ARIZONA DEPARTMENT OF TRANSPORTATION

REPORT NUMBER: FHWA-AZ88-202-III

# SMALL SIGN SUPPORT ANALYSIS

## Phase II
## Static, Pendulum and Full-Scale Crash Test Programs
## Volume II (Appendices)

**Prepared by:**
James R. Morgan
Hayes E. Ross, Jr.
Richard E. Schuler

Texas Transportation Institute
Texas A&M University
College Station, Texas 77843

**August 1988**

**Prepared for:**
Arizona Department of Transportation
206 South 17th Avenue
Phoenix, Arizona 85007
in cooperation with
U.S. Department of Transportation
Federal Highway Administration

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Arizona Department of Transportation or the Federal Highways Administration. This report does not constitute a standard, specification, or regulation. Trade or manufacturer's names which may appear herein are cited only because they are considered essential to the objectives of the report. The U.S. Government and the State of Arizona do not endorse products or manufacturers.

TECHNICAL REPORT STANDARD TITLE PAGE

| 1. Report No. | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| FHWA-AZ88-202-2 | | |

| 4. Title and Subtitle | 5. Report Date |
|---|---|
| SMALL SIGN SUPPORT ANALYSIS<br>PHASE II - STATIC, PENDULUM AND FULL-SCALE<br>CRASH TEST PROGRAMS, VOLUME II (APPENDICES) | August 1988 |
| | 6. Performing Organization Code |
| 7. Author(s) | 8. Performing Organization Report No. |
| James R. Morgan, Hayes E. Ross, Jr., and<br>Richard E. Schuler | Research Report 7024-2 |
| 9. Performing Organization Name and Address | 10. Work Unit No. |
| Texas Transportation Institute<br>Texas A&M University<br>College Station, Texas 77843 | 11. Contract or Grant No.<br>HPR-PL-1(31) Item 202 |
| 12. Sponsoring Agency Name and Address | 13. Type of Report and Period Covered |
| Arizona Department of Transportation<br>Highway Division<br>206 South Seventeenth Avenue<br>Phoenix, Arizona 85007 | Final Report<br>Phase II - Volume II |
| | 14. Sponsoring Agency Code |

15. Supplementary Notes

ADOT Contacts: Rudy Kolaja
Larry Scofield
Mumtaz Sarsam

16. Abstract

This report, in two volumes, compiles the static, pendulum and full-scale crash test results of alternative small sign support systems for Arizona Department of Transportation (ADOT). The tests were conducted and evaluated in accordance with the recommendations of NCHRP Report 230 and the 1985 AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals."

Results of this research indicate that three-3 lb/ft or (based on energy based analysis) two-4 lb/ft 80 ksi Marion steel u-post supports and stubs assembled using a 4 in. nested splice (support assembled behind the stub) with 1/2 in. spacers and grade 9 bolts, nuts and washers will meet the evaluation criteria. It also is apparent from the results of this study that a slip-base retrofit for a sign support system with up to three P2 Uni-Strut posts will meet the evaluation criteria.

In all cases, tests were conducted in NCHRP Report 230 (2) Classification S1 (STRONG) soil. In cases where installation in a "weak" soil is anticipated, further evaluation is required.

This report is one of three reports prepared in the subject project. The other two are:
Small Sign Support Analysis:
Phase I - Crash Test Program
Phase III - Benefit/Cost Analysis

| 17. Key Words | 18. Distribution Statement |
|---|---|
| Sign, Support, Safety, Test, Crash,<br>Small, Impact, Upgrade, Retrofit,<br>Cost Effectiveness | |

| 19. Security Classif. (of this report) | 20. Security Classif. (of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| | | 349 | |

Form DOT F 1700.7 (8-69)

**TABLE OF CONTENTS**
PHASE II
Volume II (Appendices)

**TABLE OF CONTENTS**
PHASE II(continued)
Volume II (Appendices)

Section — Page

**TABLE OF CONTENTS**
PHASE II(continued)
Volume II (Appendices)

**TABLE OF CONTENTS**
PHASE II(continued)
Volume II (Appendices)

Section — Page

# APPENDIX A

## PRELIMINARY 72 " BENDING TESTS

## FIELD BOLT SUMMARY TABLES

Marion 3 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back, Nested and Face to Face Splices

Critical and Non-critical Configurations

# APPENDIX A

## LIST OF TABLES

# APPENDIX A

## LIST OF TABLES (CONT.)

Table A.1. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 3.00
Dist to bolt A (in) .. 1.38
Dist to gauge (in) ...12.00
Moment arm (in) .....72.25

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.951 | | | | | | |
| | DL | 2.686 | | 0.00 | 0.037 | 0.037 | 1.89 | 1.11 |
| 60 | 60 | 2.807 | 0.77 | 0.77 | 0.112 | 0.277 | 12.44 | 3.37 |
| 32 | 92 | 3.101 | 0.43 | 1.19 | 0.296 | 0.404 | 18.06 | 8.87 |
| 32 | 124 | 3.309 | 0.45 | 1.64 | 0.425 | 0.532 | 23.69 | 12.76 |
| 32 | 156 | 3.513 | 0.50 | 2.14 | 0.552 | 0.660 | 29.32 | 16.57 |
| 32 | 188 | 3.724 | 0.48 | 2.62 | 0.684 | 0.788 | 34.94 | 20.51 |
| 32 | 220 | 3.928 | 0.48 | 3.09 | 0.811 | 0.915 | 40.57 | 24.33 |
| 32 | 252 | 4.123 | 0.46 | 3.55 | 0.932 | 1.043 | 46.19 | 27.97 |
| 32 | 284 | 4.323 | 0.32 | 3.87 | 1.057 | 1.171 | 51.82 | 31.71 |
| 32 | 316 | 4.519 | 0.53 | 4.40 | 1.179 | 1.299 | 57.44 | 35.37 |
| 16 | 332 | 4.615 | 0.32 | 4.72 | 1.239 | 1.363 | 60.25 | 37.17 |
| 16 | 348 | 4.696 | 0.33 | 5.05 | 1.289 | 1.427 | 63.07 | 38.68 |

* Nominal yield stress

Table A.2. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 3.00
Dist to bolt A (in) .. 1.50
Dist to gauge (in) ...11.75
Moment arm (in) .....72.06

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) | | | Tip | Total | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Defl (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 1.851 | | | | | | |
| | DL | 1.927 | | 0.00 | 0.037 | 0.037 | 1.90 | 1.11 |
| 60 | 60 | 2.324 | 0.90 | 0.90 | 0.283 | 0.277 | 12.42 | 8.50 |
| 32 | 92 | 2.534 | 0.50 | 1.39 | 0.414 | 0.405 | 18.03 | 12.41 |
| 48 | 140 | 2.743 | 0.51 | 1.90 | 0.544 | 0.597 | 26.45 | 16.31 |
| 32 | 172 | 2.945 | 0.50 | 2.40 | 0.669 | 0.725 | 32.06 | 20.07 |
| 32 | 204 | 3.141 | 0.49 | 2.89 | 0.791 | 0.853 | 37.67 | 23.72 |
| 32 | 236 | 3.350 | 0.54 | 3.43 | 0.921 | 0.981 | 43.28 | 27.62 |
| 32 | 268 | 3.542 | 0.52 | 3.95 | 1.040 | 1.109 | 48.89 | 31.19 |
| 48 | 316 | 3.848 | 0.93 | 4.88 | 1.230 | 1.300 | 57.30 | 36.89 |
| 16 | 332 | 3.946 | 0.33 | 5.21 | 1.291 | 1.364 | 60.11 | 38.72 |
| 16 | 348 | 4.053 | 0.48 | 5.69 | 1.357 | 1.428 | 62.91 | 40.71 |
| 16 | 364 | 4.148 | 0.50 | 6.19 | 1.416 | 1.492 | 65.72 | 42.48 |
| 16 | 380 | 4.250 | 0.54 | 6.73 | 1.479 | 1.556 | 68.53 | 44.38 |

* Nominal yield stress

Table A.3. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Face to Face Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 3.00
Dist to bolt A (in) .. 1.75
Dist to gauge (in) ... 8.25
Moment arm (in) .....72.62

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Face to face; gr 5 bolts
Critical orientation

| LOAD (lbs) | | | Tip | Total | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Defl (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 2.259 | | | | | | |
| | DL | 2.129 | | 0.00 | 0.041 | 0.041 | 1.91 | 1.23 |
| 60 | 60 | 1.667 | 0.97 | 0.97 | 0.329 | 0.297 | 12.51 | 9.87 |
| 32 | 92 | 1.434 | 0.55 | 1.51 | 0.474 | 0.434 | 18.17 | 14.22 |
| 32 | 124 | 1.223 | 0.50 | 2.02 | 0.605 | 0.570 | 23.82 | 18.16 |
| 32 | 156 | 1.010 | 0.53 | 2.55 | 0.738 | 0.707 | 29.48 | 22.15 |
| 32 | 188 | 0.805 | 0.54 | 3.08 | 0.866 | 0.843 | 35.13 | 25.98 |
| 32 | 220 | 0.571 | 0.63 | 3.71 | 1.012 | 0.980 | 40.78 | 30.35 |
| 16 | 236 | 0.486 | 0.26 | 3.97 | 1.065 | 1.048 | 43.61 | 31.94 |
| 16 | 252 | 0.371 | 0.31 | 4.28 | 1.136 | 1.117 | 46.44 | 34.09 |
| 16 | 268 | 0.275 | 0.28 | 4.56 | 1.196 | 1.185 | 49.27 | 35.88 |
| 16 | 284 | 0.196 | 0.25 | 4.81 | 1.245 | 1.253 | 52.09 | 37.36 |
| 16 | 300 | 0.098 | 0.33 | 5.13 | 1.306 | 1.321 | 54.92 | 39.19 |
| 16 | 316 | 0.008 | 0.35 | 5.48 | 1.362 | 1.390 | 57.75 | 40.87 |
| 16 | 332 | -0.096 | 0.45 | 5.93 | 1.427 | 1.458 | 60.58 | 42.82 |

* Nominal yield stress

Table A.4. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 3.00
Dist to bolt A (in) .. 1.38
Dist to gauge (in) ... 7.88
Moment arm (in) .....72.38

MARION 3 lb/ft - 80 ksi *
Back to back; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | ** | | | | | | |
| | DL | 8.242 | | 0.00 | 0.042 | 0.042 | 1.89 | 1.26 |
| 60 | 60 | 7.848 | 0.74 | 0.74 | 0.287 | 0.298 | 12.46 | 8.62 |
| 32 | 92 | 7.661 | 0.38 | 1.11 | 0.404 | 0.435 | 18.09 | 12.12 |
| 32 | 124 | 7.471 | 0.39 | 1.50 | 0.522 | 0.572 | 23.73 | 15.67 |
| 32 | 156 | 7.266 | 0.41 | 1.91 | 0.650 | 0.709 | 29.36 | 19.50 |
| 32 | 188 | 7.068 | 0.43 | 2.34 | 0.773 | 0.845 | 35.00 | 23.20 |
| 32 | 220 | 6.878 | 0.46 | 2.79 | 0.892 | 0.982 | 40.63 | 26.76 |
| 32 | 252 | 6.653 | 0.55 | 3.34 | 1.032 | 1.119 | 46.27 | 30.96 |
| 32 | 284 | 6.446 | 0.50 | 3.84 | 1.161 | 1.256 | 51.90 | 34.83 |
| 32 | 316 | 6.252 | 0.51 | 4.34 | 1.282 | 1.392 | 57.54 | 38.46 |
| 32 | 348 | 6.052 | 0.67 | 5.01 | 1.406 | 1.529 | 63.17 | 42.19 |
| 16 | 364 | 5.980 | 0.66 | 5.66 | 1.451 | 1.598 | 65.99 | 43.54 |

* Nominal yield stress

** Strain gauge malfunction - data omitted

Table A.5. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 3.00
Dist to bolt A (in) .. 1.50
Dist to gauge (in) ...12.00
Moment arm (in) .....72.37

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Nested; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.949 | | | | | | |
| | DL | 2.059 | | 0.00 | 0.037 | 0.037 | 1.90 | 1.11 |
| 60 | 60 | 1.652 | 0.92 | 0.92 | 0.291 | 0.277 | 12.46 | 8.72 |
| 32 | 92 | 1.444 | 0.58 | 1.49 | 0.420 | 0.405 | 18.10 | 12.61 |
| 32 | 124 | 1.221 | 0.52 | 2.01 | 0.559 | 0.533 | 23.73 | 16.77 |
| 32 | 156 | 1.009 | 0.50 | 2.51 | 0.691 | 0.661 | 29.37 | 20.74 |
| 32 | 188 | 0.696 | 0.75 | 3.26 | 0.886 | 0.789 | 35.00 | 26.59 |
| 32 | 220 | 0.480 | 0.53 | 3.79 | 1.021 | 0.917 | 40.64 | 30.62 |
| 32 | 252 | 0.277 | 0.51 | 4.29 | 1.147 | 1.045 | 46.27 | 34.42 |
| 32 | 284 | 0.073 | 0.52 | 4.81 | 1.274 | 1.173 | 51.91 | 38.23 |
| 32 | 316 | -0.125 | 0.56 | 5.37 | 1.398 | 1.301 | 57.54 | 41.93 |
| 32 | 348 | -0.323 | 0.62 | 5.99 | 1.521 | 1.430 | 63.18 | 45.63 |
| 16 | 364 | -0.422 | 0.46 | 6.45 | 1.583 | 1.494 | 66.00 | 47.48 |

* Nominal yield stress

Table A.6. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Face to Face Splice in Non-critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 3.00
Dist to bolt A (in) .. 1.31
Dist to gauge (in) ... 7.75
Moment arm (in) .....72.19

MARION 3 lb/ft - 80 ksi *
Face to face; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 2.240 | | | | | | |
| | DL | 2.328 | | 0.00 | 0.042 | 0.042 | 1.89 | 1.26 |
| 60 | 60 | 2.824 | 1.03 | 1.03 | 0.351 | 0.294 | 12.43 | 10.53 |
| 32 | 92 | 3.032 | 0.47 | 1.50 | 0.481 | 0.429 | 18.05 | 14.42 |
| 32 | 124 | 3.242 | 0.50 | 2.00 | 0.611 | 0.563 | 23.67 | 18.34 |
| 32 | 156 | 3.469 | 0.55 | 2.55 | 0.753 | 0.698 | 29.29 | 22.59 |
| 32 | 188 | 3.705 | 0.58 | 3.12 | 0.900 | 0.832 | 34.91 | 27.00 |
| 32 | 220 | 3.909 | 0.52 | 3.64 | 1.027 | 0.967 | 40.53 | 30.81 |
| 16 | 236 | 4.011 | 0.27 | 3.91 | 1.091 | 1.034 | 43.34 | 32.72 |
| 16 | 252 | 4.115 | 0.28 | 4.18 | 1.155 | 1.101 | 46.15 | 34.66 |
| 16 | 268 | 4.213 | 0.29 | 4.47 | 1.216 | 1.168 | 48.96 | 36.49 |
| 16 | 284 | 4.327 | 0.33 | 4.79 | 1.287 | 1.236 | 51.77 | 38.62 |
| 16 | 300 | 4.431 | 0.35 | 5.15 | 1.352 | 1.303 | 54.58 | 40.57 |
| 16 | 316 | 4.539 | 0.37 | 5.52 | 1.420 | 1.370 | 57.39 | 42.59 |
| 16 | 332 | 4.656 | 0.37 | 5.89 | 1.492 | 1.437 | 60.20 | 44.77 |
| 16 | 348 | 4.757 | 0.45 | 6.34 | 1.555 | 1.505 | 63.01 | 46.66 |
| 16 | 364 | 4.902 | 0.60 | 6.94 | 1.646 | 1.572 | 65.82 | 49.37 |

* Nominal yield stress

Table A.7. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.50
Dist to gauge (in) ... 9.00
Moment arm (in) .....72.50

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 0.015 | | | | | | |
| | DL | 0.049 | | 0.00 | 0.041 | 0.041 | 1.90 | 1.23 |
| 60 | 60 | 0.459 | 0.78 | 0.78 | 0.296 | 0.293 | 12.48 | 8.89 |
| 32 | 92 | 0.668 | 0.41 | 1.18 | 0.427 | 0.428 | 18.13 | 12.80 |
| 32 | 124 | 0.884 | 0.43 | 1.61 | 0.561 | 0.562 | 23.77 | 16.84 |
| 32 | 156 | 1.106 | 0.43 | 2.04 | 0.700 | 0.697 | 29.42 | 20.99 |
| 32 | 188 | 1.321 | 0.42 | 2.46 | 0.834 | 0.832 | 35.06 | 25.01 |
| 32 | 220 | 1.536 | 0.43 | 2.89 | 0.967 | 0.966 | 40.71 | 29.02 |
| 32 | 252 | 1.536 | 0.43 | 3.32 | 0.967 | 1.101 | 46.35 | 29.02 |
| 32 | 284 | 1.772 | 0.50 | 3.82 | 1.115 | 1.236 | 52.00 | 33.44 |
| 32 | 316 | 1.979 | 0.47 | 4.29 | 1.243 | 1.370 | 57.64 | 37.30 |
| 32 | 348 | 2.175 | 0.47 | 4.76 | 1.366 | 1.505 | 63.28 | 40.97 |
| 16 | 364 | 2.293 | 0.30 | 5.06 | 1.439 | 1.572 | 66.11 | 43.17 |
| 32 | 396 | 2.502 | 0.43 | 5.49 | 1.569 | 1.707 | 71.75 | 47.08 |
| 16 | 412 | 2.630 | 0.35 | 5.84 | 1.649 | 1.774 | 74.57 | 49.47 |
| 16 | 428 | 2.728 | 0.27 | 6.11 | 1.710 | 1.842 | 77.40 | 51.30 |
| 16 | 444 | 2.828 | 0.28 | 6.39 | 1.772 | 1.909 | 80.22 | 53.17 |
| 16 | 460 | 2.912 | 0.27 | 6.66 | 1.825 | 1.976 | 83.04 | 54.74 |
| 16 | 476 | 3.013 | 0.35 | 7.01 | 1.888 | 2.044 | 85.86 | 56.63 |
| 16 | 492 | 3.104 | 0.33 | 7.33 | 1.944 | 2.111 | 88.69 | 58.33 |

* Nominal yield stress

Table A.8. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.50
Dist to gauge (in) ... 8.88
Moment arm (in) .....73.38

MARION 3 lb/ft - 80 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 2.251 | | | | | | |
| | DL | 8.706 | | 0.00 | ** | 0.041 | 1.90 | ** |
| 60 | 60 | 12.700 | 0.81 | 0.81 | 0.297 | 0.297 | 12.61 | 8.91 |
| 32 | 92 | 12.890 | 0.52 | 1.33 | 0.415 | 0.434 | 18.35 | 12.46 |
| 32 | 124 | 13.110 | 0.45 | 1.78 | 0.552 | 0.571 | 24.09 | 16.57 |
| 32 | 156 | 13.330 | 0.45 | 2.23 | 0.690 | 0.708 | 29.83 | 20.69 |
| 32 | 188 | 13.530 | 0.43 | 2.67 | 0.814 | 0.844 | 35.57 | 24.42 |
| 32 | 220 | 13.730 | 0.46 | 3.13 | 0.939 | 0.981 | 41.31 | 28.16 |
| 32 | 252 | 13.910 | 0.41 | 3.53 | 1.051 | 1.118 | 47.05 | 31.53 |
| 32 | 284 | 14.110 | 0.42 | 3.96 | 1.176 | 1.255 | 52.80 | 35.27 |
| 32 | 316 | 14.370 | 0.53 | 4.49 | 1.338 | 1.391 | 58.54 | 40.13 |
| 32 | 348 | 14.580 | 0.48 | 4.96 | 1.468 | 1.528 | 64.28 | 44.05 |
| 32 | 380 | 14.790 | 0.51 | 5.47 | 1.599 | 1.665 | 70.02 | 47.98 |
| 32 | 412 | 15.010 | 0.55 | 6.02 | 1.736 | 1.802 | 75.76 | 52.09 |
| 16 | 428 | 15.140 | 0.38 | 6.40 | 1.817 | 1.870 | 78.63 | 54.52 |
| 16 | 444 | 15.270 | 0.40 | 6.80 | 1.898 | 1.939 | 81.50 | 56.95 |
| 16 | 460 | 15.390 | 0.54 | 7.33 | 1.973 | 2.007 | 84.37 | 59.19 |
| 16 | 476 | 15.530 | 0.57 | 7.90 | 2.060 | 2.075 | 87.24 | 61.81 |

* Nominal yield stress

** Strain gauge malfunction - data omitted

Table A.9. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.25
Dist to gauge (in) ... 8.75
Moment arm (in) .....72.25

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Face to face; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 2.423 | | | | | | |
| | DL | 2.244 | | 0.00 | 0.041 | 0.041 | 1.90 | 1.23 |
| 60 | 60 | 1.831 | 0.82 | 0.82 | 0.298 | 0.293 | 12.45 | 8.95 |
| 32 | 92 | 1.624 | 0.40 | 1.22 | 0.427 | 0.428 | 18.07 | 12.82 |
| 32 | 124 | 1.415 | 0.42 | 1.64 | 0.558 | 0.563 | 23.70 | 16.73 |
| 32 | 156 | 1.201 | 0.45 | 2.09 | 0.691 | 0.697 | 29.32 | 20.73 |
| 32 | 188 | 0.993 | 0.43 | 2.52 | 0.820 | 0.832 | 34.95 | 24.61 |
| 32 | 220 | 0.783 | 0.45 | 2.97 | 0.951 | 0.967 | 40.57 | 28.54 |
| 32 | 252 | 0.547 | 0.51 | 3.48 | 1.098 | 1.101 | 46.20 | 32.95 |
| 32 | 284 | 0.325 | 0.49 | 3.97 | 1.237 | 1.236 | 51.82 | 37.10 |
| 32 | 316 | 0.106 | 0.50 | 4.47 | 1.373 | 1.371 | 57.45 | 41.19 |
| 32 | 348 | -0.134 | 0.57 | 5.04 | 1.523 | 1.505 | 63.07 | 45.68 |
| 16 | 364 | -0.260 | 0.32 | 5.36 | 1.601 | 1.573 | 65.89 | 48.03 |
| 16 | 380 | -0.345 | 0.24 | 5.60 | 1.654 | 1.640 | 68.70 | 49.62 |
| 16 | 396 | -0.465 | 0.35 | 5.94 | 1.729 | 1.707 | 71.51 | 51.87 |
| 16 | 412 | -0.582 | 0.42 | 6.36 | 1.802 | 1.775 | 74.32 | 54.05 |
| 16 | 428 | -0.702 | 0.52 | 6.88 | 1.877 | 1.842 | 77.14 | 56.30 |

* Nominal yield stress

Table A.10. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.38
Dist to gauge (in) ... 8.88
Moment arm (in) .....73.31

MARION 3 lb/ft - 80 ksi *
Back to back; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -0.129 | | | | | | |
| | DL | -0.231 | | 0.00 | 0.041 | 0.041 | 1.89 | 1.23 |
| 60 | 60 | -0.646 | 0.68 | 0.68 | 0.300 | 0.297 | 12.59 | 8.99 |
| 32 | 92 | -0.863 | 0.37 | 1.05 | 0.435 | 0.434 | 18.30 | 13.04 |
| 32 | 124 | -1.083 | 0.37 | 1.41 | 0.572 | 0.570 | 24.01 | 17.16 |
| 32 | 156 | -1.283 | 0.36 | 1.77 | 0.696 | 0.707 | 29.72 | 20.89 |
| 32 | 188 | -1.485 | 0.36 | 2.13 | 0.822 | 0.843 | 35.43 | 24.67 |
| 32 | 220 | -1.701 | 0.39 | 2.52 | 0.957 | 0.980 | 41.13 | 28.71 |
| 32 | 252 | -1.905 | 0.37 | 2.89 | 1.084 | 1.117 | 46.84 | 32.52 |
| 32 | 284 | -2.137 | 0.42 | 3.31 | 1.229 | 1.253 | 52.55 | 36.86 |
| 32 | 316 | -2.346 | 0.39 | 3.70 | 1.359 | 1.390 | 58.26 | 40.76 |
| 32 | 348 | -2.544 | 0.38 | 4.08 | 1.482 | 1.527 | 63.97 | 44.46 |
| 32 | 380 | -2.769 | 0.44 | 4.52 | 1.622 | 1.663 | 69.67 | 48.67 |
| 32 | 412 | -2.993 | 0.47 | 4.99 | 1.762 | 1.800 | 75.38 | 52.86 |
| 16 | 428 | -3.103 | 0.35 | 5.33 | 1.830 | 1.868 | 78.24 | 54.91 |
| 16 | 444 | -3.220 | 0.28 | 5.62 | 1.903 | 1.936 | 81.09 | 57.10 |
| 16 | 460 | -3.322 | 0.27 | 5.89 | 1.967 | 2.005 | 83.95 | 59.01 |
| 16 | 476 | -3.438 | 0.36 | 6.24 | 2.039 | 2.073 | 86.80 | 61.17 |

* Nominal yield stress

Table A.11. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.75
Dist to gauge (in) ... 7.25
Moment arm (in) .....73.75

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Nested; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 2.238 | | | | | | |
| | DL | 2.191 | | 0.00 | 0.043 | 0.043 | 1.91 | 1.29 |
| 60 | 60 | 1.770 | 0.86 | 0.86 | 0.304 | 0.307 | 12.68 | 9.13 |
| 32 | 92 | 1.561 | 0.44 | 1.30 | 0.434 | 0.448 | 18.42 | 13.02 |
| 48 | 140 | 1.222 | 0.72 | 2.02 | 0.645 | 0.660 | 27.03 | 19.34 |
| 32 | 172 | 1.005 | 0.46 | 2.47 | 0.779 | 0.801 | 32.77 | 23.38 |
| 32 | 204 | 0.774 | 0.50 | 2.97 | 0.923 | 0.942 | 38.52 | 27.68 |
| 32 | 236 | 0.543 | 0.48 | 3.45 | 1.066 | 1.083 | 44.26 | 31.99 |
| 32 | 268 | 0.329 | 0.45 | 3.90 | 1.199 | 1.224 | 50.00 | 35.97 |
| 32 | 300 | 0.107 | 0.47 | 4.36 | 1.337 | 1.365 | 55.74 | 40.11 |
| 32 | 332 | -0.121 | 0.48 | 4.84 | 1.479 | 1.506 | 61.48 | 44.36 |
| 32 | 364 | -0.347 | 0.49 | 5.32 | 1.619 | 1.647 | 67.23 | 48.57 |
| 32 | 396 | -0.558 | 0.47 | 5.79 | 1.750 | 1.788 | 72.97 | 52.50 |
| 16 | 412 | -0.651 | 0.22 | 6.01 | 1.808 | 1.858 | 75.84 | 54.23 |
| 16 | 428 | -0.752 | 0.25 | 6.26 | 1.870 | 1.929 | 78.71 | 56.11 |
| 16 | 444 | -0.867 | 0.31 | 6.57 | 1.942 | 1.999 | 81.58 | 58.25 |
| 16 | 460 | -0.962 | 0.29 | 6.85 | 2.001 | 2.070 | 84.45 | 60.02 |
| 16 | 476 | -1.078 | 0.36 | 7.21 | 2.073 | 2.140 | 87.32 | 62.19 |
| 16 | 492 | -1.209 | 0.48 | 7.69 | 2.154 | 2.211 | 90.19 | 64.63 |
| 16 | 508 | -1.295 | 0.26 | 7.95 | 2.208 | 2.281 | 93.07 | 66.23 |

* Nominal yield stress

Table A.12. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.44
Dist to gauge (in) ... 9.00
Moment arm (in) .....72.38

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Face to face; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 2.235 | | | | | | |
| | DL | 2.442 | | 0.00 | 0.041 | 0.041 | 1.90 | 1.23 |
| 60 | 60 | 2.849 | 0.88 | 0.88 | 0.295 | 0.293 | 12.52 | 8.84 |
| 32 | 92 | 3.041 | 0.40 | 1.28 | 0.414 | 0.427 | 18.18 | 12.43 |
| 32 | 124 | 3.255 | 0.45 | 1.73 | 0.548 | 0.561 | 23.85 | 16.43 |
| 32 | 156 | 3.478 | 0.47 | 2.20 | 0.686 | 0.696 | 29.51 | 20.59 |
| 32 | 188 | 3.711 | 0.49 | 2.68 | 0.832 | 0.830 | 35.17 | 24.95 |
| 32 | 220 | 3.927 | 0.46 | 3.14 | 0.966 | 0.965 | 40.83 | 28.99 |
| 32 | 252 | 4.139 | 0.47 | 3.61 | 1.098 | 1.099 | 46.50 | 32.95 |
| 32 | 284 | 4.358 | 0.48 | 4.09 | 1.235 | 1.233 | 52.16 | 37.04 |
| 32 | 316 | 4.598 | 0.55 | 4.64 | 1.384 | 1.368 | 57.82 | 41.53 |
| 32 | 348 | 4.808 | 0.51 | 5.14 | 1.515 | 1.502 | 63.49 | 45.45 |
| 32 | 380 | 5.006 | 0.51 | 5.65 | 1.639 | 1.637 | 69.15 | 49.16 |
| 32 | 412 | 5.204 | 0.59 | 6.24 | 1.762 | 1.771 | 74.81 | 52.86 |
| 16 | 428 | 5.310 | 0.31 | 6.55 | 1.828 | 1.838 | 77.64 | 54.84 |
| 16 | 444 | 5.398 | 0.35 | 6.90 | 1.883 | 1.905 | 80.47 | 56.48 |
| 16 | 460 | 5.506 | 0.40 | 7.30 | 1.950 | 1.972 | 83.30 | 58.50 |
| 16 | 476 | 5.603 | 0.41 | 7.71 | 2.010 | 2.040 | 86.14 | 75.26 |

* Nominal yield stress

Table A.13. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 5 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 5.00
Dist to bolt A (in) .. 1.38
Dist to gauge (in) ...10.00
Moment arm (in) .....73.38

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.762 | | | | | | |
| | DL | 2.172 | | 0.00 | 0.039 | 0.039 | 1.90 | 1.17 |
| 60 | 60 | 2.585 | 0.67 | 0.67 | 0.296 | 0.287 | 12.61 | 8.89 |
| 32 | 92 | 2.818 | 0.40 | 1.07 | 0.442 | 0.420 | 18.32 | 13.25 |
| 32 | 124 | 3.046 | 0.40 | 1.46 | 0.584 | 0.552 | 24.04 | 17.51 |
| 32 | 156 | 3.276 | 0.40 | 1.86 | 0.727 | 0.684 | 29.75 | 21.81 |
| 32 | 188 | 3.502 | 0.39 | 2.25 | 0.868 | 0.817 | 35.46 | 26.03 |
| 32 | 220 | 3.735 | 0.40 | 2.65 | 1.013 | 0.949 | 41.17 | 30.39 |
| 32 | 252 | 3.963 | 0.40 | 3.05 | 1.155 | 1.081 | 46.89 | 34.65 |
| 32 | 284 | 4.194 | 0.41 | 3.46 | 1.299 | 1.214 | 52.60 | 38.97 |
| 32 | 316 | 4.408 | 0.40 | 3.86 | 1.432 | 1.346 | 58.31 | 42.97 |
| 32 | 348 | 4.614 | 0.39 | 4.25 | 1.561 | 1.478 | 64.03 | 46.82 |
| 32 | 380 | 4.834 | 0.42 | 4.67 | 1.698 | 1.610 | 69.74 | 50.93 |
| 32 | 412 | 5.051 | 0.42 | 5.09 | 1.833 | 1.743 | 75.45 | 54.98 |
| 32 | 444 | 5.278 | 0.45 | 5.53 | 1.974 | 1.875 | 81.16 | 59.23 |
| 32 | 476 | 5.492 | 0.44 | 5.97 | 2.108 | 2.007 | 86.88 | 63.23 |
| 32 | 508 | 5.705 | 0.50 | 6.46 | 2.240 | 2.140 | 92.59 | 67.21 |
| 32 | 540 | 5.872 | 0.43 | 6.89 | 2.344 | 2.272 | 98.30 | 70.33 |
| 16 | 556 | 5.965 | 0.34 | 7.23 | 2.402 | 2.338 | 101.16 | 72.07 |

* Nominal yield stress

Table A.14. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 5 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 5.00
Dist to bolt A (in) .. 1.44
Dist to gauge (in) ...10.00
Moment arm (in) .....72.38

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 2.034 | | | | | | |
| | DL | 2.413 | | 0.00 | 0.039 | 0.039 | 1.90 | 1.17 |
| 60 | 60 | 2.810 | 0.75 | 0.75 | 0.286 | 0.287 | 12.46 | 8.59 |
| 32 | 92 | 3.025 | 0.40 | 1.15 | 0.420 | 0.420 | 18.10 | 12.61 |
| 32 | 124 | 3.237 | 0.41 | 1.56 | 0.552 | 0.552 | 23.73 | 16.57 |
| 32 | 156 | 3.454 | 0.43 | 1.99 | 0.688 | 0.684 | 29.37 | 20.63 |
| 32 | 188 | 3.664 | 0.41 | 2.40 | 0.818 | 0.816 | 35.00 | 24.55 |
| 32 | 220 | 3.902 | 0.47 | 2.87 | 0.967 | 0.949 | 40.64 | 29.00 |
| 32 | 252 | 4.091 | 0.37 | 3.24 | 1.084 | 1.081 | 46.27 | 32.53 |
| 32 | 284 | 4.302 | 0.42 | 3.66 | 1.216 | 1.213 | 51.91 | 36.48 |
| 32 | 316 | 4.518 | 0.43 | 4.09 | 1.351 | 1.346 | 57.54 | 40.52 |
| 32 | 348 | 4.721 | 0.41 | 4.50 | 1.477 | 1.478 | 63.18 | 44.31 |
| 32 | 380 | 4.904 | 0.38 | 4.87 | 1.591 | 1.610 | 68.81 | 47.73 |
| 32 | 412 | 5.101 | 0.41 | 5.28 | 1.714 | 1.742 | 74.45 | 51.41 |
| 32 | 444 | 5.289 | 0.39 | 5.67 | 1.831 | 1.875 | 80.08 | 54.93 |
| 32 | 476 | 5.504 | 0.47 | 6.14 | 1.965 | 2.007 | 85.72 | 58.95 |
| 32 | 508 | 5.729 | 0.52 | 6.65 | 2.105 | 2.139 | 91.35 | 63.15 |
| 32 | 540 | 5.918 | 0.49 | 7.14 | 2.223 | 2.271 | 96.99 | 66.68 |
| 32 | 572 | 6.165 | 0.75 | 7.88 | 2.377 | 2.404 | 102.62 | 71.30 |
| 16 | 588 | 6.303 | 0.41 | 8.29 | 2.463 | 2.470 | 105.44 | 73.88 |

* Nominal yield stress

Table A.15. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 5 Inch Face to Face Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 5.00
Dist to bolt A (in) .. 1.88
Dist to gauge (in) ...10.50
Moment arm (in) .....72.88

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Face to face; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 0.870 | | | | | | |
| | DL | 0.667 | | 0.00 | 0.039 | 0.039 | 1.90 | 1.17 |
| 60 | 60 | 0.271 | 0.78 | 0.78 | 0.286 | 0.287 | 12.54 | 8.57 |
| 32 | 92 | 0.061 | 0.41 | 1.19 | 0.417 | 0.419 | 18.21 | 12.50 |
| 32 | 124 | -0.144 | 0.42 | 1.60 | 0.544 | 0.551 | 23.88 | 16.33 |
| 32 | 156 | -0.335 | 0.39 | 2.00 | 0.663 | 0.684 | 29.56 | 19.90 |
| 32 | 188 | -0.535 | 0.41 | 2.41 | 0.788 | 0.816 | 35.23 | 23.64 |
| 32 | 220 | -0.745 | 0.44 | 2.85 | 0.919 | 0.948 | 40.91 | 27.56 |
| 32 | 252 | -0.946 | 0.43 | 3.27 | 1.044 | 1.081 | 46.58 | 31.32 |
| 32 | 284 | -1.170 | 0.47 | 3.75 | 1.184 | 1.213 | 52.25 | 35.51 |
| 32 | 316 | -1.358 | 0.41 | 4.16 | 1.301 | 1.345 | 57.93 | 39.02 |
| 32 | 348 | -1.571 | 0.45 | 4.61 | 1.433 | 1.477 | 63.60 | 43.00 |
| 32 | 380 | -1.786 | 0.47 | 5.07 | 1.567 | 1.610 | 69.28 | 47.02 |
| 32 | 412 | -1.977 | 0.42 | 5.49 | 1.686 | 1.742 | 74.95 | 50.59 |
| 16 | 428 | -2.076 | 0.23 | 5.71 | 1.748 | 1.808 | 77.79 | 52.44 |
| 16 | 444 | -2.171 | 0.22 | 5.93 | 1.807 | 1.874 | 80.62 | 54.22 |
| 16 | 460 | -2.266 | 0.24 | 6.17 | 1.866 | 1.940 | 83.46 | 55.99 |
| 16 | 476 | -2.391 | 0.32 | 6.49 | 1.944 | 2.006 | 86.30 | 58.33 |
| 16 | 492 | -2.520 | 0.34 | 6.83 | 2.025 | 2.073 | 89.14 | 60.74 |
| 16 | 508 | -2.623 | 0.31 | 7.13 | 2.089 | 2.139 | 91.97 | 62.67 |
| 16 | 524 | -2.750 | 0.37 | 7.50 | 2.168 | 2.205 | 94.81 | 65.04 |
| 16 | 540 | -2.838 | 0.29 | 7.78 | 2.223 | 2.271 | 97.65 | 66.68 |
| 16 | 556 | -2.943 | 0.34 | 8.12 | 2.288 | 2.337 | 100.48 | 68.65 |
| 16 | 572 | -3.042 | 0.40 | 8.52 | 2.350 | 2.403 | 103.32 | 70.50 |

* Nominal yield stress

Table A.16. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 5 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 5.00
Dist to bolt A (in) .. 1.75
Dist to gauge (in) ...10.25
Moment arm (in) .....73.75

MARION 3 lb/ft - 80 ksi *
Back to back; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.897 | | | | | | |
| | DL | 1.704 | | 0.00 | 0.048 | 0.048 | 1.90 | 1.44 |
| 60 | 60 | 1.300 | 0.73 | 0.73 | 0.300 | 0.357 | 12.66 | 8.99 |
| 32 | 92 | 1.079 | 0.41 | 1.14 | 0.437 | 0.522 | 18.41 | 13.12 |
| 32 | 124 | 0.863 | 0.41 | 1.55 | 0.572 | 0.687 | 24.15 | 17.16 |
| 32 | 156 | 0.652 | 0.41 | 1.96 | 0.703 | 0.851 | 29.89 | 21.10 |
| 32 | 188 | 0.418 | 0.46 | 2.42 | 0.849 | 1.016 | 35.63 | 25.48 |
| 32 | 220 | 0.202 | 0.43 | 2.85 | 0.984 | 1.181 | 41.38 | 29.51 |
| 32 | 252 | -0.017 | 0.44 | 3.28 | 1.120 | 1.346 | 47.12 | 33.61 |
| 32 | 284 | -0.236 | 0.44 | 3.72 | 1.257 | 1.511 | 52.86 | 37.70 |
| 32 | 316 | -0.455 | 0.44 | 4.15 | 1.393 | 1.675 | 58.60 | 41.79 |
| 32 | 348 | -0.677 | 0.44 | 4.59 | 1.531 | 1.840 | 64.34 | 45.94 |
| 32 | 380 | -0.902 | 0.46 | 5.05 | 1.672 | 2.005 | 70.09 | 50.15 |
| 32 | 412 | -1.118 | 0.44 | 5.48 | 1.806 | 2.170 | 75.83 | 54.19 |
| 32 | 444 | -1.347 | 0.48 | 5.96 | 1.949 | 2.335 | 81.57 | 58.47 |
| 32 | 476 | -1.539 | 0.41 | 6.36 | 2.069 | 2.499 | 87.31 | 62.06 |
| 32 | 508 | -1.738 | 0.44 | 6.80 | 2.193 | 2.664 | 93.05 | 65.78 |
| 32 | 540 | -1.957 | 0.53 | 7.32 | 2.329 | 2.829 | 98.80 | 69.87 |
| 16 | 556 | -2.038 | 0.24 | 7.56 | 2.379 | 2.911 | 101.67 | 71.38 |
| 16 | 572 | -2.162 | 0.35 | 7.90 | 2.457 | 2.994 | 104.54 | 73.70 |
| 16 | 588 | -2.263 | 0.38 | 8.28 | 2.520 | 3.076 | 107.41 | 75.59 |
| 12 | 600 | -2.242 | 0.22 | 8.50 | 2.507 | 3.138 | 109.56 | 75.20 |

* Nominal yield stress

Table A.17. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 5 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 5.00
Dist to bolt A (in) .. 1.63
Dist to gauge (in) ...10.19
Moment arm (in) .....72.38

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Nested; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 2.218 | | | | | | |
| | DL | 2.042 | | 0.00 | 0.039 | 0.039 | 1.90 | 1.17 |
| 60 | 60 | 1.640 | 0.77 | 0.77 | 0.289 | 0.286 | 12.47 | 8.68 |
| 32 | 92 | 1.424 | 0.41 | 1.18 | 0.424 | 0.418 | 18.10 | 12.72 |
| 32 | 124 | 1.207 | 0.42 | 1.60 | 0.559 | 0.550 | 23.74 | 16.78 |
| 32 | 156 | 0.986 | 0.42 | 2.02 | 0.697 | 0.682 | 29.37 | 20.91 |
| 32 | 188 | 0.763 | 0.43 | 2.45 | 0.836 | 0.814 | 35.01 | 25.08 |
| 32 | 220 | 0.553 | 0.40 | 2.85 | 0.967 | 0.946 | 40.65 | 29.00 |
| 32 | 252 | 0.360 | 0.37 | 3.22 | 1.087 | 1.078 | 46.28 | 32.61 |
| 32 | 284 | 0.152 | 0.40 | 3.63 | 1.217 | 1.210 | 51.92 | 36.50 |
| 32 | 316 | -0.057 | 0.41 | 4.04 | 1.347 | 1.341 | 57.55 | 40.40 |
| 32 | 348 | -0.279 | 0.43 | 4.46 | 1.485 | 1.473 | 63.19 | 44.55 |
| 32 | 380 | -0.478 | 0.41 | 4.87 | 1.609 | 1.605 | 68.82 | 48.27 |
| 32 | 412 | -0.673 | 0.39 | 5.26 | 1.731 | 1.737 | 74.46 | 51.92 |
| 32 | 444 | -0.864 | 0.38 | 5.64 | 1.850 | 1.869 | 80.09 | 55.49 |
| 32 | 476 | -1.059 | 0.40 | 6.04 | 1.971 | 2.001 | 85.73 | 59.13 |
| 32 | 508 | -1.254 | 0.41 | 6.45 | 2.093 | 2.133 | 91.36 | 62.78 |
| 32 | 540 | -1.434 | 0.39 | 6.84 | 2.205 | 2.265 | 97.00 | 66.14 |
| 32 | 572 | -1.652 | 0.48 | 7.32 | 2.341 | 2.396 | 102.63 | 70.22 |
| 16 | 588 | -1.743 | 0.21 | 7.53 | 2.397 | 2.462 | 105.45 | 71.92 |
| 16 | 604 | -1.871 | 0.36 | 7.89 | 2.477 | 2.528 | 108.27 | 74.31 |
| 16 | 620 | -1.934 | 0.19 | 8.08 | 2.516 | 2.594 | 111.08 | 75.49 |
| 28 | 648 | -2.036 | 0.31 | 8.39 | 2.580 | 2.710 | 116.01 | 77.39 |
| 16 | 664 | -2.122 | 0.31 | 8.70 | 2.633 | 2.776 | 118.83 | 79.00 |
| 16 | 680 | -2.286 | 0.30 | 9.00 | 2.736 | 2.842 | 121.65 | 82.07 |

* Nominal yield stress

Table A.18. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 5 Inch Face to Face Splice in Non-critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 5.00
Dist to bolt A (in) .. 1.38
Dist to gauge (in) ... 9.81
Moment arm (in) .....72.38

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Face to face; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 0.792 | | | | | | |
| | DL | 1.011 | | 0.00 | 0.040 | 0.040 | 1.89 | 1.20 |
| 60 | 60 | 1.467 | 0.84 | 0.84 | 0.324 | 0.288 | 12.46 | 9.72 |
| 32 | 92 | 1.665 | 0.38 | 1.22 | 0.447 | 0.421 | 18.09 | 13.42 |
| 32 | 124 | 1.801 | 0.41 | 1.63 | 0.532 | 0.554 | 23.73 | 15.97 |
| 32 | 156 | 2.095 | 0.41 | 2.03 | 0.715 | 0.687 | 29.36 | 21.46 |
| 32 | 188 | 2.325 | 0.44 | 2.47 | 0.859 | 0.819 | 35.00 | 25.76 |
| 32 | 220 | 2.527 | 0.39 | 2.86 | 0.985 | 0.952 | 40.63 | 29.54 |
| 32 | 252 | 2.702 | 0.35 | 3.21 | 1.094 | 1.085 | 46.27 | 32.81 |
| 32 | 284 | 2.895 | 0.39 | 3.60 | 1.214 | 1.217 | 51.90 | 36.41 |
| 32 | 316 | 3.144 | 0.50 | 4.10 | 1.369 | 1.350 | 57.54 | 41.07 |
| 32 | 348 | 3.338 | 0.38 | 4.48 | 1.490 | 1.483 | 63.17 | 44.70 |
| 32 | 380 | 3.544 | 0.41 | 4.89 | 1.618 | 1.615 | 68.81 | 48.55 |
| 32 | 412 | 3.764 | 0.44 | 5.33 | 1.755 | 1.748 | 74.44 | 52.66 |
| 32 | 444 | 3.984 | 0.47 | 5.79 | 1.892 | 1.881 | 80.08 | 56.77 |
| 16 | 460 | 4.112 | 0.28 | 6.07 | 1.972 | 1.947 | 82.90 | 59.16 |
| 16 | 476 | 4.210 | 0.23 | 6.29 | 2.033 | 2.013 | 85.71 | 60.99 |
| 16 | 492 | 4.330 | 0.31 | 6.60 | 2.108 | 2.080 | 88.53 | 63.24 |
| 16 | 508 | 4.451 | 0.33 | 6.93 | 2.183 | 2.146 | 91.35 | 65.50 |
| 16 | 524 | 4.569 | 0.35 | 7.28 | 2.257 | 2.212 | 94.17 | 67.70 |
| 16 | 540 | 4.692 | 0.38 | 7.66 | 2.333 | 2.279 | 96.98 | 70.00 |
| 16 | 556 | 4.815 | 0.37 | 8.03 | 2.410 | 2.345 | 99.80 | 72.30 |
| 16 | 572 | 4.943 | 0.40 | 8.42 | 2.490 | 2.411 | 102.62 | 74.70 |
| 16 | 588 | 5.092 | 0.50 | 8.92 | 2.583 | 2.478 | 105.44 | 77.48 |

* Nominal yield stress

# APPENDIX B

## 17 " BENDING TESTS

### FIELD BOLT SUMMARY TABLES

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back, Nested and Face to Face Splices

Critical and Non-critical Configurations

# APPENDIX B

## LIST OF TABLES

# APPENDIX B

## LIST OF TABLES (CONT)

# APPENDIX B

## LIST OF TABLES (CONT)

Table B.1. *Results of 17 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 3.00
Dist to bolt A (in) .. 1.44
Dist to gauge (in) ... 8.13
Moment arm (in) .....16.44

FRANKLIN 3 lb/ft - 60 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) | | | Total | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Read (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 0.704 | | | | | | |
| | DL | 0.838 | | | -0.052 | -0.052 | 1.94 | -1.55 |
| 0 | 0 | 0.849 | -1.22 | 0.00 | -0.059 | -0.052 | 1.94 | -1.76 |
| 200 | 200 | 1.076 | -1.31 | 0.09 | -0.200 | -0.189 | 10.09 | -6.00 |
| 200 | 400 | 1.131 | -1.40 | 0.18 | -0.234 | -0.327 | 18.25 | -7.03 |
| 200 | 600 | 1.532 | -1.49 | 0.27 | -0.484 | -0.464 | 26.41 | -14.52 |
| 200 | 800 | 1.764 | -1.58 | 0.37 | -0.629 | -0.602 | 34.57 | -18.86 |
| 200 | 1000 | 1.982 | -1.69 | 0.47 | -0.764 | -0.739 | 42.73 | -22.93 |
| 200 | 1200 | 2.217 | -1.80 | 0.58 | -0.911 | -0.877 | 50.89 | -27.33 |
| 100 | 1300 | 2.326 | -1.87 | 0.65 | -0.979 | -0.945 | 54.97 | -29.36 |
| 100 | 1400 | 2.420 | -1.97 | 0.75 | -1.037 | -1.014 | 59.05 | -31.12 |
| 100 | 1500 | 2.545 | -2.07 | 0.85 | -1.115 | -1.083 | 63.13 | -33.46 |
| 43 | 1543 | | | | | | 64.88 | |

* Nominal yield stress

Table B.2. *Results of 17 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 3.00
Dist to bolt A (in) .. 1.75
Dist to gauge (in) ... 8.31
Moment arm (in) .....16.75

FRANKLIN 3 lb/ft - 60 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 0.644 | | | | | | |
| | DL | 0.589 | | | 0.052 | 0.052 | 1.94 | 1.55 |
| 0 | 0 | 0.606 | -0.69 | 0.00 | 0.041 | 0.052 | 1.94 | 1.23 |
| 200 | 200 | 0.396 | -0.79 | 0.10 | 0.172 | 0.191 | 10.25 | 5.74 |
| 200 | 400 | 0.153 | -0.90 | 0.21 | 0.323 | 0.331 | 18.56 | 9.93 |
| 200 | 600 | -0.083 | -1.01 | 0.32 | 0.470 | 0.471 | 26.87 | 14.12 |
| 200 | 800 | -0.335 | -1.13 | 0.44 | 0.627 | 0.610 | 35.19 | 18.30 |
| 200 | 1000 | -0.588 | -1.26 | 0.57 | 0.785 | 0.750 | 43.50 | 22.49 |
| 200 | 1200 | -0.849 | -1.40 | 0.72 | 0.948 | 0.889 | 51.81 | 26.68 |
| 200 | 1400 | -1.141 | -1.65 | 0.96 | 1.130 | 1.029 | 60.12 | 30.87 |
| 100 | 1500 | -1.261 | -1.83 | 1.14 | 1.204 | 1.099 | 64.28 | 32.96 |
| 346 | 1846 | | -2.49 | 1.80 | | | 78.66 | |

* Nominal yield stress

- Stub cracked and allowed increased load and deflection proir to bolt failure - bolt fails at 1846 lbs

Table B.3. *Results of 17 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Face to Face Splice in Critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 3.00
Dist to bolt A (in) .. 1.75
Dist to gauge (in) ... 8.25
Moment arm (in) .....16.75

FRANKLIN 3 lb/ft - 60 ksi *
Face to face; gr 5 bolts
Critical orientation

| LOAD (lbs) | | | Tip | Total | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Defl (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 1.191 | | | | | | |
| | DL | 1.259 | | | 0.052 | 0.052 | 1.94 | 1.55 |
| 0 | 0 | 1.277 | -1.33 | 0.00 | 0.040 | 0.052 | 1.94 | 1.21 |
| 200 | 200 | 1.084 | -1.43 | 0.10 | 0.161 | 0.188 | 10.25 | 4.82 |
| 200 | 400 | 0.871 | -1.52 | 0.20 | 0.293 | 0.325 | 18.56 | 8.80 |
| 200 | 600 | 0.671 | -1.63 | 0.30 | 0.418 | 0.461 | 26.87 | 12.54 |
| 200 | 800 | 0.452 | -1.79 | 0.46 | 0.555 | 0.598 | 35.19 | 16.64 |
| 200 | 1000 | 0.224 | -1.97 | 0.64 | 0.697 | 0.734 | 43.50 | 20.90 |
| 200 | 1200 | -0.001 | -2.20 | 0.88 | 0.837 | 0.871 | 51.81 | 25.10 |
| 100 | 1300 | -0.118 | -2.46 | 1.13 | 0.910 | 0.939 | 55.97 | 27.29 |
| 67 | 1367 | -0.194 | -2.98 | 1.66 | 0.957 | 0.985 | 58.75 | 28.71 |

* Nominal yield stress

- Stub cracked and allowed increased load and deflection - bolt did not fail - stroke limit reached at -2.98 in

Table B.4. *Results of 17 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 3.00
Dist to bolt A (in) .. 1.75
Dist to gauge (in) ... 8.25
Moment arm (in) .....16.75

FRANKLIN 3 lb/ft - 60 ksi *
Back to back; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Total Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -1.134 | | | | | | |
| | DL | -1.320 | | | 0.052 | 0.052 | 1.94 | 1.55 |
| 0 | 0 | -1.327 | 0.75 | 0.00 | 0.056 | 0.052 | 1.94 | 1.68 |
| 200 | 200 | -1.588 | 0.66 | 0.09 | 0.219 | 0.192 | 10.25 | 6.56 |
| 200 | 400 | -1.832 | 0.56 | 0.18 | 0.371 | 0.333 | 18.56 | 11.12 |
| 200 | 600 | -2.105 | 0.47 | 0.28 | 0.541 | 0.474 | 26.87 | 16.22 |
| 200 | 800 | -2.376 | 0.37 | 0.38 | 0.710 | 0.614 | 35.19 | 21.29 |
| 200 | 1000 | -2.654 | 0.27 | 0.48 | 0.883 | 0.755 | 43.50 | 26.49 |
| 200 | 1200 | -2.948 | 0.17 | 0.57 | 1.066 | 0.895 | 51.81 | 31.98 |
| 200 | 1400 | -3.260 | 0.06 | 0.69 | 1.260 | 1.036 | 60.12 | 37.81 |
| 100 | 1500 | -3.438 | -0.02 | 0.76 | 1.371 | 1.106 | 64.28 | 41.14 |
| 100 | 1600 | -3.613 | -0.12 | 0.86 | 1.480 | 1.177 | 68.44 | 44.41 |
| 100 | 1700 | -3.803 | -0.24 | 0.99 | 1.599 | 1.247 | 72.59 | 47.96 |
| 75 | 1775 | -3.895 | -0.36 | 1.10 | 1.656 | 1.300 | 75.71 | 49.68 |
| 75 | 1850 | -4.135 | -0.49 | 1.23 | 1.806 | 1.352 | 78.83 | 54.17 |
| 50 | 1900 | -4.267 | -0.60 | 1.34 | 1.888 | 1.388 | 80.91 | 56.64 |
| 50 | 1950 | -4.414 | -0.79 | 1.53 | 1.979 | 1.423 | 82.98 | 59.38 |
| 56 | 2006 | | | | | | 85.31 | |

* Nominal yield stress

Table B.5. *Results of 17 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 3.00
Dist to bolt A (in) .. 1.38
Dist to gauge (in) ... 8.13
Moment arm (in) .....16.38

FRANKLIN 3 lb/ft - 60 ksi *
Nested; gr 5 bolts
Non-critical orientation

| LOAD (lbs) | | | | | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Read (in) | Total Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 1.092 | | | | | | |
| | DL | 1.240 | | | -0.052 | -0.052 | 1.94 | -1.55 |
| 0 | 0 | 1.203 | 1.42 | 0.00 | -0.029 | -0.052 | 1.94 | -0.86 |
| 200 | 200 | 1.436 | 1.32 | 0.10 | -0.174 | -0.188 | 10.06 | -5.21 |
| 200 | 400 | 1.661 | 1.23 | 0.19 | -0.314 | -0.325 | 18.19 | -9.42 |
| 200 | 600 | 1.870 | 1.13 | 0.29 | -0.444 | -0.461 | 26.32 | -13.33 |
| 200 | 800 | 2.102 | 1.03 | 0.40 | -0.589 | -0.598 | 34.45 | -17.66 |
| 200 | 1000 | 2.326 | 0.92 | 0.50 | -0.728 | -0.734 | 42.58 | -21.85 |
| 200 | 1200 | 2.568 | 0.81 | 0.62 | -0.879 | -0.871 | 50.71 | -26.37 |
| 100 | 1300 | 2.688 | 0.74 | 0.68 | -0.954 | -0.939 | 54.77 | -28.62 |
| 100 | 1400 | 2.816 | 0.66 | 0.76 | -1.034 | -1.007 | 58.84 | -31.01 |
| 100 | 1500 | 2.937 | 0.58 | 0.85 | -1.109 | -1.076 | 62.90 | -33.27 |
| 100 | 1600 | 3.095 | 0.43 | 1.00 | -1.207 | -1.144 | 66.97 | -36.22 |
| 100 | 1700 | 3.250 | 0.28 | 1.14 | -1.304 | -1.212 | 71.03 | -39.12 |
| 100 | 1800 | 3.410 | 0.11 | 1.31 | -1.404 | -1.280 | 75.10 | -42.11 |
| 100 | 1900 | 3.615 | -0.13 | 1.55 | -1.531 | -1.348 | 79.16 | -45.94 |
| 100 | 2000 | 3.831 | -0.40 | 1.82 | -1.666 | -1.417 | 83.23 | -49.98 |
| 53 | 2053 | | | | | | 85.38 | |

* Nominal yield stress

Table B.6. *Results of 17 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Face to Face Splice in Non-critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 3.00
Dist to bolt A (in) .. 1.69
Dist to gauge (in) ... 8.13
Moment arm (in) .....16.69

BENDING TEST

FRANKLIN 3 lb/ft - 60 ksi *
Face to face; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.216 | | | | | | |
| | DL | 1.386 | | | -0.052 | -0.052 | 1.94 | -1.55 |
| 0 | 0 | 1.391 | 2.28 | 0.00 | -0.055 | -0.052 | 1.94 | -1.64 |
| 200 | 200 | 1.573 | 2.20 | 0.08 | -0.168 | -0.194 | 10.22 | -5.05 |
| 200 | 400 | 1.786 | 2.10 | 0.18 | -0.301 | -0.335 | 18.50 | -9.03 |
| 200 | 600 | 2.010 | 2.00 | 0.29 | -0.440 | -0.477 | 26.78 | -13.21 |
| 200 | 800 | 2.231 | 1.89 | 0.39 | -0.578 | -0.618 | 35.07 | -17.35 |
| 200 | 1000 | 2.458 | 1.78 | 0.51 | -0.720 | -0.760 | 43.35 | -21.59 |
| 200 | 1200 | 2.727 | 1.64 | 0.64 | -0.887 | -0.902 | 51.63 | -26.62 |
| 200 | 1400 | 2.983 | 1.46 | 0.82 | -1.047 | -1.043 | 59.92 | -31.40 |
| 100 | 1500 | 3.196 | 1.24 | 1.04 | -1.179 | -1.114 | 64.06 | -35.38 |
| 50 | 1550 | 3.252 | 1.15 | 1.13 | -1.214 | -1.149 | 66.13 | -36.43 |
| 50 | 1600 | 3.357 | 1.06 | 1.23 | -1.280 | -1.185 | 68.20 | -38.39 |
| 50 | 1650 | 3.457 | 0.92 | 1.36 | -1.342 | -1.220 | 70.27 | -40.26 |
| 50 | 1700 | 3.598 | 0.59 | 1.69 | -1.430 | -1.256 | 72.34 | -42.90 |

* Nominal yield stress

- End of post (79 in) displaces 18 in laterally

Table B.7. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.50
Dist to gauge (in) ... 9.19
Moment arm (in) .....17.50

BENDING TEST

FRANKLIN 4 lb/ft - 60 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Total Defl Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -0.238 | | | | | | |
| | DL | -0.075 | | | -0.048 | -0.048 | 1.86 | -1.44 |
| 0 | 0 | -0.076 | -1.09 | 0.00 | -0.047 | -0.048 | 1.86 | -1.42 |
| 200 | 200 | 0.084 | -1.18 | 0.09 | -0.147 | -0.147 | 8.11 | -4.41 |
| 200 | 400 | 0.254 | -1.26 | 0.17 | -0.253 | -0.246 | 14.36 | -7.59 |
| 200 | 600 | 0.418 | -1.33 | 0.24 | -0.355 | -0.345 | 20.61 | -10.65 |
| 200 | 800 | 0.594 | -1.41 | 0.32 | -0.465 | -0.444 | 26.86 | -13.94 |
| 200 | 1000 | 0.773 | -1.49 | 0.40 | -0.576 | -0.543 | 33.11 | -17.29 |
| 200 | 1200 | 0.952 | -1.56 | 0.47 | -0.688 | -0.642 | 39.36 | -20.64 |
| 200 | 1400 | 1.137 | -1.65 | 0.56 | -0.803 | -0.741 | 45.61 | -24.09 |
| 200 | 1600 | 1.319 | -1.76 | 0.67 | -0.917 | -0.840 | 51.86 | -27.50 |
| 100 | 1700 | 1.416 | -1.88 | 0.79 | -0.977 | -0.889 | 54.98 | -29.31 |
| 51 | 1751 | | | | | | 56.58 | |

* Nominal yield stress

Table B.8. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.63
Dist to gauge (in) ... 9.25
Moment arm (in) .....16.63

BENDING TEST

FRANKLIN 4 lb/ft - 60 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Total Defl Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 0.145 | | | | | | |
| | DL | 0.065 | | | 0.049 | 0.049 | 1.86 | 1.48 |
| 0 | 0 | 0.061 | -0.90 | 0.00 | 0.052 | 0.049 | 1.86 | 1.55 |
| 200 | 200 | -0.082 | -0.96 | 0.06 | 0.141 | 0.136 | 7.80 | 4.22 |
| 200 | 400 | -0.232 | -1.02 | 0.12 | 0.234 | 0.224 | 13.74 | 7.03 |
| 200 | 600 | -0.372 | -1.09 | 0.19 | 0.321 | 0.312 | 19.68 | 9.64 |
| 200 | 800 | -0.514 | -1.16 | 0.26 | 0.410 | 0.400 | 25.61 | 12.30 |
| 200 | 1000 | -0.673 | -1.22 | 0.32 | 0.509 | 0.488 | 31.55 | 15.27 |
| 200 | 1200 | -0.819 | -1.28 | 0.39 | 0.600 | 0.576 | 37.49 | 18.00 |
| 200 | 1400 | -0.981 | -1.35 | 0.46 | 0.701 | 0.664 | 43.43 | 21.03 |
| 200 | 1600 | -1.130 | -1.43 | 0.53 | 0.794 | 0.751 | 49.37 | 23.81 |
| 100 | 1700 | -1.315 | -1.47 | 0.58 | 0.909 | 0.795 | 52.34 | 27.27 |
| 100 | 1800 | -1.294 | -1.53 | 0.63 | 0.896 | 0.839 | 55.31 | 26.88 |
| 100 | 1900 | -1.381 | -1.57 | 0.67 | 0.950 | 0.883 | 58.28 | 28.50 |
| 100 | 2000 | -1.455 | -1.63 | 0.74 | 0.996 | 0.927 | 61.25 | 29.89 |

* Nominal yield stress

Table B.9. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration; Assembled Backwards (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.56
Dist to gauge (in) ... 9.19
Moment arm (in) .....16.56

FRANKLIN 4 lb/ft - 60 ksi *
Nested; gr 5 bolts
Critical (backwards)

| LOAD (lbs) | | | Tip | Total | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Defl (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 0.088 | | | | | | |
| | DL | 0.128 | | | -0.048 | -0.048 | 1.86 | -1.44 |
| 0 | 0 | 0.119 | -0.27 | 0.00 | -0.042 | -0.048 | 1.86 | -1.27 |
| 200 | 200 | 0.260 | -0.34 | 0.07 | -0.130 | -0.136 | 7.77 | -3.91 |
| 200 | 400 | 0.413 | -0.40 | 0.13 | -0.226 | -0.224 | 13.69 | -6.77 |
| 200 | 600 | 0.558 | -0.47 | 0.20 | -0.316 | -0.312 | 19.60 | -9.48 |
| 200 | 800 | 0.711 | -0.51 | 0.24 | -0.411 | -0.399 | 25.51 | -12.34 |
| 200 | 1000 | 0.876 | -0.60 | 0.33 | -0.514 | -0.487 | 31.43 | -15.42 |
| 200 | 1200 | 1.022 | -0.67 | 0.40 | -0.605 | -0.575 | 37.34 | -18.15 |
| 200 | 1400 | 1.191 | -0.74 | 0.47 | -0.710 | -0.663 | 43.26 | -21.31 |
| 200 | 1600 | 1.341 | -0.82 | 0.55 | -0.804 | -0.750 | 49.17 | -24.11 |
| 200 | 1800 | 1.493 | -0.90 | 0.63 | -0.898 | -0.838 | 55.09 | -26.95 |
| 200 | 2000 | 1.654 | -1.00 | 0.73 | -0.999 | -0.926 | 61.00 | -29.96 |
| 80 | 2080 | 1.704 | -1.11 | 0.84 | -1.030 | -0.961 | 63.37 | -30.90 |
| 17 | 2097 | | | | | | 63.87 | |

* Nominal yield stress

Table B.10. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.50
Dist to gauge (in) ... 9.13
Moment arm (in) .....16.50

BENDING TEST

FRANKLIN 4 lb/ft - 60 ksi *
Face to face; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -0.100 | | | | | | |
| | DL | -0.158 | | | 0.048 | 0.048 | 1.86 | 1.44 |
| 0 | 0 | -0.169 | -1.34 | 0.00 | 0.055 | 0.048 | 1.86 | 1.64 |
| 200 | 200 | -0.322 | -1.42 | 0.08 | 0.150 | 0.136 | 7.75 | 4.50 |
| 200 | 400 | -0.470 | -1.49 | 0.15 | 0.242 | 0.224 | 13.64 | 7.27 |
| 200 | 600 | -0.604 | -1.56 | 0.22 | 0.326 | 0.312 | 19.54 | 9.78 |
| 200 | 800 | -0.760 | -1.63 | 0.29 | 0.423 | 0.399 | 25.43 | 12.69 |
| 200 | 1000 | -0.906 | -1.70 | 0.36 | 0.514 | 0.487 | 31.32 | 15.42 |
| 200 | 1200 | -1.064 | -1.78 | 0.44 | 0.612 | 0.575 | 37.21 | 18.37 |
| 200 | 1400 | -1.215 | -1.85 | 0.51 | 0.707 | 0.663 | 43.11 | 21.20 |
| 200 | 1600 | -1.487 | -1.94 | 0.60 | 0.876 | 0.750 | 49.00 | 26.28 |
| 200 | 1800 | -1.560 | -2.03 | 0.69 | 0.921 | 0.838 | 54.89 | 27.64 |
| 200 | 2000 | -1.702 | -2.12 | 0.78 | 1.010 | 0.926 | 60.79 | 30.30 |
| 100 | 2100 | -1.786 | -2.19 | 0.85 | 1.062 | 0.970 | 63.73 | 31.87 |
| 50 | 2150 | | | | | | 65.21 | 0.00 |

* Nominal yield stress

Table B.11. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.75
Dist to gauge (in) ... 9.38
Moment arm (in) .....16.75

BENDING TEST

FRANKLIN 4 lb/ft - 60 ksi *
Back to back; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Total Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -0.170 | | | | | | |
| | DL | -0.287 | | | 0.048 | 0.048 | 1.86 | 1.44 |
| 0 | 0 | -0.297 | 0.89 | 0.00 | 0.054 | 0.048 | 1.86 | 1.63 |
| 200 | 200 | -0.438 | 0.83 | 0.06 | 0.142 | 0.136 | 7.84 | 4.26 |
| 200 | 400 | -0.599 | 0.77 | 0.12 | 0.242 | 0.224 | 13.82 | 7.27 |
| 200 | 600 | -0.736 | 0.70 | 0.19 | 0.328 | 0.311 | 19.80 | 9.83 |
| 200 | 800 | -0.889 | 0.64 | 0.25 | 0.423 | 0.399 | 25.79 | 12.69 |
| 200 | 1000 | -1.033 | 0.57 | 0.32 | 0.513 | 0.487 | 31.77 | 15.38 |
| 200 | 1200 | -1.190 | 0.50 | 0.39 | 0.611 | 0.575 | 37.75 | 18.32 |
| 200 | 1400 | -1.351 | 0.44 | 0.45 | 0.711 | 0.662 | 43.73 | 21.33 |
| 100 | 1500 | -1.431 | 0.40 | 0.49 | 0.761 | 0.706 | 46.72 | 22.82 |
| 100 | 1600 | -1.511 | 0.37 | 0.52 | 0.811 | 0.750 | 49.71 | 24.32 |
| 100 | 1700 | -1.584 | 0.33 | 0.56 | 0.856 | 0.794 | 52.71 | 25.68 |
| 100 | 1800 | -1.672 | 0.29 | 0.60 | 0.911 | 0.838 | 55.70 | 27.33 |
| 100 | 1900 | -1.745 | 0.26 | 0.63 | 0.956 | 0.882 | 58.69 | 28.69 |
| 100 | 2000 | -1.835 | 0.22 | 0.67 | 1.012 | 0.925 | 61.68 | 30.37 |
| 100 | 2100 | -1.916 | 0.18 | 0.71 | 1.063 | 0.969 | 64.67 | 31.89 |
| 100 | 2200 | -2.000 | 0.13 | 0.76 | 1.115 | 1.013 | 67.66 | 33.46 |
| 100 | 2300 | -2.095 | 0.08 | 0.81 | 1.174 | 1.057 | 70.65 | 35.23 |
| 100 | 2400 | -2.190 | -0.01 | 0.90 | 1.234 | 1.101 | 73.64 | 37.01 |
| 100 | 2500 | -2.293 | -0.11 | 1.00 | 1.298 | 1.145 | 76.63 | 38.93 |
| 100 | 2600 | -2.392 | -0.24 | 1.12 | 1.348 | 1.189 | 79.63 | 40.43 |
| 80 | 2680 | | | | | | 82.02 | |

* Nominal yield stress

Table B.12. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.88
Dist to gauge (in) ... 9.44
Moment arm (in) .....16.88

BENDING TEST

FRANKLIN 4 lb/ft - 60 ksi *
Nested; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Total Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -0.175 | | | | | | |
| | DL | -0.022 | | | -0.048 | -0.048 | 1.86 | -1.44 |
| 0 | 0 | -0.022 | 1.55 | 0.00 | -0.048 | -0.048 | 1.86 | -1.44 |
| 200 | 200 | 0.125 | 1.46 | 0.09 | -0.140 | -0.137 | 7.89 | -4.19 |
| 200 | 400 | 0.279 | 1.40 | 0.16 | -0.236 | -0.225 | 13.91 | -7.07 |
| 200 | 600 | 0.438 | 1.32 | 0.23 | -0.335 | -0.314 | 19.94 | -10.04 |
| 200 | 800 | 0.612 | 1.25 | 0.31 | -0.443 | -0.402 | 25.97 | -13.29 |
| 200 | 1000 | 0.758 | 1.18 | 0.38 | -0.534 | -0.491 | 32.00 | -16.02 |
| 200 | 1200 | 0.919 | 1.11 | 0.44 | -0.634 | -0.579 | 38.03 | -19.03 |
| 200 | 1400 | 1.079 | 1.04 | 0.51 | -0.734 | -0.668 | 44.06 | -22.02 |
| 200 | 1600 | 1.244 | 0.97 | 0.58 | -0.837 | -0.757 | 50.09 | -25.10 |
| 100 | 1700 | 1.323 | 0.93 | 0.62 | -0.886 | -0.801 | 53.10 | -26.58 |
| 100 | 1800 | 1.459 | 0.89 | 0.66 | -0.971 | -0.845 | 56.11 | -29.12 |
| 100 | 1900 | 1.596 | 0.85 | 0.71 | -1.056 | -0.889 | 59.13 | -31.68 |
| 100 | 2000 | 1.576 | 0.80 | 0.75 | -1.044 | -0.934 | 62.14 | -31.31 |
| 100 | 2100 | 1.711 | 0.75 | 0.80 | -1.128 | -0.978 | 65.16 | -33.83 |
| 100 | 2200 | 1.847 | 0.66 | 0.89 | -1.212 | -1.022 | 68.17 | -36.37 |
| 100 | 2300 | 1.930 | 0.60 | 0.96 | -1.264 | -1.067 | 71.19 | -37.93 |
| 100 | 2400 | 1.962 | 0.52 | 1.04 | -1.284 | -1.111 | 74.20 | -38.52 |
| 100 | 2500 | 2.083 | 0.42 | 1.14 | -1.360 | -1.155 | 77.21 | -40.79 |
| 100 | 2600 | 2.164 | 0.29 | 1.26 | -1.410 | -1.199 | 80.23 | -42.30 |
| 100 | 2700 | 2.286 | 0.17 | 1.38 | -1.486 | -1.244 | 83.24 | -44.58 |
| 74 | 2774 | | | | | | 85.47 | |

* Nominal yield stress

Table B.13. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Non-critical Configuration; Assembled Backwards (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.63
Dist to gauge (in) ... 9.06
Moment arm (in) .....16.63

BENDING TEST

FRANKLIN 4 lb/ft - 60 ksi *
Nested; gr 5 bolts
Non-critical (backwards)

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Total Defl Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -0.168 | | | | | | |
| | DL | -0.239 | | | 0.049 | 0.049 | 1.86 | 1.48 |
| 0 | 0 | -0.212 | 0.46 | 0.00 | 0.032 | 0.049 | 1.86 | 0.97 |
| 200 | 200 | -0.381 | 0.39 | 0.07 | 0.138 | 0.139 | 7.80 | 4.16 |
| 200 | 400 | -0.535 | 0.34 | 0.13 | 0.234 | 0.229 | 13.74 | 6.86 |
| 200 | 600 | -0.667 | 0.28 | 0.18 | 0.316 | 0.319 | 19.68 | 9.57 |
| 200 | 800 | -0.832 | 0.21 | 0.25 | 0.419 | 0.409 | 25.61 | 12.27 |
| 200 | 1000 | -0.980 | 0.15 | 0.31 | 0.511 | 0.499 | 31.55 | 14.97 |
| 200 | 1200 | -1.133 | 0.09 | 0.37 | 0.606 | 0.589 | 37.49 | 17.68 |
| 200 | 1400 | -1.296 | 0.02 | 0.44 | 0.708 | 0.679 | 43.43 | 20.38 |
| 200 | 1600 | -1.451 | -0.04 | 0.50 | 0.804 | 0.769 | 49.37 | 23.08 |
| 200 | 1800 | -1.618 | -0.11 | 0.57 | 0.908 | 0.860 | 55.31 | 25.79 |
| 200 | 2000 | -1.784 | -0.19 | 0.65 | 1.012 | 0.950 | 61.25 | 28.49 |
| 100 | 2100 | -1.862 | -0.23 | 0.69 | 1.060 | 0.995 | 64.22 | 29.84 |
| 100 | 2200 | -1.942 | -0.27 | 0.73 | 1.110 | 1.040 | 67.19 | 31.20 |
| 100 | 2300 | -2.029 | -0.33 | 0.79 | 1.164 | 1.085 | 70.16 | 32.55 |
| 100 | 2400 | -2.107 | -0.39 | 0.85 | 1.213 | 1.130 | 73.13 | 33.90 |
| 100 | 2500 | -2.198 | -0.46 | 0.92 | 1.270 | 1.175 | 76.10 | 35.25 |
| 100 | 2600 | -2.298 | -0.54 | 1.00 | 1.332 | 1.220 | 79.07 | 36.60 |
| 100 | 2700 | -2.382 | -0.64 | 1.10 | 1.384 | 1.265 | 82.04 | 37.95 |
| 100 | 2800 | -2.463 | -0.74 | 1.20 | 1.435 | 1.310 | 85.01 | 39.31 |
| 73 | 2873 | | | | | | 87.18 | |

* Nominal yield stress

Table B.14. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.50
Dist to gauge (in) ... 9.13
Moment arm (in) .....16.50

BENDING TEST

FRANKLIN 4 lb/ft - 60 ksi *
Face to face; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -0.105 | | | | | | |
| | DL | 0.064 | | | -0.048 | -0.048 | 1.86 | -1.44 |
| 0 | 0 | 0.074 | 2.36 | 0.00 | -0.054 | -0.048 | 1.86 | -1.63 |
| 200 | 200 | 0.202 | 2.31 | 0.05 | -0.134 | -0.136 | 7.75 | -4.02 |
| 200 | 400 | 0.351 | 2.25 | 0.11 | -0.227 | -0.224 | 13.64 | -6.80 |
| 200 | 600 | 0.512 | 2.19 | 0.17 | -0.327 | -0.312 | 19.54 | -9.81 |
| 200 | 800 | 0.653 | 2.13 | 0.23 | -0.415 | -0.399 | 25.43 | -12.45 |
| 200 | 1000 | 0.812 | 2.07 | 0.29 | -0.514 | -0.487 | 31.32 | -15.42 |
| 200 | 1200 | 0.972 | 2.01 | 0.36 | -0.614 | -0.575 | 37.21 | -18.41 |
| 200 | 1400 | 1.132 | 1.95 | 0.42 | -0.713 | -0.663 | 43.11 | -21.40 |
| 200 | 1600 | 1.288 | 1.88 | 0.49 | -0.811 | -0.750 | 49.00 | -24.32 |
| 200 | 1800 | 1.451 | 1.81 | 0.55 | -0.912 | -0.838 | 54.89 | -27.36 |
| 200 | 2000 | 1.621 | 1.72 | 0.64 | -1.018 | -0.926 | 60.79 | -30.54 |
| 100 | 2100 | 1.702 | 1.67 | 0.69 | -1.069 | -0.970 | 63.73 | -32.06 |
| 100 | 2200 | 1.793 | 1.61 | 0.75 | -1.125 | -1.014 | 66.68 | -33.76 |
| 100 | 2300 | 1.889 | 1.54 | 0.83 | -1.185 | -1.057 | 69.63 | -35.55 |
| 100 | 2400 | 1.982 | 1.44 | 0.92 | -1.243 | -1.101 | 72.57 | -37.29 |
| 100 | 2500 | 2.086 | 1.34 | 1.03 | -1.308 | -1.145 | 75.52 | -39.23 |
| 100 | 2600 | 2.187 | 1.24 | 1.13 | -1.371 | -1.189 | 78.46 | -41.12 |
| 100 | 2700 | 2.312 | 1.11 | 1.25 | -1.449 | -1.233 | 81.41 | -43.46 |

* Nominal yield stress

- Bolt did not break-lateral translation of 18"

Table B.15. *Results of 17 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.38
Dist to gauge (in) ... 9.00
Moment arm (in) .....17.38

Marion 3 lb/ft - 80 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Total Defl Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.016 | | | | | | |
| | DL | 1.130 | | | 0.041 | 0.041 | 1.90 | 1.23 |
| 0 | 0 | 1.134 | -1.09 | 0.00 | 0.043 | 0.041 | 1.90 | 1.30 |
| 200 | 200 | 1.332 | -1.16 | 0.07 | 0.167 | 0.152 | 10.36 | 5.01 |
| 200 | 400 | 1.527 | -1.22 | 0.14 | 0.288 | 0.263 | 18.81 | 8.65 |
| 200 | 600 | 1.718 | -1.29 | 0.20 | 0.407 | 0.374 | 27.27 | 12.22 |
| 200 | 800 | 1.909 | -1.37 | 0.28 | 0.526 | 0.485 | 35.73 | 15.79 |
| 200 | 1000 | 2.094 | -1.43 | 0.35 | 0.642 | 0.596 | 44.19 | 19.25 |
| 200 | 1200 | 2.299 | -1.54 | 0.45 | 0.769 | 0.707 | 52.64 | 23.08 |
| 200 | 1400 | 2.482 | -1.63 | 0.54 | 0.883 | 0.818 | 61.10 | 26.50 |
| 200 | 1600 | 2.693 | -1.73 | 0.64 | 1.015 | 0.929 | 69.56 | 30.44 |
| 100 | 1700 | 2.892 | -1.79 | 0.70 | 1.139 | 0.985 | 73.79 | 34.16 |
| 100 | 1800 | 2.892 | -1.95 | 0.87 | | | 78.01 | |

* Nominal yield stress

Table B.16. *Results of 17 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.96
Dist to gauge (in) ... 9.25
Moment arm (in) .....16.96

BENDING TEST

Marion 3 lb/ft - 80 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) | | | | | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Read (in) | Total Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 0.944 | | | | | | |
| | DL | 0.880 | | | 0.040 | 0.040 | 1.90 | 1.20 |
| 0 | 0 | 0.865 | -0.31 | 0.00 | 0.049 | 0.040 | 1.90 | 1.48 |
| 200 | 200 | 0.705 | -0.39 | 0.08 | 0.149 | 0.142 | 10.15 | 4.27 |
| 200 | 400 | 0.538 | -0.46 | 0.15 | 0.253 | 0.245 | 18.40 | 7.34 |
| 200 | 600 | 0.391 | -0.53 | 0.22 | 0.345 | 0.347 | 26.66 | 10.41 |
| 200 | 800 | 0.223 | -0.61 | 0.29 | 0.449 | 0.449 | 34.91 | 13.47 |
| 200 | 1000 | 0.058 | -0.68 | 0.37 | 0.552 | 0.551 | 43.16 | 16.54 |
| 200 | 1200 | -0.120 | -0.76 | 0.45 | 0.663 | 0.653 | 51.42 | 19.60 |
| 200 | 1400 | -0.297 | -0.84 | 0.53 | 0.773 | 0.756 | 59.67 | 22.67 |
| 200 | 1600 | -0.470 | -0.93 | 0.61 | 0.881 | 0.858 | 67.92 | 25.73 |
| 200 | 1800 | -0.650 | -1.02 | 0.71 | 0.993 | 0.960 | 76.18 | 28.80 |
| 200 | 2000 | -0.831 | -1.15 | 0.84 | 1.106 | 1.062 | 84.43 | 31.87 |
| 100 | 2100 | -0.928 | -1.23 | 0.92 | 1.166 | 1.113 | 88.56 | 33.40 |
| 50 | 2150 | -0.967 | -1.37 | 1.05 | 1.191 | 1.139 | 90.62 | 34.16 |
| 49 | 2199 | | | | | | 92.64 | |

* Nominal yield stress

Table B.17. *Results of 17 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.88
Dist to gauge (in) ... 9.38
Moment arm (in) .....16.88

BENDING TEST

Marion 3 lb/ft - 80 ksi *
Face to face; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.152 | | | | | | |
| | DL | 1.067 | | | 0.040 | 0.040 | 1.90 | 1.20 |
| 0 | 0 | 0.997 | -1.52 | 0.00 | 0.084 | 0.040 | 1.90 | 2.51 |
| 200 | 200 | 0.894 | -1.60 | 0.08 | 0.148 | 0.140 | 10.11 | 4.43 |
| 200 | 400 | 0.725 | -1.68 | 0.16 | 0.253 | 0.239 | 18.33 | 7.59 |
| 200 | 600 | 0.572 | -1.76 | 0.24 | 0.348 | 0.338 | 26.54 | 10.45 |
| 200 | 800 | 0.409 | -1.84 | 0.32 | 0.450 | 0.438 | 34.75 | 13.50 |
| 200 | 1000 | 0.231 | -1.93 | 0.41 | 0.561 | 0.537 | 42.97 | 16.83 |
| 200 | 1200 | 0.053 | -2.02 | 0.50 | 0.672 | 0.637 | 51.18 | 20.15 |
| 200 | 1400 | -0.128 | -2.10 | 0.58 | 0.785 | 0.736 | 59.40 | 23.54 |
| 200 | 1600 | -0.302 | -2.21 | 0.69 | 0.893 | 0.835 | 67.61 | 26.79 |
| 150 | 1750 | -0.442 | -2.31 | 0.79 | 0.980 | 0.910 | 73.77 | 29.41 |
| 206 | 1956 | -0.616 | -2.43 | 0.91 | 1.089 | 1.012 | 82.23 | 32.66 |

* Nominal yield stress

Table B.18. *Results of 17 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.19
Dist to gauge (in) ... 9.13
Moment arm (in) .....16.19

BENDING TEST

Marion 3 lb/ft - 80 ksi *
Back to back; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Total Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.002 | | | | | | |
| | DL | 0.928 | | | 0.040 | 0.040 | 1.90 | 1.20 |
| 0 | 0 | 1.006 | 0.96 | 0.00 | -0.009 | 0.040 | 1.90 | -0.26 |
| 200 | 200 | 0.833 | 0.90 | 0.07 | 0.099 | 0.134 | 9.78 | 2.98 |
| 200 | 400 | 0.672 | 0.84 | 0.13 | 0.200 | 0.228 | 17.65 | 5.99 |
| 200 | 600 | 0.419 | 0.77 | 0.19 | 0.357 | 0.321 | 25.53 | 10.71 |
| 200 | 800 | 0.334 | 0.71 | 0.26 | 0.410 | 0.415 | 33.41 | 12.30 |
| 200 | 1000 | 0.162 | 0.65 | 0.32 | 0.517 | 0.508 | 41.29 | 15.52 |
| 200 | 1200 | -0.005 | 0.58 | 0.38 | 0.621 | 0.602 | 49.17 | 18.64 |
| 200 | 1400 | -0.181 | 0.50 | 0.46 | 0.731 | 0.695 | 57.05 | 21.93 |
| 200 | 1600 | -0.372 | 0.43 | 0.54 | 0.850 | 0.789 | 64.92 | 25.50 |
| 200 | 1800 | -0.548 | 0.35 | 0.62 | 0.960 | 0.883 | 72.80 | 28.79 |
| 200 | 2000 | -0.727 | 0.23 | 0.73 | 1.071 | 0.976 | 80.68 | 32.13 |
| 100 | 2100 | -0.815 | 0.17 | 0.79 | 1.126 | 1.023 | 84.62 | 33.78 |
| 100 | 2200 | -0.909 | 0.09 | 0.88 | 1.185 | 1.070 | 88.56 | 35.54 |
| 100 | 2300 | -0.990 | 0.02 | 0.94 | 1.235 | 1.117 | 92.50 | 37.05 |
| 90 | 2390 | -1.076 | -0.07 | 1.03 | 1.289 | 1.159 | 96.04 | 38.66 |
| 80 | 2470 | -1.145 | -0.16 | 1.12 | 1.332 | 1.196 | 99.20 | 39.95 |
| 130 | 2600 | -1.240 | -0.31 | 1.27 | 1.391 | 1.257 | 104.32 | 41.72 |
| 83 | 2683 | | | | | | 107.59 | |

* Nominal yield stress

Table B.19. *Results of 17 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.50
Dist to gauge (in) ... 8.94
Moment arm (in) .....17.50

BENDING TEST

Marion 3 lb/ft - 80 ksi *
Nested; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Total Defl Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.161 | | | | | | |
| | DL | 1.226 | | | 0.041 | 0.041 | 1.90 | 1.23 |
| 0 | 0 | 1.216 | 1.40 | 0.00 | 0.035 | 0.041 | 1.90 | 1.04 |
| 200 | 200 | 1.419 | 1.32 | 0.09 | 0.161 | 0.154 | 10.41 | 4.84 |
| 200 | 400 | 1.592 | 1.24 | 0.17 | 0.269 | 0.268 | 18.93 | 8.07 |
| 200 | 600 | 1.808 | 1.15 | 0.26 | 0.404 | 0.381 | 27.45 | 12.11 |
| 200 | 800 | 1.980 | 1.07 | 0.33 | 0.511 | 0.494 | 35.96 | 15.32 |
| 200 | 1000 | 2.180 | 0.98 | 0.43 | 0.635 | 0.608 | 44.48 | 19.06 |
| 200 | 1200 | 2.372 | 0.88 | 0.52 | 0.755 | 0.721 | 52.99 | 22.65 |
| 200 | 1400 | 2.567 | 0.79 | 0.61 | 0.877 | 0.835 | 61.51 | 26.30 |
| 200 | 1600 | 2.761 | 0.67 | 0.73 | 0.997 | 0.948 | 70.02 | 29.92 |
| 230 | 1830 | 3.017 | 0.52 | 0.89 | 1.157 | 1.079 | 79.82 | 34.71 |
| 220 | 2050 | 3.246 | 0.38 | 1.02 | 1.300 | 1.204 | 89.19 | 38.99 |
| 140 | 2190 | 3.388 | 0.27 | 1.14 | 1.388 | 1.283 | 95.15 | 41.64 |
| 160 | 2350 | 3.555 | 0.13 | 1.28 | 1.492 | 1.374 | 101.96 | 44.76 |
| 125 | 2475 | 3.702 | -0.03 | 1.44 | 1.584 | 1.445 | 107.28 | 47.51 |
| 115 | 2590 | 3.856 | -0.29 | 1.70 | 1.680 | 1.510 | 112.18 | 50.39 |
| 102 | 2692 | | | | | | 116.52 | |

* Nominal yield stress

Table B.20. *Results of 17 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.38
Dist to gauge (in) ... 8.75
Moment arm (in) .....17.38

Marion 3 lb/ft - 80 ksi *
Face to face; gr 5 bolts
Non-critical orientation

| LOAD (lbs) | | | Tip | Total | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Defl (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 1.159 | | | | | | |
| | DL | 1.197 | | | 0.041 | 0.041 | 1.90 | 1.23 |
| 0 | 0 | 1.199 | 2.57 | 0.00 | 0.042 | 0.041 | 1.90 | 1.27 |
| 200 | 200 | 1.385 | 2.48 | 0.08 | 0.158 | 0.158 | 10.36 | 4.74 |
| 200 | 400 | 1.563 | 2.40 | 0.17 | 0.269 | 0.275 | 18.81 | 8.07 |
| 200 | 600 | 1.771 | 2.31 | 0.25 | 0.399 | 0.392 | 27.27 | 11.96 |
| 200 | 800 | 1.954 | 2.23 | 0.34 | 0.513 | 0.508 | 35.73 | 15.38 |
| 200 | 1000 | 2.152 | 2.13 | 0.43 | 0.636 | 0.625 | 44.19 | 19.08 |
| 200 | 1200 | 2.352 | 2.05 | 0.52 | 0.761 | 0.742 | 52.64 | 22.82 |
| 200 | 1400 | 2.462 | 1.95 | 0.61 | 0.829 | 0.859 | 61.10 | 24.87 |
| 200 | 1600 | 2.727 | 1.87 | 0.70 | 0.994 | 0.976 | 69.56 | 29.83 |
| 200 | 1800 | 2.963 | 1.76 | 0.81 | 1.141 | 1.093 | 78.01 | 34.24 |
| 200 | 2000 | 3.159 | 1.62 | 0.94 | 1.263 | 1.210 | 86.47 | 37.90 |
| 200 | 2200 | 3.372 | 1.45 | 1.12 | 1.396 | 1.327 | 94.93 | 41.88 |
| 100 | 2300 | 3.461 | 1.34 | 1.22 | 1.452 | 1.385 | 99.16 | 43.55 |
| 100 | 2400 | 3.565 | 1.20 | 1.37 | 1.516 | 1.444 | 103.39 | 45.49 |

* Nominal yield stress

Table B.21. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.56
Dist to gauge (in) ...13.19
Moment arm (in) .....16.56

BENDING TEST

MARION 4 lb/ft - 80 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) | | | Total | | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Read (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 1.259 | | | | | | |
| | DL | 1.302 | | | 0.034 | 0.034 | 1.91 | 1.02 |
| 0 | 0 | 1.305 | -1.01 | 0.00 | 0.036 | 0.034 | 1.91 | 1.08 |
| 200 | 200 | 1.418 | -1.06 | 0.05 | 0.106 | 0.066 | 7.99 | 3.19 |
| 200 | 400 | 1.547 | -1.10 | 0.09 | 0.187 | 0.097 | 14.06 | 5.60 |
| 200 | 600 | 1.658 | -1.14 | 0.13 | 0.256 | 0.129 | 20.14 | 7.67 |
| 200 | 800 | 1.774 | -1.18 | 0.18 | 0.328 | 0.160 | 26.22 | 9.84 |
| 200 | 1000 | 1.898 | -1.23 | 0.22 | 0.405 | 0.192 | 32.29 | 12.16 |
| 200 | 1200 | 2.018 | -1.27 | 0.26 | 0.480 | 0.224 | 38.37 | 14.40 |
| 200 | 1400 | 2.145 | -1.32 | 0.31 | 0.559 | 0.255 | 44.45 | 16.78 |
| 200 | 1600 | 2.271 | -1.37 | 0.36 | 0.638 | 0.287 | 50.53 | 19.13 |
| 200 | 1800 | 2.387 | -1.44 | 0.43 | 0.710 | 0.319 | 56.60 | 21.30 |
| 200 | 2000 | 2.515 | -1.57 | 0.56 | 0.790 | 0.279 | 62.68 | 23.69 |
| 21 | 2021 | | | | | | 63.32 | |

* Nominal yield stress

Table B.22. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.56
Dist to gauge (in) ...13.19
Moment arm (in) .....16.56

BENDING TEST

MARION 4 lb/ft - 80 ksi *
Back to back; gr 9 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Total Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.259 | | | | | | |
| | DL | 1.287 | | | 0.034 | 0.034 | 1.91 | 1.02 |
| 0 | 0 | 1.297 | -1.01 | 0.00 | 0.040 | 0.034 | 1.91 | 1.21 |
| 200 | 200 | 1.422 | -1.06 | 0.05 | 0.118 | 0.066 | 7.99 | 3.54 |
| 200 | 400 | 1.536 | -1.10 | 0.10 | 0.189 | 0.097 | 14.06 | 5.67 |
| 200 | 600 | 1.650 | -1.15 | 0.14 | 0.260 | 0.129 | 20.14 | 7.81 |
| 200 | 800 | 1.770 | -1.19 | 0.18 | 0.335 | 0.160 | 26.22 | 10.05 |
| 200 | 1000 | 1.898 | -1.23 | 0.23 | 0.415 | 0.192 | 32.29 | 12.44 |
| 200 | 1200 | 2.009 | -1.28 | 0.27 | 0.484 | 0.224 | 38.37 | 14.52 |
| 200 | 1400 | 2.126 | -1.32 | 0.31 | 0.557 | 0.255 | 44.45 | 16.70 |
| 200 | 1600 | 2.261 | -1.37 | 0.36 | 0.641 | 0.287 | 50.53 | 19.23 |
| 200 | 1800 | 2.387 | -1.41 | 0.41 | 0.719 | 0.319 | 56.60 | 21.58 |
| 200 | 2000 | 2.507 | -1.46 | 0.45 | 0.794 | 0.350 | 62.68 | 23.82 |
| 200 | 2200 | 2.635 | -1.52 | 0.51 | 0.874 | 0.382 | 68.76 | 26.22 |
| 200 | 2400 | 2.765 | -1.58 | 0.58 | 0.955 | 0.414 | 74.83 | 28.65 |
| 200 | 2600 | 2.890 | -1.68 | 0.67 | 1.033 | 0.445 | 80.91 | 30.98 |
| 100 | 2700 | 2.939 | -1.75 | 0.74 | 1.063 | 0.461 | 83.95 | 31.90 |
| 30 | 2730 | | | | | | 84.86 | |

* Nominal yield stress

Table B.23. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.63
Dist to gauge (in) ... 9.31
Moment arm (in) .....16.63

BENDING TEST

MARION 4 lb/ft - 80 ksi *
Nested; gr 9 bolts
Critical orientation

| LOAD (lbs) | | | Total | | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Read (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | -0.343 | | | | | | |
| | DL | -0.388 | | | 0.038 | 0.038 | 1.91 | 1.14 |
| 0 | 0 | -0.392 | -0.10 | 0.00 | 0.040 | 0.038 | 1.91 | 1.21 |
| 200 | 200 | -0.517 | -0.14 | 0.04 | 0.118 | 0.107 | 8.01 | 3.55 |
| 200 | 400 | -0.632 | -0.18 | 0.09 | 0.190 | 0.175 | 14.11 | 5.70 |
| 200 | 600 | -0.751 | -0.23 | 0.13 | 0.264 | 0.244 | 20.22 | 7.93 |
| 200 | 800 | -0.876 | -0.27 | 0.18 | 0.342 | 0.313 | 26.32 | 10.26 |
| 200 | 1000 | -1.004 | -0.32 | 0.23 | 0.422 | 0.382 | 32.42 | 12.65 |
| 200 | 1200 | -1.128 | -0.37 | 0.27 | 0.499 | 0.450 | 38.53 | 14.97 |
| 200 | 1400 | -1.260 | -0.42 | 0.32 | 0.581 | 0.519 | 44.63 | 17.44 |
| 200 | 1600 | -1.396 | -0.47 | 0.37 | 0.666 | 0.588 | 50.73 | 19.98 |
| 200 | 1800 | -1.503 | -0.52 | 0.42 | 0.733 | 0.657 | 56.83 | 21.98 |
| 200 | 2000 | -1.636 | -0.57 | 0.47 | 0.816 | 0.725 | 62.94 | 24.47 |
| 200 | 2200 | -1.764 | -0.63 | 0.53 | 0.895 | 0.794 | 69.04 | 26.86 |
| 200 | 2400 | -1.888 | -0.70 | 0.60 | 0.973 | 0.863 | 75.14 | 29.18 |
| 200 | 2600 | -2.020 | -0.77 | 0.67 | 1.055 | 0.932 | 81.24 | 31.64 |
| 188 | 2788 | | | | | | 86.98 | |

* Nominal yield stress

Table B.24. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Grade 8 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.56
Dist to gauge (in) ... 9.13
Moment arm (in) .....16.56

BENDING TEST

MARION 4 lb/ft - 80 ksi *
Face to face; gr 8 bolts
Critical orientation

| LOAD (lbs) | | | Tip | Total | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Defl (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 1.267 | | | | | | |
| | DL | 1.244 | | | 0.038 | 0.038 | 1.91 | 1.14 |
| 0 | 0 | 1.227 | -1.36 | 0.00 | 0.049 | 0.038 | 1.91 | 1.46 |
| 200 | 200 | 1.102 | -1.42 | 0.07 | 0.126 | 0.108 | 7.99 | 3.79 |
| 200 | 400 | 0.982 | -1.48 | 0.12 | 0.201 | 0.178 | 14.06 | 6.04 |
| 200 | 600 | 0.865 | -1.53 | 0.17 | 0.274 | 0.247 | 20.14 | 8.22 |
| 200 | 800 | 0.744 | -1.59 | 0.23 | 0.350 | 0.317 | 26.22 | 10.49 |
| 200 | 1000 | 0.612 | -1.65 | 0.29 | 0.432 | 0.387 | 32.29 | 12.95 |
| 200 | 1200 | 0.489 | -1.70 | 0.35 | 0.508 | 0.457 | 38.37 | 15.25 |
| 200 | 1400 | 0.367 | -1.76 | 0.40 | 0.584 | 0.527 | 44.45 | 17.53 |
| 200 | 1600 | 0.241 | -1.82 | 0.46 | 0.663 | 0.596 | 50.53 | 19.89 |
| 200 | 1800 | 0.109 | -1.89 | 0.53 | 0.745 | 0.666 | 56.60 | 22.36 |
| 200 | 2000 | -0.023 | -1.95 | 0.60 | 0.827 | 0.736 | 62.68 | 24.82 |
| 200 | 2200 | -0.148 | -2.04 | 0.69 | 0.905 | 0.806 | 68.76 | 27.16 |
| 40 | 2240 | -0.173 | -2.14 | 0.78 | 0.921 | 0.820 | 69.97 | 27.63 |
| 44 | 2284 | | | | | | 71.31 | |

* Nominal yield stress

Table B.25. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.63
Dist to gauge (in) ...13.19
Moment arm (in) .....16.63

MARION 4 lb/ft - 80 ksi *
Back to back; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Total Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.272 | | | | | | |
| | DL | 1.139 | | | 0.034 | 0.034 | 1.91 | 1.02 |
| 0 | 0 | 1.145 | 1.19 | 0.00 | 0.030 | 0.034 | 1.91 | 0.91 |
| 200 | 200 | 1.027 | 1.14 | 0.05 | 0.104 | 0.066 | 8.01 | 3.11 |
| 200 | 400 | 0.905 | 1.10 | 0.09 | 0.180 | 0.098 | 14.11 | 5.39 |
| 200 | 600 | 0.770 | 1.06 | 0.13 | 0.264 | 0.131 | 20.22 | 7.92 |
| 200 | 800 | 0.649 | 1.01 | 0.17 | 0.339 | 0.163 | 26.32 | 10.18 |
| 200 | 1000 | 0.521 | 0.97 | 0.22 | 0.419 | 0.195 | 32.42 | 12.57 |
| 200 | 1200 | 0.385 | 0.93 | 0.26 | 0.504 | 0.228 | 38.53 | 15.11 |
| 200 | 1400 | 0.269 | 0.88 | 0.31 | 0.576 | 0.260 | 44.63 | 17.28 |
| 200 | 1600 | 0.140 | 0.83 | 0.35 | 0.656 | 0.292 | 50.73 | 19.69 |
| 200 | 1800 | 0.012 | 0.79 | 0.40 | 0.736 | 0.325 | 56.83 | 22.09 |
| 200 | 2000 | -0.126 | 0.74 | 0.45 | 0.822 | 0.357 | 62.94 | 24.67 |
| 200 | 2200 | -0.254 | 0.68 | 0.50 | 0.902 | 0.389 | 69.04 | 27.06 |
| 200 | 2400 | -0.380 | 0.62 | 0.56 | 0.980 | 0.421 | 75.14 | 29.41 |
| 200 | 2600 | -0.510 | 0.55 | 0.64 | 1.061 | 0.454 | 81.24 | 31.84 |
| 100 | 2700 | -0.579 | 0.48 | 0.71 | 1.104 | 0.470 | 84.30 | 33.13 |
| 59 | 2759 | | | | | | 86.10 | |

* Nominal yield stress

Table B.26. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Grade 9 Field Bolts).*

BENDING TEST

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.63
Dist to gauge (in) ...13.19
Moment arm (in) .....16.63

MARION 4 lb/ft - 80 ksi *
Back to back; gr 9 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.272 | | | | | | |
| | DL | 1.131 | | | 0.034 | 0.034 | 1.91 | 1.02 |
| 0 | 0 | 1.116 | 1.18 | 0.00 | 0.043 | 0.034 | 1.91 | 1.30 |
| 200 | 200 | 0.985 | 1.13 | 0.05 | 0.125 | 0.066 | 8.01 | 3.75 |
| 200 | 400 | 0.862 | 1.09 | 0.09 | 0.202 | 0.098 | 14.11 | 6.05 |
| 200 | 600 | 0.754 | 1.05 | 0.13 | 0.269 | 0.131 | 20.22 | 8.07 |
| 200 | 800 | 0.630 | 1.00 | 0.17 | 0.346 | 0.163 | 26.32 | 10.39 |
| 200 | 1000 | 0.500 | 0.96 | 0.22 | 0.427 | 0.195 | 32.42 | 12.81 |
| 200 | 1200 | 0.386 | 0.91 | 0.26 | 0.498 | 0.228 | 38.53 | 14.95 |
| 200 | 1400 | 0.246 | 0.87 | 0.31 | 0.585 | 0.260 | 44.63 | 17.56 |
| 200 | 1600 | 0.118 | 0.82 | 0.35 | 0.665 | 0.292 | 50.73 | 19.96 |
| 200 | 1800 | -0.009 | 0.77 | 0.40 | 0.744 | 0.325 | 56.83 | 22.33 |
| 200 | 2000 | -0.141 | 0.73 | 0.45 | 0.827 | 0.357 | 62.94 | 24.80 |
| 200 | 2200 | -0.261 | 0.68 | 0.50 | 0.901 | 0.389 | 69.04 | 27.04 |
| 200 | 2400 | -0.401 | 0.62 | 0.56 | 0.989 | 0.421 | 75.14 | 29.66 |
| 200 | 2600 | -0.527 | 0.56 | 0.62 | 1.067 | 0.454 | 81.24 | 32.01 |
| 200 | 2800 | -0.657 | 0.50 | 0.68 | 1.148 | 0.486 | 87.35 | 34.44 |
| 200 | 3000 | -0.795 | 0.42 | 0.76 | 1.234 | 0.518 | 93.45 | 37.02 |
| 200 | 3200 | -0.934 | 0.33 | 0.85 | 1.321 | 0.551 | 99.55 | 39.62 |
| 200 | 3400 | -1.063 | 0.21 | 0.96 | 1.401 | 0.583 | 105.66 | 42.03 |
| 100 | 3500 | -1.138 | 0.15 | 1.03 | 1.462 | 0.599 | 108.71 | 43.85 |
| 71 | 3571 | | | | | | 110.87 | |

* Nominal yield stress

Table B.27. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.38
Dist to gauge (in) ... 9.00
Moment arm (in) .....16.38

BENDING TEST

MARION 4 lb/ft - 80 ksi *
Nested; gr 5 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Total Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -0.339 | | | | | | |
| | DL | -0.264 | | | 0.038 | 0.038 | 1.91 | 1.14 |
| 0 | 0 | -0.268 | 1.51 | 0.00 | 0.036 | 0.038 | 1.91 | 1.07 |
| 200 | 200 | -0.145 | 1.45 | 0.06 | 0.112 | 0.108 | 7.92 | 3.36 |
| 200 | 400 | -0.033 | 1.40 | 0.11 | 0.182 | 0.177 | 13.93 | 5.46 |
| 200 | 600 | 0.089 | 1.35 | 0.16 | 0.258 | 0.246 | 19.94 | 7.74 |
| 200 | 800 | 0.248 | 1.30 | 0.21 | 0.357 | 0.316 | 25.95 | 10.71 |
| 200 | 1000 | 0.338 | 1.25 | 0.26 | 0.413 | 0.385 | 31.96 | 12.39 |
| 200 | 1200 | 0.473 | 1.20 | 0.31 | 0.497 | 0.454 | 37.97 | 14.92 |
| 200 | 1400 | 0.603 | 1.15 | 0.36 | 0.578 | 0.523 | 43.99 | 17.35 |
| 200 | 1600 | 0.722 | 1.10 | 0.41 | 0.652 | 0.593 | 50.00 | 19.57 |
| 200 | 1800 | 0.853 | 1.04 | 0.46 | 0.734 | 0.662 | 56.01 | 22.02 |
| 200 | 2000 | 0.982 | 0.99 | 0.51 | 0.814 | 0.731 | 62.02 | 24.43 |
| 200 | 2200 | 1.102 | 0.94 | 0.57 | 0.889 | 0.801 | 68.03 | 26.67 |
| 200 | 2400 | 1.355 | 0.88 | 0.63 | 1.047 | 0.870 | 74.04 | 31.40 |
| 200 | 2600 | 1.355 | 0.82 | 0.69 | 1.047 | 0.939 | 80.05 | 31.40 |
| 200 | 2800 | 1.480 | 0.74 | 0.76 | 1.125 | 1.008 | 86.06 | 33.74 |
| 117 | 2917 | | | | | | 89.58 | |

* Nominal yield stress

Table B.28. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Grade 9 Field Bolts).*

BENDING TEST

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.38
Dist to gauge (in) ... 9.00
Moment arm (in) .....16.38

MARION 4 lb/ft - 80 ksi *
Nested; gr 9 bolts
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Read (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -0.339 | | | | | | |
| | DL | -0.268 | | | 0.038 | 0.038 | 1.91 | 1.14 |
| 0 | 0 | -0.275 | 1.46 | 0.00 | 0.034 | 0.038 | 1.91 | 1.01 |
| 200 | 200 | -0.148 | 1.41 | 0.06 | 0.113 | 0.108 | 7.92 | 3.38 |
| 200 | 400 | -0.003 | 1.36 | 0.10 | 0.203 | 0.177 | 13.93 | 6.09 |
| 200 | 600 | 0.090 | 1.31 | 0.15 | 0.261 | 0.246 | 19.94 | 7.83 |
| 200 | 800 | 0.208 | 1.26 | 0.20 | 0.335 | 0.316 | 25.95 | 10.04 |
| 200 | 1000 | 0.334 | 1.21 | 0.25 | 0.413 | 0.385 | 31.96 | 12.39 |
| 200 | 1200 | 0.462 | 1.16 | 0.30 | 0.493 | 0.454 | 37.97 | 14.79 |
| 200 | 1400 | 0.586 | 1.11 | 0.35 | 0.570 | 0.523 | 43.99 | 17.10 |
| 200 | 1600 | 0.711 | 1.06 | 0.40 | 0.648 | 0.593 | 50.00 | 19.44 |
| 200 | 1800 | 0.870 | 1.01 | 0.46 | 0.747 | 0.662 | 56.01 | 22.41 |
| 200 | 2000 | 0.996 | 0.95 | 0.51 | 0.826 | 0.731 | 62.02 | 24.77 |
| 200 | 2200 | 1.119 | 0.90 | 0.56 | 0.902 | 0.801 | 68.03 | 27.07 |
| 200 | 2400 | 1.243 | 0.84 | 0.62 | 0.979 | 0.870 | 74.04 | 29.38 |
| 200 | 2600 | 1.349 | 0.78 | 0.68 | 1.045 | 0.939 | 80.05 | 31.36 |
| 200 | 2800 | 1.476 | 0.72 | 0.74 | 1.125 | 1.008 | 86.06 | 33.74 |
| 200 | 3000 | 1.598 | 0.66 | 0.80 | 1.201 | 1.078 | 92.07 | 32.33 |
| 200 | 3200 | 1.731 | 0.59 | 0.87 | 1.283 | 1.147 | 98.08 | 34.41 |
| 150 | 3350 | 1.840 | 0.53 | 0.93 | 1.351 | 1.199 | 102.59 | 35.97 |
| 150 | 3500 | 1.942 | 0.46 | 1.01 | 1.415 | 1.251 | 107.10 | 37.53 |
| 100 | 3600 | 1.988 | 0.40 | 1.06 | 1.444 | 1.286 | 110.11 | 38.57 |
| 100 | 3700 | 2.056 | 0.34 | 1.12 | 1.486 | 1.320 | 113.11 | 39.61 |
| 79 | 3779 | | | | | | 115.49 | |

* Nominal yield stress

Table B.29. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Grade 8 Field Bolts).*

BENDING TEST

Splice length (in) ... 4.00
Dist to bolt A (in) .. 1.63
Dist to gauge (in) ... 9.25
Moment arm (in) .....16.63

MARION 4 lb/ft - 80 ksi *
Face to face; gr 8 bolts
Non-critical orientation

| LOAD (lbs) | | | Tip | Total | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Defl (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 1.246 | | | | | | |
| | DL | 1.258 | | | 0.038 | 0.038 | 1.91 | 1.14 |
| 0 | 0 | 1.211 | 2.85 | 0.00 | 0.009 | 0.038 | 1.91 | 0.26 |
| 200 | 200 | 1.015 | 2.80 | 0.05 | -0.113 | 0.107 | 8.01 | -3.40 |
| 200 | 400 | 1.117 | 2.75 | 0.10 | -0.050 | 0.177 | 14.11 | -1.50 |
| 200 | 600 | 1.220 | 2.70 | 0.15 | 0.014 | 0.246 | 20.22 | 0.43 |
| 200 | 800 | 1.278 | 2.64 | 0.21 | 0.050 | 0.315 | 26.32 | 1.51 |
| 200 | 1000 | 1.389 | 2.59 | 0.26 | 0.120 | 0.385 | 32.42 | 3.59 |
| 200 | 1200 | 1.511 | 2.54 | 0.31 | 0.196 | 0.454 | 38.53 | 5.87 |
| 200 | 1400 | 1.635 | 2.48 | 0.37 | 0.273 | 0.523 | 44.63 | 8.19 |
| 200 | 1600 | 1.758 | 2.43 | 0.42 | 0.350 | 0.592 | 50.73 | 10.49 |
| 200 | 1800 | 1.877 | 2.37 | 0.48 | 0.424 | 0.662 | 56.83 | 12.71 |
| 200 | 2000 | 2.012 | 2.31 | 0.54 | 0.508 | 0.731 | 62.94 | 15.23 |
| 200 | 2200 | 2.136 | 2.25 | 0.60 | 0.585 | 0.800 | 69.04 | 17.55 |
| 200 | 2400 | 2.264 | 2.19 | 0.66 | 0.665 | 0.870 | 75.14 | 19.94 |
| 200 | 2600 | 2.402 | 2.12 | 0.73 | 0.751 | 0.939 | 81.24 | 22.52 |
| 200 | 2800 | 2.532 | 2.04 | 0.81 | 0.832 | 1.008 | 87.35 | 24.95 |
| 200 | 3000 | 2.662 | 1.95 | 0.90 | 0.913 | 1.078 | 93.45 | 27.38 |
| 100 | 3100 | 2.727 | 1.91 | 0.94 | 0.953 | 1.112 | 96.50 | 28.60 |
| 75 | 3175 | 2.767 | 1.84 | 1.01 | 0.978 | 1.138 | 98.79 | 29.35 |
| 26 | 3201 | | | | | | 99.58 | |

* Nominal yield stress

- Bolt did not break - post tip translated 18 in laterally

# APPENDIX C

## FINAL 71" BENDING TESTS

## FIELD BOLT SUMMARY TABLES

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back and Nested Splices

Critical Configuration

# APPENDIX C

## LIST OF TABLES

# APPENDIX C

## LIST OF TABLES (CONT)

Table C.1. *Results of 71 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

| Splice length (in) ..... 3.00<br>Dist to bolt A (in) ..... 1.56<br>Dist to strain gauge (in) 7.56<br>Moment arm (in) .....71.38 | | | | BENDING TEST<br>FRANKLIN 3 lb/ft - 60 ksi *<br>Back to back; gr 5 bolts<br>Critical orientation | | | |
|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
| Appl | Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 0.317 | | | | | | |
| | tight | 0.333 | | | | | | |
| | DL | 0.456 | 0.00 | 0.00 | -0.053 | -0.053 | 1.93 | -1.59 |
| 60 | 60 | 0.986 | 0.94 | 0.94 | -0.383 | -0.368 | 12.50 | -11.50 |
| 32 | 92 | 1.286 | 0.51 | 1.45 | -0.570 | -0.536 | 18.14 | -17.10 |
| 32 | 124 | 1.559 | 0.51 | 1.96 | -0.740 | -0.704 | 23.78 | -22.21 |
| 32 | 156 | 1.843 | 0.54 | 2.50 | -0.917 | -0.872 | 29.42 | -27.51 |
| 32 | 188 | 2.119 | 0.54 | 3.04 | -1.089 | -1.040 | 35.06 | -32.67 |
| 32 | 220 | 2.389 | 0.55 | 3.59 | -1.257 | -1.208 | 40.70 | -37.72 |
| 32 | 252 | 2.638 | 0.52 | 4.11 | -1.412 | -1.376 | 46.34 | -42.37 |
| 32 | 284 | 2.883 | 0.54 | 4.65 | -1.565 | -1.544 | 51.98 | -46.95 |
| 32 | 316 | 3.141 | 0.60 | 5.24 | -1.726 | -1.712 | 57.62 | -51.78 |
| 32 | 348 | 3.369 | 0.62 | 5.86 | -1.868 | -1.880 | 63.26 | -56.04 |
| 32 | 380 | 3.589 | 0.71 | 6.57 | -2.005 | -2.048 | 68.90 | -60.15 |
| 16 | 396 | 3.608 | 0.42 | 6.98 | -2.017 | -2.132 | 71.72 | -60.50 |
| 16 | 412 | 3.711 | 0.46 | 7.44 | -2.081 | -2.216 | 74.53 | -62.43 |
| 16 | 428 | 3.796 | 0.59 | 8.03 | -2.134 | -2.300 | 77.35 | -64.02 |

* Nominal yield stress

Table C.2. *Results of 71 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.63
Dist to strain gauge (in) 7.69
Moment arm (in) .....71.56

BENDING TEST

FRANKLIN 3 lb/ft - 60 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 0.249 | | | | | | |
| | tight | 0.415 | | | | | | |
| | DL | 0.380 | 0.00 | 0.00 | 0.052 | 0.052 | 1.93 | 1.55 |
| 60 | 60 | -0.158 | 1.35 | 1.35 | 0.387 | 0.368 | 12.53 | 11.61 |
| 32 | 92 | -0.445 | 0.60 | 1.95 | 0.566 | 0.536 | 18.18 | 16.97 |
| 32 | 124 | -0.710 | 0.53 | 2.48 | 0.731 | 0.704 | 23.84 | 21.93 |
| 32 | 156 | -1.004 | 0.62 | 3.10 | 0.914 | 0.872 | 29.49 | 27.42 |
| 32 | 188 | -1.265 | 0.58 | 3.67 | 1.077 | 1.041 | 35.14 | 32.30 |
| 32 | 220 | -1.539 | 0.62 | 4.29 | 1.247 | 1.209 | 40.80 | 37.42 |
| 32 | 252 | -1.809 | 0.63 | 4.91 | 1.416 | 1.377 | 46.45 | 42.47 |
| 32 | 284 | -2.094 | 0.71 | 5.62 | 1.593 | 1.545 | 52.11 | 47.79 |
| 32 | 316 | -2.399 | 0.92 | 6.54 | 1.783 | 1.713 | 57.76 | 53.50 |
| 16 | 332 | -2.540 | 0.48 | 7.01 | 1.871 | 1.798 | 60.59 | 56.13 |
| 16 | 348 | -2.699 | 0.58 | 7.59 | 1.970 | 1.882 | 63.41 | 59.10 |
| 16 | 364 | -2.829 | 0.55 | 8.13 | 2.051 | 1.966 | 66.24 | 61.53 |
| 16 | 380 | -2.963 | 0.81 | 8.94 | 2.135 | 2.050 | 69.07 | 64.04 |

* Nominal yield stress

Table C.3. *Results of 71 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.44
Dist to strain gauge (in) 9.25
Moment arm (in) .....71.50

FRANKLIN 4 lb/ft - 60 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) | | | Tip | Total | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Defl (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | -1.412 | | | | | | |
| | tight | -1.410 | | | 0.000 | | | |
| | DL | -1.015 | 0.00 | 0.00 | -0.036 | -0.036 | 1.39 | -1.08 |
| 60 | 60 | -0.665 | 0.71 | 0.71 | -0.254 | -0.259 | 9.05 | -7.63 |
| 32 | 92 | -0.473 | 0.41 | 1.12 | -0.374 | -0.377 | 13.14 | -11.21 |
| 32 | 124 | -0.274 | 0.41 | 1.53 | -0.498 | -0.496 | 17.23 | -14.93 |
| 32 | 156 | -0.077 | 0.41 | 1.93 | -0.621 | -0.614 | 21.31 | -18.62 |
| 32 | 188 | 0.108 | 0.40 | 2.33 | -0.736 | -0.733 | 25.40 | -22.07 |
| 32 | 220 | 0.314 | 0.43 | 2.76 | -0.864 | -0.851 | 29.48 | -25.93 |
| 32 | 252 | 0.512 | 0.42 | 3.18 | -0.988 | -0.970 | 33.57 | -29.63 |
| 32 | 284 | 0.703 | 0.42 | 3.60 | -1.107 | -1.089 | 37.65 | -33.20 |
| 32 | 316 | 0.915 | 0.45 | 4.05 | -1.239 | -1.207 | 41.74 | -37.16 |
| 32 | 348 | 1.091 | 0.42 | 4.47 | -1.348 | -1.326 | 45.83 | -40.45 |
| 32 | 380 | 1.291 | 0.42 | 4.89 | -1.473 | -1.444 | 49.91 | -44.19 |
| 32 | 412 | 1.500 | 0.51 | 5.39 | -1.603 | -1.563 | 54.00 | -48.09 |
| 16 | 428 | | 0.28 | 5.67 | | -1.622 | 56.04 | |

* Nominal yield stress

Table C.4. *Results of 71 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) 8.94
Moment arm (in) .....71.56

FRANKLIN 4 lb/ft - 60 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -1.216 | | | | | | |
| | tight | -1.147 | | | 0.000 | | | |
| | DL | -1.311 | 0.00 | 0.00 | 0.037 | 0.037 | 1.39 | 1.10 |
| 60 | 60 | -1.662 | 0.68 | 0.68 | 0.255 | 0.260 | 9.06 | 7.66 |
| 32 | 92 | -1.851 | 0.39 | 1.06 | 0.373 | 0.379 | 13.15 | 11.20 |
| 32 | 124 | -2.036 | 0.37 | 1.43 | 0.488 | 0.499 | 17.24 | 14.65 |
| 32 | 156 | -2.225 | 0.38 | 1.81 | 0.606 | 0.618 | 21.33 | 18.19 |
| 32 | 188 | -2.417 | 0.38 | 2.19 | 0.726 | 0.737 | 25.42 | 21.78 |
| 32 | 220 | -2.618 | 0.41 | 2.60 | 0.851 | 0.857 | 29.51 | 25.53 |
| 32 | 252 | -2.799 | 0.37 | 2.97 | 0.964 | 0.976 | 33.60 | 28.92 |
| 32 | 284 | -2.989 | 0.39 | 3.35 | 1.082 | 1.095 | 37.68 | 32.47 |
| 32 | 316 | -3.198 | 0.43 | 3.78 | 1.212 | 1.214 | 41.77 | 36.37 |
| 32 | 348 | -3.402 | 0.43 | 4.21 | 1.340 | 1.334 | 45.86 | 40.19 |
| 32 | 380 | -3.598 | 0.42 | 4.63 | 1.462 | 1.453 | 49.95 | 43.85 |
| 32 | 412 | -3.827 | 0.51 | 5.14 | 1.604 | 1.572 | 54.04 | 48.13 |
| 32 | 444 | -4.083 | 0.59 | 5.73 | 1.764 | 1.691 | 58.13 | 52.92 |
| 16 | 460 | -4.216 | 0.35 | 6.08 | 1.847 | 1.751 | 60.17 | 55.40 |

* Nominal yield stress

Table C.5. *Results of 71 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) 7.88
Moment arm (in) .....72.38

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | ** | | | | | | |
| | tight | ** | | | | | | |
| | DL | 8.242 | 0.00 | 0.00 | 0.042 | 0.042 | 1.90 | 1.26 |
| 60 | 60 | 7.848 | 0.74 | 0.74 | 0.287 | 0.298 | 12.46 | 8.62 |
| 32 | 92 | 7.661 | 0.38 | 1.11 | 0.404 | 0.435 | 18.10 | 12.12 |
| 32 | 124 | 7.471 | 0.39 | 1.50 | 0.522 | 0.572 | 23.73 | 15.67 |
| 32 | 156 | 7.266 | 0.41 | 1.91 | 0.650 | 0.709 | 29.37 | 19.50 |
| 32 | 188 | 7.068 | 0.43 | 2.34 | 0.773 | 0.845 | 35.00 | 23.20 |
| 32 | 220 | 6.878 | 0.46 | 2.79 | 0.892 | 0.982 | 40.64 | 26.75 |
| 32 | 252 | 6.653 | 0.55 | 3.34 | 1.032 | 1.119 | 46.27 | 30.96 |
| 32 | 284 | 6.446 | 0.50 | 3.84 | 1.161 | 1.256 | 51.91 | 34.83 |
| 32 | 316 | 6.252 | 0.51 | 4.34 | 1.282 | 1.393 | 57.54 | 38.45 |
| 32 | 348 | 6.052 | 0.67 | 5.01 | 1.406 | 1.529 | 63.18 | 42.19 |
| 16 | 364 | 5.980 | 0.66 | 5.66 | 1.451 | 1.598 | 66.00 | 43.54 |

* Nominal yield stress

** Strain gauge malfunction - data omitted

Table C.6. *Results of 71 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

BENDING TEST

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.63
Dist to strain gauge (in) 8.13
Moment arm (in) .....71.38

MARION 3 lb/ft - 80 ksi *
Back to back; gr 9 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 2.253 | | | | | | |
| | tight | 2.233 | | | | | | |
| | DL | 2.372 | 0.00 | 0.00 | 0.042 | 0.042 | 1.90 | 1.25 |
| 60 | 60 | 2.801 | 0.82 | 0.82 | 0.309 | 0.293 | 12.32 | 9.27 |
| 32 | 92 | 3.017 | 0.41 | 1.22 | 0.443 | 0.427 | 17.88 | 13.30 |
| 32 | 124 | 3.250 | 0.47 | 1.69 | 0.589 | 0.561 | 23.43 | 17.66 |
| 32 | 156 | 3.474 | 0.47 | 2.16 | 0.728 | 0.695 | 28.99 | 21.85 |
| 32 | 188 | 3.697 | 0.51 | 2.67 | 0.867 | 0.830 | 34.55 | 26.01 |
| 32 | 220 | 3.917 | 0.50 | 3.17 | 1.004 | 0.964 | 40.11 | 30.13 |
| 32 | 252 | 4.125 | 0.52 | 3.69 | 1.134 | 1.098 | 45.66 | 34.01 |
| 32 | 284 | 4.318 | 0.51 | 4.20 | 1.254 | 1.232 | 51.22 | 37.62 |
| 32 | 316 | 4.158 | 0.56 | 4.75 | 1.154 | 1.366 | 56.78 | 34.63 |
| 32 | 348 | 4.709 | 0.60 | 5.35 | 1.498 | 1.500 | 62.34 | 44.93 |
| 32 | 380 | 4.935 | 0.76 | 6.10 | 1.639 | 1.634 | 67.89 | 49.16 |
| 32 | 412 | 5.140 | 0.70 | 6.80 | 1.766 | 1.769 | 73.45 | 52.99 |
| 32 | 444 | 5.348 | 0.79 | 7.59 | 1.896 | 1.903 | 79.01 | 56.87 |
| 16 | 460 | 5.496 | 0.62 | 8.21 | 1.988 | 1.970 | 81.79 | 59.64 |
| 16 | 476 | 5.617 | 0.46 | 8.67 | 2.063 | 2.037 | 84.57 | 61.90 |
| 16 | 492 | 5.739 | 0.57 | 9.24 | 2.139 | 2.104 | 87.35 | 64.18 |

* Nominal yield stress

Table C.7. *Results of 71 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) 7.75
Moment arm (in) .....72.06

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) | | | Tip | Total | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Defl (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 4.797 | | | | | | |
| | tight | 4.112 | | | | | | |
| | DL | ** | 0.00 | 0.00 | ** | 0.042 | 1.90 | ** |
| 60 | 60 | ** | 0.90 | 0.90 | ** | 0.298 | 12.42 | ** |
| 32 | 92 | 4.952 | 0.50 | 1.39 | 0.434 | 0.434 | 18.03 | 13.02 |
| 32 | 124 | 5.188 | 0.51 | 1.90 | 0.581 | 0.571 | 23.64 | 17.43 |
| 32 | 156 | 5.415 | 0.50 | 2.40 | 0.722 | 0.707 | 29.25 | 21.67 |
| 32 | 188 | 5.634 | 0.49 | 2.89 | 0.859 | 0.843 | 34.86 | 25.77 |
| 32 | 220 | 5.866 | 0.54 | 3.43 | 1.003 | 0.980 | 40.47 | 30.10 |
| 32 | 252 | 6.078 | 0.52 | 3.95 | 1.136 | 1.116 | 46.08 | 34.07 |
| 48 | 300 | 6.415 | 0.93 | 4.88 | 1.346 | 1.321 | 54.50 | 40.37 |
| 16 | 316 | 6.525 | 0.33 | 5.21 | 1.414 | 1.389 | 57.30 | 42.42 |
| 16 | 332 | 6.647 | 0.48 | 5.69 | 1.490 | 1.457 | 60.11 | 44.70 |
| 16 | 348 | 6.756 | 0.50 | 6.19 | 1.558 | 1.525 | 62.91 | 46.74 |
| 16 | 364 | 6.878 | 0.59 | 6.78 | 1.634 | 1.593 | 65.72 | 49.02 |

* Nominal yield stress

** Strain gauge malfunction - data omitted

Table C.8. *Results of 71 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.44
Dist to strain gauge (in) 10.06
Moment arm (in) .....71.44

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Nested; gr 9 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 1.800 | | | | | | |
| | tight | 1.811 | | | | | | |
| | DL | 1.726 | 0.00 | 0.00 | 0.039 | 0.039 | 1.90 | 1.18 |
| 60 | 60 | 1.339 | 0.92 | 0.92 | 0.280 | 0.283 | 12.33 | 8.41 |
| 32 | 92 | 1.135 | 0.51 | 1.43 | 0.408 | 0.414 | 17.89 | 12.23 |
| 32 | 124 | 0.922 | 0.52 | 1.95 | 0.540 | 0.544 | 23.45 | 16.21 |
| 32 | 156 | 0.717 | 0.52 | 2.47 | 0.668 | 0.674 | 29.01 | 20.04 |
| 32 | 188 | 0.492 | 0.57 | 3.03 | 0.808 | 0.804 | 34.58 | 24.25 |
| 32 | 220 | 0.285 | 0.53 | 3.56 | 0.937 | 0.934 | 40.14 | 28.12 |
| 32 | 252 | 0.081 | 0.53 | 4.09 | 1.064 | 1.064 | 45.70 | 31.93 |
| 32 | 284 | -0.107 | 0.52 | 4.61 | 1.181 | 1.195 | 51.26 | 35.44 |
| 32 | 316 | -0.306 | 0.59 | 5.20 | 1.305 | 1.325 | 56.83 | 39.16 |
| 32 | 348 | -0.516 | 0.80 | 6.00 | 1.436 | 1.455 | 62.39 | 43.09 |
| 32 | 380 | -0.709 | 0.80 | 6.80 | 1.557 | 1.585 | 67.95 | 46.70 |
| 32 | 412 | -0.837 | 0.60 | 7.39 | 1.636 | 1.715 | 73.51 | 49.09 |
| 32 | 444 | -1.006 | 0.92 | 8.31 | 1.742 | 1.845 | 79.07 | 52.25 |
| 16 | 460 | -1.129 | 0.60 | 8.91 | 1.818 | 1.910 | 81.86 | 54.55 |
| 16 | 476 | -1.200 | 0.48 | 9.38 | 1.862 | 1.976 | 84.64 | 55.87 |
| 16 | 492 | -1.368 | 1.13 | 10.51 | 1.967 | 2.041 | 87.42 | 59.01 |

* Nominal yield stress

Table C.9. *Results of 71 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.44
Dist to strain gauge (in) 8.88
Moment arm (in) .....71.25

BENDING TEST

MARION 4 lb/ft - 80 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Total | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -0.430 | | | | | | |
| | tight | -0.426 | | | | | | |
| | DL | -0.319 | 0.00 | 0.00 | 0.038 | 0.038 | 1.91 | 1.14 |
| 60 | 60 | -0.022 | 0.53 | 0.53 | 0.223 | 0.214 | 9.75 | 6.69 |
| 32 | 92 | 0.156 | 0.32 | 0.85 | 0.334 | 0.308 | 13.94 | 10.02 |
| 32 | 124 | 0.299 | 0.25 | 1.10 | 0.423 | 0.402 | 18.12 | 12.69 |
| 32 | 156 | 0.459 | 0.29 | 1.38 | 0.523 | 0.495 | 22.30 | 15.68 |
| 32 | 188 | 0.635 | 0.31 | 1.69 | 0.632 | 0.589 | 26.49 | 18.97 |
| 32 | 220 | 0.793 | 0.29 | 1.98 | 0.731 | 0.683 | 30.67 | 21.93 |
| 32 | 252 | 0.965 | 0.31 | 2.29 | 0.838 | 0.776 | 34.85 | 25.14 |
| 32 | 284 | 1.125 | 0.30 | 2.58 | 0.938 | 0.870 | 39.04 | 28.13 |
| 32 | 316 | 1.295 | 0.31 | 2.89 | 1.044 | 0.964 | 43.22 | 31.31 |
| 32 | 348 | 1.468 | 0.33 | 3.22 | 1.151 | 1.057 | 47.40 | 34.54 |
| 32 | 380 | 1.633 | 0.34 | 3.55 | 1.254 | 1.151 | 51.59 | 37.63 |
| 32 | 412 | 1.801 | 0.34 | 3.89 | 1.359 | 1.245 | 55.77 | 40.77 |
| 16 | 428 | | 0.34 | 4.22 | | 1.292 | 57.79 | |

* Nominal yield stress

Table C.10. *Results of 71 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.44
Dist to strain gauge (in) 8.88
Moment arm (in) .....71.25

BENDING TEST

MARION 4 lb/ft - 80 ksi *
Back to back; gr 9 bolts
Critical orientation

| Appl. load (lbs) | Total Load (lbs) | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | -0.430 | | | | | | |
| | tight | -0.426 | | | | | | |
| | DL | -0.337 | 0.00 | 0.00 | 0.038 | 0.038 | 1.91 | 1.15 |
| 60 | 60 | -0.028 | 0.56 | 0.56 | 0.231 | 0.214 | 9.75 | 6.93 |
| 32 | 92 | 0.132 | 0.29 | 0.85 | 0.331 | 0.308 | 13.94 | 9.92 |
| 32 | 124 | 0.296 | 0.30 | 1.15 | 0.433 | 0.402 | 18.12 | 12.99 |
| 32 | 156 | 0.458 | 0.30 | 1.45 | 0.534 | 0.495 | 22.30 | 16.01 |
| 32 | 188 | 0.628 | 0.32 | 1.77 | 0.640 | 0.589 | 26.49 | 19.19 |
| 32 | 220 | 0.797 | 0.31 | 2.08 | 0.745 | 0.683 | 30.67 | 22.35 |
| 32 | 252 | 0.960 | 0.31 | 2.38 | 0.847 | 0.776 | 34.85 | 25.40 |
| 32 | 284 | 1.120 | 0.30 | 2.68 | 0.946 | 0.870 | 39.04 | 28.39 |
| 32 | 316 | 1.279 | 0.30 | 2.98 | 1.045 | 0.964 | 43.22 | 31.36 |
| 32 | 348 | 1.444 | 0.32 | 3.29 | 1.148 | 1.057 | 47.40 | 34.44 |
| 32 | 380 | 1.604 | 0.31 | 3.60 | 1.248 | 1.151 | 51.59 | 37.43 |
| 32 | 412 | 1.767 | 0.33 | 3.93 | 1.349 | 1.245 | 55.77 | 40.48 |
| 32 | 444 | 1.926 | 0.34 | 4.27 | 1.448 | 1.339 | 59.95 | 43.45 |
| 32 | 476 | 2.071 | 0.33 | 4.59 | 1.539 | 1.432 | 64.14 | 46.16 |
| 32 | 508 | 2.244 | 0.40 | 4.99 | 1.647 | 1.526 | 68.32 | 49.40 |
| 32 | 540 | 2.398 | 0.38 | 5.37 | 1.743 | 1.620 | 72.50 | 52.28 |
| 32 | 572 | 2.568 | 0.49 | 5.85 | 1.848 | 1.713 | 76.69 | 55.45 |
| 16 | 588 | 2.635 | 0.24 | 6.09 | 1.890 | 1.760 | 78.78 | 56.71 |

* Nominal yield stress

Table C.11. *Results of 71 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.75
Dist to strain gauge (in) 9.25
Moment arm (in) .....71.75

MARION 4 lb/ft - 80 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) | | | Tip | Total | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|
| Appl | Total | Ch.#1 (mV) | Defl (in) | Defl (in) | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | 0.356 | | | | | | |
| | tight | 0.384 | | | | | | |
| | DL | 0.305 | 0.00 | 0.00 | 0.038 | 0.038 | 1.91 | 1.14 |
| 60 | 60 | -0.015 | 0.61 | 0.61 | 0.237 | 0.214 | 9.81 | 7.12 |
| 32 | 92 | -0.164 | 0.29 | 0.90 | 0.330 | 0.308 | 14.02 | 9.91 |
| 32 | 124 | -0.326 | 0.32 | 1.21 | 0.431 | 0.402 | 18.23 | 12.94 |
| 32 | 156 | -0.488 | 0.33 | 1.54 | 0.532 | 0.496 | 22.45 | 15.96 |
| 32 | 188 | -0.653 | 0.33 | 1.87 | 0.635 | 0.590 | 26.66 | 19.05 |
| 32 | 220 | -0.818 | 0.33 | 2.19 | 0.738 | 0.684 | 30.87 | 22.13 |
| 32 | 252 | -0.973 | 0.31 | 2.50 | 0.834 | 0.778 | 35.08 | 25.03 |
| 32 | 284 | -1.128 | 0.31 | 2.81 | 0.931 | 0.871 | 39.30 | 27.93 |
| 32 | 316 | -1.283 | 0.31 | 3.12 | 1.027 | 0.965 | 43.51 | 30.82 |
| 32 | 348 | -1.375 | 0.41 | 3.53 | 1.085 | 1.059 | 47.72 | 32.54 |
| 32 | 380 | -1.596 | 0.23 | 3.76 | 1.222 | 1.153 | 51.94 | 36.67 |
| 32 | 412 | -1.745 | 0.31 | 4.07 | 1.315 | 1.247 | 56.15 | 39.46 |
| 32 | 444 | -1.903 | 0.32 | 4.39 | 1.414 | 1.341 | 60.36 | 42.41 |
| 32 | 476 | -2.054 | 0.38 | 4.77 | 1.508 | 1.435 | 64.57 | 45.24 |

* Nominal yield stress

Table C.12. *Results of 71 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.75
Dist to strain gauge (in) 9.25
Moment arm (in) .....71.75

BENDING TEST

MARION 4 lb/ft - 80 ksi *
Nested; gr 9 bolts
Critical orientation

| Appl. load (lbs) | Total Load (lbs) | Ch.#1 (mV) | Tip Defl (in) | Total Defl (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|
| | floor | 0.356 | | | | | | |
| | tight | 0.384 | | | | | | |
| | DL | 0.304 | 0.00 | 0.00 | 0.038 | 0.038 | 1.91 | 1.14 |
| 60 | 60 | -0.013 | 0.62 | 0.62 | 0.236 | 0.214 | 9.81 | 7.07 |
| 32 | 92 | -0.165 | 0.30 | 0.91 | 0.330 | 0.308 | 14.02 | 9.91 |
| 32 | 124 | -0.330 | 0.33 | 1.24 | 0.433 | 0.402 | 18.23 | 12.99 |
| 32 | 156 | -0.491 | 0.32 | 1.56 | 0.533 | 0.496 | 22.45 | 16.00 |
| 32 | 188 | -0.652 | 0.32 | 1.88 | 0.634 | 0.590 | 26.66 | 19.01 |
| 32 | 220 | -0.815 | 0.33 | 2.21 | 0.735 | 0.684 | 30.87 | 22.06 |
| 32 | 252 | -0.968 | 0.32 | 2.52 | 0.831 | 0.778 | 35.08 | 24.92 |
| 32 | 284 | -1.126 | 0.32 | 2.84 | 0.929 | 0.871 | 39.30 | 27.87 |
| 32 | 316 | -1.287 | 0.34 | 3.18 | 1.029 | 0.965 | 43.51 | 30.88 |
| 32 | 348 | -1.444 | 0.32 | 3.49 | 1.127 | 1.059 | 47.72 | 33.81 |
| 32 | 380 | -1.587 | 0.30 | 3.79 | 1.216 | 1.153 | 51.94 | 36.49 |
| 32 | 412 | -1.743 | 0.32 | 4.11 | 1.313 | 1.247 | 56.15 | 39.40 |
| 32 | 444 | -1.891 | 0.32 | 4.43 | 1.406 | 1.341 | 60.36 | 42.17 |
| 32 | 476 | -2.04 | 0.33 | 4.76 | 1.495 | 1.435 | 64.57 | 44.86 |
| 32 | 508 | -2.19 | 0.35 | 5.11 | 1.593 | 1.529 | 68.79 | 47.80 |
| 32 | 540 | -2.34 | 0.35 | 5.46 | 1.687 | 1.623 | 73.00 | 50.60 |
| 32 | 572 | -2.48 | 0.36 | 5.81 | 1.770 | 1.716 | 77.21 | 53.09 |
| 32 | 604 | -2.63 | 0.52 | 6.34 | 1.866 | 1.810 | 81.43 | 55.98 |
| 16 | 620 | -2.71 | 0.23 | 6.57 | 1.917 | 1.857 | 83.53 | 57.50 |

* Nominal yield stress

# APPENDIX D

## TORSION TESTS

## FIELD AND CALIBRATED BOLT SUMMARY TABLES

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back and Nested Splices

& Post W/O Splice

# APPENDIX D

## LIST OF TABLES

Table D.1. *Results of Torsion Test: Franklin 3 lb/ft - 60 ksi Post; Post W/O Splice.*

| TORSION TEST | | |
|---|---|---|
| FRANKLIN 3 lb/ft 60 (ksi) * NO SPLICE post length: 123 in | | |
| Total Load (lbs) | Applied Moment (k-in) | Theta (deg) |
| 0 | 0.00 | 0.0 |
| 50 | 0.21 | 15.0 |
| 100 | 0.41 | 30.0 |
| 150 | 0.62 | 45.0 |
| 200 | 0.83 | 60.5 |
| 250 | 1.03 | 75.0 |
| 300 | 1.24 | 91.0 |
| 350 | 1.44 | 107.0 |
| 400 | 1.65 | 123.0 |
| 450 | 1.86 | 136.0 |
| 500 | 2.06 | 147.5 |
| 550 | 2.27 | 166.5 |
| 600 | 2.48 | 183.5 |
| 650 | 2.68 | 203.5 |
| 700 | 2.89 | 224.0 |
| 750 | 3.09 | 246.5 |
| 800 | 3.30 | 267.0 |
| 850 | 3.51 | 295.5 |
| 900 | 3.71 | 315.5 |
| 950 | 3.92 | 338.0 |
| 1000 | 4.13 | 362.0 |
| 750 | 3.09 | 315.0 |
| 500 | 2.06 | 252.0 |
| 250 | 1.03 | 179.5 |
| 0 | 0.00 | 92.0 |

* Nominal yield stress

Table D.2. *Results of Torsion Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice (Calibrated and Grade 5 Field Bolts).*

| TORSION TEST<br>FRANKLIN 3 lb/ft - 60 ksi *<br>back to back; gr 5 bolts<br>splice length: 3 in<br>post length: 123 in | | | | | BOLT LOADS | |
|---|---|---|---|---|---|---|
| Total Load (lbs) | Applied Moment (k-in) | Theta (deg) | Ch.#1 (mV) | Ch.#2 (mV) | Bolt A Obs. (kips) | Bolt B Obs. (kips) |
| loose | | | 0.421 | 0.065 | 0.00 | 0.00 |
| tight | | | -1.740 | -2.327 | 3.71 | 3.67 |
| 0 | 0.00 | 0.0 | -1.710 | -2.274 | 3.66 | 3.59 |
| 50 | 0.21 | 16.5 | -1.724 | -2.249 | 3.68 | 3.55 |
| 100 | 0.41 | 33.0 | -1.748 | -2.216 | 3.72 | 3.50 |
| 150 | 0.62 | 50.5 | -1.780 | -2.181 | 3.78 | 3.45 |
| 200 | 0.83 | 66.0 | -1.818 | -2.162 | 3.84 | 3.42 |
| 250 | 1.03 | 81.5 | -1.860 | -2.159 | 3.92 | 3.41 |
| 300 | 1.24 | 96.5 | -1.192 | -2.154 | 2.77 | 3.41 |
| 350 | 1.44 | 111.5 | -1.964 | -2.149 | 4.09 | 3.40 |
| 400 | 1.65 | 126.5 | -2.024 | -2.145 | 4.20 | 3.39 |
| 450 | 1.86 | 139.0 | -2.071 | -2.165 | 4.28 | 3.42 |
| 500 | 2.06 | 152.0 | -2.121 | -2.189 | 4.36 | 3.46 |
| 550 | 2.27 | 170.0 | -2.175 | -2.268 | 4.46 | 3.58 |
| 600 | 2.48 | 190.0 | -2.199 | -2.409 | 4.50 | 3.80 |
| 650 | 2.68 | 215.5 | -2.204 | -2.609 | 4.51 | 4.10 |
| 700 | 2.89 | 240.5 | -2.169 | -2.813 | 4.45 | 4.42 |
| 750 | 3.09 | 266.5 | -2.092 | -3.061 | 4.31 | 4.80 |
| 800 | 3.30 | 295.0 | -2.008 | -3.371 | 4.17 | 5.27 |
| 850 | 3.51 | 331.0 | -1.904 | ** | 3.99 | ** |
| 900 | 3.71 | 371.5 | -1.832 | | 3.87 | |
| 500 | 2.06 | 284.0 | -1.697 | | 3.64 | |
| 250 | 1.03 | 221.5 | -1.599 | | 3.47 | |
| 0 | 0.00 | 125.0 | -1.417 | | 3.15 | |

* Nominal yield stress

** Bolt #7 not working properly - data omitted

Table D.3. *Results of Torsion Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice (Calibrated and Grade 5 Field Bolts).*

TORSION TEST

FRANKLIN 3 lb/ft - 60 ksi *
nested; gr 5 bolts
splice length: 3 in
post length: 123 in

| Total Load (lbs) | Applied Moment (k-in) | Theta (deg) | Ch.#1 (mV) | Ch.#2 (mV) | BOLT LOADS Bolt A Obs. (kips) | BOLT LOADS Bolt B Obs. (kips) |
|---|---|---|---|---|---|---|
| loose | | | ** | 0.434 | ** | 0.00 |
| tight | | | | -1.336 | | 3.04 |
| 0 | 0.00 | 0.0 | | -1.282 | | 2.95 |
| 50 | 0.21 | 14.0 | | -1.283 | | 2.95 |
| 100 | 0.41 | 29.5 | | -1.277 | | 2.94 |
| 150 | 0.62 | 43.5 | | -1.278 | | 2.94 |
| 200 | 0.83 | 58.4 | | -1.290 | | 2.96 |
| 250 | 1.03 | 74.0 | | -1.294 | | 2.97 |
| 300 | 1.24 | 89.5 | | -1.312 | | 3.00 |
| 350 | 1.44 | 105.0 | | -1.351 | | 3.06 |
| 400 | 1.65 | 122.5 | | -1.391 | | 3.13 |
| 450 | 1.86 | 137.5 | | -1.414 | | 3.17 |
| 500 | 2.06 | 149.0 | | -1.454 | | 3.24 |
| 550 | 2.27 | 169.0 | | -1.504 | | 3.33 |
| 600 | 2.48 | 191.5 | | -1.566 | | 3.43 |
| 650 | 2.68 | 214.5 | | -1.628 | | 3.54 |
| 700 | 2.89 | 236.0 | | -1.713 | | 3.69 |
| 750 | 3.09 | 259.5 | | -1.785 | | 3.81 |
| 800 | 3.30 | 285.0 | | -1.860 | | 3.94 |
| 850 | 3.51 | 309.5 | | -1.918 | | 4.04 |
| 900 | 3.71 | 337.0 | | -1.985 | | 4.15 |
| 950 | 3.92 | 369.0 | | -2.012 | | 4.20 |
| 500 | 2.06 | 277.0 | | -1.301 | | 2.98 |
| 250 | 1.03 | 213.0 | | -0.971 | | 2.41 |
| 0 | 0.00 | 114.0 | | -0.668 | | 1.89 |

* Nominal yield stress

** Bolt #7 not working properly - data omitted

Table D.4. *Results of Torsion Test: Franklin 4 lb/ft - 60 ksi Post; Post W/O Splice.*

| TORSION TEST | | |
|---|---|---|
| FRANKLIN 4 lb/ft * 60 (ksi) NO SPLICE post length: 123 in | | |
| Total Load (lbs) | Applied Moment (k-in) | Theta (deg) |
| 0 | 0.00 | 0.0 |
| 100 | 0.41 | 13.5 |
| 200 | 0.83 | 26.5 |
| 300 | 1.24 | 40.0 |
| 400 | 1.65 | 53.5 |
| 500 | 2.06 | 68.0 |
| 600 | 2.48 | 83.0 |
| 700 | 2.89 | 98.0 |
| 800 | 3.30 | 114.0 |
| 900 | 3.71 | 130.5 |
| 1000 | 4.13 | 142.0 |
| 1100 | 4.54 | 161.0 |
| 1200 | 4.95 | 185.0 |
| 1300 | 5.36 | 212.5 |
| 1400 | 5.78 | 246.5 |
| 1500 | 6.19 | 286.0 |
| 1600 | 6.60 | 325.0 |
| 1700 | 7.01 | 360.0 |
| 1000 | 4.13 | 298.0 |
| 500 | 2.06 | 240.0 |
| 0 | 0.00 | 158.0 |

* Nominal yield stress

Table D.5. *Results of Torsion Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice (Calibrated and Grade 5 Field Bolts).*

TORSION TEST

FRANKLIN 4 lb/ft - 60 ksi *
back to back; gr 5 bolts
splice length: 4 in
post length: 123 in

| Total Load (lbs) | Applied Moment (k-in) | Theta (deg) | Ch.#1 (mV) | Ch.#2 (mV) | BOLT LOADS Bolt A Obs. (kips) | BOLT LOADS Bolt B Obs. (kips) |
|---|---|---|---|---|---|---|
| loose | | | -0.136 | 0.115 | 0.00 | 0.00 |
| tight | | | -2.633 | -2.719 | 3.56 | 4.35 |
| 0 | 0.00 | 0.0 | -2.569 | -2.679 | 3.47 | 4.29 |
| 100 | 0.41 | 13.5 | -2.561 | -2.669 | 3.46 | 4.27 |
| 200 | 0.83 | 26.0 | -2.556 | -2.661 | 3.45 | 4.26 |
| 300 | 1.24 | 37.5 | -2.574 | -2.656 | 3.48 | 4.25 |
| 400 | 1.65 | 52.0 | -2.639 | -2.682 | 3.57 | 4.29 |
| 500 | 2.06 | 66.0 | -2.746 | -2.719 | 3.72 | 4.35 |
| 600 | 2.48 | 81.0 | -2.890 | -2.806 | 3.93 | 4.48 |
| 700 | 2.89 | 97.0 | -3.077 | -2.944 | 4.19 | 4.70 |
| 800 | 3.30 | 116.0 | -3.227 | -3.102 | 4.41 | 4.94 |
| 900 | 3.71 | 131.5 | -3.436 | -3.237 | 4.71 | 5.15 |
| 1000 | 4.13 | 146.5 | -3.577 | -3.349 | 4.91 | 5.32 |
| 1100 | 4.54 | 168.5 | -3.782 | -3.483 | 5.20 | 5.52 |
| 1200 | 4.95 | 201.5 | -4.014 | -3.764 | 5.53 | 5.95 |
| 1300 | 5.36 | 241.5 | -4.125 | -3.913 | 5.69 | 6.18 |
| 1400 | 5.78 | 270.0 | -4.175 | -4.104 | 5.76 | 6.48 |
| 1500 | 6.19 | 298.0 | -4.220 | -4.261 | 5.83 | 6.72 |
| 1600 | 6.60 | 335.0 | -4.280 | -4.397 | 5.91 | 6.93 |
| 1000 | 4.13 | 275.5 | -3.512 | -3.224 | 4.82 | 5.13 |
| 500 | 2.06 | 209.5 | -2.712 | -2.155 | 3.67 | 3.48 |
| 0 | 0.00 | 104.0 | -2.200 | -1.450 | 2.94 | 2.40 |

* Nominal yield stress

Table D.6. *Results of Torsion Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice (Calibrated and Grade 5 Field Bolts).*

TORSION TEST

FRANKLIN 4 lb/ft - 60 ksi *
nested; gr 5 bolts
splice length: 4 in
post length: 123 in

| Total Load (lbs) | Applied Moment (k-in) | Theta (deg) | Ch.#1 (mV) | Ch.#2 (mV) | BOLT LOADS Bolt A Obs. (kips) | BOLT LOADS Bolt B Obs. (kips) |
|---|---|---|---|---|---|---|
| loose | | | -0.410 | 0.262 | 0.00 | 0.00 |
| tight | | | -3.126 | -0.251 | 3.87 | 0.79 |
| 0 | 0.00 | 0.0 | -3.042 | -0.257 | 3.75 | 0.80 |
| 100 | 0.41 | 13.0 | -3.044 | -0.220 | 3.76 | 0.74 |
| 200 | 0.83 | 26.5 | -3.048 | -0.249 | 3.76 | 0.78 |
| 300 | 1.24 | 40.5 | -3.051 | -0.249 | 3.77 | 0.78 |
| 400 | 1.65 | 54.0 | -3.059 | -0.291 | 3.78 | 0.85 |
| 500 | 2.06 | 68.5 | -3.073 | -0.362 | 3.80 | 0.96 |
| 600 | 2.48 | 83.0 | -3.089 | -0.441 | 3.82 | 1.08 |
| 700 | 2.89 | 98.0 | -3.114 | -0.550 | 3.86 | 1.25 |
| 800 | 3.30 | 116.5 | -3.149 | -0.690 | 3.91 | 1.46 |
| 900 | 3.71 | 132.5 | -3.181 | -0.820 | 3.95 | 1.66 |
| 1000 | 4.13 | 144.0 | -3.203 | -0.925 | 3.98 | 1.82 |
| 1100 | 4.54 | 164.5 | -3.249 | -1.087 | 4.05 | 2.07 |
| 1200 | 4.95 | 192.0 | -3.313 | -1.286 | 4.14 | 2.38 |
| 1300 | 5.36 | 223.5 | -3.370 | -1.507 | 4.22 | 2.72 |
| 1400 | 5.78 | 258.0 | -3.425 | -1.765 | 4.30 | 3.11 |
| 1400 | 5.78 | 286.5 | -4.954 | ** | 6.48 | ** |
| 1000 | 4.13 | 242.5 | -3.962 | ** | 5.07 | ** |
| 500 | 2.06 | 175.0 | -2.611 | ** | 3.14 | ** |
| 0 | 0.00 | 86.0 | -0.685 | ** | 0.39 | ** |

* Nominal yield stress

** bolt #8 breaks at 3.11 kips; probably due to fatigue since Pu = 12 kips

Table D.7. *Results of Torsion Test: Marion 3 lb/ft - 80 ksi Post; Post W/O Splice.*

| TORSION TEST | | |
|---|---|---|
| MARION 3 lb/ft<br>80 (ksi) *<br>NO SPLICE<br>post length: 123 in | | |
| Total Load (lbs) | Applied Moment (k-in) | Theta (deg) |
| 0 | 0.00 | 0.0 |
| 50 | 0.21 | 14.0 |
| 100 | 0.41 | 28.5 |
| 150 | 0.62 | 42.5 |
| 200 | 0.83 | 67.5 |
| 250 | 1.03 | 72.0 |
| 300 | 1.24 | 86.0 |
| 350 | 1.44 | 100.0 |
| 400 | 1.65 | 114.0 |
| 450 | 1.86 | 128.5 |
| 500 | 2.06 | 138.0 |
| 550 | 2.27 | 148.0 |
| 600 | 2.48 | 161.0 |
| 650 | 2.68 | 177.0 |
| 700 | 2.89 | 189.0 |
| 750 | 3.09 | 204.5 |
| 800 | 3.30 | 219.5 |
| 850 | 3.51 | 234.5 |
| 900 | 3.71 | 251.0 |
| 950 | 3.92 | 269.0 |
| 1000 | 4.13 | 288.5 |
| 1050 | 4.33 | 306.0 |
| 1100 | 4.54 | 331.0 |
| 1200 | 4.95 | 380.0 |
| 500 | 2.06 | 222.0 |
| 0 | 0.00 | 73.5 |

* Nominal yield stress

Table D.8. *Results of Torsion Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice (Calibrated and Grade 5 Field Bolts).*

TORSION TEST

MARION 3 lb/ft - 80 ksi *
back to back; gr 5 bolts
splice length: 3 in
post length: 123 in

| Total Load (lbs) | Applied Moment (k-in) | Theta (deg) | Ch.#1 (mV) | Ch.#2 (mV) | BOLT LOADS Bolt A Obs. (kips) | BOLT LOADS Bolt B Obs. (kips) |
|---|---|---|---|---|---|---|
| loose | | | -0.308 | 0.097 | 0.00 | 0.00 |
| tight | | | -2.034 | -1.669 | 2.46 | 2.71 |
| 0 | 0.00 | 0.0 | -2.101 | -1.624 | 2.56 | 2.64 |
| 100 | 0.41 | 16.5 | -2.097 | -1.655 | 2.55 | 2.69 |
| 200 | 0.83 | 44.0 | -2.102 | -1.685 | 2.56 | 2.74 |
| 300 | 1.24 | 71.5 | -2.119 | -1.704 | 2.58 | 2.76 |
| 400 | 1.65 | 100.0 | -2.144 | -1.721 | 2.62 | 2.79 |
| 500 | 2.06 | 129.0 | -2.144 | -1.729 | 2.62 | 2.80 |
| 600 | 2.48 | 159.0 | -2.140 | -1.720 | 2.61 | 2.79 |
| 700 | 2.89 | 203.0 | -2.144 | -1.707 | 2.62 | 2.77 |
| 800 | 3.30 | 241.0 | -2.124 | -1.931 | 2.59 | 3.11 |
| 900 | 3.71 | 271.0 | -2.124 | -2.190 | 2.59 | 3.51 |
| 1000 | 4.13 | 305.0 | -2.124 | -2.449 | 2.59 | 3.91 |
| 1100 | 4.54 | 345.0 | -2.115 | -2.674 | 2.58 | 4.25 |
| 1200 | 4.95 | 383.0 | -2.117 | -2.813 | 2.58 | 4.47 |
| 1000 | 4.13 | 356.5 | -1.947 | -2.373 | 2.34 | 3.79 |
| 500 | 2.06 | 256.0 | -1.621 | -1.115 | 1.87 | 1.86 |
| 0 | 0.00 | 78.0 | -1.533 | -0.270 | 1.75 | 0.56 |

* Nominal yield stress

Table D.9. *Results of Torsion Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice (Calibrated and Grade 5 Field Bolts).*

TORSION TEST

MARION 3 lb/ft - 80 ksi *
nested; gr 5 bolts
splice length: 3 in
post length: 123 in

| Total Load (lbs) | Applied Moment (k-in) | Theta (deg) | Ch.#1 (mV) | Ch.#2 (mV) | BOLT LOADS Bolt A Obs. (kips) | BOLT LOADS Bolt B Obs. (kips) |
|---|---|---|---|---|---|---|
| loose | | | 0.448 | ** | ** | 0.00 |
| tight | | | -1.571 | | | 3.47 |
| 0 | 0.00 | 0.00 | -1.455 | | | 3.27 |
| 100 | 0.41 | 28.50 | -1.471 | | | 3.29 |
| 200 | 0.83 | 57.50 | -1.523 | | | 3.38 |
| 300 | 1.24 | 86.50 | -1.598 | | | 3.51 |
| 400 | 1.65 | 105.50 | -1.671 | | | 3.64 |
| 500 | 2.06 | 138.00 | -1.736 | | | 3.75 |
| 600 | 2.48 | 165.50 | -1.806 | | | 3.87 |
| 700 | 2.89 | 195.50 | -1.894 | | | 4.02 |
| 800 | 3.30 | 226.00 | -2.062 | | | 4.31 |
| 900 | 3.71 | 260.50 | -2.293 | | | 4.70 |
| 1000 | 4.13 | 296.50 | -2.584 | | | 5.20 |
| 1100 | 4.54 | 340.00 | -2.937 | | | 5.81 |
| 1200 | 4.95 | 384.00 | -3.308 | | | 6.45 |
| 750 | 3.09 | 304.50 | -2.455 | | | 4.98 |
| 500 | 2.06 | 260.00 | -2.111 | | | 4.39 |
| 250 | 1.03 | 179.00 | -1.559 | | | 3.44 |
| 0 | 0.00 | 94.00 | -1.223 | | | 2.87 |

* Nominal yield stress

** Bolt #7 not working properly - data omitted

Table D.10. *Results of Torsion Test: Marion 4 lb/ft - 80 ksi Post; Post W/O Splice.*

| TORSION TEST | | |
|---|---|---|
| MARION 4 lb/ft 80 (ksi) * NO SPLICE post length: 123 in | | |
| Total Load (lbs) | Applied Moment (k-in) | Theta (deg) |
| 0 | 0.00 | 0.0 |
| 100 | 0.41 | 11.5 |
| 200 | 0.83 | 23.0 |
| 300 | 1.24 | 33.5 |
| 400 | 1.65 | 45.0 |
| 500 | 2.06 | 56.5 |
| 600 | 2.48 | 68.5 |
| 700 | 2.89 | 79.0 |
| 800 | 3.30 | 91.0 |
| 900 | 3.71 | 112.0 |
| 1000 | 4.13 | 128.5 |
| 1100 | 4.54 | 139.5 |
| 1200 | 4.95 | 148.5 |
| 1300 | 5.36 | 164.5 |
| 1400 | 5.78 | 180.0 |
| 1500 | 6.19 | 201.0 |
| 1600 | 6.60 | 221.5 |
| 1700 | 7.01 | 246.5 |
| 1800 | 7.43 | 275.0 |
| 1900 | 7.84 | 307.0 |
| 2000 | 8.25 | 341.0 |
| 2100 | 8.66 | 375.0 |
| 1400 | 5.78 | 311.0 |
| 500 | 2.06 | 206.0 |
| 0 | 0.00 | 130.0 |

* Nominal yield stress

Table D.11. *Results of Torsion Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice (Calibrated and Grade 5 Field Bolts).*

TORSION TEST

MARION 4 lb/ft - 80 ksi *
back to back; gr 5 bolts
splice length: 4 in
post length: 123 in

| Total Load (lbs) | Applied Moment (k-in) | Theta (deg) | Ch.#1 (mV) | Ch.#2 (mV) | BOLT LOADS Bolt A Obs. (kips) | BOLT LOADS Bolt B Obs. (kips) |
|---|---|---|---|---|---|---|
| loose | | | -0.219 | 0.456 | 0.00 | 0.00 |
| tight | | | -2.128 | -1.674 | 2.72 | 3.27 |
| 0 | 0.00 | 0.0 | -2.216 | -1.595 | 2.85 | 3.15 |
| 100 | 0.41 | 10.5 | -2.213 | -1.602 | 2.84 | 3.16 |
| 200 | 0.83 | 20.0 | -2.215 | -1.607 | 2.85 | 3.17 |
| 300 | 1.24 | 31.0 | -2.216 | -1.609 | 2.85 | 3.17 |
| 400 | 1.65 | 41.5 | -2.220 | -1.612 | 2.85 | 3.17 |
| 500 | 2.06 | 51.0 | -2.240 | -1.613 | 2.88 | 3.18 |
| 600 | 2.48 | 62.0 | -2.228 | -1.612 | 2.87 | 3.17 |
| 700 | 2.89 | 71.5 | -2.229 | -1.608 | 2.87 | 3.17 |
| 800 | 3.30 | 82.5 | -2.224 | -1.602 | 2.86 | 3.16 |
| 900 | 3.71 | 93.5 | -2.248 | -1.593 | 2.89 | 3.15 |
| 900 | 3.71 | 109.0 | -2.246 | -1.560 | 2.89 | 3.09 |
| 1000 | 4.13 | 122.0 | -2.301 | -1.561 | 2.97 | 3.10 |
| 1100 | 4.54 | 134.5 | -2.344 | -1.547 | 3.03 | 3.07 |
| 1200 | 4.95 | 144.0 | -2.400 | -1.533 | 3.11 | 3.05 |
| 1300 | 5.36 | 158.0 | -2.497 | -1.546 | 3.25 | 3.07 |
| 1400 | 5.78 | 178.5 | -2.653 | -1.715 | 3.47 | 3.33 |
| 1500 | 6.19 | 202.0 | -2.773 | -1.867 | 3.64 | 3.57 |
| 1600 | 6.60 | 229.0 | -2.857 | -2.094 | 3.76 | 3.91 |
| 1700 | 7.01 | 257.5 | -2.863 | -2.328 | 3.77 | 4.27 |
| 1800 | 7.43 | 281.0 | -2.862 | -2.537 | 3.77 | 4.59 |
| 1900 | 7.84 | 305.5 | -2.837 | -2.748 | 3.73 | 4.92 |
| 2000 | 8.25 | 332.5 | -2.818 | -2.971 | 3.71 | 5.26 |
| 1000 | 4.13 | 243.5 | -1.879 | -1.127 | 2.37 | 2.43 |
| 500 | 2.06 | 179.0 | -1.413 | -0.274 | 1.70 | 1.12 |
| 0 | 0.00 | 90.0 | -1.376 | 0.020 | 1.65 | 0.67 |

* Nominal yield stress

Table D.12. *Results of Torsion Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice (Calibrated and Grade 5 Field Bolts).*

| TORSION TEST<br>MARION 4 lb/ft - 80 ksi *<br>nested; gr 5 bolts<br>splice length: 4 in<br>post length: 123 in | | | | | BOLT LOADS | |
|---|---|---|---|---|---|---|
| Total Load (lbs) | Applied Moment (k-in) | Theta (deg) | Ch.#1 (mV) | Ch.#2 (mV) | Bolt A Obs. (kips) | Bolt B Obs. (kips) |
| loose | | | -0.228 | 0.572 | 0.00 | 0.00 |
| tight | | | -1.873 | -1.049 | 2.35 | 2.49 |
| 0 | 0.00 | 0.0 | -1.780 | -0.929 | 2.21 | 2.30 |
| 100 | 0.41 | 12.0 | -1.750 | -0.918 | 2.17 | 2.29 |
| 200 | 0.83 | 25.0 | -1.697 | -0.951 | 2.10 | 2.34 |
| 300 | 1.24 | 36.5 | -1.682 | -0.956 | 2.07 | 2.35 |
| 400 | 1.65 | 48.5 | -1.665 | -0.973 | 2.05 | 2.37 |
| 500 | 2.06 | 61.5 | -1.633 | -1.007 | 2.00 | 2.42 |
| 600 | 2.48 | 73.5 | -1.606 | -1.048 | 1.97 | 2.49 |
| 700 | 2.89 | 86.5 | -1.614 | -1.103 | 1.98 | 2.57 |
| 800 | 3.30 | 99.5 | -1.555 | -1.158 | 1.89 | 2.66 |
| 900 | 3.71 | 113.0 | -1.539 | -1.232 | 1.87 | 2.77 |
| 1000 | 4.13 | 126.0 | -1.546 | -1.326 | 1.88 | 2.91 |
| 1100 | 4.54 | 136.0 | -1.538 | -1.396 | 1.87 | 3.02 |
| 1200 | 4.95 | 145.5 | -1.543 | -1.477 | 1.88 | 3.15 |
| 1300 | 5.36 | 160.5 | -1.552 | -1.599 | 1.89 | 3.33 |
| 1400 | 5.78 | 177.0 | -1.559 | -1.749 | 1.90 | 3.56 |
| 1500 | 6.19 | 195.0 | -1.571 | -1.955 | 1.92 | 3.88 |
| 1600 | 6.60 | 216.5 | -1.571 | -2.210 | 1.92 | 4.27 |
| 1700 | 7.01 | 238.5 | -1.585 | -2.471 | 1.94 | 4.67 |
| 1800 | 7.43 | 263.0 | -1.594 | -2.753 | 1.95 | 5.10 |
| 1900 | 7.84 | 288.0 | -1.601 | -3.029 | 1.96 | 5.53 |
| 2000 | 8.25 | 319.5 | -1.603 | -3.338 | 1.96 | 6.00 |
| 1000 | 4.13 | 220.0 | -1.387 | -1.974 | 1.65 | 3.91 |
| 500 | 2.06 | 158.0 | -1.236 | -1.057 | 1.44 | 2.50 |
| 0 | 0.00 | 83.0 | -1.072 | -0.442 | 1.20 | 1.56 |

* Nominal yield stress

# APPENDIX E

## 75" COMBINED BENDING AND TORSION TESTS

## (NEGLECTING AND INCLUDING WARPING STRESSES)

## FIELD BOLT SUMMARY TABLES

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back and Nested Splices

Critical Configuration

# APPENDIX E

## LIST OF TABLES

# APPENDIX E

## LIST OF TABLES (CONT)

Table E.1. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 7.88
Moment arm (in) ..... 75.38
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Warping Neglected)
FRANKLIN 3 lb/ft - 60 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Tip Defl (in) | Tip Rot (deg) | Tor Arm (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | BASE STRESSES (ksi) Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1.003 | 0.00 | 0.0 | 6.30 | 0.052 | 0.052 | 1.94 | 0.00 | 0.00 | 1.94 |
| 26 | 26 | 1.238 | 0.60 | 7.5 | 6.25 | 0.198 | 0.195 | 6.74 | 2.80 | 0.00 | 7.75 |
| 24 | 50 | 1.457 | 1.18 | 13.0 | 6.14 | 0.335 | 0.327 | 11.17 | 5.34 | 0.00 | 13.32 |
| 24 | 74 | 1.671 | 1.83 | 17.5 | 6.01 | 0.468 | 0.460 | 15.61 | 7.83 | 0.00 | 18.86 |
| 24 | 98 | 1.878 | 2.47 | 22.0 | 5.84 | 0.597 | 0.592 | 20.04 | 10.24 | 0.00 | 24.35 |
| 24 | 122 | 2.080 | 3.12 | 25.0 | 5.71 | 0.723 | 0.724 | 24.47 | 12.61 | 0.01 | 29.80 |
| 24 | 146 | 2.276 | 3.76 | 28.0 | 5.56 | 0.845 | 0.856 | 28.90 | 14.91 | 0.01 | 35.21 |
| 24 | 170 | 2.472 | 4.43 | 30.0 | 5.46 | 0.967 | 0.989 | 33.32 | 17.17 | 0.01 | 40.59 |
| 24 | 194 | 2.646 | 5.13 | 32.5 | 5.31 | 1.076 | 1.121 | 37.74 | 19.36 | 0.01 | 45.92 |
| 24 | 218 | 2.813 | 5.84 | 34.5 | 5.19 | 1.180 | 1.253 | 42.17 | 21.51 | 0.02 | 51.22 |
| 24 | 242 | 2.976 | 6.70 | 36.0 | 5.10 | 1.281 | 1.384 | 46.58 | 23.62 | 0.02 | 56.48 |
| 24 | 266 | 3.095 | 7.65 | 38.0 | 4.96 | 1.355 | 1.516 | 50.99 | 25.68 | 0.03 | 61.71 |
| 24 | 290 | 3.146 | 8.81 | 39.0 | 4.90 | 1.387 | 1.647 | 55.40 | 27.70 | 0.04 | 66.90 |
| 8 | 298 | 3.249 | 9.24 | 40.0 | 4.83 | 1.451 | 1.691 | 56.86 | 28.37 | 0.04 | 68.63 |
| 8 | 306 | 3.124 | 9.81 | 40.5 | 4.79 | 1.374 | 1.735 | 58.33 | 29.03 | 0.04 | 70.35 |
| 8 | 314 | 3.036 | 10.55 | 41.5 | 4.72 | 1.319 | 1.779 | 59.79 | 29.68 | 0.05 | 72.06 |

* Nominal yield stress

Table E.2. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 8.25
Moment arm (in) ..... 75.50
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Warping Neglected)
FRANKLIN 3 lb/ft - 60 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Tip Defl (in) | Tip Rot (deg) | Tor Arm (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | BASE STRESSES (ksi) Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DL | 0.411 | 0.00 | 0.0 | 6.30 | 0.052 | 0.051 | 1.94 | 0.00 | 0.00 | 1.94 |
| 26 | 26 | 0.177 | 0.61 | 7.0 | 6.25 | 0.198 | 0.194 | 6.75 | 2.80 | 0.00 | 7.76 |
| 24 | 50 | -0.042 | 1.17 | 13.5 | 6.13 | 0.334 | 0.326 | 11.19 | 5.34 | 0.00 | 13.33 |
| 24 | 74 | -0.261 | 1.71 | 18.5 | 5.97 | 0.471 | 0.458 | 15.63 | 7.81 | 0.00 | 18.86 |
| 24 | 98 | -0.480 | 2.27 | 23.5 | 5.78 | 0.607 | 0.589 | 20.07 | 10.20 | 0.00 | 24.34 |
| 24 | 122 | -0.701 | 2.85 | 27.0 | 5.61 | 0.745 | 0.721 | 24.51 | 12.52 | 0.01 | 29.78 |
| 24 | 146 | -0.920 | 3.41 | 30.5 | 5.43 | 0.881 | 0.853 | 28.94 | 14.77 | 0.01 | 35.15 |
| 24 | 170 | -1.137 | 3.98 | 34.0 | 5.22 | 1.017 | 0.985 | 33.38 | 16.93 | 0.01 | 40.47 |
| 24 | 194 | -1.353 | 4.56 | 36.5 | 5.06 | 1.151 | 1.116 | 37.81 | 19.03 | 0.01 | 45.74 |
| 24 | 218 | -1.569 | 5.22 | 38.0 | 4.96 | 1.286 | 1.248 | 42.24 | 21.08 | 0.02 | 50.98 |
| 24 | 242 | -1.785 | 5.90 | 40.0 | 4.83 | 1.420 | 1.379 | 46.67 | 23.08 | 0.02 | 56.17 |
| 24 | 266 | -1.999 | 6.70 | 42.5 | 4.64 | 1.554 | 1.511 | 51.09 | 25.00 | 0.03 | 61.31 |
| 24 | 290 | -2.226 | 7.76 | 43.0 | 4.61 | 1.695 | 1.642 | 55.51 | 26.91 | 0.03 | 66.44 |
| 8 | 298 | -2.323 | 8.30 | 44.0 | 4.53 | 1.755 | 1.685 | 56.98 | 27.53 | 0.04 | 68.14 |
| 8 | 306 | -2.401 | 8.68 | 44.5 | 4.49 | 1.804 | 1.729 | 58.45 | 28.15 | 0.04 | 69.84 |
| 8 | 314 | -2.493 | 9.16 | 45.0 | 4.45 | 1.861 | 1.773 | 59.92 | 28.77 | 0.04 | 71.53 |

* Nominal yield stress

Table E.3. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 9.25
Moment arm (in) ..... 75.63
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Warping Neglected)
FRANKLIN 4 lb/ft - 60 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Tip Defl (in) | Tip Rot (deg) | Tor Arm (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | BASE STRESSES (ksi) Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DL | -0.888 | 0.00 | 0.0 | 6.30 | 0.049 | 0.049 | 1.45 | 0.00 | 0.00 | 1.45 |
| 55 | 55 | -0.521 | 0.99 | 7.5 | 6.25 | 0.278 | 0.272 | 9.07 | 4.38 | 0.00 | 10.84 |
| 32 | 87 | -0.320 | 1.51 | 11.5 | 6.17 | 0.403 | 0.402 | 13.50 | 6.90 | 0.00 | 16.41 |
| 32 | 119 | -0.113 | 2.04 | 15.0 | 6.09 | 0.532 | 0.532 | 17.93 | 9.39 | 0.00 | 21.95 |
| 32 | 151 | 0.113 | 2.62 | 18.5 | 5.97 | 0.673 | 0.661 | 22.36 | 11.82 | 0.00 | 27.46 |
| 32 | 183 | 0.320 | 3.19 | 21.0 | 5.88 | 0.802 | 0.791 | 26.79 | 14.22 | 0.01 | 32.94 |
| 32 | 215 | 0.534 | 3.74 | 23.5 | 5.78 | 0.935 | 0.920 | 31.22 | 16.58 | 0.01 | 38.39 |
| 32 | 247 | 0.753 | 4.37 | 26.0 | 5.66 | 1.071 | 1.050 | 35.64 | 18.89 | 0.01 | 43.80 |
| 32 | 279 | 0.972 | 4.92 | 27.5 | 5.59 | 1.208 | 1.179 | 40.06 | 21.17 | 0.02 | 49.19 |
| 32 | 311 | 1.205 | 5.53 | 29.5 | 5.48 | 1.353 | 1.308 | 44.48 | 23.41 | 0.02 | 54.55 |
| 32 | 343 | 1.441 | 6.14 | 31.5 | 5.37 | 1.500 | 1.438 | 48.90 | 25.61 | 0.02 | 59.87 |
| 32 | 375 | 1.738 | 7.11 | 33.5 | 5.25 | 1.685 | 1.567 | 53.31 | 27.75 | 0.03 | 65.16 |

* Nominal yield stress

Table E.4. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 7.06
Moment arm (in) ..... 75.56
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Warping Neglected)
FRANKLIN 4 lb/ft - 60 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Tip Defl (in) | Tip Rot (deg) | Tor Arm (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | BASE STRESSES (ksi) Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DL | 0.367 | 0.00 | 0.0 | 6.30 | 0.053 | 0.053 | 1.41 | 0.00 | 0.00 | 1.41 |
| 55 | 55 | -0.058 | 0.81 | 7.5 | 6.25 | 0.318 | 0.283 | 9.02 | 4.38 | 0.00 | 10.80 |
| 32 | 87 | -0.300 | 1.72 | 15.5 | 6.07 | 0.469 | 0.416 | 13.45 | 6.86 | 0.00 | 16.33 |
| 32 | 119 | -0.306 | 2.19 | 18.0 | 5.99 | 0.472 | 0.550 | 17.88 | 9.31 | 0.00 | 21.84 |
| 32 | 151 | -0.530 | 2.66 | 22.0 | 5.84 | 0.612 | 0.684 | 22.30 | 11.69 | 0.00 | 27.31 |
| 32 | 183 | -0.761 | 3.12 | 24.5 | 5.73 | 0.756 | 0.818 | 26.73 | 14.03 | 0.01 | 32.75 |
| 32 | 215 | -1.002 | 3.61 | 27.5 | 5.59 | 0.906 | 0.951 | 31.15 | 16.31 | 0.01 | 38.14 |
| 32 | 247 | -1.222 | 4.06 | 29.0 | 5.51 | 1.043 | 1.085 | 35.57 | 18.56 | 0.01 | 43.50 |
| 32 | 279 | -1.467 | 4.53 | 32.0 | 5.34 | 1.196 | 1.218 | 40.00 | 20.74 | 0.01 | 48.82 |
| 32 | 311 | -1.683 | 5.03 | 33.5 | 5.25 | 1.330 | 1.352 | 44.41 | 22.88 | 0.02 | 54.11 |
| 32 | 343 | -1.927 | 5.57 | 35.5 | 5.13 | 1.482 | 1.485 | 48.83 | 24.98 | 0.02 | 59.36 |
| 32 | 375 | -2.157 | 6.21 | 38.0 | 4.96 | 1.626 | 1.619 | 53.24 | 27.00 | 0.03 | 64.56 |
| 32 | 407 | -2.426 | 6.95 | 40.0 | 4.83 | 1.793 | 1.752 | 57.65 | 28.97 | 0.03 | 69.73 |
| 32 | 439 | -2.706 | 7.32 | 41.5 | 4.72 | 1.968 | 1.885 | 62.06 | 30.90 | 0.04 | 74.85 |
| 16 | 455 | ** | 7.32 | 41.5 | 4.72 | ** | ** | 64.27 | 31.86 | 0.04 | 77.42 |

* Nominal yield stress

** Data not taken

Table E.5. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 10.00
Moment arm (in) ..... 75.50
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Warping Neglected)
MARION 3 lb/ft - 80 ksi *
Back to back; gr 9 bolts
Critical orientation

| LOAD (lbs) | | | Tip | Tip | Tor | STRAIN At Gauge (uin/in) | | BASE STRESSES (ksi) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Appl | Tot | Ch.#1 (mV) | Defl (in) | Rot (deg) | Arm (in) | Obs. | Calc. | Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
| | DL | 1.378 | 0.00 | 0.0 | 6.30 | 0.039 | 0.039 | 1.92 | 0.00 | 0.00 | 1.92 |
| 55 | 55 | 1.709 | 1.00 | 14.0 | 6.11 | 0.245 | 0.278 | 12.02 | 4.70 | 0.00 | 13.64 |
| 32 | 87 | 1.902 | 1.61 | 19.5 | 5.94 | 0.365 | 0.417 | 17.90 | 7.36 | 0.00 | 20.54 |
| 32 | 119 | 2.100 | 2.22 | 24.5 | 5.73 | 0.489 | 0.556 | 23.78 | 9.92 | 0.00 | 27.38 |
| 32 | 151 | 2.299 | 2.85 | 29.0 | 5.51 | 0.613 | 0.695 | 29.65 | 12.39 | 0.01 | 34.15 |
| 32 | 183 | 2.495 | 3.46 | 32.0 | 5.34 | 0.735 | 0.833 | 35.52 | 14.78 | 0.01 | 40.87 |
| 32 | 215 | 2.704 | 4.12 | 34.5 | 5.19 | 0.865 | 0.972 | 41.39 | 17.10 | 0.01 | 47.55 |
| 32 | 247 | 2.914 | 4.81 | 37.0 | 5.03 | 0.996 | 1.111 | 47.26 | 19.35 | 0.02 | 54.19 |
| 32 | 279 | 3.117 | 5.54 | 39.0 | 4.90 | 1.122 | 1.249 | 53.12 | 21.54 | 0.02 | 60.78 |
| 16 | 295 | 3.237 | 5.94 | 40.0 | 4.83 | 1.197 | 1.318 | 56.05 | 22.62 | 0.03 | 64.06 |
| 16 | 311 | 3.342 | 6.36 | 40.5 | 4.79 | 1.263 | 1.388 | 58.98 | 23.69 | 0.03 | 67.34 |
| 16 | 327 | 3.447 | 6.77 | 41.5 | 4.72 | 1.328 | 1.457 | 61.91 | 24.74 | 0.03 | 70.61 |
| 16 | 343 | 3.566 | 7.26 | 42.5 | 4.64 | 1.402 | 1.526 | 64.83 | 25.78 | 0.04 | 73.87 |
| 16 | 359 | 3.680 | 7.72 | 43.0 | 4.61 | 1.473 | 1.595 | 67.76 | 26.81 | 0.04 | 77.12 |
| 16 | 375 | 3.791 | 8.26 | 44.0 | 4.53 | 1.542 | 1.664 | 70.68 | 27.83 | 0.04 | 80.36 |
| 16 | 391 | 3.928 | 8.85 | 44.5 | 4.49 | 1.628 | 1.733 | 73.60 | 28.83 | 0.05 | 83.59 |

* Nominal yield stress

Table E.6. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 10.13
Moment arm (in) ..... 73.50
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Warping Neglected)
MARION 3 lb/ft - 80 ksi *
Nested; gr 9 bolts
Critical orientation

| LOAD (lbs) | | | Tip | Tip | Tor | STRAIN At Gauge (uin/in) | | BASE STRESSES (ksi) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Appl | Tot | Ch.#1 (mV) | Defl (in) | Rot (deg) | Arm (in) | Obs. | Calc. | Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
| | DL | 0.994 | 0.00 | 0.0 | 6.30 | 0.039 | 0.039 | 1.92 | 0.00 | 0.00 | 1.92 |
| 50 | 50 | 0.607 | 0.87 | 13.0 | 6.14 | 0.280 | 0.249 | 10.86 | 4.29 | 0.00 | 12.35 |
| 24 | 74 | 0.423 | 1.28 | 18.0 | 5.99 | 0.395 | 0.350 | 15.15 | 6.30 | 0.00 | 17.43 |
| 24 | 98 | 0.237 | 1.66 | 22.0 | 5.84 | 0.511 | 0.451 | 19.45 | 8.26 | 0.00 | 22.48 |
| 24 | 122 | 0.053 | 2.08 | 26.0 | 5.66 | 0.625 | 0.552 | 23.74 | 10.16 | 0.00 | 27.49 |
| 24 | 146 | -0.133 | 2.52 | 29.0 | 5.51 | 0.741 | 0.652 | 28.03 | 12.01 | 0.01 | 32.47 |
| 24 | 170 | -0.317 | 2.95 | 32.0 | 5.34 | 0.856 | 0.753 | 32.31 | 13.80 | 0.01 | 37.41 |
| 24 | 194 | -0.500 | 3.35 | 35.0 | 5.16 | 0.970 | 0.854 | 36.60 | 15.53 | 0.01 | 42.31 |
| 24 | 218 | -0.685 | 3.82 | 36.5 | 5.06 | 1.085 | 0.954 | 40.89 | 17.23 | 0.01 | 47.19 |
| 24 | 242 | -0.858 | 4.24 | 39.0 | 4.90 | 1.193 | 1.055 | 45.17 | 18.87 | 0.02 | 52.03 |
| 25 | 267 | -1.061 | 4.75 | 41.0 | 4.75 | 1.319 | 1.160 | 49.63 | 20.54 | 0.02 | 57.04 |
| 25 | 292 | -1.253 | 5.30 | 43.0 | 4.61 | 1.439 | 1.264 | 54.09 | 22.15 | 0.02 | 62.02 |
| 25 | 317 | -1.449 | 5.88 | 44.0 | 4.53 | 1.561 | 1.369 | 58.55 | 23.73 | 0.03 | 66.98 |
| 24 | 341 | -1.628 | 6.49 | 46.0 | 4.38 | 1.673 | 1.470 | 62.82 | 25.20 | 0.03 | 71.71 |
| 24 | 365 | -1.815 | 7.20 | 47.0 | 4.30 | 1.789 | 1.570 | 67.10 | 26.64 | 0.04 | 76.42 |
| 24 | 389 | -2.001 | 8.21 | 49.0 | 4.13 | 1.905 | 1.670 | 71.36 | 28.03 | 0.05 | 81.09 |
| 24 | 413 | -2.049 | 9.23 | 50.0 | 4.05 | 1.935 | 1.770 | 75.62 | 29.38 | 0.06 | 85.75 |
| 24 | 437 | -2.228 | 10.29 | 51.0 | 3.96 | 2.046 | 1.870 | 79.87 | 30.71 | 0.07 | 90.38 |
| 16 | 453 | -2.400 | 10.81 | 51.5 | 3.92 | 2.154 | 1.936 | 82.70 | 31.59 | 0.07 | 93.45 |

* Nominal yield stress

Table E.7. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 9.13
Moment arm (in) ..... 75.63
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Warping Neglected)
MARION 4 lb/ft - 80 ksi *
Back to back; gr 9 bolts
Critical orientation

| Appl. load (lbs) | Total Load (lbs) | Ch.#1 (mV) | Tip Defl (in) | Tip Rot (deg) | Tor Arm (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | BASE STRESSES (ksi) Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DL | -0.245 | 0.00 | 0.0 | 6.30 | 0.038 | 0.038 | 1.45 | 0.00 | 0.00 | 1.45 |
| 55 | 55 | 0.060 | 0.67 | 7.5 | 6.25 | 0.228 | 0.210 | 9.08 | 3.10 | 0.00 | 10.04 |
| 32 | 87 | 0.222 | 1.03 | 10.5 | 6.19 | 0.329 | 0.310 | 13.52 | 4.88 | 0.00 | 15.10 |
| 32 | 119 | 0.394 | 1.42 | 13.0 | 6.14 | 0.436 | 0.410 | 17.96 | 6.65 | 0.00 | 20.16 |
| 32 | 151 | 0.558 | 1.79 | 16.5 | 6.04 | 0.538 | 0.510 | 22.40 | 8.40 | 0.00 | 25.20 |
| 32 | 183 | 0.738 | 2.22 | 19.5 | 5.94 | 0.650 | 0.610 | 26.84 | 10.11 | 0.00 | 30.22 |
| 32 | 215 | 0.909 | 2.60 | 21.5 | 5.86 | 0.757 | 0.709 | 31.28 | 11.80 | 0.01 | 35.23 |
| 32 | 247 | 1.092 | 3.01 | 24.0 | 5.76 | 0.871 | 0.809 | 35.71 | 13.46 | 0.01 | 40.22 |
| 32 | 279 | 1.262 | 3.36 | 25.5 | 5.69 | 0.977 | 0.909 | 40.15 | 15.10 | 0.01 | 45.20 |
| 32 | 311 | 1.445 | 3.79 | 27.5 | 5.59 | 1.091 | 1.009 | 44.58 | 16.71 | 0.01 | 50.16 |
| 32 | 343 | 1.611 | 4.23 | 29.0 | 5.51 | 1.194 | 1.109 | 49.02 | 18.30 | 0.02 | 55.11 |
| 32 | 375 | 1.782 | 4.64 | 30.5 | 5.43 | 1.301 | 1.208 | 53.45 | 19.87 | 0.02 | 60.04 |
| 32 | 407 | 1.966 | 5.07 | 32.5 | 5.31 | 1.416 | 1.308 | 57.88 | 21.40 | 0.02 | 64.95 |
| 32 | 439 | 2.125 | 5.48 | 33.5 | 5.25 | 1.515 | 1.408 | 62.31 | 22.91 | 0.03 | 69.85 |
| 32 | 471 | 2.344 | 6.02 | 34.5 | 5.19 | 1.651 | 1.507 | 66.73 | 24.41 | 0.03 | 74.74 |
| 32 | 503 | 2.514 | 6.51 | 35.5 | 5.13 | 1.757 | 1.607 | 71.16 | 25.89 | 0.04 | 79.61 |
| 32 | 535 | 2.723 | 7.24 | 37.0 | 5.03 | 1.887 | 1.706 | 75.58 | 27.34 | 0.04 | 84.47 |

* Nominal yield stress

Table E.8. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 9.19
Moment arm (in) ..... 75.63
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Warping Neglected)
MARION 4 lb/ft - 80 ksi *
Nested; gr 9 bolts
Critical orientation

| Appl. load (lbs) | Total Load (lbs) | Ch.#1 (mV) | Tip Defl (in) | Tip Rot (deg) | Tor Arm (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | BASE STRESSES (ksi) Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DL | -0.488 | 0.00 | 0.0 | 6.30 | 0.038 | 0.038 | 1.40 | 0.00 | 0.00 | 1.40 |
| 55 | 55 | -0.821 | 0.64 | 7.0 | 6.25 | 0.245 | 0.210 | 8.76 | 3.32 | 0.00 | 9.88 |
| 32 | 87 | -1.003 | 1.02 | 11.0 | 6.18 | 0.359 | 0.310 | 13.04 | 5.23 | 0.00 | 14.88 |
| 32 | 119 | -1.184 | 1.39 | 14.0 | 6.11 | 0.472 | 0.409 | 17.33 | 7.12 | 0.00 | 19.88 |
| 32 | 151 | -1.355 | 1.77 | 17.5 | 6.01 | 0.578 | 0.509 | 21.61 | 8.98 | 0.00 | 24.85 |
| 32 | 183 | -1.530 | 2.12 | 20.5 | 5.90 | 0.687 | 0.609 | 25.89 | 10.80 | 0.00 | 29.81 |
| 32 | 215 | -1.706 | 2.48 | 23.5 | 5.78 | 0.797 | 0.709 | 30.17 | 12.59 | 0.01 | 34.74 |
| 32 | 247 | -1.880 | 2.85 | 26.0 | 5.66 | 0.905 | 0.809 | 34.45 | 14.34 | 0.01 | 39.64 |
| 32 | 279 | -2.044 | 3.24 | 28.5 | 5.54 | 1.007 | 0.908 | 38.73 | 16.05 | 0.01 | 44.52 |
| 32 | 311 | -2.214 | 3.60 | 30.5 | 5.43 | 1.113 | 1.008 | 43.01 | 17.72 | 0.01 | 49.38 |
| 32 | 343 | -2.379 | 4.00 | 32.5 | 5.31 | 1.216 | 1.108 | 47.28 | 19.37 | 0.01 | 54.22 |
| 32 | 375 | -2.533 | 4.40 | 33.5 | 5.25 | 1.312 | 1.207 | 51.56 | 20.99 | 0.02 | 59.04 |
| 32 | 407 | -2.713 | 4.83 | 36.0 | 5.10 | 1.424 | 1.307 | 55.83 | 22.56 | 0.02 | 63.83 |
| 32 | 439 | -2.874 | 5.23 | 37.5 | 5.00 | 1.525 | 1.406 | 60.11 | 24.11 | 0.02 | 68.61 |
| 32 | 471 | -3.043 | 5.65 | 39.0 | 4.90 | 1.630 | 1.506 | 64.38 | 25.62 | 0.03 | 73.36 |
| 32 | 503 | -3.226 | 6.09 | 40.5 | 4.79 | 1.744 | 1.606 | 68.65 | 27.10 | 0.03 | 78.09 |
| 32 | 535 | -3.396 | 6.09 | 42.0 | 4.68 | 1.850 | 1.705 | 72.92 | 28.55 | 0.04 | 82.80 |
| 24 | 559 | -3.552 | 6.09 | 42.0 | 4.68 | 1.947 | 1.780 | 76.12 | 29.63 | 0.04 | 86.33 |

* Nominal yield stress

Table E.9. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 7.88
Moment arm (in) ..... 75.38
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Including Warping)
FRANKLIN 3 lb/ft - 60 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Tip Defl (in) | Tip Rot (deg) | Tor Arm (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | BASE STRESSES (ksi) Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1.003 | 0.00 | 0.0 | 6.30 | 0.052 | 0.052 | 1.94 | 0.00 | 0.00 | 1.94 |
| 26 | 26 | 1.238 | 0.60 | 7.5 | 6.25 | 0.198 | 0.246 | 8.26 | 1.49 | 0.00 | 8.52 |
| 24 | 50 | 1.457 | 1.18 | 13.0 | 6.14 | 0.335 | 0.424 | 14.07 | 2.85 | 0.00 | 14.62 |
| 24 | 74 | 1.671 | 1.83 | 17.5 | 6.01 | 0.468 | 0.601 | 19.85 | 4.17 | 0.00 | 20.69 |
| 24 | 98 | 1.878 | 2.47 | 22.0 | 5.84 | 0.597 | 0.777 | 25.59 | 5.46 | 0.00 | 26.71 |
| 24 | 122 | 2.080 | 3.12 | 25.0 | 5.71 | 0.723 | 0.952 | 31.31 | 6.72 | 0.01 | 32.69 |
| 24 | 146 | 2.276 | 3.76 | 28.0 | 5.56 | 0.845 | 1.126 | 36.98 | 7.94 | 0.01 | 38.63 |
| 24 | 170 | 2.472 | 4.43 | 30.0 | 5.46 | 0.967 | 1.299 | 42.64 | 9.15 | 0.01 | 44.53 |
| 24 | 194 | 2.646 | 5.13 | 32.5 | 5.31 | 1.076 | 1.471 | 48.25 | 10.32 | 0.01 | 50.38 |
| 24 | 218 | 2.813 | 5.84 | 34.5 | 5.19 | 1.180 | 1.642 | 53.84 | 11.46 | 0.02 | 56.20 |
| 24 | 242 | 2.976 | 6.70 | 36.0 | 5.10 | 1.281 | 1.812 | 59.40 | 12.59 | 0.02 | 61.98 |
| 24 | 266 | 3.095 | 7.65 | 38.0 | 4.96 | 1.355 | 1.980 | 64.92 | 13.68 | 0.03 | 67.72 |
| 24 | 290 | 3.146 | 8.81 | 39.0 | 4.90 | 1.387 | 2.149 | 70.43 | 14.76 | 0.04 | 73.43 |
| 8 | 298 | 3.249 | 9.24 | 40.0 | 4.83 | 1.451 | 2.204 | 72.26 | 15.12 | 0.04 | 75.33 |
| 8 | 306 | 3.124 | 9.81 | 40.5 | 4.79 | 1.374 | 2.260 | 74.08 | 15.47 | 0.04 | 77.22 |
| 8 | 314 | 3.036 | 10.55 | 41.5 | 4.72 | 1.319 | 2.316 | 75.90 | 15.81 | 0.05 | 79.11 |

* Nominal yield stress

Table E.10. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 8.25
Moment arm (in) ..... 75.50
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Including Warping)
FRANKLIN 3 lb/ft - 60 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Tip Defl (in) | Tip Rot (deg) | Tor Arm (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | BASE STRESSES (ksi) Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DL | 0.411 | 0.00 | 0.0 | 6.30 | 0.052 | 0.051 | 1.94 | 0.00 | 0.00 | 1.94 |
| 26 | 26 | 0.177 | 0.61 | 7.0 | 6.25 | 0.198 | 0.245 | 8.27 | 1.49 | 0.00 | 8.53 |
| 24 | 50 | -0.042 | 1.17 | 13.5 | 6.13 | 0.334 | 0.422 | 14.08 | 2.84 | 0.00 | 14.64 |
| 24 | 74 | -0.261 | 1.71 | 18.5 | 5.97 | 0.471 | 0.599 | 19.87 | 4.16 | 0.00 | 20.70 |
| 24 | 98 | -0.480 | 2.27 | 23.5 | 5.78 | 0.607 | 0.774 | 25.60 | 5.44 | 0.00 | 26.71 |
| 24 | 122 | -0.701 | 2.85 | 27.0 | 5.61 | 0.745 | 0.948 | 31.30 | 6.67 | 0.01 | 32.67 |
| 24 | 146 | -0.920 | 3.41 | 30.5 | 5.43 | 0.881 | 1.120 | 36.96 | 7.87 | 0.01 | 38.57 |
| 24 | 170 | -1.137 | 3.98 | 34.0 | 5.22 | 1.017 | 1.291 | 42.56 | 9.02 | 0.01 | 44.41 |
| 24 | 194 | -1.353 | 4.56 | 36.5 | 5.06 | 1.151 | 1.460 | 48.13 | 10.14 | 0.01 | 50.19 |
| 24 | 218 | -1.569 | 5.22 | 38.0 | 4.96 | 1.286 | 1.629 | 53.68 | 11.23 | 0.02 | 55.95 |
| 24 | 242 | -1.785 | 5.90 | 40.0 | 4.83 | 1.420 | 1.797 | 59.19 | 12.30 | 0.02 | 61.66 |
| 24 | 266 | -1.999 | 6.70 | 42.5 | 4.64 | 1.554 | 1.963 | 64.66 | 13.32 | 0.03 | 67.32 |
| 24 | 290 | -2.226 | 7.76 | 43.0 | 4.61 | 1.695 | 2.128 | 70.11 | 14.34 | 0.03 | 72.96 |
| 8 | 298 | -2.323 | 8.30 | 44.0 | 4.53 | 1.755 | 2.183 | 71.92 | 14.67 | 0.04 | 74.83 |
| 8 | 306 | -2.401 | 8.68 | 44.5 | 4.49 | 1.804 | 2.238 | 73.73 | 15.00 | 0.04 | 76.70 |
| 8 | 314 | -2.493 | 9.16 | 45.0 | 4.45 | 1.861 | 2.293 | 75.53 | 15.33 | 0.04 | 78.56 |

* Nominal yield stress

Table E.11. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 9.25
Moment arm (in) ..... 75.63
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Including Warping)
FRANKLIN 4 lb/ft - 60 ksi *
Back to back; gr 5 bolts
Critical orientation

| LOAD (lbs) | | | Tip | Tip | Tor | STRAIN At Gauge (uin/in) | | BASE STRESSES (ksi) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Appl | Tot | Ch.#1 (mV) | Defl (in) | Rot (deg) | Arm (in) | Obs. | Calc. | Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
| | DL | -0.888 | 0.00 | 0.0 | 6.30 | 0.049 | 0.049 | 1.45 | 0.00 | 0.00 | 1.45 |
| 55 | 55 | -0.521 | 0.99 | 7.5 | 6.25 | 0.278 | 0.309 | 10.18 | 3.61 | 0.00 | 11.33 |
| 32 | 87 | -0.320 | 1.51 | 11.5 | 6.17 | 0.403 | 0.460 | 15.25 | 5.69 | 0.00 | 17.14 |
| 32 | 119 | -0.113 | 2.04 | 15.0 | 6.09 | 0.532 | 0.611 | 20.31 | 7.73 | 0.00 | 22.92 |
| 32 | 151 | 0.113 | 2.62 | 18.5 | 5.97 | 0.673 | 0.761 | 25.36 | 9.74 | 0.00 | 28.67 |
| 32 | 183 | 0.320 | 3.19 | 21.0 | 5.88 | 0.802 | 0.911 | 30.39 | 11.72 | 0.01 | 34.39 |
| 32 | 215 | 0.534 | 3.74 | 23.5 | 5.78 | 0.935 | 1.060 | 35.42 | 13.66 | 0.01 | 40.08 |
| 32 | 247 | 0.753 | 4.37 | 26.0 | 5.66 | 1.071 | 1.209 | 40.43 | 15.57 | 0.01 | 45.74 |
| 32 | 279 | 0.972 | 4.92 | 27.5 | 5.59 | 1.208 | 1.358 | 45.43 | 17.45 | 0.02 | 51.37 |
| 32 | 311 | 1.205 | 5.53 | 29.5 | 5.48 | 1.353 | 1.506 | 50.41 | 19.29 | 0.02 | 56.97 |
| 32 | 343 | 1.441 | 6.14 | 31.5 | 5.37 | 1.500 | 1.654 | 55.39 | 21.10 | 0.02 | 62.53 |
| 32 | 375 | 1.738 | 7.11 | 33.5 | 5.25 | 1.685 | 1.801 | 60.34 | 22.86 | 0.03 | 68.05 |

* Nominal yield stress

Table E.12. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 7.06
Moment arm (in) ..... 75.56
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Including Warping)
FRANKLIN 4 lb/ft - 60 ksi *
Nested; gr 5 bolts
Critical orientation

| LOAD (lbs) | | | Tip | Tip | Tor | STRAIN At Gauge (uin/in) | | BASE STRESSES (ksi) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Appl | Tot | Ch.#1 (mV) | Defl (in) | Rot (deg) | Arm (in) | Obs. | Calc. | Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
| | DL | 0.367 | 0.00 | 0.0 | 6.30 | 0.053 | 0.053 | 1.41 | 0.00 | 0.00 | 1.41 |
| 55 | 55 | -0.058 | 0.81 | 7.5 | 6.25 | 0.318 | 0.320 | 10.14 | 3.61 | 0.00 | 11.29 |
| 32 | 87 | -0.300 | 1.72 | 15.5 | 6.07 | 0.469 | 0.474 | 15.20 | 5.65 | 0.00 | 17.07 |
| 32 | 119 | -0.306 | 2.19 | 18.0 | 5.99 | 0.472 | 0.629 | 20.25 | 7.67 | 0.00 | 22.83 |
| 32 | 151 | -0.530 | 2.66 | 22.0 | 5.84 | 0.612 | 0.783 | 25.28 | 9.63 | 0.00 | 28.54 |
| 32 | 183 | -0.761 | 3.12 | 24.5 | 5.73 | 0.756 | 0.936 | 30.30 | 11.56 | 0.01 | 34.22 |
| 32 | 215 | -1.002 | 3.61 | 27.5 | 5.59 | 0.906 | 1.089 | 35.31 | 13.44 | 0.01 | 39.85 |
| 32 | 247 | -1.222 | 4.06 | 29.0 | 5.51 | 1.043 | 1.242 | 40.30 | 15.29 | 0.01 | 45.46 |
| 32 | 279 | -1.467 | 4.53 | 32.0 | 5.34 | 1.196 | 1.394 | 45.28 | 17.09 | 0.01 | 51.02 |
| 32 | 311 | -1.683 | 5.03 | 33.5 | 5.25 | 1.330 | 1.545 | 50.25 | 18.85 | 0.02 | 56.55 |
| 32 | 343 | -1.927 | 5.57 | 35.5 | 5.13 | 1.482 | 1.696 | 55.20 | 20.58 | 0.02 | 62.04 |
| 32 | 375 | -2.157 | 6.21 | 38.0 | 4.96 | 1.626 | 1.847 | 60.13 | 22.25 | 0.03 | 67.49 |
| 32 | 407 | -2.426 | 6.95 | 40.0 | 4.83 | 1.793 | 1.997 | 65.04 | 23.87 | 0.03 | 72.89 |
| 32 | 439 | -2.706 | 7.32 | 41.5 | 4.72 | 1.968 | 2.146 | 69.94 | 25.46 | 0.04 | 78.26 |
| 16 | 455 | ** | 7.32 | 41.5 | 4.72 | ** | ** | 72.39 | 26.25 | 0.04 | 80.94 |

* Nominal yield stress

** Data not taken

Table E.13. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 10.00
Moment arm (in) ..... 75.50
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Including Warping)
MARION 3 lb/ft - 80 ksi *
Back to back; gr 9 bolts
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Tip Defl (in) | Tip Rot (deg) | Tor Arm (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | BASE STRESSES (ksi) Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DL | 1.378 | 0.00 | 0.0 | 6.30 | 0.039 | 0.039 | 1.92 | 0.00 | 0.00 | 1.92 |
| 55 | 55 | 1.709 | 1.00 | 14.0 | 6.11 | 0.245 | 0.383 | 15.17 | 3.09 | 0.00 | 15.78 |
| 32 | 87 | 1.902 | 1.61 | 19.5 | 5.94 | 0.365 | 0.581 | 22.82 | 4.83 | 0.00 | 23.81 |
| 32 | 119 | 2.100 | 2.22 | 24.5 | 5.73 | 0.489 | 0.777 | 30.42 | 6.52 | 0.00 | 31.76 |
| 32 | 151 | 2.299 | 2.85 | 29.0 | 5.51 | 0.613 | 0.971 | 37.94 | 8.14 | 0.01 | 39.62 |
| 32 | 183 | 2.495 | 3.46 | 32.0 | 5.34 | 0.735 | 1.163 | 45.41 | 9.71 | 0.01 | 47.41 |
| 32 | 215 | 2.704 | 4.12 | 34.5 | 5.19 | 0.865 | 1.354 | 52.84 | 11.24 | 0.01 | 55.14 |
| 32 | 247 | 2.914 | 4.81 | 37.0 | 5.03 | 0.996 | 1.542 | 60.21 | 12.72 | 0.02 | 62.80 |
| 32 | 279 | 3.117 | 5.54 | 39.0 | 4.90 | 1.122 | 1.730 | 67.54 | 14.16 | 0.02 | 70.41 |
| 16 | 295 | 3.237 | 5.94 | 40.0 | 4.83 | 1.197 | 1.823 | 71.19 | 14.86 | 0.03 | 74.19 |
| 16 | 311 | 3.342 | 6.36 | 40.5 | 4.79 | 1.263 | 1.916 | 74.84 | 15.57 | 0.03 | 77.97 |
| 16 | 327 | 3.447 | 6.77 | 41.5 | 4.72 | 1.328 | 2.009 | 78.47 | 16.26 | 0.03 | 81.74 |
| 16 | 343 | 3.566 | 7.26 | 42.5 | 4.64 | 1.402 | 2.101 | 82.09 | 16.95 | 0.04 | 85.49 |
| 16 | 359 | 3.680 | 7.72 | 43.0 | 4.61 | 1.473 | 2.193 | 85.70 | 17.62 | 0.04 | 89.22 |
| 16 | 375 | 3.791 | 8.26 | 44.0 | 4.53 | 1.542 | 2.285 | 89.30 | 18.29 | 0.04 | 92.95 |
| 16 | 391 | 3.928 | 8.85 | 44.5 | 4.49 | 1.628 | 2.376 | 92.90 | 18.95 | 0.05 | 96.66 |

* Nominal yield stress

Table E.14. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 10.13
Moment arm (in) ..... 73.50
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Including Warping)
MARION 3 lb/ft - 80 ksi *
Nested; gr 9 bolts
Critical orientation

| LOAD (lbs) | | | Tip | Tip | Tor | STRAIN At Gauge (uin/in) | | BASE STRESSES (ksi) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Appl | Tot | Ch.#1 (mV) | Defl (in) | Rot (deg) | Arm (in) | Obs. | Calc. | Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
| | DL | 0.994 | 0.00 | 0.0 | 6.30 | 0.039 | 0.039 | 1.92 | 0.00 | 0.00 | 1.92 |
| 50 | 50 | 0.607 | 0.87 | 13.0 | 6.14 | 0.280 | 0.345 | 13.73 | 2.82 | 0.00 | 14.29 |
| 24 | 74 | 0.423 | 1.28 | 18.0 | 5.99 | 0.395 | 0.491 | 19.37 | 4.14 | 0.00 | 20.22 |
| 24 | 98 | 0.237 | 1.66 | 22.0 | 5.84 | 0.511 | 0.635 | 24.97 | 5.43 | 0.00 | 26.10 |
| 24 | 122 | 0.053 | 2.08 | 26.0 | 5.66 | 0.625 | 0.778 | 30.54 | 6.68 | 0.00 | 31.94 |
| 24 | 146 | -0.133 | 2.52 | 29.0 | 5.51 | 0.741 | 0.920 | 36.06 | 7.89 | 0.01 | 37.72 |
| 24 | 170 | -0.317 | 2.95 | 32.0 | 5.34 | 0.856 | 1.061 | 41.55 | 9.07 | 0.01 | 43.45 |
| 24 | 194 | -0.500 | 3.35 | 35.0 | 5.16 | 0.970 | 1.200 | 47.00 | 10.21 | 0.01 | 49.13 |
| 24 | 218 | -0.685 | 3.82 | 36.5 | 5.06 | 1.085 | 1.339 | 52.42 | 11.32 | 0.01 | 54.77 |
| 24 | 242 | -0.858 | 4.24 | 39.0 | 4.90 | 1.193 | 1.476 | 57.80 | 12.40 | 0.02 | 60.37 |
| 25 | 267 | -1.061 | 4.75 | 41.0 | 4.75 | 1.319 | 1.618 | 63.38 | 13.50 | 0.02 | 66.15 |
| 25 | 292 | -1.253 | 5.30 | 43.0 | 4.61 | 1.439 | 1.758 | 68.92 | 14.55 | 0.02 | 71.89 |
| 25 | 317 | -1.449 | 5.88 | 44.0 | 4.53 | 1.561 | 1.898 | 74.43 | 15.60 | 0.03 | 77.60 |
| 24 | 341 | -1.628 | 6.49 | 46.0 | 4.38 | 1.673 | 2.032 | 79.69 | 16.56 | 0.03 | 83.03 |
| 24 | 365 | -1.815 | 7.20 | 47.0 | 4.30 | 1.789 | 2.164 | 84.93 | 17.51 | 0.04 | 88.43 |
| 24 | 389 | -2.001 | 8.21 | 49.0 | 4.13 | 1.905 | 2.295 | 90.12 | 18.42 | 0.05 | 93.79 |
| 24 | 413 | -2.049 | 9.23 | 50.0 | 4.05 | 1.935 | 2.426 | 95.29 | 19.31 | 0.06 | 99.11 |
| 24 | 437 | -2.228 | 10.29 | 51.0 | 3.96 | 2.046 | 2.555 | 100.44 | 20.19 | 0.07 | 104.41 |
| 16 | 453 | -2.400 | 10.81 | 51.5 | 3.92 | 2.154 | 2.641 | 103.86 | 20.76 | 0.07 | 107.92 |

* Nominal yield stress

Table E.15. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 9.13
Moment arm (in) ..... 75.63
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Including Warping)
MARION 4 lb/ft - 80 ksi *
Back to back; gr 9 bolts
Critical orientation

| Appl. load (lbs) | Total Load (lbs) | Ch.#1 (mV) | Tip Defl (in) | Tip Rot (deg) | Tor Arm (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | BASE STRESSES (ksi) Bending Mc/I | BASE STRESSES (ksi) Torsion Th/J | BASE STRESSES (ksi) Axial P/A | BASE STRESSES (ksi) Combined (Mohr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DL | -0.245 | 0.00 | 0.0 | 6.30 | 0.038 | 0.038 | 1.45 | 0.00 | 0.00 | 1.45 |
| 55 | 55 | 0.060 | 0.67 | 7.5 | 6.25 | 0.228 | 0.256 | 10.46 | 3.61 | 0.00 | 11.58 |
| 32 | 87 | 0.222 | 1.03 | 10.5 | 6.19 | 0.329 | 0.382 | 15.69 | 5.69 | 0.00 | 17.54 |
| 32 | 119 | 0.394 | 1.42 | 13.0 | 6.14 | 0.436 | 0.508 | 20.92 | 7.76 | 0.00 | 23.48 |
| 32 | 151 | 0.558 | 1.79 | 16.5 | 6.04 | 0.538 | 0.634 | 26.13 | 9.79 | 0.00 | 29.39 |
| 32 | 183 | 0.738 | 2.22 | 19.5 | 5.94 | 0.650 | 0.759 | 31.33 | 11.79 | 0.00 | 35.27 |
| 32 | 215 | 0.909 | 2.60 | 21.5 | 5.86 | 0.757 | 0.884 | 36.52 | 13.76 | 0.01 | 41.13 |
| 32 | 247 | 1.092 | 3.01 | 24.0 | 5.76 | 0.871 | 1.009 | 41.69 | 15.69 | 0.01 | 46.95 |
| 32 | 279 | 1.262 | 3.36 | 25.5 | 5.69 | 0.977 | 1.133 | 46.86 | 17.61 | 0.01 | 52.74 |
| 32 | 311 | 1.445 | 3.79 | 27.5 | 5.59 | 1.091 | 1.256 | 52.01 | 19.48 | 0.01 | 58.51 |
| 32 | 343 | 1.611 | 4.23 | 29.0 | 5.51 | 1.194 | 1.380 | 57.15 | 21.34 | 0.02 | 64.25 |
| 32 | 375 | 1.782 | 4.64 | 30.5 | 5.43 | 1.301 | 1.503 | 62.28 | 23.16 | 0.02 | 69.96 |
| 32 | 407 | 1.966 | 5.07 | 32.5 | 5.31 | 1.416 | 1.625 | 67.39 | 24.95 | 0.02 | 75.64 |
| 32 | 439 | 2.125 | 5.48 | 33.5 | 5.25 | 1.515 | 1.747 | 72.49 | 26.72 | 0.03 | 81.30 |
| 32 | 471 | 2.344 | 6.02 | 34.5 | 5.19 | 1.651 | 1.869 | 77.58 | 28.46 | 0.03 | 86.93 |
| 32 | 503 | 2.514 | 6.51 | 35.5 | 5.13 | 1.757 | 1.990 | 82.66 | 30.19 | 0.04 | 92.54 |
| 32 | 535 | 2.723 | 7.24 | 37.0 | 5.03 | 1.887 | 2.111 | 87.73 | 31.88 | 0.04 | 98.13 |

* Nominal yield stress

Table E.16. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) . 9.19
Moment arm (in) ..... 75.63
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Including Warping)
MARION 4 lb/ft - 80 ksi *
Nested; gr 9 bolts
Critical orientation

| Appl. load (lbs) | Total Load (lbs) | Ch.#1 (mV) | Tip Defl (in) | Tip Rot (deg) | Tor Arm (in) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | BASE STRESSES (ksi) Bending Mc/I | Torsion Th/J | Axial P/A | Combined (Mohr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | DL | -0.488 | 0.00 | 0.0 | 6.30 | 0.038 | 0.038 | 1.40 | 0.00 | 0.00 | 1.40 |
| 55 | 55 | -0.821 | 0.64 | 7.0 | 6.25 | 0.245 | 0.256 | 10.41 | 3.61 | 0.00 | 11.54 |
| 32 | 87 | -1.003 | 1.02 | 11.0 | 6.18 | 0.359 | 0.382 | 15.64 | 5.69 | 0.00 | 17.49 |
| 32 | 119 | -1.184 | 1.39 | 14.0 | 6.11 | 0.472 | 0.508 | 20.86 | 7.75 | 0.00 | 23.43 |
| 32 | 151 | -1.355 | 1.77 | 17.5 | 6.01 | 0.578 | 0.633 | 26.07 | 9.77 | 0.00 | 29.33 |
| 32 | 183 | -1.530 | 2.12 | 20.5 | 5.90 | 0.687 | 0.758 | 31.27 | 11.75 | 0.00 | 35.20 |
| 32 | 215 | -1.706 | 2.48 | 23.5 | 5.78 | 0.797 | 0.883 | 36.44 | 13.70 | 0.01 | 41.02 |
| 32 | 247 | -1.880 | 2.85 | 26.0 | 5.66 | 0.905 | 1.007 | 41.61 | 15.60 | 0.01 | 46.81 |
| 32 | 279 | -2.044 | 3.24 | 28.5 | 5.54 | 1.007 | 1.130 | 46.75 | 17.46 | 0.01 | 52.57 |
| 32 | 311 | -2.214 | 3.60 | 30.5 | 5.43 | 1.113 | 1.253 | 51.88 | 19.29 | 0.01 | 58.28 |
| 32 | 343 | -2.379 | 4.00 | 32.5 | 5.31 | 1.216 | 1.375 | 57.00 | 21.08 | 0.01 | 63.96 |
| 32 | 375 | -2.533 | 4.40 | 33.5 | 5.25 | 1.312 | 1.497 | 62.11 | 22.84 | 0.02 | 69.62 |
| 32 | 407 | -2.713 | 4.83 | 36.0 | 5.10 | 1.424 | 1.619 | 67.19 | 24.56 | 0.02 | 75.23 |
| 32 | 439 | -2.874 | 5.23 | 37.5 | 5.00 | 1.525 | 1.740 | 72.26 | 26.24 | 0.02 | 80.80 |
| 32 | 471 | -3.043 | 5.65 | 39.0 | 4.90 | 1.630 | 1.860 | 77.32 | 27.88 | 0.03 | 86.35 |
| 32 | 503 | -3.226 | 6.09 | 40.5 | 4.79 | 1.744 | 1.980 | 82.36 | 29.49 | 0.03 | 91.86 |
| 32 | 535 | -3.396 | 6.09 | 42.0 | 4.68 | 1.850 | 2.100 | 87.38 | 31.07 | 0.04 | 97.33 |
| 24 | 559 | -3.552 | 6.09 | 42.0 | 4.68 | 1.947 | 2.189 | 91.15 | 32.25 | 0.04 | 101.44 |

* Nominal yield stress

# APPENDIX F

## PRELIMINARY 72 " BENDING TESTS

## CALIBRATED BOLT SUMMARY TABLES

Marion 3 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back, Nested and Face to Face Splices

Critical and Non-critical Configurations

# APPENDIX F

## LIST OF TABLES

# APPENDIX F

## LIST OF TABLES (CONT)

Table F.1. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.25
Dist to strain gauge (in) .. 8.00
Moment arm (in) .....72.25

BENDING TEST

MARION 3 LB/FT POST - 80 ksi *
Back to back splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.791 | -0.580 | 7.325 | | | | | | | | |
| | tight | -2.575 | -3.428 | 7.321 | | | 2.69 | 4.48 | | | | |
| | DL | -2.602 | -3.137 | 7.048 | 0.00 | 0.00 | 2.73 | 4.02 | 0.042 | 0.042 | 1.90 | 1.26 |
| 60 | 60 | -2.605 | -3.071 | 7.499 | 0.72 | 0.72 | 2.74 | 3.91 | 0.323 | 0.297 | 12.45 | 9.69 |
| 32 | 92 | -2.603 | -3.043 | 7.732 | 0.39 | 1.11 | 2.73 | 3.87 | 0.468 | 0.433 | 18.07 | 14.04 |
| 32 | 124 | -2.598 | -3.019 | 7.969 | 0.40 | 1.50 | 2.73 | 3.83 | 0.616 | 0.570 | 23.70 | 18.47 |
| 32 | 156 | -2.592 | -3.016 | 8.220 | 0.43 | 1.94 | 2.72 | 3.83 | 0.772 | 0.706 | 29.32 | 23.17 |
| 32 | 188 | -2.586 | -3.029 | 8.464 | 0.42 | 2.35 | 2.71 | 3.85 | 0.924 | 0.842 | 34.95 | 27.73 |
| 32 | 220 | -2.563 | -3.092 | 8.690 | 0.40 | 2.75 | 2.67 | 3.95 | 1.065 | 0.978 | 40.57 | 31.95 |
| 32 | 252 | -2.542 | -3.265 | 8.934 | 0.44 | 3.19 | 2.64 | 4.22 | 1.217 | 1.115 | 46.20 | 36.51 |
| 32 | 284 | -2.504 | -3.422 | 9.181 | 0.46 | 3.65 | 2.58 | 4.47 | 1.371 | 1.251 | 51.82 | 41.13 |
| 32 | 316 | -2.454 | -3.621 | 9.426 | 0.51 | 4.15 | 2.51 | 4.78 | 1.524 | 1.387 | 57.45 | 45.71 |
| 32 | 348 | -2.396 | -3.799 | 9.646 | 0.48 | 4.63 | 2.42 | 5.06 | 1.661 | 1.523 | 63.07 | 49.82 |
| 32 | 380 | -2.337 | -4.001 | 9.877 | 0.53 | 5.16 | 2.33 | 5.38 | 1.805 | 1.660 | 68.70 | 54.14 |
| 16 | 396 | -2.307 | -4.100 | 9.989 | 0.27 | 5.42 | 2.29 | 5.53 | 1.874 | 1.728 | 71.51 | 56.23 |
| 16 | 412 | -2.277 | -4.196 | 10.100 | 0.26 | 5.68 | 2.24 | 5.68 | 1.944 | 1.796 | 74.32 | 58.31 |
| 16 | 428 | -2.244 | -4.286 | 10.210 | 0.29 | 5.97 | 2.19 | 5.82 | 2.012 | 1.864 | 77.14 | 60.36 |
| 16 | 444 | -2.214 | -4.392 | 10.330 | 0.30 | 6.27 | 2.15 | 5.99 | 2.087 | 1.932 | 79.95 | 62.61 |
| 16 | 460 | -2.180 | -4.467 | 10.440 | 0.29 | 6.55 | 2.10 | 6.11 | 2.155 | 2.000 | 82.76 | 64.66 |
| 16 | 476 | -2.145 | -4.544 | 10.550 | 0.31 | 6.86 | 2.04 | 6.23 | 2.224 | 2.068 | 85.57 | 66.72 |
| 16 | 492 | -2.116 | -4.643 | 10.670 | 0.31 | 7.17 | 2.00 | 6.38 | 2.299 | 2.137 | 88.39 | 68.96 |

Effective splice length (critical bolt) ..... 5.0 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table F.2. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.06
Dist to strain gauge (in) .. 7.75
Moment arm (in) .....72.06

BENDING TEST

MARION 3 LB/FT POST - 80 ksi *
Nested splice
Critical orientation

| LOAD (lbs) Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | Bolt B | STRAIN At Gauge (uin/in) Obs. | Calc. | STRESS (ksi) Base | Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | -0.765 | -0.531 | 4.797 | | | | | | | | |
| tight | | -3.959 | -4.029 | 4.112 | | | 4.82 | 5.50 | | | | |
| DL | | -3.683 | -3.918 | 9.506 | 0.00 | 0.00 | 4.40 | 5.32 | 0.042 | 0.042 | 1.90 | 1.26 |
| 60 | 60 | -3.432 | -3.992 | 9.964 | 0.88 | 0.88 | 4.02 | 5.44 | 0.327 | 0.298 | 12.42 | 9.82 |
| 32 | 92 | -3.338 | -4.060 | 10.190 | 0.44 | 1.32 | 3.88 | 5.55 | 0.468 | 0.434 | 18.03 | 14.04 |
| 32 | 124 | -3.242 | -4.123 | 10.400 | 0.57 | 1.89 | 3.74 | 5.64 | 0.599 | 0.571 | 23.64 | 17.97 |
| 32 | 156 | -3.150 | -4.203 | 10.640 | 0.52 | 2.41 | 3.60 | 5.77 | 0.749 | 0.707 | 29.25 | 22.46 |
| 32 | 188 | -3.081 | -4.285 | 10.860 | 0.50 | 2.91 | 3.49 | 5.90 | 0.886 | 0.843 | 34.86 | 26.57 |
| 32 | 220 | -3.022 | -4.374 | 10.100 | 0.58 | 3.48 | 3.41 | 6.04 | 0.412 | 0.980 | 40.47 | 12.36 |
| 32 | 252 | -2.987 | -4.472 | 11.330 | 0.58 | 4.06 | 3.35 | 6.19 | 1.178 | 1.116 | 46.08 | 35.35 |
| 32 | 284 | -2.969 | -4.515 | 11.530 | 0.54 | 4.60 | 3.33 | 6.26 | 1.303 | 1.252 | 51.69 | 39.09 |
| 32 | 316 | -2.962 | -4.596 | 11.760 | 0.68 | 5.28 | 3.31 | 6.39 | 1.446 | 1.389 | 57.30 | 43.39 |
| 16 | 332 | -2.965 | -4.640 | 11.890 | 0.43 | 5.71 | 3.32 | 6.46 | 1.527 | 1.457 | 60.11 | 45.82 |
| 16 | 348 | -2.970 | -4.658 | 12.010 | 0.40 | 6.11 | 3.33 | 6.48 | 1.602 | 1.525 | 62.91 | 48.06 |
| 16 | 364 | -2.976 | -4.700 | 12.120 | 0.36 | 6.46 | 3.34 | 6.55 | 1.671 | 1.593 | 65.72 | 50.12 |

Effective splice length (critical bolt) ..... 3.8 in

Effective splice length (both bolts) ..... 3.8 in

* Nominal yield stress

Table F.3. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Face to Face Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.63
Dist to strain gauge (in) .. 8.25
Moment arm (in) .....72.63

BENDING TEST

MARION 3 LB/FT POST - 80 ksi *
Face to face splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 1.081 | 0.708 | 2.259 | | | | | | | | |
| | tight | 0.388 | -0.349 | 2.230 | | | 1.30 | 2.09 | | | | |
| | DL | 0.454 | -0.366 | 2.156 | 0.00 | 0.00 | 1.18 | 2.13 | 0.041 | 0.041 | 1.90 | 1.23 |
| 60 | 60 | 0.622 | -0.649 | 1.739 | 1.02 | 1.02 | 0.86 | 2.69 | 0.301 | 0.297 | 12.50 | 9.02 |
| 32 | 92 | 0.699 | -0.813 | 1.528 | 0.52 | 1.54 | 0.72 | 3.01 | 0.432 | 0.434 | 18.16 | 12.97 |
| 32 | 124 | 0.771 | -1.088 | 1.303 | 0.57 | 2.11 | 0.58 | 3.56 | 0.572 | 0.570 | 23.81 | 17.17 |
| 32 | 156 | 0.834 | -1.227 | 1.094 | 0.55 | 2.65 | 0.46 | 3.83 | 0.703 | 0.707 | 29.47 | 21.08 |
| 32 | 188 | 0.879 | -1.483 | 0.890 | 0.43 | 3.09 | 0.38 | 4.34 | 0.830 | 0.844 | 35.12 | 24.89 |
| 32 | 220 | 0.931 | -1.819 | 0.648 | 0.69 | 3.77 | 0.28 | 5.01 | 0.981 | 0.980 | 40.78 | 29.42 |
| 16 | 236 | 0.949 | -1.980 | 0.534 | 0.32 | 4.09 | 0.25 | 5.33 | 1.052 | 1.048 | 43.60 | 31.55 |
| 16 | 252 | 0.969 | -2.128 | 0.433 | 0.31 | 4.40 | 0.21 | 5.62 | 1.115 | 1.117 | 46.43 | 33.44 |
| 16 | 268 | 0.983 | -2.285 | 0.327 | 0.31 | 4.71 | 0.18 | 5.93 | 1.181 | 1.185 | 49.26 | 35.42 |
| 16 | 284 | 1.001 | -2.454 | 0.211 | 0.36 | 5.07 | 0.15 | 6.27 | 1.253 | 1.253 | 52.09 | 37.59 |
| 16 | 300 | 1.022 | -2.651 | 0.076 | 0.55 | 5.62 | 0.11 | 6.66 | 1.337 | 1.321 | 54.91 | 40.11 |
| 16 | 316 | 1.036 | -2.794 | -0.026 | 0.34 | 5.96 | 0.08 | 6.94 | 1.400 | 1.390 | 57.74 | 42.01 |
| 16 | 332 | 1.056 | -2.948 | -0.131 | 0.41 | 6.36 | 0.05 | 7.24 | 1.466 | 1.458 | 60.57 | 43.98 |

Effective splice length (critical bolt) ..... 3.1 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table F.4. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) . 7.88
Moment arm (in) .....72.38

BENDING TEST

MARION 3 LB/FT POST - 80 ksi *
Back to back splice
Non-critical orientation

| LOAD (lbs) | | | | | | BOLT LOADS (kips) | | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | Bolt A | Bolt B | Obs. | Calc. | Base | Obs @ Gauge |
| floor | | -0.874 | -0.598 | 95.490 | | | | | | | | |
| tight | | -3.068 | -2.926 | 30.230 | | | 3.31 | 3.66 | | | | |
| DL | | -3.069 | -2.847 | 7.649 | 0.00 | 0.00 | 3.31 | 3.53 | 0.042 | 0.042 | 1.90 | 1.26 |
| 60 | 60 | -3.087 | -2.884 | 7.326 | 0.75 | 0.75 | 3.34 | 3.59 | 0.243 | 0.298 | 12.46 | 7.30 |
| 32 | 92 | -3.116 | -2.891 | 7.196 | 0.39 | 1.14 | 3.38 | 3.60 | 0.324 | 0.435 | 18.10 | 9.73 |
| 32 | 124 | -3.164 | -2.910 | 7.012 | 0.39 | 1.53 | 3.46 | 3.63 | 0.439 | 0.572 | 23.73 | 13.17 |
| 32 | 156 | -3.229 | -2.928 | 6.834 | 0.41 | 1.94 | 3.55 | 3.66 | 0.550 | 0.709 | 29.37 | 16.49 |
| 32 | 188 | -3.325 | -2.942 | 6.654 | 0.43 | 2.36 | 3.70 | 3.68 | 0.662 | 0.845 | 35.00 | 19.86 |
| 32 | 220 | -3.514 | -2.947 | 6.460 | 0.43 | 2.79 | 3.98 | 3.69 | 0.783 | 0.982 | 40.64 | 23.48 |
| 32 | 252 | -3.717 | -2.956 | 6.281 | 0.45 | 3.24 | 4.29 | 3.71 | 0.894 | 1.119 | 46.27 | 26.83 |
| 32 | 284 | -3.927 | -2.960 | 6.073 | 0.48 | 3.72 | 4.61 | 3.71 | 1.024 | 1.256 | 51.91 | 30.72 |
| 32 | 316 | -4.162 | -2.954 | 5.863 | 0.52 | 4.23 | 4.96 | 3.70 | 1.155 | 1.393 | 57.54 | 34.64 |
| 32 | 348 | -4.385 | -2.928 | 5.671 | 0.50 | 4.73 | 5.30 | 3.66 | 1.274 | 1.529 | 63.18 | 38.23 |
| 32 | 380 | -4.611 | -2.900 | 5.464 | 0.54 | 5.27 | 5.64 | 3.62 | 1.403 | 1.666 | 68.81 | 42.10 |
| 32 | 412 | -4.805 | -2.867 | 5.257 | 0.58 | 5.85 | 5.93 | 3.57 | 1.532 | 1.803 | 74.45 | 45.97 |
| 32 | 444 | -4.861 | -2.840 | 5.125 | 0.59 | 6.44 | 6.02 | 3.52 | 1.615 | 1.940 | 80.08 | 48.44 |

Effective splice length (critical bolt) ..... 5.0 in

Effective splice length (both bolts) ..... N/A

* Nominal yeild stress

Table F.5. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.33
Dist to strain gauge (in) .. 8.00
Moment arm (in) .....72.33

BENDING TEST

MARION 3 LB/FT POST - 80 ksi *
Nested splice
Non-critical orientation

| LOAD (lbs) | | | | Tip | Total | BOLT LOADS (kips) | | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl (in) | Defl (in) | Bolt A | Bolt B | Obs. | Calc. | Base | Obs @ Gauge |
| | floor | -0.766 | -0.673 | 8.314 | | | | | | | | |
| | tight | -3.414 | -3.374 | 7.561 | | | 3.98 | 4.24 | | | | |
| | DL | -3.353 | -3.186 | 8.184 | 0.00 | 0.00 | 3.89 | 3.95 | 0.042 | 0.042 | 1.90 | 1.26 |
| 60 | 60 | -3.509 | -3.019 | 7.792 | 0.90 | 0.90 | 4.12 | 3.69 | 0.286 | 0.298 | 12.46 | 8.59 |
| 32 | 92 | -3.600 | -2.934 | 7.594 | 0.51 | 1.41 | 4.26 | 3.55 | 0.410 | 0.434 | 18.09 | 12.29 |
| 32 | 124 | -3.712 | -2.864 | 7.384 | 0.53 | 1.94 | 4.43 | 3.44 | 0.540 | 0.570 | 23.72 | 16.21 |
| 32 | 156 | -3.828 | -2.808 | 7.160 | 0.56 | 2.50 | 4.60 | 3.35 | 0.680 | 0.707 | 29.35 | 20.40 |
| 32 | 188 | -3.965 | -2.768 | 6.898 | 0.62 | 3.11 | 4.81 | 3.29 | 0.843 | 0.843 | 34.98 | 25.30 |
| 32 | 220 | -4.063 | -2.756 | 6.681 | 0.54 | 3.65 | 4.96 | 3.27 | 0.978 | 0.980 | 40.61 | 29.35 |
| 32 | 252 | -4.193 | -2.761 | 6.459 | 0.60 | 4.24 | 5.16 | 3.28 | 1.117 | 1.116 | 46.25 | 33.50 |
| 32 | 284 | -4.279 | -2.787 | 6.234 | 0.67 | 4.91 | 5.29 | 3.32 | 1.257 | 1.252 | 51.88 | 37.71 |
| 32 | 316 | -4.400 | -2.817 | 6.015 | 0.63 | 5.53 | 5.47 | 3.37 | 1.393 | 1.389 | 57.51 | 41.80 |
| 32 | 348 | -4.486 | -2.858 | 5.283 | 0.63 | 6.16 | 5.60 | 3.43 | 1.849 | 1.525 | 63.14 | 55.48 |
| 16 | 364 | -4.500 | -2.883 | 5.720 | 0.35 | 6.51 | 5.62 | 3.47 | 1.577 | 1.594 | 65.96 | 47.32 |
| 16 | 380 | -4.524 | -2.907 | 5.621 | 0.37 | 6.88 | 5.65 | 3.51 | 1.639 | 1.662 | 68.77 | 49.17 |
| 16 | 396 | -4.539 | -2.933 | 5.516 | 0.37 | 7.24 | 5.68 | 3.55 | 1.704 | 1.730 | 71.59 | 51.13 |
| 16 | 412 | -4.541 | -2.957 | 5.437 | 0.36 | 7.60 | 5.68 | 3.59 | 1.754 | 1.798 | 74.40 | 52.61 |

Effective splice length (critical bolt) ..... 4.9 in

Effective splice length (both bolts) ..... 4.6 in

* Nominal yield stress

Table F.6. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.31
Dist to strain gauge (in) .. 7.75
Moment arm (in) .....72.19

MARION 3 LB/FT POST - 80 ksi *
Face to face splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 1.077 | 0.707 | 2.240 | | | | | | | | |
| | tight | 0.768 | -0.433 | 2.226 | | | 0.58 | 2.26 | | | | |
| | DL | 0.775 | -0.277 | 2.319 | 0.00 | 0.00 | 0.57 | 1.95 | 0.041 | 0.041 | 1.90 | 1.23 |
| 60 | 60 | 0.342 | 0.026 | 2.801 | 1.10 | 1.10 | 1.38 | 1.35 | 0.341 | 0.297 | 12.44 | 10.24 |
| 32 | 92 | 0.100 | 0.141 | 3.020 | 0.53 | 1.63 | 1.83 | 1.12 | 0.478 | 0.434 | 18.06 | 14.33 |
| 32 | 124 | -0.155 | 0.242 | 3.233 | 0.53 | 2.16 | 2.31 | 0.92 | 0.610 | 0.570 | 23.68 | 18.31 |
| 48 | 172 | -0.502 | 0.391 | 3.479 | 0.80 | 2.96 | 2.96 | 0.63 | 0.764 | 0.775 | 32.11 | 22.91 |
| 32 | 204 | -0.782 | 0.445 | 3.682 | 0.43 | 3.39 | 3.49 | 0.52 | 0.890 | 0.912 | 37.73 | 26.71 |
| 32 | 236 | -1.073 | 0.503 | 3.891 | 0.67 | 4.06 | 4.03 | 0.40 | 1.020 | 1.049 | 43.35 | 30.61 |
| 32 | 268 | -1.344 | 0.562 | 4.088 | 0.60 | 4.65 | 4.54 | 0.29 | 1.143 | 1.185 | 48.97 | 34.30 |
| 16 | 284 | -1.513 | 0.589 | 4.211 | 0.34 | 4.99 | 4.86 | 0.23 | 1.220 | 1.254 | 51.78 | 36.59 |
| 16 | 300 | -1.672 | 0.613 | 4.324 | 0.34 | 5.33 | 5.16 | 0.19 | 1.290 | 1.322 | 54.59 | 38.71 |
| 16 | 316 | -1.809 | 0.634 | 4.425 | 0.31 | 5.63 | 5.41 | 0.14 | 1.353 | 1.390 | 57.40 | 40.59 |

Effective splice length (critical bolt) ..... 4.0 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table F.7. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.56
Dist to strain gauge (in) 9.06
Moment arm (in) .....72.56

BENDING TEST

MARION 3 lb/ft post - 80ksi *
Back to back splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | -0.651 | -0.707 | 0.031 | | | | | | | | |
| tight | | -4.857 | -3.784 | 0.007 | | | 6.35 | 4.84 | | | | |
| DL | | -4.867 | -3.712 | 0.079 | 0.00 | 0.00 | 6.36 | 4.72 | 0.057 | 0.041 | 1.90 | 1.72 |
| 60 | 60 | -4.895 | -3.671 | 0.502 | 0.79 | 0.79 | 6.40 | 4.66 | 0.321 | 0.293 | 12.49 | 9.63 |
| 32 | 92 | -4.901 | -3.656 | 0.702 | 0.40 | 1.19 | 6.41 | 4.63 | 0.446 | 0.428 | 18.14 | 13.37 |
| 32 | 124 | -4.906 | -3.651 | 0.910 | 0.42 | 1.61 | 6.42 | 4.63 | 0.575 | 0.562 | 23.79 | 17.26 |
| 32 | 156 | -4.907 | -3.653 | 1.134 | 0.46 | 2.07 | 6.42 | 4.63 | 0.715 | 0.697 | 29.44 | 21.44 |
| 32 | 188 | -4.902 | -3.659 | 1.343 | 0.42 | 2.49 | 6.41 | 4.64 | 0.845 | 0.832 | 35.09 | 25.35 |
| 32 | 220 | -4.898 | -3.679 | 1.550 | 0.42 | 2.90 | 6.41 | 4.67 | 0.974 | 0.966 | 40.74 | 29.22 |
| 32 | 252 | -4.875 | -3.721 | 1.781 | 0.47 | 3.37 | 6.37 | 4.74 | 1.118 | 1.101 | 46.39 | 33.54 |
| 32 | 284 | -4.866 | -3.811 | 1.997 | 0.44 | 3.81 | 6.36 | 4.88 | 1.252 | 1.236 | 52.04 | 37.57 |
| 32 | 316 | -4.847 | -4.068 | 2.209 | 0.46 | 4.27 | 6.33 | 5.28 | 1.385 | 1.370 | 57.69 | 41.54 |
| 32 | 348 | -4.816 | -4.314 | 2.400 | 0.43 | 4.70 | 6.28 | 5.67 | 1.504 | 1.505 | 63.34 | 45.11 |
| 32 | 380 | -4.783 | -4.601 | 2.621 | 0.59 | 5.29 | 6.23 | 6.12 | 1.641 | 1.640 | 68.99 | 49.24 |
| 32 | 412 | -4.741 | -4.927 | 2.874 | 0.59 | 5.87 | 6.17 | 6.63 | 1.799 | 1.774 | 74.64 | 53.97 |
| 16 | 428 | -4.699 | -5.067 | 2.985 | 0.26 | 6.13 | 6.11 | 6.85 | 1.868 | 1.842 | 77.46 | 56.04 |
| 16 | 444 | -4.678 | -5.195 | 3.079 | 0.23 | 6.36 | 6.08 | 7.05 | 1.927 | 1.909 | 80.29 | 57.80 |
| 16 | 460 | -4.657 | -5.339 | 3.191 | 0.25 | 6.61 | 6.04 | 7.28 | 1.996 | 1.976 | 83.11 | 59.89 |
| 16 | 476 | -4.614 | -5.465 | 3.290 | 0.24 | 6.86 | 5.98 | 7.48 | 2.058 | 2.044 | 85.94 | 61.74 |

Effective splice length (critical bolt) .... 4.3 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table F.8. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) 8.88
Moment arm (in) .....73.38

BENDING TEST

MARION 3 lb/ft post - 80ksi *
Nested splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | -0.894 | -0.596 | 2.251 | | | | | | | | |
| tight | | -2.480 | -3.359 | 2.258 | | | 5.09 | 6.21 | | | | |
| DL | | -2.368 | -3.231 | 2.945 | | | 4.92 | 6.01 | 0.041 | 0.041 | 1.90 | 1.23 |
| 60 | 60 | -2.140 | -3.288 | 3.370 | 0.69 | 0.69 | 4.58 | 6.10 | 0.306 | 0.297 | 12.46 | 9.17 |
| 32 | 92 | -2.015 | -3.321 | 3.581 | 0.43 | 1.12 | 4.39 | 6.15 | 0.437 | 0.434 | 18.10 | 13.12 |
| 32 | 124 | -1.887 | -3.373 | 3.824 | 0.50 | 1.62 | 4.20 | 6.24 | 0.589 | 0.571 | 23.73 | 17.66 |
| 32 | 156 | -1.787 | -3.427 | 4.043 | 0.47 | 2.08 | 4.04 | 6.32 | 0.725 | 0.708 | 29.37 | 21.75 |
| 32 | 188 | -1.694 | -3.486 | 4.280 | 0.51 | 2.59 | 3.90 | 6.41 | 0.873 | 0.844 | 35.00 | 26.18 |
| 32 | 220 | -1.628 | -3.567 | 4.516 | 0.52 | 3.11 | 3.81 | 6.54 | 1.020 | 0.981 | 40.64 | 30.59 |
| 32 | 252 | -1.574 | -3.641 | 4.772 | 0.59 | 3.70 | 3.72 | 6.66 | 1.179 | 1.118 | 46.27 | 35.38 |
| 32 | 284 | -1.547 | -3.731 | 4.995 | 0.51 | 4.20 | 3.68 | 6.80 | 1.318 | 1.255 | 51.91 | 39.55 |
| 32 | 316 | -1.525 | -3.819 | 5.224 | 0.55 | 4.75 | 3.65 | 6.94 | 1.461 | 1.391 | 57.54 | 43.83 |
| 32 | 348 | -1.515 | -3.928 | 5.453 | 0.54 | 5.29 | 3.63 | 7.11 | 1.604 | 1.528 | 63.18 | 48.11 |
| 32 | 380 | -1.513 | -4.043 | 5.696 | 0.59 | 5.88 | 3.63 | 7.29 | 1.755 | 1.665 | 68.81 | 52.65 |
| 32 | 412 | -1.521 | -4.153 | 5.928 | 0.58 | 6.46 | 3.64 | 7.46 | 1.900 | 1.802 | 74.45 | 56.99 |
| 16 | 428 | -1.535 | -4.256 | 6.168 | 0.63 | 7.08 | 3.66 | 7.62 | 2.049 | 1.870 | 77.27 | 61.47 |

Effective splice length (critical bolt) .... 3.8 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table F.9. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.25
Dist to strain gauge (in) 8.75
Moment arm (in) .....72.25

BENDING TEST

MARION 3 lb/ft post - 80ksi *
Face to face splice
Critical orientation

| LOAD (lbs) Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | Bolt B | STRAIN At Gauge (uin/in) Obs | Calc | STRESS (ksi) Base | Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | 1.087 | 0.702 | 2.423 | | | | | | | | |
| tight | | -0.211 | -0.368 | 2.418 | | | 2.43 | 1.91 | | | | |
| DL | | -0.097 | -0.224 | 2.375 | | | 2.22 | 1.62 | 0.041 | 0.041 | 1.90 | 1.23 |
| 60 | 60 | 0.122 | -0.423 | 1.950 | 0.87 | 0.87 | 1.81 | 2.02 | 0.306 | 0.293 | 12.45 | 9.17 |
| 32 | 92 | 0.220 | -0.542 | 1.735 | 0.48 | 1.35 | 1.63 | 2.25 | 0.440 | 0.428 | 18.07 | 13.19 |
| 32 | 124 | 0.311 | -0.684 | 1.522 | 0.48 | 1.83 | 1.46 | 2.54 | 0.572 | 0.563 | 23.70 | 17.17 |
| 32 | 156 | 0.414 | -0.846 | 1.297 | 0.51 | 2.34 | 1.26 | 2.86 | 0.713 | 0.697 | 29.32 | 21.38 |
| 32 | 188 | 0.515 | -1.022 | 1.089 | 0.48 | 2.82 | 1.07 | 3.21 | 0.842 | 0.832 | 34.95 | 25.27 |
| 32 | 220 | 0.612 | -1.210 | 0.871 | 0.49 | 3.31 | 0.89 | 3.58 | 0.978 | 0.967 | 40.57 | 29.34 |
| 32 | 252 | 0.693 | -1.427 | 0.655 | 0.50 | 3.81 | 0.74 | 4.01 | 1.113 | 1.101 | 46.20 | 33.38 |
| 32 | 284 | 0.762 | -1.660 | 0.431 | 0.52 | 4.33 | 0.61 | 4.47 | 1.252 | 1.236 | 51.82 | 37.57 |
| 32 | 316 | 0.833 | -1.890 | 0.217 | 0.52 | 4.85 | 0.48 | 4.93 | 1.386 | 1.371 | 57.45 | 41.57 |
| 32 | 348 | 0.905 | -2.179 | -0.039 | 0.64 | 5.49 | 0.34 | 5.50 | 1.545 | 1.505 | 63.07 | 46.35 |
| 16 | 364 | 0.930 | -2.301 | -0.148 | 0.28 | 5.76 | 0.29 | 5.74 | 1.613 | 1.573 | 65.89 | 48.39 |
| 16 | 380 | 0.968 | -2.420 | -0.262 | 0.32 | 6.08 | 0.22 | 5.98 | 1.684 | 1.640 | 68.70 | 50.52 |
| 16 | 396 | 1.004 | -2.556 | -0.390 | 0.35 | 6.43 | 0.16 | 6.25 | 1.764 | 1.707 | 71.51 | 52.91 |

Effective splice length (critical bolt) .... 4.2 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table F.10. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.31
Dist to strain gauge (in) 6.88
Moment arm (in) .....72.31

BENDING TEST

MARION 3 lb/ft post - 80ksi *
Back to back splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | -1.330 | -0.712 | 0.041 | | | | | | | | |
| tight | | -6.482 | -3.790 | 0.011 | | | 7.77 | 4.84 | | | | |
| DL | | -6.430 | -3.829 | -0.053 | 0.00 | 0.00 | 7.69 | 4.90 | 0.043 | 0.043 | 1.55 | 1.29 |
| 60 | 60 | -6.407 | -3.850 | -0.481 | 0.71 | 0.71 | 7.66 | 4.93 | 0.310 | 0.303 | 12.10 | 9.29 |
| 32 | 92 | -6.380 | -3.853 | -0.685 | 0.35 | 1.05 | 7.62 | 4.94 | 0.437 | 0.442 | 17.73 | 13.10 |
| 32 | 124 | -6.360 | -3.868 | -0.902 | 0.37 | 1.42 | 7.59 | 4.96 | 0.572 | 0.581 | 23.36 | 17.16 |
| 32 | 156 | -6.337 | -3.881 | -1.119 | 0.38 | 1.80 | 7.55 | 4.98 | 0.707 | 0.719 | 28.99 | 21.21 |
| 32 | 188 | -6.318 | -3.894 | -1.327 | 0.40 | 2.20 | 7.53 | 5.00 | 0.837 | 0.858 | 34.62 | 25.10 |
| 32 | 220 | -6.291 | -3.909 | -1.574 | 0.40 | 2.59 | 7.48 | 5.02 | 0.991 | 0.997 | 40.25 | 29.72 |
| 32 | 252 | -6.273 | -3.930 | -1.804 | 0.41 | 3.01 | 7.46 | 5.06 | 1.134 | 1.136 | 45.88 | 34.02 |
| 32 | 284 | -6.254 | -3.946 | -2.004 | 0.36 | 3.37 | 7.43 | 5.08 | 1.259 | 1.275 | 51.51 | 37.76 |
| 32 | 316 | -6.228 | -3.966 | -2.256 | 0.46 | 3.82 | 7.39 | 5.11 | 1.416 | 1.413 | 57.14 | 42.47 |
| 32 | 348 | -6.206 | -3.985 | -2.485 | 0.41 | 4.23 | 7.36 | 5.14 | 1.558 | 1.552 | 62.77 | 46.75 |
| 32 | 380 | -6.180 | -3.996 | -2.708 | 0.41 | 4.64 | 7.32 | 5.16 | 1.697 | 1.691 | 68.40 | 50.92 |
| 32 | 412 | -6.156 | -4.014 | -2.935 | 0.42 | 5.06 | 7.28 | 5.19 | 1.839 | 1.830 | 74.03 | 55.16 |
| 16 | 428 | -6.157 | -4.018 | -3.053 | 0.22 | 5.28 | 7.28 | 5.19 | 1.912 | 1.899 | 76.85 | 57.36 |
| 16 | 444 | -6.155 | -4.022 | -3.152 | 0.19 | 5.46 | 7.28 | 5.20 | 1.974 | 1.968 | 79.66 | 59.21 |
| 16 | 460 | -6.161 | -4.026 | -3.623 | 0.21 | 5.67 | 7.29 | 5.21 | 2.267 | 2.038 | 82.48 | 68.02 |
| 16 | 476 | -6.223 | -4.028 | -3.377 | 0.20 | 5.88 | 7.38 | 5.21 | 2.114 | 2.107 | 85.29 | 63.42 |
| 16 | 492 | -6.318 | -4.026 | -3.476 | 0.20 | 6.08 | 7.53 | 5.21 | 2.176 | 2.176 | 88.11 | 65.27 |
| 16 | 508 | -6.427 | -4.021 | -3.596 | 0.23 | 6.31 | 7.69 | 5.20 | 2.250 | 2.246 | 90.92 | 67.51 |

Effective splice length (critical bolt) .... 4.4 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table F.11. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.75
Dist to strain gauge (in) 9.25
Moment arm (in) .....73.75

BENDING TEST

MARION 3 lb/ft post - 80ksi *
Nested splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | -1.347 | -0.410 | 2.283 | | | | | | | | |
| tight | | -5.958 | -4.630 | 2.249 | | | 6.96 | 6.63 | | | | |
| DL | | -5.826 | -4.424 | 2.191 | 0.00 | 0.00 | 6.76 | 6.31 | 0.040 | 0.040 | 1.89 | 1.20 |
| 60 | 60 | -5.981 | -4.284 | 1.762 | 0.84 | 0.84 | 6.99 | 6.09 | 0.307 | 0.297 | 12.45 | 9.22 |
| 32 | 92 | -6.064 | -4.223 | 1.558 | 0.42 | 1.26 | 7.12 | 5.99 | 0.434 | 0.434 | 18.08 | 13.03 |
| 32 | 124 | -6.154 | -4.160 | 1.330 | 0.48 | 1.74 | 7.25 | 5.89 | 0.576 | 0.570 | 23.71 | 17.29 |
| 32 | 156 | -6.244 | -4.108 | 1.102 | 0.49 | 2.23 | 7.39 | 5.81 | 0.719 | 0.707 | 29.34 | 21.56 |
| 32 | 188 | -6.283 | -4.063 | 0.891 | 0.46 | 2.68 | 7.45 | 5.74 | 0.850 | 0.844 | 34.97 | 25.50 |
| 32 | 220 | -5.761 | -4.028 | 0.659 | 0.51 | 3.19 | 6.66 | 5.69 | 0.995 | 0.981 | 40.60 | 29.84 |
| 32 | 252 | -5.743 | -3.997 | 0.406 | 0.50 | 3.68 | 6.63 | 5.64 | 1.152 | 1.117 | 46.23 | 34.56 |
| 32 | 284 | -5.771 | -3.978 | 0.205 | 0.43 | 4.11 | 6.67 | 5.61 | 1.277 | 1.254 | 51.86 | 38.32 |
| 32 | 316 | -5.816 | -3.966 | -0.029 | 0.50 | 4.61 | 6.74 | 5.59 | 1.423 | 1.391 | 57.49 | 42.70 |
| 32 | 348 | -5.802 | -3.957 | -0.252 | 0.50 | 5.10 | 6.72 | 5.57 | 1.562 | 1.528 | 63.12 | 46.86 |
| 32 | 380 | -5.841 | -3.956 | -0.474 | 0.48 | 5.58 | 6.78 | 5.57 | 1.700 | 1.665 | 68.75 | 51.01 |
| 32 | 412 | -5.767 | -3.960 | -0.685 | 0.50 | 6.08 | 6.67 | 5.58 | 1.832 | 1.801 | 74.38 | 54.96 |
| 32 | 444 | -5.731 | -3.969 | -0.907 | 0.55 | 6.63 | 6.61 | 5.59 | 1.970 | 1.938 | 80.01 | 59.11 |

Effective splice length (critical bolt) .... **

Effective splice length (both bolts) ..... **

* Nominal yield stress

** Bolt gauge slipped at 35 ksi - data omitted

Table F.12. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) 9.00
Moment arm (in) .....72.38

MARION 3 lb/ft post - 80ksi *
Face to face splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | 1.094 | 0.708 | 2.235 | | | | | | | | |
| tight | | -0.351 | -1.517 | 2.226 | | | 2.70 | 4.19 | | | | |
| DL | | -0.292 | -1.424 | 2.308 | | | 2.59 | 4.00 | 0.041 | 0.041 | 1.90 | 1.23 |
| 60 | 60 | -0.526 | -1.224 | 2.738 | 0.89 | 0.89 | 3.03 | 3.61 | 0.309 | 0.293 | 12.46 | 9.27 |
| 32 | 92 | -0.643 | -1.131 | 2.938 | 0.42 | 1.31 | 3.25 | 3.42 | 0.434 | 0.427 | 18.10 | 13.01 |
| 32 | 124 | -0.766 | -1.044 | 3.133 | 0.42 | 1.73 | 3.48 | 3.25 | 0.555 | 0.561 | 23.73 | 16.65 |
| 32 | 156 | -0.915 | -0.950 | 3.345 | 0.45 | 2.18 | 3.76 | 3.06 | 0.687 | 0.696 | 29.37 | 20.61 |
| 32 | 188 | -1.089 | -0.851 | 3.577 | 0.50 | 2.68 | 4.08 | 2.87 | 0.832 | 0.830 | 35.00 | 24.95 |
| 32 | 220 | -1.295 | -0.755 | 3.815 | 0.51 | 3.19 | 4.47 | 2.68 | 0.980 | 0.964 | 40.64 | 29.40 |
| 32 | 252 | -1.479 | -0.653 | 4.038 | 0.50 | 3.69 | 4.81 | 2.47 | 1.119 | 1.099 | 46.27 | 33.57 |
| 32 | 284 | -1.691 | -0.541 | 4.275 | 0.54 | 4.23 | 5.21 | 2.25 | 1.267 | 1.233 | 51.91 | 38.00 |
| 32 | 316 | -1.923 | -0.431 | 4.520 | 0.57 | 4.79 | 5.65 | 2.03 | 1.419 | 1.368 | 57.54 | 42.58 |
| 16 | 332 | -2.033 | -0.358 | 4.646 | 0.31 | 5.10 | 5.85 | 1.89 | 1.498 | 1.435 | 60.36 | 44.93 |
| 16 | 348 | -2.134 | -0.275 | 4.760 | 0.29 | 5.39 | 6.04 | 1.73 | 1.569 | 1.502 | 63.17 | 47.06 |
| 16 | 364 | -2.240 | -0.218 | 4.877 | 0.28 | 5.67 | 6.24 | 1.61 | 1.642 | 1.569 | 65.99 | 49.25 |
| 16 | 380 | -2.337 | -0.163 | 4.985 | 0.26 | 5.93 | 6.42 | 1.50 | 1.709 | 1.636 | 68.81 | 51.27 |
| 16 | 396 | -2.441 | -0.100 | 5.099 | 0.29 | 6.21 | 6.62 | 1.38 | 1.780 | 1.704 | 71.63 | 53.40 |
| 16 | 412 | -2.576 | -0.039 | 5.245 | 0.36 | 6.57 | 6.87 | 1.26 | 1.871 | 1.771 | 74.44 | 56.13 |
| 16 | 428 | -2.685 | 0.022 | 5.360 | 0.32 | 6.89 | 7.08 | 1.14 | 1.943 | 1.838 | 77.26 | 58.28 |

Effective splice length (critical bolt) .... 4.1 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table F.13. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 5 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 5.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) 10.25
Moment arm (in) .....73.38

MARION 3 LB/FT POST - 80 ksi *
Back to back splice
Critical orientation

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | -0.741 | -0.628 | 1.762 | | | | | | | | |
| tight | | -2.413 | -2.146 | 1.764 | | | 2.56 | 2.39 | | | | |
| DL | | -2.399 | -2.156 | 1.838 | 0.00 | 0.00 | 2.54 | 2.40 | 0.039 | 0.039 | 1.90 | 1.17 |
| 60 | 60 | -2.343 | -2.141 | 2.258 | 0.80 | 0.80 | 2.46 | 2.38 | 0.301 | 0.290 | 12.46 | 9.02 |
| 32 | 92 | -2.344 | -2.127 | 2.492 | 0.39 | 1.19 | 2.46 | 2.36 | 0.446 | 0.424 | 18.10 | 13.39 |
| 32 | 124 | -2.334 | -2.119 | 2.709 | 0.38 | 1.56 | 2.44 | 2.34 | 0.582 | 0.558 | 23.74 | 17.45 |
| 32 | 156 | -2.323 | -2.115 | 2.934 | 0.39 | 1.95 | 2.43 | 2.34 | 0.722 | 0.692 | 29.37 | 21.66 |
| 32 | 188 | -2.311 | -2.119 | 3.145 | 0.35 | 2.30 | 2.41 | 2.34 | 0.853 | 0.826 | 35.01 | 25.60 |
| 32 | 220 | -2.295 | -2.140 | 3.383 | 0.41 | 2.70 | 2.39 | 2.38 | 1.002 | 0.960 | 40.64 | 30.05 |
| 32 | 252 | -2.277 | -2.250 | 3.625 | 0.43 | 3.13 | 2.36 | 2.55 | 1.152 | 1.093 | 46.28 | 34.57 |
| 32 | 284 | -2.253 | -2.357 | 3.851 | 0.40 | 3.53 | 2.32 | 2.72 | 1.293 | 1.227 | 51.91 | 38.80 |
| 32 | 316 | -2.231 | -2.460 | 4.083 | 0.41 | 3.94 | 2.29 | 2.88 | 1.438 | 1.361 | 57.55 | 43.13 |
| 32 | 348 | -2.207 | -2.575 | 4.309 | 0.42 | 4.36 | 2.25 | 3.06 | 1.579 | 1.495 | 63.18 | 47.36 |
| 32 | 380 | -2.182 | -2.716 | 4.533 | 0.42 | 4.77 | 2.21 | 3.28 | 1.718 | 1.629 | 68.82 | 51.54 |
| 32 | 412 | -2.146 | -2.861 | 4.794 | 0.41 | 5.18 | 2.16 | 3.51 | 1.881 | 1.763 | 74.45 | 56.42 |
| 32 | 444 | -2.121 | -3.016 | 5.039 | 0.47 | 5.65 | 2.12 | 3.75 | 2.033 | 1.897 | 80.09 | 61.00 |
| 32 | 476 | -2.088 | -3.183 | 5.323 | 0.56 | 6.21 | 2.07 | 4.01 | 2.210 | 2.031 | 85.73 | 66.31 |
| 32 | 508 | -2.058 | -3.323 | 5.557 | 0.52 | 6.73 | 2.03 | 4.23 | 2.356 | 2.164 | 91.36 | 70.68 |
| 32 | 540 | -2.015 | -3.449 | 5.839 | 0.56 | 7.29 | 1.96 | 4.43 | 2.532 | 2.298 | 97.00 | 75.96 |
| 32 | 572 | -1.979 | -3.599 | 6.113 | 0.58 | 7.87 | 1.91 | 4.67 | 2.703 | 2.432 | 102.63 | 81.08 |
| 16 | 588 | -1.961 | -3.670 | 6.240 | 0.28 | 8.15 | 1.88 | 4.78 | 2.782 | 2.499 | 105.45 | 83.45 |
| 16 | 604 | -1.939 | -3.752 | 6.382 | 0.31 | 8.46 | 1.85 | 4.91 | 2.870 | 2.566 | 108.27 | 86.10 |

Effective splice length (critical bolt) .... ** in

Effective splice length (both bolts) ..... ** in

* Nominal yield stress

** Bolt gauge nearing end of life - data omitted

Table F.14. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 5 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 5.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) 10.00
Moment arm (in) .....72.38

MARION 3 LB/FT POST - 80 ksi *
Nested splice
Critical orientation

| LOAD (lbs) App | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | Bolt B | STRAIN At Gauge (uin/in) Obs. | Calc. | STRESS (ksi) Base | Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | -0.784 | -0.548 | 2.034 | | | | | | | | |
| tight | | -2.985 | -2.982 | 2.007 | | | 3.32 | 3.82 | | | | |
| DL | | -2.786 | -2.895 | 2.092 | 0.00 | 0.00 | 3.02 | 3.69 | 0.039 | 0.039 | 1.90 | 1.17 |
| 60 | 60 | -2.627 | -2.935 | 2.496 | 0.75 | 0.75 | 2.78 | 3.75 | 0.291 | 0.287 | 12.46 | 8.72 |
| 32 | 92 | -2.542 | -2.950 | 2.709 | 0.41 | 1.16 | 2.65 | 3.77 | 0.423 | 0.420 | 18.10 | 12.70 |
| 32 | 124 | -2.461 | -2.969 | 2.917 | 0.41 | 1.57 | 2.53 | 3.80 | 0.553 | 0.552 | 23.74 | 16.59 |
| 32 | 156 | -2.391 | -2.981 | 3.126 | 0.42 | 1.99 | 2.42 | 3.82 | 0.683 | 0.684 | 29.37 | 20.50 |
| 32 | 188 | -2.333 | -3.012 | 3.317 | 0.38 | 2.37 | 2.34 | 3.87 | 0.802 | 0.817 | 35.01 | 24.07 |
| 32 | 220 | -2.272 | -3.063 | 3.547 | 0.47 | 2.84 | 2.25 | 3.95 | 0.946 | 0.949 | 40.64 | 28.37 |
| 32 | 252 | -2.242 | -3.116 | 3.761 | 0.44 | 3.28 | 2.20 | 4.04 | 1.079 | 1.081 | 46.28 | 32.37 |
| 32 | 284 | -2.212 | -3.193 | 4.009 | 0.51 | 3.78 | 2.15 | 4.16 | 1.233 | 1.213 | 51.91 | 37.00 |
| 32 | 316 | -2.192 | -3.248 | 4.209 | 0.42 | 4.20 | 2.12 | 4.24 | 1.358 | 1.346 | 57.55 | 40.74 |
| 32 | 348 | -2.173 | -3.359 | 4.468 | 0.52 | 4.73 | 2.10 | 4.42 | 1.519 | 1.478 | 63.18 | 45.58 |
| 32 | 380 | -2.167 | -3.458 | 4.706 | 0.53 | 5.25 | 2.09 | 4.57 | 1.668 | 1.610 | 68.82 | 50.03 |
| 32 | 412 | -2.155 | -3.556 | 4.954 | 0.52 | 5.77 | 2.07 | 4.73 | 1.822 | 1.743 | 74.45 | 54.67 |
| 32 | 444 | -2.149 | -3.658 | 5.217 | 0.57 | 6.34 | 2.06 | 4.89 | 1.986 | 1.875 | 80.09 | 59.58 |
| 32 | 476 | -2.152 | -3.762 | 5.461 | 0.55 | 6.88 | 2.06 | 5.05 | 2.138 | 2.007 | 85.73 | 64.14 |
| 32 | 508 | -2.153 | -3.883 | 5.713 | 0.57 | 7.45 | 2.07 | 5.24 | 2.295 | 2.139 | 91.36 | 68.85 |
| 32 | 540 | -2.161 | -3.972 | 5.938 | 0.54 | 7.98 | 2.08 | 5.38 | 2.435 | 2.272 | 97.00 | 73.06 |
| 32 | 572 | -2.172 | -4.101 | 6.229 | 0.69 | 8.67 | 2.09 | 5.58 | 2.617 | 2.404 | 102.63 | 78.50 |

Effective splice length (critical bolt) .... ** in

Effective splice length (both bolts) ..... ** in

* Nominal yield stress

** Bolt gauge nearing end of life - data omitted

Table F.15. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 5 Inch Face to Face Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 5.00
Dist to bolt A (in) ..... 1.88
Dist to strain gauge (in) 10.50
Moment arm (in) .....72.88

BENDING TEST

MARION 3 LB/FT POST - 80 ksi *
Face to face splice
Critical orientation

| LOAD (lbs) App | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | Bolt B | STRAIN At Gauge (uin/in) Obs. | Calc. | STRESS (ksi) Base | Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | 1.105 | 0.723 | 0.870 | | | | | | | | |
| tight | | -0.043 | -0.612 | 0.798 | | | 2.15 | 2.65 | | | | |
| DL | | -0.092 | -0.630 | 0.723 | 0.00 | 0.00 | 2.25 | 2.68 | 0.040 | 0.040 | 1.90 | 1.20 |
| 60 | 60 | 0.104 | -0.775 | 0.320 | 0.77 | 0.77 | 1.88 | 2.97 | 0.291 | 0.288 | 12.54 | 8.73 |
| 32 | 92 | 0.212 | -0.851 | 0.103 | 0.40 | 1.17 | 1.68 | 3.12 | 0.426 | 0.420 | 18.21 | 12.79 |
| 32 | 124 | 0.308 | -0.936 | -0.113 | 0.43 | 1.61 | 1.50 | 3.29 | 0.561 | 0.553 | 23.89 | 16.83 |
| 32 | 156 | 0.399 | -1.023 | -0.324 | 0.43 | 2.04 | 1.32 | 3.46 | 0.692 | 0.685 | 29.56 | 20.77 |
| 32 | 188 | 0.479 | -1.123 | -0.539 | 0.44 | 2.47 | 1.17 | 3.66 | 0.826 | 0.817 | 35.23 | 24.79 |
| 32 | 220 | 0.549 | -1.220 | -0.732 | 0.40 | 2.87 | 1.04 | 3.85 | 0.947 | 0.949 | 40.91 | 28.40 |
| 32 | 252 | 0.616 | -1.335 | -0.945 | 0.44 | 3.31 | 0.92 | 4.08 | 1.079 | 1.082 | 46.58 | 32.38 |
| 32 | 284 | 0.676 | -1.454 | -1.153 | 0.44 | 3.74 | 0.80 | 4.31 | 1.209 | 1.214 | 52.26 | 36.27 |
| 32 | 316 | 0.734 | -1.595 | -1.365 | 0.45 | 4.19 | 0.70 | 4.59 | 1.341 | 1.346 | 57.93 | 40.23 |
| 32 | 348 | 0.789 | -1.753 | -1.568 | 0.44 | 4.63 | 0.59 | 4.91 | 1.467 | 1.479 | 63.61 | 44.02 |
| 32 | 380 | 0.829 | -1.911 | -1.757 | 0.41 | 5.03 | 0.52 | 5.22 | 1.585 | 1.611 | 69.28 | 47.56 |
| 32 | 412 | 0.878 | -2.079 | -1.995 | 0.45 | 5.48 | 0.43 | 5.55 | 1.733 | 1.743 | 74.96 | 52.00 |
| 16 | 428 | 0.892 | -2.153 | -2.043 | 0.19 | 5.66 | 0.40 | 5.70 | 1.763 | 1.809 | 77.79 | 52.90 |
| 16 | 444 | 0.909 | -2.251 | -2.145 | 0.25 | 5.91 | 0.37 | 5.89 | 1.827 | 1.875 | 80.63 | 54.81 |
| 16 | 460 | 0.928 | -2.336 | -2.256 | 0.23 | 6.14 | 0.33 | 6.06 | 1.896 | 1.942 | 83.47 | 56.88 |

Effective splice length (critical bolt) .... 5.1 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table F.16. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 5 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 5.00
Dist to bolt A (in) ..... 1.75
Dist to strain gauge (in) 10.25
Moment arm (in) .....73.75

BENDING TEST

MARION 3 LB/FT POST - 80 ksi *
Back to back splice
Non-critical orientation

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | -0.789 | -0.645 | 1.897 | | | | | | | | |
| tight | | -2.437 | -2.551 | 1.892 | | | 2.49 | 2.99 | | | | |
| DL | | -2.435 | -2.504 | 1.837 | 0.00 | 0.00 | 2.36 | 2.99 | 0.039 | 0.039 | 1.90 | 1.17 |
| 60 | 60 | -2.405 | -2.492 | 1.425 | 0.70 | 0.70 | 2.31 | 2.98 | 0.296 | 0.292 | 12.52 | 8.87 |
| 32 | 92 | -2.384 | -2.484 | 1.211 | 0.38 | 1.08 | 2.28 | 2.96 | 0.429 | 0.426 | 18.18 | 12.87 |
| 32 | 124 | -2.366 | -2.478 | 0.984 | 0.41 | 1.49 | 2.25 | 2.95 | 0.570 | 0.561 | 23.85 | 17.11 |
| 32 | 156 | -2.353 | -2.475 | 0.762 | 0.41 | 1.89 | 2.23 | 2.95 | 0.709 | 0.696 | 29.51 | 21.26 |
| 32 | 188 | -2.345 | -2.470 | 0.548 | 0.40 | 2.29 | 2.22 | 2.94 | 0.842 | 0.830 | 35.18 | 25.26 |
| 32 | 220 | -2.337 | -2.465 | 0.328 | 0.41 | 2.69 | 2.21 | 2.93 | 0.979 | 0.965 | 40.84 | 29.38 |
| 32 | 252 | -2.333 | -2.462 | 0.090 | 0.44 | 3.13 | 2.20 | 2.93 | 1.127 | 1.100 | 46.50 | 33.82 |
| 32 | 284 | -2.331 | -2.453 | -0.140 | 0.43 | 3.56 | 2.20 | 2.91 | 1.271 | 1.234 | 52.17 | 38.12 |
| 32 | 316 | -2.338 | -2.446 | -0.375 | 0.43 | 3.99 | 2.21 | 2.90 | 1.417 | 1.369 | 57.83 | 42.52 |
| 32 | 348 | -2.357 | -2.434 | -0.594 | 0.42 | 4.41 | 2.24 | 2.88 | 1.554 | 1.504 | 63.50 | 46.61 |
| 32 | 380 | -2.449 | -2.423 | -0.801 | 0.40 | 4.81 | 2.38 | 2.87 | 1.683 | 1.638 | 69.16 | 50.48 |
| 32 | 412 | -2.596 | -2.403 | -1.042 | 0.49 | 5.29 | 2.60 | 2.84 | 1.833 | 1.773 | 74.83 | 54.98 |
| 32 | 444 | -2.749 | -2.383 | -1.257 | 0.44 | 5.73 | 2.83 | 2.80 | 1.967 | 1.908 | 80.49 | 59.00 |
| 32 | 476 | -2.873 | -2.354 | -1.463 | 0.44 | 6.17 | 3.02 | 2.76 | 2.095 | 2.042 | 86.15 | 62.85 |
| 32 | 508 | -3.012 | -2.326 | -1.681 | 0.47 | 6.64 | 3.23 | 2.72 | 2.231 | 2.177 | 91.82 | 66.93 |
| 32 | 540 | -3.131 | -2.288 | -1.921 | 0.53 | 7.17 | 3.41 | 2.66 | 2.380 | 2.312 | 97.48 | 71.41 |
| 32 | 572 | -3.282 | -2.238 | -2.220 | 0.69 | 7.86 | 3.63 | 2.58 | 2.567 | 2.446 | 103.15 | 77.00 |

Effective splice length (critical bolt) .... ** in

Effective splice length (both bolts) ..... ** in

* Nominal yield stress

** Bolt gauge nearing end of life - data omitted

Table F.17. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 5 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 5.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) 10.19
Moment arm (in) .....72.38

BENDING TEST

MARION 3 LB/FT POST - 80 ksi *
Nested splice
Non-critical orientation

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | -0.804 | -0.597 | 2.210 | | | | | | | | |
| tight | | -1.735 | -1.805 | 2.213 | | | 1.40 | 1.90 | | | | |
| DL | | -1.715 | -1.668 | 2.149 | 0.00 | 0.00 | 1.37 | 1.68 | 0.039 | 0.039 | 1.90 | 1.17 |
| 60 | 60 | -1.856 | -1.523 | 1.744 | 0.76 | 0.76 | 1.59 | 1.46 | 0.291 | 0.290 | 12.46 | 8.74 |
| 32 | 92 | -1.920 | -1.461 | 1.537 | 0.41 | 1.17 | 1.68 | 1.36 | 0.420 | 0.424 | 18.10 | 12.61 |
| 32 | 124 | -1.973 | -1.405 | 1.338 | 0.38 | 1.55 | 1.76 | 1.27 | 0.544 | 0.558 | 23.74 | 16.33 |
| 32 | 156 | -2.040 | -1.360 | 1.121 | 0.41 | 1.96 | 1.86 | 1.20 | 0.680 | 0.692 | 29.37 | 20.39 |
| 32 | 188 | -2.096 | -1.323 | 0.901 | 0.43 | 2.39 | 1.95 | 1.14 | 0.817 | 0.826 | 35.01 | 24.50 |
| 32 | 220 | -2.187 | -1.303 | 0.677 | 0.43 | 2.82 | 2.09 | 1.11 | 0.956 | 0.960 | 40.64 | 28.68 |
| 32 | 252 | -2.274 | -1.286 | 0.451 | 0.44 | 3.26 | 2.22 | 1.08 | 1.097 | 1.094 | 46.28 | 32.91 |
| 32 | 284 | -2.356 | -1.274 | 0.242 | 0.41 | 3.67 | 2.34 | 1.06 | 1.227 | 1.228 | 51.91 | 36.81 |
| 32 | 316 | -2.458 | -1.265 | 0.013 | 0.46 | 4.13 | 2.50 | 1.05 | 1.370 | 1.362 | 57.55 | 41.10 |
| 32 | 348 | -2.530 | -1.260 | -0.169 | 0.37 | 4.49 | 2.60 | 1.04 | 1.483 | 1.496 | 63.18 | 44.50 |
| 32 | 380 | -2.635 | -1.258 | -0.381 | 0.44 | 4.93 | 2.76 | 1.04 | 1.615 | 1.630 | 68.82 | 48.46 |
| 32 | 412 | -2.747 | -1.262 | -0.582 | 0.42 | 5.34 | 2.93 | 1.04 | 1.741 | 1.764 | 74.45 | 52.22 |
| 32 | 444 | -2.858 | -1.268 | -0.794 | 0.47 | 5.81 | 3.10 | 1.05 | 1.873 | 1.898 | 80.09 | 56.18 |
| 32 | 476 | -2.979 | -1.280 | -1.014 | 0.50 | 6.31 | 3.28 | 1.07 | 2.010 | 2.032 | 85.73 | 60.29 |
| 32 | 508 | -3.093 | -1.298 | -1.228 | 0.51 | 6.81 | 3.45 | 1.10 | 2.143 | 2.166 | 91.36 | 64.29 |
| 32 | 540 | -3.201 | -1.318 | -1.420 | 0.49 | 7.30 | 3.62 | 1.13 | 2.263 | 2.300 | 97.00 | 67.88 |
| 32 | 572 | -3.319 | -1.344 | -1.627 | 0.53 | 7.83 | 3.79 | 1.17 | 2.392 | 2.434 | 102.63 | 71.75 |
| 16 | 588 | -3.369 | -1.364 | -1.755 | 0.33 | 8.16 | 3.87 | 1.21 | 2.471 | 2.501 | 105.45 | 74.14 |
| 16 | 604 | -3.432 | -1.383 | -1.876 | 0.32 | 8.48 | 3.96 | 1.24 | 2.547 | 2.568 | 108.27 | 76.40 |

Effective splice length (critical bolt) .... ** in

Effective splice length (both bolts) ..... ** in

* Nominal yield stress

** Bolt gauge nearing end of life - data omitted

Table F.18. *Results of 72 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 5 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 5.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) 9.81
Moment arm (in) .....72.38

BENDING TEST

MARION 3 LB/FT POST - 80 ksi *
Face to face splice
Non-critical orientation

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | 1.084 | 0.765 | 0.791 | | | | | | | | |
| tight | | 0.522 | 0.136 | 0.745 | | | 1.05 | 1.25 | | | | |
| DL | | 0.657 | 0.467 | 0.816 | 0.00 | 0.00 | 0.80 | 0.59 | 0.040 | 0.040 | 1.90 | 1.20 |
| 60 | 60 | 0.318 | 0.604 | 1.244 | 0.88 | 0.88 | 1.44 | 0.32 | 0.307 | 0.288 | 12.46 | 9.20 |
| 32 | 92 | 0.136 | 0.641 | 1.463 | 0.45 | 1.33 | 1.78 | 0.25 | 0.443 | 0.421 | 18.10 | 13.29 |
| 32 | 124 | -0.041 | 0.668 | 1.681 | 0.44 | 1.76 | 2.11 | 0.19 | 0.579 | 0.554 | 23.74 | 17.37 |
| 32 | 156 | -0.218 | 0.694 | 1.898 | 0.44 | 2.20 | 2.44 | 0.14 | 0.714 | 0.687 | 29.37 | 21.41 |
| 32 | 188 | -0.385 | 0.713 | 2.107 | 0.43 | 2.63 | 2.76 | 0.10 | 0.844 | 0.819 | 35.01 | 25.33 |
| 32 | 220 | -0.574 | 0.736 | 2.345 | 0.48 | 3.11 | 3.11 | 0.06 | 0.993 | 0.952 | 40.64 | 29.78 |
| 32 | 252 | -0.767 | 0.754 | 2.582 | 0.47 | 3.58 | 3.47 | 0.02 | 1.140 | 1.085 | 46.28 | 34.21 |
| 32 | 284 | -0.949 | 0.759 | 2.816 | 0.49 | 4.07 | 3.81 | 0.01 | 1.286 | 1.217 | 51.91 | 38.58 |
| 32 | 316 | -1.139 | 0.761 | 3.045 | 0.48 | 4.55 | 4.17 | 0.01 | 1.429 | 1.350 | 57.55 | 42.86 |
| 32 | 348 | -1.327 | 0.763 | 3.264 | 0.47 | 5.02 | 4.52 | 0.00 | 1.565 | 1.483 | 63.18 | 46.96 |
| 32 | 380 | -1.511 | 0.760 | 3.472 | 0.46 | 5.48 | 4.87 | 0.01 | 1.695 | 1.615 | 68.82 | 50.84 |
| 32 | 412 | -1.736 | 0.759 | 3.730 | 0.58 | 6.06 | 5.29 | 0.01 | 1.856 | 1.748 | 74.45 | 55.67 |
| 16 | 428 | -1.825 | 0.761 | 3.836 | 0.25 | 6.31 | 5.46 | 0.01 | 1.922 | 1.814 | 77.27 | 57.65 |
| 16 | 444 | -1.950 | 0.761 | 3.980 | 0.34 | 6.65 | 5.69 | 0.01 | 2.011 | 1.881 | 80.09 | 60.34 |
| 16 | 460 | -2.026 | 0.760 | 4.072 | 0.21 | 6.85 | 5.83 | 0.01 | 2.069 | 1.947 | 82.91 | 62.06 |
| 16 | 476 | -2.118 | 0.761 | 4.194 | 0.30 | 7.15 | 6.01 | 0.01 | 2.145 | 2.013 | 85.73 | 64.34 |
| 16 | 492 | -2.219 | 0.759 | 4.324 | 0.31 | 7.46 | 6.20 | 0.01 | 2.226 | 2.080 | 88.54 | 66.77 |
| 16 | 508 | -2.298 | 0.760 | 4.426 | 0.26 | 7.72 | 6.34 | 0.01 | 2.289 | 2.146 | 91.36 | 68.68 |

Effective splice length (critical bolt) .... 5.4 in

Effective splice length (both bolts) ..... 5.4 in

* Nominal yield stress

# APPENDIX G

## 17 " BENDING TESTS

### FIELD BOLT SUMMARY TABLES

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back, Nested, Face to Face and Box Splices

Critical and Non-critical Configurations

# APPENDIX G

## LIST OF TABLES

# APPENDIX G

## LIST OF TABLES (CONT)

# APPENDIX G

## LIST OF TABLES (CONT)

Table G.1. *Results of 17 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.44
Dist to strain gauge (in) 8.13
Moment arm (in) .....16.44

FRANKLIN 3 lb/ft - 60ksi *
Back to back splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl Total @ Load (in) | Defl Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 0.210 | 0.280 | 0.704 | | | | | | | | |
| | tight | -2.550 | -2.768 | 0.737 | | | 3.94 | 4.64 | | | | |
| | DL | -2.349 | -2.608 | 0.839 | | | 3.65 | 4.40 | -0.052 | -0.052 | 1.95 | -1.55 |
| 0 | 0 | -2.329 | -2.600 | 0.847 | -1.01 | 0.00 | 3.62 | 4.39 | -0.057 | -0.052 | 1.95 | -1.70 |
| 200 | 200 | -2.280 | -2.762 | 1.061 | -1.10 | 0.08 | 3.55 | 4.63 | -0.190 | -0.189 | 10.11 | -5.70 |
| 200 | 400 | -2.252 | -2.958 | 1.292 | -1.19 | 0.18 | 3.51 | 4.93 | -0.334 | -0.327 | 18.27 | -10.02 |
| 200 | 600 | -2.259 | -3.209 | 1.539 | -1.28 | 0.27 | 3.52 | 5.31 | -0.488 | -0.464 | 26.42 | -14.64 |
| 200 | 800 | -2.271 | -3.465 | 1.767 | -1.39 | 0.38 | 3.54 | 5.70 | -0.630 | -0.602 | 34.58 | -18.90 |
| 200 | 1000 | -2.291 | -3.806 | 1.998 | -1.51 | 0.49 | 3.57 | 6.22 | -0.774 | -0.739 | 42.74 | -23.21 |
| 200 | 1200 | -2.313 | -4.211 | 2.233 | -1.65 | 0.64 | 3.60 | 6.84 | -0.920 | -0.877 | 50.90 | -27.61 |
| 200 | 1400 | -2.336 | -4.684 | 2.484 | -1.80 | 0.78 | 3.63 | 7.56 | -1.077 | -1.014 | 59.06 | -32.30 |
| 100 | 1500 | -2.351 | -4.560 | 2.294 | -1.89 | 0.88 | 3.65 | 7.37 | -0.958 | -1.083 | 63.14 | -28.75 |

Effective splice length (critical bolt) ..... 3.3 in

Effective splice length (both bolts) ..... 3.3 in

* Nominal yield stress

Table G.2. *Results of 17 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.75
Dist to strain gauge (in). 8.31
Moment arm (in) .....16.75

BENDING TEST

FRANKLIN 3 lb/ft - 60ksi *
Nested splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs at Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 0.147 | 0.180 | 0.644 | | | | | | | | |
| | tight | -1.962 | -1.801 | 0.682 | | | 3.01 | 3.02 | | | | |
| | DL | -1.792 | -1.773 | 0.620 | | | 2.77 | 2.97 | 0.050 | 0.050 | 1.93 | 1.50 |
| 0 | 0 | -1.792 | -1.765 | 0.649 | -0.39 | 0.00 | 2.77 | 2.96 | 0.032 | 0.050 | 1.93 | 0.95 |
| 200 | 200 | -1.708 | -1.850 | 0.422 | -0.49 | 0.10 | 2.65 | 3.09 | 0.173 | 0.190 | 10.24 | 5.20 |
| 200 | 400 | -1.632 | -1.951 | 0.191 | -0.60 | 0.22 | 2.54 | 3.25 | 0.317 | 0.330 | 18.55 | 9.51 |
| 200 | 600 | -1.575 | -2.160 | -0.052 | -0.73 | 0.35 | 2.46 | 3.56 | 0.469 | 0.469 | 26.87 | 14.06 |
| 200 | 800 | -1.547 | -2.537 | -0.302 | -0.88 | 0.50 | 2.42 | 4.14 | 0.624 | 0.609 | 35.18 | 18.73 |
| 200 | 1000 | -1.555 | -3.018 | -0.553 | -1.06 | 0.67 | 2.43 | 4.87 | 0.781 | 0.748 | 43.49 | 23.42 |
| 200 | 1200 | -1.597 | -3.605 | -0.841 | -1.28 | 0.89 | 2.49 | 5.77 | 0.960 | 0.888 | 51.81 | 28.80 |
| 100 | 1300 | -1.631 | -3.916 | -0.988 | -1.41 | 1.03 | 2.54 | 6.24 | 1.052 | 0.958 | 55.96 | 31.55 |
| 100 | 1400 | -1.670 | -4.228 | -1.128 | -1.54 | 1.15 | 2.59 | 6.71 | 1.139 | 1.028 | 60.12 | 34.17 |

Effective splice length (critical bolt) ..... 3.5 in

Effective splice length (both bolts) ..... 3.4 in

* Nominal yield stress

Table G.3. *Results of 17 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Face to Face Splice in Critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.75
Dist to strain gauge (in) 8.25
Moment arm (in) .....16.75

FRANKLIN 3 lb/ft - 60ksi *
Face to face splice
Critical orientation

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl Total @ Load (in) | Defl Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs at Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 1.048 | 0.794 | 1.191 | | | | | | | | |
| | tight | -0.590 | -1.140 | 1.298 | | | 3.07 | 3.83 | | | | |
| | DL | -0.406 | -1.068 | 1.271 | | | 2.73 | 3.69 | 0.051 | 0.051 | 1.94 | 1.53 |
| 0 | 0 | -0.404 | -1.068 | 1.275 | -1.25 | 0.00 | 2.72 | 3.69 | 0.049 | 0.051 | 1.94 | 1.46 |
| 200 | 200 | -0.353 | -1.124 | 1.070 | -1.35 | 0.10 | 2.63 | 3.80 | 0.176 | 0.192 | 10.25 | 5.29 |
| 200 | 400 | -0.297 | -1.194 | 0.872 | -1.45 | 0.20 | 2.52 | 3.94 | 0.300 | 0.332 | 18.56 | 8.99 |
| 200 | 600 | -0.243 | -1.322 | 0.668 | -1.55 | 0.30 | 2.42 | 4.19 | 0.427 | 0.473 | 26.87 | 12.80 |
| 200 | 800 | -0.165 | -1.486 | 0.448 | -1.68 | 0.43 | 2.28 | 4.52 | 0.564 | 0.613 | 35.19 | 16.92 |
| 200 | 1000 | -0.080 | -1.802 | 0.219 | -1.82 | 0.57 | 2.12 | 5.14 | 0.707 | 0.754 | 43.50 | 21.20 |
| 200 | 1200 | 0.020 | -2.268 | -0.026 | -2.05 | 0.80 | 1.93 | 6.07 | 0.859 | 0.895 | 51.81 | 25.78 |
| 200 | 1400 | 0.109 | -2.712 | -2.610 | -2.33 | 1.08 | 1.76 | 6.95 | 2.469 | 1.035 | 60.12 | 74.07 |

Effective splice length (critical bolt) ..... 3.4 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table G.4. *Results of 17 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.75
Dist to strain gauge (in) 8.25
Moment arm (in) .....16.75

BENDING TEST

FRANKLIN 3 lb/ft - 60ksi *
Back to back splice
Non-critical orientation

| LOAD (lbs) | | | | Defl Total | | BOLT LOADS (kips) | | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | @ Load (in) | Defl (in) | Bolt A | Bolt B | Obs | Calc | Base | Obs @ Gauge |
| | floor | 0.316 | 0.292 | -1.134 | | | | | | | | |
| | tight | -2.055 | -2.152 | -1.086 | | | 3.38 | 3.72 | | | | |
| | DL | -1.998 | -2.087 | -1.181 | | | 3.30 | 3.62 | 0.052 | 0.052 | 1.94 | 1.55 |
| 0 | 0 | -1.990 | -2.076 | -1.185 | 0.91 | 0.00 | 3.29 | 3.61 | 0.054 | 0.052 | 1.94 | 1.63 |
| 200 | 200 | -2.155 | -1.946 | -1.426 | 0.81 | 0.10 | 3.52 | 3.41 | 0.204 | 0.192 | 10.26 | 6.13 |
| 200 | 400 | -2.369 | -1.888 | -1.602 | 0.72 | 0.19 | 3.83 | 3.32 | 0.314 | 0.333 | 18.57 | 9.42 |
| 200 | 600 | -2.605 | -1.868 | -1.951 | 0.62 | 0.29 | 4.17 | 3.29 | 0.531 | 0.474 | 26.88 | 15.94 |
| 200 | 800 | -2.869 | -1.882 | -2.201 | 0.52 | 0.38 | 4.54 | 3.31 | 0.687 | 0.614 | 35.20 | 20.62 |
| 200 | 1000 | -3.147 | -1.896 | -2.499 | 0.41 | 0.50 | 4.94 | 3.33 | 0.873 | 0.755 | 43.51 | 26.19 |
| 200 | 1200 | -3.481 | -1.911 | -2.776 | 0.30 | 0.61 | 5.42 | 3.36 | 1.045 | 0.895 | 51.82 | 31.36 |
| 100 | 1300 | -3.666 | -1.913 | -2.951 | 0.23 | 0.68 | 5.68 | 3.36 | 1.155 | 0.966 | 55.98 | 34.64 |
| 100 | 1400 | -3.840 | -1.917 | -3.074 | 0.17 | 0.74 | 5.93 | 3.36 | 1.231 | 1.036 | 60.13 | 36.93 |
| 100 | 1500 | -4.067 | -1.920 | -3.271 | 0.07 | 0.83 | 6.25 | 3.37 | 1.354 | 1.106 | 64.29 | 40.62 |

Effective splice length (critical bolt) ..... 4.0 in

Effective splice length (both bolts) ..... 4.0 in

* Nominal yield stress

Table G.5. *Results of 17 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) 8.13
Moment arm (in) .....16.38

FRANKLIN 3 lb/ft - 60ksi *
Nested splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl Total @ Load (in) | Defl Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Obs at Base | STRESS (ksi) Obs at Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 0.226 | 0.182 | 1.092 | | | | | | | | |
| | tight | -1.940 | -1.840 | 1.168 | | | 3.09 | 3.08 | | | | |
| | DL | -1.896 | -1.755 | 1.245 | | | 3.03 | 2.95 | -0.051 | -0.051 | 1.94 | -1.53 |
| 0 | 0 | -1.877 | -1.753 | 1.237 | 1.59 | 0.00 | 3.00 | 2.95 | -0.046 | -0.051 | 1.94 | -1.38 |
| 200 | 200 | -1.934 | -1.668 | 1.446 | 1.49 | 0.10 | 3.08 | 2.82 | -0.176 | -0.187 | 10.06 | -5.29 |
| 200 | 400 | -2.024 | -1.616 | 1.642 | 1.40 | 0.19 | 3.21 | 2.74 | -0.298 | -0.324 | 18.19 | -8.95 |
| 200 | 600 | -2.145 | -1.584 | 1.847 | 1.30 | 0.29 | 3.38 | 2.69 | -0.426 | -0.460 | 26.32 | -12.79 |
| 200 | 800 | -2.329 | -1.570 | 2.076 | 1.18 | 0.41 | 3.64 | 2.67 | -0.569 | -0.597 | 34.44 | -17.07 |
| 200 | 1000 | -2.608 | -1.587 | 2.287 | 1.07 | 0.52 | 4.04 | 2.69 | -0.700 | -0.733 | 42.57 | -21.01 |
| 200 | 1200 | -2.951 | -1.630 | 2.508 | 0.93 | 0.66 | 4.53 | 2.76 | -0.838 | -0.870 | 50.70 | -25.14 |
| 100 | 1300 | -3.162 | -1.668 | 2.632 | 0.84 | 0.75 | 4.83 | 2.82 | -0.915 | -0.938 | 54.76 | -27.46 |
| 100 | 1400 | -3.379 | -1.708 | 2.749 | 0.75 | 0.83 | 5.14 | 2.88 | -0.988 | -1.006 | 58.82 | -29.64 |
| 100 | 1500 | -3.609 | -1.751 | 2.874 | 0.64 | 0.95 | 5.47 | 2.94 | -1.066 | -1.074 | 62.88 | -31.98 |

Effective splice length (critical bolt) ..... 4.5 in

Effective splice length (both bolts) ..... 4.4 in

* Nominal yield stress

Table G.6. *Results of 17 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.75
Dist to strain gauge (in) 8.25
Moment arm (in) .....16.75

BENDING TEST

FRANKLIN 3 lb/ft - 60ksi *
Face to face splice
Non-critical orientation

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs at Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | 1.067 | 0.804 | 1.216 | | | | | | | | |
| tight | | -0.714 | -1.846 | 1.385 | | | 3.34 | 5.25 | | | | |
| DL | | -0.499 | -1.749 | 1.418 | | | 2.94 | 5.06 | -0.051 | -0.051 | 1.94 | -1.53 |
| 0 | 0 | -0.493 | -1.712 | 1.410 | 2.44 | 0.00 | 2.93 | 4.99 | -0.046 | -0.051 | 1.94 | -1.38 |
| 200 | 200 | -0.615 | -1.585 | 1.593 | 2.36 | 0.08 | 3.16 | 4.73 | -0.160 | -0.191 | 10.25 | -4.80 |
| 200 | 400 | -0.768 | -1.448 | 1.768 | 2.27 | 0.18 | 3.44 | 4.46 | -0.269 | -0.332 | 18.56 | -8.07 |
| 200 | 600 | -0.965 | -1.302 | 1.977 | 2.17 | 0.28 | 3.81 | 4.17 | -0.399 | -0.472 | 26.87 | -11.98 |
| 200 | 800 | -1.211 | -1.133 | 2.184 | 2.04 | 0.41 | 4.27 | 3.84 | -0.528 | -0.613 | 35.19 | -15.85 |
| 200 | 1000 | -1.510 | -0.984 | 2.410 | 1.90 | 0.54 | 4.83 | 3.54 | -0.669 | -0.754 | 43.50 | -20.07 |
| 200 | 1200 | -1.866 | -0.818 | 2.677 | 1.74 | 0.70 | 5.50 | 3.21 | -0.836 | -0.894 | 51.81 | -25.07 |
| 100 | 1300 | -2.033 | -0.723 | 2.779 | 1.64 | 0.81 | 5.82 | 3.03 | -0.899 | -0.965 | 55.97 | -26.97 |
| 100 | 1400 | -2.250 | -0.621 | 2.942 | 1.52 | 0.92 | 6.22 | 2.82 | -1.001 | -1.035 | 60.12 | -30.02 |

Effective splice length (critical bolt) ..... 3.8 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table G.7. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) 9.19
Moment arm (in) .....17.50

BENDING TEST

FRANKLIN 4 lb/ft - 60ksi *
Back to back splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 0.418 | 0.411 | -0.238 | | | | | | | | |
| | tight | -2.924 | -2.686 | -0.232 | | | 4.77 | 4.75 | | | | |
| | DL | -2.873 | -2.639 | -0.157 | | | 4.69 | 4.68 | -0.048 | -0.048 | 1.86 | -1.44 |
| 0 | 0 | -2.843 | -2.633 | -0.158 | -0.91 | 0.00 | 4.65 | 4.67 | -0.047 | -0.048 | 1.86 | -1.42 |
| 200 | 200 | -2.835 | -2.728 | 0.008 | -0.98 | 0.07 | 4.64 | 4.82 | -0.151 | -0.147 | 8.11 | -4.52 |
| 200 | 400 | -2.732 | -2.830 | 0.179 | -1.05 | 0.14 | 4.49 | 4.97 | -0.257 | -0.246 | 14.36 | -7.72 |
| 200 | 600 | -2.569 | -2.936 | 0.346 | -1.15 | 0.24 | 4.26 | 5.14 | -0.361 | -0.345 | 20.61 | -10.84 |
| 200 | 800 | -2.481 | -3.068 | 0.522 | -1.23 | 0.32 | 4.13 | 5.34 | -0.471 | -0.444 | 26.86 | -14.13 |
| 200 | 1000 | -2.391 | -3.220 | 0.703 | -1.32 | 0.41 | 4.01 | 5.57 | -0.584 | -0.543 | 33.11 | -17.51 |
| 200 | 1200 | -2.292 | -3.444 | 0.894 | -1.42 | 0.51 | 3.87 | 5.92 | -0.703 | -0.642 | 39.36 | -21.08 |
| 200 | 1400 | -2.209 | -3.701 | 1.072 | -1.52 | 0.61 | 3.75 | 6.31 | -0.814 | -0.741 | 45.61 | -24.41 |
| 200 | 1600 | -2.107 | -4.009 | 1.294 | -1.64 | 0.73 | 3.60 | 6.78 | -0.952 | -0.840 | 51.86 | -28.56 |
| 100 | 1700 | -2.089 | -4.168 | 1.381 | -1.69 | 0.78 | 3.58 | 7.03 | -1.006 | -0.889 | 54.98 | -30.19 |
| 100 | 1800 | -2.066 | -4.323 | 1.462 | -1.75 | 0.84 | 3.54 | 7.27 | -1.057 | -0.939 | 58.11 | -31.70 |
| 100 | 1900 | -2.033 | -4.537 | 1.580 | -1.82 | 0.91 | 3.50 | 7.59 | -1.130 | -0.988 | 61.23 | -33.91 |

Effective lap splice (critical bolt) . 4.4 in

Effective lap splice (both bolts) .... N/A

* Nominal yield stress

Table G.8. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.63
Dist to strain gauge (in) 9.25
Moment arm (in) .....16.63

FRANKLIN 4 lb/ft - 60ksi *
Nested splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 0.297 | 0.288 | 0.145 | | | | | | | | |
| | tight | -1.672 | -1.652 | 0.148 | | | 2.81 | 2.98 | | | | |
| | DL | -1.626 | -1.559 | 0.072 | | | 2.74 | 2.83 | 0.049 | 0.049 | 1.86 | 1.48 |
| 0 | 0 | -1.521 | -1.598 | 0.051 | -0.77 | 0.00 | 2.59 | 2.89 | 0.062 | 0.049 | 1.86 | 1.87 |
| 200 | 200 | -1.443 | -1.731 | -0.098 | -0.83 | 0.06 | 2.48 | 3.10 | 0.155 | 0.136 | 7.80 | 4.65 |
| 200 | 400 | -1.346 | -1.894 | -0.227 | -0.90 | 0.13 | 2.34 | 3.35 | 0.236 | 0.224 | 13.74 | 7.07 |
| 200 | 600 | -1.250 | -2.065 | -0.373 | -0.97 | 0.20 | 2.21 | 3.61 | 0.326 | 0.312 | 19.68 | 9.79 |
| 200 | 800 | -1.146 | -2.247 | -0.528 | -1.05 | 0.28 | 2.06 | 3.89 | 0.423 | 0.400 | 25.61 | 12.69 |
| 200 | 1000 | -1.079 | -2.470 | -0.688 | -1.12 | 0.35 | 1.96 | 4.23 | 0.523 | 0.488 | 31.55 | 15.68 |
| 200 | 1200 | -1.006 | -2.745 | -0.822 | -1.20 | 0.43 | 1.86 | 4.66 | 0.606 | 0.576 | 37.49 | 18.19 |
| 200 | 1400 | -0.964 | -3.078 | -0.977 | -1.28 | 0.51 | 1.80 | 5.17 | 0.703 | 0.664 | 43.43 | 21.08 |
| 200 | 1600 | -0.938 | -3.432 | -1.123 | -1.37 | 0.60 | 1.76 | 5.71 | 0.794 | 0.751 | 49.37 | 23.81 |
| 200 | 1800 | -0.920 | -3.832 | -1.287 | -1.46 | 0.70 | 1.74 | 6.32 | 0.896 | 0.839 | 55.31 | 26.88 |
| 200 | 2000 | -0.960 | -2.886 | -0.961 | -1.57 | 0.80 | 1.79 | 4.87 | 0.693 | 0.927 | 61.25 | 20.79 |

Effective lap splice (critical bolt) . 4.7 in (@ 1800 lbs)

Effective lap splice (both bolts) .... N/A

* Nominal yield stress

Table G.9. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration; Assembled Backwards (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.56
Dist to strain gauge (in) 9.39
Moment arm (in) .....16.56

BENDING TEST

FRANKLIN 4 lb/ft - 60ksi *
Nested splice
Critical (backwards)

| LOAD (lbs) | | | | Defl Total | | BOLT LOADS (kips) | | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | @ Load (in) | Defl (in) | Bolt A | Bolt B | Obs | Calc | Base | Obs @ Gauge |
| | floor | 0.258 | 0.206 | 0.088 | | | | | | | | |
| | tight | -1.431 | -1.541 | 0.050 | | | 2.41 | 2.68 | | | | |
| | DL | -1.427 | -1.486 | 0.130 | | | 2.40 | 2.60 | -0.049 | -0.048 | 1.86 | -1.48 |
| 0 | 0 | -1.395 | -1.473 | 0.126 | -0.18 | 0.00 | 2.36 | 2.58 | -0.047 | -0.048 | 1.86 | -1.40 |
| 200 | 200 | -1.202 | -1.546 | 0.295 | -0.25 | 0.07 | 2.08 | 2.69 | -0.152 | -0.133 | 7.77 | -4.56 |
| 200 | 400 | -1.120 | -1.660 | 0.434 | -0.31 | 0.13 | 1.97 | 2.86 | -0.239 | -0.219 | 13.69 | -7.16 |
| 200 | 600 | -1.002 | -1.843 | 0.585 | -0.37 | 0.19 | 1.80 | 3.15 | -0.333 | -0.304 | 19.60 | -9.98 |
| 200 | 800 | -0.882 | -2.069 | 0.729 | -0.44 | 0.26 | 1.63 | 3.49 | -0.422 | -0.389 | 25.51 | -12.67 |
| 200 | 1000 | -0.788 | -2.399 | 0.883 | -0.52 | 0.34 | 1.49 | 4.00 | -0.518 | -0.475 | 31.43 | -15.55 |
| 200 | 1200 | -0.696 | -2.751 | 1.043 | -0.60 | 0.42 | 1.36 | 4.54 | -0.618 | -0.560 | 37.34 | -18.54 |
| 200 | 1400 | -0.642 | -3.126 | 1.197 | -0.69 | 0.51 | 1.28 | 5.11 | -0.714 | -0.646 | 43.26 | -21.42 |
| 200 | 1600 | -0.610 | -3.498 | 1.341 | -0.78 | 0.60 | 1.24 | 5.69 | -0.804 | -0.731 | 49.17 | -24.11 |
| 200 | 1800 | -0.585 | -3.922 | 1.506 | -0.95 | 0.77 | 1.20 | 6.34 | -0.907 | -0.816 | 55.09 | -27.20 |
| 100 | 1900 | -0.577 | -4.140 | 1.588 | -0.95 | 0.77 | 1.19 | 6.67 | -0.958 | -0.859 | 58.04 | -28.73 |

Effective lap splice (critical bolt) . 4.7 in

Effective lap splice (both bolts) .... N/A

* Nominal yield stress

Table G.10. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) 9.13
Moment arm (in) .....16.50

FRANKLIN 4 lb/ft - 60ksi *
Face to face splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 1.096 | 0.800 | -0.100 | | | | | | | | |
| | tight | -0.523 | -0.734 | -0.077 | | | 3.04 | 3.04 | | | | |
| | DL | -0.555 | -0.680 | -0.149 | | | 3.10 | 2.93 | 0.048 | 0.048 | 1.86 | 1.44 |
| 0 | 0 | -0.541 | -0.676 | -0.160 | -1.30 | 0.00 | 3.07 | 2.92 | 0.055 | 0.048 | 1.86 | 1.64 |
| 200 | 200 | -0.467 | -0.752 | -0.304 | -1.37 | 0.08 | 2.93 | 3.08 | 0.145 | 0.136 | 7.75 | 4.34 |
| 200 | 400 | -0.396 | -0.880 | -0.464 | -1.44 | 0.15 | 2.80 | 3.33 | 0.244 | 0.224 | 13.64 | 7.33 |
| 200 | 600 | -0.330 | -1.047 | -0.603 | -1.52 | 0.22 | 2.67 | 3.66 | 0.331 | 0.312 | 19.54 | 9.93 |
| 200 | 800 | -0.267 | -1.258 | -0.740 | -1.59 | 0.29 | 2.56 | 4.08 | 0.416 | 0.399 | 25.43 | 12.49 |
| 200 | 1000 | -0.201 | -1.479 | -0.891 | -1.67 | 0.37 | 2.43 | 4.52 | 0.510 | 0.487 | 31.32 | 15.31 |
| 200 | 1200 | -0.115 | -1.746 | -1.051 | -1.76 | 0.46 | 2.27 | 5.04 | 0.610 | 0.575 | 37.21 | 18.30 |
| 200 | 1400 | -0.039 | -2.027 | -1.209 | -1.84 | 0.54 | 2.13 | 5.60 | 0.708 | 0.663 | 43.11 | 21.25 |
| 200 | 1600 | 0.031 | -2.325 | -1.362 | -1.92 | 0.62 | 2.00 | 6.19 | 0.804 | 0.750 | 49.00 | 24.11 |
| 200 | 1800 | 0.164 | -2.655 | -1.531 | -2.01 | 0.71 | 1.75 | 6.85 | 0.909 | 0.838 | 54.89 | 27.27 |
| 200 | 2000 | 0.323 | -3.005 | -1.686 | -2.11 | 0.81 | 1.45 | 7.54 | 1.006 | 0.926 | 60.79 | 30.17 |

Effective lap splice (critical bolt) . 4.4 in

Effective lap splice (both bolts) .... N/A

* Nominal yield stress

Table G.11. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.75
Dist to strain gauge (in) 9.38
Moment arm (in) .....16.75

BENDING TEST

FRANKLIN 4 lb/ft - 60ksi *
Back to back splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 0.431 | 0.416 | -0.170 | | | | | | | | |
| | tight | -2.014 | -2.672 | -1.640 | | | 3.49 | 4.74 | | | | |
| | DL | -2.105 | -2.607 | -0.237 | | | 3.62 | 4.64 | 0.048 | 0.048 | 1.87 | 1.44 |
| 0 | 0 | -2.089 | -2.596 | -0.232 | 0.93 | 0.00 | 3.59 | 4.62 | 0.045 | 0.048 | 1.87 | 1.35 |
| 200 | 200 | -2.170 | -2.501 | -0.329 | 0.86 | 0.07 | 3.71 | 4.48 | 0.105 | 0.136 | 7.85 | 3.16 |
| 200 | 400 | -2.274 | -2.433 | -0.563 | 0.79 | 0.14 | 3.86 | 4.37 | 0.251 | 0.224 | 13.83 | 7.53 |
| 200 | 600 | -2.382 | -2.370 | -0.724 | 0.72 | 0.22 | 4.01 | 4.28 | 0.351 | 0.311 | 19.81 | 10.54 |
| 200 | 800 | -2.495 | -2.305 | -1.023 | 0.64 | 0.29 | 4.17 | 4.18 | 0.538 | 0.399 | 25.79 | 16.13 |
| 200 | 1000 | -2.634 | -2.241 | -1.085 | 0.56 | 0.37 | 4.37 | 4.08 | 0.576 | 0.487 | 31.78 | 17.29 |
| 200 | 1200 | -2.806 | -2.209 | -1.254 | 0.48 | 0.45 | 4.62 | 4.03 | 0.682 | 0.575 | 37.76 | 20.45 |
| 200 | 1400 | -3.013 | -2.173 | -1.439 | 0.40 | 0.54 | 4.91 | 3.97 | 0.797 | 0.662 | 43.74 | 23.91 |
| 200 | 1600 | -3.239 | -2.167 | -1.633 | 0.32 | 0.61 | 5.23 | 3.96 | 0.918 | 0.750 | 49.72 | 27.53 |
| 200 | 1800 | -3.474 | -2.163 | -1.822 | 0.22 | 0.71 | 5.57 | 3.96 | 1.036 | 0.838 | 55.71 | 31.07 |
| 100 | 1900 | -3.601 | -2.165 | -1.921 | 0.18 | 0.75 | 5.75 | 3.96 | 1.097 | 0.882 | 58.70 | 32.92 |
| 100 | 2000 | -3.762 | -2.171 | -2.025 | 0.11 | 0.82 | 5.98 | 3.97 | 1.162 | 0.925 | 61.69 | 34.86 |

Effective lap splice (critical bolt) . 5.6 in

Effective lap splice (both bolts) .... 5.6 in

* Nominal yield stress

Table G.12. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.88
Dist to strain gauge (in). 9.44
Moment arm (in) .....16.88

BENDING TEST

FRANKLIN 4 lb/ft - 60ksi *
Nested splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl Total @ Load (in) | Defl Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | 0.414 | 0.375 | -0.175 | | | | | | | | |
| tight | | -1.451 | -0.999 | -0.116 | | | 2.66 | 2.11 | | | | |
| DL | | -1.391 | -0.853 | -0.039 | | | 2.57 | 1.88 | -0.048 | -0.048 | 1.86 | -1.44 |
| 0 | 0 | -1.389 | -0.835 | -0.034 | 1.63 | 0.00 | 2.57 | 1.86 | -0.051 | -0.048 | 1.86 | -1.53 |
| 200 | 200 | -1.489 | -0.725 | 0.116 | 1.56 | 0.07 | 2.71 | 1.69 | -0.145 | -0.137 | 7.89 | -4.34 |
| 200 | 400 | -1.608 | -0.636 | 0.274 | 1.49 | 0.14 | 2.88 | 1.55 | -0.243 | -0.225 | 13.91 | -7.29 |
| 200 | 600 | -1.746 | -0.576 | 0.424 | 1.42 | 0.21 | 3.08 | 1.46 | -0.336 | -0.314 | 19.94 | -10.09 |
| 200 | 800 | -1.905 | -0.529 | 0.591 | 1.35 | 0.29 | 3.31 | 1.39 | -0.440 | -0.402 | 25.97 | -13.21 |
| 200 | 1000 | -2.093 | -0.495 | 0.754 | 1.27 | 0.37 | 3.58 | 1.34 | -0.542 | -0.491 | 32.00 | -16.26 |
| 200 | 1200 | -2.309 | -0.469 | 0.914 | 1.19 | 0.44 | 3.88 | 1.30 | -0.642 | -0.580 | 38.03 | -19.25 |
| 200 | 1400 | -2.545 | -0.452 | 1.072 | 1.11 | 0.52 | 4.22 | 1.27 | -0.740 | -0.668 | 44.06 | -22.21 |
| 200 | 1600 | -2.823 | -0.442 | 1.245 | 1.02 | 0.61 | 4.62 | 1.25 | -0.848 | -0.757 | 50.09 | -25.44 |
| 200 | 1800 | -3.124 | -0.445 | 1.482 | 0.93 | 0.70 | 5.05 | 1.26 | -0.996 | -0.845 | 56.11 | -29.87 |
| 200 | 2000 | -3.450 | -0.463 | 1.451 | 0.81 | 0.82 | 5.51 | 1.29 | -0.976 | -0.934 | 62.14 | -29.29 |

Effective lap splice (critical bolt) . 6.1 in

Effective lap splice (both bolts) .... 6.1 in

* Nominal yield stress

Table G.13. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Non-critical Configuration; Assembled Backwards (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.63
Dist to strain gauge (in) 9.06
Moment arm (in) .....16.63

FRANKLIN 4 lb/ft - 60ksi *
Nested splice
Non-critical (backwards)

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl Total @ Load (in) | Defl Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 0.157 | 0.165 | -0.168 | | | | | | | | |
| | tight | -1.997 | -1.860 | -0.171 | | | 3.07 | 3.11 | | | | |
| | DL | -1.844 | -1.734 | -0.238 | | | 2.85 | 2.91 | 0.049 | 0.049 | 1.86 | 1.48 |
| 0 | 0 | -1.824 | -1.726 | -0.215 | 0.60 | 0.00 | 2.83 | 2.90 | 0.035 | 0.049 | 1.86 | 1.05 |
| 200 | 200 | -1.945 | -1.610 | -0.363 | 0.54 | 0.06 | 3.00 | 2.72 | 0.127 | 0.139 | 7.80 | 3.81 |
| 200 | 400 | -2.064 | -1.493 | -0.520 | 0.48 | 0.12 | 3.17 | 2.54 | 0.225 | 0.229 | 13.74 | 6.75 |
| 200 | 600 | -2.189 | -1.403 | -0.649 | 0.42 | 0.18 | 3.35 | 2.41 | 0.305 | 0.319 | 19.68 | 9.16 |
| 200 | 800 | -2.331 | -1.317 | -0.799 | 0.36 | 0.24 | 3.55 | 2.27 | 0.399 | 0.409 | 25.61 | 11.96 |
| 200 | 1000 | -2.486 | -1.234 | -0.963 | 0.29 | 0.31 | 3.77 | 2.15 | 0.501 | 0.499 | 31.55 | 15.03 |
| 200 | 1200 | -2.664 | -1.178 | -1.114 | 0.22 | 0.38 | 4.02 | 2.06 | 0.595 | 0.589 | 37.49 | 17.85 |
| 200 | 1400 | -2.850 | -1.131 | -1.274 | 0.14 | 0.46 | 4.29 | 1.99 | 0.695 | 0.679 | 43.43 | 20.84 |
| 200 | 1600 | -3.070 | -1.105 | -1.431 | 0.07 | 0.54 | 4.60 | 1.95 | 0.793 | 0.769 | 49.37 | 23.78 |
| 200 | 1800 | -3.303 | -1.088 | -1.603 | -0.03 | 0.63 | 4.94 | 1.92 | 0.900 | 0.860 | 55.31 | 26.99 |
| 200 | 2000 | -3.553 | -1.086 | -1.759 | -0.12 | 0.73 | 5.29 | 1.92 | 0.997 | 0.950 | 61.25 | 29.91 |
| 200 | 2200 | -3.836 | -1.107 | -1.666 | -0.24 | 0.84 | 5.70 | 1.95 | 0.939 | 1.040 | 67.19 | 28.17 |

Effective lap splice (critical bolt) . 6.4 in

Effective lap splice (both bolts) .... 6.4 in

* Nominal yield stress

Table G.14. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) 9.13
Moment arm (in) .....16.50

FRANKLIN 4 lb/ft - 60ksi *
Face to face splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | 1.091 | 0.809 | -1.050 | | | | | | | | |
| tight | | -0.427 | -0.719 | -0.058 | | | 2.85 | 3.03 | | | | |
| DL | | -0.196 | -0.575 | 0.015 | | | 2.41 | 2.74 | -0.048 | -0.048 | 1.86 | -1.44 |
| 0 | 0 | -0.171 | -0.504 | 0.033 | 2.47 | 0.00 | 2.37 | 2.60 | -0.059 | -0.048 | 1.86 | -1.78 |
| 200 | 200 | -0.244 | -0.429 | 0.017 | 2.42 | 0.05 | 2.50 | 2.45 | -0.049 | -0.136 | 7.75 | -1.48 |
| 200 | 400 | -0.320 | -0.337 | 0.326 | 2.36 | 0.11 | 2.65 | 2.27 | -0.242 | -0.224 | 13.64 | -7.25 |
| 200 | 600 | -0.411 | -0.260 | 0.444 | 2.30 | 0.17 | 2.82 | 2.12 | -0.315 | -0.312 | 19.54 | -9.46 |
| 200 | 800 | -0.518 | -0.157 | 0.607 | 2.24 | 0.23 | 3.02 | 1.91 | -0.417 | -0.399 | 25.43 | -12.50 |
| 200 | 1000 | -0.650 | -0.056 | 0.766 | 2.16 | 0.31 | 3.27 | 1.71 | -0.516 | -0.487 | 31.32 | -15.48 |
| 200 | 1200 | -0.804 | 0.022 | 0.914 | 2.10 | 0.37 | 3.55 | 1.56 | -0.608 | -0.575 | 37.21 | -18.24 |
| 200 | 1400 | -0.938 | 0.116 | 1.087 | 2.02 | 0.45 | 3.81 | 1.37 | -0.716 | -0.663 | 43.11 | -21.48 |
| 200 | 1600 | -1.181 | 0.207 | 1.262 | 1.93 | 0.54 | 4.26 | 1.19 | -0.825 | -0.750 | 49.00 | -24.75 |
| 200 | 1800 | -1.407 | 0.306 | 1.430 | 1.83 | 0.64 | 4.69 | 1.00 | -0.930 | -0.838 | 54.89 | -27.89 |
| 200 | 2000 | -1.693 | 0.392 | 1.596 | 1.73 | 0.74 | 5.22 | 0.83 | -1.033 | -0.926 | 60.79 | -30.99 |

Effective lap splice (critical bolt) . 6.3 in

Effective lap splice (both bolts) .... N/A

* Nominal yield stress

Table G.15. *Results of 17 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) 9.00
Moment arm (in) .....17.38

MARION 3 lb/ft - 80ksi *
Back to back splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.833 | -0.657 | 0.995 | | | | | | | | |
| | tight | -2.533 | -2.371 | 1.021 | | | 3.19 | 3.40 | | | | |
| | DL | -2.638 | -2.363 | 1.105 | | | 3.39 | 3.38 | 0.041 | 0.041 | 1.91 | 1.23 |
| 0 | 0 | -2.609 | -2.356 | 1.103 | -1.03 | 0.00 | 3.33 | 3.37 | 0.040 | 0.041 | 1.91 | 1.19 |
| 200 | 200 | -2.622 | -2.344 | 1.288 | -1.10 | 0.07 | 3.36 | 3.34 | 0.155 | 0.152 | 10.37 | 4.65 |
| 200 | 400 | -2.644 | -2.343 | 1.481 | -1.17 | 0.14 | 3.40 | 3.34 | 0.275 | 0.263 | 18.82 | 8.26 |
| 200 | 600 | -2.643 | -2.336 | 1.677 | -1.24 | 0.21 | 3.40 | 3.33 | 0.397 | 0.374 | 27.28 | 11.92 |
| 200 | 800 | -2.632 | -2.328 | 1.868 | -1.31 | 0.28 | 3.37 | 3.31 | 0.516 | 0.485 | 35.74 | 15.49 |
| 200 | 1000 | -2.646 | -2.373 | 2.066 | -1.37 | 0.35 | 3.40 | 3.40 | 0.640 | 0.596 | 44.20 | 19.19 |
| 200 | 1200 | -2.638 | -2.477 | 2.275 | -1.45 | 0.42 | 3.39 | 3.61 | 0.770 | 0.707 | 52.65 | 23.10 |
| 200 | 1400 | -2.599 | -2.685 | 2.481 | -1.55 | 0.52 | 3.31 | 4.02 | 0.898 | 0.818 | 61.11 | 26.95 |
| 200 | 1600 | -2.602 | -2.981 | 2.688 | -1.63 | 0.60 | 3.32 | 4.60 | 1.027 | 0.929 | 69.57 | 30.82 |
| 200 | 1800 | -2.553 | -3.184 | 2.895 | -1.74 | 0.71 | 3.23 | 5.01 | 1.156 | 1.040 | 78.03 | 34.69 |
| 200 | 2000 | -2.552 | -3.508 | 3.114 | -1.83 | 0.81 | 3.22 | 5.65 | 1.293 | 1.151 | 86.48 | 38.78 |
| 200 | 2200 | -2.486 | -3.746 | 3.333 | -1.96 | 0.94 | 3.10 | 6.12 | 1.429 | 1.262 | 94.94 | 42.87 |
| 200 | 2400 | -2.427 | -4.029 | 3.541 | -2.11 | 1.08 | 2.99 | 6.68 | 1.559 | 1.373 | 103.40 | 46.76 |

Effective splice length (critical bolt) ..... 6.2 in

Effective splice length (both bolts) ..... N/A in

* Nominal yield stress

Table G.16. *Results of 17 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.69
Dist to strain gauge (in). 9.25
Moment arm (in) .....16.69

BENDING TEST

MARION 3 lb/ft - 80ksi *
Nested splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs at Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.253 | -0.135 | 0.944 | | | | | | | | |
| | tight | -2.363 | -2.094 | 0.941 | | | 3.01 | 3.01 | | | | |
| | DL | -2.223 | -2.070 | 0.868 | | | 2.81 | 2.97 | 0.040 | 0.040 | 1.89 | 1.20 |
| 0 | 0 | -2.208 | -2.053 | 0.849 | -0.21 | 0.00 | 2.79 | 2.94 | 0.052 | 0.040 | 1.89 | 1.56 |
| 200 | 200 | -2.154 | -2.141 | 0.688 | -0.29 | 0.07 | 2.71 | 3.08 | 0.152 | 0.139 | 10.01 | 4.56 |
| 200 | 400 | -2.108 | -2.220 | 0.539 | -0.35 | 0.14 | 2.65 | 3.20 | 0.245 | 0.238 | 18.14 | 7.35 |
| 200 | 600 | -2.069 | -2.325 | 0.382 | -0.43 | 0.22 | 2.59 | 3.36 | 0.343 | 0.336 | 26.26 | 10.28 |
| 200 | 800 | -2.038 | -2.455 | 0.223 | -0.51 | 0.30 | 2.55 | 3.56 | 0.442 | 0.435 | 34.38 | 13.26 |
| 200 | 1000 | -2.024 | -2.650 | 0.056 | -0.59 | 0.38 | 2.53 | 3.86 | 0.546 | 0.533 | 42.50 | 16.38 |
| 200 | 1200 | -2.017 | -2.907 | -0.113 | -0.68 | 0.46 | 2.52 | 4.25 | 0.651 | 0.632 | 50.62 | 19.54 |
| 200 | 1400 | -2.019 | -3.229 | -2.890 | -0.77 | 0.55 | 2.52 | 4.75 | 2.381 | 0.731 | 58.74 | 71.44 |
| 200 | 1600 | -2.027 | -3.602 | -0.468 | -0.86 | 0.65 | 2.53 | 5.32 | 0.872 | 0.829 | 66.87 | 26.17 |
| 200 | 1800 | -2.041 | -3.931 | -0.649 | -0.96 | 0.75 | 2.55 | 5.83 | 0.985 | 0.928 | 74.99 | 29.56 |
| 100 | 1900 | -2.051 | -3.116 | -0.739 | -1.01 | 0.80 | 2.56 | 4.58 | 1.041 | 0.977 | 79.05 | 31.24 |
| 100 | 2000 | -2.064 | -3.277 | -0.835 | -1.07 | 0.86 | 2.58 | 4.82 | 1.101 | 1.026 | 83.11 | 33.03 |

Effective splice length (critical bolt) ..... 5.2 in (@ 1800 lbs)

Effective splice length (both bolts) ..... 5.1 in (@ 1800 lbs)

* Nominal yield stress

Table G.17. *Results of 17 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.88
Dist to strain gauge (in) 9.38
Moment arm (in) .....16.88

MARION 3 lb/ft - 80ksi *
Face to face splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Obs at Base | STRESS (ksi) Obs at Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 1.079 | 0.753 | 1.152 | | | | | | | | |
| | tight | -1.389 | -1.003 | 1.118 | | | 4.63 | 3.48 | | | | |
| | DL | -1.361 | -1.270 | 1.061 | | | 4.58 | 4.01 | 0.041 | 0.041 | 1.90 | 1.23 |
| 0 | 0 | -1.349 | -1.273 | 1.078 | -1.47 | 0.00 | 4.55 | 4.01 | 0.030 | 0.041 | 1.90 | 0.91 |
| 200 | 200 | -1.259 | -1.467 | 0.881 | -1.55 | 0.08 | 4.39 | 4.40 | 0.153 | 0.140 | 10.11 | 4.59 |
| 200 | 400 | -1.161 | -1.541 | 0.751 | -1.63 | 0.16 | 4.20 | 4.55 | 0.234 | 0.240 | 18.33 | 7.02 |
| 200 | 600 | -1.063 | -1.706 | 0.553 | -1.72 | 0.25 | 4.02 | 4.87 | 0.358 | 0.339 | 26.54 | 10.73 |
| 200 | 800 | -0.958 | -1.860 | 0.390 | -1.80 | 0.33 | 3.82 | 5.18 | 0.459 | 0.438 | 34.75 | 13.77 |
| 200 | 1000 | -0.882 | -2.038 | 0.234 | -1.87 | 0.40 | 3.68 | 5.53 | 0.556 | 0.538 | 42.97 | 16.69 |
| 200 | 1200 | -0.747 | -2.227 | 0.073 | -1.97 | 0.50 | 3.43 | 5.90 | 0.657 | 0.637 | 51.18 | 19.70 |
| 200 | 1400 | -0.630 | -2.474 | -0.100 | -2.07 | 0.60 | 3.21 | 6.39 | 0.764 | 0.737 | 59.40 | 22.93 |
| 200 | 1600 | -0.524 | -2.750 | -0.286 | -2.17 | 0.70 | 3.01 | 6.94 | 0.880 | 0.836 | 67.61 | 26.41 |
| 200 | 1800 | -0.421 | -3.032 | 0.456 | -2.27 | 0.80 | 2.81 | 7.50 | 0.418 | 0.936 | 75.83 | 12.54 |

Effective splice length (critical bolt) ..... 4.1 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table G.18. *Results of 17 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.63
Dist to strain gauge (in) 9.13
Moment arm (in) .....16.63

MARION 3 lb/ft - 80ksi *
Back to back splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.868 | -0.696 | 1.006 | | | | | | | | |
| | tight | -2.762 | -2.126 | 1.034 | | | 2.86 | 2.25 | | | | |
| | DL | -2.852 | -2.248 | 0.984 | | | 2.99 | 2.44 | 0.040 | 0.040 | 1.91 | 1.20 |
| 0 | 0 | -2.840 | -2.233 | 0.989 | 1.11 | 0.00 | 2.98 | 2.42 | 0.037 | 0.040 | 1.91 | 1.11 |
| 200 | 200 | -2.805 | -2.229 | 0.817 | 1.05 | 0.06 | 2.92 | 2.41 | 0.144 | 0.140 | 10.00 | 4.32 |
| 200 | 400 | -2.781 | -2.222 | 0.634 | 0.99 | 0.12 | 2.89 | 2.40 | 0.258 | 0.239 | 18.09 | 7.74 |
| 200 | 600 | -2.748 | -2.222 | 0.467 | 0.93 | 0.17 | 2.84 | 2.40 | 0.362 | 0.339 | 26.18 | 10.86 |
| 200 | 800 | -2.720 | -2.211 | 0.311 | 0.86 | 0.25 | 2.79 | 2.38 | 0.459 | 0.438 | 34.28 | 13.78 |
| 200 | 1000 | -2.690 | -2.210 | 0.098 | 0.78 | 0.32 | 2.75 | 2.38 | 0.592 | 0.537 | 42.37 | 17.76 |
| 200 | 1200 | -2.678 | -2.211 | -0.056 | 0.72 | 0.39 | 2.73 | 2.38 | 0.688 | 0.637 | 50.46 | 20.64 |
| 200 | 1400 | -2.661 | -2.214 | -0.232 | 0.64 | 0.47 | 2.71 | 2.39 | 0.798 | 0.736 | 58.55 | 23.93 |
| 200 | 1600 | -2.650 | -2.218 | -0.414 | 0.56 | 0.55 | 2.69 | 2.39 | 0.911 | 0.836 | 66.65 | 27.33 |
| 200 | 1800 | -2.659 | -2.219 | -0.588 | 0.47 | 0.64 | 2.70 | 2.39 | 1.019 | 0.935 | 74.74 | 30.58 |
| 200 | 2000 | -2.779 | -2.209 | -0.773 | 0.37 | 0.73 | 2.88 | 2.38 | 1.135 | 1.034 | 82.83 | 34.04 |
| 200 | 2200 | -2.900 | -2.183 | -0.957 | 0.26 | 0.85 | 3.07 | 2.34 | 1.249 | 1.134 | 90.92 | 37.48 |
| 200 | 2400 | -3.095 | -2.127 | -1.134 | 0.11 | 1.00 | 3.36 | 2.25 | 1.360 | 1.233 | 99.02 | 40.79 |
| 200 | 2600 | -3.303 | -2.061 | -1.328 | -0.01 | 1.11 | 3.67 | 2.14 | 1.480 | 1.333 | 107.11 | 44.41 |
| 200 | 2800 | -3.479 | -1.989 | -1.508 | -0.29 | 1.39 | 3.94 | 2.03 | 1.593 | 1.432 | 115.20 | 47.78 |

Effective splice length (critical bolt) ..... 11.8 in

Effective splice length (both bolts) ..... N/A in

* Nominal yield stress

Table G.19. *Results of 17 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) 9.00
Moment arm (in) .....17.50

MARION 3 lb/ft - 80ksi *
Nested splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tota | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs at Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 0.685 | 0.556 | 1.148 | | | | | | | | |
| | tight | -3.497 | -3.109 | 1.183 | | | 4.01 | 3.92 | | | | |
| | DL | -3.985 | -3.627 | 1.265 | | | 4.71 | 4.71 | 0.041 | 0.041 | 1.90 | 1.23 |
| 0 | 0 | -3.946 | -3.540 | 1.274 | 1.41 | 0.00 | 4.65 | 4.58 | 0.047 | 0.041 | 1.90 | 1.40 |
| 200 | 200 | -4.007 | -3.420 | 1.461 | 1.33 | 0.08 | 4.74 | 4.40 | 0.163 | 0.153 | 10.41 | 4.89 |
| 200 | 400 | -4.057 | -3.308 | 1.620 | 1.27 | 0.14 | 4.81 | 4.22 | 0.262 | 0.266 | 18.93 | 7.87 |
| 200 | 600 | -4.105 | -3.170 | 1.811 | 1.18 | 0.23 | 4.88 | 4.01 | 0.381 | 0.379 | 27.45 | 11.44 |
| 200 | 800 | -4.210 | -3.098 | 2.011 | 1.10 | 0.31 | 5.03 | 3.90 | 0.506 | 0.491 | 35.96 | 15.17 |
| 200 | 1000 | -4.290 | -3.012 | 2.204 | 1.01 | 0.41 | 5.14 | 3.77 | 0.626 | 0.604 | 44.48 | 18.78 |
| 200 | 1200 | -4.415 | -2.968 | 2.385 | 0.93 | 0.48 | 5.32 | 3.70 | 0.739 | 0.717 | 52.99 | 22.16 |
| 200 | 1400 | -4.480 | -2.906 | 2.580 | 0.82 | 0.60 | 5.41 | 3.61 | 0.860 | 0.829 | 61.51 | 25.81 |
| 200 | 1600 | -4.651 | -2.879 | 2.781 | 0.73 | 0.68 | 5.66 | 3.57 | 0.986 | 0.942 | 70.02 | 29.57 |

Effective splice length (critical bolt) ..... 4.9 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table G.20. *Results of 17 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) 8.75
Moment arm (in) .....17.38

MARION 3 lb/ft - 80ksi *
Face to face splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl Total @ Load (in) | Defl Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs at Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 1.098 | 0.797 | 1.159 | | | | | | | | |
| | tight | -0.621 | -1.307 | 1.127 | | | 3.22 | 4.17 | | | | |
| | DL | -0.582 | -1.138 | 1.208 | | | 3.15 | 3.83 | 0.041 | 0.041 | 1.90 | 1.23 |
| 0 | 0 | -0.558 | -1.145 | 1.192 | 2.67 | 0.00 | 3.11 | 3.85 | 0.031 | 0.041 | 1.90 | 0.93 |
| 200 | 200 | -0.675 | -0.930 | 1.425 | 2.56 | 0.11 | 3.33 | 3.42 | 0.176 | 0.155 | 10.36 | 5.29 |
| 200 | 400 | -0.785 | -0.779 | 1.602 | 2.48 | 0.19 | 3.53 | 3.12 | 0.286 | 0.269 | 18.81 | 8.59 |
| 200 | 600 | -0.926 | -0.654 | 1.776 | 2.40 | 0.27 | 3.80 | 2.87 | 0.395 | 0.384 | 27.27 | 11.85 |
| 200 | 800 | -1.078 | -0.519 | 1.972 | 2.30 | 0.37 | 4.08 | 2.61 | 0.517 | 0.498 | 35.73 | 15.51 |
| 200 | 1000 | -1.261 | -0.385 | 2.169 | 2.20 | 0.47 | 4.43 | 2.34 | 0.640 | 0.612 | 44.19 | 19.19 |
| 200 | 1200 | -1.466 | -0.268 | 2.371 | 2.11 | 0.56 | 4.81 | 2.11 | 0.766 | 0.727 | 52.64 | 22.97 |
| 200 | 1400 | -1.696 | -0.161 | 2.578 | 2.01 | 0.67 | 5.24 | 1.90 | 0.895 | 0.841 | 61.10 | 26.84 |
| 200 | 1600 | -1.926 | -0.063 | 2.765 | 1.91 | 0.76 | 5.67 | 1.70 | 1.011 | 0.956 | 69.56 | 30.33 |
| 200 | 1800 | -2.198 | 0.039 | 2.989 | 1.79 | 0.89 | 6.18 | 1.50 | 1.151 | 1.070 | 78.01 | 34.52 |

Effective splice length (critical bolt) ..... 5.1 in

Effective splice length (both bolts) ..... N/A in

* Nominal yield stress

Table G.21. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.56
Dist to strain gauge (in) 13.19
Moment arm (in) .....16.56

BENDING TEST

MARION 4 lb/ft - 80ksi *
Back to back splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 0.228 | 0.195 | 1.259 | | | | | | | | |
| | tight | -1.313 | -1.400 | 1.235 | | | 2.20 | 2.45 | | | | |
| | DL | -1.416 | -1.435 | 1.313 | | | 2.34 | 2.50 | 0.034 | 0.034 | 1.92 | 1.02 |
| 0 | 0 | -1.329 | -1.426 | 1.317 | -0.99 | 0.00 | 2.22 | 2.49 | 0.037 | 0.034 | 1.92 | 1.10 |
| 200 | 200 | -1.361 | -1.459 | 1.435 | -1.04 | 0.05 | 2.27 | 2.54 | 0.110 | 0.066 | 7.99 | 3.30 |
| 200 | 400 | -1.372 | -1.493 | 1.551 | -1.08 | 0.09 | 2.28 | 2.59 | 0.182 | 0.097 | 14.07 | 5.47 |
| 200 | 600 | -1.358 | -1.543 | 1.677 | -1.13 | 0.14 | 2.26 | 2.67 | 0.261 | 0.129 | 20.15 | 7.82 |
| 200 | 800 | -1.338 | -1.667 | 1.788 | -1.17 | 0.18 | 2.23 | 2.86 | 0.330 | 0.160 | 26.23 | 9.90 |
| 200 | 1000 | -1.312 | -2.029 | 1.950 | -1.22 | 0.23 | 2.20 | 3.41 | 0.431 | 0.192 | 32.30 | 12.93 |
| 200 | 1200 | -1.286 | -2.442 | 2.031 | -1.28 | 0.29 | 2.16 | 4.05 | 0.481 | 0.224 | 38.38 | 14.44 |
| 200 | 1400 | -1.270 | -2.898 | 2.163 | -1.33 | 0.34 | 2.14 | 4.75 | 0.564 | 0.255 | 44.46 | 16.91 |
| 200 | 1600 | -1.248 | -3.293 | 2.278 | -1.39 | 0.40 | 2.11 | 5.35 | 0.635 | 0.287 | 50.53 | 19.06 |
| 200 | 1800 | -1.229 | -3.743 | 2.411 | -1.44 | 0.45 | 2.08 | 6.04 | 0.718 | 0.319 | 56.61 | 21.54 |
| 200 | 2000 | -1.218 | -4.153 | 2.523 | -1.49 | 0.50 | 2.06 | 6.67 | 0.788 | 0.350 | 62.69 | 23.64 |
| 200 | 2200 | -1.200 | -4.604 | 2.640 | -1.55 | 0.56 | 2.04 | 7.37 | 0.861 | 0.382 | 68.77 | 25.82 |

Effective splice length (critical bolt) ..... 4.9 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table G.22. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.63
Dist to strain gauge (in). 9.31
Moment arm (in) .....16.63

BENDING TEST

MARION 4 lb/ft - 80ksi *
Nested splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl Total @ Load (in) | Defl Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs at Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 0.209 | 0.176 | -0.343 | | | | | | | | |
| | tight | -1.961 | -1.653 | -0.307 | | | 3.10 | 2.81 | | | | |
| | DL | -1.889 | -1.708 | -0.360 | | | 2.99 | 2.89 | 0.038 | 0.038 | 1.92 | 1.14 |
| | 0 | -1.849 | -1.622 | -0.367 | -0.13 | 0.00 | 2.94 | 2.76 | 0.042 | 0.038 | 1.92 | 1.27 |
| 200 | 200 | -1.710 | -1.790 | -0.429 | -0.18 | 0.05 | 2.74 | 3.02 | 0.081 | 0.107 | 8.02 | 2.43 |
| 200 | 400 | -1.618 | -1.939 | -0.606 | -0.22 | 0.09 | 2.61 | 3.25 | 0.191 | 0.175 | 14.13 | 5.74 |
| 200 | 600 | -1.499 | -2.101 | -0.718 | -0.27 | 0.14 | 2.44 | 3.50 | 0.261 | 0.244 | 20.23 | 7.83 |
| 200 | 800 | -1.409 | -2.289 | -0.837 | -0.31 | 0.19 | 2.31 | 3.78 | 0.335 | 0.313 | 26.33 | 10.06 |
| 200 | 1000 | -1.273 | -2.533 | -0.966 | -0.37 | 0.24 | 2.11 | 4.16 | 0.416 | 0.382 | 32.43 | 12.47 |
| 200 | 1200 | -1.187 | -2.820 | -1.082 | -0.42 | 0.30 | 1.99 | 4.60 | 0.488 | 0.450 | 38.54 | 14.64 |
| 200 | 1400 | -1.113 | -3.161 | -1.204 | -0.48 | 0.35 | 1.89 | 5.12 | 0.564 | 0.519 | 44.64 | 16.92 |
| 200 | 1600 | -1.052 | -3.451 | -1.327 | -0.53 | 0.41 | 1.80 | 5.57 | 0.640 | 0.588 | 50.74 | 19.21 |
| 200 | 1800 | -1.001 | -3.967 | -1.455 | -0.59 | 0.47 | 1.73 | 6.36 | 0.720 | 0.657 | 56.85 | 21.61 |
| 200 | 2000 | -0.965 | -4.389 | -1.582 | -0.65 | 0.52 | 1.67 | 7.01 | 0.799 | 0.725 | 62.95 | 23.98 |
| 100 | 2100 | -0.942 | -4.631 | -1.643 | -0.69 | 0.56 | 1.64 | 7.38 | 0.837 | 0.760 | 66.00 | 25.12 |

Effective splice length (critical bolt) ..... 4.7 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table G.23. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Grade 8 Field Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.63
Dist to strain gauge (in) 9.25
Moment arm (in) .....16.63

BENDING TEST

MARION 4 lb/ft - 80ksi *
Face to face splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl Total @ Load (in) | Defl Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs at Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | 1.050 | 0.801 | 1.267 | | | | | | | | |
| tight | | -0.489 | -0.851 | 1.272 | | | 2.89 | 3.27 | | | | |
| DL | | -0.365 | -0.851 | 1.216 | | | 2.65 | 3.27 | 0.038 | 0.038 | 1.92 | 1.14 |
| 0 | 0 | -0.360 | -0.838 | 1.237 | -1.40 | 0.00 | 2.64 | 3.25 | 0.025 | 0.038 | 1.92 | 0.75 |
| 200 | 200 | -0.290 | -0.947 | 1.119 | -1.46 | 0.06 | 2.51 | 3.46 | 0.098 | 0.107 | 8.02 | 2.95 |
| 200 | 400 | -0.209 | -1.031 | 0.997 | -1.51 | 0.11 | 2.36 | 3.63 | 0.174 | 0.177 | 14.13 | 5.23 |
| 200 | 600 | -0.156 | -1.147 | 0.879 | -1.56 | 0.16 | 2.26 | 3.86 | 0.248 | 0.246 | 20.23 | 7.44 |
| 200 | 800 | -0.087 | -1.259 | 0.753 | -1.62 | 0.21 | 2.13 | 4.08 | 0.326 | 0.315 | 26.33 | 9.79 |
| 200 | 1000 | -0.011 | -1.402 | 0.627 | -1.67 | 0.27 | 1.99 | 4.36 | 0.405 | 0.385 | 32.43 | 12.15 |
| 200 | 1200 | 0.053 | -1.622 | 0.503 | -1.73 | 0.32 | 1.87 | 4.80 | 0.482 | 0.454 | 38.54 | 14.47 |
| 200 | 1400 | 0.128 | -1.904 | 0.379 | -1.79 | 0.38 | 1.73 | 5.36 | 0.560 | 0.523 | 44.64 | 16.79 |
| 200 | 1600 | 0.209 | -2.290 | 0.252 | -1.85 | 0.44 | 1.58 | 6.12 | 0.639 | 0.592 | 50.74 | 19.16 |
| 200 | 1800 | 0.287 | -2.558 | 0.126 | -1.91 | 0.50 | 1.43 | 6.66 | 0.717 | 0.662 | 56.85 | 21.51 |
| 200 | 2000 | 0.345 | -2.877 | 0.005 | -1.96 | 0.56 | 1.32 | 7.29 | 0.793 | 0.731 | 62.95 | 23.78 |
| 200 | 2200 | 0.431 | -3.230 | -0.121 | -2.21 | 0.81 | 1.16 | 7.99 | 0.871 | 0.800 | 69.05 | 26.13 |

Effective splice length (critical bolt) ..... 4.6 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table G.24. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.56
Dist to strain gauge (in) 13.19
Moment arm (in) .....16.56

BENDING TEST

MARION 4 lb/ft - 80ksi *
Back to back splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 0.225 | 0.190 | 1.272 | | | | | | | | |
| | tight | -1.663 | -1.966 | 1.249 | | | 2.69 | 3.28 | | | | |
| | DL | -1.578 | -1.858 | 1.170 | | | 2.57 | 3.12 | 0.034 | 0.034 | 1.92 | 1.02 |
| 0 | 0 | -1.564 | -1.884 | 1.178 | 1.22 | 0.00 | 2.55 | 3.16 | 0.029 | 0.034 | 1.92 | 0.87 |
| 200 | 200 | -1.575 | -1.815 | 1.056 | 1.18 | -0.05 | 2.57 | 3.05 | 0.105 | 0.066 | 8.00 | 3.15 |
| 200 | 400 | -1.597 | -1.787 | 0.928 | 1.14 | -0.09 | 2.60 | 3.01 | 0.185 | 0.097 | 14.07 | 5.54 |
| 200 | 600 | -1.644 | -1.760 | 0.810 | 1.09 | -0.13 | 2.67 | 2.97 | 0.258 | 0.129 | 20.15 | 7.75 |
| 200 | 800 | -1.718 | -1.730 | 0.683 | 1.05 | -0.17 | 2.77 | 2.92 | 0.337 | 0.160 | 26.23 | 10.12 |
| 200 | 1000 | -1.848 | -1.699 | 0.554 | 1.00 | -0.22 | 2.96 | 2.88 | 0.418 | 0.192 | 32.31 | 12.53 |
| 200 | 1200 | -2.002 | -1.672 | 0.428 | 0.96 | -0.27 | 3.18 | 2.84 | 0.496 | 0.224 | 38.38 | 14.89 |
| 200 | 1400 | -2.248 | -1.638 | 0.302 | 0.91 | -0.32 | 3.53 | 2.78 | 0.575 | 0.255 | 44.46 | 17.24 |
| 200 | 1600 | -2.546 | -1.606 | 0.175 | 0.86 | -0.36 | 3.95 | 2.74 | 0.654 | 0.287 | 50.54 | 19.62 |
| 200 | 1800 | -2.857 | -1.575 | 0.052 | 0.81 | -0.41 | 4.40 | 2.69 | 0.731 | 0.319 | 56.61 | 21.92 |
| 200 | 2000 | -3.181 | -1.542 | -0.081 | 0.75 | -0.47 | 4.86 | 2.64 | 0.813 | 0.350 | 62.69 | 24.40 |
| 200 | 2200 | -3.507 | -1.510 | -0.212 | 0.70 | -0.52 | 5.32 | 2.59 | 0.895 | 0.382 | 68.77 | 26.85 |
| 200 | 2400 | -3.834 | -1.476 | -0.340 | 0.64 | -0.58 | 5.79 | 2.54 | 0.975 | 0.414 | 74.85 | 29.24 |
| 200 | 2600 | -4.171 | -1.444 | -0.471 | 0.58 | -0.65 | 6.27 | 2.49 | 1.056 | 0.445 | 80.92 | 31.69 |

Effective splice length (critical bolt) ..... 6.9 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table G.25. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in). 9.19
Moment arm (in) .....16.38

BENDING TEST

MARION 4 lb/ft - 80ksi *
Nested splice
Non-critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Defl @ Load (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs | STRAIN At Gauge (uin/in) Calc | STRESS (ksi) Base | STRESS (ksi) Obs at Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 0.195 | 0.004 | -0.339 | | | | | | | | |
| | tight | -1.641 | -1.751 | -0.303 | | | 2.62 | 2.69 | | | | |
| | DL | -1.575 | -1.616 | -0.231 | | | 2.52 | 2.49 | 0.038 | 0.038 | 1.91 | 1.14 |
| | 0 | -1.561 | -1.608 | -0.227 | 1.41 | 0.00 | 2.50 | 2.47 | 0.040 | 0.038 | 1.91 | 1.21 |
| 200 | 200 | -1.689 | -1.434 | -0.106 | 1.36 | 0.05 | 2.69 | 2.21 | 0.116 | 0.106 | 7.92 | 3.48 |
| 200 | 400 | -1.850 | -1.237 | 0.008 | 1.31 | 0.10 | 2.92 | 1.90 | 0.187 | 0.173 | 13.93 | 5.61 |
| 200 | 600 | -2.007 | -1.109 | 0.125 | 1.26 | 0.15 | 3.14 | 1.71 | 0.260 | 0.241 | 19.94 | 7.79 |
| 200 | 800 | -2.184 | -0.982 | 0.246 | 1.20 | 0.20 | 3.39 | 1.51 | 0.335 | 0.308 | 25.95 | 10.06 |
| 200 | 1000 | -2.349 | -0.892 | 0.371 | 1.15 | 0.26 | 3.63 | 1.38 | 0.413 | 0.376 | 31.96 | 12.39 |
| 200 | 1200 | -2.541 | -0.834 | 0.486 | 1.09 | 0.31 | 3.90 | 1.29 | 0.485 | 0.443 | 37.97 | 14.54 |
| 200 | 1400 | -2.750 | -0.791 | 0.606 | 1.03 | 0.37 | 4.20 | 1.22 | 0.560 | 0.511 | 43.99 | 16.79 |
| 200 | 1600 | -2.982 | -0.754 | 0.734 | 0.98 | 0.43 | 4.53 | 1.16 | 0.639 | 0.578 | 50.00 | 19.18 |
| 200 | 1800 | -3.246 | -0.731 | 0.848 | 0.92 | 0.49 | 4.91 | 1.13 | 0.710 | 0.646 | 56.01 | 21.31 |
| 200 | 2000 | -3.532 | -0.710 | 0.974 | 0.86 | 0.55 | 5.32 | 1.10 | 0.789 | 0.713 | 62.02 | 23.66 |
| 200 | 2200 | -3.882 | -0.708 | 1.105 | 0.80 | 0.61 | 5.82 | 1.09 | 0.870 | 0.781 | 68.03 | 26.11 |
| 200 | 2400 | -4.275 | -0.705 | 1.234 | 0.73 | 0.68 | 6.38 | 1.09 | 0.951 | 0.848 | 74.04 | 28.52 |

Effective splice length (critical bolt) ..... 6.2 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table G.26. *Results of 17 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

BENDING TEST

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.63
Dist to strain gauge (in) 9.25
Moment arm (in) .....16.63

MARION 4 lb/ft - 80ksi *
Face to face splice
Non-critical orientation

| LOAD (lbs) | | | | | Defl Total | | BOLT LOADS (kips) | | STRAIN At Gauge (uin/in) | | STRESS (ksi) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | @ Load (in) | Defl (in) | Bolt A | Bolt B | Obs | Calc | Base | Obs at Gauge |
| | floor | 1.128 | 0.782 | 1.246 | | | | | | | | |
| | tight | -0.943 | -1.025 | 1.244 | | | 3.88 | 3.58 | | | | |
| | DL | -0.821 | -0.951 | 1.361 | | | 3.66 | 3.43 | 0.038 | 0.038 | 1.91 | 1.14 |
| 0 | 0 | -0.810 | -0.953 | 1.369 | 2.85 | 0.00 | 3.64 | 3.44 | 0.043 | 0.038 | 1.91 | 1.29 |
| 200 | 200 | -0.891 | -0.834 | 1.476 | 2.80 | 0.05 | 3.79 | 3.20 | 0.110 | 0.107 | 8.01 | 3.29 |
| 200 | 400 | -0.979 | -0.699 | 1.596 | 2.76 | 0.09 | 3.95 | 2.93 | 0.184 | 0.177 | 14.11 | 5.53 |
| 200 | 600 | -1.073 | -0.568 | 1.722 | 2.71 | 0.14 | 4.13 | 2.67 | 0.263 | 0.246 | 20.22 | 7.89 |
| 200 | 800 | -1.177 | -0.446 | 1.843 | 2.66 | 0.19 | 4.32 | 2.43 | 0.338 | 0.315 | 26.32 | 10.15 |
| 200 | 1000 | -1.291 | -0.320 | 1.976 | 2.61 | 0.24 | 4.54 | 2.18 | 0.421 | 0.385 | 32.42 | 12.64 |
| 200 | 1200 | -1.417 | -0.207 | 2.097 | 2.56 | 0.29 | 4.77 | 1.96 | 0.497 | 0.454 | 38.53 | 14.90 |
| 200 | 1400 | -1.565 | -0.095 | 2.224 | 2.50 | 0.35 | 5.05 | 1.74 | 0.576 | 0.523 | 44.63 | 17.27 |
| 200 | 1600 | -1.735 | 0.032 | 2.360 | 2.43 | 0.42 | 5.37 | 1.49 | 0.660 | 0.592 | 50.73 | 19.81 |
| 200 | 1800 | -1.915 | 0.102 | 2.472 | 2.39 | 0.46 | 5.71 | 1.35 | 0.730 | 0.662 | 56.83 | 21.91 |
| 200 | 2000 | -2.127 | 0.205 | 2.605 | 2.33 | 0.52 | 6.11 | 1.14 | 0.813 | 0.731 | 62.94 | 24.39 |
| 200 | 2200 | -2.315 | 0.296 | 2.737 | 2.26 | 0.59 | 6.46 | 0.96 | 0.895 | 0.800 | 69.04 | 26.86 |
| 200 | 2400 | -2.575 | 0.379 | 2.859 | 2.20 | 0.65 | 6.95 | 0.80 | 0.971 | 0.870 | 75.14 | 29.14 |

Effective splice length (critical bolt) ..... 5.7 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table G.27. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Box Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to channel (in) ..... 0.69
Dist to strain gauge (in) . 1.19, +3.00, +3.56
Moment arm (in) ..... 16.81

BENDING TEST

Franklin 4 lb/ft post - 60ksi *
Back to back splice; critical orientation
Box section splice - 36ksi *

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Ch.#4 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOAD (kips) | OBSERVED STRAIN (uin/in) Gauge A | Gauge B | Gauge C | OBSERVED STRESS (ksi) Gauge A | Gauge B | Gauge C | BASE STRESS (ksi) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | 1.105 | 1.200 | 1.027 | 0.361 | | | | | | | | | | |
| tight | | 1.051 | 1.152 | 0.973 | 0.359 | | | 0.10 | | | | | | | |
| DL | | 1.089 | 1.120 | 0.927 | 0.443 | | | 0.03 | 0.050 | 0.062 | -0.051 | 1.50 | 1.87 | -1.53 | 1.84 |
| 0 | 0 | 1.087 | 1.107 | 0.919 | 0.447 | -1.05 | 0.00 | 0.03 | 0.058 | 0.067 | -0.054 | 1.74 | 2.02 | -1.61 | 1.84 |
| 200 | 200 | 1.094 | 1.124 | 0.819 | 0.620 | -1.15 | 0.11 | 0.02 | 0.047 | 0.130 | -0.161 | 1.42 | 3.89 | -4.84 | 7.79 |
| 200 | 400 | 1.092 | 1.145 | 0.719 | 0.818 | -1.27 | 0.22 | 0.02 | 0.034 | 0.192 | -0.285 | 1.03 | 5.76 | -8.54 | 13.74 |
| 200 | 600 | 1.093 | 1.160 | 0.663 | 1.002 | -1.38 | 0.33 | 0.02 | 0.025 | 0.227 | -0.399 | 0.75 | 6.80 | -11.98 | 19.69 |
| 200 | 800 | 1.097 | 1.179 | 0.544 | 1.204 | -1.50 | 0.45 | 0.02 | 0.013 | 0.301 | -0.525 | 0.39 | 9.03 | -15.76 | 25.65 |
| 200 | 1000 | 1.109 | 1.198 | 0.464 | 1.406 | -1.63 | 0.58 | -0.01 | 0.001 | 0.351 | -0.651 | 0.04 | 10.52 | -19.53 | 31.60 |
| 200 | 1200 | 1.121 | 1.217 | 0.395 | 1.590 | -1.75 | 0.71 | -0.03 | -0.011 | 0.394 | -0.766 | -0.32 | 11.81 | -22.97 | 37.55 |
| 200 | 1400 | 1.139 | 1.240 | 0.330 | 1.803 | -1.91 | 0.86 | -0.06 | -0.025 | 0.434 | -0.898 | -0.75 | 13.03 | -26.95 | 43.50 |
| 200 | 1600 | 1.158 | 1.271 | 0.283 | 2.028 | -2.08 | 1.04 | -0.10 | -0.044 | 0.464 | -1.039 | -1.33 | 13.91 | -31.16 | 49.45 |
| 100 | 1700 | 1.162 | 1.286 | 0.272 | 2.130 | -2.18 | 1.14 | -0.11 | -0.054 | 0.470 | -1.102 | -1.61 | 14.11 | -33.07 | 52.43 |
| 100 | 1800 | 1.151 | 1.304 | 0.272 | 2.263 | -2.31 | 1.27 | -0.09 | -0.065 | 0.470 | -1.185 | -1.94 | 14.11 | -35.55 | 55.40 |
| 100 | 1900 | 1.142 | 1.318 | 0.271 | 2.367 | -2.39 | 1.35 | -0.07 | -0.074 | 0.471 | -1.250 | -2.21 | 14.13 | -37.50 | 58.38 |
| 100 | 2000 | 1.128 | 1.333 | 0.293 | 2.495 | -2.51 | 1.47 | -0.04 | -0.083 | 0.457 | -1.330 | -2.49 | 13.72 | -39.89 | 61.35 |

* Nominal yield stress

Table G.28. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Box Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to channel (in) ..... 1.88
Dist to strain gauge (in) . 2.13 +2.00, +4.00
Moment arm (in) ..... 16.44

BENDING TEST

Franklin 4 lb/ft post - 60ksi *
Face to face splice; critical orientation
Box section splice - 36ksi *

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Ch.#4 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOAD (kips) | OBSERVED STRAIN (uin/in) Gauge A | Gauge B | Gauge C | OBSERVED STRESS (ksi) Gauge A | Gauge B | Gauge C | BASE STRESS (ksi) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | -1.102 | -1.213 | 0.902 | -0.762 | | | | | | | | | | |
| tight | | -1.060 | -1.146 | -1.030 | -0.726 | | | 0.08 | | | | | | | |
| DL | | -0.983 | -1.235 | -1.172 | -0.663 | | | 0.22 | 0.014 | 0.168 | 0.062 | 0.41 | 5.05 | 1.85 | 1.84 |
| 0 | 0 | -0.979 | -1.240 | -1.185 | -0.677 | -2.06 | 0.00 | 0.23 | 0.017 | 0.176 | 0.053 | 0.50 | 5.29 | 1.59 | 1.84 |
| 100 | 100 | -0.857 | -1.304 | -1.305 | -0.575 | -2.30 | 0.24 | 0.46 | 0.057 | 0.251 | 0.117 | 1.70 | 7.53 | 3.50 | 4.82 |
| 100 | 200 | -0.693 | -1.387 | -1.453 | -0.490 | -2.51 | 0.45 | 0.77 | 0.108 | 0.343 | 0.169 | 3.25 | 10.30 | 5.08 | 7.79 |
| 100 | 300 | -0.540 | -1.472 | -1.611 | -0.404 | -2.75 | 0.69 | 1.05 | 0.161 | 0.442 | 0.223 | 4.84 | 13.25 | 6.69 | 10.77 |
| 95 | 395 | -0.373 | -1.554 | -1.767 | -0.328 | -2.89 | 0.83 | 1.37 | 0.212 | 0.539 | 0.270 | 6.37 | 16.17 | 8.11 | 13.59 |

* Nominal yield stress

Table G.29. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Box Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to channel (in) ..... 0.69
Dist to strain gauge (in) . 1.19, +3.00, +3.56
Moment arm (in) ..... 16.81

BENDING TEST

Franklin 4 lb/ft post - 60ksi *
Back to back splice; non-critical orientation
Box section splice - 36ksi *

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Ch.#4 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOAD (kips) | OBSERVED STRAIN (uin/in) Gauge A | Gauge B | Gauge C | OBSERVED STRESS (ksi) Gauge A | Gauge B | Gauge C | BASE STRESS (ksi) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 1.092 | 1.241 | 0.980 | 0.417 | | | | | | | | | | |
| | tight | 1.027 | 1.192 | 0.932 | 0.418 | | | 0.12 | | | | | | | |
| | DL | 1.043 | 1.198 | 0.949 | 0.336 | | | 0.09 | 0.027 | 0.019 | 0.050 | 0.80 | 0.58 | 1.51 | 1.84 |
| 0 | 0 | 1.050 | 1.202 | 0.943 | 0.337 | 1.00 | 0.00 | 0.08 | 0.024 | 0.023 | 0.050 | 0.73 | 0.69 | 1.50 | 1.84 |
| 200 | 200 | 1.038 | 1.141 | 0.951 | 0.154 | 0.90 | 0.10 | 0.10 | 0.062 | 0.018 | 0.164 | 1.87 | 0.54 | 4.92 | 7.79 |
| 200 | 400 | 1.026 | 1.073 | 0.961 | -0.029 | 0.82 | 0.18 | 0.12 | 0.105 | 0.012 | 0.278 | 3.14 | 0.36 | 8.34 | 13.74 |
| 200 | 600 | 1.011 | 1.000 | 0.971 | -0.231 | 0.73 | 0.27 | 0.15 | 0.150 | 0.006 | 0.404 | 4.50 | 0.17 | 12.11 | 19.69 |
| 200 | 800 | 0.992 | 0.843 | 0.988 | -0.612 | 0.63 | 0.37 | 0.19 | 0.248 | -0.005 | 0.641 | 7.44 | -0.15 | 19.23 | 25.65 |
| 200 | 1000 | 0.977 | 0.843 | 0.988 | -0.612 | 0.53 | 0.47 | 0.22 | 0.248 | -0.005 | 0.641 | 7.44 | -0.15 | 19.23 | 31.60 |
| 200 | 1200 | 0.963 | 0.768 | 0.992 | -0.816 | 0.43 | 0.57 | 0.24 | 0.295 | -0.007 | 0.768 | 8.84 | -0.22 | 23.05 | 37.55 |
| 200 | 1400 | 0.943 | 0.701 | 0.995 | -1.017 | 0.31 | 0.68 | 0.28 | 0.336 | -0.009 | 0.893 | 10.09 | -0.28 | 26.80 | 43.50 |
| 200 | 1600 | 0.918 | 0.638 | 0.999 | -1.238 | 0.19 | 0.81 | 0.33 | 0.376 | -0.012 | 1.031 | 11.27 | -0.36 | 30.93 | 49.45 |
| 100 | 1700 | 0.909 | 0.614 | 1.001 | -1.351 | 0.13 | 0.87 | 0.34 | 0.391 | -0.013 | 1.102 | 11.72 | -0.39 | 33.05 | 52.43 |
| 100 | 1800 | 0.896 | 0.591 | 1.003 | -1.458 | 0.06 | 0.93 | 0.37 | 0.405 | -0.014 | 1.168 | 12.15 | -0.43 | 35.05 | 55.40 |
| 100 | 1900 | 0.878 | 0.566 | 1.004 | -1.585 | 0.02 | 0.98 | 0.40 | 0.421 | -0.015 | 1.247 | 12.62 | -0.45 | 37.42 | 58.38 |
| 100 | 2000 | 0.864 | 0.546 | 1.007 | -1.710 | -0.09 | 1.09 | 0.43 | 0.433 | -0.017 | 1.325 | 12.99 | -0.50 | 39.76 | 61.35 |

Significant yielding of box section; splice became loose after test

* Nominal yield stress

Table G.30. *Results of 17 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Box Splice in Non-critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to channel (in) ..... 0.69
Dist to strain gauge (in) . 1.19, +3.00, +3.50
Moment arm (in) ..... 16.75

BENDING TEST

Franklin 4 lb/ft post - 60ksi *
Face to face splice; non-critical orientation
Box section splice - 36ksi *

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Ch.#4 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOAD (kips) | OBSERVED STRAIN (uin/in) Gauge A | Gauge B | Gauge C | OBSERVED STRESS (ksi) Gauge A | Gauge B | Gauge C | BASE STRESS (ksi) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | 1.099 | 1.193 | 0.938 | 0.471 | | | | | | | | | | |
| | tight | 1.064 | 1.148 | 0.897 | 0.470 | | | 0.07 | | | | | | | |
| | DL | 0.986 | 1.174 | 1.072 | 0.396 | | | 0.21 | 0.012 | 0.083 | 0.047 | 0.36 | 2.50 | 1.40 | 1.84 |
| 0 | 0 | 0.991 | 1.117 | 1.082 | 0.403 | -1.82 | 0.00 | 0.20 | 0.047 | 0.090 | 0.042 | 1.42 | 2.69 | 1.27 | 1.84 |
| 200 | 200 | 0.741 | 1.245 | 1.465 | 0.220 | -2.12 | 0.30 | 0.67 | -0.032 | 0.328 | 0.156 | -0.97 | 9.85 | 4.69 | 7.77 |
| 200 | 400 | 0.422 | 1.290 | 1.813 | 0.040 | -2.40 | 0.58 | 1.27 | -0.060 | 0.545 | 0.269 | -1.81 | 16.36 | 8.06 | 13.70 |
| 200 | 600 | -0.003 | 1.326 | 1.993 | -0.166 | -2.69 | 0.87 | 2.07 | -0.083 | 0.657 | 0.397 | -2.49 | 19.72 | 11.91 | 19.63 |
| 200 | 800 | -0.461 | 1.314 | 1.862 | -0.389 | -2.99 | 1.17 | 2.93 | -0.075 | 0.576 | 0.536 | -2.26 | 17.27 | 16.07 | 25.56 |

Reached stroke limit at 800 lbs - box section severely distorted

* Nominal yield stress

# APPENDIX H

## FINAL 7T' BENDING TESTS

## CALIBRATED BOLT SUMMARY TABLES

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back and Nested Splices

Critical Configuration

# APPENDIX H

## LIST OF TABLES

Table H.1. *Results of 71 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) 7.56
Moment arm (in) .....71.38

BENDING TEST

FRANKLIN 3 lb/ft - 60 ksi *
Back to back splice
Critical configuration

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.146 | -1.281 | 0.317 | | | | | | | | |
| | tight | -2.321 | -3.073 | 0.333 | | | 3.26 | 2.70 | | | 0.00 | |
| | DL | -2.103 | -2.972 | 0.521 | 0.00 | 0.00 | 2.94 | 2.55 | -0.053 | -0.053 | 1.93 | -1.59 |
| 60 | 60 | -2.045 | -3.111 | 0.965 | 0.99 | 0.99 | 2.85 | 2.76 | -0.330 | -0.368 | 12.50 | -9.89 |
| 32 | 92 | -2.031 | -3.235 | 1.248 | 0.52 | 1.51 | 2.83 | 2.95 | -0.506 | -0.536 | 18.14 | -15.18 |
| 32 | 124 | -2.018 | -3.379 | 1.518 | 0.52 | 2.03 | 2.81 | 3.16 | -0.674 | -0.704 | 23.78 | -20.22 |
| 32 | 156 | -2.005 | -3.572 | 1.787 | 0.53 | 2.55 | 2.79 | 3.45 | -0.842 | -0.872 | 29.42 | -25.25 |
| 32 | 188 | -1.994 | -3.830 | 2.059 | 0.54 | 3.09 | 2.77 | 3.84 | -1.011 | -1.040 | 35.06 | -30.34 |
| 32 | 220 | -1.984 | -4.097 | 2.315 | 0.54 | 3.62 | 2.76 | 4.25 | -1.171 | -1.208 | 40.70 | -35.12 |
| 32 | 252 | -1.972 | -4.385 | 2.574 | 0.57 | 4.19 | 2.74 | 4.68 | -1.332 | -1.376 | 46.34 | -39.96 |
| 32 | 284 | -1.962 | -4.679 | 2.818 | 0.55 | 4.74 | 2.73 | 5.12 | -1.484 | -1.544 | 51.98 | -44.52 |
| 32 | 316 | -1.934 | -5.024 | 3.079 | 0.57 | 5.30 | 2.68 | 5.64 | -1.647 | -1.712 | 57.62 | -49.40 |
| 32 | 348 | -1.939 | -5.333 | 3.326 | 0.56 | 5.86 | 2.69 | 6.11 | -1.801 | -1.880 | 63.26 | -54.02 |

Effective splice length (critical bolt only) ..... 3.8 in

Effective splice length (both bolts) ..... 3.8 in

* Nominal yield stress

Table H.2. *Results of 71 Inch Bending Test: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.56
Dist to strain gauge (in) 7.69
Moment arm (in) .....71.56

BENDING TEST

FRANKLIN 3 lb/ft - 60 ksi *
Nested splice
Critical configuration

| LOAD (lbs) App | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | Bolt B | STRAIN At Gauge (uin/in) Obs. | Calc. | STRESS (ksi) Base | Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | -0.168 | -1.277 | 0.249 | | | | | | | | |
| tight | | -2.304 | -3.458 | 0.415 | | | 3.21 | 3.29 | | | 0.00 | |
| DL | | -2.071 | -3.045 | 0.327 | 0.00 | 0.00 | 2.86 | 2.67 | 0.052 | 0.052 | 1.93 | 1.55 |
| 60 | 60 | -2.032 | -3.237 | -0.185 | 1.02 | 1.02 | 2.80 | 2.95 | 0.371 | 0.368 | 12.53 | 11.12 |
| 32 | 92 | -2.015 | -3.298 | -4.810 | 0.69 | 1.71 | 2.77 | 3.05 | 3.252 | 0.536 | 18.18 | 97.57 |
| 32 | 124 | -2.025 | -3.450 | -0.779 | 0.73 | 2.44 | 2.79 | 3.28 | 0.741 | 0.704 | 23.84 | 22.22 |
| 32 | 156 | -2.042 | -3.749 | -1.066 | 0.71 | 3.15 | 2.81 | 3.73 | 0.920 | 0.872 | 29.49 | 27.59 |
| 32 | 188 | -2.069 | -4.120 | -1.353 | 0.75 | 3.90 | 2.85 | 4.29 | 1.098 | 1.041 | 35.14 | 32.95 |
| 32 | 220 | -2.087 | -4.338 | -1.514 | 0.48 | 4.38 | 2.88 | 4.61 | 1.199 | 1.209 | 40.80 | 35.96 |
| 32 | 252 | -2.123 | -4.677 | -1.757 | 0.68 | 5.05 | 2.93 | 5.13 | 1.350 | 1.377 | 46.45 | 40.50 |
| 32 | 284 | -2.173 | -5.078 | -2.040 | 0.86 | 5.91 | 3.01 | 5.73 | 1.526 | 1.545 | 52.11 | 45.79 |
| 32 | 316 | -2.230 | -5.483 | -2.290 | 0.79 | 6.70 | 3.10 | 6.34 | 1.682 | 1.713 | 57.76 | 50.47 |
| 16 | 332 | -2.262 | -5.641 | -2.431 | 0.49 | 7.19 | 3.14 | 6.58 | 1.770 | 1.798 | 60.59 | 53.10 |
| 16 | 348 | -2.293 | -5.821 | -2.555 | 0.44 | 7.63 | 3.19 | 6.85 | 1.847 | 1.882 | 63.41 | 55.42 |

Effective splice length (critical bolt only) ..... 3.4 in

Effective splice length (both bolts) ..... 3.2 in

* Nominal yield stress

Table H.3. *Results of 71 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) 9.25
Moment arm (in) .....71.50

BENDING TEST

FRANKLIN 4 lb/ft - 60 ksi *
Back to back splice
Critical configuration

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.164 | -1.286 | -1.412 | | | | | | | | |
| | tight | -2.650 | -3.416 | -1.410 | | | 3.73 | 3.21 | | | 0.00 | |
| | DL | -2.533 | -3.369 | -1.326 | 0.00 | 0.00 | 3.56 | 3.14 | -0.048 | -0.048 | 1.86 | -1.44 |
| 60 | 60 | -2.434 | -3.520 | -0.967 | 0.74 | 0.74 | 3.41 | 3.37 | -0.272 | -0.271 | 9.52 | -8.15 |
| 32 | 92 | -2.380 | -3.609 | -0.768 | 0.32 | 1.06 | 3.33 | 3.50 | -0.396 | -0.389 | 13.60 | -11.87 |
| 32 | 124 | -2.330 | -3.722 | -0.558 | 0.43 | 1.49 | 3.25 | 3.67 | -0.526 | -0.508 | 17.69 | -15.79 |
| 32 | 156 | -2.286 | -3.840 | -0.360 | 0.41 | 1.90 | 3.19 | 3.85 | -0.650 | -0.626 | 21.78 | -19.50 |
| 32 | 188 | -2.246 | -4.002 | -0.144 | 0.44 | 2.34 | 3.13 | 4.09 | -0.784 | -0.745 | 25.86 | -23.53 |
| 32 | 220 | -2.210 | -4.205 | 0.068 | 0.43 | 2.77 | 3.07 | 4.40 | -0.917 | -0.863 | 29.95 | -27.50 |
| 32 | 252 | -2.180 | -4.409 | 0.274 | 0.43 | 3.20 | 3.03 | 4.71 | -1.045 | -0.982 | 34.03 | -31.35 |
| 32 | 284 | -2.153 | -4.633 | 0.489 | 0.45 | 3.65 | 2.99 | 5.05 | -1.179 | -1.101 | 38.12 | -35.36 |
| 32 | 316 | -2.132 | -4.908 | 0.705 | 0.45 | 4.10 | 2.95 | 5.46 | -1.313 | -1.219 | 42.20 | -39.40 |
| 32 | 348 | -2.116 | -5.216 | 0.932 | 0.47 | 4.57 | 2.93 | 5.92 | -1.455 | -1.338 | 46.29 | -43.64 |
| 32 | 380 | -2.105 | -5.527 | 1.169 | 0.49 | 5.06 | 2.91 | 6.39 | -1.602 | -1.456 | 50.38 | -48.07 |
| 32 | 412 | -2.097 | -5.842 | 1.428 | 0.51 | 5.56 | 2.90 | 6.87 | -1.764 | -1.575 | 54.46 | -52.92 |

Effective splice length (critical bolt only) ..... 4.0 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table H.4. *Results of 71 Inch Bending Test: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.56
Dist to strain gauge (in) 8.94
Moment arm (in) .....71.56

BENDING TEST

FRANKLIN 4 lb/ft - 60 ksi *
Nested splice
Critical configuration

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.178 | -1.273 | -1.216 | | | | | | | | |
| | tight | -2.492 | -3.588 | -1.147 | | | 3.47 | 3.49 | | | 0.00 | |
| | DL | -2.243 | -3.538 | -1.220 | 0.00 | 0.00 | 3.10 | 3.41 | 0.049 | 0.049 | 1.86 | 1.48 |
| 60 | 60 | -2.033 | -3.723 | -1.580 | 0.71 | 0.71 | 2.78 | 3.69 | 0.274 | 0.272 | 9.52 | 8.21 |
| 32 | 92 | -1.918 | -3.802 | -1.774 | 0.38 | 1.09 | 2.61 | 3.81 | 0.394 | 0.392 | 13.61 | 11.83 |
| 32 | 124 | -1.849 | -3.963 | -1.976 | 0.41 | 1.49 | 2.51 | 4.06 | 0.520 | 0.511 | 17.70 | 15.61 |
| 32 | 156 | -1.782 | -4.128 | -2.175 | 0.42 | 1.91 | 2.41 | 4.30 | 0.644 | 0.630 | 21.79 | 19.33 |
| 32 | 188 | -1.727 | -4.300 | -2.371 | 0.41 | 2.32 | 2.33 | 4.56 | 0.766 | 0.749 | 25.88 | 22.99 |
| 32 | 220 | -1.684 | -4.488 | -2.569 | 0.42 | 2.74 | 2.26 | 4.85 | 0.890 | 0.869 | 29.97 | 26.69 |
| 32 | 252 | -1.656 | -4.680 | -2.766 | 0.42 | 3.16 | 2.22 | 5.14 | 1.012 | 0.988 | 34.06 | 30.37 |
| 32 | 284 | -1.646 | -4.923 | -3.008 | 0.51 | 3.67 | 2.20 | 5.50 | 1.163 | 1.107 | 38.15 | 34.90 |
| 32 | 316 | -1.643 | -5.138 | -3.200 | 0.41 | 4.07 | 2.20 | 5.83 | 1.283 | 1.227 | 42.24 | 38.49 |
| 32 | 348 | -1.651 | -5.387 | -3.411 | 0.45 | 4.52 | 2.21 | 6.20 | 1.414 | 1.346 | 46.33 | 42.43 |
| 32 | 380 | -1.671 | -5.646 | -3.629 | 0.49 | 5.01 | 2.24 | 6.59 | 1.550 | 1.465 | 50.42 | 46.50 |

Effective splice length (critical bolt only) ..... 3.8 in

Effective splice length (both bolts) ..... 3.8 in

* Nominal yield stress

Table H.5. *Results of 71 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.38
Dist to strain gauge (in) 8.13
Moment arm (in) .....71.38

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Back to back splice
Critical configuration

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.247 | -1.362 | 2.253 | | | | | | | | |
| | tight | -2.103 | -3.169 | 2.233 | | | 2.79 | 2.72 | | | 0.00 | |
| | DL | -1.992 | -3.245 | 2.337 | 0.00 | 0.00 | 2.62 | 2.84 | 0.042 | 0.042 | 1.90 | 1.25 |
| 60 | 60 | -1.721 | -3.481 | 2.777 | 0.86 | 0.86 | 2.21 | 3.19 | 0.316 | 0.293 | 12.32 | 9.47 |
| 32 | 92 | -1.635 | -3.679 | 2.995 | 0.46 | 1.32 | 2.08 | 3.49 | 0.452 | 0.427 | 17.88 | 13.55 |
| 32 | 124 | -1.576 | -3.908 | 3.218 | 0.48 | 1.80 | 1.99 | 3.84 | 0.591 | 0.561 | 23.43 | 17.72 |
| 32 | 156 | -1.511 | -4.149 | 3.477 | 0.50 | 2.30 | 1.90 | 4.20 | 0.752 | 0.695 | 28.99 | 22.56 |
| 32 | 188 | -1.442 | -4.420 | 3.677 | 0.51 | 2.81 | 1.79 | 4.61 | 0.877 | 0.830 | 34.55 | 26.30 |
| 32 | 220 | -1.364 | -4.707 | 3.894 | 0.49 | 3.30 | 1.68 | 5.04 | 1.012 | 0.964 | 40.11 | 30.35 |
| 32 | 252 | -1.276 | -5.017 | 4.122 | 0.52 | 3.82 | 1.54 | 5.51 | 1.154 | 1.098 | 45.66 | 34.61 |
| 32 | 284 | -1.195 | -5.297 | 4.323 | 0.46 | 4.28 | 1.42 | 5.93 | 1.279 | 1.232 | 51.22 | 38.37 |
| 32 | 316 | -1.107 | -5.600 | 4.534 | 0.50 | 4.78 | 1.29 | 6.39 | 1.410 | 1.366 | 56.78 | 42.31 |
| 32 | 348 | -1.015 | -5.937 | 4.746 | 0.53 | 5.31 | 1.15 | 6.90 | 1.543 | 1.500 | 62.34 | 46.28 |
| 32 | 380 | -0.938 | -6.300 | 4.950 | 0.51 | 5.81 | 1.04 | 7.44 | 1.670 | 1.634 | 67.89 | 50.09 |
| 32 | 412 | -0.846 | -6.774 | 5.204 | 0.53 | 6.34 | 0.90 | 8.16 | 1.828 | 1.769 | 73.45 | 54.84 |

Effective splice length (critical bolt only) ..... 3.4 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table H.6. *Results of 71 Inch Bending Test: Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.44
Dist to strain gauge (in) 10.06
Moment arm (in) .....71.44

BENDING TEST

MARION 3 lb/ft - 80 ksi *
Nested splice
Critical configuration

| LOAD (lbs) App | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | Bolt B | STRAIN At Gauge (uin/in) Obs. | Calc. | STRESS (ksi) Base | Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| floor | | -0.232 | -1.352 | 1.800 | | | | | | | | |
| tight | | -3.101 | -3.205 | 1.811 | | | 4.31 | 2.79 | | | 0.00 | |
| DL | | -3.028 | -3.180 | 1.730 | 0.00 | 0.00 | 4.20 | 2.76 | 0.039 | 0.039 | 1.90 | 1.18 |
| 60 | 60 | -2.856 | -3.419 | 1.349 | 0.89 | 0.89 | 3.94 | 3.12 | 0.277 | 0.283 | 12.33 | 8.30 |
| 32 | 92 | -2.768 | -3.631 | 1.147 | 0.50 | 1.39 | 3.81 | 3.44 | 0.403 | 0.444 | 17.92 | 12.08 |
| 32 | 124 | -2.694 | -3.888 | 0.937 | 0.55 | 1.93 | 3.70 | 3.82 | 0.533 | 0.604 | 23.51 | 16.00 |
| 32 | 156 | -2.634 | -4.177 | 0.726 | 0.55 | 2.48 | 3.61 | 4.26 | 0.665 | 0.764 | 29.10 | 19.95 |
| 32 | 188 | -2.576 | -4.491 | 0.514 | 0.58 | 3.06 | 3.52 | 4.73 | 0.797 | 0.924 | 34.69 | 23.91 |
| 32 | 220 | -2.536 | -4.817 | 0.306 | 0.57 | 3.63 | 3.46 | 5.22 | 0.927 | 1.084 | 40.27 | 27.80 |
| 32 | 252 | -2.515 | -5.174 | 0.087 | 0.60 | 4.23 | 3.43 | 5.76 | 1.063 | 1.244 | 45.86 | 31.89 |
| 32 | 284 | -2.498 | -5.530 | -0.119 | 0.59 | 4.82 | 3.40 | 6.30 | 1.191 | 1.404 | 51.45 | 35.74 |
| 32 | 316 | -2.497 | -5.949 | -0.348 | 0.70 | 5.51 | 3.40 | 6.93 | 1.334 | 1.564 | 57.04 | 40.02 |
| 32 | 348 | -2.499 | -6.316 | -0.541 | 0.65 | 6.16 | 3.40 | 7.48 | 1.454 | 1.724 | 62.63 | 43.63 |

Effective splice length (critical bolt only) ..... 3.1 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table H.7. *Results of 71 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

BENDING TEST

MARION 4 lb/ft - 80 ksi *
Back to back splice
Critical configuration

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.25
Dist to strain gauge (in) 8.88
Moment arm (in) .....71.25

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.194 | -1.302 | -0.430 | | | | | | | | |
| | tight | -2.387 | -3.248 | -0.426 | | | 3.29 | 2.93 | | | 0.00 | |
| | DL | -2.541 | -3.289 | -0.347 | 0.00 | 0.00 | 3.52 | 3.00 | 0.039 | 0.038 | 1.91 | 1.16 |
| 60 | 60 | -2.478 | -3.355 | -0.032 | 0.56 | 0.56 | 3.43 | 3.10 | 0.235 | 0.214 | 9.75 | 7.04 |
| 32 | 92 | -2.433 | -3.408 | 0.125 | 0.29 | 0.84 | 3.36 | 3.18 | 0.333 | 0.308 | 13.94 | 9.98 |
| 32 | 124 | -2.410 | -3.503 | 0.298 | 0.31 | 1.15 | 3.33 | 3.32 | 0.440 | 0.402 | 18.12 | 13.21 |
| 32 | 156 | -2.372 | -3.619 | 0.457 | 0.30 | 1.45 | 3.27 | 3.49 | 0.539 | 0.495 | 22.30 | 16.18 |
| 32 | 188 | -2.335 | -3.779 | 0.623 | 0.32 | 1.77 | 3.21 | 3.73 | 0.643 | 0.589 | 26.49 | 19.29 |
| 32 | 220 | -2.296 | -3.998 | 0.787 | 0.32 | 2.09 | 3.16 | 4.06 | 0.745 | 0.683 | 30.67 | 22.35 |
| 32 | 252 | -2.248 | -4.264 | 0.957 | 0.33 | 2.41 | 3.08 | 4.47 | 0.851 | 0.776 | 34.85 | 25.53 |
| 32 | 284 | -2.201 | -4.578 | 1.130 | 0.34 | 2.75 | 3.01 | 4.94 | 0.959 | 0.870 | 39.04 | 28.76 |
| 32 | 316 | -2.154 | -4.879 | 1.289 | 0.32 | 3.07 | 2.94 | 5.39 | 1.058 | 0.964 | 43.22 | 31.73 |
| 32 | 348 | -2.105 | -5.212 | 1.464 | 0.35 | 3.42 | 2.87 | 5.89 | 1.167 | 1.057 | 47.40 | 35.01 |
| 32 | 380 | -2.062 | -5.509 | 1.620 | 0.32 | 3.74 | 2.80 | 6.34 | 1.264 | 1.151 | 51.59 | 37.92 |
| 32 | 412 | -2.018 | -5.812 | 1.779 | 0.32 | 4.06 | 2.74 | 6.80 | 1.363 | 1.245 | 55.77 | 40.89 |

Effective splice length (critical bolt only) ..... 4.0 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

Table H.8. *Results of 71 Inch Bending Test: Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.75
Dist to strain gauge (in) 9.25
Moment arm (in) .....71.75

BENDING TEST

MARION 4 lb/ft - 80 ksi *
Nested splice
Critical configuration

| LOAD (lbs) App | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Tip Defl (in) | Total Defl (in) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. | STRESS (ksi) Base | STRESS (ksi) Obs @ Gauge |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.176 | -1.279 | 0.356 | | | | | | | | |
| | tight | -2.360 | -2.557 | 0.384 | | | 3.28 | 1.93 | | | 0.00 | |
| | DL | -2.337 | -2.614 | 0.318 | 0.00 | 0.00 | 3.24 | 2.01 | 0.038 | 0.038 | 1.91 | 1.14 |
| 60 | 60 | -2.100 | -2.833 | 0.016 | 0.65 | 0.65 | 2.89 | 2.34 | 0.226 | 0.214 | 9.81 | 6.79 |
| 32 | 92 | -2.003 | -3.009 | -0.142 | 0.32 | 0.96 | 2.74 | 2.61 | 0.325 | 0.308 | 14.02 | 9.74 |
| 32 | 124 | -1.901 | -3.233 | -0.305 | 0.34 | 1.30 | 2.59 | 2.95 | 0.426 | 0.402 | 18.23 | 12.79 |
| 32 | 156 | -1.813 | -3.483 | -0.467 | 0.34 | 1.64 | 2.46 | 3.32 | 0.527 | 0.496 | 22.45 | 15.82 |
| 32 | 188 | -1.735 | -3.757 | -0.635 | 0.35 | 1.99 | 2.34 | 3.74 | 0.632 | 0.590 | 26.66 | 18.96 |
| 32 | 220 | -1.668 | -4.031 | -0.798 | 0.35 | 2.33 | 2.24 | 4.15 | 0.733 | 0.684 | 30.87 | 22.00 |
| 32 | 252 | -1.613 | -4.292 | -0.955 | 0.33 | 2.66 | 2.16 | 4.54 | 0.831 | 0.778 | 35.08 | 24.94 |
| 32 | 284 | -1.564 | -4.560 | -1.110 | 0.34 | 3.00 | 2.08 | 4.95 | 0.928 | 0.871 | 39.30 | 27.84 |
| 32 | 316 | -1.519 | -4.847 | -1.270 | 0.34 | 3.33 | 2.02 | 5.38 | 1.028 | 0.965 | 43.51 | 30.83 |
| 32 | 348 | -1.480 | -5.163 | -1.431 | 0.35 | 3.68 | 1.96 | 5.86 | 1.128 | 1.059 | 47.72 | 33.84 |
| 32 | 380 | -1.445 | -5.477 | -1.587 | 0.35 | 4.02 | 1.90 | 6.33 | 1.225 | 1.153 | 51.94 | 36.75 |
| 32 | 412 | -1.414 | -5.803 | -1.749 | 0.35 | 4.37 | 1.86 | 6.82 | 1.326 | 1.247 | 56.15 | 39.78 |
| 32 | 444 | -1.388 | -6.118 | -1.899 | 0.34 | 4.71 | 1.82 | 7.30 | 1.419 | 1.341 | 60.36 | 42.58 |

Effective splice length (critical bolt only) ..... 4.0 in

Effective splice length (both bolts) ..... N/A

* Nominal yield stress

# APPENDIX I

## 75" COMBINED BENDING AND TORSION TESTS

## (NEGLECTING AND INCLUDING WARPING STRESSES)

## CALIBRATED BOLT SUMMARY TABLES

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back and Nested Splices

Critical Configuration

# APPENDIX I

## LIST OF TABLES

# APPENDIX I

## LIST OF TABLES

Table I.1. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

| Splice length (in) ..... 3.00<br>Dist to bolt A (in) ..... 1.50<br>Dist to strain gauge (in) 7.88<br>Moment arm (in) ..... 75.38<br>Eccentricity (in) ..... 6.30 | | | | BENDING TORSION TEST<br>(Warping Neglected)<br>FRANKLIN 3 lb/ft - 60 ksi *<br>Back to back splice<br>Critical orientation | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | | BOLT LOADS (kips) | | COMBINED BASE | STRAIN At Gauge (uin/in) | |
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Bolt A | Bolt B | STRESS (ksi) | Obs. | Calc. |
| | floor | -0.130 | -1.335 | 0.679 | | | | | |
| | tight | -2.268 | -3.565 | 0.676 | 3.21 | 3.37 | | | |
| | DL | -2.143 | -3.484 | 0.792 | 3.02 | 3.25 | 1.94 | 0.052 | 0.052 |
| 26 | 26 | -2.041 | -3.387 | 1.058 | 2.87 | 3.10 | 7.75 | 0.218 | 0.195 |
| 24 | 50 | -1.962 | -3.345 | 1.290 | 2.75 | 3.04 | 13.32 | 0.362 | 0.327 |
| 24 | 74 | -1.893 | -3.385 | 1.515 | 2.65 | 3.10 | 18.86 | 0.502 | 0.460 |
| 24 | 98 | -1.844 | -3.467 | 1.733 | 2.57 | 3.22 | 24.35 | 0.638 | 0.592 |
| 24 | 122 | -1.818 | -3.635 | 1.945 | 2.53 | 3.48 | 29.80 | 0.770 | 0.724 |
| 24 | 146 | -1.815 | -3.871 | 2.156 | 2.53 | 3.83 | 35.21 | 0.902 | 0.856 |
| 24 | 170 | -1.831 | -4.095 | 2.360 | 2.55 | 4.17 | 40.59 | 1.029 | 0.989 |
| 24 | 194 | -1.854 | -4.367 | 2.561 | 2.59 | 4.58 | 45.92 | 1.154 | 1.121 |
| 24 | 218 | -1.865 | -4.670 | 2.758 | 2.60 | 5.04 | 51.22 | 1.277 | 1.253 |
| 24 | 242 | -1.852 | -5.025 | 2.937 | 2.58 | 5.57 | 56.48 | 1.388 | 1.384 |
| 24 | 266 | -1.819 | -5.385 | 3.123 | 2.54 | 6.11 | 61.71 | 1.504 | 1.516 |
| 24 | 290 | -1.788 | -5.792 | 3.327 | 2.49 | 6.73 | 66.90 | 1.631 | 1.647 |

* Nominal yield stress

Table I.2. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) 8.25
Moment arm (in) ..... 75.50
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Warping Neglected)
FRANKLIN 3 lb/ft - 60 ksi *
Nested splice
Critical orientation

| LOAD (lbs) | | | | | BOLT LOADS (kips) | | COMBINED BASE | STRAIN At Gauge (uin/in) | |
|---|---|---|---|---|---|---|---|---|---|
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Bolt A | Bolt B | STRESS (ksi) | Obs. | Calc. |
| | floor | -0.135 | -1.359 | 0.689 | | | | | |
| | tight | -2.262 | -3.481 | 0.738 | 3.19 | 3.20 | | | |
| | DL | -2.115 | -3.454 | 0.671 | 2.97 | 3.16 | 1.94 | 0.051 | 0.051 |
| 26 | 26 | -2.057 | -3.544 | 0.443 | 2.89 | 3.29 | 7.76 | 0.193 | 0.194 |
| 24 | 50 | -2.021 | -3.626 | 0.218 | 2.83 | 3.42 | 13.33 | 0.333 | 0.326 |
| 24 | 74 | -1.997 | -3.702 | -0.002 | 2.79 | 3.53 | 18.86 | 0.470 | 0.458 |
| 24 | 98 | -1.994 | -3.809 | -0.229 | 2.79 | 3.69 | 24.34 | 0.612 | 0.589 |
| 24 | 122 | -2.013 | -3.966 | -0.466 | 2.82 | 3.93 | 29.78 | 0.760 | 0.721 |
| 24 | 146 | -2.053 | -4.169 | -0.712 | 2.88 | 4.24 | 35.15 | 0.913 | 0.853 |
| 24 | 170 | -2.111 | -4.410 | -0.959 | 2.97 | 4.60 | 40.47 | 1.067 | 0.985 |
| 24 | 194 | -2.177 | -4.681 | -1.207 | 3.07 | 5.01 | 45.74 | 1.221 | 1.116 |
| 24 | 218 | -2.237 | -4.980 | -1.475 | 3.16 | 5.46 | 50.98 | 1.388 | 1.248 |
| 24 | 242 | -2.305 | -5.288 | -1.748 | 3.26 | 5.92 | 56.17 | 1.558 | 1.379 |
| 24 | 266 | -2.371 | -5.613 | -2.004 | 3.36 | 6.41 | 61.31 | 1.718 | 1.511 |
| 24 | 290 | -2.457 | -5.939 | -2.312 | 3.49 | 6.90 | 66.44 | 1.910 | 1.642 |

* Nominal yield stress

Table I.3. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

| Splice length (in) ..... 4.00<br>Dist to bolt A (in) ..... 1.50<br>Dist to strain gauge (in) 9.25<br>Moment arm (in) ..... 75.63<br>Eccentricity (in) ..... 6.30 | | | | BENDING TORSION TEST<br>(Warping Neglected)<br>FRANKLIN 4 lb/ft - 60 ksi *<br>Back to back splice<br>Critical orientation | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | | BOLT LOADS (kips) | | COMBINED BASE | STRAIN At Gauge (uin/in) | |
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Bolt A | Bolt B | STRESS (ksi) | Obs. | Calc. |
| | floor | -0.141 | -1.520 | -1.027 | | | | | |
| | tight | -2.078 | -3.648 | -1.021 | 2.91 | 3.21 | | | |
| | DL | -1.937 | -3.623 | -0.930 | 2.70 | 3.17 | 1.45 | 0.049 | 0.049 |
| 55 | 55 | -1.773 | -3.831 | -0.554 | 2.45 | 3.48 | 10.84 | 0.283 | 0.272 |
| 32 | 87 | -1.688 | -4.039 | -0.351 | 2.32 | 3.80 | 16.41 | 0.409 | 0.402 |
| 32 | 119 | -1.595 | -4.299 | -0.131 | 2.18 | 4.19 | 21.95 | 0.546 | 0.532 |
| 32 | 151 | -1.510 | -4.563 | 0.080 | 2.05 | 4.59 | 27.46 | 0.678 | 0.661 |
| 32 | 183 | -1.432 | -4.861 | 0.298 | 1.94 | 5.04 | 32.94 | 0.814 | 0.791 |
| 32 | 215 | -1.368 | -5.153 | 0.511 | 1.84 | 5.48 | 38.39 | 0.946 | 0.920 |
| 32 | 247 | -1.313 | -5.449 | 0.737 | 1.76 | 5.92 | 43.80 | 1.087 | 1.050 |
| 32 | 279 | -1.279 | -5.720 | 0.954 | 1.71 | 6.33 | 49.19 | 1.223 | 1.179 |
| 32 | 311 | -1.256 | -6.019 | 1.203 | 1.67 | 6.78 | 54.55 | 1.378 | 1.308 |

* Nominal yield stress

Table I.4. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 4.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) 7.06
Moment arm (in) ..... 75.56
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Warping Neglected)
FRANKLIN 4 lb/ft - 60 ksi *
Nested splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | COMBINED BASE STRESS (ksi) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. |
|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.149 | -1.535 | 1.101 | | | | | |
| | tight | -2.497 | -3.712 | 1.119 | 3.52 | 3.28 | | | |
| | DL | -2.278 | -3.620 | 1.022 | 3.20 | 3.14 | 1.41 | 0.053 | 0.053 |
| 55 | 55 | -1.995 | -3.735 | 0.568 | 2.77 | 3.32 | 10.80 | 0.336 | 0.283 |
| 32 | 87 | -1.860 | -3.828 | 0.317 | 2.57 | 3.46 | 16.33 | 0.492 | 0.416 |
| 32 | 119 | -1.703 | -3.956 | 0.063 | 2.33 | 3.65 | 21.84 | 0.650 | 0.550 |
| 32 | 151 | -1.558 | -4.120 | -0.200 | 2.11 | 3.90 | 27.31 | 0.814 | 0.684 |
| 32 | 183 | -1.428 | -4.352 | -0.488 | 1.92 | 4.25 | 32.75 | 0.994 | 0.818 |
| 32 | 215 | -1.318 | -4.596 | -0.777 | 1.75 | 4.61 | 38.14 | 1.174 | 0.951 |
| 16 | 231 | -1.283 | -4.727 | -0.911 | 1.70 | 4.81 | 40.82 | 1.257 | 1.085 |
| 32 | 263 | -1.230 | -5.013 | -1.217 | 1.62 | 5.24 | 46.16 | 1.448 | 1.152 |
| 32 | 295 | -1.206 | -5.271 | -1.515 | 1.59 | 5.63 | 51.47 | 1.634 | 1.285 |
| 32 | 327 | -1.208 | -5.594 | -1.856 | 1.59 | 6.12 | 56.74 | 1.846 | 1.419 |
| 32 | 359 | -1.223 | -5.916 | -2.200 | 1.61 | 6.60 | 61.96 | 2.060 | 1.552 |
| 32 | 391 | -1.256 | -6.267 | -2.580 | 1.66 | 7.13 | 67.15 | 2.297 | 1.686 |

* Nominal yield stress

Table I.5. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

| Splice length (in) ..... 3.00<br>Dist to bolt A (in) .... 1.50<br>Dist to strain gauge (in 10.00<br>Moment arm (in) ..... 75.50<br>Eccentricity (in) ..... 6.30 | | | | BENDING TORSION TEST<br>(Warping Neglected)<br>MARION 3 lb/ft - 80 ksi *<br>Back to back splice<br>Critical orientation | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | BOLT LOADS (kips) | | COMBINED BASE | STRAIN At Gauge (uin/in) | |
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Bolt A | Bolt B | STRESS (ksi) | Obs. | Calc. |
| | floor | -0.136 | -1.552 | 1.049 | | | | | |
| | tight | -2.198 | -3.566 | 1.125 | 3.10 | 3.04 | | | |
| | DL | -2.235 | -3.444 | 1.221 | 3.15 | 2.85 | 1.90 | 0.039 | 0.039 |
| 55 | 55 | -2.211 | -3.385 | 1.584 | 3.11 | 2.76 | 13.64 | 0.265 | 0.278 |
| 32 | 87 | -2.169 | -3.583 | 1.794 | 3.05 | 3.06 | 20.54 | 0.396 | 0.417 |
| 32 | 119 | -2.110 | -3.849 | 2.014 | 2.96 | 3.46 | 27.38 | 0.533 | 0.556 |
| 32 | 151 | -2.052 | -4.158 | 2.231 | 2.88 | 3.93 | 34.15 | 0.669 | 0.695 |
| 32 | 183 | -2.001 | -4.507 | 2.442 | 2.80 | 4.45 | 40.87 | 0.800 | 0.833 |
| 32 | 215 | -1.937 | -4.903 | 2.654 | 2.70 | 5.05 | 47.55 | 0.932 | 0.972 |
| 32 | 247 | -1.871 | -5.316 | 2.868 | 2.60 | 5.67 | 54.19 | 1.065 | 1.111 |
| 32 | 279 | -1.802 | -5.731 | 3.077 | 2.50 | 6.30 | 60.78 | 1.196 | 1.249 |
| 32 | 311 | -1.731 | -6.131 | 3.279 | 2.39 | 6.90 | 67.34 | 1.321 | 1.388 |

* Nominal yield stress

Table I.6. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

| Splice length (in) ..... 3.00<br>Dist to bolt A (in) ..... 1.50<br>Dist to strain gauge (in) 10.13<br>Moment arm (in) ..... 73.50<br>Eccentricity (in) ..... 6.30 | | | | BENDING TORSION TEST<br>(Warping Neglected)<br>MARION 3 lb/ft - 80 ksi *<br>Nested splice<br>Critical orientation | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | | BOLT LOADS (kips) | | COMBINED BASE | STRAIN At Gauge (uin/in) | |
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Bolt A | Bolt B | STRESS (ksi) | Obs. | Calc. |
| | floor | -0.120 | -1.435 | 1.087 | | | | | |
| | tight | -2.612 | -3.980 | 1.091 | 3.74 | 3.84 | | | |
| | DL | -2.419 | -3.874 | 1.003 | 3.45 | 3.68 | 1.92 | 0.039 | 0.039 |
| 50 | 50 | -2.321 | -4.170 | 0.618 | 3.30 | 4.12 | 12.35 | 0.279 | 0.249 |
| 24 | 74 | -2.272 | -4.316 | 0.435 | 3.23 | 4.34 | 17.43 | 0.393 | 0.350 |
| 24 | 98 | -2.226 | -4.464 | 0.250 | 3.16 | 4.57 | 22.48 | 0.508 | 0.451 |
| 24 | 122 | -2.188 | -4.632 | 0.078 | 3.10 | 4.82 | 27.49 | 0.616 | 0.552 |
| 24 | 146 | -2.158 | -4.816 | -0.121 | 3.06 | 5.10 | 32.47 | 0.740 | 0.652 |
| 24 | 170 | -2.137 | -5.019 | -0.302 | 3.03 | 5.40 | 37.41 | 0.852 | 0.753 |
| 25 | 195 | -2.124 | -5.274 | -0.510 | 3.01 | 5.79 | 42.31 | 0.982 | 0.854 |
| 25 | 220 | -2.111 | -5.554 | -0.698 | 2.99 | 6.21 | 47.19 | 1.099 | 0.954 |
| 25 | 245 | -2.103 | -5.804 | -0.880 | 2.98 | 6.59 | 52.03 | 1.212 | 1.055 |
| 24 | 269 | -2.097 | -6.127 | -1.083 | 2.97 | 7.07 | 57.04 | 1.339 | 1.160 |

* Nominal yield stress

Table I.7. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

| Splice length (in) ..... 4.00<br>Dist to bolt A (in) ..... 1.50<br>Dist to strain gauge (in) 9.13<br>Moment arm (in) ..... 75.63<br>Eccentricity (in) ..... 6.30 | | | | BENDING TORSION TEST<br>(Warping Neglected)<br>MARION 4 lb/ft - 80 ksi *<br>Back to back splice<br>Critical orientation | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | BOLT LOADS (kips) | | COMBINED BASE | STRAIN At Gauge (uin/in) | |
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Bolt A | Bolt B | STRESS (ksi) | Obs. | Calc. |
| | floor | -0.143 | -1.527 | -0.309 | | | | | |
| | tight | -2.187 | -3.423 | -0.299 | 3.07 | 2.86 | | | |
| | DL | -2.313 | -3.452 | -0.234 | 3.26 | 2.90 | 1.45 | 0.038 | 0.038 |
| 55 | 55 | -2.257 | -3.501 | 0.061 | 3.17 | 2.98 | 10.04 | 0.222 | 0.210 |
| 32 | 87 | -2.226 | -3.556 | 0.229 | 3.13 | 3.06 | 15.10 | 0.326 | 0.310 |
| 32 | 119 | -2.196 | -3.771 | 0.388 | 3.08 | 3.38 | 20.16 | 0.426 | 0.410 |
| 32 | 151 | -2.157 | -4.048 | 0.574 | 3.02 | 3.80 | 25.20 | 0.541 | 0.510 |
| 32 | 183 | -2.101 | -4.410 | 0.819 | 2.94 | 4.35 | 30.22 | 0.694 | 0.610 |
| 32 | 215 | -2.064 | -4.690 | 0.991 | 2.88 | 4.77 | 35.23 | 0.801 | 0.709 |
| 32 | 247 | -2.019 | -4.995 | 1.179 | 2.82 | 5.23 | 40.22 | 0.918 | 0.809 |
| 32 | 279 | -1.986 | -5.248 | 1.337 | 2.77 | 5.61 | 45.20 | 1.017 | 0.909 |
| 32 | 311 | -1.955 | -5.534 | 1.510 | 2.72 | 6.04 | 50.16 | 1.125 | 1.009 |
| 32 | 343 | -1.916 | -5.871 | 1.705 | 2.66 | 6.55 | 55.11 | 1.246 | 1.109 |
| 32 | 375 | -1.885 | -6.162 | 1.874 | 2.61 | 6.99 | 60.04 | 1.351 | 1.208 |

* Nominal yield stress

Table I.8. *Results of 75 Inch Combined Bending and Torsion Test (Neglecting Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

| Splice length (in) ..... 4.00<br>Dist to bolt A (in) ..... 1.50<br>Dist to strain gauge (in) 9.19<br>Moment arm (in) ..... 75.38<br>Eccentricity (in) ..... 6.30 | | | | BENDING TORSION TEST<br>(Warping Neglected)<br>MARION 4 lb/ft - 80 ksi *<br>Nested splice<br>Critical orientation | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | BOLT LOADS (kips) | | COMBINED BASE | STRAIN At Gauge (uin/in) | |
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Bolt A | Bolt B | STRESS (ksi) | Obs. | Calc. |
| | floor | -0.148 | -1.572 | -0.392 | | | | | |
| | tight | -2.404 | -3.368 | -0.408 | 3.39 | 2.71 | | | |
| | DL | -2.393 | -3.300 | -0.478 | 3.37 | 2.81 | 1.40 | 0.038 | 0.038 |
| 55 | 55 | -2.137 | -3.458 | -0.806 | 2.99 | 3.05 | 9.88 | 0.242 | 0.210 |
| 32 | 87 | -1.999 | -3.598 | -0.989 | 2.78 | 3.26 | 14.88 | 0.356 | 0.310 |
| 32 | 119 | -1.860 | -3.777 | -1.168 | 2.57 | 3.53 | 19.88 | 0.468 | 0.409 |
| 32 | 151 | -1.749 | -3.993 | -1.343 | 2.40 | 3.86 | 24.85 | 0.577 | 0.509 |
| 32 | 183 | -1.652 | -4.236 | -1.511 | 2.26 | 4.22 | 29.81 | 0.682 | 0.609 |
| 32 | 215 | -1.543 | -4.602 | -1.698 | 2.09 | 4.77 | 34.74 | 0.798 | 0.709 |
| 32 | 247 | -1.503 | -4.804 | -1.860 | 2.03 | 5.08 | 39.64 | 0.899 | 0.809 |
| 32 | 279 | -1.449 | -5.100 | -2.026 | 1.95 | 5.53 | 44.52 | 1.002 | 0.908 |
| 32 | 311 | -1.403 | -5.433 | -2.203 | 1.88 | 6.03 | 49.38 | 1.113 | 1.008 |
| 32 | 343 | -1.368 | -5.809 | -2.378 | 1.83 | 6.59 | 54.22 | 1.222 | 1.108 |
| 32 | 375 | -1.346 | -6.192 | -2.534 | 1.80 | 7.17 | 59.04 | 1.319 | 1.207 |

* Nominal yield stress

Table I.9. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

| Splice length (in) ..... 3.00<br>Dist to bolt A (in) ..... 1.50<br>Dist to strain gauge (in) 7.88<br>Moment arm (in) ..... 75.38<br>Eccentricity (in) ..... 6.30 | | | | BENDING TORSION TEST (Including Warping) FRANKLIN 3 lb/ft - 60 ksi * Back to back splice Critical orientation | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | | BOLT LOADS (kips) | | COMBINED BASE | STRAIN At Gauge (uin/in) | |
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Bolt A | Bolt B | STRESS (ksi) | Obs. | Calc. |
| | floor | -0.130 | -1.335 | 0.679 | | | | | |
| | tight | -2.268 | -3.565 | 0.676 | 3.21 | 3.37 | | | |
| | DL | -2.143 | -3.484 | 0.792 | 3.02 | 3.25 | 1.94 | 0.052 | 0.052 |
| 26 | 26 | -2.041 | -3.387 | 1.058 | 2.87 | 3.10 | 8.52 | 0.218 | 0.246 |
| 24 | 50 | -1.962 | -3.345 | 1.290 | 2.75 | 3.04 | 14.62 | 0.362 | 0.424 |
| 24 | 74 | -1.893 | -3.385 | 1.515 | 2.65 | 3.10 | 20.69 | 0.502 | 0.601 |
| 24 | 98 | -1.844 | -3.467 | 1.733 | 2.57 | 3.22 | 26.71 | 0.638 | 0.777 |
| 24 | 122 | -1.818 | -3.635 | 1.945 | 2.53 | 3.48 | 32.69 | 0.770 | 0.952 |
| 24 | 146 | -1.815 | -3.871 | 2.156 | 2.53 | 3.83 | 38.63 | 0.902 | 1.126 |
| 24 | 170 | -1.831 | -4.095 | 2.360 | 2.55 | 4.17 | 44.53 | 1.029 | 1.299 |
| 24 | 194 | -1.854 | -4.367 | 2.561 | 2.59 | 4.58 | 50.38 | 1.154 | 1.471 |
| 24 | 218 | -1.865 | -4.670 | 2.758 | 2.60 | 5.04 | 56.20 | 1.277 | 1.642 |
| 24 | 242 | -1.852 | -5.025 | 2.937 | 2.58 | 5.57 | 61.98 | 1.388 | 1.812 |
| 24 | 266 | -1.819 | -5.385 | 3.123 | 2.54 | 6.11 | 67.72 | 1.504 | 1.980 |
| 24 | 290 | -1.788 | -5.792 | 3.327 | 2.49 | 6.73 | 73.43 | 1.631 | 2.149 |

* Nominal yield stress

Table I.10. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) ..... 1.50
Dist to strain gauge (in) 8.25
Moment arm (in) ..... 75.50
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Including Warping)
FRANKLIN 3 lb/ft - 60 ksi *
Nested splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | COMBINED BASE STRESS (ksi) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. |
|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.135 | -1.359 | 0.689 | | | | | |
| | tight | -2.262 | -3.481 | 0.738 | 3.19 | 3.20 | | | |
| | DL | -2.115 | -3.454 | 0.671 | 2.97 | 3.16 | 1.94 | 0.051 | 0.051 |
| 26 | 26 | -2.057 | -3.544 | 0.443 | 2.89 | 3.29 | 8.53 | 0.193 | 0.245 |
| 24 | 50 | -2.021 | -3.626 | 0.218 | 2.83 | 3.42 | 14.64 | 0.333 | 0.422 |
| 24 | 74 | -1.997 | -3.702 | -0.002 | 2.79 | 3.53 | 20.70 | 0.470 | 0.599 |
| 24 | 98 | -1.994 | -3.809 | -0.229 | 2.79 | 3.69 | 26.71 | 0.612 | 0.774 |
| 24 | 122 | -2.013 | -3.966 | -0.466 | 2.82 | 3.93 | 32.67 | 0.760 | 0.948 |
| 24 | 146 | -2.053 | -4.169 | -0.712 | 2.88 | 4.24 | 38.57 | 0.913 | 1.120 |
| 24 | 170 | -2.111 | -4.410 | -0.959 | 2.97 | 4.60 | 44.41 | 1.067 | 1.291 |
| 24 | 194 | -2.177 | -4.681 | -1.207 | 3.07 | 5.01 | 50.19 | 1.221 | 1.460 |
| 24 | 218 | -2.237 | -4.980 | -1.475 | 3.16 | 5.46 | 55.95 | 1.388 | 1.629 |
| 24 | 242 | -2.305 | -5.288 | -1.748 | 3.26 | 5.92 | 61.66 | 1.558 | 1.797 |
| 24 | 266 | -2.371 | -5.613 | -2.004 | 3.36 | 6.41 | 67.32 | 1.718 | 1.963 |
| 24 | 290 | -2.457 | -5.939 | -2.312 | 3.49 | 6.90 | 72.96 | 1.910 | 2.128 |

* Nominal yield stress

Table I.11. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

| Splice length (in) ..... 4.00<br>Dist to bolt A (in) ..... 1.50<br>Dist to strain gauge (in) 9.25<br>Moment arm (in) ..... 75.63<br>Eccentricity (in) ..... 6.30 | | | | BENDING TORSION TEST<br>(Including Warping)<br>FRANKLIN 4 lb/ft - 60 ksi *<br>Back to back splice<br>Critical orientation | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | | BOLT LOADS (kips) | | COMBINED BASE | STRAIN At Gauge (uin/in) | |
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Bolt A | Bolt B | STRESS (ksi) | Obs. | Calc. |
| | floor | -0.141 | -1.520 | -1.027 | | | | | |
| | tight | -2.078 | -3.648 | -1.021 | 2.91 | 3.21 | | | |
| | DL | -1.937 | -3.623 | -0.930 | 2.70 | 3.17 | 1.45 | 0.049 | 0.049 |
| 55 | 55 | -1.773 | -3.831 | -0.554 | 2.45 | 3.48 | 11.33 | 0.283 | 0.309 |
| 32 | 87 | -1.688 | -4.039 | -0.351 | 2.32 | 3.80 | 17.14 | 0.409 | 0.460 |
| 32 | 119 | -1.595 | -4.299 | -0.131 | 2.18 | 4.19 | 22.92 | 0.546 | 0.611 |
| 32 | 151 | -1.510 | -4.563 | 0.080 | 2.05 | 4.59 | 28.67 | 0.678 | 0.761 |
| 32 | 183 | -1.432 | -4.861 | 0.298 | 1.94 | 5.04 | 34.39 | 0.814 | 0.911 |
| 32 | 215 | -1.368 | -5.153 | 0.511 | 1.84 | 5.48 | 40.08 | 0.946 | 1.060 |
| 32 | 247 | -1.313 | -5.449 | 0.737 | 1.76 | 5.92 | 45.74 | 1.087 | 1.209 |
| 32 | 279 | -1.279 | -5.720 | 0.954 | 1.71 | 6.33 | 51.37 | 1.223 | 1.358 |
| 32 | 311 | -1.256 | -6.019 | 1.203 | 1.67 | 6.78 | 56.97 | 1.378 | 1.506 |

* Nominal yield stress

Table I.12. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

| Splice length (in) ..... 4.00<br>Dist to bolt A (in) ..... 1.50<br>Dist to strain gauge (in) 7.06<br>Moment arm (in) ..... 75.56<br>Eccentricity (in) ..... 6.30 | | | | BENDING TORSION TEST (Including Warping) FRANKLIN 4 lb/ft - 60 ksi * Nested splice Critical orientation | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | BOLT LOADS (kips) | | COMBINED BASE | STRAIN At Gauge (uin/in) | |
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Bolt A | Bolt B | STRESS (ksi) | Obs. | Calc. |
| | floor | -0.149 | -1.535 | 1.101 | | | | | |
| | tight | -2.497 | -3.712 | 1.119 | 3.52 | 3.28 | | | |
| | DL | -2.278 | -3.620 | 1.022 | 3.20 | 3.14 | 1.41 | 0.053 | 0.053 |
| 55 | 55 | -1.995 | -3.735 | 0.568 | 2.77 | 3.32 | 11.29 | 0.336 | 0.320 |
| 32 | 87 | -1.860 | -3.828 | 0.317 | 2.57 | 3.46 | 17.07 | 0.492 | 0.474 |
| 32 | 119 | -1.703 | -3.956 | 0.063 | 2.33 | 3.65 | 22.83 | 0.650 | 0.629 |
| 32 | 151 | -1.558 | -4.120 | -0.200 | 2.11 | 3.90 | 28.54 | 0.814 | 0.783 |
| 32 | 183 | -1.428 | -4.352 | -0.488 | 1.92 | 4.25 | 34.22 | 0.994 | 0.936 |
| 32 | 215 | -1.318 | -4.596 | -0.777 | 1.75 | 4.61 | 39.85 | 1.174 | 1.089 |
| 16 | 231 | -1.283 | -4.727 | -0.911 | 1.70 | 4.81 | 42.66 | 1.257 | 1.166 |
| 32 | 263 | -1.230 | -5.013 | -1.217 | 1.62 | 5.24 | 48.24 | 1.448 | 1.318 |
| 32 | 295 | -1.206 | -5.271 | -1.515 | 1.59 | 5.63 | 53.79 | 1.634 | 1.470 |
| 32 | 327 | -1.208 | -5.594 | -1.856 | 1.59 | 6.12 | 59.30 | 1.846 | 1.621 |
| 32 | 359 | -1.223 | -5.916 | -2.200 | 1.61 | 6.60 | 64.77 | 2.060 | 1.772 |
| 32 | 391 | -1.256 | -6.267 | -2.580 | 1.66 | 7.13 | 70.19 | 2.297 | 1.922 |

* Nominal yield stress

Table I.13. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

Splice length (in) ..... 3.00
Dist to bolt A (in) .... 1.50
Dist to strain gauge (in 10.00
Moment arm (in) ..... 75.50
Eccentricity (in) ..... 6.30

BENDING TORSION TEST
(Including Warping)
MARION 3 lb/ft - 80 ksi *
Back to back splice
Critical orientation

| LOAD (lbs) Appl | LOAD (lbs) Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | BOLT LOADS (kips) Bolt A | BOLT LOADS (kips) Bolt B | COMBINED BASE STRESS (ksi) | STRAIN At Gauge (uin/in) Obs. | STRAIN At Gauge (uin/in) Calc. |
|---|---|---|---|---|---|---|---|---|---|
| | floor | -0.136 | -1.552 | 1.049 | | | | | |
| | tight | -2.198 | -3.566 | 1.125 | 3.10 | 3.04 | | | |
| | DL | -2.235 | -3.444 | 1.221 | 3.15 | 2.85 | 1.92 | 0.039 | 0.039 |
| 55 | 55 | -2.211 | -3.385 | 1.584 | 3.11 | 2.76 | 15.78 | 0.265 | 0.383 |
| 32 | 87 | -2.169 | -3.583 | 1.794 | 3.05 | 3.06 | 23.81 | 0.396 | 0.581 |
| 32 | 119 | -2.110 | -3.849 | 2.014 | 2.96 | 3.46 | 31.76 | 0.533 | 0.777 |
| 32 | 151 | -2.052 | -4.158 | 2.231 | 2.88 | 3.93 | 39.62 | 0.669 | 0.971 |
| 32 | 183 | -2.001 | -4.507 | 2.442 | 2.80 | 4.45 | 47.41 | 0.800 | 1.163 |
| 32 | 215 | -1.937 | -4.903 | 2.654 | 2.70 | 5.05 | 55.14 | 0.932 | 1.354 |
| 32 | 247 | -1.871 | -5.316 | 2.868 | 2.60 | 5.67 | 62.80 | 1.065 | 1.542 |
| 32 | 279 | -1.802 | -5.731 | 3.077 | 2.50 | 6.30 | 70.41 | 1.196 | 1.730 |
| 32 | 311 | -1.731 | -6.131 | 3.279 | 2.39 | 6.90 | 74.19 | 1.321 | 1.823 |

* Nominal yield stress

Table I.14. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

| Splice length (in) ..... 3.00<br>Dist to bolt A (in) ..... 1.50<br>Dist to strain gauge (in) 10.13<br>Moment arm (in) ..... 73.50<br>Eccentricity (in) ..... 6.30 | | | | BENDING TORSION TEST (Including Warping) MARION 3 lb/ft - 80 ksi * Nested splice Critical orientation | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | | | | | |
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | BOLT LOADS (kips) Bolt A | Bolt B | COMBINED BASE STRESS (ksi) | STRAIN At Gauge (uin/in) Obs. | Calc. |
| | floor | -0.120 | -1.435 | 1.087 | | | | | |
| | tight | -2.612 | -3.980 | 1.091 | 3.74 | 3.84 | | | |
| | DL | -2.419 | -3.874 | 1.003 | 3.45 | 3.68 | 1.92 | 0.039 | 0.039 |
| 50 | 50 | -2.321 | -4.170 | 0.618 | 3.30 | 4.12 | 14.29 | 0.279 | 0.345 |
| 24 | 74 | -2.272 | -4.316 | 0.435 | 3.23 | 4.34 | 20.22 | 0.393 | 0.491 |
| 24 | 98 | -2.226 | -4.464 | 0.250 | 3.16 | 4.57 | 26.10 | 0.508 | 0.635 |
| 24 | 122 | -2.188 | -4.632 | 0.078 | 3.10 | 4.82 | 31.94 | 0.616 | 0.778 |
| 24 | 146 | -2.158 | -4.816 | -0.121 | 3.06 | 5.10 | 37.72 | 0.740 | 0.920 |
| 24 | 170 | -2.137 | -5.019 | -0.302 | 3.03 | 5.40 | 43.45 | 0.852 | 1.061 |
| 25 | 195 | -2.124 | -5.274 | -0.510 | 3.01 | 5.79 | 49.13 | 0.982 | 1.200 |
| 25 | 220 | -2.111 | -5.554 | -0.698 | 2.99 | 6.21 | 54.77 | 1.099 | 1.339 |
| 25 | 245 | -2.103 | -5.804 | -0.880 | 2.98 | 6.59 | 60.37 | 1.212 | 1.476 |
| 24 | 269 | -2.097 | -6.127 | -1.083 | 2.97 | 7.07 | 66.15 | 1.339 | 1.618 |

* Nominal yield stress

Table I.15. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

| Splice length (in) ..... 4.00<br>Dist to bolt A (in) ..... 1.50<br>Dist to strain gauge (in) 9.13<br>Moment arm (in) ..... 75.63<br>Eccentricity (in) ..... 6.30 | | | | BENDING TORSION TEST (Including Warping) MARION 4 lb/ft - 80 ksi * Back to back splice Critical orientation | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | BOLT LOADS (kips) | | COMBINED BASE | STRAIN At Gauge (uin/in) | |
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Bolt A | Bolt B | STRESS (ksi) | Obs. | Calc. |
| | floor | -0.143 | -1.527 | -0.309 | | | | | |
| | tight | -2.187 | -3.423 | -0.299 | 3.07 | 2.86 | | | |
| | DL | -2.313 | -3.452 | -0.234 | 3.26 | 2.90 | 1.45 | 0.038 | 0.038 |
| 55 | 55 | -2.257 | -3.501 | 0.061 | 3.17 | 2.98 | 11.58 | 0.222 | 0.256 |
| 32 | 87 | -2.226 | -3.556 | 0.229 | 3.13 | 3.06 | 17.54 | 0.326 | 0.382 |
| 32 | 119 | -2.196 | -3.771 | 0.388 | 3.08 | 3.38 | 23.48 | 0.426 | 0.508 |
| 32 | 151 | -2.157 | -4.048 | 0.574 | 3.02 | 3.80 | 29.39 | 0.541 | 0.634 |
| 32 | 183 | -2.101 | -4.410 | 0.819 | 2.94 | 4.35 | 35.27 | 0.694 | 0.759 |
| 32 | 215 | -2.064 | -4.690 | 0.991 | 2.88 | 4.77 | 41.13 | 0.801 | 0.884 |
| 32 | 247 | -2.019 | -4.995 | 1.179 | 2.82 | 5.23 | 46.95 | 0.918 | 1.090 |
| 32 | 279 | -1.986 | -5.248 | 1.337 | 2.77 | 5.61 | 52.74 | 1.017 | 1.133 |
| 32 | 311 | -1.955 | -5.534 | 1.510 | 2.72 | 6.04 | 58.51 | 1.125 | 1.256 |
| 32 | 343 | -1.916 | -5.871 | 1.705 | 2.66 | 6.55 | 64.25 | 1.246 | 1.380 |
| 32 | 375 | -1.885 | -6.162 | 1.874 | 2.61 | 6.99 | 69.96 | 1.351 | 1.503 |

* Nominal yield stress

Table I.16. *Results of 75 Inch Combined Bending and Torsion Test (Including Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

| Splice length (in) ..... 4.00<br>Dist to bolt A (in) ..... 1.50<br>Dist to strain gauge (in) 9.19<br>Moment arm (in) ..... 75.38<br>Eccentricity (in) ..... 6.30 | | | | BENDING TORSION TEST<br>(Including Warping)<br>MARION 4 lb/ft - 80 ksi *<br>Nested splice<br>Critical orientation | | | | |
|---|---|---|---|---|---|---|---|---|
| LOAD (lbs) | | | | | BOLT LOADS (kips) | | COMBINED BASE | STRAIN At Gauge (uin/in) | |
| Appl | Tot | Ch.#1 (mV) | Ch.#2 (mV) | Ch.#3 (mV) | Bolt A | Bolt B | STRESS (ksi) | Obs. | Calc. |
| | floor | -0.148 | -1.572 | -0.392 | | | | | |
| | tight | -2.404 | -3.368 | -0.408 | 3.39 | 2.71 | | | |
| | DL | -2.393 | -3.300 | -0.478 | 3.37 | 2.81 | 1.40 | 0.038 | 0.038 |
| 55 | 55 | -2.137 | -3.458 | -0.806 | 2.99 | 3.05 | 9.88 | 0.242 | 0.210 |
| 32 | 87 | -1.999 | -3.598 | -0.989 | 2.78 | 3.26 | 14.88 | 0.356 | 0.310 |
| 32 | 119 | -1.860 | -3.777 | -1.168 | 2.57 | 3.53 | 19.88 | 0.468 | 0.409 |
| 32 | 151 | -1.749 | -3.993 | -1.343 | 2.40 | 3.86 | 24.85 | 0.577 | 0.509 |
| 32 | 183 | -1.652 | -4.236 | -1.511 | 2.26 | 4.22 | 29.81 | 0.682 | 0.609 |
| 32 | 215 | -1.543 | -4.602 | -1.698 | 2.09 | 4.77 | 34.74 | 0.798 | 0.709 |
| 32 | 247 | -1.503 | -4.804 | -1.860 | 2.03 | 5.08 | 39.64 | 0.899 | 0.809 |
| 32 | 279 | -1.449 | -5.100 | -2.026 | 1.95 | 5.53 | 44.52 | 1.002 | 0.908 |
| 32 | 311 | -1.403 | -5.433 | -2.203 | 1.88 | 6.03 | 49.38 | 1.113 | 1.008 |
| 32 | 343 | -1.368 | -5.809 | -2.378 | 1.83 | 6.59 | 54.22 | 1.222 | 1.108 |
| 32 | 375 | -1.346 | -6.192 | -2.534 | 1.80 | 7.17 | 59.04 | 1.319 | 1.207 |

* Nominal yield stress

# APPENDIX J

## PRELIMINARY 72 " BENDING TESTS

## BASE STRESS VS TIP DEFLECTION

## (FIELD BOLTS)

Marion 3 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back, Nested and Face to Face Splices

Critical and Non-critical Configurations

# APPENDIX J

## LIST OF FIGURES

# APPENDIX J

## LIST OF FIGURES (CONT)

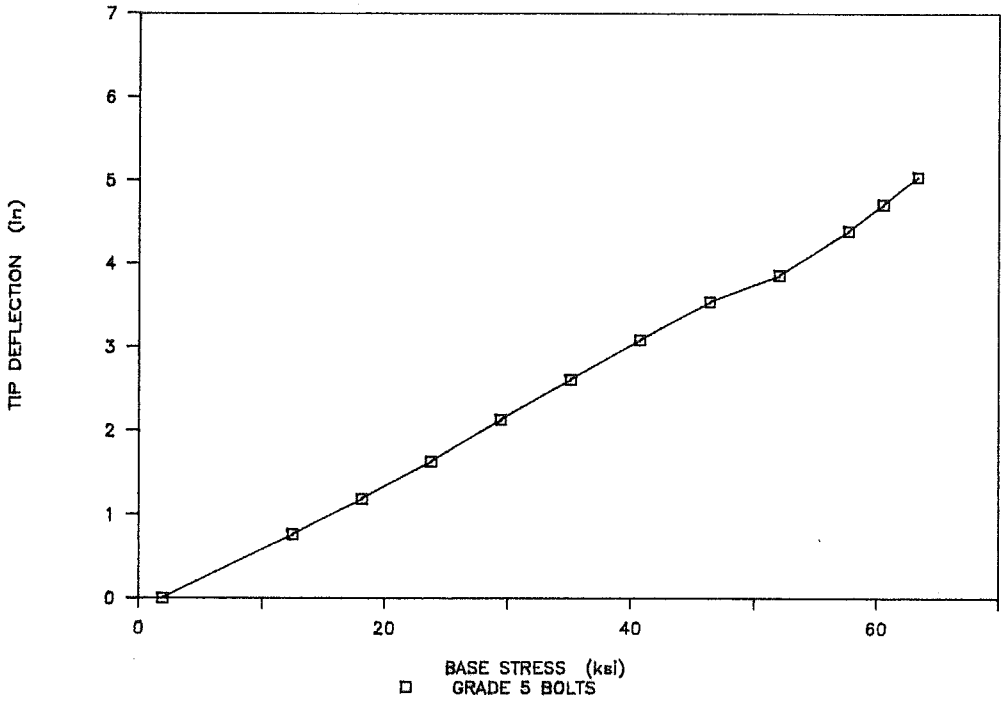


Figure J.1. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

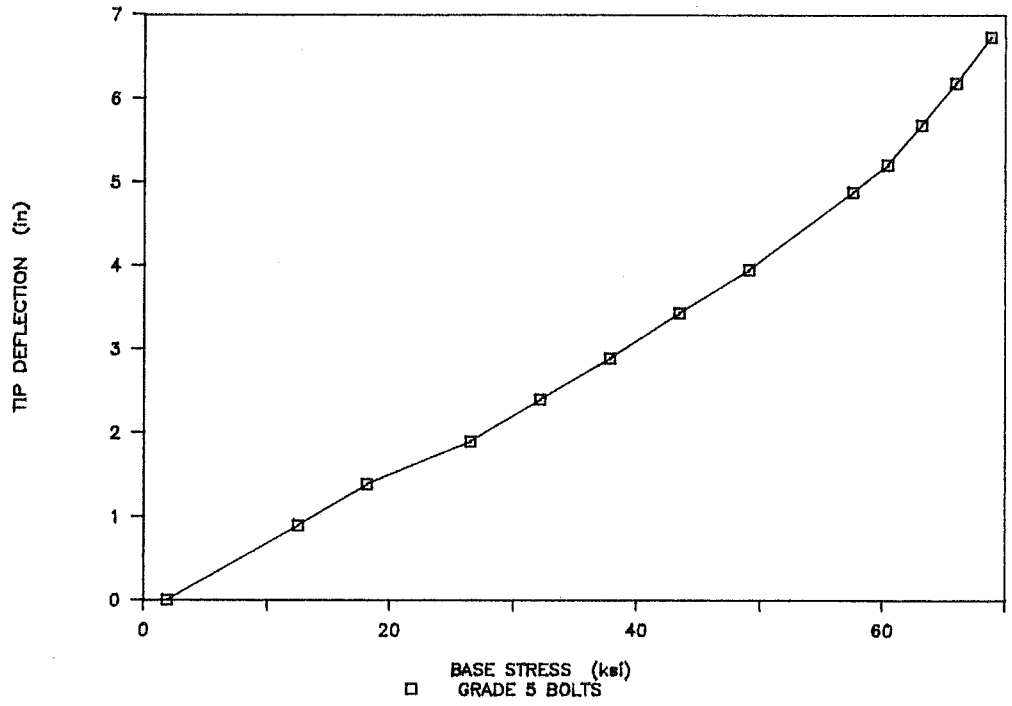


Figure J.2. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

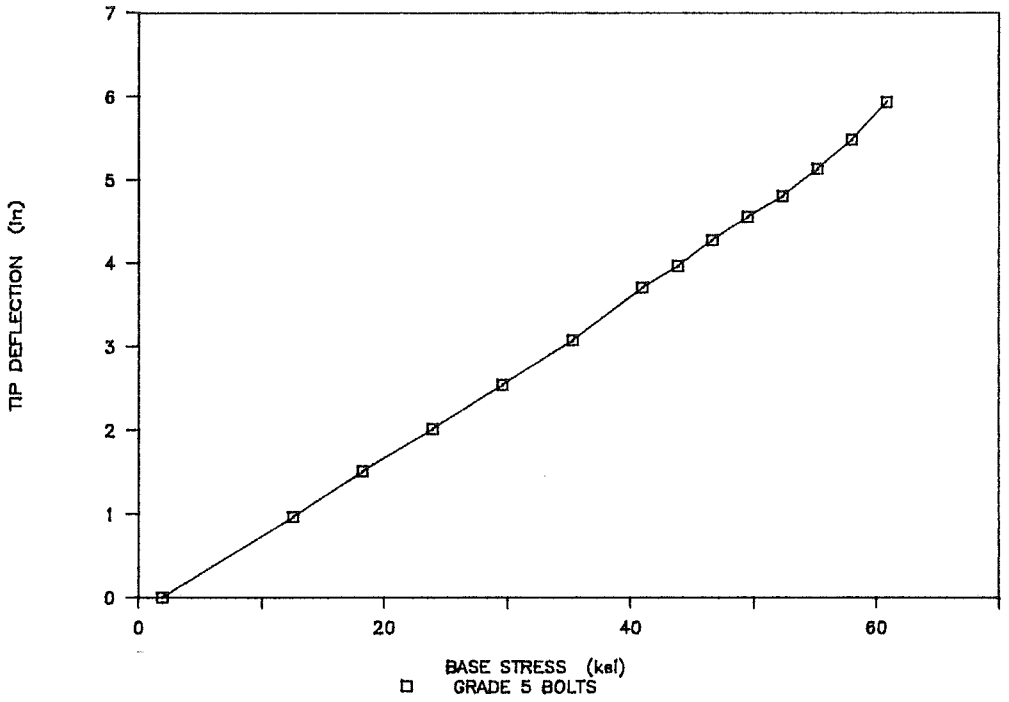


Figure J.3. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Face to Face Splice in Critical Configuration (Grade 5 Field Bolts).*

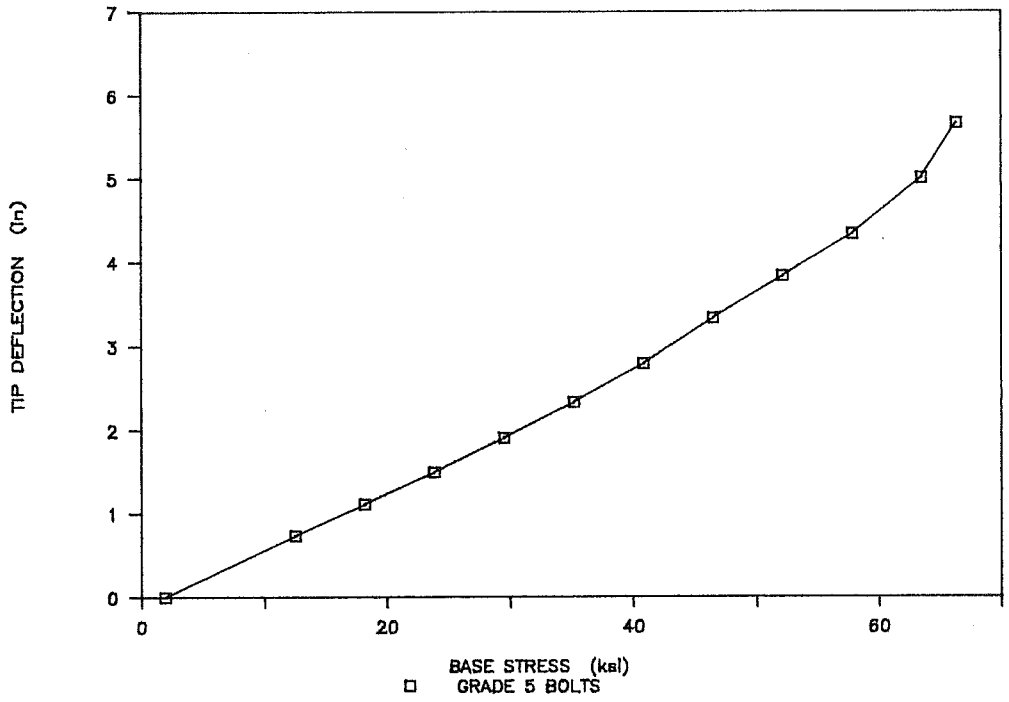


Figure J.4. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

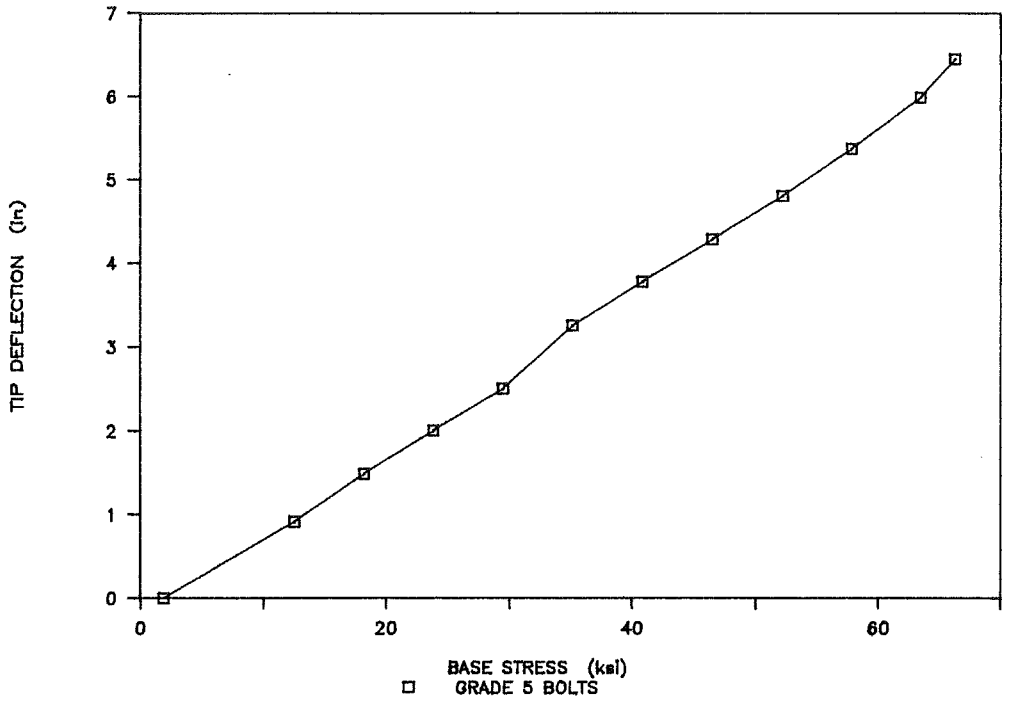


Figure J.5. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

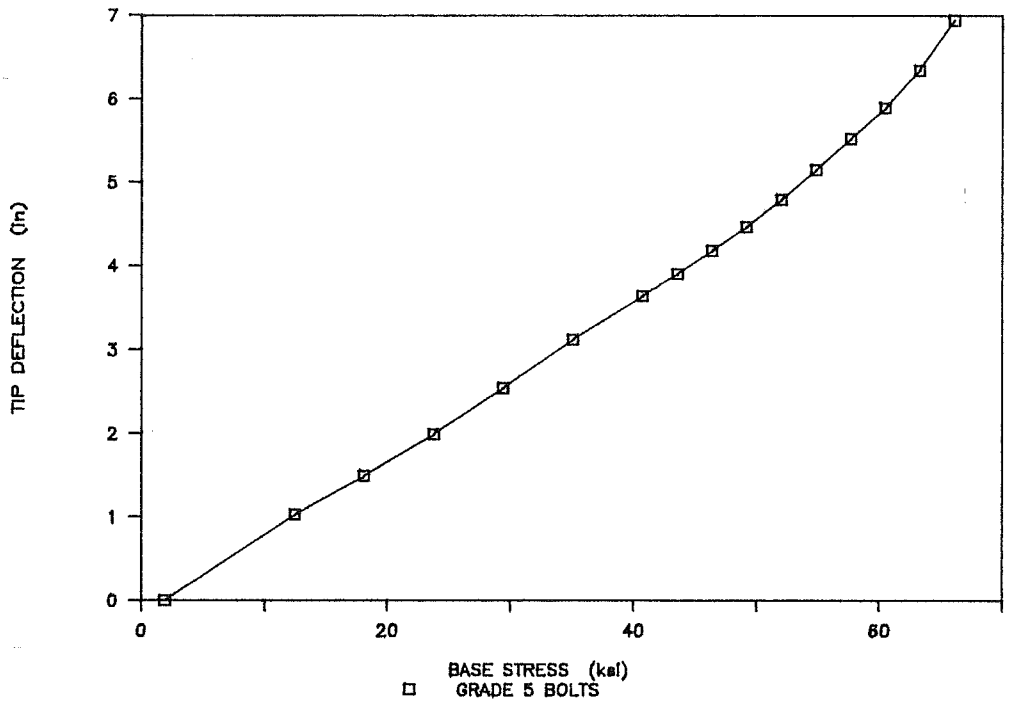


Figure J.6. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Face to Face Splice in Non-critical Configuration (Grade 5 Field Bolts).*

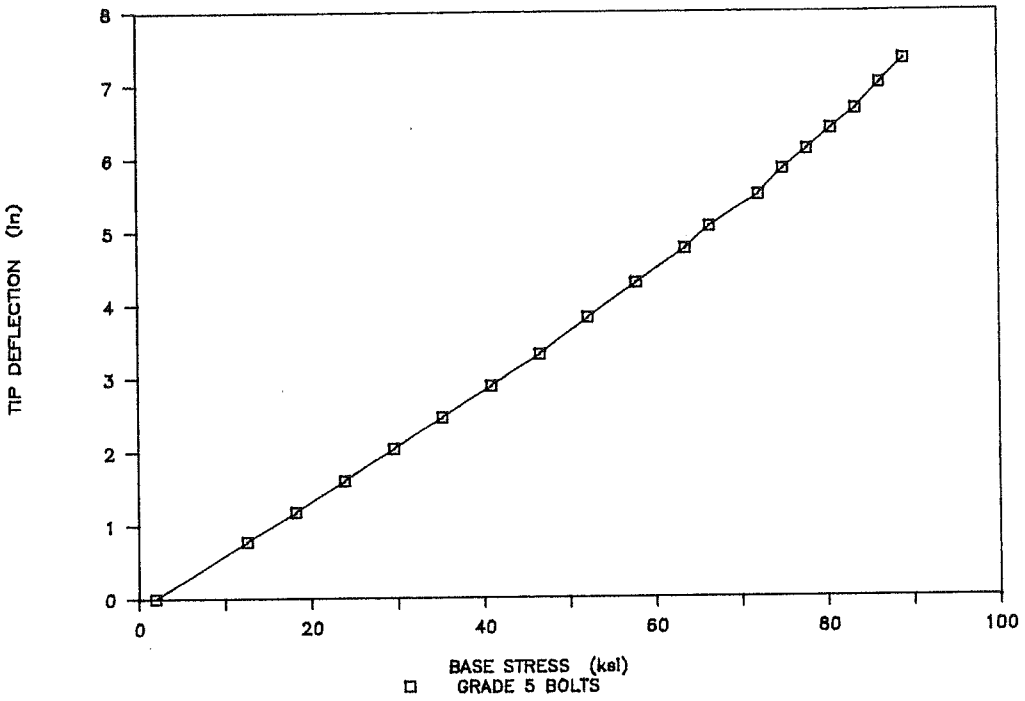


Figure J.7. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

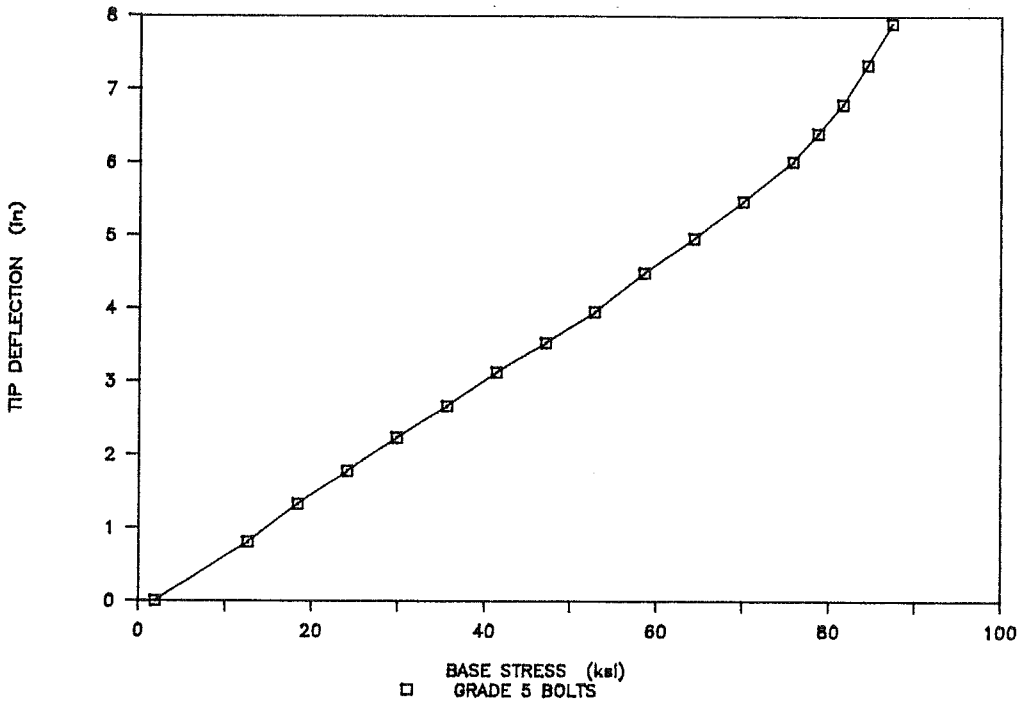


Figure J.8. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

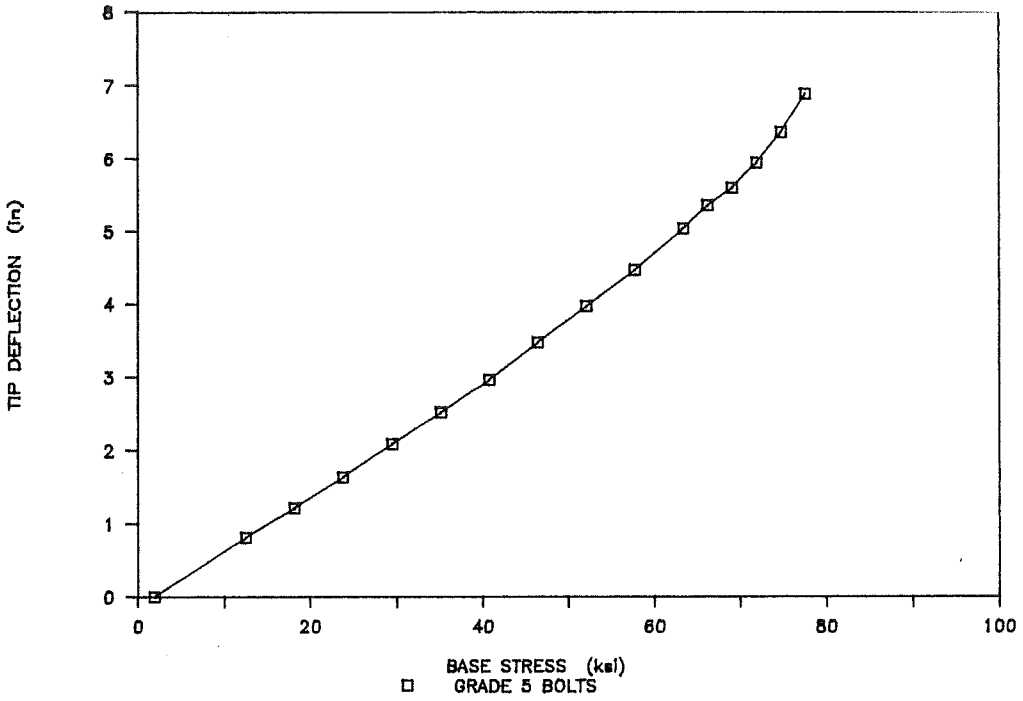


Figure J.9. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Grade 5 Field Bolts).*

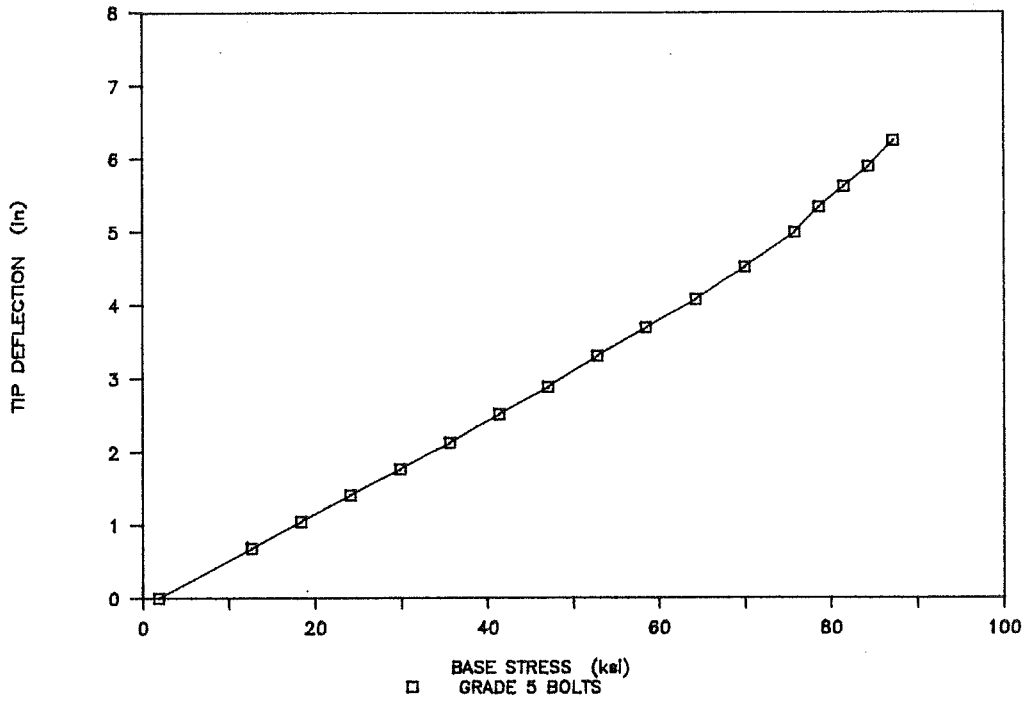


Figure J.10. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

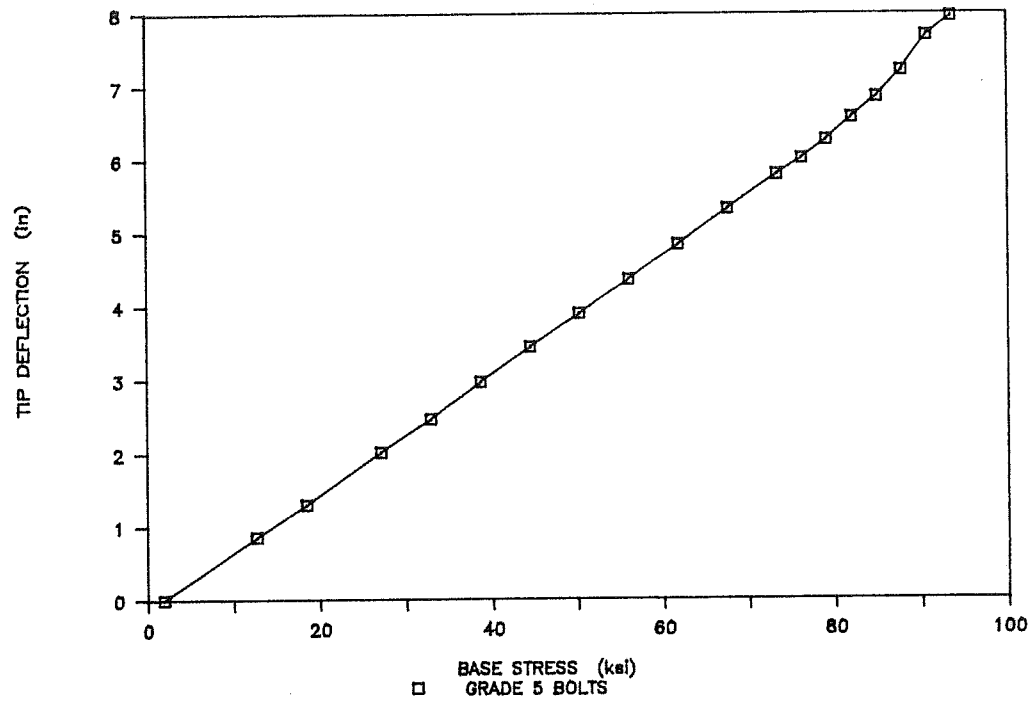


**Figure J.11.** *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

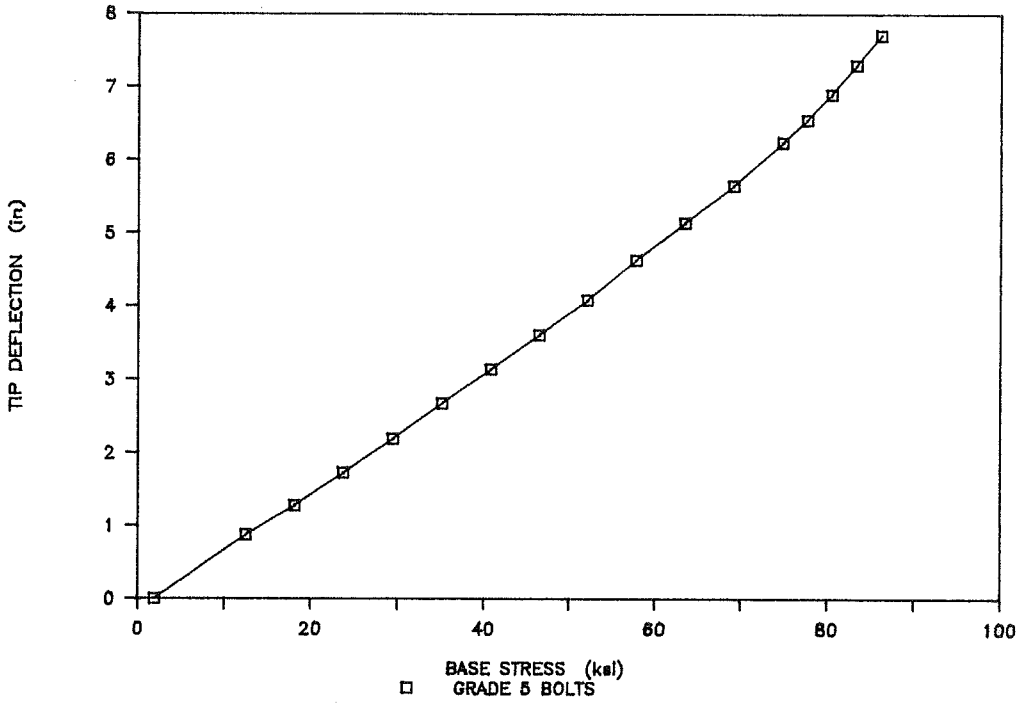


**Figure J.12.** *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Grade 5 Field Bolts).*

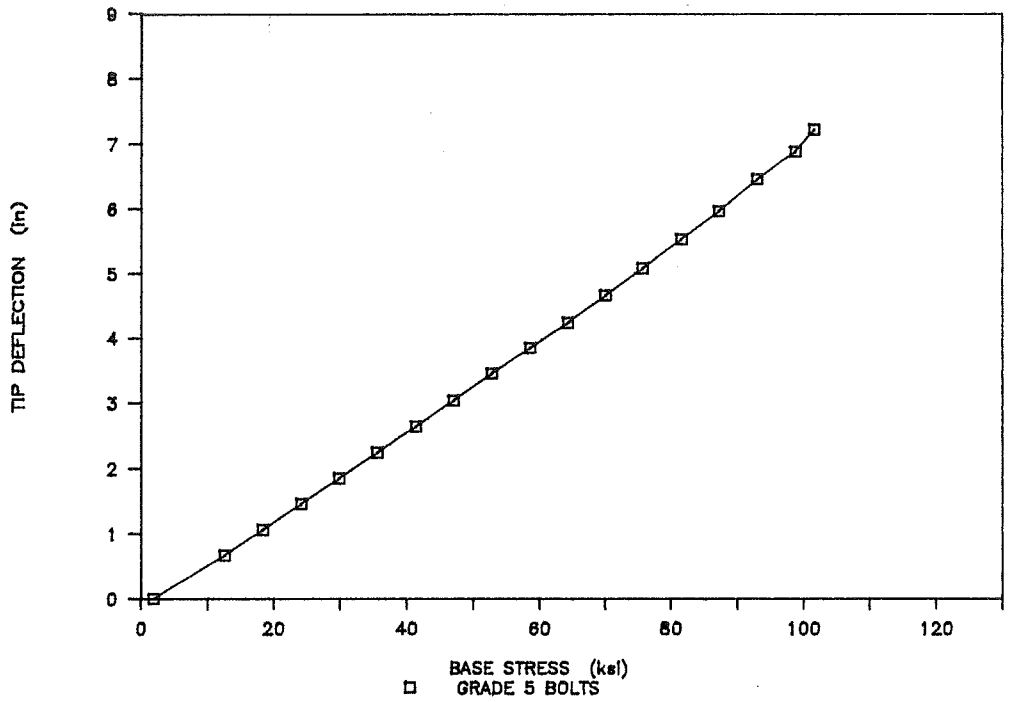


Figure J.13. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 5 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

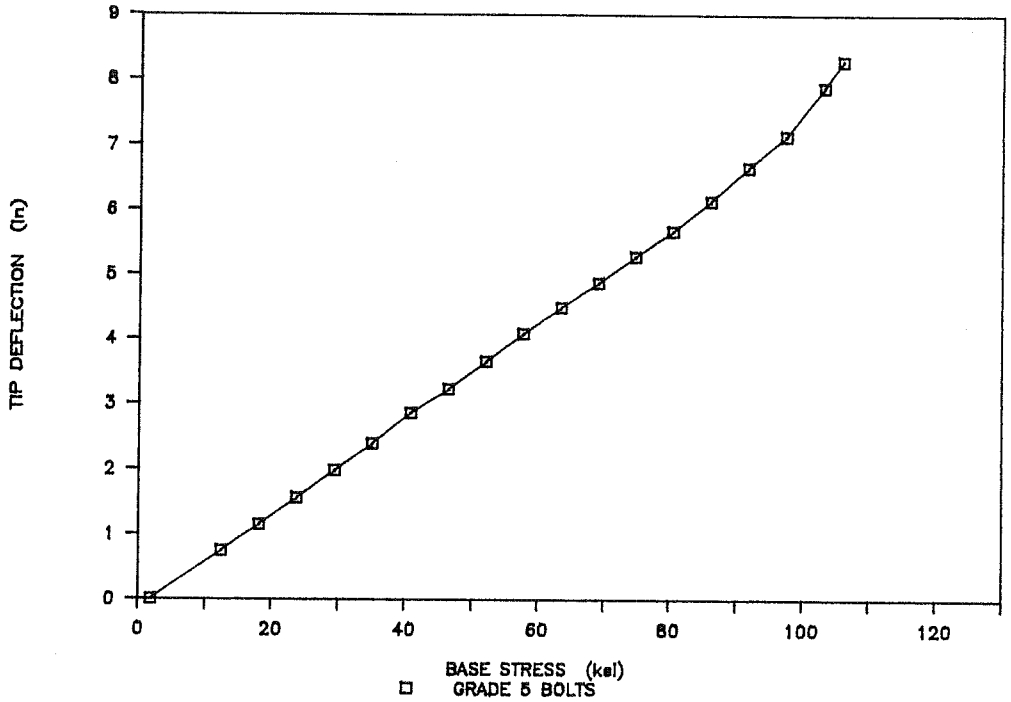


Figure J.14. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 5 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

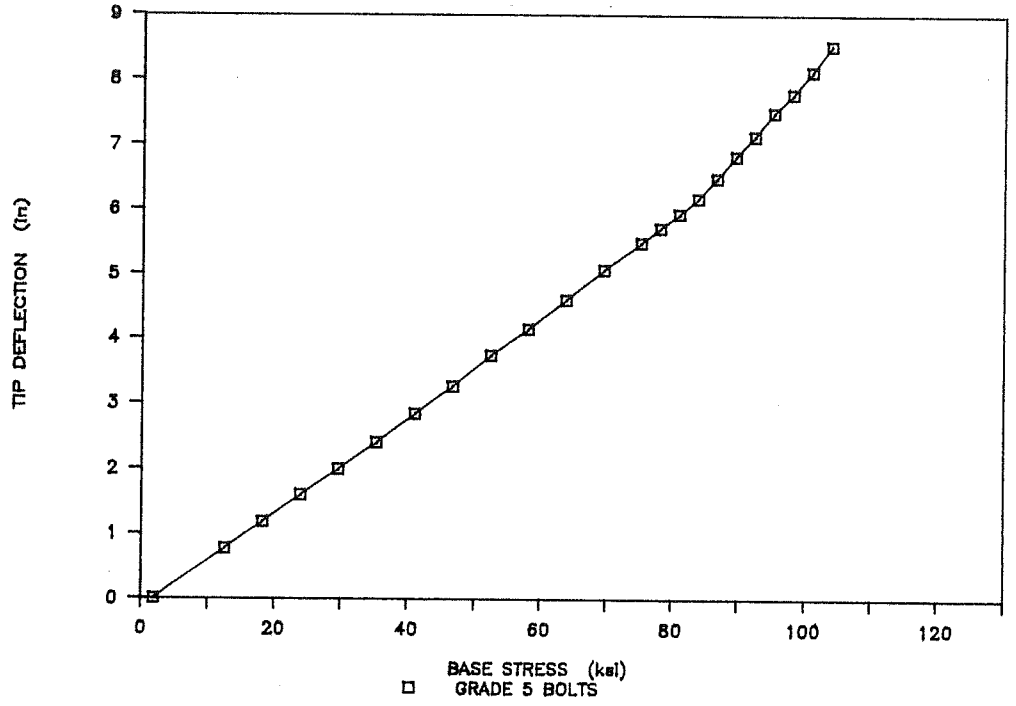


Figure J.15. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 5 Inch Face to Face Splice in Critical Configuration (Grade 5 Field Bolts).*

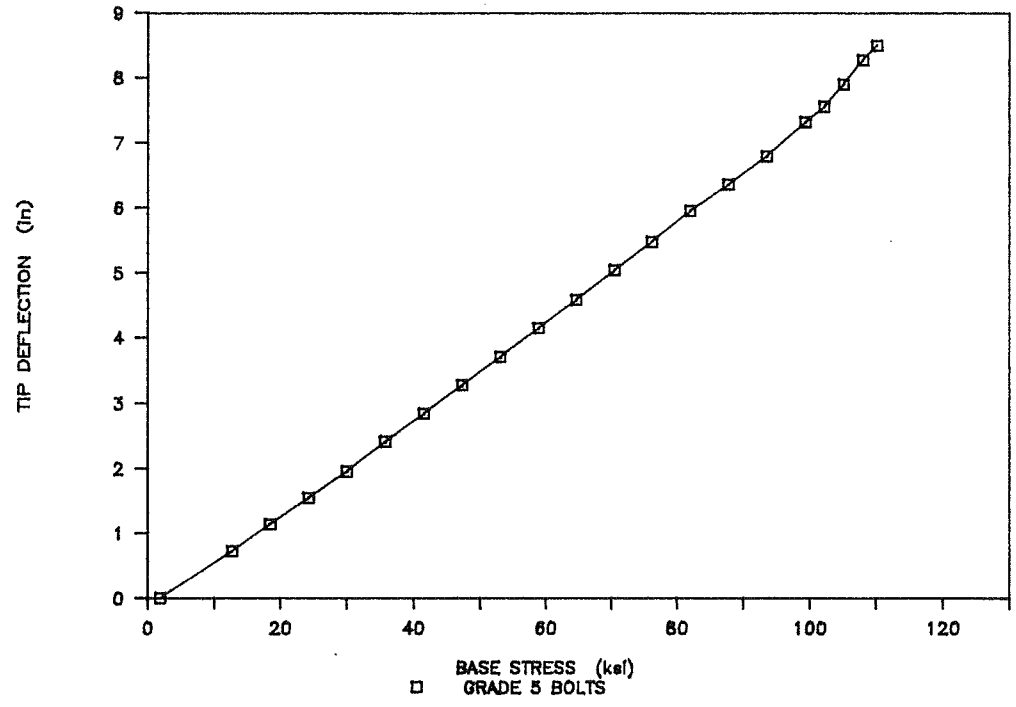


Figure J.16. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 5 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

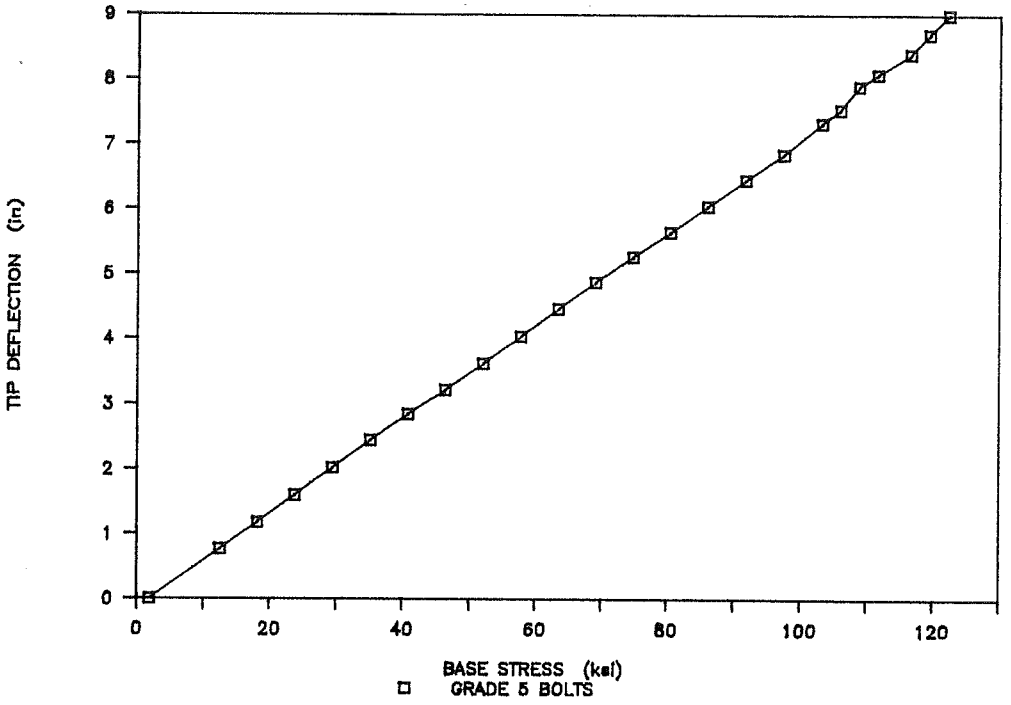


Figure J.17. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 5 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

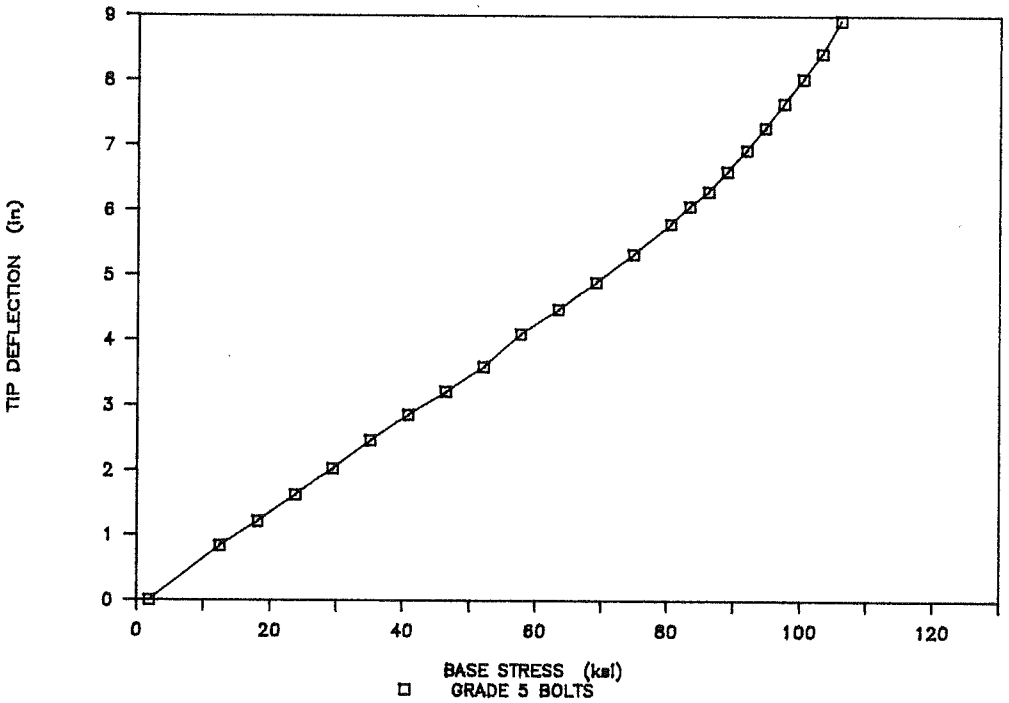


Figure J.18. *Base Stress vs Tip Deflection (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 5 Inch Face to Face Splice in Non-critical Configuration (Grade 5 Field Bolts).*

# APPENDIX K

## 17 " BENDING TESTS

BASE STRESS VS DEFLECTION AT POINT OF LOAD

(FIELD BOLTS)

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back, Nested, Face to Face and Box Splices

Critical and Non-critical Configurations

# APPENDIX K

## LIST OF FIGURES

# APPENDIX K

## LIST OF FIGURES (CONT)

# APPENDIX K

## LIST OF FIGURES (CONT)

# APPENDIX K

## LIST OF FIGURES (CONT)

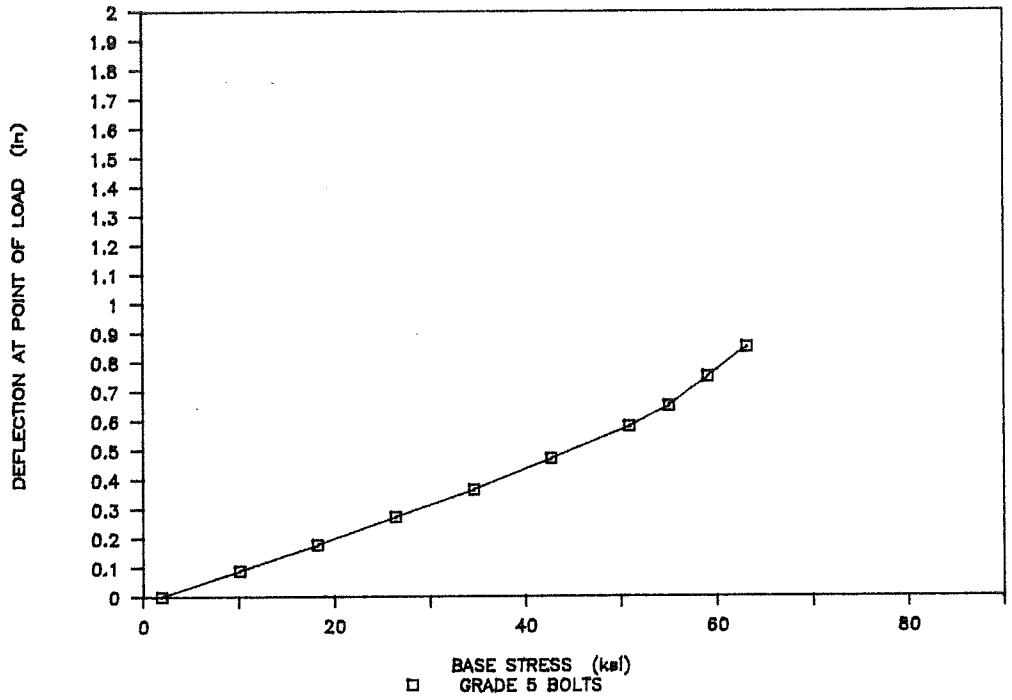


Figure K.1. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

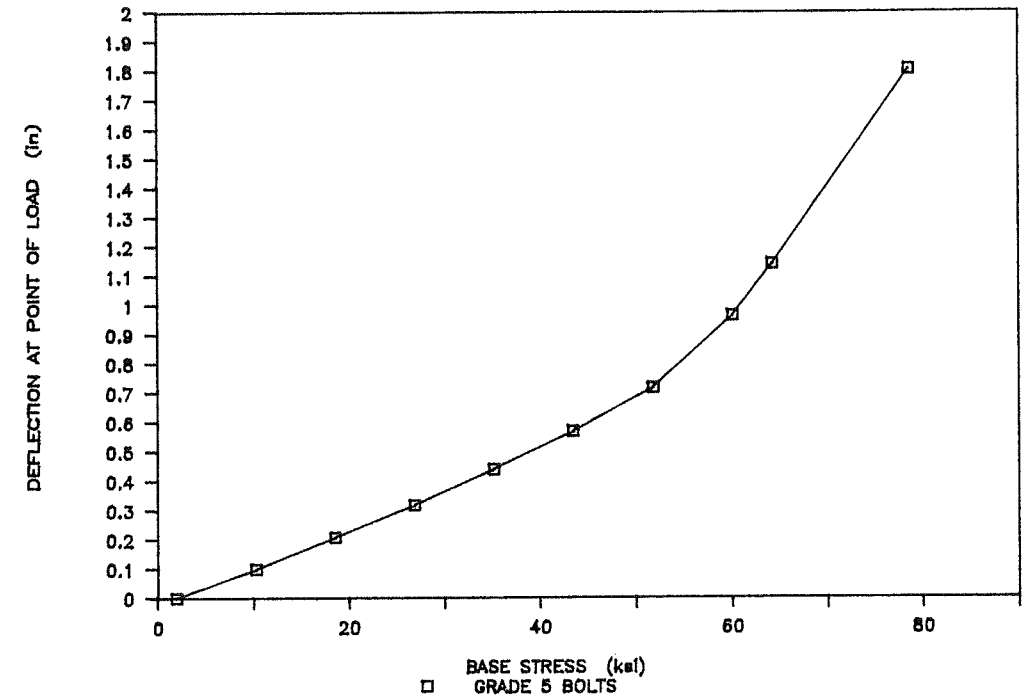


Figure K.2. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

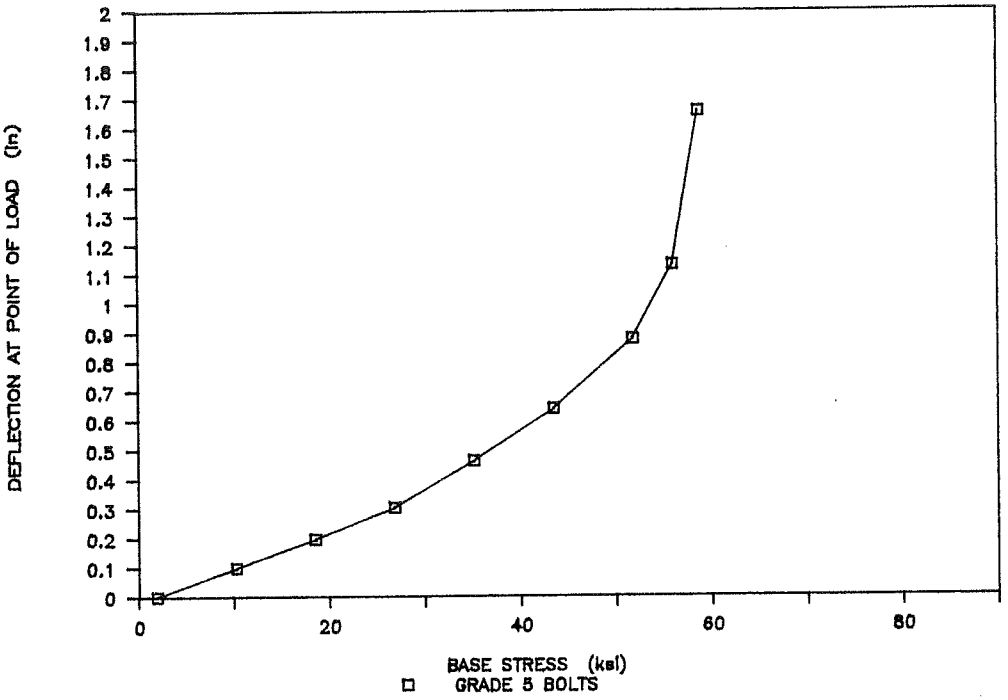


Figure K.3. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Face to Face Splice in Critical Configuration (Grade 5 Field Bolts).*

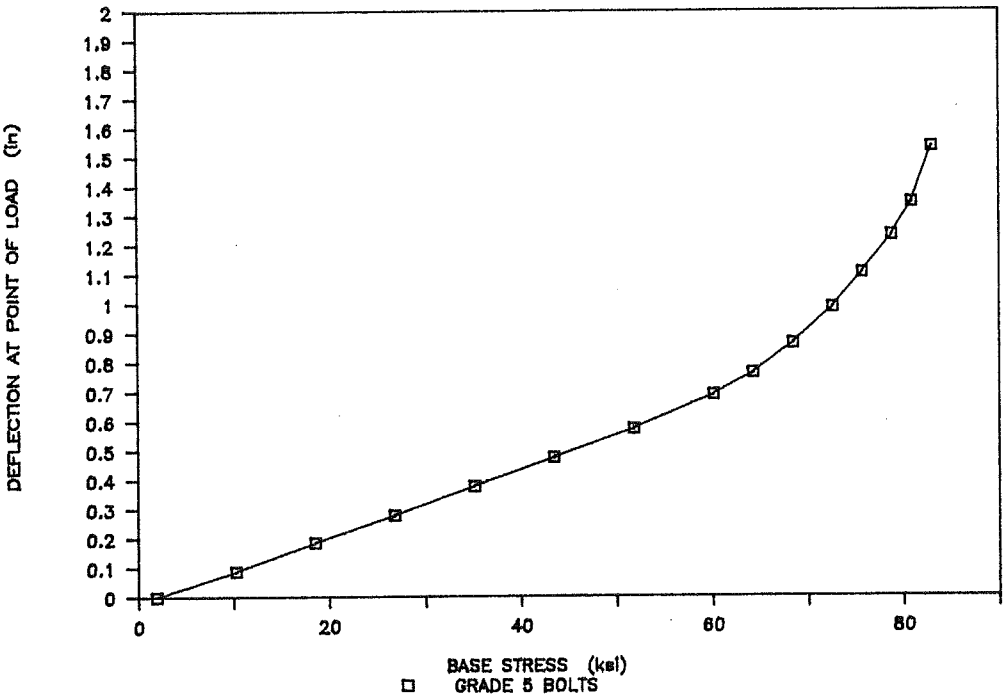


Figure K.4. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

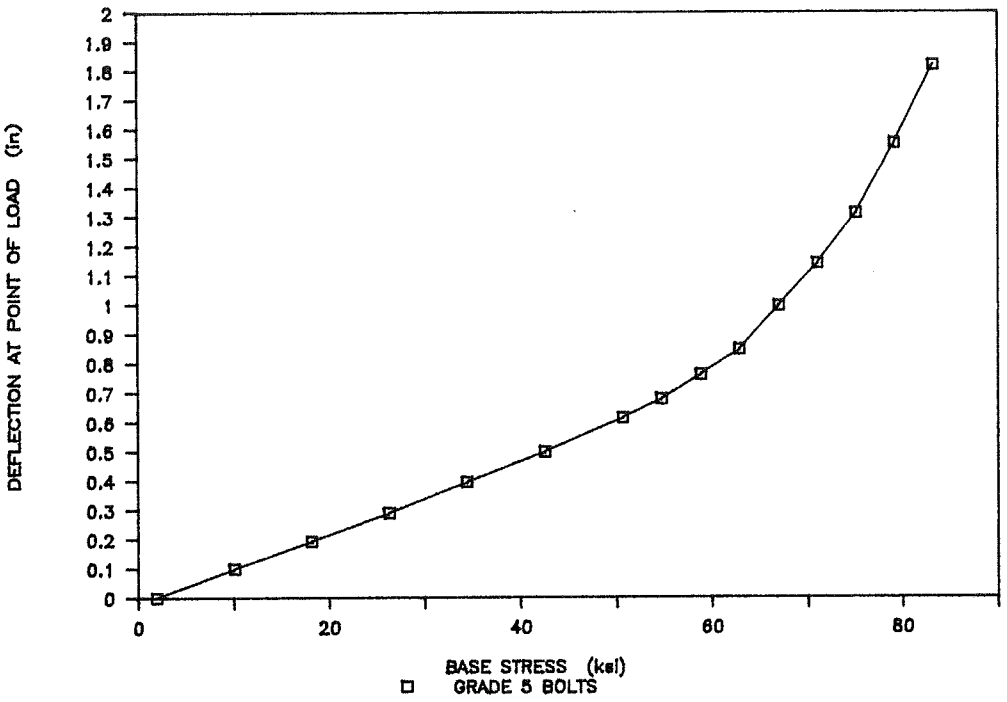


Figure K.5. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

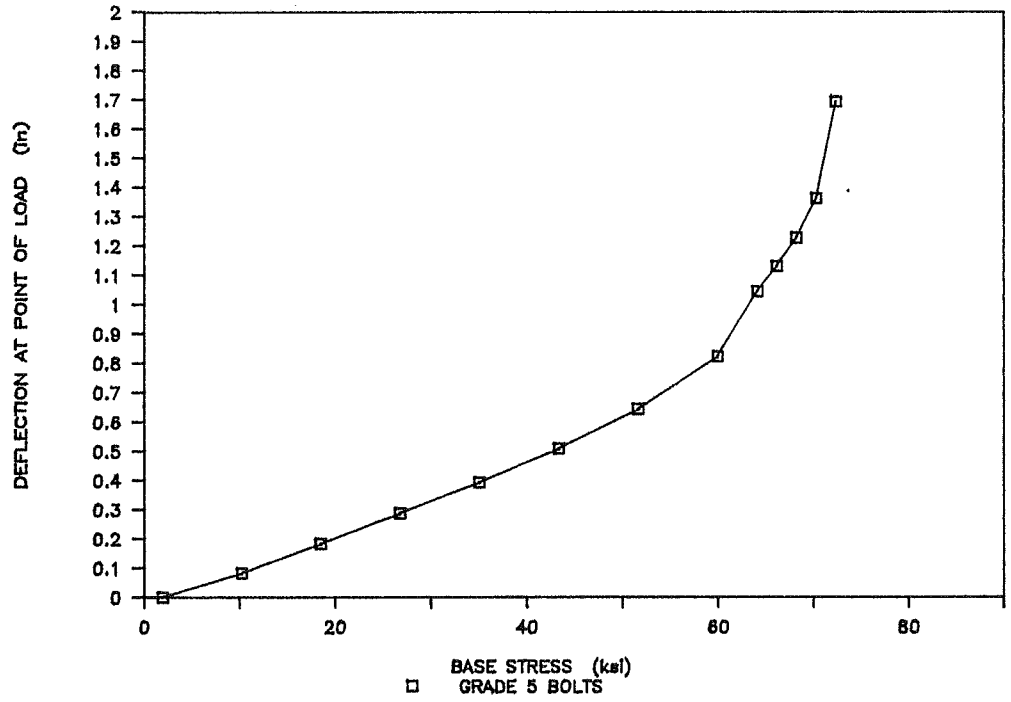


Figure K.6. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Face to Face Splice in Non-critical Configuration (Grade 5 Field Bolts).*

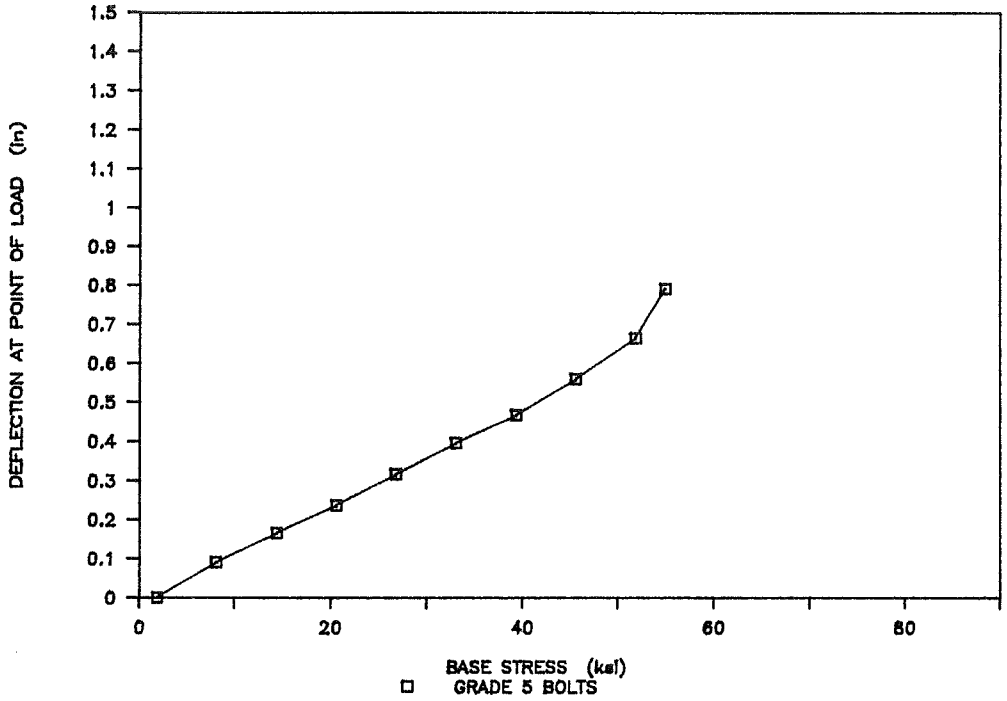


Figure K.7. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

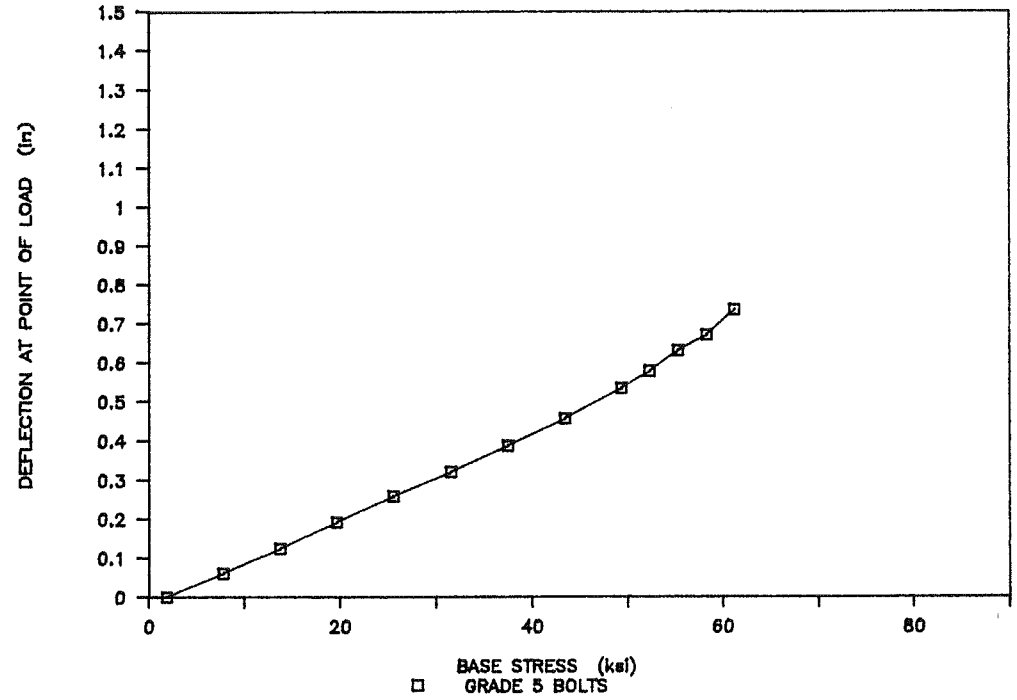


Figure K.8. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

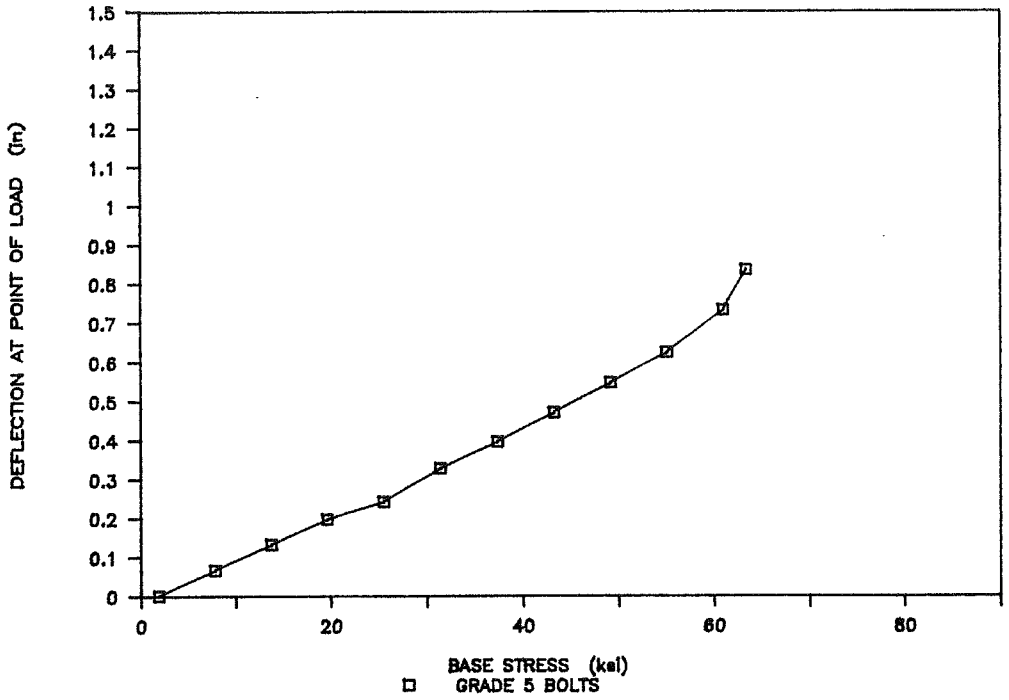


Figure K.9. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration; Assembled Backwards (Grade 5 Field Bolts).*

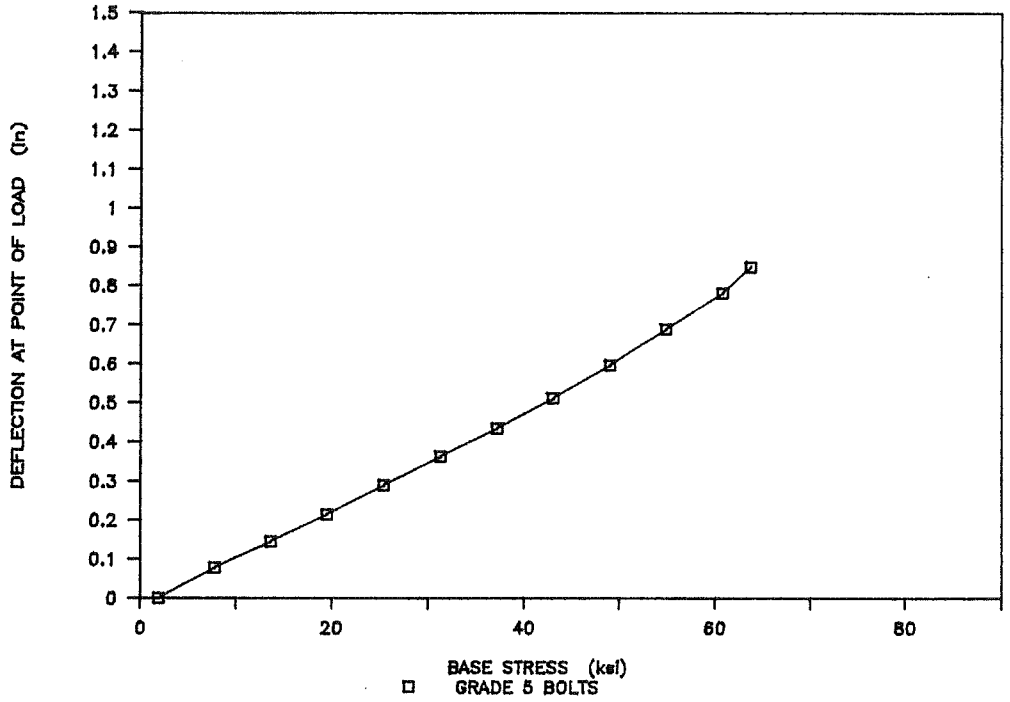


Figure K.10. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Grade 5 Field Bolts).*

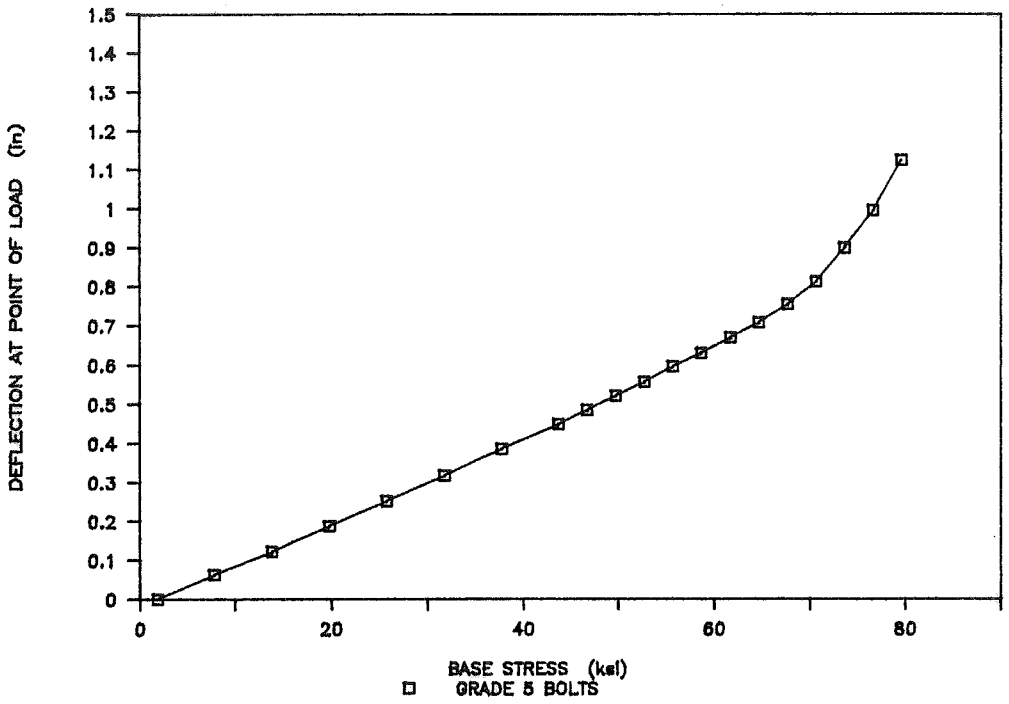


Figure K.11. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

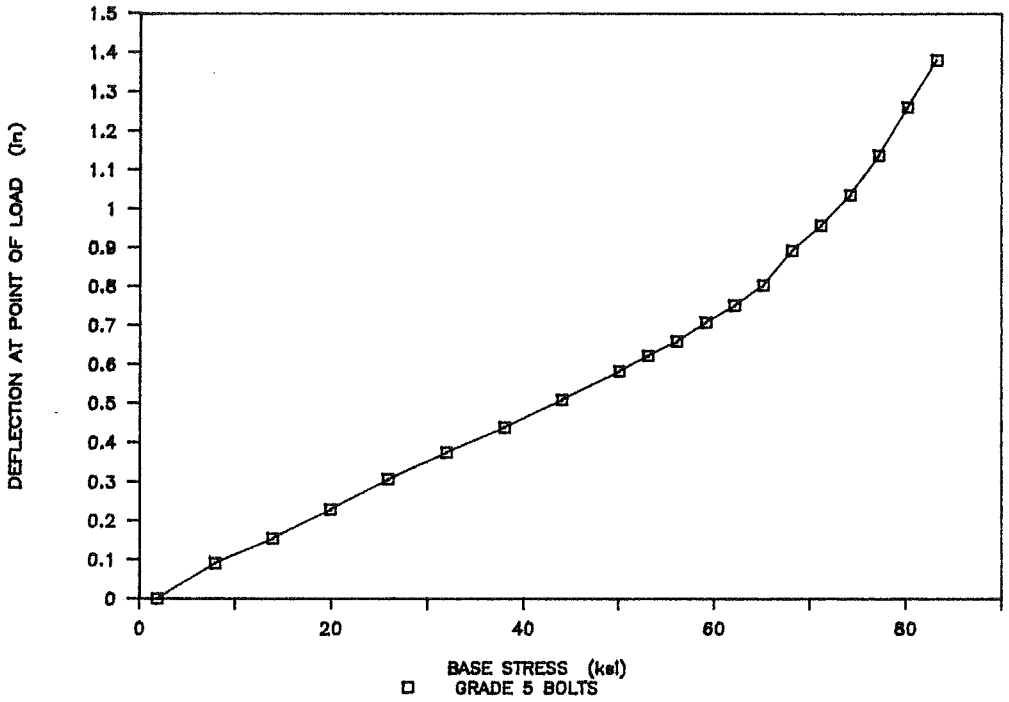


Figure K.12. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

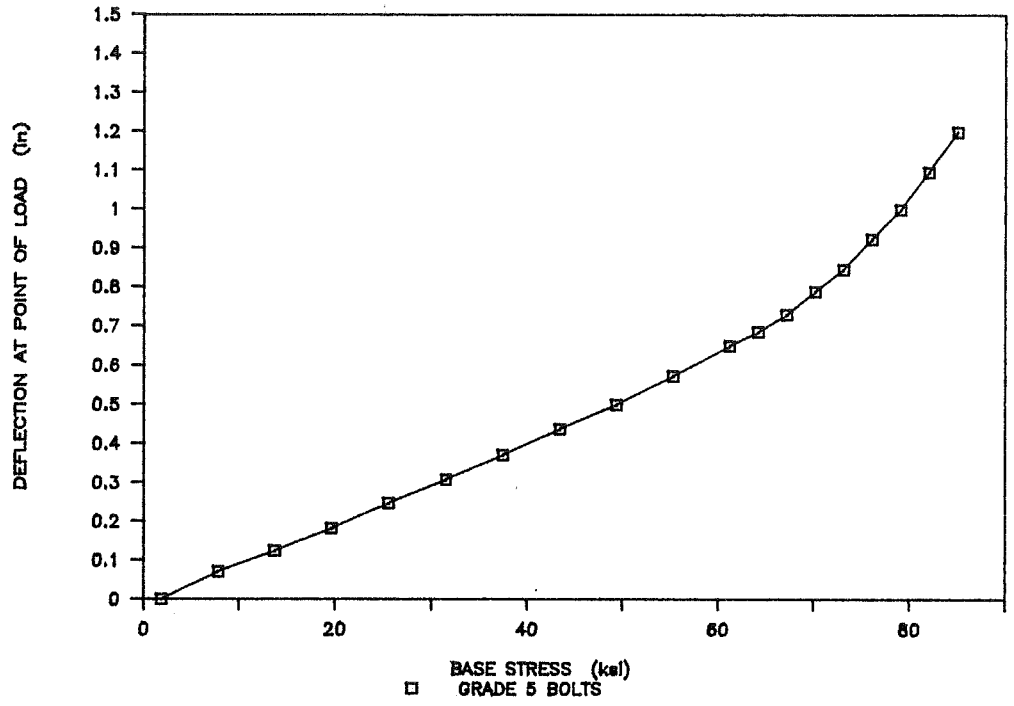


Figure K.13. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Non-critical Configuration; Assembled Backwards (Grade 5 Field Bolts).*

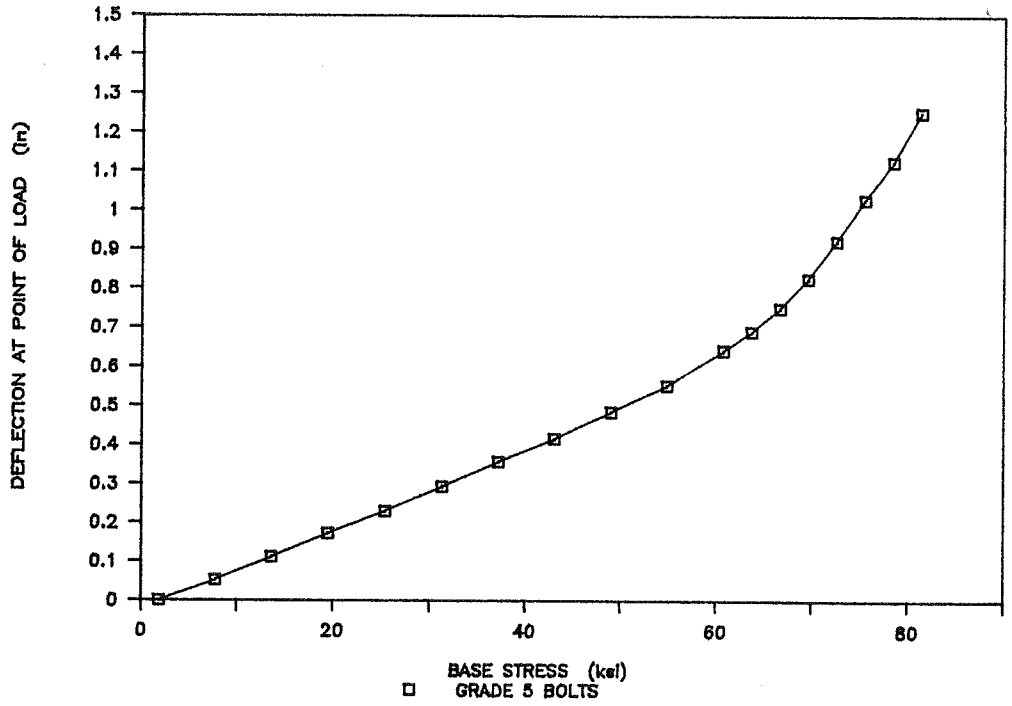


Figure K.14. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Grade 5 Field Bolts).*

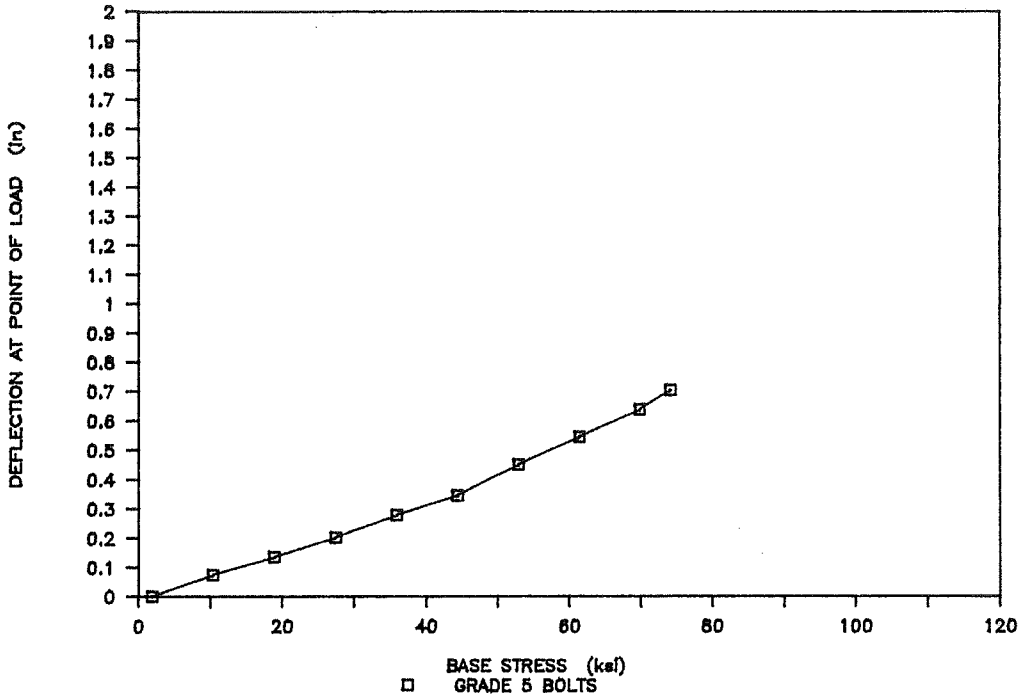


Figure K.15. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

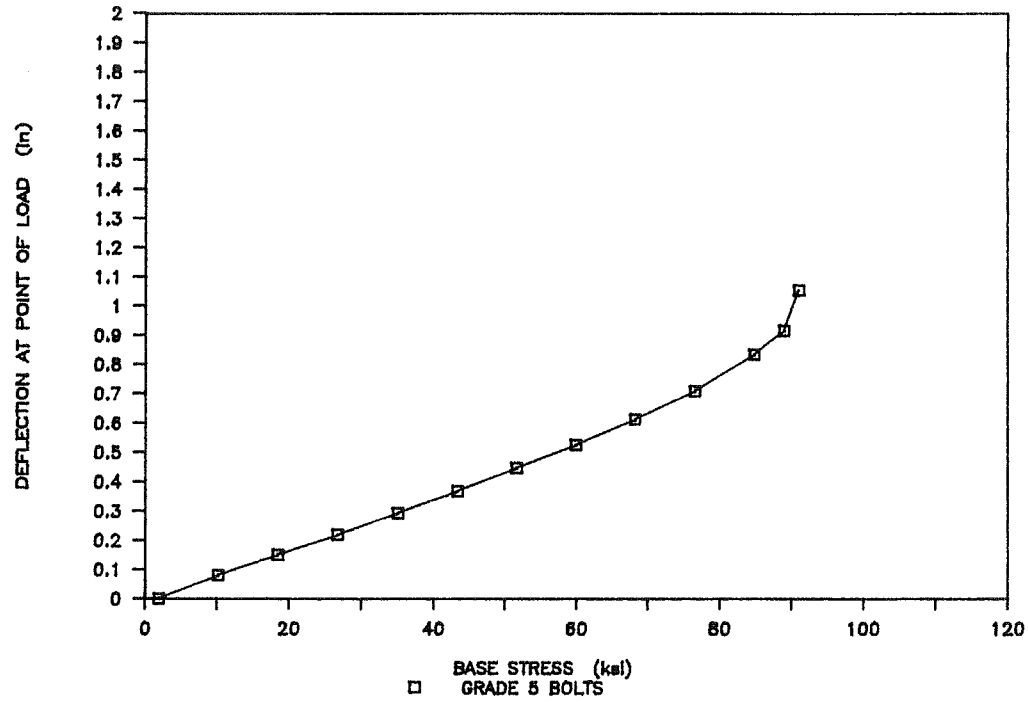


Figure K.16. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

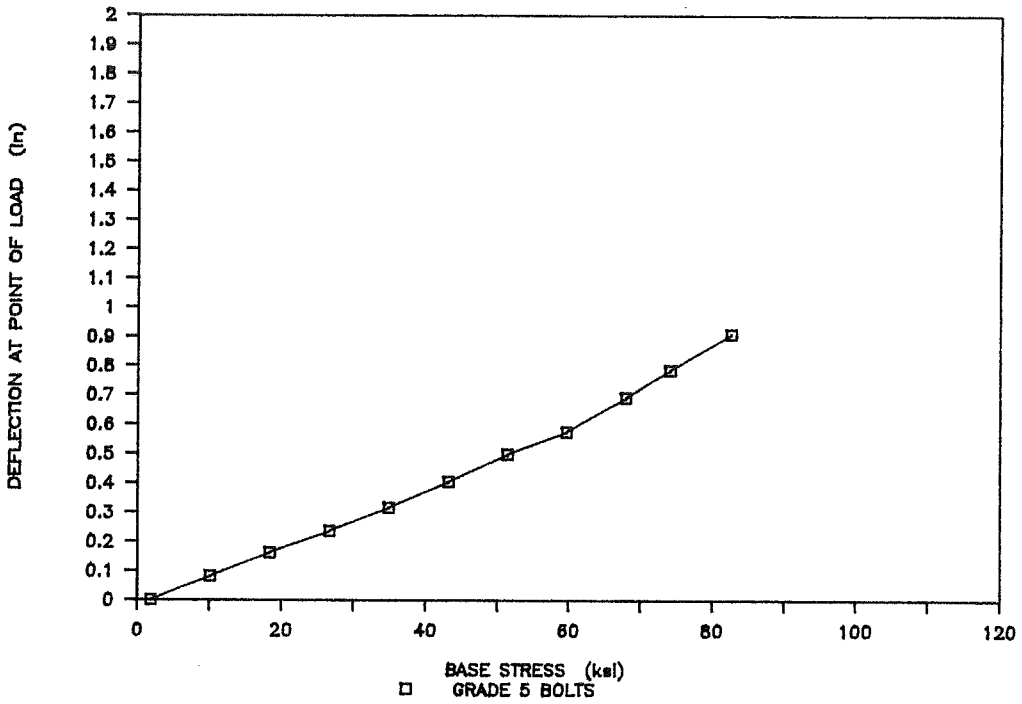


Figure K.17. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Grade 5 Field Bolts).*

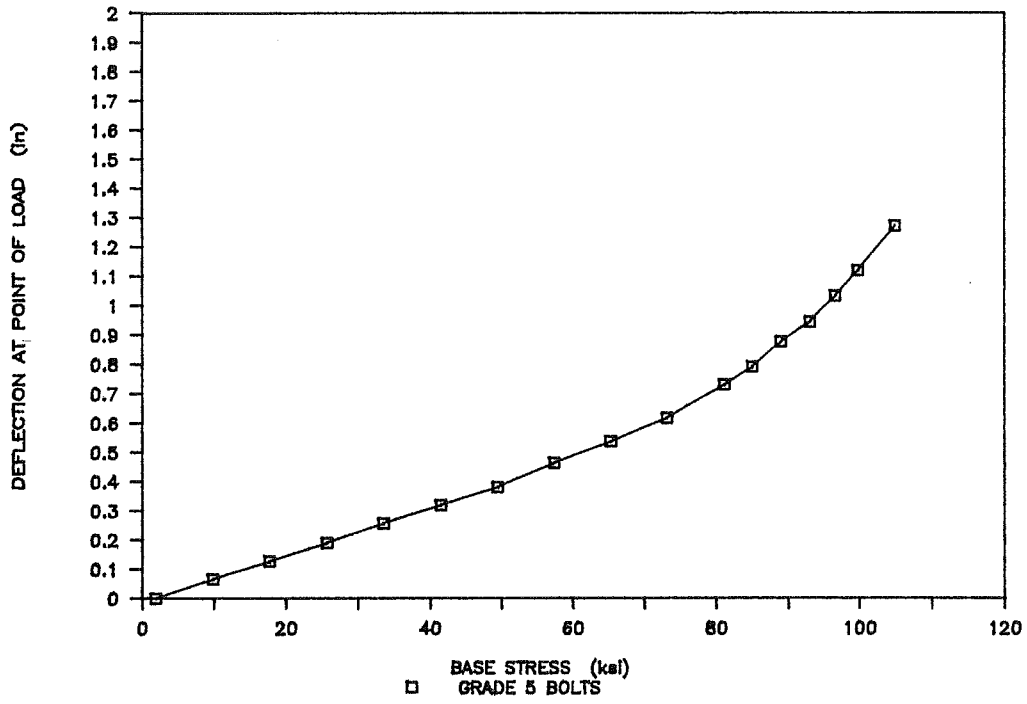


Figure K.18. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

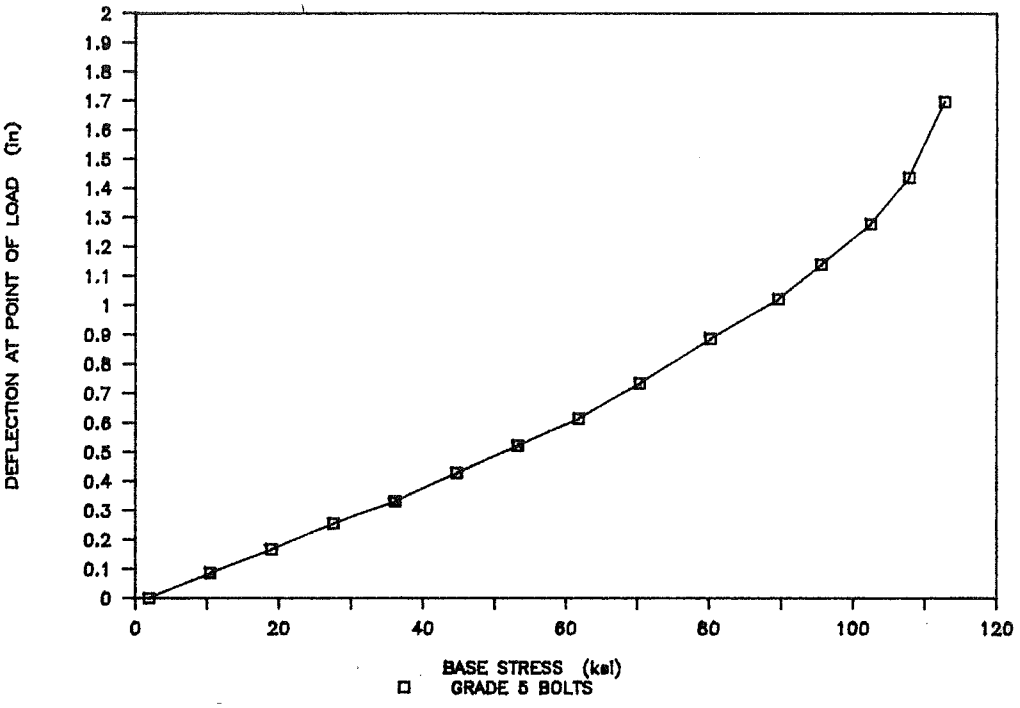


Figure K.19. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

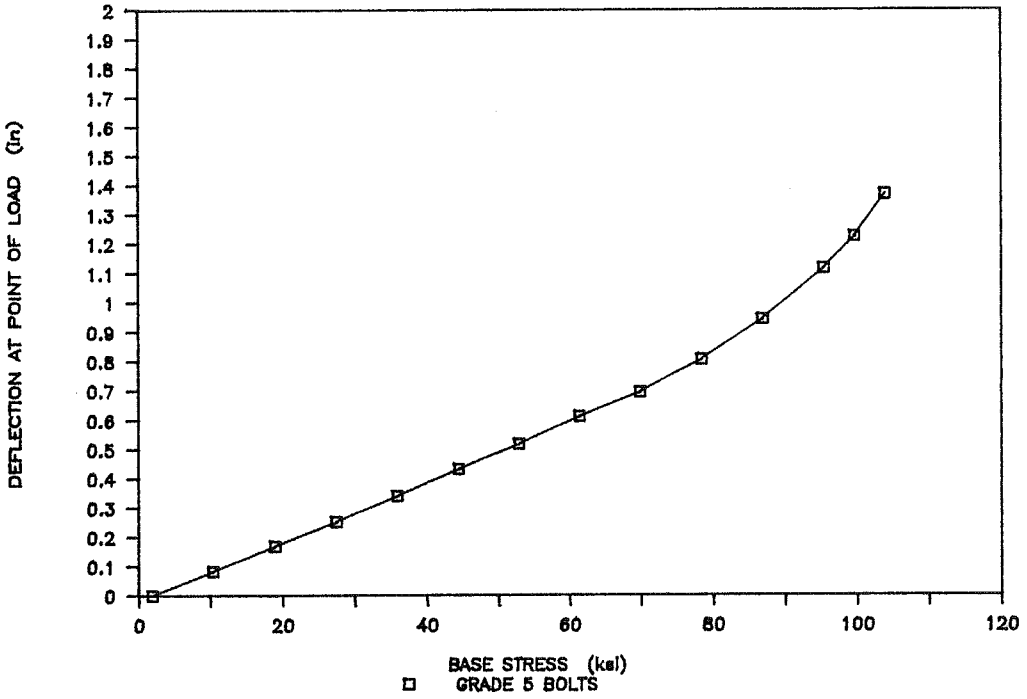


Figure K.20. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Grade 5 Field Bolts).*

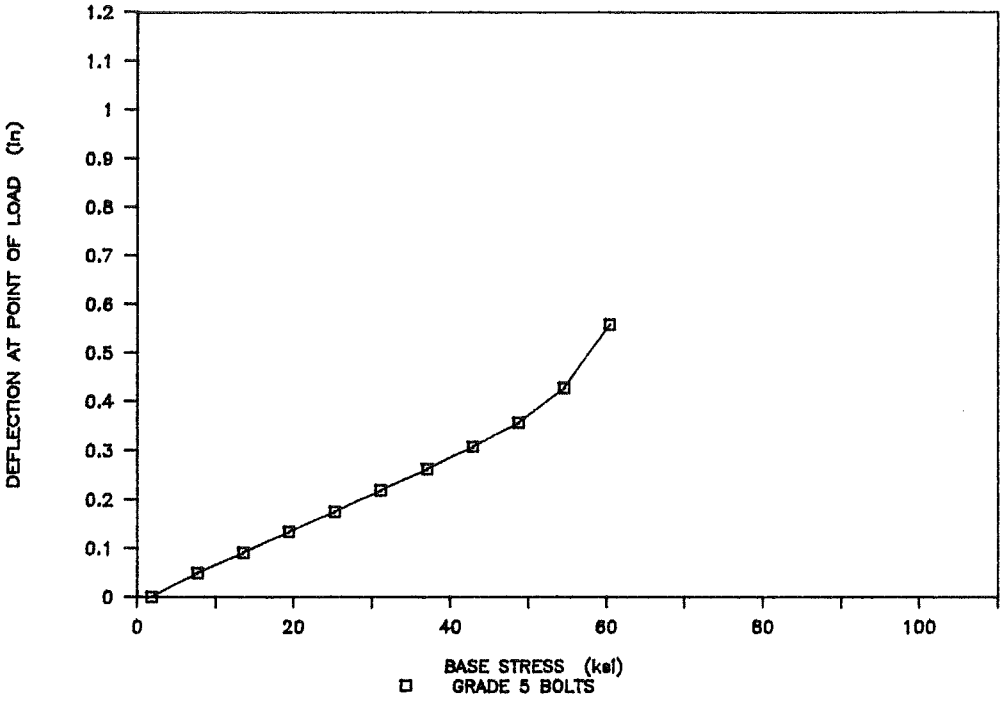


Figure K.21. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

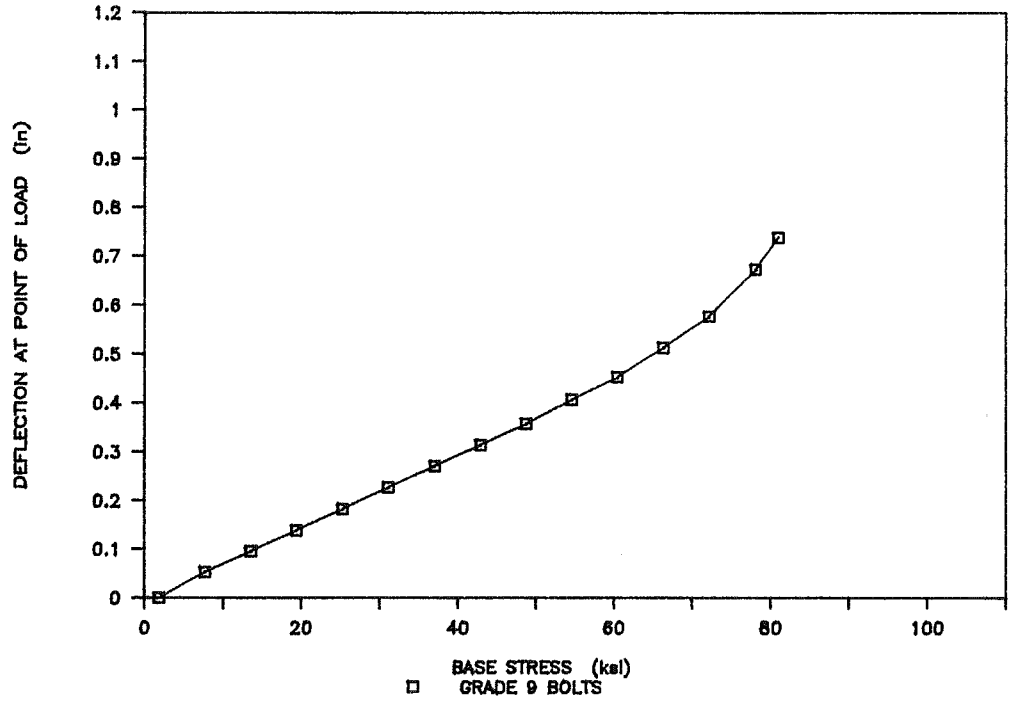


Figure K.22. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

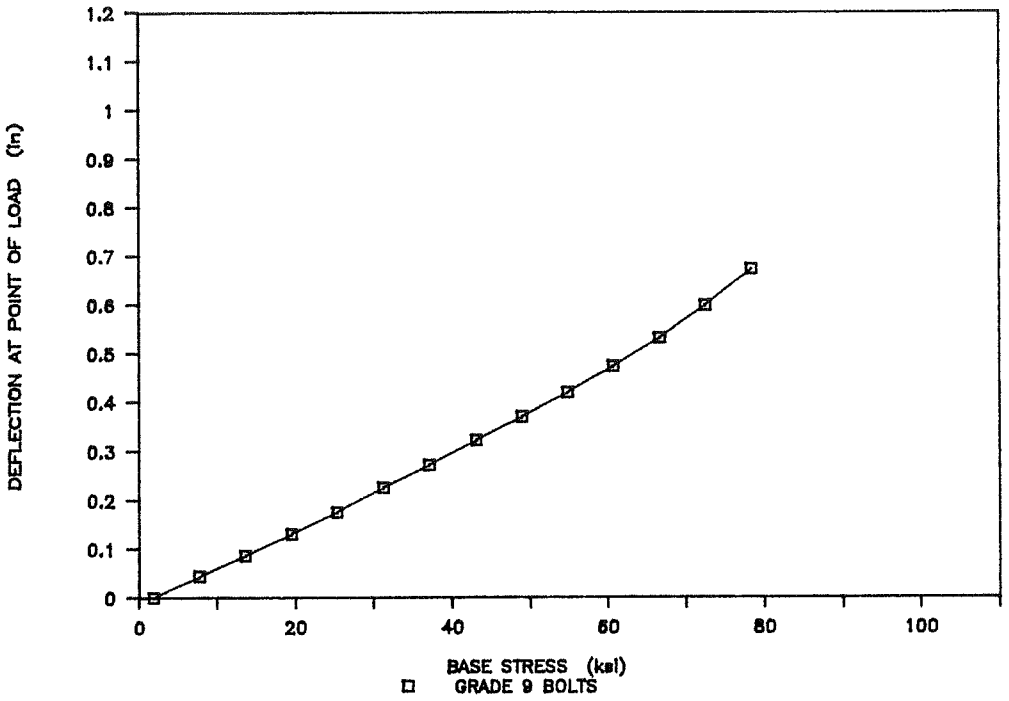


Figure K.23. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

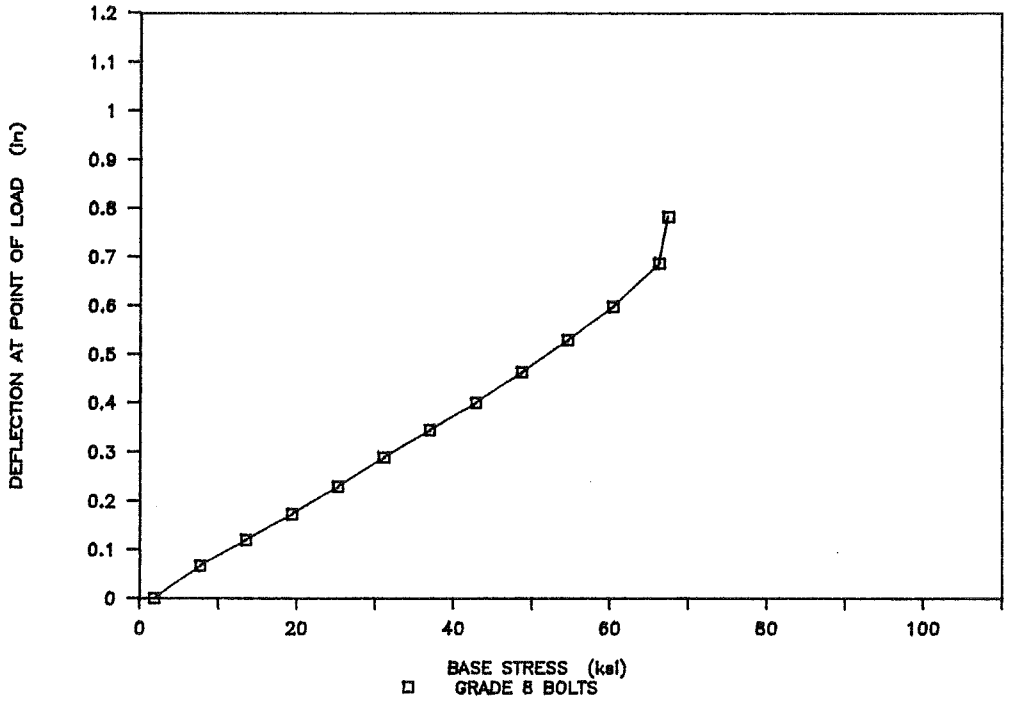


Figure K.24. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Grade 8 Field Bolts).*

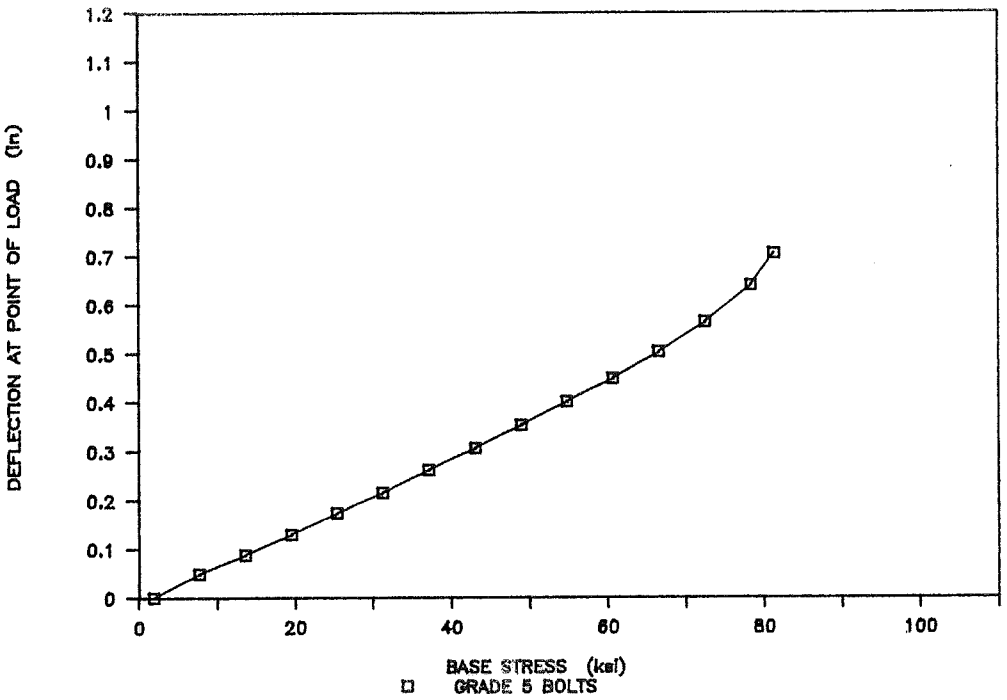


Figure K.25. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Grade 5 Field Bolts).*

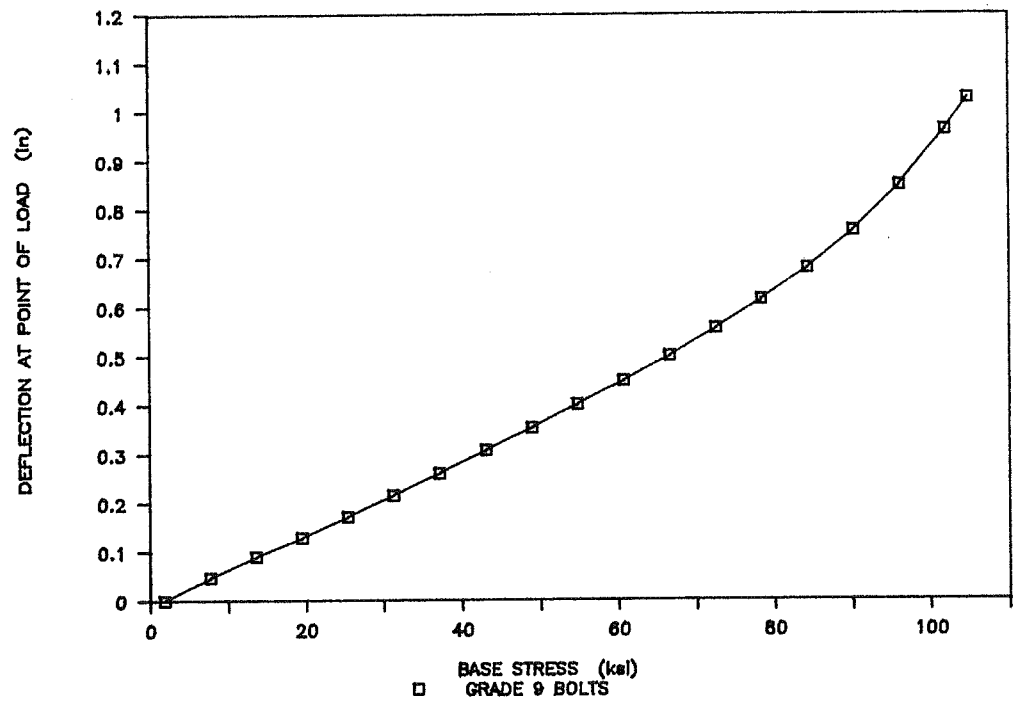


Figure K.26. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Grade 9 Field Bolts).*

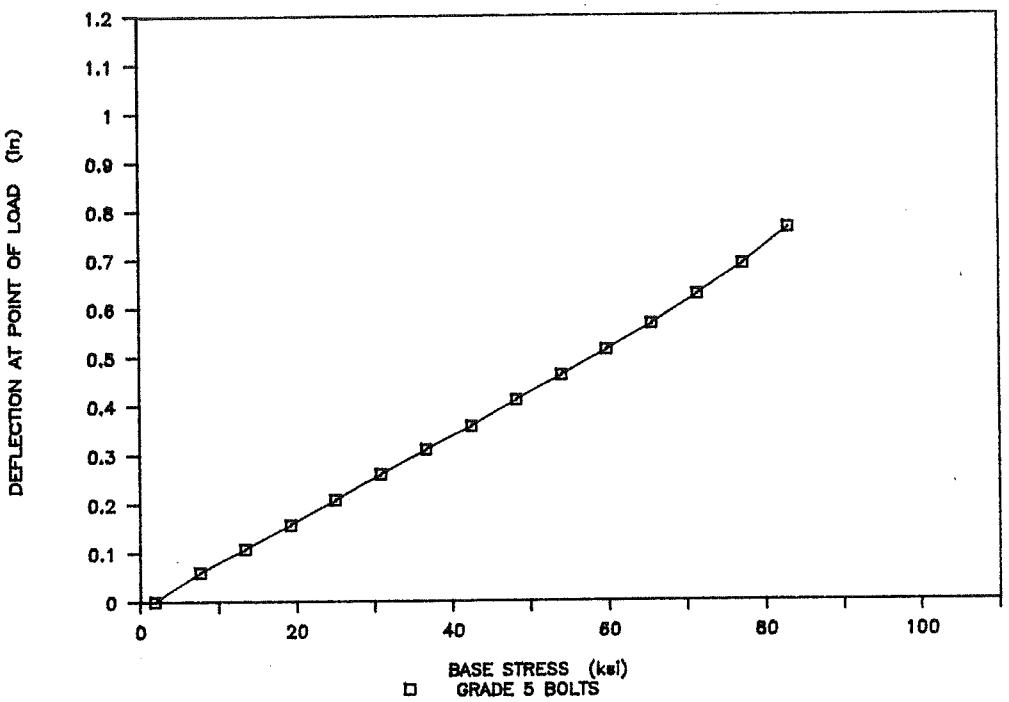


Figure K.27. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Grade 5 Field Bolts).*

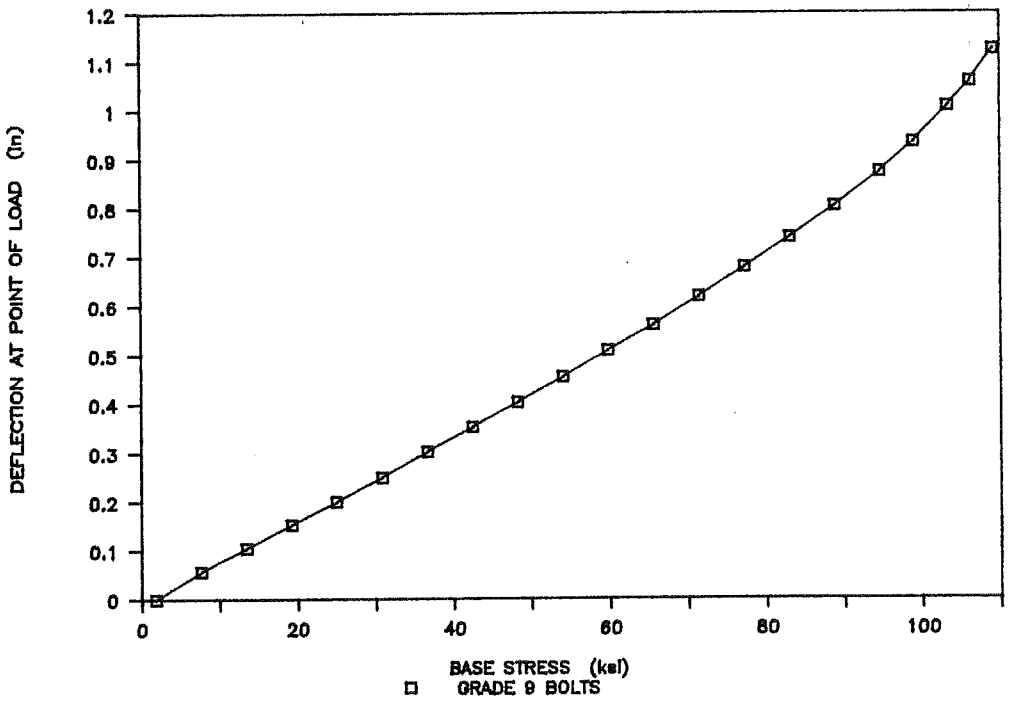


Figure K.28. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Grade 9 Field Bolts).*

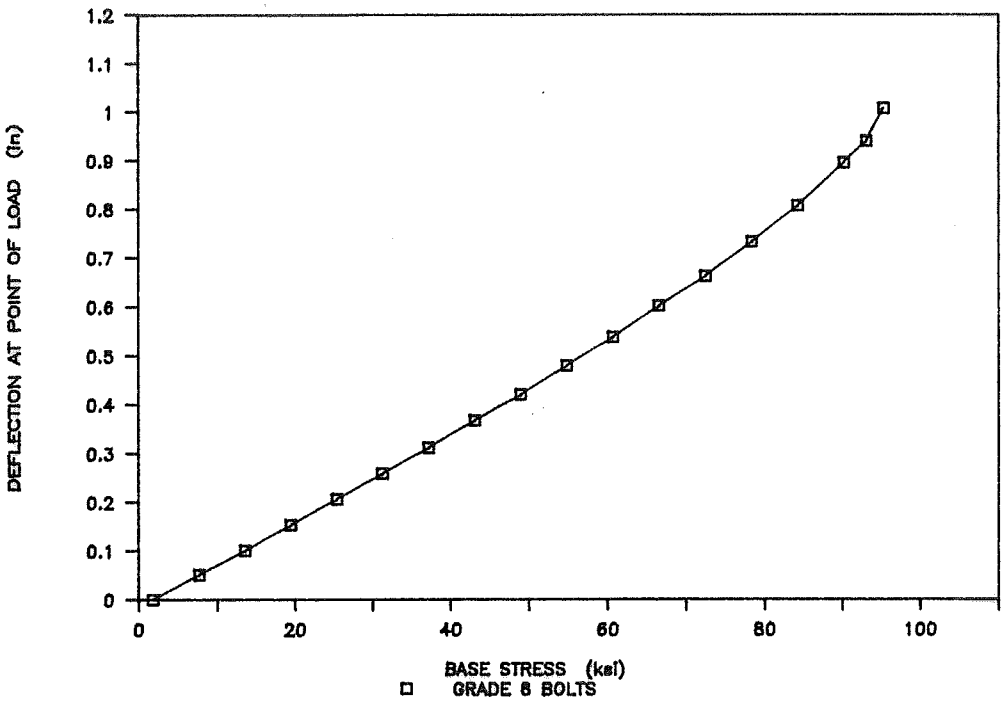


Figure K.29. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Grade 8 Field Bolts).*

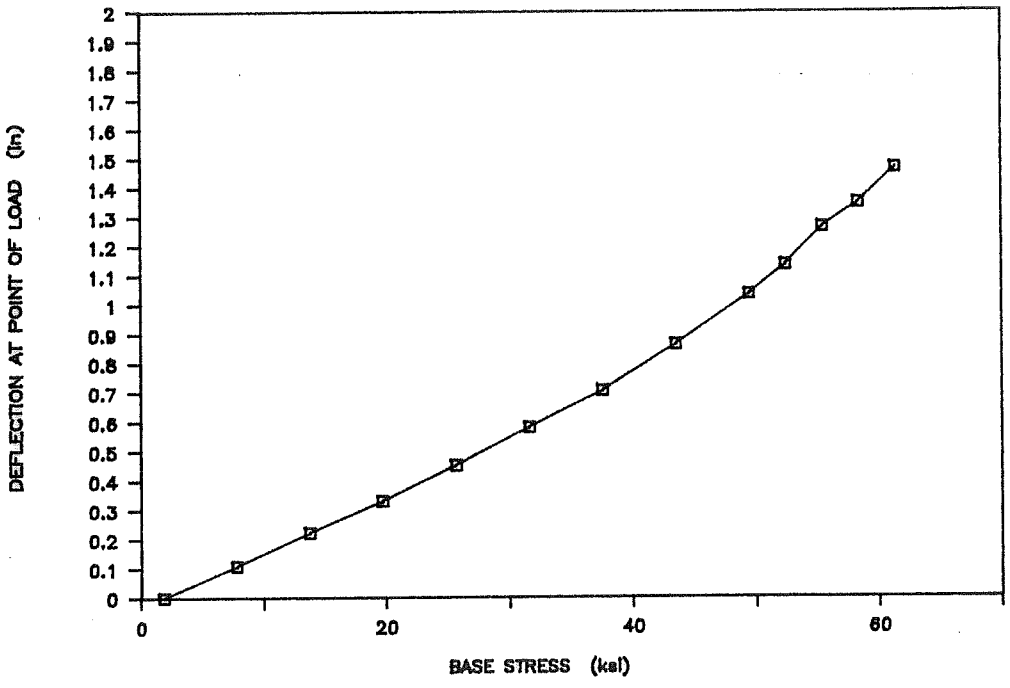


Figure K.30. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Box Splice in Critical Configuration (Calibrated Bolts).*

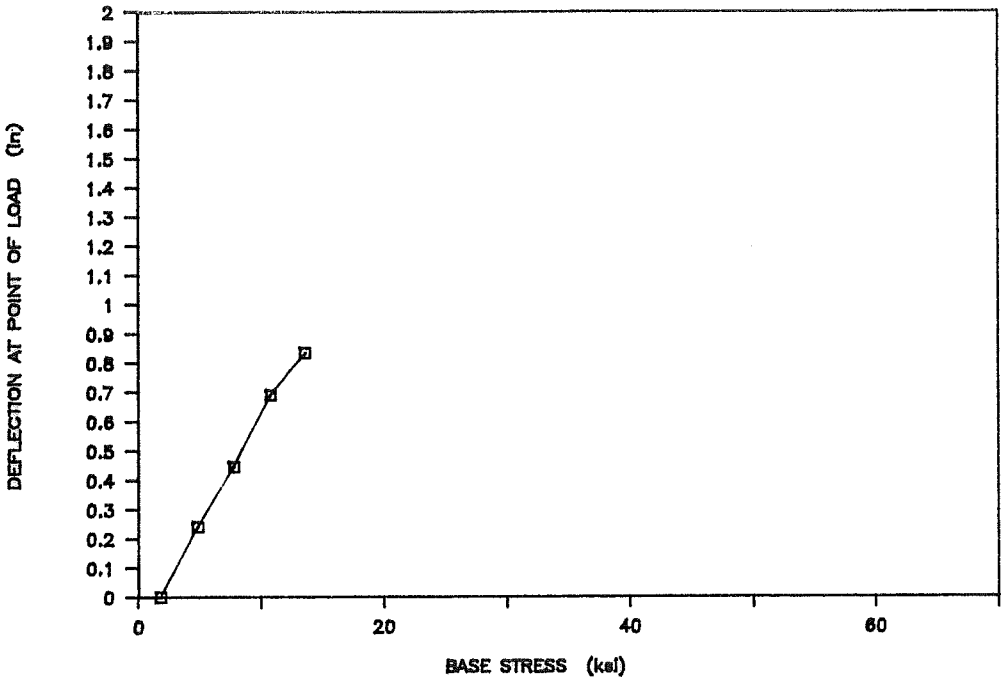


Figure K.31. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Box Splice in Critical Configuration (Calibrated Bolts).*

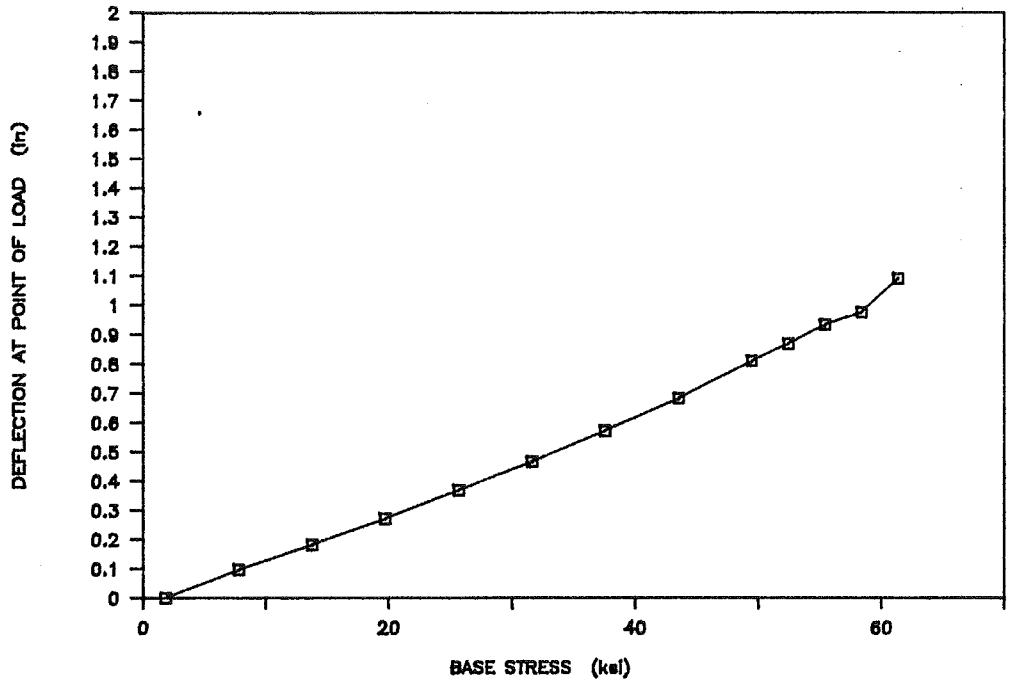


Figure K.32. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Box Splice in Non-critical Configuration (Calibrated Bolts).*

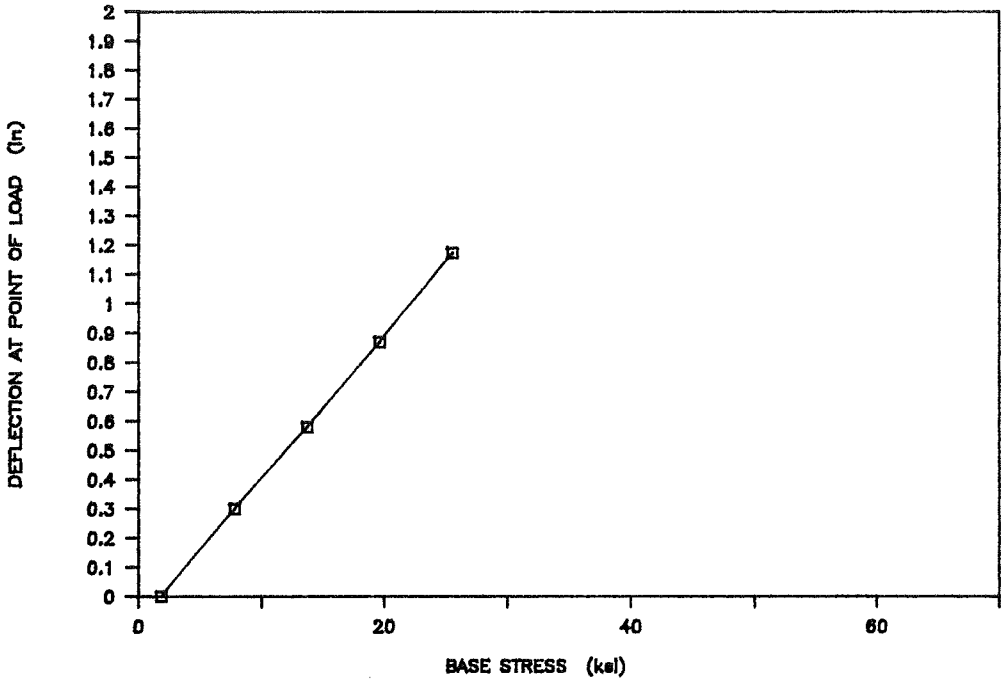


Figure K.33. *Base Stress vs Deflection at Point of Load (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Box Splice in Non-critical Configuration (Calibrated Bolts).*

# APPENDIX L

## FINAL 71" BENDING TESTS

BASE STRESS VS TIP DEFLECTION

(FIELD BOLTS)

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back and Nested Splices

Critical Configuration

# APPENDIX L

## LIST OF FIGURES

# APPENDIX L

## LIST OF FIGURES (CONT)

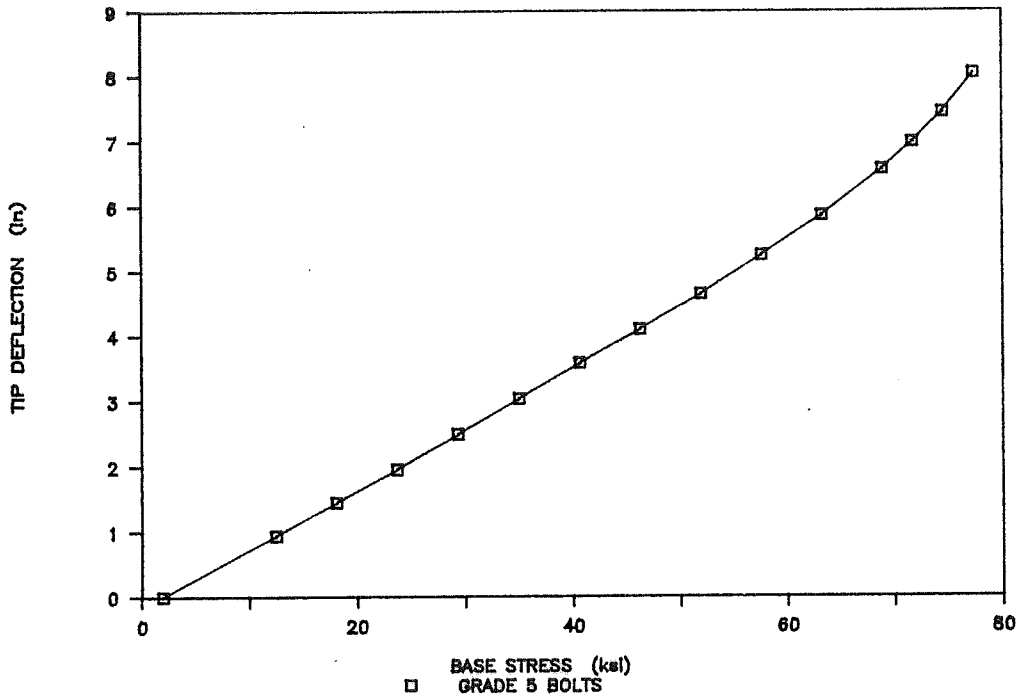


Figure L.1. *Base Stress vs Tip Deflection (71 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

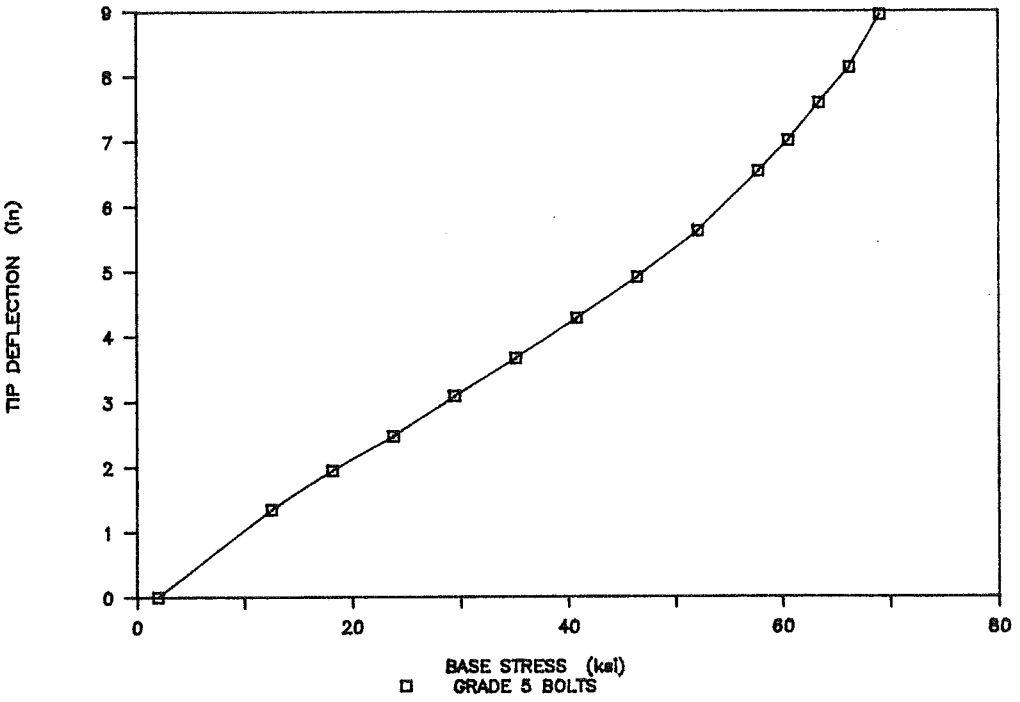


Figure L.2. *Base Stress vs Tip Deflection (71 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

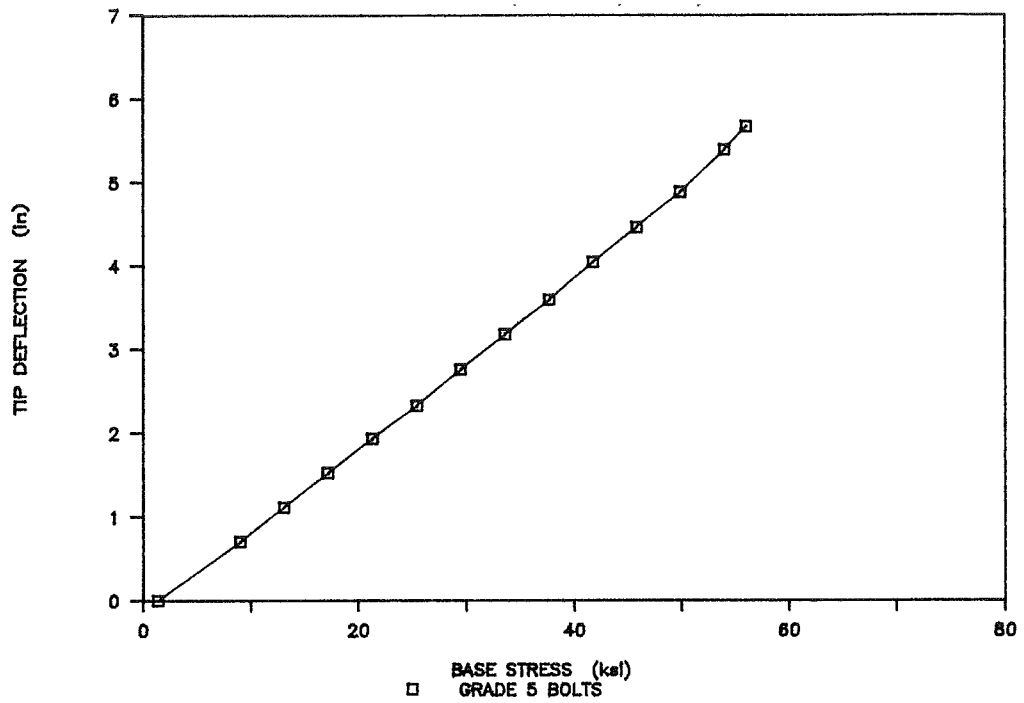


Figure L.3. *Base Stress vs Tip Deflection (71 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

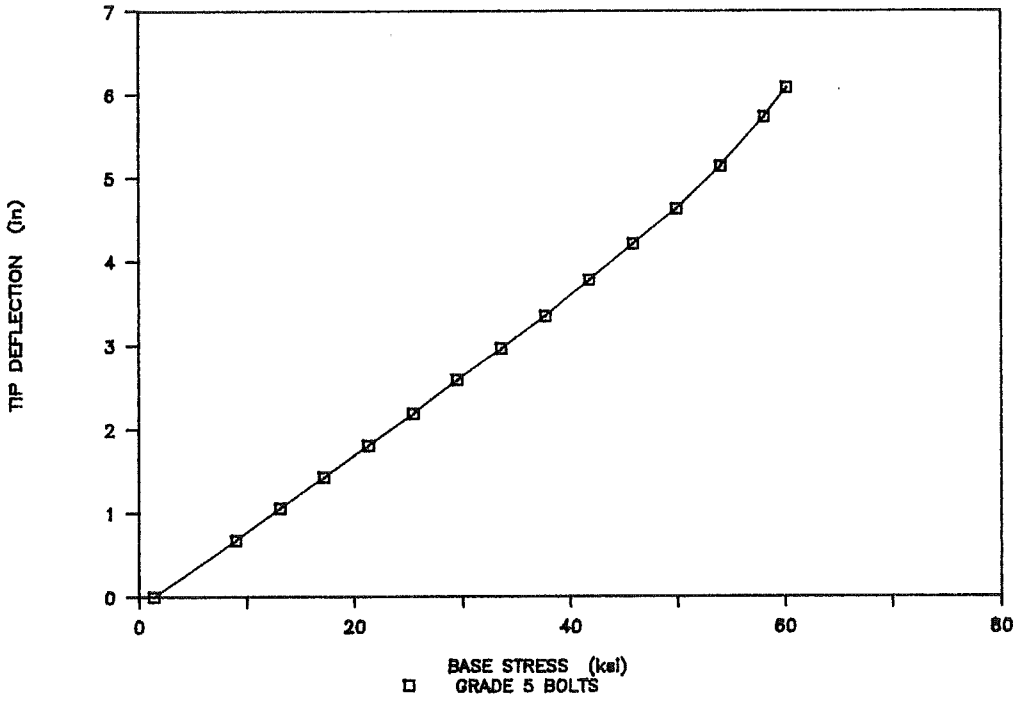


Figure L.4. *Base Stress vs Tip Deflection (71 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

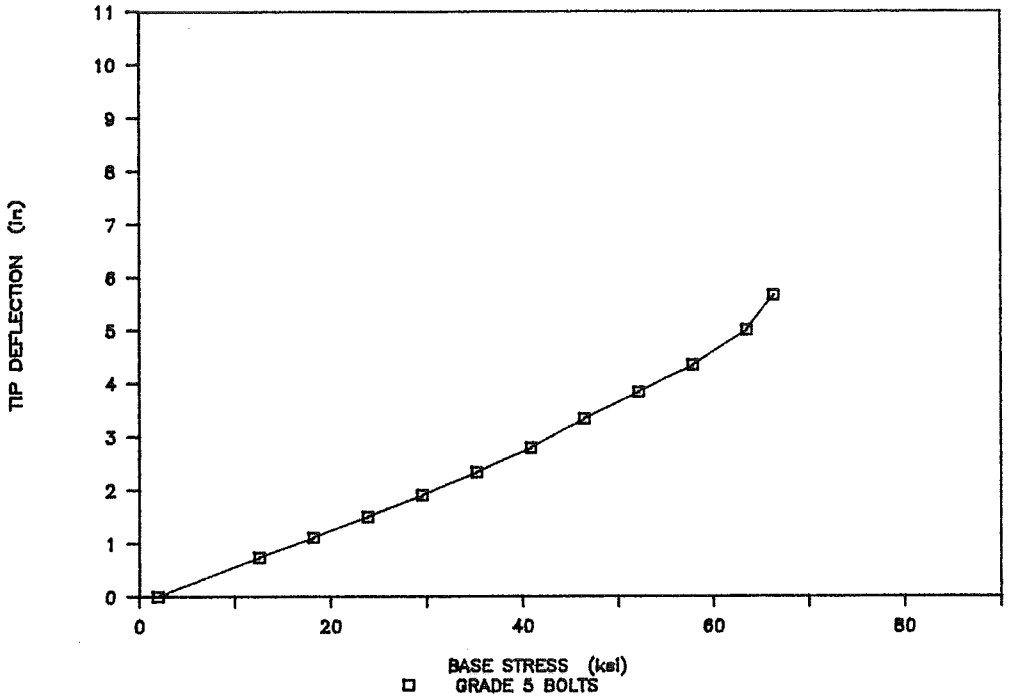


Figure L.5. *Base Stress vs Tip Deflection (71 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

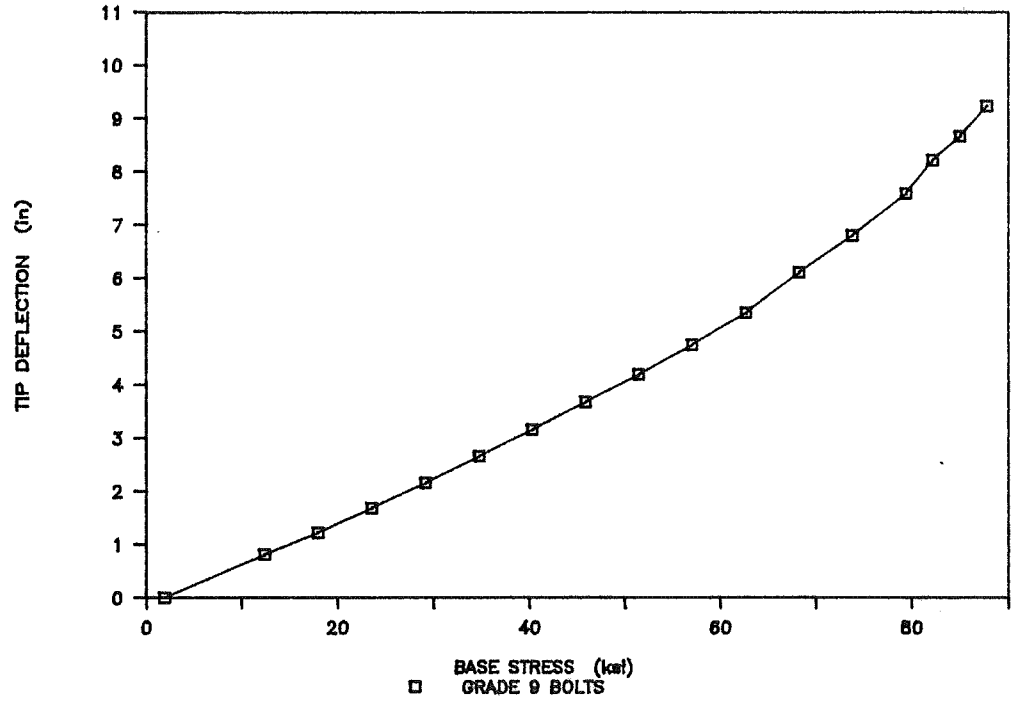


Figure L.6. *Base Stress vs Tip Deflection (71 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

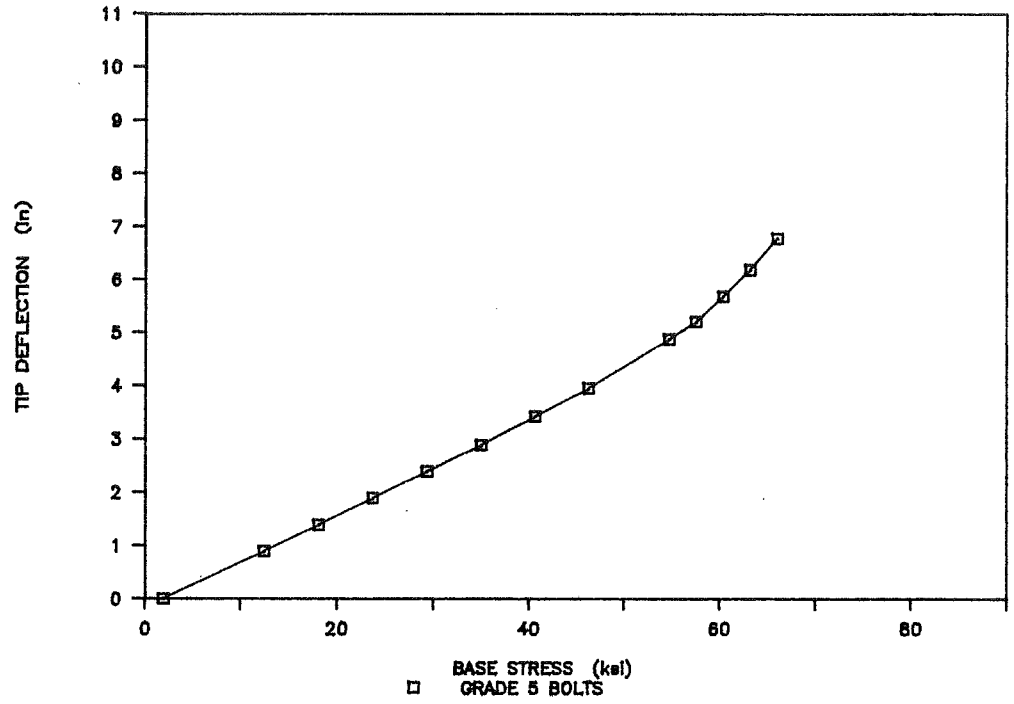


Figure L.7. *Base Stress vs Tip Deflection (71 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

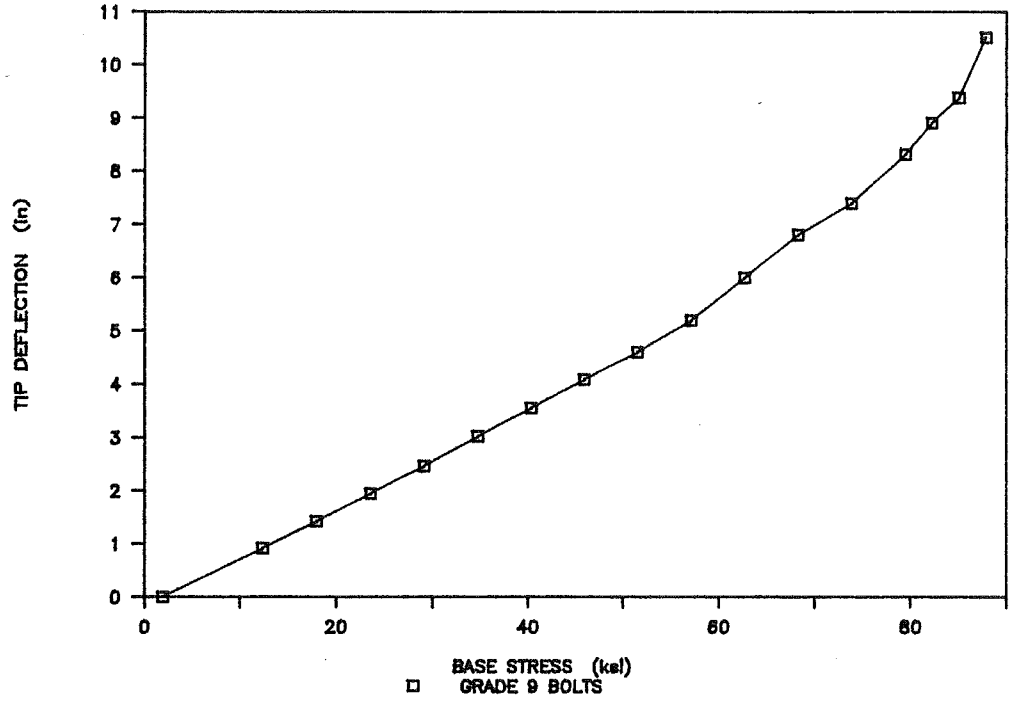


Figure L.8. *Base Stress vs Tip Deflection (71 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

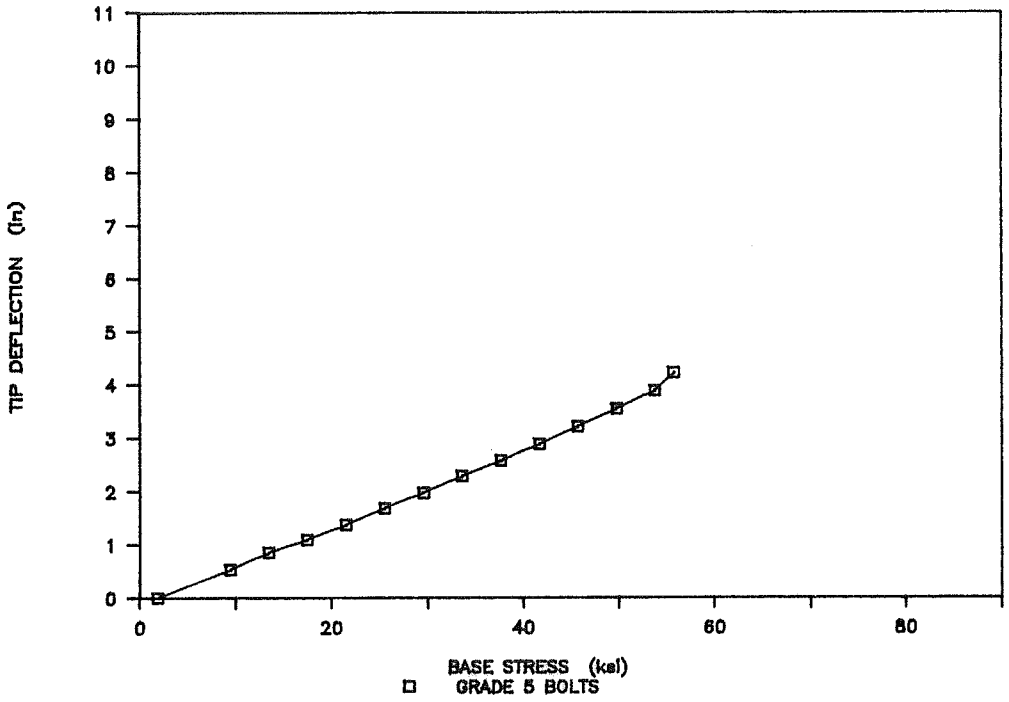


Figure L.9. *Base Stress vs Tip Deflection (71 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

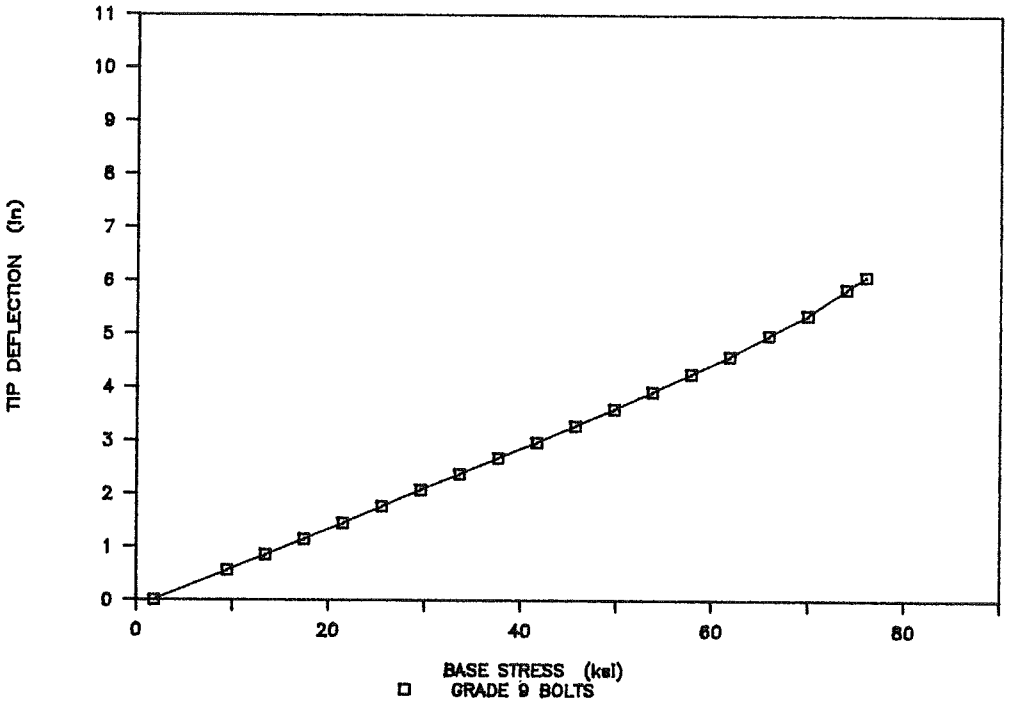


Figure L.10. *Base Stress vs Tip Deflection (71 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

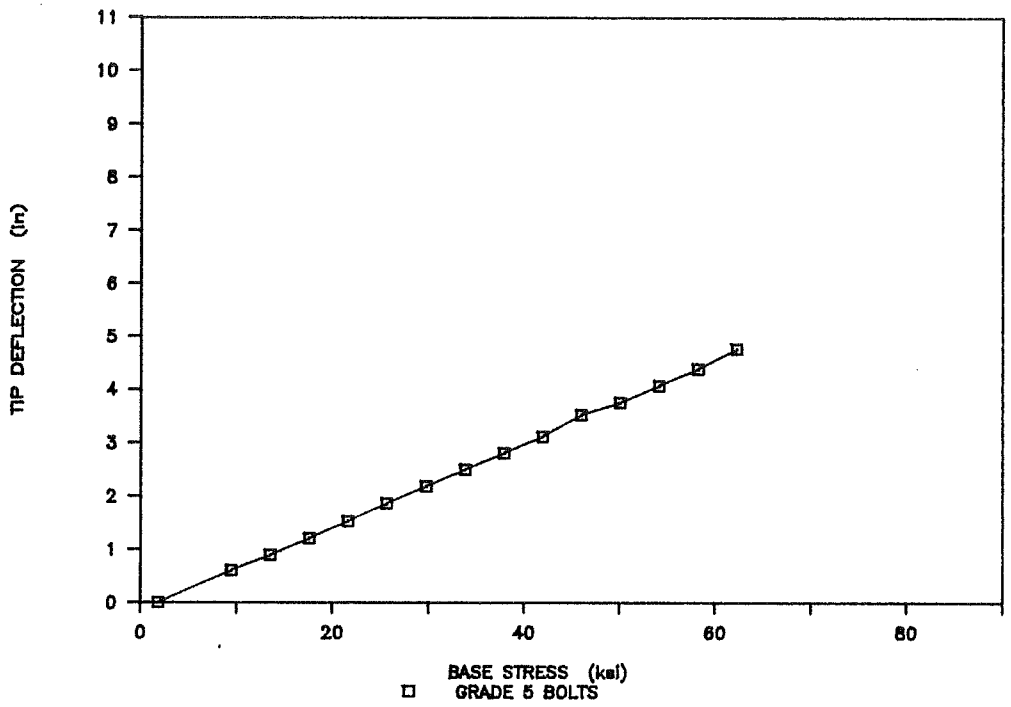


Figure L.11. *Base Stress vs Tip Deflection (71 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

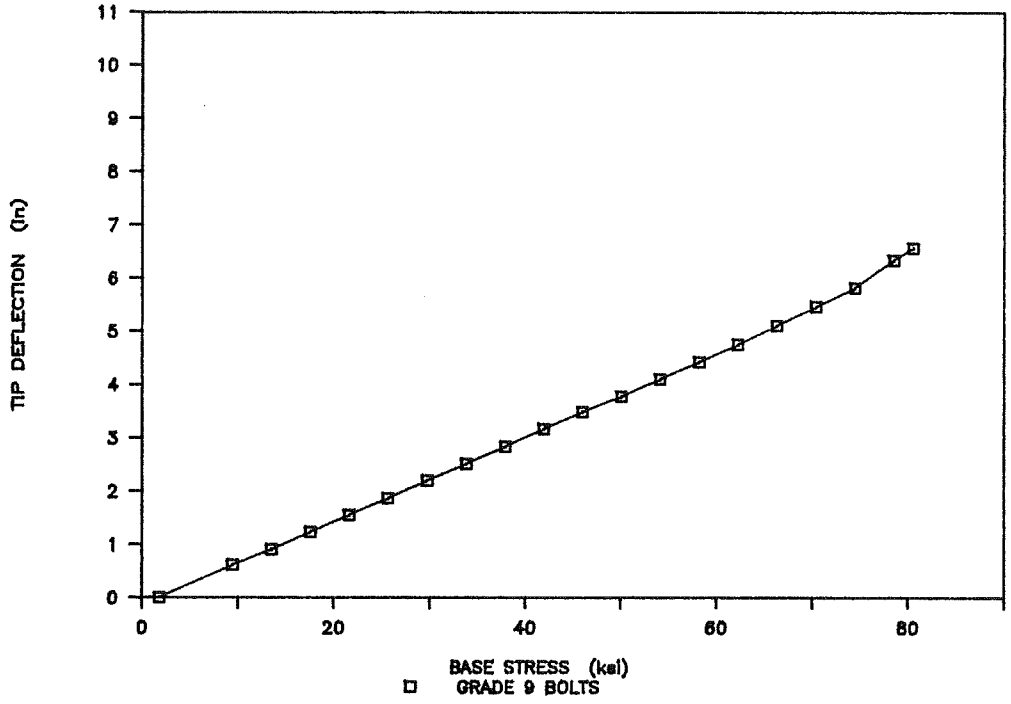


Figure L.12. *Base Stress vs Tip Deflection (71 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

# APPENDIX M

## TORSION TESTS

## APPLIED TORQUE VS POST ROTATION

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back and Nested Splices

& Post W/O Splice

# APPENDIX M

## LIST OF FIGURES

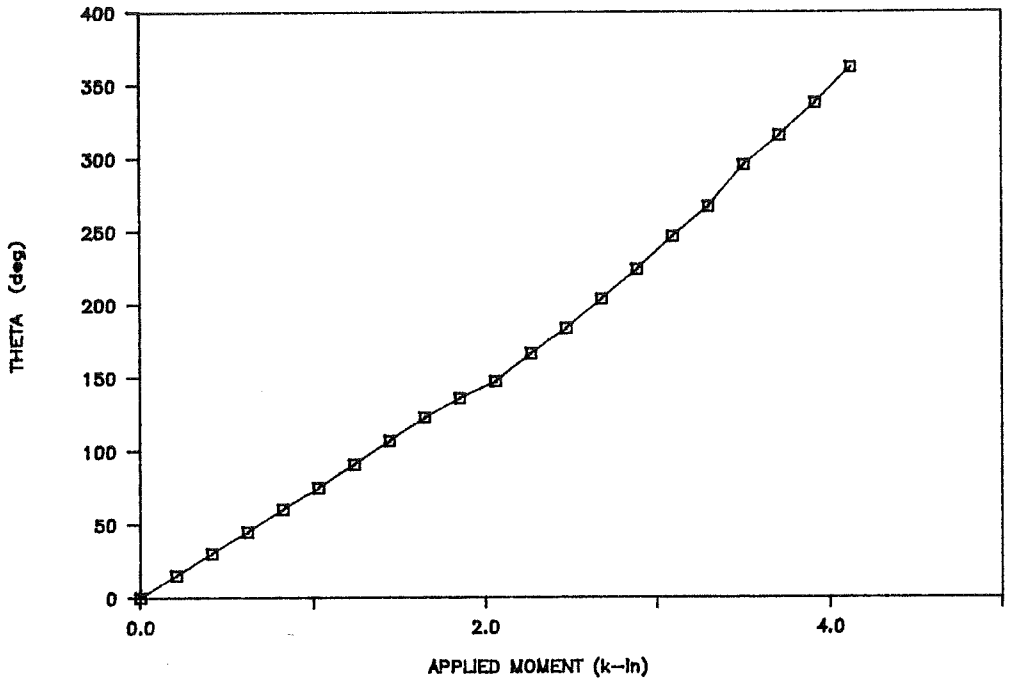


Figure M.1. *Applied Torque vs Post Rotation: Franklin 3 lb/ft - 60 ksi Post; Post W/O Splice.*

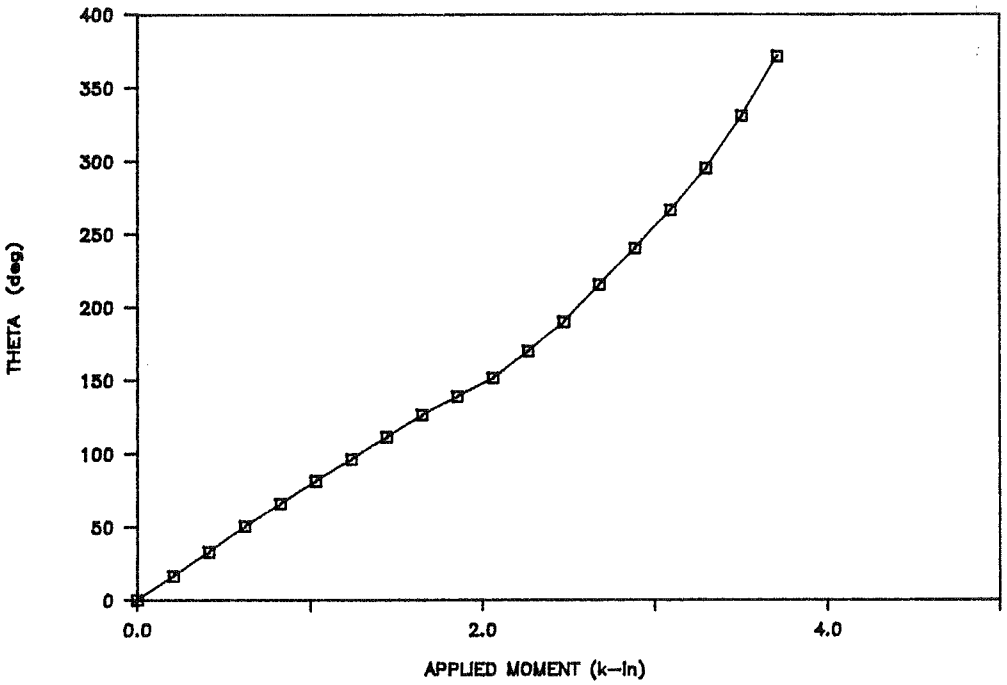


Figure M.2. *Applied Torque vs Post Rotation: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice (Calibrated and Grade 5 Field Bolts).*

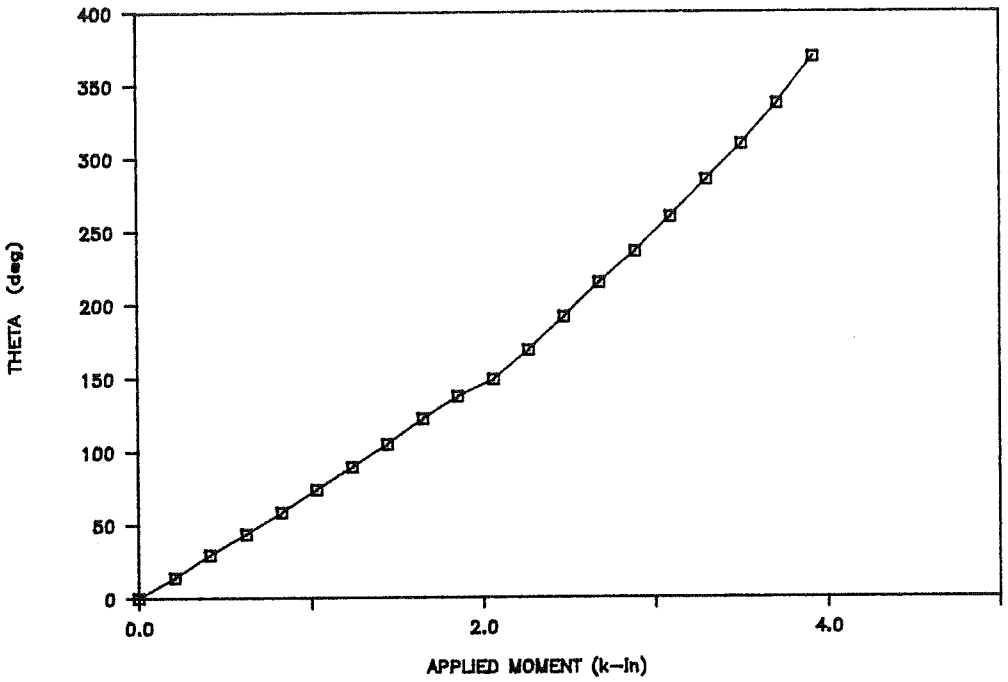


Figure M.3. *Applied Torque vs Post Rotation: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice (Calibrated and Grade 5 Field Bolts).*

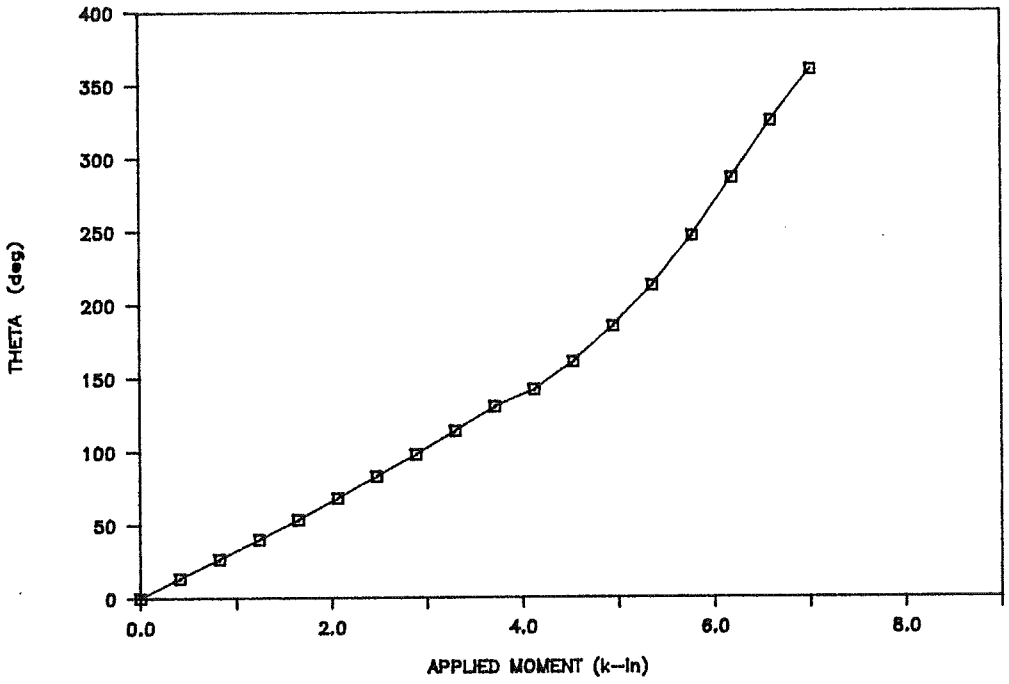


Figure M.4. *Applied Torque vs Post Rotation: Franklin 4 lb/ft - 60 ksi Post; Post W/O Splice.*

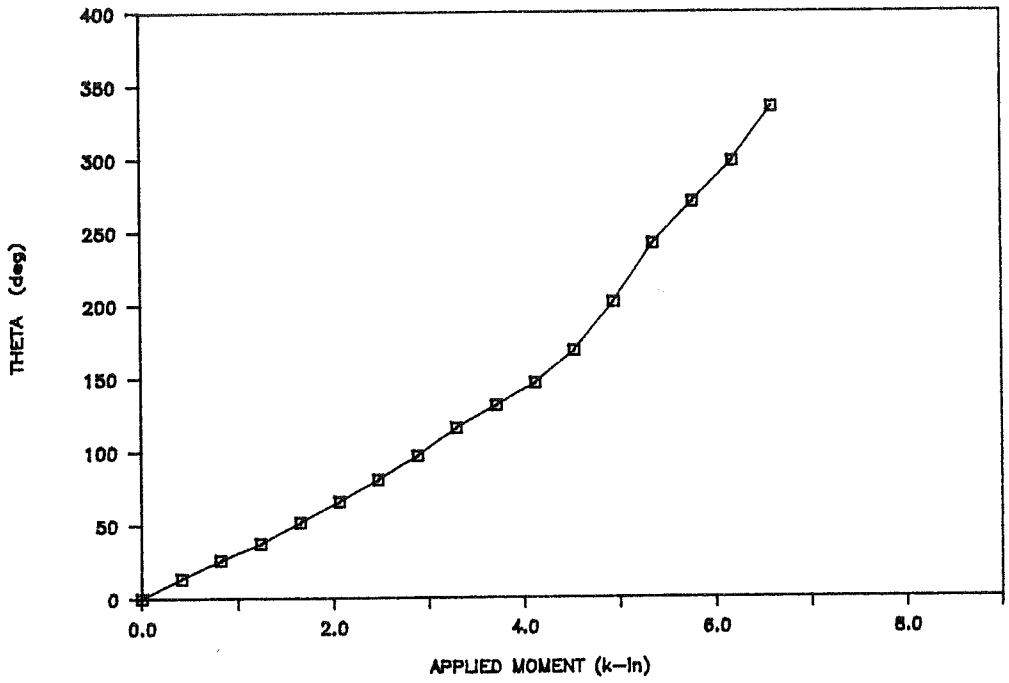


Figure M.5. *Applied Torque vs Post Rotation: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice (Calibrated and Grade 5 Field Bolts).*

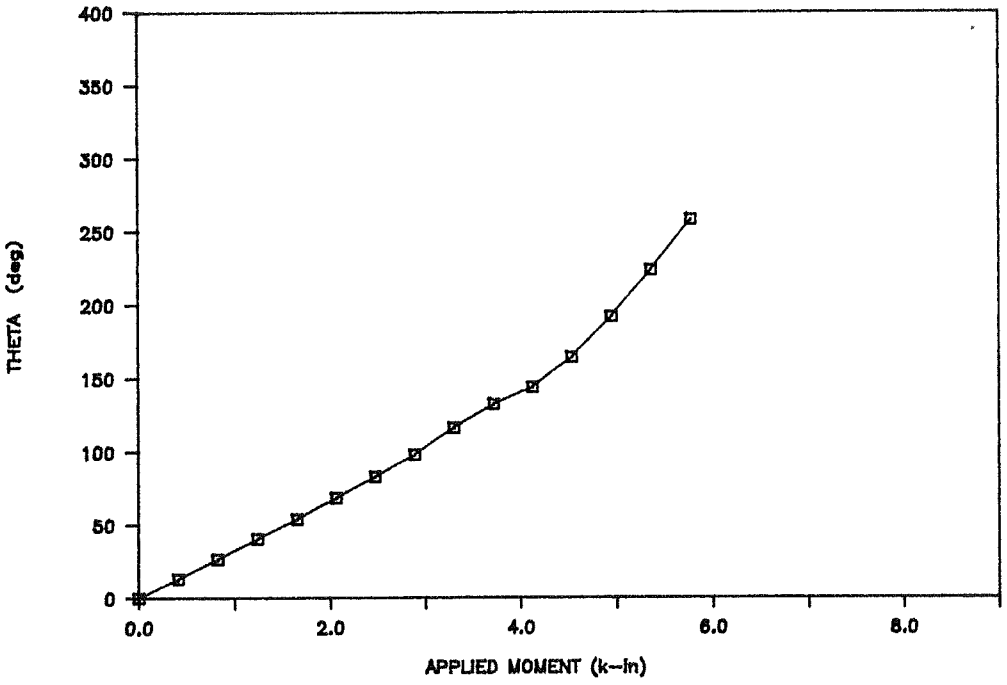


Figure M.6. *Applied Torque vs Post Rotation: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice (Calibrated and Grade 5 Field Bolts).*

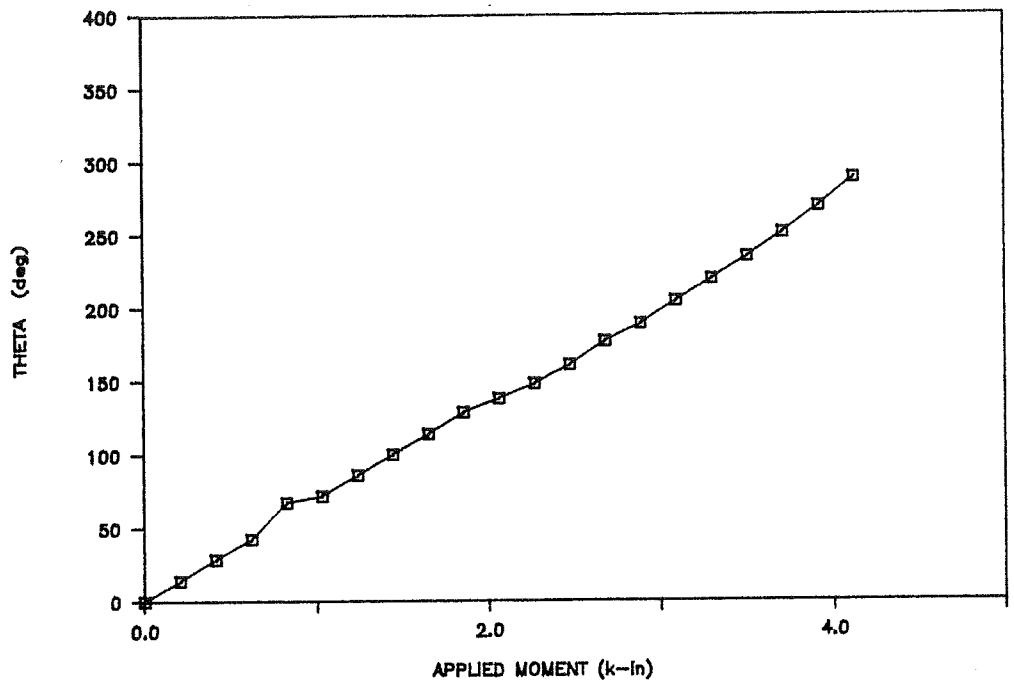


Figure M.7. *Applied Torque vs Post Rotation: Marion 3 lb/ft - 80 ksi Post; Post W/O Splice.*

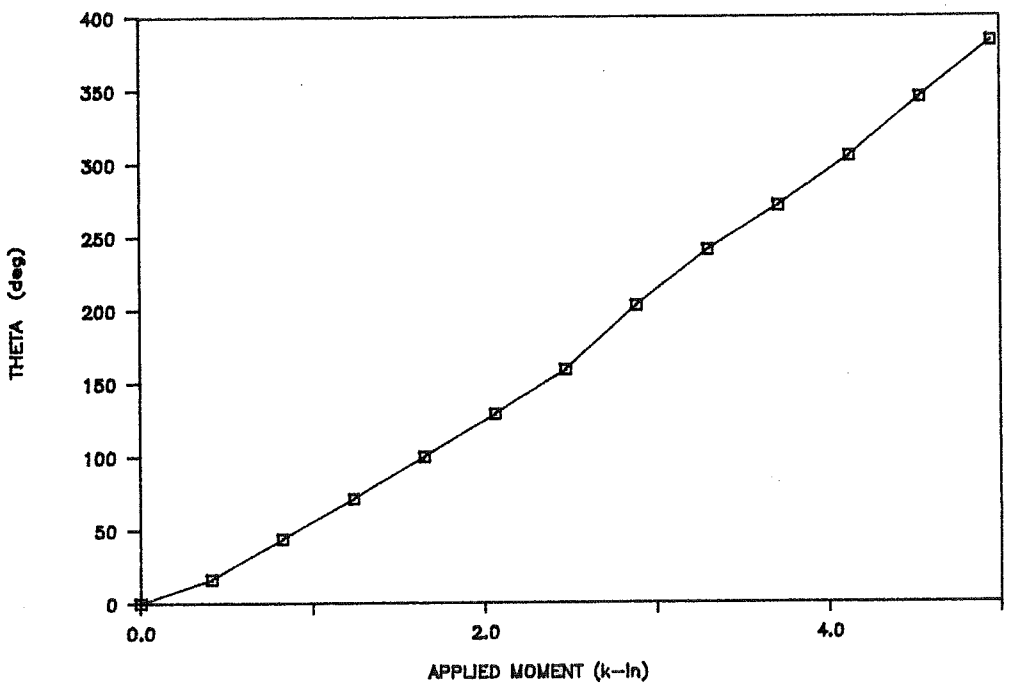


Figure M.8. *Applied Torque vs Post Rotation: Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice (Calibrated and Grade 5 Field Bolts).*

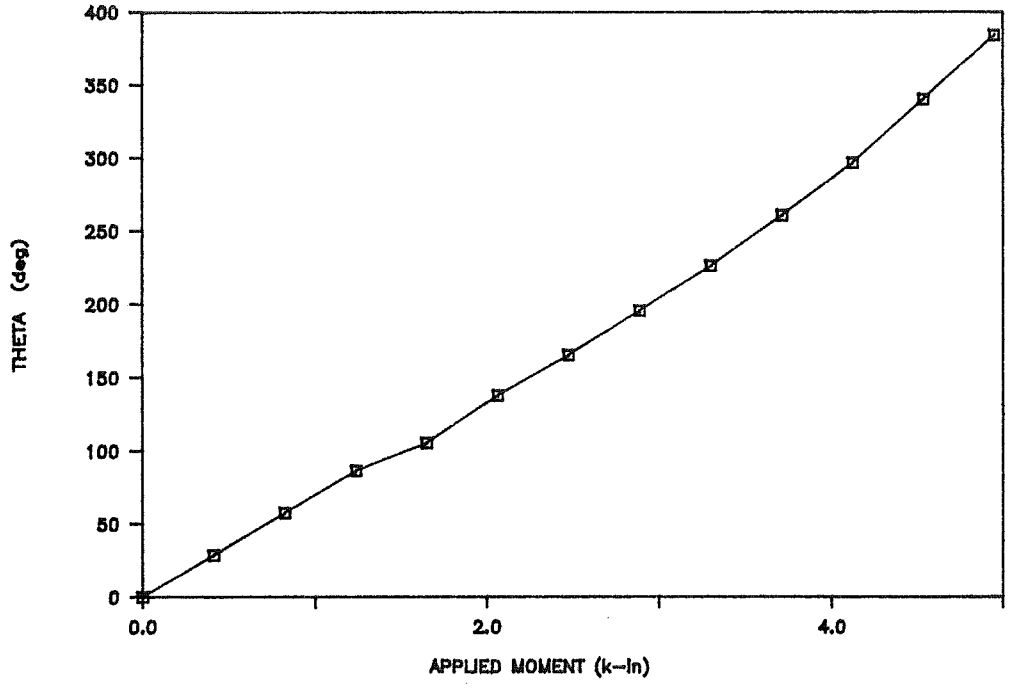


Figure M.9. *Applied Torque vs Post Rotation: Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice (Calibrated and Grade 5 Field Bolts).*

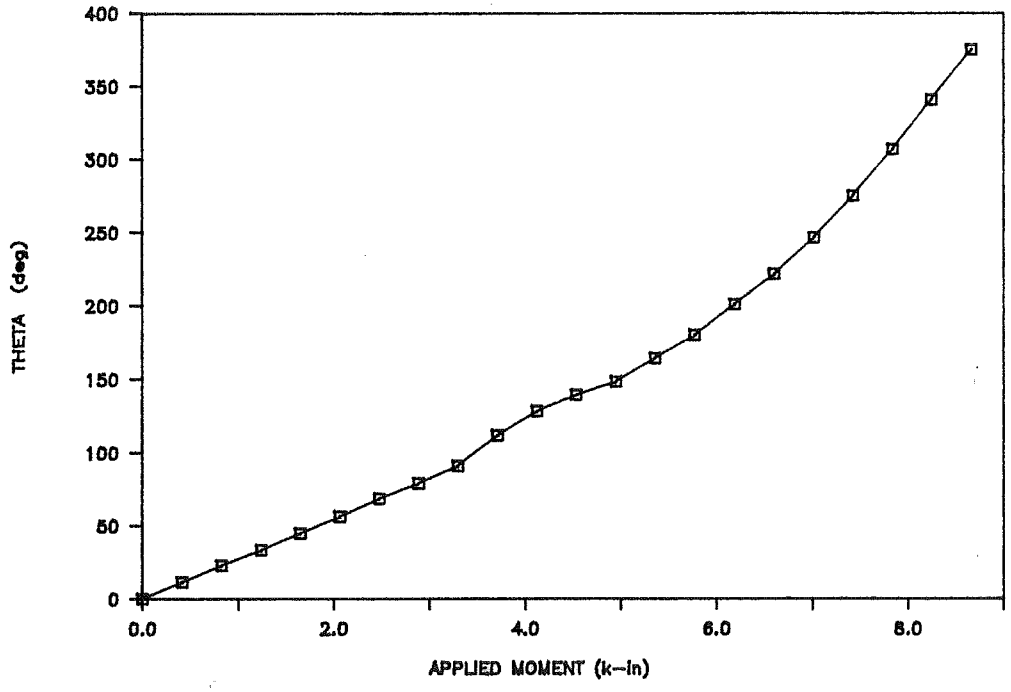


Figure M.10. *Applied Torque vs Post Rotation: Marion 4 lb/ft - 80 ksi Post; Post W/O Splice.*

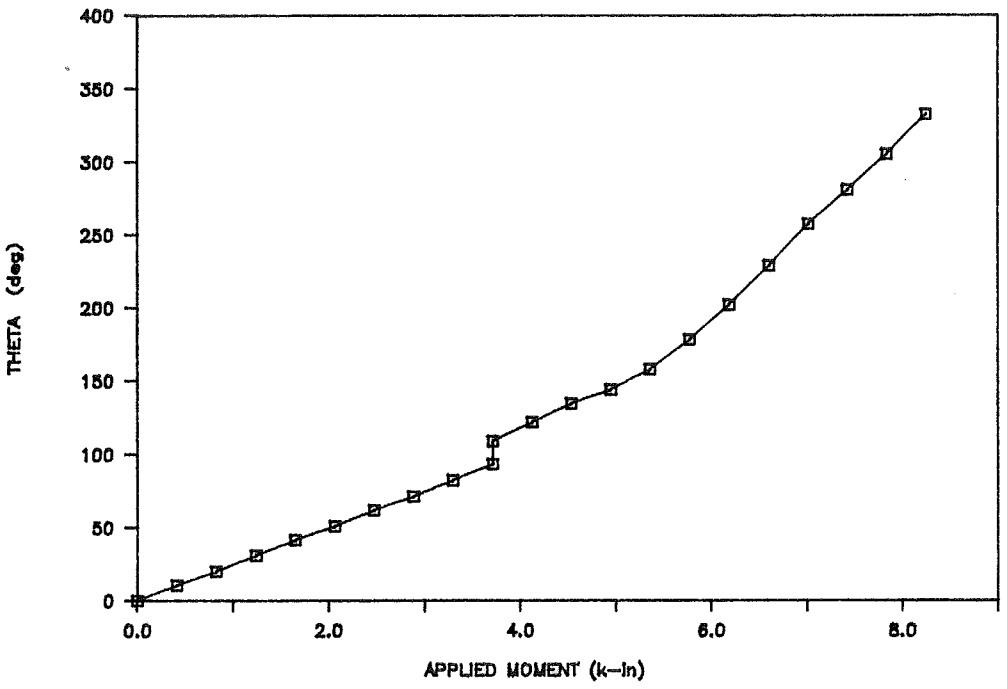


Figure M.11. *Applied Torque vs Post Rotation: Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice (Calibrated and Grade 5 Field Bolts).*

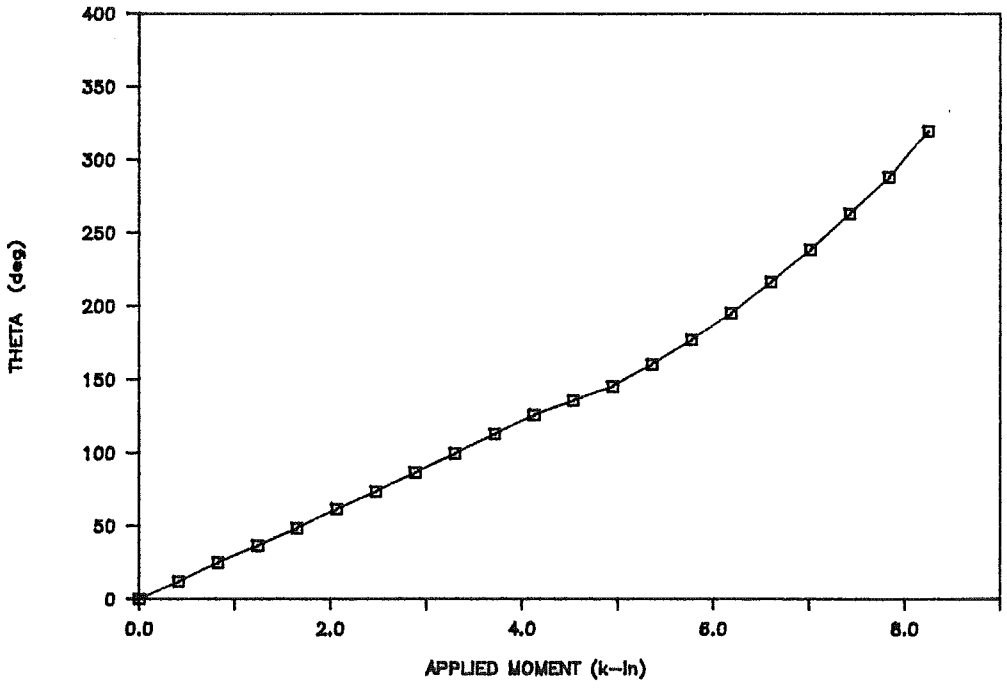


Figure M.12. *Applied Torque vs Post Rotation: Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice (Calibrated and Grade 5 Field Bolts).*

# APPENDIX N

## 75" COMBINED BENDING AND TORSION TESTS

## BASE STRESS VS TIP ROTATION

## (FIELD BOLTS)

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back and Nested Splices

Critical Configuration

# APPENDIX N

## LIST OF FIGURES

# APPENDIX N

## LIST OF FIGURES (CONT)

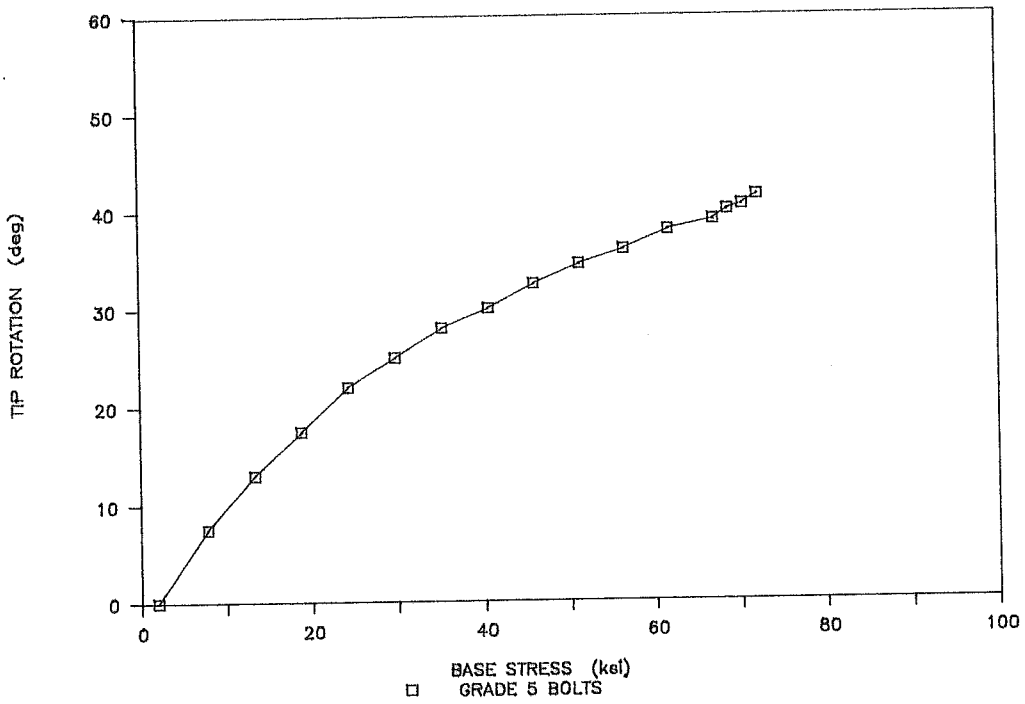


**Figure N.1.** *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

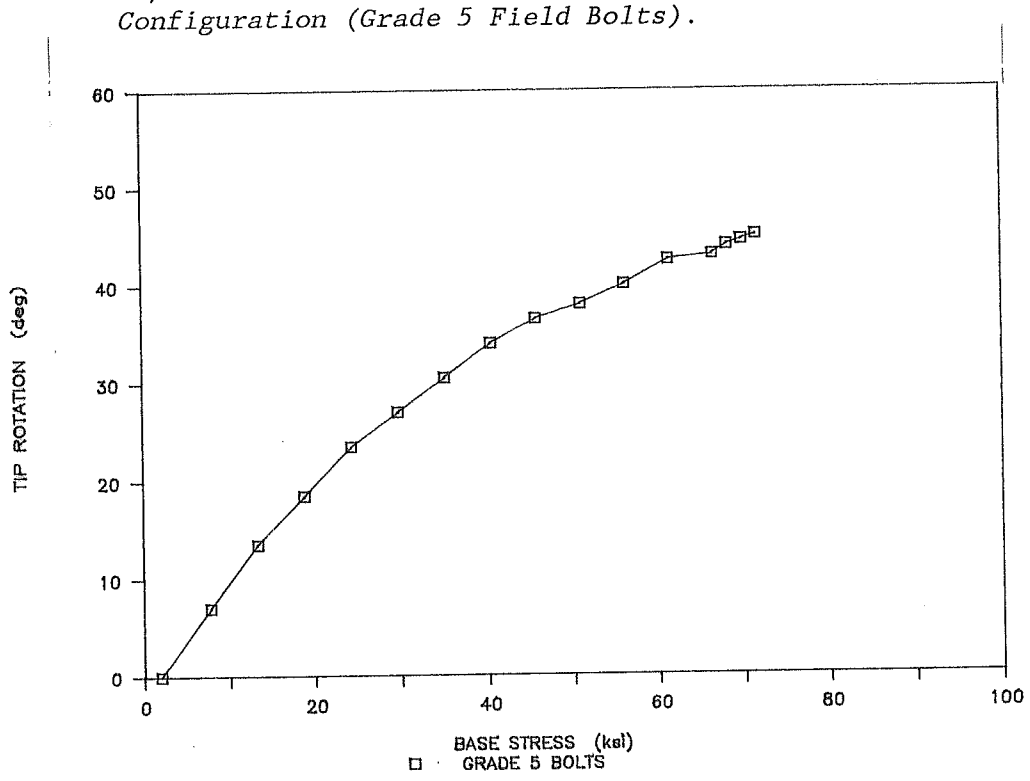


**Figure N.2.** *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

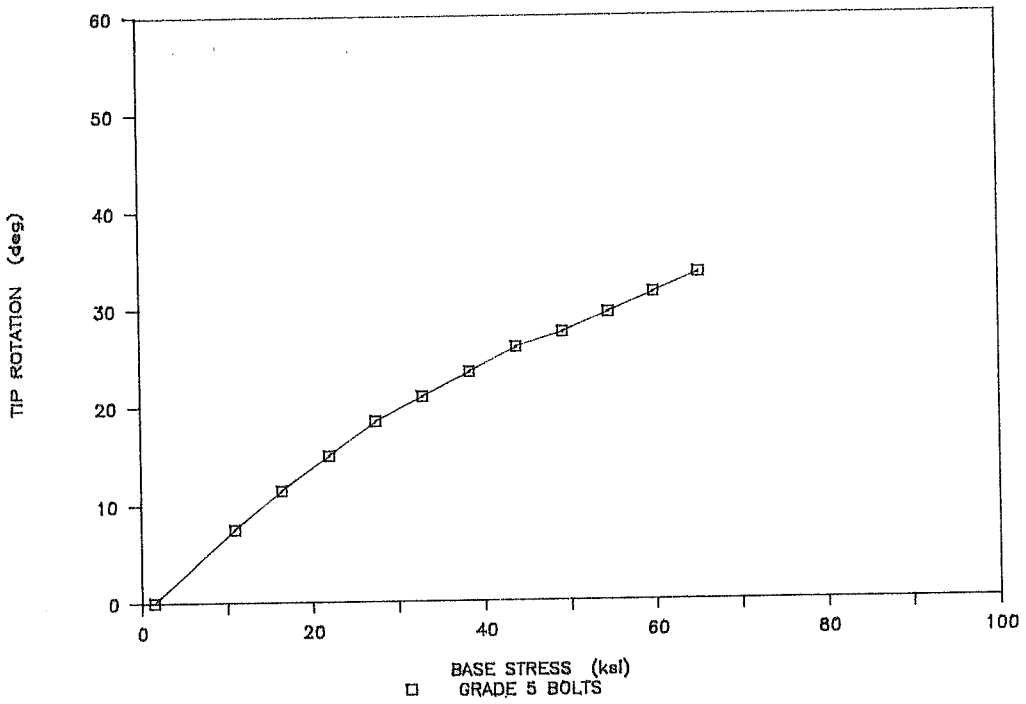


**Figure N.3.** *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field*

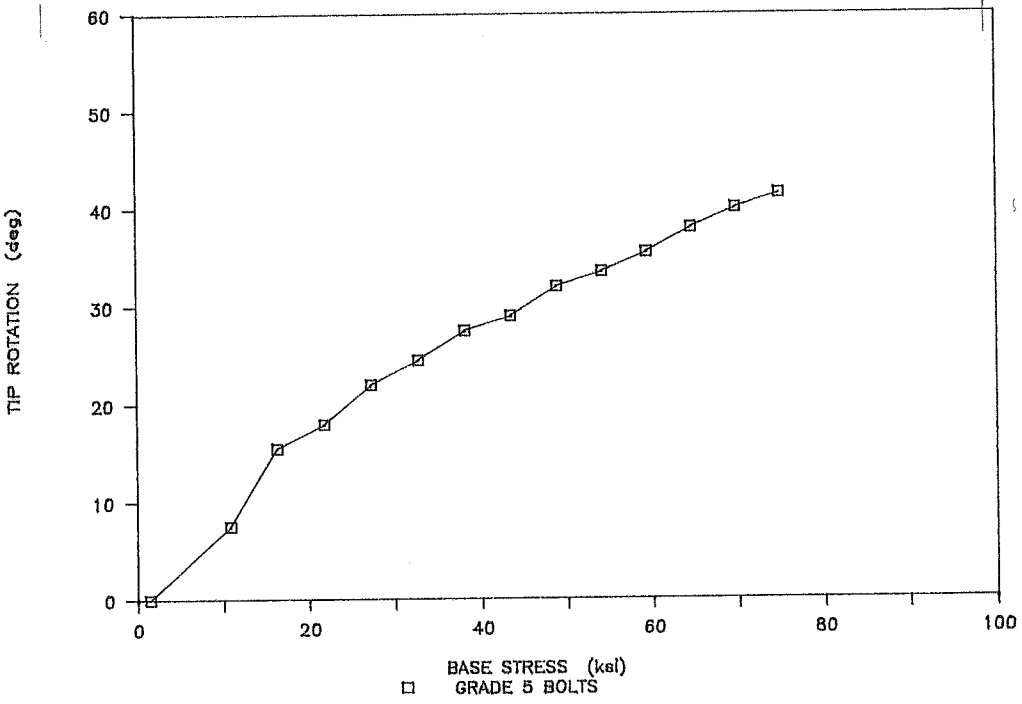


**Figure N.4.** *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

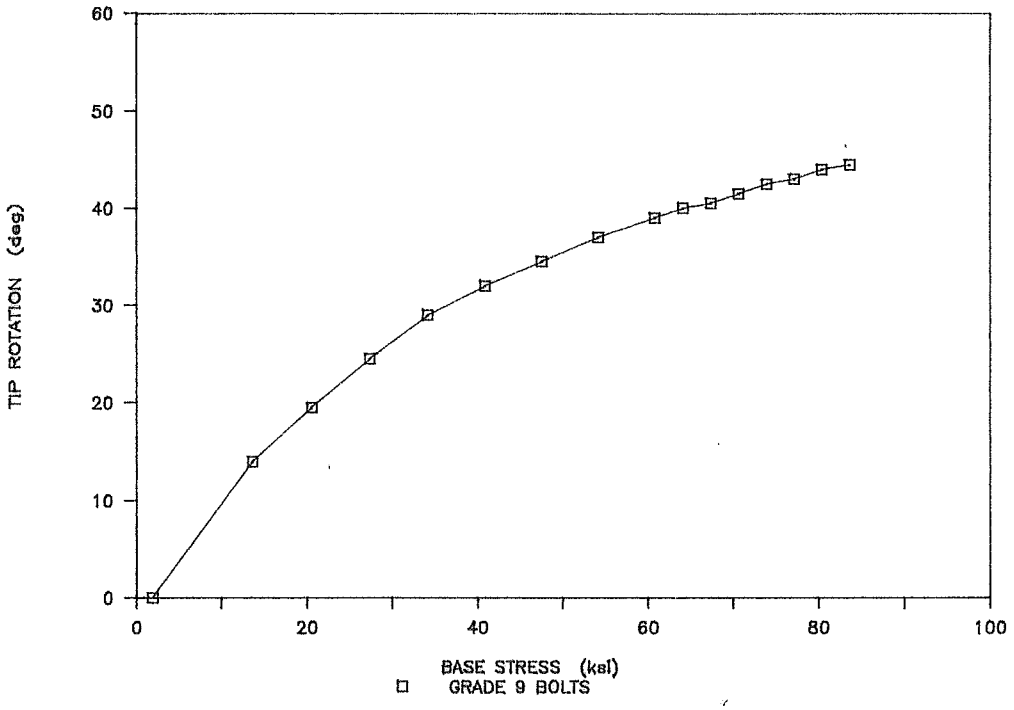


**Figure N.5.** *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

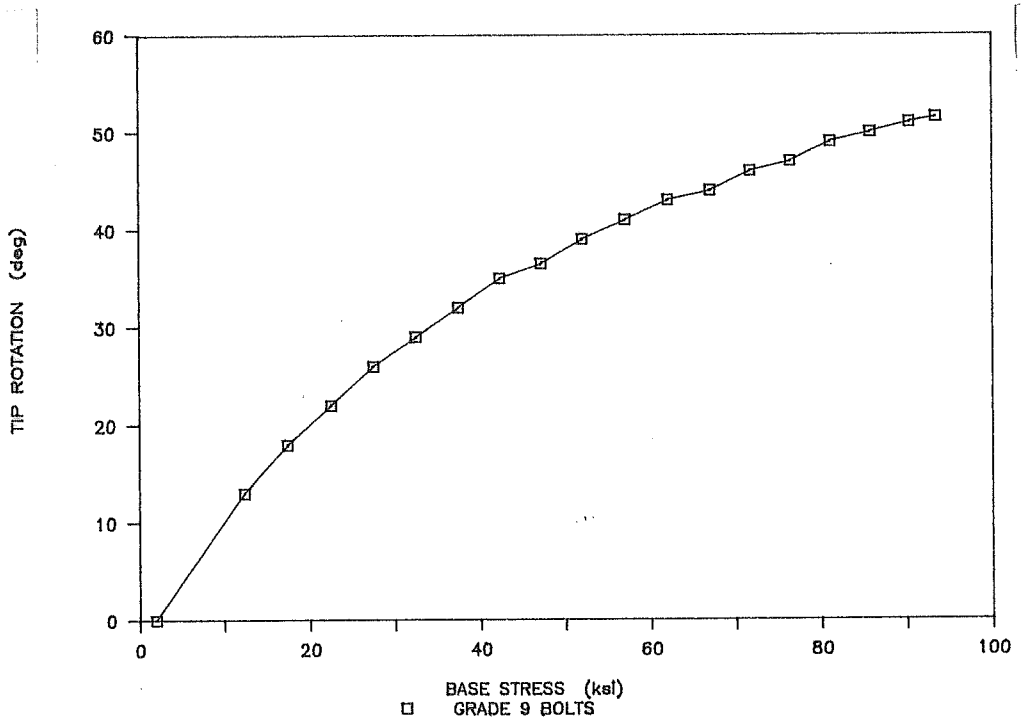


**Figure N.6.** *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

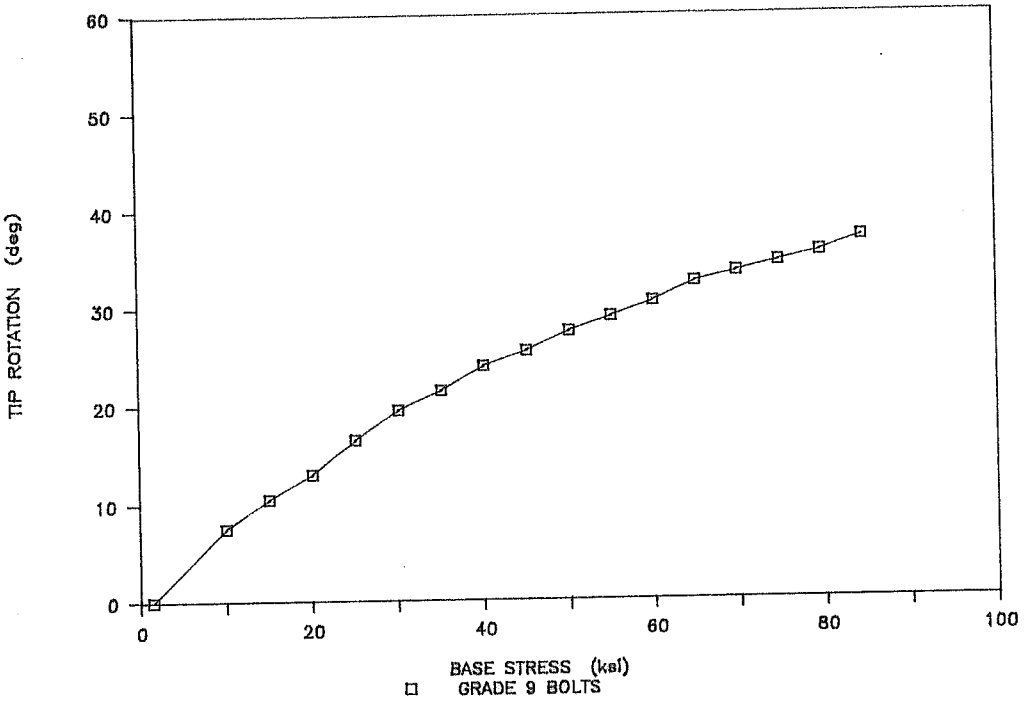


**Figure N.7.** *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

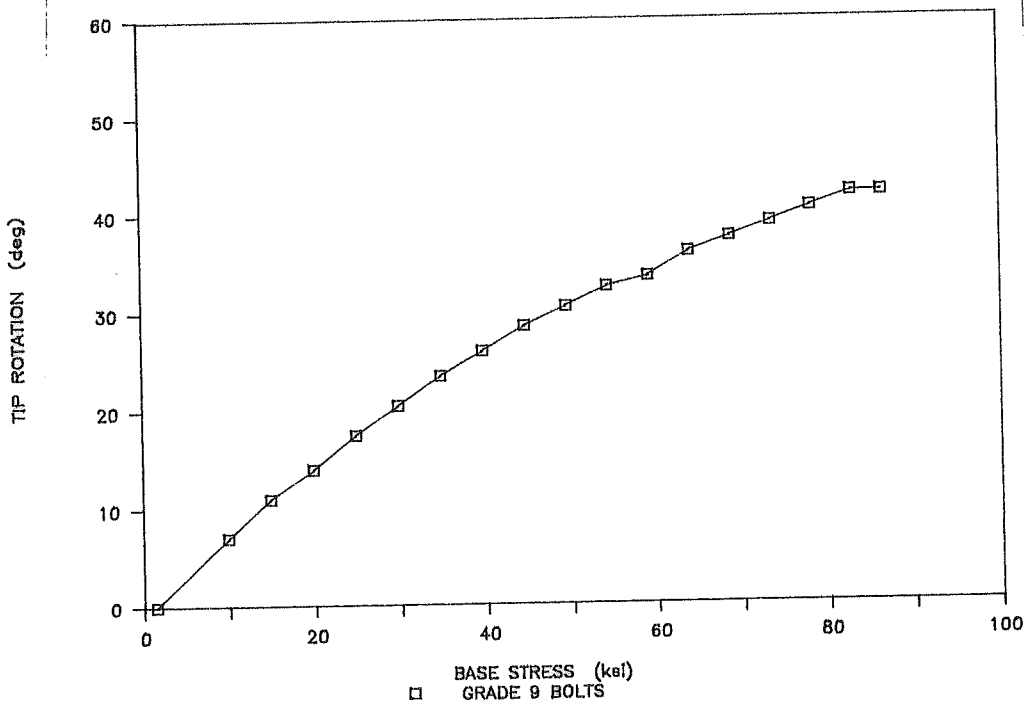


**Figure N.8.** *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

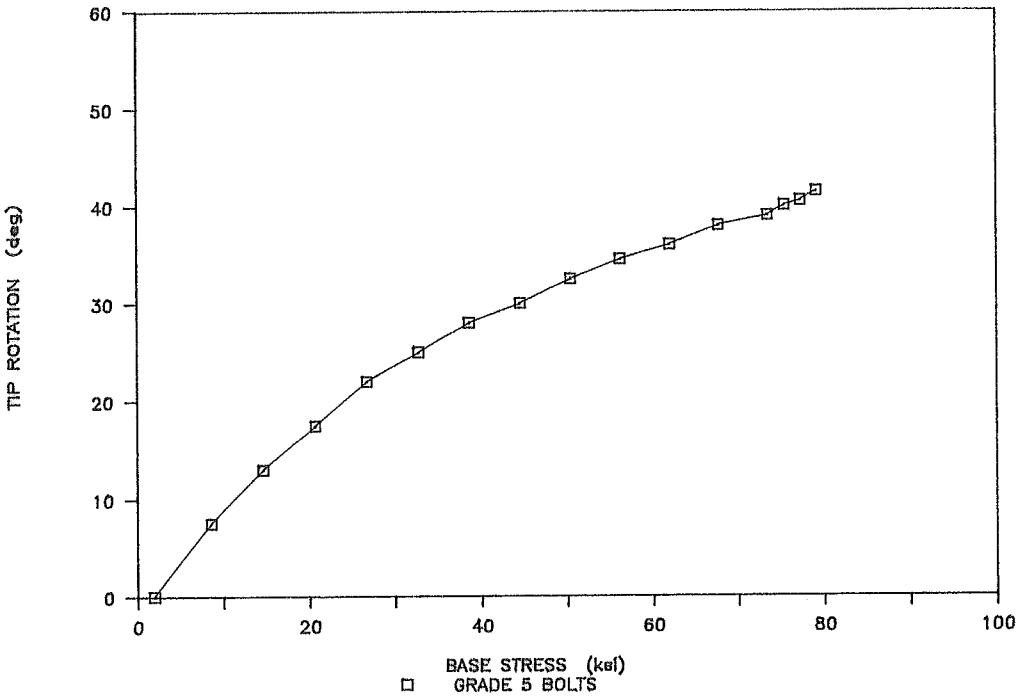


Figure N.9. *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 5 Field Bolts).*

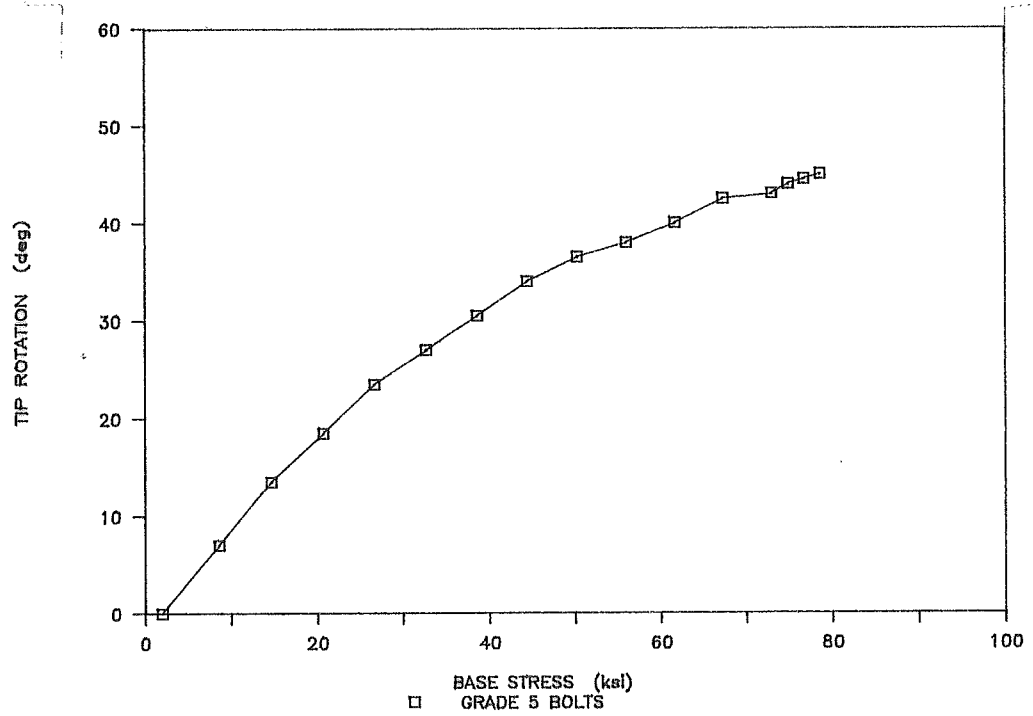


Figure N.10. *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

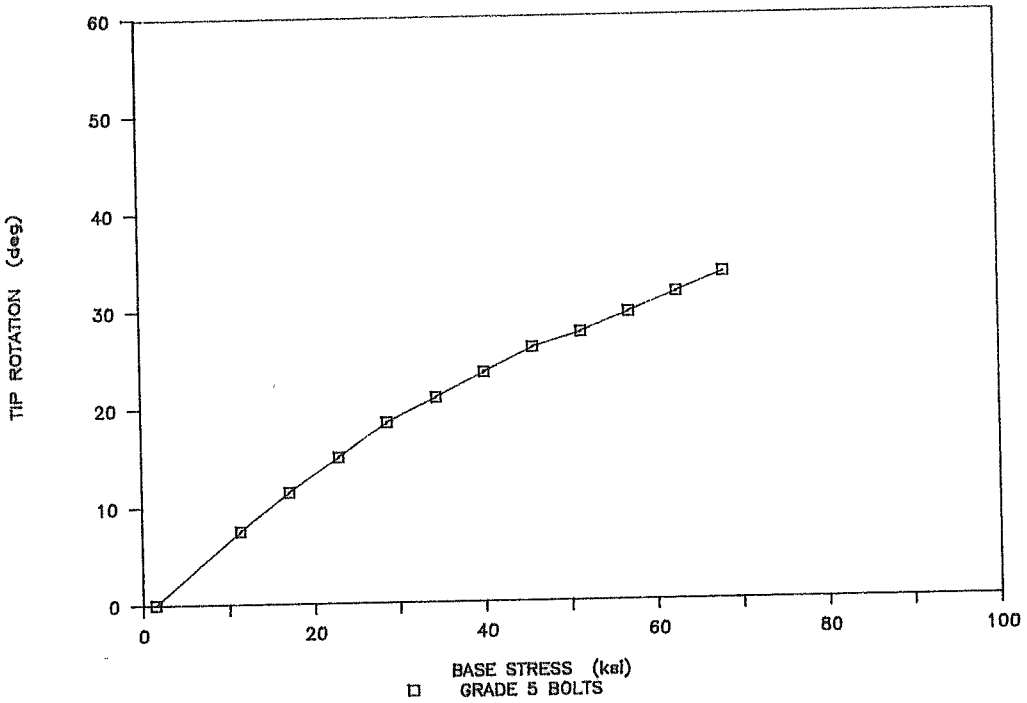


Figure N.11. *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 5 Field*

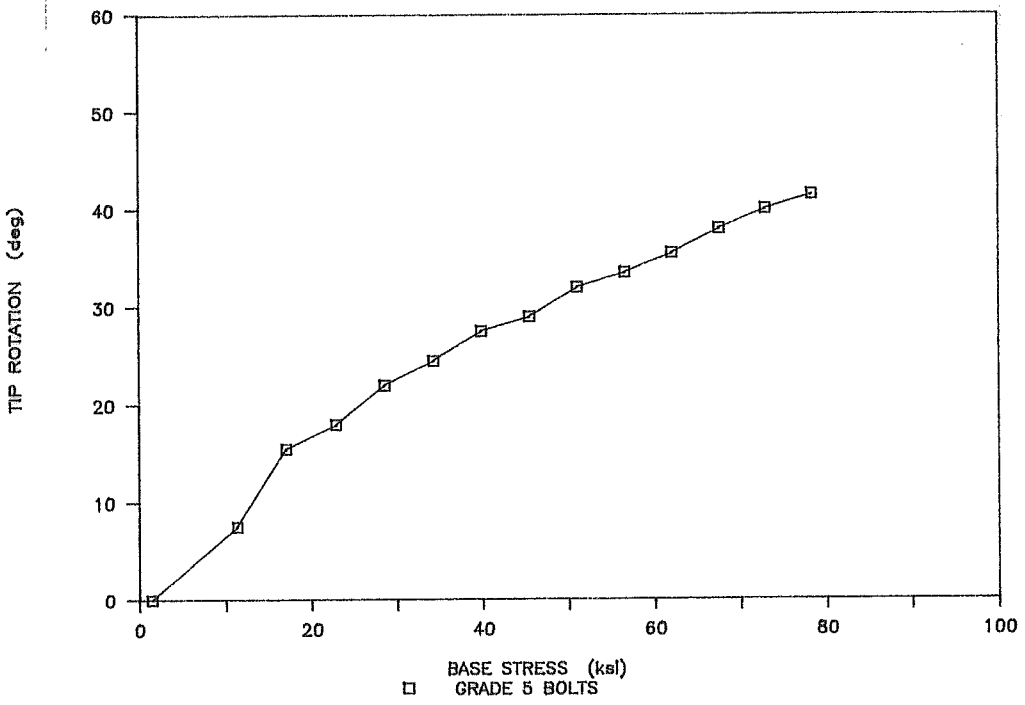


Figure N.12. *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 5 Field Bolts).*

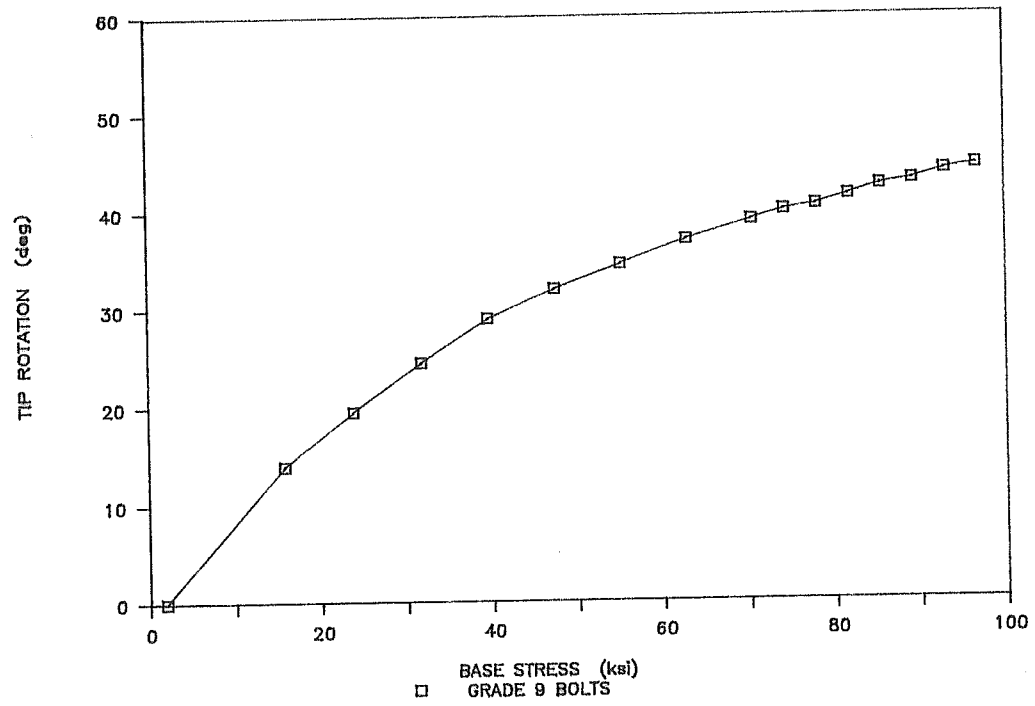


Figure N.13. *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

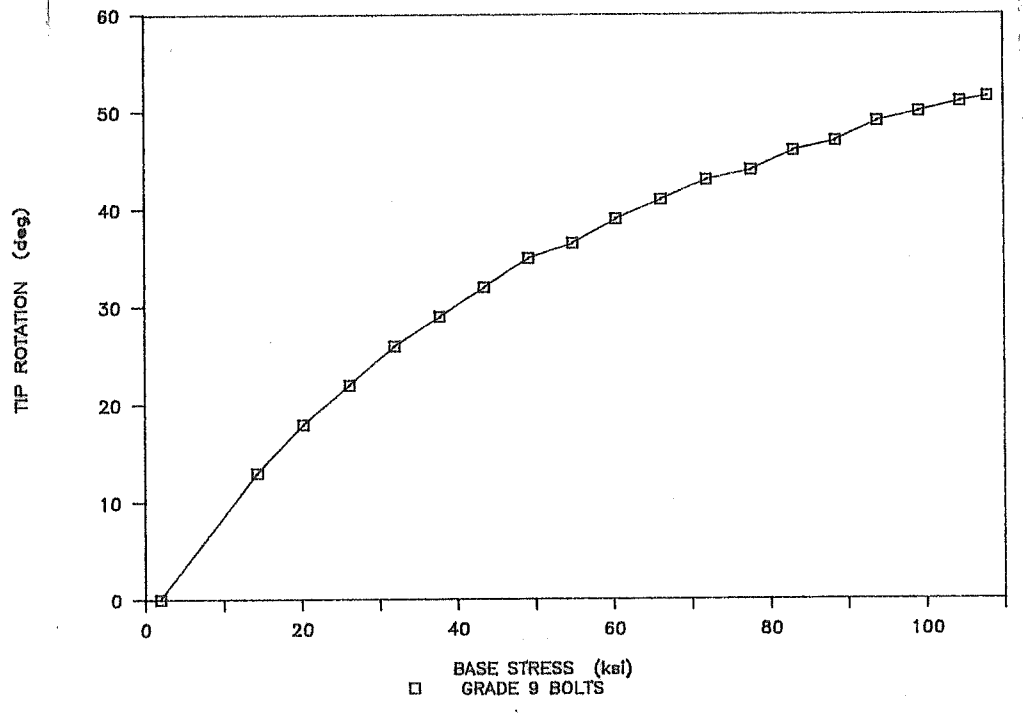


Figure N.14. *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

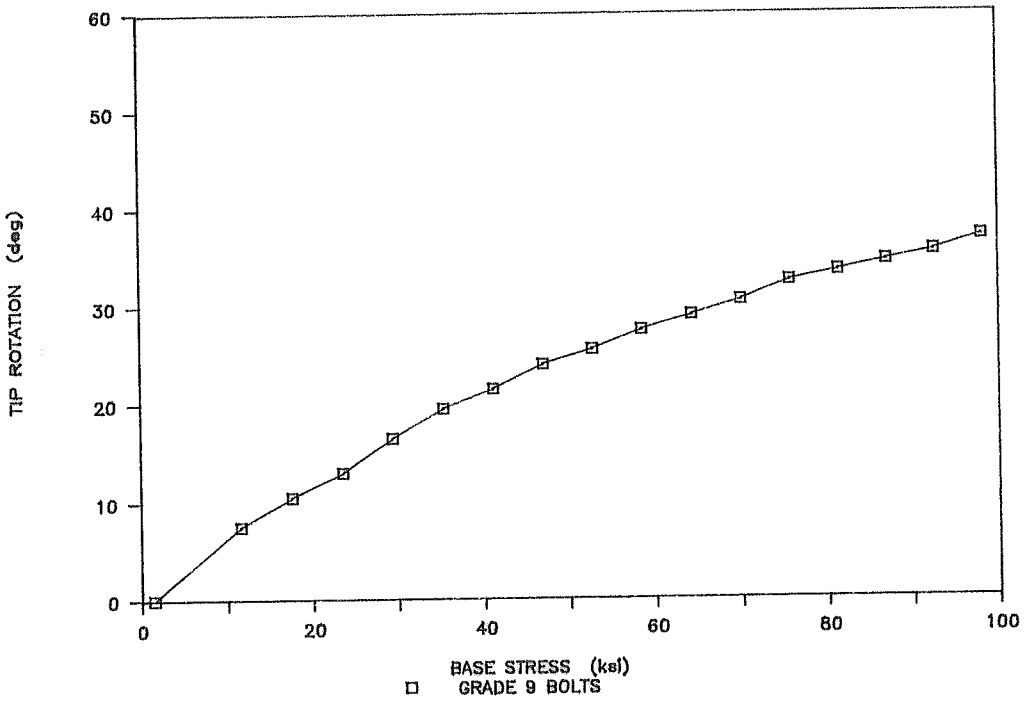


Figure N.15. *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Grade 9 Field Bolts).*

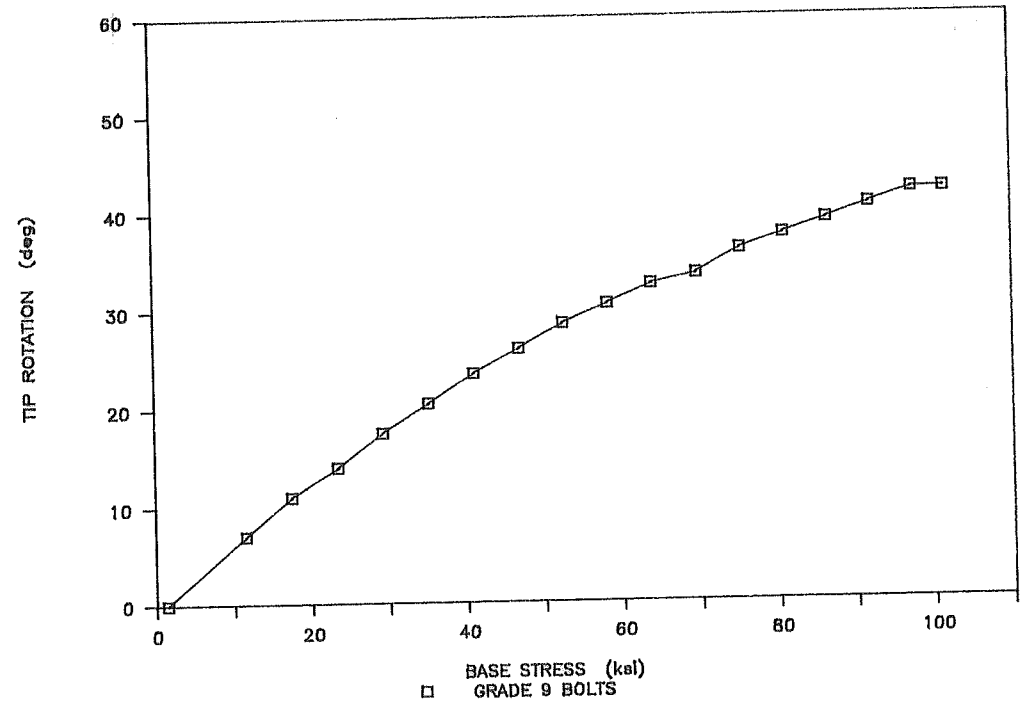


Figure N.16. *Base Stress vs Post Tip Rotation (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Grade 9 Field Bolts).*

# APPENDIX O

## PRELIMINARY 72 " BENDING TESTS

## BASE STRESS VS RELATIVE BOLT TENSION

## (CALIBRATED BOLTS)

Marion 3 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back, Nested and Face to Face Splices

Critical and Non-critical Configurations

# APPENDIX O

## LIST OF FIGURES

# APPENDIX O

## LIST OF FIGURES (CONT)

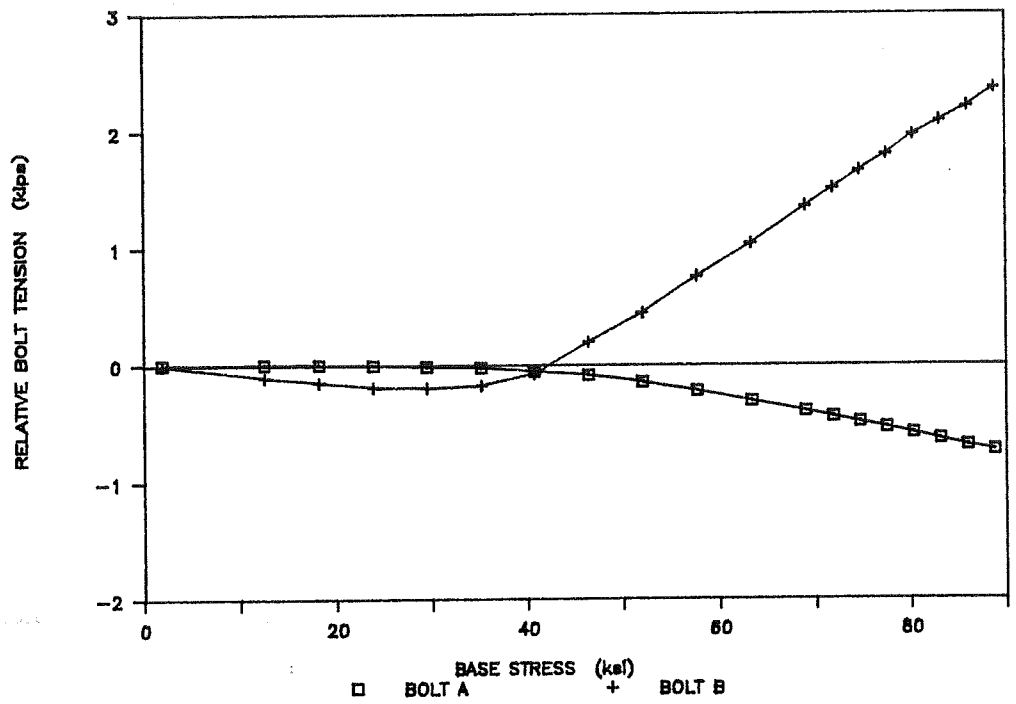


Figure 0.1. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

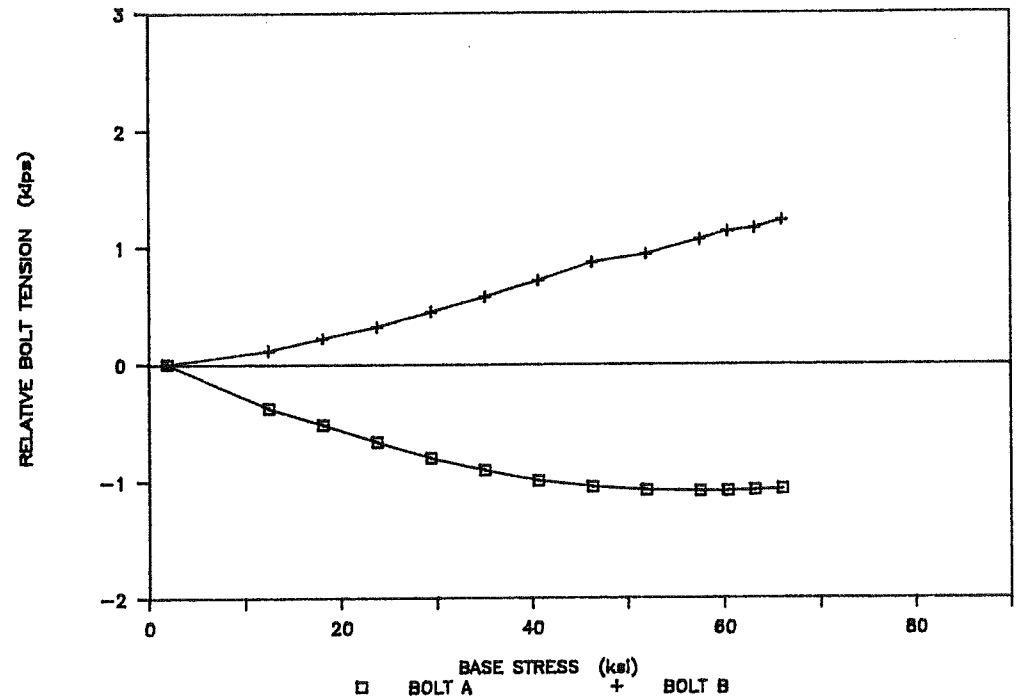


Figure 0.2. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

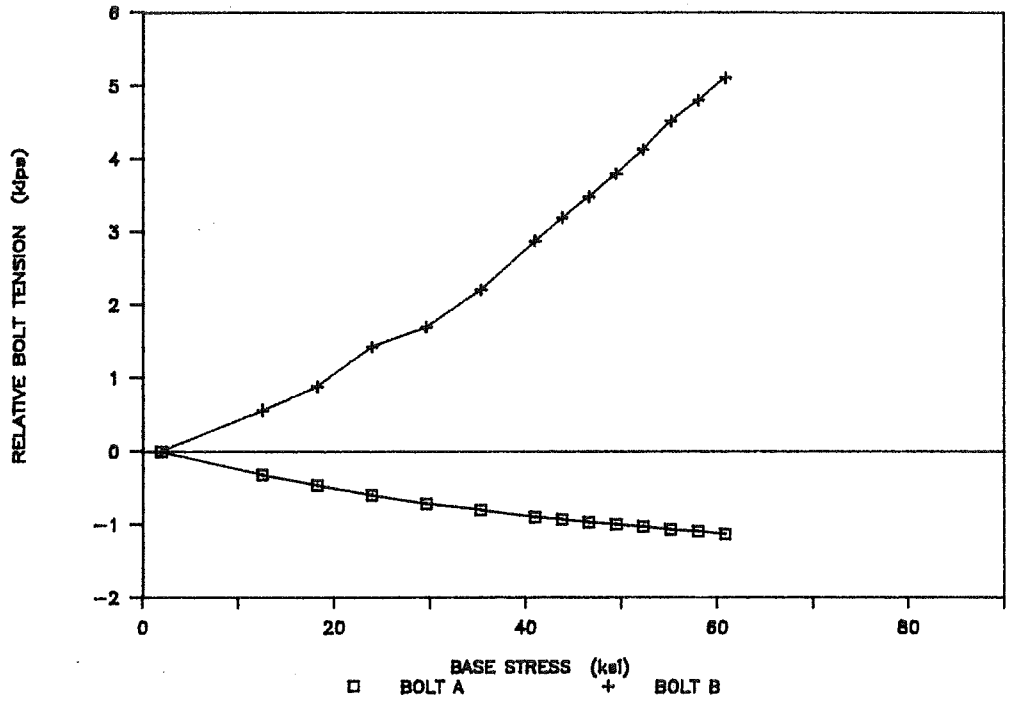


Figure O.3. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Face to Face Splice in Critical Configuration (Calibrated Bolts).*

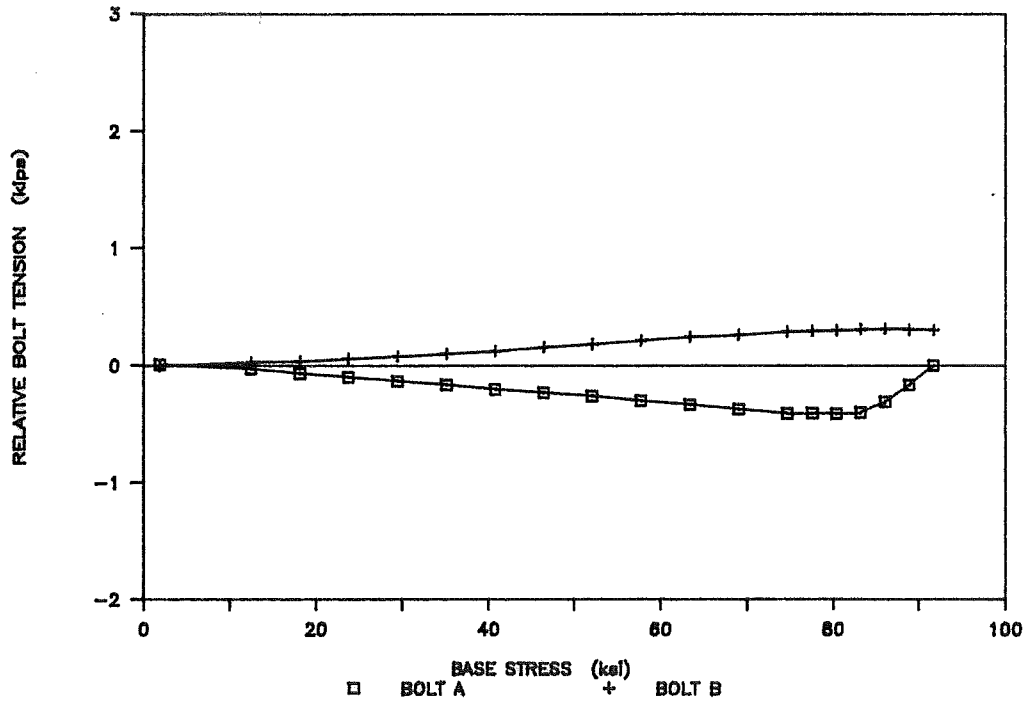


Figure O.4. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

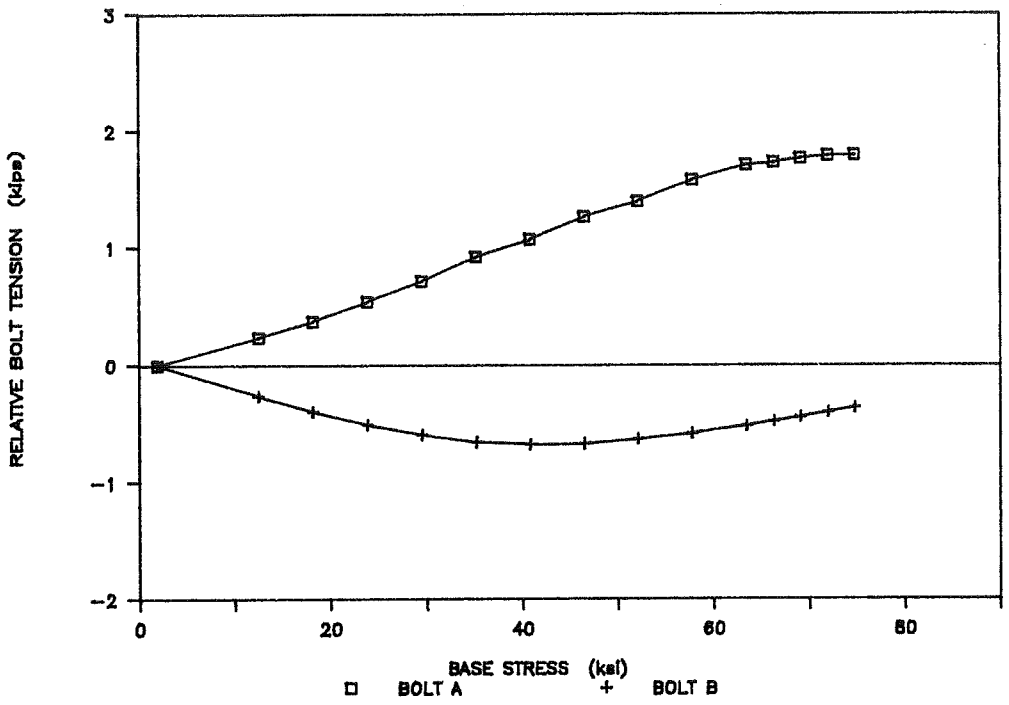


Figure 0.5. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

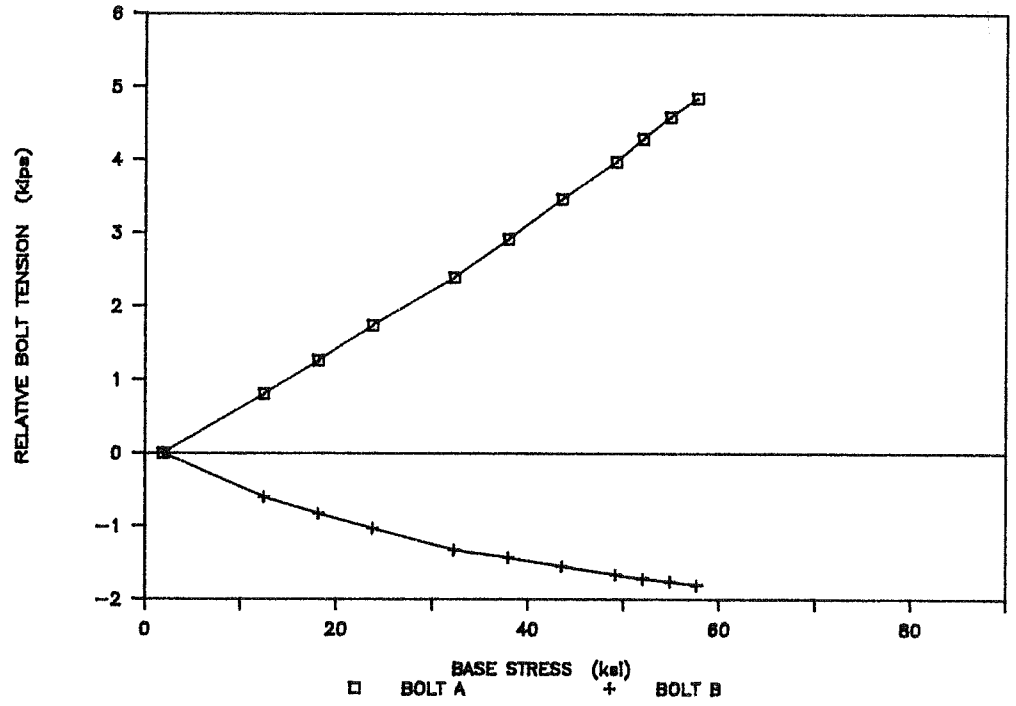


Figure 0.6. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

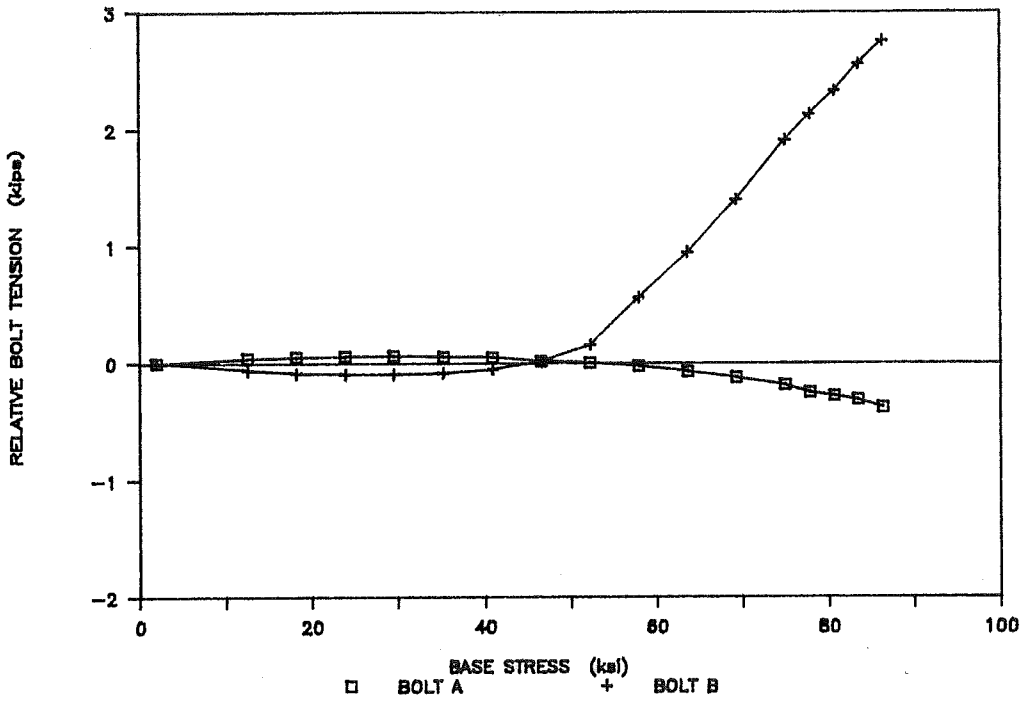


Figure 0.7. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

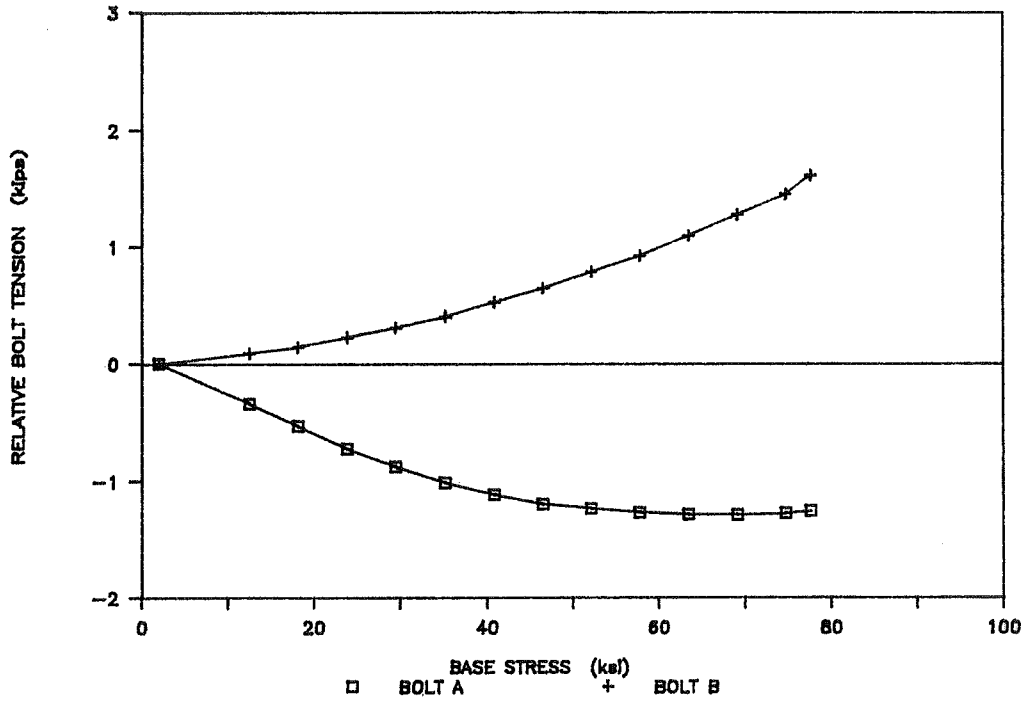


Figure 0.8. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

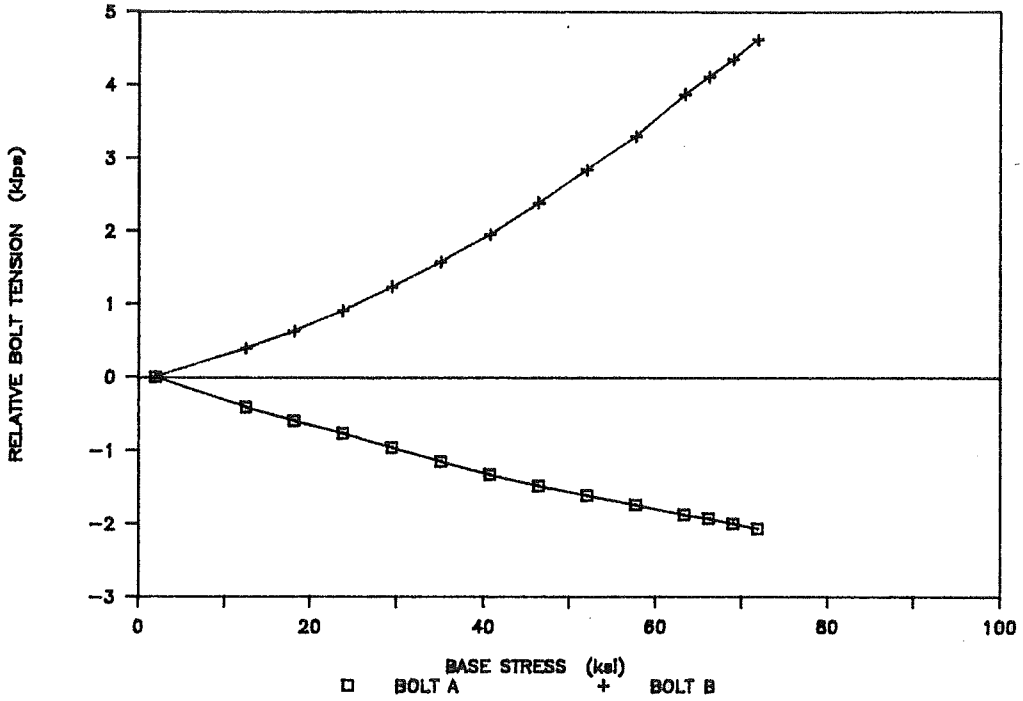


Figure 0.9. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Calibrated Bolts).*

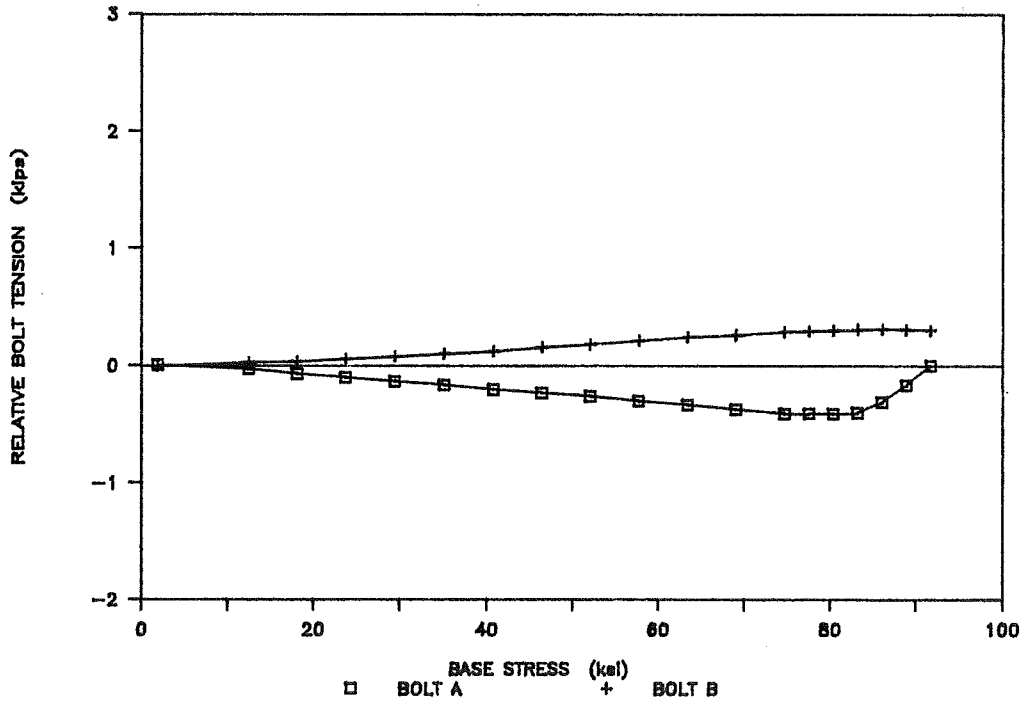


Figure 0.10. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

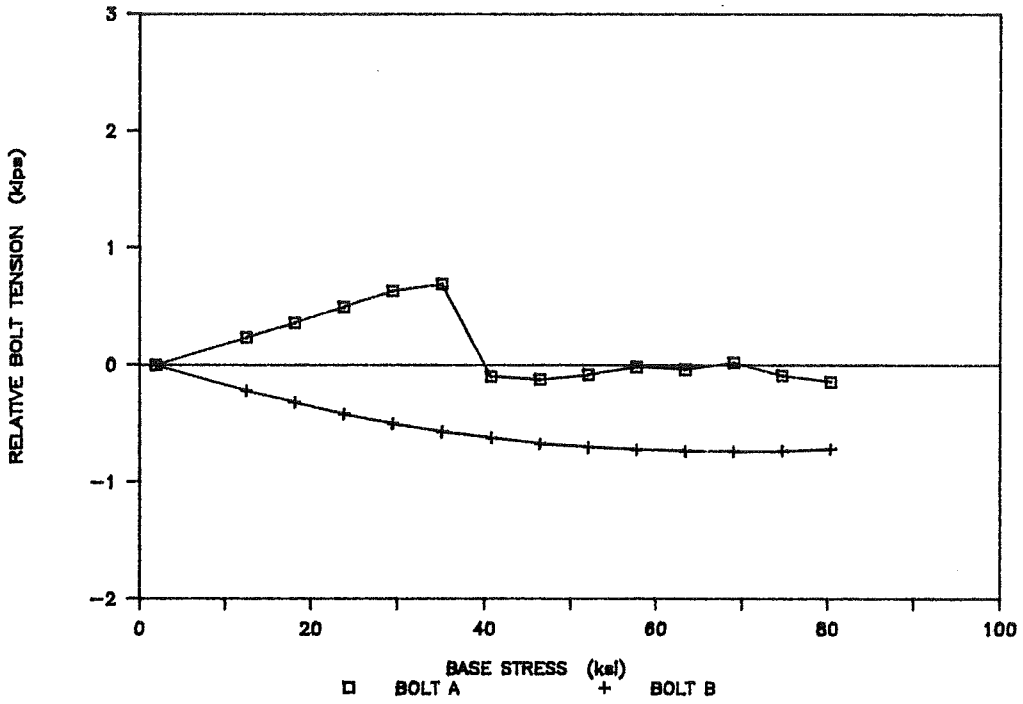


Figure 0.11. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

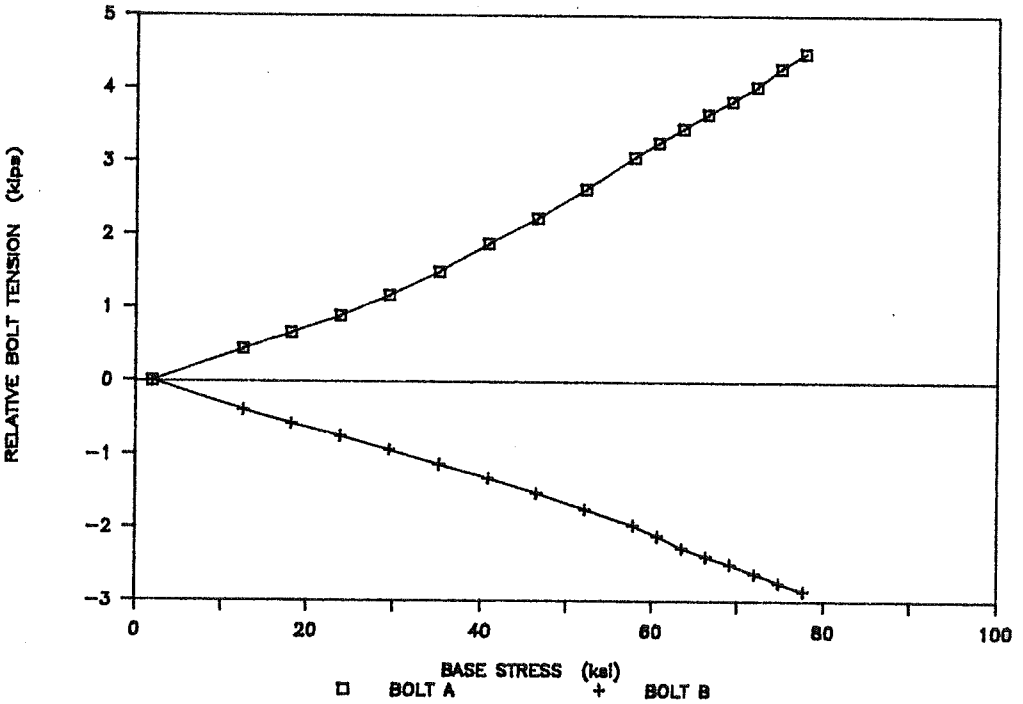


Figure 0.12. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

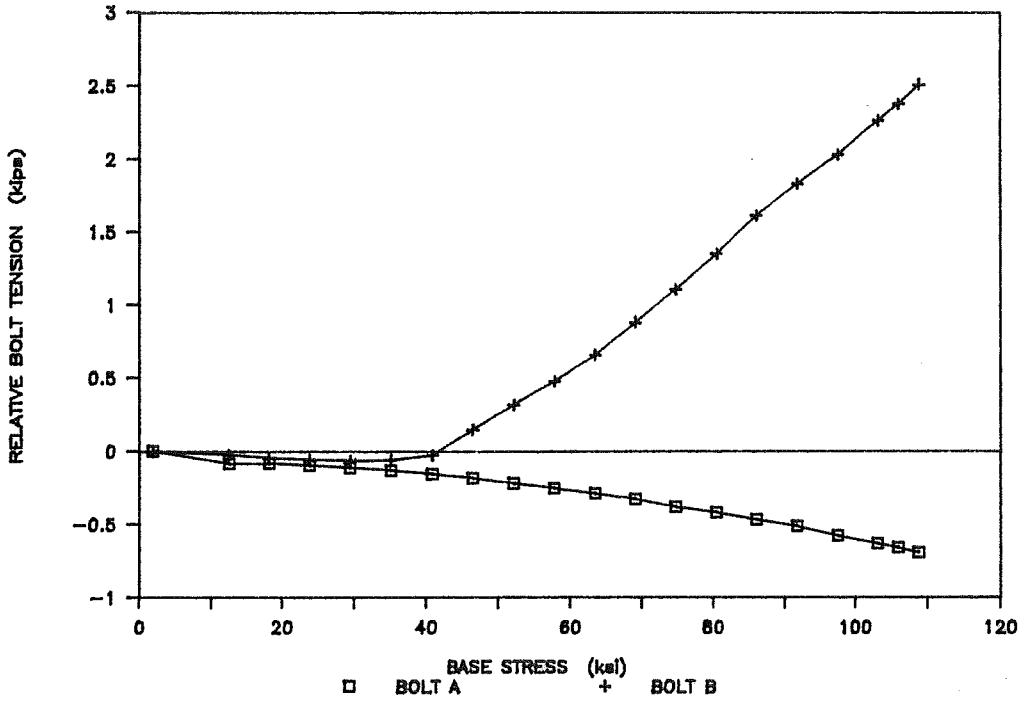


Figure 0.13. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 5 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

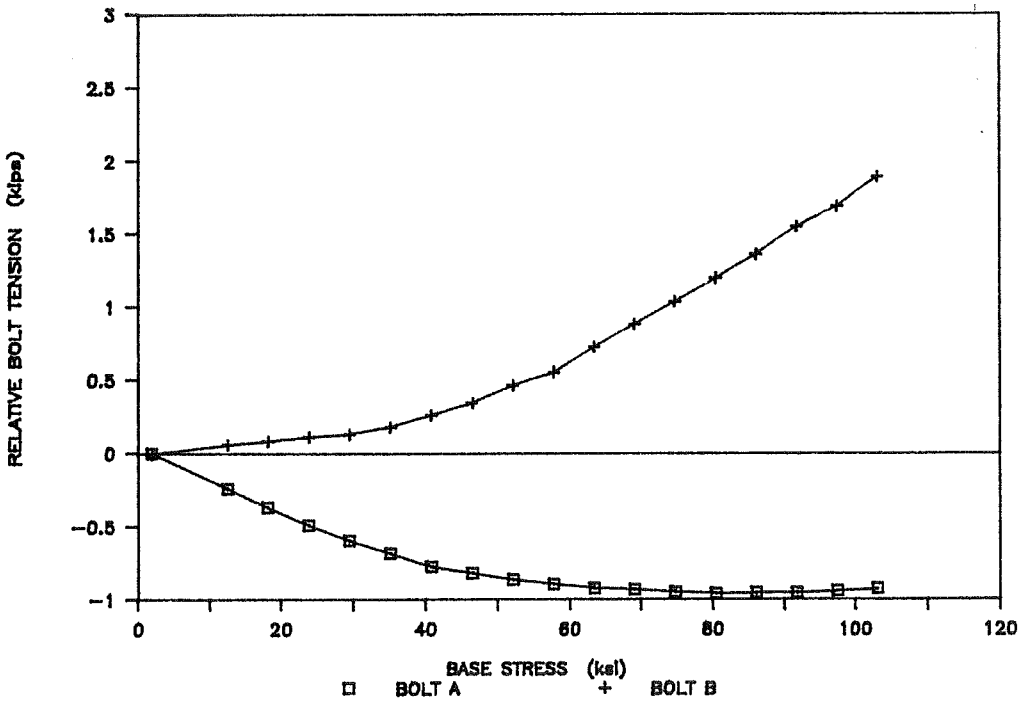


Figure 0.14. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 5 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

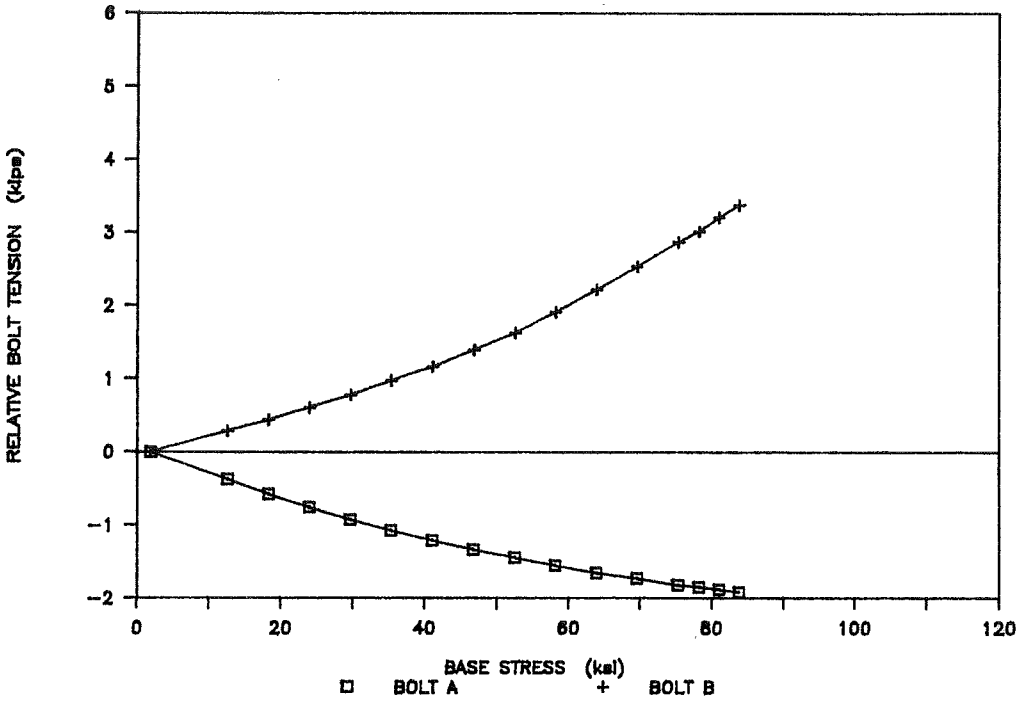


Figure 0.15. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 5 Inch Face to Face Splice in Critical Configuration (Calibrated Bolts).*

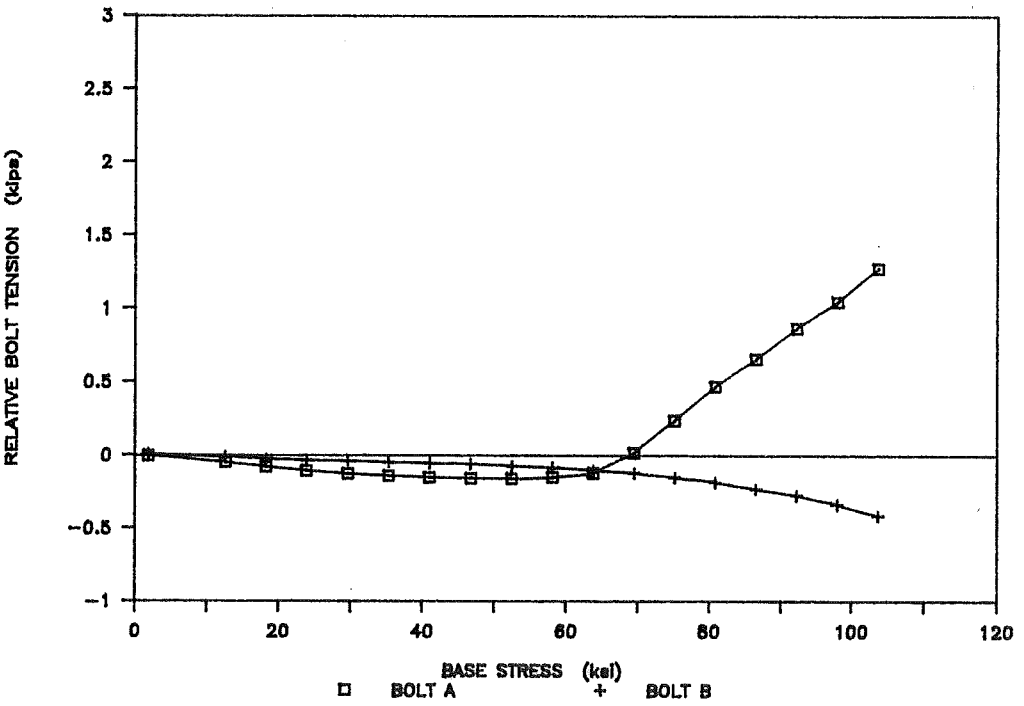


Figure 0.16. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 5 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

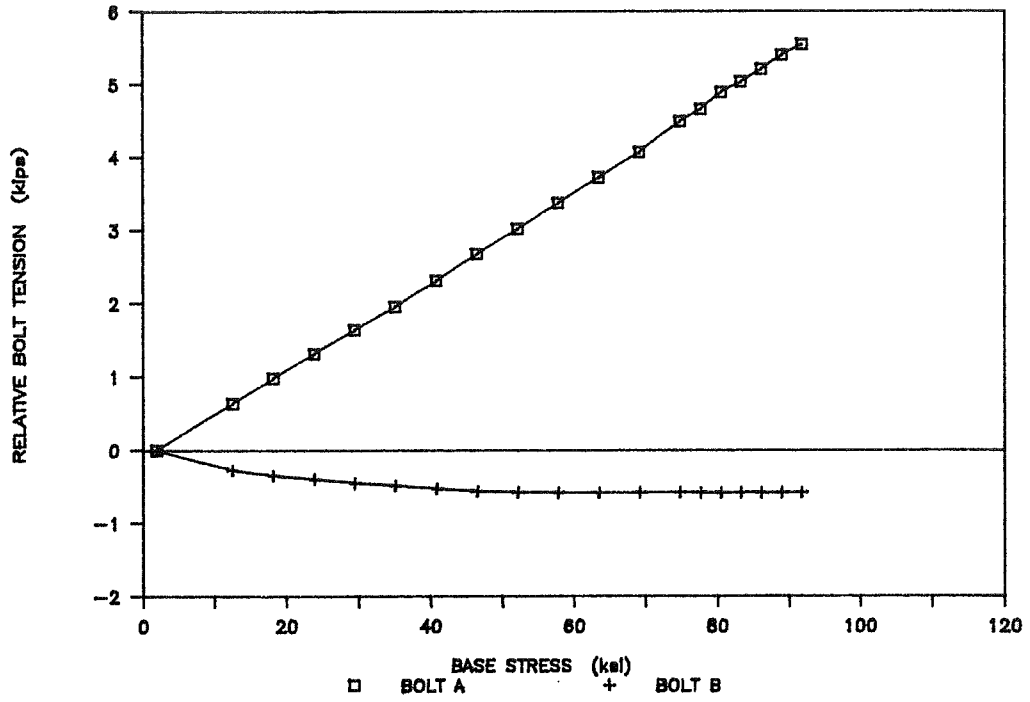


Figure O.17. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 5 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

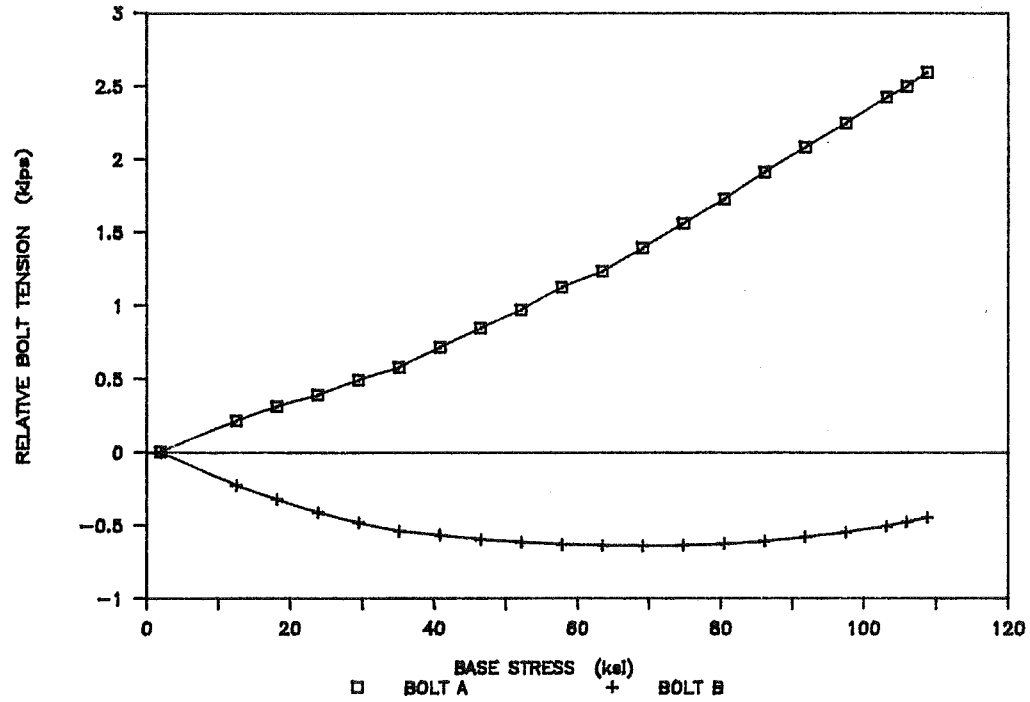


Figure O.18. *Base Stress vs Relative Bolt Tension (72 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 5 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

# APPENDIX P

## 17 " BENDING TESTS

BASE STRESS VS RELATIVE BOLT TENSION

(CALIBRATED BOLTS)

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back, Nested Face to Face, and Box Splices

Critical and Non-critical Configurations

# APPENDIX P

## LIST OF FIGURES

# APPENDIX P

## LIST OF FIGURES (CONT)

# APPENDIX P

## LIST OF FIGURES (CONT)

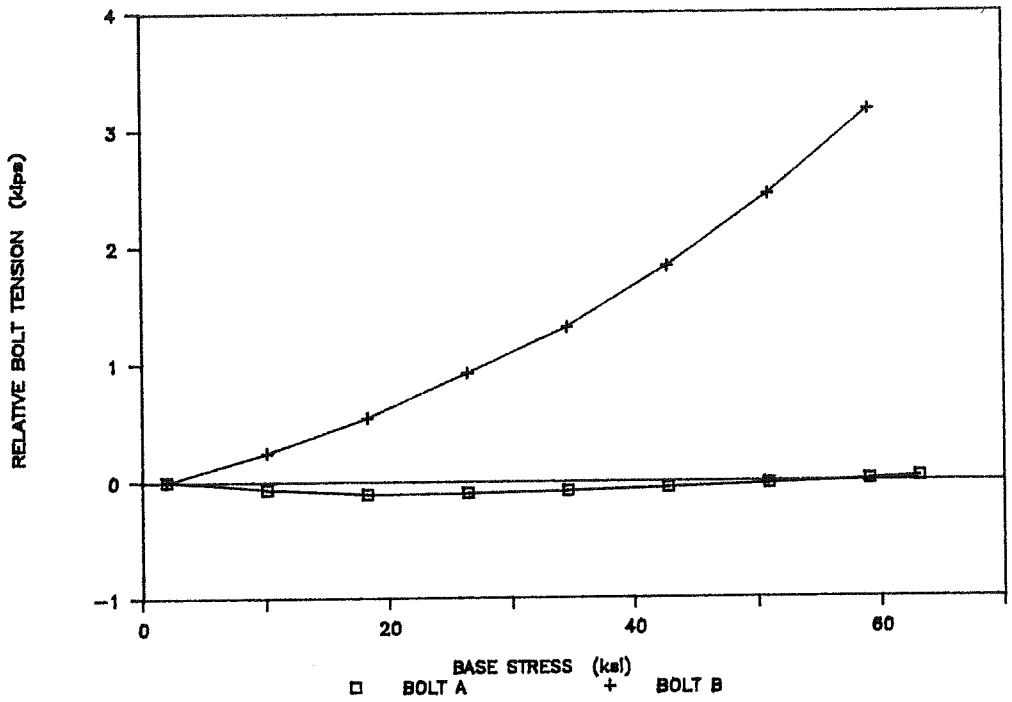


Figure P.1. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

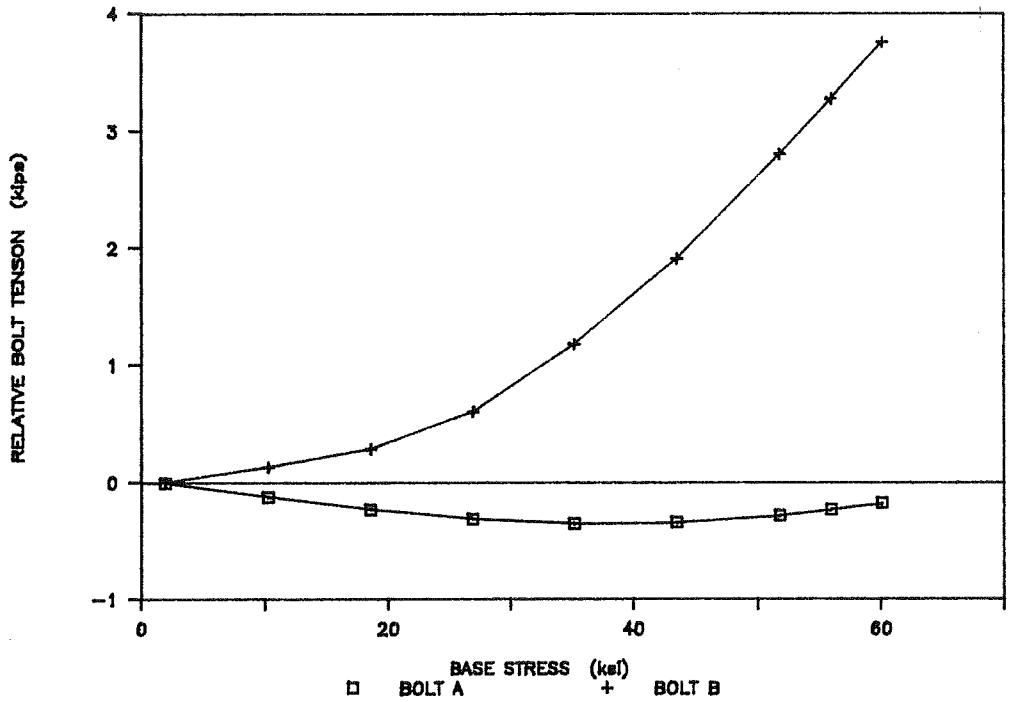


Figure P.2. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

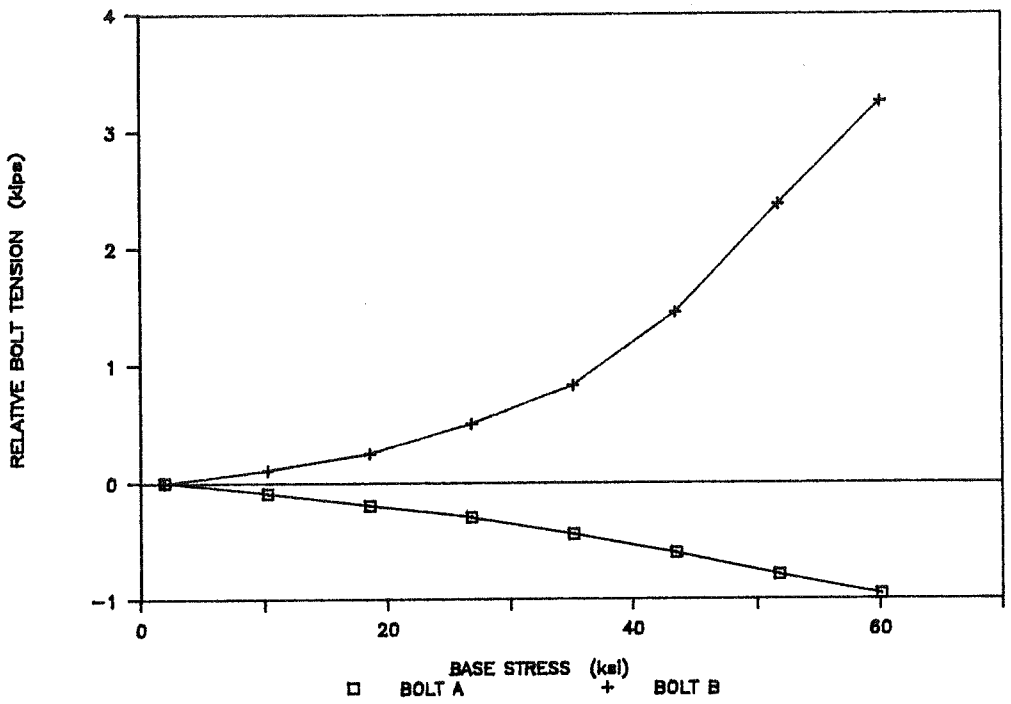


Figure P.3. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Face to Face Splice in Critical Configuration (Calibrated Bolts).*

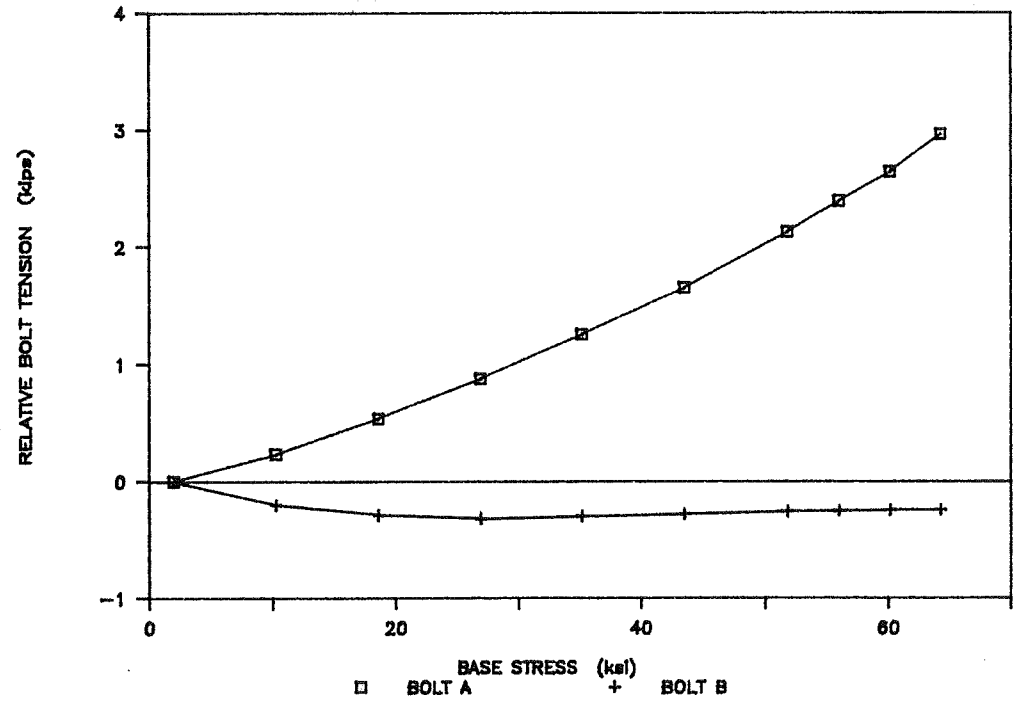


Figure P.4. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

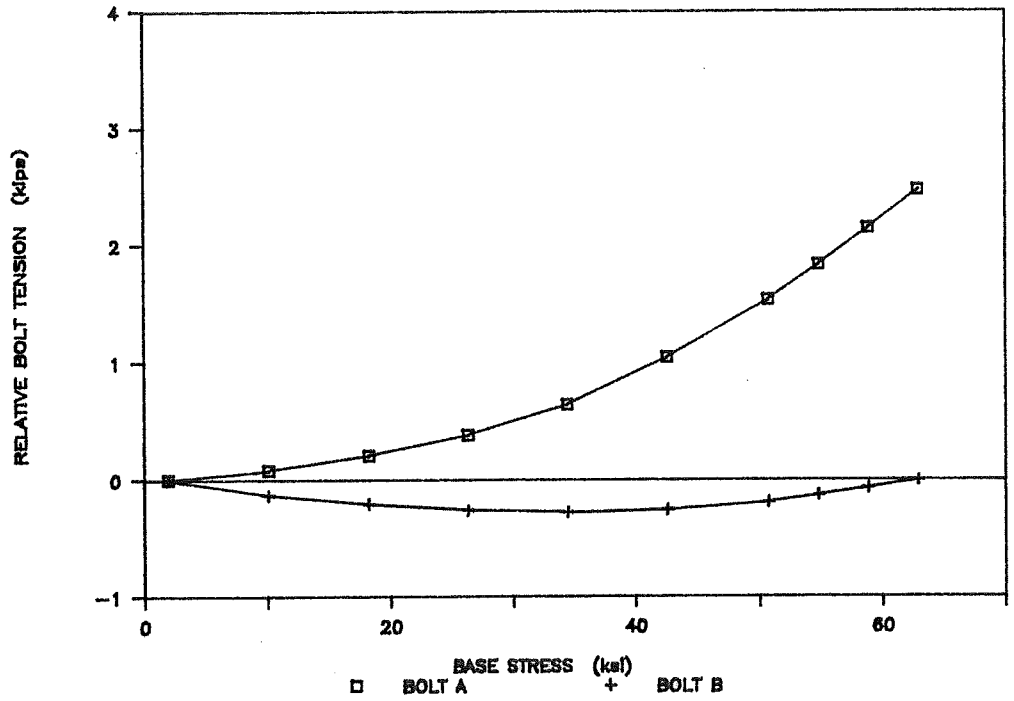


Figure P.5. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

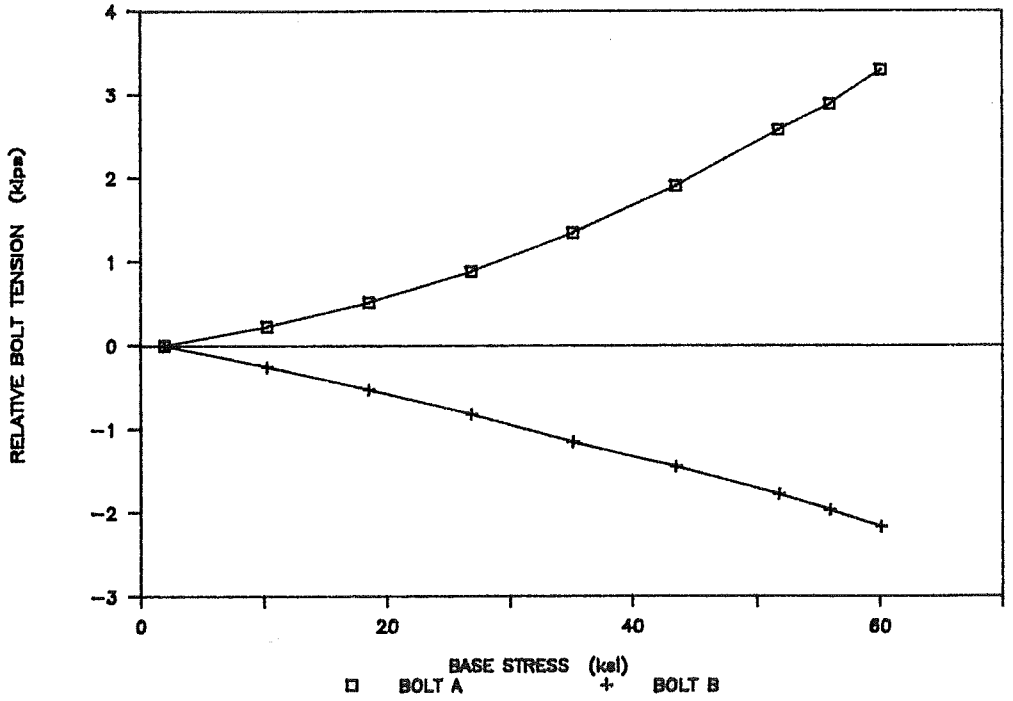


Figure P.6. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

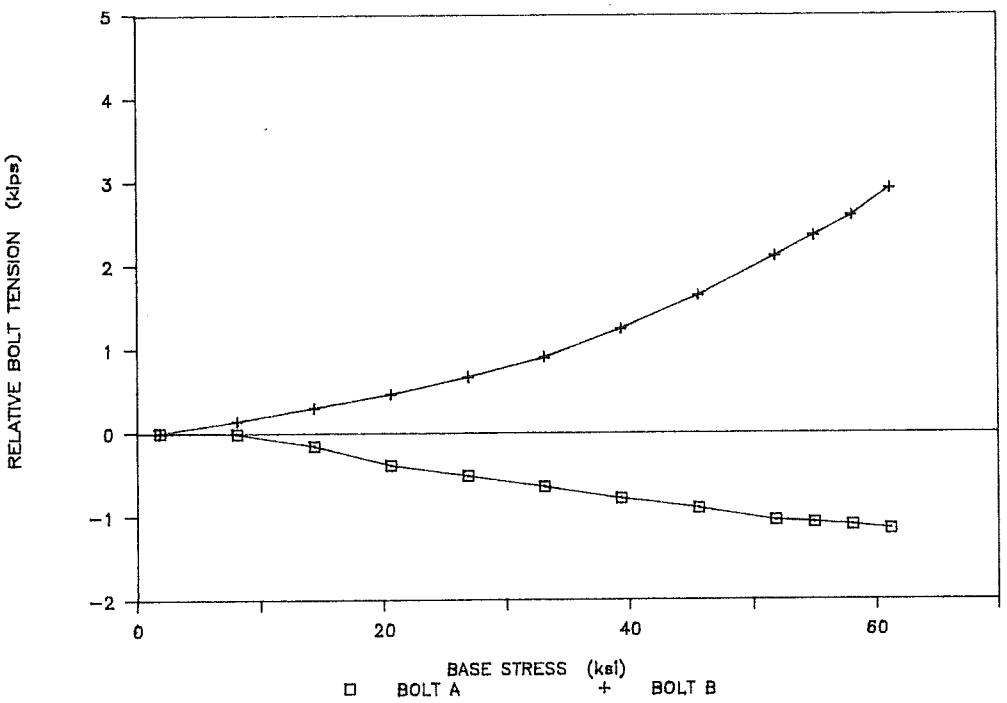


**Figure P.7.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

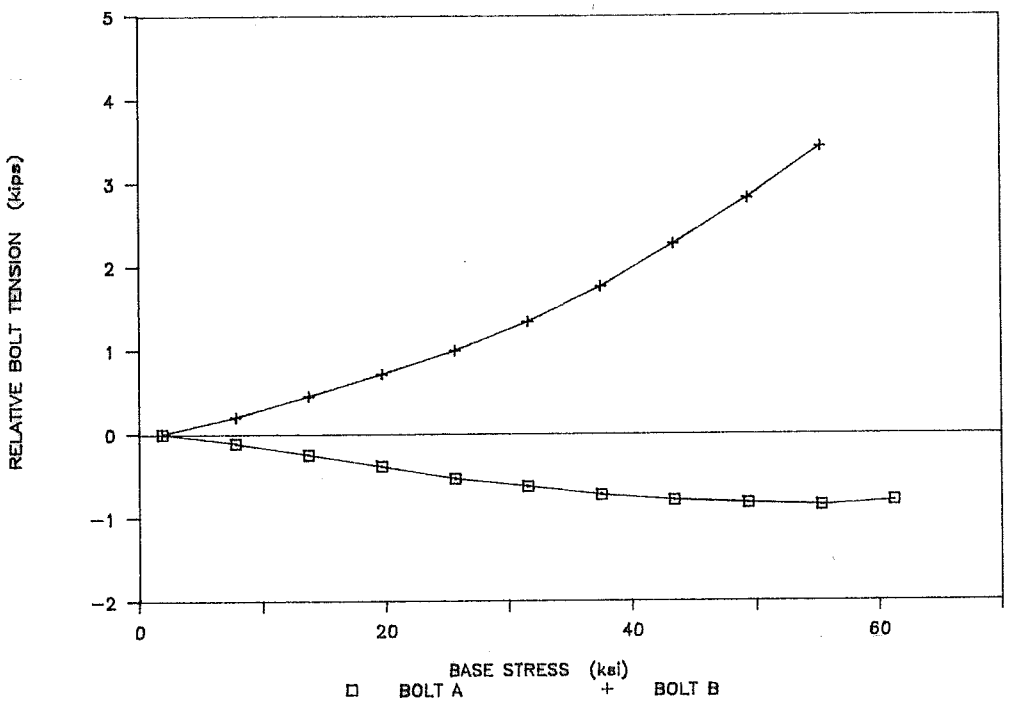


**Figure P.8.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

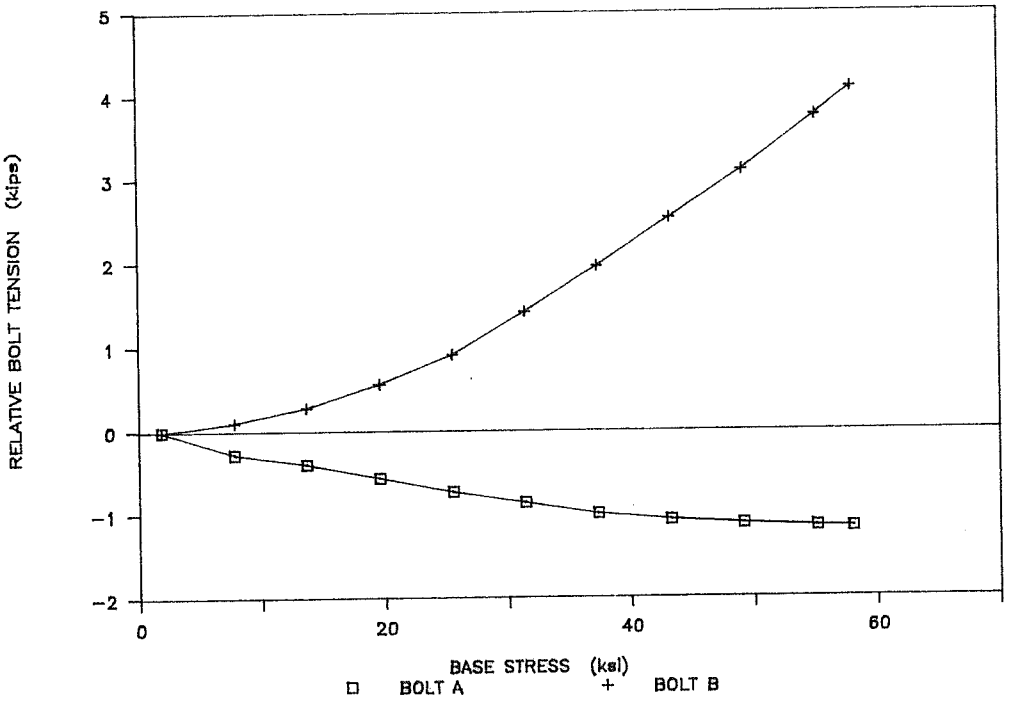


**Figure P.9.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration; Assembled Backwards (Calibrated Bolts).*

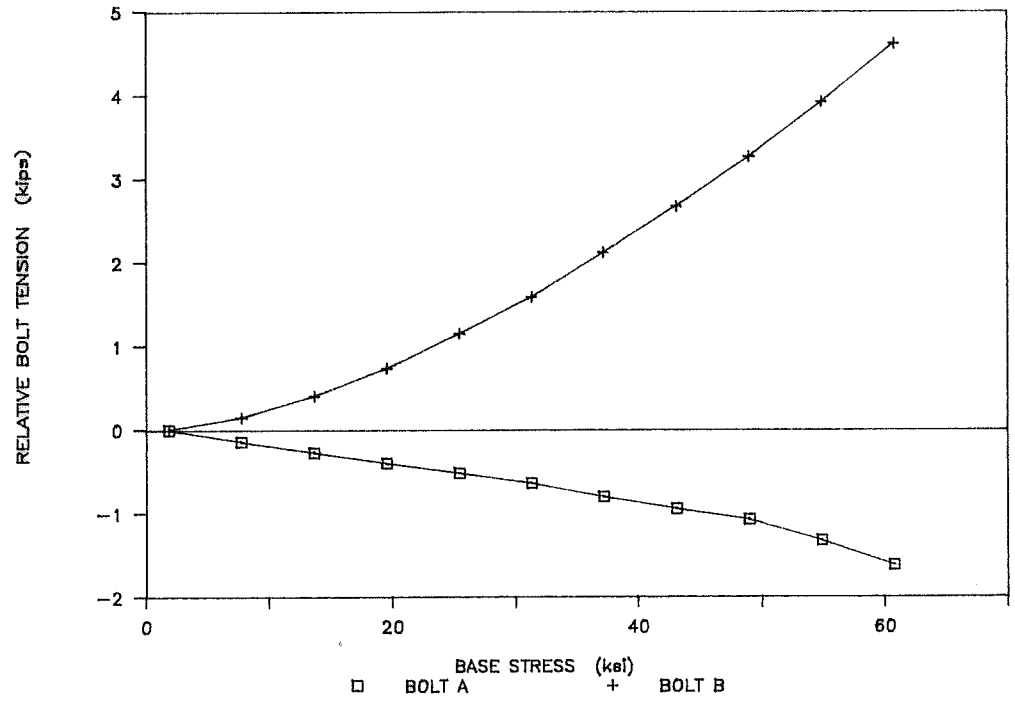


**Figure P.10.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Calibrated Bolts).*

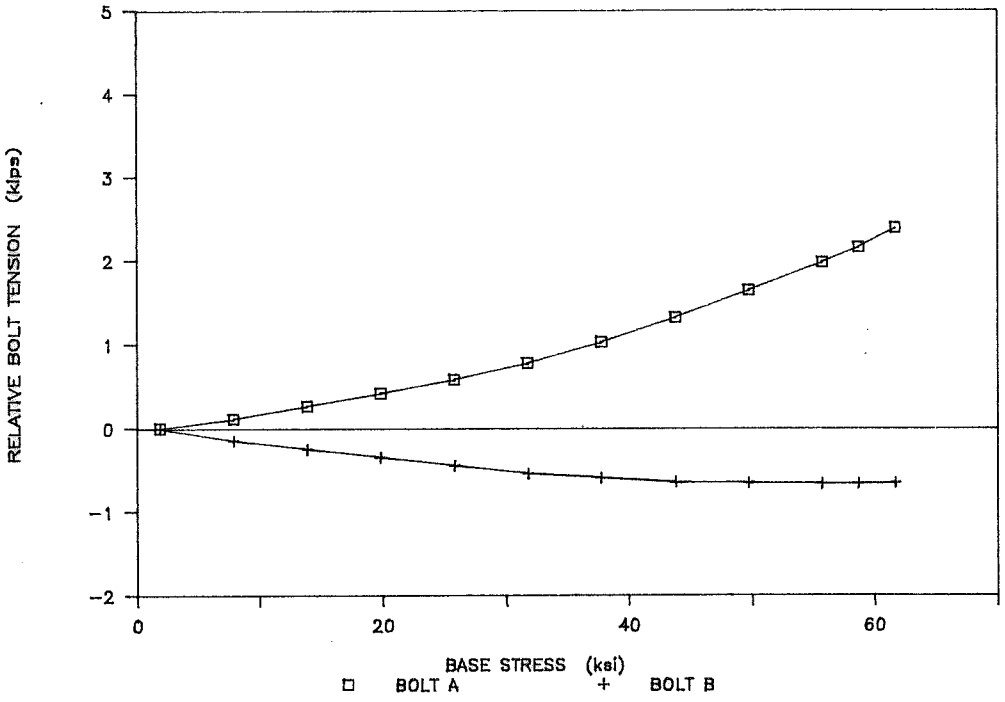


**Figure P.11.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

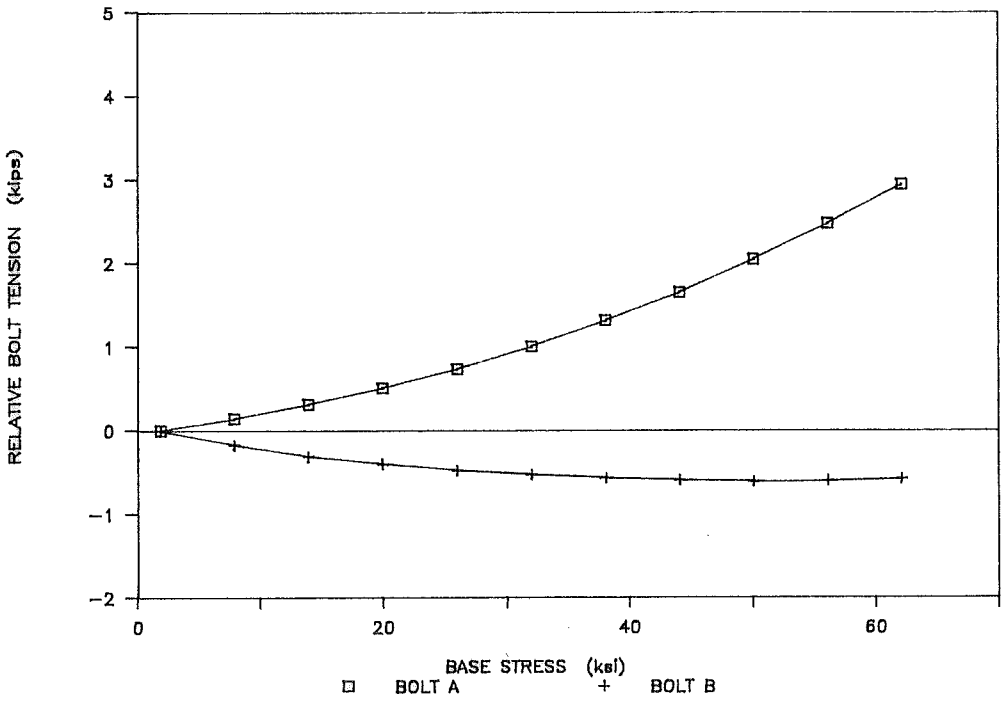


**Figure P.12.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

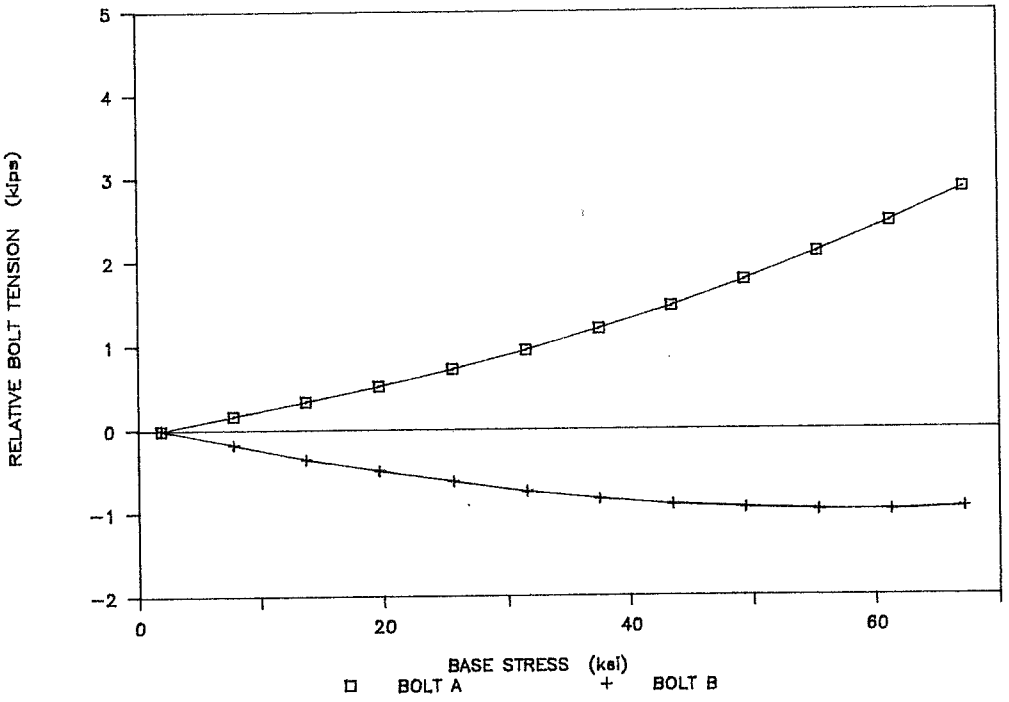


**Figure P.13.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Non-critical Configuration; Assembled Backwards (Calibrated Bolts).*

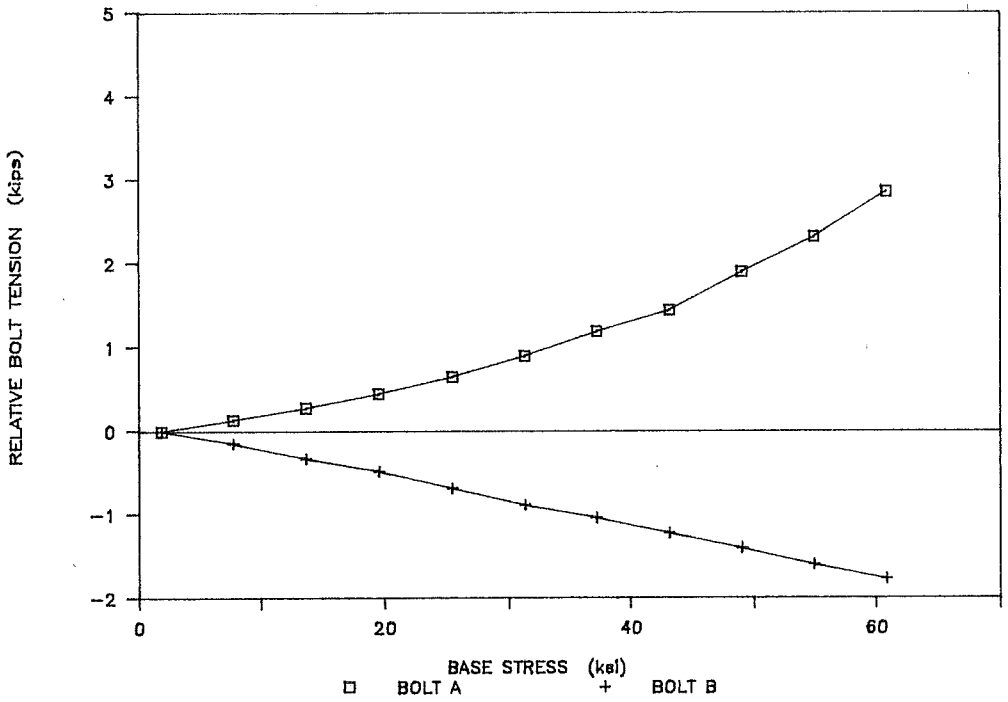


**Figure P.14.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

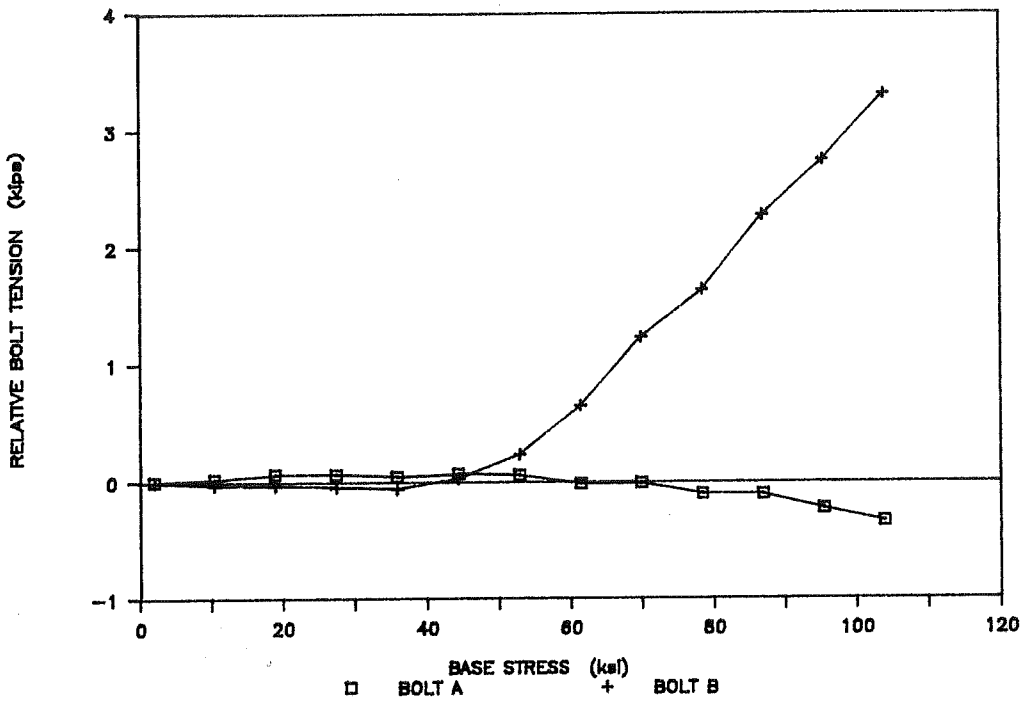


Figure P.15. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

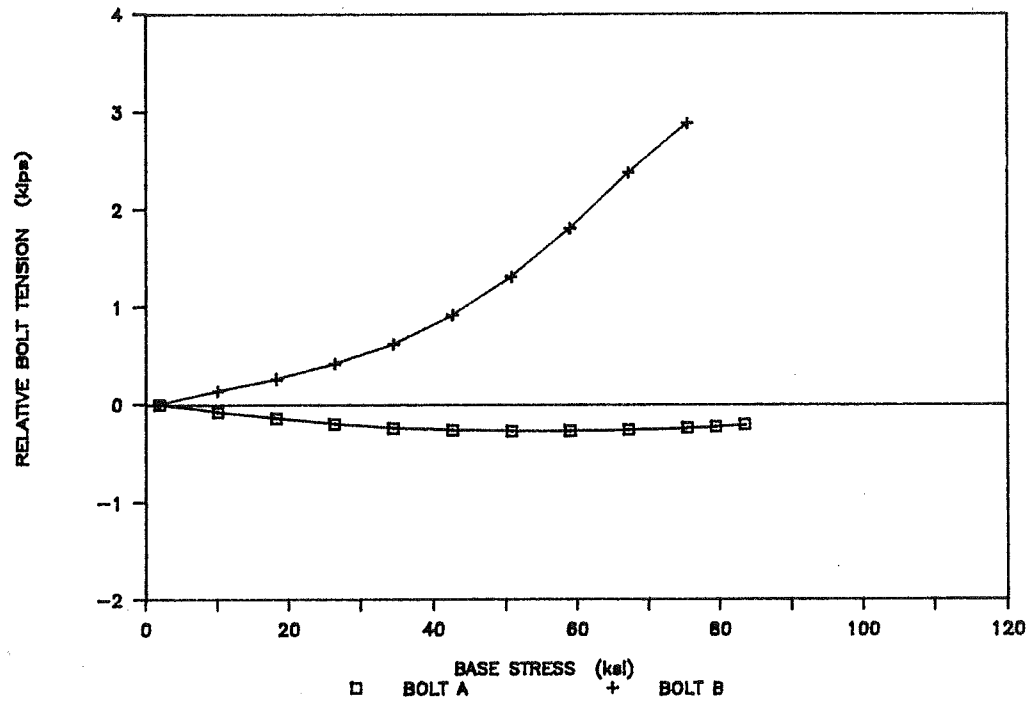


Figure P.16. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

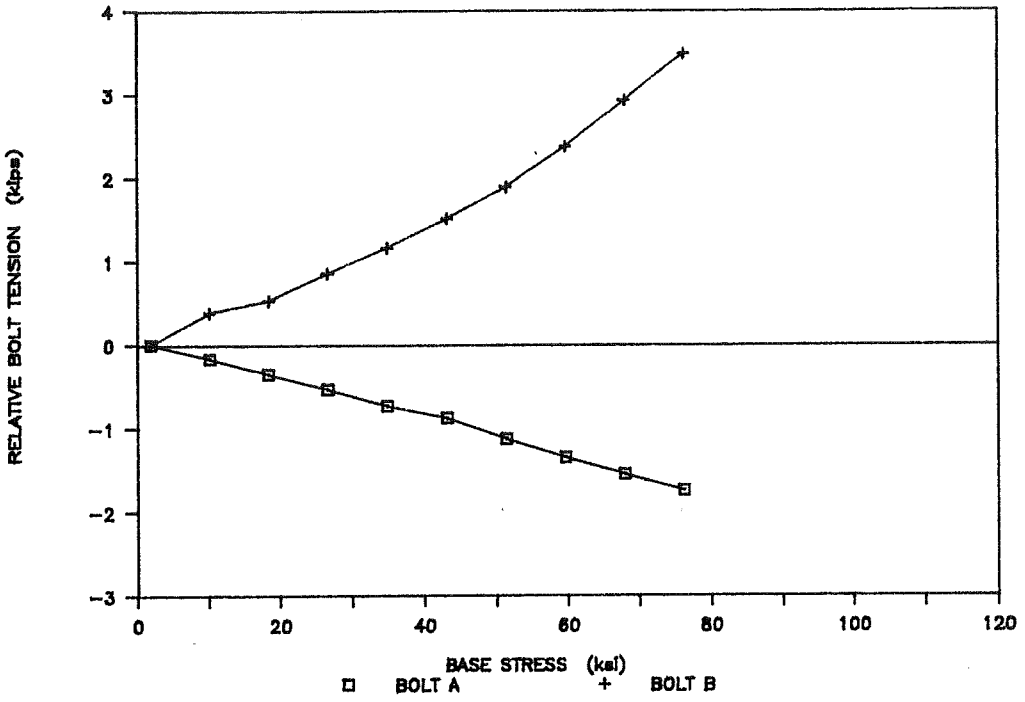


Figure P.17. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Calibrated Bolts).*

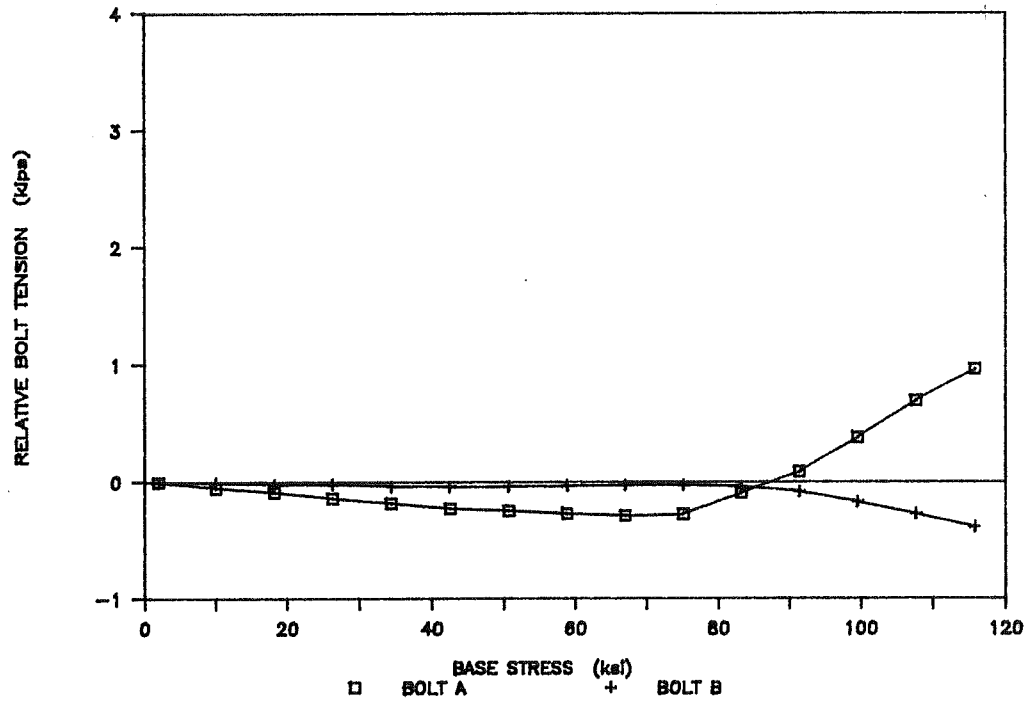


Figure P.18. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

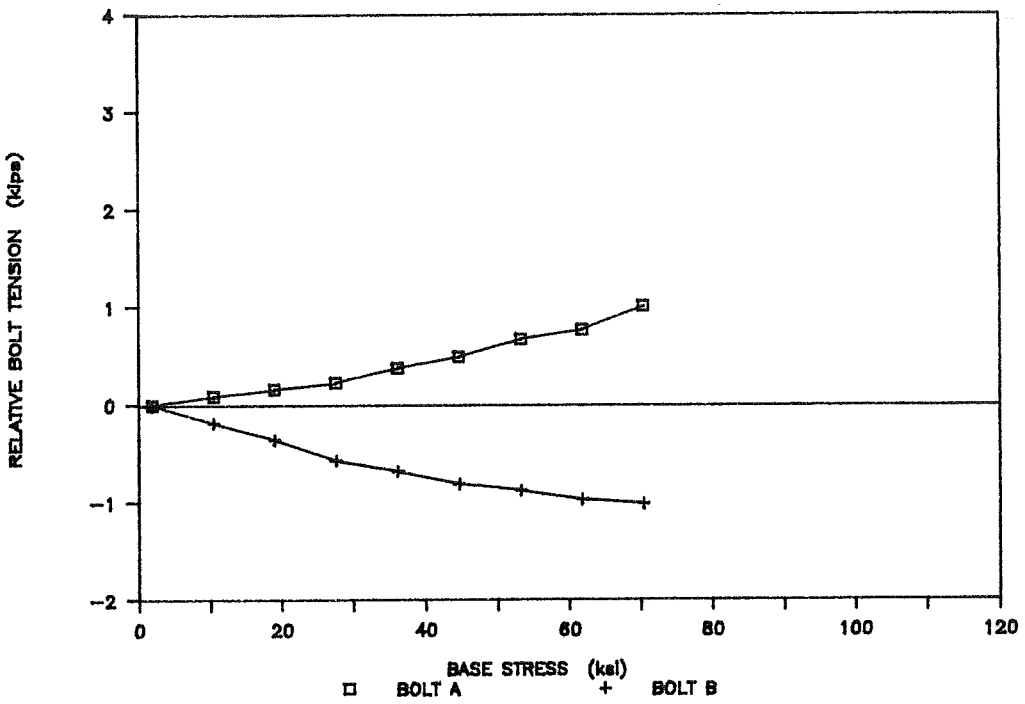


Figure P.19. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

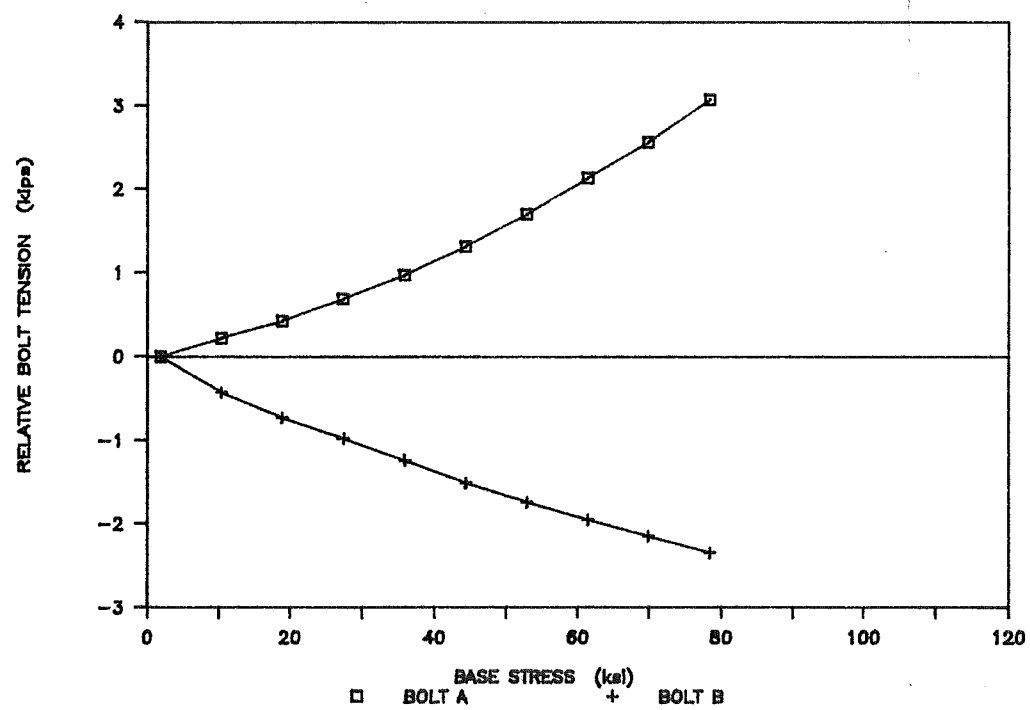


Figure P.20. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

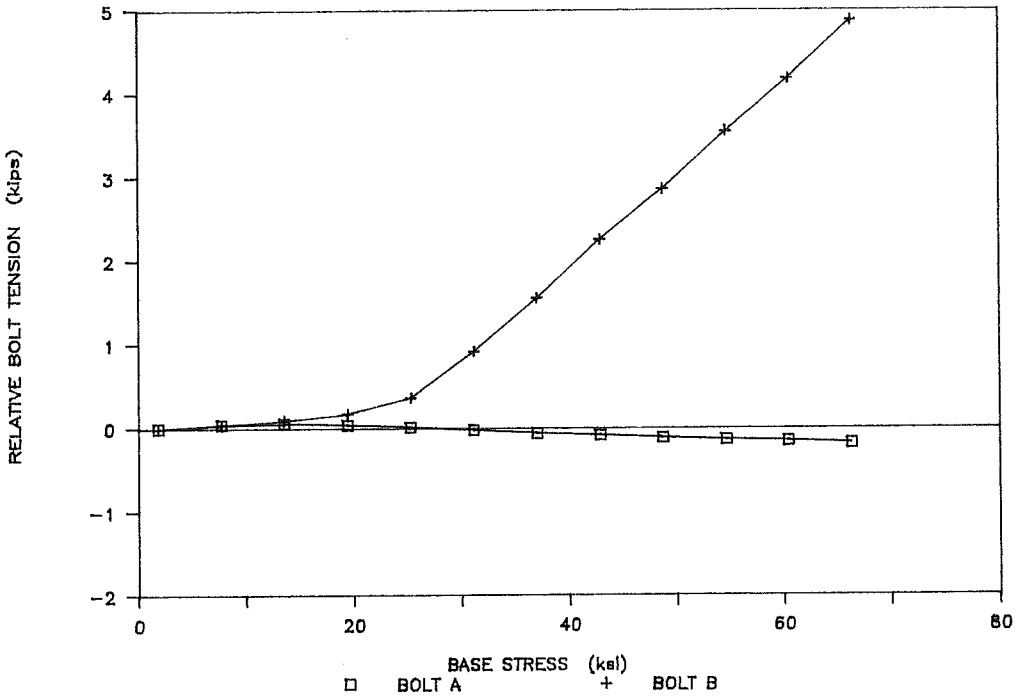


**Figure P.21.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

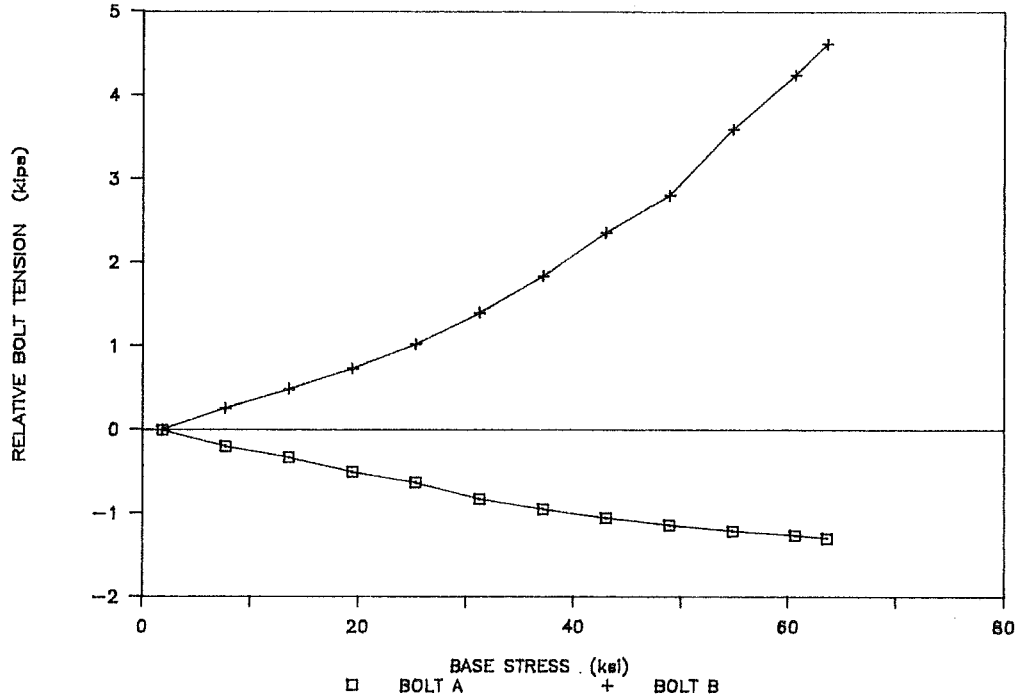


**Figure P.22.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

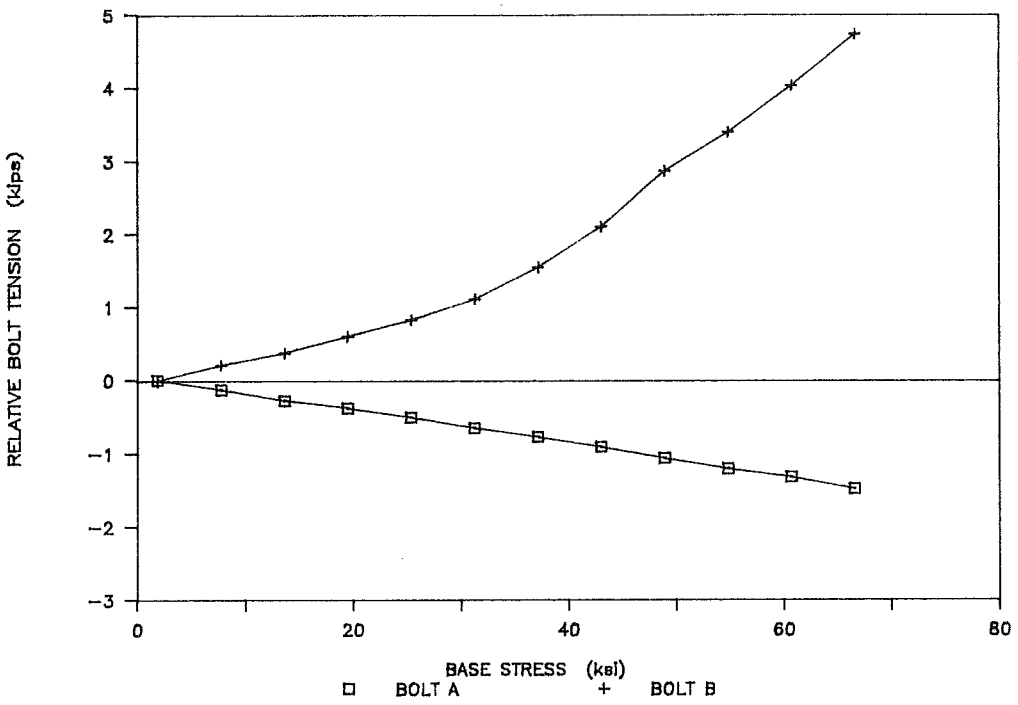


**Figure P.23.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Critical Configuration (Grade 8 Field Bolts).*

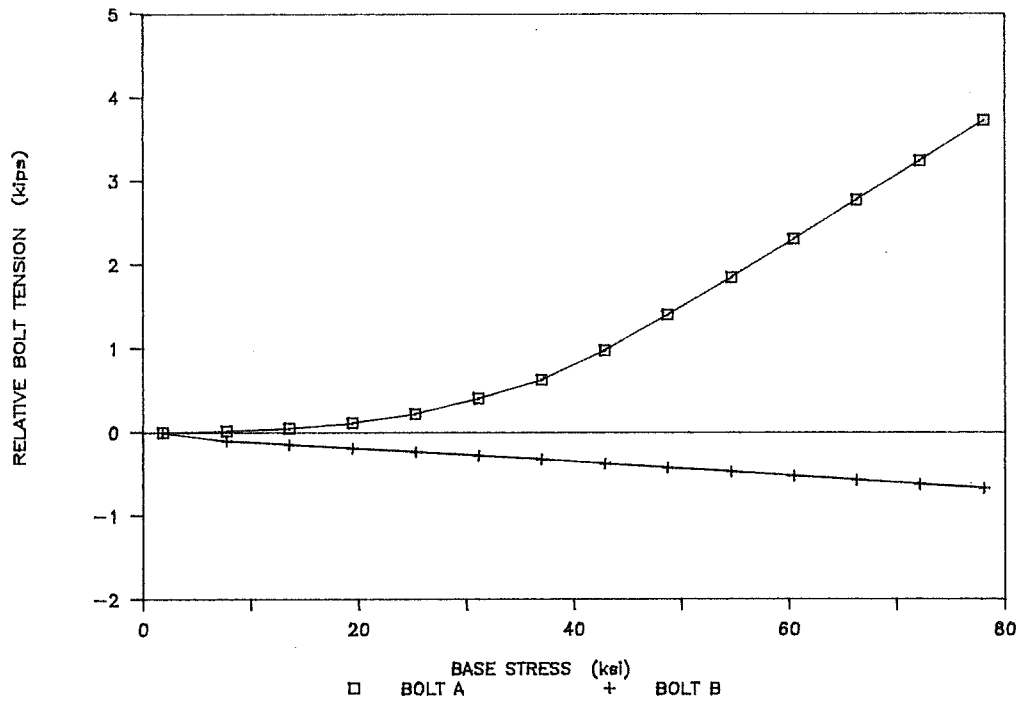


**Figure P.24.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Non-critical Configuration (Calibrated Bolts).*

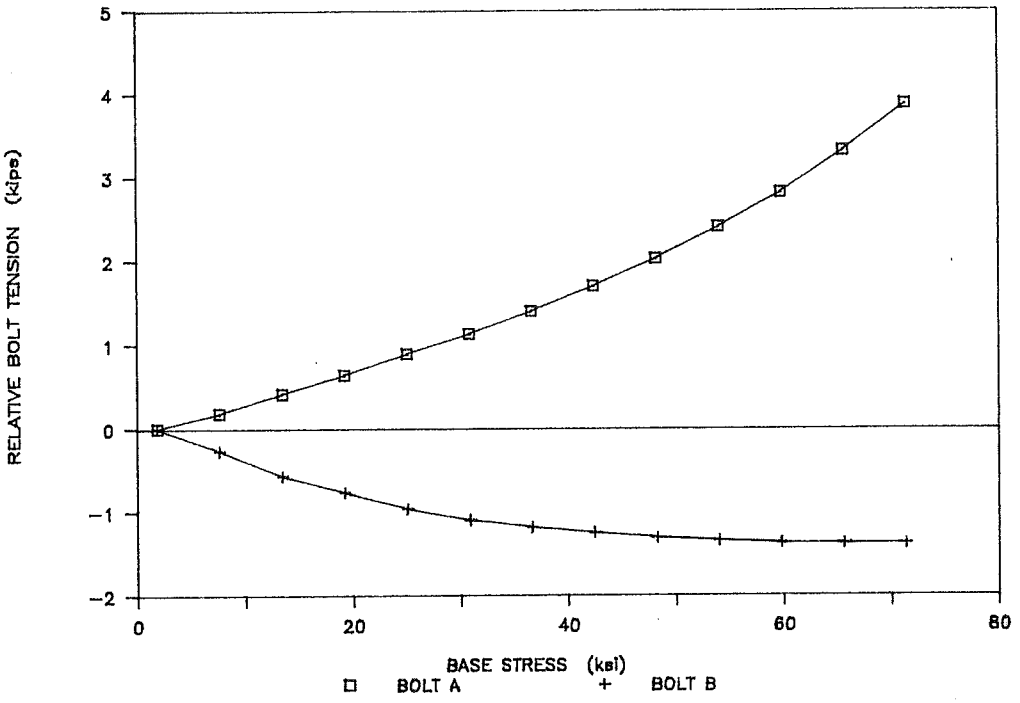


**Figure P.25.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Non-critical Configuration (Calibrated Bolts).*

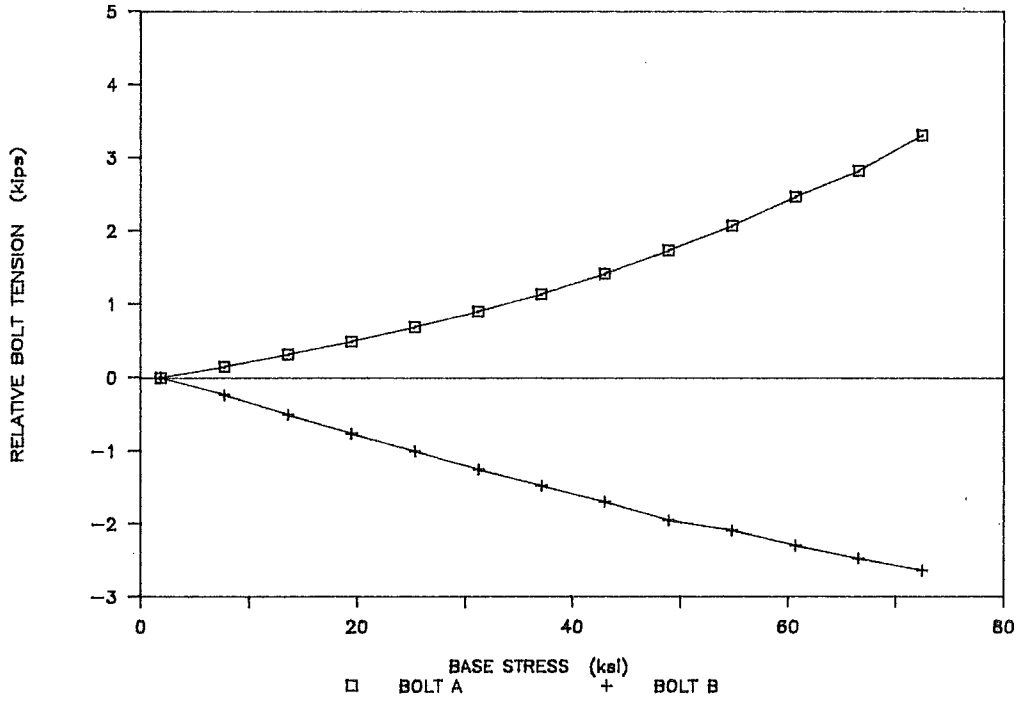


**Figure P.26.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Face to Face Splice in Non-critical Configuration (Calibrated Bolts).*

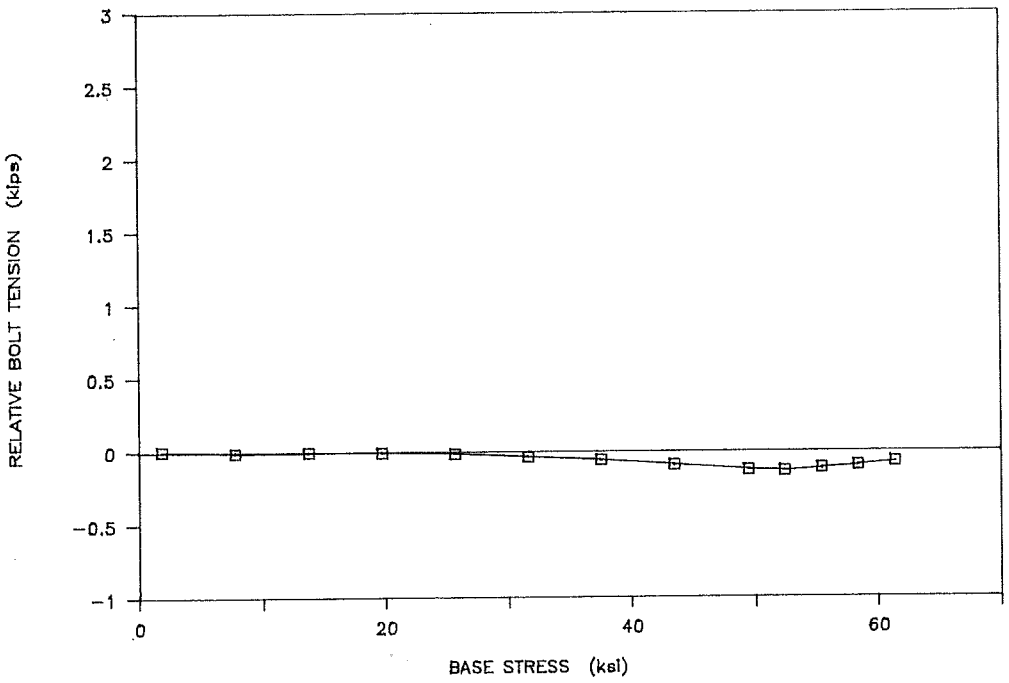


**Figure P.27.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Box Splice in Critical Configuration (Calibrated Bolts).*

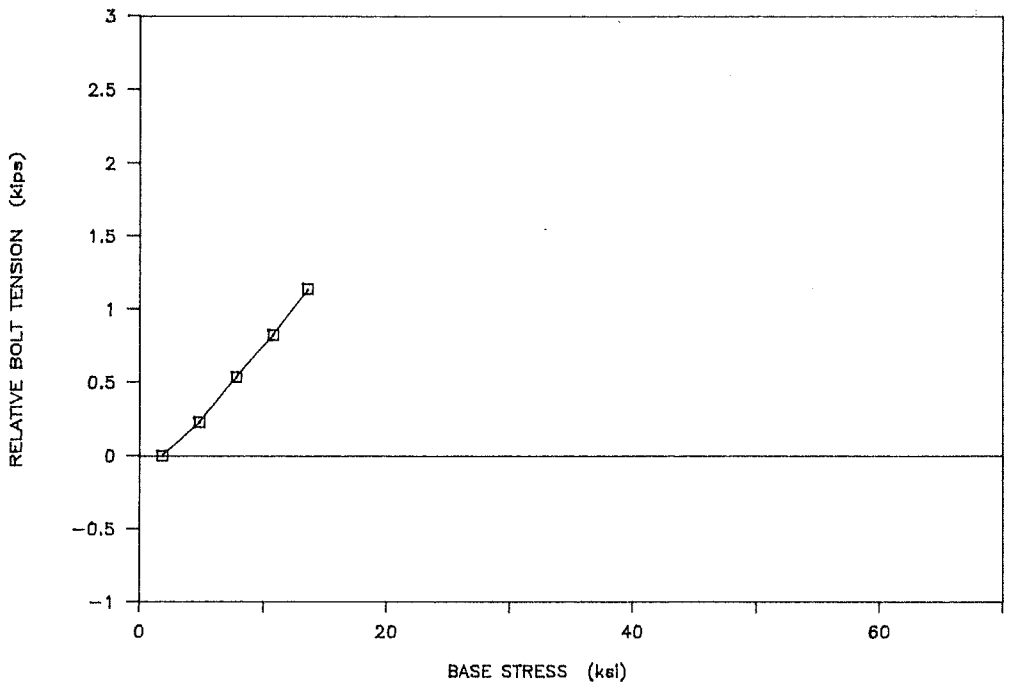


**Figure P.28.** *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Box Splice in Critical Configuration (Calibrated Bolts).*

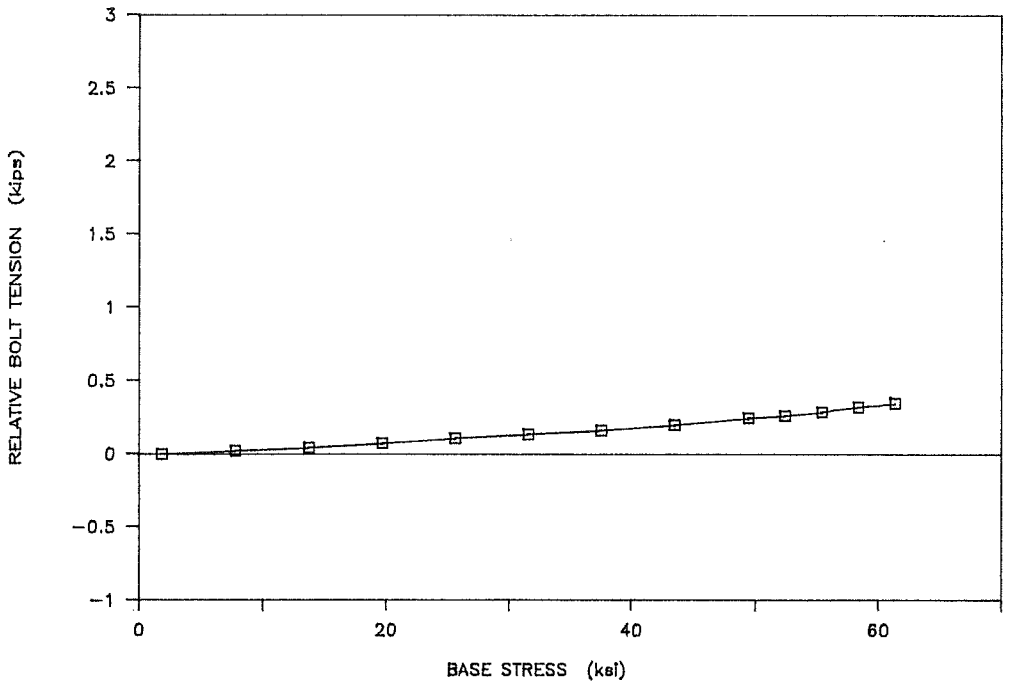


Figure P.29. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Box Splice in Non-critical Configuration (Calibrated Bolts).*

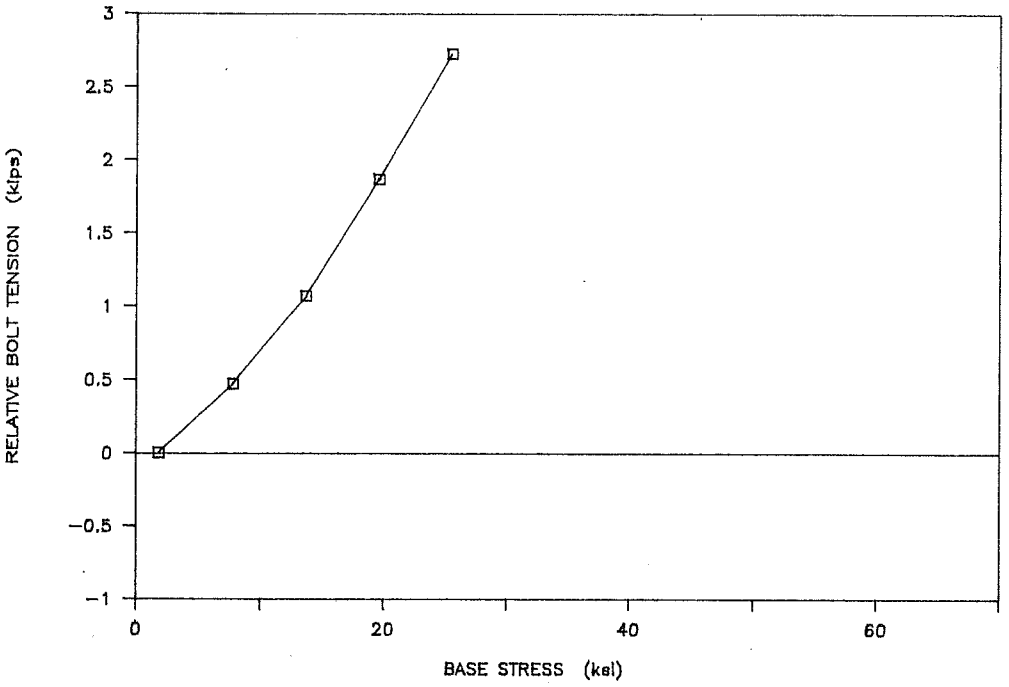


Figure P.30. *Base Stress vs Relative Bolt Tension (17 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Face to Face Box Splice in Non-critical Configuration (Calibrated Bolts).*

# APPENDIX Q

## FINAL 71" BENDING TESTS

BASE STRESS VS RELATIVE BOLT TENSION

(CALIBRATED BOLTS)

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back and Nested Splices

Critical Configuration

# APPENDIX Q

## LIST OF FIGURES

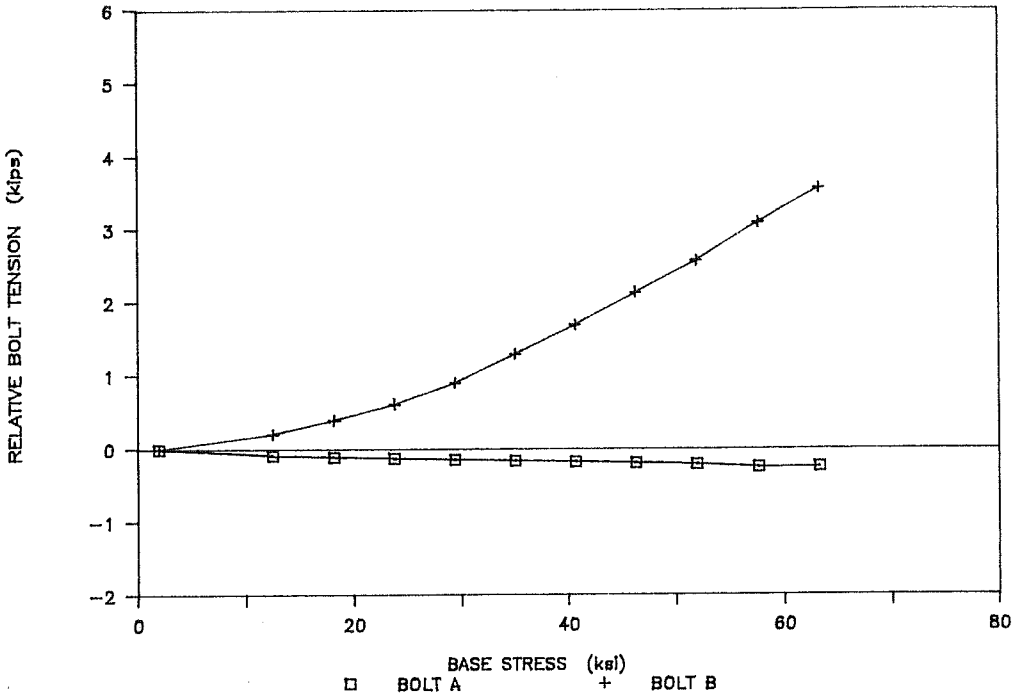


**Figure Q.1.** *Base Stress vs Relative Bolt Tension (71 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

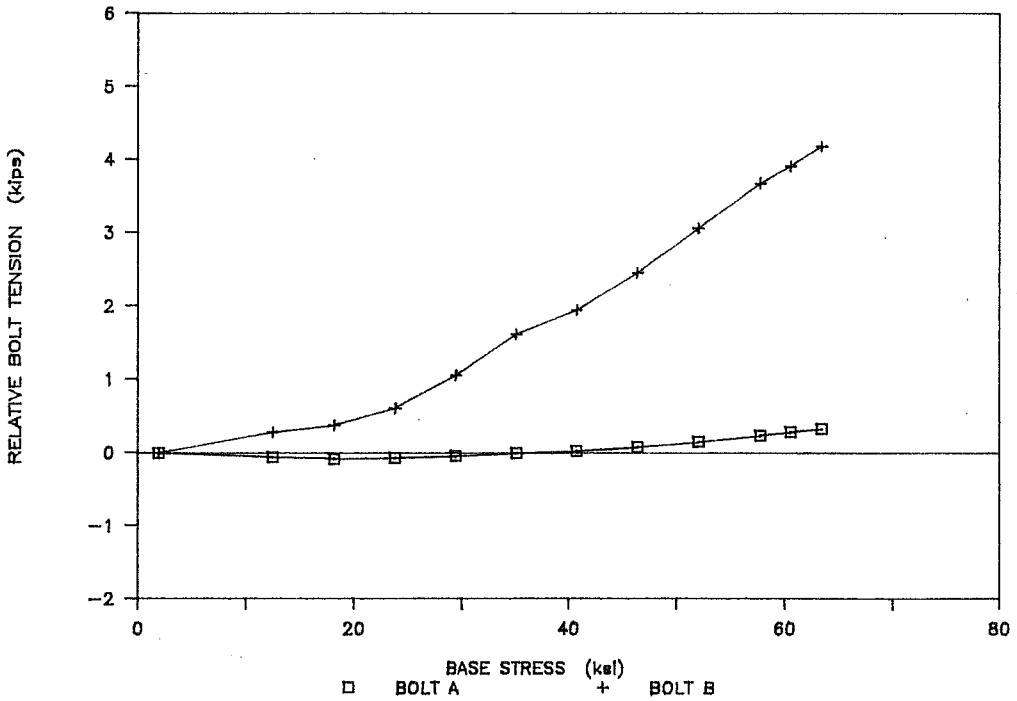


**Figure Q.2.** *Base Stress vs Relative Bolt Tension (71 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

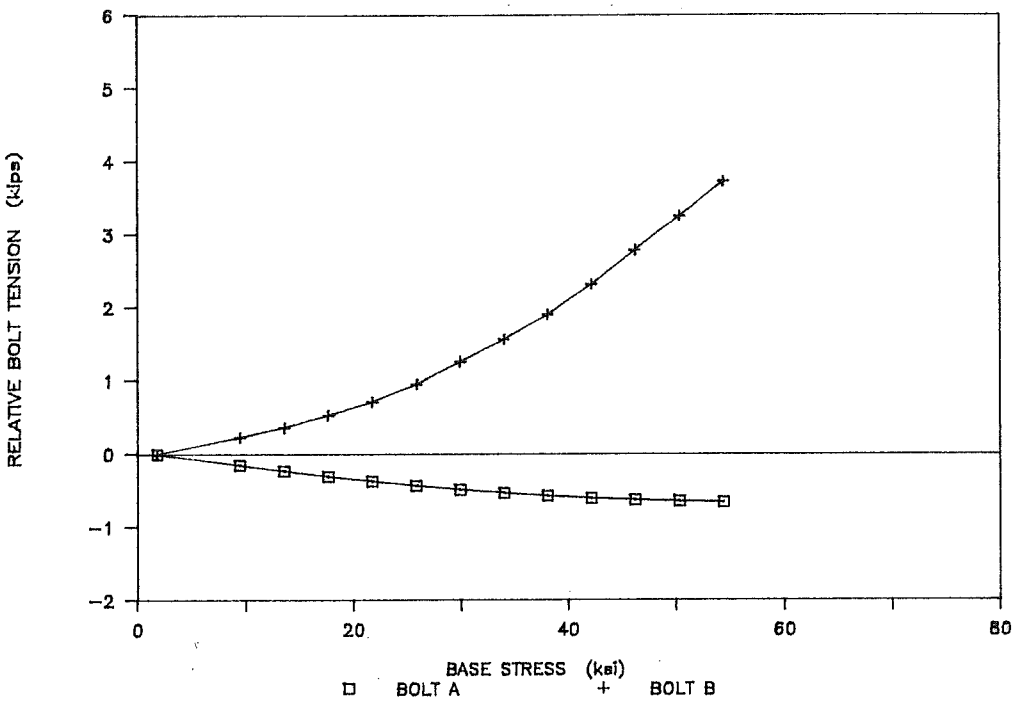


Figure Q.3. *Base Stress vs Relative Bolt Tension (71 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

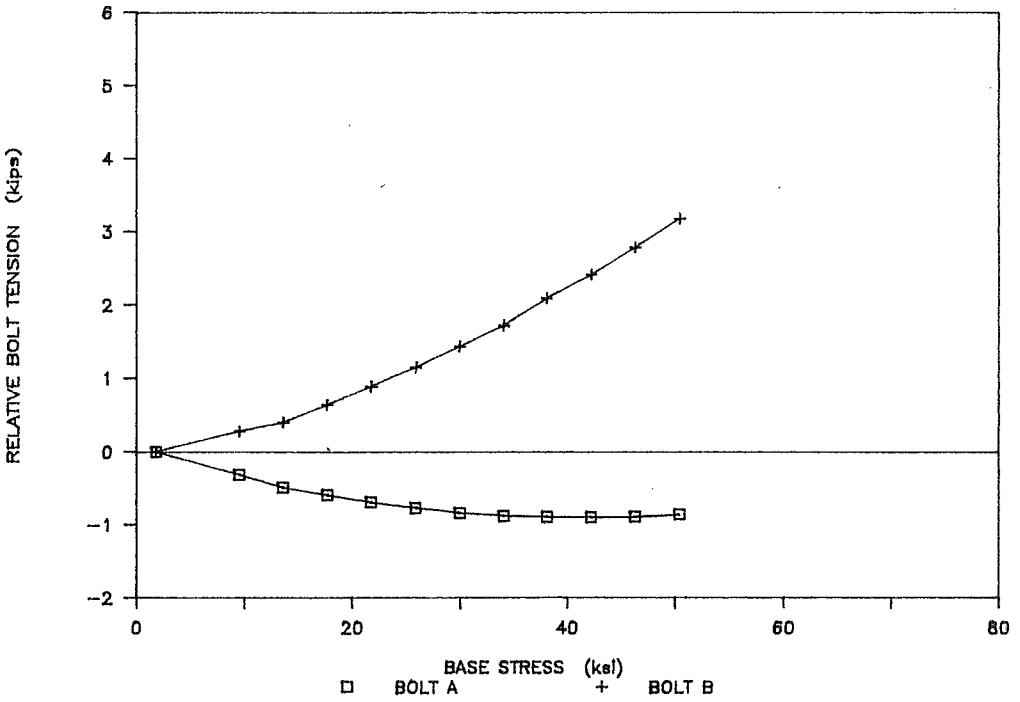


Figure Q.4. *Base Stress vs Relative Bolt Tension (71 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

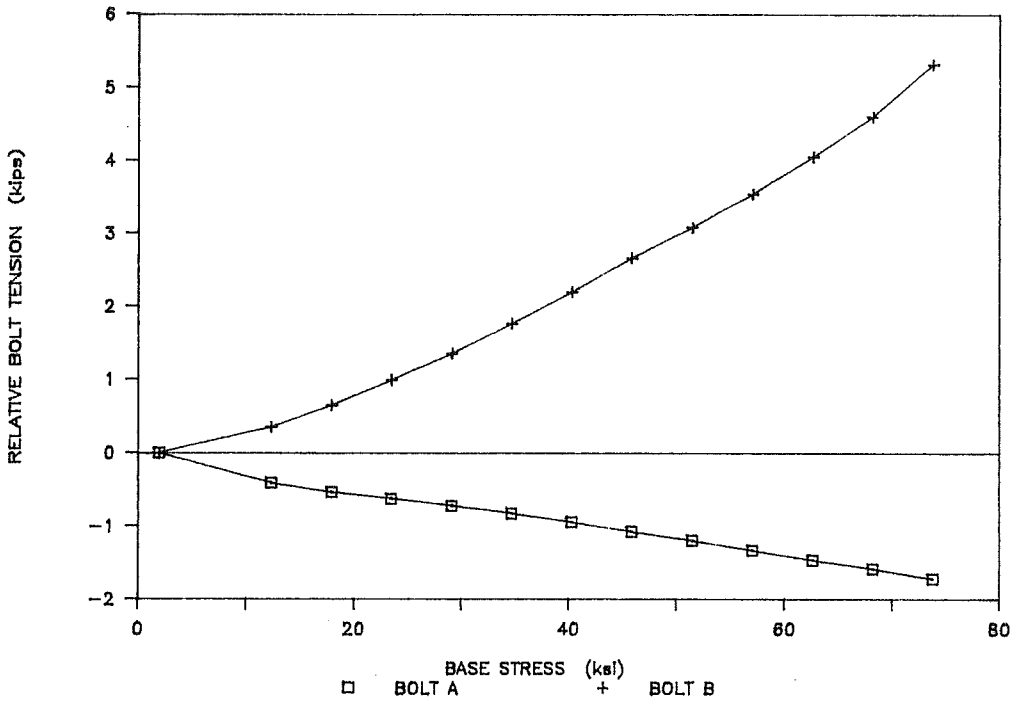


Figure Q.5. *Base Stress vs Relative Bolt Tension (71 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

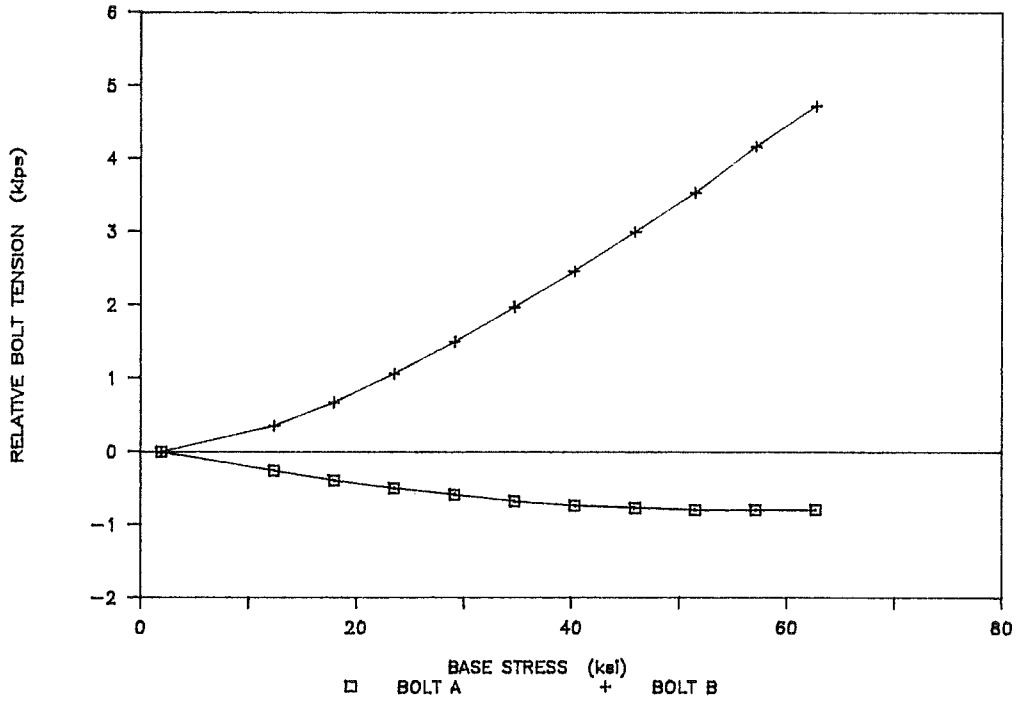


Figure Q.6. *Base Stress vs Relative Bolt Tension (71 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

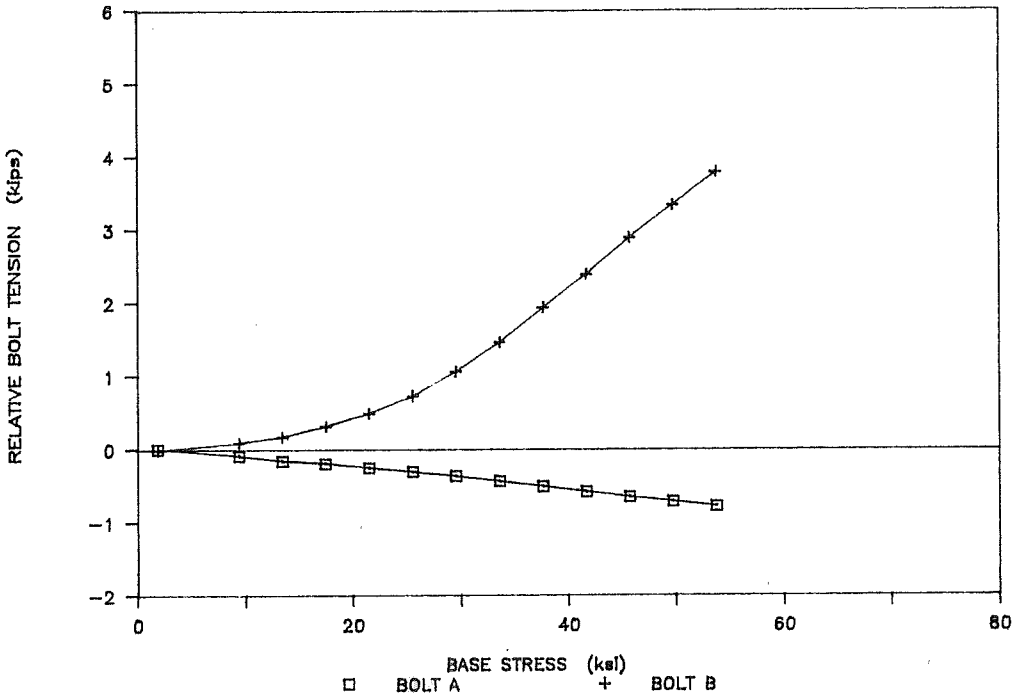


**Figure Q.7.** *Base Stress vs Relative Bolt Tension (71 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

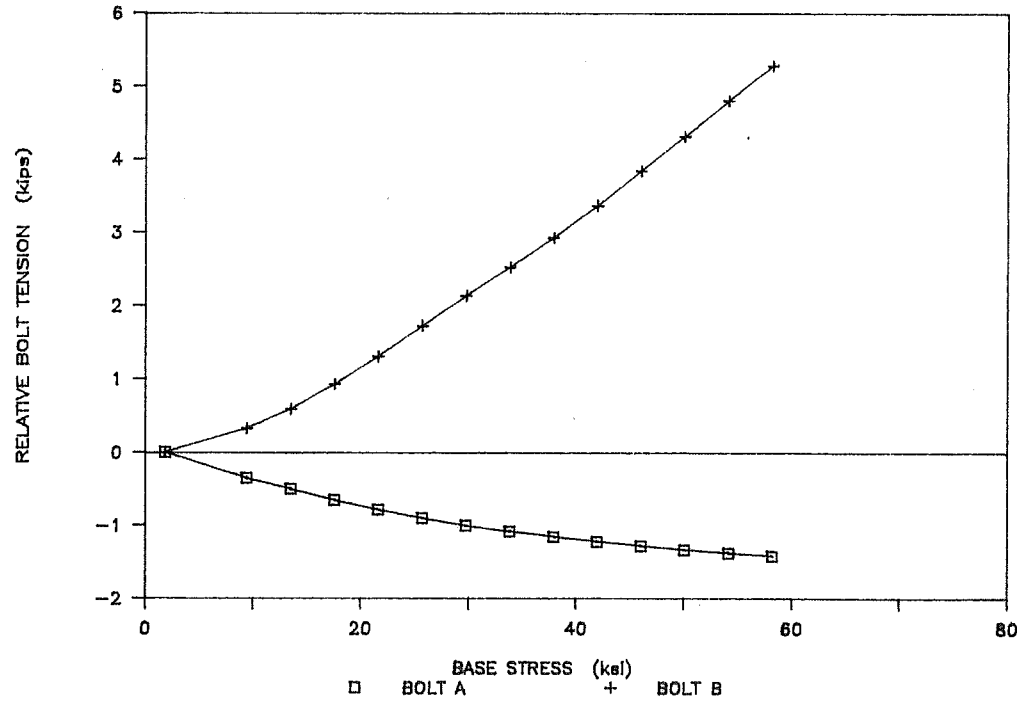


**Figure Q.8.** *Base Stress vs Relative Bolt Tension (71 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

# APPENDIX R

## TORSION TESTS

### APPLIED TORQUE VS RELATIVE BOLT TENSION
### (CALIBRATED BOLTS)

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back and Nested Splices

# APPENDIX R

## LIST OF FIGURES

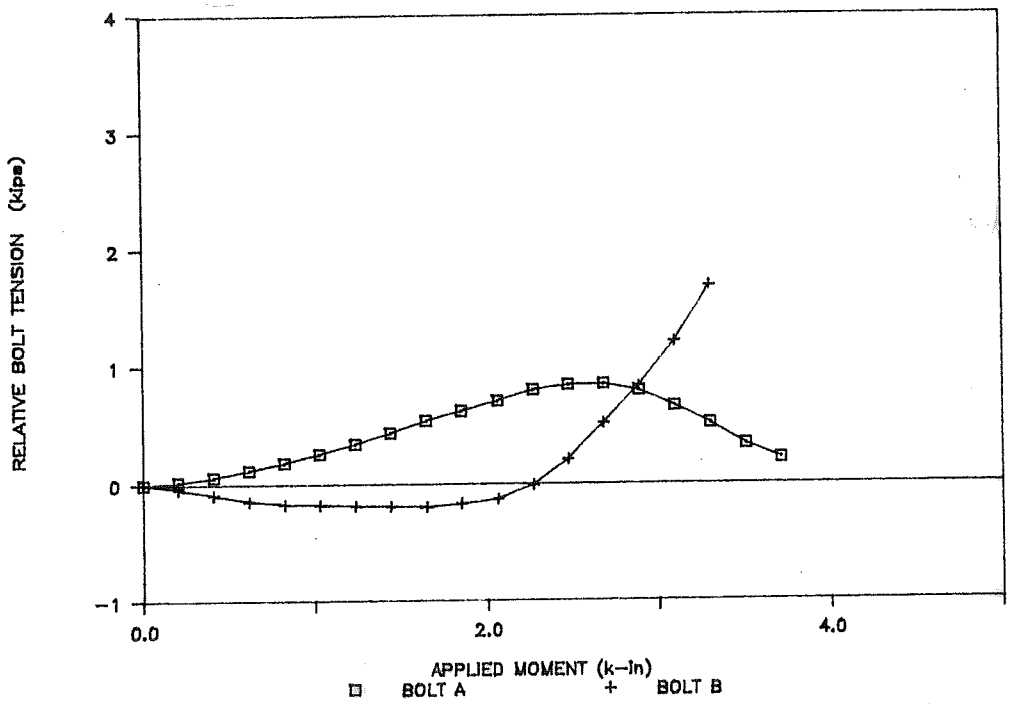


Figure R.1. *Applied Torque vs Relative Bolt Tension: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice (Calibrated and Grade 5 Field Bolts).*

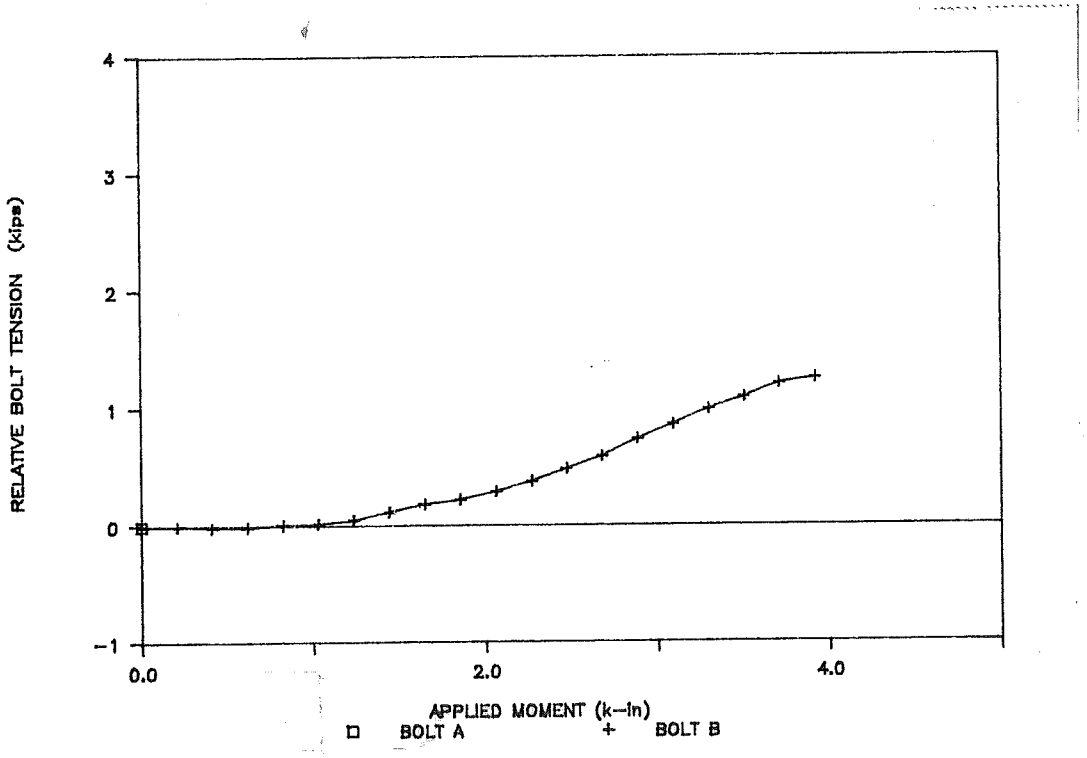


Figure R.2. *Applied Torque vs Relative Bolt Tension: Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice (Calibrated and Grade 5 Field Bolts).*

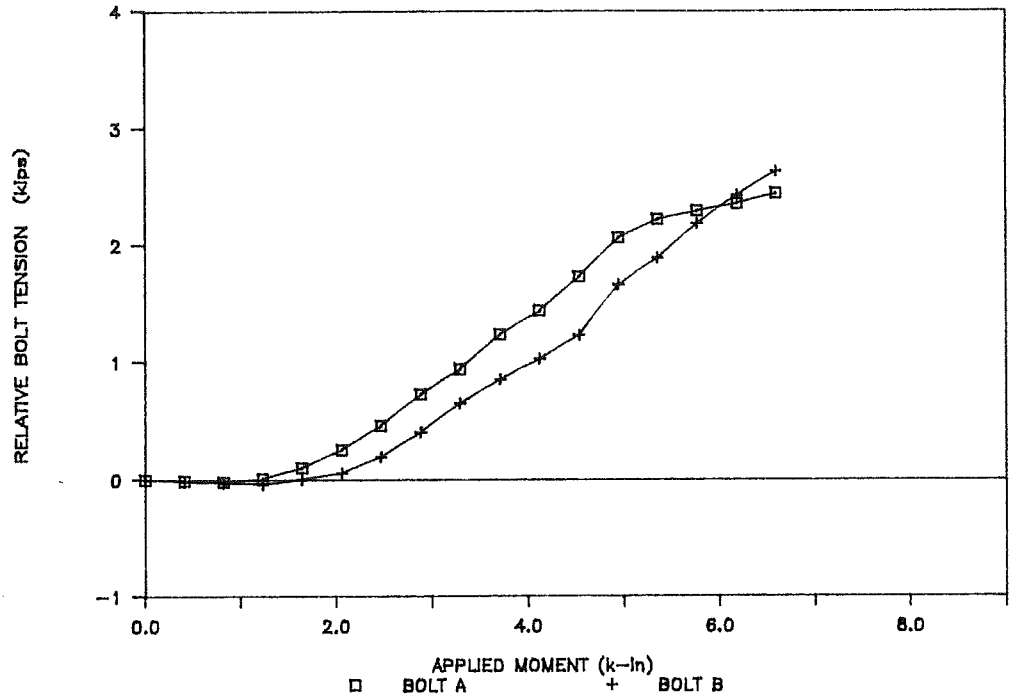


Figure R.3. *Applied Torque vs Relative Bolt Tension: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice (Calibrated and Grade 5 Field Bolts).*

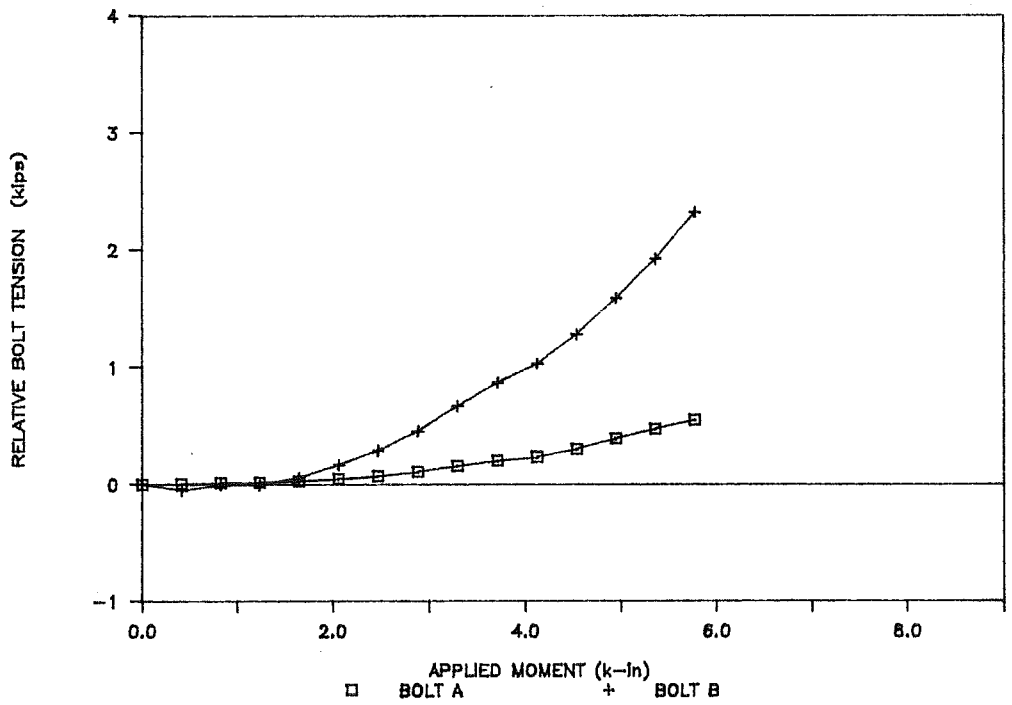


Figure R.4. *Applied Torque vs Relative Bolt Tension: Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice (Calibrated and Grade 5 Field Bolts).*

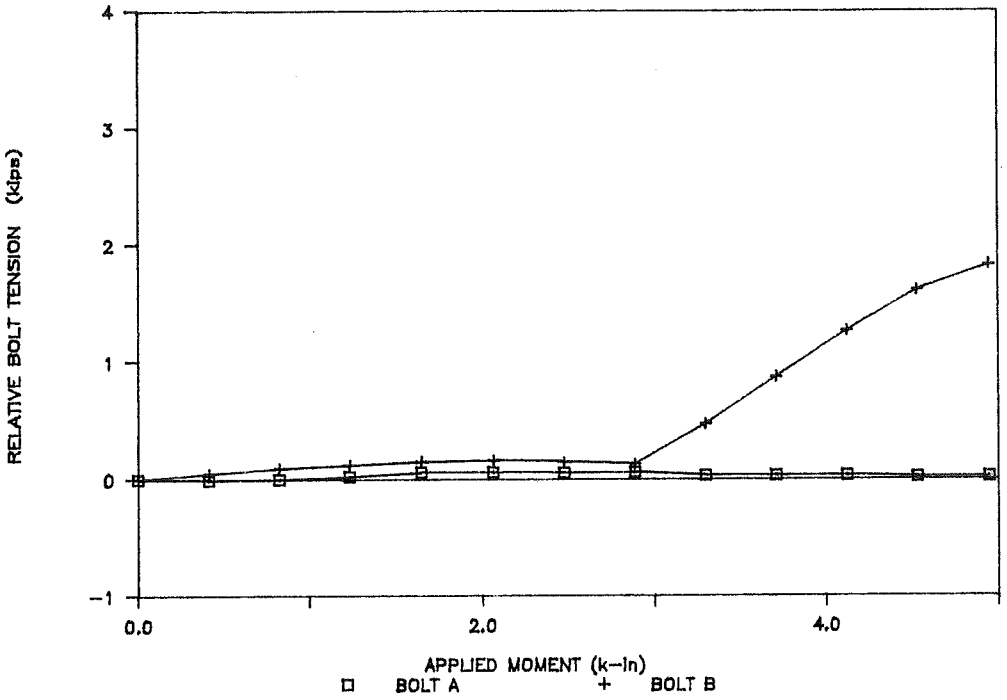


Figure R.5. *Applied Torque vs Relative Bolt Tension: Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice (Calibrated and Grade 5 Field Bolts).*

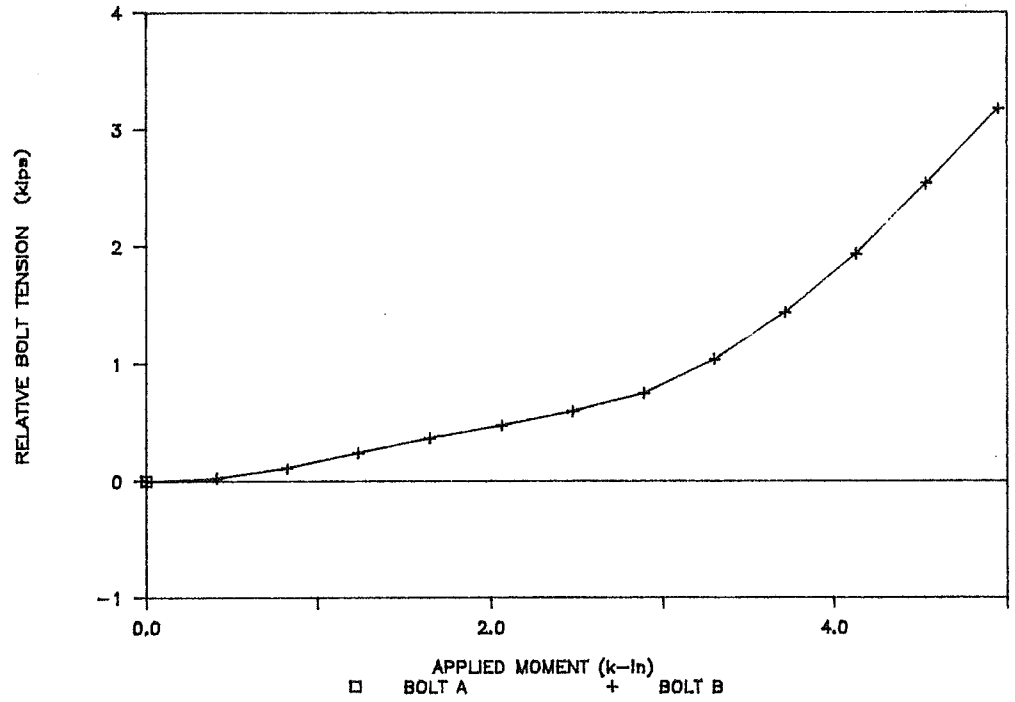


Figure R.6. *Applied Torque vs Relative Bolt Tension: Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice (Calibrated and Grade 5 Field Bolts).*

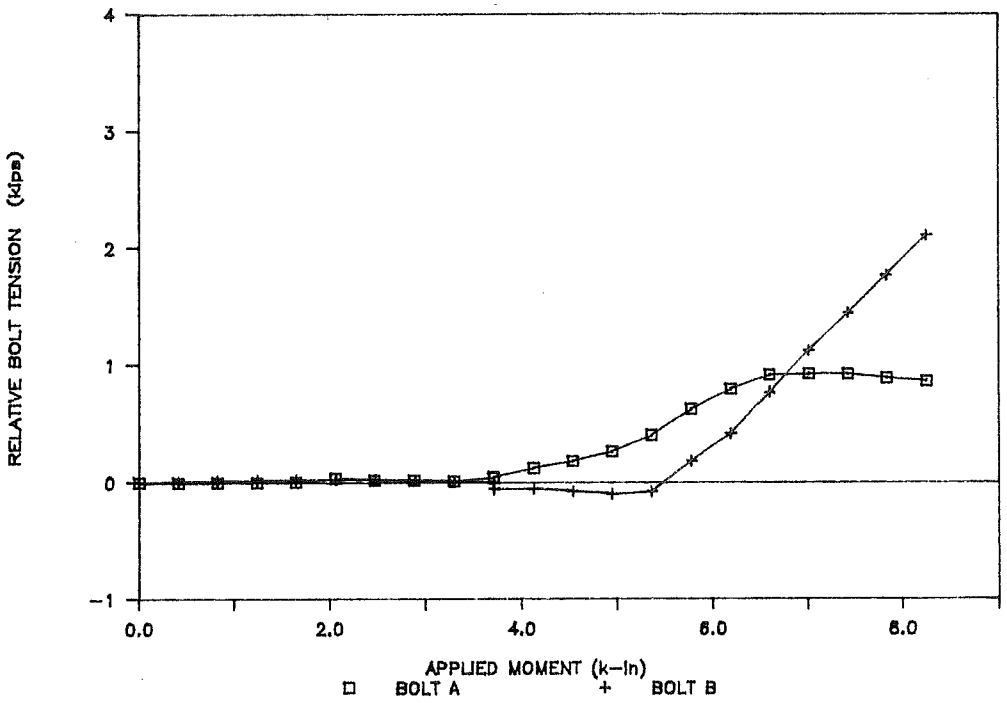


Figure R.7. *Applied Torque vs Relative Bolt Tension: Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice (Calibrated and Grade 5 Field Bolts).*

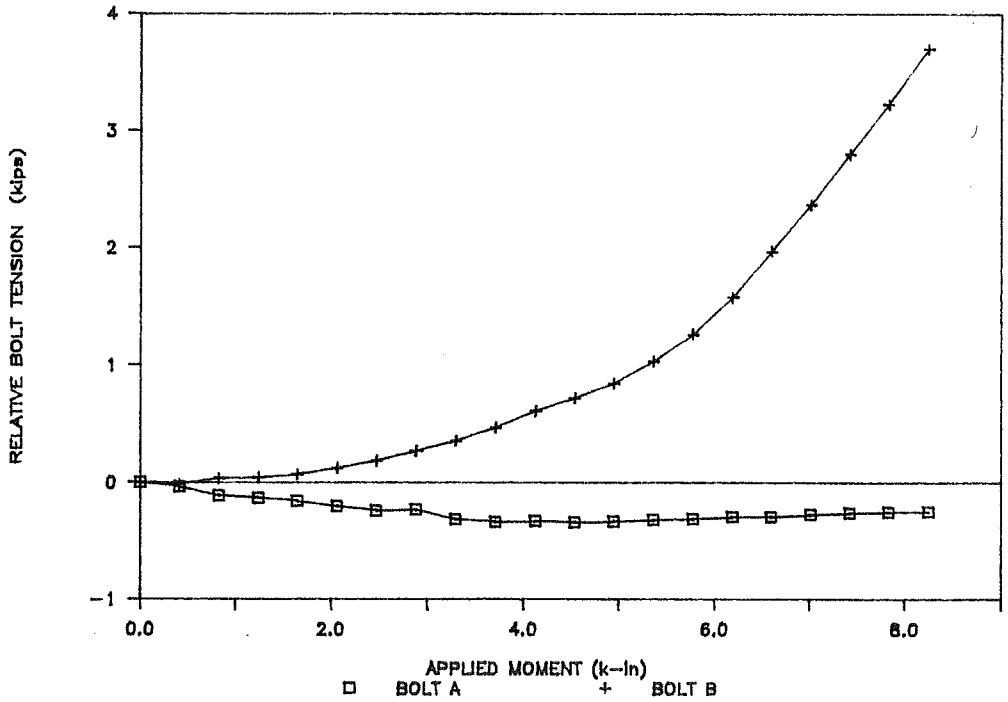


Figure R.8. *Applied Torque vs Relative Bolt Tension: Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice (Calibrated and Grade 5 Field Bolts).*

# APPENDIX S

## 75" COMBINED BENDING AND TORSION TESTS

## BASE STRESS VS RELATIVE BOLT TENSION

## (CALIBRATED BOLTS)

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back and Nested Splices

Critical Configuration

# APPENDIX S

## LIST OF FIGURES

# APPENDIX S

## LIST OF FIGURES (CONT)

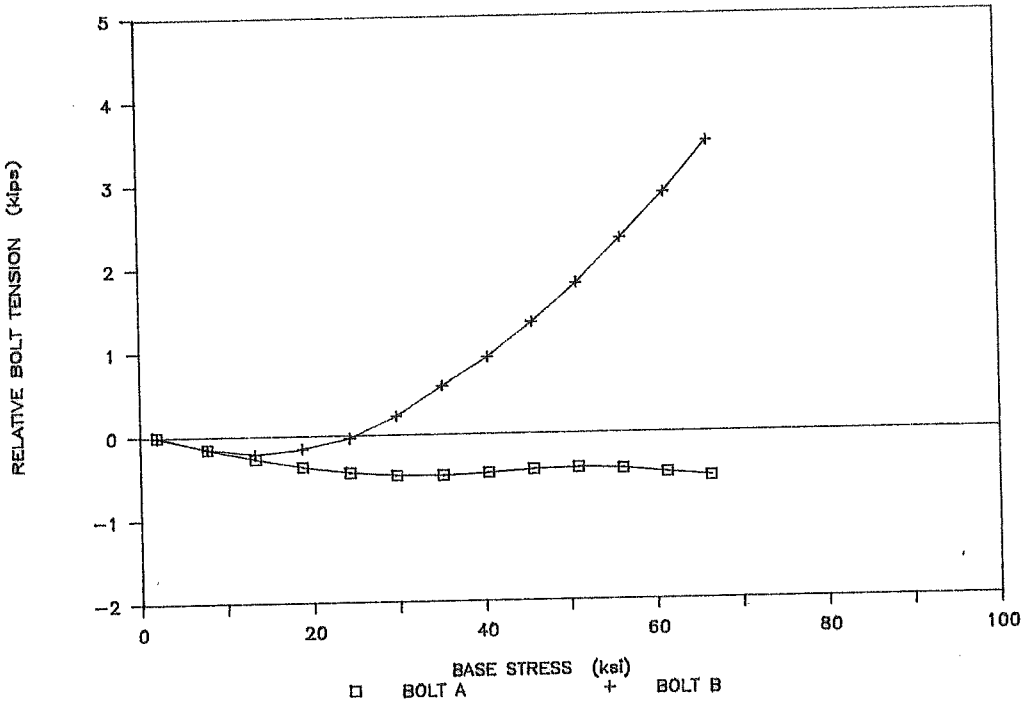


Figure S.1. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

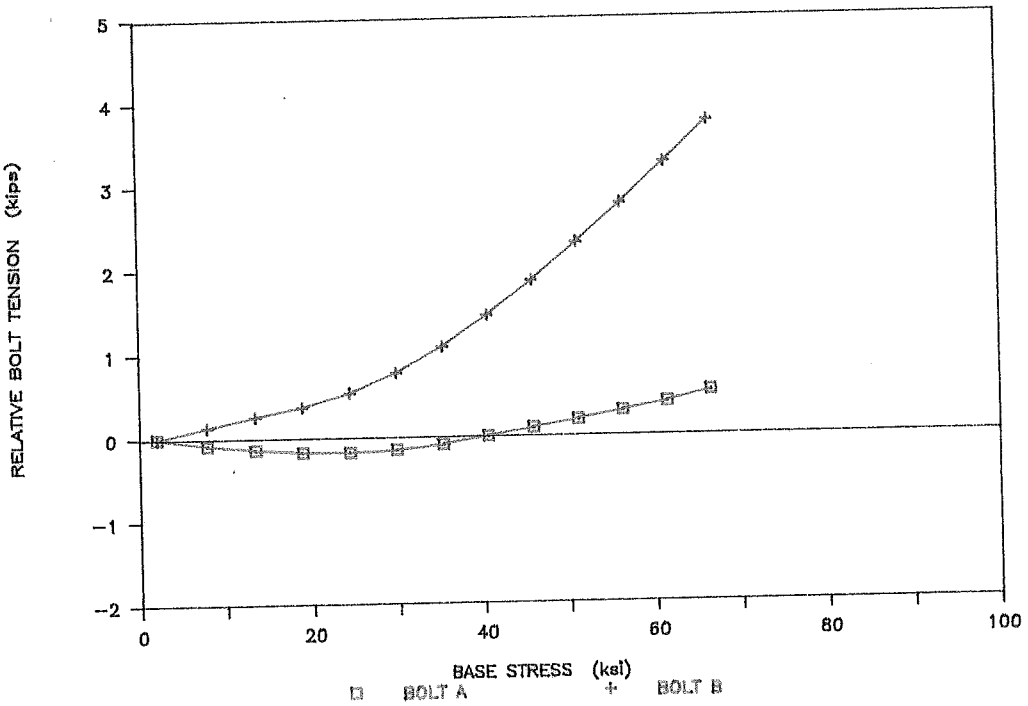


Figure S.2. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

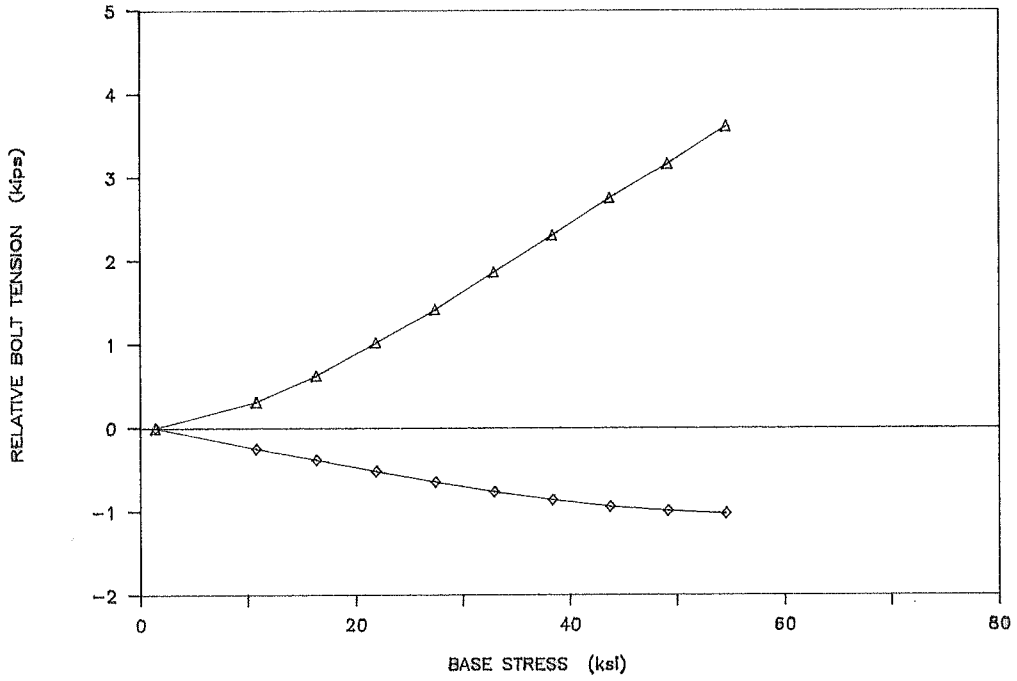


Figure S.3. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

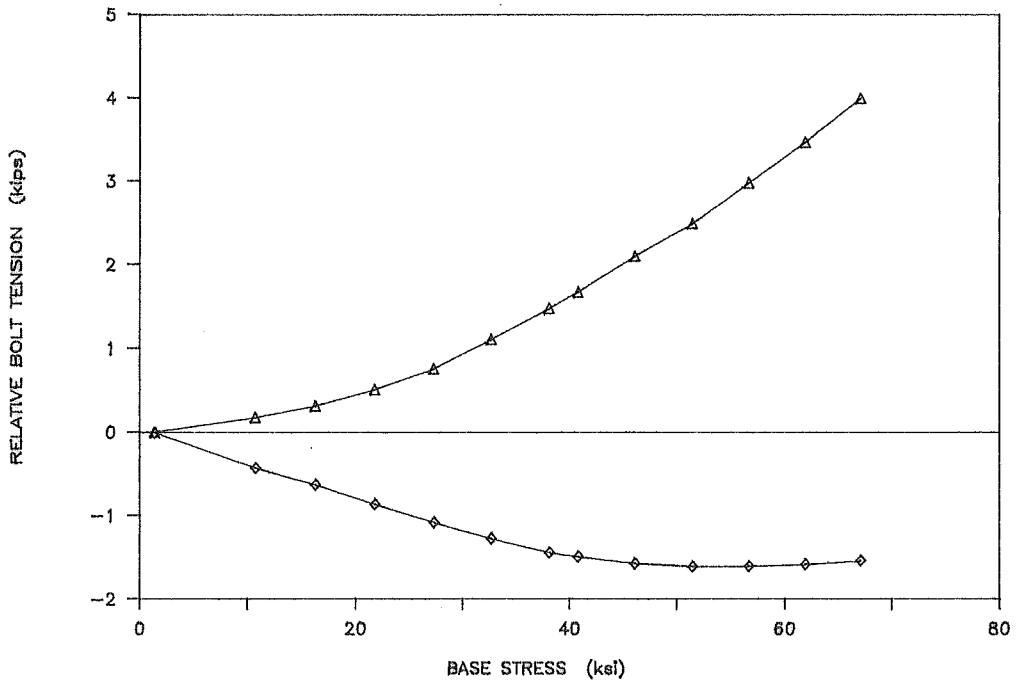


Figure S.4. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

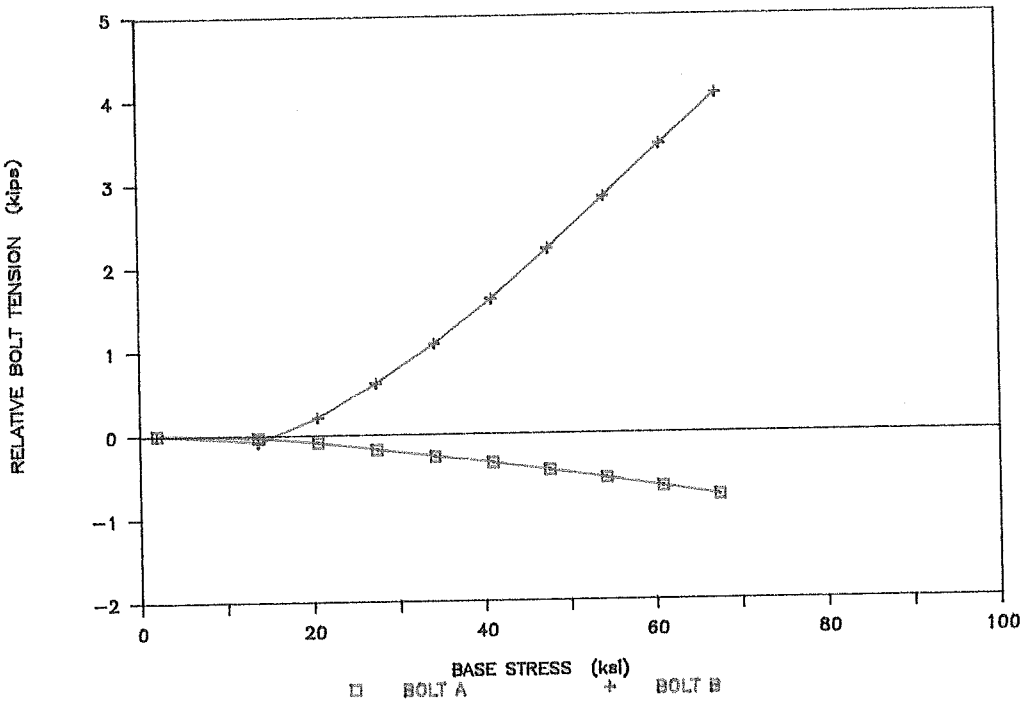


Figure S.5. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

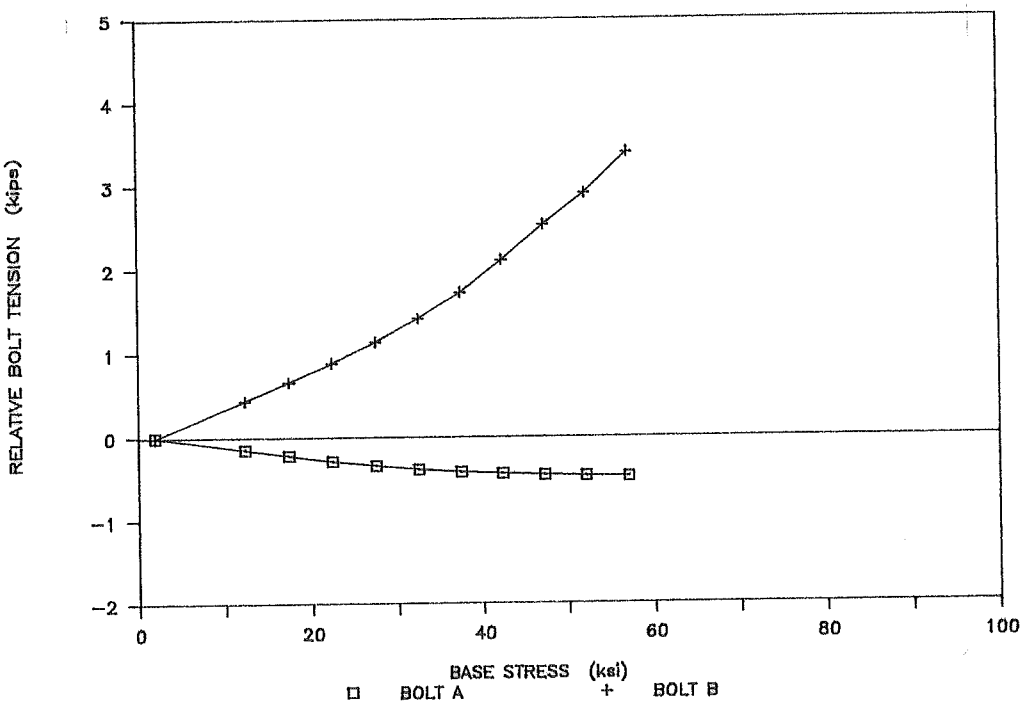


Figure S.6. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

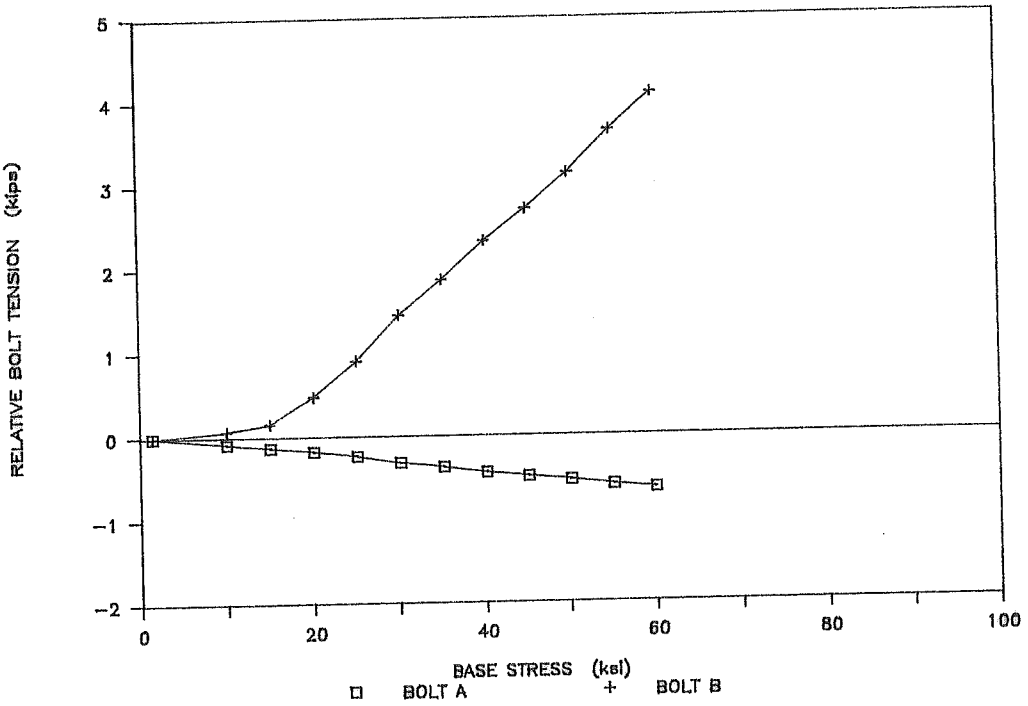


Figure S.7. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

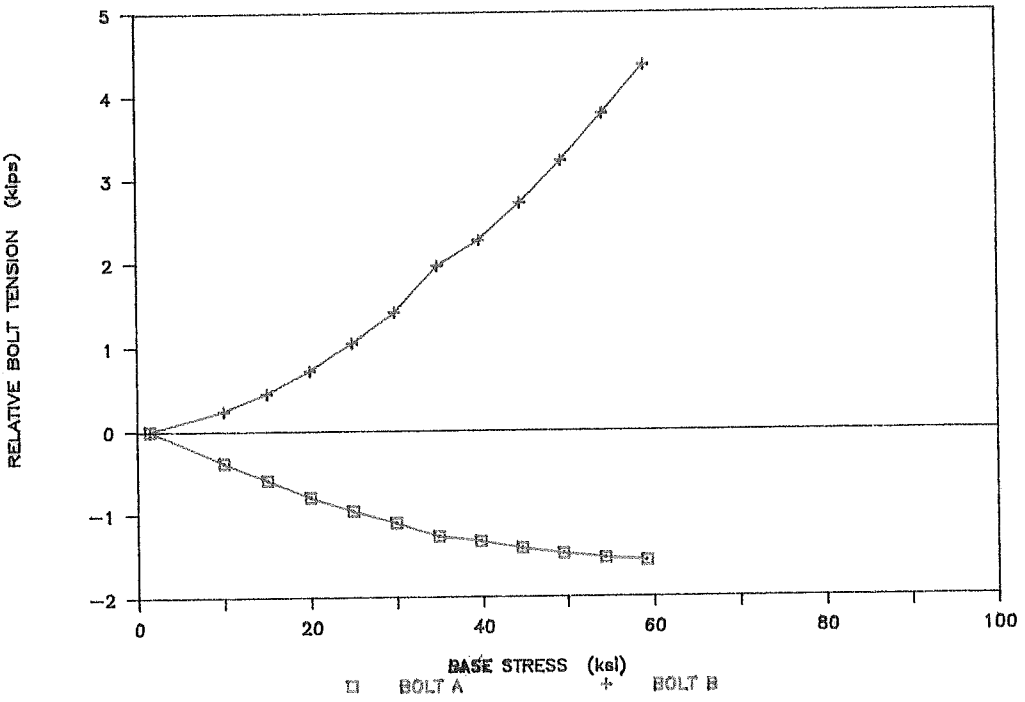


Figure S.8. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Neglecting Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

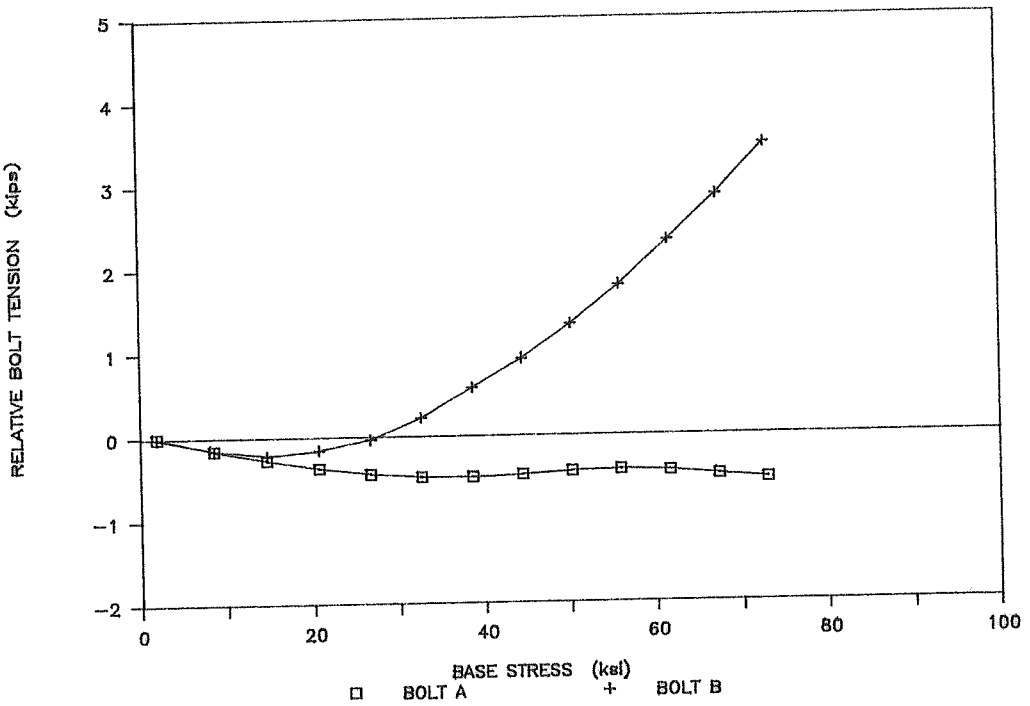


Figure S.9. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

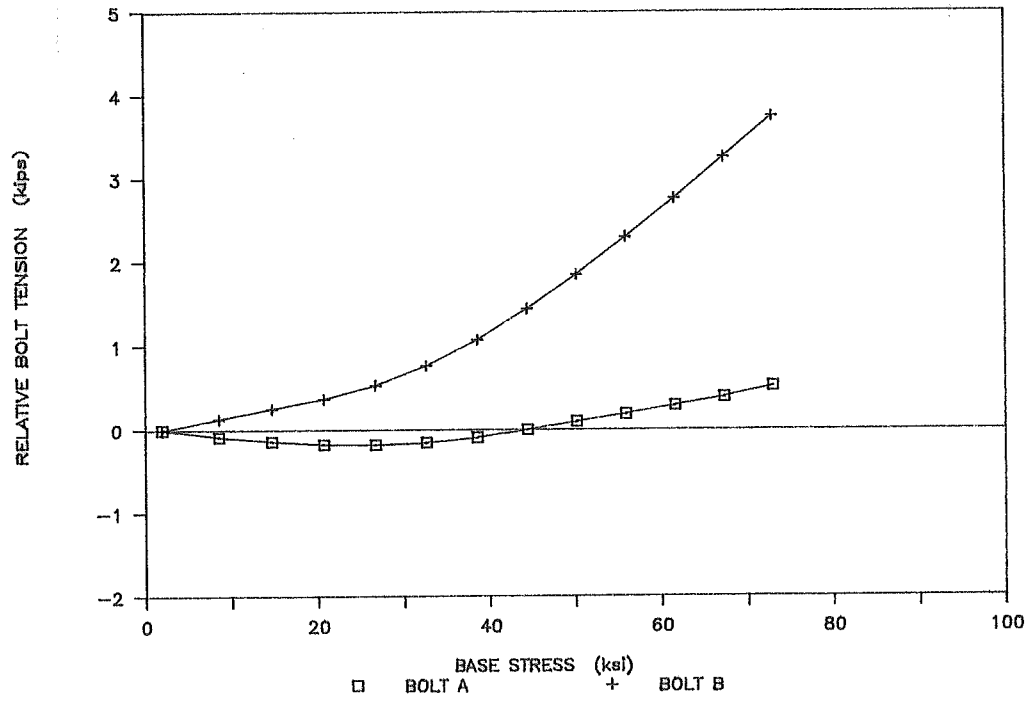


Figure S.10. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

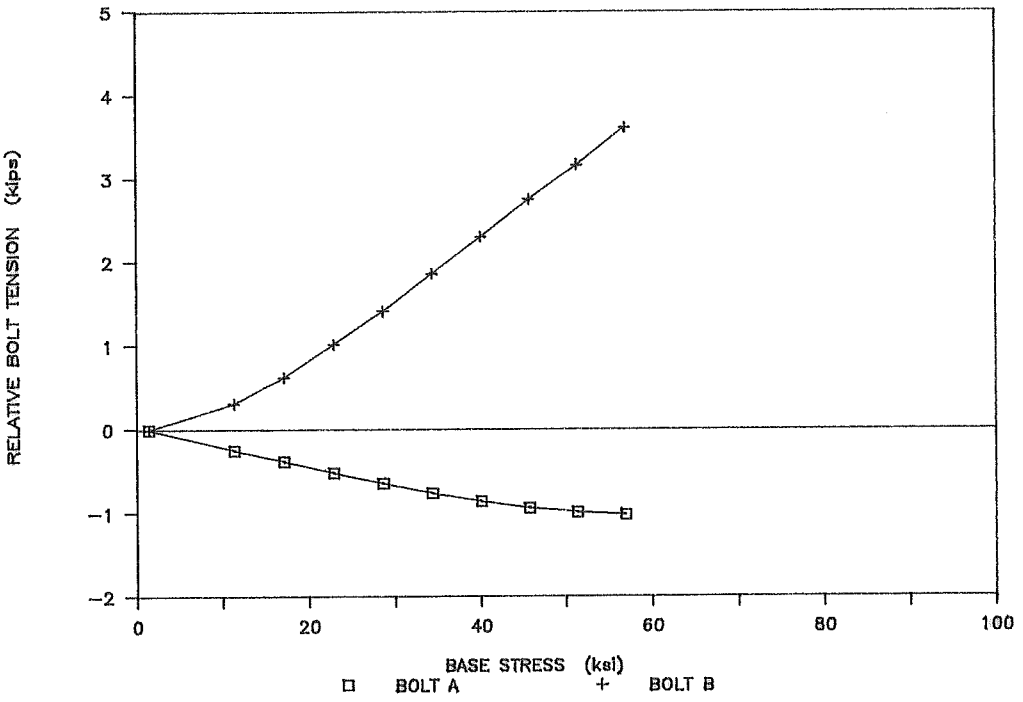


Figure S.11. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

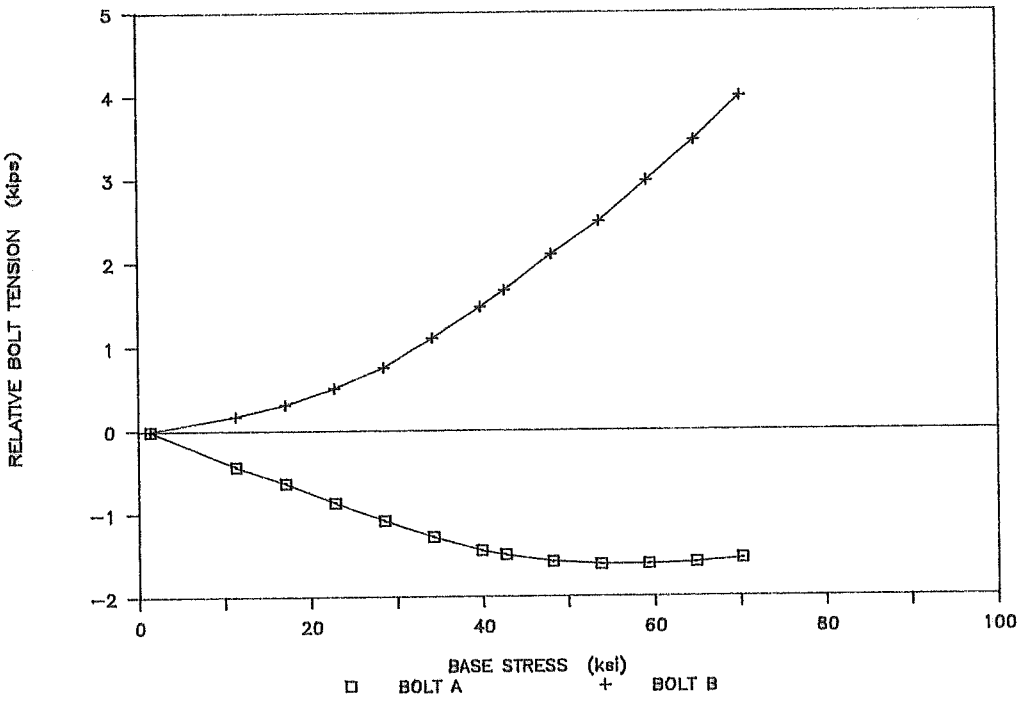


Figure S.12. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

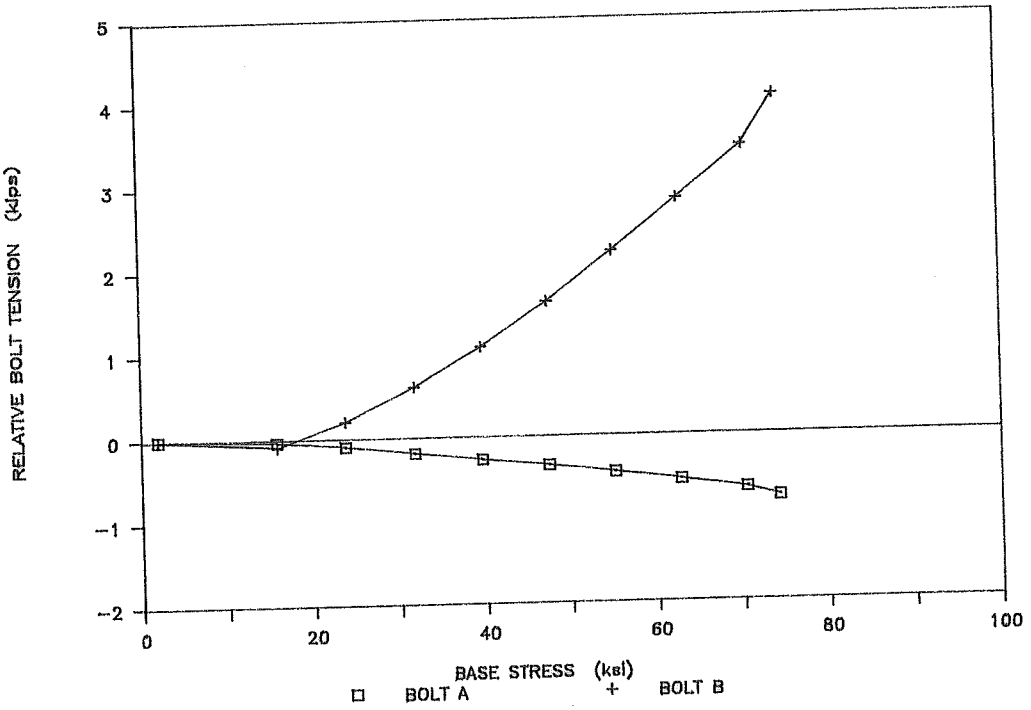


Figure S.13. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

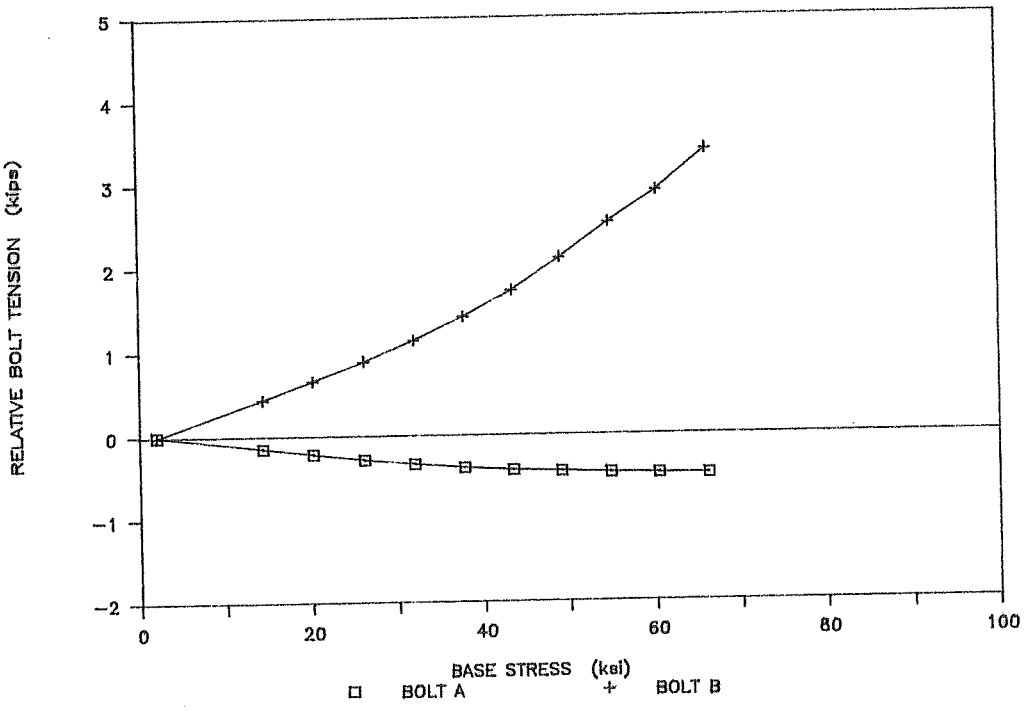


Figure S.14. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

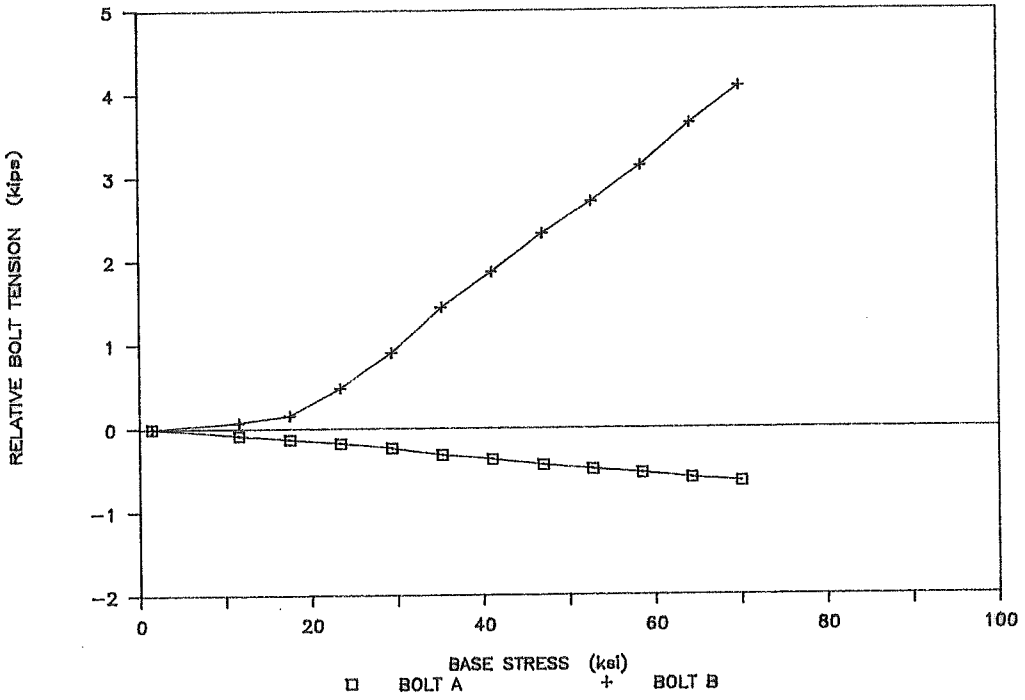


Figure S.15. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

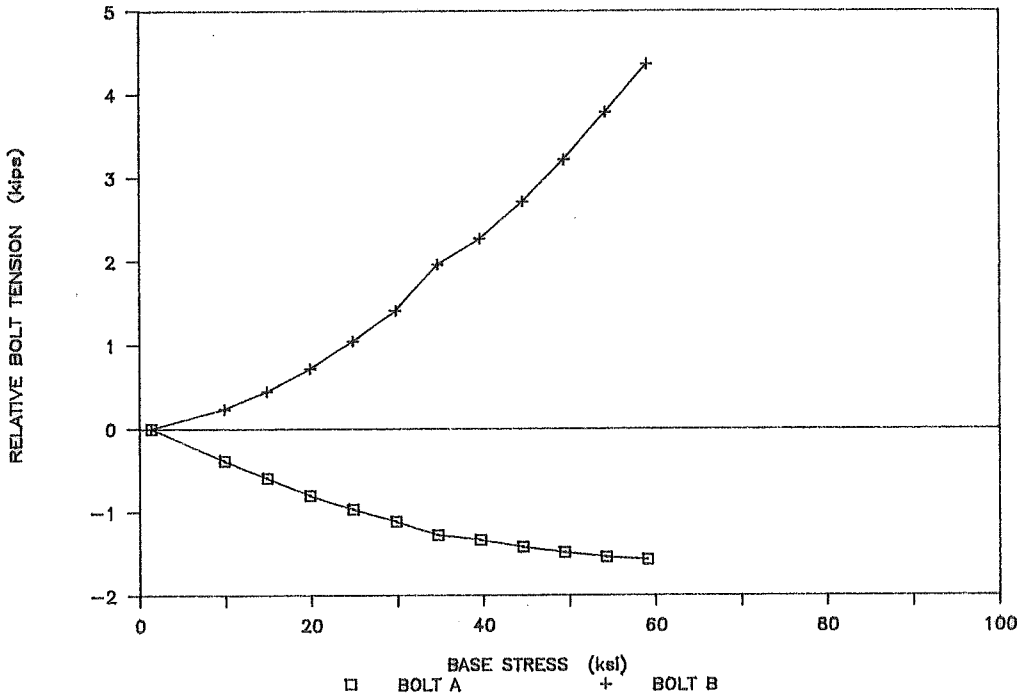


Figure S.16. *Base Stress vs Relative Bolt Tension (75 Inch Combined Bending and Torsion Test - Including Warping Stresses): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

# APPENDIX T

## FINAL 71" BENDING TESTS

BASE STRESS VS ABSOLUTE BOLT TENSION

WITH PREDICTED BOLT TENSION BOLT ENVELOPES

(CALIBRATED BOLTS)

Franklin 3 & 4 lb/ft Posts - 60 ksi Nominal Yield Stress

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

Back to Back and Nested Splices

Critical Configuration

# APPENDIX T

## LIST OF FIGURES

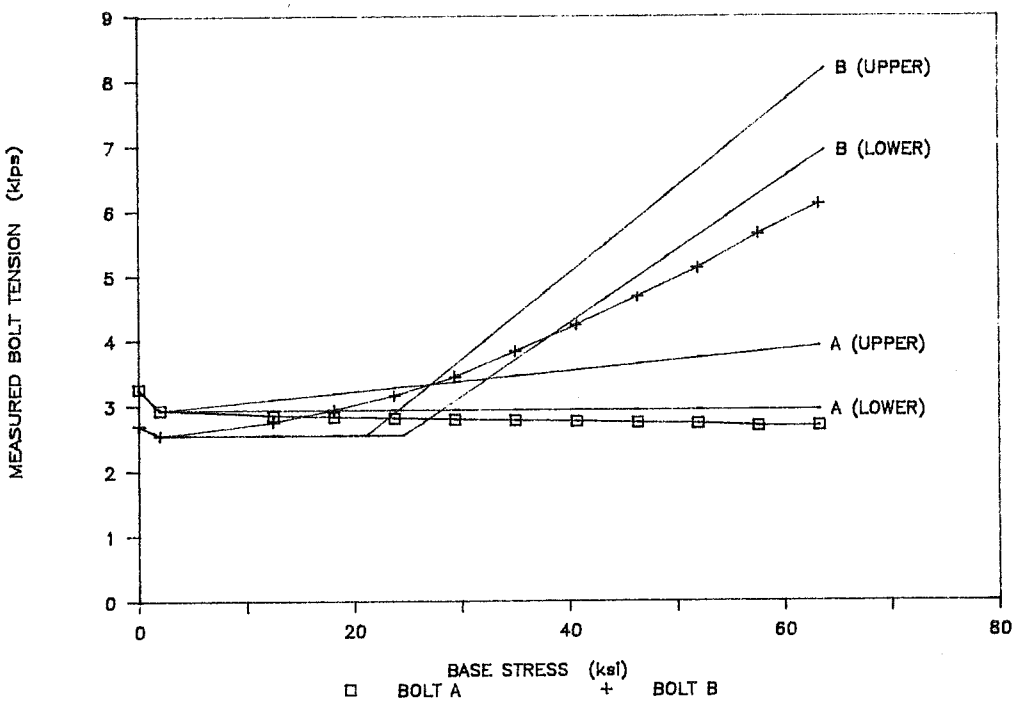


**Figure T.1.** *Base Stress vs Absolute Bolt Tension with Predicted Bolt Tension Envelopes (71 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

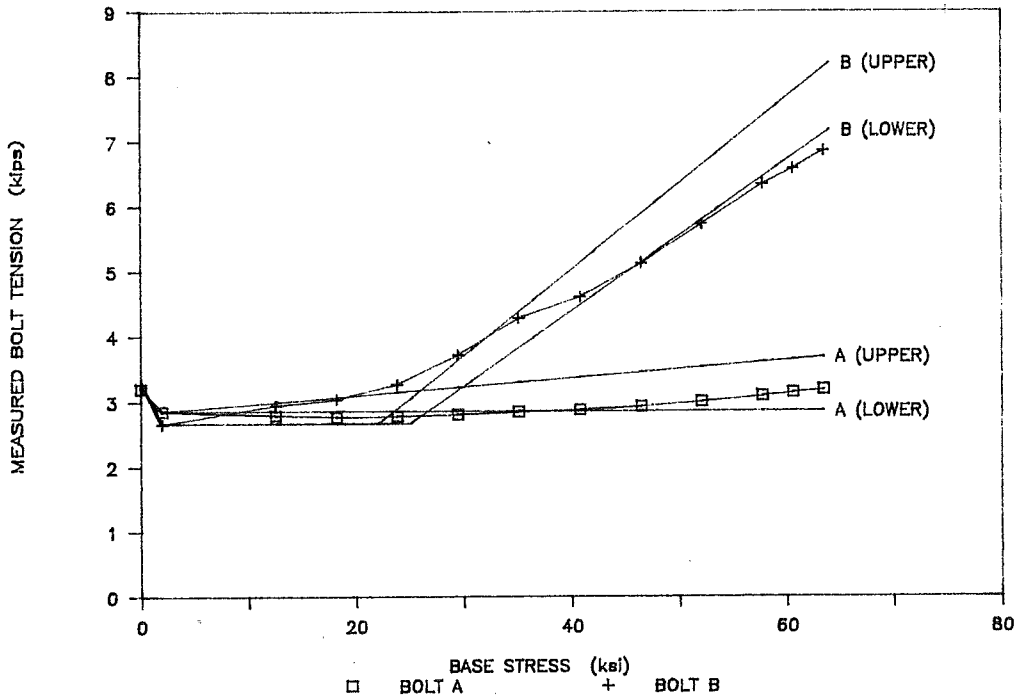


**Figure T.2.** *Base Stress vs Absolute Bolt Tension with Predicted Bolt Tension Envelopes (71 Inch Bending Test): Franklin 3 lb/ft - 60 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

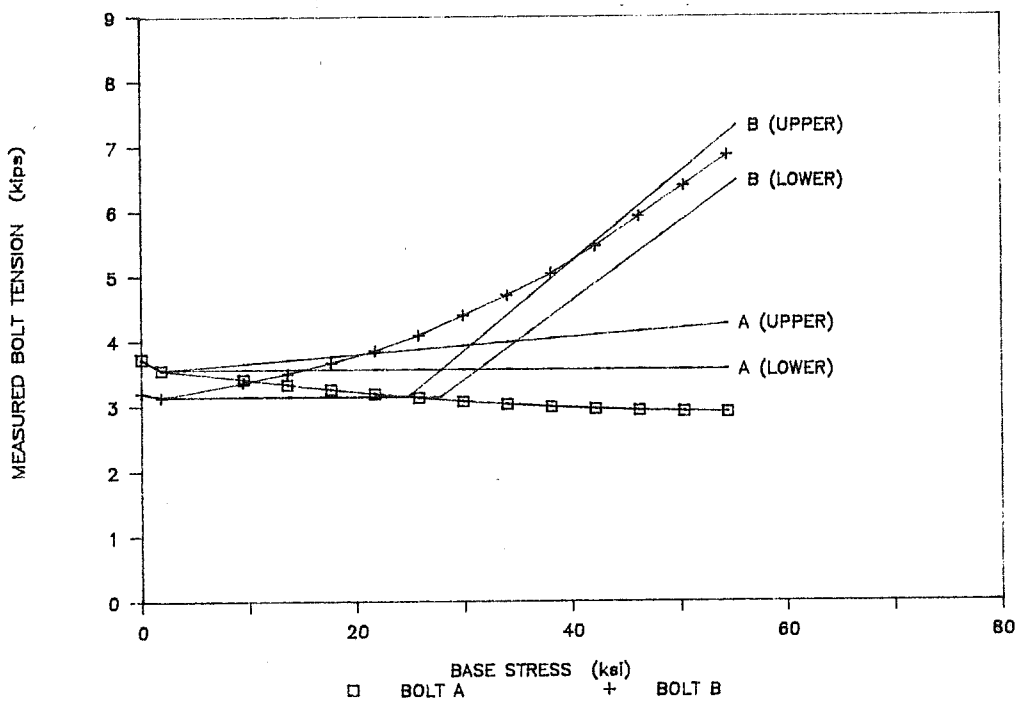


Figure T.3. *Base Stress vs Absolute Bolt Tension with Predicted Bolt Tension Envelopes (71 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

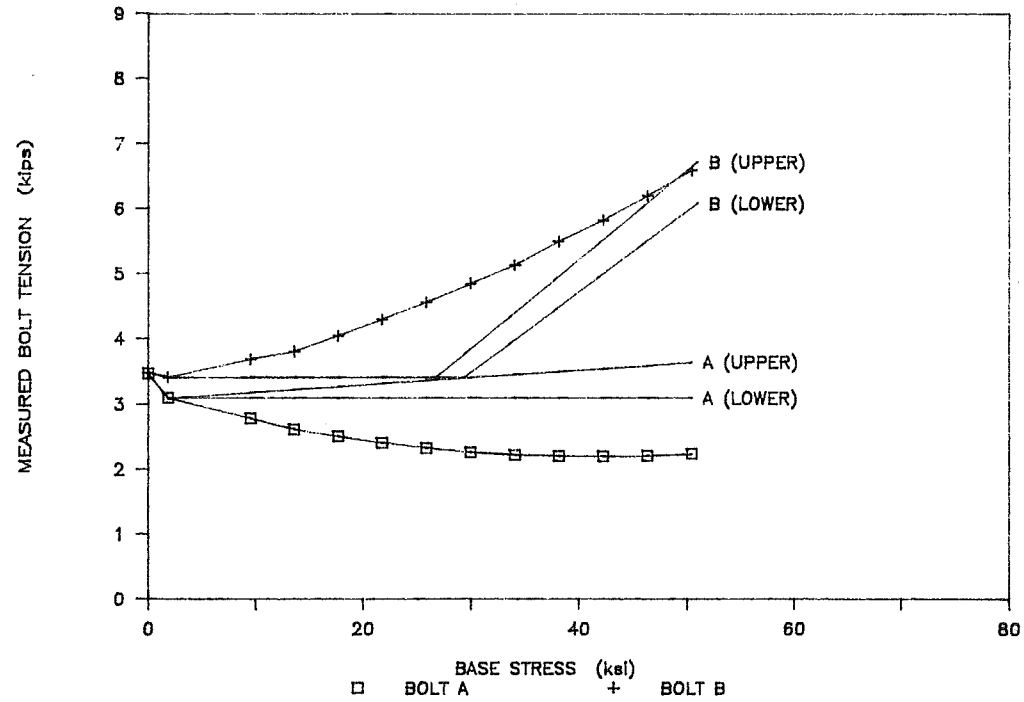


Figure T.4. *Base Stress vs Absolute Bolt Tension with Predicted Bolt Tension Envelopes (71 Inch Bending Test): Franklin 4 lb/ft - 60 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

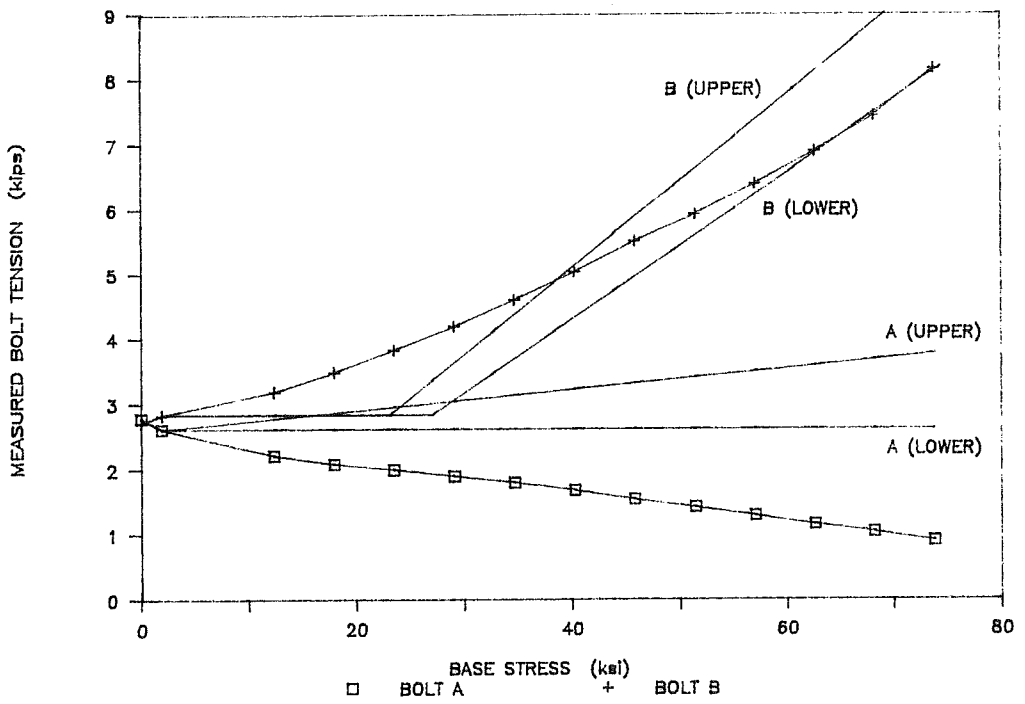


**Figure T.5.** *Base Stress vs Absolute Bolt Tension with Predicted Bolt Tension Envelopes (71 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

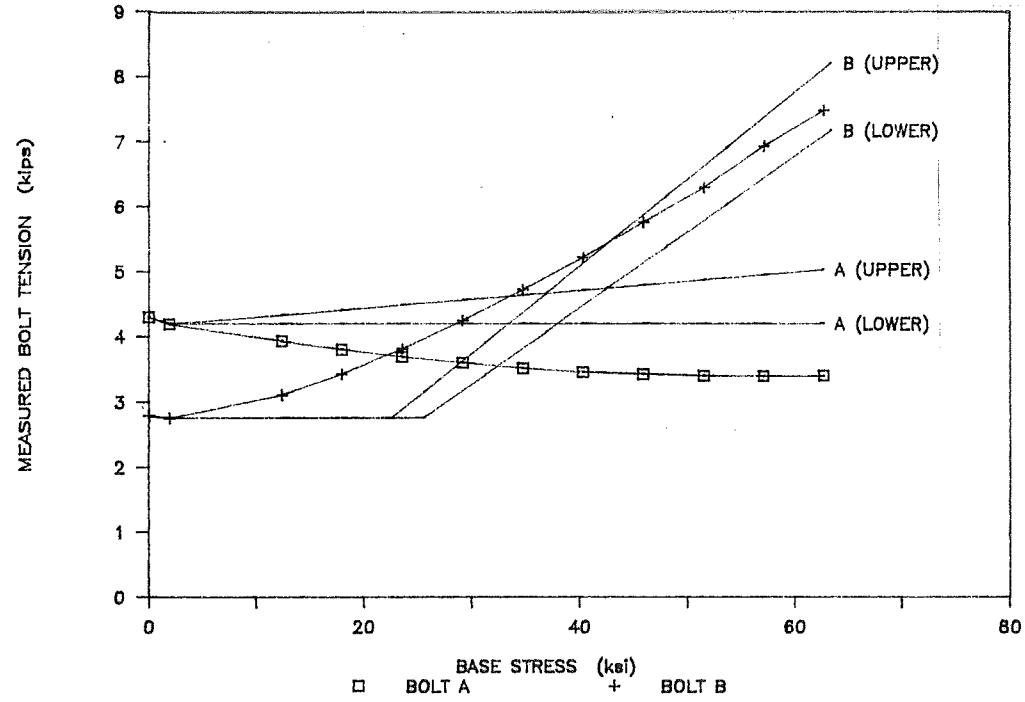


**Figure T.6.** *Base Stress vs Absolute Bolt Tension with Predicted Bolt Tension Envelopes (71 Inch Bending Test): Marion 3 lb/ft - 80 ksi Post; 3 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

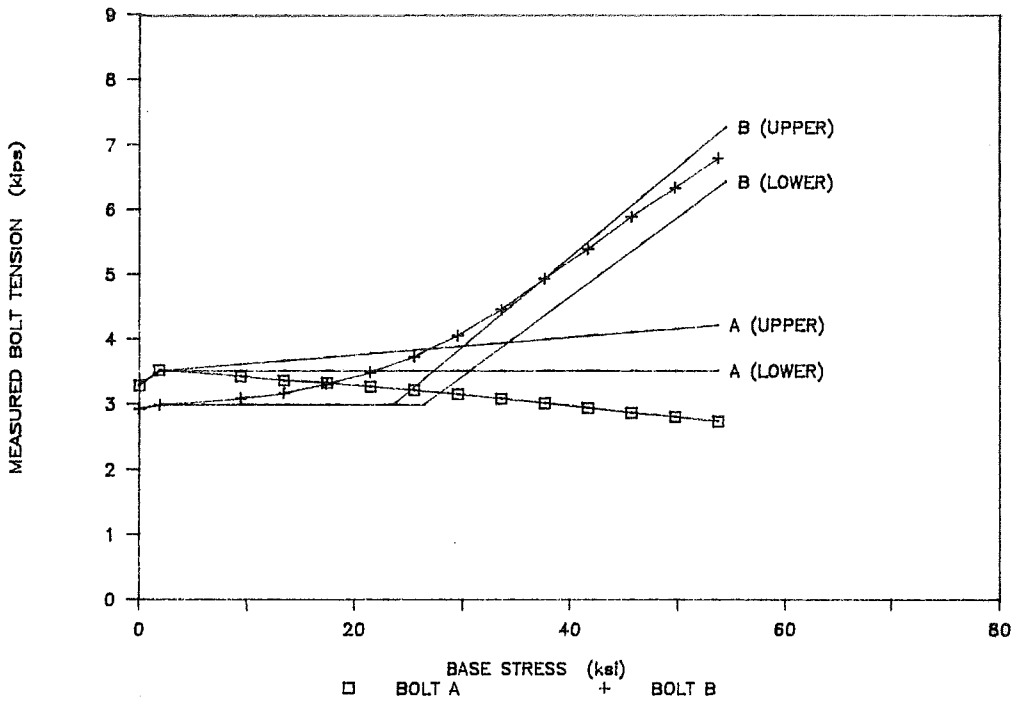


**Figure T.7.** *Base Stress vs Absolute Bolt Tension with Predicted Bolt Tension Envelopes (71 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Back to Back Splice in Critical Configuration (Calibrated Bolts).*

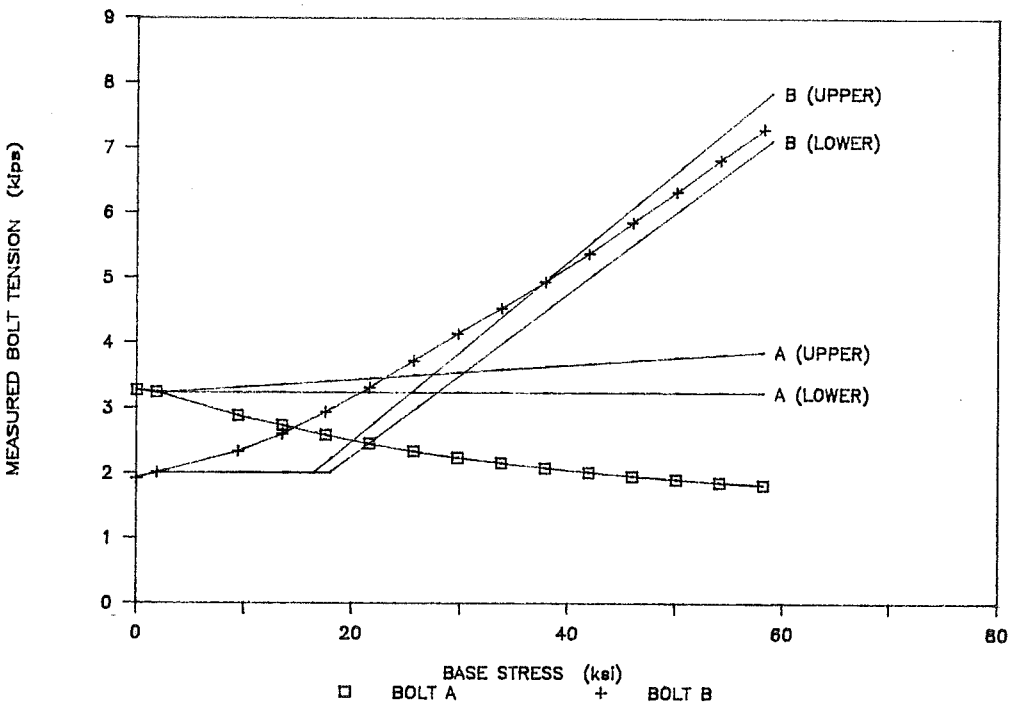


**Figure T.8.** *Base Stress vs Absolute Bolt Tension with Predicted Bolt Tension Envelopes (71 Inch Bending Test): Marion 4 lb/ft - 80 ksi Post; 4 Inch Nested Splice in Critical Configuration (Calibrated Bolts).*

# APPENDIX U

BOLT CALIBRATION CURVES

APPLIED TENSION VS MILLI-VOLTS

(FROM WHEATSTONE BRIDGE)

3/8 Inch Grade 9 Bolts

1-3/4 and 4-1/2 Inch Bolt Lengths

TML Bolt Strain Gauges

TML and MM AE-10 Epoxies

# APPENDIX U

## LIST OF FIGURES

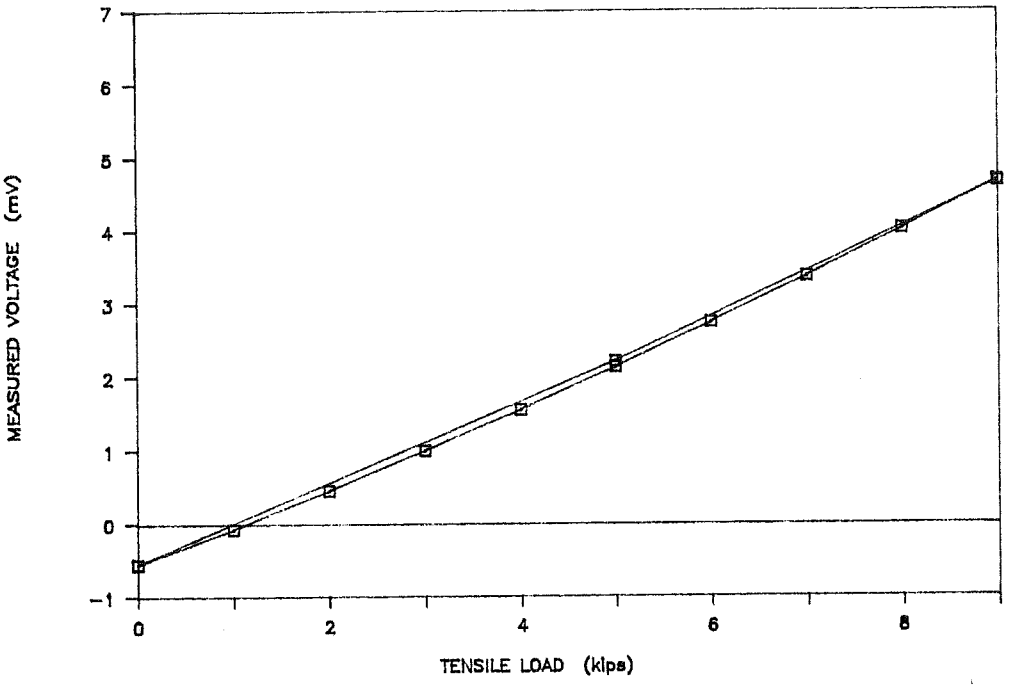


**Figure U.1.** *Applied Tension vs Milli-volts Read from Wheatstone Bridge; 1-3/4 Inch Bolt and TML Epoxy (Bolt 1).*

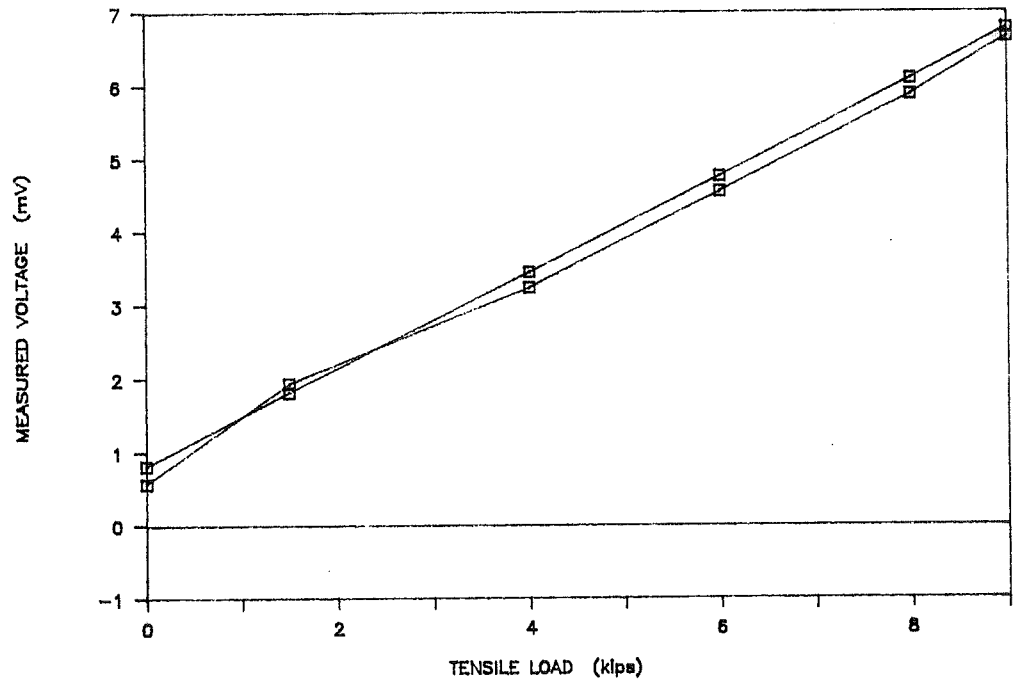


**Figure U.2.** *Applied Tension vs Milli-volts Read from Wheatstone Bridge; 1-3/4 Inch Bolt and TML Epoxy (Bolt 2).*

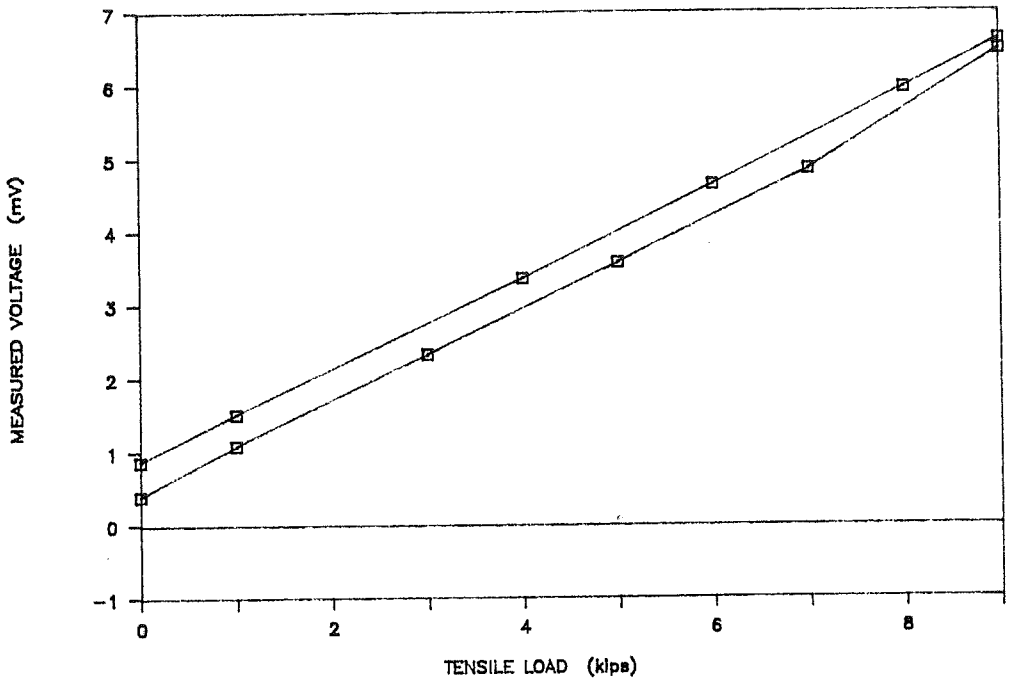


**Figure U.3.** *Applied Tension vs Milli-volts Read from Wheatstone Bridge; 1-3/4 Inch Bolt and TML Epoxy (Bolt 3).*

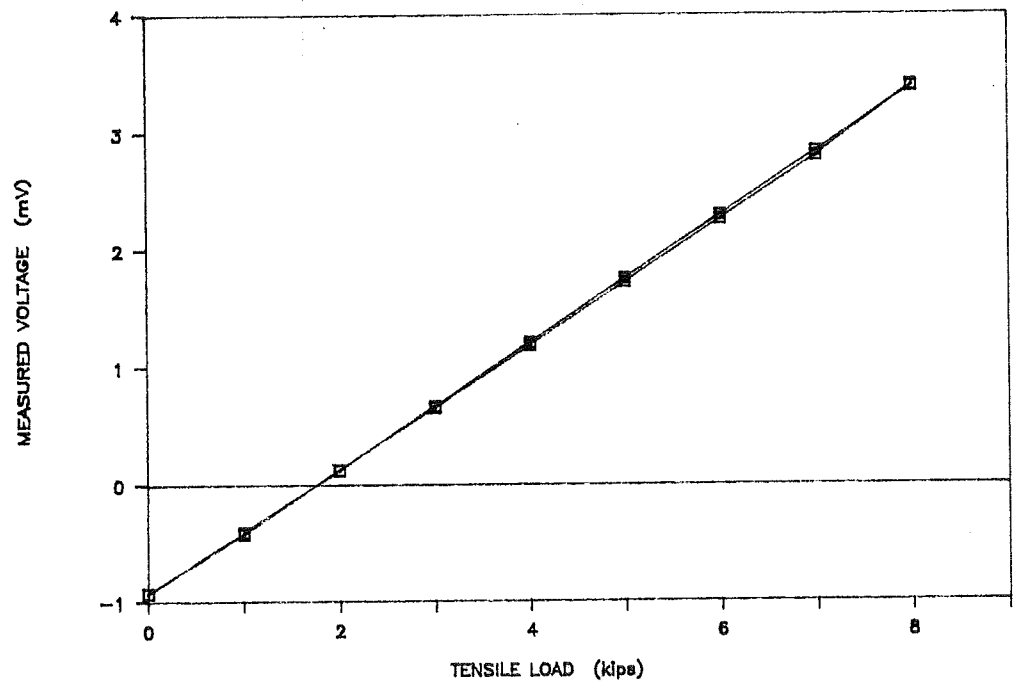


**Figure U.4.** *Applied Tension vs Milli-volts Read from Wheatstone Bridge; 1-3/4 Inch Bolt and MM AE-10 Epoxy (Bolt 5).*

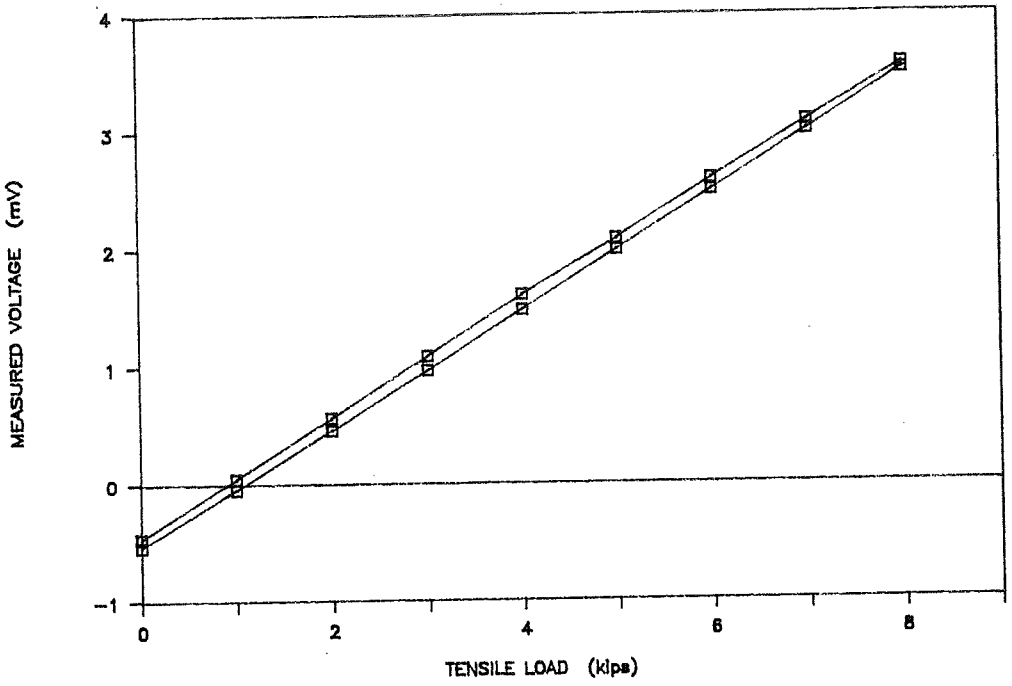


Figure U.5. *Applied Tension vs Milli-volts Read from Wheatstone Bridge; 4-1/2 Inch Bolt and MM AE-10 Epoxy (Bolt 6).*

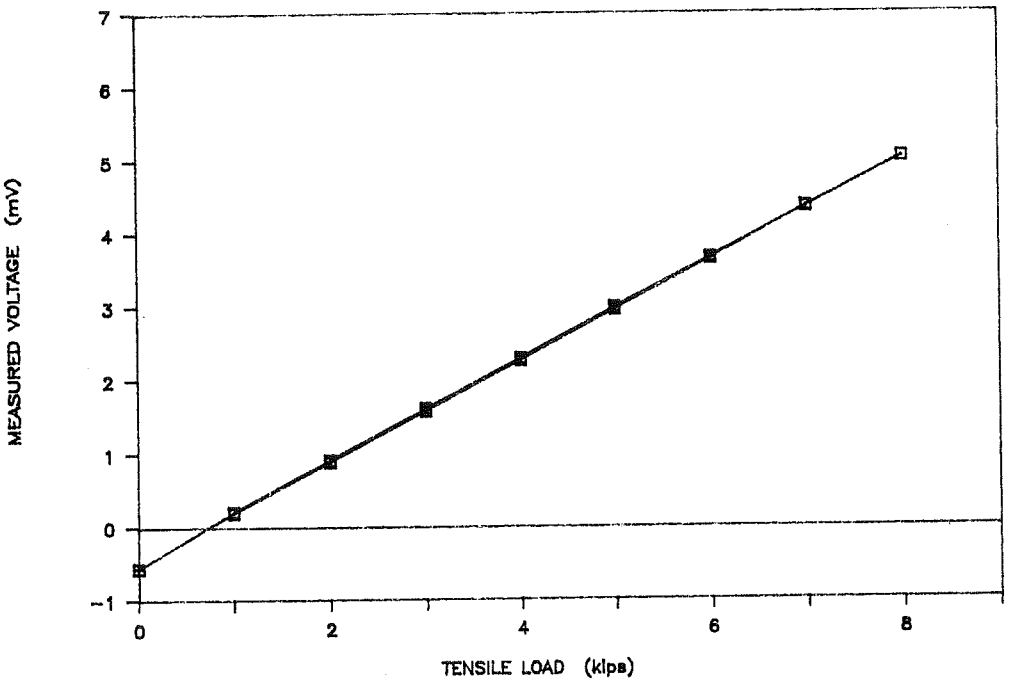


Figure U.6. *Applied Tension vs Milli-volts Read from Wheatstone Bridge; 4-1/2 Inch Bolt and MM AE-10 Epoxy (Bolt 7).*

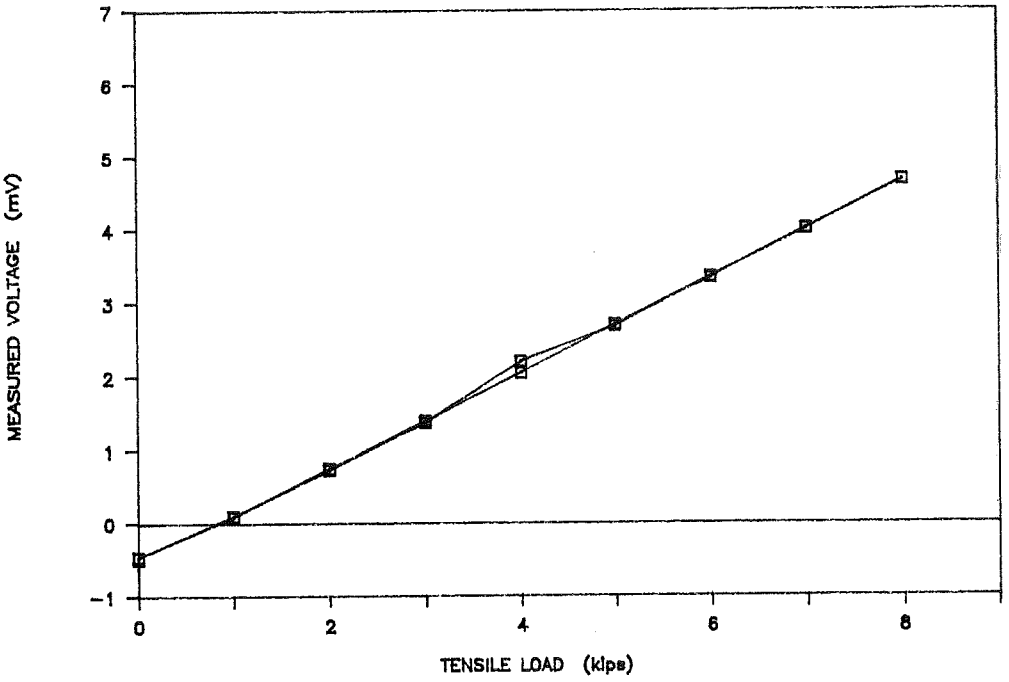


Figure U.7. *Applied Tension vs Milli-volts Read from Wheatstone Bridge; 1-3/4 Inch Bolt and MM AE-10 Epoxy (Bolt 8).*

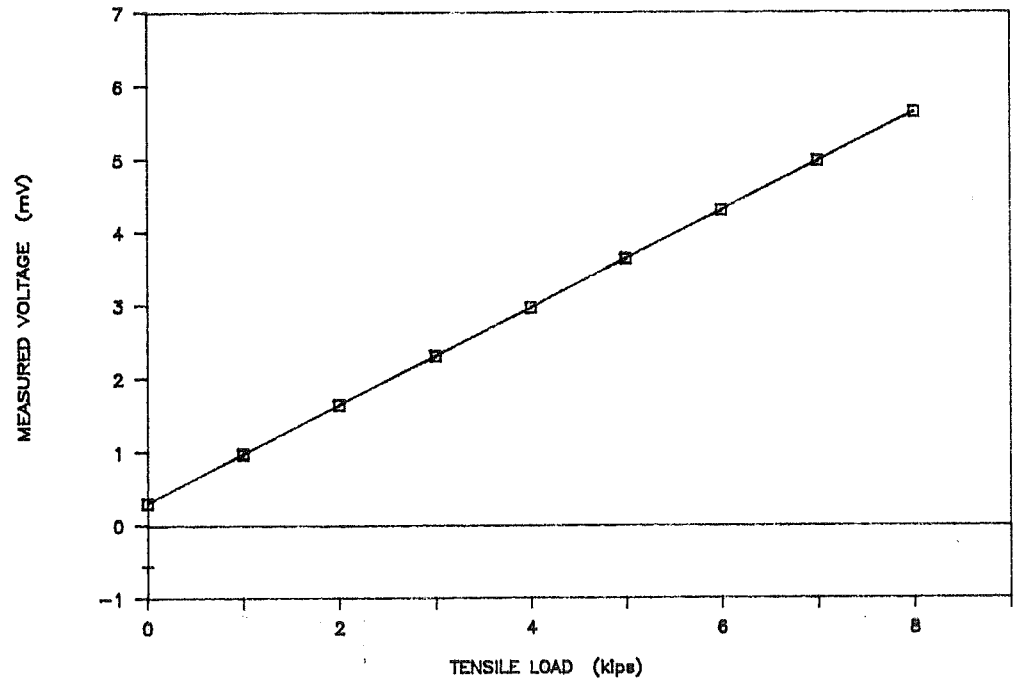


Figure U.8. *Applied Tension vs Milli-volts Read from Wheatstone Bridge; 1-3/4 Inch Bolt and MM AE-10 Epoxy (Bolt 9).*

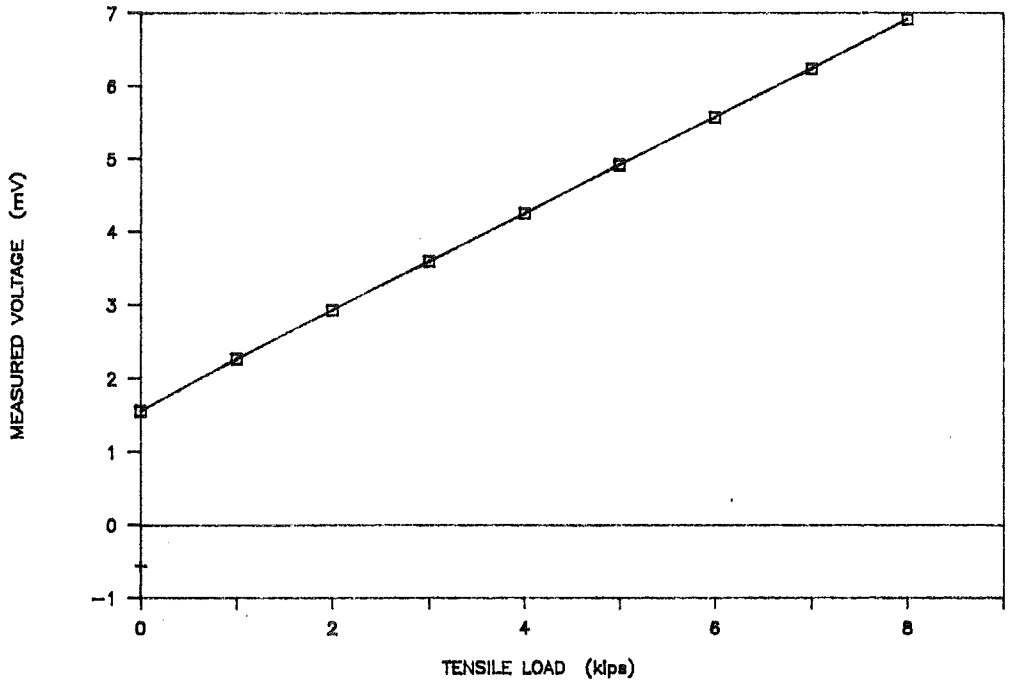


**Figure U.9.** *Applied Tension vs Milli-volts Read from Wheatstone Bridge; 1-3/4 Inch Bolt and MM AE-10 Epoxy (Bolt 10).*

# APPENDIX V

## PHYSICAL AND CHEMICAL TEST RESULTS

Franklin 4 lb/ft Posts - 60 ksi Nominal Yield Stress

SwL SOUTHWESTERN LABORATORIES

*Materials, environmental and geotechnical engineering, nondestructive, metallurgical and analytical services*

222 Cavalcade St. • P.O. Box 8768, Houston, Texas 77249 • 713/692-9151

Report No. 87135
File No. 2-8387-27
Date: 02/27/87

Texas Transportation Institute
Highway Safety Research Center
The Texas A&M University System
College Station, Texas 77843-3135
Attention: Mr. Dean Sicking

Project: Physical and Chemical Testing of a Highway Sign Post Section.
Ref: Texas Transporation Institute Project No. 7043-7

## INTRODUCTION

One section of a highway sign post was received at Southwestern Laboratories on February 16, 1987.

The material was to be tested for its tensile properties, impact properties (at ambient and 150°F temperature), hardness and its chemical composition.

## MECHANICAL PROPERTIES

A tensile specimen machined from the submitted material was tested in accordance with ASTM Standard A370. Results of the test are given below.

| | |
|---|---|
| Tensile Strength, psi | 136,100 |
| Yield Strength, psi | 76,100* |
| Elongation, % in 2 inches | 14 |

* Yield strength was calculated at 0.2% offset. The specimen had a gage area of 0.0805 square inches.

Four impact specimens were machined from the submitted material. Two (2) specimens were tested at ambient temperature and two at 150°F. Results of the tests are given on the following page.

| Specimen Temperature | Width, Inches | Effective Section Size, Inches | Impact Value, ft/lbs. | Lateral Expansion, In. | % Ductile Failure |
|---|---|---|---|---|---|
| Ambient | 0.130 | 0.315 | 2.5 | 0.0 | 0.0 |
| Ambient | 0.130 | 0.315 | 3.0 | 0.0 | 0.0 |
| 150°F+ | 0.130 | 0.315 | 3.0 | 0.0 | 0.0 |
| 150°F+ | 0.130 | 0.315 | 3.0 | 0.0 | 0.0 |

Parameters for the above tests are listed below:

Linear Velocity of Hammer = 16.8 ft./sec.
Effective Energy = 264 ft./lbs.
Test Specification: ASTM Standard E 23

## CHEMICAL ANALYSIS

| Element | Composition, Wt% |
|---|---|
| Carbon | 0.78 |
| Manganese | 0.98 |
| Phosphorus | 0.011 |
| Sulfur | 0.026 |
| Silicon | 0.18 |
| Nickel | 0.03 |
| Chromium | 0.05 |
| Molybdenum | <0.01 |
| Copper | 0.02 |
| Aluminum | 0.005 |
| Titanium | <0.005 |
| Magnesium | 0.005 |
| Zinc | 0.003 |
| Tin | 0.005 |

Note: The submitted material will be discarded after a period of thirty (30) days unless otherwise directed.

Sincerely,

SOUTHWESTERN LABORATORIES, INC.

Adil H. Khan

Adil H. Khan, P.E.
Metallurgical Engineering Division

STATE OF TEXAS
ADIL H. KHAN
68258
REGISTERED PROFESSIONAL ENGINEER

Reviewed By

AHK:ckl

# APPENDIX W

PHYSICAL AND CHEMICAL TEST RESULTS

Marion 3 & 4 lb/ft Posts - 80 ksi Nominal Yield Stress

SwL **SOUTHWESTERN LABORATORIES**

*Materials, environmental and geotechnical engineering, nondestructive, metallurgical and analytical services*

222 Cavalcade St. • P.O. Box 8768, Houston, Texas 77249 • 713/692-9151

Report No. 87215
File No. 2-8387-27
Date: 03/27/87

The Texas A&M University System
Texas Transportation Institute
Highway Safety Research Center
College Station, Texas 77843-3135
Attention: Dr. Jim Morgan

Project: Physical and Chemical Testing of Two Highway Sign Post Sections.
Ref: Test Materials for Task 3; Purchase Order No. 68220; Project: 7024.

## INTRODUCTION

Two (2) - sections of a highway sign post were received at Southwestern Laboratories on March 13, 1987.

The components were to be tested for their tensile properties, impact properties (at ambient and 150°F temperature), hardness and their chemical composition. The samples were identified as:

Project #7024-24 63°
Project #7024-26 67°

## CHEMICAL ANALYSIS

| Element | Composition, Wt% 7024-24 63° | 7024-26 67° |
|---|---|---|
| Carbon | 0.75 | 0.72 |
| Manganese | 0.90 | 0.90 |
| Phosphorus | 0.024 | 0.033 |
| Sulfur | 0.030 | 0.019 |
| Silicon | 0.18 | 0.23 |
| Nickel | 0.12 | 0.12 |
| Chromium | 0.12 | 0.17 |
| Molybdenum | 0.02 | 0.02 |
| Copper | 0.42 | 0.60 |
| Aluminum | <0.005 | 0.008 |
| Titanium | <0.001 | <0.001 |
| Magnesium | 0.012 | 0.008 |
| Zinc | 0.003 | 0.009 |
| Tin | 0.020 | 0.019 |

MECHANICAL PROPERTIES

Tensile specimens were machined from the submitted material and tested in accordance with ASTM Standard A 370. Results of the test are given below:

| Tensile Property | Submitted Sample 7024-24 63° | 7024-26 67° |
|---|---|---|
| Tensile Strength, p.s.i. | 158,600 | 150,000 |
| Yield Strength, p.s.i. | 107,200* | 107,700* |
| Elongation, % in 2 inches | 11 | 10 |

*Yield Strength was calculated at 0.2% offset.

The gage areas of the specimens were:

7024-24 63°=0.0752 sq. inches
7024-26 67°=0.0590 sq. inches

Four impact specimens were machined from each of the submitted components. Two specimens from each were tested at ambient temperature and two from each were tested at 150°F. Results of the tests are given below:

| Specimen Temperature | Width, Inches | Effective Section Size, Inches | Impact Value, Ft./Lbs. | Lateral Expansion, Inches | % Ductile Failure |
|---|---|---|---|---|---|
| | | PROJECT #7024-24 63° | | | |
| Ambient | 0.118 | 0.315 | 1.5 | 0.001 | 0.0 |
| Ambient | 0.118 | 0.315 | 2.0 | 0.000 | 0.0 |
| 150°F+ | 0.118 | 0.315 | 3.0 | 0.000 | 0.0 |
| 150°F+ | 0.118 | 0.315 | 3.0 | 0.000 | 0.0 |

| Specimen Temperature | Width, Inches | Effective Section Size, Inches | Impact Value, Ft./Lbs. | Lateral Expansion, Inches | % Ductile Failure |
|---|---|---|---|---|---|
| | | **PROJECT #7024-26 67°** | | | |
| Ambient | 0.118 | 0.315 | 2.5 | 0.000 | 0.0 |
| Ambient | 0.118 | 0.315 | 2.5 | 0.000 | 0.0 |
| 150°F+ | 0.118 | 0.315 | 3.5 | 0.000 | 0.0 |
| 150°F+ | 0.118 | 0.315 | 3.0 | 0.000 | 0.0 |

Parameters for the above tests are listed below:

Linear Velocity of Hammer = 16.8 ft./sec.
Effective Energy = 264 ft./lbs.
Test Specification ASTM Standard E 23

Hardness measurements were taken on the two materials using a Rockwell "C" indentor and a 150 kg. load. The readings were then converted into the Brinell hardness number. Direct Brinell readings could not be taken due to the low thickness of the material. Results of the hardness tests are listed below:

| Sample Number | Rockwell Hardness HRc, As Measured | Average Hardness HRc | Approx. Average Hardness, BHN |
|---|---|---|---|
| 7024-24 63° | 30.4, 32.3, 33.5 | 32.1 | 303 |
| 7024-26 67° | 31.5, 30.9, 31.5 | 31.3 | 294 |

Report No. 87215

Note: The submitted material will be discarded after a period of thirty (30) days unless otherwise directed.

SOUTHWESTERN LABORATORIES, INC.

Adil H. Khan

Adil H. Khan, P.E.
Metallurgical Engineering Division

STATE OF TEXAS
ADIL H. KHAN
58258
REGISTERED PROFESSIONAL ENGINEER

DES
Reviewed By

AHK:ckl

# APPENDIX X

## RESULTS OF PULLOUT TESTS

# APPENDIX X

## LIST OF FIGURES

A series of pullout tests were performed to determine the behavior of sign attachments fabricated using commonly available washers. In all cases the sign panels were attached to the posts with 5/16 inch Grade 5 bolts in the following configuration (starting at the head of the bolt): the washer(s) to be tested, the sign panel (5/8 inch plywood panels provided by ADOT during phase I of this project), the u-post, a Grade 8 washer, and finally a grade 9 nut.

In all cases the washer/bolt assembly pulled through[1] the plywood before the bolt failed. However, the degree to which the washer(s) was deformed and the area of the plywood involved in the failure varied widely. The types of washers tested and the typical failure mode are summarized below (in each case behavior is quantified in terms of the turn of the nut method--where # turns refers to the # of turns of the nut past finger tight--all bolts were lubricated to minimize variations in test conditions):

SAE Grade 9 (approximately 11/16 inch diameter and 1/16 inch thick) had a typical failure mode which resulted in a punching shear type of failure of the plywood with no apparent deformation of the washer. Easy penetration of the panel began at 3-3/4 turns past finger tight, the nut was fully embedded in the plywood panel after 6-3/4 turns. (see Figure X.1 and X.2)

---

[1]Pull through was defined as a loss of resistance, tests were terminated before actual pull through in order to maximize the information obtained from each test.

SAE Grade 2 (approximately 11/16 inch diameter and 1/16 inch thick)had a typical failure mode which resulted in a punching shear type of failure of the plywood with slight deformation of the washer. Initial behavior of this washer was identical to the SAE Grade 8 washer, then after 7-1/2 turns the plywood failed. (see Figure X.3)

US Standard (approximately 7/8 inch diameter and 1/16 inch thick)had a typical failure mode which resulted in a punching shear type of failure of the plywood with noticeable deformation of the washer. This deformation was often accompanied by a permanent imprint of the bolt head "hex" pattern on the washer. Initial penetration of the plywood began at 5 turns, with failure of the plywood occuring at 12-1/2 turns--although initial loss of resistance was approximately as in the SAE washers. (see Figure X.4 and X.5)

Medium Fender Washer (approximately 1-1/4 inch diameter and 1/16 inch thick) had a typical failure mode which resulted in the washer bending and the plywood splitting. This deformation was always accompanied by a permanent imprint of the bolt head "hex" pattern on the washer. Initial penetration occured after 5 turns as in the USStandard washer, with total embedment by 7-1/2 turns and no significant resistance thereafter. (see Figure X.6 and X.7)

Large Fender Washer (approximately 1-1/2 inch diameter and 1/16 inch thick) had a typical failure mode which resulted in the washer bending and the plywood splitting. This deformation was

accompanied by an imprint of the bolt head "hex" pattern on the washer, in fact the bolt head embedded in the washer and in one case actually pulled through the washer. This washer exhibited nearly constant (small) resistance until the bolt head pulled through the washer at 13-1/4 turns. (see Figure X.8 and X.9)

Stacked washers also were tested in an attempt to assess the feasibility of using special (thick) washers to improve pullout capacity. It should be noted that, since there is no shear transfer between washers these tests indicate trends only and can not be used to predict actual pullout behavior of special thick washers. The data from these tests show a marked improvement in performance with large diameter washers if they are sufficiently prevented from bending. The best overall performance achieved in any test was obtained from a stack containg 3 large diameter fender washers which were backed up by 2 medium diameter washers, in this case it took 14 full turns before resistance was lost (see Figure X.10). While this is not a large increase over some of the previous cases, this combination was sufficient to convert the failure mode from a splitting of the plywood (Figure X.11) to a punching shear failure (Figure X.12--similar to that seen for high strength washers--but with a much larger diameter and therefore a much higher load required to fail the plywood).

In summary larger diameter, thicker, higher strength washers improve the pull out resistance of the sign attachment. However, the commonly available high strength washers are not of sufficient diameter to provide a significant improvement over a bolt head with no washer. Moreover the commonly available large diameter washers do not have adequate strength

or thickness to resist cupping of the washer and pull through of the bolt head. It appears from these tests that for a 1-1/2 inch diameter washer, a thickness of 1/4 inch or more would be sufficient to cause a punching shear failure mode. These design of the sign blank attachment system would then be dependent on only the shear strength of the plywood panel.

Finally, it should be noted that the turn of the nut method may not be directly correlated to the load required for pullout. The general behavior and mode of failure are probably much better indicators of the relative merits of each washer (with punching shear providing the highest resistance to pullout).

**Figure X.1.** Photograph of SAE Grade 8 Washer Following Pullout Test

Figure X.2. Photograph of Plywood Following SAE Grade 8 Pullout Test

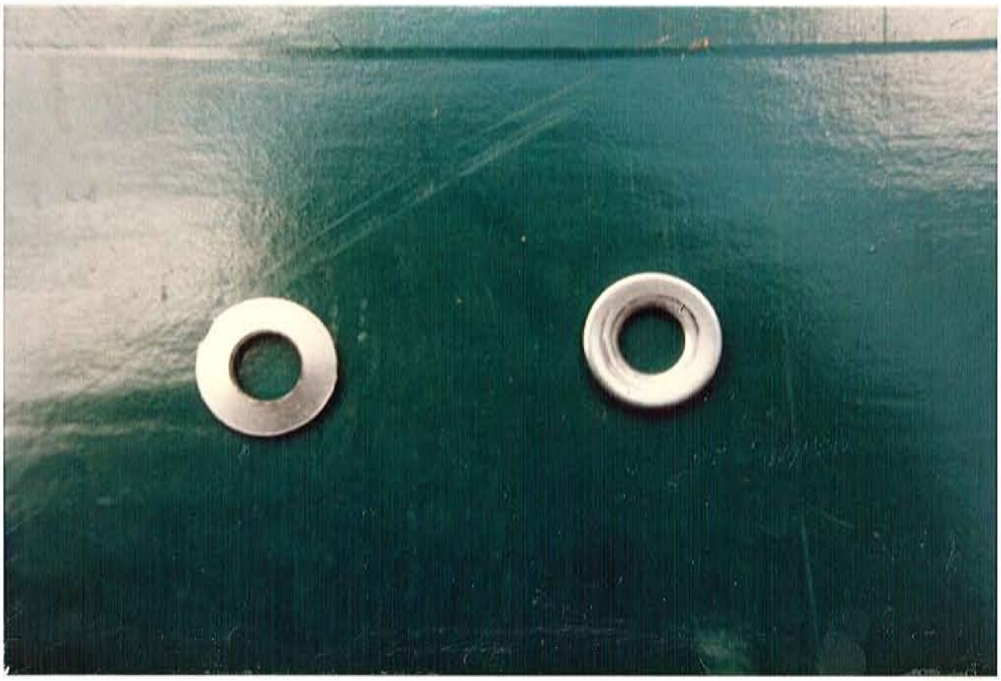

Figure X.3. Photograph of SAE Grade 2 Washer Following Pullout Test

**Figure X.4.** Photograph of USStandard Washer Following Pullout Test

**Figure X.5.** Photograph of Plywood Following USStandard Pullout Test

**Figure X.6.** Photograph of Medium Fender Washer Following Pullout Test

Figure X.7. Photograph of Plywood Following Medium Fender Pullout Test

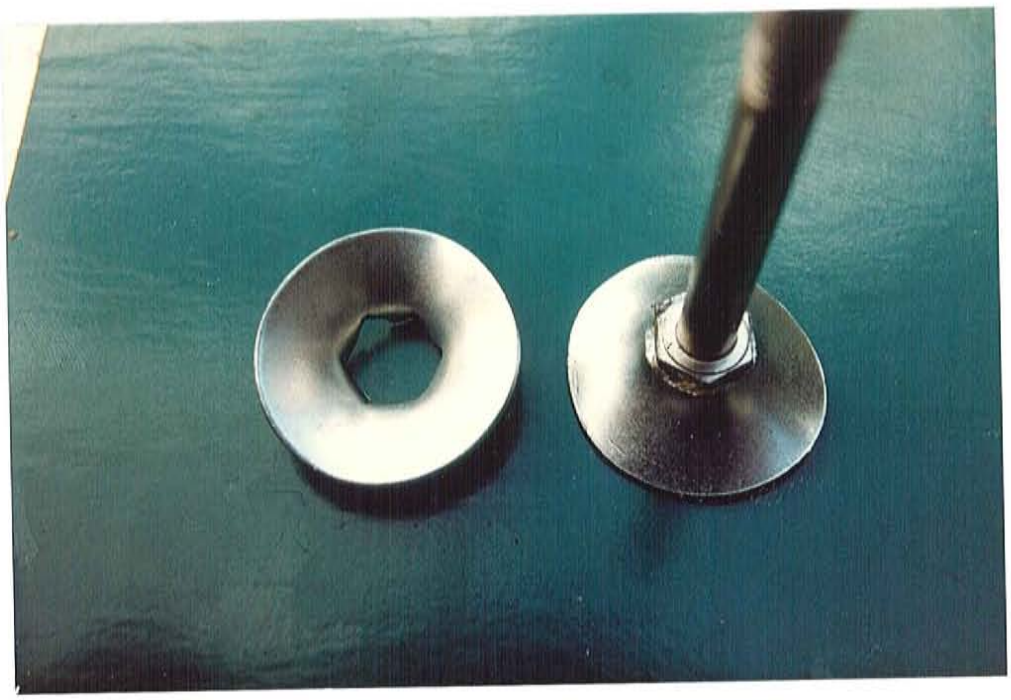

Figure X.8. Photograph of Large Fender Washer Following Pullout Test

Figure X.9. Photograph of Plywood Following Large Fender Pullout Test

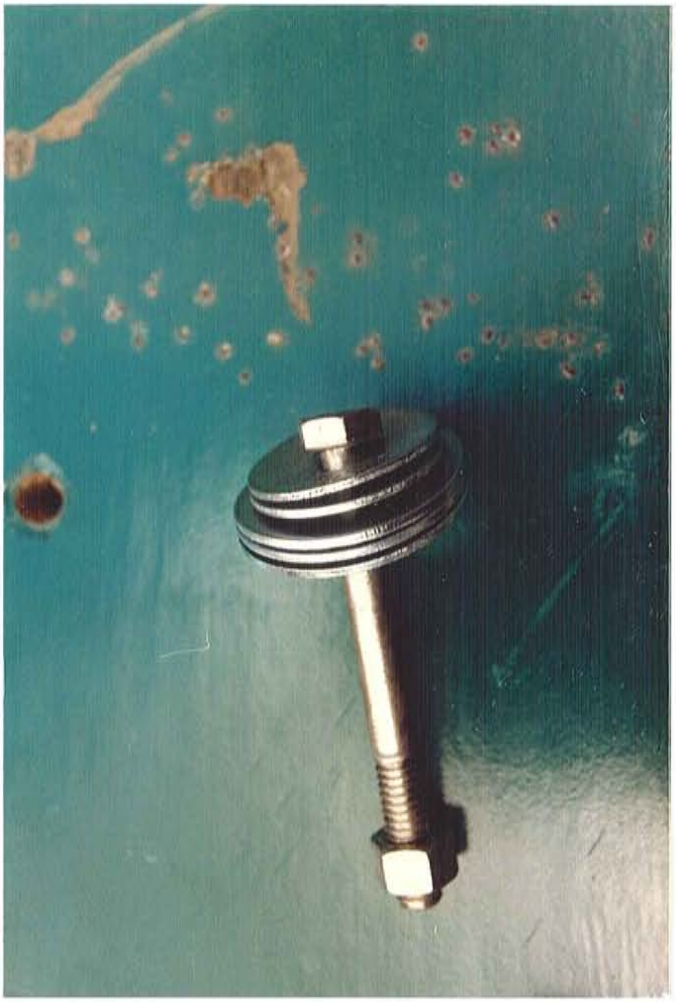

Figure X.10. Photograph of Stacked Fender Washers Following Pullout Test


Figure X.11. Photograph of Typical Plywood Punching Shear Failure

Figure X.12. Photograph of Typical Plywood Splitting Failure