NCHRP Project 12-71
Design Specifications and Commentary for Horizontally Curved Concrete Box-Girder Highway Bridges

Appendix D
State of Practice Summary for the United States
**California Colorado Florida Hawaii Idaho Nevada New York Oregon Tennessee Texas Washington Wisconsin**

1. **Number or Percentage of Curved Concrete Box Girder Bridges in Inventory**
   - **Concrete**: 45% of all bridges have concrete box
   - **Box Girder**: Out of a total of 950 bridges, 10-20 are box girder, mostly ramps
   - **Concrete Box**: Mostly balance carriageway
   - **Curved Bridges**: 39% of all bridges are curved, 10-20 are curved box, mostly ramps

2. **Method of Construction Used**
   - **Segmental Construction**: Some, perhaps more in future (Carriageway and span-by-span, both Precast and CIP)
   - **Precast Girders with CIP Deck**: None built, but OK for future (Girders are chords)
   - **Precast Tubing**: Using spliced precast tubing with CIP deck

3. **Percentage of Bridges with Geometric Attributes**
   - **Single Span**: 15%, 75% (maybe only one)
   - **Constant Width Multispan**: 50%, 50% (Majority are constant depth. Many with integral pier caps but most have 2 bearings)
   - **Skewed Abutments**: 30%, 15% (Most)

4. **How Will the Answers to Questions 1 to 3 Change in the Future**
   - **Trend**: To longer spans, more precast tubs, and precast segments

5. **Identify and Describe Your Problems with Curved Concrete Box Girder Bridge**
   - **Surface Crack Along Tendon Path**: Much use tendons in webs
   - **Bearing Uplift or Overload**: Shasta County
   - **Shear/Torsion Cracking**: No

6. **Other Information**
   - **5,000 Bridge Inventory**: 1/3 of inventory are box girders; 80% of these are curved. Of these RC/PT is 50/50. Everything over 130' is PT.

---

**NCHRP 12-71 - Design Specifications and Commentary for Horizontally Curved Box Girder Highway Bridges**

**Results of State-of-Practice Survey of Selected State DOTs**

**Table**: Identifying and describing problems with curved concrete box girder bridges.
**NCHRP 12-71 - Design Specifications and Commentary for Horizontally Curved Box Girder Highway Bridges**

**Results of State-of-Practice Survey of Selected State DOTs**

### Unexpected Displacements

<table>
<thead>
<tr>
<th>California</th>
<th>Colorado</th>
<th>Florida</th>
<th>Hawaii</th>
<th>Idaho</th>
<th>Nevada</th>
<th>New York</th>
<th>Oregon</th>
<th>Tennessee</th>
<th>Texas</th>
<th>Washington</th>
<th>Wisconsin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, mainly on skewed supports where movement about CG of column group causes the shear key to engage</td>
<td>More due to skew</td>
<td>Because balanced paneliker construction, displacements are well controlled</td>
<td>No</td>
<td>Yes in steel box, but not in concrete</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>None</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

### Other Problems

| Lateral displacement of columns | Problems have occurred because expansion joints must accommodate multidirectional displacements | Deck replacement an issue - difficult to do | No |

### Describe Design and Construction Procedures

| Type of Global Analysis | SBC, C-I bridge may do a better job for curved | Typically 2D with adjustments. 3D at designers discretion to Rx > 800 ft. 3D more common with multiple webs | Not prescribed - Most designs use 2D analysis with supplementation by 3D analysis | 3D analysis, SAP, FEM | 3D FEM for R > 800 | FEM, case by case | No guide | Always 2D plane frame (usually STRUDL) |

| Wheel Load Distribution | Nothing special | UDL tabulated via program for spread box beams | None | AASHTO and influence surfaces | None | AASHTO, unless FEM is used | AASHTO | No guide |

| Distribution and Sequence of Longitudinal Prestressing | Nothing special; Allowing contractor to distribute the PT with variation may be a problem | Usually the same. Designer’s discretion if girder lengths materially different | Established by designer and included in the construction documents | Nothing specific | None | Yes, but no guidelines | Y | Nothing special |

| Prevention of Tendon Breakout | Nothing special, except tendon loss | Memos for addressing breakout. 1:24 maximum flare. Construction quality an issue. | Have had no problems | No | Caltrans details | Caltrans Details | Y | Nothing special |

| Design of Bearings | Nothing special | Designed for vertical and torsion. | Not prescribed - Most designs use 2D analysis with supplementation by 3D analysis | No guide | None | Use all bearing, but less spherical bend | No guide | Have not done extra, but sometimes more dead loads for exterior girders |

| Torsion Design | Nothing special | Consider vertical and torsion for outside and inside web | Torsion demands obtained from 3D frame analysis and results | No | Code | No guide | Y | Nothing needed, don’t design for torsion |

| Design of Web Reinforcing for Combined Shear and Transverse Bending | Memo to designers Chapter 11 | LRFD 2000 - use modified compression field theory with interaction with web | Designer’s choice | No, case by case | Concrete, Caltrans | Y | Nothing needed |

| Number and Spacing of Diaphragms | Nothing special, do not believe interior | Use as few as possible at designer discretion | Diaphragms placed at support locations | No | No guide, but usually use at 40’ OC | Midspan for curved or straight with L > 100’ | No guide | Follow AASHTO |

### Other Quality Control

| Describe Design and Construction Procedures | Memo to designer, checker, tester | Quality control - designer, checker, tester |

### Other Comments

| | | | | | | | | | | | |

---

### Notes

- **a** Type of Global Analysis: SBC, C-I bridge may do a better job for curved.
- **b** Wheel Load Distribution: Usually 2D with adjustments. 3D at designers discretion to Rx > 800 ft. 3D more common with multiple webs.
- **c** Distribution and Sequence of Longitudinal Prestressing: Typically 2D plane frame (usually STRUDL).
- **d** Prevention of Tendon Breakout: Usually the same. Designer’s discretion if girder lengths materially different.
- **e** Design of Bearings: Consider vertical and torsion for outside and inside web.
- **f** Torsion Design: Torsion demands obtained from 3D frame analysis and results.
- **g** Design of Web Reinforcing for Combined Shear and Transverse Bending: LRFD 2000 - use modified compression field theory with interaction with web.
- **h** Number and Spacing of Diaphragms: Use as few as possible at designer discretion.

---

D-4