APPENDIX G. STRAIN GAUGE DATA

This Appendix will graphically outline the strain gauge data collected for all specimens in the final test to failure. No plots are presented for the elastic scenarios investigated for each specimen. Interested reader can contact the PI for raw data files if they need more detailed information about strains during the elastic loading.
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DESCRIPTION OF GAUGE LOCATIONS

In total there were approximately 200 strain gauges used during every gusset plate test. All the strain gauges used in the project were manufactured by Tokyo Sokki Kenkyujo Co. Ltd. and purchased from Texas Measurement, Inc. (TML). All the uniaxial strain gauges had 6 mm grids (FLA-6) and the rosettes were 3-element 45°/90° stacked rosettes with 6 mm grids (FRA-6).

The interior surface of every gusset plate had nine rosettes applied according to the dimensions shown in Figure G1 and Table G1. All rosettes applied to both the north and south plates used the same orientation as shown in the figure, from an observer’s standpoint outside the connection looking from south to north. In other words, the 90 degree gauge on the rosette was vertical, the 45 degree gauge was inclined to the east, and the 135 degree gauge was inclined to the west on both plates. In addition, five uniaxial strain gauges were affixed near the end of each of the diagonal members as shown in Figure G2.

Figures G3 through G7 outline the strain gauge placement on the five reusable members of the connection. One cross-section, approximately at the mid length of the member, was heavily gauged so the internal axial and bending moments could be determined. In addition, the two chord members also got a line of gauges near the top and bottom corners to try to deduce how load may shed from the member into the gusset plate.

Figure G8 shows the locations of all the uniaxial gauges applied to the chord splice plates.

DESCRIPTION OF PLOTS

For each specimen a series of 25 plots is presented that should outline the data collected from most strain gauges affixed to each specimen. For some specimens, there may be more plots as in some special circumstance there were extra gauges applied.

No data is presented from the gauges affixed to the splice plates. The data from these gauges was judged not to be worthy as the strain gradient were very sharp throughout the plate as a consequence of the tight the hole spacing. Attempts were made to analyze the data from the splice plate gauges but it proved to be futile.

In the sections entitled “Maximum Shear Strain Plots,” are two graphs of the maximum shear strains for the five collinear rosettes along the horizontal plane above the chord. One plot is from the five rosettes on the north plate, the other from the five rosettes on the south plate. They are plotted versus the distance along the width of the plate where the west edge of the plate is considered the origin. As a reference, the compression diagonal framed into the connection from
the west. Four plots are presented within each graph corresponding to the strain readings at approximately the ¼, ½, ¾ and maximum applied load fractions (ALF). The ALF is the proportion of the applied reference load combination. Also shown in each of these graphs is a dashed line which corresponds to the maximum shear strain calculated using the yield strength of a uniaxial specimen.

In the section entitled “Variations in Principal Strain” are 10 graphs, where each graph shows the data from each individual rosette affixed along the horizontal plane just above the chord. Four plots are presented for each rosette, “ε1” is the first principle strain, “ε2” is the second principle strain, “γ_max” is the maximum shear strain, and “θ1” is the angle to the first principle strain direction. As a note, the 45, 90, and 135 degree gauges within the rosettes were always oriented in the same manner. That is, from a prospective outside of the assembled connection, looking from south to north, the 90 degree orientation was straight up, the 45 degree orientation was to the right, and the 135 degree to the left. This orientation was used for both the north and south plates. This is also shown in Figure G1. All data are plotted against the ALF along the horizontal axis. As a reference, the maximum shear strain for the measured yield stress is shown as a dashed line.

In the sections entitled “Member Cross-Sectional Plots” are five graph that outline the post-processed strain data from the five members. A least-squares fit strain plane was fit to all the individual strain gauges readings. Then using the member cross-sectional properties, this strain plane was integrated to get the measured axial load, strong axis moment, and weak axis moment internal to the member. Also shown is the combined axial load coming from the two jacks, or in the case of the west chord, the resolved reaction force based on equilibrium. Each plot within the graphs is plotted versus the ALF throughout the test.

In the sections titled “Chord Load Shedding Plots” represents the data collected from the lines of uniaxial gauges affixed to the four corners of the chord members. The intent of the gauges was to try and capture how the load transfers between the chord and the gusset by seeing over what distance it takes for the strain to decrease to zero, or how the load sheds from the chord into the gusset. Four graphs are presented, each plots the four gauge lines against the distance away from the theoretical chord splice location. Each graph is made at point in the load approximately representing the ¼, ½, ¾ and maximum ALFs.

In the section entitled “Uniaxial Gauge Plots” are the data from the five strain gauges affixed to each gusset at the base of the tension and compression diagonals. Each graph contains four plots representing the strain readings taken at approximately the ¼, ½, ¾ and maximum ALFs. The strain readings are plotted again the distance along the member width on the horizontal axis.
All rosettes affixed such that the 45, 90, and 135 degree gauges always use this orientation.

Figure G1. Placement and labeling (of north plate) of nine strain rosettes on the interior surface of each gusset plate.
### Table G1. Dimension Cross Reference to Figure G1 Rosette Gauge Location

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Figure G2. Location and labeling (for north plate) of ten uniaxial strain gauges on interior of each gusset plate.
Figure G3. Location and labeling of uniaxial and rosette strain gauge applied to vertical member.
Figure G4. Location and labeling of uniaxial and rosette strain gauge applied to tension diagonal.
Figure G5. Location and labeling of uniaxial and rosette strain gauge applied to compression diagonal.
Figure G6.  Location and labeling of uniaxial and rosette strain gauge applied to east chord.
Figure G7. Location and labeling of uniaxial and rosette strain gauge applied to west chord.
Figure G8. Location and labeling of uniaxial strain gauges applied to splice plates.
SPECIMEN 307SS3

Maximum Shear Strain Plots

Figure G9. Horizontal line of rosettes above chord; south gusset plate

Figure G10. Horizontal line of rosettes above chord; north gusset plate
Variations in Principal Strain

Figure G11. South gusset west bottom

Figure G12. South gusset west mid bottom
Figure G13. South gusset mid bottom

Figure G14. South gusset east mid bottom
Figure G15. South gusset east bottom

Figure G16. North gusset west bottom
Figure G17. North gusset west mid bottom

Figure G18. North gusset mid bottom
Figure G19. North gusset mid east bottom

Figure G20. North gusset east bottom
Member Cross-Sectional Plots

Figure G21. Vertical

Figure G22. Compression Diagonal
Figure G23. Tension Diagonal

Figure G24. West Chord
Figure G25. East Chord

Chord Load Shedding Plots

Figure G26. ALF=0.30.
Figure G27. ALF=0.42.

Figure G28. ALF=0.57
Figure G29. Max ALF

Uniaxial Gauge Plots

Figure G30. North Compression Diagonal
Figure G31. South Compression Diagonal

Figure G32. North Tension Diagonal
Figure G33. South Tension Diagonal
SPECIMEN 490SS3

Maximum Shear Strain Plots

Figure G34. Horizontal line of rosettes above chord; south gusset plate

Figure G35. Horizontal line of rosettes above chord; north gusset plate
Variations in Principal Strain

Figure G36. South gusset west bottom

Figure G37. South gusset west mid bottom
Figure G38. South gusset mid bottom

Figure G39. South gusset east mid bottom
Figure G40. South gusset east bottom

Figure G41. North gusset west bottom
Figure G42. North gusset west mid bottom

Figure G43. North gusset mid bottom
Figure G44. North gusset mid east bottom

Figure G45. North gusset east bottom
Member Cross-Sectional Plots

Figure G46. Compression Diagonal

Figure G47. Tension Diagonal
Figure G48. West Chord

Figure G49. East Chord
Chord Load Shedding Plots

Figure G50. Vertical.

Figure G51. ALF=0.24
**Figure G52.** ALF=0.43

**Figure G53.** ALF=0.59
Figure G54. Max ALF=0.73

Uniaxial Gauge Plots

Figure G55. North Compression Diagonal
Figure G56. South Compression Diagonal

Figure G57. North Tension Diagonal
Figure G58. South Tension Diagonal
SPECIMEN 490LS3

Maximum Shear Strain Plots

Figure G59. Horizontal line of rosettes above chord; south gusset plate

Figure G60. Horizontal line of rosettes above chord; north gusset plate
Variations in Principal Strain

Figure G61. South gusset west bottom

Figure G62. South gusset west mid bottom
Figure G63. South gusset mid bottom

Figure G64. South gusset east mid bottom
Figure G65. South gusset east bottom

Figure G66. North gusset west bottom
Figure G67. North gusset west mid bottom

Figure G68. North gusset mid bottom
Figure G69. North gusset mid east bottom

Figure G70. North gusset east bottom
Member Cross-Sectional Plots

Figure G71. Vertical

Figure G72. Compression Diagonal
Figure G73. Tension Diagonal

Figure G74. West Chord
Figure G75. East Chord

Chord Load Shedding Plots

Figure G76. ALF = 0.18
Figure G77.  ALF = 0.39

Figure G78.  ALF = 0.55
Figure G79. Max ALF = 0.85

Uniaxial Gauge Plots

Figure G80. North Compression Diagonal
Figure G81. South Compression Diagonal

Figure G82. North Tension Diagonal
Figure G83. South Tension Diagonal
SPECIMEN 490LS3-1

Maximum Shear Strain Plots

Figure G84. Horizontal line of rosettes above chord; south gusset plate
Figure G85. Horizontal line of rosettes above chord; north gusset plate

Variations in Principal Strain

Figure G86. South gusset west bottom

Figure G87. South gusset west mid bottom

G-55
Figure G88. South gusset mid bottom

Figure G89. South gusset east mid bottom
Figure G90. South gusset east bottom

Figure G91. North gusset west bottom
Figure G92. North gusset west mid bottom

Figure G93. North gusset mid bottom
Figure G94. North gusset mid east bottom

Figure G95. North gusset east bottom
Member Cross-Sectional Plots

Figure G96. Vertical

Figure G97. Compression Diagonal
Figure G98. Tension Diagonal

Figure G99. West Chord
Figure G100. East Chord

Chord Load Shedding Plots

Figure G101. ALF=0.43
Figure G102. ALF=0.52

Figure G103. ALF=0.68
Figure G104. Max ALF=0.88

Uniaxial Gauge Plots

Figure G105. North Compression Diagonal
Figure G106. South Compression Diagonal

Figure G107. North Tension Diagonal
Figure G108. South Tension Diagonal
SPECIMEN 307LS3

Maximum Shear Strain Plots

Figure G109. Horizontal line of rosettes above chord; south gusset plate

Figure G110. Horizontal line of rosettes above chord; north gusset plate
Variations in Principal Strain

Figure G111. South gusset west bottom

Figure G112. South gusset west mid bottom
Figure G113. South gusset mid bottom

Figure G114. South gusset east mid bottom
Figure G115. South gusset east bottom

Figure G116. North gusset west bottom
Figure G117. North gusset west mid bottom

Figure G118. North gusset mid bottom
Figure G119. North gusset mid east bottom

Figure G120. North gusset east bottom
Member Cross-Sectional Plots

Figure G121. Compression Diagonal

Figure G122. Tension Diagonal
Figure G123. West Chord

Figure G124. East Chord.
Figure G125. Vertical.

Chord Load Shedding Plots

Figure G126. ALF=0.21
Figure G127. ALF=0.40

Figure G128. ALF=0.98
**Figure G129. Max ALF=1.14**

**Figure G130. North Compression Diagonal**
Figure G131. South Compression Diagonal

Figure G132. North Tension Diagonal
Figure G133. South Tension Diagonal
SPECIMEN 307SL3

Maximum Shear Strain Plots

Figure G134. Horizontal line of rosettes above chord; south gusset plate

Figure G135. Horizontal line of rosettes above chord; north gusset plate
Variations in Principal Strain

Figure G136. South gusset west bottom

Figure G137. South gusset west mid bottom

G-81
Figure G138. South gusset mid bottom

Figure G139. South gusset east mid bottom
Figure G140. South gusset east bottom

Figure G141. North gusset west bottom
DEAD GAUGE

Figure G142. North gusset west mid bottom

Figure G143. North gusset mid bottom

Figure G144. North gusset mid east bottom

G-84
Figure G145. North gusset east bottom

Member Cross-Sectional Plots

Figure G146. Compression Diagonal
Figure G147. Tension Diagonal

Figure G148. West Chord
Figure G149. East Chord.

Figure G150. Vertical.
Chord Load Shedding Plots

Figure G151. ALF=0.33

Figure G152. ALF=0.52
Figure G153. ALF=0.71

Figure G154. Max ALF=0.95
Uniaxial Gauge Plots

Figure G155. North Compression Diagonal

Figure G156. South Compression Diagonal
Figure G157. North Tension Diagonal

Figure G158. South Tension Diagonal
SPECIMEN 307SL4

Maximum Shear Strain Plots

Figure G159. Horizontal line of rosettes above chord; south gusset plate

Figure G160. Horizontal line of rosettes above chord; north gusset plate
Variations in Principal Strain

Figure G161. South gusset west bottom

Figure G162. South gusset west mid bottom
Figure G163. South gusset mid bottom

Figure G164. South gusset east mid bottom
Figure G165. South gusset east bottom

Figure G166. North gusset west bottom
Figure G167. North gusset west mid bottom

Figure G168. North gusset mid bottom
Figure G169. North gusset mid east bottom (DEAD GUAGE).

Figure G170. North gusset east bottom (DEAD GUAGE).
Member Cross-Sectional Plots

Figure G171. Vertical

Figure G172. Compression Diagonal
Figure G173. Tension Diagonal

Figure G174. West Chord
Figure G175. East Chord

Chord Load Shedding Plots

Figure G176. ALF = 0.37
Figure G177. ALF = 0.48

Figure G178. ALF = 0.79
**Figure G179. Peak ALF**

**Uniaxial Gauge Plots**

**Figure G180. North Gusset Compression Diagonal**
Figure G181. South Gusset Compression Diagonal

Figure G182. North Gusset Tension Diagonal
Figure G183. South Tension Diagonal
SPECIMEN 490LS3-2

Maximum Shear Strain Plots

Figure G184. Horizontal line of rosettes above chord; south gusset plate

Figure G185. Horizontal line of rosettes above chord; north gusset plate
Variations in Principal Strain

Figure G186. South gusset west bottom

Figure G187. South gusset west mid bottom
Figure G188. South gusset mid bottom

Figure G189. South gusset east mid bottom
Figure G190. South gusset east bottom

Figure G191. North gusset west bottom
Figure G192. North gusset west mid bottom

Figure G193. North gusset mid bottom
Figure G194. North gusset mid east bottom

Figure G195. North gusset east bottom
Member Cross-Sectional Plots

Figure G196. Vertical

Figure G197. Compression Diagonal
Figure G198. Tension Diagonal

Figure G199. West Chord
Figure G200. East Chord

Chord Load Shedding Plots

Figure G201. ALF=0.27
Figure G202. ALF=0.46

Figure G203. ALF=0.68
Figure G204. Max ALF=0.86

Uniaxial Gauge Plots

Figure G205. North Compression Diagonal
Figure G206. South Compression Diagonal

Figure G207. North Tension Diagonal
Angle Plots

These four graphs in this section represent the gauges that were affixed to the stiffening angles.
Figure G210. Top gage pairs

Figure G211. Middle gage pairs.
Figure G212. Bottom gage pairs.
SPECIMEN 490SS3-1

Maximum Shear Strain Plots

Figure G213. Horizontal line of rosettes above chord; south gusset plate

Figure G214. Horizontal line of rosettes above chord; north gusset plate
Variations in Principal Strain

Figure G215. South gusset west bottom

Figure G216. South gusset west mid bottom
Figure G217. South gusset mid bottom

Figure G218. South gusset east mid bottom
Figure G219. South gusset east bottom

DEAD GAUGE

Figure G220. North gusset west bottom

Figure G221. North gusset west mid bottom
Figure G222. North gusset mid bottom

Figure G223. North gusset mid east bottom
Figure G224. North gusset east bottom

Member Cross-Sectional Plots

Figure G225. Vertical
Figure G226. Compression Diagonal

Figure G227. Tension Diagonal
Figure G228. West Chord

Figure G229. East Chord
Chord Load Shedding Plots

Figure G230. ALF=0.20

Figure G231. ALF=0.47
Figure G232. ALF=0.67

Figure G233. Max ALF=0.91
Uniaxial Gauge Plots

Figure G234. North Compression Diagonal

Figure G235. South Compression Diagonal
Figure G236. North Tension Diagonal

Figure G237. South Tension Diagonal
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Maximum Shear Strain Plots

Figure G238. Horizontal line of rosettes above chord; south gusset plate

Figure G239. Horizontal line of rosettes above chord; north gusset plate
Variations in Principal Strain

Figure G240. South gusset west bottom

Figure G241. South gusset west mid bottom
Figure G242. South gusset mid bottom

Figure G243. South gusset east mid bottom
Figure G244. South gusset east bottom

Figure G245. North gusset west bottom

DEAD GAUGE
Figure G246. North gusset west mid bottom

Figure G247. North gusset mid bottom
Figure G248. North gusset mid east bottom

Figure G249. North gusset east bottom
Member Cross-Sectional Plots

Figure G250. Vertical

Figure G251. Compression Diagonal
DEAD GAUGES

Figure G252. Tension Diagonal

![Graph showing tension diagonal with various load fractions and moments.]

Figure G253. West Chord

![Graph showing west chord with load fractions and moments.]

Axial Load (kips) vs. Applied Load Fraction (ALF)
DEAD GAUGES

Figure G254. East Chord

Chord Load Shedding Plots

Figure G255. ALF=0.11
Figure G256. ALF=0.24

Figure G257. ALF=0.33
Figure G258. Max ALF=0.45

Uniaxial Gauge Plots

Figure G259. North Compression Diagonal
Figure G260. South Compression Diagonal

Figure G261. North Tension Diagonal
Figure G262. South Tension Diagonal
SPECIMEN 307SS3-2

Maximum Shear Strain Plots

Figure G263. Horizontal line of rosettes above chord; south gusset plate

Figure G264. Horizontal line of rosettes above chord; north gusset plate
Variations in Principal Strain

Figure G265. South gusset west bottom

Figure G266. South gusset west mid bottom
Figure G267. South gusset mid bottom

Figure G268. South gusset east mid bottom
Figure G269. South gusset east bottom

DEAD GAUGE

Figure G270. North gusset west bottom

DEAD GAUGE

Figure G271. North gusset west mid bottom
Figure G272. North gusset mid bottom

Figure G273. North gusset mid east bottom
Figure G274. North gusset east bottom

Member Cross-Sectional Plots

Figure G275. Vertical
Figure G276. Compression Diagonal

Figure G277. Tension Diagonal
Figure G278. West Chord

Figure G279. East Chord
Chord Load Shedding Plots

![Figure G280. ALF=0.23](image1)

![Figure G281. ALF=0.36](image2)
Figure G282. ALF=0.56

Figure G283. Max ALF=0.70
Uniaxial Gauge Plots

Figure G284. North Compression Diagonal

Figure G285. South Compression Diagonal
Figure G286. North Tension Diagonal

Figure G287. South Tension Diagonal
SPECIMEN 307SS3-3

Maximum Shear Strain Plots

Figure G288. Horizontal line of rosettes above chord; south gusset plate

Figure G289. Horizontal line of rosettes above chord; north gusset plate
Variations in Principal Strain

Figure G290. South gusset west bottom

Figure G291. South gusset west mid bottom
Figure G292. South gusset mid bottom

Figure G293. South gusset east mid bottom
Figure G294. South gusset east bottom

Figure G295. North gusset west bottom
Figure G296. North gusset west mid bottom

Figure G297. North gusset mid bottom
Figure G298. North gusset mid east bottom

Figure G299. North gusset east bottom
Member Cross-Sectional Plots

Figure G300. Vertical

Figure G301. Compression Diagonal
Figure G302. Tension Diagonal

Figure G303. West Chord
**Figure G304.** East Chord

**Chord Load Shedding Plots**

**Figure G305.** ALF=0.23
Figure G306. ALF=0.29

Figure G307. ALF=0.70
Figure G308. Max ALF=0.73

Figure G309. North Compression Diagonal
Figure G310. South Compression Diagonal

Figure G311. North Tension Diagonal
Figure G312. South Tension Diagonal
SPECIMEN 307SS3-4

Maximum Shear Strain Plots

Figure G313. Horizontal line of rosettes above chord; south gusset plate.

Figure G314. Horizontal line of rosettes above chord; north gusset plate.
Variations in Principal Strain

Figure G315. South gusset west bottom

Figure G316. South gusset west mid bottom
Figure G317. South gusset mid bottom

Figure G318. South gusset east mid bottom
Figure G319. South gusset east bottom

Figure G320. North gusset west bottom.
Figure G321. North gusset west mid bottom.

Figure G322. South gusset mid bottom.
Figure G323. South gusset east mid bottom.

Figure G324. South gusset east bottom.
Member Cross-Sectional Plots

Figure G325. Vertical

Figure G326. Compression Diagonal
Figure G327. Tension Diagonal

Figure G328. West Chord
Figure G329. East Chord

Chord Load Shedding Plots

Figure G330. ALF=0.26
Figure G331. ALF=0.54

Figure G332. ALF=0.89
Figure G333. ALF=1.00

Uniaxial Gauge Plots

Figure G334. North Compression Diagonal
Figure G335. South Compression Diagonal

Figure G336. North Tension Diagonal
Figure G337. South Tension Diagonal