September 2, 2016

<u>Executive Summary</u>: Austin Avenue Bridges at North/South San Gabriel River – Forensic Investigation Condition Assessment/Evaluation (Supplemental Testing and Analysis)

Wiss, Janney, Elstner Associates, Inc. (WJE) provided Aguirre & Fields LP (AF) with a Forensic Investigation Supplemental Testing and Analysis Report on September 1, 2016, documenting their additional testing and analysis of the Austin Avenue Bridges.

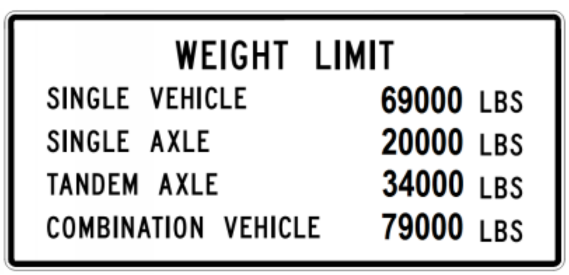
In summary, the WJE report covers:

<u>Material Sampling and Testing</u>

1. Six (6) steel samples were taken from existing steel girder webs.
2. Samples were tested in accordance with American Society for Testing and Materials (ASTM) standards for tensile and hardness properties.
3. The average yield strength of the samples was 38.5ksi with a standard deviation of 0.7ksi.

<u>Load Rating Analysis and Recommendations</u>

4. Analysis was completed using a yield strength of <u>37.3ksi</u> in accordance with American Association of State Highway and Transportation Officials (AASHTO) standards.
5. Recommended load restrictions as follows:



- Axle 20,000 lbs (legal limit)
- Tandem axle 34,000 lbs (legal limit)
- Single Gross vehicle 69,000 lbs (legal limit)
- Combination vehicle 79,000 lbs (legal limit is 80,000)

6. *Load restriction recommendations are pending verification from TxDOT.*

At this time, these recommendations are being provided to TxDOT. The City and project team will continue to coordinate with TxDOT in 2016 on the testing/analysis results and follow-up actions.

Summarized by Dave Lubitz, PE and Oscar Aguirre, PE

12708 Riata Vista Circle, Suite A-109 ◆ Austin, TX 78727 ◆ 512-610-8900

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

Wiss, Janney, Elstner Associates, Inc.
9511 North Lake Creek Parkway
Austin, Texas 78717
512.257.4800 tel | 512.219.9883 fax
Texas Registered Engineering Firm F-0093
www.wje.com

Via E-mail

September 1, 2016

Mr. David Lubitz, PE
Aguirre & Fields, LP
12708 Riata Vista Circle, Suite A-109
Austin, Texas 78727

Re: Austin Avenue Bridges at San Gabriel River
Supplemental Testing and Analysis
WJE No. 2015.5402.1

Dear Mr. Lubitz:

At the request of Aguirre & Fields, LP (A&F) and in accordance with our proposal dated June 8, 2016, Wiss, Janney, Elstner Associates, Inc. (WJE) has completed supplemental testing and analysis of the Austin Avenue Bridges over the North and South San Gabriel Rivers in Georgetown, Texas. This letter summarizes the work WJE performed.

BACKGROUND

Refer to WJE's report dated January 12, 2016 for summary information regarding our previous work for the Austin Avenue Bridges and to Figure 1 and Figure 2 for schematic orientation. The bridges are currently load-posted for loads not to exceed 48,000 pounds gross vehicle weight or 21,000 pounds tandem-axle weight based on an assumed steel yield strength of 33 ksi and conditions reported from a routine Texas Department of Transportation (TxDOT) bridge inspection completed in December 2013. The TxDOT report indicated that the inventory load rating factor was 0.79, which corresponds to an Inventory Rating (IR) of HS 15.9. As reported previously, no steel grade was clearly specified on existing project documentation. The AASHTO Manual for Bridge Evaluation (2011)[1] provisions referenced by TxDOT for load rating purposes indicate that the minimum yield stress of unknown steel constructed between 1936 and 1963 may be assumed as 33 ksi unless tested to determine an appropriate value for yield strength. The City of Georgetown requested additional testing and analysis of the structural steel members to determine the plausibility of removing existing load postings.

SUPPLEMENTAL MATERIAL TESTING

Material Sampling

On June 30 and July 1, 2016, Aaron Sterns, PE, Sam Keske, PhD, EIT, and Lane Thompson, all of WJE, visited the site to coordinate steel sample removal from the North and South Bridges. We accessed the bridge with our subconsultant, Coyote Welding of Cedar Park (Coyote), using a 50-foot articulating boom lift and marked three sample removal locations per bridge, as shown in Appendix A. The sample locations were selected to minimize the impact of removal on the structural capacity of the girders; minimize the impact on bridge aesthetics and serviceability; accommodate tensile testing in accordance with ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*; and represent the

controlling bridge spans (suspended spans between cantilevers) without affecting that span or ongoing traffic service on the bridges.
Coyote used a drill to create pilot holes at sample corners and an oxygen/acetylene torch to cut the samples from the bridge (Figure 3). The remaining holes were ground smooth to remove sharp edges and corners around the sampling voids. The adjacent heat-affected coatings were also ground and sealed with a zinc-rich paint (Figure 4).

Material Testing

WJE delivered the six steel samples, identified as Samples N1–N3 and S1–S3 for the North and South Bridges, respectively, to Richard Lewis of Lewis Engineering and Consulting (Lewis). Lewis prepared the samples and tested them in accordance with ASTM A370. Lewis reported mechanical properties to WJE, as shown in Appendix B. Table 1 summarizes the samples and obtained tensile test results. Lewis also obtained Rockwell B hardness test results as summarized in Appendix B; those results are not directly applicable to this report at this time but will be reserved for future use.

The average yield strength of the six samples as reported by Lewis is 38.5 ksi with a standard deviation of 0.73 ksi.

SUPPLEMENTAL LOAD RATING ANALYSIS

WJE reanalyzed the load rating of the controlling span using the yield strength value derived from Lewis's material testing, in accordance with AASHTO Section 6B.5.3.1. Per that section, "the nominal yield value should be substituted in strength formulas and is typically taken as the mean test value minus 1.65 standard deviations." As such, the span was reanalyzed utilizing a yield strength of 37.3 ksi.

The suspended span's inventory load rating factor equals 0.96 when calculated using the AASHTO-recommended yield strength value. This factor corresponds to an IR of HS 19.3.

DISCUSSION AND RECOMMENDATIONS

Refer to the "Bridge Inspection and Load Rating" section of our previous report dated January 12, 2016 for further background information regarding caveats to the current bridge load ratings, bridge inspection practices, and condition ratings. Based on the revised IR of HS 19.3, the resulting load restrictions, determined in accordance with TxDOT procedures, should be as follows:

- Axle 20,000 lbs (legal limit)
- Tandem axle 34,000 lbs (legal limit)
- Single Gross vehicle 69,000 lbs (legal limit)
- Combination vehicle 79,000 lbs (legal limit is 80,000)

Posting the bridges for the above signifies that nearly all typical commercial vehicles will be permitted to utilize the bridges. Such a posting also indicates that, per TxDOT practice, no Permit Loads (specialized, overweight vehicles) are allowed to utilize the bridges. The corresponding load posting sign is shown in Figure 5.

CLOSING

WJE's findings and recommendations are based on the material test results and structural analyses that represent known conditions at the time of our assessment. Other conditions may exist, or develop over time, that were not accounted for in our testing or analysis. WJE reserves the right to modify our findings should additional information become available. Our recommendations should be considered preliminary and will require verification by TxDOT before discussed actions are undertaken. If requested, WJE is available and prepared to assist with finalization of analyses or development of a load-posting modification request for TxDOT consideration. This report was prepared for, on behalf of, and for the exclusive use of, Aguirre & Fields.

Sincerely,

WISS, JANNEY, ELSTNER ASSOCIATES, INC.

STATE OF TEXAS
AARON J. STERNS
109314
LICENSED
PROFESSIONAL ENGINEER
9/1/2016

Aaron Sterns, PE
Senior Associate and Project Manager

Sam Keske, PhD, EIT
Associate II

Brian Merrill, PE
Associate Principal

Attachments: Appendix A: Sample Removal Plan
Appendix B: Lewis Steel Testing Report

TABLE

Table 1. Steel Sample Summary

Sample ID	Location	Testing Results		
		Yield Strength (ksi)	Tensile Strength (ksi)	% Elongation
N1	N. bridge, Span 6, Girder 3	39.5	64.4	41
N2	N. bridge, Span 6, Girder 5	38.8	66.5	38
N3	N. bridge, Span 6, Girder 7	37.8	66.0	40
S1	S. bridge, Span 2, Girder 3	38.6	66.0	39
S2	S. bridge, Span 2, Girder 5	38.9	72.0	36
S3	S. bridge, Span 2, Girder 7	37.5	64.0	38

FIGURES

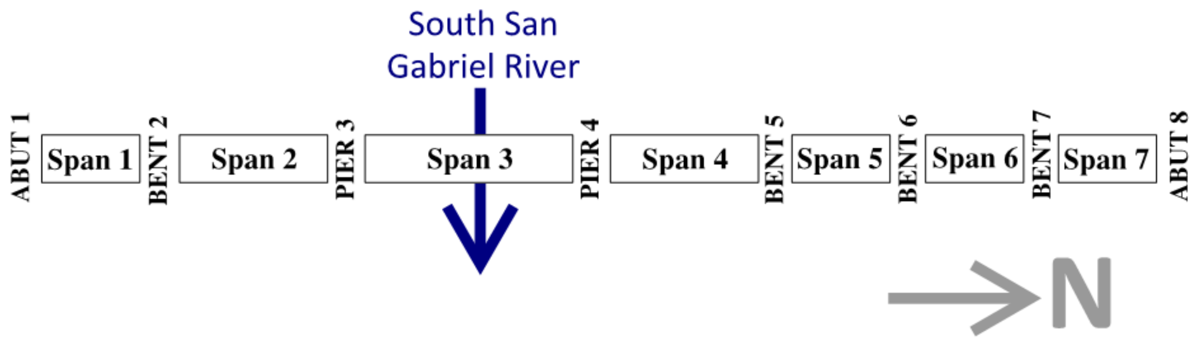


Figure 1. Schematic orientation of South Austin Avenue Bridge; Span 3 includes a 56-foot suspended span between 14-1/2-foot cantilevered extensions from Spans 2 and 4.

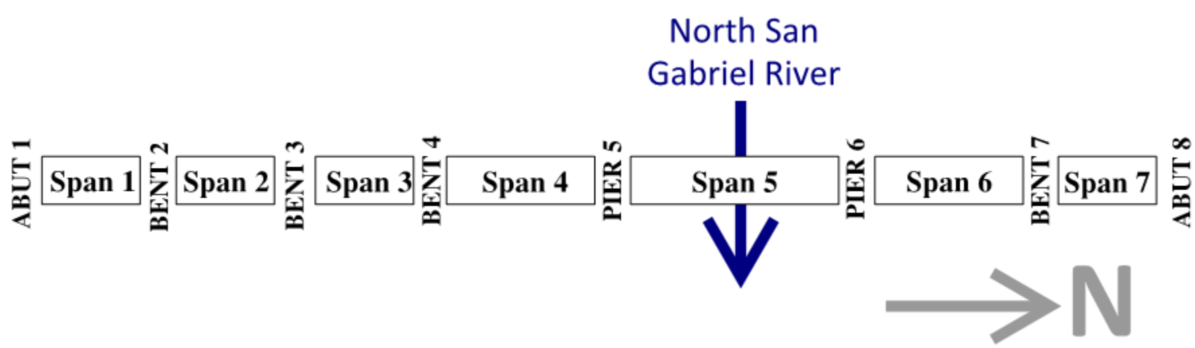


Figure 2. Schematic orientation of North Austin Avenue Bridge; Span 5 includes a 56-foot suspended span between 14-1/2-foot cantilevered extensions from Spans 4 and 6.

Figure 3. Ongoing torch-cut removal of steel web specimens.

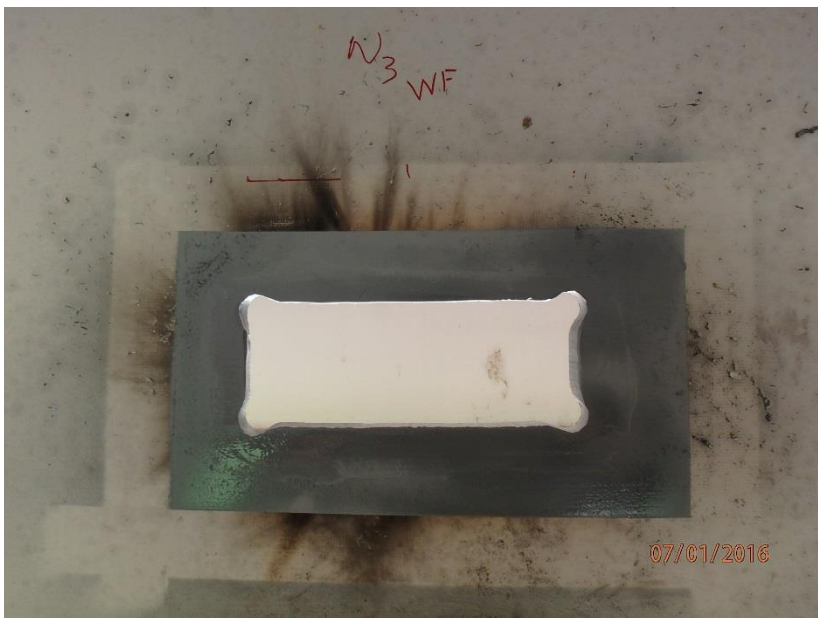


Figure 4. Typical corner grinding and zinc coating application (N3 shown).

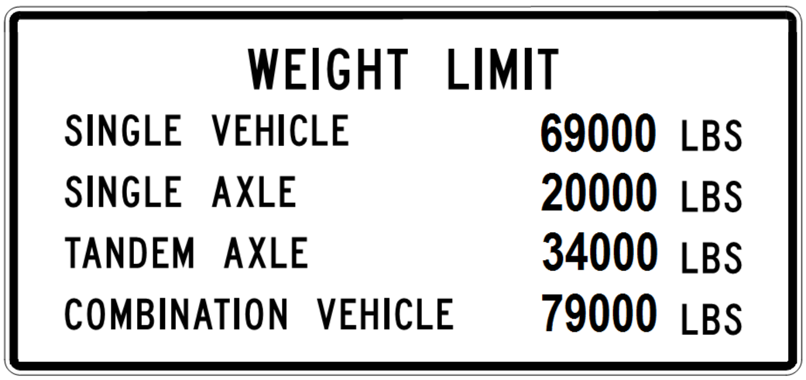
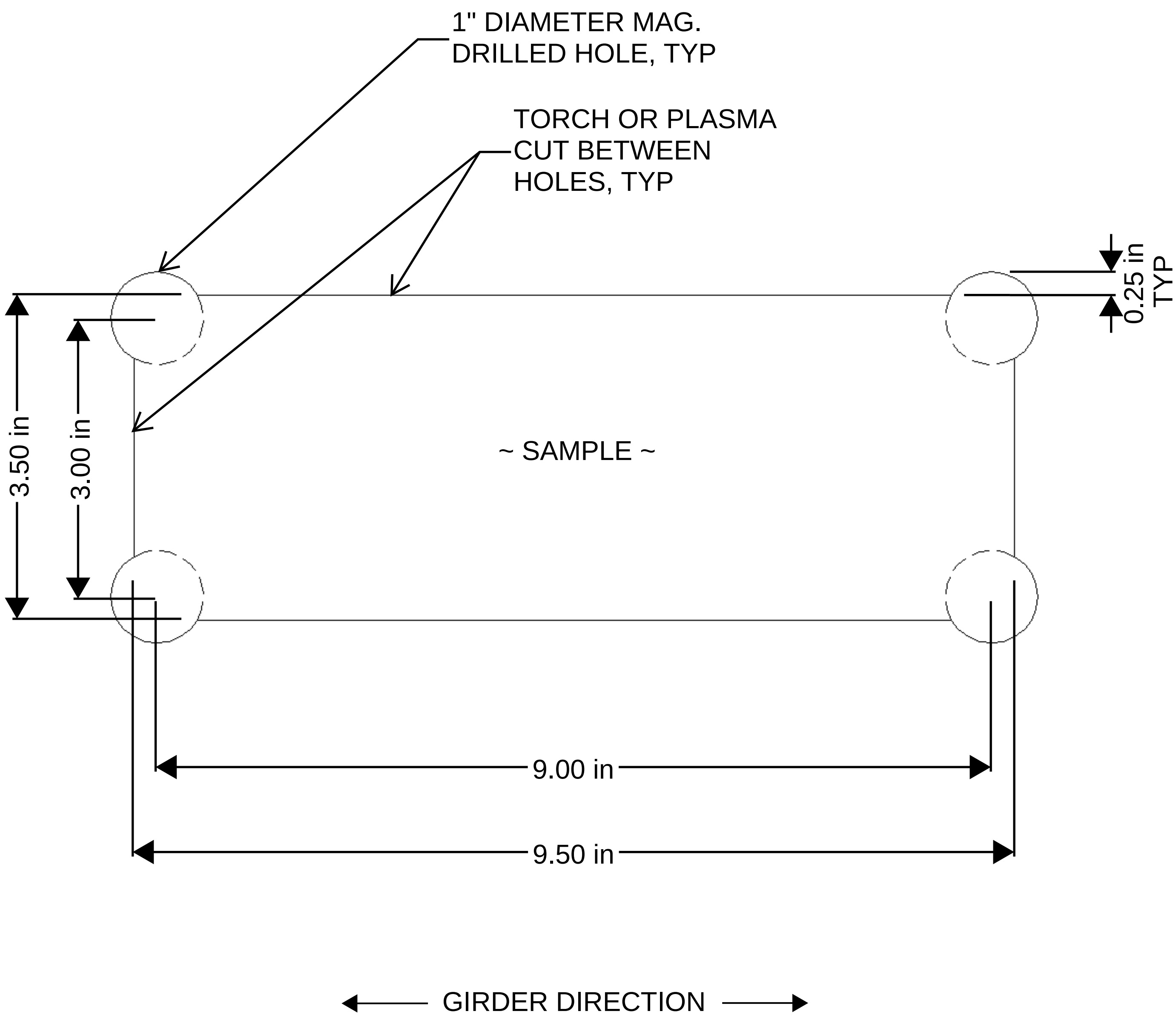


Figure 5. TxDOT R12-8aT sign, with corresponding load posting weights that should be considered if modifying the existing load posting.

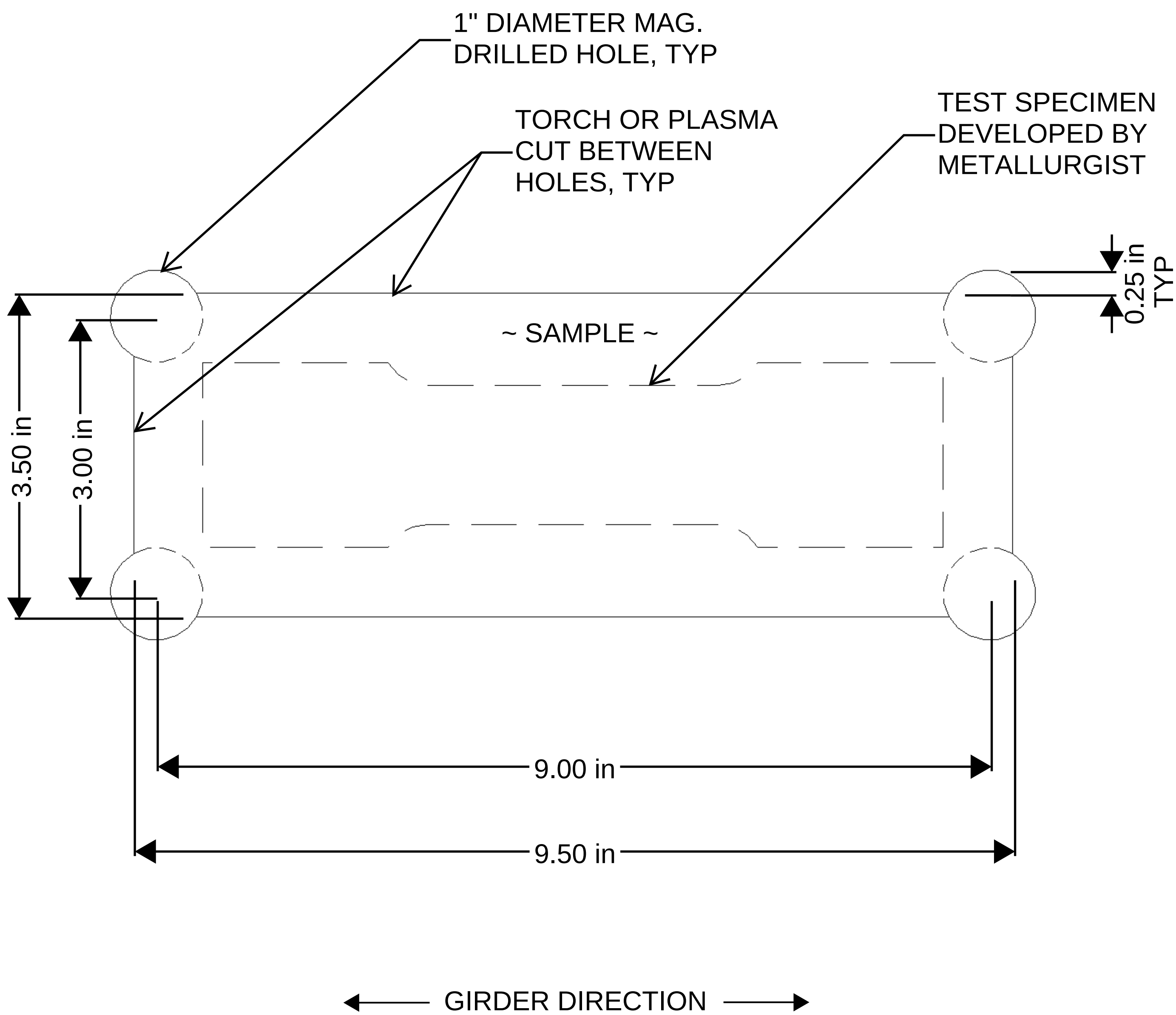
APPENDIX A: SAMPLE REMOVAL PLAN

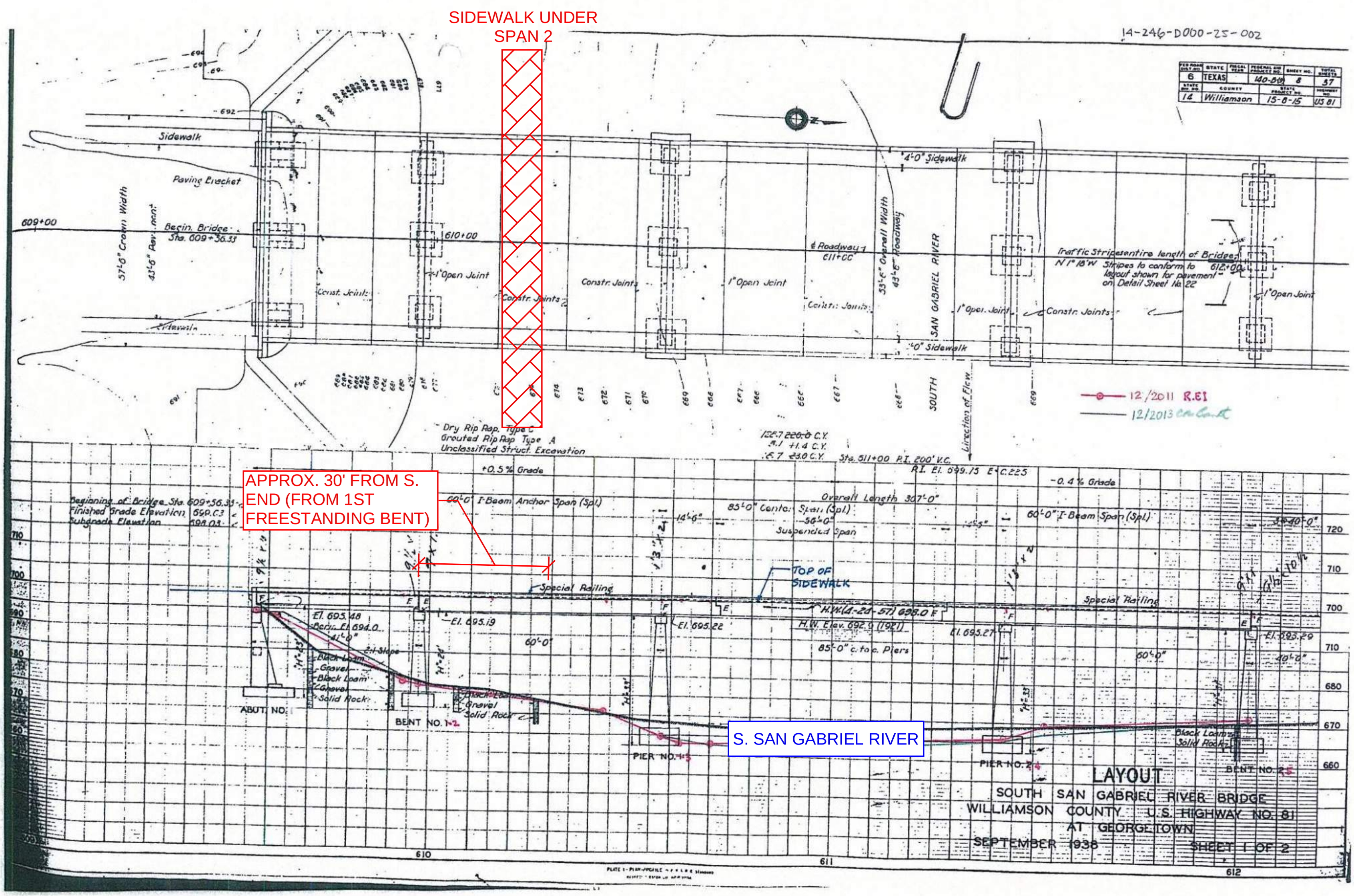
		MADE BY	SHEET NUMBER
WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS	**Wiss, Janney, Elstner Associates, Inc.** *9511 N. Lake Creek Parkway* *Austin, TX 78729*	SDK/AJS	1 of 1
AUSTIN AVENUE BRIDGE		CHECKED BY AJS	PROJECT NUMBER 2015.5402.1
Steel Sample for Tension Test		PROJECT MANAGER AJS	DATE 06/22/16



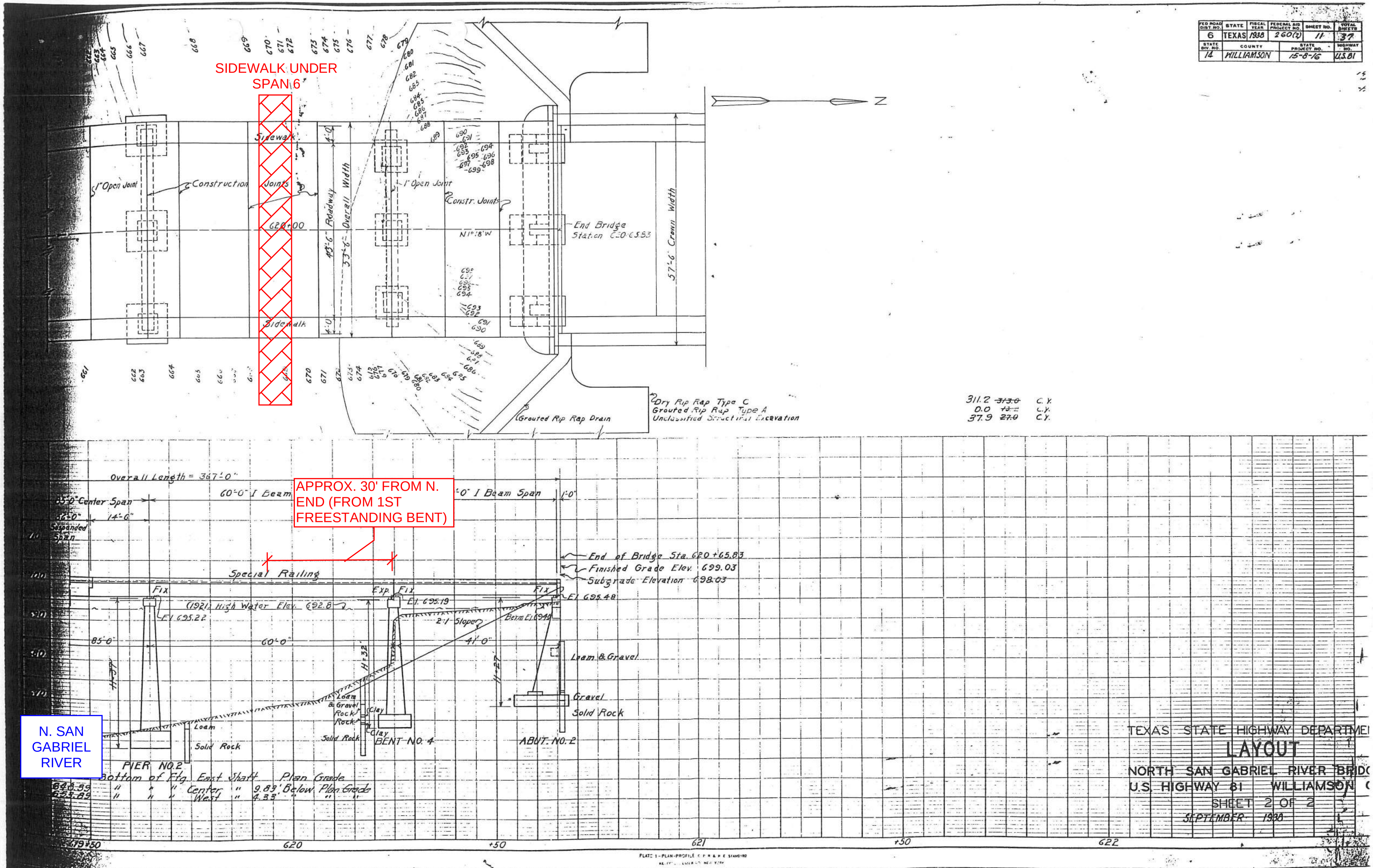
NOTES:
1) GRIND SMOOTH TRANSITIONS FROM TORCH/PLASMA CUTS TO DRILLED HOLES
2) APPLY COLD GALVANIZING AT EXPOSED STEEL SURFACES FROM SAMPLE REMOVAL

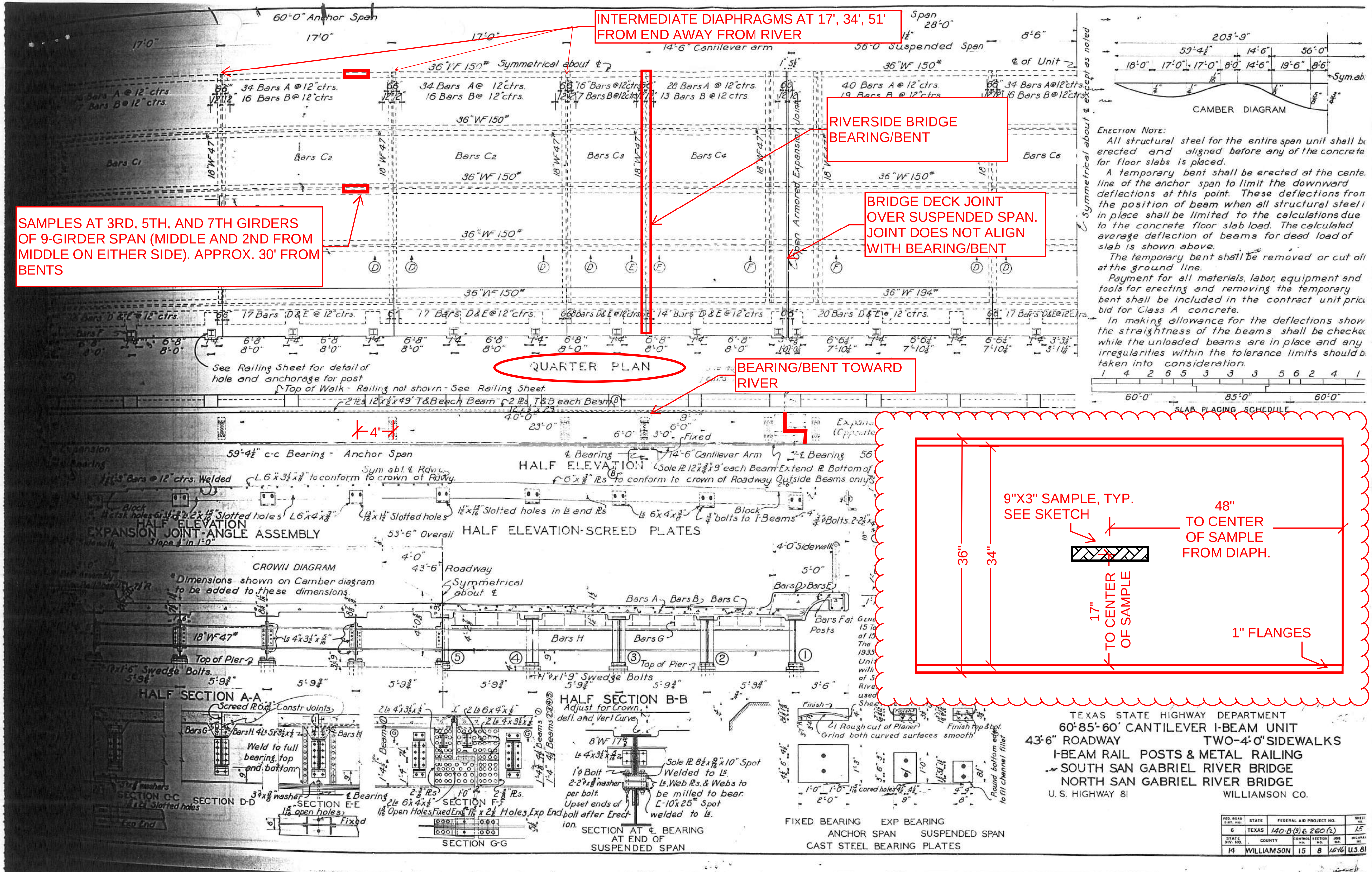
WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS **Wiss, Janney, Elstner Associates, Inc.** *9511 N. Lake Creek Parkway* *Austin, TX 78729*	MADE BY SDK/AJS	SHEET NUMBER 1 of 1
AUSTIN AVENUE BRIDGE **Steel Sample for Tension Test**	CHECKED BY AJS	PROJECT NUMBER 2015.5402.1
	PROJECT MANAGER AJS	DATE 06/22/16





SIDEWALK UNDER SPAN 2
14-246-D000-25-002
6 TEXAS 140-B-0 8 37
14 Williamson 15-8-15 US 81
Sidewalk
Paving Bracket
Begin. Bridge Sta. 609+56.33
57'-6" Crown Width
43'-6" Pav. mnt
609+00
610+00
1" Open Joint
Const. Joint
Constr. Joints
4'-0" Sidewalk
33'-6" Overall Width
43'-6" Roadway
SAN GABRIEL RIVER
SOUTH
Direction of Flow
Traffic Stripe entire length of Bridge. N 1° 18' W. Stripes to conform to layout shown for pavement on Detail Sheet No. 22
612+00
12/2011 R.EI
12/2013
Dry Rip Rap, Type C
Grouted Rip Rap Type A
Unclassified Struct. Excavation
Sta. 611+00 P.I. 200' V.C.
P.I. El. 699.15 E C.225
+0.5% Grade
-0.4% Grade
APPROX. 30' FROM S. END (FROM 1ST FREESTANDING BENT)
Beginning of Bridge Sta. 609+56.33
Finished Grade Elevation 699.03
Subgrade Elevation 698.03
60'-0" I-Beam Anchor Span (Spl.)
Overall Length 307'-0"
85'-0" Cantil. Span (Spl.)
50'-0" Suspended Span
60'-0" I-Beam Span (Spl.)
Special Railing
TOP OF SIDEWALK
H.W. (4-24-57) 698.0
H.W. Elev. 692.9 (1921)
El. 695.48
Berm El. 694.0
El. 695.19
El. 695.22
El. 695.27
El. 693.29
85'-0" c. to c. Piers
2:1 Slope
Black Loam
Gravel
Solid Rock
ABUT. NO.
BENT NO. 1-2
PIER NO. 1-3
PIER NO. 2-4
BENT NO. 2-5
S. SAN GABRIEL RIVER
LAYOUT
SOUTH SAN GABRIEL RIVER BRIDGE
WILLIAMSON COUNTY U.S. HIGHWAY NO. 81
AT GEORGETOWN
SEPTEMBER 1938
SHEET 1 OF 2
610
611
612


FED ROAD DIST. NO. 6 | STATE TEXAS | FISCAL YEAR 1938 | FEDERAL AID PROJECT NO. 260(2) | SHEET NO. 11 | TOTAL SHEETS 37
STATE DIV. NO. 14 | COUNTY WILLIAMSON | STATE PROJECT NO. 15-8-16 | HIGHWAY NO. U.S. 81
SIDEWALK UNDER SPAN 6
N
Sidewalk
1" Open Joint
Construction Joints
620+00
43'-6" Roadway
53'-6" Overall Width
4'-0"
1" Open Joint
Constr. Joints
N1°18'W
End Bridge Station 620+65.83
57'-6" Crown Width
Grouted Rip Rap Drain
Dry Rip Rap Type C
Grouted Rip Rap Type A
Unclassified Structural Excavation
311.2 C.Y.
0.0 C.Y.
37.9 C.Y.
Overall Length = 367'-0"
85'-0" Center Span
36'-0" Suspended Span
14'-6"
60'-0" I Beam
-0" I Beam Span
1'-0"
APPROX. 30' FROM N. END (FROM 1ST FREESTANDING BENT)
End of Bridge Sta. 620+65.83
Finished Grade Elev. 699.03
Subgrade Elevation 698.03
Special Railing
Fix
Exp. Fix
Fix
El. 695.48
(1921) High Water Elev. 692.8
El. 695.22
El. 695.19
2:1 Slope
Berm El. 694.0
85'-0"
60'-0"
41'-0"
H=37
H=32
H=27
Loam & Gravel
Gravel
Solid Rock
Loam
Solid Rock
Loam & Gravel
Rock
Clay
Solid Rock
BENT NO. 4
ABUT. NO. 2
PIER NO. 2
Bottom of Ftg. East Shaft Plan Grade
648.59 " " " Center " 9.83' Below Plan Grade
623.89 " " " West " 4.33' " " "
N. SAN GABRIEL RIVER
TEXAS STATE HIGHWAY DEPARTMENT
LAYOUT
NORTH SAN GABRIEL RIVER BRIDGE
U.S. HIGHWAY 81 WILLIAMSON CO.
SHEET 2 OF 2
SEPTEMBER 1938
619+50
620
+50
621
+50
622



INTERMEDIATE DIAPHRAGMS AT 17', 34', 51' FROM END AWAY FROM RIVER
SAMPLES AT 3RD, 5TH, AND 7TH GIRDERS OF 9-GIRDER SPAN (MIDDLE AND 2ND FROM MIDDLE ON EITHER SIDE). APPROX. 30' FROM BENTS
RIVERSIDE BRIDGE BEARING/BENT
BRIDGE DECK JOINT OVER SUSPENDED SPAN. JOINT DOES NOT ALIGN WITH BEARING/BENT
BEARING/BENT TOWARD RIVER
9"X3" SAMPLE, TYP. SEE SKETCH
48" TO CENTER OF SAMPLE FROM DIAPH.
17" TO CENTER OF SAMPLE
36"
34"
1" FLANGES
4'
60'-0" Anchor Span
Span 28'-0"
56'-0" Suspended Span
14'-6" Cantilever arm
Symmetrical about ℄
℄ of Unit
QUARTER PLAN
See Railing Sheet for detail of hole and anchorage for post
Railing not shown - See Railing Sheet.
Open Armored Expansion Joint
CAMBER DIAGRAM
ERECTION NOTE:
All structural steel for the entire span unit shall be erected and aligned before any of the concrete for floor slabs is placed.
A temporary bent shall be erected at the center line of the anchor span to limit the downward deflections at this point. These deflections from the position of beam when all structural steel in place shall be limited to the calculations due to the concrete floor slab load. The calculated average deflection of beams for dead load of slab is shown above.
The temporary bent shall be removed or cut off at the ground line.
Payment for all materials, labor, equipment and tools for erecting and removing the temporary bent shall be included in the contract unit price bid for Class A concrete.
In making allowance for the deflections shown the straightness of the beams shall be checked while the unloaded beams are in place and any irregularities within the tolerance limits should be taken into consideration.
SLAB PLACING SCHEDULE
HALF ELEVATION
HALF ELEVATION-SCREED PLATES
HALF ELEVATION EXPANSION JOINT-ANGLE ASSEMBLY
CROWN DIAGRAM
*Dimensions shown on Camber diagram to be added to these dimensions.
HALF SECTION A-A
HALF SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
SECTION F-F
SECTION G-G
SECTION AT ℄ BEARING AT END OF SUSPENDED SPAN
FIXED BEARING ANCHOR SPAN
EXP BEARING SUSPENDED SPAN
CAST STEEL BEARING PLATES
TEXAS STATE HIGHWAY DEPARTMENT
60'-85'-60' CANTILEVER I-BEAM UNIT
43'-6" ROADWAY
TWO-4'-0" SIDEWALKS
I-BEAM RAIL POSTS & METAL RAILING
SOUTH SAN GABRIEL RIVER BRIDGE
NORTH SAN GABRIEL RIVER BRIDGE
U. S. HIGHWAY 81
WILLIAMSON CO.
TEXAS 140-B(3) & 260(2)
WILLIAMSON

ENGINEERS
ARCHITECTS
MATERIALS SCIENTISTS

APPENDIX B: LEWIS STEEL TESTING REPORT

REPORT OF FINDINGS:

TENSILE PROPERTY TESTING OF SIX SAMPLES OF STEEL FROM THE AUSTIN AVENUE BRIDGE

CONDUCTED FOR:
WISS, JANNEY, ELSTNER ASSOCIATES, INC.
AUSTIN, TX

INTRODUCTION

Six samples of steel plate from the Austin Avenue Bridge were submitted to Lewis Engineering and Consulting, Inc. (LEC), Gainesville, Florida by Wiss, Janney, Elstner Associates, Inc. (WJE), Austin, TX for tensile property testing. LEC advised that the most reliable tensile test data would be obtained using full plate thickness samples rather than subsize machined samples. Based upon the objective of preparing a recommended 2 inch gage length by 0.500 inch gage width test specimen, an overall plate sample size of 9.5 inch long by 3.5 inch wide sample was suggested so that the target dimensioned tensile test specimen could be machined exclusive of any heating effects induced by the plate sample removal procedure. The schematic attached in **Appendix A** prepared by WJE shows the plate sample dimensions and the location of the tensile test specimen to be removed from it. LEC utilizes the laboratory services of Applied Technical Services (ATS), Marietta, GA for mechanical property testing. The samples were received and documented by LEC prior to sending to ATS. Included in the laboratory documentation was measurement of plate thickness and hardness testing.

TEST METHODS AND RESULTS

Hardness testing on the steel samples prior to submittal for tensile testing was performed in accordance with hardness testing procedures specified in ASTM A370-15 employing an Instron Wilson Model 103R hardness testing instrument. Preliminary calibration was performed with the instrument configured to measure hardness on the Rockwell B (R_B) scale and using Hardness Test Block Serial No. 98T50047 with a calibrated hardness of R_B 63.0. Four hardness measurements were performed on each steel sample, two at each end in the area that would be the grip area following machining into dog-bone shaped flat tensile test specimens. The following hardness data for each steel sample is the average of the four measurements.

It is often very useful to obtain hardness data for steels as there is a long standing and widely accepted general correlation between hardness and tensile strength. However, the tabulated hardness conversion and tensile data table such as the one published in Table 2 and Table 3 of ASTM A370 has a lower limit on hardness to tensile strength correlation of R_B 65. Below that value, the correlation becomes unreliable and for that reason is not published. The tensile strength of steel with a hardness of R_B 65 in Table 3 of A370 is 56,000 psi, or 56 ksi.

SAMPLE ID		THICKNESS (inch)	ROCKWELL B HARDNESS	APPROXIMATE TENSILE STRENGTH FROM HARDNESS CONVERSION*
WJE	ATS			
N1	4	0.649	64	---
N2	3	0.628	62	---
N3	2	0.632	68	59 ksi
S1	5	0.646	66.5	57.5 ksi
S2	1	0.640	62.5	---
S3	6	0.633	50	---

* From ASTM A370 Table 3

The majority of the hardness data on the bridge plate steels falls close to or below the lower hardness to tensile strength correlation limit. The footnote to Table 2/3 in A370 states that the tensile strength conversions are approximate and should be used cautiously because "*it is possible that steels of various compositions and processing histories will deviate in hardness-tensile strength relationship from the data presented in this table.*"

However, it was the objective of this testing to measure actual bridge steel hardness values on the steel samples for direct correlation with the tensile strengths measured on the same samples. In this way, further hardness measurements on the bridge steel components can be made and usefully correlated with measured tensile properties rather than relying on the approximate tensile strength values presented in Table 3 of ASTM A370.

TENSILE TEST RESULTS

ATS was requested to prepare flat dog-bone shaped full thickness tensile test specimens in accordance with the dimensions and specifications for full thickness tensile tests in Figure 3 of

ASTM A370. The results are attached in the ATS TENSILE TEST REPORT in **Appendix B**. Included with the data table are the corresponding stress vs. strain graphs recorded for each individual specimen.

The average tensile strength and yield strength of the group of six bridge steel tensile specimens was 66.4 ksi and 38.5 ksi, respectively. As shown in the ATS TENSILE TEST REPORT, the lowest tensile strength reported was 64 ksi for both Sample N1 and S3 while the highest measured tensile strength was 72 ksi for Sample S2. The tensile elongation ductility of all six tensile specimens was very good, ranging from 36 percent to 41 percent.

A comparison of measured and reported hardness values of the bridge steel samples with measured and reported values of tensile strength show that there is a relatively close grouping for four of the six samples. Slightly skewed in the data is the R_B 62.5 hardness and 72 ksi tensile strength of Sample S2 and the R_B 50 hardness and 64 ksi tensile strength of Sample S3. It is concluded that the low value of R_B 50 for Sample S3 is somewhat inconsistent with the hardness data for the other five samples and should be considered not typical and representative for a bridge steel having a reported tensile strength of 64 ksi. Based upon the hardness and tensile test data for the other five samples, it is concluded that a hardness measurements on the subject bridge steels should fall within the range of R_B 62 to 68.

A review of the tensile stress vs strain graphs shows that five of the six test specimens had a yield point followed by a flat stress vs strain curve to failure. One specimen, Sample S2, a both an upper yield point and a lower yield point. In low to moderate strength carbon steels, it is not uncommon for the tensile stress vs strain graph to exhibit an upper and lower yield point. The tensile properties of all six bridge steel samples are compliant with the tensile strength, yield strength and tensile elongation ductility requirements specified in Table 3 of ASTM A36, Standard Specification for Structural Steel.

Laboratory photographs of the fractured ends of the six tensile test specimens are attached in **Figures 1 through 6**. All six fractures were consistent and similar in necking deformation and fracture appearance.

Prepared and submitted by,

Richard O. Lewis

Richard O. Lewis, P.E.
JULY 22, 2016

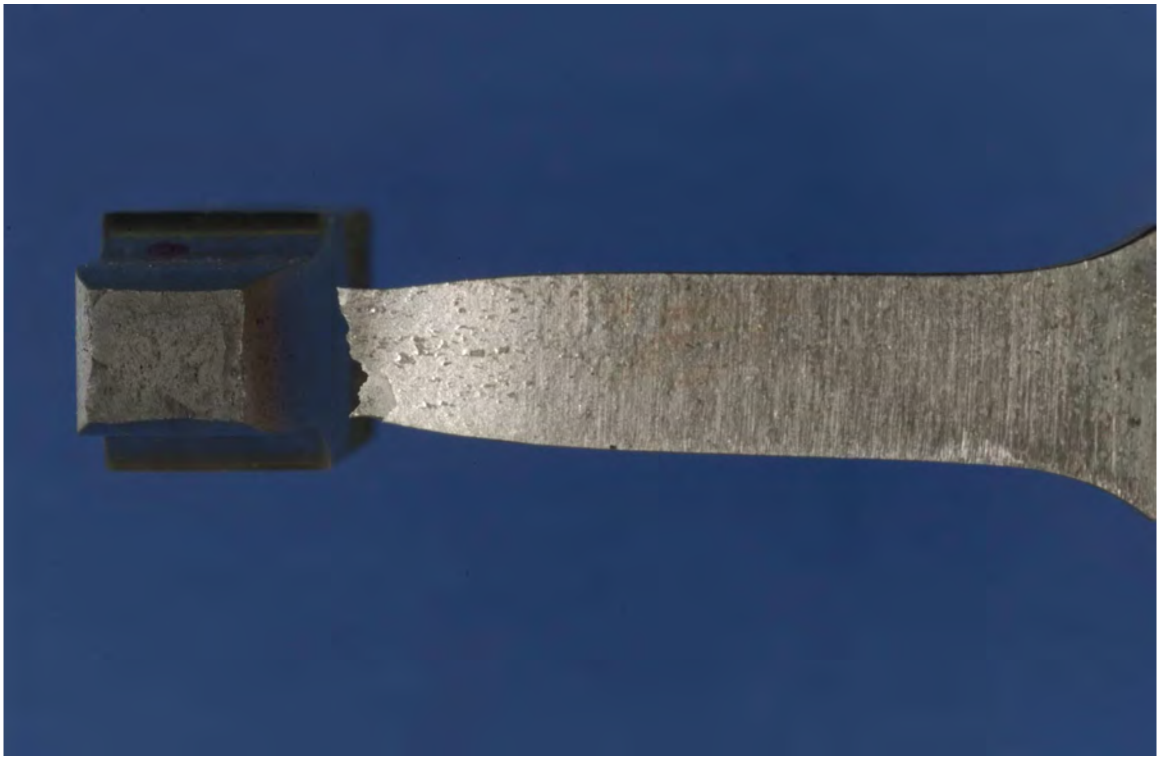


Figure 1. Tensile test specimen fracture on sample N1. L3937 071816 04

Figure 2. Tensile test specimen fracture on sample N2. L3937 071816 03

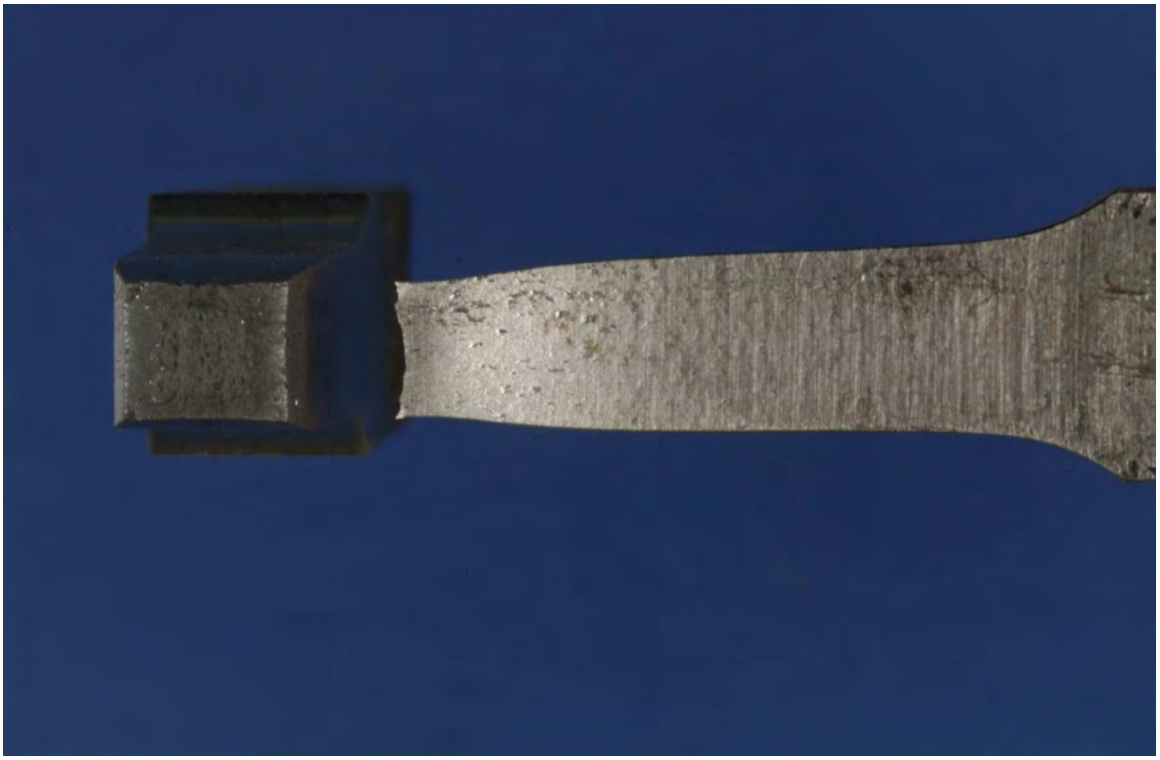


Figure 3. Tensile test specimen fracture on sample N3. L3937 071816 02

Figure 4. Tensile test specimen fracture on sample S1. L3937 071816 05

Figure 5. Tensile test specimen fracture on sample S2. L3937 071816 01

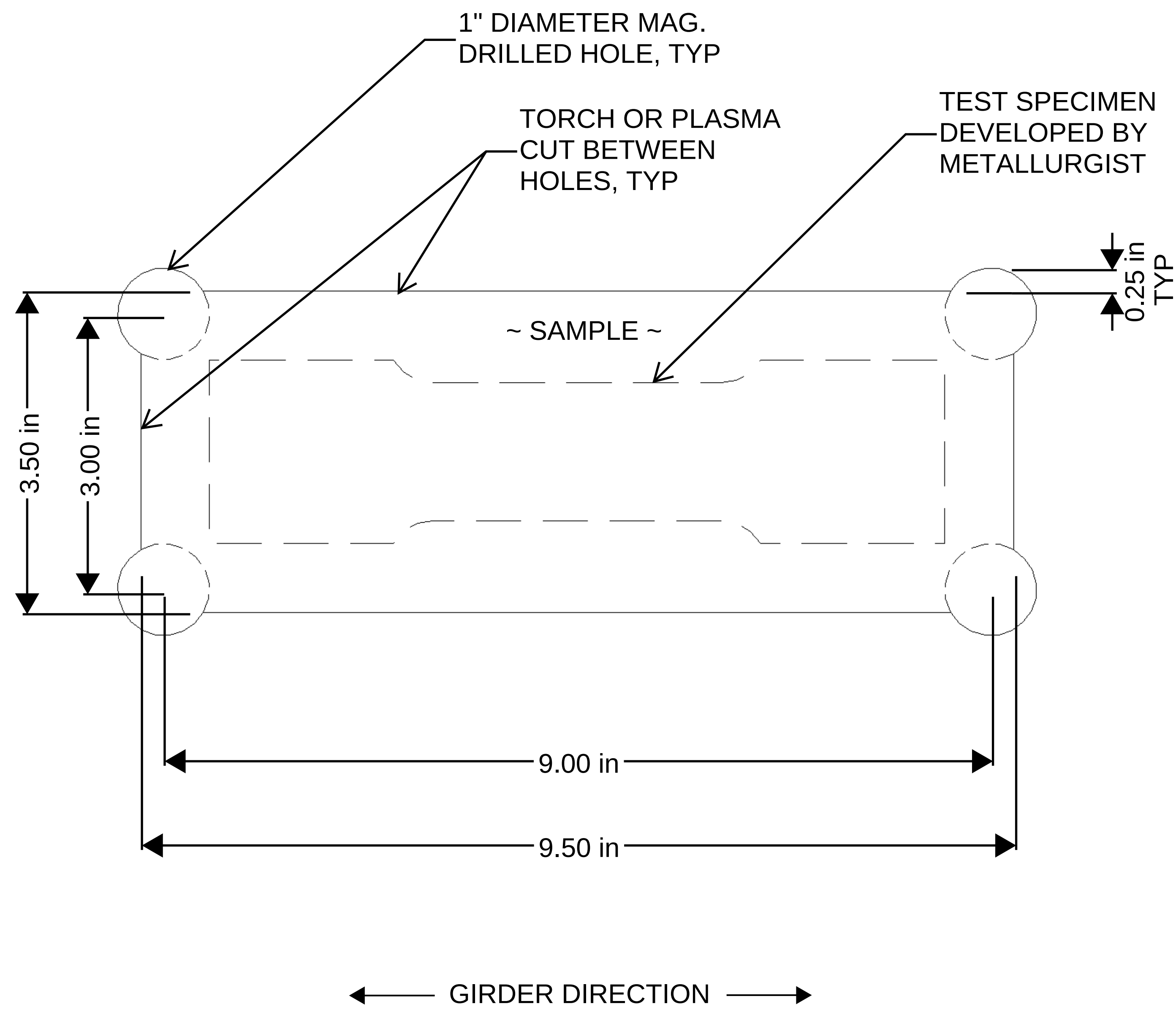
Figure 6. Tensile test specimen fracture on sample S3. L3937 071816 06

APPENDIX A

WJE SCHEMATIC OF SAMPLES TO BE

REMOVED FOR TESTING

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS **Wiss, Janney, Elstner Associates, Inc.** *9511 N. Lake Creek Parkway* *Austin, TX 78729*	MADE BY SDK/AJS	SHEET NUMBER 1 of 1
AUSTIN AVENUE BRIDGE	CHECKED BY AJS	PROJECT NUMBER 2015.5402.1
Steel Sample for Tension Test	PROJECT MANAGER AJS	DATE 06/22/16



APPENDIX B

ATS TENSILE TEST REPORT WITH

STRESS-STRAIN GRAPHS

APPLIED TECHNICAL SERVICES, INCORPORATED

1049 Triad Court, Marietta, Georgia 30062 • (770) 423-1400 Fax (770) 424-6415

TENSILE TEST REPORT

Ref. D256979 **Date** July 13, 2016 **Page** 1 **of** 1

Customer: Lewis Engineering and Consulting, Inc., 2106 NW 67th Place, Suite 2, Gainesville, FL 32653

Attention: Richard Lewis, P. E.

Purchase Order #: L3937 Part #/Name: Bridge Girder Web Samples, N2015.5402.1

Material Designation: Steel Specimen Type: Flat Reduced Section

Tensile Test Equipment: Tinius Olsen ATS #: 2246 Cal. Due: 11/4/16

Extensometer: Tinius Olsen ATS #: 2321 Cal. Due: 11/5/16

Lab Comment: Tested per ASTM A370-15. [1]Upper yield. [2]Lower yield

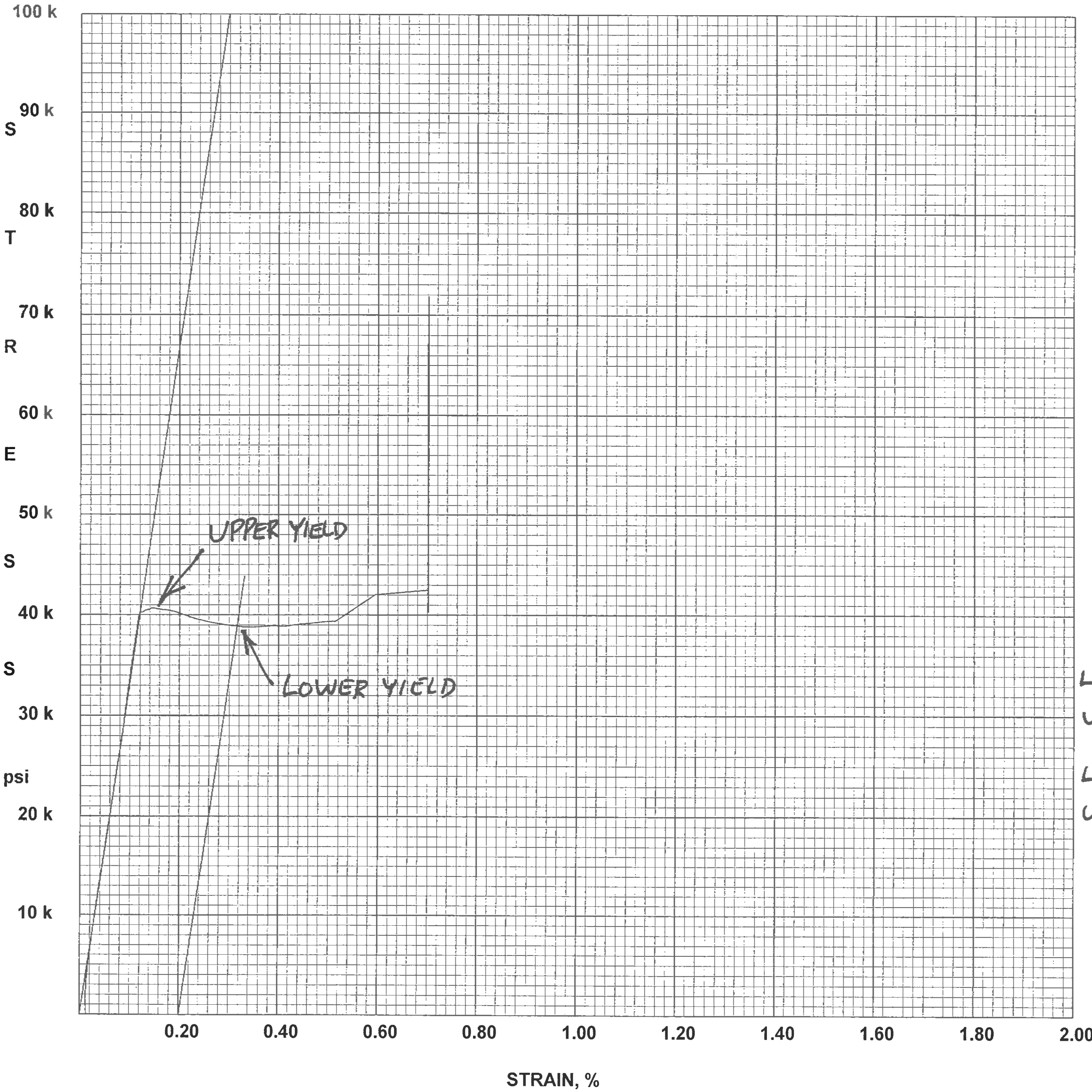
Test Results

Specimen Identification	Thickness, in.	Diameter or Width in.	Area, in.^{2}	Ultimate Load, lbs.	0.2% Offset Load, lbs.	Tensile Strength, psi	Yield Strength, psi	Elong. % in 2 in.	Red. in Area, %
N1	0.649	0.503	0.326	20,866	12,865	64,000	39,500	41	—
N2	0.628	0.503	0.316	20,972	12,271	66,500	38,800	38	—
N3	0.632	0.503	0.318	20,945	12,021	66,000	37,800	40	—
S1	0.646	0.503	0.325	21,376	12,554	66,000	38,600	39	—
S2	0.640	0.503	0.322	23,130	13,091[1] 12,518[2]	72,000	40,700[1] 38,900[2]	36	—
S3	0.633	0.503	0.318	20,351	11,922	64,000	37,500	38	—

ISO 9001

Prepared by: E. Boggs — E. Boggs, Materials Testing

Approved by: W. R. Allen — W. R. Allen, Materials Testing



Applied Technical Services
1049 Triad Court
Marietta, GA 30062

Metals Tensile w/ Ext.

Reference Number	D256979
Customer	LEW135
Purchase Order	L3937
Material	STEEL
Performed By	EB
Approved By	SM
Test Method	ASTM A370-15
Test Date	07/12/2016
Test Setting	Metals with Ext - 2 in GL
Sample No.:	1:S2,2015.54 02.1
Width, in:	0.503
Thickness, in:	0.64
Area, in²:	0.32192
Ultimate, lbf:	23130.5
LOWER OS @ .2, lbf:	12517.6
UPPER Yield, lbf:	13090.92
Ultimate, psi:	71851.4
LOWER OS @ .2, psi:	38884.1
UPPER Yield, psi:	40665
TE, %:	35.9
Reduction, %:	0.0000
Modulus, psi:	33400000

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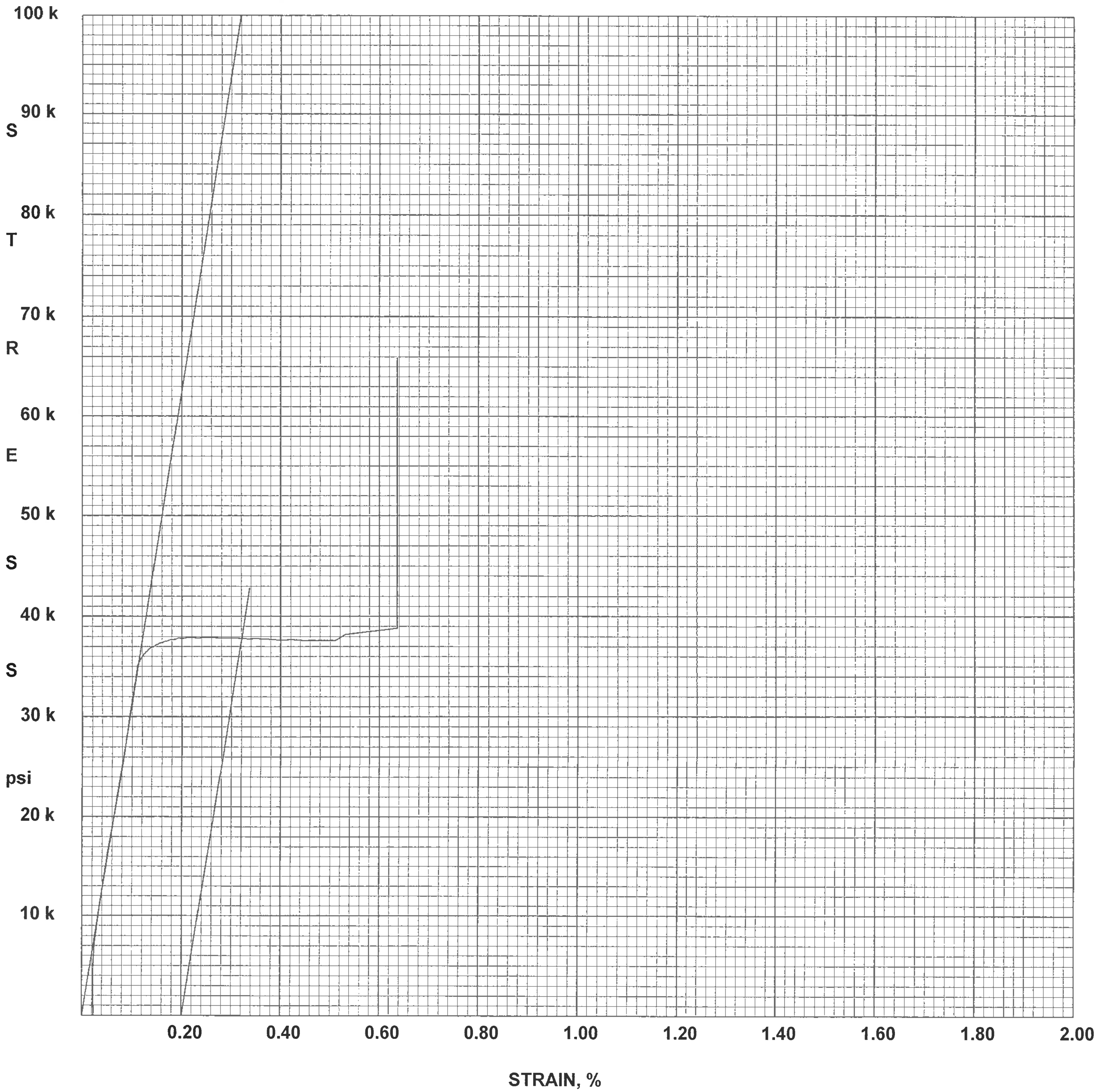

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Marietta, GA 30062

Metals Tensile w/ Ext.

Reference Number	D256979
Customer	LEW135
Purchase Order	L3937
Material	STEEL
Performed By	EB
Approved By	SM
Test Method	ASTM A370-15
Test Date	07/12/2016
Test Setting	Metals with Ext - 2 in GL

Sample No.:	2:N3,2015.54 02.1
Width, in:	0.503
Thickness, in:	0.632
Area, in²:	0.3179
Ultimate, lbf:	20944.7
OS @ .2, lbf:	12021.42
Yield, lbf:	12051.95
Ultimate, psi:	65885.2
OS @ .2, psi:	37815.5
Yield, psi:	37911.5
TE, %:	39.5
Reduction, %:	0.0000
Modulus, psi:	31300000

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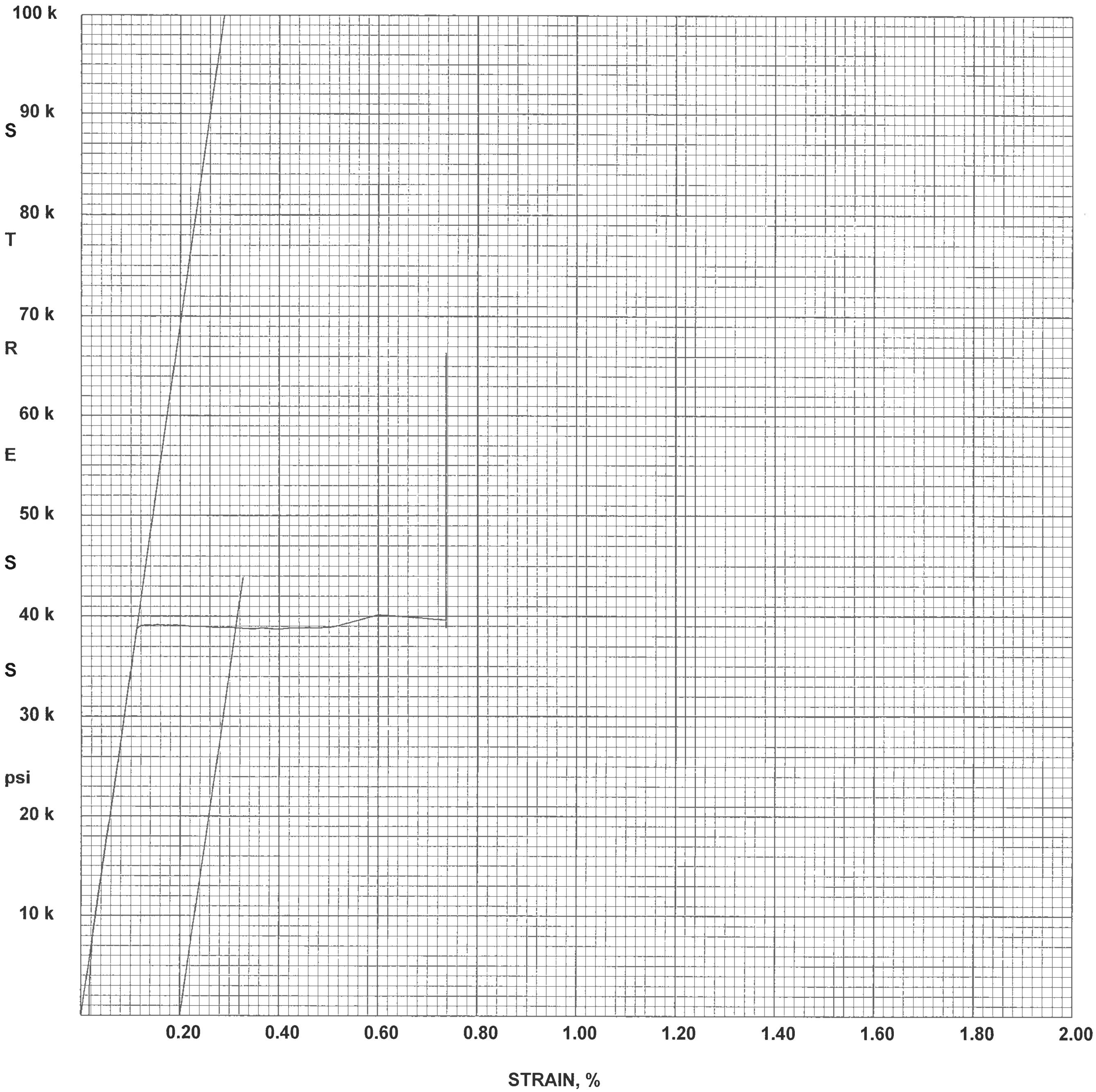

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Marietta, GA 30062

Metals Tensile w/ Ext.

Reference Number	D256979
Customer	LEW135
Purchase Order	L3937
Material	STEEL
Performed By	EB
Approved By	SM
Test Method	ASTM A370-15
Test Date	07/12/2016
Test Setting	Metals with Ext - 2 in GL
Sample No.:	3:N2,2015.54 02.1
Width, in:	0.503
Thickness, in:	0.628
Area, in²:	0.31588
Ultimate, lbf:	20971.6
OS @ .2, lbf:	12270.91
Yield, lbf:	12373.27
Ultimate, psi:	66389.9
OS @ .2, psi:	38846.2
Yield, psi:	39170.2
TE, %:	37.6
Reduction, %:	-0.6369
Modulus, psi:	34700000

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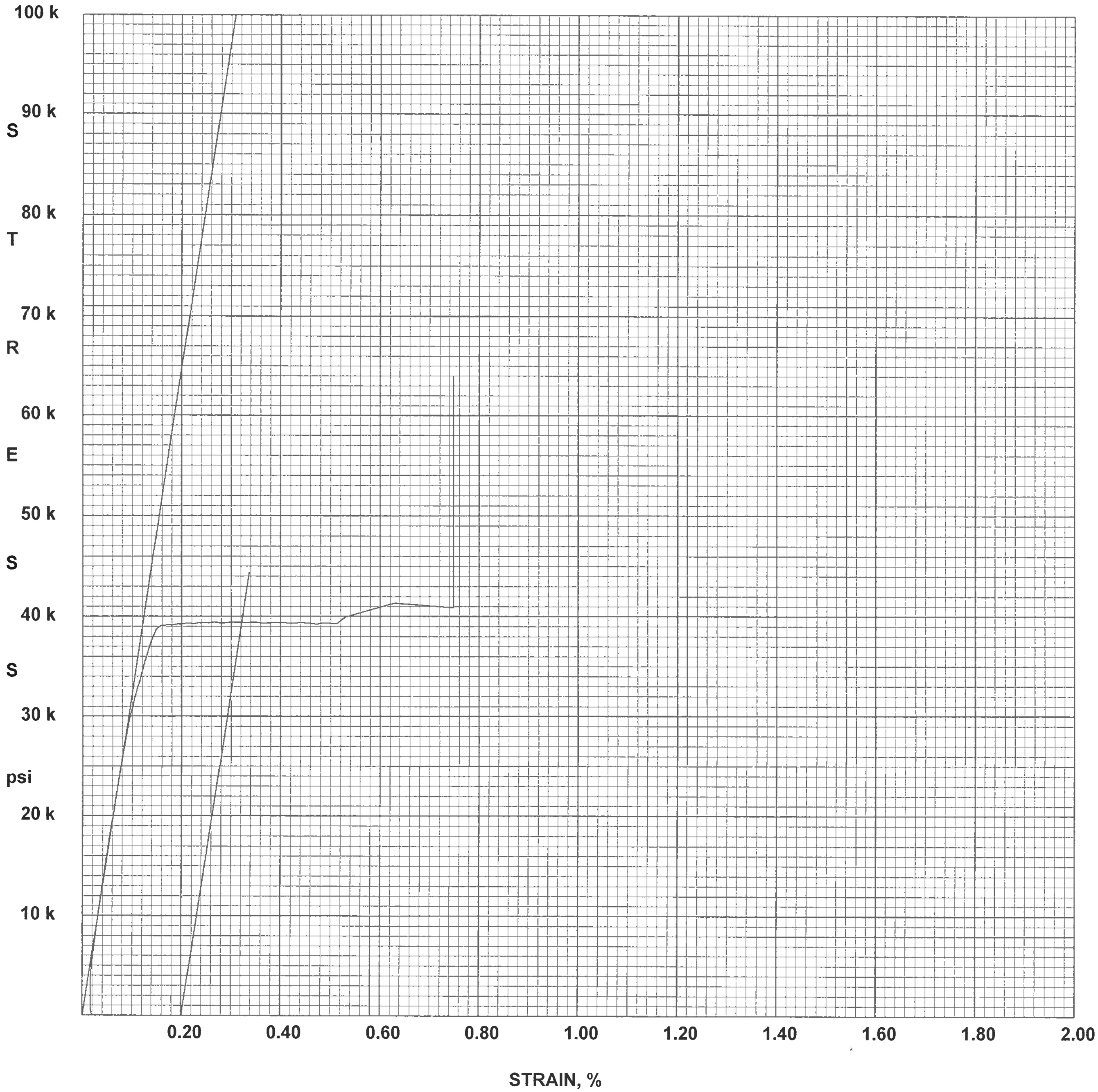

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Metals Tensile w/ Ext.

Reference Number	D256979
Customer	LEW135
Purchase Order	L3937
Material	STEEL
Performed By	EB
Approved By	SM
Test Method	ASTM A370-15
Test Date	07/12/2016
Test Setting	Metals with Ext - 2 in GL
Sample No.:	4:N1,2015.54 02.1
Width, in:	0.503
Thickness, in:	0.649
Area, in²:	0.32645
Ultimate, lbf:	20865.9
OS @ .2, lbf:	12865.24
Yield, lbf:	12843.09
Ultimate, psi:	63917.9
OS @ .2, psi:	39409.8
Yield, psi:	39341.9
TE, %:	40.9
Reduction, %:	0.0000
Modulus, psi:	32400000

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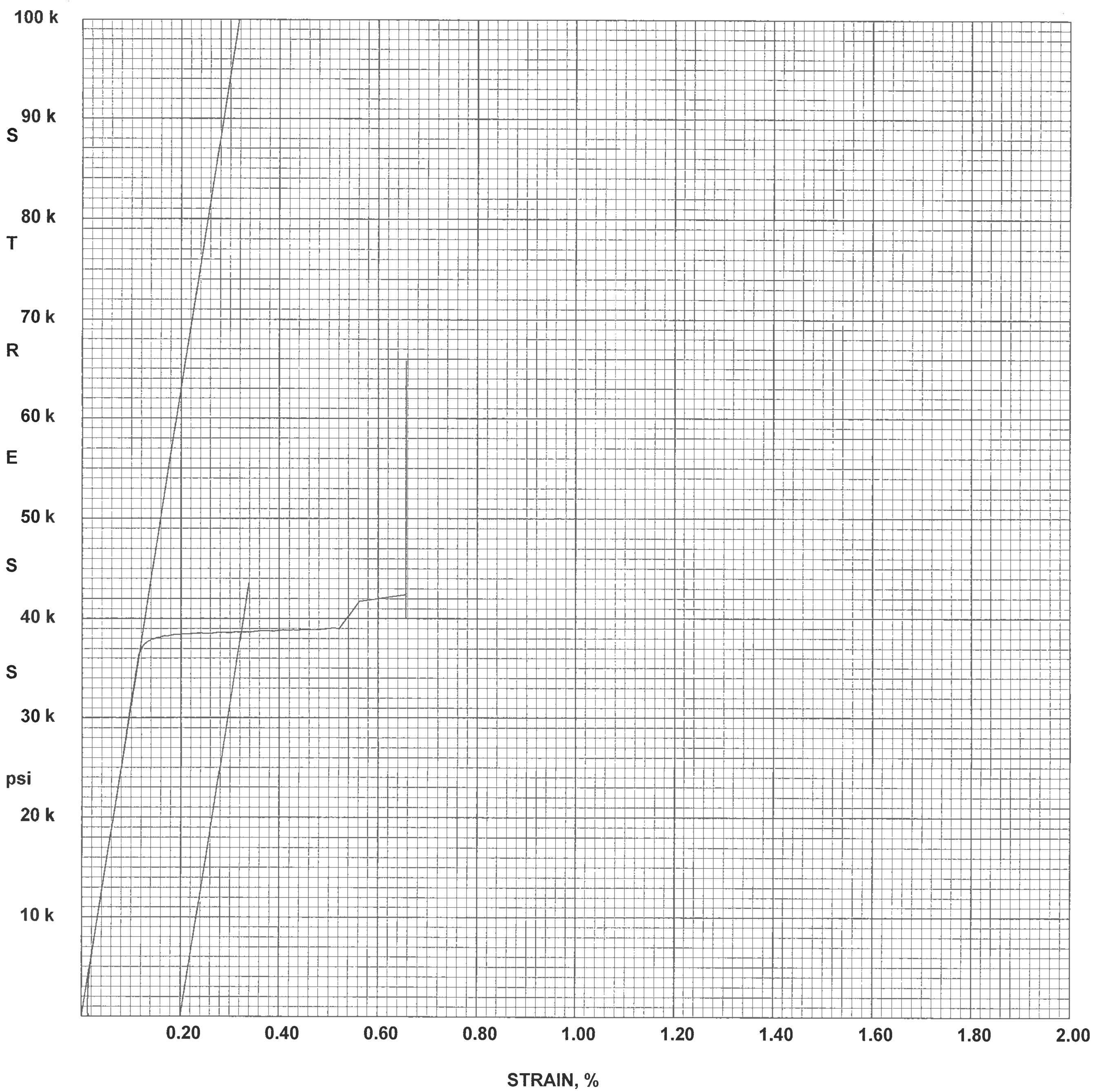

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Metals Tensile w/ Ext.

Reference Number	D256979
Customer	LEW135
Purchase Order	L3937
Material	STEEL
Performed By	EB
Approved By	SM
Test Method	ASTM A370-15
Test Date	07/12/2016
Test Setting	Metals with Ext - 2 in GL

Sample No.:	5:S1,2015.54 02.1
Width, in:	0.503
Thickness, in:	0.646
Area, in²:	0.32494
Ultimate, lbf:	21375.7
OS @ .2, lbf:	12554.17
Yield, lbf:	12687.17
Ultimate, psi:	65783.8
OS @ .2, psi:	38635.5
Yield, psi:	39044.8
TE, %:	38.9
Reduction, %:	-0.4644
Modulus, psi:	31400000

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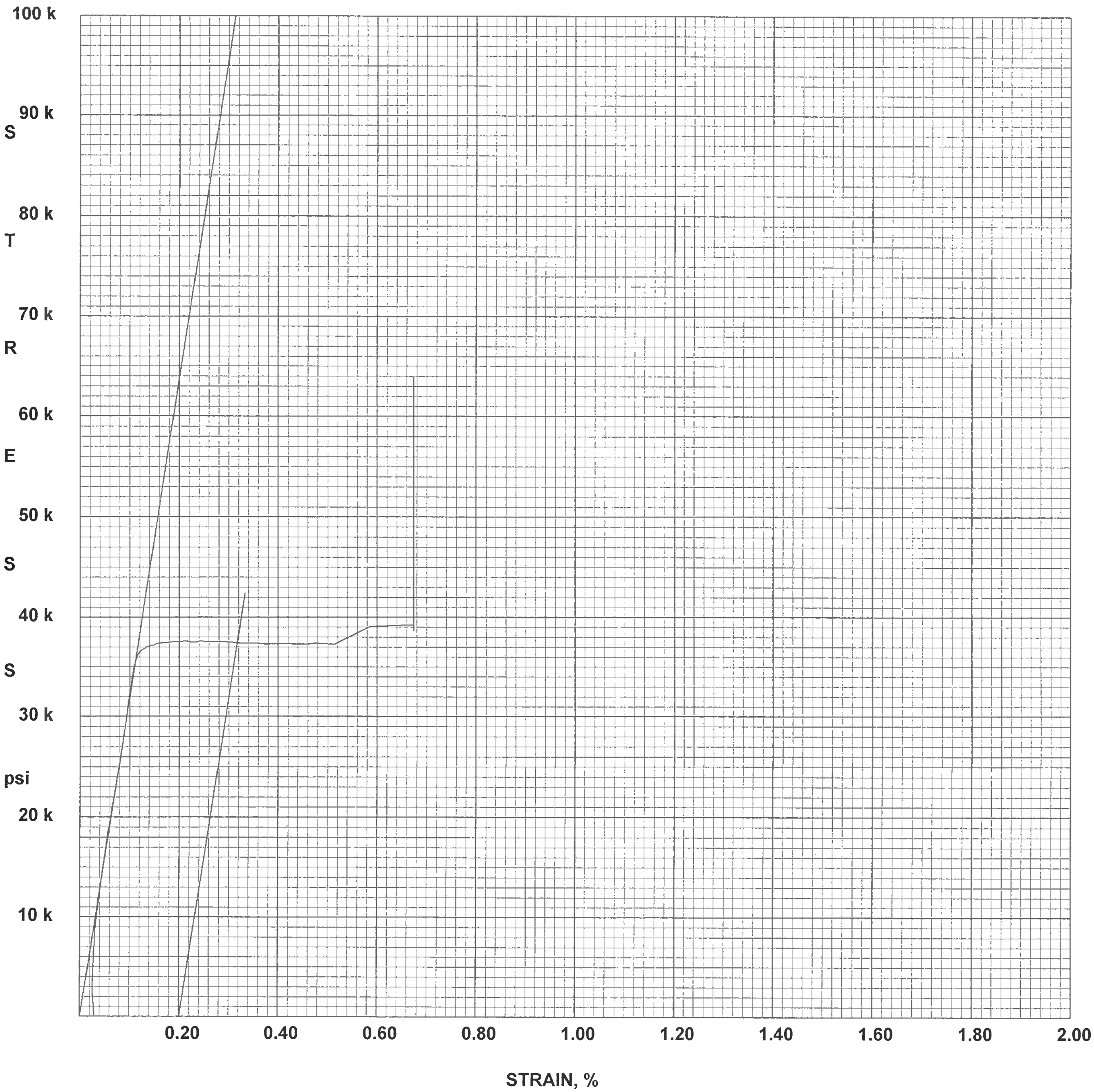

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Metals Tensile w/ Ext.

Reference Number	D256979
Customer	LEW135
Purchase Order	L3937
Material	STEEL
Performed By	EB
Approved By	SM
Test Method	ASTM A370-15
Test Date	07/12/2016
Test Setting	Metals with Ext - 2 in GL

Sample No.:	6:S3,2015.54 02.1
Width, in:	0.503
Thickness, in:	0.633
Area, in²:	0.3184
Ultimate, lbf:	20351.1
OS @ .2, lbf:	11921.67
Yield, lbf:	11974.04
Ultimate, psi:	63916.8
OS @ .2, psi:	37442.4
Yield, psi:	37606.9
TE, %:	37.8
Reduction, %:	0.0000
Modulus, psi:	31900000

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