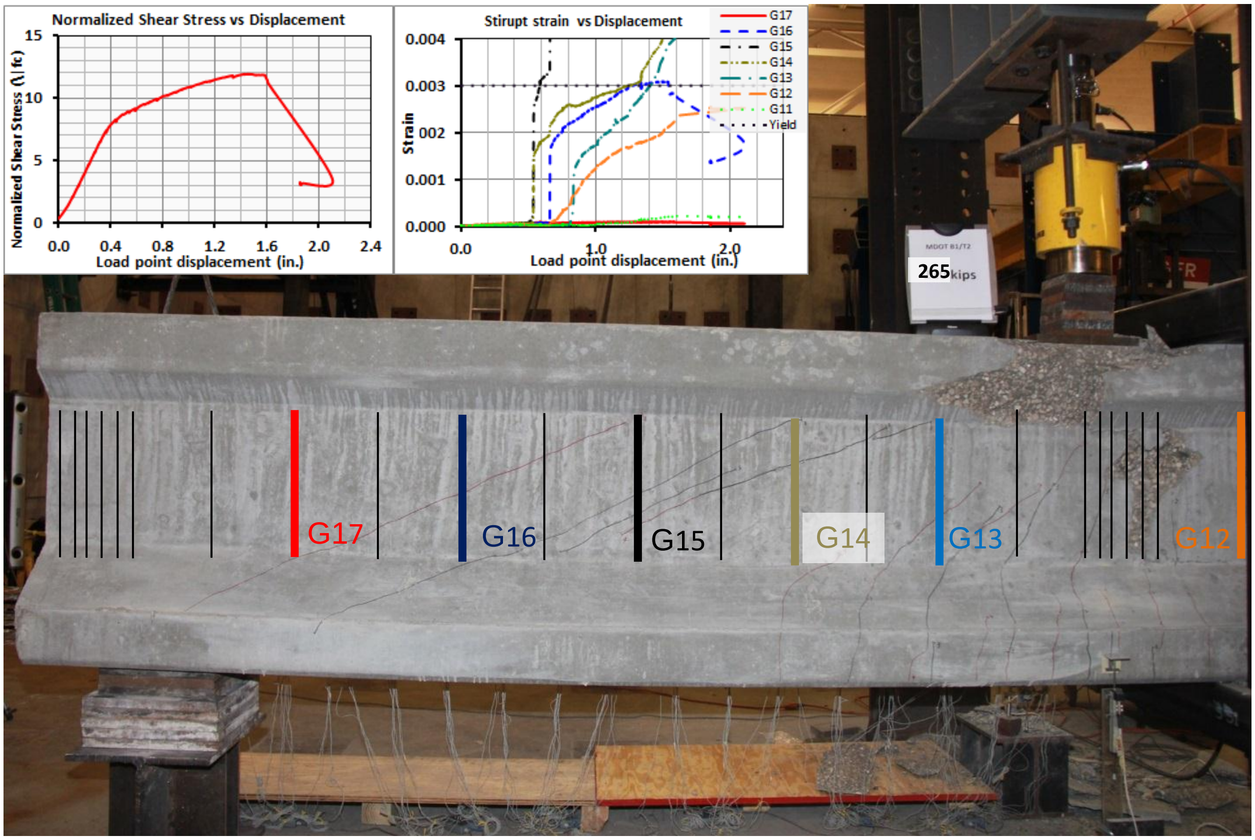


Figure D7. Beam 1 Test 2 Failure.

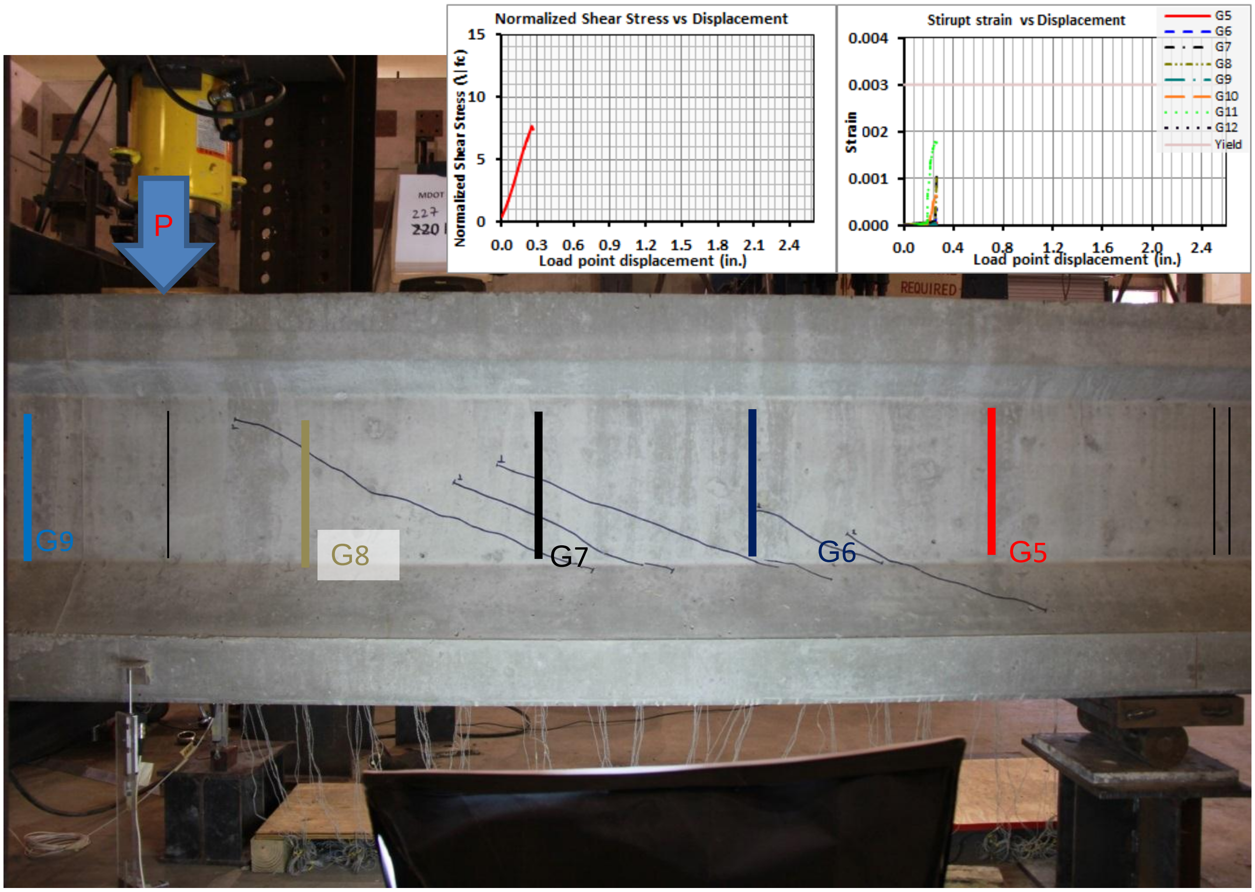


Figure D8. Beam 1 Test 3 First Cracking Load.

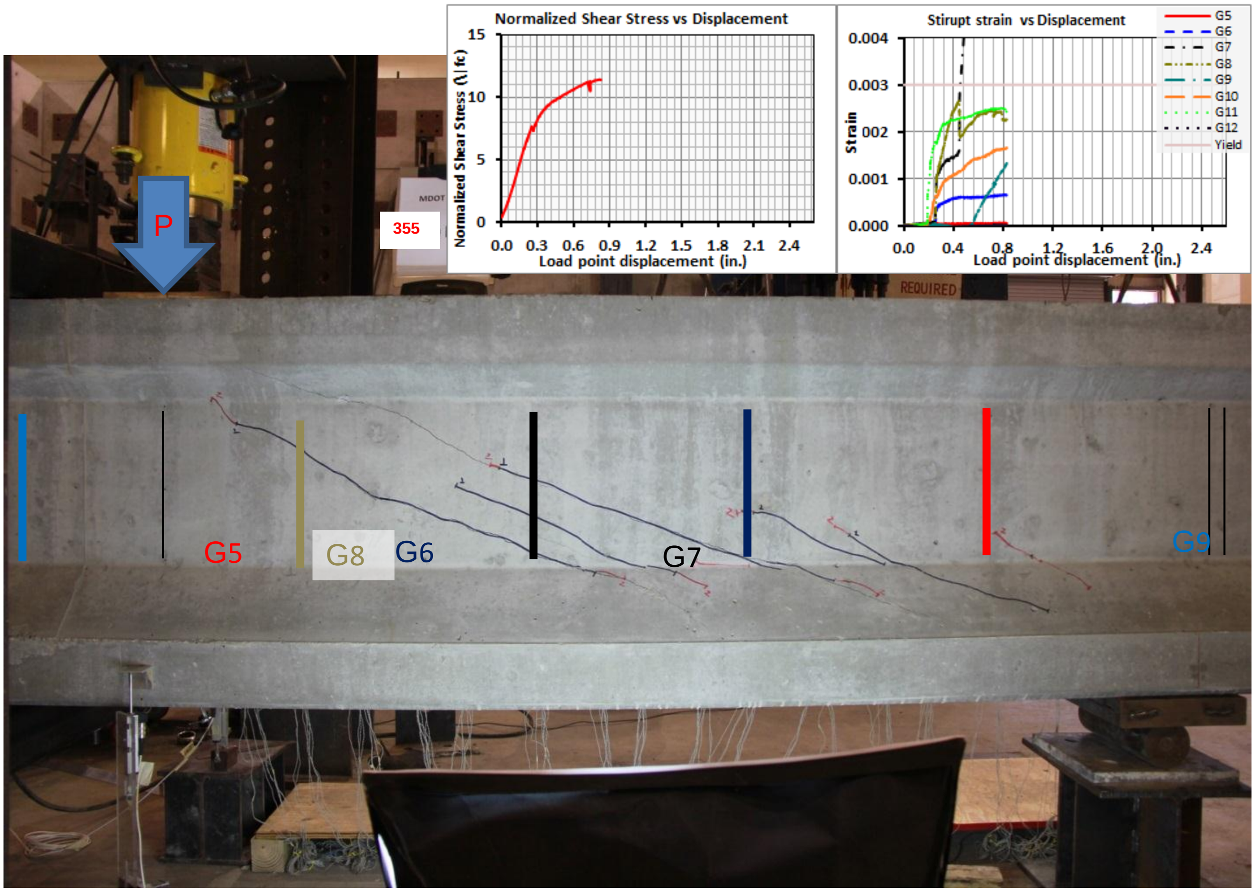


Figure D9. Beam 1 Test 3 Peak Load Before Failure.

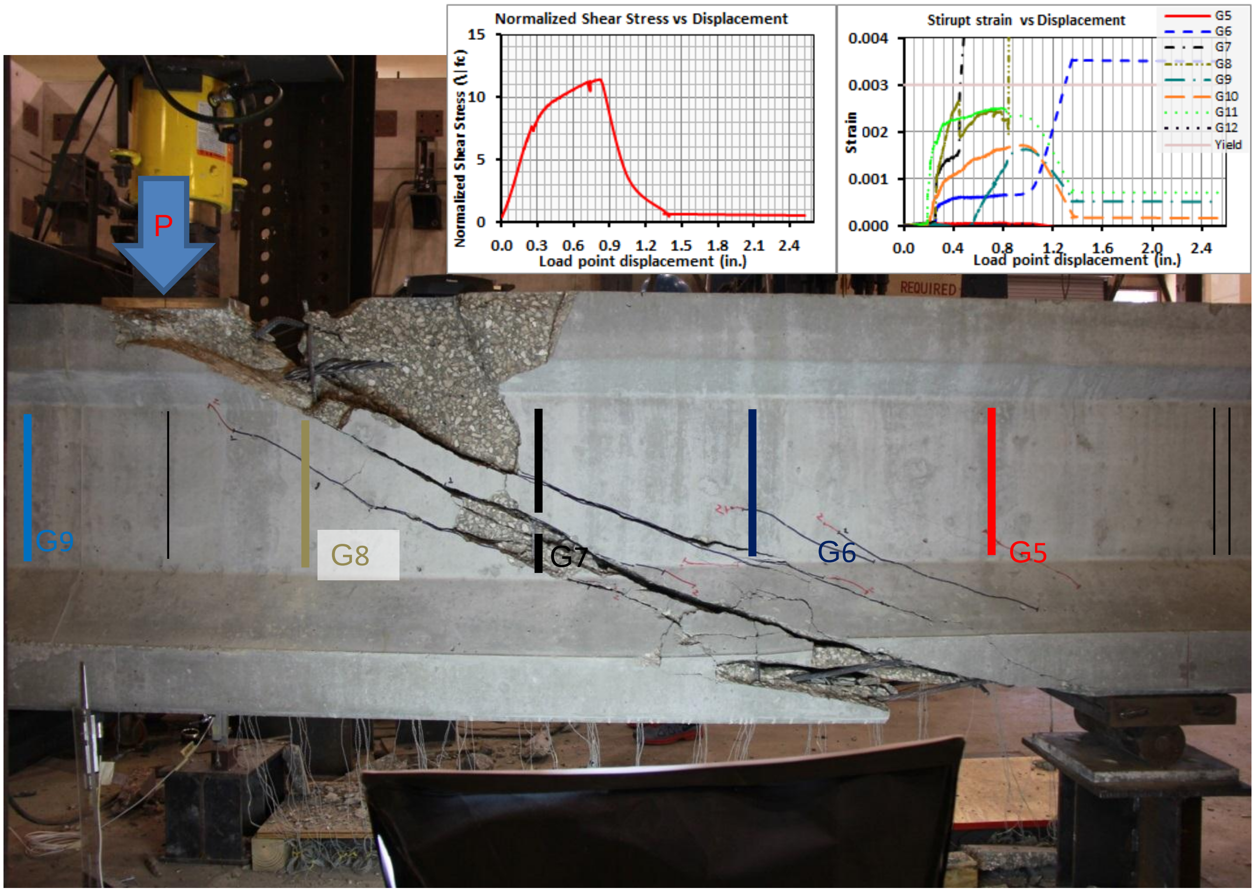


Figure D10. Beam 1 Test 3 Failure.

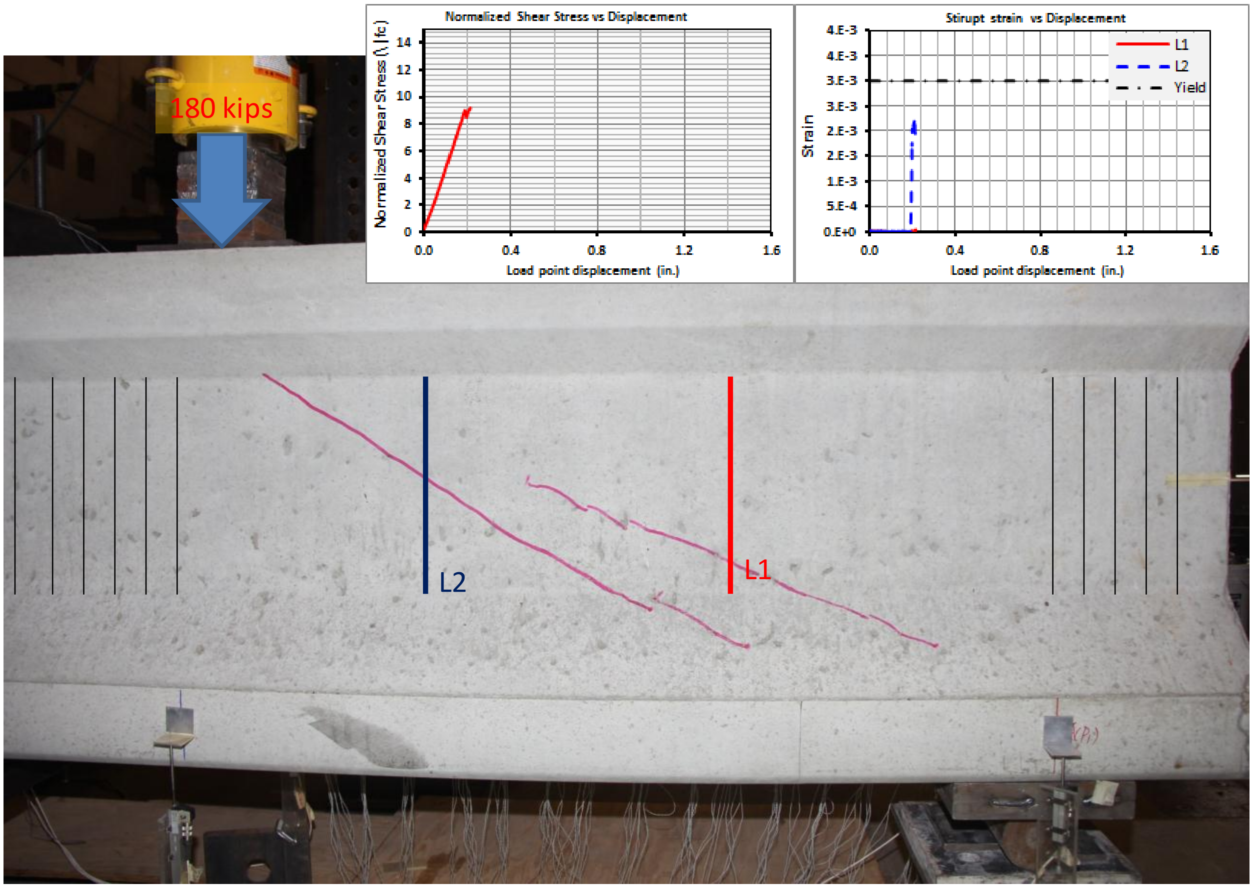


Figure D11. Beam 2 Test 1 First Cracking Load.

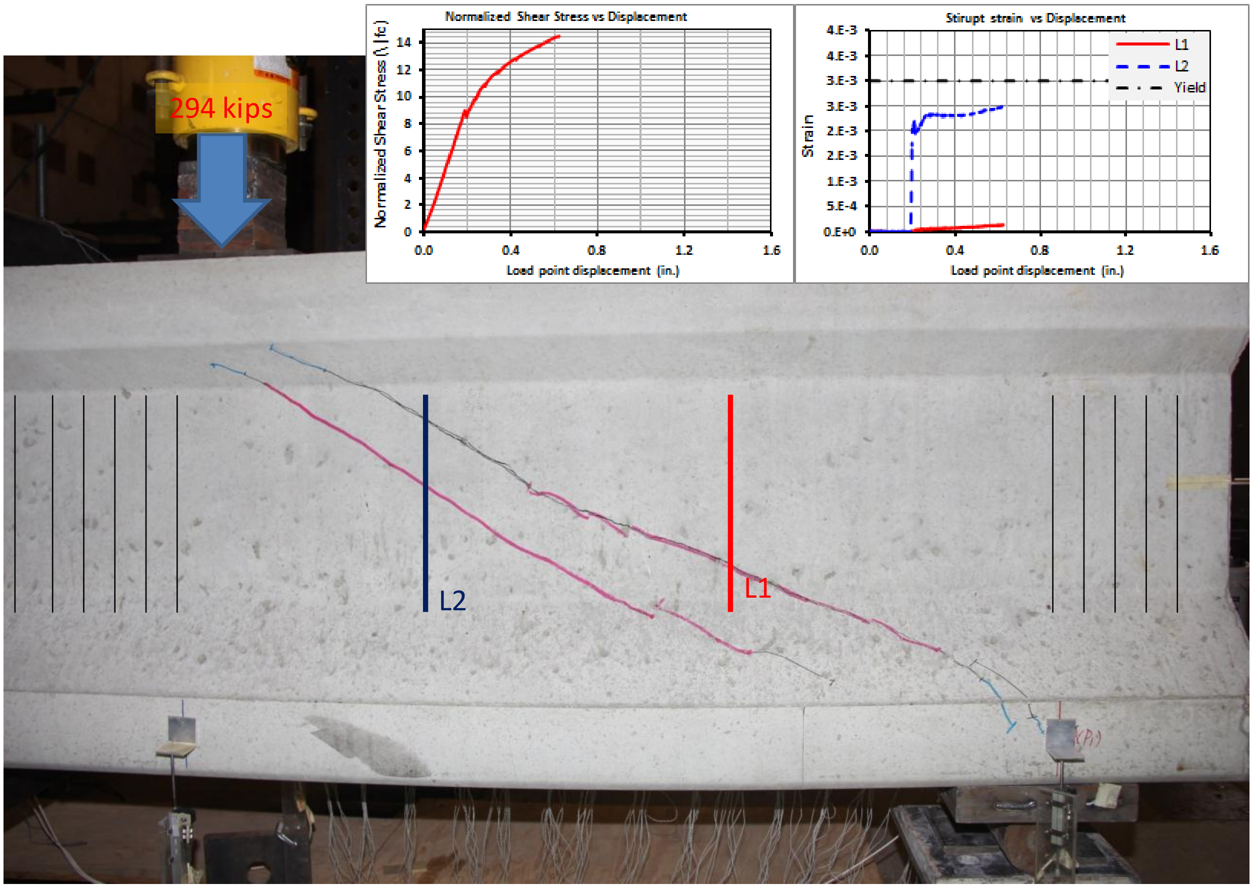


Figure D12. Beam 2 Test 1 Peak Load Before Failure.

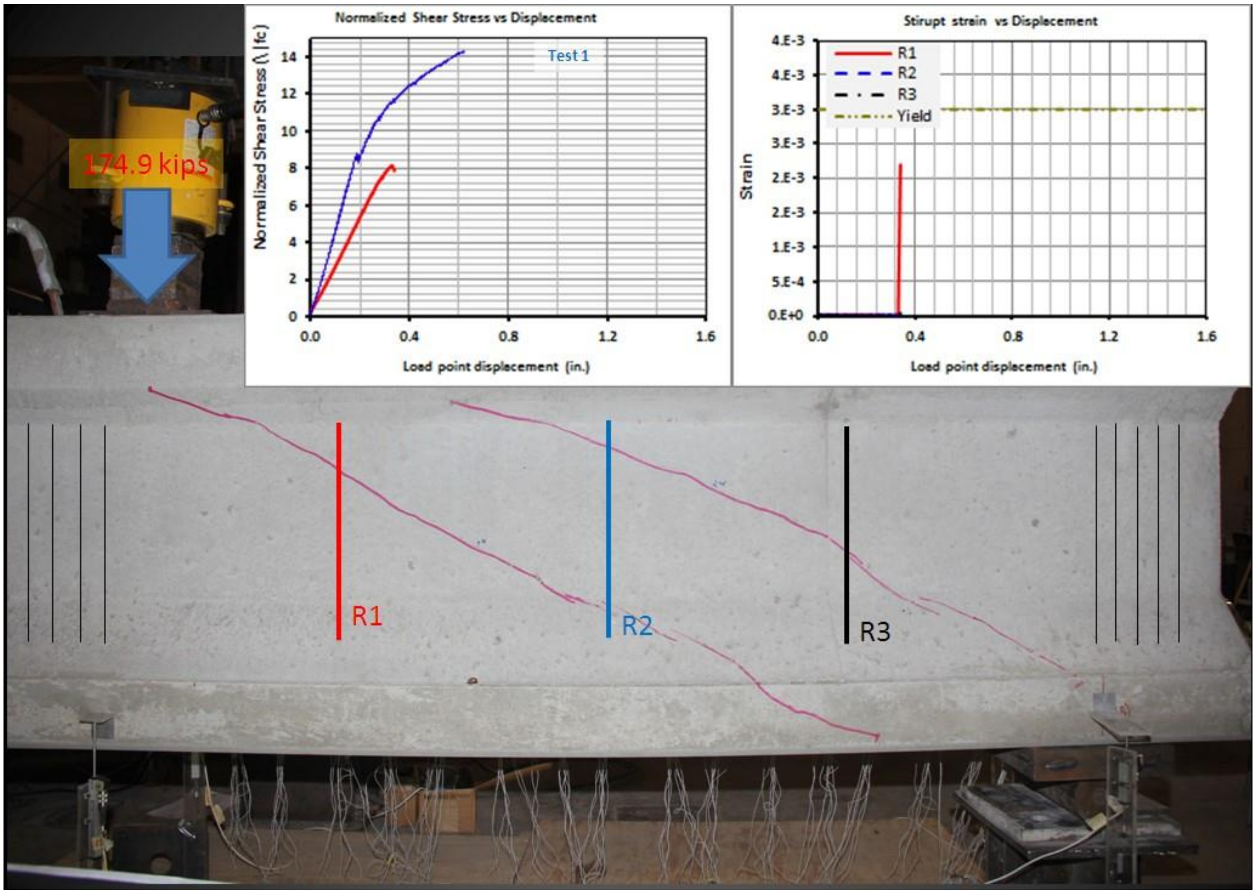


Figure D13. Beam 2 Test 2 First Cracking Load.

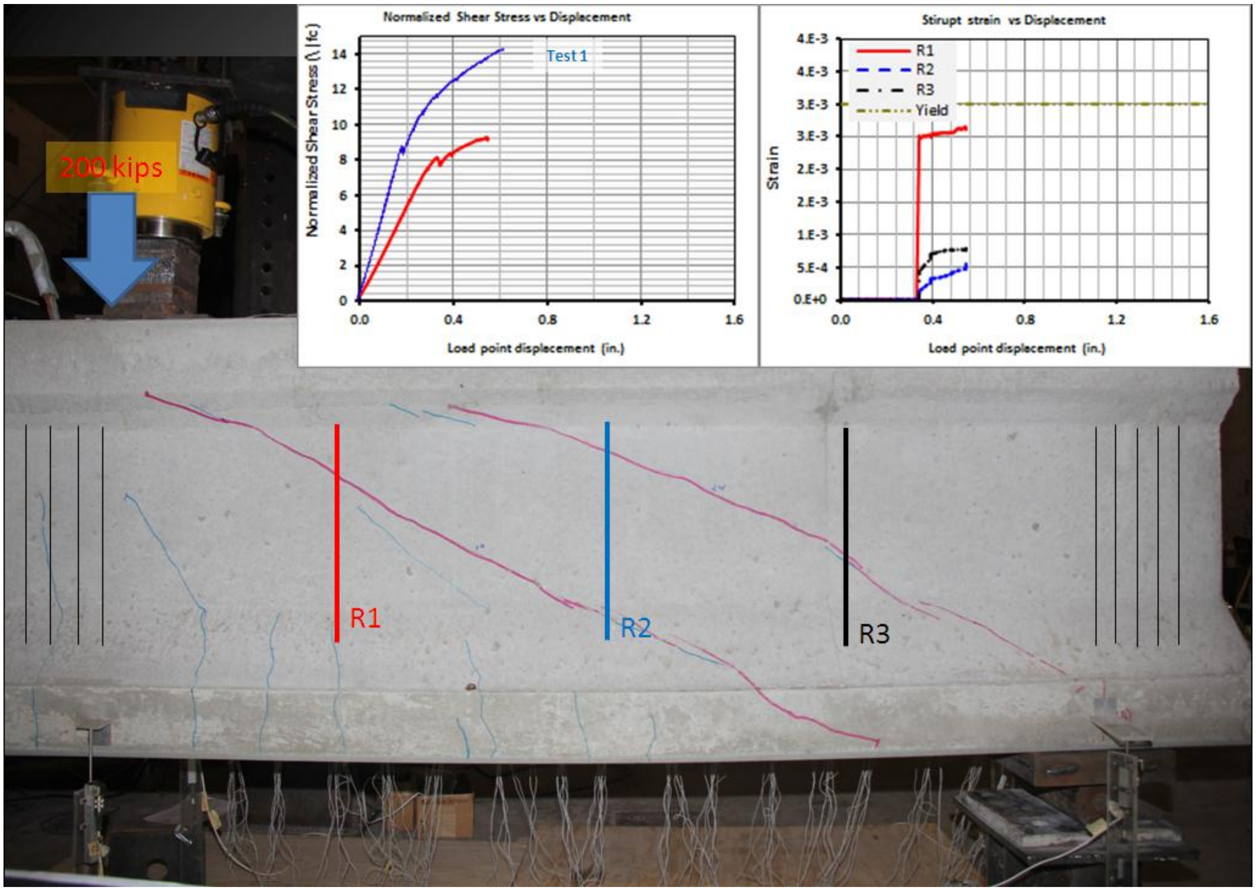


Figure D14. Beam 2 Test 2 Flexural Cracks.

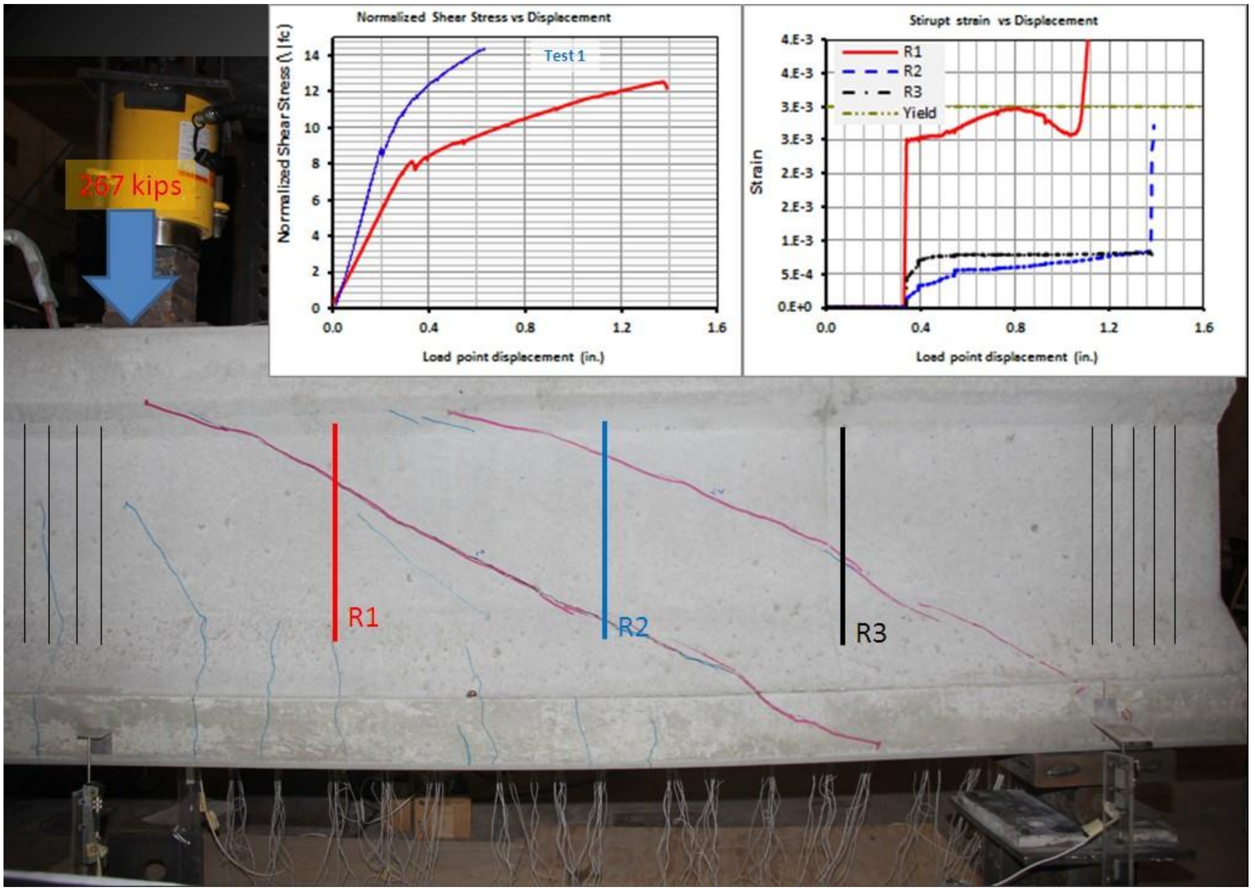


Figure D15. Beam 2 Test 2 Peak Load Before Failure.

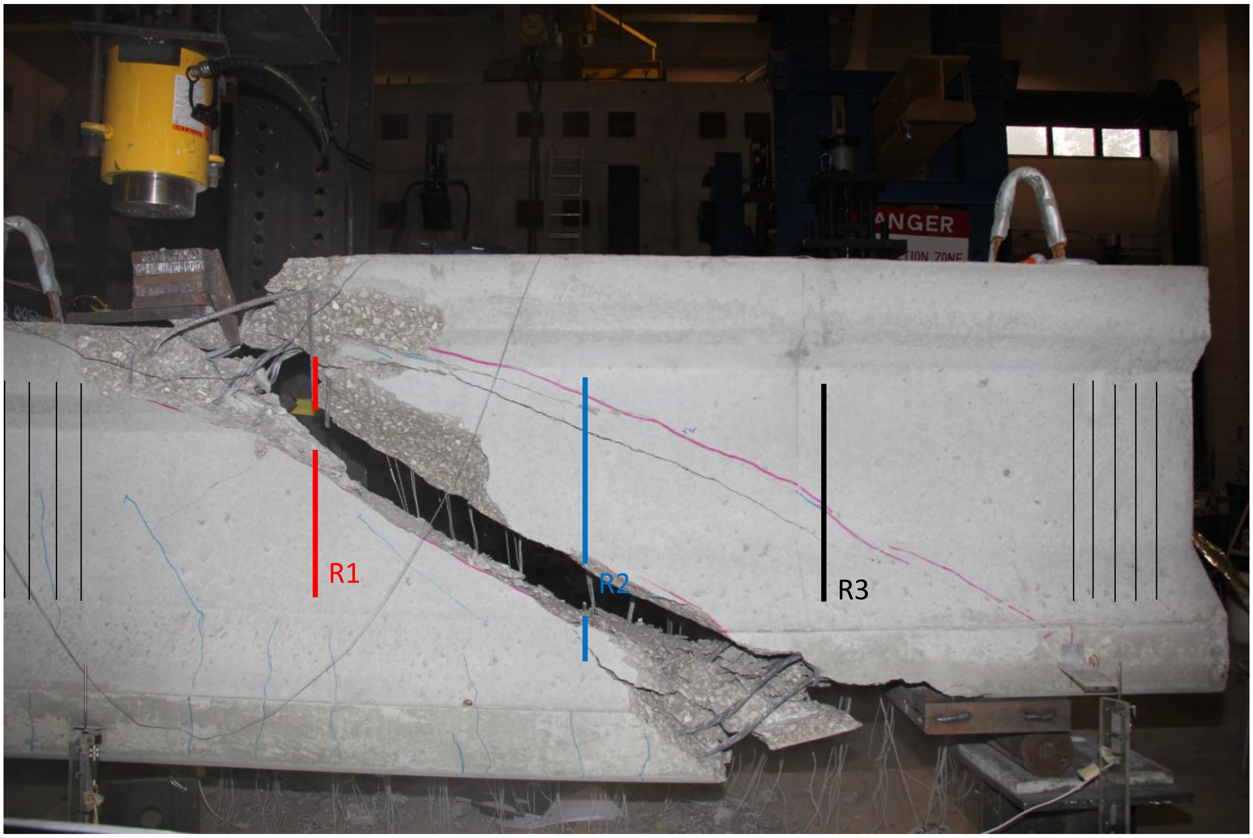


Figure D16. Beam 2 Test 2 Failure.

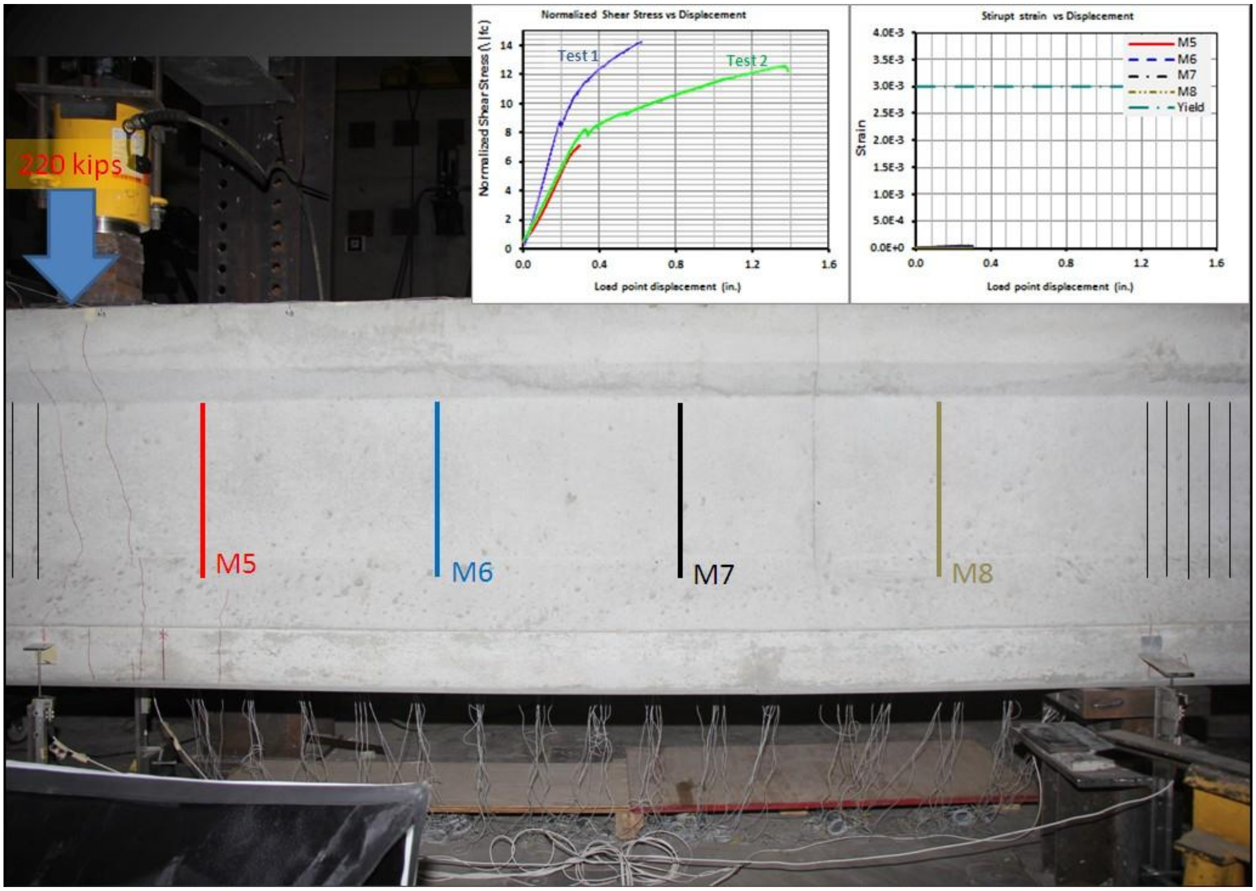


Figure D17. Beam 2 Test 3 First Cracking Load.

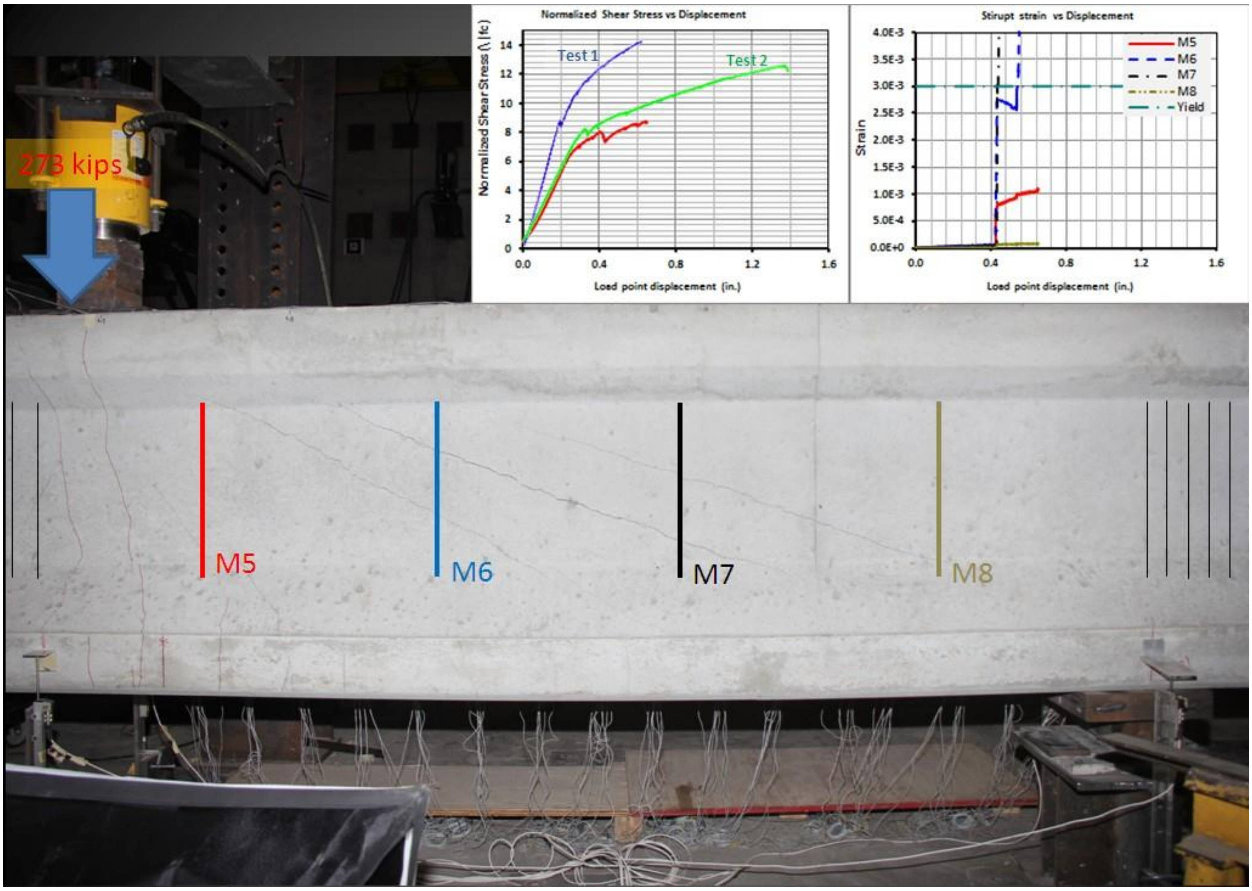


Figure D18. Beam 2 Test 3 Peak Load Before Failure.

APPENDIX E: FEA MODEL VERIFICATION

Verification Data Set 1: Saqan and Frosch Tests

<u>Test Beams</u>

Test beam characteristics used for model verification are shown in Table E1, while beam cross-sections are shown in Figure E1.

Table E1. Specimens details (Saqan and Frosch 2009).

Series	Specimen	Prestressed strand 1/2 in. (No. 13)	Mild reinforcement		Width b_w, in. (mm)	Effective depth of strands d_p, in. (mm)	Effective depth of bars d, in. (mm)
			Bars	Area, in.^{2} (mm^2)			
1	V-4-0	4	—	0	14.25 (362)	24 (610)	-
	V-4-0.93	4	Three No. 5 (Three No. 16)	0.93 (600)	14.50 (368)	24 (610)	26.40 (671)
	V-4-2.37	4	Three No. 8 (Three No. 25)	2.37 (1529)	14.68 (373)	24 (610)	26.00 (660)

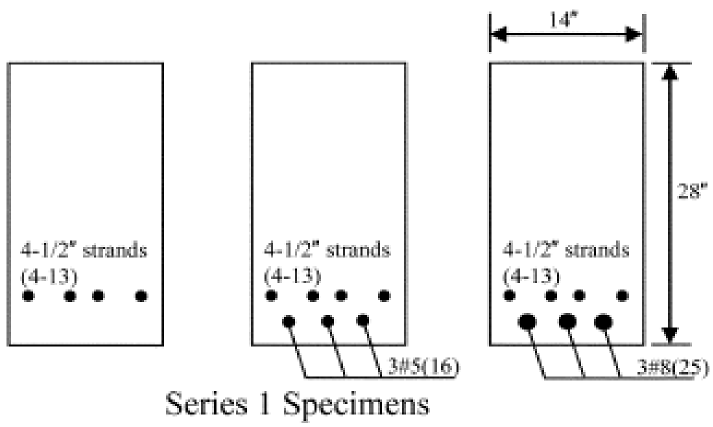


Figure E1. Test Beam Cross-Sections (Saqan and Frosch 2009).

Beam reinforcement consisted of ASTM A416, 1/2 in seven-wire Grade 270 low-relaxation prestressing strands and ASTM A615, Grade 60 reinforcing bars. The concrete had a nominal design strength of 6000 psi (7550 psi at 28 days). Cement was specified as ASTM C150, Type I. The coarse aggregate maximum-size is 3/4 in. The effective prestress force that was applied to each beam was 108 kips. The experimental tests consisted of a simply supported beam with a concentrated load applied at mid-span. The beam length, loading and boundary conditions are shown in Figure E2. These conditions are the same for all the tested beams.

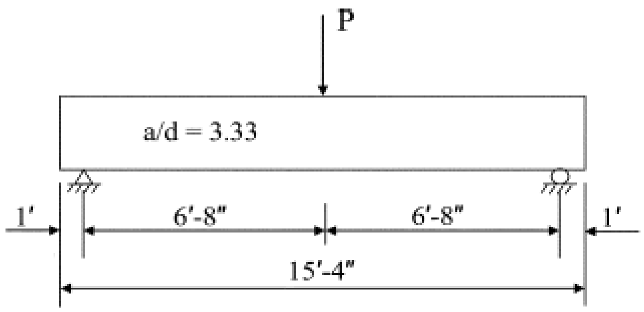


Figure E2. Test Setup (Saqan and Frosch 2009).

FEA Model

The dimensions and reinforcement details used to model the beams are given in Figures E3-E5 and Table E2.

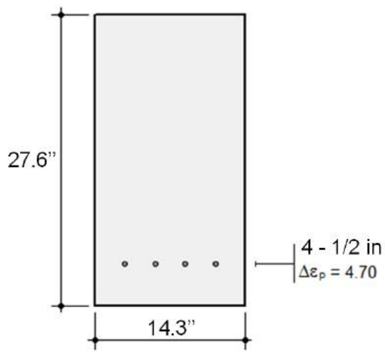


Figure E3. Test Beam V-4-0.

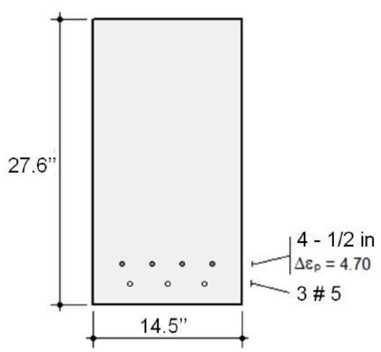


Figure E4. Test Beam V-4-0.93.

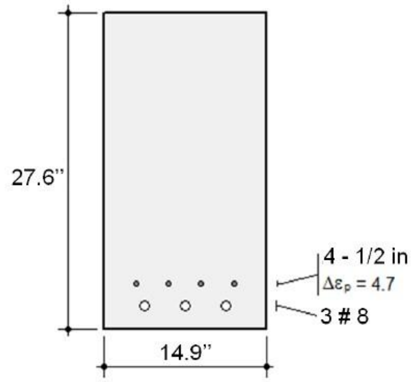


Figure E5. Test Beam V-4-2.37.

In the analysis, prestress strands are modeled with truss elements while the concrete is modeled with plane stress quadrilateral elements. The reinforcement is assumed perfectly bonded over the entire beam length and a prestress force of 108 kips was applied as a prestrain to the prestress steel truss elements. Steel properties used in the models are given in Table E2. For concrete, compressive strength $f_c' = 7550\ psi$; tensile strength $f_t' = 0.345\ ksi$; cylinder strain at $f_c', eo = 2.1\ me$; Poisson's ratio $u = 0.15$; and maximum aggregate size $a = 3/4\ in.$

Table E2. Steel Material Properties.

	Prestressing Steel	Mild Steel
Yield stress (Fy) (ksi)	220	60
Ultimate Stress (Fu) (ksi)	270	90
Elastic Modulus (Es) (ksi)	27992	29000
Strain hardening (esh)	10 me (milli-strain)	10 me
Prestrain (Dep)	4.7 me (milli-strain)	0

Models had approximately 2600-2800 plane stress and 180 truss elements. Since both the load and the supports are symmetrical about mid-span, only half of each beam is modeled, with symmetry boundary conditions imposed. The node at the support (left side) was restrained against the displacement in the transverse direction (Y direction) while the nodes at the mid span slice (right side) were restrained against displacement in the longitudinal direction (X direction), as shown in Figure E6.

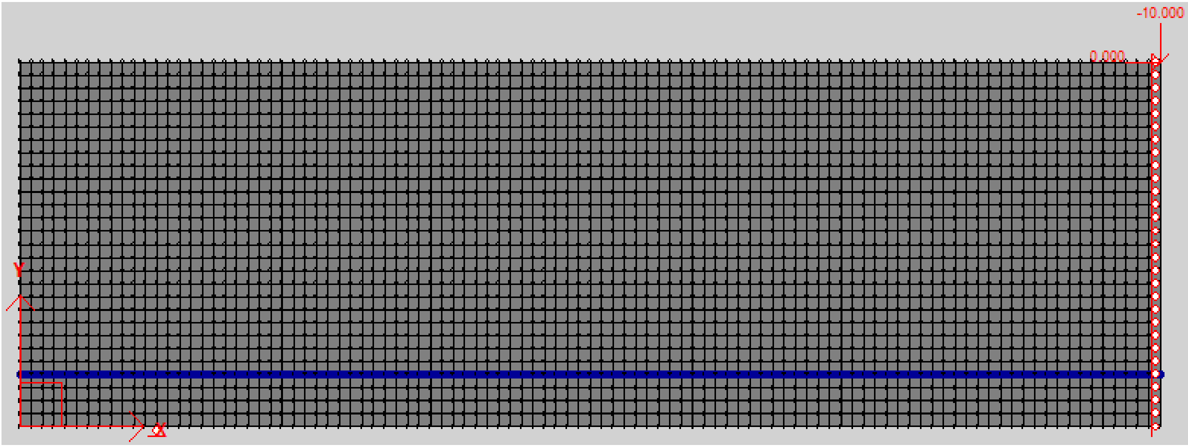


Figure E6. Mesh of Left Half of Symmetric FEA Model (Beam V-4-0.93).

A concentrated load of 2.2 kips was applied at the mid-span top node (Figure E6) in the negative Y direction. The load was increased at a rate of 2.2 kips per analysis step until the failure point was reached for each beam.

Results

The deformed shapes of the beams (exaggerated) at ultimate capacity are shown in Figures E7-E9. Damaged elements, indicating concrete crack locations, are shown in red.

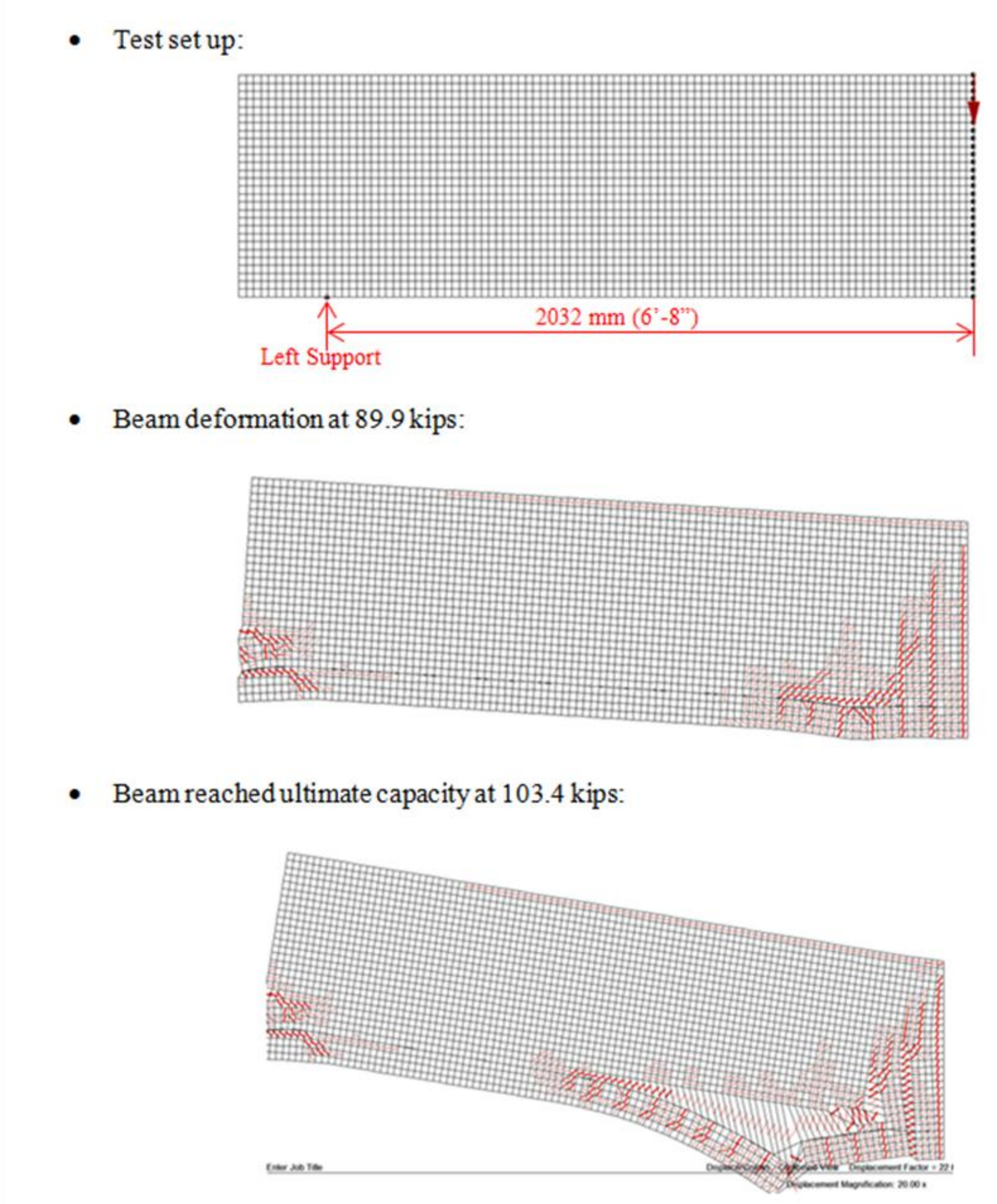
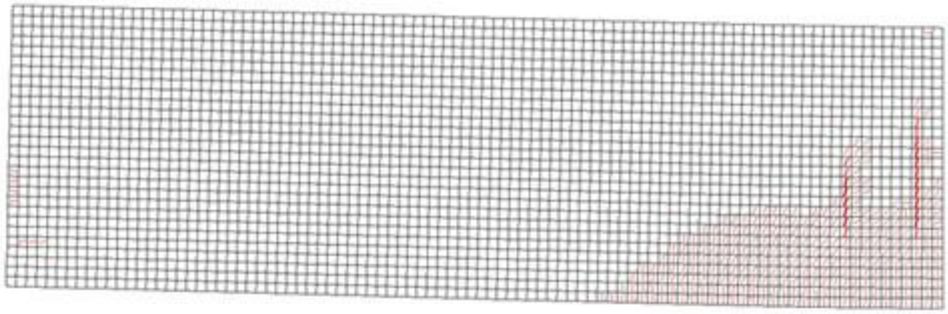


Figure E7. FEA Model for Beam V-4-0.

- Beam deformation at 98.9 kips:



- Beam reached ultimate capacity at 125.9 kips:

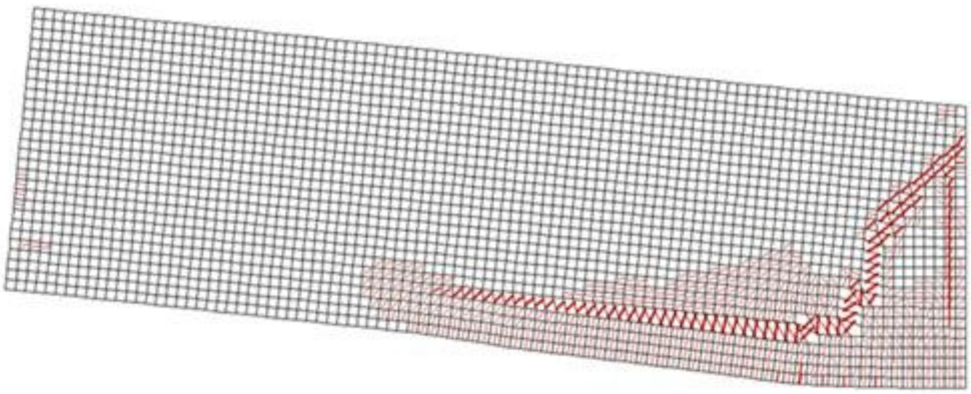
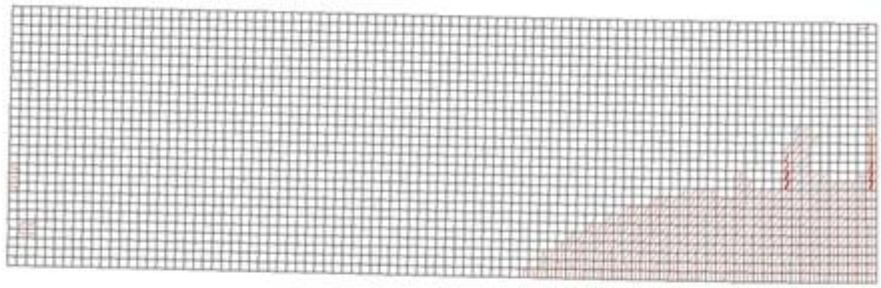


Figure E8. FEA Model for Beam V-4-0.93.

- Beam deformation at 107.9 kips:



- Beam reached ultimate capacity at 143.9 kips:

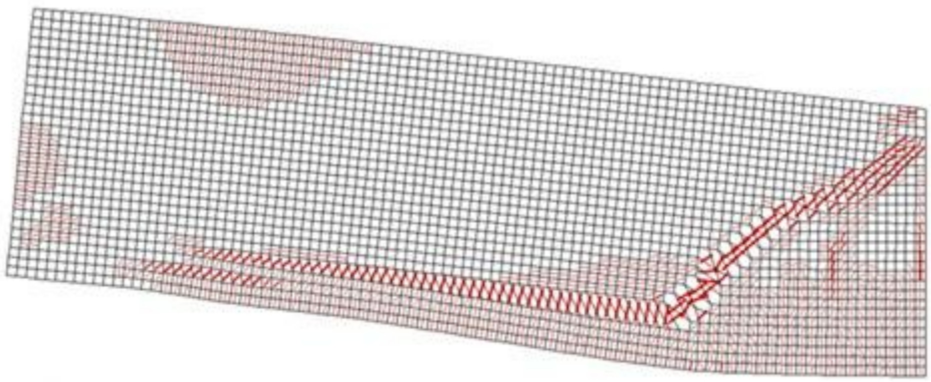


Figure E9. FEA Model For Beam V-4-2.37.

Verification Data Set 2: UM Test Beams

Beam 1

As noted in Chapter 4, beam 1 reinforcement consisted of sixteen 1/2 in seven-wire Grade 270 low-relaxation prestressing strands and two Grade 60 reinforcing bars. Concrete had an average compressive strength of approximately 7500 psi for Test 1, 7900 psi for Test 2, and 8620 psi for Test 3, with a coarse aggregate maximum-size of 3/4 in. The average prestress force that was applied to each strand is 32.2 kips (average stress of 1.4 ksi in the concrete cross section). Figure E10 presents the initial beam model used for Beam 1 in VecTor2.

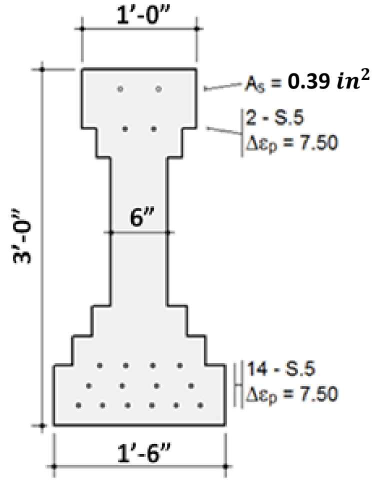


Figure E10. Initial Beam 1 Model Cross Section

It is assumed that the truss reinforcement is perfectly bonded over the entire beam length and a prestress force of 32.2 kips was applied as a prestrain (7.52 *me*) to each strand. Steel input properties are given in Table E3. Concrete compressive strength was taken from 6-9 ksi (minimum, mean, and maximum found from cylinder tests) for different model runs, with corresponding tensile strength from 0.33-0.39 ksi and cylinder strain at $f_c', eo = 2.55\, me$. Concrete Poisson ratio is taken as 0.15, with maximum aggregate size set to 1 in.

Table E3. Beam 1 Steel Material Model Parameters.

	Prestressing Steel	Mild Steel
Yield stress (Fy) (ksi)	243	60
Ultimate Stress (Fu) (ksi)	270	90
Elastic Modulus (Es) (ksi)	28500	29000
Strain hardening (esh)	10 me	10 me
Prestrain (Dep)	7.52	0

Beam 1 Test 1

In Test 1, only the left part of the full beam between supports A and C was modeled (Figure E11). The boundary conditions were modeled as a roller at support A and pinned at support C. No clamps were applied to the FEA model. Instead, the amount of transverse reinforcement at the clamped section was significantly increased (approximately 3 times) to prevent any cracking along that section. Due to a limitation in the number of elements allowed (6000) in the currently available version of the VecTor2 preprocessor (FormWorks, version 3.5), a fine mesh was applied only at the section of interest where critical shear cracks are expected to occur. A 6 in. line load was applied at P1 (Figure E11) in the negative Y direction, to prevent local element crushing and distortion. The load was increased monotonically at a rate of 4.5 kips/step until beam failure (the same load scenario was used for the other two tests as well). To prevent cracks at the zero-width supports, a higher-strength concrete material was modeled in the elements just above these locations.

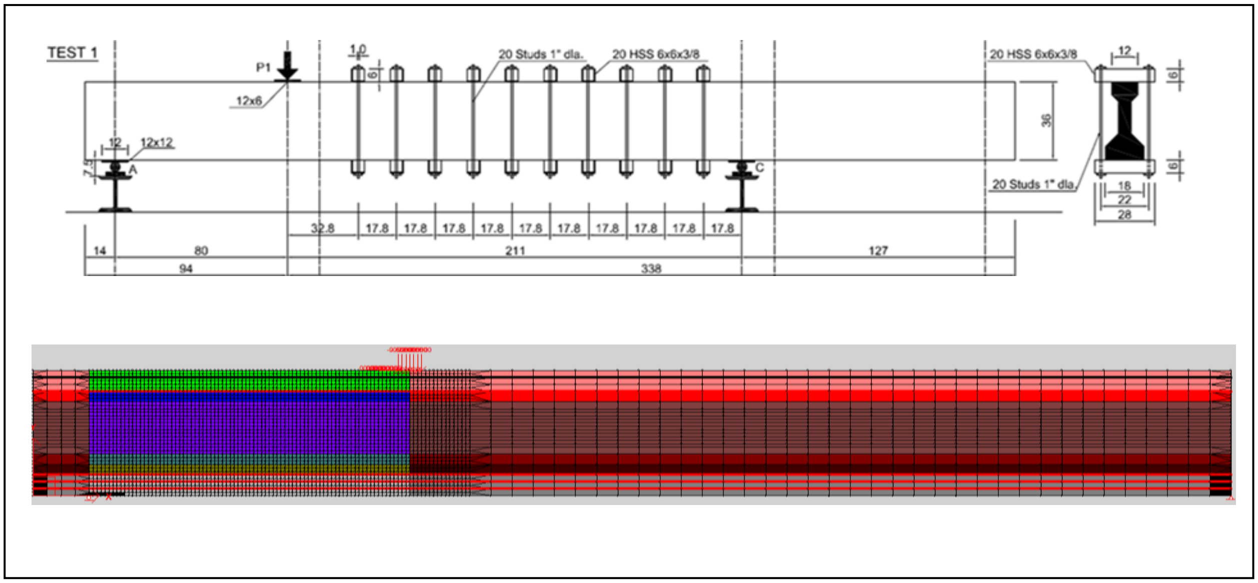


Figure E11. Beam 1 Test 1 Model (dimensions in inches).

At the beginning of the analysis, the left end of the beam cracked immediately as shown in Figure E12a. These cracks appeared to be as a result of the reinforcement prestrain at that location. In order to prevent the left face from prematurely cracking, a coarse mesh was applied at that section, which reduced crack potential, as shown in Figure E12b. Note that as this coarse mesh is outside of the beam span (i.e. to the left of the leftmost support), diagonal cracking potential is not affected. This adjustment was applied to all models. The results of the adjusted model are shown in Table E4 and Figure E13. Figure E14 shows intermediate deformation results with f'c = 7.5 ksi.

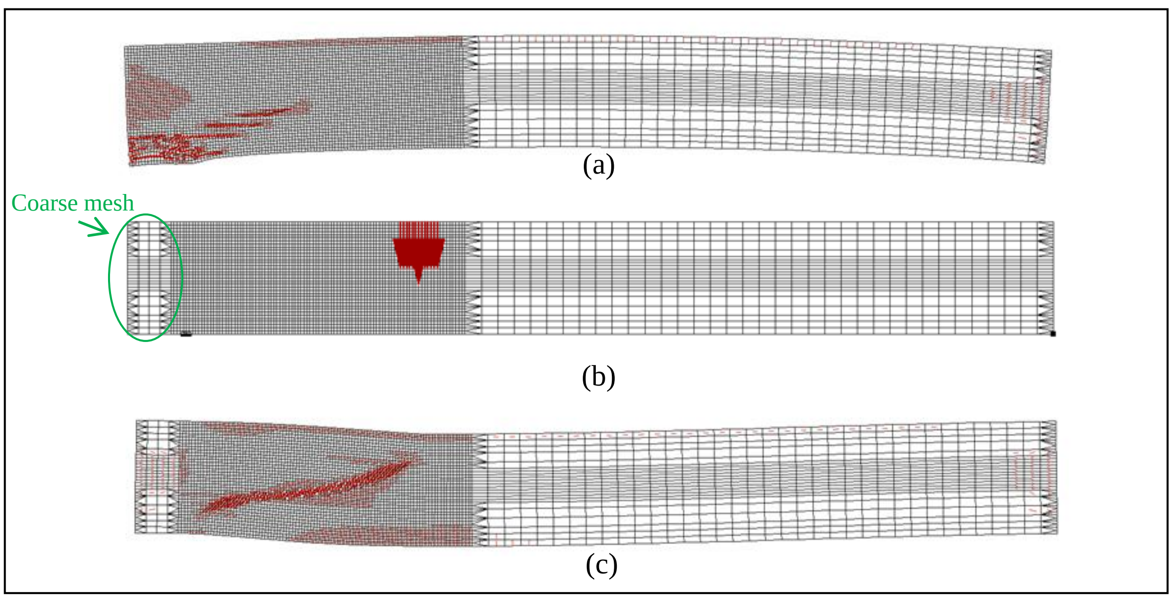


Figure E12. Beam 1 Test 1 Model Results: (a) Fine mesh at the left face (b) Coarse mesh at the left face (c) Deformation shape at failure.

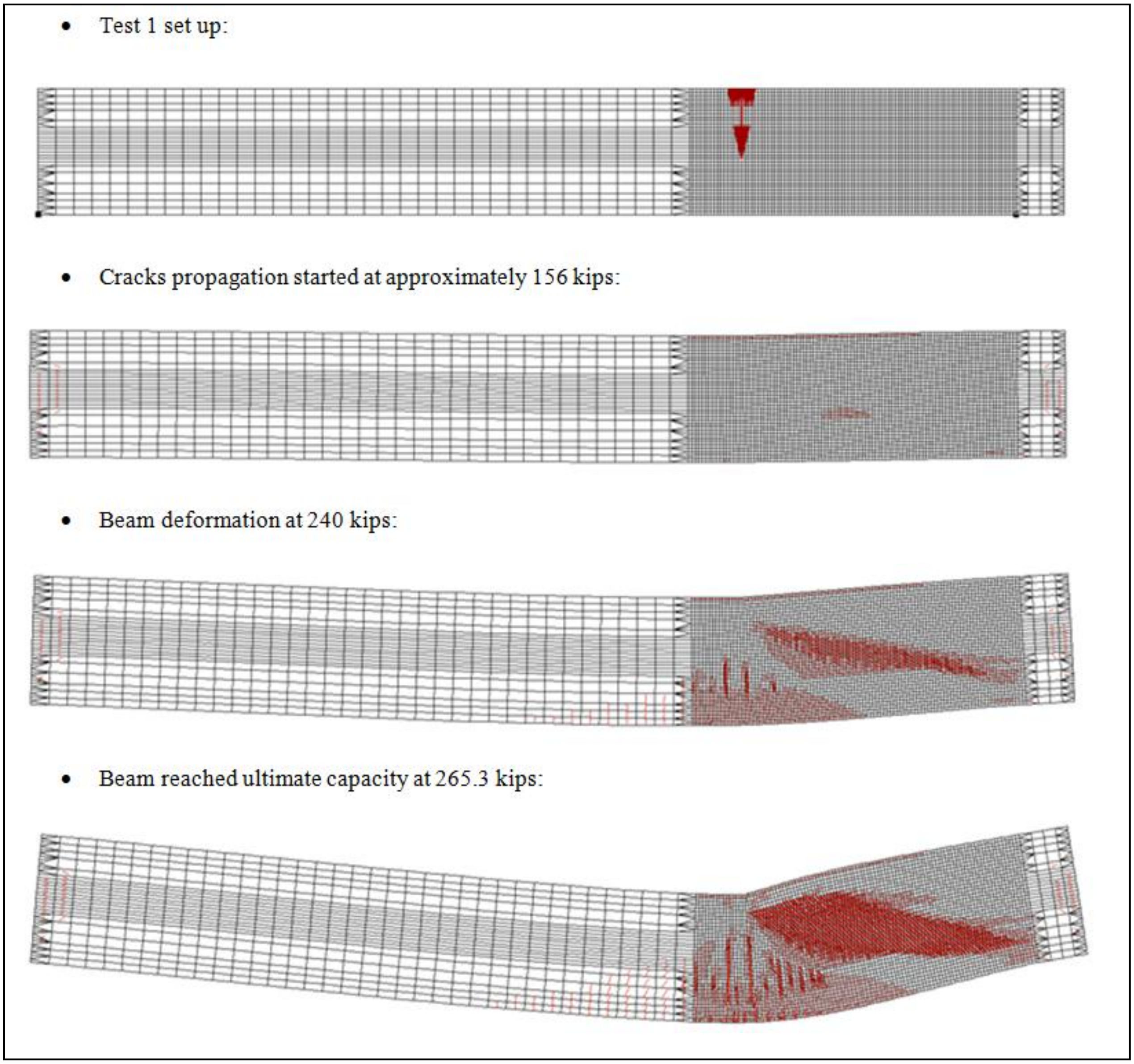


Figure E13. Beam 1 Test 1 Model Results.

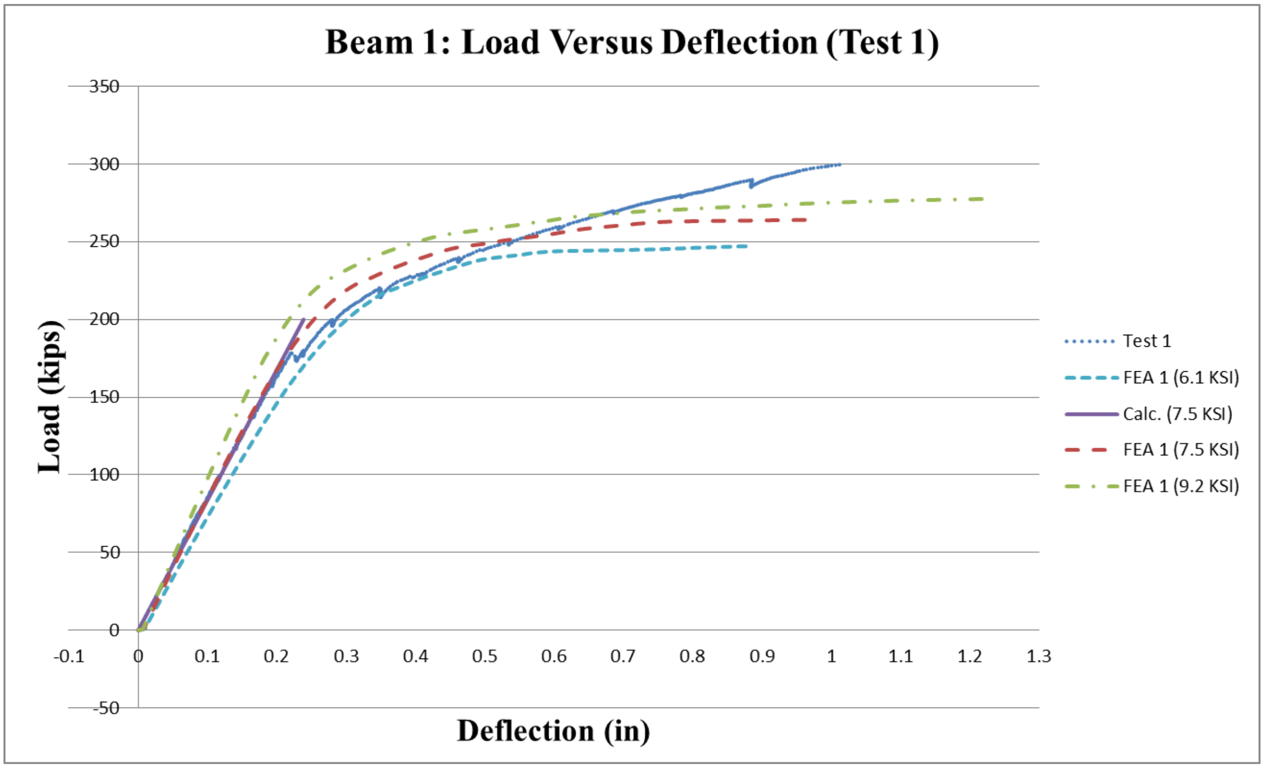


Figure E14. Beam 1 Test 1 Load-Deflection Results.

Table E4. Beam 1 Test 1 Model Results.

f'_c (ksi)	Shear cracking load (Kips)	Ultimate failure load (Kips)
Test	180	299
6.1	147	248
7.5	156	265
9.2	166	278

<u>Beam 1 Test 2</u>

In Test 2, only the portion of the beam between supports B and D was modeled. The boundary conditions consisted of a pin at support B (left) and a roller at support D (right). The transverse reinforcement at the clamped section (Figure E15) was increased as in the Test 1 model to prevent any cracking along that section. Results are shown in Table E5 and Figure E16. Figure E17 shows intermediate deformation results with f'_c = 7.8 ksi.

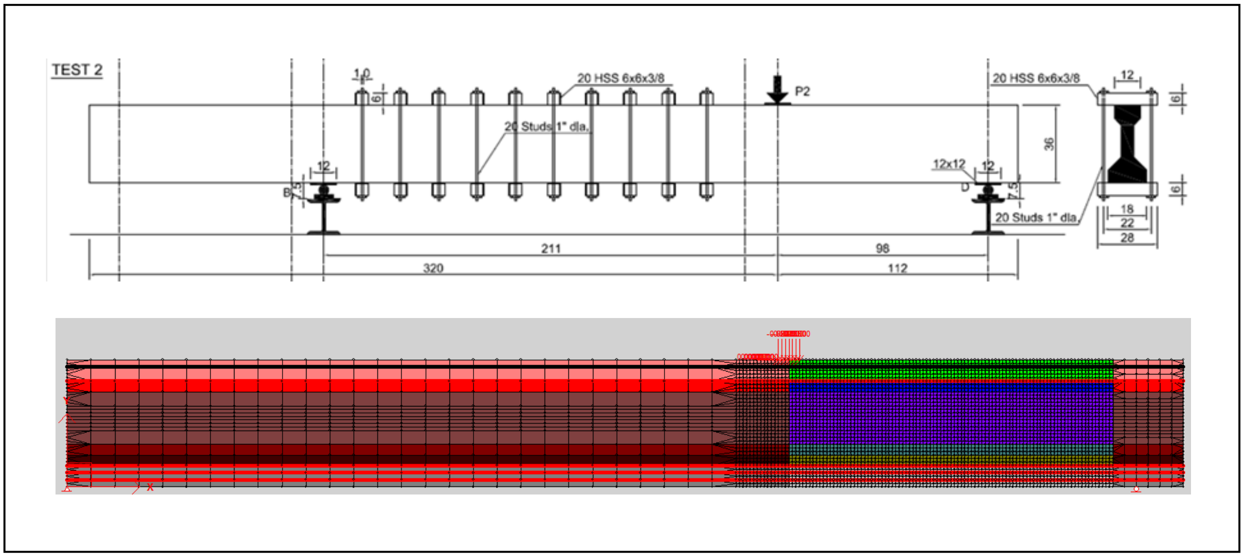


Figure E15. Beam 1 Test 2 Model (dimensions in inches).

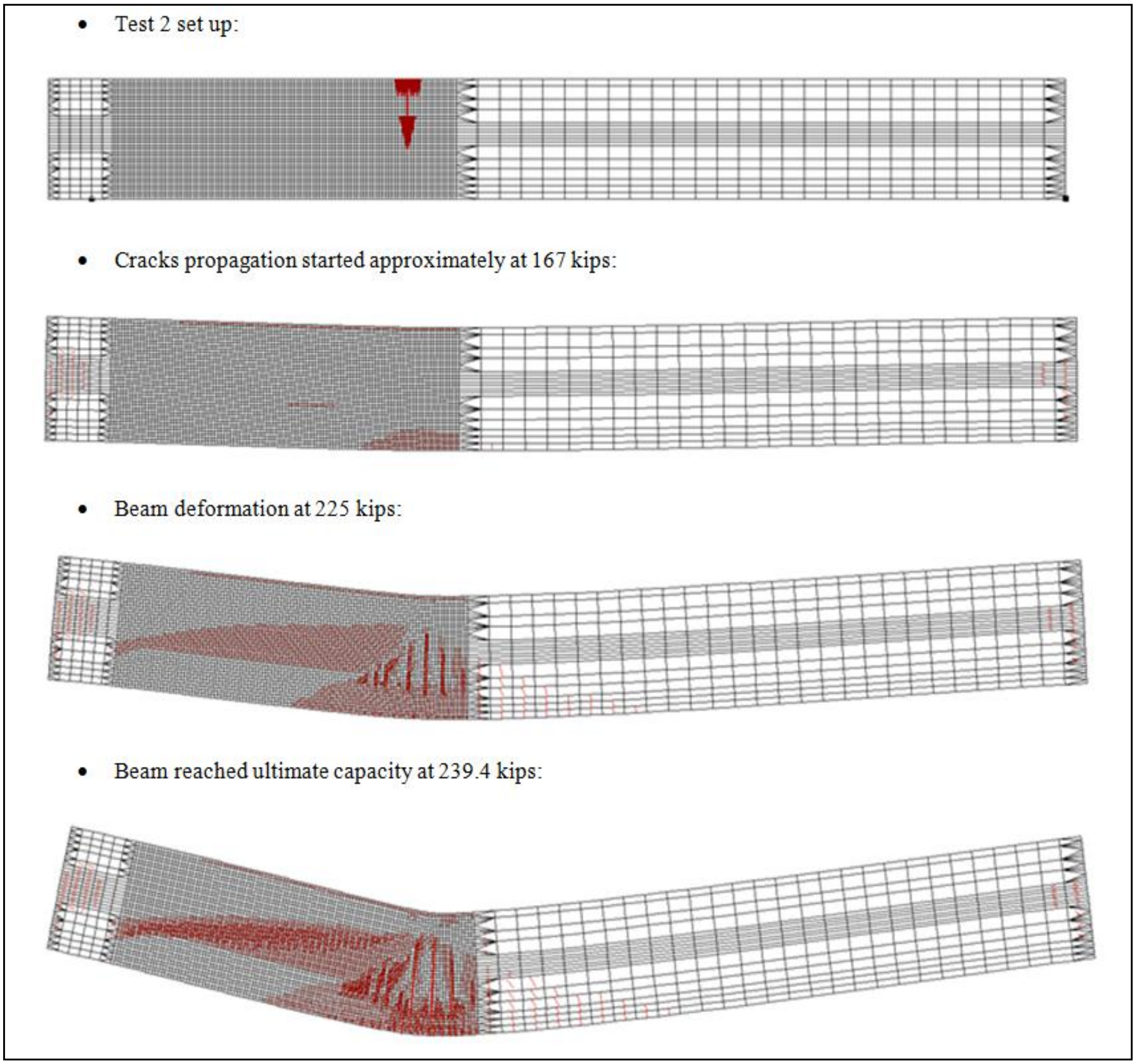


Figure E16. Beam 1 Test 2 Model Results.

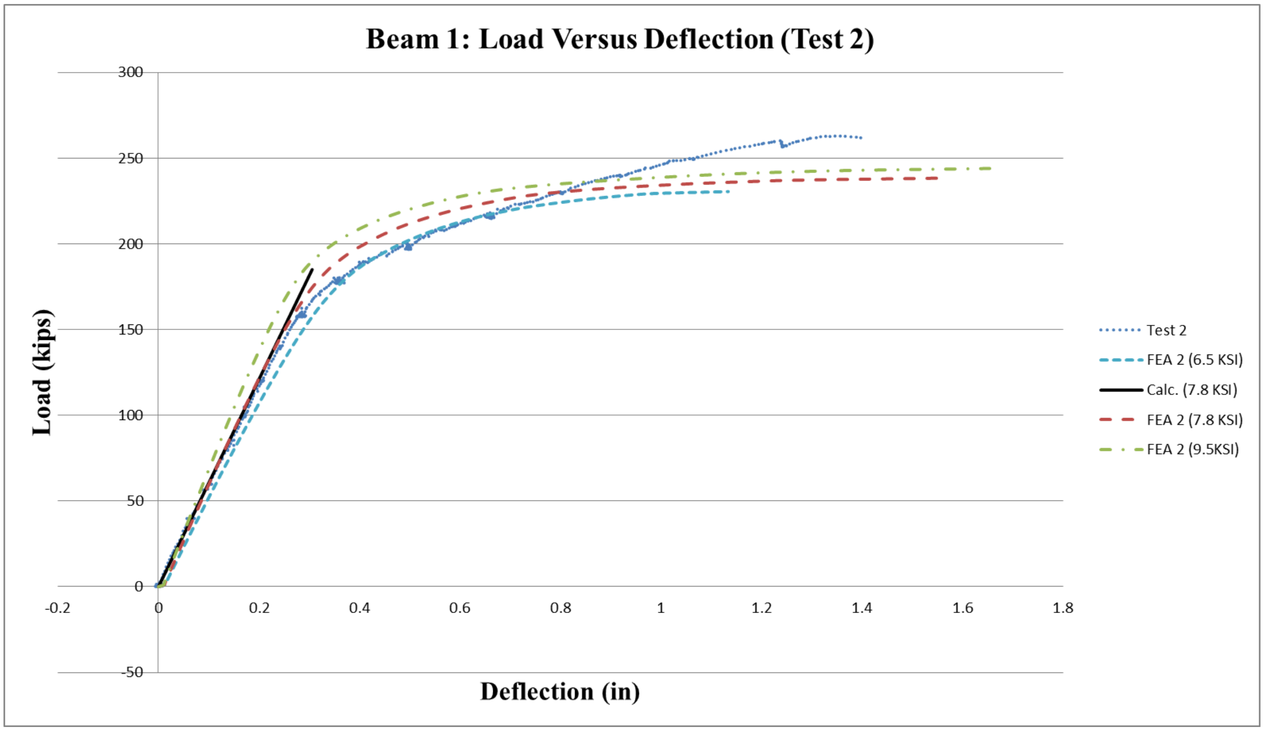


Figure E17. Beam 1 Test 2 Load-Deflection Results.

Table E5. Beam 1 Test 2 Model Results.

f'_c (ksi)	Shear cracking load (Kips)	Ultimate failure load (Kips)
Test	190	262
6.5	157	232
7.8	167	239
9.5	175	245

Beam 1 Test 3

In Test 3, the portion of the beam between supports B and C was modeled, as shown in Figure E18.

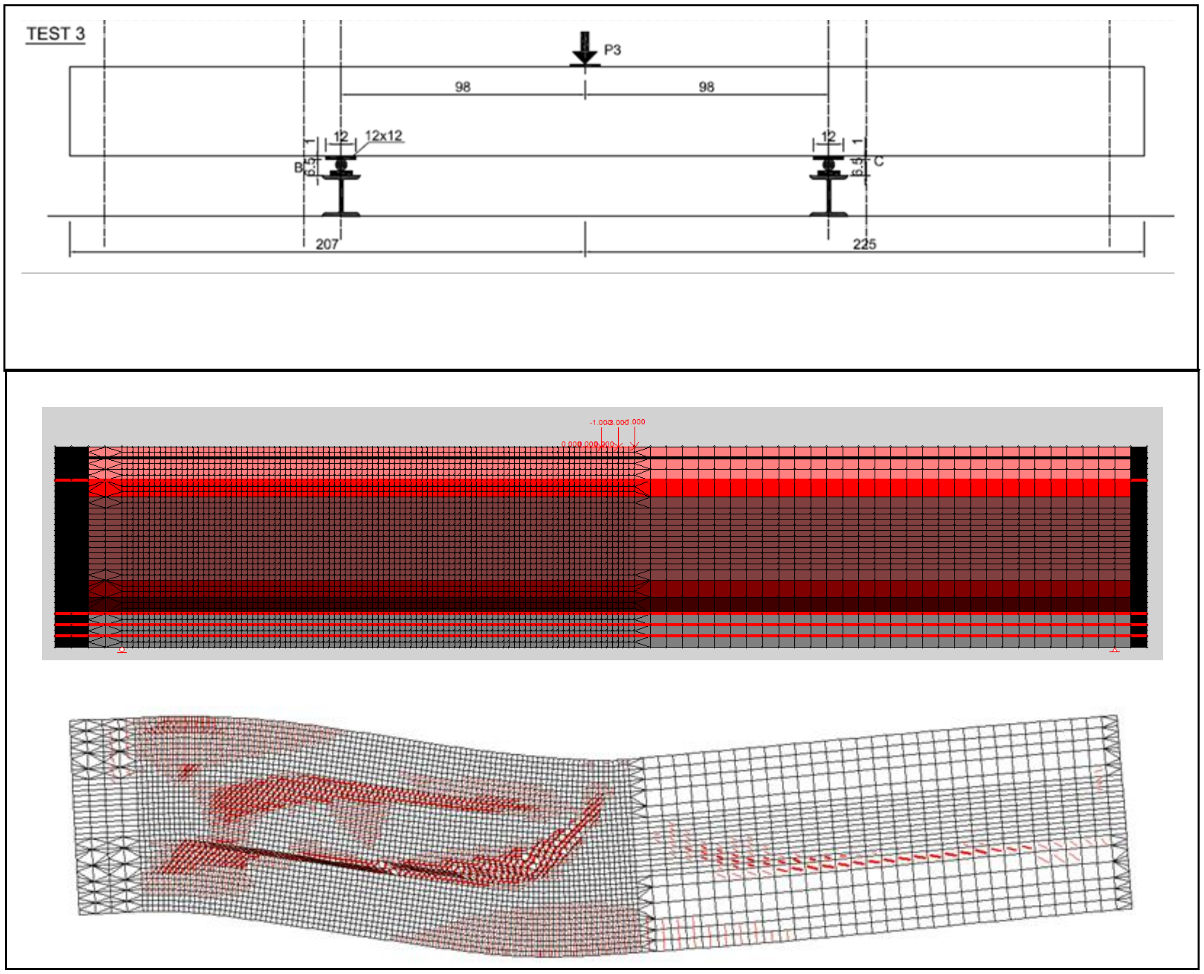


Figure E18. Beam 1 Test 3 Model (dimensions in inches).

The results of the model are shown in Table E6 and Figure E19. Figure E19 shows intermediate deformation results with f'_c = 8.6 ksi. As seen in Figures E19 and E20, a long horizontal crack appeared in the FEA model, which caused a beam failure significantly under the test result. It was determined that this crack was caused by artificially high stress concentrations that occurred at the abrupt, step-like width change of the idealized model, as a result of the prestress force (as shown in Figure E10). To avoid this problem, the modeling approach was again adjusted as shown in Figure E21. As shown in the figure, this method eliminated the section width change in the middle of the web, which was prone to shear cracking, and modeled the section with an “I” shape. In this method, the areas of the sloped, triangular web regions of the original section were distributed into a constant-width web of equal area as the original beam, resulting in a new modeled web width of 7.86” rather than the original 6.0”, as shown in Figure E21. This modified approach left the cracking load unchanged, but resulted in a substantial increase in predicted ultimate capacity, which was much closer to test results.

To verify the validity of the new "I" shaped modeling approach, it was applied to previous test results as well, as summarized in the load-displacement plots in Figures E22-E24 and in the ultimate capacity results shown in Tables E7-E9. Table E10 presents a summary of the critical beam test parameters. Figure E25 shows the final deformed shapes of the FEA models using the latest model. Good agreement with all test results were realized.

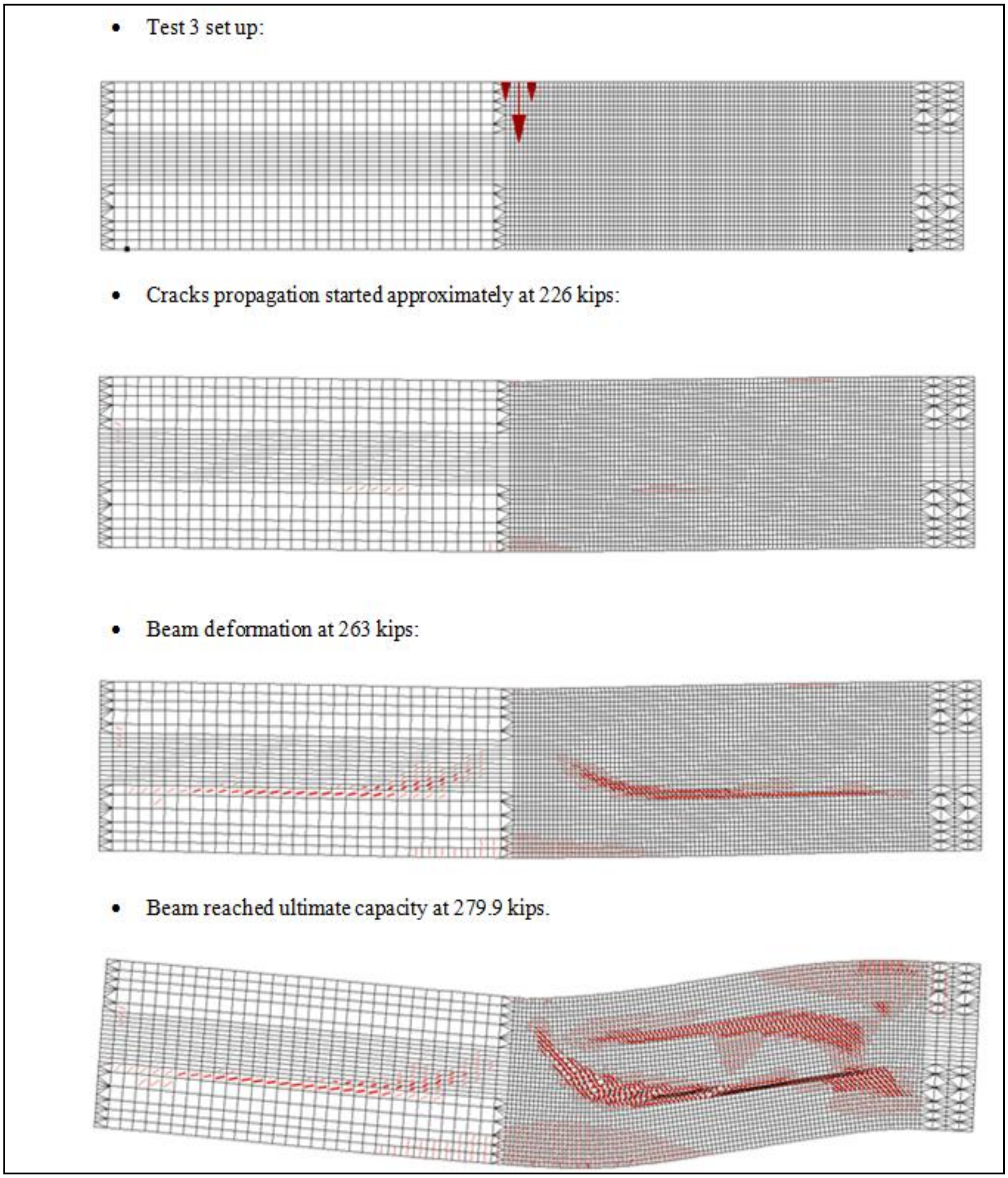


Figure E19. Beam 1 Test 3 Results.

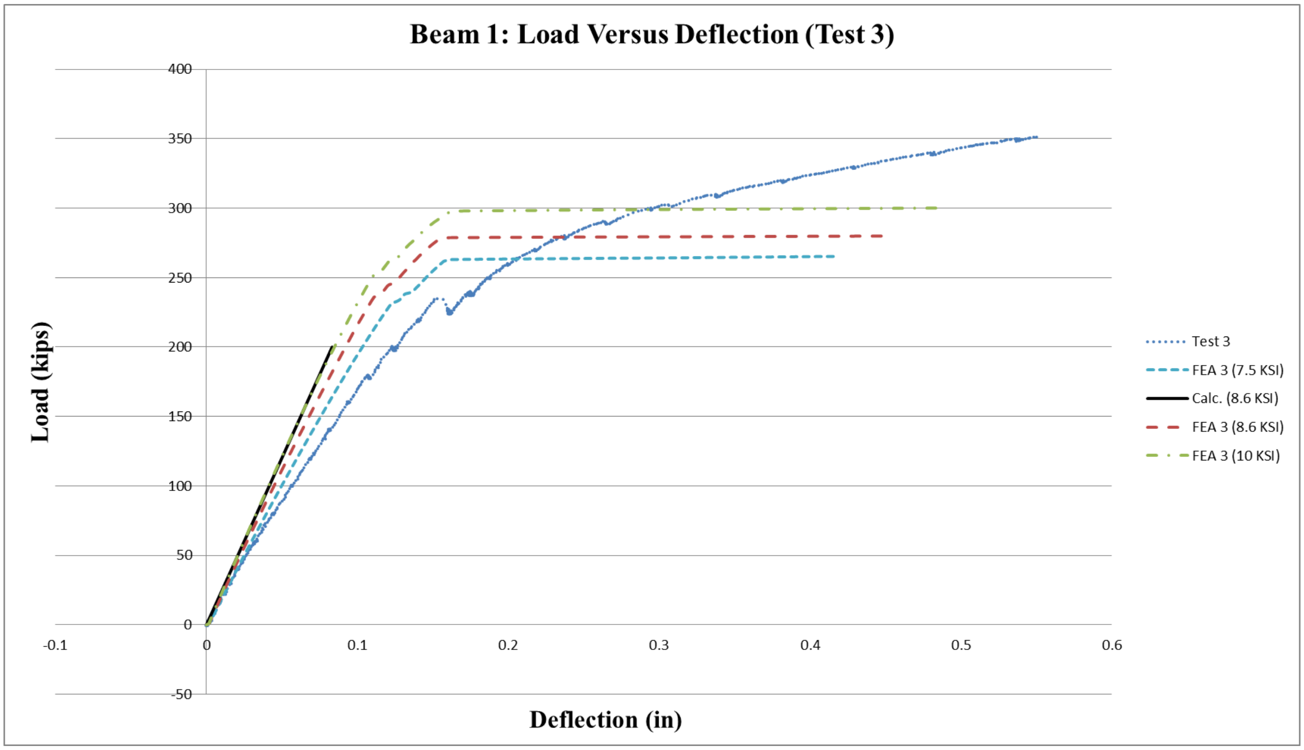


Figure E20. Beam 1 Test 3 Load-Deflection Results.

Table E6. Beam 1 Test 3 Model Results.

f'_c (ksi)	Shear cracking load (Kips)*	Ultimate failure load (Kips)
Test	227	356
7.5	225	264
8.6	226	280
8.6 Modified Model	245	337
10.0	242	299

*Shear cracking load in Test 3 was less than the FEA model results due to the existing cracks in the beam from Test 1 and Test 2.

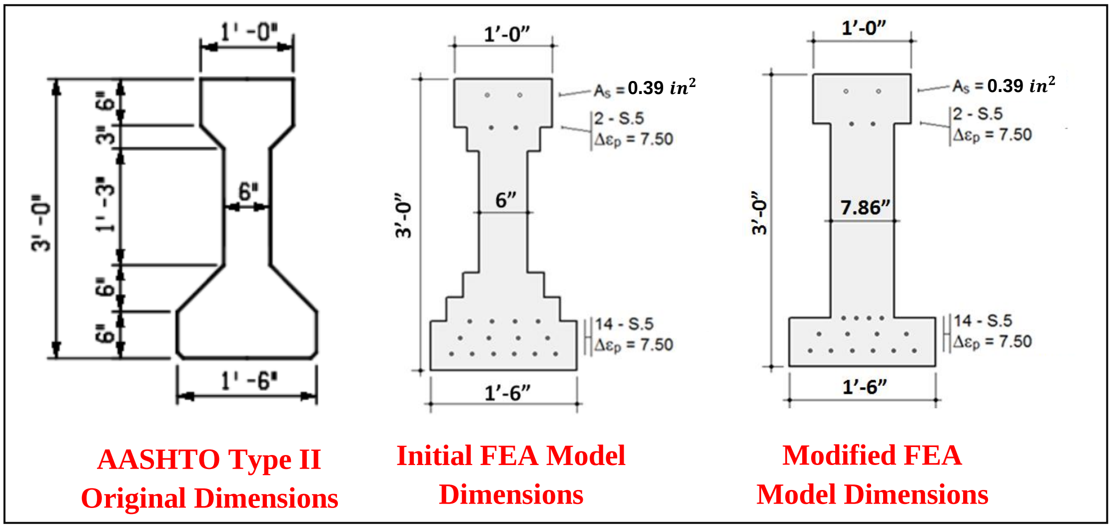


Figure E21. Modified FEA Model

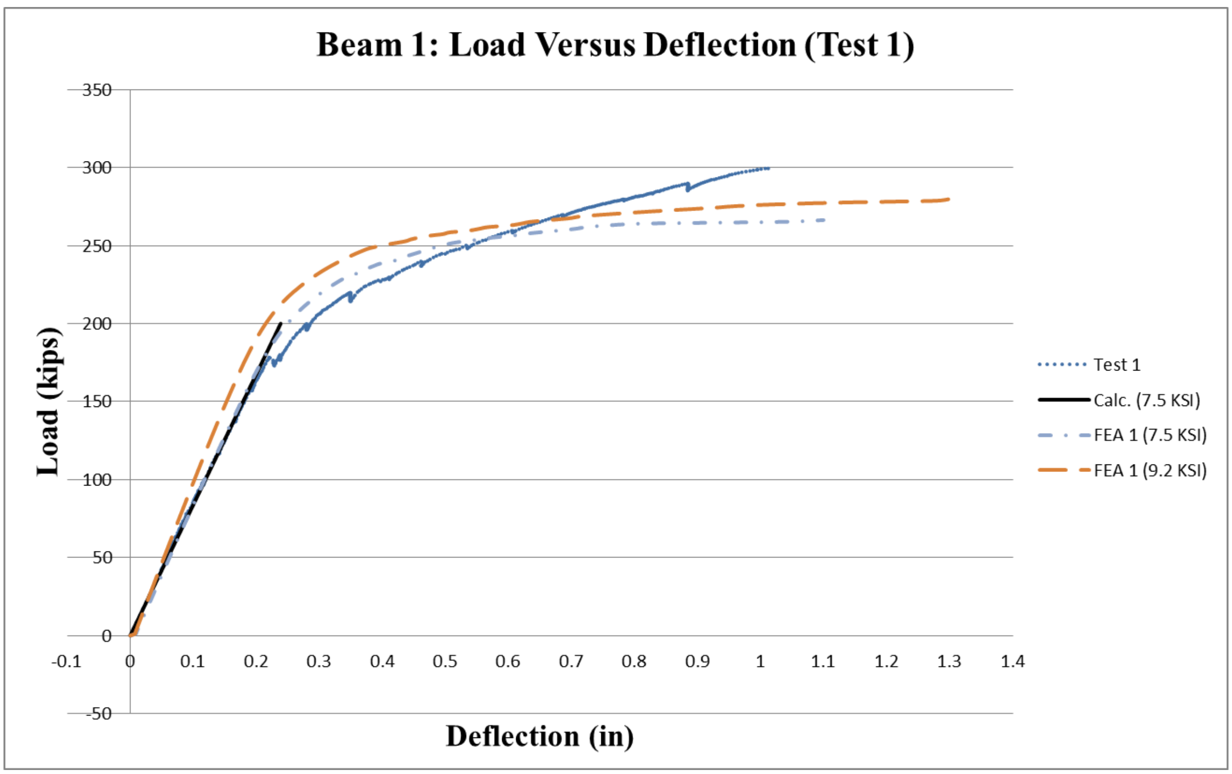


Figure E22. Modified Model Beam 1 Test 1 Load-Deflection Results

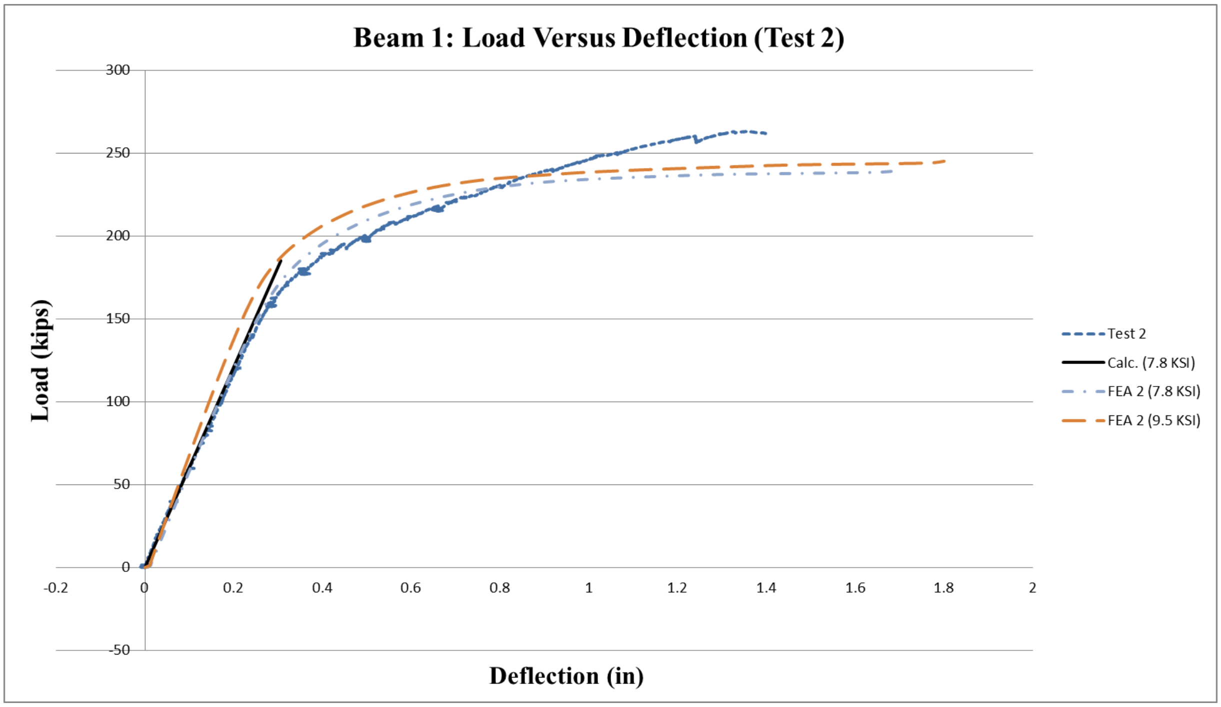


Figure E23. Modified Model Beam 1 Test 2 Load-Deflection Results.

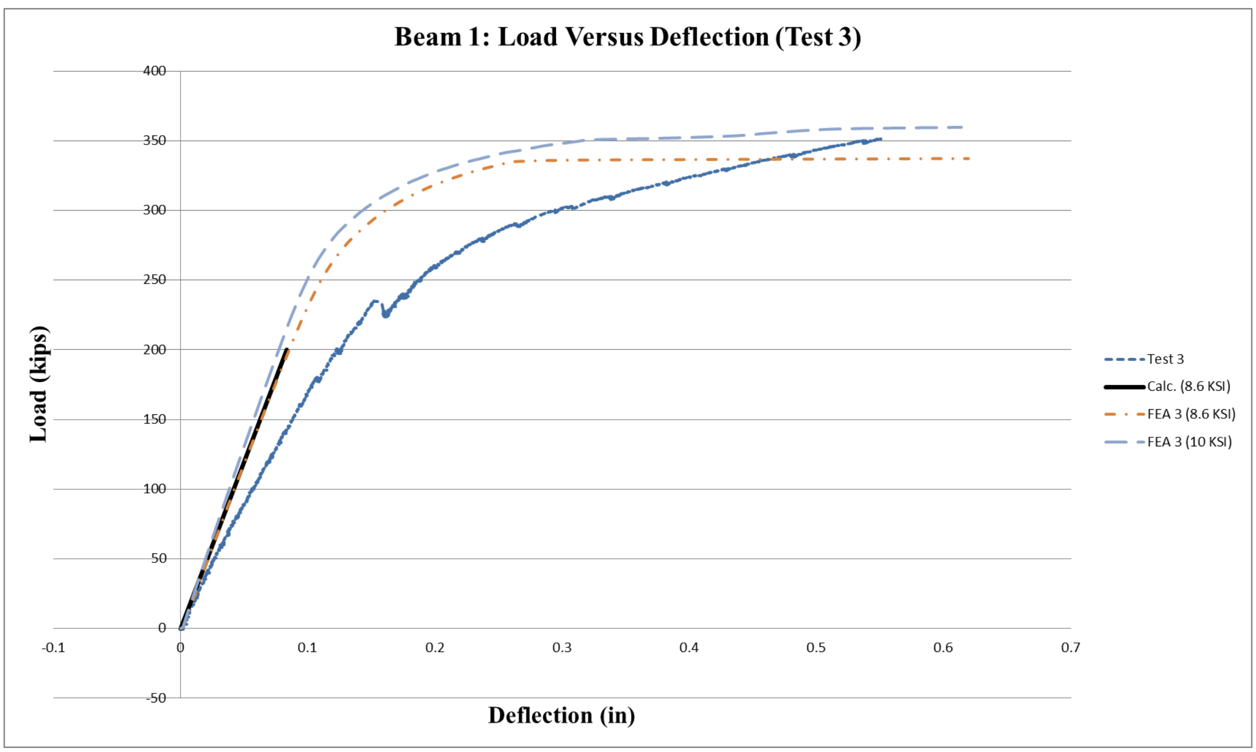


Figure E24. Modified Model Beam 1 Test 3 Load-Deflection Results.

Table E7. Modified Model Results for Beam 1 Test 1.

	Ultimate failure load (Kips)
Test 1	299
f'_c = 7.5 ksi	266
f'_c = 9.2 ksi	279

Table E8. Modified Model Results for Beam 1 Test 2.

	Ultimate failure load (Kips)
Test 2	262
f'_c = 7.8 ksi	239
f'_c = 9.5 ksi	244

Table E9. Modified Model Results for Beam 1 Test 3.

	Ultimate failure load (Kips)
Test 3	356
f'_c = 8.6 ksi	337
f'_c = 10.0 ksi	353

Table E10. Summary of Beam 1 Test Parameters.

Design	Stirrups spacing (in)	*a/d* ratio
Test 1	8	2.8
Test 2	8	3.4
Test 3	21	3.4

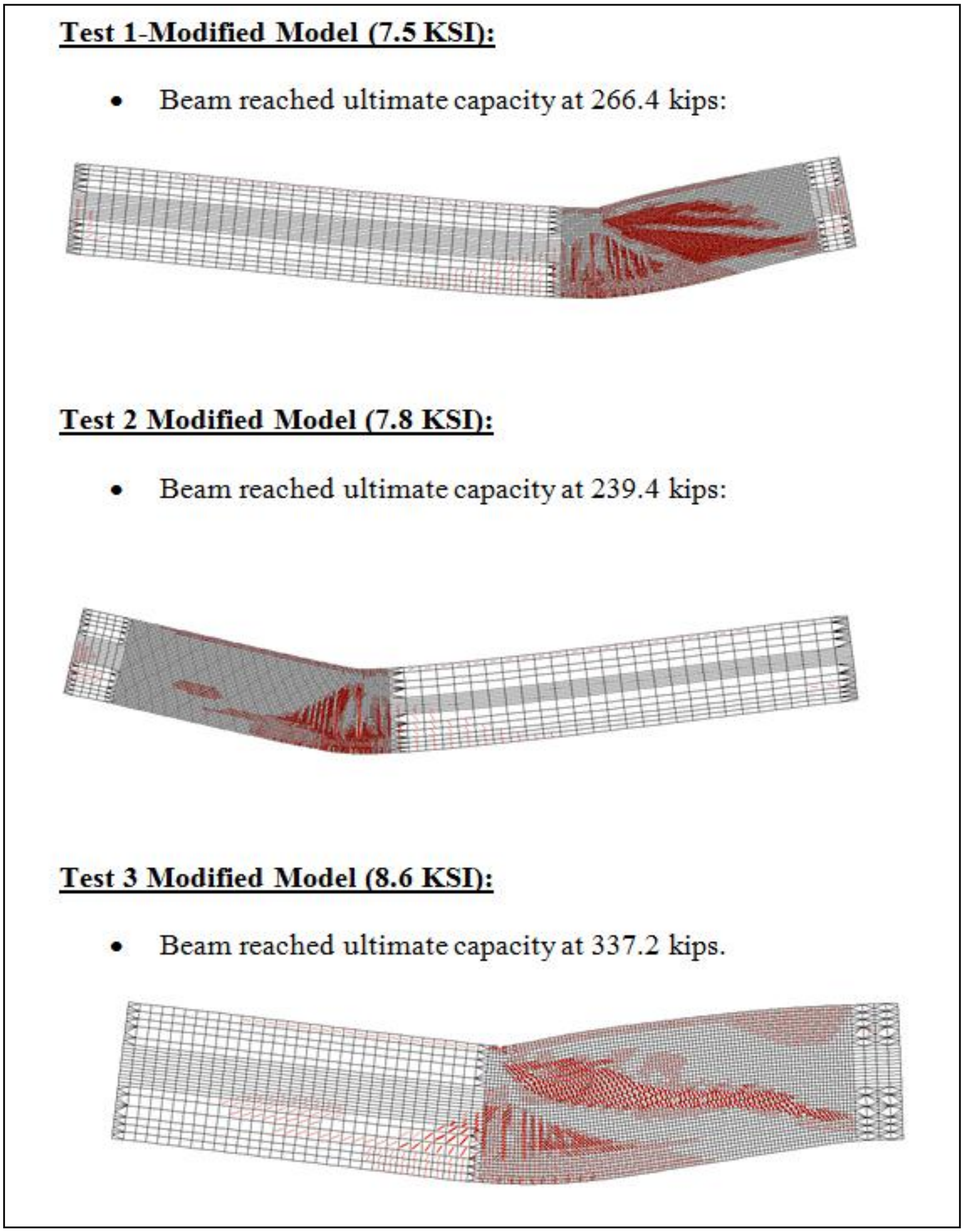
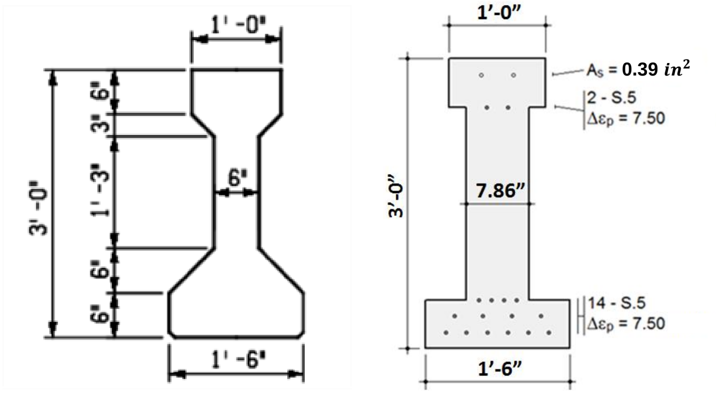


Figure E25. Beam 1 Modified Model Failure Results

Beam 2

As discussed in Chapter 4, similar to Beam 1, three tests were performed on Beam 2. The layout for Beam 2 is shown in Figure E26. Only the final, most successful FEA modeling approach used to model Beam 1 was used for Beam 2. The same material model parameters used for Beam 1 were used for Beam 2, with the exception of the prestrain value, taken as Dep = 5.43 *me*, and differing concrete strengths, to correspond to the test cylinders, as discussed below. A typical value was $f_c' = 9200\ psi$, with corresponding tensile strength $f_t' = 381\ psi$ and cylinder strain at $f_c', eo = 2.70\ me$.



FEA Model

Figure E26. Beam 2 Section and FEA Model.

<u>Beam 2 Test 1</u>

Using the same approach taken for Beam 1, Beam 2 was modeled and loaded as shown in Figure E27 for Test 1. Results are summarized in Figures E28 and E29.

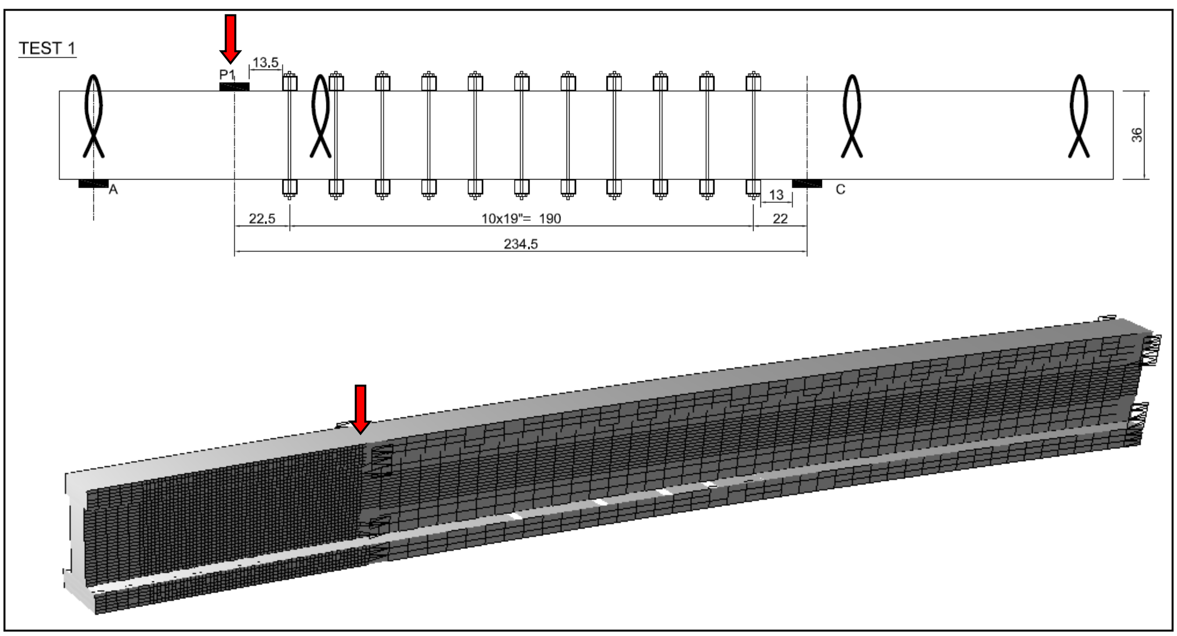
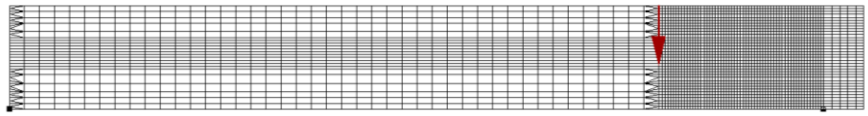


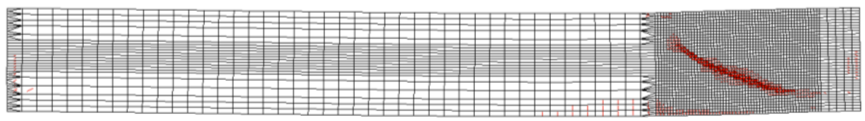
Figure E27. Beam 2 Test 1 Model (dimensions in inches).

Test 1 (f'_c = 9.2 ksi)

- Test 1 set up:



- Beam deformation at 204.6 kips:



- Beam reached ultimate capacity at 260.8 kips:

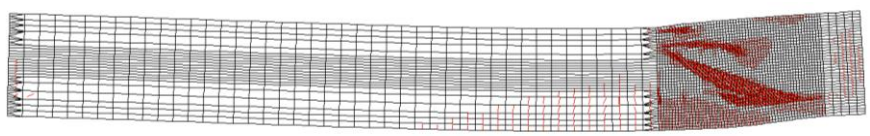


Figure E28. Beam 2 Test 1 Model Results.

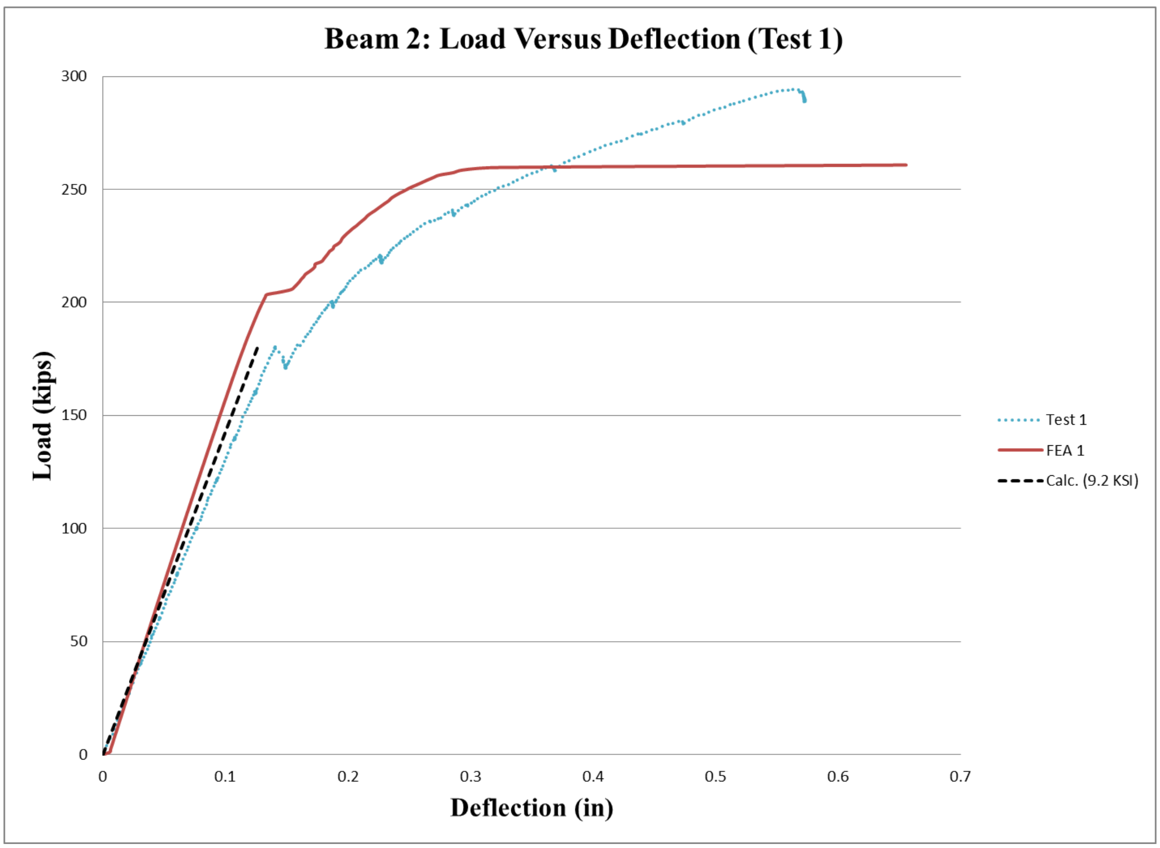


Figure E29. Beam 2 Test 2 Load-Displacement Results.

Test 2

For Test 2, the beam was supported and loaded as shown in Figure E30, and results summarized in Figures E31 and E32.

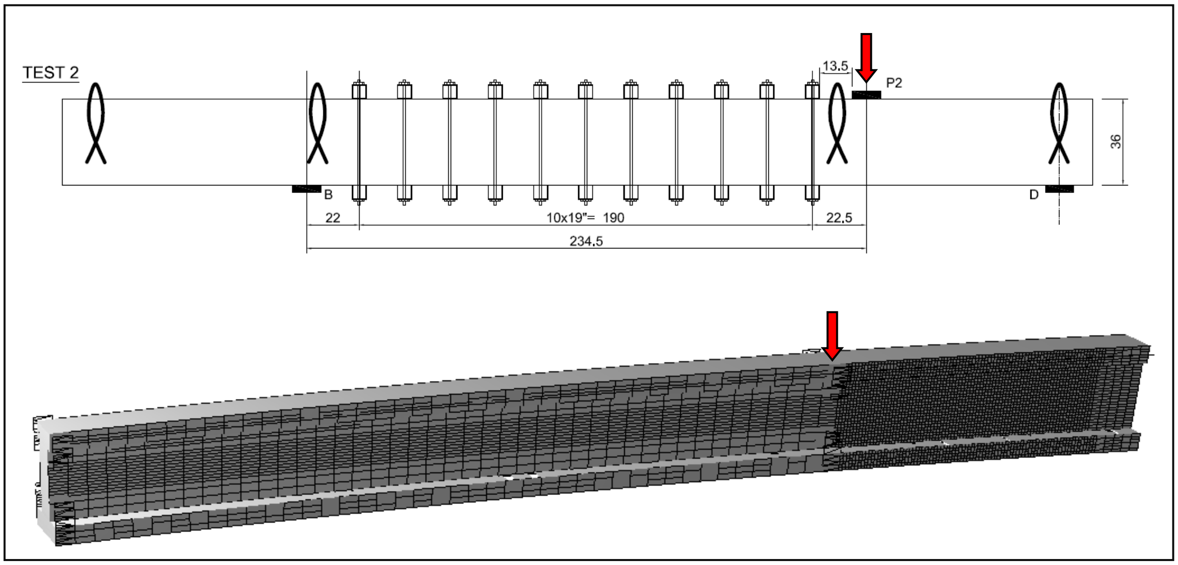
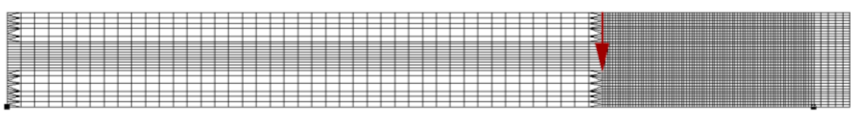


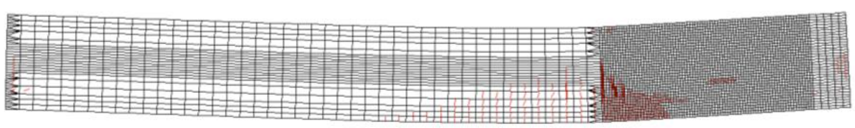
Figure E30. Beam 2 Test 2 Model (dimensions in inches).

Test 2 (f'_c = 9.2 ksi)

- Test 1 set up:



- Beam deformation at 202.3 kips:



- Beam reached ultimate capacity at 213.6 kips:

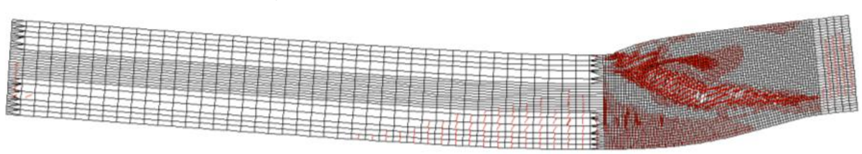


Figure E31. Beam 2 Test 2 Model Results.

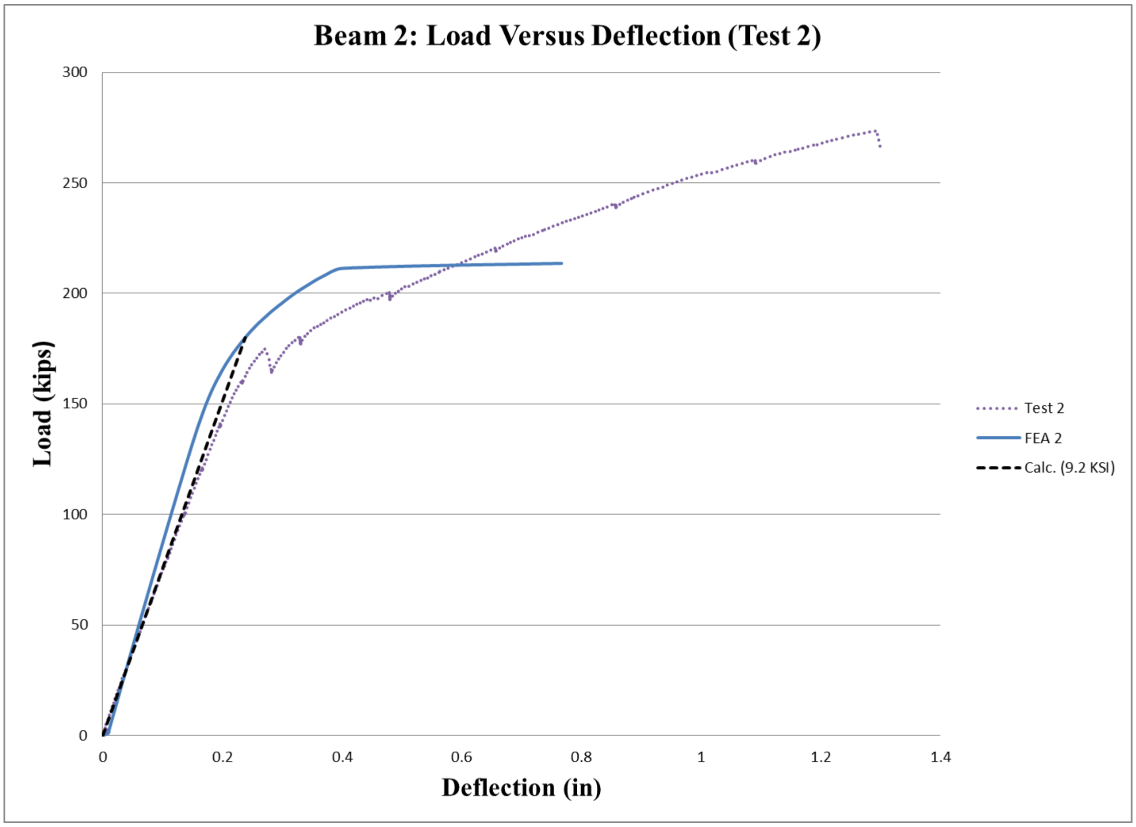


Figure E32. Beam 2 Test 2 Load-Displacement Results.

Test 3

For Test 3, the beam was supported and loaded as shown in Figure E33, with results summarized in Figures E34 and E35.

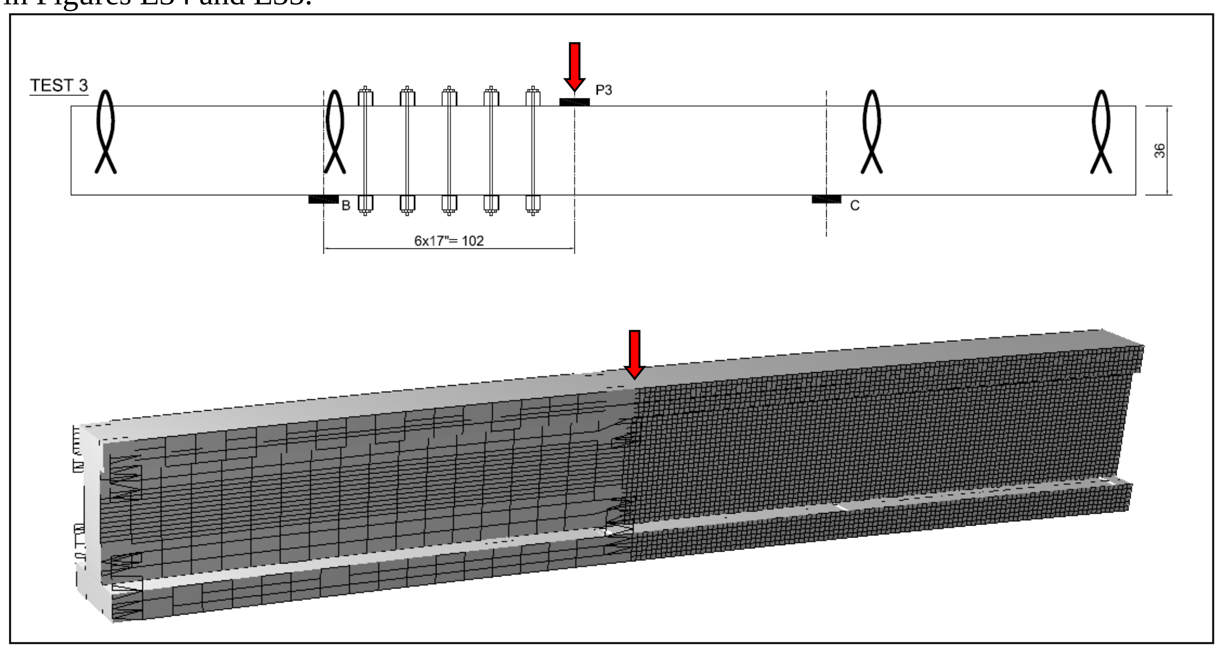
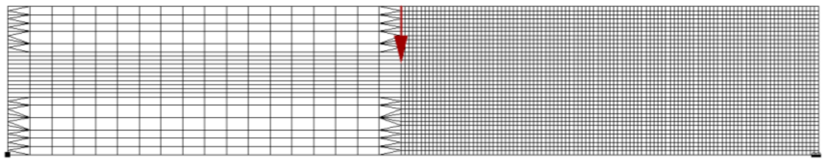


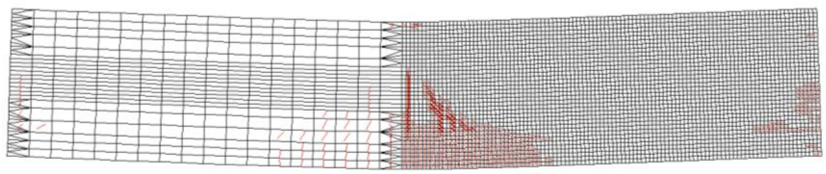
Figure E33. Beam 2 Test 3 Model (dimensions in inches).

Test 3 (f'_c = 9.2 ksi)

- Test 3 set up:



- Beam deformation at 258.5 kips:



- Beam reached ultimate capacity at 275.4 kips:

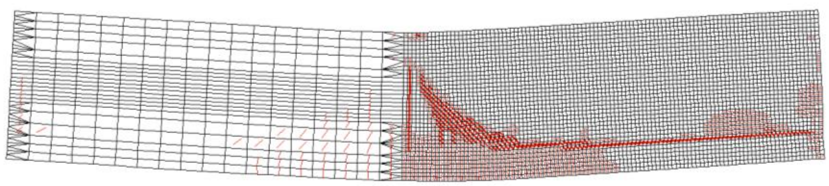


Figure E34. Beam 2 Test 3 Model Results.

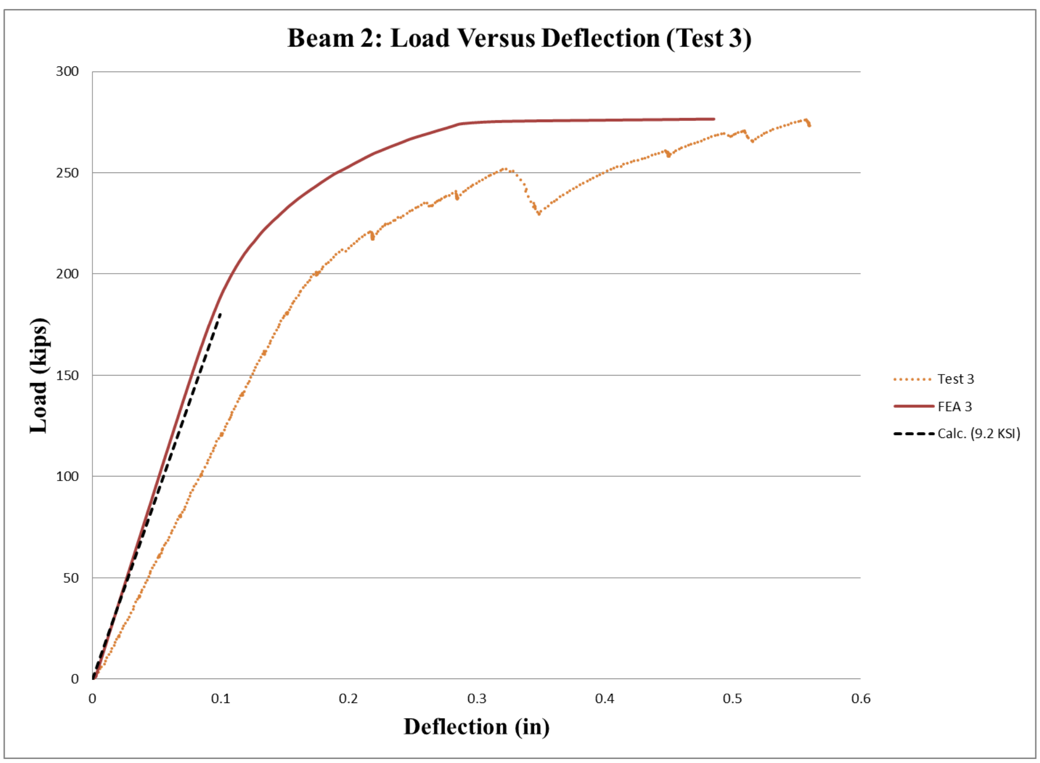


Figure E35. Beam 2 Test 3 Load-Displacement Results.

APPENDIX F: PARAMETRIC ANALYSIS

Table F1. Variables used in Tables F2 and F3.

Variable #	Avg. Stress (ksi)	Concrete f'c (ksi)	Strand Profile	Load Location	Stirrups Spacing (in)
1	0.5	5.5	Straight/Harped	h/2 (Standard)	3 (min)
2	1.5	8	Straight/Harped	LRFD CS	24 (max)
3	2.5	-	Straight/Harped	L/4 (Interim 1979)	12 (avg)

Table F2. Parameter combinations for beam types II, III, and IV.

Combination #	Beam Type	Avg. Stress	Concrete f'c	Load Location	Stirrups Spacing	Strand Profile
1	II,III,IV	1	1	1	1	S/H
2	II,III,IV	2	1	1	1	S/H
3	II,III,IV	1	2	1	1	S/H
4	II,III,IV	1	1	1	2	S/H
5	II,III,IV	2	2	1	2	S/H
6	II,III,IV	2	2	1	1	S/H
7	II,III,IV	2	1	1	2	S/H
8	II,III,IV	1	2	1	2	S/H
9	II,III,IV	3	1	1	1	S/H
10	II,III,IV	3	2	1	2	S/H
11	II,III,IV	3	2	1	1	S/H
12	II,III,IV	3	1	1	2	S/H
13	II,III,IV	1	1	1	3	S/H
14	II,III,IV	2	2	1	3	S/H
15	II,III,IV	2	1	1	3	S/H
16	II,III,IV	1	2	1	3	S/H
17	II,III,IV	3	1	1	3	S/H
18	II,III,IV	3	2	1	3	S/H
19	II,III,IV	1	1	2	1	S/H
20	II,III,IV	2	1	2	1	S/H
21	II,III,IV	1	2	2	1	S/H
22	II,III,IV	1	1	2	2	S/H
23	II,III,IV	2	2	2	2	S/H
24	II,III,IV	2	2	2	1	S/H
25	II,III,IV	2	1	2	2	S/H
26	II,III,IV	1	2	2	2	S/H
27	II,III,IV	3	1	2	1	S/H
28	II,III,IV	3	2	2	2	S/H
29	II,III,IV	3	2	2	1	S/H
30	II,III,IV	3	1	2	2	S/H
31	II,III,IV	1	1	2	3	S/H
32	II,III,IV	2	2	2	3	S/H
33	II,III,IV	2	1	2	3	S/H
34	II,III,IV	1	2	2	3	S/H
35	II,III,IV	3	1	2	3	S/H
36	II,III,IV	3	2	2	3	S/H
37	II,III,IV	1	1	3	1	S/H
38	II,III,IV	2	1	3	1	S/H
39	II,III,IV	1	2	3	1	S/H
40	II,III,IV	1	1	3	2	S/H
41	II,III,IV	2	2	3	2	S/H
42	II,III,IV	2	2	3	1	S/H
43	II,III,IV	2	1	3	2	S/H
44	II,III,IV	1	2	3	2	S/H
45	II,III,IV	3	1	3	1	S/H
46	II,III,IV	3	2	3	2	S/H
47	II,III,IV	3	2	3	1	S/H
48	II,III,IV	3	1	3	2	S/H
49	II,III,IV	1	1	3	3	S/H
50	II,III,IV	2	2	3	3	S/H
51	II,III,IV	2	1	3	3	S/H
52	II,III,IV	1	2	3	3	S/H
53	II,III,IV	3	1	3	3	S/H
54	II,III,IV	3	2	3	3	S/H

Table F3. Models combinations for beam MI-1800.

Combination #	Beam Type	Avg. Stress	Concrete f'c	Load Location	Stirrups Spacing	Strand Profile
1	MI-1800	1	1	1	1	S
2	MI-1800	2	1	1	1	S
3	MI-1800	1	2	1	1	S
4	MI-1800	1	1	1	2	S
5	MI-1800	2	2	1	2	S
6	MI-1800	2	2	1	1	S
7	MI-1800	2	1	1	2	S
8	MI-1800	1	2	1	2	S
9	MI-1800	1	1	1	3	S
10	MI-1800	2	2	1	3	S
11	MI-1800	2	1	1	3	S
12	MI-1800	1	2	1	3	S
13	MI-1800	1	1	2	1	S
14	MI-1800	2	1	2	1	S
15	MI-1800	1	2	2	1	S
16	MI-1800	1	1	2	2	S
17	MI-1800	2	2	2	2	S
18	MI-1800	2	2	2	1	S
19	MI-1800	2	1	2	2	S
20	MI-1800	1	2	2	2	S
21	MI-1800	1	1	2	3	S
22	MI-1800	2	2	2	3	S
23	MI-1800	2	1	2	3	S
24	MI-1800	1	2	2	3	S
25	MI-1800	1	1	3	1	S
26	MI-1800	2	1	3	1	S
27	MI-1800	1	2	3	1	S
28	MI-1800	1	1	3	2	S
29	MI-1800	2	2	3	2	S
30	MI-1800	2	2	3	1	S
31	MI-1800	2	1	3	2	S
32	MI-1800	1	2	3	2	S
33	MI-1800	1	1	3	3	S
34	MI-1800	2	2	3	3	S
35	MI-1800	2	1	3	3	S
36	MI-1800	1	2	3	3	S

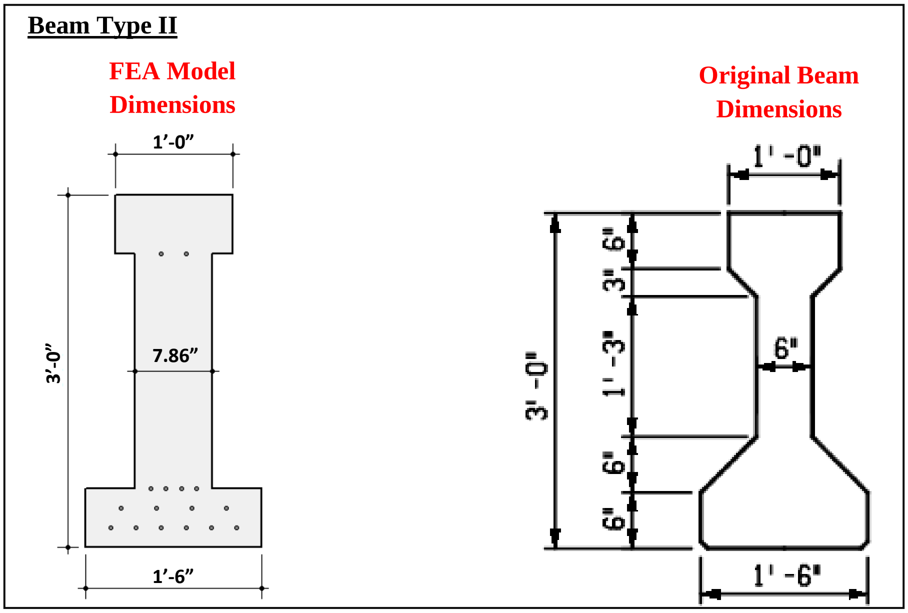


Figure F1. Beam type II Model Dimensions.

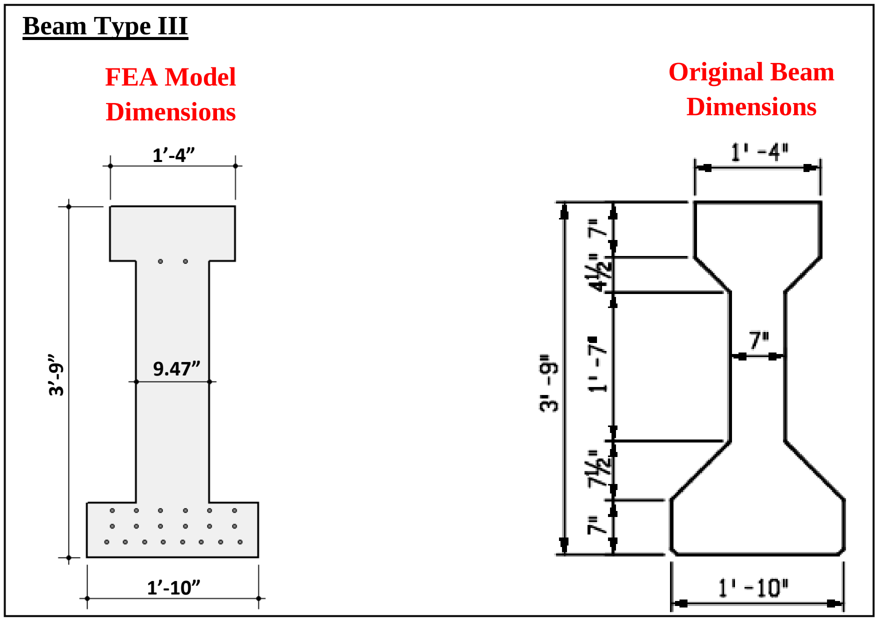


Figure F2. Beam Type III Model Dimensions.

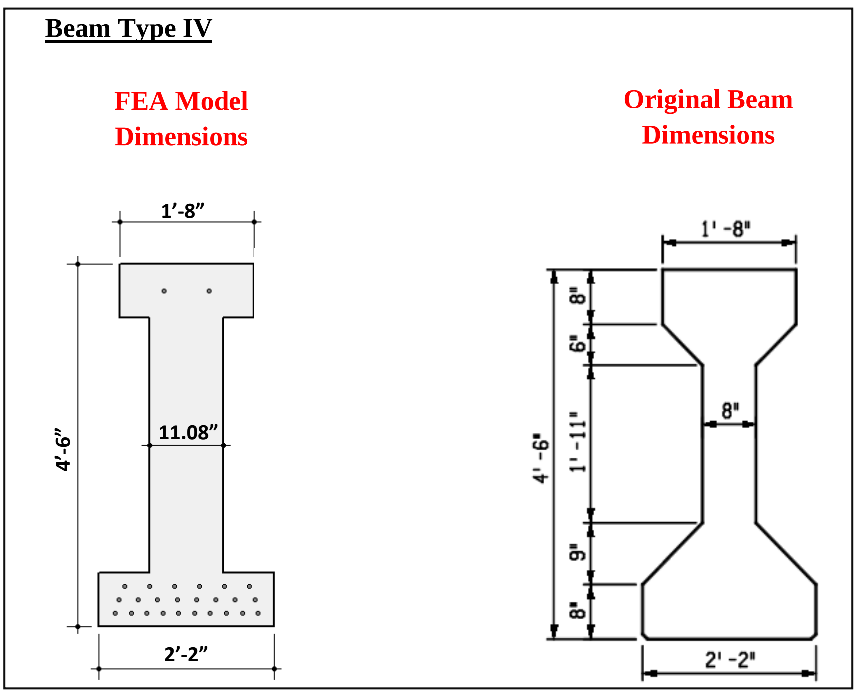


Figure F3. Beam Type IV Model Dimensions.

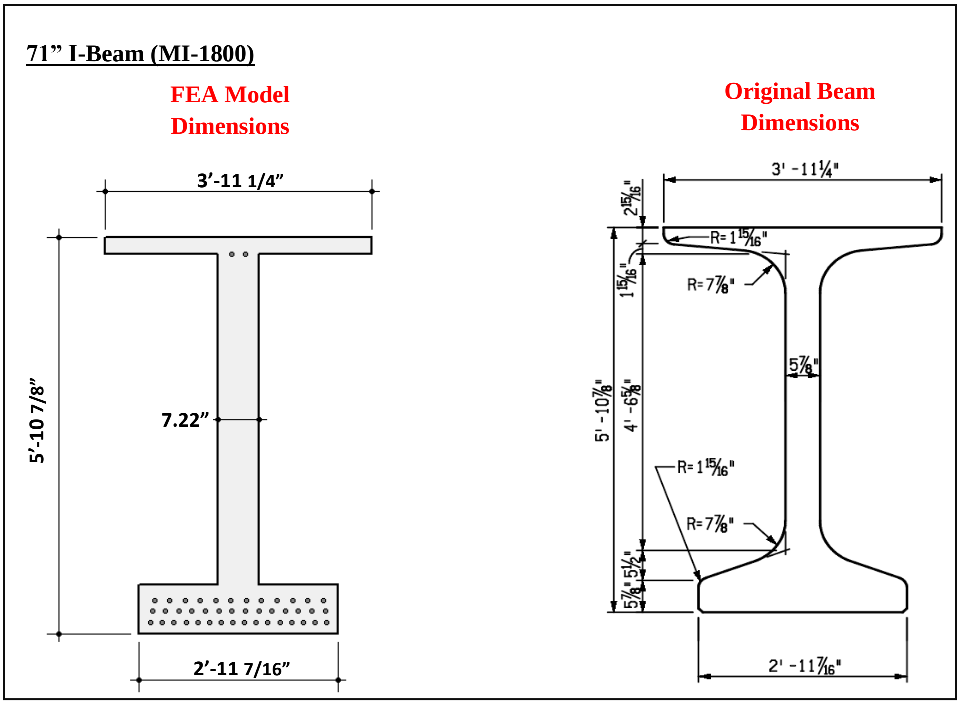
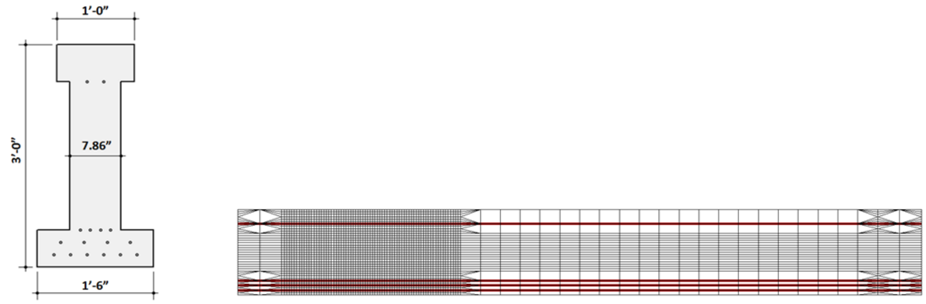
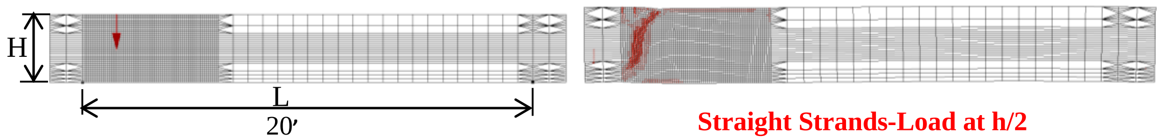


Figure F4. MI-1800 Beam Model Dimensions.

Beam Type II-Straight Strands

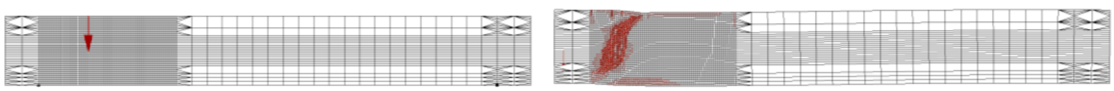


Load at H/2: Failure Load = 517.1 kips



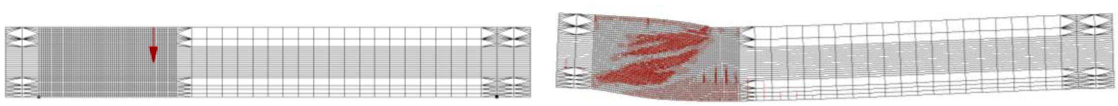
Straight Strands-Load at h/2

Load at LRFD Critical Section: Failure Load = 445.1 kips



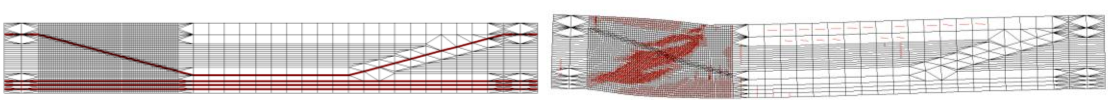
Straight Strands-Load at LRFD CS

Load at L/4: Failure Load = 310.2 kips



Straight Strands-Load at L/4

Beam Type II- Harped Strands: Load at L/4



Harped Strands-Load at L/4

Figure F5. Example of Beam Type II Failure.

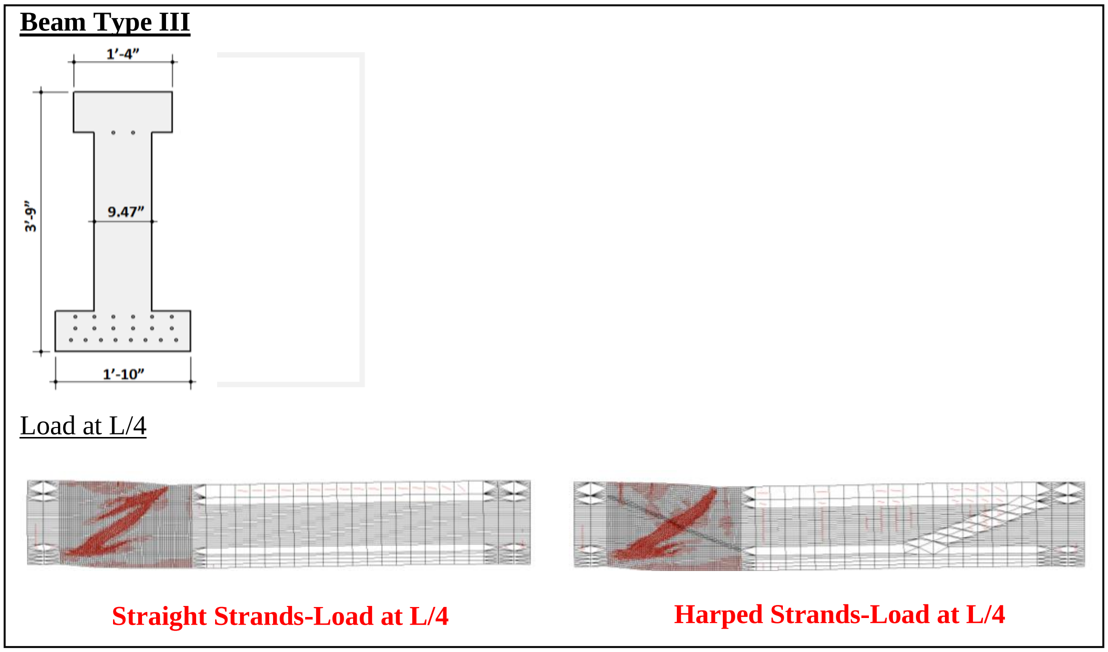


Figure F6. Example of Beam Type III Failure.

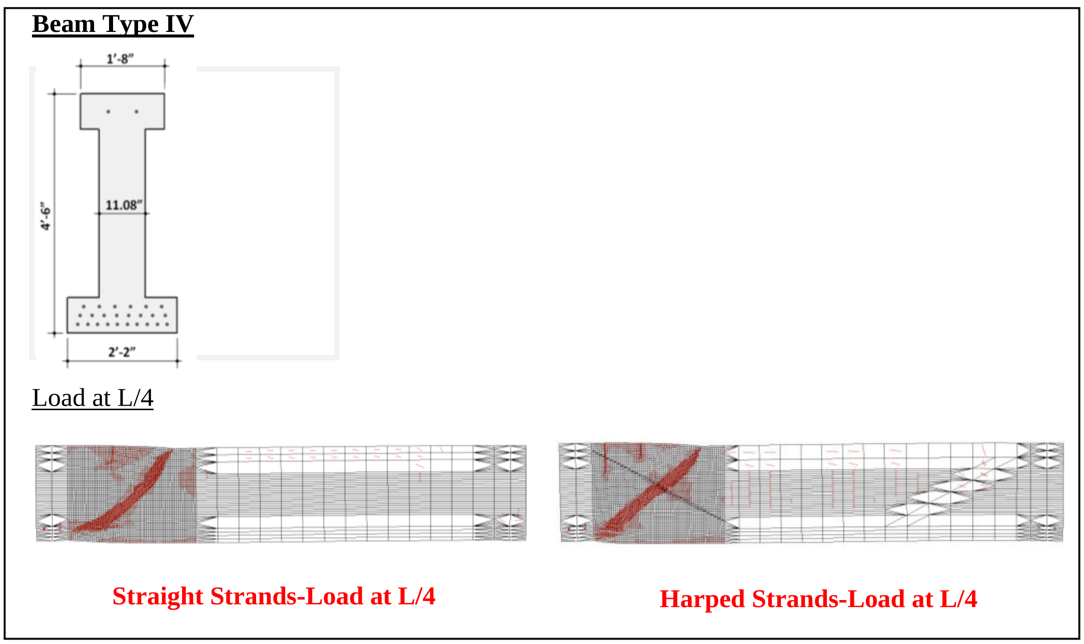
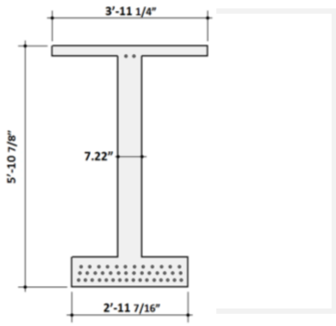
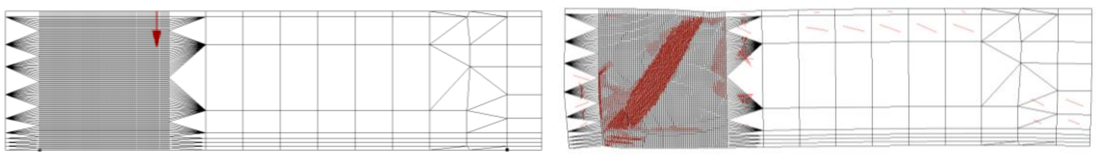


Figure F7. Example of Beam Type IV Failure.

MI-1800



Load at L/4



Straight Strands-Load at L/4

Figure F8. Example of MI-1800 Beam Failure.

Table F4. Results for Beam Type II, Straight Strands, Aps at Tension Controlled Limit.

	FEA			Code (Vn)				
II	1	2	3	4	5	6	7	8
Combination #	h/2	LRFD	L/4	Standard	LRFD	Interim 1979	LRFD (εx_max)	LRFD (HL-93)
1	346.2	323.7	310.2	243.3	260.1	282.2	106.8	270.9
2	404.7	427.1	337.2	243.3	260.1	282.2	106.8	270.9
3	431.6	400.2	328.2	252.6	235.0	305.7	108.9	281.8
4	314.7	274.3	170.9	131.3	88.6	80.5	24.3	86.4
5	490.1	445.1	274.3	140.6	99.3	104.0	24.3	86.4
6	508.1	517.1	364.2	252.6	235.0	305.7	108.9	281.8
7	391.2	364.2	233.8	131.3	88.6	80.5	24.3	86.4
8	355.2	305.7	193.3	140.6	99.3	104.0	24.3	86.4
9	463.1	458.6	346.2	243.3	260.1	282.2	106.8	270.9
10	521.6	454.1	292.3	140.6	99.3	104.0	24.3	86.4
11	526.1	530.5	368.7	252.6	235.0	305.7	108.9	281.8
12	418.1	386.7	256.3	131.3	88.6	80.5	24.3	86.4
13	319.2	287.8	193.3	147.3	113.6	109.3	34.3	112.7
14	517.1	445.1	310.2	156.6	124.2	132.8	36.4	124.1
15	404.7	382.2	274.3	147.3	113.6	109.3	34.3	112.7
16	355.2	332.7	220.3	156.6	124.2	132.8	36.4	124.1
17	436.1	395.7	296.7	147.3	113.6	109.3	34.3	112.7
18	521.6	467.6	328.2	156.6	124.2	132.8	36.4	124.1

Comparison #	(1/4)	(2/5)	(3/6)	(3/4)	(3/5)	(3/7)	(2/8)	(3/8)
1	1.42	1.24	1.10	1.27	1.19	2.90	1.20	1.15
2	1.66	1.64	1.20	1.39	1.30	3.16	1.58	1.24
3	1.71	1.70	1.07	1.30	1.40	3.01	1.42	1.16
4	2.40	3.09	2.12	1.30	1.93	7.03	3.17	1.98
5	3.49	4.48	2.64	1.95	2.76	11.29	5.15	3.17
6	2.01	2.20	1.19	1.44	1.55	3.34	1.83	1.29
7	2.98	4.11	2.90	1.78	2.64	9.62	4.22	2.71
8	2.53	3.08	1.86	1.38	1.95	7.96	3.54	2.24
9	1.90	1.76	1.23	1.42	1.33	3.24	1.69	1.28
10	3.71	4.57	2.81	2.08	2.94	12.03	5.26	3.38
11	2.08	2.26	1.21	1.46	1.57	3.38	1.88	1.31
12	3.18	4.36	3.18	1.95	2.89	10.55	4.48	2.97
13	2.17	2.53	1.77	1.31	1.70	5.64	2.55	1.71
14	3.30	3.58	2.34	1.98	2.50	8.53	3.59	2.50
15	2.75	3.37	2.51	1.86	2.42	8.00	3.39	2.43
16	2.27	2.68	1.66	1.41	1.77	6.05	2.68	1.78
17	2.96	3.48	2.71	2.01	2.61	8.65	3.51	2.63
18	3.33	3.76	2.47	2.10	2.64	9.02	3.77	2.65
Mean	2.55	3.00	2.00	1.63	2.06	6.85	3.05	2.09
STDEV.	0.692	1.049	0.719	0.316	0.609	3.110	1.270	0.749
COV	0.272	0.350	0.360	0.194	0.296	0.454	0.416	0.359

Table F5. Results for Beam Type III, Straight Strands, Aps at Tension Controlled Limit.

		FEA			Code (Vn)		
III	1	2	3	4	5	6	7
Combination #	h/2	LRFD	L/4	Standard	LRFD	Interim 1979	LRFD (Ɛx_max)
1	499.1	499.1	458.6	334.8	327.7	381.9	142.5
2	589.0	616.0	580.0	334.8	327.7	381.9	142.5
3	589.0	593.5	526.1	349.0	332.8	417.9	145.7
4	422.6	373.2	296.7	187.6	134.5	117.0	31.4
5	660.9	607.0	467.6	201.9	159.2	153.0	34.6
6	737.4	714.9	643.0	349.0	332.8	417.9	145.7
7	562.0	499.1	395.7	187.6	134.5	117.0	31.4
8	512.6	422.6	319.2	201.9	159.2	153.0	34.6
9	625.0	629.5	602.5	334.8	327.7	381.9	142.5
10	705.9	602.5	472.1	201.9	159.2	153.0	34.6
11	714.9	737.4	660.9	349.0	332.8	417.9	145.7
12	589.0	539.5	660.9	187.6	134.5	117.0	31.4
13	440.6	391.2	328.2	208.6	170.9	154.9	47.3
14	674.4	616.0	499.1	222.9	186.9	190.9	50.5
15	566.5	508.1	440.6	208.6	170.9	154.9	47.3
16	481.1	449.6	350.7	222.9	186.9	190.9	50.5
17	580.0	539.5	458.6	208.6	170.9	154.9	47.3
18	687.9	620.5	517.1	222.9	186.9	190.9	50.5

Comparison #	(1/4)	(2/5)	(3/6)	(3/4)	(3/5)	(3/7)
1	1.49	1.52	1.20	1.37	1.40	3.22
2	1.76	1.88	1.52	1.73	1.77	4.07
3	1.69	1.78	1.26	1.51	1.58	3.61
4	2.25	2.78	2.54	1.58	2.21	9.45
5	3.27	3.81	3.06	2.32	2.94	13.52
6	2.11	2.15	1.54	1.84	1.93	4.41
7	3.00	3.71	3.38	2.11	2.94	12.60
8	2.54	2.66	2.09	1.58	2.01	9.23
9	1.87	1.92	1.58	1.80	1.84	4.23
10	3.50	3.79	3.08	2.34	2.97	13.65
11	2.05	2.22	1.58	1.89	1.99	4.54
12	3.14	4.01	5.65	3.52	4.92	21.05
13	2.11	2.29	2.12	1.57	1.92	6.94
14	3.03	3.29	2.61	2.24	2.67	9.89
15	2.72	2.97	2.84	2.11	2.58	9.32
16	2.16	2.41	1.84	1.57	1.88	6.95
17	2.78	3.16	2.96	2.20	2.68	9.70
18	3.09	3.32	2.71	2.32	2.77	10.24
Mean	2.47	2.76	2.42	1.98	2.39	8.70
STDEV.	0.608	0.783	1.062	0.500	0.805	4.607
COV	0.246	0.284	0.439	0.253	0.337	0.529

Table F6. Results for Beam Type IV, Straight Strands, Aps at Tension Controlled Limit.

		FEA			Code (Vn)		
IV	1	2	3	4	5	6	7
Combination #	**h/2**	**LRFD**	**L/4**	**Standard**	**LRFD**	**Interim 1979**	**LRFD (Ɛx_max)**
1	634.0	638.5	634.0	418.2	405.4	482.9	177.7
2	728.4	800.3	813.8	418.2	405.4	482.9	177.7
3	737.4	741.9	714.9	438.2	412.0	533.4	182.2
4	535.0	445.1	418.1	237.5	172.5	157.6	41.3
5	827.3	723.9	625.0	257.5	195.7	208.1	45.8
6	908.2	926.2	912.7	438.2	412.0	533.4	182.2
7	683.4	643.0	557.5	237.5	172.5	157.6	41.3
8	607.0	535.0	463.1	257.5	195.7	208.1	45.8
9	782.3	791.3	822.8	418.2	405.4	482.9	177.7
10	867.8	741.9	683.4	257.5	195.7	208.1	45.8
11	939.7	935.2	930.7	438.2	412.0	533.4	182.2
12	741.9	651.9	598.0	237.5	172.5	157.6	41.3
13	526.1	508.1	449.6	263.3	212.7	204.1	60.8
14	863.3	750.9	710.4	283.4	235.8	254.6	65.3
15	687.9	643.0	598.0	263.3	212.7	204.1	60.8
16	616.0	580.0	481.1	283.4	235.8	254.6	65.3
17	741.9	669.9	634.0	263.3	212.7	204.1	60.8
18	876.8	800.3	723.9	283.4	235.8	254.6	65.3

Comparison #	**(1/4)**	**(2/5)**	**(3/6)**	**(3/4)**	**(3/5)**	**(3/7)**
1	1.52	1.57	1.31	1.52	1.56	3.57
2	1.74	1.97	1.69	1.95	2.01	4.58
3	1.68	1.80	1.34	1.63	1.74	3.92
4	2.25	2.58	2.65	1.76	2.42	10.13
5	3.21	3.70	3.00	2.43	3.19	13.66
6	2.07	2.25	1.71	2.08	2.22	5.01
7	2.88	3.73	3.54	2.35	3.23	13.51
8	2.36	2.73	2.23	1.80	2.37	10.12
9	1.87	1.95	1.70	1.97	2.03	4.63
10	3.37	3.79	3.28	2.65	3.49	14.93
11	2.14	2.27	1.74	2.12	2.26	5.11
12	3.12	3.78	3.79	2.52	3.47	14.49
13	2.00	2.39	2.20	1.71	2.11	7.40
14	3.05	3.18	2.79	2.51	3.01	10.89
15	2.61	3.02	2.93	2.27	2.81	9.84
16	2.17	2.46	1.89	1.70	2.04	7.37
17	2.82	3.15	3.11	2.41	2.98	10.43
18	3.09	3.39	2.84	2.55	3.07	11.09
Mean	2.44	2.76	2.43	2.11	2.56	8.93
STDEV.	0.587	0.731	0.771	0.365	0.606	3.840
COV	0.240	0.265	0.317	0.173	0.237	0.430

Table F7. Summary of Results for Beam Types II-IV, Straight Strands, Aps at Tension Controlled Limit.

Mean						
Comparison #	**(1/4)**	**(2/5)**	**(3/6)**	**(3/4)**	**(3/5)**	**(3/7)**
II	2.55	3.00	2.00	1.63	2.06	6.85
III	2.47	2.76	2.42	1.98	2.39	8.70
IV	2.44	2.76	2.43	2.11	2.56	8.93
Mean	2.49	2.84	2.28	1.91	2.33	8.16

COV						
Comparison #	**(1/4)**	**(2/5)**	**(3/6)**	**(3/4)**	**(3/5)**	**(3/7)**
II	0.272	0.350	0.360	0.194	0.296	0.454
III	0.246	0.284	0.439	0.253	0.337	0.529
IV	0.240	0.265	0.317	0.173	0.237	0.430
Mean	0.253	0.300	0.372	0.207	0.290	0.471
STDEV	0.0166	0.0449	0.0619	0.0412	0.0503	0.0519
COV	0.066	0.150	0.166	0.200	0.173	0.110

Table F8. Results for MI-1800 Beam, Straight Strands, Aps at Tension Controlled Limit.

		FEA			Code (Vn)		
MI-1800	1	2	3	4	5	6	7
Combination #	h/2	LRFD	L/4	Standard	LRFD	Interim 1979	LRFD (Ɛx_max)
1	732.9	791.3	791.3	583.8	628.8	651.2	247.7
2	687.9	854.3	854.3	583.8	628.8	651.2	247.7
3	899.2	989.2	989.2	604.9	650.3	704.5	252.4
4	732.9	687.9	687.9	324.2	258.3	184.0	51.1
5	944.2	917.2	917.2	345.3	276.3	237.3	55.9
6	944.2	1038.6	1038.6	604.9	650.2	704.5	55.9
7	741.9	777.8	777.8	324.2	258.3	184.0	51.1
8	876.8	849.8	849.8	345.3	276.3	237.3	55.9
9	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-
13	723.9	696.9	696.9	362.3	311.4	251.4	79.2
14	944.2	921.7	921.7	383.4	330.1	304.8	83.9
15	638.5	553.0	553.0	362.3	311.4	251.4	79.2
16	858.8	863.3	863.3	383.4	330.1	304.8	83.9
17	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-

Comparison #	(1/4)	(2/5)	(3/6)	(3/4)	(3/5)	(3/7)
1	1.3	1.3	1.2	1.4	1.3	3.2
2	1.2	1.4	1.3	1.5	1.4	3.4
3	1.5	1.5	1.4	1.6	1.5	3.9
4	2.3	2.7	3.7	2.1	2.7	13.5
5	2.7	3.3	3.9	2.7	3.3	16.4
6	1.6	1.6	1.5	1.7	1.6	18.6
7	2.3	3.0	4.2	2.4	3.0	15.2
8	2.5	3.1	3.6	2.5	3.1	15.2
9	-	-	-	-	-	-
10	-	-	-	-	-	-
11	-	-	-	-	-	-
12	-	-	-	-	-	-
13	2.0	2.2	2.8	1.9	2.2	8.8
14	2.5	2.8	3.0	2.4	2.8	11.0
15	1.8	1.8	2.2	1.5	1.8	7.0
16	2.2	2.6	2.8	2.3	2.6	10.3
17	-	-	-	-	-	-
18	-	-	-	-	-	-
Mean	1.98	2.27	2.64	1.99	2.27	10.54
STDEV.	0.521	0.736	1.095	0.446	0.736	5.357
COV	0.263	0.324	0.415	0.224	0.324	0.508

Table F9. Results for Beam Type II, Harped Strands, Aps at Tension Controlled Limit.

II (Harped)		FEA			Code		
	1	2	3	4	5	6	7
Combination #	h/2	LRFD	L/4	Standard	LRFD	Interim 1979	LRFD (Ɛx_max)
1	368.7	-	314.7	255.1	236.1	288.0	112.7
2	463.1	-	355.2	278.5	236.1	299.7	124.4
3	431.6	-	368.7	264.4	239.0	311.5	114.8
4	332.7	-	197.8	143.0	94.3	86.3	28.1
5	512.6	-	296.7	175.7	116.4	121.5	41.9
6	553.0	-	386.7	287.8	247.5	323.2	126.5
7	436.1	-	265.3	166.4	105.7	98.1	39.8
8	386.7	-	220.3	152.3	105.0	109.8	30.2
9	467.6	-	368.7	301.9	253.0	311.5	136.1
10	539.5	-	337.2	199.2	127.9	133.3	53.6
11	566.5	-	395.7	311.2	270.8	334.9	138.2
12	445.1	-	283.3	189.9	117.1	109.8	51.5
13	373.2	-	287.8	159.0	119.2	115.2	40.2
14	526.1	-	337.2	191.7	141.3	150.4	54.0
15	454.1	-	355.2	182.4	130.6	126.9	51.9
16	368.7	-	247.3	168.3	129.9	138.6	42.2
17	476.6	-	364.2	205.9	142.0	138.6	63.6
18	548.5	-	364.2	215.2	152.7	162.1	65.7

Comparison #	(1/4)	(3/6)	(3/4)	(3/5)	(3/7)
1	1.45	1.09	1.23	1.33	2.79
2	1.66	1.19	1.28	1.50	2.86
3	1.63	1.18	1.39	1.54	3.21
4	2.33	2.29	1.38	2.10	7.05
5	2.92	2.44	1.69	2.55	7.09
6	1.92	1.20	1.34	1.56	3.06
7	2.62	2.71	1.59	2.51	6.67
8	2.54	2.01	1.45	2.10	7.31
9	1.55	1.18	1.22	1.46	2.71
10	2.71	2.53	1.69	2.64	6.29
11	1.82	1.18	1.27	1.46	2.86
12	2.34	2.58	1.49	2.42	5.50
13	2.35	2.50	1.81	2.41	7.17
14	2.74	2.24	1.76	2.39	6.25
15	2.49	2.80	1.95	2.72	6.85
16	2.19	1.78	1.47	1.90	5.85
17	2.32	2.63	1.77	2.56	5.73
18	2.55	2.25	1.69	2.38	5.55
Mean	2.23	1.99	1.53	2.09	5.27
STDEV.	0.450	0.641	0.223	0.486	1.795
COV	0.202	0.322	0.146	0.233	0.341

Table F10. Results for Beam Type III, Harped Strands, Aps at Tension Controlled Limit.

		FEA			Code (Vn)		
III (Harped)	1	2	3	4	5	6	7
Combination #	**h/2**	**LRFD**	**L/4**	**Standard**	**LRFD**	**Interim 1979**	**LRFD (Ɛx_max)**
1	517.1	-	485.6	343.7	334.1	390.9	151.5
2	629.5	-	620.5	361.6	346.8	408.8	169.4
3	616.0	-	548.5	358.0	339.2	426.9	154.7
4	449.6	-	346.2	196.5	143.0	126.0	40.3
5	696.9	-	517.1	228.7	176.0	179.8	61.4
6	755.4	-	678.9	375.8	395.8	444.8	172.6
7	607.0	-	445.1	214.4	160.2	143.8	58.2
8	512.6	-	377.7	210.8	158.7	162.0	43.5
9	634.0	-	643.0	379.5	359.8	426.6	187.2
10	746.4	-	517.1	246.5	193.2	197.7	79.3
11	777.8	-	701.4	393.7	364.7	462.6	190.4
12	625.0	-	472.1	232.3	177.3	161.7	76.1
13	445.1	-	364.2	217.6	174.9	163.8	56.2
14	705.9	-	566.5	249.7	207.9	217.7	77.3
15	593.5	-	494.6	235.4	192.1	181.7	74.1
16	526.1	-	404.7	217.6	190.7	163.8	59.4
17	584.5	-	512.6	253.3	215.8	199.6	92.0
18	741.9	-	584.5	267.6	230.6	235.6	95.2

Comparison #	**(1/4)**	**(3/6)**	**(3/4)**	**(3/5)**	**(3/7)**
1	1.50	1.24	1.41	1.45	3.21
2	1.74	1.52	1.72	1.79	3.66
3	1.72	1.28	1.53	1.62	3.55
4	2.29	2.75	1.76	2.42	8.58
5	3.05	2.88	2.26	2.94	8.42
6	2.01	1.53	1.81	1.72	3.93
7	2.83	3.09	2.08	2.78	7.65
8	2.43	2.33	1.79	2.38	8.68
9	1.67	1.51	1.69	1.79	3.43
10	3.03	2.62	2.10	2.68	6.52
11	1.98	1.52	1.78	1.92	3.68
12	2.69	2.92	2.03	2.66	6.20
13	2.05	2.22	1.67	2.08	6.48
14	2.83	2.60	2.27	2.73	7.33
15	2.52	2.72	2.10	2.58	6.68
16	2.42	2.47	1.86	2.12	6.81
17	2.31	2.57	2.02	2.37	5.57
18	2.77	2.48	2.18	2.53	6.14
Mean	2.32	2.24	1.89	2.25	5.92
STDEV.	0.487	0.622	0.248	0.452	1.901
COV	0.209	0.278	0.131	0.201	0.321

Table F11. Results for Beam Type IV, Harped Strands, Aps at Tension Controlled Limit.

		FEA			Code		
IV (Harped)	1	2	3	4	5	6	7
Combination #	h/2	LRFD	L/4	Standard	LRFD	Interim 1979	LRFD (Ɛx_max)
1	669.9	-	660.9	432.3	418.5	497.0	191.8
2	719.4	-	858.8	460.6	439.0	525.2	220.1
3	782.3	-	750.9	452.3	425.1	547.5	196.3
4	557.5	-	485.6	251.6	187.2	171.7	55.4
5	858.8	-	732.9	299.9	238.0	250.4	88.1
6	867.8	-	953.2	480.6	445.5	575.7	224.5
7	701.4	-	660.9	279.8	214.8	199.9	83.6
8	710.4	-	548.5	271.6	210.5	222.2	59.9
9	791.3	-	876.8	488.8	459.7	553.4	248.3
10	881.3	-	777.8	328.1	265.6	278.6	116.3
11	944.2	-	980.2	508.8	466.1	603.9	252.8
12	741.9	-	665.4	308.1	242.3	228.1	111.8
13	602.5	-	508.1	277.5	228.4	218.2	74.9
14	890.2	-	746.4	325.7	279.2	296.9	107.6
15	773.3	-	696.9	305.7	255.9	246.4	103.1
16	705.9	-	557.5	297.5	251.6	268.7	79.4
17	795.8	-	701.4	333.9	283.5	274.6	131.3
18	894.7	-	791.3	353.9	306.7	325.1	135.8

Comparison #	(1/4)	(3/6)	(3/4)	(3/5)	(3/7)
1	1.55	1.33	1.53	1.58	3.45
2	1.56	1.64	1.86	1.96	3.90
3	1.73	1.37	1.66	1.77	3.82
4	2.22	2.83	1.93	2.59	8.77
5	2.86	2.93	2.44	3.08	8.32
6	1.81	1.66	1.98	2.14	4.25
7	2.51	3.31	2.36	3.08	7.91
8	2.62	2.47	2.02	2.61	9.16
9	1.62	1.58	1.79	1.91	3.53
10	2.69	2.79	2.37	2.93	6.69
11	1.86	1.62	1.93	2.10	3.88
12	2.41	2.92	2.16	2.75	5.95
13	2.17	2.33	1.83	2.22	6.79
14	2.73	2.51	2.29	2.67	6.94
15	2.53	2.83	2.28	2.72	6.76
16	2.37	2.08	1.87	2.22	7.03
17	2.38	2.55	2.10	2.47	5.34
18	2.53	2.43	2.24	2.58	5.83
Mean	2.23	2.29	2.04	2.41	6.02
STDEV.	0.434	0.615	0.260	0.444	1.880
COV	0.195	0.269	0.128	0.184	0.312

Table F12. Summary of Results for Beam Types II-IV, Harped Strands, Aps at Tension Controlled Limit.

Mean					
Comparison #	(1/4)	(3/6)	(3/4)	(3/5)	(3/7)
II	2.23	1.99	1.53	2.09	5.27
III	2.32	2.24	1.89	2.25	5.92
IV	2.23	2.29	2.04	2.41	6.02
Mean	2.26	2.17	1.82	2.25	5.73

COV					
Comparison #	(1/4)	(3/6)	(3/4)	(3/5)	(3/7)
II	0.202	0.322	0.146	0.233	0.341
III	0.209	0.278	0.131	0.201	0.321
IV	0.195	0.269	0.128	0.184	0.312
Mean	0.202	0.290	0.135	0.206	0.325
STDEV	0.0074	0.0286	0.0098	0.0248	0.0146
COV	0.037	0.099	0.072	0.121	0.045

Table F13. Results for Beam Type II, Straight Strands, High Aps.

II	FEA		Code (Vn)			
	3	4	5	6	7	8
Combination #	L/4	Standard	LRFD	Interim 1979	LRFD (Ɛx_max)	LRFD (HL-93)
1	328.2	286.5	278.3	289.9	109.7	285.1
2	382.2	286.5	278.3	289.9	109.7	285.1
3	382.2	296.0	288.8	314.0	111.9	295.8
4	197.8	171.4	100.8	82.7	22.8	93.3
5	274.3	180.9	111.1	106.8	25.0	104.9
6	454.1	296.0	288.8	314.0	111.9	295.8
7	238.3	171.4	100.8	82.7	22.8	93.3
8	202.3	180.9	111.1	106.8	25.0	104.9
9	422.6	286.5	278.3	289.9	109.7	285.1
10	305.7	180.9	111.1	106.8	25.0	104.9
11	508.1	296.0	288.8	314.0	111.9	295.8
12	278.8	171.4	100.8	82.7	22.8	93.3
13	211.3	187.8	126.5	112.3	35.2	120.7
14	323.7	197.4	136.8	136.4	37.4	132.2
15	278.8	187.8	126.5	112.3	35.2	120.7
16	233.8	197.4	136.8	136.4	37.4	132.2
17	305.7	187.8	126.5	112.3	35.2	120.7
18	373.2	197.4	136.8	136.4	37.4	132.2

Comparison #	(3/6)	(3/4)	(3/5)	(3/7)	(3/8)
1	1.13	1.15	1.18	2.99	1.15
2	1.32	1.33	1.37	3.48	1.34
3	1.22	1.29	1.32	3.42	1.29
4	2.39	1.15	1.96	8.67	2.12
5	2.57	1.52	2.47	10.99	2.61
6	1.45	1.53	1.57	4.06	1.54
7	2.88	1.39	2.36	10.44	2.55
8	1.89	1.12	1.82	8.10	1.93
9	1.46	1.48	1.52	3.85	1.48
10	2.86	1.69	2.75	12.25	2.91
11	1.62	1.72	1.76	4.54	1.72
12	3.37	1.63	2.77	12.22	2.99
13	1.88	1.13	1.67	6.00	1.75
14	2.37	1.64	2.37	8.66	2.45
15	2.48	1.48	2.20	7.91	2.31
16	1.71	1.18	1.71	6.25	1.77
17	2.72	1.63	2.42	8.68	2.53
18	2.74	1.89	2.73	9.98	2.82
Mean	2.12	1.44	2.00	7.36	2.07
STDEV.	0.676	0.235	0.521	3.133	0.595
COV	0.319	0.163	0.261	0.426	0.287

Table F14. Results for Beam Type III, Straight Strands, High Aps.

	FEA		Code (Vn)		
III	3	4	5	6	7
Combination #	L/4	Standard	LRFD	Interim 1979	LRFD (Ɛx_max)
1	490.1	419.9	386.7	388.2	144.9
2	607.0	419.9	386.7	388.2	144.9
3	571.0	434.4	401.4	424.8	148.1
4	296.7	270.3	163.5	119.0	31.9
5	467.6	284.8	177.1	155.5	35.2
6	705.9	434.4	401.4	424.8	148.1
7	395.7	270.3	163.5	119.0	31.9
8	332.7	284.8	177.1	155.5	35.2
9	634.0	419.9	386.7	388.2	144.9
10	548.5	284.8	177.1	155.5	35.2
11	777.8	434.4	401.4	424.8	148.1
12	472.1	270.3	163.5	119.0	31.9
13	332.7	291.7	195.6	157.4	48.0
14	512.6	306.2	209.4	194.0	51.3
15	440.6	291.7	195.6	157.4	48.0
16	377.7	306.2	209.4	194.0	51.3
17	494.6	291.7	195.6	157.4	48.0
18	616.0	306.2	209.4	194.0	51.3

Comparison #	(3/6)	(3/4)	(3/5)	(3/7)
1	1.26	1.17	1.27	3.38
2	1.56	1.45	1.57	4.19
3	1.34	1.31	1.42	3.86
4	2.49	1.10	1.82	9.30
5	3.01	1.64	2.64	13.30
6	1.66	1.62	1.76	4.77
7	3.33	1.46	2.42	12.40
8	2.14	1.17	1.88	9.46
9	1.63	1.51	1.64	4.38
10	3.53	1.93	3.10	15.60
11	1.83	1.79	1.94	5.25
12	3.97	1.75	2.89	14.79
13	2.11	1.14	1.70	6.92
14	2.64	1.67	2.45	9.99
15	2.80	1.51	2.25	9.17
16	1.95	1.23	1.80	7.36
17	3.14	1.70	2.53	10.29
18	3.18	2.01	2.94	12.01
Mean	2.42	1.51	2.11	8.69
STDEV.	0.813	0.278	0.554	3.903
COV	0.336	0.184	0.262	0.449

Table F15. Results for Beam Type IV, Straight Strands, High Aps.

	FEA		Code (Vn)		
IV	3	4	5	6	7
Combination #	**L/4**	**Standard**	**LRFD**	**Interim 1979**	**LRFD (Ɛx_max)**
1	687.9	553.0	489.0	493.4	181.6
2	840.8	553.0	489.0	493.4	181.6
3	813.8	573.4	511.1	545.0	186.2
4	418.1	368.4	201.8	161.0	42.2
5	701.4	388.8	223.9	212.6	46.8
6	998.2	573.4	511.1	545.0	186.2
7	625.0	368.4	201.8	161.0	42.2
8	467.6	388.8	223.9	212.6	46.8
9	822.8	553.0	489.0	493.4	181.6
10	778.6	388.8	223.9	212.6	46.8
11	1043.1	573.4	511.1	545.0	186.2
12	700.5	368.4	201.8	161.0	42.2
13	449.6	394.7	243.2	208.5	62.1
14	750.9	415.2	265.3	260.1	66.7
15	665.4	394.7	243.2	208.5	62.1
16	499.1	415.2	265.3	260.1	66.7
17	680.1	394.7	243.2	208.5	62.1
18	840.1	415.2	265.3	260.1	66.7

Comparison #	**(3/6)**	**(3/4)**	**(3/5)**	**(3/7)**
1	1.39	1.24	1.41	3.79
2	1.70	1.52	1.72	4.63
3	1.49	1.42	1.59	4.37
4	2.60	1.14	2.07	9.91
5	3.30	1.80	3.13	15.00
6	1.83	1.74	1.95	5.36
7	3.88	1.70	3.10	14.82
8	2.20	1.20	2.09	10.00
9	1.67	1.49	1.68	4.53
10	3.66	2.00	3.48	16.65
11	1.91	1.82	2.04	5.60
12	4.35	1.90	3.47	16.61
13	2.16	1.14	1.85	7.24
14	2.89	1.81	2.83	11.26
15	3.19	1.69	2.74	10.72
16	1.92	1.20	1.88	7.48
17	3.26	1.72	2.80	10.95
18	3.23	2.02	3.17	12.60
Mean	2.59	1.59	2.39	9.53
STDEV.	0.902	0.301	0.690	4.378
COV	0.348	0.190	0.289	0.459

Table F16. Summary of Results for Beam Types II-IV, Straight Strands, High Aps.

Mean				
Comparison #	**(3/6)**	**(3/4)**	**(3/5)**	**(3/7)**
II	2.12	1.44	2.00	7.36
III	2.42	1.51	2.11	8.69
IV	2.59	1.59	2.39	9.53
Mean	2.38	1.51	2.17	8.53

COV				
Comparison #	**(3/6)**	**(3/4)**	**(3/5)**	**(3/7)**
II	0.319	0.163	0.261	0.426
III	0.336	0.184	0.262	0.449
IV	0.348	0.190	0.289	0.459
Mean	0.334	0.179	0.271	0.445
STDEV	0.0143	0.0139	0.0159	0.0173
COV	0.043	0.077	0.059	0.039

Table F17. Results for Beam Type II, Harped Strands, High Aps.

	FEA		Code (Vn)		
II (Harped)	3	4	5	6	7
Combination #	**L/4**	**Standard**	**LRFD**	**Interim 1979**	**LRFD (Ɛx_max)**
1	332.7	309.1	283.1	294.8	114.7
2	400.2	328.8	292.6	304.6	124.5
3	400.2	318.7	293.5	318.9	116.8
4	202.3	194.0	105.5	87.6	27.8
5	328.2	223.3	125.4	121.6	39.8
6	481.1	338.4	303.1	328.8	126.7
7	278.8	213.7	115.1	97.5	37.6
8	233.8	203.6	115.9	111.7	29.9
9	454.1	348.6	302.1	314.5	134.4
10	341.7	243.0	135.0	131.5	49.6
11	539.5	358.1	312.6	338.6	136.5
12	314.7	233.5	124.6	107.3	47.5
13	332.7	210.5	131.3	117.2	40.2
14	359.7	239.7	151.1	151.2	52.2
15	409.2	230.2	140.8	127.1	50.0
16	269.8	220.0	141.6	141.3	42.3
17	454.1	249.9	150.3	136.9	59.9
18	413.6	259.5	160.7	161.1	62.0

Comparison #	**(3/6)**	**(3/4)**	**(3/5)**	**(3/7)**
1	1.13	1.08	1.18	2.90
2	1.31	1.22	1.37	3.21
3	1.25	1.26	1.36	3.43
4	2.31	1.04	1.92	7.29
5	2.70	1.47	2.62	8.26
6	1.46	1.42	1.59	3.80
7	2.86	1.30	2.42	7.41
8	2.09	1.15	2.02	7.82
9	1.44	1.30	1.50	3.38
10	2.60	1.41	2.53	6.89
11	1.59	1.51	1.73	3.95
12	2.93	1.35	2.53	6.63
13	2.84	1.58	2.53	8.28
14	2.38	1.50	2.38	6.89
15	3.22	1.78	2.91	8.18
16	1.91	1.23	1.91	6.38
17	3.32	1.82	3.02	7.58
18	2.57	1.59	2.57	6.67
Mean	2.22	1.39	2.12	6.05
STDEV.	0.713	0.219	0.569	1.984
COV	0.322	0.157	0.269	0.328

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Table F18. Results for Beam Type III, Harped Strands, High Aps.

	FEA		Code (Vn)		
III (Harped)	3	4	5	6	7
Combination #	L/4	Standard	LRFD	Interim 1979	LRFD (Ɛx_max)
1	512.6	426.9	393.4	395.2	151.9
2	651.9	441.0	406.6	409.3	165.9
3	616.0	441.4	408.1	431.8	155.1
4	346.2	277.4	170.1	126.0	38.9
5	566.5	305.9	197.1	176.6	56.2
6	768.8	455.5	421.4	445.8	169.2
7	454.1	291.4	183.3	140.0	53.0
8	391.2	291.9	183.8	162.6	42.2
9	683.4	455.0	420.0	423.3	180.0
10	611.5	319.9	210.4	190.6	70.3
11	845.3	469.5	434.8	459.9	183.2
12	553.0	305.4	196.5	154.1	67.0
13	386.7	298.7	202.2	164.4	55.1
14	589.0	327.3	229.4	215.1	72.4
15	499.1	312.8	215.5	178.5	69.1
16	440.6	313.2	216.1	201.0	58.3
17	549.8	326.8	228.7	192.5	83.2
18	683.4	341.3	242.8	229.1	86.4

Comparison #	(3/6)	(3/4)	(3/5)	(3/7)
1	1.30	1.20	1.30	3.37
2	1.59	1.48	1.60	3.93
3	1.43	1.40	1.51	3.97
4	2.75	1.25	2.04	8.89
5	3.21	1.85	2.87	10.08
6	1.72	1.69	1.82	4.54
7	3.24	1.56	2.48	8.57
8	2.41	1.34	2.13	9.27
9	1.61	1.50	1.63	3.80
10	3.21	1.91	2.91	8.70
11	1.84	1.80	1.94	4.61
12	3.59	1.81	2.81	8.25
13	2.35	1.29	1.91	7.02
14	2.74	1.80	2.57	8.14
15	2.80	1.60	2.32	7.22
16	2.19	1.41	2.04	7.56
17	2.86	1.68	2.40	6.61
18	2.98	2.00	2.81	7.91
Mean	2.43	1.59	2.17	6.80
STDEV.	0.711	0.243	0.501	2.180
COV	0.292	0.153	0.231	0.320

Table F19. Results for Beam Type IV, Harped Strands, High Aps.

IV (Harped)	FEA		Code (Vn)		
	3	4	5	6	7
Combination #	L/4	Standard	LRFD	Interim 1979	LRFD (Ɛx_max)
1	723.9	562.6	498.3	503.0	191.3
2	912.7	581.9	517.0	522.3	210.6
3	858.8	583.1	520.4	554.6	195.9
4	503.6	378.0	211.1	170.7	51.8
5	876.8	417.8	252.0	241.6	75.7
6	1043.1	602.4	539.1	574.0	215.2
7	710.4	397.3	229.8	190.0	71.1
8	571.0	398.4	233.3	222.3	56.4
9	912.7	601.2	535.6	541.6	229.9
10	863.3	437.1	270.8	260.9	95.0
11	1065.6	621.7	557.8	593.3	234.5
12	683.4	416.6	248.5	209.3	90.4
13	530.5	404.4	252.6	218.2	71.7
14	890.2	444.1	293.4	289.1	95.6
15	728.4	423.7	271.3	237.5	91.0
16	602.5	424.8	274.7	269.8	76.3
17	749.0	443.0	289.9	256.8	110.4
18	908.2	463.4	312.2	308.4	114.9

Comparison #	(3/6)	(3/4)	(3/5)	(3/7)
1	1.44	1.29	1.45	3.78
2	1.75	1.57	1.77	4.33
3	1.55	1.47	1.65	4.38
4	2.95	1.33	2.39	9.72
5	3.63	2.10	3.48	11.58
6	1.82	1.73	1.93	4.85
7	3.74	1.79	3.09	9.99
8	2.57	1.43	2.45	10.12
9	1.69	1.52	1.70	3.97
10	3.31	1.98	3.19	9.09
11	1.80	1.71	1.91	4.54
12	3.27	1.64	2.75	7.56
13	2.43	1.31	2.10	7.39
14	3.08	2.00	3.03	9.31
15	3.07	1.72	2.69	8.00
16	2.23	1.42	2.19	7.89
17	2.92	1.69	2.58	6.79
18	2.95	1.96	2.91	7.90
Mean	2.56	1.65	2.40	7.29
STDEV.	0.748	0.251	0.599	2.455
COV	0.292	0.152	0.249	0.337

Table F20. Summary of Results for Beam Types II-IV, Harped Strands, High Aps.

AVERAGE				
Comparison #	**(3/6)**	**(3/4)**	**(3/5)**	**(3/7)**
II	2.22	1.39	2.12	6.05
III	2.43	1.59	2.17	6.80
IV	2.56	1.65	2.40	7.29
Mean	2.41	1.54	2.23	6.71

COV				
Comparison #	**(3/6)**	**(3/4)**	**(3/5)**	**(3/7)**
II	0.322	0.157	0.269	0.328
III	0.292	0.153	0.231	0.320
IV	0.292	0.152	0.249	0.337
Mean	0.302	0.154	0.250	0.328
STDEV	0.0172	0.0028	0.0190	0.0082
COV	0.057	0.018	0.076	0.025

APPENDIX G: FIELD TEST RESULTS

<u>Bridge 1 Run 1: Two trucks side by side, centered in each lane</u>

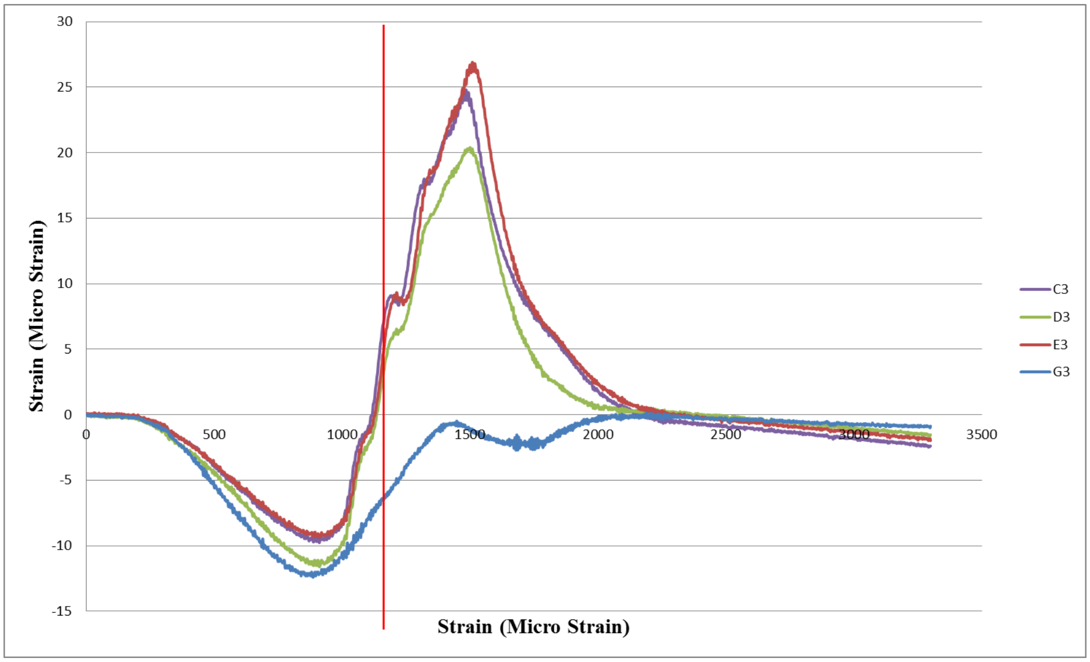

Figure G1. Bridge 1 Run 1 Girder Strains, Gage Line 3.

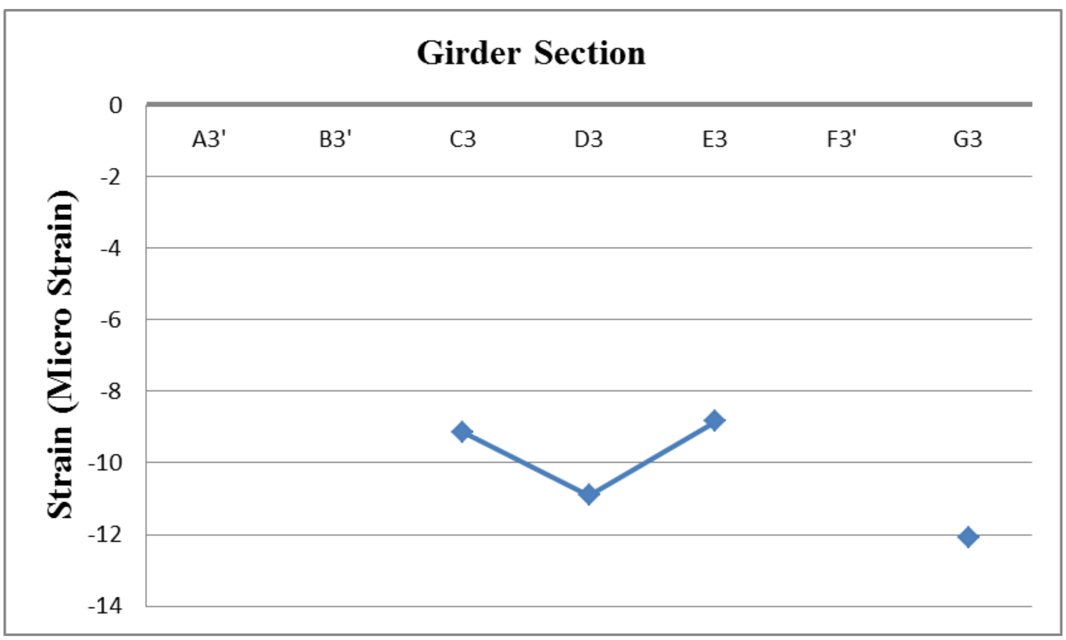

Figure G2. Bridge 1 Run 1 Girder Strains for Maximum Negative Moment, Span 2.

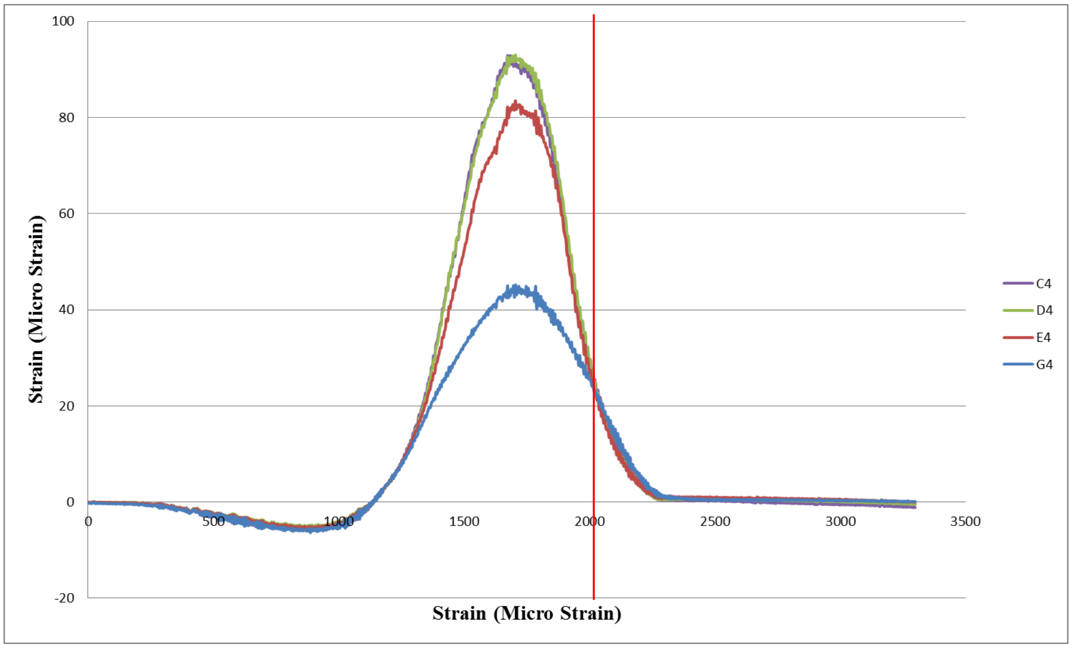

Figure G3. Bridge 1 Run 1 Girder Strains, Gage Line 4.

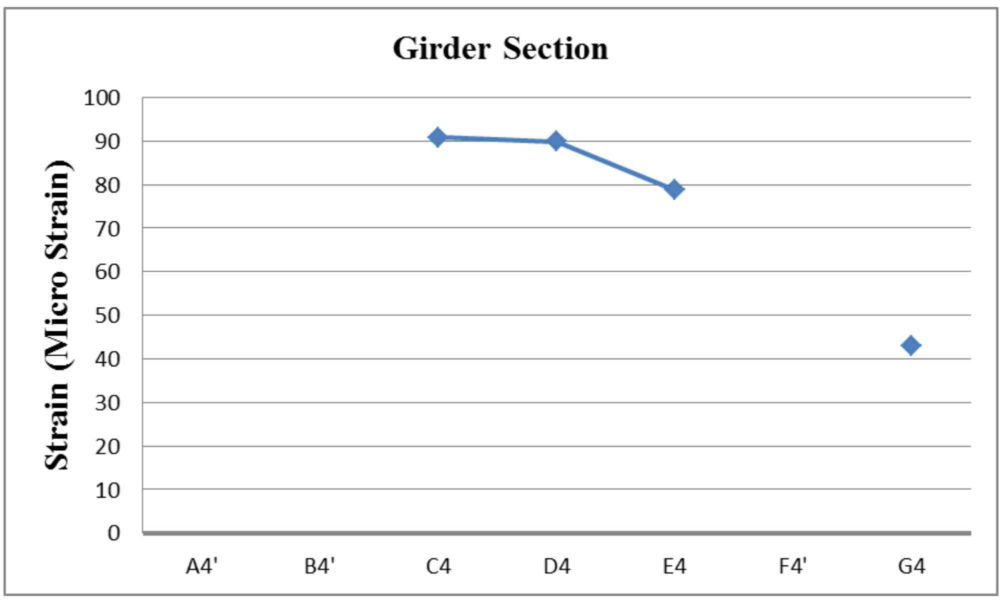

Figure G4. Bridge 1 Run 1 Girder Strains for Maximum Positive Moment, Span 2.

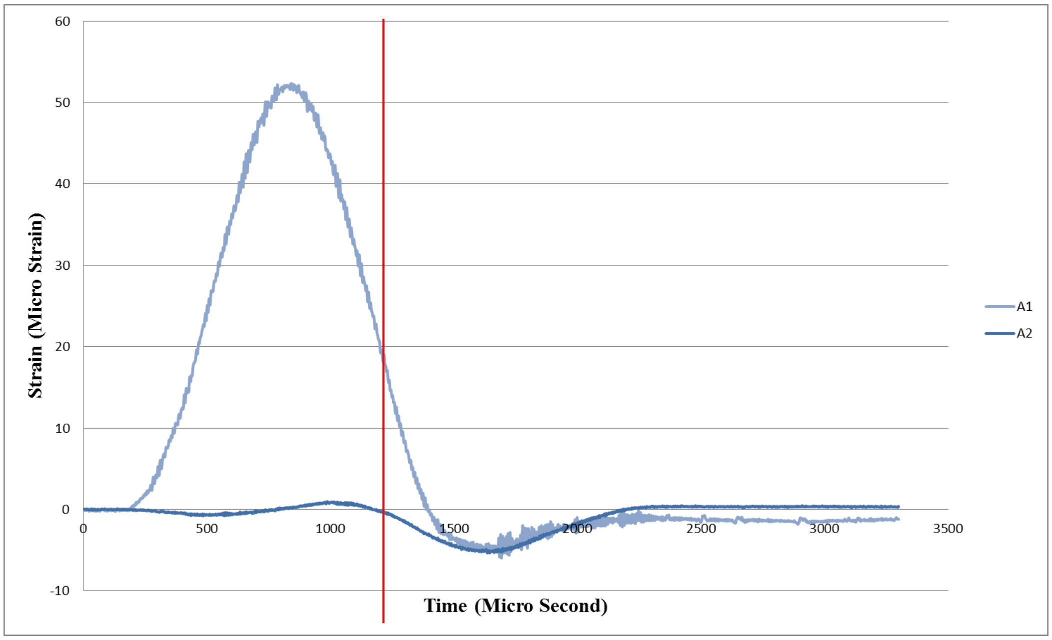

Figure G5. Bridge 1 Run 1 Girder Strains Along Girder A.

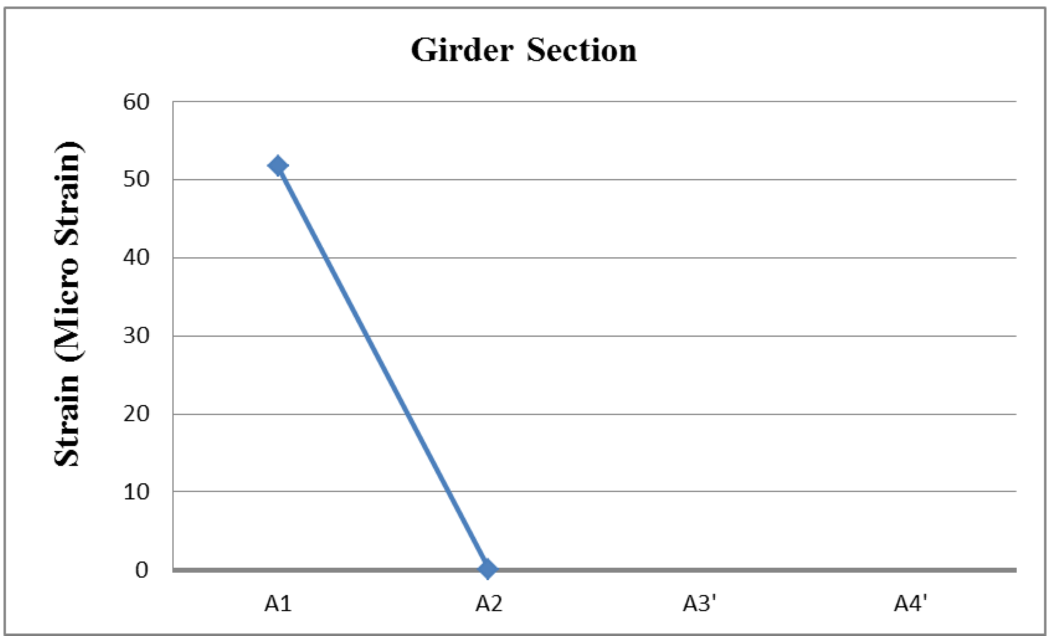

Figure G6. Girder A Strains For Maximum Positive Moment.

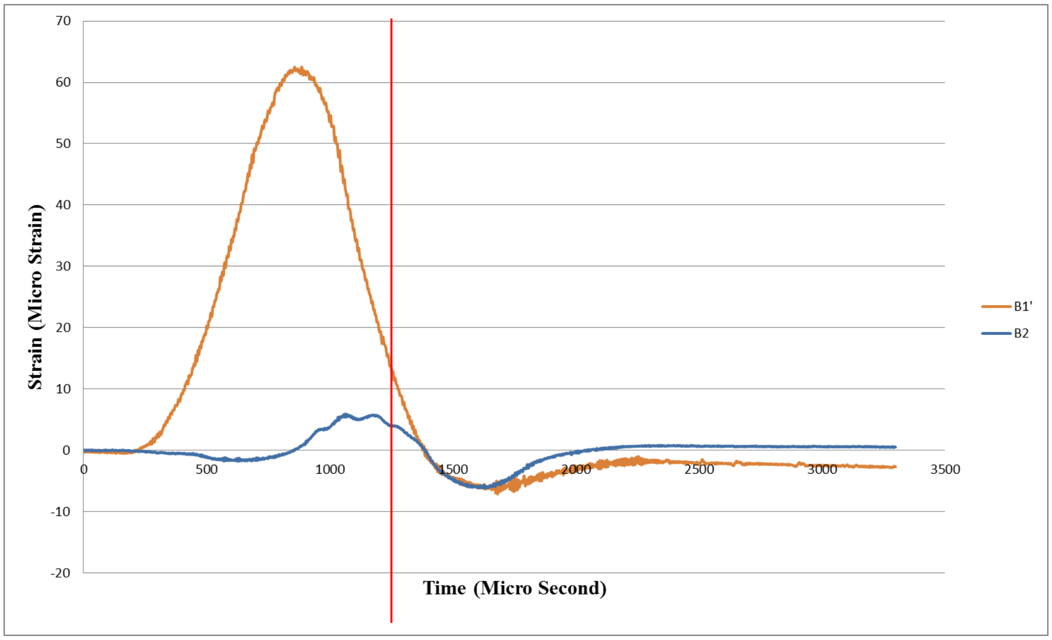

Figure G7. Bridge 1 Run 1 Girder Strains Along Girder B.

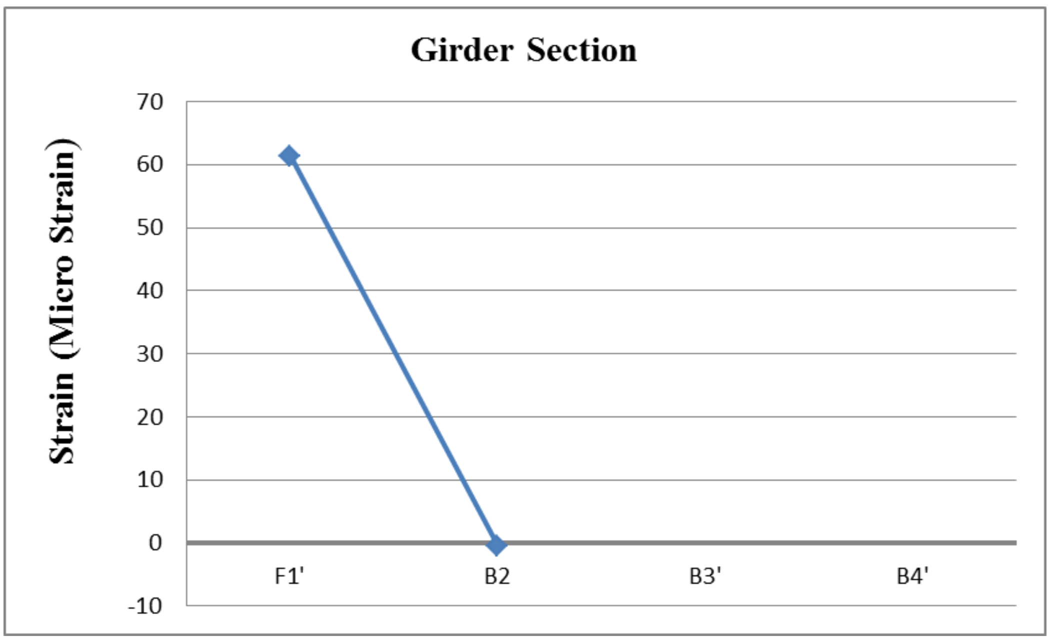

Figure G8. Girder B Strains for Maximum Positive Moment.

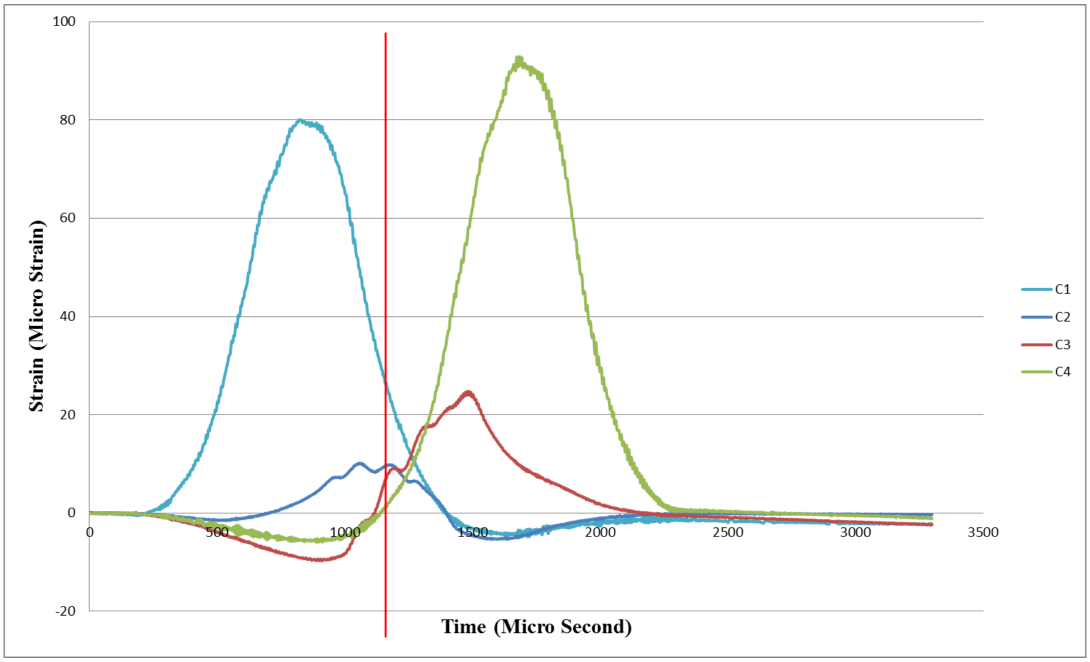

Figure G9. Girder Strains Along Girder C.

Figure G10. Girder C Strains For Maximum Positive Moment.

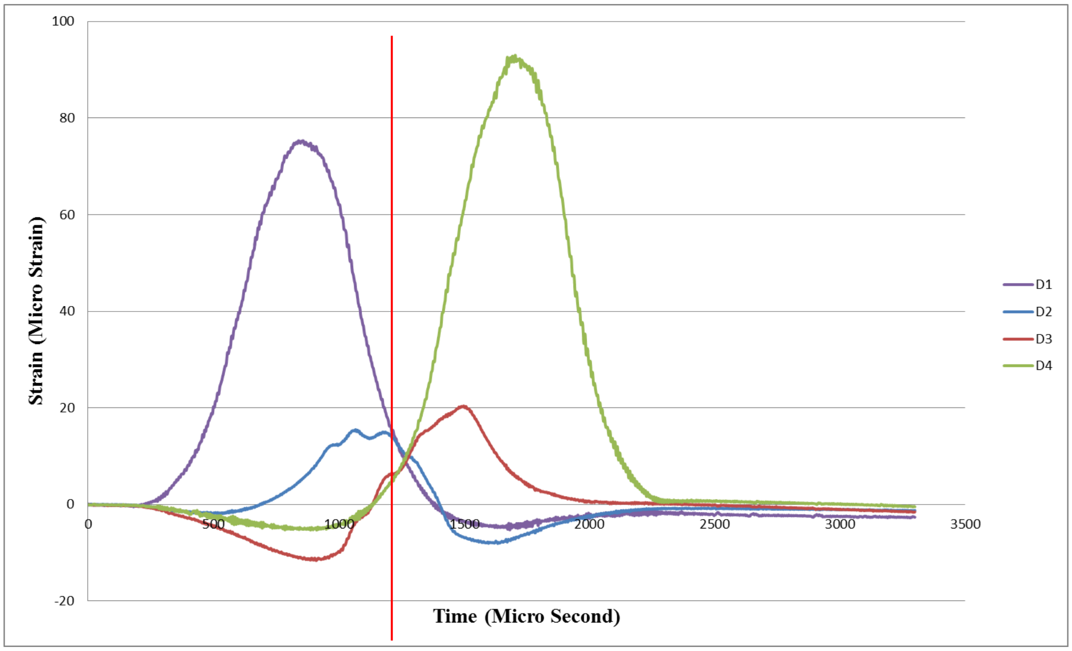

Figure G11. Girder Strains Along Girder D.

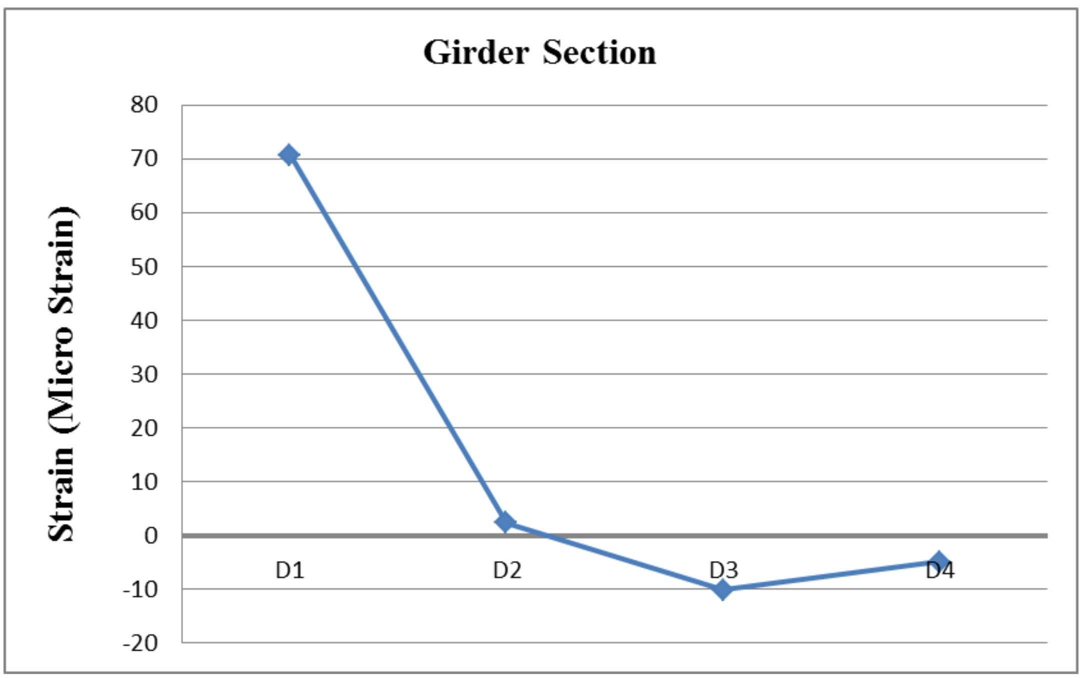

Figure G12. Girder D Strains For Maximum Positive Moment.

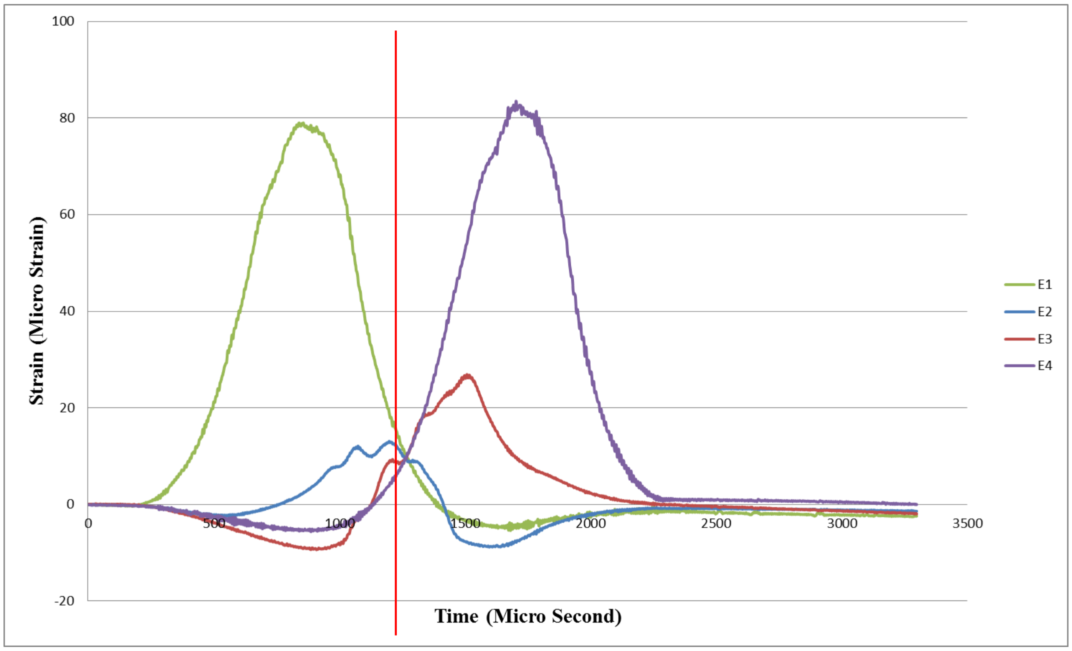

Figure G13. Girder Strains Along Girder E.

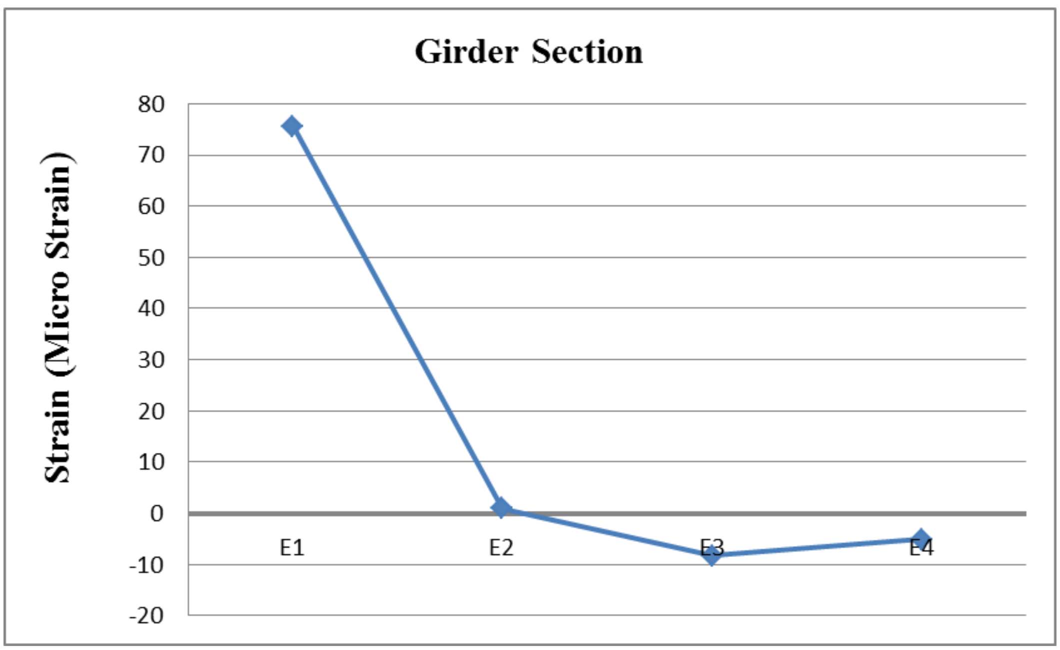

Figure G14. Girder E Strains For Maximum Positive Moment.

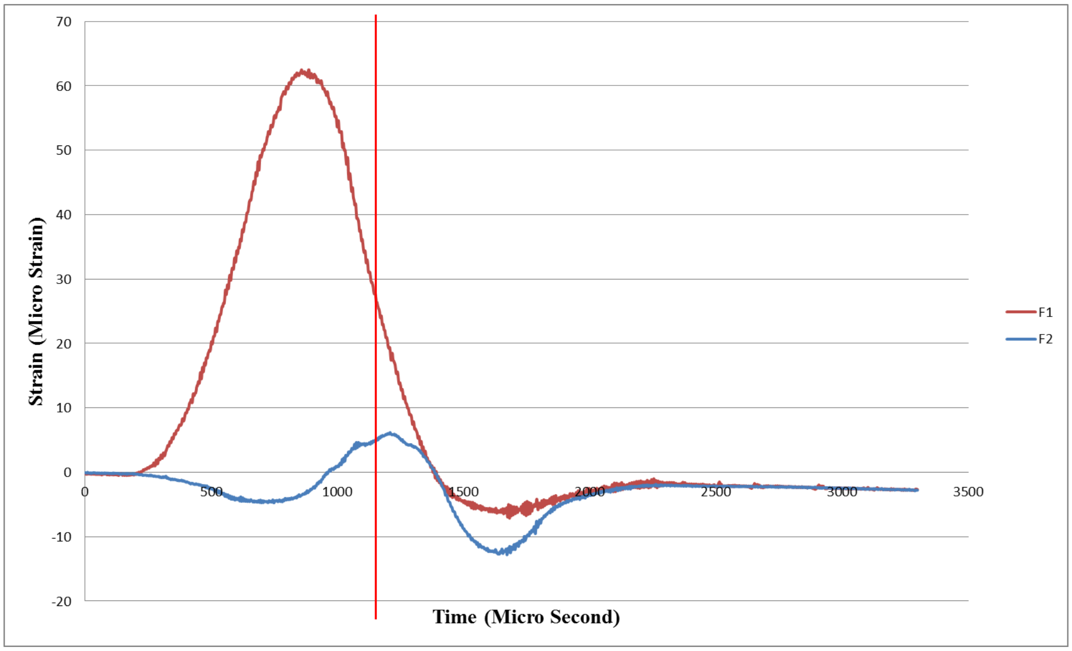

Figure G15. Girder Strains Along Girder F.

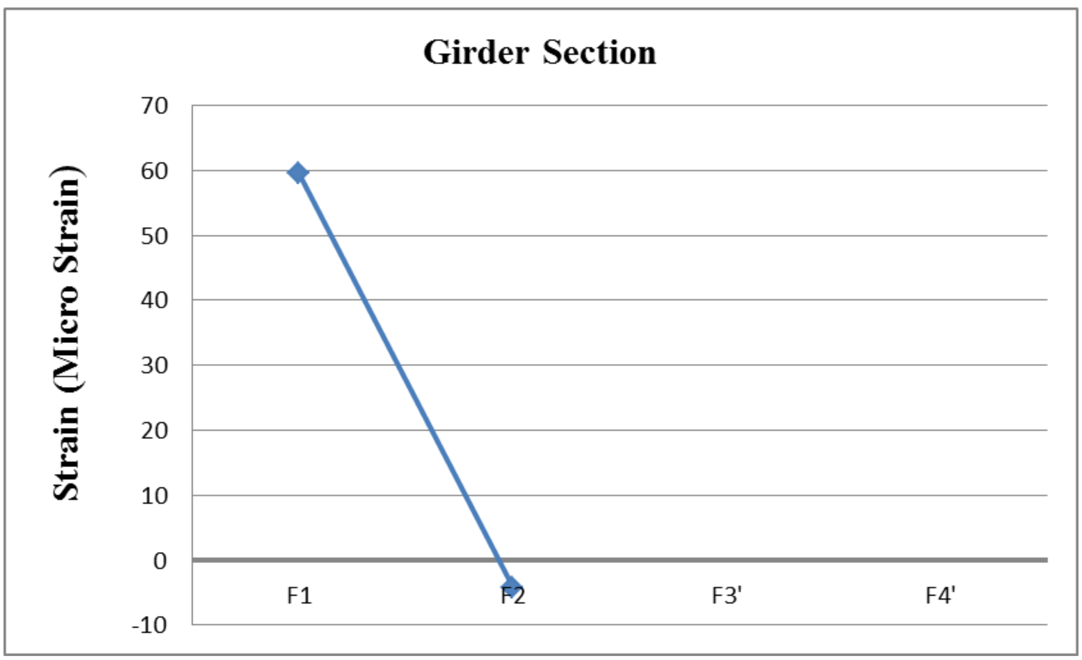

Figure G16. Girder F Strains for Maximum Positive Moment.

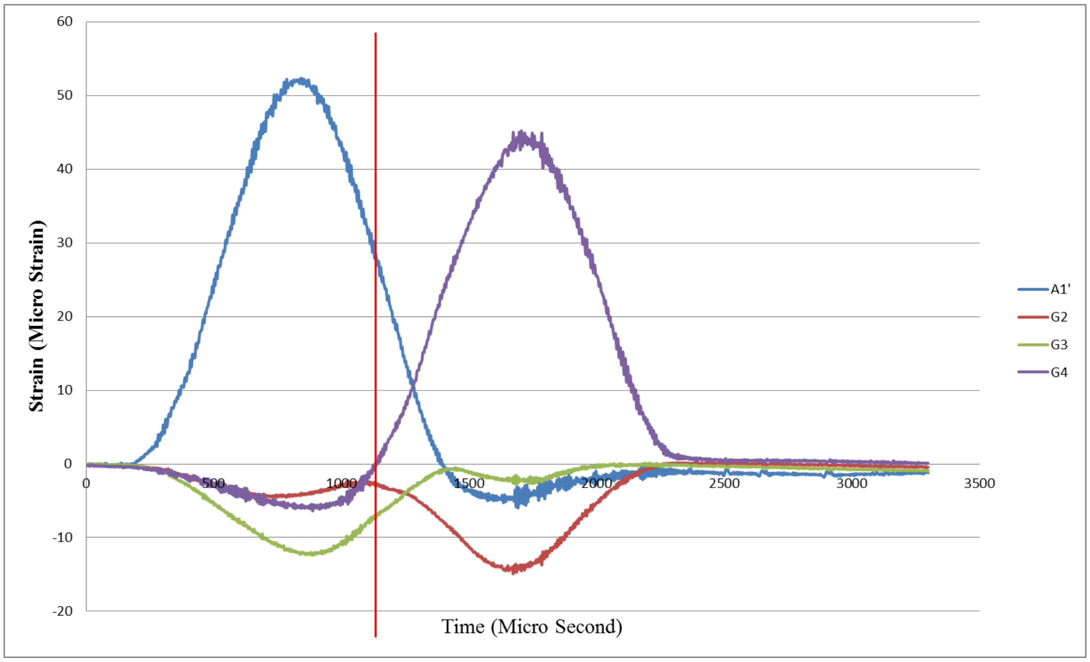

Figure G17. Girder Strains Along Girder Line G.

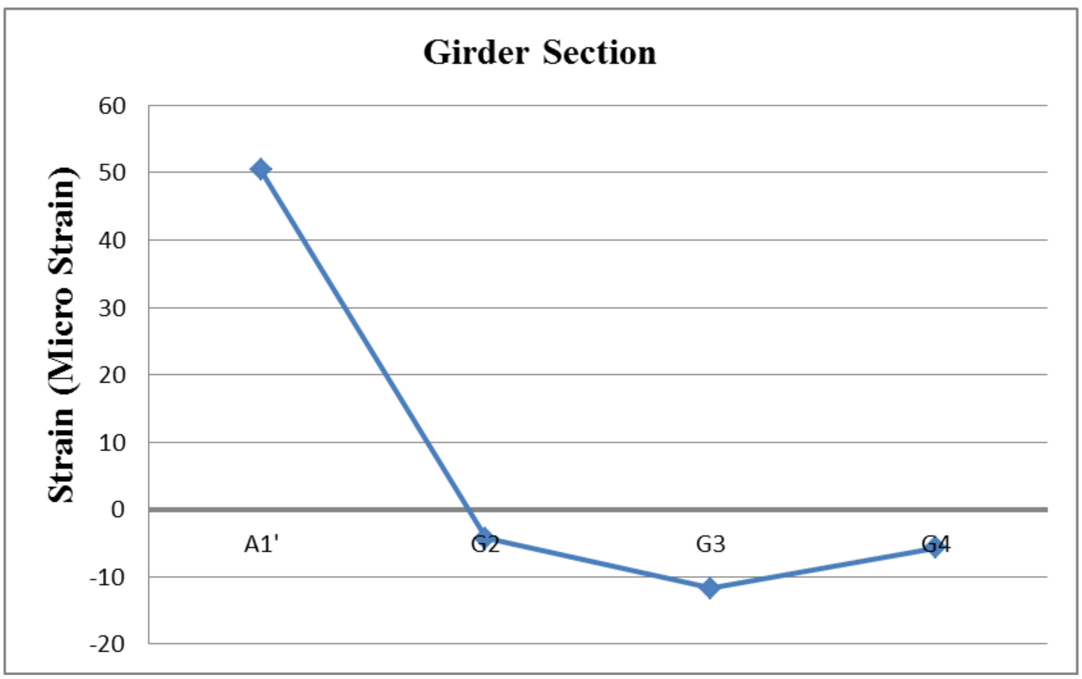

Figure G18. Girder G Strains for Maximum Positive Moment.

Bridge 1 Run 3: Two trucks side by side, as close as possible to the left edge.

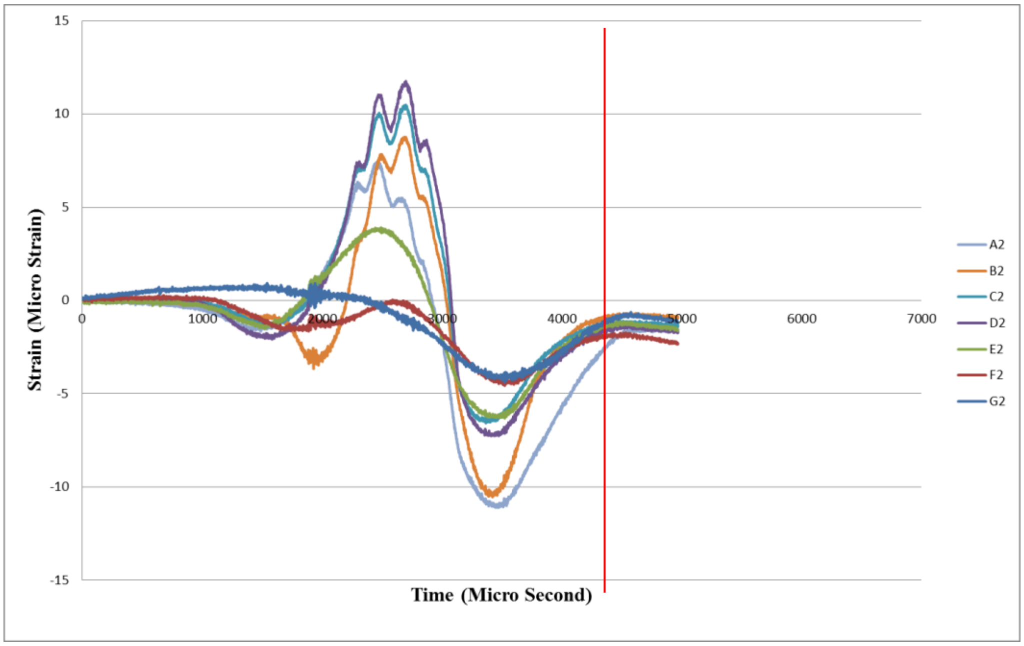

Figure G19. Bridge 1 Run 3 Girder Strains, Gage Line 2.

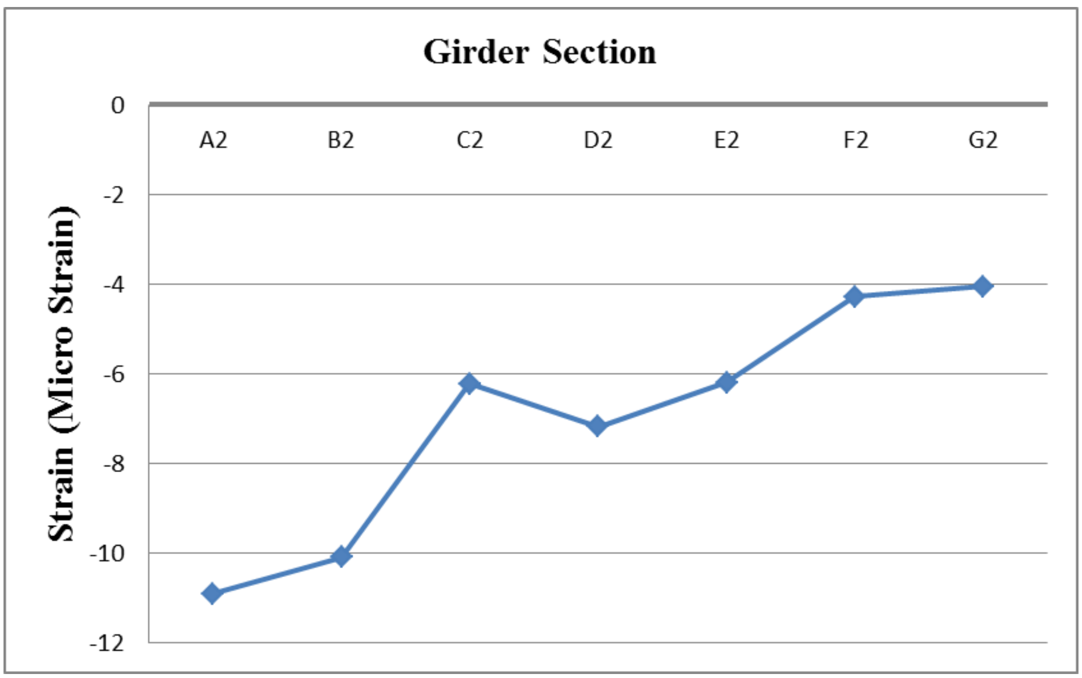

Figure G20. Bridge 1 Run 3 Girder Strains for Maximum Negative Moment.

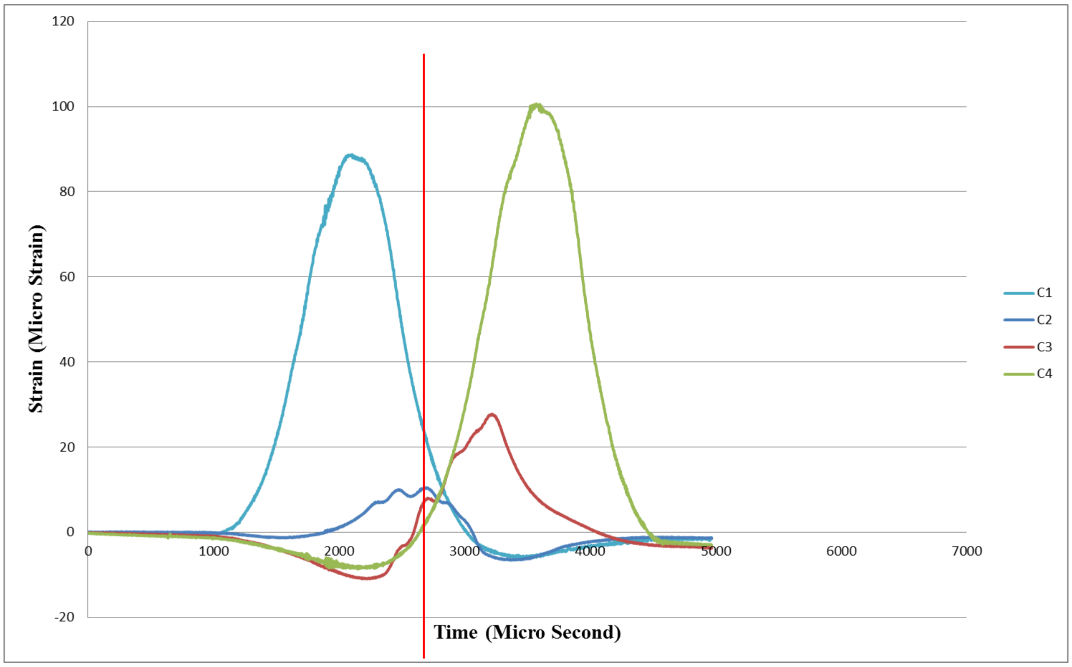

Figure G21. Bridge 1 Run 3 Girder Strains Along Girder C.

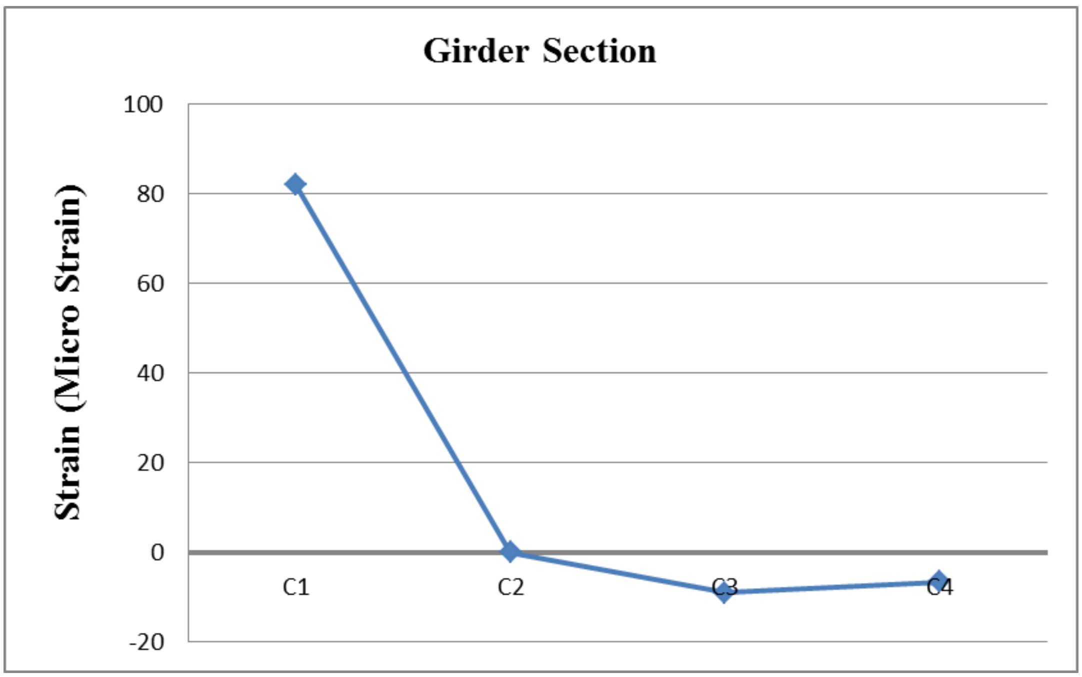

Figure G22. Girder C Strains for Maximum Positive Moment.

Bridge 1 Run 5: Two trucks separated to provide maximum negative moment, center of bridge.

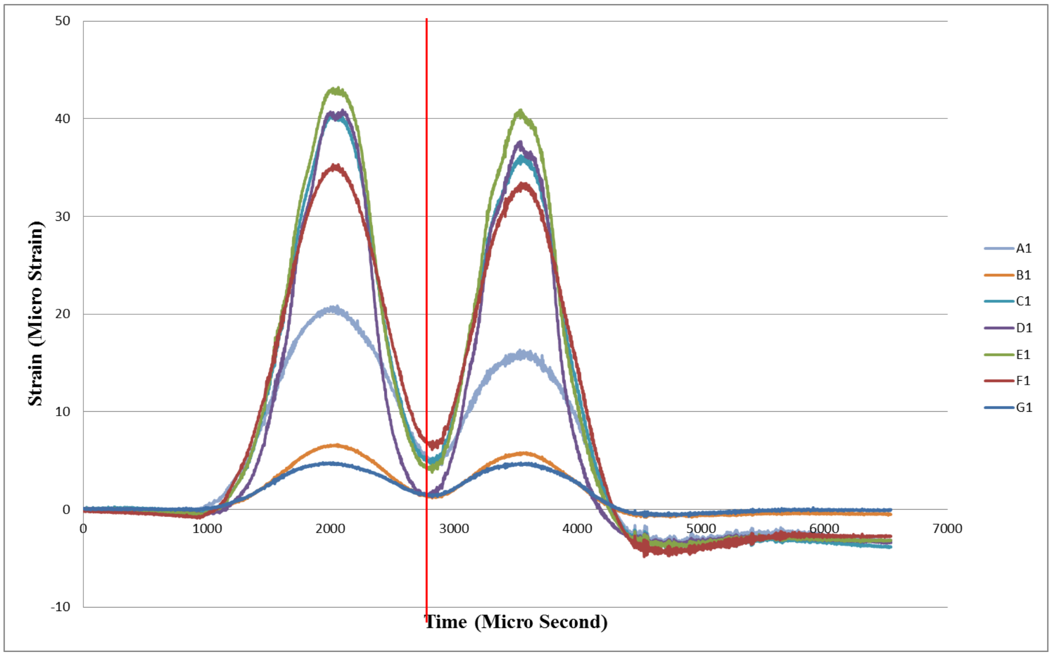

Figure G23. Bridge 1 Run 5 Girder Strains, Gage Line 1.

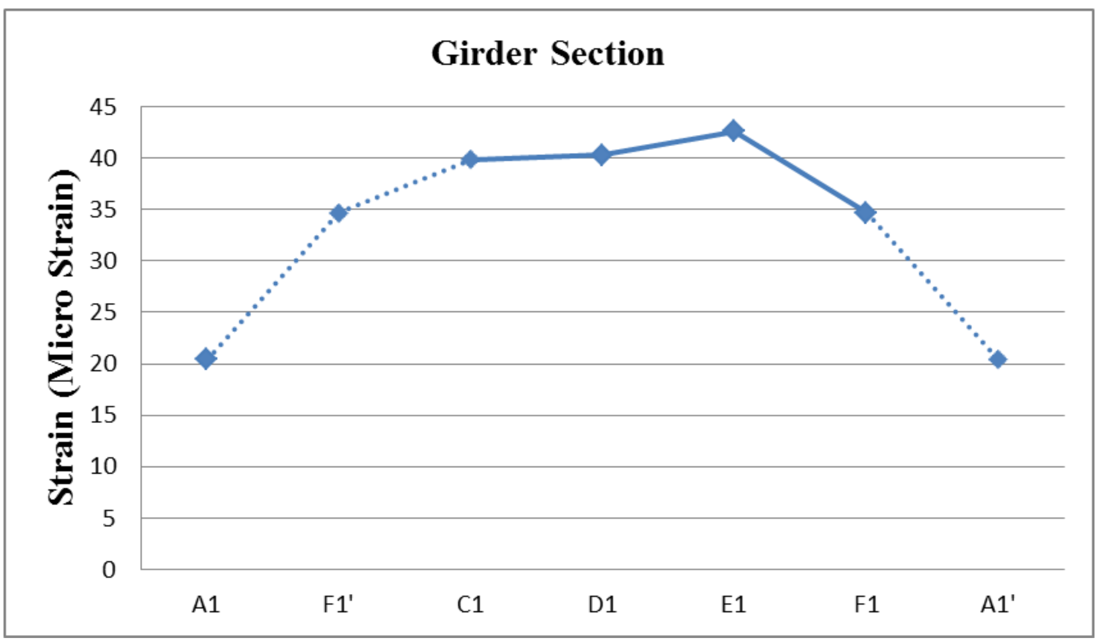

Figure G24. Bridge 1 Run 5 Girder Strains for Maximum Positive Moment.

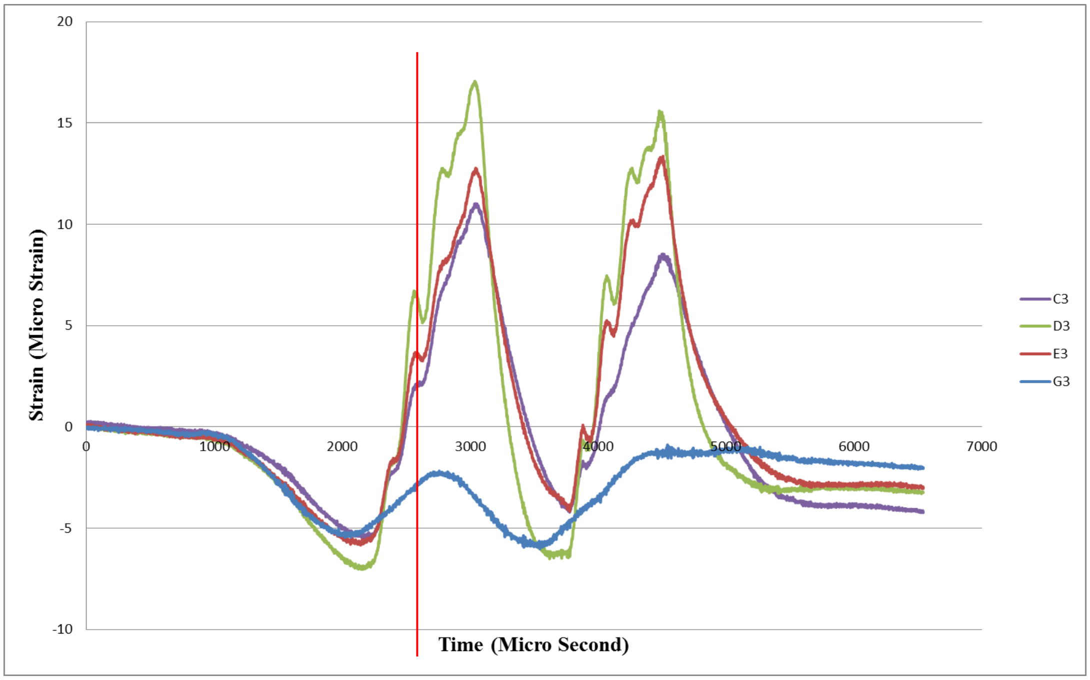

Figure G25. Bridge 1 Run 5 Girder Strains gage Line 3.

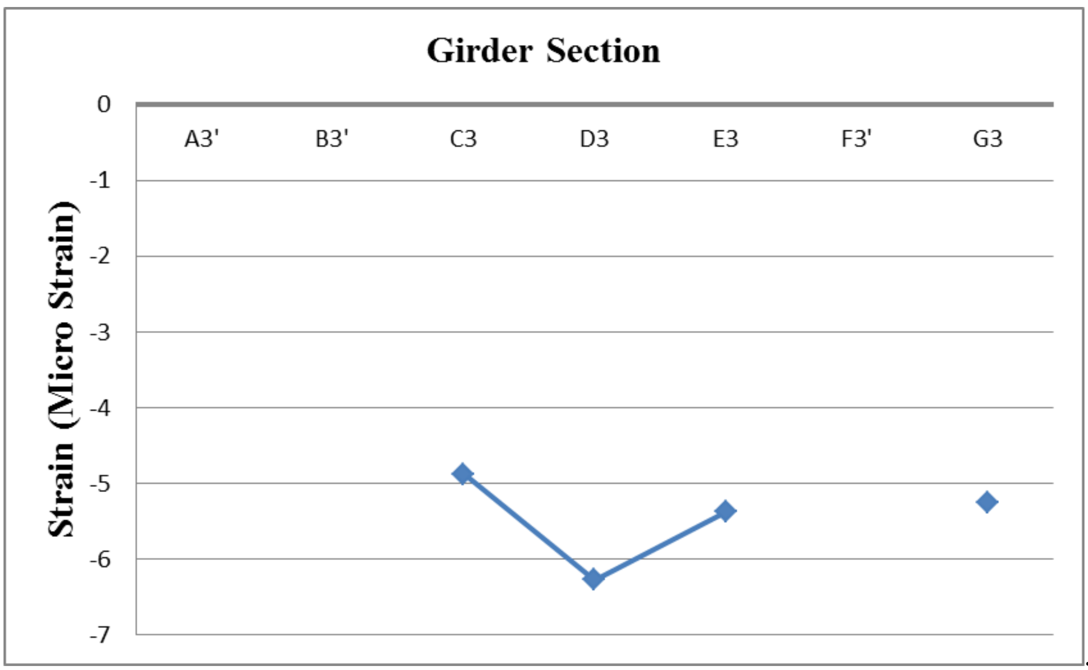

Figure G26. Bridge 1 Run 5 Girder Strains for Maximum Negative Moment.

Bridge 1 Run 8: Two trucks minimally separated, center of bridge.

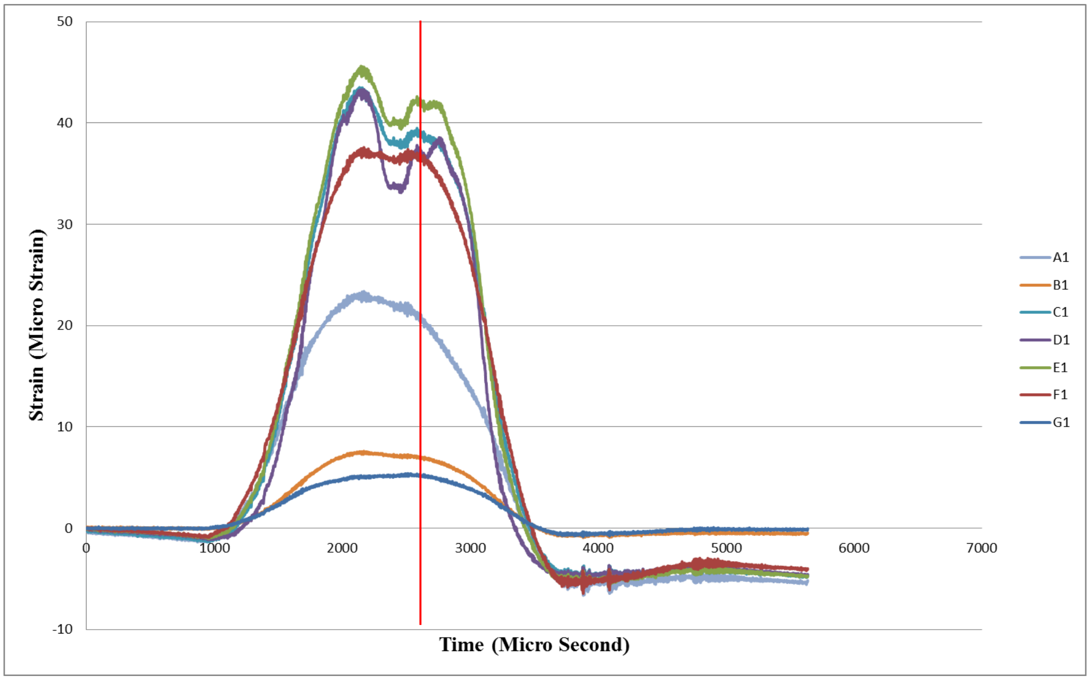

Figure G27. Bridge 1 Run 8 Girder Strains, Gage Line 1.

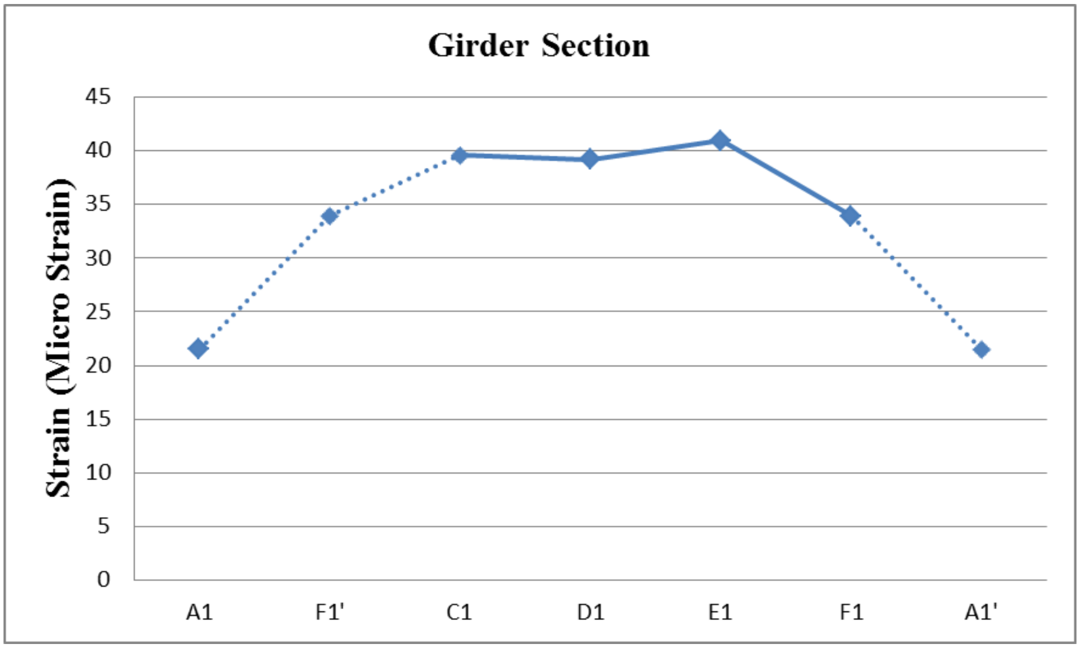

Figure G28. Bridge 1 Run 8 Girder Strains for Maximum Positive Moment.

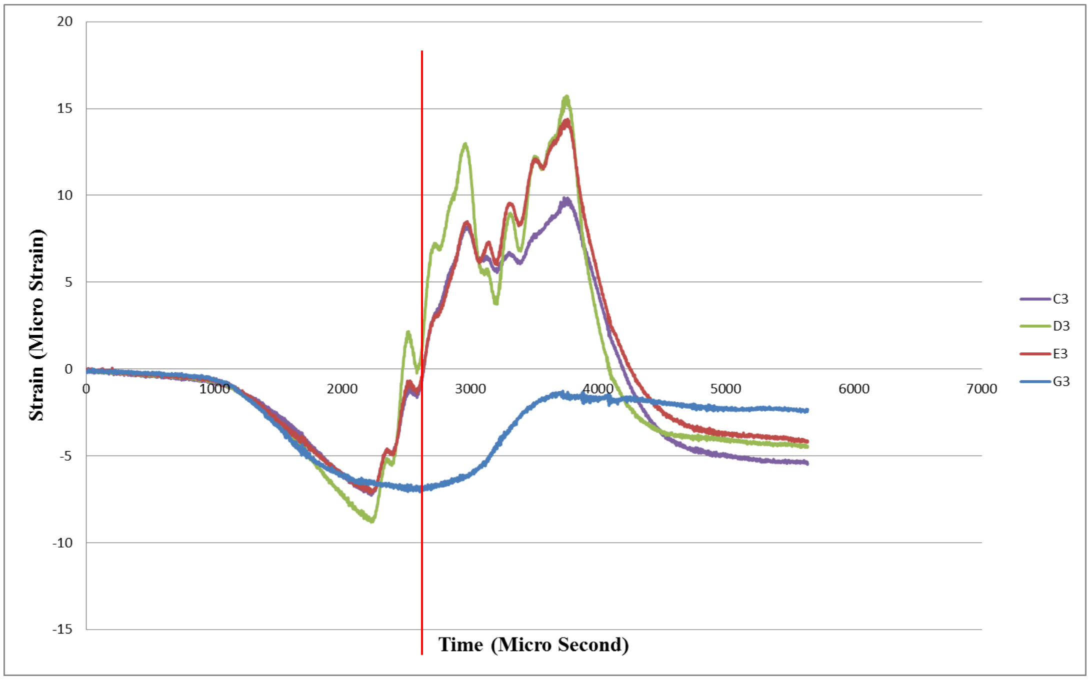

Figure G29. Bridge 1 Run 8 Girder Strains, Gage Line 3.

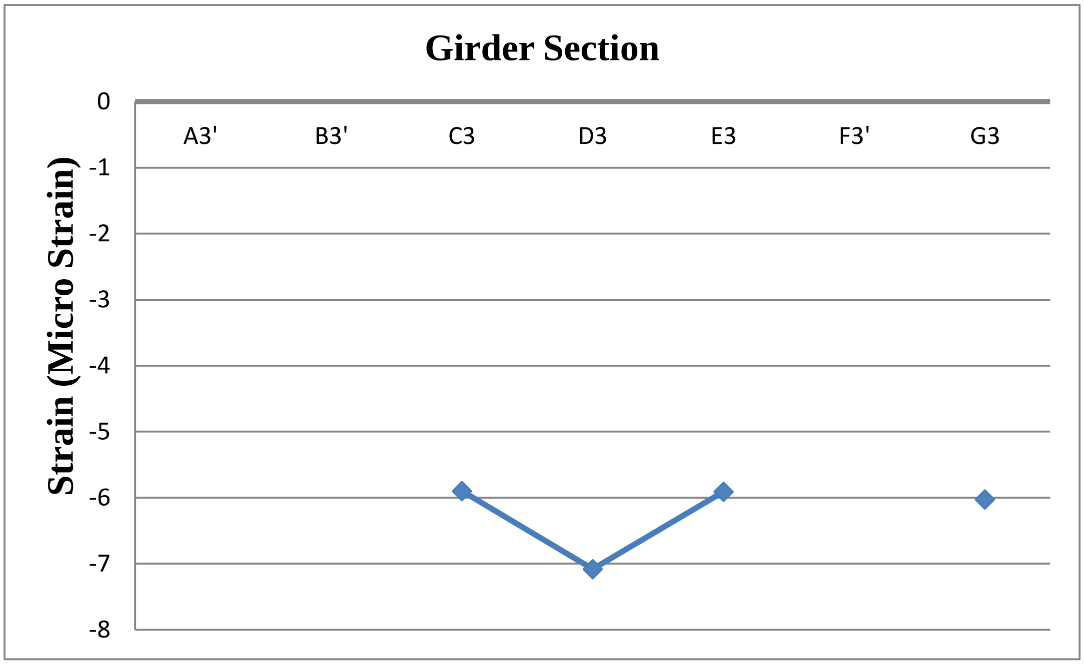

Figure G30. Bridge 1 Run 8 Girder Strains for Maximum Negative Moment.

Bridge 1 Run 11: One truck, center of bridge.

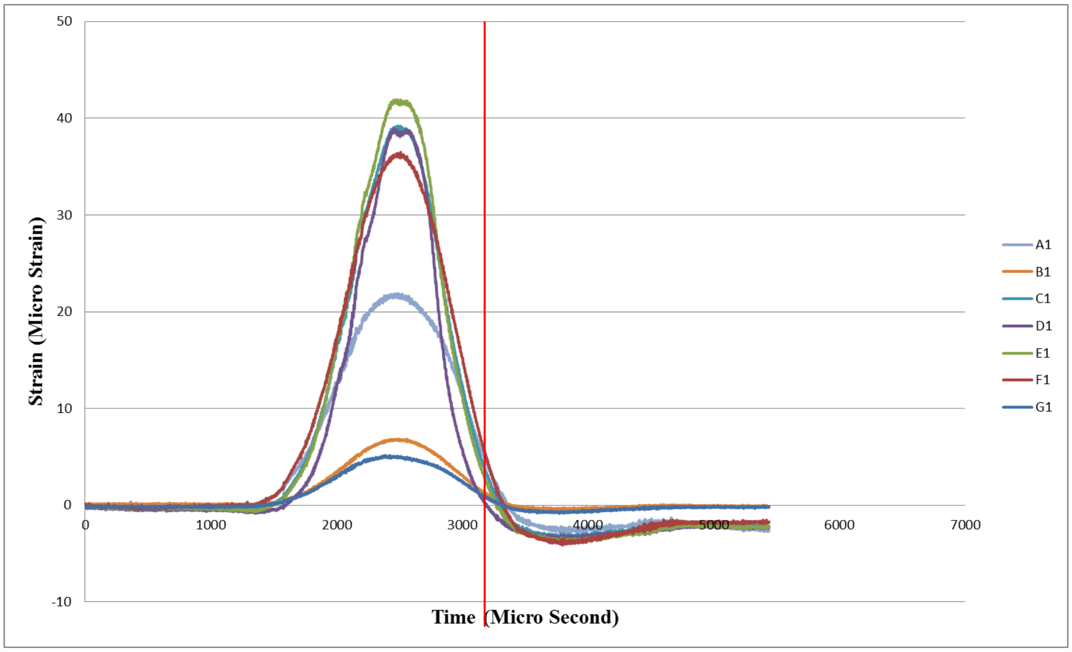

Figure G31. Bridge 1 Run 11 Girder Strains, Gage Line 1.

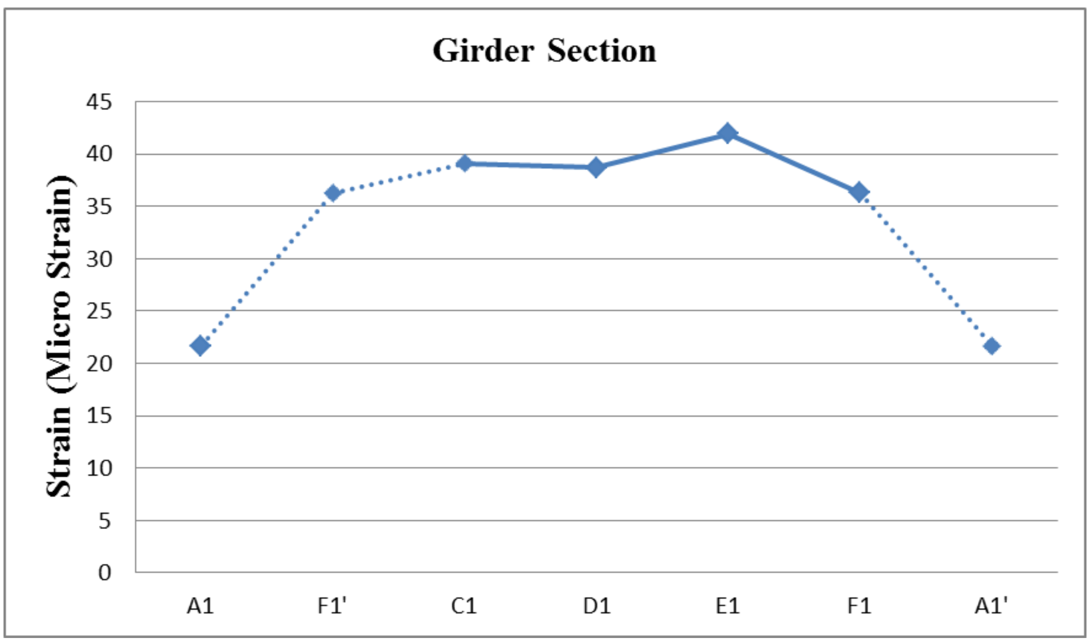

Figure G32. Bridge 1 Run 11 Girder Strains for Maximum Positive Moment.

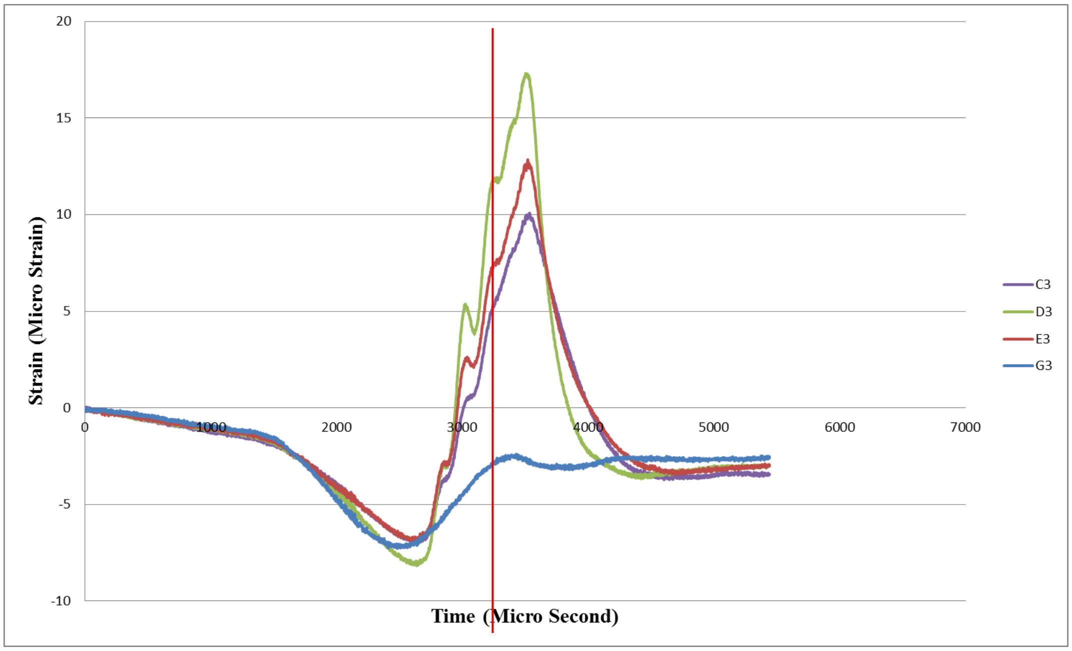

Figure G33. Bridge 1 Run 11 Girder Strains, Gage Line 3.

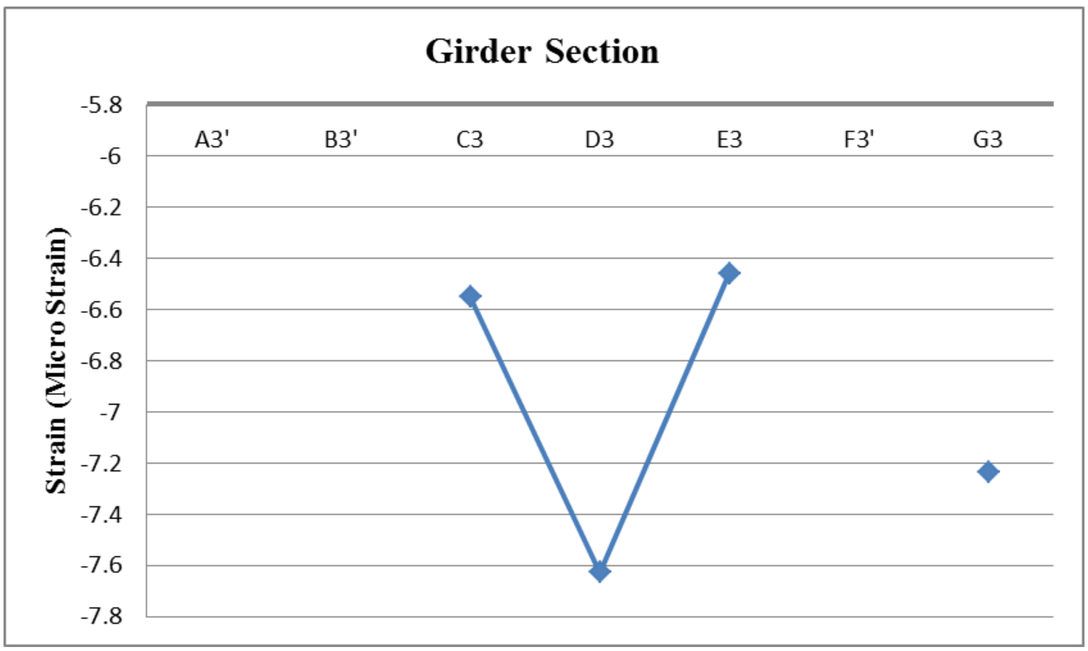

Figure G34. Bridge 1 Run 11 Girder Strains for Maximum Negative Moment.

Bridge 2 Run 1: Two trucks side by side, centered in each lane.

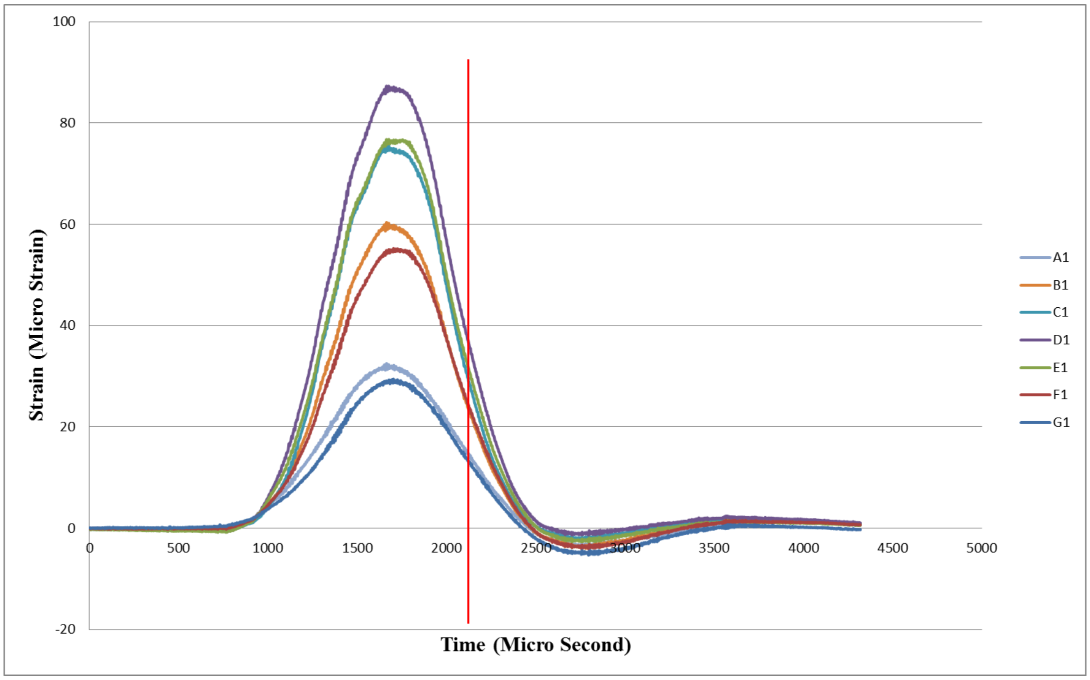

Figure G35. Bridge 2 Run 1 Girder Strains, Gage Line 1.

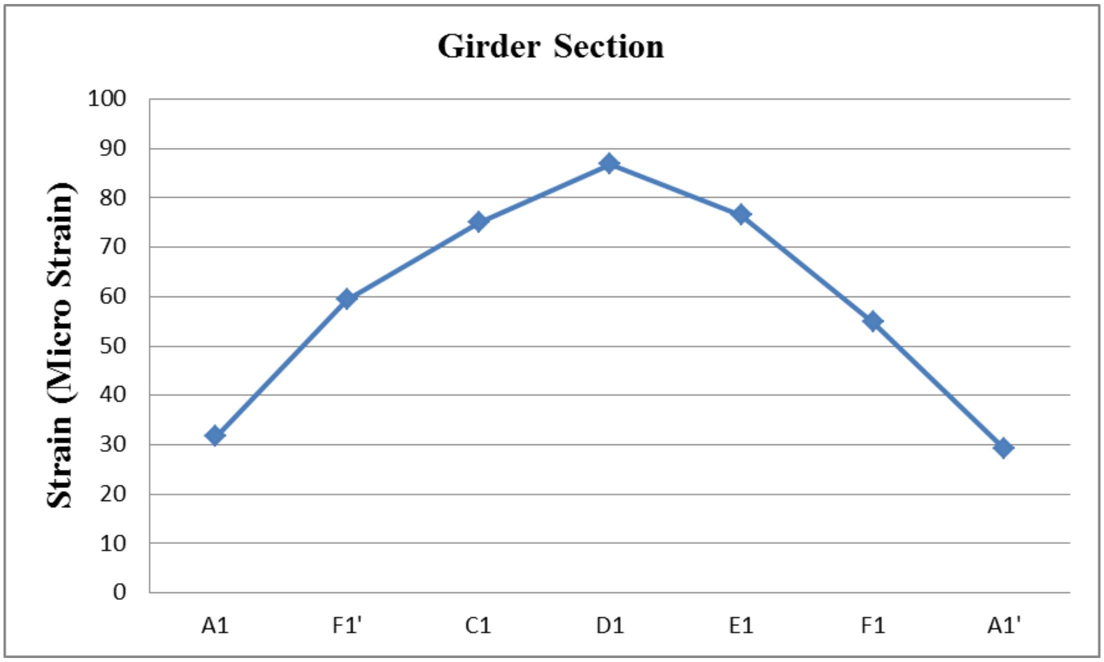

Figure G36. Bridge 2 Run 1 Girder Strains for Maximum Positive Moment.

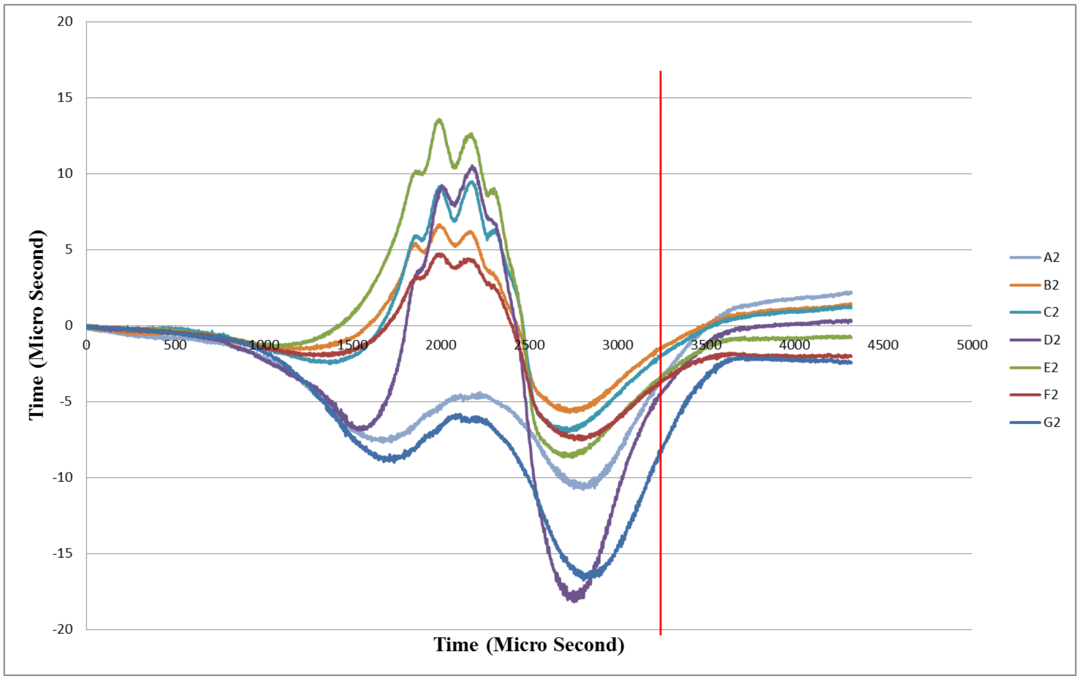

Figure G37. Bridge 2 Run 1 Girder Strains, Gage Line 2.

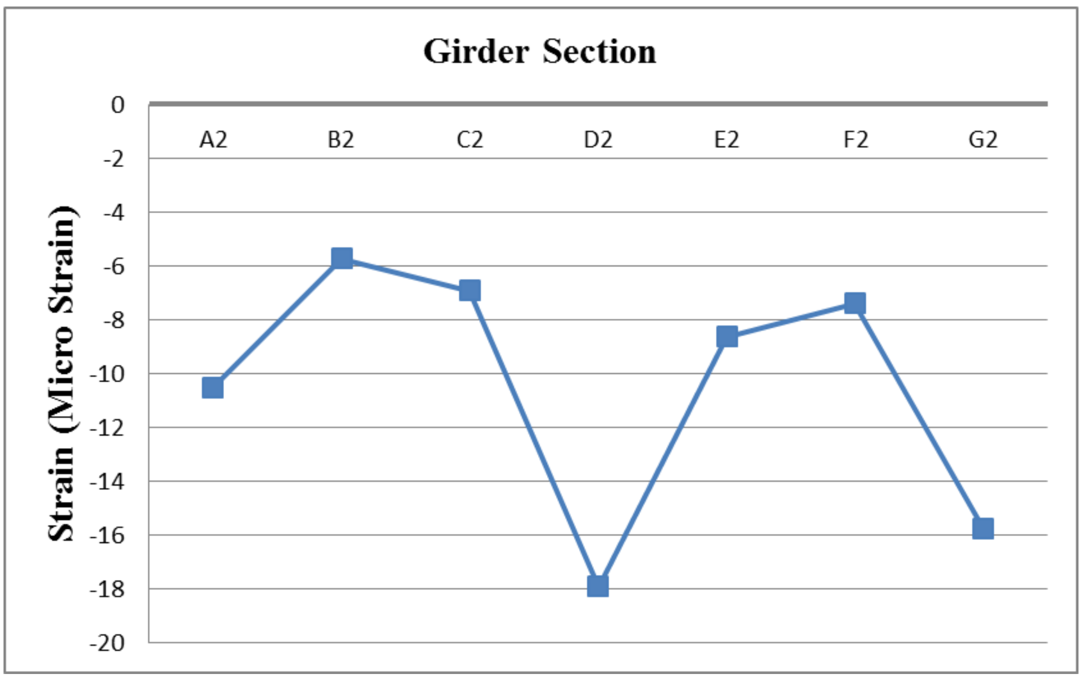

Figure G38. Bridge 2 Run 1 Girder Strains for Maximum Negative Moment.

APPENDIX H: V_n=V_u SECTIONAL METHOD ITERATION PROCEURE

The following example calculation is performed on an AASHTO Type II beam (modeled after Beam 1- Test 2 in Chapter 4) to illustrate how to determine the nominal shear capacity (Vn) using the general LRFD method by iteration to achieve $V_u = V_n$. Note this procedure is not how the general method as outlined in the LRFD Code is applied in design, where $V_u = V_n$ is not enforced. The beam characteristics are given in Table H1.

Table H1. Beam Parameters.

Variable	Value	Unit(s)
Beam type	AASHTO II	-
Area (Ac)	369	in^2
Clear span	14.83	ft
Weight	384	lb/ft
Flange width (be)	12	in
Web Thicknes (bv)	6	in
Yt	20.17	in
Yb	15.83	in
St	2530	in^3
Sb	3220	in^3
I	51000	in^4
Height (in)	36	in
f'c (28)	8.6	ksi
Ec beam	5622.12	ksi
f's (ksi)	270	ksi
# of Strands	16	#
Diameter	0.5	in
Nominal area	0.15	in^2
fpe	23.25	kips/strand
fpc	1.01	ksi
Bar size	3	#
# beams	1	#
Ep	28500	ksi
Av	0.221	in^2
fy	60	ksi
Stirrups spacing	21	in
vu	0.746	ksi
vu/f'c	0.008	<0.125
S_max	20.9	in (<24 in)
k	0.28	-
dp	29.0	in
c	9.07	in
Aps	2.1	in^2
fpu	270	ksi
f'c slab	8.6	ksi
β1	0.65	-
be	12	in
a	5.897509328	in
de	29	in
de-a/2	26.05124534	in
0.9de	26.1	in
0.72h	25.92	in
dv	26.10	in

The iteration process starts by assuming a value for V_u. In this example, the iteration is started by assuming that V_u=200 kips. V_n is then calculated with the standard LRFD procedure; results are shown in column 1 in Table H2. Since the calculated V_n at the first iteration (100 kips) is smaller than the assumed V_u, a smaller value of V_u is then taken in the second iteration. This process is repeated until convergence at $V_u = V_n$ (at approximately 105.2 kips). In Table H2, this has been achieved at the fifth iteration, as shown below.

Table H2. Results of Iteration.

Iteraion #	**1**	**2**	**3**	**4**	**5**
Vu (kips)	200.00	150.00	100.00	105.00	105.20
Mu (ft-kips)	376.50	283.70	190.89	200.17	200.55
ε_x (original)	-0.0003976	-0.0019459	-0.0034943	-0.0033394	-0.0033332
ε_x (alternative)	-0.0000115	-0.0000561	-0.0001008	-0.0000963	-0.0000962
θ (degrees)	28.96	28.80	28.65	28.66	28.66
β	4.84	5.01	5.19	5.17	5.17
Vc (kips)	70.26	72.72	75.36	75.08	75.07
Vs (kips)	29.75	29.94	30.14	30.12	30.12
Vn (kips)	100.01	102.66	105.49	105.20	105.19

where:

$$\varepsilon_s = \frac{|M_u| + 0.5N_u + |(V_u - V_p)| - A_{ps}f_{po}}{(E_sA_s + E_pA_{ps})}$$

When ε_x is negative, it is taken as either zero or recalculated as the following:

$$\varepsilon_s = \frac{|M_u| + 0.5N_u + |(V_u - V_p)| - A_{ps}f_{po}}{(E_sA_s + E_pA_{ps} + E_cA_{ct})}$$

$S_{xe} = \frac{1.38\, S_x}{0.63 + a_g}$ (for members having less than the minimum shear reinforcement)

$S_{xe} = S_{ze} = 12$ (for members having at least the minimum shear reinforcement)

For the first iteration:

$$\beta 1 = \frac{4.8}{(1 + 750\varepsilon_s)} = \frac{4.8}{1 + 750(-0.0000115)} = 4.84$$

$$\theta 1 = 29 + 3500\varepsilon_s = 29 + 3500(-0.0000115) = 28.96^0$$

$$V_c 1 = 0.0316\, \beta\sqrt{f_c'}b_v d_v = 0.0316\,(4.84)(6)(\sqrt{8.6})(26.10) = 70.26 \text{ kips}$$

$$V_s 1 = \frac{A_v f_y d_v(\cot\theta + \cot\alpha)\sin\alpha}{S} = \frac{(0.221)(60)(26.1)(\cot 28.96)}{21} = 29.75 \text{ kips}$$

$$V_n 1 = V_c 1 + V_s 1 + V_p = 70.26 + 29.75 + 0 = 100.01 \text{ kips}$$

This process is continued for the remaining iterations, as shown in Table H2.

APPENDIX I: REGRESSION ANALYSIS

Table I1. LRFD Model Regression Analysis Results.

#	f'c (ksi)	Stress (ksi)	Stirrups Spacing(in)	h (in)	(FEA/LRFD)	Reg.1	Reg.2	FEA/(Reg.1*LRFD)	FEA/(Reg.2*LRFD)
1	5.5	0.5	3	36	1.19	0.91	0.66	1.31	1.81
2	5.5	1.5	3	36	1.30	1.11	1.18	1.17	1.10
3	8	0.5	3	36	1.40	0.94	0.74	1.49	1.88
4	5.5	0.5	24	36	1.93	1.65	1.77	1.17	1.09
5	8	1.5	24	36	2.76	1.87	2.38	1.48	1.16
6	8	1.5	3	36	1.55	1.14	1.27	1.37	1.22
7	5.5	1.5	24	36	2.64	1.85	2.29	1.43	1.15
8	8	0.5	24	36	1.95	1.67	1.86	1.17	1.05
9	5.5	2.5	3	36	1.33	1.31	1.28	1.01	1.04
10	8	2.5	24	36	2.94	2.07	2.48	1.42	1.19
11	8	2.5	3	36	1.57	1.34	1.37	1.18	1.15
12	5.5	2.5	24	36	2.89	2.05	2.40	1.41	1.21
13	5.5	0.5	12	36	1.70	1.23	1.46	1.39	1.17
14	8	1.5	12	36	2.50	1.45	2.07	1.72	1.21
15	5.5	1.5	12	36	2.42	1.43	1.98	1.69	1.22
16	8	0.5	12	36	1.77	1.25	1.54	1.42	1.15
17	5.5	2.5	12	36	2.61	1.63	2.08	1.61	1.25
18	8	2.5	12	36	2.64	1.65	2.17	1.60	1.22
19	5.5	0.5	3	36	1.33	0.91	0.66	1.46	2.02
20	5.5	1.5	3	36	1.50	1.11	1.18	1.35	1.27
21	8	0.5	3	36	1.54	0.94	0.74	1.65	2.07
22	5.5	0.5	24	36	2.10	1.65	1.77	1.27	1.18
23	8	1.5	24	36	2.55	1.87	2.38	1.36	1.07
24	8	1.5	3	36	1.56	1.14	1.27	1.38	1.23
25	5.5	1.5	24	36	2.51	1.85	2.29	1.36	1.09
26	8	0.5	24	36	2.10	1.67	1.86	1.26	1.13
27	5.5	2.5	3	36	1.46	1.31	1.28	1.11	1.14
28	8	2.5	24	36	2.64	2.07	2.48	1.27	1.06
29	8	2.5	3	36	1.46	1.34	1.37	1.09	1.07
30	5.5	2.5	24	36	2.42	2.05	2.40	1.18	1.01
31	5.5	0.5	12	36	2.41	1.23	1.46	1.97	1.65
32	8	1.5	12	36	2.39	1.45	2.07	1.65	1.15
33	5.5	1.5	12	36	2.72	1.43	1.98	1.90	1.37
34	8	0.5	12	36	1.90	1.25	1.54	1.52	1.23
35	5.5	2.5	12	36	2.56	1.63	2.08	1.58	1.23
36	8	2.5	12	36	2.38	1.65	2.17	1.45	1.10
37	5.5	0.5	3	36	1.18	0.91	0.66	1.29	1.79
38	5.5	1.5	3	36	1.37	1.11	1.18	1.23	1.16
39	8	0.5	3	36	1.32	0.94	0.74	1.42	1.78
40	5.5	0.5	24	36	1.96	1.65	1.77	1.19	1.11
41	8	1.5	24	36	2.47	1.87	2.38	1.32	1.04
42	8	1.5	3	36	1.57	1.14	1.27	1.39	1.24
43	5.5	1.5	24	36	2.36	1.85	2.29	1.28	1.03
44	8	0.5	24	36	1.82	1.67	1.86	1.09	0.98
45	5.5	2.5	3	36	1.52	1.31	1.28	1.16	1.18
46	8	2.5	24	36	2.75	2.07	2.48	1.33	1.11
47	8	2.5	3	36	1.76	1.34	1.37	1.32	1.29
48	5.5	2.5	24	36	2.77	2.05	2.40	1.35	1.15
49	5.5	0.5	12	36	1.67	1.23	1.46	1.36	1.14
50	8	1.5	12	36	2.37	1.45	2.07	1.63	1.15

Table I1. LRFD Model Regression Analysis Results (cont).

#	f'c (ksi)	Stress (ksi)	Stirrups Spacing(in)	h (in)	(FEA/LRFD)	Reg.1	Reg.2	FEA/(Reg.1*LRFD)	FEA/(Reg.2*LRFD)
51	5.5	1.5	12	36	2.20	1.43	1.98	1.54	1.11
52	8	0.5	12	36	1.71	1.25	1.54	1.37	1.11
53	5.5	2.5	12	36	2.42	1.63	2.08	1.48	1.16
54	8	2.5	12	36	2.73	1.65	2.17	1.65	1.26
55	5.5	0.5	3	36	1.18	0.91	0.66	1.29	1.78
56	5.5	1.5	3	36	1.37	1.11	1.18	1.23	1.16
57	8	0.5	3	36	1.36	0.94	0.74	1.46	1.83
58	5.5	0.5	24	36	1.92	1.65	1.77	1.16	1.08
59	8	1.5	24	36	2.62	1.87	2.38	1.40	1.10
60	8	1.5	3	36	1.59	1.14	1.27	1.40	1.25
61	5.5	1.5	24	36	2.42	1.85	2.29	1.31	1.06
62	8	0.5	24	36	2.02	1.67	1.86	1.21	1.09
63	5.5	2.5	3	36	1.50	1.31	1.28	1.15	1.17
64	8	2.5	24	36	2.53	2.07	2.48	1.22	1.02
65	8	2.5	3	36	1.73	1.34	1.37	1.29	1.26
66	5.5	2.5	24	36	2.53	2.05	2.40	1.23	1.05
67	5.5	0.5	12	36	2.53	1.23	1.46	2.06	1.74
68	8	1.5	12	36	2.38	1.45	2.07	1.64	1.15
69	5.5	1.5	12	36	2.91	1.43	1.98	2.04	1.47
70	8	0.5	12	36	1.91	1.25	1.54	1.52	1.23
71	5.5	2.5	12	36	3.02	1.63	2.08	1.86	1.45
72	8	2.5	12	36	2.57	1.65	2.17	1.56	1.19
73	5.5	0.5	3	45	1.40	1.07	0.64	1.30	2.19
74	5.5	1.5	3	45	1.77	1.27	1.16	1.39	1.52
75	8	0.5	3	45	1.58	1.10	0.73	1.44	2.18
76	5.5	0.5	24	45	2.21	1.81	1.75	1.22	1.26
77	8	1.5	24	45	2.94	2.03	2.36	1.45	1.24
78	8	1.5	3	45	1.93	1.30	1.25	1.49	1.55
79	5.5	1.5	24	45	2.94	2.01	2.28	1.46	1.29
80	8	0.5	24	45	2.01	1.83	1.84	1.09	1.09
81	5.5	2.5	3	45	1.84	1.47	1.26	1.25	1.45
82	8	2.5	24	45	2.97	2.23	2.46	1.33	1.20
83	8	2.5	3	45	1.99	1.50	1.35	1.33	1.47
84	5.5	2.5	24	45	4.92	2.21	2.38	2.22	2.07
85	5.5	0.5	12	45	1.92	1.39	1.44	1.38	1.33
86	8	1.5	12	45	2.67	1.61	2.05	1.66	1.30
87	5.5	1.5	12	45	2.58	1.59	1.96	1.62	1.31
88	8	0.5	12	45	1.88	1.41	1.53	1.33	1.23
89	5.5	2.5	12	45	2.68	1.79	2.07	1.50	1.30
90	8	2.5	12	45	2.77	1.81	2.15	1.53	1.29
91	5.5	0.5	3	45	1.45	1.07	0.64	1.35	2.27
92	5.5	1.5	3	45	1.79	1.27	1.16	1.40	1.54
93	8	0.5	3	45	1.62	1.10	0.73	1.47	2.23
94	5.5	0.5	24	45	2.42	1.81	1.75	1.34	1.38
95	8	1.5	24	45	2.94	2.03	2.36	1.45	1.24
96	8	1.5	3	45	1.72	1.30	1.25	1.32	1.37
97	5.5	1.5	24	45	2.78	2.01	2.28	1.38	1.22
98	8	0.5	24	45	2.38	1.83	1.84	1.30	1.29
99	5.5	2.5	3	45	1.79	1.47	1.26	1.21	1.41
100	8	2.5	24	45	2.68	2.23	2.46	1.20	1.09
101	8	2.5	3	45	1.92	1.50	1.35	1.28	1.42

Table I1. LRFD Model Regression Analysis Results (cont).

#	f'c (ksi)	Stress (ksi)	Stirrups Spacing(in)	h (in)	(FEA/LRFD)	Reg.1	Reg.2	FEA/(Reg.1*LRFD)	FEA/(Reg.2*LRFD)
102	5.5	2.5	24	45	2.66	2.21	2.38	1.20	1.12
103	5.5	0.5	12	45	2.08	1.39	1.44	1.50	1.44
104	8	1.5	12	45	2.73	1.61	2.05	1.69	1.33
105	5.5	1.5	12	45	2.58	1.59	1.96	1.62	1.31
106	8	0.5	12	45	2.12	1.41	1.53	1.50	1.39
107	5.5	2.5	12	45	2.37	1.79	2.07	1.33	1.15
108	8	2.5	12	45	2.53	1.81	2.15	1.40	1.18
109	5.5	0.5	3	45	1.27	1.07	0.64	1.18	1.98
110	5.5	1.5	3	45	1.57	1.27	1.16	1.23	1.35
111	8	0.5	3	45	1.42	1.10	0.73	1.30	1.96
112	5.5	0.5	24	45	1.82	1.81	1.75	1.00	1.04
113	8	1.5	24	45	2.64	2.03	2.36	1.30	1.12
114	8	1.5	3	45	1.76	1.30	1.25	1.36	1.41
115	5.5	1.5	24	45	2.42	2.01	2.28	1.20	1.06
116	8	0.5	24	45	1.88	1.83	1.84	1.03	1.02
117	5.5	2.5	3	45	1.64	1.47	1.26	1.11	1.30
118	8	2.5	24	45	3.10	2.23	2.46	1.39	1.26
119	8	2.5	3	45	1.94	1.50	1.35	1.29	1.44
120	5.5	2.5	24	45	2.89	2.21	2.38	1.31	1.21
121	5.5	0.5	12	45	1.70	1.39	1.44	1.22	1.18
122	8	1.5	12	45	2.45	1.61	2.05	1.52	1.19
123	5.5	1.5	12	45	2.25	1.59	1.96	1.42	1.15
124	8	0.5	12	45	1.80	1.41	1.53	1.28	1.18
125	5.5	2.5	12	45	2.53	1.79	2.07	1.41	1.22
126	8	2.5	12	45	2.94	1.81	2.15	1.62	1.37
127	5.5	0.5	3	45	1.30	1.07	0.64	1.21	2.03
128	5.5	1.5	3	45	1.60	1.27	1.16	1.26	1.38
129	8	0.5	3	45	1.51	1.10	0.73	1.38	2.08
130	5.5	0.5	24	45	2.04	1.81	1.75	1.13	1.16
131	8	1.5	24	45	2.87	2.03	2.36	1.41	1.22
132	8	1.5	3	45	1.82	1.30	1.25	1.41	1.46
133	5.5	1.5	24	45	2.48	2.01	2.28	1.23	1.09
134	8	0.5	24	45	2.13	1.83	1.84	1.16	1.16
135	5.5	2.5	3	45	1.63	1.47	1.26	1.10	1.29
136	8	2.5	24	45	2.91	2.23	2.46	1.30	1.18
137	8	2.5	3	45	1.94	1.50	1.35	1.30	1.44
138	5.5	2.5	24	45	2.81	2.21	2.38	1.27	1.18
139	5.5	0.5	12	45	1.91	1.39	1.44	1.38	1.33
140	8	1.5	12	45	2.57	1.61	2.05	1.59	1.25
141	5.5	1.5	12	45	2.32	1.59	1.96	1.46	1.18
142	8	0.5	12	45	2.04	1.41	1.53	1.44	1.34
143	5.5	2.5	12	45	2.40	1.79	2.07	1.34	1.16
144	8	2.5	12	45	2.81	1.81	2.15	1.55	1.31
145	5.5	0.5	3	54	1.56	1.24	0.62	1.26	2.51
146	5.5	1.5	3	54	2.01	1.44	1.14	1.40	1.75
147	8	0.5	3	54	1.74	1.26	0.71	1.38	2.45
148	5.5	0.5	24	54	2.42	1.97	1.74	1.23	1.40
149	8	1.5	24	54	3.19	2.19	2.34	1.46	1.36
150	8	1.5	3	54	2.22	1.46	1.23	1.52	1.80
151	5.5	1.5	24	54	3.23	2.17	2.26	1.49	1.43
152	8	0.5	24	54	2.37	1.99	1.82	1.19	1.30

Table I1. LRFD Model Regression Analysis Results (cont).

#	f'c (ksi)	Stress (ksi)	Stirrups Spacing(in)	h (in)	(FEA/LRFD)	Reg.1	Reg.2	FEA/(Reg.1*LRFD)	FEA/(Reg.2*LRFD)
153	5.5	2.5	3	54	2.03	1.64	1.25	1.24	1.63
154	8	2.5	24	54	3.49	2.39	2.44	1.46	1.43
155	8	2.5	3	54	2.26	1.66	1.33	1.36	1.70
156	5.5	2.5	24	54	3.47	2.37	2.36	1.46	1.47
157	5.5	0.5	12	54	2.11	1.55	1.42	1.36	1.49
158	8	1.5	12	54	3.01	1.77	2.03	1.70	1.48
159	5.5	1.5	12	54	2.81	1.75	1.95	1.61	1.45
160	8	0.5	12	54	2.04	1.57	1.51	1.30	1.35
161	5.5	2.5	12	54	2.98	1.95	2.05	1.53	1.46
162	8	2.5	12	54	3.07	1.97	2.13	1.55	1.44
163	5.5	0.5	3	54	1.58	1.24	0.62	1.28	2.54
164	5.5	1.5	3	54	1.96	1.44	1.14	1.36	1.71
165	8	0.5	3	54	1.77	1.26	0.71	1.40	2.50
166	5.5	0.5	24	54	2.59	1.97	1.74	1.32	1.49
167	8	1.5	24	54	3.08	2.19	2.34	1.40	1.31
168	8	1.5	3	54	2.14	1.46	1.23	1.47	1.74
169	5.5	1.5	24	54	3.08	2.17	2.26	1.42	1.36
170	8	0.5	24	54	2.61	1.99	1.82	1.31	1.43
171	5.5	2.5	3	54	1.91	1.64	1.25	1.17	1.53
172	8	2.5	24	54	2.93	2.39	2.44	1.22	1.20
173	8	2.5	3	54	2.10	1.66	1.33	1.27	1.58
174	5.5	2.5	24	54	2.75	2.37	2.36	1.16	1.16
175	5.5	0.5	12	54	2.22	1.55	1.42	1.43	1.56
176	8	1.5	12	54	2.67	1.77	2.03	1.51	1.32
177	5.5	1.5	12	54	2.72	1.75	1.95	1.55	1.40
178	8	0.5	12	54	2.22	1.57	1.51	1.41	1.47
179	5.5	2.5	12	54	2.47	1.95	2.05	1.27	1.21
180	8	2.5	12	54	2.58	1.97	2.13	1.31	1.21
181	5.5	0.5	3	54	1.41	1.24	0.62	1.14	2.26
182	5.5	1.5	3	54	1.72	1.44	1.14	1.20	1.50
183	8	0.5	3	54	1.59	1.26	0.71	1.26	2.25
184	5.5	0.5	24	54	2.07	1.97	1.74	1.05	1.19
185	8	1.5	24	54	3.13	2.19	2.34	1.43	1.34
186	8	1.5	3	54	1.95	1.46	1.23	1.34	1.59
187	5.5	1.5	24	54	3.10	2.17	2.26	1.43	1.37
188	8	0.5	24	54	2.09	1.99	1.82	1.05	1.15
189	5.5	2.5	3	54	1.68	1.64	1.25	1.03	1.35
190	8	2.5	24	54	3.48	2.39	2.44	1.45	1.42
191	8	2.5	3	54	2.04	1.66	1.33	1.23	1.53
192	5.5	2.5	24	54	3.47	2.37	2.36	1.46	1.47
193	5.5	0.5	12	54	1.85	1.55	1.42	1.19	1.30
194	8	1.5	12	54	2.83	1.77	2.03	1.60	1.39
195	5.5	1.5	12	54	2.74	1.75	1.95	1.56	1.41
196	8	0.5	12	54	1.88	1.57	1.51	1.19	1.25
197	5.5	2.5	12	54	2.80	1.95	2.05	1.43	1.37
198	8	2.5	12	54	3.17	1.97	2.13	1.60	1.48
199	5.5	0.5	3	54	1.45	1.24	0.62	1.17	2.33
200	5.5	1.5	3	54	1.77	1.44	1.14	1.23	1.54
201	8	0.5	3	54	1.65	1.26	0.71	1.31	2.33
202	5.5	0.5	24	54	2.39	1.97	1.74	1.21	1.37
203	8	1.5	24	54	3.48	2.19	2.34	1.59	1.48
204	8	1.5	3	54	1.93	1.46	1.23	1.33	1.57

Table I1. LRFD Model Regression Analysis Results (cont).

#	f'c (ksi)	Stress (ksi)	Stirrups Spacing(in)	h (in)	(FEA/LRFD)	Reg.1	Reg.2	FEA/(Reg.1*LRFD)	FEA/(Reg.2*LRFD)
205	5.5	1.5	24	54	3.09	2.17	2.26	1.42	1.37
206	8	0.5	24	54	2.45	1.99	1.82	1.23	1.34
207	5.5	2.5	3	54	1.70	1.64	1.25	1.04	1.37
208	8	2.5	24	54	3.19	2.39	2.44	1.33	1.30
209	8	2.5	3	54	1.91	1.66	1.33	1.15	1.43
210	5.5	2.5	24	54	2.75	2.37	2.36	1.16	1.17
211	5.5	0.5	12	54	2.10	1.55	1.42	1.35	1.48
212	8	1.5	12	54	3.03	1.77	2.03	1.71	1.49
213	5.5	1.5	12	54	2.69	1.75	1.95	1.53	1.38
214	8	0.5	12	54	2.19	1.57	1.51	1.39	1.45
215	5.5	2.5	12	54	2.58	1.95	2.05	1.32	1.26
216	8	2.5	12	54	2.91	1.97	2.13	1.47	1.36
				Mean	2.25	1.64	1.70	1.37	1.39
				STDEV.	0.59	0.37	0.55	0.19	0.32
				COV	0.26	0.23	0.32	0.14	0.23

Table I2. Standard Code Regression Analysis Results.

#	f'c (ksi)	Stress (ksi)	Stirrups Spacing(in)	h (in)	(FEA/STD.)	Reg.3	FEA/(Reg.3*LRFD)
1	5.5	0.5	3	36	1.27	0.74	1.73
2	5.5	1.5	3	36	1.39	0.87	1.60
3	8	0.5	3	36	1.30	0.82	1.58
4	5.5	0.5	24	36	1.30	0.95	1.37
5	8	1.5	24	36	1.95	1.16	1.68
6	8	1.5	3	36	1.44	0.95	1.52
7	5.5	1.5	24	36	1.78	1.08	1.65
8	8	0.5	24	36	1.38	1.03	1.33
9	5.5	2.5	3	36	1.42	1.00	1.42
10	8	2.5	24	36	2.08	1.29	1.61
11	8	2.5	3	36	1.46	1.08	1.35
12	5.5	2.5	24	36	1.95	1.21	1.62
13	5.5	0.5	12	36	1.31	0.83	1.58
14	8	1.5	12	36	1.98	1.04	1.90
15	5.5	1.5	12	36	1.86	0.96	1.94
16	8	0.5	12	36	1.41	0.91	1.54
17	5.5	2.5	12	36	2.01	1.09	1.85
18	8	2.5	12	36	2.10	1.17	1.79
19	5.5	0.5	3	36	1.23	0.74	1.67
20	5.5	1.5	3	36	1.28	0.87	1.47
21	8	0.5	3	36	1.39	0.82	1.70
22	5.5	0.5	24	36	1.38	0.95	1.46
23	8	1.5	24	36	1.69	1.16	1.45
24	8	1.5	3	36	1.34	0.95	1.41
25	5.5	1.5	24	36	1.59	1.08	1.48
26	8	0.5	24	36	1.45	1.03	1.40
27	5.5	2.5	3	36	1.22	1.00	1.22
28	8	2.5	24	36	1.69	1.29	1.31
29	8	2.5	3	36	1.27	1.08	1.18
30	5.5	2.5	24	36	1.49	1.21	1.23
31	5.5	0.5	12	36	1.81	0.83	2.18
32	8	1.5	12	36	1.76	1.04	1.69
33	5.5	1.5	12	36	1.95	0.96	2.03
34	8	0.5	12	36	1.47	0.91	1.61
35	5.5	2.5	12	36	1.77	1.09	1.63
36	8	2.5	12	36	1.69	1.17	1.45
37	5.5	0.5	3	36	1.15	0.74	1.55
38	5.5	1.5	3	36	1.33	0.87	1.54
39	8	0.5	3	36	1.29	0.82	1.57
40	5.5	0.5	24	36	1.15	0.95	1.22
41	8	1.5	24	36	1.52	1.16	1.31
42	8	1.5	3	36	1.53	0.95	1.61
43	5.5	1.5	24	36	1.39	1.08	1.29
44	8	0.5	24	36	1.12	1.03	1.08
45	5.5	2.5	3	36	1.48	1.00	1.48
46	8	2.5	24	36	1.69	1.29	1.31
47	8	2.5	3	36	1.72	1.08	1.59
48	5.5	2.5	24	36	1.63	1.21	1.35
49	5.5	0.5	12	36	1.13	0.83	1.36
50	8	1.5	12	36	1.64	1.04	1.58

Table I2. Standard Code Regression Analysis Results (cont).

#	f'c (ksi)	Stress (ksi)	Stirrups Spacing(in)	h (in)	(FEA/STD.)	Reg.3	FEA/(Reg.3*LRFD)
51	5.5	1.5	12	36	1.48	0.96	1.55
52	8	0.5	12	36	1.18	0.91	1.30
53	5.5	2.5	12	36	1.63	1.09	1.50
54	8	2.5	12	36	1.89	1.17	1.61
55	5.5	0.5	3	36	1.08	0.74	1.46
56	5.5	1.5	3	36	1.22	0.87	1.40
57	8	0.5	3	36	1.26	0.82	1.53
58	5.5	0.5	24	36	1.04	0.95	1.10
59	8	1.5	24	36	1.47	1.16	1.27
60	8	1.5	3	36	1.42	0.95	1.49
61	5.5	1.5	24	36	1.30	1.08	1.21
62	8	0.5	24	36	1.15	1.03	1.11
63	5.5	2.5	3	36	1.30	1.00	1.30
64	8	2.5	24	36	1.41	1.29	1.09
65	8	2.5	3	36	1.51	1.08	1.39
66	5.5	2.5	24	36	1.35	1.21	1.12
67	5.5	0.5	12	36	1.58	0.83	1.91
68	8	1.5	12	36	1.50	1.04	1.44
69	5.5	1.5	12	36	1.78	0.96	1.85
70	8	0.5	12	36	1.23	0.91	1.35
71	5.5	2.5	12	36	1.82	1.09	1.67
72	8	2.5	12	36	1.59	1.17	1.36
73	5.5	0.5	3	45	1.37	0.89	1.54
74	5.5	1.5	3	45	1.73	1.02	1.70
75	8	0.5	3	45	1.51	0.97	1.55
76	5.5	0.5	24	45	1.58	1.10	1.44
77	8	1.5	24	45	2.32	1.31	1.76
78	8	1.5	3	45	1.84	1.10	1.67
79	5.5	1.5	24	45	2.11	1.23	1.71
80	8	0.5	24	45	1.58	1.18	1.34
81	5.5	2.5	3	45	1.80	1.15	1.56
82	8	2.5	24	45	2.34	1.44	1.62
83	8	2.5	3	45	1.89	1.23	1.53
84	5.5	2.5	24	45	3.52	1.36	2.59
85	5.5	0.5	12	45	1.57	0.98	1.60
86	8	1.5	12	45	2.24	1.19	1.88
87	5.5	1.5	12	45	2.11	1.11	1.90
88	8	0.5	12	45	1.57	1.06	1.48
89	5.5	2.5	12	45	2.20	1.24	1.77
90	8	2.5	12	45	2.32	1.32	1.75
91	5.5	0.5	3	45	1.41	0.89	1.58
92	5.5	1.5	3	45	1.72	1.02	1.68
93	8	0.5	3	45	1.53	0.97	1.57
94	5.5	0.5	24	45	1.76	1.10	1.60
95	8	1.5	24	45	2.26	1.31	1.72
96	8	1.5	3	45	1.81	1.10	1.64
97	5.5	1.5	24	45	2.08	1.23	1.69
98	8	0.5	24	45	1.79	1.18	1.51
99	5.5	2.5	3	45	1.69	1.15	1.47
100	8	2.5	24	45	2.10	1.44	1.45
101	8	2.5	3	45	1.78	1.23	1.44

Table I2. Standard Code Regression Analysis Results (cont).

#	f'c (ksi)	Stress (ksi)	Stirrups Spacing(in)	h (in)	(FEA/STD.)	Reg.3	FEA/(Reg.3*LRFD)
102	5.5	2.5	24	45	2.03	1.36	1.49
103	5.5	0.5	12	45	1.67	0.98	1.71
104	8	1.5	12	45	2.27	1.19	1.90
105	5.5	1.5	12	45	2.10	1.11	1.89
106	8	0.5	12	45	1.86	1.06	1.75
107	5.5	2.5	12	45	2.02	1.24	1.63
108	8	2.5	12	45	2.18	1.32	1.65
109	5.5	0.5	3	45	1.17	0.89	1.31
110	5.5	1.5	3	45	1.45	1.02	1.42
111	8	0.5	3	45	1.31	0.97	1.35
112	5.5	0.5	24	45	1.10	1.10	1.00
113	8	1.5	24	45	1.64	1.31	1.25
114	8	1.5	3	45	1.62	1.10	1.47
115	5.5	1.5	24	45	1.46	1.23	1.19
116	8	0.5	24	45	1.17	1.18	0.99
117	5.5	2.5	3	45	1.51	1.15	1.31
118	8	2.5	24	45	1.93	1.44	1.33
119	8	2.5	3	45	1.79	1.23	1.45
120	5.5	2.5	24	45	1.75	1.36	1.28
121	5.5	0.5	12	45	1.14	0.98	1.16
122	8	1.5	12	45	1.67	1.19	1.40
123	5.5	1.5	12	45	1.51	1.11	1.36
124	8	0.5	12	45	1.23	1.06	1.16
125	5.5	2.5	12	45	1.70	1.24	1.37
126	8	2.5	12	45	2.01	1.32	1.52
127	5.5	0.5	3	45	1.20	0.89	1.35
128	5.5	1.5	3	45	1.48	1.02	1.45
129	8	0.5	3	45	1.40	0.97	1.43
130	5.5	0.5	24	45	1.25	1.10	1.13
131	8	1.5	24	45	1.85	1.31	1.41
132	8	1.5	3	45	1.69	1.10	1.53
133	5.5	1.5	24	45	1.56	1.23	1.27
134	8	0.5	24	45	1.34	1.18	1.13
135	5.5	2.5	3	45	1.50	1.15	1.30
136	8	2.5	24	45	1.91	1.44	1.32
137	8	2.5	3	45	1.80	1.23	1.46
138	5.5	2.5	24	45	1.81	1.36	1.33
139	5.5	0.5	12	45	1.29	0.98	1.32
140	8	1.5	12	45	1.80	1.19	1.51
141	5.5	1.5	12	45	1.60	1.11	1.44
142	8	0.5	12	45	1.41	1.06	1.32
143	5.5	2.5	12	45	1.68	1.24	1.36
144	8	2.5	12	45	2.00	1.32	1.51
145	5.5	0.5	3	54	1.52	1.04	1.45
146	5.5	1.5	3	54	1.95	1.17	1.66
147	8	0.5	3	54	1.63	1.13	1.45
148	5.5	0.5	24	54	1.76	1.25	1.40
149	8	1.5	24	54	2.43	1.47	1.65
150	8	1.5	3	54	2.08	1.26	1.66
151	5.5	1.5	24	54	2.35	1.38	1.70
152	8	0.5	24	54	1.80	1.34	1.34

Table I2. Standard Code Regression Analysis Results (cont).

#	f'c (ksi)	Stress (ksi)	Stirrups Spacing(in)	h (in)	(FEA/STD.)	Reg.3	FEA/(Reg.3*LRFD)
153	5.5	2.5	3	54	1.97	1.30	1.51
154	8	2.5	24	54	2.65	1.60	1.66
155	8	2.5	3	54	2.12	1.39	1.53
156	5.5	2.5	24	54	2.52	1.51	1.66
157	5.5	0.5	12	54	1.71	1.13	1.50
158	8	1.5	12	54	2.51	1.35	1.86
159	5.5	1.5	12	54	2.27	1.26	1.80
160	8	0.5	12	54	1.70	1.22	1.40
161	5.5	2.5	12	54	2.41	1.39	1.73
162	8	2.5	12	54	2.55	1.48	1.73
163	5.5	0.5	3	54	1.53	1.04	1.46
164	5.5	1.5	3	54	1.86	1.17	1.59
165	8	0.5	3	54	1.66	1.13	1.47
166	5.5	0.5	24	54	1.93	1.25	1.54
167	8	1.5	24	54	2.44	1.47	1.67
168	8	1.5	3	54	1.98	1.26	1.58
169	5.5	1.5	24	54	2.36	1.38	1.71
170	8	0.5	24	54	2.02	1.34	1.51
171	5.5	2.5	3	54	1.79	1.30	1.38
172	8	2.5	24	54	2.37	1.60	1.48
173	8	2.5	3	54	1.93	1.39	1.39
174	5.5	2.5	24	54	2.16	1.51	1.43
175	5.5	0.5	12	54	1.83	1.13	1.61
176	8	1.5	12	54	2.29	1.35	1.70
177	5.5	1.5	12	54	2.28	1.26	1.80
178	8	0.5	12	54	1.87	1.22	1.54
179	5.5	2.5	12	54	2.10	1.39	1.51
180	8	2.5	12	54	2.24	1.48	1.51
181	5.5	0.5	3	54	1.24	1.04	1.19
182	5.5	1.5	3	54	1.52	1.17	1.29
183	8	0.5	3	54	1.42	1.13	1.26
184	5.5	0.5	24	54	1.14	1.25	-
185	8	1.5	24	54	1.80	1.47	1.23
186	8	1.5	3	54	1.74	1.26	1.38
187	5.5	1.5	24	54	1.70	1.38	1.23
188	8	0.5	24	54	1.20	1.34	-
189	5.5	2.5	3	54	1.49	1.30	1.14
190	8	2.5	24	54	2.00	1.60	1.25
191	8	2.5	3	54	1.82	1.39	1.31
192	5.5	2.5	24	54	1.90	1.51	1.26
193	5.5	0.5	12	54	1.14	1.13	1.00
194	8	1.5	12	54	1.81	1.35	1.34
195	5.5	1.5	12	54	1.69	1.26	1.33
196	8	0.5	12	54	1.20	1.22	0.99
197	5.5	2.5	12	54	1.72	1.39	1.24
198	8	2.5	12	54	2.02	1.48	1.37
199	5.5	0.5	3	54	1.29	1.04	1.23
200	5.5	1.5	3	54	1.57	1.17	1.34
201	8	0.5	3	54	1.47	1.13	1.31
202	5.5	0.5	24	54	1.33	1.25	1.06
203	8	1.5	24	54	2.10	1.47	1.43
204	8	1.5	3	54	1.73	1.26	1.38

Table I2. Standard Code Regression Analysis Results (cont).

#	f'c (ksi)	Stress (ksi)	Stirrups Spacing(in)	h (in)	(FEA/STD.)	Reg.3	FEA/(Reg.3*LRFD)
205	5.5	1.5	24	54	1.79	1.38	1.29
206	8	0.5	24	54	1.43	1.34	1.07
207	5.5	2.5	3	54	1.52	1.30	1.16
208	8	2.5	24	54	1.98	1.60	1.24
209	8	2.5	3	54	1.71	1.39	1.24
210	5.5	2.5	24	54	1.64	1.51	1.08
211	5.5	0.5	12	54	1.31	1.13	1.16
212	8	1.5	12	54	2.00	1.35	1.49
213	5.5	1.5	12	54	1.72	1.26	1.36
214	8	0.5	12	54	1.42	1.22	1.17
215	5.5	2.5	12	54	1.69	1.39	1.21
216	8	2.5	12	54	1.96	1.48	1.33
				Mean	1.69	1.16	1.47
				STDEV.	0.43	0.24	0.33
				COV	0.26	0.21	0.22