APPENDIX D. MATERIAL TEST RESULTS

Tensile coupon testing was used to characterize the steel plate used to make the five connection members, gusset plates, and splice plates. Testing was performed according to the ASTM E8-08 Specification. The coupons were CNC machined according to one of the two drawings shown in Figure D1. Sometimes etched or stamped identification marks on the material sample plates interfered with using the full-size Plate-types specimen and instead a Sheet-type specimen were used instead. According to ASTM E8, the sheet type specimen is valid for material thickness up to 0.75 inches thick. All pretest measurements and markings were also performed in accordance to ASTM E8.

Testing was performed on a MTS four-post testing machine with hydraulic wedge grips and a 220 kip capacity. As the project progressed through time, the lab benefitted from certain machine upgrades. Therefore, the testing machine was controlled with either an analog MTS 458.20 controller using an external command or a digital MTS Flex Test 60 controller running MTS Test Works software. The external command came from a personal computer with custom written software that collected load/displacement/strain data and provided a displacement command to the controller. The custom software allowed the user to increase the loading rate in the middle of the test, a function the 458 controller was not capable of performing. The MTS Test Works software was able to integrate the same functionality without an external computer providing the command signal.

Strain measurements were made using one of two extensometers, which depended on the coupon size. One was a clip-on extensometer with a 1 inch measurement range, but was fitted with an extension bar to measure strain over an 8.000 inch gauge length. The second extensometer was also clip-on but had a fixed 2.000 inch gauge length and a 1 inch range, it was used exclusively in testing the Sheet-type coupons.

Specimens were initially loaded at a rate of 0.0003 inch/sec. Once the specimen had yielded, the static yield was attained by pausing the loading for a period of 60-90 seconds in three locations along the yield plateau. Once strain hardening had begun, the loading rate was gradually increased to 0.01 inch/sec until the specimen fractured. Typically it took approximately 20 minutes to fracture a specimen.

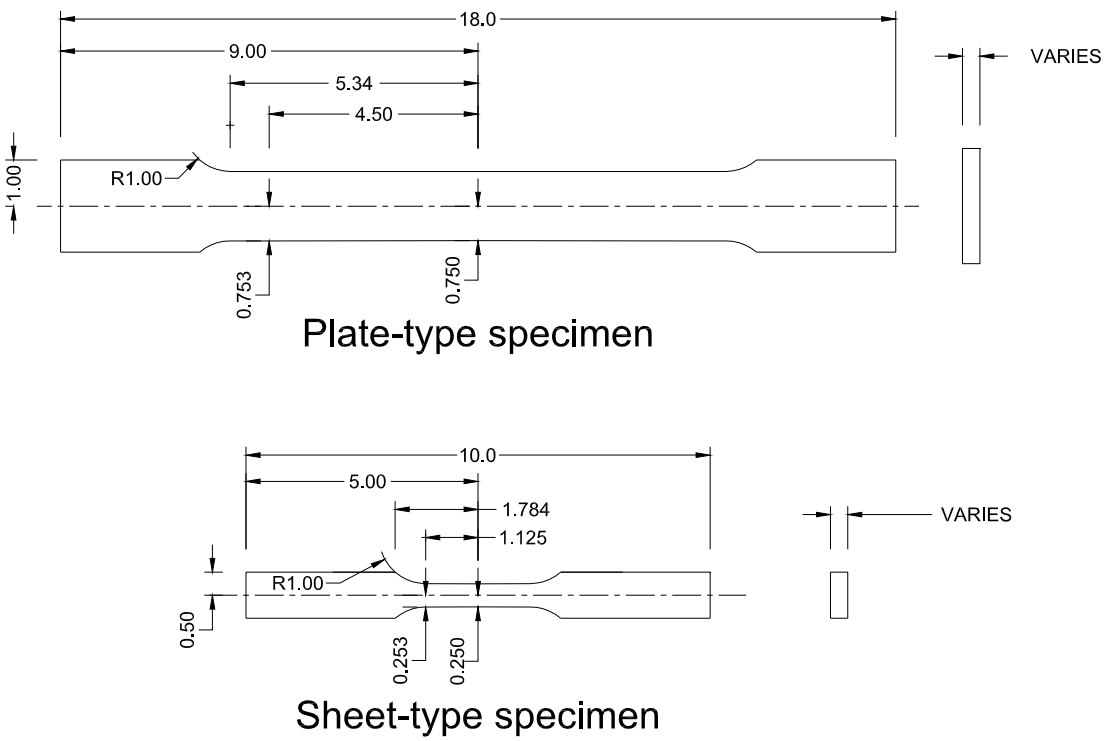

Figure D1. ASTM E8 specimens (units = inches).

GUSSET PLATE MATERIAL

The gusset and splice plates were all cut and drilled on a CNC plate processing machine. Figure D2 shows how the plates for each connection were cut from a single 4’ x 20’ steel plate. Notice four additional rectangular plates above and to the left of each gusset plate for material characterization. These plates were either etched or stamped with “Long1,” “Long2,” “Tran1,” and “Tran2” proceeded by the specimen designation. Figure D3 shows how the individual coupons were labeled within each of the material characterization plates, note on some of the longitudinal plates location of the identification etch dictated whether a Plate- or Sheet-type coupon was used. In Figure D3 the “m” and the “n" are generic identifications which according to the following denote which plate and connection the coupon came from:

“m” is a capitol letter signifying which connection the coupon comes from

C for GP307SS3
D for GP307LS3
E for GP307SL3
F for GP307SL4
G for GP307SS3-1
H for GP307SS3-2
I for GP490LS3
J for GP490SS3

K for GP490SS3-1 South Plate
L for GP490LS3-1
M for GP490LS3-2
N for GP490SS3-1 North plate (original North plate was lost in shipment)
P for GP307SS3-3
R for GP307SS3-4
S for Shingle Plates

"n" is a number signifying which material characterization plate the coupon originated

1 for "Long1"
2 for "Long2"
3 for "Trans1"
4 for "Trans2"
5 for "Extra" (which is not shown in the figure)

As testing was performed, it was noted that in some of the specimens, there was no difference in the longitudinal or transverse material properties. It was hypothesized that the fabricator did not follow the provided cutting instructions and the material sampling plates were all cut from the same direction. In expectation of this, an extra plate (not shown in Figure D2) was also ordered for each connection with dimensions large enough such that coupons could be cut from two orthogonal directions. For some specimens, the "extra" plate was tested to reaffirm the material properties.

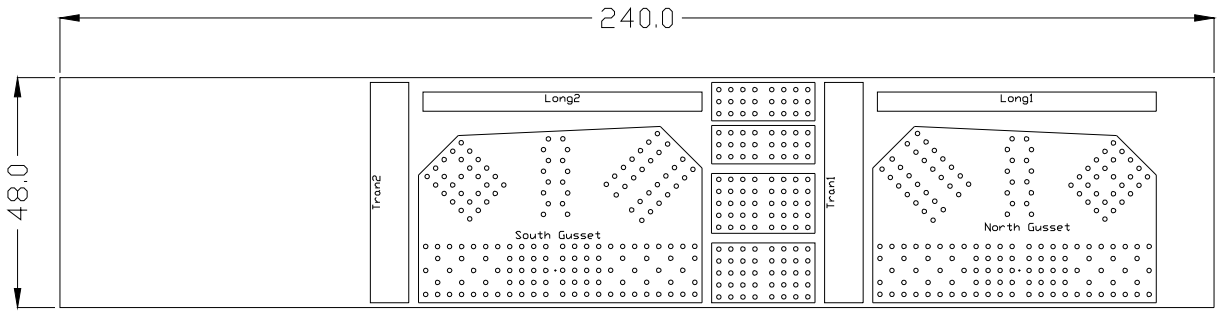

Figure D2. Sample gusset plate cutting pattern.

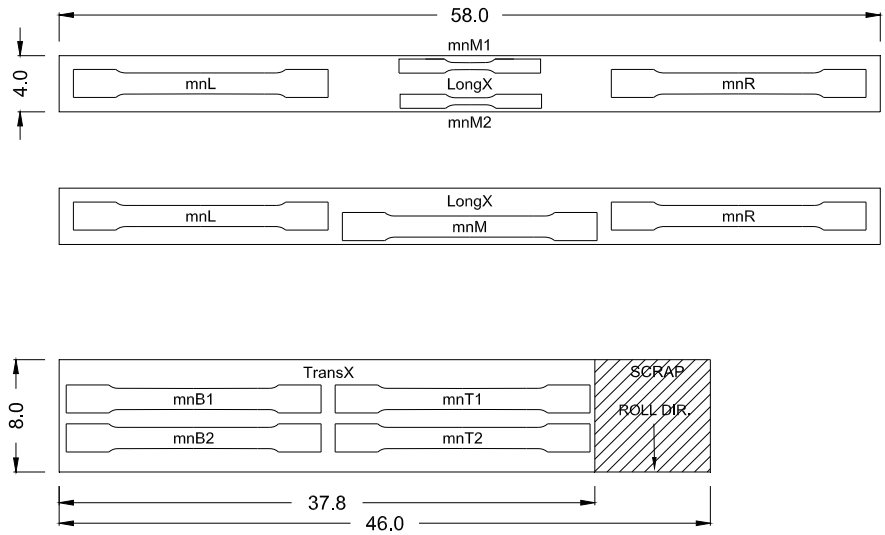

Figure D3. Coupon labeling scheme.

RESULTS

A summary of all the plate specimen properties is presented in Table D1. The data reported are modulus, 0.2% offset yield, static yield, tensile strength, elongation, and area reduction. The data for each batch of coupons is shown in Tables D2 through D15. The data statistics are reported three ways; in the longitudinal rolling direction, transverse rolling direction, and both rolling directions combined. Coupons are identified if they failed the ASTM acceptance criteria for not fracturing in the gauge length and these specimens are therefore not included in the statistical analysis.

Two graphs are presented following each table. The first shows all the engineering stress versus engineering strain data for all coupons, for that particular connection. Longitudinal coupons are plotted in black and transverse in red. The second figure plots the results in terms of true stress versus true plastic strain, this is the form the data must be in to input into the Abaqus finite element analysis. The plastic strain is the total strain with the elastic portion removed. Also shown in this second plot in light blue is the actual material model input into Abaqus. Note the material model was first fit to the average of all the data, then offset downward by the difference between the 0.2% yield and the static yield, therefore the curve represented a nonlinear static yield material model. The final Abaqus inputs for the nonlinear material plate properties for all the Phase 1 and Phase 2 specimens is shown in Table D16 and Table D17 respectively.

For some of the specimens, a smaller Sheet-type coupon was tested, and the 2.000 inch gauge length extensometer was used to monitor elongation. The advantage with this arrangement is the extensometer could remain on the specimen all the way through fracture. Contrast this with the Plate-type specimens that used a 1.000 inch stroke extensometer over an 8.000 inch gauge length that had to be removed prior to failure. As can be seen in the plots for the sheet-type specimens

appear to have more elongation capacity than the plate-type specimens. Because of this inherent difference, the results of the Sheet-type specimens were not included in any of the statistics for elongation. The difference is surely because the stroke of the testing machine was used to calculate strain after extensometer removal for the Plate-type specimens. This aberration would not affect any of the presented results beyond the plots of the stress versus strain data.

Table D1. *Summary of All Specimen Plate Properties*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
GP307SS3	27349	38.4	36.4	62.6	26	56
GP307LS3	29894	51.4	48.2	67.4	25	66
GP307SL3	27774	48.6	46.6	65.0	25	60
GP307SL4	29569	35.2	33.2	61.8	23	61
GP307SS3-1	29190	49.9	47.2	66.3	25	67
GP307SS3-2	29579	49.6	47.8	66.5	21	64
GP307SS3-3	28892	39.9	37.9	63.0	27	65
GP307SS3-4	28984	40.2	38.0	63.0	27	65
GP490LS3	27412	47.5	45.6	63.7	23	57
GP490SS3	28222	48.6	46.4	65.2	25	66
GP490SS3-1	29832	48.3	45.9	66.8	27	69
GP490LS3-1	29825	48.7	46.2	67.3	28	69
GP490LS3-2	29870	48.2	45.7	66.2	29	69
Shingle plates	30293	48.8	46.3	66.8	27	68
Angles	29725	50.8	47.1	74.3	24	55

NOTE
Shading dictates plates cut from the same parent material. The stiffening angles were hot rolled and obviously not from the same parent as the GP307SS3 plate.

Table D2. *Tensile Coupon Results from GP307SS3 plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
C1L [a]	27048	38.5	36.3	63.1	25	57
C1M	26587	38.0	36.1	62.6	24	58
C1R	26954	37.9	35.9	61.8	26	57
C2L	27656	38.7	36.5	63.8	24	47
C2M	27117	36.4	34.6	60.3	25	57
C2R	28012	41.4	39.6	65.8	27	54
Average [b]	27265	*38.5*	*36.5*	*62.9*	*25*	*54*
COV [b]	0.021	*0.048*	*0.051*	*0.033*	*0.050*	*0.084*
C3B1 [a]	28692	36.8	34.0	62.6	23	57
C3B2	27450	35.6	33.4	60.1	26	58
C3T1	26852	40.2	37.9	64.1	26	58
C3T2	26961	39.0	36.9	62.3	24	57
C4B1 [a]	27749	40.5	38.1	65.4	21	57
C4B2 [a]	28065	38.7	37.0	63.4	26	55
C4T1	27684	38.4	36.8	62.9	25	58
C4T2	28211	38.6	36.2	62.6	28	57
Average [b]	27432	*38.4*	*36.2*	*62.4*	*26*	*57*
COV [b]	0.020	*0.044*	*0.046*	*0.023*	*0.055*	*0.015*
Average [b]	**27349**	***38.4***	***36.4***	***62.6***	***26***	***56***
COV [b]	**0.020**	***0.043***	***0.046***	***0.027***	***0.051***	***0.062***

[a] – Indicates specimens where fracture occurred outside the original gauge length marks or was located less than 25 % of the elongated gage length from either of the original gauge length marks
[b] – Specimens failing ASTM acceptance criteria were not included in statistical analysis

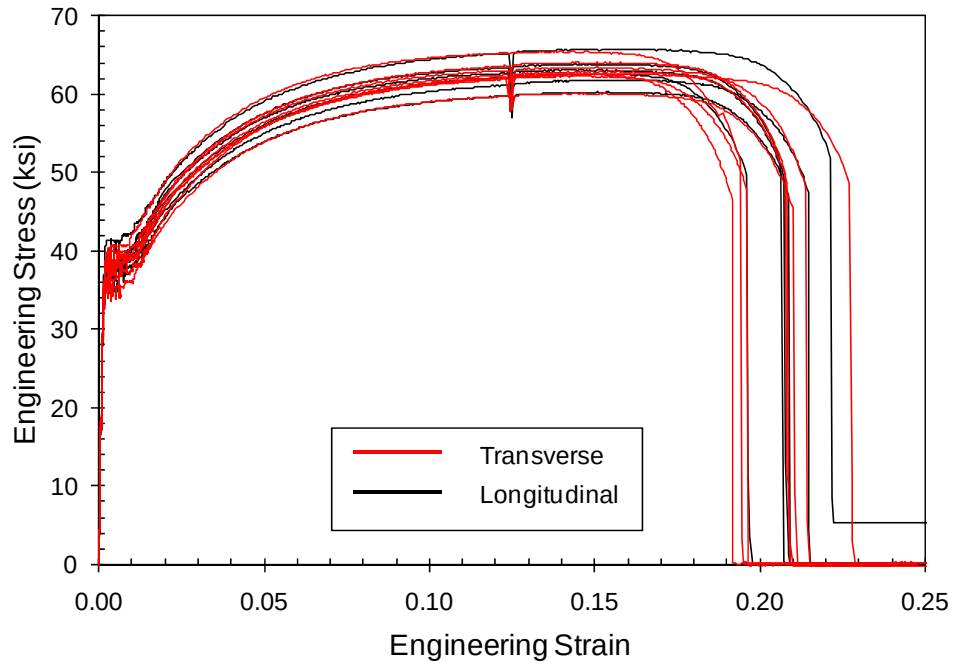

Figure D4. All GP307SS3 coupon engineering stress/engineering strain plots.

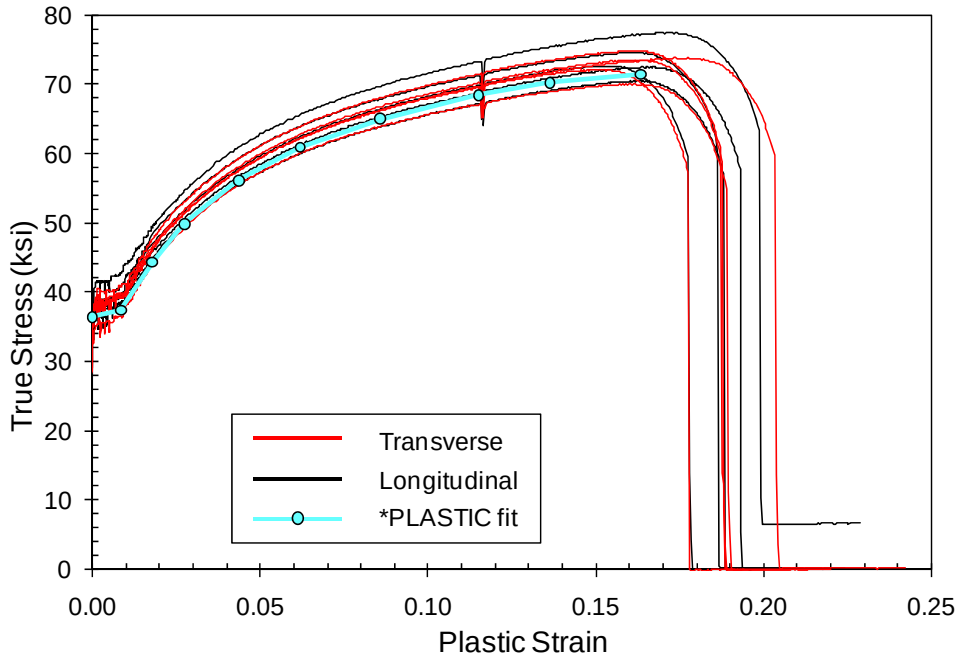

Figure D5. All GP307SS3 coupon true stress/true plastic strain plots (rejected specimens excluded).

Table D3. *Tensile Coupon Results from GP307LS3 plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
D1L	29004	52.5	49.6	68.0	26	61
D1M	29242	53.4	50.7	69.3	27	68
D1R	28441	50.3	46.6	67.7	24	66
D2L	30083	53.4	50.0	68.7	24	66
D2M	29872	52.1	48.7	68.2	23	67
D2R [a]	30203	52.0	49.5	68.7	16	64
Average [b]	29328	*52.3*	*49.1*	*68.4*	*25*	*65*
COV [b]	0.023	*0.024*	*0.032*	*0.009*	*0.065*	*0.043*
D3B1	30507	51.3	48.2	66.8	24	66
D3B2	30636	51.0	46.8	66.9	25	67
D3T1	30230	51.0	48.4	66.8	26	65
D3T2	29777	51.0	47.5	66.8	24	66
D4B1	30004	50.5	48.3	66.7	25	66
D4B2	30654	50.6	47.4	66.7	25	66
D4T1	30104	50.1	47.0	65.8	25	67
D4T2	30068	51.4	47.5	67.4	26	67
Average	30248	*50.9*	*47.6*	*66.7*	*25*	*66*
COV	0.011	*0.009*	*0.013*	*0.007*	*0.025*	*0.011*
Average [b]	**29894**	**51.4**	**48.2**	**67.4**	**25**	**66**
COV [b]	**0.022**	**0.021**	**0.026**	**0.014**	**0.042**	**0.026**

[a] –indicates specimens where fracture occurred outside the original gauge length marks or was located less than 25 % of the elongated gage length from either of the original gauge length marks.
[b] – Specimens failing ASTM acceptance criteria were not included in statistical analysis

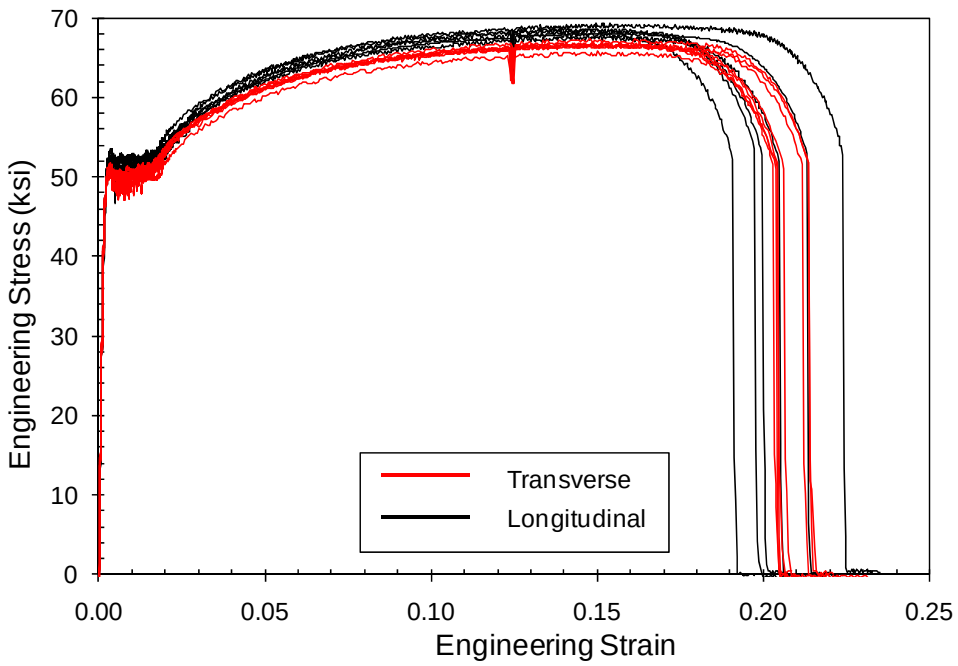

Figure D6. All GP307LS3 coupon engineering stress/engineering strain plots.

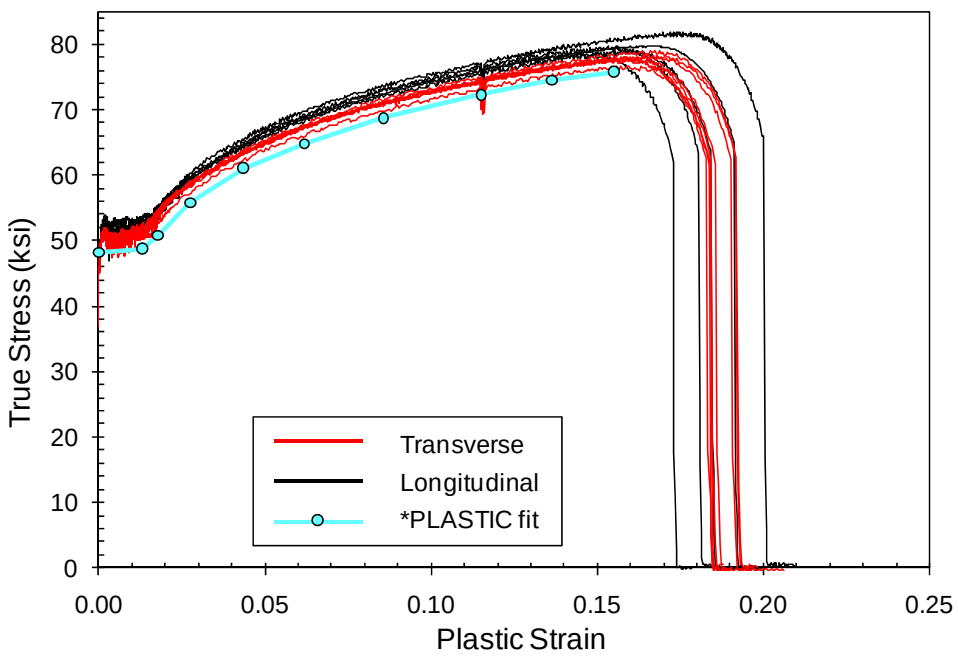

Figure D7. All GP307LS3 coupon true stress/true plastic strain plots.

Table D4. *Tensile Coupon Results from GP307SL3 plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
E1L	28138	50.1	47.0	66.7	24	60
E1M	28347	48.5	46.9	66.1	23	61
E1R	28439	50.8	48.3	67.3	25	60
E2L	28328	50.0	47.8	66.9	23	56
E2M	28937	49.8	48.4	67.3	26	61
E2R	28269	50.6	48.9	67.9	24	59
Average	28410	*50.0*	*47.9*	*67.0*	*24*	*59*
COV	0.010	*0.016*	*0.017*	*0.009*	*0.050*	*0.031*
E3B1	26719	46.9	45.1	62.5	25	62
E3B2 [a]	27756	47.8	45.9	64.0	25	59
E3T1	26832	47.0	45.2	62.7	26	60
E3T2	27368	47.8	45.3	63.6	22	59
E4B1	27211	47.4	45.6	62.7	26	58
E4B2 [a]	28191	48.2	45.8	63.9	23	60
E4T1	27246	47.1	45.5	62.9	24	61
E4T2	27452	47.6	45.8	64.0	27	63
Average [b]	27138	*47.3*	*45.4*	*63.1*	*25*	*61*
COV [b]	0.017	*0.008*	*0.006*	*0.009*	*0.066*	*0.029*
Average [b]	**29458**	**48.6**	**45.4**	**65.0**	**25**	**61**
COV [b]	**0.011**	**0.008**	**0.006**	**0.009**	**0.066**	**0.029**

[a] –indicates specimens where fracture occurred outside the original gauge length marks or was located less than 25 % of the elongated gage length from either of the original gauge length marks.
[b] – Specimens failing ASTM acceptance criteria were not included in statistical analysis

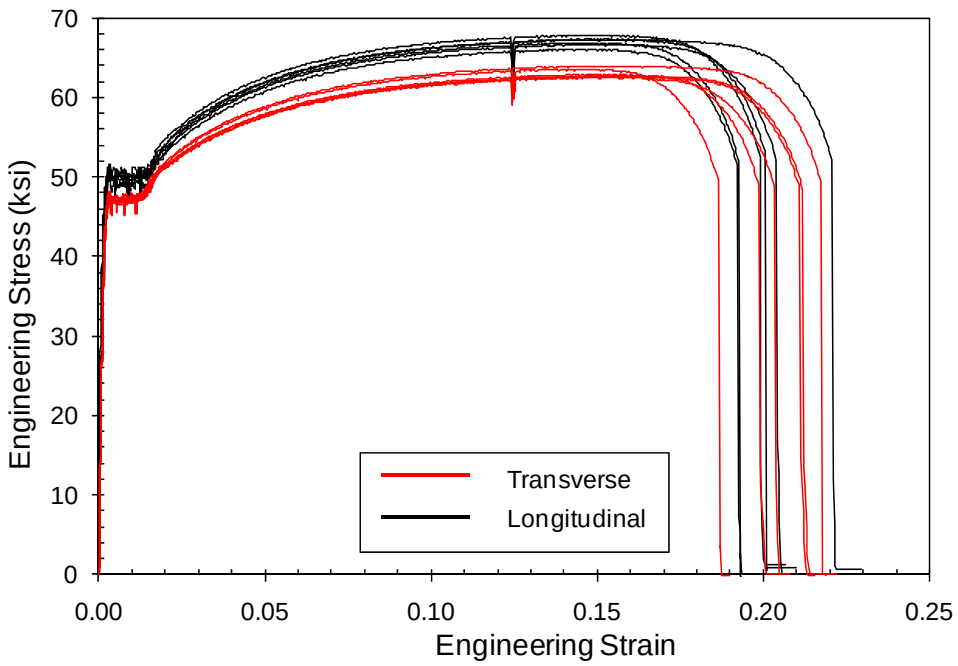

Figure D8. All GP307SL3 coupon engineering stress/engineering strain plots.

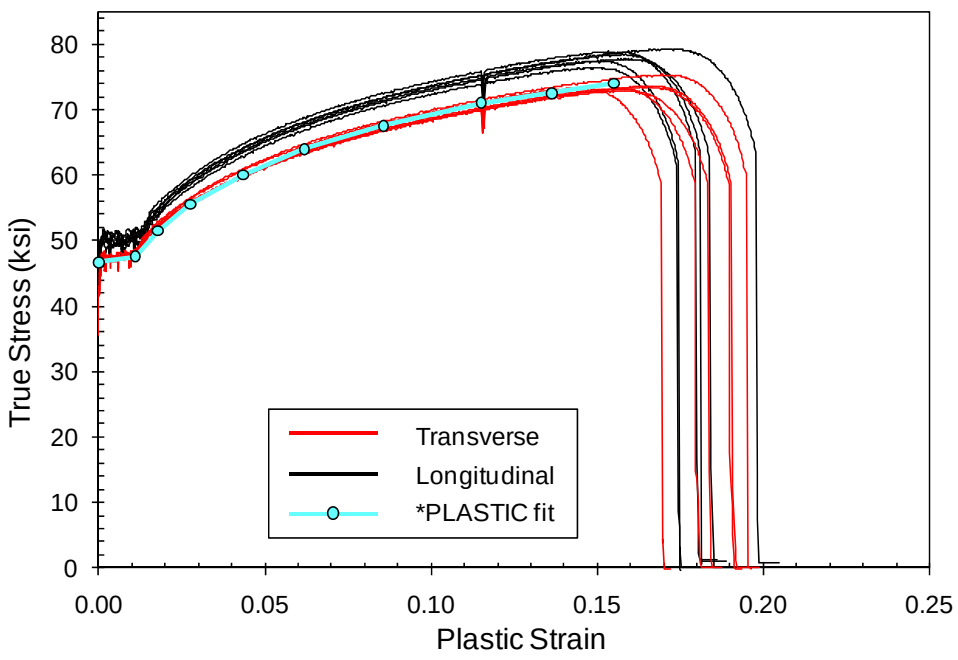

Figure D9. GP307SL3 coupon true stress/true plastic strain plots.

Table D5. *Tensile Coupon Results from GP307SL4 plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
F1L [a]	28406	35.0	32.9	62.0	29	64
F1M	29590	34.8	32.5	61.8	28	63
F1R [c]	28890	34.7	32.5	62.2	30	68
F2L	28760	35.0	33.2	61.7	30	68
F2M	28527	34.9	32.8	61.7	30	66
F2R	28764	34.6	32.7	61.5	33	64
F5L1	28858	34.8	32.9	62.1	29	60
F5L2	29987	33.9	31.8	61.2	30	63
F5L3	28918	34.0	32.0	60.5	31	61
F5L4	29402	34.2	32.3	60.9	29	64
Average [b]	*29532*	*35.6*	*33.7*	*62.1*	*29*	*61*
COV [b]	*0.027*	*0.027*	*0.034*	*0.007*	*0.091*	*0.105*
F3B1	29986	36.0	34.0	62.1	30	63
F3B2	29589	34.7	32.6	61.3	29	64
F3T1	29676	36.1	34.1	62.0	30	65
F3T2	28892	34.6	32.6	61.3	30	60
F4B1	29739	35.9	33.9	62.6	28	60
F4B2	28951	34.4	32.3	61.3	31	60
F4T1 [c]	30350	35.3	31.8	61.9	28	59
F4T2	30824	34.8	32.7	62.3	29	63
F5T1	30508	36.6	34.9	62.6	25	55
F5T2	30307	36.5	34.8	62.7	27	50
F5T3	30136	36.4	34.6	62.4	30	57
F5T4	30301	36.9	35.2	62.6	25	56
Average	*29598*	*34.9*	*32.8*	*61.6*	*30*	*62*
COV	*0.021*	*0.022*	*0.026*	*0.010*	*0.029*	*0.030*
Average [b]	**29569**	**35.2**	**33.2**	**61.8**	**29**	**61**
COV [b]	**0.023**	**0.026**	**0.032**	**0.010**	**0.063**	**0.070**

[a] –indicates specimens where fracture occurred outside the original gauge length marks or was located less than 25 % of the elongated gage length from either of the original gauge length marks.
[b] – Specimens failing ASTM acceptance criteria were not included in statistical analysis
[c] – Equipment failures resulted in load being released, then reloaded

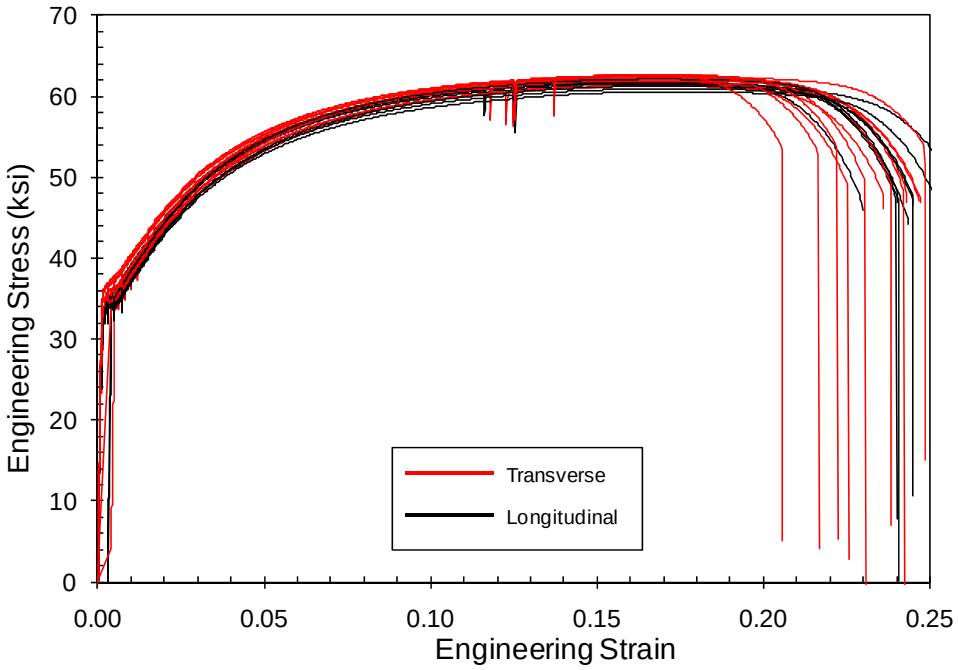

Figure D10. All GP307SL4 coupon engineering stress/engineering strain plots.

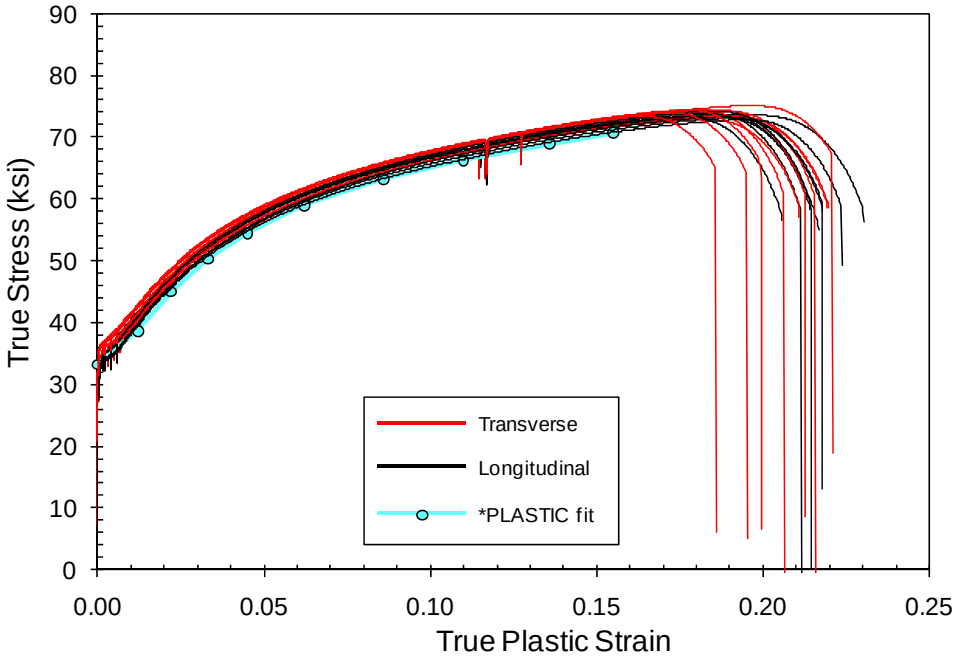

Figure D11. GP307SL4 coupon true stress/true plastic strain plots.

Table D6. *Tensile Coupon Results from GP307SS3-1 plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
G1L	29282	50.7	47.6	67.0	24	66
G1M	29238	50.8	48.1	66.9	23	66
G1R [a]	29406	51.0	48.4	51.1	25	66
G2L	29073	51.2	48.3	67.7	24	67
G2M	29091	50.8	49.0	68.3	26	66
G2R	29041	51.3	49.0	68.3	23	67
Average [b]	*29145*	*51.0*	*48.4*	*67.6*	*24*	*66*
COV [b]	*0.004*	*0.005*	*0.012*	*0.010*	*0.050*	*0.007*
G3B1	29287	49.0	46.6	65.4	25	71
G3B2	29124	49.1	46.5	65.0	26	67
G3T1 [a]	29098	48.4	46.3	65.3	20	47
G3T2	29253	49.5	46.2	65.6	23	66
G4B1	29418	49.2	46.4	65.3	26	69
G4B2	29130	49.1	46.1	65.0	25	68
G4T1 [a]	29018	48.3	46.1	64.9	23	53
G4T2	29159	48.7	45.7	64.7	27	68
Average [b]	*29228*	*49.1*	*46.2*	*65.2*	*25*	*68*
COV [b]	*0.004*	*0.005*	*0.007*	*0.005*	*0.052*	*0.023*
Average [b]	**29190**	**49.9**	**47.2**	**66.3**	**25**	**67**
COV [b]	**0.004**	**0.020**	**0.026**	**0.021**	**0.057**	**0.023**

[a] –indicates specimens where fracture occurred outside the original gauge length marks or was located less than 25 % of the elongated gage length from either of the original gauge length marks.
[b] – Specimens failing ASTM acceptance criteria were not included in statistical analysis

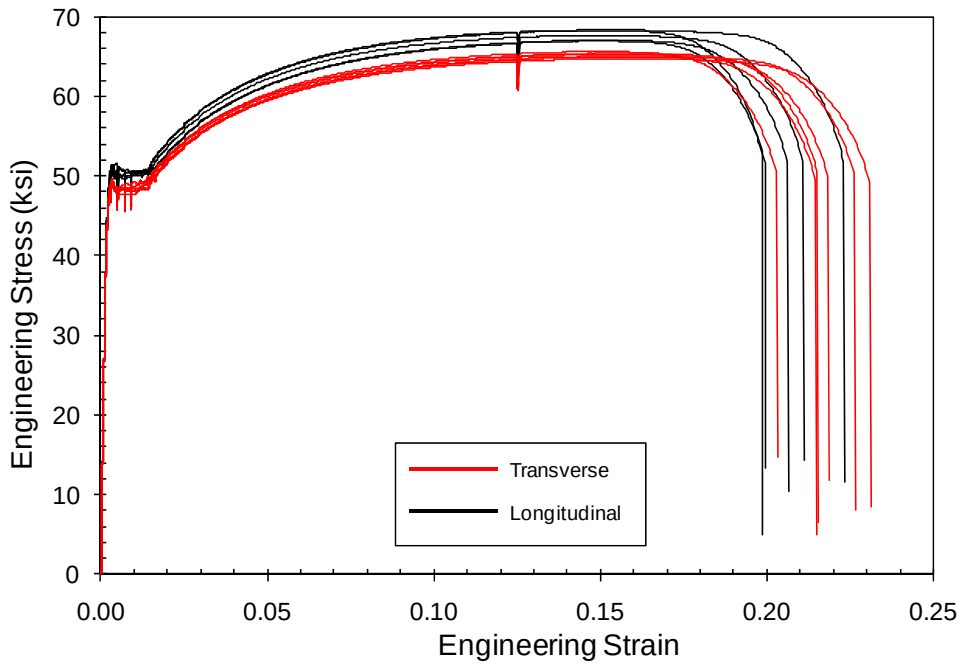

Figure D12. All GP307SS3-1 coupon engineering stress/engineering strain plots.

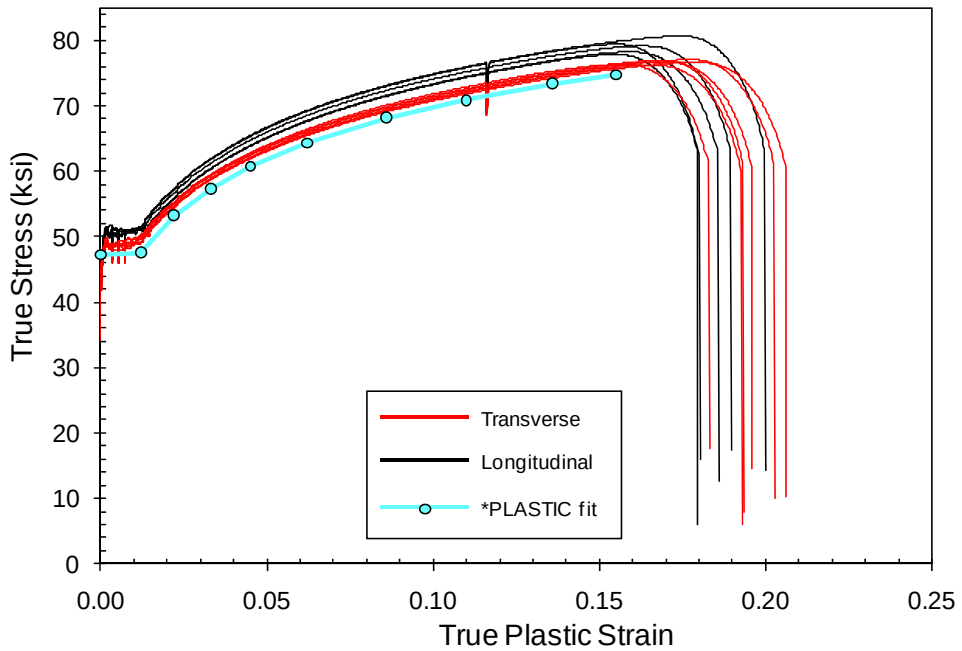

Figure D13. GP307SS3-1 coupon true stress/true plastic strain plots.

Table D7. *Tensile Coupon Results from GP307SS3-2 plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
H1L [a]	29787	50.2	48.7	67.7	17	55
H1M [a]	29820	50.4	49.4	68.8	21	67
H1R [a]	29295	50.9	48.3	66.9	22	69
H2L [a]	30221	50.4	49.5	68.0	21	62
H2M [a]	29967	50.3	49.1	67.9	22	68
H2R [a]	30201	52.3	49.6	68.3	23	67
Average	*29882*	*50.7*	*49.3*	*68.2*	*21*	*64*
COV	*0.011*	*0.017*	*0.007*	*0.006*	*0.115*	*0.085*
H3B1 [a]	29274	49.0	47.5	65.9	21	62
H3B2 [a]	29639	48.8	47.2	65.9	21	65
H3T1 [a]	29013	47.8	46.2	64.0	20	43
H3T2 [a]	30247	49.6	47.8	66.2	21	65
H4B1 [a]	29641	48.9	46.9	66.0	22	67
H4B2 [a]	29383	48.0	46.4	65.2	21	67
H4T1 [a]	28812	48.8	46.4	64.9	26	65
H4T2 [a]	28811	48.6	46.4	64.8	22	68
Average	*29352*	*48.7*	*46.9*	*65.4*	*22*	*63*
COV	*0.017*	*0.012*	*0.012*	*0.012*	*0.084*	*0.131*
Average	**29579**	**49.6**	**47.8**	**66.5**	**21**	**64**
COV	**0.017**	**0.024**	**0.026**	**0.021**	**0.075**	**0.061**

a – Specimen was significant gouged while removing mill scale prior to testing, which likely initiated premature failure.

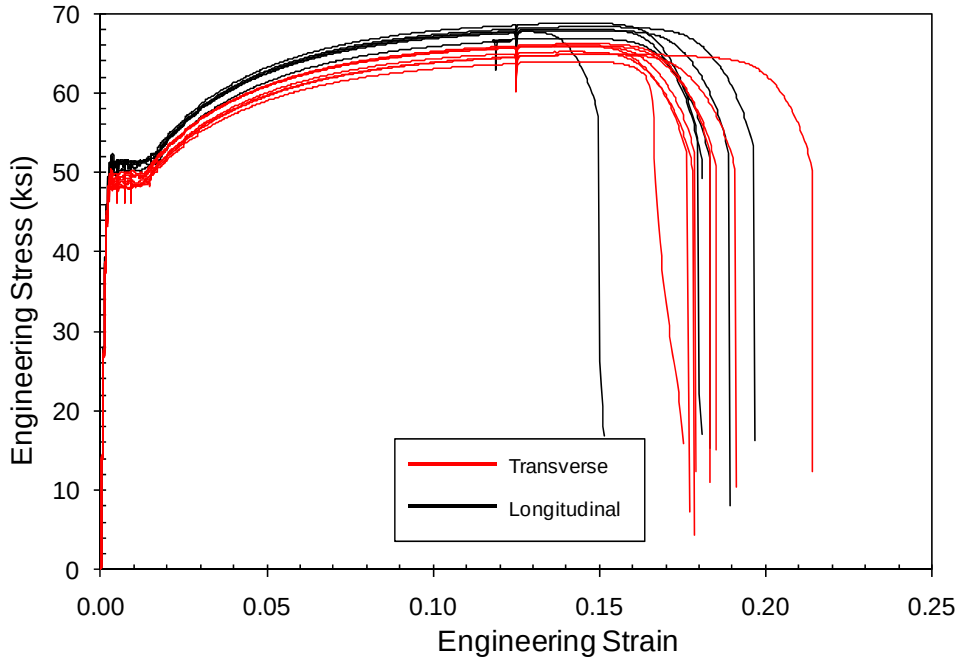

Figure D14. All GP307SS3-2 coupon engineering stress/engineering strain plots.

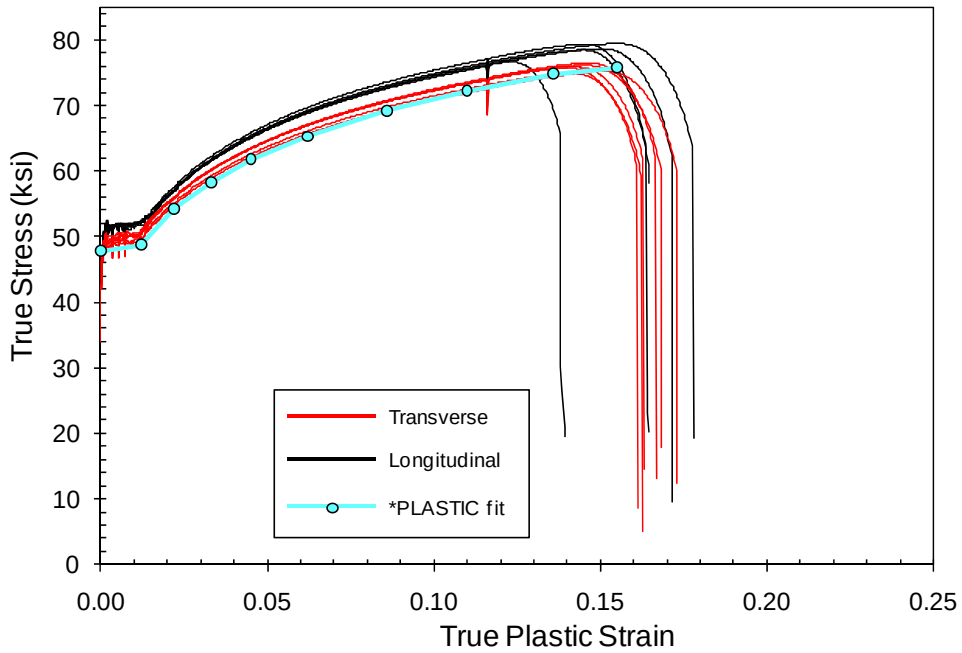

Figure D15. GP307SS3-2 coupon true stress/true plastic strain plots.

Table D8. *Tensile Coupon Results from GP307SS3-3 plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
P1L	28705	40.5	38.6	63.5	26	69
P1M	28637	40.7	38.8	63.1	27	69
P1R	28940	41.1	39.2	63.8	27	67
P2L	28734	40.6	38.3	63.0	27	68
P2M	28082	40.7	38.7	63.2	27	66
P2R	28700	40.3	39.1	64.2	29	64
Average	*28633*	*40.7*	*38.8*	*63.5*	*27*	*67*
COV	*0.010*	*0.007*	*0.008*	*0.007*	*0.035*	*0.030*
P3B1	28742	38.4	37.5	61.0	25	61
P3B2	28950	39.0	36.6	62.0	24	65
P3T1 [a]	29294	39.8	37.6	63.7	24	63
P3T2 [a]	28513	39.2	36.5	62.5	27	65
P4B1	29957	40.0	37.8	64.6	26	63
P4B2	29574	39.2	36.8	62.7	26	65
P4T1	28806	39.1	36.7	62.1	30	60
P4T2	28875	39.5	37.3	63.0	29	63
Average [b]	*29151*	*39.2*	*37.1*	*62.6*	*27*	*63*
COV [b]	*0.017*	*0.014*	*0.013*	*0.019*	*0.078*	*0.034*
Average [b]	**28892**	**39.9**	**37.9**	**63.0**	**27**	**65**
COV [b]	**0.016**	**0.021**	**0.025**	**0.016**	**0.058**	**0.046**

[a] –indicates specimens where fracture occurred outside the original gauge length marks or was located less than 25 % of the elongated gage length from either of the original gauge length marks.
[b] – Specimens failing ASTM acceptance criteria were not included in statistical analysis

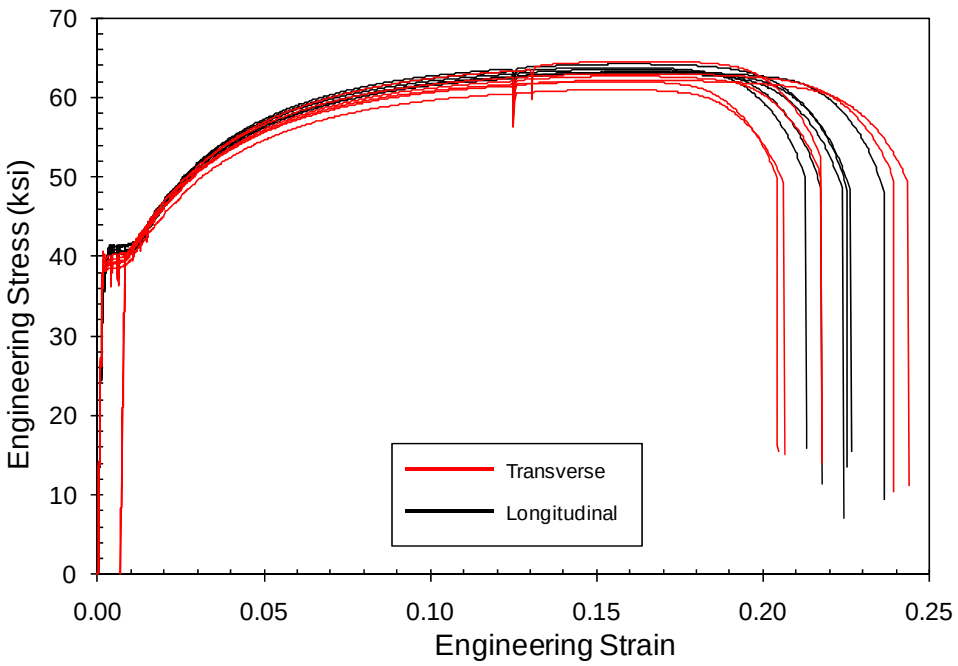

Figure D16. All GP307SS3-3 coupon engineering stress/engineering strain plots.

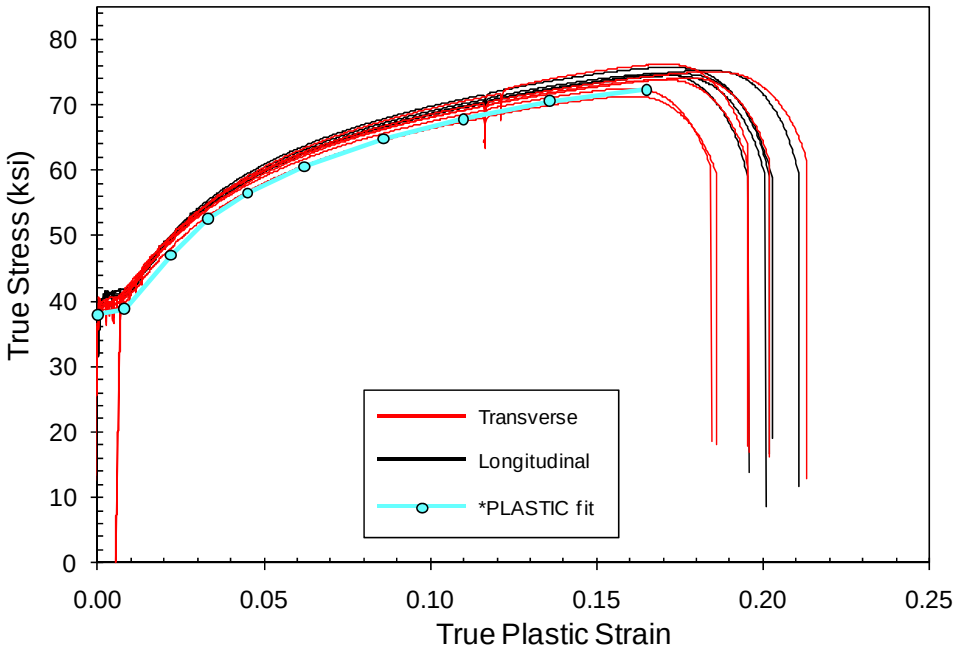

Figure D17. GP307SS3-3 coupon true stress/true plastic strain plots.

Table D9. *Tensile Coupon Results from GP307SS3-4 Gusset Plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
R1L	28408	40.8	38.2	63.7	28	66
R1M	28338	39.6	37.1	62.0	26	65
R1R	28601	40.4	37.4	63.2	27	68
R2L	29201	40.9	39.3	63.4	28	64
R2M	28912	39.7	37.9	61.9	28	69
R2R	29319	41.3	39.5	64.0	30	63
Average	*28796*	*40.5*	*38.4*	*63.0*	*28*	*65*
COV	*0.014*	*0.017*	*0.025*	*0.014*	*0.052*	*0.033*
R3B1 [a]	29175	39.3	38.3	62.4	26	60
R3B2 [a]	28800	39.1	36.7	61.7	25	65
R3T1 [a]	29169	39.4	37.2	62.7	25	65
R3T2 [a]	30005	40.5	38.3	64.5	26	65
R4B1	29555	40.5	38.3	64.3	30	65
R4B2 [a]	28885	39.3	37.3	62.6	25	62
R4T1	29949	40.4	38.1	63.9	24	64
R4T2	28575	38.4	35.9	60.8	24	61
Average [b]	*29360*	*39.8*	*37.4*	*63.0*	*26*	*63*
COV [b]	*0.024*	*0.030*	*0.036*	*0.031*	*0.129*	*0.034*
Average [b]	**28984**	**40.2**	**38.0**	**63.0**	**27**	**65**
COV [b]	**0.019**	**0.022**	**0.029**	**0.019**	**0.082**	**0.038**

[a] –indicates specimens where fracture occurred outside the original gauge length marks or was located less than 25 % of the elongated gage length from either of the original gauge length marks.
[b] – Specimens failing ASTM acceptance criteria were not included in statistical analysis

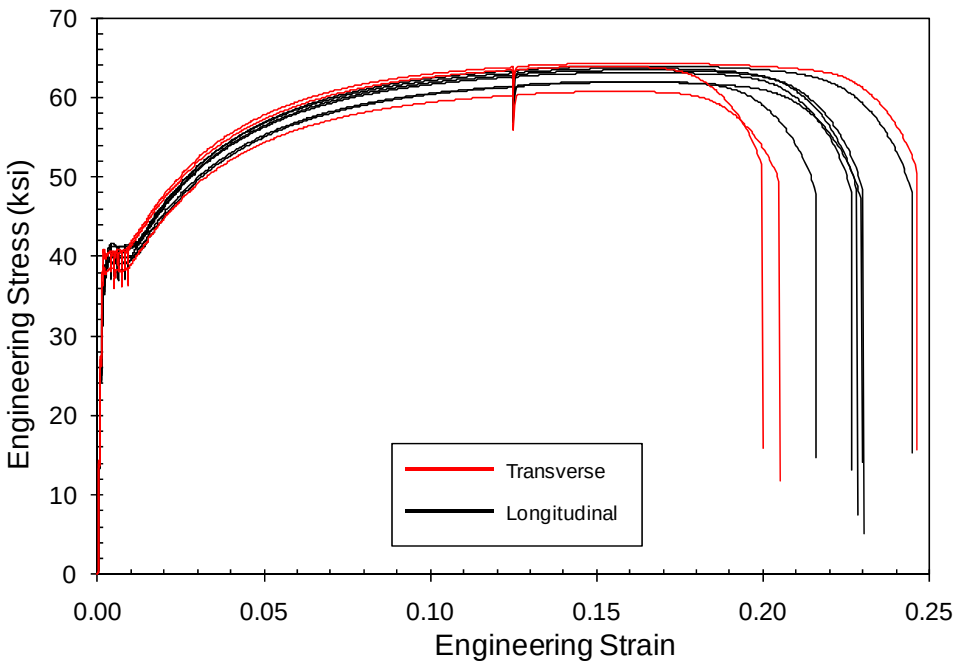

Figure D18. All GP307SS3-4 gusset coupon engineering stress/engineering strain plots.

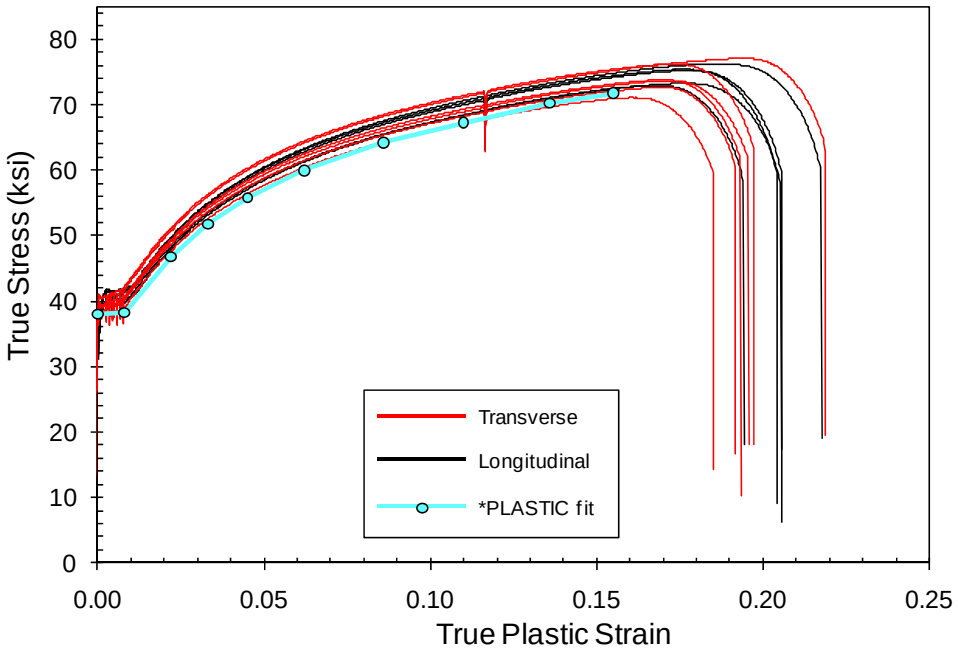

Figure D19. GP307SS3-4 gusset coupon true stress/true plastic strain plots.

Table D10. *Tensile Coupon Results from GP307SS3-4 Shingle Plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
S5L1	30361	49.2	46.6	67.0	27	66
S5L2	30390	48.6	46.2	67.1	27	66
S5L3	29919	49.3	46.9	67.4	27	64
S5L4	30541	49.0	46.5	66.8	27	66
Average	*30303*	*49.0*	*46.5*	*67.1*	*27*	*66*
COV	*0.009*	*0.006*	*0.006*	*0.004*	*0.005*	*0.015*
S5T1	30172	48.0	45.4	65.7	28	70
S5T2	29801	48.6	46.1	66.9	27	69
S5T3	30850	48.7	45.9	67.2	27	71
S5T4	30313	48.9	46.5	66.6	27	70
Average [b]	*30284*	*48.6*	*46.0*	*66.6*	*27*	*70*
COV [b]	*0.014*	*0.008*	*0.010*	*0.010*	*0.019*	*0.010*
Average [b]	**30293**	**48.8**	**46.3**	**66.8**	**27**	**68**
COV [b]	**0.011**	**0.008**	**0.010**	**0.008**	**0.015**	**0.038**

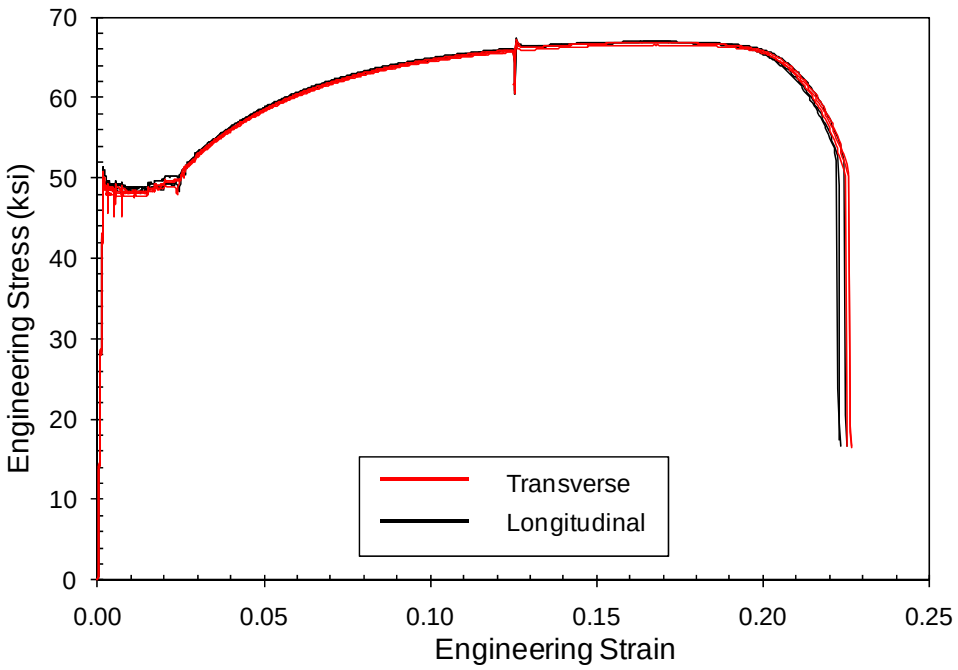

Figure D20. All shingle plate coupon engineering stress/engineering strain plots.

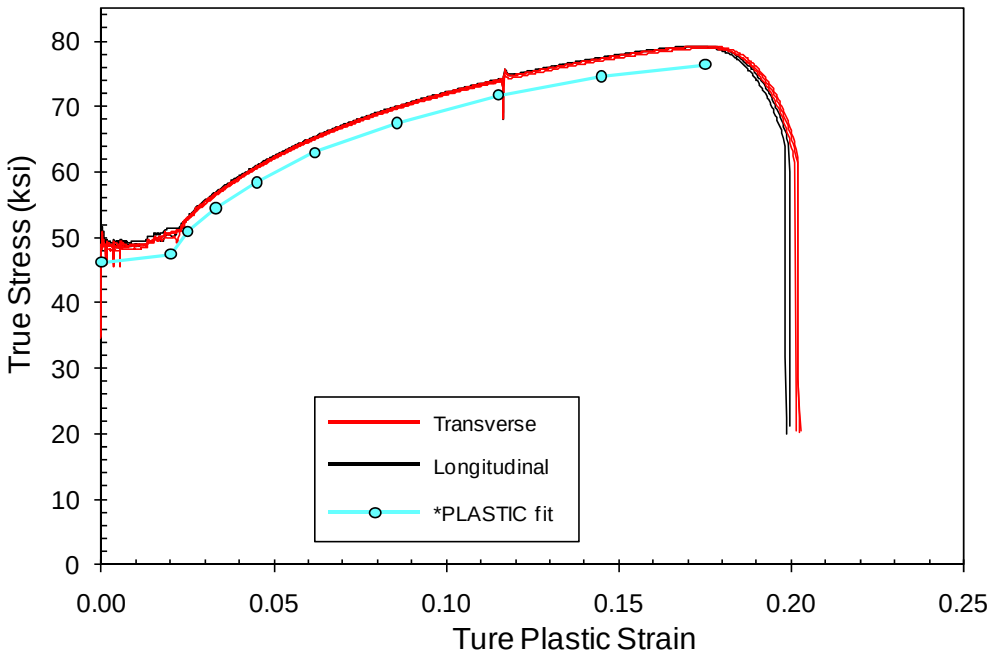

Figure D21. Shingle plate coupon true stress/true plastic strain plots.

Table D11. *Tensile Coupon Results from GP490LS3 plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
I1L [a]	27950	50.2	47.3	67.1	25	60
I1M	28609	49.5	47.5	66.7	22	63
I1R	28358	50.3	48.6	67.7	21	58
I2L	28029	49.3	47.1	66.0	24	60
I2M [a]	27902	49.6	47.0	66.1	25	58
I2R	28057	49.6	47.0	66.2	24	61
Average [b]	28263	*49.7*	*47.5*	*66.6*	*23*	*61*
COV [b]	0.011	*0.007*	*0.016*	*0.011*	*0.078*	*0.039*
I3B1	26468	46.3	44.7	61.6	25	61
I3B2	27518	46.5	44.5	62.4	24	61
I3T1	27005	46.2	44.5	62.1	20	34
I3T2	27580	46.5	44.6	62.6	24	58
I4B1	26175	45.9	44.2	61.4	24	56
I4B2	27456	46.9	45.2	63.2	22	62
I4T1	26440	46.7	45.0	62.2	22	55
I4T2	27246	46.8	44.5	62.4	25	58
Average	26986	*46.5*	*44.7*	*62.2*	*23*	*56*
COV	0.021	*0.007*	*0.007*	*0.009*	*0.073*	*0.163*
Average [b]	**27412**	**47.5**	**45.6**	**63.7**	**23**	**57**
COV [b]	**0.029**	**0.034**	**0.033**	**0.035**	**0.068**	**0.135**

[a] –indicates specimens where fracture occurred outside the original gauge length marks or was located less than 25 % of the elongated gage length from either of the original gauge length marks.
[b] – Specimens failing ASTM acceptance criteria were not included in statistical analysis

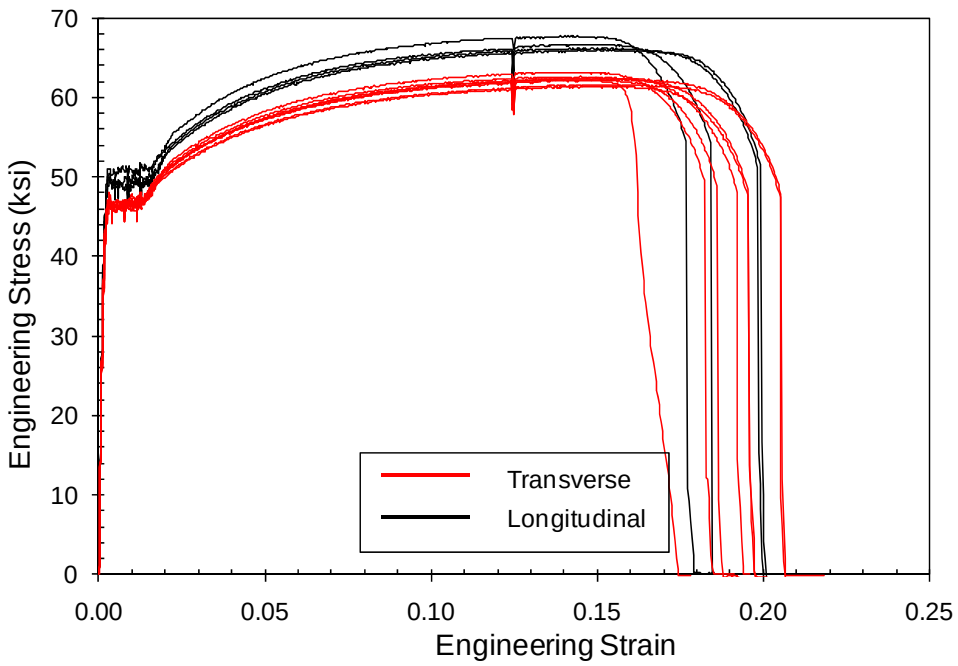

Figure D22. All GP490LS3 coupon engineering stress/engineering strain plots.

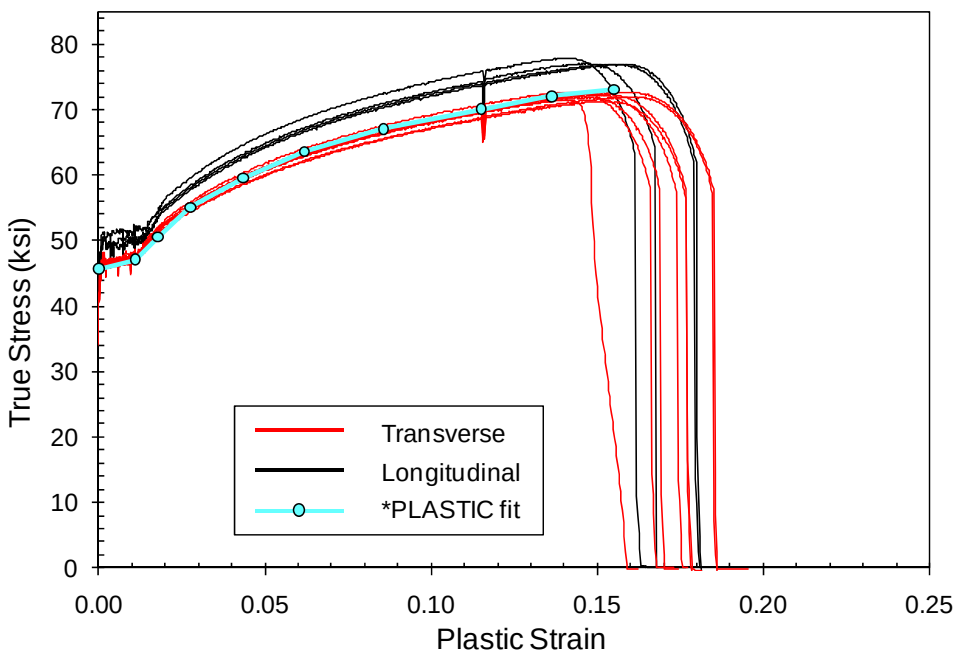

Figure D23. GP490LS3 coupon true stress/true plastic strain plots.

Table D12. *Tensile Coupon Results from GP490SS3 Plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
J1L	28538	50.1	47.6	67.4	25	66
J1M	28382	50.9	47.8	68.0	25	65
J1R	28404	50.2	47.9	67.2	27	64
J2L	28413	49.6	47.3	66.9	24	68
J2M [a]	28619	49.3	48.1	67.4	24	59
J2R	28165	51.1	48.3	67.5	25	63
Average [b]	28380	*50.4*	*47.8*	*67.4*	*25*	*65*
COV [b]	0.005	*0.012*	*0.008*	*0.006*	*0.042*	*0.029*
J3B1	28091	48.0	45.9	64.4	26	66
J3B2	28278	47.5	46.0	64.2	25	65
J3T1	27606	45.6	43.7	61.6	24	65
J3T2	28267	47.5	45.3	64.0	24	65
J4B1	28041	47.0	45.3	63.2	24	69
J4B2	27968	47.8	45.3	63.7	25	66
J4T1	28347	48.5	46.8	65.2	22	65
J4T2	28391	48.5	46.4	64.9	25	66
Average	28123	*47.6*	*45.6*	*63.9*	*24*	*66*
COV	0.009	*0.020*	*0.021*	*0.018*	*0.058*	*0.019*
Average [b]	**28222**	**48.6**	**46.4**	**65.2**	**25**	**66**
COV [b]	**0.009**	**0.034**	**0.029**	**0.030**	**0.053**	**0.023**

[a] –indicates specimens where fracture occurred outside the original gauge length marks or was located less than 25 % of the elongated gage length from either of the original gauge length marks.
[b] – Specimens failing ASTM acceptance criteria were not included in statistical analysis

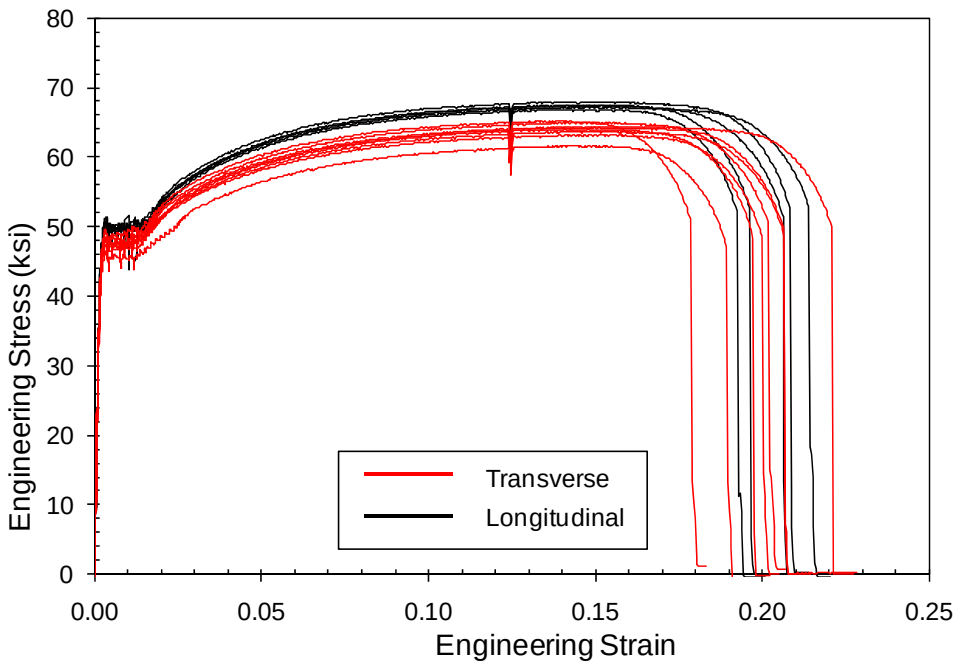

Figure D24. All GP490SS3 coupon engineering stress/engineering strain plots.

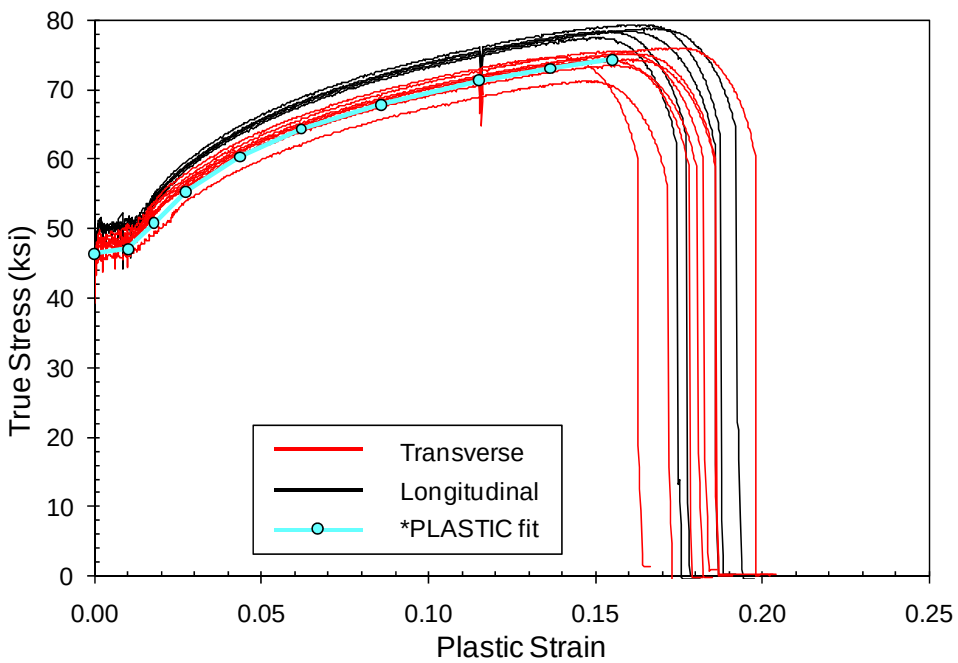

Figure D25. All GP490SS3 coupon true stress/true plastic strain plots (rejected specimens excluded).

Table D13. *Tensile Coupon Results from GP490SS3-1 plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
K1L	29917	48.2	45.5	66.4	27	70
K1M1	28923	46.5	44.9	66.7	36 [a]	76
K1M2	29522	48.0	44.6	67.3	36 [a]	76
K1R	29787	47.6	45.0	66.2	28	69
K2L	29776	48.5	46.1	66.8	29	72
K2M1	28915	47.2	45.3	67.4	36 [a]	76
K2M2	28839	46.9	45.2	67.2	37 [a]	76
K2R	29746	48.7	45.8	66.9	27	73
N1L	30010	48.7	46.1	66.6	27	72
N1M1	29112	48.7	46.6	67.1	37 [a]	77
N1M2	28962	46.4	44.8	66.9	36 [a]	74
N1R	29901	48.7	46.1	66.5	28	70
K5L1	30088	49.5	46.8	68.1	28	66
K5L2	30256	49.9	47.3	67.9	26	68
K5L3	30457	49.6	46.9	67.7	27	64
K5L4	30565	49.5	47.1	67.6	26	67
Average	*29674*	*48.3*	*45.9*	*67.1*	*28* [a]	*72*
COV	*0.019*	*0.023*	*0.019*	*0.008*	*0.029* [a]	*0.057*
K3B1	29981	48.2	45.6	66.3	27	69
K3B2	30025	47.8	45.3	66.4	28	68
K3T1	29861	46.9	44.4	65.7	27	70
K3T2	29902	48.1	45.7	66.2	27	70
K4B1	29811	48.4	46.1	66.5	30	69
K4B2	29859	48.2	45.7	66.6	28	68
K4T1	29838	48.2	45.8	66.4	27	71
K4T2	29618	47.8	45.2	66.2	26	69
N3B1	30146	48.7	46.2	66.3	27	64
N3B2	30036	48.5	46.1	66.4	27	67
N3T1	30000	48.6	46.1	66.7	27	62
N3T2	30021	48.3	45.7	66.4	27	63
K5T1	30244	48.7	46.3	67.7	28	61
K5T2	30251	49.0	46.6	67.6	27	67
K5T3	30146	48.5	46.1	67.0	27	69
K5T4	30100	48.7	46.3	67.2	27	70
Average	*29990*	*48.3*	*45.8*	*66.6*	*27*	*67*
COV	*0.006*	*0.010*	*0.012*	*0.008*	*0.029*	*0.044*
Average	**29832**	**48.3**	**45.9**	**66.8**	**27** [a]	**69**
COV	**0.015**	**0.017**	**0.016**	**0.009**	**0.029** [a]	**0.060**

[a] –ASTM "Sheet-Type" specimens were not included in statistical analysis

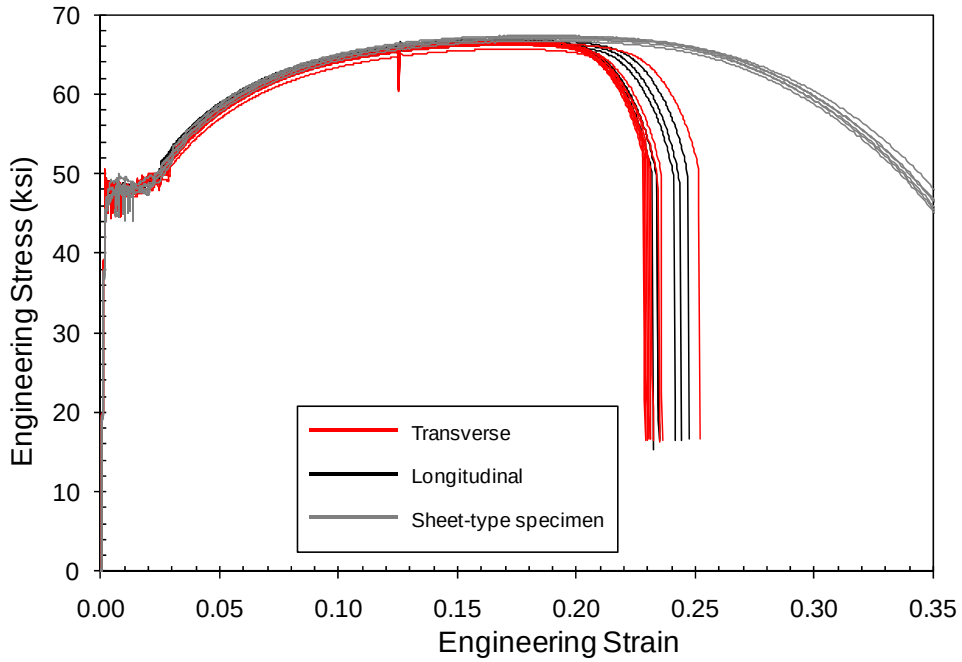

Figure D26. All GP490SS3-1 coupon engineering stress/engineering strain plots.

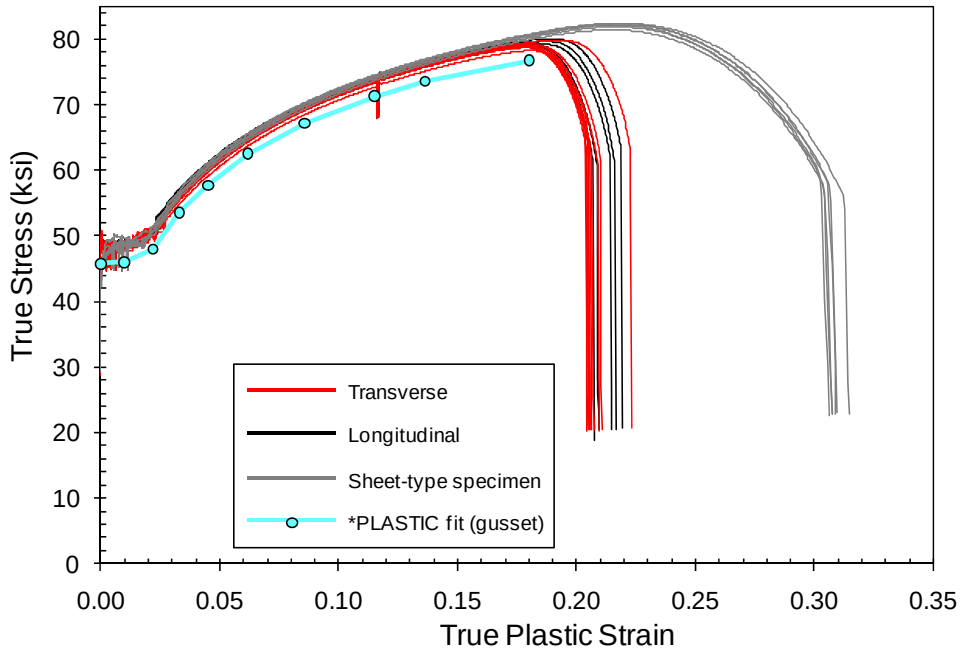

Figure D27. GP490SS3-1 coupon true stress/true plastic strain plots.

Table D14. *Tensile Coupon Results from GP490LS3-1 Plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
L1L	29593	48.4	46.1	66.4	28	71
L1M1	28962	46.1	45.1	67.4	36 [a]	75
L1M2	28729	46.3	45.0	67.3	36 [a]	76
L1R	29378	48.3	45.7	66.3	27	68
L2L	29762	49.0	46.5	66.8	28	72
L2M1	29281	47.9	45.9	68.1	37 [a]	76
L2M2	29046	49.7	46.1	67.8	34 [a]	66
L2R	30144	48.7	46.4	66.7	27	72
L5L1	30613	50.0	47.4	68.4	29	68
L5L2	30687	49.7	47.2	68.0	30	69
L5L3 [b]	30911	49.9	47.4	68.1	29	65
L5L4	30868	49.8	47.1	67.8	30	67
Average	29733	*48.5*	*46.2*	*67.4*	*28* [a]	*71*
COV	0.025	*0.028*	*0.018*	*0.011*	*0.042* [a]	*0.053*
L3B1	29466	48.4	45.6	66.7	27	65
L3B2	29732	48.3	45.4	66.6	28	66
L3T1	29663	48.1	45.5	66.7	28	69
L3T2	29273	49.0	46.4	66.8	28	68
L4B1	29935	48.6	45.9	66.8	27	69
L4B2	29791	48.7	46.2	67.1	28	69
L4T1	29807	48.3	45.8	67.0	27	69
L4T2	29637	48.3	45.5	66.8	27	71
L5T1	30339	49.5	47.1	68.3	29	67
L5T2	30503	50.0	47.2	68.3	28	66
L5T3	30422	49.8	47.2	68.0	28	64
L5T4	30338	49.4	46.9	67.7	27	70
Average	29909	*48.9*	*46.2*	*67.2*	*28*	*68*
COV	0.013	*0.013*	*0.015*	*0.010*	*0.025*	*0.033*
Average [c]	**29825**	**48.7**	**46.2**	**67.3**	**28** [a]	**69**
COV [c]	**0.020**	**0.021**	**0.016**	**0.010**	**0.033** [a]	**0.049**

[a] –These smaller ASTM E8 sheet-type specimens demonstrated different ductility and strength than the larger plate-type coupons
[b] - Indicates specimens where fracture occurred outside the original gauge length marks or was located less than 25 % of the elongated gage length from either of the original gauge length marks.
[c] –Rejectable specimens were not included in statistical analysis

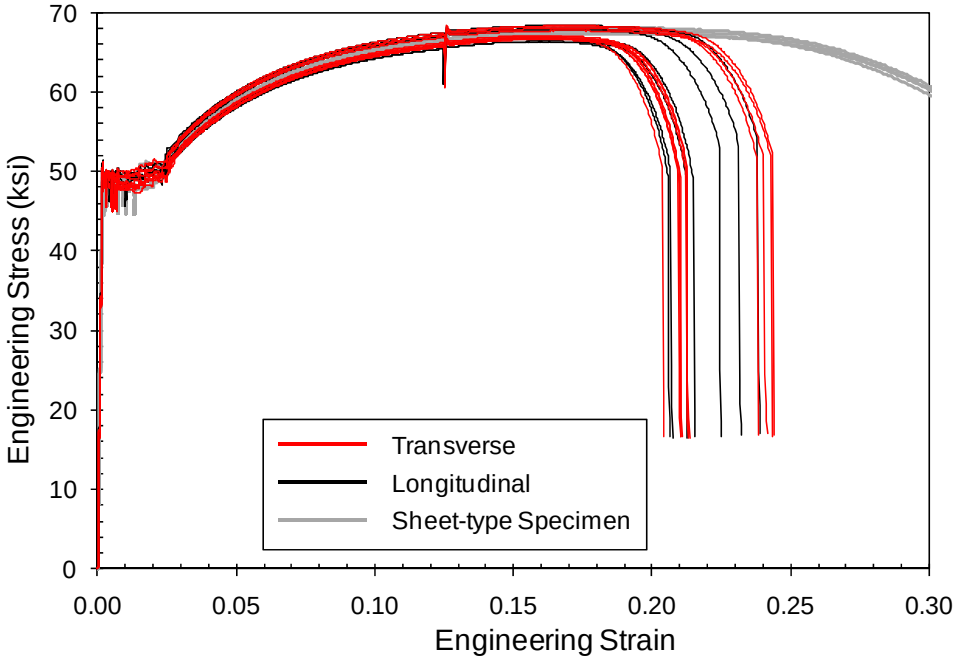

Figure D28. All GP490LS3-1 coupon engineering stress/engineering strain plots.

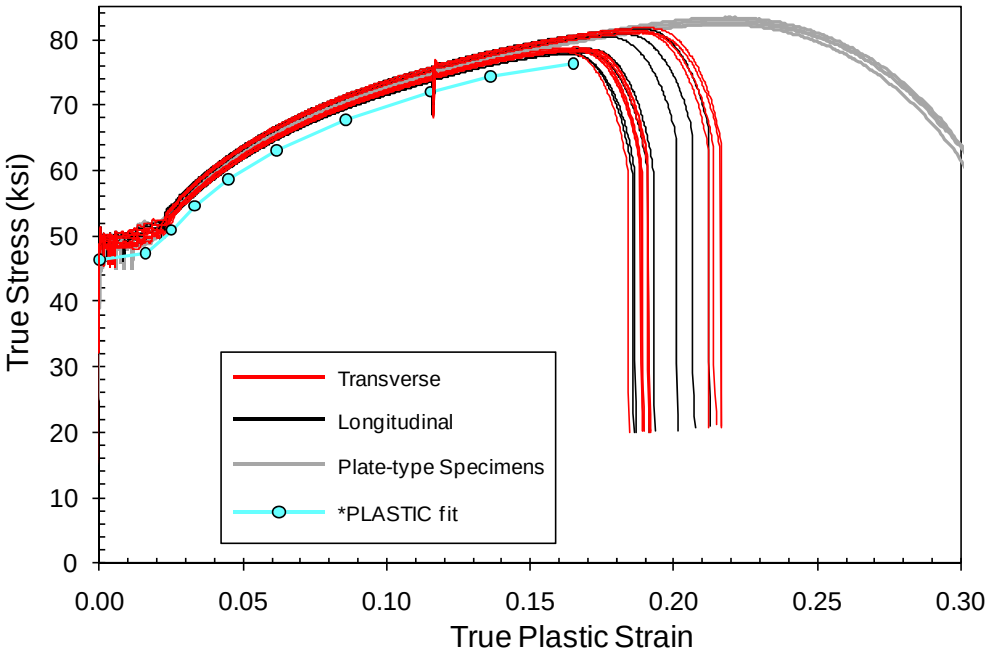

Figure D29. GP490LS3-1 coupon true stress/true plastic strain plots.

Table D15. *Tensile Coupon Results from GP490LS3-2 Plate*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
M1L	29728	48.5	45.9	66.3	28	68
M1M1	29337	46.2	45.3	67.2	37 [a]	75
M1M2	29140	47.5	45.3	67.6	36 [a]	75
M1R	29724	47.9	45.5	66.3	27	69
M2L	29557	47.7	45.3	66.1	28	70
M2M1	28868	47.1	44.6	68.2	36 [a]	75
M2M2	29045	46.2	44.9	67.4	36 [a]	76
M2R	29735	48.1	45.1	50.1	27	69
M5L1	30709	49.5	47.0	68.2	27	67
M5L2	30741	49.1	46.9	68.0	27	65
M5L3	30667	49.7	47.2	67.9	25	62
M5L4	30641	49.0	46.5	67.4	26	68
Average	29824	*48.0*	*45.8*	*65.9*	*27* [a]	*70*
COV	0.023	*0.024*	*0.020*	*0.076*	*0.042* [a]	*0.064*
M3B1	29716	48.2	45.7	66.2	27	70
M3B2	29562	48.0	45.5	66.1	28	71
M3T1	29658	48.2	45.5	66.0	27	69
M3T2	29961	47.8	45.4	66.1	28	71
M4B1 [b]						
M4B2	29984	48.1	45.7	66.8	28	66
M4T1	29858	47.9	45.5	66.3	27	70
M4T2	29813	47.5	45.1	66.3	27	69
M5T1	30206	48.6	46.2	67.1	28	68
M5T2	30212	48.4	46.0	66.9	28	70
M5T3	30067	50.1		66.4	27	64
M5T4	30068	48.6	46.2	67.0	27	70
Average	29919	*48.3*	*45.7*	*66.5*	*27*	*69*
COV	0.007	*0.014*	*0.008*	*0.006*	*0.018*	*0.030*
Average	**29870**	**48.2**	**45.7**	**66.2**	**29** [a]	**69**
COV	**0.017**	**0.020**	**0.015**	**0.054**	**0.128** [a]	**0.051**
MA1 [c]	29556	49.9	46.9	73.9	24	54
MA2 [c]	29895	51.7	47.2	74.6	23	55
Average	29725	50.8	47.1	74.3	24	55

[a] – Sheet-type specimens were not included in statistical analysis
[b] – This specimen was accidently destroyed
[c] – Longitudinal coupons from stiffening angles

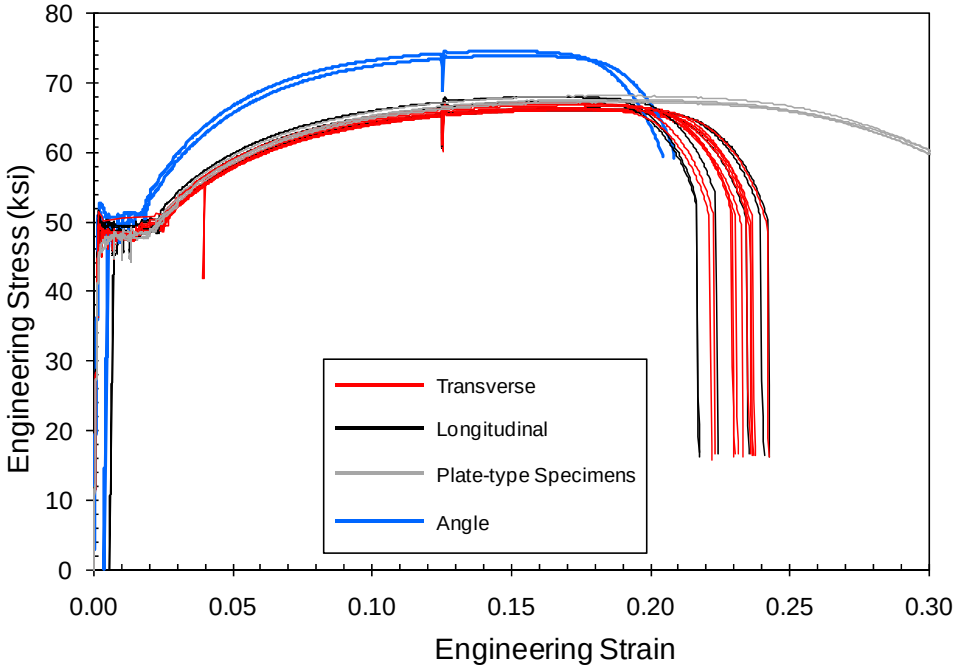

Figure D30. All GP490LS3-2 coupon engineering stress/engineering strain plots.

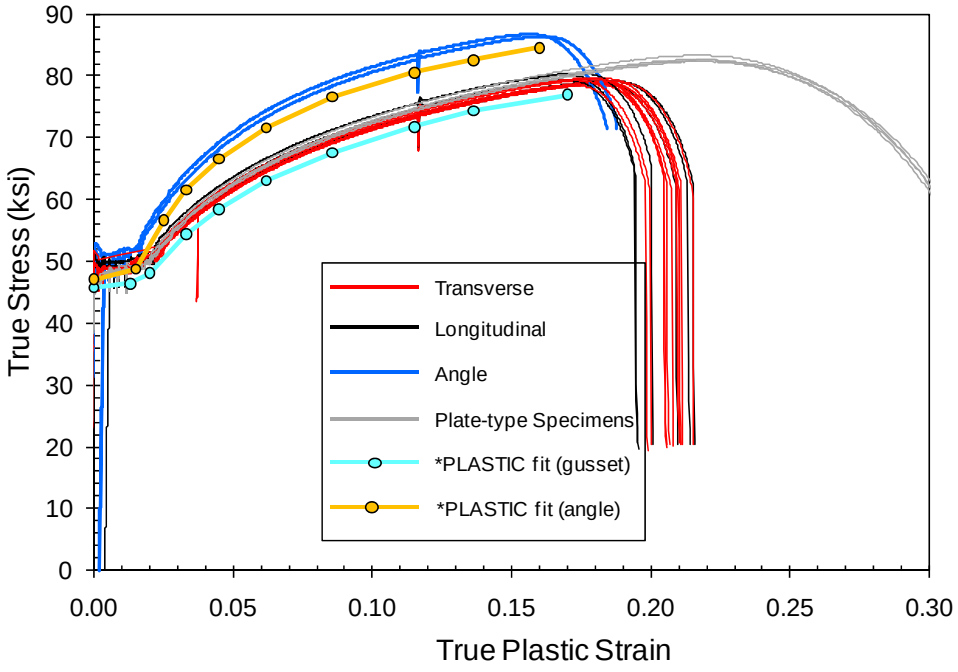

Figure D31. GP490LS3-2 coupon true stress/true plastic strain plots.

Table D16. *Abaqus *PLASTIC Input Data for Phase 1 Specimens*

	307SS3		307LS3		307SL3		307SL4		490SS3		490LS3		490LS-1	
	True Stress (ksi)	True Plastic Strain	True Stress (ksi)	True Plastic Strain	True Stress (ksi)	True Plastic Strain	True Stress (ksi)	True Plastic Strain	True Stress (ksi)	True Plastic Strain	True Stress (ksi)	True Plastic Strain	True Stress (ksi)	True Plastic Strain
Line 1	36.38	0	48.20	0	46.65	0	33.16	0	46.42	0	45.62	0	46.42	0
Line 2	37.38	0.0084	48.77	0.013	47.51	0.011	34.47	0.005	47.08	0.01	47.08	0.011	47.41	0.016
Line 3	44.31	0.0178	50.77	0.0178	51.51	0.0178	42.97	0.018	50.78	0.0178	50.58	0.0178	50.91	0.025
Line 4	49.86	0.0274	55.77	0.0274	55.51	0.0274	50.27	0.034	55.28	0.0274	55.08	0.0274	54.61	0.033
Line 5	56.09	0.0435	61.07	0.0435	60.01	0.0435	54.47	0.046	60.28	0.0435	59.58	0.0435	58.71	0.045
Line 6	60.87	0.0618	64.77	0.0618	64.01	0.0618	58.47	0.062	64.28	0.0618	63.58	0.0618	63.11	0.0618
Line 7	65.02	0.0857	68.77	0.0857	67.51	0.0857	62.67	0.086	67.78	0.0857	67.08	0.0857	67.81	0.0857
Line 8	68.41	0.1151	72.27	0.1151	71.01	0.1151	65.77	0.11	71.28	0.1151	70.08	0.1151	72.01	0.1151
Line 9	70.26	0.1363	74.47	0.1363	72.51	0.1363	68.97	0.143	73.03	0.1363	72.08	0.1363	74.41	0.1363
Line 10	36.38	0	75.77	0.155	74.01	0.155	70.97	0.17	74.28	0.155	73.08	0.155	76.41	0.165

Table D17. *Abaqus *PLASTIC Input Data for Phase 2 Specimens*

	490SS3-1		490LS3-2		307SS3-1		307SS3-2		307SS3-3		307SS3-4 gusset		307SS3-4 shingle	
	True Stress (ksi)	True Plastic Strain	True Stress (ksi)	True Plastic Strain	True Stress (ksi)	True Plastic Strain	True Stress (ksi)	True Plastic Strain	True Stress (ksi)	True Plastic Strain	True Stress (ksi)	True Plastic Strain	True Stress (ksi)	True Plastic Strain
Line 1	46.01	0	45.74	0	47.22	0	47.81	0	37.94	0	37.97	0	46.25	0
Line 2	46.49	0.01	46.37	0.013	47.57	0.012	48.74	0.012	38.77	0.008	38.25	0.008	47.46	0.02
Line 3	48.49	0.022	48.07	0.02	53.27	0.022	54.24	0.022	47.02	0.022	46.75	0.022	50.96	0.025
Line 4	53.99	0.033	54.37	0.033	57.27	0.033	58.24	0.033	52.52	0.033	51.75	0.033	54.46	0.033
Line 5	58.29	0.045	58.47	0.045	60.77	0.045	61.74	0.045	56.52	0.045	55.75	0.045	58.46	0.045
Line 6	62.99	0.0618	63.07	0.0618	64.27	0.062	65.24	0.062	60.52	0.062	60.00	0.062	62.96	0.0618
Line 7	67.49	0.0857	67.57	0.0857	68.17	0.086	69.24	0.086	64.77	0.086	64.25	0.086	67.56	0.0857
Line 8	71.69	0.1151	71.77	0.1151	70.87	0.11	72.24	0.11	67.77	0.11	67.25	0.11	71.76	0.1151
Line 9	75.29	0.15	74.37	0.1363	73.37	0.136	74.84	0.136	70.52	0.136	70.25	0.136	74.66	0.145
Line 10	76.99	0.18	76.97	0.17	74.77	0.155	75.74	0.155	72.27	0.165	71.75	0.155	76.46	0.175

A514 CONNECTION MEMBER MATERIAL

The five reusable connection members for the full-scale testing were constructed from A514 Grade B material in three plate sizes of ½, ¾, and 1 inch thicknesses. Unfortunately, the fabricator was not able to provide extra ¾ inch material for characterization. From the remnants of the one inch thick plate, four transverse and two longitudinal coupons were made. The remnant of ½ inch thick plate could not facilitate a transverse Plate-type coupon and only four longitudinal coupons were made.

The results from the tensile coupon testing of the 1 inch and ½ inch thickness plate are shown in Tables D18 and D198 respectively. The plots of the engineering stress versus engineering strain for each plate thickness is represented in Figure D32 and Figure D33. The true stress versus plastic and associated curve fit needed in an Abaqus analysis are shown in Figure D34.

Table D18. *A514 Results (1 inch plate)*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
T1	29879	111.8	110.0	118.9	15	54
T2	30462	112.1	110.0	119.0	15	55
T3	30518	111.2	109.2	118.6	15	54
T4	30054	109.7	107.5	117.3	15	55
L1	30126	110.6	108.8	117.8	17	66
L2	30654	110.0	108.2	117.3	17	66
Average	**30282**	**110.9**	**108.9**	**118.1**	**16**	**58**
COV	**0.010**	**0.009**	**0.009**	**0.007**	**0.058**	**0.103**

Table D19. *A514 Results (0.5 inch plate)*

Specimen ID	Measured Modulus of Elasticity (ksi)	0.2% Offset Yield Stress (ksi)	Static Yield Stress (ksi)	Tensile Strength (ksi)	Elongation (%)	Area Reduction (%)
L1	27920	104.3	102.1	109.6	13	56
L2	28069	104.3	102.0	109.0	13	55
L3	27973	104.0	101.6	109.4	12	52
L4	28210	103.7	101.4	109.0	12	53
Average	**28043**	**104.1**	**101.8**	**109.3**	**12**	**54**
COV	**0.005**	**0.003**	**0.003**	**0.002**	**0.019**	**0.032**

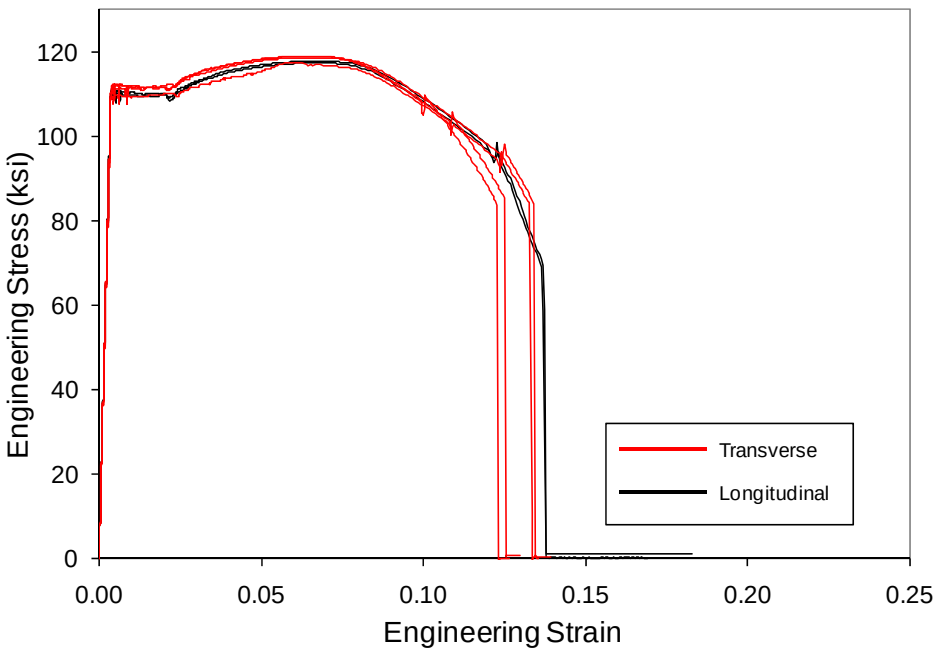

Figure D32. A514 Gr. B one inch thick coupon engineering stress/engineering strain plots.

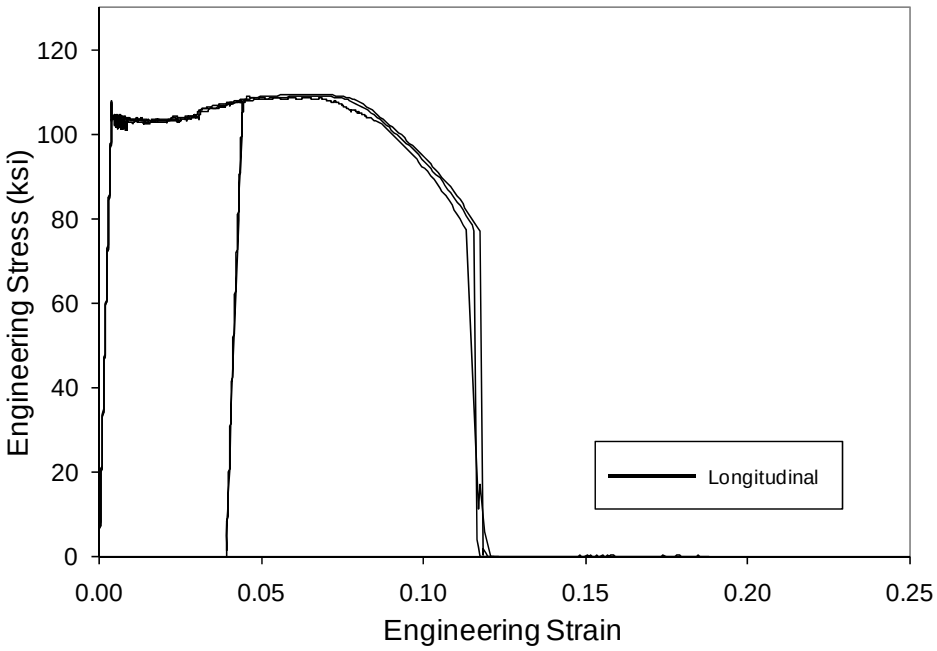

Figure D33. A514 Gr. B half inch thick coupon engineering stress/engineering strain plots.

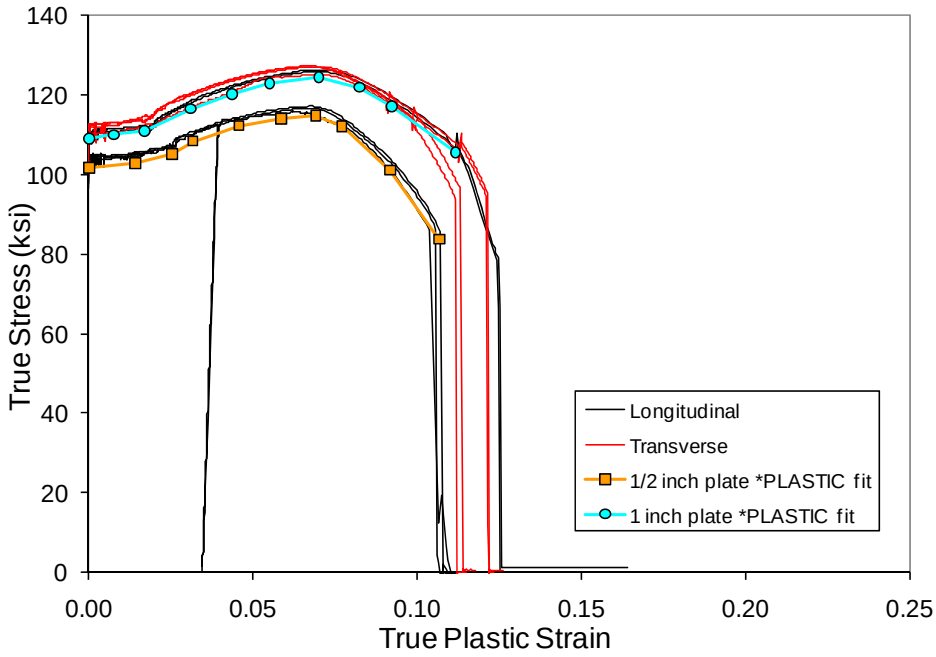

Figure D34. A514 Gr. B coupon true stress/true plastic strain plots.

MILL CERTIFICATIONS

Figures 35 through 38 show the mill certifications for the gusset plate received from the fabricator. A mill certification was never received for connection GP307SS3.

F5183200 (AFP Rev 04-08)

Severstal Sparrows Point, LLC
QUALITY & CUSTOMER TECHNICAL SERVICES
REPORT OF TEST AND ANALYSIS

REQ. JOB CONTRACT NO.	PURCHASE ORDER DATE	PURCHASE ORDER NO.	
	06/23/09	090634	
VENDOR	SHIPMENT NO.	MILL ORDER NO.	INVOICE NO.
SEVERSTAL SPARROWS POINT, LLC SPARROWS POINT PLANT SPARROWS POINT, MARYLAND 21219	405-08616	41630476F	405-08616
	VEHICLE IDENTIFICATION		DATE SHIPPED 09/23/09

SOLD TO
SHERWOOD INDUSTRIES INC
CERTIFIED STEEL CO DIV
1333 BRUNSWICK PK STE 200
LAWRENCEVILLE NJ 08648

SHIP TO
SHERWOOD INDUSTRIES INC
CERTIFIED STEEL CO DIV
199 WHITEHEAD ROAD
TRENTON NJ 08610

SPECIFICATION DESCRIPTION

THICKNESS	TYPE	WIDTH	LENGTH
.365	M	60.00	

STEEL CHAR: HOT ROLLED STRUCTURAL STEEL DRY COILS-ME
SPEC CODE : 36000 PSI MIN YIELD 58000-80000 PSI TENSILE ELONG 23% IN 2 "

NOTE	QUANTITY Pieces	QUANTITY Packages	Actual Weight	Coil/Lift Serial No.	Heat Number and/or Test Identification	Yield	Tensile Strength	ELONG in.	ELONG %	Bend	
	1		46370	261043T	402P7541	50,100	69,100	2	33.0		FRONT

MELTED & MANUFACTURED IN THE USA

37643

NOTES

Heat Number	CHEMICAL ANALYSIS C	Mn	P	S	SI	CU	NI	CR	MO	V	CB
402P7541	.13	.59	.014	.013	.016	.020	0.01	0.02	.001	.001	.018

I certify that the above results are a true and correct copy of actual results contained in records maintained by Severstal SP, LLC, and are in full compliance with the requirements of the specification cited. This test report cannot be altered and must be transmitted intact with any subsequent third party test reports, if required.

MANAGER, QUALITY/CUSTOMER TECHNICAL SERVICES
J. P. ECKSTEIN

DATE 09/30/09 R14:35
PER

PAGE 1

Figure D35. MTR for $^{3}/_{8}$ inch gusset material for specimen GP307LS3, GP307SL3, GP490SS3, GP490LS3.

FS163000 (AFP Rev 3-06)

ISG SPARROWS POINT, INC.
QUALITY & CUSTOMER TECHNICAL SERVICES
REPORT OF TEST AND ANALYSIS

REL. JOB CONTRACT NO.

PURCHASE ORDER DATE: 01/21/08
PURCHASE ORDER NO.: 080057

VENDOR: ISG SPARROWS POINT INC
SPARROWS POINT PLANT
SPARROWS POINT, MARYLAND 21219

SHIPMENT NO.: 405-05027
MILL ORDER NO.: 416 32411 J
INVOICE NO.: 405-05027
VEHICLE IDENTIFICATION
DATE SHIPPED: 04/17/08

SOLD TO:
SHERWOOD INDUSTRIES INC
CERTIFIED STEEL CO DIV
1333 BRUNSWICK PK STE 200
LAWRENCEVILLE NJ 08648

SHIP TO:
SHERWOOD INDUSTRIES INC
CERTIFIED STEEL CO DIV
199 WHITEHEAD ROAD
TRENTON NJ 08610

SPECIFICATION DESCRIPTION

THICKNESS	TYPE	WIDTH	LENGTH
.480	M	60.00	

STEEL CHAR: HOT ROLLED STRUCTURAL STEEL DRY COILS-ME
SPEC CODE : 36000 PSI MIN YIELD 58000-80000 PSI TENSILE ELONG 23% IN 2 "

NOTE	QUANTITY Pieces	QUANTITY Packages	Actual Weight	Coil/Lift Serial No.	Heat Number Assigned Test Identification	Yield	Tensile Strength	ELONG Lt.	ELONG %	Hard	
	1		47420	135619T	412K9661	49,500	72,700	2	28.0		FRONT

MELTED & MANUFACTURED IN THE USA

36920

REMARKS: Material to be used for conversion to ASTM A36/ASME SA36. Statement added to test report 07/20/09.

Heat Number	CHEMICAL ANALYSIS C	Mn	P	S	SI	CU	NI	CR	MO	V	CB
412K9661	.22	.85	.011	.014	.009	.040	0.02	0.02	.002	.002	.001

I certify that the above results are a true and correct copy of actual results contained in records maintained by ISG Sparrows Point, Inc. and are in full compliance with the requirements of the specification cited. This test report cannot be altered and must be transmitted intact with any subsequent third party test reports, if required.

MANAGER, QUALITY/CUSTOMER TECHNICAL SERVICES
J. P. ECKSTEIN

DATE: 04/17/08 15:00
PER

Figure D36. MTR for $^{1}/_{2}$ inch gusset material for specimen GP307SL4.

NUCOR PLATE MILL

P.O.Box 279
Winton, NC 27986
(252) 356-3700

Mill Test Report

Page 2

NUCOR It's our Nature.

Issuing Date : 11/01/2010 B/L No. : 276330 Load No. : 277813 Our Order No. : 85636/1 Cust. Order No. : MA-23388

Vehicle No: RICKY GARDNER 767

Specification : 0.3750" x 96.000" x 240.000"
ASTM A36-08/ABS Grade A/ASME SA36-03a/ASTM A709 Grade 36-09a

Sold To : INFRA-METALS CO
500 MIDDLETOWN BLVD
SUITE D-100
410-355-9395
LANGHORNE,PA 19047

Ship To : INFRA-METALS CO
4501 CURTIS AVENUE
410-355-9395
BALTIMORE,MD 21225

Marking :

Heat No	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Al(tot)	V	Nb	Ti	N	Ca	B	Sn	CEQ	PCM
0507505	0.06	0.85	0.008	0.002	0.30	0.28	0.10	0.08	0.02	0.031	0.006	0.003	0.002		0.0012	0.0002	0.014	0.25	0.13
0507506	0.07	0.80	0.008	0.001	0.28	0.30	0.10	0.08	0.03	0.027	0.005	0.002	0.002		0.0010	0.0002	0.015	0.25	0.14
0507507	0.06	0.84	0.011	0.002	0.22	0.30	0.10	0.10	0.02	0.027	0.004	0.002	0.002		0.0009	0.0002	0.014	0.25	0.13

Tensile Test

Plate Serial No	Pieces	Tons	Dir.	(psi) Yield	(psi) Tensile	Elongation % in 2"	Elongation % in 8"
0507505-08	3	3.67	T	44,900	62,600		28.9
			T	42,300	61,900		30.0
0507506-03	7	8.57	T	45,500	62,800		29.3
			T	41,400	61,200		29.5
0507507-09	4	4.90	T	40,500	60,600		31.4
			T	48,400	65,500		29.4

Charpy Impacts

Dir.	1	(%) shear	2	(%) shear	3	(%) shear	Ave.	(%) shear	Size	Temp	Min Ave.

0507507

42092
42093

Manufactured to fully killed fine grain practice by Electric Arc Furnace. Welding or weld repair was not performed on this material. Mercury has not been used in the direct manufacturing of this material. Produced as continuous cast discrete plate as-rolled, unless otherwise noted in Specification.
Yield by 0.5EUL method unless otherwise specified. Ceq = C+(Mn/6)+((Cr+Mo+V)/5)+((Cu+Ni)/15)
Pcm = C+(Si/30)+(Mn/20)+(Cu/20)+(Ni/60)+(Cr/20)+(Mo/15)+(V/10)+5B
Melted and manufactured in the USA. ISO 9001:2008 certified (#008063) by SRI Quality System Registrar (#0985-09). PED 97/23/EC 7/2 Annex 1, Para. 4.3 Compliant.
DIN 50049 3.1 B/EN 10204 3.1B(2004). DIN EN 10204 3.1(2005) compliant. For ABS grades only, Quality Assurance certificate 09-MMPQA-546

We hereby certify that the contents of this report are accurate and correct. All test results and operations performed by the material manufacturer are in compliance with the applicable specifications, including customer specifications.

T. A. Depretis

T. A. Depretis, Metallurgist

11/01/2010 3:05:08 PM

Figure D37. MTR for $^{3}/_{8}$ inch gusset material for specimen GP307SS3-1, GP307SS3-2, GP490LS3-1, GP490LS3-2, GP490SS3-1.

*** S E V E R S T A L *** 886603

PAGE 1 of 1

SEVERSTAL WARREN, INC.
1040 PINE AVE. SE
WARREN, OHIO 44483-6520

MELTED AND MANUFACTURED IN USA

PURCHASE ORDER:
11/24/10 6304886-MID

C E R T I F I C A T E
O F T E S T S

DATE/INVOICE: 01/17/11 690663224
ORDER: 217 19 35235 03

SOLD TO:
NAMASCO CORP MIDDLETOWN
500 COLONIAL CENTER PARKWAY
SUITE 500
ROSWELL GA 30076

SHIP TO:
NAMASCO CORPORATION MIDDLETOWN
760 NEWFIELD STREET
MIDDLETOWN CT 06457

I certify that the properties of the items tested are true and accurate. Material was sampled, tested and inspected in accordance with the methods prescribed in the governing specifications. Subject material also conforms to the requirements of the governing specifications.
This report shall not be reproduced except in full.

D.L. Moore
General Manager - Met. Services & QC

All tests are conducted in-house unless noted with an asterisk.

Item	Specification and Description	03:15:10
	HR SHEET SS + GRADE 36 TYPE 2	
	ASTM-A-1018-08A TYPE B SNA 36 SK	
	NON-TEMPER ROLLED DRY NO OIL	
3	.361M X 48.000 ME X COILS	
	COIL WGT 38400MN/48000MX	

HEAT-NO COIL NUMBERS
2148194 L110304

HEAT-NO	C	MN	P	S	SI	CU	NI	CR
2148194	.19	.75	.008	.005	.013	.03	.01	.03
	MO	SN	AL	V	CB	B	TI	ZR
	.01	.002	.058	.000	.000	.0000	.001	
	CA	CE	SB	H	N	O		
	.0030	.000	.000		.0040			

EU CONVERSION TO A36 - SHEETS/FLATNESS IMPORTANT NO COIL BREAKS

TI 01 C R/A
FAX NBR: 866 598 1572 ATTENTION OF:

CH C 25MX MN 1.35MX P 035MX S 040MX NI 20MX CR 15MX MO 06MX CU 20MX
CB 008MX TI 025MX V 008MX

NAMASCO
klöckner & co multi metal distribution

New Castle Division
20 Davidson Lane
New Castle DE 19720

NAMASCO CORPORATION
ATTENTION: KENT WINCHELL

DATE: February 18, 2011
PO # VERBAL

MATERIAL: CARBON STEEL

SPECIFICATION: ASTM A36-08 / ASME SA36-07 EDITION / ASTM A709-07 GR 36

SAMPLE DESIGNATION: 2 SAMPLES, # 618, SIZE 3/8 X 48.00, MILL COIL ID, L110303
HEAT # 2148194

MECHANICAL PROPERTIES (per ASTM A370-09A)

	# 1 HEAD	# 2 CENTER
WIDTH (inches):	.491	.519
THICKNESS (inches):	.373	.374
AREA (square inches):	.183	.194
YIELD STRENGTH (ksi) 0.2% offset:	41.6	42.5
TENSILE STRENGTH (ksi)	65.8	65.9
ELONGATION (%) IN 2"	33.5	33.5

Based on the above testing this material meets the tensile requirements of ASTM A36-08 / ASME SA36-07 EDITION / ASTM A709-07 GR 36.

Daniel J. Iadisernia, Quality Manager

Figure D38. MTR for $^{3}/_{8}$ inch gusset material for specimen GP307SS3-3, GP307SS3-4, and Shingle plates.