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STRUCTURAL SYSTEMS RESEARCH PROJECT

Report No.
SSRP-2026/02
Final

Mechanical Properties Characterization for the CFS10 (10-Story Cold-Formed Steel Framed Building) Shake Table Test Program

By

T.Mueller, D.A. Blair, J.Zhang, and T.C. Hutchinson

Final Report.

September 2026

Department of Structural Engineering
University of California San Diego
La Jolla, California 92093-0085

University of California San Diego
Department of Structural Engineering
Structural Systems Research Project

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DISCLAIMER

The opinions, recommendations and conclusions contained within this report are solely those of the authors, and do not necessarily reflect the views or policies of the project sponsors. This report does not constitute a standard, specification, or regulation.

ACKNOWLEDGEMENTS

The CFS10 project is a collaborative research effort supported through National Science Foundation (NSF) Grants CMMI-1663569 and CMMI-1663348, entitled *Collaborative Research: Seismic Resiliency of Repetitively Framed Mid-Rise Cold-Formed Steel Buildings*, together with numerous federal, state, and industry partners. A complete list of project sponsors and partners is available at https://cfs10.ucsd.edu [1] (see the CFS10 Sponsors and Partners page). The efforts of all undergraduate and graduate students, visiting scholars (CFS10 Personnel), and the LHPOST6 staff (NHERI@UC San Diego Personnel, https://nheri.ucsd.edu/about/personnel) are greatly appreciated.

The authors gratefully acknowledge the support provided during data collection by Michael Sanders and Zach Kamibayashiyam, staff at the Charles Lee Powell Laboratories at UC San Diego, and Steve Porter, Undergraduate Laboratory Manager.

The authors also gratefully acknowledge the contributions of the industry partners who supplied the structural materials used in this study. Throughout this report, ClarkDietrich, the primary supplier of the cold-formed steel framing members for the CFS10 project, is referred to as Mnf-1. A limited number of CFS members installed in the CFS10 specimen were identified from an alternative manufacturer designated as Mnf-2. Mill certificate data was unavailable for Mnf-2 and are therefore excluded from comparisons involving reported material properties. The all-thread rod (ATR) system was designed in collaboration with MiTek Inc. and distributed by Bay Standard Manufacturing Inc. (BSMI), collectively referred to as Mnf-3. The hollow structural sections (HSS) were supplied by Atlas Tube Inc., referred to throughout this report as Mnf-4. Findings, opinions, recommendations, and conclusions are those of the authors and do not necessarily reflect those of the sponsoring organizations.

EXECUTIVE SUMMARY

A ten-story cold-formed steel (CFS) framed building, referred to as CFS10, underwent seismic and post-seismic live fire testing at the 6-Degree-of-Freedom Large High Performance Outdoor Shake Table (LHPOST6) facility at the University of California San Diego. Construction of the CFS10 specimen spanned from September 2024 to March 2025 and involved assembly using three different methods: conventional stick-framing, two-dimensional (2D) prefabricated panels, and three-dimensional (3D) volumetric modular units. CFS10 was then outfitted with more than 1000 sensors (April–June 2025) and subjected to earthquake testing over a two-week span (June 2025), with motions reaching up to MCE_R-scaled events. The specimen was subsequently subjected to two post-earthquake live fire tests within distinct seismically damaged compartments (July 2025).

This report summarizes the material testing program conducted on three component types used in the CFS10 specimen: (1) cold-formed steel framing members, including studs, tracks, joists, and sheet steel; (2) tie-rods used within the lateral force-resisting system (LFRS); and (3) hot-rolled steel hollow structural sections (HSS) used in the LFRS. Specifically, mechanical monotonic tension testing was conducted on ASTM coupon sized samples of the CFS, on HSS, and directly using predefined length samples of the all-thread bars. In total 119 mechanical tension tests were performed. Material both set aside before testing and salvaged after testing was used in this program. The resulting material data will be particularly valuable for future post-test numerical modeling efforts.

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1 Introduction

A full-scale ten story CFS building, referred to as CFS10, was constructed on the 6-Degree-of-Freedom Large High-Performance Outdoor Shake Table (LHPOST6) facility at the University of California San Diego to investigate structural performance under sequential earthquake and post-earthquake fire loading [2–4].

As part of the overall experimental program, representative material samples were obtained for tensile testing to establish the mechanical properties of the structural steel materials used throughout the project.

The materials evaluated in this study included CFS framing members, hollow structural sections (HSS), and all-thread rods (ATR). The CFS and HSS specimens were fabricated from unused material reserved by the research team prior to construction of the test specimen, while the ATR had some members set aside and others removed undamaged within the CFS10 structure following completion of the seismic and post-fire testing program. Figures 1 and 2 illustrate representative structural members incorporated throughout the CFS10 specimen, including the primary CFS framing members, ATR, and HSS used in the structural system. Members highlighted in red indicate those selected for material testing, while members highlighted in blue, while still used in the building, were left out of this testing program and are shown for labeling purposes only.

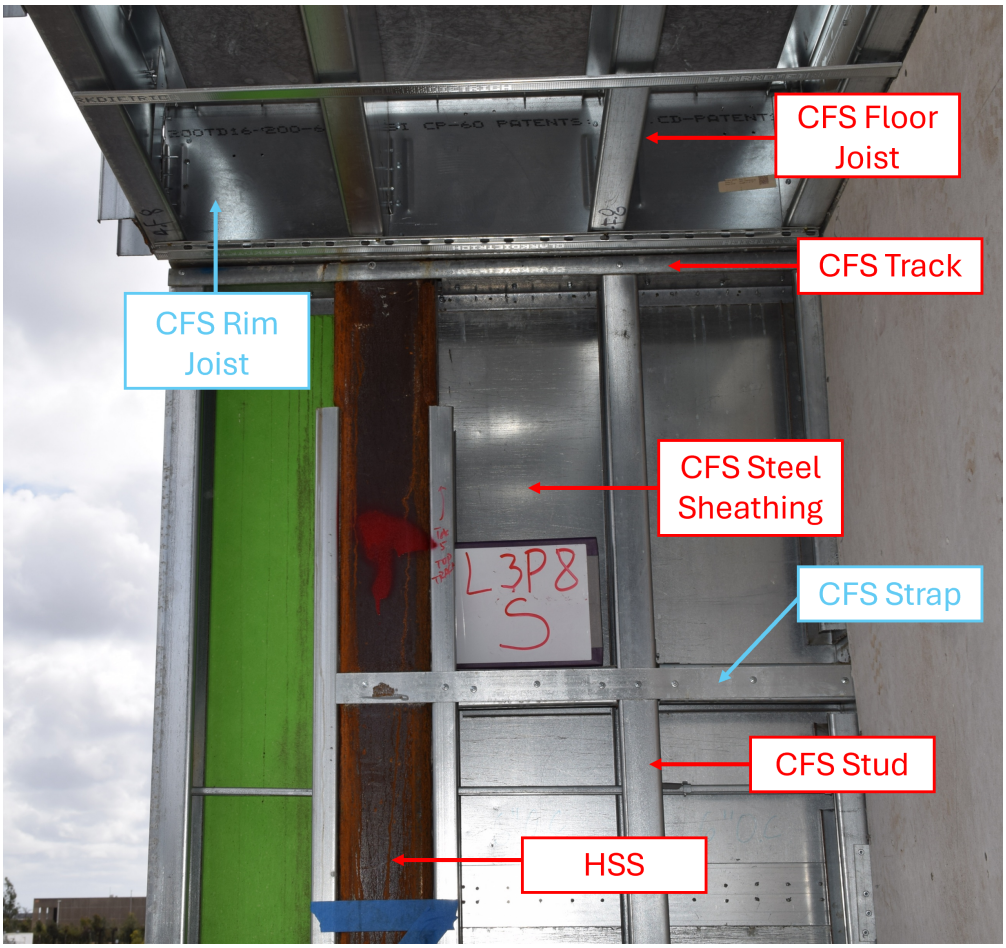


Figure 1: Illustration of representative structural members used in the CFS10 specimen (Top of Level 3)

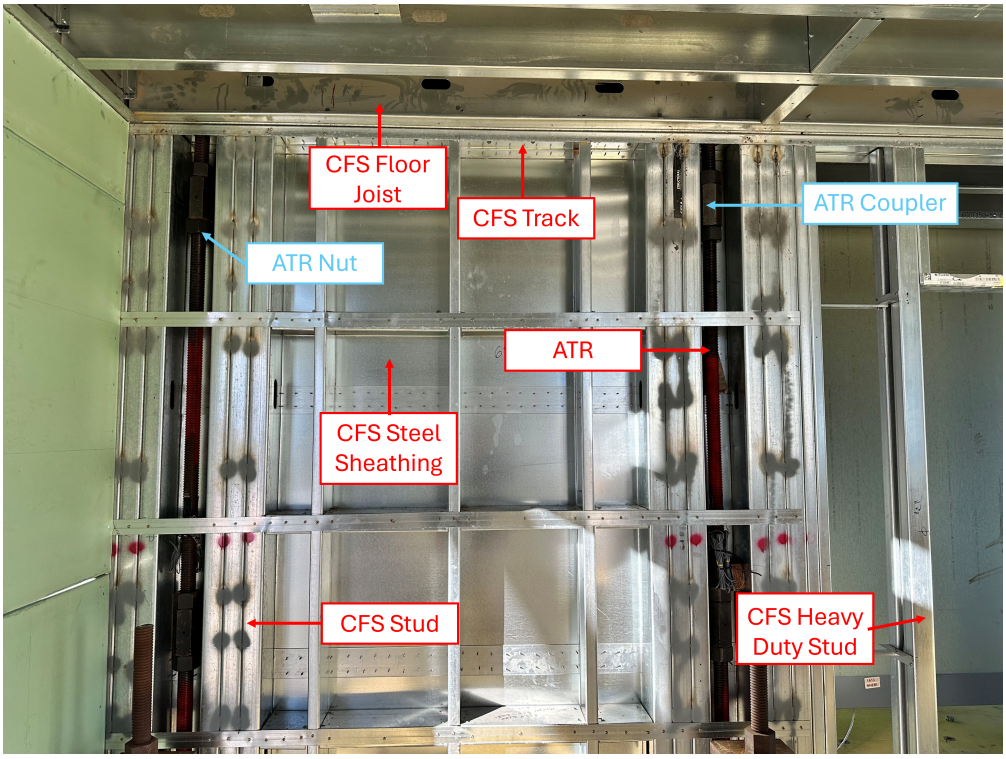


Figure 2: Interior shear wall illustration of representative structural members used in the CFS10 specimen (Level 1)

Tensile testing was performed in accordance with the applicable ASTM standards to determine the yield strength, ultimate tensile strength, elastic modulus, ultimate load, and elongation of each specimen. For the CFS and HSS materials, the experimentally measured properties were compared with the manufacturers' certified mill certificate values to experimentally verify the mechanical properties reported on the manufacturers' mill certificates. The threaded tie-rods were similarly tested to characterize the mechanical properties of components that served as tension chord elements in the shear walls.

2 Tested Materials

2.1 CFS Members

CFS members served as the primary structural framing components throughout the CFS10 building specimen. These members were used repetitively in the wall and floor framing systems, including structural studs, joists, tracks, and heavy-duty stud (HDS) sections that formed both the gravity and lateral force resisting systems of the structure. Following completion of the seismic and post-seismic fire testing program, coupon specimens were fabricated from the unused CFS material from the original construction of the CFS10 specimen, such as shown in Figure 3. These CFS coupons were subjected to tensile coupon testing to establish baseline material properties for comparison with the corresponding mill certification values.



Figure 3: Representative CFS material pallets prior to construction on-site of CFS10 building - samples were fabricated from these identical batches of material

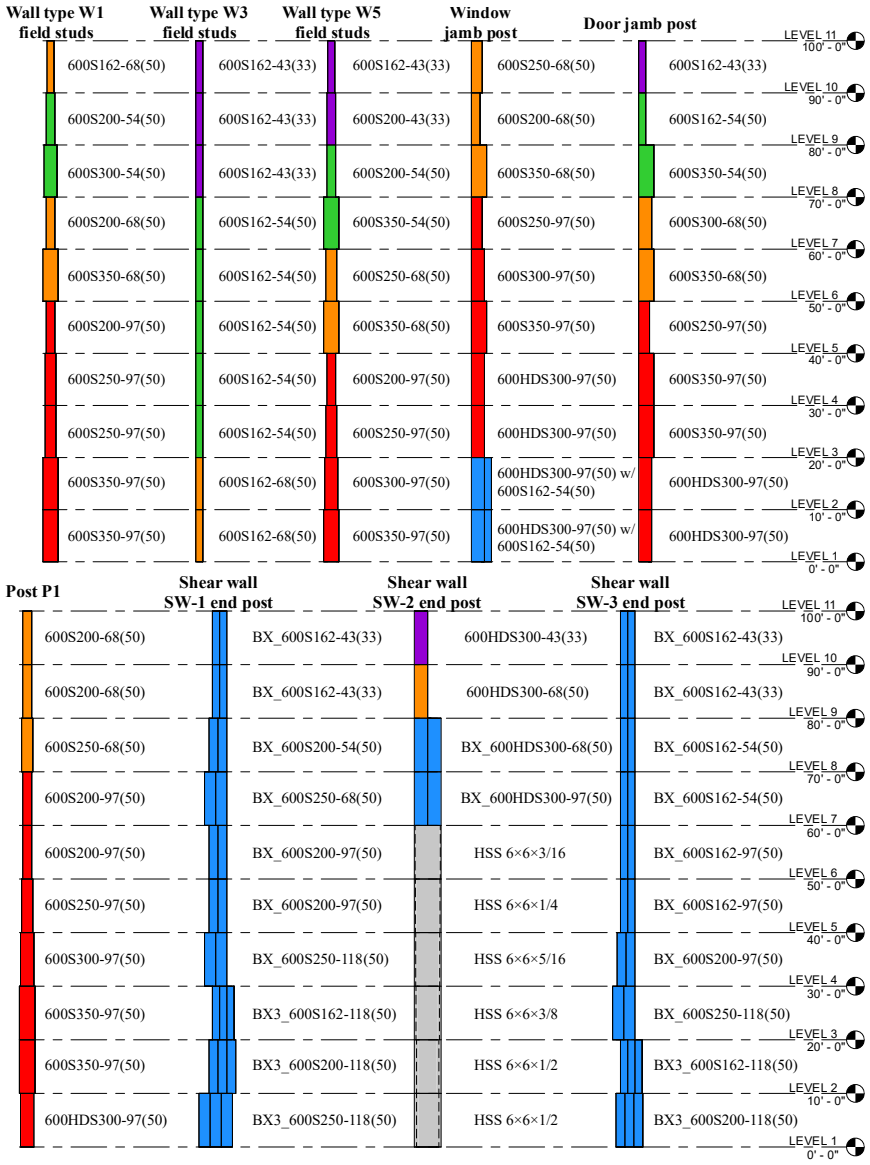


Figure 4: CFS10 framing profile elevations by member category and level (Graphic from Rivera [5])

Figure 4 illustrates the distribution of the primary cold-formed steel framing members used throughout the height of the CFS10 building. Different stud, joist, and heavy-duty stud (HDS) sections were utilized depending on the structural demands associated with each wall type and floor level. In general, thicker and stronger sections were used in the lower levels of the structure where gravity and lateral force demands were greatest, while lighter sections were used at upper floors to reduce overall structural weight. The color coding shown in Figure 4 identifies the nominal thickness of the CFS members with red, orange, green, and purple representing 97, 68, 54, and 43 mil thickness, respectively. Additionally, the blue and gray colors denotes box studs (BX) and HSS, respectively. These two colors are used

only to distinguish these member types from the CFS framing rather than indicate material thickness.

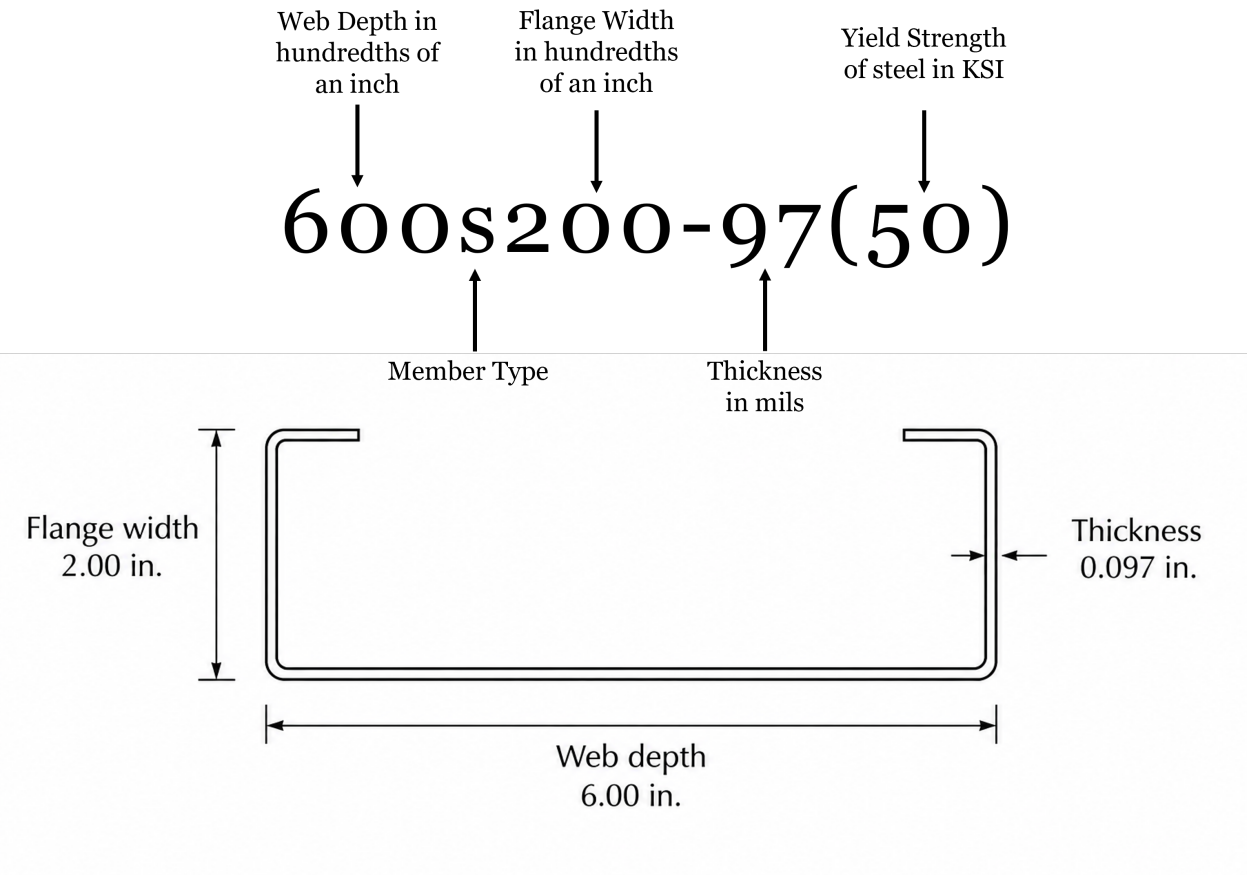


Figure 5: Typical cold-formed steel stud geometry and nomenclature designation

The CFS10 building incorporated five primary CFS member categories, including studs, heavy-duty studs, tracks, joists, and sheet materials. The standardized CFS nomenclature used to identify these members is illustrated in Figure 5. For example, the designation 600S200-97 can be interpreted as follows: 600 represents the web depth of the stud in hundredths of an inch, indicating a nominal web depth of 6.00 in. The letter S identifies the member type, where S denotes a stud section, T represents Track, and HDS represents Heavy Duty Stud. The next number, 200, refers to the flange width in hundredths of an inch, indicating a flange width of 2.00 in. The final number, 97, represents the base metal thickness in mils (1 mil = 0.001 in.), corresponding to approximately 0.097 in. thick steel. This naming convention allows engineers and manufacturers to quickly identify the geometry and thickness of a CFS member directly from its designation.

Material certifications (mill certificates) provided by Mnf-1 documented the reported mechanical properties for each CFS member type, including yield strength (f_y), tensile strength (f_u), predicted ultimate load, and percent elongation, as summarized in Table 1. These reported values served as the baseline material properties for comparison with the experimental tensile testing results presented in this study. A limited number of CFS members were iden-

tified as products supplied by Mnf-2 after they had been incorporated into the CFS10 specimen. Consequently, corresponding mill certificate data were unavailable for these members and are therefore excluded from comparisons involving the reported material properties.

Table 1: Mill certificate mechanical properties for CFS members

Material	f_y (ksi)	f_u (ksi)	Ultimate Load (kips)	Elongation (%)
Studs				
600S162-43	50.9	55.2	1.02	27.9
600S162-54	52.5	71.0	1.86	31.0
600S162-68	55.2	72.2	2.47	31.0
600S162-118	63.0	74.0	4.56	24.0
600S200-43	40.2	53.8	1.17	40
600S200-54	60.0	77.0	2.00	27
600S200-68	60.9	78.0	2.72	28
600S200-97	54.3	72.7	3.58	31
600S200-118	–	–	–	–
600S250-54	–	–	–	–
600S250-97	50.0	72.0	3.53	32
600S250-118	55.2	82.1	4.92	27
600S300-68	58.1	75.5	2.56	29
600S350-54	54.3	72.7	1.95	28
600S350-68	58.1	75.5	2.50	29
600S350-97	56.2	76.8	3.90	27
Heavy Duty Studs				
600HDS300-43	44.0	54.0	1.34	35
600HDS300-68	56.4	73.2	2.49	30
600HDS300-97	54.9	72.3	3.50	30
Tracks				
600T150-54	79.7	82.6	2.25	14
600T150-97	53.0	72.0	3.58	31
600T150-118	60.4	73.4	4.47	31
600T300-54	–	–	–	–
1200T150-68	55.0	73.0	2.50	31
Joists				
1200S250-54	55.0	72.0	2.03	31
1200S250-68	58.1	75.5	2.45	29
Sheet Steel				
27 MIL Sheet	-	-	-	-
33 MIL Sheet	44.8	56.0	0.82	38

Note: Red material with blank entries indicate Mnf-2 members for which mill certificate data were unavailable.

2.2 All-Thread Rods

The North-South shear walls of the CFS10 specimen, seen in Figure 6 as lines C, D, and E, utilized an ATR system to resist overturning forces generated during seismic loading. Following completion of the experimental program, representative ATR specimens were removed from the structure for material characterization. The ATR system consisted of ASTM F1554 Grade 36 (A36) and ASTM A193 Grade B7 threaded rods with diameters ranging from 5/8 in. to 2 in. A36 rods were primarily used in the upper levels of the structure where lower tensile demands were expected, while the higher-strength B7 rods were used in the lower levels to resist the larger overturning forces associated with increased lateral loading. Figure 6 presents the plan view of the CFS10 building and identifies the wall line designations used throughout the structure. SW identifies each section of shear wall used in CFS10. For specimen identification, the nomenclature first denotes the floor level followed by the corresponding wall line designation. For example, L10 Line C refers to Wall Line C on Level 10. The geometry of the ATR specimens is illustrated in Figure 7, while Table 2 summarizes the specimen dimensions, ASTM-defined tensile stress areas, and reported material properties.

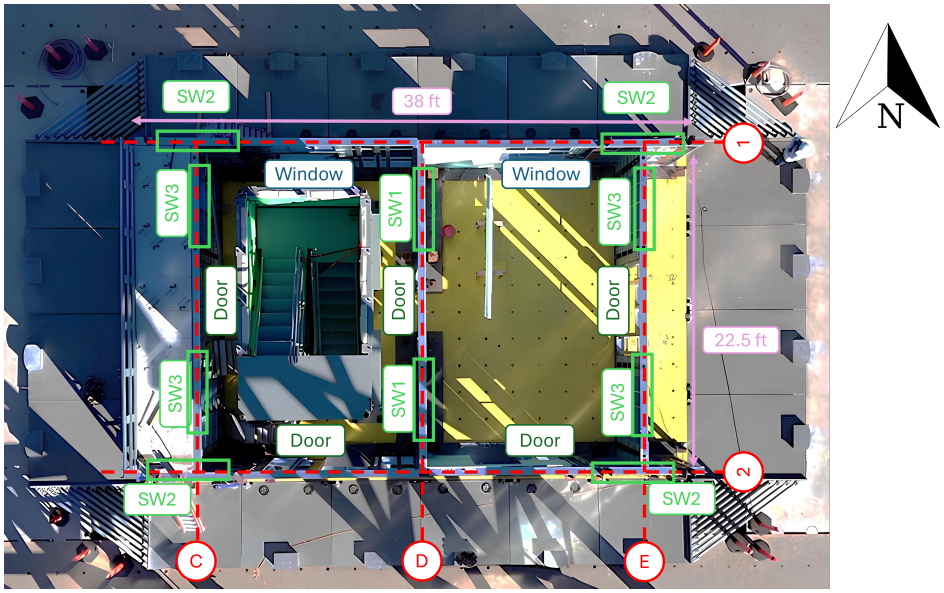


Figure 6: CFS10 plan view

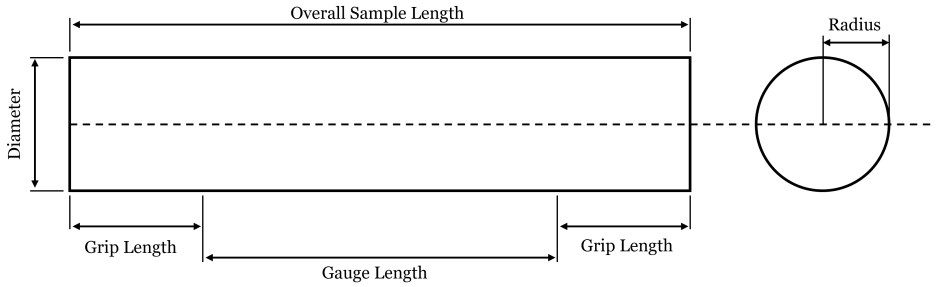


Figure 7: Tie rod layout

Because the ATR samples were threaded, the nominal cross-sectional area does not accurately represent the area that resists tensile forces. Therefore, the tensile stress area (A_s) was determined according to ASTM F1554-20 [6], which specifies the effective tensile stress areas for the Unified Coarse Thread Series (UNC) and 8UN threaded rods. These tabulated values, shown in Table 2, were used in all subsequent stress calculations.

Table 2: Typical tie rod geometry and mill certificate properties

Test ID	Diameter and ASTM Specification	CFS10 Location	ASTM F1554 Stress Area (in^2)	Mill Cert f_y (ksi)	Mill Cert f_u (ksi)	Sample Length (in)	Gauge Length (in)
1	0.625" A36	L10 Line C	0.23	60.4	65.4	12.00	5.50
2	0.75" A36	L9 Line C	0.33	60.9	69.2	12.00	5.50
3	1" A36	L8 Line C	0.61	47.5	64.0	12.00	5.50
4	1" A36	L8 Line C	0.61	47.5	64.0	12.00	5.50
5	1.25" A36	L9 Line D	0.97	47.5	64.0	12.00	5.50
6	1.25" A36	L9 Line D	0.97	47.5	64.0	12.00	5.50
7	1.25" A36	L9 Line D	0.97	47.5	64.0	12.00	5.50
8	1.5" A36	L8 Line D	1.41	60.7	71.0	56.88	36.88
9	1" B7	L7 Line C	0.61	136	149	36.25	16.25
10	1" B7	L7 Line C	0.61	136	149	36.50	16.50
11	1" B7	L7 Line C	0.61	136	149	44.00	24.00
12	1.125" B7	L7 Line E	0.76	126	141	36.00	16.00
13	1.125" B7	L7 Line E	0.76	126	141	36.38	16.38
14	1.125" B7	L7 Line E	0.76	126	141	42.13	22.13
15	1.125" B7	L6 Line C	0.76	126	141	44.50	24.50
16	1.125" B7	L6 Line C	0.76	126	141	36.25	16.25
17	1.125" B7	L6 Line C	0.76	126	141	36.88	16.88
18	1.25" B7	L5 Line C	0.97	123	136	42.75	22.75
19	1.25" B7	L5 Line C	0.97	123	136	36.56	16.56
20	1.25" B7	L5 Line C	0.97	123	136	36.94	16.94
21	1.5" B7	L4 Line C	1.41	124	140	37.06	17.06
22	1.5" B7	L4 Line C	1.41	124	140	37.00	17.00
23	1.75" B7	L1 Line C	1.90	129	145	37.00	17.00
24	1.75" B7	L1 Line C	1.90	129	145	38.50	18.50
25	1.75" B7	L1 Line C	1.90	129	145	44.00	24.00
26	2" B7	L3 Line D	2.50	125	141	36.56	16.56
27	2" B7	L2 Line D	2.50	125	141	37.63	17.63
28	2" B7	L1 Line D	2.50	125	141	42.31	22.31
29	2" B7	L1 Line D	2.50	125	141	30.19	10.19
30	1.75" B7	L2 Line C	1.90	129	145	37.00	17.00

2.3 Hollow Structural Sections (HSS)

The East-West shear walls of the CFS10 test building partially utilized hollow structural square tubular sections as compression posts and shear wall boundary elements due to large

compression demands. As shown in Figure 4, HSS members were used as the end post of shear walls in lines 1 and 2, extending from Level 2 through Level 6 of the structure, with member thickness ranging from 3/16 in. at the upper levels to 1/2 in. at the lower levels to accommodate increasing compression demand. Following completion of the experimental program, one representative coupon specimen was extracted from the HSS material at each level for material characterization. Table 3 shows the representative material properties for each HSS section used. Material was set aside by the provider and used for the testing applications described in this report.

Table 3: Mill certificate mechanical properties for HSS members

Level	Dimensions	f_y (ksi)	f_u (ksi)	Ultimate Load (kip)	Elongation (%)
L6	$6'' \times 6'' \times 3/16''$	65.30	78.70	7.38	34
L5	$6'' \times 6'' \times 1/4''$	65.09	78.96	9.87	35
L4	$6'' \times 6'' \times 5/16''$	67.03	86.93	13.58	35
L3	$6'' \times 6'' \times 3/8''$	63.62	79.50	14.91	36
L2	$6'' \times 6'' \times 1/2''$	69.57	79.87	19.97	36

3 Material Testing

3.1 CFS Testing Procedure

ASTM A370 [7], *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*, describes procedures for the mechanical testing of steels, stainless steels, and related alloys. Among the procedures covered is the tension test (Sections 6–14), in which a specimen is subjected to a measured axial tensile load until failure to determine mechanical properties including yield strength, tensile strength, elongation, and reduction of area. These procedures are directly applicable to the tensile testing of CFS coupon specimens, where coupons are tested under uniaxial tension to evaluate material behavior and mechanical properties.

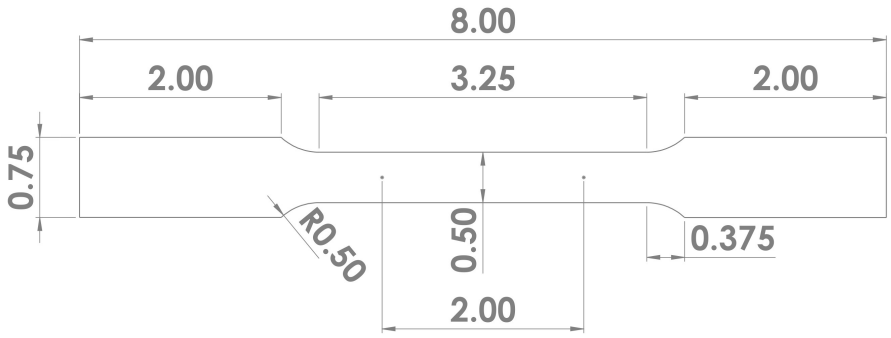


Figure 8: ASTM E8/E8M [8] coupon geometry for CFS specimens (inches)

The geometry of the CFS tensile coupons used in this study followed the subsize sheet-type specimen specified in ASTM E8/E8M-13a [8]. The coupon had an overall length of 8.00 in., consisting of 2.00 in. grip regions at each end and a reduced gauge section at the center. The reduced section had a gauge width of 0.50 in., with smooth transitions into the grip regions formed by 0.50 in. radii. Specimens were fabricated using a MAXIEM Model 0707 abrasive waterjet cutting system. The use of waterjet cutting provided accurate specimen geometry while avoiding heat-affected zones and potential material property alterations associated with thermal cutting processes.

For each CFS member designation, three individual coupon specimens were fabricated and tested, identified as Coupon A, B, and C. Labeling the specimens individually allowed the mechanical properties obtained from each coupon test to be directly compared against the corresponding reported mill certificate values. This testing approach reduced the influence of specimen-to-specimen variability and provided a more representative characterization of the material behavior for each CFS member. The average results obtained from the three coupon tests were subsequently used for comparison with the reported mill certificate properties.



Figure 9: 600HDS300-97 coupon C loading process

The CFS coupon specimens were tested under uniaxial tensile loading using an MTS Criterion Model 43 universal testing machine with a maximum load capacity of 5 kips and equipped with wedge grips, as shown in Figure 9. Preliminary tensile tests evaluated several loading rates to establish a testing protocol that provided stable data acquisition while maintaining a practical test duration. An optimal crosshead displacement rate of 0.18 in./min was reached for the majority of coupon tests, as it produced consistent stress-strain responses. Tensile load was applied continuously until specimen fracture while load and displacement data were recorded throughout the duration of the test. Axial strain was measured using an MTS 634.12F-24 extensometer attached to the center gauge section of each coupon specimen using the pre-marked gauge locations shown in Figure 9. The pre-marked gauge locations ensured that the extensometer was positioned consistently for each specimen, improving the repeatability and comparability of the measured strain data between coupon tests. Extensometer measurements were primarily used for characterization of the elastic response and elastic modulus calculations, while crosshead displacement data were used to evaluate the full stress-strain response through fracture. One exception occurred for specimen 600S250-118 Coupon B, which did not fracture during testing because the applied load reached the maximum capacity of the testing machine prior to specimen failure.

The universal testing machine continuously recorded crosshead displacement, applied load, elapsed time, and extensometer deformation throughout each tensile test. The raw data obtained from the testing machine were adjusted such that strain curves initiated at zero in order to eliminate initial seating effects and measurement offsets prior to loading. Engineering strain was calculated using both the extensometer deformation and crosshead displacement measurements. Crosshead displacement data were converted to engineering strain using the overall coupon gauge length of 8.00 in. according to:

$$\epsilon = \frac{\Delta L}{L_0}$$

where ϵ is the engineering strain, ΔL is the measured displacement, and L_0 is the original gauge length of the coupon specimen. Engineering stress was calculated by dividing the

measured tensile load by the original cross-sectional area of the coupon specimen:

$$\sigma = \frac{P}{A_0}$$

where σ is the engineering stress, P is the applied tensile load, and A_0 is the original cross-sectional area determined from the measured coupon dimensions provided in Appendix A.

The yield strength (f_y) of each coupon specimen was determined using the 0.2% offset method in accordance with ASTM E8/E8M procedures. The ultimate tensile strength (f_u) was defined as the maximum engineering stress reached during the tensile test. The elastic modulus (E) was calculated by performing a linear fit of the stress-strain response within the elastic region using the extensometer strain measurements. The ultimate load capacity of each coupon specimen was determined by multiplying the ultimate tensile strength by the original cross-sectional area, A_0 of the coupon:

$$P_u = f_u A_0$$

where P_u is the ultimate load capacity. Percent elongation was calculated using the total engineering strain at fracture obtained from the complete stress-strain response.

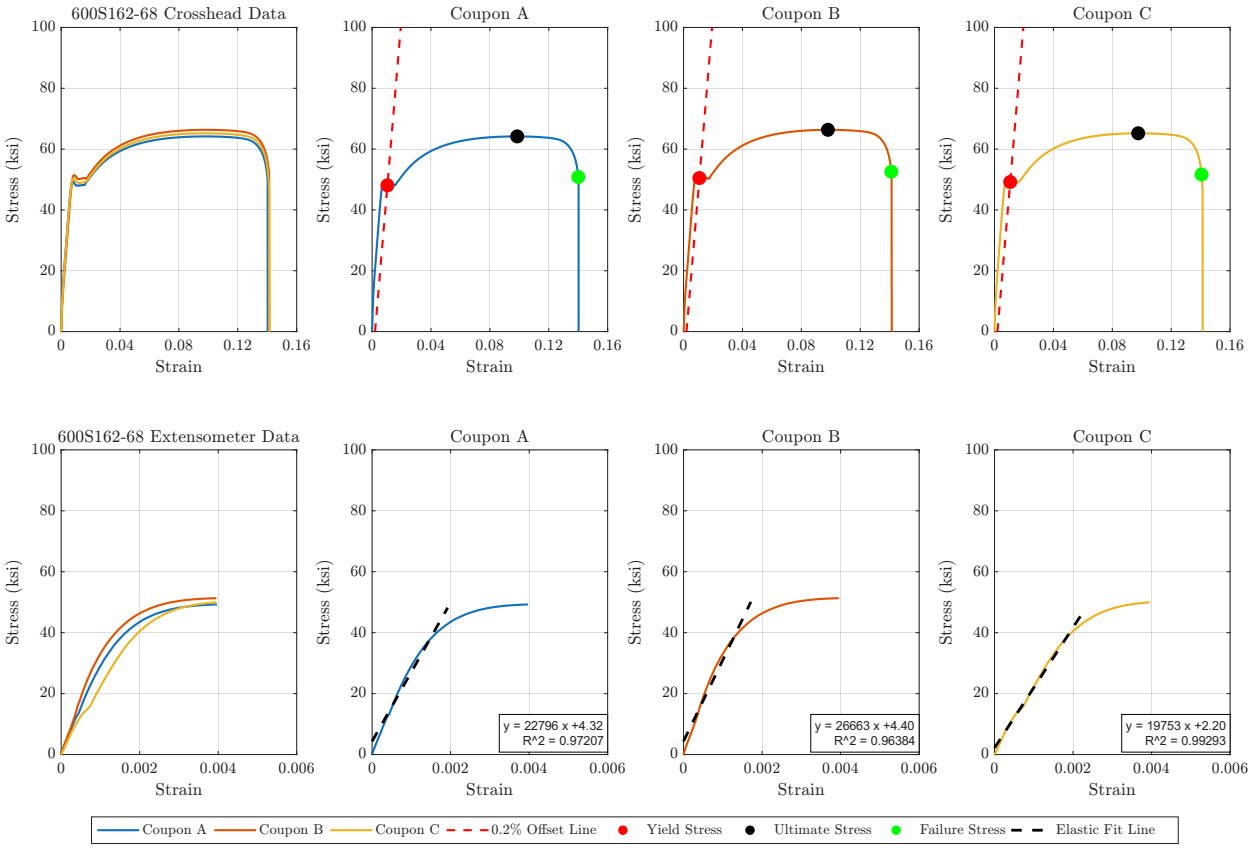


Figure 10: 600S162-68 stress-strain curves

An example of the processed stress-strain results obtained from the tensile testing program is shown in Figure 10. The top row presents the stress-strain response generated from

the crosshead displacement measurements, including the combined response of Coupons A, B, and C, followed by the individual coupon responses with the corresponding 0.2% offset yield stress, ultimate stress, and failure stress identified. The bottom row presents the extensometer-derived stress-strain response used for elastic modulus determination. The dashed black line shown in each individual extensometer plot represents the linear best-fit trendline for the selected elastic region. The displayed equation and corresponding coefficient of determination (R^2) define the best-fit relationship used to calculate the elastic modulus while providing a measure of the goodness of fit.

3.2 CFS Test Data

CFS test data is complied below in Table 4. Reported is the CFS member, separated by coupon, with yield and ultimate strengths, elastic modulus, ultimate load, and elongation tabulated. Appendix B includes the stress-strain plot of the test data for every CFS member tested.

Table 4: Mechanical properties from coupon tensile testing of CFS members

Member	Coupon	f_y (ksi)	f_u (ksi)	Elastic Modulus (ksi)	ultimate load (kips)	Elongation (%)
			Studs			
600S162-43	A	57.49	72.76	31502	1.34	13.30
	B	56.65	71.81	38462	1.33	13.63
	C	55.61	70.47	36052	1.32	14.13
600S162-54	A	61.48	78.36	20102	2.08	8.84
	B	62.40	80.44	27036	2.08	9.85
	C	62.19	79.96	24021	2.10	9.67
600S162-68	A	48.08	64.17	22796	2.21	14.01
	B	50.50	66.34	26663	2.26	14.11
	C	49.20	65.20	19753	2.22	14.06
600S162-118	A	53.68	65.43	23645	4.06	11.69
	B	54.57	66.14	23757	4.07	10.90
	C	53.90	65.45	24388	4.00	11.48
600S200-43	A	35.85	52.11	38917	1.14	13.91
	B	35.81	52.02	33836	1.13	14.63
	C	33.65	49.86	35944	1.08	13.95
600S200-54	A	59.75	79.26	21633	2.09	9.68
	B	58.56	78.72	25336	2.03	10.38
	C	59.07	76.80	19746	1.95	9.95
600S200-68	A	55.87	75.69	18746	2.67	11.87
	B	58.57	78.15	15712	2.72	12.07
	C	59.07	79.05	23658	2.72	12.07
600S200-97	A	52.31	70.80	30688	3.48	12.94

Table 4: Mechanical properties from coupon tensile testing of CFS members (continued)

Member	Coupon	f_y (ksi)	f_u (ksi)	Elastic Modulus (ksi)	ultimate load (kips)	Elongation (%)
	B	49.98	68.91	22751	3.40	12.55
	C	51.14	70.82	23407	3.48	12.24
600S200-118	A	55.01	76.77	34042	4.69	11.94
	B	54.06	76.23	26653	4.65	12.21
	C	53.34	76.23	30415	4.65	12.07
600S250-54	A	48.62	65.79	26145	1.82	12.04
	B	48.38	65.42	33613	1.82	13.06
	C	47.85	65.24	26445	1.80	12.42
600S250-97	A	62.61	80.00	26734	3.72	9.77
	B	60.29	78.28	18527	3.95	10.22
	C	60.52	78.71	19638	3.95	11.08
600S250-118	A	73.11	81.20	34485	4.87	7.81
	B	75.15	82.40	38426	4.95	–
	C	74.74	82.85	32373	4.95	8.55
600S300-68	A	59.39	77.95	52541	2.68	12.24
	B	60.18	78.97	22001	2.68	12.01
	C	61.10	80.89	12710	2.70	12.00
600S350-54	A	54.11	69.19	18083	1.87	13.54
	B	52.35	67.64	21314	1.86	13.40
	C	53.80	68.97	20827	1.78	12.23
600S350-68	A	55.97	71.32	25547	2.36	13.93
	B	54.68	70.08	17223	2.30	14.02
	C	53.04	67.92	22649	2.27	13.96
600S350-97	A	48.56	66.55	14283	3.42	13.46
	B	49.12	67.15	16504	3.39	13.57
	C	50.44	67.72	27463	3.43	14.32
Heavy Duty Studs						
600HDS300-43	A	58.93	76.21	25965	1.92	12.46
	B	60.81	78.39	19717	1.90	12.92
	C	58.48	75.98	29185	1.90	13.71
600HDS300-68	A	86.49	98.25	28652	3.33	6.32
	B	79.06	92.97	27685	3.17	6.60
	C	82.14	95.02	25080	3.24	6.52
600HDS300-97	A	51.87	70.76	22113	3.48	14.71
	B	52.30	70.91	20994	3.45	13.69
	C	50.92	69.92	24554	3.29	13.57
Tracks						

Table 4: Mechanical properties from coupon tensile testing of CFS members (continued)

Member	Coupon	f_y (ksi)	f_u (ksi)	Elastic Modulus (ksi)	ultimate load (kips)	Elongation (%)
600T150-54	A	58.41	71.97	20934	4.37	12.35
	B	56.68	70.59	23908	4.31	12.41
	C	57.91	71.72	23025	4.37	12.12
600T150-97	A	51.30	69.58	26919	3.46	13.57
	B	51.11	69.91	23300	3.45	13.52
	C	50.58	69.26	37833	3.46	13.56
600T150-118	A	51.56	68.47	26828	1.85	11.23
	B	54.43	71.00	31703	1.96	11.77
	C	54.90	71.79	25660	1.95	11.00
600T300-54	A	62.89	79.45	21037	2.08	9.78
	B	58.62	77.27	20903	2.05	10.55
	C	60.39	75.59	22134	2.03	9.75
1200T150-68	A	52.33	68.60	31477	2.37	13.69
	B	52.10	68.91	22911	2.35	13.55
	C	50.06	67.32	21070	2.31	13.90
Joists						
1200S250-54	A	55.37	71.43	21657	1.92	12.43
	B	56.08	72.16	32629	1.94	10.80
	C	55.19	71.11	21615	1.91	11.61
1200S250-68	A	52.15	68.61	35320	2.33	13.00
	B	52.37	69.03	36624	2.35	13.38
	C	50.59	67.06	22102	2.29	13.38
Sheet Materials						
27 MIL Sheet	A	50.84	57.44	39052	0.83	–
	B	51.60	60.42	37316	0.89	14.35
	C	49.25	59.14	38560	0.86	14.38
33 MIL Sheet	A	51.15	60.46	39092	0.92	13.38
	B	49.06	57.93	35063	0.88	14.04
	C	49.94	59.23	34863	0.91	13.71

3.3 All-Thread Rod Testing Procedure

The ASTM F1554 A36 ATR and ASTM A193 B7 threaded rods tested in this study were evaluated using uniaxial tensile testing to determine their residual mechanical properties following the seismic and post-seismic fire testing of the CFS10 structure. Tensile testing was performed in accordance with ASTM F1554 [6], *Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength*, which references ASTM A370 [7], *Standard Test*

Methods and Definitions for Mechanical Testing of Steel Products, for mechanical testing procedures. Accordingly, tension tests followed the applicable ASTM A370 procedures for determining yield strength, tensile strength, elongation, and other tensile properties of steel products. Multiple specimens were tested for each rod diameter to evaluate the repeatability of the measured mechanical properties and assess specimen-to-specimen variability. The Grade 36 specimens used in the testing program, representing the range of rod diameters evaluated, are shown in Figure 11. The specimens consisted of full-size threaded rods both set aside and removed from the tested structure which were tested without machining of the reduced section.



Figure 11: Grade 36 threaded rods for tensile testing

The ASTM F1554 Grade 36 specimens were tested using an MTS 810 Material Test System equipped with threaded rod grips capable of providing axial load transfer while minimizing eccentric loading. The ASTM A193 Grade B7 specimens were tested using a Satec Sytems universal testing machine. For the B7 specimens, the wedge grip configuration was adjusted according to the diameter of each threaded rod to provide consistent gripping conditions and improve the accuracy and repeatability of the tensile tests. Each specimen was secured using 10-in.-long V-shaped wedge grips at both ends of the threaded rod, providing a consistent gripping length and minimizing the potential for slippage during testing. Rep-

resentative testing setups and post-test fracture specimens are shown in Figures 12 and 13. For both testing programs, distinct load rates were used before and after yielding; load and displacement data were recorded throughout the duration of each test. Engineering stress was calculated by dividing the applied tensile load by the nominal cross-sectional area of the rod. Engineering strain was determined from the measured crosshead displacement over the effective gauge length of each specimen. Because each specimen was gripped using 10-in.-long wedge grips at both ends, the effective gauge length was taken as the overall specimen length minus 20 in., representing the unsupported length of the threaded rod between the grips.The yield strength (f_y) was determined using the 0.2% offset method, and the ultimate tensile strength (f_u) was defined as the maximum engineering stress reached during the test. The resulting material properties were compared with the corresponding reported mill certificate values. Note that for the calculation of material properties for all rods, unless noted otherwise, crosshead data was used for all calculations. Due to large force requirements and ensuring displacement of Satec load testing machine, both the 2"and 1-3/4" diameter rods utilized a 634.25E-24 model extensometer with a two-inch gauge length to capture elastic and quasi-elastic behavior.



Figure 12: Grade 36 1-1/2" threaded rod: (left) Test setup and (right) sample fractured bar



Figure 13: Grade B7 1" threaded rod: (left) Test setup with fractured rod, (center) measurement of fractured rod, and (right) fractured sample

3.4 All-Thread Rod Test Data

ATR test data is complied below in Table 5. Reported is the ATR diameter and steel type, with its location within the building, predicted and actual peak axial load, ultimate and yield stress, and elongation. On average, 2-3 samples per type were tested. Appendix C graphs the stress-strain plot of the test data for every ATR tested.

Table 5: All-Thread rod test results

Diameter and ASTM Specification	CFS10 Location	(Mill Cert) Ultimate Load (kips)	(Test) Peak Load (kips)	(Mill Cert) Ultimate Stress (ksi)	(Test) Ultimate Stress (ksi)	Elongation (%)
0.625" A36	L10 Line C	17.88	16.77	65.4	74.20	5.79
0.75" A36	L9 Line C	30.08	26.28	69.2	78.67	10.23
1.0" A36	L8 Line C	49.61	42.74	64	70.53	15.91
1.0" A36	L8 Line C	49.36	42.76	64	70.56	14.77
1.25" A36	L9 Line D	77.54	72.45	64	67.20	18.18
1.25" A36	L9 Line D	76.60	72.28	64	67.12	13.64
1.25" A36	L9 Line D	72.93	75.54	64	67.35	21.59
1.5" A36	L8 Line D	106.70	104.77	60.00	74.57	14.58
1" B7	L7 Line C	90.29	86.51	149.00	142.76	12.31
1" B7	L7 Line C	90.29	86.42	149.00	142.60	10.99
1" B7	L7 Line C	90.29	86.19	149.00	142.22	10.94
1.125" B7	L7 Line E	107.58	107.76	141.00	141.23	14.06
1.125" B7	L7 Line E	107.58	108.72	141.00	142.49	8.40
1.125" B7	L7 Line E	107.58	107.30	141.00	140.62	9.89
1.125" B7	L6 Line C	107.58	110.52	141.00	144.85	9.69
1.125" B7	L6 Line C	107.58	110.68	141.00	145.06	12.31
1.125" B7	L6 Line C	107.58	110.78	141.00	145.20	11.85
1.25" B7	L5 Line C	131.78	129.05	136.00	133.18	12.64
1.25" B7	L5 Line C	131.78	129.28	136.00	133.42	14.72
1.25" B7	L5 Line C	131.78	128.98	136.00	133.11	14.76
1.5" B7	L4 Line C	196.70	190.40	140.00	135.52	15.02
1.5" B7	L4 Line C	196.70	190.06	140.00	135.27	13.97
1.75" B7	L1 Line C	275.50	259.71	145.00	136.69	11.76
1.75" B7	L1 Line C	275.50	266.70	145.00	140.37	13.51
1.75" B7	L1 Line C	275.50	267.66	145.00	140.88	11.46
2" B7	L3 Line D	352.50	343.01	141.00	137.20	14.72
2" B7	L2 Line D	352.50	341.51	141.00	136.60	14.89
2" B7	L1 Line D	352.50	343.15	141.00	137.26	12.05
2" B7	L1 Line D	352.50	343.21	141.00	137.28	25.15
1.75" B7	L2 Line C	275.50	253.1	145.00	133.31	20.59

3.5 HSS Testing Procedure

ASTM A370 [7], *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*, describes procedures for the mechanical testing of steels, stainless steels, and related alloys. Among the procedures covered is the tension test (Sections 6–14), in which a specimen is subjected to a measured axial tensile load until failure to determine mechanical properties including yield strength, tensile strength, elongation, and reduction of area. These procedures are directly applicable to the tensile testing of HSS coupon specimens, where coupons are tested under uniaxial tension to evaluate material behavior and mechanical properties.

The HSS material tested was fabricated in accordance with the manufacturer's mill certifications, which identified the 3/16 in. thickness material as conforming to ASTM A500-21, Grades B and C, and all other thicknesses as conforming to ASTM A500-23, Grades B and C.

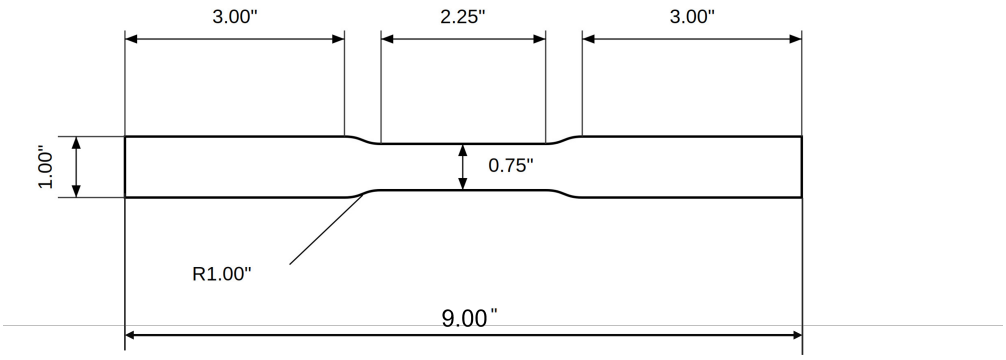


Figure 14: ASTM E8/E8M [8] coupon geometry of HSS specimens (inches)

The geometry of the HSS tensile coupons used in this study followed the subsize sheet-type specimen specified in ASTM E8/E8M-13a [8]. The coupon had an overall length of 9 in., consisting of 3.00 in. grip regions at each end and a reduced gauge section at the center. The reduced section had a gauge width of 0.75 in., with smooth transitions into the grip regions formed by 1.00 in. radii over a transition length of 2.25 in. Specimens were fabricated using a waterjet cutting system by Miramar Waterjet. The use of waterjet cutting provided accurate specimen geometry while avoiding heat-affected zones and potential material property alterations associated with thermal cutting processes. Figure 15 shows how the tensile tests were conducted using an MTS 810 Material Test System equipped with an MTS extensometer - model number 634.25E-24 - which was applied throughout the test until a 5% load drop from the ultimate was experienced.

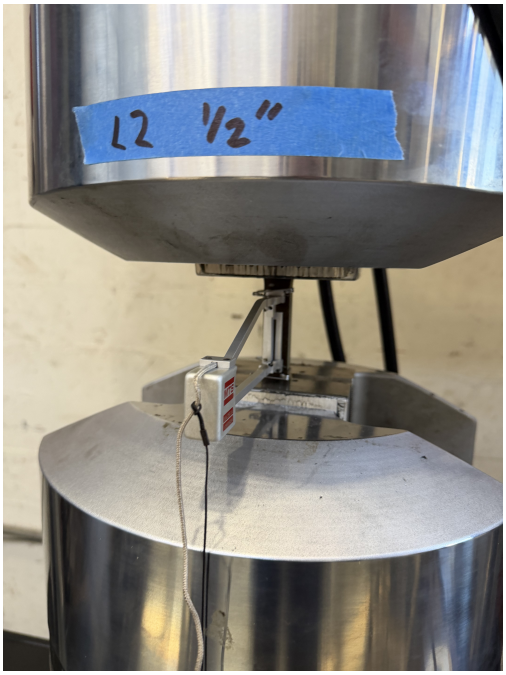


Figure 15: Level 2 1/2" thick HSS tensile test setup

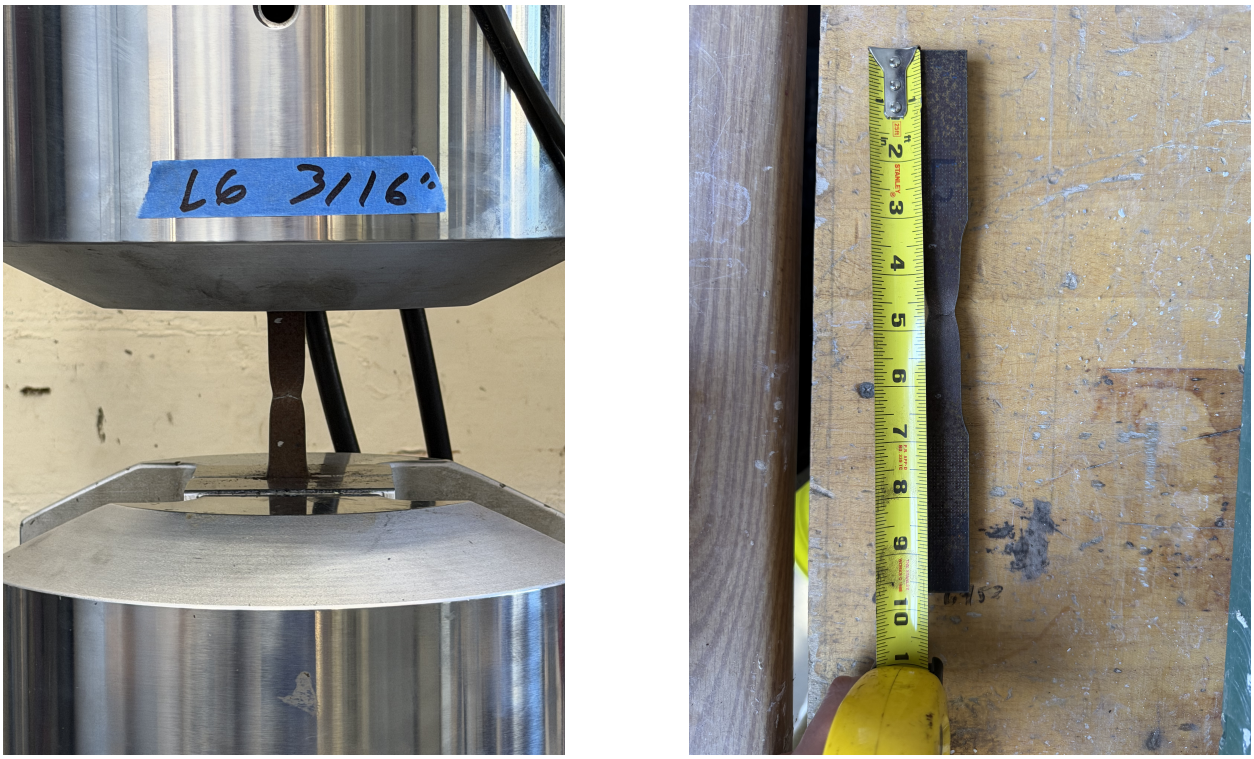


Figure 16: (left) Level 6 3/16" thick HSS specimen after fracture and (right) measured elongation after fracture

3.6 HSS Test Data

HSS test data is complied below in Table 6. Reported is the HSS coupon and thickness, with its cross sectional area, peak load, ultimate stress, yield stress, and stress at fracture. Appendix D plots the experimental values compared with the mill certifications of all HSS members.

Table 6: HSS tensile coupon test results

Coupon ID	Thickness (in.)	Area ($in.^2$)	Peak Load (kips)	Ultimate Stress (ksi)	Yield Stress (ksi)	Stress at Fracture (ksi)
HSS A	1/2	0.38	27.05	72.14	63.81	50.54
HSS B	3/8	0.28	20.98	74.58	67.88	52.31
HSS C	5/16	0.23	18.28	77.98	69.77	57.70
HSS D	1/4	0.19	13.19	70.33	62.50	52.13
HSS E	3/16	0.14	11.20	79.63	70.32	59.31

4 Statistical Analysis

4.1 CFS Statistical Analysis

The statistical analysis presented in this section compares the experimentally determined tensile properties of the post-tested CFS coupon specimens with the corresponding mill certificate values provided by the manufacturer. Mechanical properties evaluated in this comparison include yield strength (F_y), ultimate tensile strength (F_u), Elastic Modulus, ultimate load capacity, and percent elongation.

To quantify the variation between the experimental results and the mill certificate material properties, the percent difference was calculated for each coupon specimen using the following relationship:

$$\% \text{ Difference} = \frac{X_{\text{test}} - X_{\text{cert}}}{X_{\text{cert}}} \times 100 \tag{1}$$

where X_{test} represents the experimentally measured property obtained from tensile testing and X_{cert} represents the corresponding mill certificate value provided by the manufacturer. Positive percent difference values indicate that the experimentally measured property exceeded the mill certificate material property, while negative values indicate a reduction relative to the mill certification value. The calculated percent differences for each coupon specimen are summarized in Table 7.

Table 7: Percent difference between experimental results and mill certificate properties for individual CFS coupon specimens

Member	Coupon	% Diff f_y	% Diff f_u	% Diff Elastic Modulus	% Diff Peak Load
Studs					
600S162-43	A	12.95	46.70	8.63	31.97
	B	11.30	31.81	32.63	30.28
	C	9.25	30.09	24.32	27.54
600S162-54	A	17.10	-2.45	-30.68	10.31
	B	18.86	10.37	-6.77	13.10
	C	18.46	13.30	-17.17	12.86
600S162-68	A	-12.90	-2.40	-21.39	-11.03
	B	-8.51	-11.12	-8.06	-8.25
	C	-10.87	-8.12	-31.89	-9.61
600S162-118	A	-14.79	-8.49	-18.47	-11.63
	B	-13.38	-11.58	-18.08	-10.62
	C	-14.44	-10.62	-15.90	-11.64
600S200-43	A	-10.82	21.26	34.20	-2.78
	B	-10.92	-3.14	16.68	-3.56
	C	-16.29	-3.31	23.94	-7.37

Table 7: Percent difference between experimental results and mill certificate properties for individual CFS coupon specimens (continued)

Member	Coupon	% Diff f_y	% Diff f_u	% Diff Elastic Modulus	% Diff Peak Load
600S200-54	A	-0.42	-3.60	-25.40	2.80
	B	-2.40	2.94	-12.63	1.98
	C	3.40	2.23	-31.91	-0.20
600S200-68	A	-8.26	-1.54	-35.36	-2.88
	B	-3.83	-2.96	-45.82	0.08
	C	-3.00	0.19	-18.42	1.45
600S200-97	A	-0.18	9.99	5.82	1.90
	B	1.80	1.88	-21.55	2.79
	C	0.18	2.74	-19.29	2.10
600S250-97	A	24.42	-9.10	-7.81	10.99
	B	20.58	11.11	-36.11	8.77
	C	21.04	8.72	-32.28	9.35
600S250-118	A	32.45	-12.64	18.91	-1.03
	B	36.14	-1.10	32.50	0.34
	C	35.40	0.37	11.63	0.84
600S300-68	A	2.22	-10.04	81.18	3.42
	B	3.58	3.25	-24.13	4.65
	C	5.16	4.60	-56.17	7.35
600S350-54	A	-11.15	4.11	-37.64	-8.37
	B	-14.04	-8.48	-26.50	-10.34
	C	-11.66	-10.53	-28.18	-8.86
600S350-68	A	-3.67	0.12	-11.91	-5.52
	B	-5.89	-5.54	-40.61	-7.10
	C	-8.71	-7.18	-21.90	-10.02
600S350-97	A	-13.59	-35.08	-50.75	-13.34
	B	-12.60	-13.35	-43.09	-12.67
	C	-10.25	-12.57	-5.30	-11.72
Heavy Duty Studs					
600HDS300-43	A	33.93	28.93	-10.47	41.09
	B	38.20	41.13	-32.01	45.43
	C	32.91	45.17	0.64	40.89
600HDS300-68	A	53.35	-2.86	-1.20	34.34
	B	40.18	34.22	-4.53	26.99
	C	45.64	27.01	-13.52	29.79

Table 7: Percent difference between experimental results and mill certificate properties for individual CFS coupon specimens (continued)

Member	Coupon	% Diff f_y	% Diff f_u	% Diff Elastic Modulus	% Diff Peak Load
600HDS300-97	A	-5.52	-18.20	-23.75	-2.00
	B	-4.74	-2.13	-27.61	-2.03
	C	-7.25	-1.92	-15.33	-3.71
Tracks					
600T150-54	A	-35.31	-4.30	-27.81	-16.96
	B	-31.71	-17.11	-17.56	-14.23
	C	-31.12	-14.04	-20.60	-13.26
600T150-97	A	-3.21	5.88	-7.18	-3.48
	B	-3.57	-3.36	-19.66	-2.77
	C	-4.57	-2.90	30.46	-3.87
600T150-118	A	-3.29	-6.04	-7.49	-1.89
	B	-6.16	-1.95	9.32	-3.76
	C	-4.12	-3.83	-11.52	-2.33
1200T150-68	A	-4.85	-10.68	8.54	-6.18
	B	-5.27	-6.03	-21.00	-5.41
	C	-8.98	-5.60	-27.34	-7.58
Joists					
1200S250-54	A	-4.70	-11.18	-25.32	-5.43
	B	-3.48	-5.39	12.51	-4.35
	C	-5.01	-4.42	-25.47	-5.83
1200S250-68	A	-5.18	-6.50	21.79	-4.82
	B	-4.78	-4.71	26.29	-4.00
	C	-8.02	-4.13	-23.79	-6.92
Sheet Materials					
33 MIL Sheet	A	14.17	69.68	34.80	8.26
	B	9.51	7.96	20.91	3.24
	C	11.47	3.45	20.22	5.90

The percent differences summarized in Table 7 provide a quantitative comparison between the experimentally measured material properties and the corresponding mill certificate values. The percent-difference plots in Figures 17, 18, and 19 further quantify the comparison between the mill certification values and the experimentally measured results for yield strength, ultimate tensile strength, and peak load, respectively. The plots show the percent difference for each coupon relative to the corresponding mill certification value, with positive and negative values indicating whether the experimentally measured property is above or below the mill certification value. This provides a direct measure of the agreement between the experimental results and the mill certification values across the tested structural members.

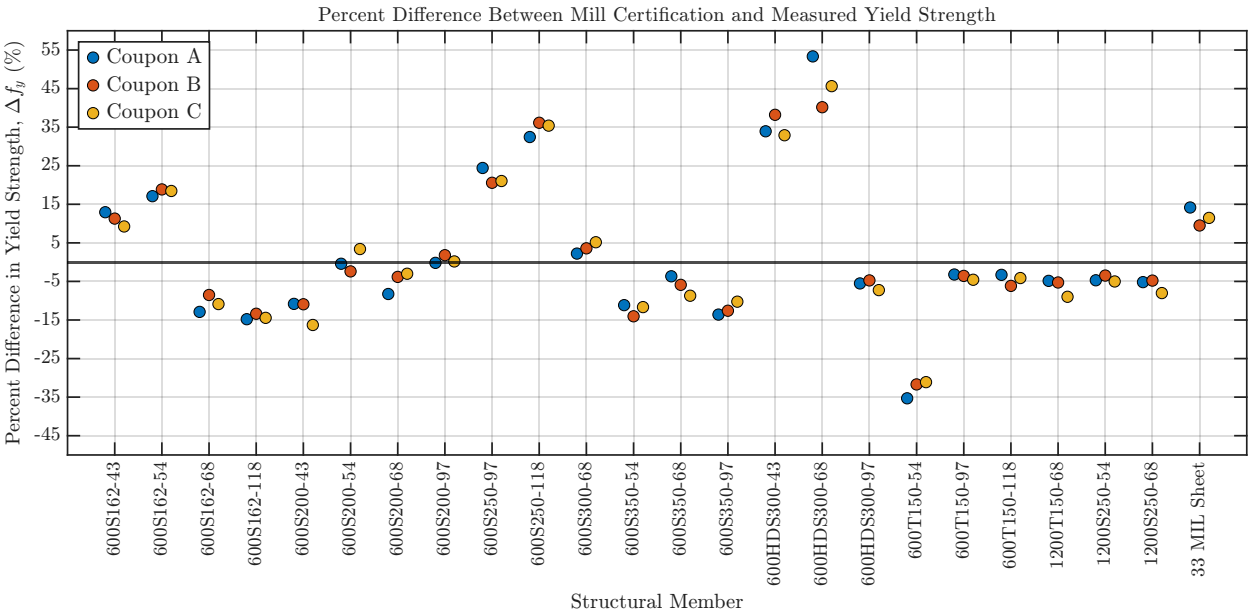


Figure 17: Comparison of the percent difference between mill certification and experimentally measured yield strength (f_y) for CFS coupon specimens

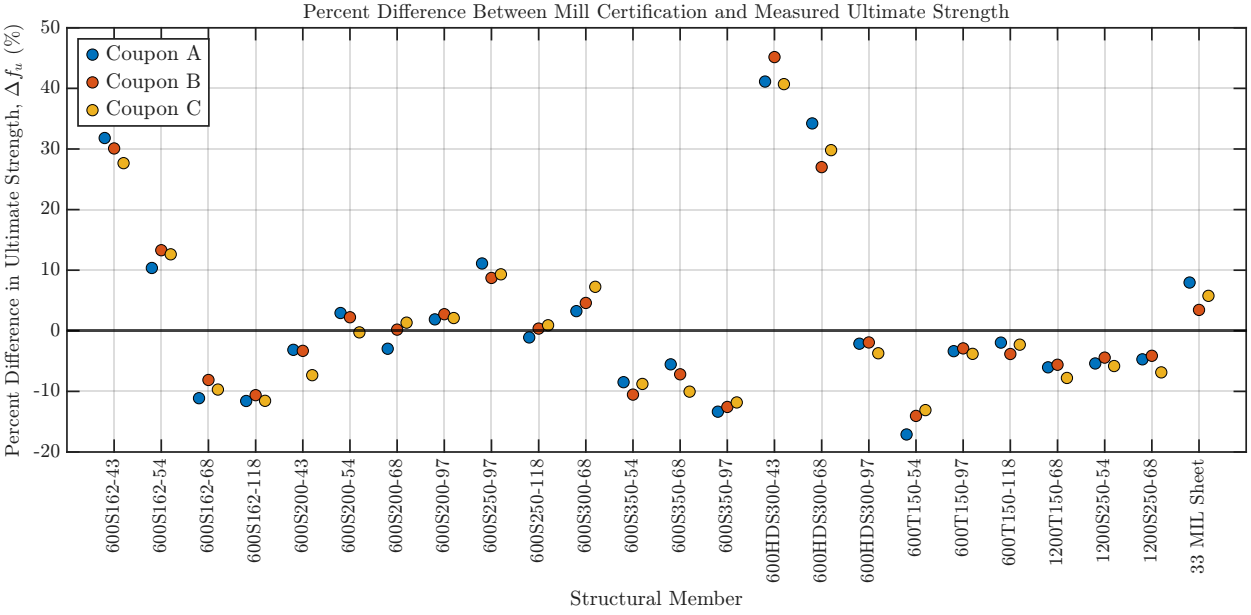


Figure 18: Comparison of the percent difference between mill certification and experimentally measured ultimate tensile strength (f_u) for CFS coupon specimens

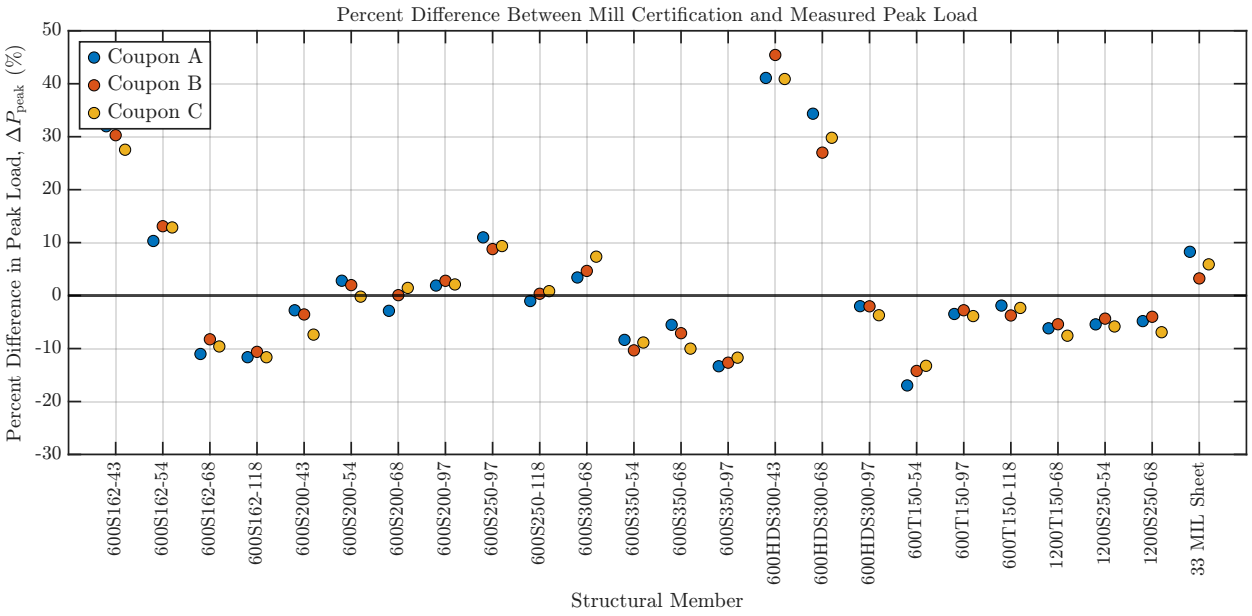


Figure 19: Comparison of the percent difference between mill certification and experimentally measured peak load for CFS coupon specimens.

To further illustrate these relationships, Figures 20, 21, and 22 compare the mill certification and measured values for yield strength, ultimate tensile strength, and ultimate load, respectively. In each figure, the red marker represents the mill certificate value, while the blue, orange, and yellow markers correspond to Coupon A, B, and C from the same structural member. This presentation allows both the variability between coupons and the agreement with the mill certificate material properties to be evaluated visually.

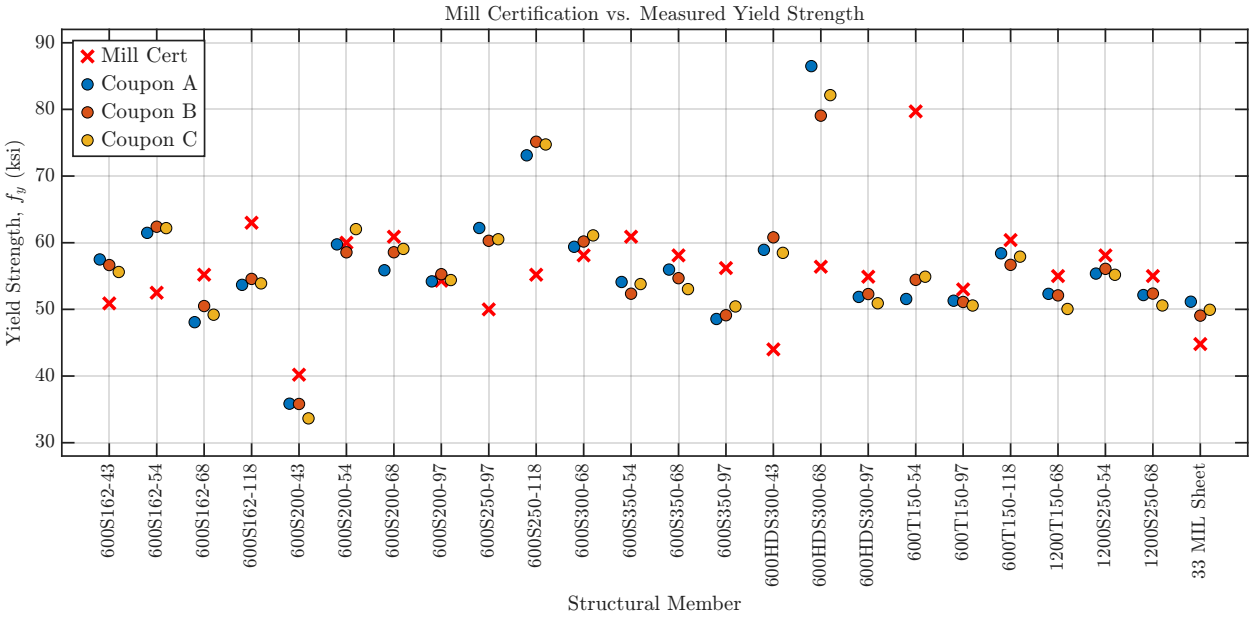


Figure 20: Comparison of mill certification and experimentally measured yield strength (f_y) for CFS coupon specimens

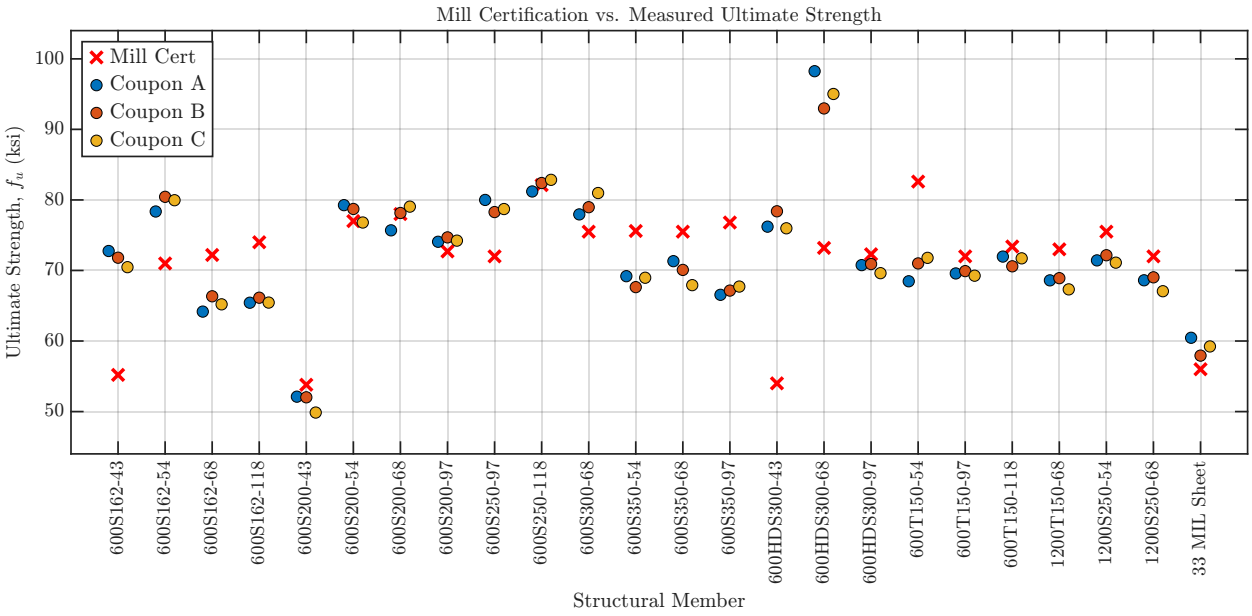


Figure 21: Comparison of mill certification and experimentally measured ultimate tensile strength (f_u) for CFS coupon specimens

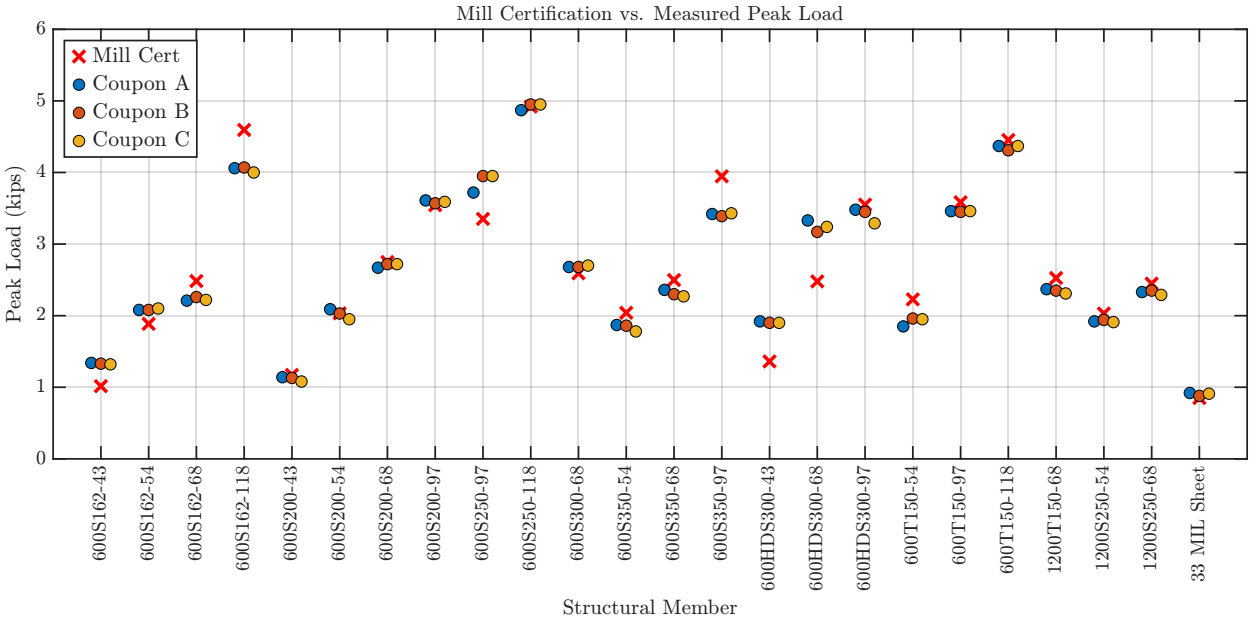


Figure 22: Comparison of mill certification and experimentally measured ultimate load capacities for CFS coupon specimens

4.2 ATR Statistical Analysis

The analysis presented in this section compares the experimentally determined tensile properties of the post-tested ATR (B7 and A36) specimens with the corresponding mill certification provided by the manufacturer. This analysis serves to provide accurate as-built material

properties for numerical models. Mechanical properties evaluated in this comparison include yield strength (F_y), ultimate tensile strength (F_u), and ultimate load capacity. Across the graphs and table, a trend of the A36 tested rods over performing the mill certs emerges , while the higher strength steel (B7) achieves or under-performs the certification values.

Table 8: Percent difference between experimental results and mill certificate properties for ATR specimens

Test ID	CFS10 Location and Diameter	Type	% Diff f_y	% Diff f_u	% Diff Peak Load
1	L10 Line C $\frac{5}{8}$"	A36	+7.98	+12.86	+12.85
2	L9 Line C $\frac{3}{4}$"	A36	+13.97	+13.63	+13.62
3	L8 Line C 1"	A36	−1.01	+10.11	+10.11
4	L8 Line C 1"	A36	+4.06	+10.05	+10.04
5	L9 Line D $1\frac{1}{4}$"	A36	+17.11	−4.14	+6.53
6	L9 Line D $1\frac{1}{4}$"	A36	+14.20	−4.25	+6.39
7	L9 Line D $1\frac{1}{4}$"	A36	+17.66	−3.92	+6.78
8	L8 Line D $1\frac{1}{2}$"	A36	+10.49	+5.01	+5.03
9	L7 Line C 1"	B7	−13.12	−4.28	−4.27
10	L7 Line C 1"	B7	−11.99	−4.32	−4.31
11	L7 Line C 1"	B7	−10.68	−4.55	−4.55
12	L7 Line E $1\frac{1}{8}$"	B7	−3.59	+0.15	+0.15
13	L7 Line E $1\frac{1}{8}$"	B7	−8.57	+1.04	+1.03
14	L7 Line E $1\frac{1}{8}$"	B7	−4.67	−0.28	−0.28
15	L6 Line C $1\frac{1}{8}$"	B7	−4.45	+2.64	+2.64
16	L6 Line C $1\frac{1}{8}$"	B7	−5.37	+2.90	+2.90
17	L6 Line C $1\frac{1}{8}$"	B7	−2.70	+2.83	+2.83
18	L5 Line C $1\frac{1}{4}$"	B7	−12.06	−2.09	−2.09
19	L5 Line C $1\frac{1}{4}$"	B7	−11.25	−1.90	−1.90
20	L5 Line C $1\frac{1}{4}$"	B7	−11.35	−2.14	−2.14
21	L4 Line C $1\frac{1}{2}$"	B7	−5.19	−3.20	−3.20
22	L4 Line C $1\frac{1}{2}$"	B7	−11.85	−3.36	−3.36
23	L1 Line C $1\frac{3}{4}$"	B7	−9.33	−5.70	−5.70
24	L1 Line C $1\frac{3}{4}$"	B7	−7.07	−3.26	−3.26
25	L1 Line C $1\frac{3}{4}$"	B7	−5.49	−2.83	−2.83
26	L3 Line D 2"	B7	−7.47	−2.25	−2.25
27	L2 Line D 2"	B7	−4.82	−3.12	−3.12
28	L1 Line D 2"	B7	−7.36	−2.66	−2.66
29*	L1 Line D 2"	B7	−46.33	−2.68	−2.68
30*	L2 Line C $1\frac{3}{4}$"	B7	−16.09	−8.13	−8.13

* Additional specimen to confirm test mechanical calibration.

Much like in the previous section, Table 8 provides a statistical comparison between the experimentally measured material properties versus the corresponding mill certificate values. To further illustrate these relationships, Figures 23-28 compare the mill certificate and measured values for yield strength, ultimate tensile strength, and ultimate load for both A36 and B7 rod types. In each figure, the red marker represents the mill certificate value, while the blue markers correspond to the experimentally obtained values.

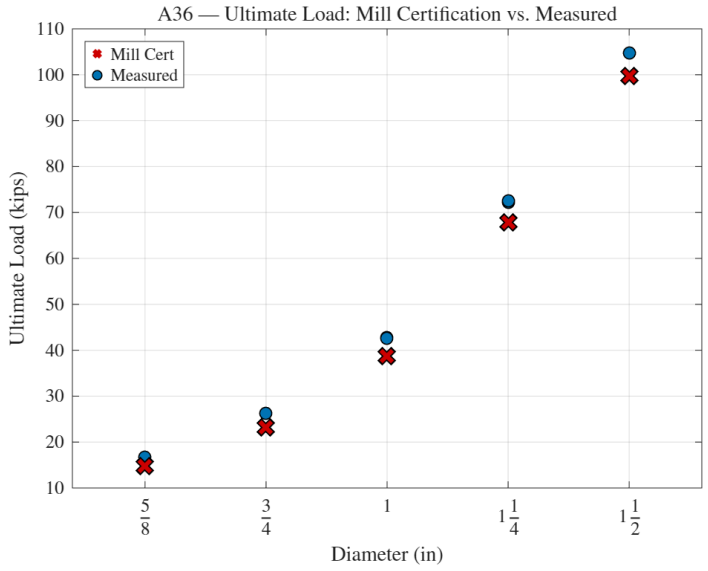


Figure 23: Comparison of mill certification and experimentally measured ultimate load capacities for A36 ATR specimens

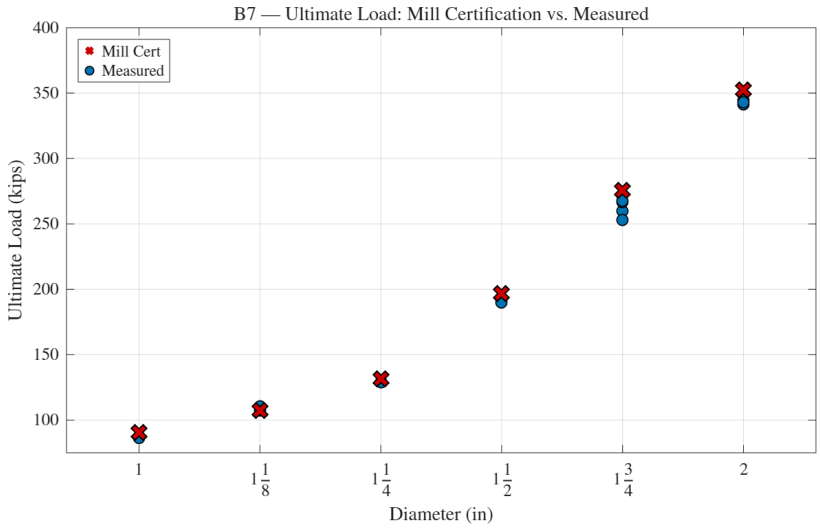


Figure 24: Comparison of mill certification and experimentally measured ultimate load capacities for B7 ATR specimens

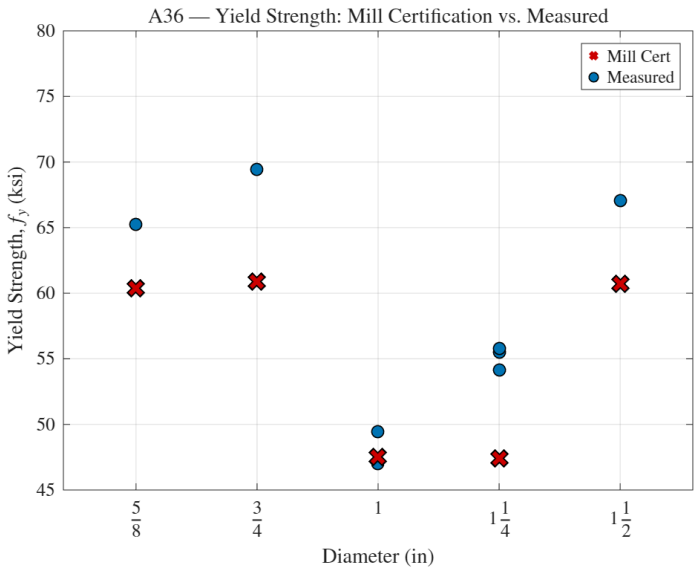


Figure 25: Comparison of mill certification and experimentally measured yield strength for A36 ATR specimens

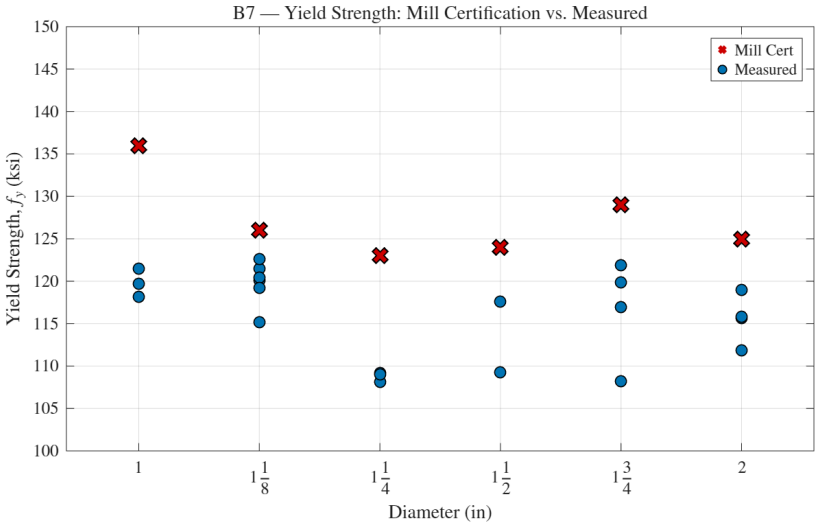


Figure 26: Comparison of mill certification and experimentally measured yield strength for B7 ATR specimens

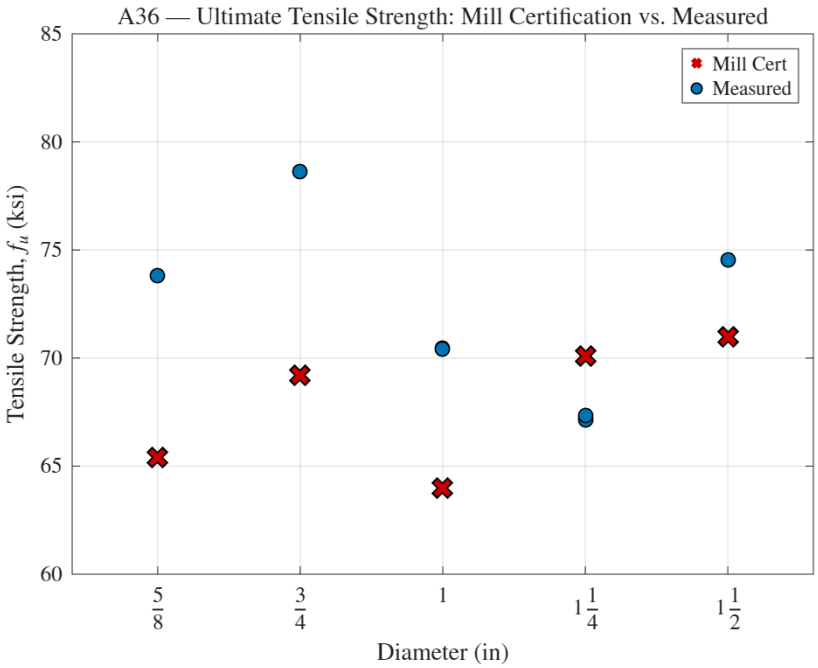


Figure 27: Comparison of mill certification and experimentally measured ultimate strength for A36 ATR specimens

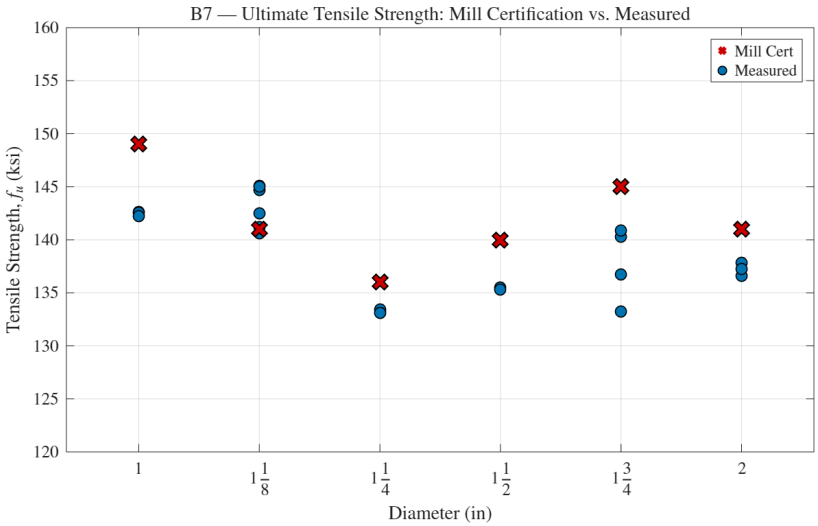


Figure 28: Comparison of mill certification and experimentally measured ultimate strength for B7 ATR specimens

4.3 HSS Statistical Analysis

Similar to the CFS coupon analysis presented above, the statistical analysis in this section compares the experimentally determined tensile properties of the post-tested HSS coupon specimens with the corresponding mill certificate values provided by the manufacturer. Mechanical properties evaluated include yield strength (f_y), ultimate tensile strength (f_u), Elas-

tic Modulus, and ultimate load capacity. Percent differences were calculated using the same relationship defined in Equation 1, where positive values indicate that the experimentally measured property exceeded the mill certificate value, and negative values indicate a reduction relative to that value. The calculated percent differences for each HSS coupon specimen are summarized in Table 9, and Figures 29-31 compare the mill certificate and measured values for yield strength, ultimate tensile strength, and ultimate load, respectively.

Table 9: Percent difference between experimental results and mill certificate properties for individual HSS coupon specimens

Member	Coupon	% Diff f_y	% Diff f_u	% Diff Elastic Modulus	% Diff Peak Load
6" x 6" x 1/2"	A	-8.28	-9.67	-38.87	-2.99
6" x 6" x 3/8"	B	6.69	-6.19	-18.79	-1.86
6" x 6" x 5/16"	C	4.09	-10.30	-8.77	-5.93
6" x 6" x 1/4"	D	-3.98	-10.93	-13.77	-5.87
6" x 6" x 3/16"	E	7.70	1.19	9.58	2.89

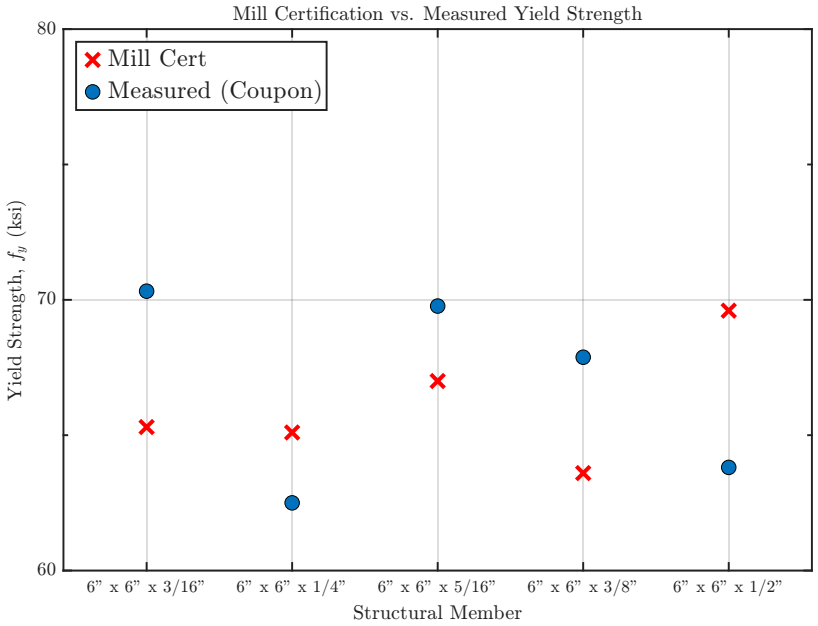


Figure 29: Comparison of mill certification and experimentally measured yield strength (f_y) for HSS coupon specimens (single coupon per thickness)

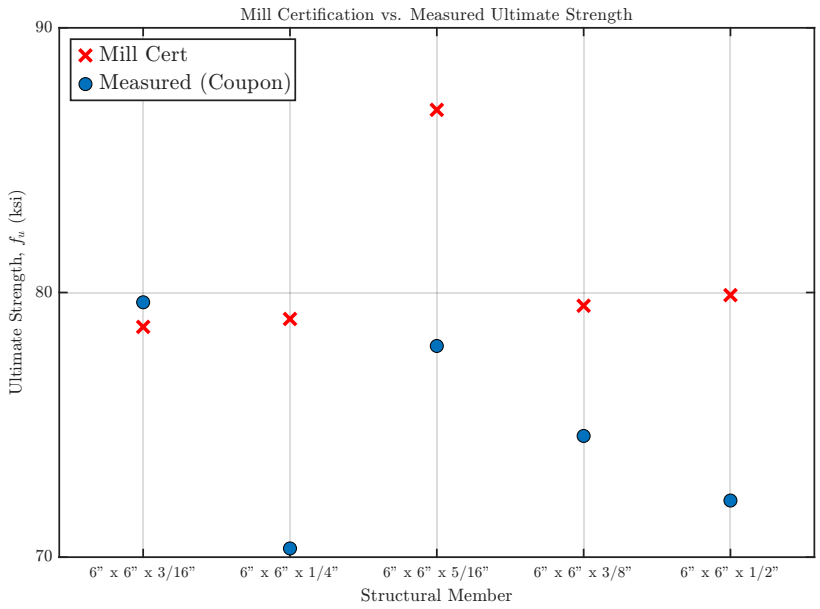


Figure 30: Comparison of mill certification and experimentally measured ultimate tensile strength (f_u) for HSS coupon specimens (single coupon per thickness)

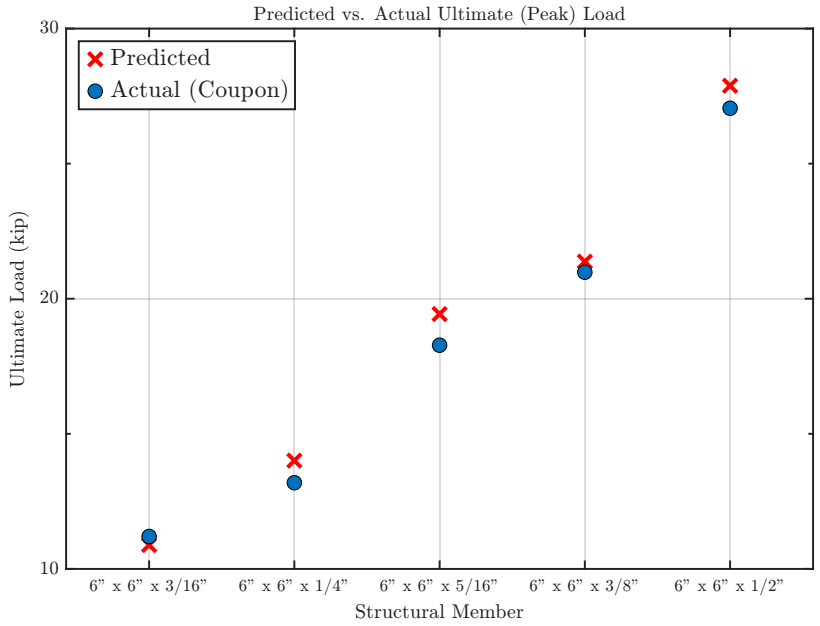


Figure 31: Comparison of predicted and experimentally measured ultimate load capacities for HSS coupon specimens (single coupon per thickness)

5 Concluding Remarks

This report presents the results of a material testing program conducted on three structural component types utilized throughout the CFS10 specimen and compares the experimentally measured mechanical properties against manufacturer certification. A total of 84 CFS and 5 HSS coupons were cut from structural members using a water jet and tested under slow controlled ASTM monotonic tension testing. Similarly, 30 ATR samples were set aside and tested - totaling 119 samples.

For CFS members, the measured yield and the ultimate strengths generally fell within a reasonable distribution of mill certification values, with individual coupons showing deviations exceeding 30 - 50% in both over- and understrength. 600HDS300-43/68 and 600S250-118 showed over-strength, while 600T150-54 showed understrength This variability is attributed to inherent scatter from coupon-to-coupon, rather than a systematic trend.

The ATR results showcased a clearer pattern as the A36 rods consistently tested at or above their mill certification yield and ultimate strengths, with the exception of 1-1/4" diameter specimens which were 4% lower than the mill certification for ultimate tensile strength. Meanwhile, B7 rods generally tested at or slightly below mill certification values.

HSS coupons were in closest overall agreement with certification properties, with percent differences in strength generally within 10%. No discernible trend with member thickness was observed.

Collectively, these results indicate the mechanical properties of the CFS10 structural materials overall remained consistent with their certification values, with no clear material strength degradation any of the three component types. The measured properties documented herein, provide a validated basis for future post-testing numerical modeling efforts using like CFS, HSS, or ATR materials. Raw data, including sample photographs, videos, and raw mechanical test data is archived in the DesignSafe Data Depot.

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Appendix A: CFS Coupon Geometry

Appendix A provides the measured geometric properties used to calculate the cross-sectional area of each cold-formed steel coupon specimen tested in this study. As shown in Table 10 for each coupon specimen, the thickness and gauge width were measured at the center of the reduced gauge section prior to testing. The measured dimensions were then used to determine the original cross-sectional area of each coupon specimen, which was subsequently used in the calculation of engineering stress and predicted peak load capacity. Coupons 5, 12, 15, and 20 were excluded from the analysis because they represented duplicate members and were therefore not included in tensile testing.

Table 10: CFS coupon geometry and area properties

Member Name	Coupon Name	Actual Thickness (in)	Actual Gauge Width (in)	Cross Sectional Area (in^2)
600S250-54	1A	0.0551	0.5020	0.02766
600S250-54	1B	0.0556	0.5015	0.02788
600S250-54	1C	0.0550	0.5015	0.02758
600S200-43	2A	0.0432	0.5045	0.02179
600S200-43	2B	0.0433	0.5030	0.02178
600S200-43	2C	0.0433	0.5005	0.02167
600S350-97	3A	0.0993	0.5175	0.05139
600S350-97	3B	0.0993	0.5090	0.05054
600S350-97	3C	0.0992	0.5100	0.05059
600S162-118	4A	0.1221	0.5085	0.06209
600S162-118	4B	0.1209	0.5090	0.06154
600S162-118	4C	0.1209	0.5060	0.06118
600S250-97	6A	0.0980	0.4750	0.04655
600S250-97	6B	0.0987	0.5110	0.05044
600S250-97	6C	0.0978	0.5130	0.05017
600S350-54	7A	0.0534	0.5055	0.02699
600S350-54	7B	0.0545	0.5035	0.02744
600S350-54	7C	0.0531	0.4865	0.02583
600T150-118	8A	0.1191	0.5095	0.06068
600T150-118	8B	0.1201	0.5080	0.06101
600T150-118	8C	0.1200	0.5080	0.06096
600S250-118	9A	0.1181	0.5075	0.05994
600S250-118	9B	0.1184	0.5075	0.06009
600S250-118	9C	0.1184	0.5050	0.05979
600S200-118	10A	0.1201	0.5085	0.06107
600S200-118	10B	0.1202	0.5075	0.06100

Table 10: CFS coupon geometry and area properties (continued)

Member Name	Coupon Name	Measured Thickness (in)	Measured Gauge Width (in)	Cross Sectional Area (in^2)
600S200-118	10C	0.1200	0.5080	0.06096
600T150-97	11A	0.0981	0.5075	0.04979
600T150-97	11B	0.0973	0.5065	0.04928
600T150-97	11C	0.0986	0.5070	0.04999
600S162-54	13A	0.0528	0.5030	0.02656
600S162-54	13B	0.0516	0.5020	0.02590
600S162-54	13C	0.0521	0.5030	0.02621
600S200-97	14A	0.0965	0.5050	0.04873
600S200-97	14B	0.0946	0.5050	0.04777
600S200-97	14C	0.0953	0.5075	0.04836
600S200-54	16A	0.0527	0.5010	0.02640
600S200-54	16B	0.0515	0.5020	0.02585
600S200-54	16C	0.0506	0.5015	0.02538
600S200-68	17A	0.0700	0.5035	0.03524
600S200-68	17B	0.0690	0.5050	0.03485
600S200-68	17C	0.0680	0.5055	0.03437
600T150-54	18A	0.0540	0.4995	0.02697
600T150-54	18B	0.0550	0.5030	0.02766
600T150-54	18C	0.0540	0.5040	0.02722
600T300-54	19A	0.0517	0.5060	0.02616
600T300-54	19B	0.0526	0.5045	0.02654
600T300-54	19C	0.0530	0.5075	0.02690
600S350-68	21A	0.0650	0.5090	0.03309
600S350-68	21B	0.0650	0.5045	0.03279
600S350-68	21C	0.0661	0.5055	0.03341
600S300-68	22A	0.0677	0.5070	0.03432
600S300-68	22B	0.0669	0.5070	0.03392
600S300-68	22C	0.0661	0.5040	0.03331
600S162-43	23A	0.0369	0.4985	0.01839
600S162-43	23B	0.0371	0.4985	0.01849
600S162-43	23C	0.0375	0.5000	0.01875
600S162-68	24A	0.0686	0.5015	0.03440
600S162-68	24B	0.0681	0.5010	0.03412
600S162-68	24C	0.0681	0.4995	0.03402
1200T150-68	25A	0.0690	0.5015	0.03460
1200T150-68	25B	0.0680	0.5005	0.03403

Table 10: CFS coupon geometry and area properties (continued)

Member Name	Coupon Name	Measured Thickness (in)	Measured Gauge Width (in)	Cross Sectional Area (in^2)
1200T150-68	25C	0.0680	0.5035	0.03424
1200S250-68	26A	0.0680	0.5000	0.03400
1200S250-68	26B	0.0680	0.5000	0.03400
1200S250-68	26C	0.0680	0.5025	0.03417
1200S250-54	27A	0.0540	0.4980	0.02689
1200S250-54	27B	0.0540	0.4975	0.02686
1200S250-54	27C	0.0540	0.4975	0.02686
600HDS300-68	28A	0.0680	0.4980	0.03386
600HDS300-68	28B	0.0680	0.5015	0.03410
600HDS300-68	28C	0.0680	0.5015	0.03410
33 MIL Sheet	29A	0.0310	0.4895	0.01517
33 MIL Sheet	29B	0.0310	0.4910	0.01522
33 MIL Sheet	29C	0.0310	0.4950	0.01534
27 MIL Sheet	30A	0.0291	0.4945	0.01439
27 MIL Sheet	30B	0.0297	0.4955	0.01472
27 MIL Sheet	30C	0.0294	0.4960	0.01458
600HDS300-97	31A	0.0964	0.5095	0.04912
600HDS300-97	31B	0.0955	0.5100	0.04871
600HDS300-97	31C	0.0923	0.5120	0.04726
600HDS300-43	32A	0.0501	0.5030	0.02520
600HDS300-43	32B	0.0481	0.5030	0.02419
600HDS300-43	32C	0.0496	0.5035	0.02497

Appendix B: CFS stress-strain plots

Appendix B provides the stress-strain plot for each CFS member tested. Each plot identifies the yield stress, ultimate stress, and failure stress. The upper plots use data from the machine crosshead while the lower plots use the extensometer data.

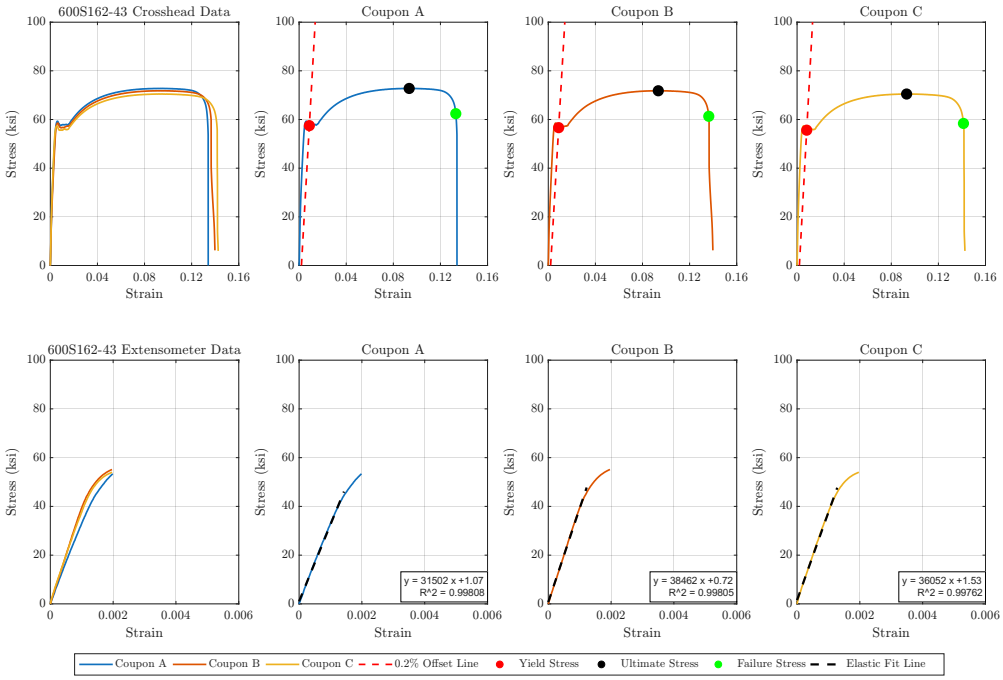


Figure 32: 600S162-43 stress-strain plot

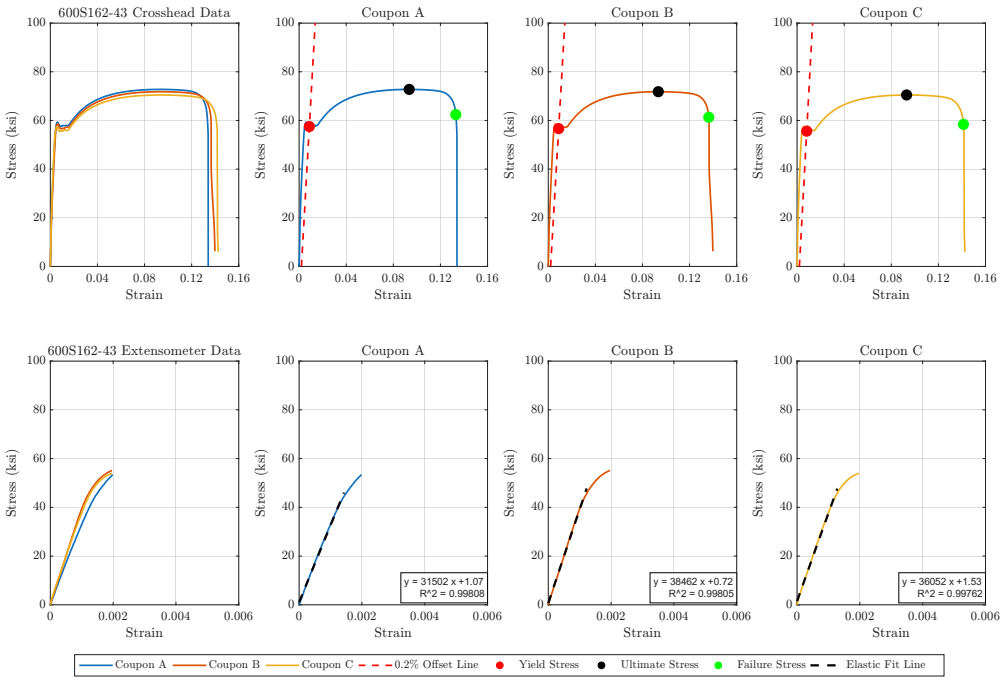


Figure 33: 600S162-43 stress-strain plot

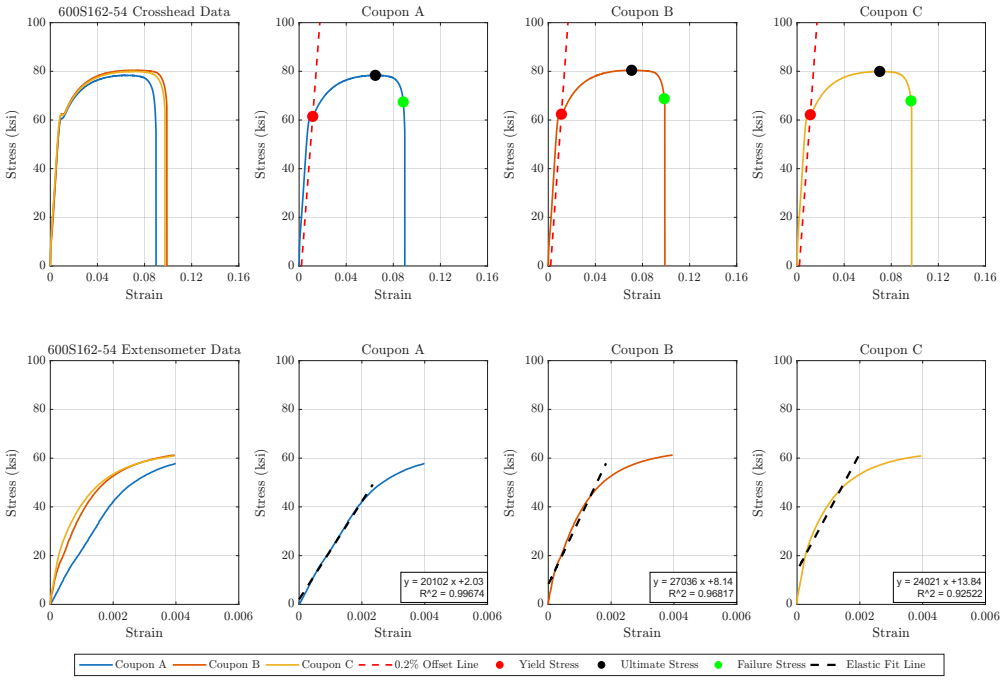


Figure 34: 600S162-54 stress-strain plot

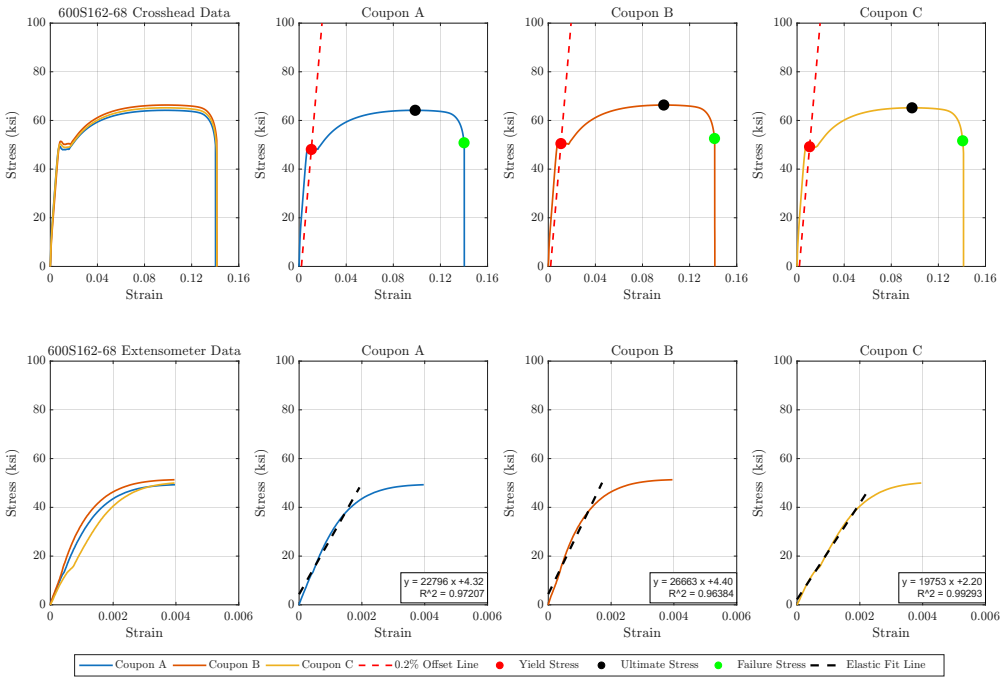


Figure 35: 600S162-68 stress-strain plot

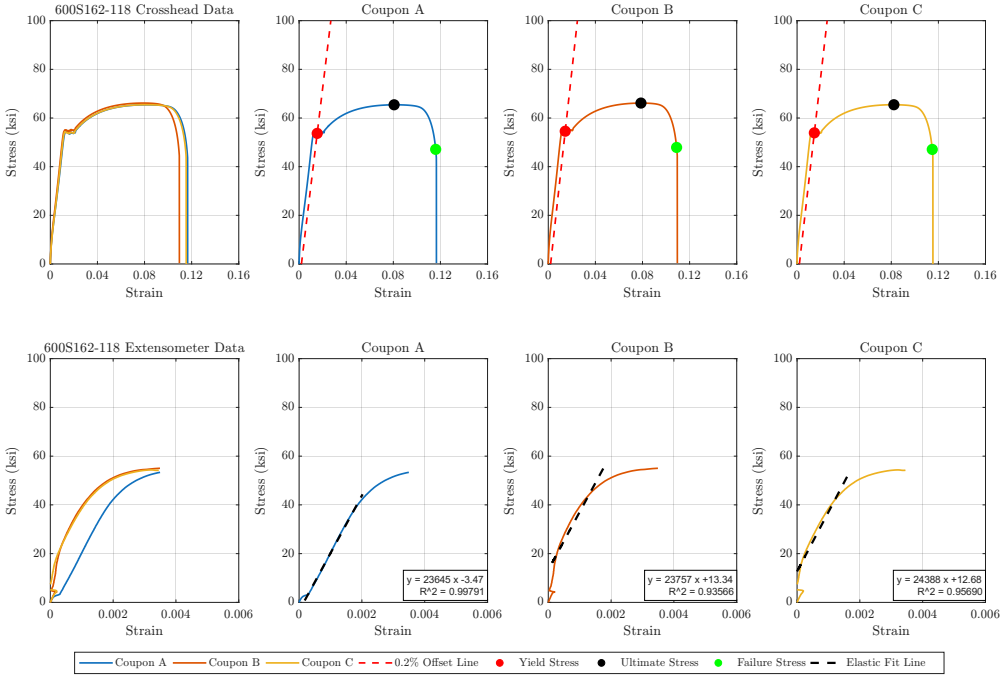


Figure 36: 600S162-118 stress-strain plot

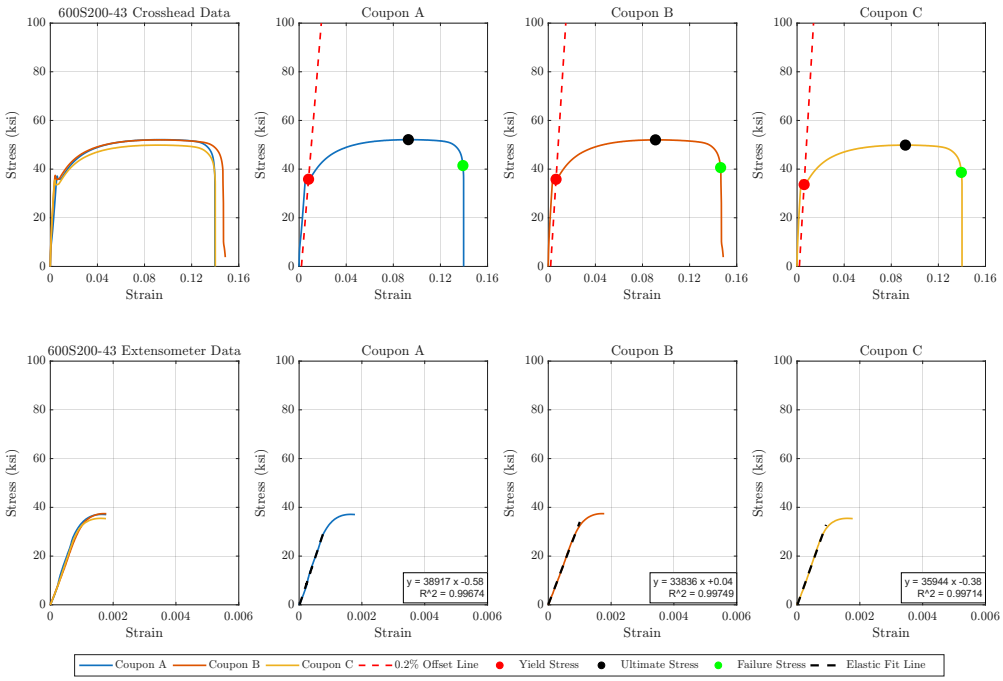


Figure 37: 600S200-43 stress-strain plot

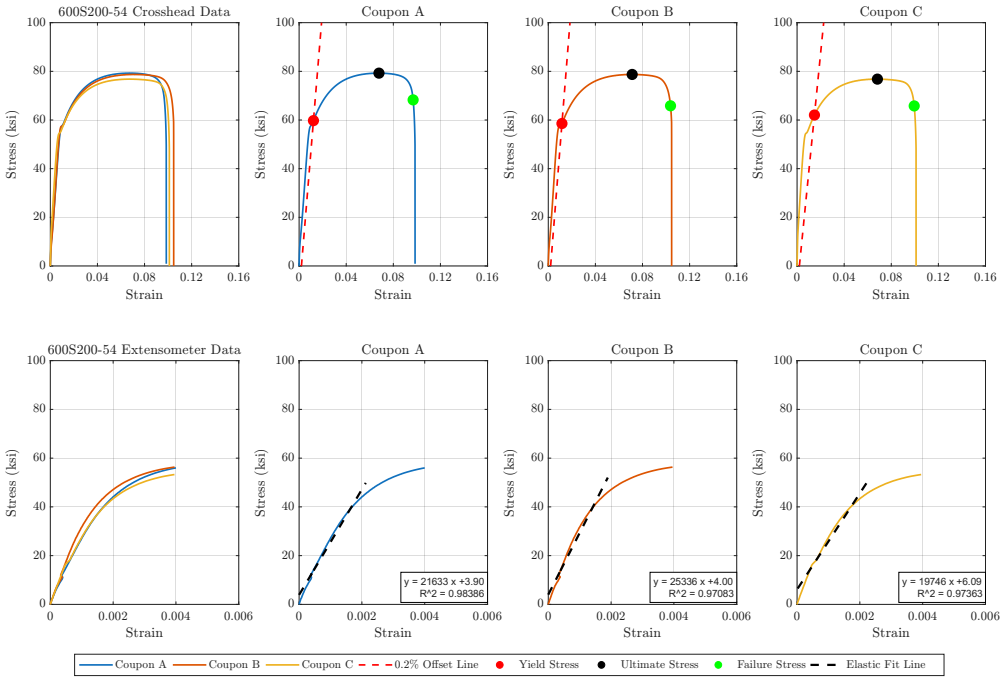


Figure 38: 600S200-54 stress-strain plot

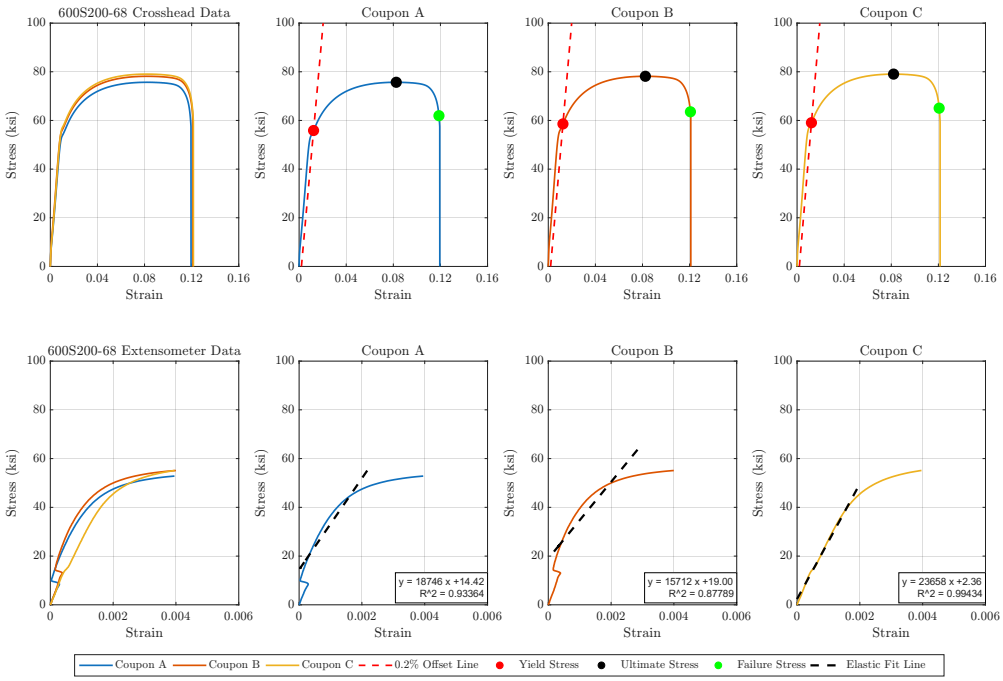


Figure 39: 600S200-68 stress-strain plot

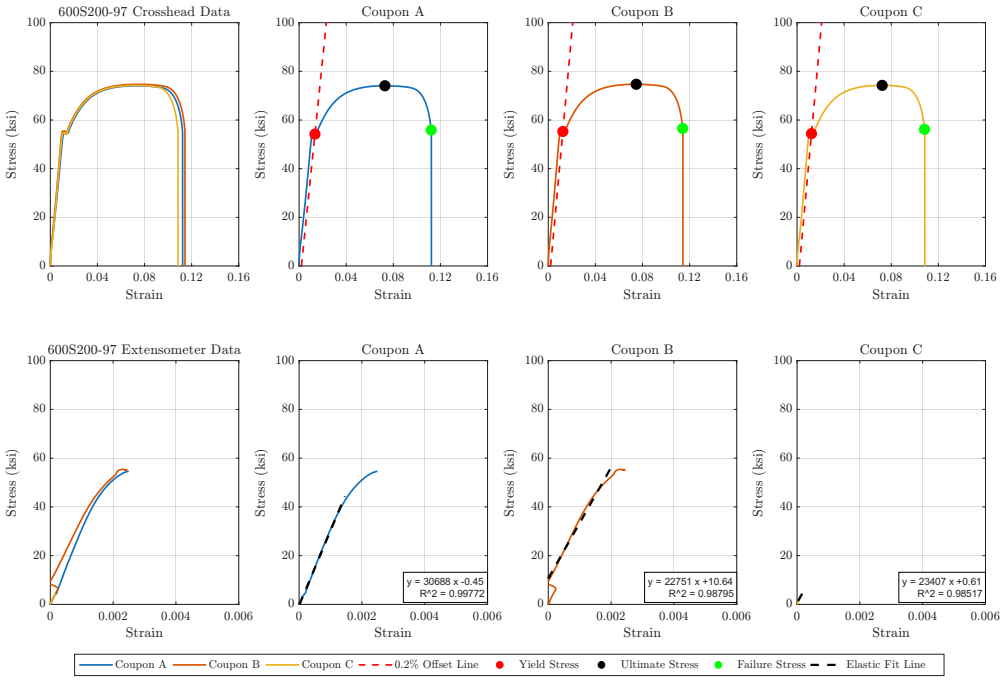


Figure 40: 600S200-97 stress-strain plot

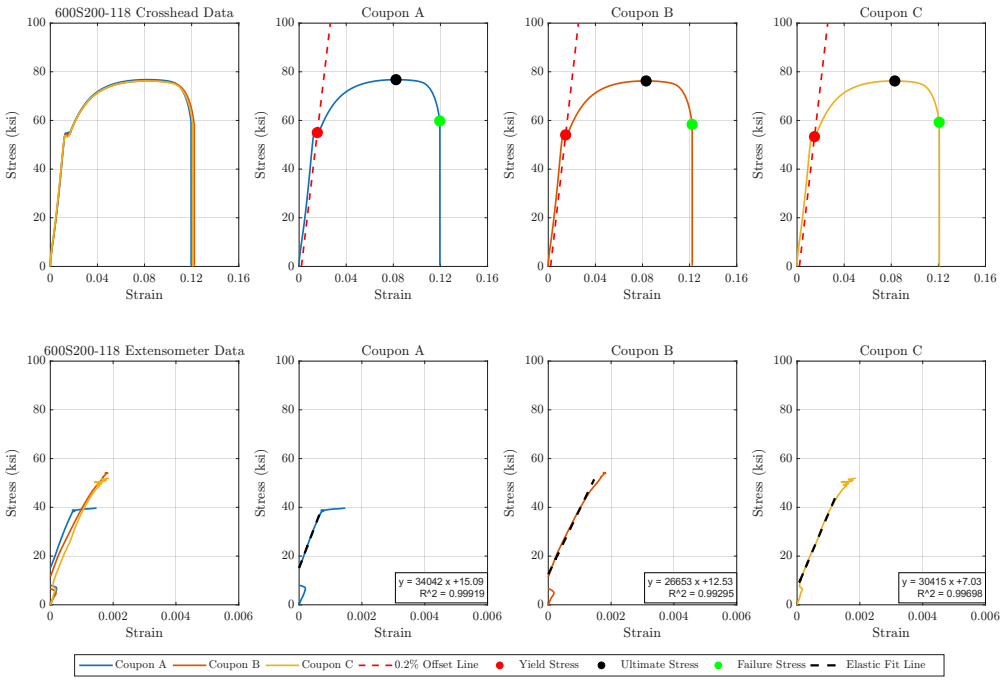


Figure 41: 600S200-118 stress-strain plot

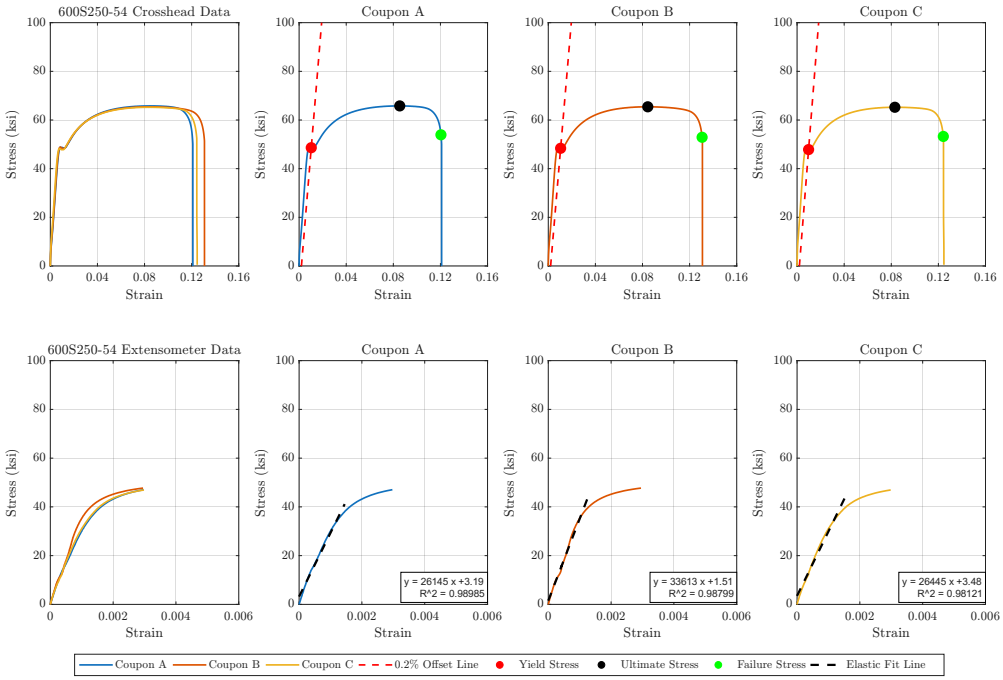


Figure 42: 600S250-54 stress-strain plot

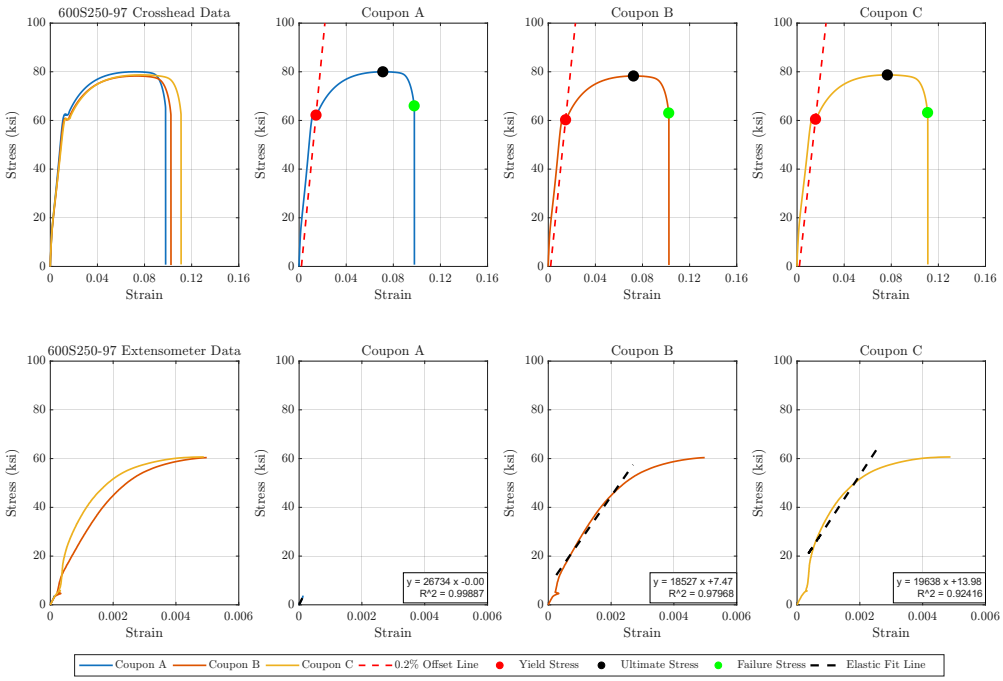


Figure 43: 600S250-97 stress-strain plot

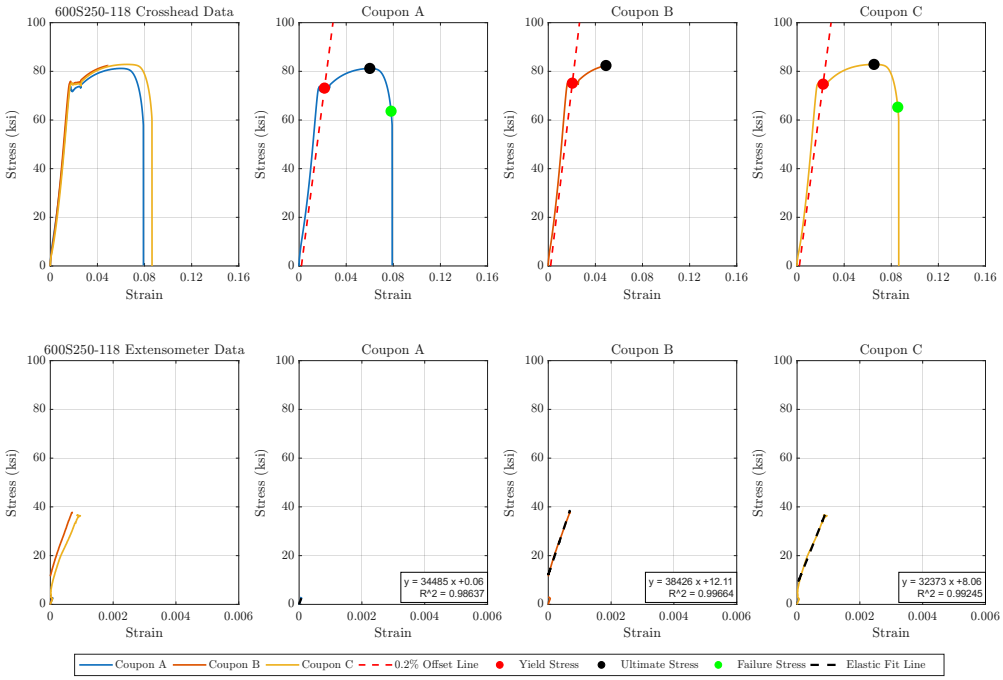


Figure 44: 600S250-118 stress-strain plot

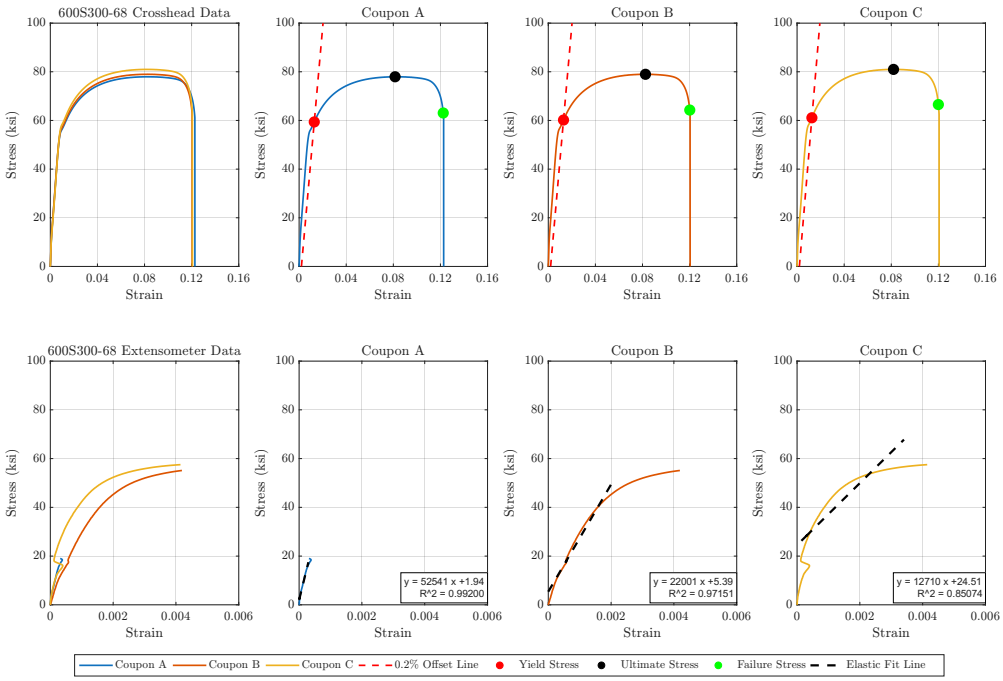


Figure 45: 600S300-68 stress-strain plot

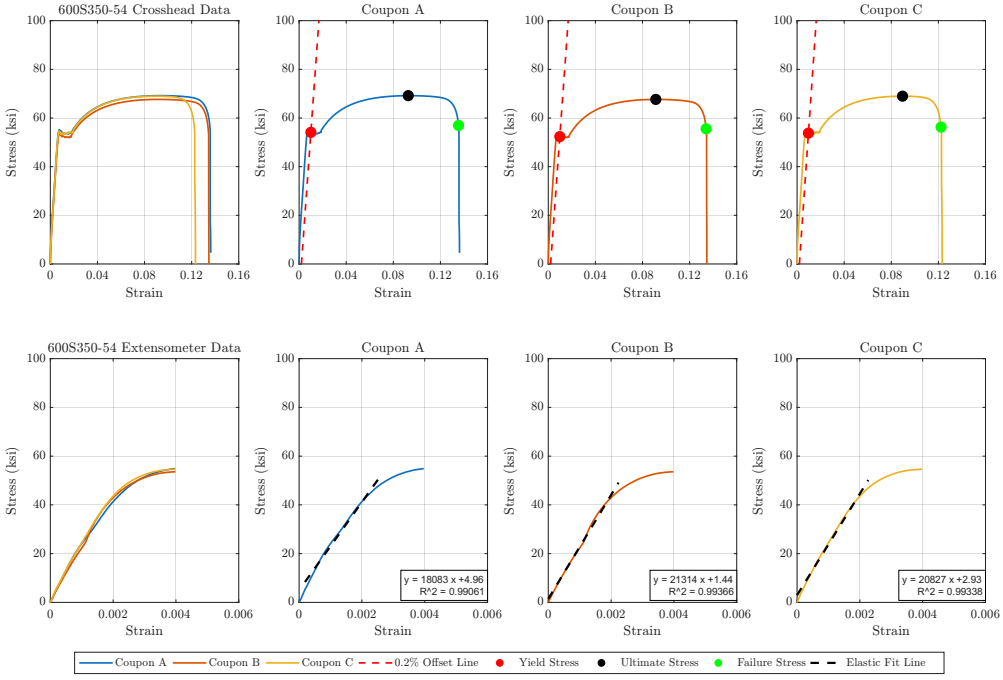


Figure 46: 600S350-54 stress-strain plot

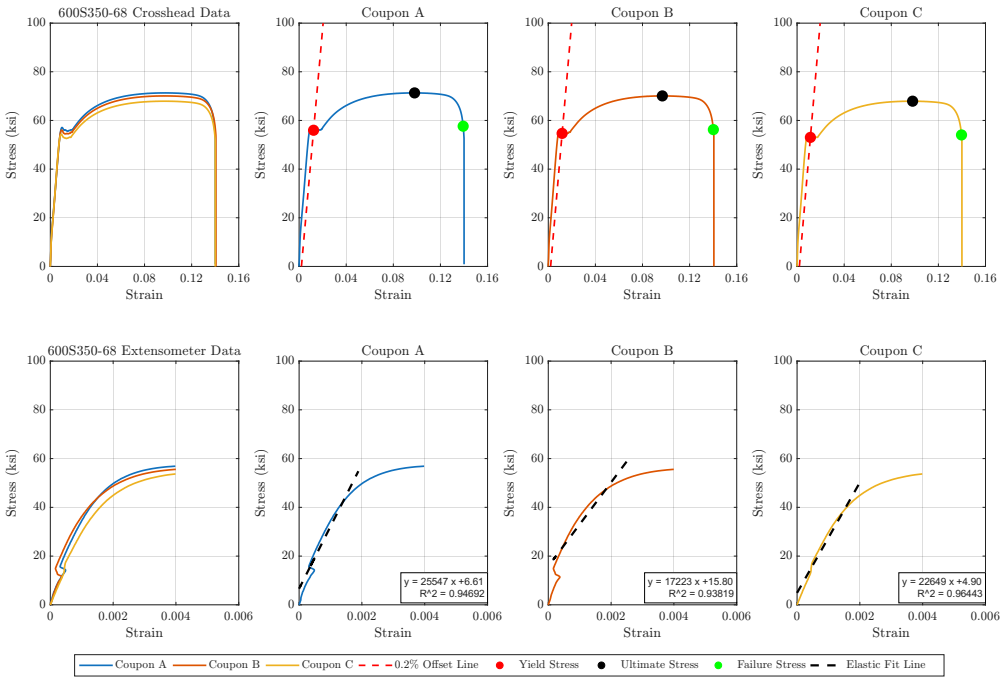


Figure 47: 600S350-68 stress-strain plot

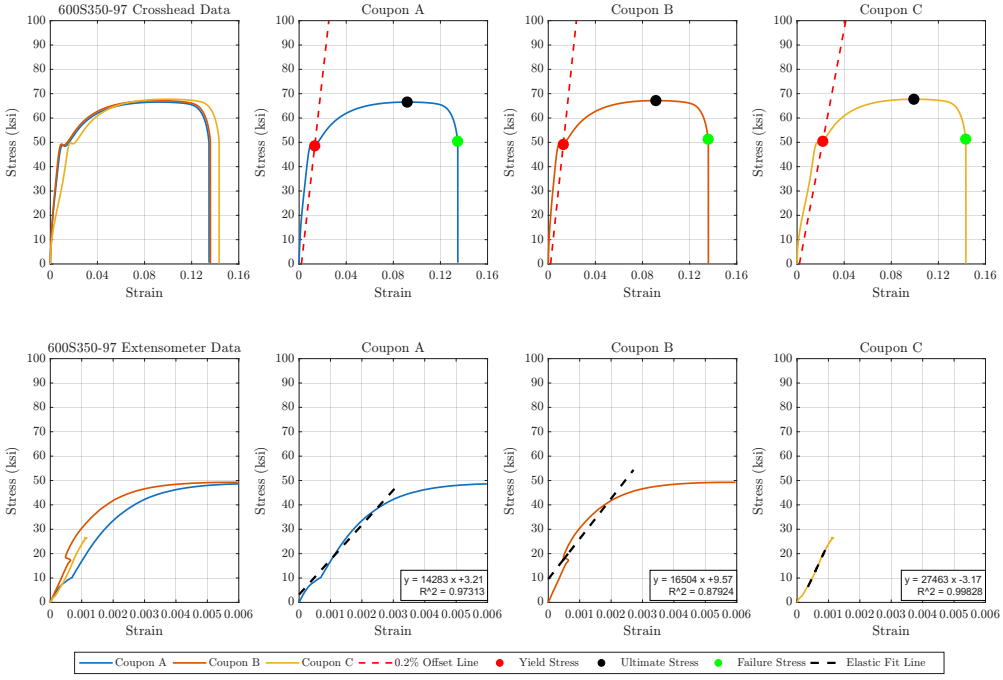


Figure 48: 600S350-97 stress-strain plot

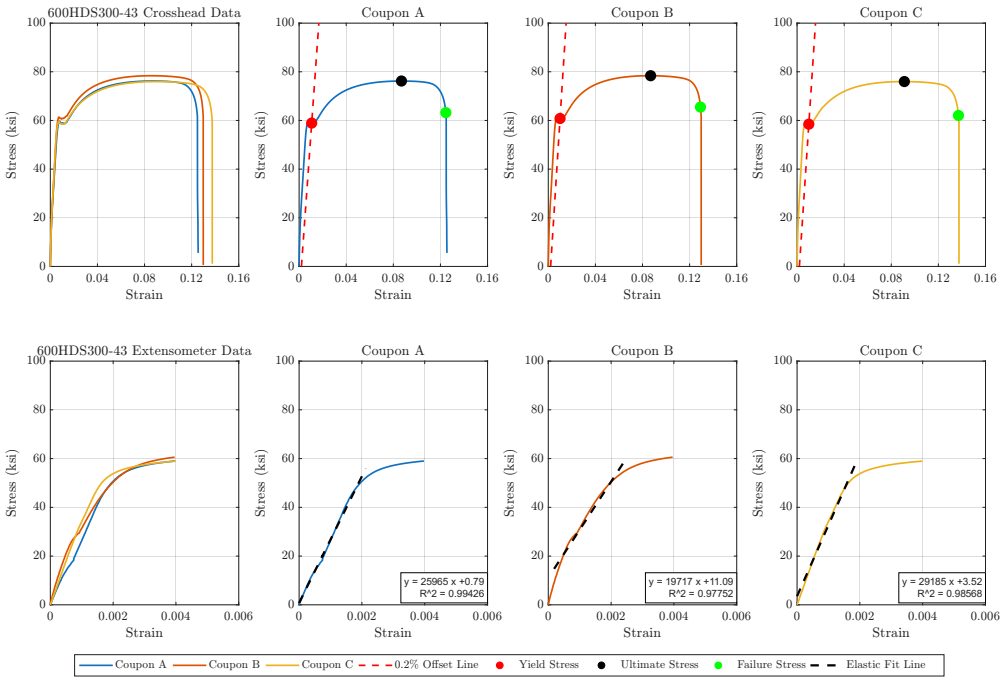


Figure 49: 600HDS300-43 stress-strain plot

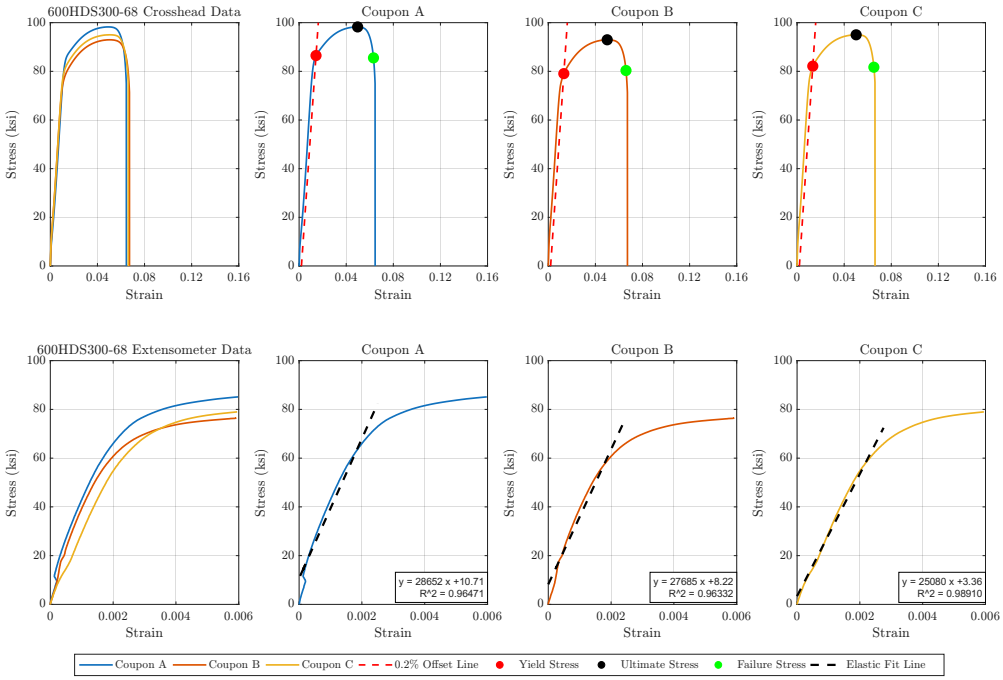


Figure 50: 600HDS300-68 stress-strain plot

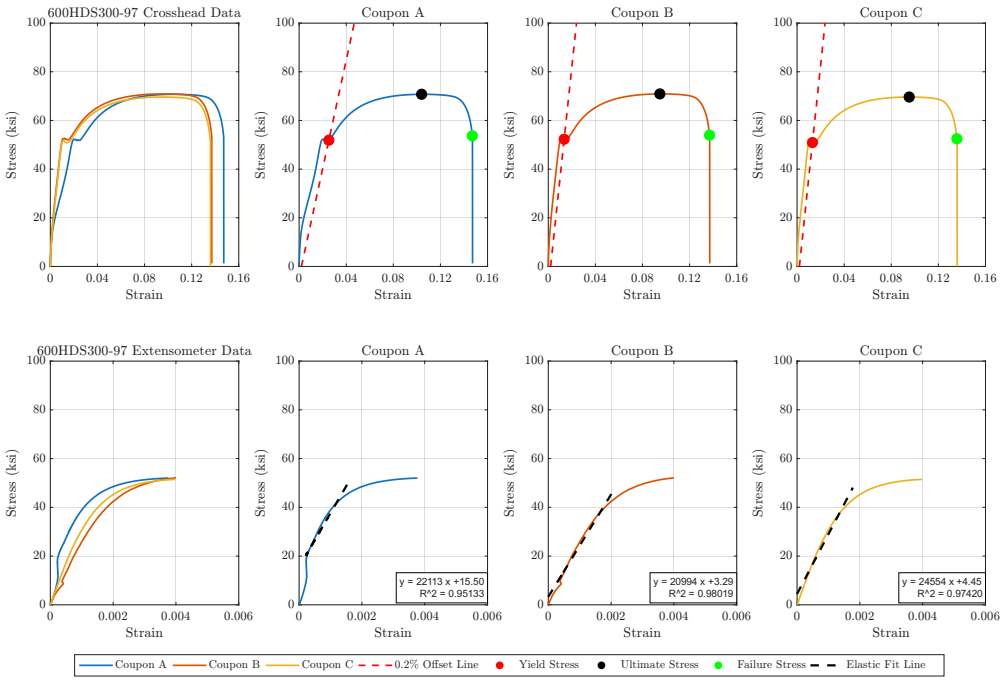


Figure 51: 600HDS300-97 stress-strain plot

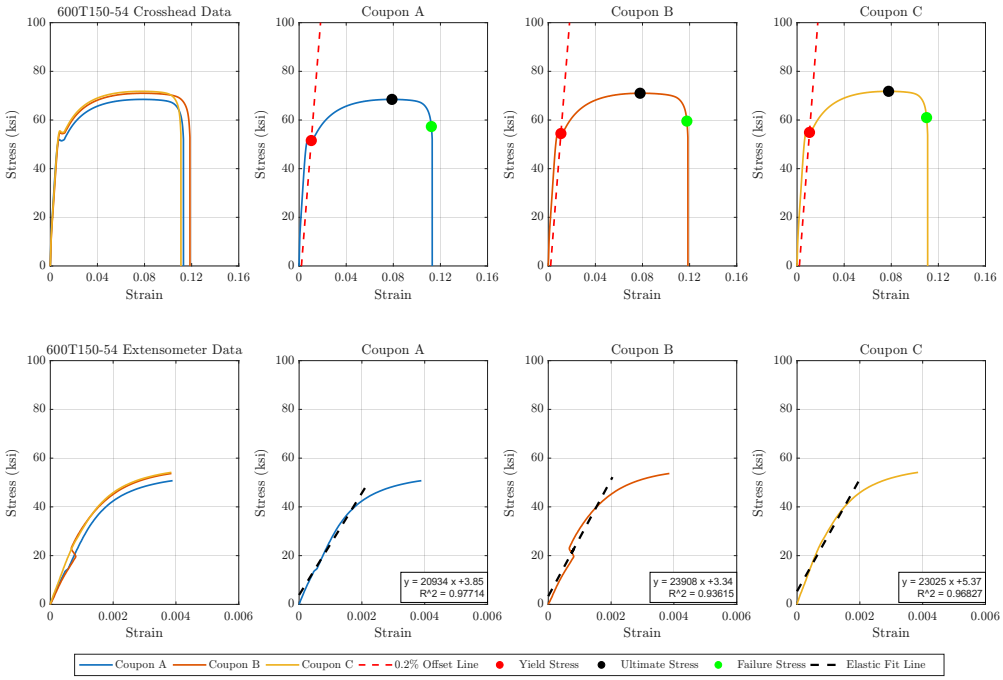


Figure 52: 600T150-54 stress-strain plot

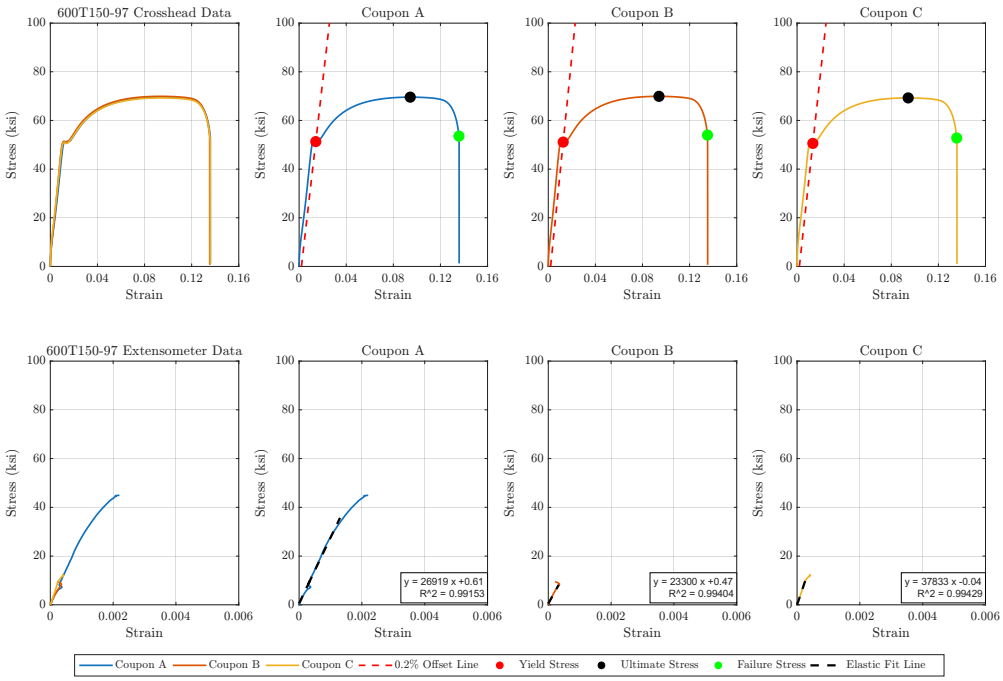


Figure 53: 600T150-97 stress-strain plot

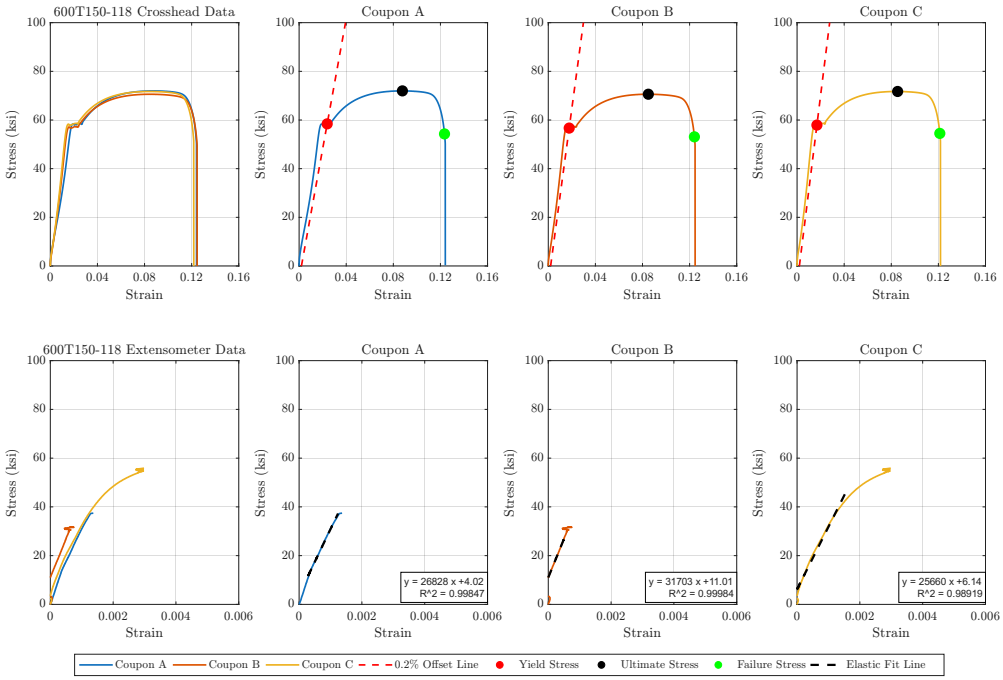


Figure 54: 600T150-118 stress-strain plot

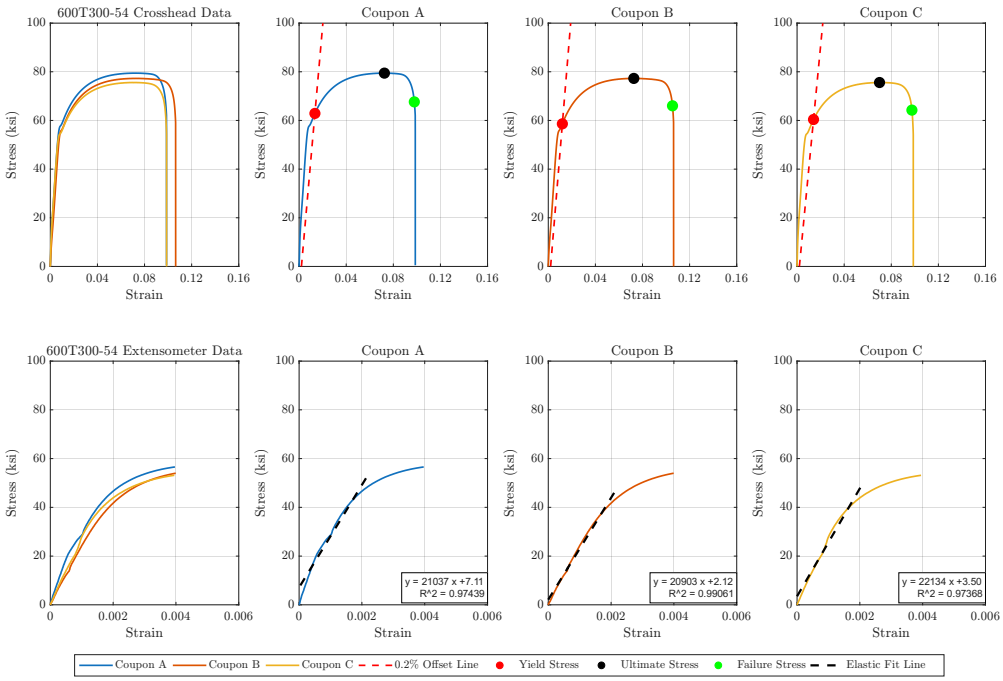


Figure 55: 600T300-54 stress-strain plot

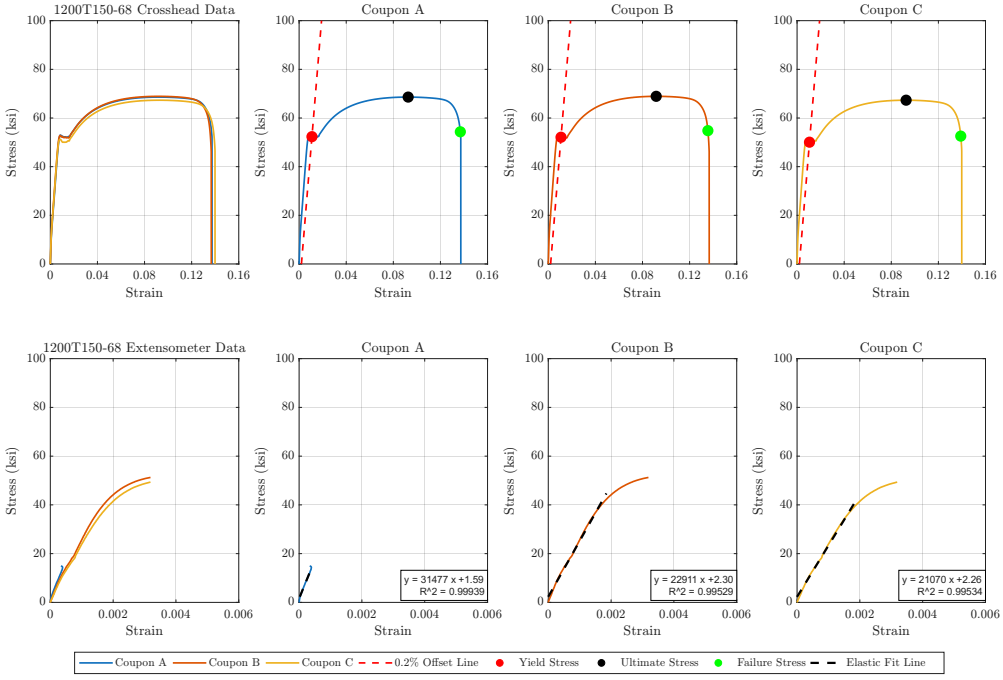


Figure 56: 1200T150-68 stress-strain plot

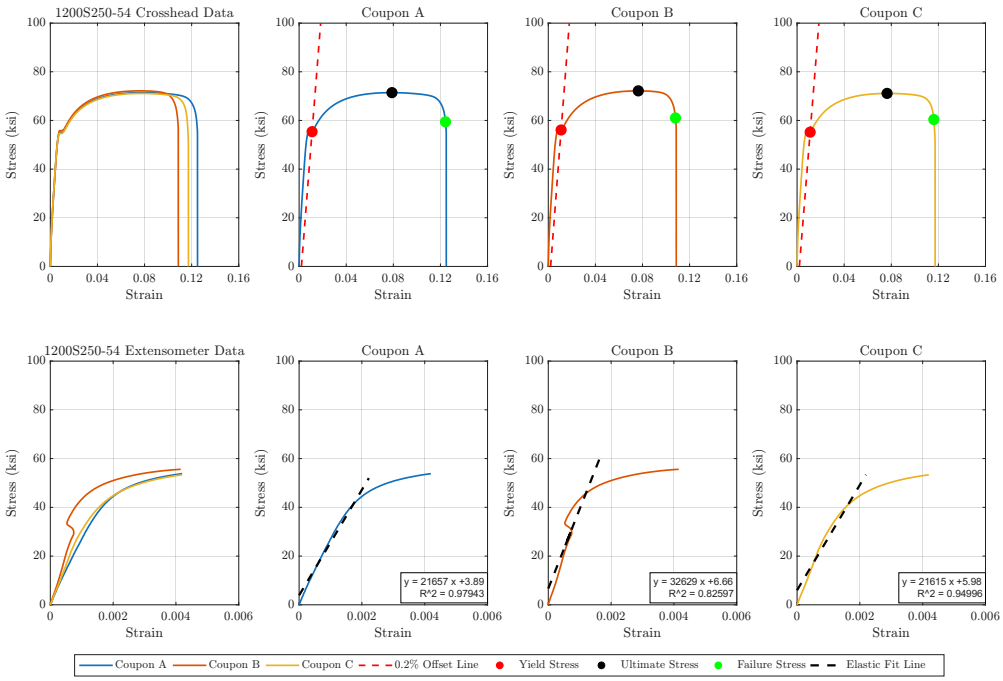


Figure 57: 1200S250-54 stress-strain plot

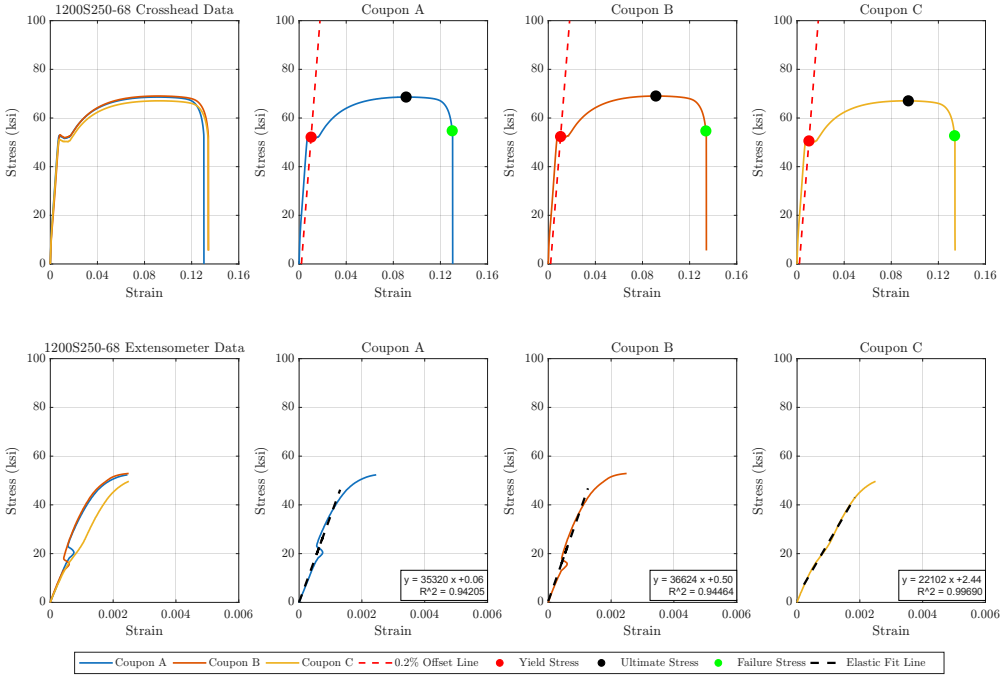


Figure 58: 1200S250-68 stress-strain plot

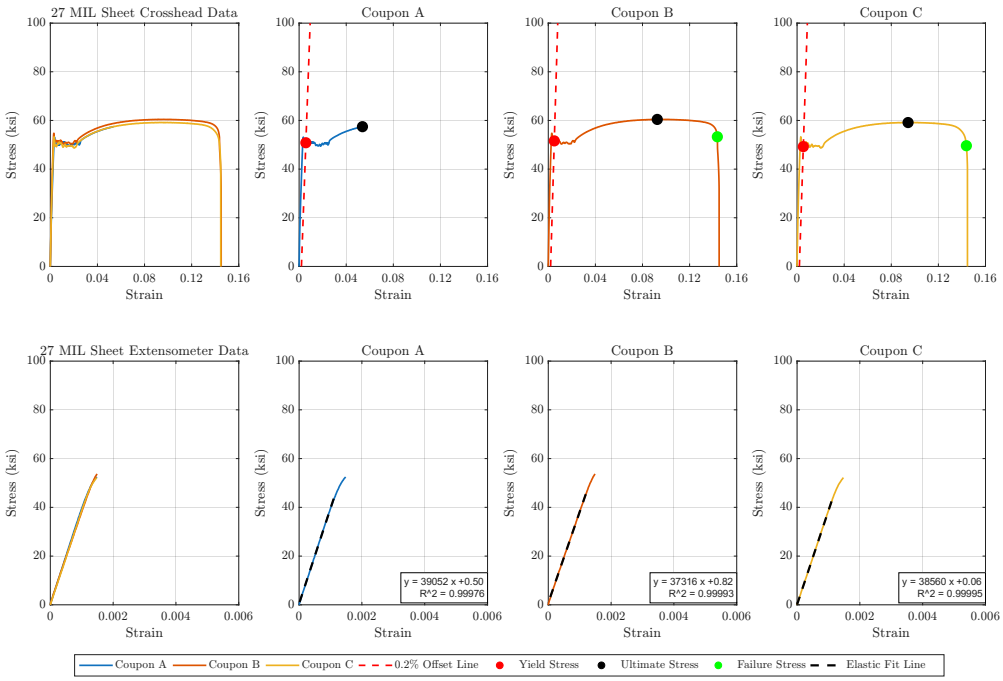


Figure 59: 27 MIL Sheet stress-strain plot

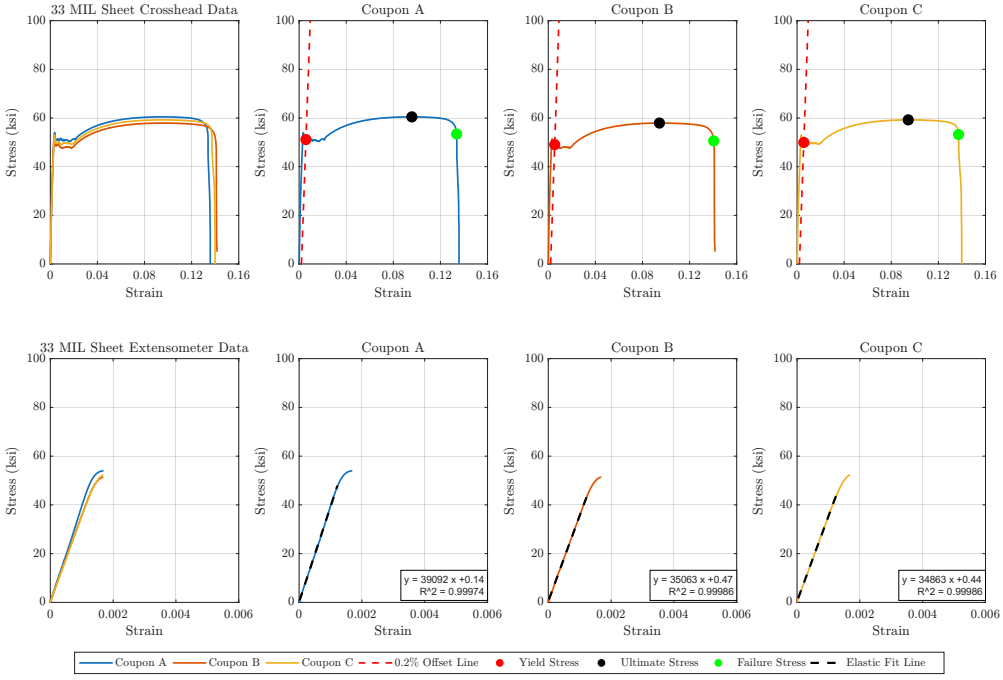


Figure 60: 33 MIL Sheet stress-strain plot

Appendix C: ATR Stress-Strain Plots

Appendix C provides the force-displacement plot and stress-strain plot for each ATR member tested. Each plot identifies the diameter of the rod and the number of each specific diameter tested.

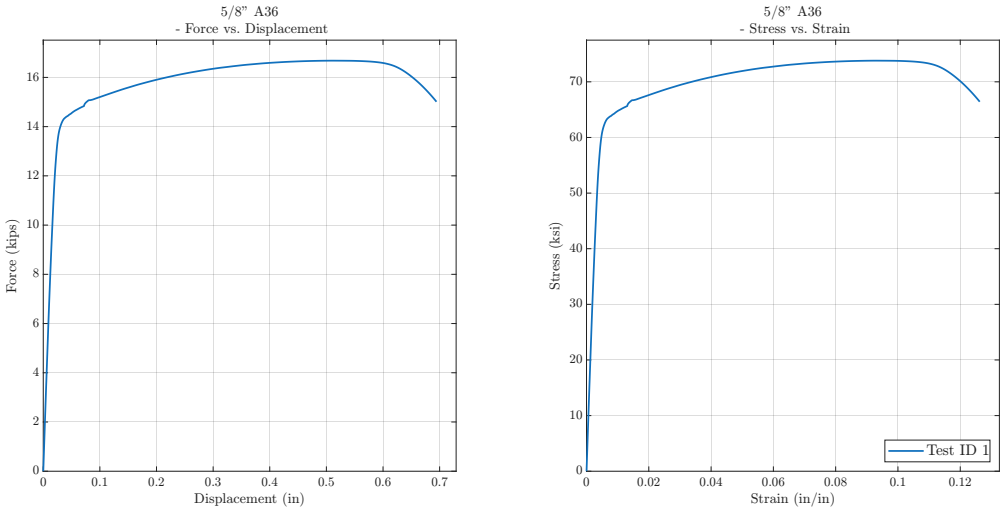


Figure 61: 5/8" Diameter A36 plot

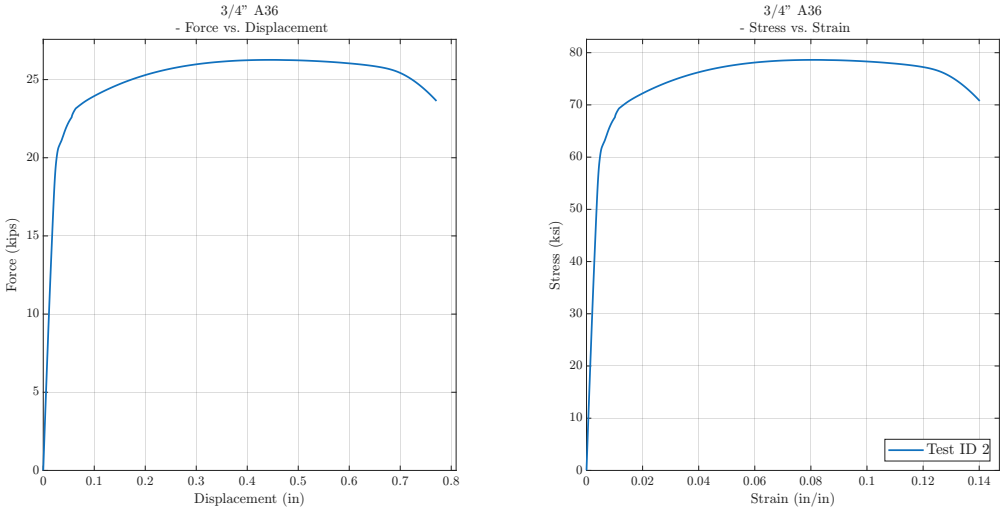


Figure 62: 3/4" Diameter A36 plot

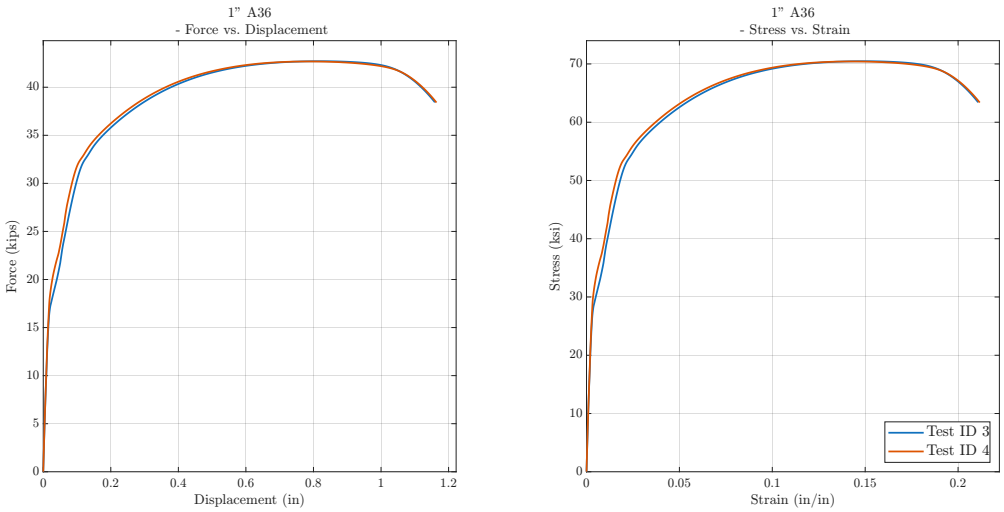


Figure 63: 1" Diameter A36 plot

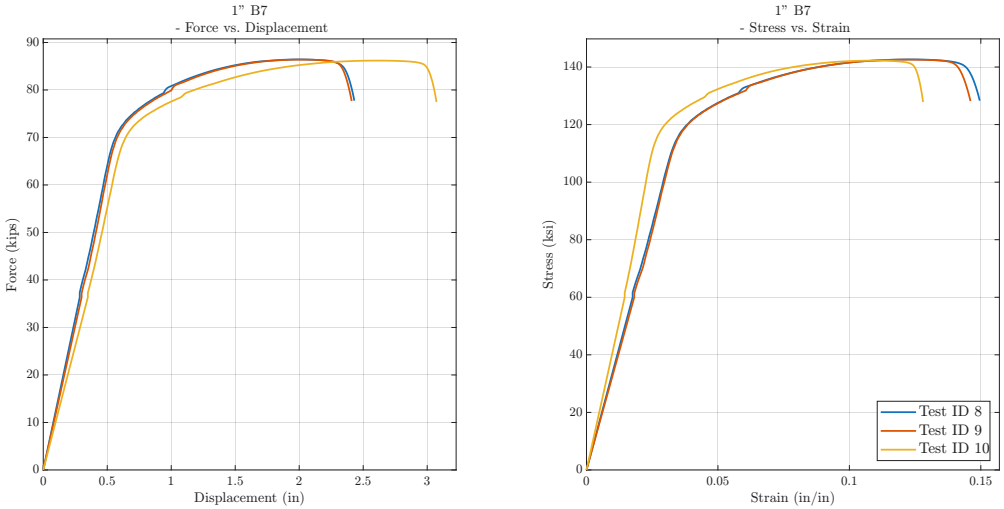


Figure 64: 1" Diameter B7 plot

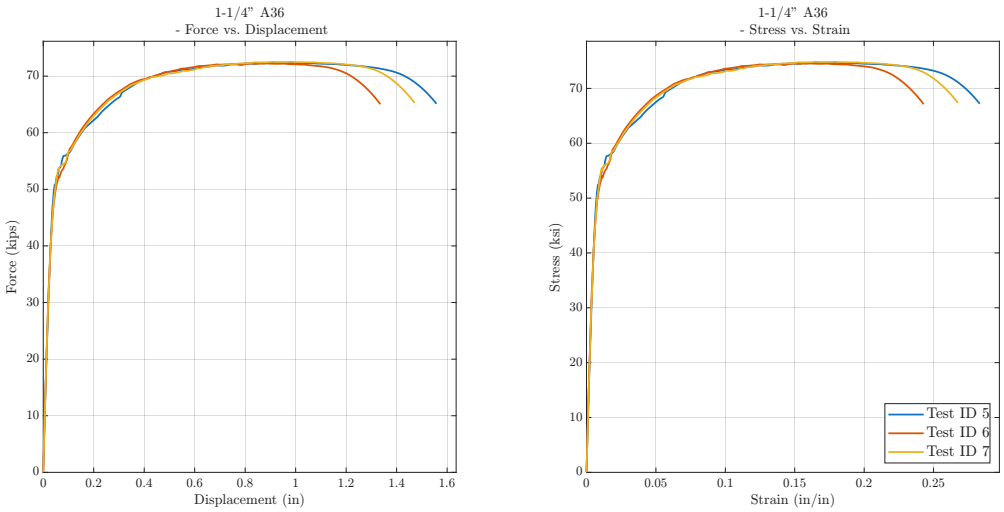


Figure 65: 1-1/4" Diameter A36 plot

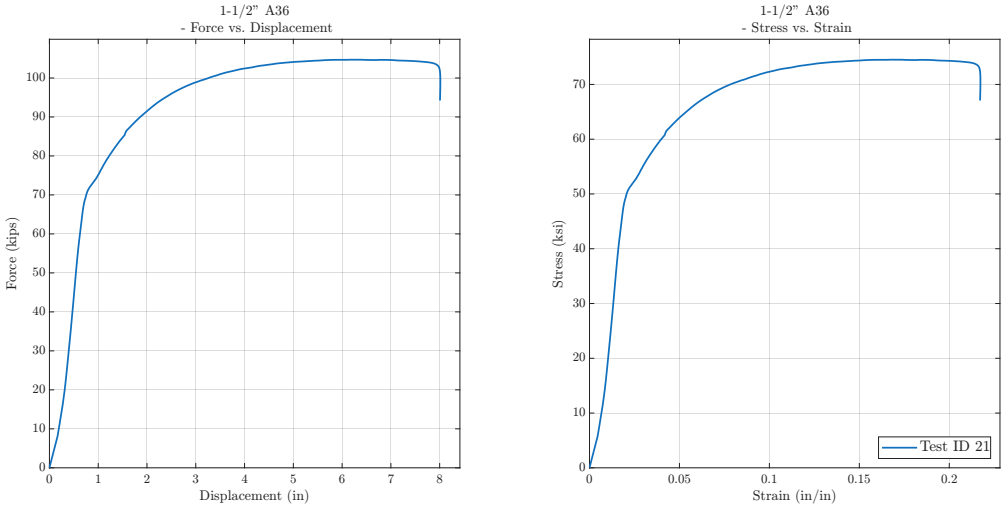


Figure 66: 1-1/2" Diameter A36 plot

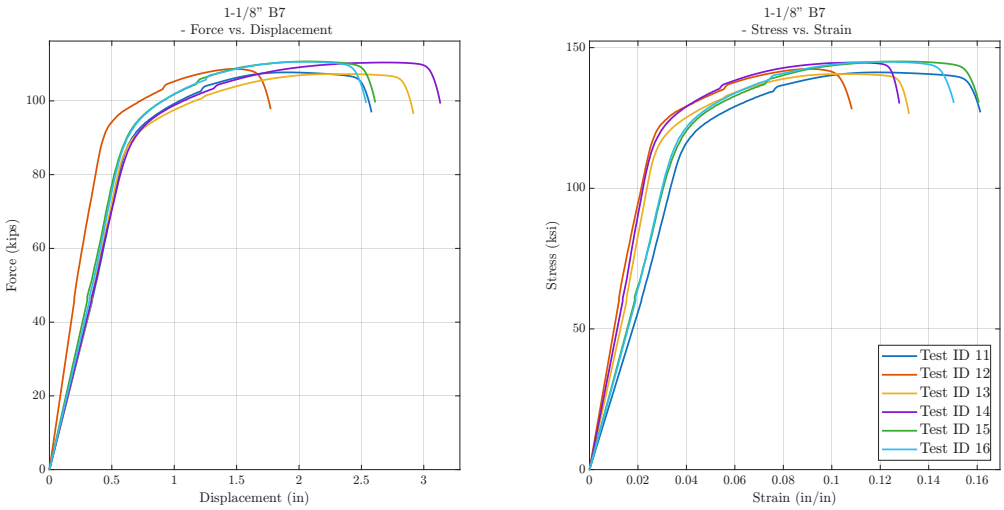


Figure 67: 1-1/8" Diameter B7 plot

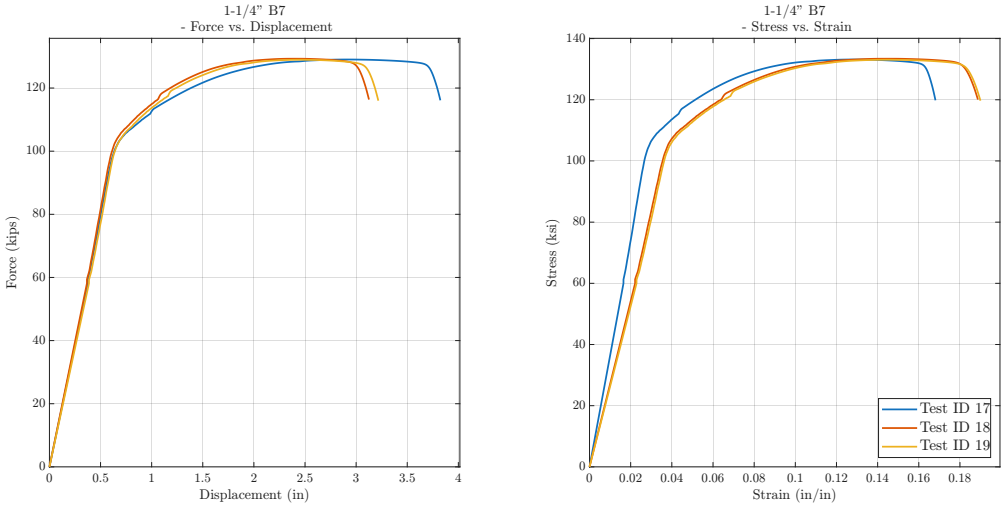


Figure 68: 1-1/4" Diameter B7 plot

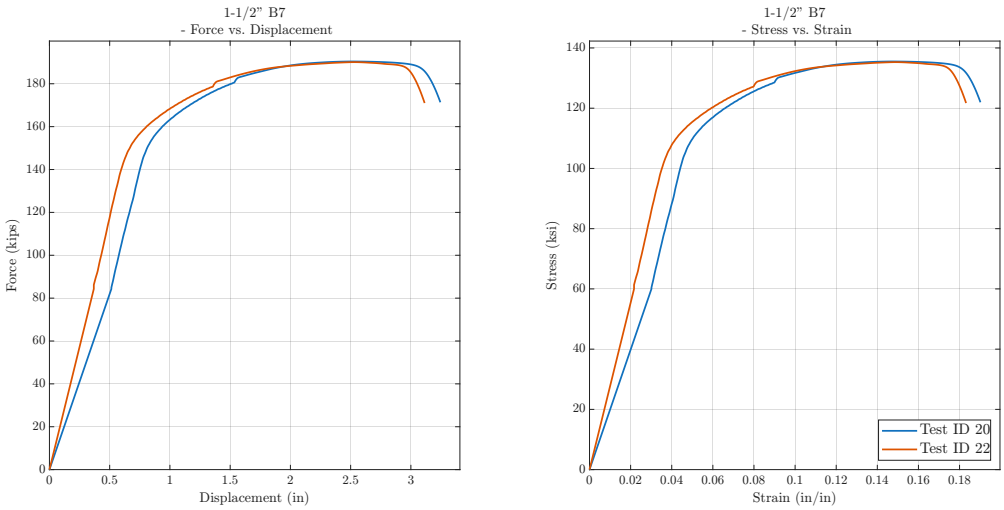


Figure 69: 1-1/2" Diameter B7 plot

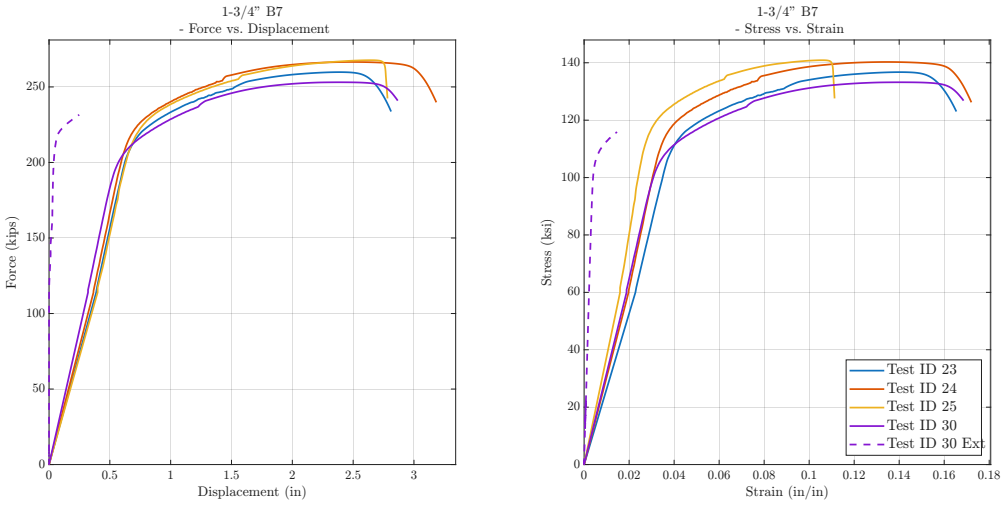


Figure 70: 1-3/4" Diameter B7 plot

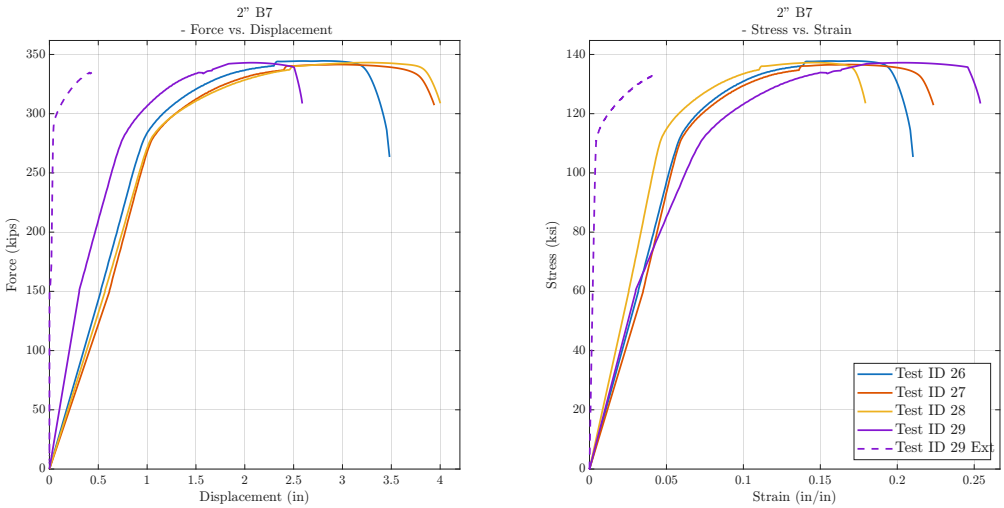


Figure 71: 2" Diameter B7 plot

Appendix D: HSS stress-strain plots

Appendix D provides the stress-strain plot for each HSS member tested. Each plot identifies the yield stress, ultimate stress, and failure stress for each member. Each HSS member is 6" x 6", varying in thickness.

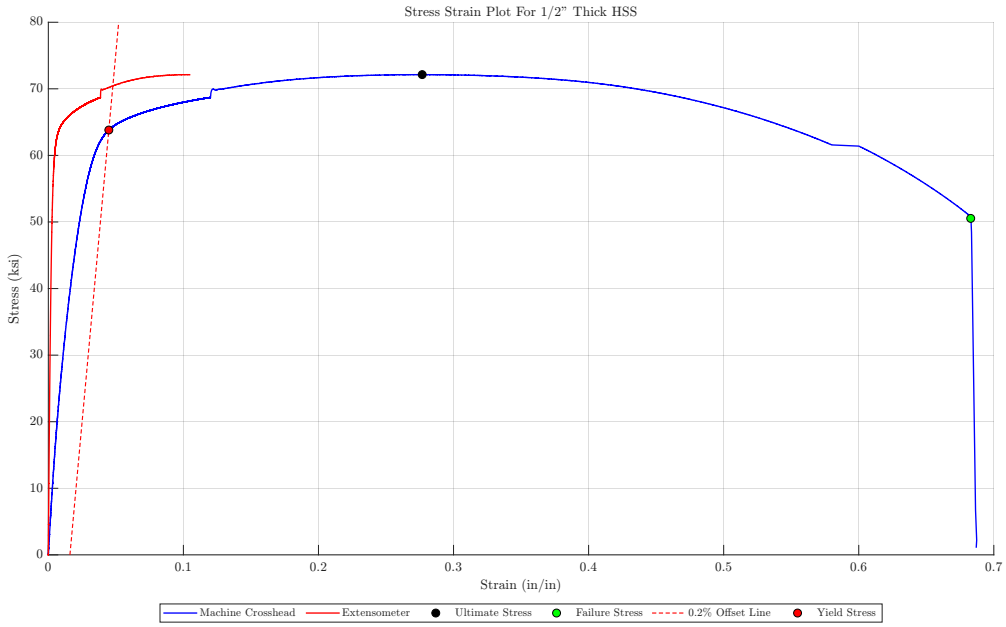


Figure 72: 6"x 6"x 1/2" HSS stress-strain plot

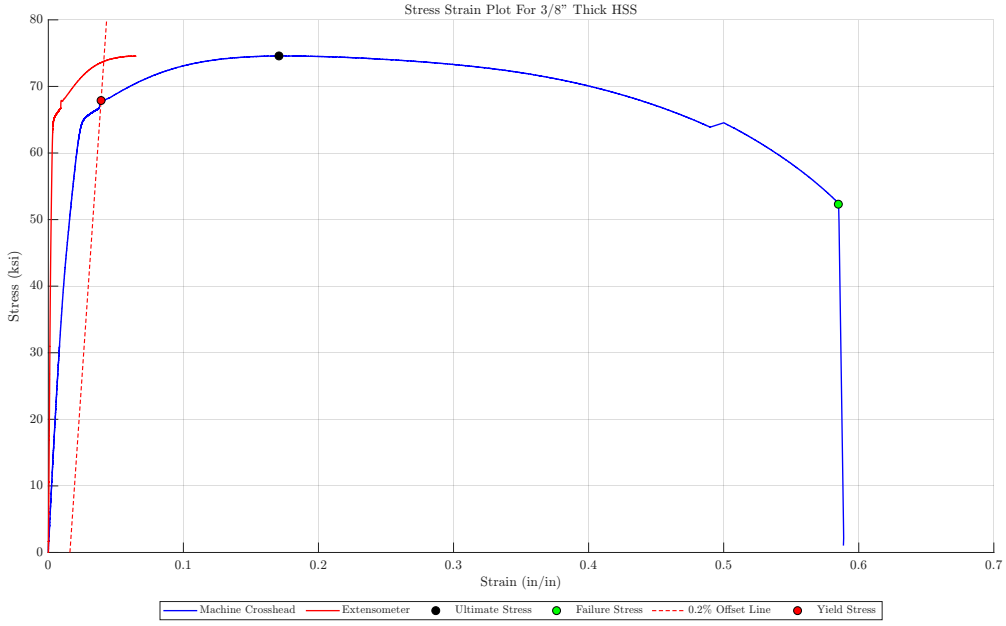


Figure 73: 6"x 6"x 3/8" HSS stress-strain plot

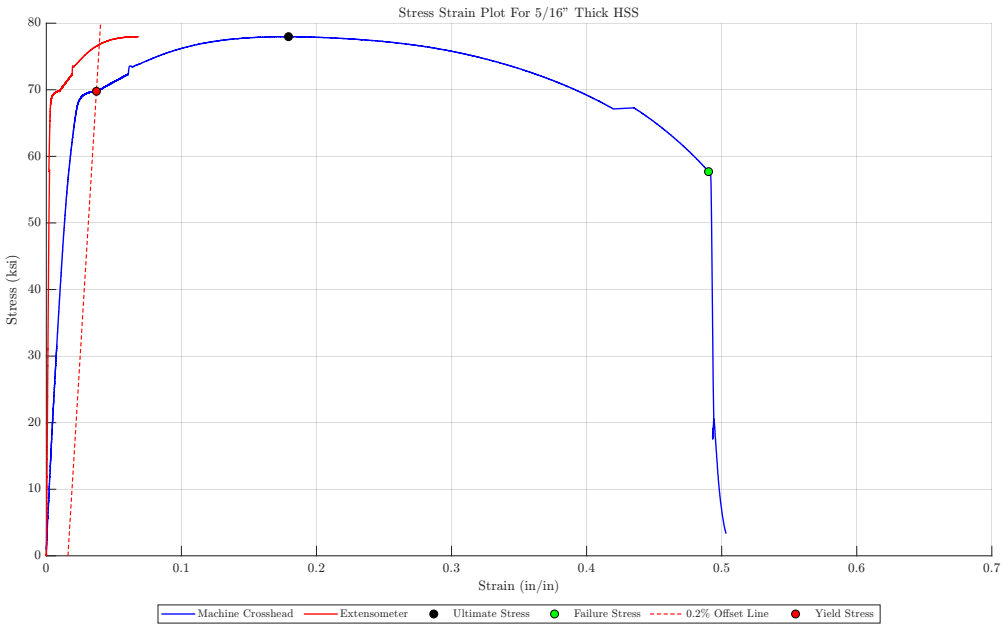


Figure 74: 6"x 6"x 5/16" HSS stress-strain plot

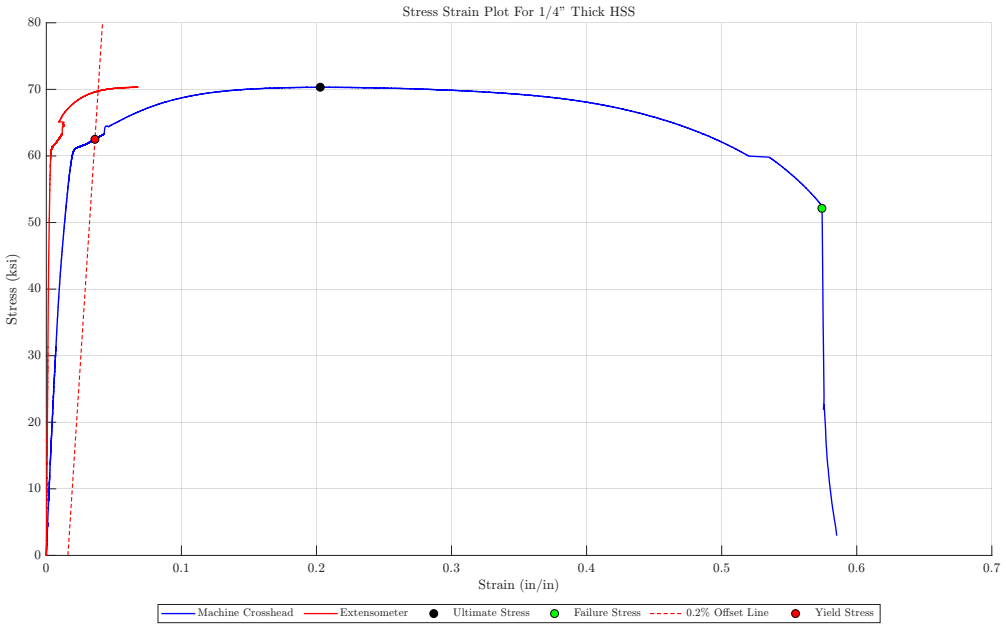


Figure 75: 6"x 6"x 1/4" HSS stress-strain plot

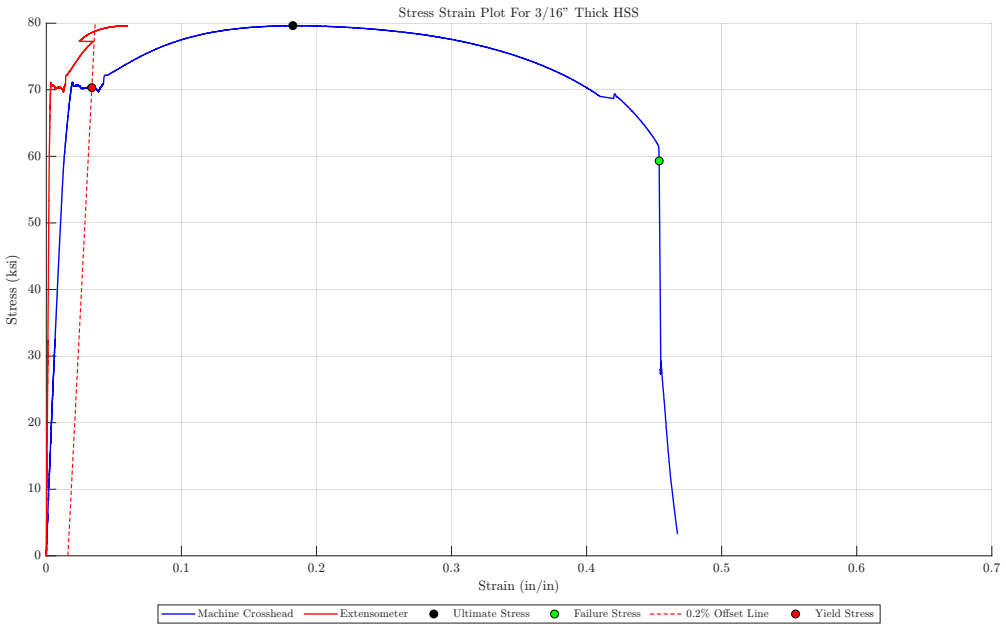


Figure 76: 6"x 6"x 3/16" HSS stress-strain plot

Appendix E: CFS Mill Certifications

The following mill certifications were provided by Mnf-1 and document the material properties of the tested members. The highlighted rows indicate the mill certifications corresponding to the members tested in this study. When multiple mill certifications were available for the same member size, the average material properties from the applicable certifications were used for analysis.

Mechanical Properties Test Report

ClarkDietrich BUILDING SYSTEMS
9050 Centre Pointe Dr. Suite 400
West Chester, OH 45069
Phone: 513-857-4400
clarkdietrich.com

Mill Coil #	Slit Coil #	Skid(s)	Product	SO #	Customer Name	PO #	Coated Thickness	Coating Weight	Yield Strength (KSI)	Tensile Strength (KSI)	Elongation (%)
7765466	7783431	24965813	STRUCTURAL STUD 3-5/8IN 18G 1-5/8IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0456	G60	41600	52700.00	41.00
7776331	7796049	24965814 24965815 24965816	STRUCTURAL STUD 6IN 18G 1-5/8IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0438	G60	50900	55200.00	27.90
7765442	7805747	24965817 24965819	STRUCTURAL STUD 6IN 16G 1-5/8IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0556	G60	52500	71000.00	31.00
7765447	7803728	24965818 24965819	STRUCTURAL STUD 6IN 16G 1-5/8IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0556	G60	55500	73000.00	29.00
7765446	7803757 7803758	24965818	STRUCTURAL STUD 6IN 16G 1-5/8IN FL, STRUCTURAL STUD 6IN 16G 3IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0556	G60	55500	73000.00	29.00
7681908	7782736	24965820 24965821	STRUCTURAL STUD 6IN 14G 1-5/8IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0690	G60	60000	77800.00	25.00
7545727	7796386	24965822 24965823	STRUCTURAL STUD 6IN 12G 1-5/8IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0989	G90	58700	77700.00	28.00
7297210	7527502	24965824	STRUCTURAL STUD 6IN 10G 1-5/8IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.1190	G90	63000	74000.00	24.00
7637282	7796422	24965824 24965825	STRUCTURAL STUD 6IN 10G 1-5/8IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.1195	G90	55200	82100.00	27.00
7618600	7795152	24965826 24965827	STRUCTURAL STUD 6IN 18G 2IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0438	G60	40200	53800.00	40.00
7648971	7803224	24965828 24965829	STRUCTURAL STUD 6IN 16G 2IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0550	G60	60000	77000.00	27.00
7729175	7739046	24965830 24965831 24965832 24965833	STRUCTURAL STUD 6IN 14G 2IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0689	G60	60900	78000.00	28.00

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Phone: 513-857-4400
clarkdietrich.com

7765465	7777206 7804566	24965834 24965835	STRUCTURAL STUD 6IN 12G 2IN FL, STRUCTURAL STUD 6IN 12G 3IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0989	G90	54300	72700.00	31.00
7765464	7800266	24965834	STRUCTURAL STUD 6IN 12G 2IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0989	G90	54300	72700.00	31.00
7661649	7717183 7762676	24965836 24965840 24965841	STRUCTURAL STUD 6IN 10G 2-1/2IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.1190	G90	59700	70300.00	27.00
7681905	7803936	24965837 24965838	STRUCTURAL STUD 6IN 14G 2-1/2IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0700	G60	57400	74600.00	30.00
7143657	7804534	24965839	STRUCTURAL STUD 6IN 12G 2-1/2IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0989	G90	50000	72000.00	32.00
7433813	7776464 7806386	24965839	STRUCTURAL STUD 6IN 12G 3-1/2IN FL Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0980	G90	54000	73600.00	31.00
7647976	7723802	24968315 24968316	HEAVY DUTY STUD 6IN 12G Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0978	G90	54900	72300.00	30.00
7619723	7748266	24968317 24968318	HEAVY DUTY STUD 6IN 14G Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0700	G90	56400	73200.00	30.00
7324471	7754583	24968319 24968320	HEAVY DUTY STUD 6IN 18G Flat Roll Galvanized Sheet Coil	3449757	27993 - CLARKDIETRICH SAMPLES	04-51025-000-1B	0.0441	G60	44000	54000.00	35.00

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CLARKDIETRICH SAMPLES (3449679)

Master Coil Number	Slit Coil Number	Skid(s)	PO #	Product	NOM Thickness	Coating Weight	Yield Strength (KSI)	Tensile Strength (KSI)	Elongation %
6869250	7455772	24965748 24965749 24965750 24965751 24965752 24965753	04-51025-000-1A	STRUCTURAL TRACK 6IN 10G 1-1/2IN LEGS	0.120	G90	60400	73400	31
7239108	7638129	24965743 24965744 24965745 24965746	04-51025-000-1A	STRUCTURAL TRACK 6IN 12G 1-1/2IN LEGS	0.099	G90	53000	72000	31
7433786	7736214	24965742	04-51025-000-1A	STRUCTURAL STUD 6IN 12G 3-1/2IN FL	0.099	G90	56200	76800	27
7433813	7776464	24965741 24965742	04-51025-000-1A	STRUCTURAL STUD 6IN 12G 3-1/2IN FL	0.099	G90	54000	73600	31
7463647	7786839	24965747	04-51025-000-1A	STRUCTURAL TRACK 12IN 14G 1-1/2IN LEGS	0.070	G60	55000	73000	31
7591644	7805193	24965737	04-51025-000-1A	STRUCTURAL STUD 6IN 14G 1-5/8IN FL	0.070	G90	55200	72200	31
7637281	7797143 7797144	24965740 24965738 24965739	04-51025-000-1A	STRUCTURAL STUD 6IN 10G 2-1/2IN FL	0.120	G90	55200	82100	27
7647976	7723802	24968345 24968346	04-51025-000-1A	HEAVY DUTY STUD 6IN 12G	0.099	G90	54900	72300	30
7661649	7717183 7762676	24965740 24965738	04-51025-000-1A	STRUCTURAL STUD 6IN 10G 2-1/2IN FL	0.120	G90	59700	70300	27
7681908	7782736	24965736 24965737	04-51025-000-1A	STRUCTURAL STUD 6IN 14G 1-5/8IN FL	0.070	G60	60000	77800	25
7716441	7802789	25041288 25041289	04-51025-000-1A	SHEET 4FT X 8FT (20G)	0.035	G60	44800	56000	38
7718260	7731399	24965715	04-51025-000-1A	RC-1 PRO RESILIENT CHANNEL	0.019	G40	51000	57000	25.48
7765442	7803671	24965734 24965735	04-51025-000-1A	STRUCTURAL STUD 6IN 16G 1-5/8IN FL	0.056	G60	52500	71000	31
7765446	7803757	24965731 24965732 24965733	04-51025-000-1A	STRUCTURAL STUD 6IN 16G 1-5/8IN FL	0.056	G60	55500	73000	29

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CLARKDIETRICH SAMPLES (3449689)

Master Coil Number	Slit Coil Number	Skid(s)	PO #	Product	NOM Thickness	Coating Weight	Yield Strength (KSI)	Tensile Strength (KSI)	Elongation %
6869250	7455772	24974918 24974919 24974920	04-51025-000-1B1	STRUCTURAL TRACK 6IN 10G 1-1/2IN LEGS	0.120	G90	60400	73400	31
7001703	7761918	24974879	04-51025-000-1B1	STRUCTURAL STUD 12IN 16G 2-1/2IN FL	0.056	G90	53000	75000	27
7309191	7783964	24974888	04-51025-000-1B1	STR TRACK 3-5/8IN 18G 1-1/2IN LEGS	0.045	G90	44000	54000	38
7347443	7732235	24974878 24974879	04-51025-000-1B1	STRUCTURAL STUD 12IN 16G 2-1/2IN FL	0.056	G90	55000	72000	31
7483468	7522481	24974895 24974896	04-51025-000-1B1	STRUCTURAL TRACK 6IN 18G 1-1/2IN LEGS	0.045	G90	45000	54000	42
7555594	7724671	24974901 24974902 24974903 24974904 24974905	04-51025-000-1B1	STRUCTURAL TRACK 6IN 14G 1-1/2IN LEGS	0.070	G60	58000	75400	30
7612730	7758314	24974876 24974877	04-51025-000-1B1	STRUCTURAL STUD 4IN 16G 2IN FL	0.056	G60	65400	86700	17
7618597	7790664	24974896	04-51025-000-1B1	STRUCTURAL TRACK 6IN 18G 1-1/2IN LEGS	0.045	G60	45400	56600	37
7632328	7713619	24974891 24974892 24974893 24974894	04-51025-000-1B1	STRUCTURAL TRACK 6IN 18G 1-1/2IN LEGS	0.045	G60	51000	56000	27
7637282	7796423	24974915 24974916 24974917	04-51025-000-1B1	STRUCTURAL TRACK 6IN 10G 1-1/2IN LEGS	0.120	G90	55200	82100	27
7648982	7794192	24974882 24974883 24974884	04-51025-000-1B1	STRUCTURAL STUD 12IN 14G 2-1/2IN FL	0.070	G90	59100	72700	32
7667065	7794166	24974880 24974881 24974882	04-51025-000-1B1	STRUCTURAL STUD 12IN 14G 2-1/2IN FL	0.070	G90	58100	75500	29
7699160	7757282	24974914	04-51025-000-1B1	STRUCTURAL TRACK 12IN 14G 1-1/2IN LEGS	0.070	G90	55100	71100	32
7699250	7794116	24974886 24974887	04-51025-000-1B1	STRUCTURAL STUD 12IN 14G 2-1/2IN FL	0.070	G90	54300	69800	34
7699251	7794147	24974884 24974885 24974886	04-51025-000-1B1	STRUCTURAL STUD 12IN 14G 2-1/2IN FL	0.070	G90	54300	69800	34
7729213	7786875	24974897 24974898 24974899 24974900	04-51025-000-1B1	STRUCTURAL TRACK 6IN 16G 1-1/2IN LEGS	0.056	G60	79700	82600	14.3

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CLARKDIETRICH SAMPLES (3449689)

Master Coil Number	Slit Coil Number	Skid(s)	PO #	Product	NOM Thickness	Coating Weight	Yield Strength (KSI)	Tensile Strength (KSI)	Elongation %
7737833	7762337	24989555 24989556 24989557 24989558	04-51025-000-1B1	TRADEREADY TD16 RIM 16in OC14ga 12in	0.070	G60	56700	69500	31
7761776	7806290	24989559 24989560	04-51025-000-1B1	TRADEREADY TD16 RIM 16in OC16ga 12in	0.056	G60	55600	75300	27
7765465	7777209	24974906 24974907 24974908 24974909 24974910 24974911 24974912 24974913	04-51025-000-1B1	STRUCTURAL TRACK 6IN 12G 1-1/2IN LEGS	0.099	G90	54300	72700	31
7765477	7792892	24974889 24974890	04-51025-000-1B1	STRUCTURAL TRACK 4IN 16G 1-1/2IN LEGS	0.056	G60	54200	71800	32

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Mechanical Properties Test Report

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CLARKDIETRICH SAMPLES (3449757)

Master Coil Number	Slit Coil Number	Skid(s)	PO #	Product	NOM Thickness	Coating Weight	Yield Strength (KSI)	Tensile Strength (KSI)	Elongation %
7143657	7804534	24965839	04-51025-000-1B	STRUCTURAL STUD 6IN 12G 2-1/2IN FL	0.099	G90	50000	72000	32
7297210	7527502	24965824	04-51025-000-1B	STRUCTURAL STUD 6IN 10G 1-5/8IN FL	0.120	G90	63000	74000	24
7324471	7754583	24968319 24968320	04-51025-000-1B	HEAVY DUTY STUD 6IN 18G	0.045	G60	44000	54000	35
7433813	7776464 7806386	24965848 24965849 24965839	04-51025-000-1B	STRUCTURAL STUD 6IN 12G 3-1/2IN FL	0.099	G90	54000	73600	31
7545727	7796386	24965822 24965823	04-51025-000-1B	STRUCTURAL STUD 6IN 12G 1-5/8IN FL	0.099	G90	58700	77700	28
7618600	7795152	24965826 24965827	04-51025-000-1B	STRUCTURAL STUD 6IN 18G 2IN FL	0.045	G60	40200	53800	40
7619723	7748266	24968317 24968318	04-51025-000-1B	HEAVY DUTY STUD 6IN 14G	0.070	G90	56400	73200	30
7633724	7770989	24965843	04-51025-000-1B	STRUCTURAL STUD 6IN 14G 3IN FL	0.070	G90	58100	75500	29
7637282	7796422	24965824 24965825	04-51025-000-1B	STRUCTURAL STUD 6IN 10G 1-5/8IN FL	0.120	G90	55200	82100	27
7647976	7723802	24968315 24968316	04-51025-000-1B	HEAVY DUTY STUD 6IN 12G	0.099	G90	54900	72300	30
7648971	7803224	24965828 24965829	04-51025-000-1B	STRUCTURAL STUD 6IN 16G 2IN FL	0.056	G60	60000	77000	27
7661649	7717183 7762676	24965840 24965841 24965836	04-51025-000-1B	STRUCTURAL STUD 6IN 10G 2-1/2IN FL	0.120	G90	59700	70300	27
7667064	7773664	24965846 24965847	04-51025-000-1B	STRUCTURAL STUD 6IN 14G 3-1/2IN FL	0.070	G90	58100	75500	29
7681905	7803936	24965837 24965838	04-51025-000-1B	STRUCTURAL STUD 6IN 14G 2-1/2IN FL	0.070	G60	57400	74600	30
7681908	7782736	24965820 24965821	04-51025-000-1B	STRUCTURAL STUD 6IN 14G 1-5/8IN FL	0.070	G60	60000	77800	25
7716441	7802789 7802790 7802791	25041618 25041619 25041620 25041621 25041622	04-51025-000-1B	SHEET 4FT X 8FT (20G)	0.035	G60	44800	56000	38
7729175	7739046	24965830 24965831 24965832 24965833	04-51025-000-1B	STRUCTURAL STUD 6IN 14G 2IN FL	0.070	G60	60900	78000	28
7757541	7806355	24965845	04-51025-000-1B	STRUCTURAL STUD 6IN 16G 3-1/2IN FL	0.056	G60	60900	75600	28
7765442	7805747	24965817 24965819	04-51025-000-1B	STRUCTURAL STUD 6IN 16G 1-5/8IN FL	0.056	G60	52500	71000	31

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CLARKDIETRICH SAMPLES (3449757)

Master Coil Number	Slit Coil Number	Skid(s)	PO #	Product	NOM Thickness	Coating Weight	Yield Strength (KSI)	Tensile Strength (KSI)	Elongation %
7765446	7803757 7803758	24965818 24965842	04-51025-000-1B	STRUCTURAL STUD 6IN 16G 1-5/8IN FL	0.056	G60	55500	73000	29
7765447	7803728	24965818 24965819	04-51025-000-1B	STRUCTURAL STUD 6IN 16G 1-5/8IN FL	0.056	G60	55500	73000	29
7765464	7800266	24965834	04-51025-000-1B	STRUCTURAL STUD 6IN 12G 2IN FL	0.099	G90	54300	72700	31
7765465	7777206 7804566	24965834 24965835 24965844	04-51025-000-1B	STRUCTURAL STUD 6IN 12G 2IN FL	0.099	G90	54300	72700	31
7765466	7783431	24965813	04-51025-000-1B	STRUCTURAL STUD 3-5/8IN 18G 1-5/8IN FL	0.045	G60	41600	52700	41
7776331	7796049	24965814 24965815 24965816	04-51025-000-1B	STRUCTURAL STUD 6IN 18G 1-5/8IN FL	0.045	G60	50900	55200	27.9
7795505	7801037	25041625 25041627	04-51025-000-1B	SHEET 4FT X 6FT (20G) 30MIL	0.030	G60	41100	53200	41

Appendix F: ATR Mill Certifications

The following mill certifications were provided by Mnf-3 and document the material properties of the tested members. The highlighted rows indicate the mill certifications corresponding to the members tested in this study. When multiple mill certifications were available for the same member size, the average material properties from the applicable certifications were used for analysis.

Bay Standard Manufacturing, Inc.
24485 Marsh Creek Road
Brentwood, CA 94513
925-634-1181

* * * CERTIFICATE OF TEST * * *

Customer Information

Invoiced 9/13/2024

Bill to:
HARDY FRAMES, DBA ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00290275
PO# P548765
4 PCS - 62C10400ATR2/M

Item Information

Part No - 62C10400ATR2/M
Part Desc. - 5/8-11 X 104" ATR DOM A307A PLAIN
Size (Major Diameter) - 5/8 "
Size (Overall Length) - 104 "
Specification - ASTM F1554-18 GR36
Test Method - Table 2 - Axial Testing

Heat Number - 1000226813
BSMI Lot Number - 2409135-15

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (lbf) = 13700	Min Yield (lbf) = 8100	*Elongation - 21.5 %
Tensile (lbf) = 14800	Min Tensile (lbf) = 13100	*Reduction of Area - 74.2 %
	Max Tensile (lbf) = 18100	*Yield (ksi) - 60.4
		*Tensile (ksi) - 65.4
		* Values are for information purposes and are not required for ASTM F1554-18 GR36.

Chemical Analysis

C - 0.040 %	Si - 0.116 %
Mn - 0.340 %	Cu - 0.230 %
P - 0.011 %	Ni - 0.090 %
S - 0.033 %	Cr - 0.080 %
	Mo - 0.020 %

We Certify that the material indicated above was tested at the mill or by BSMI and found to conform to the grade and specification indicated.
We Hereby certify that the forgoing data is a true copy of the data furnished with the raw material from the Mill, or Bay Standard in-house testing results, or outside lab testing results.

By:
Wally Gross, President and CEO

Completed by:
Andrea Gaylor

Bay Standard Manufacturing, Inc.
24485 Marsh Creek Road
Brentwood, CA 94513
925-634-1181

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Customer Information

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555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00290275
PO# P548765
4 PCS - 75C13000ATR3/M

Item Information

Part No - 75C13000ATR3/M
Part Desc. - 3/4-10 X 130" ATR DOM F1554-36 PLAIN
Size (Major Diameter) - 3/4 "
Size (Overall Length) - 130 "
Specification - ASTM F1554-18 GR36
Test Method - Table 2 - Axial Testing

Heat Number - 171424
BSMI Lot Number - 2409135-14

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (lbf) = 19900	Min Yield (lbf) = 12000	*Elongation - 25.2 %
Tensile (lbf) = 23400	Min Tensile (lbf) = 19400	*Reduction of Area - 68.2 %
	Max Tensile (lbf) = 26700	*Yield (ksi) - 59.5
		*Tensile (ksi) - 70.1
		* Values are for information purposes and are not required for ASTM F1554-18 GR36.

Chemical Analysis

C - 0.140 %	Cu - 0.110 %
Mn - 0.480 %	Ni - 0.040 %
P - 0.008 %	Cr - 0.110 %
S - 0.023 %	Mo - 0.013 %
Si - 0.210 %	V - 0.002 %
	Sn - 0.012 %

We Certify that the material indicated above was tested at the mill or by BSMI and found to conform to the grade and specification indicated.
We Hereby certify that the forgoing data is a true copy of the data furnished with the raw material from the Mill, or Bay Standard in-house testing results, or outside lab testing results.

By:
Wally Gross, President and CEO

Completed by:
Andrea Gaylor

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555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00290275
PO# P548765
4 PCS - 75C12000ATR2/M

Item Information

Part No - 75C12000ATR2/M
Part Desc. - 3/4-10 X 120" ATR DOM A307A PLAIN (200)
Size (Major Diameter) - 3/4 "
Size (Overall Length) - 120 "
Specification - ASTM F1554-18 GR36
Test Method - Table 2 - Axial Testing

Heat Number - 121524
BSMI Lot Number - 2406124-24A

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (lbf) = 20400	Min Yield (lbf) = 12000	*Elongation - 26.2 %
Tensile (lbf) = 23100	Min Tensile (lbf) = 19400	*Reduction of Area - 66.8 %
	Max Tensile (lbf) = 26700	*Yield (ksi) - 60.9
		*Tensile (ksi) - 69.2
		* Values are for information purposes and are not required for ASTM F1554-18 GR36.

Chemical Analysis

C - 0.140 %	Cu - 0.120 %
Mn - 0.460 %	Ni - 0.040 %
P - 0.009 %	Cr - 0.100 %
S - 0.020 %	Mo - 0.013 %
Si - 0.120 %	Sn - 0.019 %

We Certify that the material indicated above was tested at the mill or by BSMI and found to conform to the grade and specification indicated.
We Hereby certify that the forgoing data is a true copy of the data furnished with the raw material from the Mill, or Bay Standard in-house testing results, or outside lab testing results.

By:
Wally Gross, President and CEO

Completed by:
Andrea Gaylor

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Brentwood, CA 94513
925-634-1181

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Customer Information

Invoiced 9/27/2024

Bill to:
HARDY FRAMES, DBA ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00291576
PO# P550593
5 PCS - 87C3000ATR3/M

Item Information

Part No - 87C3000ATR3/M
Part Desc. - 7/8-9 X 30" ATR DOM F1554-36 PLAIN
Size (Major Diameter) - 7/8 "
Size (Overall Length) - 30 "
Specification - ASTM F1554-18 GR36
Test Method - Table 2 - Axial Testing

Heat Number - 3500037296
BSMI Lot Number - 2409265-9

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (lbf) = 31000	Min Yield (lbf) = 16600	*Elongation - 23.6 %
Tensile (lbf) = 34600	Min Tensile (lbf) = 26800	*Reduction of Area - 65.9 %
	Max Tensile (lbf) = 37000	*Yield (ksi) - 67.1
		*Tensile (ksi) - 74.9

* Values are for information purposes and are not required for ASTM F1554-18 GR36.

Chemical Analysis

C - 0.100 %	Si - 0.180 %
Mn - 0.560 %	Cu - 0.310 %
P - 0.009 %	Ni - 0.080 %
S - 0.025 %	Cr - 0.120 %
	Mo - 0.020 %

We Certify that the material indicated above was tested at the mill or by BSMI and found to conform to the grade and specification indicated.
We Hereby certify that the forgoing data is a true copy of the data furnished with the raw material from the Mill, or Bay Standard in-house testing results, or outside lab testing results.

By:
Wally Gross, President and CEO

Completed by:
Elizabeth Denis

Bay Standard Manufacturing, Inc.
24485 Marsh Creek Road
Brentwood, CA 94513
925-634-1181

* * * CERTIFICATE OF TEST * * *

Customer Information

Invoiced 9/27/2024

Bill to:
HARDY FRAMES, DBA ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00291576
PO# P550593
5 PCS - 87C2400ATR3/M

Item Information

Part No - 87C2400ATR3/M
Part Desc. - 7/8-9 X 24" ATR DOM F1554-36 PLAIN (300)
Size (Major Diameter) - 7/8 "
Size (Overall Length) - 24 "
Specification - ASTM F1554-18 GR36
Test Method - Table 2 - Axial Testing

Heat Number - 3500036850
BSMI Lot Number - 2407165-4

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (lbf) = 28700	Min Yield (lbf) = 16600	*Elongation - 26.3 %
Tensile (lbf) = 33500	Min Tensile (lbf) = 26800	*Reduction of Area - 67.5 %
	Max Tensile (lbf) = 37000	*Yield (ksi) - 62.1
		*Tensile (ksi) - 72.5
		* Values are for information purposes and are not required for ASTM F1554-18 GR36.

Chemical Analysis

C - 0.100 %	Si - 0.190 %
Mn - 0.580 %	Cu - 0.320 %
P - 0.013 %	Ni - 0.100 %
S - 0.024 %	Cr - 0.180 %
	Mo - 0.030 %

We Certify that the material indicated above was tested at the mill or by BSMI and found to conform to the grade and specification indicated.
We Hereby certify that the forgoing data is a true copy of the data furnished with the raw material from the Mill, or Bay Standard in-house testing results, or outside lab testing results.

By:
Wally Gross, President and CEO

Completed by:
Elizabeth Denis

Bay Standard Manufacturing, Inc.
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Brentwood, CA 94513
925-634-1181

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Customer Information

Invoiced 9/27/2024

Bill to:
HARDY FRAMES, DBA ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00291576
PO# P550593
3 PCS - 87C1600ATR3/M

Item Information

Part No - 87C1600ATR3/M
Part Desc. - 7/8-9 X 16" ATR DOM F1554-36 PLAIN
Size (Major Diameter) - 7/8 "
Size (Overall Length) - 16 "
Specification - ASTM F1554-18 GR36
Test Method - Table 2 - Axial Testing

Heat Number - 3500036851
BSMI Lot Number - 2409265-8

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (lbf) = 32200	Min Yield (lbf) = 16600	*Elongation - 7790 %
Tensile (lbf) = 36000	Min Tensile (lbf) = 26800	*Reduction of Area - 0.66 %
	Max Tensile (lbf) = 37000	*Yield (ksi) - 0.1
		*Tensile (ksi) - 0.1
		* Values are for information purposes and are not required for ASTM F1554-18 GR36.

Chemical Analysis

C - 0.100 %	Si - 0.160 %
Mn - 0.550 %	Cu - 0.350 %
P - 0.015 %	Ni - 0.110 %
S - 0.025 %	Cr - 0.200 %
	Mo - 0.030 %

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By:
Wally Gross, President and CEO

Completed by:
Elizabeth Denis

Bay Standard Manufacturing, Inc.
24485 Marsh Creek Road
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CORONA, CA 92879

Order Information

Order No. 05-00290275
PO# P548765
8 PCS - 100C12000ATR2/M

Item Information

Part No - 100C12000ATR2/M
Part Desc. - 1-8 X 120" ATR DOM A307A PLAIN (120)
Size (Major Diameter) - 1 "
Size (Overall Length) - 120 "
Specification - ASTM F1554-18 GR36
Test Method - Table 2 - Axial Testing

Heat Number - 1000224730
BSMI Lot Number - 2404154-29A

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (lbf) = 28800	Min Yield (lbf) = 21800	*Elongation - 28.5 %
Tensile (lbf) = 38700	Min Tensile (lbf) = 35200	*Reduction of Area - 62.5 %
	Max Tensile (lbf) = 48500	*Yield (ksi) - 47.5
		*Tensile (ksi) - 64

* Values are for information purposes and are not required for ASTM F1554-18 GR36.

Chemical Analysis

C - 0.120 %	Ni - 0.110 %
Mn - 0.450 %	Cr - 0.070 %
P - 0.008 %	Mo - 0.030 %
S - 0.031 %	V - 0.003 %
Si - 0.170 %	Nb - 0.002 %
Cu - 0.250 %	Al - 0.001 %
	Sn - 0.009 %

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By:
Wally Gross, President and CEO

Completed by:
Andrea Gaylor

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CORONA, CA 92879

Order Information

Order No. 05-00290275
PO# P548765
4 PCS - 100C13000ATR3/M

Item Information

Part No - 100C13000ATR3/M
Part Desc. - 1-8 X 130" ATR DOM F1554-36 PLAIN
Size (Major Diameter) - 1 "
Size (Overall Length) - 130 "
Specification - ASTM F1554-18 GR36
Test Method - Table 2 - Axial Testing

Heat Number - 1000122903
BSMI Lot Number - 2409135-10

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (lbf) = 29700	Min Yield (lbf) = 21800	*Elongation - 31 %
Tensile (lbf) = 38000	Min Tensile (lbf) = 35200	*Reduction of Area - 65.4 %
	Max Tensile (lbf) = 48500	*Yield (ksi) - 49
		*Tensile (ksi) - 62.7
		* Values are for information purposes and are not required for ASTM F1554-18 GR36.

Chemical Analysis

C - 0.100 %	Cr - 0.070 %
Mn - 0.510 %	Mo - 0.020 %
P - 0.010 %	V - 0.002 %
S - 0.020 %	Nb - 0.001 %
Si - 0.180 %	Al - 0.002 %
Cu - 0.190 %	Sn - 0.009 %
Ni - 0.080 %	Ti - 0.001 %

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Order Information

Order No. 05-00291576
PO# P550593
15 PCS - 100C2400ATR3/M

Item Information

Part No - 100C2400ATR3/M
Part Desc. - 1-8 X 24" ATR DOM F1554-36 PLAIN (240)
Size (Major Diameter) - 1 "
Size (Overall Length) - 24 "
Specification - ASTM F1554-18 GR36
Test Method - Table 2 - Axial Testing

Heat Number - 1000226055
BSMI Lot Number - 2406134-64B

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (lbf) = 33600	Min Yield (lbf) = 21800	*Elongation - 27.3 %
Tensile (lbf) = 41200	Min Tensile (lbf) = 35200	*Reduction of Area - 60.8 %
	Max Tensile (lbf) = 48500	*Yield (ksi) - 55.5
		*Tensile (ksi) - 68.1
		* Values are for information purposes and are not required for ASTM F1554-18 GR36.

Chemical Analysis

C - 0.130 %	Ni - 0.100 %
Mn - 0.490 %	Cr - 0.060 %
P - 0.012 %	Mo - 0.030 %
S - 0.029 %	V - 0.003 %
Si - 0.210 %	Nb - 0.002 %
Cu - 0.230 %	Al - 0.002 %
	Sn - 0.010 %

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Order Information

Order No. 05-00291576
PO# P550593
3 PCS - 100C1600ATR3/MB

Item Information

Part No - 100C1600ATR3/MB
Part Desc. - 1-8 X 16" ATR DOM F1554-36 PLAIN BULK
Size (Major Diameter) - 1 "
Size (Overall Length) - 16 "
Specification - ASTM F1554-18 GR36
Test Method - Table 2 - Axial Testing

Heat Number - 1000122229
BSMI Lot Number - 2409265-27

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (lbf) = 33700	Min Yield (lbf) = 21800	*Elongation - 25.8 %
Tensile (lbf) = 41200	Min Tensile (lbf) = 35200	*Reduction of Area - 57.8 %
	Max Tensile (lbf) = 48500	*Yield (ksi) - 55.6
		*Tensile (ksi) - 68

* Values are for information purposes and are not required for ASTM F1554-18 GR36.

Chemical Analysis

C - 0.100 %	Cr - 0.170 %
Mn - 0.560 %	Mo - 0.030 %
P - 0.016 %	V - 0.002 %
S - 0.033 %	Nb - 0.002 %
Si - 0.190 %	Al - 0.001 %
Cu - 0.240 %	Sn - 0.011 %
Ni - 0.100 %	Ti - 0.001 %

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Order Information

Order No. 05-00291576
PO# P550593
15 PCS - 100C3000ATR3/M

Item Information

Part No - 100C3000ATR3/M
Part Desc. - 1-8 X 30" ATR DOM F1554-36 PLAIN
Size (Major Diameter) - 1 "
Size (Overall Length) - 30 "
Specification - ASTM F1554-18 GR36
Test Method - Table 2 - Axial Testing

Heat Number - 1000224731
BSMI Lot Number - 2409265-28

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (lbf) = 32900	Min Yield (lbf) = 21800	*Elongation - 25.6 %
Tensile (lbf) = 40600	Min Tensile (lbf) = 35200	*Reduction of Area - 61.1 %
	Max Tensile (lbf) = 48500	*Yield (ksi) - 54.4
		*Tensile (ksi) - 67.1

* Values are for information purposes and are not required for ASTM F1554-18 GR36.

Chemical Analysis

C - 0.130 %	Ni - 0.120 %
Mn - 0.440 %	Cr - 0.070 %
P - 0.009 %	Mo - 0.040 %
S - 0.037 %	V - 0.002 %
Si - 0.130 %	Nb - 0.002 %
Cu - 0.260 %	Sn - 0.009 %

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Order Information

Order No. 05-00290275
PO# P548765
1 PCS - 125C12000ATR2/M

Item Information

Part No - 125C12000ATR2/M
Part Desc. - 1 1/4-7 X 120" ATR DOM A307A PLAIN (75)
Size (Major Diameter) - 1 1/4 "
Size (Overall Length) - 120 "
Specification - ASTM F1554-18 GR36
Test Method -Table 3 - Mill Certification

Heat Number - 120205770020
BSMI Lot Number - 2404184-17A

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 44.8
Tensile (ksi) - 64.3
Elongation - 35 %
Reduction of Area - 64 %

Chemical Analysis

C - 0.130 %
Mn - 0.720 %
P - 0.009 %
S - 0.031 %
Si - 0.180 %
Cu - 0.420 %
Ni - 0.090 %
Cr - 0.130 %
Mo - 0.020 %
V - 0.001 %

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By:
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Completed by:
Andrea Gaylor

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Order Information

Order No. 05-00290275
PO# P548765
3 PCS - 125C12000ATR2/M

Item Information

Part No - 125C12000ATR2/M
Part Desc. - 1 1/4-7 X 120" ATR DOM A307A PLAIN (75)
Size (Major Diameter) - 1 1/4 "
Size (Overall Length) - 120 "
Specification - ASTM F1554-18 GR36
Test Method -Table 3 - Mill Certification

Heat Number - 100012516621
BSMI Lot Number - 2407254-30A

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 46
Tensile (ksi) - 68.7
Elongation - 23 %
Reduction of Area - 40 %

Chemical Analysis

C - 0.170 %
Mn - 0.620 %
P - 0.013 %
S - 0.030 %
Si - 0.150 %
Cu - 0.180 %
Ni - 0.060 %
Cr - 0.090 %
Mo - 0.020 %
V - 0.002 %
Nb - 0.000 %
Al - 0.001 %
Sn - 0.008 %
Ti - 0.001 %

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Order Information

Order No. 05-00290275
PO# P548765
4 PCS - 150C12000ATR2/M

Item Information

Part No - 150C12000ATR2/M
Part Desc. - 1 1/2-6 X 120" ATR DOM A307A PLAIN (50)
Size (Major Diameter) - 1 1/2 "
Size (Overall Length) - 120 "
Specification - ASTM F1554-18 GR36
Test Method -Table 3 - Mill Certification

Heat Number - 100022579321
BSMI Lot Number - 2407094-1A

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 47.4
Tensile (ksi) - 70.1
Elongation - 24 %
Reduction of Area - 41 %

Chemical Analysis

C - 0.160 %
Mn - 0.660 %
P - 0.016 %
S - 0.010 %
Si - 0.180 %
Cu - 0.170 %
Ni - 0.110 %
Cr - 0.160 %
Mo - 0.030 %
V - 0.003 %
Nb - 0.002 %
Al - 0.001 %
Sn - 0.008 %
Ti - 0.001 %

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Order Information

Order No. 05-00291576
PO# P550593
3 PCS - 75C1600ATR7/M

Item Information

Part No - 75C1600ATR7/M
Part Desc. - 3/4-10 X 16" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 3/4 "
Size (Overall Length) - 16 "
Specification - ASTM F1554-18 GR105
Test Method -Table 3

Heat Number - 8000018336
BSMI Lot Number - 2409265-2

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 134
Tensile (ksi) - 145
Elongation - 23.9 %
Reduction of Area - 57.1 %

Mid-radius Hardness (HRC) - 31

Chemical Analysis

C - 0.430 %
Mn - 0.900 %
P - 0.012 %
S - 0.002 %
Si - 0.283 %
Cu - 0.180 %
Ni - 0.070 %
Cr - 0.860 %
Mo - 0.160 %
V - 0.005 %
Al - 0.031 %

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Order Information

Order No. 05-00291576
PO# P550593
38 PCS - 75C1200ATR7/M

Item Information

Part No - 75C1200ATR7/M
Part Desc. - 3/4-10 X 12" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 3/4 "
Size (Overall Length) - 12 "
Specification - ASTM F1554-18 GR105
Test Method -Table 3

Heat Number - 800002446522
BSMI Lot Number - 2409265-4

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 119
Tensile (ksi) - 135
Elongation - 24.5 %
Reduction of Area - 63.9 %

Mid-radius Hardness (HRC) - 30

Chemical Analysis

C - 0.410 %
Mn - 0.850 %
P - 0.007 %
S - 0.003 %
Si - 0.255 %
Cu - 0.220 %
Ni - 0.080 %
Cr - 0.930 %
Mo - 0.170 %
V - 0.008 %
Al - 0.024 %

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Order Information

Order No. 05-00290275
PO# P548765
8 PCS - 100C12000ATR7/M

Item Information

Part No - 100C12000ATR7/M
Part Desc. - 1-8 X 120" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 1 "
Size (Overall Length) - 120 "
Specification - ASTM A193-23 B7 & ASTM F1554-18 GR105
Mill & Heat Treating Certification

Heat Number - 100022423841
BSMI Lot Number - 2409135-8

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 136
Tensile (ksi) - 149
Elongation - 19 %
Reduction of Area - 55 %

Mid-radius Hardness (HRC) - 32

Chemical Analysis

C - 0.410 %
Mn - 0.950 %
P - 0.013 %
S - 0.006 %
Si - 0.320 %
Cu - 0.150 %
Ni - 0.060 %
Cr - 0.970 %
Mo - 0.190 %
V - 0.005 %
Nb - 0.004 %
Al - 0.028 %
Sn - 0.008 %
Ti - 0.002 %
N - 66.000 %

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Order Information

Order No. 05-00290275
PO# P548765
8 PCS - 112C12000ATR7/M

Item Information

Part No - 112C12000ATR7/M
Part Desc. - 1 1/8-7 X 120" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 1 1/8 "
Size (Overall Length) - 120 "
Specification - ASTM A193-23 B7 & ASTM F1554-18 GR105
Mill & Heat Treating Certification

Heat Number - 1000215643
BSMI Lot Number - 2309064-32B

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 126
Tensile (ksi) - 141

Elongation - 20 %
Reduction of Area - 57 %

Mid-radius Hardness (HRC) - 29

Chemical Analysis

C - 0.410 %
Mn - 0.930 %
P - 0.011 %
S - 0.002 %
Si - 0.290 %
Cu - 0.180 %
Ni - 0.120 %
Cr - 0.990 %
Mo - 0.200 %
V - 0.004 %
Nb - 0.004 %
Al - 0.026 %
Sn - 0.015 %
Ti - 0.002 %
N - 82.000 %

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Order Information

Order No. 05-00290275
PO# P548765
8 PCS - 125C12000ATR7/M

Item Information

Part No - 125C12000ATR7/M
Part Desc. - 1 1/4-7 X 120" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 1 1/4 "
Size (Overall Length) - 120 "
Specification - ASTM A193-23 B7 & ASTM F1554-18 GR105
Mill & Heat Treating Certification

Heat Number - 100012388020
BSMI Lot Number - 2409135-4

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 123
Tensile (ksi) - 136
Elongation - 21 %
Reduction of Area - 60 %

Mid-radius Hardness (HRC) - 31

Chemical Analysis

C - 0.410 %
Mn - 0.970 %
P - 0.013 %
S - 0.003 %
Si - 0.280 %
Cu - 0.160 %
Ni - 0.060 %
Cr - 0.990 %
Mo - 0.180 %
V - 0.004 %
Nb - 0.002 %
Al - 0.027 %
Sn - 0.007 %
Ti - 0.002 %
N - 72.000 %

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ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00290275
PO# P548765
16 PCS - 150C12000ATR7/M

Item Information

Part No - 150C12000ATR7/M
Part Desc. - 1 1/2-6 X 120" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 1 1/2 "
Size (Overall Length) - 120 "
Specification - ASTM A193-23 B7 & ASTM F1554-18 GR105
Mill & Heat Treating Certification

Heat Number - 100012080721
BSMI Lot Number - 2404104-58A

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 124
Tensile (ksi) - 140

Elongation - 21 %
Reduction of Area - 62 %

Mid-radius Hardness (HRC) - 31

Chemical Analysis

C - 0.430 %
Mn - 0.900 %
P - 0.008 %
S - 0.025 %
Si - 0.280 %
Cu - 0.150 %
Ni - 0.080 %
Cr - 0.980 %
Mo - 0.180 %
V - 0.004 %
Nb - 0.003 %
Al - 0.031 %
Sn - 0.013 %
Ti - 0.002 %
N - 69.000 %

We Certify that the material indicated above was tested at the mill or by BSMI and found to conform to the grade and specification indicated.
We Hereby certify that the forgoing data is a true copy of the data furnished with the raw material from the Mill, or Bay Standard in-house testing results, or outside lab testing results.

By:
Wally Gross, President and CEO

Completed by:
Andrea Gaylor

Bay Standard Manufacturing, Inc.
24485 Marsh Creek Road
Brentwood, CA 94513
925-634-1181

* * * CERTIFICATE OF TEST * * *

Customer Information

Invoiced 9/13/2024

Bill to:
HARDY FRAMES, DBA ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00290275
PO# P548765
28 PCS - 175C12000ATR7/M

Item Information

Part No - 175C12000ATR7/M
Part Desc. - 1 3/4-5 X 120" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 1 3/4 "
Size (Overall Length) - 120 "
Specification - ASTM A193-23 B7 & ASTM F1554-18 GR105
Mill & Heat Treating Certification

Heat Number - 1000119496
BSMI Lot Number - 2409044-3A

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 129
Tensile (ksi) - 145

Elongation - 21 %
Reduction of Area - 61 %

Mid-radius Hardness (HRC) - 31

Chemical Analysis

C - 0.400 %
Mn - 0.900 %
P - 0.008 %
S - 0.005 %
Si - 0.230 %
Cu - 0.150 %
Ni - 0.120 %
Cr - 1.000 %
Mo - 0.200 %
V - 0.004 %
Nb - 0.002 %
Al - 0.024 %
Sn - 0.007 %
Ti - 0.002 %
N - 85.000 %

We Certify that the material indicated above was tested at the mill or by BSMI and found to conform to the grade and specification indicated.
We Hereby certify that the forgoing data is a true copy of the data furnished with the raw material from the Mill, or Bay Standard in-house testing results, or outside lab testing results.

By:
Wally Gross, President and CEO

Completed by:
Andrea Gaylor

Bay Standard Manufacturing, Inc.
24485 Marsh Creek Road
Brentwood, CA 94513
925-634-1181

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Customer Information

Invoiced 9/13/2024

Bill to:
HARDY FRAMES, DBA ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00290275
PO# P548765
4 PCS - 175C9400ATR7/M

Item Information

Part No - 175C9400ATR7/M
Part Desc. - 1 3/4-5X 94" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 1 3/4 "
Size (Overall Length) - 94 "
Specification - ASTM A193-23 B7 & ASTM F1554-18 GR105
Mill & Heat Treating Certification

Heat Number - 1000119496
BSMI Lot Number - 2409135-6

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 129
Tensile (ksi) - 145

Elongation - 21 %
Reduction of Area - 61 %

Mid-radius Hardness (HRC) - 31

Chemical Analysis

C - 0.400 %
Mn - 0.900 %
P - 0.008 %
S - 0.005 %
Si - 0.230 %
Cu - 0.150 %
Ni - 0.120 %
Cr - 1.000 %
Mo - 0.200 %
V - 0.004 %
Nb - 0.002 %
Al - 0.024 %
Sn - 0.007 %
Ti - 0.002 %
N - 85.000 %

We Certify that the material indicated above was tested at the mill or by BSMI and found to conform to the grade and specification indicated.
We Hereby certify that the forgoing data is a true copy of the data furnished with the raw material from the Mill, or Bay Standard in-house testing results, or outside lab testing results.

By:
Wally Gross, President and CEO

Completed by:
Andrea Gaylor

Bay Standard Manufacturing, Inc.
24485 Marsh Creek Road
Brentwood, CA 94513
925-634-1181

*** CERTIFICATE OF TEST ***

Customer Information

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Bill to:
HARDY FRAMES, DBA ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00290275
PO# P548765
12 PCS - 200C12000ATR7/M

Item Information

Part No - 200C12000ATR7/M
Part Desc. - 2-4 1/2 X 120" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 2 "
Size (Overall Length) - 120 "
Specification - ASTM A193-23 B7 & ASTM F1554-18 GR105
Mill & Heat Treating Certification

Heat Number - 100204629
BSMI Lot Number - 2408304-27A

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 125
Tensile (ksi) - 141
Elongation - 22 %
Reduction of Area - 61 %

Mid-radius Hardness (HRC) - 30

Chemical Analysis

C - 0.410 %	Mo - 0.160 %
Mn - 0.880 %	V - 0.004 %
P - 0.012 %	Nb - 0.004 %
S - 0.020 %	Al - 0.030 %
Si - 0.290 %	Sn - 0.008 %
Cu - 0.180 %	Ti - 0.001 %
Ni - 0.070 %	N - 80.000 %
Cr - 0.960 %	Ca - 0.001 %

We Certify that the material indicated above was tested at the mill or by BSMI and found to conform to the grade and specification indicated.
We Hereby certify that the forgoing data is a true copy of the data furnished with the raw material from the Mill, or Bay Standard in-house testing results, or outside lab testing results.

By:
Wally Gross, President and CEO

Completed by:
Andrea Gaylor

Bay Standard Manufacturing, Inc.
24485 Marsh Creek Road
Brentwood, CA 94513
925-634-1181

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Customer Information

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Bill to:
HARDY FRAMES, DBA ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00290275
PO# P548765
4 PCS - 200C5800ATR7/M

Item Information

Part No - 200C5800ATR7/M
Part Desc. - 2-4 1/2 X 58" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 2 "
Size (Overall Length) - 58 "
Specification - ASTM A193-23 B7 & ASTM F1554-18 GR105
Mill & Heat Treating Certification

Heat Number - 100204629
BSMI Lot Number - 2409135-11

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 125
Tensile (ksi) - 141
Elongation - 22 %
Reduction of Area - 61 %

Mid-radius Hardness (HRC) - 30

Chemical Analysis

C - 0.410 %	Mo - 0.160 %
Mn - 0.880 %	V - 0.004 %
P - 0.012 %	Nb - 0.004 %
S - 0.020 %	Al - 0.030 %
Si - 0.290 %	Sn - 0.008 %
Cu - 0.180 %	Ti - 0.001 %
Ni - 0.070 %	N - 80.000 %
Cr - 0.960 %	Ca - 0.001 %

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By:
Wally Gross, President and CEO

Completed by:
Andrea Gaylor

Bay Standard Manufacturing, Inc.
24485 Marsh Creek Road
Brentwood, CA 94513
925-634-1181

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Customer Information

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Bill to:
HARDY FRAMES, DBA ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00290275
PO# P548765
4 PCS - 200C3600ATR7/M

Item Information

Part No - 200C3600ATR7/M
Part Desc. - 2-4 1/2 X 36" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 2 "
Size (Overall Length) - 36 "
Specification - ASTM A193-23 B7 & ASTM F1554-18 GR105
Mill & Heat Treating Certification

Heat Number - 100204629
BSMI Lot Number - 2409135-13

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 125
Tensile (ksi) - 141
Elongation - 22 %
Reduction of Area - 61 %

Mid-radius Hardness (HRC) - 30

Chemical Analysis

C - 0.410 %	Mo - 0.160 %
Mn - 0.880 %	V - 0.004 %
P - 0.012 %	Nb - 0.004 %
S - 0.020 %	Al - 0.030 %
Si - 0.290 %	Sn - 0.008 %
Cu - 0.180 %	Ti - 0.001 %
Ni - 0.070 %	N - 80.000 %
Cr - 0.960 %	Ca - 0.001 %

We Certify that the material indicated above was tested at the mill or by BSMI and found to conform to the grade and specification indicated.
We Hereby certify that the forgoing data is a true copy of the data furnished with the raw material from the Mill, or Bay Standard in-house testing results, or outside lab testing results.

By:
Wally Gross, President and CEO

Completed by:
Andrea Gaylor

Bay Standard Manufacturing, Inc.
24485 Marsh Creek Road
Brentwood, CA 94513
925-634-1181

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Customer Information

Invoiced 9/27/2024

Bill to:
HARDY FRAMES, DBA ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00291576
PO# P550593
1 PCS - 200C3600ATR7/M

Item Information

Part No - 200C3600ATR7/M
Part Desc. - 2-4 1/2 X 36" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 2 "
Size (Overall Length) - 36 "
Specification - ASTM F1554-18 GR105
Test Method -Table 3

Heat Number - 100104206
BSMI Lot Number - 2310125-4

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 122
Tensile (ksi) - 139

Elongation - 22 %
Reduction of Area - 62 %

Mid-radius Hardness (HRC) - 30

Chemical Analysis

C - 0.410 %
Mn - 0.860 %
P - 0.012 %
S - 0.019 %
Si - 0.280 %
Cu - 0.170 %
Ni - 0.070 %
Cr - 0.950 %
Mo - 0.170 %
V - 0.004 %
Nb - 0.003 %
Al - 0.027 %
Sn - 0.008 %
Ti - 0.001 %
N - 75.000 %
Ca - 0.001 %

We Certify that the material indicated above was tested at the mill or by BSMI and found to conform to the grade and specification indicated.
We Hereby certify that the forgoing data is a true copy of the data furnished with the raw material from the Mill, or Bay Standard in-house testing results, or outside lab testing results.

By:
Wally Gross, President and CEO

Completed by:
Elizabeth Denis

Bay Standard Manufacturing, Inc.
24485 Marsh Creek Road
Brentwood, CA 94513
925-634-1181

* * * CERTIFICATE OF TEST * * *

Customer Information

Invoiced 9/27/2024

Bill to:
HARDY FRAMES, DBA ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Ship to:
ZONE FOUR
555 S PROMENADE
CORONA, CA 92879

Order Information

Order No. 05-00291576
PO# P550593
4 PCS - 200C3600ATR7/M

Item Information

Part No - 200C3600ATR7/M
Part Desc. - 2-4 1/2 X 36" ATR DOM B7/GR105 PLAIN
Size (Major Diameter) - 2 "
Size (Overall Length) - 36 "
Specification - ASTM F1554-18 GR105
Test Method -Table 3

Heat Number - 100204629
BSMI Lot Number - 2409265-31

Country of Origin - USA
Domestic Made and Melt.

Mechanicals

Yield (ksi) - 125
Tensile (ksi) - 141
Elongation - 22 %
Reduction of Area - 61 %

Mid-radius Hardness (HRC) - 30

Chemical Analysis

C - 0.410 %	Mo - 0.160 %
Mn - 0.880 %	V - 0.004 %
P - 0.012 %	Nb - 0.004 %
S - 0.020 %	Al - 0.030 %
Si - 0.290 %	Sn - 0.008 %
Cu - 0.180 %	Ti - 0.001 %
Ni - 0.070 %	N - 80.000 %
Cr - 0.960 %	Ca - 0.001 %

We Certify that the material indicated above was tested at the mill or by BSMI and found to conform to the grade and specification indicated.
We Hereby certify that the forgoing data is a true copy of the data furnished with the raw material from the Mill, or Bay Standard in-house testing results, or outside lab testing results.

By:
Wally Gross, President and CEO

Completed by:
Elizabeth Denis

Appendix G: HSS Mill Certifications

The following mill certifications were provided by Mnf-4 and document the material properties of the tested members. The highlighted rows indicate the mill certifications corresponding to the members tested in this study. When multiple mill certifications were available for the same member size, the average material properties from the applicable certifications were used for analysis.

Atlas Tube Arkansas
6651 E Hwy 137
Blytheville Arkansas USA
72315
Tel:
Fax:

Atlas Tube
A DIVISION OF ZEKELMAN INDUSTRIES

REF.B/L: 81231442
Date: 07/12/2024
Customer: 2478

MATERIAL TEST REPORT

Sold To
Atlas Tube (Chicago) LLC
1855 East 122nd Street
CHICAGO IL 60633
USA

Shipped To
McMahon Steel Company Inc.
1880 Nirvana Ave.
CHULA VISTA CA 91911
USA

Material: 6.0x6.0x188x40'0"0(1x1)PBSP373 **Material No:** 60060188 **Made in:** USA
Melted and Poured in: USA
Sales Order: 2046434 **Purchase Order:** CFS10: HSS tube requ

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti	B	N	Ca
23069851	0.210	0.750	0.008	0.002	0.030	0.025	0.090	0.001	0.017	0.050	0.060	0.003	0.002	0.0002	0.0075	0.0015

Bundle No	PCs	Yield	Tensile	Eln.2in	Certification	CE: 0.37
M500476886	1	065295 Psi	078697 Psi	34 %	ASTM A500-21 GRADE B&C	

Heat	MILL	Mill Location	Method	Recycled_Content	Post_Consumer	Pre-Consumer (Post Industrial)	% Harvested	Within Miles of Location
23069851	BIGRIVER	Osceola,AR	EAF	76.00%	95.00%	5.00 %	75%	500

Material Note:
Sales Or. Note:

Material: 6.0x6.0x188x40'0"0(2x1)PB **Material No:** 60060188 **Made in:** USA
Melted and Poured in: USA
Sales Order: 2046434 **Purchase Order:** CFS10: HSS tube requ

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti	B	N	Ca
24067572	0.200	0.730	0.020	0.002	0.040	0.028	0.090	0.001	0.012	0.040	0.060	0.002	0.000	0.0000	0.0077	0.0022

Bundle No	PCs	Yield	Tensile	Eln.2in	Certification	CE: 0.35
M500520147	2	062348 Psi	076545 Psi	33 %	ASTM A500-23 GRADE B&C	

Heat	MILL	Mill Location	Method	Recycled_Content	Post_Consumer	Pre-Consumer (Post Industrial)	% Harvested	Within Miles of Location
24067572	BIGRIVER	Osceola,AR	EAF	76.00%	95.00%	5.00 %	75%	500

Material Note:
Sales Or. Note:

Authorized by Quality Assurance Jason Richard
Jason Richard

The results reported on this report represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements. CE calculated using the AWS D1.1 method. Steel is purchased fully killed with a fine grain practice. This document is in compliance with the requirements of EN10204 type3.1

Steel Tube Institute OF NORTH AMERICA

Metals Service Center Institute

Atlas Tube Arkansas
6651 E Hwy 137
Blytheville Arkansas USA
72315
Tel:
Fax:

Atlas Tube
A DIVISION OF ZEKELMAN INDUSTRIES

REF.B/L: 81231442
Date: 07/12/2024
Customer: 2478

MATERIAL TEST REPORT

Sold To
Atlas Tube (Chicago) LLC
1855 East 122nd Street
CHICAGO IL 60633
USA

Shipped To
McMahon Steel Company Inc.
1880 Nirvana Ave.
CHULA VISTA CA 91911
USA

Material: 6.0x6.0x250x30'0"0(2x2)OUT **Material No:** 60060250 **Made in:** USA
Melted and Poured in: USA
Sales Order: 2046434 **Purchase Order:** CFS10: HSS tube requ

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti	B	N	Ca
24059871	0.200	0.740	0.007	0.004	0.030	0.028	0.080	0.002	0.011	0.030	0.060	0.002	0.001	0.0002	0.0064	0.0017

Bundle No	PCs	Yield	Tensile	Eln.2in	Certification	CE: 0.35
M500514458	4	065091 Psi	078962 Psi	35 %	ASTM A500-23 GRADE B&C	

Heat	MILL	Mill Location	Method	Recycled_Content	Post_Consumer	Pre-Consumer (Post Industrial)	% Harvested	Within Miles of Location
24059871	BIGRIVER	Osceola,AR	EAF	76.00%	95.00%	5.00 %	75%	500

Material Note:
Sales Or. Note:

Material: 6.0x6.0x313x48'0"0(3x1)PB **Material No:** 60060313 **Made in:** USA
Melted and Poured in: USA
Sales Order: 2046434 **Purchase Order:** CFS10: HSS tube requ

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti	B	N	Ca
24050032	0.210	0.750	0.011	0.004	0.010	0.035	0.090	0.001	0.013	0.030	0.070	0.003	0.001	0.0001	0.0067	0.0018

Bundle No	PCs	Yield	Tensile	Eln.2in	Certification	CE: 0.36
M500511051	3	067026 Psi	086933 Psi	35 %	ASTM A500-23 GRADE B&C	

Heat	MILL	Mill Location	Method	Recycled_Content	Post_Consumer	Pre-Consumer (Post Industrial)	% Harvested	Within Miles of Location
24050032	BIGRIVER	Osceola,AR	EAF	76.00%	95.00%	5.00 %	75%	500

Material Note:
Sales Or. Note:

Authorized by Quality Assurance Jason Richard
Jason Richard

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Steel Tube Institute OF NORTH AMERICA

Metals Service Center Institute

Atlas Tube Arkansas
6651 E Hwy 137
Blytheville Arkansas USA
72315
Tel:
Fax:

Atlas Tube
A DIVISION OF ZEKELMAN INDUSTRIES

REF.B/L: 81231442
Date: 07/12/2024
Customer: 2478

MATERIAL TEST REPORT

Sold To
Atlas Tube (Chicago) LLC
1855 East 122nd Street
CHICAGO IL 60633
USA

Shipped To
McMahon Steel Company Inc.
1880 Nirvana Ave.
CHULA VISTA CA 91911
USA

Material: 6.0x6.0x375x40'6"0(1x2). **Material No:** 60060375 **Made in:** USA
Melted and Poured in: USA
Sales Order: 2046434 **Purchase Order:** CFS10: HSS tube requ

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti	B	N	Ca
24056022	0.200	0.710	0.009	0.003	0.030	0.029	0.040	0.000	0.009	0.030	0.030	0.002	0.000	0.0001	0.0068	0.0030

Bundle No	PCs	Yield	Tensile	Eln.2in	Certification	CE: 0.34
M500514665	2	063624 Psi	079504 Psi	36 %	ASTM A500-23 GRADE B&C	

Heat	MILL	Mill Location	Method	Recycled_Content	Post_Consumer	Pre-Consumer (Post Industrial)	% Harvested	Within Miles of Location
24056022	BIGRIVER	Osceola,AR	EAF	76.00%	95.00%	5.00 %	75%	500

Material Note:
Sales Or. Note:

Material: 6.0x6.0x375x48'0"0(1x1)PB **Material No:** 60060375 **Made in:** USA
Melted and Poured in: USA
Sales Order: 2046434 **Purchase Order:** CFS10: HSS tube requ

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti	B	N	Ca
24055652	0.210	0.760	0.011	0.002	0.030	0.032	0.090	0.001	0.013	0.040	0.060	0.003	0.001	0.0002	0.0059	0.0026

Bundle No	PCs	Yield	Tensile	Eln.2in	Certification	CE: 0.37
M500514751	1	068558 Psi	079903 Psi	31 %	ASTM A500-23 GRADE B&C	

Heat	MILL	Mill Location	Method	Recycled_Content	Post_Consumer	Pre-Consumer (Post Industrial)	% Harvested	Within Miles of Location
24055652	BIGRIVER	Osceola,AR	EAF	76.00%	95.00%	5.00 %	75%	500

Material Note:
Sales Or. Note:

Authorized by Quality Assurance Jason Richard
Jason Richard

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Steel Tube Institute OF NORTH AMERICA

Metals Service Center Institute

Atlas Tube Arkansas
6651 E Hwy 137
Blytheville Arkansas USA
72315
Tel:
Fax:

Atlas Tube
A DIVISION OF ZEKELMAN INDUSTRIES

REF.B/L: 81231442
Date: 07/12/2024
Customer: 2478

MATERIAL TEST REPORT

Sold To
Atlas Tube (Chicago) LLC
1855 East 122nd Street
CHICAGO IL 60633
USA

Shipped To
McMahon Steel Company Inc.
1880 Nirvana Ave.
CHULA VISTA CA 91911
USA

Material: 6.0x6.0x500x48'0"0(1x1)PB **Material No:** 60060500 **Made in:** USA
Melted and Poured in: USA
Sales Order: 2046434 **Purchase Order:** CFS10: HSS tube requ

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti	B	N	Ca
24051842	0.210	0.760	0.009	0.003	0.030	0.033	0.090	0.001	0.010	0.030	0.040	0.003	0.001	0.0002	0.0066	0.0015

Bundle No	PCs	Yield	Tensile	Eln.2in	Certification	CE: 0.36
M500514600	1	068453 Psi	086210 Psi	34 %	ASTM A500-23 GRADE B&C	

Heat	MILL	Mill Location	Method	Recycled_Content	Post_Consumer	Pre-Consumer (Post Industrial)	% Harvested	Within Miles of Location
24051842	BIGRIVER	Osceola,AR	EAF	76.00%	95.00%	5.00 %	75%	500

Material Note:
Sales Or. Note:

Material: 6.0x6.0x500x21'0"0(1x1). **Material No:** 60060500 **Made in:** USA
Melted and Poured in: USA
Sales Order: 2046434 **Purchase Order:** CFS10: HSS tube requ

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti	B	N	Ca
24052002	0.210	0.740	0.009	0.002	0.030	0.028	0.090	0.000	0.011	0.030	0.050	0.003	0.001	0.0000	0.0074	0.0019

Bundle No	PCs	Yield	Tensile	Eln.2in	Certification	CE: 0.36
M500510952	1	066672 Psi	088663 Psi	34 %	ASTM A500-23 GRADE B&C	

Heat	MILL	Mill Location	Method	Recycled_Content	Post_Consumer	Pre-Consumer (Post Industrial)	% Harvested	Within Miles of Location
24052002	BIGRIVER	Osceola,AR	EAF	76.00%	95.00%	5.00 %	75%	500

Material Note:
Sales Or. Note:

Authorized by Quality Assurance Jason Richard
Jason Richard

The results reported on this report represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements. CE calculated using the AWS D1.1 method. Steel is purchased fully killed with a fine grain practice. This document is in compliance with the requirements of EN10204 type3.1

Steel Tube Institute OF NORTH AMERICA

Metals Service Center Institute

Atlas Tube Arkansas
6651 E Hwy 137
Blytheville Arkansas USA
72315
Tel:
Fax:

Atlas Tube
A DIVISION OF ZEKELMAN INDUSTRIES

REF.B/L: 81231442
Date: 07/12/2024
Customer: 2478

MATERIAL TEST REPORT

Sold To
Atlas Tube (Chicago) LLC
1855 East 122nd Street
CHICAGO IL 60633
USA

Shipped To
McMahon Steel Company Inc.
1880 Nirvana Ave.
CHULA VISTA CA 91911
USA

Material: 6.0x6.0x500x40'0"0(3x1). **Material No:** 600605004000 **Made in:** USA
Melted and Poured in: USA

Sales Order: 2046434 **Purchase Order:** CFS10: HSS tube requ

Heat No	C	Mn	P	S	Si	Al	Cu	Cb	Mo	Ni	Cr	V	Ti	B	N	Ca
2243718	0.220	0.780	0.010	0.003	0.020	0.030	0.070	0.001	0.010	0.030	0.040	0.003	0.001	0.0000	0.0070	0.0020

Bundle No	PCs	Yield	Tensile	Eln.2in	Certification	CE: 0.37
M500519918	3	069573 Psi	079866 Psi	36 %	ASTM A500-23 GRADE B&C	

Heat	MILL	Mill Location	Method	Recycled_Content	Post_Consumer	Pre-Consumer (Post Industrial)	% Harvested	Within Miles of Location
2243718	NUCOR	HICKMAN,AR	EAF	52.50%	31.80%	20.70%	74%	500

Material Note:
Sales Or. Note:

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