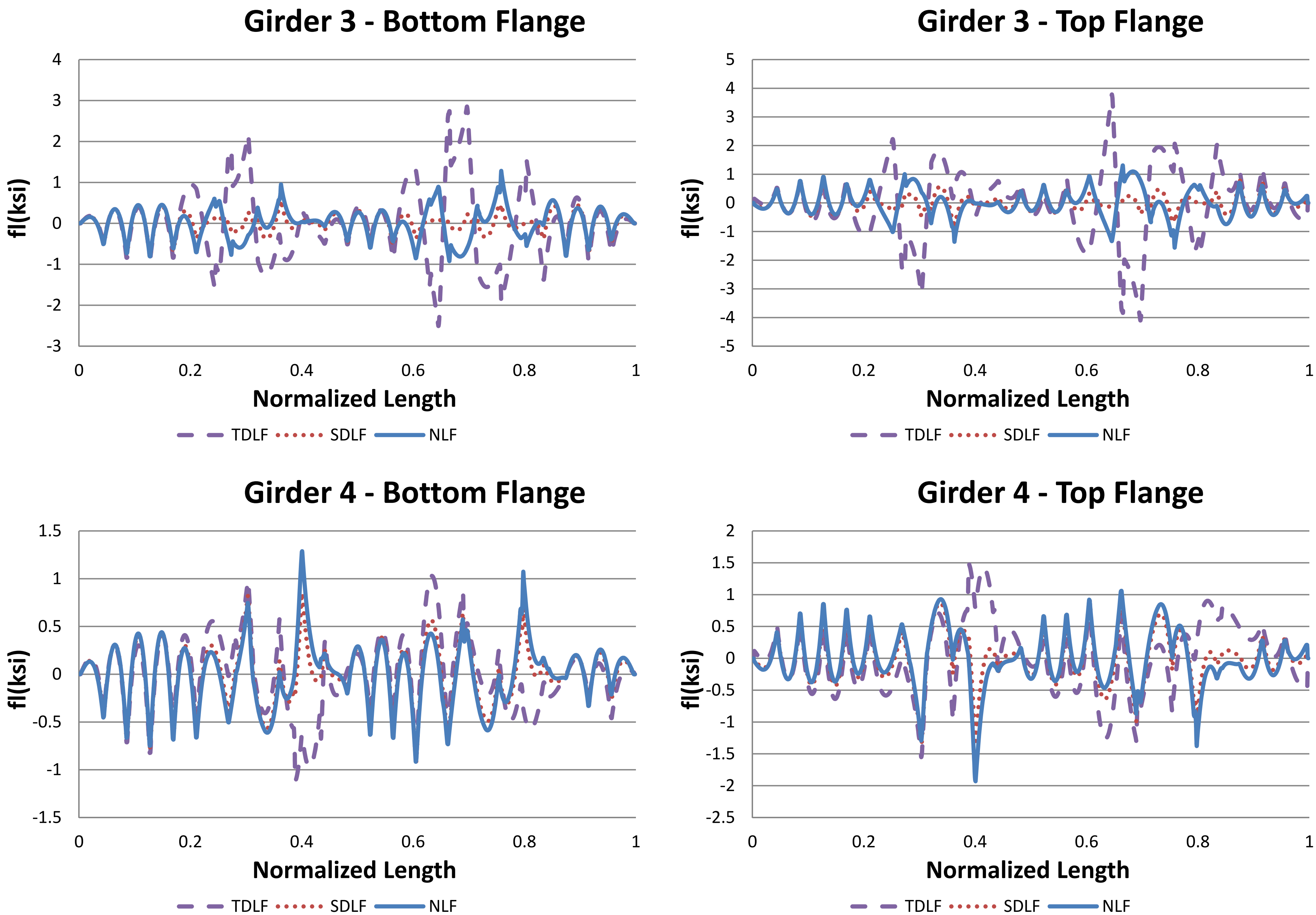


Figure S-4-19(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

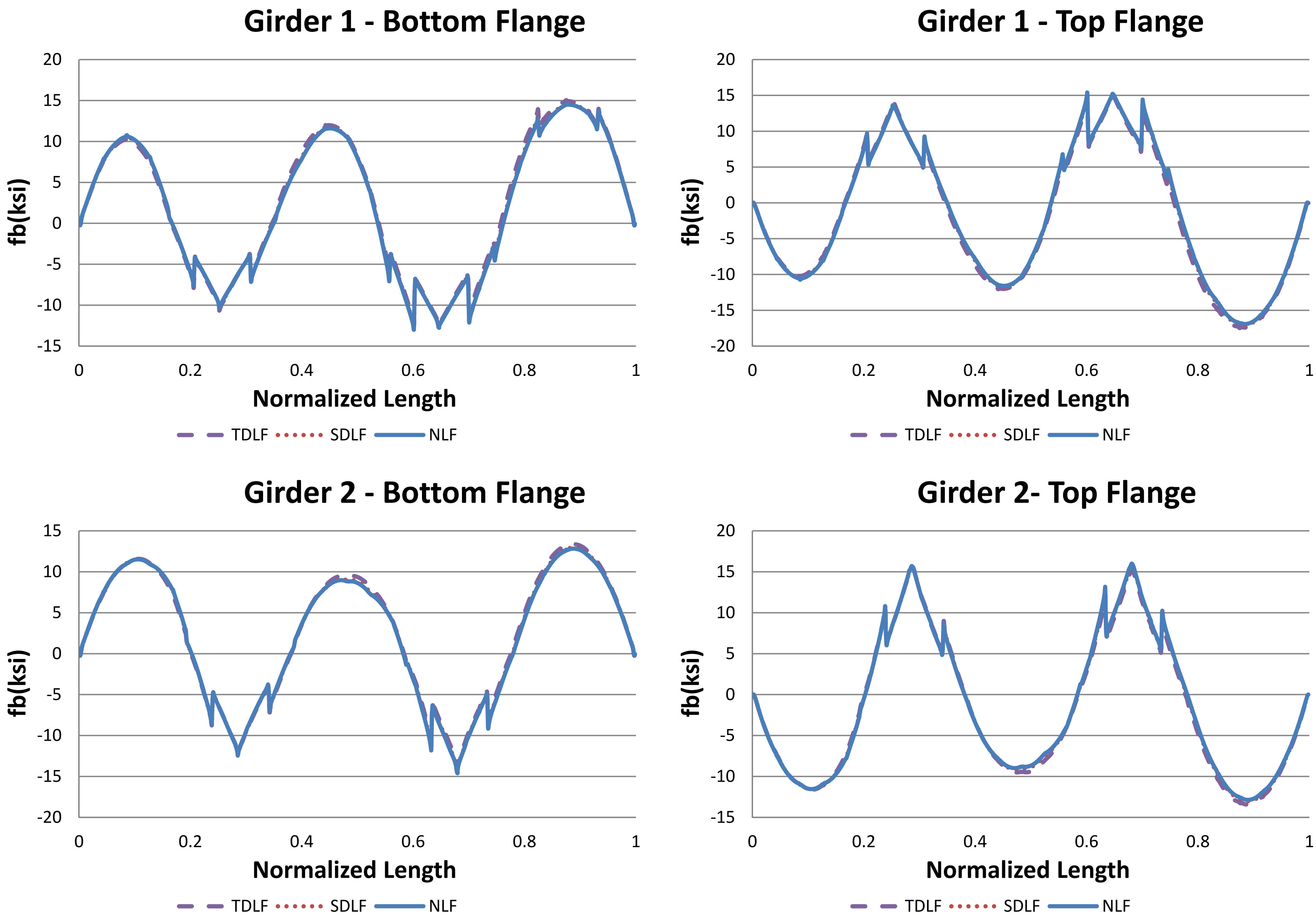


Figure S-4-20. Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

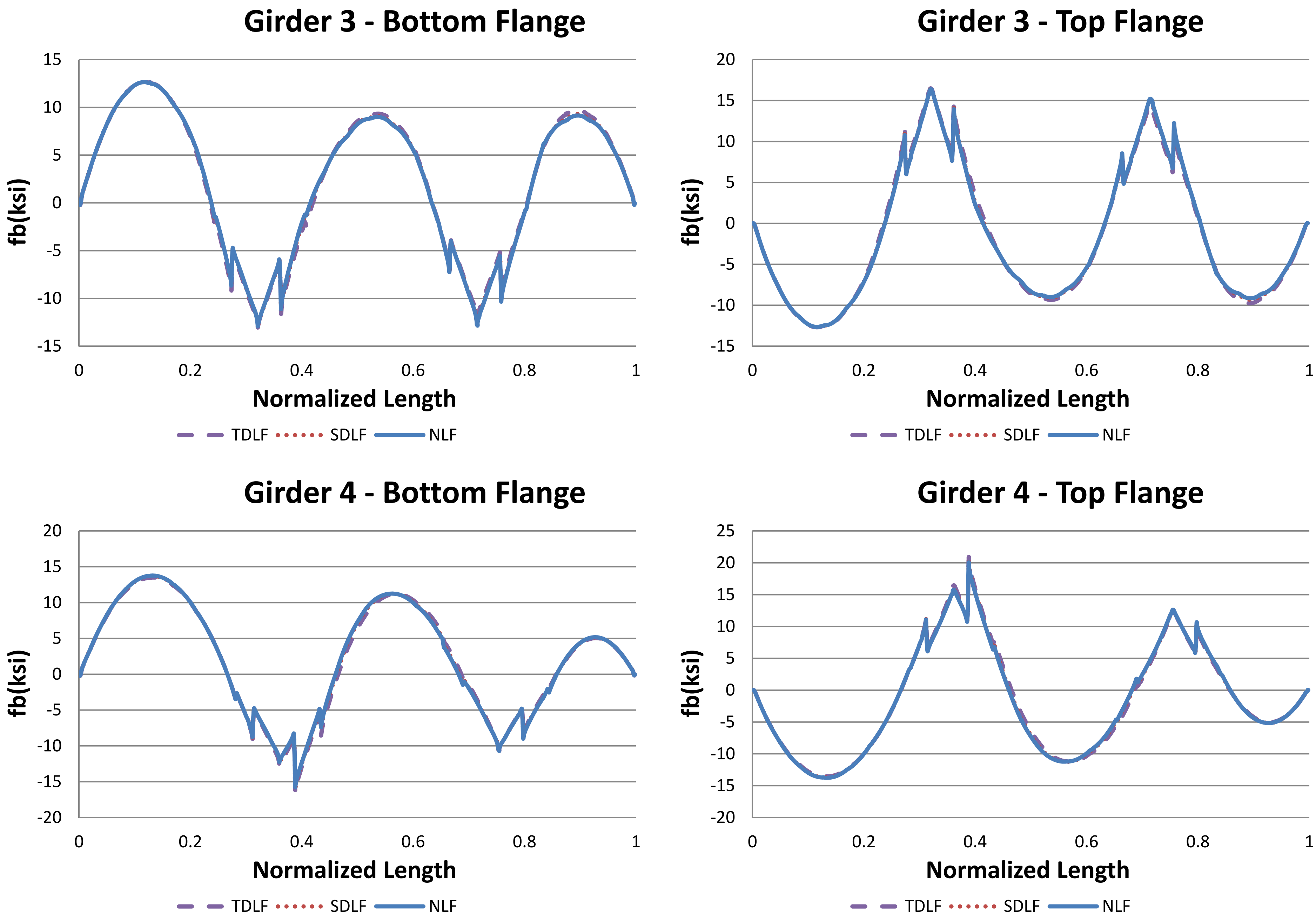


Figure S-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

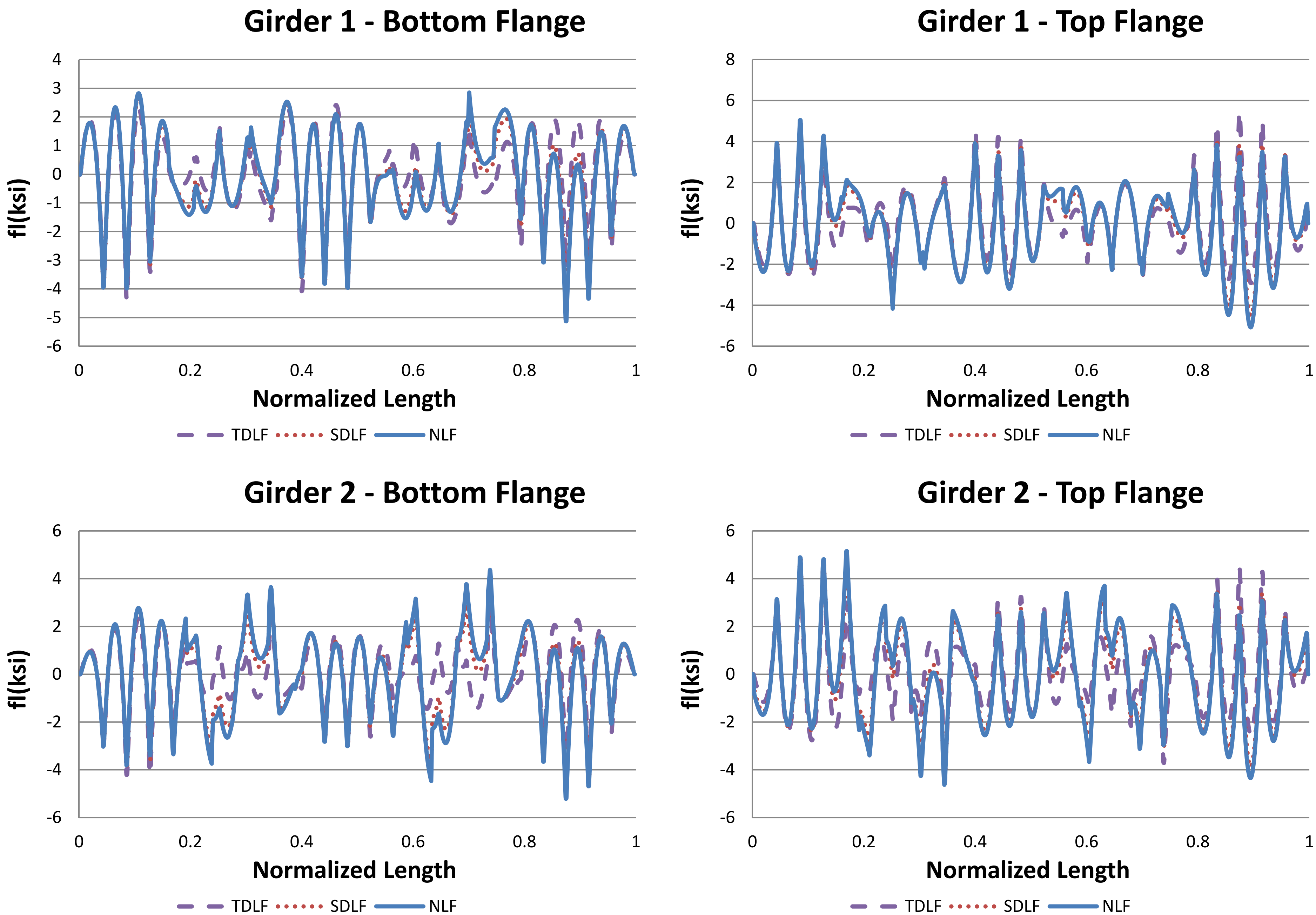


Figure S-4-21. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

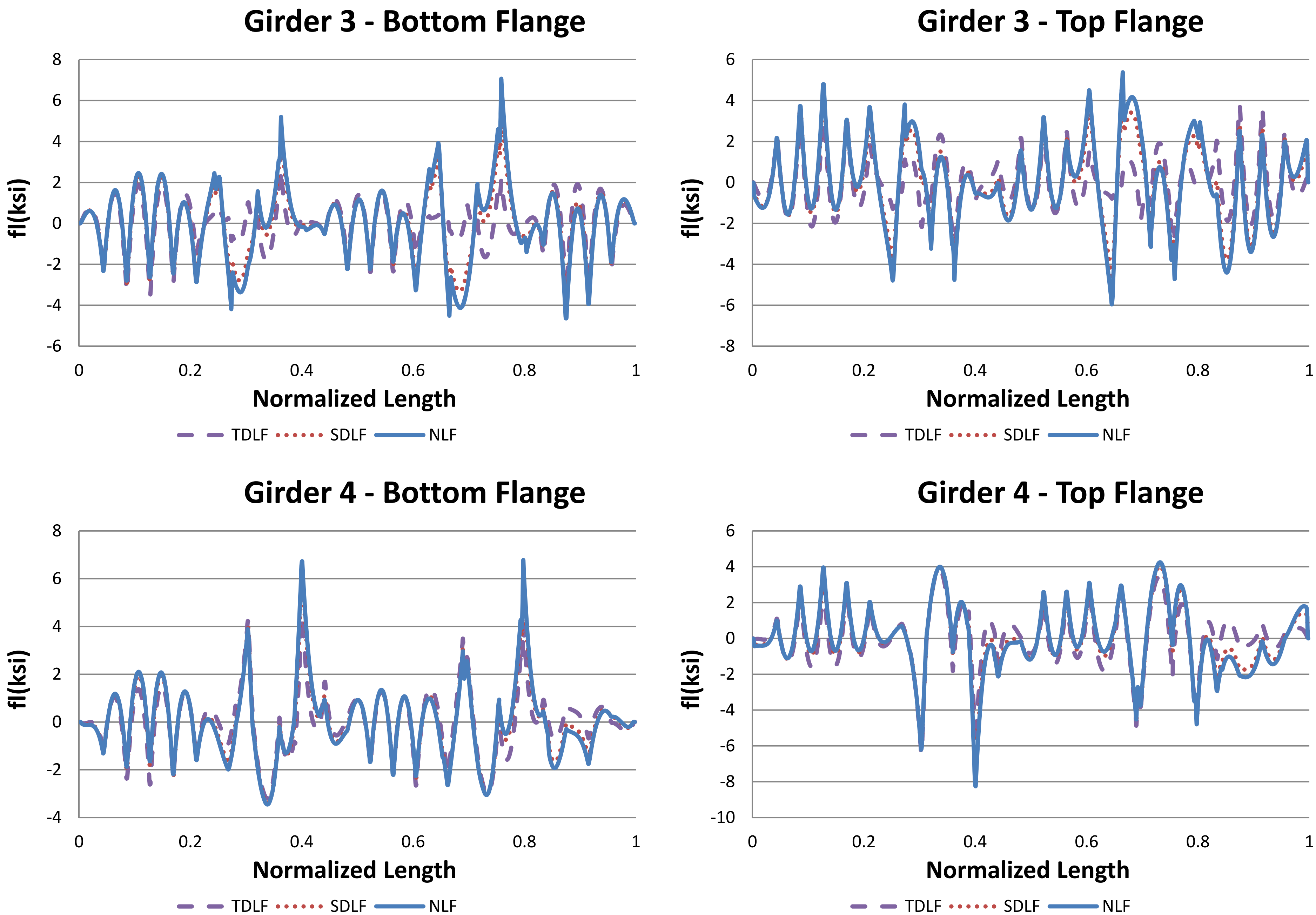


Figure S-4-21(Continued). **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

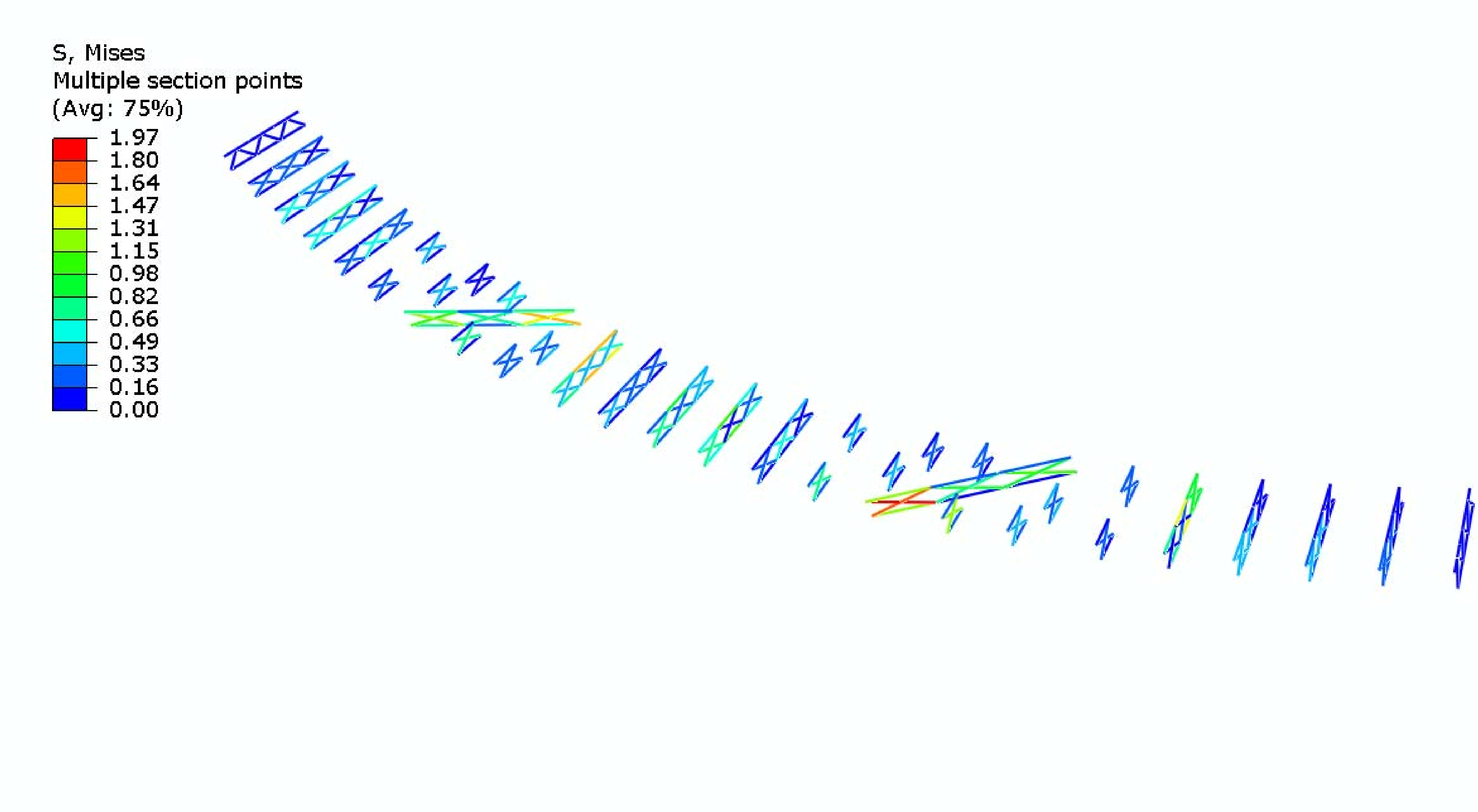


Figure S-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing

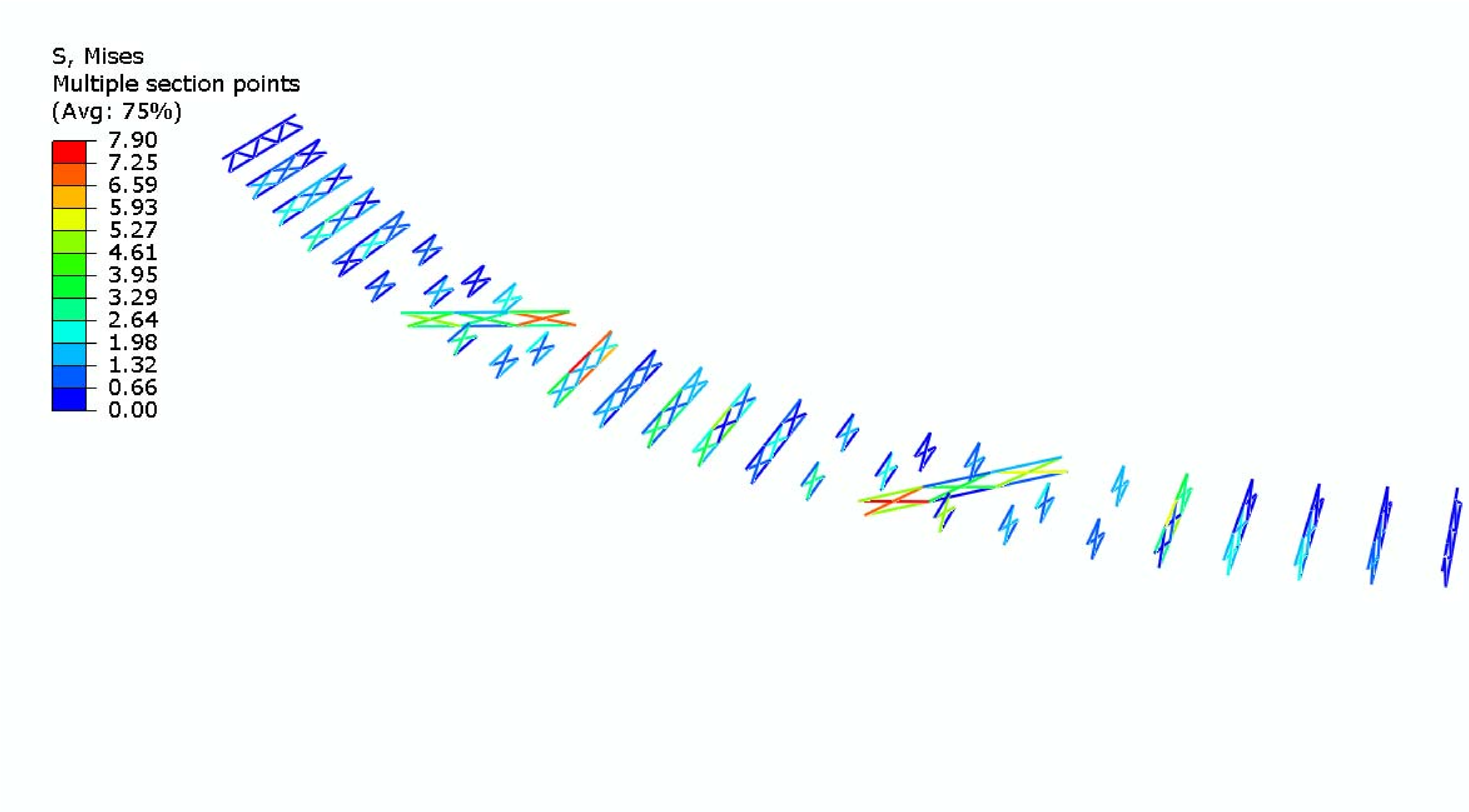


Figure S-4-23. Cross-frame stress contours under TDL, NLF detailing

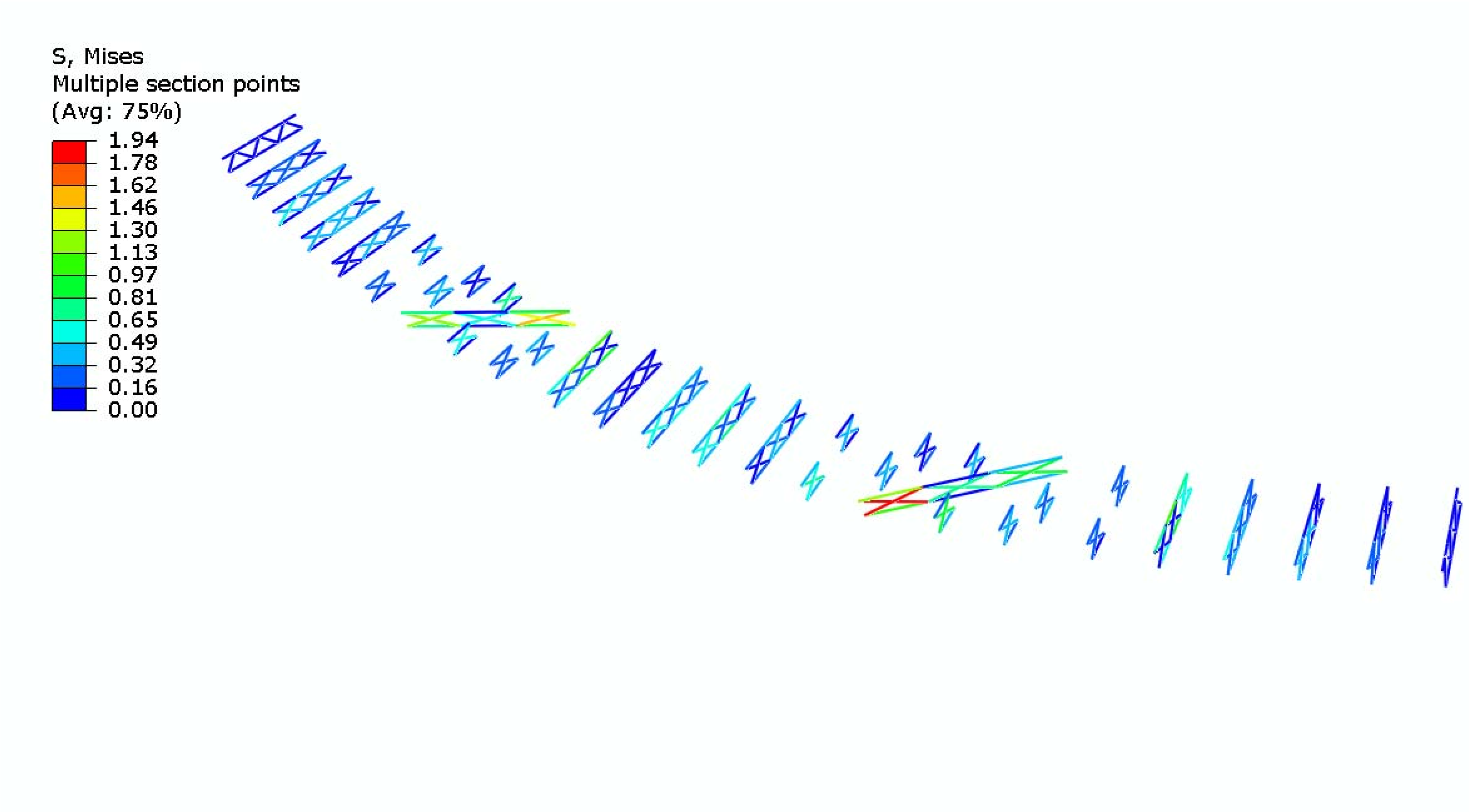


Figure S-4-24. Cross-frame stress contours under SDL, SDLF detailing

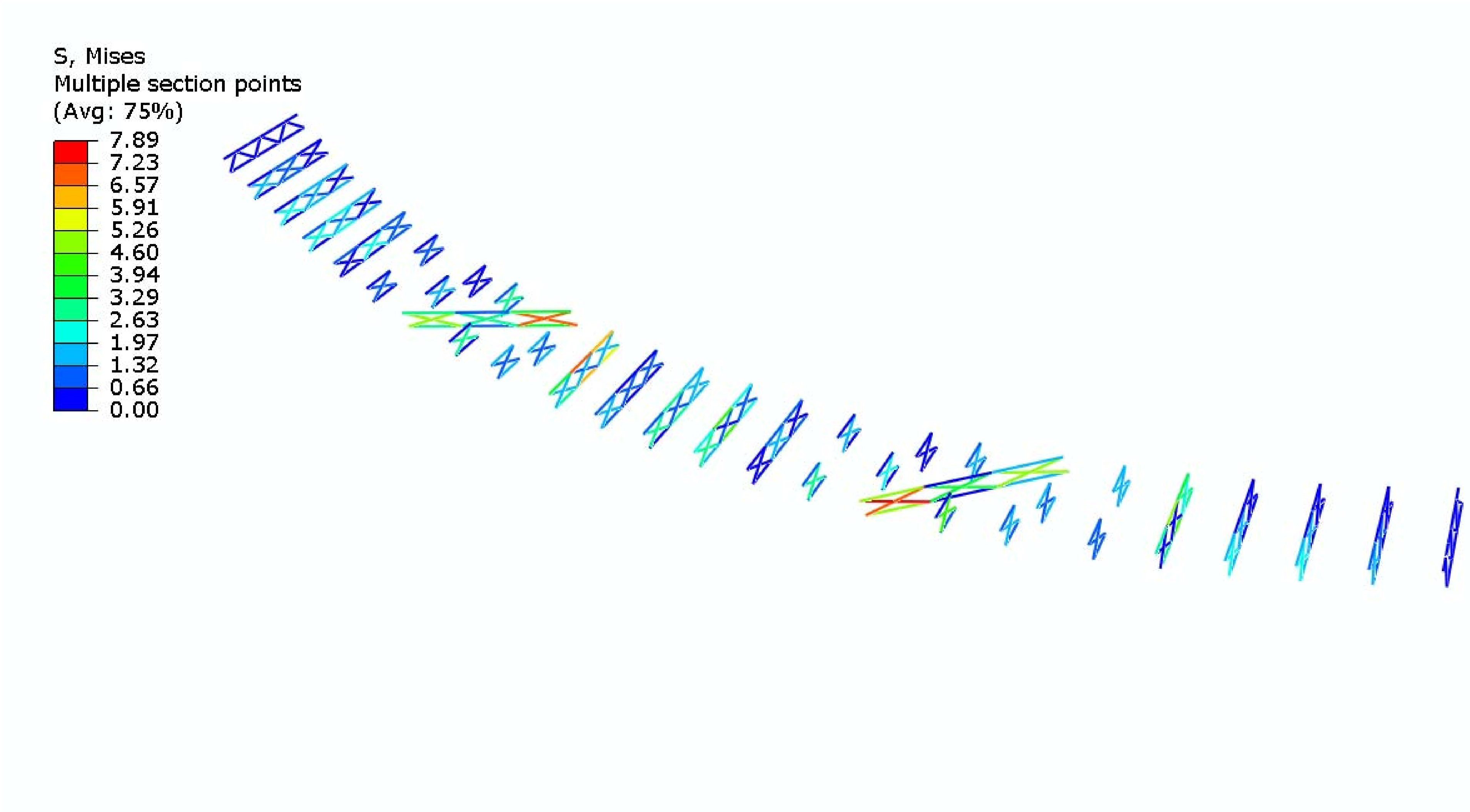


Figure S-4-25. Cross-frame stress contours under TDL, SDLF detailing

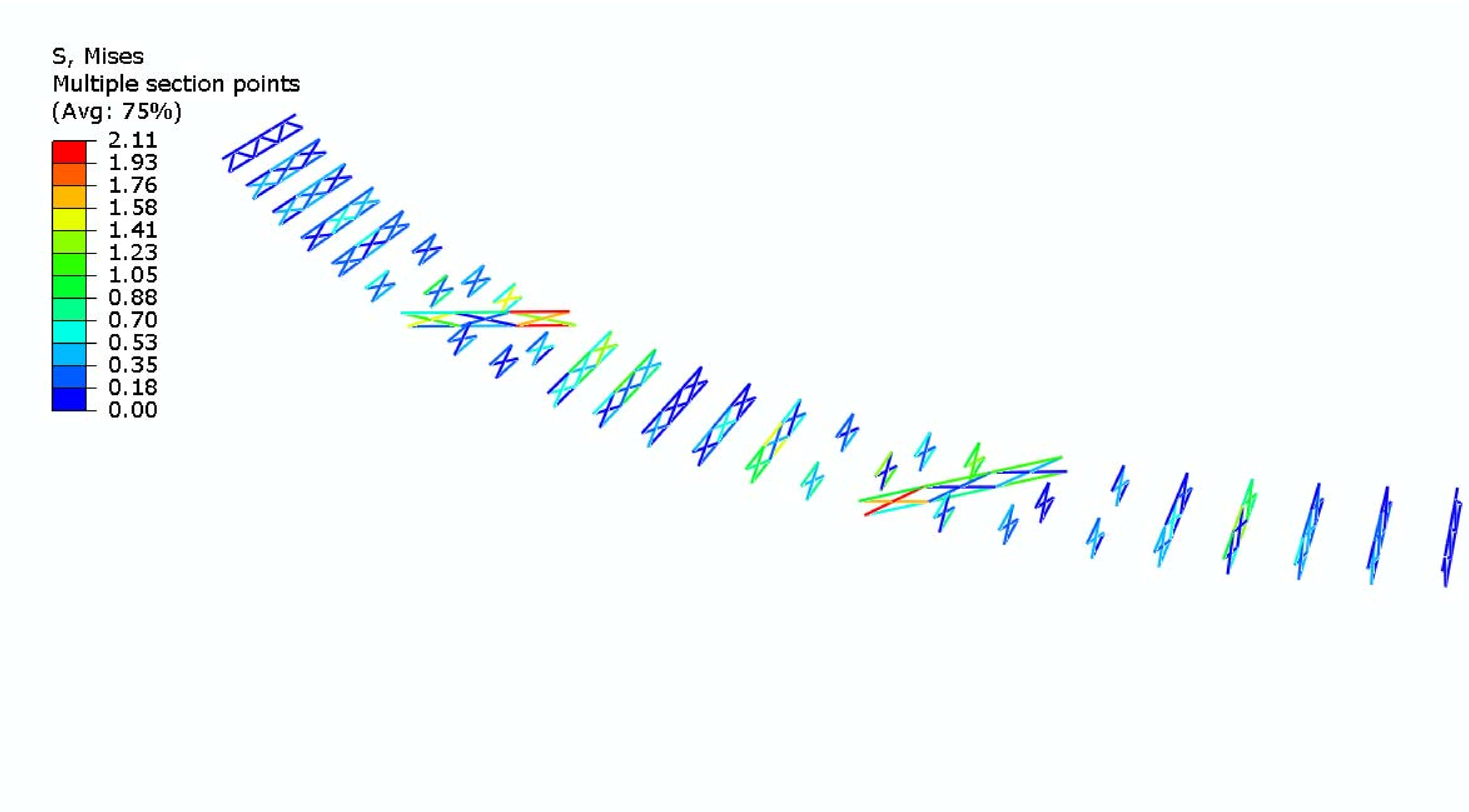


Figure S-4-26. Cross-frame stress contours under SDL, TDLF detailing

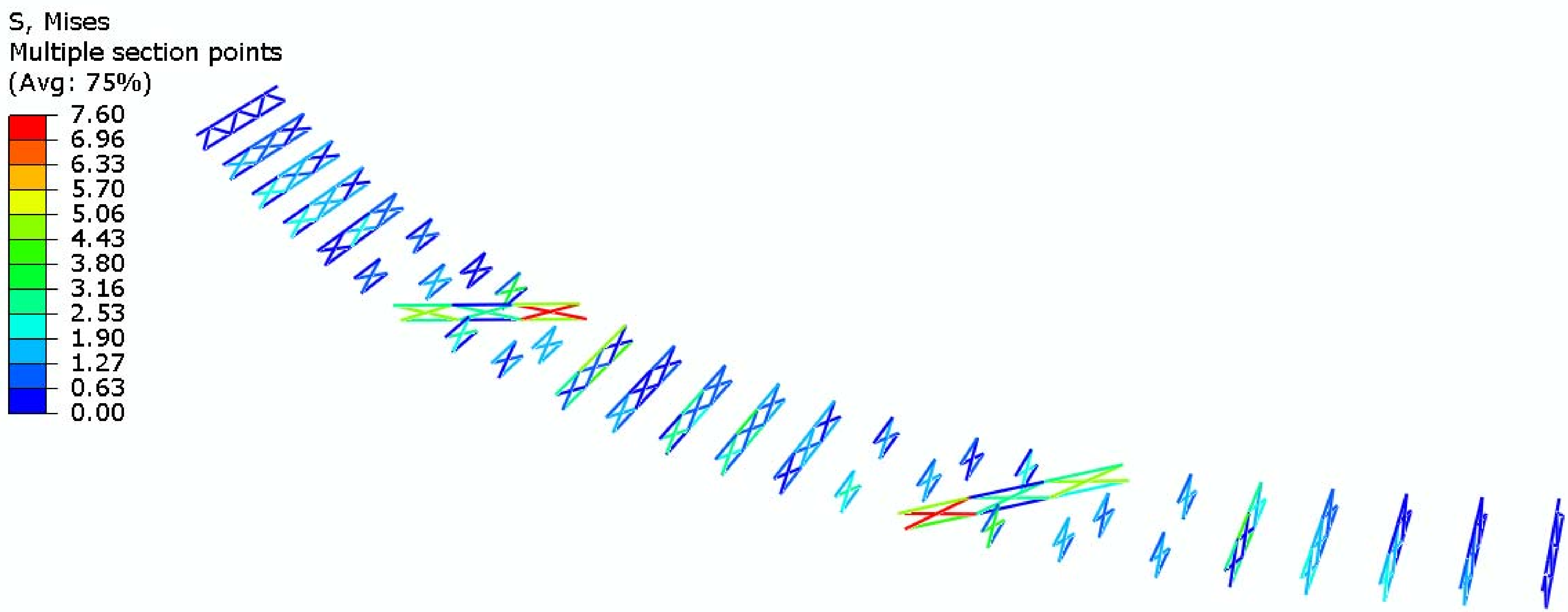


Figure S-4-27. Cross-frame stress contours under TDL, TDLF detailing

Table S-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	0.5	0.5	0.6
	SDLF	0.3	0.4	0.4
	TDLF	0.5	0.5	0.6
2	NLF	1.8	1.5	0.7
	SDLF	2.1	1.5	0.6
	TDLF	3.0	1.2	0.2
3	NLF	3.3	2.1	0.8
	SDLF	3.3	2.1	0.9
	TDLF	3.4	1.8	0.9
4	NLF	3.7	1.9	0.7
	SDLF	2.7	2.4	1.2
	TDLF	0.9	4.1	2.6
5	NLF	1.3	4.1	1.5
	SDLF	0.5	3.1	1.5
	TDLF	2.2	0.7	1.8
6	NLF	2.2	2.5	2.5
	SDLF	2.0	2.4	2.2
	TDLF	1.6	2.0	1.3
7	NLF	8.3	5.1	0.5
	SDLF	8.3	4.1	0.2
	TDLF	9.8	2.3	2.2
8	NLF	4.9	1.7	3.4
	SDLF	4.0	2.0	4.9
	TDLF	1.4	3.6	10.2
9	NLF	1.5	3.0	10.0
	SDLF	1.3	1.3	9.9
	TDLF	0.7	4.3	10.8
10	NLF	3.0	1.6	3.6
	SDLF	1.4	0.8	0.6
	TDLF	4.3	1.6	9.1

Table S-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	2.6	1.9	1.5
	SDLF	2.1	1.7	0.4
	TDLF	0.3	1.1	3.4
12	NLF	4.7	0.9	2.4
	SDLF	4.2	1.7	1.7
	TDLF	2.7	4.5	0.8
13	NLF	4.9	3.3	1.7
	SDLF	3.6	2.2	1.1
	TDLF	1.0	2.7	1.1
14	NLF	1.8	3.2	0.5
	SDLF	0.2	2.6	0.1
	TDLF	5.8	0.7	1.4
15	NLF	4.9	5.7	2.7
	SDLF	4.4	4.5	2.4
	TDLF	3.2	1.8	1.6
16	NLF	13.0	1.9	1.3
	SDLF	12.8	1.5	0.7
	TDLF	12.9	0.5	1.9
17	NLF	7.7	1.3	1.4
	SDLF	6.0	0.4	3.1
	TDLF	1.6	4.5	8.8
18	NLF	2.8	2.8	6.9
	SDLF	2.6	2.1	5.7
	TDLF	1.9	0.3	3.1
19	NLF	1.2	2.4	1.9
	SDLF	1.7	2.5	2.0
	TDLF	3.4	3.0	2.5
20	NLF	1.1	1.5	5.8
	SDLF	0.2	1.6	4.0
	TDLF	2.4	2.0	1.2

Table S-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	2.7	0.6	0.0
	SDLF	2.0	0.4	1.6
	TDLF	0.6	0.4	6.1
22	NLF	3.2	NA	0.1
	SDLF	2.8	NA	0.4
	TDLF	2.1	NA	1.4
23	NLF	1.7	NA	0.4
	SDLF	1.9	NA	0.2
	TDLF	2.9	NA	0.5
24	NLF	0.6	NA	0.5
	SDLF	0.4	NA	0.4
	TDLF	0.5	NA	0.2

Table S-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	2.2	1.7	1.2
	SDLF	2.1	1.5	1.0
	TDLF	1.7	1.0	0.5
2	NLF	10.0	6.6	2.2
	SDLF	10.2	6.6	2.1
	TDLF	11.1	6.3	1.5
3	NLF	15.9	9.0	2.7
	SDLF	16.0	9.0	2.8
	TDLF	16.3	9.0	2.9
4	NLF	18.0	8.2	1.9
	SDLF	17.1	8.8	2.4
	TDLF	13.8	10.4	3.9
5	NLF	3.4	17.1	4.8
	SDLF	2.3	15.9	4.9
	TDLF	0.8	12.9	5.3
6	NLF	8.1	11.6	8.6
	SDLF	8.0	11.5	8.4
	TDLF	7.4	11.0	7.6
7	NLF	34.0	22.5	0.3
	SDLF	34.0	21.5	0.9
	TDLF	33.0	17.9	2.8
8	NLF	20.3	7.3	17.3
	SDLF	19.4	7.6	19.0
	TDLF	16.8	9.3	24.1
9	NLF	5.0	12.6	47.3
	SDLF	4.9	10.8	46.9
	TDLF	4.3	5.2	47.8
10	NLF	12.0	7.0	13.9
	SDLF	10.3	6.3	10.9
	TDLF	4.6	3.7	0.8

Table S-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	12.6	8.3	7.2
	SDLF	12.0	8.1	6.1
	TDLF	10.1	7.4	2.4
12	NLF	22.1	4.1	11.1
	SDLF	21.6	5.0	10.5
	TDLF	19.9	7.6	8.2
13	NLF	23.0	13.8	8.5
	SDLF	21.7	12.3	7.9
	TDLF	17.4	9.0	5.8
14	NLF	5.9	14.2	1.2
	SDLF	3.8	13.5	0.9
	TDLF	2.5	11.5	1.1
15	NLF	19.3	25.5	9.3
	SDLF	18.8	24.3	9.2
	TDLF	17.3	19.5	8.6
16	NLF	52.2	8.5	3.6
	SDLF	52.1	8.1	3.1
	TDLF	50.2	7.4	1.2
17	NLF	31.2	4.4	8.8
	SDLF	29.7	2.9	10.6
	TDLF	25.2	2.1	16.4
18	NLF	9.8	13.1	35.4
	SDLF	9.7	12.1	34.1
	TDLF	9.3	9.4	30.7
19	NLF	7.3	11.2	9.8
	SDLF	7.8	11.2	10.0
	TDLF	9.2	11.2	10.6
20	NLF	1.0	6.8	20.7
	SDLF	1.7	7.0	18.7
	TDLF	3.8	7.4	12.8

Table S-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	14.5	2.0	1.4
	SDLF	13.8	1.8	0.4
	TDLF	11.4	1.0	4.4
22	NLF	15.9	NA	0.9
	SDLF	15.4	NA	0.6
	TDLF	14.0	NA	0.5
23	NLF	9.0	NA	0.3
	SDLF	9.1	NA	0.2
	TDLF	10.0	NA	0.7
24	NLF	3.0	NA	1.1
	SDLF	2.7	NA	1.0
	TDLF	1.9	NA	0.2

Table S-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	0.1	0.1	0.2
	SDLF	0.1	0.1	0.2
	TDLF	0.1	0.1	0.0
2	NLF	0.1	1.3	1.4
	SDLF	0.2	1.6	1.5
	TDLF	1.1	2.9	2.0
3	NLF	0.5	2.9	2.5
	SDLF	0.6	2.9	2.4
	TDLF	1.1	3.0	2.3
4	NLF	1.5	4.0	3.0
	SDLF	0.8	2.7	2.6
	TDLF	1.7	1.5	1.2
5	NLF	0.9	0.4	1.9
	SDLF	0.1	0.6	1.9
	TDLF	2.3	3.4	1.4
6	NLF	0.5	0.1	0.3
	SDLF	1.0	1.4	0.6
	TDLF	3.1	5.7	1.6
7	NLF	5.4	1.3	0.7
	SDLF	4.5	0.1	1.2
	TDLF	2.1	3.5	2.8
8	NLF	0.7	2.9	1.6
	SDLF	0.2	2.4	0.3
	TDLF	2.9	0.8	4.1
9	NLF	1.7	9.9	3.7
	SDLF	1.7	6.2	6.0
	TDLF	1.5	6.2	13.9
10	NLF	4.6	1.3	9.1
	SDLF	3.5	0.4	6.0
	TDLF	0.5	6.4	4.3

Table S-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
11	NLF	0.4	5.2	0.7
	SDLF	1.0	4.0	0.8
	TDLF	2.8	0.0	5.7
12	NLF	1.6	6.7	3.0
	SDLF	1.2	4.8	2.2
	TDLF	0.2	1.5	0.4
13	NLF	3.5	0.6	3.8
	SDLF	2.3	2.9	3.2
	TDLF	1.8	9.7	1.1
14	NLF	0.5	0.1	2.1
	SDLF	2.0	1.8	2.5
	TDLF	6.2	8.0	3.6
15	NLF	1.6	0.4	0.4
	SDLF	2.4	1.1	0.8
	TDLF	5.4	5.3	2.4
16	NLF	8.5	3.1	0.8
	SDLF	7.4	2.3	1.6
	TDLF	3.7	0.1	4.4
17	NLF	1.1	8.7	1.1
	SDLF	2.3	6.4	0.6
	TDLF	5.5	0.2	6.0
18	NLF	1.4	0.4	0.5
	SDLF	1.5	2.4	2.2
	TDLF	1.9	8.3	8.0
19	NLF	0.9	0.6	2.1
	SDLF	1.0	0.1	1.4
	TDLF	1.0	2.1	0.4
20	NLF	4.6	0.0	5.4
	SDLF	4.1	0.3	3.9
	TDLF	2.9	1.3	0.3

Table S-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	2.3	0.1	0.2
	SDLF	3.0	0.0	1.2
	TDLF	4.6	0.1	5.2
22	NLF	1.5	NA	0.9
	SDLF	1.9	NA	0.5
	TDLF	2.7	NA	0.5
23	NLF	1.1	NA	0.4
	SDLF	1.0	NA	0.6
	TDLF	0.5	NA	1.2
24	NLF	0.0	NA	0.2
	SDLF	0.0	NA	0.1
	TDLF	0.1	NA	0.0

Table S-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	0.8	0.1	0.3
	SDLF	0.8	0.2	0.3
	TDLF	1.0	0.3	0.5
2	NLF	2.6	4.6	3.8
	SDLF	2.3	5.0	3.9
	TDLF	1.4	6.2	4.3
3	NLF	0.4	11.5	8.8
	SDLF	0.5	11.5	8.8
	TDLF	0.9	11.6	8.7
4	NLF	4.7	16.8	11.2
	SDLF	4.0	15.6	10.9
	TDLF	1.7	11.5	9.7
5	NLF	4.3	0.4	7.6
	SDLF	3.6	0.6	7.5
	TDLF	1.6	3.2	7.0
6	NLF	0.7	0.7	0.3
	SDLF	1.3	1.9	0.0
	TDLF	3.5	6.3	1.0
7	NLF	20.0	6.1	2.1
	SDLF	19.2	4.9	2.5
	TDLF	17.1	1.2	3.9
8	NLF	4.0	12.6	9.4
	SDLF	3.0	12.1	8.1
	TDLF	0.5	10.4	3.3
9	NLF	9.3	43.8	19.6
	SDLF	9.2	40.1	22.0
	TDLF	8.9	27.7	30.5
10	NLF	22.6	4.7	41.5
	SDLF	21.3	3.0	38.5
	TDLF	17.3	3.0	28.2

Table S-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location		
		G1-G2	G2-G3	G3-G4
11	NLF	3.8	21.2	1.6
	SDLF	4.4	20.0	0.1
	TDLF	6.2	16.0	5.0
12	NLF	4.7	28.1	10.7
	SDLF	4.2	26.3	9.9
	TDLF	2.9	20.0	7.4
13	NLF	13.0	3.1	14.4
	SDLF	11.8	5.5	13.8
	TDLF	7.9	12.2	11.8
14	NLF	1.9	0.3	8.0
	SDLF	3.2	2.0	8.5
	TDLF	7.0	8.2	9.5
15	NLF	5.0	2.6	0.1
	SDLF	5.9	1.0	0.4
	TDLF	9.3	3.5	2.0
16	NLF	32.9	12.6	2.4
	SDLF	31.6	11.6	3.2
	TDLF	27.6	9.4	5.8
17	NLF	3.5	31.9	6.4
	SDLF	4.8	29.4	4.7
	TDLF	8.3	22.8	0.8
18	NLF	7.0	1.0	7.5
	SDLF	7.0	2.9	9.4
	TDLF	7.5	8.1	15.5
19	NLF	5.5	2.4	10.4
	SDLF	5.6	1.7	9.6
	TDLF	5.6	0.0	7.7
20	NLF	19.1	0.4	21.1
	SDLF	18.5	0.1	19.7
	TDLF	16.9	1.0	15.4

Table S-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location		
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**
21	NLF	11.7	0.4	0.0
	SDLF	12.1	0.5	1.2
	TDLF	13.0	0.5	4.9
22	NLF	8.5	NA	2.9
	SDLF	8.7	NA	2.6
	TDLF	9.2	NA	1.5
23	NLF	6.4	NA	0.3
	SDLF	6.3	NA	0.5
	TDLF	5.9	NA	1.2
24	NLF	1.2	NA	0.5
	SDLF	1.2	NA	0.6
	TDLF	1.2	NA	0.6

Table S-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	0.2	0.2	0.1
	SDLF	0.2	0.1	0.2
	TDLF	0.2	0.3	0.4
2	NLF	0.1	1.2	1.3
	SDLF	0.1	1.5	1.4
	TDLF	0.8	2.7	1.9
3	NLF	0.5	2.8	2.4
	SDLF	0.5	2.7	2.3
	TDLF	0.7	2.8	2.2
4	NLF	1.5	3.9	2.9
	SDLF	0.6	2.6	2.5
	TDLF	2.0	1.6	1.1
5	NLF	0.9	0.4	1.9
	SDLF	0.2	0.5	1.8
	TDLF	2.0	3.2	1.6
6	NLF	0.4	0.1	0.3
	SDLF	1.0	1.3	0.6
	TDLF	3.1	5.6	1.5
7	NLF	4.4	1.9	0.7
	SDLF	4.2	0.2	1.1
	TDLF	3.5	5.0	2.5
8	NLF	0.7	2.7	1.7
	SDLF	0.1	2.4	0.5
	TDLF	1.8	1.4	3.4
9	NLF	1.6	9.5	4.0
	SDLF	1.7	6.1	5.7
	TDLF	1.9	5.5	11.5
10	NLF	4.4	1.3	8.8
	SDLF	3.4	0.5	5.9
	TDLF	0.2	6.2	3.7

Table S-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	0.4	5.0	0.7
	SDLF	1.0	3.8	0.8
	TDLF	3.3	0.1	5.7
12	NLF	1.6	6.5	2.9
	SDLF	1.0	4.6	2.0
	TDLF	0.9	1.7	0.7
13	NLF	3.4	0.5	3.7
	SDLF	2.0	2.6	3.0
	TDLF	2.3	8.9	0.6
14	NLF	0.4	0.0	2.0
	SDLF	1.8	1.7	2.4
	TDLF	5.7	7.6	3.3
15	NLF		1.1	0.4
	SDLF		0.9	0.7
	TDLF		6.9	2.0
16	NLF	7.4	2.9	0.8
	SDLF	7.0	2.3	1.5
	TDLF	5.6	0.6	3.9
17	NLF	1.0	8.3	1.0
	SDLF	1.7	6.2	0.4
	TDLF	3.9	0.4	5.2
18	NLF	1.3	0.4	1.0
	SDLF	1.5	2.3	2.2
	TDLF	2.2	8.0	6.5
19	NLF	0.9	0.6	1.9
	SDLF	1.0	0.1	1.4
	TDLF	1.2	2.0	0.4
20	NLF	4.4	0.0	5.3
	SDLF	4.0	0.2	3.8
	TDLF	3.0	1.1	0.3

Table S-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	2.1	0.2	0.2
	SDLF	2.9	0.2	1.1
	TDLF	5.2	0.1	5.0
22	NLF	1.4	NA	0.9
	SDLF	1.9	NA	0.5
	TDLF	3.3	NA	0.6
23	NLF	1.1	NA	0.4
	SDLF	1.0	NA	0.6
	TDLF	0.8	NA	1.0
24	NLF	0.3	NA	0.2
	SDLF	0.3	NA	0.1
	TDLF	0.1	NA	0.1

Table S-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4
1	NLF	2.2	1.1	0.9
	SDLF	2.2	1.1	0.9
	TDLF	2.1	0.9	0.8
2	NLF	2.6	4.2	3.4
	SDLF	2.4	4.5	3.5
	TDLF	1.8	5.7	4.0
3	NLF	0.3	10.9	8.4
	SDLF	0.3	10.8	8.3
	TDLF	0.3	10.9	8.2
4	NLF	4.9	16.6	11.0
	SDLF	4.0	15.2	10.5
	TDLF	1.1	10.9	9.1
5	NLF	5.2	1.3	6.7
	SDLF	4.4	0.4	6.7
	TDLF	1.9	2.7	6.8
6	NLF	0.4	0.2	0.5
	SDLF	1.0	1.4	0.2
	TDLF	3.1	5.8	0.6
7	NLF	16.9	8.2	1.2
	SDLF	16.6	6.5	1.6
	TDLF	15.5	1.3	3.2
8	NLF	4.4	11.8	8.7
	SDLF	3.8	11.5	7.5
	TDLF	1.8	10.5	3.7
9	NLF	8.8	42.6	21.2
	SDLF	9.0	39.1	23.0
	TDLF	9.1	27.2	29.1
10	NLF	22.1	4.0	40.0
	SDLF	21.0	2.3	37.1
	TDLF	17.1	3.3	27.3

Table S-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	3.9	20.4	0.7
	SDLF	4.5	19.1	0.8
	TDLF	6.7	15.1	5.6
12	NLF	4.5	27.6	10.4
	SDLF	3.9	25.6	9.5
	TDLF	2.0	19.1	6.6
13	NLF	13.1	2.1	14.1
	SDLF	11.6	4.3	13.4
	TDLF	7.0	11.1	10.9
14	NLF	0.4	0.3	7.2
	SDLF	1.9	1.4	7.6
	TDLF	6.1	7.4	8.8
15	NLF		4.8	0.2
	SDLF		2.8	0.1
	TDLF		3.0	1.4
16	NLF	28.3	11.6	1.4
	SDLF	27.9	11.1	2.1
	TDLF	26.4	9.3	4.7
17	NLF	3.3	31.9	6.2
	SDLF	3.8	29.5	4.8
	TDLF	5.8	22.5	0.0
18	NLF	6.8	0.6	8.3
	SDLF	7.0	2.5	9.8
	TDLF	7.5	7.9	15.0
19	NLF	5.5	2.2	9.6
	SDLF	5.4	1.6	9.1
	TDLF	5.6	0.1	7.4
20	NLF	19.0	0.6	21.8
	SDLF	18.3	0.3	20.0
	TDLF	16.6	0.7	15.3

Table S-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	10.7	1.4	0.2
	SDLF	11.2	1.4	1.1
	TDLF	13.0	1.1	4.9
22	NLF	7.8	NA	2.8
	SDLF	8.1	NA	2.3
	TDLF	9.2	NA	1.3
23	NLF	6.5	NA	0.3
	SDLF	6.4	NA	0.4
	TDLF	6.1	NA	0.9
24	NLF	2.7	NA	1.1
	SDLF	2.7	NA	1.1
	TDLF	2.4	NA	0.8

Table S-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location		
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**
1	NLF	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00
2	NLF	-0.07	-0.06	-0.06
	SDLF	-0.08	-0.07	-0.06
	TDLF	-0.11	-0.10	-0.07
3	NLF	-0.14	-0.13	-0.12
	SDLF	-0.16	-0.14	-0.13
	TDLF	-0.22	-0.19	-0.15
4	NLF	-0.20	-0.19	-0.18
	SDLF	-0.22	-0.21	-0.19
	TDLF	-0.31	-0.28	-0.23
5	NLF	-0.22	-0.23	-0.23
	SDLF	-0.24	-0.26	-0.25
	TDLF	-0.32	-0.35	-0.32
6	NLF	-0.16	-0.17	-0.25
	SDLF	-0.18	-0.20	-0.28
	TDLF	-0.25	-0.27	-0.39
7	NLF	0.00	0.00	-0.22
	SDLF	0.00	0.00	-0.26
	TDLF	0.00	0.00	-0.39
8	NLF	0.14	0.18	-0.15
	SDLF	0.15	0.17	-0.19
	TDLF	0.15	0.16	-0.30
9	NLF	0.22	0.20	0.00
	SDLF	0.23	0.21	0.00
	TDLF	0.29	0.24	0.00
10	NLF	0.22	0.16	0.17
	SDLF	0.24	0.17	0.16
	TDLF	0.31	0.21	0.13

Table S-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	0.16	0.06	0.17
	SDLF	0.17	0.07	0.18
	TDLF	0.21	0.10	0.21
12	NLF	0.05	-0.06	0.08
	SDLF	0.05	-0.06	0.10
	TDLF	0.05	-0.05	0.17
13	NLF	-0.08	-0.16	-0.04
	SDLF	-0.09	-0.17	-0.03
	TDLF	-0.11	-0.20	0.03
14	NLF	-0.16	-0.17	-0.16
	SDLF	-0.17	-0.20	-0.16
	TDLF	-0.20	-0.26	-0.15
15	NLF	-0.13	0.00	-0.24
	SDLF	-0.14	0.00	-0.26
	TDLF	-0.21	0.00	-0.32
16	NLF	0.00	0.25	-0.26
	SDLF	0.00	0.23	-0.30
	TDLF	0.00	0.17	-0.43
17	NLF	0.16	0.37	-0.20
	SDLF	0.16	0.37	-0.24
	TDLF	0.12	0.38	-0.38
18	NLF	0.27	0.34	0.00
	SDLF	0.28	0.35	0.00
	TDLF	0.29	0.36	0.00
19	NLF	0.38	0.27	0.23
	SDLF	0.39	0.27	0.20
	TDLF	0.43	0.28	0.12
20	NLF	0.39	0.15	0.34
	SDLF	0.40	0.15	0.33
	TDLF	0.44	0.15	0.28

Table S-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	0.35	0.00	0.35
	SDLF	0.36	0.00	0.35
	TDLF	0.38	0.00	0.35
22	NLF	0.27	NA	0.27
	SDLF	0.27	NA	0.28
	TDLF	0.28	NA	0.30
23	NLF	0.15	NA	0.15
	SDLF	0.15	NA	0.15
	TDLF	0.16	NA	0.17
24	NLF	0.00	NA	0.00
	SDLF	0.00	NA	0.00
	TDLF	0.00	NA	0.00

Table S-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
1	NLF	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00
2	NLF	-0.27	-0.26	-0.25
	SDLF	-0.28	-0.27	-0.25
	TDLF	-0.31	-0.29	-0.26
3	NLF	-0.56	-0.54	-0.51
	SDLF	-0.58	-0.55	-0.51
	TDLF	-0.65	-0.59	-0.53
4	NLF	-0.85	-0.80	-0.76
	SDLF	-0.87	-0.82	-0.77
	TDLF	-0.95	-0.88	-0.81
5	NLF	-0.96	-1.00	-0.98
	SDLF	-0.98	-1.03	-1.00
	TDLF	-1.05	-1.11	-1.06
6	NLF	-0.69	-0.76	-1.10
	SDLF	-0.71	-0.78	-1.13
	TDLF	-0.78	-0.85	-1.23
7	NLF	0.00	0.00	-0.98
	SDLF	0.00	0.00	-1.02
	TDLF	0.00	0.00	-1.14
8	NLF	0.60	0.77	-0.66
	SDLF	0.60	0.76	-0.69
	TDLF	0.60	0.74	-0.81
9	NLF	0.93	0.89	0.00
	SDLF	0.95	0.90	0.00
	TDLF	1.00	0.93	0.00
10	NLF	0.97	0.71	0.75
	SDLF	0.99	0.72	0.75
	TDLF	1.06	0.76	0.72

Table S-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location		
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**
11	NLF	0.70	0.28	0.73
	SDLF	0.71	0.29	0.75
	TDLF	0.75	0.32	0.78
12	NLF	0.23	-0.25	0.34
	SDLF	0.23	-0.24	0.37
	TDLF	0.23	-0.23	0.44
13	NLF	-0.33	-0.71	-0.18
	SDLF	-0.33	-0.72	-0.17
	TDLF	-0.36	-0.74	-0.11
14	NLF	-0.69	-0.75	-0.68
	SDLF	-0.70	-0.77	-0.68
	TDLF	-0.73	-0.84	-0.67
15	NLF	-0.56	0.00	-1.04
	SDLF	-0.57	0.00	-1.06
	TDLF	-0.63	0.00	-1.12
16	NLF	0.00	1.05	-1.14
	SDLF	0.00	1.02	-1.18
	TDLF	0.00	0.95	-1.30
17	NLF	0.64	1.54	-0.84
	SDLF	0.63	1.54	-0.89
	TDLF	0.59	1.52	-1.02
18	NLF	1.10	1.43	0.00
	SDLF	1.10	1.43	0.00
	TDLF	1.10	1.42	0.00
19	NLF	1.55	1.10	0.98
	SDLF	1.56	1.10	0.95
	TDLF	1.58	1.10	0.86
20	NLF	1.60	0.60	1.44
	SDLF	1.60	0.60	1.42
	TDLF	1.62	0.60	1.36

Table S-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	1.44	0.00	1.45
	SDLF	1.45	0.00	1.44
	TDLF	1.45	0.00	1.43
22	NLF	1.10	NA	1.13
	SDLF	1.11	NA	1.13
	TDLF	1.10	NA	1.14
23	NLF	0.61	NA	0.61
	SDLF	0.61	NA	0.62
	TDLF	0.61	NA	0.62
24	NLF	0.00	NA	0.00
	SDLF	0.00	NA	0.00
	TDLF	0.00	NA	0.00

Table S-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00
2	NLF	-0.04	-0.04	-0.04
	SDLF	-0.05	-0.05	-0.04
	TDLF	-0.08	-0.07	-0.05
3	NLF	-0.09	-0.09	-0.08
	SDLF	-0.11	-0.10	-0.09
	TDLF	-0.15	-0.13	-0.10
4	NLF	-0.13	-0.13	-0.12
	SDLF	-0.15	-0.14	-0.13
	TDLF	-0.21	-0.19	-0.16
5	NLF	-0.15	-0.16	-0.15
	SDLF	-0.17	-0.18	-0.17
	TDLF	-0.22	-0.23	-0.22
6	NLF	-0.11	-0.12	-0.17
	SDLF	-0.12	-0.13	-0.19
	TDLF	-0.17	-0.18	-0.26
7	NLF	0.00	0.00	-0.15
	SDLF	0.00	0.00	-0.18
	TDLF	0.00	0.00	-0.26
8	NLF	0.10	0.12	-0.10
	SDLF	0.10	0.12	-0.13
	TDLF	0.10	0.11	-0.20
9	NLF	0.15	0.14	0.00
	SDLF	0.16	0.14	0.00
	TDLF	0.19	0.16	0.00
10	NLF	0.15	0.11	0.12
	SDLF	0.16	0.12	0.11
	TDLF	0.21	0.14	0.09

Table S-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	0.11	0.04	0.11
	SDLF	0.11	0.05	0.12
	TDLF	0.14	0.07	0.14
12	NLF	0.03	-0.04	0.05
	SDLF	0.03	-0.04	0.07
	TDLF	0.03	-0.03	0.11
13	NLF	-0.05	-0.11	-0.03
	SDLF	-0.06	-0.12	-0.02
	TDLF	-0.08	-0.14	0.02
14	NLF	-0.11	-0.12	-0.11
	SDLF	-0.11	-0.13	-0.11
	TDLF	-0.14	-0.18	-0.10
15	NLF	-0.09	0.00	-0.16
	SDLF	-0.10	0.00	-0.18
	TDLF	-0.14	0.00	-0.22
16	NLF	0.00	0.17	-0.18
	SDLF	0.00	0.16	-0.21
	TDLF	0.00	0.11	-0.29
17	NLF	0.11	0.25	-0.13
	SDLF	0.11	0.25	-0.16
	TDLF	0.08	0.25	-0.26
18	NLF	0.18	0.23	0.00
	SDLF	0.19	0.24	0.00
	TDLF	0.20	0.24	0.00
19	NLF	0.25	0.18	0.16
	SDLF	0.27	0.18	0.14
	TDLF	0.29	0.19	0.08
20	NLF	0.26	0.10	0.23
	SDLF	0.27	0.10	0.22
	TDLF	0.30	0.10	0.19

Table S-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
21	NLF	0.24	0.00	0.24
	SDLF	0.24	0.00	0.24
	TDLF	0.26	0.00	0.24
22	NLF	0.18	NA	0.19
	SDLF	0.18	NA	0.19
	TDLF	0.19	NA	0.20
23	NLF	0.10	NA	0.10
	SDLF	0.10	NA	0.10
	TDLF	0.11	NA	0.12
24	NLF	0.00	NA	0.00
	SDLF	0.00	NA	0.00
	TDLF	0.00	NA	0.00

Table S-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00
2	NLF	-0.18	-0.18	-0.17
	SDLF	-0.19	-0.18	-0.17
	TDLF	-0.21	-0.20	-0.17
3	NLF	-0.38	-0.37	-0.34
	SDLF	-0.40	-0.37	-0.35
	TDLF	-0.44	-0.40	-0.36
4	NLF	-0.57	-0.54	-0.52
	SDLF	-0.59	-0.56	-0.52
	TDLF	-0.64	-0.60	-0.55
5	NLF	-0.65	-0.68	-0.66
	SDLF	-0.67	-0.70	-0.67
	TDLF	-0.71	-0.75	-0.72
6	NLF	-0.47	-0.51	-0.74
	SDLF	-0.48	-0.53	-0.76
	TDLF	-0.53	-0.58	-0.83
7	NLF	0.00	0.00	-0.66
	SDLF	0.00	0.00	-0.69
	TDLF	0.00	0.00	-0.77
8	NLF	0.41	0.52	-0.45
	SDLF	0.41	0.52	-0.47
	TDLF	0.41	0.50	-0.55
9	NLF	0.63	0.60	0.00
	SDLF	0.64	0.61	0.00
	TDLF	0.68	0.63	0.00
10	NLF	0.66	0.48	0.51
	SDLF	0.67	0.49	0.51
	TDLF	0.72	0.51	0.49

Table S-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
11	NLF	0.47	0.19	0.50
	SDLF	0.48	0.20	0.51
	TDLF	0.51	0.22	0.53
12	NLF	0.15	-0.17	0.23
	SDLF	0.15	-0.17	0.25
	TDLF	0.16	-0.16	0.30
13	NLF	-0.22	-0.48	-0.12
	SDLF	-0.23	-0.49	-0.11
	TDLF	-0.24	-0.50	-0.07
14	NLF	-0.46	-0.51	-0.46
	SDLF	-0.47	-0.52	-0.46
	TDLF	-0.49	-0.57	-0.45
15	NLF	-0.38	0.00	-0.70
	SDLF	-0.39	0.00	-0.72
	TDLF	-0.43	0.00	-0.76
16	NLF	0.00	0.71	-0.77
	SDLF	0.00	0.69	-0.80
	TDLF	0.00	0.64	-0.88
17	NLF	0.44	1.04	-0.57
	SDLF	0.43	1.04	-0.60
	TDLF	0.40	1.03	-0.69
18	NLF	0.75	0.97	0.00
	SDLF	0.75	0.97	0.00
	TDLF	0.74	0.96	0.00
19	NLF	1.05	0.75	0.67
	SDLF	1.05	0.75	0.65
	TDLF	1.07	0.74	0.59
20	NLF	1.08	0.41	0.98
	SDLF	1.09	0.41	0.96
	TDLF	1.10	0.41	0.92

Table S-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
21	NLF	0.98	0.00	0.98
	SDLF	0.98	0.00	0.98
	TDLF	0.98	0.00	0.97
22	NLF	0.75	NA	0.76
	SDLF	0.75	NA	0.77
	TDLF	0.75	NA	0.77
23	NLF	0.41	NA	0.42
	SDLF	0.41	NA	0.42
	TDLF	0.41	NA	0.42
24	NLF	0.00	NA	0.00
	SDLF	0.00	NA	0.00
	TDLF	0.00	NA	0.00

Table S-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	21.2	79.1	105.3	31.8	95.0	302.1	374.1	134.4
	SDLF	20.9	81.2	108.5	32.4	94.7	304.4	377.1	134.8
	TDLF	19.9	87.8	117.8	34.5	93.9	311.7	385.8	136.4
G2	NLF	20.3	98.0	113.6	23.1	88.6	388.7	442.1	98.3
	SDLF	20.1	96.8	110.8	23.7	88.4	387.6	439.2	98.9
	TDLF	19.5	93.5	103.2	25.5	87.8	384.2	431.1	100.5
G3	NLF	23.4	92.6	90.2	17.6	99.9	365.8	359.5	76.9
	SDLF	23.5	89.3	85.7	18.0	99.9	362.5	354.8	77.3
	TDLF	23.6	78.2	71.2	19.0	99.9	351.2	339.7	78.5
G4	NLF	24.5	103.6	75.9	12.6	104.0	414.2	316.3	58.5
	SDLF	24.4	107.9	77.2	12.4	103.7	418.4	318.0	58.5
	TDLF	24.2	121.9	81.1	11.9	103.4	432.4	323.4	58.5

Table S-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	0.1	NA	NA	NA	0.3	NA	NA	NA
	SDLF	0.1	NA	NA	NA	0.3	NA	NA	NA
	TDLF	0.2	NA	NA	NA	0.5	NA	NA	NA
G2	NLF	0.1	NA	NA	NA	0.1	NA	NA	NA
	SDLF	0.1	NA	NA	NA	0.1	NA	NA	NA
	TDLF	0.1	NA	NA	NA	0.2	NA	NA	NA
G3	NLF	0.0	NA	NA	NA	-0.1	NA	NA	NA
	SDLF	0.0	NA	NA	NA	-0.1	NA	NA	NA
	TDLF	-0.1	NA	NA	NA	-0.2	NA	NA	NA
G4	NLF	-0.1	NA	NA	NA	-0.3	NA	NA	NA
	SDLF	-0.1	NA	NA	NA	-0.3	NA	NA	NA
	TDLF	-0.2	NA	NA	NA	-0.5	NA	NA	NA

Table S-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	0.0	0.0	0.0	0.0	0.0	-0.5	-0.2	-0.1
	SDLF	0.0	0.0	0.0	0.0	0.0	-0.4	-0.2	0.0
	TDLF	0.0	-0.1	0.0	0.0	0.0	-0.2	-0.1	0.0
G2	NLF	0.0	0.0	-0.1	0.0	0.0	-0.5	-0.7	0.0
	SDLF	0.0	0.0	-0.1	0.0	0.0	-0.4	-0.6	0.0
	TDLF	0.0	0.0	0.0	0.0	0.0	-0.2	-0.4	0.0
G3	NLF	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0
	SDLF	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
	TDLF	0.0	-0.1	-0.1	0.0	0.0	0.0	-0.1	0.0
G4	NLF	0.0	0.1	0.1	0.0	0.0	0.8	0.9	0.0
	SDLF	0.0	0.1	0.1	0.0	0.0	0.8	0.8	0.0
	TDLF	0.0	0.2	0.1	0.0	0.0	0.6	0.6	0.0

Table S-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	0.02	0.05	0.07	0.18	0.05	0.24	0.31	0.68
	SDLF	0.02	0.05	0.07	0.17	0.06	0.23	0.29	0.65
	TDLF	0.04	0.07	0.11	0.22	0.10	0.25	0.35	0.79
G2	NLF	0.01	0.06	0.07	0.15	0.01	0.28	0.31	0.58
	SDLF	0.01	0.06	0.07	0.15	0.01	0.26	0.29	0.57
	TDLF	0.02	0.08	0.11	0.18	0.04	0.28	0.35	0.70
G3	NLF	-0.01	0.06	0.07	0.12	-0.01	0.34	0.39	0.51
	SDLF	-0.01	0.06	0.08	0.12	-0.01	0.31	0.36	0.50
	TDLF	-0.01	0.08	0.12	0.14	-0.03	0.30	0.39	0.58
G4	NLF	-0.03	0.06	0.09	0.09	-0.06	0.36	0.46	0.40
	SDLF	-0.03	0.06	0.09	0.08	-0.06	0.33	0.42	0.38
	TDLF	-0.04	0.08	0.12	0.09	-0.11	0.30	0.44	0.44

Table S-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	0.00	0.00	0.00	0.00	0.01	-0.10	-0.05	-0.01
	SDLF	0.00	-0.01	0.00	0.00	0.00	-0.08	-0.04	-0.01
	TDLF	0.00	-0.01	-0.01	0.00	0.00	-0.05	-0.02	-0.01
G2	NLF	0.00	-0.01	-0.02	0.00	0.01	-0.10	-0.14	-0.01
	SDLF	0.00	-0.01	-0.02	0.00	0.01	-0.09	-0.13	-0.01
	TDLF	0.00	0.00	-0.01	0.00	0.00	-0.04	-0.09	-0.01
G3	NLF	0.00	0.00	0.00	0.00	0.01	0.03	0.02	-0.01
	SDLF	0.00	0.00	-0.01	0.00	0.01	0.02	0.01	-0.01
	TDLF	0.00	-0.01	-0.02	0.00	0.00	0.00	-0.03	0.00
G4	NLF	0.00	0.01	0.02	0.00	0.01	0.16	0.18	-0.01
	SDLF	0.00	0.02	0.02	0.00	0.01	0.15	0.17	-0.01
	TDLF	0.00	0.03	0.03	0.00	0.00	0.13	0.13	0.00

Appendix S-5. XICCS7 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge XICCS7 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table S-5-1. Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
14	14-2	NLF	-3.1	-0.2	3.1	-3.4	0.7	3.4
		SDLF	-3.1	-0.4	3.1	-3.3	0.9	3.4
		TDLF	-3.0	-1.1	3.2	-3.2	1.3	3.5
	14-3	NLF	-1.6	-1.4	2.1	-1.9	1.5	2.4
		SDLF	-1.6	-1.3	2.0	-1.6	1.4	2.1
		TDLF	-1.3	-1.0	1.6	-0.5	1.2	1.3
	14-4	NLF	-0.9	-1.7	1.9	-0.9	1.6	1.9
		SDLF	-0.3	-0.2	0.3	-0.5	0.1	0.5
		TDLF	1.4	4.1	4.3	0.5	-4.3	4.3
	14-5	NLF	-0.2	-0.3	0.4	-0.1	0.3	0.3
		SDLF	-0.2	-0.5	0.6	-0.2	0.5	0.5
		TDLF	-0.3	-1.0	1.0	-0.4	1.0	1.1

Table S-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
18	18-2	NLF	-0.6	-2.3	2.4	-0.9	1.9	2.1
		SDLF	-0.7	-2.5	2.6	-0.8	1.8	2.0
		TDLF	-1.0	-3.1	3.2	-0.6	1.7	1.8
	18-3	NLF	-0.7	0.0	0.7	-0.7	0.2	0.8
		SDLF	-0.2	0.5	0.5	-0.3	-0.3	0.4
		TDLF	1.1	1.9	2.2	0.9	-1.8	2.0
	18-4	NLF	0.6	-0.3	0.6	0.6	0.3	0.7
		SDLF	1.1	0.3	1.1	1.1	-0.3	1.1
		TDLF	2.7	2.0	3.4	2.6	-1.9	3.2
	18-5	NLF	1.6	0.9	1.8	1.6	-0.9	1.9
		SDLF	2.2	1.7	2.8	2.1	-1.7	2.7
		TDLF	4.1	4.2	5.9	3.6	-4.1	5.5
	18-6	NLF	1.2	0.7	1.4	1.2	-0.7	1.4
		SDLF	1.6	1.4	2.1	1.6	-1.3	2.1
		TDLF	2.7	2.7	3.8	2.3	-2.7	3.5
	18-7	NLF	0.5	0.2	0.5	0.5	-0.2	0.6
		SDLF	0.7	0.6	0.9	0.7	-0.6	0.9
		TDLF	1.2	1.2	1.7	1.0	-1.2	1.6

Table S-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
20	20-2	NLF	-0.1	-0.2	0.2	-0.4	0.2	0.5
		SDLF	-0.2	-0.1	0.2	-0.3	0.1	0.3
		TDLF	-0.3	-0.1	0.3	-0.1	-0.3	0.3
	20-3	NLF	-2.9	1.2	3.1	-3.0	-1.3	3.3
		SDLF	-2.3	1.2	2.6	-2.5	-1.3	2.8
		TDLF	-0.7	1.2	1.4	-0.9	-1.2	1.5
	20-4	NLF	0.3	2.6	2.6	0.3	-2.6	2.6
		SDLF	1.4	2.5	2.9	1.4	-2.6	2.9
		TDLF	4.3	2.1	4.7	4.4	-2.2	4.9
	20-5	NLF	0.7	2.1	2.2	0.7	-2.1	2.2
		SDLF	0.9	2.0	2.2	0.9	-2.0	2.2
		TDLF	1.3	1.7	2.2	1.3	-1.8	2.2
	20-6	NLF	0.4	0.9	1.0	0.4	-0.9	1.0
		SDLF	0.3	1.0	1.0	0.3	-0.9	1.0
		TDLF	0.1	1.0	1.0	-0.1	-0.9	0.9

Table S-5-2: Erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
14	NLF	14-2
	SDLF	14-2
	TDLF	14-4
18	NLF	18-2
	SDLF	18-5
	TDLF	18-5
20	NLF	20-3
	SDLF	20-4
	TDLF	20-4

Table S-5-3. Erection method 1 critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
14	A	NLF	-5.2	-2.4	5.7	NA	NA	NA
		SDLF	-5.0	0.8	5.0	NA	NA	NA
		TDLF	-0.3	-0.5	0.6	NA	NA	NA
	B	NLF	-3.1	-0.2	3.1	-3.4	0.7	3.4
		SDLF	-3.1	-0.4	3.1	-3.3	0.9	3.4
		TDLF	1.4	4.1	4.3	0.5	-4.3	4.3
18	A	NLF	-1.4	0.2	1.4	NA	NA	NA
		SDLF	2.7	0.6	2.8	NA	NA	NA
		TDLF	4.3	1.6	4.6	NA	NA	NA
	B	NLF	-0.6	-2.3	2.4	-0.9	1.9	2.1
		SDLF	2.2	1.7	2.8	2.1	-1.7	2.7
		TDLF	4.1	4.2	5.9	3.6	-4.1	5.5
20	A	NLF	1.8	1.1	2.1	NA	NA	NA
		SDLF	2.9	1.1	3.2	NA	NA	NA
		TDLF	3.6	1.0	3.7	NA	NA	NA
	B	NLF	-2.9	1.2	3.1	-3.0	-1.3	3.3
		SDLF	1.4	2.5	2.9	1.4	-2.6	2.9
		TDLF	4.3	2.1	4.7	4.4	-2.2	4.9

Table S-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
14	A	G1	NLF	23.8	76.2	35.3	57.2			
			SDLF	23.6	78.1	33.4	57.4			
			TDLF	23.1	84.1	25.1	61.1			
		G2	NLF	22.1	89.1	31.9	3.7	25.3	50.5	25.2
			SDLF	22.0	87.7	35.4	3.4	25.1	50.1	25.0
			TDLF	21.7	83.4	48.0	1.4	24.9	49.7	24.8
		G3	NLF	24.7	86.0	17.4				
			SDLF	24.9	82.9	17.1				
			TDLF	25.3	72.6	16.5				
		G4	NLF	25.0	92.8	29.3				
			SDLF	24.9	95.5	28.5				
			TDLF	25.0	104.6	26.0				
	B	G1	NLF	23.8	76.2	33.9	58.3			
			SDLF	23.6	78.1	32.2	58.3			
			TDLF	23.1	84.1	25.2	60.7			
		G2	NLF	22.1	89.2	32.9	0.3	25.9	51.8	25.9
			SDLF	22.0	87.8	36.3	0.3	25.6	51.2	25.6
			TDLF	21.7	83.4	48.2	1.1	24.8	49.5	24.7
		G3	NLF	24.7	86.0	17.8				
			SDLF	24.9	83.0	17.4				
			TDLF	25.3	72.6	16.5				
		G4	NLF	25.0	92.7	29.4				
			SDLF	24.9	95.5	28.6				
			TDLF	25.0	104.6	26.0				

Table S-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
18	A	G1	NLF	18.7	80.2	91.1	26.3	15.8		
			SDLF	18.7	82.2	98.5	22.9	21.9		
			TDLF	18.2	88.8	109.0	21.4	27.6		
		G2	NLF	18.6	106.7	94.9	12.5	24.9	12.4	4.7
			SDLF	18.6	104.4	94.7	7.6	15.3	7.6	8.8
			TDLF	18.3	99.4	90.1	0.0	0.0	0.0	15.7
		G3	NLF	22.3	100.1	66.3				
			SDLF	22.4	95.5	64.1				
			TDLF	22.7	82.9	57.6				
		G4	NLF	24.3	108.0	48.4				
			SDLF	24.2	112.7	49.3				
			TDLF	24.0	126.2	52.4				
	B	G1	NLF	18.7	80.2	92.0	25.2	16.7		
			SDLF	18.7	82.2	97.6	23.7	20.8		
			TDLF	18.1	88.8	107.6	22.5	26.0		
		G2	NLF	18.6	106.7	94.3	12.0	24.1	12.0	4.9
			SDLF	18.6	104.5	94.2	8.6	17.2	8.6	7.9
			TDLF	18.2	99.6	89.3	1.6	3.3	1.6	14.1
		G3	NLF	22.3	100.1	66.3				
			SDLF	22.4	95.7	64.1				
			TDLF	22.7	83.2	57.8				
		G4	NLF	24.3	108.0	48.4				
			SDLF	24.2	112.6	49.3				
			TDLF	24.0	125.9	52.4				

Table S-5-4(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number						
				1	2	3	4	5	6	7
20	A	G1	NLF	19.5	78.6	96.1	34.8	21.9		
			SDLF	19.2	80.7	99.7	33.5	22.9		
			TDLF	18.6	87.5	110.9	26.2	26.8		
		G2	NLF	19.2	105.5	89.9	18.4			
			SDLF	19.1	103.9	88.4	19.3			
			TDLF	18.6	99.0	85.6	22.1			
		G3	NLF	22.8	101.8	78.2	16.3			
			SDLF	22.9	98.0	74.1	17.2			
			TDLF	23.1	85.0	62.1	19.1			
		G4	NLF	24.8	97.5	89.5	2.7	4.5	1.7	10.8
			SDLF	24.7	102.4	90.7	1.1	1.8	0.7	12.6
			TDLF	24.5	117.4	92.3	0.0	0.0	0.0	12.2
	B	G1	NLF	19.5	78.6	96.1	34.5	22.0		
			SDLF	19.2	80.7	99.7	33.2	23.3		
			TDLF	18.6	87.5	110.9	25.9	27.3		
		G2	NLF	19.2	105.5	89.8	18.3			
			SDLF	19.1	103.9	88.5	19.0			
			TDLF	18.6	99.0	85.6	21.8			
		G3	NLF	22.8	101.8	78.5	16.1			
			SDLF	22.9	98.0	74.4	16.5			
			TDLF	23.1	85.1	62.4	18.2			
		G4	NLF	24.8	97.3	89.2	3.2	5.2	2.0	10.3
			SDLF	24.7	102.3	90.4	1.4	2.3	0.9	12.6
			TDLF	24.5	117.3	92.2	0.0	0.0	0.0	12.5

Appendix T1-1. EICCS27 Bridge Description

The key characteristics of EICCS27 are as follows:

- Span length along the centerline of the bridge, L_s = 279, 224, 236 ft.
- Width between the fascia girders, w_g = 79.9 ft.
- Radius of curvature to the centerline of the bridge, R =2546 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 3.5, 2.8, 3.0
- Subtended angle between the supports, L_s/R = 0.11, 0.09, 0.09
- Number of girders in the completed bridge cross-section, n_g =8.
- Skew angle, θ = -53.1, -59.4, -64.4, -69.7^o

This appendix presents the bridge description of the bridge EICCS27 in its final condition as well as during erection. The following figures and tables are provided:

Figure T1-1-1. Framing plan

Figure T1-1-2. Bridge cross-section

Figure T1-1-3. Girder Elevation

Figure T1-1-4. Cross-section dimension

Figure T1-1-5. Cross-frame details

Figure T1-1-6. Erection scheme

Table T1-1-1. Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed NLF

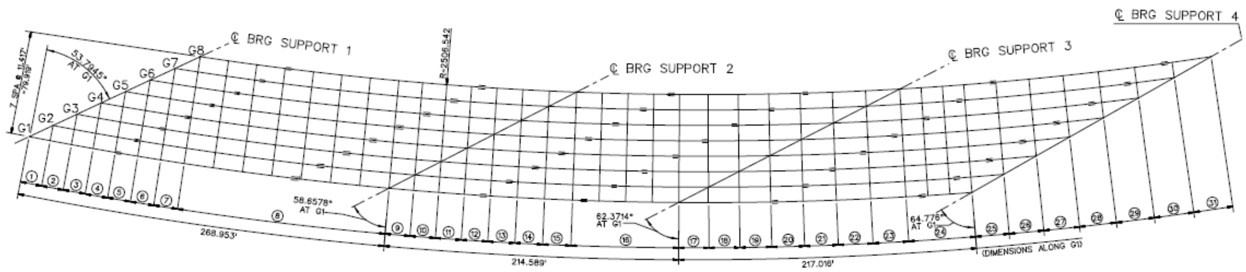


Figure T1-1-1. Framing plan.

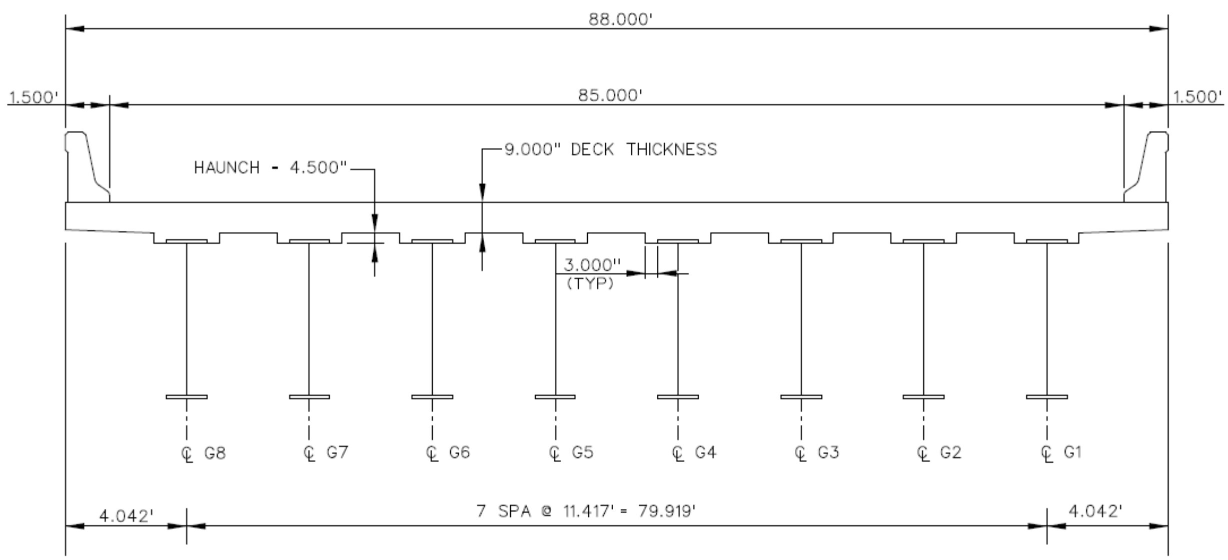
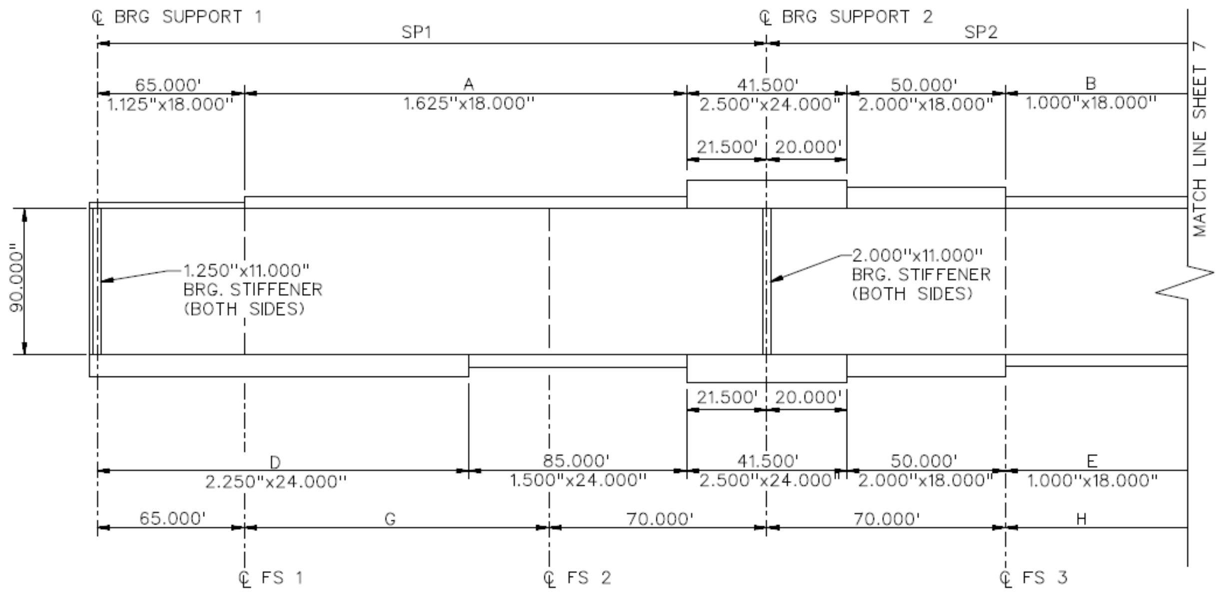
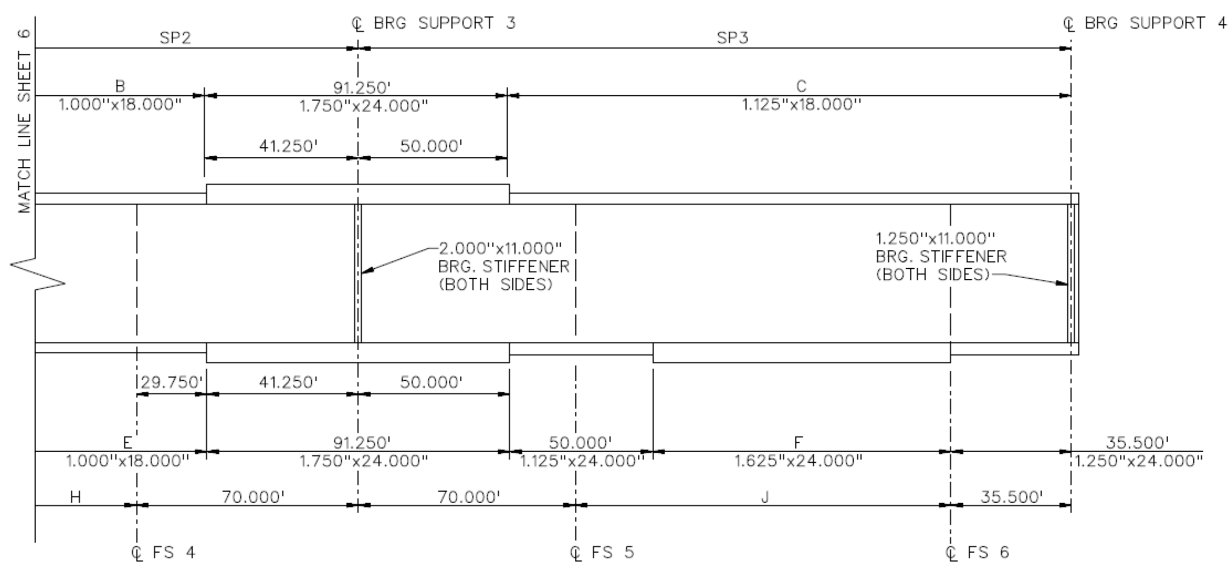


Figure T1-1-2. Bridge cross-section.



GIRDER ELEVATION
(TYP ALL GIRDERS)



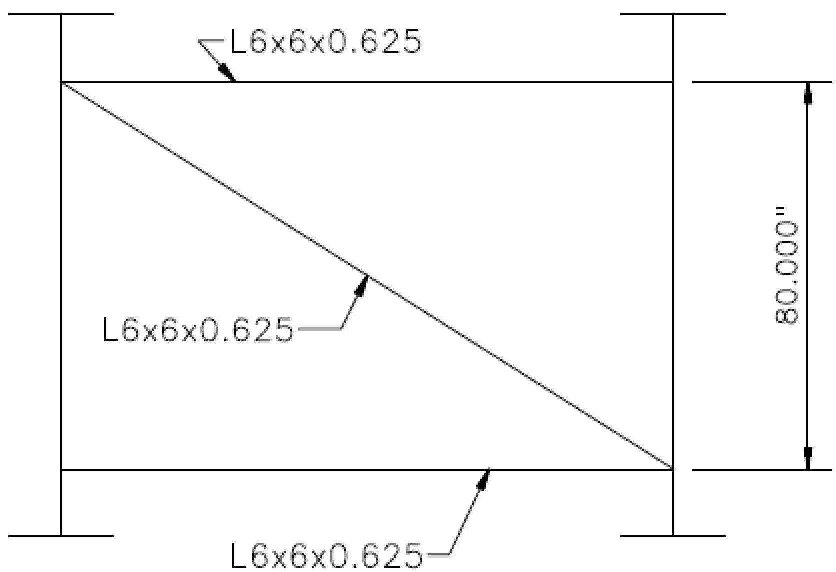
GIRDER ELEVATION
(TYP ALL GIRDERS)

Figure T1-1-3. Girder elevations

GIRDER ELEVATION DIMENSIONS (SHEETS 6&7)

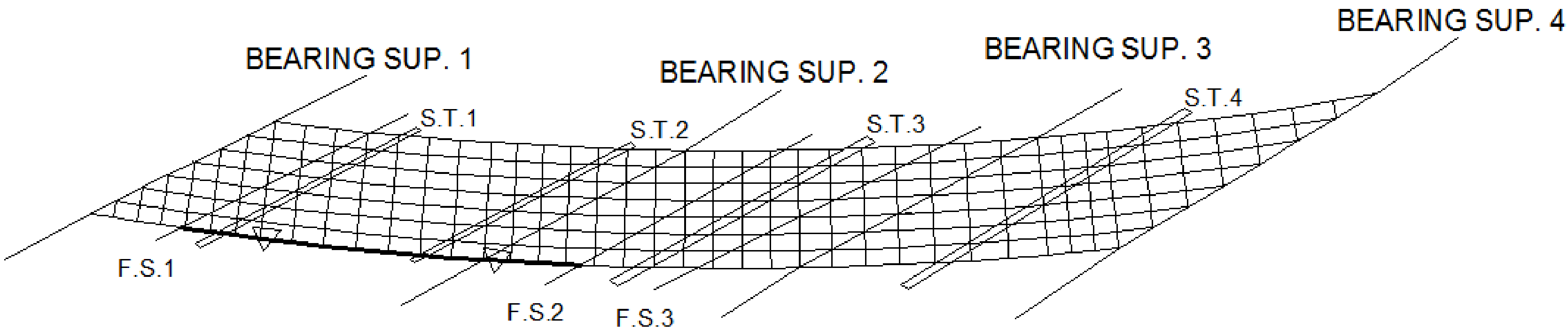
	DIMENSIONS (FT)								
	A	B	C	D	E	F	G	H	J
G1	182.453	103.339	167.016	162.453	103.339	81.516	133.953	74.589	111.516
G2	183.737	106.251	168.549	163.737	106.251	83.049	135.237	77.501	113.049
G3	185.094	109.332	170.228	165.094	109.332	84.728	136.594	80.582	114.728
G4	186.531	112.595	172.072	166.531	112.595	86.572	138.031	83.845	116.572
G5	188.054	116.059	174.103	168.054	116.059	88.603	139.554	87.309	118.603
G6	189.672	119.744	176.341	169.672	119.744	90.841	141.172	90.994	120.841
G7	191.388	123.676	178.817	171.388	123.676	93.317	142.888	94.926	123.317
G8	193.212	127.878	181.573	173.212	127.878	96.073	144.712	99.128	126.073

Figure T1-1-4. Cross-section dimensions.

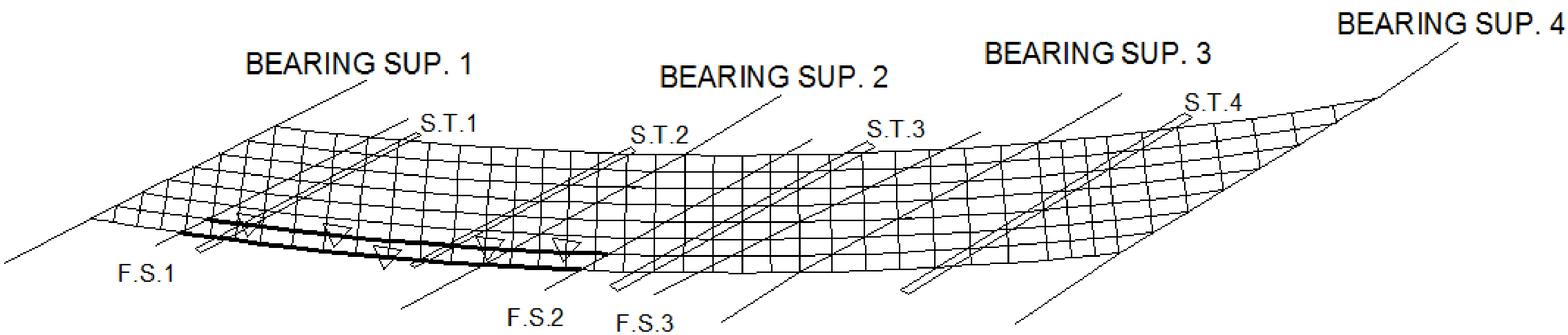


TYPICAL END AND INTERMEDIATE DIAPHRAGM

Figure T1-1-5. Cross-frame details

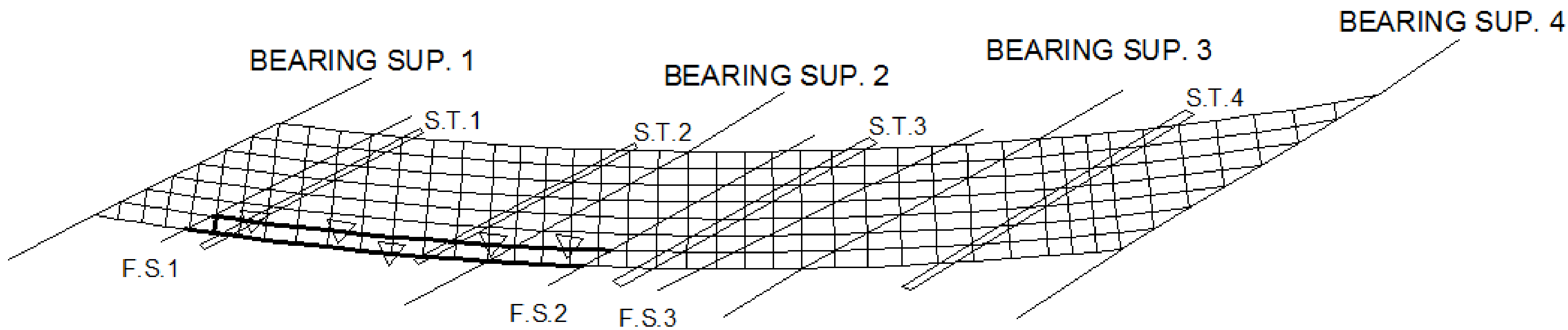


STAGE 1

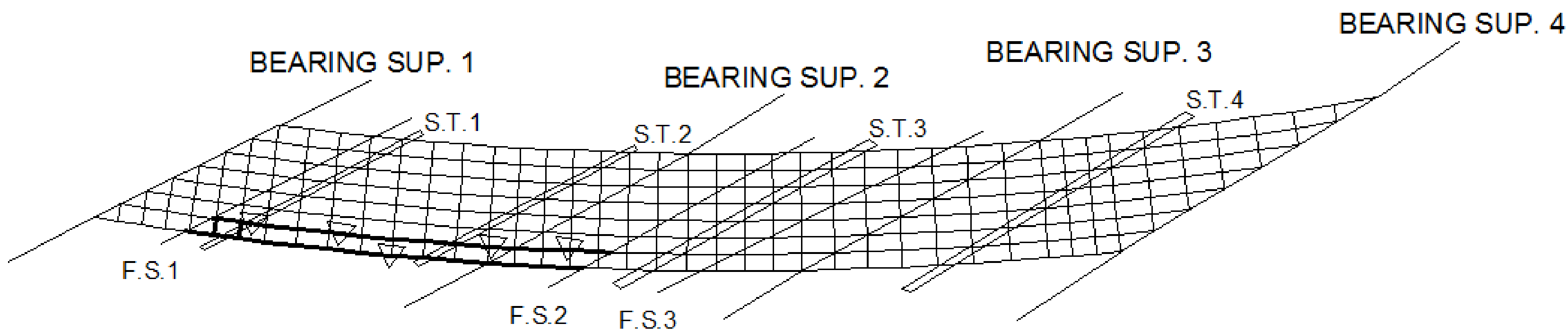


STAGE 2-1

Figure T1-1-6. Erection scheme.



STAGE 2-2



STAGE 2-3

INSTALL THE REMAINING CFS FOR STAGE 2

REPEAT THE SEQUENCE FOR G3 TO G8

THE HOLDING CRANE IS ON G1 UNTIL STAGE 2 IS FINISHED

Figure T1-1-6(Continued). Erection scheme.

ALL SHORING SHOWERS ARE IN PLACE FOR STAGES 9 TO 32

STAGES 9 TO 16: REPEAT THE SAME SEQUENCE FOR G1-G8 FIELD SECTION BETWEEN BEARING SUPPORT 1 AND FIELD SPLICE 1. THE HOLDING CRANE IS ON G1 FIELD SECTION UNTIL STAGE 10 IS FINISHED. USE ONE LIFTING CRANE.

STAGES 17 TO 24: REPEAT THE SAME SEQUENCE FOR G1-G8 FIELD SECTION BETWEEN FIELD SPLICE 3 AND BEARING SUPPORT 4. THE HOLDING CRANE IS ON G1 FIELD SECTION UNTIL STAGE 18 IS FINISHED. USE TWO LIFTING CRANES.

STAGES 25 TO 32: REPEAT THE SAME SEQUENCE FOR G1-G8 FIELD SECTION BETWEEN FIELD SPLICE 2 AND FIELD SPLICE 3. THE HOLDING CRANE IS ON G1 FIELD SECTION UNTIL STAGE 26 IS FINISHED. USE TWO LIFTING CRANES.

Figure T1-1-6(Continued). Erection scheme.

Table T1-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

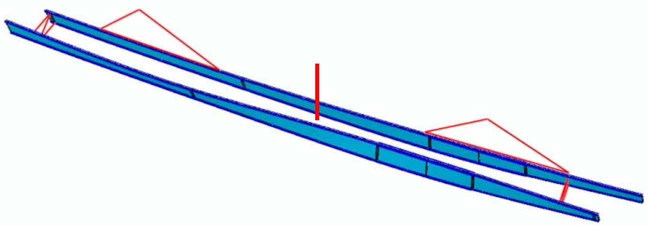
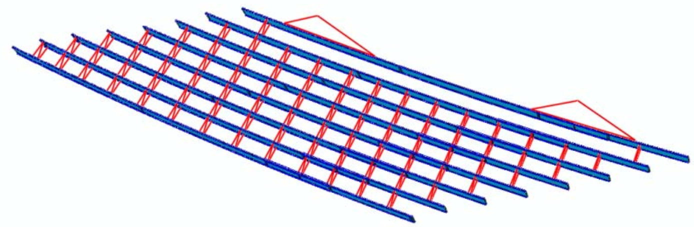
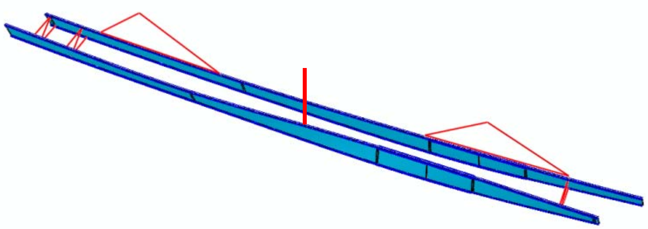
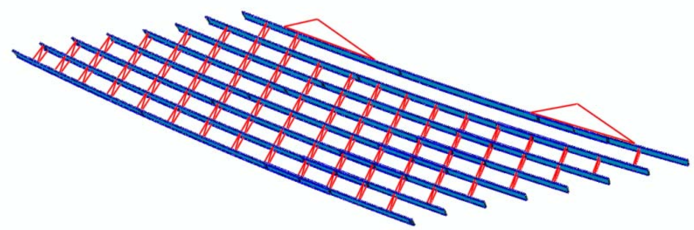
Sub-Stage	Stage	
	2	8
1		
2		

Table T1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

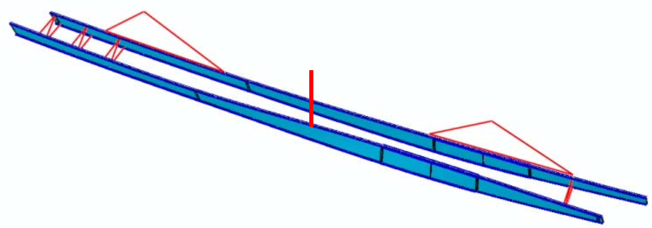
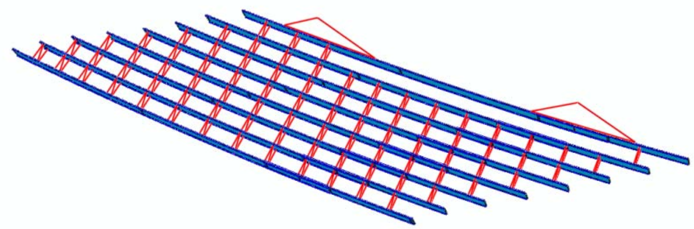
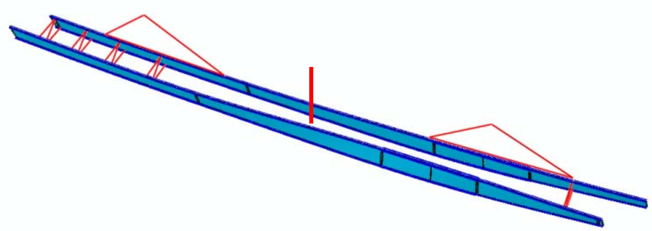
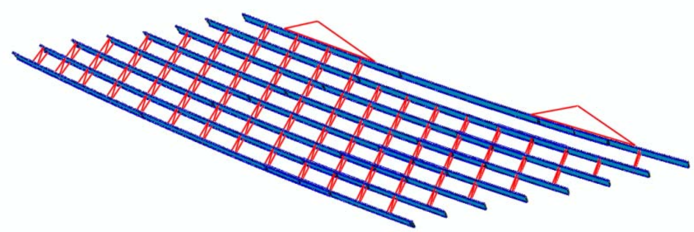
3		
4		

Table T1-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

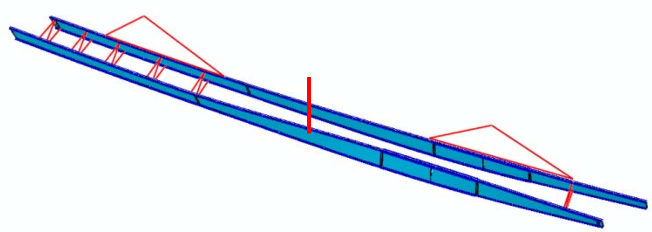
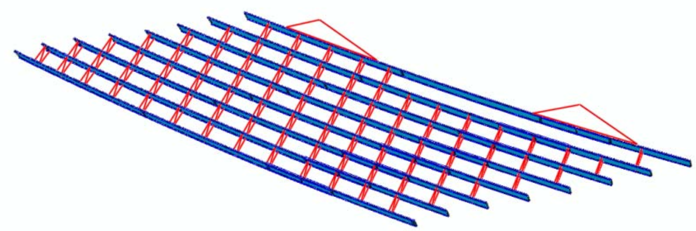
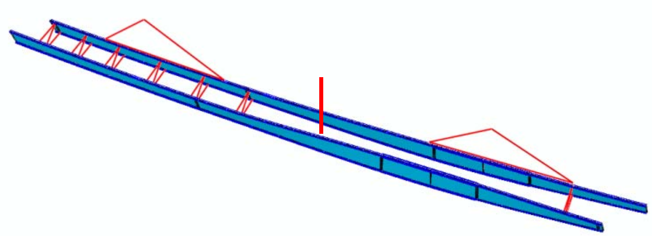
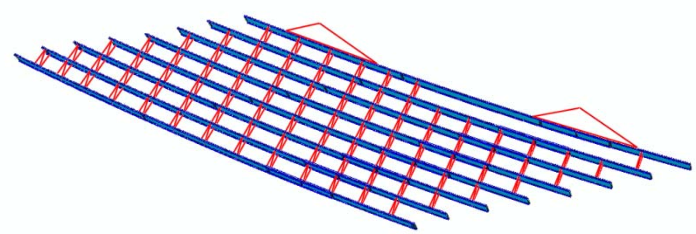
5		
6		

Table T1-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

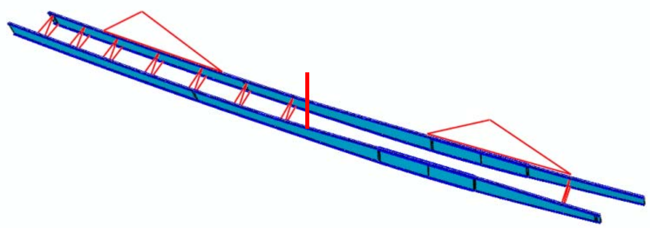
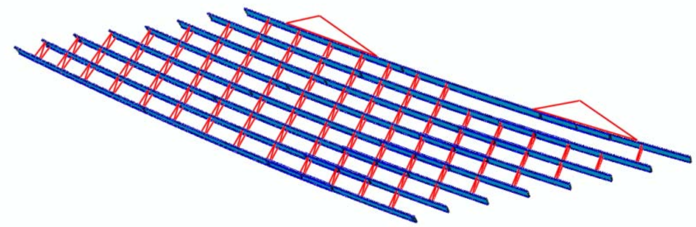
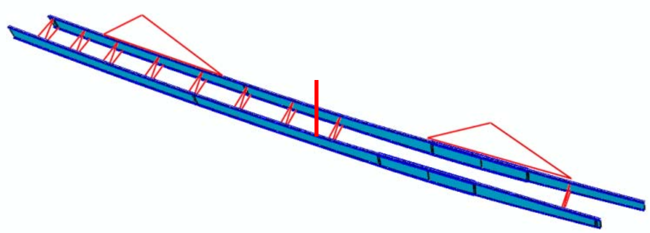
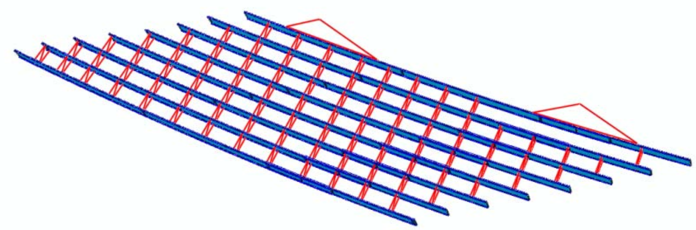
7		
8		

Table T1-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

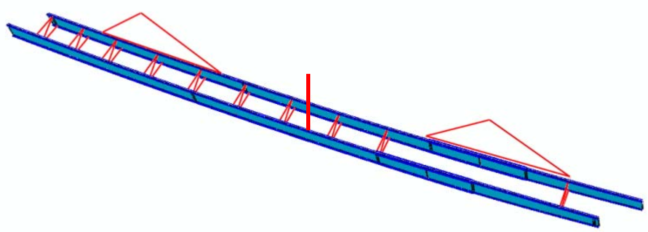
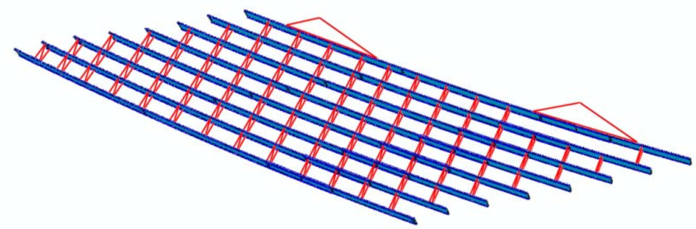
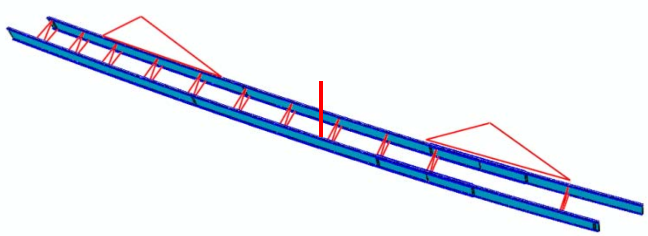
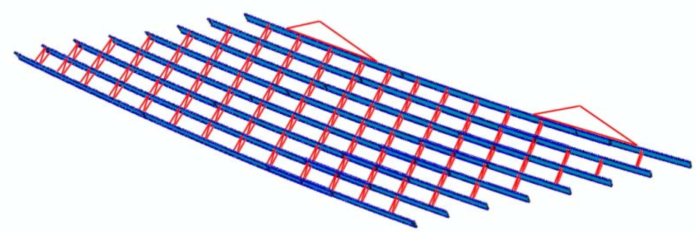
9		
10		

Table T1-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

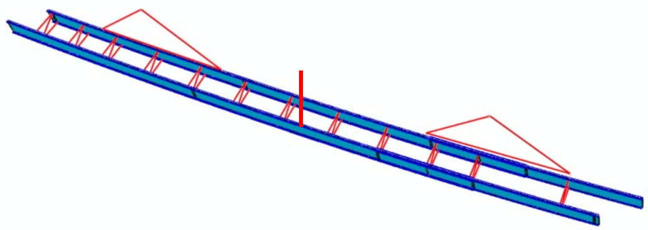
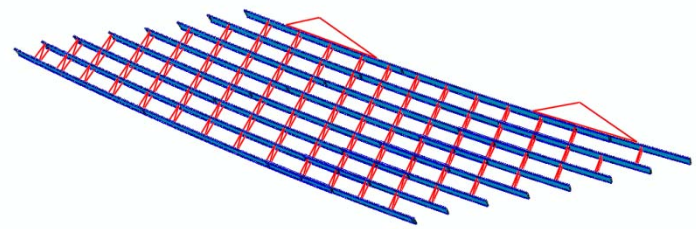
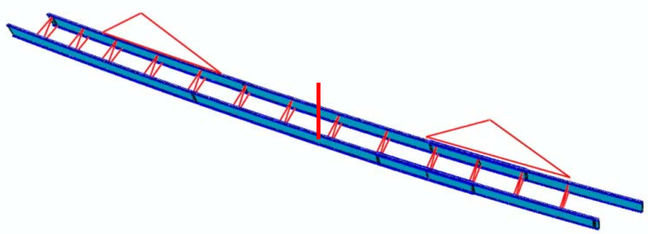
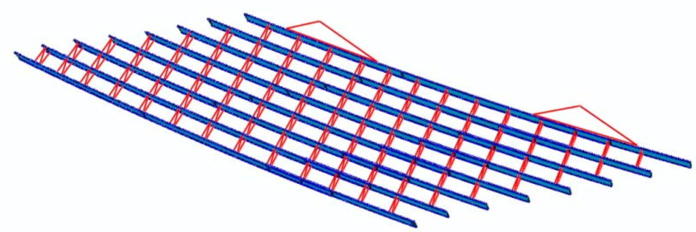
11		
12		

Table T1-1-1 (continued).. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

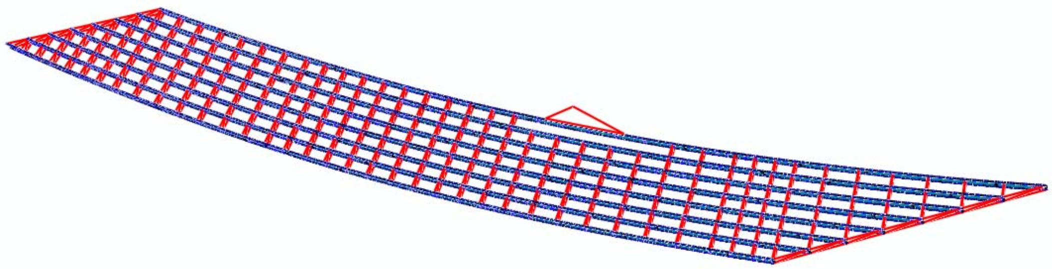
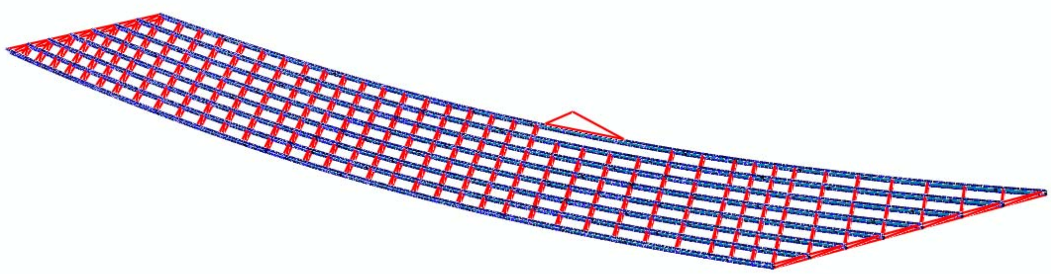
Sub-Stage	Stage 32
1	
2	

Table T1-1-1 (continued).. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

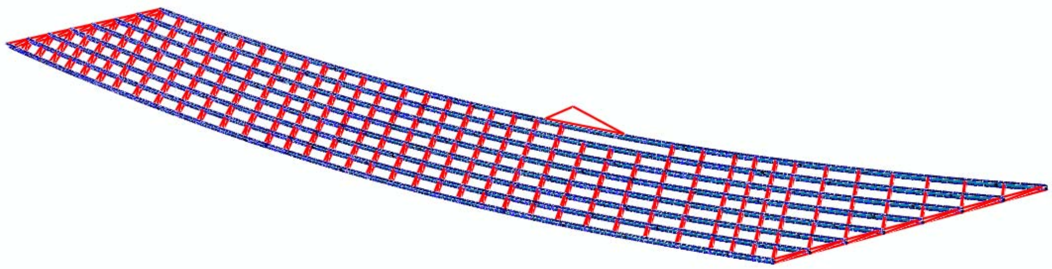
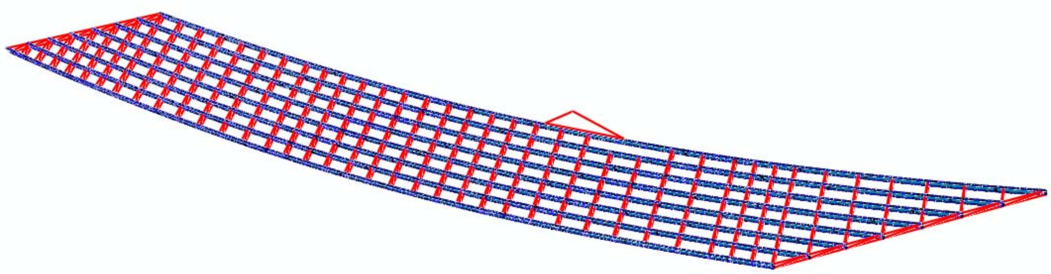
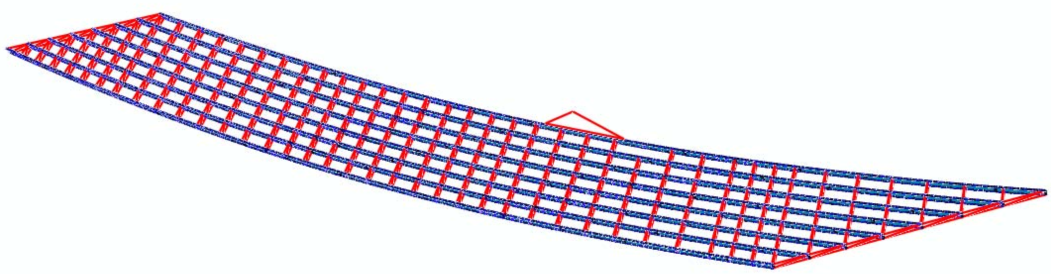
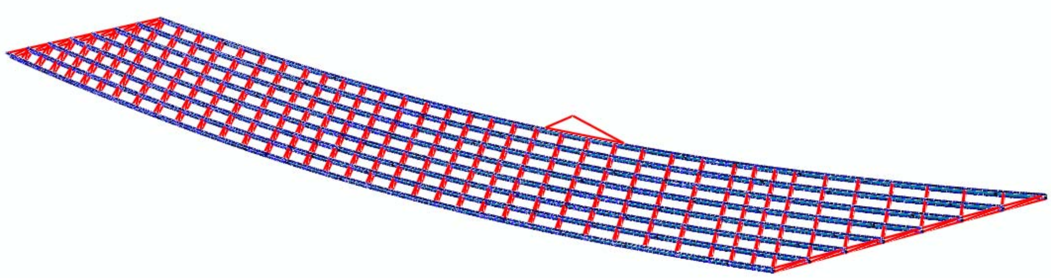
Sub-Stage	Stage 32
3	
4	

Table T1-1-1 (continued).. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

Sub-Stage	Stage 32
5	
6	

Appendix T1-2. EICCS27 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EICCS27 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table T1-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	8.2	28.6
	SDLF	7.9	28.0
	TDLF	7.1	26.9
G2	NLF	7.3	25.5
	SDLF	7.1	25.1
	TDLF	6.5	24.2
G3	NLF	6.7	23.2
	SDLF	6.6	22.9
	TDLF	6.4	22.5
G4	NLF	6.2	21.6
	SDLF	6.3	21.5
	TDLF	6.5	21.5
G5	NLF	6.0	20.8
	SDLF	6.2	20.9
	TDLF	6.6	21.1
G6	NLF	6.0	20.7
	SDLF	6.2	20.8
	TDLF	6.7	21.0
G7	NLF	6.2	21.4
	SDLF	6.4	21.4
	TDLF	6.8	21.6
G8	NLF	6.6	22.6
	SDLF	6.7	22.6
	TDLF	8.2	28.6
All Girders	NLF	8.2	28.6
	SDLF	7.9	28.0
	TDLF	7.2	26.9

Table T1-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.13	3.97
	SDLF	0.13	2.79
	TDLF	2.89	0.49
G2	NLF	1.10	3.84
	SDLF	0.11	2.68
	TDLF	2.84	0.41
G3	NLF	1.07	3.71
	SDLF	0.10	2.58
	TDLF	2.76	0.33
G4	NLF	1.01	3.53
	SDLF	0.08	2.46
	TDLF	2.64	0.26
G5	NLF	0.96	3.35
	SDLF	0.07	2.33
	TDLF	2.48	0.25
G6	NLF	0.92	3.46
	SDLF	0.08	2.62
	TDLF	2.34	0.30
G7	NLF	1.01	3.91
	SDLF	0.11	2.99
	TDLF	2.47	0.43
G8	NLF	1.08	4.35
	SDLF	0.13	3.39
	TDLF	2.61	0.56
All Girders	NLF	1.13	4.35
	SDLF	0.13	3.39
	TDLF	2.89	0.56

Table T1-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	10.4	36.0	12.4	43.2	0.7	5.6	1.1	7.9
	SDLF	10.1	35.6	12.7	42.9	0.5	4.4	1.3	6.6
	TDLF	10.6	34.4	14.1	43.6	1.2	2.3	2.8	7.2
G2	NLF	8.5	29.5	12.0	41.5	0.7	5.5	1.2	6.9
	SDLF	8.4	29.3	12.2	41.5	0.4	4.0	1.0	5.6
	TDLF	8.5	28.9	12.5	41.6	1.4	1.6	2.3	4.1
G3	NLF	7.4	26.6	11.4	39.6	0.7	5.7	1.0	6.6
	SDLF	7.7	26.8	11.3	39.3	0.4	4.0	0.9	5.2
	TDLF	8.6	27.2	10.8	38.6	1.5	1.5	1.8	3.5
G4	NLF	7.0	25.3	10.6	36.9	0.7	6.7	1.0	5.8
	SDLF	7.4	25.5	10.5	36.6	0.3	4.8	0.8	4.5
	TDLF	8.6	26.0	10.5	36.0	1.7	1.4	1.8	3.3
G5	NLF	6.9	25.1	10.0	34.7	0.8	6.9	1.1	7.5
	SDLF	7.2	25.4	10.0	34.7	0.4	4.9	0.8	5.8
	TDLF	8.4	26.0	10.6	34.6	1.6	1.3	1.8	3.3
G6	NLF	7.0	25.3	9.6	33.4	0.6	5.7	1.2	6.3
	SDLF	7.3	25.4	9.9	33.7	0.5	4.1	0.9	5.0
	TDLF	8.6	26.3	10.7	34.3	1.6	1.5	2.2	3.5
G7	NLF	7.1	25.5	9.9	34.7	0.6	5.7	1.3	6.2
	SDLF	7.3	25.7	10.0	34.7	0.4	4.2	1.1	5.3
	TDLF	9.6	26.4	10.2	34.7	1.6	1.5	2.6	4.6
G8	NLF	7.8	31.0	11.7	40.8	0.6	5.6	1.3	5.9
	SDLF	7.8	30.1	11.3	40.3	0.5	4.1	1.3	5.0
	TDLF	9.5	29.1	10.5	39.0	1.6	2.7	2.4	4.1
All Girders	NLF	10.4	36.0	12.4	43.2	0.8	6.9	1.3	7.9
	SDLF	10.1	35.6	12.7	42.9	0.5	4.9	1.3	6.6
	TDLF	10.6	34.4	14.1	43.6	1.7	2.7	2.8	7.2

Table T1-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	51.5	50.8	52.7	52.7
	SDLF	18.4	20.1	22.3	22.3
	TDLF	86.3	93.6	91.4	93.6
TDL	NLF	189.7	195.2	203.1	203.1
	SDLF	156.4	158.6	165.4	165.4
	TDLF	73.2	76.9	84.7	84.7

Table T1-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	9.5	13.0	13.9	12.1
	SDLF	4.7	5.3	6.4	5.5
	TDLF	15.4	19.5	18.5	17.8
TDL	NLF	35.9	47.5	49.7	44.4
	SDLF	30.2	39.4	42.1	37.2
	TDLF	17.9	20.2	24.2	20.8

Table T1-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	All Girders
NLF	1.67	1.60	1.51	1.42	1.37	1.35	1.53	1.67
SDLF	1.64	1.55	1.44	1.36	1.34	1.47	1.70	1.70
TDLF	1.74	1.55	1.52	1.46	1.49	1.77	2.16	2.16

Table T1-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	All Girders
NLF	5.82	5.57	5.24	4.95	4.78	5.18	5.90	5.90
SDLF	5.74	5.48	5.12	4.85	4.72	5.27	6.04	6.04
TDLF	5.61	5.30	4.90	4.67	4.66	5.54	6.46	6.46

Table T1-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	All Girders
NLF	0.98	0.94	0.88	0.83	0.80	0.79	0.89	0.98
SDLF	0.96	0.91	0.84	0.80	0.78	0.86	1.00	1.00
TDLF	1.02	0.91	0.89	0.85	0.87	1.03	1.26	1.26

Table T1-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	All Girders
NLF	3.40	3.25	3.06	2.89	2.79	3.03	3.44	3.44
SDLF	3.35	3.20	2.99	2.83	2.76	3.08	3.53	3.53
TDLF	3.28	3.10	2.86	2.73	2.72	3.23	3.77	3.77

Table T1-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	3063.6	11135.0
SDLF	3063.6	11133.4
TDLF	3063.6	11134.9

Table T1-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	200.6	702.1	0.4	1.5	0.7	9.6
SDLF	181.4	680.8	0.3	1.1	0.2	6.9
TDLF	248.0	637.6	1.4	1.6	1.6	0.8

Table T1-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.77	2.34	0.14	1.92
SDLF	0.50	1.56	0.04	1.39
TDLF	0.85	2.13	0.33	0.16

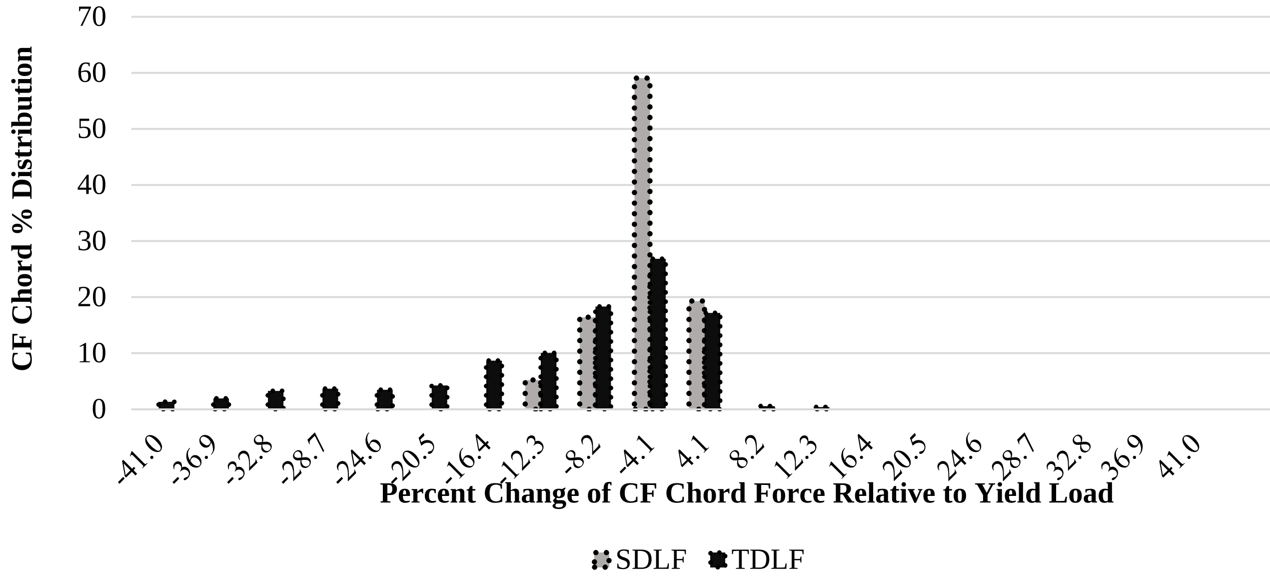


Figure T1-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

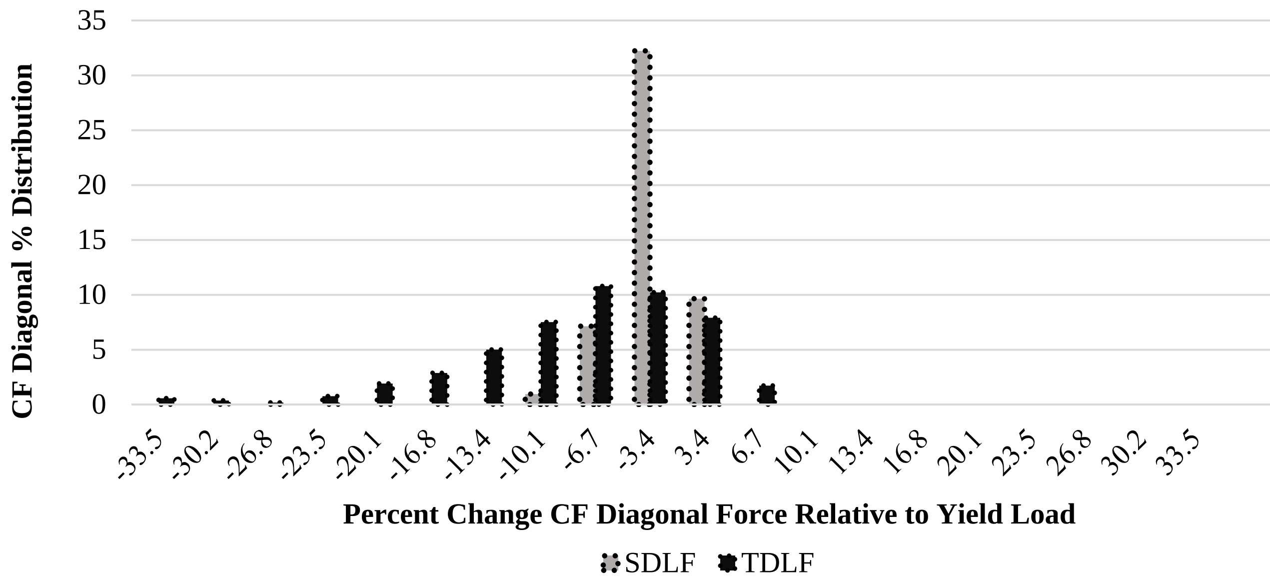


Figure T1-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

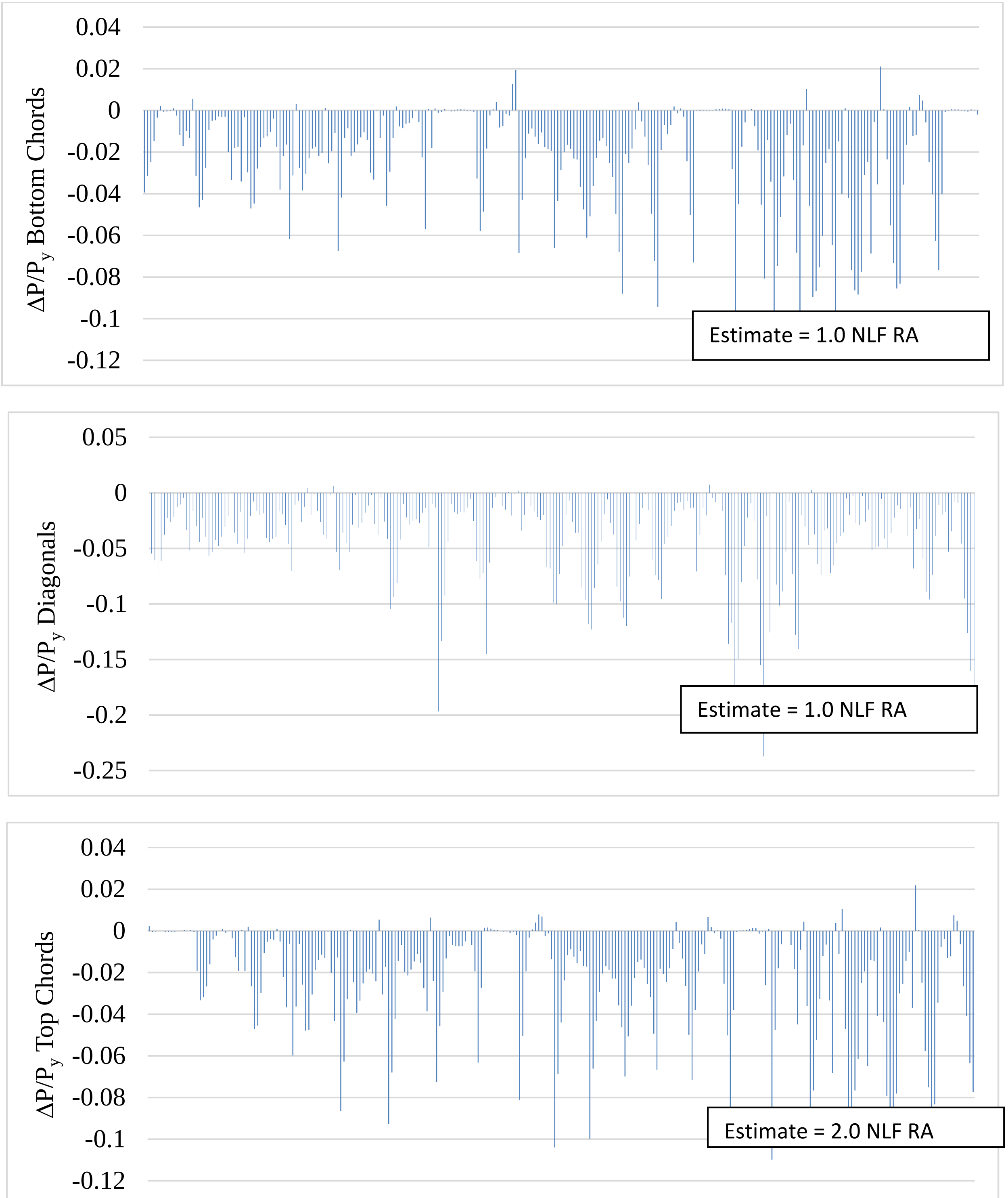


Figure T1-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

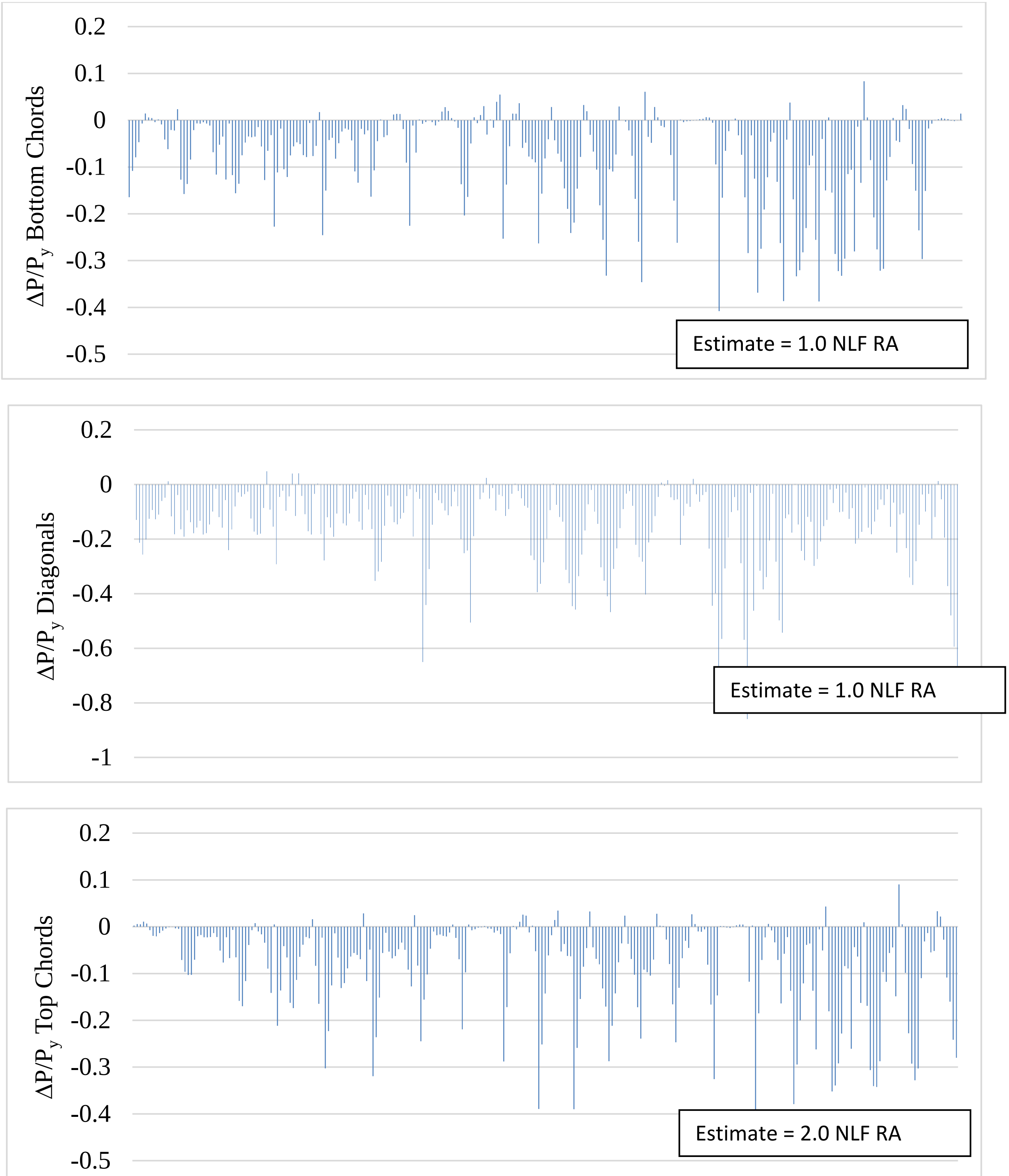


Figure T1-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix T1-3. EICCS27 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EICCS27 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table T1-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	15.2	2.0	15.2
SDLF	14.2	2.4	14.2
TDLF	46.2	3.1	46.2

Table T1-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	69.7	3.9
	SDLF	106.1	0
	TDLF	210.1	0
G2	NLF	72.9	1.7
	SDLF	97.7	4.7
	TDLF	176.4	0
G3	NLF	69.8	21
	SDLF	79.4	18.6
	TDLF	107.9	0
G4	NLF	72	20.8
	SDLF	84.4	20.8
	TDLF	145	0
G5	NLF	74.8	19.1
	SDLF	89.6	19.1
	TDLF	210.3	0
G6	NLF	85.1	17.5
	SDLF	90.3	3
	TDLF	147.4	0
G7	NLF	69.5	14.8
	SDLF	82.1	0
	TDLF	78.6	0
G8	NLF	76.5	0
	SDLF	83.3	0
	TDLF	171.1	0
All Girders	NLF	85.1	0
	SDLF	106.1	0
	TDLF	210.3	0

Table T1-3-3. Summary of erection crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	91.1	7.3	22.7	22.7
SDLF	89.5	5.9	24.5	24.2
TDLF	123.3	3.8	26.9	26.6

Table T1-3-6. Erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage											
		1	2	3	4	5	6	7	8	9	10	11	12
2	NLF	282	282	283	284	285	286	287	288	289	289	290	291
	SDLF	282	282	283	284	285	286	287	288	289	289	290	291
	TDLF	282	282	283	284	285	286	287	288	289	289	290	291
8	NLF	1199	1200	1201	1201	1202	1203	1204	1205	1206	1207	1208	1208
	SDLF	1199	1200	1200	1201	1202	1203	1204	1205	1206	1207	1207	1208
	TDLF	1199	1200	1201	1201	1202	1203	1204	1205	1206	1207	1208	1208
32	NLF	3059	3060	3061	3062	3063	3064						
	SDLF	3059	3060	3061	3062	3063	3064						
	TDLF	3059	3060	3061	3062	3063	3064						

Appendix T1-4. EICCS27 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge EICCS27 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

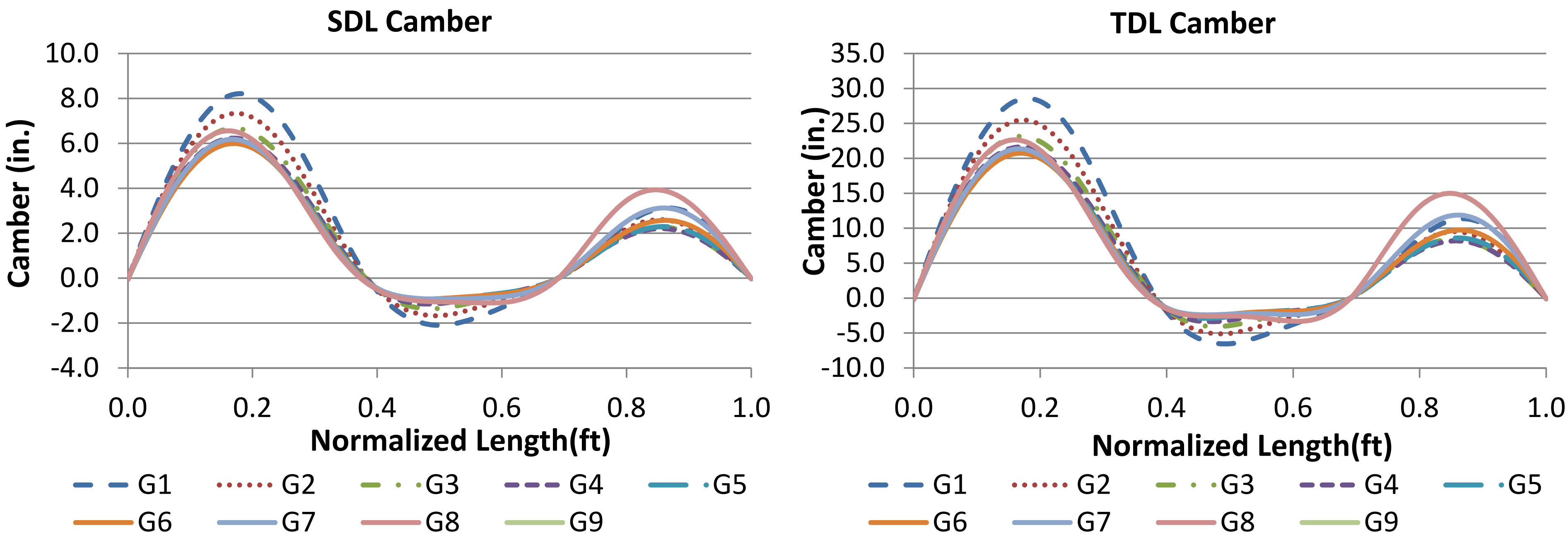


Figure T1-4-1. SDL and TDL 3D FEA cambers.

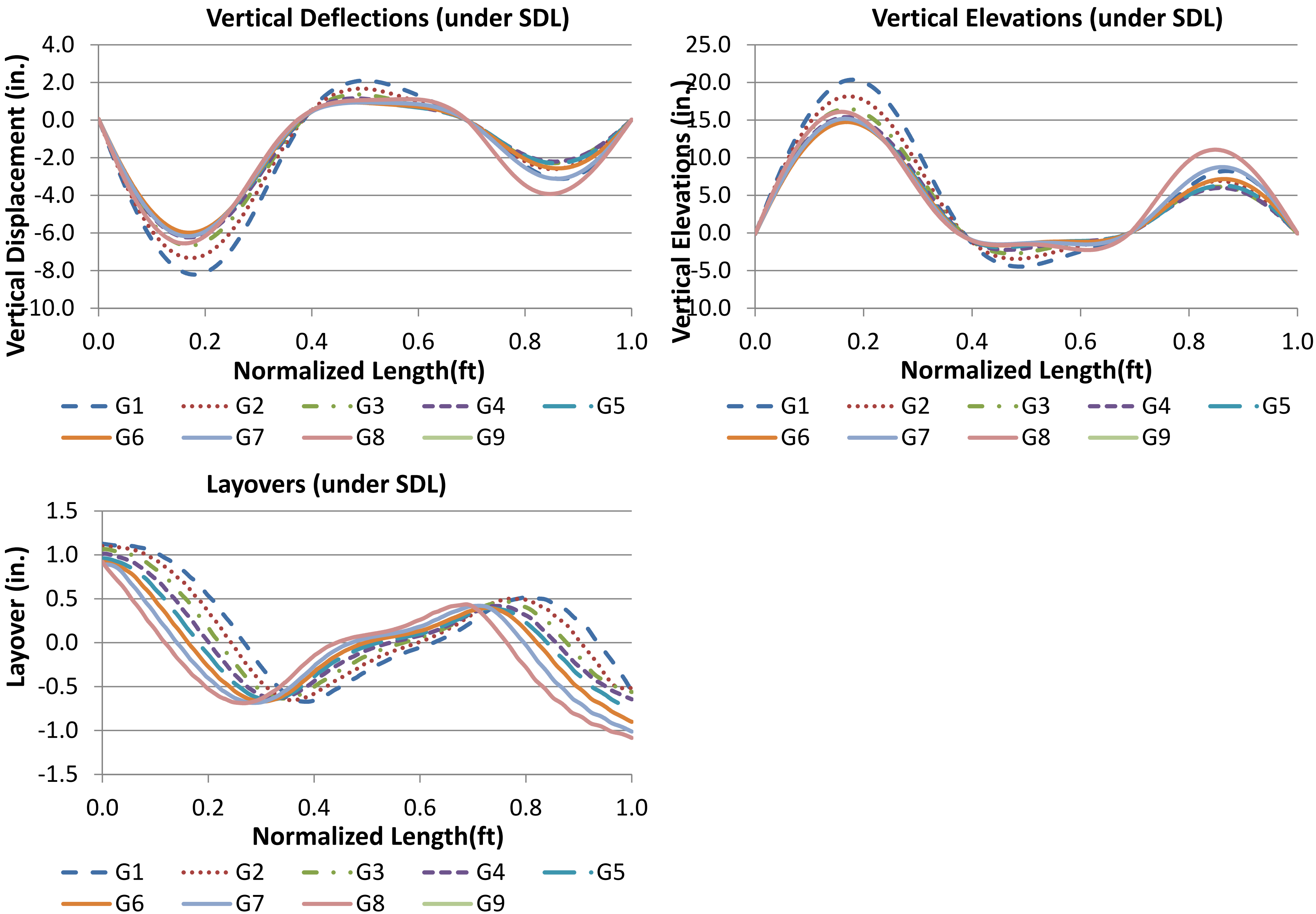


Figure T1-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

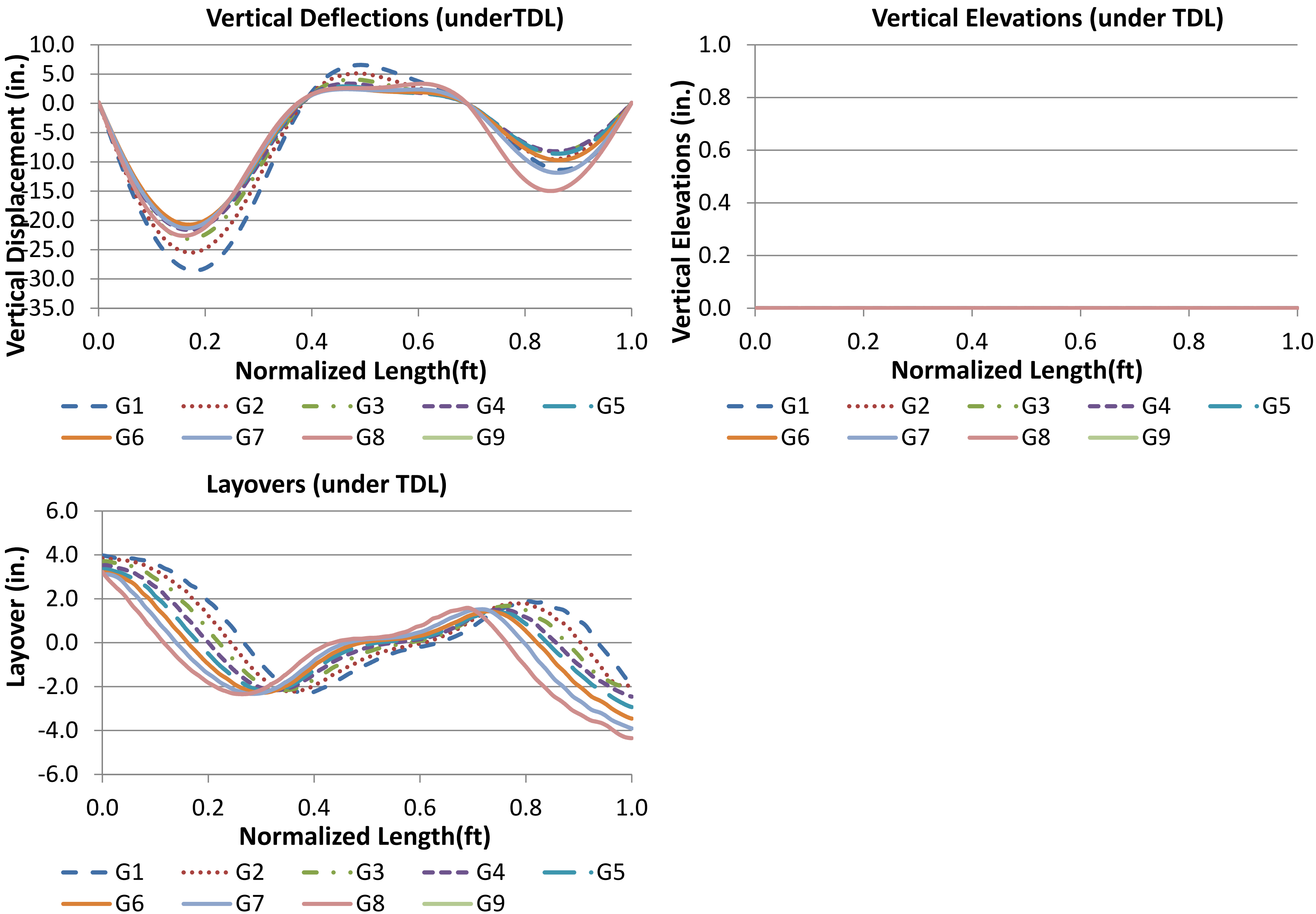


Figure T1-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

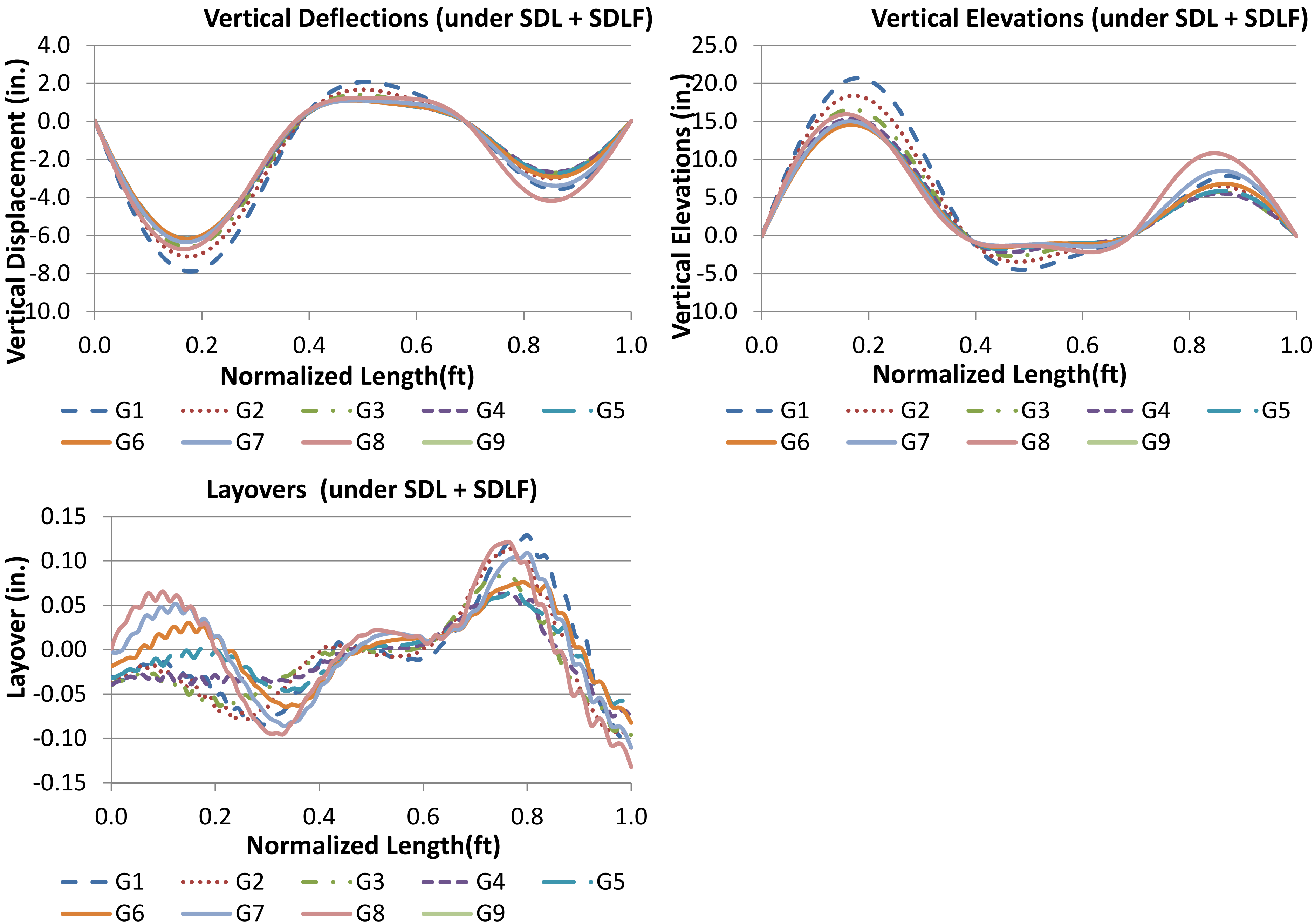


Figure T1-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

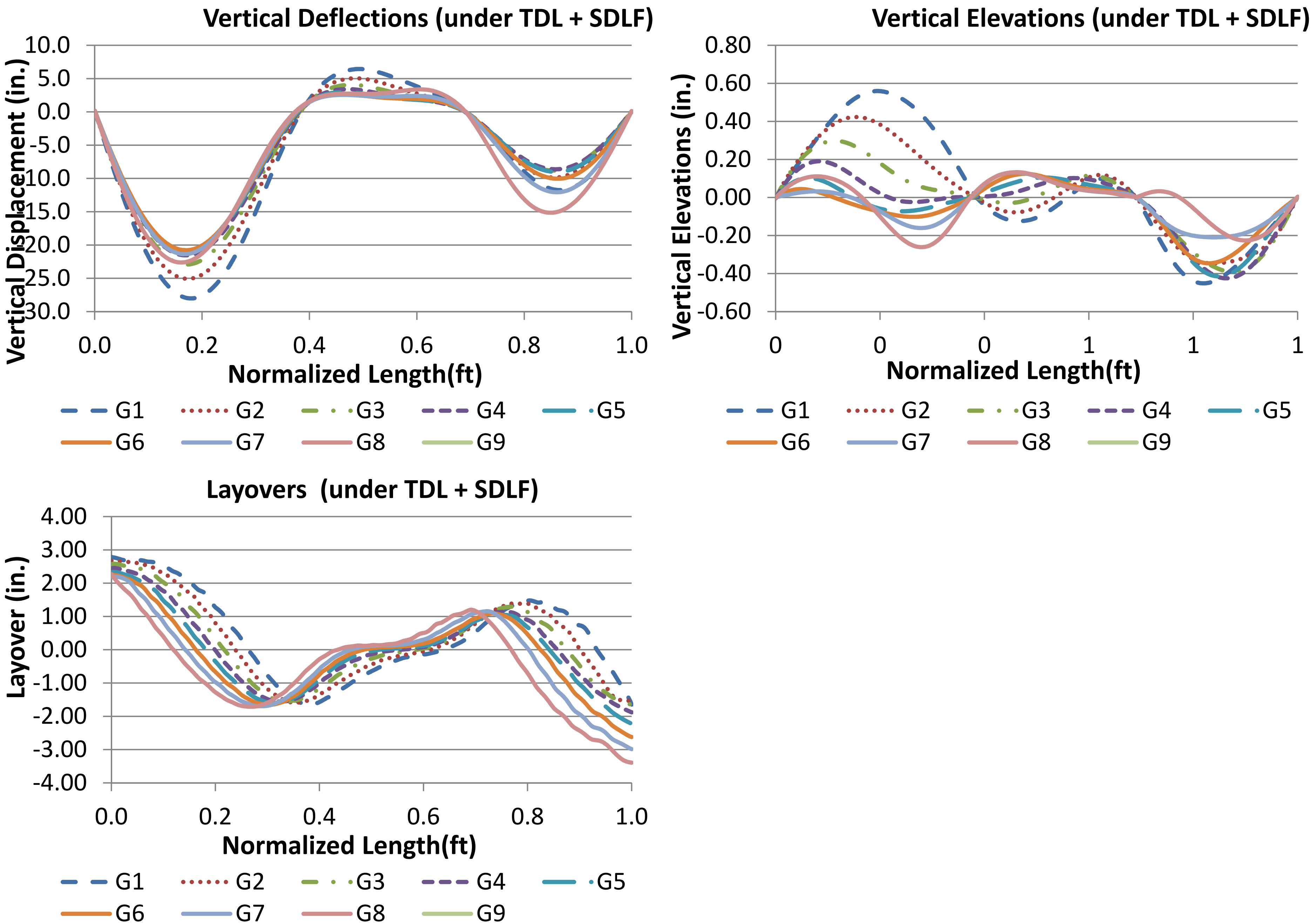


Figure T1-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

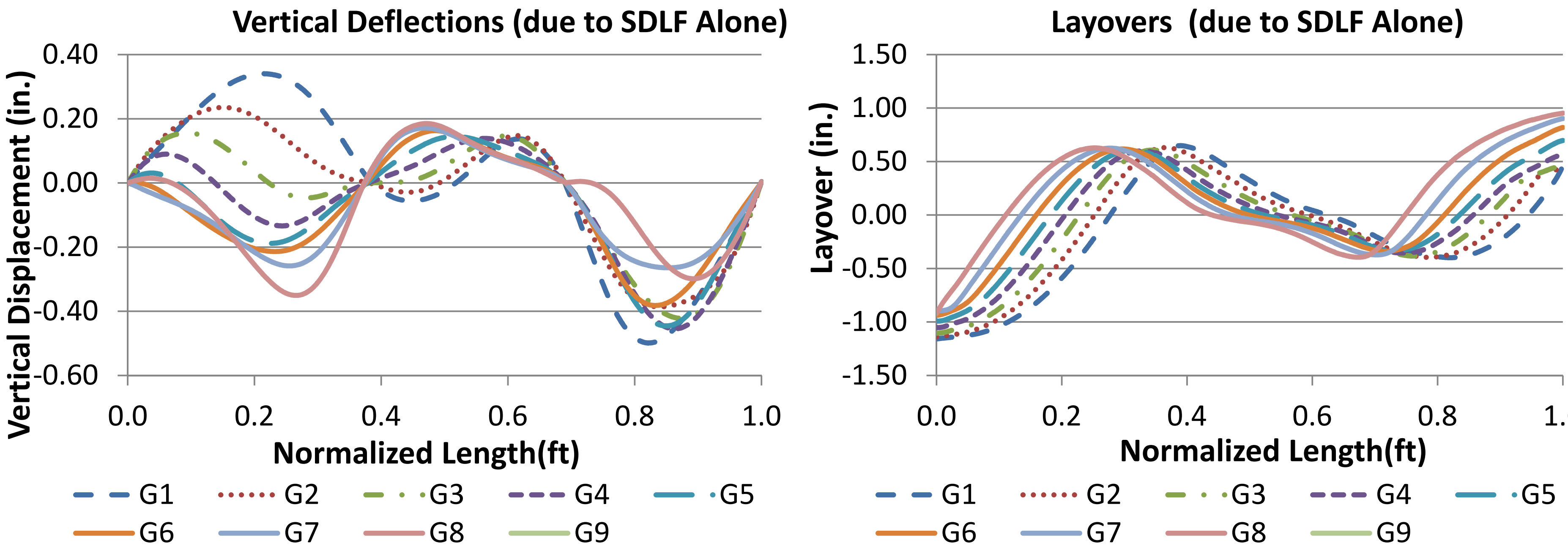


Figure T1-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

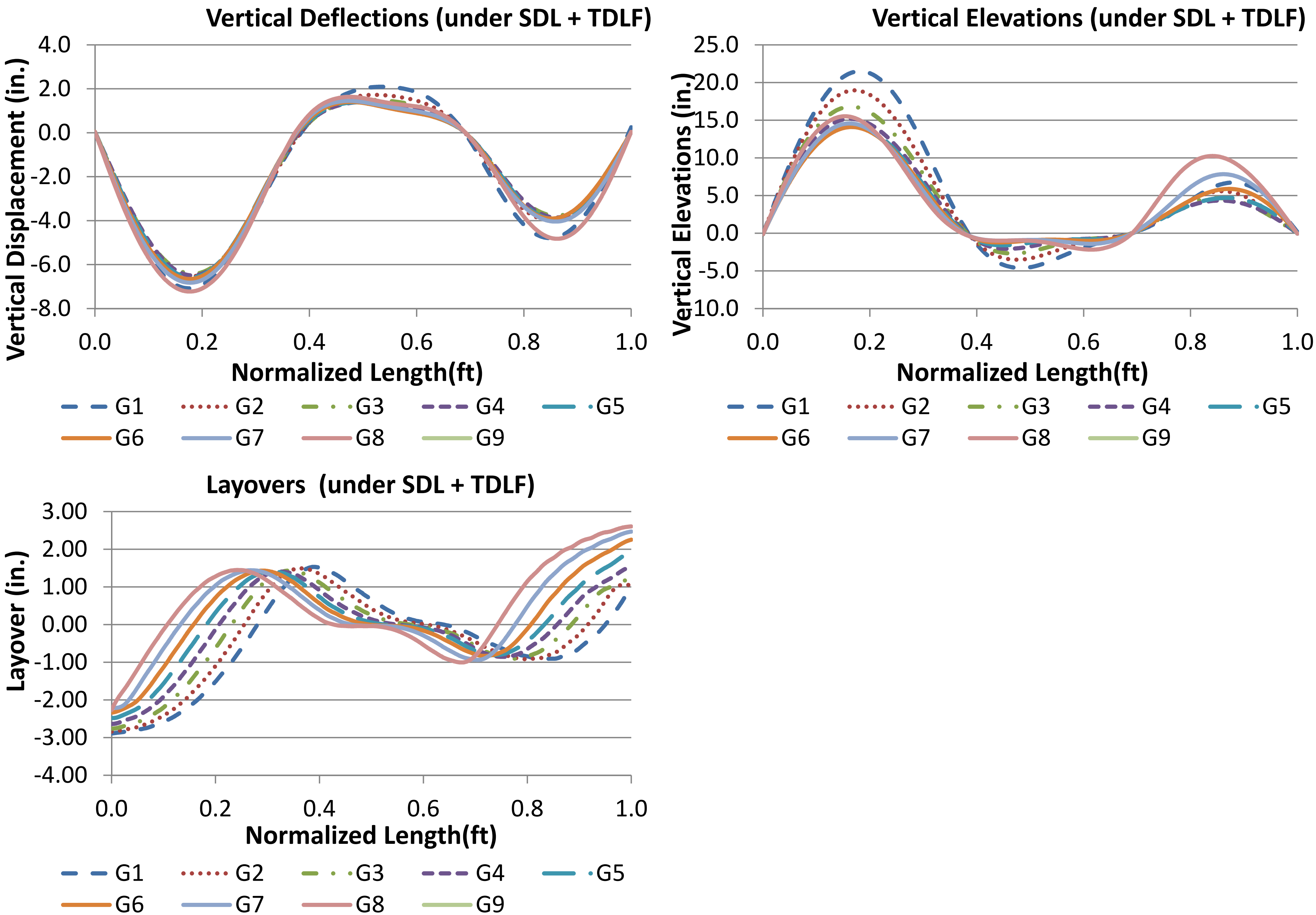


Figure T1-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

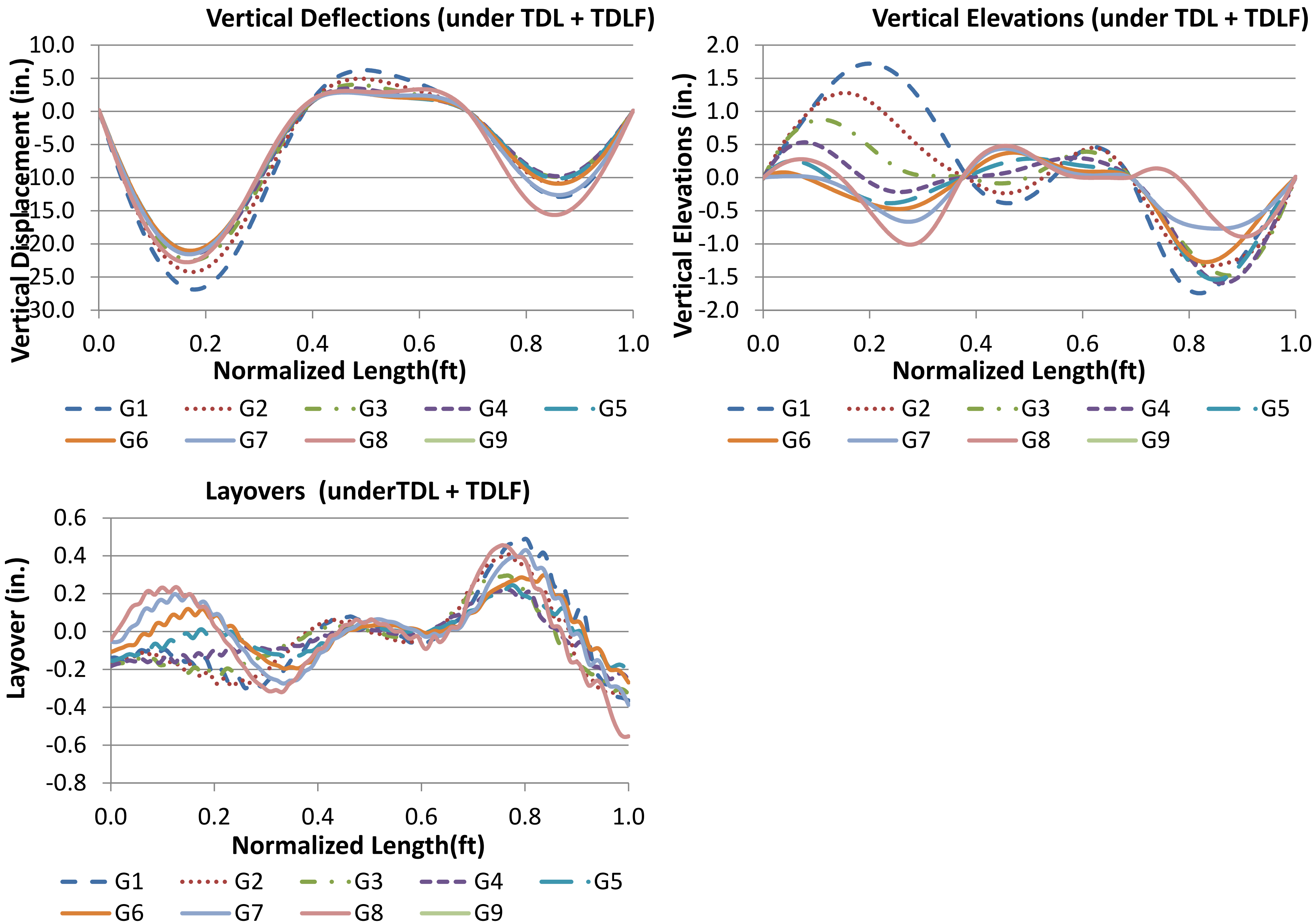


Figure T1-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

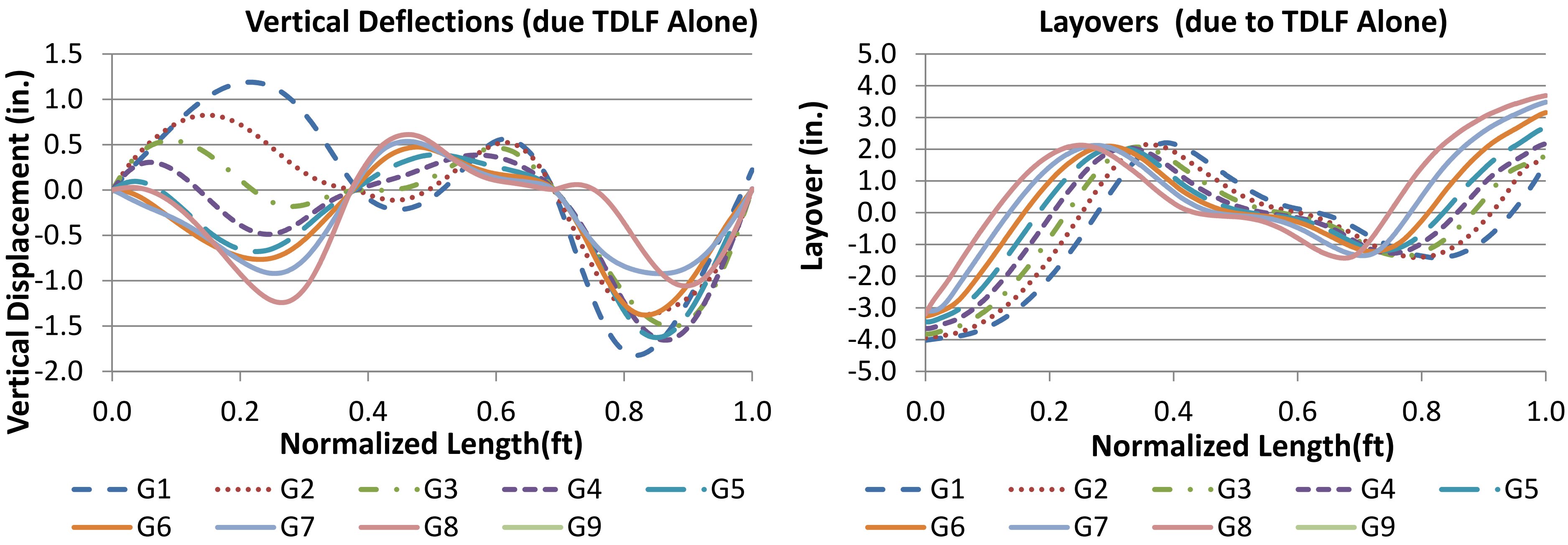


Figure T1-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

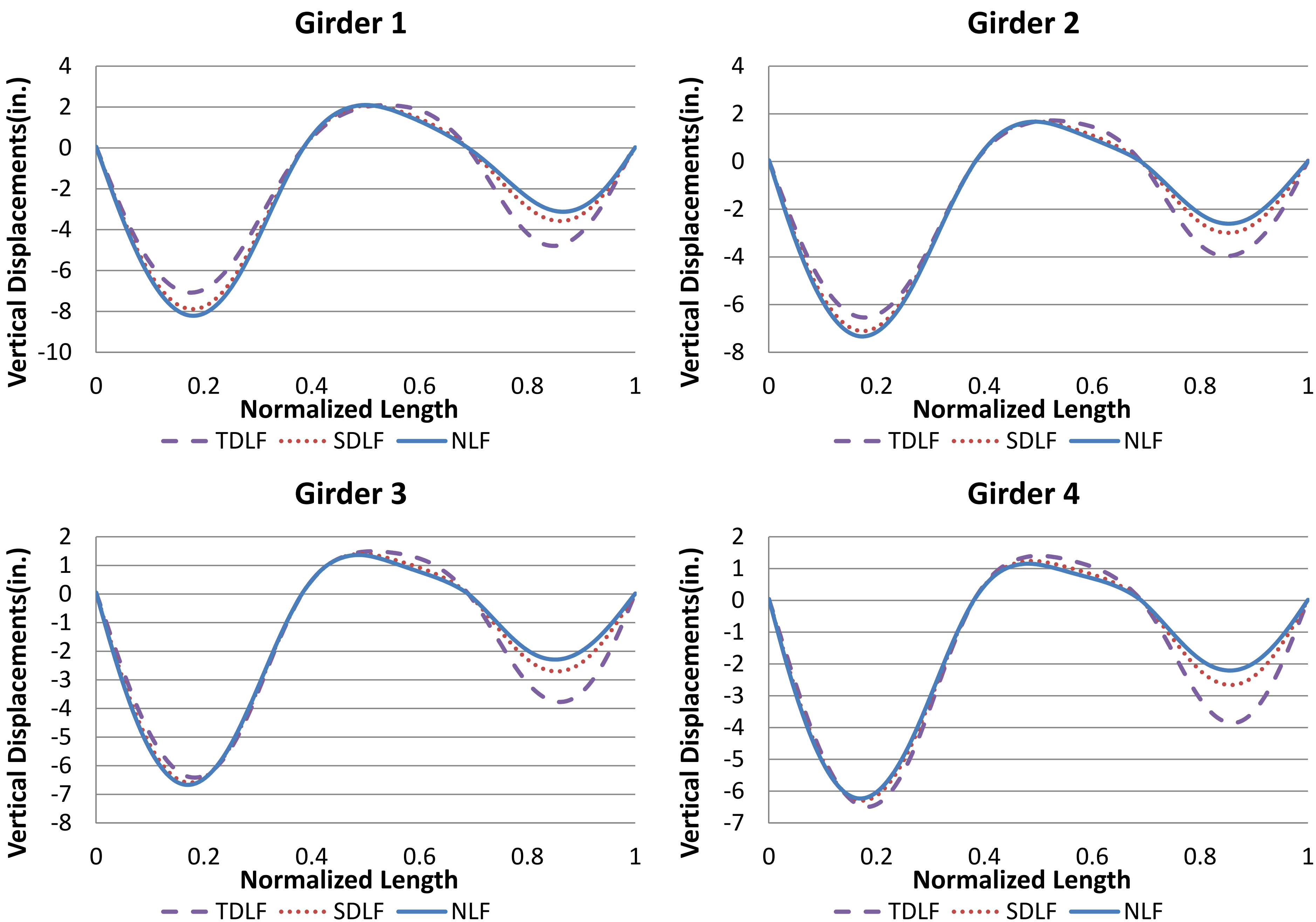


Figure T1-4-10. **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

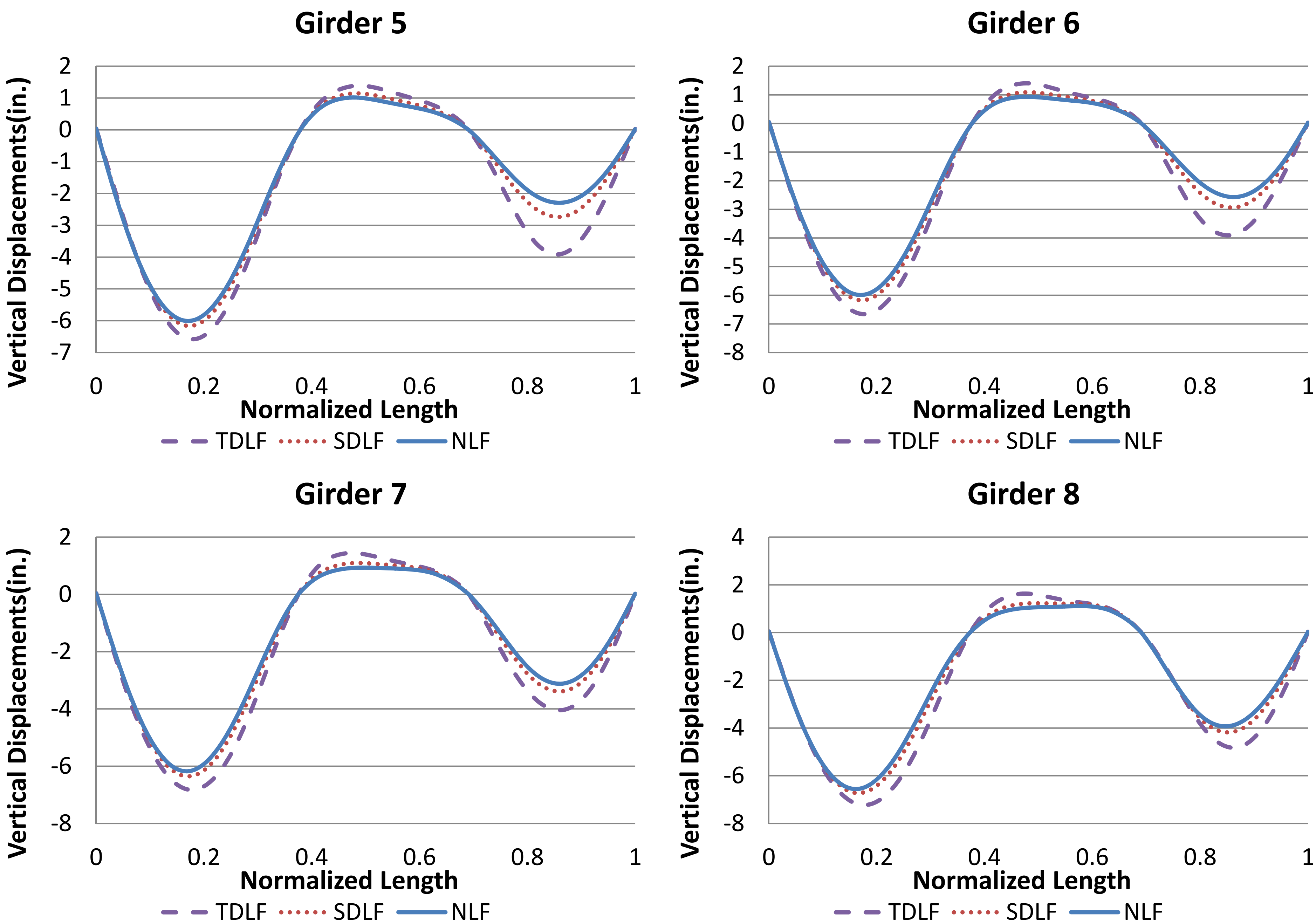


Figure T1-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

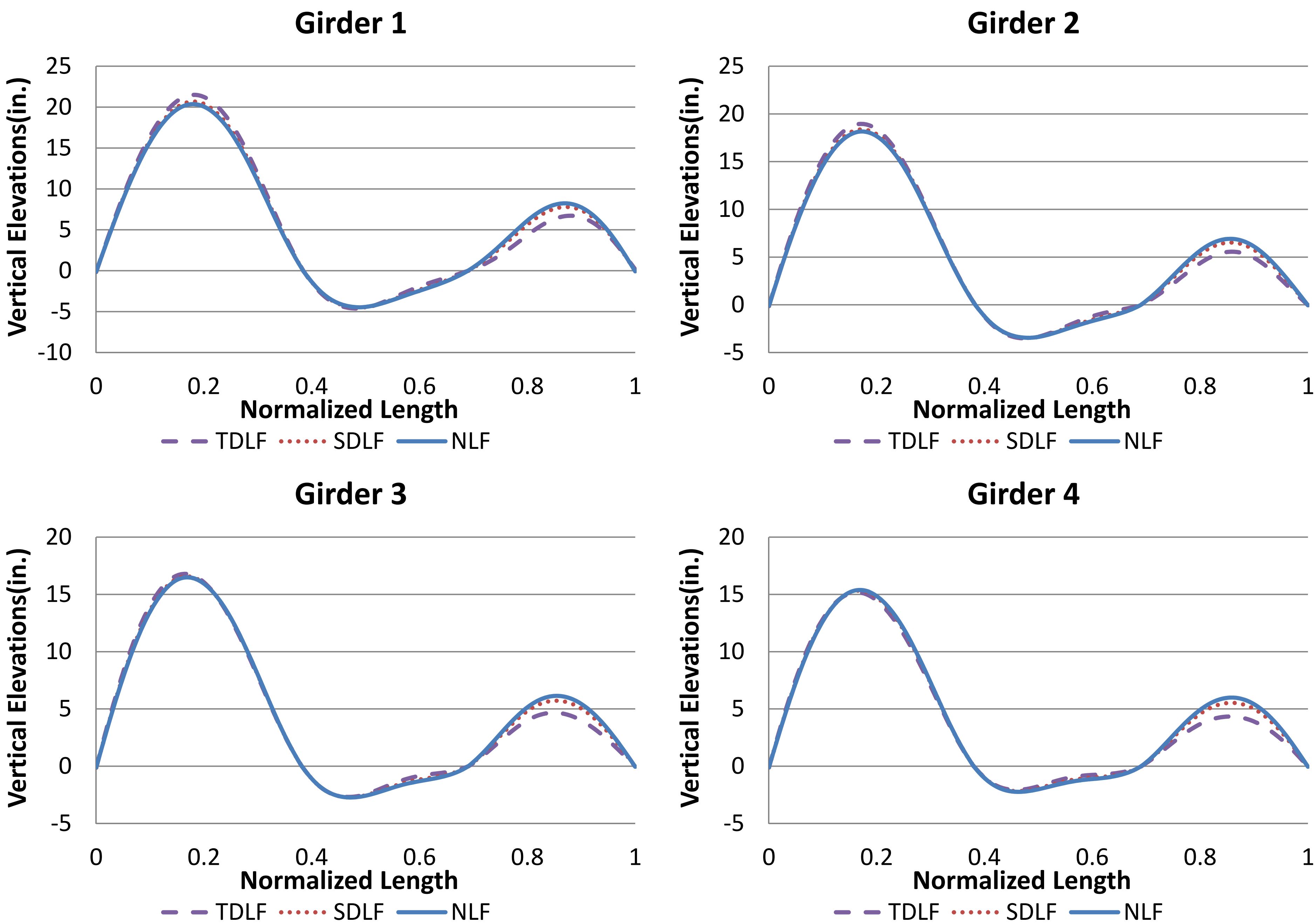


Figure T1-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

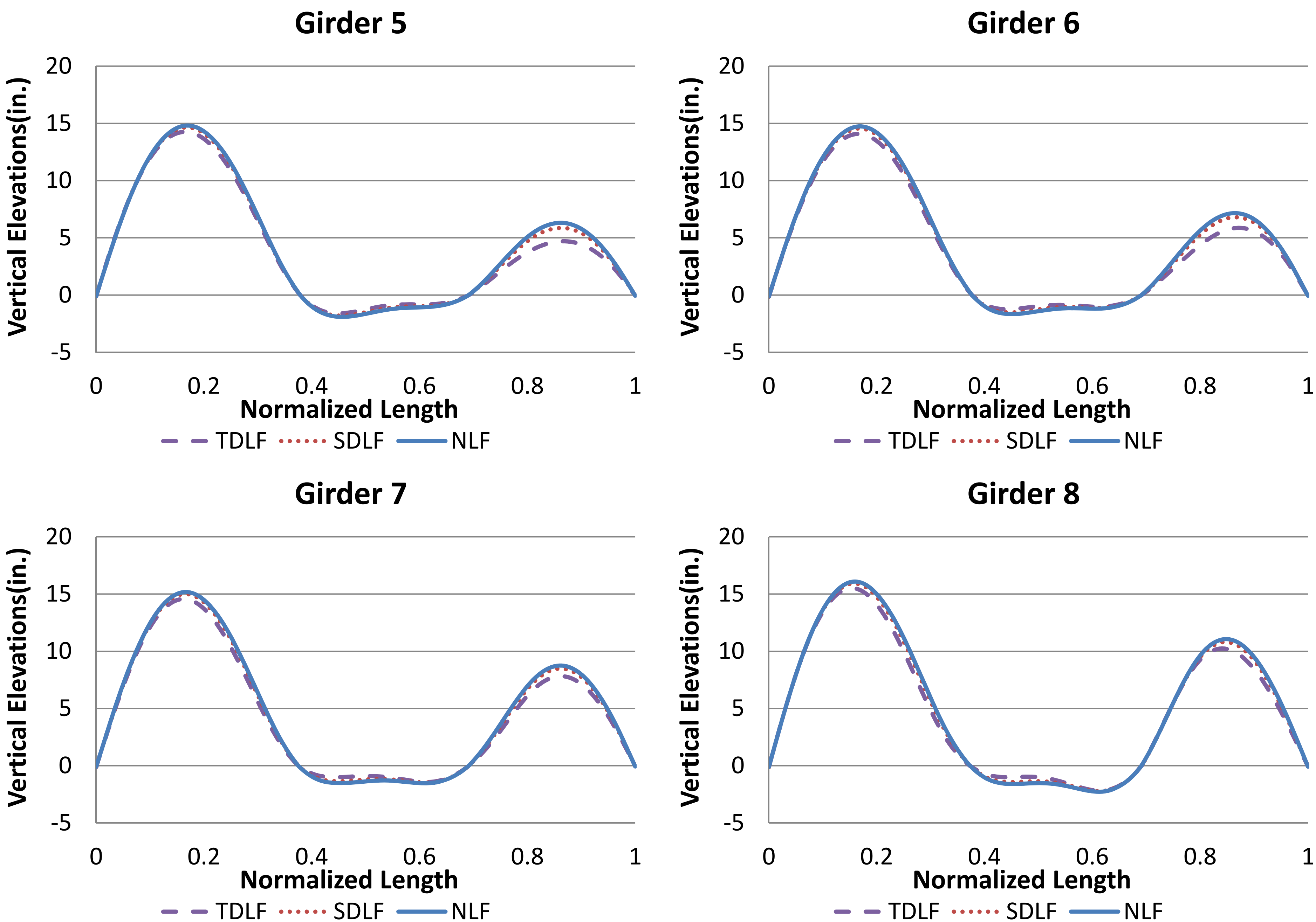


Figure T1-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

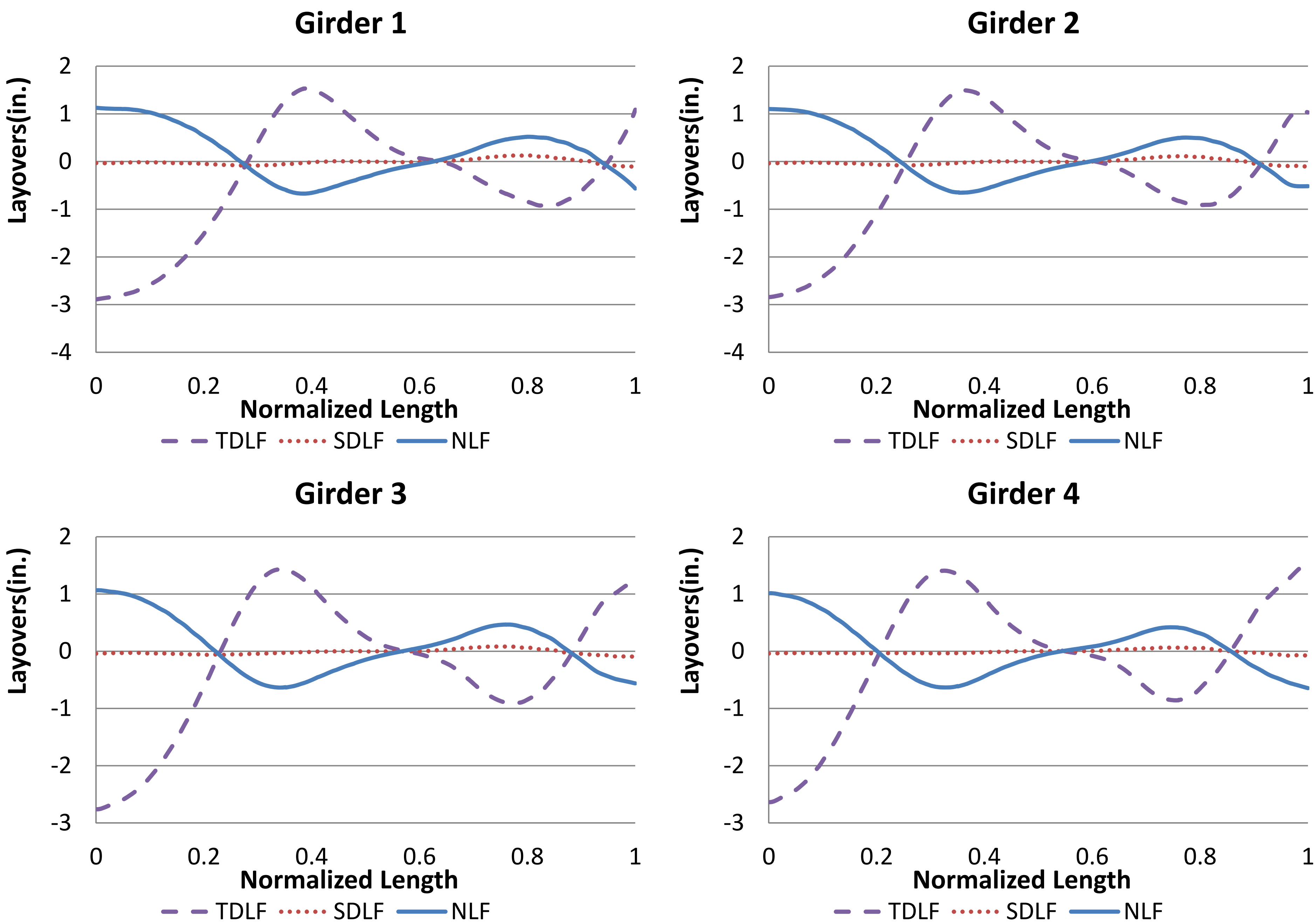


Figure T1-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

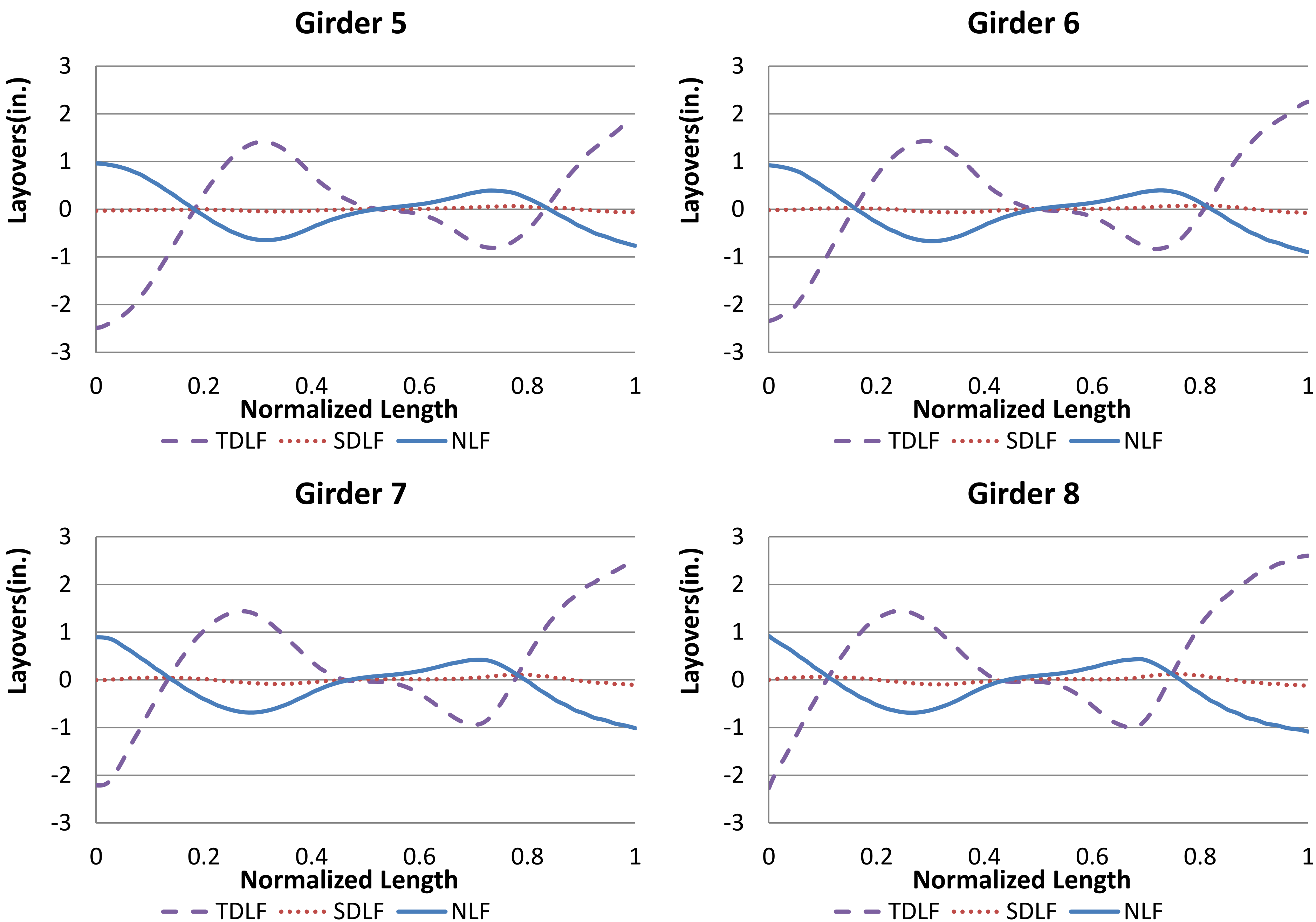


Figure T1-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

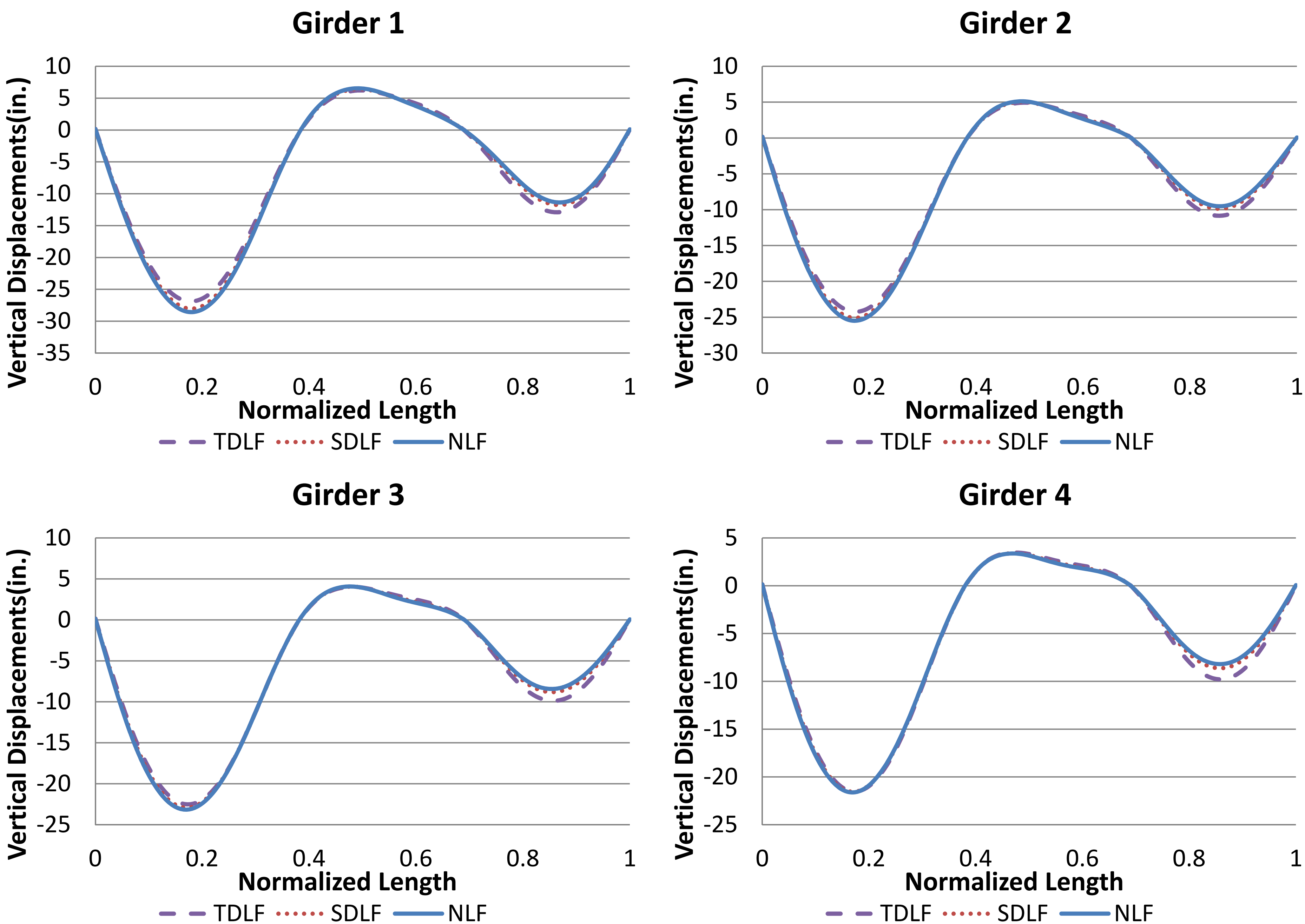


Figure T1-4-13. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

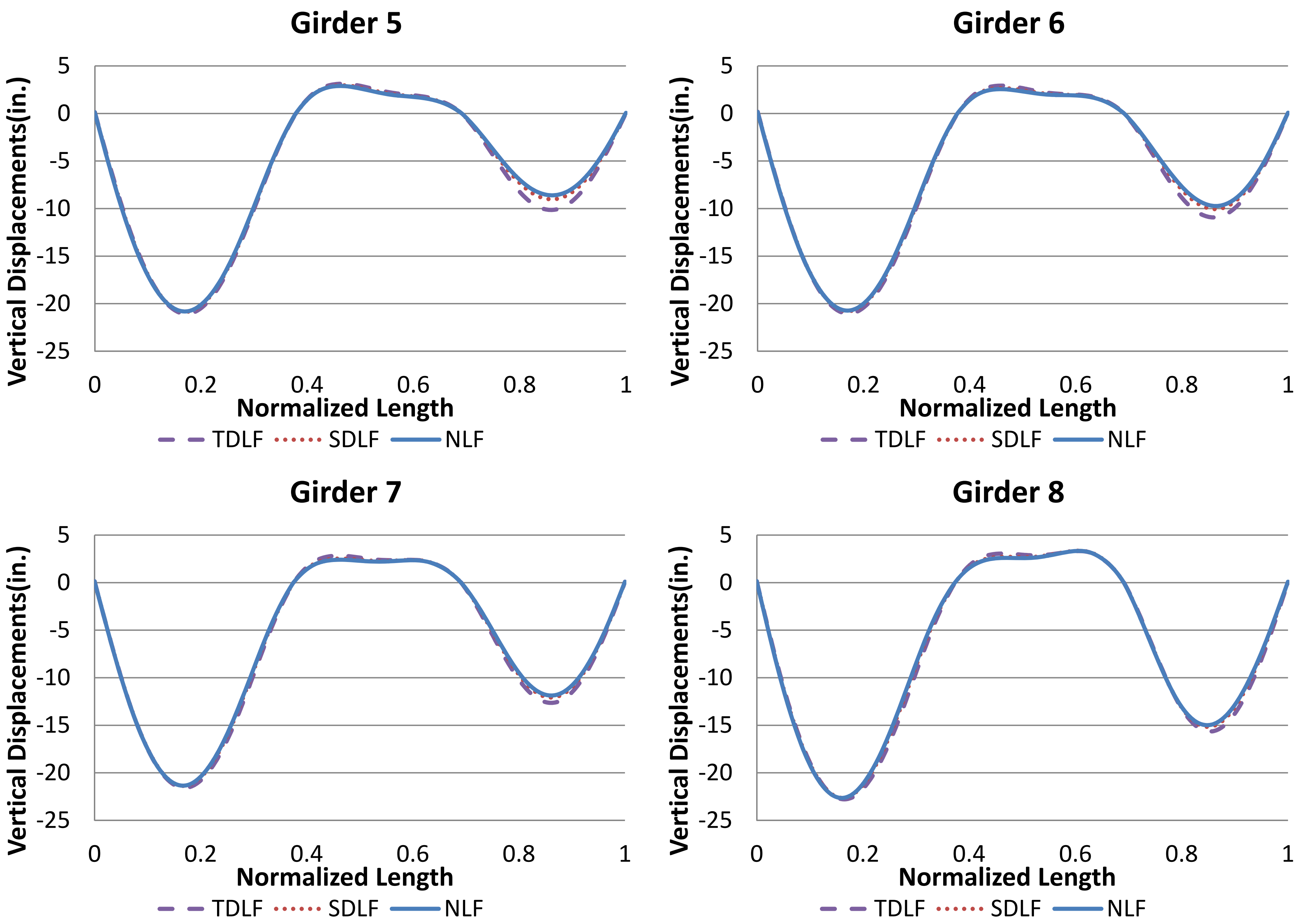


Figure T1-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

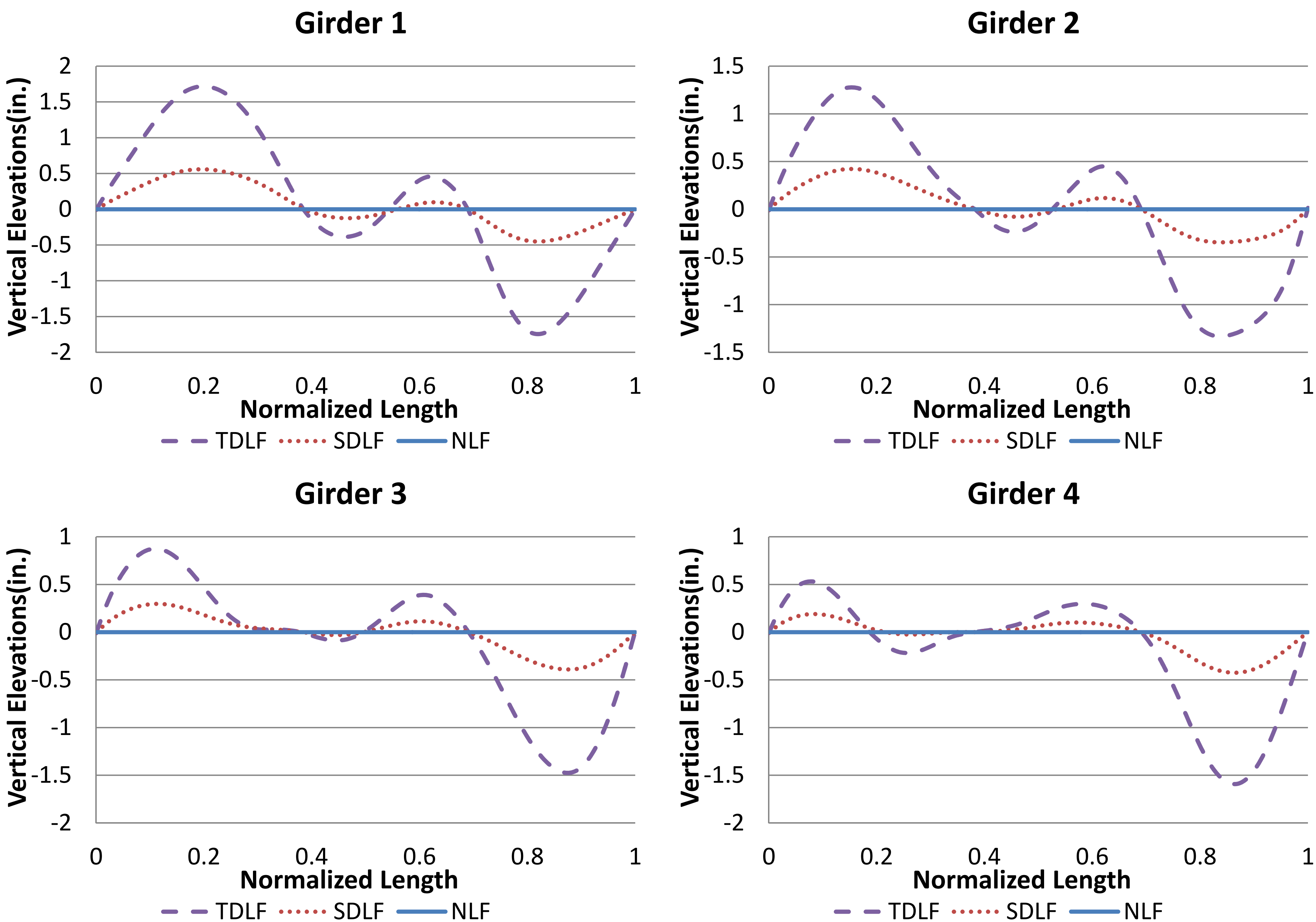


Figure T1-4-14. **Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.**

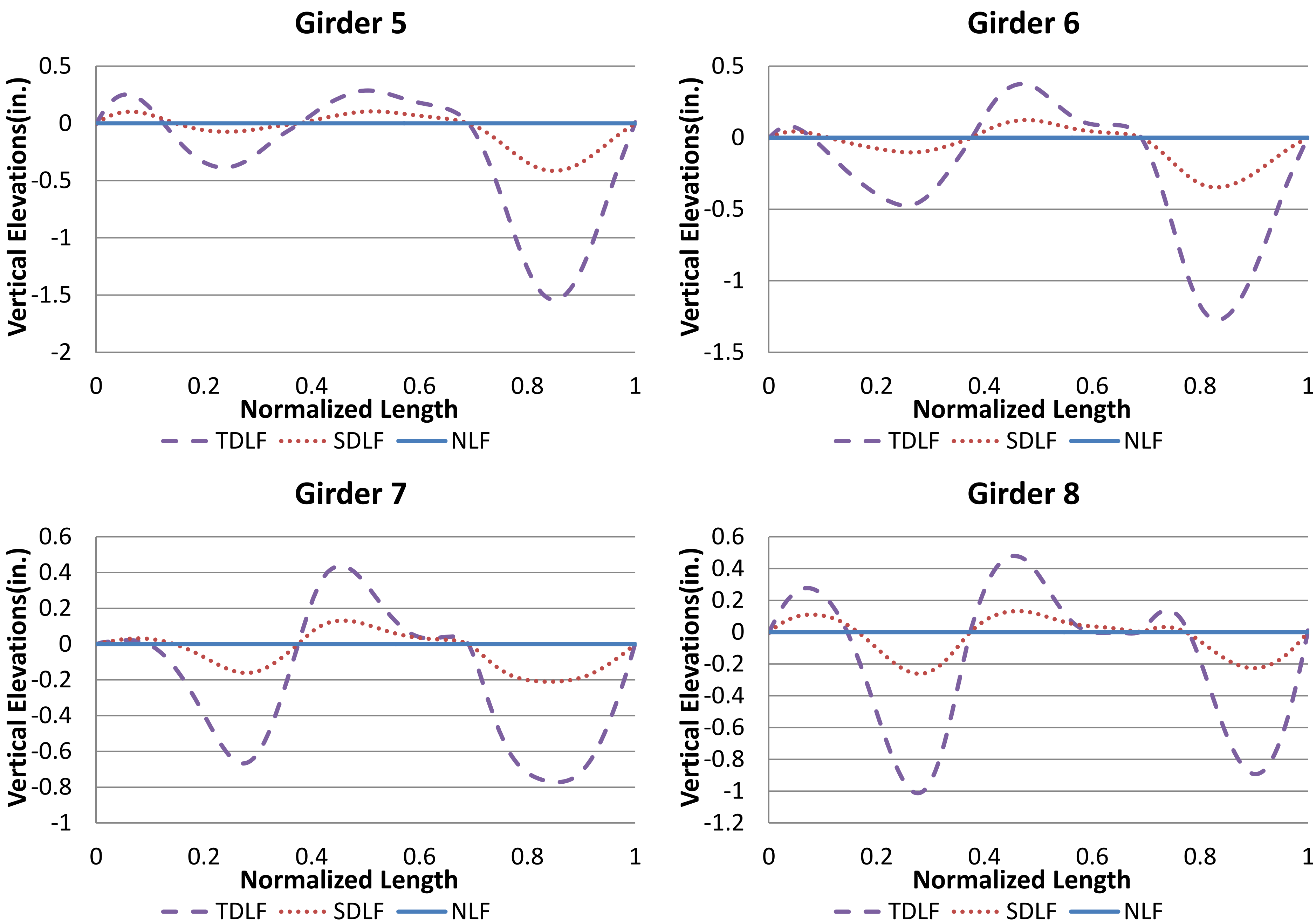


Figure T1-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

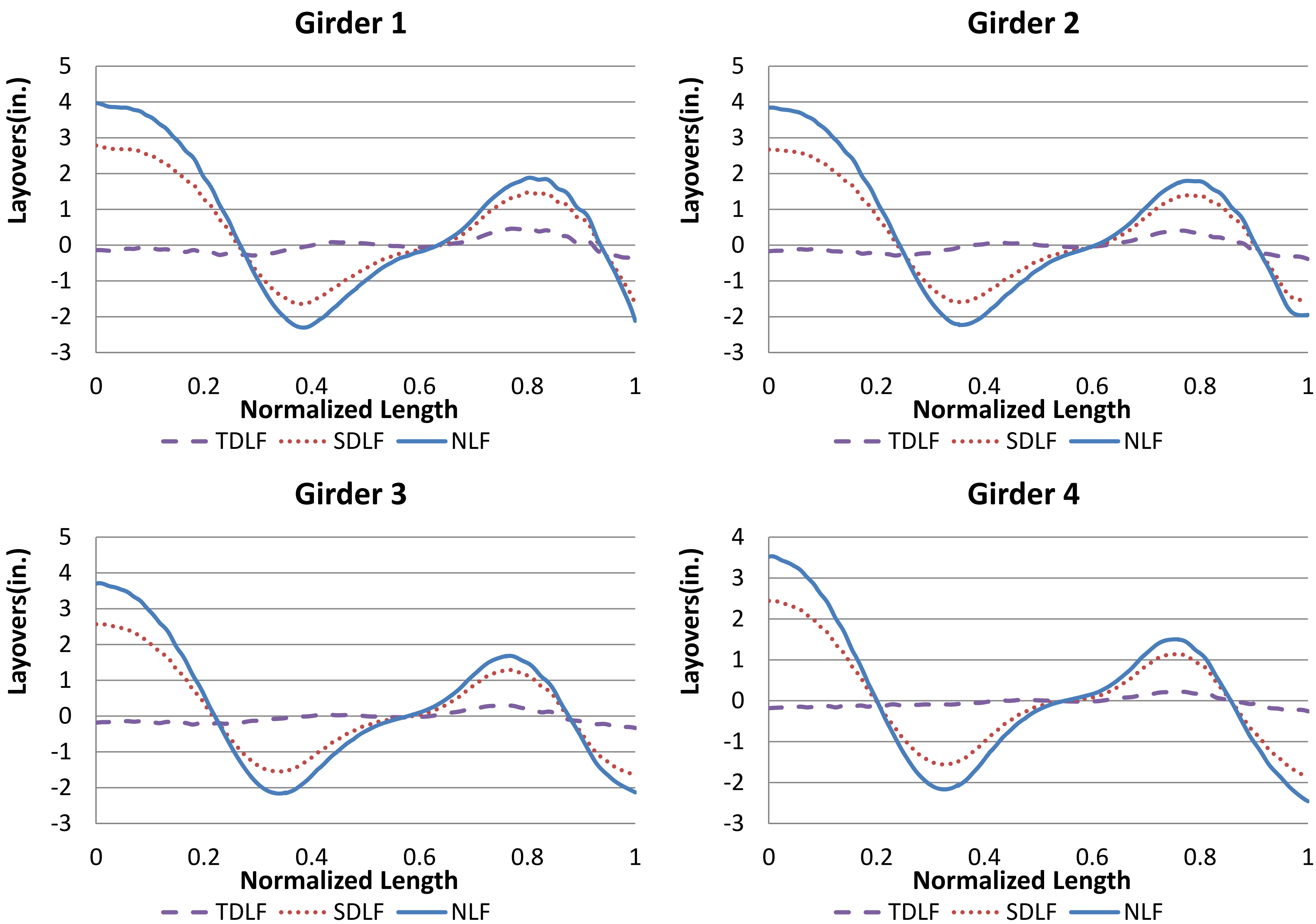


Figure T1-4-15. **Comparison of individual girder layovers (in) under TDL for different detailing methods.**

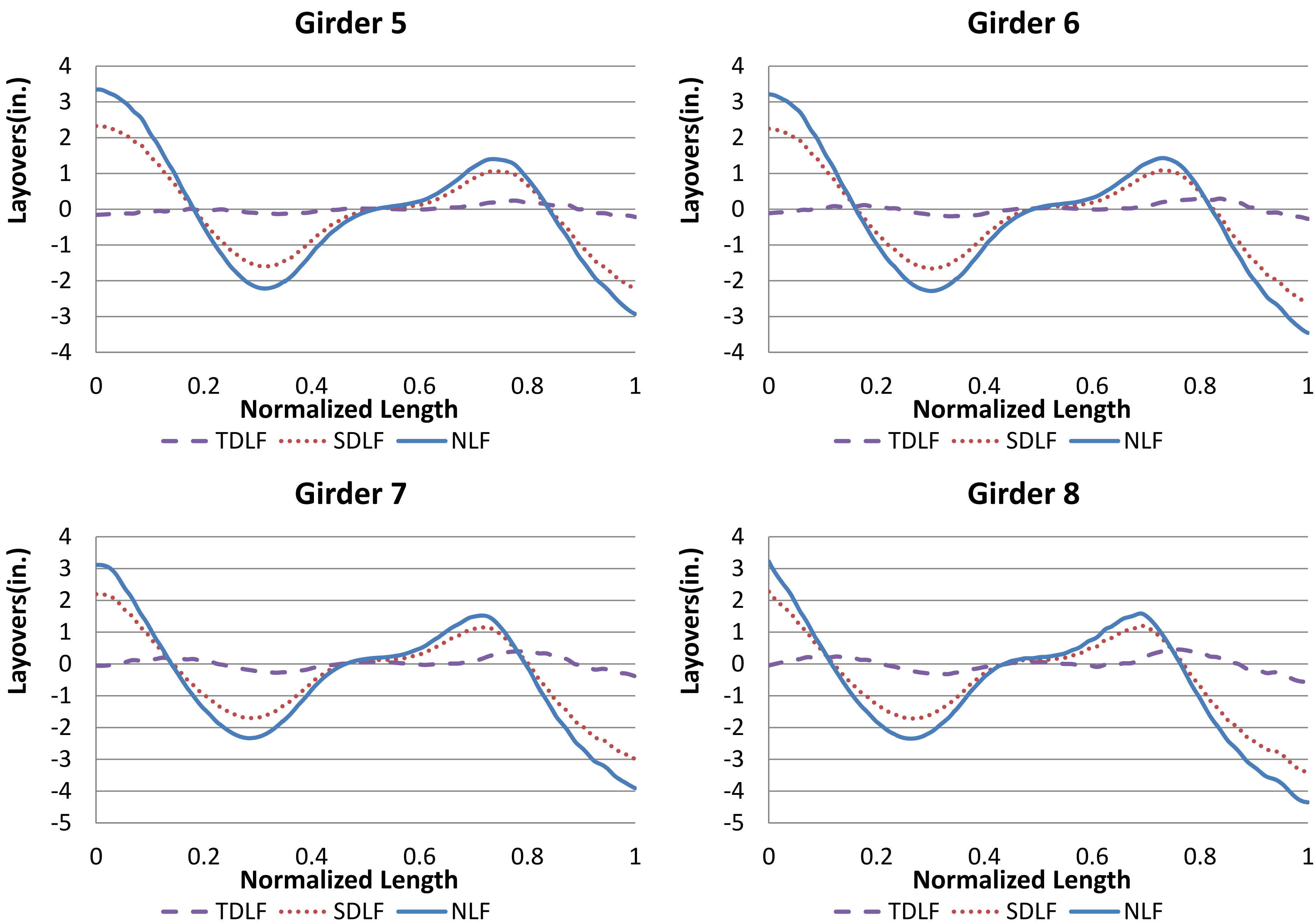


Figure T1-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

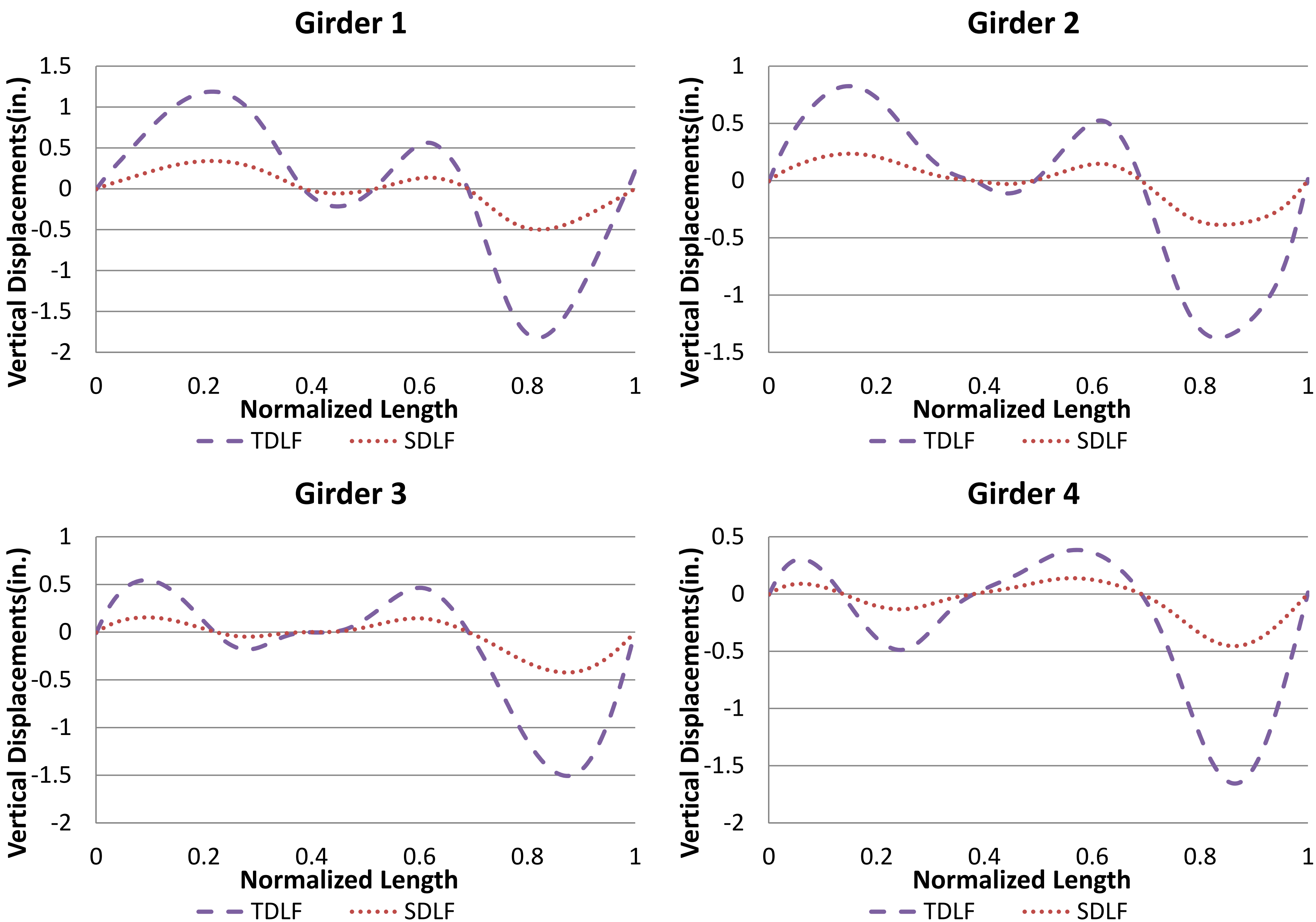


Figure T1-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

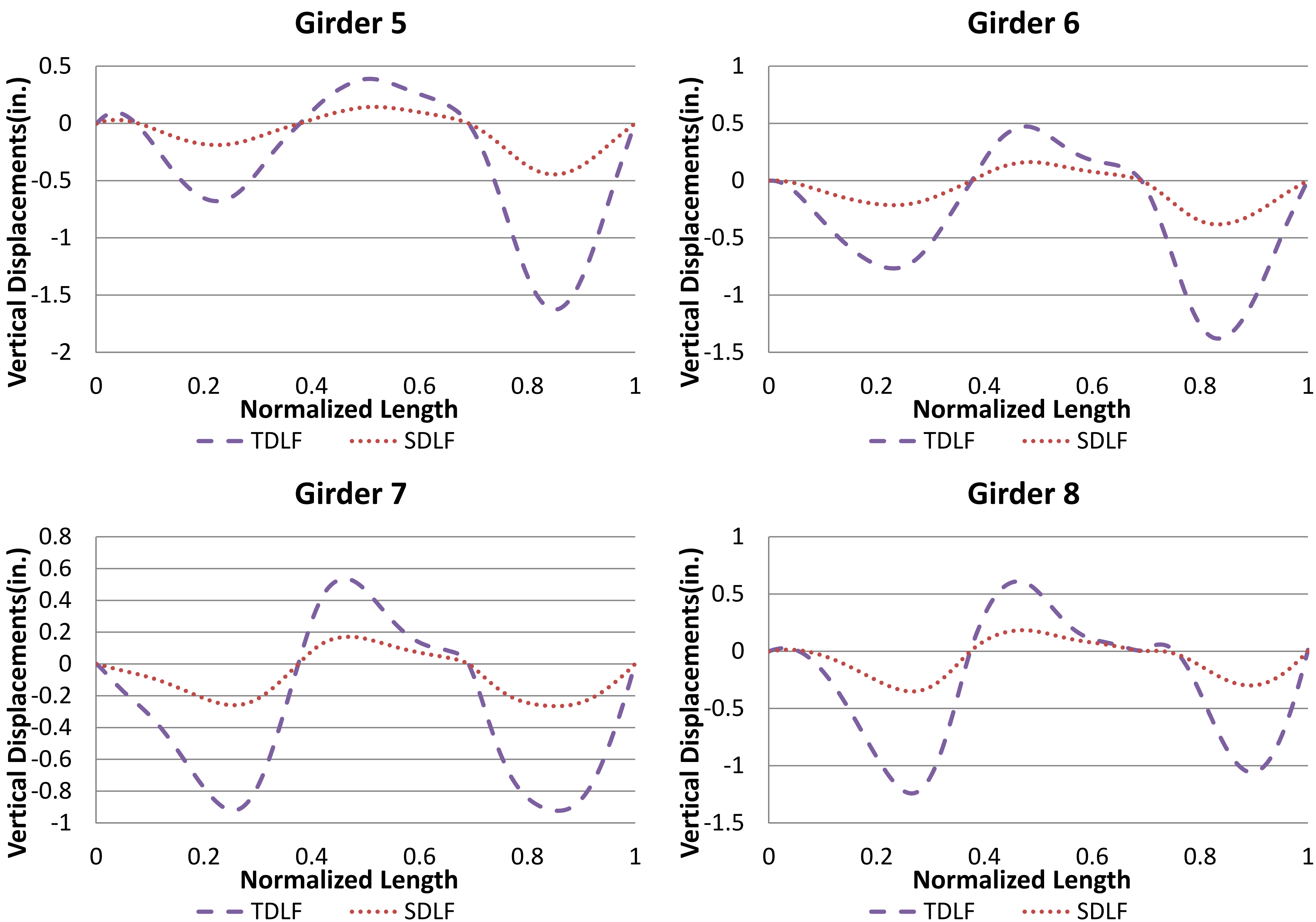


Figure T1-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

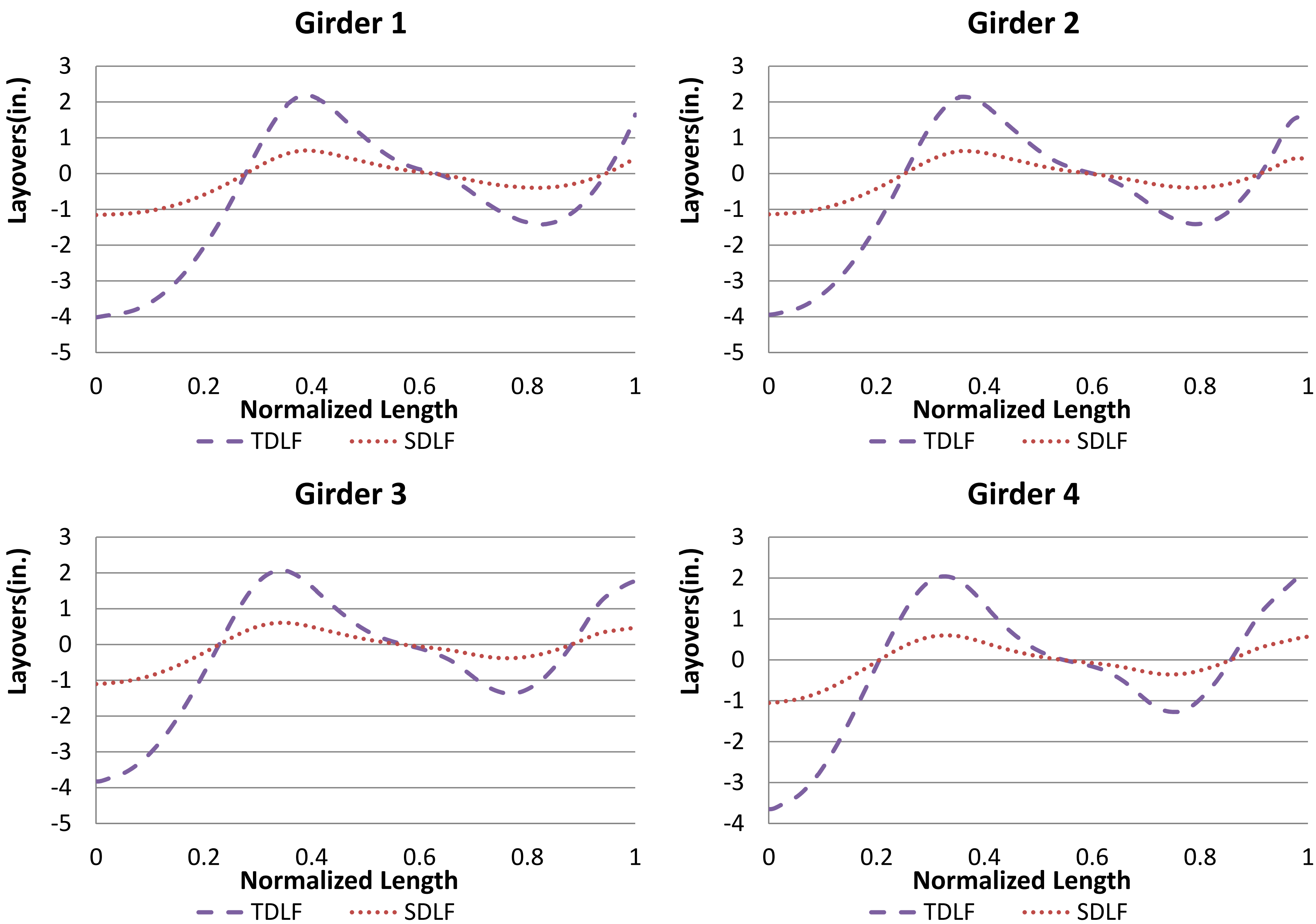


Figure T1-4-17. **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.**

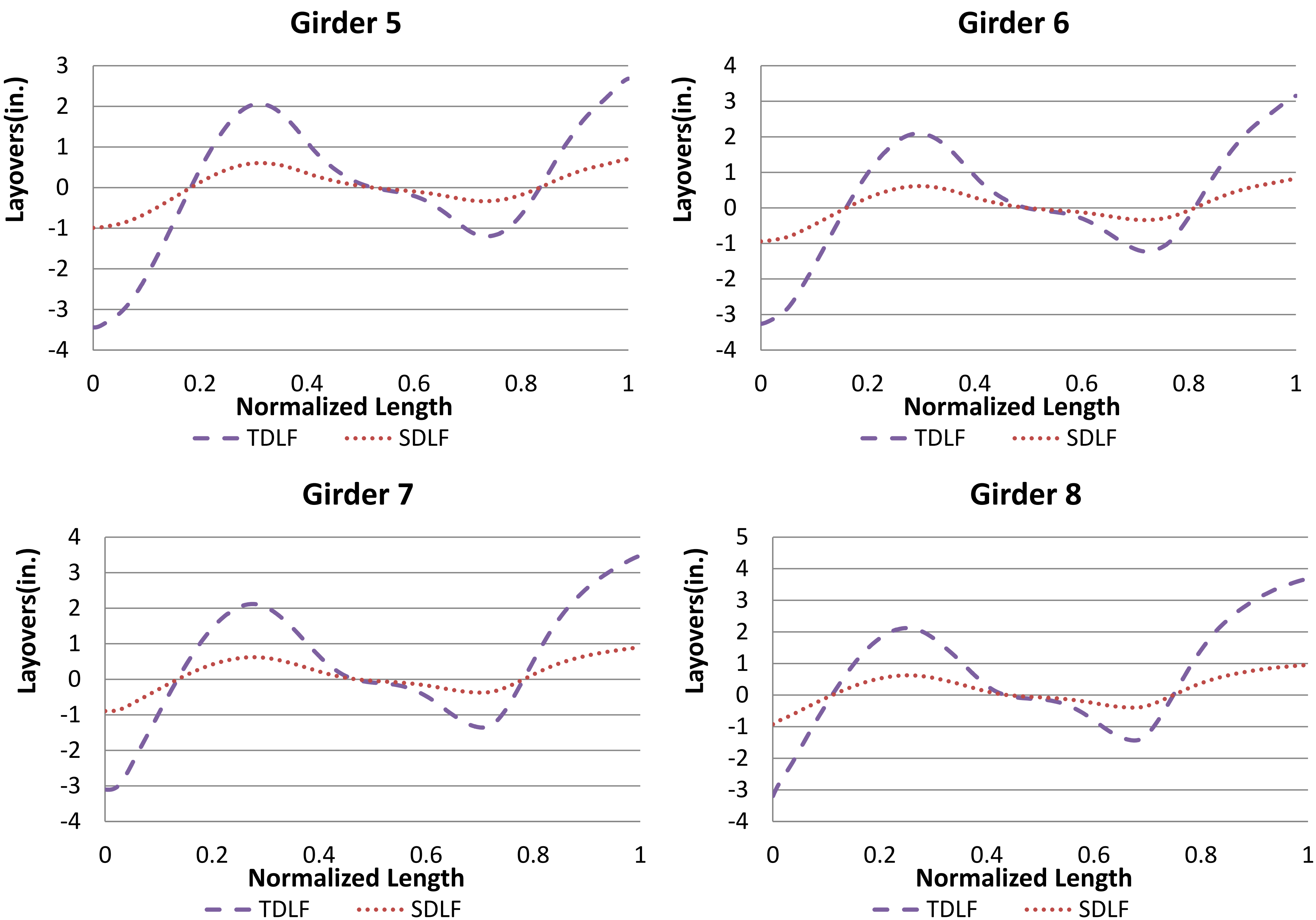


Figure T1-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

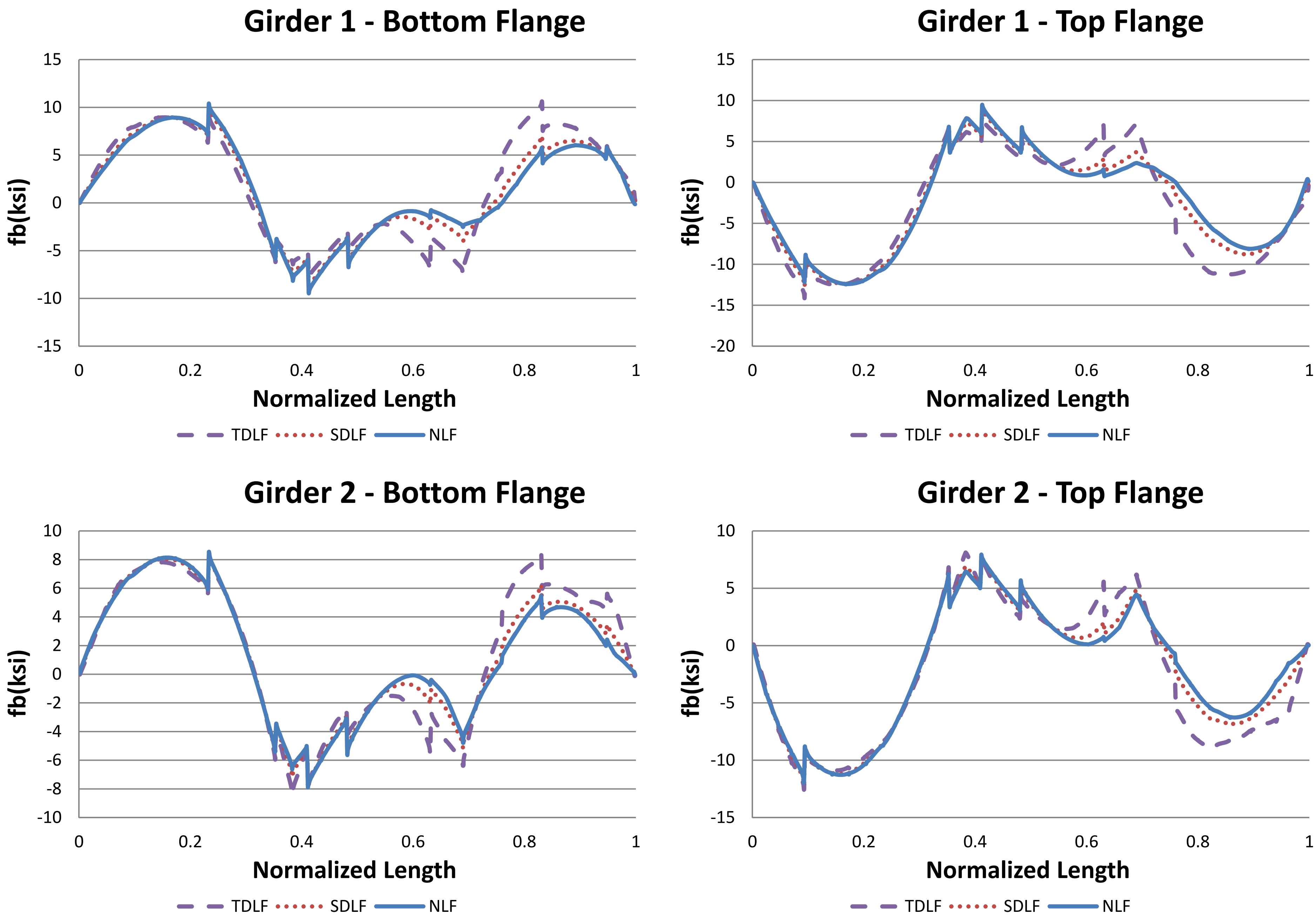


Figure T1-4-18. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

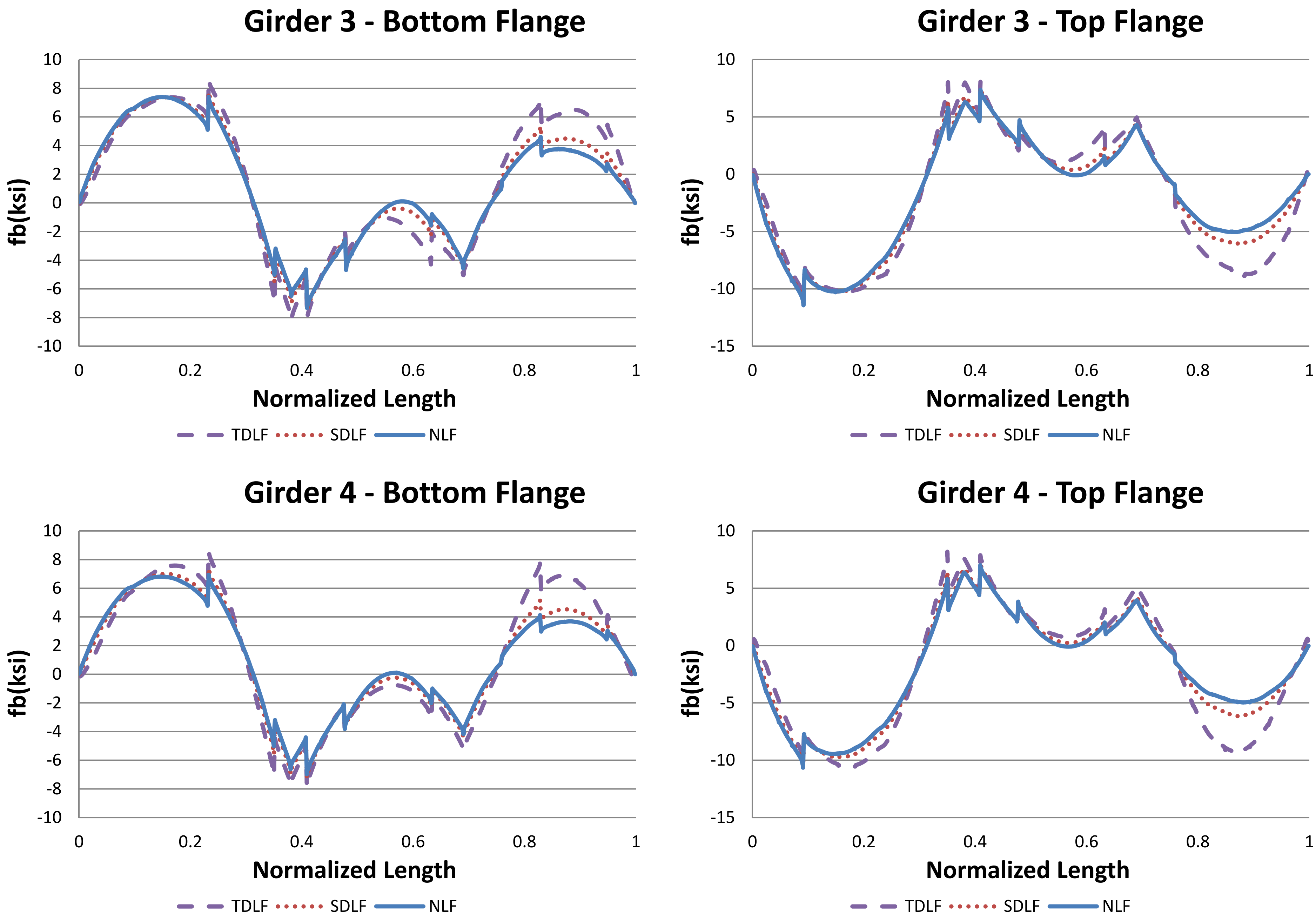


Figure T1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

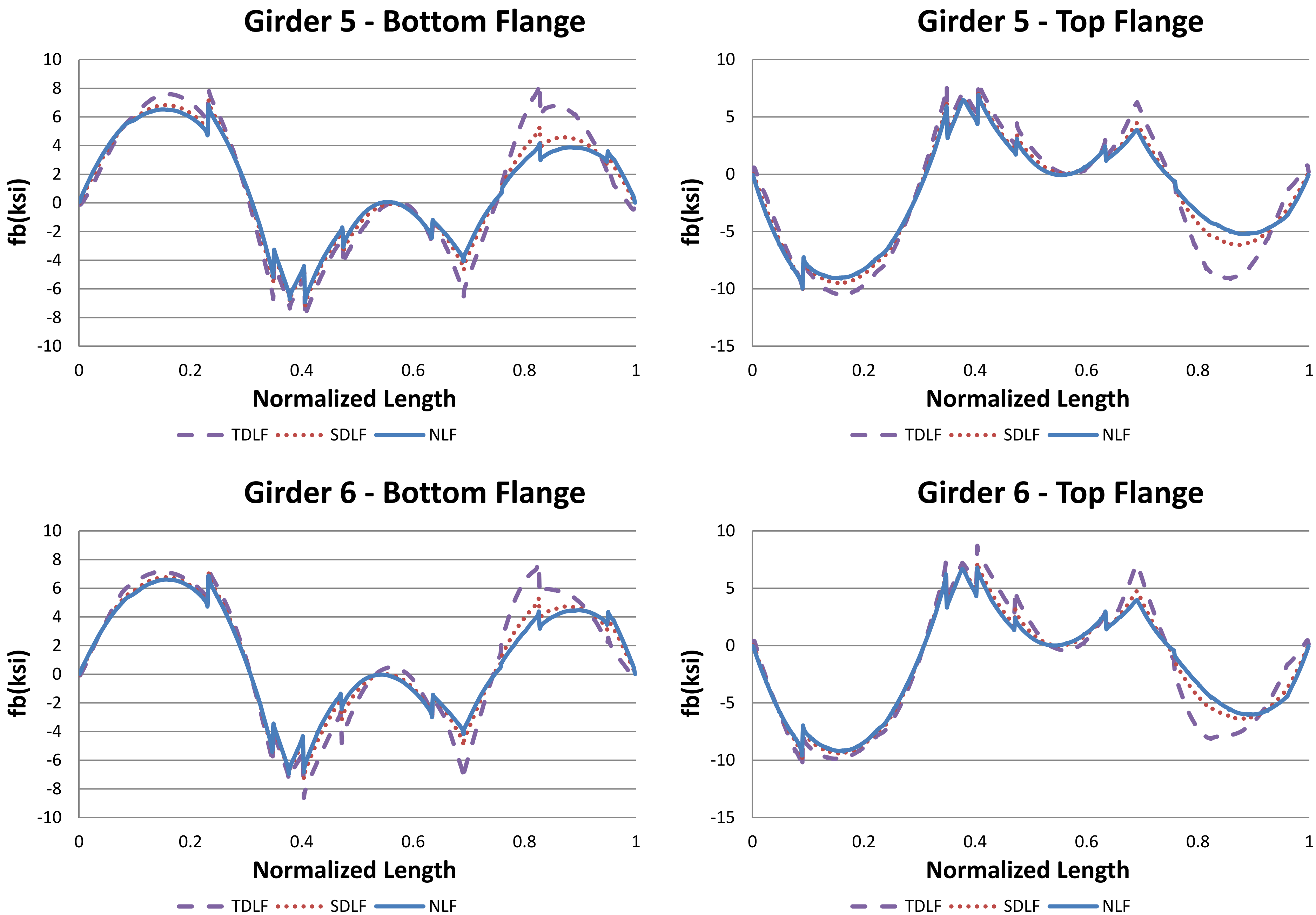


Figure T1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

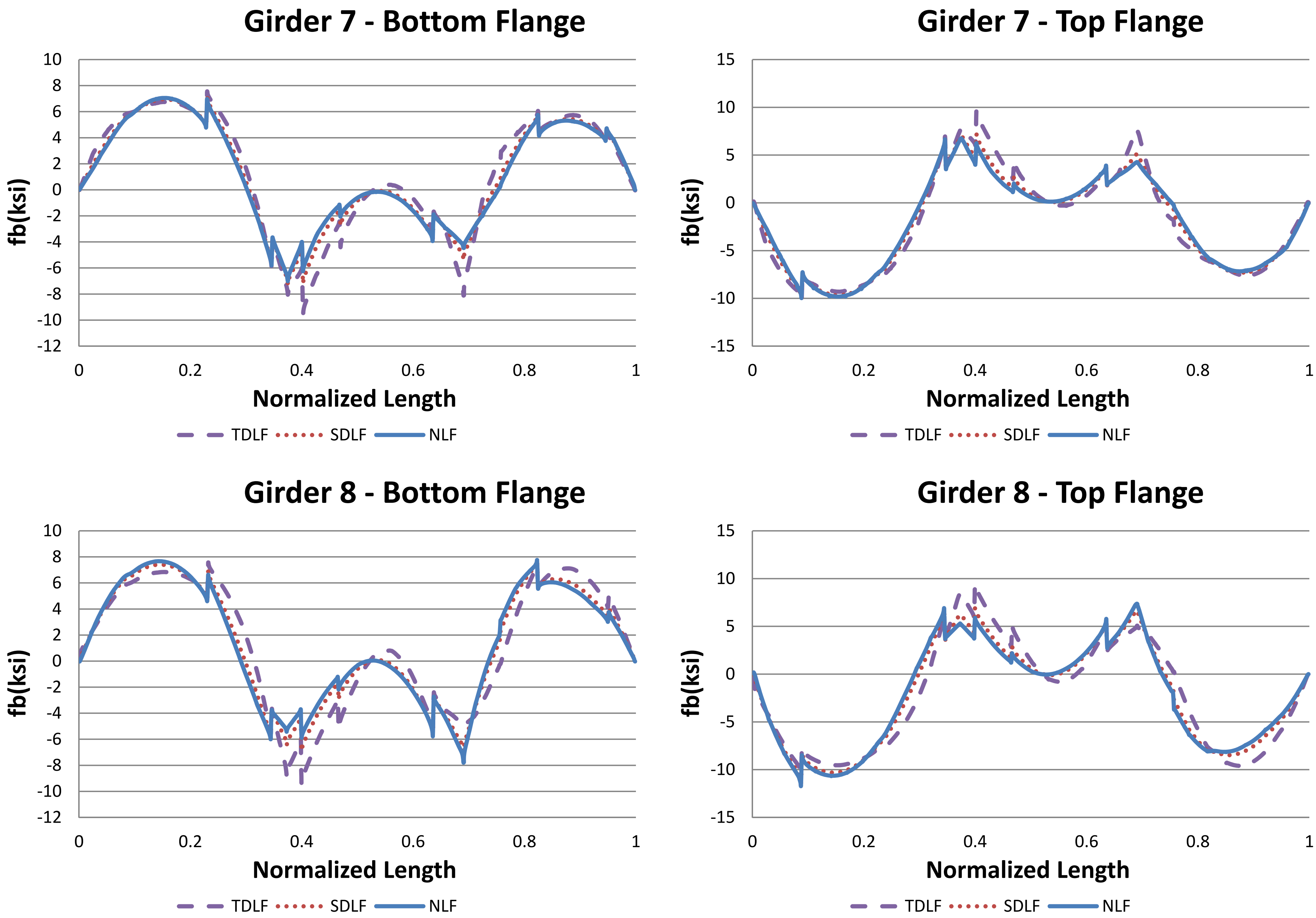


Figure T1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

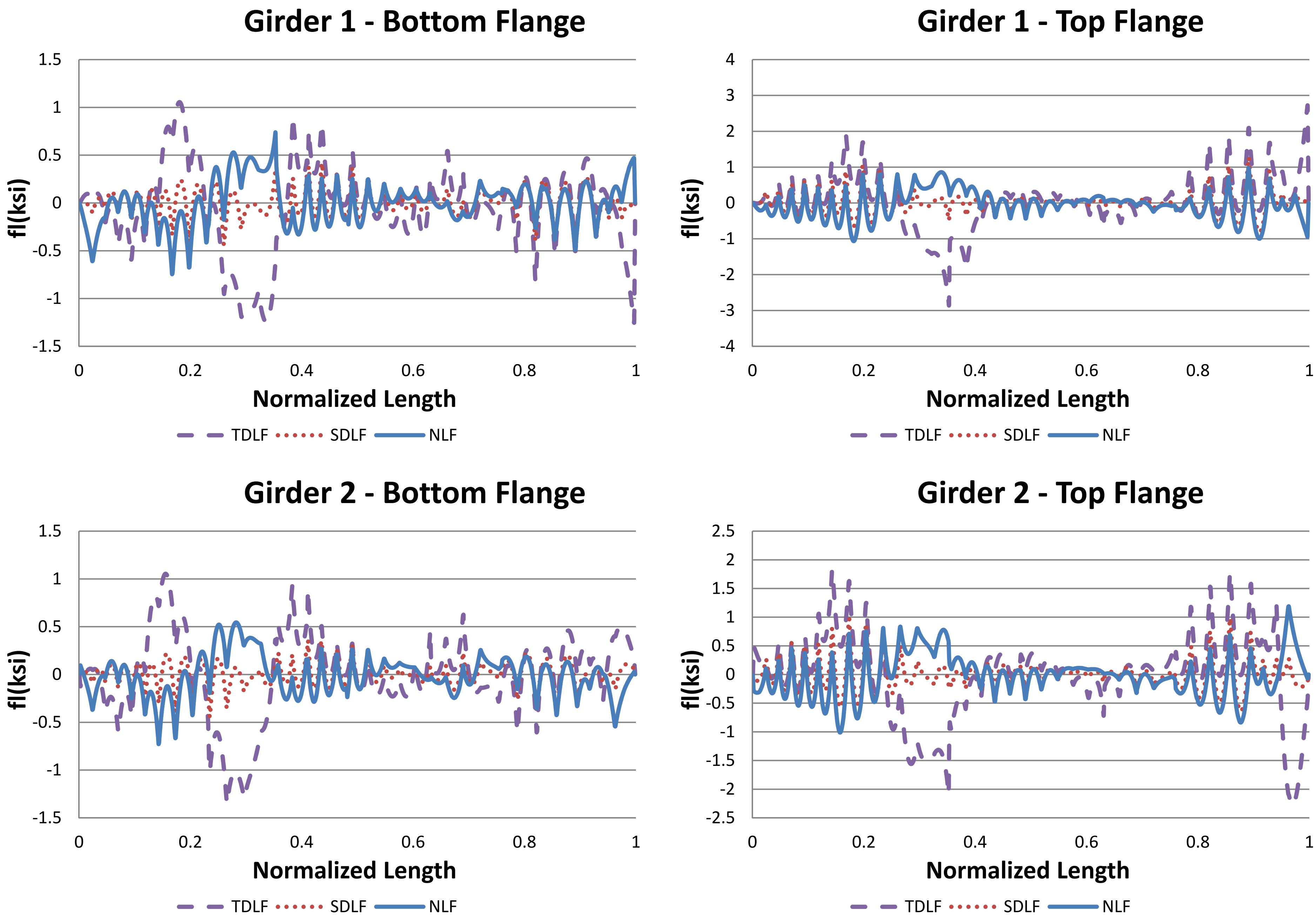


Figure T1-4-19. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

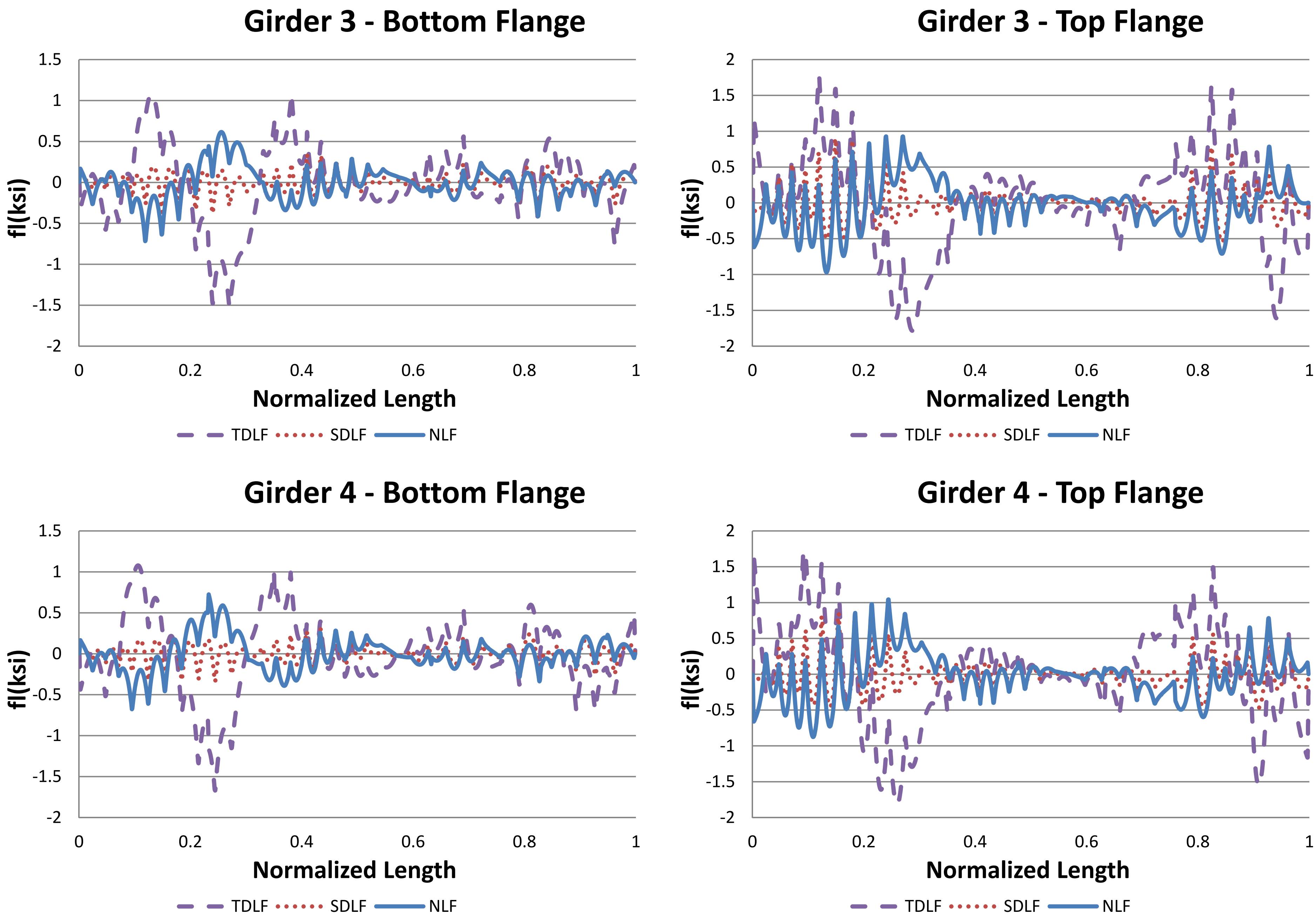


Figure T1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

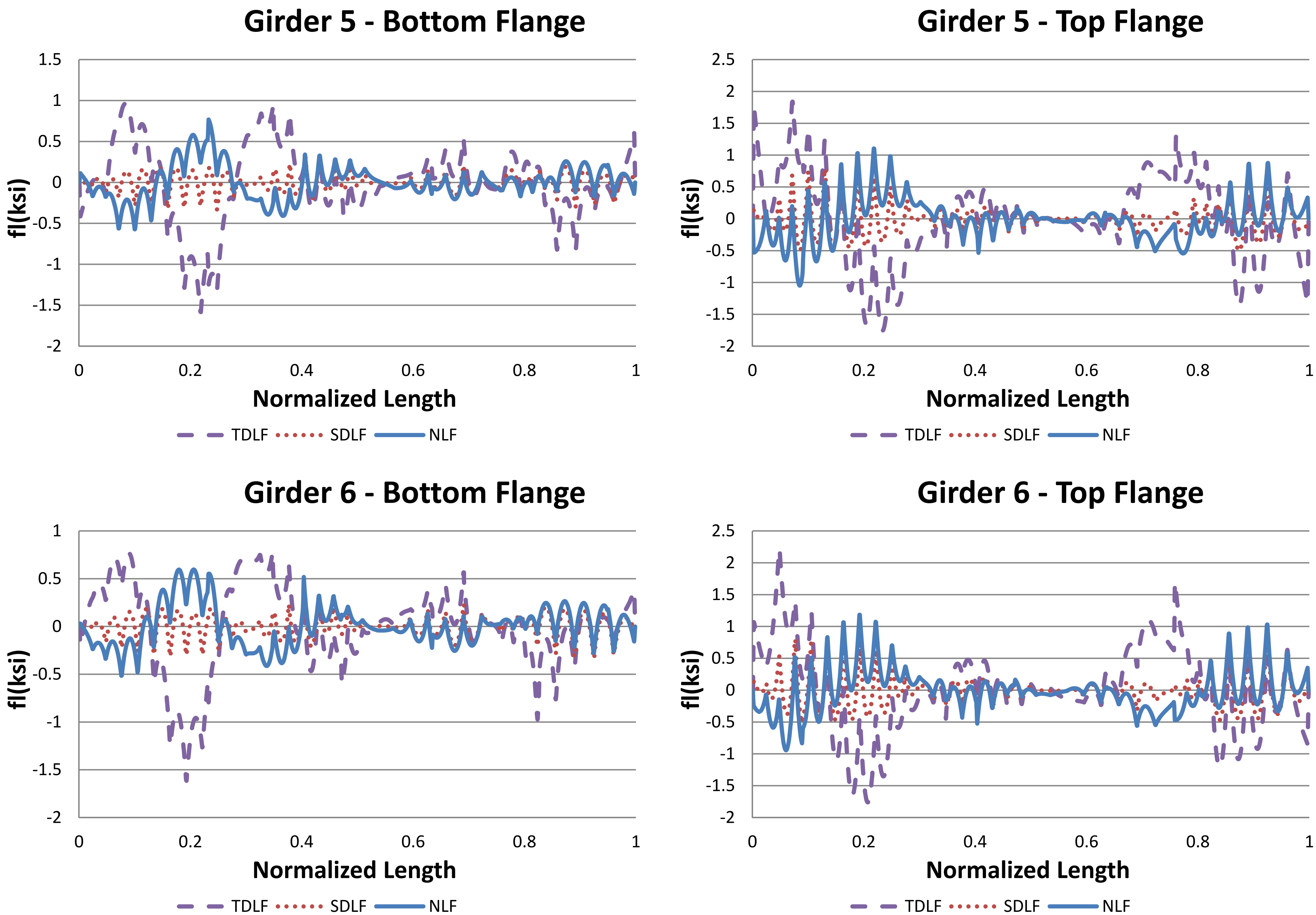


Figure T1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

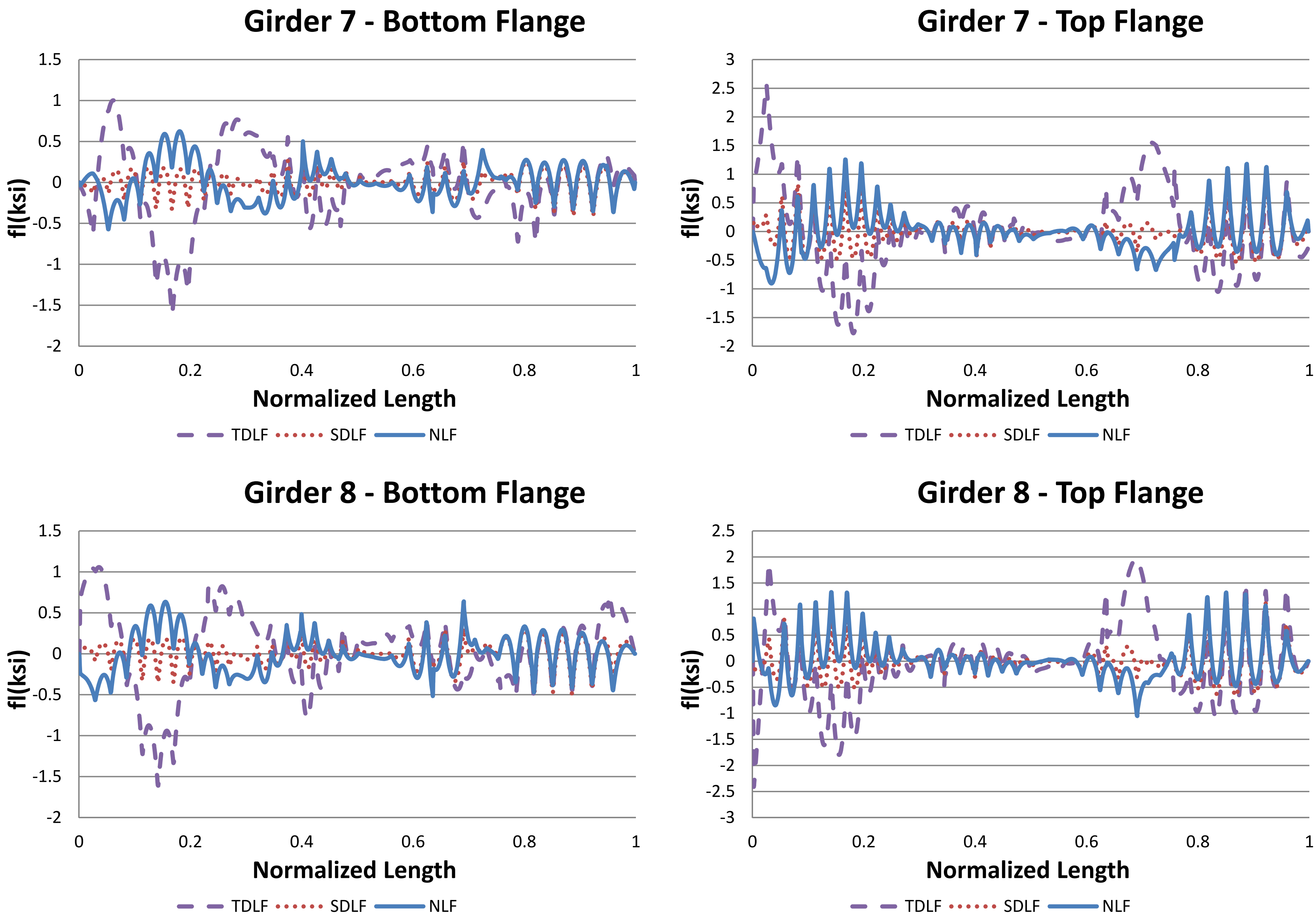


Figure T1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

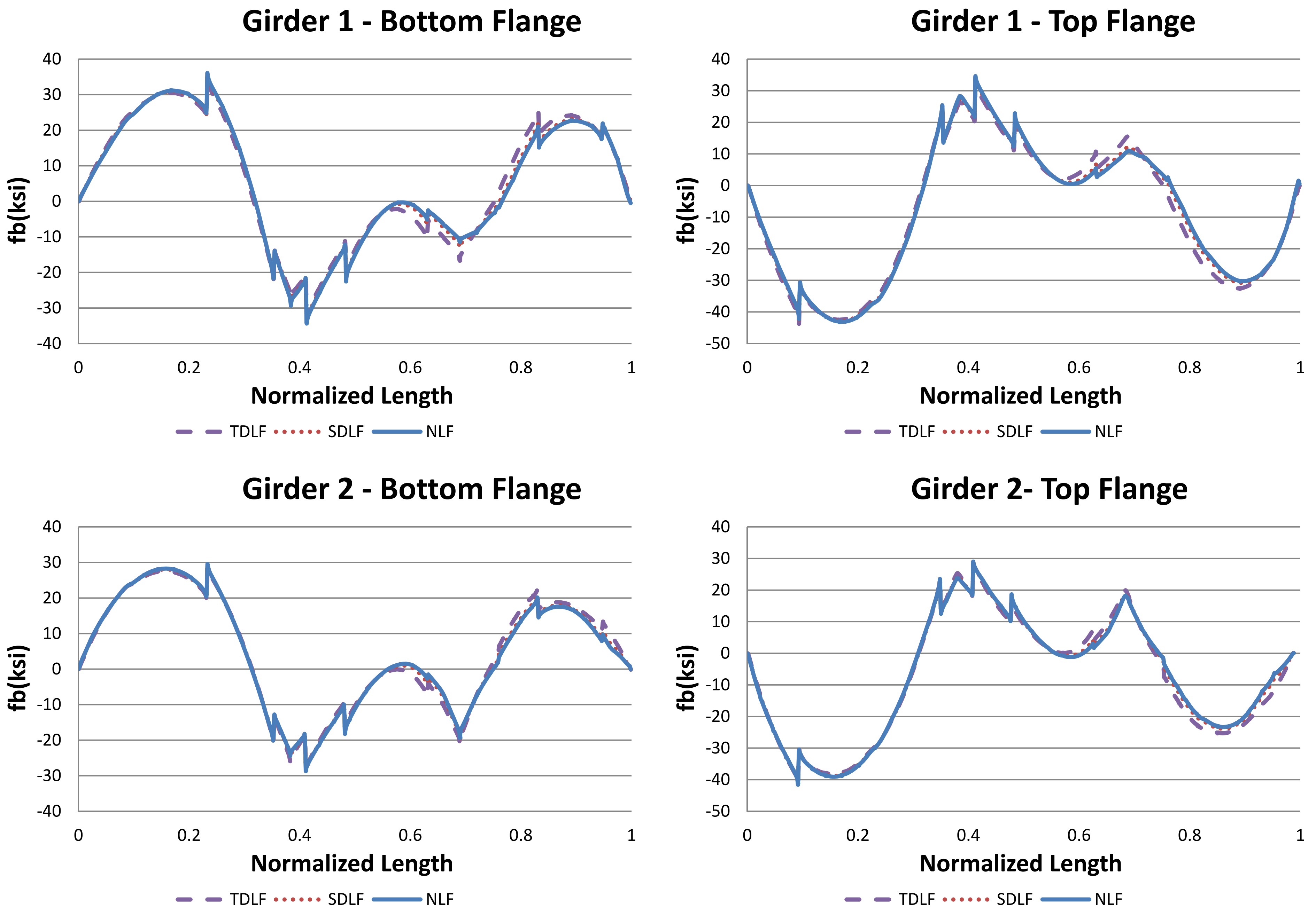


Figure T1-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

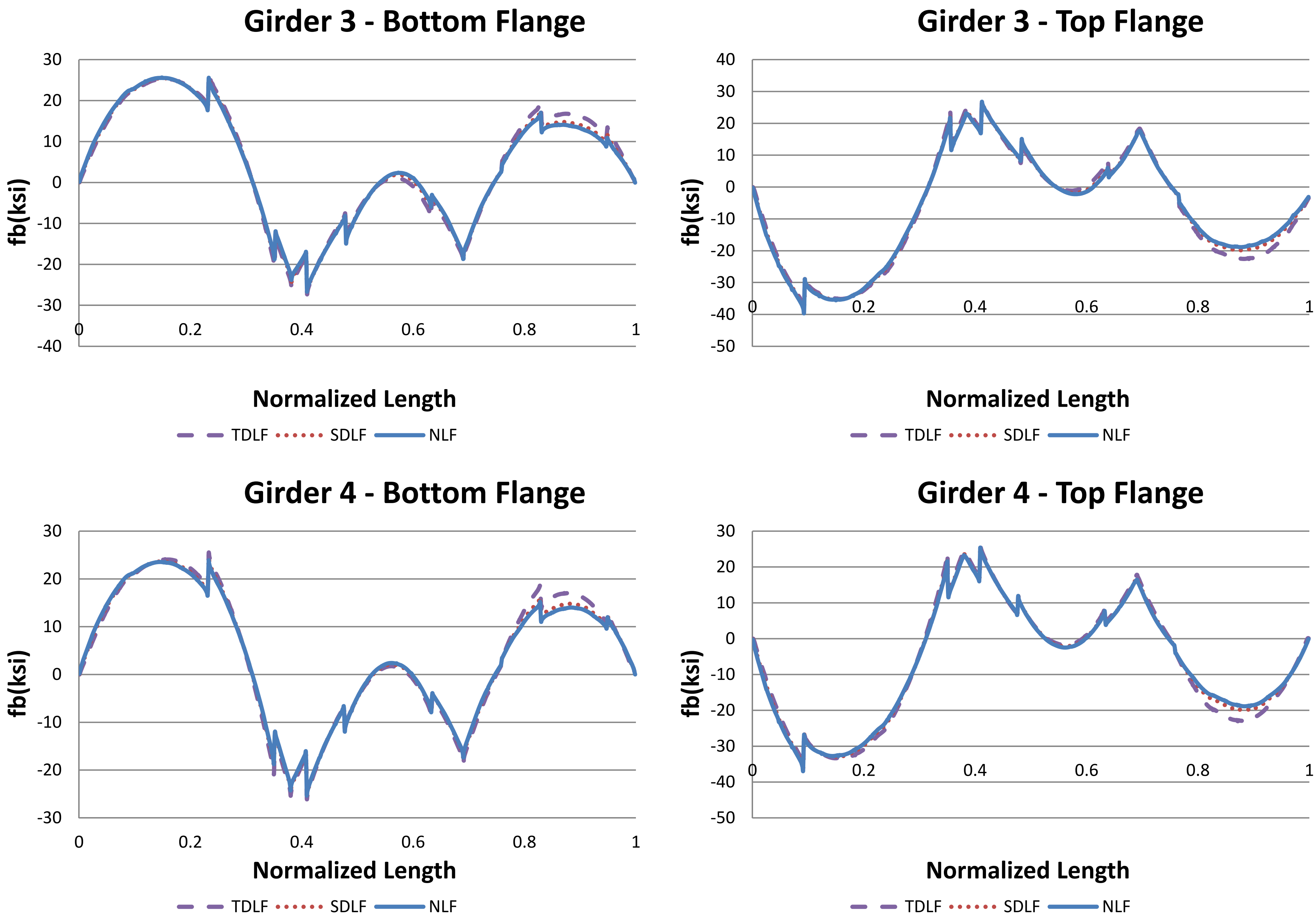


Figure T1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

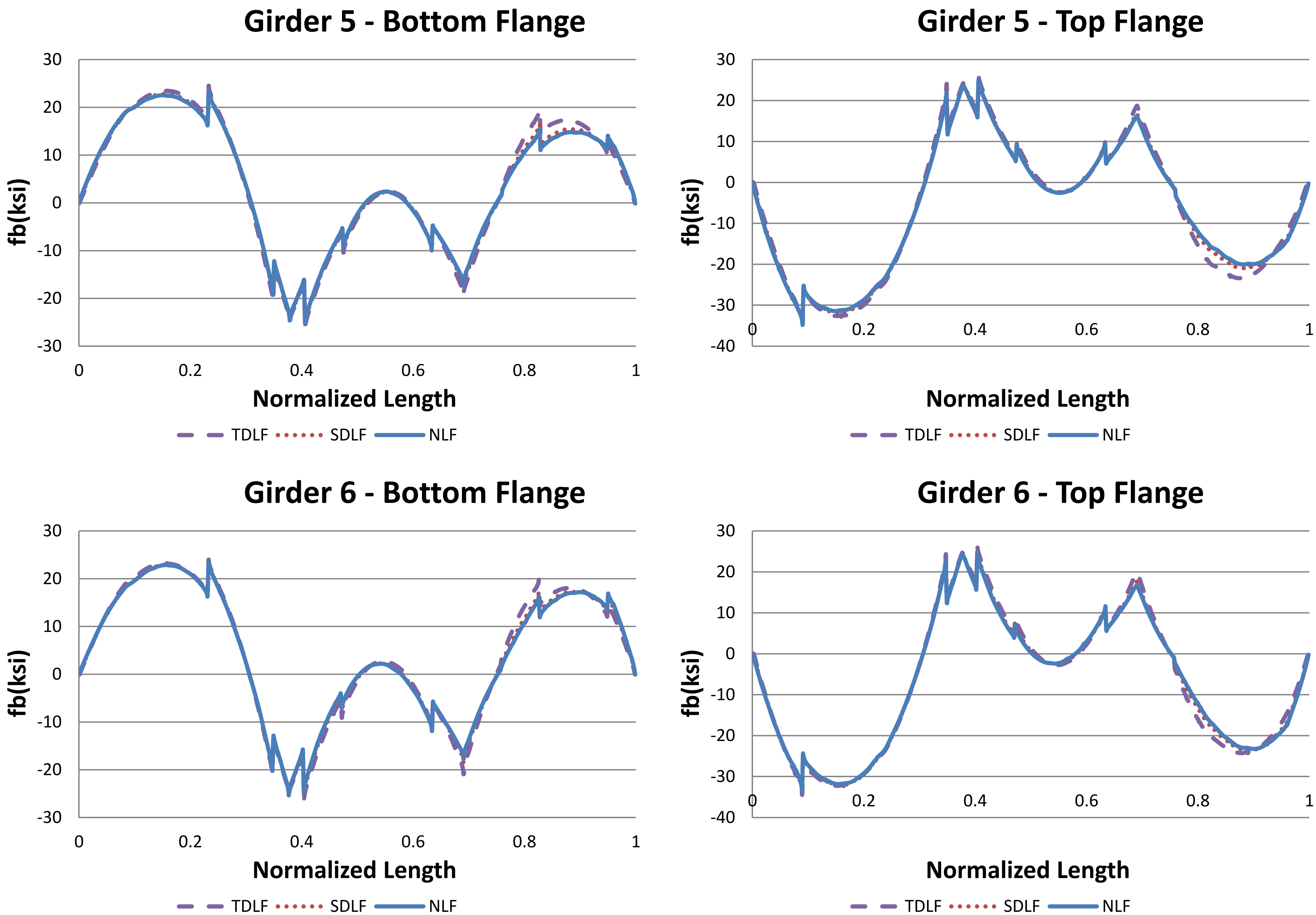


Figure T1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

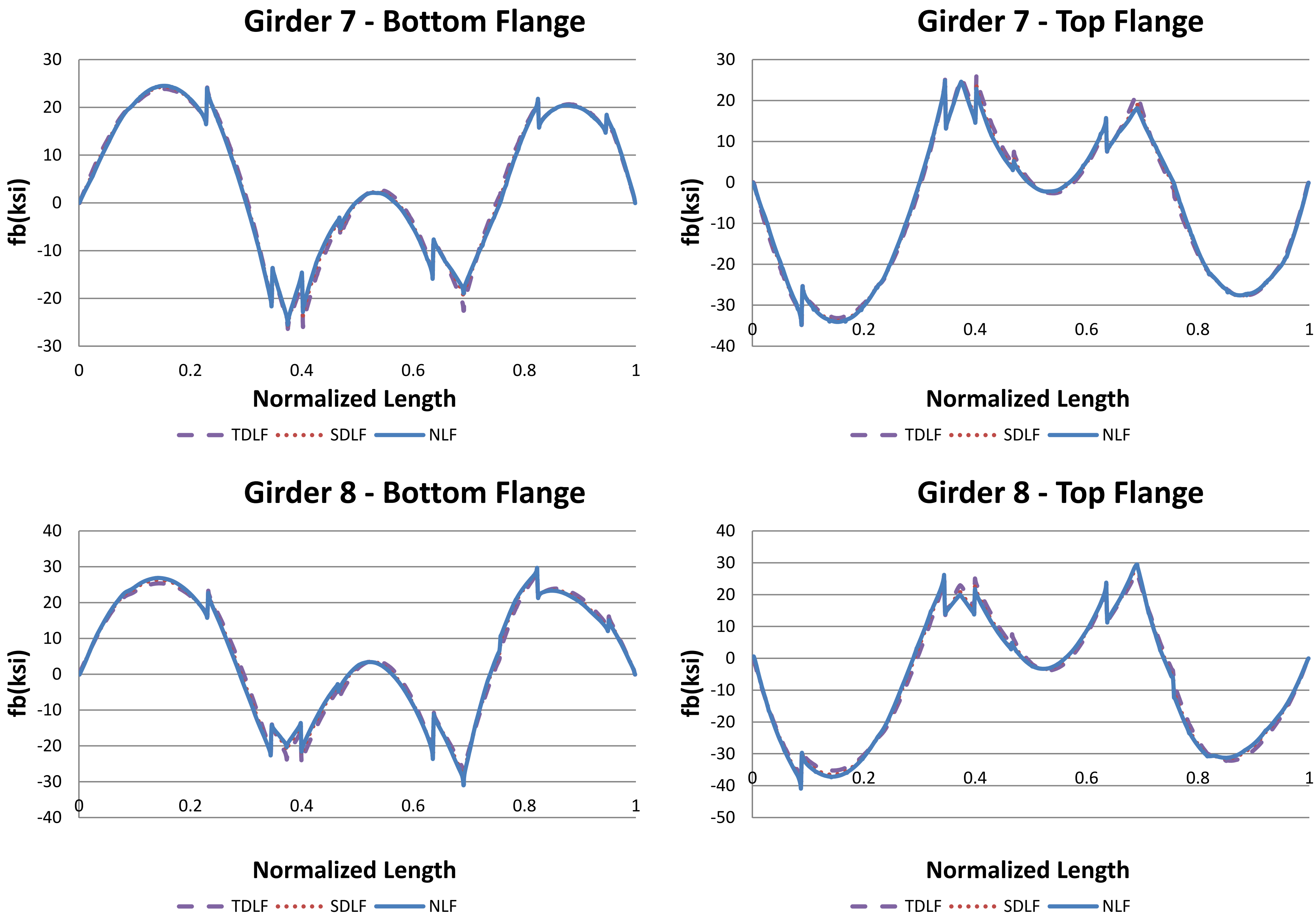


Figure T1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

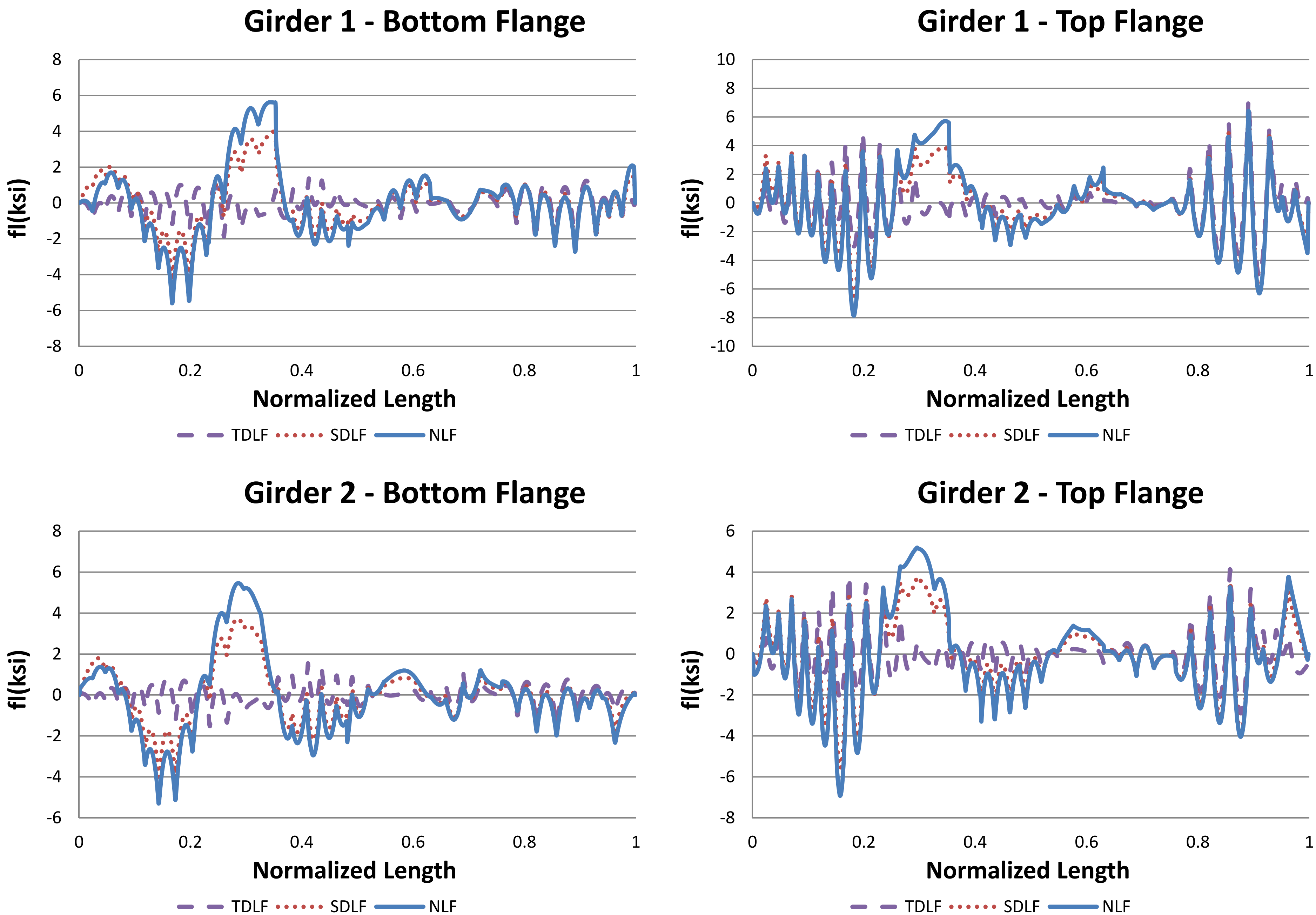


Figure T1-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

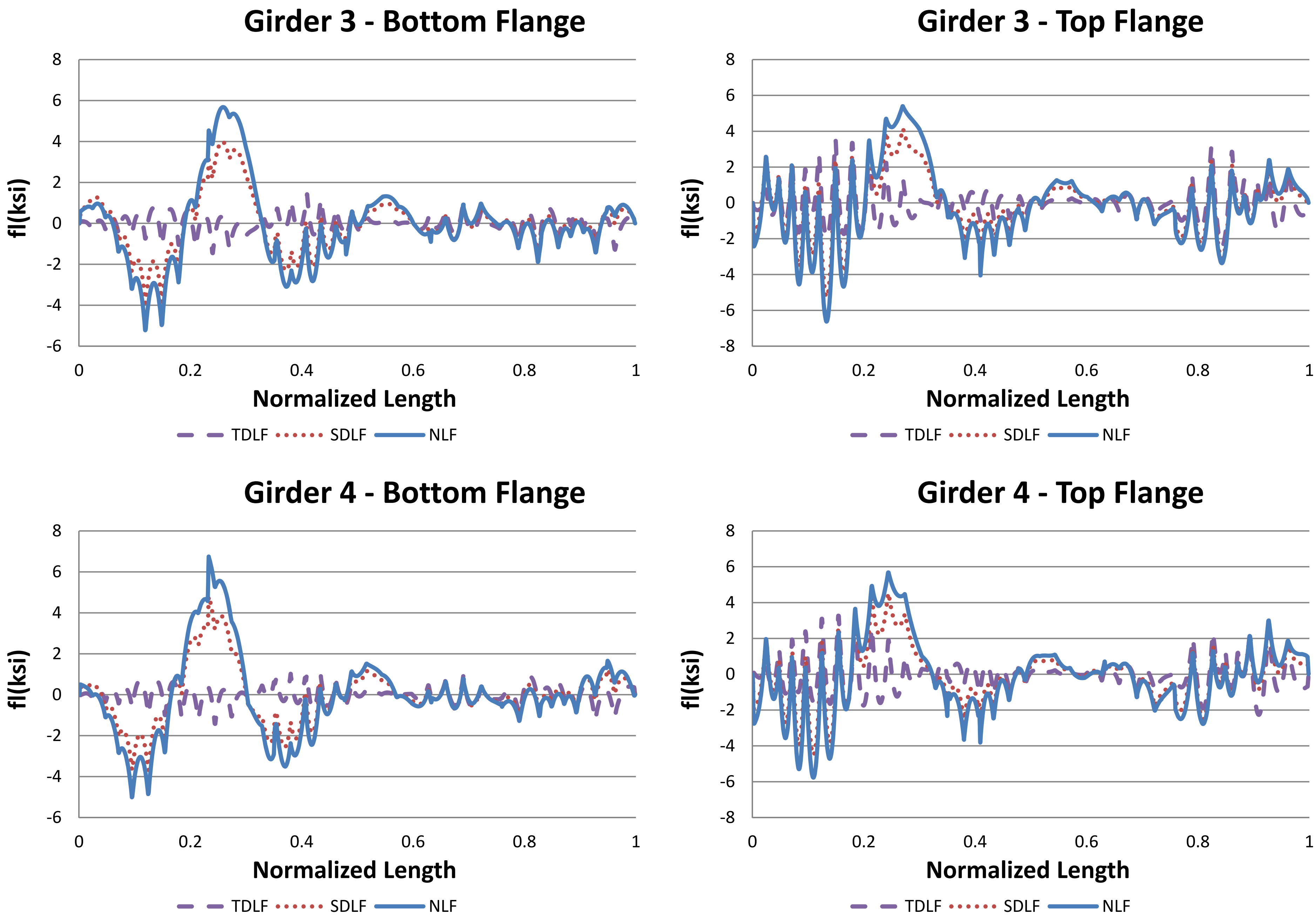


Figure T1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

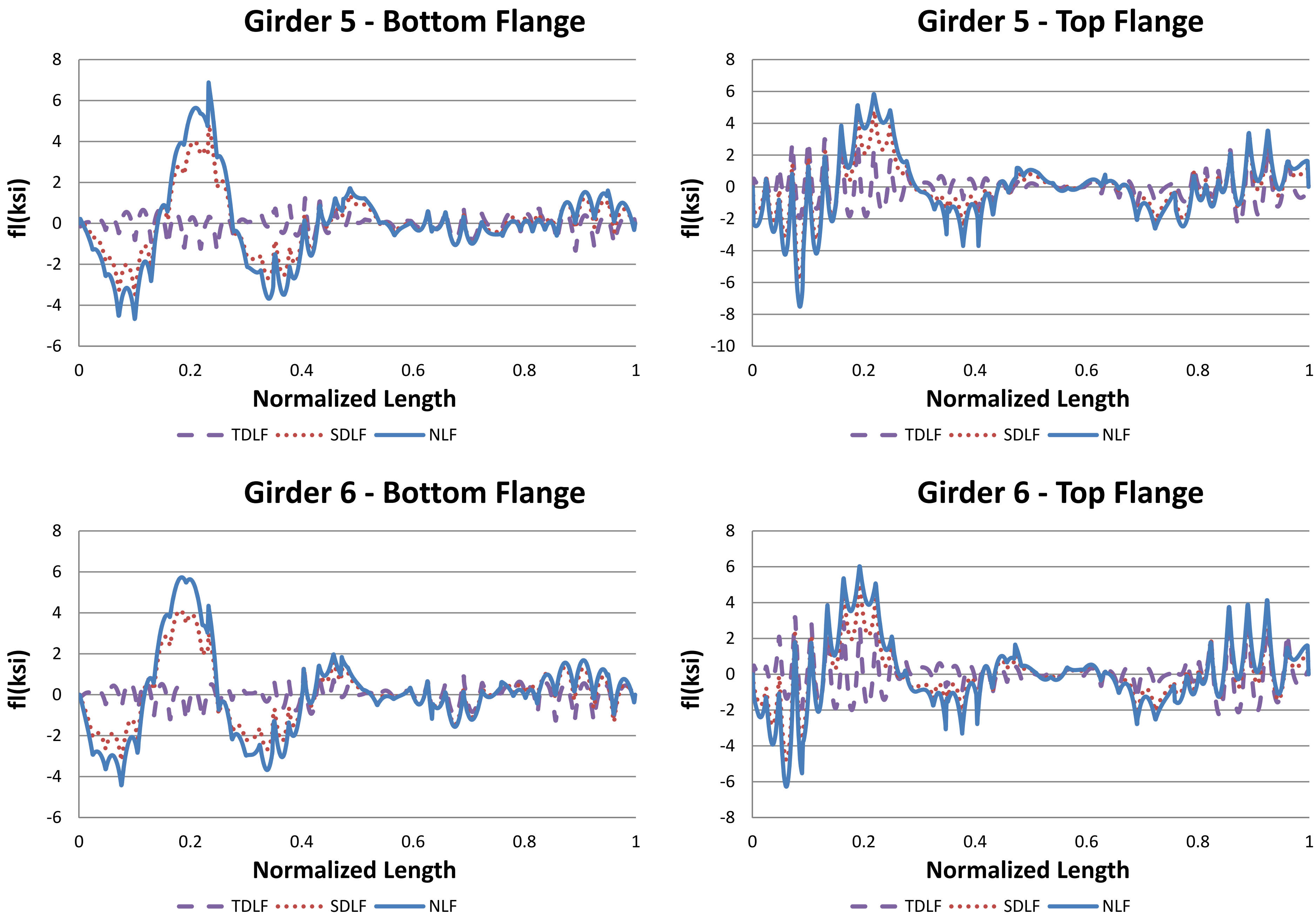


Figure T1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

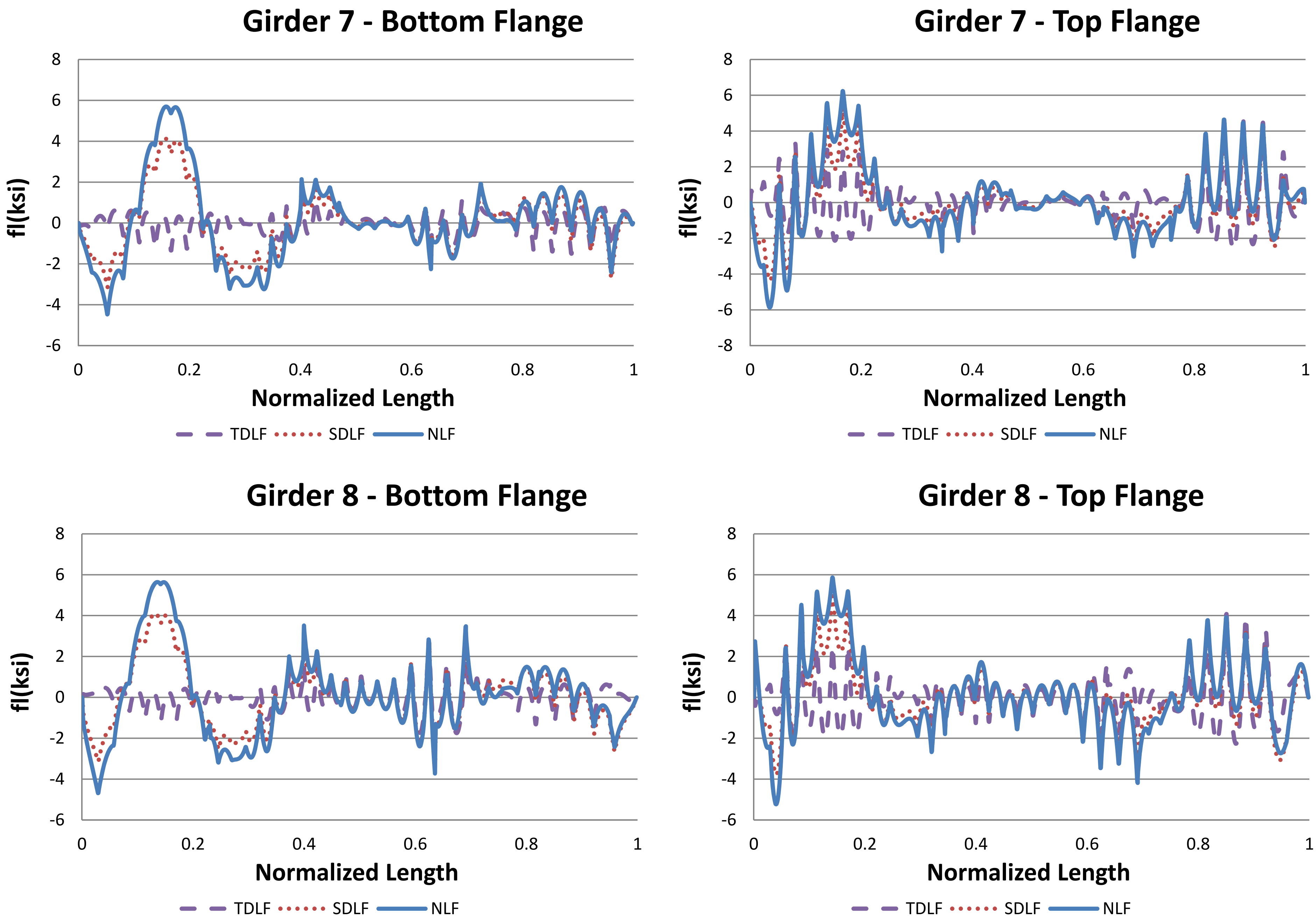


Figure T1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.

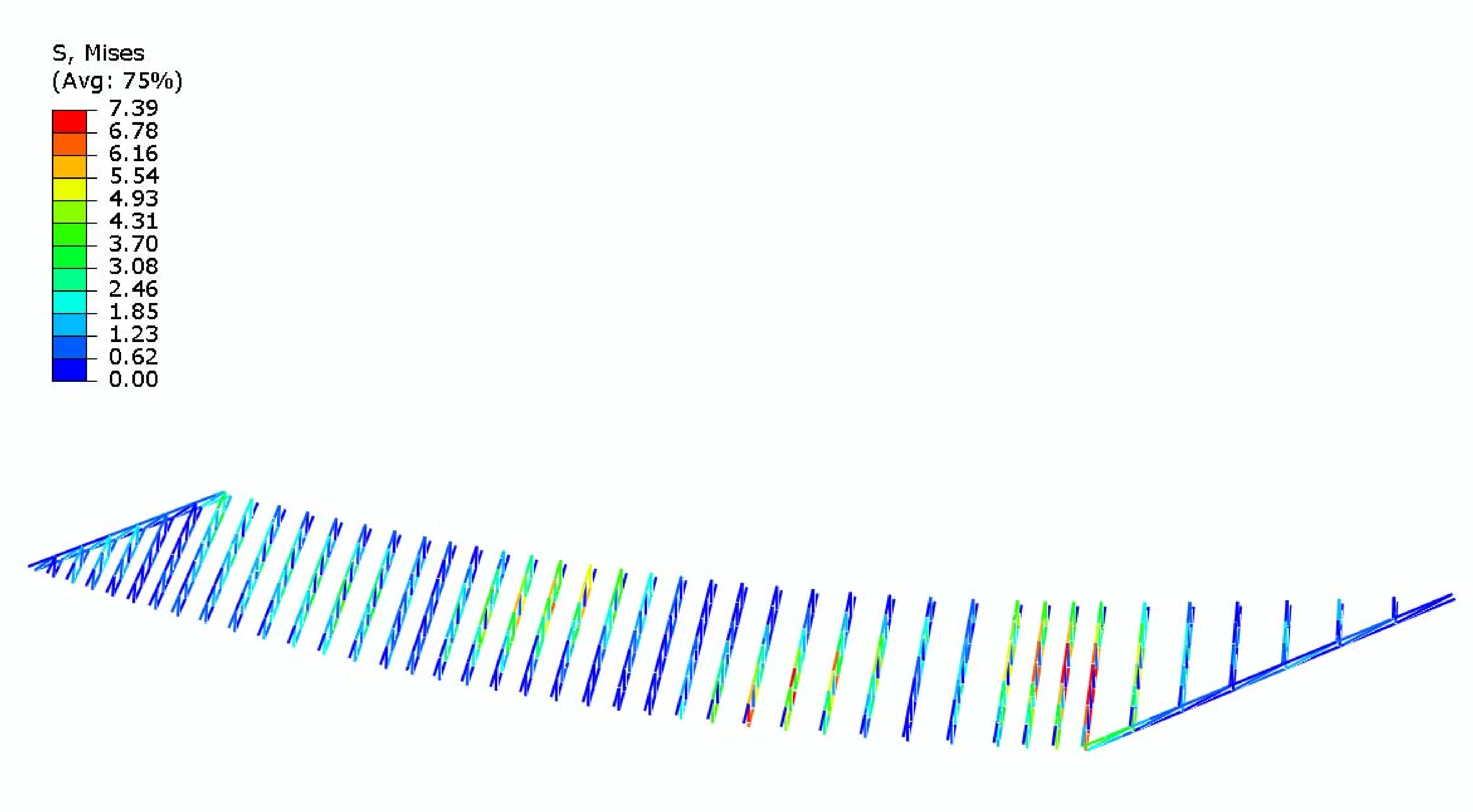


Figure T1-4-22. **Cross-frame stress contours (ksi) under SDL, NLF detailing**

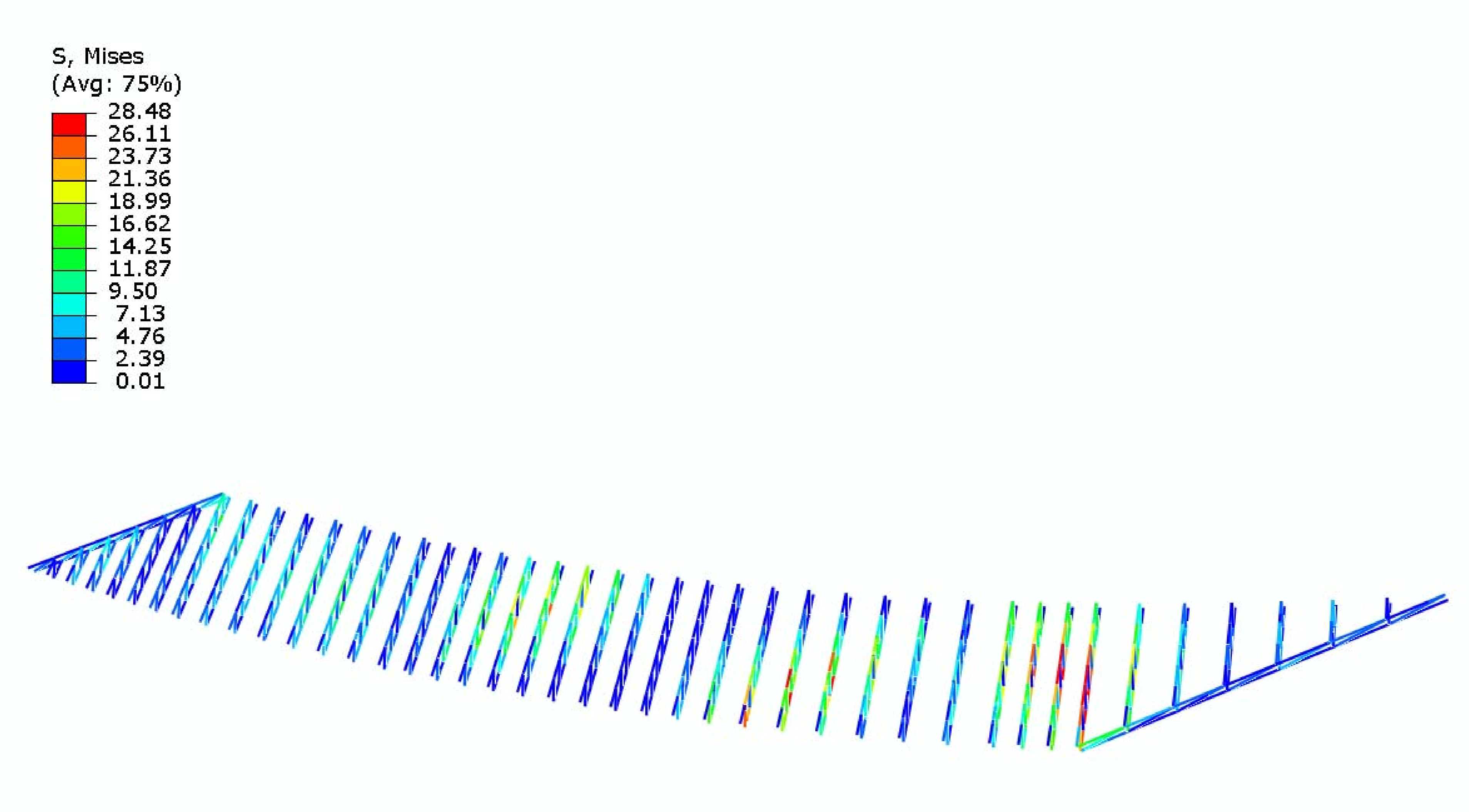


Figure T1-4-23. **Cross-frame stress contours under TDL, NLF detailing**

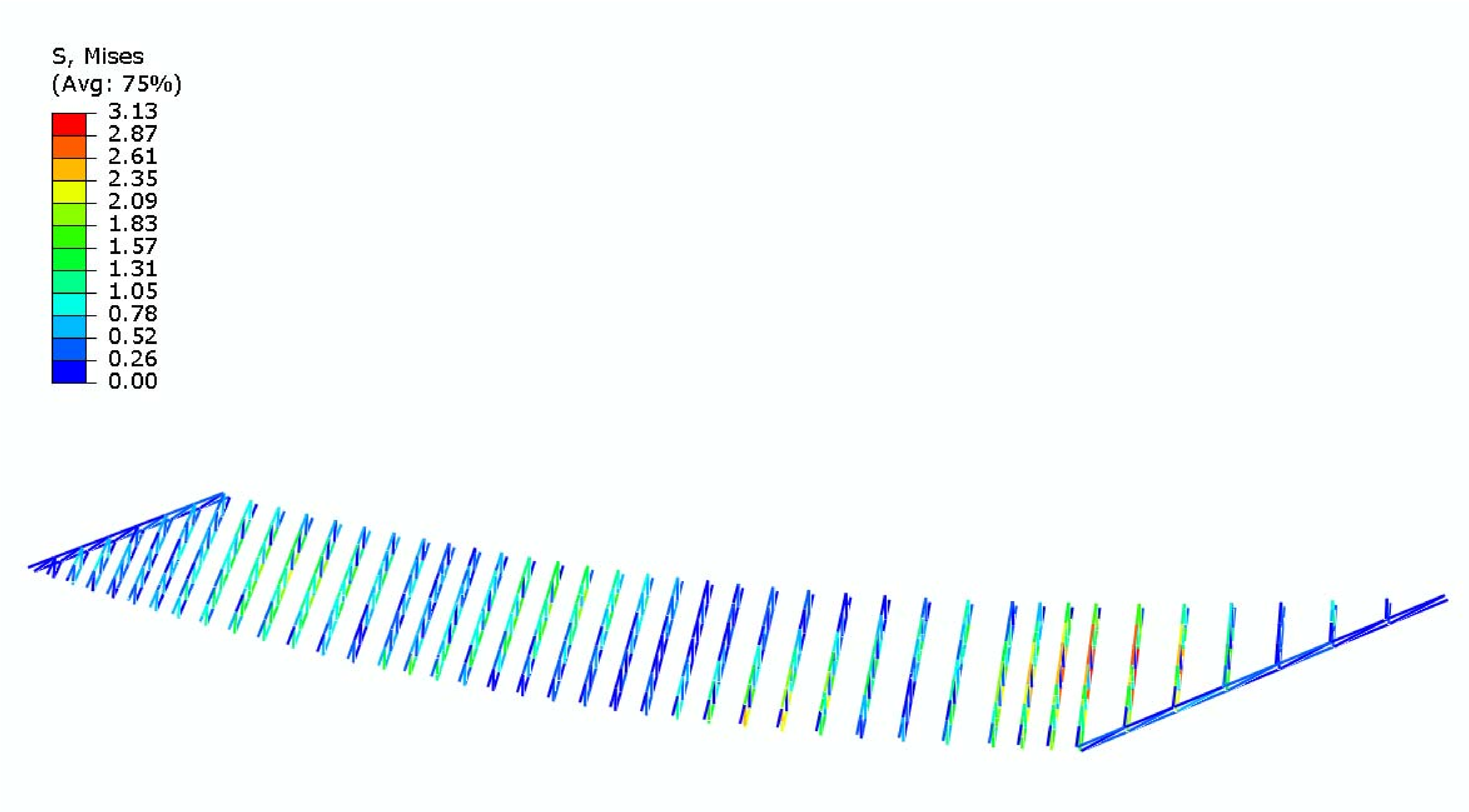


Figure T1-4-24. Cross-frame stress contours under SDL, SDLF detailing

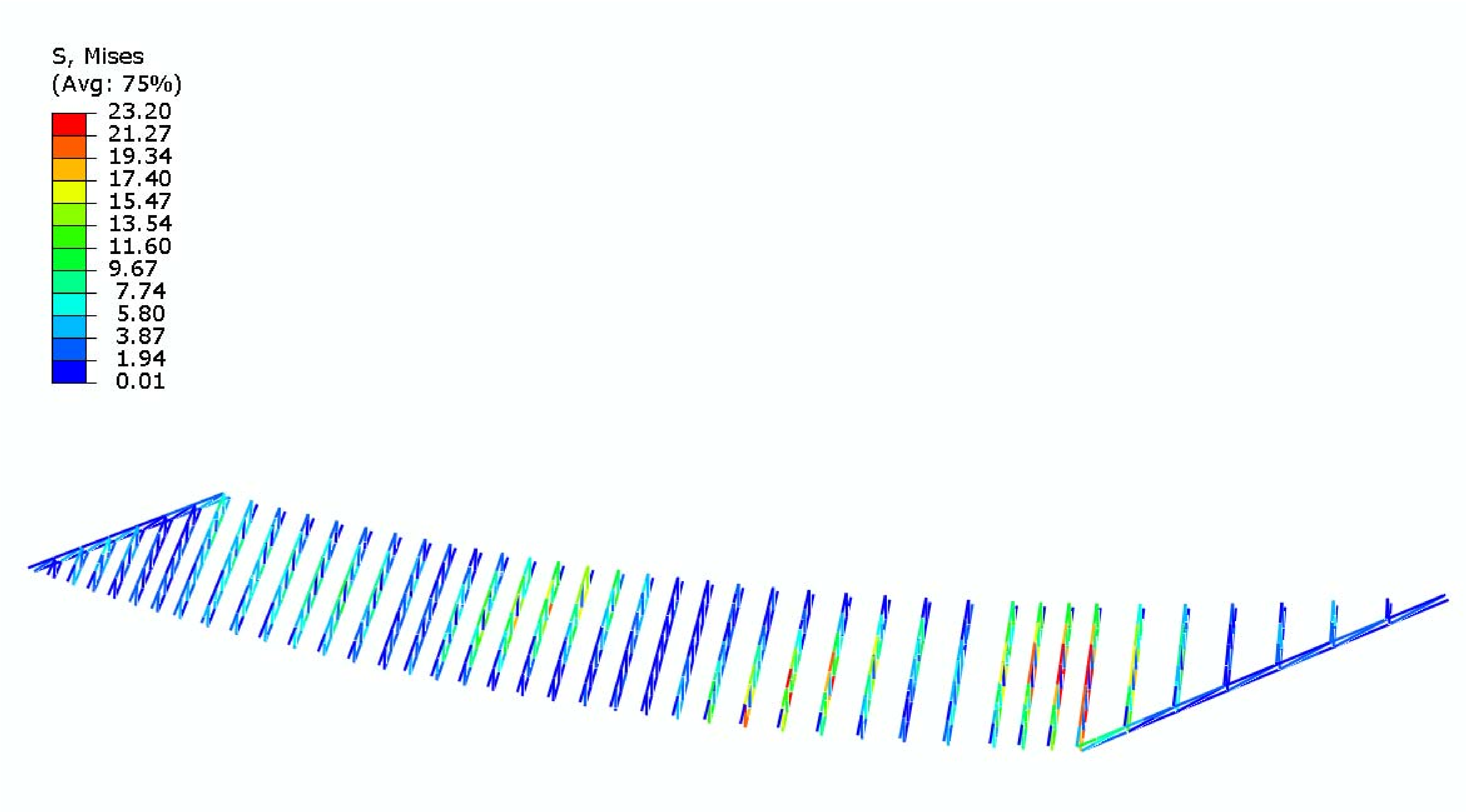


Figure T1-4-25. Cross-frame stress contours under TDL, SDLF detailing

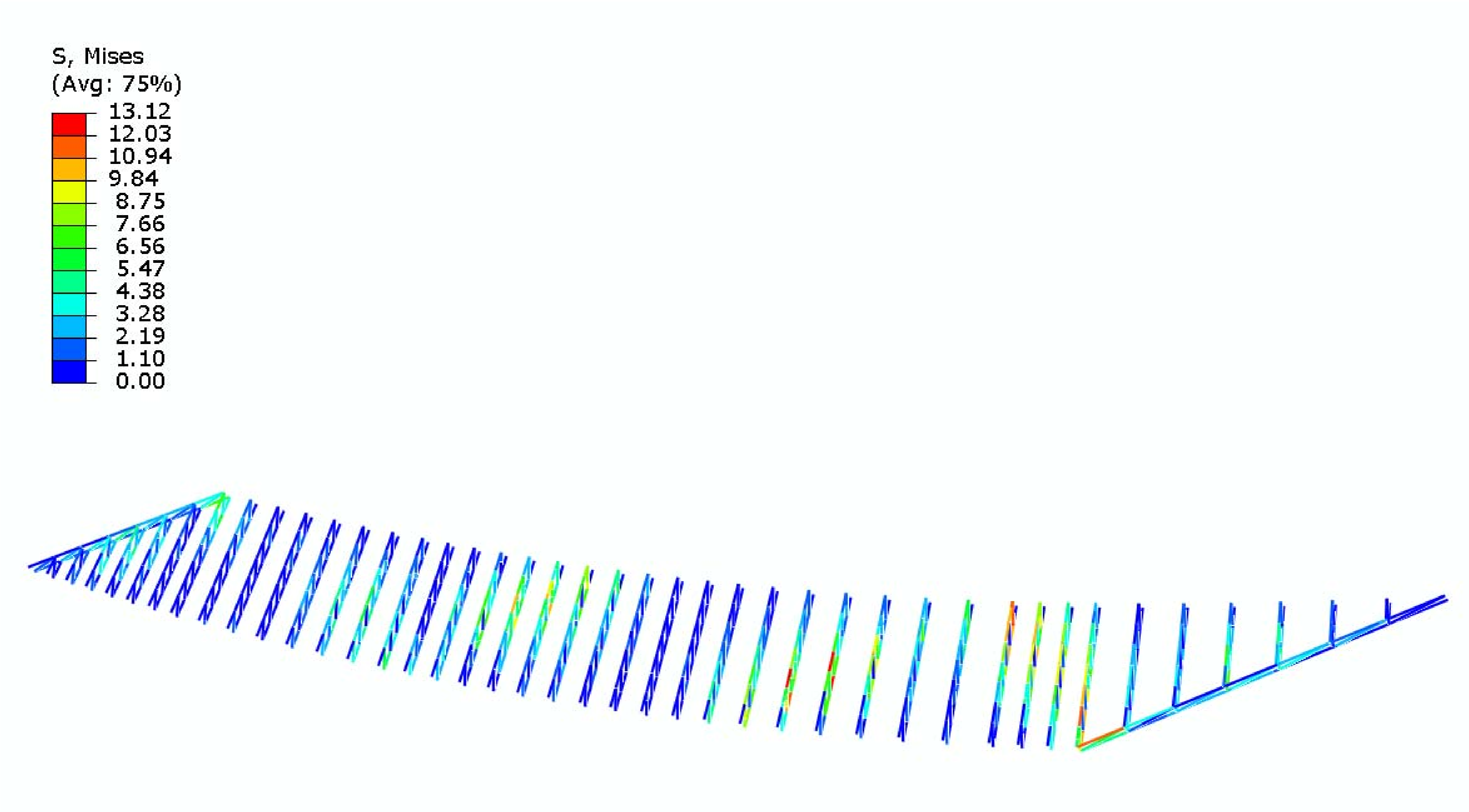


Figure T1-4-26. Cross-frame stress contours under SDL, TDLF detailing

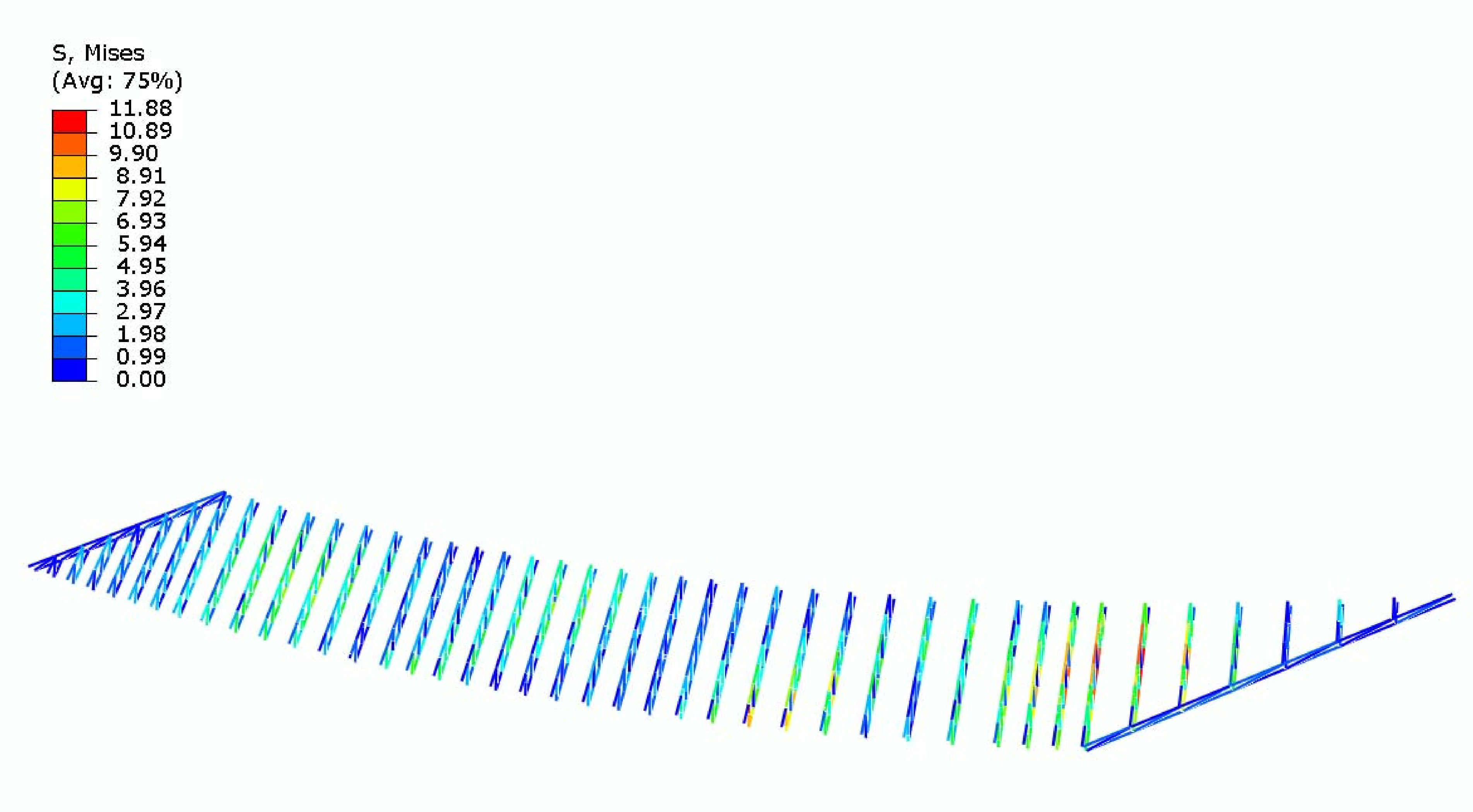


Figure T1-4-27. **Cross-frame stress contours under TDL, TDLF detailing**

Table T1-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	6.0	10.4	12.8	11.7	6.0	1.0	13.0
	SDLF	1.3	1.5	0.6	1.3	2.7	2.6	0.2
	TDLF	12.3	20.4	29.3	33.5	24.3	12.0	30.7
2	NLF	2.9	5.6	11.1	10.8	3.7	3.6	16.3
	SDLF	0.1	5.2	5.7	2.5	1.8	3.7	5.0
	TDLF	7.9	4.3	7.7	18.1	15.5	3.5	24.0
3	NLF	11.0	7.0	2.4	1.6	1.7	7.9	13.7
	SDLF	3.4	2.3	5.6	5.4	1.8	1.5	5.5
	TDLF	15.7	25.4	25.2	14.3	1.5	24.2	16.0
4	NLF	6.7	5.2	0.6	3.1	8.0	1.9	6.8
	SDLF	1.6	2.3	5.5	5.4	2.3	1.1	4.4
	TDLF	11.5	21.3	20.8	10.6	12.5	8.1	2.0
5	NLF	0.1	2.0	5.9	10.0	6.9	2.9	2.1
	SDLF	1.3	3.9	5.9	5.3	3.9	0.6	2.3
	TDLF	5.1	9.1	5.7	7.3	4.6	8.7	2.9
6	NLF	3.6	6.6	10.6	9.6	2.2	5.0	2.7
	SDLF	3.5	5.7	7.1	5.9	3.6	0.4	0.8
	TDLF	3.3	3.5	2.4	4.3	6.6	10.7	3.3
7	NLF	4.6	9.4	11.7	7.6	0.5	4.4	3.2
	SDLF	4.7	8.0	8.6	5.9	3.0	0.3	0.1
	TDLF	5.4	4.4	0.4	1.5	11.8	9.8	6.5
8	NLF	7.2	12.3	12.4	5.7	1.8	4.2	3.0
	SDLF	6.6	10.5	8.9	5.7	2.8	0.6	0.1
	TDLF	5.7	6.0	0.1	6.1	14.7	12.5	7.3
9	NLF	8.9	14.2	11.4	2.9	3.2	4.2	3.6
	SDLF	8.5	11.2	8.2	5.4	3.2	1.8	0.4
	TDLF	8.2	3.8	1.0	12.7	19.9	16.8	7.8
10	NLF	8.8	12.7	6.7	0.9	3.5	2.6	3.3
	SDLF	9.5	10.3	6.8	5.2	4.1	2.7	0.4
	TDLF	11.6	4.4	8.0	21.4	23.4	15.9	7.5

Table T1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	11.8	13.7	6.6	2.2	2.9	3.8	2.7
	SDLF	10.2	8.3	6.0	6.0	5.2	4.0	1.9
	TDLF	5.4	5.0	5.3	15.2	10.1	4.4	0.2
12	NLF	15.4	12.6	5.5	5.0	7.6	10.1	10.5
	SDLF	9.0	5.1	5.3	5.5	5.0	5.3	5.3
	TDLF	8.4	13.6	3.8	5.3	2.8	7.1	7.5
13	NLF	15.4	7.8	3.1	6.4	11.2	16.9	20.9
	SDLF	4.5	1.5	3.3	3.4	3.4	4.8	9.0
	TDLF	23.1	14.8	1.4	6.5	17.9	25.8	20.5
14	NLF	9.0	5.1	4.0	1.0	7.6	17.3	28.8
	SDLF	3.6	2.2	0.6	0.6	0.9	1.2	10.0
	TDLF	32.9	4.3	5.8	7.2	24.2	39.2	34.6
15	NLF	4.3	9.2	8.2	3.3	4.4	17.3	39.5
	SDLF	10.9	2.6	1.7	2.7	3.9	2.6	8.8
	TDLF	44.3	14.9	12.2	5.3	28.1	54.0	64.1
16	NLF	6.6	21.7	24.2	22.9	16.6	4.2	27.2
	SDLF	13.9	8.2	6.2	5.8	5.2	3.7	6.0
	TDLF	26.5	29.7	39.3	34.4	19.8	4.2	41.4
17	NLF	5.5	17.4	22.0	21.9	17.3	5.1	15.5
	SDLF	10.8	10.5	9.5	9.0	8.2	5.2	4.6
	TDLF	20.9	9.9	22.0	21.1	12.3	5.7	18.3
18	NLF	5.9	15.7	19.4	19.1	14.2	3.5	4.1
	SDLF	4.6	7.5	8.5	8.2	6.9	4.3	2.4
	TDLF	1.1	15.7	19.3	17.8	10.6	4.0	1.7
19	NLF	0.5	5.7	9.7	9.7	5.4	1.4	0.2
	SDLF	1.2	4.4	6.5	6.0	5.2	2.8	0.1
	TDLF	0.3	1.7	2.2	3.9	2.0	7.8	4.5
20	NLF	2.2	5.4	8.5	6.9	2.2	0.3	2.7
	SDLF	0.9	2.1	4.1	4.2	4.2	2.3	2.4
	TDLF	10.6	6.4	5.6	3.0	6.2	4.6	1.1

Table T1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	0.9	4.2	5.3	1.9	1.5	1.0	2.6
	SDLF	2.4	0.7	1.3	1.6	1.8	1.3	3.4
	TDLF	11.2	5.8	6.5	0.6	7.6	3.9	5.4
22	NLF	1.5	2.7	0.4	4.0	5.5	2.8	0.1
	SDLF	3.0	0.6	1.7	1.2	1.0	0.1	2.9
	TDLF	5.4	5.1	5.1	5.0	7.9	6.3	11.2
23	NLF	1.3	0.8	5.6	9.8	9.6	6.0	2.7
	SDLF	1.3	2.6	4.2	3.9	3.9	1.3	1.8
	TDLF	2.6	6.5	1.1	10.7	10.3	12.3	16.1
24	NLF	4.2	1.3	11.0	14.4	13.0	8.6	2.1
	SDLF	3.6	2.9	4.9	5.9	5.7	3.1	0.5
	TDLF	8.3	2.3	12.7	18.0	17.0	16.5	11.2
25	NLF	15.5	4.3	15.5	18.1	16.1	10.5	5.6
	SDLF	8.7	1.6	5.0	5.7	5.3	4.6	2.2
	TDLF	2.3	7.8	24.1	30.0	29.2	19.0	19.3
26	NLF	32.1	6.4	19.7	23.2	22.2	18.5	9.4
	SDLF	12.5	0.7	3.7	2.5	1.6	3.0	6.3
	TDLF	33.0	9.2	34.2	51.0	57.3	47.1	43.3
27	NLF	51.5	25.8	10.3	3.7	3.4	5.8	33.6
	SDLF	18.4	1.6	2.6	2.0	6.9	7.7	0.6
	TDLF	65.1	67.8	43.6	7.8	15.3	16.3	86.3
28	NLF	36.3	25.1	12.7	6.7	7.1	10.9	31.4
	SDLF	17.4	4.6	0.2	4.2	8.9	7.9	5.8
	TDLF	32.8	54.7	40.7	7.1	12.2	0.2	63.8
29	NLF	19.4	15.0	6.2	3.2	6.1	16.7	28.5
	SDLF	11.0	4.1	1.0	5.3	8.2	7.1	12.1
	TDLF	12.6	28.1	16.9	8.3	13.1	18.8	33.4
30	NLF	5.3	0.1	6.9	3.7	6.5	20.3	23.6
	SDLF	1.5	2.7	1.7	3.0	5.1	6.5	13.4
	TDLF	10.6	12.6	9.7	20.6	1.4	31.3	16.5

Table T1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	4.1	14.2	15.0	4.6	7.3	18.8	13.8
	SDLF	4.9	9.7	3.5	0.5	1.6	5.9	11.4
	TDLF	7.4	1.2	26.8	15.7	12.1	29.1	3.9
32	NLF	8.4	21.1	13.1	1.4	8.4	13.4	5.2
	SDLF	8.9	10.6	3.3	1.8	0.9	5.7	7.1
	TDLF	9.3	15.6	23.7	0.4	24.1	15.3	12.9
33	NLF	14.8	22.2	8.9	1.4	6.5	6.4	0.0
	SDLF	12.4	8.3	4.4	4.3	1.6	4.5	2.8
	TDLF	5.0	27.1	10.3	16.6	23.3	1.2	10.9
34	NLF	21.2	17.9	2.7	3.6	1.7	5.8	7.6
	SDLF	13.8	6.4	6.4	5.4	1.5	0.1	2.8
	TDLF	5.1	24.5	11.1	10.3	0.8	16.1	10.4
35	NLF	34.2	3.7	12.3	9.0	9.2	14.0	13.6
	SDLF	15.1	7.6	7.9	5.3	1.2	3.7	8.4
	TDLF	30.5	10.4	2.9	5.2	21.3	25.4	6.9
36	NLF	43.5	29.7	13.3	1.5	8.2	3.3	4.8
	SDLF	13.0	14.6	15.9	10.8	1.1	2.0	3.4
	TDLF	54.5	28.3	22.5	44.9	27.1	1.8	0.6
37	NLF	21.1	5.3	1.6	6.6	9.0	7.6	4.0
	SDLF	0.5	3.0	3.8	3.0	0.5	1.4	1.1
	TDLF	41.6	2.8	20.6	31.1	28.2	16.9	7.7

Table T1-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	31.9	45.5	52.8	47.0	24.3	4.7	42.9
	SDLF	26.8	34.3	37.6	31.2	13.8	0.0	29.9
	TDLF	5.1	5.2	1.5	5.3	9.8	9.3	0.3
2	NLF	5.5	19.4	36.9	35.9	12.5	11.3	52.9
	SDLF	4.0	17.6	30.6	26.9	6.4	11.7	42.1
	TDLF	2.9	18.2	18.7	7.0	7.7	12.8	16.2
3	NLF	36.9	23.4	6.6	8.2	8.8	29.9	46.1
	SDLF	29.1	13.9	1.0	10.9	7.5	18.4	39.3
	TDLF	8.8	9.7	19.7	17.5	3.9	8.1	21.1
4	NLF	22.1	16.3	1.2	14.9	32.2	2.6	23.5
	SDLF	16.7	8.8	6.6	16.0	24.5	1.6	22.5
	TDLF	2.6	10.0	19.7	17.6	5.1	0.8	18.6
5	NLF	1.6	10.6	25.7	41.2	29.7	7.8	10.8
	SDLF	3.1	12.0	24.5	34.5	24.5	5.7	11.4
	TDLF	7.3	15.7	20.9	17.0	11.0	0.5	12.2
6	NLF	16.2	28.4	44.4	40.0	10.1	20.5	17.9
	SDLF	16.0	26.5	39.0	34.3	10.4	15.8	14.6
	TDLF	15.1	21.5	24.7	19.1	10.7	4.0	7.2
7	NLF	20.4	40.9	47.8	29.3	4.6	24.0	22.5
	SDLF	20.2	37.9	43.0	26.6	0.7	18.0	17.0
	TDLF	19.3	29.7	29.9	19.8	9.3	3.3	4.8
8	NLF	33.0	51.0	46.4	17.4	14.3	26.0	18.8
	SDLF	31.2	47.5	42.2	18.0	7.5	18.3	14.0
	TDLF	26.7	38.3	31.2	19.9	9.3	0.1	3.6
9	NLF	39.7	53.0	37.0	2.5	21.2	22.5	14.5
	SDLF	38.0	49.7	34.8	7.2	11.9	14.5	11.5
	TDLF	33.8	40.7	29.6	19.6	11.2	4.3	4.6
10	NLF	35.1	42.7	17.2	10.9	18.5	10.8	12.4
	SDLF	35.8	41.3	19.3	2.3	9.0	5.4	10.1
	TDLF	37.0	37.8	25.1	19.2	13.8	7.2	4.3

Table T1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	41.7	43.5	17.7	3.7	9.1	13.0	7.2
	SDLF	41.1	39.8	19.1	9.2	11.8	12.8	5.8
	TDLF	38.7	30.8	22.8	21.6	17.1	11.6	3.2
12	NLF	52.9	41.7	18.0	17.8	27.3	35.2	33.7
	SDLF	47.7	35.4	19.0	19.2	24.8	29.8	28.0
	TDLF	33.9	19.8	20.1	20.0	16.7	16.5	14.9
13	NLF	54.4	28.3	11.7	23.5	40.0	58.2	68.9
	SDLF	43.5	22.3	13.1	21.5	32.5	45.9	56.6
	TDLF	17.3	7.2	13.2	12.8	11.6	15.4	27.4
14	NLF	31.9	19.8	14.4	3.4	26.4	58.4	94.2
	SDLF	17.9	15.6	9.5	3.1	18.6	42.5	75.1
	TDLF	12.3	5.9	0.2	1.3	3.4	3.1	31.0
15	NLF	3.6	37.5	31.3	12.7	14.2	57.5	129.0
	SDLF	10.3	28.7	22.4	10.0	7.6	38.7	98.6
	TDLF	39.1	6.8	4.0	9.2	14.4	10.9	26.2
16	NLF	32.7	83.3	88.7	82.7	60.1	17.2	88.0
	SDLF	39.9	68.1	68.6	63.5	47.3	16.2	66.0
	TDLF	50.2	26.0	18.6	19.4	19.4	15.0	17.5
17	NLF	26.9	67.3	80.4	78.8	62.9	20.9	48.0
	SDLF	31.8	59.1	66.3	64.5	52.8	20.9	36.4
	TDLF	40.3	35.9	31.9	32.0	30.9	21.3	12.1
18	NLF	25.6	59.0	70.3	69.2	53.0	17.7	6.5
	SDLF	24.1	50.1	58.5	57.6	45.4	18.5	4.4
	TDLF	17.3	25.3	29.1	30.4	27.4	18.6	3.2
19	NLF	4.1	22.2	35.9	37.4	24.6	4.3	9.9
	SDLF	4.7	20.6	32.4	33.6	24.5	8.6	10.2
	TDLF	3.4	13.9	23.2	23.5	21.5	14.1	6.0
20	NLF	5.5	15.9	28.1	25.5	12.6	7.0	18.9
	SDLF	2.3	12.6	23.7	22.8	14.6	9.6	18.6
	TDLF	7.4	4.0	13.7	15.5	16.6	12.1	15.1

Table T1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	3.4	7.8	14.6	5.9	2.7	2.6	15.5
	SDLF	6.7	4.2	10.5	5.7	0.8	5.0	16.4
	TDLF	15.6	2.5	2.5	4.6	6.7	7.7	18.2
22	NLF	14.7	0.3	4.4	16.9	18.7	7.1	3.6
	SDLF	16.2	3.1	6.5	14.0	14.1	4.2	6.4
	TDLF	18.8	7.8	10.0	7.8	5.2	2.0	14.6
23	NLF	15.7	6.9	27.0	39.5	37.1	23.3	10.5
	SDLF	15.8	10.5	25.5	33.5	31.3	18.7	6.1
	TDLF	12.1	14.6	20.3	19.0	17.2	5.2	8.1
24	NLF	4.2	13.5	47.1	59.0	53.8	38.2	12.5
	SDLF	3.4	15.2	40.9	50.4	46.4	32.8	10.1
	TDLF	7.9	14.7	23.4	26.6	24.1	13.7	0.0
25	NLF	49.2	20.0	61.4	71.5	65.4	47.3	13.9
	SDLF	42.0	17.3	50.5	58.8	54.7	41.6	5.3
	TDLF	30.8	7.7	21.1	23.2	20.6	18.9	13.0
26	NLF	113.9	23.4	73.4	87.5	86.6	78.2	23.9
	SDLF	93.8	16.7	56.3	66.0	65.5	62.3	7.6
	TDLF	47.4	5.7	17.1	11.7	6.6	12.8	31.1
27	NLF	189.7	102.1	46.2	21.5	18.6	23.3	117.6
	SDLF	156.4	78.5	34.0	20.3	22.4	25.6	85.0
	TDLF	73.2	10.7	5.0	12.1	30.9	33.5	1.9
28	NLF	134.4	99.2	55.2	33.0	32.6	42.5	115.1
	SDLF	115.8	79.3	42.8	31.1	35.0	40.5	89.3
	TDLF	65.9	20.9	4.0	21.2	38.4	32.4	18.4
29	NLF	71.4	59.0	28.2	17.6	27.2	64.3	107.7
	SDLF	63.4	48.5	23.5	20.1	29.9	55.1	91.1
	TDLF	39.9	17.1	7.7	24.5	34.8	28.4	44.4
30	NLF	18.3	1.3	23.0	10.5	27.5	78.7	92.2
	SDLF	14.8	1.0	17.4	3.4	26.4	64.9	82.2
	TDLF	2.9	9.6	3.7	14.6	22.1	26.2	51.8

Table T1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location						
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	19.3	54.9	55.5	16.1	28.3	72.5	58.3
	SDLF	19.9	50.0	43.8	10.6	22.9	59.7	55.8
	TDLF	22.1	36.8	12.0	4.1	8.2	23.7	47.2
32	NLF	36.8	80.7	49.3	5.7	31.2	52.8	25.6
	SDLF	37.2	70.1	39.3	5.8	22.0	44.7	27.2
	TDLF	37.7	40.6	11.9	5.9	2.5	22.4	31.8
33	NLF	59.5	84.3	34.7	3.8	24.9	27.7	5.4
	SDLF	56.9	70.1	30.0	1.8	16.5	25.3	8.1
	TDLF	49.6	31.5	17.1	16.6	6.5	18.0	15.4
34	NLF	80.9	69.0	12.5	14.3	5.2	18.5	24.3
	SDLF	72.9	57.2	16.1	16.4	5.5	12.9	19.3
	TDLF	52.2	25.5	25.5	21.9	6.4	2.1	6.0
35	NLF	129.0	15.8	47.0	34.0	33.5	50.5	49.1
	SDLF	108.7	19.4	42.7	30.9	26.4	40.7	43.8
	TDLF	56.4	29.7	31.1	21.6	5.2	12.0	27.5
36	NLF	156.9	108.9	49.3	6.2	32.6	16.3	9.2
	SDLF	125.9	93.4	52.2	7.1	21.9	14.0	8.3
	TDLF	46.3	52.9	59.4	42.0	5.1	9.0	6.0
37	NLF	72.5	11.4	14.6	31.3	37.2	30.0	21.4
	SDLF	51.6	9.6	8.3	20.8	26.8	22.9	17.9
	TDLF	2.6	11.8	14.8	11.9	2.8	4.8	7.4

Table T1-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location						
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	5.8	6.8	4.7	1.7	2.8	7.0	17.7
	SDLF	1.2	0.5	1.2	2.2	1.9	0.5	2.9
	TDLF	7.4	13.8	15.2	11.5	0.6	14.8	53.0
2	NLF	4.7	7.7	7.6	5.2	2.4	1.8	10.2
	SDLF	1.2	1.3	0.2	1.8	2.3	2.1	1.5
	TDLF	5.7	14.1	19.4	18.6	12.9	1.7	28.5
3	NLF	10.7	15.4	13.0	4.4	6.0	24.3	1.8
	SDLF	4.5	3.6	0.5	4.6	5.9	3.9	1.6
	TDLF	10.9	25.5	33.3	26.2	5.1	44.8	0.9
4	NLF	8.0	9.7	4.6	5.6	19.0	16.4	2.8
	SDLF	3.8	2.6	1.7	6.0	7.1	8.4	2.8
	TDLF	6.5	14.8	16.9	6.7	21.8	12.0	2.7
5	NLF	2.9	1.7	5.0	14.9	21.0	11.7	3.7
	SDLF	2.0	0.6	3.6	7.6	10.4	9.7	3.6
	TDLF	0.1	2.3	0.6	9.7	16.0	4.3	3.5
6	NLF	0.4	2.6	9.8	18.4	17.7	9.3	4.0
	SDLF	0.7	1.4	6.2	10.6	12.7	9.3	4.2
	TDLF	1.7	0.8	1.9	8.3	0.3	9.7	4.5
7	NLF	0.2	4.8	14.0	19.8	17.3	10.3	4.1
	SDLF	0.1	3.7	9.5	13.5	13.6	8.9	4.4
	TDLF	0.1	2.4	0.4	1.4	4.9	6.3	4.9
8	NLF	1.2	8.3	17.3	21.6	17.8	10.7	4.2
	SDLF	1.0	6.5	12.5	15.0	13.2	8.6	4.3
	TDLF	1.5	3.6	1.6	0.6	2.5	4.1	4.7
9	NLF	2.5	10.8	20.4	22.8	17.6	10.4	3.6
	SDLF	2.3	9.1	14.1	14.6	11.8	8.1	3.5
	TDLF	2.6	5.6	1.3	5.4	1.9	2.8	3.2
10	NLF	3.0	14.2	23.5	23.2	17.0	9.8	2.9
	SDLF	3.8	10.9	13.5	12.4	9.9	6.8	2.7
	TDLF	6.2	2.4	11.6	14.5	7.8	1.1	2.0

Table T1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	6.8	20.6	26.6	22.6	14.5	7.7	2.1
	SDLF	5.5	10.7	10.7	8.9	6.7	5.0	2.1
	TDLF	2.0	15.0	29.8	25.4	13.1	2.7	2.0
12	NLF	11.3	22.8	22.4	13.5	5.8	1.1	1.0
	SDLF	6.1	7.5	5.6	3.7	2.8	1.8	1.2
	TDLF	8.2	31.7	36.4	20.7	5.5	3.1	1.7
13	NLF	13.0	18.3	9.9	0.1	7.0	7.7	0.1
	SDLF	4.1	1.7	0.7	1.2	2.4	2.9	0.2
	TDLF	18.7	39.0	25.6	3.5	9.4	8.9	0.9
14	NLF	11.0	6.8	6.2	17.3	22.9	18.9	1.6
	SDLF	0.3	4.5	5.1	6.1	7.9	8.4	1.2
	TDLF	26.8	28.5	0.8	23.8	30.6	18.2	0.0
15	NLF	8.8	5.0	20.2	31.6	36.0	28.7	2.0
	SDLF	5.2	6.9	8.1	9.6	12.0	12.4	2.3
	TDLF	35.6	7.3	26.8	48.7	49.5	27.7	2.8
16	NLF	1.4	17.3	32.9	43.9	47.8	40.2	4.0
	SDLF	8.4	10.4	11.1	12.5	14.1	14.1	4.1
	TDLF	20.6	13.4	49.8	69.9	70.5	48.3	3.7
17	NLF	2.1	15.5	27.6	36.9	39.8	30.3	2.4
	SDLF	6.7	8.9	10.6	12.7	14.1	12.4	2.7
	TDLF	15.5	13.0	37.4	50.8	49.0	28.7	3.5
18	NLF	2.9	10.8	20.0	26.8	27.5	17.1	1.5
	SDLF	2.0	4.5	6.9	9.0	9.8	8.4	1.9
	TDLF	2.4	16.0	30.2	35.8	30.9	9.4	2.9
19	NLF	0.9	4.8	11.7	16.4	15.1	6.0	0.8
	SDLF	0.3	1.0	3.3	5.0	5.8	4.9	1.1
	TDLF	0.9	12.2	19.2	20.3	11.5	5.7	1.8
20	NLF	1.0	4.2	8.7	10.9	7.5	1.3	0.4
	SDLF	1.7	1.5	0.4	1.9	3.0	1.6	0.5
	TDLF	9.9	16.4	16.2	12.4	0.2	6.5	1.1

Table T1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	0.3	1.8	5.3	5.8	1.7	1.8	0.1
	SDLF	2.6	2.7	1.3	0.4	0.2	1.3	0.2
	TDLF	10.3	10.9	9.5	5.1	2.8	2.3	0.4
22	NLF	1.5	0.8	4.2	3.0	1.0	2.1	0.0
	SDLF	2.9	2.3	1.6	1.7	2.4	2.8	0.0
	TDLF	5.5	3.7	5.5	3.6	1.0	4.3	0.1
23	NLF	1.4	3.9	6.5	3.7	0.4	0.0	0.2
	SDLF	1.6	0.1	0.6	1.5	2.8	2.5	0.1
	TDLF	1.1	0.7	7.7	7.8	9.8	9.9	0.2
24	NLF	3.2	11.4	12.2	8.9	5.5	3.0	0.6
	SDLF	2.4	3.2	2.0	0.7	1.1	1.1	0.6
	TDLF	5.6	8.1	16.7	18.6	20.4	14.0	0.2
25	NLF	12.7	22.1	21.8	17.3	11.1	3.4	1.4
	SDLF	6.1	6.8	6.3	4.4	2.2	1.0	1.3
	TDLF	4.9	26.7	33.6	34.6	27.7	8.9	0.9
26	NLF	26.7	36.3	34.1	26.3	14.0	1.7	2.6
	SDLF	9.4	11.9	10.6	8.2	6.5	5.1	2.7
	TDLF	31.3	52.5	58.7	51.1	23.3	19.5	2.6
27	NLF	43.5	52.7	47.7	34.4	15.9	3.5	3.9
	SDLF	14.7	15.8	12.4	10.0	10.0	10.8	3.2
	TDLF	56.8	85.0	91.4	68.1	15.9	45.6	0.0
28	NLF	31.4	39.7	32.2	13.9	7.6	23.6	1.1
	SDLF	15.3	15.4	9.2	5.1	5.1	3.7	1.2
	TDLF	26.5	53.4	60.4	27.7	32.8	73.6	1.5
29	NLF	17.6	20.6	7.7	14.2	33.2	26.2	0.4
	SDLF	10.8	8.8	1.1	3.1	3.6	3.9	0.5
	TDLF	8.0	26.5	22.0	21.6	72.9	55.8	1.2
30	NLF	6.4	1.1	18.1	39.4	41.3	24.6	0.9
	SDLF	3.7	1.2	9.1	11.8	10.8	10.2	0.7
	TDLF	5.1	9.6	12.3	59.9	70.6	29.5	0.4

Table T1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	0.9	13.9	37.5	47.8	42.9	22.4	2.2
	SDLF	1.1	9.7	16.1	16.3	16.8	13.5	2.0
	TDLF	2.1	0.8	39.5	67.6	54.9	11.8	1.6
32	NLF	4.1	26.3	44.9	50.2	39.9	16.1	3.0
	SDLF	4.1	15.1	18.1	19.4	20.3	14.1	2.9
	TDLF	3.7	13.9	52.3	63.4	34.0	7.4	2.8
33	NLF	10.1	34.8	50.0	48.8	29.7	10.1	3.3
	SDLF	8.1	16.6	19.2	21.5	21.3	11.8	3.4
	TDLF	1.9	30.0	61.7	51.5	2.6	16.7	3.6
34	NLF	16.9	43.2	51.6	37.3	18.0	6.2	3.2
	SDLF	10.6	16.6	19.7	22.3	18.2	8.8	3.4
	TDLF	5.4	50.6	62.9	19.6	18.2	16.1	3.7
35	NLF	28.1	50.8	35.9	18.5	3.7	0.5	2.6
	SDLF	12.1	15.6	19.5	18.8	11.2	3.7	2.8
	TDLF	26.9	70.7	26.0	19.2	31.9	15.5	3.5
36	NLF	48.9	26.2	11.9	2.8	10.7	7.0	1.8
	SDLF	10.0	14.0	15.5	11.4	2.0	2.6	1.7
	TDLF	79.4	21.3	25.0	51.3	38.5	10.8	1.2
37	NLF	7.0	2.7	4.1	5.4	4.1	0.7	0.9
	SDLF	3.0	2.4	2.0	0.1	2.1	1.3	0.6
	TDLF	33.5	17.0	18.3	14.5	3.6	2.1	1.8

Table T1-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	12.1	14.0	6.6	1.6	13.4	25.0	60.3
	SDLF	6.7	8.9	2.9	3.3	10.7	17.2	38.9
	TDLF	4.2	1.5	4.7	7.9	5.6	0.3	12.2
2	NLF	12.4	23.3	22.2	12.8	2.5	10.7	41.0
	SDLF	8.1	16.7	14.9	6.6	1.1	9.5	26.7
	TDLF	4.9	4.6	1.1	6.8	8.2	6.6	7.8
3	NLF	37.4	52.1	41.6	10.0	26.3	90.6	7.9
	SDLF	30.8	39.6	27.9	1.7	24.3	66.5	6.1
	TDLF	15.3	10.7	3.9	17.3	19.7	10.2	2.1
4	NLF	27.8	31.5	11.8	24.2	71.5	59.6	7.4
	SDLF	23.0	23.8	5.6	23.6	57.5	50.0	6.8
	TDLF	13.0	7.1	8.3	22.0	23.9	27.3	6.5
5	NLF	10.1	4.1	20.1	56.1	75.4	39.7	7.7
	SDLF	9.0	2.8	18.4	47.9	63.7	37.6	7.9
	TDLF	6.9	0.0	14.8	28.0	36.4	32.9	9.3
6	NLF	2.0	9.5	36.6	65.5	60.8	27.8	4.3
	SDLF	2.1	8.6	32.8	57.4	56.0	28.9	6.3
	TDLF	2.5	6.9	24.0	38.9	45.4	32.5	11.4
7	NLF	0.9	16.9	49.1	67.6	56.4	26.9	2.3
	SDLF	0.5	16.3	44.9	61.8	54.0	27.9	5.2
	TDLF	0.5	15.4	36.2	49.4	49.3	31.7	12.3
8	NLF	2.5	28.0	58.8	71.9	54.7	26.4	5.4
	SDLF	2.8	26.8	54.7	66.6	52.5	27.5	7.5
	TDLF	4.2	25.5	46.4	55.1	48.4	30.8	12.0
9	NLF	6.5	36.3	68.7	73.7	52.5	28.6	10.2
	SDLF	6.8	35.2	63.4	67.7	49.8	28.7	10.1
	TDLF	8.7	33.9	51.7	53.8	43.9	28.5	9.2
10	NLF	8.4	47.0	76.3	73.1	54.1	34.6	10.3
	SDLF	9.6	44.7	68.5	65.4	49.3	31.7	9.4
	TDLF	13.6	39.5	49.5	46.3	36.6	23.3	6.4

Table T1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	21.5	68.4	87.8	77.0	53.8	29.5	5.7
	SDLF	20.7	59.9	74.0	64.7	45.8	26.3	5.4
	TDLF	19.0	38.5	39.4	33.7	24.6	16.6	4.3
12	NLF	37.1	75.5	76.8	51.8	23.9	5.2	1.4
	SDLF	32.4	61.7	60.9	41.2	20.5	5.7	1.4
	TDLF	20.4	26.9	21.2	14.5	10.6	5.8	1.3
13	NLF	41.4	62.2	39.9	3.0	22.7	26.6	3.8
	SDLF	33.4	45.7	27.2	1.0	18.3	21.9	3.4
	TDLF	13.2	5.9	1.9	3.3	7.7	10.6	2.4
14	NLF	35.4	28.4	20.3	60.7	80.9	68.1	10.3
	SDLF	23.6	13.7	20.9	50.2	66.0	57.3	9.5
	TDLF	3.2	16.9	17.7	21.0	27.3	29.8	7.5
15	NLF	36.8	17.9	74.1	114.6	129.5	102.4	11.5
	SDLF	18.2	22.3	63.0	92.6	104.9	85.5	11.6
	TDLF	21.8	26.4	29.0	33.5	42.0	44.2	12.0
16	NLF	14.2	71.7	125.7	162.4	173.2	144.5	20.4
	SDLF	21.8	65.0	103.5	130.0	138.2	117.2	20.1
	TDLF	33.7	39.6	39.8	44.0	49.9	51.1	18.5
17	NLF	14.7	64.3	105.7	135.2	142.0	105.9	10.4
	SDLF	19.8	57.8	88.3	110.0	115.1	87.2	10.8
	TDLF	28.7	34.6	38.3	44.1	49.4	44.6	12.5
18	NLF	17.0	45.7	75.4	94.6	92.7	55.7	6.8
	SDLF	16.2	39.4	61.9	76.2	74.4	46.8	7.4
	TDLF	11.2	18.0	23.4	29.7	32.8	29.2	9.1
19	NLF	1.2	20.2	39.4	50.5	43.6	15.0	4.9
	SDLF	2.1	16.5	30.9	38.8	34.1	13.9	5.2
	TDLF	1.7	3.1	7.8	12.9	16.5	15.0	6.0
20	NLF	5.2	11.4	20.0	23.4	11.7	3.6	3.2
	SDLF	2.6	5.6	11.6	14.1	7.1	3.2	3.4
	TDLF	5.8	9.6	5.5	0.5	4.0	1.8	4.0

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Table T1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	0.7	3.5	1.8	1.0	9.8	13.5	2.5
	SDLF	3.6	8.0	5.0	5.3	11.7	12.9	2.6
	TDLF	11.4	16.4	13.4	10.2	8.7	9.2	2.8
22	NLF	9.9	10.7	4.3	8.1	16.5	11.5	2.4
	SDLF	11.3	14.0	10.4	13.0	18.0	12.2	2.3
	TDLF	13.9	15.6	14.4	15.0	16.6	13.7	2.1
23	NLF	11.0	0.9	5.8	1.1	5.6	0.8	3.4
	SDLF	11.3	5.1	1.5	6.5	9.0	3.4	3.2
	TDLF	8.9	6.0	8.7	12.7	16.0	10.9	2.8
24	NLF	5.0	28.9	33.1	26.9	20.3	14.0	5.9
	SDLF	4.0	20.4	22.6	18.5	13.6	9.8	5.8
	TDLF	7.2	9.1	4.0	1.0	5.9	3.2	5.2
25	NLF	41.4	74.9	79.7	69.0	50.3	21.2	10.2
	SDLF	34.7	59.2	63.7	55.8	41.2	18.6	9.8
	TDLF	23.7	25.9	23.7	16.9	11.2	8.5	8.8
26	NLF	96.2	137.8	136.3	112.9	68.7	6.1	14.6
	SDLF	78.5	112.5	112.1	94.4	61.1	13.2	14.8
	TDLF	37.8	47.5	42.5	35.0	31.3	27.8	14.9
27	NLF	162.1	203.1	191.1	145.5	76.2	1.5	10.3
	SDLF	132.4	165.4	155.4	121.3	71.1	14.2	12.1
	TDLF	60.9	65.3	53.1	45.6	48.3	52.4	15.4
28	NLF	118.8	154.8	130.6	64.3	17.4	84.1	6.8
	SDLF	102.1	129.9	107.6	56.1	3.4	54.2	6.7
	TDLF	60.1	61.2	39.4	26.6	28.4	21.6	6.7
29	NLF	68.1	81.3	34.5	46.9	120.2	92.9	5.3
	SDLF	61.0	69.3	28.3	34.7	88.7	69.9	5.0
	TDLF	41.8	34.4	7.5	5.9	7.0	9.0	4.6
30	NLF	25.8	5.6	66.3	146.1	150.4	88.1	0.8
	SDLF	23.1	3.6	56.4	117.2	119.3	73.8	1.0
	TDLF	14.3	4.0	32.0	40.7	35.8	34.5	0.6

Table T1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	2.6	53.0	141.5	177.3	158.6	82.0	2.9
	SDLF	2.8	48.4	119.2	145.3	132.3	73.3	3.0
	TDLF	3.9	36.6	59.4	58.8	60.3	48.6	3.8
32	NLF	15.4	100.0	167.6	186.6	149.4	59.4	6.1
	SDLF	15.4	88.1	140.5	155.7	129.8	57.7	6.3
	TDLF	15.4	56.5	67.0	71.6	75.4	52.7	7.3
33	NLF	37.9	129.5	185.7	182.5	111.6	36.8	7.5
	SDLF	35.5	111.1	154.9	155.2	103.7	39.0	8.1
	TDLF	29.6	61.4	71.4	80.7	81.3	45.4	9.2
34	NLF	61.8	159.2	192.6	139.9	68.3	22.3	8.1
	SDLF	55.4	132.8	160.4	125.4	69.3	25.7	8.6
	TDLF	38.5	61.3	73.7	84.7	70.5	33.8	8.9
35	NLF	101.8	189.0	133.6	70.4	14.9	2.6	6.9
	SDLF	85.8	153.1	117.6	71.4	23.2	2.2	7.3
	TDLF	42.8	57.5	73.3	72.5	44.6	14.1	7.1
36	NLF	181.1	95.9	45.0	8.5	38.2	25.4	4.6
	SDLF	141.3	83.9	48.7	5.6	25.8	21.4	4.7
	TDLF	35.7	51.4	58.4	45.0	9.5	9.9	2.0
37	NLF	22.8	2.7	7.0	14.3	13.2	4.8	10.6
	SDLF	12.9	1.8	1.7	9.5	11.6	6.1	12.7
	TDLF	10.8	8.8	7.7	0.0	8.3	6.5	4.3

Table T1-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	0.3	0.7	3.8	5.6	5.6	6.7	6.5
	SDLF	0.1	0.8	1.6	1.0	0.6	1.9	3.2
	TDLF	0.3	1.5	3.5	9.9	15.6	23.1	27.5
2	NLF	0.9	12.5	17.8	15.8	7.0	3.1	25.3
	SDLF	1.0	5.7	4.8	0.4	3.9	5.4	2.8
	TDLF	1.0	10.7	26.6	37.0	30.6	11.0	52.5
3	NLF	1.7	10.2	12.2	7.1	2.6	18.8	13.3
	SDLF	1.7	5.7	4.4	0.0	4.6	5.0	6.4
	TDLF	2.0	5.0	14.9	17.9	9.5	29.6	11.2
4	NLF	2.4	5.9	4.8	1.6	13.5	17.4	9.0
	SDLF	2.5	4.6	3.0	1.4	4.9	7.6	6.6
	TDLF	2.8	1.6	1.8	1.7	16.6	16.7	0.3
5	NLF	3.1	3.9	1.1	7.4	14.4	14.6	5.6
	SDLF	3.2	3.9	1.4	2.8	7.1	9.2	5.6
	TDLF	3.3	3.9	1.7	8.2	10.4	4.0	5.9
6	NLF	3.8	3.7	1.4	9.7	16.2	13.7	6.6
	SDLF	3.8	3.4	0.1	5.6	9.7	9.7	4.9
	TDLF	3.7	2.3	3.3	3.5	5.9	0.4	1.2
7	NLF	4.1	3.0	3.6	13.4	18.0	14.5	7.1
	SDLF	4.0	3.3	2.2	8.5	11.1	9.2	4.5
	TDLF	3.7	3.5	0.3	3.1	5.6	3.0	1.2
8	NLF	4.9	2.5	6.8	16.9	19.8	14.7	6.9
	SDLF	4.7	2.5	4.9	10.2	10.8	8.1	4.2
	TDLF	4.5	1.6	1.0	6.4	11.2	7.7	1.9
9	NLF	5.3	1.3	10.8	20.9	21.0	14.1	6.5
	SDLF	5.1	0.5	7.0	10.0	9.0	6.5	3.9
	TDLF	4.5	1.9	2.6	17.5	20.7	12.4	3.1
10	NLF	4.6	3.5	18.3	24.9	20.3	11.5	5.3
	SDLF	4.4	2.0	7.7	7.9	6.2	4.5	2.9
	TDLF	4.0	2.2	19.9	35.1	29.0	13.6	3.6

Table T1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	3.2	9.4	21.7	20.8	11.1	3.9	0.4
	SDLF	3.3	3.6	5.5	3.7	2.3	1.4	0.5
	TDLF	3.3	11.8	35.9	39.1	19.7	5.0	2.3
12	NLF	1.7	12.6	17.6	8.2	1.5	7.9	8.1
	SDLF	1.7	3.1	0.9	1.0	1.7	2.8	3.4
	TDLF	1.5	21.1	40.1	22.5	1.0	10.3	8.5
13	NLF	0.4	11.6	6.0	6.6	17.1	22.3	18.0
	SDLF	0.3	0.2	3.5	4.4	5.3	7.2	7.6
	TDLF	0.3	26.4	23.4	4.9	26.3	31.7	18.7
14	NLF	2.9	9.5	4.1	18.6	29.6	33.8	26.2
	SDLF	2.6	2.4	4.8	5.7	7.2	9.6	9.8
	TDLF	2.2	28.1	1.2	31.4	51.8	52.1	29.9
15	NLF	3.7	2.0	13.4	28.6	39.5	43.1	35.9
	SDLF	4.5	4.9	6.6	7.3	8.7	10.1	10.1
	TDLF	6.6	17.8	16.8	52.4	72.5	73.0	51.8
16	NLF	4.1	1.6	11.8	24.0	33.3	36.5	27.0
	SDLF	3.4	3.3	5.7	7.5	9.5	11.0	9.1
	TDLF	1.3	13.0	14.8	39.4	52.7	51.4	31.7
17	NLF	2.9	0.2	8.4	17.6	24.7	25.5	15.9
	SDLF	2.8	0.2	2.4	4.9	7.1	7.7	6.8
	TDLF	2.4	3.4	17.5	31.6	37.4	32.9	12.1
18	NLF	2.3	2.9	3.0	10.1	15.0	14.3	5.2
	SDLF	1.9	2.0	0.4	2.0	3.7	4.9	3.9
	TDLF	1.0	2.0	12.9	19.9	21.3	13.0	3.9
19	NLF	1.4	0.3	3.2	7.8	10.5	7.2	1.1
	SDLF	1.3	2.8	2.3	0.3	1.4	2.5	1.2
	TDLF	1.0	10.5	16.9	16.7	13.2	1.4	5.6
20	NLF	1.0	0.5	1.3	5.1	5.7	1.8	1.9
	SDLF	0.9	3.3	3.2	1.6	0.6	0.3	1.5
	TDLF	0.6	10.7	11.1	9.9	5.9	2.3	2.0

Table T1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	0.5	1.9	0.7	4.3	3.2	0.9	2.1
	SDLF	0.5	3.3	2.4	1.8	1.7	2.4	2.8
	TDLF	0.5	5.8	3.9	6.0	4.0	1.1	4.2
22	NLF	0.3	1.5	4.0	6.7	3.8	0.3	0.2
	SDLF	0.4	1.7	0.2	0.6	1.5	2.8	2.5
	TDLF	0.7	0.8	1.3	8.1	7.9	9.5	9.8
23	NLF	0.2	3.3	11.6	12.3	8.6	5.1	2.5
	SDLF	0.4	2.1	3.1	1.8	0.6	1.3	1.5
	TDLF	1.0	4.6	8.9	17.2	18.5	20.4	14.1
24	NLF	0.3	12.7	21.9	21.3	16.6	10.3	2.4
	SDLF	0.7	5.8	6.3	5.9	3.8	1.5	0.1
	TDLF	1.8	6.3	27.8	33.8	34.9	28.0	9.3
25	NLF	0.6	26.0	35.1	32.8	24.8	12.3	3.7
	SDLF	1.2	8.1	10.6	9.2	6.8	4.9	3.2
	TDLF	2.9	33.9	54.0	60.1	52.4	24.5	18.1
26	NLF	1.0	41.5	50.8	45.9	32.7	14.1	5.5
	SDLF	1.5	12.5	13.7	10.3	7.8	7.6	8.1
	TDLF	2.9	59.0	86.9	93.6	71.3	20.1	39.9
27	NLF	1.1	30.4	38.9	31.5	13.3	8.1	25.0
	SDLF	1.0	14.3	14.6	8.3	4.2	4.2	2.6
	TDLF	0.4	26.7	53.9	61.7	29.8	29.9	73.8
28	NLF	0.2	18.0	21.4	8.5	13.1	32.9	26.5
	SDLF	0.3	11.5	9.5	1.6	2.4	3.2	3.9
	TDLF	1.8	6.3	26.0	22.7	20.4	73.7	56.4
29	NLF	0.8	7.8	2.7	16.5	38.5	40.9	24.3
	SDLF	1.3	5.3	0.3	7.6	10.7	10.1	9.8
	TDLF	2.7	2.9	8.5	13.0	62.0	72.1	30.4
30	NLF	1.9	1.2	11.8	36.3	47.3	42.5	21.8
	SDLF	2.4	1.2	7.5	14.4	15.3	15.8	12.4
	TDLF	3.7	0.7	3.1	42.9	70.1	57.5	15.2

Table T1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	2.8	1.4	24.7	44.2	49.5	39.3	14.2
	SDLF	3.1	1.4	13.1	16.8	18.1	18.7	11.9
	TDLF	4.0	0.7	17.3	54.7	66.4	38.9	4.5
32	NLF	3.3	8.2	34.0	49.2	47.9	27.9	7.4
	SDLF	3.5	5.9	15.3	17.7	19.6	19.0	9.2
	TDLF	4.1	1.1	32.3	64.7	57.3	6.4	14.1
33	NLF	2.6	15.9	42.6	50.8	35.7	15.6	3.2
	SDLF	2.7	9.5	15.3	17.9	20.1	15.8	5.9
	TDLF	2.9	7.1	53.4	68.9	23.4	16.0	13.5
34	NLF	1.2	28.1	50.0	34.6	16.4	1.1	3.4
	SDLF	1.3	11.1	14.2	17.8	17.0	8.9	0.9
	TDLF	1.5	29.6	75.8	28.8	18.3	30.8	13.3
35	NLF	1.1	48.2	25.7	10.6	4.5	12.7	9.1
	SDLF	0.9	9.1	12.8	14.3	10.1	0.4	4.5
	TDLF	0.1	83.2	23.5	25.0	51.6	38.5	9.6
36	NLF	12.3	1.1	0.1	2.0	4.2	4.5	2.6
	SDLF	1.3	1.4	1.7	1.9	0.9	0.9	1.2
	TDLF	35.5	3.7	7.2	13.7	16.1	10.0	3.0
37	NLF	28.0	9.6	4.6	1.3	2.6	5.2	4.3
	SDLF	2.8	0.3	1.4	2.7	2.4	0.1	1.5
	TDLF	80.3	28.8	7.7	6.4	16.4	14.7	6.8

Table T1-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	3.7	4.3	3.9	11.4	15.2	23.0	23.5
	SDLF	2.9	3.5	3.4	8.8	10.6	15.3	13.9
	TDLF	2.0	3.7	5.6	3.1	2.2	6.6	11.2
2	NLF	7.3	46.6	65.4	58.3	26.7	9.9	84.5
	SDLF	7.1	37.8	49.5	40.3	14.1	12.9	60.9
	TDLF	6.1	19.3	14.9	0.4	14.7	18.7	6.3
3	NLF	8.2	37.9	45.4	27.4	7.5	62.1	44.7
	SDLF	7.5	31.6	35.2	18.2	10.9	48.8	37.4
	TDLF	8.1	19.7	13.5	2.4	17.7	16.6	20.0
4	NLF	11.5	23.9	20.8	2.2	43.5	59.4	31.2
	SDLF	11.0	21.0	16.9	4.1	36.4	49.7	28.8
	TDLF	11.2	16.0	8.6	7.9	18.7	26.8	22.7
5	NLF	14.6	18.1	8.1	21.6	48.6	51.4	18.4
	SDLF	13.8	16.4	6.2	19.1	42.2	46.1	18.8
	TDLF	13.3	13.3	2.3	12.8	27.2	33.7	20.0
6	NLF	18.3	18.7	1.1	30.7	56.8	48.4	22.3
	SDLF	17.2	16.2	0.1	28.1	50.7	44.7	20.8
	TDLF	15.3	10.8	2.5	22.8	36.7	36.4	17.8
7	NLF	20.6	18.5	7.9	46.7	64.6	52.1	24.0
	SDLF	19.0	16.1	8.4	42.4	57.7	46.9	21.6
	TDLF	15.8	10.4	10.6	33.0	41.9	35.0	16.6
8	NLF	26.1	15.5	22.8	61.6	72.7	53.2	22.0
	SDLF	23.9	13.4	21.7	54.6	63.4	46.5	19.9
	TDLF	18.8	7.4	20.2	38.7	41.0	30.8	15.1
9	NLF	27.4	6.8	40.8	78.0	77.3	48.9	19.2
	SDLF	25.4	5.3	36.6	66.2	64.8	41.8	17.7
	TDLF	20.4	0.5	26.9	37.5	34.4	24.7	13.3
10	NLF	20.5	14.5	69.6	91.6	70.9	36.0	16.3
	SDLF	19.9	12.2	57.7	73.8	57.5	30.8	14.7
	TDLF	17.9	7.3	28.2	29.6	24.1	17.1	9.8

Table T1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	11.7	37.4	80.1	72.2	33.4	10.6	2.4
	SDLF	12.7	30.2	62.8	55.4	26.6	9.5	1.1
	TDLF	14.2	12.2	19.6	14.3	9.9	6.0	1.3
12	NLF	5.0	46.2	59.2	20.7	9.8	29.0	28.8
	SDLF	6.3	35.6	42.4	13.2	8.8	23.3	23.9
	TDLF	8.9	9.6	2.7	2.8	4.7	9.0	12.1
13	NLF	0.1	35.2	10.2	30.0	63.0	78.8	63.0
	SDLF	0.8	23.8	1.9	27.2	51.0	63.6	52.7
	TDLF	2.0	1.6	13.1	15.3	18.3	24.8	26.7
14	NLF	4.4	23.1	20.9	69.0	104.7	117.2	89.9
	SDLF	5.0	11.7	22.3	56.8	83.1	93.5	73.7
	TDLF	6.4	11.3	18.6	20.4	25.1	33.0	34.3
15	NLF	12.5	4.2	49.5	101.4	137.5	148.2	122.5
	SDLF	12.5	4.9	45.2	82.3	108.3	116.2	97.2
	TDLF	13.4	21.2	25.6	26.0	29.6	34.3	35.2
16	NLF	14.9	2.4	45.7	87.5	117.4	125.7	91.5
	SDLF	13.5	3.8	41.2	72.0	94.0	100.2	73.3
	TDLF	9.3	16.2	23.2	26.7	32.2	37.6	32.2
17	NLF	10.1	2.7	32.8	63.0	83.9	84.5	52.6
	SDLF	9.2	3.8	28.2	51.1	66.7	66.5	43.2
	TDLF	7.0	3.5	10.5	16.0	22.6	25.4	23.6
18	NLF	8.1	8.2	11.2	32.1	45.4	42.1	14.1
	SDLF	6.9	6.2	8.8	24.4	33.9	32.3	12.5
	TDLF	3.6	3.9	1.9	3.4	8.7	13.7	12.1
19	NLF	2.9	0.6	6.7	16.9	23.0	12.7	2.8
	SDLF	2.4	2.5	1.7	8.8	13.7	7.6	2.9
	TDLF	1.3	9.0	12.1	7.6	1.5	3.0	1.1
20	NLF	0.7	3.8	5.2	2.2	2.9	7.7	12.5
	SDLF	0.3	6.3	9.6	4.8	3.9	10.2	12.2
	TDLF	0.7	13.0	17.5	13.5	10.1	8.2	9.0

Table T1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	1.6	10.6	10.2	2.2	5.6	15.0	11.0
	SDLF	1.8	12.0	13.6	8.8	11.0	16.7	11.6
	TDLF	2.1	14.4	15.3	13.8	14.0	15.8	13.0
22	NLF	2.7	10.8	1.0	8.5	0.6	5.6	1.0
	SDLF	2.6	11.1	3.7	0.6	5.1	8.8	3.4
	TDLF	2.3	8.7	5.5	7.7	12.0	15.5	10.5
23	NLF	2.3	6.3	31.3	34.3	25.8	18.6	12.0
	SDLF	2.2	4.8	22.1	23.4	17.6	12.3	8.2
	TDLF	1.7	6.9	9.4	3.8	1.3	6.5	4.1
24	NLF	2.4	42.7	75.2	76.9	65.5	46.0	16.0
	SDLF	1.8	35.3	58.8	61.3	52.8	37.4	14.0
	TDLF	0.5	22.5	24.3	21.8	14.8	8.7	5.3
25	NLF	0.5	93.8	131.5	129.0	104.4	59.3	4.2
	SDLF	0.2	75.2	106.4	105.2	86.5	52.5	3.5
	TDLF	2.2	32.6	41.8	36.7	28.9	24.7	19.8
26	NLF	1.9	154.5	195.2	183.5	139.3	71.0	5.3
	SDLF	2.5	124.0	157.0	147.3	114.2	64.6	8.6
	TDLF	3.6	51.8	56.4	44.5	36.8	38.3	41.2
27	NLF	2.0	114.2	150.9	129.0	64.5	14.8	82.7
	SDLF	1.9	97.4	125.9	105.4	55.2	2.3	54.4
	TDLF	1.6	55.7	57.4	36.0	22.5	24.4	17.1
28	NLF	2.1	69.3	86.1	41.4	38.0	113.7	94.9
	SDLF	2.5	62.3	73.6	34.0	27.4	83.7	71.2
	TDLF	3.7	43.9	37.3	9.6	3.4	5.7	8.8
29	NLF	6.3	32.8	14.7	56.1	138.9	150.6	90.1
	SDLF	6.7	29.9	11.8	47.3	110.9	118.9	75.1
	TDLF	7.9	20.9	1.9	26.1	36.5	33.6	33.1
30	NLF	11.5	7.7	42.1	134.3	177.5	160.8	82.6
	SDLF	11.8	7.1	38.2	112.4	144.6	133.1	72.7
	TDLF	12.6	4.9	28.3	53.0	55.4	56.5	43.9

Table T1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	15.6	2.7	92.2	167.4	188.3	150.3	55.1
	SDLF	15.5	3.3	80.6	139.4	155.9	129.1	52.8
	TDLF	15.3	4.8	49.1	63.2	66.9	69.1	45.2
32	NLF	18.2	29.5	129.1	187.3	182.8	108.2	27.8
	SDLF	17.9	27.3	109.9	154.9	153.9	99.3	29.9
	TDLF	17.2	21.5	57.8	66.3	73.5	73.1	35.5
33	NLF	13.8	60.6	161.5	192.0	137.1	60.0	10.9
	SDLF	13.8	53.6	133.3	158.6	121.5	60.8	14.2
	TDLF	13.3	35.2	56.5	66.6	76.9	61.8	22.7
34	NLF	5.6	105.3	186.7	131.3	62.4	3.4	15.2
	SDLF	5.8	87.4	150.4	114.4	63.6	12.1	10.2
	TDLF	6.0	39.3	51.6	66.9	65.7	35.6	3.3
35	NLF	5.4	177.4	96.0	38.8	18.3	50.1	37.1
	SDLF	5.6	138.1	82.9	42.7	3.3	36.6	32.4
	TDLF	5.9	31.2	47.1	54.2	39.7	2.9	17.5
36	NLF	46.2	4.7	1.3	10.4	18.7	18.7	8.4
	SDLF	32.0	4.6	0.2	6.3	13.4	15.1	7.0
	TDLF	6.2	5.6	6.6	7.7	4.0	2.9	3.6
37	NLF	104.6	42.0	25.7	12.1	6.4	19.9	14.6
	SDLF	73.3	31.5	21.1	12.3	2.1	15.3	12.0
	TDLF	11.5	0.2	5.1	10.1	9.3	0.0	3.4

Table T1-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	1.66	1.59	1.50	1.42	1.37	1.34	1.38
	SDLF	1.61	1.52	1.43	1.36	1.34	1.34	1.40
	TDLF	1.48	1.35	1.25	1.22	1.28	1.35	1.46
3	NLF	1.67	1.60	1.50	1.40	1.31	1.23	1.08
	SDLF	1.64	1.55	1.44	1.33	1.27	1.23	1.14
	TDLF	1.57	1.42	1.27	1.19	1.20	1.24	1.29
4	NLF	1.64	1.55	1.42	1.29	1.17	1.00	0.73
	SDLF	1.61	1.50	1.36	1.23	1.14	1.02	0.81
	TDLF	1.55	1.39	1.20	1.08	1.06	1.06	0.99
5	NLF	1.55	1.43	1.27	1.11	0.92	0.69	0.38
	SDLF	1.52	1.37	1.20	1.05	0.89	0.72	0.45
	TDLF	1.45	1.24	1.02	0.90	0.83	0.80	0.64
6	NLF	1.43	1.27	1.08	0.85	0.62	0.36	0.05
	SDLF	1.38	1.20	1.00	0.79	0.61	0.40	0.12
	TDLF	1.28	1.02	0.80	0.64	0.57	0.51	0.27
7	NLF	1.28	1.07	0.81	0.54	0.29	0.02	-0.27
	SDLF	1.22	0.98	0.71	0.48	0.29	0.06	-0.21
	TDLF	1.08	0.76	0.47	0.34	0.28	0.17	-0.10
8	NLF	1.08	0.78	0.48	0.21	-0.04	-0.30	-0.55
	SDLF	1.00	0.67	0.38	0.15	-0.04	-0.27	-0.52
	TDLF	0.81	0.38	0.12	0.01	-0.05	-0.20	-0.47
9	NLF	0.79	0.44	0.13	-0.13	-0.36	-0.57	-0.77
	SDLF	0.68	0.31	0.03	-0.18	-0.37	-0.57	-0.78
	TDLF	0.42	-0.03	-0.24	-0.31	-0.40	-0.57	-0.81
10	NLF	0.45	0.08	-0.22	-0.44	-0.63	-0.80	-0.91
	SDLF	0.32	-0.06	-0.31	-0.49	-0.66	-0.83	-0.96
	TDLF	-0.02	-0.41	-0.56	-0.63	-0.74	-0.92	-1.07

Table T1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	0.06	-0.30	-0.55	-0.72	-0.86	-0.95	-1.02
	SDLF	-0.09	-0.43	-0.63	-0.78	-0.92	-1.02	-1.11
	TDLF	-0.48	-0.77	-0.86	-0.94	-1.06	-1.19	-1.33
12	NLF	-0.34	-0.64	-0.80	-0.91	-0.98	-1.04	-1.06
	SDLF	-0.49	-0.75	-0.88	-0.98	-1.06	-1.14	-1.19
	TDLF	-0.89	-1.03	-1.07	-1.15	-1.25	-1.38	-1.51
13	NLF	-0.69	-0.87	-0.93	-0.97	-1.02	-1.05	-1.03
	SDLF	-0.81	-0.94	-0.99	-1.04	-1.10	-1.16	-1.18
	TDLF	-1.12	-1.13	-1.15	-1.21	-1.31	-1.45	-1.58
14	NLF	-0.91	-0.94	-0.93	-0.93	-0.95	-0.95	-0.91
	SDLF	-0.97	-0.97	-0.97	-0.99	-1.02	-1.06	-1.07
	TDLF	-1.12	-1.05	-1.07	-1.12	-1.21	-1.34	-1.48
15	NLF	-0.98	-0.89	-0.84	-0.81	-0.79	-0.78	-0.75
	SDLF	-0.98	-0.90	-0.86	-0.85	-0.85	-0.87	-0.88
	TDLF	-0.96	-0.92	-0.91	-0.93	-0.99	-1.09	-1.21
16	NLF	-0.91	-0.76	-0.66	-0.59	-0.55	-0.52	-0.49
	SDLF	-0.87	-0.74	-0.66	-0.61	-0.59	-0.58	-0.58
	TDLF	-0.77	-0.69	-0.65	-0.65	-0.67	-0.73	-0.79
17	NLF	-0.79	-0.62	-0.50	-0.41	-0.35	-0.31	-0.26
	SDLF	-0.76	-0.60	-0.48	-0.41	-0.37	-0.34	-0.32
	TDLF	-0.66	-0.52	-0.44	-0.40	-0.39	-0.39	-0.43
18	NLF	-0.65	-0.48	-0.35	-0.26	-0.20	-0.16	-0.08
	SDLF	-0.62	-0.46	-0.33	-0.24	-0.19	-0.17	-0.10
	TDLF	-0.56	-0.39	-0.27	-0.19	-0.15	-0.15	-0.11
19	NLF	-0.53	-0.37	-0.24	-0.15	-0.10	-0.05	0.03
	SDLF	-0.52	-0.36	-0.22	-0.13	-0.09	-0.05	0.03
	TDLF	-0.50	-0.33	-0.18	-0.08	-0.03	0.01	0.11
20	NLF	-0.38	-0.24	-0.13	-0.06	-0.02	0.03	0.10
	SDLF	-0.38	-0.24	-0.11	-0.04	0.00	0.05	0.13
	TDLF	-0.42	-0.26	-0.10	0.00	0.06	0.13	0.26

Table T1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
21	NLF	-0.25	-0.13	-0.05	0.00	0.03	0.08	0.15
	SDLF	-0.27	-0.14	-0.04	0.01	0.05	0.11	0.19
	TDLF	-0.36	-0.20	-0.06	0.02	0.09	0.19	0.32
22	NLF	-0.15	-0.05	0.01	0.04	0.07	0.13	0.19
	SDLF	-0.17	-0.06	0.01	0.04	0.08	0.15	0.22
	TDLF	-0.31	-0.14	-0.05	0.01	0.09	0.21	0.31
23	NLF	-0.07	0.02	0.06	0.07	0.11	0.17	0.25
	SDLF	-0.08	0.02	0.05	0.07	0.11	0.19	0.28
	TDLF	-0.20	-0.06	-0.02	0.02	0.10	0.21	0.31
24	NLF	0.04	0.11	0.11	0.13	0.17	0.25	0.37
	SDLF	0.06	0.11	0.11	0.13	0.18	0.26	0.39
	TDLF	0.04	0.08	0.07	0.09	0.15	0.24	0.38
25	NLF	0.19	0.21	0.20	0.22	0.27	0.36	0.53
	SDLF	0.25	0.24	0.23	0.24	0.28	0.37	0.55
	TDLF	0.36	0.28	0.25	0.25	0.28	0.35	0.53
26	NLF	0.39	0.36	0.34	0.34	0.38	0.46	0.65
	SDLF	0.48	0.43	0.39	0.39	0.42	0.50	0.68
	TDLF	0.73	0.60	0.52	0.48	0.50	0.55	0.69
27	NLF	0.63	0.62	0.58	0.55	0.56	0.62	0.73
	SDLF	0.80	0.74	0.67	0.64	0.66	0.72	0.84
	TDLF	1.26	1.07	0.89	0.83	0.88	0.96	1.08
28	NLF	0.75	0.75	0.69	0.62	0.60	0.60	0.61
	SDLF	0.97	0.91	0.79	0.72	0.71	0.73	0.77
	TDLF	1.55	1.34	1.08	0.99	1.03	1.08	1.20
29	NLF	0.80	0.77	0.65	0.54	0.47	0.49	0.41
	SDLF	1.01	0.92	0.75	0.64	0.59	0.63	0.61
	TDLF	1.59	1.32	1.01	0.91	0.92	1.03	1.17
30	NLF	0.77	0.64	0.45	0.31	0.32	0.30	0.17
	SDLF	0.93	0.73	0.51	0.38	0.42	0.46	0.38
	TDLF	1.36	0.96	0.65	0.56	0.72	0.89	0.97

Table T1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
31	NLF	0.63	0.39	0.16	0.13	0.12	0.08	-0.25
	SDLF	0.71	0.40	0.15	0.16	0.21	0.23	-0.08
	TDLF	0.93	0.39	0.13	0.27	0.45	0.65	0.43
32	NLF	0.40	0.05	-0.05	-0.07	-0.08	-0.30	-0.64
	SDLF	0.39	-0.01	-0.08	-0.06	-0.02	-0.19	-0.55
	TDLF	0.37	-0.24	-0.19	-0.03	0.16	0.14	-0.27
33	NLF	0.03	-0.19	-0.26	-0.27	-0.42	-0.66	-0.96
	SDLF	-0.06	-0.29	-0.32	-0.29	-0.40	-0.62	-0.96
	TDLF	-0.36	-0.61	-0.51	-0.33	-0.32	-0.47	-0.94
34	NLF	-0.25	-0.43	-0.46	-0.57	-0.74	-0.99	-1.22
	SDLF	-0.39	-0.55	-0.55	-0.63	-0.77	-1.02	-1.31
	TDLF	-0.85	-0.94	-0.80	-0.79	-0.83	-1.10	-1.54
35	NLF	-0.57	-0.64	-0.71	-0.82	-1.00	-1.23	-1.42
	SDLF	-0.75	-0.78	-0.85	-0.92	-1.08	-1.33	-1.57
	TDLF	-1.33	-1.21	-1.21	-1.19	-1.27	-1.59	-1.98
36	NLF	-0.90	-0.85	-0.87	-0.96	-1.13	-1.35	-1.53
	SDLF	-1.09	-1.04	-1.05	-1.10	-1.23	-1.47	-1.70
	TDLF	-1.74	-1.55	-1.52	-1.46	-1.49	-1.77	-2.16
37	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	-0.22	0.00	0.00	-0.01	-0.01	0.00	0.00

Table T1-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.01	0.01	0.00	0.00	0.00	-0.01
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.01
2	NLF	5.78	5.55	5.23	4.95	4.78	4.66	4.79
	SDLF	5.69	5.44	5.12	4.85	4.71	4.62	4.77
	TDLF	5.50	5.21	4.89	4.66	4.61	4.59	4.79
3	NLF	5.82	5.58	5.22	4.85	4.55	4.29	3.77
	SDLF	5.74	5.48	5.11	4.75	4.48	4.26	3.80
	TDLF	5.61	5.30	4.90	4.56	4.37	4.24	3.93
4	NLF	5.69	5.38	4.94	4.48	4.05	3.48	2.54
	SDLF	5.62	5.28	4.83	4.38	3.99	3.47	2.60
	TDLF	5.50	5.12	4.62	4.20	3.89	3.50	2.79
5	NLF	5.39	4.96	4.42	3.86	3.17	2.38	1.29
	SDLF	5.31	4.86	4.31	3.77	3.13	2.40	1.37
	TDLF	5.18	4.67	4.09	3.59	3.05	2.49	1.58
6	NLF	4.98	4.41	3.75	2.95	2.14	1.23	0.14
	SDLF	4.89	4.30	3.64	2.87	2.11	1.27	0.22
	TDLF	4.72	4.07	3.39	2.69	2.08	1.40	0.43
7	NLF	4.46	3.73	2.79	1.88	1.01	0.06	-0.95
	SDLF	4.35	3.60	2.67	1.80	1.00	0.12	-0.87
	TDLF	4.14	3.33	2.41	1.65	1.00	0.26	-0.70
8	NLF	3.78	2.72	1.66	0.72	-0.15	-1.03	-1.90
	SDLF	3.65	2.58	1.53	0.65	-0.14	-0.98	-1.84
	TDLF	3.39	2.25	1.25	0.51	-0.13	-0.88	-1.73
9	NLF	2.76	1.54	0.44	-0.44	-1.23	-1.98	-2.65
	SDLF	2.62	1.38	0.33	-0.49	-1.22	-1.95	-2.63
	TDLF	2.30	1.02	0.06	-0.62	-1.23	-1.91	-2.61
10	NLF	1.57	0.28	-0.75	-1.51	-2.17	-2.76	-3.13
	SDLF	1.42	0.13	-0.84	-1.56	-2.18	-2.76	-3.15
	TDLF	1.04	-0.25	-1.09	-1.68	-2.23	-2.81	-3.22

Table T1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	0.21	-1.05	-1.89	-2.48	-2.96	-3.27	-3.48
	SDLF	0.06	-1.18	-1.97	-2.52	-3.00	-3.31	-3.55
	TDLF	-0.36	-1.53	-2.19	-2.66	-3.11	-3.44	-3.72
12	NLF	-1.20	-2.22	-2.77	-3.13	-3.37	-3.56	-3.60
	SDLF	-1.35	-2.32	-2.84	-3.18	-3.42	-3.63	-3.70
	TDLF	-1.75	-2.59	-3.01	-3.32	-3.57	-3.83	-3.98
13	NLF	-2.41	-3.01	-3.22	-3.35	-3.48	-3.56	-3.45
	SDLF	-2.51	-3.07	-3.26	-3.39	-3.54	-3.65	-3.59
	TDLF	-2.81	-3.23	-3.39	-3.53	-3.71	-3.90	-3.94
14	NLF	-3.14	-3.21	-3.16	-3.17	-3.20	-3.20	-3.02
	SDLF	-3.18	-3.23	-3.19	-3.21	-3.26	-3.29	-3.16
	TDLF	-3.31	-3.28	-3.26	-3.30	-3.40	-3.52	-3.52
15	NLF	-3.34	-3.02	-2.82	-2.70	-2.64	-2.57	-2.42
	SDLF	-3.31	-3.01	-2.82	-2.73	-2.68	-2.64	-2.53
	TDLF	-3.25	-2.99	-2.84	-2.78	-2.78	-2.83	-2.83
16	NLF	-3.04	-2.51	-2.15	-1.91	-1.74	-1.62	-1.51
	SDLF	-2.97	-2.46	-2.13	-1.91	-1.77	-1.67	-1.58
	TDLF	-2.83	-2.37	-2.10	-1.92	-1.83	-1.79	-1.77
17	NLF	-2.62	-2.01	-1.57	-1.26	-1.05	-0.90	-0.72
	SDLF	-2.55	-1.95	-1.54	-1.25	-1.05	-0.92	-0.77
	TDLF	-2.40	-1.84	-1.47	-1.21	-1.05	-0.95	-0.87
18	NLF	-2.07	-1.49	-1.04	-0.72	-0.51	-0.38	-0.14
	SDLF	-2.02	-1.44	-1.00	-0.69	-0.50	-0.38	-0.16
	TDLF	-1.90	-1.34	-0.92	-0.62	-0.44	-0.35	-0.16
19	NLF	-1.63	-1.10	-0.68	-0.38	-0.21	-0.06	0.17
	SDLF	-1.59	-1.06	-0.64	-0.35	-0.19	-0.05	0.17
	TDLF	-1.53	-1.01	-0.58	-0.28	-0.12	0.01	0.24
20	NLF	-1.13	-0.69	-0.34	-0.13	0.00	0.15	0.32
	SDLF	-1.11	-0.67	-0.32	-0.11	0.02	0.16	0.34
	TDLF	-1.12	-0.67	-0.29	-0.06	0.09	0.24	0.46

Table T1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location						
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	-0.74	-0.40	-0.15	-0.01	0.10	0.24	0.37
	SDLF	-0.75	-0.40	-0.14	0.00	0.11	0.25	0.40
	TDLF	-0.82	-0.45	-0.16	0.01	0.15	0.33	0.51
22	NLF	-0.49	-0.22	-0.04	0.04	0.13	0.27	0.43
	SDLF	-0.50	-0.22	-0.05	0.04	0.13	0.29	0.45
	TDLF	-0.63	-0.30	-0.11	0.00	0.13	0.33	0.52
23	NLF	-0.29	-0.05	0.04	0.08	0.18	0.36	0.63
	SDLF	-0.31	-0.06	0.03	0.07	0.18	0.37	0.64
	TDLF	-0.42	-0.14	-0.06	0.01	0.14	0.37	0.65
24	NLF	0.00	0.18	0.18	0.22	0.36	0.61	1.07
	SDLF	0.01	0.18	0.17	0.21	0.35	0.61	1.08
	TDLF	-0.02	0.13	0.11	0.16	0.30	0.56	1.04
25	NLF	0.47	0.51	0.49	0.55	0.71	1.05	1.72
	SDLF	0.52	0.53	0.51	0.56	0.71	1.05	1.72
	TDLF	0.62	0.56	0.52	0.55	0.69	1.00	1.67
26	NLF	1.16	1.08	1.03	1.06	1.20	1.52	2.24
	SDLF	1.25	1.14	1.07	1.09	1.22	1.54	2.25
	TDLF	1.48	1.30	1.18	1.17	1.28	1.56	2.24
27	NLF	2.10	2.12	2.01	1.93	1.99	2.21	2.66
	SDLF	2.26	2.23	2.09	2.00	2.07	2.30	2.75
	TDLF	2.70	2.54	2.29	2.19	2.28	2.52	2.97
28	NLF	2.60	2.67	2.46	2.25	2.17	2.20	2.25
	SDLF	2.80	2.81	2.56	2.34	2.29	2.32	2.41
	TDLF	3.36	3.23	2.84	2.61	2.59	2.66	2.82
29	NLF	2.84	2.76	2.37	1.99	1.75	1.81	1.53
	SDLF	3.04	2.90	2.46	2.08	1.87	1.95	1.73
	TDLF	3.60	3.30	2.72	2.36	2.20	2.35	2.28
30	NLF	2.77	2.34	1.68	1.17	1.20	1.15	0.64
	SDLF	2.92	2.42	1.73	1.23	1.30	1.30	0.86
	TDLF	3.33	2.65	1.88	1.43	1.60	1.73	1.46

Table T1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	2.30	1.44	0.58	0.47	0.47	0.31	-0.92
	SDLF	2.37	1.44	0.57	0.51	0.55	0.46	-0.74
	TDLF	2.58	1.45	0.58	0.63	0.80	0.89	-0.21
32	NLF	1.45	0.18	-0.19	-0.27	-0.31	-1.13	-2.41
	SDLF	1.44	0.12	-0.22	-0.25	-0.25	-1.01	-2.31
	TDLF	1.42	-0.07	-0.30	-0.21	-0.05	-0.66	-2.00
33	NLF	0.11	-0.73	-0.99	-1.01	-1.58	-2.52	-3.64
	SDLF	0.02	-0.82	-1.04	-1.03	-1.55	-2.46	-3.62
	TDLF	-0.25	-1.09	-1.20	-1.06	-1.45	-2.28	-3.57
34	NLF	-0.93	-1.63	-1.72	-2.16	-2.82	-3.76	-4.68
	SDLF	-1.07	-1.74	-1.81	-2.21	-2.84	-3.77	-4.74
	TDLF	-1.48	-2.07	-2.04	-2.35	-2.88	-3.82	-4.93
35	NLF	-2.14	-2.39	-2.70	-3.12	-3.83	-4.71	-5.46
	SDLF	-2.30	-2.52	-2.82	-3.21	-3.88	-4.78	-5.57
	TDLF	-2.79	-2.90	-3.16	-3.46	-4.04	-5.00	-5.95
36	NLF	-3.35	-3.18	-3.30	-3.68	-4.35	-5.18	-5.90
	SDLF	-3.52	-3.36	-3.47	-3.80	-4.42	-5.27	-6.03
	TDLF	-4.02	-3.87	-3.92	-4.13	-4.65	-5.54	-6.45
37	NLF	0.00	-0.01	-0.01	-0.01	-0.02	-0.01	-0.02
	SDLF	0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.01
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table T1-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.97	0.93	0.88	0.83	0.80	0.78	0.80
	SDLF	0.94	0.89	0.84	0.80	0.78	0.78	0.81
	TDLF	0.86	0.79	0.73	0.71	0.75	0.79	0.85
3	NLF	0.98	0.94	0.88	0.81	0.76	0.72	0.63
	SDLF	0.96	0.91	0.84	0.78	0.74	0.72	0.66
	TDLF	0.91	0.83	0.74	0.69	0.70	0.73	0.75
4	NLF	0.95	0.90	0.83	0.75	0.68	0.59	0.43
	SDLF	0.94	0.88	0.79	0.72	0.66	0.59	0.47
	TDLF	0.91	0.81	0.70	0.63	0.62	0.62	0.58
5	NLF	0.91	0.83	0.74	0.65	0.54	0.40	0.22
	SDLF	0.89	0.80	0.70	0.61	0.52	0.42	0.26
	TDLF	0.84	0.72	0.60	0.53	0.49	0.47	0.37
6	NLF	0.83	0.74	0.63	0.50	0.36	0.21	0.03
	SDLF	0.81	0.70	0.58	0.46	0.35	0.23	0.07
	TDLF	0.75	0.60	0.46	0.37	0.33	0.30	0.16
7	NLF	0.75	0.63	0.47	0.32	0.17	0.01	-0.16
	SDLF	0.71	0.58	0.42	0.28	0.17	0.04	-0.12
	TDLF	0.63	0.44	0.28	0.20	0.16	0.10	-0.06
8	NLF	0.63	0.46	0.28	0.12	-0.02	-0.17	-0.32
	SDLF	0.58	0.39	0.22	0.09	-0.03	-0.16	-0.30
	TDLF	0.47	0.22	0.07	0.01	-0.03	-0.12	-0.27
9	NLF	0.46	0.26	0.08	-0.08	-0.21	-0.34	-0.45
	SDLF	0.40	0.18	0.01	-0.11	-0.21	-0.33	-0.45
	TDLF	0.24	-0.01	-0.14	-0.18	-0.23	-0.33	-0.47
10	NLF	0.26	0.05	-0.13	-0.26	-0.37	-0.47	-0.53
	SDLF	0.19	-0.03	-0.18	-0.29	-0.39	-0.49	-0.56
	TDLF	-0.01	-0.24	-0.33	-0.37	-0.43	-0.54	-0.63

Table T1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	0.04	-0.18	-0.32	-0.42	-0.50	-0.56	-0.60
	SDLF	-0.05	-0.25	-0.37	-0.46	-0.54	-0.60	-0.65
	TDLF	-0.28	-0.45	-0.50	-0.55	-0.62	-0.70	-0.78
12	NLF	-0.20	-0.37	-0.47	-0.53	-0.57	-0.61	-0.62
	SDLF	-0.29	-0.44	-0.51	-0.57	-0.62	-0.66	-0.69
	TDLF	-0.52	-0.60	-0.63	-0.67	-0.73	-0.81	-0.88
13	NLF	-0.40	-0.51	-0.55	-0.57	-0.59	-0.61	-0.60
	SDLF	-0.47	-0.55	-0.58	-0.61	-0.64	-0.68	-0.69
	TDLF	-0.65	-0.66	-0.67	-0.71	-0.77	-0.85	-0.92
14	NLF	-0.53	-0.55	-0.54	-0.54	-0.55	-0.56	-0.53
	SDLF	-0.57	-0.57	-0.56	-0.58	-0.60	-0.62	-0.63
	TDLF	-0.66	-0.62	-0.62	-0.65	-0.71	-0.78	-0.86
15	NLF	-0.57	-0.52	-0.49	-0.47	-0.46	-0.46	-0.44
	SDLF	-0.57	-0.53	-0.50	-0.49	-0.50	-0.51	-0.51
	TDLF	-0.56	-0.54	-0.53	-0.54	-0.58	-0.64	-0.71
16	NLF	-0.53	-0.44	-0.38	-0.34	-0.32	-0.30	-0.29
	SDLF	-0.51	-0.43	-0.38	-0.35	-0.34	-0.34	-0.34
	TDLF	-0.45	-0.40	-0.38	-0.38	-0.39	-0.42	-0.46
17	NLF	-0.46	-0.36	-0.29	-0.24	-0.21	-0.18	-0.15
	SDLF	-0.44	-0.35	-0.28	-0.24	-0.21	-0.20	-0.19
	TDLF	-0.38	-0.30	-0.26	-0.23	-0.23	-0.23	-0.25
18	NLF	-0.38	-0.28	-0.21	-0.15	-0.12	-0.09	-0.05
	SDLF	-0.36	-0.27	-0.19	-0.14	-0.11	-0.10	-0.06
	TDLF	-0.32	-0.23	-0.16	-0.11	-0.09	-0.09	-0.06
19	NLF	-0.31	-0.22	-0.14	-0.09	-0.06	-0.03	0.02
	SDLF	-0.30	-0.21	-0.13	-0.08	-0.05	-0.03	0.02
	TDLF	-0.29	-0.19	-0.10	-0.04	-0.02	0.00	0.06
20	NLF	-0.22	-0.14	-0.07	-0.04	-0.01	0.02	0.06
	SDLF	-0.22	-0.14	-0.07	-0.03	0.00	0.03	0.08
	TDLF	-0.24	-0.15	-0.06	0.00	0.04	0.08	0.15

Table T1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	-0.15	-0.08	-0.03	0.00	0.02	0.05	0.09
	SDLF	-0.16	-0.08	-0.02	0.01	0.03	0.06	0.11
	TDLF	-0.21	-0.12	-0.04	0.01	0.05	0.11	0.18
22	NLF	-0.09	-0.03	0.01	0.02	0.04	0.07	0.11
	SDLF	-0.10	-0.03	0.00	0.02	0.05	0.09	0.13
	TDLF	-0.18	-0.08	-0.03	0.01	0.05	0.12	0.18
23	NLF	-0.04	0.01	0.03	0.04	0.06	0.10	0.15
	SDLF	-0.05	0.01	0.03	0.04	0.07	0.11	0.16
	TDLF	-0.11	-0.04	-0.01	0.01	0.06	0.12	0.18
24	NLF	0.03	0.06	0.07	0.08	0.10	0.14	0.21
	SDLF	0.04	0.07	0.07	0.08	0.10	0.15	0.23
	TDLF	0.02	0.04	0.04	0.05	0.09	0.14	0.22
25	NLF	0.11	0.12	0.12	0.13	0.16	0.21	0.31
	SDLF	0.15	0.14	0.13	0.14	0.16	0.22	0.32
	TDLF	0.21	0.17	0.15	0.14	0.16	0.20	0.31
26	NLF	0.23	0.21	0.20	0.20	0.22	0.27	0.38
	SDLF	0.28	0.25	0.23	0.23	0.25	0.29	0.40
	TDLF	0.43	0.35	0.30	0.28	0.29	0.32	0.41
27	NLF	0.37	0.36	0.34	0.32	0.33	0.36	0.43
	SDLF	0.47	0.43	0.39	0.37	0.38	0.42	0.49
	TDLF	0.74	0.62	0.52	0.49	0.51	0.56	0.63
28	NLF	0.44	0.44	0.40	0.36	0.35	0.35	0.36
	SDLF	0.56	0.53	0.46	0.42	0.42	0.43	0.45
	TDLF	0.91	0.78	0.63	0.58	0.60	0.63	0.70
29	NLF	0.47	0.45	0.38	0.31	0.27	0.28	0.24
	SDLF	0.59	0.53	0.44	0.37	0.34	0.37	0.36
	TDLF	0.93	0.77	0.59	0.53	0.54	0.60	0.68
30	NLF	0.45	0.37	0.27	0.18	0.19	0.18	0.10
	SDLF	0.54	0.43	0.30	0.22	0.25	0.27	0.22
	TDLF	0.79	0.56	0.38	0.33	0.42	0.52	0.57

Table T1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	0.37	0.23	0.09	0.07	0.07	0.05	-0.14
	SDLF	0.42	0.23	0.09	0.10	0.12	0.13	-0.04
	TDLF	0.54	0.23	0.08	0.16	0.26	0.38	0.25
32	NLF	0.23	0.03	-0.03	-0.04	-0.05	-0.18	-0.37
	SDLF	0.23	-0.01	-0.05	-0.04	-0.01	-0.11	-0.32
	TDLF	0.21	-0.14	-0.11	-0.02	0.10	0.08	-0.16
33	NLF	0.02	-0.11	-0.15	-0.16	-0.24	-0.39	-0.56
	SDLF	-0.04	-0.17	-0.19	-0.17	-0.23	-0.36	-0.56
	TDLF	-0.21	-0.36	-0.30	-0.19	-0.18	-0.27	-0.55
34	NLF	-0.15	-0.25	-0.27	-0.33	-0.43	-0.58	-0.71
	SDLF	-0.23	-0.32	-0.32	-0.37	-0.45	-0.60	-0.77
	TDLF	-0.49	-0.55	-0.47	-0.46	-0.49	-0.64	-0.90
35	NLF	-0.33	-0.37	-0.42	-0.48	-0.59	-0.72	-0.83
	SDLF	-0.44	-0.46	-0.49	-0.54	-0.63	-0.78	-0.92
	TDLF	-0.78	-0.71	-0.70	-0.69	-0.74	-0.93	-1.16
36	NLF	-0.53	-0.49	-0.51	-0.56	-0.66	-0.79	-0.89
	SDLF	-0.64	-0.61	-0.61	-0.64	-0.72	-0.86	-0.99
	TDLF	-1.02	-0.91	-0.89	-0.85	-0.87	-1.03	-1.26
37	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	-0.13	0.00	0.00	0.00	0.00	0.00	0.00

Table T1-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	3.38	3.24	3.06	2.89	2.79	2.72	2.80
	SDLF	3.32	3.17	2.99	2.83	2.75	2.70	2.79
	TDLF	3.21	3.04	2.85	2.72	2.69	2.68	2.80
3	NLF	3.40	3.26	3.05	2.83	2.66	2.51	2.20
	SDLF	3.35	3.20	2.99	2.78	2.62	2.49	2.22
	TDLF	3.28	3.10	2.86	2.67	2.55	2.47	2.29
4	NLF	3.32	3.14	2.88	2.62	2.37	2.03	1.48
	SDLF	3.28	3.09	2.82	2.56	2.33	2.03	1.52
	TDLF	3.21	2.99	2.70	2.45	2.27	2.04	1.63
5	NLF	3.15	2.90	2.58	2.25	1.85	1.39	0.75
	SDLF	3.10	2.84	2.51	2.20	1.83	1.40	0.80
	TDLF	3.03	2.73	2.39	2.09	1.78	1.45	0.92
6	NLF	2.91	2.57	2.19	1.72	1.25	0.72	0.08
	SDLF	2.85	2.51	2.12	1.67	1.23	0.74	0.13
	TDLF	2.76	2.38	1.98	1.57	1.22	0.82	0.25
7	NLF	2.60	2.18	1.63	1.10	0.59	0.04	-0.55
	SDLF	2.54	2.10	1.56	1.05	0.58	0.07	-0.51
	TDLF	2.42	1.94	1.40	0.96	0.58	0.15	-0.41
8	NLF	2.20	1.59	0.97	0.42	-0.09	-0.60	-1.11
	SDLF	2.13	1.51	0.90	0.38	-0.08	-0.57	-1.08
	TDLF	1.98	1.31	0.73	0.30	-0.08	-0.51	-1.01
9	NLF	1.61	0.90	0.26	-0.26	-0.72	-1.16	-1.55
	SDLF	1.53	0.81	0.19	-0.29	-0.72	-1.14	-1.54
	TDLF	1.34	0.59	0.03	-0.36	-0.72	-1.11	-1.53
10	NLF	0.92	0.16	-0.44	-0.88	-1.27	-1.61	-1.83
	SDLF	0.83	0.07	-0.49	-0.91	-1.27	-1.61	-1.84
	TDLF	0.61	-0.14	-0.64	-0.98	-1.30	-1.64	-1.88

Table T1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	0.13	-0.61	-1.11	-1.45	-1.73	-1.91	-2.03
	SDLF	0.03	-0.69	-1.15	-1.47	-1.75	-1.93	-2.07
	TDLF	-0.21	-0.89	-1.28	-1.55	-1.81	-2.01	-2.17
12	NLF	-0.70	-1.30	-1.62	-1.83	-1.97	-2.08	-2.10
	SDLF	-0.79	-1.36	-1.66	-1.86	-2.00	-2.12	-2.16
	TDLF	-1.02	-1.51	-1.76	-1.94	-2.09	-2.24	-2.33
13	NLF	-1.41	-1.76	-1.88	-1.95	-2.03	-2.08	-2.02
	SDLF	-1.47	-1.79	-1.91	-1.98	-2.07	-2.13	-2.10
	TDLF	-1.64	-1.89	-1.98	-2.06	-2.17	-2.28	-2.30
14	NLF	-1.83	-1.88	-1.85	-1.85	-1.87	-1.87	-1.76
	SDLF	-1.86	-1.88	-1.86	-1.87	-1.90	-1.92	-1.84
	TDLF	-1.93	-1.92	-1.90	-1.93	-1.99	-2.06	-2.06
15	NLF	-1.95	-1.76	-1.64	-1.58	-1.54	-1.50	-1.41
	SDLF	-1.93	-1.76	-1.65	-1.59	-1.57	-1.54	-1.48
	TDLF	-1.90	-1.75	-1.66	-1.62	-1.63	-1.65	-1.65
16	NLF	-1.78	-1.46	-1.26	-1.11	-1.02	-0.95	-0.88
	SDLF	-1.74	-1.44	-1.24	-1.11	-1.03	-0.98	-0.92
	TDLF	-1.65	-1.39	-1.22	-1.12	-1.07	-1.05	-1.03
17	NLF	-1.53	-1.17	-0.92	-0.74	-0.61	-0.52	-0.42
	SDLF	-1.49	-1.14	-0.90	-0.73	-0.61	-0.54	-0.45
	TDLF	-1.40	-1.07	-0.86	-0.71	-0.61	-0.56	-0.51
18	NLF	-1.21	-0.87	-0.61	-0.42	-0.30	-0.22	-0.08
	SDLF	-1.18	-0.84	-0.58	-0.40	-0.29	-0.22	-0.09
	TDLF	-1.11	-0.78	-0.54	-0.36	-0.26	-0.20	-0.09
19	NLF	-0.95	-0.64	-0.39	-0.22	-0.12	-0.04	0.10
	SDLF	-0.93	-0.62	-0.37	-0.21	-0.11	-0.03	0.10
	TDLF	-0.89	-0.59	-0.34	-0.17	-0.07	0.00	0.14
20	NLF	-0.66	-0.40	-0.20	-0.08	0.00	0.09	0.19
	SDLF	-0.65	-0.39	-0.18	-0.06	0.01	0.10	0.20
	TDLF	-0.65	-0.39	-0.17	-0.03	0.05	0.14	0.27

Table T1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	-0.43	-0.23	-0.09	0.00	0.06	0.14	0.21
	SDLF	-0.44	-0.23	-0.08	0.00	0.06	0.15	0.23
	TDLF	-0.48	-0.26	-0.09	0.01	0.08	0.19	0.30
22	NLF	-0.29	-0.13	-0.03	0.02	0.08	0.16	0.25
	SDLF	-0.29	-0.13	-0.03	0.02	0.08	0.17	0.26
	TDLF	-0.37	-0.18	-0.06	0.00	0.08	0.19	0.30
23	NLF	-0.17	-0.03	0.02	0.05	0.11	0.21	0.37
	SDLF	-0.18	-0.03	0.02	0.04	0.10	0.21	0.38
	TDLF	-0.25	-0.08	-0.03	0.00	0.08	0.21	0.38
24	NLF	0.00	0.10	0.11	0.13	0.21	0.35	0.62
	SDLF	0.01	0.10	0.10	0.13	0.20	0.36	0.63
	TDLF	-0.01	0.07	0.06	0.09	0.17	0.33	0.61
25	NLF	0.28	0.30	0.29	0.32	0.42	0.61	1.00
	SDLF	0.30	0.31	0.30	0.32	0.42	0.61	1.01
	TDLF	0.36	0.33	0.30	0.32	0.40	0.58	0.98
26	NLF	0.68	0.63	0.60	0.62	0.70	0.89	1.31
	SDLF	0.73	0.66	0.63	0.64	0.71	0.90	1.32
	TDLF	0.86	0.76	0.69	0.68	0.75	0.91	1.31
27	NLF	1.23	1.24	1.17	1.13	1.16	1.29	1.55
	SDLF	1.32	1.30	1.22	1.17	1.21	1.34	1.61
	TDLF	1.57	1.48	1.34	1.28	1.33	1.47	1.73
28	NLF	1.52	1.56	1.44	1.31	1.27	1.28	1.32
	SDLF	1.63	1.64	1.50	1.37	1.33	1.36	1.41
	TDLF	1.96	1.89	1.66	1.52	1.51	1.55	1.65
29	NLF	1.66	1.61	1.38	1.16	1.02	1.06	0.89
	SDLF	1.77	1.69	1.43	1.22	1.09	1.14	1.01
	TDLF	2.10	1.93	1.59	1.38	1.28	1.37	1.33
30	NLF	1.62	1.37	0.98	0.68	0.70	0.67	0.38
	SDLF	1.70	1.41	1.01	0.72	0.76	0.76	0.50
	TDLF	1.95	1.55	1.10	0.83	0.93	1.01	0.85

Table T1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	1.34	0.84	0.34	0.28	0.27	0.18	-0.53
	SDLF	1.38	0.84	0.34	0.30	0.32	0.27	-0.43
	TDLF	1.51	0.85	0.34	0.37	0.47	0.52	-0.12
32	NLF	0.85	0.11	-0.11	-0.15	-0.18	-0.66	-1.41
	SDLF	0.84	0.07	-0.13	-0.15	-0.14	-0.59	-1.35
	TDLF	0.83	-0.04	-0.17	-0.12	-0.03	-0.39	-1.17
33	NLF	0.07	-0.42	-0.58	-0.59	-0.92	-1.47	-2.13
	SDLF	0.01	-0.48	-0.61	-0.60	-0.90	-1.44	-2.12
	TDLF	-0.15	-0.64	-0.70	-0.62	-0.85	-1.33	-2.09
34	NLF	-0.55	-0.95	-1.01	-1.26	-1.65	-2.20	-2.73
	SDLF	-0.63	-1.02	-1.06	-1.29	-1.66	-2.20	-2.77
	TDLF	-0.86	-1.21	-1.19	-1.37	-1.68	-2.23	-2.88
35	NLF	-1.25	-1.40	-1.58	-1.82	-2.23	-2.75	-3.19
	SDLF	-1.34	-1.47	-1.65	-1.87	-2.27	-2.79	-3.26
	TDLF	-1.63	-1.70	-1.85	-2.02	-2.36	-2.92	-3.47
36	NLF	-1.96	-1.86	-1.93	-2.15	-2.54	-3.02	-3.44
	SDLF	-2.06	-1.96	-2.02	-2.22	-2.58	-3.08	-3.52
	TDLF	-2.35	-2.26	-2.29	-2.41	-2.72	-3.23	-3.77
37	NLF	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01
	SDLF	0.01	0.00	0.00	0.00	-0.01	-0.01	-0.01
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table T1-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	64.0	178.5	25.0	98.8	221.8	606.1	114.8	360.4
	SDLF	68.3	150.6	72.6	68.7	224.9	578.1	164.4	330.0
	TDLF	79.0	88.0	185.7	0.0	232.3	519.4	279.0	249.9
G2	NLF	77.0	133.5	153.7	36.3	258.7	481.5	578.9	133.8
	SDLF	73.9	167.3	136.0	47.4	253.9	517.7	559.3	144.8
	TDLF	66.8	248.0	102.7	63.9	246.6	601.5	524.4	174.7
G3	NLF	70.7	152.5	136.4	36.2	239.0	547.4	524.3	134.2
	SDLF	65.3	163.5	112.4	47.5	232.7	560.1	499.8	145.8
	TDLF	51.7	183.7	52.3	79.2	218.5	581.3	440.1	177.0
G4	NLF	61.5	165.6	115.8	32.8	206.7	589.3	451.6	122.1
	SDLF	58.2	161.0	100.3	43.2	203.6	584.7	436.3	133.0
	TDLF	49.5	145.6	57.2	72.2	195.4	568.1	395.7	162.3
G5	NLF	52.6	176.3	104.0	35.7	175.9	624.5	411.9	132.9
	SDLF	55.6	159.5	104.8	38.0	179.9	606.5	413.2	135.5
	TDLF	62.9	119.5	100.7	44.2	188.9	563.7	411.6	142.0
G6	NLF	52.4	188.7	98.5	46.0	176.0	665.7	396.3	170.6
	SDLF	58.6	164.7	112.5	41.7	183.3	639.9	410.9	166.5
	TDLF	74.3	110.4	144.6	28.9	200.8	582.4	444.0	153.6
G7	NLF	46.1	200.6	75.1	52.2	156.3	702.1	308.4	191.5
	SDLF	60.8	181.4	117.9	50.5	172.4	680.8	353.4	189.5
	TDLF	96.7	142.0	236.3	44.6	208.8	637.6	472.6	183.9
G8	NLF	85.5	84.5	186.7	40.7	288.2	316.4	691.6	156.1
	SDLF	69.1	132.5	136.9	43.1	271.2	363.8	640.0	157.5
	TDLF	29.0	243.6	10.4	50.0	232.6	474.2	508.9	163.3

Table T1-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.3	NA	NA	NA	-1.0	NA	NA	NA
	SDLF	-0.3	NA	NA	NA	0.0	NA	NA	NA
	TDLF	-1.4	NA	NA	NA	-1.6	NA	NA	NA
G2	NLF	-0.1	NA	NA	NA	-1.1	NA	NA	NA
	SDLF	-0.1	NA	NA	NA	-0.8	NA	NA	NA
	TDLF	-0.6	NA	NA	NA	-0.6	NA	NA	NA
G3	NLF	0.1	NA	NA	NA	-0.9	NA	NA	NA
	SDLF	0.0	NA	NA	NA	-0.9	NA	NA	NA
	TDLF	-0.1	NA	NA	NA	0.1	NA	NA	NA
G4	NLF	0.2	NA	NA	NA	-0.3	NA	NA	NA
	SDLF	0.1	NA	NA	NA	-0.5	NA	NA	NA
	TDLF	0.2	NA	NA	NA	0.6	NA	NA	NA
G5	NLF	0.2	NA	NA	NA	0.6	NA	NA	NA
	SDLF	0.1	NA	NA	NA	0.2	NA	NA	NA
	TDLF	0.3	NA	NA	NA	0.7	NA	NA	NA
G6	NLF	0.2	NA	NA	NA	1.4	NA	NA	NA
	SDLF	0.1	NA	NA	NA	0.9	NA	NA	NA
	TDLF	0.4	NA	NA	NA	0.6	NA	NA	NA
G7	NLF	0.0	NA	NA	NA	1.5	NA	NA	NA
	SDLF	0.1	NA	NA	NA	1.1	NA	NA	NA
	TDLF	0.4	NA	NA	NA	0.3	NA	NA	NA
G8	NLF	-0.4	NA	NA	NA	-0.3	NA	NA	NA
	SDLF	-0.1	NA	NA	NA	0.0	NA	NA	NA
	TDLF	0.8	NA	NA	NA	-0.2	NA	NA	NA

Table T1-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	-0.2	-0.4	-0.3	0.7	-0.4	-9.6	-2.7	0.8
	SDLF	0.0	0.0	-0.1	0.2	1.0	-6.9	-2.0	0.0
	TDLF	-0.1	1.4	0.6	-0.1	0.0	0.5	-0.5	0.8
G2	NLF	0.0	-0.3	-0.2	-0.1	-0.7	-5.0	-2.0	-2.7
	SDLF	0.0	0.0	-0.1	0.1	-0.3	-3.6	-1.6	-2.2
	TDLF	-0.1	0.7	0.3	1.1	0.1	0.0	-0.5	0.8
G3	NLF	0.1	-0.1	-0.1	-0.4	-0.7	-0.7	-1.1	-4.3
	SDLF	0.0	0.0	0.0	0.0	-0.8	-0.6	-0.8	-3.1
	TDLF	-0.1	0.1	0.0	1.4	0.2	-0.2	-0.3	0.4
G4	NLF	0.2	0.1	0.1	-0.5	0.1	2.3	0.1	-3.7
	SDLF	0.0	0.0	0.0	-0.1	-0.5	1.6	0.2	-2.4
	TDLF	-0.2	-0.3	-0.3	0.8	0.1	-0.1	0.0	-0.2
G5	NLF	0.2	0.2	0.2	-0.3	1.5	3.9	1.2	-1.2
	SDLF	0.0	0.0	0.0	-0.1	0.6	2.8	1.0	-0.4
	TDLF	-0.3	-0.6	-0.5	-0.2	0.0	0.1	0.3	-0.7
G6	NLF	0.2	0.3	0.1	0.1	2.9	3.9	1.3	2.3
	SDLF	0.0	0.1	0.0	-0.1	1.8	2.9	1.0	2.3
	TDLF	-0.4	-0.6	-0.3	-1.1	-0.2	0.4	0.4	-0.7
G7	NLF	0.1	0.3	-0.2	0.5	3.5	2.4	-0.2	5.0
	SDLF	0.0	0.1	0.0	0.0	2.5	1.8	-0.2	3.9
	TDLF	-0.5	-0.3	0.6	-1.6	-0.4	0.5	0.1	-0.4
G8	NLF	-0.2	0.0	-0.7	0.6	2.0	-0.5	-2.7	5.1
	SDLF	-0.1	0.0	-0.1	0.1	1.7	-0.3	-2.2	2.9
	TDLF	0.2	0.2	1.4	-1.2	-0.4	0.2	-0.6	0.3

Table T1-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.06	0.74	0.46	0.77	-0.20	2.22	1.26	2.30
	SDLF	-0.05	0.50	0.17	0.49	0.00	1.56	0.51	1.43
	TDLF	-0.27	0.46	0.08	0.60	-0.31	1.98	0.93	2.13
G2	NLF	-0.01	0.68	0.44	0.67	-0.22	1.92	1.11	1.88
	SDLF	-0.02	0.46	0.18	0.43	-0.16	1.28	0.40	1.10
	TDLF	-0.12	0.51	0.18	0.59	-0.12	1.88	0.98	1.91
G3	NLF	0.02	0.64	0.42	0.63	-0.18	1.74	1.00	1.72
	SDLF	0.00	0.44	0.19	0.42	-0.18	1.14	0.36	1.02
	TDLF	-0.01	0.55	0.26	0.62	0.03	1.81	1.01	1.85
G4	NLF	0.04	0.61	0.40	0.61	-0.05	1.71	1.02	1.74
	SDLF	0.02	0.43	0.20	0.42	-0.10	1.14	0.41	1.07
	TDLF	0.05	0.57	0.30	0.63	0.11	1.75	1.01	1.82
G5	NLF	0.05	0.59	0.38	0.61	0.13	1.79	1.12	1.91
	SDLF	0.03	0.42	0.20	0.42	0.05	1.23	0.52	1.22
	TDLF	0.07	0.59	0.32	0.62	0.14	1.70	0.98	1.81
G6	NLF	0.04	0.57	0.36	0.63	0.28	1.91	1.23	2.15
	SDLF	0.02	0.42	0.19	0.43	0.18	1.34	0.63	1.41
	TDLF	0.07	0.60	0.33	0.64	0.12	1.66	0.93	1.85
G7	NLF	0.01	0.55	0.33	0.65	0.30	1.95	1.24	2.34
	SDLF	0.01	0.41	0.17	0.45	0.23	1.38	0.63	1.53
	TDLF	0.08	0.63	0.35	0.69	0.07	1.64	0.86	1.96
G8	NLF	-0.09	0.50	0.25	0.66	-0.05	1.75	0.89	2.30
	SDLF	-0.01	0.42	0.14	0.47	0.00	1.21	0.33	1.42
	TDLF	0.16	0.75	0.44	0.85	-0.04	1.64	0.74	2.10

Table T1-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	-0.05	-0.09	-0.07	0.13	-0.07	-1.92	-0.53	0.15
	SDLF	0.00	0.01	-0.01	0.04	0.20	-1.39	-0.40	0.00
	TDLF	-0.02	0.28	0.11	-0.03	0.00	0.09	-0.10	0.16
G2	NLF	0.00	-0.06	-0.04	-0.01	-0.14	-0.99	-0.41	-0.54
	SDLF	0.00	-0.01	-0.01	0.03	-0.06	-0.72	-0.32	-0.44
	TDLF	-0.02	0.15	0.06	0.23	0.03	0.00	-0.11	0.16
G3	NLF	0.02	-0.02	-0.01	-0.09	-0.13	-0.15	-0.22	-0.85
	SDLF	0.00	-0.01	-0.01	0.01	-0.17	-0.11	-0.17	-0.61
	TDLF	-0.02	0.03	0.00	0.27	0.03	-0.04	-0.06	0.09
G4	NLF	0.04	0.02	0.02	-0.10	0.02	0.47	0.03	-0.74
	SDLF	0.00	-0.01	0.00	-0.01	-0.09	0.33	0.03	-0.48
	TDLF	-0.03	-0.06	-0.07	0.16	0.02	-0.03	0.01	-0.03
G5	NLF	0.05	0.05	0.04	-0.05	0.29	0.79	0.24	-0.24
	SDLF	0.00	0.00	0.01	-0.02	0.12	0.56	0.20	-0.07
	TDLF	-0.06	-0.11	-0.10	-0.04	0.00	0.02	0.07	-0.13
G6	NLF	0.05	0.07	0.03	0.02	0.57	0.78	0.26	0.45
	SDLF	0.00	0.01	0.01	-0.02	0.35	0.57	0.21	0.45
	TDLF	-0.09	-0.11	-0.05	-0.23	-0.04	0.07	0.07	-0.15
G7	NLF	0.03	0.05	-0.04	0.09	0.70	0.47	-0.04	0.99
	SDLF	-0.01	0.02	0.00	-0.01	0.49	0.36	-0.03	0.78
	TDLF	-0.09	-0.06	0.11	-0.33	-0.07	0.10	0.02	-0.09
G8	NLF	-0.05	0.00	-0.14	0.12	0.41	-0.10	-0.55	1.03
	SDLF	-0.01	0.01	-0.03	0.01	0.34	-0.06	-0.44	0.58
	TDLF	0.04	0.04	0.27	-0.23	-0.08	0.04	-0.12	0.06

Appendix T1-5. EICCS27 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge EICCS27 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table T1-5-1. Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	0.2	-0.1	0.3	0.0	0.1	0.1
		SDLF	0.4	0.1	0.4	0.0	-0.2	0.2
		TDLF	0.6	0.7	0.9	0.0	-0.7	0.7
	2-3	NLF	0.6	-0.3	0.7	0.0	0.6	0.6
		SDLF	0.7	0.1	0.7	0.0	0.2	0.2
		TDLF	1.0	0.9	1.4	0.0	-0.6	0.6
	2-4	NLF	0.6	-0.3	0.7	0.0	0.6	0.6
		SDLF	0.6	-0.2	0.7	0.0	0.6	0.6
		TDLF	0.5	-0.1	0.5	0.0	0.7	0.7
	2-5	NLF	0.5	0.0	0.5	0.0	0.4	0.4
		SDLF	0.4	-0.1	0.4	0.0	0.4	0.4
		TDLF	0.0	-0.5	0.5	0.0	0.8	0.8
	2-6	NLF	-0.5	-0.1	0.5	0.0	0.7	0.7
		SDLF	-0.6	-0.2	0.6	0.0	0.8	0.8
		TDLF	-1.1	-1.0	1.5	0.0	1.3	1.3
	2-7	NLF	-1.6	-0.3	1.7	0.0	0.8	0.8
		SDLF	-1.9	-0.6	2.0	0.0	1.0	1.0
		TDLF	-2.6	-1.5	3.0	0.0	1.5	1.5
	2-8	NLF	-2.5	-0.7	2.7	0.0	1.1	1.1
		SDLF	-2.9	-1.2	3.1	0.0	1.5	1.5
		TDLF	-4.0	-2.2	4.6	0.0	2.6	2.6
	2-9	NLF	-3.1	-1.7	3.5	0.0	2.0	2.0
		SDLF	-3.4	-2.0	3.9	0.0	2.4	2.4
		TDLF	-4.0	-2.8	4.9	0.0	3.1	3.1
	2-10	NLF	-2.9	-1.9	3.5	0.0	2.0	2.0
		SDLF	-3.0	-2.0	3.7	0.0	2.1	2.1
		TDLF	-3.3	-2.3	4.0	0.0	2.0	2.0
	2-11	NLF	-2.4	-1.9	3.0	0.0	1.8	1.8
		SDLF	-2.4	-1.9	3.1	0.0	1.7	1.7
		TDLF	-2.5	-2.0	3.2	0.0	1.3	1.3
	2-12	NLF	-1.6	-1.6	2.3	0.0	1.6	1.6
		SDLF	-1.2	-1.2	1.7	0.0	1.1	1.1
		TDLF	-0.1	-0.4	0.4	0.0	-0.3	0.3

Table T1-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	**2-13**	NLF	-0.5	-0.6	0.8	0.0	0.6	0.6
		SDLF	-0.7	-0.7	1.0	0.0	0.7	0.7
		TDLF	-1.0	-1.1	1.5	0.0	0.9	0.9

Table T1-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
8	8-2	NLF	-10.7	-0.2	10.7	0.0	0.4	0.4
		SDLF	-2.5	-0.2	2.5	0.0	0.0	0.0
		TDLF	9.1	0.2	9.1	0.0	-1.2	1.2
	8-3	NLF	-15.9	-0.2	15.9	0.0	0.1	0.1
		SDLF	-9.9	-0.9	9.9	0.0	0.6	0.6
		TDLF	3.0	-1.7	3.4	0.0	0.6	0.6
	8-4	NLF	-15.2	-0.1	15.2	0.0	-0.1	0.1
		SDLF	-10.6	-0.6	10.7	0.0	0.4	0.4
		TDLF	0.1	-1.5	1.5	0.0	1.1	1.1
	8-5	NLF	-13.1	-0.3	13.1	0.0	-0.1	0.1
		SDLF	-9.1	-0.7	9.1	0.0	0.5	0.5
		TDLF	-0.8	-2.2	2.3	0.0	1.7	1.7
	8-6	NLF	-8.8	0.0	8.8	0.0	-0.3	0.3
		SDLF	-6.3	-0.7	6.4	0.0	0.4	0.4
		TDLF	-1.4	-2.5	2.9	0.0	1.7	1.7
	8-7	NLF	-3.4	0.0	3.4	0.0	-0.3	0.3
		SDLF	-4.5	-0.7	4.6	0.0	0.3	0.3
		TDLF	-7.2	-2.6	7.6	0.0	1.3	1.3
	8-8	NLF	0.9	-0.3	1.0	0.0	0.0	0.0
		SDLF	-4.4	-1.1	4.6	0.0	0.7	0.7
		TDLF	-19.3	-2.8	19.5	0.0	1.1	1.1
	8-9	NLF	4.5	-0.4	4.5	0.0	0.3	0.3
		SDLF	-7.8	-1.2	7.9	0.0	0.9	0.9
		TDLF	-40.7	-2.1	40.7	0.0	0.6	0.6
	8-10	NLF	6.5	-0.3	6.5	0.0	0.4	0.4
		SDLF	-8.3	-0.7	8.3	0.0	0.5	0.5
		TDLF	-47.5	-0.3	47.5	0.0	-0.1	0.1
	8-11	NLF	8.0	-0.2	8.0	0.0	0.3	0.3
		SDLF	-10.3	-0.2	10.3	0.0	-0.1	0.1
		TDLF	-45.9	0.1	45.9	0.0	-1.5	1.5
	8-12	NLF	2.1	0.0	2.1	0.0	-0.1	0.1
		SDLF	-6.1	0.3	6.1	0.0	-0.4	0.4
		TDLF	-9.7	0.6	9.8	0.0	-1.5	1.5

Table T1-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
8	**8-13**	NLF	-2.0	0.1	2.0	0.0	-0.2	0.2
		SDLF	-2.4	0.0	2.4	0.0	-0.1	0.1
		TDLF	1.9	-0.2	1.9	0.0	0.0	0.0

Table T1-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
32	32-2	NLF	3.3	-0.2	3.3	0.0	0.0	0.0
		SDLF	3.9	-0.3	4.0	0.0	0.3	0.3
		TDLF	11.8	-0.8	11.8	0.0	1.3	1.3
	32-3	NLF	3.6	-0.4	3.6	0.0	0.4	0.4
		SDLF	3.7	-0.4	3.7	0.0	0.6	0.6
		TDLF	6.4	-0.4	6.4	0.0	1.4	1.4
	32-4	NLF	-3.8	-0.2	3.8	0.0	0.4	0.4
		SDLF	-6.9	-0.2	7.0	0.0	0.7	0.7
		TDLF	-16.4	0.3	16.4	0.0	1.3	1.3
	32-5	NLF	-8.3	0.0	8.3	0.0	0.1	0.1
		SDLF	-13.3	0.1	13.3	0.0	0.0	0.0
		TDLF	-29.5	1.0	29.6	0.0	-0.6	0.6
	32-6	NLF	-8.6	-0.1	8.6	0.0	0.1	0.1
		SDLF	-14.2	0.1	14.2	0.0	-0.1	0.1
		TDLF	-33.0	1.1	33.0	0.0	-0.9	0.9
	32-7	NLF	-4.7	0.1	4.7	0.0	-0.1	0.1
		SDLF	-8.6	0.2	8.6	0.0	-0.2	0.2
		TDLF	-25.5	0.9	25.5	0.0	-0.8	0.8

Drop in

Table T1-5-2: Erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
2	NLF	2-9
	SDLF	2-9
	TDLF	2-9
8	NLF	8-3
	SDLF	8-4
	TDLF	8-10
32	NLF	32-6
	SDLF	32-6
	TDLF	32-6

Table T1-5-3. Erection critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	-2.4	-1.3	2.7	NA	NA	NA
		SDLF	-2.5	-1.4	2.9	NA	NA	NA
		TDLF	-2.8	-1.7	3.3	NA	NA	NA
	B	NLF	-3.1	-1.7	3.5	0.0	2.0	2.0
		SDLF	-3.4	-2.0	3.9	0.0	2.4	2.4
		TDLF	-4.0	-2.8	4.9	0.0	3.1	3.1
8	A	NLF	-15.2	-0.2	15.2	NA	NA	NA
		SDLF	-9.0	-0.6	9.1	NA	NA	NA
		TDLF	-46.2	-0.3	46.2	NA	NA	NA
	B	NLF	-10.7	-0.2	10.7	0.0	0.4	0.4
		SDLF	-7.8	-1.2	7.9	0.0	0.9	0.9
		TDLF	-0.8	-2.2	2.3	0.0	1.7	1.7
32	A	NLF	-8.6	-0.1	8.6	NA	NA	NA
		SDLF	-14.2	0.1	14.2	NA	NA	NA
		TDLF	-33.1	0.8	33.1	NA	NA	NA
	B	NLF	3.6	-0.4	3.6	0.0	0.4	0.4
		SDLF	-6.9	-0.2	7.0	0.0	0.7	0.7
		TDLF	6.4	-0.4	6.4	0.0	1.4	1.4

Table T1-5-6. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number								
				1	2	3	4	5	6	7	8	9
2	A	G1	NLF	45.8	22.7	4.2	67.9					
			SDLF	45.8	24.2	2.6	68.0					
			TDLF	45.7	26.9	0.0	68.2					
		G2	NLF	2.8	31.8	63.8	32.0	5.5	3.7	7.3	3.7	68.4
			SDLF	5.9	29.3	58.7	29.4	8.9	2.9	5.9	2.9	68.3
			TDLF	0.3	31.7	63.6	31.8	12.5	1.9	3.8	1.9	67.4
	B	G1	NLF	45.9	22.7	3.9	67.6					
			SDLF	46.0	24.5	2.0	67.7					
			TDLF	45.9	26.6	0.0	67.9					
		G2	NLF	1.7	32.7	65.5	32.7	4.2	4.2	8.4	4.2	67.8
			SDLF	4.7	30.3	60.6	30.3	7.5	3.4	6.8	3.4	68.0
			TDLF	0.0	32.2	64.3	32.2	11.2	2.2	4.3	2.2	67.6

Table T1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ectio	Girder	Detailing	Support Number								
				1	2	3	4	5	6	7	8	9
8	A	G1	NLF	47.2	33.6	44.7						
			SDLF	49.6	9.1	42.7						
			TDLF	62.1	0.0	28.2						
		G2	NLF	53.8	46.6	72.9						
			SDLF	47.3	49.5	97.7						
			TDLF	10.6	0.0	176.						
		G3	NLF	45.6	47.9	69.8						
			SDLF	49.0	54.5	79.4						
			TDLF	55.1	67.6	107.						
		G4	NLF	39.1	39.9	69.5						
			SDLF	47.7	41.5	68.1						
			TDLF	73.3	44.4	68.5						
		G5	NLF	30.6	40.6	74.8						
			SDLF	34.2	45.9	53.3						
			TDLF	47.7	60.8	0.0						
		G6	NLF	48.7	30.4	85.1						
			SDLF	47.8	30.0	35.2						
			TDLF	50.0	44.9	0.0						
		G7	NLF	31.0	14.8	61.6						
			SDLF	22.2	48.5	82.1						
			TDLF	0.0	27.1	0.0						
		G8	NLF	4.6	45.5	91.1	45.	10.9	29.	59.	29.	6.0
			SDLF	0.0	42.9	85.8	42.	16.4	30.	60.	30.	3.1
			TDLF	0.0	27.2	54.5	27.	135.	18.	37.	18.	54.

Table T1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ectio	Girder	Detailing	Support Number								
				1	2	3	4	5	6	7	8	9
8	B	G1	NLF	47.2	33.4	44.4						
			SDLF	49.7	8.9	42.5						
			TDLF	61.9	0.0	28.2						
		G2	NLF	53.7	46.4	72.6						
			SDLF	47.3	49.4	97.6						
			TDLF	10.8	0.0	174.						
		G3	NLF	45.6	47.0	69.5						
			SDLF	49.0	54.2	79.2						
			TDLF	55.2	70.7	105.						
		G4	NLF	39.3	38.2	69.3						
			SDLF	47.7	40.6	67.9						
			TDLF	73.2	51.8	49.9						
		G5	NLF	30.7	41.3	74.5						
			SDLF	34.1	45.4	53.2						
			TDLF	47.6	66.9	0.0						
		G6	NLF	50.0	37.8	83.4						
			SDLF	48.0	34.0	34.3						
			TDLF	49.5	40.6	0.0						
		G7	NLF	30.5	19.8	60.0						
			SDLF	23.6	53.3	80.9						
			TDLF	0.0	25.7	44.6						
		G8	NLF	11.8	37.7	75.5	37.	12.3	29.	59.	29.	5.6
			SDLF	0.0	40.9	81.8	40.	13.1	29.	59.	29.	4.9
			TDLF	0.0	27.3	54.6	27.	126.	22.	45.	22.	22.

Table T1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number										
				1	2	3	4	5	6	7	8	9	10	11
32	A	G1	NLF	22.8	69.7	37.9	39.7	42.9	61.0	52.3	25.1			
			SDLF	22.8	69.7	37.9	39.7	42.9	61.0	52.3	25.1			
			TDLF	27.7	70.1	17.9	34.9	45.4	106.1	69.4	0.0			
		G2	NLF	22.5	69.8	53.7	44.5	59.5	68.4	58.3	21.0			
			SDLF	22.5	69.8	53.7	44.5	59.5	68.4	58.3	21.0			
			TDLF	21.1	57.4	60.7	66.0	66.6	41.9	36.2	10.0			
		G3	NLF	21.0	65.3	54.1	42.3	50.8	69.6	55.4	24.5			
			SDLF	21.0	65.3	54.1	42.3	50.8	69.6	55.4	24.5			
			TDLF	18.6	60.1	64.4	44.2	52.3	40.6	65.9	27.5			
		G4	NLF	20.8	70.6	51.5	41.5	48.6	72.0	54.3	26.9			
			SDLF	20.8	70.6	51.5	41.5	48.6	72.0	54.3	26.9			
			TDLF	21.3	71.7	55.7	32.2	48.7	54.8	84.4	32.4			
		G5	NLF	19.1	66.1	58.5	41.2	50.0	68.9	57.7	24.9			
			SDLF	19.1	66.1	58.5	41.2	50.0	68.9	57.7	24.9			
			TDLF	24.5	73.7	64.5	20.4	48.5	63.1	89.6	27.4			
		G6	NLF	17.5	75.6	54.9	40.3	50.6	61.1	55.1	22.2			
			SDLF	17.5	75.6	54.9	40.3	50.6	61.1	55.1	22.2			
			TDLF	23.0	90.3	61.3	3.0	46.8	63.1	78.5	19.7			
		G7	NLF	16.8	69.5	62.3	40.0	52.3	53.6	60.9	27.3			
			SDLF	16.8	69.5	62.3	40.0	52.3	53.6	60.9	27.3			
			TDLF	22.7	67.3	70.7	0.0	56.8	65.7	54.0	25.7			
		G8	NLF	15.1	75.5	48.8	37.6	37.9	75.8	37.9	0.0	41.8	76.5	26.6
			SDLF	15.1	75.5	48.8	37.6	37.9	75.8	37.9	0.0	41.8	76.5	26.6
			TDLF	0.0	54.8	83.2	74.4	44.7	89.3	44.6	0.0	0.0	66.3	28.0

Table T1-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number										
				1	2	3	4	5	6	7	8	9	10	11
32	B	G1	NLF	22.8	69.7	37.9	39.7	42.9	60.9	52.3	25.1			
			SDLF	27.7	70.1	17.9	34.9	45.4	106.1	69.4	0.0			
			TDLF	40.3	72.6	0.0	20.6	64.5	210.1	97.1	0.0			
		G2	NLF	22.5	69.8	53.7	44.5	59.5	68.4	58.3	21.0			
			SDLF	21.1	57.4	60.7	66.0	66.6	41.9	36.1	10.0			
			TDLF	18.3	13.4	45.6	121.9	73.8	0.0	0.0	0.0			
		G3	NLF	21.0	65.3	54.1	42.3	50.8	69.6	55.4	24.5			
			SDLF	18.6	60.1	64.4	44.2	52.3	40.6	65.9	27.5			
			TDLF	13.1	47.3	100.9	14.0	47.8	0.0	0.0	0.0			
		G4	NLF	20.8	70.6	51.5	41.5	48.7	72.0	54.3	26.9			
			SDLF	21.3	71.7	55.7	32.2	48.7	54.8	84.4	32.4			
			TDLF	23.1	84.5	75.4	0.0	30.9	0.0	145.0	36.9			
		G5	NLF	19.1	66.1	58.5	41.2	50.1	69.0	57.7	24.9			
			SDLF	24.5	73.7	64.5	20.4	48.5	63.1	89.6	27.4			
			TDLF	39.0	103.8	75.3	0.0	23.5	40.7	210.3	36.8			
		G6	NLF	17.5	75.6	54.9	40.3	50.6	61.2	55.1	22.2			
			SDLF	23.0	90.3	61.3	3.0	46.8	63.2	78.5	19.7			
			TDLF	36.5	130.1	43.3	0.0	28.0	80.2	147.4	14.2			
		G7	NLF	16.8	69.5	62.3	40.0	52.2	53.7	60.9	27.3			
			SDLF	22.7	67.3	70.7	0.0	56.8	65.8	54.0	25.7			
			TDLF	0.0	35.5	35.4	0.0	78.6	0.0	9.4	22.1			
		G8	NLF	15.1	75.5	48.8	37.5	38.1	76.1	38.0	0.0	41.8	76.5	26.6
			SDLF	0.0	54.8	83.3	74.4	44.8	89.5	44.7	0.0	0.0	66.3	28.0
			TDLF	0.0	16.5	171.1	92.2	61.7	123.3	61.6	0.0	0.0	39.3	33.1

Appendix T2-1. EICCS27 Bridge Description

The key characteristics of EICCS27 are as follows:

- Span length along the centerline of the bridge, L_s = 279, 224, 236 ft.
- Width between the fascia girders, w_g = 79.9 ft.
- Radius of curvature to the centerline of the bridge, R =2546 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 3.5, 2.8, 3.0
- Subtended angle between the supports, L_s/R = 0.11, 0.09, 0.09
- Number of girders in the completed bridge cross-section, n_g =8.
- Skew angle, θ = -53.1, -59.4, -64.4, -69.7°

This appendix presents the bridge description of the bridge EICCS27 in its final condition as well as during erection. The following figures and tables are provided:

Figure T2-1-1.	Framing plan
Figure T2-1-2.	Bridge cross-section
Figure T2-1-3.	Girder Elevation
Figure T2-1-4.	Cross-section dimension
Figure T2-1-5.	Cross-frame details
Figure T2-1-6.	Erection scheme
Table T2-1-1.	Three-dimensional view of erection sequence. The displacements(magnified 10x) are shown for the bridge with the cross-frames detailed NLF

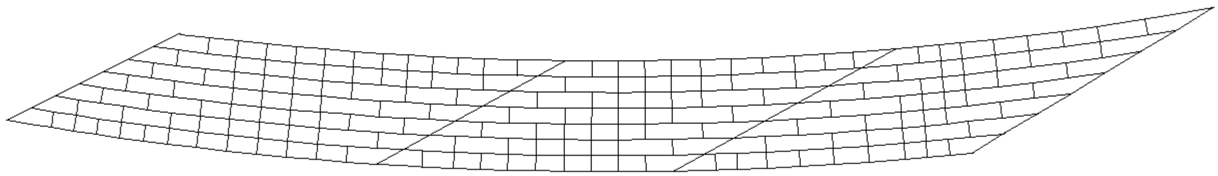


Figure T2-1-1. Framing plan.

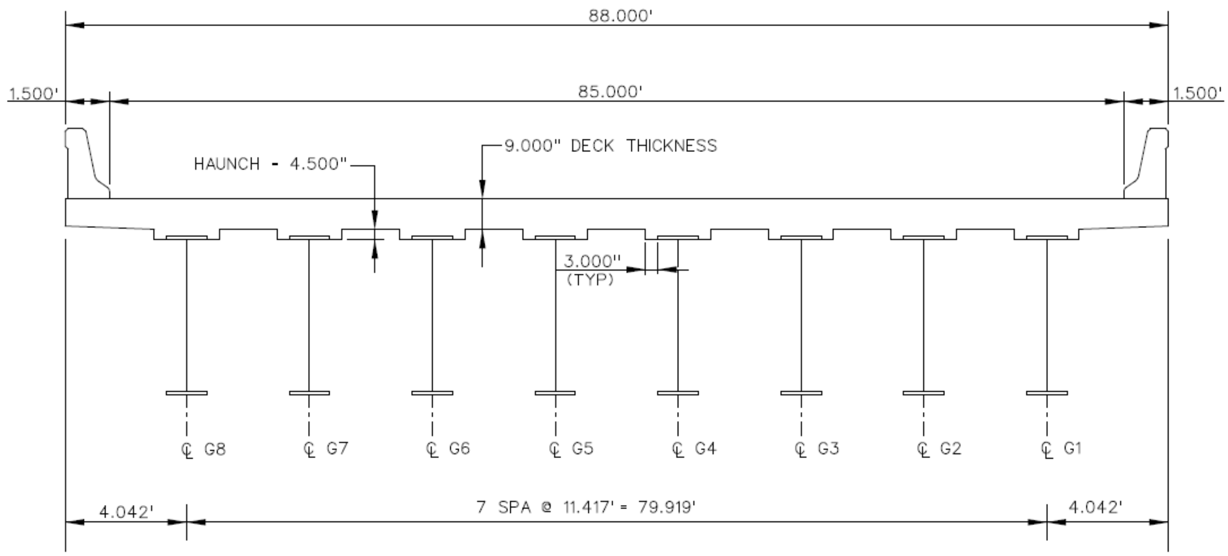
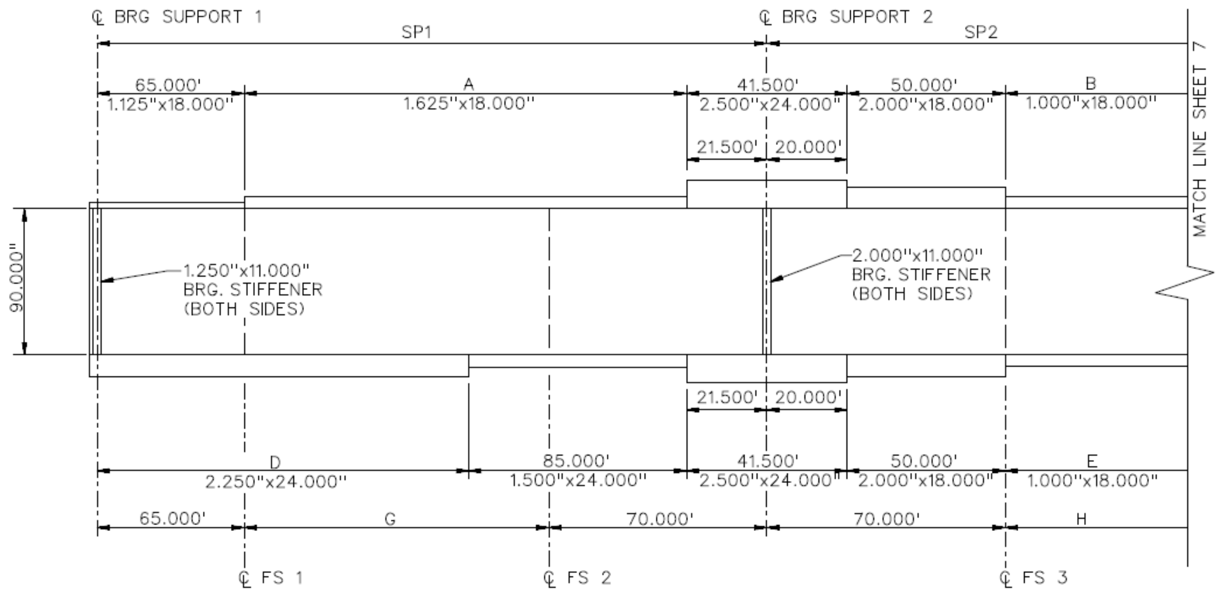
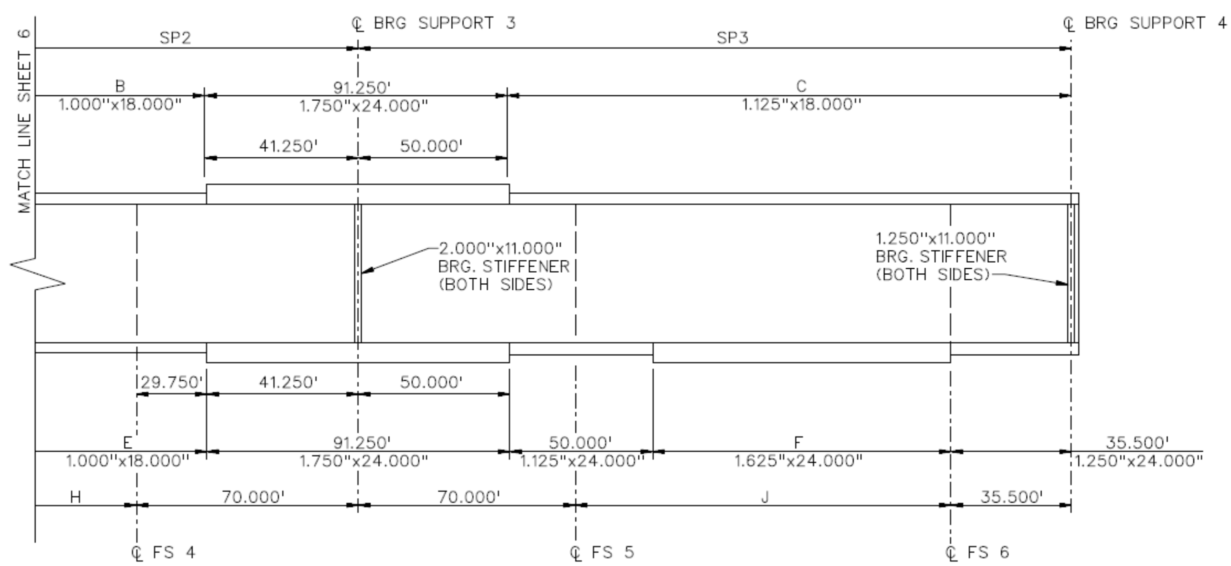


Figure T2-1-2. Bridge cross-section.



GIRDER ELEVATION
(TYP ALL GIRDERS)



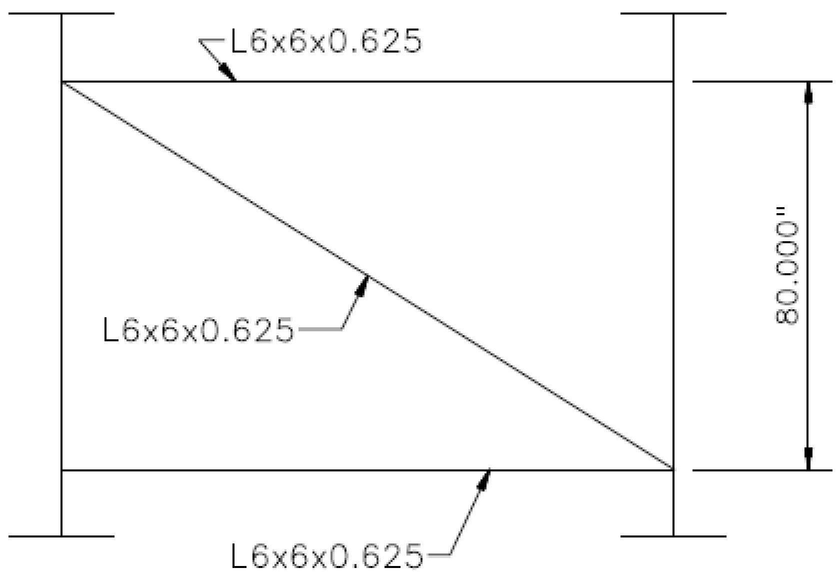
GIRDER ELEVATION
(TYP ALL GIRDERS)

Figure T2-1-3. Girder elevations

GIRDER ELEVATION DIMENSIONS (SHEETS 6&7)

	DIMENSIONS (FT)								
	A	B	C	D	E	F	G	H	J
G1	182.453	103.339	167.016	162.453	103.339	81.516	133.953	74.589	111.516
G2	183.737	106.251	168.549	163.737	106.251	83.049	135.237	77.501	113.049
G3	185.094	109.332	170.228	165.094	109.332	84.728	136.594	80.582	114.728
G4	186.531	112.595	172.072	166.531	112.595	86.572	138.031	83.845	116.572
G5	188.054	116.059	174.103	168.054	116.059	88.603	139.554	87.309	118.603
G6	189.672	119.744	176.341	169.672	119.744	90.841	141.172	90.994	120.841
G7	191.388	123.676	178.817	171.388	123.676	93.317	142.888	94.926	123.317
G8	193.212	127.878	181.573	173.212	127.878	96.073	144.712	99.128	126.073

Figure T2-1-4. Cross-section dimensions.



TYPICAL END AND INTERMEDIATE DIAPHRAGM

Figure T2-1-5. Cross-frame details

Refer to Figure T1-1-6 in Appendix T1-1 of bridge case (T1) for erection scheme. The erection scheme for bridge case (T2) is identical to that of bridge case (T1)

Figure T2-1-6. Erection scheme.

Table T2-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

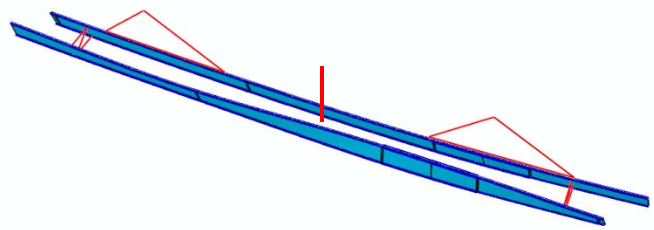
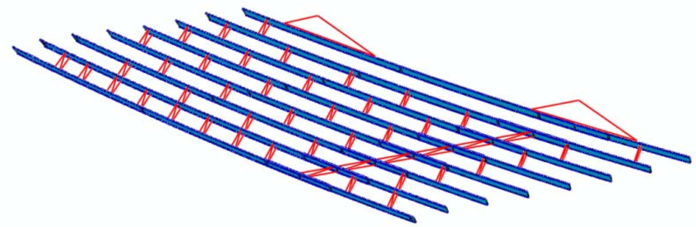
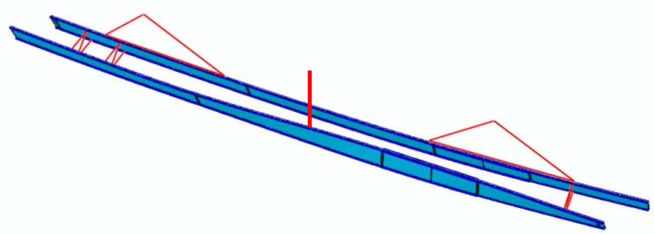
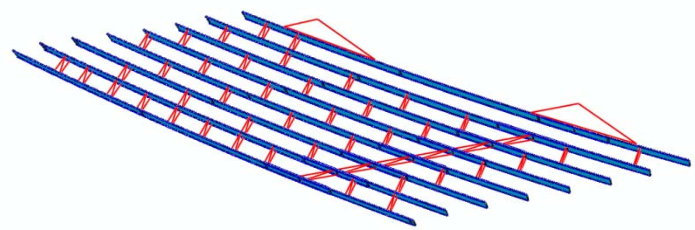
Sub-Stage	Stage	
	2	8
1		
2		

Table T2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

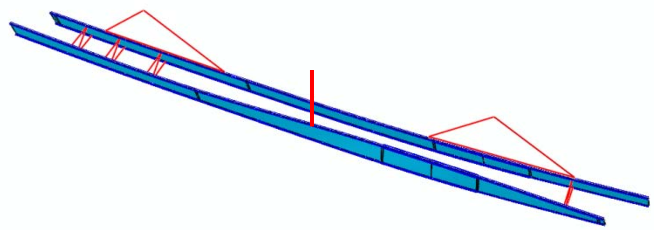
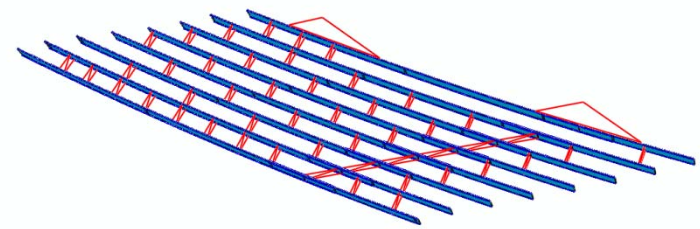
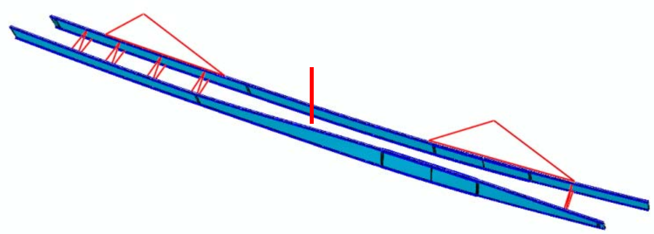
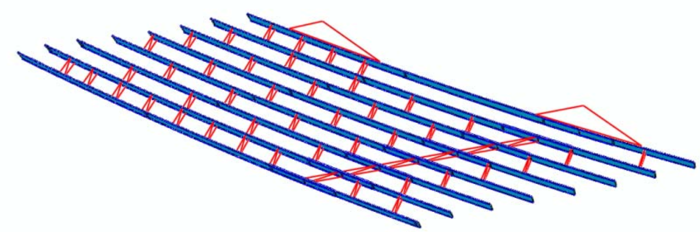
3		
4		

Table T2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

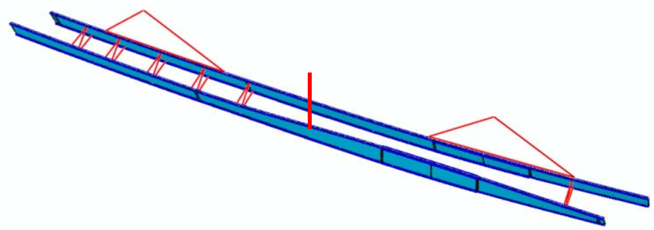
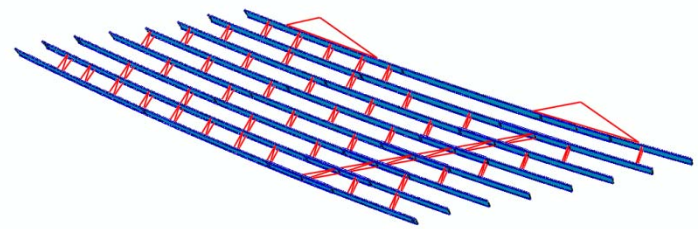
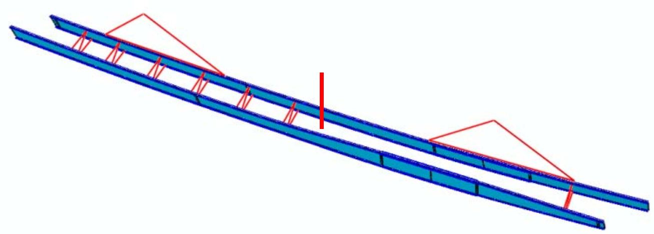
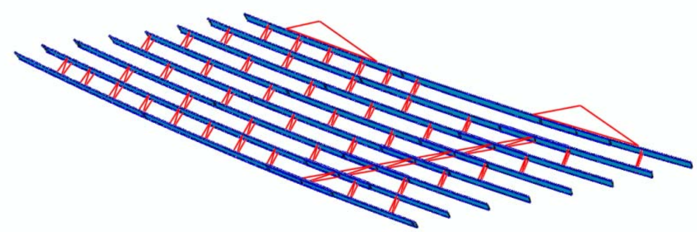
5		
6		

Table T2-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

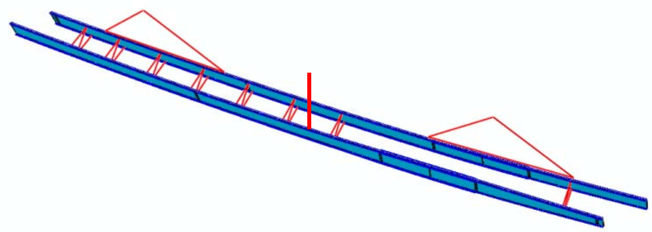
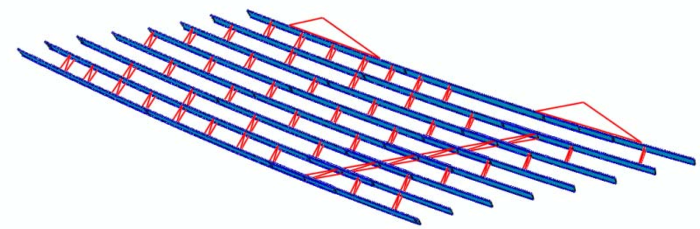
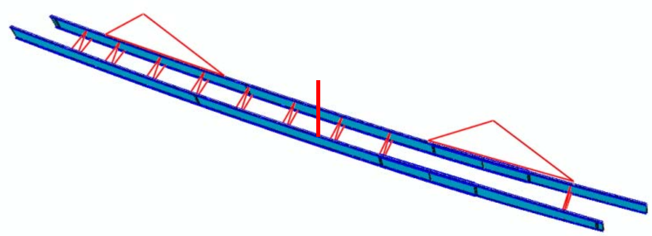
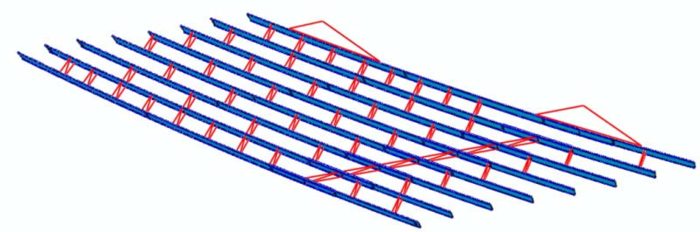
7		
8		

Table T2-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

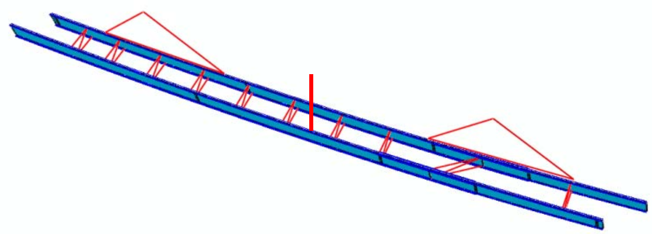
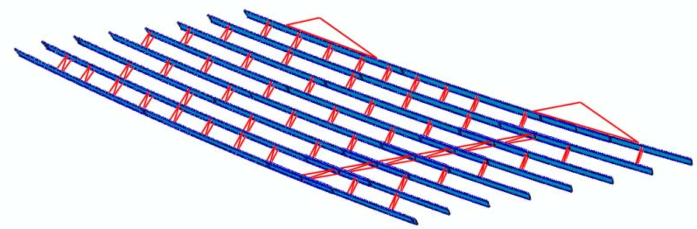
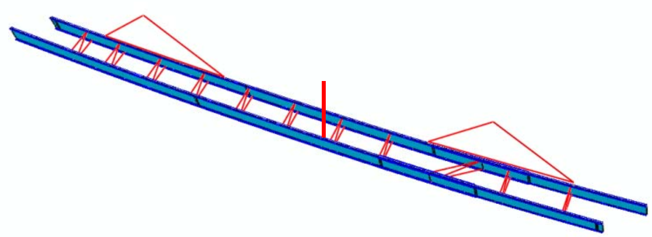
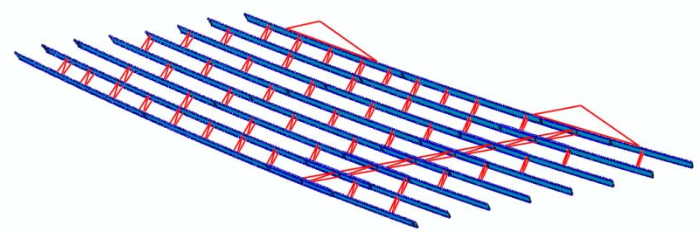
9		
10		

Table T2-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

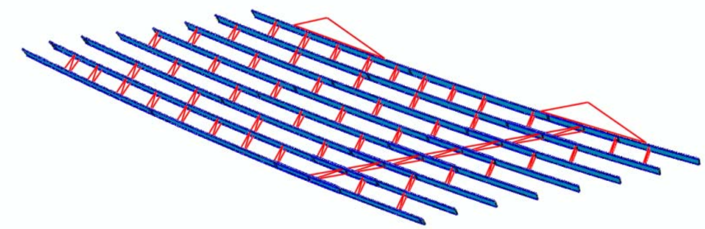
11		

Table T2-1-1 (continued).. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

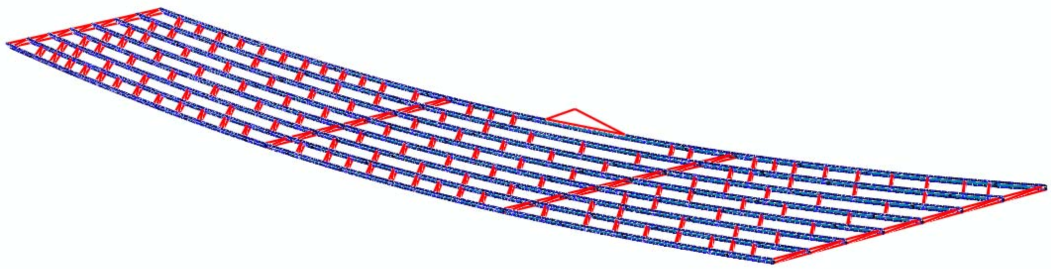
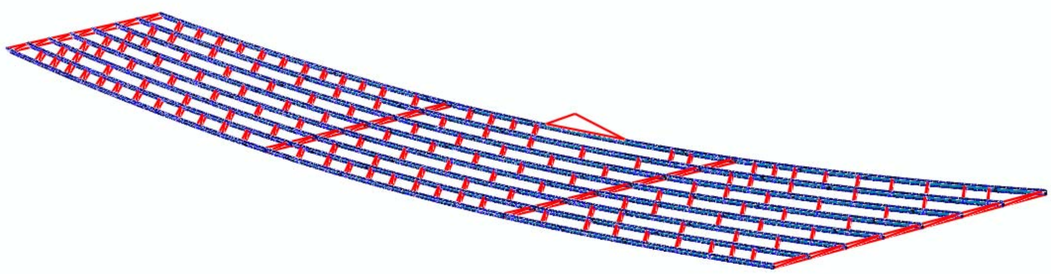
Sub-Stage	Stage 32
1	
2	

Table T2-1-1 (continued).. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

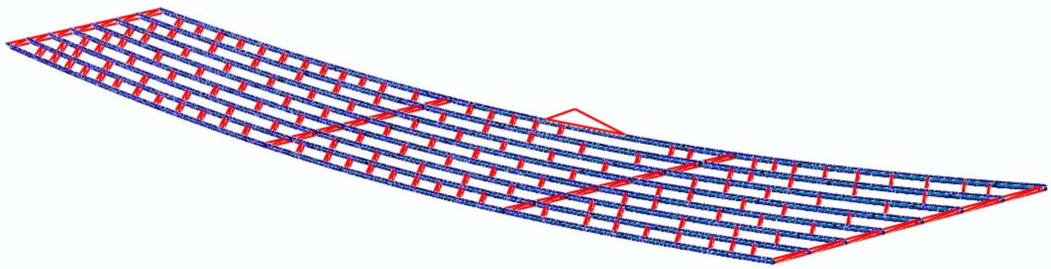
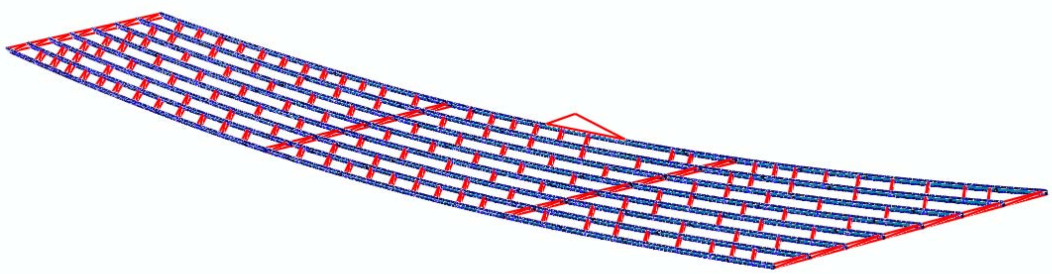
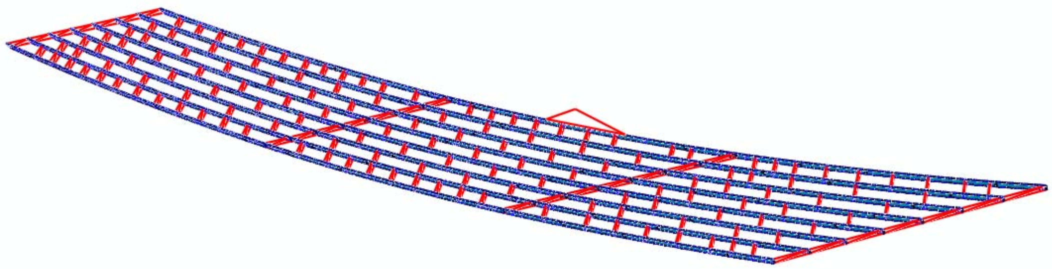
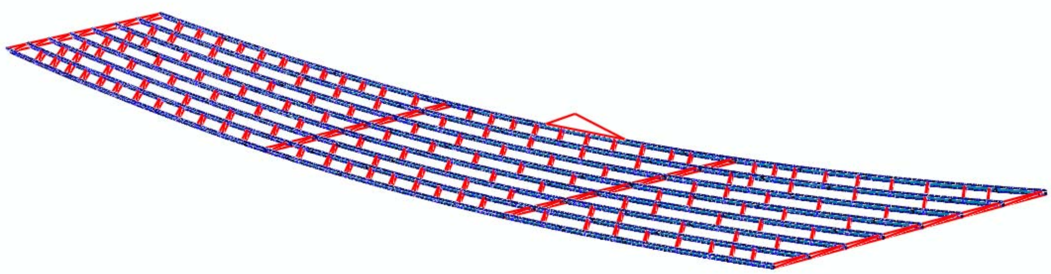
Sub-Stage	Stage 32
3	
4	

Table T2-1-1 (continued).. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

Sub-Stage	Stage
	32
5	
6	

Appendix T2-2. EICCS27 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EICCS27 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table T2-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	7.7	27.3
	SDLF	7.4	26.6
	TDLF	6.5	25.2
G2	NLF	7.1	25.0
	SDLF	6.8	24.4
	TDLF	6.0	23.3
G3	NLF	6.7	23.8
	SDLF	6.5	23.4
	TDLF	5.9	22.6
G4	NLF	6.6	23.6
	SDLF	6.5	23.4
	TDLF	6.4	23.0
G5	NLF	6.6	23.5
	SDLF	6.6	23.5
	TDLF	7.0	23.5
G6	NLF	6.5	23.2
	SDLF	6.7	23.2
	TDLF	7.2	23.5
G7	NLF	6.3	22.2
	SDLF	6.4	22.1
	TDLF	6.5	22.0
G8	NLF	6.4	22.1
	SDLF	6.3	21.8
	TDLF	6.0	21.1
All Girders	NLF	7.7	27.3
	SDLF	7.4	26.6
	TDLF	7.2	25.2

Table T2-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	1.16	4.43
	SDLF	0.49	3.19
	TDLF	2.97	1.66
G2	NLF	1.11	3.95
	SDLF	0.32	2.75
	TDLF	2.97	1.07
G3	NLF	1.05	3.71
	SDLF	0.34	2.56
	TDLF	2.83	1.17
G4	NLF	0.98	3.48
	SDLF	0.36	2.47
	TDLF	2.66	1.25
G5	NLF	0.96	3.44
	SDLF	0.37	2.58
	TDLF	2.52	1.31
G6	NLF	0.97	3.62
	SDLF	0.36	2.77
	TDLF	2.48	1.26
G7	NLF	0.96	3.47
	SDLF	0.30	2.60
	TDLF	2.52	1.00
G8	NLF	0.99	3.98
	SDLF	0.39	2.96
	TDLF	2.73	1.41
All Girders	NLF	1.16	4.43
	SDLF	0.49	3.19
	TDLF	2.97	1.66

Table T2-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	9.4	32.7	12.5	44.3	1.1	8.8	1.1	8.5
	SDLF	9.1	32.3	12.4	43.8	3.2	9.1	3.7	7.5
	TDLF	8.4	31.3	11.8	42.7	9.1	13.4	12.5	9.6
G2	NLF	8.2	28.9	11.8	41.5	1.6	8.3	2.0	7.2
	SDLF	8.0	28.7	11.6	41.1	5.2	10.3	4.7	6.8
	TDLF	7.6	28.1	10.8	39.9	16.6	21.0	16.7	14.0
G3	NLF	8.0	28.2	11.0	39.0	2.3	9.6	6.9	30.8
	SDLF	7.7	28.0	10.9	38.8	3.8	7.7	3.5	23.9
	TDLF	7.2	27.2	10.3	38.2	12.1	15.6	17.3	9.7
G4	NLF	7.8	27.7	10.7	38.0	2.7	11.5	7.6	33.6
	SDLF	7.7	27.6	10.7	38.0	3.9	11.1	3.5	25.8
	TDLF	7.5	27.4	10.7	38.0	12.2	16.3	19.8	10.0
G5	NLF	7.7	27.4	10.4	37.3	3.1	12.7	7.0	30.8
	SDLF	7.8	27.5	10.6	37.6	4.1	13.7	3.8	23.4
	TDLF	8.1	27.9	11.3	38.1	11.9	16.8	19.5	11.6
G6	NLF	7.4	27.1	10.3	36.7	2.6	13.5	6.1	28.9
	SDLF	7.6	27.3	10.6	37.0	3.8	14.0	4.0	24.1
	TDLF	8.2	27.9	11.4	37.6	12.9	15.7	15.0	13.2
G7	NLF	7.1	26.5	10.0	35.7	2.3	13.1	1.7	8.8
	SDLF	7.1	26.3	10.2	35.8	4.1	13.1	3.8	6.4
	TDLF	7.5	25.7	10.9	36.1	13.0	16.4	12.3	11.0
G8	NLF	7.0	26.0	10.2	35.0	1.7	12.3	1.6	7.5
	SDLF	7.3	26.2	9.8	34.5	3.3	13.4	2.2	6.1
	TDLF	8.2	26.8	8.4	32.9	7.6	14.5	7.5	8.1
All Girders	NLF	9.4	32.7	12.5	44.3	3.1	13.5	7.6	33.6
	SDLF	9.1	32.3	12.4	43.8	5.2	14.0	4.7	25.8
	TDLF	8.4	31.3	11.8	42.7	16.6	21.0	19.8	14.0

Table T2-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	18.6	13.5	16.8	18.6
	SDLF	29.1	18.6	19.7	29.1
	TDLF	121.9	72.2	68.7	121.9
TDL	NLF	77.7	50.9	74.2	77.7
	SDLF	70.3	44.9	63.7	70.3
	TDLF	97.7	63.1	67.5	97.7

Table T2-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	5.3	2.5	3.6	3.8
	SDLF	6.7	3.2	3.4	4.4
	TDLF	15.6	9.9	8.6	11.4
TDL	NLF	20.8	10.3	13.9	15.0
	SDLF	19.6	9.7	12.6	13.9
	TDLF	23.4	11.6	11.7	15.6

Table T2-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	All Girders
NLF	1.65	1.54	1.44	1.38	1.38	1.37	1.36	1.65
SDLF	1.57	1.45	1.33	1.31	1.36	1.41	1.39	1.57
TDLF	1.36	1.30	1.35	1.49	1.42	1.55	1.59	1.59

Table T2-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	All Girders
NLF	5.85	5.45	5.06	4.91	4.95	4.97	5.21	5.85
SDLF	5.69	5.28	4.91	4.81	4.91	4.98	5.19	5.69
TDLF	5.37	4.92	4.58	4.60	4.86	5.07	5.14	5.37

Table T2-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	All Girders
NLF	0.96	0.90	0.84	0.81	0.80	0.80	0.79	0.96
SDLF	0.92	0.84	0.78	0.76	0.79	0.82	0.81	0.92
TDLF	0.80	0.76	0.79	0.87	0.83	0.90	0.93	0.93

Table T2-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8	All Girders
NLF	3.41	3.18	2.96	2.87	2.89	2.90	3.04	3.41
SDLF	3.32	3.08	2.87	2.81	2.87	2.91	3.03	3.32
TDLF	3.14	2.87	2.67	2.69	2.84	2.96	3.00	3.14

Table T2-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	2994.8	11066.2
SDLF	2994.9	11064.5
TDLF	2994.8	11066.1

Table T2-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	159.6	582.6	0.5	3.0	0.7	5.9
SDLF	163.1	582.6	0.2	1.7	1.1	5.7
TDLF	159.6	582.6	0.5	3.0	0.7	5.9

Table T2-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.73	2.42	0.13	1.19
SDLF	0.49	1.51	0.22	1.13
TDLF	0.77	2.25	0.73	0.84

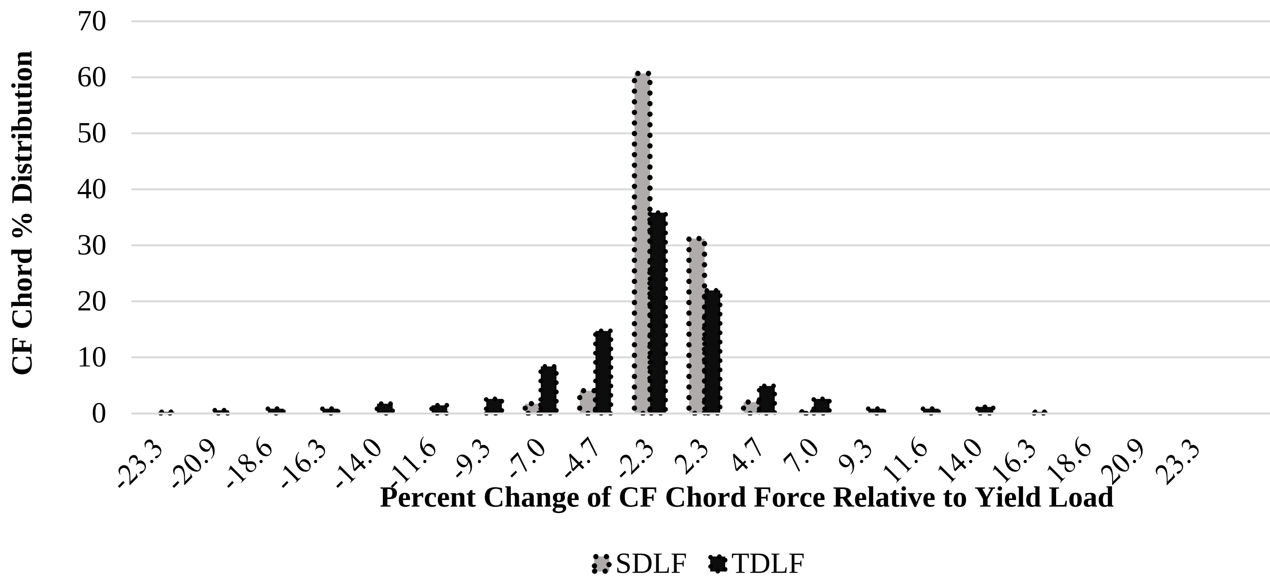


Figure T2-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

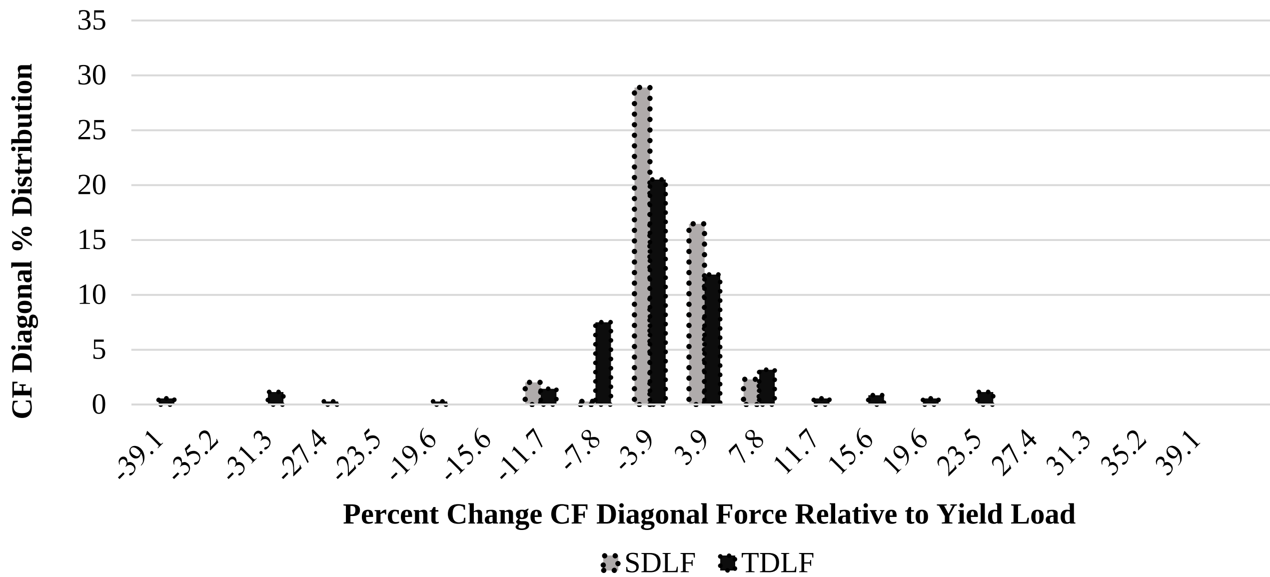


Figure T2-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

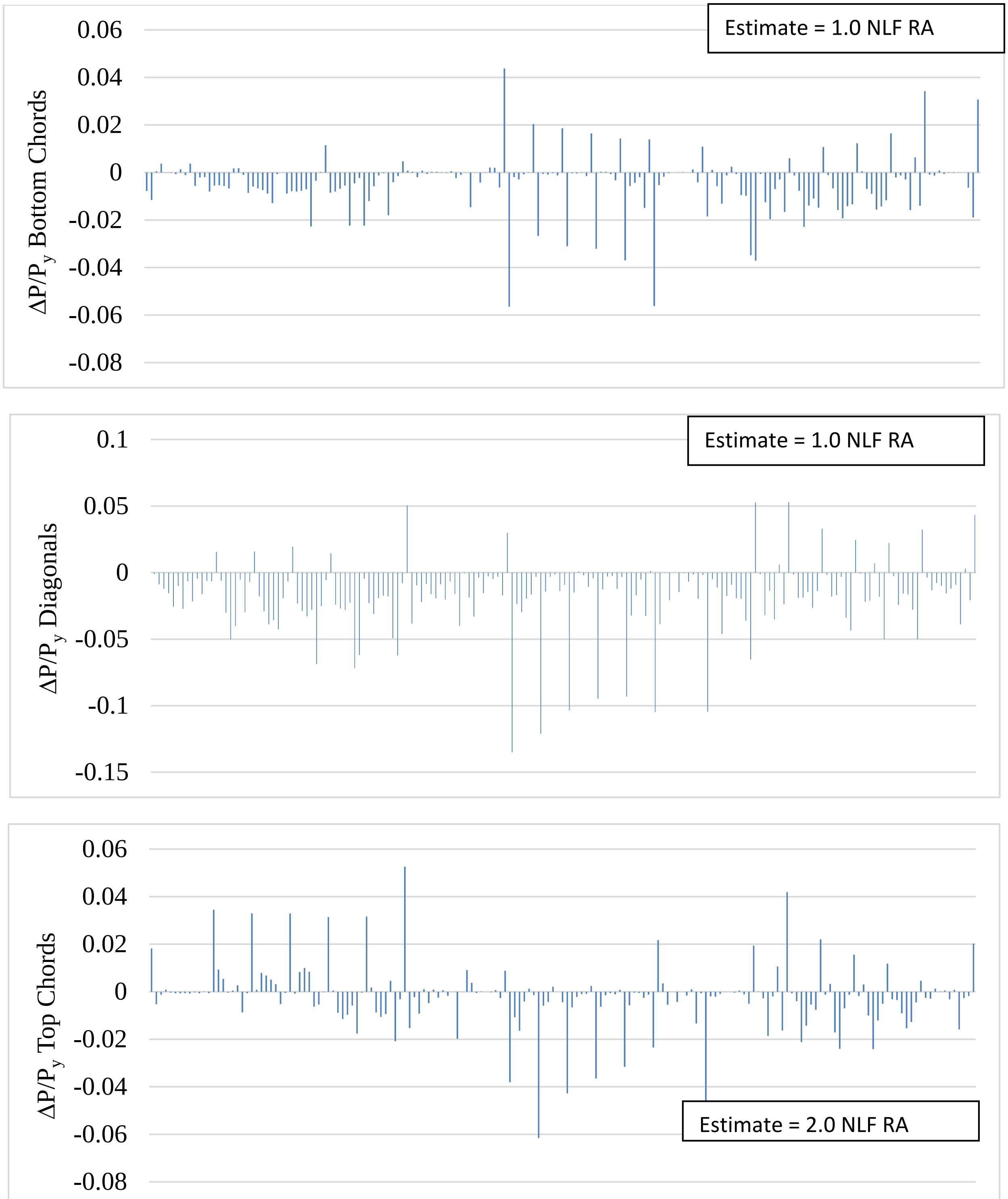


Figure T2-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

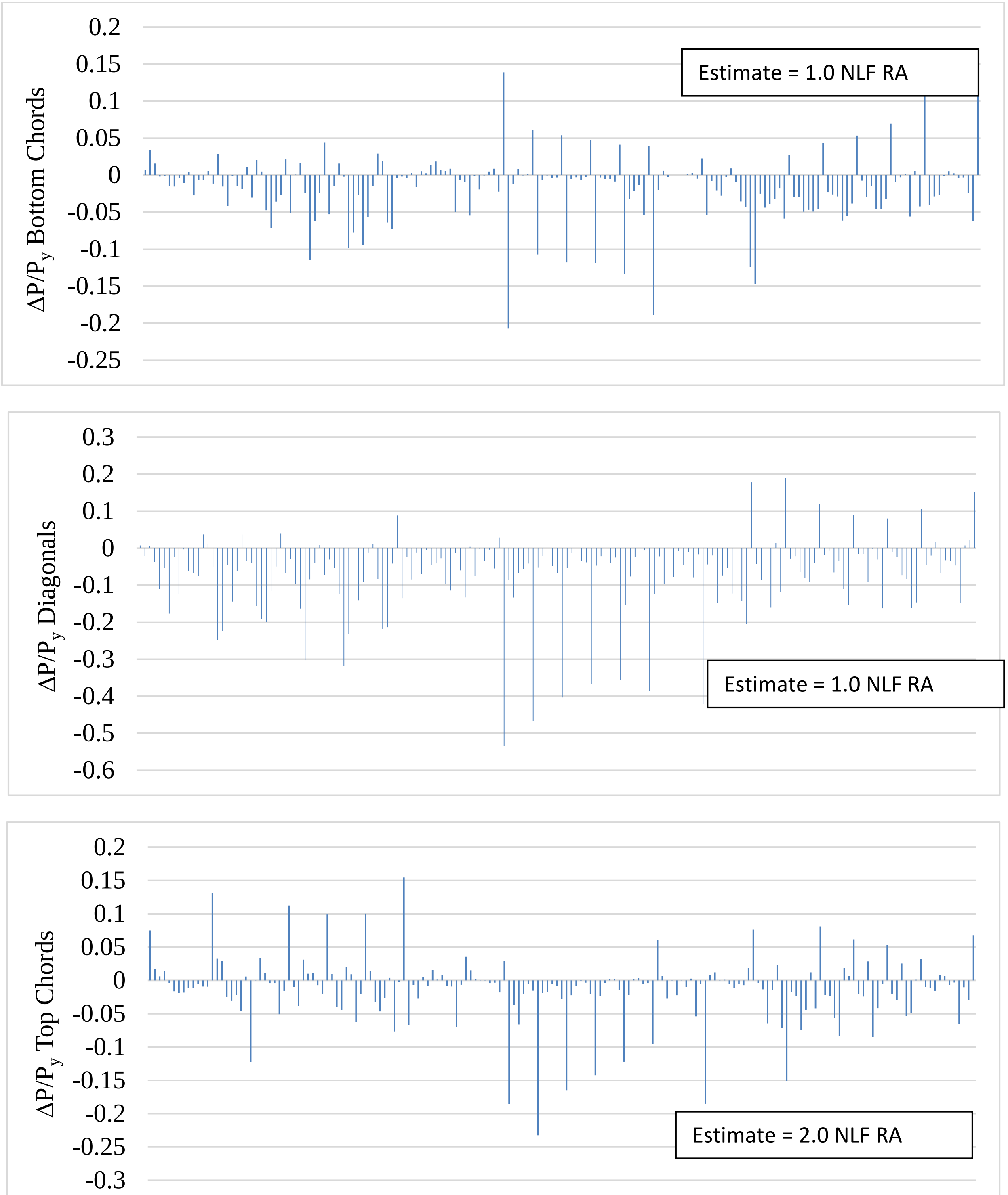


Figure T2-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.

Appendix T2-3. EICCS27 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EICCS27 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table T2-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	9.0	1.1	9.0
SDLF	8.4	9.6	9.6
TDLF	28.8	28.5	28.8

Table T2-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	70.5	3.9
	SDLF	71	0
	TDLF	78.7	0
G2	NLF	75.1	5.5
	SDLF	76.8	6.1
	TDLF	80.2	0
G3	NLF	68	20.4
	SDLF	66.3	20.4
	TDLF	75.7	19.6
G4	NLF	70.4	19.5
	SDLF	68.3	21.9
	TDLF	68.5	20.1
G5	NLF	70.2	16.4
	SDLF	70.1	20.5
	TDLF	74.2	21.5
G6	NLF	69.8	15.5
	SDLF	72	16.5
	TDLF	98.8	17
G7	NLF	71.8	15.4
	SDLF	78.6	14.4
	TDLF	89.2	0
G8	NLF	70.1	0
	SDLF	65.8	0
	TDLF	93.7	0
All Girders	NLF	75.1	0
	SDLF	78.6	0
	TDLF	98.8	0

Table T2-3-3. Summary of erection crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	76.9	58.4	23	22.9
SDLF	71.3	53.7	27.8	26.4
TDLF	75.9	41.6	31	26.8

Table T2-3-6. Erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage										
		1	2	3	4	5	6	7	8	9	10	11
2	NLF	282	283	284	285	286	286	287	288	290	291	
	SDLF	282	283	284	285	286	286	287	288	290	291	
	TDLF	282	283	284	285	286	286	287	288	290	291	
8	NLF	1176	1177	1178	1178	1179	1180	1181	1182	1183	1185	1185
	SDLF	1176	1177	1178	1178	1179	1180	1181	1182	1183	1185	1185
	TDLF	1176	1177	1178	1178	1179	1180	1181	1182	1183	1185	1185
32	NLF	2990	2991	2992	2993	2994	2995					
	SDLF	2990	2991	2992	2993	2994	2995					
	TDLF	2990	2991	2992	2993	2994	2995					

Appendix T2-4. EICCS27 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge EICCS27 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Figure T2-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing
Figure T2-4-23. Cross-frame stress contours under TDL, NLF detailing
Figure T2-4-24. Cross-frame stress contours under SDL, SDLF detailing
Figure T2-4-25. Cross-frame stress contours under TDL, SDLF detailing
Figure T2-4-26. Cross-frame stress contours under SDL, TDLF detailing
Figure T2-4-27. Cross-frame stress contours under TDL, TDLF detailing

Cross-Frame Member Axial Forces

Table T2-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

Table T2-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

Table T2-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

Table T2-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

Table T2-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

Table T2-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

Girder Differential Displacements at Cross-Frame Locations

Table T2-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

Table T2-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

Table T2-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame Deformations.

Table T2-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame Deformations.

Reactions

Table T2-4-1. Individual support vertical reactions under SDL and TDL (kips).

Table T2-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Table T2-4-13. Individual support transverse reactions under SDL and TDL (kips).

Support Displacements

Table T2-4-14. Longitudinal displacements at supports (in).

Table T2-4-15. Transverse displacements at supports (in).

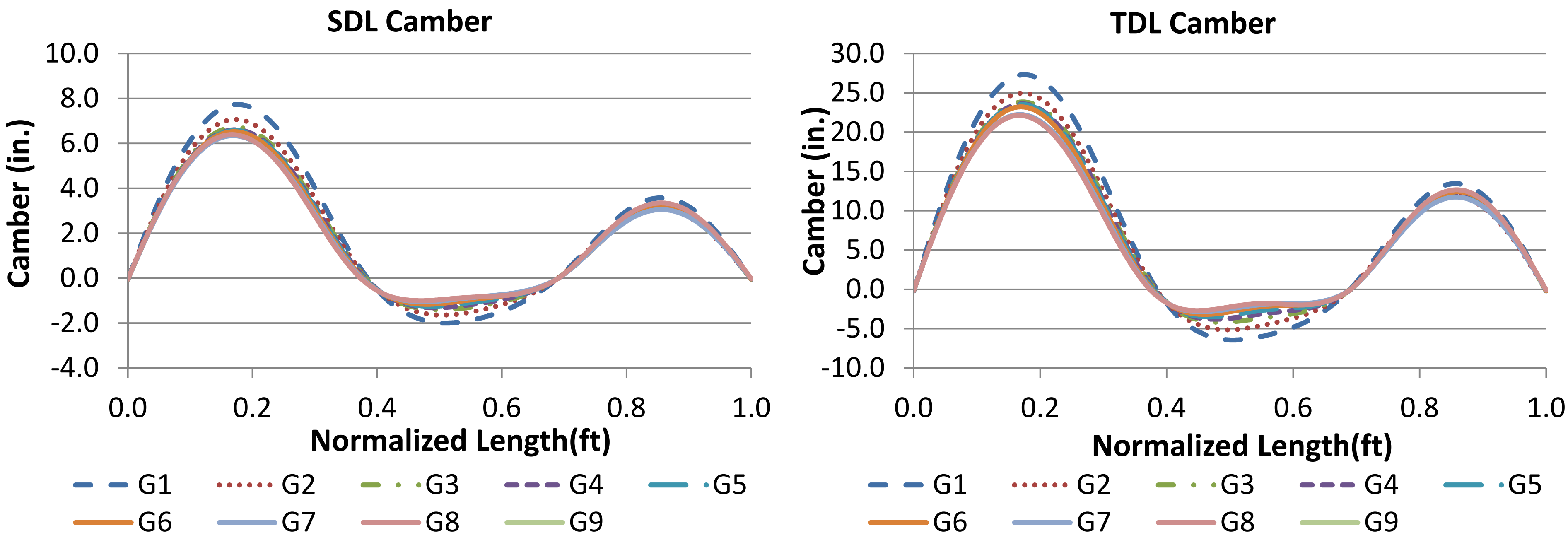


Figure T2-4-1. SDL and TDL 3D FEA cambers.

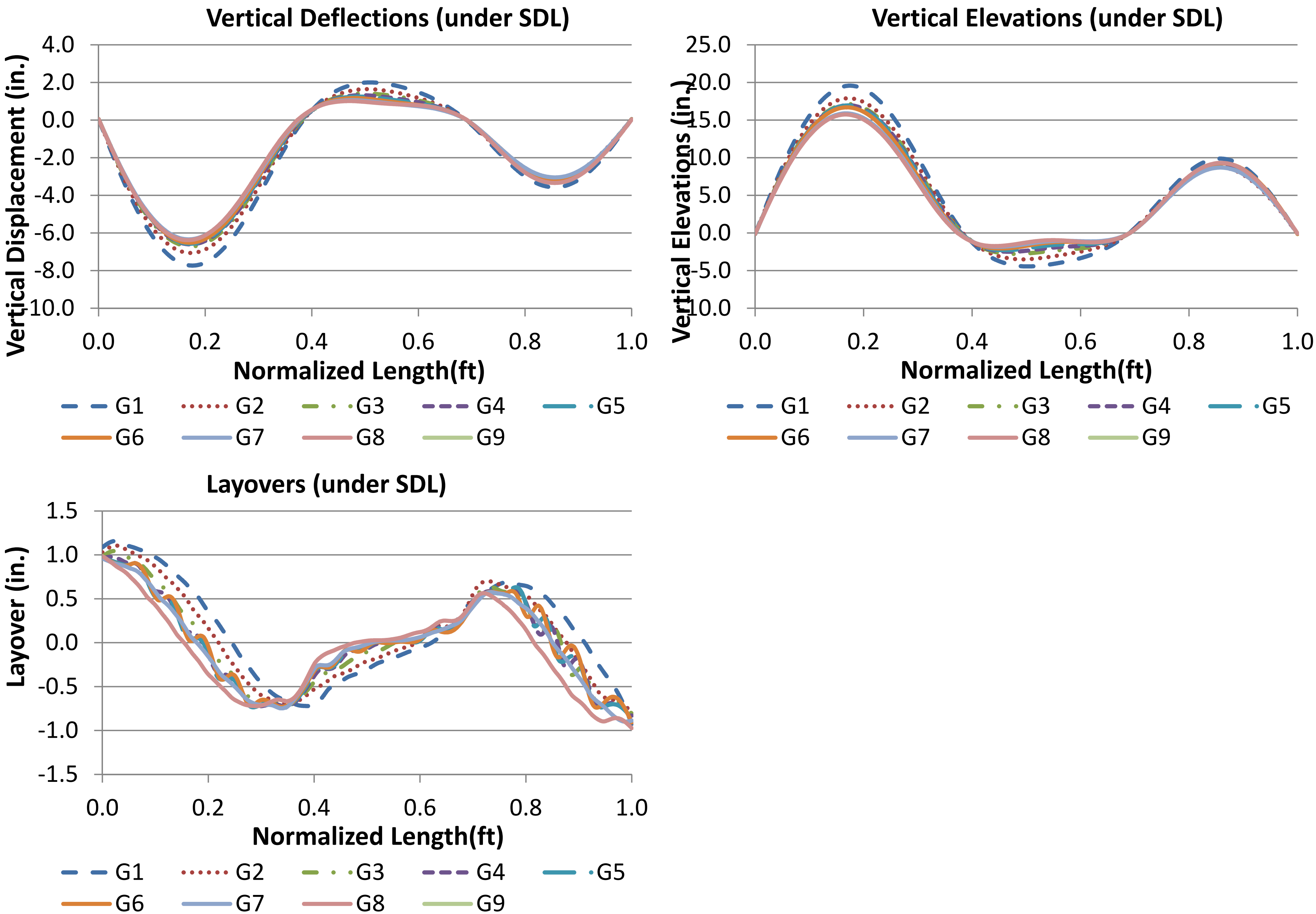


Figure T2-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

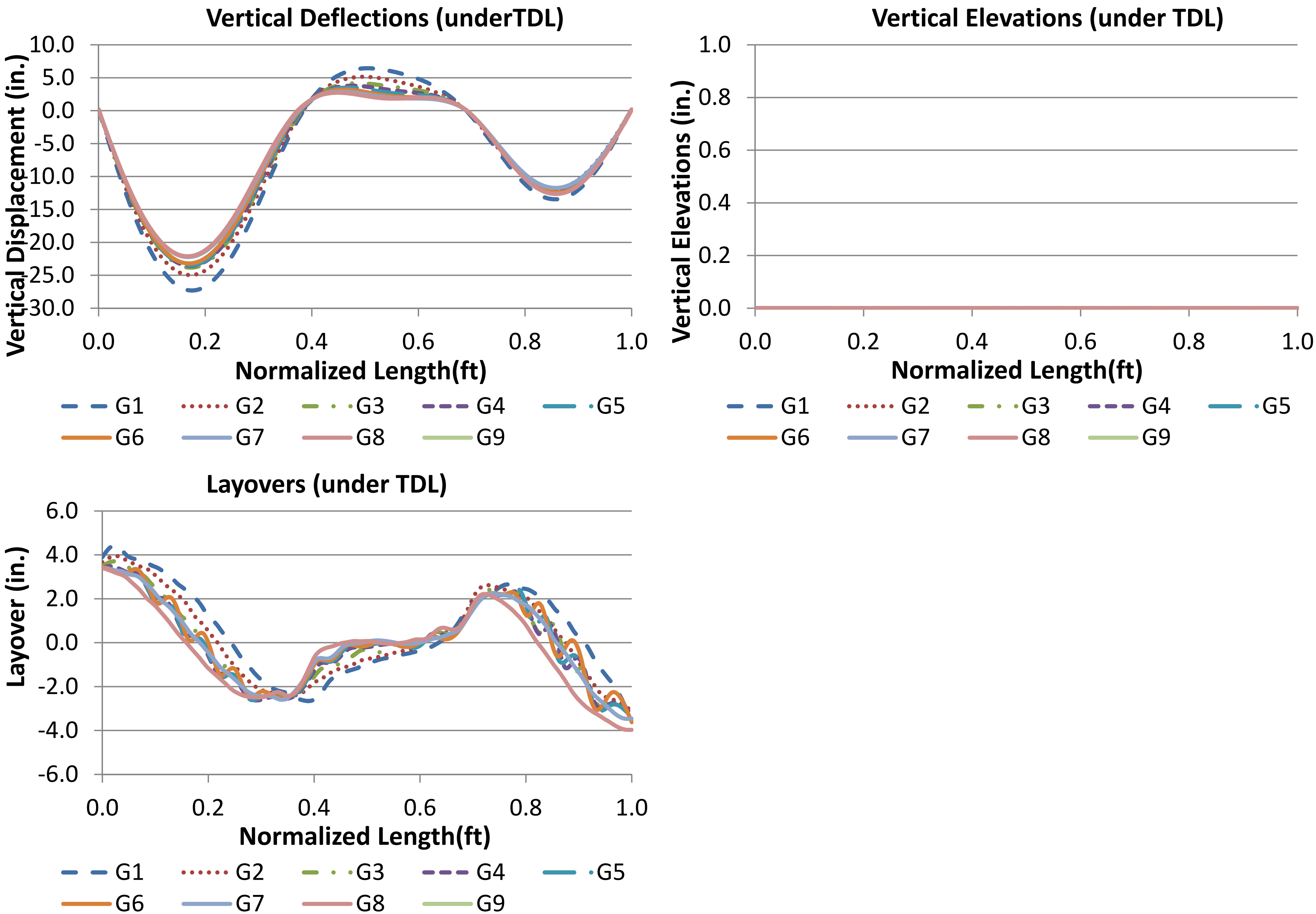


Figure T2-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

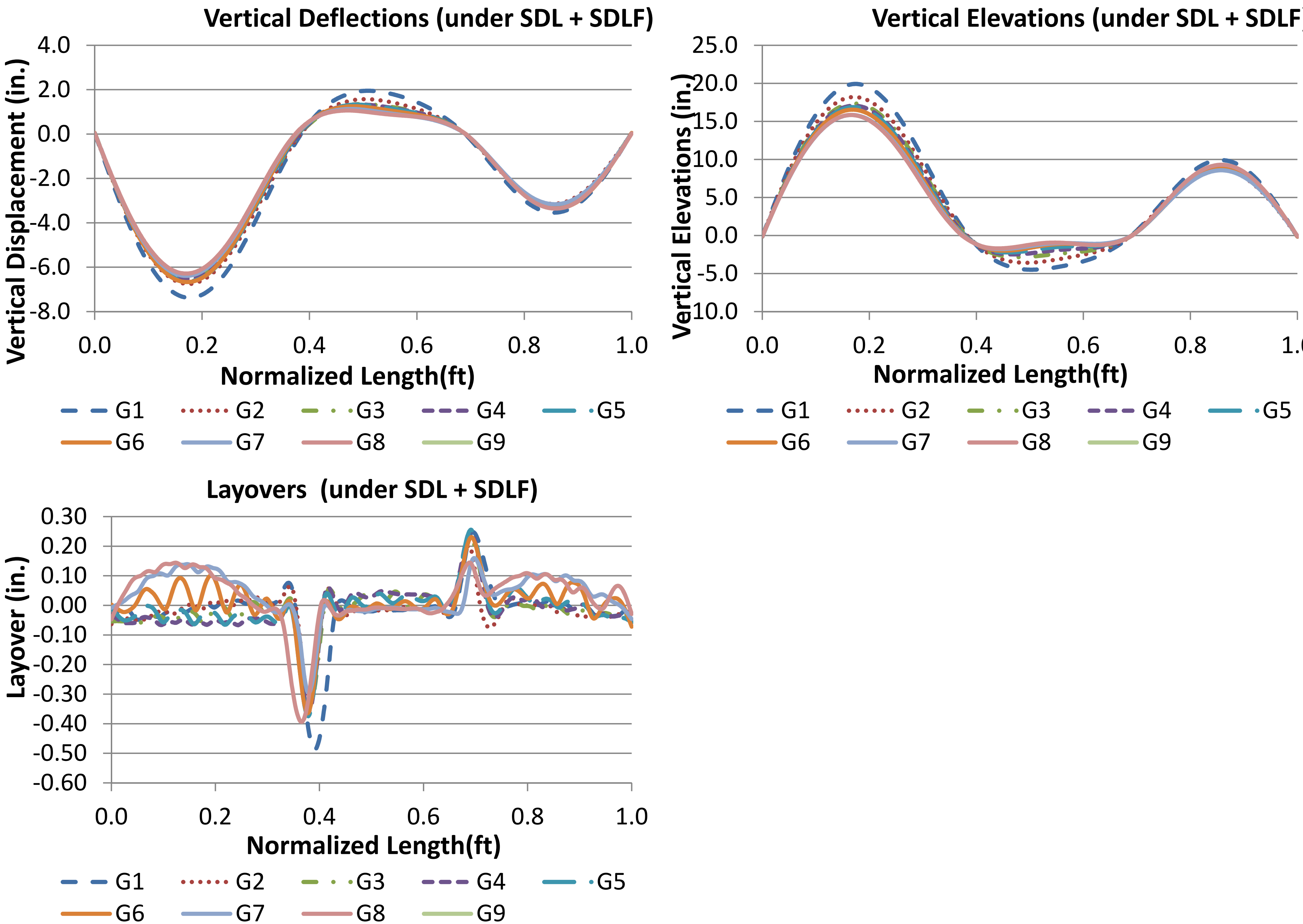


Figure T2-4-4. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

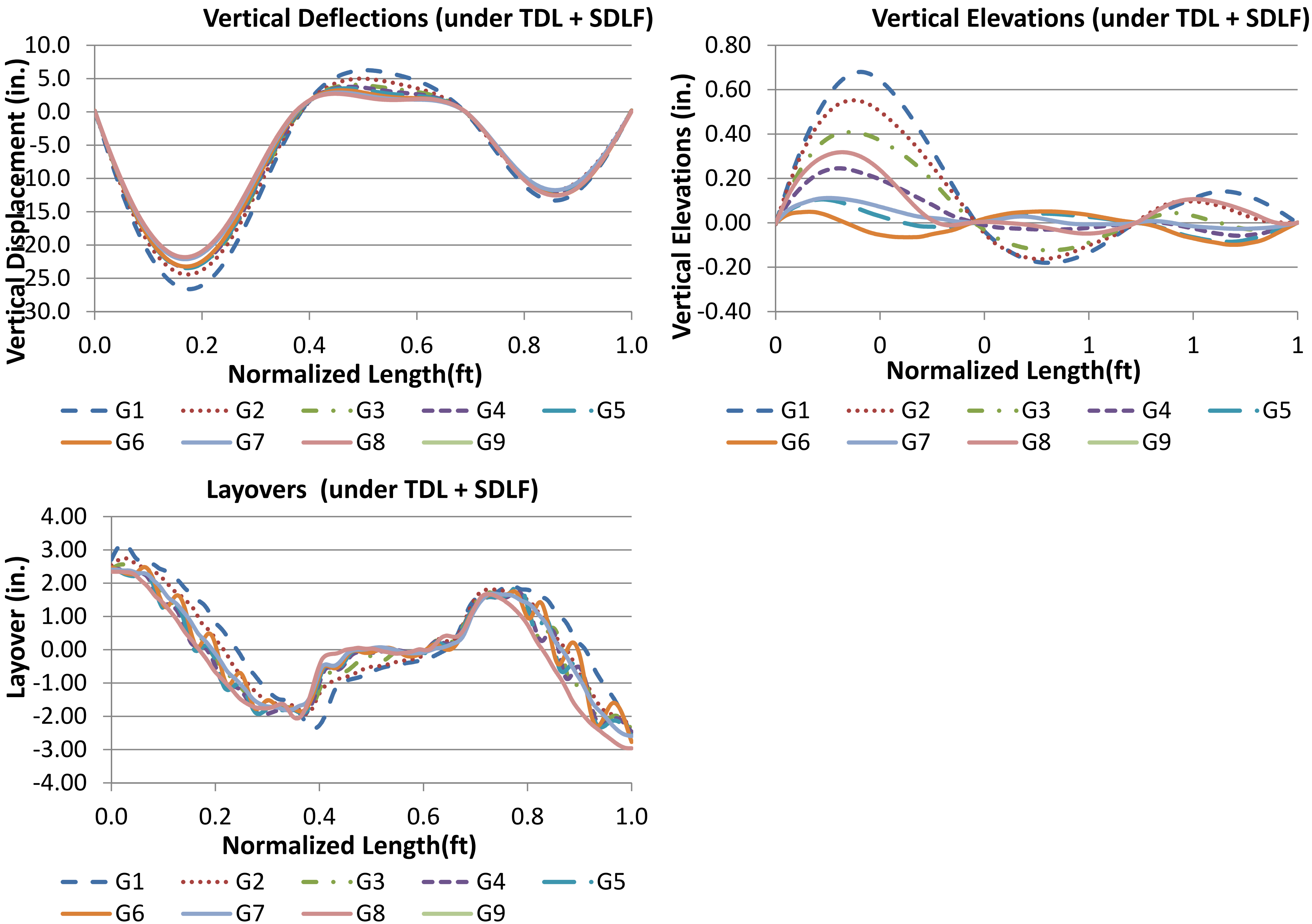


Figure T2-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

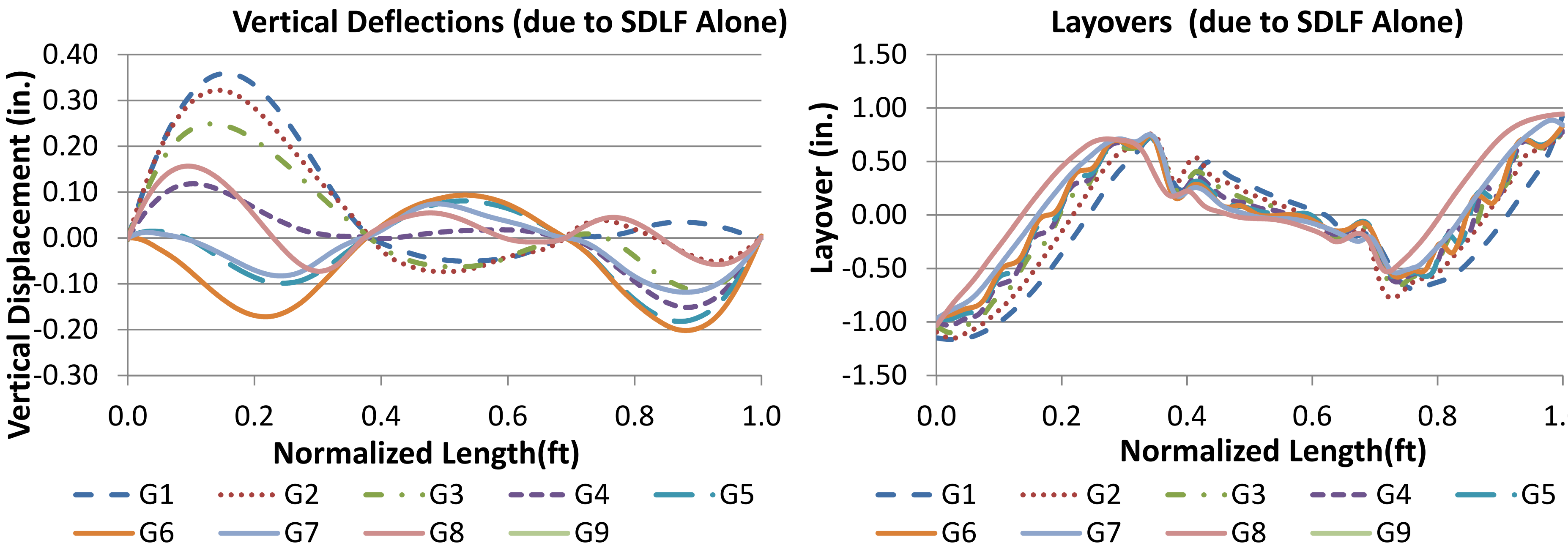


Figure T2-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

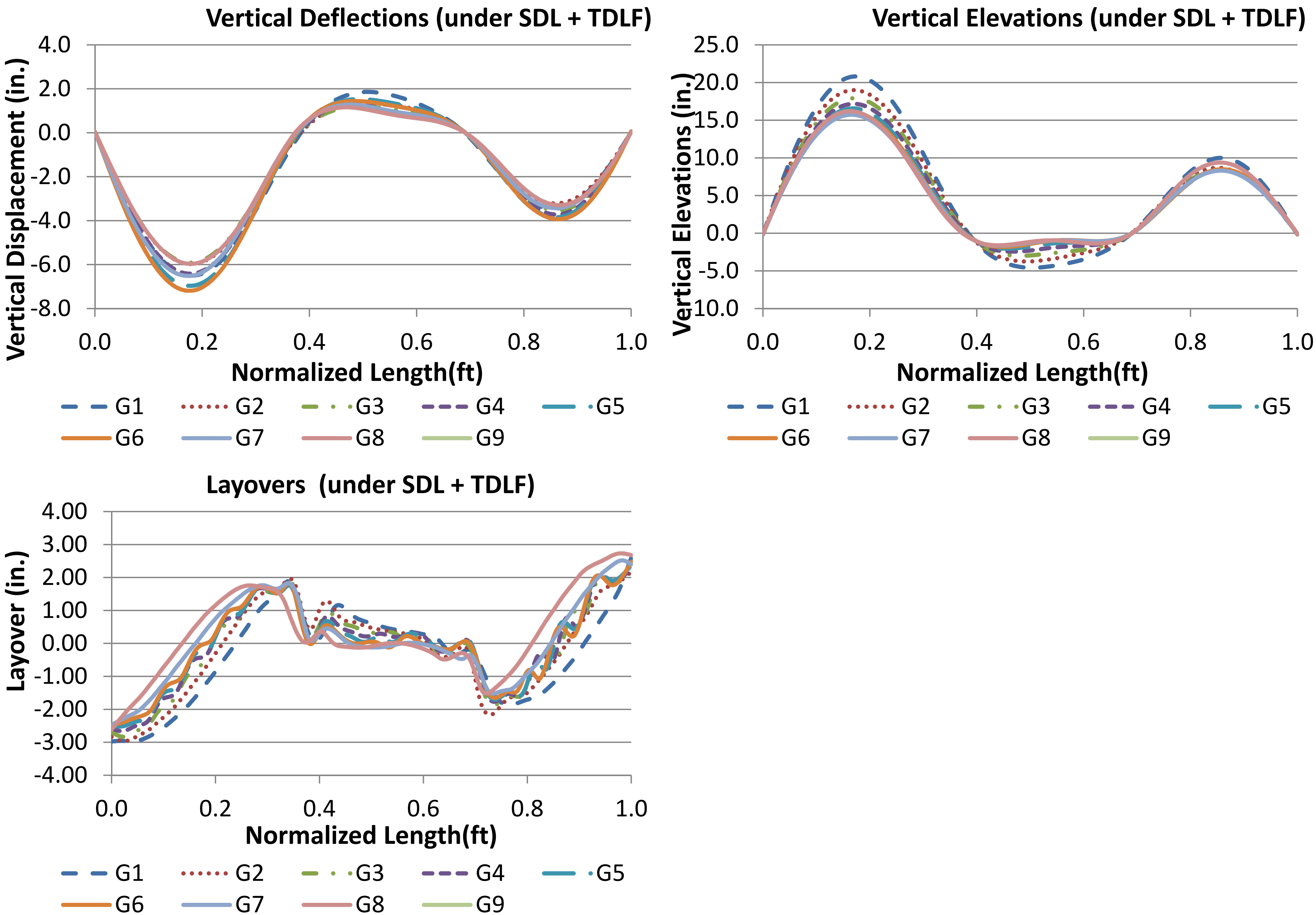


Figure T2-4-7. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

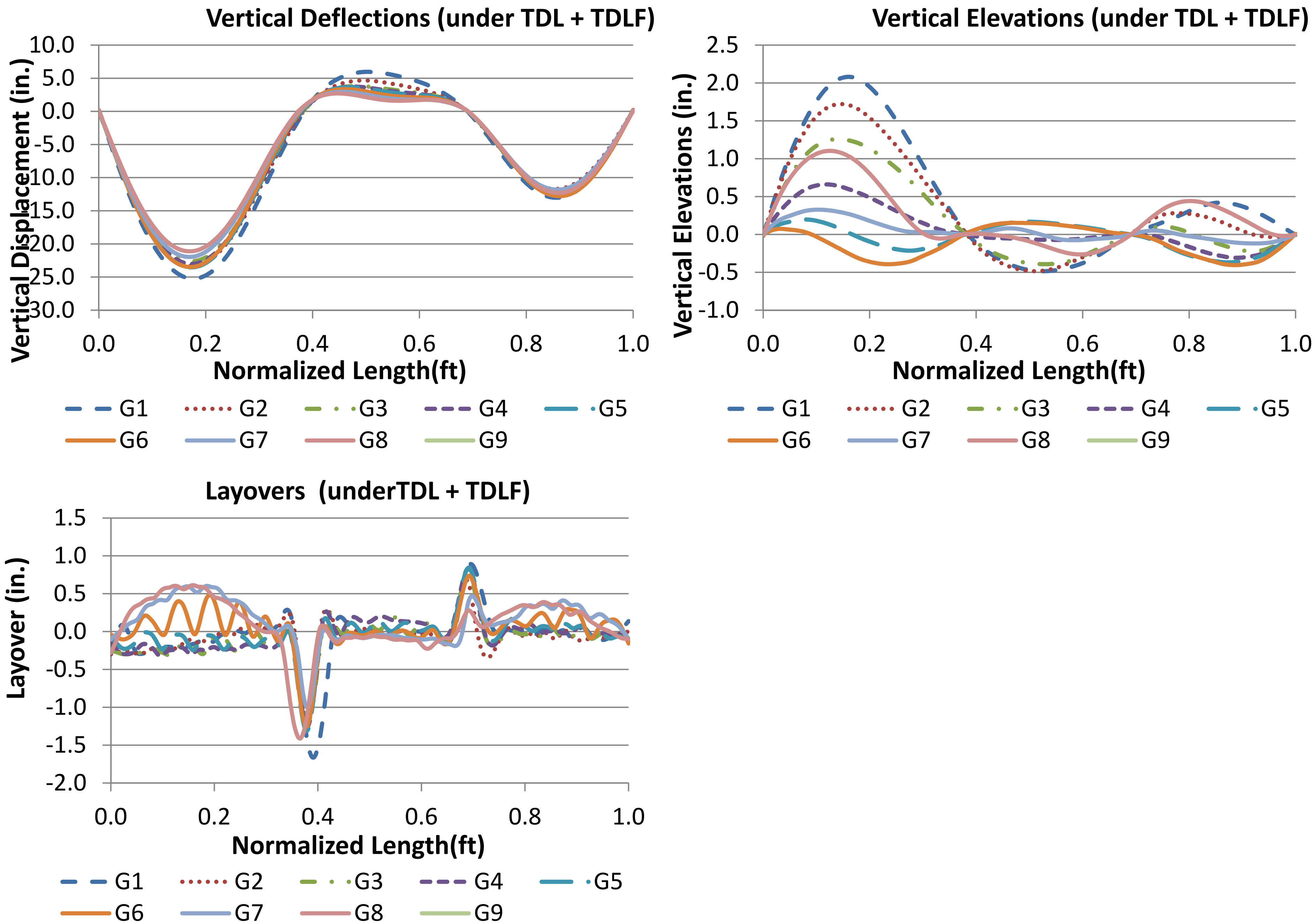


Figure T2-4-8. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

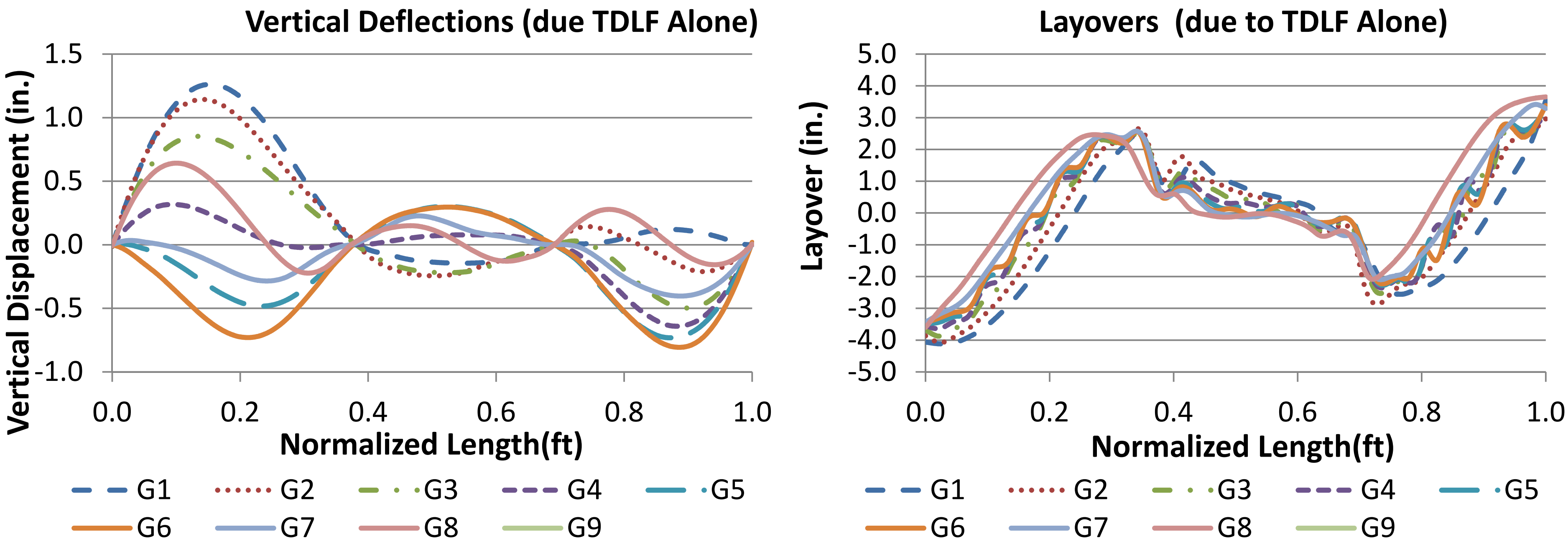


Figure T2-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

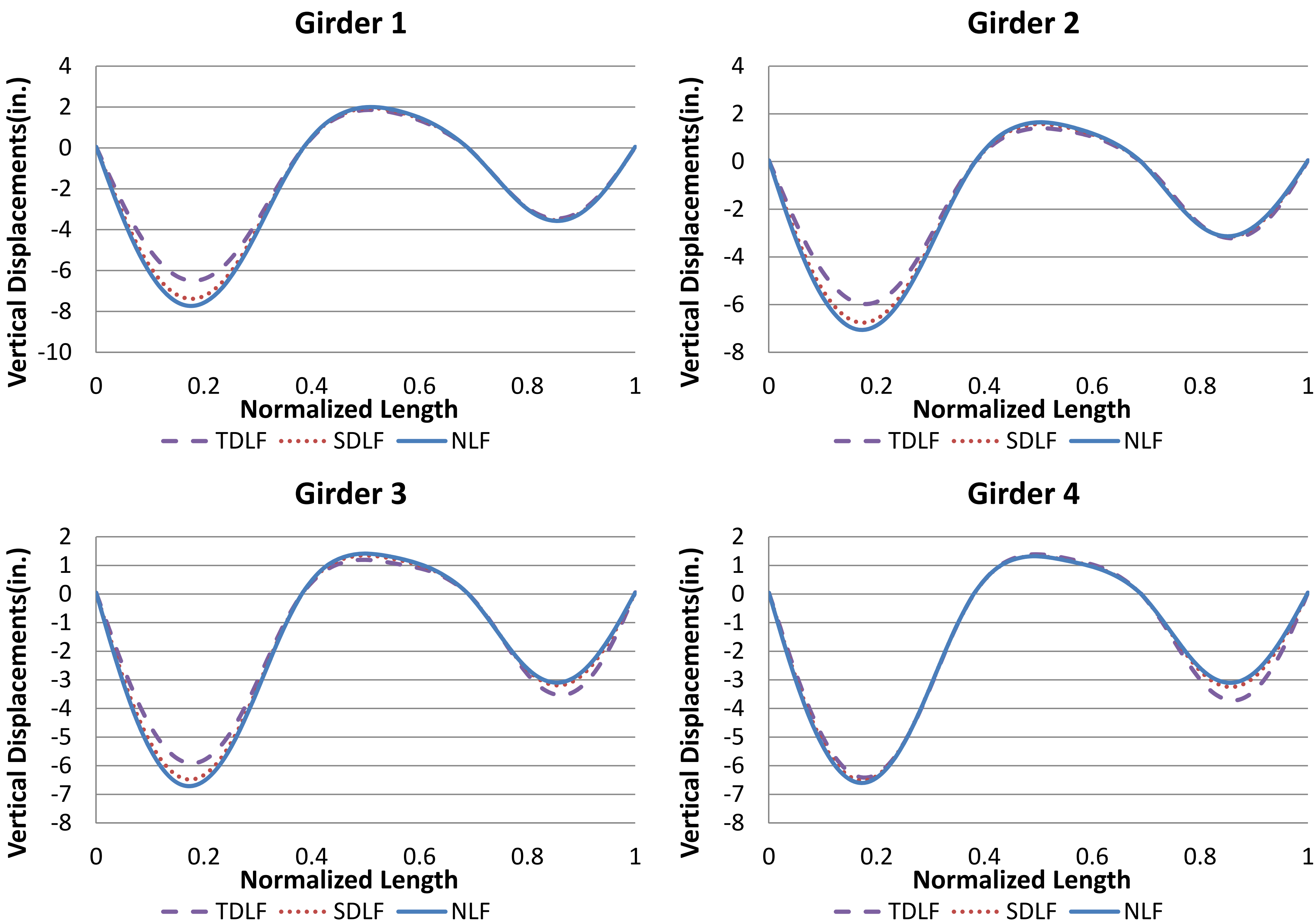


Figure T2-4-10. **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

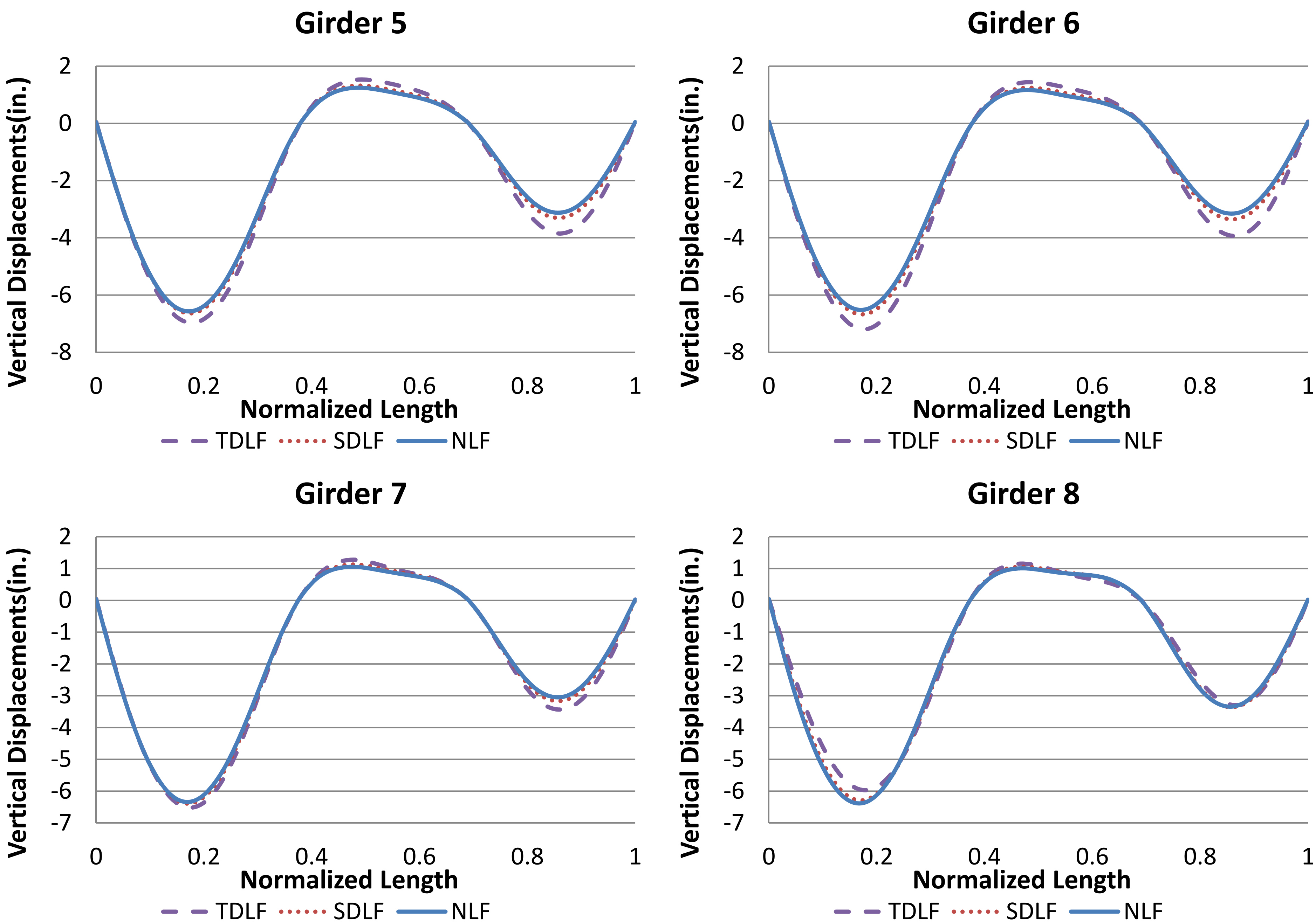


Figure T2-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

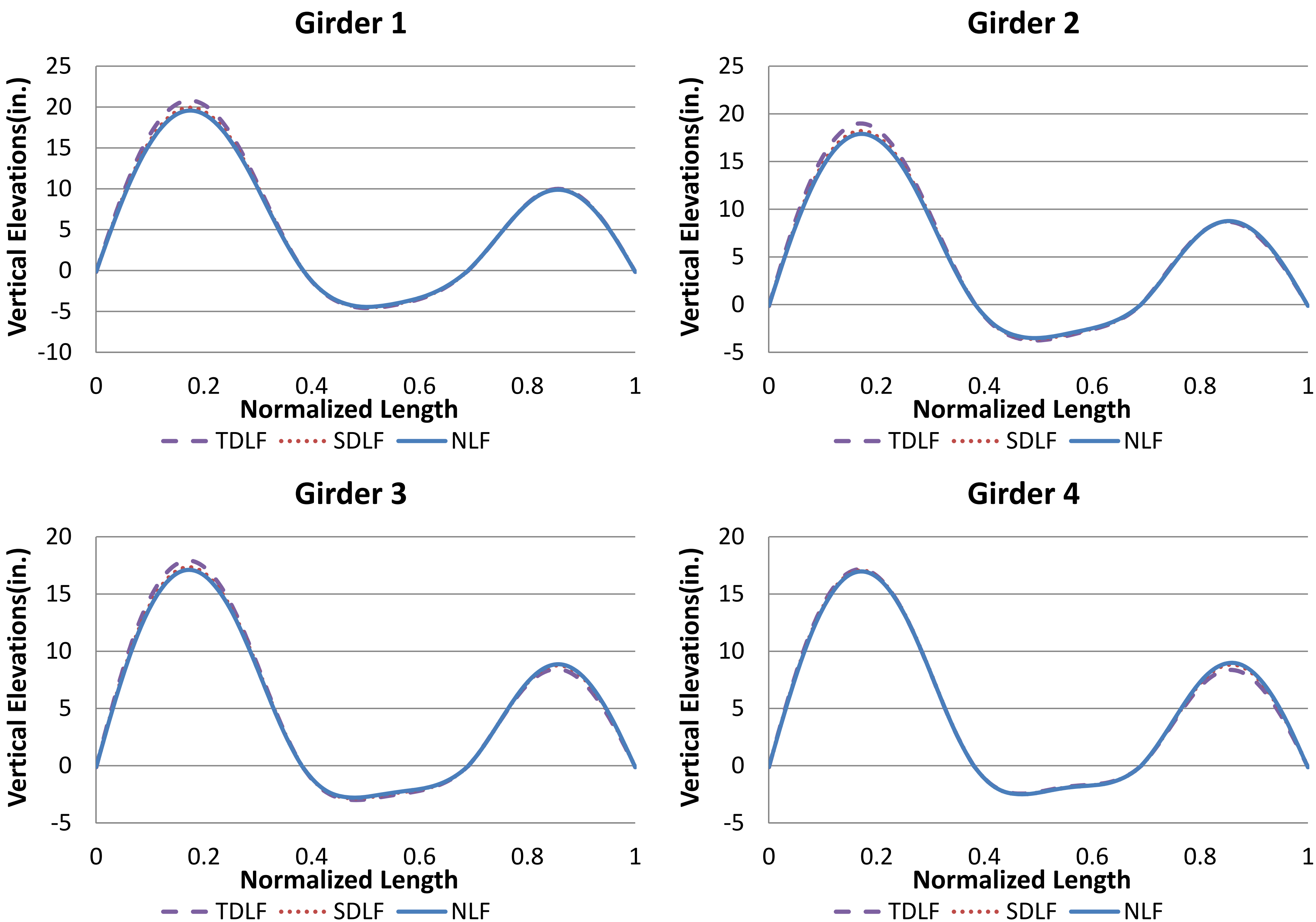


Figure T2-4-11. **Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.**

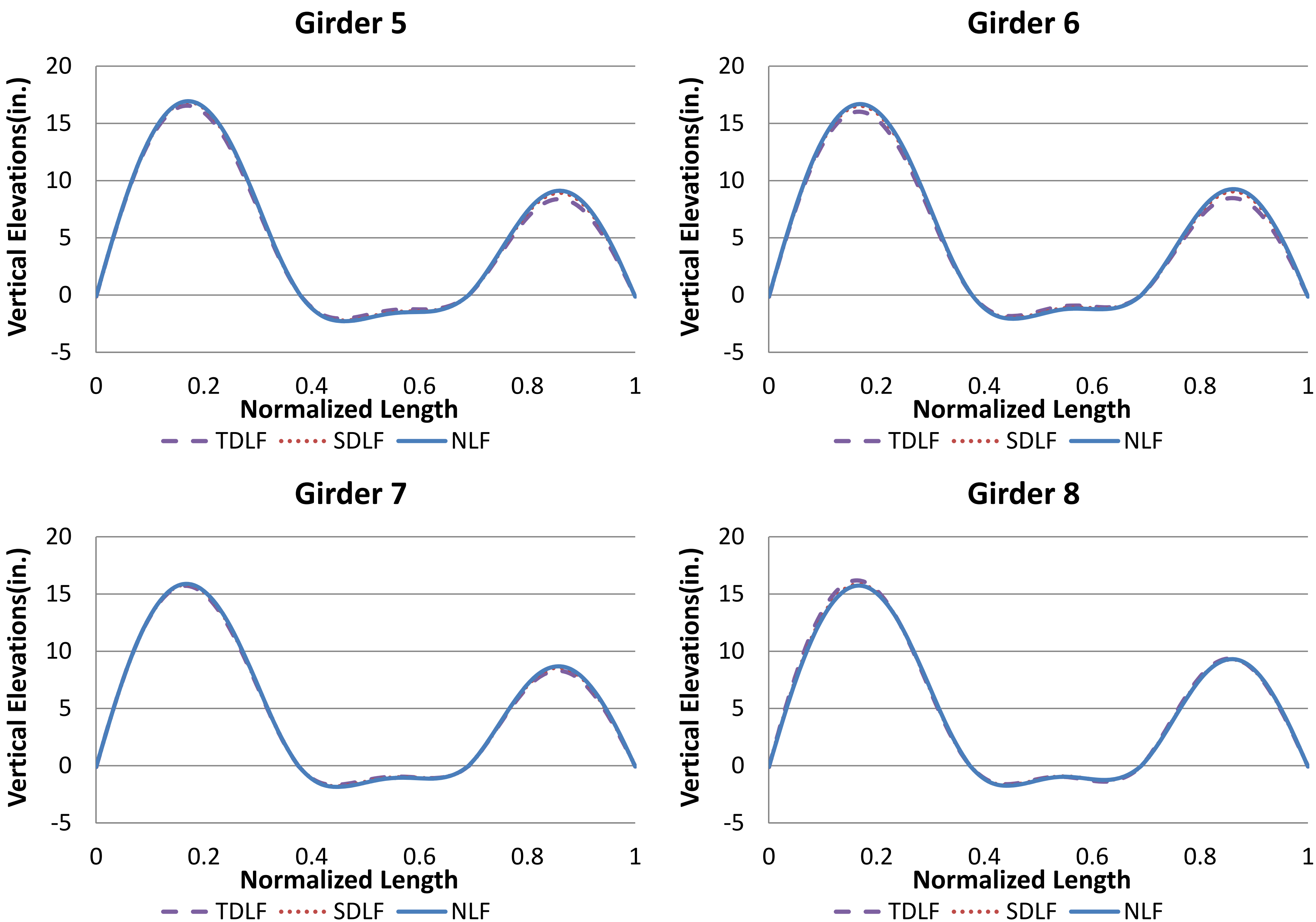


Figure T2-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

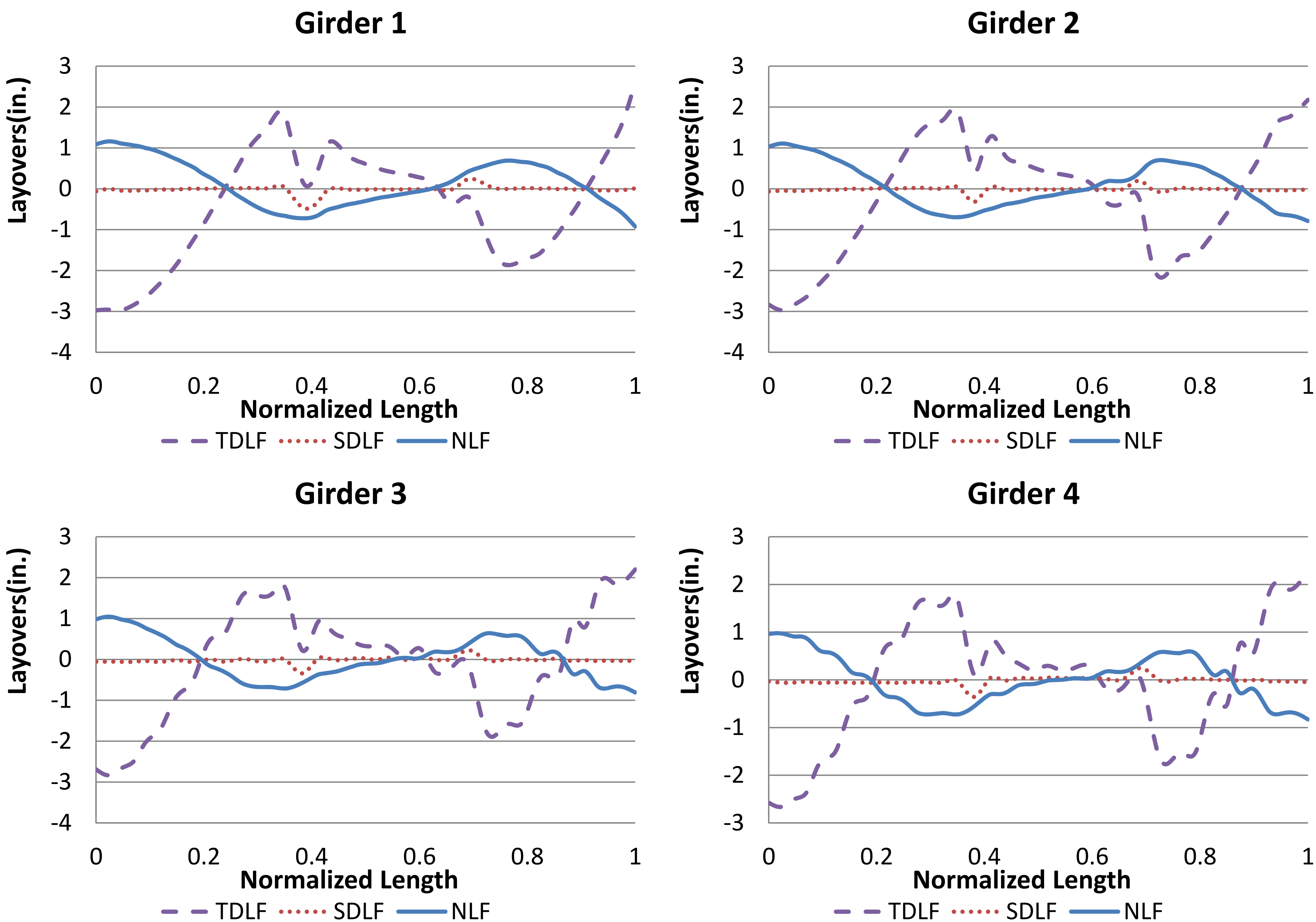


Figure T2-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

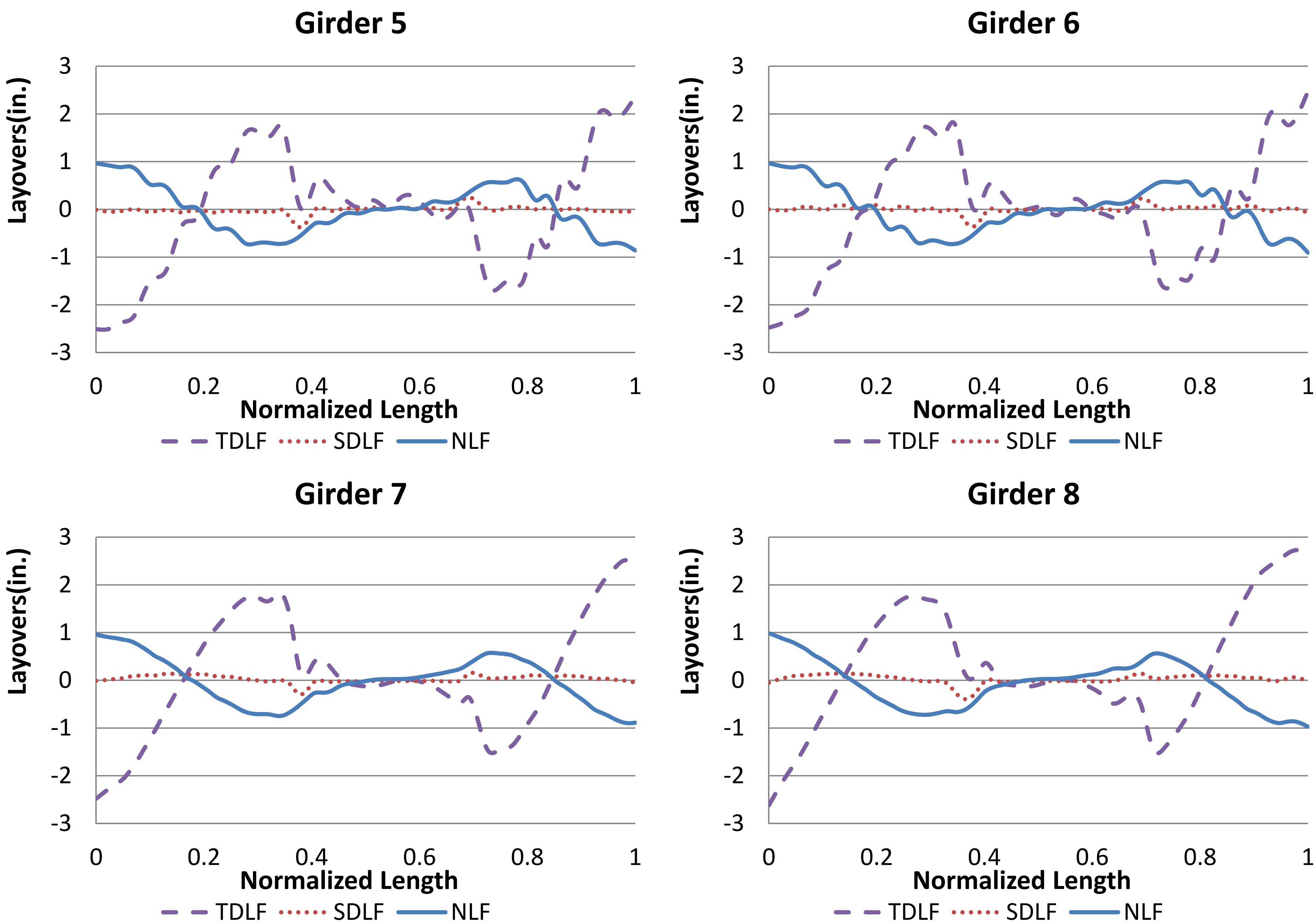


Figure T2-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

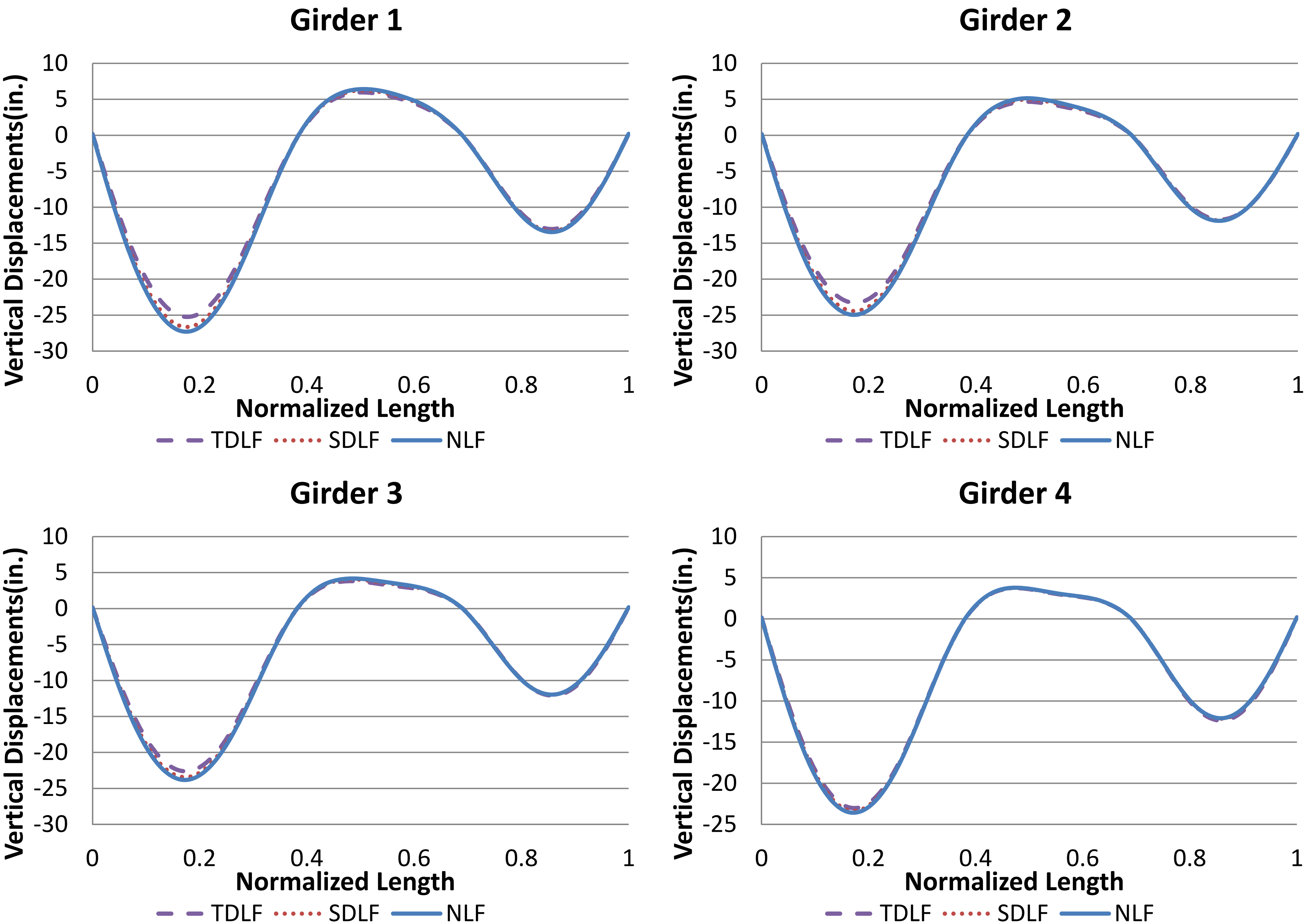


Figure T2-4-13. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

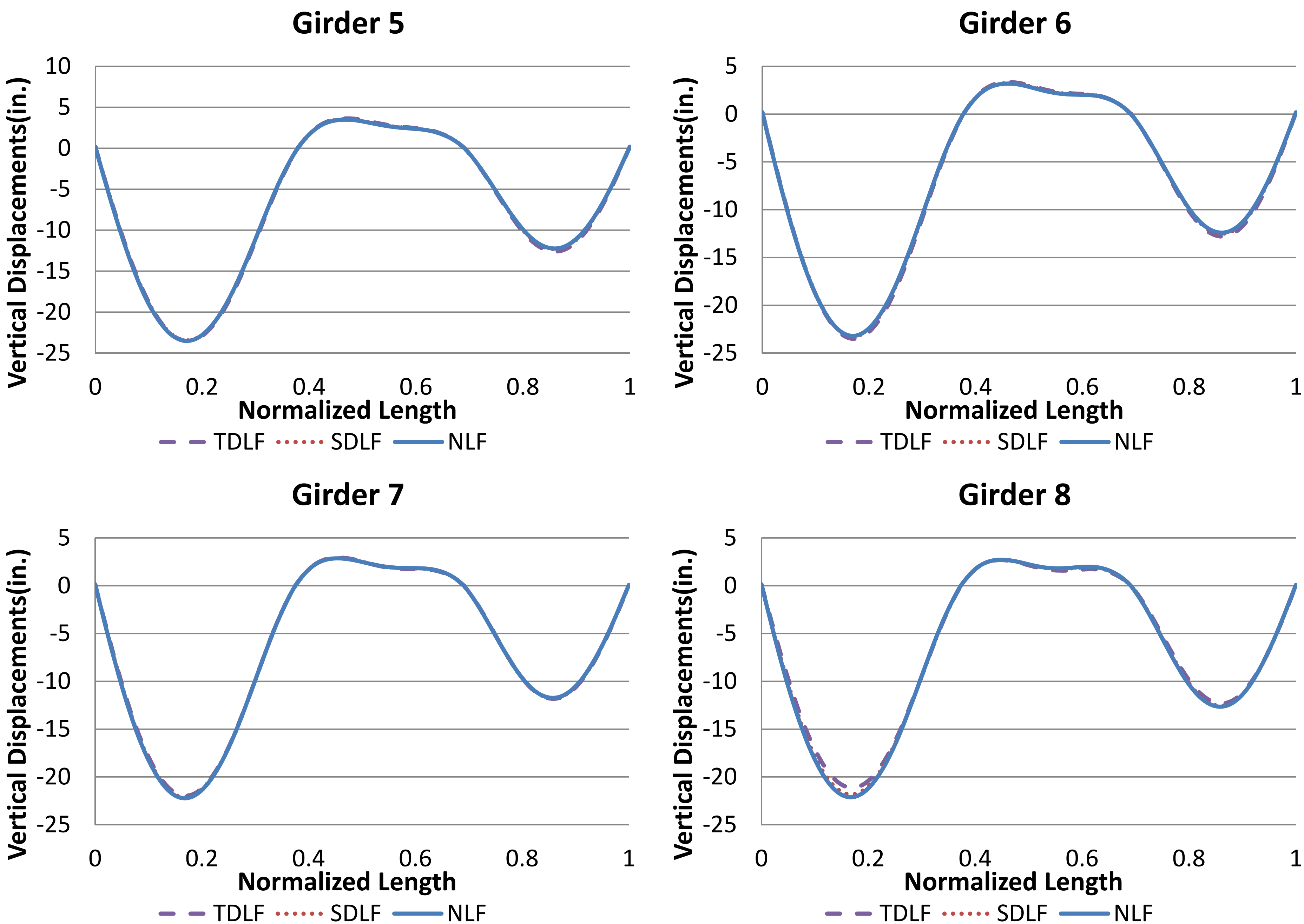


Figure T2-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

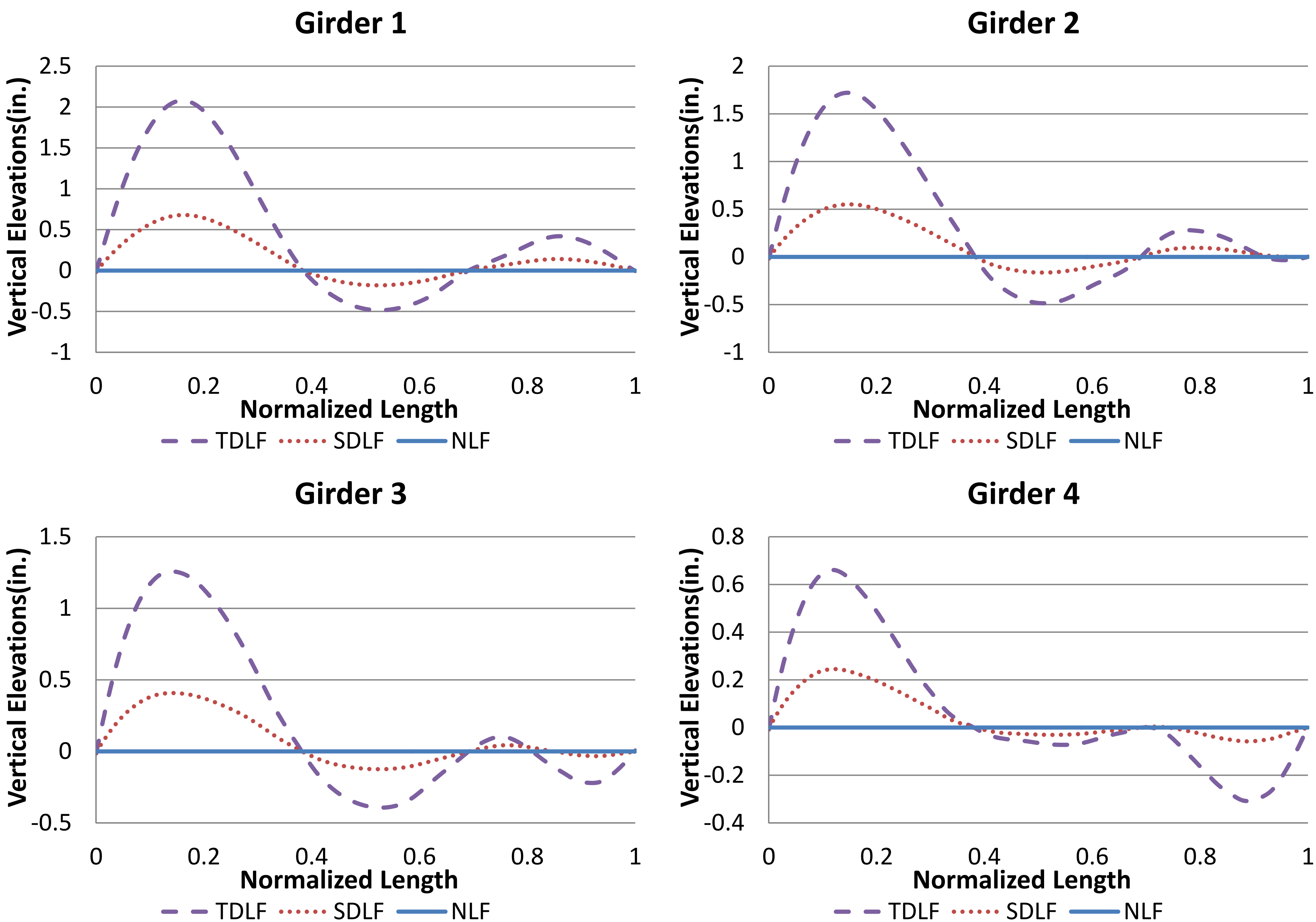


Figure T2-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

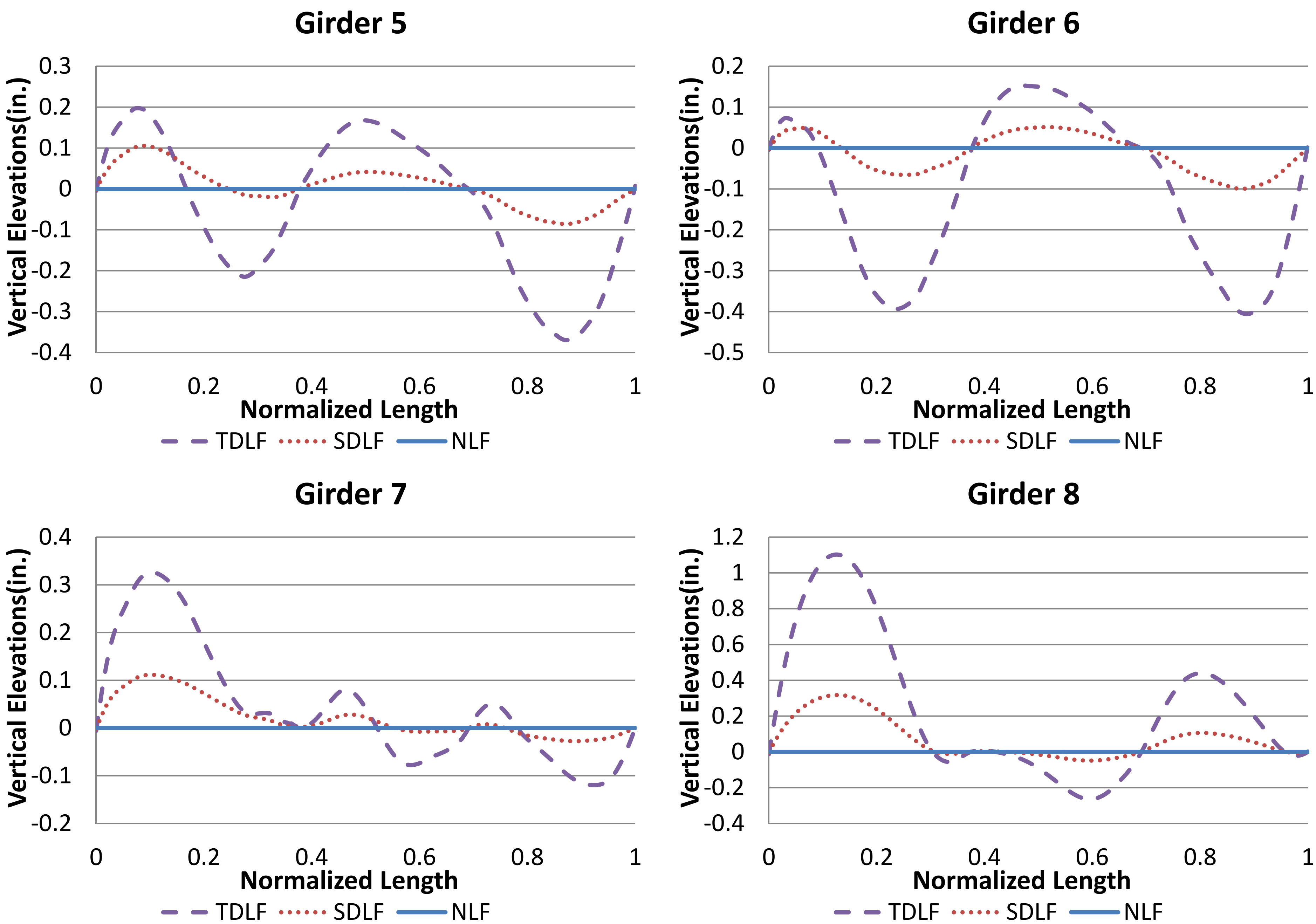


Figure T2-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

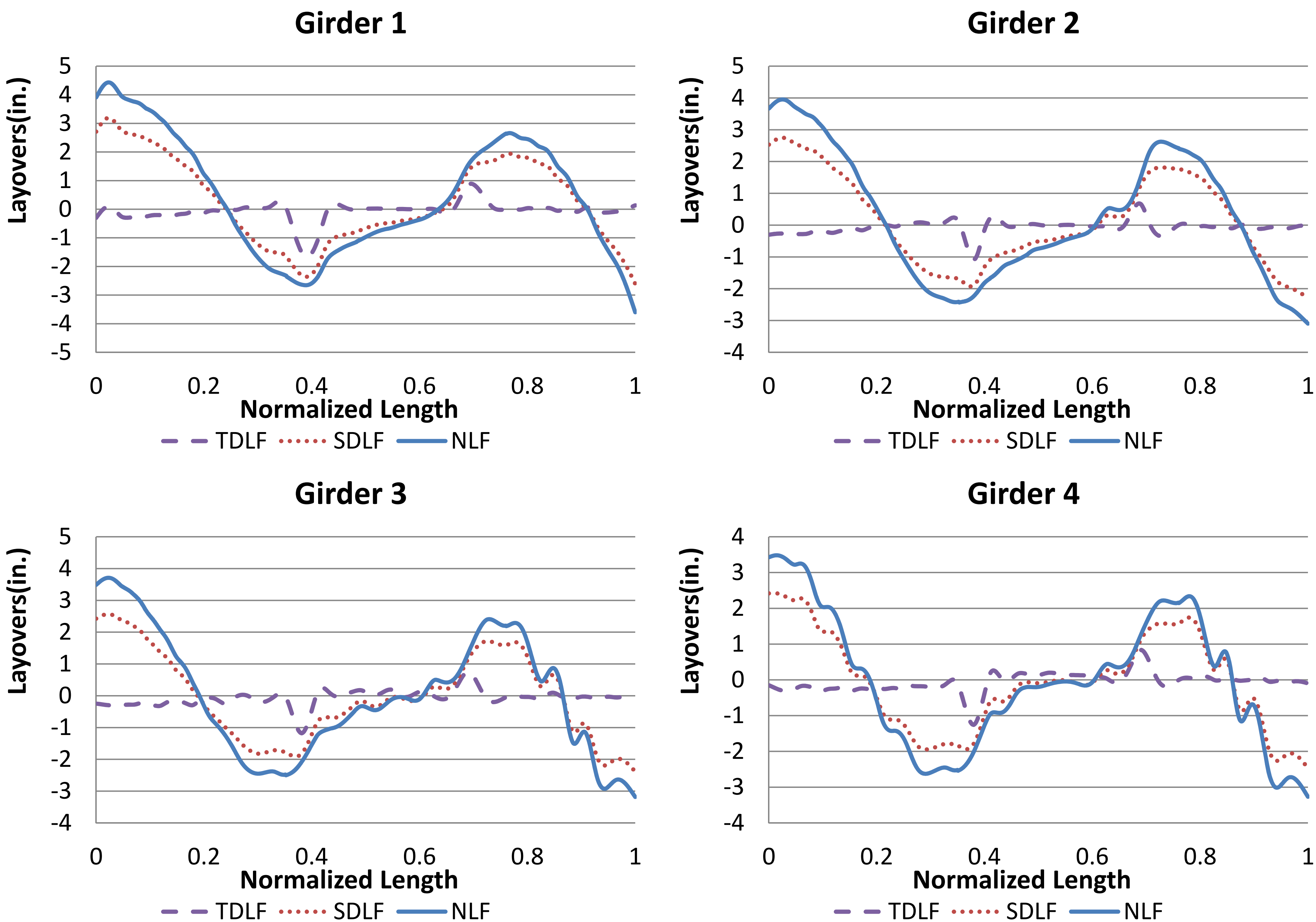


Figure T2-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

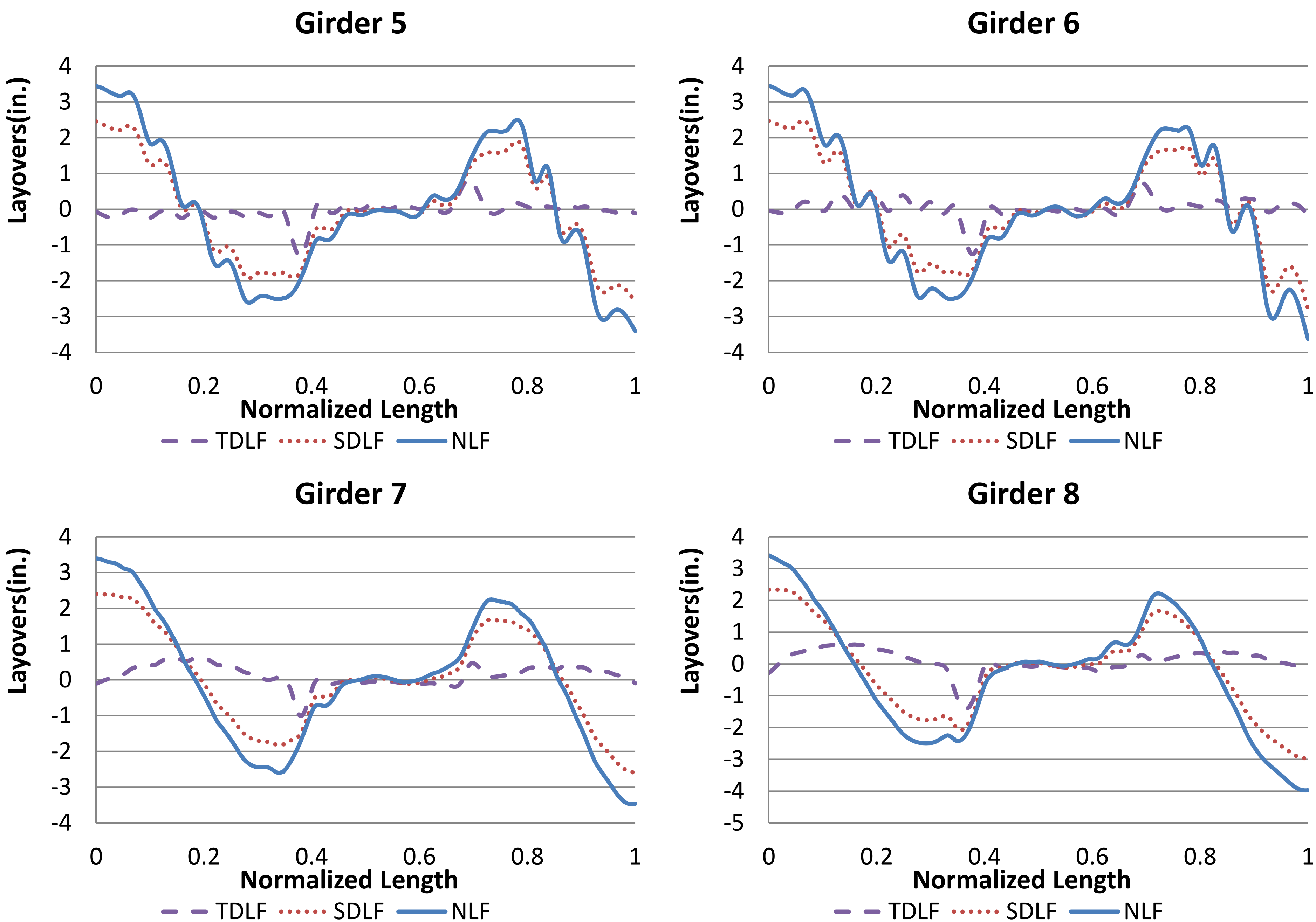


Figure T2-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

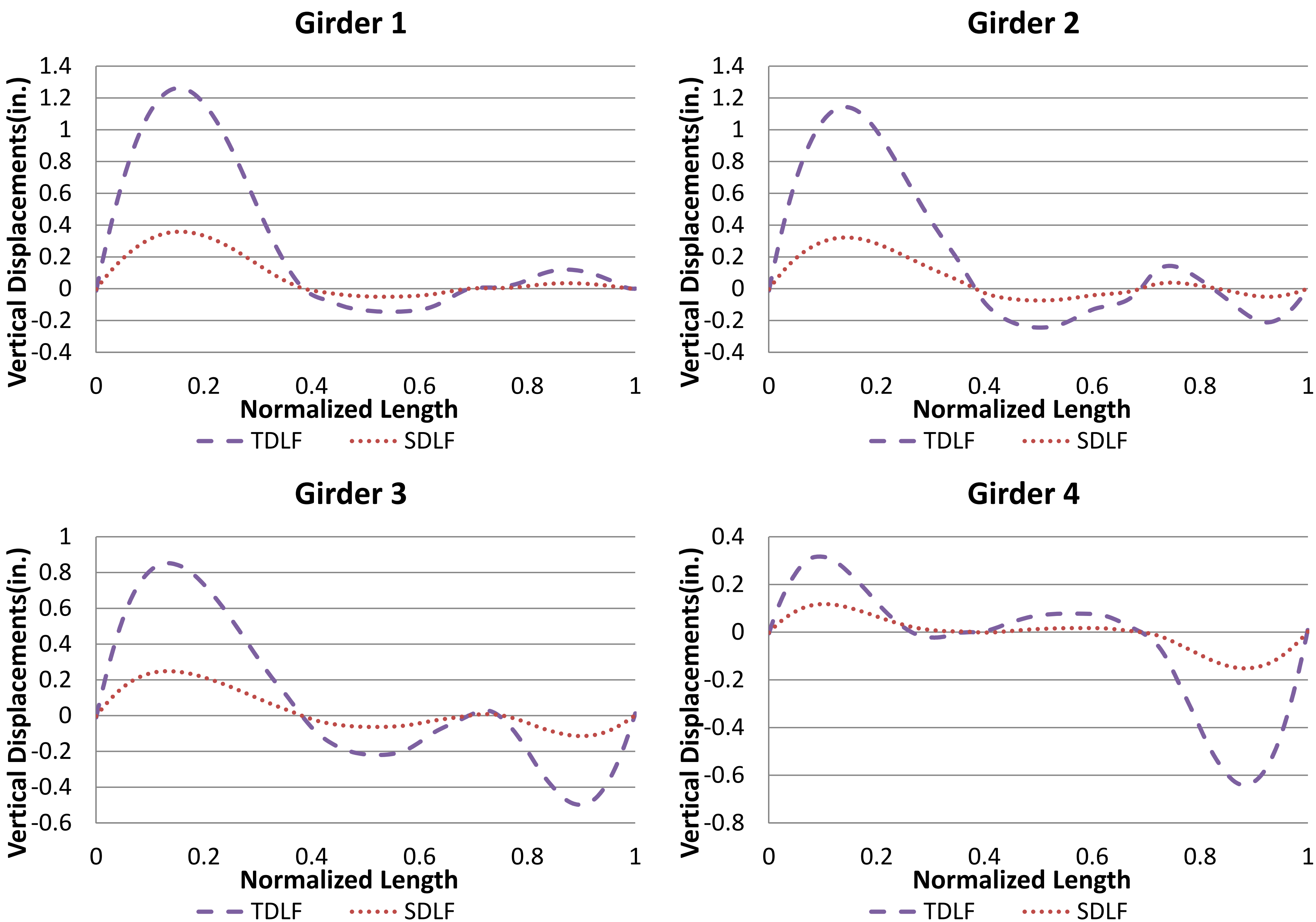


Figure T2-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

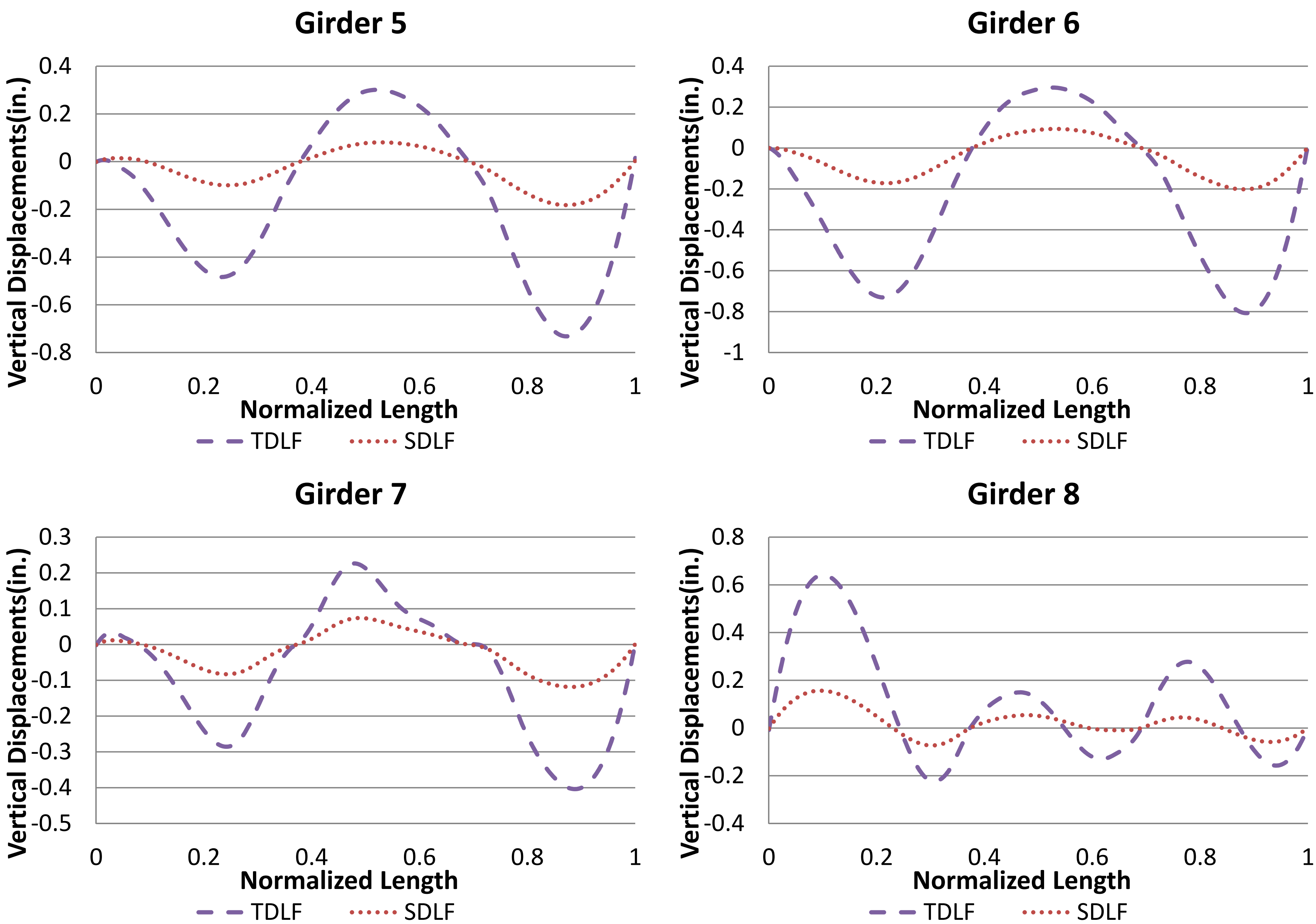


Figure T2-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

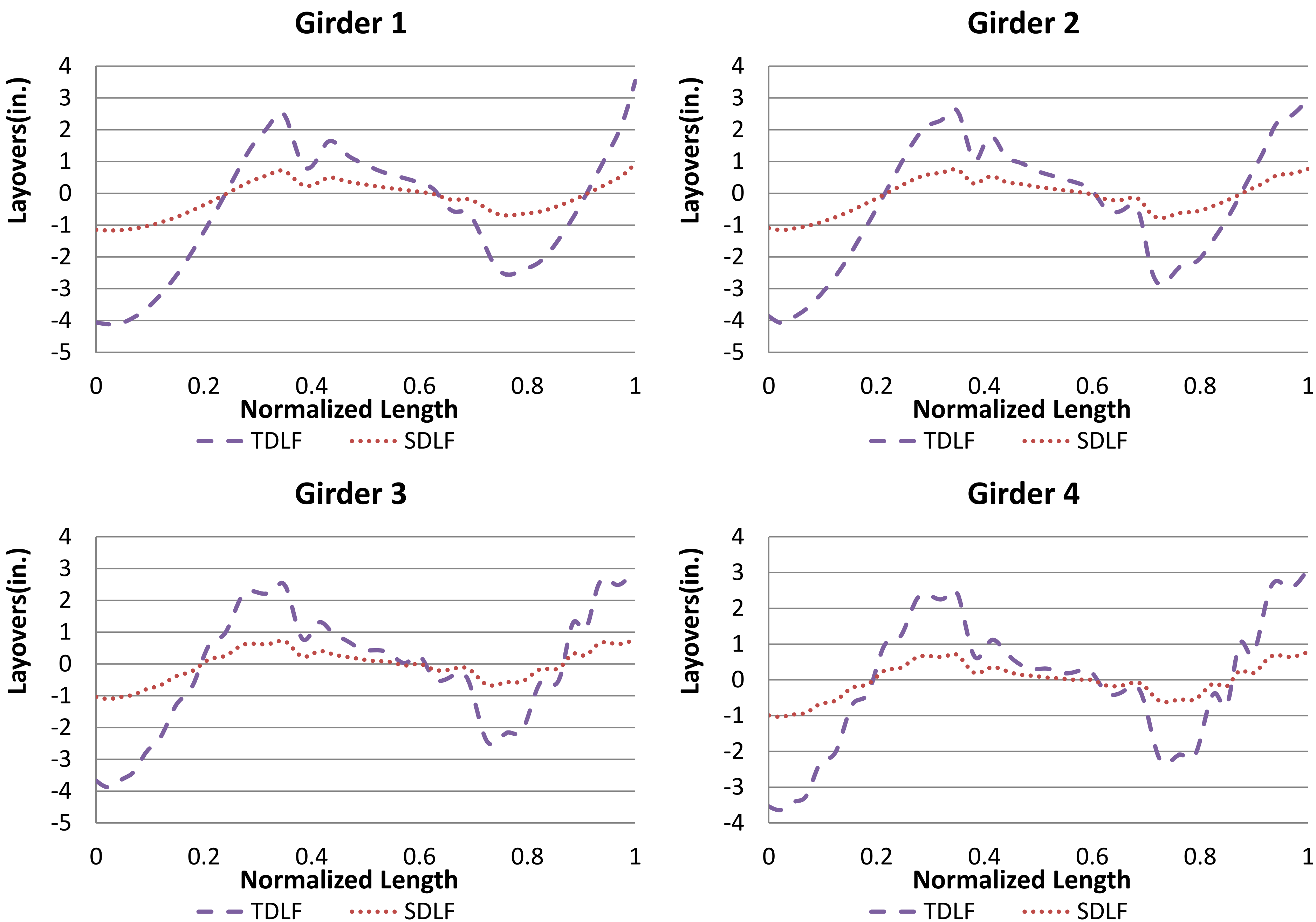


Figure T2-4-17. **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.**

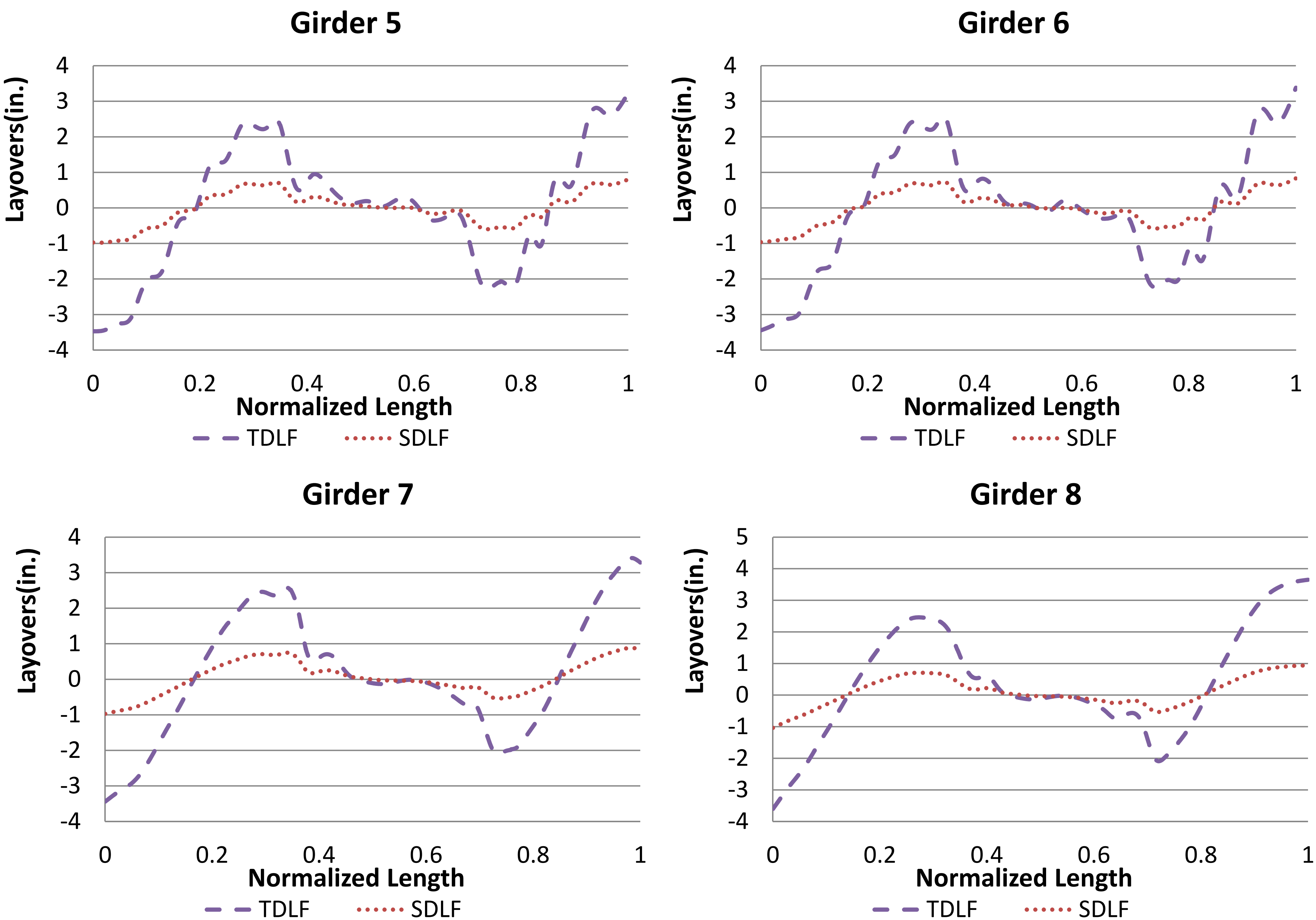


Figure T2-4-17(Continued). **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.**

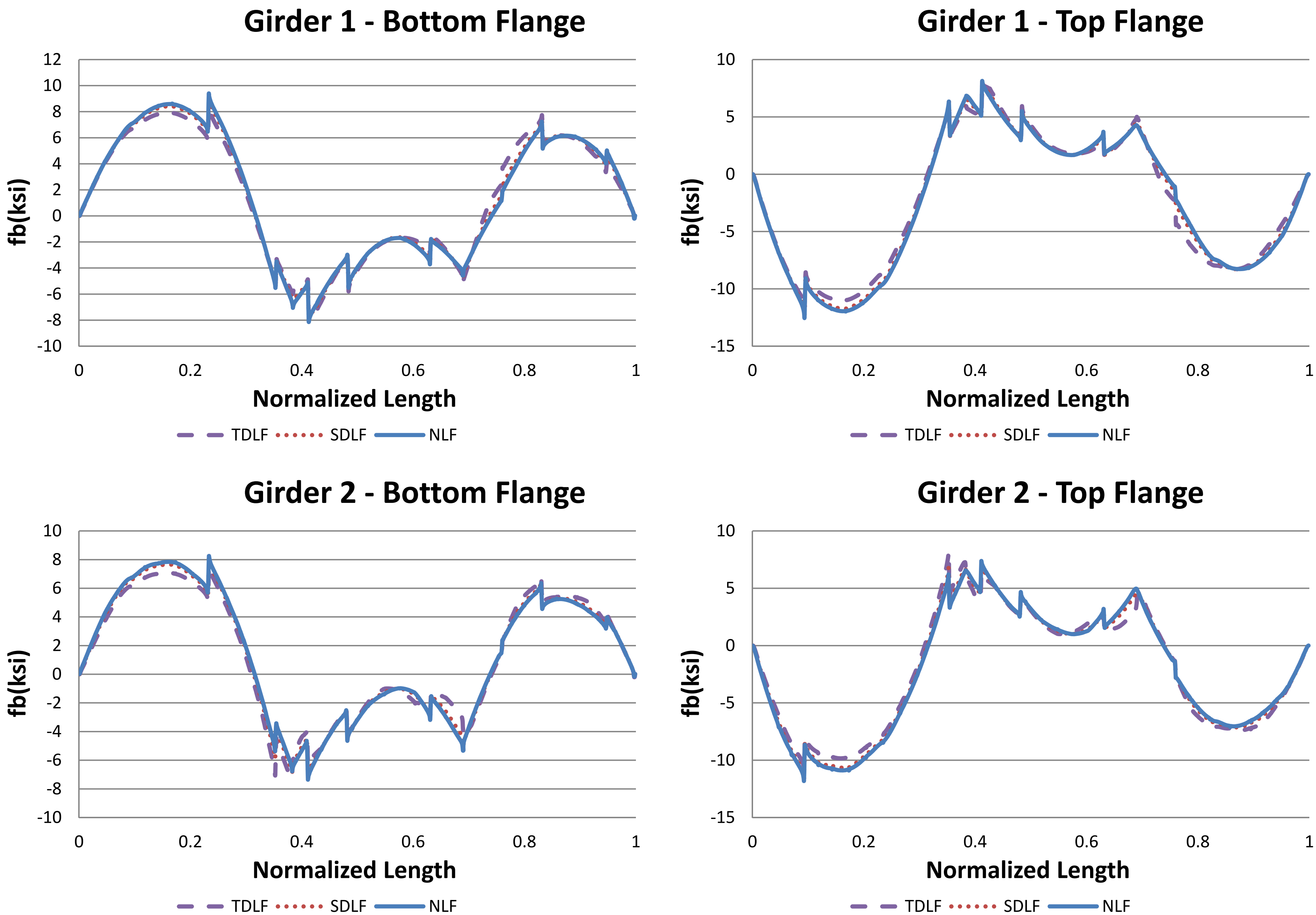


Figure T2-4-18. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

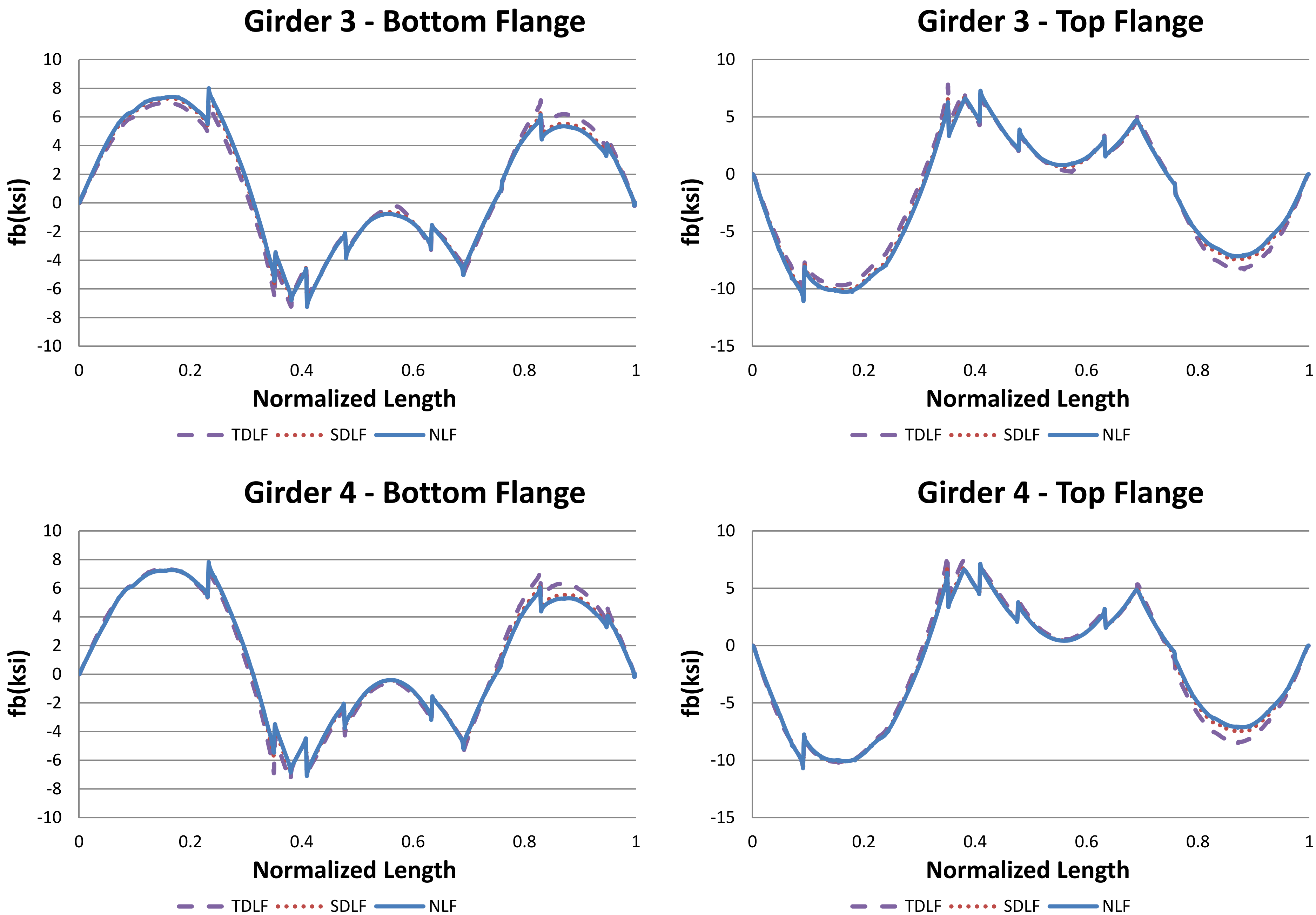


Figure T2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

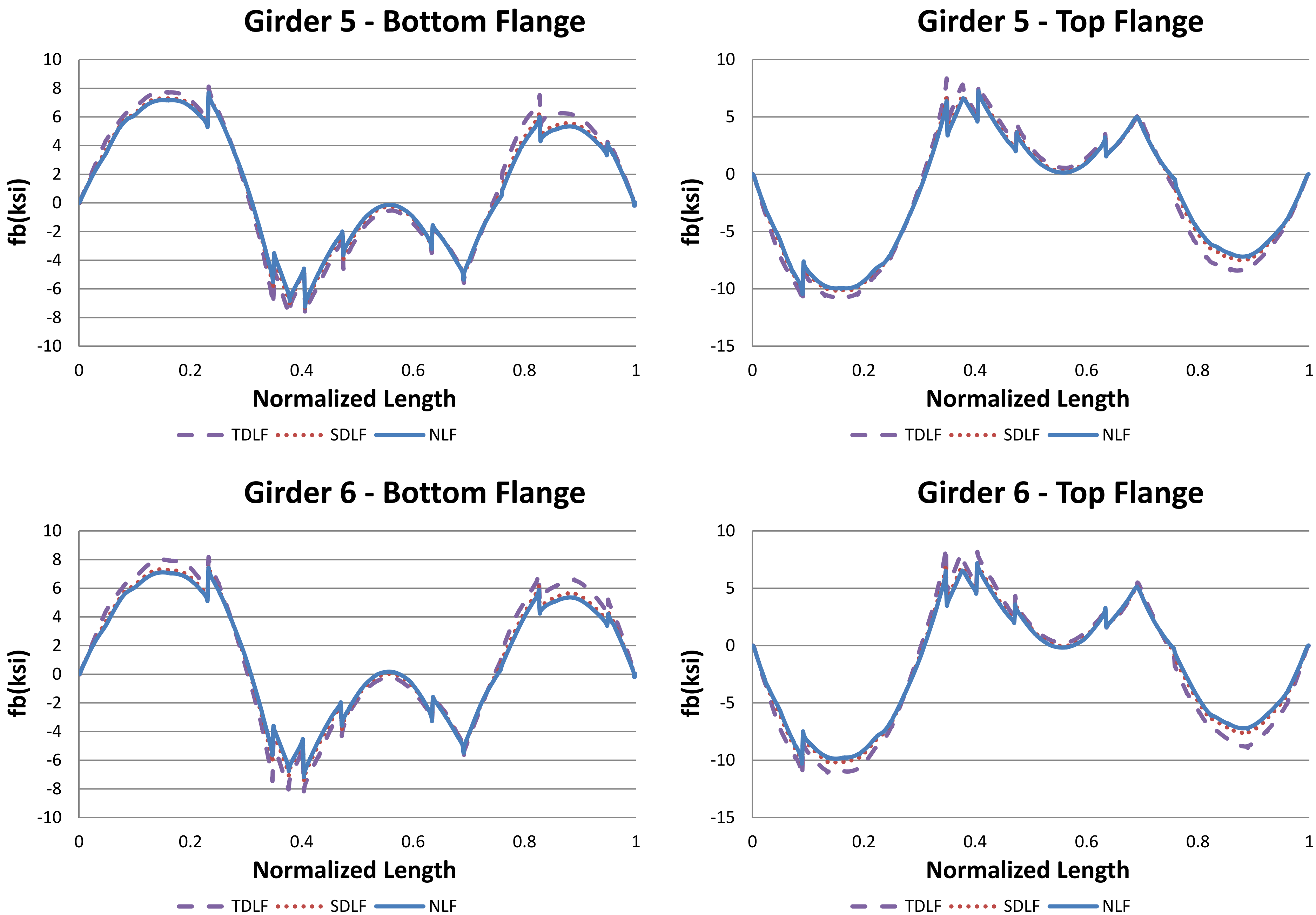


Figure T2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

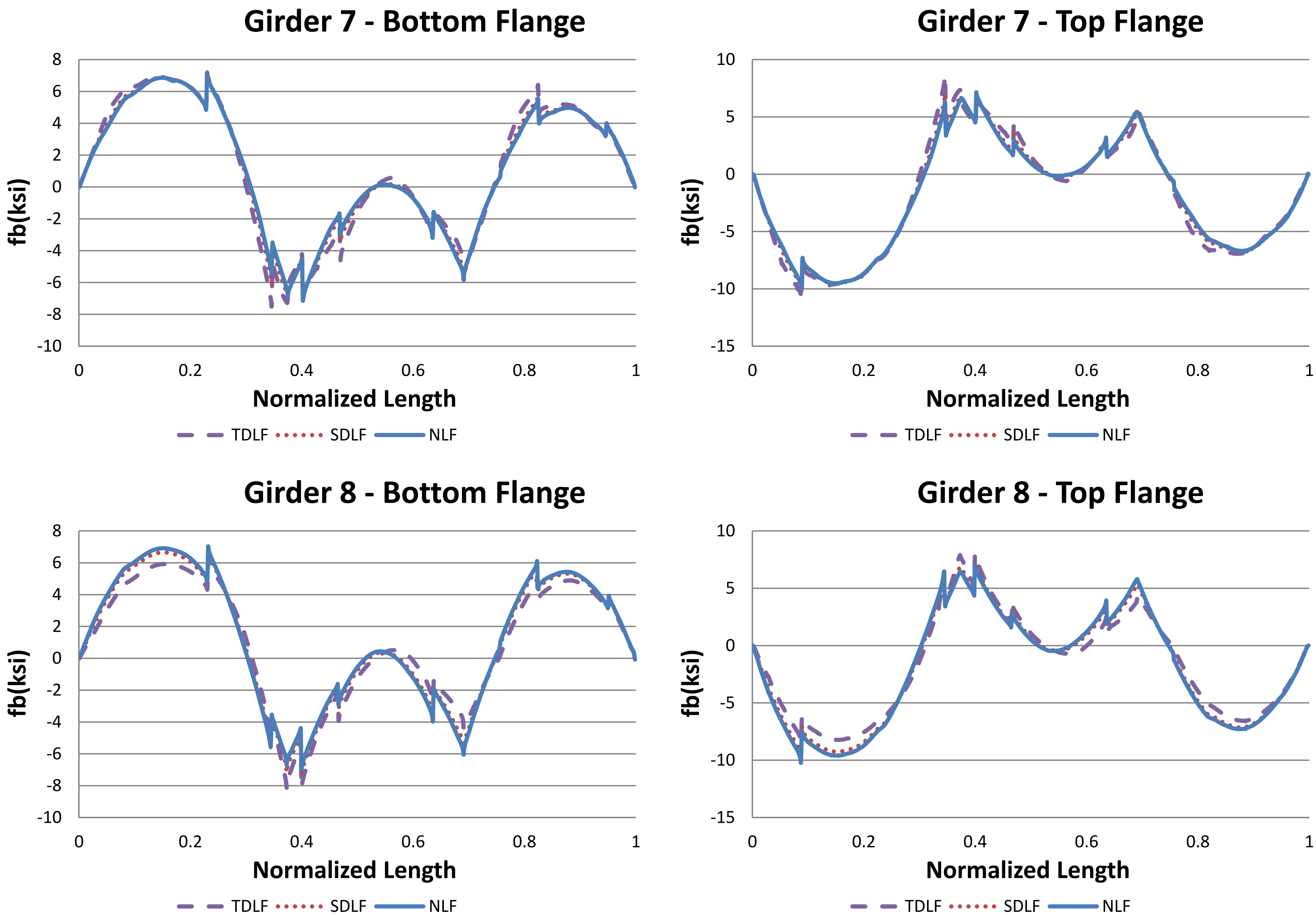


Figure T2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

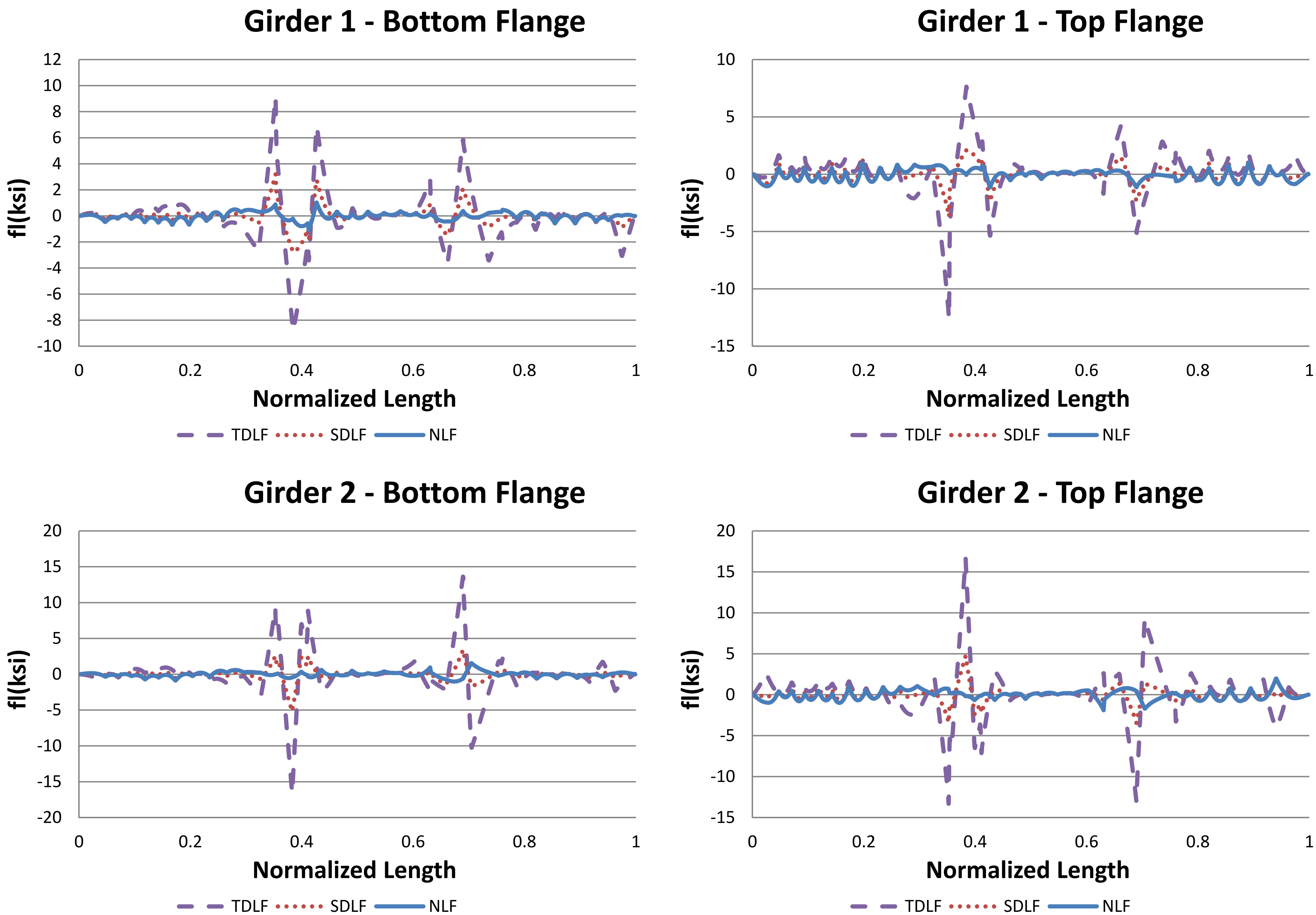
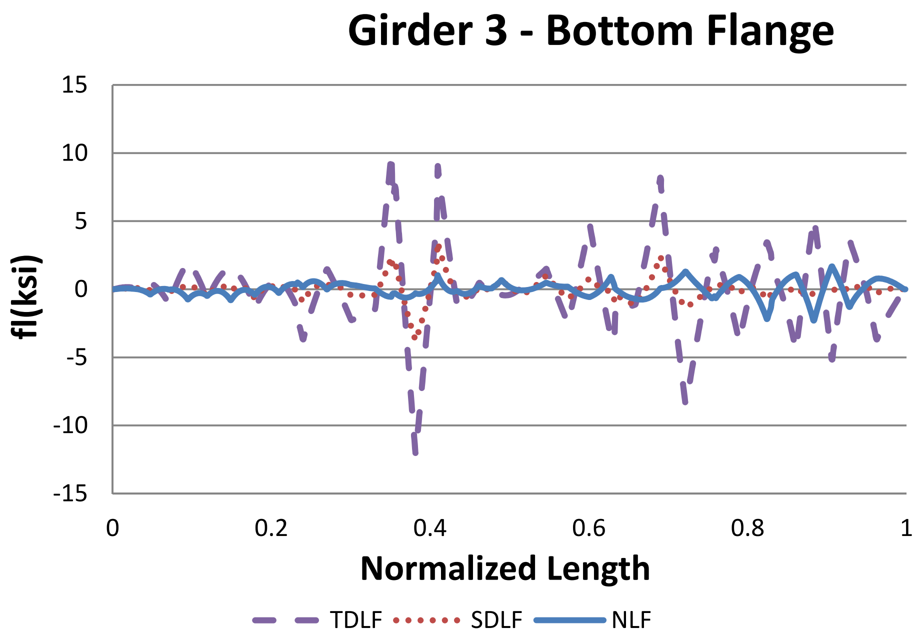
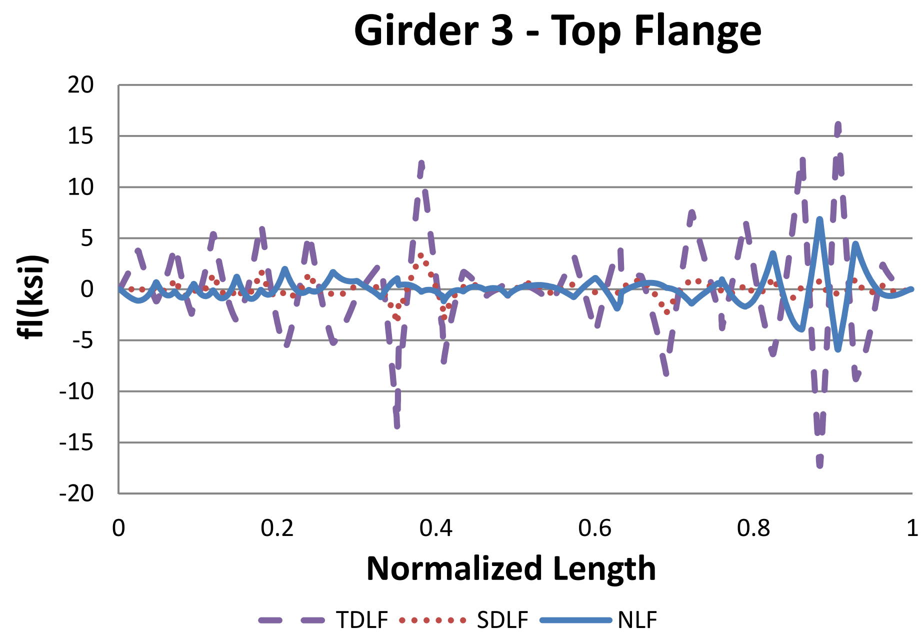
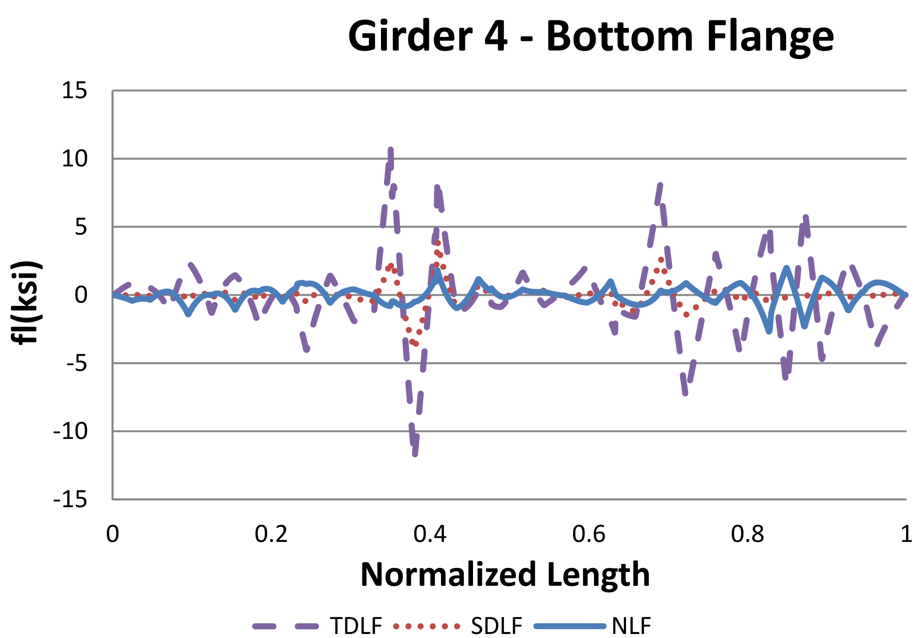


Figure T2-4-19. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**







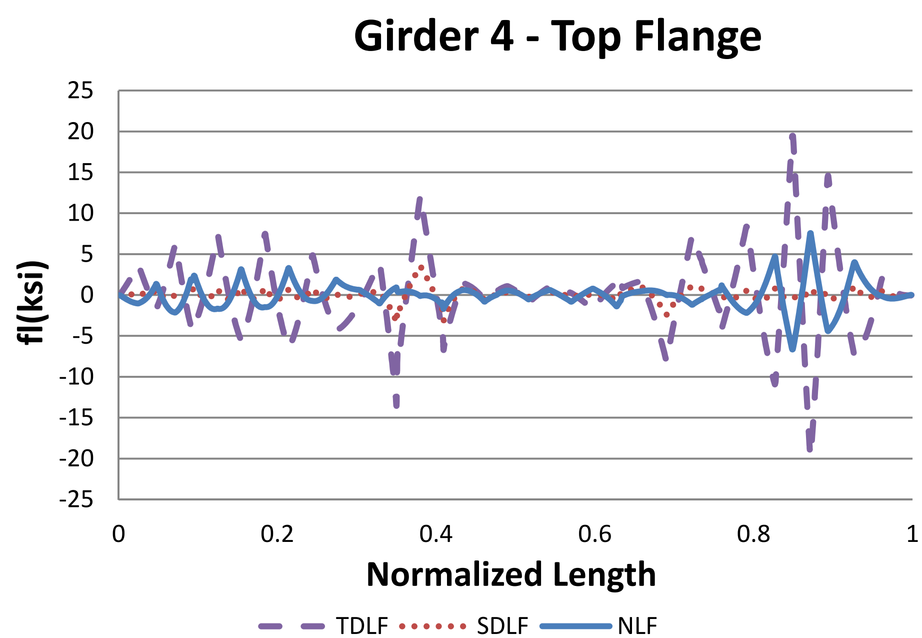


Figure T2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

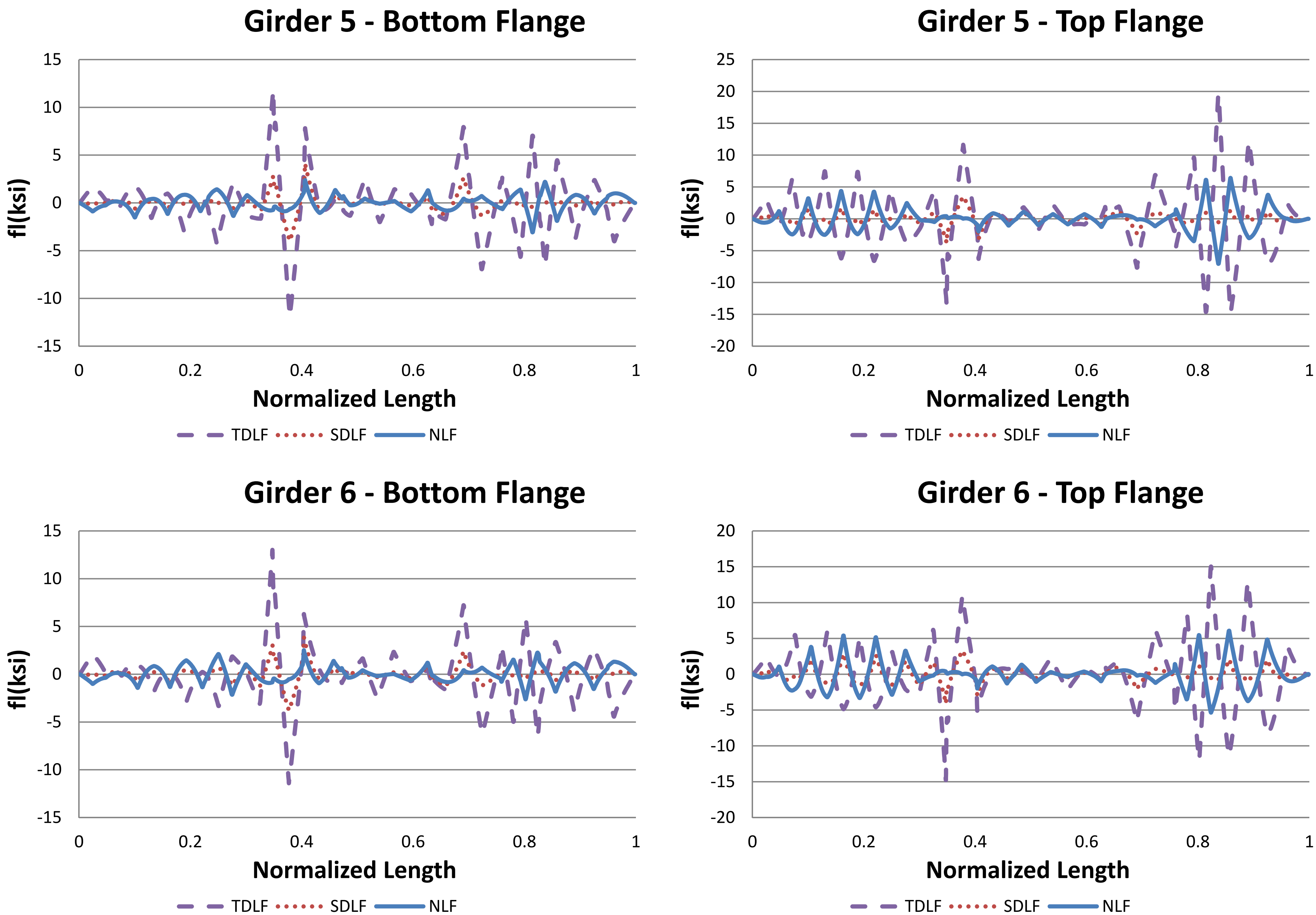


Figure T2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

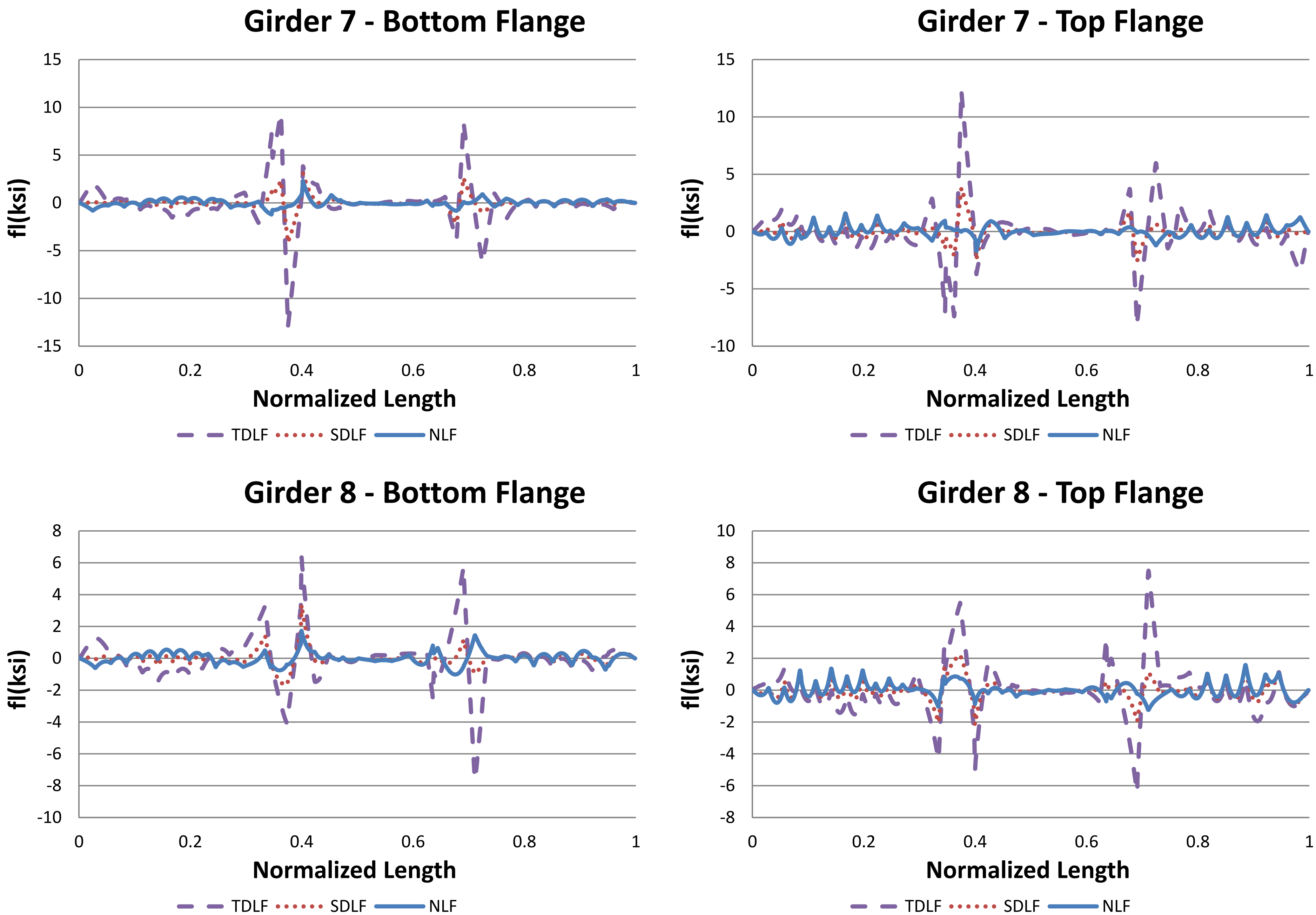


Figure T2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

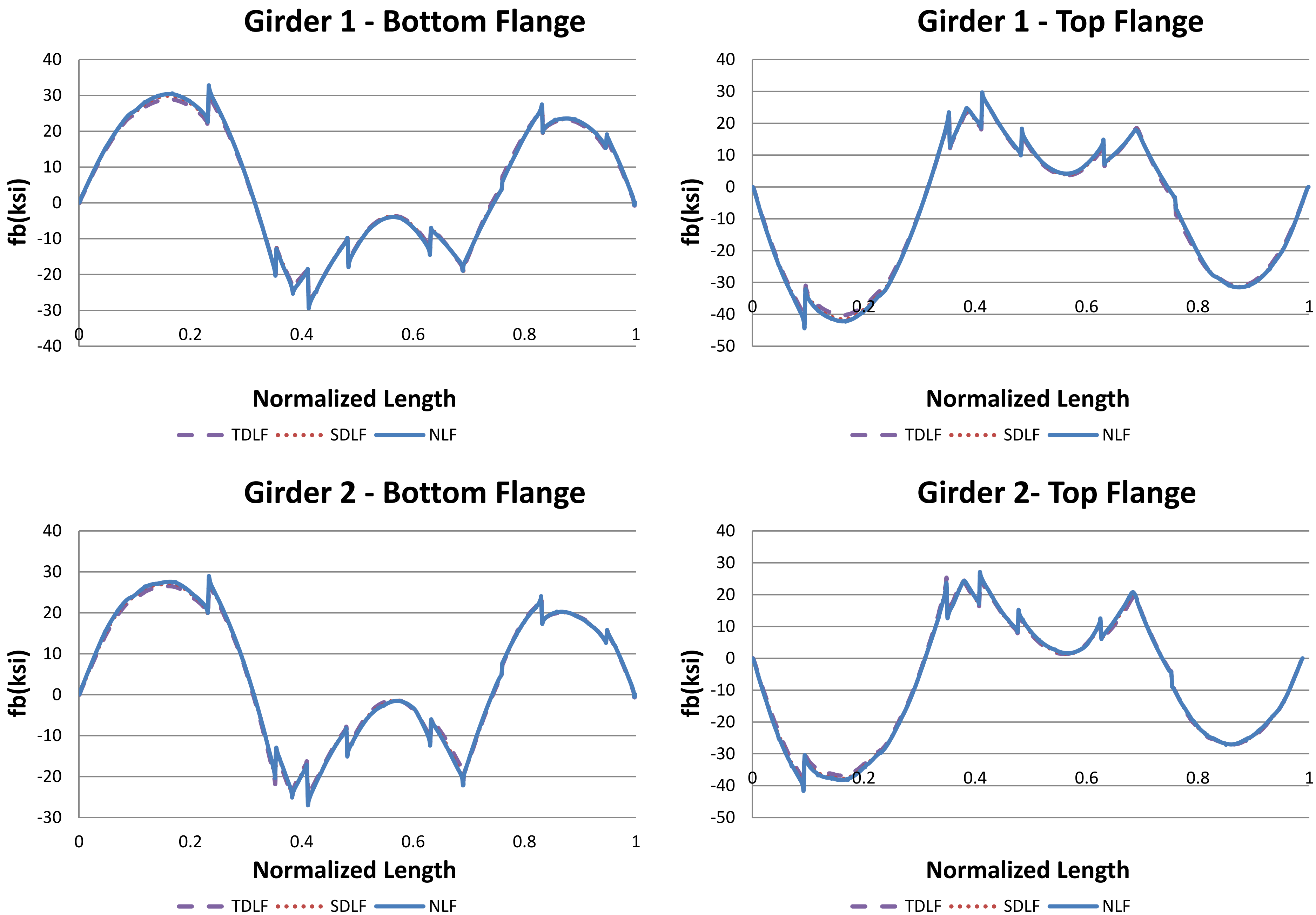


Figure T2-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

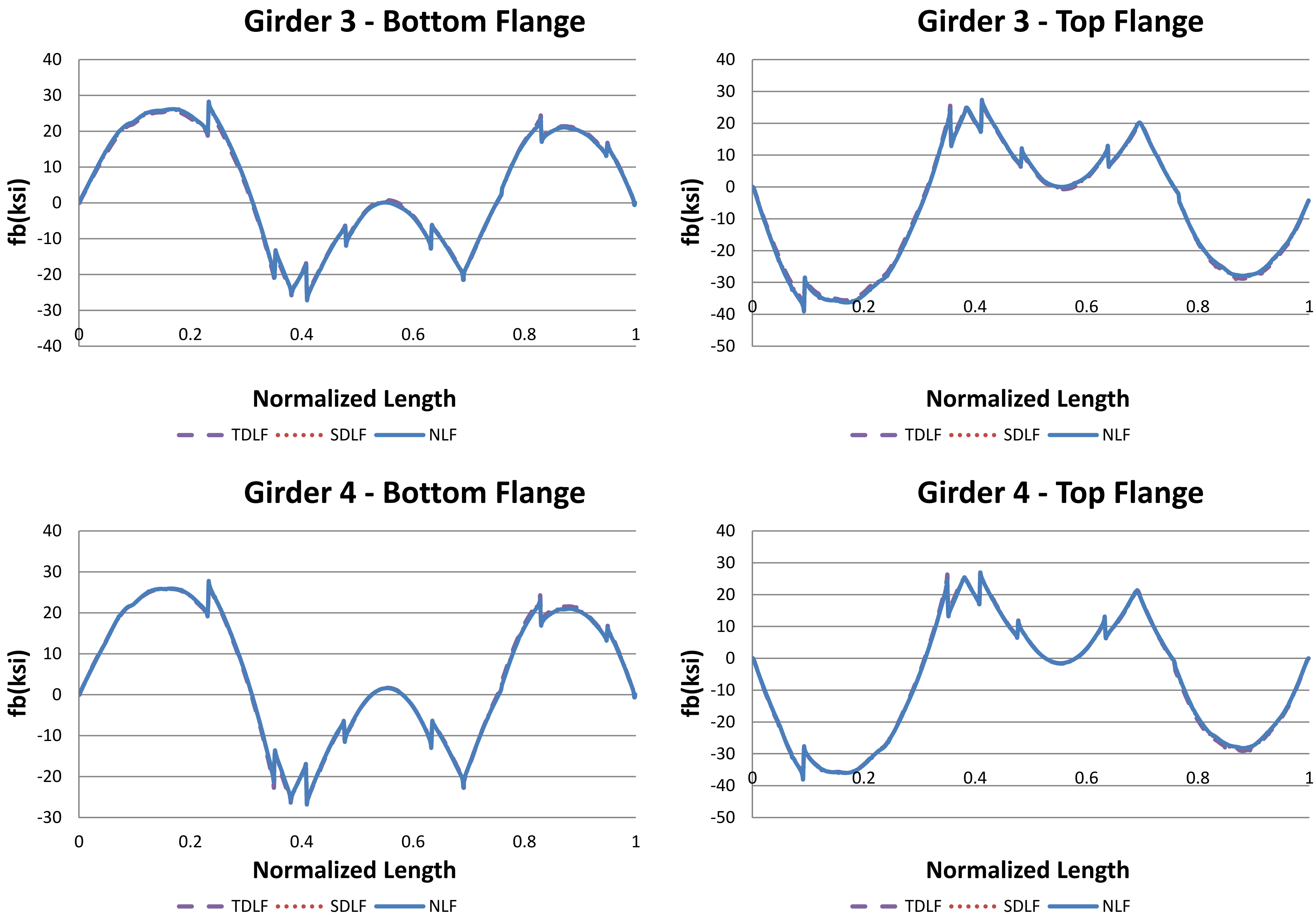


Figure T2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

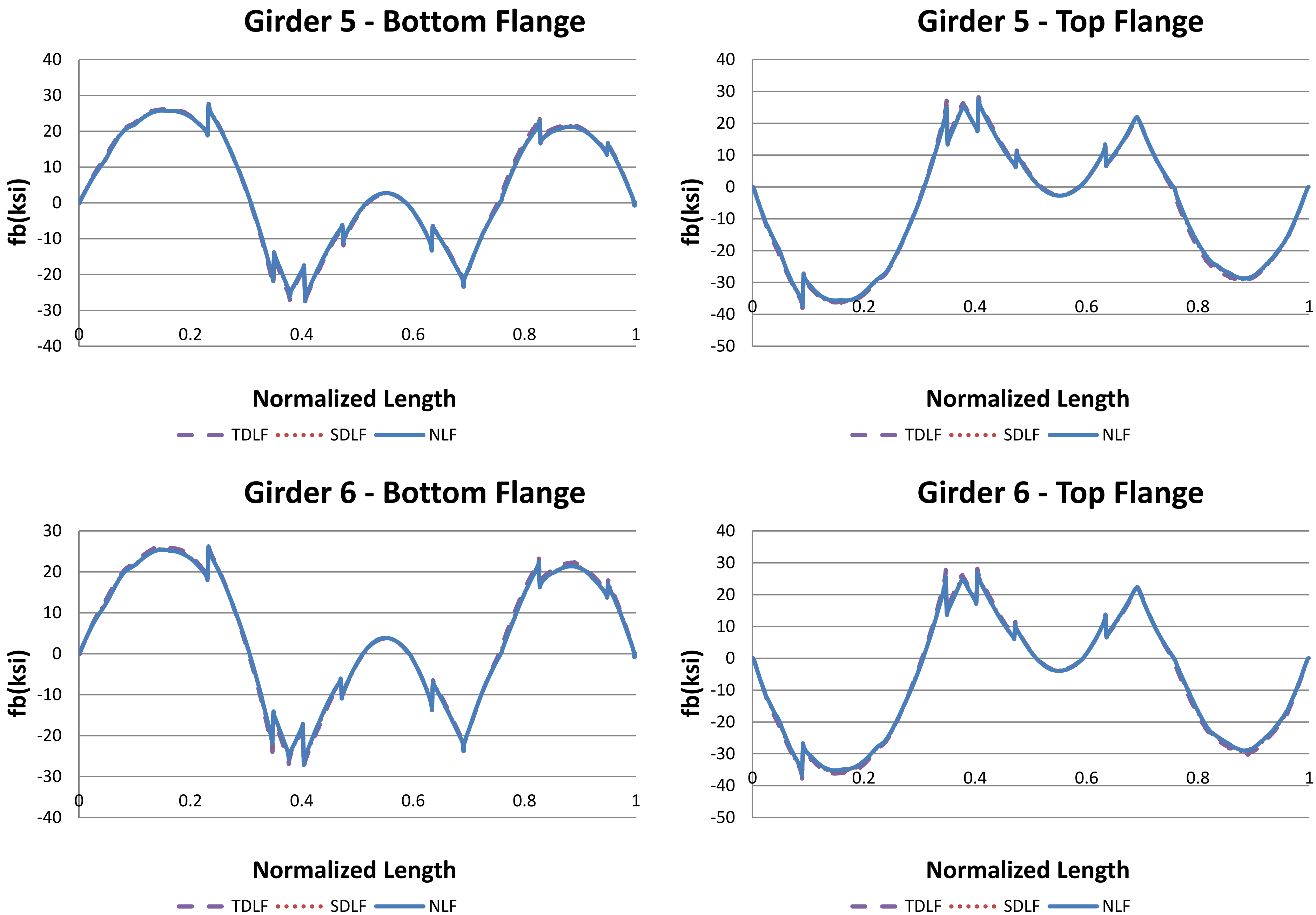


Figure T2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

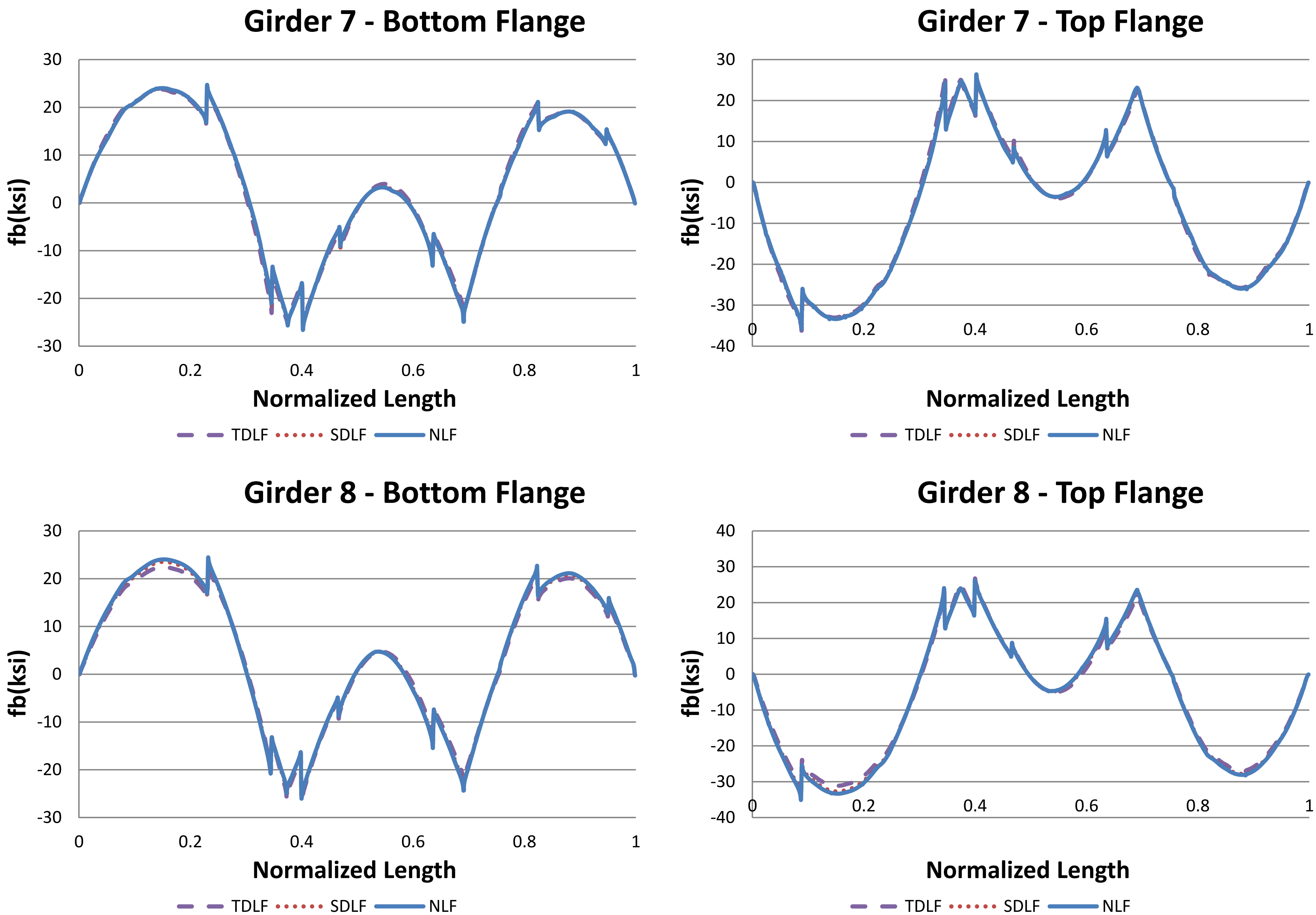


Figure T2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

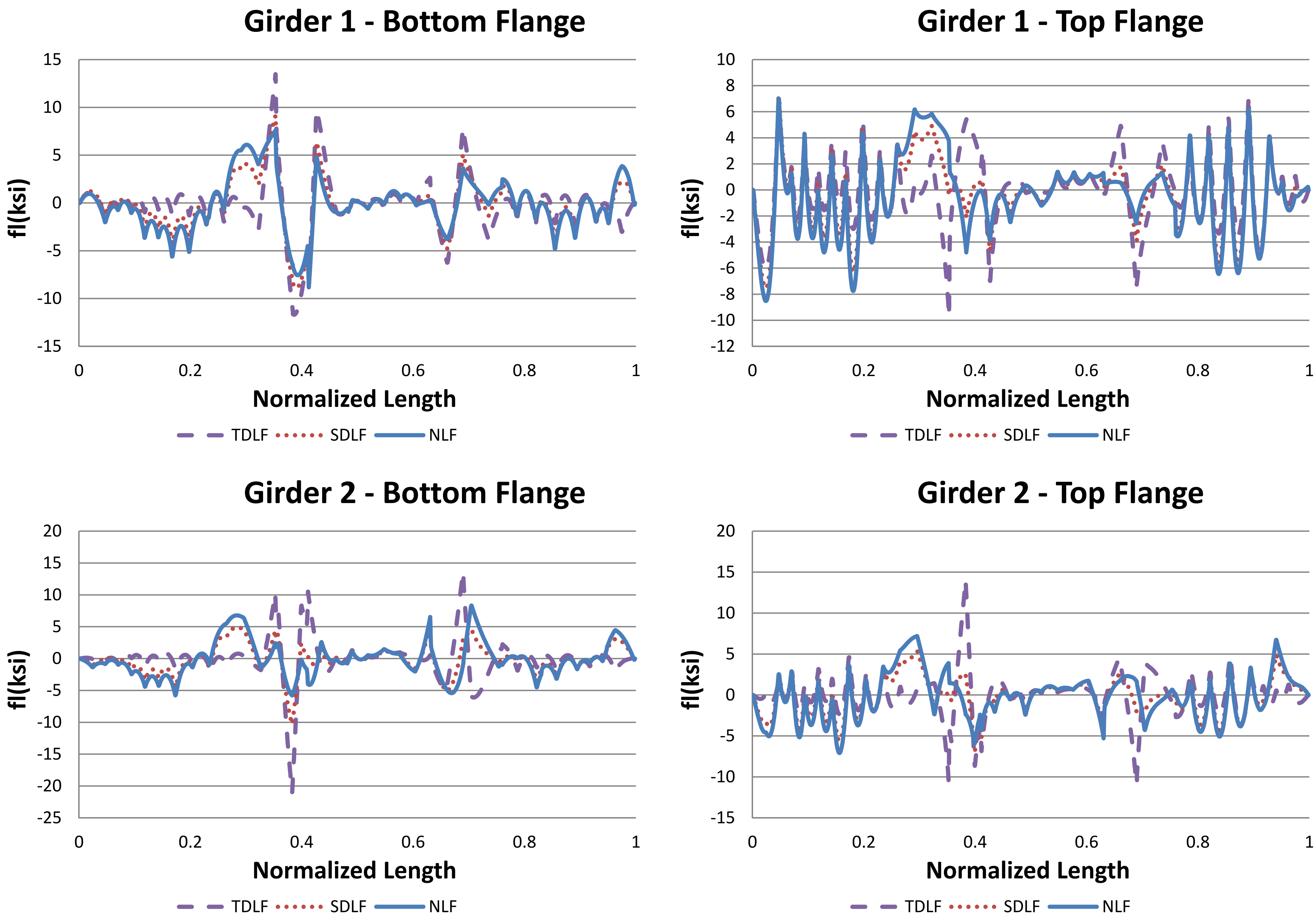


Figure T2-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

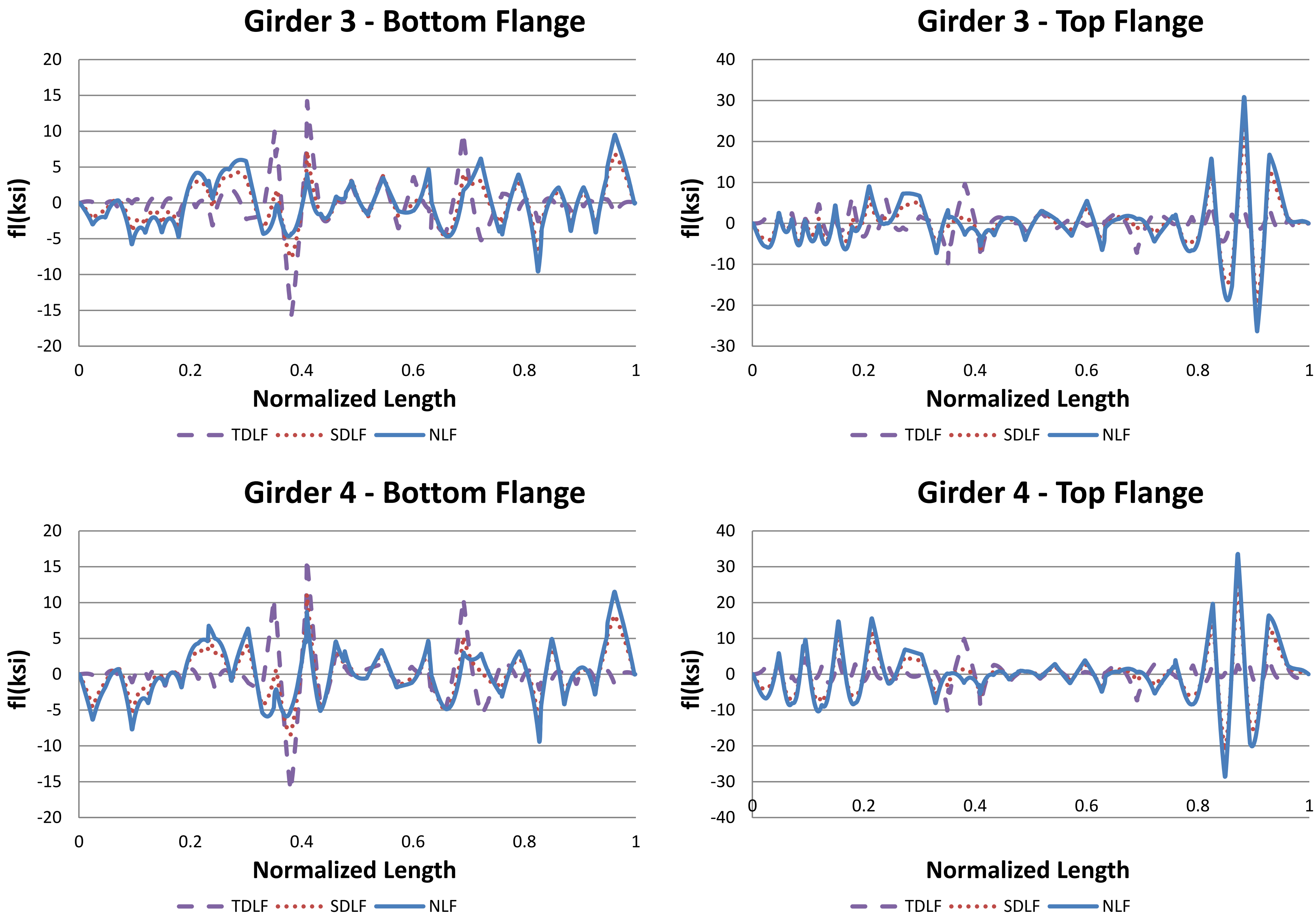


Figure T2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

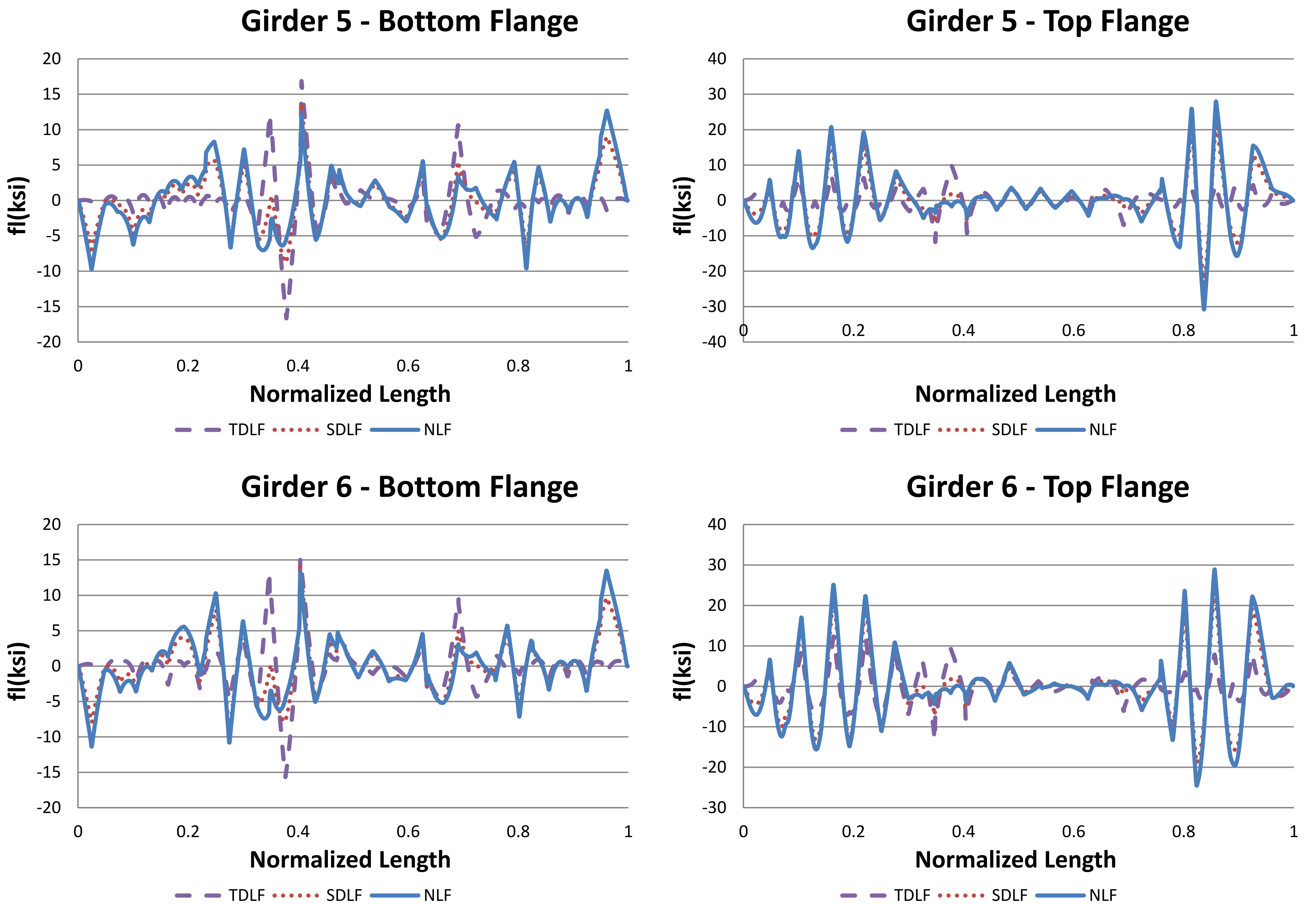


Figure T2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

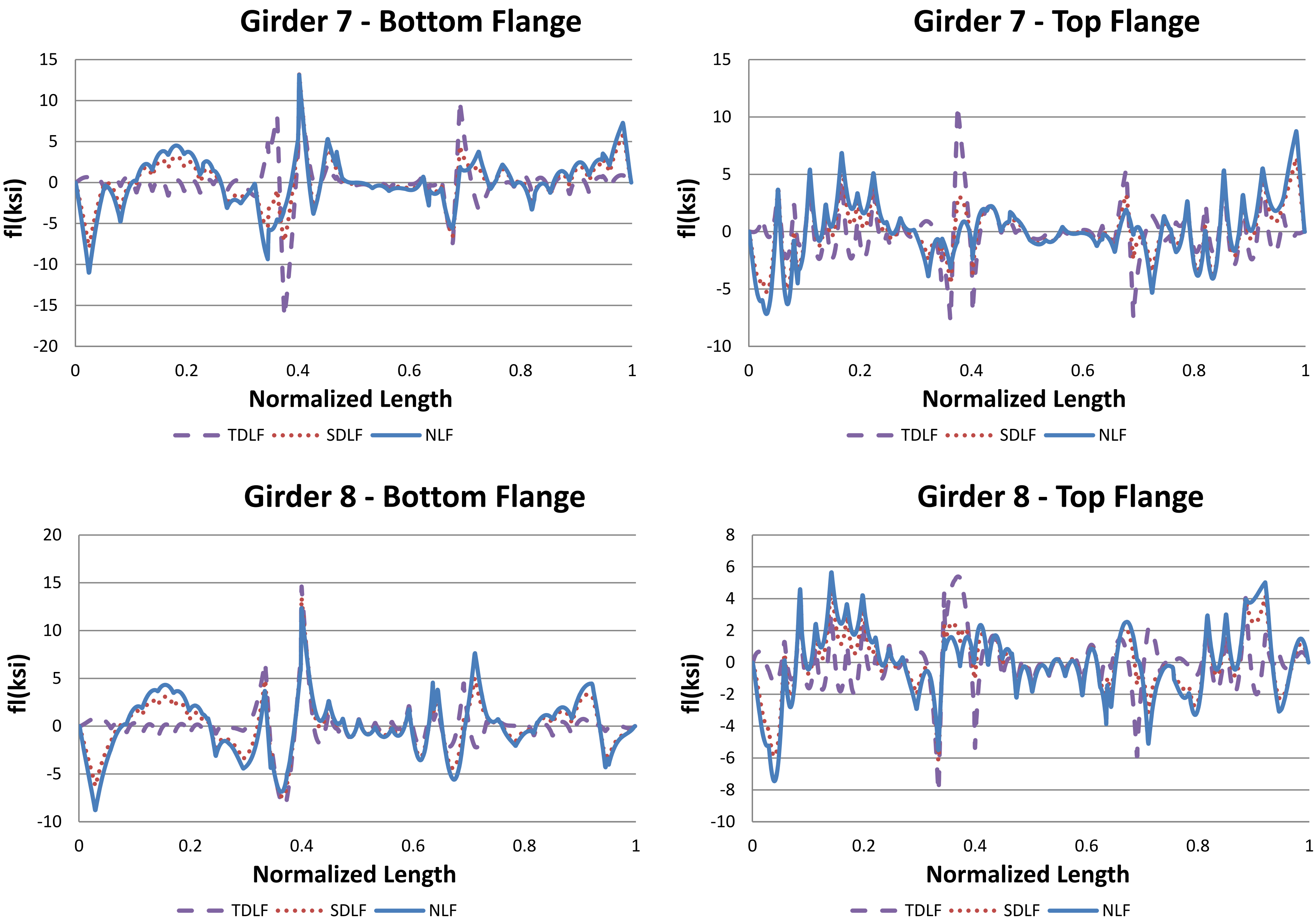


Figure T2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

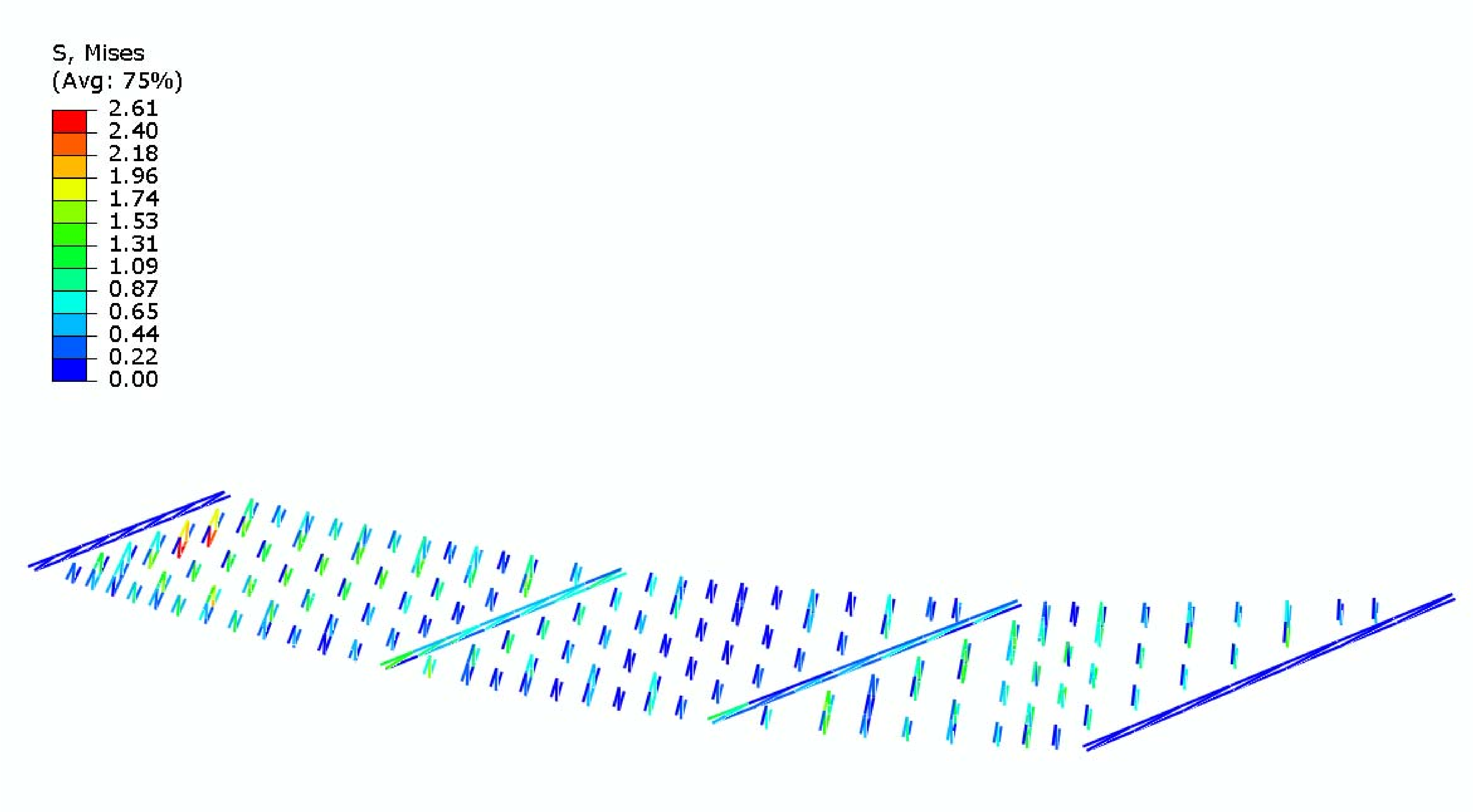


Figure T2-4-22. Cross-frame stress contours (ksi) under SDL, NLF detailing

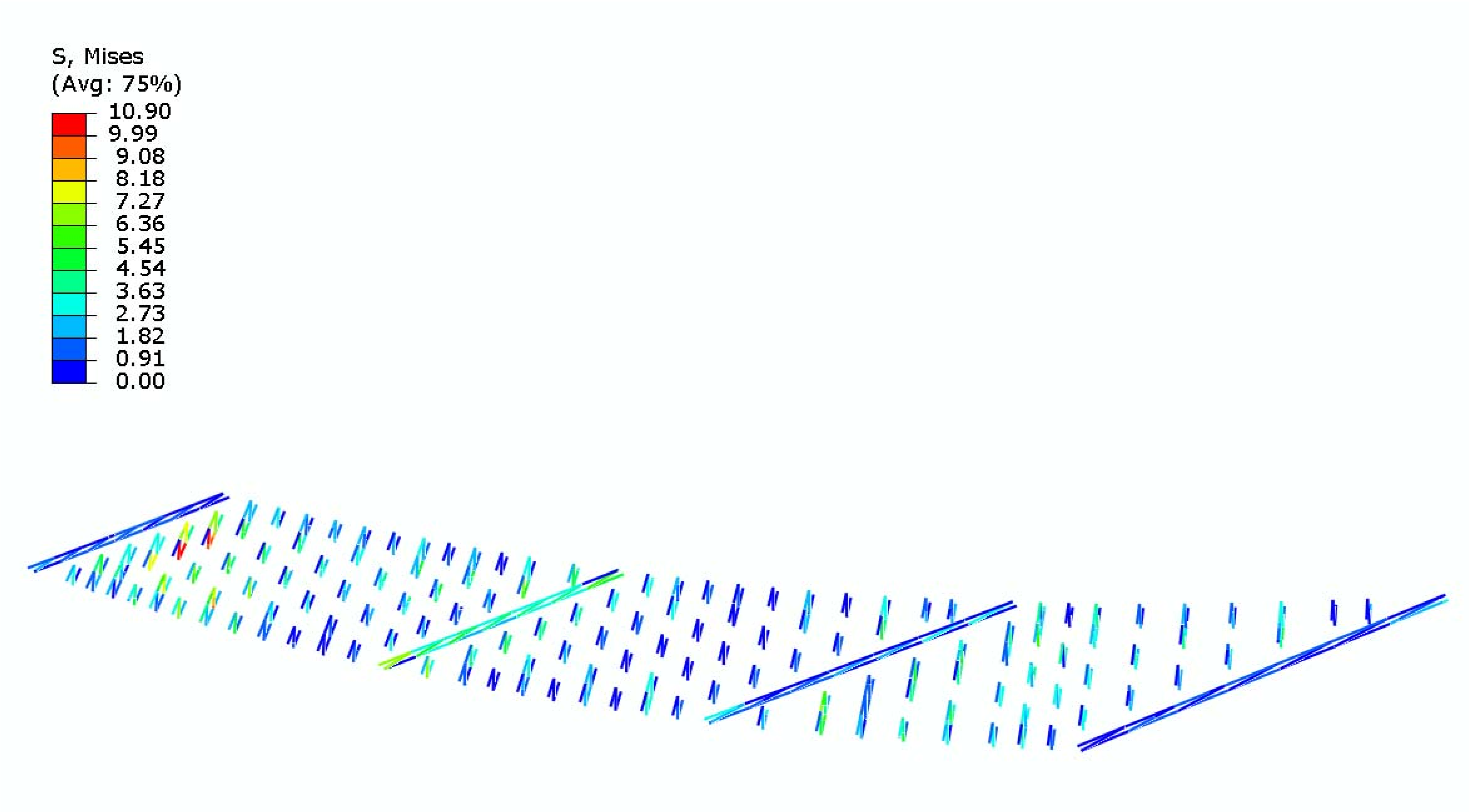


Figure T2-4-23. Cross-frame stress contours under TDL, NLF detailing

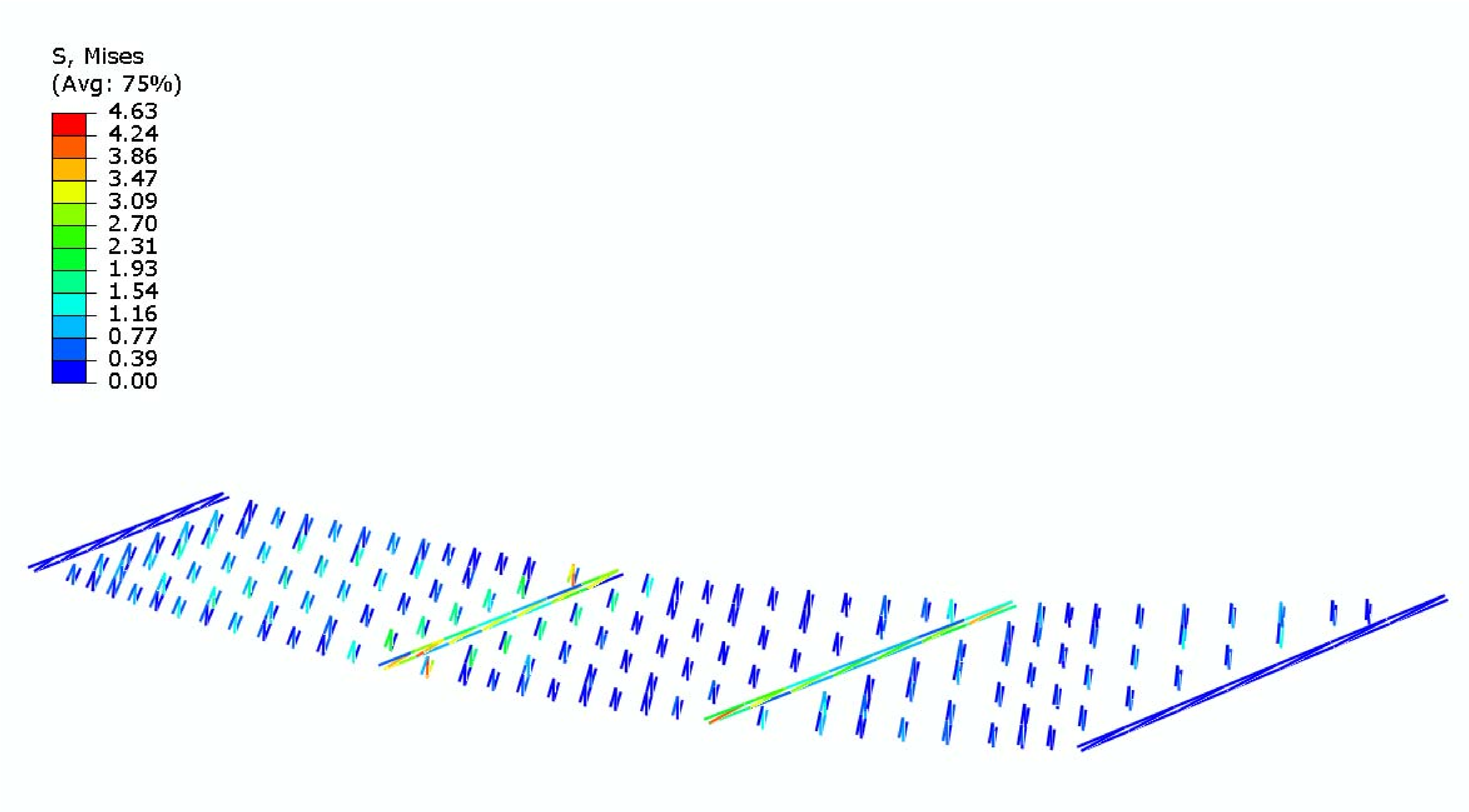


Figure T2-4-24. **Cross-frame stress contours under SDL, SDLF detailing**

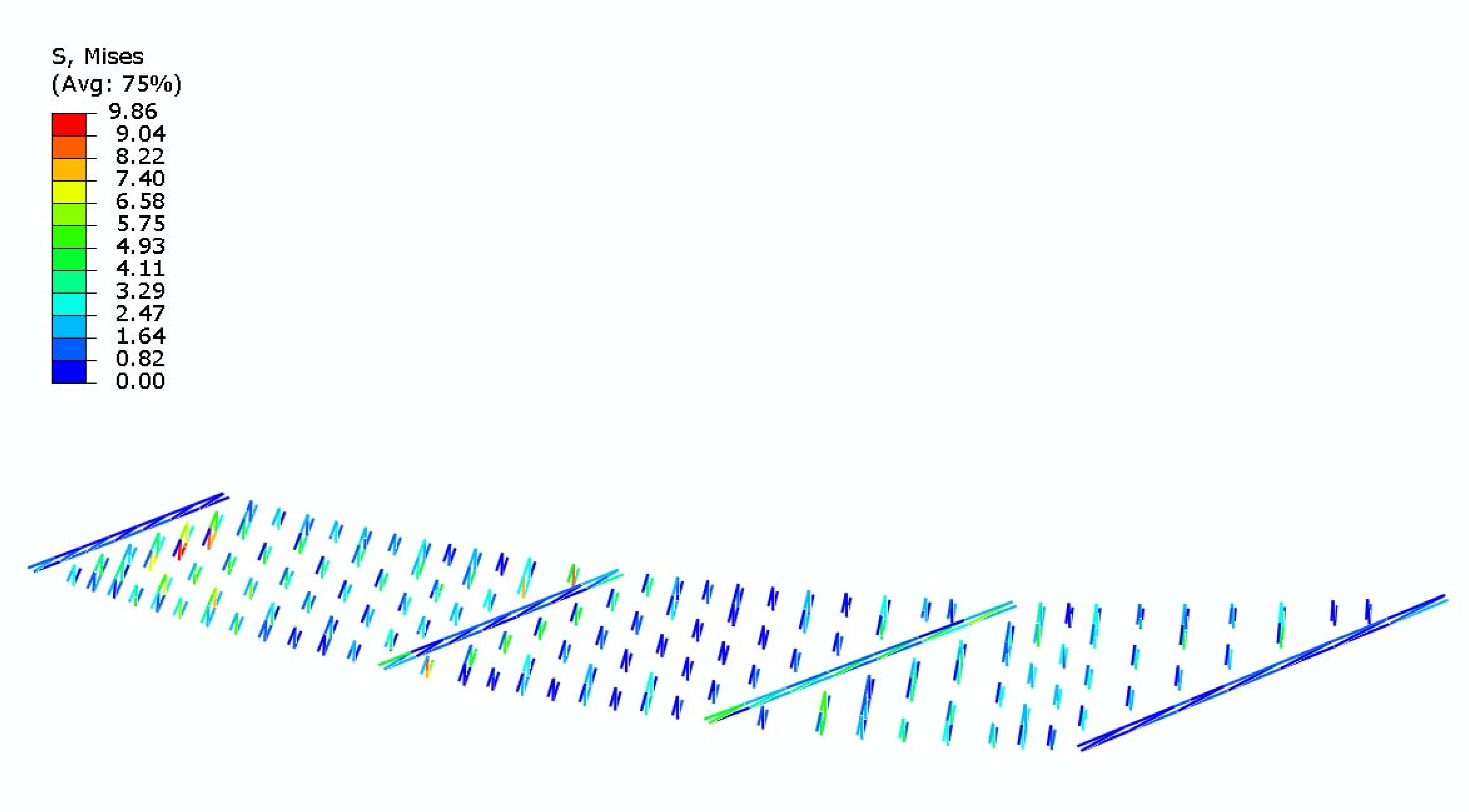


Figure T2-4-25. Cross-frame stress contours under TDL, SDLF detailing

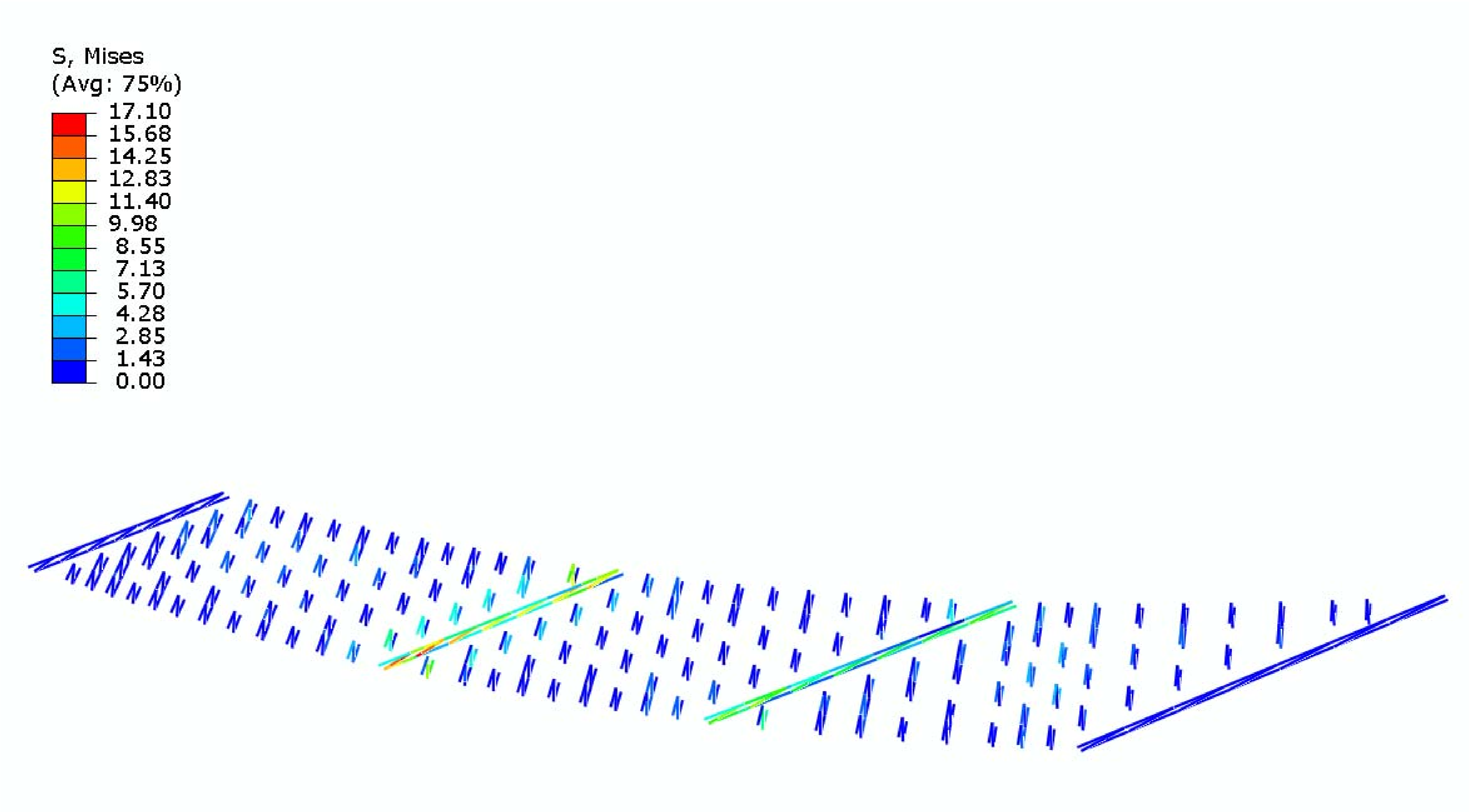


Figure T2-4-26. Cross-frame stress contours under SDL, TDLF detailing

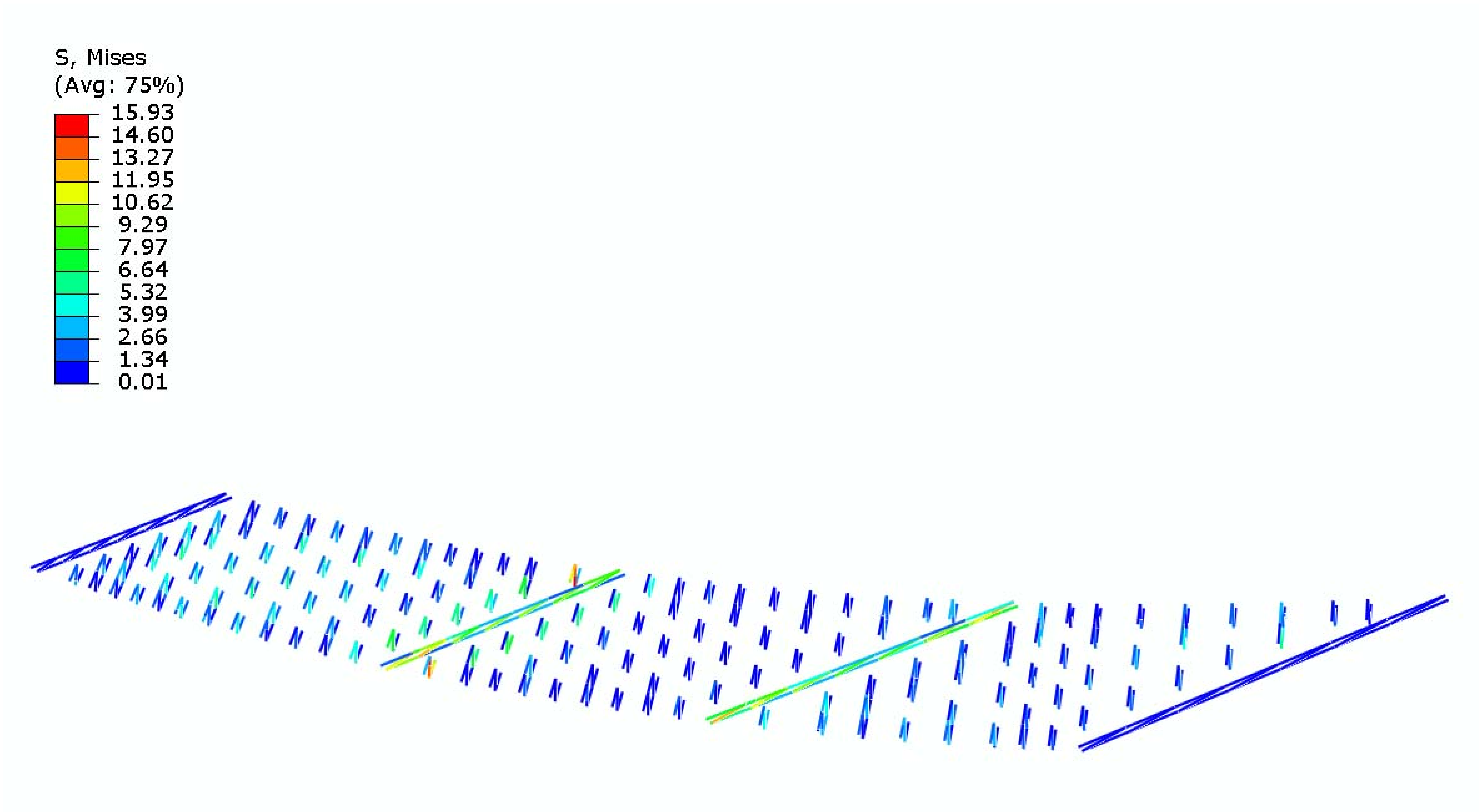


Figure T2-4-27. Cross-frame stress contours under TDL, TDLF detailing

Table T2-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
1	NLF	1.5	1.4	1.3	1.0	0.8	1.5	0.2
	SDLF	0.7	0.4	0.2	0.0	0.1	0.0	0.3
	TDLF	1.7	2.3	2.5	2.5	1.8	3.5	0.6
2	NLF	3.1	8.5	6.1	5.9	14.5	14.0	6.7
	SDLF	3.9	6.3	5.4	2.8	7.0	5.8	0.9
	TDLF	6.1	1.1	6.3	8.5	16.6	17.9	21.4
3	NLF	3.2	3.6	12.5	18.4	18.6	11.6	5.8
	SDLF	0.7	5.4	9.8	12.4	11.7	5.7	5.8
	TDLF	5.1	7.6	1.0	6.6	8.2	9.8	6.0
4	NLF	0.4	12.4	11.4	10.1	9.1	9.5	2.1
	SDLF	0.9	10.5	10.0	10.2	10.2	12.6	1.8
	TDLF	5.3	4.0	5.3	10.4	12.9	19.8	1.4
5	NLF	7.1	15.1	12.7	11.5	11.0	9.5	7.5
	SDLF	6.6	12.3	11.5	11.3	12.0	12.9	7.8
	TDLF	5.0	4.3	7.8	10.4	14.3	23.8	8.5
6	NLF	1.7	9.7	9.8	9.7	9.8	8.2	2.2
	SDLF	1.1	8.6	9.2	9.1	9.9	9.7	1.3
	TDLF	0.0	7.2	7.1	6.9	10.0	14.0	0.6
7	NLF	9.2	3.8	4.7	5.8	6.3	6.5	7.3
	SDLF	8.8	5.3	3.0	3.3	4.0	1.9	7.8
	TDLF	7.6	7.5	1.8	3.9	2.0	10.6	8.7
8	NLF	3.2	4.6	3.3	2.0	2.7	12.0	3.9
	SDLF	2.8	14.8	12.2	11.0	10.5	15.8	1.9
	TDLF	2.2	39.7	34.0	33.2	28.8	20.8	3.6
9	NLF	8.9	7.0	6.5	5.5	5.3	5.6	3.6
	SDLF	8.6	29.1	23.9	22.7	22.7	26.2	4.2
	TDLF	7.9	116.4	97.1	89.8	88.4	99.8	5.8
10	NLF	3.8	8.9	9.1	7.3	6.6	5.7	4.1
	SDLF	2.0	16.7	14.9	13.0	12.1	11.8	0.3
	TDLF	4.1	36.6	28.1	25.8	23.8	24.6	10.5

Table T2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	3.9	6.6	4.6	3.6	3.4	6.5	2.3
	SDLF	3.6	7.3	4.3	3.4	2.4	1.4	1.2
	TDLF	2.5	9.4	3.3	2.8	0.8	14.4	1.5
12	NLF	0.8	4.9	1.1	0.9	0.6	1.1	8.0
	SDLF	1.6	2.8	1.6	1.1	0.3	0.3	2.3
	TDLF	6.4	3.0	3.8	2.2	0.2	1.3	15.6
13	NLF	4.7	5.3	0.0	0.3	0.4	4.2	6.2
	SDLF	9.0	0.1	1.1	0.8	0.3	2.2	30.3
	TDLF	19.2	15.9	5.3	3.5	3.2	4.4	86.5
14	NLF	9.8	3.0	2.5	2.7	2.3	7.0	6.6
	SDLF	28.6	2.5	0.1	0.0	0.0	2.4	24.0
	TDLF	121.9	15.7	5.5	5.3	4.4	11.0	93.4
15	NLF	11.2	2.3	3.8	4.9	5.6	5.6	5.5
	SDLF	33.0	23.5	19.3	18.5	19.0	22.8	10.5
	TDLF	85.2	75.7	57.4	51.9	52.1	64.0	21.7
16	NLF	2.3	8.8	1.5	9.0	10.6	10.0	3.2
	SDLF	1.5	9.2	1.9	2.5	3.3	2.2	0.6
	TDLF	11.4	7.8	8.4	12.5	12.5	14.0	11.4
17	NLF	2.3	1.7	7.7	9.5	5.8	7.3	1.4
	SDLF	3.4	5.6	6.0	6.9	5.1	4.7	2.3
	TDLF	6.1	17.8	4.1	3.8	9.4	10.2	4.3
18	NLF	2.6	8.9	5.1	2.6	0.4	5.2	1.7
	SDLF	3.5	5.3	5.1	4.1	3.3	4.6	0.9
	TDLF	4.8	4.3	5.2	8.4	11.9	1.6	2.7
19	NLF	1.0	3.7	5.1	5.9	7.4	8.0	0.2
	SDLF	1.0	2.4	3.6	5.7	7.3	10.3	0.2
	TDLF	1.2	2.4	1.6	4.7	6.1	17.3	0.2
20	NLF	3.7	7.6	5.6	5.5	6.7	10.0	3.5
	SDLF	2.0	3.8	4.4	4.5	5.6	11.4	1.8
	TDLF	4.1	7.1	0.9	1.5	1.2	16.8	5.2

Table T2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
21	NLF	1.0	0.4	0.5	0.6	0.5	0.9	0.0
	SDLF	0.7	0.4	0.5	0.6	0.7	0.8	0.0
	TDLF	0.2	0.6	0.5	0.4	0.9	0.2	0.1
22	NLF	7.2						5.3
	SDLF	2.7						3.2
	TDLF	10.9						4.9
23	NLF	2.7						2.3
	SDLF	1.3						4.8
	TDLF	11.7						9.7
24	NLF	4.8						2.4
	SDLF	28.4						9.0
	TDLF	85.9						33.5
25	NLF	6.5						5.6
	SDLF	10.3						26.7
	TDLF	54.3						78.6
26	NLF	9.2						0.1
	SDLF	5.6						7.2
	TDLF	6.5						19.4
27	NLF	3.6						0.3
	SDLF	0.2						1.6
	TDLF	8.9						4.8
28	NLF	6.5						7.7
	SDLF	6.1						1.5
	TDLF	5.1						18.9
29	NLF	4.2						3.4
	SDLF	5.2						3.7
	TDLF	6.6						4.4
30	NLF	5.8						3.2
	SDLF	5.4						2.1
	TDLF	4.2						2.6

Table T2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	9.8						5.7
	SDLF	3.1						5.9
	TDLF	15.2						6.3
32	NLF	3.1						3.5
	SDLF	2.2						3.4
	TDLF	0.2						3.3
33	NLF	0.9						3.2
	SDLF	0.1						3.6
	TDLF	1.5						4.6
34	NLF							3.7
	SDLF							2.6
	TDLF							0.2
35	NLF							0.2
	SDLF							0.9
	TDLF							3.7

Table T2-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	15.7	11.5	8.9	7.1	0.1	7.2	2.1
	SDLF	13.4	8.7	6.3	4.9	0.1	5.2	0.9
	TDLF	4.9	1.4	0.1	0.5	0.5	0.3	0.5
2	NLF	21.7	35.9	24.8	24.9	55.8	47.6	17.0
	SDLF	21.0	30.9	18.4	25.0	49.9	40.4	10.5
	TDLF	19.6	20.3	8.2	19.8	29.3	19.0	6.8
3	NLF	10.7	21.4	57.0	77.7	76.8	45.1	26.0
	SDLF	7.1	24.0	54.5	70.3	66.9	35.6	23.7
	TDLF	0.3	26.5	42.6	47.4	40.5	12.5	17.7
4	NLF	2.0	58.8	50.8	46.3	39.6	36.5	8.6
	SDLF	3.0	52.9	45.7	42.5	38.0	38.7	9.2
	TDLF	2.8	37.7	32.9	34.4	35.0	43.5	7.6
5	NLF	35.5	66.4	47.6	36.6	30.2	21.6	20.0
	SDLF	32.8	60.1	45.1	37.2	33.5	28.6	21.6
	TDLF	26.4	44.7	39.6	38.6	41.1	47.0	25.3
6	NLF	6.9	26.5	23.0	20.9	22.6	17.8	12.0
	SDLF	6.4	28.4	26.1	24.5	26.5	22.0	10.8
	TDLF	5.6	34.4	32.2	31.1	34.1	31.6	8.1
7	NLF	48.6	8.9	11.6	18.1	20.3	17.6	13.3
	SDLF	44.1	13.6	12.0	16.8	19.0	13.8	17.2
	TDLF	34.1	21.8	11.3	12.0	14.7	2.5	25.0
8	NLF	15.7	20.3	15.3	12.4	16.9	53.2	17.5
	SDLF	14.6	30.3	23.5	20.1	22.8	55.2	15.5
	TDLF	12.4	53.8	43.5	39.1	36.7	56.3	9.9
9	NLF	36.7	37.7	35.9	31.8	30.0	29.9	7.9
	SDLF	35.9	0.0	4.1	2.4	0.8	2.7	9.2
	TDLF	34.1	91.2	72.1	67.1	66.8	77.5	11.7
10	NLF	11.0	33.6	37.7	29.1	24.7	21.3	17.2
	SDLF	10.7	38.4	41.5	33.6	29.4	27.2	14.1
	TDLF	8.5	52.5	51.3	44.4	40.6	40.4	4.3

Table T2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	6.8	22.2	15.9	11.9	10.6	24.7	4.5
	SDLF	9.7	22.6	15.5	11.8	9.7	19.5	3.3
	TDLF	16.0	24.1	14.5	11.3	6.8	3.8	0.4
12	NLF	0.9	15.6	1.9	1.0	0.8	6.0	24.3
	SDLF	1.5	13.4	2.4	1.2	1.1	5.1	18.4
	TDLF	5.8	7.4	4.3	2.2	1.6	3.5	0.4
13	NLF	12.9	25.8	2.3	1.5	4.4	18.5	41.0
	SDLF	17.7	20.3	1.2	1.0	3.7	16.6	62.5
	TDLF	28.5	4.1	2.8	1.6	1.0	9.8	113.6
14	NLF	51.3	11.5	10.4	10.8	9.4	35.5	42.9
	SDLF	10.8	5.9	7.8	8.1	7.1	30.7	10.3
	TDLF	88.1	7.7	1.9	2.3	2.1	16.2	64.4
15	NLF	51.0	6.5	12.1	15.9	18.7	20.9	21.5
	SDLF	69.0	28.3	28.2	30.0	32.5	38.0	26.0
	TDLF	112.3	80.5	66.9	64.0	66.1	79.8	37.2
16	NLF	7.0	37.2	6.1	32.7	34.8	29.6	12.2
	SDLF	3.7	36.4	3.6	26.4	27.7	22.3	8.1
	TDLF	5.5	32.2	1.8	11.0	11.7	6.9	3.6
17	NLF	5.2	8.7	26.4	30.5	12.5	40.9	7.0
	SDLF	6.3	12.3	24.3	27.3	11.3	38.9	8.0
	TDLF	8.9	22.4	20.2	21.6	14.0	24.3	10.5
18	NLF	14.1	39.5	24.6	13.8	6.4	21.0	11.2
	SDLF	14.8	34.6	23.4	14.1	7.9	19.0	10.3
	TDLF	15.7	21.8	20.4	15.0	12.1	12.3	6.4
19	NLF	1.2	14.5	18.2	22.6	30.1	32.6	2.6
	SDLF	1.3	14.1	17.1	22.6	30.0	34.7	2.6
	TDLF	1.5	11.9	13.3	21.8	27.8	39.2	2.4
20	NLF	18.6	22.8	12.4	9.8	13.0	27.2	18.4
	SDLF	16.8	20.7	13.8	11.9	15.3	32.1	16.6
	TDLF	10.7	14.8	17.1	17.1	20.2	45.8	9.3

Table T2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	0.2	6.6	3.9	2.1	1.9	1.3	2.3
	SDLF	0.6	4.4	2.3	0.9	0.8	0.5	2.2
	TDLF	1.8	2.2	2.2	2.1	1.9	1.0	2.1
22	NLF	28.2						23.5
	SDLF	23.2						21.4
	TDLF	9.0						12.7
23	NLF	7.4						13.8
	SDLF	3.5						16.0
	TDLF	6.5						19.7
24	NLF	15.1						10.9
	SDLF	38.4						0.0
	TDLF	93.7						22.3
25	NLF	16.5						21.7
	SDLF	1.0						43.2
	TDLF	39.8						97.7
26	NLF	34.2						9.0
	SDLF	30.2						15.7
	TDLF	17.5						25.8
27	NLF	16.8						2.0
	SDLF	13.7						3.5
	TDLF	5.0						6.7
28	NLF	35.6						28.6
	SDLF	33.5						23.1
	TDLF	27.4						4.4
29	NLF	21.1						13.3
	SDLF	21.9						12.5
	TDLF	23.0						9.9
30	NLF	25.4						10.6
	SDLF	25.1						10.5
	TDLF	24.5						9.3

Table T2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	31.8						15.5
	SDLF	25.8						16.6
	TDLF	10.4						19.2
32	NLF	9.2						21.9
	SDLF	9.6						21.5
	TDLF	11.4						19.6
33	NLF	6.4						2.6
	SDLF	4.6						5.0
	TDLF	2.9						11.4
34	NLF							5.2
	SDLF							4.7
	TDLF							3.4
35	NLF							8.8
	SDLF							6.6
	TDLF							1.7

Table T2-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	0.7	0.3	0.3	0.2	0.9	0.7	0.6
	SDLF	0.1	0.1	0.3	0.3	0.1	0.1	0.2
	TDLF	1.2	0.6	0.3	0.6	2.2	0.8	0.2
2	NLF	0.0	0.1	1.2	2.5	2.7	2.5	2.2
	SDLF	0.7	0.7	1.0	1.3	1.1	1.0	1.3
	TDLF	2.2	1.7	0.0	2.2	3.3	3.1	1.1
3	NLF	4.8	1.5	10.0	16.8	16.2	9.5	2.0
	SDLF	2.8	2.1	5.4	8.8	8.2	3.1	2.2
	TDLF	1.6	6.0	9.3	15.1	14.1	13.7	2.9
4	NLF	2.5	4.1	6.9	7.5	7.8	9.3	3.5
	SDLF	3.8	1.7	3.7	4.9	5.8	9.1	3.4
	TDLF	8.0	4.6	5.3	2.4	0.1	6.7	3.2
5	NLF	2.4	5.1	7.0	8.2	9.6	10.5	3.3
	SDLF	2.0	3.1	4.4	5.4	7.2	10.1	3.3
	TDLF	1.1	2.0	3.0	2.7	0.7	9.1	3.4
6	NLF	2.3	4.3	5.8	7.4	9.4	11.0	4.2
	SDLF	2.8	2.4	3.4	4.6	6.6	9.0	4.3
	TDLF	3.6	2.8	3.5	4.2	2.4	2.9	4.5
7	NLF	3.4	2.6	3.6	5.3	7.5	8.7	3.5
	SDLF	3.1	0.6	1.5	2.5	4.5	4.5	3.5
	TDLF	2.6	4.8	4.6	5.9	4.3	7.7	3.7
8	NLF	2.4	1.1	1.2	0.1	0.1	8.0	3.9
	SDLF	2.3	1.7	1.9	3.0	4.2	0.0	3.7
	TDLF	1.6	9.1	9.8	10.8	14.8	23.4	3.1
9	NLF	3.6	3.7	2.9	3.0	4.0	4.6	1.9
	SDLF	3.5	5.9	8.1	8.5	9.2	15.4	2.2
	TDLF	3.4	29.0	34.5	35.0	39.2	60.5	2.8
10	NLF	0.0	4.8	6.7	7.1	6.8	6.1	3.1
	SDLF	1.3	12.1	13.3	13.0	11.9	11.0	2.4
	TDLF	6.0	29.6	29.2	26.7	23.3	21.1	0.5

Table T2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	2.1	1.4	3.0	3.2	3.3	6.1	1.2
	SDLF	2.2	1.4	2.5	2.7	2.1	0.8	1.3
	TDLF	2.6	2.6	2.6	2.7	0.1	13.3	1.6
12	NLF	0.4	0.0	0.5	0.7	0.7	0.7	0.9
	SDLF	3.7	0.2	0.4	0.7	0.4	0.0	1.2
	TDLF	13.2	0.2	1.7	2.7	1.8	3.3	1.6
13	NLF	0.6	0.4	0.2	0.4	0.2	3.2	3.5
	SDLF	2.2	0.6	0.1	0.3	0.3	1.7	5.2
	TDLF	9.6	2.9	0.1	1.3	2.1	4.6	8.1
14	NLF	0.5	2.0	1.9	2.2	2.0	5.9	5.8
	SDLF	19.7	1.3	1.7	2.1	2.1	3.9	0.8
	TDLF	68.7	1.6	0.5	1.4	2.3	3.8	13.4
15	NLF	4.7	3.1	2.9	2.6	2.1	1.3	5.2
	SDLF	20.3	5.2	6.7	7.0	8.0	13.5	9.1
	TDLF	57.5	10.5	16.2	18.1	22.4	42.3	16.6
16	NLF	0.0	3.4	2.5	2.3	2.3	3.0	1.1
	SDLF	2.2	2.6	2.7	2.5	1.9	2.0	0.3
	TDLF	8.4	18.1	16.5	15.0	12.9	15.6	3.2
17	NLF	1.0	1.4	7.5	9.1	8.1	2.6	1.1
	SDLF	1.7	0.3	3.6	4.0	3.0	4.8	1.6
	TDLF	3.3	1.0	5.1	6.7	6.4	5.3	2.4
18	NLF	3.1	5.3	7.2	8.8	7.4	8.6	0.5
	SDLF	3.8	2.8	2.3	1.9	1.8	3.0	0.5
	TDLF	4.8	4.6	12.1	18.4	14.9	15.4	0.7
19	NLF	0.4	9.2	9.8	8.2	6.9	7.9	0.2
	SDLF	0.4	2.2	1.7	2.6	3.6	6.8	0.2
	TDLF	0.5	18.1	22.4	14.5	7.1	2.3	0.3
20	NLF	3.7	6.1	5.0	4.8	5.8	9.1	0.1
	SDLF	2.2	1.6	2.3	2.5	3.4	8.7	0.1
	TDLF	3.1	11.4	6.2	5.1	5.4	7.3	0.1

Table T2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	0.3	1.1	1.1	0.8	0.2	0.7	0.1
	SDLF	0.3	0.8	0.6	0.4	0.4	0.0	0.1
	TDLF	0.1	0.8	1.3	1.2	0.4	1.5	0.2
22	NLF	5.0						0.5
	SDLF	0.2						0.4
	TDLF	14.8						0.0
23	NLF	2.0						0.2
	SDLF	2.0						0.4
	TDLF	0.6						2.1
24	NLF	2.2						3.2
	SDLF	11.0						1.3
	TDLF	45.2						3.9
25	NLF	5.2						0.8
	SDLF	7.2						11.8
	TDLF	40.0						42.5
26	NLF	9.7						4.6
	SDLF	6.3						2.1
	TDLF	4.5						20.8
27	NLF	1.0						0.5
	SDLF	2.4						1.8
	TDLF	11.2						8.1
28	NLF	2.4						0.4
	SDLF	2.2						0.4
	TDLF	1.5						0.3
29	NLF	0.4						1.2
	SDLF	1.2						1.2
	TDLF	2.6						1.1
30	NLF	2.6						2.4
	SDLF	2.2						2.3
	TDLF	1.1						2.0

Table T2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	6.9						2.6
	SDLF	2.2						2.6
	TDLF	11.0						2.7
32	NLF	2.1						3.4
	SDLF	0.1						3.2
	TDLF	5.1						2.5
33	NLF	0.5						1.4
	SDLF	0.9						1.7
	TDLF	0.9						2.5
34	NLF							2.8
	SDLF							2.3
	TDLF							0.7
35	NLF							0.1
	SDLF							0.3
	TDLF							1.2

Table T2-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	4.1	6.9	9.4	8.1	8.6	0.6	1.3
	SDLF	4.4	5.8	7.1	6.1	6.6	1.2	0.1
	TDLF	1.6	0.2	0.1	0.3	1.0	0.8	0.9
2	NLF	5.4	7.8	16.0	25.6	29.8	28.1	17.3
	SDLF	5.4	7.0	12.5	19.3	22.1	21.5	12.8
	TDLF	2.9	2.6	3.2	3.5	2.1	2.1	0.4
3	NLF	18.4	2.1	51.7	74.2	62.7	26.9	2.2
	SDLF	15.0	3.3	45.6	63.7	53.2	19.8	2.6
	TDLF	8.6	1.7	26.2	33.4	27.6	4.0	5.3
4	NLF	9.2	22.2	30.2	25.5	19.7	21.8	5.8
	SDLF	9.0	17.9	25.4	23.0	19.3	24.0	6.3
	TDLF	10.7	7.4	13.3	16.9	19.0	28.4	7.8
5	NLF	11.0	18.3	15.0	12.4	16.7	23.0	6.5
	SDLF	9.8	16.3	15.2	14.1	18.8	26.2	7.1
	TDLF	7.2	12.8	16.8	18.3	22.3	33.3	8.8
6	NLF	11.4	0.0	4.5	14.5	27.1	35.3	4.4
	SDLF	10.9	2.8	7.0	15.5	26.7	34.6	6.5
	TDLF	10.1	10.2	11.7	14.8	21.8	30.1	11.0
7	NLF	16.3	4.0	15.1	27.3	36.9	35.7	4.9
	SDLF	14.4	3.4	12.7	22.9	32.3	30.8	6.5
	TDLF	10.8	0.1	4.3	9.1	18.0	15.7	9.7
8	NLF	13.2	4.0	4.2	6.0	3.7	30.2	8.6
	SDLF	11.9	4.5	5.1	8.1	8.0	21.7	9.1
	TDLF	8.0	6.0	7.9	13.5	19.3	3.6	9.5
9	NLF	12.7	22.6	19.0	18.7	21.6	21.5	3.2
	SDLF	12.5	11.3	6.4	5.7	6.7	0.4	3.9
	TDLF	12.3	15.7	23.0	23.6	25.9	45.9	5.1
10	NLF	7.0	21.6	28.6	29.6	27.6	25.2	11.2
	SDLF	6.5	28.1	34.2	34.5	32.0	29.7	9.7
	TDLF	6.3	43.5	47.8	46.4	42.2	39.1	5.6

Table T2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	2.6	4.7	10.2	10.6	9.8	20.9	0.6
	SDLF	4.3	4.5	9.6	10.0	8.6	15.7	0.9
	TDLF	8.1	5.2	9.1	9.6	6.7	1.7	1.6
12	NLF	6.0	2.0	0.8	1.0	1.9	6.4	2.4
	SDLF	9.8	2.3	0.8	0.8	1.9	5.4	2.1
	TDLF	18.2	1.9	0.5	1.4	0.1	1.5	1.0
13	NLF	5.2	0.7	1.5	0.9	2.1	15.1	24.9
	SDLF	5.9	1.6	1.6	0.9	1.9	13.5	25.1
	TDLF	7.6	3.7	1.4	0.1	0.2	7.3	24.2
14	NLF	6.2	9.3	9.1	10.0	9.0	29.8	34.5
	SDLF	15.1	8.5	8.8	9.6	8.7	27.4	27.3
	TDLF	67.5	5.0	6.8	8.1	7.8	18.1	15.4
15	NLF	23.5	10.1	9.0	6.3	4.8	5.1	26.1
	SDLF	38.0	12.2	13.0	11.4	11.7	18.3	29.0
	TDLF	73.0	19.7	24.5	25.4	29.6	50.3	34.2
16	NLF	4.8	13.2	8.1	6.8	6.6	9.7	0.7
	SDLF	3.0	7.5	3.5	2.9	3.3	5.5	0.2
	TDLF	3.1	7.8	8.3	6.9	4.8	5.4	1.0
17	NLF	3.0	9.1	29.0	30.8	22.9	22.3	7.4
	SDLF	4.0	7.3	23.9	24.8	17.5	24.3	7.8
	TDLF	6.2	2.7	11.4	11.1	6.5	24.4	8.5
18	NLF	10.9	22.2	25.5	28.4	21.7	25.3	3.3
	SDLF	11.6	19.1	21.1	23.0	17.9	20.7	3.4
	TDLF	12.6	10.8	8.8	6.5	5.5	5.4	3.9
19	NLF	1.0	21.8	23.4	19.2	17.5	22.4	3.0
	SDLF	0.9	18.0	19.1	17.0	16.6	22.9	3.1
	TDLF	0.9	7.9	5.8	9.0	12.2	22.9	3.1
20	NLF	14.5	22.0	19.1	18.0	21.3	34.8	1.7
	SDLF	13.0	18.5	16.9	16.0	19.1	34.8	1.8
	TDLF	7.6	6.4	8.5	8.7	10.9	33.7	1.9

Table T2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	0.9	10.4	11.6	8.9	3.2	4.9	1.9
	SDLF	0.8	8.7	9.2	7.0	2.9	3.3	1.9
	TDLF	0.4	1.5	1.2	0.7	0.6	1.4	1.9
22	NLF	20.1						5.4
	SDLF	14.8						5.2
	TDLF	0.8						4.6
23	NLF	10.7						0.5
	SDLF	10.3						1.1
	TDLF	7.4						2.7
24	NLF	10.1						18.7
	SDLF	4.0						16.7
	TDLF	42.2						11.4
25	NLF	19.8						1.8
	SDLF	7.7						13.5
	TDLF	24.5						48.3
26	NLF	39.6						20.7
	SDLF	35.5						14.6
	TDLF	24.3						1.3
27	NLF	4.3						1.3
	SDLF	0.8						1.1
	TDLF	8.4						7.4
28	NLF	11.4						3.8
	SDLF	10.4						3.4
	TDLF	8.1						2.7
29	NLF	0.4						2.3
	SDLF	1.3						1.9
	TDLF	3.6						0.7
30	NLF	9.4						3.7
	SDLF	9.0						4.0
	TDLF	8.4						4.6

Table T2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	14.8						4.7
	SDLF	11.8						5.2
	TDLF	5.0						6.6
32	NLF	8.6						7.7
	SDLF	6.8						7.7
	TDLF	1.1						7.5
33	NLF	4.1						5.0
	SDLF	4.2						2.7
	TDLF	1.2						4.3
34	NLF							13.4
	SDLF							11.1
	TDLF							3.2
35	NLF							19.9
	SDLF							16.1
	TDLF							5.3

Table T2-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	1.0	0.6	0.3	0.0	0.3	0.9	0.1
	SDLF	0.8	0.4	0.1	0.0	0.2	0.2	0.1
	TDLF	0.2	0.1	0.2	0.1	0.4	2.5	0.3
2	NLF	2.6	7.6	5.6	5.4	13.3	13.5	7.5
	SDLF	2.6	4.5	3.7	3.5	7.0	6.1	0.5
	TDLF	2.6	2.8	1.7	4.3	12.1	14.5	17.8
3	NLF	2.3	6.0	1.8	0.5	0.3	0.3	2.8
	SDLF	2.1	6.9	3.0	1.7	1.8	1.9	2.8
	TDLF	1.5	10.4	6.4	8.5	7.9	6.9	3.0
4	NLF	3.5	7.1	3.1	0.9	0.5	1.7	5.6
	SDLF	3.4	7.2	4.9	3.9	3.0	1.6	5.0
	TDLF	3.1	7.1	9.8	12.7	13.2	11.9	1.2
5	NLF	3.4	7.7	3.1	0.7	1.1	2.8	3.2
	SDLF	3.2	7.5	5.6	4.3	3.0	1.0	3.4
	TDLF	2.6	6.8	12.1	14.3	15.0	12.4	4.0
6	NLF	4.5	3.2	1.6	0.3	1.2	3.8	6.3
	SDLF	4.3	5.1	4.4	3.2	2.0	0.7	5.4
	TDLF	3.7	11.3	11.5	11.1	11.0	8.5	3.3
7	NLF	4.3	0.4	0.8	0.6	0.9	2.1	2.8
	SDLF	4.0	3.7	1.1	0.3	1.1	2.8	3.1
	TDLF	3.6	10.5	1.3	0.6	1.0	4.0	3.9
8	NLF	5.2	1.6	0.2	0.4	1.6	1.8	7.1
	SDLF	5.0	13.9	12.0	12.1	12.8	13.0	5.4
	TDLF	4.5	44.4	40.9	40.5	39.4	40.4	0.3
9	NLF	3.9	3.4	4.1	3.8	3.3	3.5	1.0
	SDLF	3.7	18.6	11.1	9.2	8.0	4.9	1.4
	TDLF	3.3	72.2	48.5	41.1	35.0	24.9	2.4
10	NLF	2.9	3.0	1.5	0.3	0.7	1.1	5.9
	SDLF	3.2	2.5	0.0	1.2	1.0	0.7	2.6
	TDLF	3.9	2.2	4.7	4.0	2.4	0.2	7.0

Table T2-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location						
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	1.3	4.5	1.2	0.1	0.8	1.1	0.7
	SDLF	0.9	5.0	1.2	0.2	0.4	0.1	0.1
	TDLF	0.4	5.3	0.0	0.4	1.1	0.6	2.1
12	NLF	0.2	4.1	0.0	0.5	0.8	0.5	6.4
	SDLF	1.7	2.7	0.8	0.1	0.6	0.3	0.9
	TDLF	6.0	2.6	1.8	0.6	1.9	2.0	16.3
13	NLF	2.7	5.6	0.9	0.7	0.6	0.3	1.7
	SDLF	9.2	0.2	0.6	0.1	0.1	0.2	20.4
	TDLF	24.9	16.9	4.8	1.9	0.7	0.8	64.4
14	NLF	8.4	0.1	0.2	0.4	0.3	0.5	3.0
	SDLF	5.2	3.7	1.9	2.0	1.9	1.6	17.7
	TDLF	39.2	11.9	5.5	6.4	6.5	5.7	65.6
15	NLF	4.9	0.6	1.3	1.6	1.8	1.9	0.5
	SDLF	8.1	15.5	9.2	7.2	5.9	3.5	0.3
	TDLF	15.8	53.4	28.8	20.9	16.6	8.3	0.9
16	NLF	2.2	11.4	1.9	4.6	6.1	5.5	4.3
	SDLF	1.3	5.6	0.8	4.2	4.3	3.9	0.4
	TDLF	1.2	11.6	10.1	5.3	2.9	4.5	13.2
17	NLF	0.9	0.8	0.3	0.7	3.4	4.4	0.1
	SDLF	1.1	4.6	1.6	1.8	0.9	0.2	0.5
	TDLF	1.8	14.4	7.2	9.0	13.5	13.3	1.3
18	NLF	1.0	2.5	3.1	7.4	8.1	4.8	0.8
	SDLF	0.9	1.8	2.0	1.2	0.5	0.7	0.2
	TDLF	0.7	0.9	17.3	26.6	26.4	17.9	2.8
19	NLF	0.4	6.9	6.7	4.2	1.0	1.3	0.0
	SDLF	0.4	0.3	0.8	1.9	2.5	2.0	0.0
	TDLF	0.5	18.1	22.8	20.0	13.4	13.0	0.1
20	NLF	0.5	0.0	0.2	0.2	0.4	0.1	3.2
	SDLF	0.5	1.0	1.3	1.3	1.5	1.2	1.6
	TDLF	0.6	3.4	5.2	4.7	4.7	6.0	4.6

Table T2-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	0.5	0.5	0.9	1.0	0.9	1.5	0.1
	SDLF	0.3	0.6	0.6	0.5	0.3	0.4	0.1
	TDLF	0.1	0.4	0.5	1.2	1.8	3.5	0.1
22	NLF	1.1						4.9
	SDLF	2.4						3.0
	TDLF	5.7						4.5
23	NLF	0.2						2.0
	SDLF	3.4						3.2
	TDLF	10.9						5.4
24	NLF	8.4						0.4
	SDLF	15.3						8.1
	TDLF	31.4						23.8
25	NLF	0.0						1.6
	SDLF	1.8						8.8
	TDLF	6.6						23.8
26	NLF	1.8						3.5
	SDLF	1.4						2.8
	TDLF	0.4						5.4
27	NLF	2.4						0.2
	SDLF	2.6						0.8
	TDLF	3.2						3.8
28	NLF	3.2						7.6
	SDLF	3.0						1.9
	TDLF	2.7						16.5
29	NLF	3.3						1.7
	SDLF	3.3						2.0
	TDLF	3.3						2.9
30	NLF	2.4						5.3
	SDLF	2.3						4.1
	TDLF	2.1						0.6

Table T2-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	1.4						2.3
	SDLF	1.1						2.5
	TDLF	0.4						3.0
32	NLF	0.1						6.1
	SDLF	0.7						6.2
	TDLF	2.4						6.1
33	NLF	0.9						0.9
	SDLF	0.2						1.3
	TDLF	1.4						2.5
34	NLF							1.2
	SDLF							0.2
	TDLF							2.4
35	NLF							1.1
	SDLF							0.2
	TDLF							2.2

Table T2-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	9.8	0.5	4.4	6.4	7.1	0.4	1.2
	SDLF	8.8	0.5	3.4	4.8	5.4	0.7	1.1
	TDLF	6.5	2.5	1.2	0.6	0.4	0.6	1.2
2	NLF	17.2	30.2	21.6	23.3	50.4	46.8	19.3
	SDLF	16.0	24.7	14.6	23.8	44.9	39.2	12.0
	TDLF	13.9	13.9	3.5	20.7	28.1	19.5	5.6
3	NLF	10.1	28.6	10.5	1.9	3.8	6.1	13.4
	SDLF	9.2	25.2	9.7	2.6	4.2	5.9	12.3
	TDLF	8.1	20.7	9.0	6.0	7.1	7.4	10.2
4	NLF	18.2	35.2	16.2	9.3	3.8	1.7	17.5
	SDLF	16.8	31.7	15.3	9.6	5.2	0.5	17.4
	TDLF	14.1	24.2	14.7	12.9	11.0	7.9	14.7
5	NLF	17.7	34.9	13.9	3.1	4.4	11.1	10.0
	SDLF	16.3	32.2	14.8	5.9	0.3	6.8	10.8
	TDLF	13.5	26.1	17.9	14.2	11.3	5.5	12.9
6	NLF	22.8	9.4	2.6	3.2	7.7	15.4	18.3
	SDLF	20.7	12.1	6.2	0.8	3.8	12.4	18.5
	TDLF	16.3	19.9	14.7	10.4	6.4	3.7	18.7
7	NLF	23.7	3.8	3.7	4.2	1.8	7.6	6.4
	SDLF	21.5	8.0	4.1	3.4	3.0	9.3	8.1
	TDLF	16.9	15.6	3.7	0.6	5.2	12.7	11.8
8	NLF	25.9	2.0	2.1	2.5	10.4	12.5	21.6
	SDLF	24.1	15.6	10.5	14.3	21.1	23.2	21.2
	TDLF	20.1	48.7	41.5	42.6	45.9	48.2	18.5
9	NLF	17.4	19.9	23.6	23.3	21.0	21.5	3.0
	SDLF	17.0	4.1	6.5	8.5	7.9	11.0	3.6
	TDLF	16.2	63.1	35.4	27.5	22.6	12.4	4.9
10	NLF	9.5	9.8	9.7	3.4	2.0	0.5	18.7
	SDLF	11.0	7.7	6.9	1.4	0.7	0.2	16.7
	TDLF	14.3	4.3	0.2	3.9	2.9	1.0	9.0

Table T2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	4.1	17.9	6.4	0.6	2.5	4.1	1.7
	SDLF	4.8	17.5	5.8	0.6	2.2	3.1	0.9
	TDLF	6.2	15.9	3.5	0.7	3.0	2.1	0.8
12	NLF	1.6	15.2	0.1	2.3	3.2	1.1	24.8
	SDLF	3.6	13.7	0.7	1.8	2.8	0.8	19.0
	TDLF	7.9	8.2	1.7	2.0	3.7	2.2	0.9
13	NLF	1.8	25.7	4.7	3.3	2.5	0.5	17.1
	SDLF	9.6	19.4	2.9	2.3	2.0	0.5	33.8
	TDLF	28.5	2.1	1.5	0.4	1.1	1.2	72.2
14	NLF	50.9	0.8	1.7	2.8	3.1	4.1	5.8
	SDLF	32.9	3.1	0.5	0.2	0.5	1.6	14.9
	TDLF	15.2	12.3	5.0	5.2	5.1	3.6	60.2
15	NLF	14.7	0.0	3.8	3.9	2.7	1.7	1.9
	SDLF	17.5	14.6	11.5	9.9	7.9	4.9	1.4
	TDLF	25.1	53.7	32.7	26.0	21.7	13.4	0.2
16	NLF	6.8	46.8	10.2	11.8	14.2	9.1	19.8
	SDLF	4.9	39.9	6.4	11.9	12.9	7.9	14.7
	TDLF	0.3	21.4	4.8	14.1	12.3	9.5	0.5
17	NLF	0.1	8.1	1.2	0.2	10.9	16.3	0.5
	SDLF	0.3	10.4	2.2	1.9	7.2	11.8	0.7
	TDLF	1.1	16.3	5.5	6.9	4.0	1.2	1.4
18	NLF	0.8	13.1	6.9	24.2	26.7	14.4	4.5
	SDLF	0.4	11.5	3.0	16.7	19.3	9.9	3.9
	TDLF	0.7	8.0	8.8	5.5	3.5	4.6	1.0
19	NLF	2.1	21.2	22.6	11.8	0.8	1.2	0.7
	SDLF	2.2	15.0	15.7	6.6	3.4	3.4	0.8
	TDLF	2.3	2.0	4.0	8.3	10.9	10.2	0.9
20	NLF	1.7	0.5	3.2	3.1	2.8	4.8	14.2
	SDLF	1.7	1.0	0.9	0.9	0.5	2.3	12.6
	TDLF	1.7	4.3	5.2	5.3	5.9	5.6	6.2

Table T2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	1.0	3.4	7.8	9.1	8.0	8.9	0.1
	SDLF	1.2	3.3	6.5	7.3	6.3	7.4	0.1
	TDLF	1.9	2.0	1.6	1.2	0.8	1.8	0.1
22	NLF	0.1						24.7
	SDLF	1.6						22.8
	TDLF	5.5						14.9
23	NLF	1.7						9.9
	SDLF	5.2						10.8
	TDLF	14.3						12.2
24	NLF	22.4						4.8
	SDLF	29.9						12.2
	TDLF	49.6						26.5
25	NLF	4.9						5.0
	SDLF	6.6						12.9
	TDLF	11.6						28.9
26	NLF	11.7						28.5
	SDLF	11.0						27.5
	TDLF	9.1						17.9
27	NLF	15.0						1.4
	SDLF	14.4						0.6
	TDLF	13.1						2.3
28	NLF	19.1						24.8
	SDLF	18.0						19.2
	TDLF	15.1						1.3
29	NLF	18.3						9.1
	SDLF	17.8						8.9
	TDLF	16.5						8.0
30	NLF	12.0						15.5
	SDLF	12.1						15.2
	TDLF	12.3						13.1

Table T2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	5.5						7.7
	SDLF	5.4						8.5
	TDLF	5.6						10.1
32	NLF	1.6						22.2
	SDLF	2.9						23.3
	TDLF	5.8						25.0
33	NLF	0.2						0.5
	SDLF	0.8						1.0
	TDLF	3.2						5.1
34	NLF							5.0
	SDLF							3.8
	TDLF							0.7
35	NLF							2.2
	SDLF							1.0
	TDLF							1.4

Table T2-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	1.65	1.54	1.44	1.38	1.38	1.37	1.30
	SDLF	1.57	1.45	1.33	1.31	1.36	1.41	1.37
	TDLF	1.36	1.18	1.06	1.15	1.36	1.55	1.59
3	NLF	1.59	1.45	1.31	1.25	1.25	1.22	1.06
	SDLF	1.52	1.36	1.19	1.16	1.21	1.28	1.19
	TDLF	1.35	1.10	0.86	0.92	1.17	1.50	1.59
4	NLF	1.48	1.08	0.87	0.74	0.69	0.72	0.77
	SDLF	1.42	1.00	0.74	0.62	0.63	0.82	0.93
	TDLF	1.27	0.76	0.34	0.30	0.54	1.20	1.44
5	NLF	1.32	0.50	0.19	0.04	0.00	0.07	0.46
	SDLF	1.27	0.43	0.06	-0.09	-0.06	0.19	0.64
	TDLF	1.15	0.24	-0.37	-0.47	-0.21	0.62	1.19
6	NLF	1.12	-0.25	-0.50	-0.62	-0.64	-0.58	0.12
	SDLF	1.08	-0.28	-0.62	-0.75	-0.71	-0.49	0.30
	TDLF	0.98	-0.36	-1.00	-1.13	-0.89	-0.18	0.85
7	NLF	0.88	-0.88	-1.02	-1.09	-1.06	-0.99	-0.21
	SDLF	0.85	-0.88	-1.10	-1.19	-1.13	-0.96	-0.04
	TDLF	0.77	-0.88	-1.35	-1.49	-1.30	-0.80	0.46
8	NLF	0.54	-1.01	-1.04	-1.06	-1.04	-1.03	-0.51
	SDLF	0.52	-0.99	-1.06	-1.11	-1.09	-1.02	-0.38
	TDLF	0.46	-0.96	-1.16	-1.28	-1.23	-0.99	0.04
9	NLF	0.17	0.00	0.00	0.00	0.00	0.00	-0.74
	SDLF	0.15	0.00	0.00	0.00	0.00	0.00	-0.64
	TDLF	0.12	0.00	0.00	0.00	0.00	0.00	-0.32
10	NLF	-0.23	-0.55	-0.45	-0.42	-0.41	-0.40	-0.94
	SDLF	-0.23	-0.52	-0.41	-0.40	-0.42	-0.43	-0.89
	TDLF	-0.24	-0.46	-0.29	-0.36	-0.48	-0.54	-0.70

Table T2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	-0.60	-0.32	-0.16	-0.12	-0.12	-0.14	-1.07
	SDLF	-0.59	-0.31	-0.09	-0.07	-0.12	-0.16	-1.06
	TDLF	-0.55	-0.27	0.10	0.05	-0.16	-0.22	-1.02
12	NLF	-0.87	-0.13	-0.02	0.00	-0.01	-0.01	-1.10
	SDLF	-0.84	-0.13	0.06	0.07	0.01	-0.03	-1.14
	TDLF	-0.76	-0.13	0.27	0.23	-0.01	-0.10	-1.22
13	NLF	-0.98	0.05	0.05	0.05	0.02	0.02	-0.94
	SDLF	-0.94	0.03	0.11	0.11	0.04	-0.01	-1.00
	TDLF	-0.83	-0.02	0.28	0.25	0.05	-0.11	-1.12
14	NLF	0.00	0.30	0.28	0.27	0.23	0.21	0.00
	SDLF	0.00	0.29	0.31	0.31	0.26	0.21	0.00
	TDLF	0.00	0.29	0.39	0.41	0.31	0.18	-0.01
15	NLF	-0.75	0.00	0.00	0.00	0.00	0.00	-0.36
	SDLF	-0.75	0.00	0.00	0.00	0.00	0.00	-0.38
	TDLF	-0.77	0.00	0.00	0.00	0.00	0.00	-0.43
16	NLF	-0.57	0.93	0.87	0.86	0.88	0.87	-0.18
	SDLF	-0.59	0.91	0.86	0.88	0.92	0.95	-0.21
	TDLF	-0.64	0.83	0.83	0.95	1.07	1.16	-0.27
17	NLF	-0.48	0.86	0.81	0.80	0.81	0.86	-0.08
	SDLF	-0.50	0.84	0.79	0.81	0.86	0.95	-0.10
	TDLF	-0.57	0.76	0.76	0.87	1.02	1.22	-0.16
18	NLF	-0.36	0.17	0.11	0.26	0.42	0.63	0.00
	SDLF	-0.38	0.11	0.09	0.25	0.45	0.72	-0.02
	TDLF	-0.46	-0.06	0.03	0.25	0.56	1.05	-0.06
19	NLF	-0.26	-0.56	-0.43	-0.28	-0.26	-0.09	0.04
	SDLF	-0.28	-0.63	-0.47	-0.31	-0.27	0.00	0.02
	TDLF	-0.35	-0.84	-0.58	-0.37	-0.31	0.34	-0.01
20	NLF	-0.17	-0.99	-1.01	-1.04	-1.07	-0.96	0.05
	SDLF	-0.18	-1.06	-1.07	-1.11	-1.16	-0.95	0.04
	TDLF	-0.24	-1.30	-1.27	-1.31	-1.42	-0.87	-0.01

Table T2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
21	NLF	-0.06	0.00	0.00	0.00	0.00	-0.02	0.08
	SDLF	-0.07	0.00	0.00	0.00	0.00	-0.02	0.06
	TDLF	-0.10	0.00	0.00	0.00	0.00	-0.03	-0.03
22	NLF	0.09						0.16
	SDLF	0.09						0.13
	TDLF	0.07						-0.01
23	NLF	0.30						0.29
	SDLF	0.28						0.27
	TDLF	0.24						0.15
24	NLF	0.00						0.39
	SDLF	0.00						0.38
	TDLF	0.00						0.28
25	NLF	0.95						0.00
	SDLF	0.97						0.00
	TDLF	1.01						0.00
26	NLF	1.01						0.83
	SDLF	1.04						0.88
	TDLF	1.11						1.00
27	NLF	0.86						0.80
	SDLF	0.86						0.89
	TDLF	0.85						1.13
28	NLF	0.57						0.69
	SDLF	0.54						0.81
	TDLF	0.45						1.16
29	NLF	0.18						0.38
	SDLF	0.13						0.52
	TDLF	-0.03						0.97
30	NLF	-0.30						-0.04
	SDLF	-0.36						0.10
	TDLF	-0.56						0.55

Table T2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	-0.60						-0.47
	SDLF	-0.67						-0.36
	TDLF	-0.87						0.02
32	NLF	-0.91						-0.90
	SDLF	-0.96						-0.83
	TDLF	-1.12						-0.58
33	NLF	0.00						-1.22
	SDLF	0.00						-1.21
	TDLF	0.01						-1.12
34	NLF							-1.36
	SDLF							-1.39
	TDLF							-1.41
35	NLF							0.00
	SDLF							0.00
	TDLF							-0.01

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Table T2-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	5.85	5.45	5.06	4.91	4.95	4.96	4.72
	SDLF	5.69	5.28	4.91	4.80	4.90	4.97	4.77
	TDLF	5.37	4.92	4.58	4.60	4.86	5.07	4.95
3	NLF	5.64	5.11	4.59	4.43	4.49	4.50	3.99
	SDLF	5.48	4.94	4.42	4.30	4.43	4.53	4.10
	TDLF	5.19	4.57	4.04	4.04	4.36	4.71	4.48
4	NLF	5.22	3.75	2.94	2.58	2.52	2.81	2.98
	SDLF	5.07	3.58	2.77	2.44	2.46	2.91	3.15
	TDLF	4.79	3.23	2.35	2.11	2.36	3.29	3.66
5	NLF	4.65	1.65	0.50	0.08	0.09	0.54	1.89
	SDLF	4.50	1.51	0.34	-0.06	0.02	0.68	2.10
	TDLF	4.24	1.22	-0.09	-0.43	-0.11	1.15	2.68
6	NLF	3.95	-0.98	-1.92	-2.29	-2.22	-1.81	0.69
	SDLF	3.80	-1.05	-2.05	-2.41	-2.27	-1.68	0.91
	TDLF	3.56	-1.19	-2.42	-2.76	-2.41	-1.30	1.52
7	NLF	3.08	-3.17	-3.70	-3.90	-3.72	-3.37	-0.51
	SDLF	2.95	-3.17	-3.78	-3.99	-3.76	-3.28	-0.29
	TDLF	2.72	-3.18	-4.01	-4.26	-3.89	-3.04	0.30
8	NLF	1.85	-3.52	-3.64	-3.69	-3.60	-3.51	-1.63
	SDLF	1.74	-3.50	-3.66	-3.74	-3.63	-3.47	-1.44
	TDLF	1.56	-3.44	-3.72	-3.88	-3.73	-3.37	-0.93
9	NLF	0.50	0.00	0.00	0.00	0.00	0.00	-2.45
	SDLF	0.43	0.00	0.00	0.00	0.00	0.00	-2.30
	TDLF	0.30	0.00	0.00	0.00	0.00	0.01	-1.89
10	NLF	-0.92	-1.82	-1.43	-1.28	-1.21	-1.14	-3.19
	SDLF	-0.96	-1.76	-1.36	-1.24	-1.22	-1.17	-3.08
	TDLF	-1.02	-1.63	-1.21	-1.17	-1.25	-1.25	-2.81

Table T2-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
11	NLF	-2.23	-1.10	-0.45	-0.28	-0.22	-0.20	-3.66
	SDLF	-2.22	-1.04	-0.36	-0.21	-0.22	-0.23	-3.61
	TDLF	-2.21	-0.95	-0.13	-0.06	-0.24	-0.28	-3.48
12	NLF	-3.13	-0.65	-0.20	-0.08	-0.06	0.08	-3.79
	SDLF	-3.10	-0.62	-0.11	0.00	-0.05	0.05	-3.79
	TDLF	-3.02	-0.59	0.12	0.16	-0.07	-0.02	-3.78
13	NLF	-3.44	-0.16	-0.15	-0.16	-0.28	-0.14	-3.21
	SDLF	-3.39	-0.18	-0.09	-0.10	-0.26	-0.18	-3.23
	TDLF	-3.25	-0.23	0.06	0.02	-0.26	-0.30	-3.27
14	NLF	0.01	0.80	0.72	0.63	0.49	0.41	-0.01
	SDLF	0.01	0.78	0.73	0.65	0.51	0.39	-0.01
	TDLF	0.01	0.74	0.78	0.72	0.51	0.33	-0.02
15	NLF	-2.54	0.01	0.00	0.00	0.00	0.00	-1.01
	SDLF	-2.49	0.01	0.00	0.00	0.00	0.00	-1.03
	TDLF	-2.42	0.00	0.00	0.00	0.00	0.00	-1.05
16	NLF	-1.90	3.49	3.29	3.30	3.37	3.38	-0.36
	SDLF	-1.86	3.43	3.25	3.30	3.40	3.43	-0.39
	TDLF	-1.83	3.30	3.18	3.31	3.49	3.58	-0.44
17	NLF	-1.58	3.26	3.10	3.14	3.23	3.41	-0.03
	SDLF	-1.56	3.20	3.05	3.13	3.25	3.48	-0.06
	TDLF	-1.55	3.08	2.98	3.13	3.35	3.67	-0.12
18	NLF	-1.24	0.54	0.45	1.07	1.77	2.69	0.14
	SDLF	-1.22	0.49	0.41	1.04	1.77	2.75	0.12
	TDLF	-1.23	0.32	0.36	1.03	1.85	2.99	0.06
19	NLF	-0.99	-2.30	-1.72	-1.08	-0.95	0.03	0.12
	SDLF	-0.98	-2.34	-1.75	-1.10	-0.96	0.11	0.10
	TDLF	-1.00	-2.49	-1.81	-1.14	-0.97	0.36	0.05
20	NLF	-0.78	-3.95	-4.02	-4.14	-4.27	-3.49	0.00
	SDLF	-0.77	-3.98	-4.04	-4.17	-4.32	-3.46	-0.02
	TDLF	-0.80	-4.13	-4.15	-4.28	-4.47	-3.38	-0.09

Table T2-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	-0.50	0.00	0.00	0.00	-0.01	-0.09	-0.02
	SDLF	-0.50	0.00	0.00	0.00	0.00	-0.08	-0.05
	TDLF	-0.51	0.00	0.00	0.00	0.00	-0.10	-0.17
22	NLF	0.04						0.18
	SDLF	0.04						0.14
	TDLF	0.01						-0.03
23	NLF	0.84						0.67
	SDLF	0.81						0.64
	TDLF	0.75						0.48
24	NLF	-0.01						1.09
	SDLF	-0.01						1.06
	TDLF	0.00						0.93
25	NLF	3.49						0.02
	SDLF	3.48						0.02
	TDLF	3.46						0.02
26	NLF	3.81						3.21
	SDLF	3.80						3.24
	TDLF	3.81						3.29
27	NLF	3.24						3.22
	SDLF	3.21						3.28
	TDLF	3.15						3.44
28	NLF	2.12						2.89
	SDLF	2.07						2.98
	TDLF	1.94						3.25
29	NLF	0.60						1.80
	SDLF	0.55						1.92
	TDLF	0.39						2.28
30	NLF	-1.23						0.20
	SDLF	-1.28						0.33
	TDLF	-1.45						0.71

Table T2-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
31	NLF	-2.41						-1.54
	SDLF	-2.45						-1.42
	TDLF	-2.60						-1.06
32	NLF	-3.54						-3.27
	SDLF	-3.56						-3.18
	TDLF	-3.67						-2.91
33	NLF	0.00						-4.64
	SDLF	0.00						-4.58
	TDLF	-0.01						-4.43
34	NLF							-5.21
	SDLF							-5.19
	TDLF							-5.14
35	NLF							-0.03
	SDLF							-0.02
	TDLF							-0.01

Table T2-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.96	0.90	0.84	0.81	0.80	0.80	0.76
	SDLF	0.91	0.84	0.78	0.76	0.79	0.82	0.80
	TDLF	0.80	0.69	0.62	0.67	0.79	0.90	0.93
3	NLF	0.93	0.85	0.77	0.73	0.73	0.71	0.62
	SDLF	0.89	0.79	0.70	0.67	0.71	0.75	0.70
	TDLF	0.79	0.64	0.50	0.54	0.68	0.87	0.93
4	NLF	0.86	0.63	0.51	0.43	0.40	0.42	0.45
	SDLF	0.83	0.58	0.43	0.36	0.37	0.48	0.54
	TDLF	0.74	0.44	0.20	0.17	0.32	0.70	0.84
5	NLF	0.77	0.29	0.11	0.03	0.00	0.04	0.27
	SDLF	0.74	0.25	0.03	-0.05	-0.04	0.11	0.37
	TDLF	0.67	0.14	-0.21	-0.27	-0.12	0.36	0.69
6	NLF	0.66	-0.15	-0.29	-0.36	-0.38	-0.34	0.07
	SDLF	0.63	-0.16	-0.36	-0.44	-0.42	-0.29	0.18
	TDLF	0.57	-0.21	-0.58	-0.66	-0.52	-0.10	0.50
7	NLF	0.51	-0.51	-0.60	-0.64	-0.62	-0.58	-0.12
	SDLF	0.49	-0.51	-0.64	-0.70	-0.66	-0.56	-0.02
	TDLF	0.45	-0.51	-0.79	-0.87	-0.76	-0.47	0.27
8	NLF	0.32	-0.59	-0.60	-0.62	-0.61	-0.60	-0.30
	SDLF	0.30	-0.58	-0.62	-0.65	-0.64	-0.60	-0.22
	TDLF	0.27	-0.56	-0.68	-0.75	-0.72	-0.58	0.02
9	NLF	0.10	0.00	0.00	0.00	0.00	0.00	-0.43
	SDLF	0.09	0.00	0.00	0.00	0.00	0.00	-0.37
	TDLF	0.07	0.00	0.00	0.00	0.00	0.00	-0.19
10	NLF	-0.13	-0.32	-0.26	-0.24	-0.24	-0.23	-0.55
	SDLF	-0.13	-0.31	-0.24	-0.23	-0.25	-0.25	-0.52
	TDLF	-0.14	-0.27	-0.17	-0.21	-0.28	-0.31	-0.41

Table T2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	-0.35	-0.19	-0.10	-0.07	-0.07	-0.08	-0.62
	SDLF	-0.34	-0.18	-0.06	-0.04	-0.07	-0.10	-0.62
	TDLF	-0.32	-0.16	0.06	0.03	-0.09	-0.13	-0.60
12	NLF	-0.51	-0.08	-0.01	0.00	0.00	-0.01	-0.64
	SDLF	-0.49	-0.08	0.03	0.04	0.00	-0.02	-0.67
	TDLF	-0.44	-0.08	0.16	0.13	-0.01	-0.06	-0.71
13	NLF	-0.57	0.03	0.03	0.03	0.01	0.01	-0.55
	SDLF	-0.55	0.02	0.07	0.06	0.02	0.00	-0.58
	TDLF	-0.48	-0.01	0.16	0.15	0.03	-0.06	-0.65
14	NLF	0.00	0.17	0.17	0.16	0.14	0.12	0.00
	SDLF	0.00	0.17	0.18	0.18	0.15	0.12	0.00
	TDLF	0.00	0.17	0.23	0.24	0.18	0.10	0.00
15	NLF	-0.44	0.00	0.00	0.00	0.00	0.00	-0.21
	SDLF	-0.44	0.00	0.00	0.00	0.00	0.00	-0.22
	TDLF	-0.45	0.00	0.00	0.00	0.00	0.00	-0.25
16	NLF	-0.33	0.55	0.51	0.50	0.51	0.51	-0.11
	SDLF	-0.34	0.53	0.50	0.51	0.54	0.55	-0.12
	TDLF	-0.38	0.48	0.49	0.56	0.63	0.68	-0.16
17	NLF	-0.28	0.50	0.47	0.47	0.48	0.50	-0.05
	SDLF	-0.29	0.49	0.46	0.47	0.50	0.55	-0.06
	TDLF	-0.33	0.44	0.44	0.51	0.59	0.71	-0.09
18	NLF	-0.21	0.10	0.07	0.15	0.25	0.37	0.00
	SDLF	-0.22	0.07	0.05	0.14	0.26	0.42	-0.01
	TDLF	-0.27	-0.04	0.02	0.15	0.33	0.62	-0.03
19	NLF	-0.15	-0.33	-0.25	-0.16	-0.15	-0.05	0.02
	SDLF	-0.16	-0.37	-0.27	-0.18	-0.16	0.00	0.01
	TDLF	-0.21	-0.49	-0.34	-0.22	-0.18	0.20	0.00
20	NLF	-0.10	-0.58	-0.59	-0.61	-0.63	-0.56	0.03
	SDLF	-0.11	-0.62	-0.63	-0.65	-0.67	-0.55	0.02
	TDLF	-0.14	-0.76	-0.74	-0.76	-0.83	-0.51	0.00

Table T2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	-0.04	0.00	0.00	0.00	0.00	-0.01	0.05
	SDLF	-0.04	0.00	0.00	0.00	0.00	-0.01	0.04
	TDLF	-0.06	0.00	0.00	0.00	0.00	-0.02	-0.02
22	NLF	0.06						0.09
	SDLF	0.05						0.08
	TDLF	0.04						0.00
23	NLF	0.18						0.17
	SDLF	0.16						0.16
	TDLF	0.14						0.09
24	NLF	0.00						0.23
	SDLF	0.00						0.22
	TDLF	0.00						0.16
25	NLF	0.55						0.00
	SDLF	0.56						0.00
	TDLF	0.59						0.00
26	NLF	0.59						0.49
	SDLF	0.61						0.52
	TDLF	0.65						0.59
27	NLF	0.50						0.47
	SDLF	0.50						0.52
	TDLF	0.50						0.66
28	NLF	0.33						0.40
	SDLF	0.32						0.47
	TDLF	0.26						0.68
29	NLF	0.10						0.22
	SDLF	0.08						0.30
	TDLF	-0.02						0.57
30	NLF	-0.17						-0.02
	SDLF	-0.21						0.06
	TDLF	-0.33						0.32

Table T2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**	**G7-G8**
31	NLF	-0.35						-0.28
	SDLF	-0.39						-0.21
	TDLF	-0.51						0.01
32	NLF	-0.53						-0.52
	SDLF	-0.56						-0.49
	TDLF	-0.65						-0.34
33	NLF	0.00						-0.71
	SDLF	0.00						-0.71
	TDLF	0.00						-0.65
34	NLF							-0.79
	SDLF							-0.81
	TDLF							-0.82
35	NLF							0.00
	SDLF							0.00
	TDLF							-0.01

Table T2-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	3.41	3.18	2.96	2.87	2.89	2.90	2.76
	SDLF	3.32	3.08	2.87	2.80	2.86	2.90	2.78
	TDLF	3.13	2.87	2.67	2.69	2.84	2.96	2.89
3	NLF	3.29	2.98	2.68	2.59	2.62	2.63	2.33
	SDLF	3.20	2.88	2.58	2.51	2.59	2.65	2.40
	TDLF	3.03	2.67	2.36	2.36	2.55	2.75	2.61
4	NLF	3.05	2.19	1.72	1.51	1.47	1.64	1.74
	SDLF	2.96	2.09	1.62	1.42	1.43	1.70	1.84
	TDLF	2.80	1.88	1.37	1.23	1.38	1.92	2.14
5	NLF	2.72	0.96	0.29	0.05	0.05	0.32	1.11
	SDLF	2.63	0.88	0.20	-0.04	0.01	0.40	1.23
	TDLF	2.48	0.71	-0.05	-0.25	-0.06	0.67	1.57
6	NLF	2.30	-0.58	-1.12	-1.34	-1.29	-1.06	0.40
	SDLF	2.22	-0.61	-1.20	-1.41	-1.33	-0.98	0.53
	TDLF	2.08	-0.69	-1.41	-1.61	-1.41	-0.76	0.89
7	NLF	1.80	-1.85	-2.16	-2.28	-2.17	-1.97	-0.30
	SDLF	1.72	-1.85	-2.21	-2.33	-2.20	-1.92	-0.17
	TDLF	1.59	-1.86	-2.34	-2.49	-2.27	-1.78	0.17
8	NLF	1.08	-2.06	-2.12	-2.16	-2.10	-2.05	-0.95
	SDLF	1.02	-2.04	-2.13	-2.18	-2.12	-2.03	-0.84
	TDLF	0.91	-2.01	-2.17	-2.26	-2.18	-1.97	-0.54
9	NLF	0.29	0.00	0.00	0.00	0.00	0.00	-1.43
	SDLF	0.25	0.00	0.00	0.00	0.00	0.00	-1.34
	TDLF	0.17	0.00	0.00	0.00	0.00	0.00	-1.10
10	NLF	-0.54	-1.06	-0.83	-0.74	-0.71	-0.66	-1.86
	SDLF	-0.56	-1.03	-0.80	-0.72	-0.71	-0.68	-1.80
	TDLF	-0.60	-0.95	-0.71	-0.68	-0.73	-0.73	-1.64

Table T2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location						
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
11	NLF	-1.30	-0.64	-0.26	-0.16	-0.13	-0.12	-2.14
	SDLF	-1.30	-0.61	-0.21	-0.12	-0.13	-0.13	-2.11
	TDLF	-1.29	-0.55	-0.08	-0.04	-0.14	-0.16	-2.03
12	NLF	-1.83	-0.38	-0.12	-0.04	-0.04	0.05	-2.21
	SDLF	-1.81	-0.36	-0.06	0.00	-0.03	0.03	-2.21
	TDLF	-1.76	-0.35	0.07	0.09	-0.04	-0.01	-2.21
13	NLF	-2.01	-0.10	-0.09	-0.09	-0.16	-0.08	-1.87
	SDLF	-1.98	-0.10	-0.05	-0.06	-0.15	-0.10	-1.88
	TDLF	-1.90	-0.13	0.04	0.01	-0.15	-0.17	-1.91
14	NLF	0.01	0.47	0.42	0.36	0.29	0.24	-0.01
	SDLF	0.01	0.46	0.43	0.38	0.29	0.23	-0.01
	TDLF	0.00	0.43	0.45	0.42	0.30	0.19	-0.01
15	NLF	-1.48	0.00	0.00	0.00	0.00	0.00	-0.59
	SDLF	-1.45	0.00	0.00	0.00	0.00	0.00	-0.60
	TDLF	-1.42	0.00	0.00	0.00	0.00	0.00	-0.61
16	NLF	-1.11	2.04	1.92	1.93	1.97	1.97	-0.21
	SDLF	-1.09	2.00	1.90	1.93	1.98	2.01	-0.23
	TDLF	-1.07	1.93	1.85	1.94	2.04	2.09	-0.26
17	NLF	-0.92	1.90	1.81	1.84	1.89	1.99	-0.02
	SDLF	-0.91	1.87	1.78	1.83	1.90	2.03	-0.03
	TDLF	-0.90	1.80	1.74	1.83	1.95	2.15	-0.07
18	NLF	-0.72	0.32	0.26	0.62	1.03	1.57	0.08
	SDLF	-0.71	0.28	0.24	0.61	1.04	1.61	0.07
	TDLF	-0.72	0.19	0.21	0.60	1.08	1.75	0.04
19	NLF	-0.58	-1.34	-1.01	-0.63	-0.56	0.02	0.07
	SDLF	-0.57	-1.36	-1.02	-0.64	-0.56	0.06	0.06
	TDLF	-0.58	-1.46	-1.06	-0.66	-0.57	0.21	0.03
20	NLF	-0.46	-2.31	-2.35	-2.42	-2.50	-2.04	0.00
	SDLF	-0.45	-2.32	-2.36	-2.44	-2.52	-2.02	-0.01
	TDLF	-0.47	-2.41	-2.42	-2.50	-2.61	-1.98	-0.05

Table T2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
21	NLF	-0.29	0.00	0.00	0.00	0.00	-0.05	-0.01
	SDLF	-0.29	0.00	0.00	0.00	0.00	-0.05	-0.03
	TDLF	-0.30	0.00	0.00	0.00	0.00	-0.06	-0.10
22	NLF	0.03						0.10
	SDLF	0.02						0.08
	TDLF	0.01						-0.02
23	NLF	0.49						0.39
	SDLF	0.47						0.37
	TDLF	0.44						0.28
24	NLF	0.00						0.64
	SDLF	0.00						0.62
	TDLF	0.00						0.54
25	NLF	2.04						0.01
	SDLF	2.03						0.01
	TDLF	2.02						0.01
26	NLF	2.22						1.87
	SDLF	2.22						1.89
	TDLF	2.22						1.92
27	NLF	1.89						1.88
	SDLF	1.87						1.91
	TDLF	1.84						2.01
28	NLF	1.24						1.69
	SDLF	1.21						1.74
	TDLF	1.14						1.90
29	NLF	0.35						1.05
	SDLF	0.32						1.12
	TDLF	0.23						1.33
30	NLF	-0.72						0.12
	SDLF	-0.75						0.19
	TDLF	-0.85						0.41

Table T2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location						
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	G7-G8
31	NLF	-1.41						-0.90
	SDLF	-1.43						-0.83
	TDLF	-1.52						-0.62
32	NLF	-2.07						-1.91
	SDLF	-2.08						-1.86
	TDLF	-2.14						-1.70
33	NLF	0.00						-2.71
	SDLF	0.00						-2.68
	TDLF	-0.01						-2.58
34	NLF							-3.04
	SDLF							-3.03
	TDLF							-3.00
35	NLF							-0.02
	SDLF							-0.01
	TDLF							-0.01

Table T2-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	68.6	148.7	94.4	53.0	242.6	504.1	363.0	191.5
	SDLF	68.2	146.3	99.0	50.2	240.1	503.4	367.8	189.8
	TDLF	66.6	140.6	112.6	42.7	234.3	503.6	381.0	186.8
G2	NLF	69.2	157.4	120.1	44.5	237.7	566.7	465.5	169.0
	SDLF	67.1	161.0	110.5	44.9	233.8	570.2	455.4	169.2
	TDLF	61.5	167.7	82.8	45.5	226.6	575.3	427.1	169.4
G3	NLF	62.7	158.1	103.5	45.3	215.7	573.6	410.6	173.5
	SDLF	61.9	157.4	105.2	46.4	214.3	572.3	412.6	174.8
	TDLF	60.5	155.8	110.3	49.6	212.5	569.3	418.1	178.2
G4	NLF	57.4	159.0	106.4	45.4	197.1	582.6	429.9	174.8
	SDLF	58.6	158.7	108.8	46.3	199.7	582.6	432.4	175.8
	TDLF	62.3	157.9	115.8	48.7	206.3	581.7	438.9	178.7
G5	NLF	56.9	157.3	109.9	46.0	198.5	577.2	445.3	177.6
	SDLF	59.7	159.9	110.9	46.8	202.4	580.3	446.1	178.5
	TDLF	67.9	168.2	114.0	48.5	212.5	588.9	448.2	180.8
G6	NLF	59.9	151.8	110.3	47.1	209.9	552.6	440.5	182.3
	SDLF	60.7	157.3	110.5	49.0	211.5	557.8	440.6	184.4
	TDLF	63.1	174.7	113.4	55.3	215.0	574.7	442.7	190.8
G7	NLF	60.7	159.6	121.3	43.6	212.7	565.4	480.7	157.9
	SDLF	61.8	147.8	122.1	43.6	214.0	553.4	480.7	157.9
	TDLF	64.5	115.0	119.4	43.5	217.2	520.7	475.0	158.1
G8	NLF	60.2	154.5	121.1	41.0	198.9	557.8	451.3	159.7
	SDLF	55.9	163.1	114.6	40.5	195.3	563.8	445.6	157.9
	TDLF	43.6	184.7	99.6	38.8	185.2	580.0	434.6	153.9

Table T2-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

		Load Type & Support Number							
Girder	Detailing	SDL	SDL	SDL	SDL	TDL	TDL	TDL	TDL
	Method	1	2	3	4	1	2	3	4
G1	NLF	-0.5	NA	NA	NA	-3.0	NA	NA	NA
	SDLF	-0.2	NA	NA	NA	-1.7	NA	NA	NA
	TDLF	0.0	NA	NA	NA	-0.8	NA	NA	NA
G2	NLF	-0.2	NA	NA	NA	-1.6	NA	NA	NA
	SDLF	0.0	NA	NA	NA	-1.1	NA	NA	NA
	TDLF	0.2	NA	NA	NA	-0.2	NA	NA	NA
G3	NLF	0.0	NA	NA	NA	-0.4	NA	NA	NA
	SDLF	0.0	NA	NA	NA	-0.3	NA	NA	NA
	TDLF	0.2	NA	NA	NA	0.2	NA	NA	NA
G4	NLF	0.1	NA	NA	NA	0.7	NA	NA	NA
	SDLF	0.1	NA	NA	NA	0.4	NA	NA	NA
	TDLF	0.0	NA	NA	NA	0.1	NA	NA	NA
G5	NLF	0.1	NA	NA	NA	1.2	NA	NA	NA
	SDLF	0.0	NA	NA	NA	0.9	NA	NA	NA
	TDLF	-0.2	NA	NA	NA	0.0	NA	NA	NA
G6	NLF	0.2	NA	NA	NA	1.4	NA	NA	NA
	SDLF	0.0	NA	NA	NA	1.0	NA	NA	NA
	TDLF	-0.3	NA	NA	NA	0.0	NA	NA	NA
G7	NLF	0.2	NA	NA	NA	1.3	NA	NA	NA
	SDLF	0.1	NA	NA	NA	0.8	NA	NA	NA
	TDLF	0.0	NA	NA	NA	0.3	NA	NA	NA
G8	NLF	0.1	NA	NA	NA	0.4	NA	NA	NA
	SDLF	0.0	NA	NA	NA	0.2	NA	NA	NA
	TDLF	0.2	NA	NA	NA	0.4	NA	NA	NA

Table T2-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.7	0.1	-0.6	0.4	-3.8	-3.1	-5.9	-2.4
	SDLF	0.0	1.1	-1.1	0.2	-1.9	-1.2	-5.7	-2.2
	TDLF	1.4	3.7	-1.9	0.3	0.3	4.2	-3.7	1.0
G2	NLF	-0.2	0.0	-0.5	0.0	-1.8	-2.5	-4.5	-2.5
	SDLF	0.1	0.5	-0.7	0.2	-1.1	-1.4	-4.1	-1.7
	TDLF	0.7	1.8	-0.9	0.9	0.2	1.9	-2.4	0.8
G3	NLF	0.0	0.0	-0.3	0.0	0.0	-1.1	-2.4	-1.1
	SDLF	0.1	0.4	-0.5	0.2	-0.1	-0.4	-2.2	-0.5
	TDLF	0.2	1.2	-0.9	0.7	0.1	1.5	-1.9	0.8
G4	NLF	0.2	0.1	-0.1	0.1	1.6	0.7	-0.2	0.8
	SDLF	0.0	0.2	-0.3	0.2	1.1	0.8	-0.4	0.9
	TDLF	-0.3	0.5	-0.9	0.4	-0.2	1.1	-1.4	0.6
G5	NLF	0.2	0.2	0.0	0.1	2.6	2.0	1.1	2.0
	SDLF	0.0	0.1	-0.2	0.2	1.7	1.6	0.7	1.6
	TDLF	-0.7	-0.2	-0.6	0.1	-0.4	0.6	-1.0	0.4
G6	NLF	0.3	0.2	0.0	0.2	3.1	2.5	1.5	2.4
	SDLF	-0.1	-0.1	0.1	0.1	2.0	1.7	1.2	1.8
	TDLF	-0.9	-1.0	0.0	-0.2	-0.6	-0.1	-0.2	0.2
G7	NLF	0.3	0.2	0.0	0.0	2.9	2.4	0.9	1.5
	SDLF	-0.1	-0.6	0.5	0.0	1.7	1.2	1.2	1.2
	TDLF	-0.9	-2.5	1.5	0.0	-0.6	-1.6	1.4	-0.2
G8	NLF	0.1	0.2	-0.3	0.1	1.6	1.5	-1.1	1.6
	SDLF	-0.1	-0.7	0.6	-0.2	0.9	0.6	0.2	1.0
	TDLF	-0.7	-2.7	2.8	-1.1	-0.5	-1.6	2.3	-0.8

Table T2-4-14. Longitudinal displacements at supports (in).

		Load Type & Support Number							
Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.10	0.64	0.35	0.73	-0.60	1.63	0.62	1.91
	SDLF	-0.03	0.48	0.18	0.49	-0.34	1.11	0.06	1.10
	TDLF	0.00	0.68	0.41	0.77	-0.16	2.00	1.02	2.25
G2	NLF	-0.03	0.63	0.37	0.69	-0.31	1.70	0.81	1.92
	SDLF	-0.01	0.45	0.20	0.46	-0.22	1.13	0.23	1.13
	TDLF	0.03	0.61	0.41	0.70	-0.04	1.87	1.05	2.09
G3	NLF	0.00	0.62	0.38	0.69	-0.08	1.81	1.00	2.08
	SDLF	0.01	0.44	0.20	0.46	-0.07	1.22	0.39	1.27
	TDLF	0.04	0.58	0.39	0.69	0.03	1.84	1.06	2.10
G4	NLF	0.02	0.62	0.39	0.70	0.13	1.98	1.19	2.27
	SDLF	0.01	0.44	0.20	0.46	0.09	1.35	0.53	1.41
	TDLF	0.00	0.57	0.35	0.66	0.03	1.83	1.05	2.10
G5	NLF	0.03	0.63	0.39	0.70	0.25	2.08	1.29	2.39
	SDLF	0.01	0.44	0.20	0.46	0.17	1.42	0.60	1.49
	TDLF	-0.05	0.56	0.33	0.64	0.00	1.81	1.02	2.08
G6	NLF	0.03	0.62	0.39	0.71	0.29	2.08	1.31	2.42
	SDLF	0.00	0.43	0.20	0.46	0.19	1.41	0.62	1.51
	TDLF	-0.06	0.55	0.32	0.63	0.00	1.77	1.01	2.07
G7	NLF	0.04	0.61	0.38	0.68	0.26	2.00	1.23	2.29
	SDLF	0.01	0.42	0.20	0.44	0.15	1.34	0.57	1.41
	TDLF	-0.01	0.54	0.34	0.58	0.06	1.71	1.00	1.95
G8	NLF	0.01	0.58	0.35	0.69	0.09	1.81	1.04	2.22
	SDLF	0.00	0.41	0.17	0.43	0.03	1.21	0.43	1.35
	TDLF	0.04	0.53	0.33	0.55	0.07	1.66	0.94	1.93

Table T2-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	-0.13	0.01	-0.12	0.07	-0.75	-0.62	-1.19	-0.48
	SDLF	0.01	0.22	-0.21	0.03	-0.38	-0.24	-1.13	-0.45
	TDLF	0.29	0.73	-0.38	0.07	0.05	0.84	-0.74	0.20
G2	NLF	-0.04	-0.01	-0.10	-0.01	-0.35	-0.50	-0.90	-0.49
	SDLF	0.01	0.10	-0.13	0.03	-0.22	-0.28	-0.81	-0.33
	TDLF	0.15	0.36	-0.18	0.18	0.03	0.39	-0.48	0.16
G3	NLF	0.01	0.00	-0.07	-0.01	-0.01	-0.22	-0.49	-0.21
	SDLF	0.01	0.07	-0.09	0.04	-0.02	-0.09	-0.45	-0.09
	TDLF	0.04	0.25	-0.18	0.15	0.01	0.31	-0.37	0.15
G4	NLF	0.04	0.02	-0.03	0.01	0.33	0.14	-0.05	0.16
	SDLF	0.00	0.04	-0.06	0.04	0.21	0.16	-0.09	0.17
	TDLF	-0.06	0.11	-0.17	0.08	-0.03	0.22	-0.28	0.13
G5	NLF	0.05	0.04	0.00	0.03	0.52	0.40	0.22	0.39
	SDLF	-0.01	0.01	-0.03	0.03	0.35	0.31	0.13	0.32
	TDLF	-0.14	-0.03	-0.13	0.01	-0.08	0.13	-0.19	0.08
G6	NLF	0.05	0.05	0.01	0.04	0.61	0.51	0.30	0.48
	SDLF	-0.01	-0.03	0.01	0.02	0.40	0.35	0.24	0.37
	TDLF	-0.19	-0.20	-0.01	-0.04	-0.11	-0.03	-0.04	0.03
G7	NLF	0.06	0.05	0.00	0.00	0.59	0.47	0.17	0.29
	SDLF	-0.01	-0.12	0.10	0.00	0.34	0.23	0.25	0.24
	TDLF	-0.18	-0.50	0.30	0.00	-0.11	-0.33	0.27	-0.04
G8	NLF	0.02	0.03	-0.06	0.01	0.33	0.30	-0.21	0.31
	SDLF	-0.02	-0.14	0.13	-0.05	0.17	0.13	0.04	0.19
	TDLF	-0.13	-0.54	0.56	-0.22	-0.11	-0.32	0.46	-0.16

Appendix T2-5. EICCS27 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge EICCS27 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Table T2-5-1. Erection fit-up forces (kips) applied to the girder being installed

Table T2-5-2. Erection critical sub-stages

Table T2-5-3. Erection critical fit-up forces (kips) applied to the girder being installed

Reactions

Table T2-5-4. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force.

Table T2-5-1. Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
2	2-2	NLF	0.2	-0.2	0.3	0.0	0.2	0.2
		SDLF	0.3	0.0	0.3	0.0	-0.1	0.1
		TDLF	0.7	0.7	1.0	0.0	-0.8	0.8
	2-3	NLF	0.6	-0.3	0.7	0.0	0.9	0.9
		SDLF	0.4	-0.4	0.6	0.0	0.9	0.9
		TDLF	-0.2	-0.7	0.7	0.0	1.3	1.3
	2-4	NLF	0.4	0.1	0.4	0.0	0.7	0.7
		SDLF	0.2	-0.2	0.3	0.0	0.9	0.9
		TDLF	-0.8	-1.2	1.4	0.0	1.6	1.6
	2-5	NLF	-0.4	0.3	0.4	0.0	0.8	0.8
		SDLF	-0.7	-0.2	0.8	0.0	1.1	1.1
		TDLF	-1.8	-1.4	2.3	0.0	2.0	2.0
	2-6	NLF	-1.2	0.5	1.3	0.0	0.7	0.7
		SDLF	-1.8	-0.1	1.8	0.0	1.1	1.1
		TDLF	-3.4	-1.9	3.9	0.0	2.2	2.2
	2-7	NLF	-1.9	0.4	1.9	0.0	0.5	0.5
		SDLF	-2.5	-0.3	2.5	0.0	1.1	1.1
		TDLF	-4.2	-2.0	4.7	0.0	2.6	2.6
	2-8	NLF	-2.0	0.0	2.0	0.0	0.6	0.6
		SDLF	-2.5	-0.7	2.6	0.0	1.3	1.3
		TDLF	-3.7	-2.2	4.3	0.0	2.6	2.6
	2-9	NLF	-1.7	0.0	1.7	0.0	0.2	0.2
		SDLF	-2.0	-0.6	2.1	0.0	0.8	0.8
		TDLF	-2.6	-1.5	3.0	0.0	1.5	1.5
	2-10	NLF	-1.7	1.5	2.2	0.0	-1.1	1.1
		SDLF	3.9	4.0	5.6	0.0	-4.7	4.7
		TDLF	17.6	10.1	20.3	0.0	-13.3	13.3
	2-11	NLF	-1.2	-1.6	2.0	0.0	1.6	1.6
		SDLF	-7.5	-9.5	12.1	0.0	9.6	9.6
		TDLF	-22.3	-28.4	36.1	0.0	28.5	28.5

Table T2-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
8	8-2	NLF	-0.4	-0.2	0.5	0.0	0.4	0.4
		SDLF	0.2	-0.1	0.2	0.0	-0.3	0.3
		TDLF	2.0	0.5	2.1	0.0	-2.4	2.4
	8-3	NLF	-7.6	-0.2	7.6	0.0	0.3	0.3
		SDLF	-4.0	-0.8	4.1	0.0	0.5	0.5
		TDLF	5.4	-1.8	5.7	0.0	0.5	0.5
	8-4	NLF	-0.7	-0.3	0.7	0.0	0.3	0.3
		SDLF	-0.7	-0.8	1.1	0.0	0.7	0.7
		TDLF	-0.2	-1.7	1.7	0.0	1.0	1.0
	8-5	NLF	-9.0	0.2	9.0	0.0	-0.3	0.3
		SDLF	-6.7	-0.5	6.7	0.0	0.4	0.4
		TDLF	-0.3	-2.3	2.3	0.0	2.0	2.0
	8-6	NLF	-0.7	0.0	0.7	0.0	0.0	0.0
		SDLF	-0.9	-0.7	1.2	0.0	0.8	0.8
		TDLF	-1.2	-2.4	2.7	0.0	2.6	2.6
	8-7	NLF	-6.4	0.2	6.4	0.0	-0.6	0.6
		SDLF	-4.6	-0.5	4.6	0.0	0.5	0.5
		TDLF	0.1	-2.7	2.7	0.0	3.5	3.5
	8-8	NLF	-0.4	-0.4	0.6	0.0	0.2	0.2
		SDLF	-0.8	-1.2	1.4	0.0	1.3	1.3
		TDLF	-1.6	-2.9	3.4	0.0	3.7	3.7
	8-9	NLF	0.9	-0.4	1.0	0.0	0.3	0.3
		SDLF	-5.0	-1.0	5.1	0.0	1.5	1.5
		TDLF	-20.4	-2.1	20.5	0.0	3.5	3.5
	8-10	NLF	-0.3	-0.2	0.3	0.0	0.1	0.1
		SDLF	-6.6	-0.5	6.6	0.0	0.7	0.7
		TDLF	-21.1	-0.9	21.1	0.0	1.4	1.4
	8-11	NLF	-0.5	1.5	1.6	0.0	-1.2	1.2
		SDLF	9.4	3.0	9.9	0.0	-4.6	4.6
		TDLF	32.2	6.6	32.8	0.0	-11.8	11.8
	8-12	NLF	-0.4	-1.0	1.1	0.0	0.9	0.9
		SDLF	-2.4	-4.1	4.7	0.0	3.9	3.9
		TDLF	-6.8	-10.5	12.5	0.0	9.9	9.9

Table T2-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
32	32-2	NLF	0.2	0.0	0.2	0.0	-0.1	0.1
		SDLF	-0.1	-0.3	0.3	0.0	0.3	0.3
		TDLF	-0.8	-0.7	1.1	0.0	1.2	1.2
	32-3	NLF	5.5	-0.5	5.5	0.0	0.4	0.4
		SDLF	5.6	-0.4	5.6	0.0	0.6	0.6
		TDLF	7.5	-0.2	7.5	0.0	1.2	1.2
	32-4	NLF	-0.4	-0.3	0.5	0.0	0.4	0.4
		SDLF	-0.5	-0.3	0.6	0.0	0.8	0.8
		TDLF	-0.7	-0.3	0.8	0.0	1.9	1.9
	32-5	NLF	-3.4	-0.2	3.4	0.0	0.2	0.2
		SDLF	-3.5	0.0	3.5	0.0	0.4	0.4
		TDLF	-3.5	0.2	3.5	0.0	0.9	0.9
	32-6	NLF	-0.4	-0.3	0.5	0.0	0.3	0.3
		SDLF	-0.5	-0.2	0.5	0.0	0.2	0.2
		TDLF	-0.8	0.0	0.8	0.0	0.2	0.2
	32-7	NLF	-6.3	0.2	6.3	0.0	-0.2	0.2
		SDLF	-8.3	0.4	8.4	0.0	-0.3	0.3
		TDLF	-15.9	1.0	15.9	0.0	-0.6	0.6

Table T2-5-2: Erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
2	NLF	2-10
	SDLF	2-11
	TDLF	2-11
8	NLF	8-5
	SDLF	8-11
	TDLF	8-11
32	NLF	32-7
	SDLF	32-7
	TDLF	32-7

Table T2-5-3. Erection critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
2	A	NLF	-2.2	0.6	2.2	NA	NA	NA
		SDLF	-2.5	-1.1	2.7	NA	NA	NA
		TDLF	-7.5	-3.4	8.2	NA	NA	NA
	B	NLF	-1.7	1.5	2.2	0.0	-1.1	1.1
		SDLF	-7.5	-9.5	12.1	0.0	9.6	9.6
		TDLF	-22.3	-28.4	36.1	0.0	28.5	28.5
8	A	NLF	-9.0	0.1	9.0	NA	NA	NA
		SDLF	8.0	-0.7	8.0	NA	NA	NA
		TDLF	28.7	-2.9	28.8	NA	NA	NA
	B	NLF	-9.0	0.2	9.0	0.0	-0.3	0.3
		SDLF	9.4	3.0	9.9	0.0	-4.6	4.6
		TDLF	32.2	6.6	32.8	0.0	-11.8	11.8
32	A	NLF	-6.3	0.1	6.3	NA	NA	NA
		SDLF	-8.4	0.3	8.4	NA	NA	NA
		TDLF	-16.1	0.8	16.1	NA	NA	NA
	B	NLF	-6.3	0.2	6.3	0.0	-0.2	0.2
		SDLF	-8.3	0.4	8.4	0.0	-0.3	0.3
		TDLF	-15.9	1.0	15.9	0.0	-0.6	0.6

Table T2-5-6. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number								
				1	2	3	4	5	6	7	8	9
2	A	G1	NLF	45.3	22.9	3.9	70.3					
			SDLF	45.0	26.4	0.0	71.0					
			TDLF	44.1	26.8	0.0	70.2					
		G2	NLF	5.5	29.1	58.4	29.2	15.5	29.8	59.6	29.8	8.0
			SDLF	6.7	27.7	55.4	27.8	20.1	29.8	59.7	29.8	6.1
			TDLF	0.0	30.4	60.9	30.5	27.8	28.0	56.1	28.1	4.6
	B	G1	NLF	45.3	23.0	3.9	70.5					
			SDLF	44.9	27.8	0.0	69.9					
			TDLF	43.8	31.0	0.0	66.6					
		G2	NLF	5.5	29.1	58.4	29.3	15.6	30.6	61.3	30.7	6.4
			SDLF	6.1	28.2	56.5	28.3	17.9	29.4	58.8	29.4	8.8
			TDLF	0.0	30.7	61.4	30.8	22.6	27.2	54.5	27.3	10.8

Table T2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ectio	Girder	Detailing	Support Number								
				1	2	3	4	5	6	7	8	9
8	A	G1	NLF	45.0	24.3	67.5						
			SDLF	45.4	27.3	65.4						
			TDLF	46.9	37.0	60.4						
		G2	NLF	51.7	33.3	75.1						
			SDLF	48.3	32.3	76.8						
			TDLF	37.0	28.3	80.2						
		G3	NLF	46.6	30.5	67.5						
			SDLF	46.8	31.1	66.3						
			TDLF	47.8	31.6	63.5						
		G4	NLF	42.7	39.0	65.2						
			SDLF	42.3	40.7	62.6						
			TDLF	41.9	45.2	55.4						
		G5	NLF	38.9	46.5	64.1						
			SDLF	39.3	49.8	61.8						
			TDLF	41.3	59.6	54.9						
		G6	NLF	43.0	49.3	62.6						
			SDLF	43.7	61.9	62.6						
			TDLF	47.1	85.9	63.8						
		G7	NLF	32.6	26.7	69.0						
			SDLF	31.8	16.0	65.0						
			TDLF	28.9	7.9	47.6						
		G8	NLF	0.0	38.3	76.7	38.	16.	30.	60.	30.	4.0
			SDLF	0.0	35.6	71.3	35.	33.	26.	53.	26.	8.7
			TDLF	0.0	26.7	53.4	26.	63.	20.	41.	20.	14.

Table T2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number								
				1	2	3	4	5	6	7	8	9
8	B	G1	NLF	45.0	24.3	67.5						
			SDLF	45.4	27.3	65.4						
			TDLF	46.9	37.0	60.4						
		G2	NLF	51.7	33.3	75.1						
			SDLF	48.3	32.3	76.8						
			TDLF	37.0	28.3	80.2						
		G3	NLF	46.6	30.5	67.5						
			SDLF	46.8	31.1	66.3						
			TDLF	47.8	31.5	63.5						
		G4	NLF	42.7	39.0	65.2						
			SDLF	42.3	40.7	62.6						
			TDLF	41.9	45.2	55.5						
		G5	NLF	38.9	46.5	64.1						
			SDLF	39.3	49.8	61.8						
			TDLF	41.3	59.6	55.0						
		G6	NLF	43.0	49.4	62.6						
			SDLF	43.7	62.0	62.6						
			TDLF	47.1	86.3	62.8						
		G7	NLF	32.6	26.7	69.0						
			SDLF	31.8	16.7	64.0						
			TDLF	28.8	9.7	47.1						
		G8	NLF	0.0	38.4	76.9	38.5	15.9	30.2	60.4	30.2	4.1
			SDLF	0.0	35.6	71.2	35.6	34.2	29.4	58.8	29.4	3.2
			TDLF	0.0	26.6	53.3	26.7	63.3	26.7	53.4	26.7	1.9

Table T2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number										
				1	2	3	4	5	6	7	8	9	10	11
32	A	G1	NLF	22.3	68.0	36.7	43.8	44.5	65.3	53.2	20.1			
			SDLF	24.6	68.2	41.1	44.7	39.2	68.5	53.6	18.2			
			TDLF	29.7	72.7	54.6	47.7	24.2	78.7	54.5	13.0			
		G2	NLF	20.9	66.1	49.9	45.8	52.7	62.4	61.1	19.3			
			SDLF	21.0	51.6	47.0	53.9	58.4	52.1	58.1	18.3			
			TDLF	20.2	6.0	37.2	73.8	73.2	22.8	47.3	14.1			
		G3	NLF	20.4	68.0	42.0	48.3	46.5	63.7	53.4	20.5			
			SDLF	21.5	64.4	43.1	46.6	47.3	64.4	58.3	20.4			
			TDLF	24.4	55.2	43.7	43.0	50.6	67.2	75.7	19.6			
		G4	NLF	19.5	70.4	50.2	42.2	49.6	65.8	55.6	22.4			
			SDLF	22.9	68.3	51.8	39.0	49.8	66.0	58.4	21.9			
			TDLF	33.0	68.0	54.9	29.4	50.9	65.7	68.5	20.1			
		G5	NLF	16.4	70.2	56.1	38.1	52.0	65.6	56.9	25.4			
			SDLF	20.5	70.1	59.4	36.5	51.7	64.6	60.7	24.6			
			TDLF	31.0	74.2	69.6	31.3	51.3	60.8	71.9	21.5			
		G6	NLF	15.5	69.8	57.0	34.6	51.7	68.2	59.0	28.8			
			SDLF	16.5	72.0	67.1	36.6	52.8	67.1	62.1	29.1			
			TDLF	17.0	83.9	98.8	37.8	56.1	65.6	73.2	30.7			
		G7	NLF	15.4	71.8	58.5	38.6	56.6	50.4	61.0	26.8			
			SDLF	14.4	78.6	56.6	24.9	55.4	46.0	67.9	27.5			
			TDLF	9.7	89.2	45.3	0.0	53.6	26.2	84.5	30.3			
		G8	NLF	14.4	70.1	54.7	36.6	33.3	66.6	33.2	0.0	47.8	63.6	25.8
			SDLF	11.7	57.1	65.7	38.9	34.6	69.0	34.5	0.0	42.0	59.5	25.4
			TDLF	6.0	23.7	93.7	39.6	37.9	75.7	37.8	0.0	33.0	45.6	24.1

Table T2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number										
				1	2	3	4	5	6	7	8	9	10	11
32	B	G1	NLF	22.3	68.0	36.7	43.8	44.5	65.3	53.2	20.1			
			SDLF	24.6	68.2	41.1	44.7	39.2	68.5	53.6	18.2			
			TDLF	29.7	72.7	54.6	47.7	24.2	78.7	54.5	13.0			
		G2	NLF	20.9	66.1	49.9	45.8	52.7	62.4	61.1	19.3			
			SDLF	21.0	51.6	47.0	53.9	58.4	52.1	58.1	18.3			
			TDLF	20.2	6.0	37.2	73.8	73.2	22.8	47.3	14.1			
		G3	NLF	20.4	68.0	42.0	48.3	46.5	63.7	53.4	20.5			
			SDLF	21.5	64.4	43.1	46.6	47.3	64.4	58.3	20.4			
			TDLF	24.4	55.2	43.7	43.0	50.6	67.2	75.7	19.6			
		G4	NLF	19.5	70.4	50.2	42.2	49.6	65.8	55.6	22.4			
			SDLF	22.9	68.3	51.8	39.0	49.8	66.0	58.4	21.9			
			TDLF	33.0	68.0	54.9	29.4	50.9	65.7	68.5	20.1			
		G5	NLF	16.4	70.2	56.1	38.1	52.0	65.6	56.9	25.4			
			SDLF	20.5	70.1	59.4	36.5	51.7	64.6	60.7	24.6			
			TDLF	31.0	74.2	69.6	31.3	51.3	60.8	71.9	21.5			
		G6	NLF	15.5	69.8	57.0	34.6	51.7	68.3	59.0	28.8			
			SDLF	16.5	72.0	67.1	36.6	52.8	67.2	62.1	29.1			
			TDLF	17.0	83.9	98.8	37.8	56.1	65.6	73.2	30.7			
		G7	NLF	15.4	71.8	58.5	38.5	56.6	50.5	61.0	26.8			
			SDLF	14.4	78.6	56.6	24.9	55.4	46.1	67.9	27.5			
			TDLF	9.7	89.2	45.3	0.0	53.6	26.1	84.4	30.3			
		G8	NLF	14.4	70.1	54.7	36.6	33.4	66.8	33.3	0.0	47.9	63.6	25.8
			SDLF	11.7	57.1	65.8	38.8	34.7	69.2	34.6	0.0	42.1	59.5	25.4
			TDLF	6.0	23.7	93.7	39.6	38.0	75.9	37.9	0.0	33.1	45.6	24.1

Appendix U1-1. EICCS28 Bridge Description

The key characteristics of EICCS28 are as follows:

- Span length along the centerline of the bridge, L_s = 326, 160, 235ft.
- Width between the fascia girders, w_g = 52 ft.
- Radius of curvature to the centerline of the bridge, R = 1255 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 6.3, 3.1, 4.5
- Subtended angle between the supports, L_s/R = 0.26, 0.13, 0.19
- Number of girders in the completed bridge cross-section, n_g =7.
- Skew angle, θ = 0, 54.5, 47, 0^o

This appendix presents the bridge description of the bridge EICCS28 in its final condition as well as during erection. The following figures and tables are provided:

Figure U1-1-1. Framing plan

Figure U1-1-2. Girder Elevation

Figure U1-1-3. Cross-frame details

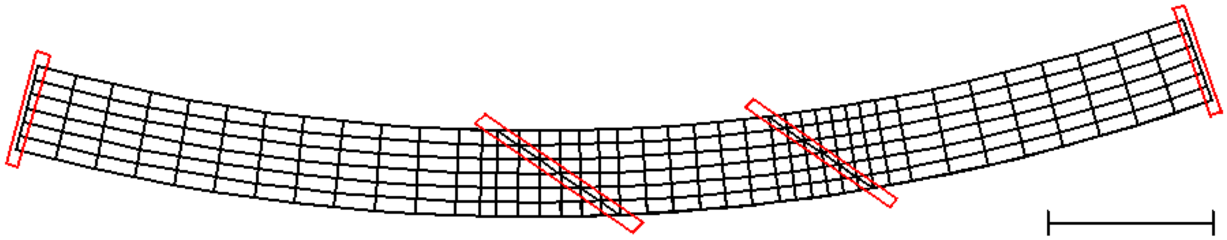


Figure U1-1-1. Framing plan.

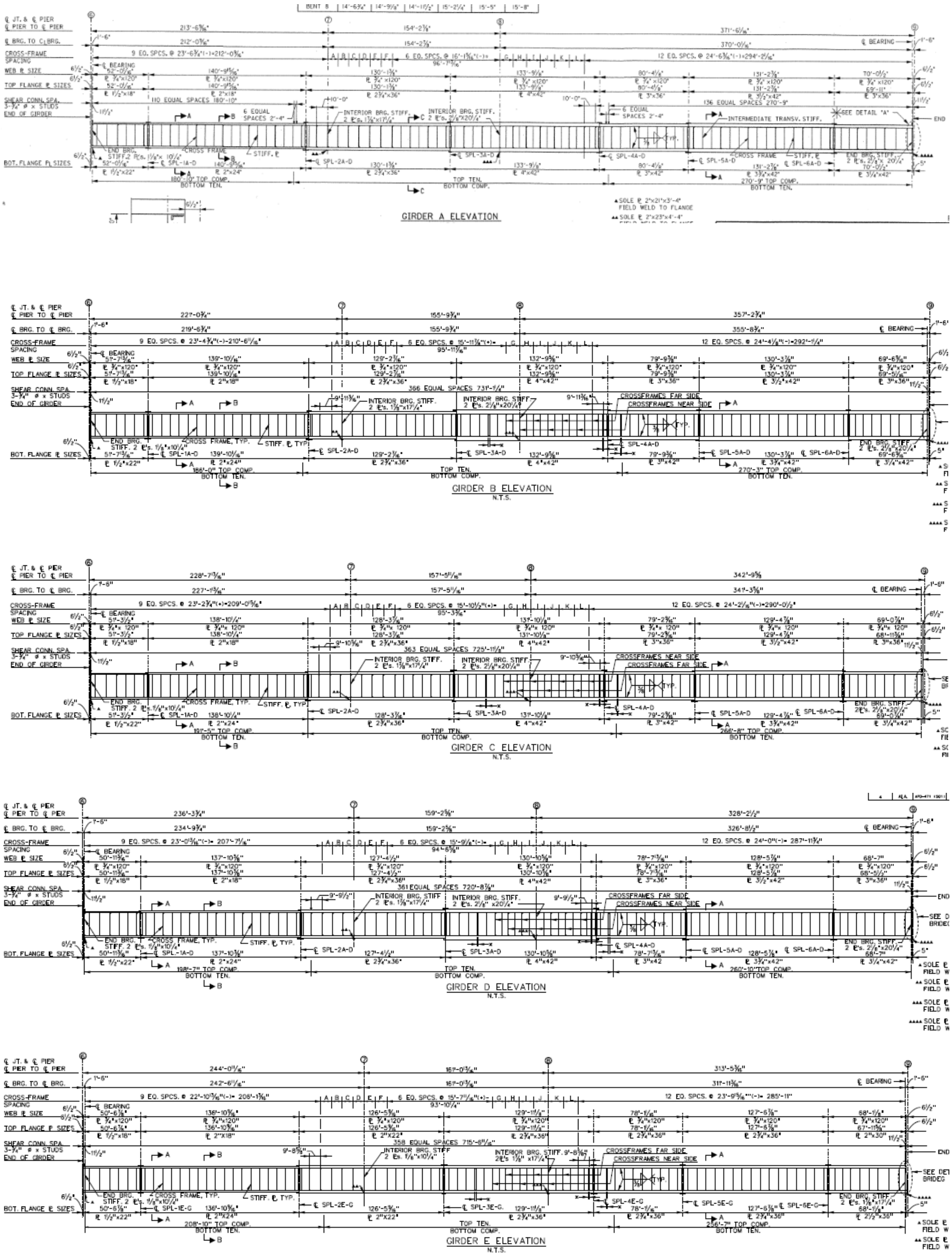



Figure U1-1-2. Girder elevations

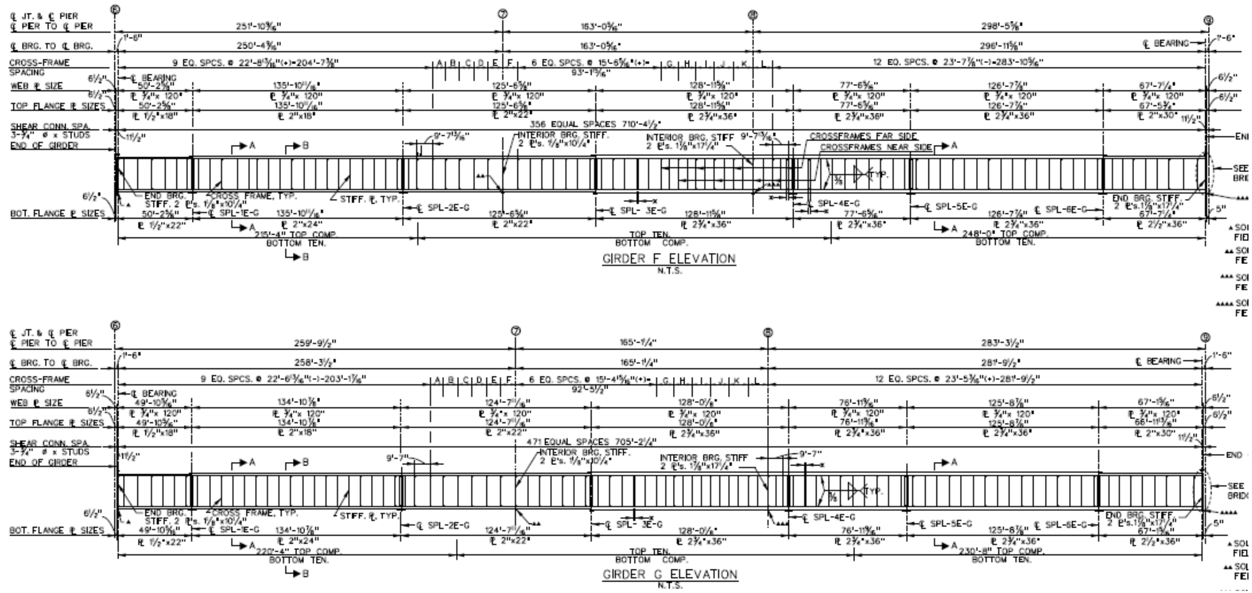


Figure U1-1-2(Continued). Girder elevations

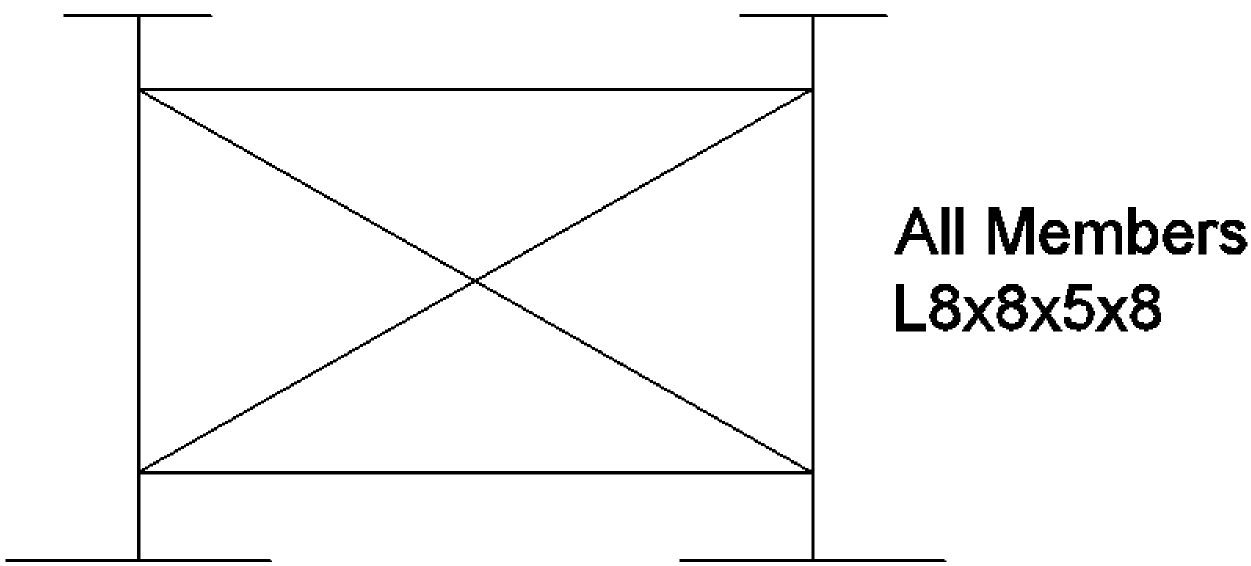


Figure U1-1-3. Cross-frame details

Appendix U1-2. EICCS28 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EICCS28 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table U1-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	13.0	23.9
	SDLF	12.9	23.5
	TDLF	12.8	23.2
G2	NLF	11.2	20.7
	SDLF	10.8	20.0
	TDLF	10.5	19.6
G3	NLF	9.5	17.5
	SDLF	8.8	16.7
	TDLF	8.3	16.1
G4	NLF	7.8	14.5
	SDLF	6.9	13.5
	TDLF	6.3	12.8
G5	NLF	6.1	11.5
	SDLF	5.1	10.5
	TDLF	4.4	9.7
G6	NLF	4.4	8.6
	SDLF	3.3	7.4
	TDLF	2.5	6.6
G7	NLF	2.8	6.1
	SDLF	2.3	5.9
	TDLF	2.3	5.9
All Girders	NLF	13.0	23.9
	SDLF	12.9	23.5
	TDLF	12.8	23.2

Table U1-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	2.21	3.95
	SDLF	0.39	2.07
	TDLF	1.04	0.60
G2	NLF	2.17	3.87
	SDLF	0.34	1.99
	TDLF	1.09	0.52
G3	NLF	2.11	3.77
	SDLF	0.28	1.89
	TDLF	1.16	0.42
G4	NLF	2.06	3.68
	SDLF	0.22	1.79
	TDLF	1.23	0.32
G5	NLF	2.01	3.60
	SDLF	0.17	1.71
	TDLF	1.27	0.26
G6	NLF	2.00	3.58
	SDLF	0.18	1.69
	TDLF	1.30	0.32
G7	NLF	2.00	3.58
	SDLF	0.20	1.68
	TDLF	1.31	0.36
All Girders	NLF	2.21	3.95
	SDLF	0.39	2.07
	TDLF	1.31	0.60

Table U1-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	11.1	20.0	12.2	22.2	1.6	4.5	2.0	5.2
	SDLF	12.0	20.9	14.3	24.2	2.1	3.2	1.8	3.6
	TDLF	13.2	21.8	16.0	25.8	2.6	3.4	2.7	3.5
G2	NLF	12.2	21.8	13.1	23.6	1.6	4.4	2.0	5.0
	SDLF	12.8	22.3	13.0	23.2	1.8	2.9	1.7	3.4
	TDLF	13.4	22.8	14.7	23.3	2.8	3.0	2.6	3.3
G3	NLF	12.3	22.1	13.3	23.9	1.5	4.2	1.9	4.9
	SDLF	11.4	21.1	13.0	23.5	2.2	2.9	2.3	3.4
	TDLF	11.5	20.1	12.8	23.2	4.1	4.3	4.1	4.4
G4	NLF	11.5	21.0	12.4	22.5	1.4	4.1	1.8	4.8
	SDLF	10.0	19.4	11.1	21.1	1.7	2.7	1.6	3.4
	TDLF	9.0	18.0	10.0	19.9	3.0	3.3	2.6	3.5
G5	NLF	11.2	20.5	10.6	19.4	1.2	3.7	1.6	4.2
	SDLF	9.2	18.4	8.8	17.5	1.5	2.4	1.5	3.3
	TDLF	7.6	16.7	7.4	16.0	2.2	2.5	2.6	3.2
G6	NLF	8.5	15.7	8.1	15.0	1.1	3.5	1.5	4.1
	SDLF	6.5	13.7	6.1	13.4	1.3	2.2	1.4	3.2
	TDLF	4.9	12.1	5.3	13.0	2.0	2.2	2.2	3.1
G7	NLF	4.9	11.5	5.3	13.2	1.2	3.6	1.9	5.5
	SDLF	4.4	11.2	4.9	12.9	1.3	1.9	1.3	3.0
	TDLF	6.1	10.9	5.5	12.5	2.0	2.2	2.1	2.9
All Girders	NLF	12.3	22.1	13.3	23.9	1.6	4.5	2.0	5.5
	SDLF	12.8	22.3	14.3	24.2	2.2	3.2	2.3	3.6
	TDLF	13.4	22.8	16.0	25.8	4.1	4.3	4.1	4.4

Table U1-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	79.7	152.1	137.5	152.1
	SDLF	43.0	68.7	69.8	69.8
	TDLF	40.3	66.0	63.8	66.0
TDL	NLF	144.4	271.7	249.7	271.7
	SDLF	94.8	180.8	165.1	180.8
	TDLF	65.5	122.7	113.6	122.7

Table U1-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	12.8	22.7	22.2	17.6
	SDLF	9.5	14.1	16.6	12.5
	TDLF	10.1	15.4	13.0	12.1
TDL	NLF	24.8	42.7	41.1	33.4
	SDLF	20.7	32.2	34.4	27.0
	TDLF	17.9	27.1	25.8	22.2

Table U1-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	1.82	1.77	1.72	1.69	1.68	1.68	1.82
SDLF	2.11	2.00	1.90	1.82	1.80	1.81	2.11
TDLF	2.33	2.18	2.03	1.92	1.90	1.92	2.33

Table U1-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	3.25	3.16	3.07	3.01	3.00	3.02	3.25
SDLF	3.49	3.34	3.20	3.10	3.08	3.10	3.49
TDLF	3.67	3.48	3.30	3.16	3.14	3.17	3.67

Table U1-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	1.93	1.87	1.82	1.78	1.78	1.78	1.93
SDLF	2.23	2.12	2.01	1.93	1.90	1.91	2.23
TDLF	2.47	2.31	2.15	2.03	2.01	2.03	2.47

Table U1-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	3.44	3.34	3.25	3.18	3.18	3.19	3.44
SDLF	3.69	3.54	3.39	3.28	3.26	3.28	3.69
TDLF	3.88	3.68	3.49	3.34	3.32	3.36	3.88

Table U1-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	5624.3	11001.3
SDLF	5624.3	11001.2
TDLF	5624.3	11001.1

Table U1-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	699.8	1260.4	1.3	1.4	3.6	6.5
SDLF	599.1	1125.4	2.3	2.2	5.3	7.7
TDLF	595.7	1044.0	4.2	4.6	6.7	8.8

Table U1-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.67	1.10	0.72	1.30
SDLF	0.95	1.31	1.06	1.54
TDLF	1.18	1.67	1.40	1.77

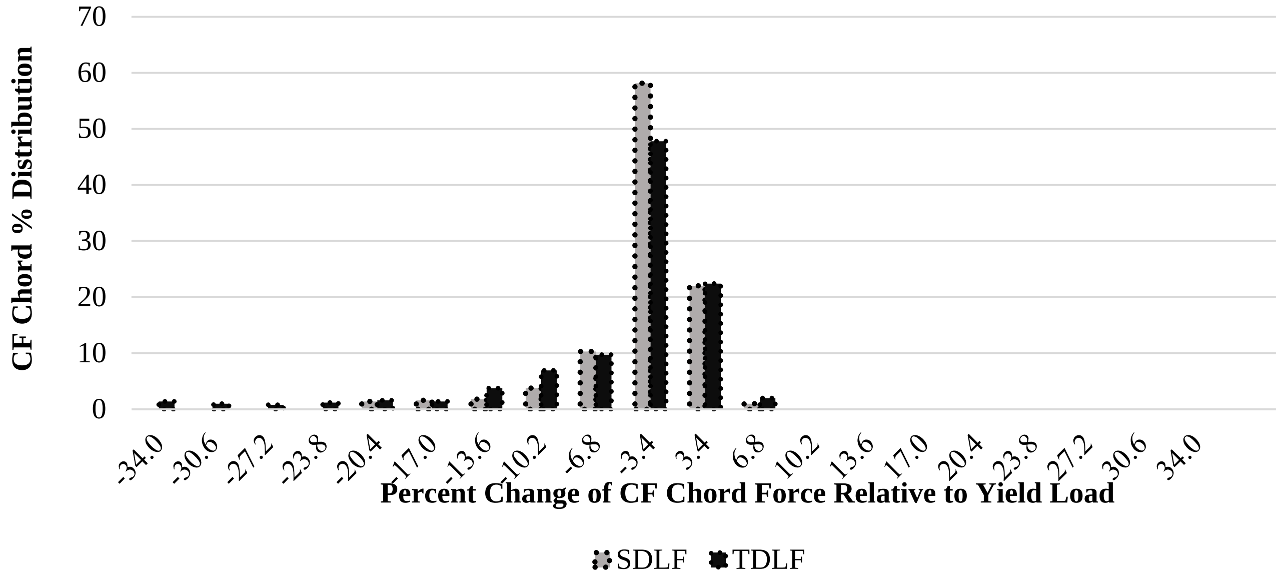


Figure U1-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

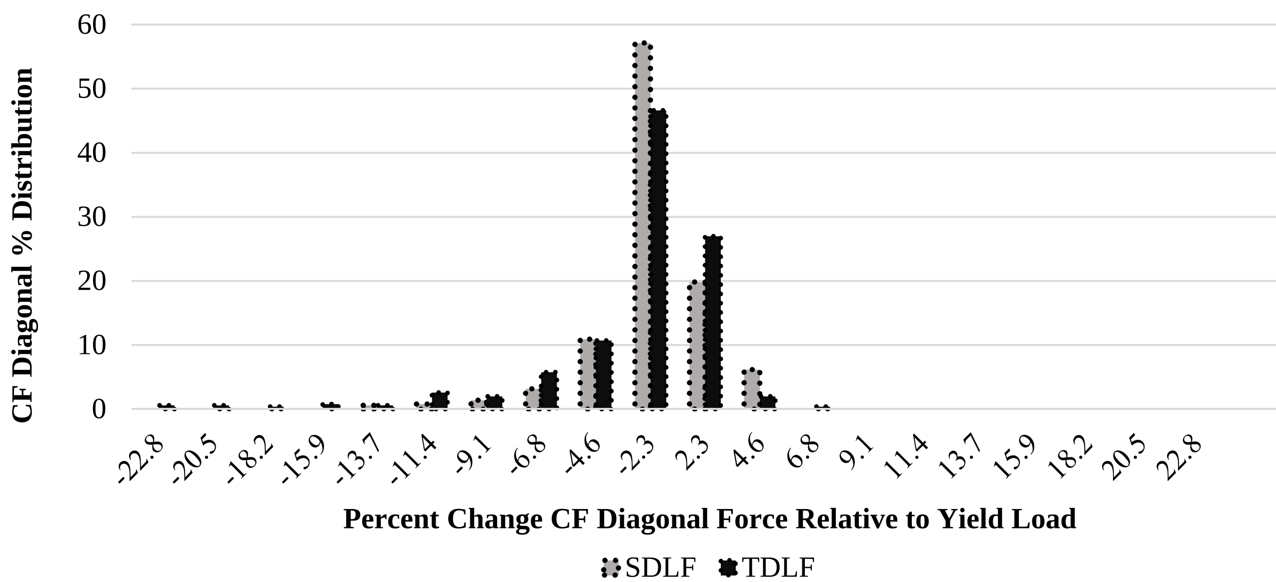


Figure U1-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

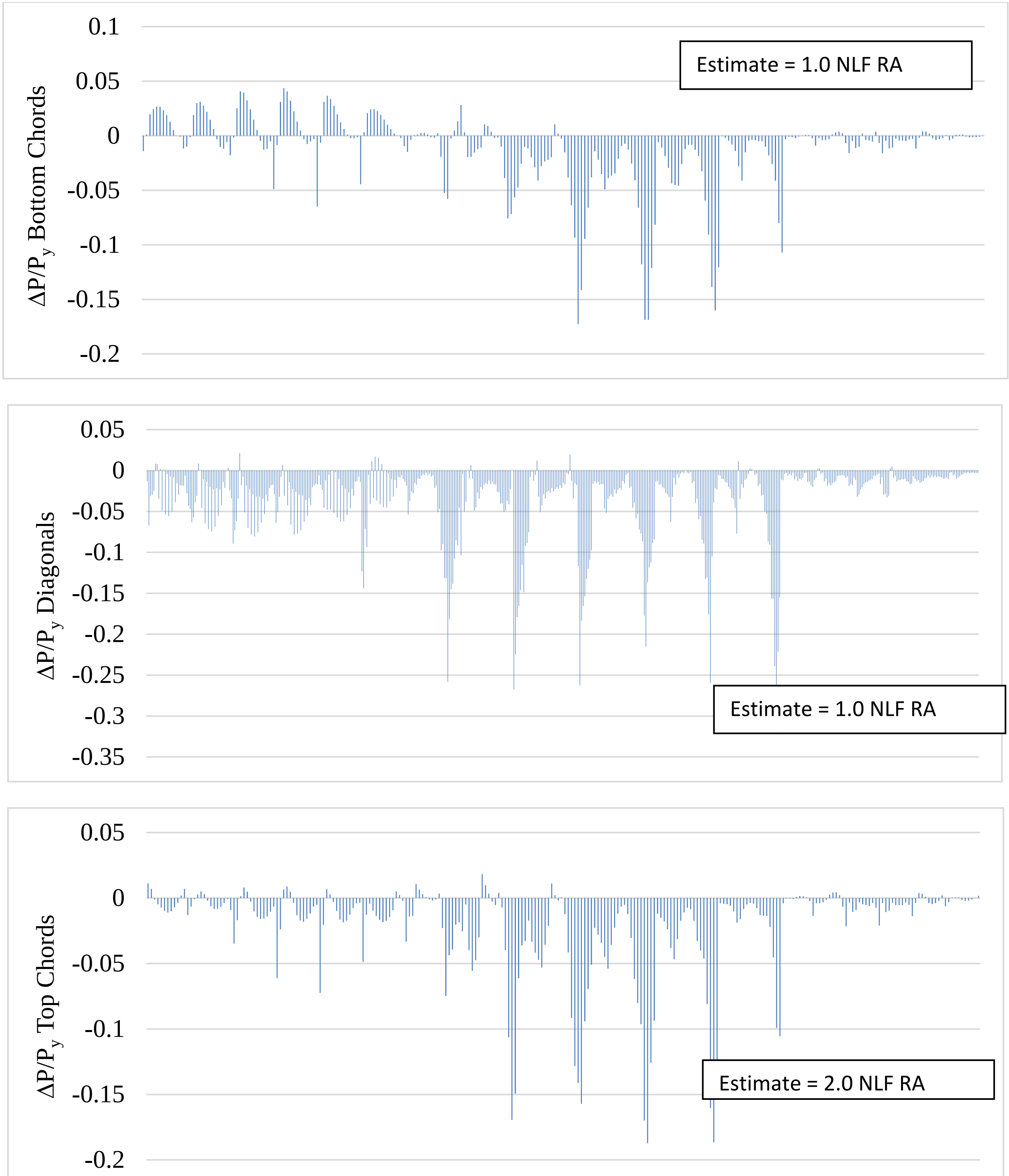


Figure U1-2-3. **Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.**

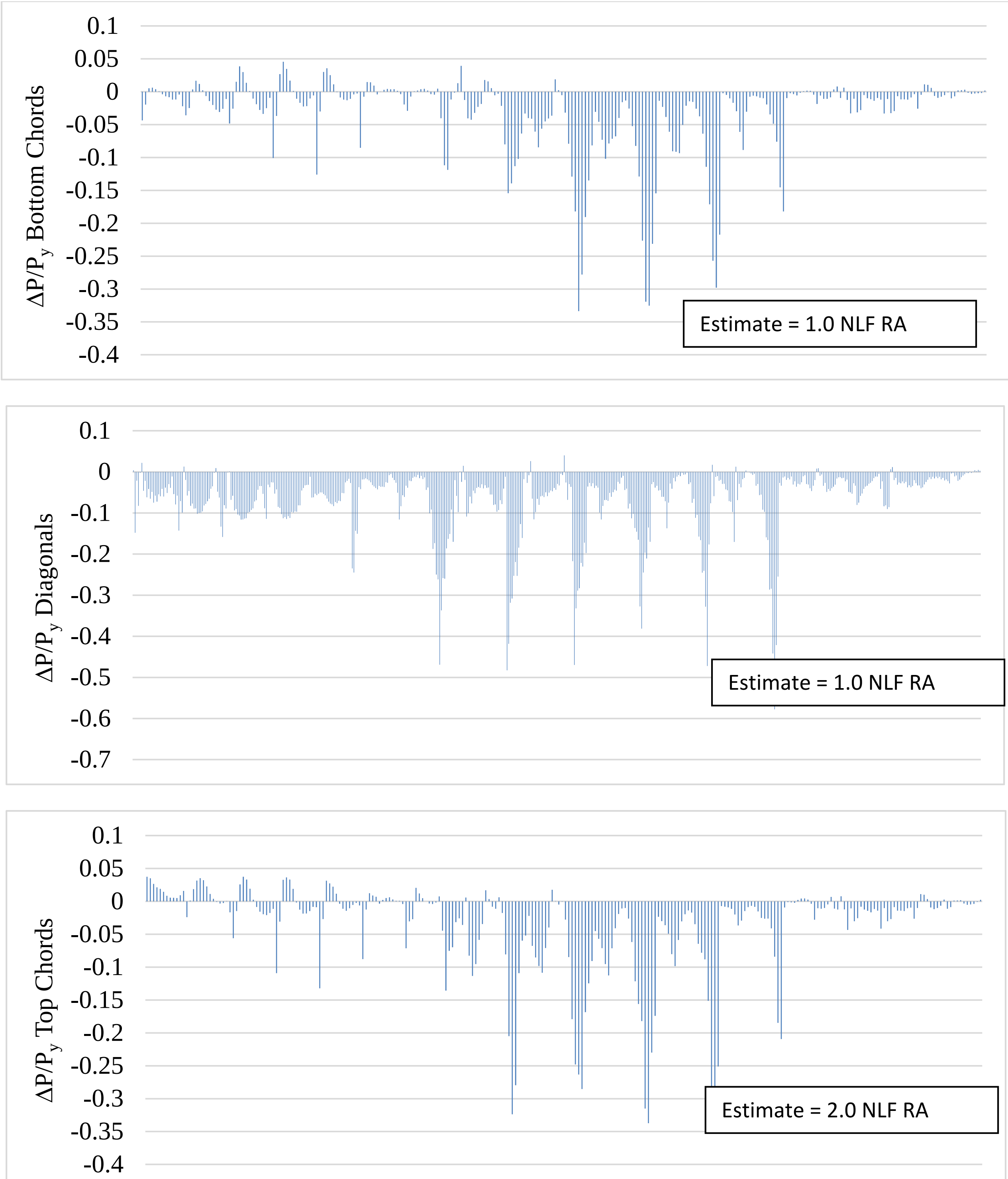


Figure U1-2-4. **Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.**

Appendix U1-4. EICCS28 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge EICCS28 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

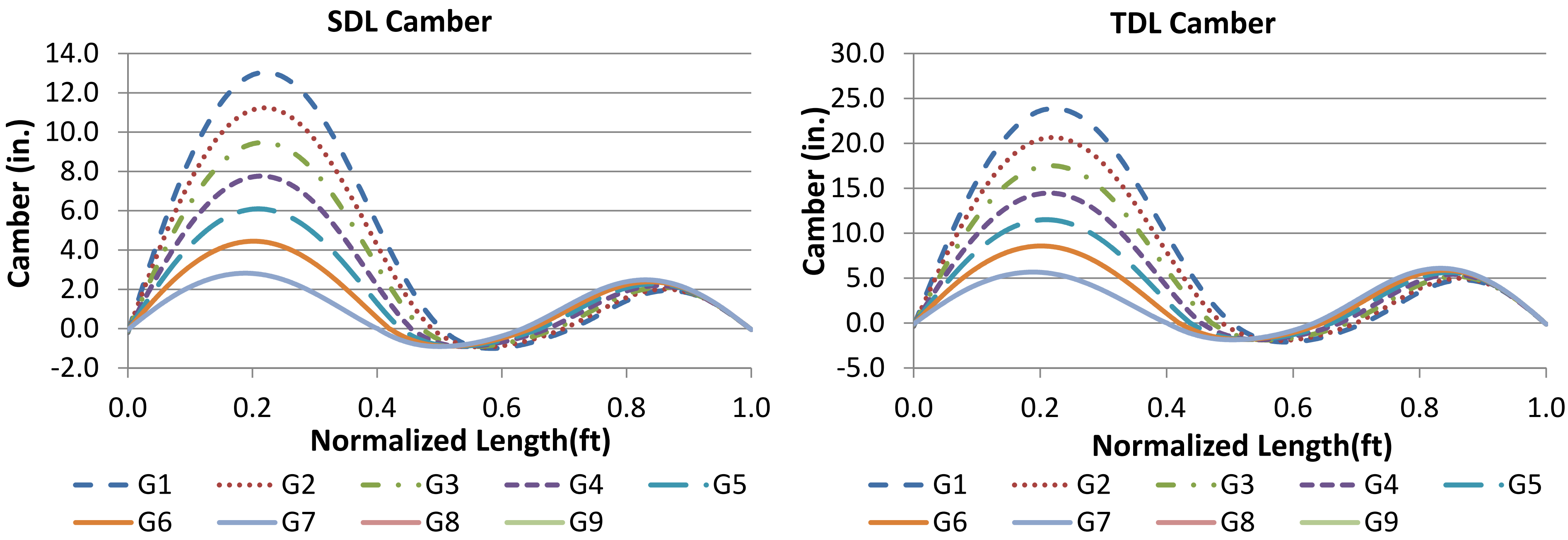


Figure U1-4-1. SDL and TDL 3D FEA cambers.

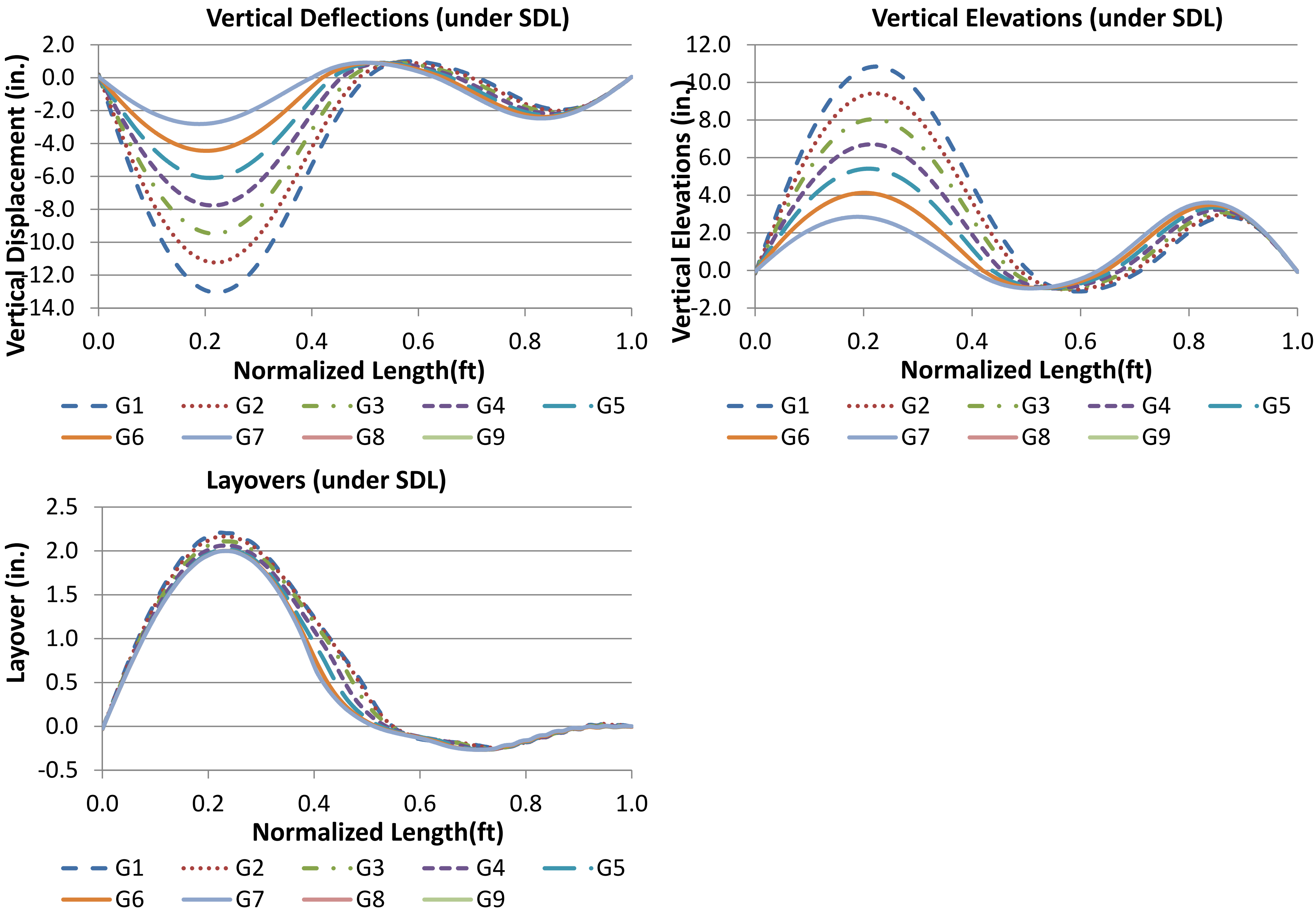
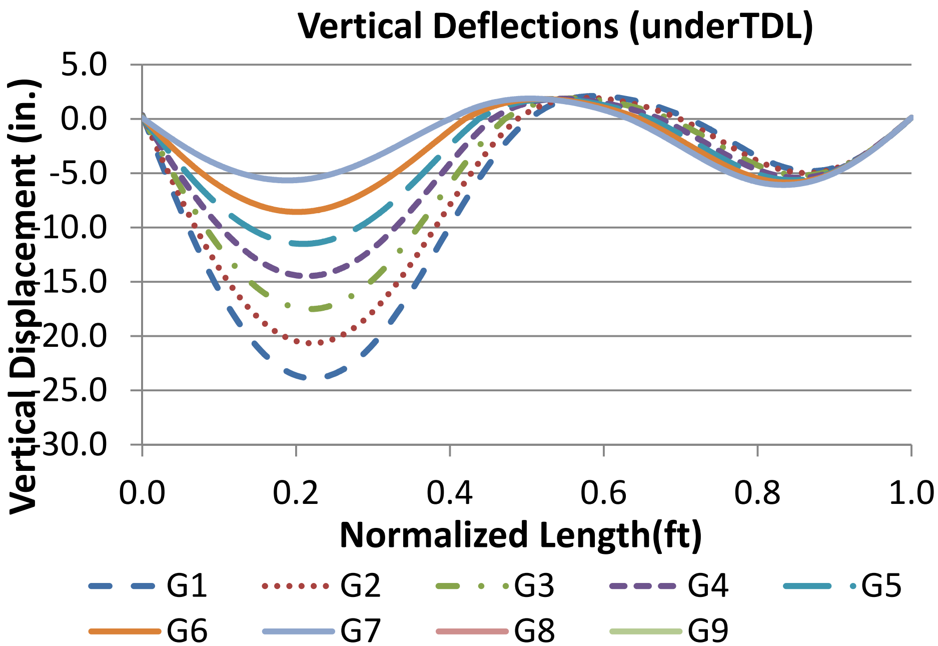
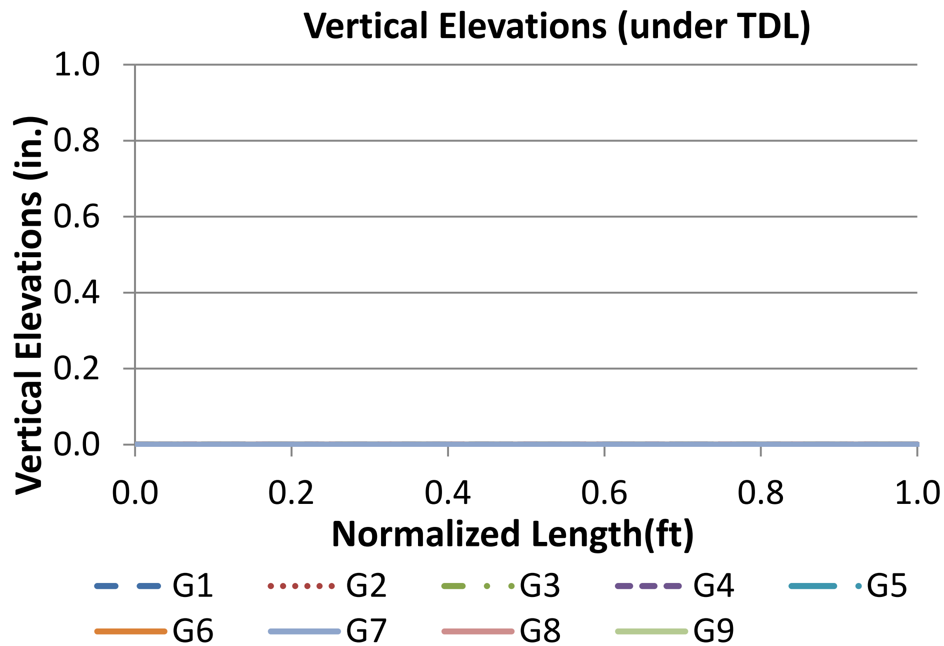


Figure U1-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.





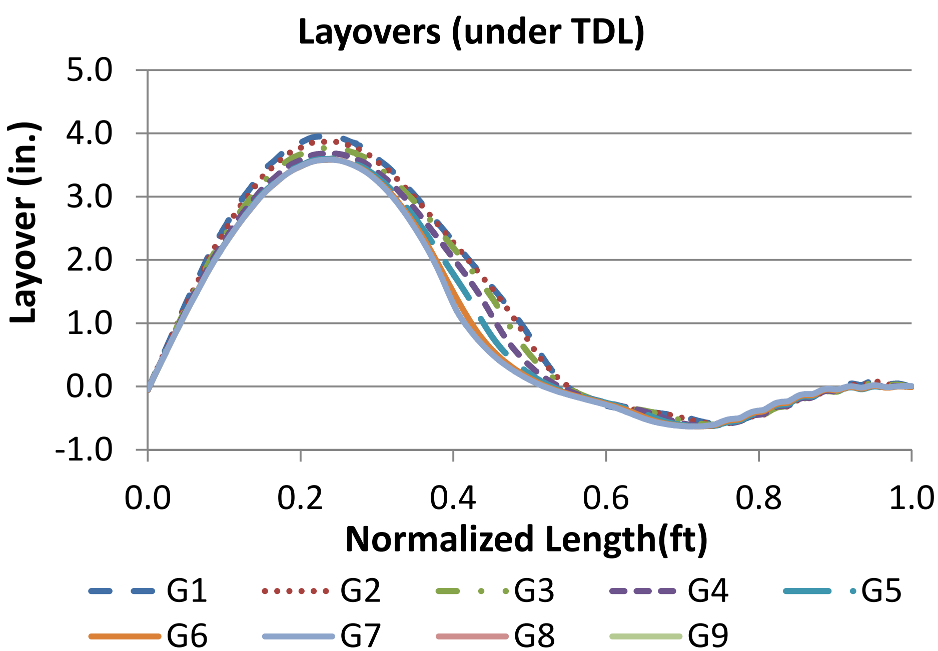


Figure U1-4-3. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

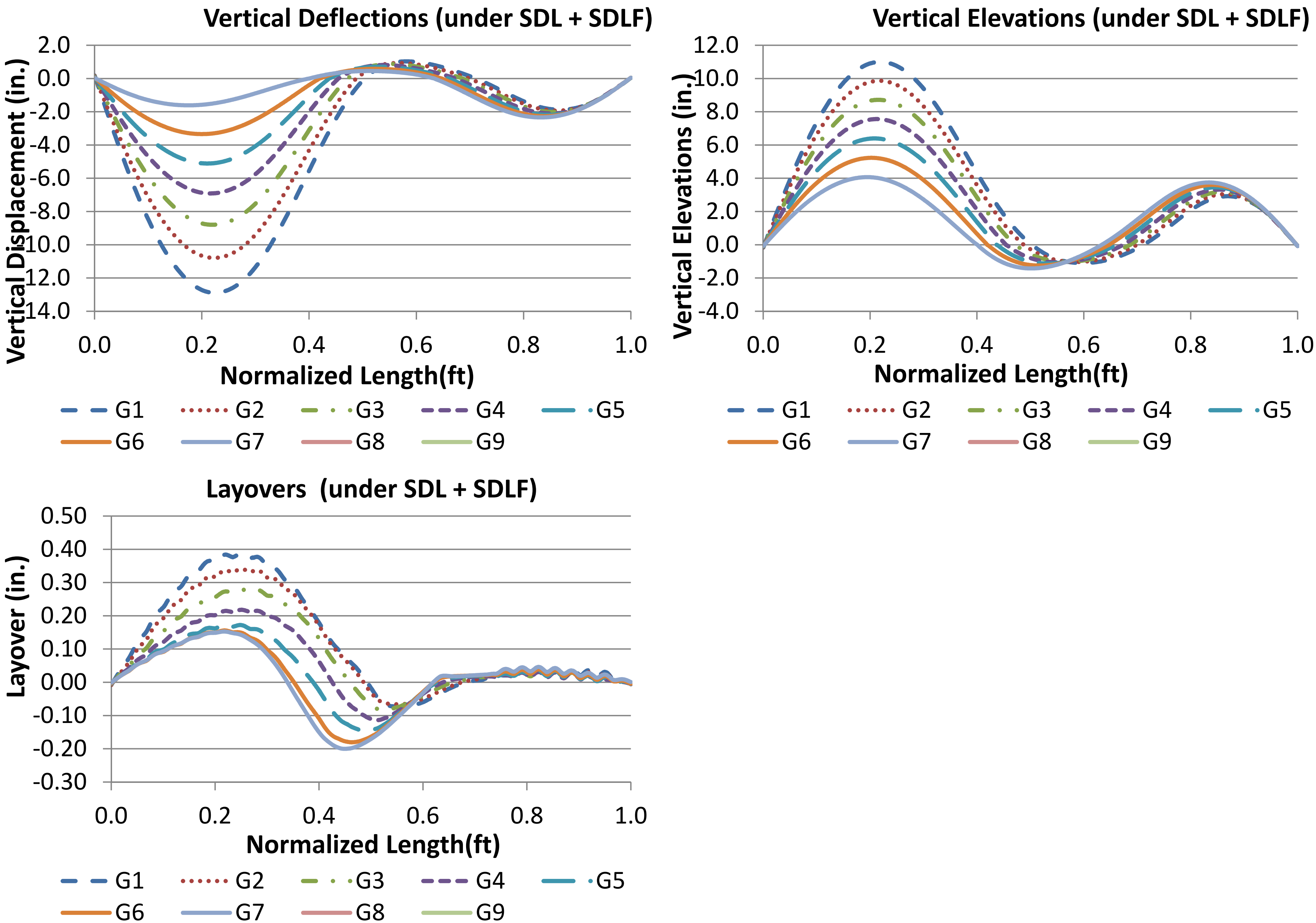


Figure U1-4-4. **Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.**

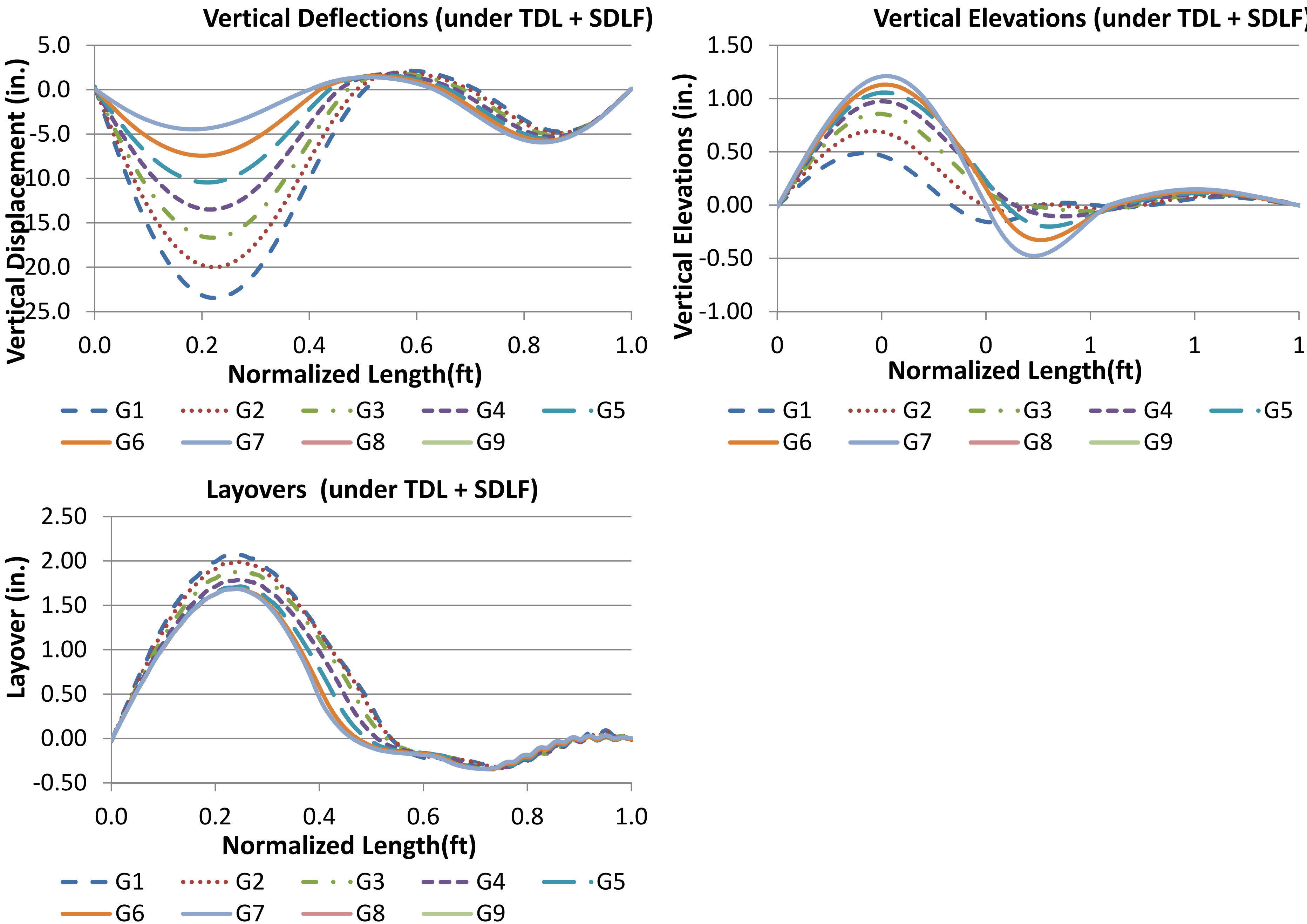


Figure U1-4-5. **Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.**

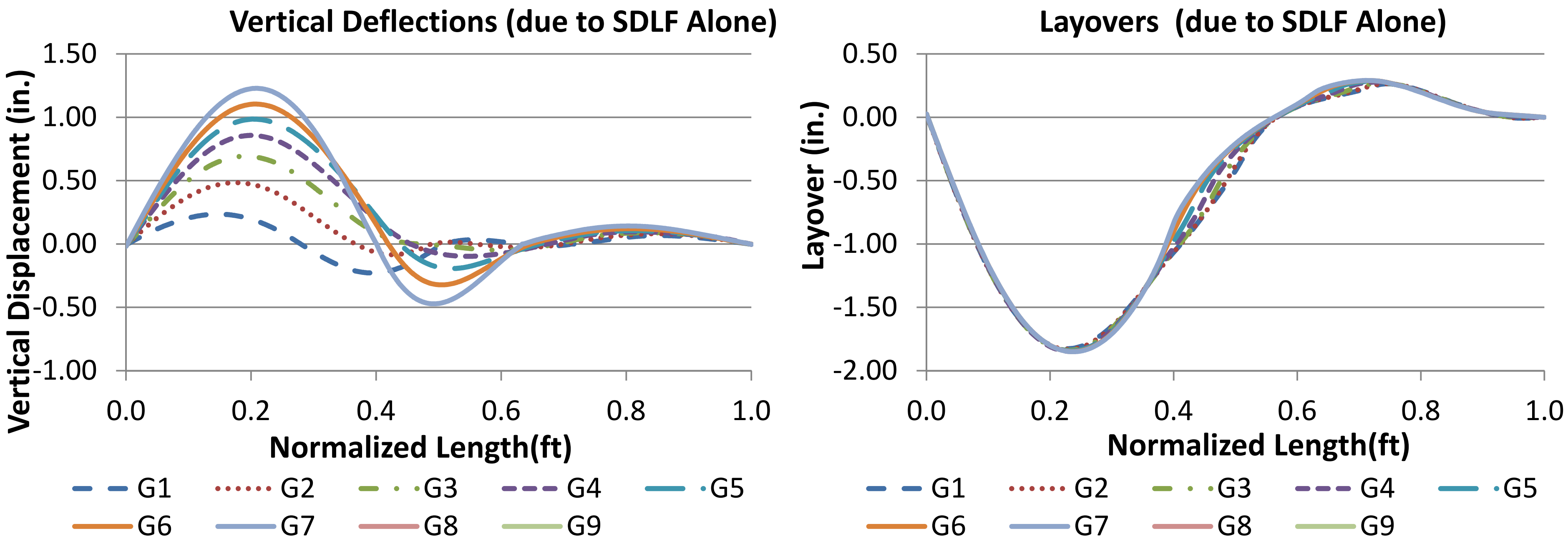


Figure U1-4-6. **Bridge displacements due to SDLF detailing effects alone, under NL (in).**

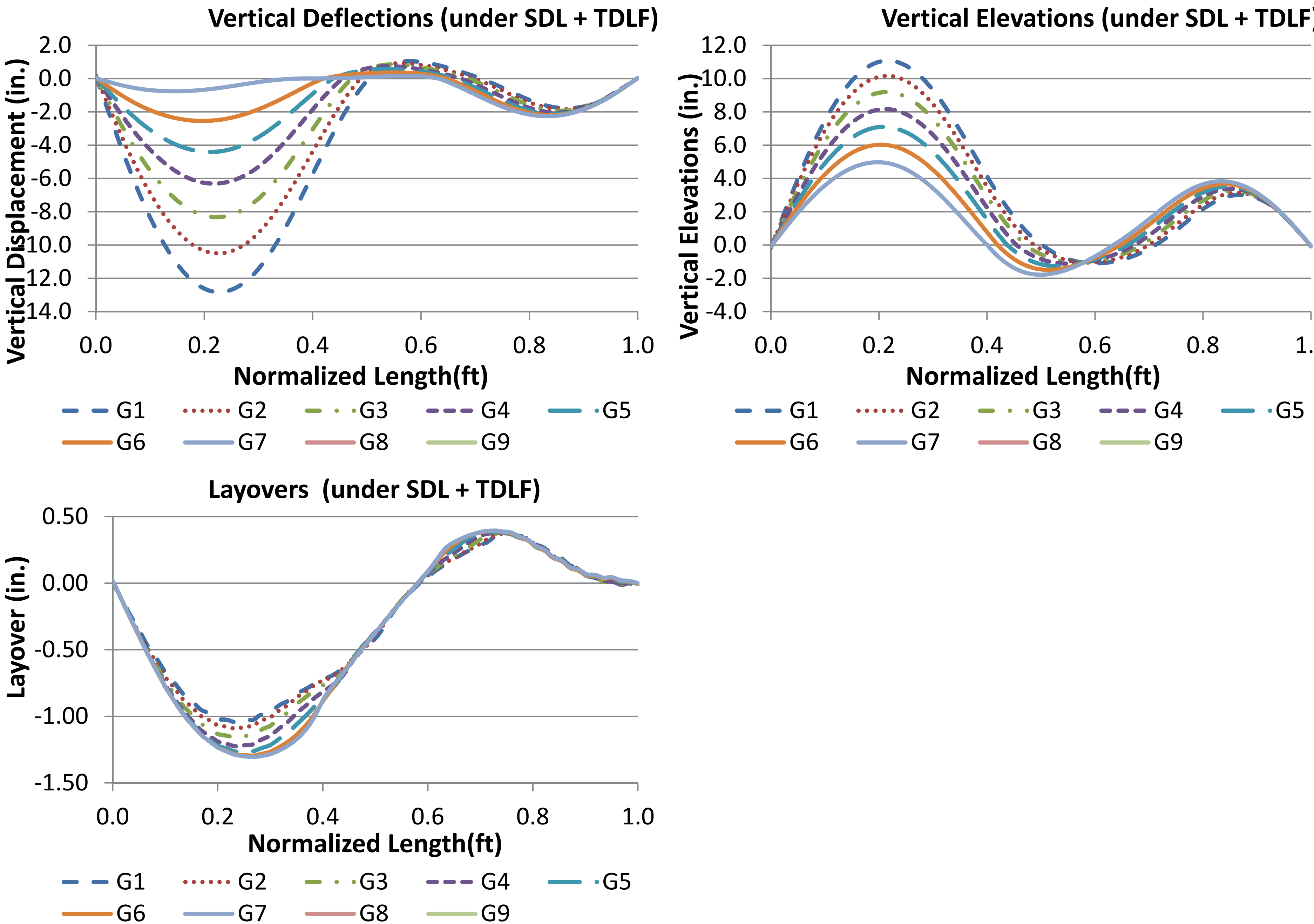
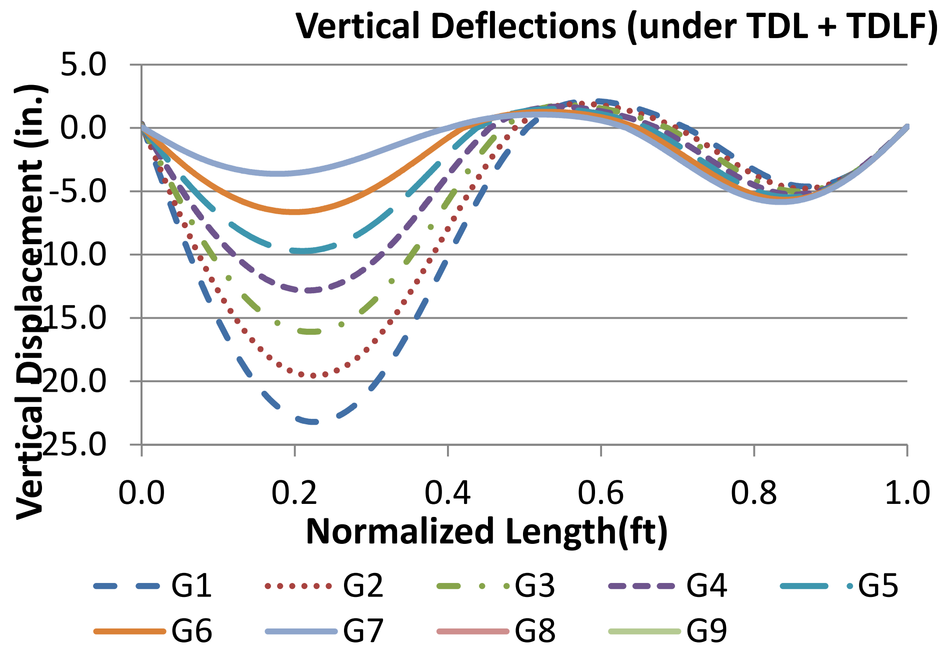
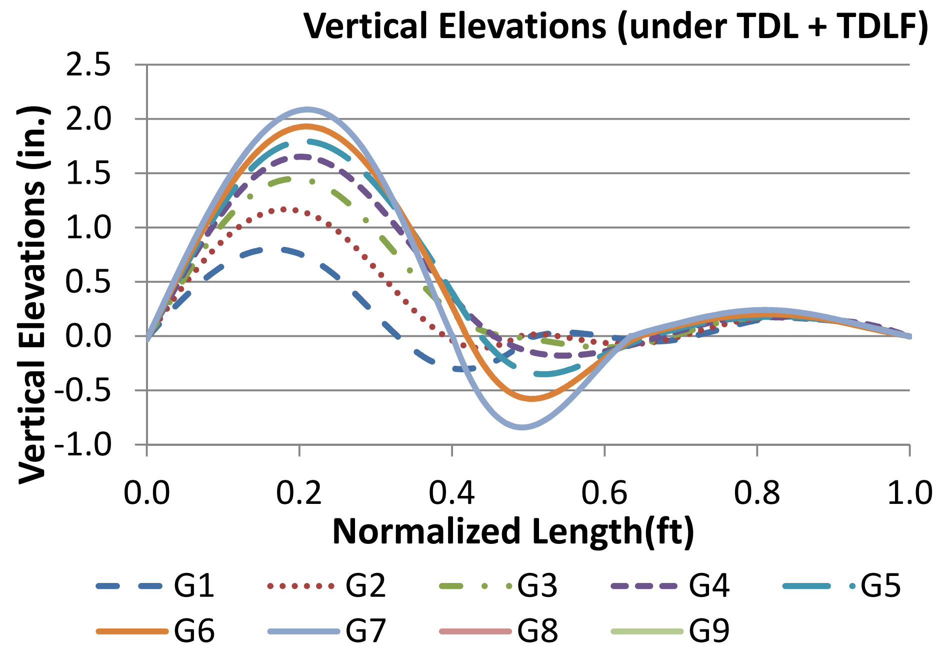


Figure U1-4-7. **Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.**





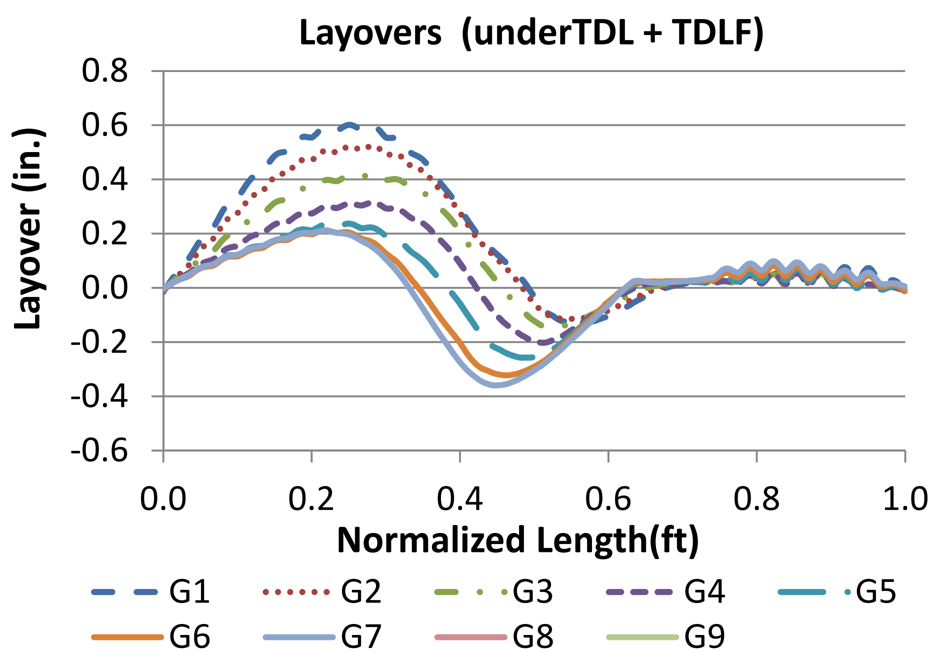


Figure U1-4-8. **Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.**

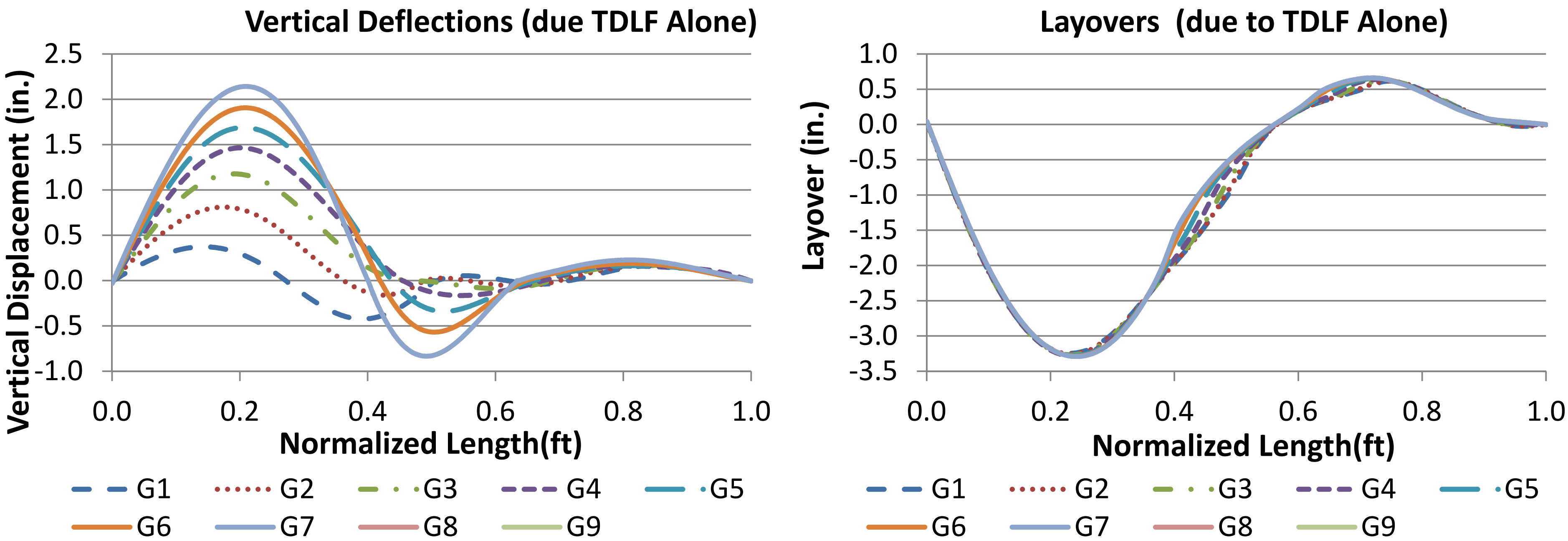


Figure U1-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

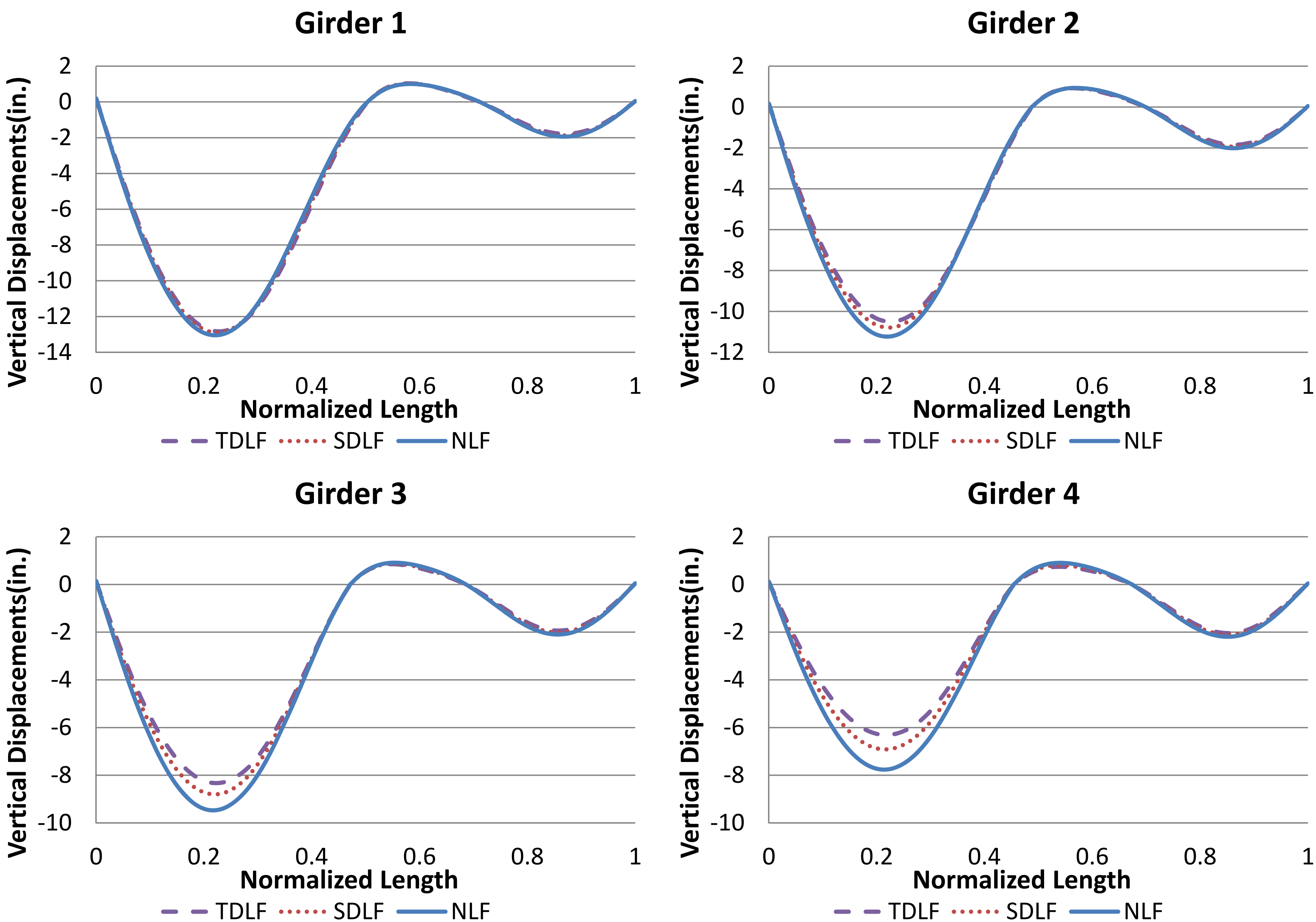


Figure U1-4-10. **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

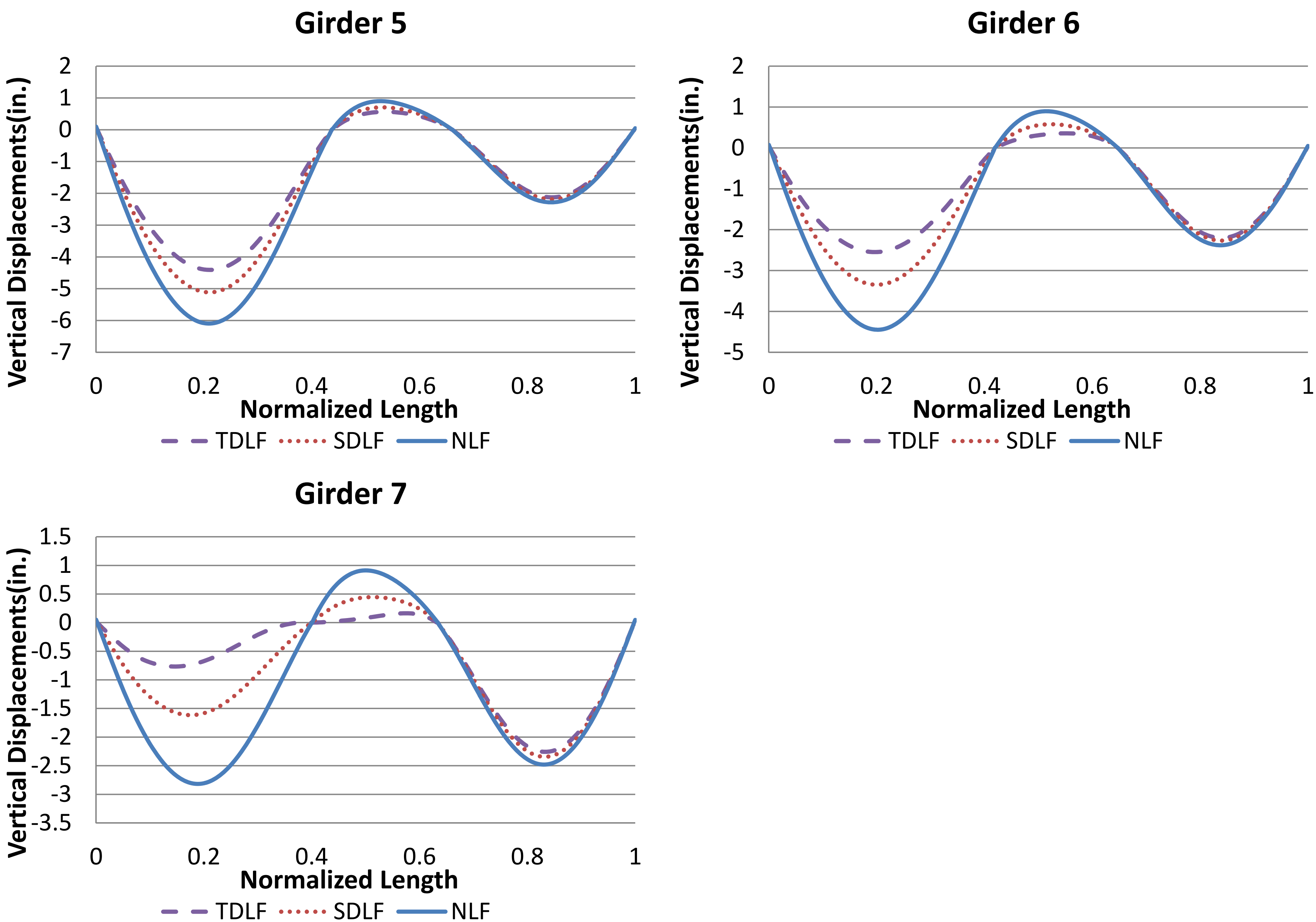


Figure U1-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

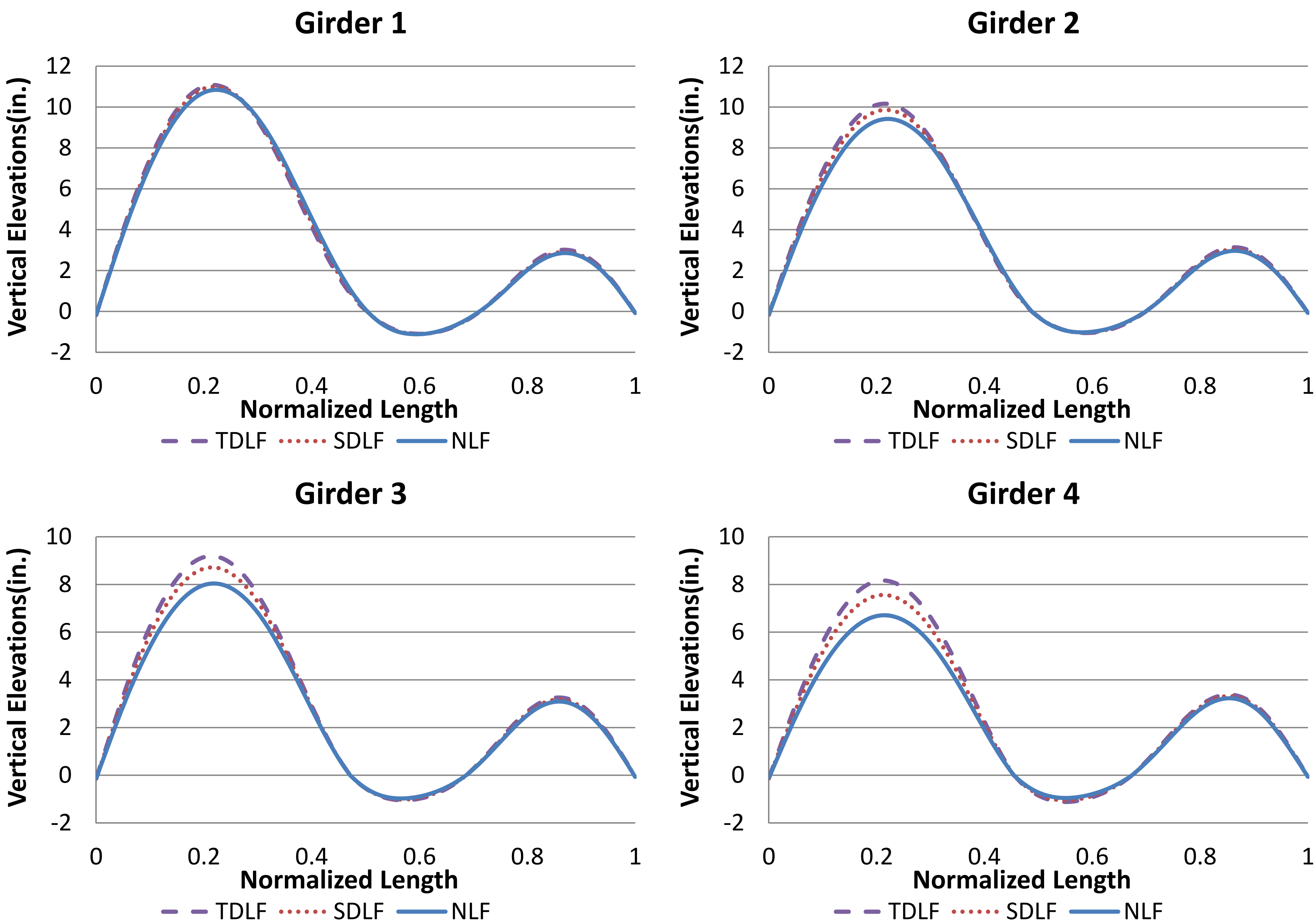


Figure U1-4-11. **Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.**

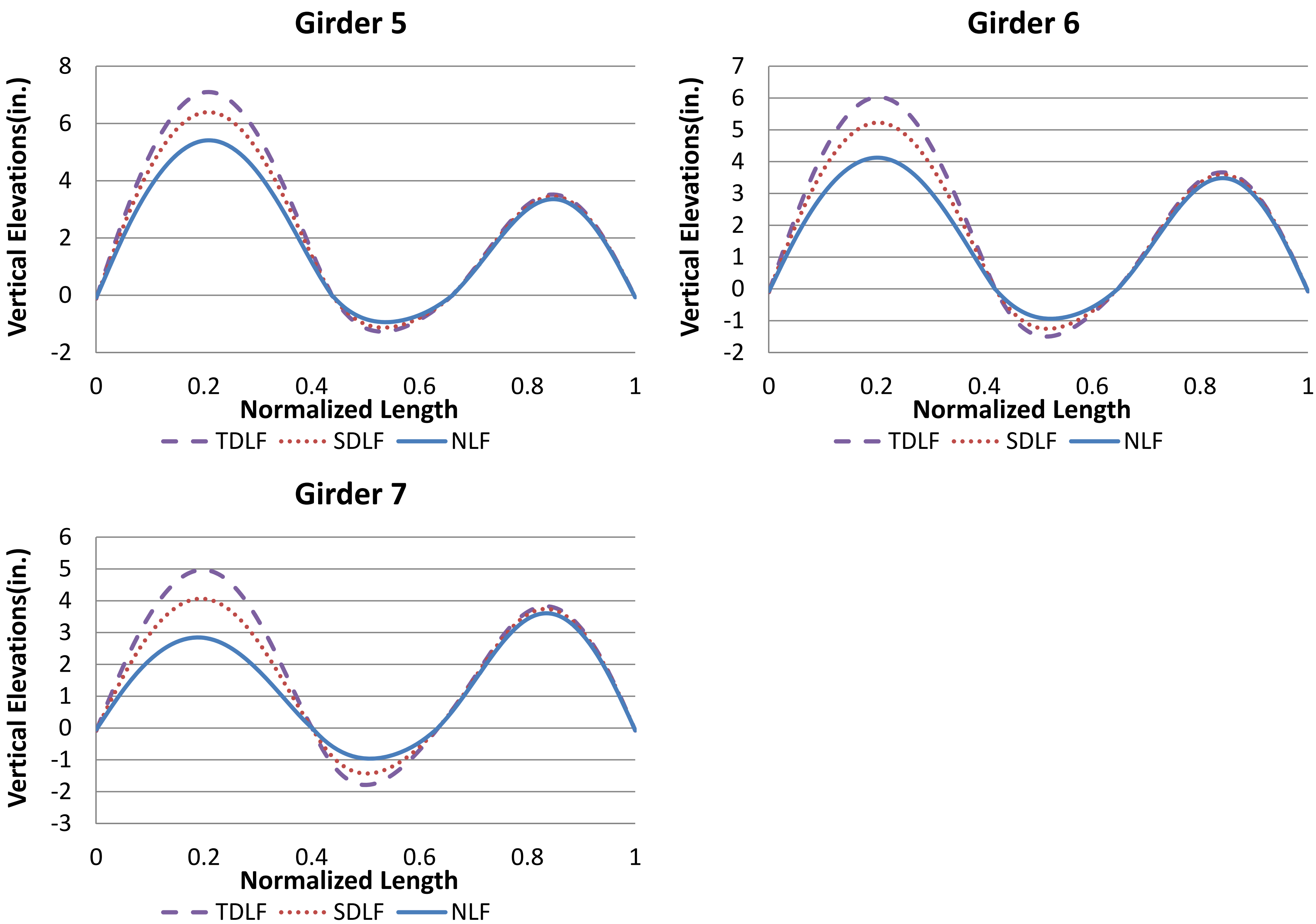


Figure U1-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

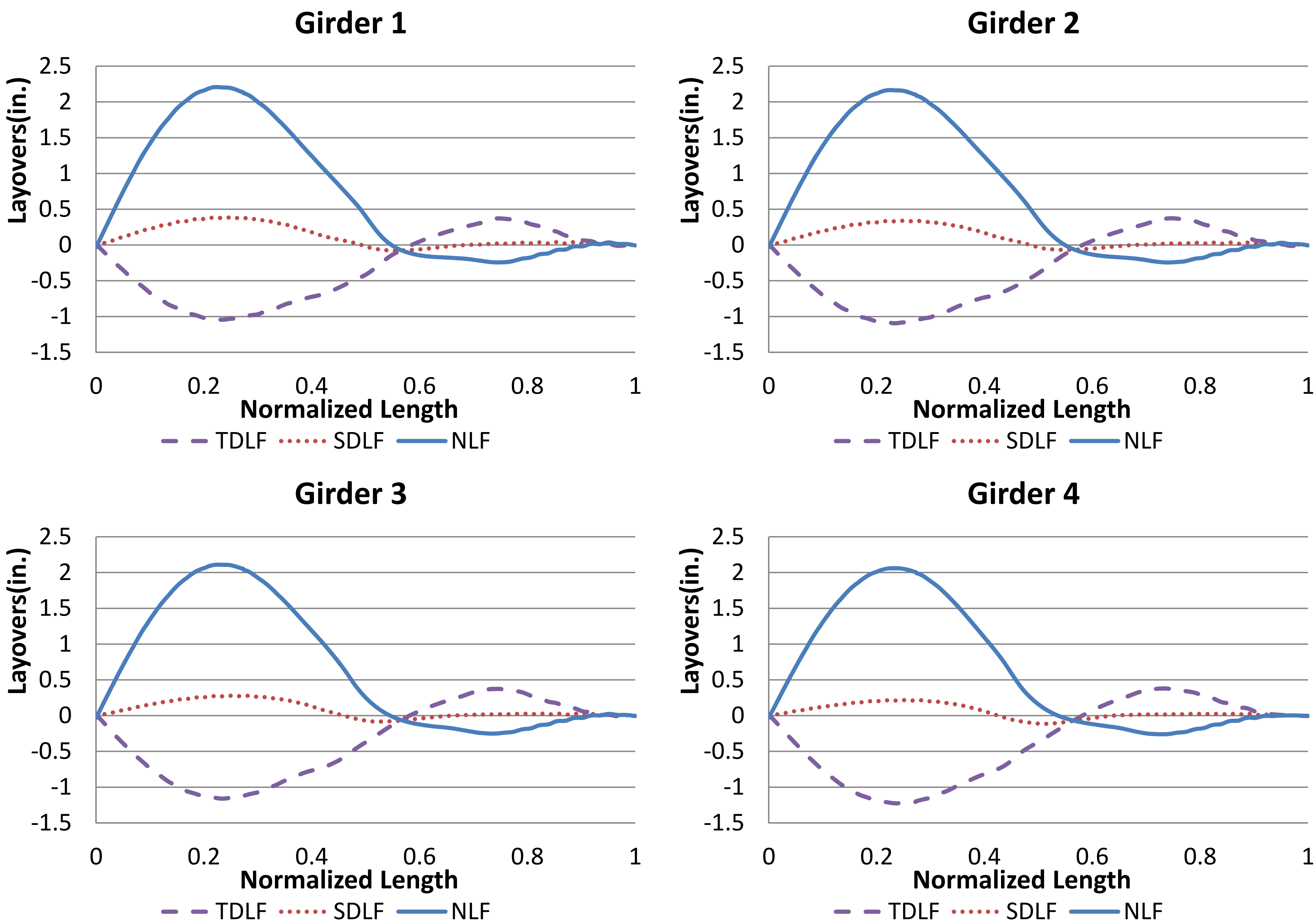


Figure U1-4-12. **Comparison of individual girder layovers (in) under SDL for different detailing methods.**

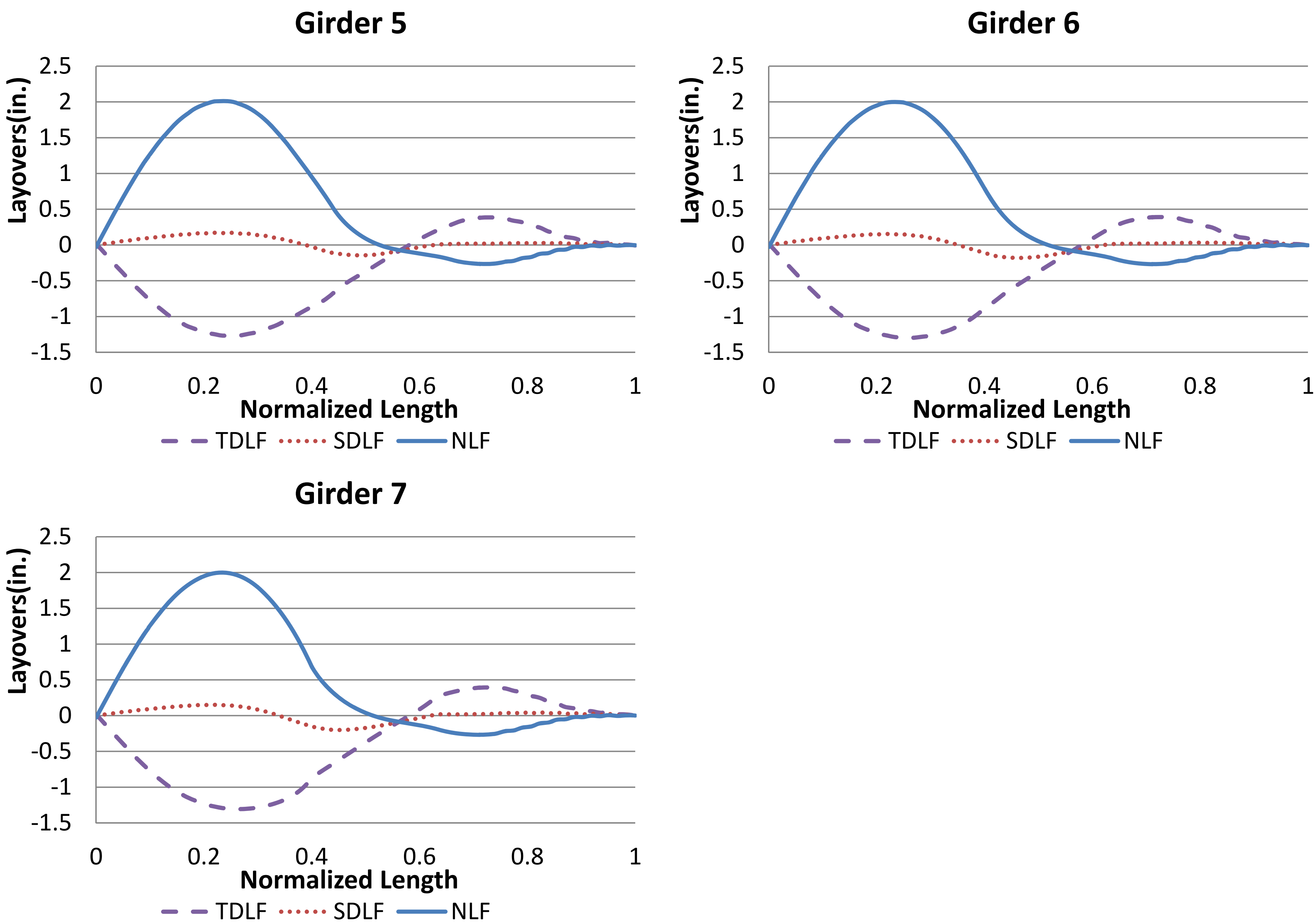


Figure U1-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

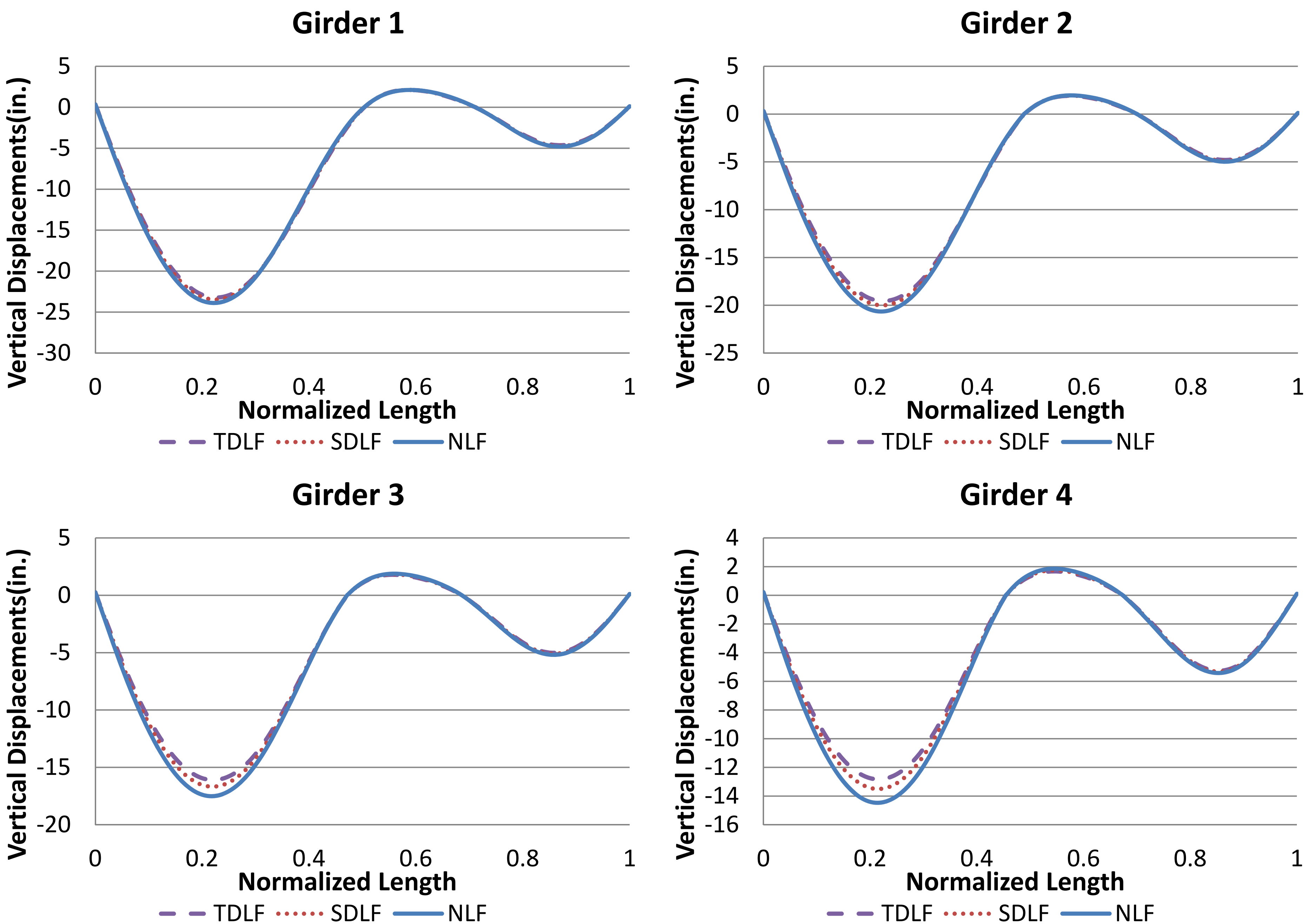


Figure U-4-13. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

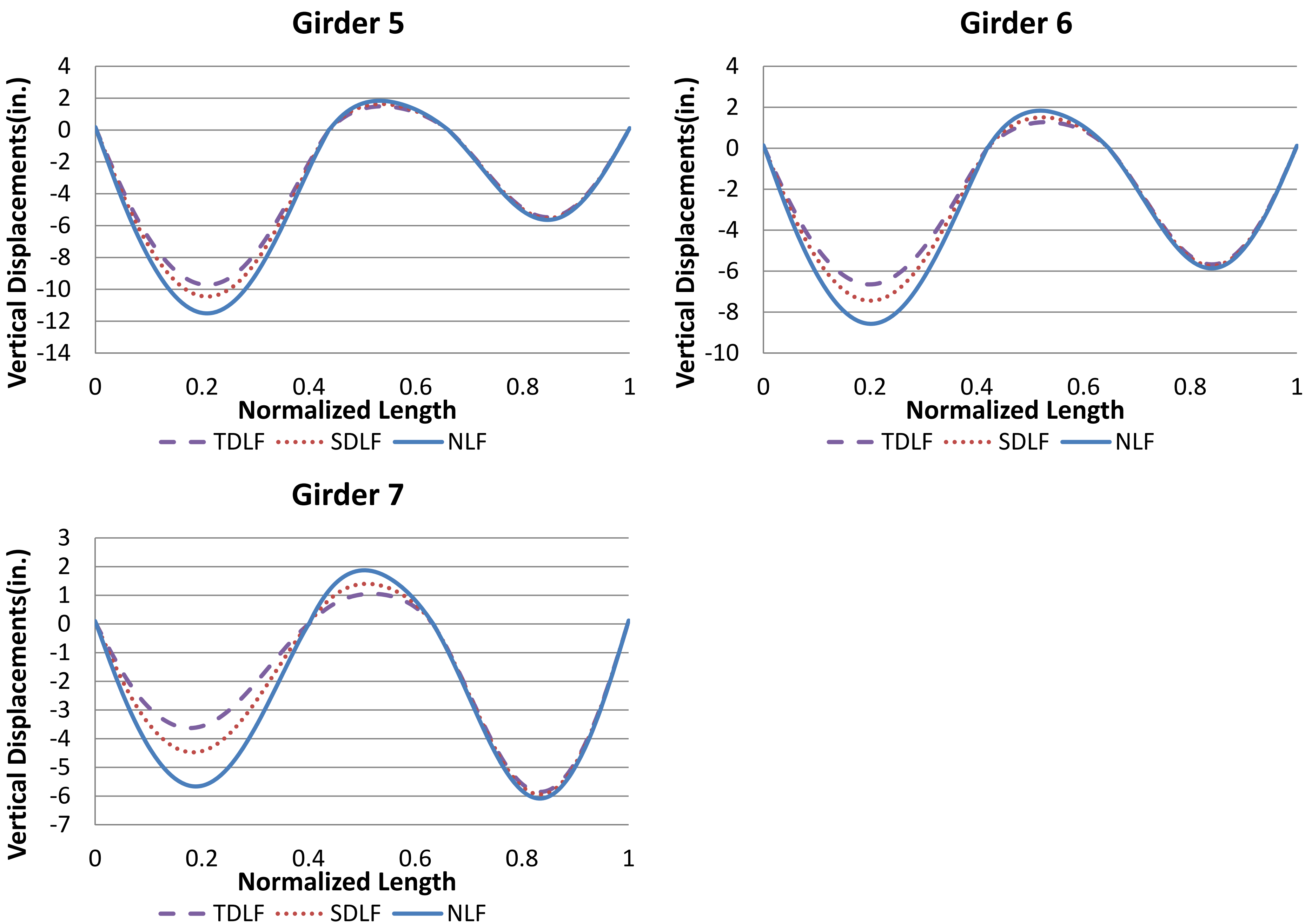


Figure U1-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

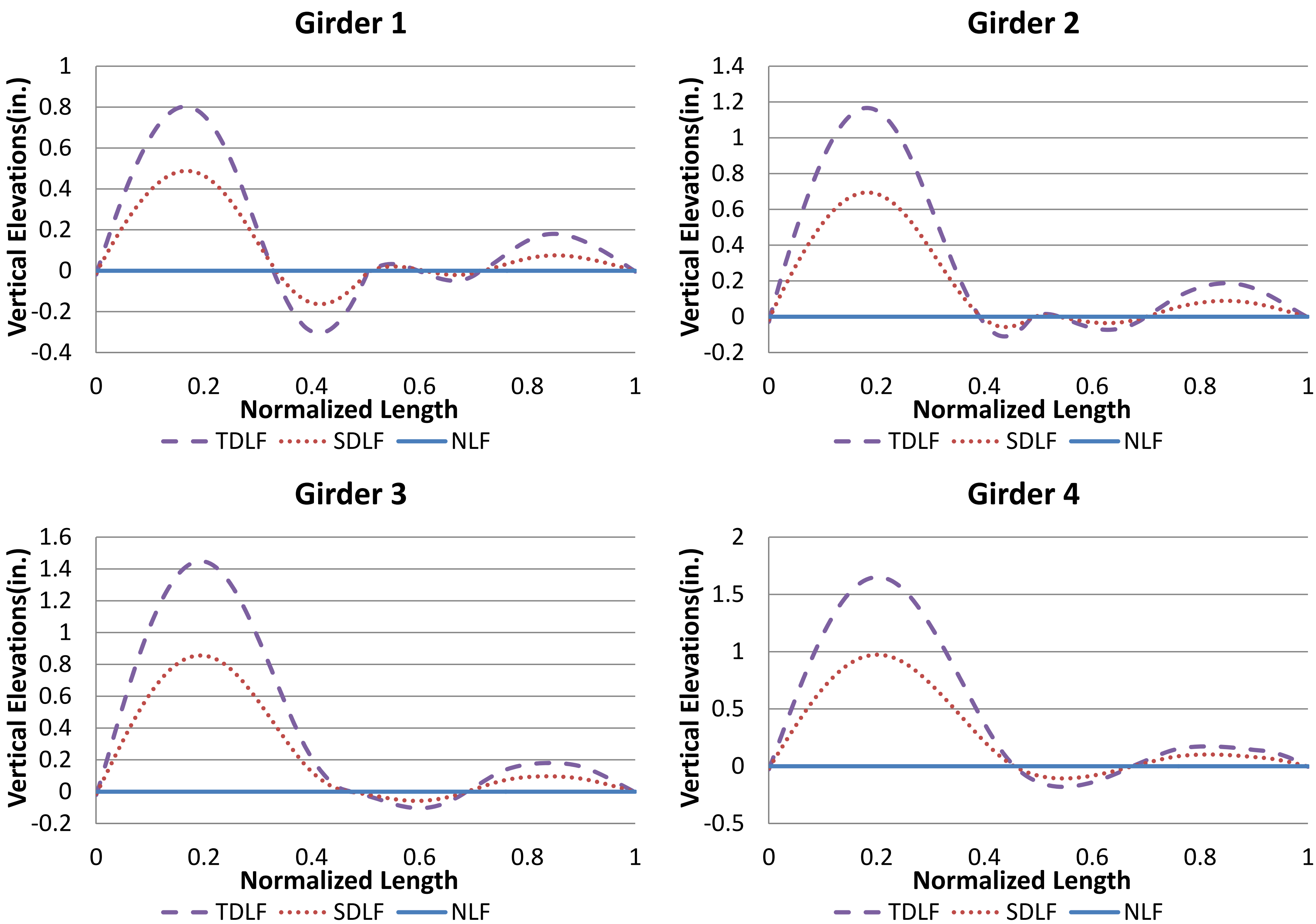


Figure U1-4-14. Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

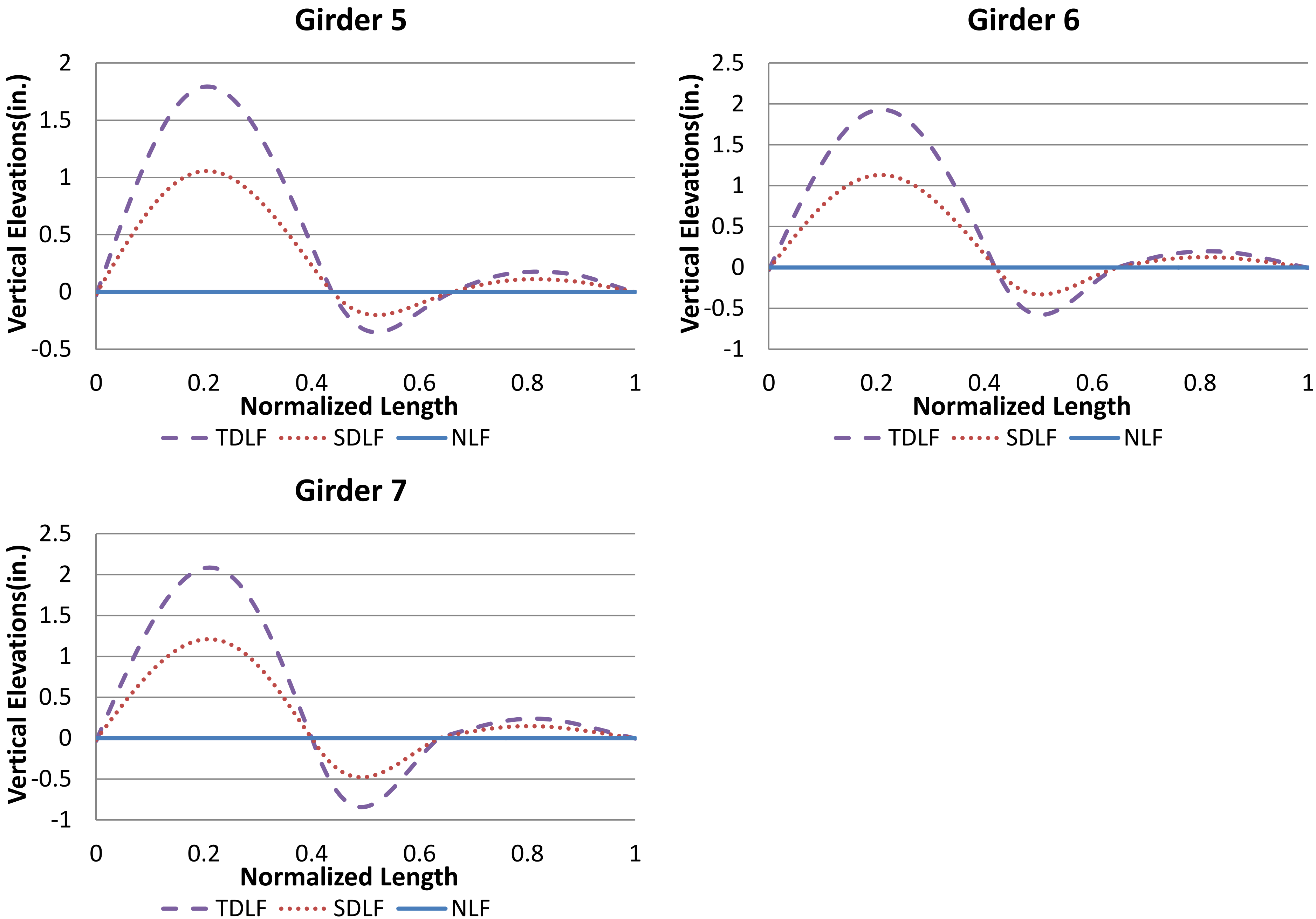


Figure U1-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

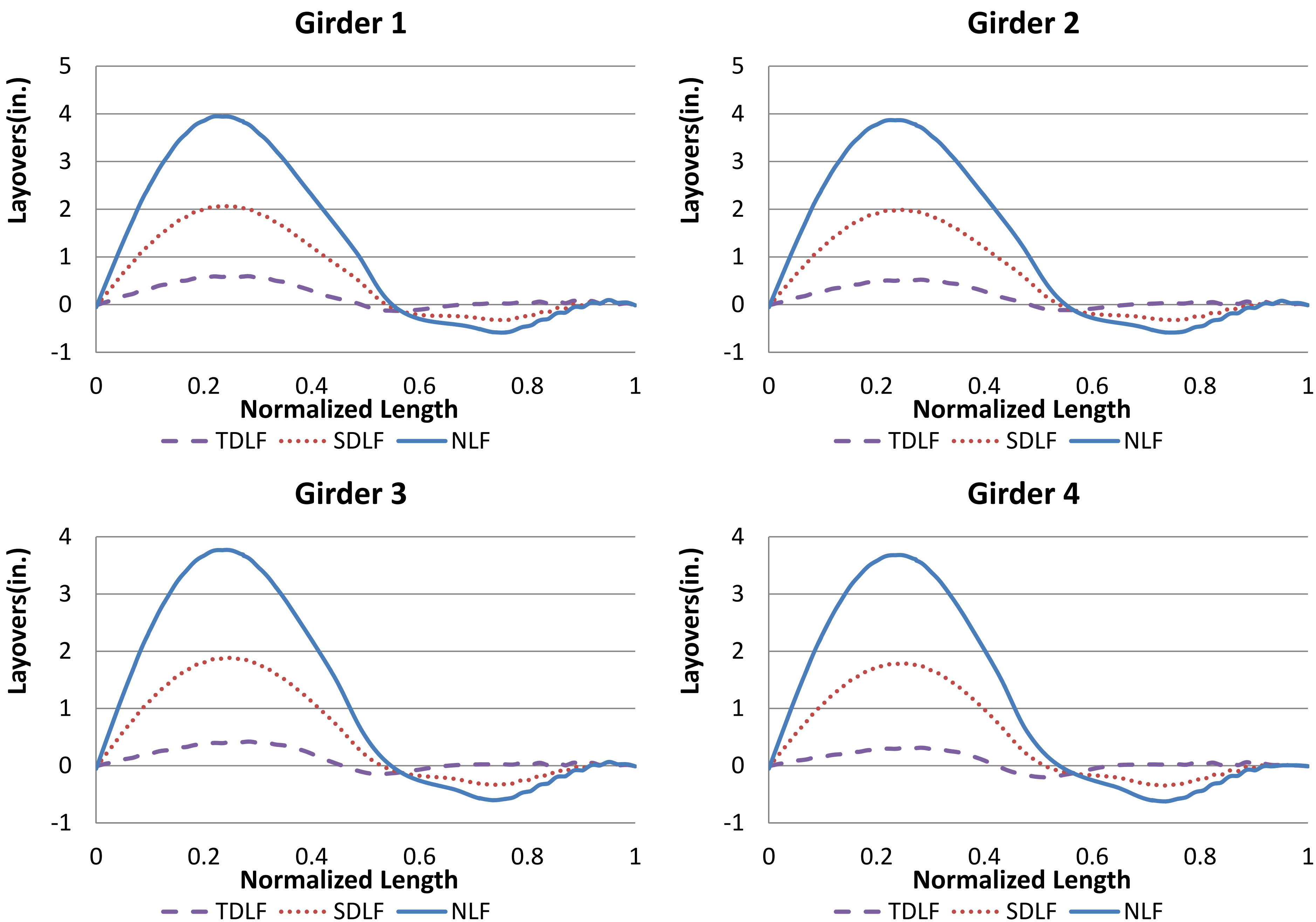


Figure U1-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.

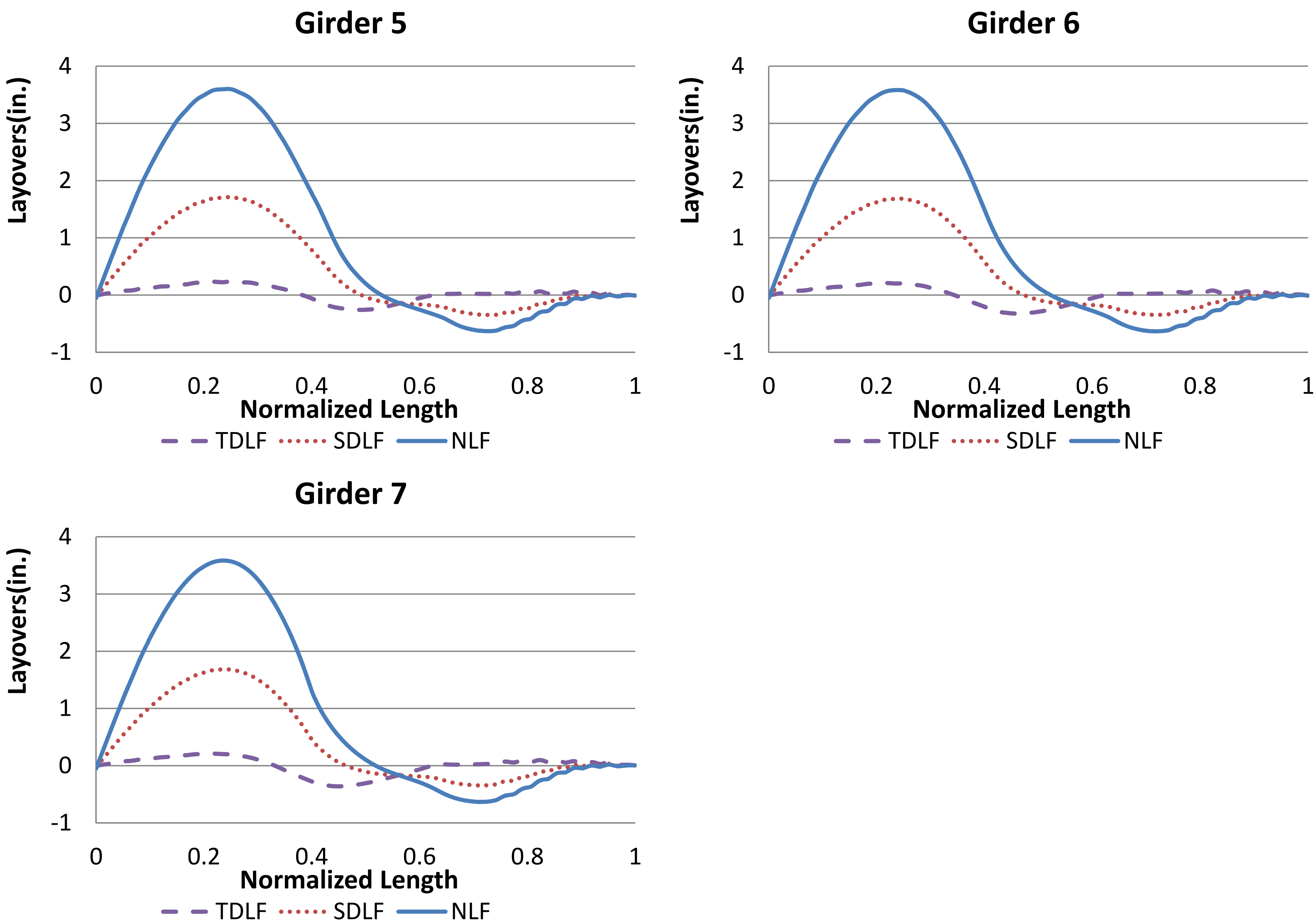


Figure U1-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

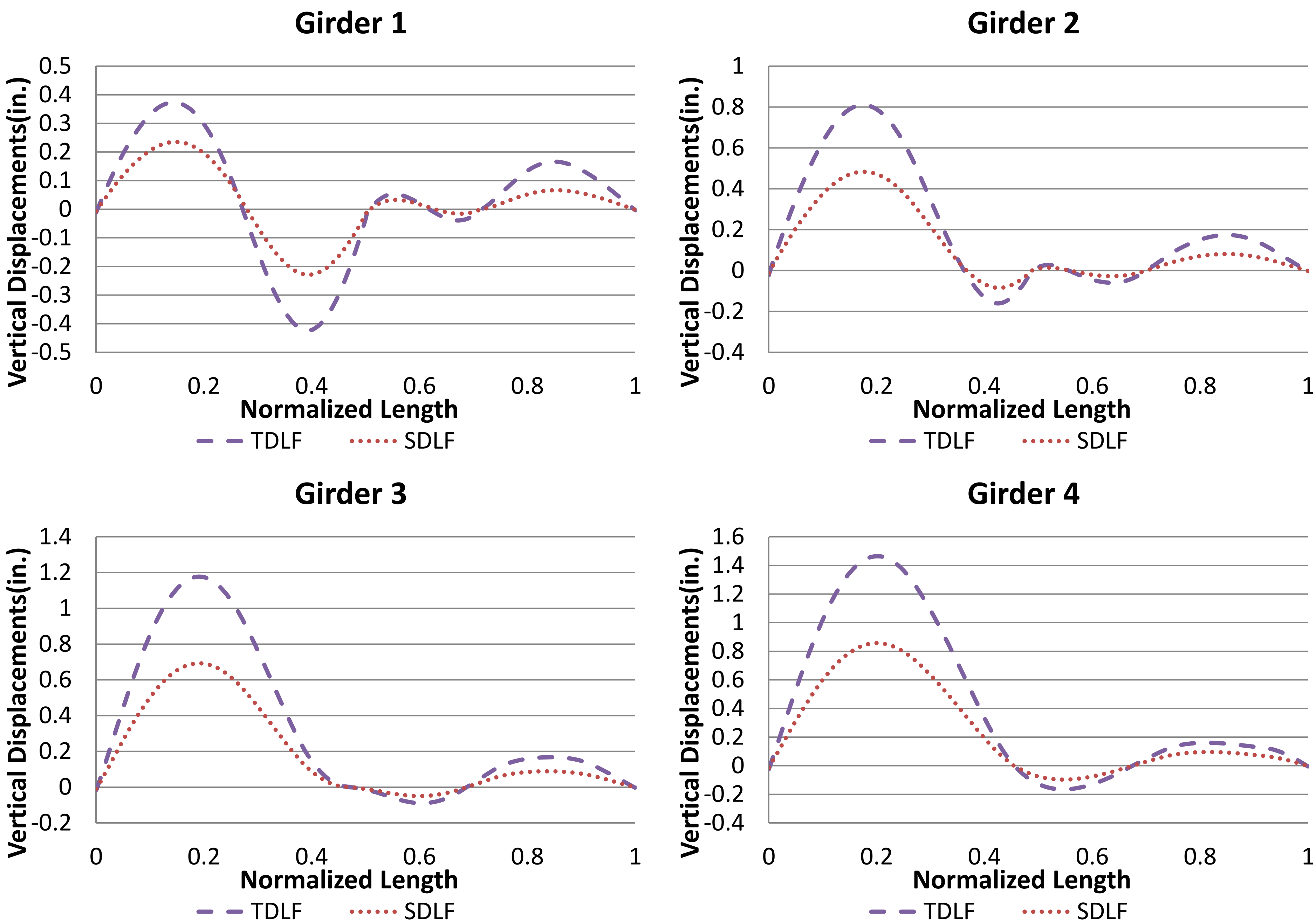


Figure U1-4-16. **Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.**

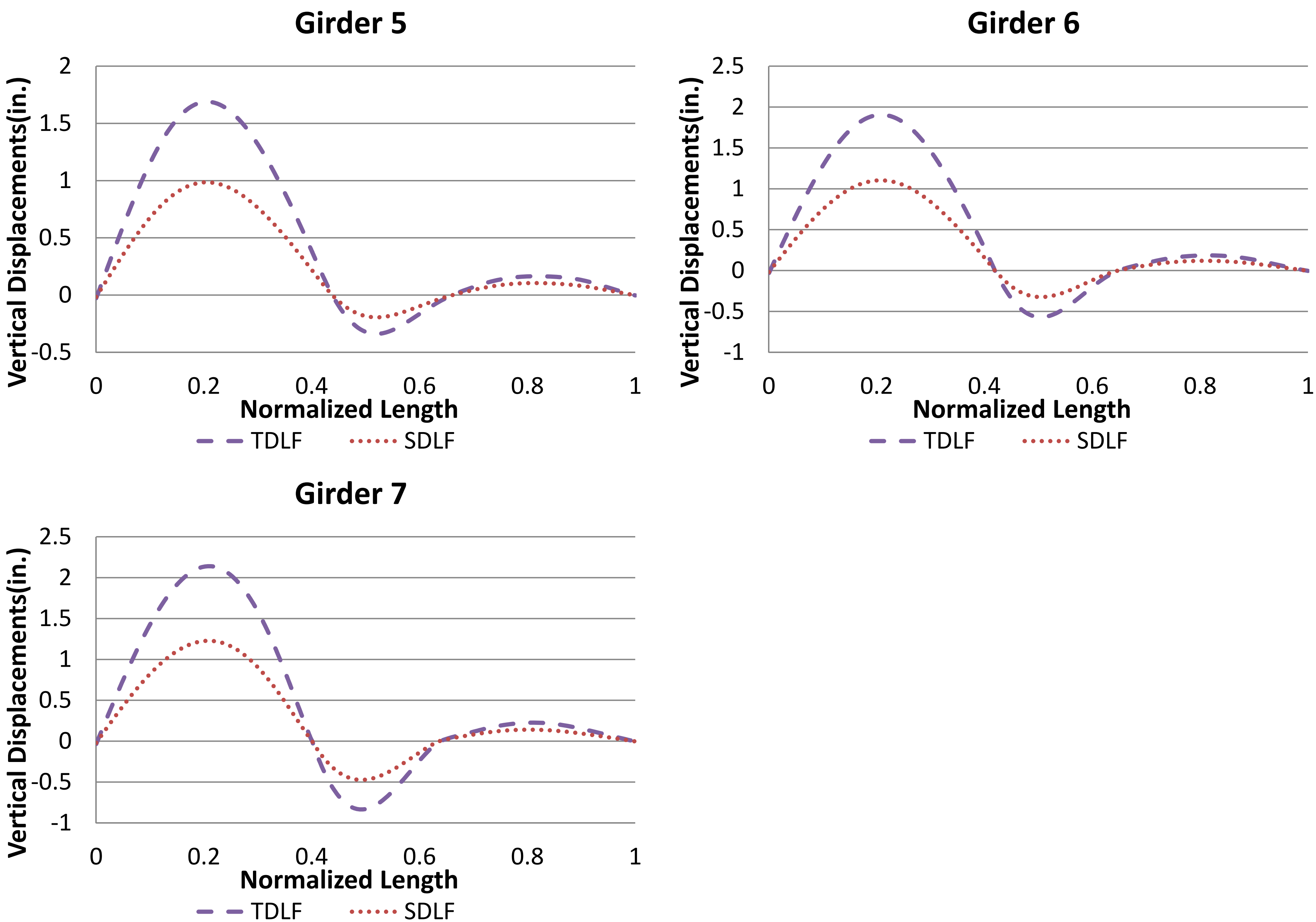


Figure U1-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

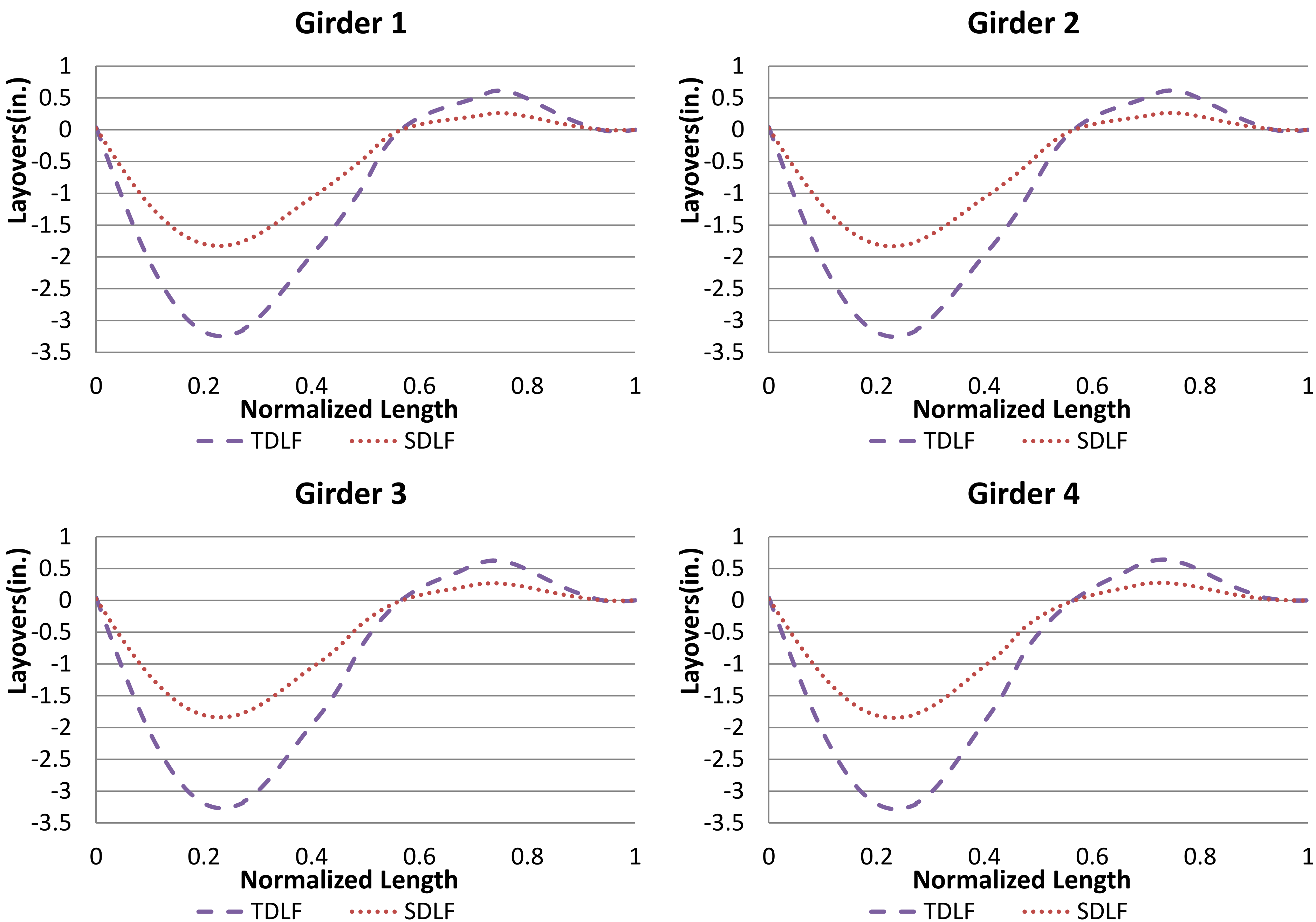


Figure U1-4-17. **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.**

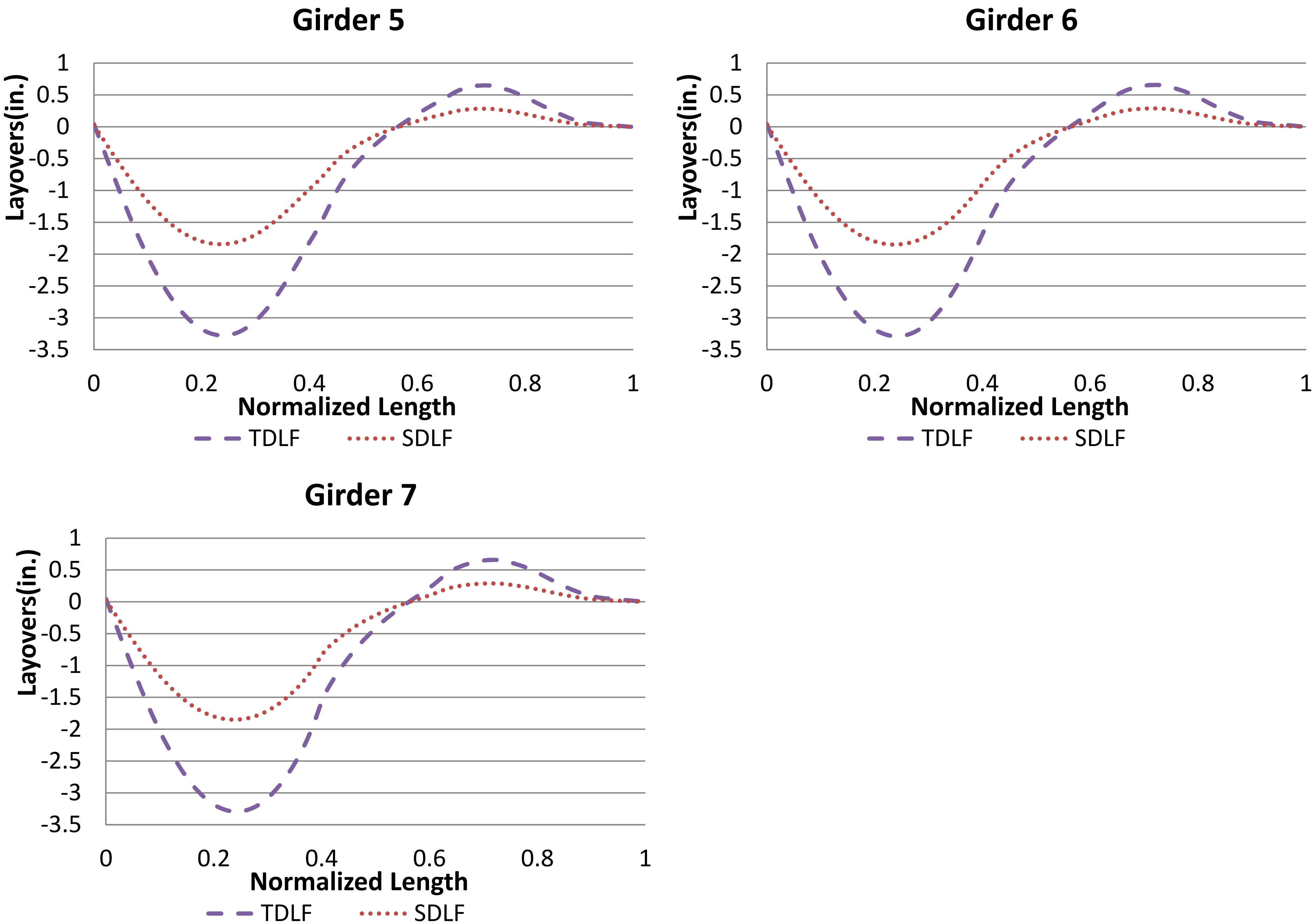


Figure U1-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

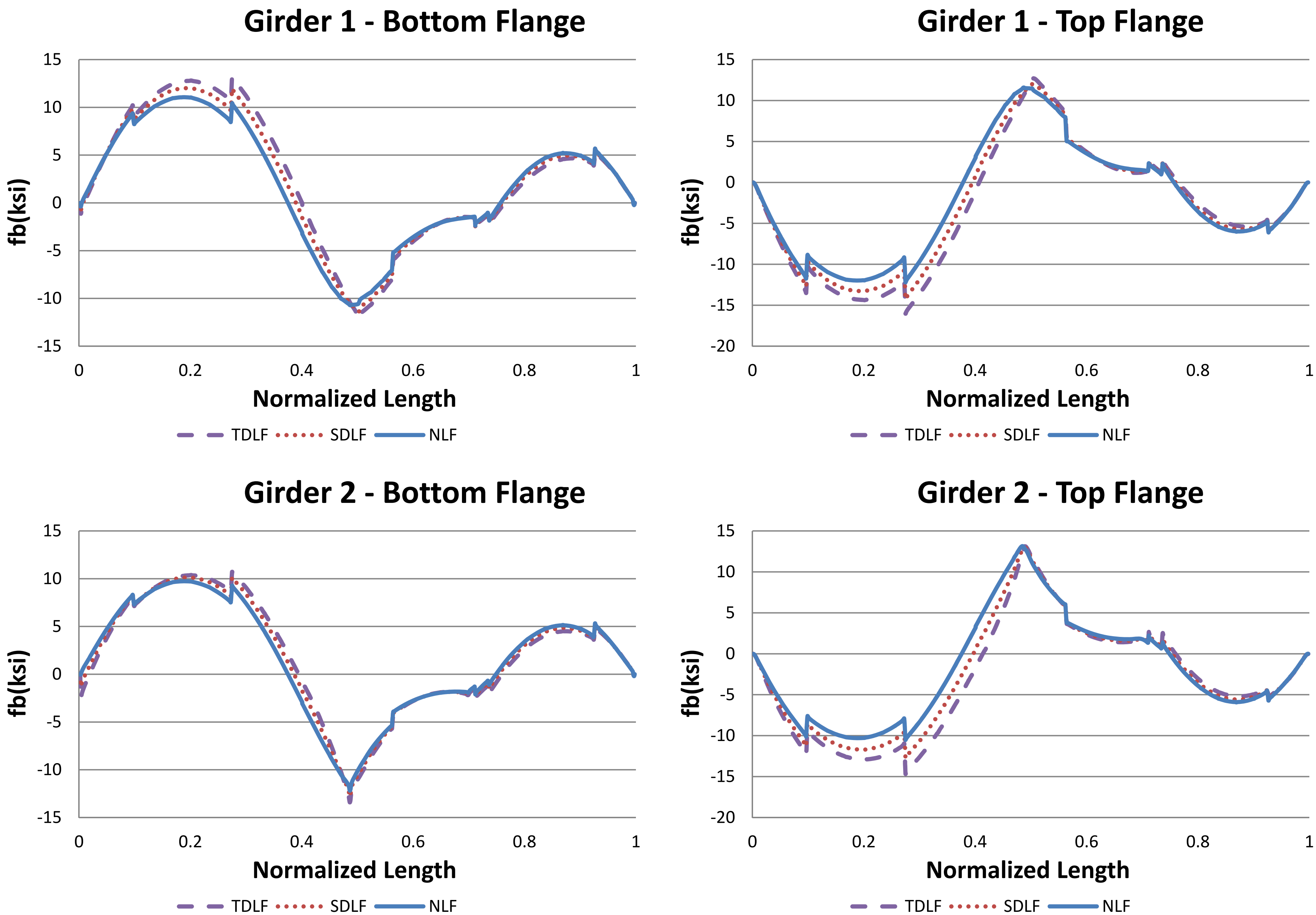


Figure U1-4-18. **Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.**

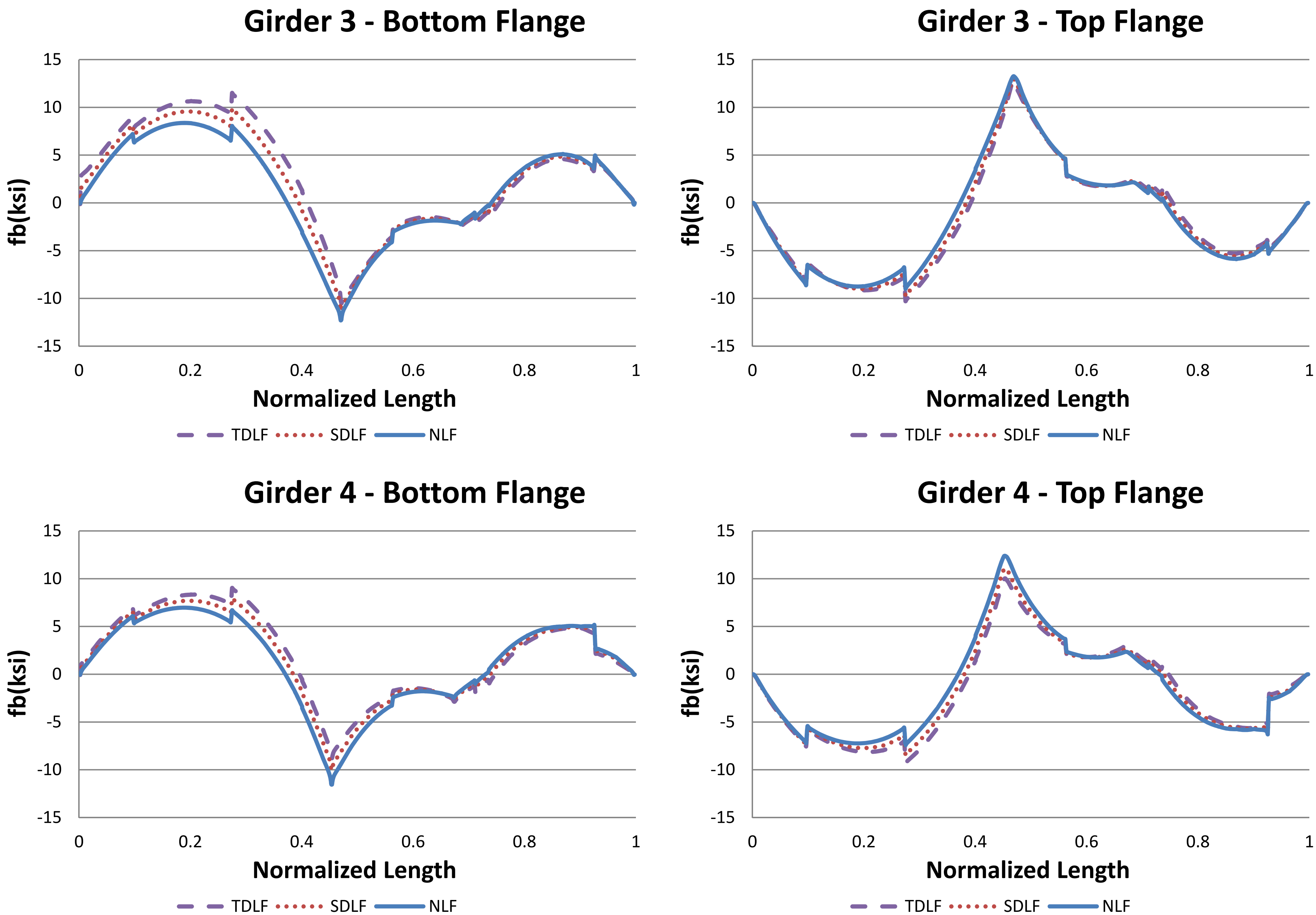


Figure U1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

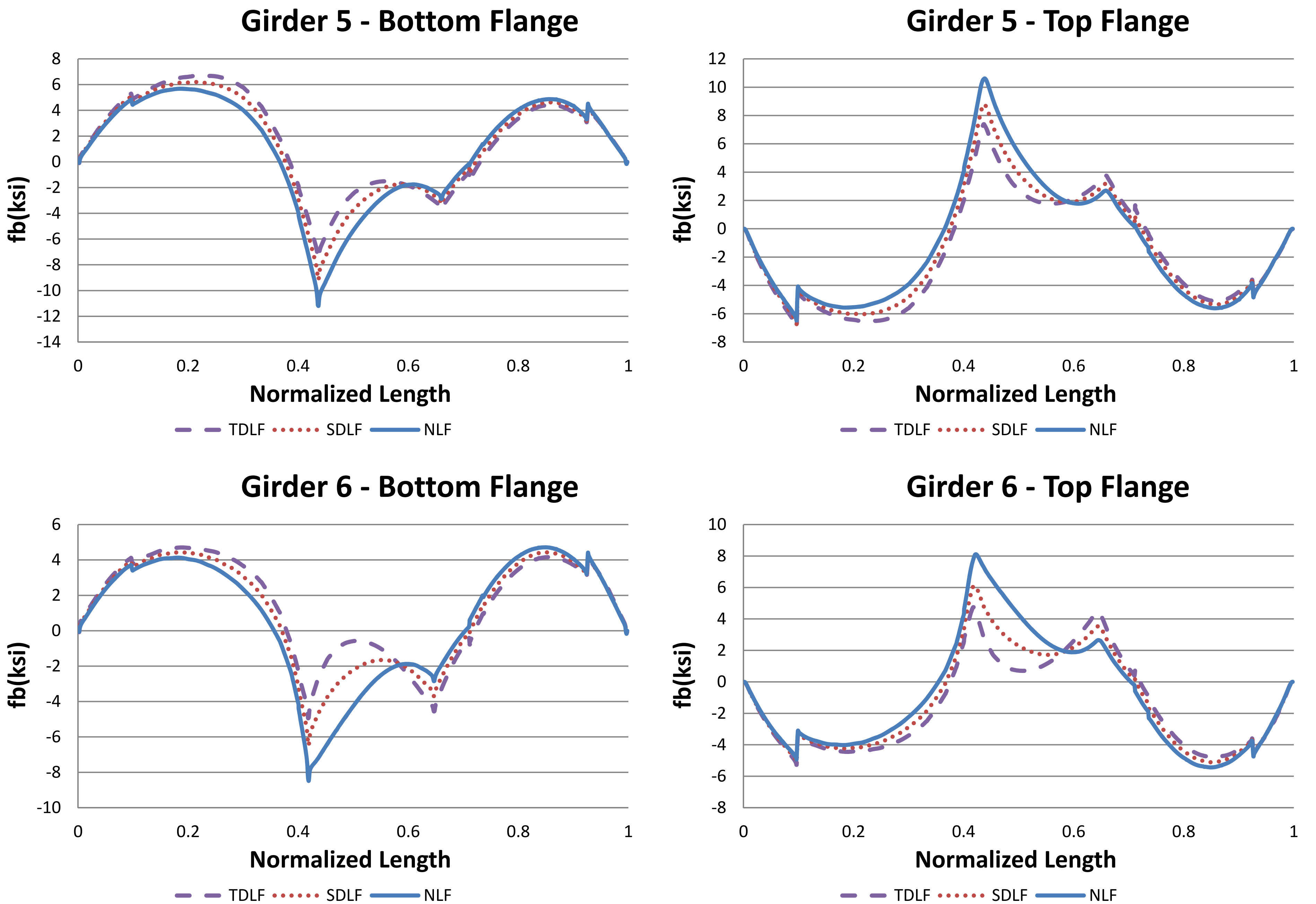


Figure U1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

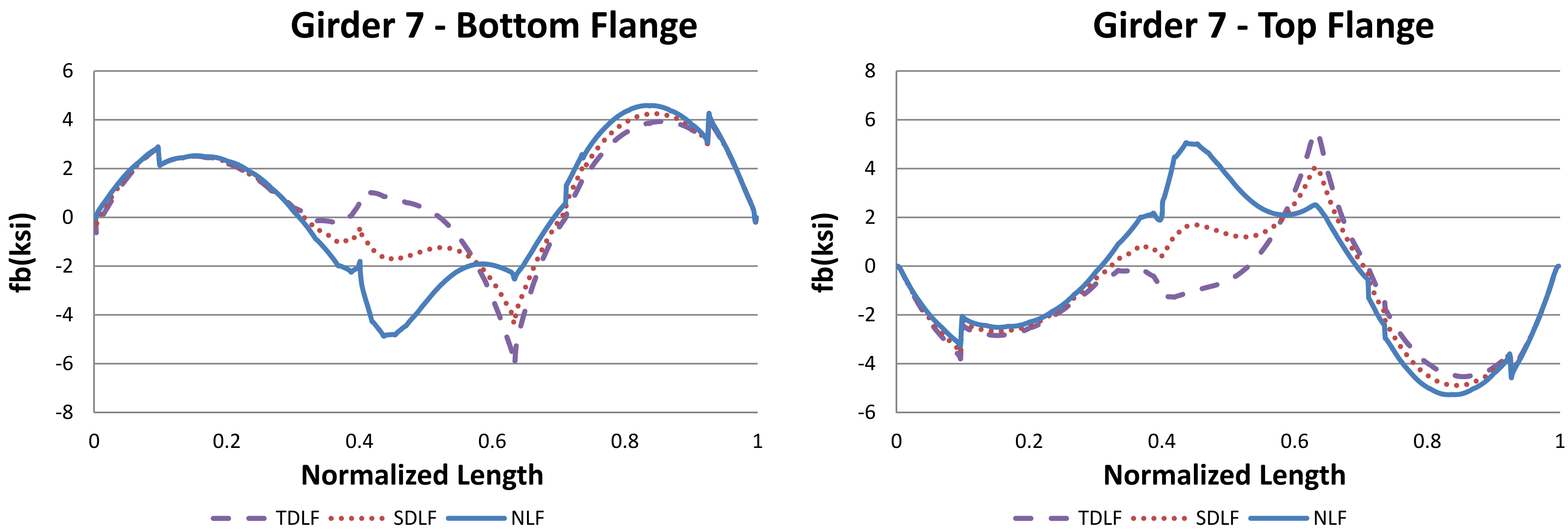


Figure U1-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

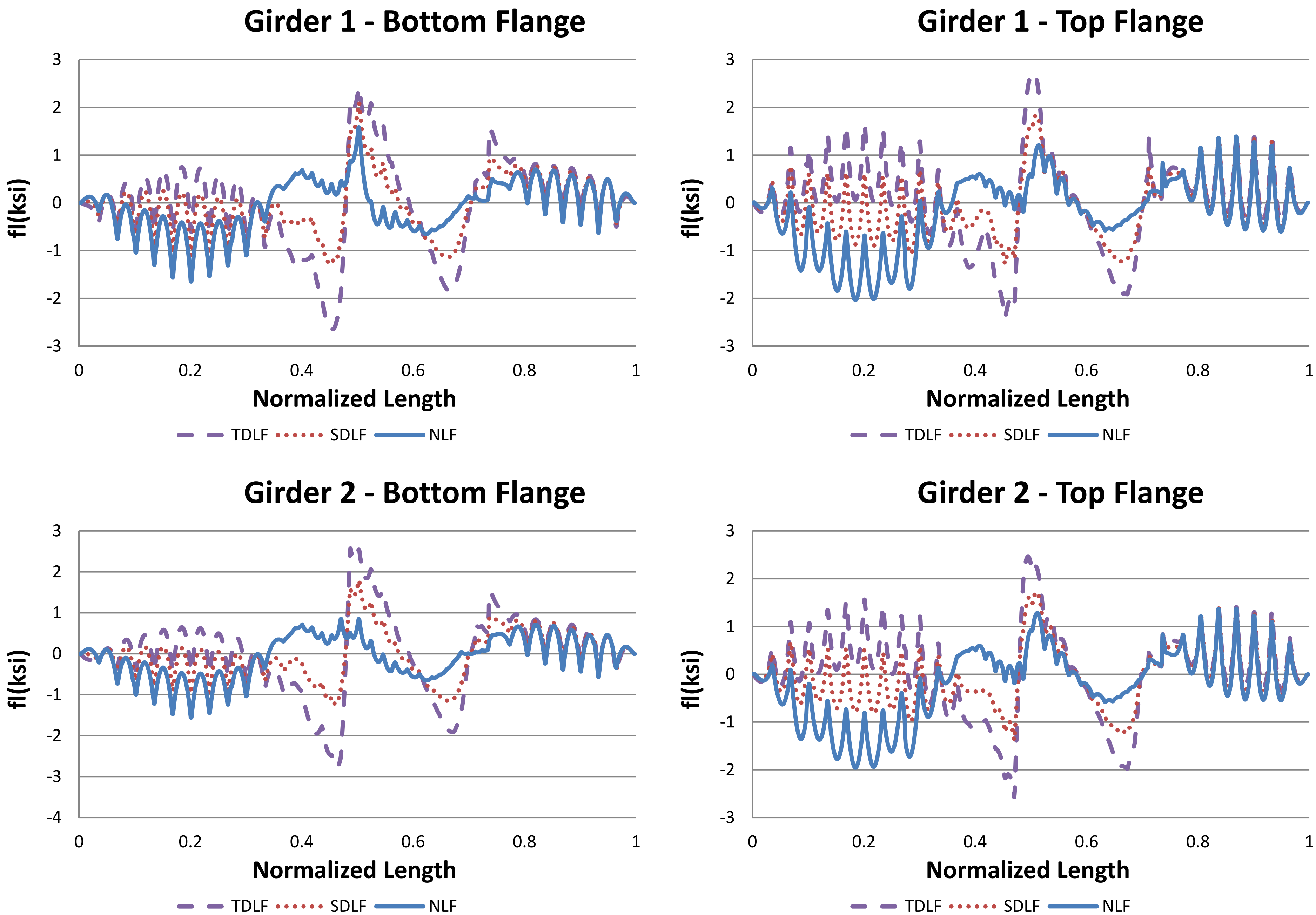


Figure U1-4-19. Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

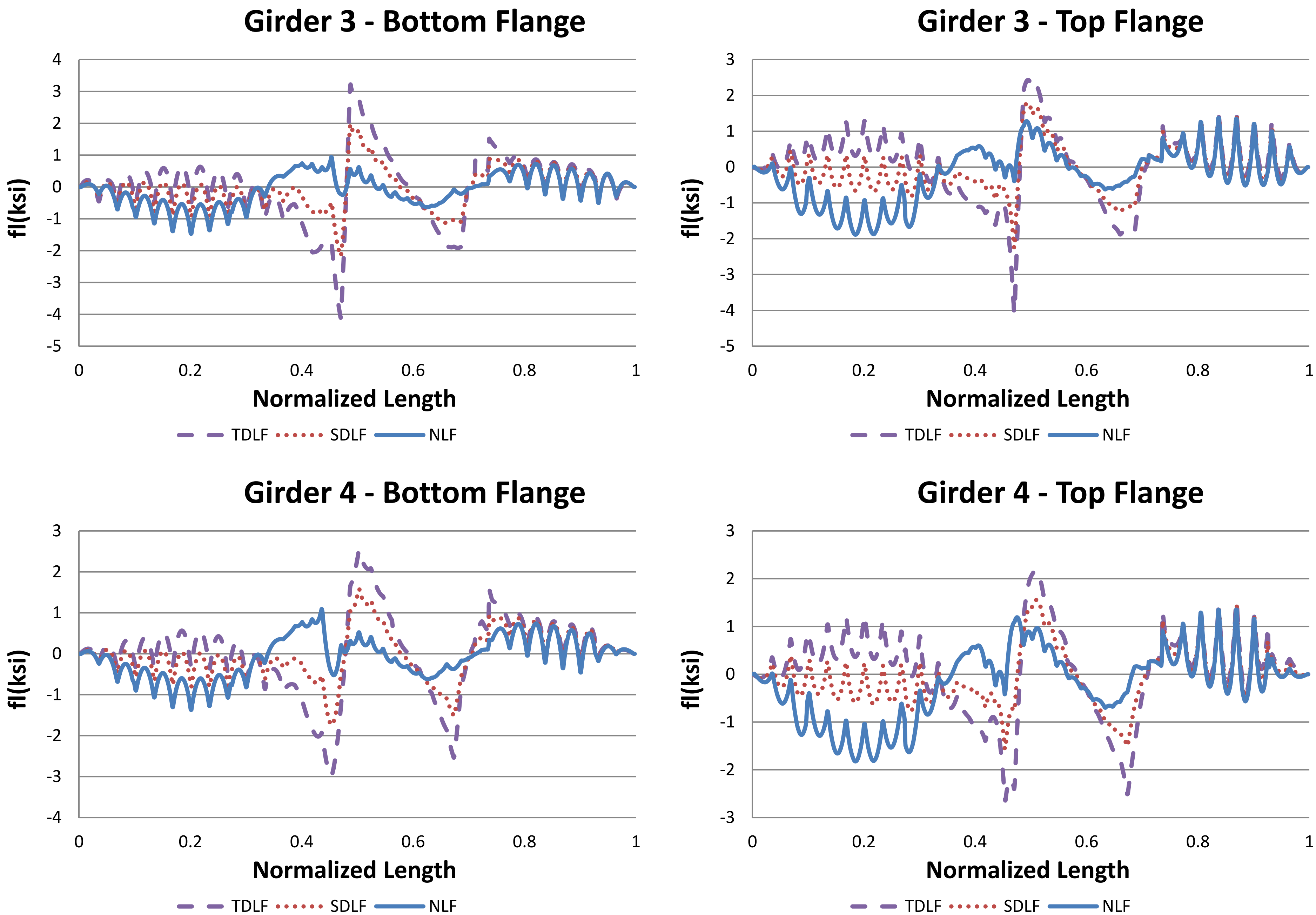


Figure U1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

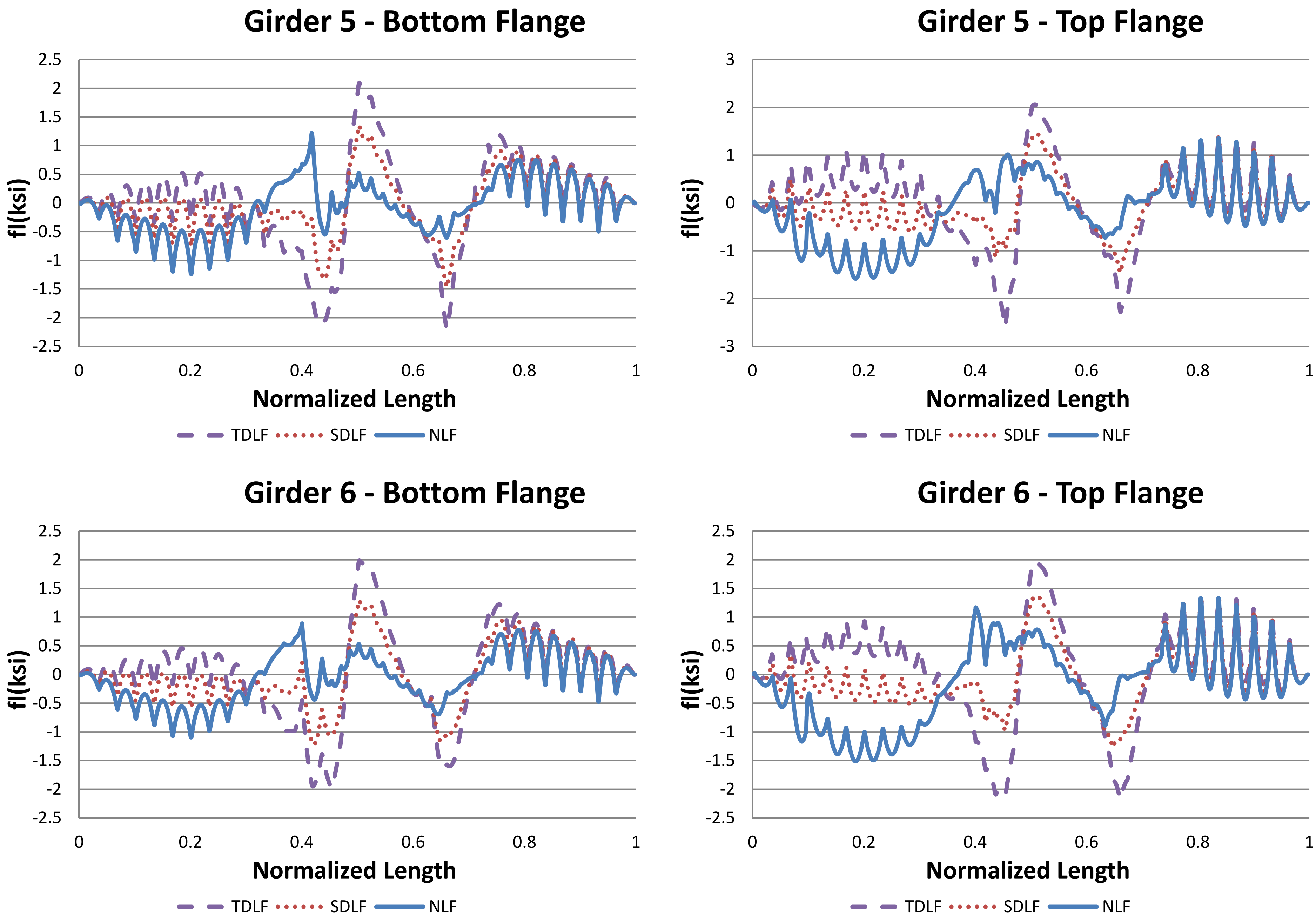
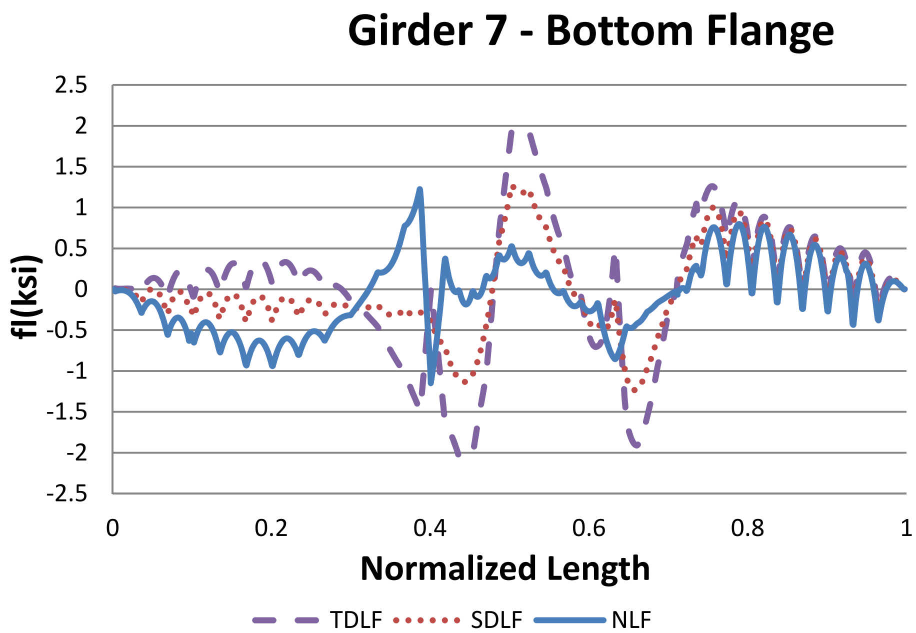


Figure U1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.



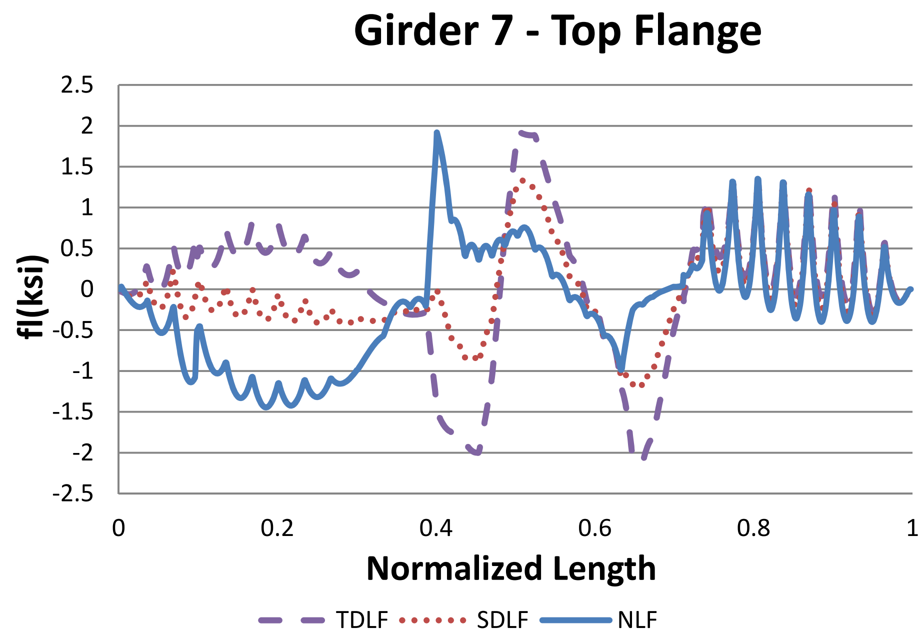


Figure U1-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under SDL for different detailing methods.

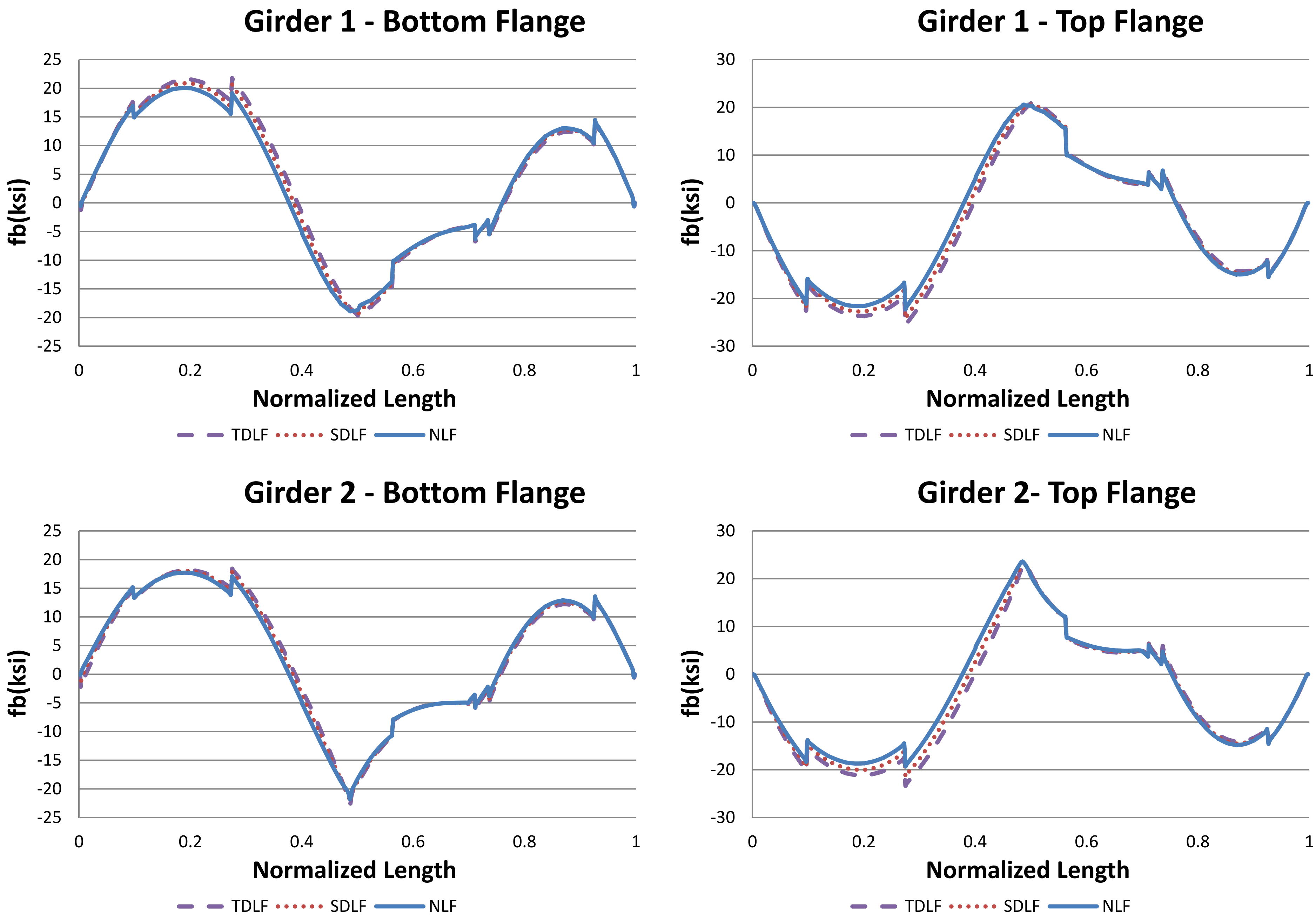


Figure U1-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

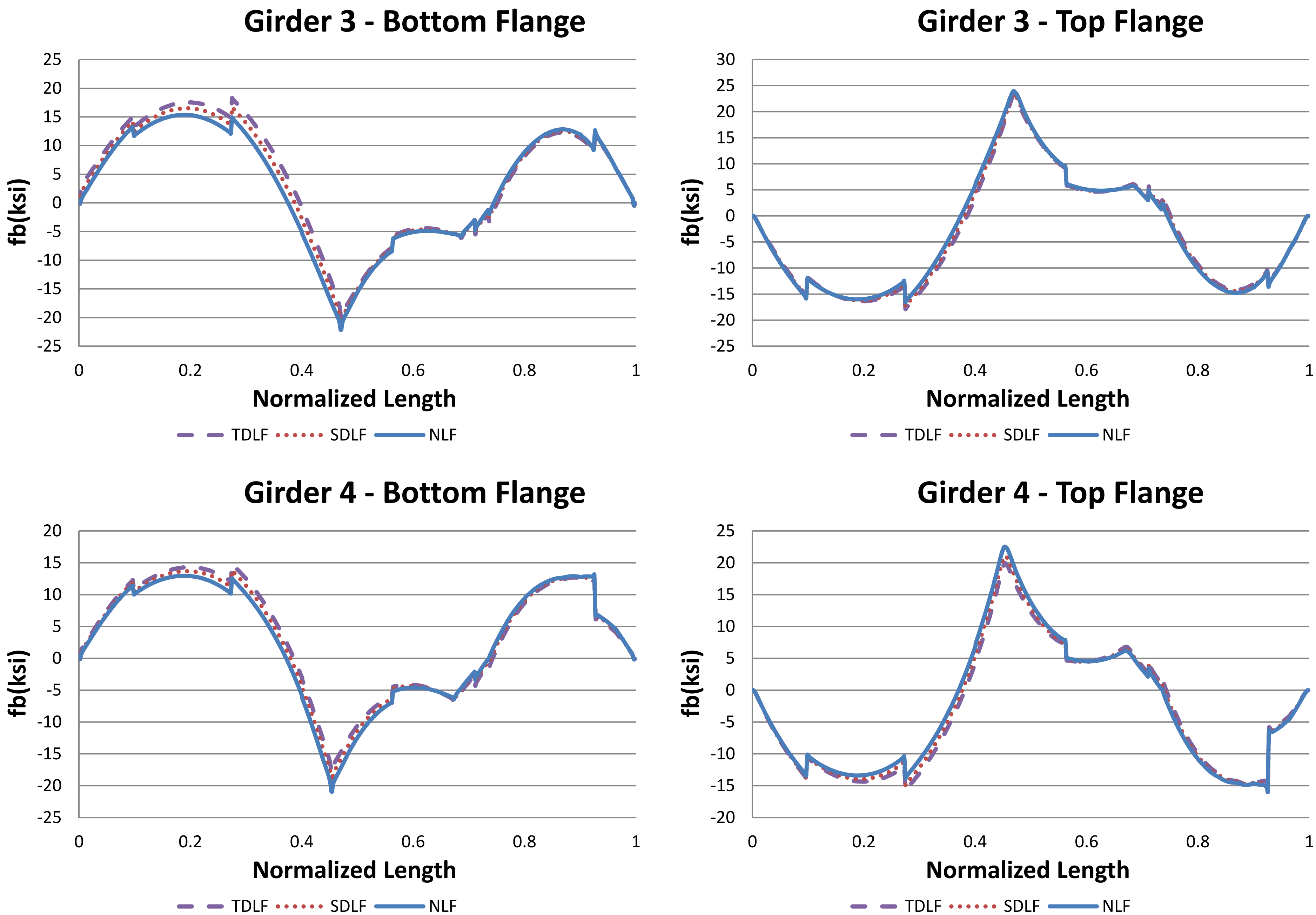


Figure U1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

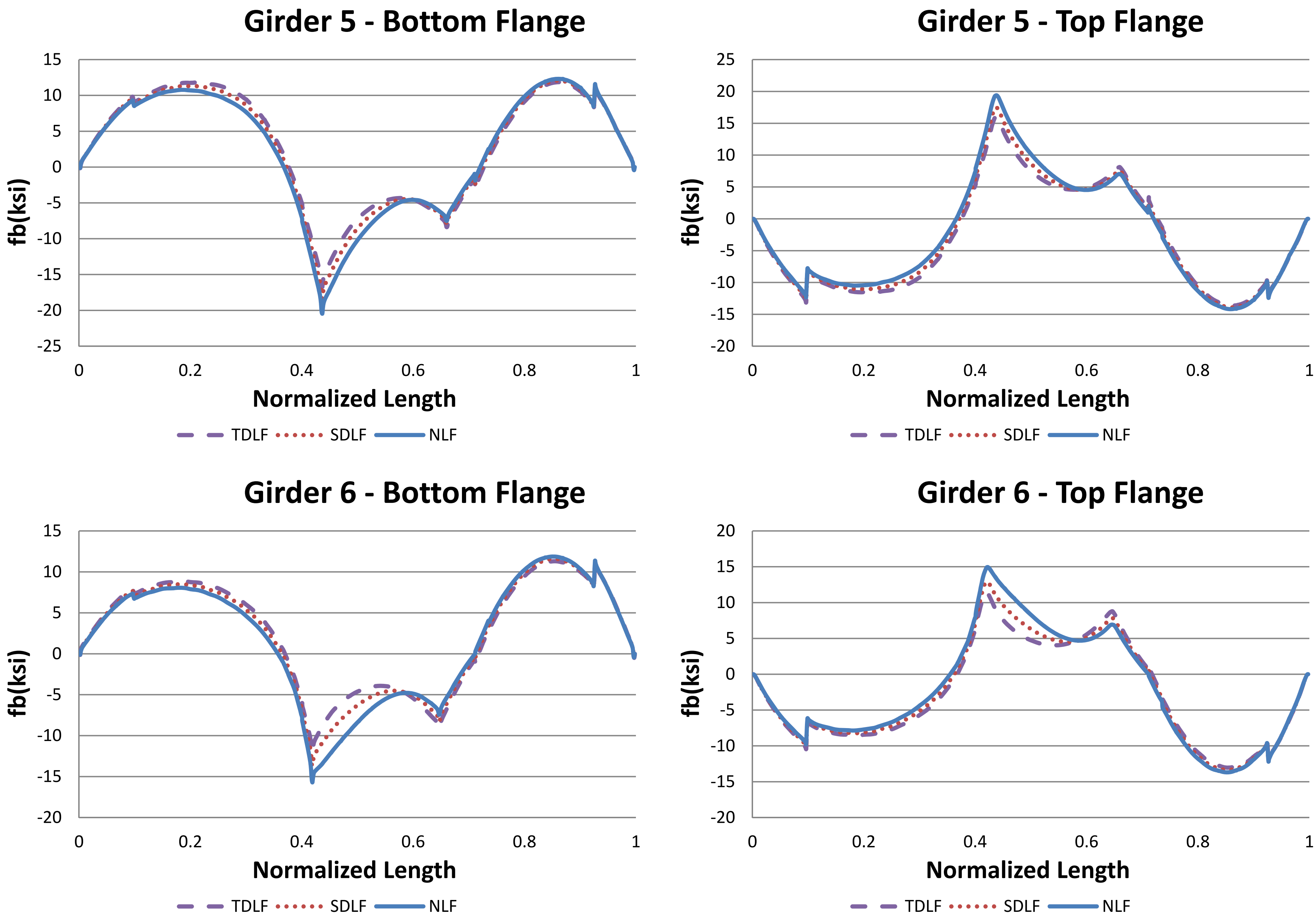
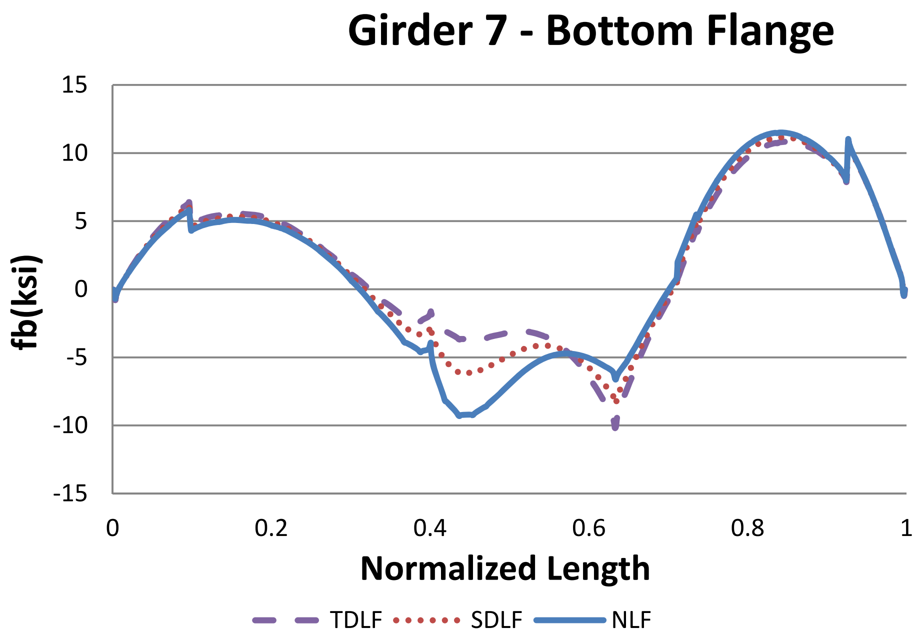


Figure U1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



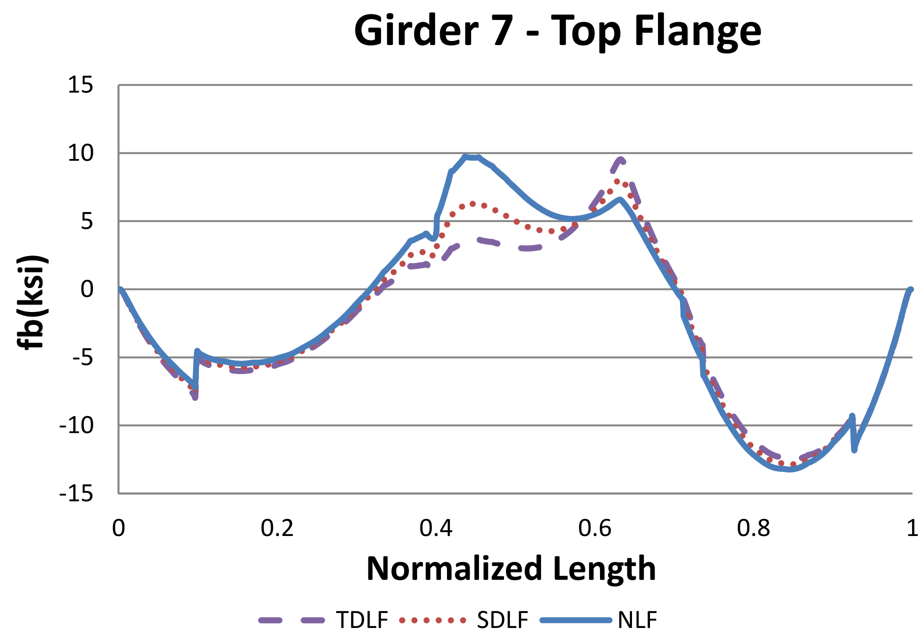


Figure U1-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

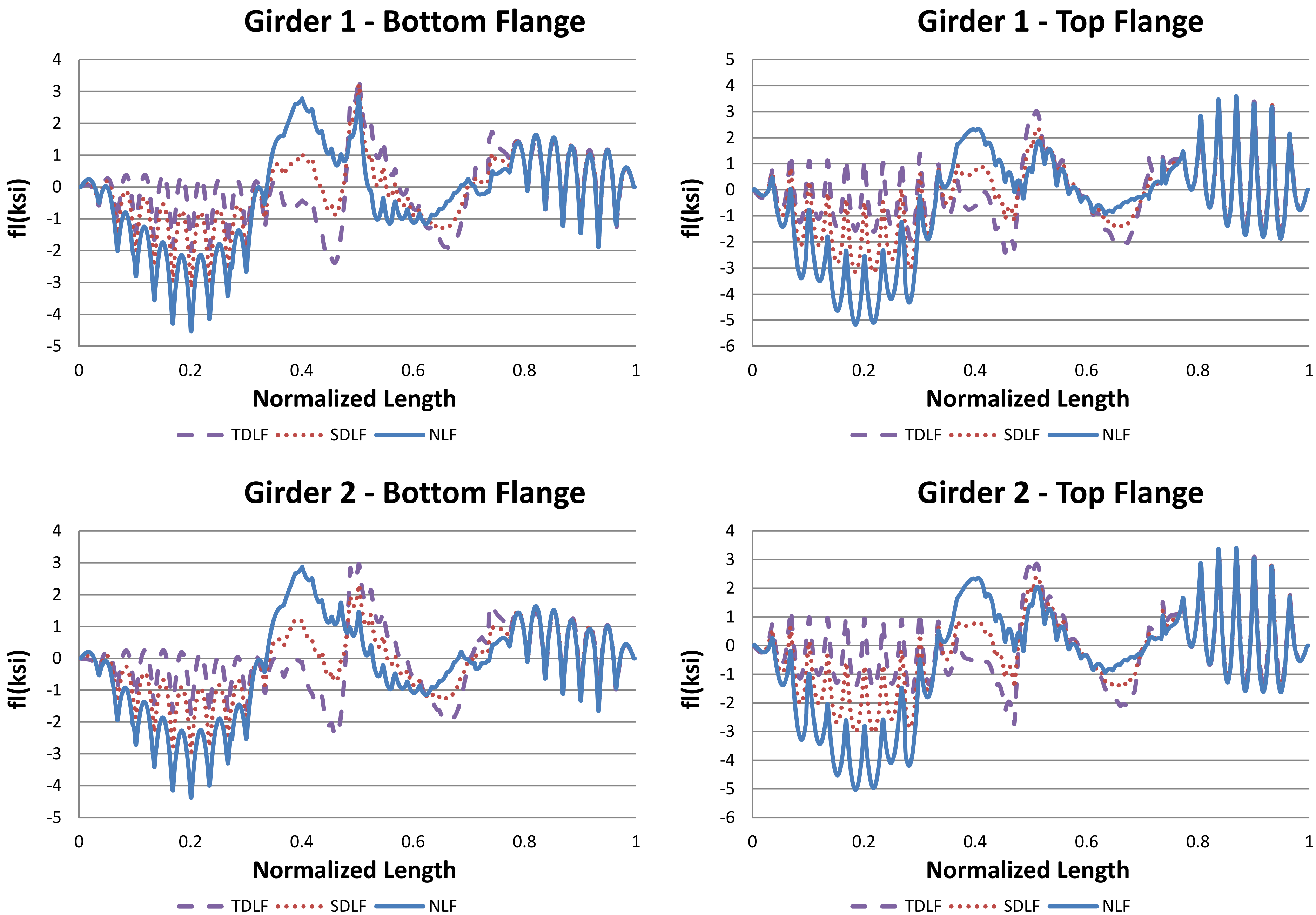


Figure U1-4-21. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.**

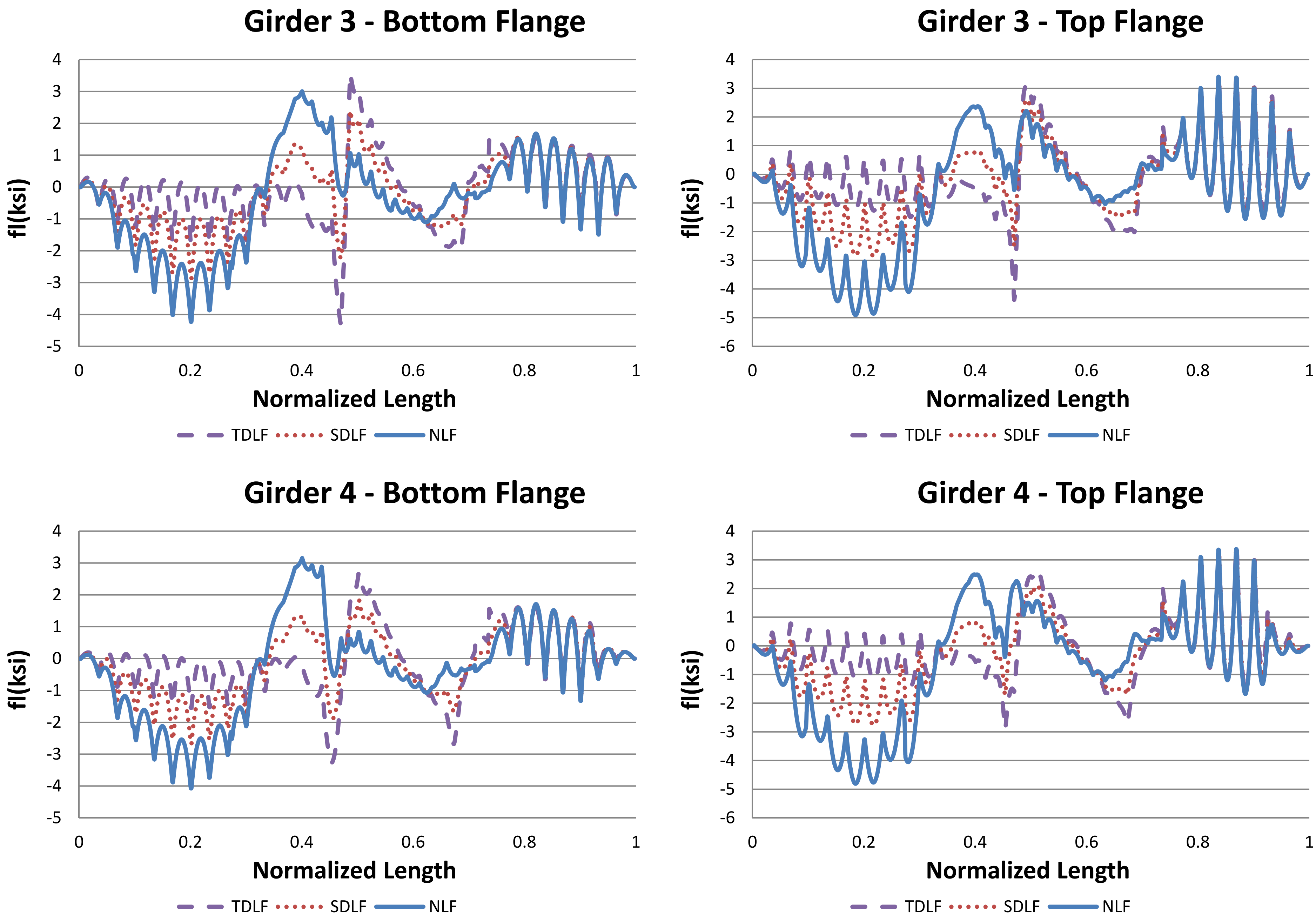


Figure U1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.

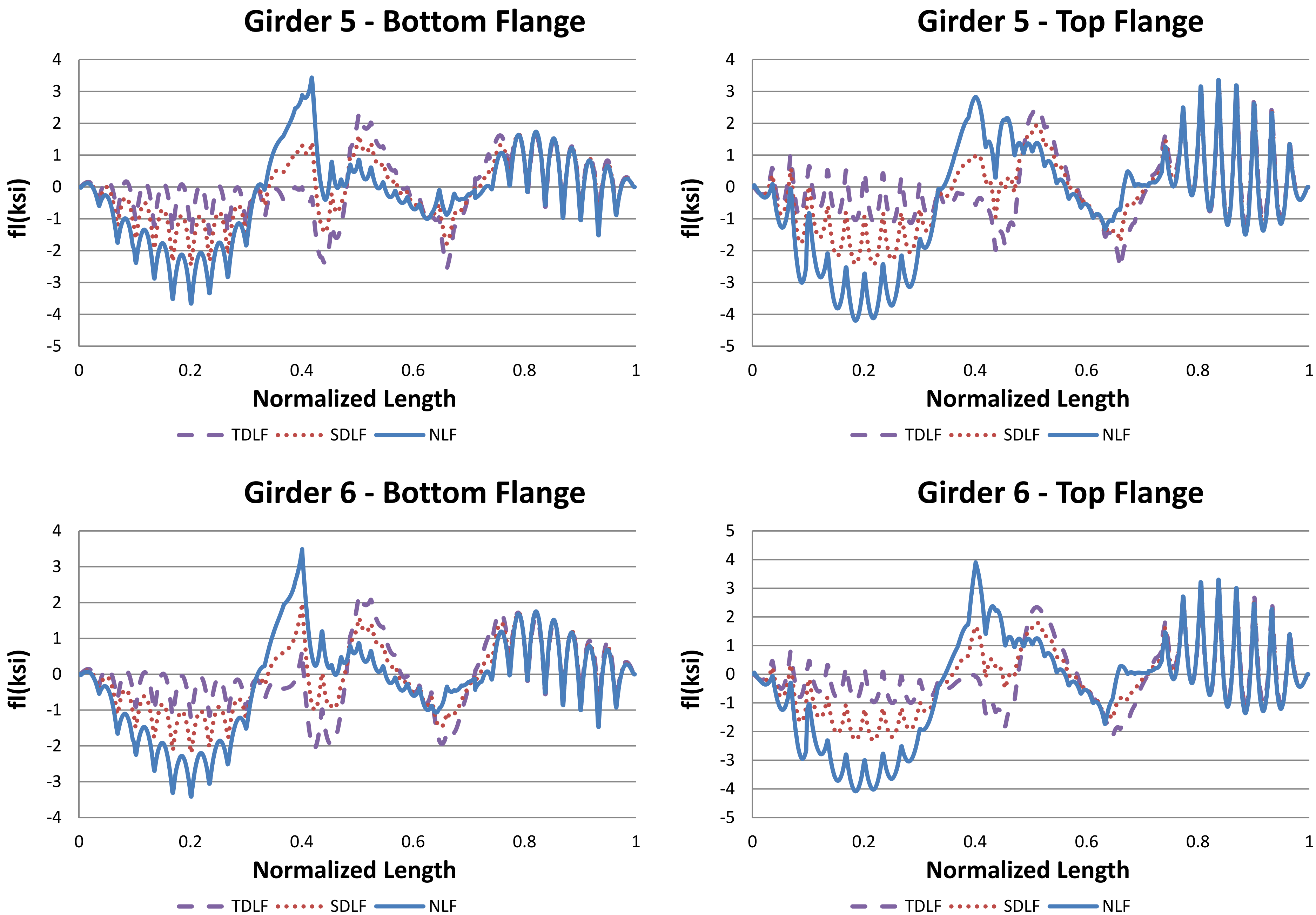
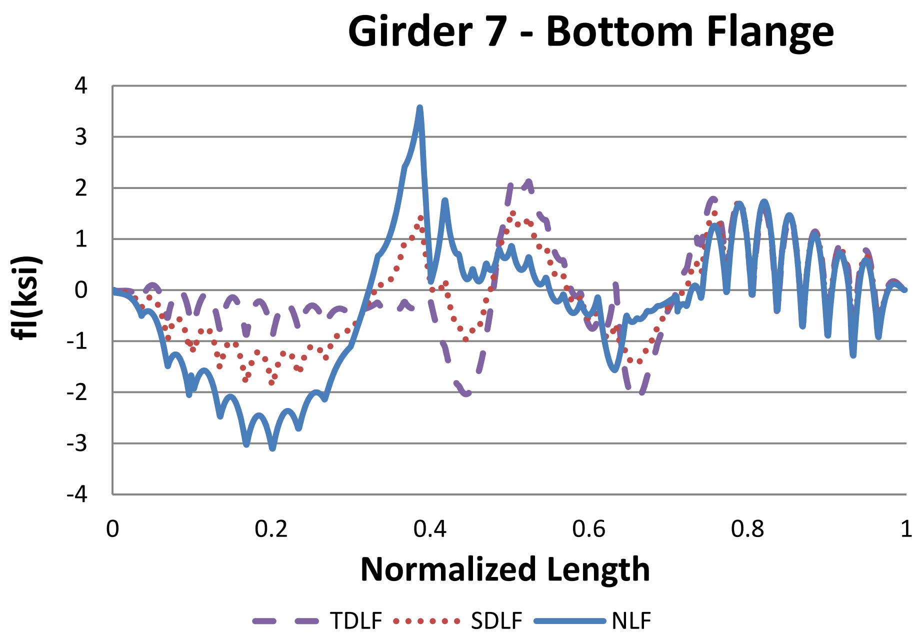


Figure U1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.



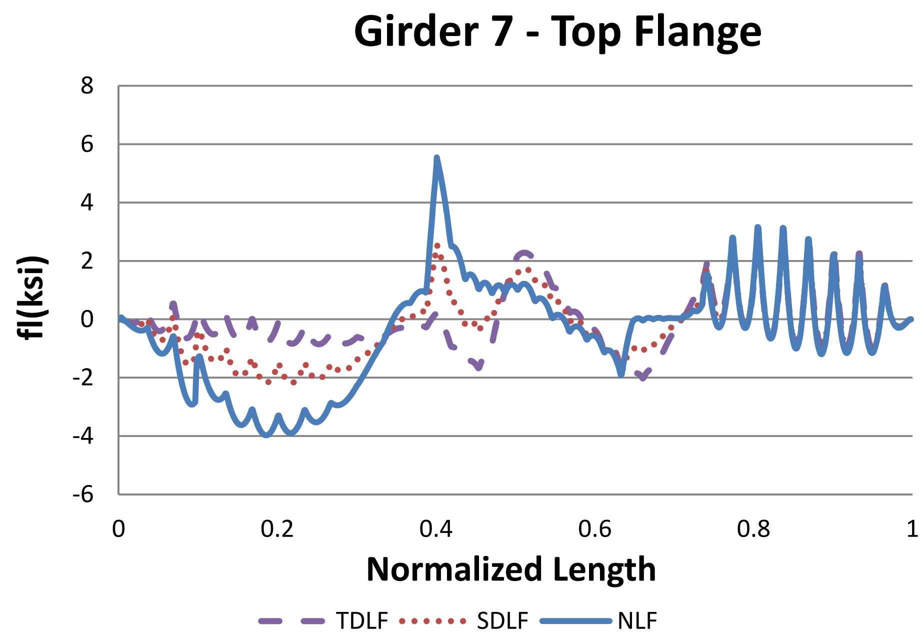


Figure U1-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

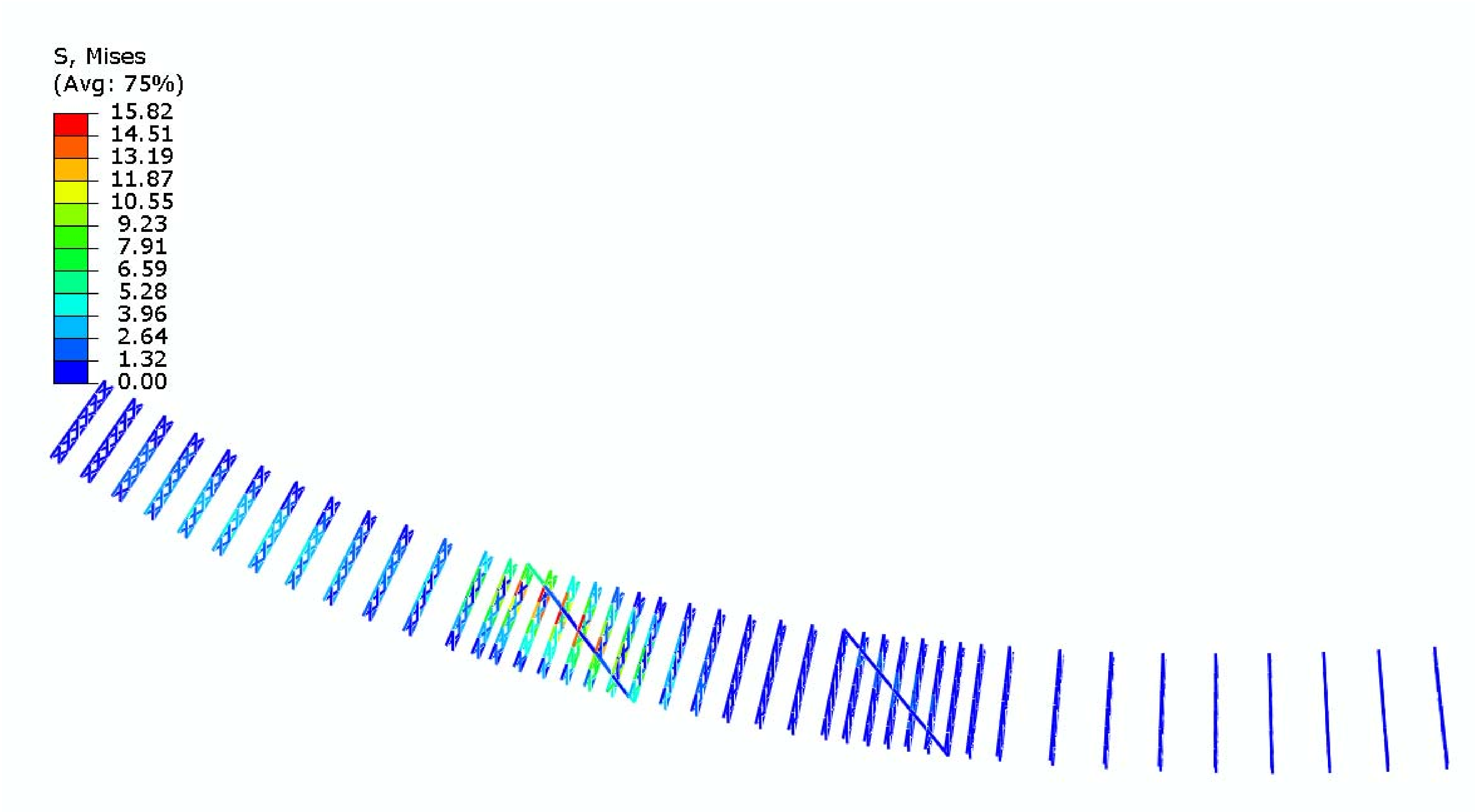


Figure U1-4-22. **Cross-frame stress contours (ksi) under SDL, NLF detailing**

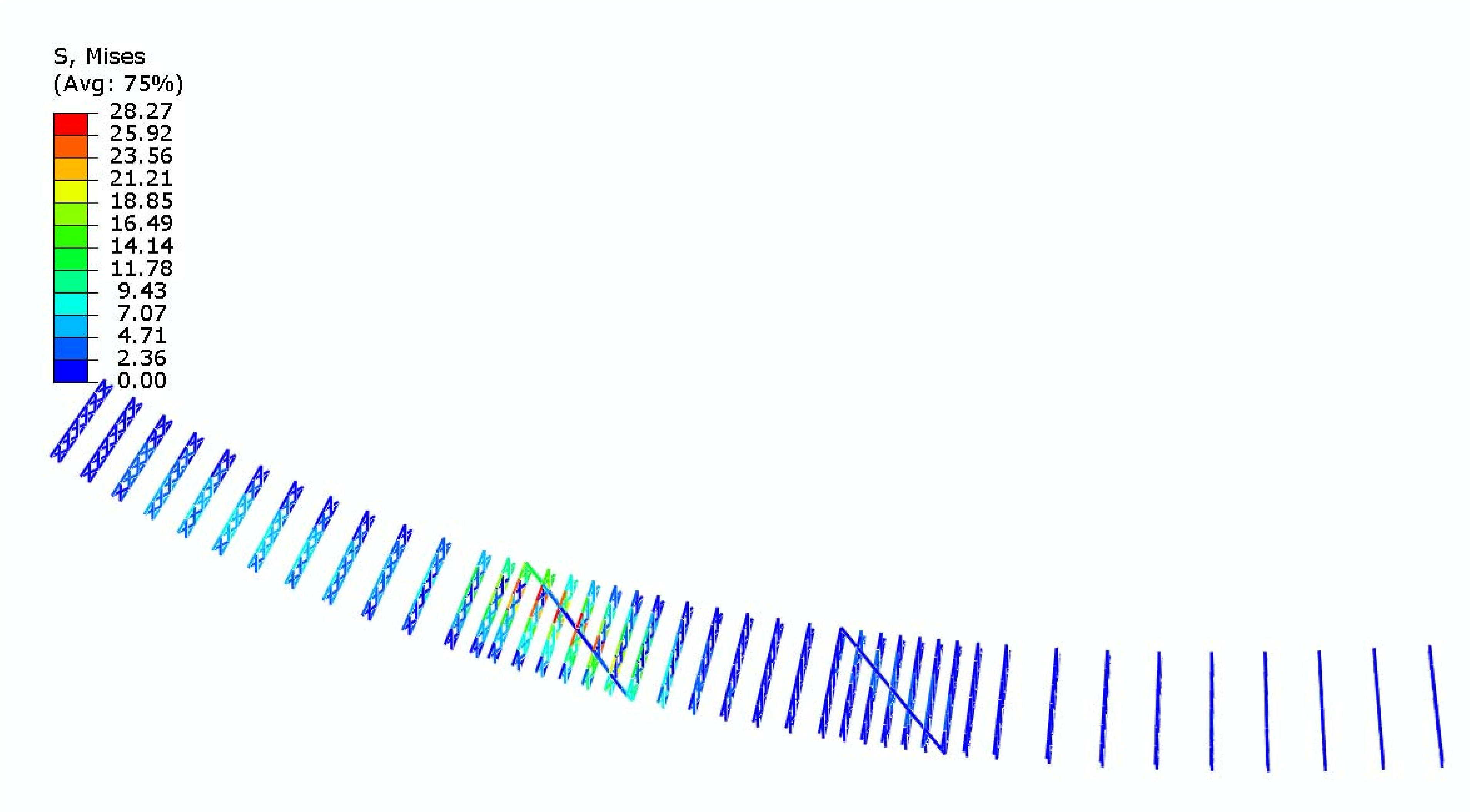


Figure U1-4-23. **Cross-frame stress contours under TDL, NLF detailing**

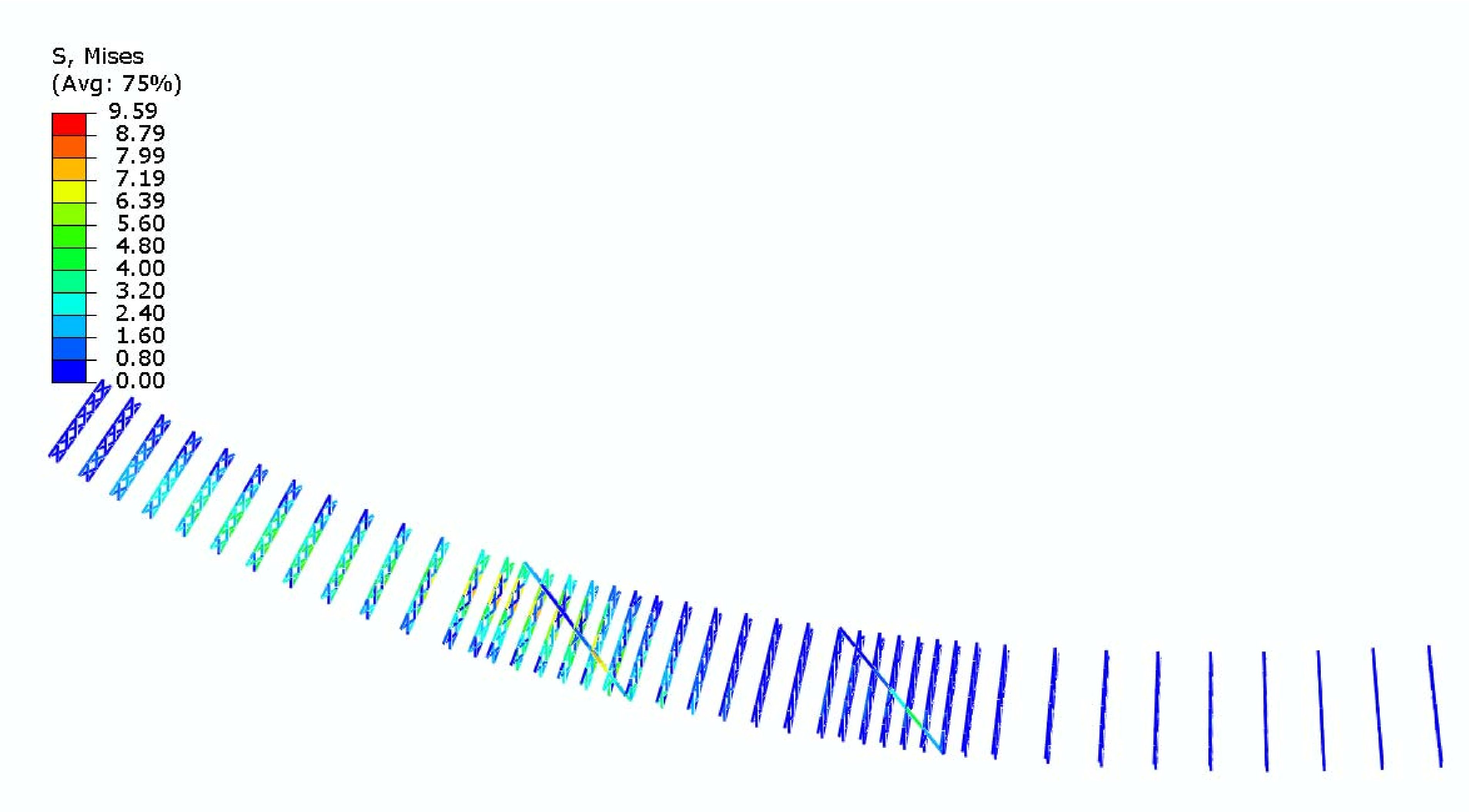


Figure U1-4-24. Cross-frame stress contours under SDL, SDLF detailing

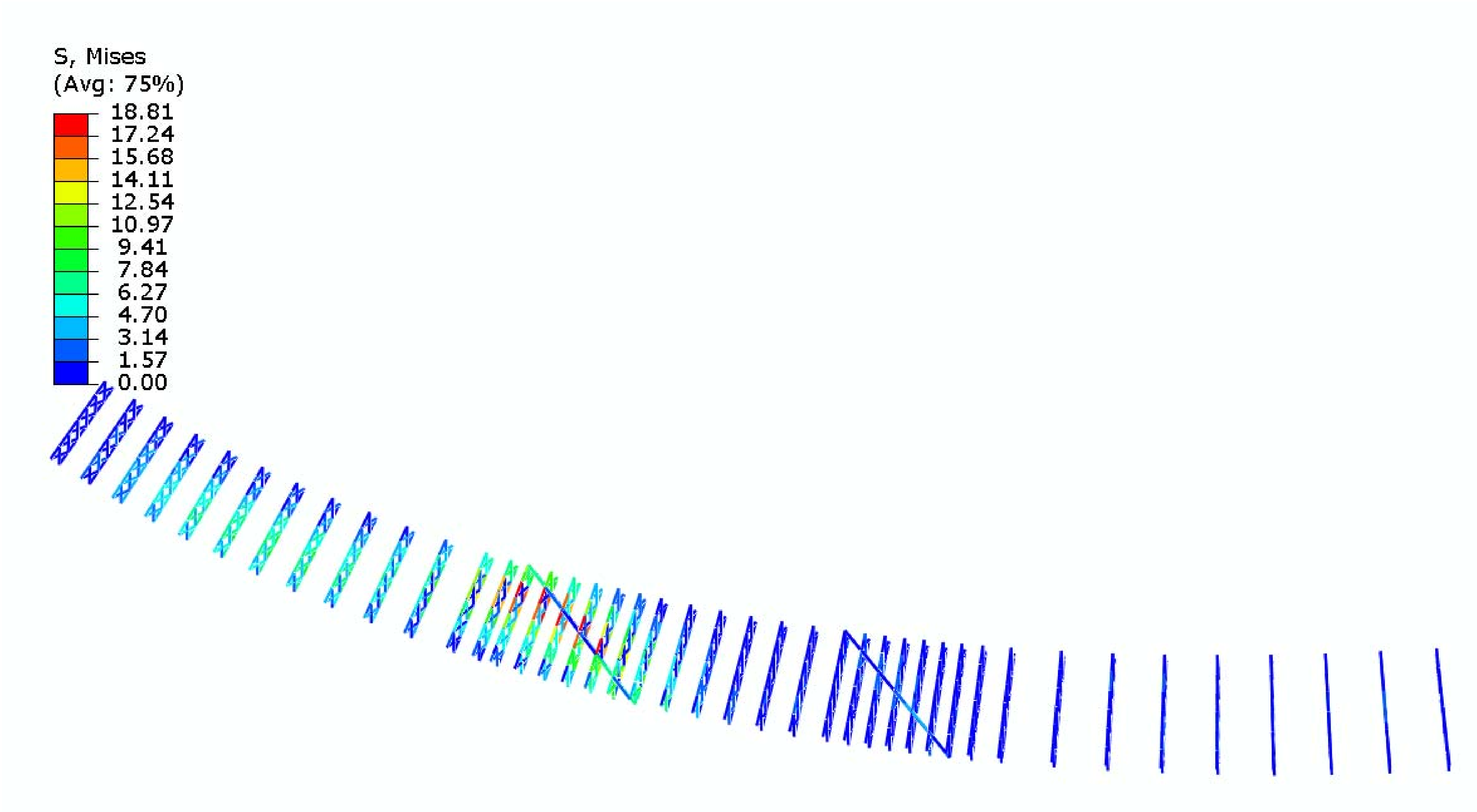


Figure U1-4-25. Cross-frame stress contours under TDL, SDLF detailing

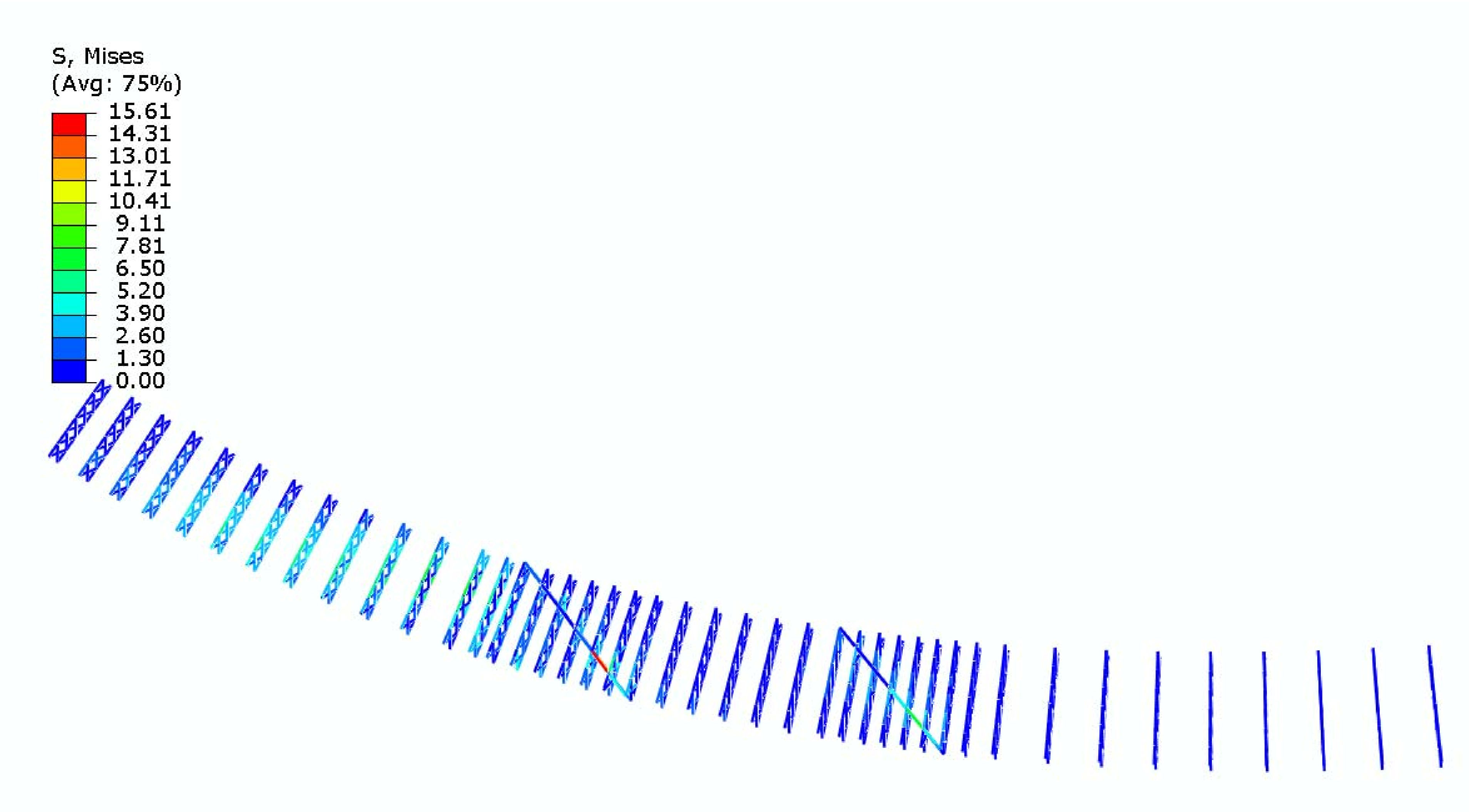


Figure U1-4-26. **Cross-frame stress contours under SDL, TDLF detailing**

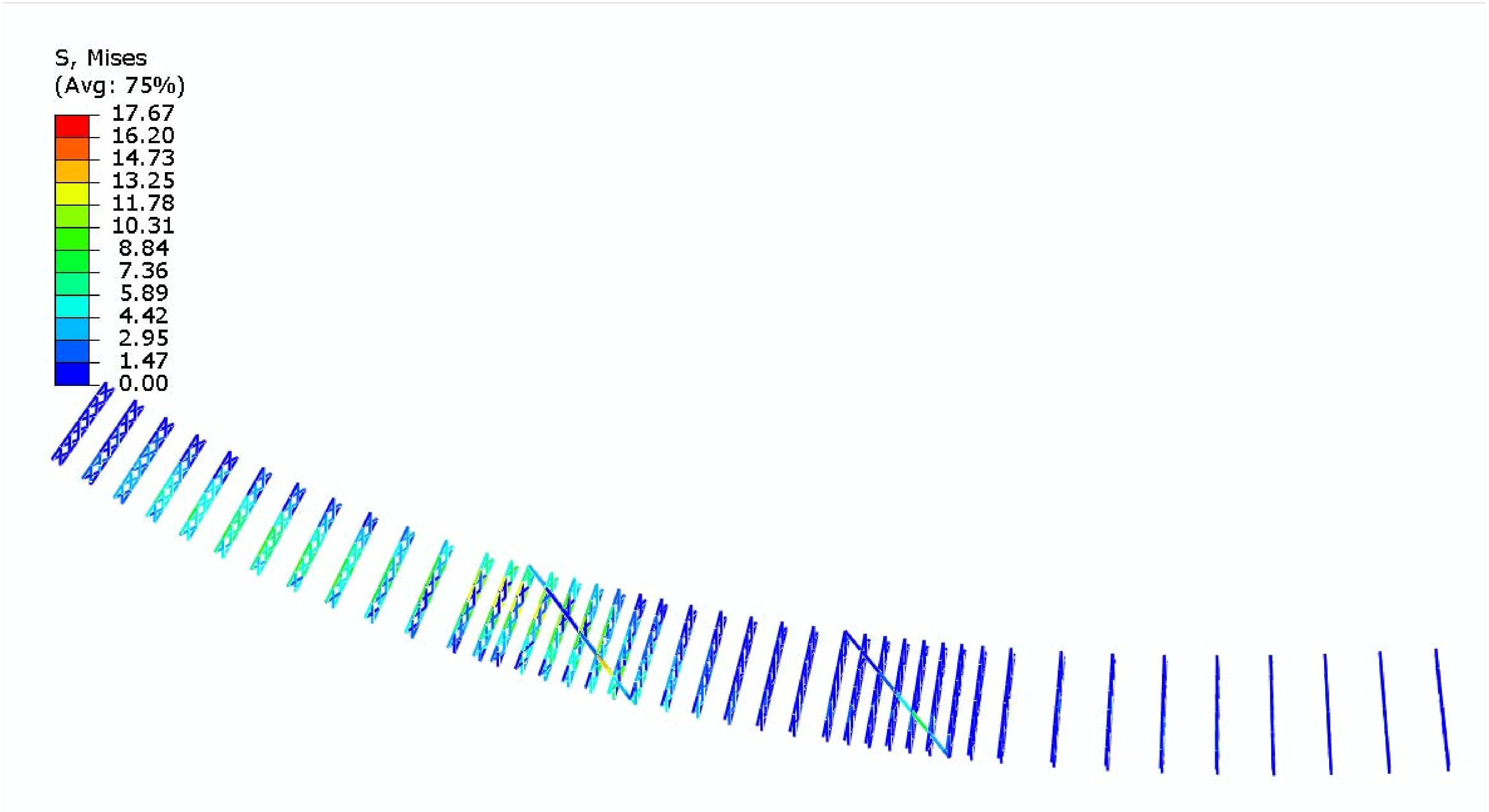


Figure U1-4-27. **Cross-frame stress contours under TDL, TDLF detailing**

Table U1-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	9.7	8.5	7.5	4.6	4.0	3.0
	SDLF	2.8	2.5	1.2	1.1	1.1	0.8
	TDLF	11.1	9.2	4.4	3.4	1.7	1.2
2	NLF	5.3	7.5	8.6	8.6	6.4	3.4
	SDLF	5.4	14.8	6.8	7.3	6.2	3.0
	TDLF	7.6	23.9	7.1	7.2	6.5	2.6
3	NLF	9.8	14.3	16.1	16.3	11.6	6.7
	SDLF	11.0	21.8	17.9	16.4	12.4	7.8
	TDLF	14.7	26.2	16.7	13.6	9.7	4.8
4	NLF	13.1	19.8	22.2	21.3	16.0	8.9
	SDLF	18.7	28.3	27.9	24.7	19.2	12.6
	TDLF	20.4	28.0	25.4	20.7	13.8	6.8
5	NLF	14.0	22.2	25.4	23.6	18.1	9.4
	SDLF	23.9	34.1	35.5	31.7	25.1	16.5
	TDLF	22.3	30.1	31.0	26.2	17.5	8.1
6	NLF	15.7	24.7	28.4	26.6	19.6	10.3
	SDLF	27.9	38.4	40.9	37.6	29.6	20.0
	TDLF	23.0	30.9	34.0	30.1	19.8	8.9
7	NLF	15.7	24.8	28.9	27.9	19.2	9.5
	SDLF	29.3	39.7	43.0	41.5	32.1	22.1
	TDLF	22.0	29.9	34.1	32.9	21.6	10.0
8	NLF	13.6	22.2	26.6	27.8	18.0	8.5
	SDLF	27.6	37.3	40.9	41.9	33.4	23.5
	TDLF	19.2	26.5	31.2	32.8	23.6	12.1
9	NLF	11.7	18.7	22.4	22.8	17.5	8.8
	SDLF	24.3	32.2	35.7	37.3	34.3	25.2
	TDLF	16.4	21.1	25.8	29.0	26.6	15.9
10	NLF	7.2	11.7	14.9	13.9	18.1	11.4
	SDLF	18.0	23.3	26.0	27.4	33.8	28.3
	TDLF	11.9	13.1	16.4	20.8	28.4	22.7

Table U1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location					
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	1.5	1.6	1.0	6.6	17.9	18.7
	SDLF	10.2	12.7	12.2	15.9	29.0	33.8
	TDLF	8.6	7.1	4.6	8.8	24.4	32.1
12	NLF	10.2	16.6	16.9	6.5	15.2	38.8
	SDLF	6.1	14.7	17.3	9.1	18.4	41.7
	TDLF	15.0	9.5	5.5	1.2	13.5	37.0
13	NLF	15.2	25.6	28.2	18.3	7.5	54.1
	SDLF	22.3	26.3	21.3	12.1	12.0	44.4
	TDLF	40.7	39.4	7.9	1.6	10.1	34.1
14	NLF	17.8	30.9	35.3	26.9	3.4	72.4
	SDLF	17.2	25.6	23.8	13.4	8.3	38.4
	TDLF	18.5	21.3	7.9	3.7	14.8	22.2
15	NLF	22.4	38.4	41.7	33.3	19.6	94.4
	SDLF	42.6	32.4	25.7	12.5	11.4	35.4
	TDLF	52.3	19.1	6.4	8.3	32.8	12.0
16	NLF	28.2	46.2	49.3	52.1	65.5	52.2
	SDLF	34.5	36.7	22.1	5.5	6.0	29.4
	TDLF	33.7	22.8	3.4	37.1	40.3	10.9
17	NLF	37.3	57.3	68.3	39.6	38.2	31.3
	SDLF	33.5	32.9	13.6	6.0	12.6	20.8
	TDLF	24.9	8.4	33.2	42.7	13.2	12.3
18	NLF	51.1	79.7	22.3	18.6	26.5	18.8
	SDLF	35.5	30.8	11.5	3.5	12.3	13.6
	TDLF	19.7	26.4	39.2	20.4	4.7	9.0
19	NLF	81.3	22.1	1.7	14.5	18.5	11.3
	SDLF	41.4	33.3	13.1	3.4	10.3	8.2
	TDLF	19.8	44.2	27.5	15.1	2.9	5.1
20	NLF	50.2	19.9	2.2	12.3	12.8	6.7
	SDLF	37.3	21.9	12.6	5.8	9.0	5.4
	TDLF	25.7	24.4	23.6	13.1	5.1	3.8

Table U1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	39.1	21.0	4.9	6.2	5.3	1.7
	SDLF	31.3	17.8	8.3	3.1	4.2	1.6
	TDLF	24.5	14.8	12.0	5.4	2.4	1.1
22	NLF	23.1	16.7	6.4	1.3	1.1	0.1
	SDLF	22.9	14.0	5.7	0.9	1.0	0.8
	TDLF	22.4	11.1	5.5	1.9	0.5	1.5
23	NLF	11.4	11.6	7.2	4.5	1.1	0.2
	SDLF	13.7	10.4	4.8	1.6	1.1	1.9
	TDLF	15.7	9.6	3.2	0.4	1.8	3.4
24	NLF	4.8	7.6	7.3	7.3	2.2	1.0
	SDLF	6.7	7.0	4.3	3.7	2.9	3.4
	TDLF	8.8	6.8	2.0	1.0	3.9	7.3
25	NLF	3.0	6.5	8.5	9.3	4.0	2.3
	SDLF	3.8	5.3	4.5	5.2	3.9	5.6
	TDLF	5.1	5.0	1.3	2.0	4.5	12.5
26	NLF	1.1	5.1	8.5	10.4	6.4	5.3
	SDLF	0.4	2.3	3.9	5.3	4.5	11.3
	TDLF	1.2	0.5	1.0	0.2	2.6	18.5
27	NLF	0.9	4.9	8.5	10.6	10.0	17.0
	SDLF	1.3	1.6	4.3	6.1	4.4	3.1
	TDLF	2.9	2.3	3.1	3.0	3.7	25.4
28	NLF	1.8	5.9	9.9	15.3	13.0	7.2
	SDLF	1.5	2.1	5.9	5.7	4.3	3.1
	TDLF	4.2	5.1	6.7	7.0	24.0	12.9
29	NLF	3.7	8.2	15.3	9.6	5.6	4.2
	SDLF	1.0	3.5	6.2	4.8	3.8	2.3
	TDLF	5.3	9.0	10.7	17.6	13.0	8.3
30	NLF	7.0	14.3	7.2	2.9	4.2	2.8
	SDLF	1.4	5.1	6.1	3.2	2.1	1.5
	TDLF	5.7	14.4	13.3	9.5	8.5	5.5

Table U1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	14.0	4.1	0.8	2.8	3.7	2.0
	SDLF	2.5	8.7	4.4	2.4	1.2	0.9
	TDLF	10.2	15.5	10.5	8.3	7.0	4.4
32	NLF	6.3	2.4	0.5	3.4	3.1	1.2
	SDLF	6.1	4.8	3.4	1.2	0.7	0.8
	TDLF	9.5	7.9	7.8	6.4	5.1	3.4
33	NLF	6.1	2.8	0.8	4.8	2.7	0.6
	SDLF	3.4	2.4	0.9	1.5	0.6	0.7
	TDLF	1.5	2.6	3.4	2.5	2.2	1.8
34	NLF	4.6	2.0	2.0	5.2	2.6	0.7
	SDLF	2.4	1.2	0.7	3.7	1.2	0.2
	TDLF	1.0	0.9	1.4	2.5	0.7	0.9
35	NLF	0.6	2.3	4.5	5.4	3.5	1.5
	SDLF	0.5	1.3	3.5	5.7	3.3	1.4
	TDLF	2.5	0.7	3.0	6.6	3.7	2.0
36	NLF	3.6	5.4	6.1	5.8	4.1	2.0
	SDLF	2.0	3.9	5.5	5.8	4.2	2.2
	TDLF	0.9	2.5	5.5	6.9	5.3	3.4
37	NLF	4.6	7.1	7.7	5.7	4.4	2.6
	SDLF	3.2	5.7	7.2	5.0	4.6	3.0
	TDLF	2.0	4.4	7.8	5.1	6.1	4.5
38	NLF	4.2	7.3	10.0	3.9	4.6	3.4
	SDLF	3.5	5.9	9.0	3.7	5.2	3.5
	TDLF	3.4	4.6	8.3	4.5	7.1	4.3
39	NLF	3.1	5.4	11.4	1.4	5.6	3.8
	SDLF	3.6	4.9	7.5	4.3	5.6	2.9
	TDLF	5.4	5.0	2.1	9.7	6.2	1.8
40	NLF	3.2	3.1	2.1	12.3	5.6	2.0
	SDLF	3.7	4.3	1.2	9.2	3.8	1.4
	TDLF	5.1	6.9	6.5	4.5	1.0	0.5

Table U1-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	2.3	0.7	5.2	10.8	4.1	0.8
	SDLF	2.8	2.5	2.6	8.0	2.1	0.4
	TDLF	3.8	5.9	4.0	2.8	1.5	0.6
42	NLF	3.3	3.2	4.8	4.0	2.8	2.8
	SDLF	0.9	0.9	0.6	0.7	0.5	0.5
	TDLF	4.3	3.8	6.2	6.2	3.1	3.3

Table U1-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	17.4	15.4	13.8	8.7	7.7	5.8
	SDLF	6.5	7.7	7.5	5.3	4.9	3.8
	TDLF	5.9	5.0	2.0	2.2	2.3	1.9
2	NLF	9.9	13.3	15.9	17.6	11.2	3.4
	SDLF	10.1	20.7	14.3	16.4	11.2	3.8
	TDLF	12.4	29.7	14.3	16.2	11.7	4.0
3	NLF	19.7	27.4	32.0	34.7	22.2	10.8
	SDLF	20.3	34.0	32.3	33.1	22.2	11.5
	TDLF	23.4	37.7	30.8	30.3	19.4	8.8
4	NLF	26.0	37.8	43.8	44.1	30.7	14.9
	SDLF	31.0	45.4	47.8	45.7	32.8	18.0
	TDLF	32.0	44.2	44.8	41.6	27.2	12.3
5	NLF	27.7	43.2	50.1	48.2	34.6	15.6
	SDLF	37.2	53.6	58.5	54.4	40.3	22.0
	TDLF	35.1	48.8	53.4	48.9	32.8	13.7
6	NLF	32.0	49.0	56.5	54.6	38.1	17.8
	SDLF	43.3	60.7	66.9	63.1	46.2	26.3
	TDLF	37.4	51.9	58.8	55.3	36.2	15.1
7	NLF	32.2	49.5	57.5	57.1	37.3	16.4
	SDLF	44.9	62.3	69.4	68.1	48.3	27.8
	TDLF	36.6	51.2	59.4	59.1	37.5	15.6
8	NLF	28.0	44.4	52.9	56.5	34.8	14.5
	SDLF	41.4	57.6	64.8	67.4	47.9	28.1
	TDLF	32.5	46.1	54.7	58.8	38.3	16.9
9	NLF	24.7	37.6	44.7	46.1	33.2	14.8
	SDLF	36.9	50.2	56.7	58.7	48.5	30.2
	TDLF	28.5	38.1	46.1	50.1	40.5	20.9
10	NLF	16.8	24.8	30.4	28.2	33.3	19.1
	SDLF	27.4	35.9	41.0	41.0	48.3	35.4
	TDLF	20.5	24.7	30.3	33.1	42.2	29.5

Table U1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location					
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	1.0	0.2	3.6	13.9	32.2	32.0
	SDLF	12.5	14.4	14.9	22.2	41.9	45.6
	TDLF	11.3	9.0	7.7	15.4	37.2	43.8
12	NLF	16.1	28.2	29.0	10.6	26.8	67.9
	SDLF	11.4	25.5	28.9	13.1	28.9	68.5
	TDLF	19.7	19.6	16.4	5.2	23.9	63.4
13	NLF	26.1	45.6	50.8	33.4	14.3	94.2
	SDLF	31.9	43.9	42.7	26.4	17.7	82.9
	TDLF	50.1	56.8	27.2	12.5	13.9	71.1
14	NLF	30.5	55.0	63.6	49.2	8.7	131.9
	SDLF	29.4	48.7	50.9	34.6	8.0	93.4
	TDLF	30.3	43.4	32.9	16.6	11.0	61.3
15	NLF	38.9	68.1	74.3	59.3	34.7	168.2
	SDLF	58.7	61.4	57.8	38.5	5.0	106.2
	TDLF	67.9	47.6	38.0	19.8	16.9	59.4
16	NLF	49.8	82.8	88.7	94.1	118.3	93.4
	SDLF	55.4	72.0	59.2	42.8	57.3	69.0
	TDLF	54.5	57.9	38.6	7.5	9.8	49.3
17	NLF	67.0	103.6	123.7	72.8	69.0	55.7
	SDLF	62.2	76.8	65.7	25.9	42.3	44.3
	TDLF	53.7	54.1	21.7	11.8	20.3	34.9
18	NLF	92.5	144.4	41.1	34.5	48.1	33.4
	SDLF	75.9	94.8	8.0	17.8	33.1	27.6
	TDLF	60.9	56.8	22.2	6.7	20.6	22.5
19	NLF	147.0	40.8	3.7	27.8	33.9	19.8
	SDLF	103.3	51.5	11.2	16.3	25.2	16.4
	TDLF	70.8	61.9	25.5	6.5	17.5	13.1
20	NLF	92.8	35.9	4.7	23.9	23.3	11.2
	SDLF	78.3	37.1	12.5	17.2	19.3	9.8
	TDLF	65.5	38.8	23.1	10.8	15.2	8.1

Table U1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	72.9	39.3	9.0	12.8	9.2	1.6
	SDLF	64.3	35.5	12.1	9.6	8.1	1.5
	TDLF	55.7	32.1	15.6	6.0	6.2	1.4
22	NLF	43.9	32.6	13.0	3.4	1.1	2.1
	SDLF	42.8	29.7	12.3	3.0	0.9	2.8
	TDLF	41.9	26.6	11.9	1.7	0.5	3.5
23	NLF	22.5	24.0	15.4	8.5	3.4	2.2
	SDLF	24.3	22.6	12.8	5.4	3.2	3.8
	TDLF	26.2	21.5	11.1	3.6	3.8	5.3
24	NLF	10.4	17.2	16.4	14.9	5.7	0.3
	SDLF	12.1	16.5	13.5	11.2	6.4	4.1
	TDLF	14.0	16.1	11.1	8.4	7.3	7.8
25	NLF	7.9	16.5	20.5	20.7	10.4	3.3
	SDLF	8.1	14.8	16.3	16.2	10.0	5.3
	TDLF	9.5	14.1	12.6	12.2	9.7	11.5
26	NLF	4.0	13.6	20.3	23.1	15.2	11.0
	SDLF	2.6	10.7	15.5	17.8	12.9	15.2
	TDLF	2.3	8.5	11.0	12.4	10.7	21.5
27	NLF	3.5	12.9	20.0	23.3	22.5	38.8
	SDLF	1.3	9.8	15.9	18.9	17.0	18.4
	TDLF	0.2	7.0	11.4	13.6	8.9	4.7
28	NLF	5.5	15.0	23.0	33.8	29.0	15.6
	SDLF	2.9	11.5	19.2	24.6	11.7	7.0
	TDLF	0.8	8.0	14.4	12.1	9.7	4.5
29	NLF	9.8	20.1	34.8	20.8	12.1	9.1
	SDLF	6.3	15.6	25.9	8.3	4.4	3.4
	TDLF	3.3	10.9	14.1	10.8	6.8	3.2
30	NLF	16.8	32.9	14.5	6.4	9.1	6.0
	SDLF	11.4	24.1	6.8	0.9	3.2	2.0
	TDLF	6.2	13.6	13.7	6.1	3.7	2.5

Table U1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	31.8	6.8	1.6	6.2	8.0	4.1
	SDLF	20.2	12.4	3.6	2.6	3.7	1.2
	TDLF	8.1	19.5	9.8	4.9	2.7	2.5
32	NLF	13.5	6.7	0.5	7.8	6.6	2.0
	SDLF	13.6	8.0	3.2	5.0	3.7	0.2
	TDLF	14.2	11.5	7.6	2.7	1.6	2.8
33	NLF	15.0	7.6	1.4	10.9	5.4	0.2
	SDLF	12.0	6.7	0.3	7.7	3.4	1.2
	TDLF	10.1	7.1	2.8	4.4	1.4	2.3
34	NLF	11.0	5.5	3.9	13.3	5.3	0.1
	SDLF	8.9	4.8	2.8	11.9	3.8	1.0
	TDLF	7.7	4.7	2.4	10.9	3.4	1.9
35	NLF	2.1	4.9	10.1	13.6	7.0	1.0
	SDLF	1.2	3.9	9.1	13.8	6.8	0.9
	TDLF	1.0	3.1	8.7	14.8	7.1	1.4
36	NLF	10.2	13.4	14.7	13.7	8.4	2.2
	SDLF	8.6	12.0	14.1	13.8	8.6	2.5
	TDLF	6.9	10.4	13.9	14.7	9.4	3.5
37	NLF	13.1	18.3	19.1	13.4	9.2	4.0
	SDLF	11.5	16.7	18.7	12.7	9.4	4.4
	TDLF	10.1	15.2	18.8	12.5	10.6	5.7
38	NLF	12.2	19.1	25.3	9.2	10.5	6.4
	SDLF	11.1	17.3	24.2	8.9	10.8	6.3
	TDLF	10.8	15.8	23.0	9.2	12.4	7.0
39	NLF	9.5	14.0	28.4	4.1	13.7	7.8
	SDLF	9.6	13.0	24.4	6.6	13.2	6.7
	TDLF	11.2	13.0	18.4	11.7	13.7	5.4
40	NLF	9.9	7.8	7.6	33.8	14.3	3.3
	SDLF	10.1	8.8	4.9	30.6	12.5	2.6
	TDLF	11.5	11.2	0.9	25.9	9.6	1.6

Table U1-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	7.3	1.5	16.4	31.0	10.6	0.5
	SDLF	7.8	3.3	13.8	28.2	8.6	0.2
	TDLF	8.8	6.8	8.9	22.9	5.2	1.0
42	NLF	9.1	8.4	12.1	9.7	7.3	7.3
	SDLF	6.5	5.7	7.6	5.7	5.1	5.0
	TDLF	1.9	1.4	0.6	1.7	1.5	1.1

Table U1-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	4.1	3.8	3.5	2.0	1.2	4.1
	SDLF	1.5	1.0	1.0	0.5	0.5	1.5
	TDLF	6.5	1.2	1.2	1.0	0.4	6.5
2	NLF	8.3	11.0	10.3	7.4	2.3	8.3
	SDLF	7.9	5.3	4.5	4.8	1.3	7.9
	TDLF	6.6	1.0	1.6	2.1	0.0	6.6
3	NLF	18.1	23.7	21.9	15.9	5.8	18.1
	SDLF	18.1	18.7	15.8	12.2	4.6	18.1
	TDLF	13.8	10.4	6.8	6.0	0.7	13.8
4	NLF	24.9	32.4	29.6	21.6	8.0	24.9
	SDLF	27.4	30.9	27.3	20.1	8.5	27.4
	TDLF	21.2	21.8	18.2	12.3	2.6	21.2
5	NLF	29.1	38.2	34.4	24.8	9.5	29.1
	SDLF	35.3	41.2	36.9	27.1	12.4	35.3
	TDLF	27.7	31.8	28.0	18.7	4.9	27.7
6	NLF	31.9	41.6	37.3	26.5	9.8	31.9
	SDLF	40.9	48.6	44.4	32.7	15.8	40.9
	TDLF	31.8	38.8	35.7	24.2	7.3	31.8
7	NLF	32.3	42.3	38.0	26.3	9.1	32.3
	SDLF	43.6	52.9	49.6	37.0	18.5	43.6
	TDLF	33.8	43.4	42.1	29.8	10.6	33.8
8	NLF	30.4	40.7	37.4	25.6	9.0	30.4
	SDLF	43.1	54.0	53.0	41.1	22.2	43.1
	TDLF	33.5	45.8	47.7	36.8	16.5	33.5
9	NLF	26.9	36.9	35.4	26.8	12.3	26.9
	SDLF	39.7	51.8	54.4	46.4	28.5	39.7
	TDLF	31.0	45.7	52.7	46.1	26.0	31.0
10	NLF	21.8	32.7	35.3	32.6	21.0	21.8
	SDLF	33.5	47.1	54.9	53.6	38.6	33.5
	TDLF	26.1	42.9	56.1	56.5	39.3	26.1

Table U1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	16.0	31.3	43.3	47.7	36.8	14.5
	SDLF	25.4	40.4	55.4	62.6	51.7	24.5
	TDLF	19.2	34.9	53.6	63.8	53.5	22.4
12	NLF	10.5	31.7	56.8	73.9	67.7	28.9
	SDLF	11.0	31.1	56.0	69.8	64.6	30.4
	TDLF	1.3	21.1	47.2	59.7	56.3	26.1
13	NLF	7.7	32.7	66.0	93.7	97.9	53.6
	SDLF	0.9	27.8	57.5	70.2	66.7	32.2
	TDLF	13.4	16.0	44.3	47.0	39.0	13.0
14	NLF	6.5	33.8	73.2	108.9	124.4	75.8
	SDLF	8.1	28.3	54.8	69.7	66.4	24.3
	TDLF	0.3	15.0	34.8	35.1	18.9	16.3
15	NLF	6.5	39.5	85.0	127.7	134.4	65.0
	SDLF	20.1	34.6	53.3	69.4	57.5	26.5
	TDLF	25.7	24.9	22.7	19.6	5.2	4.1
16	NLF	8.5	48.9	104.5	137.5	120.4	40.3
	SDLF	15.0	36.6	59.0	56.4	53.7	20.5
	TDLF	16.1	21.4	17.4	12.5	0.1	4.4
17	NLF	12.9	66.4	115.6	132.6	80.0	26.7
	SDLF	15.1	43.6	47.5	51.6	36.5	14.3
	TDLF	13.9	20.9	12.4	16.5	0.1	3.7
18	NLF	22.2	79.0	124.0	93.9	56.1	18.1
	SDLF	21.0	51.8	41.1	37.2	27.5	9.4
	TDLF	18.1	28.2	32.0	11.8	2.8	1.7
19	NLF	30.6	98.2	92.4	70.1	39.7	12.9
	SDLF	2.8	63.6	47.5	38.3	24.1	8.1
	TDLF	24.9	34.7	8.2	10.4	10.3	4.0
20	NLF	53.6	76.6	72.9	52.5	28.6	9.6
	SDLF	28.4	40.3	42.3	32.9	19.7	7.1
	TDLF	3.8	6.2	13.9	15.0	11.8	5.1

Table U1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	14.1	39.0	42.4	30.6	16.3	5.9
	SDLF	4.8	20.4	24.0	18.3	10.2	3.6
	TDLF	4.7	1.8	5.8	6.5	4.5	1.7
22	NLF	1.3	13.3	19.1	14.9	8.6	3.6
	SDLF	2.4	8.5	11.8	8.8	4.5	1.7
	TDLF	3.8	3.0	4.1	2.8	1.2	0.3
23	NLF	6.1	0.5	4.6	6.1	5.8	3.0
	SDLF	5.2	0.3	3.3	2.6	1.8	1.2
	TDLF	4.3	0.7	1.8	0.4	1.2	0.0
24	NLF	7.1	6.4	2.2	2.6	5.7	3.4
	SDLF	6.4	5.4	3.2	1.9	0.1	1.2
	TDLF	5.6	4.0	3.5	5.2	4.6	0.3
25	NLF	6.6	7.1	2.7	4.0	9.3	6.8
	SDLF	7.3	8.9	7.7	6.1	3.2	0.6
	TDLF	7.5	9.6	11.4	14.6	14.3	7.4
26	NLF	4.1	4.2	1.1	10.1	18.4	15.8
	SDLF	5.4	8.6	8.4	6.5	3.6	4.0
	TDLF	6.3	11.7	16.3	21.7	25.0	23.7
27	NLF	2.7	1.8	4.3	13.6	17.0	10.5
	SDLF	3.8	6.8	6.3	3.9	4.7	2.9
	TDLF	4.6	10.8	15.9	21.5	27.9	17.2
28	NLF	1.5	1.1	9.1	14.9	18.0	5.7
	SDLF	2.1	4.1	2.3	3.8	2.9	1.1
	TDLF	2.6	8.7	13.9	24.7	25.7	8.5
29	NLF	0.1	5.4	10.2	20.1	11.2	3.8
	SDLF	0.4	0.5	3.2	3.5	2.9	0.1
	TDLF	0.6	6.5	18.1	29.6	18.4	4.6
30	NLF	2.1	7.6	18.9	13.2	7.9	2.3
	SDLF	0.3	0.2	0.8	3.7	1.0	0.1
	TDLF	1.6	8.5	22.7	22.4	10.9	2.7

Table U1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	2.0	16.2	14.0	10.4	5.3	1.2
	SDLF	5.1	6.9	0.1	0.2	0.1	0.3
	TDLF	12.3	5.2	15.9	12.2	6.1	1.3
32	NLF	8.6	12.4	11.8	7.8	3.1	0.4
	SDLF	4.0	3.0	2.3	1.0	0.2	0.2
	TDLF	2.4	8.4	8.8	7.1	3.6	0.8
33	NLF	3.6	8.4	8.8	4.5	0.3	1.0
	SDLF	0.7	0.7	1.1	1.1	1.7	1.1
	TDLF	5.9	8.0	7.5	7.7	4.5	1.8
34	NLF	1.5	5.3	5.4	1.5	2.0	2.1
	SDLF	0.4	2.0	2.2	0.2	2.2	1.7
	TDLF	0.9	1.3	1.1	1.1	2.2	1.5
35	NLF	1.3	1.7	0.2	2.9	4.8	3.7
	SDLF	1.6	2.8	2.0	1.2	3.8	3.1
	TDLF	1.8	4.6	4.8	1.3	2.3	2.6
36	NLF	2.1	0.9	1.8	4.6	5.7	4.2
	SDLF	2.5	2.7	0.8	2.2	4.1	3.5
	TDLF	2.9	5.4	4.8	1.3	1.9	2.7
37	NLF	3.2	1.5	2.1	5.0	5.5	4.0
	SDLF	3.3	3.0	0.1	2.8	3.7	3.3
	TDLF	3.5	5.4	3.4	0.7	0.9	2.3
38	NLF	4.2	3.3	1.8	4.6	3.9	3.3
	SDLF	3.9	3.8	0.0	2.5	2.7	2.9
	TDLF	3.5	4.9	3.1	1.1	0.7	2.5
39	NLF	4.6	5.3	0.1	2.0	1.1	2.2
	SDLF	3.6	3.7	1.1	0.7	2.1	2.8
	TDLF	2.0	1.2	2.6	1.3	4.0	3.7
40	NLF	3.1	3.7	7.3	6.8	1.2	2.4
	SDLF	2.4	1.8	2.3	1.6	3.0	2.8
	TDLF	1.4	1.5	6.2	7.3	6.2	3.5

Table U1-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
41	NLF	1.5	2.2	7.6	7.3	0.6	1.7
	SDLF	1.0	0.3	2.2	1.7	2.6	2.1
	TDLF	0.4	3.0	7.4	8.2	5.9	2.6
42	NLF	2.0	1.4	2.3	2.0	1.1	1.5
	SDLF	0.5	0.3	0.0	0.1	0.2	0.2
	TDLF	2.4	1.5	3.2	3.3	1.2	1.9

Table U1-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

CF	Detailing Method	CF Location					
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	7.1	6.7	6.3	3.6	2.3	2.4
	SDLF	1.5	3.6	4.0	2.4	1.7	1.6
	TDLF	3.5	1.4	1.8	0.9	0.9	0.6
2	NLF	15.9	20.5	18.8	11.6	1.4	1.1
	SDLF	15.3	14.5	12.9	9.2	0.6	1.1
	TDLF	13.8	8.1	6.7	6.7	0.5	1.8
3	NLF	33.9	43.3	39.5	26.3	6.4	1.1
	SDLF	33.0	37.5	32.8	22.3	5.1	0.3
	TDLF	28.2	28.5	23.3	15.8	1.1	2.9
4	NLF	46.5	59.4	53.2	36.3	9.9	2.1
	SDLF	47.9	56.4	49.8	34.0	9.9	0.5
	TDLF	40.7	46.2	39.9	25.5	3.6	3.8
5	NLF	54.5	70.0	61.9	41.8	12.1	1.9
	SDLF	59.2	71.2	62.9	43.0	14.4	2.6
	TDLF	50.4	60.3	52.8	33.7	6.3	3.9
6	NLF	60.2	76.8	67.6	45.4	12.9	2.0
	SDLF	67.4	81.6	72.8	50.1	17.9	4.7
	TDLF	56.8	70.0	62.5	40.3	8.7	3.4
7	NLF	61.2	78.4	69.1	45.1	11.7	2.0
	SDLF	70.7	86.7	78.7	54.3	20.2	6.8
	TDLF	59.3	75.3	69.5	45.7	11.5	1.9
8	NLF	57.5	75.3	68.1	44.2	12.0	0.5
	SDLF	68.7	86.4	81.6	57.9	24.0	9.7
	TDLF	57.7	76.4	74.6	52.2	17.4	1.4
9	NLF	50.6	67.3	63.0	45.4	17.8	3.0
	SDLF	62.3	80.6	80.4	63.6	33.2	14.3
	TDLF	52.5	73.0	77.3	62.1	30.0	7.5
10	NLF	40.5	58.3	61.0	54.6	33.5	10.7
	SDLF	51.6	71.5	79.3	74.4	50.4	22.1
	TDLF	43.5	66.3	79.5	76.4	50.6	17.6

Table U1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	29.5	55.2	75.6	82.5	63.1	25.4
	SDLF	38.6	63.3	86.0	95.6	76.8	34.9
	TDLF	32.1	56.9	82.9	95.4	77.5	32.5
12	NLF	18.8	55.0	98.9	129.0	118.5	51.3
	SDLF	19.2	53.6	96.6	123.0	113.8	52.4
	TDLF	9.4	43.0	86.5	111.3	104.1	47.7
13	NLF	12.9	55.6	113.8	161.9	169.6	93.2
	SDLF	6.2	50.4	104.4	137.5	137.6	71.6
	TDLF	8.0	38.4	90.6	113.4	109.1	52.2
14	NLF	10.8	57.8	126.3	187.9	214.1	125.9
	SDLF	12.5	52.0	107.4	148.5	156.7	77.1
	TDLF	4.8	38.5	87.0	113.6	109.6	38.5
15	NLF	11.5	69.4	150.4	226.4	239.4	115.0
	SDLF	24.9	63.8	117.3	166.5	160.5	76.1
	TDLF	30.4	53.5	85.5	115.3	96.2	45.2
16	NLF	16.3	88.9	189.2	249.7	216.7	72.6
	SDLF	22.0	74.9	141.2	165.1	148.3	52.5
	TDLF	22.5	58.4	97.6	93.4	93.2	36.1
17	NLF	24.8	122.0	212.1	241.2	144.9	48.5
	SDLF	26.0	97.3	140.9	157.9	100.1	36.0
	TDLF	24.1	72.9	78.5	87.9	62.7	25.2
18	NLF	41.8	146.0	228.2	171.9	102.2	33.1
	SDLF	39.7	116.9	142.9	113.6	72.8	24.3
	TDLF	36.1	91.7	67.9	63.2	47.3	16.5
19	NLF	57.9	182.1	171.4	129.3	72.7	23.9
	SDLF	29.2	145.6	124.8	96.3	56.4	18.9
	TDLF	0.8	115.1	83.9	67.3	42.0	14.6
20	NLF	100.1	143.5	136.3	97.4	52.4	17.7
	SDLF	72.8	105.2	104.0	76.7	42.9	15.0
	TDLF	46.4	69.4	74.3	57.8	34.4	12.9

Table U1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	27.7	74.5	80.8	57.5	29.9	11.2
	SDLF	18.0	55.2	61.7	44.7	23.4	8.8
	TDLF	8.3	36.0	42.8	32.3	17.5	6.8
22	NLF	2.0	25.9	37.5	28.5	15.7	7.2
	SDLF	2.9	21.1	30.1	22.3	11.6	5.3
	TDLF	4.2	15.6	22.2	16.2	8.2	3.9
23	NLF	11.9	0.8	9.8	12.2	11.2	6.5
	SDLF	10.8	0.1	8.6	8.7	7.1	4.8
	TDLF	9.8	0.6	7.2	5.8	4.2	3.6
24	NLF	14.5	12.6	3.3	6.1	12.1	7.8
	SDLF	13.7	11.5	4.1	1.6	6.3	5.7
	TDLF	12.7	10.0	4.4	1.6	1.8	4.2
25	NLF	14.0	14.3	3.8	10.0	21.0	15.8
	SDLF	14.6	16.1	9.0	0.4	8.1	8.3
	TDLF	14.8	16.8	12.8	9.2	3.2	1.2
26	NLF	9.3	8.8	3.7	23.1	41.5	36.7
	SDLF	10.7	13.1	5.9	6.1	18.7	15.2
	TDLF	11.5	16.3	13.9	9.5	3.4	5.9
27	NLF	6.5	4.1	9.9	29.8	37.1	26.1
	SDLF	7.6	8.9	0.3	12.7	16.0	11.8
	TDLF	8.4	12.7	9.7	4.6	6.8	3.2
28	NLF	4.0	2.1	20.3	32.4	42.3	14.0
	SDLF	4.5	2.6	9.6	14.7	21.4	7.2
	TDLF	4.8	6.9	1.4	5.4	1.3	0.2
29	NLF	0.8	12.0	23.6	46.5	26.4	9.3
	SDLF	0.9	6.5	10.9	23.3	12.5	5.5
	TDLF	1.1	0.9	3.5	2.5	2.8	1.1
30	NLF	4.4	17.4	43.7	30.9	18.4	5.6
	SDLF	2.7	10.4	24.6	14.4	9.8	3.6
	TDLF	0.9	2.0	3.1	4.1	0.0	0.8

Table U1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	4.9	36.5	32.6	23.8	12.1	2.9
	SDLF	2.0	27.6	19.1	13.5	7.1	2.1
	TDLF	9.0	16.0	3.5	1.8	1.0	0.6
32	NLF	17.2	27.5	27.2	18.0	6.8	0.9
	SDLF	13.5	18.8	18.1	11.3	4.1	0.7
	TDLF	8.0	8.0	7.4	3.3	0.3	0.2
33	NLF	8.4	19.7	20.9	11.0	0.3	2.1
	SDLF	4.3	12.3	13.4	5.4	1.7	2.2
	TDLF	0.6	3.9	4.9	1.3	4.5	3.0
34	NLF	3.2	11.7	11.9	1.1	7.6	5.8
	SDLF	2.2	8.7	9.1	0.2	7.5	5.2
	TDLF	1.0	5.7	6.1	0.6	7.1	4.9
35	NLF	2.4	2.4	1.4	9.7	14.5	9.6
	SDLF	2.7	3.5	0.5	8.0	13.5	9.0
	TDLF	3.0	5.4	3.3	5.5	12.0	8.5
36	NLF	4.2	0.7	7.9	14.8	16.8	10.8
	SDLF	4.6	1.1	5.3	12.6	15.3	10.2
	TDLF	5.0	3.9	1.3	9.1	13.2	9.5
37	NLF	6.8	0.6	9.6	16.6	16.6	10.7
	SDLF	6.9	2.0	7.5	14.4	14.9	10.0
	TDLF	7.1	4.4	4.1	10.9	12.1	9.1
38	NLF	9.6	5.2	8.4	15.3	12.5	8.9
	SDLF	9.3	5.7	6.6	13.2	11.3	8.6
	TDLF	8.8	6.8	3.6	9.7	9.4	8.2
39	NLF	11.0	11.1	2.0	7.5	5.2	6.5
	SDLF	9.9	9.5	1.1	6.2	6.3	7.0
	TDLF	8.3	6.9	0.4	4.3	8.1	7.9
40	NLF	7.2	7.4	18.3	17.2	5.1	6.8
	SDLF	6.5	5.5	13.3	12.0	6.9	7.2
	TDLF	5.4	2.2	4.8	3.1	10.1	7.9

Table U1-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	3.5	4.4	20.5	19.7	3.0	4.8
	SDLF	3.0	2.4	15.1	14.0	5.0	5.2
	TDLF	2.4	0.8	5.4	4.1	8.4	5.7
42	NLF	5.1	3.6	5.5	5.1	3.0	4.0
	SDLF	3.4	2.6	3.4	2.9	2.2	2.7
	TDLF	0.4	0.8	0.4	0.2	0.7	0.6

Table U1-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	5.6	4.2	3.2	2.9	1.9	1.2
	SDLF	0.6	0.2	0.1	0.4	0.2	0.2
	TDLF	6.0	4.0	2.5	1.7	1.3	0.9
2	NLF	9.3	12.4	11.5	8.4	2.8	0.1
	SDLF	12.7	12.0	6.5	5.3	0.9	1.3
	TDLF	17.1	12.7	2.8	3.7	0.5	1.2
3	NLF	18.0	23.6	21.7	15.6	5.1	0.4
	SDLF	18.9	21.7	14.9	9.9	1.4	2.8
	TDLF	23.9	23.8	12.3	8.4	1.6	1.5
4	NLF	25.6	33.4	30.4	22.1	8.1	0.1
	SDLF	23.9	30.2	22.8	14.5	2.1	4.4
	TDLF	30.6	34.7	23.1	14.4	3.3	1.6
5	NLF	30.4	39.9	36.1	26.5	10.5	0.8
	SDLF	26.9	36.0	28.4	17.8	2.2	6.2
	TDLF	36.3	43.8	32.2	20.3	5.0	1.8
6	NLF	33.4	43.7	39.3	28.3	10.9	0.8
	SDLF	28.5	39.8	32.4	20.0	2.0	7.5
	TDLF	40.4	50.8	39.8	25.7	7.3	1.1
7	NLF	33.8	44.4	40.1	28.2	10.2	0.8
	SDLF	28.5	41.4	35.2	22.0	2.3	8.0
	TDLF	42.4	55.4	46.2	31.3	10.5	0.3
8	NLF	31.5	42.2	38.6	26.4	9.3	1.0
	SDLF	26.8	41.2	37.2	24.6	4.6	7.0
	TDLF	42.2	57.8	52.1	38.5	16.4	3.0
9	NLF	28.2	38.8	37.2	28.5	13.4	3.3
	SDLF	24.6	40.2	39.5	30.7	12.0	3.3
	TDLF	40.4	58.5	57.3	47.8	25.9	7.1
10	NLF	23.0	34.8	37.9	35.8	23.3	8.1
	SDLF	20.6	37.2	41.7	40.0	24.6	3.5
	TDLF	35.5	55.1	59.9	57.4	39.0	13.2

Table U1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	16.6	31.9	43.8	48.0	37.4	15.2
	SDLF	16.0	33.2	44.4	51.2	40.7	13.1
	TDLF	29.9	48.6	58.4	66.0	54.2	21.6
12	NLF	10.9	32.0	56.8	73.9	68.0	30.1
	SDLF	14.2	31.5	48.7	62.4	58.1	23.9
	TDLF	27.9	42.4	52.6	62.7	58.1	25.3
13	NLF	8.4	34.1	67.9	95.9	100.1	52.6
	SDLF	13.8	30.9	51.2	66.4	65.4	29.3
	TDLF	27.3	37.4	45.8	50.0	43.7	14.9
14	NLF	7.8	36.5	76.5	113.7	131.3	87.0
	SDLF	5.5	28.2	52.0	68.7	67.5	36.3
	TDLF	11.9	29.2	38.7	38.5	21.7	0.8
15	NLF	7.0	40.1	85.8	126.4	150.1	74.3
	SDLF	5.2	24.3	52.4	66.0	60.5	26.6
	TDLF	9.5	17.4	29.9	21.1	8.4	9.6
16	NLF	7.9	47.3	99.9	152.1	128.8	43.5
	SDLF	1.0	29.9	54.6	62.1	51.8	21.7
	TDLF	4.2	19.6	20.5	8.3	8.9	4.8
17	NLF	11.8	62.0	130.1	142.6	84.7	28.1
	SDLF	2.0	32.5	54.6	61.0	45.8	17.5
	TDLF	3.4	9.9	6.2	4.0	15.1	9.3
18	NLF	20.1	92.2	130.9	98.3	56.8	18.9
	SDLF	1.2	20.4	63.0	52.0	34.6	12.4
	TDLF	13.8	41.7	8.4	14.3	16.4	7.0
19	NLF	36.2	98.7	93.1	68.5	38.8	12.7
	SDLF	15.2	17.3	31.5	30.0	19.6	6.2
	TDLF	0.6	55.1	23.6	4.5	2.3	0.3
20	NLF	35.4	67.8	65.6	48.2	25.9	8.4
	SDLF	0.5	16.8	21.5	18.5	10.1	2.1
	TDLF	32.5	30.7	19.7	9.4	4.7	3.6

Table U1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location					
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	11.1	35.8	39.7	28.8	15.0	5.4
	SDLF	0.1	16.7	19.7	14.1	6.7	1.7
	TDLF	10.7	2.5	0.3	0.3	1.3	1.7
22	NLF	0.7	13.9	19.9	15.7	9.1	4.1
	SDLF	2.3	10.4	13.9	9.8	5.0	2.0
	TDLF	4.4	5.8	7.2	3.8	1.4	0.3
23	NLF	5.2	0.8	6.1	7.7	7.0	3.8
	SDLF	4.7	2.7	6.3	5.3	3.4	2.1
	TDLF	4.6	3.8	6.0	3.1	0.6	0.9
24	NLF	6.8	5.9	1.7	3.2	6.4	4.0
	SDLF	6.0	3.4	0.8	0.0	1.1	1.6
	TDLF	5.3	1.0	0.3	2.3	3.1	0.1
25	NLF	7.4	8.6	4.9	1.1	6.6	4.8
	SDLF	6.9	7.3	5.9	4.6	1.8	0.8
	TDLF	6.2	5.5	6.2	9.4	9.2	2.9
26	NLF	5.5	7.0	3.4	3.0	8.8	6.5
	SDLF	5.8	8.6	8.7	7.9	6.3	1.3
	TDLF	5.8	9.2	12.9	18.3	21.7	11.3
27	NLF	3.8	4.0	0.8	8.7	18.5	10.2
	SDLF	5.2	8.7	9.5	8.5	4.0	1.1
	TDLF	6.2	12.3	18.6	25.6	28.5	9.6
28	NLF	2.0	0.0	7.1	18.5	18.5	6.2
	SDLF	5.1	8.8	10.1	7.3	0.2	1.3
	TDLF	7.7	16.4	26.5	34.4	20.7	3.9
29	NLF	0.2	5.0	16.9	19.6	11.7	3.5
	SDLF	5.3	9.4	8.6	2.1	0.3	0.7
	TDLF	9.8	22.9	35.0	26.2	12.1	2.0
30	NLF	2.1	12.7	17.6	14.3	7.5	2.1
	SDLF	4.5	10.2	5.0	2.1	1.0	0.2
	TDLF	10.8	33.1	29.8	19.9	9.8	2.2

Table U1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	6.3	13.7	14.0	9.6	4.9	1.0
	SDLF	0.5	13.0	6.0	3.8	2.3	1.1
	TDLF	7.9	40.7	27.0	17.7	9.5	2.8
32	NLF	6.6	11.1	10.8	7.2	2.8	0.3
	SDLF	9.5	8.0	5.3	3.7	3.0	1.6
	TDLF	26.3	27.9	21.7	14.6	8.6	3.1
33	NLF	3.7	8.6	9.0	5.6	0.8	0.7
	SDLF	2.9	1.7	1.1	1.1	2.2	1.5
	TDLF	9.5	12.1	11.0	7.5	4.8	1.9
34	NLF	1.3	4.7	4.6	0.3	2.9	2.6
	SDLF	0.2	1.5	1.0	2.1	3.8	2.6
	TDLF	0.3	0.9	1.9	3.6	3.8	2.0
35	NLF	1.1	1.5	0.1	3.3	5.2	4.0
	SDLF	1.4	2.6	1.7	1.6	4.2	3.4
	TDLF	2.4	5.1	5.3	1.7	2.1	2.2
36	NLF	1.8	0.5	2.2	4.9	6.1	4.4
	SDLF	2.5	2.7	0.7	2.2	4.2	3.5
	TDLF	3.9	6.3	5.7	2.2	1.2	2.1
37	NLF	2.8	1.1	2.6	5.4	5.9	4.3
	SDLF	3.5	3.1	0.1	2.8	3.7	3.3
	TDLF	4.7	6.4	4.2	1.4	0.2	1.8
38	NLF	3.8	2.8	2.2	5.0	4.3	3.5
	SDLF	4.1	4.1	0.0	2.4	2.5	2.8
	TDLF	4.7	6.1	3.7	1.8	0.2	1.9
39	NLF	4.2	5.0	0.2	2.5	1.5	2.5
	SDLF	3.9	4.2	1.4	0.8	2.0	2.8
	TDLF	3.3	2.8	3.7	1.7	3.2	3.4
40	NLF	2.8	3.4	7.0	6.9	1.3	2.5
	SDLF	2.6	1.8	2.6	2.3	2.9	2.7
	TDLF	2.2	1.3	5.2	5.9	6.1	3.2

Table U1-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	1.4	2.1	7.7	7.6	0.6	1.7
	SDLF	1.2	0.2	2.6	2.4	2.5	1.9
	TDLF	0.8	3.2	6.6	6.9	5.9	2.3
42	NLF	2.0	2.2	2.2	2.1	2.0	1.7
	SDLF	0.1	0.3	0.5	0.3	0.2	0.2
	TDLF	2.8	2.8	2.7	2.8	2.8	2.5

Table U1-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	10.2	7.6	5.9	5.3	3.9	3.0
	SDLF	4.0	3.3	2.9	3.0	2.3	2.0
	TDLF	1.3	0.4	0.4	1.0	0.9	1.0
2	NLF	16.9	21.7	19.7	12.4	1.0	2.1
	SDLF	20.2	21.2	14.8	9.7	0.3	2.8
	TDLF	24.5	21.9	11.2	8.4	0.2	2.4
3	NLF	33.3	42.3	37.9	24.5	3.6	3.6
	SDLF	33.4	39.6	30.7	18.9	0.4	5.7
	TDLF	37.8	41.1	27.9	17.4	1.0	4.0
4	NLF	47.6	60.6	53.7	36.0	8.7	3.3
	SDLF	44.4	55.7	45.0	27.7	2.5	7.6
	TDLF	50.0	59.0	44.3	27.1	3.7	4.6
5	NLF	56.7	73.0	64.7	44.6	13.2	1.8
	SDLF	51.4	66.8	55.0	34.3	4.1	9.0
	TDLF	59.3	72.7	57.1	35.6	6.3	4.8
6	NLF	63.1	80.7	71.0	48.1	14.1	1.9
	SDLF	55.9	73.9	61.5	37.8	4.2	10.5
	TDLF	65.9	82.6	66.9	42.0	8.7	4.3
7	NLF	64.2	82.4	72.7	48.2	13.0	1.9
	SDLF	56.4	76.3	65.0	39.8	4.0	11.0
	TDLF	68.3	87.8	73.9	47.4	11.3	2.9
8	NLF	59.5	77.6	69.2	43.9	11.1	1.5
	SDLF	52.8	74.1	65.5	40.5	5.5	9.6
	TDLF	66.5	88.5	78.4	53.0	16.7	0.2
9	NLF	53.2	70.9	66.3	48.1	19.3	3.3
	SDLF	47.9	70.0	66.3	48.5	16.8	3.5
	TDLF	62.2	86.4	82.3	64.0	29.9	6.6
10	NLF	43.1	62.7	66.8	62.0	38.4	12.8
	SDLF	39.6	63.3	68.4	63.9	38.3	7.8
	TDLF	53.4	79.7	84.7	79.5	51.5	17.1

Table U1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	30.1	55.6	75.3	81.6	62.8	25.5
	SDLF	29.3	56.1	74.8	83.6	65.2	23.2
	TDLF	42.9	70.8	87.7	97.4	77.9	31.4
12	NLF	19.6	56.0	99.5	129.2	118.6	52.6
	SDLF	22.8	54.6	89.8	115.8	107.1	45.8
	TDLF	36.4	64.9	92.4	114.4	105.7	46.6
13	NLF	15.8	61.3	121.9	172.1	180.1	95.9
	SDLF	20.7	56.6	102.5	139.0	141.5	70.1
	TDLF	33.8	61.9	94.9	119.6	116.6	53.6
14	NLF	15.3	66.7	138.8	206.3	240.1	166.2
	SDLF	12.2	56.6	111.2	156.7	170.3	108.4
	TDLF	18.1	56.0	95.3	122.7	119.5	65.6
15	NLF	13.5	72.5	154.6	227.4	269.9	136.3
	SDLF	0.9	55.5	119.0	164.2	177.5	86.0
	TDLF	3.7	47.6	94.7	116.9	106.5	47.5
16	NLF	14.7	84.9	178.8	271.7	232.8	79.1
	SDLF	5.7	67.0	132.7	180.8	153.0	56.4
	TDLF	2.4	56.2	97.8	109.6	90.1	38.7
17	NLF	21.8	111.7	233.7	258.5	153.4	51.4
	SDLF	12.0	82.0	157.8	174.2	112.9	40.3
	TDLF	6.6	59.2	96.6	107.1	80.8	31.6
18	NLF	37.1	167.5	238.9	179.8	103.6	35.0
	SDLF	18.4	95.5	168.9	131.7	80.4	28.1
	TDLF	3.6	33.2	112.4	92.4	61.3	22.5
19	NLF	67.3	182.4	173.0	127.1	71.6	24.0
	SDLF	46.7	100.0	110.1	87.5	51.8	17.2
	TDLF	31.2	26.8	53.9	52.2	34.0	11.3
20	NLF	68.1	129.6	124.8	90.9	48.4	16.2
	SDLF	33.5	78.5	80.3	60.8	32.4	9.9
	TDLF	2.8	31.1	38.7	32.5	17.4	4.1

Table U1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	22.9	69.8	77.0	55.2	28.3	11.0
	SDLF	12.0	50.4	56.6	40.2	19.7	7.1
	TDLF	1.4	31.1	36.3	25.4	11.6	3.6
22	NLF	0.4	27.6	39.5	30.6	17.1	8.5
	SDLF	2.0	23.9	33.2	24.3	12.8	6.2
	TDLF	4.0	19.2	26.2	18.1	9.0	4.4
23	NLF	10.0	1.8	12.8	15.2	13.5	8.3
	SDLF	9.4	3.7	13.0	12.7	9.8	6.4
	TDLF	9.2	4.8	12.6	10.4	6.9	5.1
24	NLF	14.0	11.9	2.4	7.0	13.3	9.1
	SDLF	13.0	9.1	1.3	4.0	8.1	6.7
	TDLF	12.1	6.5	0.1	1.7	4.0	4.9
25	NLF	15.5	17.4	8.7	3.5	15.0	11.9
	SDLF	14.8	15.6	9.1	1.5	7.3	8.3
	TDLF	13.9	13.5	8.8	5.7	0.5	4.9
26	NLF	11.7	13.6	4.6	9.3	21.8	15.8
	SDLF	11.8	14.9	9.2	0.7	8.0	10.0
	TDLF	11.7	15.2	13.0	10.4	6.5	1.8
27	NLF	7.9	6.9	5.3	23.5	45.6	23.0
	SDLF	9.3	11.6	4.8	6.2	22.9	15.1
	TDLF	10.3	15.0	13.8	10.8	1.7	5.4
28	NLF	4.1	1.9	19.5	45.9	43.3	14.7
	SDLF	7.3	7.0	2.1	19.4	25.2	10.1
	TDLF	9.9	14.7	14.6	8.2	4.7	5.1
29	NLF	0.0	13.0	40.7	46.6	28.0	9.0
	SDLF	5.3	1.5	15.1	25.0	16.7	6.2
	TDLF	9.9	15.2	11.5	0.8	4.4	3.6
30	NLF	5.0	30.0	42.8	34.3	18.5	5.8
	SDLF	1.7	7.2	20.2	18.0	9.9	3.5
	TDLF	8.1	15.8	4.5	0.2	1.1	1.4

Table U1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	14.6	34.6	34.9	23.8	12.3	3.2
	SDLF	7.6	7.8	15.0	10.4	5.1	1.1
	TDLF	0.0	20.0	6.1	3.5	2.2	0.7
32	NLF	19.7	29.4	27.5	17.8	6.8	1.1
	SDLF	3.0	10.1	11.4	6.9	1.1	0.8
	TDLF	14.7	10.2	5.1	3.9	4.4	2.3
33	NLF	10.0	21.7	22.0	12.5	1.3	1.6
	SDLF	3.3	11.3	12.0	6.0	1.6	2.4
	TDLF	3.5	0.8	2.1	0.1	4.1	2.7
34	NLF	3.4	11.8	12.0	1.2	7.7	5.9
	SDLF	2.3	8.4	8.3	1.5	8.8	6.0
	TDLF	1.7	5.9	5.2	3.4	9.0	5.5
35	NLF	2.2	2.1	1.8	10.2	15.1	10.1
	SDLF	2.5	3.3	0.0	8.5	14.1	9.5
	TDLF	3.5	5.9	3.7	5.2	11.9	8.3
36	NLF	3.6	1.4	8.7	15.5	17.7	11.4
	SDLF	4.3	0.7	5.8	12.9	15.8	10.6
	TDLF	5.7	4.5	0.8	8.4	12.8	9.2
37	NLF	6.0	0.4	10.5	17.4	17.6	11.4
	SDLF	6.7	1.6	8.0	14.8	15.3	10.3
	TDLF	8.0	5.0	3.7	10.5	11.8	8.8
38	NLF	8.7	4.3	9.3	16.1	13.4	9.4
	SDLF	9.1	5.5	7.1	13.5	11.6	8.7
	TDLF	9.7	7.5	3.3	9.3	8.9	7.8
39	NLF	10.2	10.4	2.8	8.4	5.9	6.9
	SDLF	9.9	9.6	1.2	6.7	6.4	7.1
	TDLF	9.2	8.1	1.1	4.2	7.6	7.7
40	NLF	6.7	7.0	18.0	17.6	5.3	7.0
	SDLF	6.5	5.4	13.6	12.9	6.9	7.2
	TDLF	6.0	2.2	5.7	4.7	10.0	7.7

Table U1-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	3.5	4.5	21.0	20.3	2.9	4.7
	SDLF	3.3	2.6	15.8	15.1	4.8	4.8
	TDLF	2.9	0.9	6.5	5.8	8.2	5.2
42	NLF	5.5	5.6	5.6	5.7	5.3	4.8
	SDLF	3.7	3.7	3.9	3.8	3.5	3.2
	TDLF	1.0	0.6	0.6	0.7	0.4	0.6

Table U1-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.42	0.41	0.40	0.39	0.39	0.39
	SDLF	0.49	0.45	0.43	0.42	0.41	0.42
	TDLF	0.53	0.47	0.46	0.44	0.43	0.45
3	NLF	0.83	0.80	0.77	0.75	0.75	0.75
	SDLF	0.95	0.88	0.84	0.81	0.80	0.80
	TDLF	1.04	0.94	0.89	0.85	0.84	0.86
4	NLF	1.18	1.14	1.10	1.07	1.06	1.07
	SDLF	1.35	1.27	1.20	1.15	1.14	1.14
	TDLF	1.48	1.36	1.27	1.21	1.19	1.22
5	NLF	1.46	1.41	1.37	1.34	1.32	1.33
	SDLF	1.68	1.58	1.49	1.44	1.41	1.42
	TDLF	1.84	1.70	1.59	1.51	1.49	1.51
6	NLF	1.66	1.61	1.56	1.53	1.52	1.52
	SDLF	1.91	1.81	1.71	1.65	1.62	1.64
	TDLF	2.11	1.96	1.82	1.73	1.71	1.74
7	NLF	1.78	1.73	1.68	1.65	1.64	1.64
	SDLF	2.06	1.95	1.85	1.77	1.75	1.77
	TDLF	2.28	2.11	1.97	1.87	1.85	1.88
8	NLF	1.82	1.77	1.72	1.69	1.68	1.68
	SDLF	2.11	2.00	1.90	1.82	1.80	1.81
	TDLF	2.33	2.18	2.03	1.92	1.90	1.92
9	NLF	1.78	1.74	1.69	1.66	1.64	1.64
	SDLF	2.07	1.97	1.88	1.79	1.75	1.75
	TDLF	2.29	2.15	2.01	1.89	1.84	1.84
10	NLF	1.67	1.63	1.59	1.56	1.52	1.51
	SDLF	1.95	1.87	1.78	1.68	1.60	1.57
	TDLF	2.16	2.05	1.92	1.78	1.67	1.63

Table U1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	1.50	1.47	1.43	1.37	1.32	1.29
	SDLF	1.75	1.69	1.60	1.48	1.35	1.28
	TDLF	1.95	1.86	1.74	1.57	1.39	1.29
12	NLF	1.29	1.27	1.22	1.14	1.04	0.96
	SDLF	1.50	1.46	1.37	1.22	1.03	0.87
	TDLF	1.67	1.61	1.49	1.28	1.02	0.81
13	NLF	1.15	1.14	1.09	0.99	0.86	0.72
	SDLF	1.34	1.31	1.22	1.04	0.82	0.59
	TDLF	1.48	1.44	1.31	1.08	0.79	0.49
14	NLF	1.06	1.05	1.00	0.89	0.73	0.55
	SDLF	1.22	1.20	1.10	0.91	0.67	0.39
	TDLF	1.35	1.33	1.18	0.93	0.62	0.27
15	NLF	0.94	0.93	0.87	0.74	0.56	0.36
	SDLF	1.07	1.06	0.94	0.73	0.46	0.17
	TDLF	1.18	1.17	0.99	0.73	0.39	0.03
16	NLF	0.83	0.81	0.74	0.58	0.35	0.25
	SDLF	0.93	0.91	0.77	0.54	0.22	0.06
	TDLF	1.02	1.00	0.80	0.51	0.12	-0.08
17	NLF	0.72	0.70	0.59	0.37	0.23	0.18
	SDLF	0.81	0.76	0.59	0.29	0.09	-0.01
	TDLF	0.88	0.82	0.59	0.23	-0.02	-0.15
18	NLF	0.61	0.56	0.38	0.24	0.15	0.11
	SDLF	0.68	0.60	0.35	0.14	0.00	-0.06
	TDLF	0.74	0.63	0.32	0.07	-0.12	-0.19
19	NLF	0.50	0.38	0.25	0.15	0.08	0.06
	SDLF	0.56	0.38	0.20	0.04	-0.06	-0.10
	TDLF	0.60	0.38	0.15	-0.04	-0.17	-0.22
20	NLF	0.35	0.25	0.16	0.08	0.04	0.03
	SDLF	0.38	0.23	0.09	-0.03	-0.10	-0.12
	TDLF	0.40	0.22	0.04	-0.11	-0.20	-0.23

Table U1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
21	NLF	0.17	0.12	0.06	0.01	-0.01	-0.02
	SDLF	0.17	0.09	-0.01	-0.09	-0.13	-0.14
	TDLF	0.17	0.06	-0.06	-0.17	-0.22	-0.23
22	NLF	0.04	0.03	0.00	-0.03	-0.04	-0.05
	SDLF	0.01	-0.01	-0.07	-0.11	-0.13	-0.14
	TDLF	0.00	-0.04	-0.11	-0.18	-0.20	-0.21
23	NLF	-0.04	-0.04	-0.05	-0.06	-0.07	-0.08
	SDLF	-0.08	-0.08	-0.10	-0.12	-0.13	-0.14
	TDLF	-0.11	-0.10	-0.13	-0.16	-0.18	-0.19
24	NLF	-0.09	-0.08	-0.08	-0.08	-0.09	-0.10
	SDLF	-0.13	-0.12	-0.11	-0.11	-0.12	-0.13
	TDLF	-0.16	-0.14	-0.13	-0.13	-0.15	-0.16
25	NLF	-0.12	-0.11	-0.10	-0.10	-0.11	-0.13
	SDLF	-0.16	-0.14	-0.12	-0.11	-0.12	-0.13
	TDLF	-0.18	-0.15	-0.13	-0.12	-0.13	-0.14
26	NLF	-0.14	-0.13	-0.12	-0.12	-0.14	-0.16
	SDLF	-0.16	-0.14	-0.13	-0.12	-0.13	-0.14
	TDLF	-0.18	-0.15	-0.12	-0.11	-0.12	-0.13
27	NLF	-0.14	-0.14	-0.13	-0.14	-0.16	-0.19
	SDLF	-0.16	-0.14	-0.13	-0.12	-0.14	-0.17
	TDLF	-0.17	-0.14	-0.12	-0.11	-0.13	-0.17
28	NLF	-0.15	-0.14	-0.14	-0.16	-0.19	-0.21
	SDLF	-0.16	-0.14	-0.13	-0.14	-0.17	-0.19
	TDLF	-0.16	-0.14	-0.12	-0.13	-0.17	-0.19
29	NLF	-0.15	-0.15	-0.16	-0.19	-0.21	-0.22
	SDLF	-0.15	-0.14	-0.15	-0.17	-0.19	-0.20
	TDLF	-0.15	-0.14	-0.13	-0.16	-0.18	-0.20
30	NLF	-0.16	-0.16	-0.19	-0.21	-0.22	-0.22
	SDLF	-0.15	-0.15	-0.17	-0.19	-0.20	-0.21
	TDLF	-0.14	-0.14	-0.16	-0.18	-0.20	-0.20

Table U1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	-0.16	-0.18	-0.20	-0.22	-0.23	-0.23
	SDLF	-0.15	-0.17	-0.19	-0.20	-0.21	-0.21
	TDLF	-0.14	-0.16	-0.18	-0.19	-0.20	-0.20
32	NLF	-0.18	-0.19	-0.21	-0.22	-0.23	-0.23
	SDLF	-0.17	-0.18	-0.19	-0.21	-0.21	-0.21
	TDLF	-0.15	-0.17	-0.19	-0.21	-0.21	-0.20
33	NLF	-0.19	-0.20	-0.22	-0.23	-0.23	-0.23
	SDLF	-0.18	-0.19	-0.20	-0.21	-0.21	-0.21
	TDLF	-0.16	-0.17	-0.20	-0.21	-0.21	-0.20
34	NLF	-0.20	-0.21	-0.22	-0.23	-0.22	-0.22
	SDLF	-0.18	-0.19	-0.20	-0.21	-0.20	-0.20
	TDLF	-0.17	-0.18	-0.20	-0.22	-0.20	-0.18
35	NLF	-0.19	-0.19	-0.20	-0.20	-0.19	-0.18
	SDLF	-0.17	-0.18	-0.18	-0.19	-0.17	-0.16
	TDLF	-0.16	-0.17	-0.19	-0.19	-0.17	-0.14
36	NLF	-0.15	-0.16	-0.16	-0.15	-0.15	-0.14
	SDLF	-0.14	-0.14	-0.15	-0.14	-0.13	-0.12
	TDLF	-0.14	-0.15	-0.16	-0.15	-0.12	-0.10
37	NLF	-0.11	-0.11	-0.11	-0.11	-0.10	-0.09
	SDLF	-0.09	-0.10	-0.11	-0.10	-0.09	-0.07
	TDLF	-0.10	-0.12	-0.12	-0.10	-0.08	-0.06
38	NLF	-0.06	-0.07	-0.07	-0.06	-0.06	-0.05
	SDLF	-0.05	-0.06	-0.07	-0.05	-0.05	-0.04
	TDLF	-0.05	-0.08	-0.09	-0.06	-0.05	-0.03
39	NLF	-0.02	-0.03	-0.04	-0.03	-0.03	-0.03
	SDLF	-0.01	-0.03	-0.04	-0.02	-0.03	-0.02
	TDLF	-0.01	-0.03	-0.05	-0.03	-0.03	-0.01
40	NLF	0.00	0.00	0.00	-0.02	-0.02	-0.01
	SDLF	0.01	0.00	0.01	-0.03	-0.02	-0.01
	TDLF	0.01	0.00	0.01	-0.05	-0.02	0.00

Table U1-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
41	NLF	0.01	0.01	0.01	-0.02	-0.01	-0.01
	SDLF	0.01	0.01	0.02	-0.02	-0.01	0.00
	TDLF	0.01	0.01	0.03	-0.04	-0.01	0.00
42	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00

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Table U1-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.75	0.72	0.70	0.68	0.68	0.69
	SDLF	0.80	0.75	0.72	0.70	0.69	0.70
	TDLF	0.83	0.76	0.74	0.71	0.70	0.72
3	NLF	1.46	1.41	1.36	1.32	1.32	1.33
	SDLF	1.55	1.47	1.40	1.35	1.34	1.36
	TDLF	1.62	1.51	1.43	1.37	1.37	1.39
4	NLF	2.08	2.01	1.94	1.89	1.88	1.89
	SDLF	2.21	2.10	2.00	1.93	1.92	1.94
	TDLF	2.31	2.16	2.05	1.96	1.95	1.98
5	NLF	2.58	2.50	2.41	2.36	2.34	2.36
	SDLF	2.75	2.62	2.50	2.42	2.39	2.42
	TDLF	2.88	2.71	2.56	2.46	2.43	2.47
6	NLF	2.95	2.86	2.77	2.71	2.69	2.71
	SDLF	3.15	3.00	2.87	2.78	2.76	2.78
	TDLF	3.31	3.11	2.94	2.83	2.81	2.85
7	NLF	3.18	3.08	2.99	2.93	2.91	2.93
	SDLF	3.40	3.25	3.11	3.01	2.99	3.01
	TDLF	3.57	3.37	3.19	3.06	3.05	3.09
8	NLF	3.25	3.16	3.07	3.01	3.00	3.02
	SDLF	3.49	3.34	3.20	3.10	3.08	3.10
	TDLF	3.67	3.48	3.30	3.16	3.14	3.17
9	NLF	3.19	3.11	3.03	2.97	2.95	2.96
	SDLF	3.44	3.30	3.17	3.07	3.02	3.02
	TDLF	3.62	3.45	3.28	3.14	3.08	3.09
10	NLF	3.01	2.94	2.87	2.81	2.75	2.74
	SDLF	3.25	3.14	3.02	2.90	2.80	2.77
	TDLF	3.43	3.29	3.13	2.98	2.84	2.81

Table U1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	2.72	2.67	2.60	2.50	2.40	2.35
	SDLF	2.94	2.85	2.74	2.58	2.41	2.32
	TDLF	3.11	3.00	2.85	2.65	2.43	2.31
12	NLF	2.35	2.32	2.24	2.10	1.92	1.78
	SDLF	2.54	2.48	2.37	2.15	1.89	1.68
	TDLF	2.69	2.62	2.47	2.20	1.87	1.60
13	NLF	2.12	2.10	2.01	1.83	1.60	1.36
	SDLF	2.28	2.24	2.12	1.87	1.55	1.22
	TDLF	2.41	2.36	2.20	1.90	1.51	1.11
14	NLF	1.96	1.94	1.84	1.65	1.38	1.06
	SDLF	2.10	2.08	1.93	1.66	1.30	0.89
	TDLF	2.21	2.19	2.00	1.67	1.25	0.76
15	NLF	1.74	1.73	1.62	1.40	1.07	0.71
	SDLF	1.86	1.84	1.67	1.37	0.96	0.52
	TDLF	1.95	1.94	1.72	1.36	0.89	0.37
16	NLF	1.54	1.52	1.38	1.11	0.69	0.51
	SDLF	1.64	1.61	1.41	1.06	0.56	0.32
	TDLF	1.71	1.68	1.42	1.02	0.46	0.17
17	NLF	1.35	1.31	1.11	0.72	0.46	0.37
	SDLF	1.43	1.37	1.10	0.64	0.32	0.18
	TDLF	1.49	1.42	1.10	0.58	0.21	0.04
18	NLF	1.16	1.07	0.74	0.48	0.31	0.25
	SDLF	1.22	1.10	0.70	0.38	0.16	0.08
	TDLF	1.28	1.12	0.67	0.31	0.04	-0.06
19	NLF	0.96	0.74	0.50	0.31	0.19	0.15
	SDLF	1.01	0.73	0.44	0.20	0.04	0.00
	TDLF	1.05	0.73	0.40	0.12	-0.07	-0.13
20	NLF	0.69	0.50	0.32	0.18	0.10	0.08
	SDLF	0.71	0.48	0.25	0.07	-0.04	-0.07
	TDLF	0.73	0.46	0.20	-0.02	-0.14	-0.18

Table U1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	0.35	0.25	0.14	0.04	0.00	-0.01
	SDLF	0.34	0.22	0.07	-0.06	-0.11	-0.13
	TDLF	0.34	0.19	0.01	-0.14	-0.20	-0.22
22	NLF	0.09	0.06	0.00	-0.05	-0.08	-0.09
	SDLF	0.06	0.02	-0.06	-0.13	-0.16	-0.17
	TDLF	0.05	0.00	-0.10	-0.20	-0.23	-0.24
23	NLF	-0.08	-0.08	-0.09	-0.11	-0.13	-0.15
	SDLF	-0.12	-0.11	-0.14	-0.17	-0.19	-0.21
	TDLF	-0.14	-0.14	-0.17	-0.21	-0.24	-0.26
24	NLF	-0.19	-0.17	-0.16	-0.17	-0.19	-0.21
	SDLF	-0.23	-0.20	-0.20	-0.20	-0.22	-0.24
	TDLF	-0.26	-0.22	-0.21	-0.22	-0.24	-0.27
25	NLF	-0.26	-0.24	-0.22	-0.22	-0.25	-0.28
	SDLF	-0.30	-0.26	-0.24	-0.23	-0.25	-0.28
	TDLF	-0.32	-0.27	-0.24	-0.23	-0.26	-0.28
26	NLF	-0.30	-0.28	-0.27	-0.27	-0.31	-0.36
	SDLF	-0.33	-0.29	-0.27	-0.27	-0.30	-0.34
	TDLF	-0.34	-0.30	-0.27	-0.26	-0.29	-0.33
27	NLF	-0.32	-0.30	-0.30	-0.31	-0.37	-0.43
	SDLF	-0.34	-0.31	-0.29	-0.30	-0.35	-0.42
	TDLF	-0.34	-0.31	-0.28	-0.28	-0.33	-0.41
28	NLF	-0.33	-0.32	-0.33	-0.36	-0.44	-0.48
	SDLF	-0.34	-0.32	-0.32	-0.34	-0.42	-0.46
	TDLF	-0.34	-0.31	-0.30	-0.33	-0.41	-0.45
29	NLF	-0.35	-0.34	-0.36	-0.44	-0.49	-0.50
	SDLF	-0.35	-0.33	-0.35	-0.42	-0.47	-0.48
	TDLF	-0.34	-0.32	-0.34	-0.41	-0.46	-0.48
30	NLF	-0.36	-0.37	-0.43	-0.48	-0.51	-0.52
	SDLF	-0.35	-0.36	-0.42	-0.46	-0.49	-0.50
	TDLF	-0.35	-0.35	-0.41	-0.45	-0.49	-0.50

Table U1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	-0.38	-0.42	-0.47	-0.51	-0.53	-0.53
	SDLF	-0.37	-0.41	-0.45	-0.49	-0.51	-0.51
	TDLF	-0.36	-0.40	-0.44	-0.48	-0.51	-0.51
32	NLF	-0.42	-0.46	-0.50	-0.53	-0.54	-0.54
	SDLF	-0.41	-0.44	-0.48	-0.51	-0.52	-0.52
	TDLF	-0.39	-0.43	-0.47	-0.51	-0.52	-0.51
33	NLF	-0.46	-0.48	-0.51	-0.54	-0.54	-0.54
	SDLF	-0.44	-0.46	-0.50	-0.53	-0.53	-0.52
	TDLF	-0.42	-0.45	-0.49	-0.53	-0.52	-0.51
34	NLF	-0.49	-0.50	-0.52	-0.54	-0.53	-0.52
	SDLF	-0.46	-0.48	-0.51	-0.53	-0.51	-0.49
	TDLF	-0.45	-0.47	-0.50	-0.53	-0.51	-0.48
35	NLF	-0.47	-0.47	-0.48	-0.48	-0.46	-0.44
	SDLF	-0.45	-0.45	-0.47	-0.47	-0.44	-0.42
	TDLF	-0.44	-0.45	-0.47	-0.48	-0.44	-0.40
36	NLF	-0.39	-0.39	-0.39	-0.37	-0.35	-0.33
	SDLF	-0.37	-0.38	-0.38	-0.37	-0.34	-0.31
	TDLF	-0.37	-0.39	-0.39	-0.37	-0.33	-0.29
37	NLF	-0.28	-0.28	-0.28	-0.26	-0.24	-0.22
	SDLF	-0.26	-0.28	-0.28	-0.25	-0.22	-0.20
	TDLF	-0.27	-0.29	-0.29	-0.26	-0.22	-0.18
38	NLF	-0.16	-0.18	-0.18	-0.15	-0.14	-0.12
	SDLF	-0.15	-0.17	-0.18	-0.14	-0.13	-0.11
	TDLF	-0.16	-0.19	-0.20	-0.15	-0.13	-0.09
39	NLF	-0.07	-0.08	-0.10	-0.07	-0.07	-0.06
	SDLF	-0.05	-0.08	-0.10	-0.07	-0.07	-0.05
	TDLF	-0.06	-0.08	-0.12	-0.07	-0.07	-0.04
40	NLF	0.00	0.00	0.00	-0.06	-0.05	-0.03
	SDLF	0.01	0.00	0.01	-0.07	-0.05	-0.02
	TDLF	0.01	0.00	0.01	-0.09	-0.05	-0.02

Table U1-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	0.02	0.02	0.03	-0.04	-0.03	-0.01
	SDLF	0.03	0.02	0.04	-0.05	-0.03	-0.01
	TDLF	0.02	0.02	0.05	-0.07	-0.03	0.00
42	NLF	0.00	0.00	-0.01	0.01	0.00	0.00
	SDLF	0.00	0.00	0.00	0.01	0.00	0.00
	TDLF	0.00	0.00	0.00	0.01	0.00	0.00

Table U1-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.45	0.44	0.42	0.41	0.41	0.41
	SDLF	0.51	0.47	0.46	0.44	0.44	0.44
	TDLF	0.56	0.50	0.49	0.46	0.46	0.47
3	NLF	0.88	0.85	0.82	0.80	0.79	0.79
	SDLF	1.00	0.94	0.89	0.85	0.84	0.85
	TDLF	1.10	1.00	0.94	0.89	0.89	0.91
4	NLF	1.25	1.21	1.16	1.14	1.13	1.13
	SDLF	1.43	1.34	1.27	1.22	1.20	1.21
	TDLF	1.57	1.44	1.35	1.28	1.26	1.29
5	NLF	1.54	1.49	1.45	1.41	1.40	1.40
	SDLF	1.77	1.67	1.58	1.52	1.50	1.51
	TDLF	1.95	1.80	1.68	1.60	1.57	1.60
6	NLF	1.76	1.71	1.65	1.62	1.60	1.61
	SDLF	2.03	1.91	1.81	1.74	1.72	1.73
	TDLF	2.23	2.07	1.93	1.83	1.81	1.84
7	NLF	1.89	1.83	1.78	1.74	1.73	1.74
	SDLF	2.18	2.06	1.95	1.88	1.86	1.87
	TDLF	2.41	2.24	2.09	1.98	1.96	1.99
8	NLF	1.93	1.87	1.82	1.78	1.78	1.78
	SDLF	2.23	2.12	2.01	1.93	1.90	1.91
	TDLF	2.47	2.30	2.15	2.03	2.01	2.03
9	NLF	1.88	1.84	1.79	1.75	1.74	1.74
	SDLF	2.19	2.09	1.98	1.89	1.85	1.85
	TDLF	2.43	2.28	2.13	2.00	1.94	1.95
10	NLF	1.77	1.73	1.68	1.65	1.61	1.60
	SDLF	2.06	1.97	1.88	1.78	1.69	1.66
	TDLF	2.29	2.17	2.03	1.89	1.76	1.73

Table U1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	1.59	1.56	1.51	1.45	1.39	1.36
	SDLF	1.85	1.79	1.70	1.57	1.43	1.36
	TDLF	2.06	1.97	1.84	1.66	1.47	1.37
12	NLF	1.36	1.34	1.29	1.21	1.10	1.01
	SDLF	1.59	1.54	1.45	1.29	1.09	0.92
	TDLF	1.76	1.70	1.58	1.35	1.08	0.86
13	NLF	1.22	1.21	1.15	1.05	0.91	0.76
	SDLF	1.41	1.38	1.29	1.10	0.86	0.62
	TDLF	1.57	1.52	1.39	1.14	0.83	0.52
14	NLF	1.12	1.11	1.06	0.94	0.78	0.59
	SDLF	1.29	1.27	1.16	0.96	0.71	0.41
	TDLF	1.43	1.40	1.25	0.99	0.66	0.28
15	NLF	1.00	0.98	0.92	0.79	0.59	0.38
	SDLF	1.13	1.12	0.99	0.78	0.49	0.18
	TDLF	1.24	1.23	1.05	0.77	0.41	0.03
16	NLF	0.87	0.86	0.78	0.62	0.37	0.27
	SDLF	0.99	0.97	0.81	0.57	0.24	0.07
	TDLF	1.08	1.05	0.84	0.54	0.13	-0.09
17	NLF	0.76	0.74	0.62	0.39	0.24	0.19
	SDLF	0.85	0.81	0.62	0.31	0.09	-0.01
	TDLF	0.93	0.87	0.62	0.25	-0.03	-0.16
18	NLF	0.65	0.59	0.40	0.25	0.15	0.12
	SDLF	0.72	0.63	0.37	0.15	0.00	-0.06
	TDLF	0.79	0.67	0.34	0.08	-0.13	-0.21
19	NLF	0.53	0.40	0.27	0.16	0.09	0.07
	SDLF	0.59	0.40	0.21	0.05	-0.06	-0.10
	TDLF	0.64	0.40	0.16	-0.04	-0.18	-0.23
20	NLF	0.37	0.27	0.17	0.09	0.04	0.03
	SDLF	0.40	0.25	0.10	-0.03	-0.10	-0.13
	TDLF	0.42	0.23	0.04	-0.12	-0.22	-0.24

Table U1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	0.18	0.13	0.07	0.01	-0.01	-0.02
	SDLF	0.18	0.09	-0.01	-0.09	-0.13	-0.14
	TDLF	0.18	0.07	-0.06	-0.18	-0.23	-0.24
22	NLF	0.04	0.03	0.00	-0.03	-0.05	-0.05
	SDLF	0.01	-0.02	-0.07	-0.12	-0.14	-0.15
	TDLF	0.00	-0.04	-0.12	-0.19	-0.22	-0.22
23	NLF	-0.05	-0.04	-0.05	-0.06	-0.07	-0.08
	SDLF	-0.09	-0.08	-0.10	-0.12	-0.14	-0.15
	TDLF	-0.11	-0.11	-0.14	-0.17	-0.19	-0.20
24	NLF	-0.10	-0.09	-0.09	-0.09	-0.10	-0.11
	SDLF	-0.14	-0.12	-0.12	-0.12	-0.13	-0.14
	TDLF	-0.17	-0.14	-0.14	-0.14	-0.16	-0.17
25	NLF	-0.13	-0.12	-0.11	-0.11	-0.12	-0.13
	SDLF	-0.17	-0.14	-0.13	-0.12	-0.13	-0.14
	TDLF	-0.19	-0.16	-0.14	-0.12	-0.13	-0.15
26	NLF	-0.15	-0.14	-0.13	-0.13	-0.15	-0.17
	SDLF	-0.17	-0.15	-0.13	-0.12	-0.13	-0.15
	TDLF	-0.19	-0.16	-0.13	-0.12	-0.13	-0.14
27	NLF	-0.15	-0.14	-0.14	-0.15	-0.17	-0.20
	SDLF	-0.17	-0.15	-0.14	-0.13	-0.15	-0.18
	TDLF	-0.18	-0.15	-0.13	-0.12	-0.14	-0.18
28	NLF	-0.16	-0.15	-0.15	-0.17	-0.20	-0.22
	SDLF	-0.17	-0.15	-0.14	-0.15	-0.18	-0.20
	TDLF	-0.17	-0.15	-0.13	-0.13	-0.18	-0.20
29	NLF	-0.16	-0.16	-0.17	-0.20	-0.22	-0.23
	SDLF	-0.16	-0.15	-0.15	-0.18	-0.20	-0.21
	TDLF	-0.16	-0.14	-0.14	-0.17	-0.19	-0.21
30	NLF	-0.16	-0.17	-0.20	-0.22	-0.23	-0.24
	SDLF	-0.16	-0.16	-0.18	-0.20	-0.21	-0.22
	TDLF	-0.15	-0.15	-0.17	-0.19	-0.21	-0.21

Table U1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location					
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	-0.17	-0.19	-0.21	-0.23	-0.24	-0.24
	SDLF	-0.16	-0.18	-0.20	-0.21	-0.22	-0.22
	TDLF	-0.15	-0.17	-0.19	-0.21	-0.22	-0.22
32	NLF	-0.19	-0.21	-0.22	-0.24	-0.24	-0.24
	SDLF	-0.18	-0.19	-0.21	-0.22	-0.22	-0.22
	TDLF	-0.16	-0.18	-0.20	-0.22	-0.22	-0.22
33	NLF	-0.20	-0.21	-0.23	-0.24	-0.24	-0.24
	SDLF	-0.19	-0.20	-0.21	-0.23	-0.22	-0.22
	TDLF	-0.17	-0.18	-0.21	-0.23	-0.22	-0.21
34	NLF	-0.21	-0.22	-0.23	-0.24	-0.23	-0.23
	SDLF	-0.19	-0.20	-0.21	-0.23	-0.22	-0.21
	TDLF	-0.17	-0.19	-0.21	-0.23	-0.21	-0.19
35	NLF	-0.20	-0.20	-0.21	-0.21	-0.20	-0.19
	SDLF	-0.18	-0.19	-0.20	-0.20	-0.18	-0.17
	TDLF	-0.17	-0.18	-0.20	-0.21	-0.18	-0.15
36	NLF	-0.16	-0.17	-0.17	-0.16	-0.15	-0.15
	SDLF	-0.14	-0.15	-0.16	-0.15	-0.14	-0.12
	TDLF	-0.15	-0.16	-0.17	-0.16	-0.13	-0.10
37	NLF	-0.11	-0.12	-0.12	-0.11	-0.10	-0.10
	SDLF	-0.10	-0.11	-0.11	-0.10	-0.09	-0.08
	TDLF	-0.11	-0.12	-0.13	-0.11	-0.08	-0.06
38	NLF	-0.07	-0.07	-0.08	-0.07	-0.06	-0.06
	SDLF	-0.05	-0.07	-0.08	-0.06	-0.05	-0.04
	TDLF	-0.06	-0.08	-0.10	-0.06	-0.05	-0.03
39	NLF	-0.02	-0.03	-0.04	-0.03	-0.03	-0.03
	SDLF	-0.01	-0.03	-0.04	-0.02	-0.03	-0.02
	TDLF	-0.01	-0.03	-0.06	-0.03	-0.03	-0.01
40	NLF	0.00	0.00	0.00	-0.03	-0.02	-0.01
	SDLF	0.01	0.00	0.01	-0.03	-0.02	-0.01
	TDLF	0.01	0.00	0.01	-0.05	-0.02	0.00

Table U1-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	0.01	0.01	0.01	-0.02	-0.01	-0.01
	SDLF	0.01	0.01	0.02	-0.02	-0.01	0.00
	TDLF	0.01	0.01	0.03	-0.05	-0.02	0.00
42	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00

Table U1-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.79	0.77	0.74	0.72	0.72	0.73
	SDLF	0.84	0.79	0.76	0.74	0.73	0.74
	TDLF	0.88	0.80	0.78	0.75	0.74	0.76
3	NLF	1.54	1.49	1.44	1.40	1.39	1.41
	SDLF	1.64	1.55	1.48	1.43	1.42	1.44
	TDLF	1.71	1.59	1.52	1.45	1.44	1.47
4	NLF	2.20	2.12	2.05	2.00	1.99	2.00
	SDLF	2.34	2.22	2.12	2.04	2.03	2.05
	TDLF	2.45	2.29	2.16	2.07	2.06	2.09
5	NLF	2.73	2.64	2.55	2.49	2.48	2.49
	SDLF	2.91	2.77	2.64	2.56	2.53	2.55
	TDLF	3.05	2.86	2.70	2.60	2.58	2.61
6	NLF	3.12	3.02	2.93	2.86	2.85	2.87
	SDLF	3.33	3.18	3.03	2.94	2.91	2.94
	TDLF	3.50	3.29	3.11	2.99	2.97	3.01
7	NLF	3.36	3.26	3.16	3.09	3.08	3.10
	SDLF	3.59	3.43	3.29	3.18	3.16	3.19
	TDLF	3.78	3.57	3.38	3.24	3.22	3.27
8	NLF	3.44	3.34	3.25	3.18	3.18	3.19
	SDLF	3.69	3.54	3.39	3.28	3.26	3.28
	TDLF	3.88	3.68	3.49	3.34	3.32	3.36
9	NLF	3.38	3.29	3.21	3.14	3.12	3.13
	SDLF	3.63	3.50	3.36	3.24	3.19	3.20
	TDLF	3.83	3.65	3.47	3.32	3.25	3.27
10	NLF	3.18	3.11	3.04	2.97	2.91	2.90
	SDLF	3.44	3.32	3.19	3.07	2.96	2.93
	TDLF	3.63	3.48	3.31	3.15	3.00	2.97

Table U1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	2.87	2.82	2.75	2.64	2.54	2.49
	SDLF	3.11	3.02	2.90	2.73	2.55	2.46
	TDLF	3.29	3.18	3.02	2.80	2.57	2.45
12	NLF	2.48	2.45	2.37	2.22	2.03	1.88
	SDLF	2.68	2.63	2.50	2.28	2.00	1.77
	TDLF	2.84	2.77	2.61	2.33	1.98	1.70
13	NLF	2.24	2.22	2.12	1.94	1.69	1.44
	SDLF	2.41	2.37	2.24	1.98	1.63	1.29
	TDLF	2.55	2.50	2.33	2.01	1.59	1.17
14	NLF	2.07	2.05	1.95	1.74	1.46	1.12
	SDLF	2.22	2.20	2.04	1.76	1.38	0.94
	TDLF	2.34	2.31	2.12	1.77	1.32	0.81
15	NLF	1.84	1.83	1.71	1.48	1.13	0.75
	SDLF	1.97	1.95	1.77	1.45	1.02	0.55
	TDLF	2.07	2.05	1.82	1.44	0.94	0.39
16	NLF	1.63	1.61	1.46	1.17	0.73	0.54
	SDLF	1.73	1.70	1.49	1.12	0.59	0.33
	TDLF	1.81	1.78	1.51	1.08	0.48	0.18
17	NLF	1.43	1.38	1.17	0.76	0.49	0.39
	SDLF	1.51	1.45	1.17	0.68	0.33	0.19
	TDLF	1.58	1.50	1.16	0.61	0.22	0.04
18	NLF	1.23	1.13	0.78	0.50	0.32	0.26
	SDLF	1.30	1.16	0.74	0.40	0.17	0.08
	TDLF	1.35	1.19	0.71	0.32	0.05	-0.06
19	NLF	1.01	0.78	0.53	0.33	0.20	0.16
	SDLF	1.06	0.77	0.46	0.21	0.05	-0.01
	TDLF	1.11	0.77	0.42	0.12	-0.07	-0.13
20	NLF	0.73	0.53	0.34	0.19	0.10	0.08
	SDLF	0.75	0.51	0.27	0.07	-0.04	-0.07
	TDLF	0.77	0.49	0.21	-0.02	-0.15	-0.19

Table U1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	0.37	0.27	0.15	0.05	0.00	-0.01
	SDLF	0.36	0.23	0.07	-0.06	-0.12	-0.14
	TDLF	0.36	0.20	0.01	-0.14	-0.21	-0.23
22	NLF	0.09	0.06	0.00	-0.06	-0.08	-0.09
	SDLF	0.07	0.02	-0.06	-0.14	-0.17	-0.18
	TDLF	0.05	0.00	-0.11	-0.21	-0.24	-0.26
23	NLF	-0.09	-0.08	-0.10	-0.12	-0.14	-0.16
	SDLF	-0.13	-0.12	-0.15	-0.18	-0.21	-0.22
	TDLF	-0.15	-0.14	-0.18	-0.22	-0.25	-0.27
24	NLF	-0.21	-0.18	-0.17	-0.18	-0.20	-0.22
	SDLF	-0.24	-0.21	-0.21	-0.21	-0.23	-0.25
	TDLF	-0.27	-0.23	-0.23	-0.23	-0.26	-0.28
25	NLF	-0.28	-0.25	-0.23	-0.23	-0.26	-0.29
	SDLF	-0.31	-0.27	-0.25	-0.24	-0.27	-0.30
	TDLF	-0.34	-0.28	-0.26	-0.25	-0.27	-0.30
26	NLF	-0.32	-0.30	-0.28	-0.29	-0.33	-0.38
	SDLF	-0.34	-0.31	-0.29	-0.28	-0.31	-0.36
	TDLF	-0.36	-0.31	-0.28	-0.27	-0.31	-0.35
27	NLF	-0.34	-0.32	-0.31	-0.33	-0.39	-0.46
	SDLF	-0.35	-0.33	-0.31	-0.31	-0.37	-0.44
	TDLF	-0.36	-0.32	-0.30	-0.30	-0.35	-0.44
28	NLF	-0.35	-0.34	-0.34	-0.38	-0.47	-0.50
	SDLF	-0.36	-0.34	-0.33	-0.36	-0.45	-0.48
	TDLF	-0.36	-0.33	-0.32	-0.35	-0.44	-0.48
29	NLF	-0.37	-0.36	-0.39	-0.46	-0.51	-0.53
	SDLF	-0.37	-0.35	-0.37	-0.44	-0.49	-0.51
	TDLF	-0.36	-0.34	-0.36	-0.43	-0.48	-0.51
30	NLF	-0.38	-0.39	-0.46	-0.51	-0.54	-0.55
	SDLF	-0.38	-0.38	-0.44	-0.49	-0.52	-0.53
	TDLF	-0.37	-0.37	-0.43	-0.48	-0.51	-0.53

Table U1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
31	NLF	-0.40	-0.45	-0.50	-0.54	-0.56	-0.56
	SDLF	-0.39	-0.43	-0.48	-0.52	-0.54	-0.54
	TDLF	-0.38	-0.42	-0.47	-0.51	-0.54	-0.54
32	NLF	-0.45	-0.48	-0.52	-0.56	-0.57	-0.57
	SDLF	-0.43	-0.47	-0.51	-0.54	-0.55	-0.55
	TDLF	-0.41	-0.45	-0.50	-0.54	-0.55	-0.54
33	NLF	-0.48	-0.51	-0.54	-0.57	-0.58	-0.57
	SDLF	-0.46	-0.49	-0.53	-0.56	-0.56	-0.55
	TDLF	-0.45	-0.48	-0.52	-0.56	-0.55	-0.54
34	NLF	-0.51	-0.53	-0.55	-0.57	-0.56	-0.55
	SDLF	-0.49	-0.51	-0.54	-0.56	-0.54	-0.52
	TDLF	-0.47	-0.50	-0.53	-0.57	-0.54	-0.51
35	NLF	-0.50	-0.50	-0.51	-0.51	-0.48	-0.46
	SDLF	-0.47	-0.48	-0.49	-0.49	-0.47	-0.44
	TDLF	-0.46	-0.48	-0.50	-0.50	-0.46	-0.42
36	NLF	-0.41	-0.41	-0.41	-0.40	-0.37	-0.35
	SDLF	-0.39	-0.40	-0.40	-0.39	-0.36	-0.33
	TDLF	-0.39	-0.41	-0.41	-0.39	-0.35	-0.30
37	NLF	-0.29	-0.30	-0.30	-0.27	-0.25	-0.23
	SDLF	-0.28	-0.29	-0.29	-0.27	-0.24	-0.21
	TDLF	-0.28	-0.31	-0.31	-0.27	-0.23	-0.19
38	NLF	-0.17	-0.19	-0.19	-0.16	-0.15	-0.13
	SDLF	-0.16	-0.18	-0.19	-0.15	-0.14	-0.11
	TDLF	-0.16	-0.20	-0.21	-0.15	-0.13	-0.10
39	NLF	-0.07	-0.09	-0.11	-0.07	-0.08	-0.06
	SDLF	-0.06	-0.08	-0.11	-0.07	-0.07	-0.05
	TDLF	-0.06	-0.09	-0.12	-0.08	-0.08	-0.04
40	NLF	0.00	0.00	0.00	-0.07	-0.05	-0.03
	SDLF	0.01	0.00	0.01	-0.08	-0.05	-0.02
	TDLF	0.01	0.00	0.01	-0.10	-0.06	-0.02

Table U1-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
41	NLF	0.02	0.02	0.03	-0.05	-0.03	-0.01
	SDLF	0.03	0.03	0.04	-0.06	-0.03	-0.01
	TDLF	0.02	0.03	0.05	-0.08	-0.04	0.00
42	NLF	0.00	0.00	-0.01	0.01	0.00	0.00
	SDLF	0.00	0.00	-0.01	0.01	0.00	0.00
	TDLF	0.00	0.00	0.00	0.01	0.00	0.00

Table U1-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	272.9	-23.3	59.7	68.3	485.8	-104.6	104.1	176.0
	SDLF	288.5	161.3	105.9	68.0	497.9	82.7	151.2	175.3
	TDLF	300.3	325.9	151.6	67.4	506.8	249.2	198.0	174.2
G2	NLF	236.2	549.7	170.9	61.2	430.2	973.4	375.4	159.1
	SDLF	274.1	578.2	151.7	60.8	464.6	997.3	356.7	159.5
	TDLF	309.4	595.7	134.2	63.5	496.9	1011.4	339.5	163.1
G3	NLF	207.4	672.5	206.8	58.8	383.3	1206.1	459.5	151.5
	SDLF	188.7	599.1	187.7	56.6	365.4	1125.4	443.6	148.2
	TDLF	169.0	523.5	171.5	52.3	346.5	1044.0	429.8	142.9
G4	NLF	178.6	699.8	238.6	101.4	335.6	1260.4	531.6	250.5
	SDLF	182.2	567.1	224.9	95.2	340.7	1121.6	518.8	244.4
	TDLF	184.6	455.0	208.7	84.7	344.2	1004.5	503.1	234.1
G5	NLF	104.2	679.9	208.6	52.7	203.8	1229.6	472.8	136.8
	SDLF	106.8	502.1	181.5	50.4	208.7	1045.5	446.0	134.6
	TDLF	110.5	363.4	150.2	48.5	214.0	901.6	414.9	132.8
G6	NLF	84.7	621.5	195.9	53.4	171.6	1124.0	447.4	140.3
	SDLF	86.1	468.3	187.4	53.8	176.0	966.9	439.6	140.6
	TDLF	87.7	353.6	174.7	55.9	180.0	848.7	427.4	142.6
G7	NLF	60.9	-348.8	98.9	52.8	135.3	-601.5	225.3	138.0
	SDLF	66.4	-173.6	252.2	52.7	140.9	-406.8	377.8	137.9
	TDLF	70.7	-39.8	398.3	53.5	145.1	-256.2	523.0	138.8

Table U1-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	-1.3	NA	NA	NA	-1.4	NA	NA	NA
	SDLF	-2.3	NA	NA	NA	-2.2	NA	NA	NA
	TDLF	-4.2	NA	NA	NA	-4.6	NA	NA	NA
G2	NLF	-0.7	NA	NA	NA	-0.6	NA	NA	NA
	SDLF	-1.8	NA	NA	NA	-1.7	NA	NA	NA
	TDLF	-3.3	NA	NA	NA	-3.5	NA	NA	NA
G3	NLF	-0.2	NA	NA	NA	0.0	NA	NA	NA
	SDLF	0.2	NA	NA	NA	0.4	NA	NA	NA
	TDLF	0.6	NA	NA	NA	0.6	NA	NA	NA
G4	NLF	0.2	NA	NA	NA	0.4	NA	NA	NA
	SDLF	0.6	NA	NA	NA	0.7	NA	NA	NA
	TDLF	1.1	NA	NA	NA	1.2	NA	NA	NA
G5	NLF	0.5	NA	NA	NA	0.6	NA	NA	NA
	SDLF	0.9	NA	NA	NA	1.0	NA	NA	NA
	TDLF	1.7	NA	NA	NA	1.8	NA	NA	NA
G6	NLF	0.8	NA	NA	NA	0.6	NA	NA	NA
	SDLF	1.2	NA	NA	NA	1.1	NA	NA	NA
	TDLF	2.2	NA	NA	NA	2.4	NA	NA	NA
G7	NLF	0.9	NA	NA	NA	0.4	NA	NA	NA
	SDLF	1.2	NA	NA	NA	0.9	NA	NA	NA
	TDLF	2.2	NA	NA	NA	2.3	NA	NA	NA

Table U1-4-13. Individual support transverse reactions under SDL and TDL (kips).

		Load Type & Support Number							
Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.1	0.4	-3.2	0.0	-0.7	0.6	-4.8	0.0
	SDLF	0.0	0.3	-5.1	-0.1	-0.3	0.5	-6.7	-0.1
	TDLF	0.3	0.4	-7.0	-0.2	0.0	0.5	-8.5	-0.2
G2	NLF	-0.2	0.7	-2.7	0.0	-0.7	0.9	-4.0	0.0
	SDLF	0.0	1.2	-4.4	-0.1	-0.4	1.4	-5.6	-0.1
	TDLF	0.3	1.7	-6.0	-0.2	0.0	2.0	-7.3	-0.2
G3	NLF	-0.2	1.1	-2.2	0.0	-0.7	1.6	-3.1	0.0
	SDLF	0.0	2.3	-3.6	-0.1	-0.4	2.9	-4.6	-0.1
	TDLF	0.3	3.5	-5.1	-0.2	0.0	4.0	-6.0	-0.2
G4	NLF	-0.2	1.7	-1.7	0.0	-0.8	2.6	-2.3	0.0
	SDLF	0.0	3.3	-3.0	-0.1	-0.4	4.2	-3.6	-0.1
	TDLF	0.3	4.8	-4.2	-0.1	0.0	5.6	-4.9	-0.2
G5	NLF	-0.2	2.3	-1.2	-0.1	-0.8	3.7	-1.4	0.0
	SDLF	0.0	4.2	-2.4	-0.1	-0.4	5.5	-2.8	-0.1
	TDLF	0.3	5.8	-3.6	-0.1	0.0	7.0	-4.0	-0.2
G6	NLF	-0.2	3.0	-0.7	-0.1	-0.8	5.1	-0.6	-0.1
	SDLF	0.0	4.9	-2.0	-0.1	-0.4	6.7	-2.0	-0.1
	TDLF	0.3	6.4	-3.2	-0.1	0.0	8.1	-3.3	-0.2
G7	NLF	-0.2	3.6	-0.3	-0.1	-0.8	6.5	0.0	-0.2
	SDLF	0.0	5.3	-1.7	-0.1	-0.4	7.7	-1.5	-0.2
	TDLF	0.3	6.7	-3.0	-0.2	-0.1	8.8	-2.9	-0.3

Table U1-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	0.00	0.54	0.27	0.67	0.00	0.55	-0.01	0.84
	SDLF	0.00	0.76	0.50	0.95	0.00	0.97	0.42	1.31
	TDLF	0.00	0.94	0.70	1.18	0.00	1.30	0.77	1.67
G2	NLF	0.00	0.44	0.16	0.56	0.00	0.39	-0.19	0.67
	SDLF	0.00	0.57	0.31	0.76	0.00	0.73	0.17	1.06
	TDLF	0.00	0.67	0.43	0.91	0.00	0.98	0.44	1.35
G3	NLF	0.00	0.33	0.05	0.45	0.00	0.22	-0.37	0.49
	SDLF	0.00	0.60	0.36	0.81	0.00	0.70	0.16	1.05
	TDLF	0.00	0.85	0.64	1.13	0.00	1.09	0.60	1.51
G4	NLF	0.00	0.21	-0.07	0.33	0.00	0.04	-0.55	0.31
	SDLF	0.00	0.40	0.18	0.63	0.00	0.43	-0.09	0.80
	TDLF	0.00	0.57	0.39	0.87	0.00	0.75	0.27	1.19
G5	NLF	0.00	0.11	-0.19	0.23	0.00	-0.13	-0.74	0.14
	SDLF	0.00	0.26	0.03	0.50	0.00	0.22	-0.30	0.61
	TDLF	0.00	0.38	0.22	0.72	0.00	0.50	0.04	0.98
G6	NLF	0.00	-0.01	-0.29	0.13	0.00	-0.33	-0.92	-0.02
	SDLF	0.00	0.12	-0.08	0.39	0.00	0.01	-0.48	0.44
	TDLF	0.00	0.23	0.10	0.60	0.00	0.28	-0.14	0.81
G7	NLF	0.00	0.54	0.27	0.67	0.00	-0.58	-1.10	-0.19
	SDLF	0.00	0.76	0.50	0.95	0.00	-0.27	-0.69	0.24
	TDLF	0.00	0.94	0.70	1.18	0.00	-0.02	-0.37	0.59

Table U1-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	-0.03	0.08	-0.64	-0.01	-0.14	0.13	-0.95	0.00
	SDLF	0.01	0.07	-1.03	-0.02	-0.07	0.11	-1.33	-0.01
	TDLF	0.06	0.07	-1.40	-0.03	0.00	0.11	-1.69	-0.03
G2	NLF	-0.03	0.13	-0.54	-0.01	-0.14	0.19	-0.79	0.00
	SDLF	0.01	0.23	-0.88	-0.02	-0.07	0.29	-1.13	-0.02
	TDLF	0.06	0.34	-1.21	-0.03	0.00	0.39	-1.45	-0.03
G3	NLF	-0.03	0.22	-0.44	-0.01	-0.15	0.33	-0.63	0.00
	SDLF	0.01	0.47	-0.73	-0.02	-0.07	0.57	-0.92	-0.02
	TDLF	0.06	0.70	-1.01	-0.03	0.00	0.80	-1.20	-0.03
G4	NLF	-0.04	0.34	-0.33	-0.01	-0.15	0.52	-0.46	0.00
	SDLF	0.01	0.67	-0.60	-0.02	-0.08	0.84	-0.72	-0.02
	TDLF	0.06	0.96	-0.85	-0.03	0.00	1.13	-0.98	-0.03
G5	NLF	-0.04	0.47	-0.23	-0.01	-0.16	0.74	-0.29	-0.01
	SDLF	0.01	0.83	-0.48	-0.02	-0.08	1.09	-0.55	-0.02
	TDLF	0.06	1.16	-0.72	-0.03	0.00	1.40	-0.80	-0.03
G6	NLF	-0.04	0.61	-0.14	-0.01	-0.16	1.02	-0.13	-0.01
	SDLF	0.01	0.97	-0.40	-0.02	-0.08	1.34	-0.40	-0.02
	TDLF	0.06	1.29	-0.64	-0.03	0.00	1.63	-0.66	-0.03
G7	NLF	-0.04	0.72	-0.06	-0.02	-0.17	1.30	0.01	-0.03
	SDLF	0.00	1.06	-0.34	-0.03	-0.09	1.54	-0.30	-0.04
	TDLF	0.06	1.35	-0.59	-0.03	-0.01	1.77	-0.57	-0.05

Appendix U2-1. EICCS28 Bridge Description

The key characteristics of EICCS28 are as follows:

- Span length along the centerline of the bridge, L_s = 326, 160, 235ft.
- Width between the fascia girders, w_g = 52 ft.
- Radius of curvature to the centerline of the bridge, R = 1255 ft.
- Length-to-width aspect ratio of the bridge, L_s/w_g = 6.3, 3.1, 4.5
- Subtended angle between the supports, L_s/R = 0.26, 0.13, 0.19
- Number of girders in the completed bridge cross-section, n_g =7.
- Skew angle, θ = 0, 54.5, 47, 0^o

This appendix presents the bridge description of the bridge EICCS28 in its final condition as well as during erection. The following figures and tables are provided:

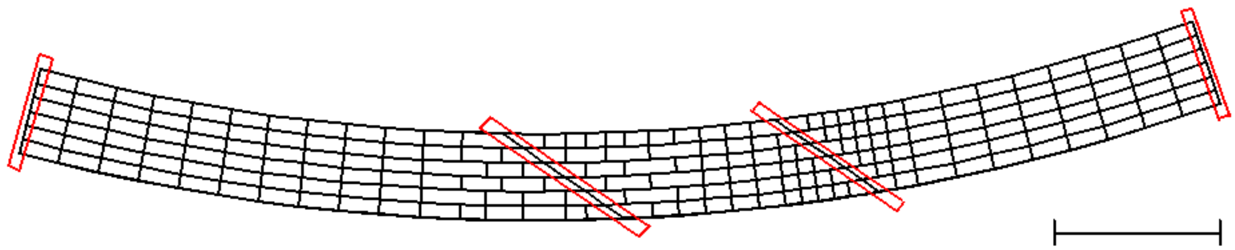


Figure U2-1-1. Framing plan.

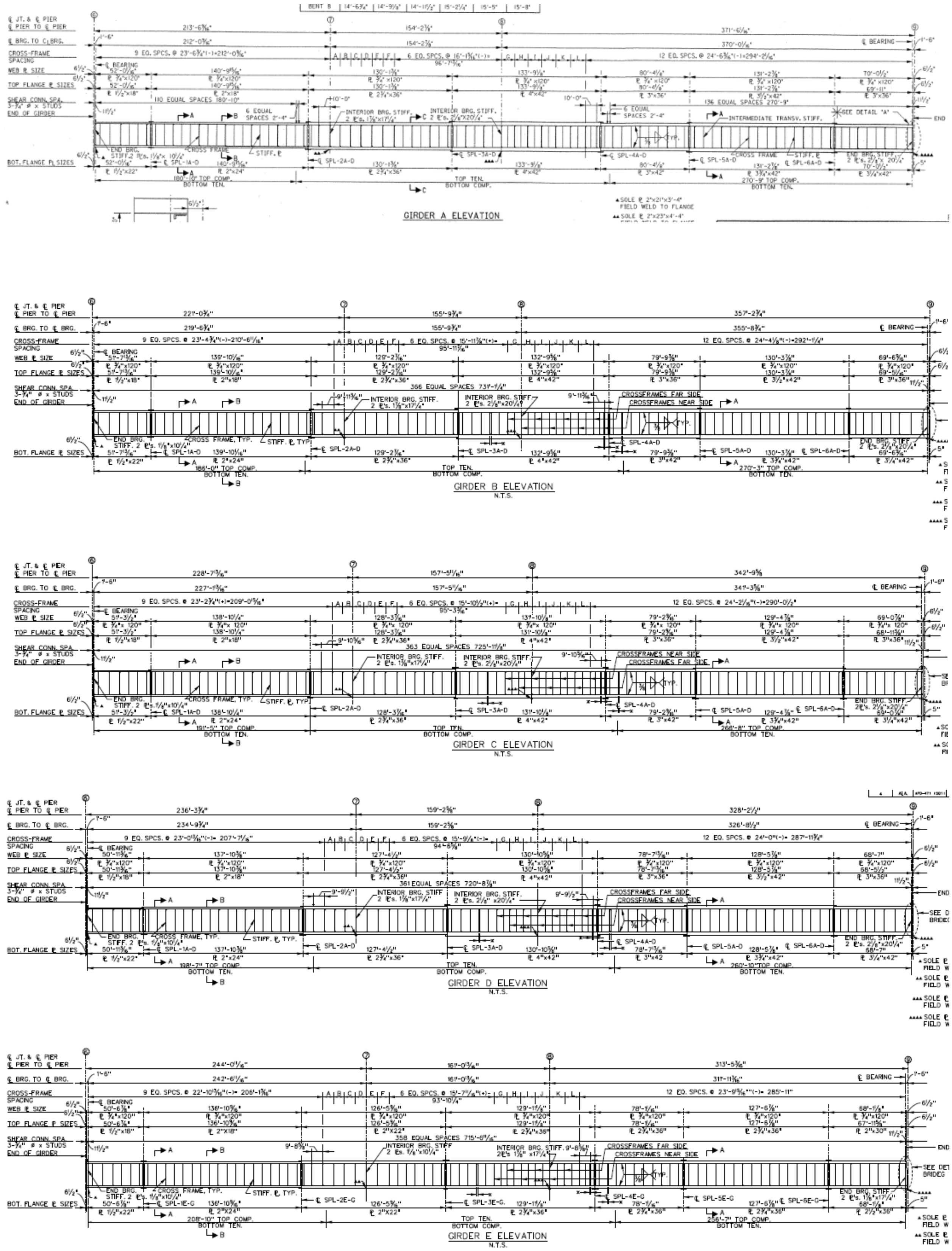


Figure U2-1-2. Girder elevations

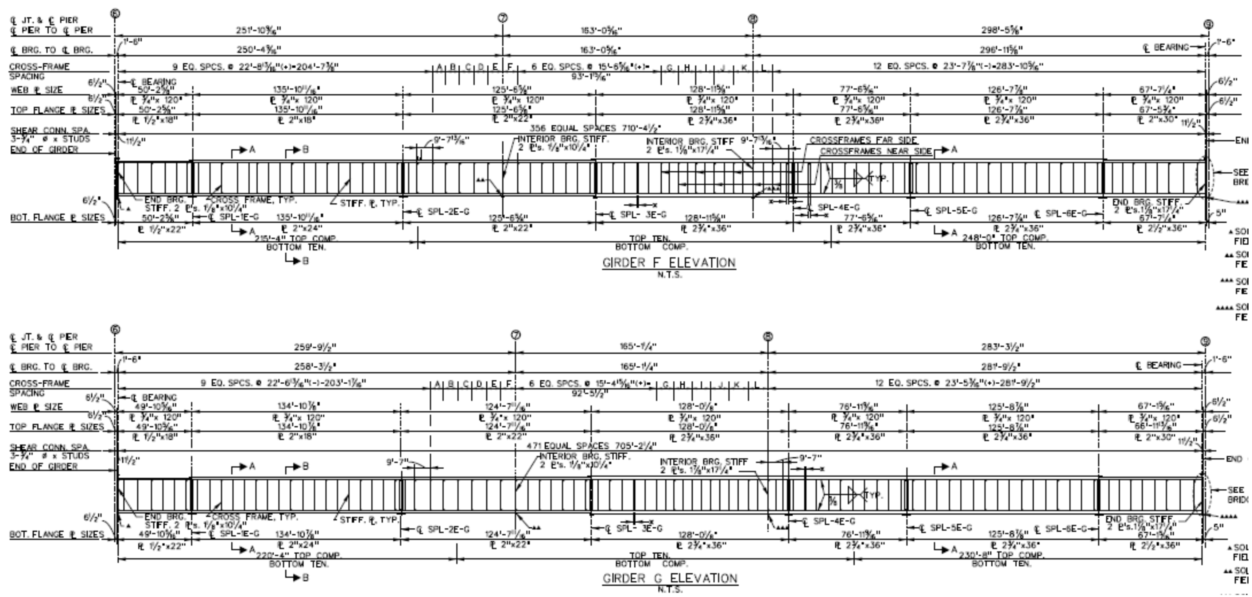


Figure U2-1-2(Continued). Girder elevations

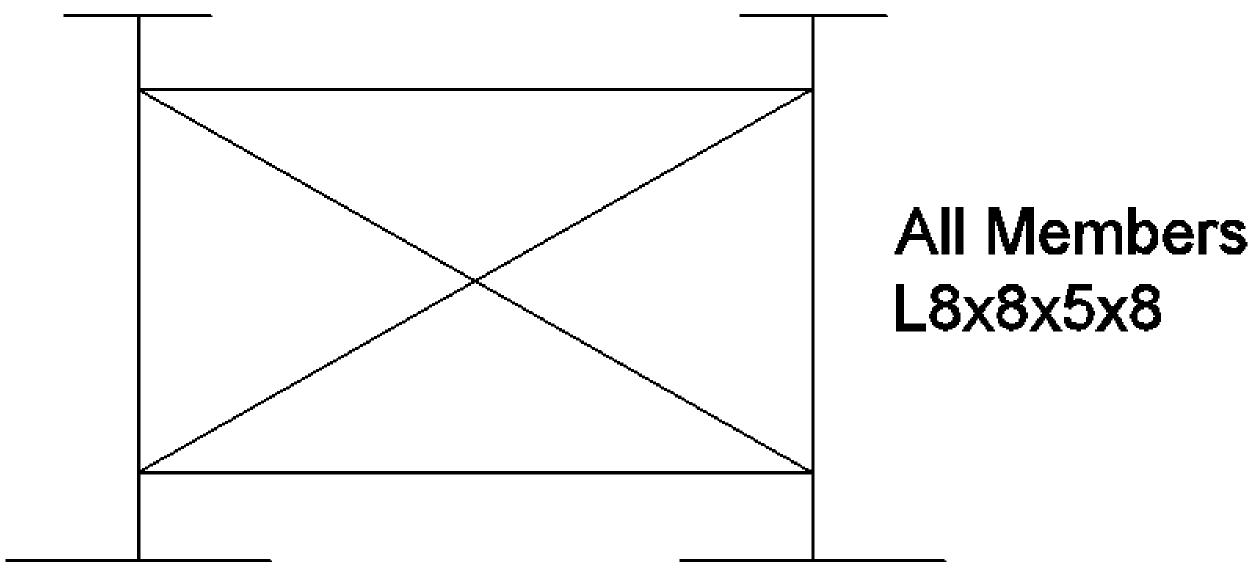
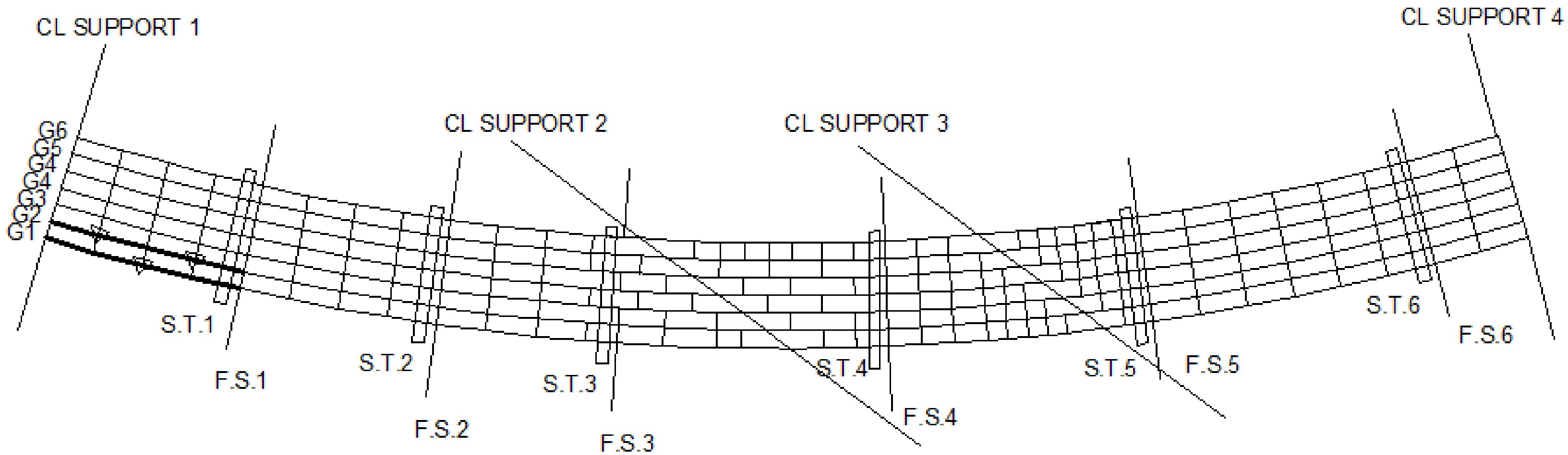
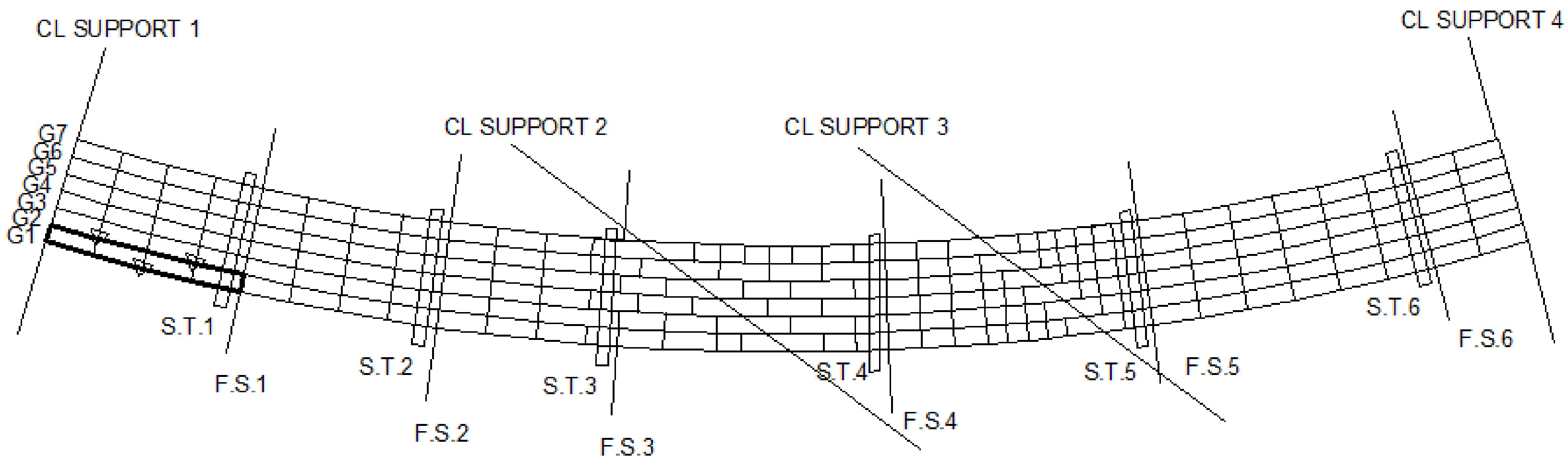


Figure U2-1-3. Cross-frame details

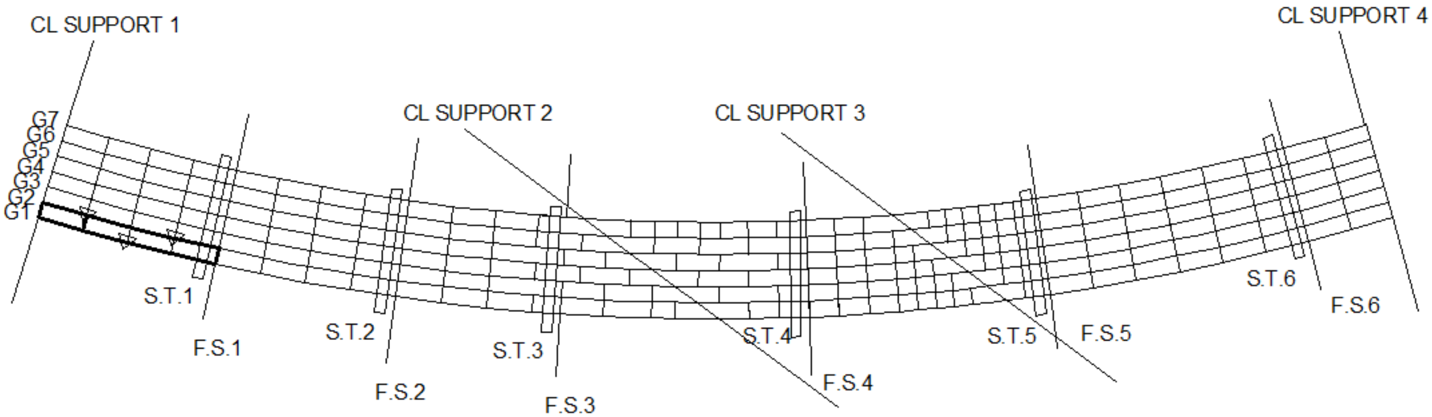


STAGE 2-1

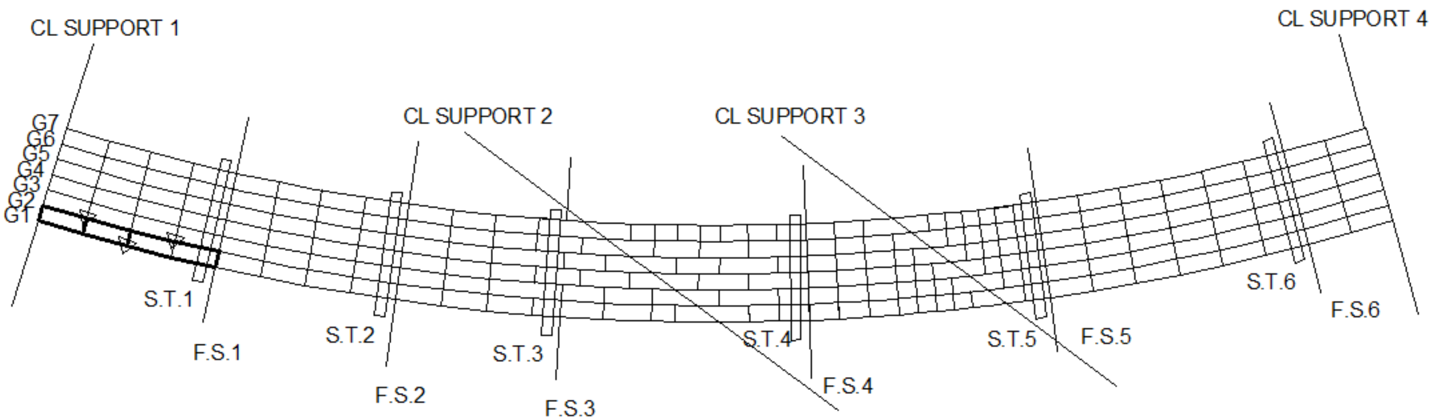


STAGE 2-2

Figure U2-1-4. Erection scheme.

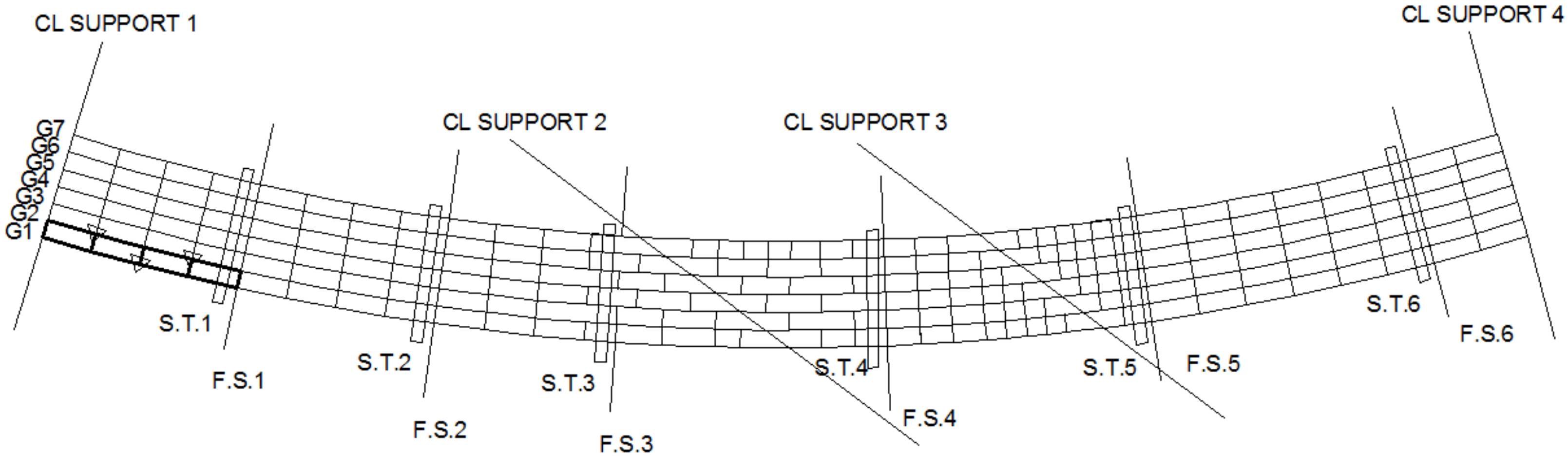


STAGE 2-3



STAGE 2-4

Figure U2-1-4(Continued). Erection scheme.



STAGE 2-5

REPEAT THE SEQUENCE FOR G3 TO G7 BETWEEN CL SUPPORT1 AND F.S 1

THE HOLDING CRANE IS ON G1 UNTIL FIELD SECTIONS OF G1 AND G2 ARE INSTALLED

SHORING SHOWERS 1 TO 6 ARE IN PLACE FROM STAGE 1 TO 35

FROM STAGE 36 TO 49: REMOVE SHORING TOWER 2.

STAGES 8 TO 14: REPEAT THE SAME SEQUENCE FOR G1-G7 FIELD SECTION BETWEEN F.S 1 AND F.S 2. THE HOLDING CRANE IS ON G1 FIELD SECTION UNTIL STAGE 9 IS FINISHED. USE ONE LIFTING CRANE.

STAGES 15 TO 21, STAGES 22 TO 28, STAGES 29 TO 35, STAGES 36 TO 42, AND STAGES 43 TO 49 ARE SIMILAR TO STAGES 8 TO 14.

Figure U2-1-4(Continued). Erection scheme.

Table U2-1-1. Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

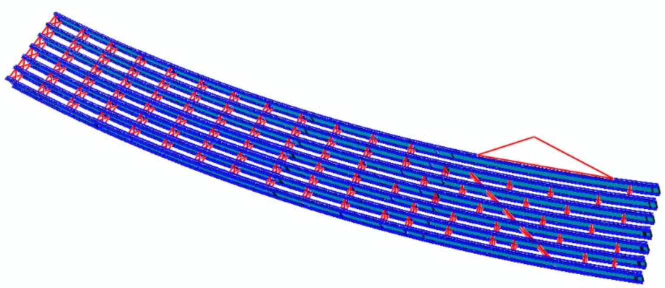
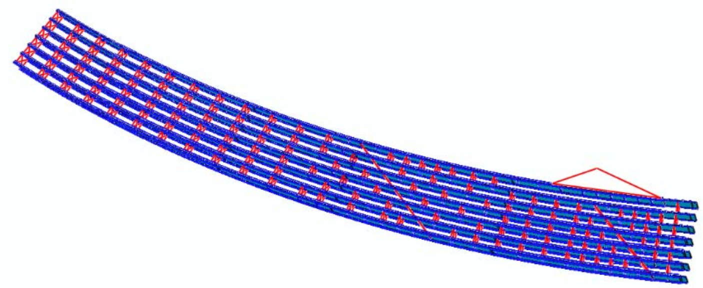
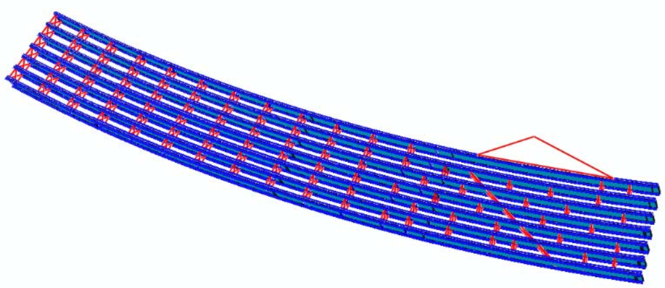
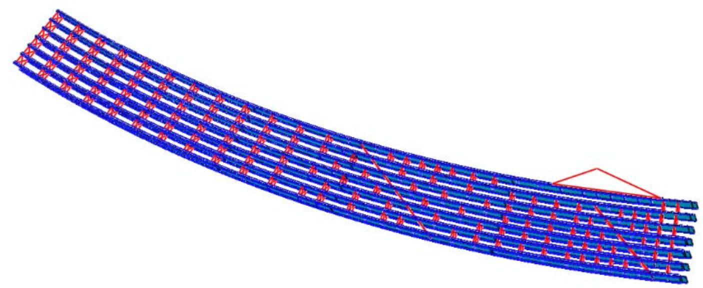
Sub-Stage	Stage	
	28	35
1		
2		

Table U2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

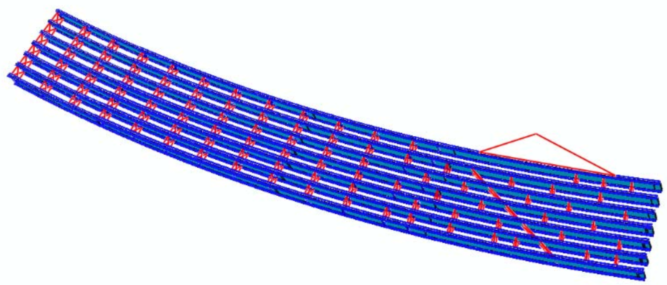
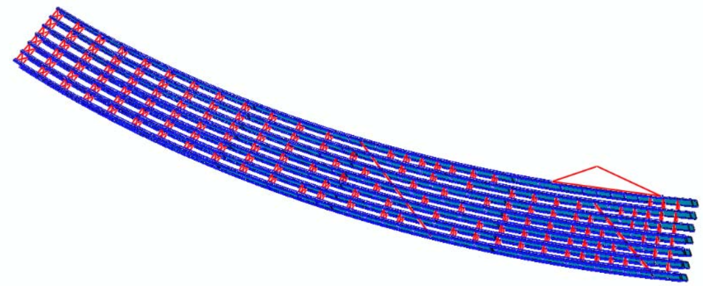
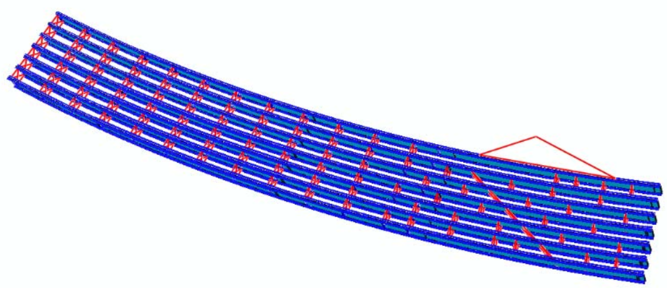
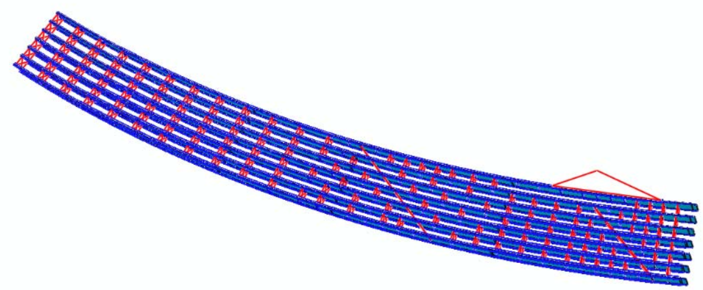
3		
4		

Table U2-1-1(Continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

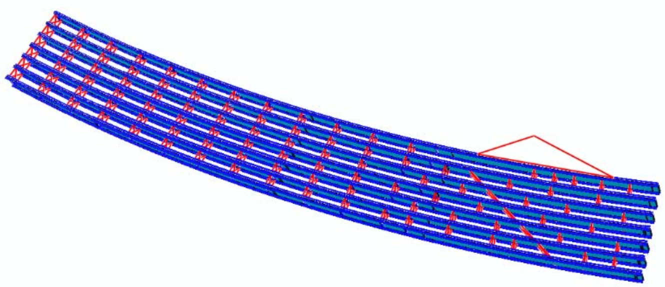
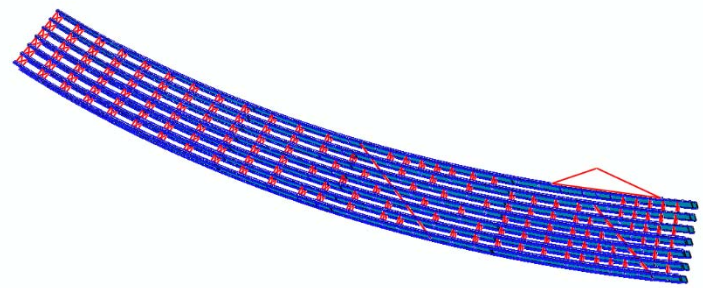
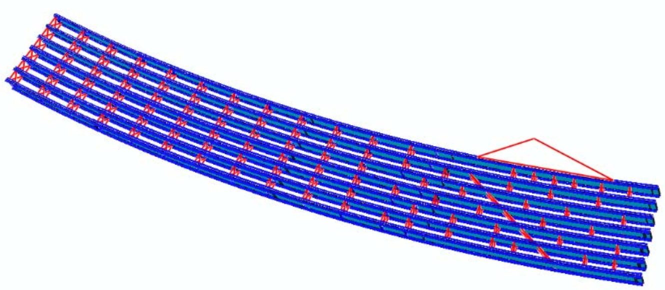
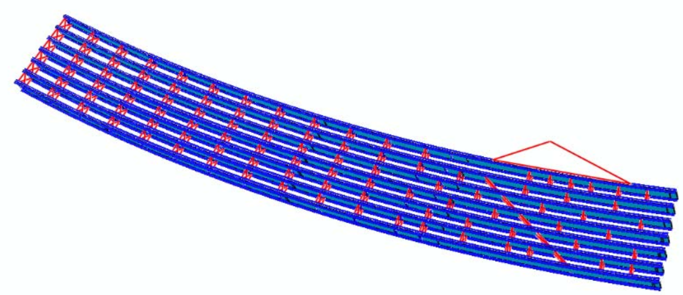
5		
6		

Table U2-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

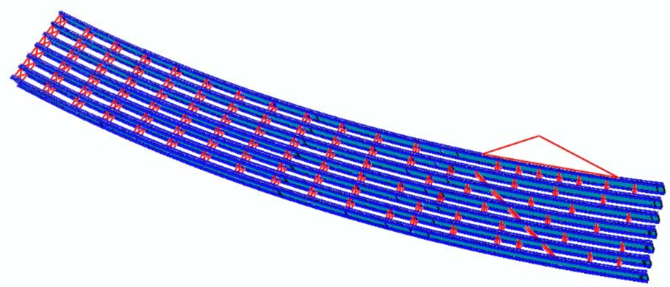
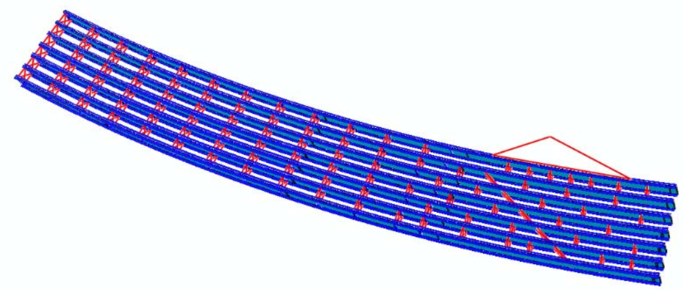
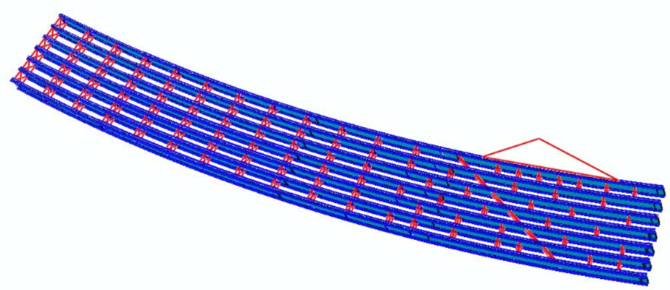
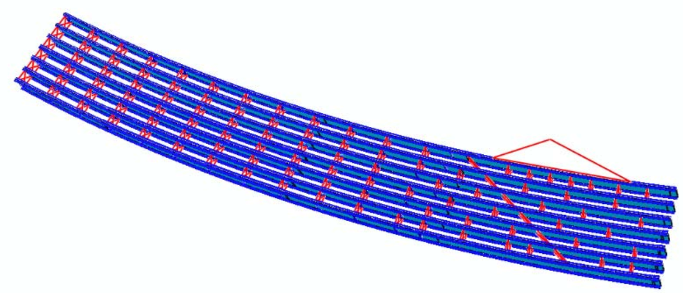
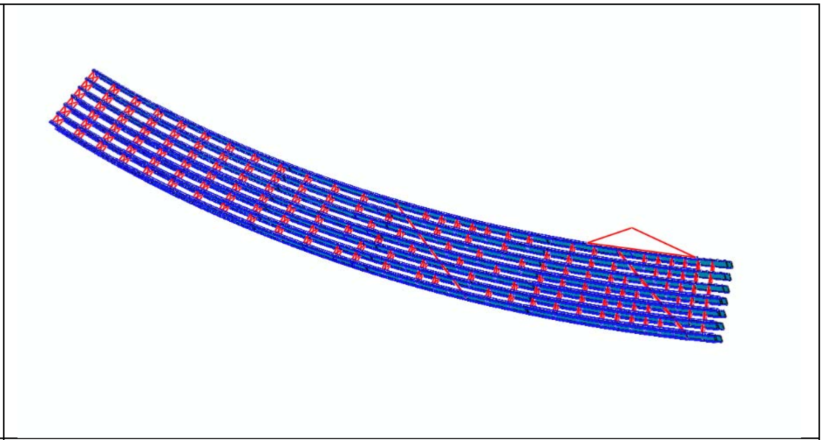
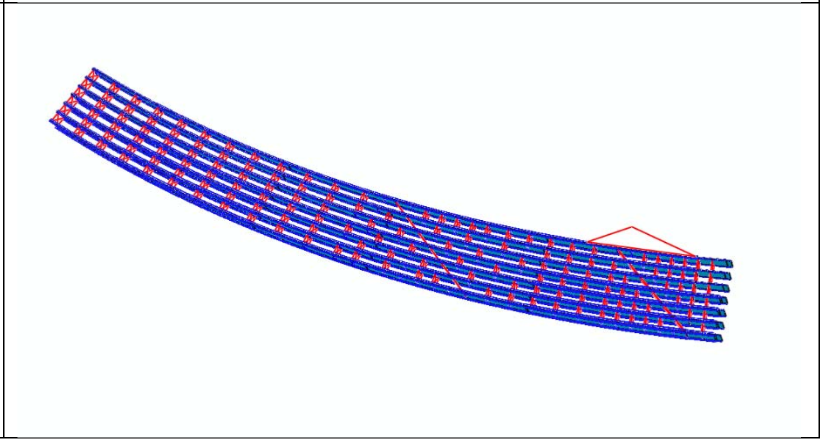
7		
8		

Table U2-1-1 (continued). Three-dimensional view of erection sequence. The displacements (magnified 10x) are shown for the bridge with the cross-frames detailed NLF and with the hold elevations on the hold crane and the lifting crane set at the NL elevations.

9		
10		

Appendix U2-2. EICCS28 Summary, Completed Bridge Responses

This appendix presents the summary SDL and TDL responses of the bridge EICCS28 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Summary

Table U2-2-1. Summary of girder maximum vertical displacements (in).

Table U2-2-2. Summary of girder maximum layovers (in).

Table U2-2-3. Summary of girder maximum stresses (ksi.)

Table U2-2-4. Summary of maximum cross-frame forces (kip.)

Table U2-2-5. Summary of average cross-frame forces (kip.)

Table U2-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in.)

Table U2-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in.)

Table U2-2-8. Summary of maximum SDL approximate horizontal differential displacements at the cross-frame locations (in.)

Table U2-2-9. Summary of maximum TDL approximate horizontal differential displacements at the cross-frame locations (in.)

Table U2-2-10. Total vertical reactions under SDL and TDL (kips.)

Table U2-2-11. Summary of maximum reactions under SDL and TDL (kips)

Table U2-2-12. Summary of maximum support displacements under SDL and TDL (in)

Figure U2-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative to the member yield load.

Figure U2-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative to the member yield load.

Figure U2-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load ($\Delta P/P_y$), under SDL, SDLF detailing.

Figure U2-2-4. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load ($\Delta P/P_y$), under TDL, TDLF detailing.

Table U2-2-1. Summary of girder maximum vertical displacements (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	14.1	25.8
	SDLF	13.6	24.9
	TDLF	13.2	24.3
G2	NLF	12.0	22.1
	SDLF	11.2	21.0
	TDLF	10.7	20.3
G3	NLF	10.0	18.5
	SDLF	9.0	17.3
	TDLF	8.3	16.4
G4	NLF	8.0	15.0
	SDLF	6.9	13.7
	TDLF	6.1	12.8
G5	NLF	6.1	11.6
	SDLF	4.9	10.3
	TDLF	4.1	9.4
G6	NLF	4.2	8.2
	SDLF	3.0	6.9
	TDLF	2.1	6.0
G7	NLF	2.4	6.0
	SDLF	2.2	5.7
	TDLF	2.0	5.5
All Girders	NLF	14.1	25.8
	SDLF	13.6	24.9
	TDLF	13.2	24.3

Table U2-2-2. Summary of girder maximum layovers (in).

Girder	Detailing Method	SDL	TDL
G1	NLF	2.52	4.54
	SDLF	0.37	2.30
	TDLF	1.35	0.51
G2	NLF	2.48	4.46
	SDLF	0.32	2.21
	TDLF	1.40	0.43
G3	NLF	2.42	4.35
	SDLF	0.25	2.10
	TDLF	1.48	0.31
G4	NLF	2.36	4.24
	SDLF	0.18	1.98
	TDLF	1.57	0.21
G5	NLF	2.31	4.15
	SDLF	0.15	1.88
	TDLF	1.64	0.27
G6	NLF	2.29	4.12
	SDLF	0.18	1.84
	TDLF	1.69	0.32
G7	NLF	2.29	4.11
	SDLF	0.19	1.84
	TDLF	1.71	0.34
All Girders	NLF	2.52	4.54
	SDLF	0.37	2.30
	TDLF	1.71	0.51

Table U2-2-3. Summary of girder maximum stresses (ksi).

		fb				fl			
		Bottom Flange		Top Flange		Bottom Flange		Top Flange	
Girder	Detailing Method	SDL	TDL	SDL	TDL	SDL	TDL	SDL	TDL
G1	NLF	12.5	22.2	13.8	24.6	1.7	5.1	2.1	5.7
	SDLF	12.8	22.1	14.5	24.8	1.0	3.2	1.2	3.4
	TDLF	14.2	23.2	16.1	26.2	1.7	2.1	2.0	3.2
G2	NLF	13.9	25.0	15.1	27.2	2.6	6.0	2.8	5.6
	SDLF	13.3	24.3	14.4	26.2	0.8	3.3	1.1	3.2
	TDLF	12.8	23.6	14.0	25.5	1.3	1.9	2.3	3.0
G3	NLF	13.1	23.8	14.2	25.7	4.9	10.4	5.0	9.3
	SDLF	11.6	22.1	12.5	23.7	1.9	6.1	2.1	5.7
	TDLF	10.6	20.7	12.0	22.2	2.4	3.3	3.7	3.5
G4	NLF	11.8	21.5	12.7	23.1	5.7	11.9	6.1	11.6
	SDLF	9.6	19.1	10.3	20.6	1.7	6.3	2.6	7.1
	TDLF	8.8	17.2	10.0	18.5	2.8	3.0	4.2	4.3
G5	NLF	10.9	20.1	10.4	19.2	6.9	13.9	6.7	13.2
	SDLF	8.1	17.2	7.8	16.4	2.7	8.0	2.4	7.8
	TDLF	6.8	14.9	6.9	14.2	3.3	4.5	4.4	3.9
G6	NLF	8.4	15.6	8.0	15.0	5.1	10.3	4.8	10.3
	SDLF	5.9	13.1	5.6	13.1	0.6	5.0	0.9	5.2
	TDLF	4.6	11.1	5.1	12.7	2.9	1.5	3.1	2.5
G7	NLF	4.4	11.3	5.1	12.9	2.5	4.8	4.7	11.1
	SDLF	5.1	10.8	4.8	12.5	0.5	2.0	0.9	5.2
	TDLF	6.3	11.5	5.8	12.0	1.9	1.4	3.5	2.2
All Girders	NLF	13.9	25.0	15.1	27.2	6.9	13.9	6.7	13.2
	SDLF	13.3	24.3	14.5	26.2	2.7	8.0	2.6	7.8
	TDLF	14.2	23.6	16.1	26.2	3.3	4.5	4.4	4.3

Table U2-2-4. Summary of maximum cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	51.2	99.6	98.7	99.6
	SDLF	38.6	80.4	78.9	80.4
	TDLF	34.8	72.0	71.6	72.0
TDL	NLF	93.5	176.1	172.9	176.1
	SDLF	72.7	152.4	149.2	152.4
	TDLF	67.0	134.9	131.8	134.9

Table U2-2-5. Summary of average cross-frame forces (kip).

	Detailing Method	Diagonals	Top Chords	Bottom Chords	All CF Member
SDL	NLF	10.2	16.2	16.0	13.1
	SDLF	8.8	12.6	12.1	10.6
	TDLF	9.4	15.0	14.3	12.1
TDL	NLF	20.3	30.6	29.8	25.2
	SDLF	18.3	25.2	24.5	21.6
	TDLF	17.3	21.5	20.6	19.2

Table U2-2-6. Summary of maximum SDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	2.09	2.03	1.98	1.94	1.93	1.93	2.09
SDLF	2.35	2.23	2.12	2.02	1.98	1.98	2.35
TDLF	2.56	2.39	2.22	2.08	2.03	2.04	2.56

Table U2-2-7. Summary of maximum TDL vertical differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	3.75	3.65	3.55	3.47	3.46	3.47	3.75
SDLF	3.93	3.77	3.62	3.49	3.45	3.47	3.93
TDLF	4.08	3.88	3.67	3.49	3.45	3.47	4.08

Table U2-2-8. Summary of maximum approximate SDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	2.21	2.15	2.09	2.05	2.04	2.04	2.21
SDLF	2.48	2.36	2.24	2.13	2.10	2.10	2.48
TDLF	2.70	2.53	2.35	2.20	2.15	2.16	2.70

Table U2-2-9. Summary of maximum approximate TDL horizontal differential displacements at the cross-frame locations (in).

Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7	All Girders
NLF	3.96	3.86	3.75	3.67	3.66	3.67	3.96
SDLF	4.16	3.99	3.82	3.69	3.65	3.66	4.16
TDLF	4.31	4.10	3.88	3.70	3.65	3.67	4.31

Table U2-2-10. Total vertical reactions under SDL and TDL (kips).

Detailing Method	Load Type	
	SDL	TDL
NLF	5564.5	10941.5
SDLF	5564.3	10940.7
TDLF	5564.5	10941.3

Table U2-2-11. Summary of maximum reactions under SDL and TDL (kips).

Detailing Method	Vertical		Longitudinal		Transverse	
	SDL	TDL	SDL	TDL	SDL	TDL
NLF	587.3	1051.1	1.3	1.4	2.3	6.6
SDLF	617.0	1057.6	2.3	2.2	0.5	3.7
TDLF	643.4	1078.3	4.2	4.6	1.3	1.1

Table U2-2-12. Summary of maximum support displacements under SDL and TDL (kips).

Detailing Method	Longitudinal		Transverse	
	SDL	TDL	SDL	TDL
NLF	0.48	1.12	0.46	1.32
SDLF	0.73	0.79	0.11	0.75
TDLF	1.18	1.44	0.27	0.21

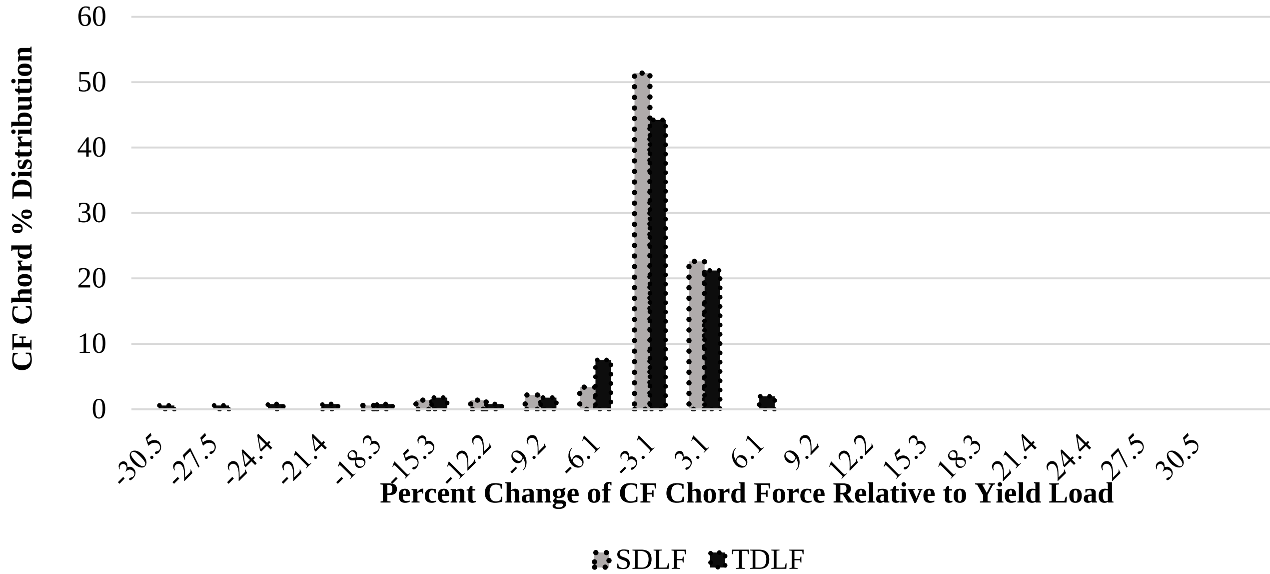


Figure U2-2-1. Cross-frame chord percent distribution versus percent change of cross-frame chord force relative the member yield load.

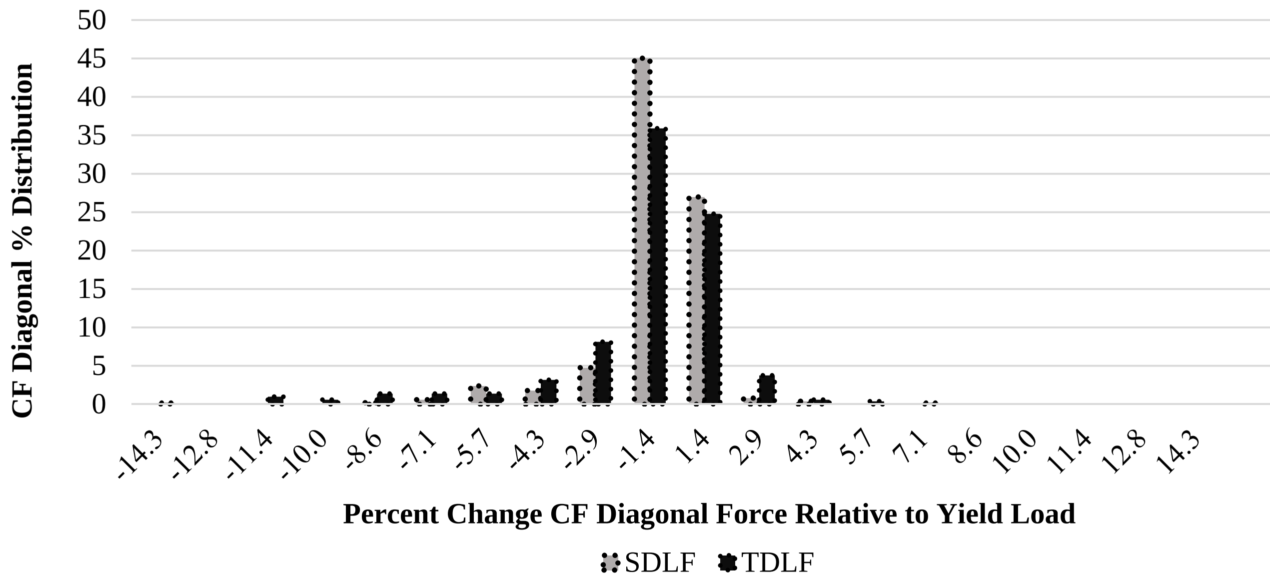


Figure U2-2-2. Cross-frame diagonal percent distribution versus percent change of cross-frame diagonal force relative the member yield load.

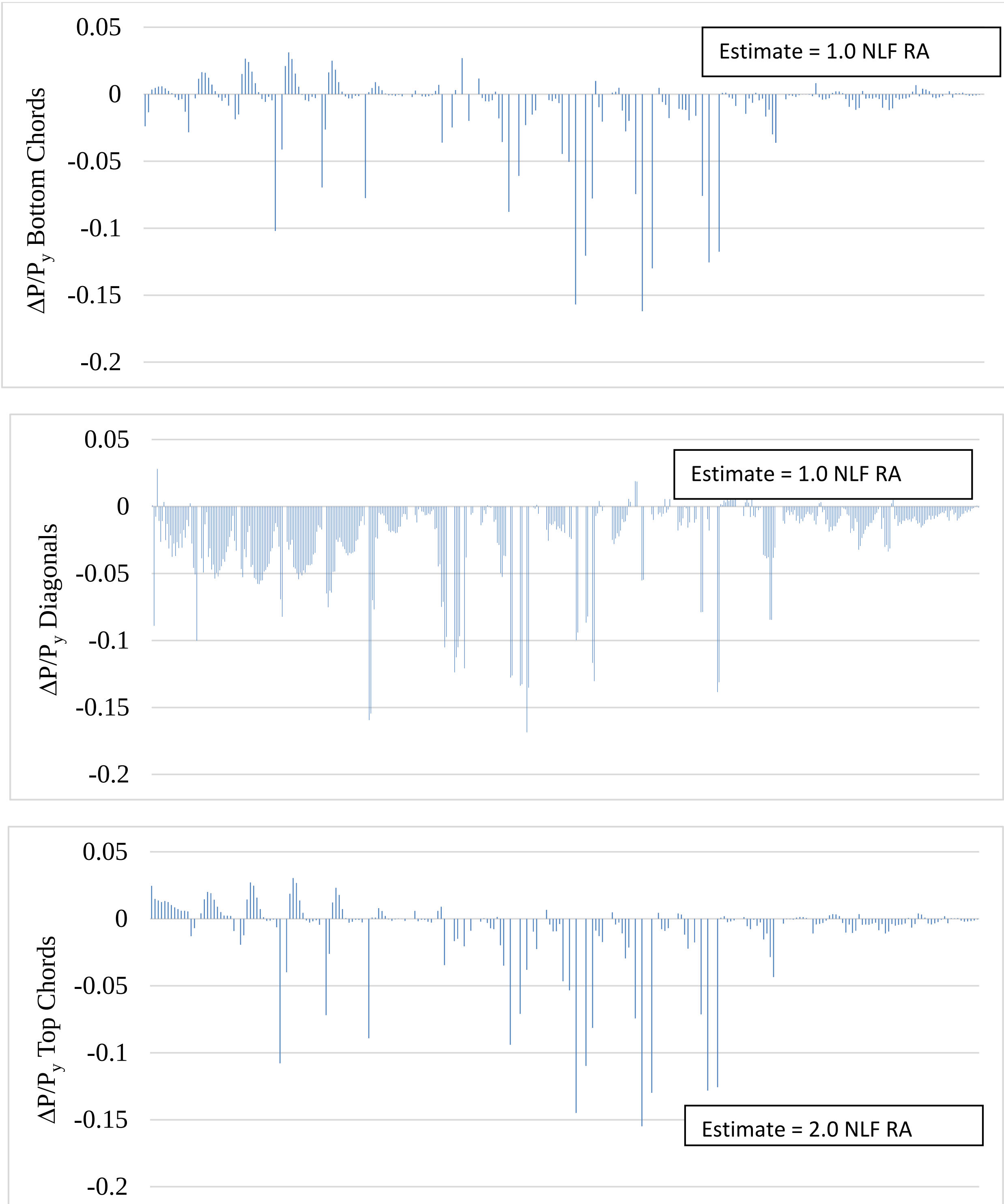


Figure U2-2-3. Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under SDL, SDLF detailing.

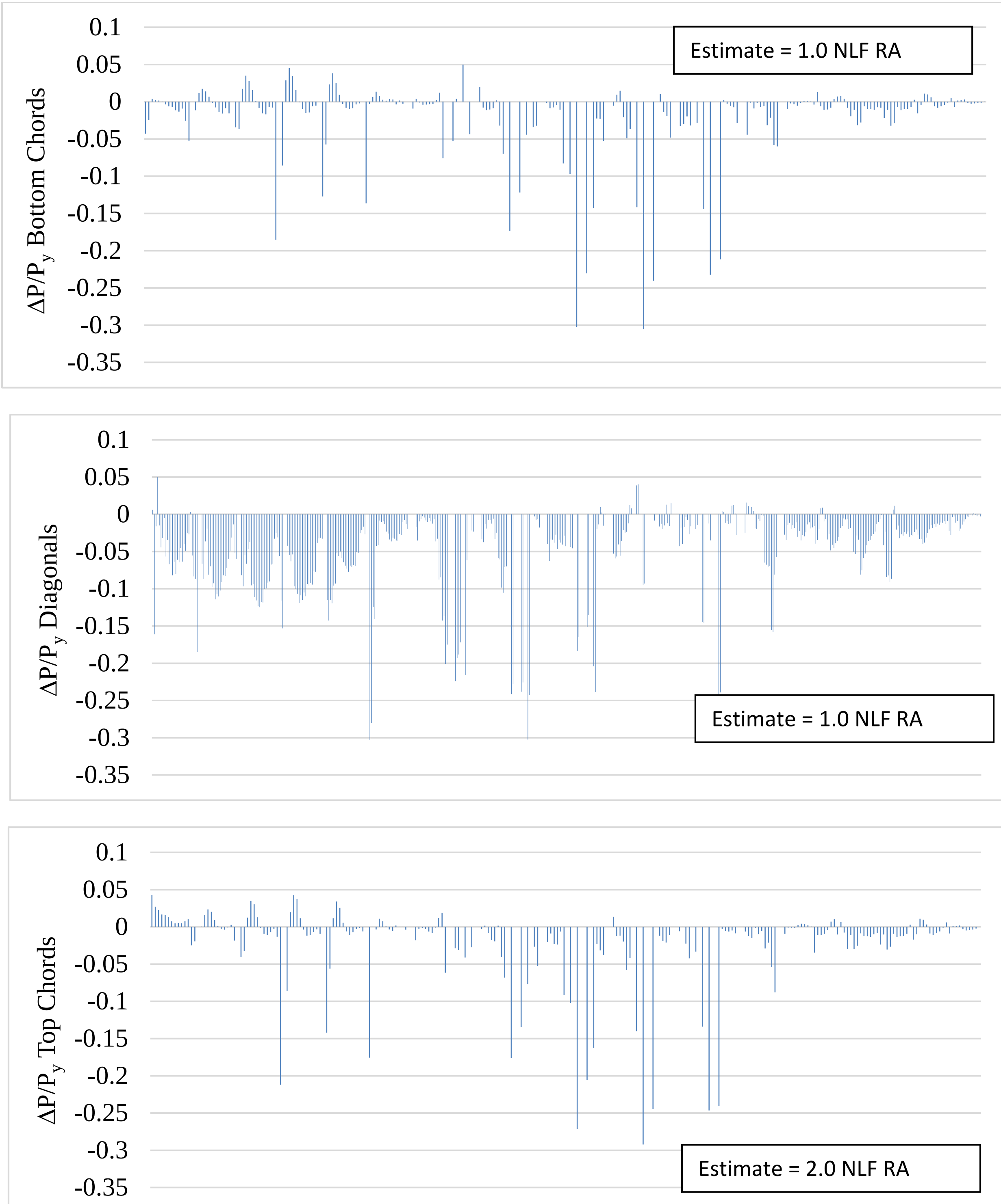


Figure U2-2-4. **Difference between magnitude of estimated and DLF RA forces, divided by the member yield load (($\Delta P/P_y$), under TDL, TDLF detailing.**

Appendix U2-3. EICCS28 Summary, Erection Fit-Up

This appendix presents the summary responses of the bridge EICCS28 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table U2-3-1. Maximums of the minimum fit-up force resultants (kips) with cranes at the NL elevations

Detailing Method	F1	F2	F_{max}
NLF	6.1	3.7	6.1
SDLF	16.8	19.6	19.6
TDLF	26.6	33.0	33.0

Table U2-3-2. Summary of erection vertical reactions (kips)

Girder	Detailing Method	Max Reaction	Min Reaction
G1	NLF	149.9	0
	SDLF	228	0
	TDLF	324.9	0
G2	NLF	150.9	0
	SDLF	142.8	0
	TDLF	158.9	0
G3	NLF	149	0
	SDLF	156.5	0
	TDLF	157.8	0
G4	NLF	145.1	10.8
	SDLF	141.5	0
	TDLF	150.1	0
G5	NLF	112.8	21.2
	SDLF	103.1	0
	TDLF	108.5	0
G6	NLF	108.3	23.1
	SDLF	144.3	0
	TDLF	163.6	0
G7	NLF	104.5	17.7
	SDLF	219.6	15.2
	TDLF	349.7	14.5
All Girders	NLF	150.9	0
	SDLF	228	0
	TDLF	349.7	0

Table U2-3-3. Summary of erection crane loads (kips)

Detailing Method	Lifting Crane		Holding Crane	
	Max Load	Min Load	Max Load	Min Load
NLF	120.4	55	NA	NA
SDLF	173.7	57.5	NA	NA
TDLF	206.2	54.2	NA	NA

Table U2-3-6. Erection total vertical reactions at each sub-stage

Stage	Detailing Method	Sub-Stage									
		1	2	3	4	5	6	7	8	9	10
28	NLF	3444	3445	3447	3448	3449	3451	3452	3454		
	SDLF	3444	3445	3446	3448	3449	3451	3452	3454		
	TDLF	3444	3445	3447	3448	3449	3451	3452	3454		
35	NLF	4686	4687	4689	4690	4692	4693	4695	4696	4698	4699
	SDLF	4686	4687	4689	4690	4691	4693	4695	4696	4698	4699
	TDLF	4686	4687	4689	4690	4692	4693	4695	4696	4698	4699

Appendix U2-4. EICCS28 Detailed Results, Completed Bridge Responses

This appendix presents the detailed SDL and TDL responses of the bridge EICCS28 in its final constructed condition. Emphasis is placed on the influence of the cross-frame detailing methods. The following figures are provided, grouped into major logical units:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Girder Differential Displacements at Cross-Frame Locations

Reactions

Support Displacements

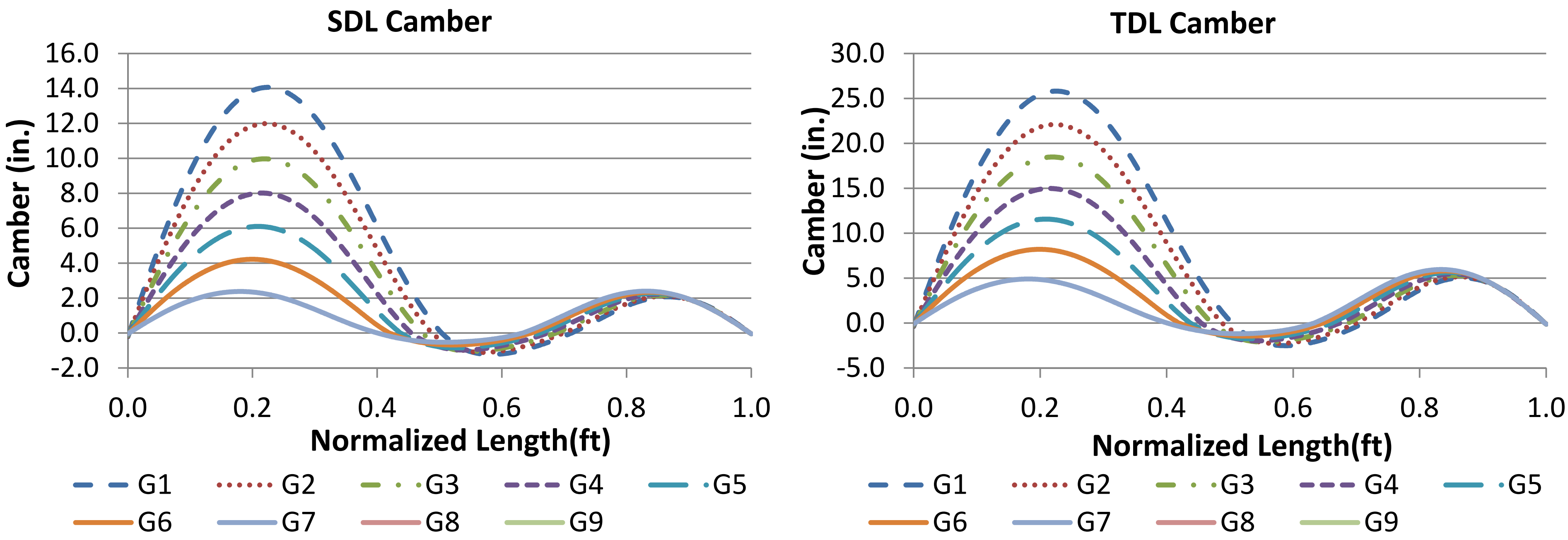


Figure U2-4-1. SDL and TDL 3D FEA cambers.

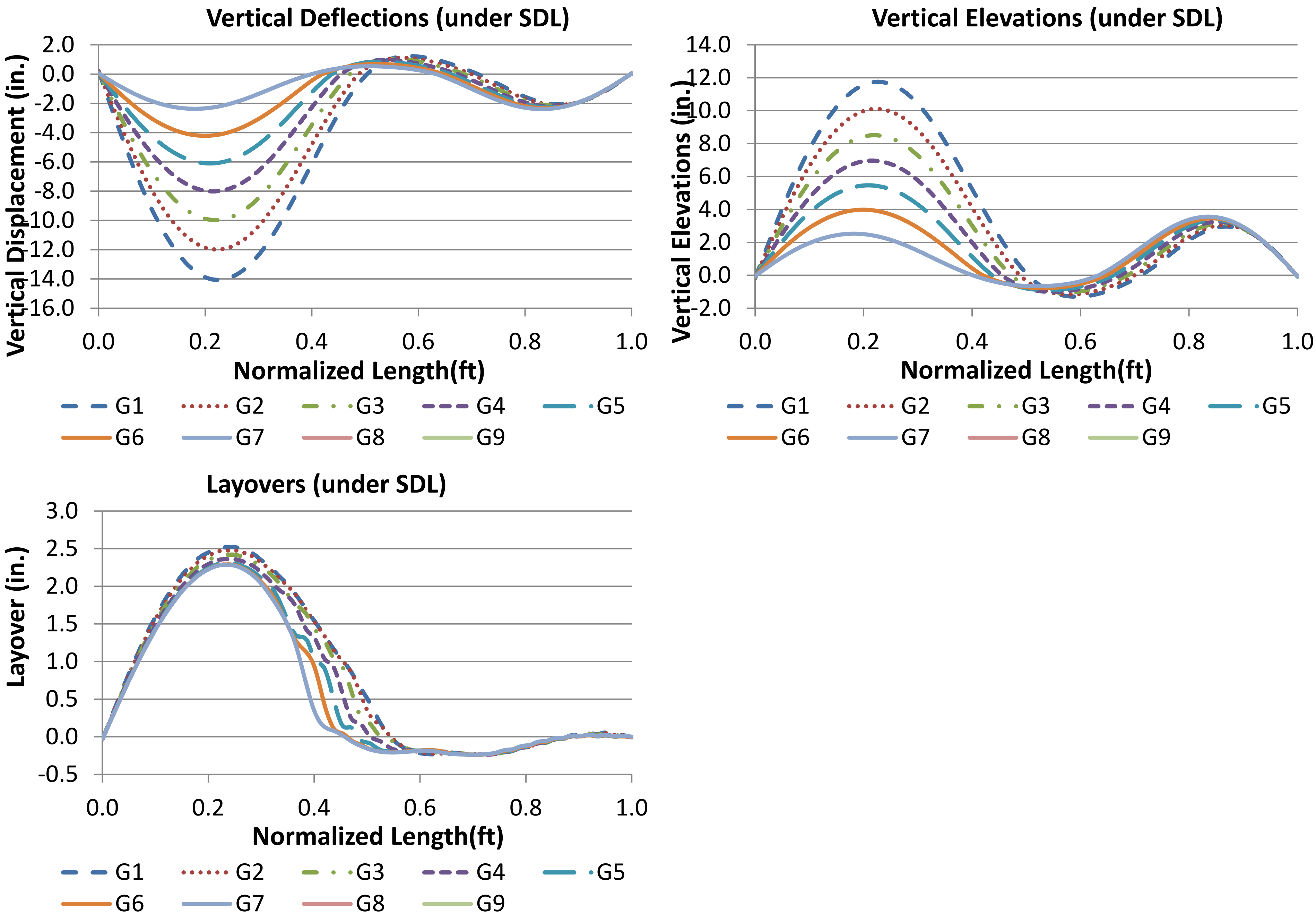


Figure U2-4-2. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

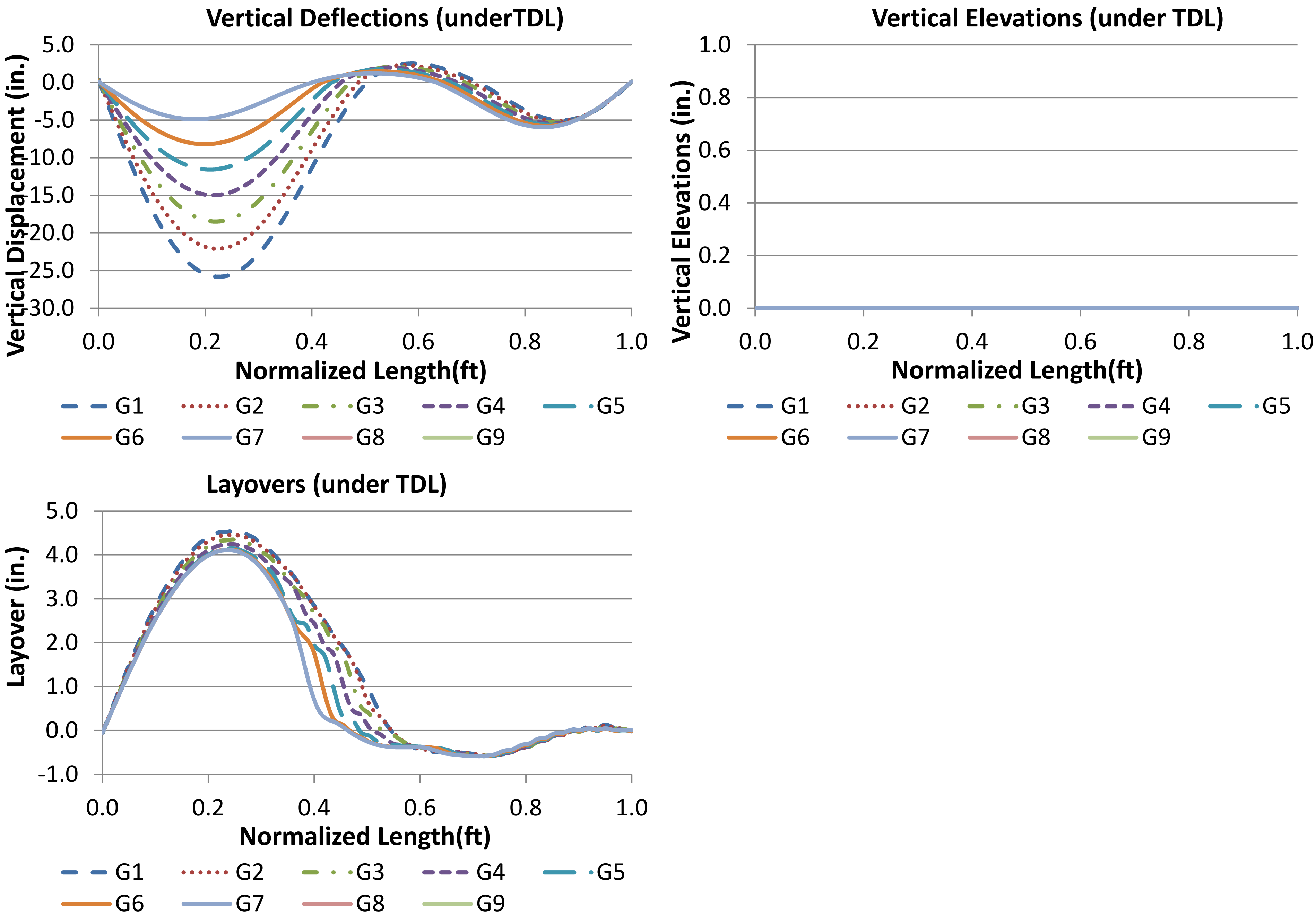


Figure U2-4-3. **Bridge displacements and elevation profiles (in) under TDL, NLF detailing.**

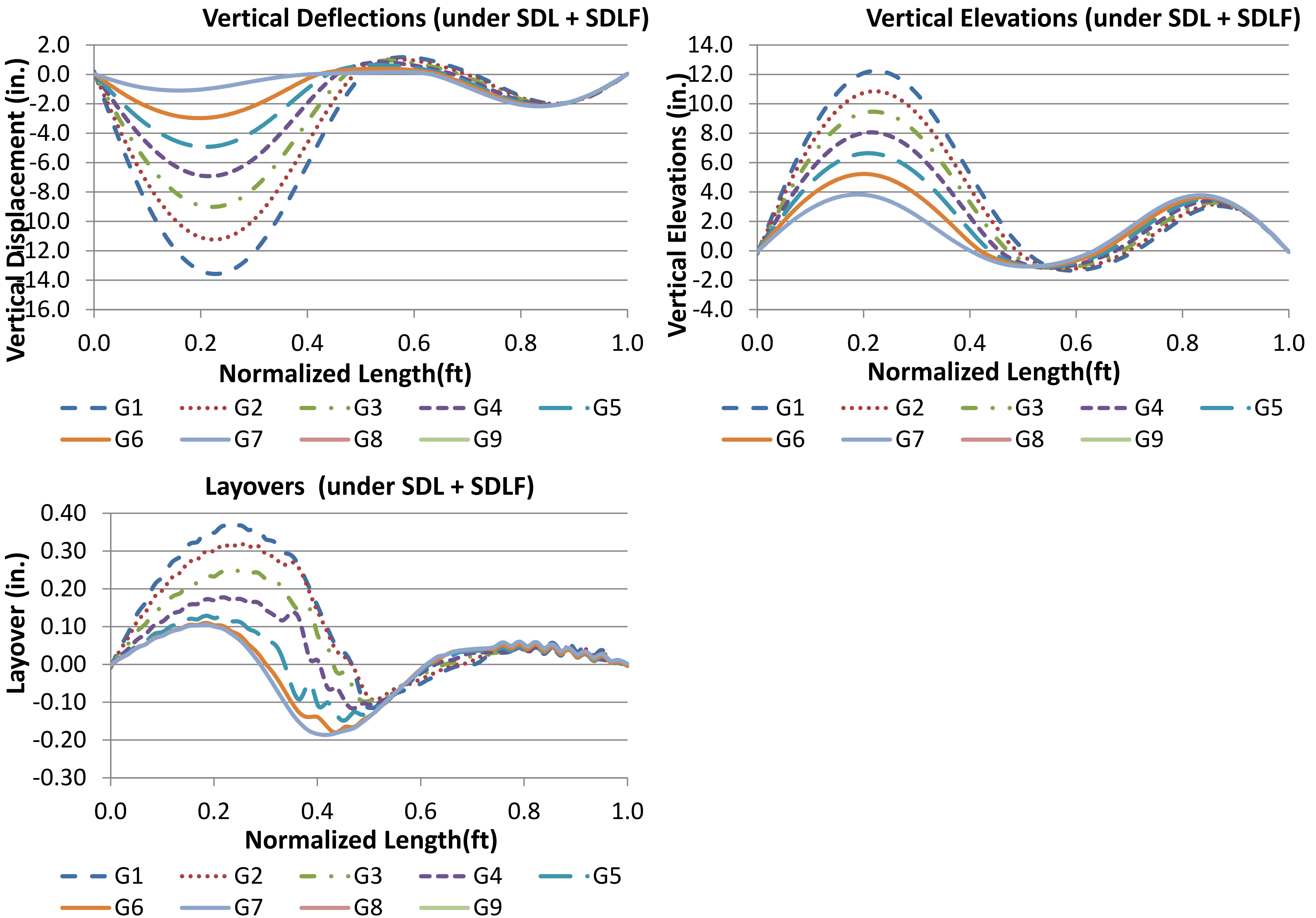


Figure U2-4-4. **Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.**

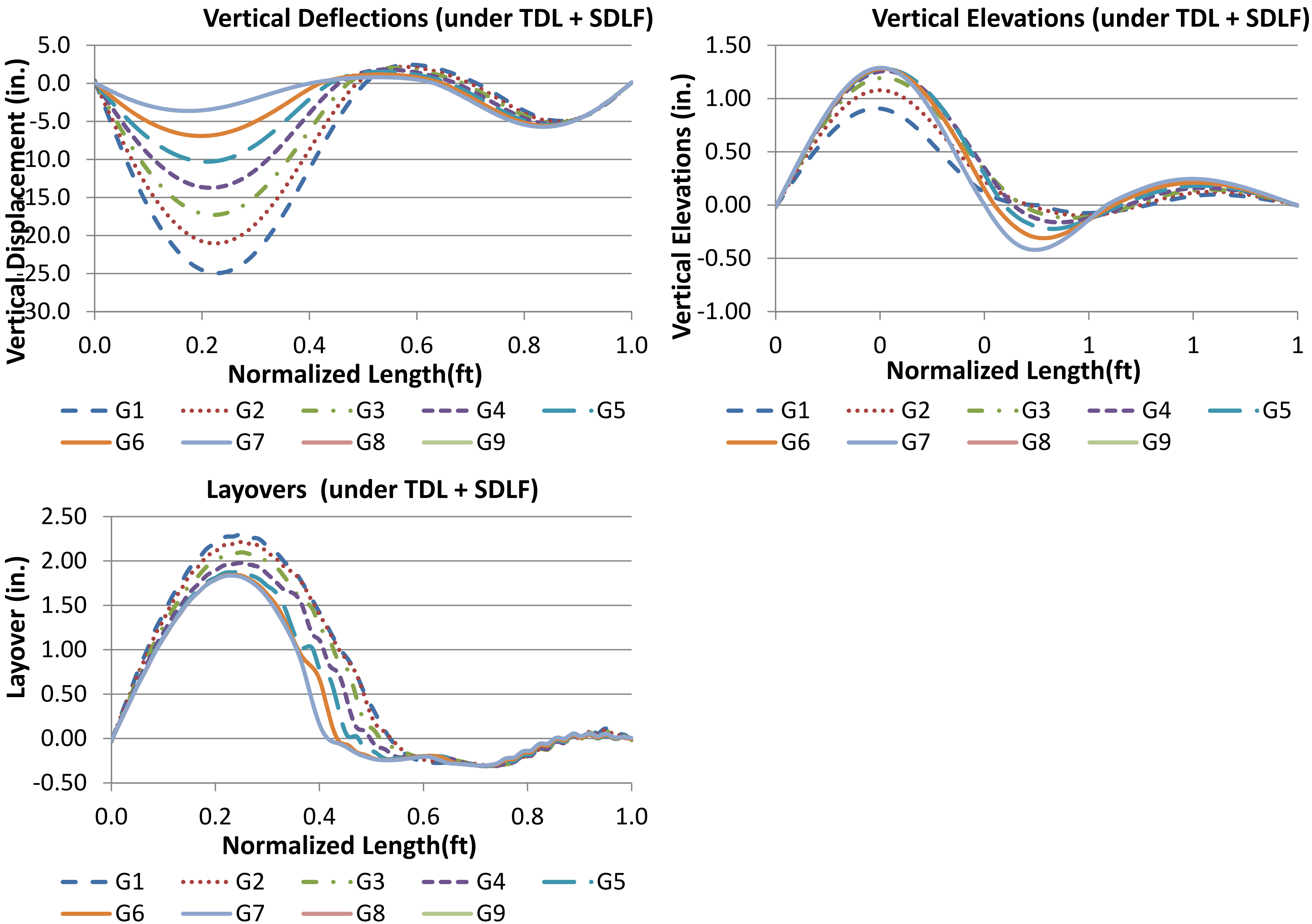


Figure U2-4-5. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

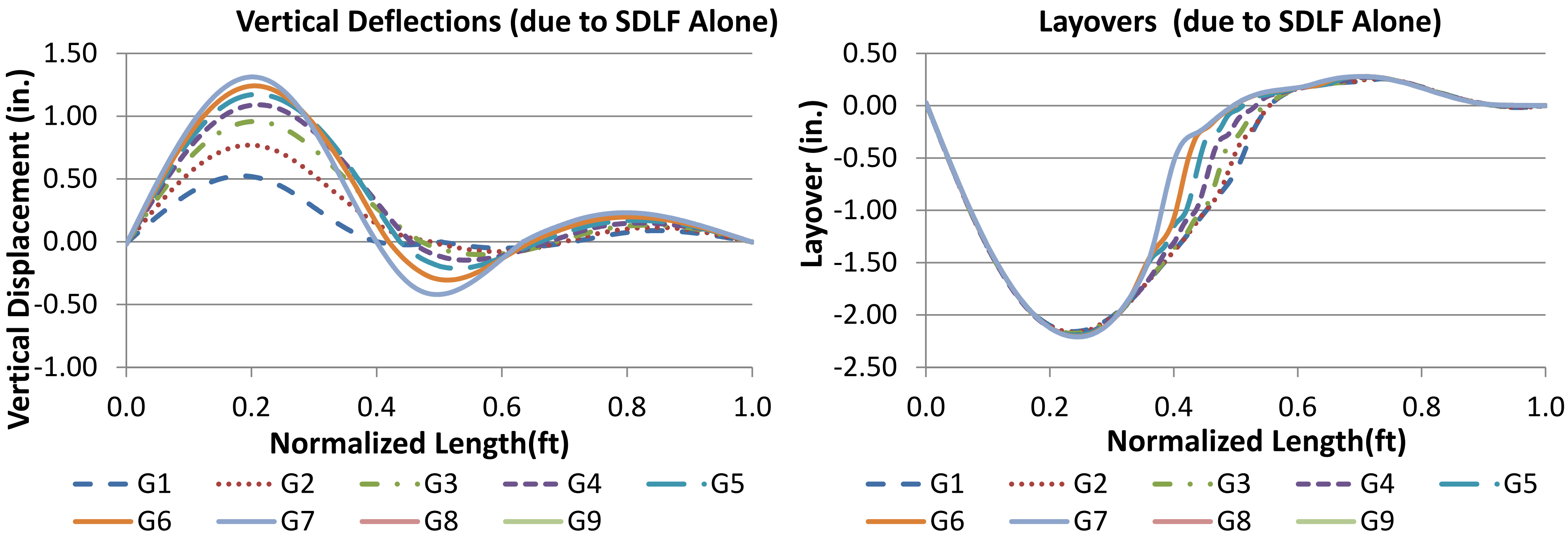


Figure U2-4-6. Bridge displacements due to SDLF detailing effects alone, under NL (in).

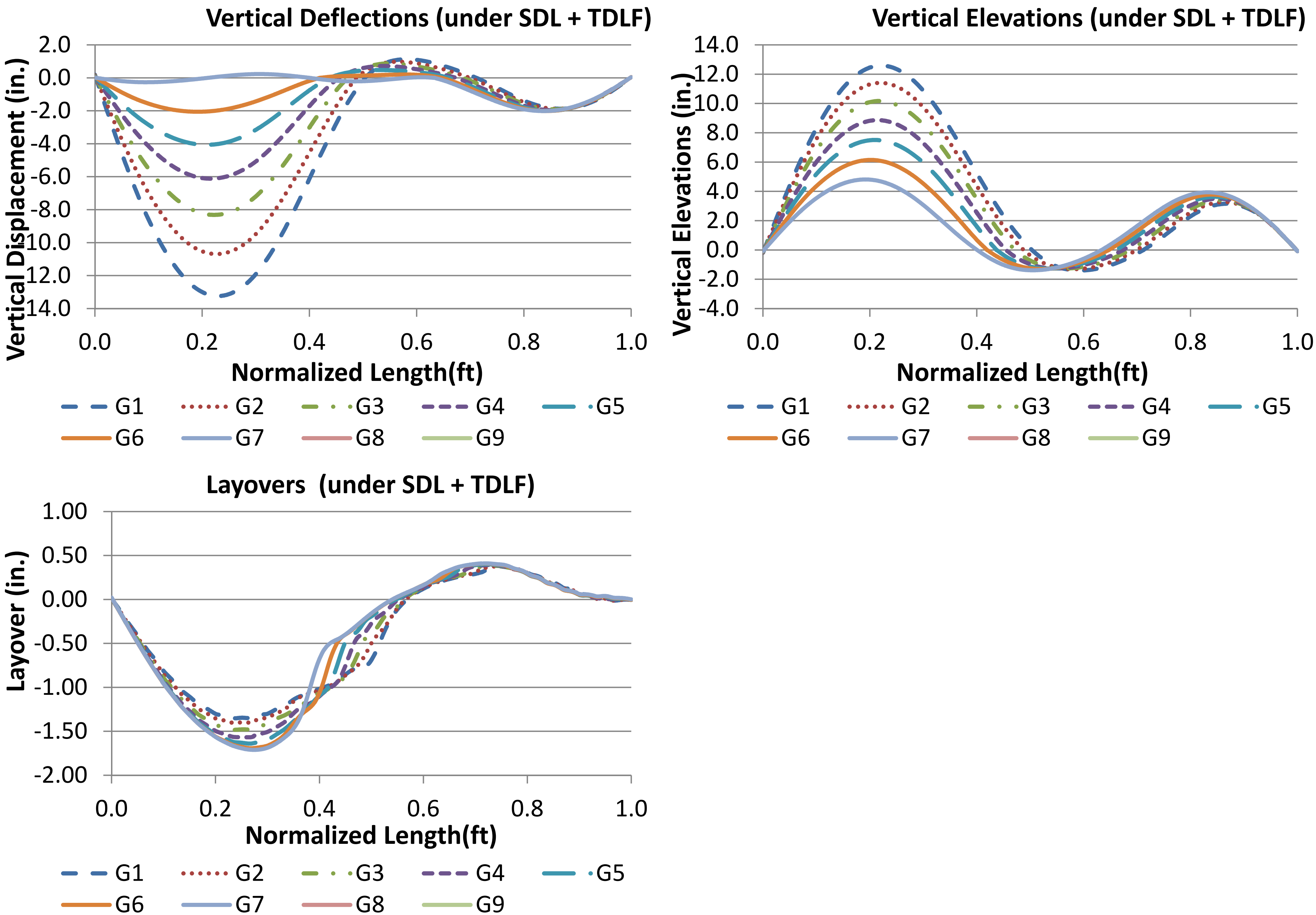


Figure U2-4-7. **Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.**

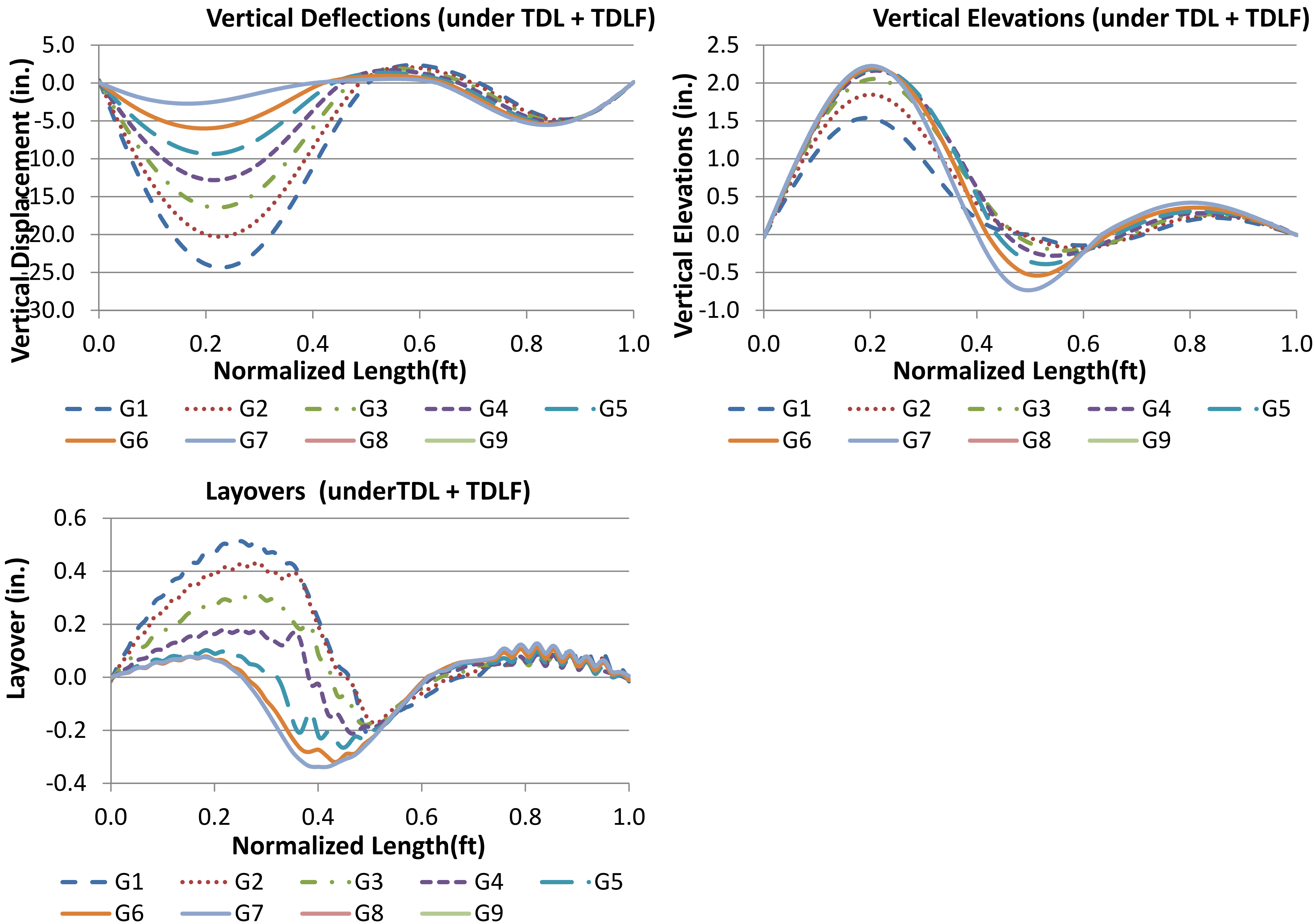


Figure U2-4-8. **Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.**

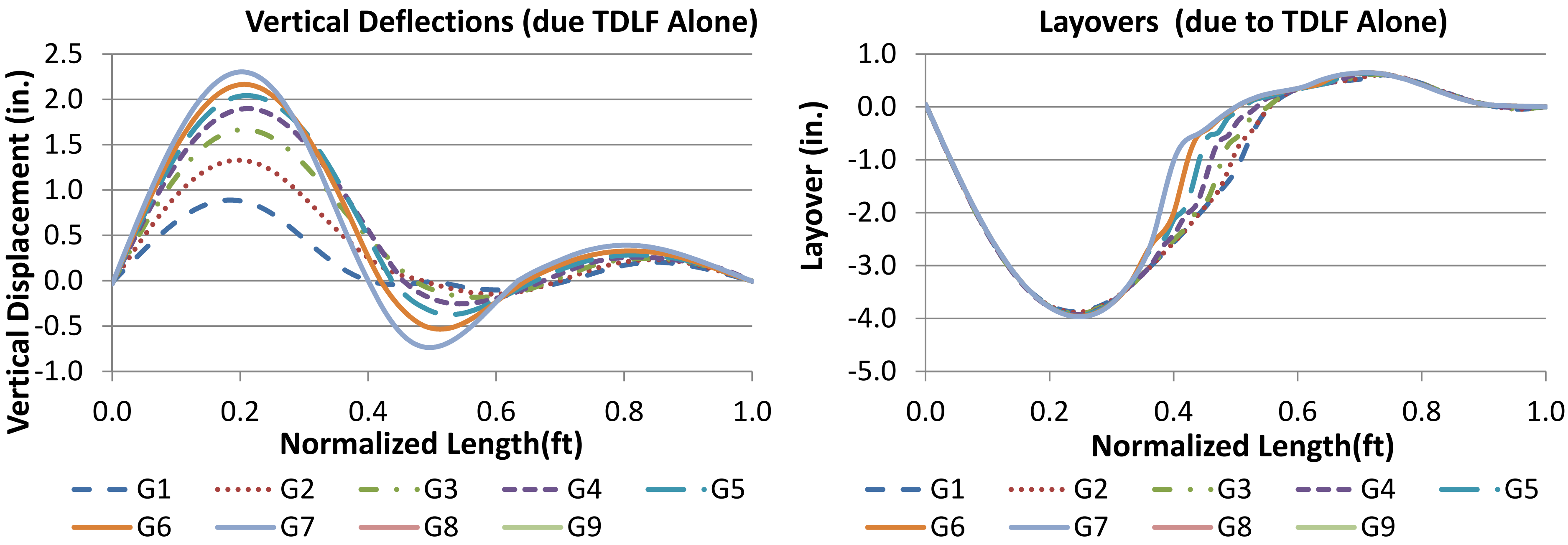


Figure U2-4-9. Bridge displacements due to TDLF detailing effects alone, under NL (in).

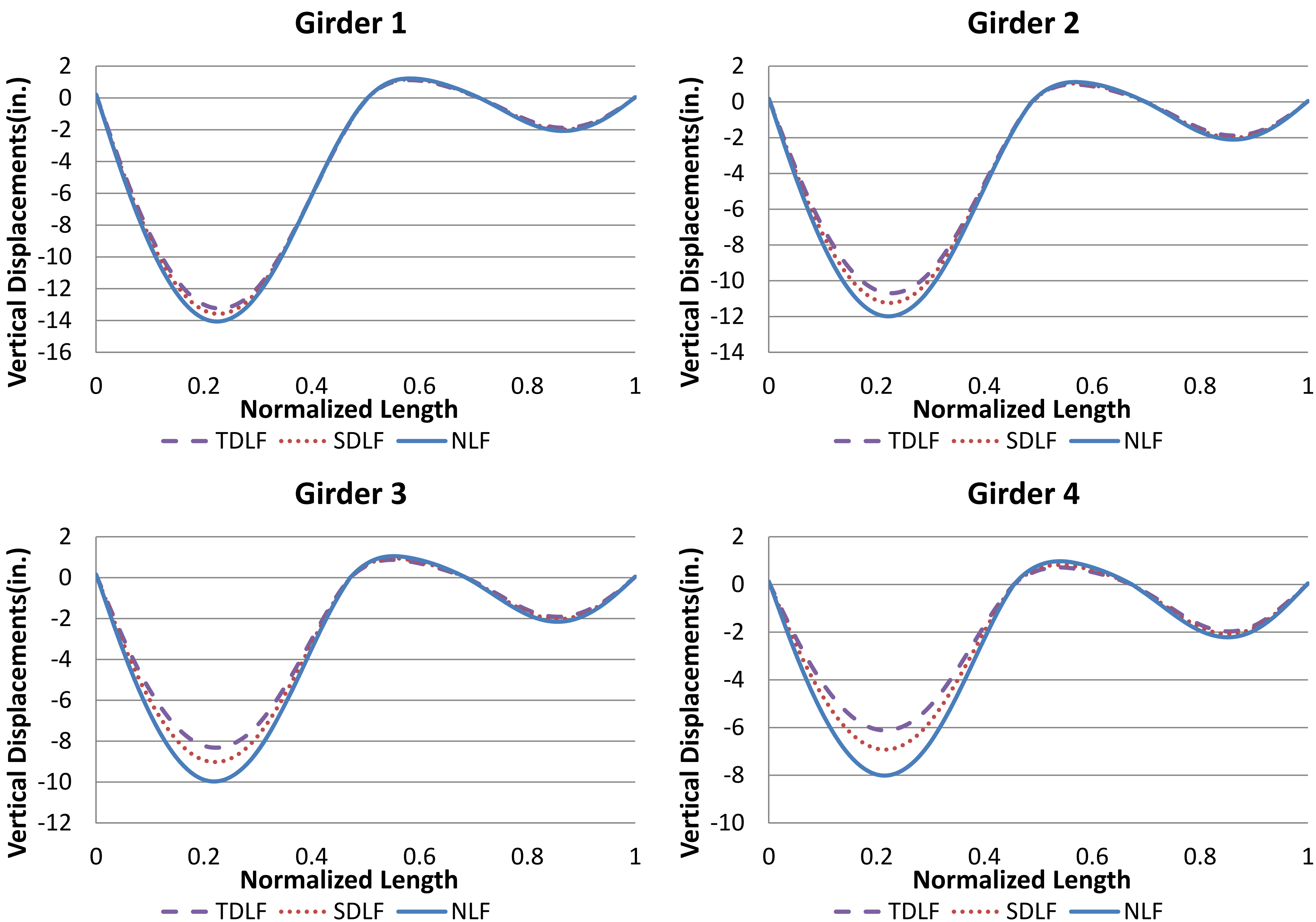


Figure U2-4-10. **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

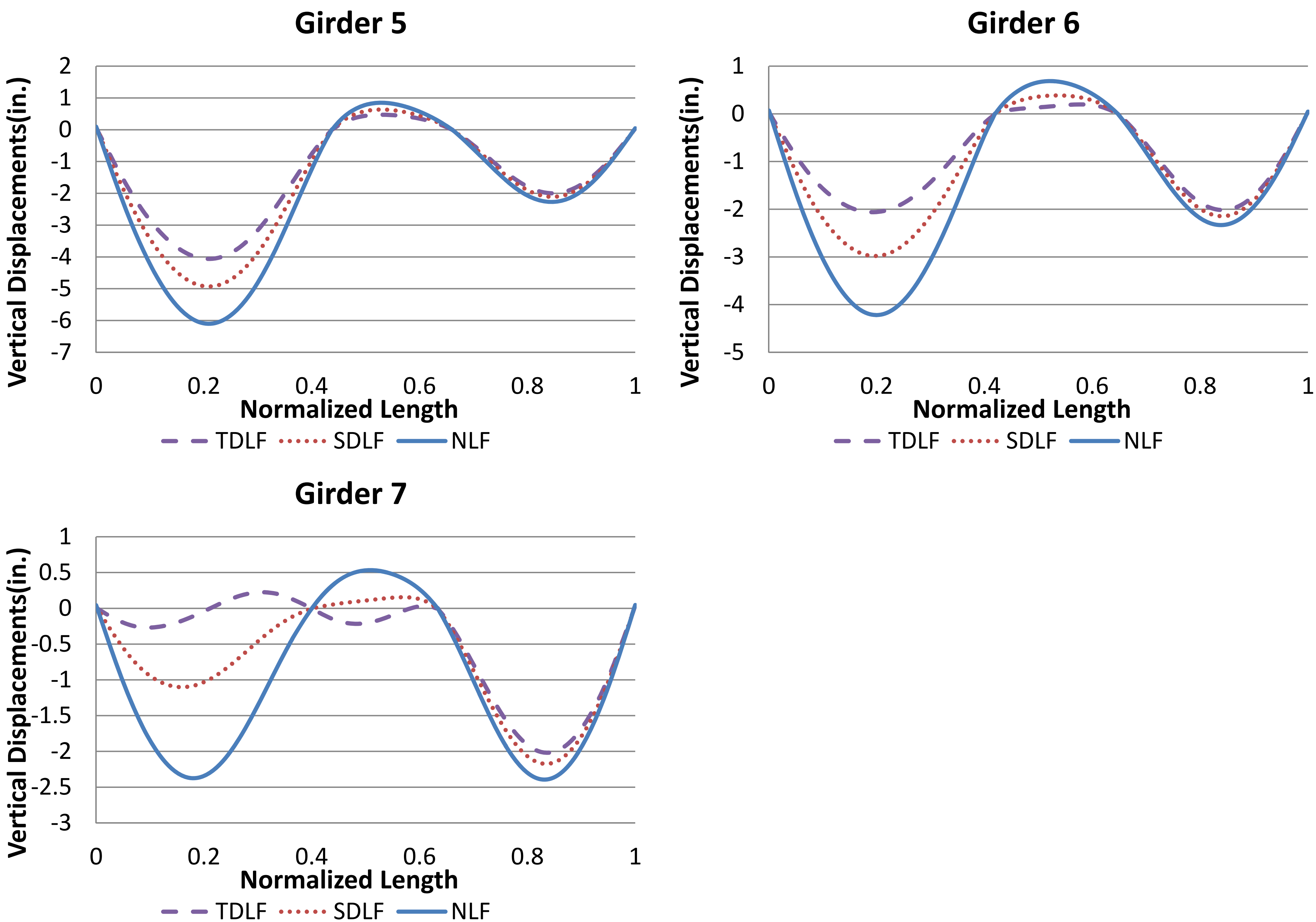


Figure U2-4-10(Continued). Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.

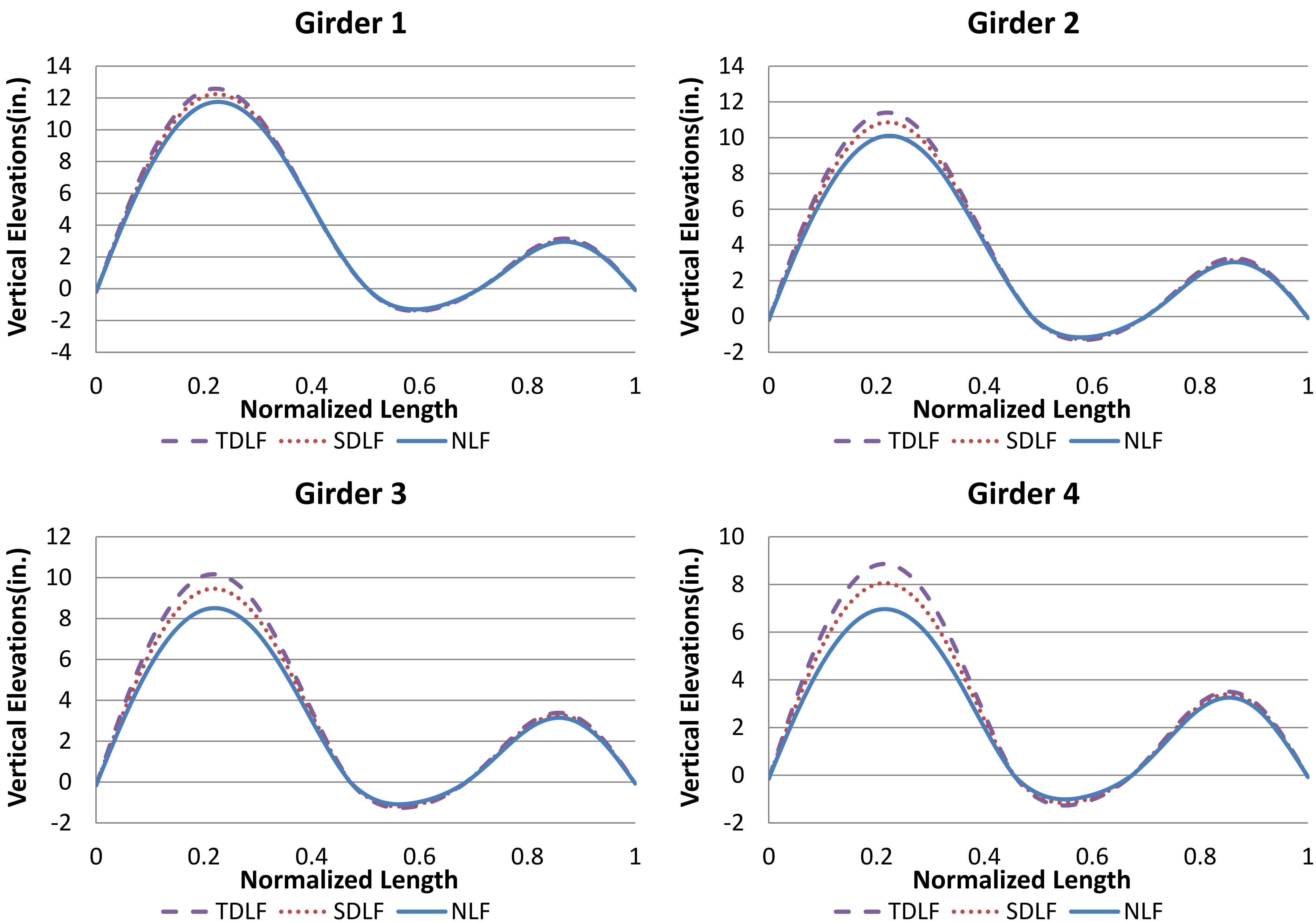


Figure U2-4-11. Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

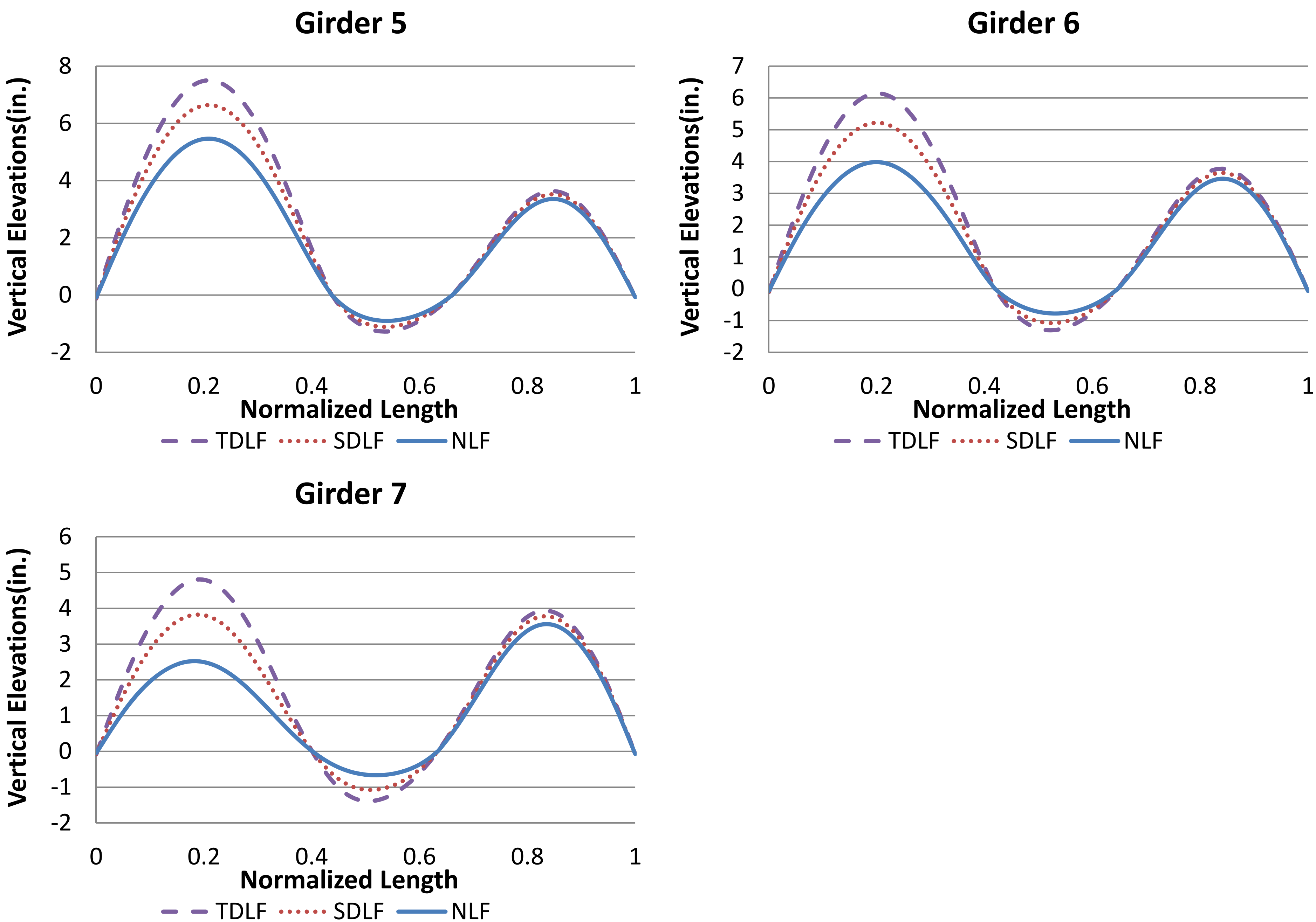


Figure U2-4-11(Continued). Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.

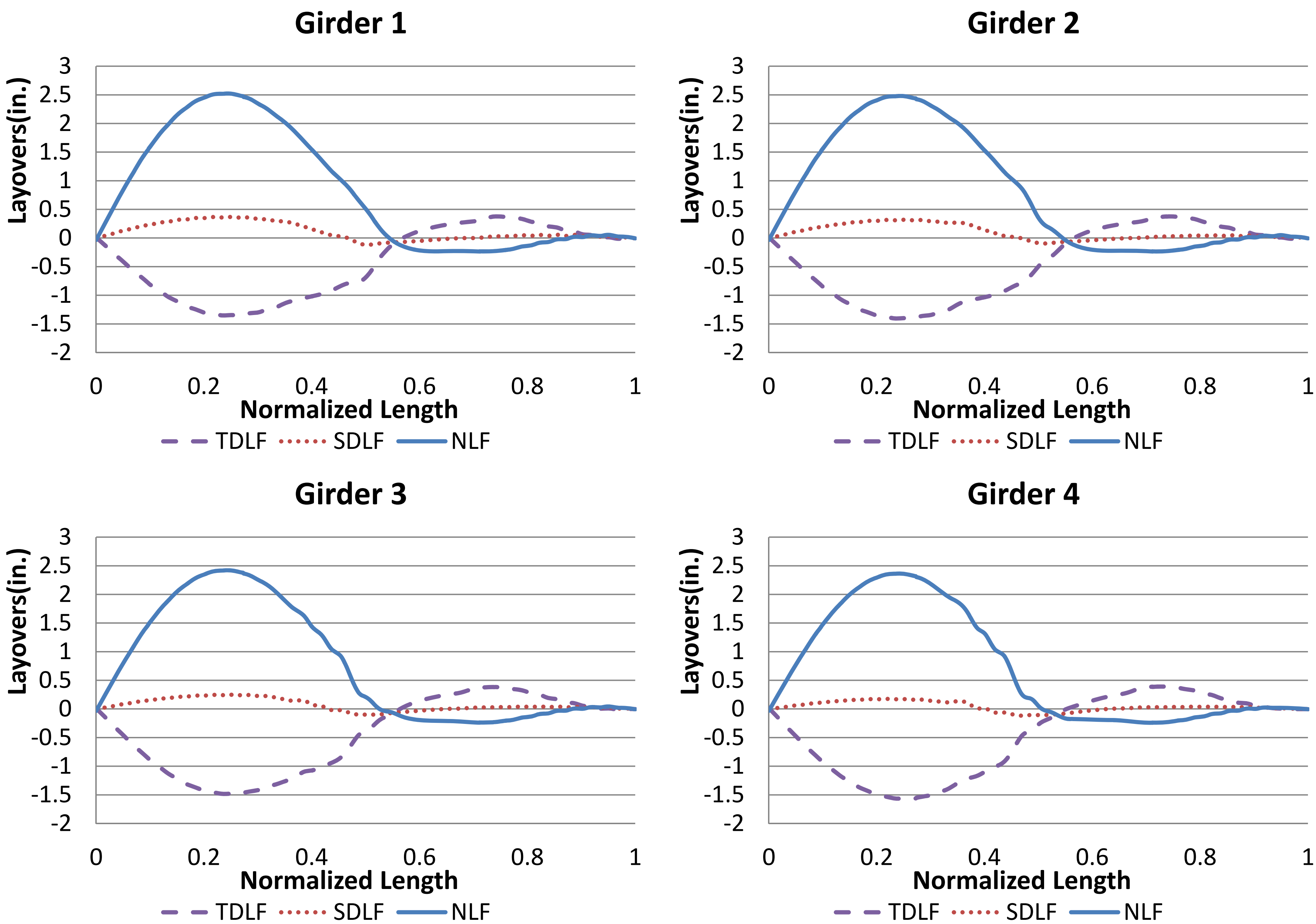


Figure U2-4-12. Comparison of individual girder layovers (in) under SDL for different detailing methods.

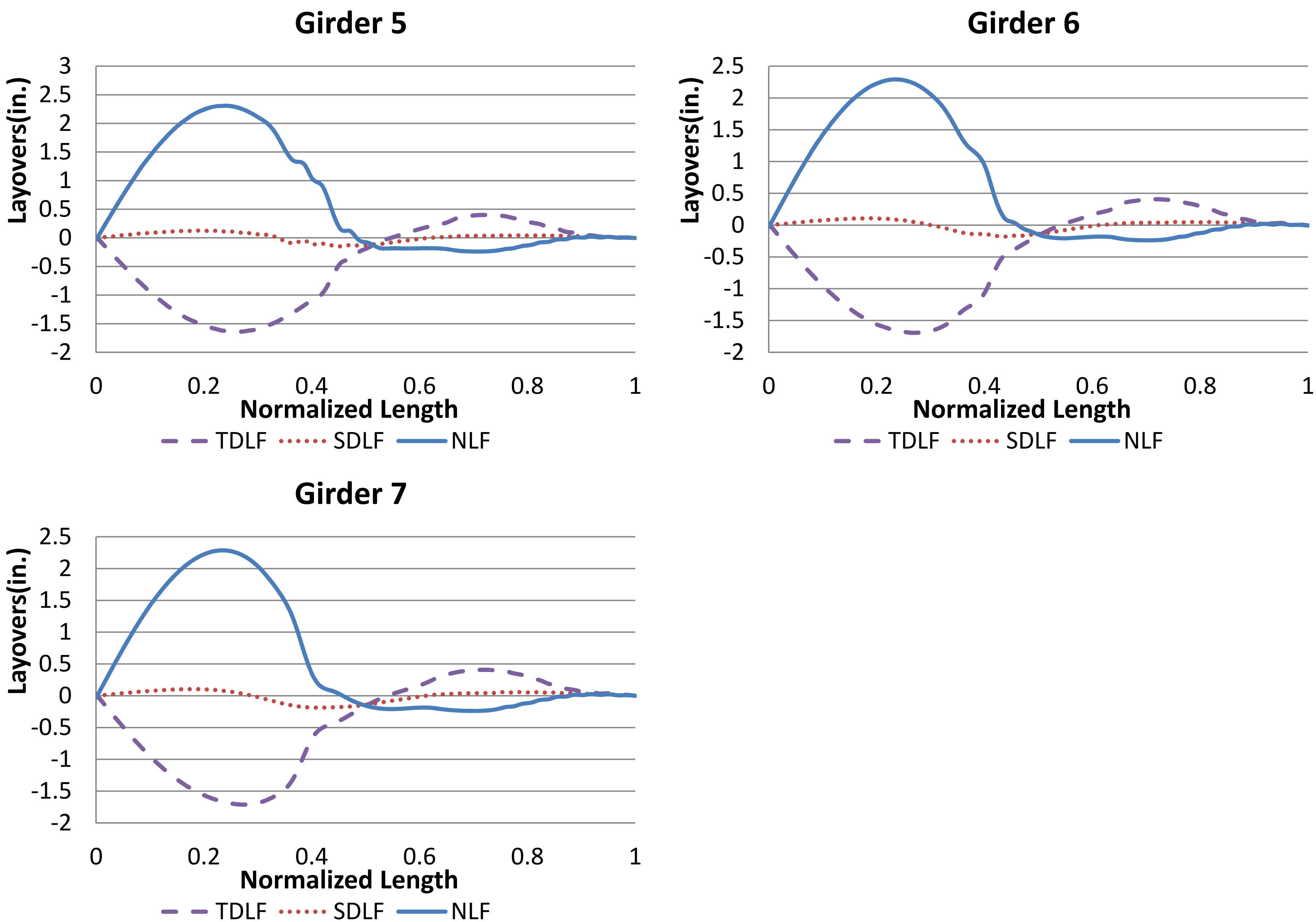


Figure U2-4-12(Continued). Comparison of individual girder layovers (in) under SDL for different detailing methods.

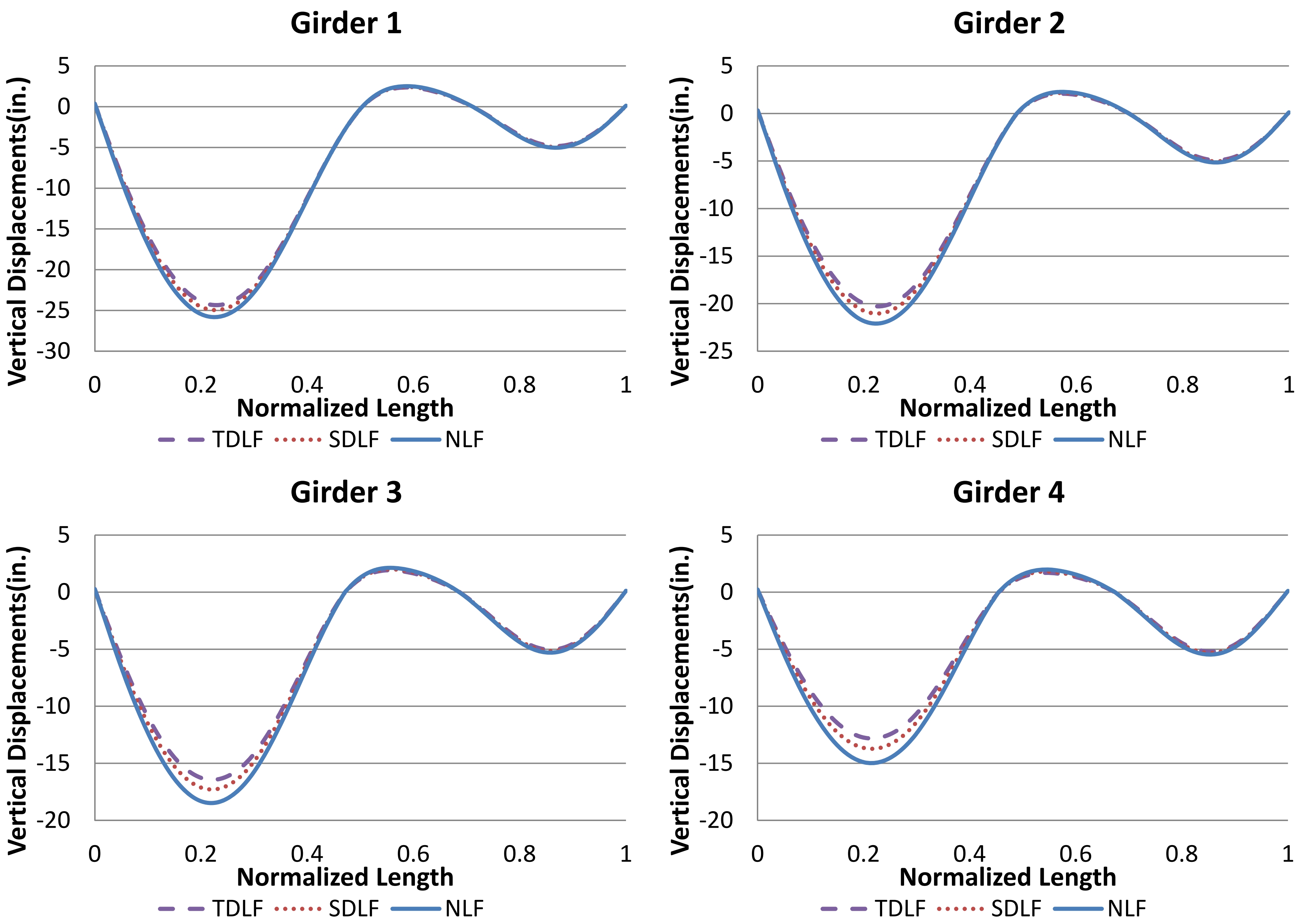


Figure U2-4-13. **Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.**

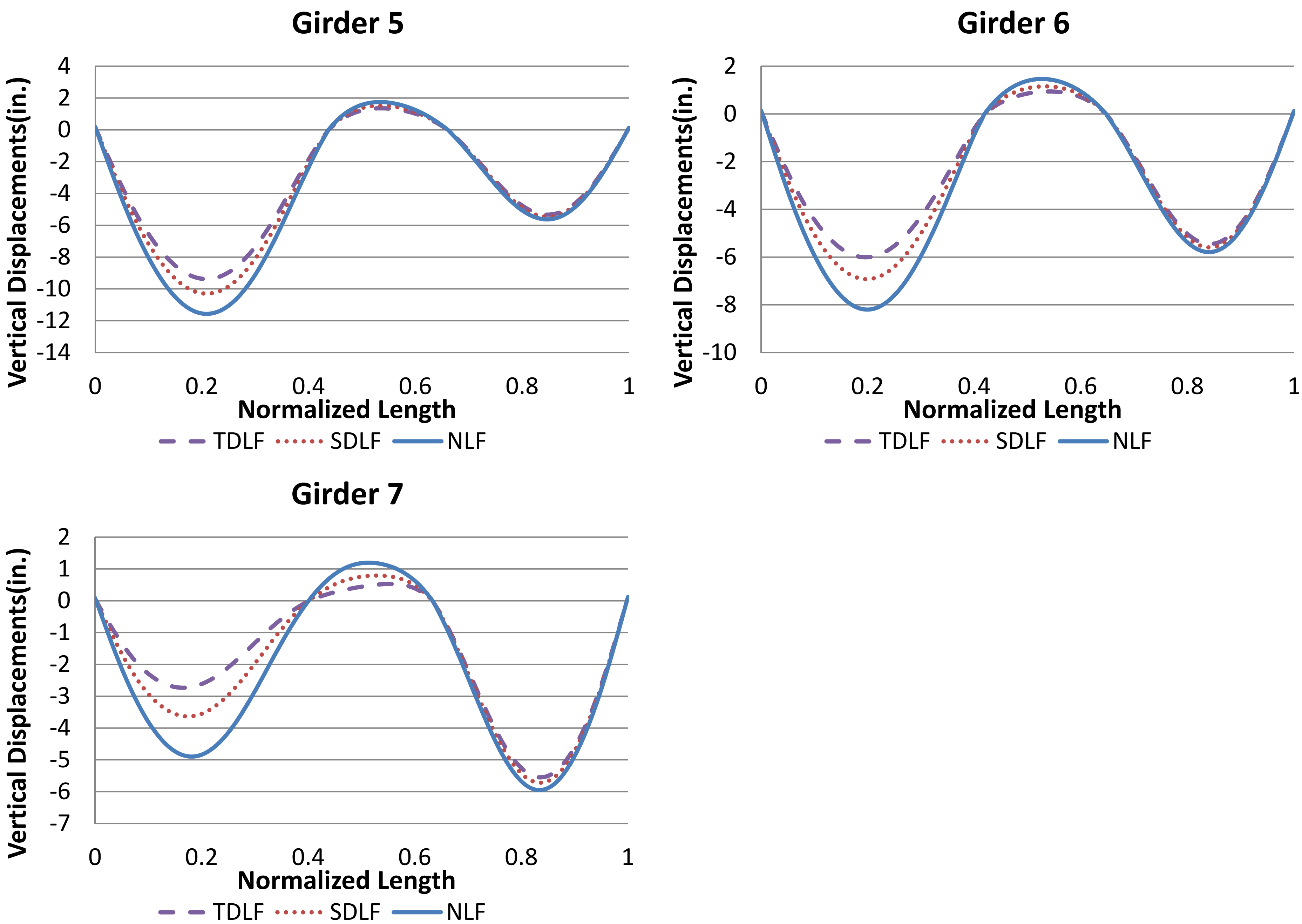


Figure U2-4-13(Continued). Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

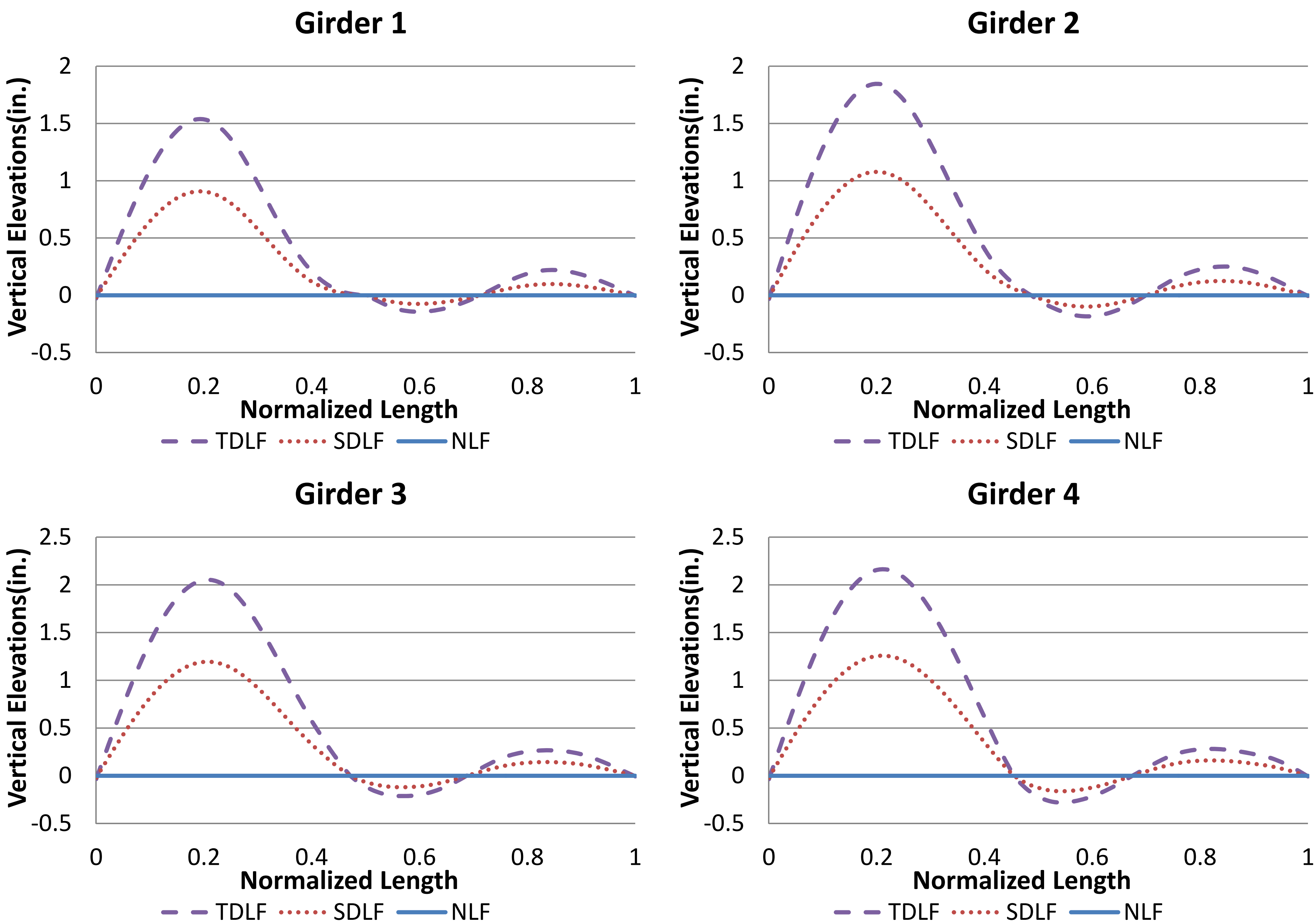
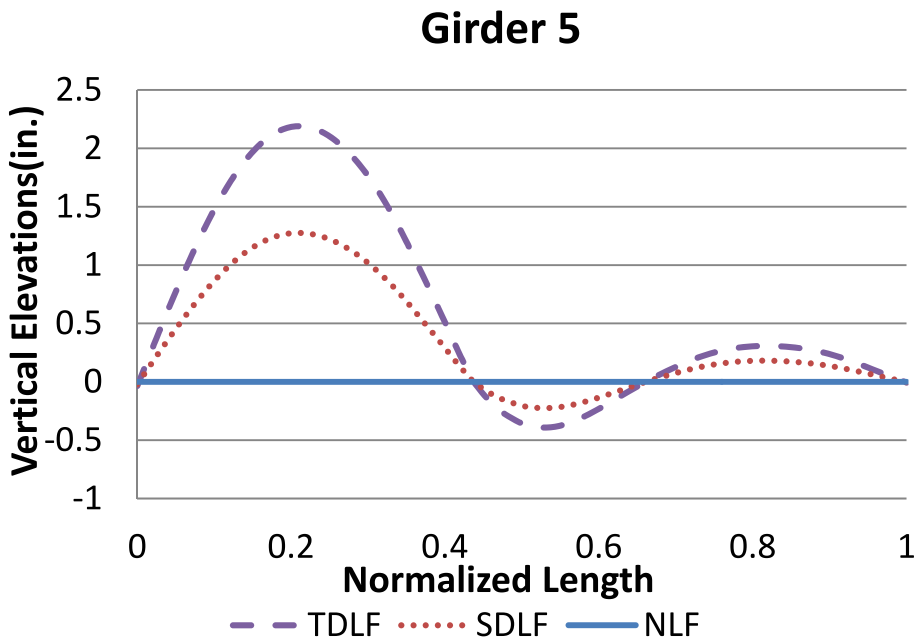
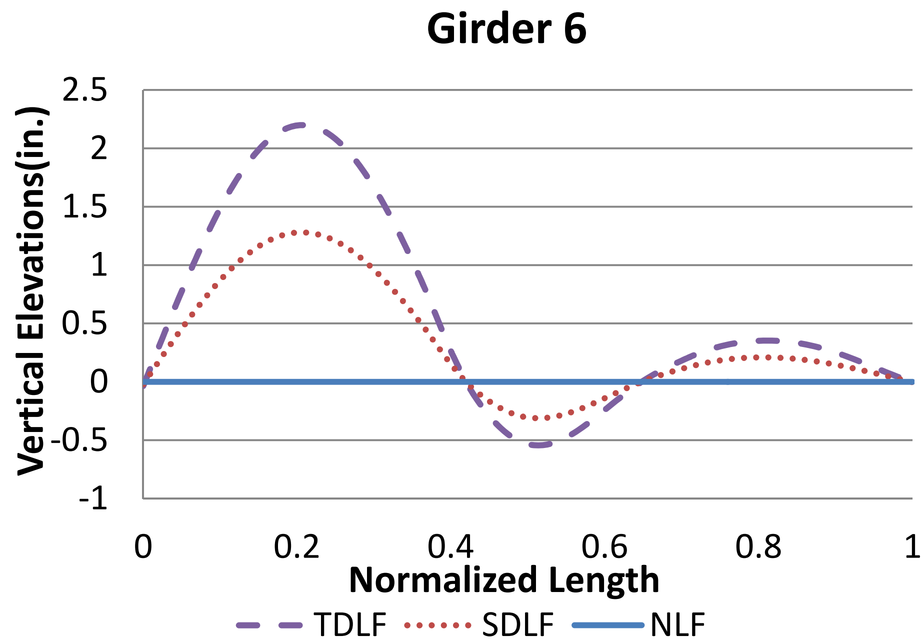


Figure U2-4-14. **Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.**





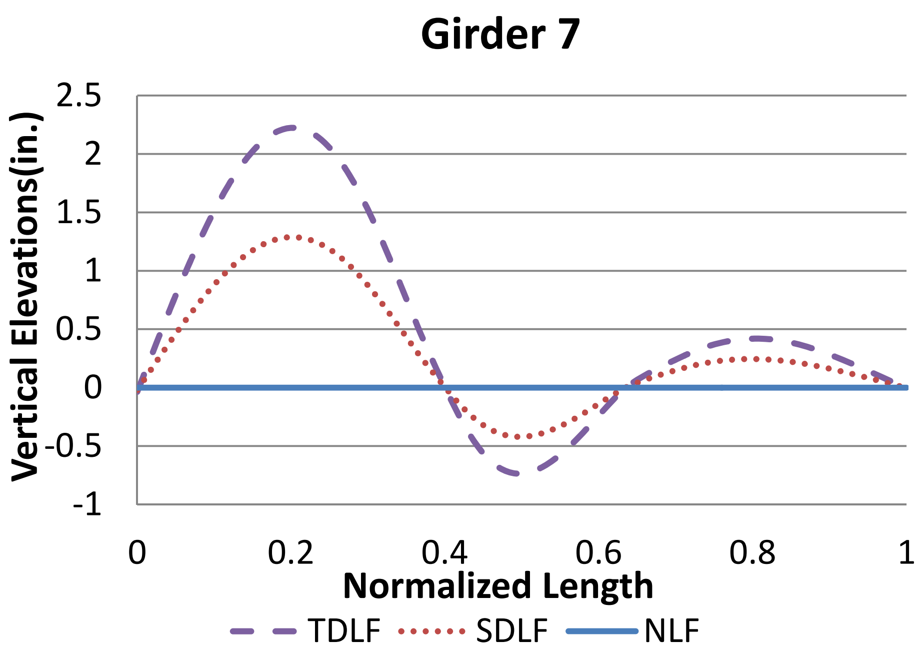


Figure U2-4-14(Continued). Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.

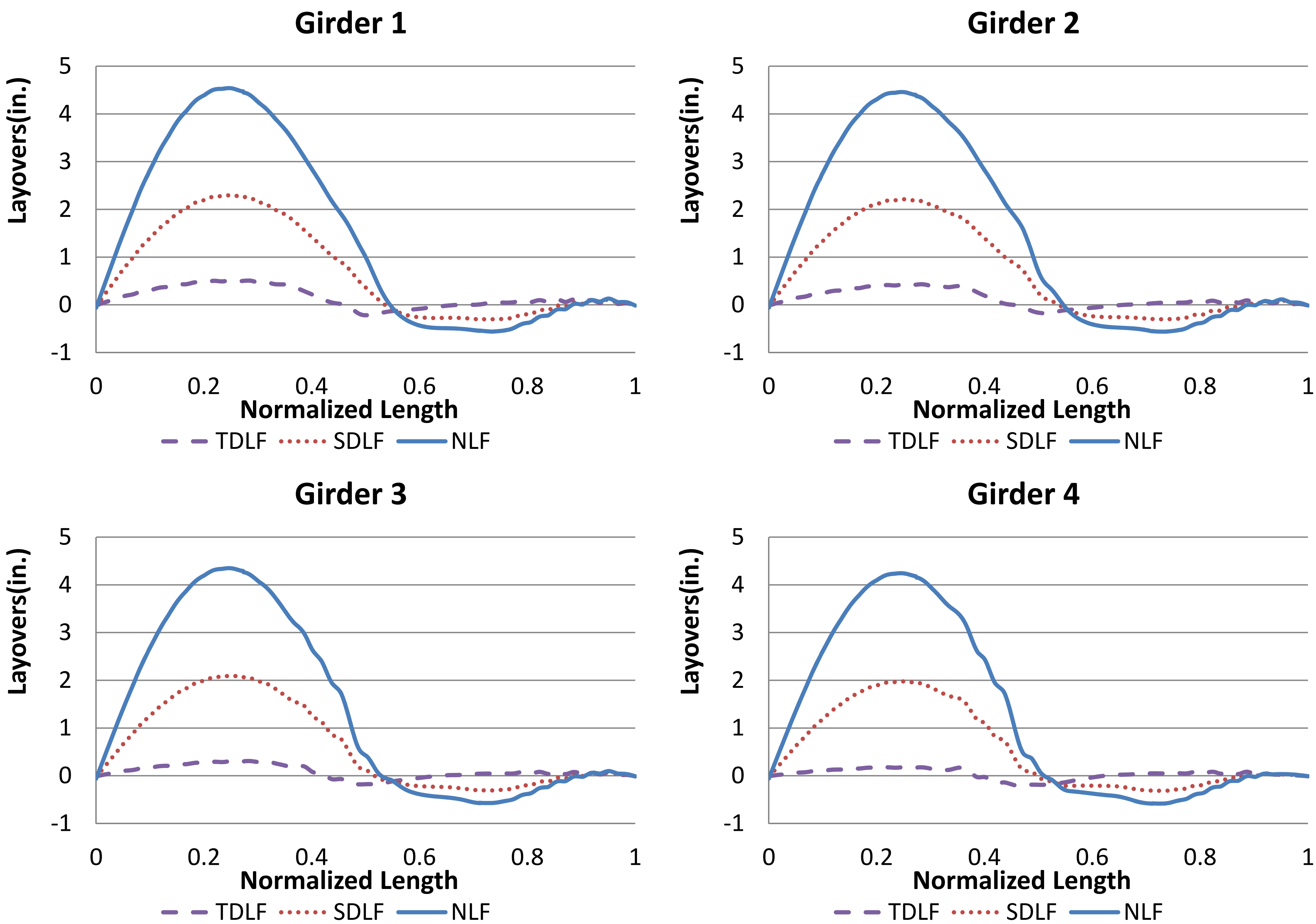
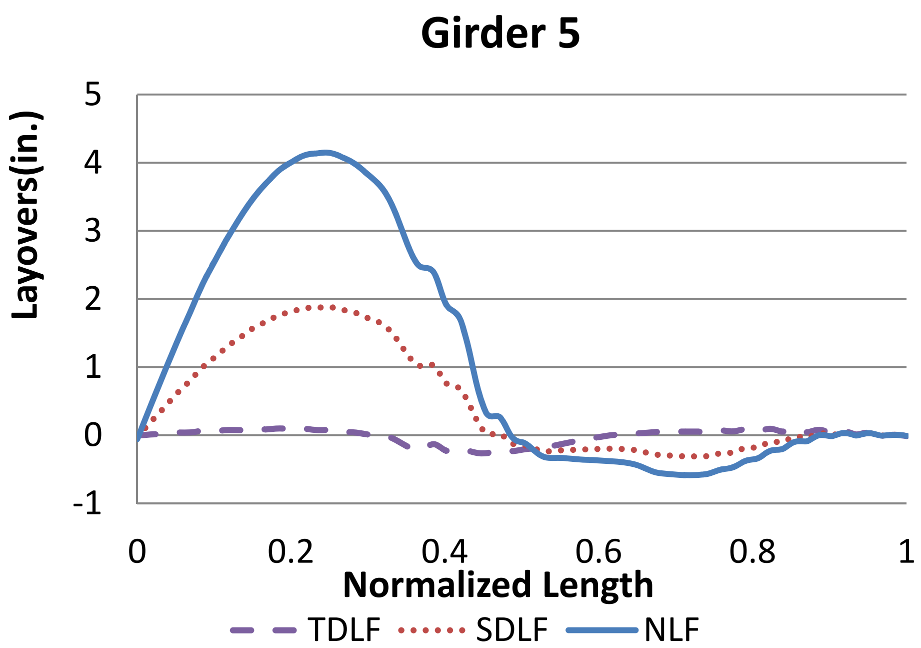
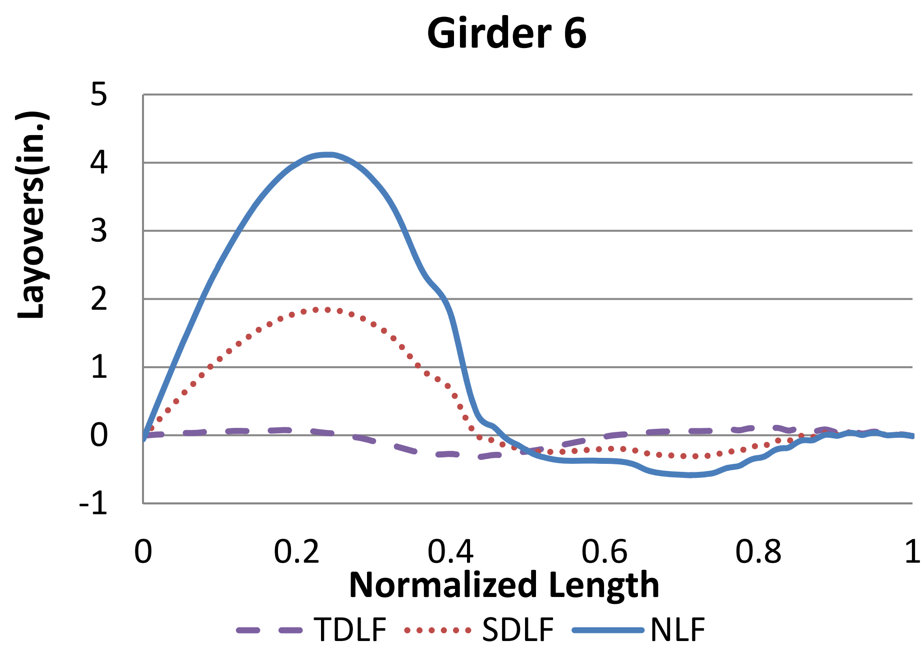


Figure U2-4-15. Comparison of individual girder layovers (in) under TDL for different detailing methods.





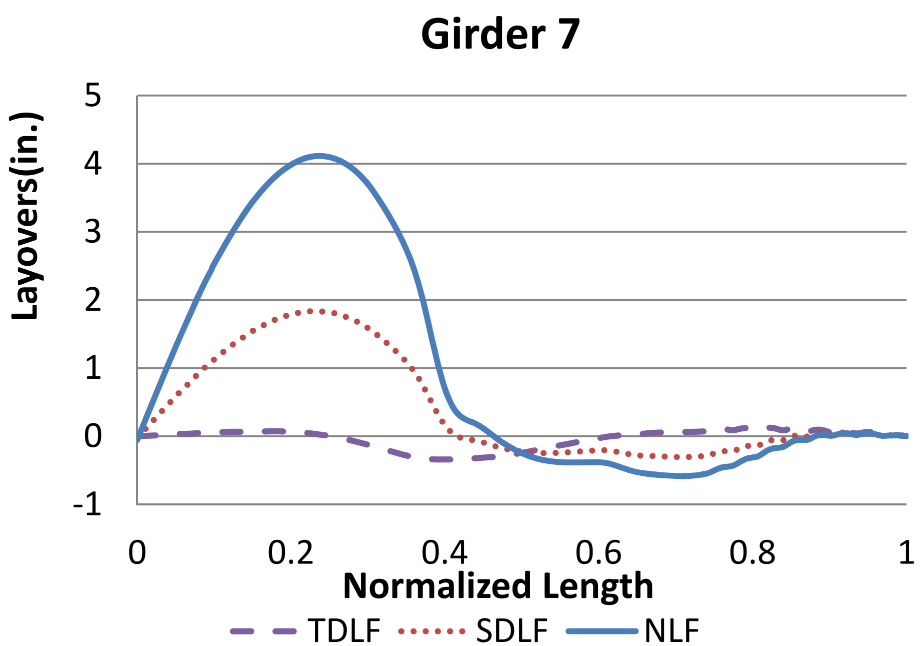


Figure U2-4-15(Continued). Comparison of individual girder layovers (in) under TDL for different detailing methods.

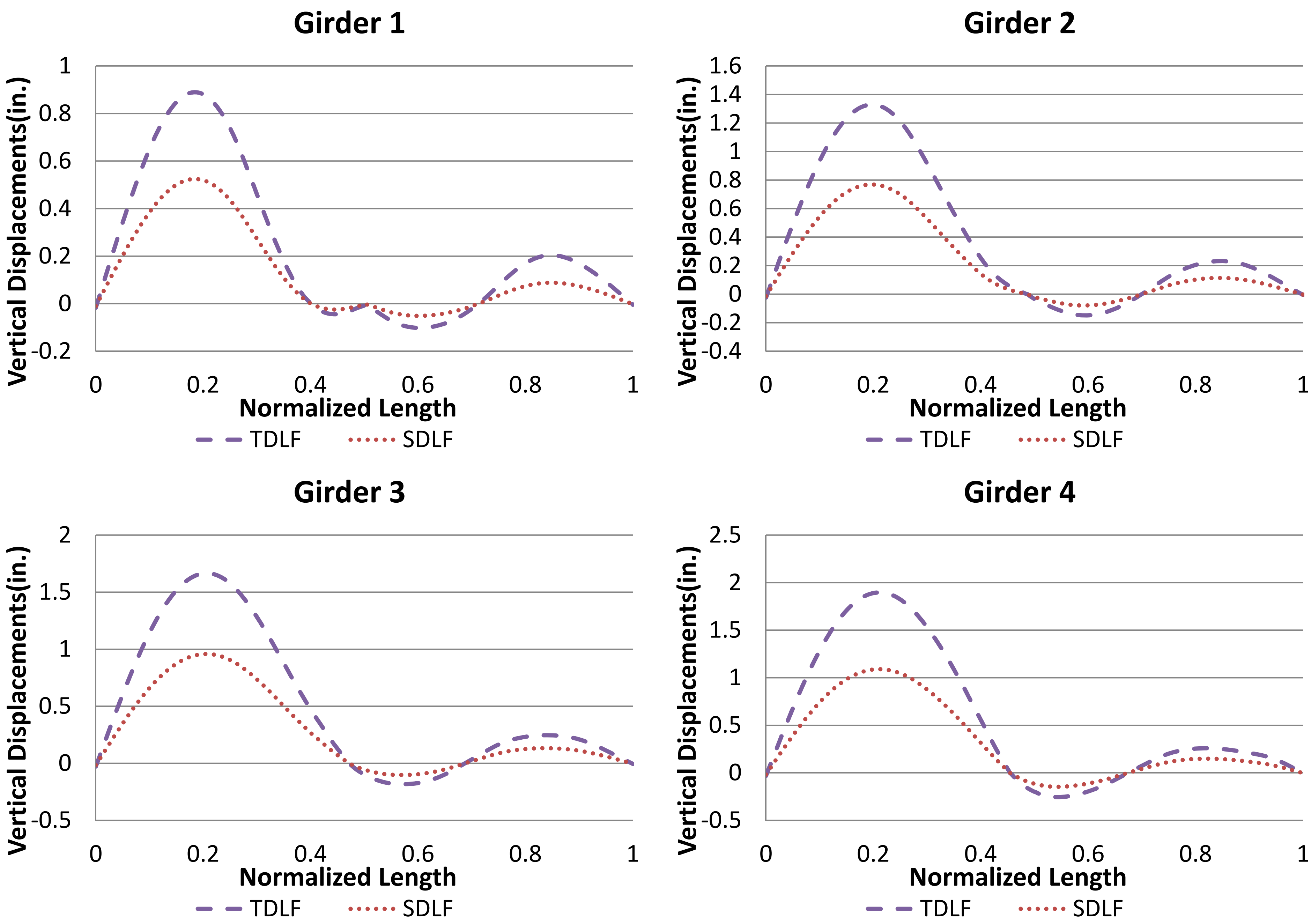


Figure U2-4-16. Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

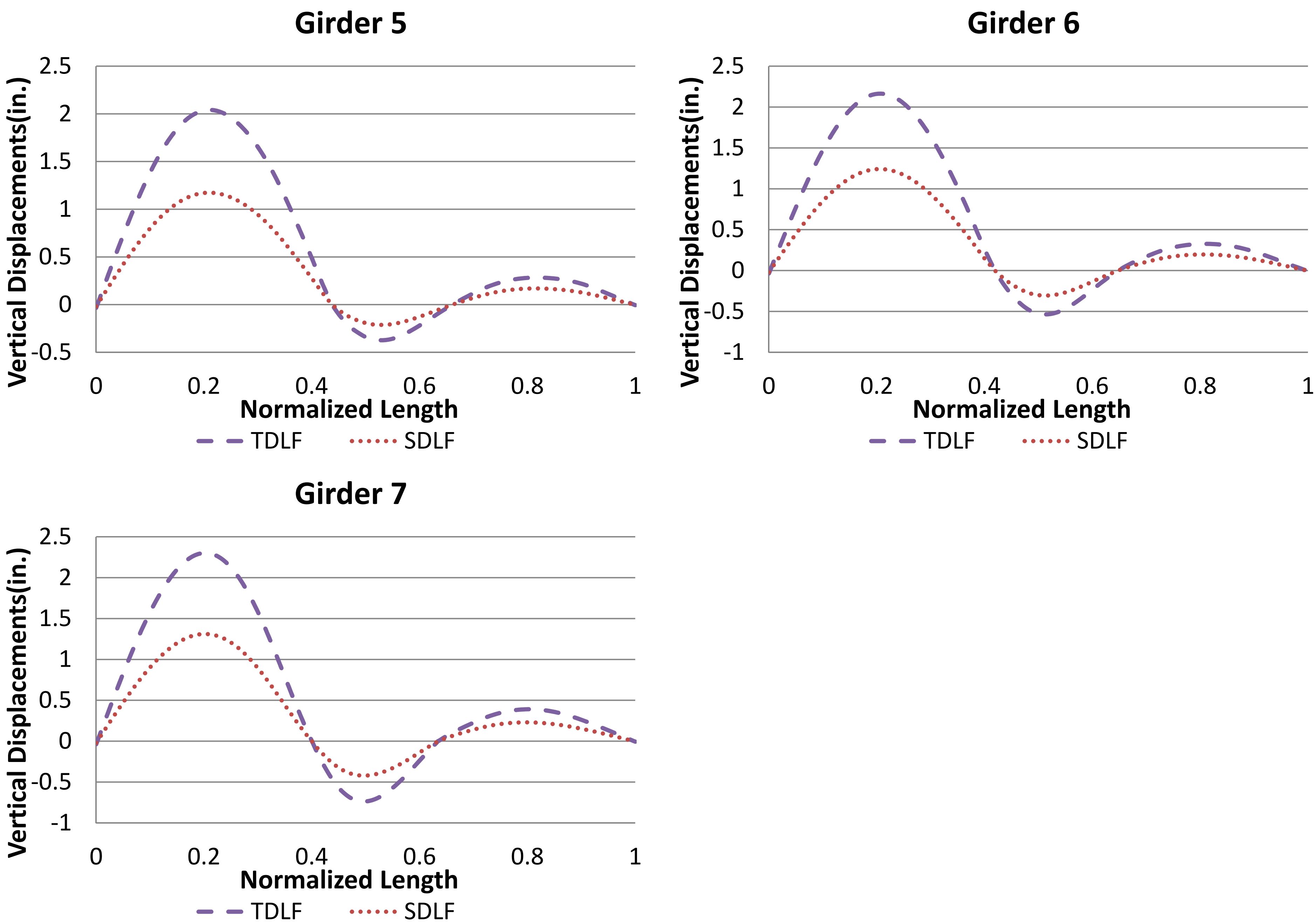


Figure U2-4-16(Continued). Comparison of individual girder vertical displacements (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

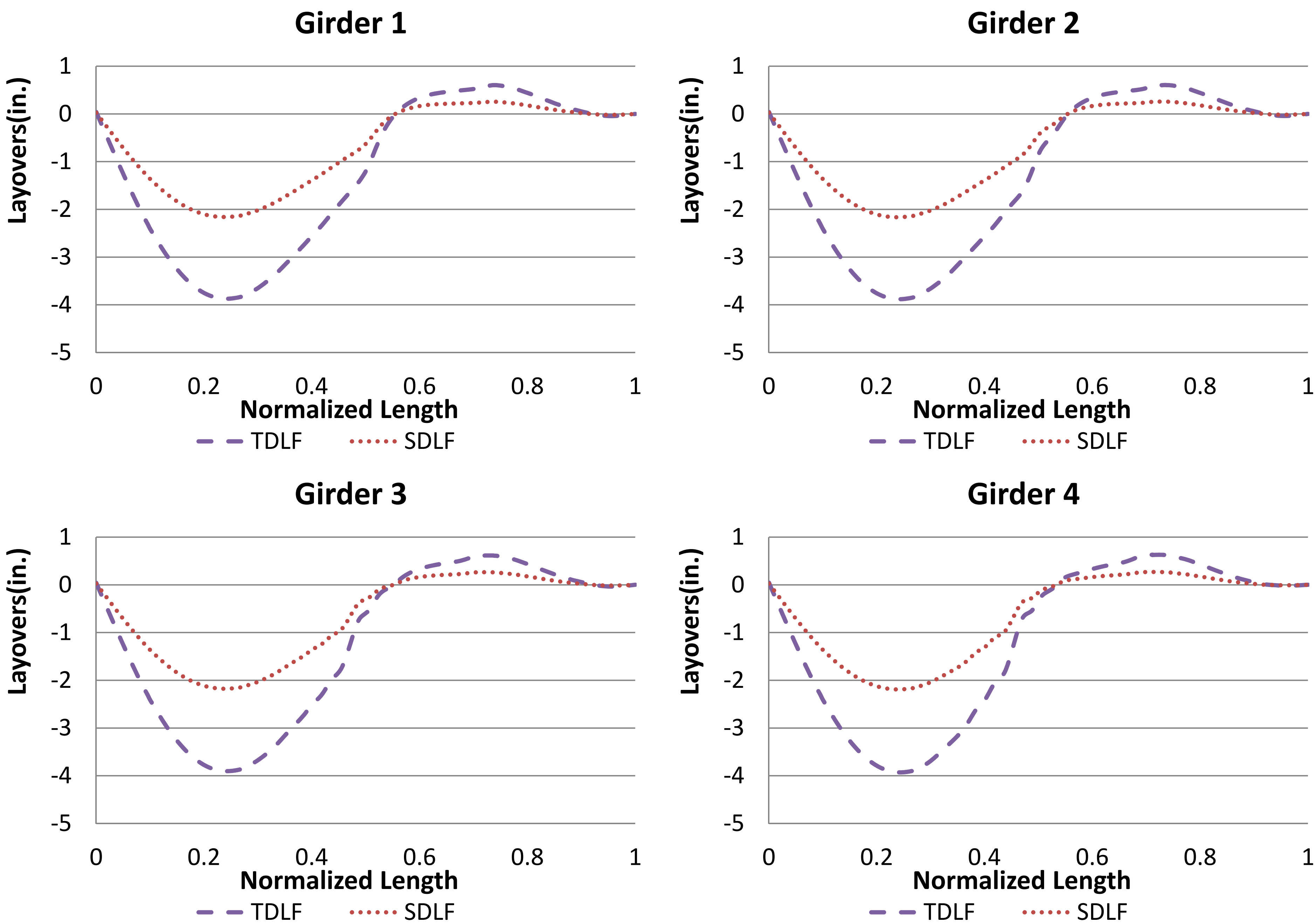
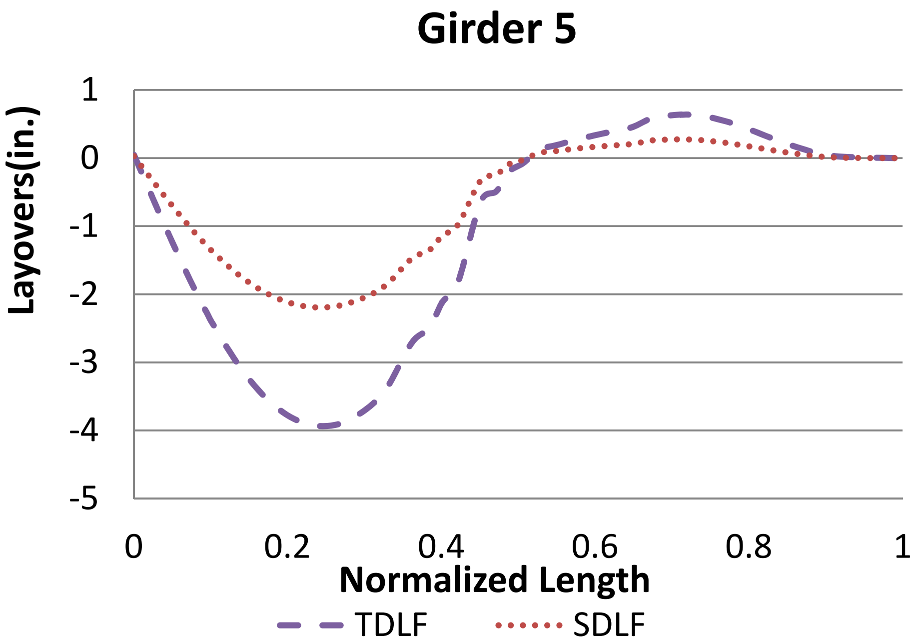
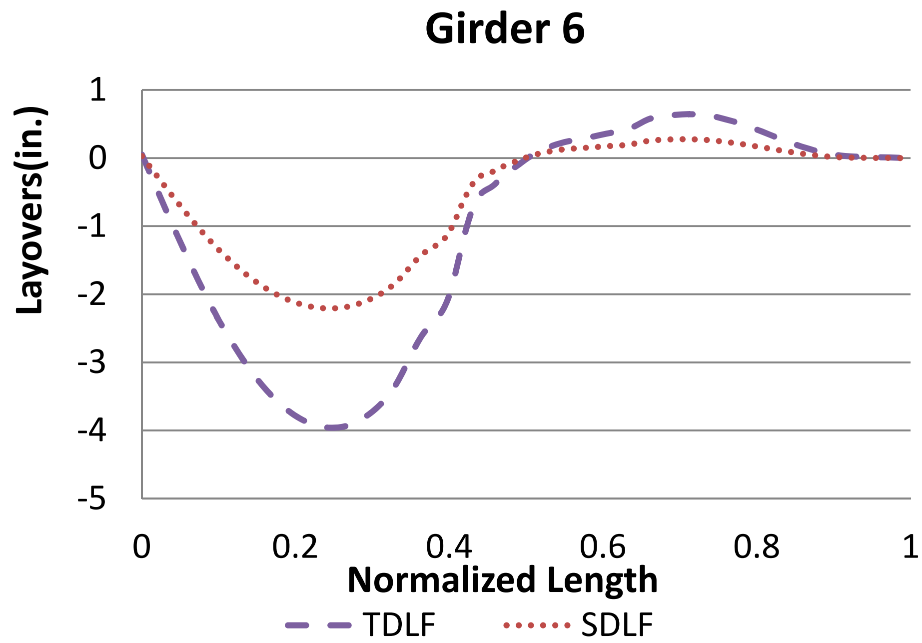


Figure U2-4-17. **Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.**





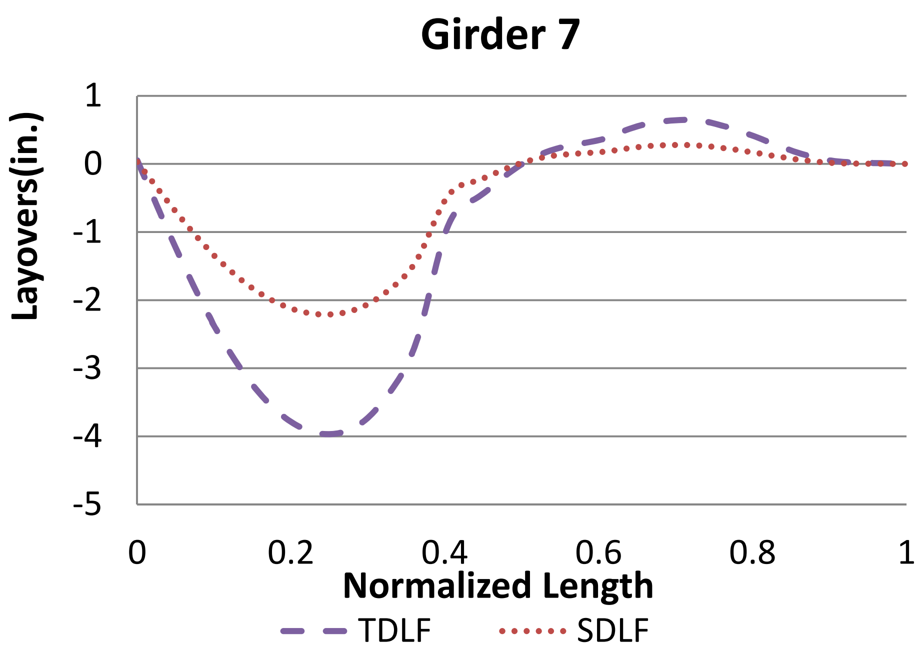


Figure U2-4-17(Continued). Comparison of individual girder layovers (in) due to detailing effects alone for SLDF and TDLF detailing, under NL.

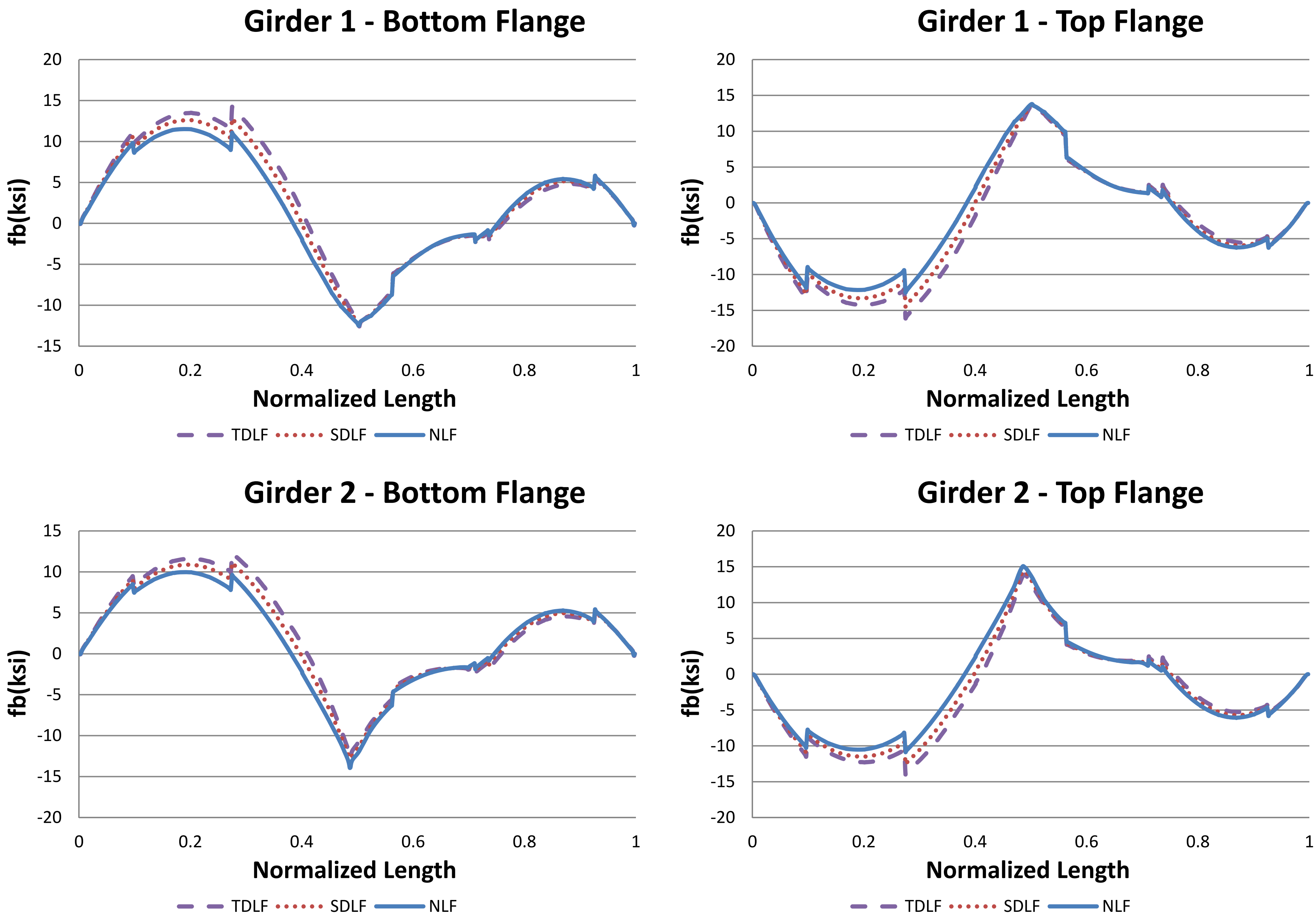


Figure U2-4-18. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

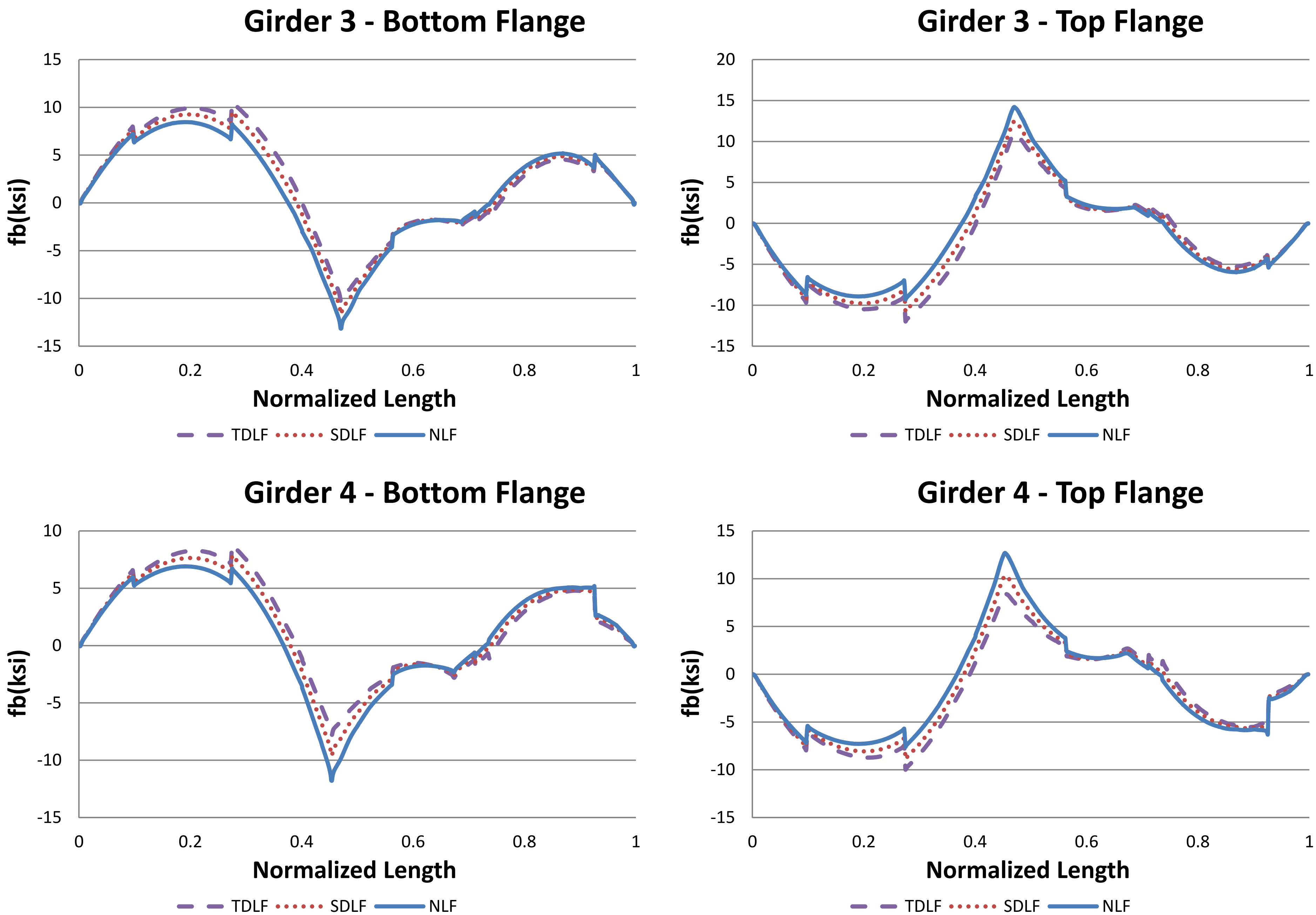


Figure U2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

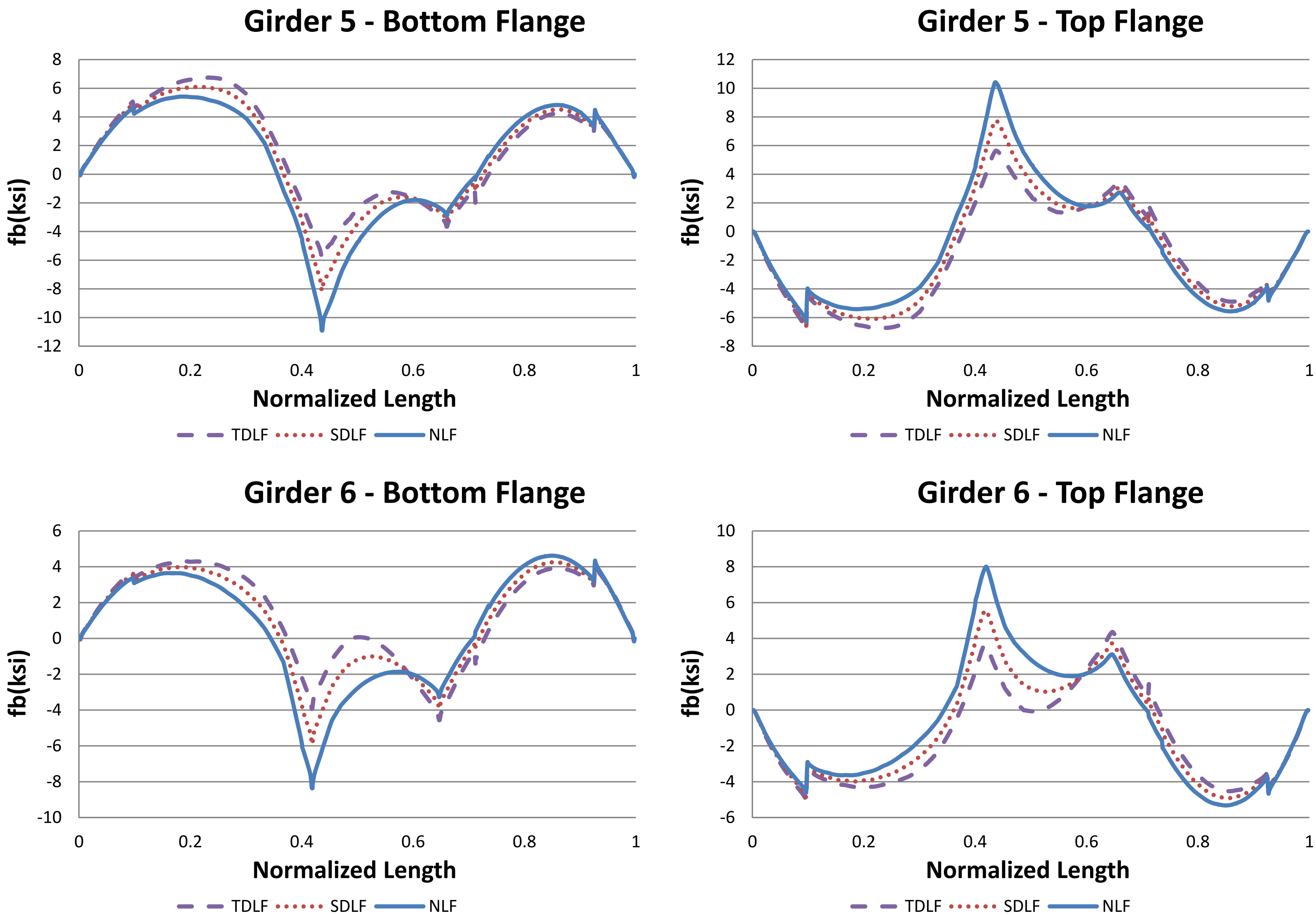
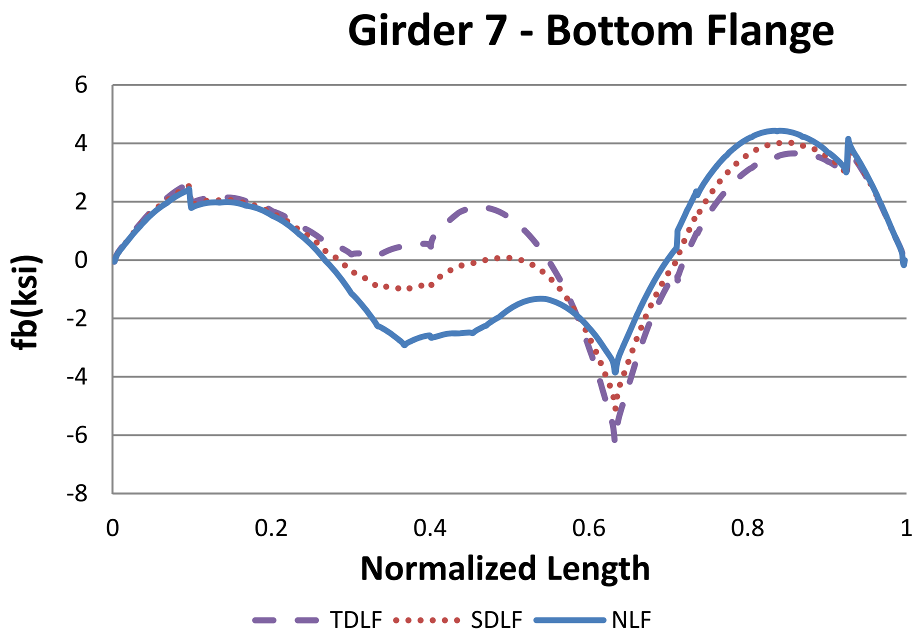


Figure U2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.



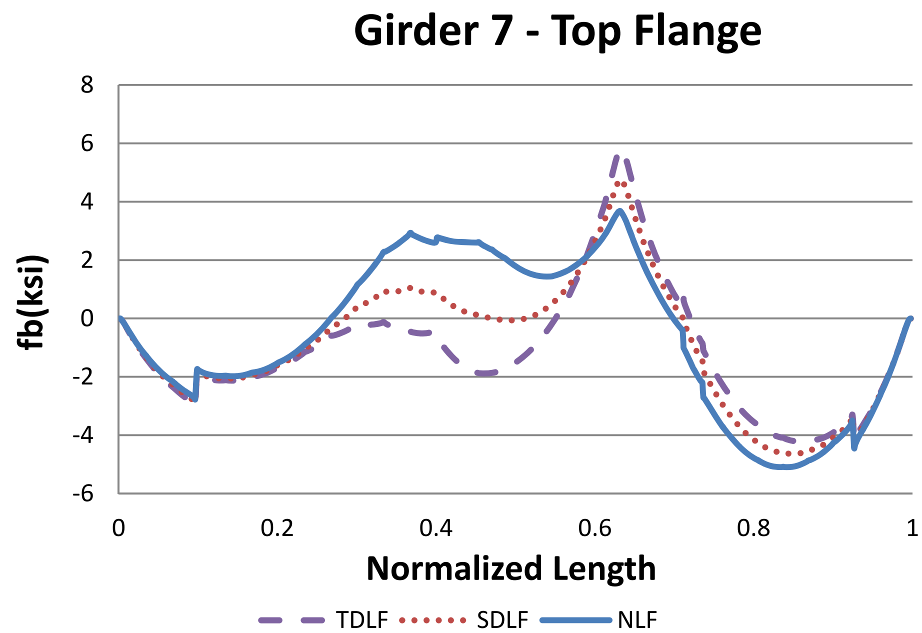


Figure U2-4-18(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

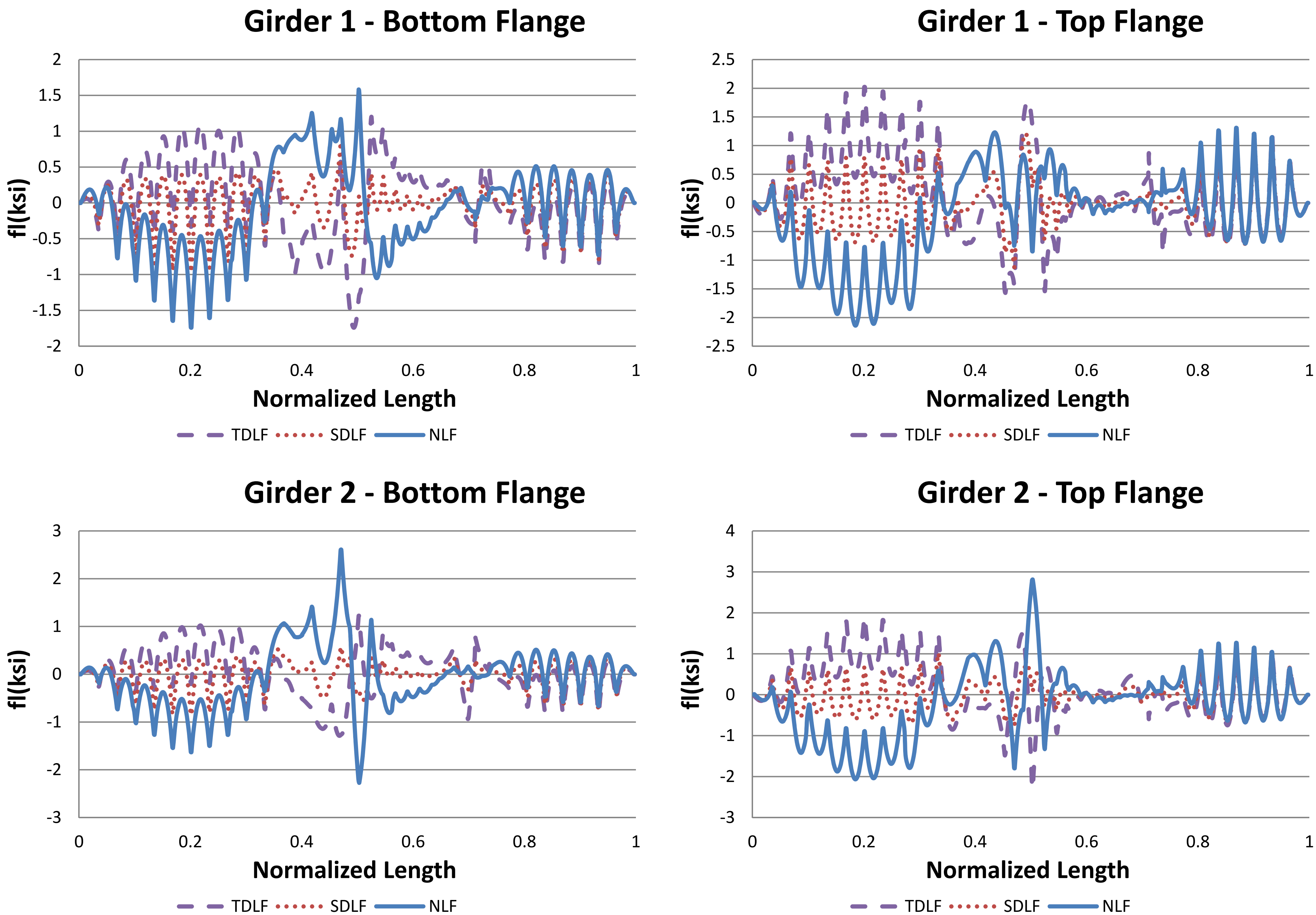


Figure U2-4-19. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

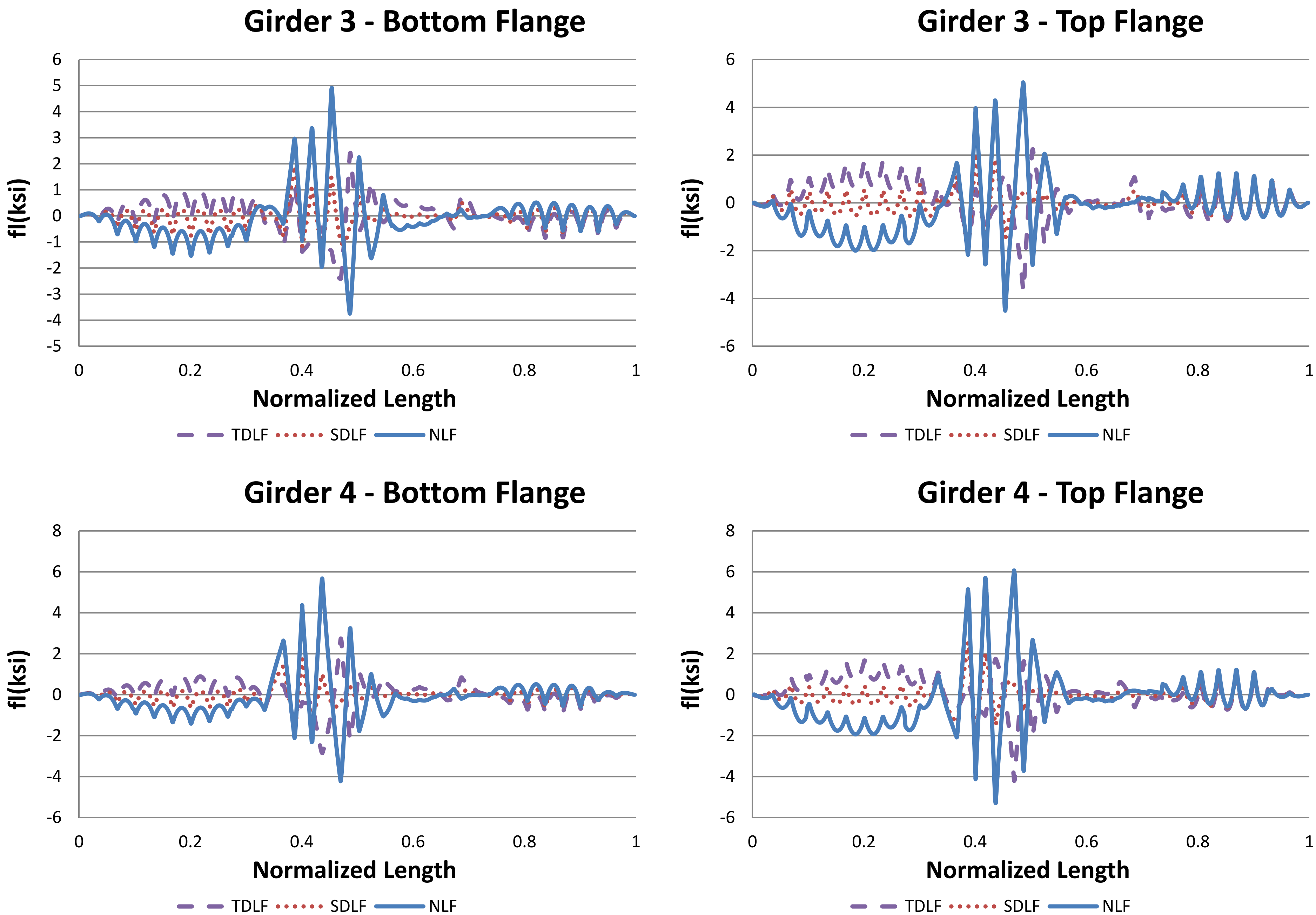


Figure U2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

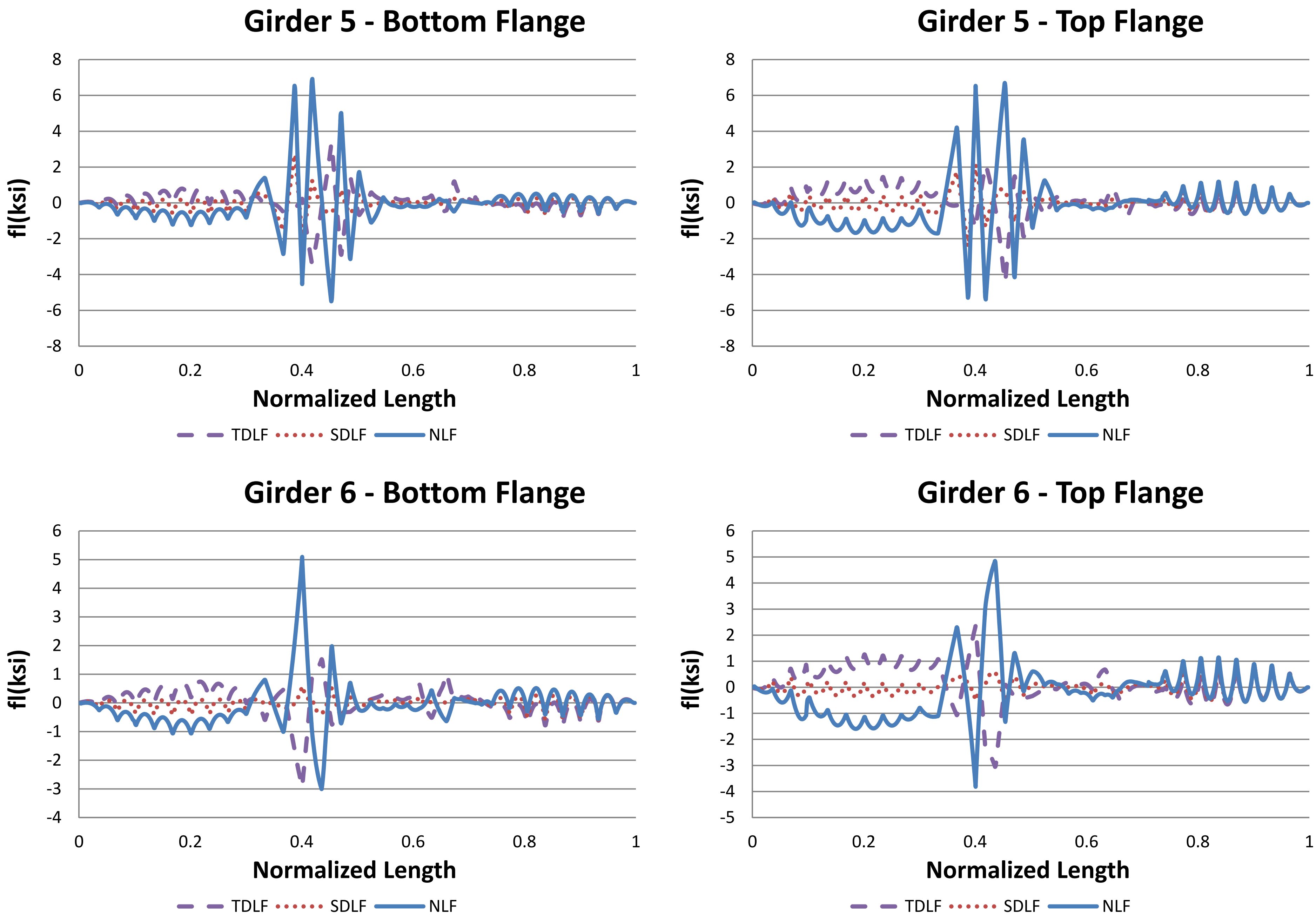
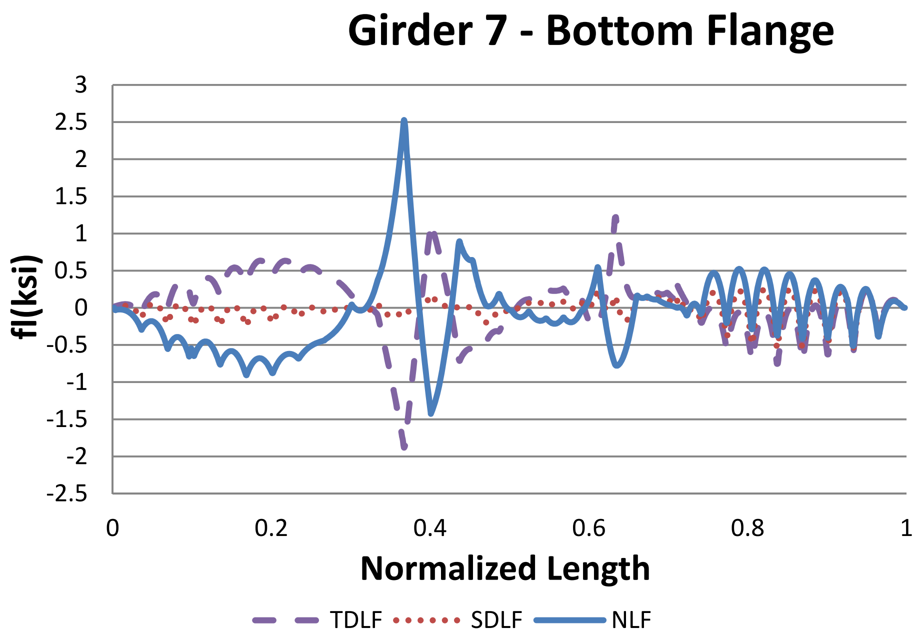


Figure U2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.



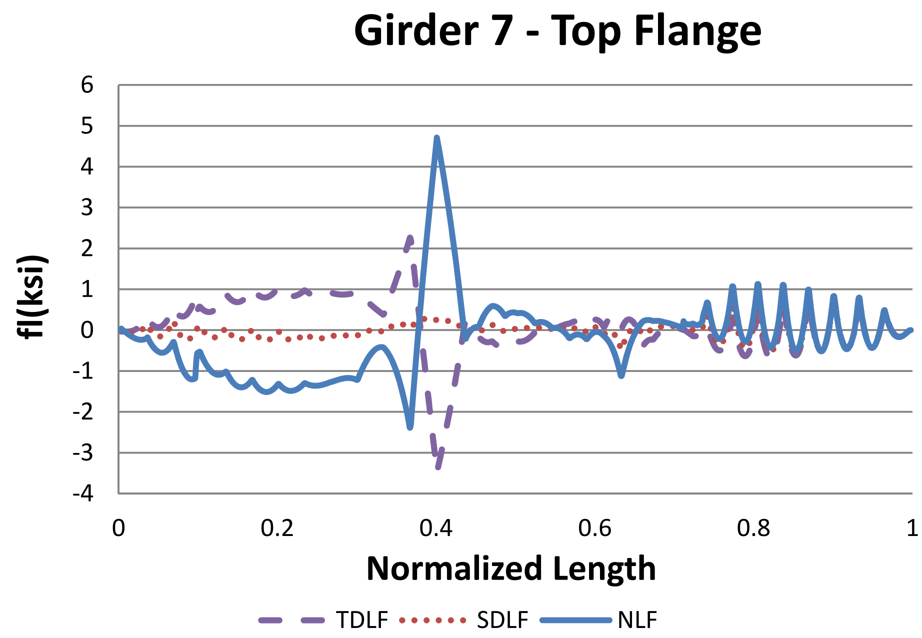


Figure U2-4-19(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

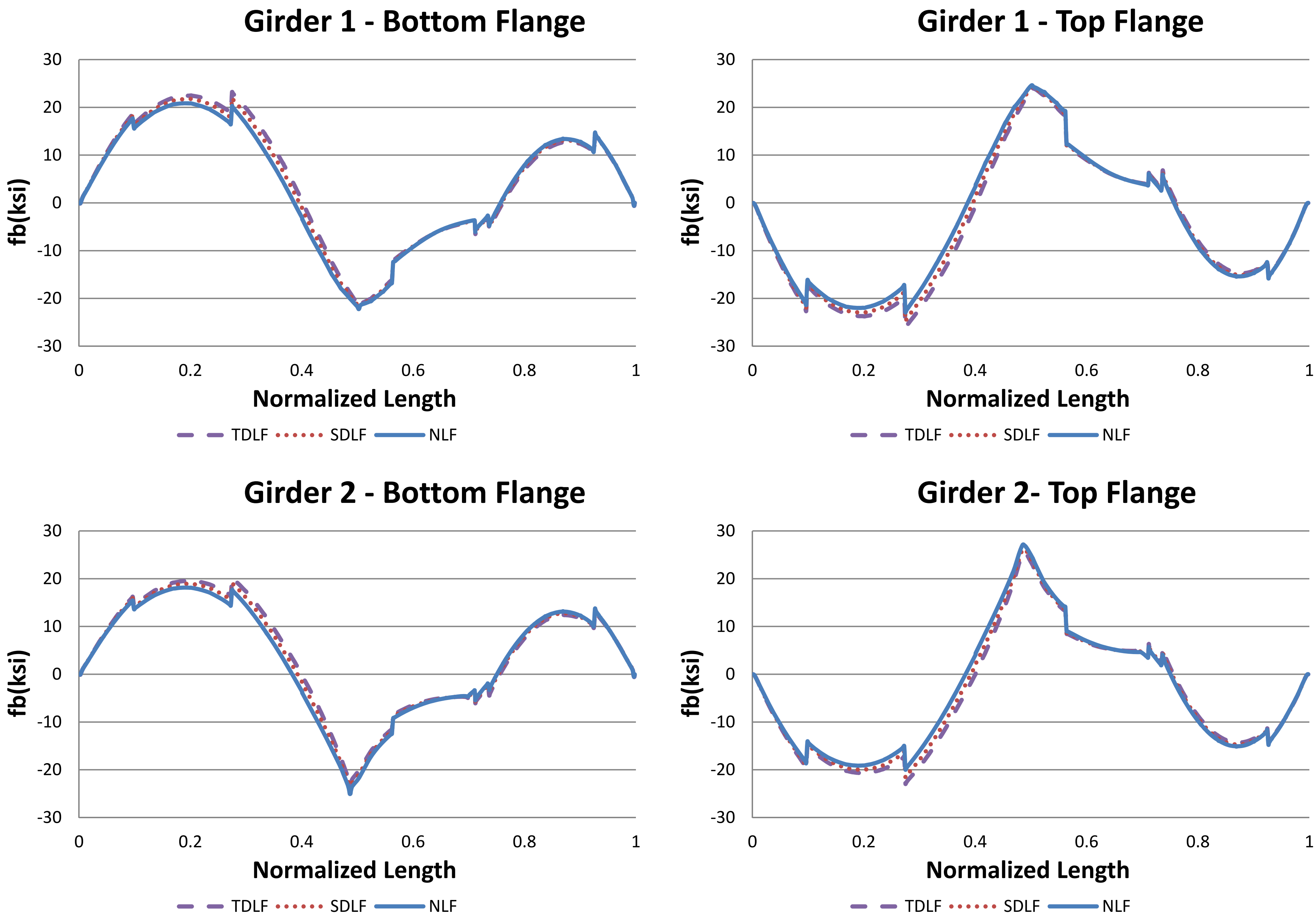


Figure U2-4-20. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

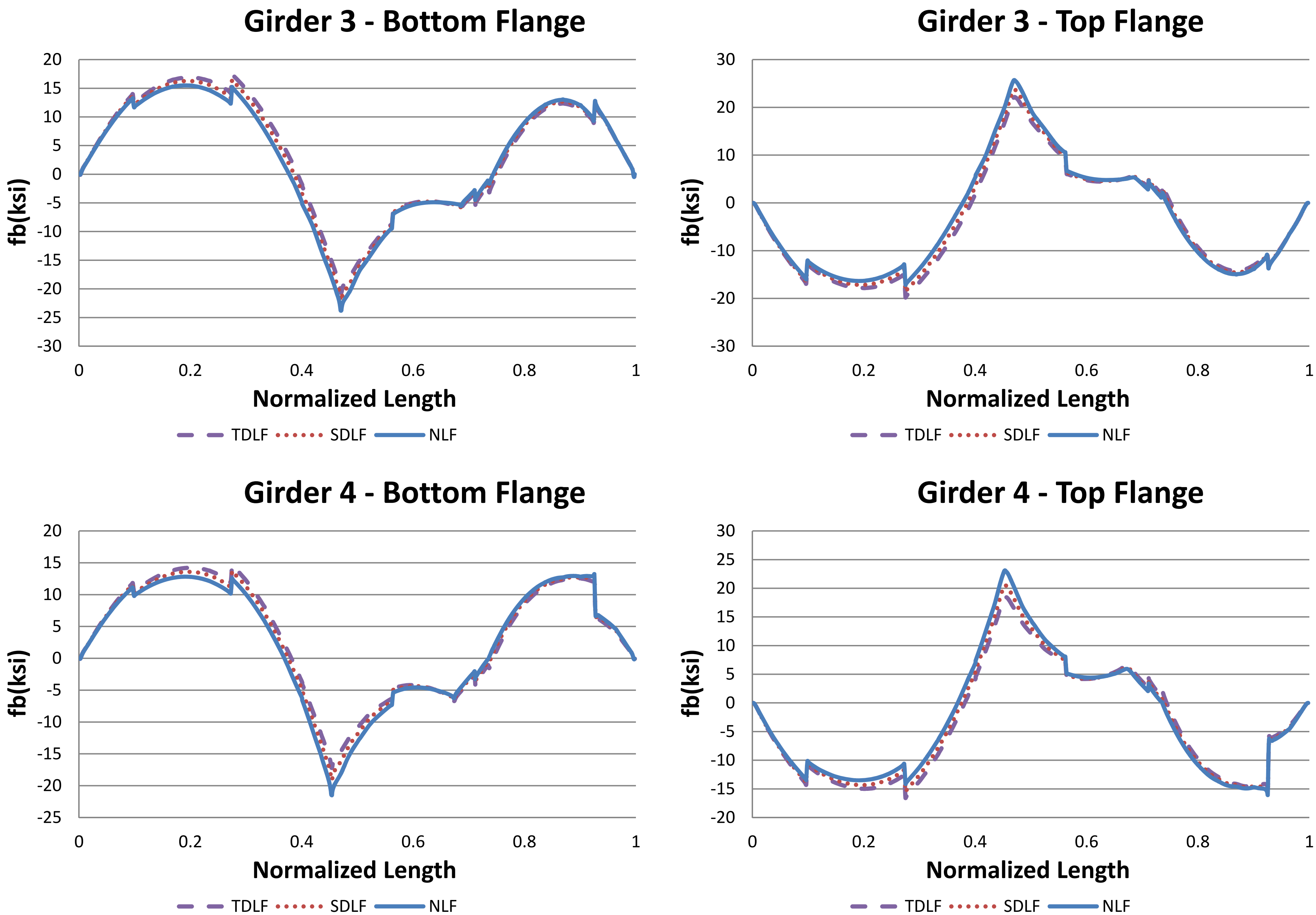


Figure U2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

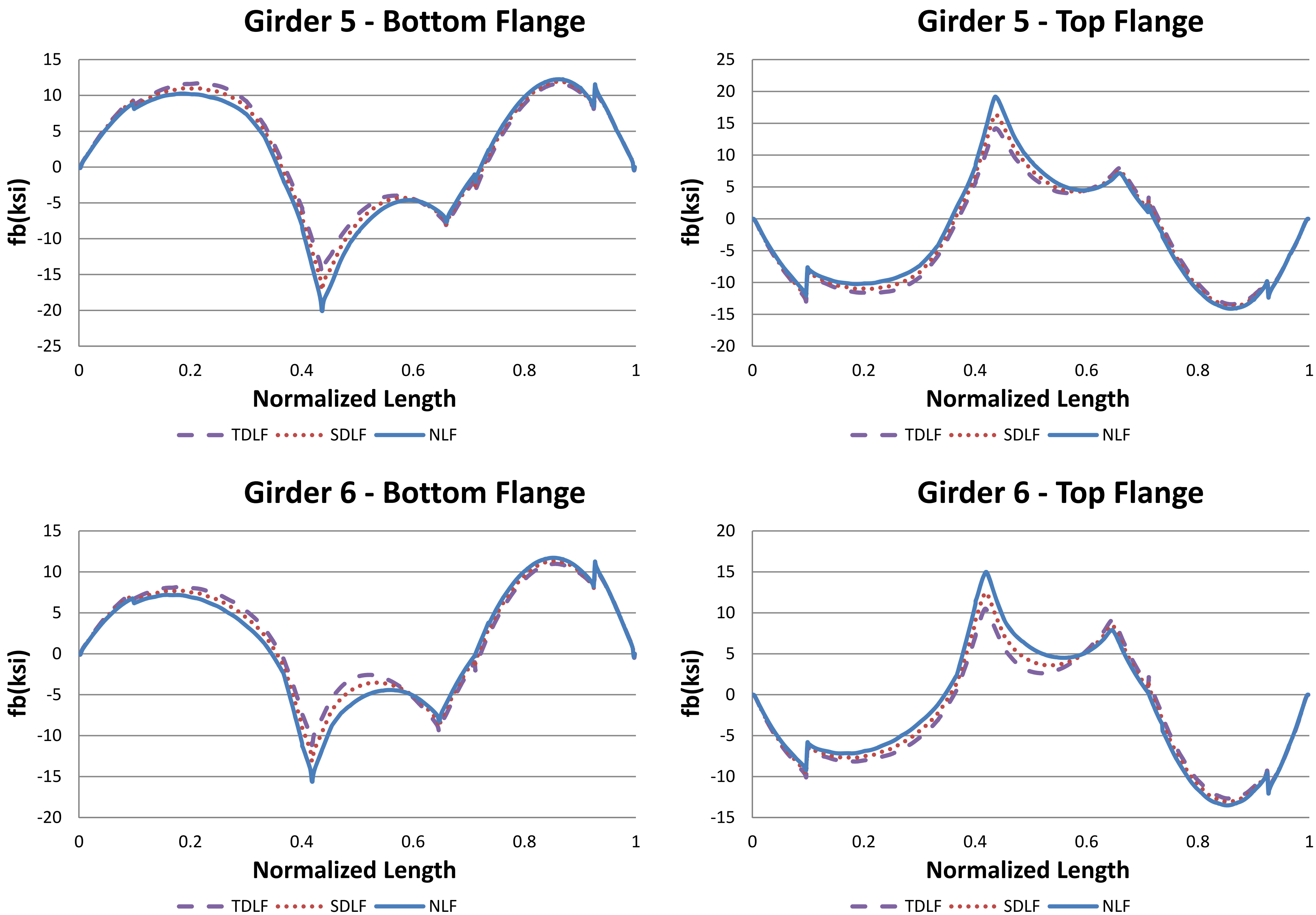
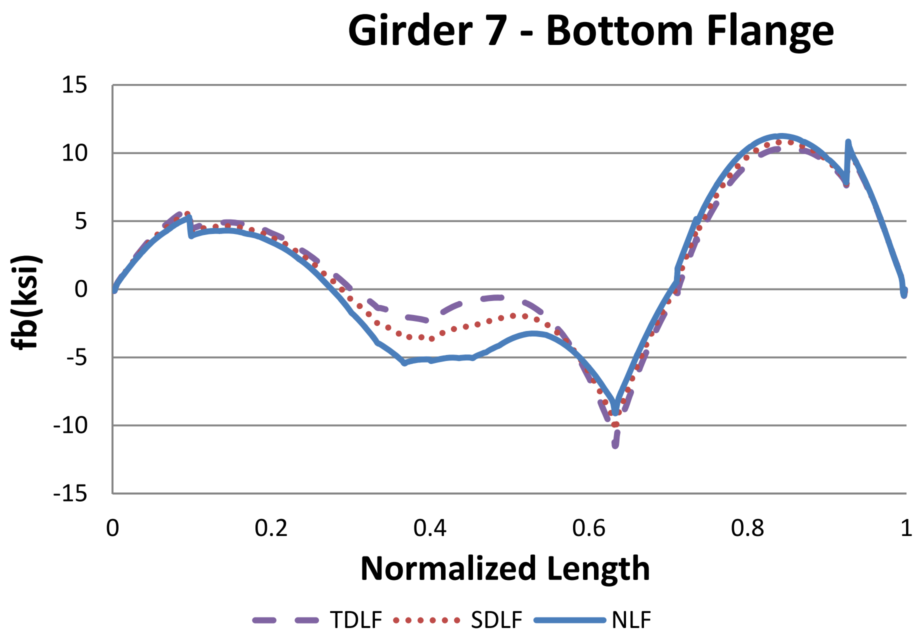


Figure U2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.



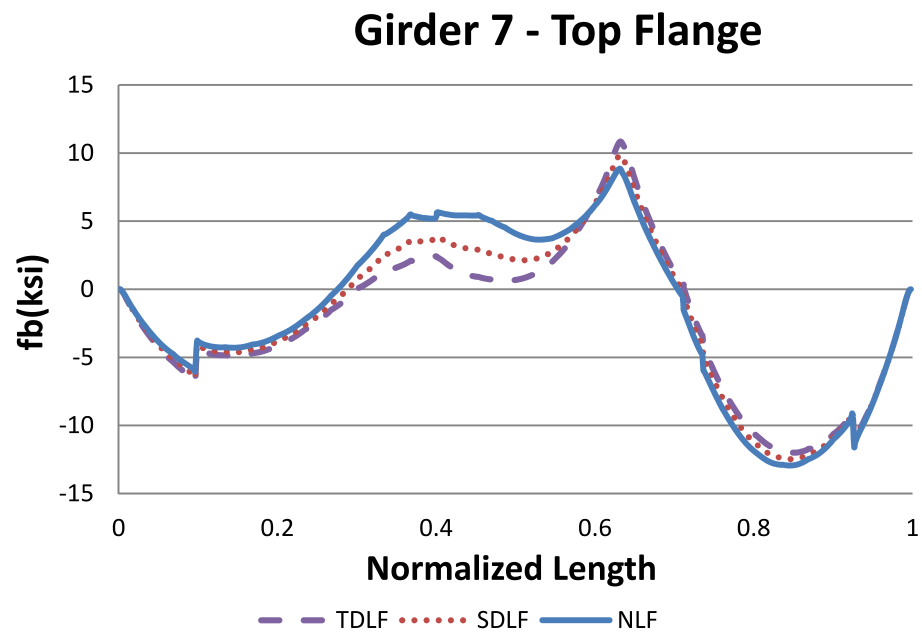


Figure U2-4-20(Continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

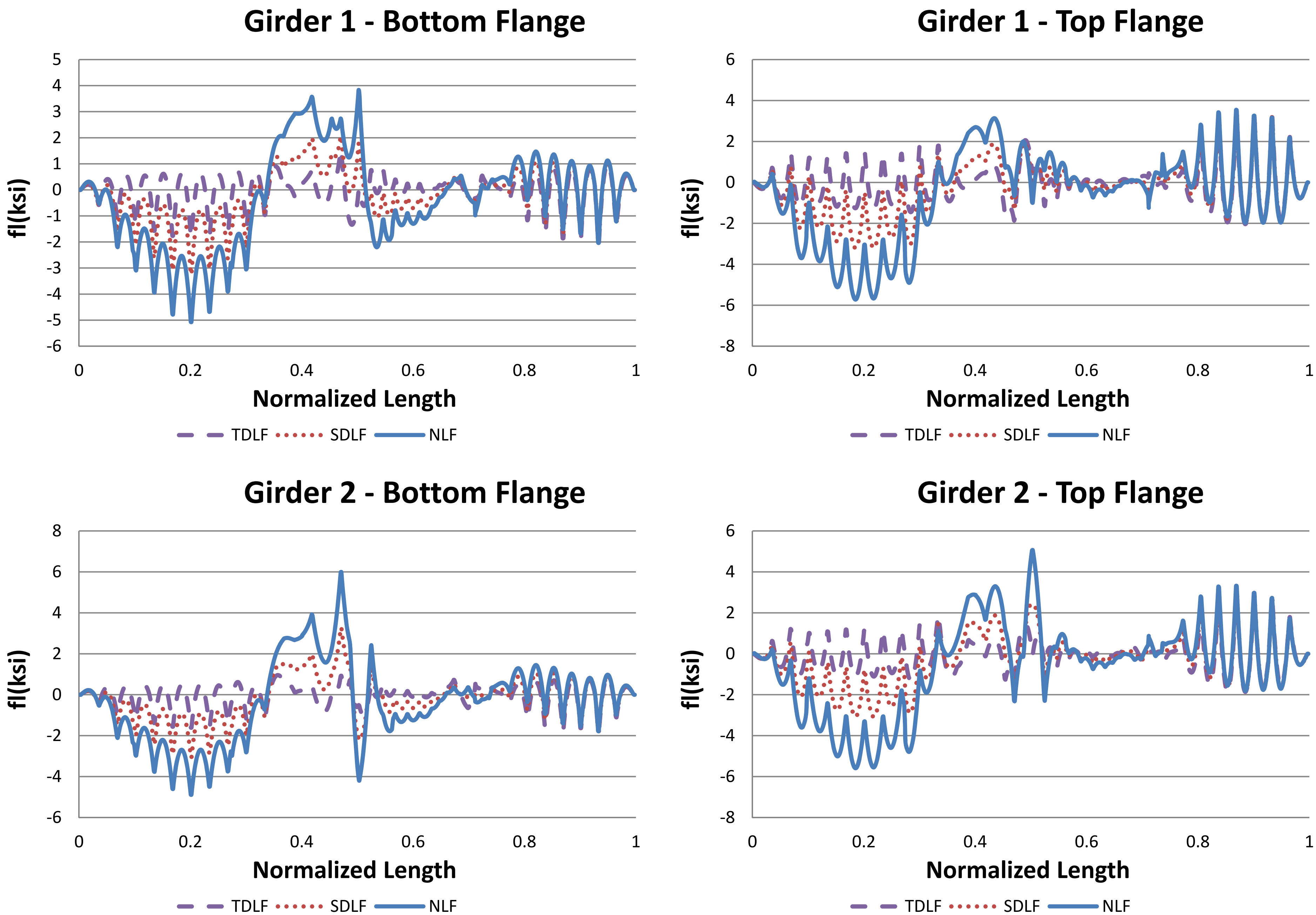


Figure U2-4-21. Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.

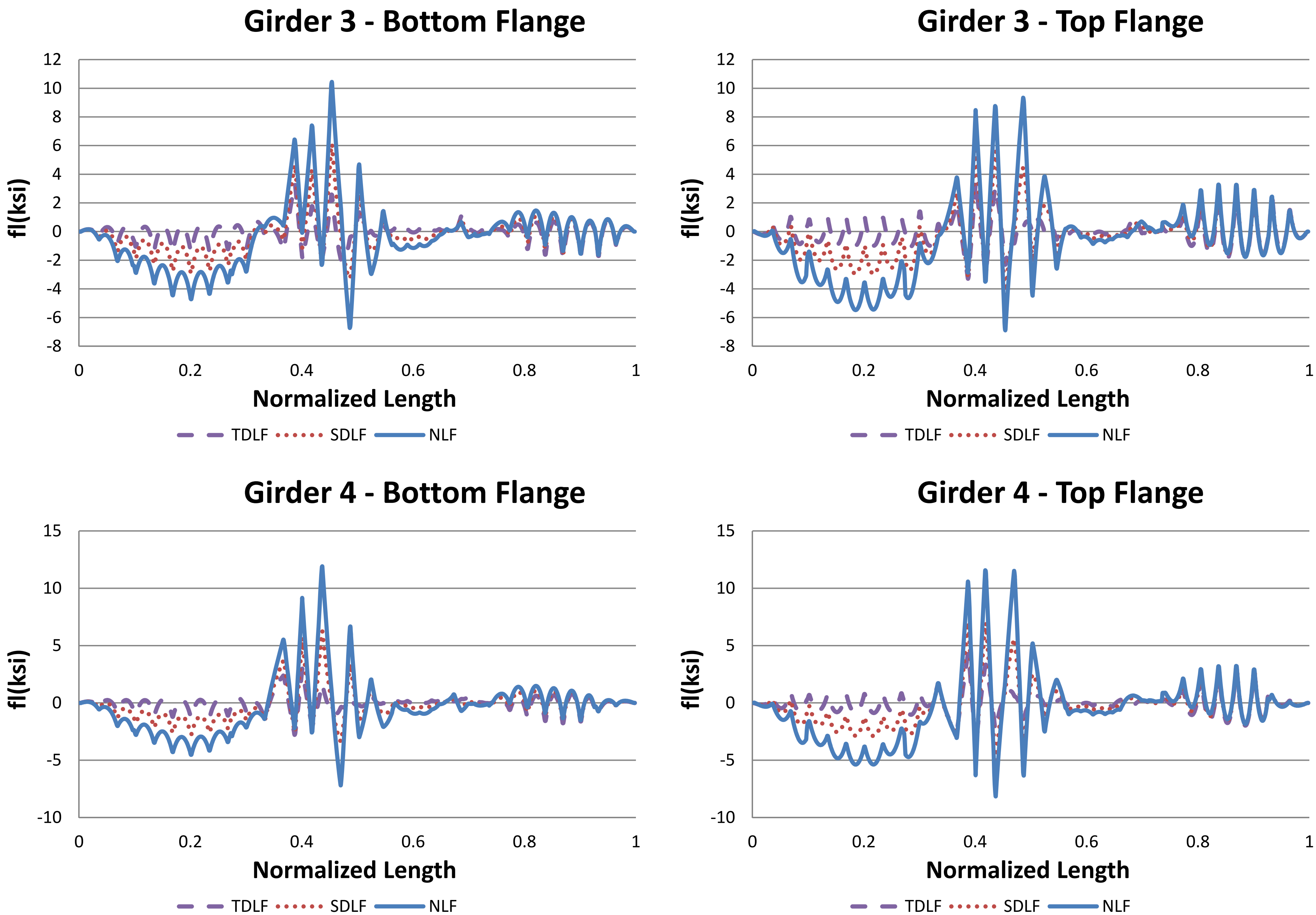


Figure U2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

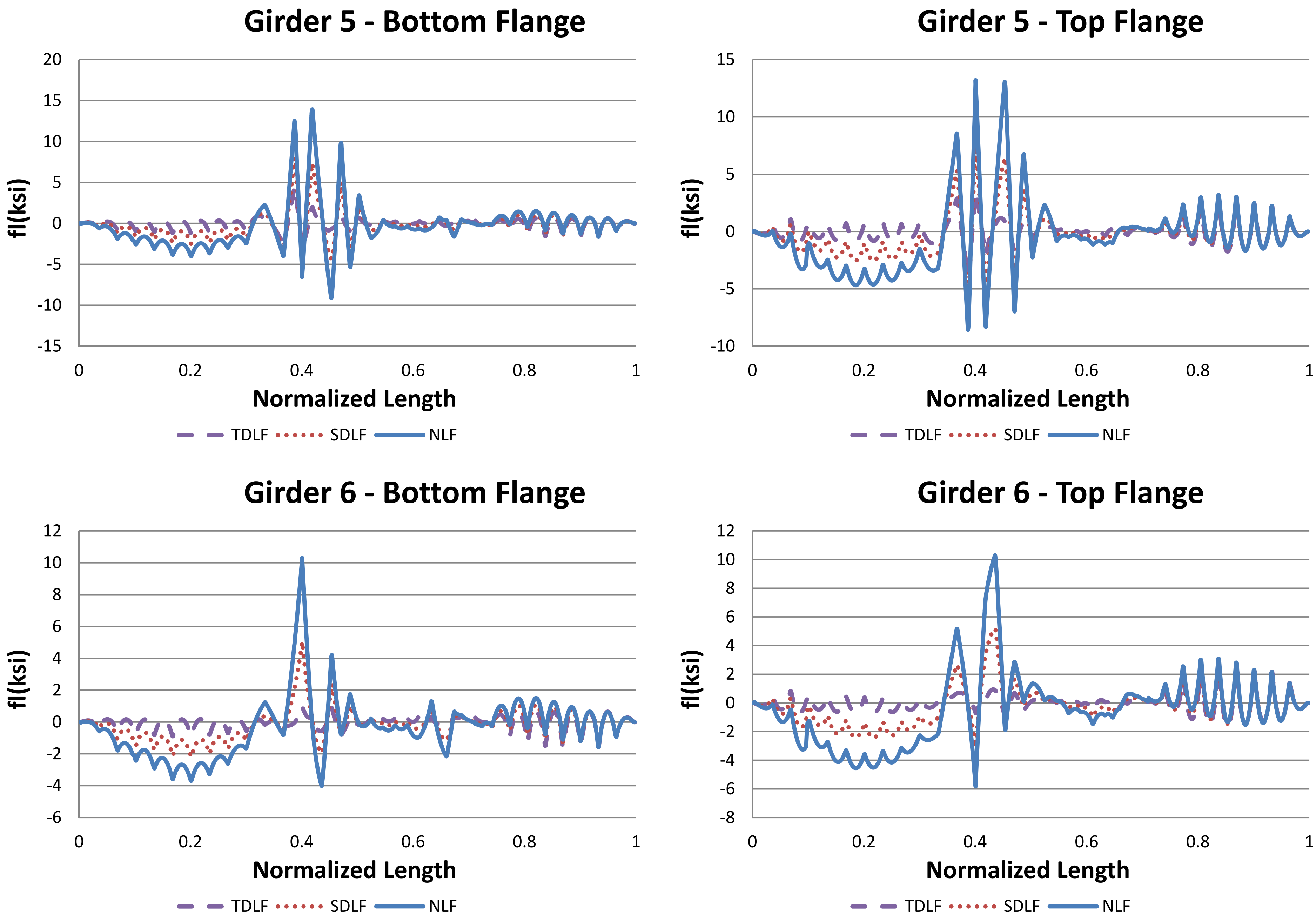
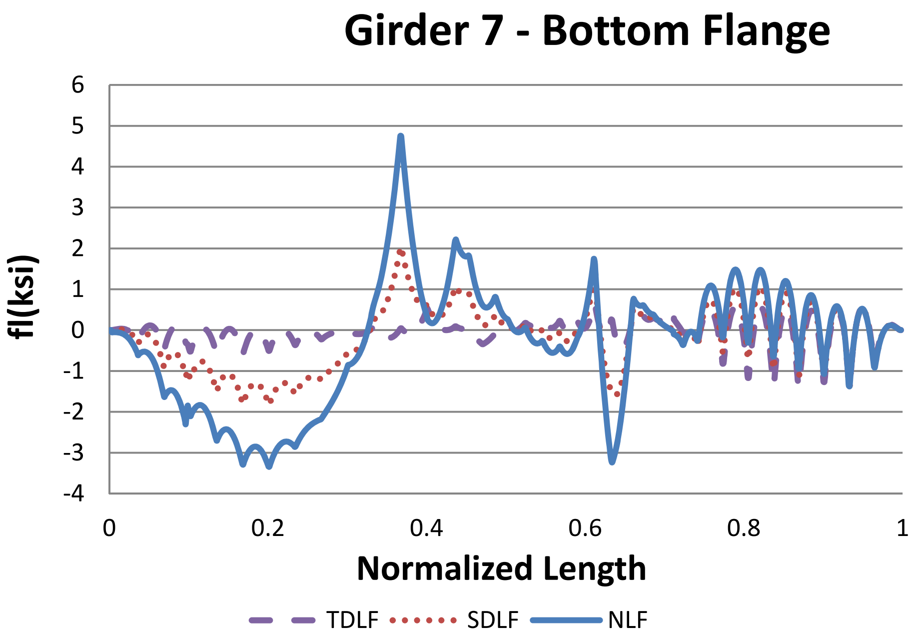


Figure U2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.



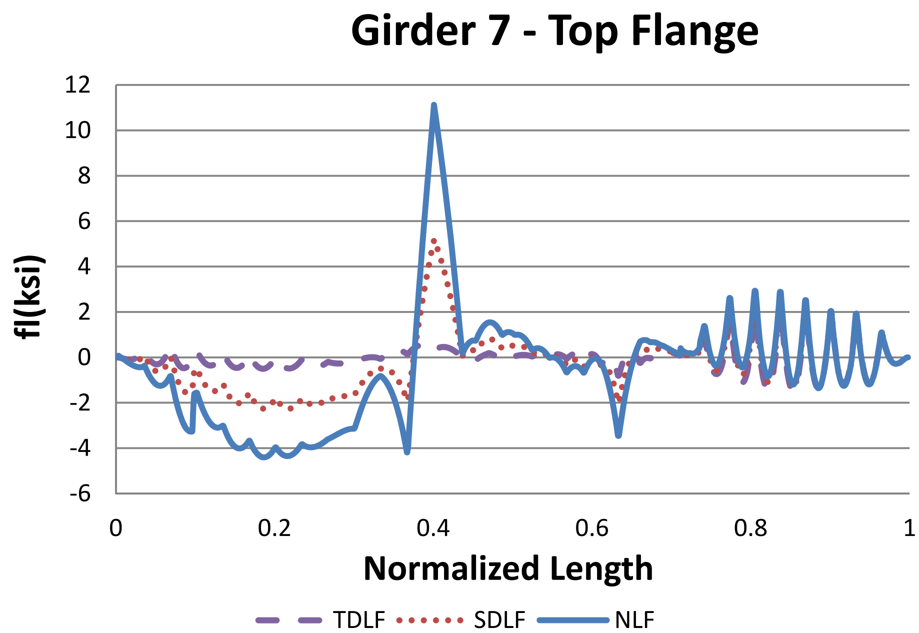


Figure U2-4-21(Continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

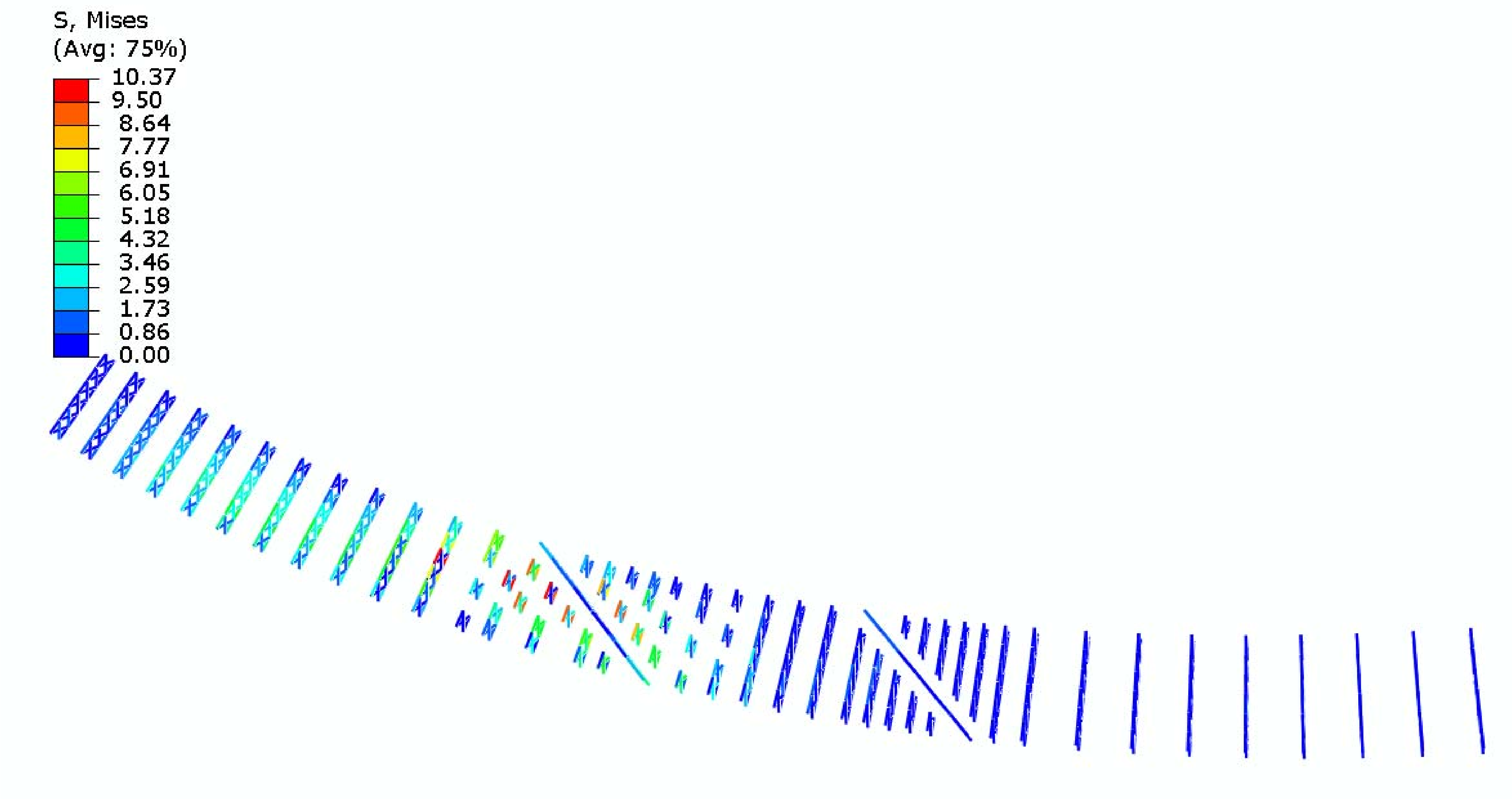


Figure U2-4-22. **Cross-frame stress contours (ksi) under SDL, NLF detailing**

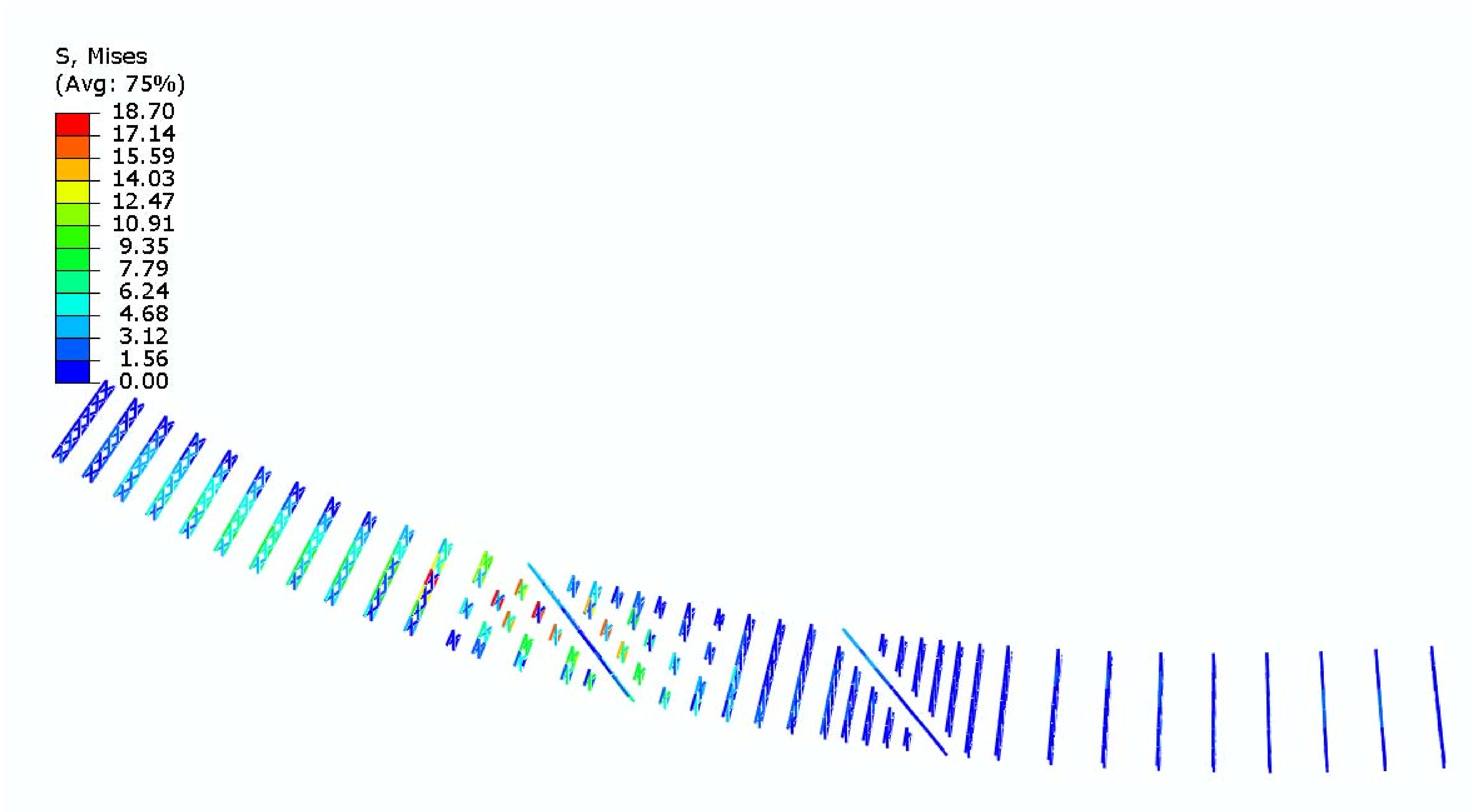


Figure U2-4-23. **Cross-frame stress contours under TDL, NLF detailing**

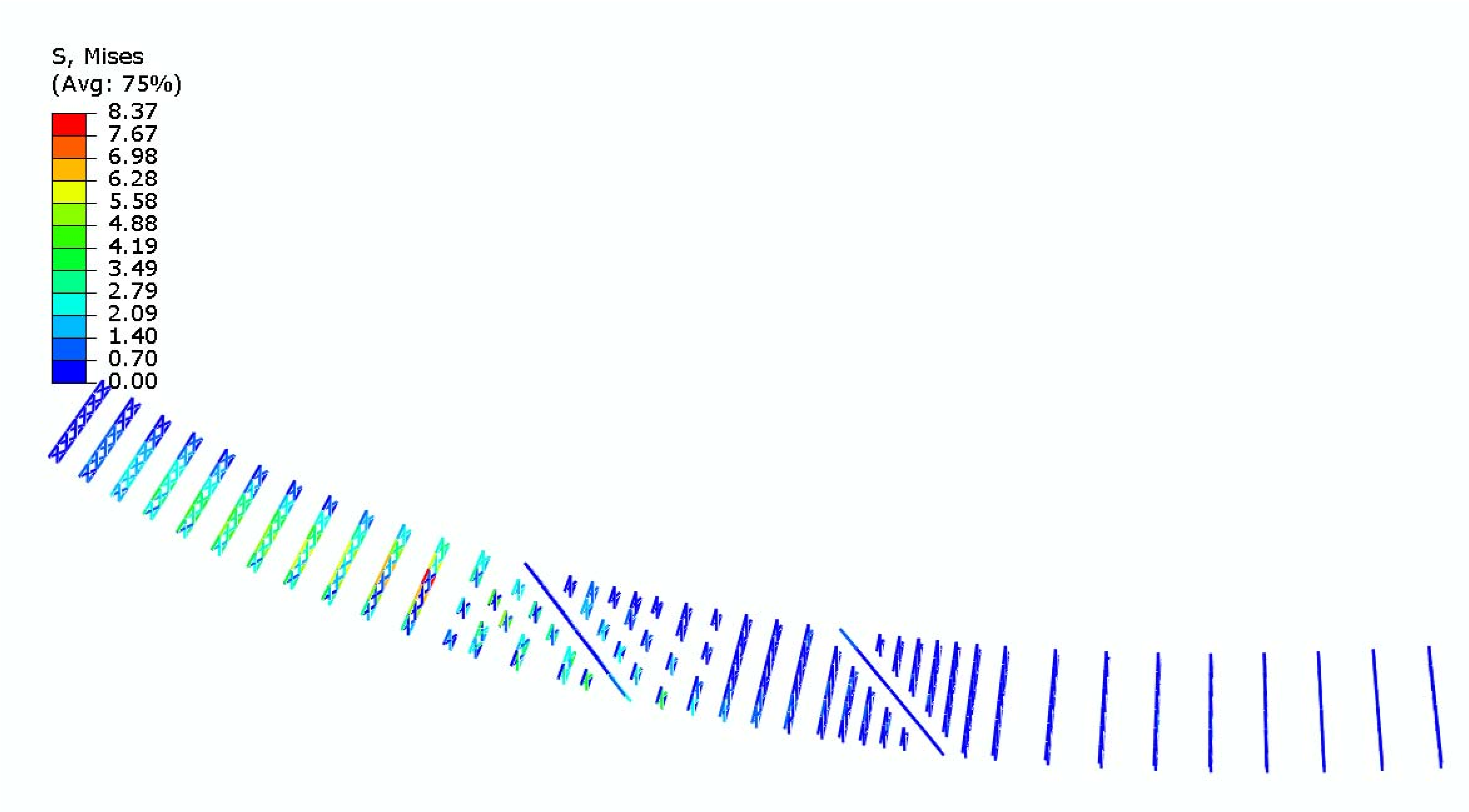


Figure U2-4-24. **Cross-frame stress contours under SDL, SDLF detailing**

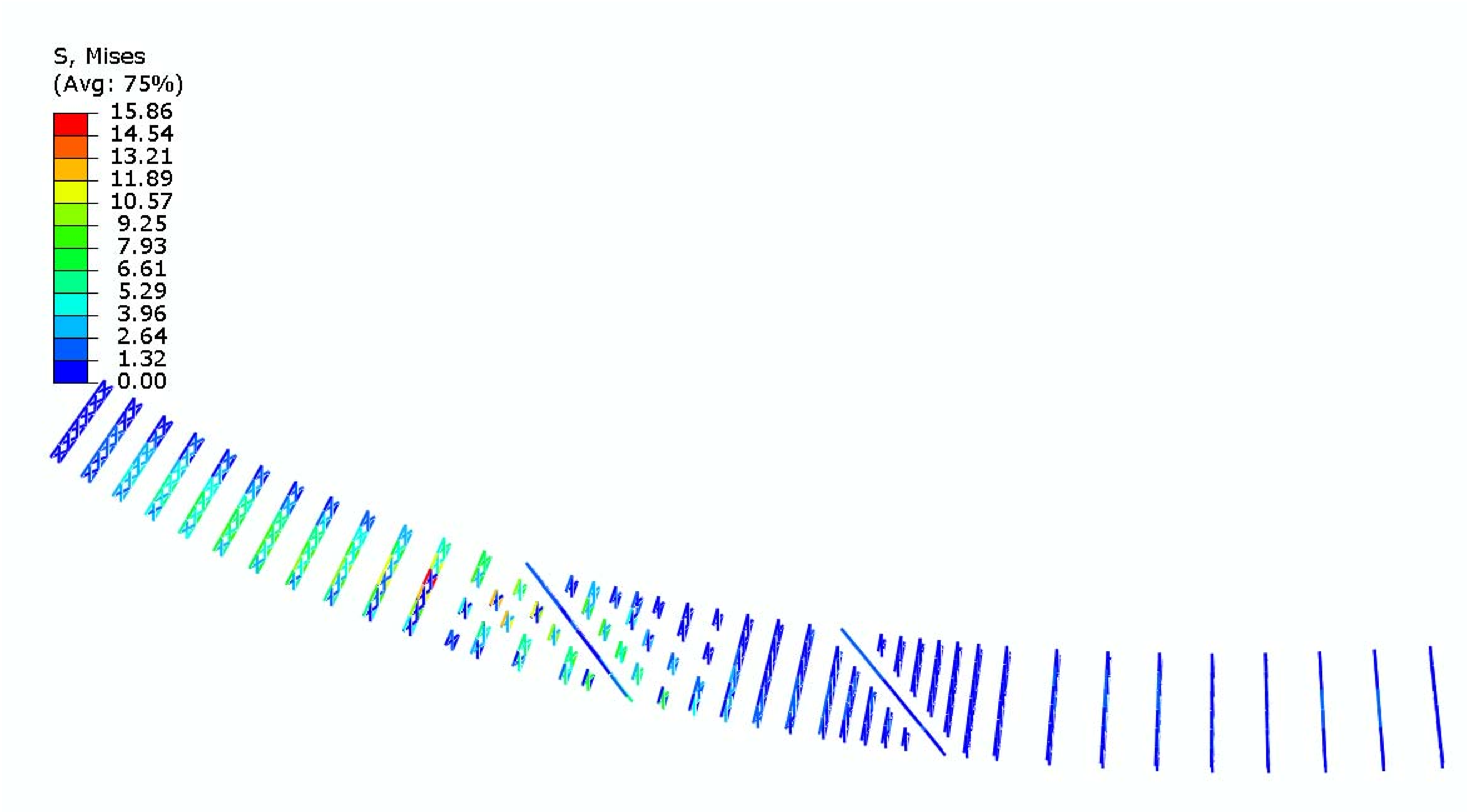


Figure U2-4-25. Cross-frame stress contours under TDL, SDLF detailing

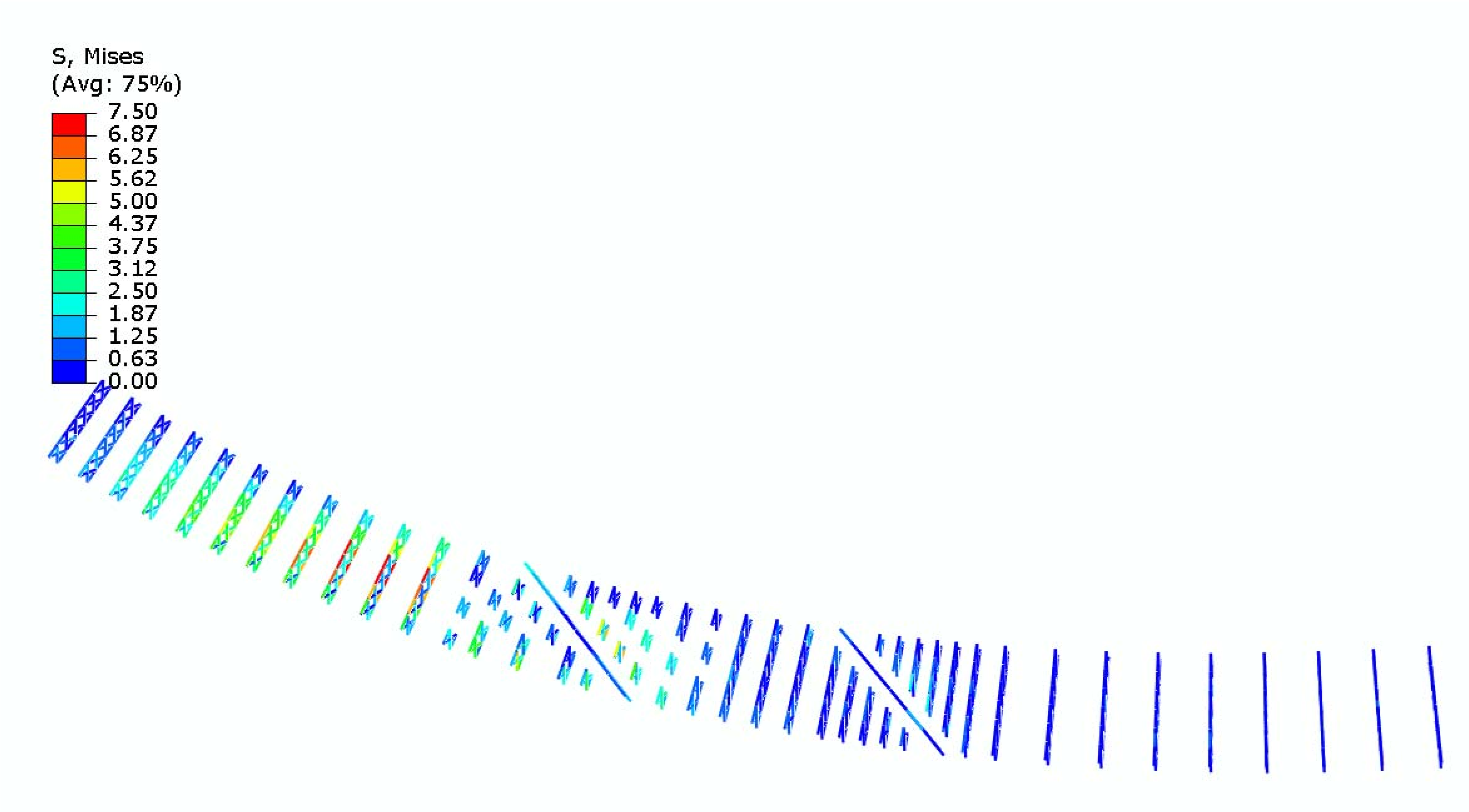


Figure U2-4-26. Cross-frame stress contours under SDL, TDLF detailing

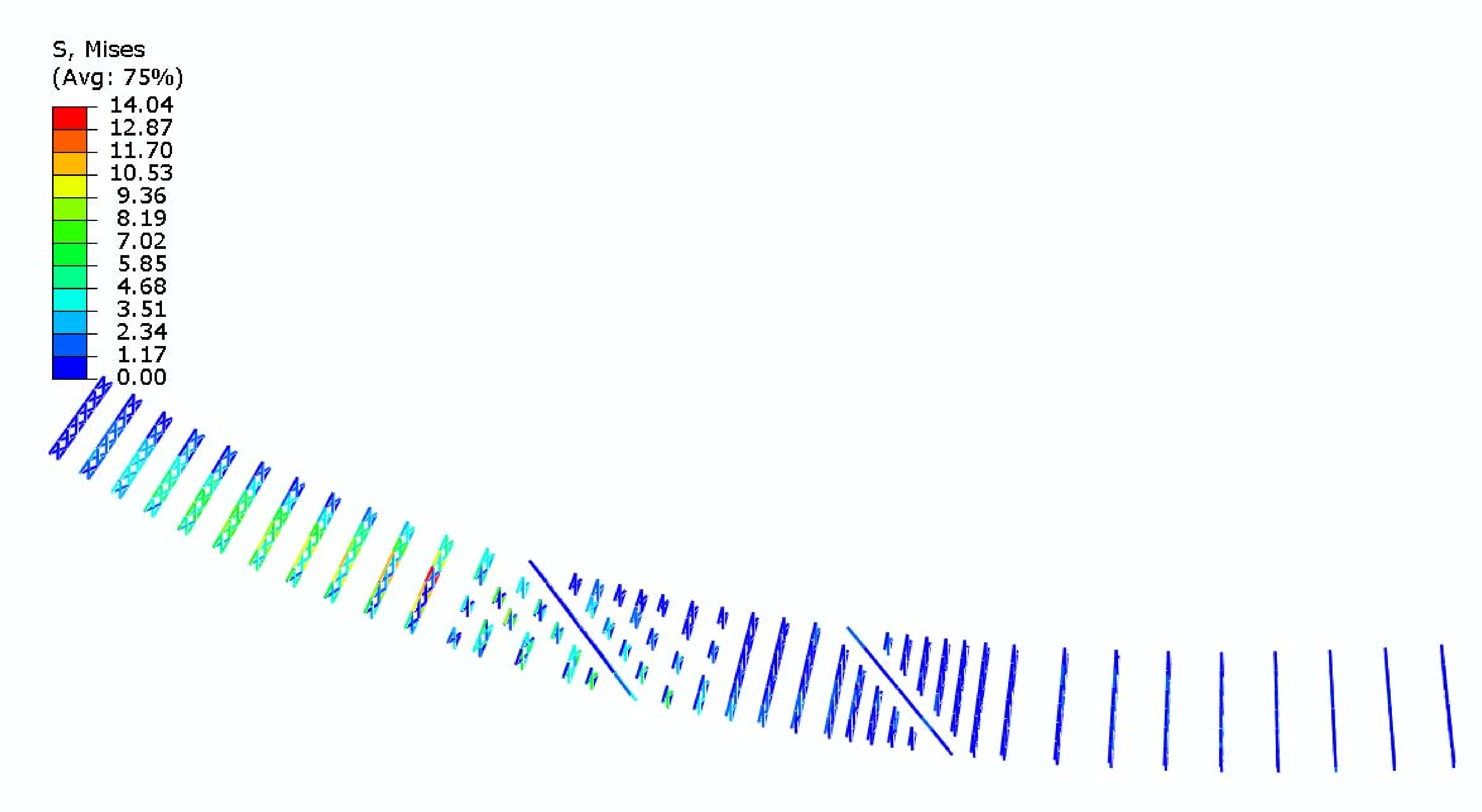


Figure U2-4-27. Cross-frame stress contours under TDL, TDLF detailing

Table U2-4-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location					
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	10.3	8.8	7.6	4.6	3.8	2.7
	SDLF	3.1	3.2	0.9	1.0	1.1	0.7
	TDLF	12.9	13.0	6.1	2.8	1.7	1.7
2	NLF	4.5	7.3	8.5	8.5	6.3	3.5
	SDLF	9.1	10.1	10.0	9.1	6.2	3.5
	TDLF	13.3	13.5	11.4	9.6	6.5	3.9
3	NLF	9.3	14.2	16.3	16.5	11.5	6.6
	SDLF	13.1	17.3	17.6	16.3	11.0	6.0
	TDLF	16.8	20.1	18.8	16.2	10.8	5.7
4	NLF	12.9	19.8	22.5	21.3	15.7	8.7
	SDLF	16.8	23.2	24.4	21.9	15.3	8.0
	TDLF	20.7	26.1	26.1	22.5	15.1	7.5
5	NLF	14.0	22.7	25.9	23.3	17.5	8.9
	SDLF	18.3	26.6	28.9	25.7	18.2	8.8
	TDLF	22.2	30.0	31.6	27.7	18.8	8.7
6	NLF	16.0	25.5	29.1	26.5	18.8	9.4
	SDLF	19.1	28.2	31.7	29.3	20.2	9.6
	TDLF	22.4	30.9	34.1	31.8	21.3	9.7
7	NLF	15.7	25.4	29.7	28.3	18.4	8.4
	SDLF	18.1	27.0	31.6	31.8	21.5	10.4
	TDLF	20.9	28.9	33.4	34.8	24.0	11.8
8	NLF	12.8	21.9	27.0	28.9	18.0	7.8
	SDLF	15.2	23.0	27.9	31.8	23.4	12.4
	TDLF	18.0	24.5	29.0	34.1	27.6	15.9
9	NLF	9.4	16.3	21.2	24.3	19.5	9.8
	SDLF	12.3	17.5	21.6	26.4	26.3	16.8
	TDLF	15.4	19.0	22.1	28.2	31.9	22.3
10	NLF	2.8	6.1	9.5	14.0	26.6	17.9
	SDLF	6.4	9.5	11.4	15.8	29.7	24.3
	TDLF	9.9	12.4	13.1	18.0	32.6	29.6

Table U2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	5.2	10.7	8.8	4.3	27.6	34.2
	SDLF	3.8	2.2	0.6	6.9	24.3	31.4
	TDLF	8.2	12.1	7.8	15.8	22.0	30.7
12	NLF	2.3		10.7		22.8	51.2
	SDLF	18.1		3.8		10.7	26.0
	TDLF	31.4		15.8		2.0	7.2
13	NLF	15.3	25.9		19.0		
	SDLF	29.0	24.6		1.6		
	TDLF	41.2	25.1		17.8		
14	NLF			36.3		42.3	
	SDLF			10.2		18.6	
	TDLF			10.8		1.8	
15	NLF	31.9	45.3		2.6		
	SDLF	45.6	25.7		0.4		
	TDLF	58.1	24.8		1.5		
16	NLF			25.6			9.3
	SDLF			9.6			0.7
	TDLF			3.5			7.2
17	NLF	40.1	42.8			13.9	25.2
	SDLF	33.7	21.3			20.1	9.7
	TDLF	27.9	4.0			26.3	3.6
18	NLF	47.5			23.3		11.9
	SDLF	38.6			20.4		5.6
	TDLF	32.3			18.1		0.5
19	NLF			35.4		16.6	11.1
	SDLF			23.0		5.1	4.5
	TDLF			14.0		22.7	1.2
20	NLF		45.1		1.2		0.6
	SDLF		28.8		11.5		1.1
	TDLF		15.0		20.7		1.3

Table U2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	42.1		14.0		1.7	0.9
	SDLF	33.7		17.0		2.4	1.1
	TDLF	27.5		20.3		6.0	1.2
22	NLF	28.6	15.5		2.1		2.8
	SDLF	22.2	13.3		7.0		2.3
	TDLF	16.7	11.9		11.9		1.8
23	NLF	17.4	17.9	7.1	1.9	3.4	0.3
	SDLF	14.1	11.3	6.1	1.6	0.9	3.7
	TDLF	11.4	5.7	6.5	5.0	4.8	6.5
24	NLF	7.7	10.9	6.2	3.2	1.1	1.9
	SDLF	7.6	8.7	4.5	1.6	1.9	5.6
	TDLF	7.9	6.6	3.1	1.0	2.9	9.3
25	NLF	3.1	6.1	6.5	7.1	5.3	6.8
	SDLF	4.5	6.8	4.7	3.6	3.7	10.2
	TDLF	6.4	7.3	2.8	0.2	2.3	14.7
26	NLF	1.5	1.9	5.4	8.6	8.1	
	SDLF	0.3	3.4	4.5	5.7	7.6	
	TDLF	1.3	4.4	3.1	2.6	7.4	
27	NLF	2.5	1.1	5.9	10.2		
	SDLF	1.9	2.6	5.6	8.5		
	TDLF	1.0	3.5	4.7	6.5		
28	NLF	1.8	2.5	9.4			2.0
	SDLF	1.8	3.2	8.0			6.3
	TDLF	2.0	3.3	6.9			12.0
29	NLF	0.5	6.3			2.2	0.6
	SDLF	0.7	6.8			3.3	3.6
	TDLF	1.4	6.6			6.0	7.2
30	NLF	4.4			2.3	0.2	0.2
	SDLF	3.8			3.0	3.1	2.7
	TDLF	4.4			4.0	6.9	5.8

Table U2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF			1.2	0.3	0.6	0.1
	SDLF			3.0	2.3	2.5	2.2
	TDLF			4.5	5.0	6.5	4.8
32	NLF		2.0	0.9	1.3	0.7	0.5
	SDLF		1.7	1.1	1.0	1.5	1.7
	TDLF		3.0	1.6	3.7	4.4	3.3
33	NLF	3.3	2.0	0.4	2.8	0.7	0.8
	SDLF	1.5	1.2	0.7	0.1	1.0	1.5
	TDLF	1.4	1.0	1.7	3.1	3.1	2.5
34	NLF	1.6	0.4	1.6	3.8	1.3	0.0
	SDLF	0.5	0.5	1.0	3.0	0.5	0.5
	TDLF	2.1	1.2	1.2	1.3	0.8	0.8
35	NLF	1.7	3.0	4.4	4.9	3.0	1.2
	SDLF	1.1	2.2	3.4	5.1	2.6	1.0
	TDLF	1.2	1.2	2.6	5.7	2.9	1.6
36	NLF	3.8	5.6	6.2	5.8	4.1	2.0
	SDLF	2.7	4.5	5.6	5.6	3.9	2.1
	TDLF	1.2	3.2	5.5	6.5	4.8	3.0
37	NLF	4.5	7.1	7.8	5.9	4.6	2.7
	SDLF	3.4	6.0	7.5	5.2	4.6	3.0
	TDLF	2.2	4.7	7.9	5.1	6.0	4.4
38	NLF	4.0	7.2	10.1	4.1	4.9	3.5
	SDLF	3.4	6.0	9.1	3.9	5.4	3.6
	TDLF	3.3	4.6	8.4	4.6	7.2	4.4
39	NLF	3.0	5.3	11.5	1.6	5.8	4.0
	SDLF	3.5	4.9	7.6	4.4	5.7	3.0
	TDLF	5.3	5.0	2.2	9.8	6.3	1.9
40	NLF	3.2	3.0	2.1	12.4	5.7	2.1
	SDLF	3.6	4.2	1.3	9.3	3.9	1.5
	TDLF	4.9	6.8	6.5	4.5	1.2	0.7

Table U2-4-1(Continued). Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location					
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	2.2	0.6	5.3	10.9	4.1	0.9
	SDLF	2.7	2.5	2.6	8.0	2.1	0.4
	TDLF	3.7	5.7	4.0	2.7	1.4	0.5
42	NLF	3.4	3.3	4.9	3.9	2.8	2.8
	SDLF	0.7	0.5	0.4	0.6	0.6	0.5
	TDLF	4.5	3.7	6.1	6.4	3.1	3.2

Table U2-4-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

CF	Detailing Method	CF Location: G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	18.1	15.9	14.1	8.8	7.6	5.4
	SDLF	6.9	7.7	7.7	5.3	4.9	3.8
	TDLF	6.6	6.6	1.3	1.8	2.2	1.4
2	NLF	8.4	12.6	15.4	17.2	11.3	5.0
	SDLF	13.8	15.8	17.4	18.2	11.4	5.2
	TDLF	18.1	18.8	18.7	18.6	11.6	5.6
3	NLF	18.9	27.7	32.3	34.8	22.6	11.6
	SDLF	22.3	29.9	32.5	33.6	21.3	10.5
	TDLF	25.5	31.9	32.9	32.7	20.4	9.8
4	NLF	25.9	38.6	44.4	44.2	30.8	15.0
	SDLF	29.2	40.8	44.8	43.4	29.3	13.7
	TDLF	32.5	42.9	45.5	43.1	28.2	12.8
5	NLF	28.5	44.4	50.9	47.9	33.8	14.8
	SDLF	31.9	46.9	52.4	48.8	33.5	14.3
	TDLF	35.3	49.4	54.1	50.0	33.4	13.8
6	NLF	33.3	50.9	58.1	54.7	36.9	16.3
	SDLF	34.9	51.4	58.4	55.4	36.7	15.6
	TDLF	37.3	52.7	59.3	56.5	36.8	15.1
7	NLF	33.2	51.2	59.5	58.0	36.0	14.4
	SDLF	34.0	50.5	58.9	59.4	37.6	15.5
	TDLF	35.8	50.9	59.1	60.9	39.0	16.4
8	NLF	27.3	44.3	54.1	58.9	35.1	13.1
	SDLF	28.8	43.6	52.9	59.6	38.8	16.9
	TDLF	30.9	44.0	52.6	60.6	42.0	19.9
9	NLF	21.3	34.1	43.2	49.1	36.9	16.4
	SDLF	23.6	34.1	42.0	49.4	42.3	22.7
	TDLF	26.1	34.7	41.4	50.1	47.0	27.7
10	NLF	9.6	15.5	21.4	29.0	48.4	30.4
	SDLF	12.7	18.1	22.0	29.0	50.2	36.1
	TDLF	15.8	20.7	23.2	30.4	52.2	40.7

Table U2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	6.6	16.7	14.0	5.8	49.5	60.3
	SDLF	4.0	5.0	3.9	5.6	44.7	55.7
	TDLF	8.2	8.3	3.8	14.4	41.6	52.8
12	NLF	5.9		18.7		42.1	93.5
	SDLF	22.1		5.1		27.3	64.5
	TDLF	35.7		9.0		18.0	41.7
13	NLF	25.9	45.7		34.8		
	SDLF	38.2	41.7		13.1		
	TDLF	50.1	41.9		3.9		
14	NLF			65.4		77.2	
	SDLF			37.8		50.0	
	TDLF			16.9		29.4	
15	NLF	54.8	79.8		2.8		
	SDLF	67.8	59.2		2.4		
	TDLF	80.0	43.0		1.7		
16	NLF			45.0			18.4
	SDLF			30.0			7.0
	TDLF			17.2			2.1
17	NLF	70.1	75.7			26.3	45.6
	SDLF	63.5	54.3			31.5	28.9
	TDLF	57.7	37.0			37.3	15.4
18	NLF	84.1			40.5		20.9
	SDLF	72.7			38.0		14.0
	TDLF	67.0			36.3		8.4
19	NLF			64.8		29.7	19.3
	SDLF			52.2		7.6	12.2
	TDLF			41.7		11.6	6.3
20	NLF		83.8		1.1		0.6
	SDLF		66.3		11.6		0.7
	TDLF		51.6		20.9		0.8

Table U2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	78.1		27.1		1.2	3.5
	SDLF	68.7		29.9		3.1	3.7
	TDLF	59.6		33.0		7.0	3.9
22	NLF	53.5	30.0		4.0		7.7
	SDLF	46.2	27.5		8.9		7.1
	TDLF	40.3	25.9		13.9		6.7
23	NLF	33.6	36.0	16.2	4.0	4.2	2.8
	SDLF	29.8	28.5	13.8	0.3	0.7	5.8
	TDLF	26.6	22.7	14.2	3.3	4.5	8.6
24	NLF	15.9	23.5	14.8	7.4	4.2	5.1
	SDLF	15.2	21.1	12.9	5.6	4.7	7.9
	TDLF	15.3	18.8	11.4	4.2	5.7	11.3
25	NLF	8.2	16.2	17.6	17.9	14.2	16.2
	SDLF	9.4	16.5	15.2	13.5	11.7	17.9
	TDLF	10.6	16.6	12.8	9.1	9.3	20.5
26	NLF	1.3	8.2	15.1	20.0	17.7	
	SDLF	1.2	9.5	13.8	16.3	16.1	
	TDLF	2.3	10.3	12.0	12.7	14.9	
27	NLF	3.0	5.9	14.8	21.2		
	SDLF	2.3	7.5	14.4	19.1		
	TDLF	1.3	8.4	13.4	16.9		
28	NLF	1.2	8.7	22.3			7.0
	SDLF	1.0	9.1	18.6			10.1
	TDLF	1.1	9.4	17.6			14.4
29	NLF	3.8	17.4			8.2	0.8
	SDLF	4.0	17.5			8.3	3.7
	TDLF	4.7	16.7			8.9	7.2
30	NLF	13.6			7.9	0.6	1.1
	SDLF	11.9			8.1	3.1	1.8
	TDLF	11.7			8.5	6.8	4.8

Table U2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF			6.3	0.7	2.5	0.7
	SDLF			8.0	2.4	0.6	1.4
	TDLF			9.4	5.2	4.6	4.0
32	NLF		9.2	3.7	4.2	2.7	0.8
	SDLF		8.9	3.5	1.9	0.6	1.9
	TDLF		7.4	3.8	1.1	2.4	3.5
33	NLF	12.9	7.1	1.2	8.1	2.4	2.3
	SDLF	10.5	6.2	1.3	5.4	0.7	2.8
	TDLF	6.9	4.7	2.0	2.2	1.5	3.8
34	NLF	6.5	2.7	3.7	11.1	3.1	1.3
	SDLF	5.5	2.9	3.1	10.5	2.4	1.9
	TDLF	3.9	2.8	2.3	9.0	1.6	2.3
35	NLF	3.7	6.2	10.1	12.8	6.2	0.5
	SDLF	3.2	5.5	9.2	13.1	5.8	0.2
	TDLF	2.0	4.5	8.5	13.9	6.1	0.9
36	NLF	10.5	13.8	15.0	13.8	8.4	2.3
	SDLF	9.3	12.6	14.2	13.6	8.3	2.3
	TDLF	7.9	11.5	14.3	14.6	9.2	3.3
37	NLF	13.0	18.3	19.4	13.9	9.7	4.3
	SDLF	11.5	16.9	18.9	13.0	9.6	4.5
	TDLF	10.4	15.8	19.3	13.0	10.9	5.8
38	NLF	12.0	19.0	25.6	9.6	10.9	6.7
	SDLF	11.0	17.3	24.5	9.3	11.2	6.6
	TDLF	10.8	16.0	23.4	9.8	12.9	7.2
39	NLF	9.4	14.0	28.5	4.3	14.1	8.1
	SDLF	9.5	13.0	24.5	7.0	13.6	7.0
	TDLF	11.1	13.1	18.7	12.1	14.2	5.8
40	NLF	9.9	7.7	7.7	34.1	14.5	3.5
	SDLF	10.0	8.7	4.7	30.9	12.7	2.7
	TDLF	11.4	11.1	1.0	26.1	9.9	1.9

Table U2-4-2(Continued). Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	7.3	1.4	16.5	31.2	10.6	0.5
	SDLF	7.7	3.5	13.9	28.2	8.6	0.2
	TDLF	8.7	6.7	8.9	22.9	5.2	0.9
42	NLF	9.2	8.6	12.2	9.7	7.3	7.2
	SDLF	6.1	5.1	7.2	5.7	5.2	4.7
	TDLF	2.0	1.5	0.6	1.7	1.5	1.1

Table U2-4-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

CF	Detailing Method	CF Location					
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	3.8	3.5	3.3	1.8	1.1	1.2
	SDLF	2.5	0.5	1.0	0.4	0.4	0.4
	TDLF	9.1	4.0	0.3	0.6	0.1	0.4
2	NLF	9.8	13.0	11.9	8.5	3.2	0.1
	SDLF	8.0	11.7	11.0	7.6	2.6	0.1
	TDLF	6.3	10.2	9.5	6.5	2.1	0.3
3	NLF	19.7	25.9	24.0	17.4	6.9	0.9
	SDLF	17.6	23.5	21.2	14.9	5.4	0.3
	TDLF	15.5	21.3	18.8	12.8	4.2	0.2
4	NLF	26.4	34.4	31.3	23.0	9.2	0.7
	SDLF	25.3	33.2	29.6	20.8	7.7	0.4
	TDLF	23.8	32.0	28.0	18.9	6.4	0.0
5	NLF	30.5	39.8	35.7	25.8	10.5	1.2
	SDLF	30.8	40.9	36.4	25.6	9.7	0.8
	TDLF	30.5	41.2	36.5	25.0	8.8	0.4
6	NLF	33.3	43.2	38.6	27.4	10.9	1.3
	SDLF	34.5	46.7	42.5	30.1	11.8	1.6
	TDLF	34.7	48.5	44.8	31.4	12.0	1.6
7	NLF	34.0	44.7	40.2	27.8	10.5	1.6
	SDLF	36.1	50.7	48.4	35.2	14.8	3.0
	TDLF	36.9	54.2	53.6	40.1	17.6	3.9
8	NLF	32.7	45.0	42.6	29.8	12.1	2.9
	SDLF	35.5	52.7	54.1	42.4	20.9	5.8
	TDLF	36.9	57.6	62.0	51.3	27.3	8.0
9	NLF	30.2	44.7	45.9	38.0	19.8	6.3
	SDLF	33.0	52.6	58.7	53.0	31.8	10.6
	TDLF	34.4	58.1	68.2	64.3	40.9	13.9
10	NLF	26.6	44.4	56.4	53.2	39.6	15.4
	SDLF	28.9	49.9	63.7	63.4	47.4	17.6
	TDLF	30.3	54.2	69.9	71.6	53.4	19.3

Table U2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	22.0	50.2	69.2	98.7	71.4	23.2
	SDLF	23.6	48.7	61.9	78.9	58.7	23.9
	TDLF	24.9	48.4	57.2	64.1	48.7	23.9
12	NLF	3.0		31.8		62.6	56.7
	SDLF	3.5		22.8		29.2	19.5
	TDLF	9.0		16.3		3.2	10.0
13	NLF	8.8	38.1		95.5		
	SDLF	2.7	24.4		46.4		
	TDLF	11.8	14.0		8.2		
14	NLF			83.5		79.4	
	SDLF			46.1		22.9	
	TDLF			16.8		22.3	
15	NLF	7.3	42.1		89.7		
	SDLF	20.2	31.0		27.3		
	TDLF	31.9	22.5		23.2		
16	NLF			87.3			17.8
	SDLF			29.4			0.4
	TDLF			18.4			12.9
17	NLF	11.5	63.5			73.1	21.9
	SDLF	13.0	34.1			12.8	7.4
	TDLF	14.8	9.9			35.8	4.6
18	NLF	8.6			83.6		7.2
	SDLF	3.3			5.8		1.7
	TDLF	13.9			57.8		2.8
19	NLF			78.5		46.4	11.8
	SDLF			3.1		9.9	3.8
	TDLF			59.8		20.4	2.9
20	NLF		48.0		39.9		1.5
	SDLF		5.9		4.1		0.1
	TDLF		29.5		26.0		1.4

Table U2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	15.8		26.3		8.0	2.0
	SDLF	1.6		2.0		0.3	0.2
	TDLF	16.6		19.0		5.7	1.8
22	NLF	1.4	20.8		9.7		0.1
	SDLF	4.7	3.7		0.1		0.6
	TDLF	7.8	11.8		7.8		1.0
23	NLF	5.3	7.5	23.6	13.2	8.3	2.5
	SDLF	6.5	1.2	2.2	0.1	1.1	0.6
	TDLF	7.5	8.9	16.6	11.0	7.9	2.5
24	NLF	7.5	4.1	0.5	2.9	2.3	0.6
	SDLF	7.2	5.1	2.7	3.0	3.4	1.0
	TDLF	6.6	5.6	5.1	7.7	8.0	1.6
25	NLF	8.5	10.3	8.0	3.4	1.3	6.4
	SDLF	7.8	8.2	6.4	5.7	4.2	0.6
	TDLF	6.9	5.9	5.0	8.4	10.4	9.3
26	NLF	6.7	11.0	9.9	4.3	4.1	
	SDLF	5.9	8.4	7.4	5.2	1.2	
	TDLF	4.9	5.9	5.6	7.5	9.2	
27	NLF	5.5	9.8	8.3	2.2		
	SDLF	4.7	7.3	6.2	2.8		
	TDLF	3.8	5.0	5.0	6.1		
28	NLF	4.4	7.4	5.0			4.4
	SDLF	4.5	6.1	5.0			0.2
	TDLF	4.4	5.1	7.4			5.1
29	NLF	3.2	4.1			5.2	0.9
	SDLF	4.5	9.7			3.3	0.7
	TDLF	5.8	16.6			14.4	2.8
30	NLF	3.0			5.4	1.5	0.5
	SDLF	2.0			4.5	2.4	0.6
	TDLF	0.7			18.6	7.9	2.3

Table U2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF			3.3	0.9	0.3	0.2
	SDLF			2.5	3.8	2.5	0.8
	TDLF			13.0	11.1	6.9	1.8
32	NLF		1.8	1.5	0.0	1.1	0.8
	SDLF		7.7	5.8	4.8	3.3	1.3
	TDLF		21.4	16.4	11.8	6.8	2.1
33	NLF	1.2	0.5	0.7	1.0	2.6	1.7
	SDLF	5.1	4.0	4.1	4.3	3.6	1.7
	TDLF	11.2	11.1	11.2	9.2	5.4	2.0
34	NLF	0.3	1.1	0.5	2.3	3.9	2.6
	SDLF	0.4	0.7	1.3	3.2	4.0	2.4
	TDLF	1.1	3.0	3.8	4.1	3.7	2.0
35	NLF	1.1	0.7	1.2	4.0	5.3	3.8
	SDLF	1.0	1.1	0.1	2.9	4.6	3.3
	TDLF	1.3	2.7	2.5	0.4	3.0	2.6
36	NLF	2.5	1.3	1.5	4.3	5.4	4.0
	SDLF	2.5	2.2	0.1	2.8	4.3	3.5
	TDLF	2.9	4.8	3.8	0.5	2.2	2.7
37	NLF	3.7	2.4	1.2	4.2	5.0	3.8
	SDLF	3.6	3.4	0.3	2.6	3.5	3.2
	TDLF	3.8	5.7	3.5	0.8	0.8	2.2
38	NLF	4.6	4.1	0.8	3.7	3.3	3.0
	SDLF	4.3	4.5	0.8	1.8	2.2	2.7
	TDLF	3.9	5.7	3.8	1.8	0.3	2.3
39	NLF	4.9	5.9	0.9	1.4	0.7	2.1
	SDLF	4.0	4.5	2.0	0.1	1.7	2.6
	TDLF	2.4	2.1	3.8	1.9	3.5	3.6
40	NLF	3.3	4.0	7.7	7.4	0.8	2.2
	SDLF	2.6	2.2	2.7	2.2	2.5	2.6
	TDLF	1.6	1.0	5.7	6.4	5.6	3.2

Table U2-4-3(Continued). Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	1.6	2.4	7.9	7.6	0.4	1.6
	SDLF	1.1	0.4	2.4	2.0	2.4	2.0
	TDLF	0.4	2.7	7.0	7.6	5.5	2.4
42	NLF	2.0	1.3	2.2	2.0	1.0	1.5
	SDLF	0.2	0.3	0.2	0.0	0.3	0.3
	TDLF	2.5	1.7	3.6	3.4	1.3	1.9

Table U2-4-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	6.9	6.4	5.9	3.3	2.1	2.2
	SDLF	0.9	2.4	3.4	1.8	1.5	1.6
	TDLF	5.5	1.1	2.2	0.9	1.0	0.9
2	NLF	18.4	24.2	22.4	14.7	3.9	0.5
	SDLF	16.2	22.4	21.1	13.6	3.2	0.8
	TDLF	13.9	20.1	18.9	11.9	2.2	1.2
3	NLF	36.8	47.8	44.2	30.3	9.3	0.0
	SDLF	33.6	43.8	39.9	26.6	7.0	0.9
	TDLF	30.5	40.2	36.1	23.4	5.2	1.7
4	NLF	49.4	63.5	57.4	39.8	12.5	1.0
	SDLF	46.8	60.2	53.5	36.0	10.0	1.7
	TDLF	44.0	56.9	49.9	32.5	7.8	2.4
5	NLF	57.3	73.7	65.2	44.4	14.3	0.5
	SDLF	55.8	72.2	63.4	42.3	12.4	1.3
	TDLF	53.8	70.1	61.1	39.9	10.4	2.2
6	NLF	63.3	80.6	70.7	47.6	14.9	0.4
	SDLF	62.2	81.0	71.8	48.0	14.5	0.6
	TDLF	60.3	80.0	71.3	47.2	13.5	1.1
7	NLF	64.9	83.7	73.9	48.4	14.3	0.2
	SDLF	64.6	86.4	79.0	53.5	17.2	1.1
	TDLF	63.2	87.0	81.4	56.0	18.8	1.5
8	NLF	62.3	83.9	78.1	52.1	17.6	3.1
	SDLF	63.0	88.5	86.5	62.3	24.8	5.3
	TDLF	62.4	90.5	91.4	68.7	29.8	6.8
9	NLF	57.1	81.9	82.5	65.7	31.3	9.2
	SDLF	58.1	87.2	92.4	78.4	41.9	12.9
	TDLF	57.9	90.2	99.2	87.4	49.7	15.7
10	NLF	49.7	79.6	99.1	91.9	66.6	25.5
	SDLF	50.7	82.9	103.5	99.4	73.1	27.4
	TDLF	50.9	85.3	107.4	105.6	77.8	28.7

Table U2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	39.9	88.5	121.6	172.9	125.4	42.0
	SDLF	41.0	84.9	111.2	149.2	109.9	41.6
	TDLF	41.7	83.0	104.2	131.8	97.8	40.6
12	NLF	5.6		55.1		109.6	98.5
	SDLF	0.9		45.5		74.9	61.8
	TDLF	6.3		38.7		48.5	32.9
13	NLF	15.3	65.4		166.1		
	SDLF	3.7	51.0		115.8		
	TDLF	5.3	40.3		77.0		
14	NLF			145.6		138.9	
	SDLF			106.8		82.3	
	TDLF			77.0		37.2	
15	NLF	13.7	74.3		160.0		
	SDLF	26.0	62.0		95.9		
	TDLF	37.6	53.1		44.5		
16	NLF			159.2			29.8
	SDLF			98.2			13.3
	TDLF			48.5			1.0
17	NLF	22.1	118.2			131.8	40.9
	SDLF	22.7	85.8			69.7	25.5
	TDLF	24.1	59.6			20.1	13.0
18	NLF	19.0			153.4		13.4
	SDLF	5.2			72.5		7.7
	TDLF	6.5			6.7		3.1
19	NLF			147.7		84.7	22.0
	SDLF			68.3		46.7	13.6
	TDLF			2.4		15.4	6.8
20	NLF		92.4		73.7		2.9
	SDLF		46.9		36.6		1.3
	TDLF		9.1		5.6		0.1

Table U2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	33.1		49.8		13.5	4.0
	SDLF	13.4		24.8		5.8	1.9
	TDLF	3.4		3.3		0.1	0.5
22	NLF	3.0	39.5		17.5		0.1
	SDLF	6.0	21.9		7.8		0.4
	TDLF	8.8	5.9		0.2		0.6
23	NLF	11.2	12.8	44.3	23.7	13.8	4.8
	SDLF	11.8	4.7	23.1	10.8	4.9	2.1
	TDLF	12.3	2.6	4.5	0.2	1.4	0.5
24	NLF	15.4	8.7	1.5	6.2	5.3	0.7
	SDLF	14.8	9.3	1.4	0.7	0.1	0.0
	TDLF	14.0	9.5	3.6	3.8	4.2	0.1
25	NLF	17.0	19.1	11.8	0.8	10.0	23.9
	SDLF	16.3	17.1	10.7	4.1	3.0	13.9
	TDLF	15.4	15.0	9.8	7.8	4.5	2.6
26	NLF	13.5	20.0	14.8	1.6	17.5	
	SDLF	12.7	17.5	12.5	3.1	11.0	
	TDLF	11.7	15.0	11.1	6.2	1.8	
27	NLF	11.3	17.9	12.6	0.8		
	SDLF	10.3	15.0	9.9	1.0		
	TDLF	9.3	12.5	8.5	1.7		
28	NLF	9.1	13.5	6.2			15.6
	SDLF	8.9	11.3	4.4			9.2
	TDLF	8.6	9.7	5.5			1.9
29	NLF	6.8	7.1			18.5	3.3
	SDLF	7.8	11.1			8.1	1.7
	TDLF	8.7	16.5			4.6	0.3
30	NLF	7.3			18.9	6.3	2.6
	SDLF	5.3			8.4	2.6	1.5
	TDLF	2.9			6.4	2.8	0.1

Table U2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF			13.6	5.9	3.2	0.7
	SDLF			8.3	1.7	0.8	0.2
	TDLF			1.9	5.2	3.3	0.7
32	NLF		8.1	8.1	3.7	0.5	1.3
	SDLF		0.1	1.7	0.4	2.4	1.6
	TDLF		12.8	8.2	7.0	5.6	2.3
33	NLF	1.7	4.8	6.0	0.8	5.1	3.6
	SDLF	3.9	1.5	2.0	2.0	5.8	3.5
	TDLF	8.1	4.5	4.5	6.7	7.5	3.7
34	NLF	2.0	5.5	4.3	4.6	10.4	6.5
	SDLF	1.1	3.8	2.8	5.3	10.4	6.3
	TDLF	0.1	1.6	0.5	6.0	9.9	5.7
35	NLF	2.3	0.9	3.6	11.4	15.2	9.7
	SDLF	2.1	1.3	2.5	10.4	14.7	9.4
	TDLF	2.4	2.9	0.0	8.1	13.2	8.8
36	NLF	4.9	0.1	7.3	14.4	16.5	10.6
	SDLF	4.9	1.0	5.8	12.9	15.5	10.3
	TDLF	5.4	3.6	2.1	9.8	13.6	9.6
37	NLF	7.7	2.1	7.9	15.2	15.8	10.4
	SDLF	7.7	3.1	6.5	13.7	14.4	9.9
	TDLF	8.0	5.4	3.2	10.4	11.8	9.0
38	NLF	10.4	6.6	6.7	13.8	11.6	8.5
	SDLF	10.1	7.1	5.2	11.9	10.6	8.3
	TDLF	9.8	8.3	2.1	8.4	8.7	7.9
39	NLF	11.6	12.2	0.7	6.4	4.5	6.2
	SDLF	10.6	10.7	0.4	5.2	5.6	6.7
	TDLF	9.1	8.4	2.2	3.1	7.4	7.7
40	NLF	7.5	8.0	19.1	18.1	4.5	6.6
	SDLF	6.8	6.1	14.0	12.9	6.2	6.9
	TDLF	5.8	3.0	5.7	4.3	9.2	7.5

Table U2-4-4(Continued). Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
41	NLF	3.6	4.7	21.0	20.2	2.7	4.6
	SDLF	3.2	2.6	15.2	14.3	4.8	5.0
	TDLF	2.5	0.5	5.9	4.7	7.9	5.5
42	NLF	5.1	3.6	5.5	5.1	3.0	4.0
	SDLF	3.0	2.7	3.9	3.3	2.4	2.9
	TDLF	0.3	0.7	0.2	0.1	0.8	0.6

Table U2-4-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	5.6	3.9	2.8	2.5	1.6	1.0
	SDLF	0.6	0.5	0.2	0.4	0.3	0.2
	TDLF	5.7	5.1	4.8	2.5	1.7	1.1
2	NLF	9.8	13.3	12.4	9.1	3.4	0.2
	SDLF	12.5	14.3	12.1	8.5	3.0	0.1
	TDLF	15.2	15.4	11.6	8.0	2.9	0.2
3	NLF	18.6	24.7	22.8	16.5	5.8	0.1
	SDLF	21.5	25.8	22.1	15.6	5.5	0.2
	TDLF	24.2	26.9	21.7	15.0	5.3	0.3
4	NLF	26.2	34.4	31.3	22.9	9.0	0.7
	SDLF	29.1	35.5	30.5	21.6	7.9	0.5
	TDLF	31.8	36.8	30.4	20.9	7.3	0.5
5	NLF	30.9	40.6	36.7	27.1	11.3	1.7
	SDLF	34.4	43.0	37.3	26.5	9.9	0.9
	TDLF	37.6	45.3	38.1	26.2	9.0	0.3
6	NLF	34.0	44.4	39.9	28.7	11.7	1.8
	SDLF	38.1	48.8	43.4	30.9	11.9	1.6
	TDLF	41.7	52.5	46.3	32.6	12.1	1.5
7	NLF	34.7	46.0	41.6	29.4	11.4	2.1
	SDLF	39.6	52.8	49.2	36.0	14.9	3.1
	TDLF	43.9	58.2	55.1	41.1	17.5	3.8
8	NLF	33.1	45.6	43.1	30.2	12.2	3.1
	SDLF	39.1	54.8	55.0	43.0	20.8	5.8
	TDLF	44.2	62.1	64.3	53.2	27.6	8.0
9	NLF	30.6	45.6	47.1	39.6	20.9	6.9
	SDLF	37.0	55.3	60.1	54.2	32.0	10.7
	TDLF	42.5	63.2	70.6	66.1	41.1	13.8
10	NLF	26.6	44.8	57.4	55.4	42.0	17.2
	SDLF	32.6	51.8	64.3	64.4	47.8	17.7
	TDLF	37.8	57.8	70.5	72.0	52.9	18.2

Table U2-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	22.3	50.7	70.4	99.6	72.2	23.2
	SDLF	28.9	52.6	64.5	80.4	59.6	23.7
	TDLF	34.6	55.0	60.8	66.3	50.8	25.1
12	NLF	2.6		31.3		64.6	63.2
	SDLF	9.7		21.9		30.1	20.3
	TDLF	15.7		14.5		2.3	14.0
13	NLF	9.7	39.4		98.8		
	SDLF	21.5	36.0		46.9		
	TDLF	31.3	33.6		5.4		
14	NLF			88.0		84.8	
	SDLF			48.8		24.5	
	TDLF			16.8		24.3	
15	NLF	7.4	43.0		92.6		
	SDLF	2.5	24.7		30.2		
	TDLF	11.4	8.9		20.9		
16	NLF			84.1			22.2
	SDLF			31.3			1.2
	TDLF			13.0			15.9
17	NLF	10.8	58.8			76.1	21.7
	SDLF	3.6	24.7			14.5	8.0
	TDLF	3.8	6.2			36.3	3.4
18	NLF	5.0			83.3		7.5
	SDLF	3.1			8.9		2.2
	TDLF	10.7			52.8		2.3
19	NLF			76.0		45.7	11.7
	SDLF			6.4		11.5	4.3
	TDLF			52.4		17.0	2.0
20	NLF		44.6		40.0		1.6
	SDLF		0.5		4.3		0.3
	TDLF		40.4		25.8		0.8

Table U2-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	13.0		26.1		8.5	2.3
	SDLF	3.6		0.4		0.0	0.2
	TDLF	18.6		22.2		6.8	2.1
22	NLF	0.7	20.9		10.0		0.0
	SDLF	5.0	4.1		0.3		0.3
	TDLF	9.3	11.4		9.3		0.6
23	NLF	4.0	9.1	26.1	15.1	9.8	3.4
	SDLF	6.9	0.5	3.7	0.9	0.9	0.3
	TDLF	9.7	9.4	16.3	11.2	9.3	3.1
24	NLF	7.4	4.0	0.3	3.2	3.1	2.5
	SDLF	7.4	4.7	1.6	2.0	2.6	0.1
	TDLF	7.5	5.3	3.2	6.5	7.5	2.1
25	NLF	9.4	12.0	10.6	7.0	2.9	1.1
	SDLF	8.0	8.2	6.2	5.7	4.4	1.7
	TDLF	6.8	4.7	2.2	5.1	6.9	4.2
26	NLF	7.6	12.8	12.6	8.0	1.1	
	SDLF	6.6	9.4	8.1	5.9	3.0	
	TDLF	5.7	6.3	4.4	5.3	7.4	
27	NLF	5.9	10.6	9.3	3.5		
	SDLF	5.5	9.1	7.3	5.8		
	TDLF	5.2	7.8	6.1	10.1		
28	NLF	4.2	6.6	2.2			0.4
	SDLF	3.9	6.8	5.5			0.2
	TDLF	3.6	7.4	10.7			0.6
29	NLF	2.6	1.2			0.3	0.6
	SDLF	1.7	0.2			3.0	0.3
	TDLF	0.8	0.5			9.1	1.9
30	NLF	0.7			1.1	0.8	0.3
	SDLF	3.5			7.2	3.5	0.9
	TDLF	7.4			19.7	9.6	2.8

Table U2-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF			2.7	1.2	0.4	0.1
	SDLF			8.2	5.0	3.3	1.0
	TDLF			23.5	13.9	8.7	2.5
32	NLF		2.9	2.3	1.0	0.4	0.4
	SDLF		1.4	2.3	3.2	2.5	0.8
	TDLF		9.5	10.1	9.7	5.9	1.6
33	NLF	2.0	2.6	2.3	0.3	1.7	1.2
	SDLF	3.3	2.3	1.8	2.9	2.6	1.1
	TDLF	11.8	10.3	8.4	7.7	4.3	1.1
34	NLF	0.3	0.6	0.0	2.8	4.4	2.8
	SDLF	0.3	0.9	1.3	3.1	4.0	2.2
	TDLF	0.3	3.1	3.7	3.8	3.5	1.6
35	NLF	0.9	0.4	1.6	4.3	5.7	4.0
	SDLF	1.2	1.3	0.1	2.6	4.5	3.2
	TDLF	1.9	3.4	3.2	0.2	2.6	2.1
36	NLF	2.2	0.9	1.8	4.6	5.8	4.3
	SDLF	2.8	2.5	0.4	2.5	4.2	3.4
	TDLF	3.9	5.7	4.6	1.3	1.5	2.1
37	NLF	3.2	2.0	1.6	4.5	5.4	4.1
	SDLF	3.9	3.7	0.5	2.4	3.4	3.1
	TDLF	5.1	6.7	4.4	1.5	0.1	1.6
38	NLF	4.2	3.6	1.3	4.1	3.7	3.3
	SDLF	4.6	4.9	0.9	1.6	2.0	2.6
	TDLF	5.2	6.9	4.6	2.5	0.6	1.7
39	NLF	4.5	5.5	0.5	1.8	1.0	2.3
	SDLF	4.2	4.9	2.2	0.1	1.5	2.5
	TDLF	3.6	3.4	4.6	2.8	2.5	3.1
40	NLF	3.0	3.7	7.5	7.4	1.0	2.4
	SDLF	2.8	2.3	3.2	2.8	2.6	2.5
	TDLF	2.5	0.7	4.5	5.3	5.6	3.0

Table U2-4-5(Continued). Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	1.5	2.3	8.0	7.8	0.5	1.6
	SDLF	1.3	0.5	2.9	2.5	2.4	1.8
	TDLF	1.0	2.7	6.0	6.7	5.7	2.2
42	NLF	2.0	2.2	2.2	2.2	2.0	1.7
	SDLF	0.3	0.2	0.1	0.3	0.2	0.1
	TDLF	2.9	2.9	2.6	2.5	2.6	2.4

Table U2-4-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	10.3	7.4	5.6	5.1	3.5	2.6
	SDLF	3.8	3.3	3.5	3.5	2.7	2.1
	TDLF	1.7	1.4	0.8	0.6	0.6	0.8
2	NLF	17.9	23.7	22.2	15.1	3.7	0.6
	SDLF	20.3	24.3	21.5	14.2	3.2	0.7
	TDLF	22.7	25.0	20.8	13.6	3.0	0.7
3	NLF	34.7	45.0	41.1	27.8	6.6	1.9
	SDLF	36.5	44.7	39.2	26.0	5.8	1.8
	TDLF	38.3	44.7	37.8	24.6	5.3	1.8
4	NLF	49.1	63.1	56.7	39.0	11.6	1.3
	SDLF	50.1	61.7	53.4	35.8	9.4	1.9
	TDLF	51.5	61.2	51.6	33.8	8.1	2.2
5	NLF	58.2	75.3	67.1	47.0	15.8	0.5
	SDLF	59.2	74.1	64.1	43.4	12.6	1.1
	TDLF	60.7	74.0	62.6	41.3	10.6	2.1
6	NLF	65.1	83.3	73.4	50.1	16.5	0.6
	SDLF	65.9	83.3	72.7	48.9	14.7	0.4
	TDLF	67.3	84.0	72.8	48.4	13.6	1.0
7	NLF	66.7	86.4	76.8	51.7	16.1	1.2
	SDLF	68.2	88.6	79.9	54.5	17.4	1.3
	TDLF	70.2	91.0	82.9	57.3	18.7	1.5
8	NLF	63.1	84.8	78.4	51.6	17.1	3.0
	SDLF	66.2	89.9	86.2	61.2	23.8	5.0
	TDLF	69.3	94.5	92.9	69.6	29.4	6.7
9	NLF	58.4	84.1	84.9	69.0	33.7	10.6
	SDLF	62.3	90.1	93.9	79.9	42.4	13.4
	TDLF	66.0	95.4	101.8	89.5	50.0	15.8
10	NLF	50.4	81.6	102.9	98.2	72.9	30.3
	SDLF	54.6	85.5	105.7	103.0	75.5	29.2
	TDLF	58.4	89.2	108.9	107.7	78.5	28.6

Table U2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	41.0	90.4	124.7	176.1	126.3	39.8
	SDLF	46.9	90.1	115.4	152.4	110.3	39.1
	TDLF	51.9	90.6	109.1	134.9	99.4	40.0
12	NLF	4.9		56.6		118.4	118.4
	SDLF	12.0		45.9		80.4	71.1
	TDLF	18.0		37.2		50.2	34.0
13	NLF	18.5	71.5		179.7		
	SDLF	29.8	66.2		123.1		
	TDLF	39.1	62.1		77.8		
14	NLF			159.9		155.3	
	SDLF			117.0		91.1	
	TDLF			81.8		39.8	
15	NLF	15.1	78.5		167.0		
	SDLF	4.8	58.7		102.3		
	TDLF	4.7	41.5		49.4		
16	NLF			150.5			44.8
	SDLF			96.8			21.6
	TDLF			51.7			2.6
17	NLF	20.5	105.0			141.9	40.0
	SDLF	13.4	71.3			76.6	25.6
	TDLF	5.6	40.4			23.4	14.0
18	NLF	9.2			153.4		14.2
	SDLF	2.4			76.5		8.6
	TDLF	4.6			13.0		4.0
19	NLF			139.7		83.0	21.8
	SDLF			69.0		47.8	14.3
	TDLF			9.4		18.6	7.9
20	NLF		81.5		73.5		3.3
	SDLF		36.7		37.0		2.0
	TDLF		3.1		6.2		0.8

Table U2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	23.1		49.5		15.4	5.2
	SDLF	7.7		23.4		6.6	2.6
	TDLF	6.5		0.4		0.5	0.6
22	NLF	0.3	39.7		18.9		0.6
	SDLF	4.9	22.7		8.2		0.3
	TDLF	9.4	6.9		1.1		0.0
23	NLF	7.5	17.8	51.4	29.6	19.2	8.2
	SDLF	10.4	7.8	28.1	14.7	7.8	4.0
	TDLF	13.3	1.6	7.3	2.0	1.2	1.0
24	NLF	15.1	8.2	1.3	7.3	8.1	7.6
	SDLF	14.8	8.6	0.3	2.3	2.3	4.3
	TDLF	14.7	9.0	1.7	2.1	2.7	1.7
25	NLF	19.8	24.7	20.7	13.5	4.7	2.4
	SDLF	17.7	19.8	14.6	10.1	4.1	0.2
	TDLF	16.0	15.3	9.3	7.8	4.8	0.6
26	NLF	16.3	25.6	23.4	13.6	1.0	
	SDLF	14.6	21.1	17.4	9.7	1.1	
	TDLF	13.3	17.1	12.5	7.7	1.8	
27	NLF	12.3	19.9	14.9	0.9		
	SDLF	11.6	17.8	12.2	3.0		
	TDLF	11.1	16.1	10.6	7.4		
28	NLF	8.3	10.6	3.1			2.1
	SDLF	8.0	10.7	0.5			0.8
	TDLF	7.6	11.4	6.6			2.0
29	NLF	4.3	3.6			1.1	2.8
	SDLF	3.7	3.7			0.0	2.0
	TDLF	3.1	2.3			4.0	0.5
30	NLF	1.7			6.3	5.1	2.3
	SDLF	2.1			0.5	1.0	1.1
	TDLF	7.0			11.8	5.0	0.7

Table U2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF			12.1	7.5	4.5	1.3
	SDLF			1.8	1.4	0.7	0.3
	TDLF			13.2	7.6	4.8	1.2
32	NLF		13.1	11.7	7.3	1.9	0.1
	SDLF		8.5	7.1	3.0	0.3	0.4
	TDLF		0.1	1.0	3.7	3.9	1.3
33	NLF	11.4	12.8	11.6	4.6	2.5	2.2
	SDLF	4.8	7.4	7.3	1.4	3.5	2.1
	TDLF	5.2	1.4	0.2	3.6	5.3	2.3
34	NLF	0.2	4.9	4.2	4.5	10.5	6.6
	SDLF	0.4	3.5	3.0	4.8	10.2	6.0
	TDLF	0.4	1.2	0.3	6.0	10.0	5.5
35	NLF	2.0	0.4	4.2	12.0	15.9	10.2
	SDLF	2.3	1.4	2.5	10.3	14.8	9.4
	TDLF	3.0	3.5	0.6	7.6	13.0	8.4
36	NLF	4.2	0.7	8.1	15.0	17.3	11.2
	SDLF	4.9	1.0	5.9	13.0	15.7	10.4
	TDLF	6.1	4.2	1.6	9.2	13.2	9.2
37	NLF	6.8	1.2	8.8	16.0	16.7	11.0
	SDLF	7.6	2.9	6.7	13.8	14.7	10.0
	TDLF	8.8	6.1	2.8	10.0	11.5	8.7
38	NLF	9.5	5.7	7.6	14.6	12.4	9.1
	SDLF	10.0	7.0	5.4	12.1	10.7	8.4
	TDLF	10.6	9.1	1.7	8.0	8.1	7.6
39	NLF	10.8	11.4	1.6	7.2	5.1	6.5
	SDLF	10.5	10.8	0.1	5.3	5.6	6.7
	TDLF	9.9	9.4	2.6	2.6	6.6	7.4
40	NLF	7.1	7.7	18.9	18.5	4.7	6.8
	SDLF	6.9	6.1	14.5	13.8	6.3	6.9
	TDLF	6.5	3.2	6.8	5.6	9.4	7.4

Table U2-4-6(Continued). Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	3.6	4.9	21.5	20.7	2.7	4.5
	SDLF	3.5	2.9	16.1	15.3	4.7	4.8
	TDLF	3.2	0.3	7.2	6.0	7.9	5.1
42	NLF	5.5	5.7	5.7	5.7	5.3	4.8
	SDLF	4.1	3.6	3.1	3.6	3.2	3.0
	TDLF	1.0	0.5	0.4	0.9	0.5	0.6

Table U2-4-7. Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location					
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.48	0.47	0.45	0.44	0.43	0.44
	SDLF	0.54	0.51	0.48	0.46	0.45	0.46
	TDLF	0.58	0.54	0.50	0.47	0.47	0.47
3	NLF	0.93	0.90	0.87	0.85	0.84	0.85
	SDLF	1.05	0.99	0.93	0.89	0.88	0.88
	TDLF	1.13	1.05	0.97	0.92	0.91	0.92
4	NLF	1.32	1.28	1.24	1.22	1.20	1.21
	SDLF	1.49	1.40	1.33	1.28	1.26	1.26
	TDLF	1.61	1.49	1.39	1.31	1.30	1.31
5	NLF	1.64	1.59	1.55	1.52	1.50	1.51
	SDLF	1.84	1.74	1.65	1.59	1.57	1.57
	TDLF	2.00	1.86	1.73	1.64	1.62	1.64
6	NLF	1.88	1.83	1.78	1.74	1.73	1.73
	SDLF	2.11	2.00	1.89	1.82	1.80	1.81
	TDLF	2.29	2.13	1.98	1.88	1.86	1.88
7	NLF	2.03	1.97	1.92	1.88	1.87	1.88
	SDLF	2.28	2.16	2.05	1.97	1.94	1.95
	TDLF	2.47	2.31	2.15	2.03	2.00	2.02
8	NLF	2.09	2.03	1.98	1.94	1.93	1.93
	SDLF	2.35	2.23	2.12	2.02	1.98	1.98
	TDLF	2.55	2.39	2.22	2.08	2.03	2.04
9	NLF	2.07	2.02	1.96	1.91	1.88	1.88
	SDLF	2.33	2.22	2.10	1.99	1.91	1.90
	TDLF	2.54	2.38	2.21	2.04	1.94	1.92
10	NLF	1.97	1.92	1.87	1.80	1.74	1.71
	SDLF	2.22	2.13	2.01	1.87	1.72	1.67
	TDLF	2.42	2.29	2.12	1.92	1.72	1.65

Table U2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	1.80	1.77	1.70	1.61	1.48	1.42
	SDLF	2.04	1.96	1.83	1.65	1.43	1.31
	TDLF	2.22	2.10	1.93	1.68	1.39	1.24
12	NLF	1.58	1.56	1.48	1.35	1.13	0.98
	SDLF	1.78	1.72	1.58	1.35	1.04	0.82
	TDLF	1.93	1.83	1.66	1.35	0.98	0.71
13	NLF	1.43	1.41	1.32	1.16	0.93	0.65
	SDLF	1.59	1.55	1.39	1.14	0.82	0.50
	TDLF	1.72	1.66	1.44	1.12	0.73	0.38
14	NLF	1.32	1.31	1.20	1.02	0.78	0.44
	SDLF	1.46	1.43	1.25	0.98	0.65	0.28
	TDLF	1.57	1.53	1.28	0.95	0.55	0.17
15	NLF	1.17	1.16	1.04	0.83	0.54	0.20
	SDLF	1.28	1.26	1.05	0.76	0.41	0.05
	TDLF	1.36	1.34	1.05	0.70	0.32	-0.06
16	NLF	1.04	1.01	0.86	0.62	0.27	0.07
	SDLF	1.12	1.08	0.83	0.53	0.16	-0.09
	TDLF	1.18	1.12	0.81	0.46	0.07	-0.20
17	NLF	0.90	0.86	0.67	0.35	0.09	0.00
	SDLF	0.95	0.88	0.61	0.27	-0.02	-0.16
	TDLF	1.00	0.90	0.57	0.21	-0.10	-0.28
18	NLF	0.77	0.69	0.41	0.18	-0.01	-0.06
	SDLF	0.80	0.68	0.35	0.10	-0.12	-0.21
	TDLF	0.83	0.67	0.31	0.04	-0.21	-0.32
19	NLF	0.64	0.44	0.23	0.06	-0.08	-0.11
	SDLF	0.65	0.41	0.17	-0.02	-0.20	-0.24
	TDLF	0.66	0.39	0.13	-0.08	-0.28	-0.34
20	NLF	0.45	0.27	0.12	-0.02	-0.13	-0.14
	SDLF	0.43	0.23	0.06	-0.11	-0.23	-0.25
	TDLF	0.42	0.21	0.02	-0.17	-0.31	-0.34

Table U2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	0.20	0.12	-0.01	-0.10	-0.16	-0.16
	SDLF	0.18	0.08	-0.06	-0.17	-0.25	-0.25
	TDLF	0.16	0.05	-0.11	-0.23	-0.32	-0.32
22	NLF	0.02	0.00	-0.08	-0.14	-0.17	-0.17
	SDLF	0.00	-0.04	-0.13	-0.20	-0.24	-0.24
	TDLF	-0.02	-0.07	-0.16	-0.25	-0.28	-0.29
23	NLF	-0.09	-0.09	-0.12	-0.15	-0.16	-0.17
	SDLF	-0.12	-0.12	-0.16	-0.19	-0.21	-0.21
	TDLF	-0.14	-0.13	-0.18	-0.23	-0.24	-0.24
24	NLF	-0.15	-0.14	-0.14	-0.15	-0.16	-0.16
	SDLF	-0.18	-0.16	-0.17	-0.17	-0.18	-0.17
	TDLF	-0.20	-0.17	-0.18	-0.19	-0.19	-0.18
25	NLF	-0.18	-0.17	-0.16	-0.15	-0.15	-0.15
	SDLF	-0.21	-0.18	-0.17	-0.15	-0.15	-0.14
	TDLF	-0.23	-0.19	-0.17	-0.15	-0.14	-0.13
26	NLF	-0.19	-0.18	-0.16	-0.15	-0.15	-0.15
	SDLF	-0.21	-0.19	-0.16	-0.14	-0.13	-0.12
	TDLF	-0.22	-0.18	-0.15	-0.13	-0.12	-0.10
27	NLF	-0.19	-0.18	-0.16	-0.15	-0.16	-0.18
	SDLF	-0.21	-0.18	-0.15	-0.13	-0.13	-0.14
	TDLF	-0.21	-0.18	-0.14	-0.12	-0.11	-0.12
28	NLF	-0.19	-0.18	-0.17	-0.16	-0.18	-0.19
	SDLF	-0.20	-0.18	-0.15	-0.14	-0.15	-0.16
	TDLF	-0.20	-0.17	-0.14	-0.12	-0.13	-0.14
29	NLF	-0.19	-0.18	-0.17	-0.19	-0.19	-0.20
	SDLF	-0.19	-0.17	-0.15	-0.16	-0.16	-0.16
	TDLF	-0.19	-0.16	-0.13	-0.14	-0.14	-0.14
30	NLF	-0.19	-0.18	-0.19	-0.20	-0.20	-0.20
	SDLF	-0.18	-0.16	-0.17	-0.17	-0.17	-0.17
	TDLF	-0.17	-0.15	-0.15	-0.15	-0.15	-0.15

Table U2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	-0.18	-0.19	-0.20	-0.20	-0.20	-0.20
	SDLF	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17
	TDLF	-0.16	-0.16	-0.16	-0.16	-0.15	-0.15
32	NLF	-0.19	-0.20	-0.20	-0.20	-0.20	-0.20
	SDLF	-0.18	-0.18	-0.18	-0.17	-0.17	-0.17
	TDLF	-0.16	-0.16	-0.16	-0.16	-0.15	-0.15
33	NLF	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20
	SDLF	-0.17	-0.17	-0.17	-0.18	-0.17	-0.16
	TDLF	-0.16	-0.16	-0.16	-0.16	-0.15	-0.14
34	NLF	-0.19	-0.19	-0.19	-0.20	-0.19	-0.18
	SDLF	-0.16	-0.17	-0.17	-0.17	-0.16	-0.15
	TDLF	-0.14	-0.15	-0.16	-0.16	-0.14	-0.12
35	NLF	-0.16	-0.16	-0.16	-0.16	-0.16	-0.15
	SDLF	-0.13	-0.14	-0.14	-0.14	-0.12	-0.11
	TDLF	-0.12	-0.13	-0.13	-0.13	-0.11	-0.08
36	NLF	-0.12	-0.12	-0.12	-0.12	-0.11	-0.10
	SDLF	-0.09	-0.10	-0.10	-0.10	-0.08	-0.07
	TDLF	-0.08	-0.10	-0.10	-0.09	-0.07	-0.04
37	NLF	-0.07	-0.07	-0.08	-0.07	-0.06	-0.06
	SDLF	-0.04	-0.06	-0.06	-0.05	-0.04	-0.03
	TDLF	-0.04	-0.06	-0.07	-0.05	-0.03	0.00
38	NLF	-0.03	-0.03	-0.04	-0.03	-0.03	-0.02
	SDLF	0.00	-0.02	-0.03	-0.01	-0.01	0.00
	TDLF	0.00	-0.02	-0.04	-0.01	0.00	0.02
39	NLF	0.01	0.00	-0.01	0.00	0.00	0.00
	SDLF	0.03	0.01	-0.01	0.01	0.01	0.01
	TDLF	0.03	0.01	-0.01	0.01	0.01	0.03
40	NLF	0.02	0.02	0.02	0.00	0.00	0.01
	SDLF	0.04	0.03	0.03	-0.01	0.00	0.02
	TDLF	0.04	0.03	0.04	-0.02	0.00	0.03

Table U2-4-7(Continued). Vertical differential displacements (in) at cross-frames under SDL for different detailing methods.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
41	NLF	0.02	0.02	0.02	-0.01	0.00	0.00
	SDLF	0.03	0.03	0.03	-0.01	0.00	0.01
	TDLF	0.03	0.03	0.04	-0.03	0.00	0.02
42	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00

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Table U2-4-8. Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.01	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.85	0.82	0.79	0.77	0.77	0.77
	SDLF	0.89	0.85	0.81	0.78	0.77	0.78
	TDLF	0.92	0.86	0.81	0.77	0.77	0.78
3	NLF	1.65	1.60	1.54	1.50	1.49	1.50
	SDLF	1.73	1.64	1.57	1.51	1.50	1.51
	TDLF	1.78	1.68	1.58	1.51	1.50	1.52
4	NLF	2.35	2.27	2.20	2.15	2.13	2.15
	SDLF	2.46	2.34	2.24	2.16	2.14	2.16
	TDLF	2.54	2.39	2.26	2.16	2.15	2.17
5	NLF	2.92	2.83	2.75	2.69	2.67	2.68
	SDLF	3.05	2.91	2.79	2.71	2.68	2.70
	TDLF	3.16	2.98	2.82	2.71	2.69	2.72
6	NLF	3.35	3.25	3.16	3.10	3.08	3.10
	SDLF	3.51	3.35	3.21	3.12	3.09	3.11
	TDLF	3.63	3.43	3.25	3.12	3.10	3.13
7	NLF	3.63	3.52	3.43	3.36	3.35	3.37
	SDLF	3.80	3.64	3.49	3.38	3.35	3.37
	TDLF	3.93	3.73	3.53	3.39	3.36	3.39
8	NLF	3.75	3.65	3.55	3.47	3.46	3.47
	SDLF	3.93	3.77	3.62	3.49	3.45	3.47
	TDLF	4.08	3.87	3.67	3.49	3.45	3.47
9	NLF	3.72	3.63	3.53	3.44	3.40	3.40
	SDLF	3.91	3.77	3.61	3.45	3.37	3.36
	TDLF	4.07	3.88	3.66	3.46	3.35	3.34
10	NLF	3.56	3.48	3.38	3.26	3.15	3.12
	SDLF	3.75	3.63	3.46	3.28	3.09	3.03
	TDLF	3.90	3.74	3.53	3.29	3.05	2.97

Table U2-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	3.27	3.21	3.10	2.93	2.70	2.60
	SDLF	3.46	3.35	3.18	2.93	2.61	2.46
	TDLF	3.60	3.46	3.24	2.93	2.55	2.36
12	NLF	2.89	2.85	2.70	2.48	2.09	1.82
	SDLF	3.04	2.97	2.77	2.45	1.98	1.64
	TDLF	3.16	3.05	2.82	2.42	1.90	1.51
13	NLF	2.62	2.59	2.44	2.14	1.74	1.24
	SDLF	2.75	2.70	2.47	2.09	1.60	1.07
	TDLF	2.85	2.78	2.50	2.06	1.50	0.95
14	NLF	2.43	2.42	2.22	1.89	1.47	0.85
	SDLF	2.54	2.51	2.24	1.83	1.33	0.69
	TDLF	2.63	2.58	2.26	1.78	1.22	0.58
15	NLF	2.17	2.15	1.93	1.55	1.04	0.41
	SDLF	2.25	2.22	1.92	1.47	0.90	0.26
	TDLF	2.32	2.28	1.91	1.40	0.80	0.15
16	NLF	1.93	1.89	1.61	1.18	0.53	0.18
	SDLF	1.98	1.93	1.57	1.07	0.42	0.02
	TDLF	2.03	1.96	1.53	1.00	0.34	-0.09
17	NLF	1.68	1.61	1.26	0.69	0.22	0.04
	SDLF	1.72	1.62	1.20	0.60	0.11	-0.11
	TDLF	1.75	1.62	1.14	0.54	0.03	-0.23
18	NLF	1.45	1.30	0.79	0.37	0.02	-0.07
	SDLF	1.47	1.28	0.72	0.28	-0.09	-0.21
	TDLF	1.48	1.25	0.68	0.22	-0.17	-0.32
19	NLF	1.22	0.86	0.46	0.14	-0.11	-0.16
	SDLF	1.22	0.82	0.40	0.07	-0.22	-0.28
	TDLF	1.21	0.79	0.36	0.01	-0.30	-0.38
20	NLF	0.87	0.54	0.24	-0.02	-0.20	-0.22
	SDLF	0.84	0.50	0.19	-0.10	-0.30	-0.33
	TDLF	0.82	0.47	0.14	-0.16	-0.38	-0.41

Table U2-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	0.40	0.25	0.01	-0.17	-0.27	-0.28
	SDLF	0.37	0.21	-0.04	-0.24	-0.36	-0.36
	TDLF	0.35	0.18	-0.08	-0.29	-0.42	-0.43
22	NLF	0.06	0.01	-0.13	-0.26	-0.30	-0.31
	SDLF	0.03	-0.03	-0.18	-0.31	-0.36	-0.37
	TDLF	0.01	-0.05	-0.20	-0.36	-0.41	-0.41
23	NLF	-0.16	-0.16	-0.22	-0.28	-0.31	-0.31
	SDLF	-0.19	-0.19	-0.25	-0.32	-0.35	-0.35
	TDLF	-0.20	-0.20	-0.27	-0.35	-0.37	-0.37
24	NLF	-0.30	-0.27	-0.28	-0.29	-0.30	-0.31
	SDLF	-0.32	-0.29	-0.30	-0.31	-0.32	-0.32
	TDLF	-0.34	-0.30	-0.31	-0.33	-0.33	-0.33
25	NLF	-0.37	-0.34	-0.32	-0.31	-0.31	-0.32
	SDLF	-0.39	-0.35	-0.32	-0.31	-0.30	-0.30
	TDLF	-0.40	-0.35	-0.32	-0.30	-0.30	-0.29
26	NLF	-0.40	-0.37	-0.34	-0.32	-0.33	-0.35
	SDLF	-0.41	-0.37	-0.33	-0.31	-0.31	-0.31
	TDLF	-0.42	-0.37	-0.32	-0.29	-0.29	-0.29
27	NLF	-0.41	-0.38	-0.35	-0.34	-0.36	-0.42
	SDLF	-0.42	-0.38	-0.34	-0.32	-0.33	-0.38
	TDLF	-0.42	-0.37	-0.33	-0.30	-0.31	-0.36
28	NLF	-0.41	-0.39	-0.37	-0.37	-0.43	-0.45
	SDLF	-0.41	-0.38	-0.35	-0.34	-0.39	-0.42
	TDLF	-0.41	-0.37	-0.33	-0.32	-0.37	-0.40
29	NLF	-0.41	-0.39	-0.39	-0.43	-0.46	-0.47
	SDLF	-0.41	-0.38	-0.36	-0.40	-0.43	-0.44
	TDLF	-0.40	-0.37	-0.35	-0.39	-0.41	-0.42
30	NLF	-0.41	-0.40	-0.44	-0.47	-0.48	-0.49
	SDLF	-0.41	-0.39	-0.42	-0.44	-0.45	-0.45
	TDLF	-0.40	-0.37	-0.40	-0.42	-0.43	-0.43

Table U2-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	-0.42	-0.44	-0.47	-0.48	-0.49	-0.49
	SDLF	-0.40	-0.42	-0.44	-0.45	-0.46	-0.46
	TDLF	-0.39	-0.41	-0.42	-0.44	-0.44	-0.44
32	NLF	-0.45	-0.46	-0.48	-0.50	-0.50	-0.50
	SDLF	-0.43	-0.44	-0.46	-0.47	-0.46	-0.46
	TDLF	-0.41	-0.42	-0.44	-0.45	-0.45	-0.44
33	NLF	-0.46	-0.47	-0.49	-0.50	-0.50	-0.49
	SDLF	-0.44	-0.45	-0.46	-0.47	-0.46	-0.45
	TDLF	-0.42	-0.43	-0.45	-0.46	-0.44	-0.43
34	NLF	-0.47	-0.47	-0.49	-0.49	-0.48	-0.46
	SDLF	-0.44	-0.45	-0.46	-0.47	-0.44	-0.42
	TDLF	-0.42	-0.43	-0.44	-0.46	-0.42	-0.40
35	NLF	-0.42	-0.42	-0.43	-0.42	-0.40	-0.38
	SDLF	-0.39	-0.40	-0.40	-0.40	-0.37	-0.34
	TDLF	-0.37	-0.39	-0.39	-0.39	-0.35	-0.31
36	NLF	-0.32	-0.33	-0.33	-0.31	-0.29	-0.27
	SDLF	-0.29	-0.31	-0.31	-0.29	-0.26	-0.23
	TDLF	-0.29	-0.30	-0.30	-0.28	-0.24	-0.20
37	NLF	-0.21	-0.22	-0.22	-0.20	-0.18	-0.16
	SDLF	-0.18	-0.20	-0.20	-0.18	-0.15	-0.13
	TDLF	-0.18	-0.20	-0.21	-0.17	-0.14	-0.10
38	NLF	-0.10	-0.12	-0.12	-0.09	-0.08	-0.07
	SDLF	-0.08	-0.10	-0.12	-0.08	-0.07	-0.05
	TDLF	-0.07	-0.10	-0.12	-0.07	-0.05	-0.02
39	NLF	-0.01	-0.03	-0.05	-0.02	-0.03	-0.01
	SDLF	0.01	-0.02	-0.05	-0.01	-0.02	0.00
	TDLF	0.01	-0.02	-0.05	-0.01	-0.01	0.02
40	NLF	0.04	0.03	0.04	-0.03	-0.02	0.00
	SDLF	0.05	0.04	0.05	-0.03	-0.01	0.01
	TDLF	0.06	0.05	0.06	-0.05	-0.01	0.03

Table U2-4-8(Continued). Vertical differential displacements (in) at cross-frames under TDL for different detailing methods.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	0.04	0.04	0.05	-0.03	-0.01	0.00
	SDLF	0.05	0.05	0.06	-0.03	-0.01	0.01
	TDLF	0.05	0.05	0.07	-0.05	-0.01	0.02
42	NLF	0.00	0.00	0.00	0.01	0.00	0.00
	SDLF	0.00	0.00	0.00	0.01	0.00	0.00
	TDLF	0.00	0.00	0.00	0.01	0.00	0.00

Table U2-4-9. Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.28	0.27	0.26	0.26	0.25	0.25
	SDLF	0.32	0.30	0.28	0.27	0.26	0.27
	TDLF	0.34	0.32	0.29	0.28	0.27	0.28
3	NLF	0.54	0.53	0.51	0.50	0.49	0.49
	SDLF	0.61	0.58	0.54	0.52	0.51	0.52
	TDLF	0.66	0.61	0.57	0.54	0.53	0.54
4	NLF	0.77	0.75	0.73	0.71	0.70	0.71
	SDLF	0.87	0.82	0.78	0.74	0.73	0.74
	TDLF	0.94	0.87	0.81	0.77	0.76	0.77
5	NLF	0.96	0.93	0.90	0.89	0.88	0.88
	SDLF	1.08	1.02	0.96	0.93	0.91	0.92
	TDLF	1.17	1.08	1.01	0.96	0.94	0.96
6	NLF	1.10	1.07	1.04	1.02	1.01	1.01
	SDLF	1.23	1.17	1.11	1.07	1.05	1.06
	TDLF	1.34	1.24	1.16	1.10	1.08	1.10
7	NLF	1.18	1.15	1.12	1.10	1.09	1.10
	SDLF	1.33	1.26	1.20	1.15	1.13	1.14
	TDLF	1.44	1.35	1.25	1.18	1.17	1.18
8	NLF	1.22	1.19	1.16	1.13	1.13	1.13
	SDLF	1.37	1.30	1.24	1.18	1.16	1.16
	TDLF	1.49	1.40	1.30	1.21	1.19	1.19
9	NLF	1.21	1.18	1.15	1.12	1.10	1.10
	SDLF	1.36	1.30	1.23	1.16	1.12	1.11
	TDLF	1.48	1.39	1.29	1.19	1.13	1.12
10	NLF	1.15	1.12	1.09	1.05	1.01	1.00
	SDLF	1.30	1.24	1.17	1.09	1.01	0.98
	TDLF	1.42	1.34	1.24	1.12	1.00	0.97

Table U2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
11	NLF	1.05	1.03	0.99	0.94	0.86	0.83
	SDLF	1.19	1.14	1.07	0.96	0.83	0.77
	TDLF	1.30	1.23	1.13	0.98	0.81	0.72
12	NLF	0.92	0.91	0.86	0.79	0.66	0.57
	SDLF	1.04	1.00	0.92	0.79	0.61	0.48
	TDLF	1.13	1.07	0.97	0.79	0.57	0.41
13	NLF	0.83	0.82	0.77	0.68	0.54	0.38
	SDLF	0.93	0.91	0.81	0.66	0.48	0.29
	TDLF	1.01	0.97	0.84	0.65	0.43	0.22
14	NLF	0.77	0.77	0.70	0.59	0.46	0.26
	SDLF	0.85	0.84	0.73	0.57	0.38	0.17
	TDLF	0.92	0.89	0.75	0.55	0.32	0.10
15	NLF	0.69	0.68	0.61	0.48	0.32	0.12
	SDLF	0.75	0.74	0.61	0.44	0.24	0.03
	TDLF	0.80	0.78	0.61	0.41	0.19	-0.04
16	NLF	0.60	0.59	0.50	0.36	0.16	0.04
	SDLF	0.65	0.63	0.49	0.31	0.09	-0.05
	TDLF	0.69	0.66	0.48	0.27	0.04	-0.12
17	NLF	0.52	0.50	0.39	0.21	0.05	0.00
	SDLF	0.56	0.52	0.36	0.16	-0.01	-0.09
	TDLF	0.58	0.53	0.33	0.12	-0.06	-0.16
18	NLF	0.45	0.40	0.24	0.10	-0.01	-0.04
	SDLF	0.47	0.39	0.21	0.06	-0.07	-0.12
	TDLF	0.48	0.39	0.18	0.02	-0.12	-0.19
19	NLF	0.38	0.26	0.14	0.03	-0.05	-0.06
	SDLF	0.38	0.24	0.10	-0.01	-0.11	-0.14
	TDLF	0.38	0.23	0.08	-0.05	-0.16	-0.20
20	NLF	0.26	0.16	0.07	-0.01	-0.08	-0.08
	SDLF	0.25	0.14	0.03	-0.06	-0.14	-0.15
	TDLF	0.24	0.12	0.01	-0.10	-0.18	-0.20

Table U2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
21	NLF	0.12	0.07	0.00	-0.06	-0.09	-0.10
	SDLF	0.10	0.05	-0.04	-0.10	-0.15	-0.15
	TDLF	0.09	0.03	-0.06	-0.13	-0.18	-0.19
22	NLF	0.01	0.00	-0.05	-0.08	-0.10	-0.10
	SDLF	0.00	-0.02	-0.07	-0.12	-0.14	-0.14
	TDLF	-0.01	-0.04	-0.09	-0.15	-0.17	-0.17
23	NLF	-0.05	-0.05	-0.07	-0.09	-0.10	-0.10
	SDLF	-0.07	-0.07	-0.09	-0.11	-0.12	-0.12
	TDLF	-0.08	-0.08	-0.10	-0.13	-0.14	-0.14
24	NLF	-0.09	-0.08	-0.08	-0.09	-0.09	-0.09
	SDLF	-0.10	-0.09	-0.10	-0.10	-0.10	-0.10
	TDLF	-0.12	-0.10	-0.10	-0.11	-0.11	-0.11
25	NLF	-0.11	-0.10	-0.09	-0.09	-0.09	-0.09
	SDLF	-0.12	-0.11	-0.10	-0.09	-0.09	-0.08
	TDLF	-0.13	-0.11	-0.10	-0.09	-0.08	-0.08
26	NLF	-0.11	-0.10	-0.10	-0.09	-0.09	-0.09
	SDLF	-0.12	-0.11	-0.09	-0.08	-0.08	-0.07
	TDLF	-0.13	-0.11	-0.09	-0.07	-0.07	-0.06
27	NLF	-0.11	-0.11	-0.10	-0.09	-0.09	-0.10
	SDLF	-0.12	-0.11	-0.09	-0.08	-0.08	-0.08
	TDLF	-0.12	-0.10	-0.08	-0.07	-0.07	-0.07
28	NLF	-0.11	-0.10	-0.10	-0.09	-0.11	-0.11
	SDLF	-0.12	-0.10	-0.09	-0.08	-0.09	-0.09
	TDLF	-0.12	-0.10	-0.08	-0.07	-0.08	-0.08
29	NLF	-0.11	-0.10	-0.10	-0.11	-0.11	-0.12
	SDLF	-0.11	-0.10	-0.09	-0.09	-0.09	-0.09
	TDLF	-0.11	-0.09	-0.08	-0.08	-0.08	-0.08
30	NLF	-0.11	-0.10	-0.11	-0.11	-0.12	-0.12
	SDLF	-0.11	-0.10	-0.10	-0.10	-0.10	-0.10
	TDLF	-0.10	-0.09	-0.09	-0.09	-0.09	-0.09

Table U2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	-0.11	-0.11	-0.12	-0.12	-0.12	-0.12
	SDLF	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
	TDLF	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
32	NLF	-0.11	-0.11	-0.12	-0.12	-0.12	-0.12
	SDLF	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
	TDLF	-0.09	-0.09	-0.09	-0.09	-0.09	-0.08
33	NLF	-0.11	-0.11	-0.12	-0.12	-0.12	-0.12
	SDLF	-0.10	-0.10	-0.10	-0.10	-0.10	-0.09
	TDLF	-0.09	-0.09	-0.09	-0.10	-0.09	-0.08
34	NLF	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
	SDLF	-0.10	-0.10	-0.10	-0.10	-0.09	-0.09
	TDLF	-0.08	-0.09	-0.09	-0.10	-0.08	-0.07
35	NLF	-0.09	-0.10	-0.10	-0.09	-0.09	-0.09
	SDLF	-0.08	-0.08	-0.08	-0.08	-0.07	-0.07
	TDLF	-0.07	-0.07	-0.08	-0.08	-0.06	-0.05
36	NLF	-0.07	-0.07	-0.07	-0.07	-0.06	-0.06
	SDLF	-0.05	-0.06	-0.06	-0.06	-0.05	-0.04
	TDLF	-0.05	-0.06	-0.06	-0.05	-0.04	-0.02
37	NLF	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03
	SDLF	-0.02	-0.03	-0.04	-0.03	-0.02	-0.02
	TDLF	-0.02	-0.03	-0.04	-0.03	-0.01	0.00
38	NLF	-0.01	-0.02	-0.02	-0.02	-0.01	-0.01
	SDLF	0.00	-0.01	-0.02	-0.01	-0.01	0.00
	TDLF	0.00	-0.01	-0.02	0.00	0.00	0.01
39	NLF	0.00	0.00	-0.01	0.00	0.00	0.00
	SDLF	0.02	0.01	0.00	0.01	0.00	0.01
	TDLF	0.02	0.01	-0.01	0.01	0.00	0.02
40	NLF	0.01	0.01	0.01	0.00	0.00	0.00
	SDLF	0.02	0.02	0.02	0.00	0.00	0.01
	TDLF	0.02	0.02	0.02	-0.01	0.00	0.02

Table U2-4-9(Continued). Approximate horizontal differential displacements (in) at cross-frames under SDL for different detailing methods, assuming negligible cross-frame deformations.

CF	Detailing Method	CF Location					
		G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	0.01	0.01	0.01	0.00	0.00	0.00
	SDLF	0.02	0.01	0.02	-0.01	0.00	0.01
	TDLF	0.02	0.02	0.03	-0.02	0.00	0.01
42	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00

Table U2-4-10. Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
1	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00
2	NLF	0.49	0.48	0.46	0.45	0.45	0.45
	SDLF	0.52	0.49	0.47	0.45	0.45	0.45
	TDLF	0.54	0.50	0.47	0.45	0.45	0.46
3	NLF	0.96	0.93	0.90	0.88	0.87	0.88
	SDLF	1.01	0.96	0.92	0.88	0.87	0.88
	TDLF	1.04	0.98	0.92	0.88	0.88	0.89
4	NLF	1.37	1.33	1.28	1.25	1.25	1.25
	SDLF	1.43	1.37	1.31	1.26	1.25	1.26
	TDLF	1.48	1.40	1.32	1.26	1.25	1.27
5	NLF	1.70	1.65	1.60	1.57	1.56	1.57
	SDLF	1.78	1.70	1.63	1.58	1.56	1.58
	TDLF	1.84	1.74	1.65	1.58	1.57	1.59
6	NLF	1.96	1.90	1.84	1.81	1.80	1.81
	SDLF	2.05	1.96	1.88	1.82	1.80	1.82
	TDLF	2.12	2.00	1.90	1.82	1.81	1.83
7	NLF	2.12	2.06	2.00	1.96	1.96	1.97
	SDLF	2.22	2.12	2.04	1.97	1.96	1.97
	TDLF	2.30	2.18	2.06	1.98	1.96	1.98
8	NLF	2.19	2.13	2.07	2.03	2.02	2.03
	SDLF	2.29	2.20	2.11	2.04	2.02	2.02
	TDLF	2.38	2.26	2.14	2.04	2.02	2.03
9	NLF	2.17	2.12	2.06	2.01	1.98	1.98
	SDLF	2.28	2.20	2.11	2.02	1.97	1.96
	TDLF	2.37	2.26	2.14	2.02	1.96	1.95
10	NLF	2.08	2.03	1.97	1.91	1.84	1.82
	SDLF	2.19	2.12	2.02	1.91	1.80	1.77
	TDLF	2.28	2.18	2.06	1.92	1.78	1.74

Table U2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
11	NLF	1.91	1.87	1.81	1.71	1.58	1.52
	SDLF	2.02	1.96	1.86	1.71	1.53	1.44
	TDLF	2.10	2.02	1.89	1.71	1.49	1.38
12	NLF	1.68	1.66	1.58	1.45	1.22	1.06
	SDLF	1.78	1.73	1.62	1.43	1.16	0.96
	TDLF	1.85	1.78	1.65	1.41	1.11	0.88
13	NLF	1.53	1.51	1.42	1.25	1.01	0.72
	SDLF	1.61	1.58	1.45	1.22	0.94	0.63
	TDLF	1.67	1.62	1.46	1.20	0.88	0.55
14	NLF	1.42	1.41	1.30	1.11	0.86	0.50
	SDLF	1.48	1.47	1.31	1.07	0.78	0.40
	TDLF	1.53	1.51	1.32	1.04	0.71	0.34
15	NLF	1.27	1.25	1.13	0.91	0.61	0.24
	SDLF	1.32	1.30	1.12	0.86	0.53	0.15
	TDLF	1.35	1.33	1.11	0.82	0.47	0.09
16	NLF	1.12	1.10	0.94	0.69	0.31	0.10
	SDLF	1.16	1.13	0.91	0.63	0.25	0.01
	TDLF	1.18	1.15	0.90	0.58	0.20	-0.05
17	NLF	0.98	0.94	0.74	0.40	0.13	0.02
	SDLF	1.00	0.95	0.70	0.35	0.06	-0.07
	TDLF	1.02	0.95	0.67	0.31	0.02	-0.13
18	NLF	0.85	0.76	0.46	0.21	0.01	-0.04
	SDLF	0.86	0.74	0.42	0.17	-0.05	-0.13
	TDLF	0.87	0.73	0.40	0.13	-0.10	-0.19
19	NLF	0.71	0.50	0.27	0.08	-0.06	-0.09
	SDLF	0.71	0.48	0.24	0.04	-0.13	-0.17
	TDLF	0.71	0.46	0.21	0.00	-0.18	-0.22
20	NLF	0.51	0.31	0.14	-0.01	-0.12	-0.13
	SDLF	0.49	0.29	0.11	-0.06	-0.18	-0.19
	TDLF	0.48	0.27	0.08	-0.09	-0.22	-0.24

Table U2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**	**G4-G5**	**G5-G6**	**G6-G7**
21	NLF	0.23	0.15	0.01	-0.10	-0.16	-0.16
	SDLF	0.22	0.12	-0.03	-0.14	-0.21	-0.21
	TDLF	0.21	0.10	-0.05	-0.17	-0.24	-0.25
22	NLF	0.03	0.01	-0.08	-0.15	-0.18	-0.18
	SDLF	0.02	-0.02	-0.10	-0.18	-0.21	-0.21
	TDLF	0.01	-0.03	-0.12	-0.21	-0.24	-0.24
23	NLF	-0.09	-0.10	-0.13	-0.16	-0.18	-0.18
	SDLF	-0.11	-0.11	-0.15	-0.19	-0.20	-0.20
	TDLF	-0.12	-0.12	-0.16	-0.20	-0.22	-0.22
24	NLF	-0.17	-0.16	-0.16	-0.17	-0.18	-0.18
	SDLF	-0.19	-0.17	-0.17	-0.18	-0.19	-0.19
	TDLF	-0.20	-0.17	-0.18	-0.19	-0.19	-0.19
25	NLF	-0.22	-0.20	-0.19	-0.18	-0.18	-0.18
	SDLF	-0.23	-0.20	-0.19	-0.18	-0.18	-0.18
	TDLF	-0.24	-0.20	-0.19	-0.18	-0.17	-0.17
26	NLF	-0.23	-0.22	-0.20	-0.19	-0.19	-0.20
	SDLF	-0.24	-0.22	-0.20	-0.18	-0.18	-0.18
	TDLF	-0.25	-0.22	-0.19	-0.17	-0.17	-0.17
27	NLF	-0.24	-0.22	-0.21	-0.20	-0.21	-0.24
	SDLF	-0.24	-0.22	-0.20	-0.19	-0.19	-0.22
	TDLF	-0.25	-0.22	-0.19	-0.18	-0.18	-0.21
28	NLF	-0.24	-0.23	-0.21	-0.21	-0.25	-0.27
	SDLF	-0.24	-0.22	-0.20	-0.20	-0.23	-0.24
	TDLF	-0.24	-0.22	-0.19	-0.19	-0.22	-0.23
29	NLF	-0.24	-0.23	-0.23	-0.25	-0.27	-0.28
	SDLF	-0.24	-0.22	-0.21	-0.24	-0.25	-0.26
	TDLF	-0.24	-0.21	-0.20	-0.22	-0.24	-0.24
30	NLF	-0.24	-0.24	-0.26	-0.27	-0.28	-0.28
	SDLF	-0.24	-0.23	-0.24	-0.25	-0.26	-0.26
	TDLF	-0.23	-0.22	-0.23	-0.24	-0.25	-0.25

Table U2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
31	NLF	-0.24	-0.26	-0.27	-0.28	-0.29	-0.29
	SDLF	-0.24	-0.25	-0.26	-0.26	-0.27	-0.27
	TDLF	-0.23	-0.24	-0.25	-0.25	-0.26	-0.26
32	NLF	-0.26	-0.27	-0.28	-0.29	-0.29	-0.29
	SDLF	-0.25	-0.26	-0.27	-0.27	-0.27	-0.27
	TDLF	-0.24	-0.25	-0.26	-0.26	-0.26	-0.26
33	NLF	-0.27	-0.28	-0.29	-0.29	-0.29	-0.29
	SDLF	-0.26	-0.26	-0.27	-0.28	-0.27	-0.26
	TDLF	-0.24	-0.25	-0.26	-0.27	-0.26	-0.25
34	NLF	-0.27	-0.28	-0.28	-0.29	-0.28	-0.27
	SDLF	-0.26	-0.26	-0.27	-0.27	-0.26	-0.25
	TDLF	-0.24	-0.25	-0.26	-0.27	-0.25	-0.23
35	NLF	-0.24	-0.25	-0.25	-0.25	-0.23	-0.22
	SDLF	-0.23	-0.23	-0.23	-0.23	-0.21	-0.20
	TDLF	-0.22	-0.22	-0.23	-0.23	-0.20	-0.18
36	NLF	-0.19	-0.19	-0.19	-0.18	-0.17	-0.16
	SDLF	-0.17	-0.18	-0.18	-0.17	-0.15	-0.14
	TDLF	-0.17	-0.18	-0.18	-0.17	-0.14	-0.12
37	NLF	-0.12	-0.13	-0.13	-0.12	-0.10	-0.09
	SDLF	-0.11	-0.12	-0.12	-0.10	-0.09	-0.07
	TDLF	-0.10	-0.12	-0.12	-0.10	-0.08	-0.06
38	NLF	-0.06	-0.07	-0.07	-0.06	-0.05	-0.04
	SDLF	-0.04	-0.06	-0.07	-0.05	-0.04	-0.03
	TDLF	-0.04	-0.06	-0.07	-0.04	-0.03	-0.01
39	NLF	-0.01	-0.02	-0.03	-0.01	-0.02	-0.01
	SDLF	0.00	-0.01	-0.03	-0.01	-0.01	0.00
	TDLF	0.01	-0.01	-0.03	-0.01	-0.01	0.01
40	NLF	0.02	0.02	0.02	-0.02	-0.01	0.00
	SDLF	0.03	0.03	0.03	-0.02	-0.01	0.01
	TDLF	0.03	0.03	0.03	-0.03	-0.01	0.02

Table U2-4-10(Continued). Approximate horizontal differential displacements (in) at cross-frames under TDL for different detailing methods, assuming negligible cross-frame deformations.

		CF Location					
CF	Detailing Method	G1-G2	G2-G3	G3-G4	G4-G5	G5-G6	G6-G7
41	NLF	0.02	0.02	0.03	-0.02	-0.01	0.00
	SDLF	0.03	0.03	0.04	-0.02	-0.01	0.01
	TDLF	0.03	0.03	0.04	-0.03	-0.01	0.01
42	NLF	0.00	0.00	0.00	0.00	0.00	0.00
	SDLF	0.00	0.00	0.00	0.00	0.00	0.00
	TDLF	0.00	0.00	0.00	0.00	0.00	0.00

Table U2-4-11. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	274.2	204.0	84.9	69.6	489.3	323.9	158.6	178.5
	SDLF	289.6	295.7	96.2	68.7	502.1	412.7	172.9	176.7
	TDLF	300.1	374.6	109.3	68.5	511.0	489.9	188.5	176.4
G2	NLF	239.6	578.6	128.6	62.0	436.7	1023.8	296.2	160.5
	SDLF	255.0	617.0	133.8	63.1	446.6	1057.6	302.6	163.9
	TDLF	273.8	643.4	142.1	63.5	460.6	1078.3	313.4	164.5
G3	NLF	209.5	587.3	168.1	59.5	387.4	1051.1	388.3	152.9
	SDLF	215.9	531.9	181.2	55.3	395.4	987.2	406.5	146.2
	TDLF	214.8	484.2	188.1	52.8	396.0	934.8	415.6	143.6
G4	NLF	178.3	562.3	207.0	101.8	336.2	1017.0	473.5	251.2
	SDLF	187.3	462.1	217.9	95.2	345.4	911.9	485.9	244.9
	TDLF	195.3	378.9	223.2	83.9	353.6	824.3	492.2	233.4
G5	NLF	102.4	487.6	175.9	52.5	202.4	892.0	407.1	136.5
	SDLF	105.2	358.9	175.6	50.0	206.4	760.7	407.4	134.0
	TDLF	108.4	257.3	171.5	47.6	210.5	656.3	403.7	131.7
G6	NLF	81.5	396.1	178.3	52.7	167.4	739.7	407.2	139.2
	SDLF	84.5	328.8	191.3	52.6	173.2	667.2	420.2	138.6
	TDLF	87.0	271.3	200.6	54.5	177.8	609.7	429.3	140.5
G7	NLF	55.3	0.0	214.9	51.7	119.5	13.2	456.1	136.1
	SDLF	57.4	53.9	289.0	51.2	124.6	86.3	527.8	135.8
	TDLF	59.5	97.5	361.4	51.3	129.3	143.0	597.9	135.7

Table U2-4-12. Individual support longitudinal reactions under SDL and TDL (kips).

Girder	Detailing Method	Load Type & Support Number							
		SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-1.3	NA	NA	NA	-1.4	NA	NA	NA
	SDLF	-2.3	NA	NA	NA	-2.2	NA	NA	NA
	TDLF	-4.2	NA	NA	NA	-4.6	NA	NA	NA
G2	NLF	-0.7	NA	NA	NA	-0.6	NA	NA	NA
	SDLF	-1.8	NA	NA	NA	-1.7	NA	NA	NA
	TDLF	-3.3	NA	NA	NA	-3.5	NA	NA	NA
G3	NLF	-0.2	NA	NA	NA	0.0	NA	NA	NA
	SDLF	0.2	NA	NA	NA	0.4	NA	NA	NA
	TDLF	0.6	NA	NA	NA	0.6	NA	NA	NA
G4	NLF	0.2	NA	NA	NA	0.4	NA	NA	NA
	SDLF	0.6	NA	NA	NA	0.7	NA	NA	NA
	TDLF	1.1	NA	NA	NA	1.2	NA	NA	NA
G5	NLF	0.5	NA	NA	NA	0.6	NA	NA	NA
	SDLF	0.9	NA	NA	NA	1.0	NA	NA	NA
	TDLF	1.7	NA	NA	NA	1.8	NA	NA	NA
G6	NLF	0.8	NA	NA	NA	0.6	NA	NA	NA
	SDLF	1.2	NA	NA	NA	1.1	NA	NA	NA
	TDLF	2.2	NA	NA	NA	2.4	NA	NA	NA
G7	NLF	0.9	NA	NA	NA	0.4	NA	NA	NA
	SDLF	1.2	NA	NA	NA	0.9	NA	NA	NA
	TDLF	2.2	NA	NA	NA	2.3	NA	NA	NA

Table U2-4-13. Individual support transverse reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.2	-0.1	-1.0	0.0	-0.8	-0.3	-3.0	0.0
	SDLF	0.0	0.1	-0.1	0.0	-0.5	-0.1	-1.6	0.0
	TDLF	0.2	0.3	0.8	0.0	-0.1	0.2	-0.3	0.0
G2	NLF	-0.2	-0.2	-0.8	0.0	-0.8	-0.3	-2.5	0.0
	SDLF	0.0	0.0	-0.2	0.0	-0.5	-0.1	-1.4	0.0
	TDLF	0.2	0.1	0.6	0.0	-0.1	0.1	-0.3	0.0
G3	NLF	-0.3	0.0	-0.6	0.0	-0.8	0.2	-2.0	0.0
	SDLF	0.0	0.2	-0.3	0.0	-0.5	0.3	-1.2	0.0
	TDLF	0.2	0.3	0.2	0.0	-0.1	0.5	-0.5	0.0
G4	NLF	-0.3	0.3	-0.4	0.0	-0.8	1.1	-1.4	0.0
	SDLF	0.0	0.2	-0.2	0.0	-0.5	0.8	-0.9	0.0
	TDLF	0.2	0.0	0.0	0.0	-0.1	0.5	-0.5	0.0
G5	NLF	-0.3	0.8	-0.2	0.0	-0.9	2.5	-0.7	0.0
	SDLF	-0.1	0.3	-0.2	0.0	-0.5	1.6	-0.6	0.0
	TDLF	0.2	-0.3	-0.2	0.0	-0.1	0.7	-0.5	0.0
G6	NLF	-0.3	1.4	0.1	0.0	-0.9	4.3	0.1	0.0
	SDLF	-0.1	0.4	-0.2	0.0	-0.5	2.6	-0.2	0.0
	TDLF	0.2	-0.7	-0.5	0.0	-0.1	0.9	-0.5	0.0
G7	NLF	-0.3	2.3	0.4	-0.1	-0.9	6.6	1.1	-0.1
	SDLF	-0.1	0.5	-0.2	0.0	-0.5	3.7	0.3	-0.1
	TDLF	0.2	-1.3	-0.8	0.0	-0.2	1.1	-0.4	-0.1

Table U2-4-14. Longitudinal displacements at supports (in).

Girder	Detailing Method	Load Type & Support Number							
		SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
G1	NLF	-0.26	0.48	0.14	0.48	-0.28	0.41	-0.27	0.54
	SDLF	-0.46	0.51	0.17	0.43	-0.45	0.62	-0.05	0.64
	TDLF	-0.84	0.64	0.32	0.50	-0.91	0.99	0.34	0.95
G2	NLF	-0.15	0.44	0.11	0.44	-0.12	0.31	-0.36	0.45
	SDLF	-0.36	0.47	0.16	0.40	-0.33	0.54	-0.11	0.57
	TDLF	-0.66	0.60	0.32	0.48	-0.70	0.92	0.31	0.90
G3	NLF	-0.05	0.39	0.07	0.39	0.00	0.19	-0.46	0.34
	SDLF	0.05	0.73	0.44	0.68	0.08	0.74	0.13	0.79
	TDLF	0.12	1.18	0.92	1.08	0.11	1.44	0.87	1.44
G4	NLF	0.04	0.32	0.02	0.34	0.08	0.03	-0.58	0.20
	SDLF	0.12	0.65	0.41	0.63	0.14	0.59	0.03	0.67
	TDLF	0.22	1.09	0.89	1.03	0.24	1.29	0.79	1.34
G5	NLF	0.10	0.25	-0.04	0.28	0.13	-0.15	-0.74	0.05
	SDLF	0.19	0.58	0.37	0.59	0.19	0.43	-0.08	0.57
	TDLF	0.33	1.02	0.88	1.02	0.36	1.15	0.72	1.27
G6	NLF	0.15	0.14	-0.10	0.22	0.13	-0.41	-0.92	-0.12
	SDLF	0.24	0.48	0.33	0.55	0.22	0.21	-0.20	0.44
	TDLF	0.44	0.94	0.86	0.99	0.47	0.97	0.64	1.19
G7	NLF	0.18	0.01	-0.16	0.15	0.08	-0.71	-1.12	-0.33
	SDLF	0.25	0.32	0.25	0.45	0.17	-0.10	-0.39	0.24
	TDLF	0.44	0.74	0.76	0.87	0.47	0.67	0.47	1.00

Table U2-4-15. Transverse displacements at supports (in).

Girder	Detailing Method	SDL 1	SDL 2	SDL 3	SDL 4	TDL 1	TDL 2	TDL 3	TDL 4
		Load Type & Support Number							
G1	NLF	-0.05	-0.03	-0.21	0.00	-0.16	-0.06	-0.61	0.01
	SDLF	-0.01	0.02	-0.03	0.00	-0.09	-0.02	-0.32	0.01
	TDLF	0.04	0.07	0.16	0.00	-0.03	0.05	-0.06	0.00
G2	NLF	-0.05	-0.04	-0.17	0.00	-0.16	-0.06	-0.51	0.00
	SDLF	-0.01	0.00	-0.03	0.00	-0.09	-0.03	-0.28	0.00
	TDLF	0.04	0.03	0.12	0.00	-0.02	0.01	-0.07	0.00
G3	NLF	-0.05	-0.01	-0.13	0.00	-0.17	0.04	-0.39	0.00
	SDLF	-0.01	0.04	-0.05	0.00	-0.09	0.07	-0.24	0.00
	TDLF	0.04	0.06	0.04	0.00	-0.02	0.09	-0.10	0.00
G4	NLF	-0.05	0.06	-0.09	0.00	-0.17	0.23	-0.27	0.00
	SDLF	-0.01	0.05	-0.05	0.00	-0.10	0.17	-0.18	0.00
	TDLF	0.04	0.00	0.00	0.00	-0.02	0.11	-0.10	0.00
G5	NLF	-0.06	0.16	-0.04	-0.01	-0.17	0.50	-0.14	-0.01
	SDLF	-0.01	0.06	-0.05	0.00	-0.10	0.32	-0.11	0.00
	TDLF	0.04	-0.07	-0.05	0.01	-0.03	0.13	-0.10	0.00
G6	NLF	-0.06	0.29	0.02	-0.01	-0.18	0.86	0.02	-0.01
	SDLF	-0.01	0.09	-0.05	0.00	-0.10	0.51	-0.04	0.00
	TDLF	0.04	-0.15	-0.10	0.01	-0.03	0.18	-0.09	0.00
G7	NLF	-0.06	0.46	0.08	-0.01	-0.18	1.32	0.22	-0.03
	SDLF	-0.01	0.11	-0.04	-0.01	-0.11	0.75	0.06	-0.03
	TDLF	0.04	-0.27	-0.15	0.00	-0.03	0.21	-0.08	-0.02

Appendix U2-5. EICCS28 Detailed Results, Erection Fit-Up

This appendix presents the detailed responses of the bridge EICCS28 in during the erection. The following figures and tables are provided, grouped by cross-frame fit-up forces and girder reactions:

Fit-up Forces

Reactions

Table U2-5-1. Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
28	28-2	NLF	0.1	0.3	0.3	0.1	-0.3	0.3
		SDLF	0.4	0.6	0.7	0.0	-0.4	0.4
		TDLF	0.7	1.0	1.2	0.0	-0.7	0.7
	28-3	NLF	-3.5	1.2	3.7	-3.5	-1.2	3.7
		SDLF	-10.2	0.8	10.2	-10.5	-0.4	10.5
		TDLF	-16.1	1.5	16.1	-16.7	-0.7	16.7
	28-4	NLF	-0.2	0.9	0.9	-0.2	-0.9	0.9
		SDLF	-2.7	0.2	2.7	-3.2	0.0	3.2
		TDLF	-4.5	0.5	4.5	-5.3	0.2	5.3
	28-5	NLF	-2.7	1.0	2.9	-2.7	-1.0	2.8
		SDLF	-11.0	1.4	11.0	-11.0	-1.1	11.1
		TDLF	-17.7	2.4	17.9	-17.8	-1.6	17.9
	28-6	NLF	-0.6	-0.1	0.6	-0.6	0.1	0.6
		SDLF	-4.1	-1.3	4.3	-4.5	1.6	4.7
		TDLF	-6.7	-1.8	6.9	-7.4	2.5	7.8
	28-7	NLF	-2.9	-0.3	2.9	-2.9	0.2	2.9
		SDLF	-19.2	-0.7	19.2	-19.6	1.0	19.6
		TDLF	-32.4	-0.6	32.4	-33.0	1.5	33.0
	28-8	NLF	-1.0	-1.0	1.4	-1.0	1.0	1.4
		SDLF	-8.6	-5.6	10.3	-9.1	5.8	10.8
		TDLF	-14.3	-9.1	17.0	-15.4	9.6	18.1
	28-9	NLF	1.0	-0.1	1.0	0.3	-0.1	0.3
		SDLF	12.4	-2.8	12.7	13.9	2.1	14.0
		TDLF	20.6	-6.4	21.6	24.7	4.6	25.1

Table U2-5-1(Continued). Erection fit-up forces (kips) applied to the girder being installed with the cranes at the NL elevations.

Stage	Sub-Stage	Detailing Method	V1	H1	F1	V2	H2	F2
35	35-2	NLF	-1.0	0.6	1.1	-1.0	-0.6	1.1
		SDLF	-1.1	0.3	1.1	-1.4	-0.3	1.4
		TDLF	-3.3	-0.2	3.3	-3.7	0.0	3.7
	35-3	NLF	-1.2	0.9	1.5	-0.9	-1.0	1.3
		SDLF	-2.2	-0.4	2.2	-2.2	0.9	2.4
		TDLF	-5.3	-2.2	5.8	-5.5	3.3	6.4
	35-4	NLF	-0.4	0.8	0.9	-0.4	-1.0	1.1
		SDLF	-1.7	-1.1	2.0	-2.2	2.0	3.0
		TDLF	-4.9	-3.7	6.2	-5.7	5.5	7.9
	35-5	NLF	0.1	0.2	0.2	0.1	-0.5	0.5
		SDLF	-1.2	-1.7	2.1	-1.6	2.1	2.6
		TDLF	-4.2	-4.3	6.0	-4.8	5.0	7.0
	35-6	NLF	0.4	-0.5	0.7	0.5	0.3	0.6
		SDLF	-1.3	-2.4	2.7	-1.7	2.7	3.2
		TDLF	-4.6	-4.9	6.7	-5.2	5.5	7.6
	35-7	NLF	0.5	-1.2	1.3	0.5	1.0	1.2
		SDLF	-1.5	-2.7	3.0	-2.1	3.5	4.1
		TDLF	-4.9	-4.8	6.9	-6.1	6.5	8.9
	358	NLF	0.6	-2.2	2.3	-0.5	1.7	1.8
		SDLF	-0.9	-2.4	2.6	0.9	4.1	4.2
		TDLF	-2.0	-1.9	2.8	3.6	5.6	6.6
	35-9	NLF	0.5	-2.4	2.5	0.5	2.5	2.6
		SDLF	0.4	-4.8	4.8	0.0	4.3	4.3
		TDLF	-1.9	-6.1	6.4	-2.5	4.9	5.5
	35-10	NLF	-0.2	-0.7	0.8	-0.2	0.7	0.7
		SDLF	-2.0	-2.2	2.9	-2.4	2.5	3.5
		TDLF	-4.3	-4.1	5.9	-5.0	4.6	6.8
	35-11	NLF	-0.4	-0.6	0.7	-0.3	0.6	0.7
		SDLF	-3.2	-1.4	3.5	-3.4	1.7	3.8
		TDLF	-5.5	-2.2	5.9	-6.0	2.7	6.5

Table U2-5-2: Erection Critical Sub-Stages with cranes at the NL elevations

Stage	Detailing Method	Critical Sub-Stage
28	NLF	28-3
	SDLF	28-7
	TDLF	28-7
35	NLF	35-9
	SDLF	35-9
	TDLF	35-7

Table U2-5-3. Erection critical fit-up forces (kips) applied to the girder being installed with cranes at the NL elevations

Stage	Conn-ection	Detailing Method	V1	H1	F1	V2	H2	F2
28	A	NLF	-6.0	0.6	6.1	NA	NA	NA
		SDLF	-16.8	0.7	16.8	NA	NA	NA
		TDLF	-26.6	1.4	26.6	NA	NA	NA
	B	NLF	-3.5	1.2	3.7	-3.5	-1.2	3.7
		SDLF	-19.2	-0.7	19.2	-19.6	1.0	19.6
		TDLF	-32.4	-0.6	32.4	-33.0	1.5	33.0
35	A	NLF	1.4	-1.2	1.8	NA	NA	NA
		SDLF	1.5	-2.7	3.1	NA	NA	NA
		TDLF	-5.9	-3.2	6.7	NA	NA	NA
	B	NLF	0.5	-2.4	2.5	0.5	2.5	2.6
		SDLF	0.4	-4.8	4.8	0.0	4.3	4.3
		TDLF	-4.9	-4.8	6.9	-6.1	6.5	8.9

Table U2-5-6. Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number								
				1	2	3	4	5	6	7	8	9
28	A	G1	NLF	50.2	149.8	122.7	111.0	85.1	20.7			
			SDLF	88.1	227.3	226.3	191.4	114.1	42.7			
			TDLF	115.8	289.9	306.2	256.0	138.8	61.8			
		G2	NLF	49.3	150.9	125.9	105.1	85.9	33.3			
			SDLF	87.8	83.5	67.1	99.2	74.7	35.5			
			TDLF	125.6	28.3	0.0	89.1	65.0	37.7			
		G3	NLF	48.9	149.0	126.8	94.4	81.5	41.8			
			SDLF	71.6	72.6	40.6	94.0	74.0	57.9			
			TDLF	82.0	4.3	0.0	75.4	68.2	71.9			
		G4	NLF	48.2	145.1	125.9	82.8	84.4	49.7			
			SDLF	80.5	95.2	40.3	39.3	88.3	58.8			
			TDLF	106.8	54.3	0.0	0.0	85.8	68.5			
		G5	NLF	36.0	112.7	102.8	65.2	79.6	49.5			
			SDLF	57.1	99.3	57.8	0.0	58.6	57.2			
			TDLF	75.4	100.5	0.0	0.0	19.7	68.6			
		G6	NLF	35.1	108.1	100.0	56.0	75.7	42.1			
			SDLF	57.7	113.1	87.8	0.0	144.3	45.3			
			TDLF	73.3	127.4	73.3	0.0	163.6	49.2			
		G7	NLF	30.7	104.1	97.2	51.4	5.2	60.3	120.4	60.1	4.8
			SDLF	54.5	89.1	88.7	122.6	3.3	78.5	156.8	78.3	0.0
			TDLF	72.8	71.4	70.3	154.9	11.7	90.7	181.2	90.4	0.0

Table U2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number								
				1	2	3	4	5	6	7	8	9
28	B	G1	NLF	50.2	149.8	122.7	111.0	85.1	20.7			
			SDLF	88.1	227.3	226.2	191.4	114.1	42.7			
			TDLF	115.7	290.0	306.2	255.9	138.7	61.7			
		G2	NLF	49.3	150.9	125.9	105.1	85.9	33.3			
			SDLF	87.8	83.5	67.1	99.2	74.6	35.5			
			TDLF	125.6	28.3	0.0	89.1	64.8	37.8			
		G3	NLF	48.9	149.0	126.8	94.4	81.5	41.8			
			SDLF	71.6	72.6	40.7	93.9	74.9	58.2			
			TDLF	82.0	4.4	0.0	75.7	69.5	72.5			
		G4	NLF	48.2	145.1	125.9	82.7	84.8	49.9			
			SDLF	80.5	95.2	40.7	39.5	94.4	60.3			
			TDLF	106.8	54.3	0.0	0.0	95.9	70.7			
		G5	NLF	36.0	112.7	102.8	65.1	79.7	50.1			
			SDLF	57.1	99.2	58.2	0.0	64.7	54.7			
			TDLF	75.4	100.5	0.0	0.0	29.4	64.1			
		G6	NLF	35.1	108.1	100.0	56.3	74.8	40.1			
			SDLF	57.7	113.0	87.9	0.0	116.6	40.1			
			TDLF	73.1	127.2	74.5	0.0	117.9	40.7			
		G7	NLF	30.7	104.1	97.2	51.9	5.3	59.8	119.4	59.6	7.0
			SDLF	54.5	89.1	88.8	120.5	13.4	87.0	173.7	86.7	0.0
			TDLF	72.9	71.4	70.2	151.8	28.4	103.3	206.2	102.9	0.0

Table U2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number										
				1	2	3	4	5	6	7	8	9	10	11
35	A	G1	NLF	50.2	149.9	122.5	113.2	53.7	137.3	91.9	0.0			
			SDLF	88.1	228.0	222.1	224.4	129.3	162.1	83.0	0.0			
			TDLF	115.8	291.0	298.1	324.9	202.8	187.2	84.9	0.0			
		G2	NLF	49.3	150.9	125.7	108.0	69.2	131.5	142.8	0.0			
			SDLF	87.4	83.5	65.3	123.0	74.1	142.8	142.5	0.0			
			TDLF	124.1	28.1	0.0	120.4	43.7	158.8	138.1	0.0			
		G3	NLF	48.9	149.0	126.6	98.2	71.7	123.4	142.6	0.0			
			SDLF	71.9	72.8	41.1	87.5	20.2	123.3	156.5	0.0			
			TDLF	83.0	5.9	0.0	0.0	0.0	117.4	157.8	0.0			
		G4	NLF	48.2	145.1	125.8	87.1	75.9	115.0	126.2	10.8			
			SDLF	80.3	95.0	42.4	8.5	22.0	105.9	141.5	0.0			
			TDLF	106.0	55.0	0.0	0.0	0.0	86.5	150.1	0.0			
		G5	NLF	36.0	112.8	102.6	68.4	75.4	97.6	87.2	21.3			
			SDLF	56.9	99.3	58.8	0.0	26.0	103.1	85.1	11.5			
			TDLF	74.5	101.6	0.0	0.0	0.0	108.5	80.5	0.0			
		G6	NLF	35.0	108.3	99.1	52.8	82.7	89.5	69.5	23.3			
			SDLF	58.4	114.0	84.8	0.0	108.8	120.8	63.1	21.8			
			TDLF	76.8	131.1	65.6	0.0	39.3	143.1	58.3	13.3			
		G7	NLF	30.7	104.5	95.0	38.1	82.0	81.4	38.8	27.5	55.0	27.5	18.1
			SDLF	53.9	89.8	82.1	76.2	219.6	129.5	33.6	28.8	57.5	28.8	16.0
			TDLF	70.0	71.7	59.6	80.4	349.7	167.8	29.6	38.4	76.7	38.3	14.5

Table U2-5-6(Continued). Erection vertical reactions (kips) at the sub-stage corresponding of the critical fit-up force. The holding crane loads load are highlighted in red and the total lifting crane loads are highlighted in yellow.

Stage	Conn-ection	Girder	Detailing Method	Support Number										
				1	2	3	4	5	6	7	8	9	10	11
35	B	G1	NLF	50.2	149.9	122.5	113.2	53.7	137.3	91.9	0.0			
			SDLF	88.1	228.0	222.1	224.4	129.3	162.1	83.0	0.0			
			TDLF	115.8	291.0	298.1	324.9	202.7	187.4	84.5	0.0			
		G2	NLF	49.3	150.9	125.7	108.0	69.2	131.5	142.8	0.0			
			SDLF	87.4	83.5	65.3	123.0	74.1	142.7	142.5	0.0			
			TDLF	124.1	28.1	0.0	120.5	43.8	158.9	137.2	0.0			
		G3	NLF	48.8	149.0	126.6	98.2	71.7	123.3	142.6	0.0			
			SDLF	71.9	72.8	41.1	87.5	20.3	123.2	156.5	0.0			
			TDLF	83.0	5.9	0.0	0.0	0.0	117.3	156.0	0.0			
		G4	NLF	48.2	145.1	125.8	87.1	75.9	114.9	126.1	10.8			
			SDLF	80.3	95.0	42.4	8.5	22.0	105.7	141.4	0.0			
			TDLF	106.0	55.0	0.0	0.0	0.0	86.3	147.0	0.0			
		G5	NLF	36.0	112.8	102.6	68.5	75.4	97.6	87.1	21.2			
			SDLF	56.9	99.3	58.8	0.0	25.9	103.0	85.0	11.5			
			TDLF	74.5	101.6	0.0	0.0	0.0	107.9	80.0	0.0			
		G6	NLF	35.0	108.3	99.1	52.8	82.6	90.1	70.8	23.1			
			SDLF	58.5	114.0	84.8	0.0	108.7	121.5	64.7	21.5			
			TDLF	76.8	131.1	65.6	0.0	39.3	140.9	78.6	19.0			
		G7	NLF	30.7	104.5	95.0	38.1	81.9	81.3	37.7	28.1	56.2	28.1	17.7
			SDLF	53.9	89.8	82.2	76.2	219.5	129.4	31.9	29.9	59.8	29.9	15.2
			TDLF	70.0	71.7	59.6	80.5	349.3	179.2	15.5	27.1	54.2	27.1	17.2

APPENDIX V-1 Detailed Results for GT-LOFT Example of Straight Skewed Bridge NISSS4

This appendix provides detailed analytical results for straight skewed bridge NISSS4 used an example of using GT-LOFTT to determine the initial strains associated with No Load Fit (NLF), Steel Dead Load Fit (SDLF) and Total Dead Load Fit (TDLF) detailing methods. This bridge has a span length of 150 ft and severe skew angles of 70 degrees. For illustration purposes, all girders have the same prismatic section (1.125 in. x 16 in. top flanges and 2 in. x 18 in. bottom flanges). The intermediate cross-frames are X type, and the end cross-frames are K type. All cross-frame members are L6x6x1.

These results are with SDLF and TDLF detailing effects included via the initial strains calculated by GT-LOFT. Since the nonlinearity effects in bridge NISSS4 are insignificant, the responses are approximately the same with engineering and log strains. Thus, this appendix shows only the responses with the initial engineering strains.

The initial strains for SDLF and TDLF detailing calculated by GT-LOFT are comparable to the initial strains for SDLF and TDLF detailing calculated by an accurate refined analysis. There are small but negligible difference in the initial strains calculated by GT-LOFT and an accurate refined analysis. The responses of bridge NISSS4 are comparable using the initial strains from GT-LOFT and the initial strains from an accurate refined analysis.

Figure V-1-1 shows the SDL and TDL cambers determined from a Line Girder Analysis. These cambers are important in determining the initial strains by GT-LOFT associated with SDLF and TDLF detailing. Figure V-1-2 shows the SDL and TDL cambers determined from 3D FEA. The results in this appendix are calculated with the LGA cambers in Figure V-1-1.

Figures V-1-3 to V-1-9, except V-1-7, show the girder vertical displacements, girder elevations, and girder layovers under SDL and TDL for different detailing methods. Figures V-1-7 and V-1-10 show the girder vertical displacements, girder elevations, and girder layovers due to SDLF and TDLF detailing solely under NL. Figures V-1-11 to V-1-16 shows the comparison of girder displacements and elevations for different detailing methods.

Figures V-1-17 to V-1-20 shows the comparisons of girder stresses for different detailing methods. Figures V-1-21 to V-1-26 shows the contours of cross-frame forces for different detailing methods. Tables 1 to 6 shows the comparisons of cross-frame forces for different detailing methods. Lastly, Table 7 shows the comparisons of vertical reactions for different detailing methods.

The important point from these results is that SDLF and TDLF effects, included in the structural analysis via initial engineering strains calculated by GT-LOFT, are beneficial and subtractive to the dead load cross-frame forces. The cross-frame forces are approximately zero under SDL for SDLF detailing and under TDL for TDLF detailing. The girders are approximately plumb under the targeted conditions. The figures and tables are grouped into major units as follows:

Camber Information

Overview of Bridge Displacements and Elevation Profiles

Girder Displacements and Elevations for Different Detailing Methods

Girder Flange Stresses for Different Detailing Methods

Cross-Frame Member Axial Stresses

Cross-Frame Member Axial Forces

Reactions

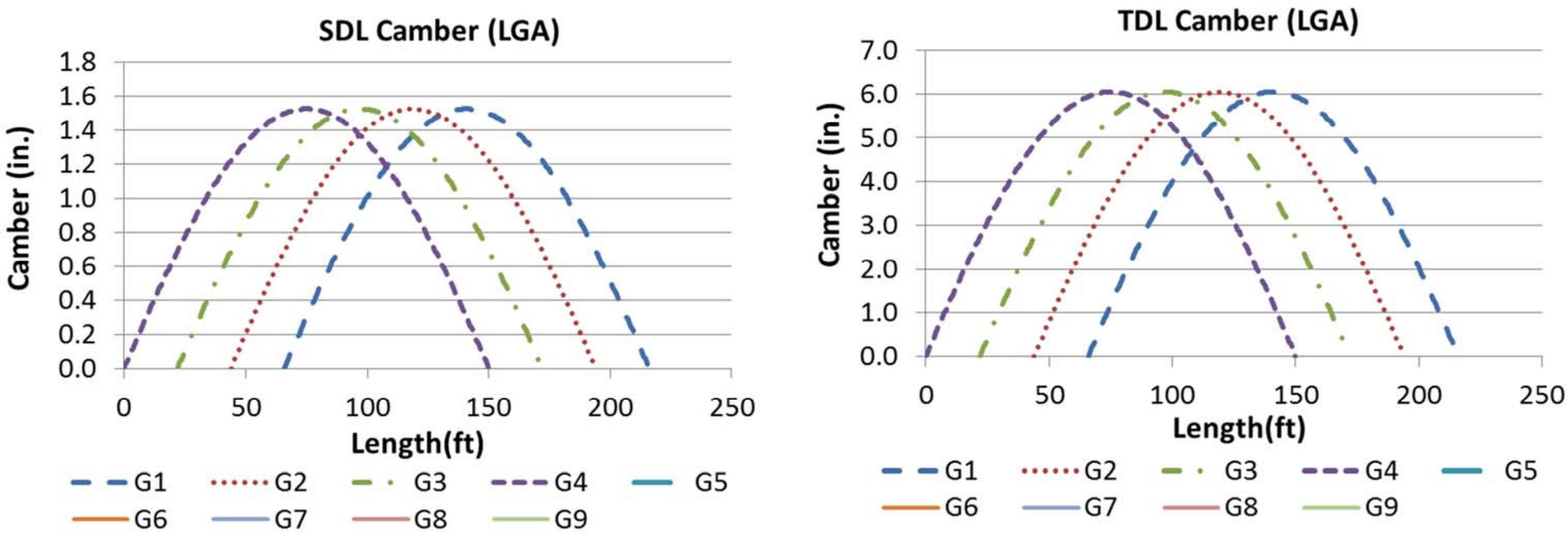
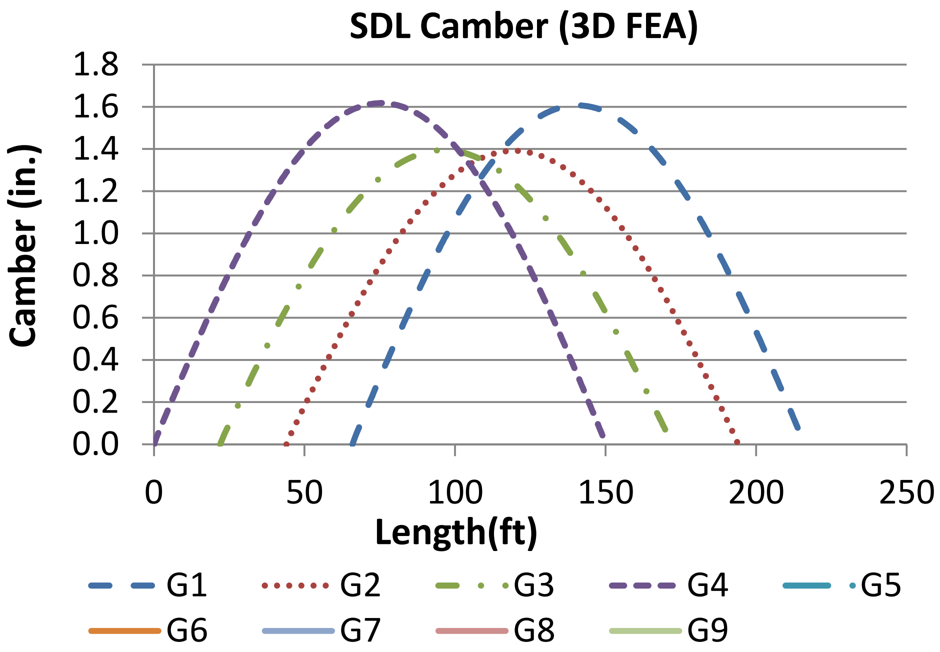


Figure V-1-1. SDL and TDL Line Girder Analysis cambers.



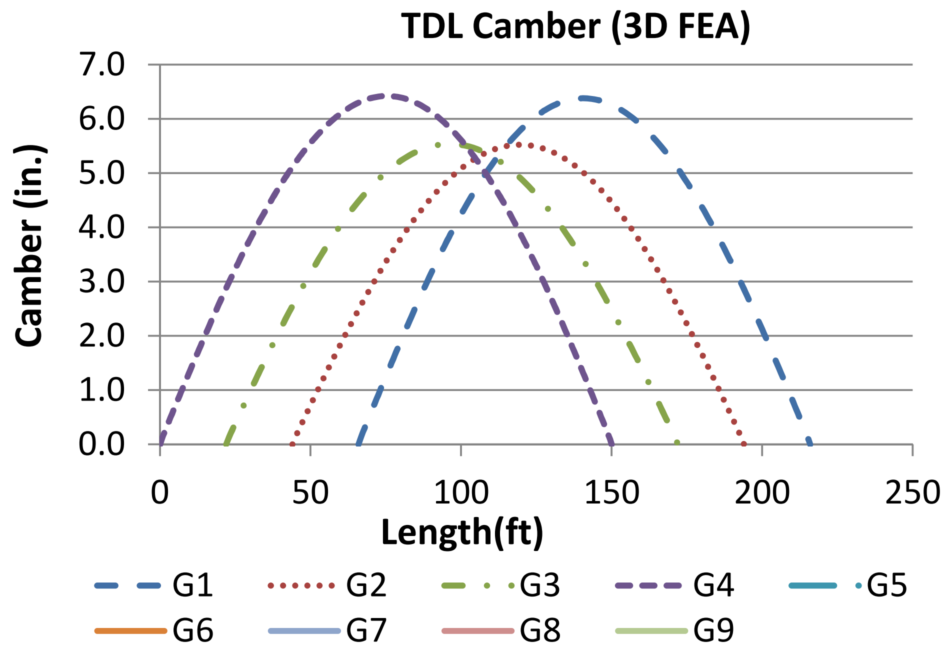


Figure V-1-2. SDL and TDL 3D FEA cambers.

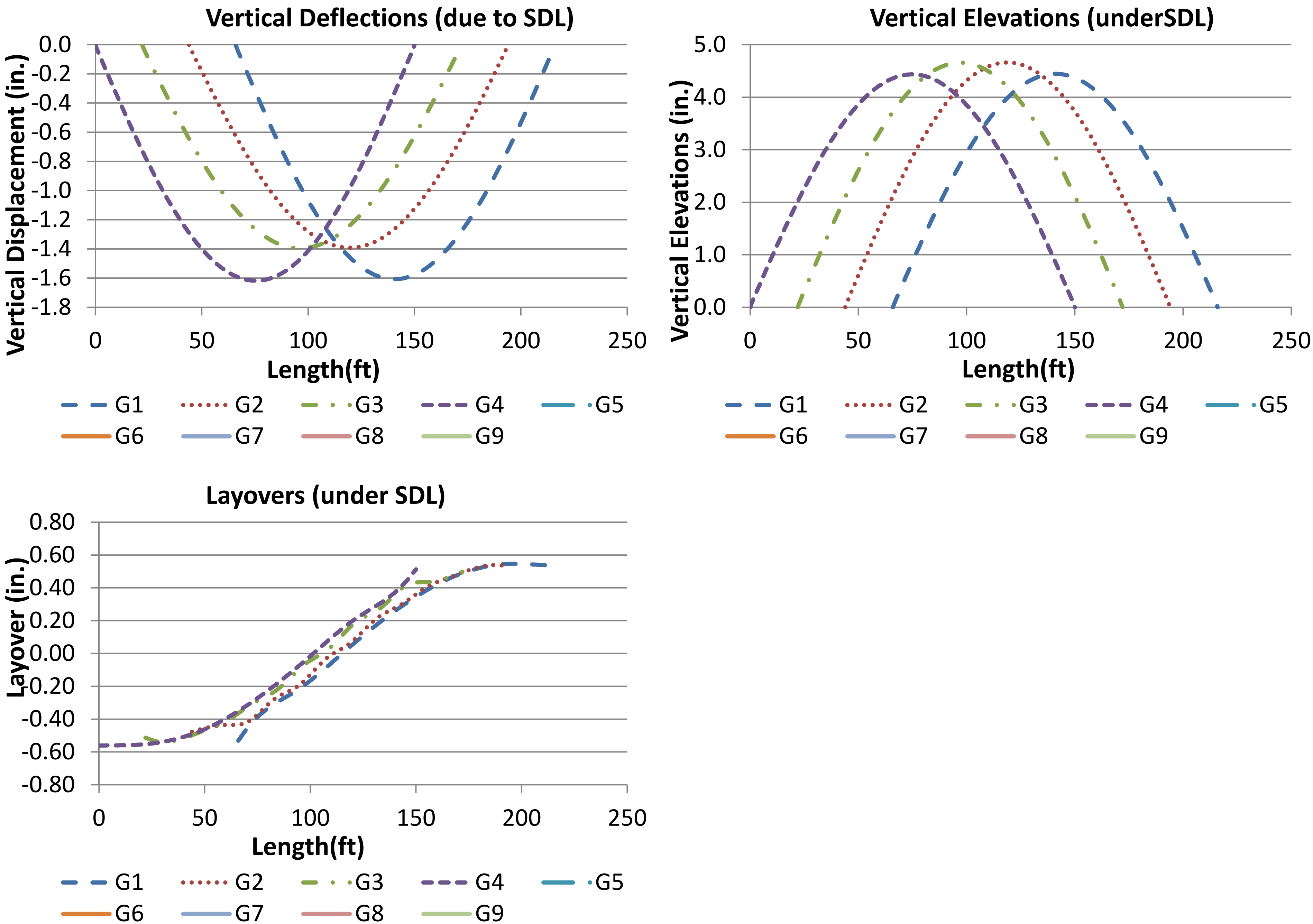


Figure V-1-3. Bridge displacements and elevation profiles (in) under SDL, NLF detailing.

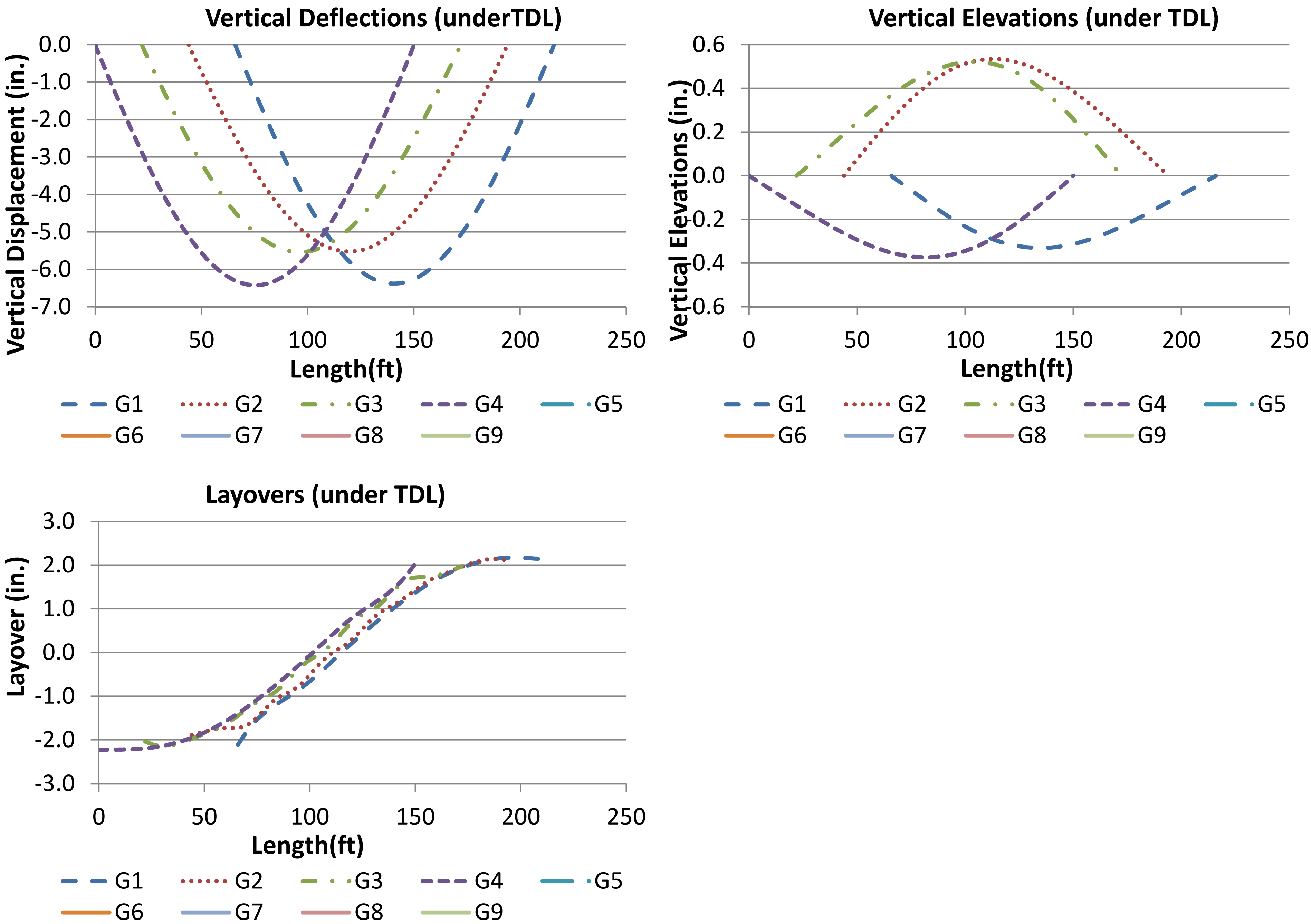


Figure V-1-4. Bridge displacements and elevation profiles (in) under TDL, NLF detailing.

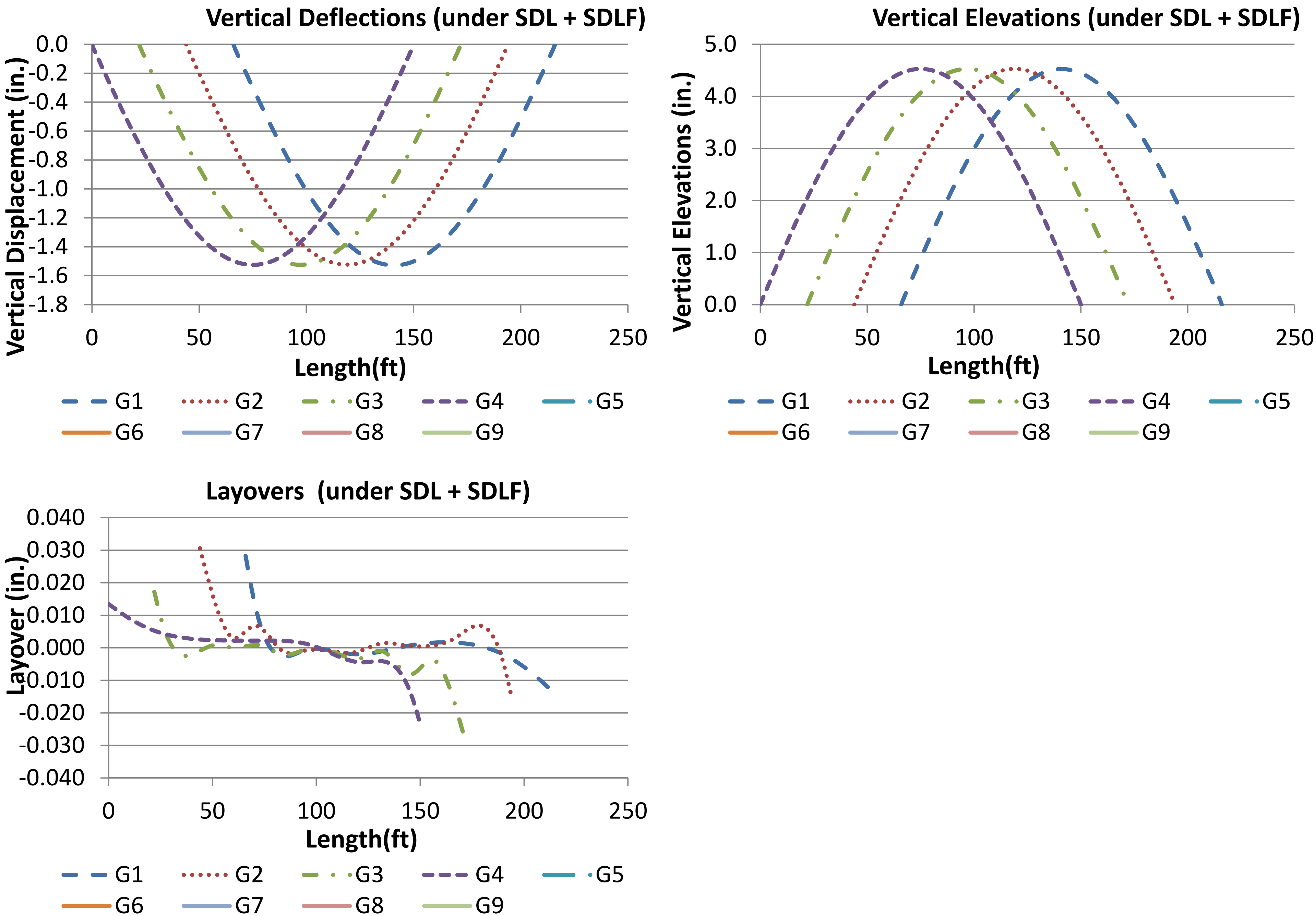


Figure V-1-5. Bridge displacements and elevation profiles (in) under SDL, SDLF detailing.

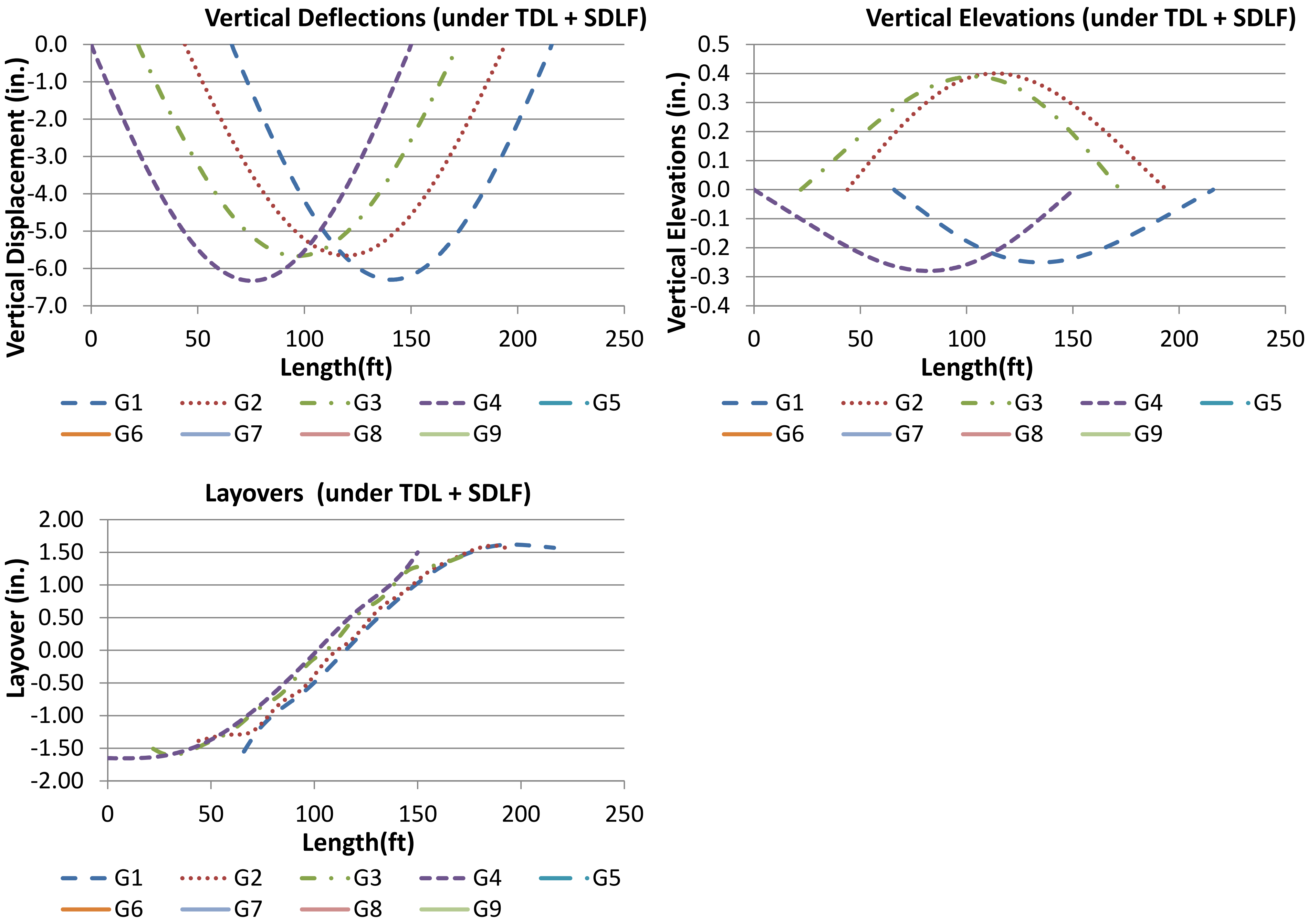


Figure V-1-6. Bridge displacements and elevation profiles (in) under TDL, SDLF detailing.

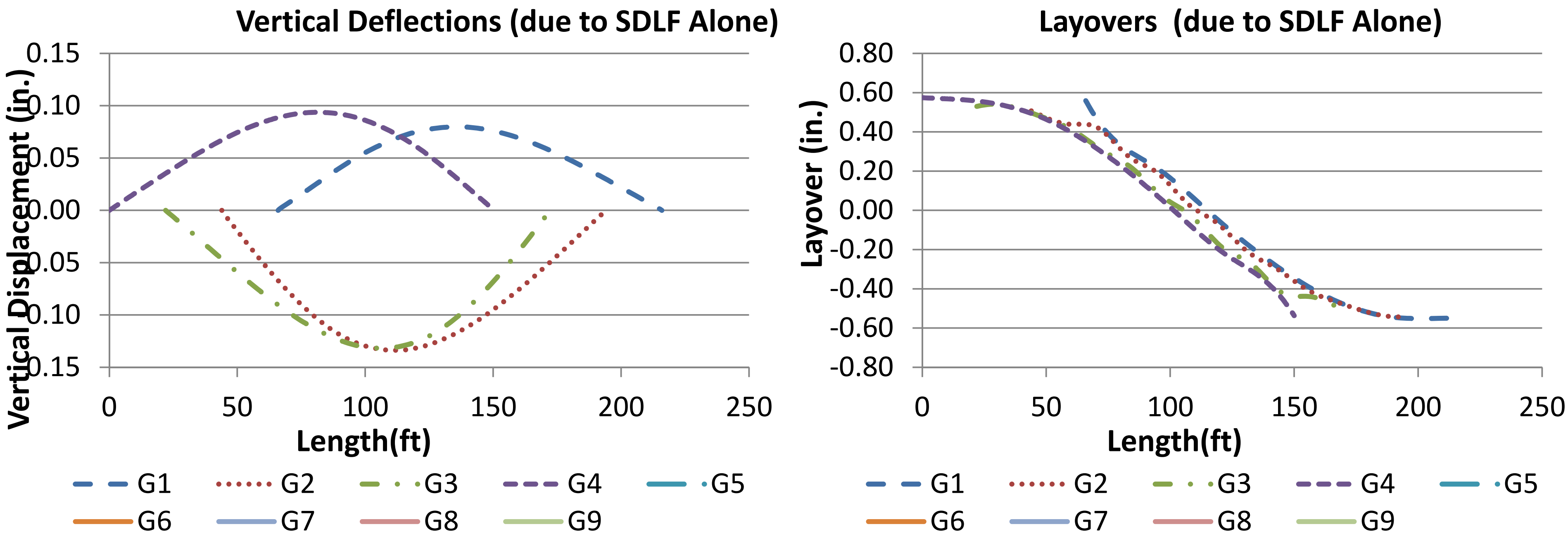


Figure V-1-7. Bridge displacements due to SDLF detailing effects alone under NL(in).

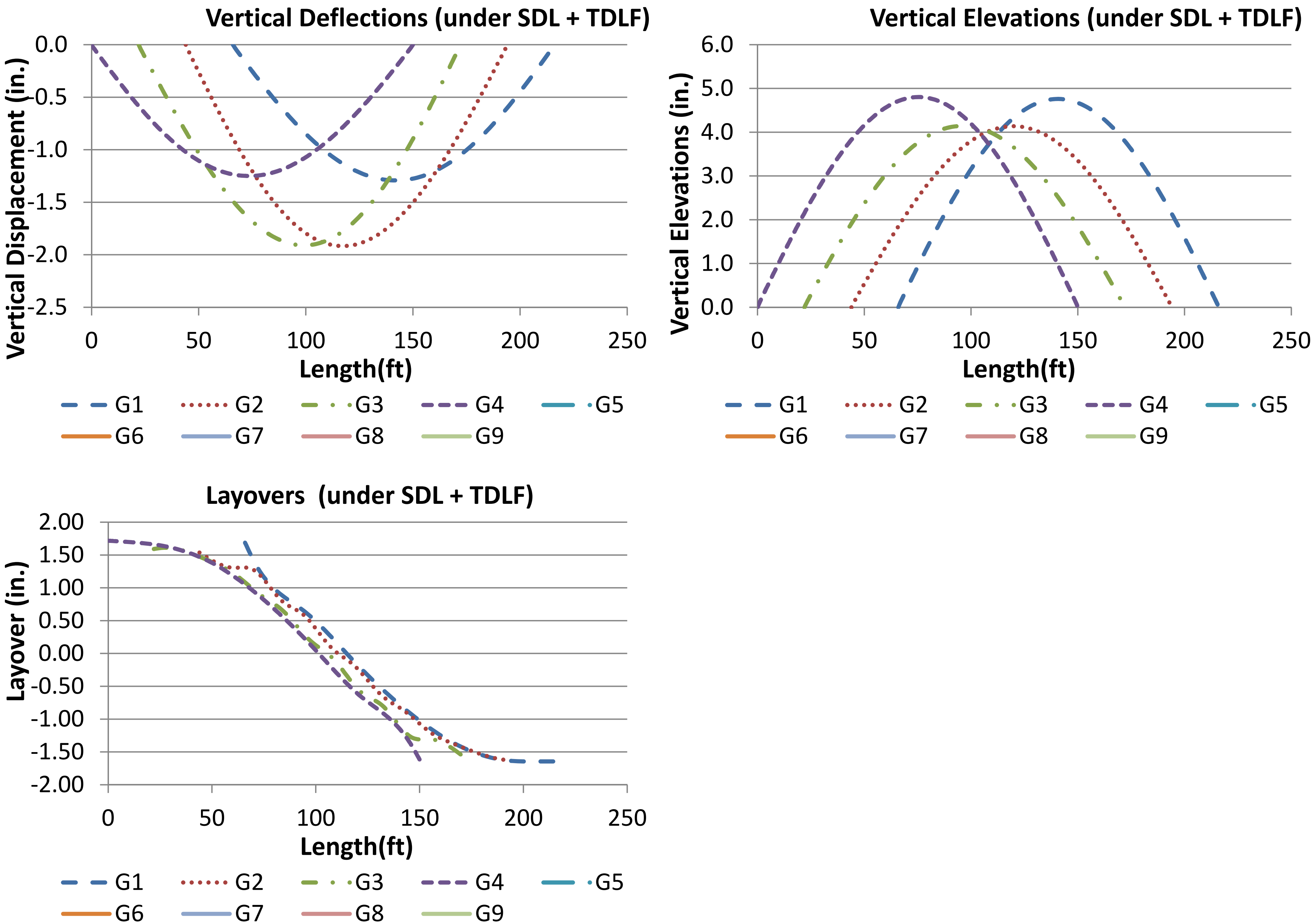


Figure V-1-8. Bridge displacements and elevation profiles (in) under SDL, TDLF detailing.

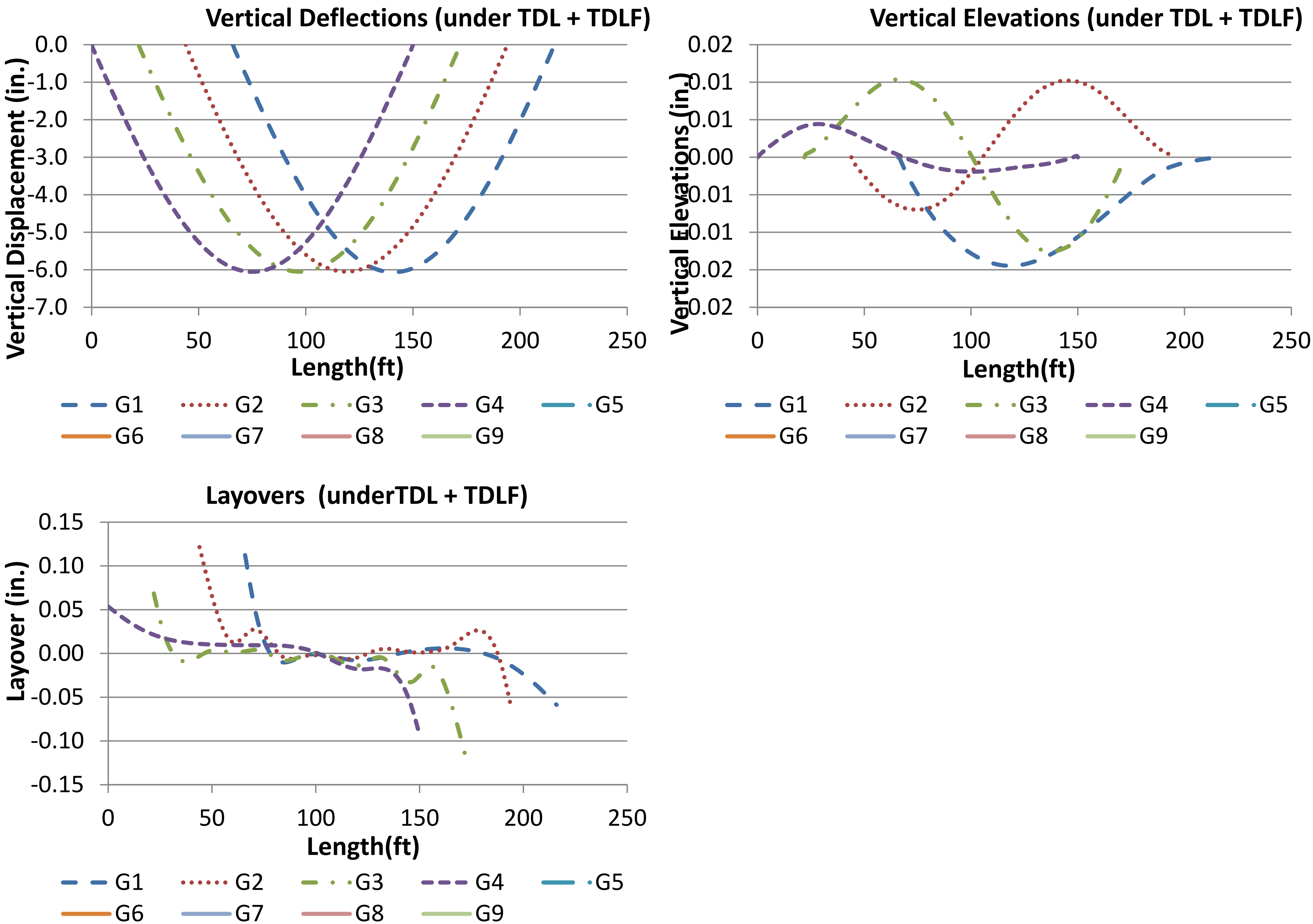


Figure V-1-9. Bridge displacements and elevation profiles (in) under TDL, TDLF detailing.

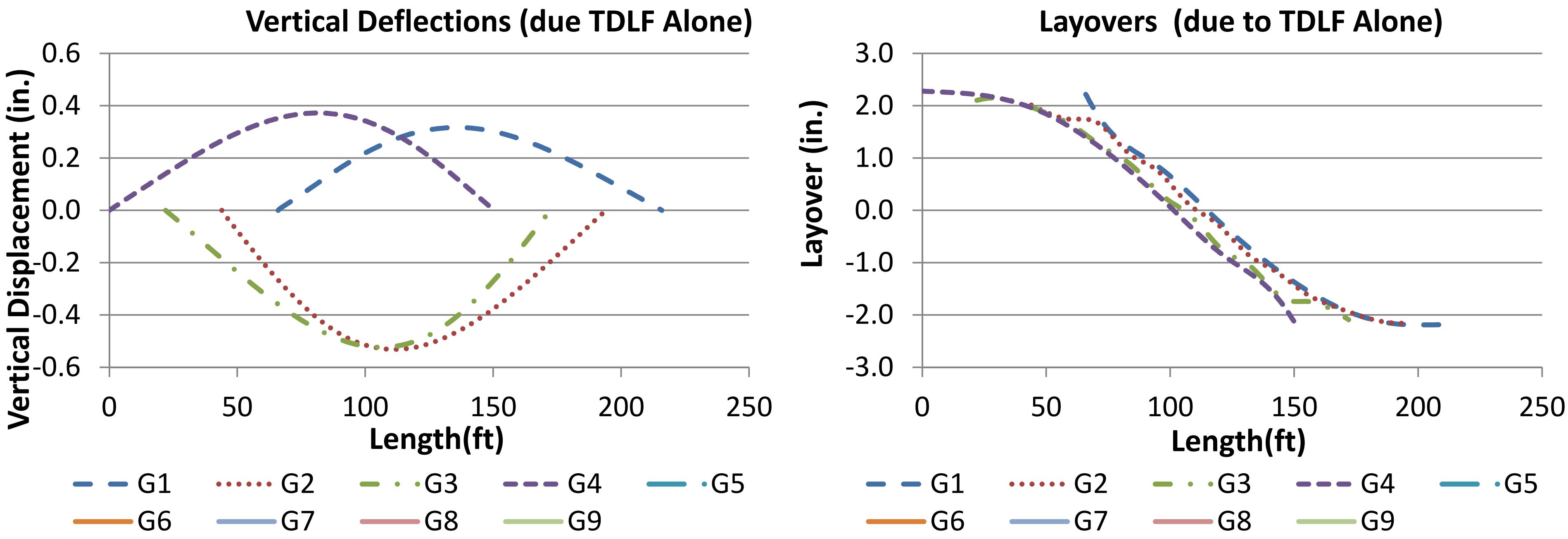


Figure V-1-10. Bridge displacements due to TDLF detailing effects alone under NL (in).

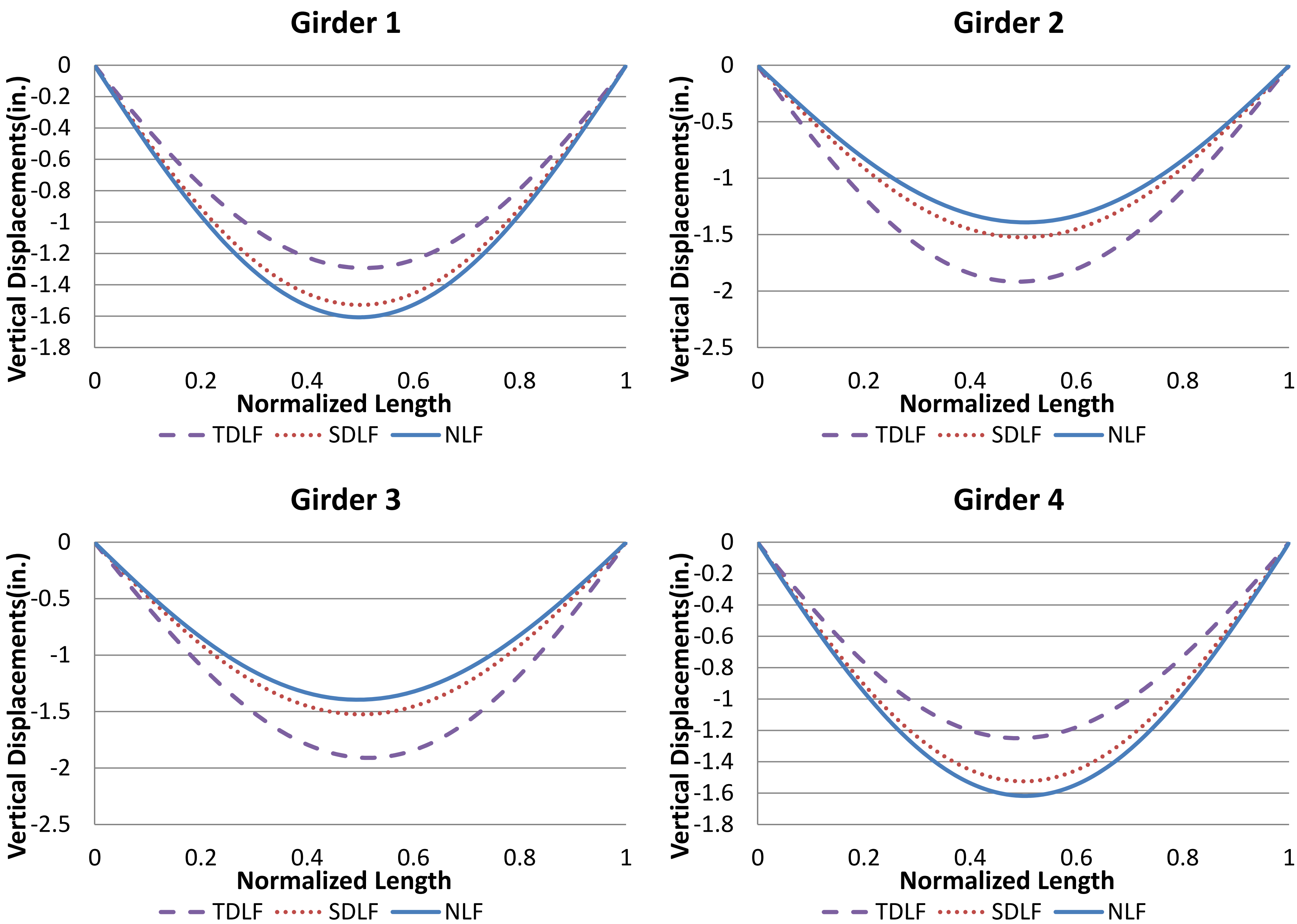


Figure V-1-11. **Comparison of individual girder vertical displacements (in) under SDL for different detailing methods.**

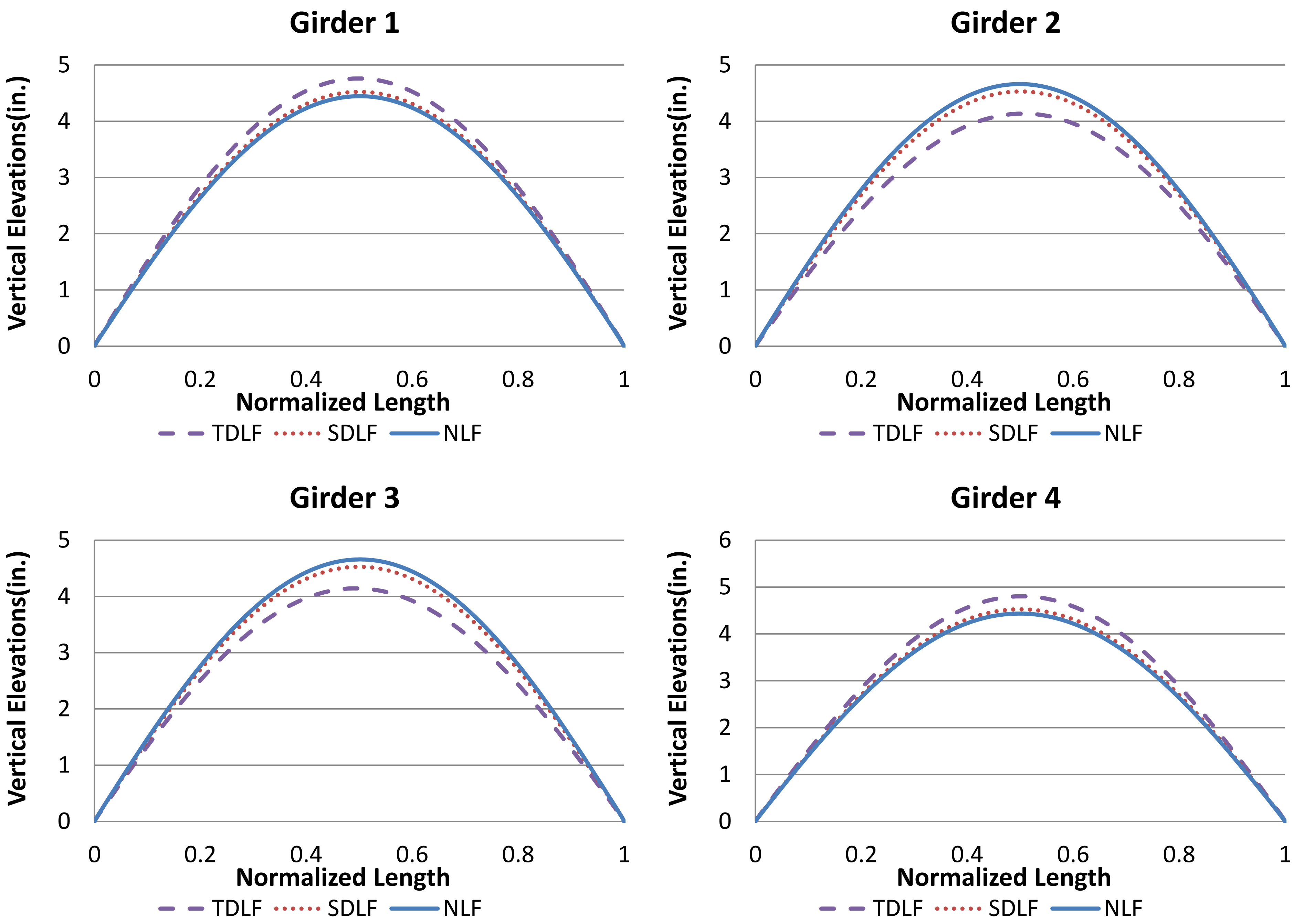


Figure V-1-12. **Comparison of individual girder elevation profiles (in) under SDL for different detailing methods.**

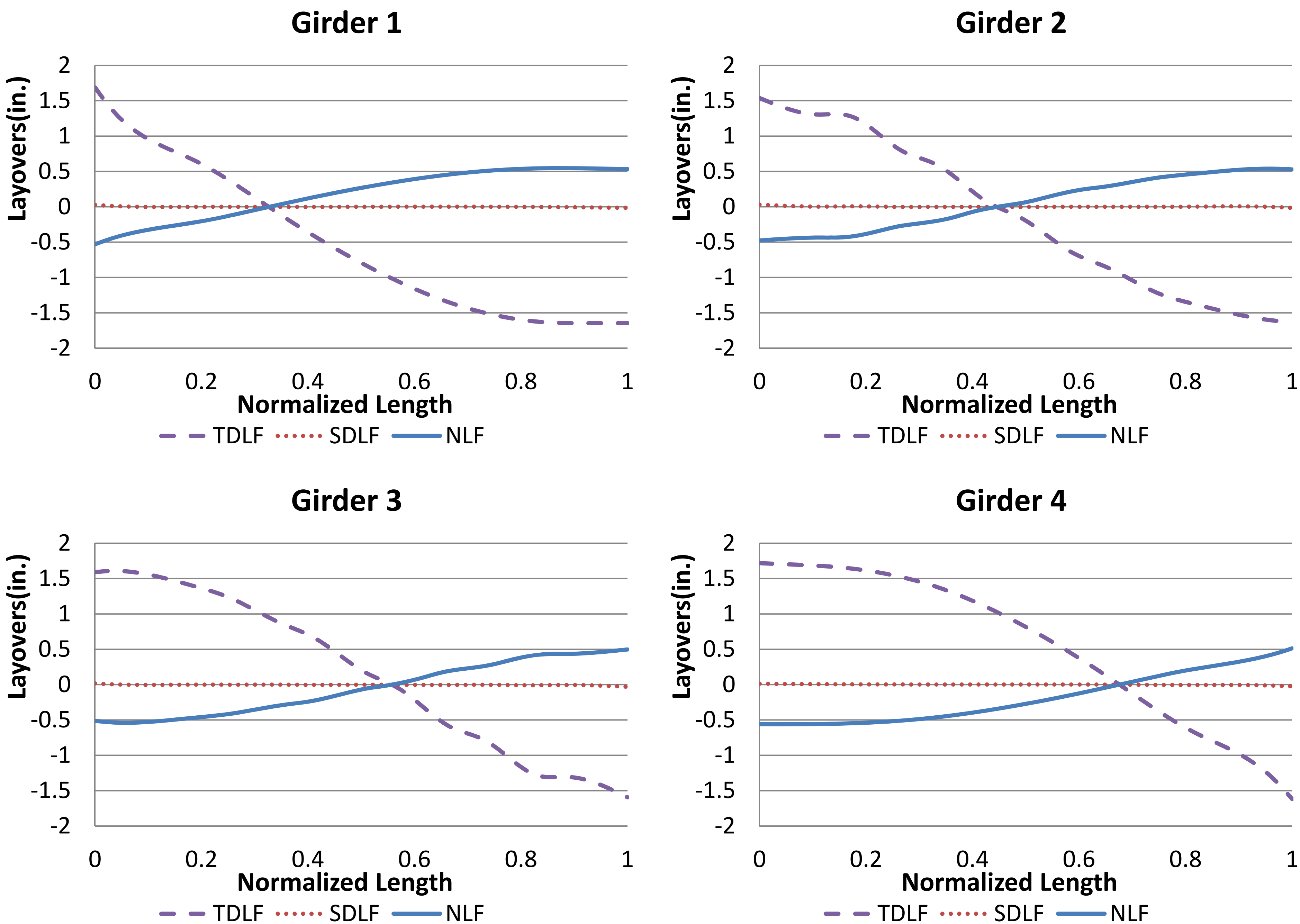


Figure V-1-13. Comparison of individual girder layovers (in) under SDL for different detailing methods.

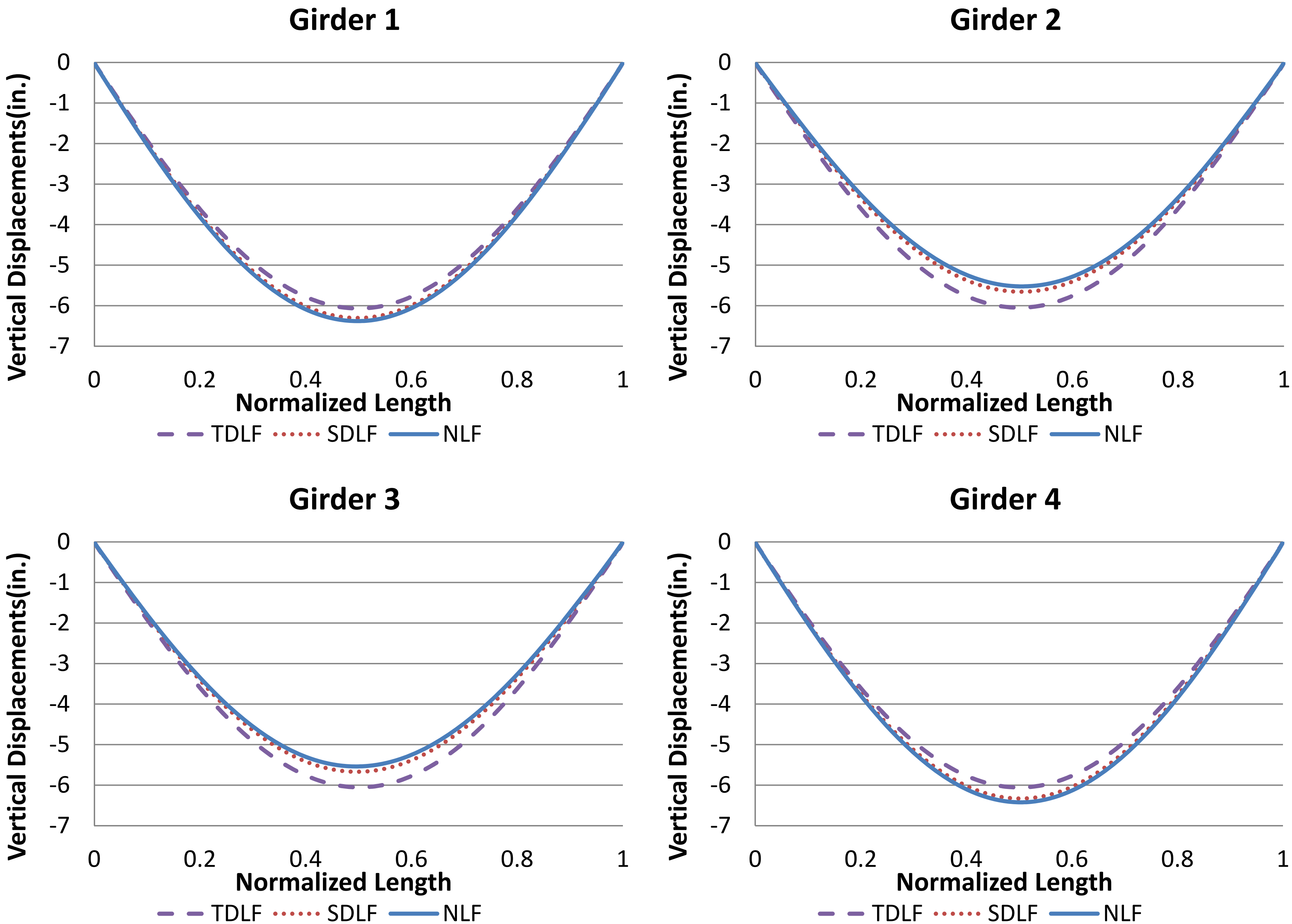


Figure V-1-14. Comparison of individual girder vertical displacements (in) under TDL for different detailing methods.

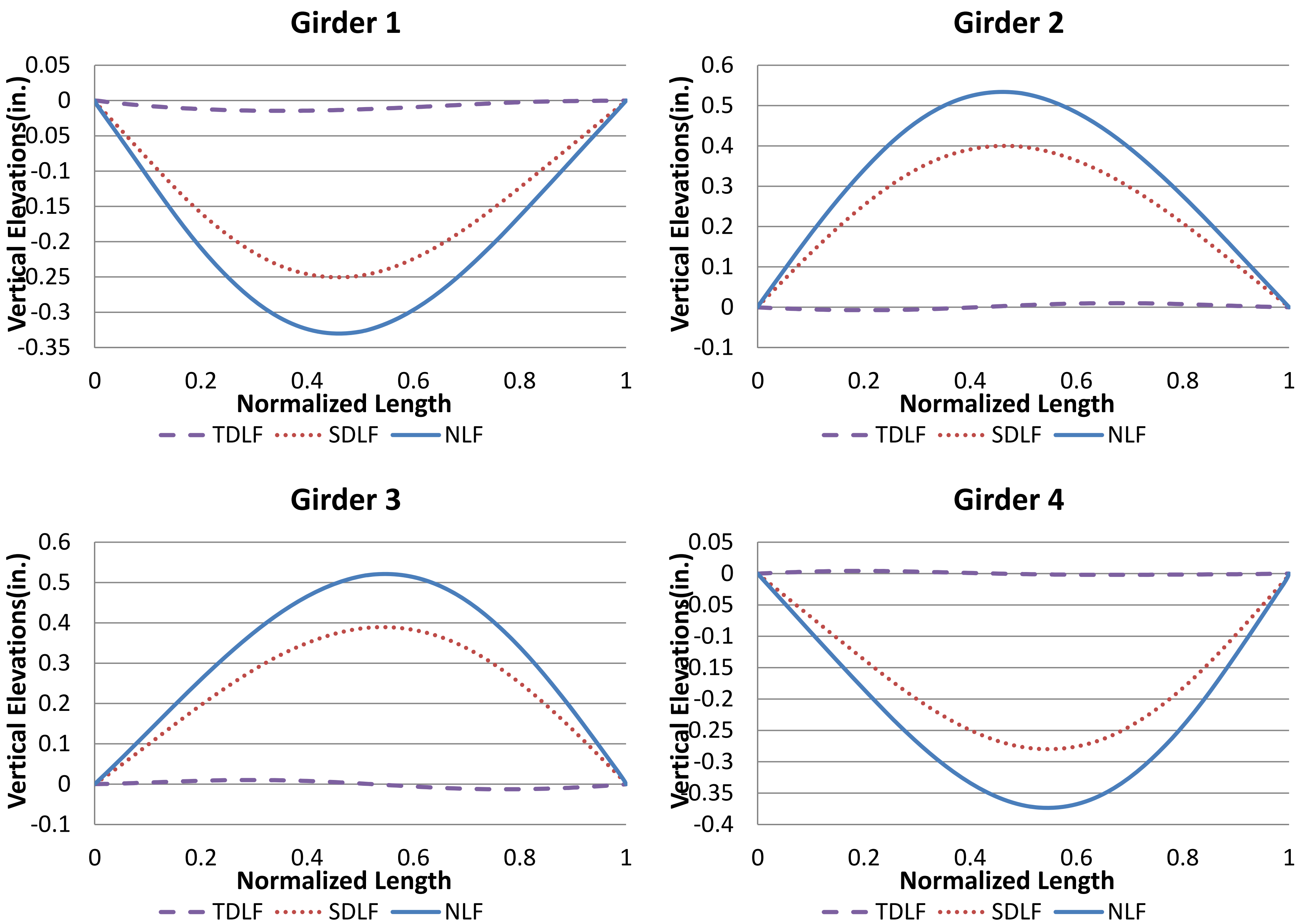


Figure V-1-15. **Comparison of individual girder elevation profiles (in) under TDL for different detailing methods.**

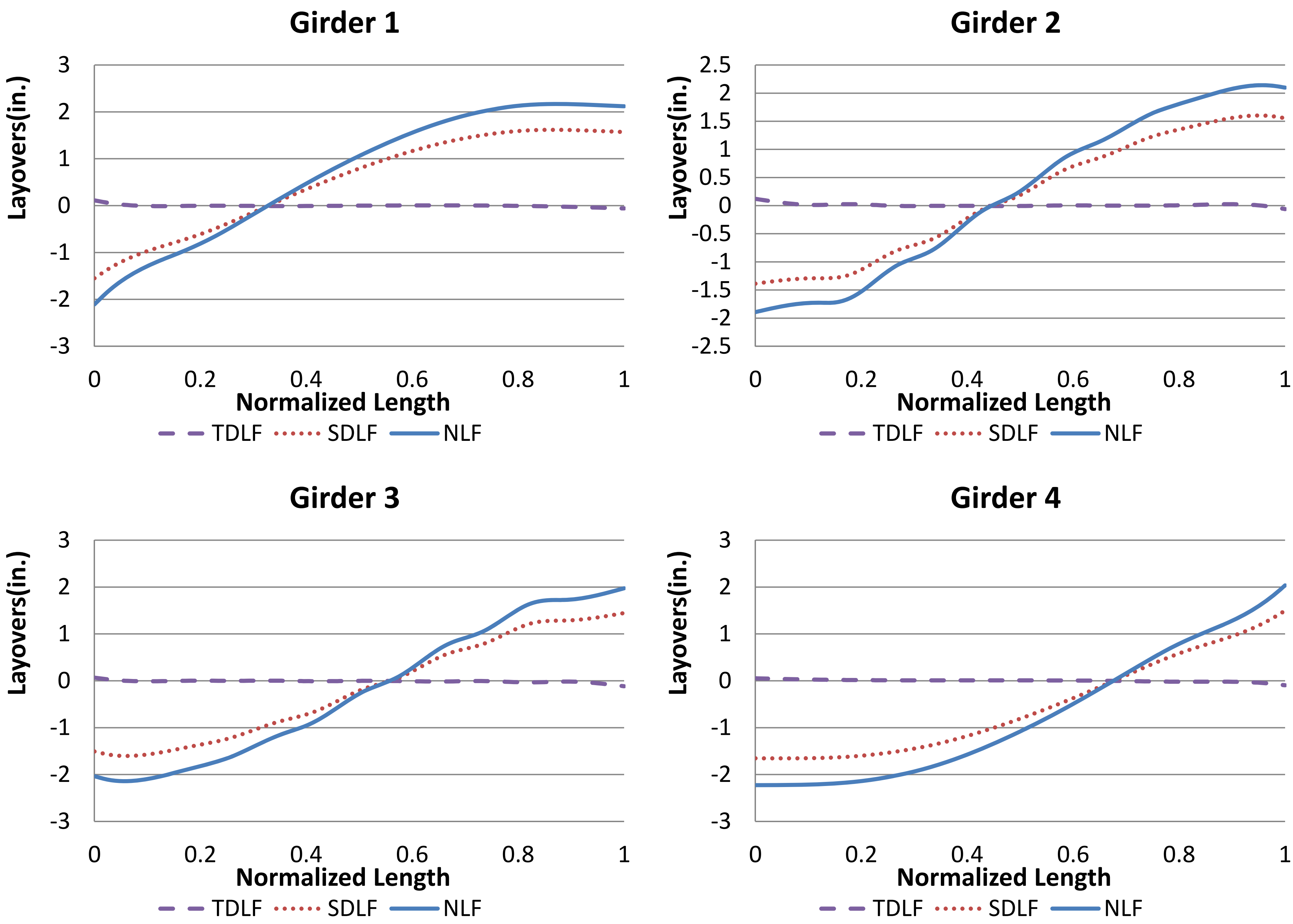


Figure V-1-16. Comparison of individual girder layovers (in) under TDL for different detailing methods.

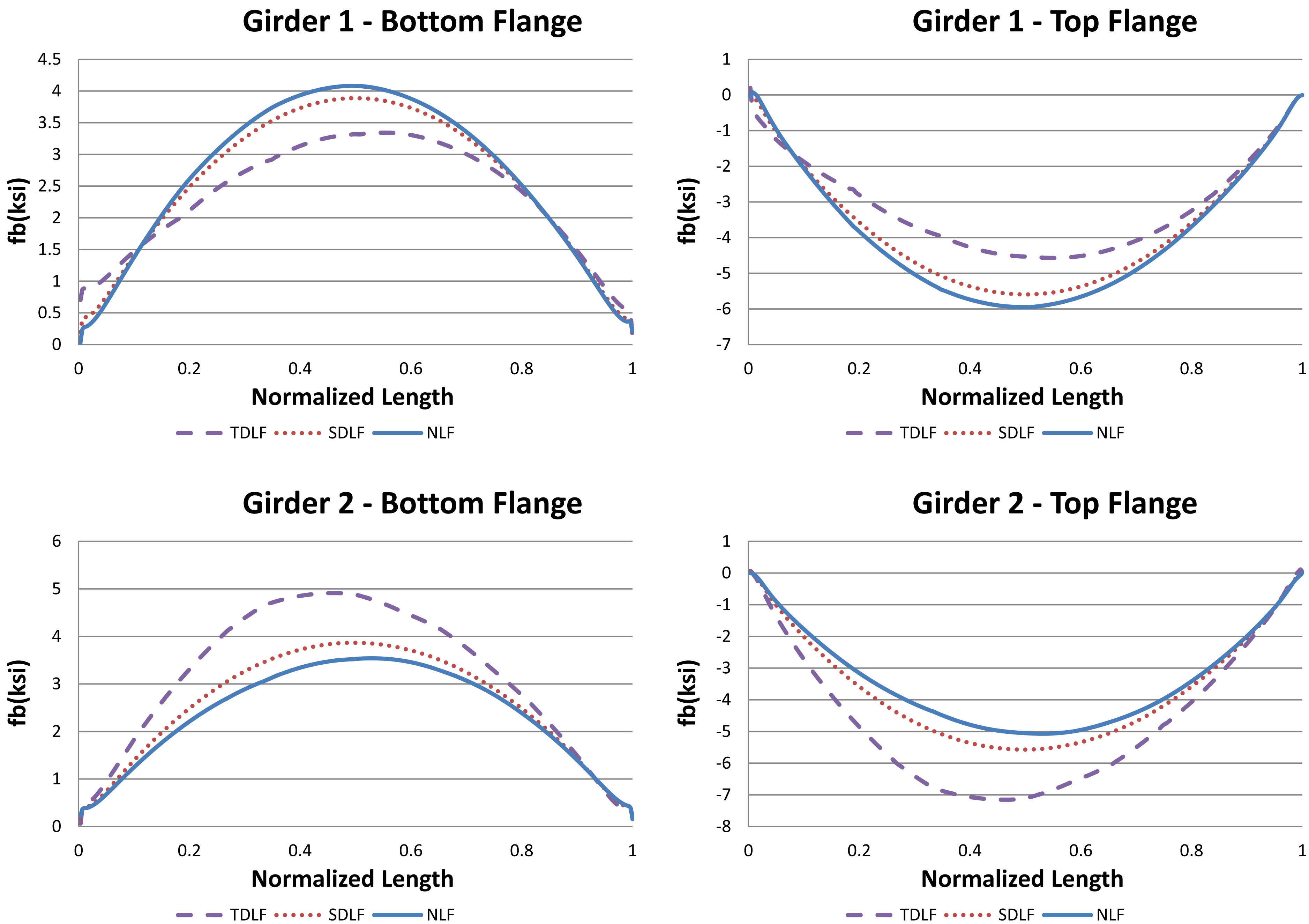


Figure V-1-17. Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

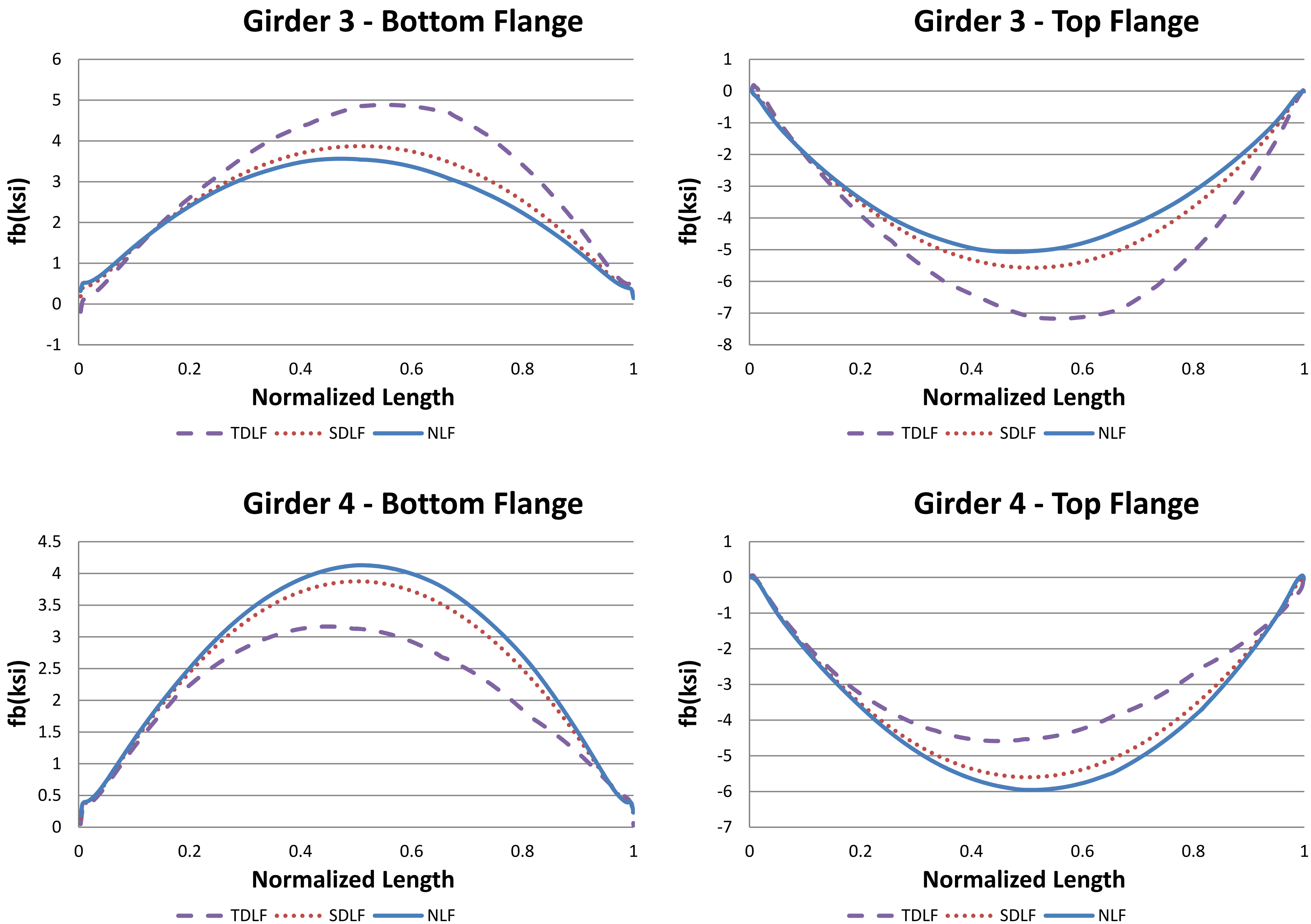


Figure V-1-17 (continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under SDL for different detailing methods.

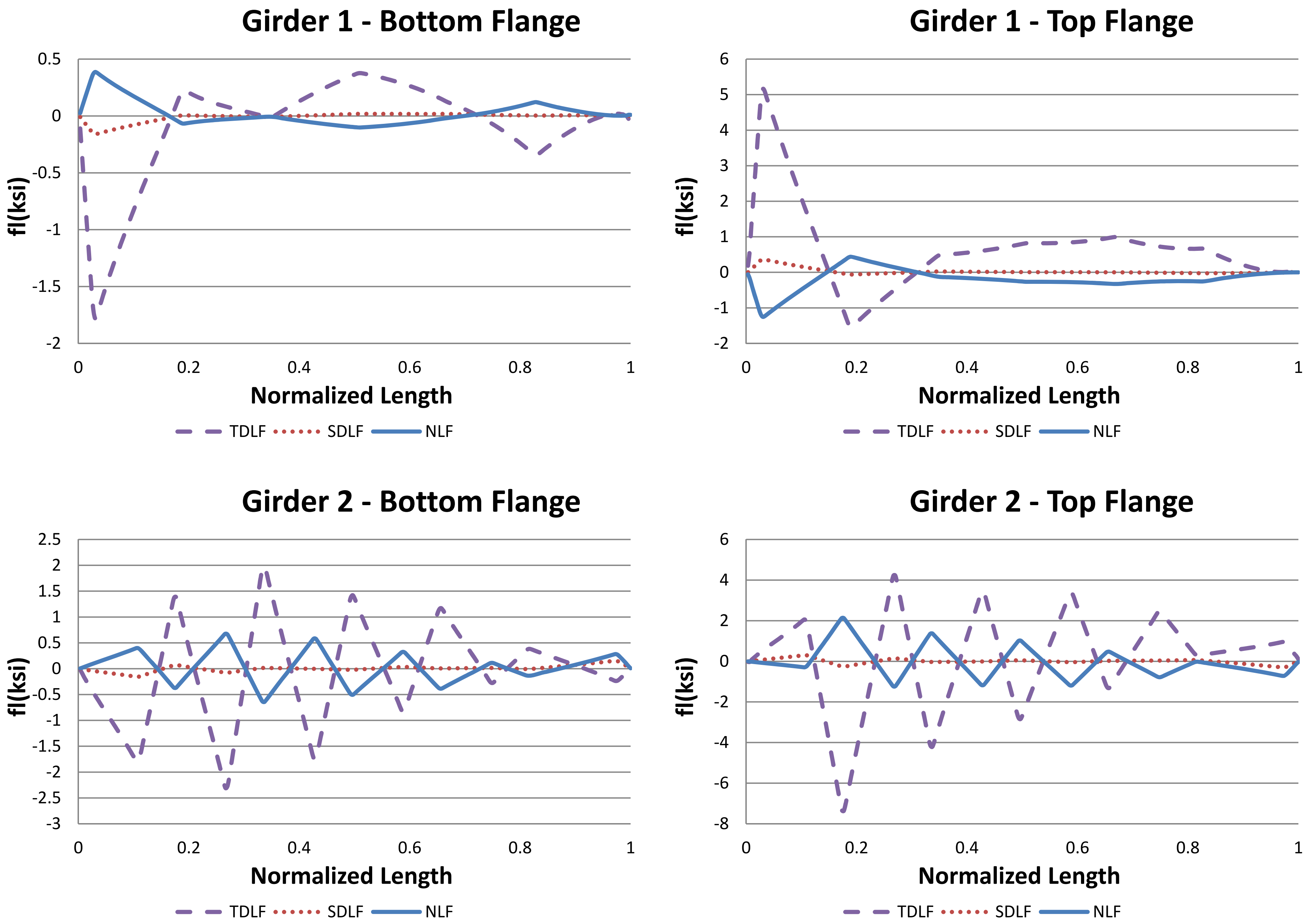


Figure V-1-18. **Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.**

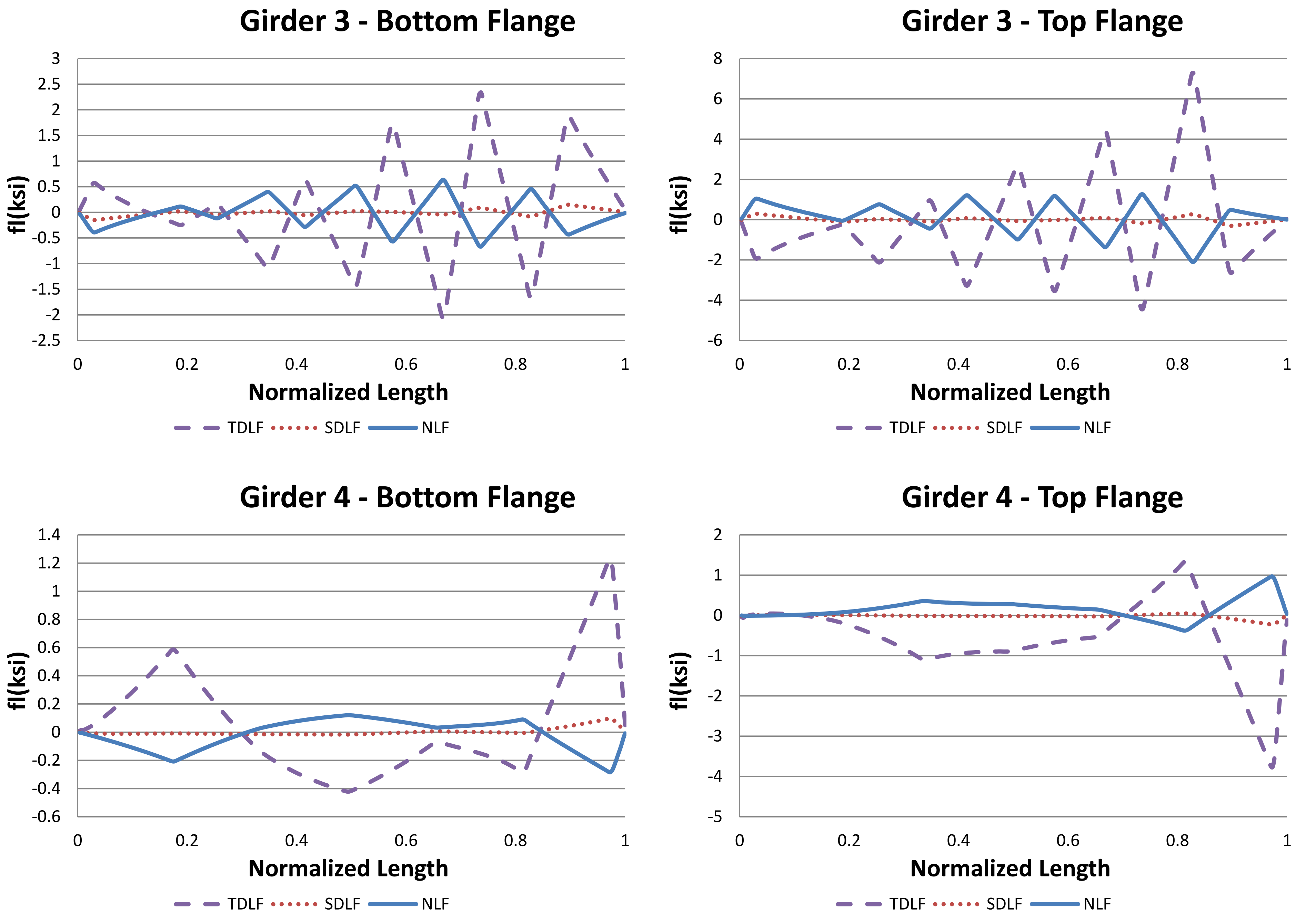


Figure V-1-18 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under SDL for different detailing methods.

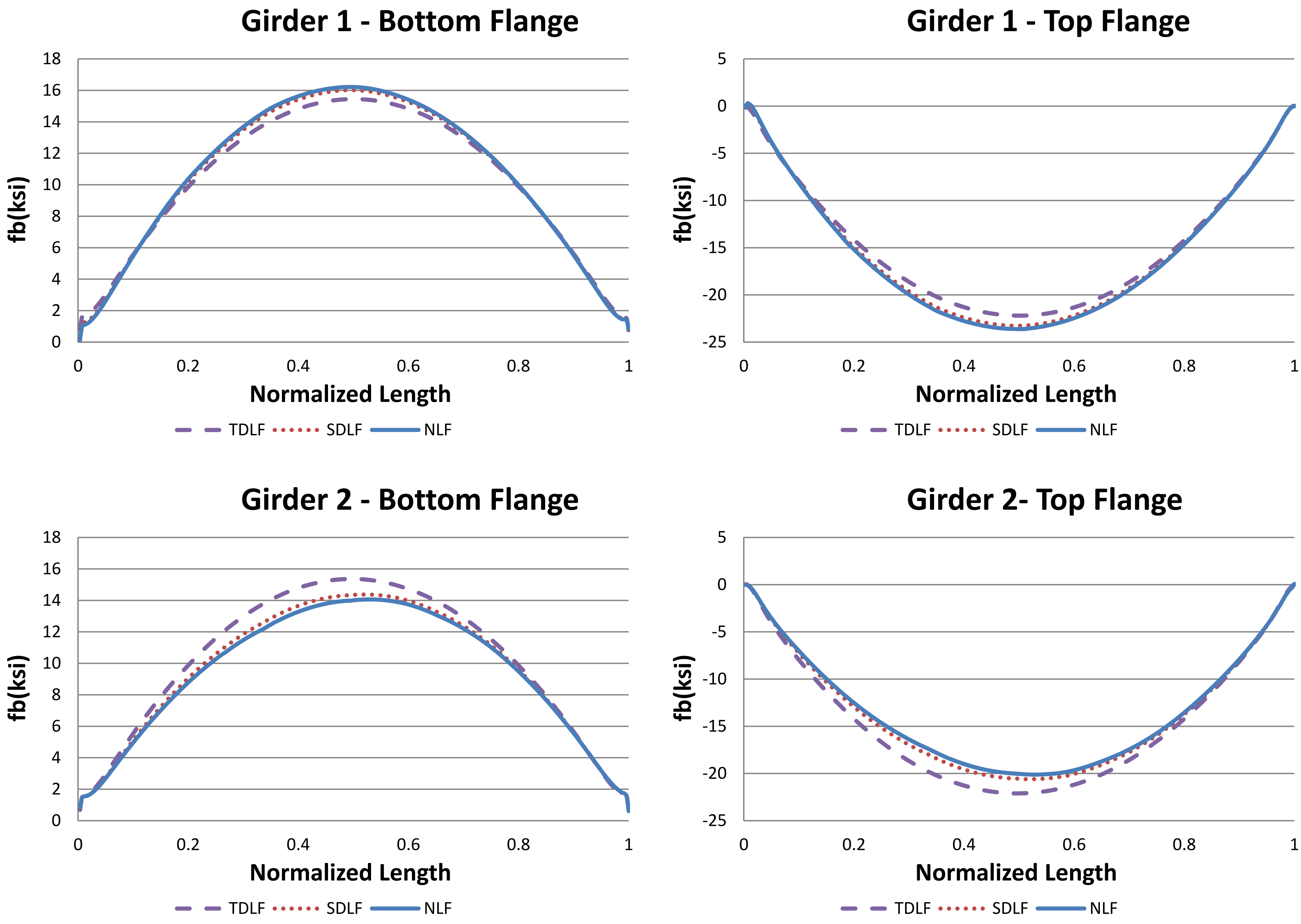


Figure V-1-19. **Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.**

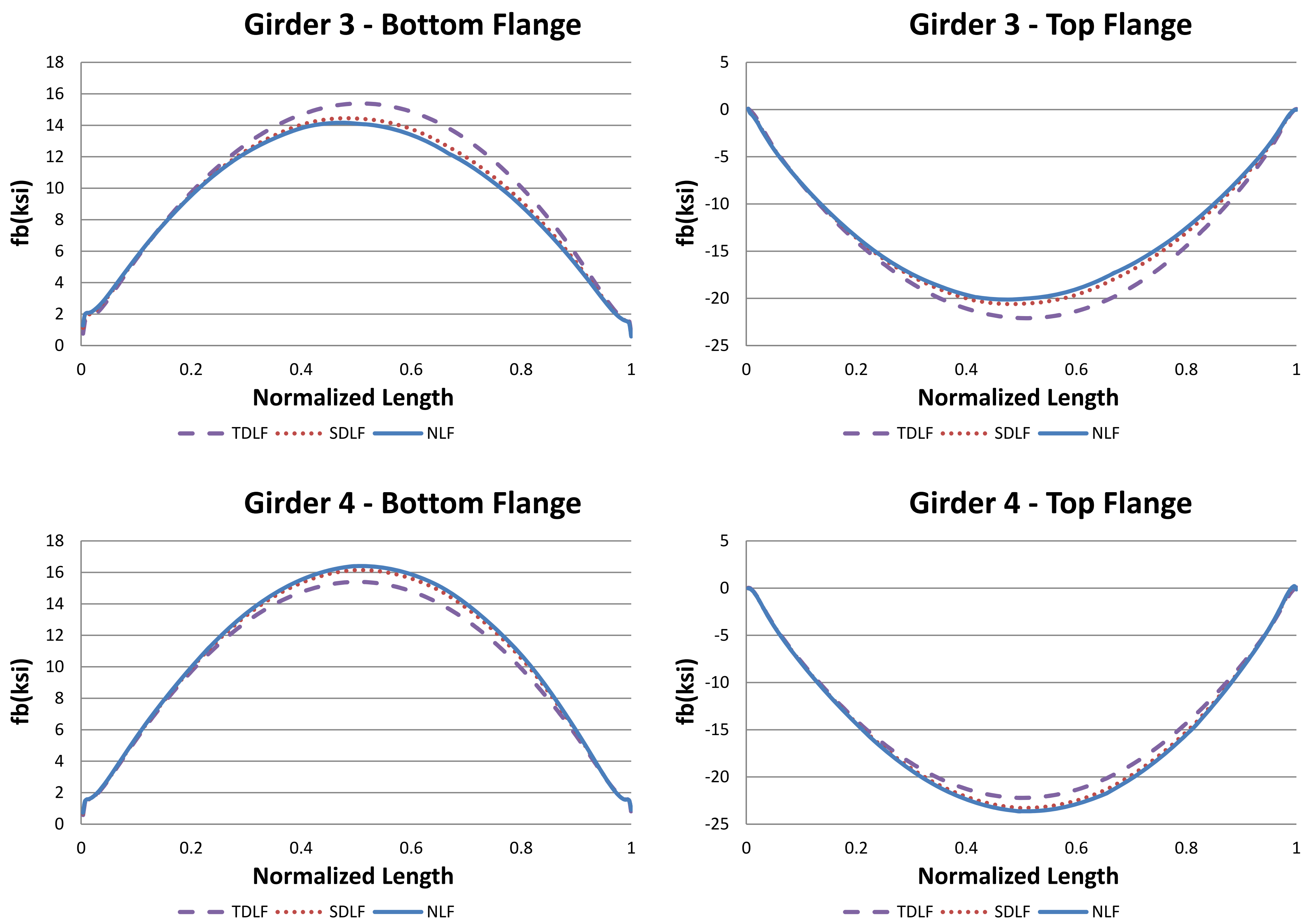


Figure V-1-19(continued). Comparison of individual girder major-axis bending stresses f_b (ksi) under TDL for different detailing methods.

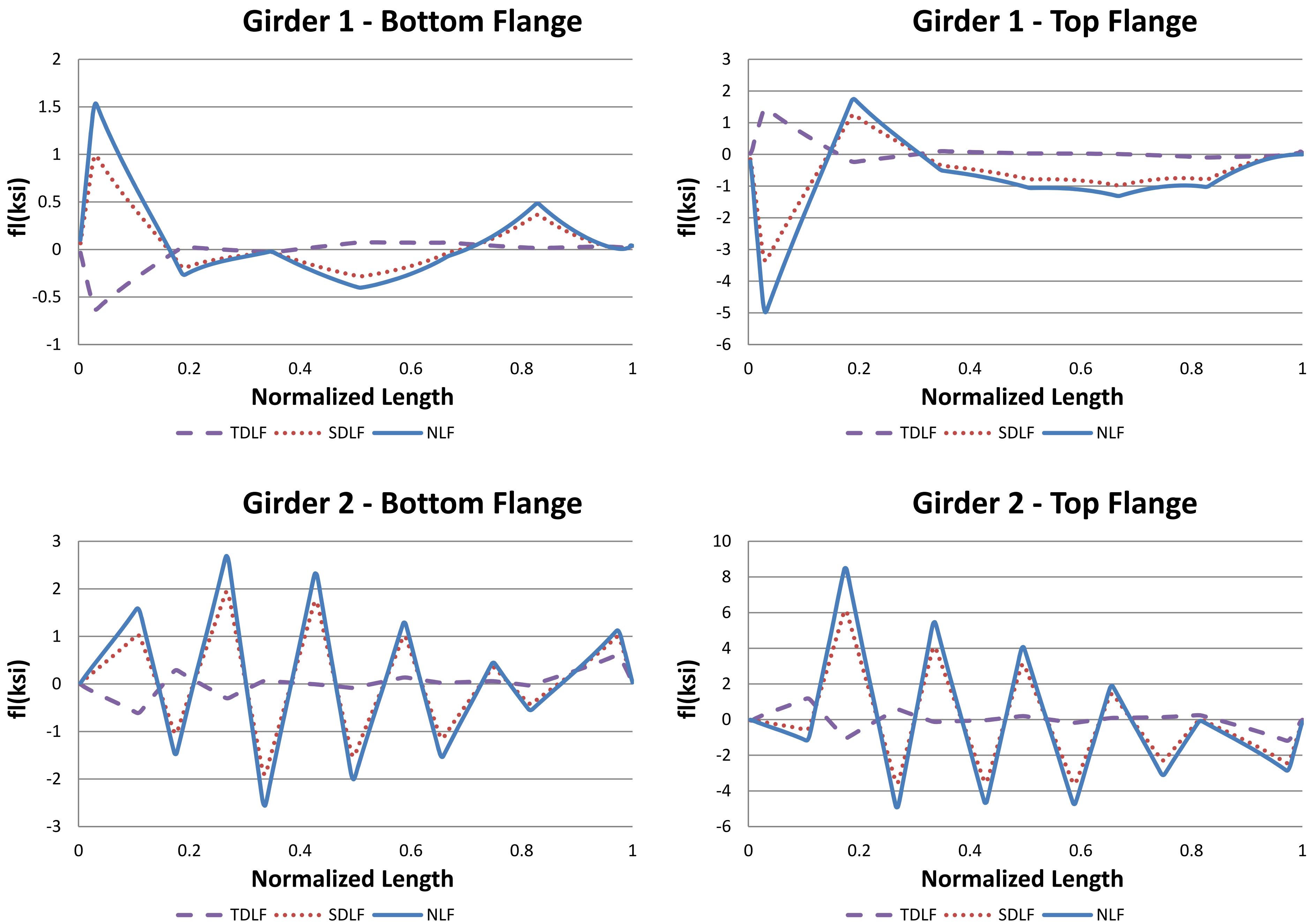


Figure V-1-20. Comparison of individual girder flange lateral bending stresses f_{ℓ} (ksi) under TDL for different detailing methods.

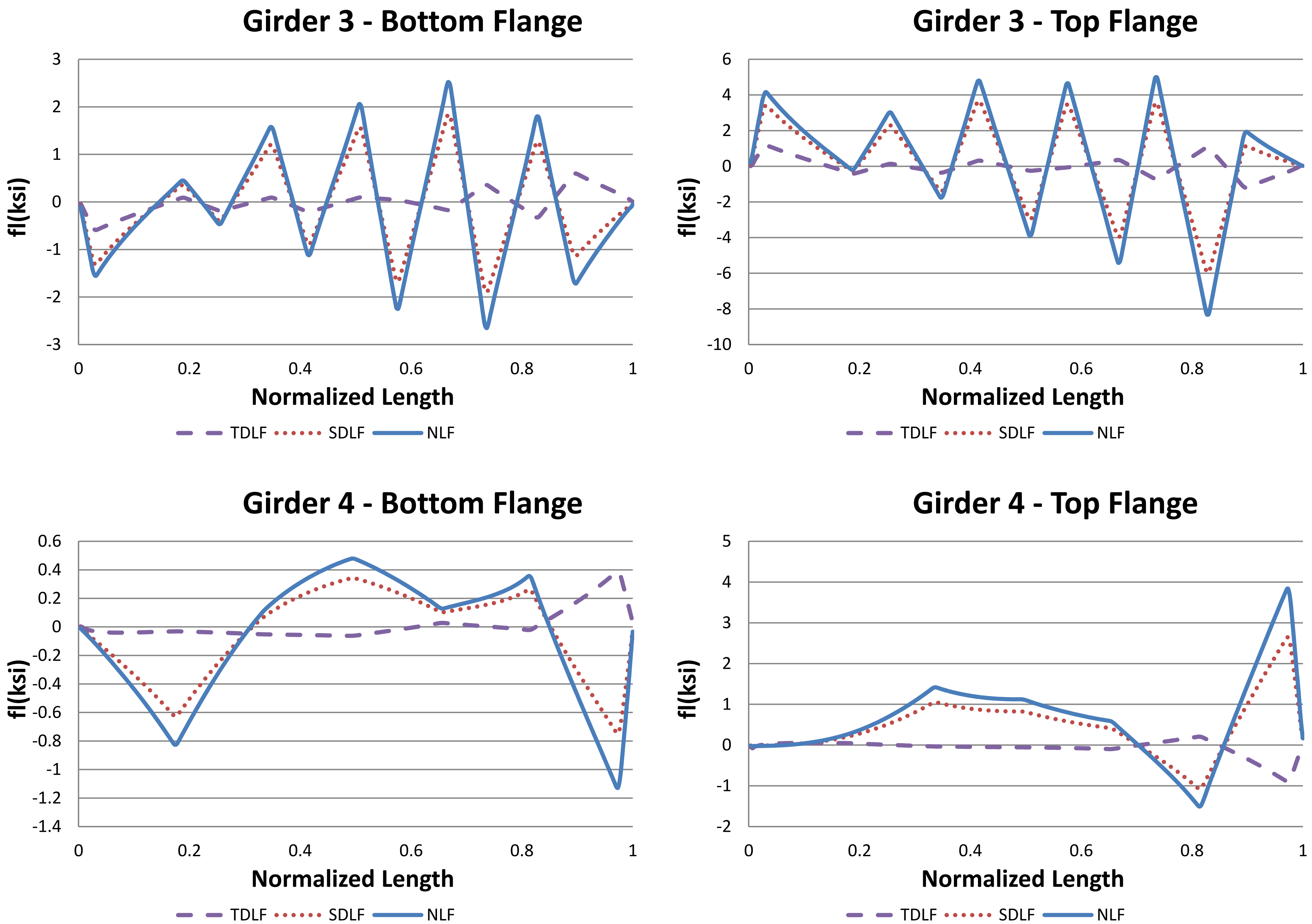


Figure V-1-20 (continued). Comparison of individual girder flange lateral bending stresses f_ℓ (ksi) under TDL for different detailing methods.

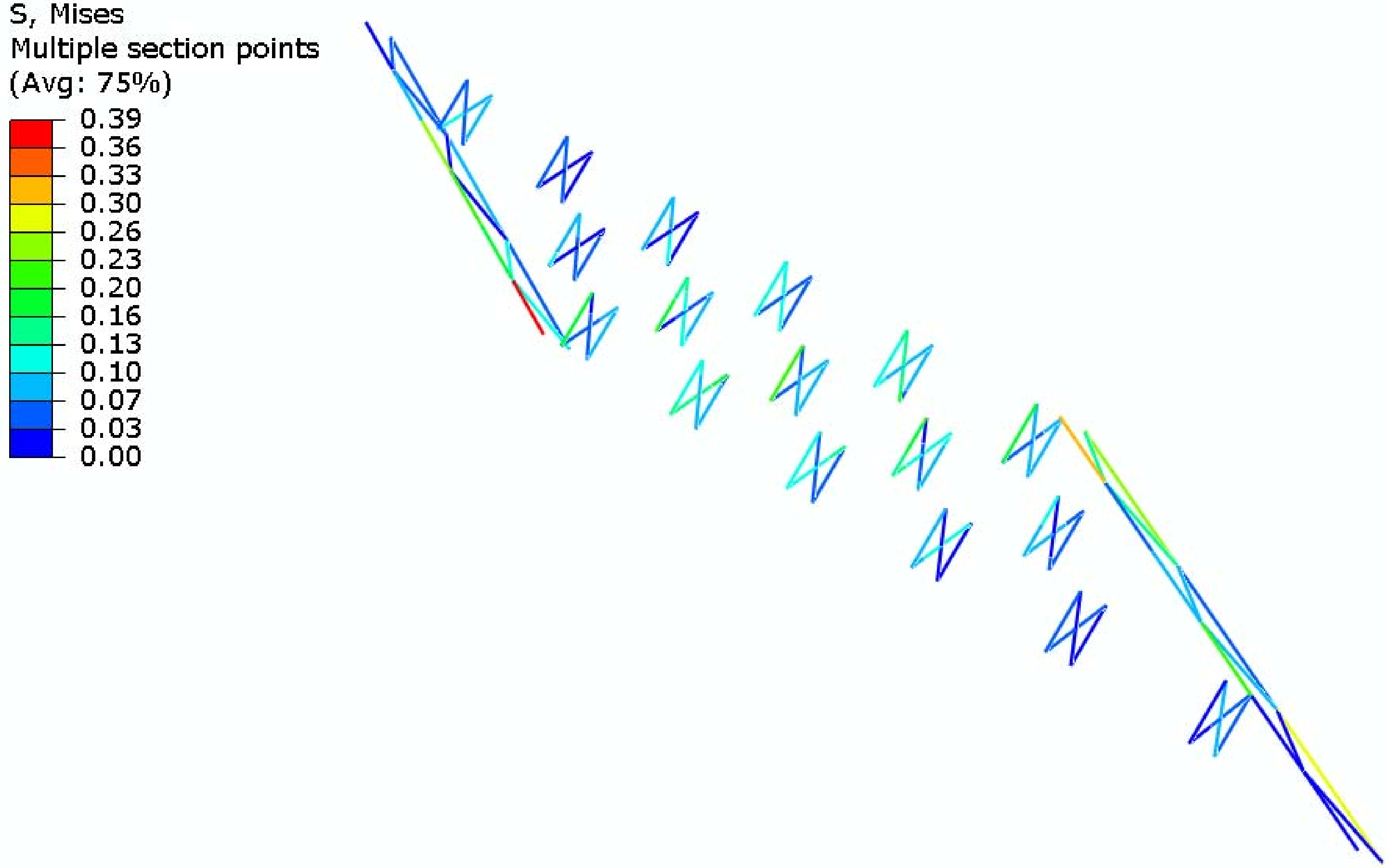


Figure V-1-21. Cross-frame stress contours (ksi) under SDL, NLF detailing (all cross-frame member areas = 11 in^2).

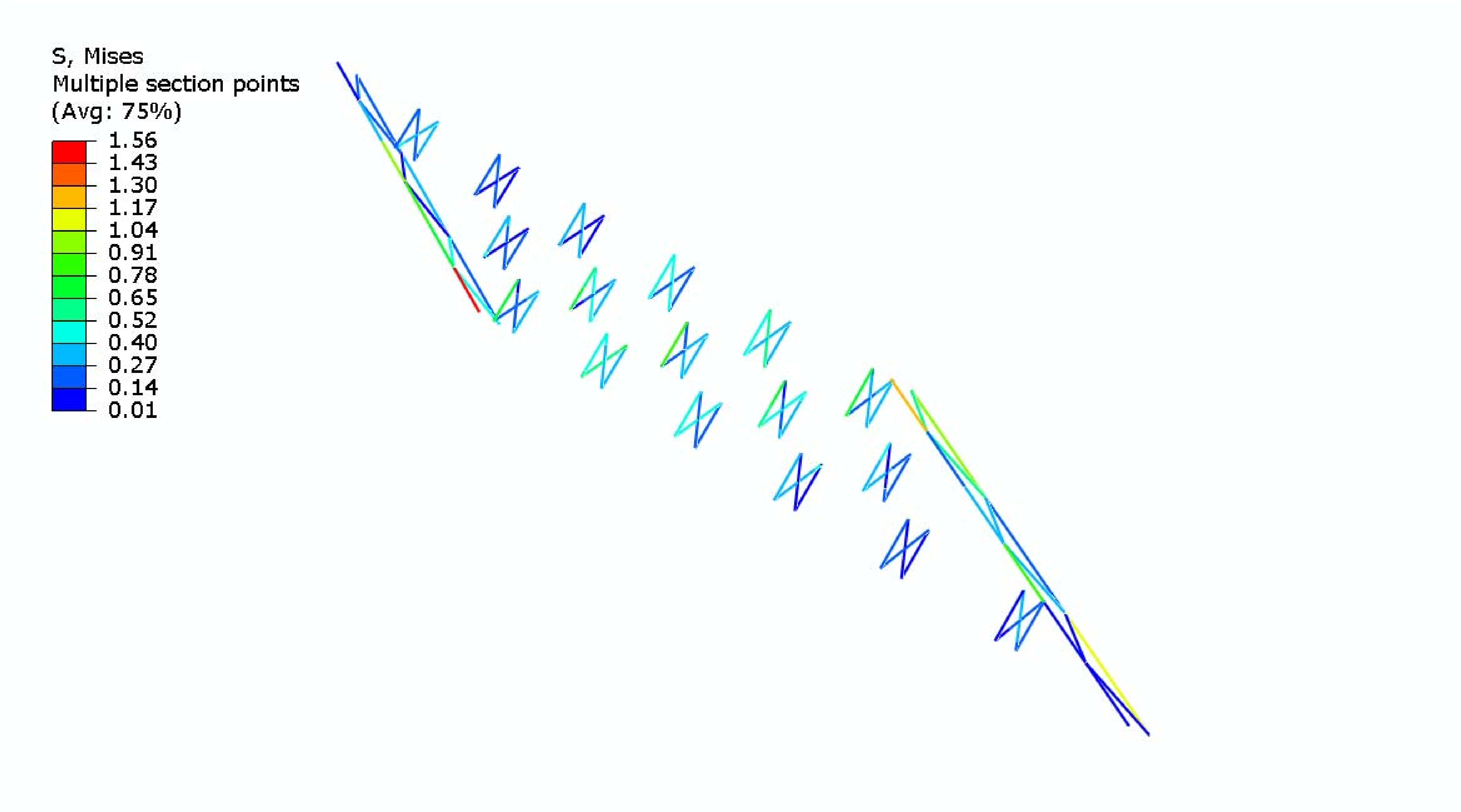


Figure V-1-22. Cross-frame stress contours under TDL, NLF detailing (all cross-frame member areas = 11 in^2).

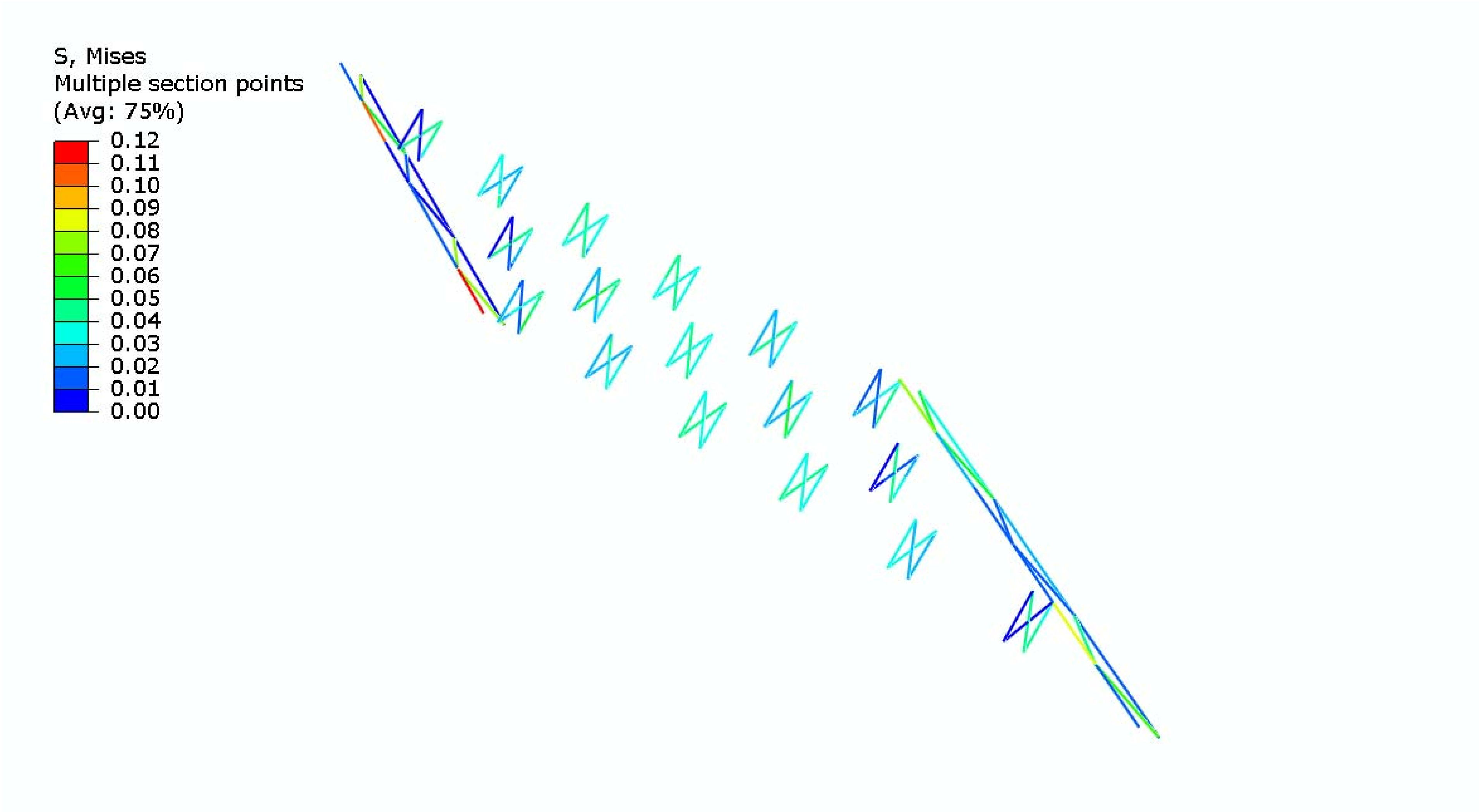


Figure V-1-23. Cross-frame stress contours under SDL, SDLF detailing (all cross-frame member areas = 11 in^2).

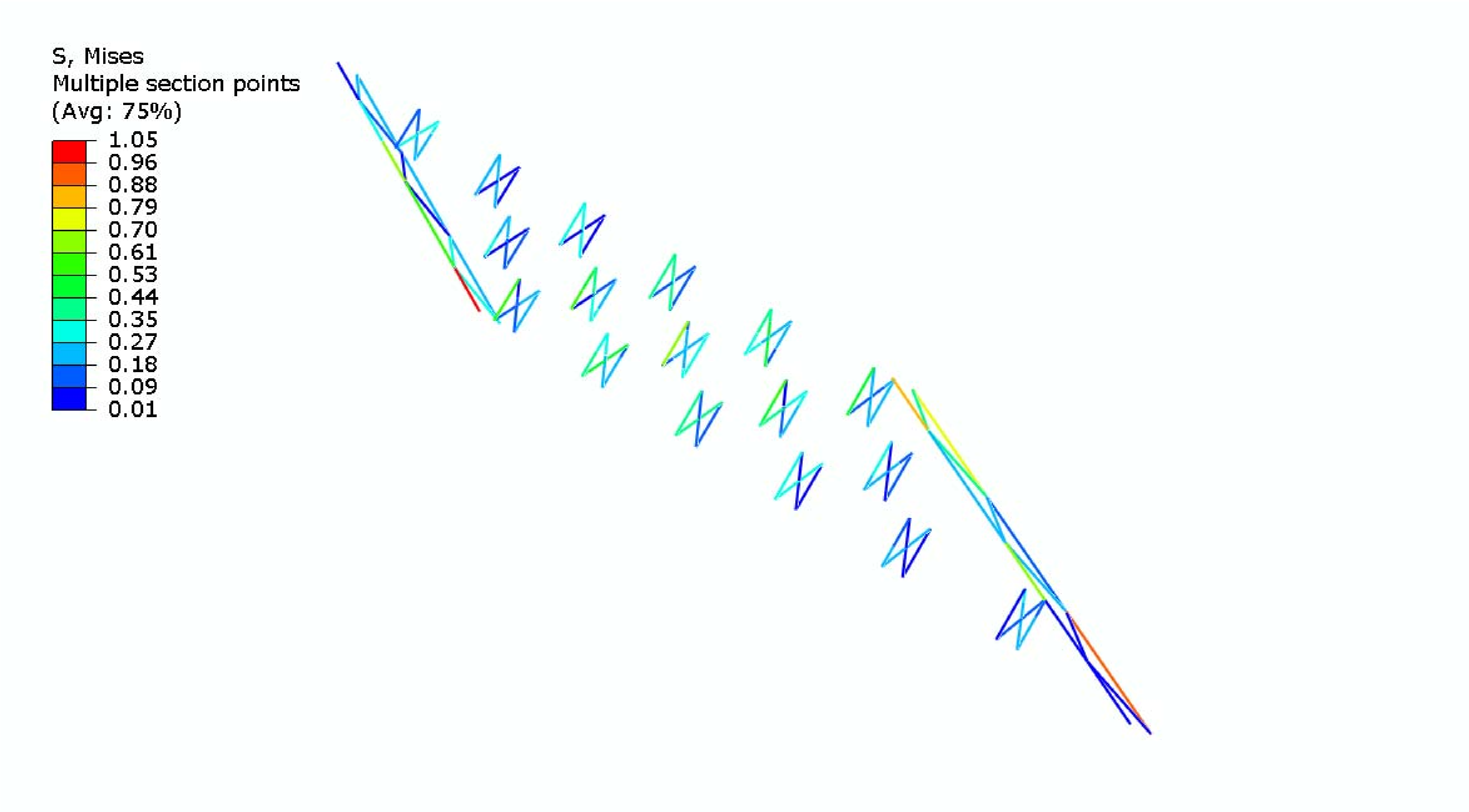


Figure V-1-24. Cross-frame stress contours under TDL, SDLF detailing (all cross-frame member areas = 11 in^2).

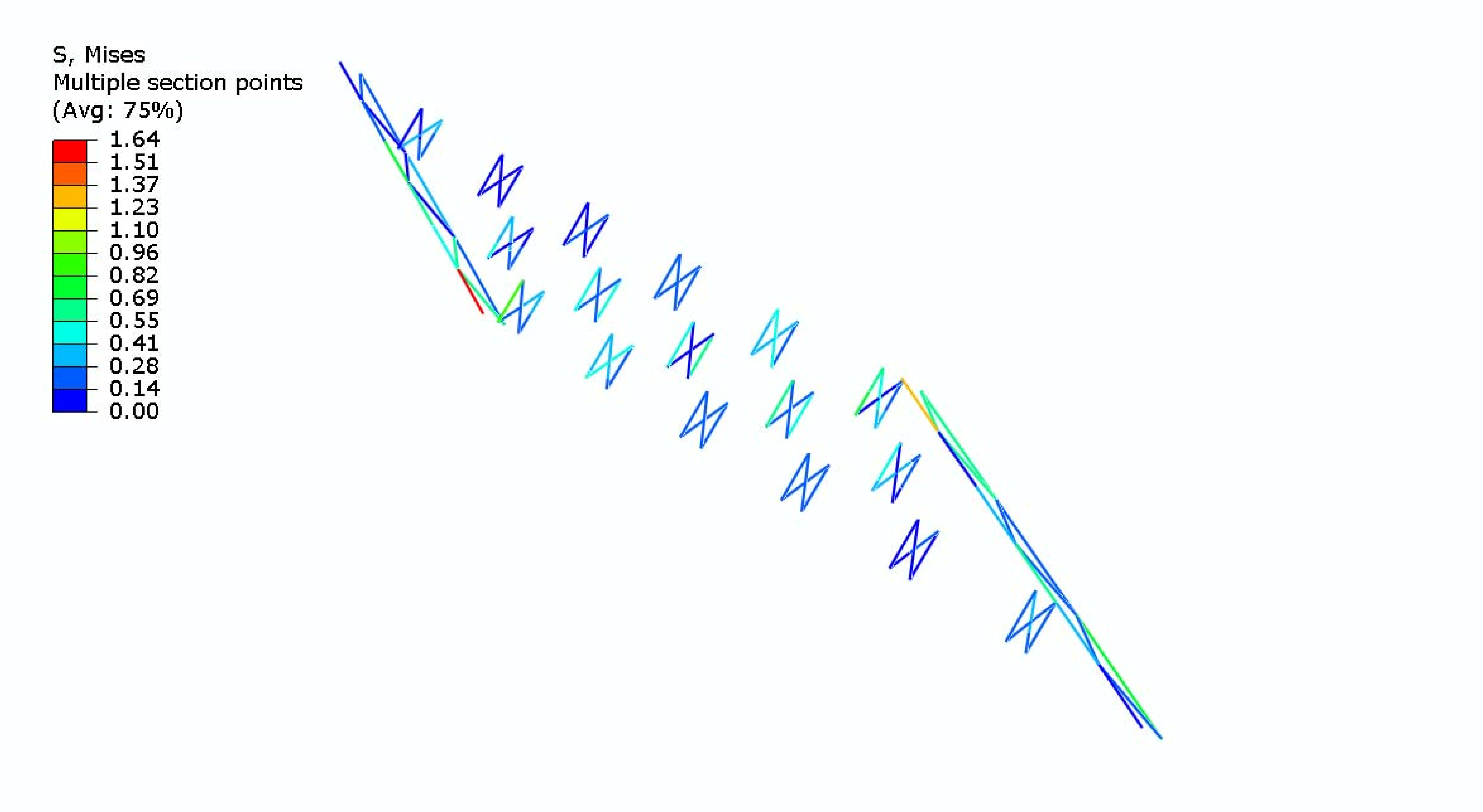


Figure V-1-25. Cross-frame stress contours under SDL, TDLF detailing (all cross-frame member areas = 11 in^2).

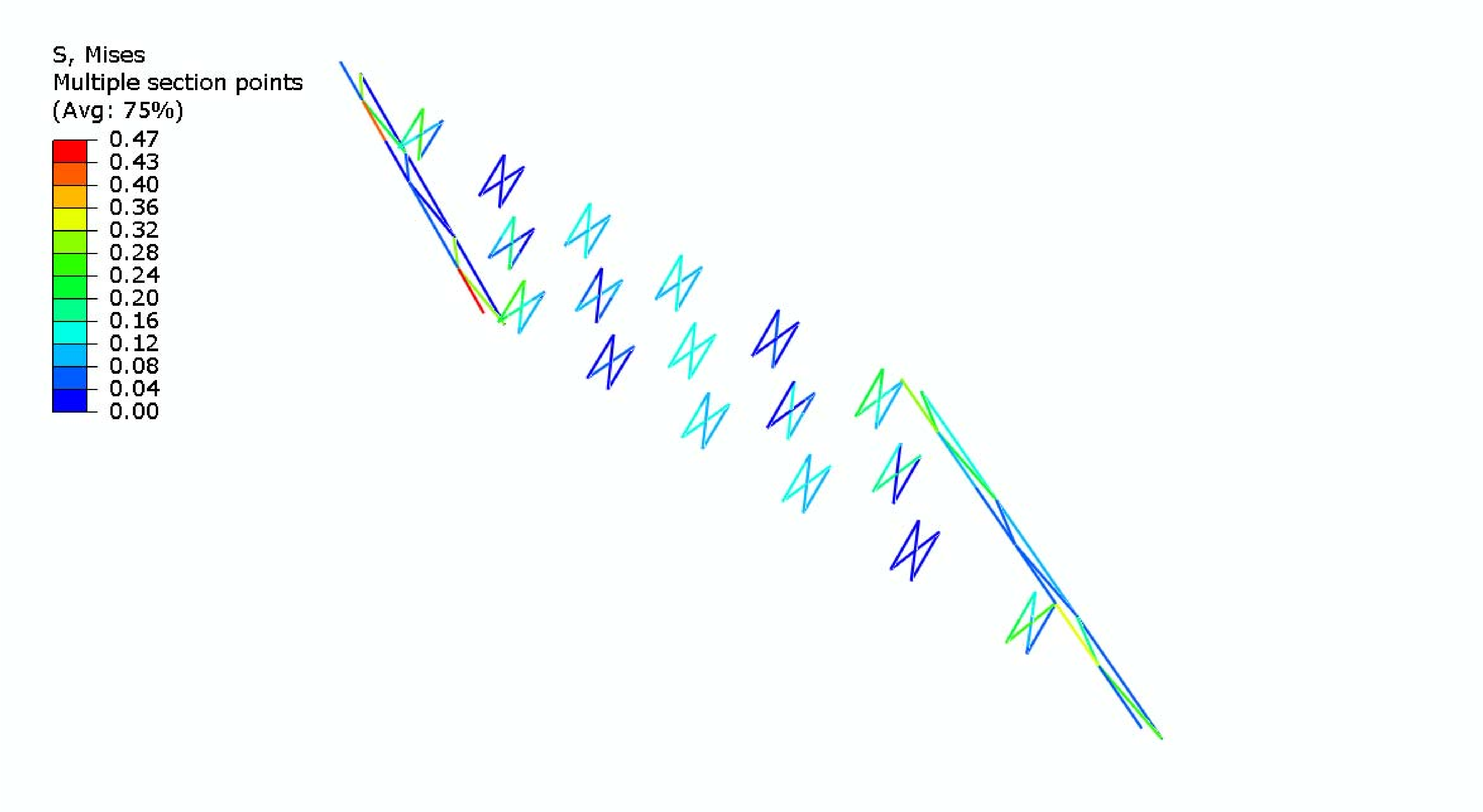


Figure V-1-26. Cross-frame stress contours under TDL, TDLF (all cross-frame member areas = 11 in^2).

Table V-1-1. Maximum axial forces (kips) in cross-frame diagonals under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
1	NLF	1.3	0.2	0.4
	SDLF	0.8	0.1	0.8
	TDLF	7.0	0.4	1.7
2	NLF	0.4	0.5	1.2
	SDLF	0.3	0.6	0.5
	TDLF	2.7	3.4	4.2
3	NLF	1.9	0.8	0.6
	SDLF	0.5	0.6	0.5
	TDLF	6.1	2.4	1.4
4	NLF	1.5	0.5	1.1
	SDLF	0.5	0.5	0.5
	TDLF	3.0	0.4	1.9
5	NLF	1.1	0.8	1.4
	SDLF	0.5	0.6	0.5
	TDLF	2.2	2.3	2.9
6	NLF	0.6	0.6	1.9
	SDLF	0.4	0.5	0.5
	TDLF	1.6	3.5	6.0
7	NLF	0.9	0.8	0.7
	SDLF	0.5	0.2	0.3
	TDLF	3.4	2.0	4.1
8	NLF	0.1	NA	1.6
	SDLF	0.7	NA	0.6
	TDLF	2.8	NA	7.1

Table V-1-2. Maximum axial forces (kips) in cross-frame diagonals under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	5.1	0.9	1.8
	SDLF	3.0	0.8	2.1
	TDLF	3.2	0.5	3.1
2	NLF	1.5	1.7	4.5
	SDLF	1.4	1.2	3.9
	TDLF	2.2	2.2	2.9
3	NLF	7.4	3.2	2.2
	SDLF	5.8	2.6	2.1
	TDLF	0.5	1.6	0.4
4	NLF	5.7	1.7	4.3
	SDLF	4.7	1.8	3.7
	TDLF	1.6	1.7	1.7
5	NLF	4.4	3.2	5.6
	SDLF	3.7	2.6	4.7
	TDLF	1.5	1.6	1.6
6	NLF	2.3	2.1	7.3
	SDLF	2.1	1.6	5.6
	TDLF	0.3	2.0	0.6
7	NLF	3.5	3.3	2.8
	SDLF	3.0	2.6	2.3
	TDLF	2.9	0.7	2.1
8	NLF	0.3	NA	6.2
	SDLF	0.5	NA	4.1
	TDLF	2.6	NA	2.5

Table V-1-3. Maximum axial forces (kips) in cross-frame bottom chord under SDL for different detailing methods.

		CF Location		
CF	**Detailing Method**	**G1-G2**	**G2-G3**	**G3-G4**
1	NLF	0.7	1.0	0.7
	SDLF	0.1	0.1	0.1
	TDLF	1.9	3.3	1.8
2	NLF	1.3	0.7	0.8
	SDLF	0.6	0.3	0.4
	TDLF	4.0	1.5	2.9
3	NLF	0.7	1.4	0.1
	SDLF	0.3	0.4	0.2
	TDLF	2.1	5.2	0.5
4	NLF	0.5	1.6	0.1
	SDLF	0.4	0.4	0.3
	TDLF	2.8	6.4	1.5
5	NLF	0.1	1.5	0.5
	SDLF	0.4	0.5	0.4
	TDLF	1.6	5.6	2.7
6	NLF	0.1	0.7	0.7
	SDLF	0.3	0.4	0.4
	TDLF	0.4	2.0	2.3
7	NLF	0.6	0.4	1.2
	SDLF	0.4	0.3	0.5
	TDLF	2.3	2.4	3.4
8	NLF	3.2	NA	2.6
	SDLF	0.1	NA	0.4
	TDLF	9.0	NA	6.3

Table V-1-4. Maximum axial forces (kips) in cross-frame bottom chord under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	2.8	3.9	2.6
	SDLF	2.2	2.8	2.0
	TDLF	0.2	0.4	0.2
2	NLF	5.4	2.7	3.0
	SDLF	3.4	1.7	2.6
	TDLF	0.0	0.6	0.7
3	NLF	2.8	5.9	0.2
	SDLF	1.8	4.0	0.4
	TDLF	0.0	0.8	0.4
4	NLF	2.2	6.6	0.7
	SDLF	1.3	4.6	0.2
	TDLF	1.1	1.4	0.9
5	NLF	0.7	6.0	2.1
	SDLF	0.2	4.1	1.3
	TDLF	1.1	1.1	1.1
6	NLF	0.2	3.1	2.8
	SDLF	0.4	1.9	1.8
	TDLF	0.3	0.4	0.2
7	NLF	2.2	1.8	4.9
	SDLF	2.1	1.1	3.1
	TDLF	0.7	1.0	0.3
8	NLF	12.9	NA	10.3
	SDLF	9.8	NA	8.1
	TDLF	0.6	NA	1.4

Table V-1-5. Maximum axial forces (kips) in cross-frame top chord under SDL for different detailing methods.

CF	Detailing Method	CF Location G1-G2	G2-G3	G3-G4
1	NLF	4.3	2.6	0.8
	SDLF	1.3	0.2	1.2
	TDLF	18.1	7.9	2.3
2	NLF	2.1	1.2	0.5
	SDLF	0.2	0.1	0.0
	TDLF	9.6	4.8	0.9
3	NLF	1.2	2.2	0.6
	SDLF	0.3	0.3	0.4
	TDLF	3.4	5.9	1.5
4	NLF	1.3	2.3	1.0
	SDLF	0.4	0.4	0.5
	TDLF	2.5	5.2	1.3
5	NLF	1.0	2.2	1.3
	SDLF	0.4	0.3	0.4
	TDLF	1.6	6.2	2.4
6	NLF	0.6	1.2	1.2
	SDLF	0.3	0.1	0.3
	TDLF	1.5	5.2	3.6
7	NLF	0.2	2.4	1.9
	SDLF	0.0	0.2	0.2
	TDLF	1.7	6.5	8.7
8	NLF	0.1	NA	3.5
	SDLF	1.0	NA	0.9
	TDLF	3.9	NA	13.8

Table V-1-6. Maximum axial forces (kips) in cross-frame top chord under TDL for different detailing methods.

		CF Location		
CF	Detailing Method	G1-G2	G2-G3	G3-G4
1	NLF	17.2	10.2	3.0
	SDLF	11.5	7.6	3.4
	TDLF	5.2	0.9	4.6
2	NLF	8.3	4.5	2.1
	SDLF	5.9	3.5	1.6
	TDLF	3.4	1.5	2.4
3	NLF	4.5	8.7	2.3
	SDLF	3.6	6.8	2.1
	TDLF	0.1	0.5	0.2
4	NLF	5.1	8.8	3.8
	SDLF	4.2	7.0	3.2
	TDLF	1.3	1.4	1.4
5	NLF	3.8	8.7	5.0
	SDLF	3.3	6.8	4.1
	TDLF	1.3	0.3	1.3
6	NLF	2.2	4.8	4.5
	SDLF	2.0	3.7	3.6
	TDLF	0.1	1.7	0.3
7	NLF	1.0	9.5	7.6
	SDLF	0.8	7.3	5.5
	TDLF	2.4	0.6	3.0
8	NLF	0.3	NA	13.9
	SDLF	0.9	NA	9.5
	TDLF	3.8	NA	3.4

Table V-1-7. Individual support vertical reactions under SDL and TDL (kips).

Girder	Detailing Method	SDL 1	SDL 2	TDL 1	TDL 2
		Load Type & Support Number			
G1	NLF	29	26	115	103
	SDLF	25	26	111	102
	TDLF	14	25	100	101
G2	NLF	22	25	89	98
	SDLF	26	25	92	100
	TDLF	37	26	104	100
G3	NLF	25	22	98	899
	SDLF	25	26	100	92
	TDLF	26	37	100	104
G4	NLF	26	29	103	115
	SDLF	26	25	103	111
	TDLF	25	14	101	100

Appendix V-2. NISSS4 Results with GT-LOFT Initial Fixed-End Forces

This appendix provides detailed analytical results for straight skewed bridge NISSS4 used an example of using GT-LOFT to determine the initial fixed-end forces associated with No Load Fit (NLF), Steel Dead Load Fit (SDLF) and Total Dead Load Fit (TDLF) detailing methods. This bridge has a span length of 150 ft and severe skew angles of 70 degrees. For illustration purposes, all girders have the same prismatic section (1.125 in. x 16 in. top flanges and 2 in. x 18 in. bottom flanges). The intermediate cross-frames are X type, and the end cross-frames are K type. All cross-frame members are L6x6x1.

These results are with SDLF and TDLF detailing effects included via the initial fixed-end forces calculated by GT-LOFT.

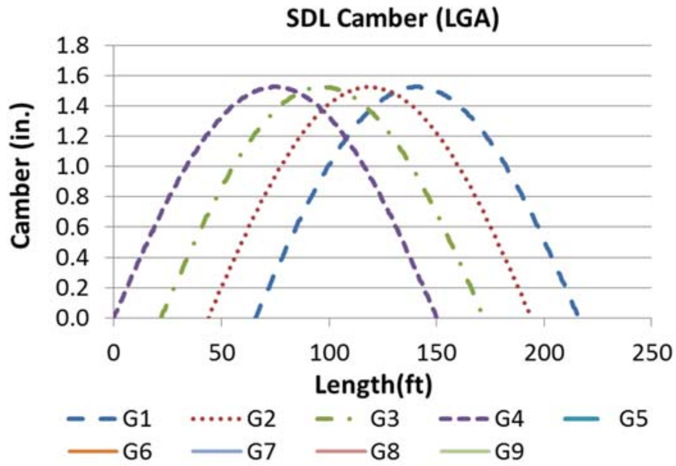


Figure V-2-1. NISSS4 LGA SDL cambers

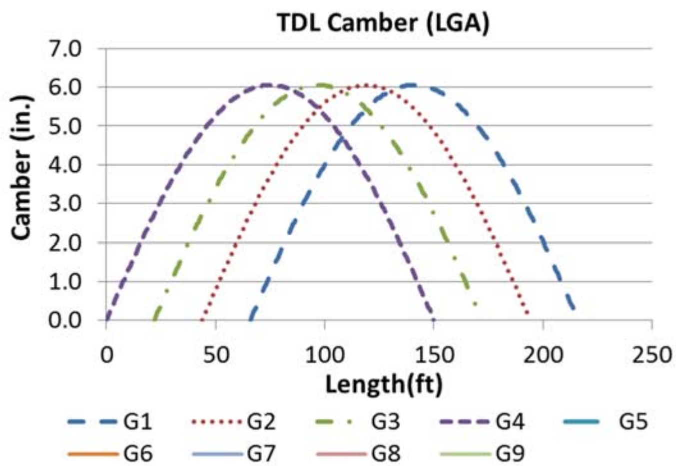


Figure V-2-2. NISSS4 LGA TDL cambers

Table V-2-1. Girder Properties

Girder	Length (ft)	Area (in^2)	I_y (in^4)	I_z (in^4)	J (in^4)	J_{new} (in^4)
G1	150	99	1357	88213	61	4906,610@5,188
G2	150	99	1357	88213	61	376,(3166,1652)@4,3166,610,4906
G3	150	99	1357	88213	61	4906,610,(3166,1652)@4,3166,376
G4	150	99	1357	88213	61	188,610@5,4906

Table V-2-2. Cross-Frame Properties (Timoshenko Approach)

Girder	Length (in)	Area (Chords Only) (in^2)	Shear Area (in^2)	I_y (Chords Only) (in^4)	$I_{z\_equiv.}$ (in^4)	J (Chords Only) (in^4)
End CFs	96	22	3.40	71	21142	7.4
Interm. CFs	281	22	17.63	71	21142	7.4

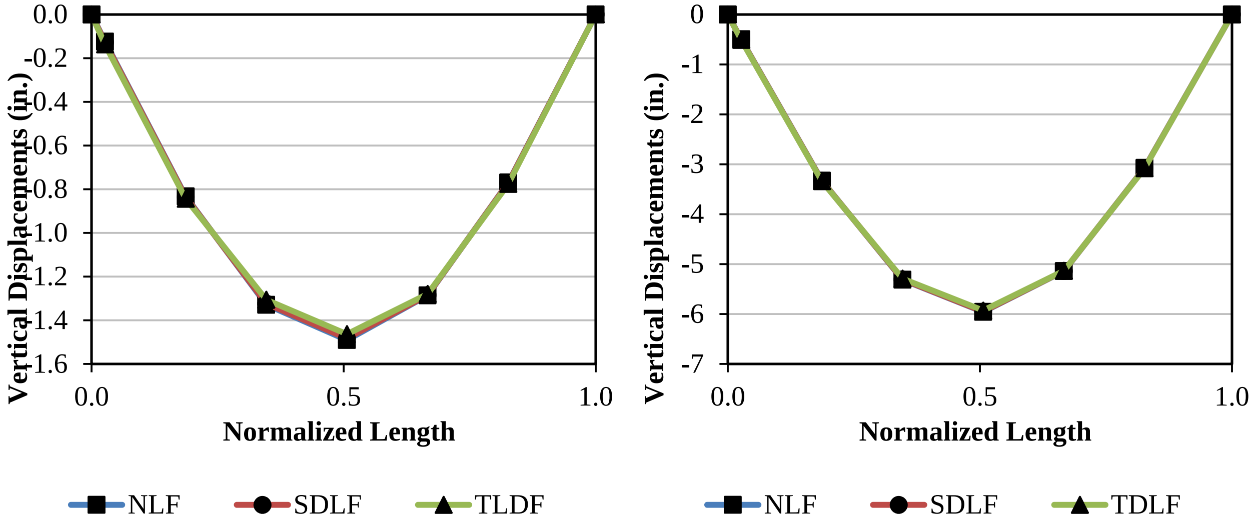


Figure V-2-3. G1 Vertical Displacements under SDL (left) and TDL (right).

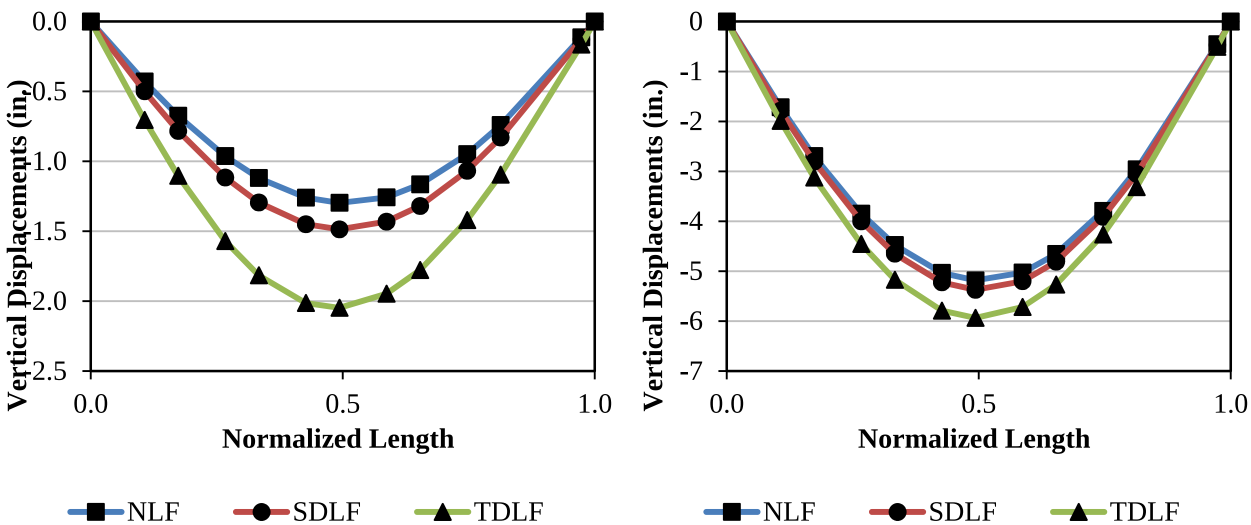


Figure V-2-4. G2 Vertical Displacements under SDL (left) and TDL (right).

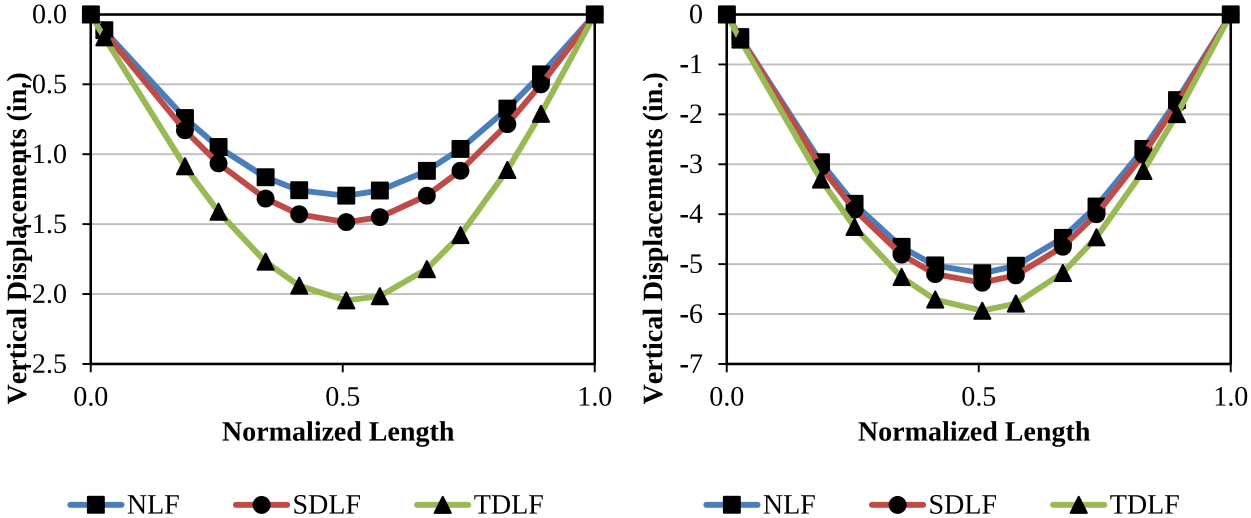


Figure V-2-5. G3 Vertical Displacements under SDL (left) and TDL (right).

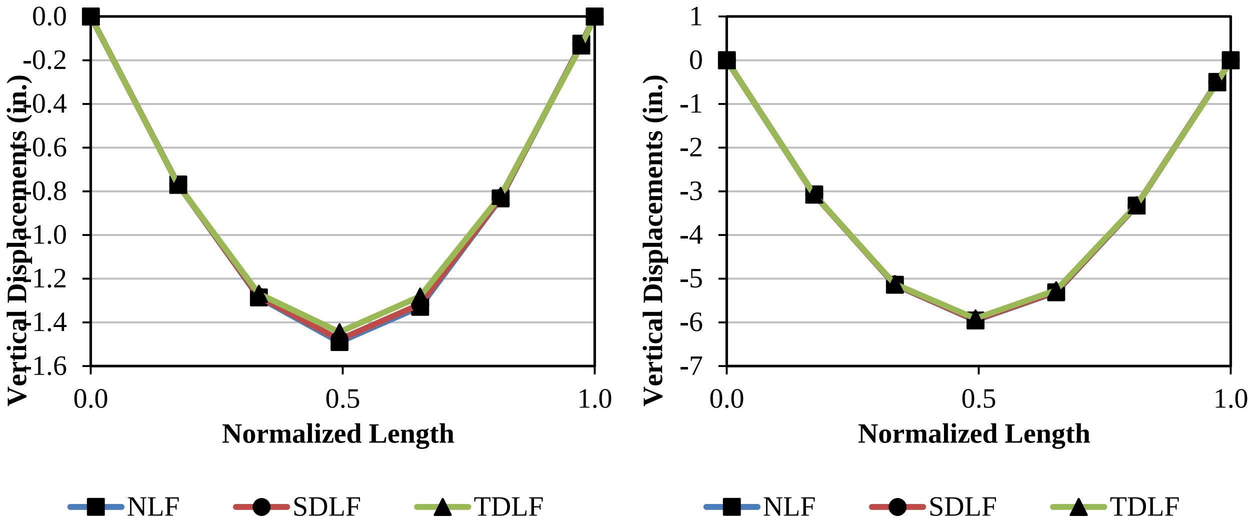


Figure V-2-6. G4 Vertical Displacements under SDL (left) and TDL (right).

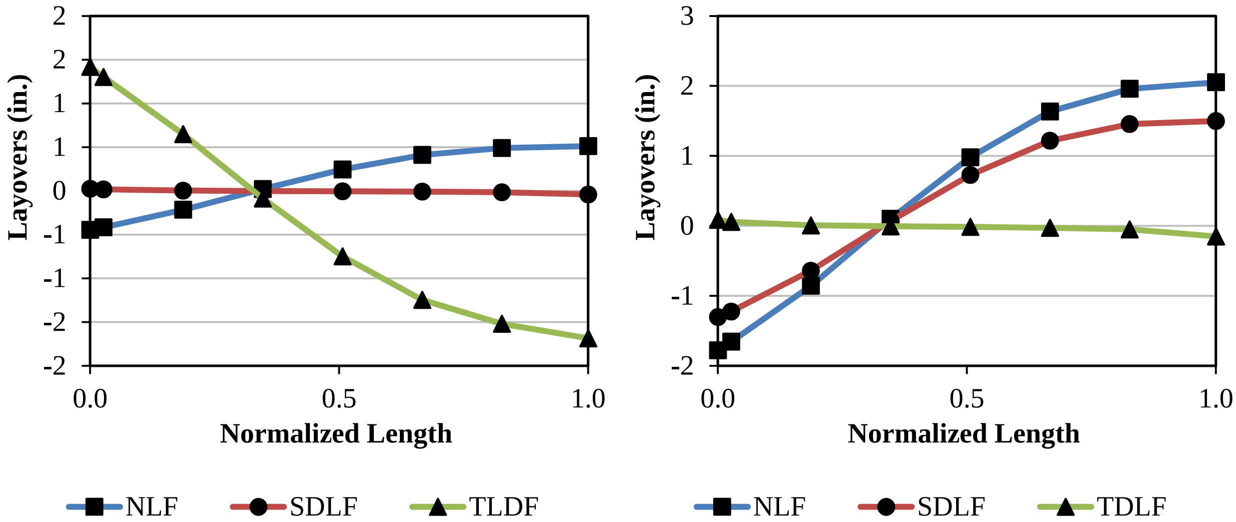


Figure V-2-7. G1 Layovers under SDL (left) and TDL (right).

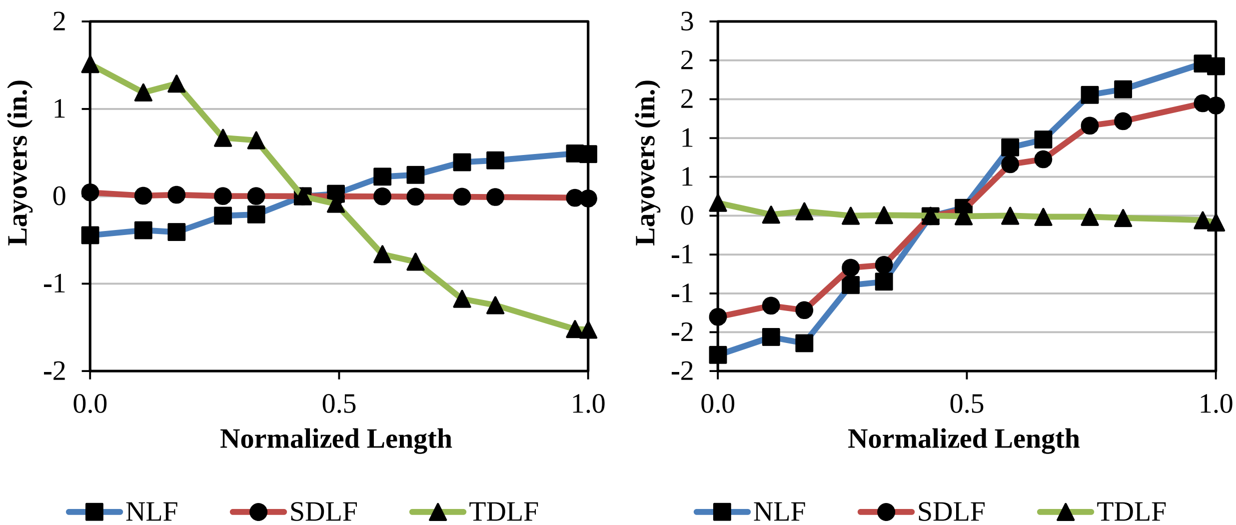


Figure V-2-8. G2 Layovers under SDL (left) and TDL (right).

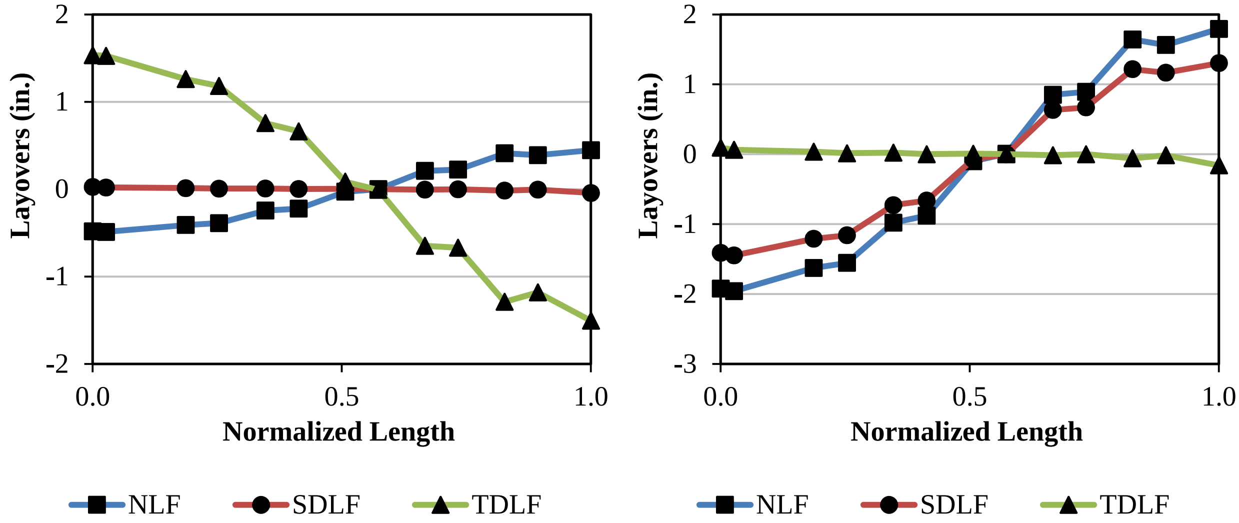


Figure V-2-9. G3 Layovers under SDL (left) and TDL (right).

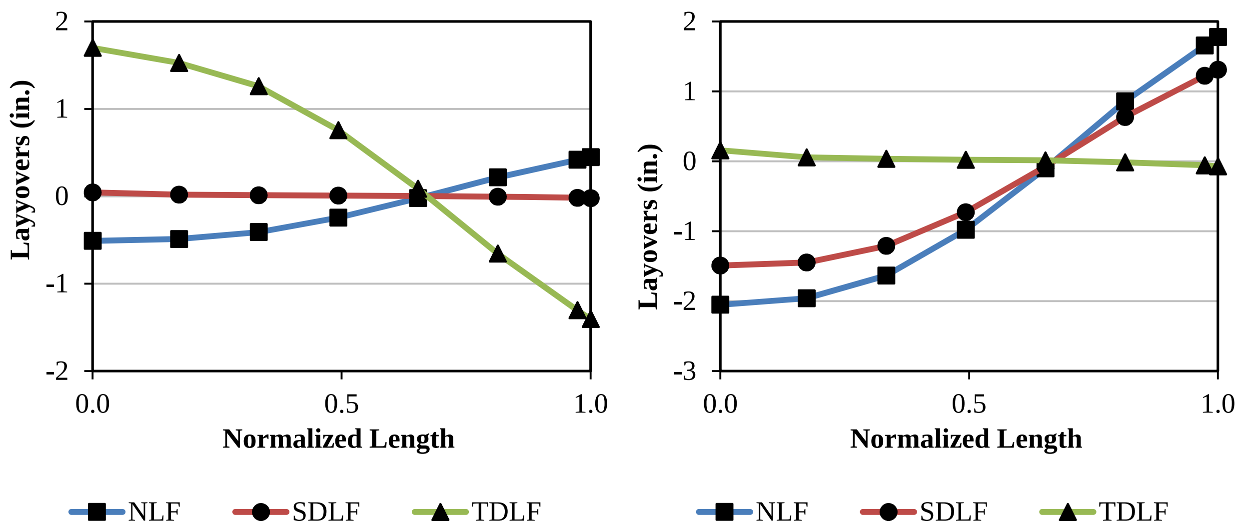


Figure V-2-10. G4 Layovers under SDL (left) and TDL (right).

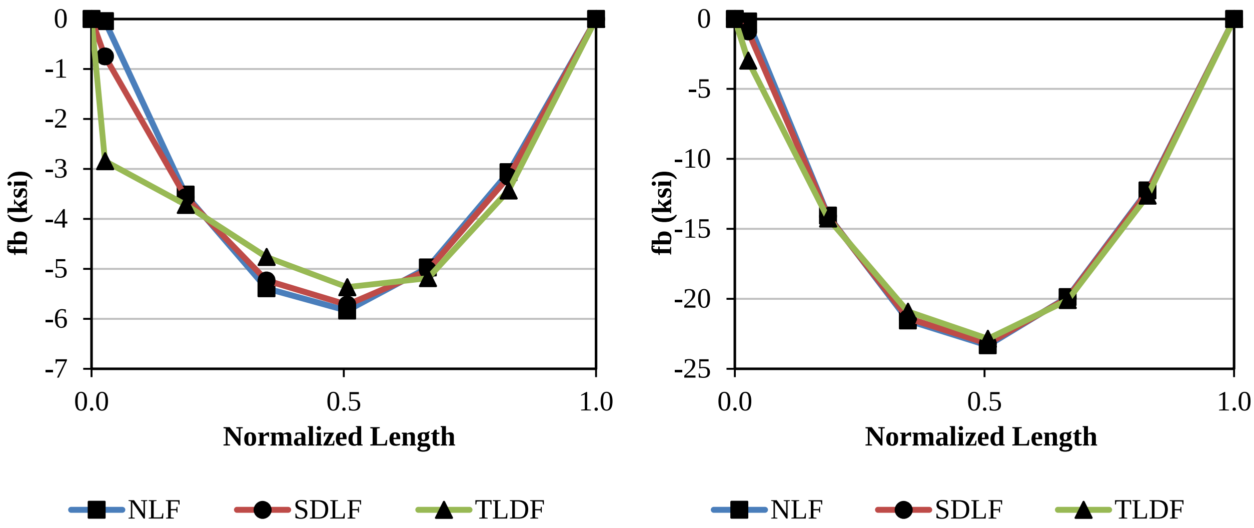


Figure V-2-11. G1 Major-Axis Bending Stresses under SDL (left) and TDL (right).

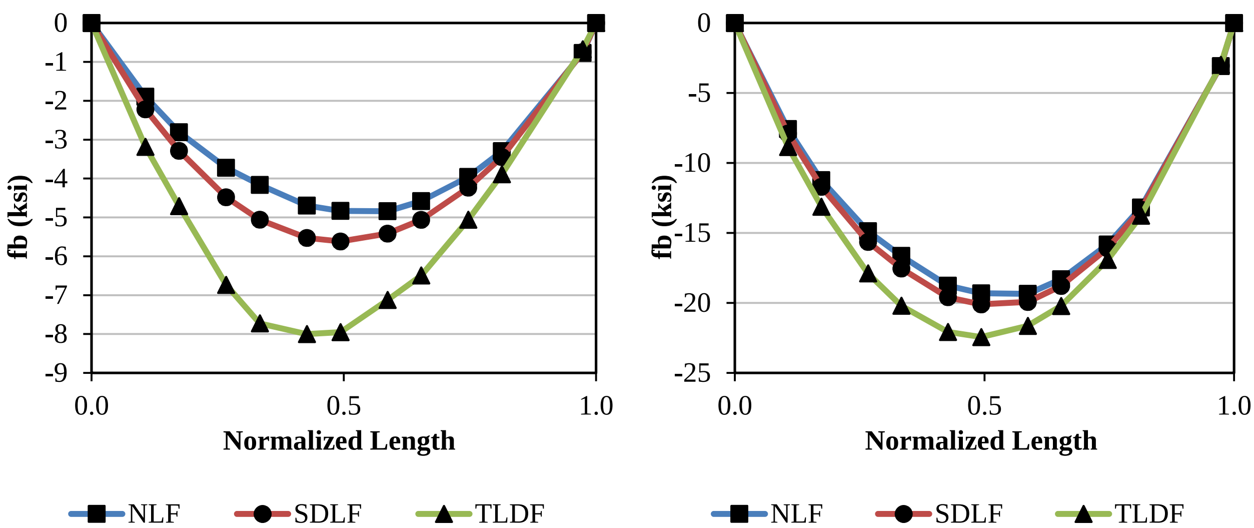


Figure V-2-12. G2 Major-Axis Bending Stresses under SDL (left) and TDL (right).

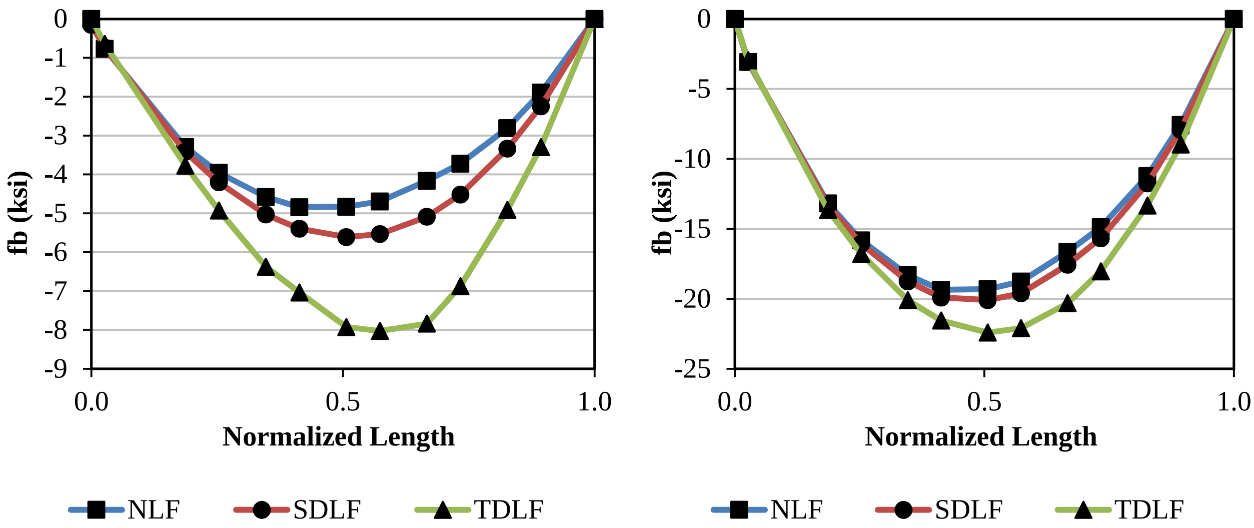


Figure V-2-13. G3 Major-Axis Bending Stresses under SDL (left) and TDL (right).

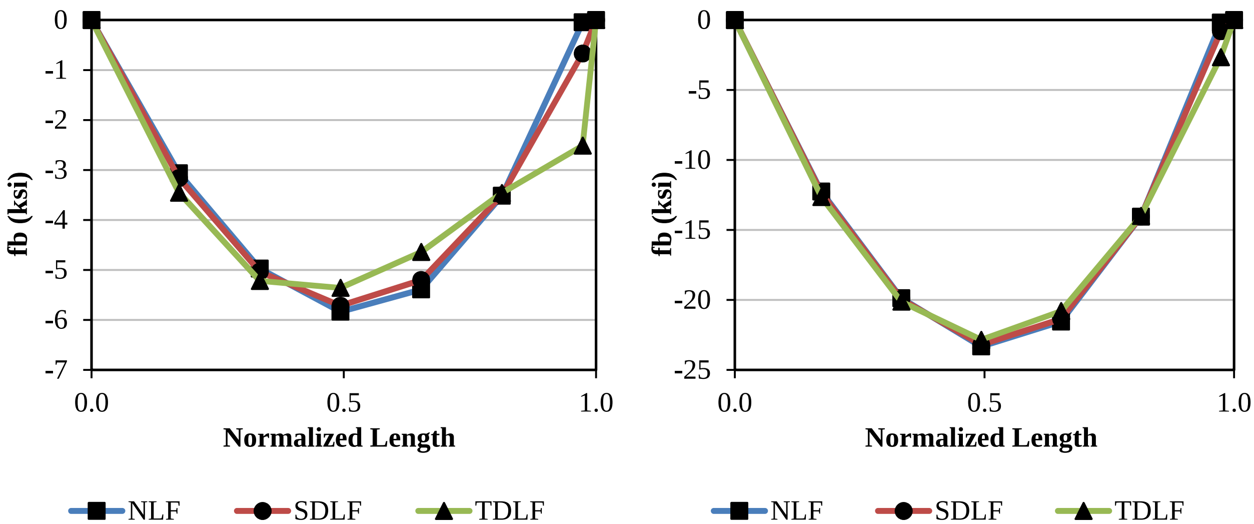


Figure V-2-14. G4 Major-Axis Bending Stresses under SDL (left) and TDL (right).

Table V-2-3. Cross-Frame Equivalent Element Forces and Moments under SDL

CF	Detailing Method	G1-G2			G2-G3			G3-G4		
		V (kip)	M1 (kip*in)	M2 (kip*in)	V (kip)	M1 (kip*in)	M2 (kip*in)	V (kip)	M1 (kip*in)	M2 (kip*in)
1	NLF	4.7	1363	-35	-0.4	86	-205	-0.7	-199	7
	SDLF	-1.2	-337	-10	-0.7	-24	-163	-0.6	-164	-7
	TDLF	-18.9	-5380	63	-1.4	-351	-34	-0.4	-56	-48
2	NLF	-0.3	-400	370	0.4	-102	140	2.0	165	25
	SDLF	0.5	110	-65	0.8	54	24	1.1	109	0
	TDLF	2.8	1624	-1357	2.0	516	-322	-1.4	-57	-73
3	NLF	3.0	12	278	-0.5	-242	196	0.8	52	27
	SDLF	-0.1	3	-9	0.5	28	24	-0.2	-20	1
	TDLF	-9.3	-25	-865	3.6	829	-487	-3.2	-233	-77
4	NLF	1.9	-6	185	0.0	-211	211	-1.0	-118	18
	SDLF	0.1	1	11	0.0	4	5	-0.2	-23	0
	TDLF	-5.0	23	-507	0.0	602	598	2.1	258	-54
5	NLF	1.0	-18	118	0.5	-196	242	-1.9	-185	6
	SDLF	0.1	1	-12	-0.5	14	34	-0.2	15	1
	TDLF	-2.6	-52	303	-3.4	-527	854	4.9	-491	24
6	NLF	-0.8	-27	-52	-0.4	-140	102	-3.0	-278	-12
	SDLF	0.1	1	-12	-0.7	14	56	0.2	-19	1
	TDLF	2.9	-75	-201	-1.7	-362	524	9.7	-901	-31
7	NLF	-2.0	-25	-165	0.4	205	-86	0.3	-370	400
	SDLF	-1.2	0	112	0.7	-167	-17	0.1	-67	58
	TDLF	1.3	-74	-48	1.3	-50	-327	-0.6	-1363	1417
8	NLF	0.7	-7	199	NA	NA	NA	-4.7	35	-1363
	SDLF	0.6	-7	-167	NA	NA	NA	0.7	-16	-182
	TDLF	0.4	-47	-70	NA	NA	NA	16.8	41	-4765

Table V-2-4. Cross-Frame Equivalent Element Forces and Moments under TDL

CF	Detailing Method	G1-G2			G2-G3			G3-G4		
		V (kip)	M1 (kip*in)	M2 (kip*in)	V (kip)	M1 (kip*in)	M2 (kip*in)	V (kip)	M1 (kip*in)	M2 (kip*in)
1	NLF	18.9	5448	-138	-1.7	345	-819	-2.7	-795	27
	SDLF	12.9	3748	-114	-1.9	235	-777	-2.7	-760	13
	TDLF	-4.8	-1295	-41	-2.6	-93	-649	-2.4	-651	-28
2	NLF	-1.3	-1598	1478	1.6	-407	560	7.9	658	99
	SDLF	-0.5	-1088	1043	2.0	-251	443	7.1	603	75
	TDLF	1.8	425	-249	3.2	210	97	4.6	436	2
3	NLF	12.1	50	1113	-1.9	-969	782	3.3	207	107
	SDLF	9.0	40	825	-0.9	-699	611	2.2	135	81
	TDLF	-0.2	12	-30	2.1	103	100	-0.8	-78	3
4	NLF	7.5	-25	741	0.0	-843	843	-4.1	-471	73
	SDLF	5.7	-18	567	0.0	636	637	-3.3	-376	55
	TDLF	0.6	4	49	0.0	21	26	-1.0	-96	1
5	NLF	4.1	-73	471	1.9	-782	969	-7.5	-741	25
	SDLF	3.2	56	-365	1.0	600	-693	-5.8	571	-18
	TDLF	0.5	3	-50	-2.0	59	128	-0.7	64	5
6	NLF	-3.3	-107	-207	-1.6	-560	407	-12.1	-1113	-50
	SDLF	-2.3	81	143	-1.9	433	-249	-8.9	816	39
	TDLF	0.4	5	-46	-2.9	58	219	0.6	-67	6
7	NLF	-7.9	-99	-658	1.7	819	-345	1.3	-1478	1598
	SDLF	-7.1	74	605	1.9	-781	241	1.0	1041	-1140
	TDLF	-4.6	0	445	2.6	-664	-68	0.4	-255	218
8	NLF	2.7	-27	795	NA	NA	NA	-18.9	138	-5448
	SDLF	2.7	13	-763	NA	NA	NA	-13.5	-120	3903
	TDLF	2.5	-27	-666	NA	NA	NA	2.6	-63	-680

Table V-2-5. Individual support vertical reactions under SDL and TDL (kips).

		Load Type & Support Number			
Girder	**Detailing Method**	**SDL 1**	**SDL 2**	**TDL 1**	**TDL 2**
G1	**NLF**	29	24	117	96
	SDLF	25	25	113	97
	TDLF	14	25	101	99
G2	**NLF**	23	25	91	100
	SDLF	26	25	94	100
	TDLF	35	27	103	101
G3	**NLF**	25	23	100	91
	SDLF	25	26	100	94
	TDLF	27	35	101	103
G4	**NLF**	24	29	96	117
	SDLF	25	25	97	113
	TDLF	25	14	99	101

APPENDIX W Synthesis of Survey of Current Industry Practice

The results of this survey will be used to help identify areas where knowledge is lacking in the industry, and will be used to assess current practices and trends that are working well so that the recommendations of this research project do not inadvertently change currently successful practices.

Total Number of Responses:

- State DOTs = 28
- Consulting Bridge Engineers = 2
- Steel Detailers = 2
- Fabricators = 2
- Erectors = 1

Key used to identify respondents in this Summary of Responses:

- S = State DOT
- D = Designer /Consulting Bridge Engineer
- E = Erector
- F = Steel Detailers and Fabricators.

1.0 A) What terms does your organization routinely use to describe the choice of cross-frame detailing?

- Cross-Frame Detailing Method – 8
- Detailing Method – 1
- Cross-Frame Fit Condition – 8
- Fit Condition – 2
- None…we do not currently address this topic in our policies or practices – 15
- Other: Describe
    - Respondent S18: We specify the assembly methodology (i.e. Line assembly or full assembly)
    - Respondent S19: Steel Alone in Place
    - Respondent S23: Cross-frame, K-frame, diaphragm

Summary Evaluation of Survey Responses:

The results do not show a single clear trend in terminology used to describe the choice of cross-frame detailing method. Nearly half of the respondents do not currently address this topic at all. Of those who do, roughly half use the term “Cross-frame Detailing Method” while roughly half use the term “Cross-frame Fit Condition.”

1.0 B) What terms does your organization use to describe the different methods or conditions of cross-frame detailing?

- No Load Fit (NLF), Steel Dead Load (SLF), Total Dead Load Fit (TDLF) – 16
- Fully Cambered Fit, Erected Fit, Final Fit – 5

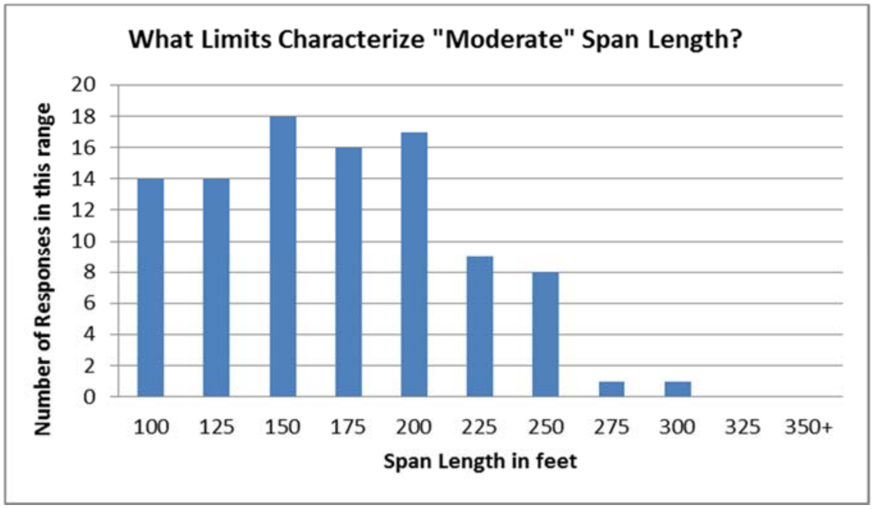
- None…we do not currently address this topic in our policies or practices – 11
- Other: Describe
    - Respondent S2: No "term" used, but assumed SDLF
    - Respondent S23: Plumb stiffeners and webs at final condition
    - Respondent S25: Addressed using different terms
    - Respondent E1: We have not used Fully Cambered Fit
    - Respondent D1: No Load Fit, Erected Fit, Final Fit

Summary Evaluation of Survey Responses:

Over a third of the respondents currently do not address this topic at all. Of those who do, approximately two-thirds use the terms No Load Fit (NLF), Steel Dead Load Fit (SLDF), Total Dead Load Fit (TDLF), while approximately one-third use the terms Fully Cambered Fit, Erected Fit, Final Fit. Of those using the terms Fully Cambered Fit, Erected Fit, Final Fit, two were state DOTs, two were steel detailers/fabricators/erectors, and one was a design engineer.

2.0 Detailing Preferences Questions- Straight, Skewed Steel I-Girder Bridges of <u>Moderate</u> Span Length

- **What limit do you characterize "Moderate" span length**
  - The responses covered a wide range from 100-300 ft without any clear trends. The graph below shows a distribution of span lengths that respondents consider to be "moderate."



Note: The above table shows the number of respondents who indicated that a given span length was characterized as "Moderate." In other words if the respondent indicated that their "moderate" range was from 100 feet to 200 feet, inclusive, the above graph shows that they responded that span lengths of 100 ft, 125 ft, 150 ft, 175 ft and 200 ft are considered "moderate" by that respondent. This same method is used in all graphs that follow that are used to indicate the limits of various parameters.

- **Detailing Methods used for Slightly Skewed Bridges**
  - Slight Skew Limit
    - General Range of 0 to 20 degrees

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	3	3	1	4
SDLF	5	7	3	2
TDLF	6	6	3	0
None	14	11	n/a	15
Any/No Policy	n/a	n/a	14	n/a

- **Detailing Methods used for Moderately Skewed Bridges**
    - Moderate Skew Limit
        - General Range of 20 to 45 degrees

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	3	1	1	4
SDLF	5	7	3	3
TDLF	6	7	3	0
None	14	11	n/a	15
Any/No Policy	n/a	n/a	14	n/a

- **Detailing Methods used for Severely Skewed Bridges**
    - Severe Skew Limit
        - Generally greater than 45 degrees

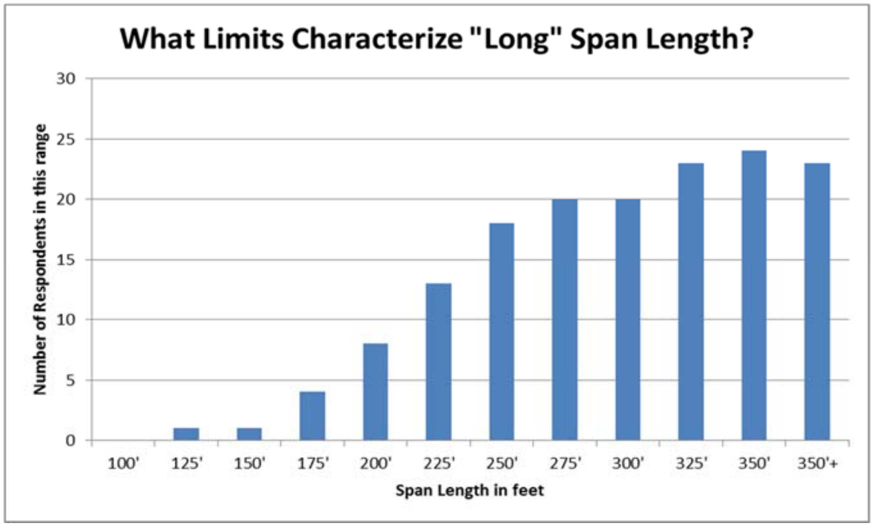
Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	2	3	1	4
SDLF	5	8	3	2
TDLF	6	4	3	0
None	14	11	n/a	16
Any/No Policy	n/a	n/a	15	n/a

Summary Evaluation of Survey Responses:

A large number of respondents do not address this issue at all at this time. Of those who do address this issue, the preference appears to be for either SDLF or TDLF detailing for these types of structures. Use of NLF is much less prevalent, and in fact 4 states prohibit the use of NLF for all skewed bridges with moderate span length.

3.0 Detailing Preference Questions – Straight, Skewed Steel I-Girder Bridges of <u>Long</u> Span Length

- **What limit do you use to characterize "long" span length**
  - The responses covered a wide range from 150-450 ft without any distinct limits. However, a majority of respondents consider spans greater than 250 ft to be a long span. The graph below shows a distribution of span lengths that respondents consider to be "long."



- **Detailing Methods used for Slightly Skewed Bridges**
  - Slight Skew Limit
    - General Range of 0 to 20 Degrees

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	3	3	1	4
SDLF	5	7	3	2
TDLF	5	5	3	0
None	13	10	n/a	14
Any/No Policy	n/a	n/a	13	n/a

- **Detailing Methods used for Moderately Skewed Bridges**
  - Moderate Skew Limit
    - General Range of 20 to 45 degrees

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	2	0	1	4
SDLF	5	7	3	2
TDLF	5	6	2	1
None	13	10	n/a	15
Any/No Policy	n/a	n/a	14	n/a

- **Detailing Methods used for Severely Skewed Bridges**
  - Severe Skew Limit
    - Typically greater than 45 degrees

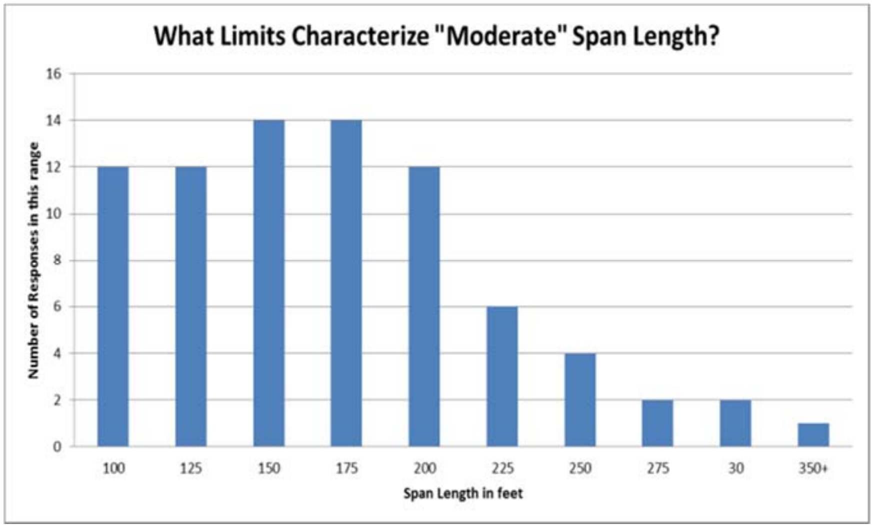
Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	1	1	1	4
SDLF	5	8	3	2
TDLF	6	4	2	1
None	13	11	n/a	15
Any/No Policy	n/a	n/a	15	n/a

Summary Evaluation of Survey Responses:

A large number of respondents do not address this issue at all at this time. Of those who do address this issue, the preference appears to be for either SDLF or TDLF detailing for these types of structures. Use of NLF is much less prevalent, and in fact 4 states prohibit the use of NLF for all skewed bridges with moderate span length.

4.0 Detailing Preference Questions – Curved, Radially Supported Steel I-Girder Bridges of Moderate Span Length

- **What limit do you use to characterize "moderate" span length**
  - The responses covered a range from 100-300 ft. However, a majority of respondents consider spans between 100 and 200 ft to be of moderate span length for curved steel I-girder bridges. The graph below shows a distribution of span lengths that respondents consider to be "moderate."



- **Detailing Methods used for Slightly Curved Bridges**
  - Slight Curvature Limit
    - Six responses considered a bridge with a radius greater than 1000 ft to be slightly curved.
    - Five responses considered a slightly curved bridge to be one where $L_{as}/R < 0.06$, and where the girder/bridge can be analyzed as a straight girder per AASHTO LRFD 4.6.1.2.4b.
    - Other responses varied, with some using the enclosed angle or degree of curvature, or simply not specifying.

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	4	4	2	13
SDLF	5	5	3	3
TDLF	4	4	4	1
None	11	8	n/a	12
Any/No Policy	n/a	n/a	12	n/a

- **Detailing Methods used for Slightly Curved Bridges**
    - Moderate Curvature Limit
        - Five responses indicated a radius of 500 ft as a lower bound limit for moderately curved, one response indicated 600 ft, and another indicated 700 ft.
        - One response considered a moderately curved bridge to be one that exceeded the curvature limits of AASHTO LRFD 4.6.1.2.4b
        - Other responses varied, with some using the enclosed angle or degree of curvature, or simply not specifying.

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	3	5	2	2
SDLF	5	6	4	2
TDLF	4	3	2	3
None	12	8	n/a	13
Any/No Policy	n/a	n/a	12	n/a

- **Detailing Methods used for Slightly Curved Bridges**
    - Severe Curvature Limit
        - Six responses indicated a radius of 500 ft as an upper bound limit for severely curved, one response indicated 300 ft, and another indicated 100 ft.
        - Three responses indicated a radius of 1000 ft as an upper bound limit for severely curved.
        - Other responses varied, with some using the enclosed angle or degree of curvature, or simply not specifying.

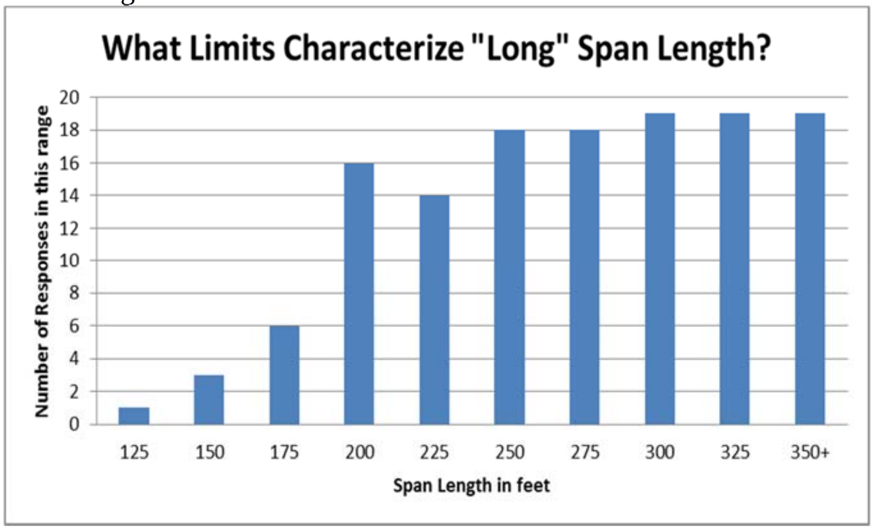
Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	3	5	2	3
SDLF	5	6	3	2
TDLF	4	2	1	3
None	13	9	n/a	14
Any/No Policy	n/a	n/a	15	n/a

Summary Evaluation of Survey Responses:

A large number of respondents do not address the issue of detailing at this time. Of those who do address this issue, there is not a clear preference among the three detailing methods, but SDLF detailing appears to be the most prevalent choice by a small margin. It is interesting to note that 13 respondents prohibit the use of NLF for “slightly” curved bridges of moderate span length.

5.0 Detailing Preference Questions – Curved Radially Supported Steel I-Girder Bridges of Long Span Length

- **What limit do you use to characterize "long" span length**
  - The responses covered a range from 125 to more than 350 ft. However, a majority of respondents consider spans greater than 250 ft to be a long span for curved steel I-girder bridges. The graph below shows a distribution of span lengths that respondents consider to be "long."



- **Detailing Methods used for Slightly Curved Bridges**
  - Slight Curvature Limit
    - Responses were generally the same as the responses to Question 4.

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	4	4	2	3
SDLF	5	5	3	3
TDLF	4	4	3	2
None	13	9	n/a	14
Any/No Policy	n/a	n/a	13	n/a

- **Detailing Methods used for Slightly Curved Bridges**
  - Moderate Curvature Limit
    - Responses were generally the same as the responses to Question 4.

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	3	4	2	3
SDLF	5	6	4	3
TDLF	4	3	2	2
None	13	9	n/a	14
Any/No Policy	n/a	n/a	13	n/a

- **Detailing Methods used for Slightly Curved Bridges**
  - Moderate Curvature Limit
    - Responses were generally the same as the responses to Question 4.

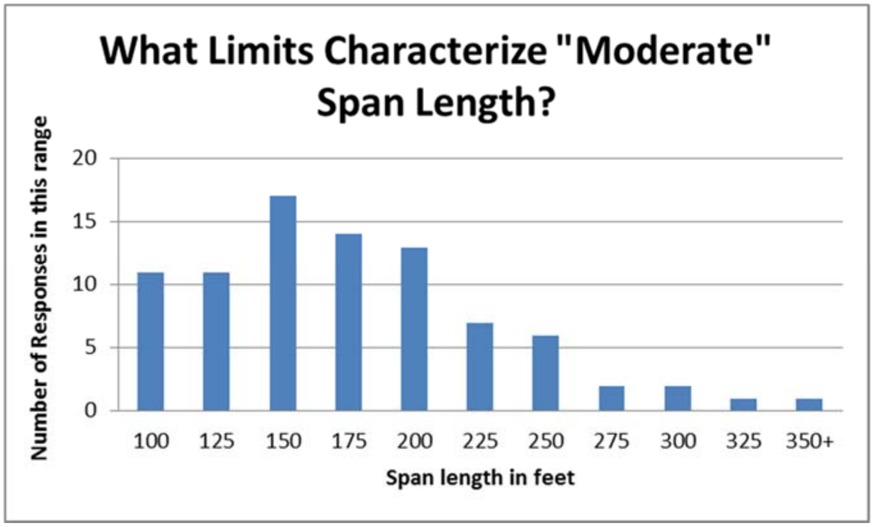
Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	3	4	2	3
SDLF	5	6	4	3
TDLF	4	3	2	2
None	13	9	n/a	14
Any/No Policy	n/a	n/a	13	n/a

Summary Evaluation of Survey Responses:

A large number of respondents do not address the issue of detailing at this time. Of those who do address this issue, there is not a clear preference among the three detailing methods, but SDLF detailing appears to be the most prevalent choice by a small margin.

6.0 Detailing Preference Questions – Curved and Skewed Steel I-Girder Bridges of <u>Moderate</u> Span Length

- **What limit do you use to characterize "moderate" span length**
  - The responses covered a range from 100 to more than 350 ft. However, a majority of respondents consider spans between 100 and 200 ft to be of moderate span length for curved and skewed steel I-girder bridges. The graph below shows a distribution of span lengths that respondents consider to be "moderate."



- **Detailing Methods used for Slightly Curved Bridges**
  - Slight Curvature Limit
    - Six responses considered a bridge with a radius greater than 1000 ft to be slightly curved.
    - Four responses considered a slightly curved bridge to be on where $L_{as}/R < 0.06$, and where the girder/bridge can be analyzed as a straight girder per AASHTO LRFD 4.6.1.2.4b.
    - Other responses varied, with some using the enclosed angle or degree of curvature, or simply not specifying.

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	4	5	2	3
SDLF	5	5	3	3
TDLF	4	4	3	2
None	13	9	n/a	14
Any/No Policy	n/a	n/a	13	n/a

- **Detailing Methods used for Moderately Curved Bridges**
  - Moderate Curvature Limit
    - Four responses indicated a radius of 500 ft to 1000 ft as limits for moderately curved, one response indicated 800 ft as a lower bound limit, another response indicated 700ft, and another response indicate 600ft.
    - Four responses considered a moderate curved bridge to be one that exceeded the curvature limits of AASHTO LRFD 4.6.1.2.4b.
    - Other responses varied, with some using the enclosed angle or degree of curvature, or simply not specifying.

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	3	4	2	3
SDLF	5	6	4	2
TDLF	4	3	2	3
None	13	9	n/a	14
Any/No Policy	n/a	n/a	13	n/a

- **Detailing Methods used for Severely Curved Bridges**
  - Severe Curvature Limit
    - Six responses indicated a radius of 500 ft as an upper bound limit for severely curved, one response indicated 300 ft, and another indicated 100 ft.
    - Other responses varied, with some using the enclosed angle or degree of curvature, or simply not specifying.

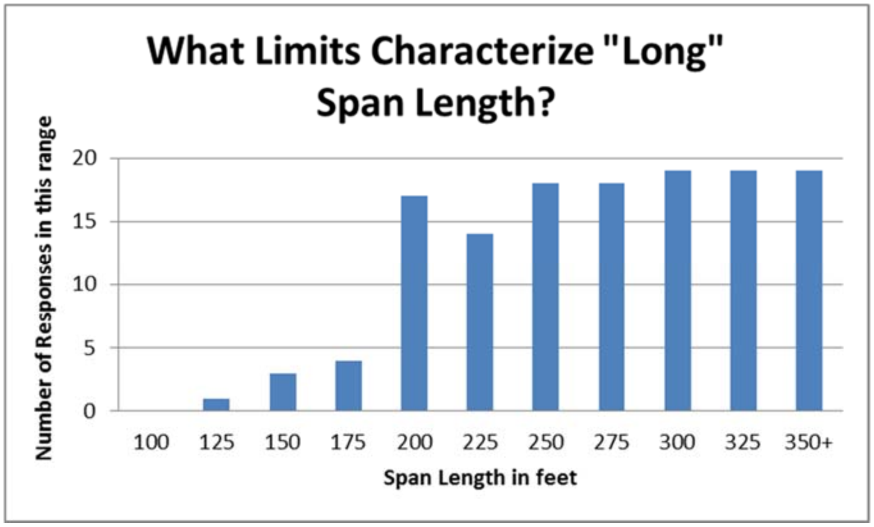
Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	3	4	2	3
SDLF	5	6	3	2
TDLF	4	2	1	3
None	13	9	n/a	14
Any/No Policy	n/a	n/a	15	n/a

Summary Evaluation of Survey Responses:

A large number of respondents do not address the issue of detailing at this time. Of those who do address this issue, there is not a clear preference among the three detailing methods, but SDLF detailing appears to be the most prevalent choice by a small margin.

7.0 Detailing Preference Questions – Curved and Skewed Steel I-Girder Bridges of Long Span Length

- **What limit do you use to characterize "long" span length**
  - The responses covered a range from 125 to more than 350 ft. However, a majority of respondents consider spans greater than 200 ft to be a long span for curved and skewed steel I-girder bridges. The graph below shows a distribution of span lengths that respondents consider to be "long."



- **Detailing Methods used for Slightly Curved Bridges**
  - Slight Curvature Limit
    - Similar responses as those given to Question 6.

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	3	4	2	3
SDLF	5	5	3	3
TDLF	4	4	3	2
None	13	9	n/a	14
Any/No Policy	n/a	n/a	13	n/a

- **Detailing Methods used for Slightly Curved Bridges**
  - Moderate Curvature Limit
    - Similar responses as those given to Question 6.

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	3	4	2	3
SDLF	5	6	4	2
TDLF	4	2	2	3
None	12	9	n/a	14
Any/No Policy	n/a	n/a	13	n/a

- **Detailing Methods used for Slightly Curved Bridges**
  - Severe Curvature Limit
    - Similar responses as those given to Question 6.

Response Type	Response Categories & Tabulation of Responses			
	Required	Recommended	Permitted	Prohibited
NLF	3	4	2	3
SDLF	5	6	3	2
TDLF	4	2	1	3
None	12	9	n/a	14
Any/No Policy	n/a	n/a	14	n/a

Summary Evaluation of Survey Responses:

A large number of respondents do not address the issue of detailing at this time. Of those who do address this issue, there is not a clear preference among the three detailing methods, but SDLF detailing appears to be the most prevalent choice by a small margin.

8.0 Detailing Preference Questions – Policies or Procedures not described above

Survey Statement: *If the policies or procedures of your organization do not fit into the categories described in Questions 2-7 on the previous pages, please describe your organization's policies or procedures below, or feel free to attach reference information describing your organization's policies or procedures.*

Respondent S1: We limit the maximum skew to 45 degrees. We allow, for welded plate girders, the use of oversized holes in one ply of the stiffener to gusset plate connection. No oversized holes for a curved girder. We allow either bolted or welded connections for the cross-frame members.

Respondent S3: We detail contract plans based on theoretical vertical and horizontal dimensions. The steel suppliers are responsible to meet the horizontal lengths, deck and beam seat evaluations, horizontal sweep, and girder cambers.

Respondent S5: Shop Assembly Requirements - See Section 709.4.1.19 (page 629) of Standard Specifications. http://www.scdot.org/doing/doingPDFs/2007_full_specbook.pdf

Respondent S8: For most bridges, our policy is NLF. Shop assembly is to be done with girders continuously supported. For R<1000', assembly is to be done with the webs vertical. For unusual geometries, (high skew+sharp curvature or s-curve or SPUI), it's up to the designer to specify fit conditions. For some bridges, fabricators have requested modifications to our standard procedure. We review these requests on a case-by-case basis through the RFI process.

Respondent S9: Our policy is that the girder will be in the proper horizontal and vertical positions, and the girder webs are to be vertical in the final as-built condition with full dead load in place. We require that the fabricator/contractor are responsible for the proper detailing, fabrication and fit-up that will accomplish the desired results.

Respondent S10: Previous questions are adequate.

Respondent S11: A standard note in our bridge plans for steel girder bridges is: "Under full dead load and deck shrinkage, the girder web shall be vertical the full length of the girder." We do very few curved and/or severely skewed steel girder bridges. So policies and procedures are more of a case by case basis, for these types of bridges.

Respondent S12: Refer to IDOT Bridge Manual (BM), specifically, Section 3.3.

Respondent S13: 2013 TxDOT Bridge Design Manual (Chapter 3, Section 15 and 16): Regarding Article 6.7.2, do not specify girders to be out-of-plumb in the steel-dead-load-only or theoretical-no-load condition. Diaphragms and cross frames have traditionally been installed with girders plumb and no significant problems have been reported to date. If analysis indicates that girders will be significantly beyond plumb after slab concrete is placed, contact the Director of the Bridge Division for guidance.

Respondent S14: The fabricator decides which fit method is used.

Respondent S15: Detailing methods are not specified or described. Shop fit up and assembly is based on SDLF method. No significant problems have been experienced.

Respondent S16: Our Bridge Design Manual refers to the AASHTO LRFD Specifications, 4th Edition which incorporates the 2003 edition of the Horizontally Curved Steel Girder Guide Specifications. We prefer that straight CWPG superstructures be detailed by the fabricator for a no-load fit (BDM 5.5.2.1.1). Most of our curved girder bridges are designed by consultants and we typically ask them to indicate SDLF or TDLF on the plans for the contractor. http://www.iowadot.gov/bridge/manuallrfd.htm

Respondent S17: Please see Caltrans MTD 12-3 * There are links attached to the survey document.

Respondent S18: We use an individual line assembly method for fabrication of straight steel bridges. These bridges have oversize holes at diaphragm connections and all holes are drilled in the no load condition. We use a full assembly method (full length and width of the structure) for fabrication of curved steel bridges. These bridges have full size holes and at diaphragm connections and all holes are drilled in a vertical assembly blocked in the no load condition. In all cases, regardless of skew, curvature, or length holes are drilled in the no load position. Essentially the fabrication fits the design. If the bridge is designed with a line girder analysis it is built that way too. If it is designed using a system analysis it is built as a complete system.

Respondent S19: The following is a link to the NCDOT Structures Management Design Manual. Chapter 6 covers superstructure design policy. https://connect.ncdot.gov/resources/Structures/StructureResources/LRFDManual(Feb2014).pdf

Respondent S21: SEE ATTACHED TO PDF

Respondent S23: Web of steel plate girders, connection plates and stiffeners remain plumb at final position. This would ease design calculation because there would be:

- no major concern with lock in forces at K-frames, cross-frames or diaphragms connections,
- no extra design time needed for checking or designing girders strength with out-of-plumb web,
- out-of-plumb web may complicate road rating of a bridge based on degree of out-of-plumbness,
- out-of-plumb web may require extra design time for a bridge bearing design,
- no fabrication cost increase for machining the sole plate to fit up bearings for uniform load distribution,
- inspector expectation will be having plumb webs which eases the inspection work,
- no need to calculate and note allowable out of plumbness in the contract drawings.

AASHTO LRFD Bridge Design Specifications has not provided limits for out-of-plumbness for different construction type.

Respondent S24: We will be shortly issuing more specific guidance on detailing practices.

Respondent S25: Our acceptable policies and procedures do not categorize (nor recognize the detailing procedures) into options described in Questions 2-7.Our acceptable plans, mostly fall under SDLF and for the less frequent conditions of severe skew and curvature and were stability concerns validate, fall under NLF or TDLF, as required. In other words, The design engineers are responsible for type of fit suitable for the particular bridge conditions and ensure that the plan details are constructible, safe and complete.

Respondent S27: We refer to AASHTO/NSBA Steel Collaboration Standards G12.1 "Guidelines for Design for Constructability",G1.4 "Guidelines for Design Details" and G13.1 "Guidelines for Steel Girder Bridge Analysis" for superstructure steel design in the FDOT "Structures Manual. "The majority of our bridges are designed by consultants. Our current policy is that the designer is to determine the cross-frame fit condition and state this on the plans. Per AASHTO LRFD BDS and AASHTO/NSBA, this can be NLF, SDLF, or TDLF. We recently added a limitation on skew angles that states, "The maximum allowable skew angle at bridge supports shall be limited to 50° unless otherwise required by geometric constraints such as when supports have to be placed within narrow skewed medians of underlying roadways. In no case shall the skew angle be greater than 60° unless approved by the Structures Design Office."

Respondent S28: We are inclined (will be proposed as policy) to use a fit condition according to the skew index for the structure. Is < or = 0.3 use TDLF Is > 0.3 use SDLF

Respondent E1: The responses to questions 1 thru 7 are preferences (rather than recommendations) from a detailer's point of view. It is our policy to confirm with the owner that our preferences are acceptable via RFI (request for information) if the cross-frame detailing position is not described in the general notes section of the contract documents.

Respondent F4: In addition to the general preferences/recommendations above, we have a very general rule of thumb for the "tolerable" misalignment of cross-frame connections if the fit condition of the cross-frames does not match the erected position of the girders. In general, a misalignment in the holes of cross-frame gusset plates and girder connection plates of 1-1/2" or less is considered tolerable in the field. If the misalignment exceeds 1-1/2", we will raise the issue with the erector and designer. Of course, this is a very general rule, as girder depth/spacing and relative flexibility of the girder-cross-frame geometry is considered.

Respondent F1: As a detailer, rather than a designer, we work with a design that is already created. We have no set policies, rather each bridge is reviewed and decisions based on the design presented. Our normal procedure is to review geometry and camber. Then we present the results of our review to the designer and decide the best detailing method as a joint decision. In many cases where the detailing method is called for on the plans, we then review that method for fit and provide feedback as to feasibility (pro & cons).

Respondent F2: Our approach to the method used to detail cross-frames applies to all structures straight, curved, square or skewed. The deflection of the girders is what is critical, not the geometry or length, although they are contributing factors. We calculate the drop between girders in both the fully cambered position and the final position (after all dead load is applied). We call this the differential camber. We then calculate the effect of the differential camber. Divide the differential camber by the horizontal distance between the end connection lines of bolts. This gives us a rotation due to the differential camber. We then multiply this by the depth of cross-frame connection. When this value exceeds 3/8" – ½" or 1/8" per foot slope, we will send an RFI to the engineer requesting their preference. Note: this applies to structures where the state or engineer has NOT specified how the cross-frames shall be detailed. Our preference is to detail cross-frames on straight bridges to "TDLF" providing it meets our connection rotation test (above). Our preference for detailing cross-frames on curved structures is to detail them to the SDLF unless the structure requires full bridge assembly, in which case we will detail them to (NLF) and inform the shop that the girders will have to be supported with false work.

Summary Evaluation of Survey Responses:

The responses suggest a wide range of policies, and also a wide range of understanding of the issues. For instance, some respondents indicated a preference for TDLF detailing based on their understanding that this results in no locked-in force effects. TDLF detailing typically results in the largest locked-in force effects; sometimes these locked-in force effects are additive to gravity-induced load effects, while sometimes they are relieving, depending on the type and configuration of the bridge.

The responses also suggest a wide range of experiences with these issues. Some respondents have experienced no problems with fit-up of steel girder bridges, while others have experienced problems of a variety of types and severity. These anecdotal accounts appear to support the hypothesis that in a large number of cases, there are few reported problems associated with fit-up of steel girder bridges, but in certain cases the problems can be significant. The problematic cases appear to be associated with more severe geometry (more severe curvature, more severe skew, longer spans, poor span balance or other complicating geometric factors).

Some of the responses from fabricators and erectors are of interest. They cite rules of thumb based on geometric limits associated with differential deflections, misalignment, etc. While these rules of thumb may not be based on quantitative research, they are based on extensive anecdotal field experience and may offer valuable insights.

9.0 Your Organization's Experiences with Cross-Frame Detailing or Fit Condition

Survey Statement: *Please use the space below to provide any information or accounts of your organization's experiences with Crossframe detailing, fit conditions, fit-up problems, etc. for steel I-girder bridges. If you have specified cross-frame detailing methods or fit conditions, how have those policies worked? Have there been any notable problems associated with cross-frame detailing methods or fit conditions used for your organization's bridges? Have there been any notable successes? Have there been specific projects you would like to highlight, either positive or negative (if so, please attach information)?*

Respondent S1: We rarely have any fit up issues, and when we do, they are typically related to fabrication issues. We recently have built several bridges with 45 degree skews. In discussion with the resident engineers (RE) overseeing the project, no fit up issues were encountered. I asked the RE to check the webs and all were vertical.

Respondent S2: We will typically skew the cross-frames up to 35 degrees, this seems to reduce the fit-up issues.

Respondent S3: We are not aware of any fit-up issues under current practices.

Respondent S7: Perhaps we have been fortunate, but historically we have not had problems with cross frame fit up on steel bridges. These are considered minor issues. Contractor erection choices, which are not under the control of the designer, can greatly affect these issues. The use of shoring towers, or holding cranes with no shoring, assembling girder pairs on the ground, order of release of jacks at shoring towers, and the order of bolting tightening in the erection process, etc. can greatly affect the outcome. Contractor means and methods probably have the most affect on the final outcome.

Respondent S8: For most bridges, there have not been serious fit-up or assembly issues, even on curved or high skew situations. On one recent job (110' span, 40 degree skew), there were fit issues in the field, but this was attributed to inaccurate fabrication of the end diaphragms rather than any issue related to our policy. A few years ago, there were no noteworthy problems on a complex SPUI job with multiple girders with significantly varying radii.

Respondent S9: We have not specified a detailing method or fit condition and we have had no major issues.

Respondent S10: We do not construct many steel bridges. I believe the methods are successful as, I do not recall comments back from construction regarding cross frame fit issues.

Respondent S11: The following is taken from our Bridge Manual: There are several constructability issues that are unique to steel plate girder bridges that designers should account for in the design, plan preparation, and shop drawing review stages of a project. Diaphragm Installation for Skewed Bridges: On straight non-skewed bridges all girders across the width of the bridge rotate at their bearings about a single axis line which is perpendicular to the girders, therefore as each girder is loaded all the girders rotate about a common line and the end diaphragms that connect the girders are unaffected. On skewed bridges each girder rotates about its own axis offset from adjacent girders, consequently as the girders are loaded and the girder ends rotate a distorting force is induced in the end diaphragms that connect the girders, since the diaphragms are very stiff diagonally and the girders are relatively flexible torsional the diaphragms will twist the girders, pulling the web out of plumb. While there is no way to prevent girder twisting without the complete removal of diaphragms, when and how the girders twist can be controlled by the way the girders are detailed and fabricated. If the girders and diaphragms are detailed and fabricated for the diaphragms to fit the initial position of the girders, before the bridge deck is placed, then the girders will be plumb when the erection is complete. However, after the deck is placed, the girders will be twisted permanently in their final position, the girders will not sit level on the bearings and high distortional stresses will be locked into the diaphragms and girders. The only advantage to this method is that the girders and diaphragms fit initially, making it easier for the contractor to assemble. On the other hand, if the girders and diaphragms are detailed and fabricated for the final position then the girders will need to be twisted out of plumb initially in order to get the diaphragms installed. However, after the deck is placed, the girders will be plumb for their final permanent position with a minimum amount of permanent distortional stresses in the diaphragms and girders. Standard practice for us is to detail diaphragms for the final position. Since some fabricators detail for the initial fit all shop drawings should be carefully checked to ensure they conform to the plans and the design. It is also good practice to specify the direction of the deck placement on the plans. The girders will initially be out of plumb to the greatest extent at the ends of the girders so the deck placement should progress from the dead load inflection point of the span toward the end of the girders so that the girders are near plumb by the time the placement reaches the girder ends. There is a similar effect from intermediate diaphragms on skewed bridges. Because intermediate diaphragms are typically detailed to attach to the girders such that the diaphragms are perpendicular to the girder lines, they connect adjacent girders at slightly different span points. Since the amount of camber is different at each of these points the girders will need to twist initially out of plumb if the diaphragms are detailed to fit in the final deflected position. But, like the end diaphragms, once the deck has been placed the girders at the intermediate diaphragms will be in the correct upright position.

Respondent S12: Our policies have generally left it up to the Contractor/Fabricator to determine detailing and fit-up of steel girders, except for curved girders where plumb at SDLF is generally recommended or required. In most other cases SDLF is also provided. Our policies and practices have generally been successful with few notable problems.

Respondent S13: We do not specify cross-frame detailing methods on the construction documents. See response to question #15.0 on page 16 of 16 related to some fit-up issues.

Respondent S14: With steel I-girder bridges, there have not been an appreciable number of fit-up problems during erection.

Respondent S15: Detailing methods are not specified or described. Shop fit p and assembly is based on SDLF method. No significant problems have been experienced.

Respondent S16: no record of notable problems

Respondent S23: We experienced with fit up problems are limited to: The erector used wrong marked-up cross-frames causing fit up issues. After having the erector using correct marked-up cross-frame fit-up problem resolved. On a skew bridge with skew angle almost 30 degrees the designer's camber diagram was much more than needed. It resulted in fit up of cross-frame become challenging. The engineer did not call final condition of steel plate girders in the contract document. Connection plate installed was out of alignment with designed diaphragm's alignment, Fabrication blow-up. This problem could have been resolved, in the shop in the fabrication shop with partial girders assembly.

Respondent S24: We will be shortly issuing more specific guidance on detailing practices.

Respondent S27: Some problems have been in regards to miscommunication and/or misunderstanding of the plan requirement (e.g. did the fabricator get the General Notes sheet with the plan notes, did they understand NLF or TDLF etc...).

Respondent S28: 1. BRIDGE CHARACTERISTICS: Single Span : 185 feet Skew : 52 degree Camber varies: 14" to 22" Fit Condition TDLF PROBLEM: Difficulty attaching diaphragm; girder layover; girder shifted laterally away from bearings with some rotation. At the last stage, the deck was poured parallel to the skew and the deck was plumb. 2. BRIDGE CHARACTERISTICS: Single Span curved girder : 190 feet Fit Condition: TDLF. PROBLEM: During erection the girders moved along the longitudinal axis.

Respondent D2: Numerous bridge design experience. Development of bridge design manual for DelDOT - with a section establishing criteria for cross frame detailing.

Respondent E1: Our organization was recently closed. The above responses regarding detailing practices were provided by a detailer for that group who still works for the organization. Our organization usually purchases fabricated materials from other sources, and our projects tend to be long span bridges with little skew or curvature. We carefully review the desired fit for detailing purposes with the steel detailer and the designer before commencing work and do not proceed until everyone is on the same page. Consequently, we have not experienced the kinds of fit problems in the field that would be more common for shorter spans with greater skew or curvature. Generally all our long span bridges of any type are detailed for NLF and we seldom experience fit up problems in the field because we support and adjust girders to the NLF condition as much as possible (at least assuring that girders are in the correct position relative to fit of the crossframes). This includes a variety of bridge types such as plate girders, arches, trusses, orthotropic deck box girders, tub girder with concrete deck, etc.

Respondent F4: On most occasions, we will follow the fit condition specified in the contract plans, unless we foresee field issues. We do receive inquiries from designers, contractors and erectors regarding out of plumb or fit issues/questions, which reinforces the need for guidance within the industry.

Respondent F1: For years, we fit cross-frames to the erected position which guarantees the erector fit in the field without too much trouble. As the steel industry has developed and designs have become more complex, cross-frame fit has become much more necessary to review and understand the implications at the different conditions of construction. Attached is an example NY project. It is a 265' simple span with a 62 degree skew and 10 foot deep girders. This project was reviewed geometrically and then decided, due to the 4" girder layover, to detail all the cross-frames to fit the final condition. This required the erector to twist the girders out of plumb at time of erection. All went well, although eyebrows were raised at the pre-construction meetings. The contractor must be aware of the layover as well to properly place form work.

Respondent F3: We have always used Steel Dead Load Fit; have never had a problem using this method. Have been forced to use Total Dead Load Fit on several occasions.

Summary Evaluation of Survey Responses:

The responses suggest a wide range of policies, and also a wide range of understanding of the issues.

The responses also suggest a wide range of experiences with these issues. Some respondents have experienced no problems with fit-up of steel girder bridges, while others have experienced problems of a variety of types and severity. These anecdotal accounts appear to support the hypothesis that in a large number of cases, there are few reported problems associated with fit-up of steel girder bridges, but in certain cases the problems can be significant. The problematic cases appear to be associated with more severe geometry (more severe curvature, more severe skew, longer spans, poor span balance or other complicating geometric factors).

10.0 Cross-Frame Arrangement Questions

Survey Statement: *Please indicate your organization's strategies in selecting the cross-frame arrangements for the following:*

Straight skewed bridges:

- ***Survey Statement:*** *Please indicate cross-frame arrangements your organization specifies for straight skewed bridges:*
  - Contiguous – 20
  - Staggered – 14
  - Lean-on – 0
  - Other:
    - **Respondent S9:** contiguous and perpendicular to beams - sometimes this results in a staggered condition depending on the severity of the skew.
    - **Respondent S10:** 0-20 - Contiguous, >20 - Staggered
    - **Respondent S12**: Contiguous up to 10 deg skews, staggered for skews > 10.
    - **Respondent S13:** Set cross-frames parallel to skew up to 20 degrees. Set radial to girders beyond 20 degrees
    - **Respondent S14:** continuous <= 15 deg., staggered > 15 deg.
    - **Respondent S27:** Contiguous with eliminating "troublesome" c
    - **Respondent D2:** Contiguous when practical, but stagger when optimal for design.
    - **Respondent E1:** Varies with the designer.
    - **Respondent F4:** As a fabricator, we do not specify
    - **Respondent F3:** Per Contract Drawings

Curved radially supported bridges:

- ***Survey Statement:*** *Please indicate cross-frame arrangements your organization specifies for curved radially supported bridges:*
  - Contiguous – 25
  - Staggered – 3
  - Lean-on – 0
  - Other:
    - **Respondent S13:** Set cross-frames radial
    - **Respondent S20:** No established criteria
    - **Respondent S23:** cross-frame may be added in one bay for a special case
    - **Respondent E1:** Not a common bridge type for us
    - **Respondent F4:** Do not specify
    - **Respondent F3:** Per Contract Drawings

Curved and Skewed bridges:

- ***Survey Statement:*** *Please indicate cross-frame arrangements your organization specifies for curved and skewed bridges:*
  - Contiguous – 22
  - Staggered – 7
  - Lean-on – 0
  - Other:
    - **Respondent S9:** we try to avoid this situation whenever possible. Contiguous and perpendicular to beams - sometimes this results in a staggered condition depending on the severity of the skew.
    - **Respondent S10:** 0-20 - Contiguous, >20 - Staggered

- **Respondent S11:** Depends on the amount of skew
- **Respondent S12:** Staggered has been used for some slightly curved structures.
- **Respondent S13:** Set cross-frames radial except at supports
- **Respondent S20:** No established criteria
- **Respondent S23:** one bay cross-frame may be added or dropped in some cases in a bay.
- **Respondent S24:** At accurate corners, the 1st cross frame is typically eliminated.
- **Respondent S27:** Contiguous with eliminating "troublesome" c
- **Respondent D2:** Contiguous when practical, but stagger when optimal for design.
- **Respondent E1:** Not a common bridge type for us
- **Respondent F4:** Do not specify
- **Respondent F3:** Per Contract Drawings

Survey Statement: *Please indicate your organization's strategies in mitigating the skew effects in steel I-girder bridges (eg. setting the offset of the first intermediate cross-frame from the bearing lines, using no bearing line cross-frames but with intermediate cross-frames framing into bearing location at interior pier locations in continuous span bridges)*

Our Strategies:

- **Respondent S1:** Stagger when skew is > 20 degrees. Cross-frame at bents matches the skew. No cross-frame at abutments for integral abutments, otherwise cross-frame matches the skew.
- **Respondent S2:** We use cross-frames at bearing locations, for fatigue we do not allow framing in the pier location with offset frames
- **Respondent S3:** Dependent on the structure.
- **Respondent S7:** Set first cross frame out into the span, and not at the bearing.
- **Respondent S8:** First, we NEVER stagger diaphragms nowadays. To do so would be asking for cracks from out-of-plane effects. For skews <20 degrees, all diaphragm lines are parallel to the skew. For greater skews, intermediate diaphragms are normal to the girder lines with a positive diaphragm-bottom flange connection (see our BD sheets, available online, for more information). For curved bridges, all intermediate diaphragm lines are radial.
- **Respondent S9:** Setting the first intermediate x-frame at a minimum of twice the girder depth away from the bearing and running contiguously across the bridge. As you go across the bridge, if the spacing from the bearing to the first intermediate x-frame exceeds 20', then another line of contiguous x-frames is introduced.
- **Respondent S10:** We try to space the first intermediate cross-frame similar to the commentary in the AASHTO LRFD 7th Edition. We also have used cast-in-place concrete end and pier diaphragms to accommodate more highly skewed bridges.
- **Respondent S11:** We do very few curved and/or severely skewed steel girder bridges. So policies and procedures are more of a case by case basis, for these types of bridges.
- **Respondent S12:** End diaphragms or cross frames at supports are typically placed along the centerline of bearings (support line).
- **Respondent S13:** Setting the offset of the first intermediate cross-frame from the bearing lines-Lean-on bracing system (straight girders only)
- **Respondent S15:** Abutment and pier diaphragms are used. Cross-frames frames into girder lines.

- **Respondent S18:** We do not use bearing line cross-frames but instead intermediate cross-frames into bearing locations at interior piers for continuous span bridges.
- **Respondent S19:** Diaphragms are detailed radial for curved girders and perpendicular to tangent girders. For tangent steel girders on severe skews the end bent and bent diaphragms are detailed along the skew utilizing bent gusset plates and connector plates. For curved girders on skewed supports the intermediate cross-frames are framed into the bearing location at interior pier locations. End bents are typically radial.
- **Respondent S21:** see attached
- **Respondent S22:** Over severe skew. We do not provide cross frame along the support line but we make sure at least one continuous normal cross frame go over one bearing point.
- **Respondent S23:** It is recommended designers to minimizing torsional forces or stresses in structural members and connections. Recommendation is to eliminate diagonal members in cross-frame or K-frames close to obtuse corner of end bents or interior bents in which differential deflection between two adjacent girder connections to a cross-frame or K-frames are significant.
- **Respondent S24:** Setting the offset of the first intermediate cross-frame from the bearing lines, using no bearing line cross-frames but with intermediate cross-frames framing into bearing location at interior pier locations in continuous span bridges
- **Respondent S27:** We have used:
    - -offset the first intermediate cross-frame
    - -Eliminating "troublesome" cross frames - usually at the obtuse corner at the support.
    - -using 50% TDLF for "troublesome" cross frames

  We recently added a limitation on skew angle in our SDG that states, "The maximum allowable skew angle at bridge supports shall be limited to 50° unless otherwise required by geometric constraints such as when supports have to be placed within narrow skewed medians of underlying roadways. In no case shall the skew angle be greater than 60° unless approved by the Structures Design Office."
- **Respondent D2:** 1. Lessen or eliminate skew whenever possible, even by increasing span.2. Use no bearing line cross-frames but with intermediate cross-frames framing into bearing location at interior pier locations in continuous span bridges.
- **Respondent F3:** Per Contract Drawings

Summary Evaluation of Survey Responses:

The responses cover a wide range, particularly with regard to the strategies used to determine cross-frame arrangements. Some states have clear rules and guidelines, others have less specific suggestions. Suggestions include eliminating cross-frames in troublesome “nuisance stiffness” locations, using lean-on bracing, locating cross-frames a minimum distance from supports, etc.

11.0 Fit-Up Force Estimation Questions

Survey Statement: *Please indicate whether your organization performs or requires estimates of the magnitude of fit-up forces (the forces required to assemble the steel during erection) during the erection engineering for certain steel I-girder bridges:*

- Yes – 3
- No – 31
- If yes Why?
    - **Respondent S10**: Imposed deflection on girder.
    - **Respondent D1**: Erection Simulation, Cross-frame forces method
    - **Respondent E1**: Occasionally we will estimate fit-up forces during erection engineering if there is a reason to do so, but generally this is not an issue for the types of long span bridges we erect.
    - **Respondent F4**: N/A as a fabricator

Our Experiences:

Survey Statement: *Please use the space below to provide information of your organization's experiences with predicting the erection stages where substantial difficulty of fit-up of the steel components was anticipated.*

- **Respondent S2:** We have found the NSBA documents on the erection to be useful
- **Respondent S8:** Again, our policy is to require fabrication to NLF conditions. If this results in excessive forces to attain fit in the field, it is up to the fabricator to ascertain this before fabrication commences and to propose alternative fit conditions, usually SDLF, although it's been our experience that this doesn't happen very often.
- **Respondent S10**: Do not recall comments back from construction regarding substantial difficulties.
- **Respondent S11:** We generally have a rule of thumb in regards to calculated layover based on girder camber and skew that if the extreme holes on the gusset connection plate and the holes on the transverse stiffener or connection plate overlap at erection that large fit-up force will not be necessary to install the bolts. This is on a case by case basis.
- **Respondent S12**: Erection and fit-up forces are the responsibility of the Contractor/Erector/Fabricator to determine and mitigate to achieve the specified structure geometry in the constructed position/condition.
- **Respondent S13:** During the design phase, the designer predicts an assumed construction sequence to ensure that the bridge is stable during construction. The concrete slab placement is shown on the plans, but the erection sequence of the steel girders is not shown on the plans. For unique situations, the bridge is input into the UT Bridge Software to ensure the stability of the bridge while the bridge is partially erected. We require the contractor to submit an erection plan with supporting calculations to verify the stability of the system as well as ensure the safety for all those involved (workers, traveling public).
- **Respondent S22:** we require per-construction meeting before the erection and submission of the erection plans
- **Respondent S23:** Design challenge in erection was widening existing bridge with adding one girder line to existing bridge with skewing all bents 30 degrees with respect to existing bents. There was not fit up problem.
- **Respondent F4:** See response to Question 14.0 Erection Sequence Control.

Summary Evaluation of Survey Responses:

Not surprisingly, very few respondents have addressed the calculation of fit-up forces in a rigorous, quantitative manner. Qualitative means of addressing any concerns about excessively high fit-up forces vary greatly.

12.0 Effects of Cross-Frame Detailing on Locked-in Forces Questions

Survey Statement: *Please indicate whether your organization includes the effects of locked-in forces which may result from the chosen cross-frame detailing method in the analysis and design of steel I-girder bridges:*

- Yes-5
- No-25
- If yes Why?
  - **Respondent S10:** Imposed deflection on girder.
  - **Respondent S27:** The terminology of "locked-in Forces" is confusing. We would say that cross- frames all have locked-in forces from the dead load of the concrete deck in usual construction (NLF or SDLF). It would be better to say that for TDLF condition, there is a "lack of fit" effect that needs to be considered.
  - **Respondent D1:** Initial strains, element birth and death
  - **Respondent D2:** By refined analysis for either skewed and/or curved structures, by either 2-D grid or finite element analysis based on severity of skew/curvature.
  - **Respondent E1:** We do consider during erection engineering if this is anticipated to be a problem, but we seldom encounter designers who have considered this in great detail. Some designers totally ignore these effects and simply apply a gravity switch for the before and after condition, which may be a poor decision depending on the bridge type, configuration and behavior as the structure is loaded from the NLF condition.
  - **Respondent F4:** N/A as a fabricator

Our Preferences:

Survey Statement: *If your organization includes the effects of cross-frame detailing in the analysis and design, in what of limits (e.g., skew angles, curvature radius...) do you start including the effects? Do you include the effects during the erection as well as in the final constructed condition***?**

- **Respondent S8:** This is a non-issue if NLF is required. The forces imposed when fitting together in initial erection are counteracted by the effect of pouring the deck.
- **Respondent S10:** Varies by structure and designer.
- **Respondent S13:** We do not include the effects of cross-frame detailing in the analysis and design phase. The fabricator chooses how the cross-frames are detailed.
- **Respondent S23:** Final fit minimizes locked-in forces to the level that can consider negligible.
- **Respondent D2:** We use the NCHRP Report 725 recommendations for analysis type based on severity of skew and/or curvature. Typically, as a designer we are only looking at final constructed condition, except that we typically perform deck placement sequence analysis.
- **Respondent E1:** Not considered, as we have traditionally been design-bid-build contractors erecting long span bridges with little curve or skew effects. However, this is quickly changing, and we are performing much more Design-Build currently than in the past.

Summary Evaluation of Survey Responses:

Not surprisingly, very few respondents have addressed the calculation of locked-in force effects in a rigorous, quantitative manner. Qualitative means of addressing any concerns about excessively high fit-up forces vary greatly.

13.0 Bearing Rotation and Girder Layover Questions

Survey Statement: *What practices or policies does your organization follow for the calculation of bearing rotations for steel I-girder bridges? Do you use simplified methods or refined analysis? Do you use different methods based on structure geometry (curvature, skew, etc.)? Do you account for the reduction in the bearing rotations due to Steel Dead Load Fit or Total Dead Load Fit detailing of the cross-frames? Please discuss both major axis bending (longitudinal) rotations and girder layover (transverse) rotations.*

- **Our Practices / Policies for Calculation of Bearing Rotations:**
  - **Bearing Rotations:**
    - **Respondent S1:** We use the rotations from our girder line analysis program BRASS. No changed for skewed, curved, or straight.
    - **Respondent S2:** We use simplified methods not based on structure skew or rotation- we do not account for DL fit in either the transverse or longitudinal direction.
    - **Respondent S4:** Simplified Analysis
    - **Respondent S6:** Typically, we use simplified results form a line girder analysis. For curved girders, we use results from a grillage analysis, which gives rotations about both axes. We camber girders for total dead load and account for this in out rotation analysis.
    - **Respondent S9:** We do not specify any particular methodology. We do not take into account the reduction in bearing rotations. We rely on the fabricator/contractor to detail, fabricate and construct the bridge such that the web is vertical after the deck slab has been placed.
    - **Respondent S10:** We use a simplified analysis to calculate the bearing rotation. We do account for the fit condition for the girder lay over.
    - **Respondent S11:** Generally we use elastomeric bearing pads and allow temporary high edge stress during the concrete placement as the girder flange does not sit flat on the elastomeric bearing pad at erection.
    - **Respondent S12:** Simplified methods to determine bearing rotations would typically be used. No. No.
    - **Respondent S13:** We use the output from analysis software for bearing rotations.
    - **Respondent S15:** Longitudinal bearing rotations designed in accordance with AASHTO.
    - **Respondent S16:** simplified methods to assure bearings can handle the major axis rotation
    - **Respondent S17:** We do not have specific polices on those issue
    - **Respondent S18:** Longitudinal rotation is determined by the computer program used for the design. Girder layover is typically not considered.
    - **Respondent S19:** Bearing rotation is calculated using a simplified method.
    - **Respondent S20:** Simplified
    - **Respondent S21:** see attached
    - **Respondent S22:** based on the structure geometry
    - **Respondent S23:** This question was answered. Our design and construction preferences are limits girders layover to fabrication or construction error which will not be significant.
    - **Respondent S24:** For moderately and severely skewed bridges, we require the design to determine the girder layover rotations. Since this is basically a function

of geometry, layover is related to the primary dead load vertical rotations, a 3d analysis is not needed.

- **Respondent S26:** We use both simplified methods and refined analysis method for the calculation of bearing rotations depending on structure geometry. We do not account for the reduction in the bearing rotations due to SDLF or TDLF detailing of the cross-frames.
- **Respondent S27:** We use both simplified and refined analyses based on the geometry of the structure. Since most skew and/or curved structures use refine analysis for the design, rotations are also calculated. We account for the rotations due to steel and concrete dead loads. Both major axis and twisting is considered in bearing rotations.
- **Respondent D2:** By refined analysis. We account for dead load rotations in bearings based on fit up requirements.
- **Respondent E1:** During Erection Engineering we will look at bearing rotation and how they change from the NLF to SDLF to TDLF. Bearing will be preset in the correct orientation for the final loading. This requires sophisticated analysis.
- **Respondent F4:** Most severely skewed bridges that we have erected, being of moderate span length range, are on multi-rotational bearings. As such, we have often block the steel on timbers (esp. at variable-direction guided/un-guided expansion bearing portions of superstructures) to facilitate geometric control/stability (via temporary fixity), securing the bridge via temporary tie-downs similar to what is shown in AASHTO/NSBA's S10.1-2007, Steel Bridge Erection Guide Specification. Once the framing is established, we can then transfer the load onto the bearings at a point where the web layover effects are somewhat mitigated.

Our Practices / Policies Regarding Presentation of Girder Layover Information on Plans:

- ***Survey Statement:*** *Does your organization include girder layover (transverse rotation) information on construction plans? If so, for what types of structures do you do so (i.e., moderately curved bridges, severely curved bridges, moderately skewed bridges, etc.)?*
    - No/NA -14
    - **Respondent S2:** We do not include lay-over information on the plans. This may be added to our specifications in the future.
    - **Respondent S8:** Only for very unusual situations.
    - **Respondent S10:** We typically detail the webs plumb in the final condition.
    - **Respondent S13:** We do not include girder layover (transverse rotation) information on construction plans.
    - **Respondent S18:** No transverse rotation information is included in our bridge plans.
    - **Respondent S20:** Girder layover information not included in construction plans.
    - **Respondent S24:** For bearing detailing on skewed bridges, we require the bearing to be level at TDL (level within a given tolerance). For sharply skewed bridges, we require the design plans to show the dead load rotation of the girder (out of plumb, layover) along the length if the girder at 10 th points.
    - **Respondent 26:** Yes, we include girder layover information on construction plans of severely curved bridges
    - **Respondent S27:** Not usually, would have to be a complex framing system
    - **Respondent D2:** Yes, for all horizontally curved steel superstructures and typically for skews greater than 20 degrees (and less than 20 degrees when designed by refined analysis).

- **Respondent E1:** Currently do not show unless there is an unusual project where this is appropriate and necessary.
- **Respondent F4:** As a fabricator, if we anticipate girder layover in the erected condition due to the cross-frame fit condition detailed, we will use simplified, geometrical methods to calculate the girder layover, and provide this information on our erection plans as forewarning to the erector.
- **Respondent F1:** We rarely, if ever, see layover information on designs.

Our Experience with Bearing Rotation Problems:

- ***Survey Statement:*** *Does your organization include girder layover (transverse rotation) information on construction plans? If so, for what types of structures do you do so (i.e., moderately curved bridges, severely curved bridges, moderately skewed bridges, etc.)?*

    - No/NA/None-11
    - **Respondent S2:** We have had uplift of imbalanced spans during redecking and deck placement. In one instance the contractor removed the deck on a short end span and the bearing lifted off and because the bridge was curved moved along a cord displacing the pin from the cradle.
    - **Respondent S3:** There have been a few instances. The erector either provided temporary bracing, shoring, or modified the erection plan.
    - **Respondent S7:** We have experienced problems where the contractor did not follow exactly, the erection scheme provided by designer in the plans. Uplift forces at the final stage thus exceeded the forces shown in the plans. This lead to overstress / failure of a hold down device and required having to reinstall shoring towers and jack the steel back up, in order to make repairs, supplement the hold down device, and correct the problem.
    - **Respondent S11:** We have had occasional issues in the past
    - **Respondent S12:** We have not experienced severe issues or problems.
    - **Respondent S13:** Yes. There is much manipulation of the girders during erection to get things to fit. See response to question 15.0 (page 16 of 16) for some of the more unusual events. A successful (meaning quickest) erection contractor utilizes multiple cranes (4 to 6 large ones and smaller ones to place cross-frames) to perform girder erection which allows for adjustment to get things to fit. Another erection contractor that does a lot of work but is very slow typically uses one crane and many shore towers. This method is very slow and there are always issues to work out – typically surveying related. This is usually only a problem with bolted cross-frame connections. Field welded cross-frame connections allow for more flexibility in fit-up issues.
    - **Respondent S18:** We have experienced issues with fit-up on bridges with significant skew where a girder would not sit sown on the bearing. One solution that has been used has been to use oversize holes for the end diaphragms, hand tighten the bolts in the end diaphragms during erection, and come back after the deck has been poured to fully tighten the end diaphragm bolts.
    - **Respondent S23:** One of single span bridges, spanning ~260', did not call for TDLF. Layover in stage one of construction in deck placement was concerning and global stability of the superstructure was questioned. Lateral bracing added to stage two of construction to minimize layover of girders in second stage of construction.

- **Respondent S24:** Primarily, the issue has been with multi-rotational bearings not being "level" at total dead load. Thus we have jacked bridges and provided new tapered sole plates to provide a "level" bearing.
- **Respondent E1:** The best solution is to anticipate the problems and pre-set bearings anticipating the movement and rotations that will occur.

Summary Evaluation of Survey Responses:
The answers provided by the respondents cover a wide range.

With regard to methods for calculating bearing rotations, most respondents either have no specific policy, or simply use the results of the design analysis without consideration of the detailing method specified.

With regard to presenting girder layover information on plans, few respondents have ever done this, and even those have only done it rarely.

With regard to bearing rotation problems, the respondents report a variety of problems, but there does not appear to be a trend associating bearing rotation problems with a specific bridge geometry or a specific detailing method.

14.0 Erection Sequence Questions

Survey Statement: *Please use the space below to provide any information or accounts of your organization's experiences with specifying the erection sequence (specifying the use and/or location of shoring, specifying the erection of girders from the inside to the outside of the curve for curved bridges, etc.) to facilitate fit-up of the steel components and control of the targeted constructed geometry.*

- **Our Experiences:**
  - **Not Specified- 8**
  - **Respondent S1:** We allow the contractor to determine the sequence using an approved erection plan. No shoring has been used to date for the erection of steel I-girder bridges. Note: WYDOT builds approximately one curved bridge about every five years.
  - **Respondent S2:** We require the Contractor to provide an steel erection plan sealed by a PE. Erection, fit-up and bolting are prescriptively described in our Construction Specifications. In our experiences these requirements help eliminate many fundamental problems.
  - **Respondent S3:** We do not typically specify erection sequences. This is considered a methods and means of the contractor.
  - **Respondent S8:** There is no official policy regarding sequence. Deciding the necessity of a sequence or what the sequence actually will be is at the discretion of the designer. Usually, erection sequence is part of the Contractor's means and methods and is developed by it. However, we do review the erection procedure to insure that stability and adequate safety against crane overturning is maintained. We have at times found it necessary to require revisions.
  - **Respondent S11:** We do very few curved and/or severely skewed steel girder bridges. So policies and procedures are more of a case by case basis, for these type of bridges.
  - **Respondent S12:** We require the designers to investigate and ensure at least one feasible sequence of erection exists; however we do not typically specify or suggest erection procedures, means, or methods on the construction contract plans. The Contractor is required to submit an erection plan to the Engineer for review and acceptance. For curved girder structures or complex long-spanned structures, the erection plan must be prepared and sealed by an licensed Structural Engineer (the Erection Engineer).
  - **Respondent S13:** We do not specifically detail where to place the supports or cranes. We require a professional engineer to come up with an erection plan with some minimum requirements of supports to maintain safety. If a "lean-on" cross-frame bracing system is utilized, the design engineer will specify an erection sequence on the construction documents as far as the order of girders to be lifted and set. In this situation, the contractor can revise the sequence, but the "lean-on" system would have to be re-analyzed and possibly revised.
  - **Respondent S17:** We have not built curved girder bridges in last 20 years.
  - **Respondent S18:** We have not typically required the use of temporary shoring for steel bridge erections. Field erection is considered "construction means and methods" that we prefer to leave as the responsibility of the contractor. See also the answer to previous question.
  - **Respondent S19:** The following is a link to the NCDOT Structures Management Design Manual. Chapter 6 Section 6.6.10 covers girder erection policy. https://connect.ncdot.gov/resources/Structures/StructureResources/LRFDManual(Feb2014).pdf
  - **Respondent S22:** It's the contractor responsibility to provide an erection plan

- **Respondent S23:** Contractors are responsible for erection of steel girders. Contractors are having different construction means and method therefore it is logical to leave girder erection decision to them. However, the contractor has to provide erection drawings signed and stamped with a registered engineer who is licensed to practice in the State of Oregon. But designers will provide suggested temporary shoring location in the contract documents.
- **Respondent S24:** Geometry control to ensure fitup of steel members is a key. For the moderate to long span girders, the best approach to control the geometry is to use shoring towers instead of holding cranes. We may show a schematic of erection with shoring towers, but ultimately the contractor has the final decision on means and methods to erect the bridge.
- **Respondent S26:** Depending on the geometry and complexity of the structure, we specify the use and/or location of temporary shoring. We show one possible erection sequence scheme, and also require the contractor to submit an engineered erection plan, before approval of structural steel shop drawings, for review and approval. We do not specify whether girders should be erected from inside to outside of the curve. However, if warranted we would provide it as a comment during review of the erection plan. See attached construction plan notes.
- **Respondent S27:** Our Structure Design Guidelines (SDG) states: "For all steel girder, segmental beam or box girder bridges, and CIP box girder bridges on false work, include in the plans a workable erection scheme that addresses all major phases of erection. Investigate superstructure stability at all major phases of construction consistent with the erection scheme shown in the plans. Show required temporary support locations and associated loads assumed in design. Coordinate temporary support locations with the Traffic Control Plans. See PPM, Volume 1, Article 10.4. Show maximum allowable vertical displacements of the temporary supports in the plans as required for fit up, alignment, and stability, or where excessive settlements would affect stresses of the permanent structure." The SDG also provide guidance on construction loads and wind loads during construction.
- **Respondent D2**: As a designer, for long span or complex (curved or skewed) bridges, we provide one feasible erection sequence/scheme on the design plans - for the purpose of fair bidding. The contractor may choose to use tech scheme shown on the plans or submit for approval an alternate scheme.
- **Respondent E1:** We do this on every steel bridge we erect, but curvature and skew seldom are of a magnitude that requires special sequences. Site conditions and access generally predetermine the sequences (especially when constructing a new bridge close to an existing bridge).
- **Respondent F4:** As an erector, we generally follow the practices shown in the skewed bridge Erection Procedure example shown in the S10.1, Steel Bridge Erection Guide Specification. Thus, while fit-up of the 2nd & 3rd girder lines can be somewhat challenging for the multi-girder framing types, most bridge superstructures which we've encountered require a at most a moderate amount of bridge erection effort to make the cross-frame connections, which then inherently establish the skewed bridge geometry satisfactorily. We typically use temporary tie-downs & occasional false work (when holding cranes are not practical due to site geometry, proximity of under-bridge traffic or construction staging constraints) to establish a compatible profile between adjacent girders' skew-induced differential deflection (see response to Section 8.0 for conditions when this can become create the above-mentioned challenge). Thus, at least for those recent skewed bridges which we've encountered as one erector, system flexibility & bearing rotation construction allowances have tended to lend themselves to successful completion with an effort similar to what is required for horizontally curved bridges on

radial supports (especially when cross-frame positions are detailed following our preferences stated in the previous sections). Erecting from inside-to-outside of curve at abutments (when backwall is present) tends to be our preference (facilitates cross-frame installation by mitigating cheekwall clearance restriction); interior spans (especially when temporary blocked) can be generally be adjusted longitudinally, especially when a drop-in closure field section is to be erected. We have used both sequences, which are often dictated by available crane placements. Again, refer to Section 8.0 response, for it facilitates erection sequence when the deflections of adjacent girder lines are compatible. Note: variable/flared girder spacing in vicinity of (previously/partially decked) construction stages may warrant field reaming of new-to-existing cross-frame connections, when composite action limits/restrains the amount of web layover that can be dissipated as the non-composite stage deflects under slab placement loading.

- **Respondent F1:** As a detailer, we generally stay away from erection schemes. If there is a concept shown in the designs, we briefly review it to see that it will be constructible. Problems are identified. If there is a required sequence from the detailing perspective, we will make it known to the erector.

Summary Evaluation of Survey Responses:

Among the state DOTs, very few report regularly specifying an erection sequence on their plans. Those who do not do so typically explain that their policy is that determining the erection sequence is the responsibility of the contractor and is considered "means and methods"; these owners typically explain that they try to avoid specifying "means and methods" partly to allow contractors the flexibility to bid projects as competitively as possible, and partly to leave the responsibility for successfully erecting the bridge clearly with the contractor.

15.0 Construction Inspection Questions

Survey Statement: *Please use the space below to provide any information or accounts of your organization's policies and/or practices with regard to construction inspection of the erected geometry of skewed and /or curved I-girder bridges. For example, does your organization inspect/evaluate the plumbness of girder webs? If so, when (prior to deck placement or after deck placement)? What tolerances does your organization permit?*

- **Our Policies/Practices:**
  - **Respondent S1:** On a few of the bridges with larger skews (>35 degrees) we have had the RE shoot the top of the girder elevations, prior to deck placement, to compare with our computed screed elevations. We have had little differences in the values, but for the most part good agreement. We also have them check the plumbness of the webs, prior to deck forming, and to date no problems noted.
  - **Respondent S2:** We assume webs are plumb after erection but before the concrete is placed this is a point of inspection.
  - **Respondent S3:** Geometry is typically verified after the erection. This usually includes theoretical span length , top of flange elevations versus theoretical bottom of slab /top of flange elevation, and plumbness. Plumbness is evaluated tolerance is evaluated on a case by case basis.
  - **Respondent S6:** We have no special provisions in place to inspect the girders.
  - **Respondent S8:** Our requirement is that girders are plumb in the final condition, i.e. after deck placement. Tolerances are in our Steel Construction Manual, Section 12. See https://www.dot.ny.gov/divisions/engineering/structures/manuals/scm
  - **Respondent S9:** We inspect the plumbness of the girder webs prior to and after deck placement. Tolerance is on a case-by-case basis.
  - **Respondent S10:** We do not inspect for web plumbness and erected geometry of that type. We inspect more for global items such as girder spacing and out to out deck width.
  - **Respondent S11:** Currently we have no specification tolerances for girder plumbness in our construction specifications other than fabrication tolerances.
  - **Respondent S12:** Steel structures are inspected during erection to ensure that excessive deformations or reaming of holes is not employed, and the fully erected steel is inspected for fit, alignment, plumb, and seating on bearings at key locations for conformance to the contract plans and specifications and the approved erection plans.
  - **Respondent S13:** Construction inspection of the erected geometry of skewed and/or curved I-girder bridges is not routinely required. When the girders appear to be out of plumb we have checked and then notified the contractor and design engineer of a potential issue to investigate. We do not have tolerances.
  - **Respondent S17:** We do not have specific policies on those issues.
  - **Respondent S18:** We do not inspect plumbness of girder webs to any tolerance values during field erection.
  - **Respondent S20:** Plumbness of girder webs not inspected unless there is obvious layover.
  - **Respondent S22:** All steel inspection done during fabrication according to a camber and blocking diagram provided on the plans.
  - **Respondent S23:** There is no written inspection policy for checking web plumbness however it is understood web should plumb in the final condition. However, the contract drawing requires web plumbess.
  - **Respondent S24:** For the moderate to severely skewed bridges, we evaluate the bearing for "level". The bearing tolerance is 0.02 radians.

- **Respondent S26:** Our practice is to check/inspect the plumbness of the girder webs for the specified fit; SDLF - prior to deck placement or TDLF - after deck placement.
- **Respondent S27:** From our standard specification for bridge construction, it states, "A web will be considered plumb if it is within a tolerance horizontally between the top and bottom of the web of 3/32 inch per foot of web depth compared against the theoretical position as required in the Contract Documents. Measure the out-of-plumb perpendicular to the face of the web. Erect trapezoidal girders to the geometry shown in the Contract Documents to the same 3/32 inch per foot of web depth tolerance."
- **Respondent S28:** Tolerance is 1/8" per foot.
- **Respondent D2:** We specify tolerances listed in agency specifications or use AWS tolerances as a guide for final plumbness of girder webs.
- **Respondent E1:** We do not have a specific policy or practice -- generally the Owner specifies what is required and we follow those guidelines. Also, since our bridges tender to have less skew and/or curvature, "layover" tends to be less of a problem.

Survey Statement: *Please use the space below to provide any information or accounts of your organization's experiences with construction inspection of the erected geometry of skewed and /or curved I-girder bridges to ensure adequate bridge performance under subsequent service and potential ultimate strength conditions.*

- **Our Experiences:**
  - **Respondent S2:** We, in the past, have had fit-up problems, but these have be greatly reduced by requirements for a percentage of drift pin to be used by the contractor at each splice location.
  - **Respondent S8:** As mentioned before, we have not had a significant issue with erection or fit-up. Generally, it is up to designers to be aware of assembly/erection issues and add notes to the plans accordingly, rather than relying on policy which may or may not be applicable in a given situation.
  - **Respondent S10:** We do not inspect differently for skewed and/or curved I-girder bridges.
  - **Respondent S12:** We have experienced few issues with construction inspection, or lack thereof, resulting in problems with final in-service structures. p:/winword/specialprojects/nchrp 20-07 355 survey-ILDOT 071514.pdf
  - **Respondent S13:** Our typical cross-frame connection method is using single fit up (erection) bolts at each gusset connection and then field welding for permanent placement after all steel erection is complete. It is common to have the girders set plumb at the time of welding. Field welded connections have proved more forgiving than bolted connections in terms of cross-frame fit. On two projects 1/4" oversized holes were allowed in fabrication of the cross-frame connection plates for 1" erection bolts. Temporary shore towers were removed from girder mid-spans prior to welding the cross-frames. The plate girders rolled outward 1/2" (1/4" hole diameter X 2) further at each subsequent girder line in mid-span creating a 1-1/2" roll assuming the girder 1 was plumb. Due to this leaning, an excessive force was applied to the 1" erection bolts causing some of them to shear in the top outside connections of the cross-frames after all girders were erected and work had commenced elsewhere. On another project, the hole diameters for the 1" erection bolts were oversized by only 1/16". Due to a known camber design issue in the girders, erection bolt shearing was encountered as well as proper even loading of several bearings. This was due to girders leaning (out-of-plumb) at the caps. On all of the fore-mentioned "welded" cross-frame projects, temporary shoring was re-

installed at various locations to manipulate the girders back to a more desirable condition. On occasion (couple of times) – Full bolted connections for cross-frame diaphragms were used. A description of what happened is below: The bearing seat elevations were constructed either too low or too high at various locations on the same cap. Since the all bolted cross-frames are generally fabricated with standard hole diameters and due to the wider bolt pattern geometry, the girders could not fully load each bearing, if at all, with 100% bolts installed. Thus the all bolted cross-frames became very unforgiving. On some caps the entire load was being carried by as little as two bearings on a five girder line unit. Even when the girders had engaged the bearing, it was often difficult, if not impossible, to determine if adequate loading of the bearing had been achieved. This situation can and does create havoc during the erection process as lane closure time schedules must be maintained. Correctness of cross-frame fabrication as well as the design of the girders themselves also becomes a issue as there is little room for error and much less room for quick correction in the field. Multi-dimensional shimming of the girders can be the only viable method of correction for the mis-constructed bearing seats. However, assumed measurements must be collected and then sent out for fabrication of shims. Meanwhile the girders must be lifted by crane or hydraulic jacks to allow full bolting and then either held in position or raised again later to allow installation of shims at which time the entire unit at each bent must be raised rather than a single girder as would be in a welded cross-frame scenario that has only the erection bolts installed prior to welding.

- **Respondent S23:** Our construction project manger offices and inspectors are administering the contract based on contract documents which is limited to construction drawings and specifications.
- **Respondent S24:** In-service performance of skewed, or curved and skewed bridges has not been an issue. Upon proper and successful construction, the in-service performance is as anticipated.
- **Respondent S26:** We are very thorough in reviews of the structural steel erection plans and shop drawings, and our construction inspectors are very thorough in ensuring the steel erector is not deviating from the approved steel erection plans. Following completion of the superstructure construction, the steel superstructure is jacked and bearings are reset. See attached construction plan notes.

Summary Evaluation of Survey Responses:

With regard to construction inspection policies, a surprising number of state DOTs do not have specific requirements regarding web plumbness, and/or do not inspect for web plumbness as part of their regular policy. Of those who do inspect for web plumbness, most inspect after steel erection is complete (prior to deck placement). Interestingly, one state DOT inspects both before and after deck placement.

With regard to experiences with construction inspection, a significant number of respondents stated they have had few or no reported problems. This may be because they truly have had no problems, or it may be that their policies are loose enough that a wide range of outcomes (webs out of plumb, bearings not fully seated, connections having to be force-fit or field adjusted, etc.) are considered acceptable by the field personnel responsible for construction inspection.

APPENDIX X. AASHTO/NSBA Collaboration Group Guidelines Document

SKEWED AND CURVED STEEL I-GIRDER BRIDGE FIT

NSBA Technical Subcommittee

Contributors:

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This document is dedicated to the late Fred R. Beckmann of the American Institute of Steel Construction, who diligently gave of himself to help others achieve the best solutions for the nation's steel bridges.

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2. Foreword

Tighter constraints on right-of-way, particularly in urban environments, have led to a significantly increased utilization of skewed and curved alignments in highway bridge construction. Due to the relative ease of configuring the structure to the roadway geometry, steel I-girder bridges are often a preferred option for these cases.

Skewed and curved I-girder bridges have been successfully fabricated and erected for many years and have performed well in service. However, challenging attributes of the framing arrangements combined with long-used detailing practices and common erection procedures can result in issues during construction at certain extremes. Some of the issues encountered have included:

- Girders and cross-frames that are difficult to assemble during the erection, requiring unplanned operations such as substantial force fitting of connections, field drilling and field welding;
- Erected girders with webs that are significantly out-of-plumb (although out-of-plumbness of girder webs is not necessarily problematic);
- Additive locked-in stresses in the cross-frames and girders, which may be significant in some cases;
- Bearing rotations that are larger than allowable design limits; and
- Deck joints and barrier rails that are out-of-alignment between the approach and the end of the bridge.

In certain instances, these issues, which often result from a poor understanding of the behavior of these bridge types and/or poor communication between the various parties associated with the project, have resulted in construction delays, rework, cost overruns, and disputes and litigation.

Skewed and curved I-girder bridges generally exhibit torsional displacements, or twisting, of the individual girders and of the overall bridge cross-section under load, including the loads during construction. The above issues can be avoided by developing a better understanding of the causes and effects of this twisting, and the ways in which framing arrangements, cross-frame detailing practices, and erection procedures influence the behavior of the bridge.

The following terms are used commonly to refer to the deflected or undeflected geometry under which the cross-frames in these bridges are detailed to attach to theoretically plumb girders with theoretically zero load in the cross-frame members. The most commonly referenced fit conditions are:

- No-Load Fit (NLF), also referred to as Fully-Cambered Fit, where the cross-frames are detailed to attach to the girders without any force-fitting in their initially fabricated, plumb, undeflected geometry under zero load;
- Steel Dead Load Fit (SDLF), also referred to as Erected Fit, where the cross-frames are detailed to attach to the girders in a plumb position in which the girders are deflected only vertically under the bridge steel dead loads, and

- Total Dead Load Fit (TDLF), also referred to as Final Fit, where the cross-frames are detailed to fit to the girders in a plumb position in which the girders are deflected only vertically under the bridge total dead loads.

The "fit" or "fit condition" is selected by considering the dead load condition (i.e., no load, steel dead load, or total dead load) at which it is desired for the girders to be approximately plumb. The choice of fit condition can influence the constructability and long-term performance of the bridge because it can affect the magnitude of the locked-in force effects in the cross-frames and the girders, and it can influence the forces required to assemble the steel together during the erection. This paper addresses the behavior of skewed and/or curved I-girder bridges, and the intricate interplay of the fit decision with this behavior.

Different skewed and curved I-girder bridges experience the above issues to different degrees. Bridges with smaller skew, larger radii and/or shorter spans are not as sensitive to the choice of the fit condition. For a given skew and/or horizontal curvature, bridges with longer spans potentially can experience more difficulties with respect to key responses during and at the completion of the construction, such as: fit-up (i.e., assembly) of the steel during the erection, achievement of the targeted constructed geometry under dead load, and development of significant changes in the internal force states in the structure under dead load due to detailing and erection procedures.

The Design Engineer typically analyzes and designs a bridge as if it is fully constructed in the unstressed (No-Load) position, without any force-fitting, and then the gravity loads are simply "turned on." This is a simplifying assumption which does not account for the influence of the fit condition on the bridge response. Article 6.7.2 of the *AASHTO LRFD Bridge Design Specifications* specifies that for straight skewed I-girder bridges and horizontally curved I-girder bridges with or without skewed supports, the contract documents should state an intended erected position of the girders and the load condition under which that position is to be achieved. The intent of this provision is to ensure that the preferences of the Owner and Engineer of Record regarding the fit condition are clearly conveyed to those involved in the fabrication and construction of the bridge.

Since the fit decision directly influences the cross-frame fabricated geometry, as well as the bridge constructability and subsequent internal forces, the fit condition should ideally be selected by the designer, who best knows the loads and capacities of the structural members, with proper consideration of the bridge erection. To facilitate an informed decision, the designer can (and should) discuss their bridge with experienced fabricators, detailers, erectors, and contractors. The desired outcome, safe, easy and economical construction of skewed and curved steel I-girder bridges, is more likely to be achieved if all parties involved in the design and construction of the bridge understand the issues and communicate early (and with a common language) to ensure that an appropriate fit decision is made for a particular bridge project.

A fit decision always must be made so that the Fabricator/Detailer can complete the shop drawings and fabricate the bridge components in a way that allows the Erector/Contractor to assemble the steel and achieve a desired geometry in the field. The fit decision also affects design decisions regarding the rotation demands on the bearings as well as the internal forces for which the cross-frames and girders must be designed. The Design Engineer needs to understand how the bridge will respond to a specific fit condition, particularly how the fit decision may influence the erectability of the steel, the deflected geometry of the structure under its dead load, and the internal stresses in the various bridge components.

The key question, then, is under what (load) condition should an I-girder bridge be detailed to fit? Certainly, the Total Dead Load condition is of great interest: to perform effectively in service, girders and cross-frames need to be in place, properly connected and properly functioning, with internal loads which do not exceed the capacity of the structure. Therefore, one might infer that bridges should be detailed simply to fit in their final constructed condition. For some bridges fitting the cross-frames to the final condition is fine; however, for others, fitting to the final condition significantly increases the internal cross-frame forces and can potentially make the bridge unconstructable. For every bridge, the fit condition must be selected to effectively manage the structure's constructed geometry and internal forces, and to facilitate the construction of the bridge.

The behavior of straight skewed bridges is fundamentally different than the behavior of curved girder bridges. These differences in the fundamental behavior characteristics should be fully understood and carefully considered, as the selected fit condition will affect the constructibility and performance of these bridges types in different ways. Sections 2 and 3 of this document therefore discuss the fundamental behavior characteristics of straight skewed and horizontally curved I-girder bridges, respectively, and highlight the important differences in these characteristics and how they might influence the selection of a particular fit condition.

In addition to pointing out the important fundamental differences in the behavior of straight skewed and horizontally curved I-girder bridges, this document is also intended to assist the Owner and the Engineer of Record, in consultation with fabrication and construction professionals, to make a more informed consensus decision in specifying the fit condition for a particular skewed and/or curved steel I-girder bridge based on the fundamental behavior characteristics. Section 7 of this document provides tables of recommended and acceptable fit conditions for straight skewed and curved steel I-girder bridges (with or without skew) as a function of broad generalized characteristics of the bridge geometry. The tables also indicate which fit condition(s) should be avoided for a particular bridge type. The recommendations represent an industry consensus based on experience, recent research regarding steel I-girder bridge fit behavior, and state-of-the-art practices and knowledge related to skewed and curved steel I-girder bridge fit. It is further noted that this document should also be useful for a Field Engineer to better understand the observed behavior of these bridges during construction.

In addition to the above summary recommendations, this document also includes detailed discussions of the three most common options for the fit condition: NLF, SDLF and TDLF. Section 4 includes a thorough explanation of the cross-frame detailing procedure that is used for each option, the outcomes that can be expected when each option is employed, and the effects of these outcomes on various bridge components. Important issues the designer should consider in the design and analysis of straight skewed and horizontally curved I-girder bridges are discussed in Section 5. Section 6 summarizes the advantages and disadvantages of each fit option. Lastly, Section 8 briefly describes additional considerations related to the design of bearings at skewed supports, fabrication of bolt holes and bolt tightening during erection, shop assembly practices, and some fit considerations for tub girders. After brief conclusions are presented in Section 9, commonly used terms are defined in Section 10 of the document to assist the reader in understanding the discussions.

1. Introduction

Skewed and/or curved I-girder bridges generally exhibit torsional displacements of the individual girders and of the overall bridge cross-section under load. As a result, the girder webs can be plumb in only one load condition. For instance, if the structure is fabricated such that the girder webs are plumb in the ideal No-Load (NL) position, they cannot be plumb under the action of the structure's dead load. Furthermore, live loads produce additional deflections.

It is important to recognize that twisting of the girders in a skewed and/or curved I-girder bridge is not necessarily indicative of a structural problem or deficiency; it is a natural, predictable, and controllable response to the gravity loading of these types of structures. If this were not the case, essentially all of these bridges would be deficient under the design live loads (since they twist under live load).

Skewed and curved I-girder bridges have been successfully fabricated and erected and have performed well in service for many years. However, it is important to recognize and understand the effects of the girder twisting in these bridges so that an informed decision on an appropriate fit condition can be made as a function of the bridge geometry, thus avoiding construction problems and ensuring a successful project.

In selecting a particular fit condition, it is important to keep in mind that the behavior of straight skewed bridges is fundamentally different than the behavior of curved girder bridges. Therefore, the following Sections 2 and 3 first discuss the fundamental behavior characteristics of straight skewed and horizontally curved I-girder bridges, respectively, and highlight the important differences in those characteristics and how they might influence the selection of a particular fit condition. A thorough explanation of the cross-frame detailing procedure used for each of the three most common options for the fit condition discussed in Sections 2 and 3 (i.e., NLF, SDLF and TDLF) follows in Section 4.

Section 5 next discusses important issues the designer should consider related to the selection of the fit condition as they apply to the design and analysis of straight skewed and horizontally curved I-girder bridges. The advantages and disadvantages of each fit option are summarized subsequently in Section 6. Section 7 then provides tables of recommended and acceptable fit conditions for straight skewed and curved I-girder bridges (with or without skew) as a function of broad generalized characteristics of the bridge geometry, which are based on industry consensus. The tables also indicate which fit condition(s) should be avoided for a particular bridge type. Section 8 briefly describes additional considerations related to the design of bearings at skewed supports, fabrication of bolt holes and bolt tightening during erection, shop assembly practices, and some fit considerations for tub girders. Following brief conclusions that are presented in Section 9, commonly used terms are defined in Section 10 of the document to assist the reader in understanding the discussions.

2. **Behavior of Straight Skewed I-Girder Bridges**

In straight-skewed I-girder bridges, the girders deflect only vertically under their self-weight as long as the cross-frames are not connected to the girders in a manner such that they are engaged and can transfer internal shears and moments (Figure 1).

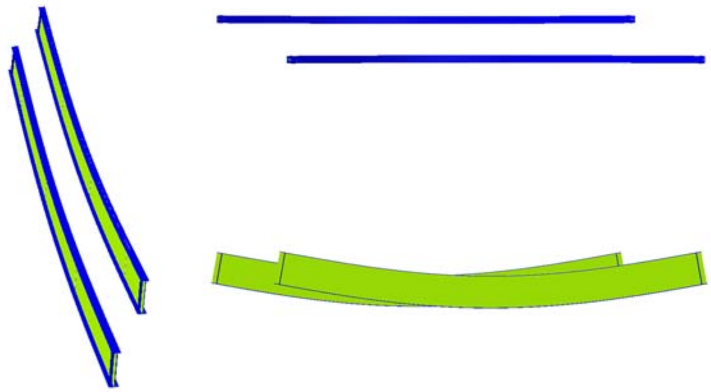

Figure 1 – Magnified Girder Vertical Deflections for Two Simple-Span I-Girders on Parallel Skewed Supports Subjected to Steel Dead Load (SDL) Prior to Connecting the Cross-Frames

If the cross-frames are detailed for SDLF or TDLF using these deflections, i.e., the deflections determined from a 1D line-girder analysis, the cross-frames will fit exactly to the girders in the above Steel Dead Load (SDL) or Total Dead Load (TDL) geometry. Therefore, if SDLF detailing is used, the cross-frame internal forces are essentially zero under the SDL and the cross-frame connections to the girders can be completed with little to no force-fitting during the steel erection. Similarly, if TDLF detailing is used, the cross-frame internal dead load forces are essentially zero under the TDL condition. However, the Erector will need to apply some additional force to the steel to make the connections during the steel erection (Nguyen and White, 2014). The conclusion of essentially zero cross-frame forces under TDL, for TDLF detailing, assumes that the influence of three-dimensional interactions of the girders and the deck associated with staged deck placement are negligible and that the deck overhang loads predominantly affect only the fascia girders and the adjacent cross-frame lines (such that the deck overhang load effects can be calculated separately and independently from the above effects).

Once the cross-frames are connected to the girders, the interconnected girders deflect as a three-dimensional system under all subsequent loads. The cross-frames brace the girders, but they also serve as an additional transverse load path in the system. As a result, the girders deflect vertically and simultaneously twist under the dead loads (Figure 2).

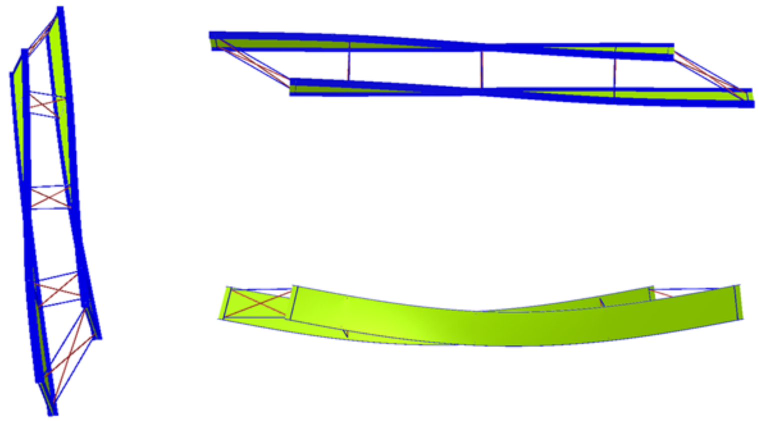

Figure 2 – Magnified Girder Vertical Deflections and Twist for Two Simple-Span I-Girders on Parallel Skewed Supports Subjected to Vertical Load.

Where the cross-frames are perpendicular to the girders, the twisting occurs primarily because of the differential vertical deflections between the girders at each of the intermediate cross-frames, since these cross-frames connect to different positions within the span of each of the girders. In straight skewed bridges with parallel skews and contiguous cross-frames aligned with the skewed bearing lines, which is permitted by AASHTO for skew angles less than or equal to 20 degrees from normal, the differential vertical deflections at the ends of the cross-frames are essentially zero. However, in this case, girder twisting is induced by the rotational continuity between the skewed cross-frames and the girders. Similarly, along skewed bearing lines where the vertical deflections of the girders are zero, the girders have to twist to maintain rotational continuity between the bearing-line cross-frames and the girders. Basically, at any position along the bridge where the cross-frames are skewed relative to the girders, if the girders have non-zero major-axis rotations, the girders must twist to maintain rotational continuity with the cross-frames. If the skewed cross-frames are detailed for SDLF or TDLF, the corresponding lack-of-fit in the fully-cambered NL geometry induces girder twist rotations that approximately compensate for all the above twist rotations in the SDL or TDL condition of the bridge.

If the cross-frames are detailed for SDLF using the vertical self-weight deflections computed considering the three-dimensional interaction of the girders with the cross-frames as an overall structural system, i.e., if the vertical deflections are calculated from a 2D or 3D refined analysis, the connections to the girders typically still can be completed with little force-fitting (outside of any "nuisance stiffness" or other framing arrangement effects described below in Section 4.4).

It should be noted that the girder deflections in a partially erected structure are different from those at the completion of the steel erection. However, SDLF detailing is always based on the computed girder deflections due to the steel self-weight applied to the fully erected steel system. The computed SDL deflections and internal forces at the completion of the erection are essentially independent of the steel erection sequence assuming the following: 1) the bridge responds elastically under the dead loads and any erection loads; 2) the influence of connection tolerances is small and may be ignored (i.e., oversize or slotted holes are not used); and 3) the influence of any incidental restraint from friction at bearing locations is small and may be ignored. These are the assumptions generally made by the Design Engineer when analyzing a bridge. (This does not mean that the Erector can neglect the movements induced by play in the connections associated with connection tolerances.)

If the cross-frames are detailed for TDLF, the Erector will need to apply force during the steel erection in order to complete the connections. This is because the TDL is not yet applied to the bridge. Therefore, the girders must be twisted out-of-plumb to overcome the fact that they are not yet subjected to the TDL deflections. However, in many cases with straight skewed bridges, the girders are relatively flexible in torsion and can be twisted out-of-plumb with minimal force during the cross-frame installation.

Once installed, the cross-frames are typically able to hold the girders in their intended (plumb) position with relative ease under the targeted dead load. In fact, straight girders naturally tend to remain straight under gravity loads if they are not connected to the cross-frames, global stability effects aside. As such, in a straight skewed bridge, the locked-in forces that result due to the lack-of-fit detailed between the cross-frames and the girders in the base NL geometry are approximately canceled (i.e., offset) by the dead load effects. That is, the sum of the locked-in cross-frame forces from the lack-of-fit effects and the dead load effects in the targeted dead load condition (obtained from a structural analysis neglecting the SDLF or TDLF detailing effects) is approximately zero. The locked-in forces tend to be largely opposite in sign (direction) to the internal dead load forces and stresses (NCHRP, 2012). Since the resulting cross-frame forces are approximately zero in the targeted dead load condition, and since the girders are approximately plumb in this condition, the lateral bending of the girder flanges is negligible and the girder flange lateral bending stresses are essentially zero in the targeted dead load condition. This is a desirable dead load geometry and stress condition.

NLF detailing is not typically used and should be avoided for straight skewed bridges. This is because this type of detailing generally requires the use of temporary shoring and/or a significant number of holding cranes during the erection in order to avoid excessive forced fit-up of the cross-frames to the girders that are deflected under their self-weight. Also, with NLF detailing, there is no compensation for the twist rotations that occur at skewed bearing lines. This increases the total rotation demands on the bearings under the dead and live loads and can cause potential alignment difficulties at deck joints and barrier rails at skewed end supports.

3. Behavior of Horizontally Curved I-Girder Bridges

The bridge cross-section in horizontally-curved I-girder bridges is subjected to significant internal torsional moments due to the fact that the resultant of the bridge vertical loads within the spans has an eccentricity relative to a straight chord between the supports. In a straight skewed bridge, the total internal torsion tends to be relatively small and the girder torques are induced predominantly by the compatibility of deformations between the girders and the cross-frames; that is, if the girders are not interconnected by the cross-frames, there is no tendency for them to twist under the primary vertical loads. However, the internal torsion in curved bridges exists independently of the interconnection of the girders by the cross-frames. If the curved I-girders are not connected to the overall bridge structural system by the cross-frames, they tend to exhibit large torsional deflections.

The predominant resistance to the above internal torsion in horizontally-curved I-girder bridges is developed by interconnecting the girders by the cross-frames across the entire bridge width. Vertical forces ("V-loads") are applied to the girders at the cross-frames by the diagonal cross-frame members. This produces a shift in the internal vertical forces toward the girders on the outside of the horizontal curve. Associated radial forces are applied from the cross-frames to the girders that prevent excessive individual girder torsional rotations by attaching the girders to the overall bridge cross-section. Because the girders and the overall bridge cross-section want to rotate torsionally (Figure 3), curved I-girders and curved I-girder bridge units often cannot be erected without providing some type of intermediate vertical support within the spans, typically via holding cranes or temporary shoring at critical stages of the erection.

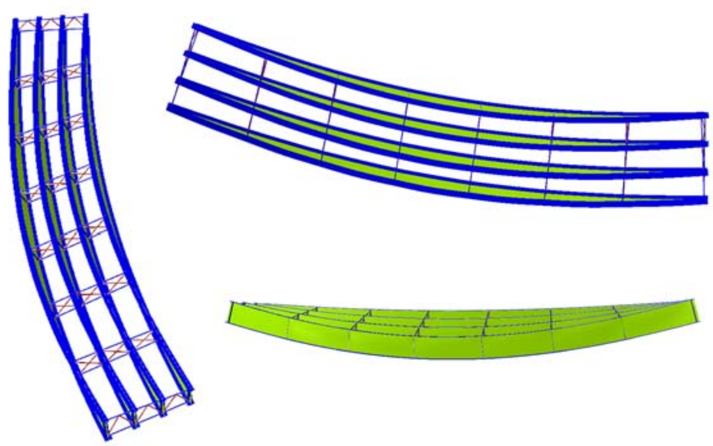

Figure 3 – Magnified Girder Vertical Deflections and Twist for Four Horizontally Curved Simple Span I-Girders on Non-Skewed Supports Subjected to Vertical Load

In addition, horizontally curved I-girders generally exhibit significant coupling between their major-axis bending displacements and their twisting or torsional rotations. Major-axis bending of curved girders cannot occur without also inducing twisting of the girders, and twisting of curved girders cannot occur without also inducing major-axis bending. This behavior can exacerbate fit-up problems in curved girder bridges since it is more difficult to adjust the twist of the girders to connect them with the cross-frames. Both the completed bridge, as well as separate curved-bridge units during construction, exhibit these overall structural system deflection characteristics.

In horizontally curved bridges built with either SDLF or TLDF detailing, the cross-frames are fabricated such that they twist the girders an additional amount in the opposite direction that they and the bridge cross-section want to roll under the corresponding dead load. That is, the cross-frames generally restrain excessive torsional deflection of the girders in a curved bridge, and SDLF and TDLF detailing increases these restraining effects. With NLF detailing, there will be a non-zero twist of the girders that is essentially equal to the overall twist rotation of the bridge cross-section at the cross-frame locations under SDL and TDL. In contrast, with SDLF or TDLF detailing, the lack-of-fit fabricated into the cross-frames twists the girders back an additional amount in the direction opposite from the twist rotations of the bridge cross-section such that the girders are approximately plumb, at the cross-frame locations, under SDL or TDL. As such, both SDLF and TLDF detailing tend to increase the cross-frame forces in curved girder bridges, particularly the forces in the cross-frame diagonals. That is, unlike straight skewed bridges, the locked-in cross-frame forces associated with SDLF and TDLF detailing tend to be additive with the general dead load effects in the cross-frames in horizontally curved bridges (NCHRP, 2012). These additive cross-frame force effects can make the cross-frames more difficult to install in horizontally-curved bridges compared to the use of NLF detailing. Fortunately, for SDLF detailing, the additional forces usually are not particularly large. As such, the cross-frame installation can be completed successfully. This fact has been demonstrated extensively in practice, since SDLF is the most common detailing practice used for curved bridges.

However, for the case of TDLF detailing of curved bridges, the additional forces required to twist the girders back in the opposite direction from which they and the bridge cross-section want to roll, and the resulting additive locked-in force effects, can be more substantial. This is because TDLF aims to over-come the rotations caused by the total dead loads. Also, the TDL is not yet in place on the structure when it is being erected. Due to the above issues, the use of TDLF detailing should be avoided for horizontally curved bridges, unless the supports are skewed, the spans are relatively small and the horizontal curvature is minor. "Small span length" may be interpreted as less than or equal to about 200 feet in length, and "minor horizontal curvature" may be defined as a subtended angle L/R in all spans less than or equal to about 0.03 radians (where L is the actual span length between adjacent bearing lines along the bridge centerline and R is the radius at the bridge centerline – refer to Table 2 in Section 7).

NLF detailing is recommended for horizontally curved bridges with spans longer than about 250 feet (for either radial or sharply skewed supports) and L/R greater than approximately 0.1 (as indicated in Table 3 in Section 7). The cross-frame installation is likely to be more difficult and the resulting additive locked-in force effects are apt to be more significant should SDLF or TDLF detailing be employed for these bridges. Furthermore, such bridges are likely to require temporary shoring and support during the erection as a matter of course – as such, the bridge can be erected in a "quasi" NL condition as a general practice and the cross-frames can be easily installed in this shored condition. In addition, for curved radially supported bridges, the resulting girder out-of-plumbness under load will occur out in the spans and not at the supports and is not likely to be objectionable from an aesthetic or structural performance standpoint. These girder twist rotations generally do not connote a structural problem for the girders and cross-frames as long as the global stability provisions in Article 6.10.3.4.2 of the AASHTO LRFD Specifications (2015 Interims to the 7^{th} Edition) are properly satisfied. For horizontally curved bridges that also have significant support skew, the twist rotations at the supports can be (and need to be) addressed in the bearing design and in the deck joint alignment.

It should be noted that for straight-skewed bridges, SDLF and TDLF detailing do not have a significant effect on the girder elevations in the completed structure. However, for curved bridges, SDLF and TDLF generally tend to increase the elevations of all the girders within the bridge spans (NCHRP, 2012). These effects are smaller for SDLF and are commonly neglected in current design practice.

4. **Definition of the "Fit" or "Fit Condition"**

4.1 General

The "fit" or "fit condition" of an I-girder bridge refers to the deflected or undeflected girder geometry under which the cross-frames are detailed to connect to the theoretically plumb girders with theoretically zero load in the cross-frame members. The fit condition is selected by considering the dead load condition (i.e., NL, SDL, or TDL) at which it is desired for the girders to be approximately plumb. The choice of fit condition can influence the constructability and long-term performance of the bridge because it can affect the magnitude of the locked-in force effects in the cross-frames and the girders, and it can influence the forces required to assemble the steel together during the erection.

In all bridge systems (trusses, arches, etc.), the steel components change shape between the fabricated condition, the erected condition, and the final condition. Therefore the associated relationship, or fitting, of the members also changes. When the relative changes in the deflected geometry between the members are small, the fit choice can be inconsequential, but when the changes are large, the proper fit choice is essential for achieving a successful bridge project.

In straight bridges with no skew, the vertical dead load deflections in adjacent girders are essentially equal across the width of the bridge at any given location along their length (aside from some twisting of the fascia girders between cross-frames that may occur due to eccentric vertical loads applied to the deck overhangs). In these bridges, the cross-frames simply deflect along with the girders. As a result, there are no special fit condition considerations for these bridges.

Skewed and/or curved I-girder bridges, however, respond differently. The fit of a skewed and/or curved I-girder bridge is influenced by the difference in girder deflections at the ends (i.e., sides) of the cross-frames. The differential deflections increase with larger skew, sharper curves, and larger span lengths. Indeed, a quick way to evaluate potential constructability issues is to note the magnitude of the differences in the deflections across the width of the bridge at each stage of loading.

Given that dead loads cause deflections, and differences in girder deflections affect fit, it follows that the common fit conditions are associated with different bridge dead load conditions. Table 1 summarizes the three most common fit conditions considered in skewed and/or curved I-girder bridges. Designers tend to be more familiar with names associated with the loading conditions; fabricators and detailers tend to be more familiar with terms associated with stages of construction; the names are used interchangeably in practice.

I-girder bridge fit is accomplished by the choice the detailer makes in setting the "drops" for the cross-frame and connection plate fabrication. The drops are defined as the difference in the vertical elevation between the top of the girder webs at a cross-frame location under NL or the targeted dead load condition. The setting of drops discussed in the "Practice" column of Table 1 refers to the detailer establishing the relative position of each cross-frame to each girder. This terminology is discussed further in the explanations below.

TABLE 1 - COMMON FIT CONDITIONS

Loading Condition Fit	Construction Stage Fit	Description	Practice
No-Load Fit (NLF)	Fully-Cambered Fit	The cross-frames are detailed to fit to the girders in their fabricated, plumb, fully-cambered position under zero load.	The fabricator (detailer) sets the drops using the no-load elevations of the girders (i.e., the fully cambered girder profiles).
Steel Dead Load Fit (SDLF)	Erected Fit	The cross-frames are detailed to fit to the girders in their ideally plumb as-deflected positions under the self-weight of the steel at the completion of the erection.	The fabricator (detailer) sets the drops using the steel dead load elevations, calculated as the fully cambered girder profiles minus the steel dead load deflections.
Total Dead Load Fit (TDLF)	Final Fit	The cross-frames are detailed to fit to the girders in their ideally plumb as-deflected positions under the total dead load.	The fabricator (detailer) sets the drops using the total dead load girder profiles, which are equal to the fully cambered girder profiles minus the total dead load deflections.

Steel Dead Load Fit (SDLF) gives approximately plumb girder webs once the erection of the steel is completed. Total Dead Load Fit (TDLF) gives approximately plumb girder webs once the bridge is subjected to its TDL. For the purposes of evaluating the behavior of the bridge to choose an appropriate fit condition, the term "Total Dead Load," typically refers to the self-weight of the structural steel plus the self-weight of the concrete deck. In most (but not all) cases, composite dead loads such as the weight of barrier rails, future wearing surface loads, utilities, etc. are not considered as a part of the TDL in setting the drops for TDLF. No-Load Fit (NLF) corresponds to detailing of the cross-frames so that they fit with the girders in their NL undeflected geometry. In this case, the girder webs will not be plumb, except at non-skewed bearing lines, once the bridge is subjected to dead loads. In any case, it should be recognized that due to common construction tolerances and variations in factors such as early set-up of the concrete during staged deck placement, incidental stiffness of the deck forms and reinforcement, friction at supports, etc., the girders may not be truly plumb in the associated fit condition. For straight skewed bridges, both SDLF and TDLF are common and effective. For curved bridges, the use of SDLF is most common. Furthermore, practice and research studies have demonstrated that the use of TDLF on curved bridges can potentially render the bridge unconstructable. This is largely because curved girders cannot be twisted as readily as straight girders to facilitate erection.

4.2 Displacement Contributions to the Cross-Frame Detailing

There are two important displacement contributions to the detailing of cross-frames for SDLF or TDLF:

(1) The girder vertical SDL or TDL deflections provided on the Design plans, and
(2) The associated major-axis bending rotations at the girder connection plates under the targeted dead load.

To accomplish SDLF or TDLF at intermediate cross-frames that are normal to the girder tangents, the Detailer typically determines the girder geometry in the targeted fit condition by subtracting the vertical SDL or TDL deflections from the girder plumb fully-cambered NL geometry. (Note that the fully-cambered NL girder profiles are based on the roadway profile and the deck cross-slope plus the total vertical cambers, which are the negative of the girder TDL deflections.) The girders are assumed to be plumb in their initial fully-cambered NL geometry as well as in their targeted SDL or TDL positions, i.e., only the girder vertical deflections are considered. The fabricated SDLF or TDLF cross-frame geometries are then calculated such that the cross-frames fit to the work points at the girder connection plates in these targeted plumb SDL or TDL positions. Alternatively, some Detailers start from the TDL position and add the appropriate deflections to that position (e.g., no adjustment for TDLF, the TDL minus the SDL deflections for SDLF, and the TDL deflections for NLF) to determine the girder geometry in the targeted fit condition.

The resulting difference in elevations between the sides of the cross-frames (typically measured at the top of the girder webs) with the girders in their NL, SDL, and TDL positions are referred to as the drops. The drops generally will be different at each of the cross-frames along the span, as well as along a given line across the bridge. At intermediate cross-frames that are framed normal to the girders, the different drops at the cross-frame locations are the key distinguishing factor between cross-frames detailed for NLF, SDLF or TDLF (Figure 4).

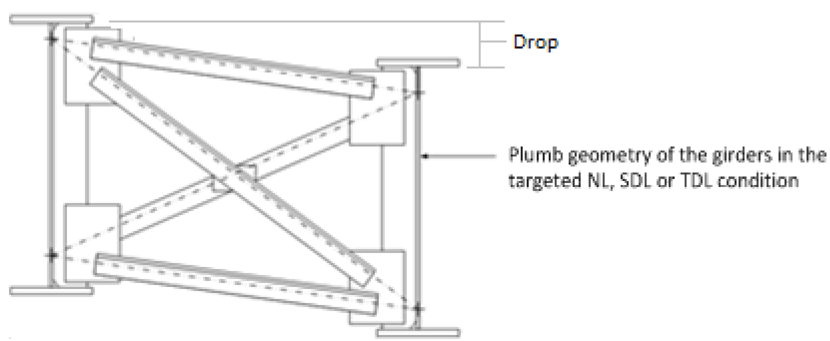

Figure 4 – Drop Between Girders at an Intermediate Cross-Frame Framed Normal to the Girder Tangents

Along skewed cross-frame lines (either intermediate or at the bearing lines, as applicable), the rotated positions of the girder connection plates on the plumb girder webs in the targeted dead load (or NL) geometry also must be considered by the Detailer in determining the cross-frame geometries. Due to major axis bending rotation of the girders, the points on the connection plates move longitudinally when the girders deflect vertically. Correspondingly, the cross-frames rotate about their own axes, which are not normal to the girder web; as a result, the corners of skewed cross-frames move both longitudinally and transversely when the girders deflect vertically (Figure 5).

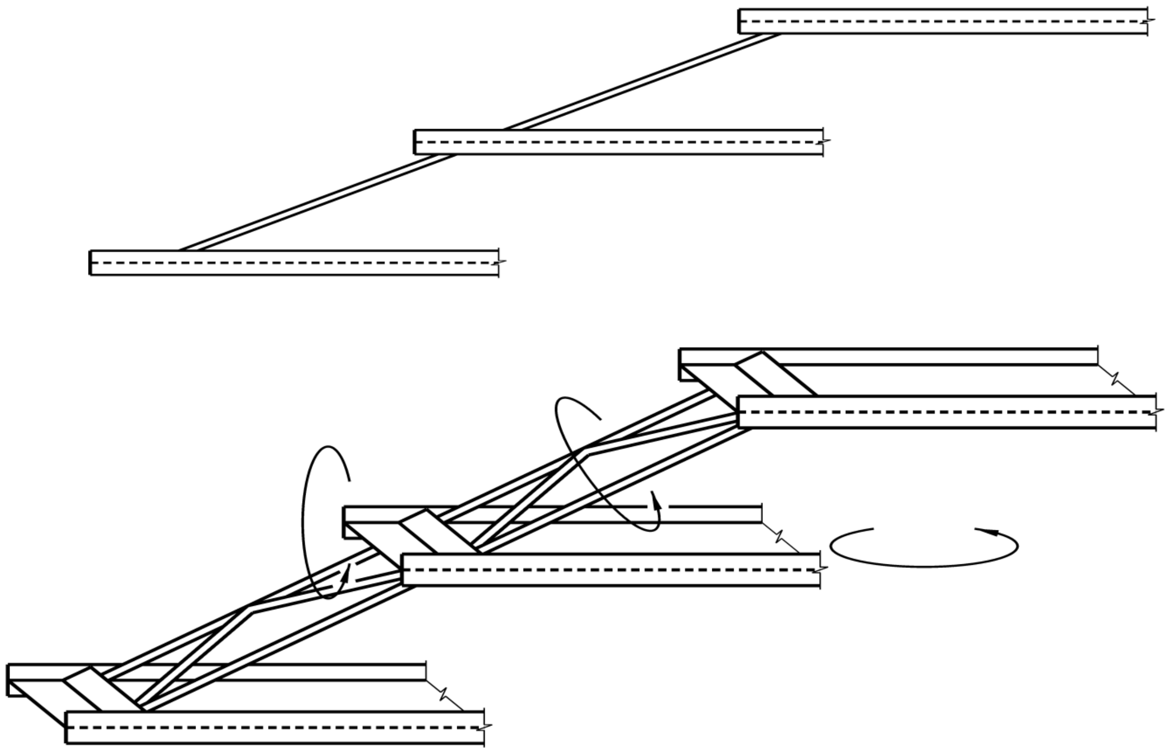

Figure 5 – Rotations of Girders and Cross-Frames & Layover of Girders at Skewed Cross-Frame Lines

At skewed support lines, the girders do not deflect vertically, but the girders still experience major axis bending rotations (rotation about an axis normal to the girder web) and layover (rotation about the longitudinal axis of the girder), as illustrated in Figure 5; hence, the cross-frames are detailed to fit to the rotated positions of the girder bearing stiffeners or connection plates on the plumb girder webs in the targeted dead load geometry. The bearing stiffener and connection plate rotated positions are determined starting with the rotated positions on the plumb fully-cambered NL girder geometry and then subtracting the major-axis bending rotations corresponding to the girder SDL or TDL vertical deflections. These rotations are determined indirectly from the SDL or TDL displacements. At the bearing lines, the girder bearing stiffeners and connection plates are customarily detailed so that they are vertical under the TDL (neglecting any non-verticality due to twisting of the girder about its longitudinal axis). This can be used as a starting point to establish the rotated position of these plates in the SDL or NL conditions, and is preferred by some Detailers.

At skewed intermediate cross-frames, *both* the drops (i.e., the differences in the girder elevations) as well as the rotational orientation of the connection plates in the targeted dead load geometry must be considered by the Detailer in determining the fabricated cross-frame geometries (i.e., the cross-frame member lengths and their angles of orientation within the plane of the fabricated cross-frames).

The Detailer does not require the girder twist rotations, i.e., the rotations about the longitudinal axis of the girders, which are associated with the three-dimensional interaction of the girders with the cross-frames in the structural system, in order to perform the above calculations. This is because the girders are assumed to be plumb in detailing for the selected fit condition. Therefore, the girder twist rotations need not be shown on the Design Plans.

4.3 Key Behavior Associated with the Cross-Frame Detailing

For SDLF or TDLF detailing, since the cross-frames are detailed to connect to an ideal plumb *deflected* position of the girders, they do not fit to the girders in the initial fully-cambered NL geometry. For purposes of illustration, Figure 6 shows a hypothetical cross-frame and girder configuration under NL (i.e., zero load). For this example, the cross-frame is assumed to be at a location where the girders eventually will be at the same elevation in the TDL condition, and it is assumed that the cross-frames are detailed for TDLF. The sketch corresponds to a case where the cross-frame is normal to the girder tangent lines. Since the girders are assumed to be at the same elevation under the TDL in this example (i.e., the deck cross slope is ignored), the cross-frame chords are horizontal in the sketch. The cross-frame is assumed to be attached to the girder on the left. Since the cross-frame is detailed to fit between the girders only after the targeted dead load is applied to the bridge (the TDL in this example), the cross-frame does not "fit up" with the girder on the right. This displacement incompatibility on the right-hand side of the cross-frame is referred to in structural mechanics as a "lack-of-fit."

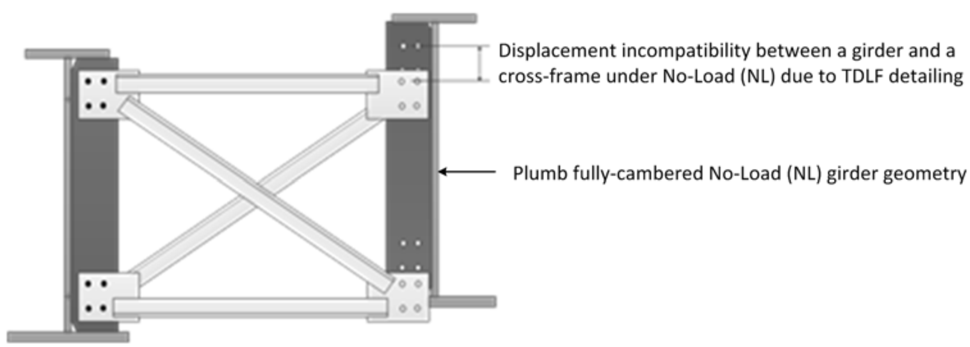

Figure 6 – Displacement Incompatibility due to TDLF Detailing at a Cross-Frame Framed Normal to the Girder Tangents

Since the NL geometry is the reference from which all strains in the structural system are measured, this means that some straining must be induced in the structure to resolve the above incompatibility. For a simple two-girder case, such as illustrated here, typically the cross-frame is relatively rigid compared to the torsional stiffness of the girders. Therefore, when the girders and cross-frames are forced to fit together, the above initial lack-of-fit results in a twisting of the girders. This is shown in Figure 7.

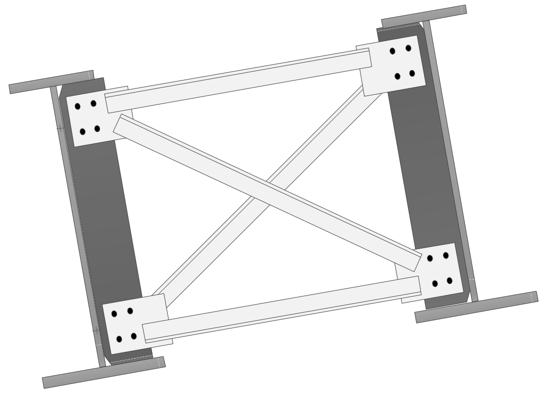

Figure 7 – Girder Twist Rotations due to the Resolution of the Lack-of-Fit Illustrated in Figure 6

It is important to note that, in general, the cross-frames must be twisted from their planar fabricated geometry when the Erector installs them during the erection of the steel. This is because the work points on the girders at the connection plates, in the idealized plumb girder positions of the targeted deflected geometry (or undeflected geometry for NLF detailing), are generally not all in one plane. The above process implicitly assumes that the cross-frames can be easily twisted to attach them to the connection plates, which is a reasonable assumption in the majority of cases (except perhaps for cross-frames to be installed between deep closely-spaced girders).

The twisting of the girders due to the above lack-of-fit is generally in the opposite direction from which the girders want to twist under the targeted dead load. Therefore, once these rotations are combined with the rotations caused by the targeted dead load, the girders deflect into an approximately plumb position within the targeted dead load condition (Figure 8). Figure 8 again assumes that the cross-frames have been detailed for TDLF so that the girders are at the same elevation under the TDL (the roadway profile and deck cross slope are ignored to simplify the sketch).

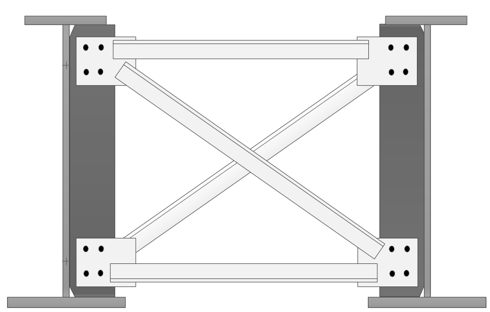

Figure 8 – Girder and Cross-Frame Geometry in the TDL Condition corresponding to the Combined TDL and the Targeted TDLF Detailing Effects

The internal forces associated with the resolution of the displacement incompatibility shown in Figure 6 are referred to as "locked-in forces." As discussed subsequently, in some cases, the locked-in forces are opposite in sign to the internal forces caused by the targeted dead load. In fact, in these cases, the locked-in forces can result in a *substantial reduction* in the net internal cross-frame forces within the targeted dead load condition. In other cases, the locked-in forces tend to be additive with the internal force effects due to the dead load, and therefore, they can result in a net increase in the internal cross-frame forces. This increase can be significant in some cases.

Targeting the girder webs to be plumb under the TDL might at first seem to be the obvious choice. However, the TDL bridge deflections can be substantially larger than the SDL deflections in many bridges. Since the TDL is not fully applied to the bridge during the erection of the steel, the use of TDLF detailing may require the Erector to apply relatively large forces during the steel erection (via cranes, jacks, come-alongs, etc.), in some cases, to twist the girders out-of-plumb so that the connections of the steel components can be completed. This issue can be particularly problematic in bridges involving combinations of longer spans, sharper skews and/or tighter horizontal curves.

4.4 Stiffness and Geometry Effects

The framing arrangement (or layout) of the cross-frames within the bridge plan also can be an important factor. Cross-frame arrangements that inadvertently create stiff transverse load paths in certain portions of the structure, sometimes called "nuisance stiffness" load paths (Krupicka and Poellot, 1993), combined with other attributes of the bridge geometry such as large span length to girder depth ratios, simply-supported spans, or poor span balance in continuous-spans, can lead to difficulties in assembling the bridge. Basically, substantial differences in stiffness of different portions of a large bridge structure can be problematic.

Nuisance stiffness can produce dramatically increased cross-frame forces and can result in potential fit-up difficulties during the steel erection. The use of discontinuous cross-frames adjacent to skewed supports can mitigate nuisance stiffness effects in these regions (FHWA/NHI, 2010). In addition, NCHRP Report 725 (NCHRP, 2012) and AASHTO LRFD (7th Edition) Article C6.7.4.2 recommend that when cross-frames are provided along a skewed support line (i.e., either an end support or an interior support line), the first intermediate cross-frame placed perpendicular to the girders next to that support line should be offset by a specified minimum distance from the support, where practicable, to reduce nuisance stiffness effects (Figure 9).

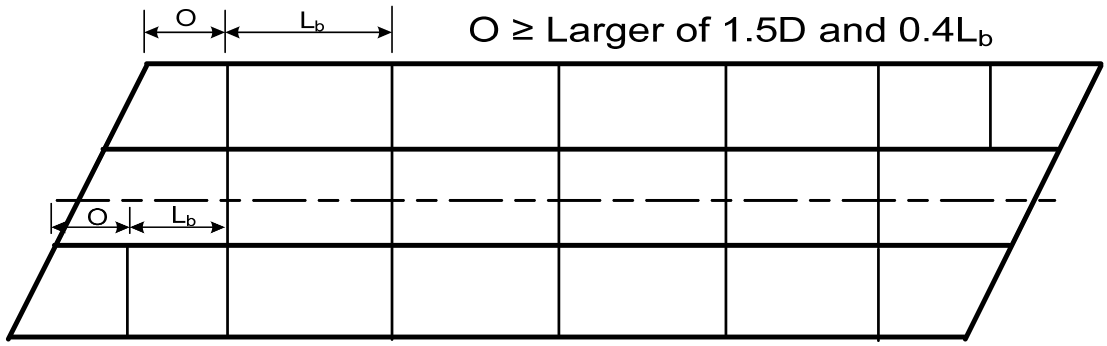

Figure 9 – Recommended Offset of the First Intermediate Cross-Frame Placed Perpendicular to the Girders Adjacent to a Skewed Support to Reduce Nuisance Stiffness Effects

In addition, NCHRP 20-07/Task 355 (White et al., 2015), recommends that the cross-frames can be staggered within the spans as shown in Figs. #a, b and c to both dramatically reduce the number of cross-frames required in the bridge as well as to reduce overall nuisance stiffness effects.

INSERT FIGS #a, b & c

Elimination of skewed interior supports in curved continuous long-span bridges is always desirable, where practicable; an integral pier cap in conjunction with a single-shaft pier is one possible option to avoid a skewed interior support while maintaining adequate vertical clearance. In addition, extending the end spans to eliminate skewed end supports is also a desirable option where practicable.

3. 5. Design & Analysis Considerations

Two different types of forces are influenced by the selected fit condition:

(1) *The bridge internal dead load forces, and*
(2) *The "fit-up" forces, which are external forces the Erector may need to apply to assemble the structural steel during erection.*

In the following, these two force effects are discussed separately in the context of straight skewed and horizontally curved bridges.

3.1 5.1 Straight Skewed Bridges

For SDLF/TDLF on a straight skewed bridge, the cross-frame internal forces due to the SDLF/TDLF detailing are approximately equal and opposite to the internal steel dead load/total dead load (SDL/TDL) forces calculated by building an accurate grid (as defined in NCHRP (2012)) or 3D FEA model, and simply turning the corresponding gravity loads on. The internal forces due to the SDLF/TDLF detailing are not necessarily small; they are approximately equal and opposite to the corresponding internal cross-frame SDL or TDL forces one can estimate from the above type of analysis (or which are nominally present in the cross-frames if the bridge were built with NLF detailing). However, since the locked-in forces due to the SDLF/TDLF detailing are approximately equal and opposite to the above SDL/TDL internal forces, the total internal dead load forces in the cross-frames of a straight skewed bridge detailed for SDLF are small under the SDL (at the completion of the steel erection), and the total internal dead load forces in the cross-frames of a straight skewed bridge detailed for TDLF are small under the TDL (at the completion of the bridge construction).

It is conservative to design the cross-frames in a straight-skewed bridge using the results from an accurate grid or 3D FEA model and neglecting the SLDF or TDLF effects. This is the current common practice when the engineer chooses to utilize more than a line girder analysis for the design. In I-girder bridges having a particularly large skew index (I_s – see Table 2 in Section 7 and Equation 2 below), the cross-frame forces estimated in this way can be significantly conservative. In some cases, this can lead to excessively large cross-frame member designs. As a better alternative to this common practice, a large fraction of the SDL cross-frame forces may be subtracted from the SDL results of an accurate grid or 3D FEA analysis, if SDLF detailing is employed, and a large fraction of the TDL cross-frame forces may be subtracted from the TDL results of these types of analysis if TDLF detailing is employed. Based on the NCHRP 20-07/Task 355 studies (White et al. 2015), it is recommended that 15 % of the SDL or TDL cross-frame forces obtained from the above types of analysis should be considered with the live load effects for the cross-frame designs (i.e., 85 % of the SDL or TDL cross-frame forces may be subtracted from the cross-frame member TDL forces for SDLF and TDLF detailing respectively in straight skewed I-girder bridges). The small 15 % value is a coarse estimate of the influence of various incidental effects that can cause these forces to be *nonzero in the targeted dead load condition. Theoretically, the SDLF and TDLF lack-of-fit effects completely cancel the corresponding SDL and TDL forces in the cross-frames.*

When a line girder analysis is employed for the design of a straight-skewed I-girder bridge, the line girder analysis assumption that the cross-frames have zero force actually is approximately correct in the SDL condition for SDLF, or in the TDL condition for TDLF. However, it should be emphasized that line girder analysis does not provide any estimate of the non-zero cross-frame forces caused by other effects such as live loads, wind loads, and/or stability bracing effects. Also, it should be emphasized that the cross-frame forces are approximately zero only under the corresponding dead load condition (approximately zero forces under SDL for SDLF and approximately zero forces under TDL for TDLF).

Since the I-girder flange SDL/TDL lateral bending stresses are directly related to the cross-frame internal SDL/TDL forces, the above comments also apply to the girder flange lateral bending stresses. Also, it should be noted that the above comments do not apply to the internal cross-frame forces and girder flange lateral bending stresses due to eccentric overhang bracket loads on fascia girders; the effects of these internal forces should be calculated separately and added to the above overall bridge dead load effects.

For straight skewed bridges detailed for SDLF, since the internal cross-frame forces induced by SDLF detailing are approximately equal and opposite to the internal SDL forces obtained from an accurate grid or 3D FEA (or nominally present in the cross-frames if the bridge were built with NLF detailing), little to no forcing is needed to fit the cross-frames and girders during the steel erection, as mentioned above. That is, the required external "fit-up" forces are small. Stated more directly, since the cross-frames are detailed to fit to the elevations at which the girders are deflected under the full SDL of the bridge, the cross-frames fit to the girders, if the girders are deflected under their self-weight during the steel erection, without any significant force-fitting. Later, when final dead loads are applied, the girders deflect and the cross-frames resist the differential deflections. As a result, the girders experience torsion and the cross-frames are subjected to internal dead load forces during deck placement and other subsequent loading of the composite bridge system. In straight skewed bridges detailed for TDLF, the cross-frames must be forced to fit to the girders during the erection of the steel, but the associated internal forces largely come back out when the final dead loads are applied and the system deflects to the TDLF condition.

As the skew approaches zero in a straight I-girder bridge, both the internal forces due to SDLF or TDLF detailing, as well as the fit-up forces required to erect the steel, become small and inconsequential. As the skew increases and the differential deflections increase in a straight-skewed bridge, all of the above effects become more important.

3.2 5.2 Horizontally Curved Bridges

Horizontally curved I-girder bridges also have internal forces that are induced due to SDLF/TDLF detailing and require externally applied fit-up forces to erect the steel. However, there are important differences in the characteristics of both of these types of forces in curved bridges versus straight skewed bridges. The girders in curved bridges require radial forces to be introduced by the cross-frames to satisfy equilibrium with their major-axis bending moments, and to restrain their tendency to twist. SDLF and TDLF detailing tends to increase these internal cross-frame forces, since the cross-frames are used to twist the girders back in the direction opposite to the direction they naturally roll under the dead loads.

The fundamental difference in the behavior with respect to straight skewed bridges is that, in straight skewed bridges, internal dead load cross-frame forces are not required for the equilibrium of the girders. Furthermore, curved girders are generally much stiffer than straight girders and the girder vertical and torsional deflections are generally coupled; therefore curved bridges cannot be detailed for TDLF with the *simple expectation that the girders and cross-frames can be forced together during the steel erection. In fact, there is potentially no practical way to erect some curved bridges detailed using TDLF.*

Curved I-girder bridges have been detailed successfully for SDLF in common practice. As discussed above, this results in some additional internal forces due to the SDLF effects; however, the additional internal cross-frame forces in curved bridges, due to SDLF effects, tend to be relatively small, and as such, these forces can be neglected in most curved bridges (i.e., in bridges for which SDLF detailing is recommended in Table 3 in Section 7) without adverse impacts. As indicated by Table 3 in Section 7, for bridges with longer spans and significant horizontal curvature, NLF is recommended to limit these effects. These types of bridges are more likely to require significant shoring and support during the erection as a matter of course – as such, the bridge can be erected in a "quasi" no-load condition as the general practice and the cross-frames can be easily installed in this shored condition.

3.3 5.3 Calculation of Internal Forces due to SDLF and TDLF Detailing

It is possible to directly calculate the internal "locked-in forces" associated with SDLF or TDLF detailing directly by analysis, but such an analysis is not customary in I-girder bridge design practice. NCHRP-funded research has helped to close this knowledge gap, and findings and recommendations are published in NCHRP (2012), in the NCHRP 20-07/Task 355 report (White et al. 2015), and in Nguyen et al. (20XX). Furthermore, the AASHTO/NSBA Steel Bridge Collaboration "Guidelines for Steel Girder Bridge Analysis", G13.1 (NSBA, 2014), has been updated with findings from NCHRP (2012) aimed at improvement of the internal force calculations.

4. 6. Summary Advantages & Disadvantages of Various Fit Conditions

The advantages of NLF detailing are as follows:

- NLF detailing is completely consistent with the analysis assumptions commonly made in bridge design; that is, it is commonly (and implicitly) assumed in the dead load analysis that the bridge is fully erected in the unstressed (NL) position and then the gravity load is simply "turned on." Thus, the stress state and final geometry of the bridge is as close as possible to that intended by the designer when NLF is used.
- In bridges constructed with some amount of temporary shoring or hold cranes (in the case of longer spans, for example), NLF detailing more closely approximates the actual geometry during erection, resulting in easier fit-up and reductions in additive locked-in force effects.

The disadvantages of NLF detailing are as follows:

- The girders must be adequately supported in the field such that the girder self-weight stresses are reasonably small and the girder webs are plumb. Under this scenario, the cross-frames can be installed without any significant force fitting. As noted previously, for horizontally curved bridges, the girders and bridge units generally need to be supported to some extent under critical erection conditions regardless of the type of fit. However, NLF detailing does not necessarily imply the need to use temporary shoring, nor does the use of SDLF or TDLF detailing imply that temporary shoring cannot be used. As discussed in the Design and Analysis section of this document, the choice of detailing method affects the nature and magnitude of the bridge's internal dead load forces and of the "fit-up" forces which the Erector may need to apply to assemble the structural steel. The nature and magnitude of these forces are also influenced by the use of temporary shoring. Bridges erected without temporary shoring can be detailed for NLF and successfully erected if the fit-up forces are manageable. Likewise, bridges which are to be erected using some form of temporary shoring can be detailed for SDLF or TDLF and successfully erected if the fit-up forces are manageable.
- The girders will deflect out-of-plumb under the dead loads. (However, in curved radially supported bridges, this out-of-plumbness occurs in the spans and not at the supports and is not likely to be objectionable from an aesthetic viewpoint, nor is it likely to be a significant issue from a structural viewpoint as long as the global lateral stability of the bridge is ensured).
- For straight skewed bridges, NLF detailing results in the largest possible cross-frame forces (and corresponding girder flange lateral bending stresses) of all the potential fit options since there are no beneficial compensating or offsetting locked-in forces in the structure. However, in current practice, these are the cross-frame forces and girder flange lateral bending stresses that are commonly calculated for these types of bridges when a 2D or 3D refined analysis is employed.
- At highly skewed end supports, the deck and barriers may be significantly out-of-alignment with the approach; that is, the alignment at the deck joints may be compromised.
- The girder twist rotations due to the total dead loads at skewed end supports should be considered in the design of the bearings, in addition to the other rotational demands on the bearings, since there is no compensation for or offsetting of these rotations by the detailing of

the cross-frames when NLF detailing is used. Section 8.1 provides additional discussion of the bearing rotations at skewed supports.

The advantages of SDLF detailing are as follows:

- The girders will be approximately plumb at the end of erection, when the Erector leaves the site.
- The girders typically require little or no temporary support in straight skewed bridges in order to install the cross-frames.
- Cross-frames typically can be installed with little force-fitting, particularly if the girders can be allowed to deflect under their self-weight. This reduces the erection time.
- The out-of-plumbness of the girders under the total dead loads is less than that corresponding to NLF detailing.
- In straight skewed bridges, a large fraction of the SDL cross-frame forces determined from a structural analysis (and the corresponding girder flange lateral bending stresses) *can be subtracted from the SDL results from an accurate grid or 3D FEA analysis* (see Section 5.1 for the recommended reductions). The cross-frame forces are largely offset by the SDLF detailing effects.
- In horizontally curved bridges, *the additional internal cross-frame forces due to SDLF effects, tend to be relatively small, and as such, these forces can be neglected in most cases (i.e., in bridges for which SDLF detailing is recommended in Table 3 in Section 7) without adverse impacts*.

The disadvantages of SDLF detailing are as follows:

- The girders will be out-of-plumb under the total dead loads (however, as stated previously in Section 1, this out-of-plumbness is not indicative of a structural problem or deficiency).

The advantages of TDLF detailing are as follows:

- Provides approximately plumb girders under the total dead loads.
- At skewed bearing lines, the lateral position of the deck and barriers with respect to the approach and the alignment of the deck joints are more likely to be correct under the total dead loads. The girders are also more likely to rest squarely on the bearings under the total dead loads.
- In straight skewed bridges, a large fraction of the TDL cross-frame forces (as well as the corresponding girder flange lateral bending stresses) determined from the structural analysis *can be subtracted from the TDL results from an accurate grid or 3D FEA analysis*, with the exception of localized effects from eccentric overhang bracket loads (see Section 5.1 for the recommended reductions). The TDL internal cross-frame forces and girder flange lateral bending stresses are largely offset by the TDLF detailing effects.

The disadvantages of TDLF detailing are as follows:

- The girders will be out-of-plumb when the Erector leaves the site since the deck weight and any other composite dead loads will not yet have been applied. However, this out of-plumbness (or girder layover, Δ, in inches) at skewed supports can be estimated with reasonable accuracy using the negative of the girder major-axis bending rotations, ϕ_x, at the supports caused by the deck weight and any other composite dead loads considered as part of the TDL in the following equation:

$$\Delta = \phi_x d(\tan\theta)$$

(1)

where d is the girder depth and θ is the skew angle of the support measured with respect to a line drawn normal to the girder tangent (equal to zero for no-skew). These layovers may be used for inspection of the geometry at the completion of the steel erection.

- The girders are not likely to twist as much as theoretically predicted in some cases when the deck weight is applied (due to incidental restraint from deck forming and deck pans, unintended early setup of the concrete, etc.). As such, the girders may not reach their ideal vertical position unless some approximate adjustments are made in the detailing; these adjustments are usually based on experience and judgment (e.g., use of a fraction of the considered TDL rather than the TDL).
- Since the girders are twisted an additional amount in the opposite direction from that which they want to roll under the dead loads, compared to the result for SDLF detailing, larger forces generally are required during the cross-frame installation. This is particularly true for horizontally curved bridges.
- In horizontally curved bridges, the additive locked-in force effects are likely to be significant in the majority of cases. Practically speaking, these effects are not readily calculable for consideration in design at the present time, although NCHRP 20-07/Task 355 (White, et al. 2015) and Nguyen et al. (2015) provide specific guidelines and software tools for calculating these effects.
- TDLF detailing tends to amplify uplift in horizontally curved bridges at supports where uplift is detected due to the design loads, due to combined curvature and skew effects, poor span balance, etc. TDLF also tends to increase the elevations of all the girders within the bridge spans in horizontally curved bridges, which may make it more difficult to achieve the desired bridge profile. The NCHRP 20-07/Task 355 studies provide some quantification of these increases in the girder elevations.

5. 7. Recommended Fit

Tables 2 and 3 provide general fit recommendations. The goals of these recommendations are:

(1) To facilitate fit-up (i.e., assembly of the steel) during erection;
(2) To limit bearing rotation demands and to facilitate deck joint alignment and barrier rail alignment at skewed bearing lines; and
(3) In horizontally curved bridges, to limit the magnitude of additive locked-in dead load force effects.

These recommendations reflect historic experience blended with improved understanding of the fit behavior of I-girder bridges from recent research.

TABLE 2 - RECOMMENDED FIT CONDITIONS FOR STRAIGHT I-GIRDER BRIDGES (INCLUDING CURVED I-GIRDER BRIDGES WITH *L/R* IN ALL SPANS ≤ 0.03 +/-)[1]

Square Bridges and Skewed Bridges up to 20 deg +/- Skew			
	Recommended	***Acceptable***	***Avoid***
Any span length	Any		None
Skewed Bridges with Skew > 20 deg +/- and $I_s \le 0.30$ +/-			
	Recommended	***Acceptable***	***Avoid***
Any span length	TDLF or SDLF		NLF
Skewed Bridges with Skew > 20 deg +/- and $I_s > 0.30$ +/-			
	Recommended	***Acceptable***	***Avoid***
Span lengths up to 200' +/-	SDLF	TDLF	NLF
Span lengths greater than 200' +/-	SDLF		TDLF & NLF

TABLE 3 - RECOMMENDED FIT CONDITIONS FOR HORIZONTALLY CURVED I-GIRDER BRIDGES ($(L/R)_{MAX} > 0.03$ +/-)[1]

Radial or Skewed Supports			
	Recommended	***Acceptable***	***Avoid***
Span lengths greater than 250' +/- and *L/R* > 0.1 +/-	NLF[3]	SDLF	TDLF
All other cases	SDLF[2]	NLF	TDLF

Note 1: For the various recommended fit conditions presented in Tables 2 and 3, the span length, skew, and curvature limits should be considered approximate guidelines and should be evaluated in the full context of the geometric and structural complexity of the given bridge.

Note 2: The recommendation of SDLF up to about 250' in Table 3 is based on many years of practice: use of SDLF has been almost universal for long span curved I-girder bridges *such as direct connectors and curved ramps. The recommendation transitions to NLF above this length because limited studies of these types of bridges show that the increase in the cross-frame forces from SDLF and TDLF detailing can become significant as spans get longer and radii get smaller. NLF matches the normal analysis methods used in the design and will provide a better match between predicted forces and displacements than SDLF when the steel dead load displacements become large.*

Note 3: The recommendation to use NLF detailing does not necessarily imply the need to use temporary shoring, nor does the use of SDLF or TDLF detailing imply that temporary shoring cannot be used. As discussed in Section 5 of this document, the choice of detailing method affects the nature and magnitude of the bridge's internal dead load forces as well as the "fit-up" forces which the Erector may need to apply to assemble the structural steel. The nature and magnitude of these forces are also influenced by the use of temporary shoring. Bridges erected without temporary shoring can be detailed for NLF and successfully erected if the fit-up forces are manageable. Likewise, bridges which are to be erected using some form of temporary shoring can be detailed for SDLF or TDLF and successfully erected if the fit-up forces are manageable.

The generalized terms used in these tables are as follows:

- L = actual span length, bearing to bearing along the centerline of the girder
- R = radius at bridge centerline
- I_s = skew index, defined as follows (AASHTO LRFD Eq. 4.6.3.3.2-2):

$$I_s = \frac{w_g \tan\theta}{L} \quad (2)$$

where:

- o w_g is the bridge width perpendicular to the centerline, fascia girder to fascia girder, and
- o θ is the maximum skew angle of the bearing lines at the end of a given span measured from a line perpendicular to the span centerline (equal to zero for no skew).

For continuous-span bridges, I_s is defined as the largest value for any of the spans. Equation 2 has been observed to be a useful indicator of the influence of skew on the potential development of transverse load paths in the bridge system in straight skewed bridges (NCHRP, 2012). A strong correlation was found between I_s and the general magnitude of the cross-frame forces caused by skew. For highly curved bridges, there is a complex interrelationship between the direction of the skew and the direction of the horizontal curvature when considering the fit behavior. Therefore, in highly curved bridges, the associated effects are more involved than just the consideration of I_s.

Both SDLF and TDLF are customary long-used industry practices for straight bridges, but they are not used universally for all situations. That is, there are trade-offs between the two approaches. TDLF results in a bridge whose webs are nominally plumb after construction and produces smaller rotation demands at the bearings. However, at the end of the steel erection there will be an initial girder layover (until final dead loads are applied), and the girders and cross-frames must be forced together during erection. The use of such force is common, but may not be workable in some cases for longer span highly-skewed bridges.

Conversely, SDLF makes straight skewed bridges easier to erect and results in webs that are plumb after erection; however, after the final dead loads are applied, some girder layover will be present. This final layover is not known to cause any particular girder behavior problems as long as the overall bridge system is globally stable. However, the bearings must be able to accommodate the associated girder rotations.

Generally NLF is not recommended for straight skewed bridges because NLF would lead to a need to accommodate girder twist rotations at the abutment bearings that can otherwise be avoided, and it does not facilitate fit-up or improve the final plumb condition. In the limiting condition of a bridge which is straight with no skew in any of the supports, (i.e., a "square" bridge), the effects of the fit condition become small and essentially inconsequential and the results of the different cross-frame detailing methods are all the same.

In horizontally curved bridges, *the additional internal cross-frame forces due to SDLF effects, tend to be relatively small, and as such, these forces can be neglected in most cases. However, for longer span curved bridges with significant horizontal curvature, as quantified in Table 3, the designer should evaluate the additive force effects from SDLF before specifying this method of detailing*. The local twisting of I-girders to make connections also tends to become more difficult for bridges having longer spans and tighter curves. In these cases, NLF is recommended as a preferred option.

In some cases, it may be desirable to use an intermediate fit condition, e.g., somewhere in-between SDLF and TDLF in order to achieve a better balance of the preceding objectives for a given project, particularly if the bridge geometry is relatively complex. To facilitate an informed decision, the designer can discuss their bridge with experienced fabricators, detailers, erectors, and contractors. The Engineer of Record should be kept informed of the decision so that any necessary re-evaluations of the design performance, such as the rotation demands on the bearings at skewed end supports, can be made.

The recommendations in Tables 2 and 3 assume that the proper steps have been taken to ensure global stability of the bridge system during construction, as detailed in AASHTO LRFD Article 6.10.3.4.2 (2015 Interims to the 7^{th} Edition).

6. **8. Special Considerations**

6.1 8.1 Bearing Rotations at Skewed Supports

At skewed bearing lines, the girder layover can contribute substantially to the bearing rotation demands. AASHTO LRFD Article 2.5.2.6.1 requires that the computed bearing rotations in skewed bridges be accumulated over the assumed construction sequence. The accumulated factored bearing rotations due to the dead loads at any construction stage (as affected by SDLF or TDLF detailing effects, when these types of detailing are used) are not to exceed the rotation capacities of the bearings.

Girder layover occurs at skewed bearing lines due to the dead and live load effects as discussed in Section 2. However, when SDLF or TDLF detailing is used, "relieving" layovers (in the direction opposite to the layover caused by dead loads) are induced at skewed bearing lines. These relieving layovers can partially or fully offset the effects of dead load layovers; however, before the various dead loads are in place, the girders can have layovers that are opposite in direction to that caused by the dead loads.

In addition, the vertical load demand on the bearings is different at each stage of construction (structural steel alone, structural steel plus deck, etc.) as well as under in-service conditions (bridge open to traffic, subject to live load, thermal expansion/contraction, wind loads, etc.). Therefore, designers should consider the bearing load and rotation demands that occur at each stage of construction and service (i.e., under NL conditions, SDL conditions, and TDL conditions) when designing the bearings.

The designer should keep in mind that the rotation demands on the bearings during construction are temporary. The bearings can be designed to accommodate these demands, or if these temporary rotations are a cause for concern, the girders can be "blocked" (i.e., supported on temporary blocking) to protect the bearings during construction. If the rotational demands on the bearings are excessive under final conditions, one way to mitigate these effects and reduce long term rotational demand on the bearings is to use beveled sole plates, with the sole plate bevels determined so as to compensate for the girder layover and provide a level surface at the top of the bearing.

In addition, it should be noted that the girder layovers at interior piers of continuous spans are generally much smaller than at the end supports, and thus the bearing rotation demands at the interior bearing lines on continuous-span bridges are generally much smaller.

Listed below are some specific considerations related to bearing rotational demands, associated with the various fit conditions:

- For TDLF detailing, where the bearings can be protected by blocking during the steel erection, the maximum rotation demand from the girder twisting occurs at the completion of the steel erection, when the blocks commonly are removed prior to the concrete deck placement; the magnitude of this rotation is equal to the girder twist rotation caused by the TDL minus the girder twist rotation due to the SDL. Where the bearings are not protected by blocking during the steel erection, the maximum girder layover during the erection is due to the TDLF detailing effects and it can be estimated directly as the negative of the girder rotations caused by the TDL. These rotations can cause uneven seating or lift-off at the bearings. However, these rotations are temporary and will be removed when the TDL is applied and the girders rotate to an approximately plumb position. For TDLF detailing, the maximum rotations in the completed bridge occur under the live loads. However, the girders are approximately plumb at the skewed bearing lines under the nominal TDL and therefore, the dead load contribution to the twist rotation about the axis of the girders is essentially zero. This is contrary to the assumption often made in design practice that the bearings are level and plumb under NL and "fully rotated" under the TDL and live load.

- For SDLF detailing, there is essentially zero net layover at the bearings at the completion of the steel erection. Layovers can occur prior to completion of the steel erection, and uneven seating or lift-off may be observed at the bearings during the erection at highly skewed end supports (since the vertical loads may not be large enough to maintain contact between the sole plates and the bearings). However, these are temporary conditions that will be relieved as the erection proceeds and the girders rotate to an approximately plumb position. As such, these rotations usually should not be a cause for concern. If there is concern, the bearings can be protected against these rotations by blocking. The girder layovers due to SDLF detailing effects are opposite to the girder rotations caused by the SDL.
- For SDLF detailing, the maximum final rotation demand from the girder twisting occurs due to the effects of the additional dead load applied after the structural steel is fully erected (i.e., the additional dead load associated with the changes from the SDL to the TDL condition) plus the subsequent live load effects; however, this rotation is smaller than if the bridge is detailed for NLF. The girders are approximately plumb at the skewed bearing lines at the completion of the steel erection, and they rotate out-of-plumb under the subsequent dead and live loads.
- For NLF detailing, the girder twist rotations at the skewed bearing lines are small during the construction as long as the girders are adequately supported in their NL position, since there are no compensating effects from the detailing of the cross-frames. The girder layovers from SDL and TDL contribute additively to the final rotation demands on the bearings. This is consistent with typical design approaches that ignore the temporary conditions and focus on the final load and rotation demands on the bearings. However, it is important to note that at highly skewed bearing locations, the use of NLF detailing and/or the neglect of SDLF or TDLF detailing effects can result in substantial dead load layover (substantial rotation demand) for bearing design. This is one reason why Table 2 recommends that NLF should be avoided for sharply skewed bridges.
- In all of the above cases, AASHTO LRFD requires that various factored load combinations be considered in determining the rotation demands for the design of the bearings. Although the SDLF and TDLF detailing effects are technically "locked-in" force effects, these effects are closely tied to the corresponding dead loads. Therefore, the LRFD dead load factors should be used for these effects, not the load factors for the *EL* load case. The factored twist rotations associated with the SDLF or TDLF detailing effects are to be superimposed with the appropriate factored dead and live load effects to obtain the total factored twist rotation demands on the bearings.

The girder twist (layover) rotations at skewed bearing lines due to the SDL or the TDL effects alone (unfactored or factored) may be estimated as

$$\phi_z = \phi_x \tan\theta \quad (3)$$

where ϕ_x is the girder major-axis bending rotation due to the desired dead load effect, and θ is the skew angle of the support measured with respect to a line drawn normal to the girder tangent (equal to zero for no-skew). This equation is applicable as a reasonable approximation for both straight skewed and curved and skewed bridges.

The total rotational demands on the bearings at a skewed bearing line should consider both the twist and the major-axis bending rotations from the girders (i.e., the dead and live load rotations about the longitudinal axis of the girders as well as the dead and live load rotations about the transverse axis of the girders). It is important to recognize that the initial camber of the girders generally offsets the girder major-axis rotations at the bearings due to the TDL, much like the TDLF effects offset the girder twist rotations due to the TDL. Depending on the type and configuration of the bearings, it may be appropriate to consider the vector sum of the two orthogonal rotational demands to determine the total rotational demand on the bearings, that is:

$$\text{Total Bearing Rotation Demand} = \sqrt{\Phi_X^2 + \Phi_Z^2} \quad (4)$$

where Φ_x and Φ_z are the maximum factored major-axis and twist rotation demands, respectively, for the LRFD load combination being considered.

One should keep in mind that, for skewed and/or curved bridges, the bearing vertical reactions for each girder at any given support will likely be different. In some cases (i.e., severe skew or severe curvature), one or more bearings at a given support may experience uplift under certain loading conditions. An accurate 2D grid or 3D finite element analysis may be appropriate or necessary to properly quantify the bearing reactions for some curved and/or skewed bridges.

In summary, it is critical that designers fully consider the vertical load, horizontal load, and rotational demands on bearings at critical stages of construction and under final, in-service conditions. The choice of fit condition (NLF, SDLF, or TDLF) affects the girder twist (layover) rotation demands. In addition, the girder cambers affect the bearing major-axis rotation demands. A step-by-step evaluation of the concurrent vertical and horizontal loads and the longitudinal and transverse rotations at each stage of construction and under final in-service conditions should be performed to identify all potentially critical bearing design cases. In addition, designers should consider options to mitigate or reduce the rotational demands on bearings, including the use of beveled sole plates (potentially beveled both longitudinal and transversely), and specifying that girders be blocked to protect bearings during the steel erection. The use of TDLF and SDLF reduces girder layover rotations at skewed bearing lines. Engineers should include this consideration when choosing the method of detailing, but this is only one of a number of pros and cons that must be considered in making a fit decision. Fit-up during erection, when that may be an issue, is typically the overriding consideration.

6.2 8.2 Bolt Holes & Bolt Tightening

Unless otherwise permitted in the contract documents, oversize or slotted holes are not permitted for bolted cross-frame connections in horizontally curved bridges (AASHTO LRFD Article 6.13.1). This requirement is specified to ensure sufficient control of the geometry during the bridge construction. The perceived advantage of using oversize or slotted holes to aid in the fit-up can prove to be disadvantageous in terms of the overall loss of the geometry control in these types of bridges.

Vertical slotted holes have sometimes been used in the cross-frame connections of straight skewed bridges in an attempt to minimize the girder twisting and reduce the cross-frame forces. The use of vertically slotted holes nullifies the results of any analysis that assumes that the cross-frames are effective in resisting dead loads applied prior to tightening of the cross-frame bolts. If the bolts are left loose in these holes during the placement of the deck, there is a corresponding loss of geometry control and the girders will likely deflect differently than predicted. The Erector will also have to return to the site to tighten the bolts after the deck is cast, a potentially cumbersome, time-consuming and costly operation. If the bolts are tightened prior to the deck placement, the slots must be of the proper size and location to allow the SDL deflections to occur freely (assuming that it is desired that no forces should be induced in the cross-frames). The resistance of the bolts in the slotted holes is reduced for all loads that are applied after the bolts are tightened. Thus, the use of vertical slotted holes is not recommended.

Ideally, installed bolts in curved bridges should be tightened as the erection progresses to help maintain the geometry of the steel. However, it is common that not all bolts are installed in the connections, and those that are installed typically are not fully tightened as the erection progresses. Final installation and tensioning of all the bolts typically occurs after the steel is substantially or fully completed. Recommendations are specified in Article 2.2.7 of AASHTO/NSBA (2014a) regarding the minimum number of standard-size holes that should be filled with erection bolts, pins and/or bolts in at least a snug-tight condition in connections of horizontally curved bridges during the erection. These recommendations should be followed to help maintain the geometry of the erected steel. All bolts in both skewed and curved bridges should be fully tightened and inspected prior to the deck placement to preserve the bridge geometry during this operation and to avoid the need for the Erector to go underneath the bridge to tighten the bolts after the completion of the deck.

6.3 8.3 Shop Assembly

Full shop assembly of the entire bridge or any significant portion of the bridge is not customary and is typically not needed, except possibly for highly complex framing (e.g. SPUI structures) detailed for NLF. Such a requirement adds unnecessary cost to projects that utilize less complex and more conventional framing. Full shop assembly cannot be done if the bridge has been detailed for SDLF or TDLF. The cross-frames will not fit to the girders with the girders blocked to their fully-cambered NL geometry.

6.4 8.4 Tub Girders

Steel tub girders with properly designed top flange lateral bracing effectively behave as closed sections, and as such, they are torsionally quite stiff. Straight or slightly curved tub girders without external intermediate diaphragms generally exhibit little twist under non-composite loading. Tub girders with longer spans and more significant curvature are potentially subject to more significant twisting of the individual girders, but this is often controlled and minimized by providing external intermediate cross-frames. Helwig et al. (2007) provide a simple preliminary analytical procedure to help determine if external intermediate cross-frames are needed to help control twist deformations in curved tub girders.

Tub girders are typically designed and detailed to be normal to the deck (cross-slope of the roadway) with all of the webs having equal depth (Figure 10). Thus, the concepts of NLF, SDLF, and TDLF -- with their reference to identifying a fit condition that results in the girders being plumb under a given loading condition -- do not apply. Also, since tub girders are inherently torsionally stiff, it is difficult to twist them in the field to achieve fit-up of external cross-frames. As a result, tub girder external cross-frames are typically detailed and fabricated to fit to the girder geometry under NL or SDL conditions depending on the intended erection sequence. In addition, depending on the magnitude of their twist deformations under loading, tub girders may need to be detailed and fabricated with a built-in "reverse" twist so that when they twist under dead load, they deflect to a position normal to the roadway cross-slope. The camber of the two webs in skewed and/or curved bridges can be significantly different.

A detailed discussion of tub girders is beyond the scope of this document; instead it is recommended that the detailing of tub girders to facilitate proper fit-up and control of the constructed geometry be addressed on a case-by-case basis, in consultation with experienced tub girder designers, detailers, fabricators, and erectors.

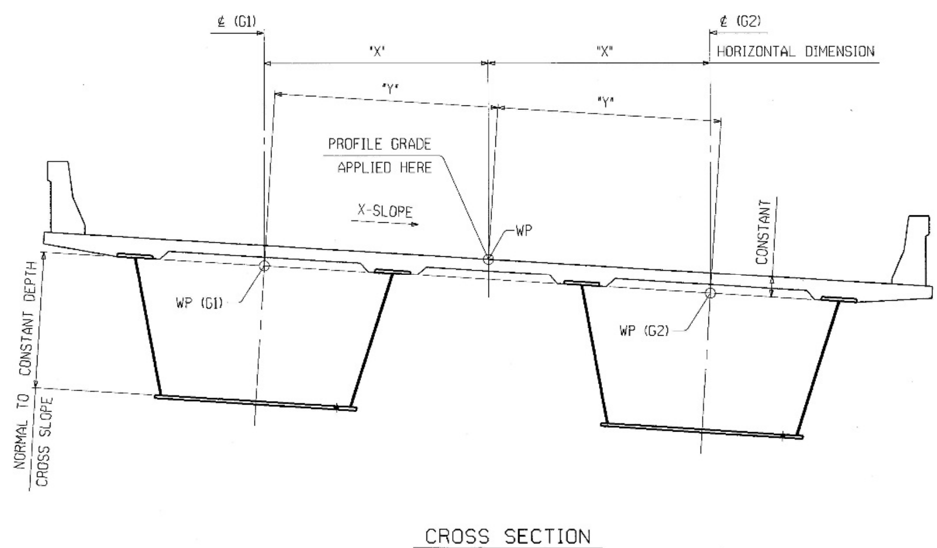

Figure 10 - Orientation of Steel Tub Girders Normal to the Deck (adapted from AASHTO/NSBA (2006))

7. 9. Conclusions

In curved and skewed I-girder bridges, the relationship between the girders changes as gravity loads are applied and the girders deflect. These changes introduce internal loads and affect the fit-up of the steel during erection; if the changes are significant, special considerations are needed to manage the internal loads and the constructed geometry, and to ensure that the bridge can be built.

Curved and skewed steel I-girder bridges are successfully fabricated and erected nearly every week. Making the right fit choice is one key consideration that can impact the ability of designers, fabricators and erectors to ensure the completion of a successful project. The best fit choice is an informed one understood all of the stakeholders.

8. 10.Definitions

Contiguous Cross-Frames - Intermediate cross-frames arranged in a continuous line across the entire bridge cross-section.

Cross-Frame - A transverse truss framework connecting adjacent I-girders used to transfer and distribute vertical and lateral loads and to provide stability to the girder compression flanges. In this document, only the term cross-frame is used; the term cross-frame is considered to be synonymous with the term diaphragm herein.

Diaphragm – A vertically oriented solid transverse member connecting adjacent I-girders to transfer and distribute vertical and lateral loads and to provide stability to the compression flanges, sometimes used to refer to both solid-web transverse members as well as cross-frames. In this document, only the term cross-frame is used; the term cross-frame is considered to be synonymous with the term diaphragm herein.

Discontinuous Cross-Frames – Intermediate cross-frames arranged in a discontinuous line across the bridge cross-section.

Drop - The difference in the vertical elevation between the top of the girder webs at a cross-frame location under the No-Load (NL) or a targeted dead load condition. For SDLF or TDLF, the drops are calculated by the Detailer by subtracting the vertical dead load deflections provided on the Design Plans from the fully-cambered No-Load (NL) geometry, with consideration of the roadway profile and deck cross slope. Alternatively, some Detailers may start from the TDL position and add the appropriate deflections to that position (e.g., the TDL minus the SDL deflections for a SDLF, or the TDL deflections for a NLF) in order to determine the girder geometry in the targeted fit condition. The goal is for the cross-frames to fit to the girders in these idealized deflected positions (or undeflected positions for NLF), thus achieving the desired fit condition. It is important to note that, generally, there are two major contributors to the detailing of the cross-frame geometry. The drops are one contributor. The other contributor, particularly at skewed cross-frame lines, is the girder connection plate rotated positions in the targeted geometry.

Fit-Up Forces – External forces that may need to be applied by the Erector to connect the steel together during the erection.

Girder Major-Axis Bending Rotation, φ_x – A rotation of a girder about its own major axis, i.e., the axis perpendicular to the girder web, causing displacements that are parallel to the plane of the web.

Girder Twist Rotation, φ_z – A rotation of a girder about its own longitudinal axis resulting from twisting, causing displacements out of the plane of the web.

Locked-in Forces – The internal forces induced into the structural system when SDLF or TDLF detailing is employed. These internal forces are caused by the lack-of-fit detailed between the cross-frames and the girders in the base fully-cambered No-Load (NL) geometry. These internal forces would remain if the structure's dead loads were theoretically removed. The locked-in forces in the cross-frames of straight skewed bridges are largely opposite in sign to the corresponding targeted dead load effects. The locked-in forces in the cross-frames of curved radially supported bridges are largely additive to the dead load effects. When the locked-in forces are opposite in sign to the dead load forces, they offset them, resulting in reduced total internal dead load forces (approximately zero in the targeted dead load condition for straight skewed bridges).

No-Load Fit (NLF) Detailing – A method of detailing in which the cross-frames are detailed such that the cross-frame connection work points fit with the corresponding work points on the girders without any force-fitting, with the girders assumed erected in their fully-cambered (plumb) geometry under zero load. When NLF detailing is employed, the girders will twist and rotate out-of-plumb about their respective longitudinal axes under the dead loads. Girders at non-skewed supports will remain plumb throughout. NLF detailing is also synonymously referred to as fully-cambered fit detailing.

Nuisance Stiffness – An undesirable stiff transverse load path in the structural system near skewed supports that can result in excessively large cross-frame forces at these locations, and somewhat difficult cross-frame installation along (and adjacent to) the skewed support line. Nuisance stiffness effects can be attenuated when cross-frames are provided along a skewed support by offsetting the first intermediate cross-frame placed perpendicular to the girders adjacent to that support, where practicable, by the minimum recommended distance indicated in AASHTO LRFD (7th Edition) Article C6.7.4.2, and by providing discontinuous cross-frame lines in the vicinity of skewed interior supports.

Skew Angle, θ – The angle of skew measured with respect to the normal to a girder tangent. A zero skew angle corresponds to no skew according to the definition of θ herein.

Steel Dead Load Fit (SDLF) Detailing – A method of detailing in which the cross-frames are detailed such that the cross-frame connection work points fit with the corresponding work points on the girders with the steel dead-load deflections and the associated girder major-axis rotations at the connection plates (where applicable) subtracted from the fully-cambered geometry of the girders, and with the girder webs assumed in an ideal plumb position under the Steel Dead Load (SDL) condition at the completion of the steel erection. When SDLF detailing is employed, installation of the cross-frames will result in the girders twisting and rotating out-of-plumb about their respective longitudinal axes in the direction opposite to the girder twist under the SDL. The girders will be approximately plumb at the completion of steel erection, and will twist out-of-plumb when the deck weight and any other subsequent loads are applied. The girders at non-skewed supports will remain plumb throughout. SDLF detailing is also synonymously referred to as erected-fit detailing.

Total Dead Load Fit (TDLF) Detailing – A method of detailing in which the cross-frames are detailed such that the cross-frame connection work points fit with the corresponding work points on the girders with the total dead-load deflections and the associated girder major-axis rotations at the connection plates (where applicable) subtracted from the fully-cambered geometry of the adjacent girders, and with the girder webs assumed in an ideal plumb position under the Total Dead Load (TDL) condition. When TDLF detailing is employed, installation of the cross-frames will result in the girders twisting and rotating out-of-plumb about their respective longitudinal axes in the direction opposite to the girder twist under the TDL. The girders will be out-of-plumb at the completion of steel erection, and will be approximately plumb when the deck weight and other considered contributions to the total dead load are applied. The girders at non-skewed supports will remain plumb throughout. TDLF detailing is also synonymously referred to as final-fit detailing.

9. 11.References

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