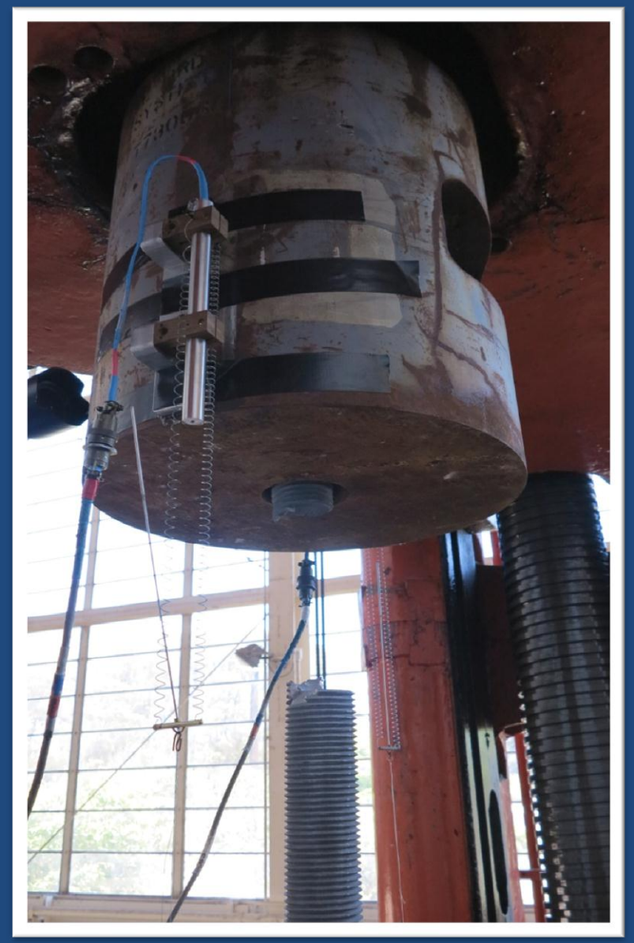

SAS A354BD TESTING PROGRAM RESULTS

Test I, II & III

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GLOBAL SUMMARY

Item No.		TEST I	TEST II				TEST III													
		Average Hardness	Average Hardness	Charpy		Chemistry	Full-Size Sample	Reduced Section				Hardness		Charpy (ft-lb)		Chemistry	Galv. Chemistry		Micro-structural Analysis	Fracture Analysis
				40°F	70°F		Tensile (ksi)	Tensile (ksi)	Yield (ksi)	% Elongation	Reduction in Area (%)	Knoop	HRC	40°F	70°F		Tin	Bismuth		
2		33.1	-	-	-	-	158.2	158.5	140.8	17.6	53.3	-	33.9	37.2	37.6	Pass	-	-	Banded Micro Struc.	Ductile Failure
3		33.5	33.0	36.9	37.6	Pass	156.1	157.9	139.7	18.3	54.0	354.0	33.4	36.8	39.3	Pass	0.00625	0.0011	Banded Micro Struc.	Ductile Failure
4		35.4	34.4	27.3	36.7	Pass	157.8	158.3	145.6	16.0	48.5	363.0	35.4	24.8	39.3	Pass	0.00600	0.0011	Banded Micro Struc.	Ductile Failure
7		34.0	31.8	39.0	40.8	Pass	158.6	158.3	138.8	17.0	53.1	364.0	33.4	36.3	39.0	Pass	0.00600	0.014	Banded Micro Struc.	Ductile Failure
8		34.8	32.7	16.9	20.8	Pass	151.3	161.5	136.4	17.0	49.3	364.0	33.6	16.7	18.3	Pass	0.00700	0.009	Banded Micro Struc.	Ductile Failure
9	NNF	34.8	33.9	52.3	52.7	Pass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	NTA		33.4	13.0	16.0	Pass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11		-	-	-	-	-	167.0	Reduced Section Not Performed due to Unavailable Sample Length				Not Performed due to Unavailable Sample Length							Banded Micro Struc.	Ductile Failure
12		34.6	33.9	39.1	41.8	Pass	162.8	163.3	147.6	17.0	54.8	359.0	33.7	49.0	51.0	Pass	0.003	0.012	Banded Micro Struc.	Ductile Failure
13		35.3	34.5	31.7	36.3	Pass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14		34.6	34.0	Sample too small		Pass	150.4	Reduced Section Not Performed due to Unavailable Sample Length				352.0	33.7	27.0	47.0	Pass	0.003	0.005	Banded Micro Struc.	Ductile Failure
15		34.3	31.9	17.8	23.7	Pass	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16		34.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SAS A354BD Bolt Tests - 6/20/13 Update (DRAFT)

					Testing Plan - Number of samples to test									
					I (in-situ test)		II (lab test) (Note 1)		III (full size)		IV (stress corrosion test)		V (Incremental Step Load)	
ID	Structural Component	Number of Bolts	Nominal Bolt Diameter [in]	Sustained Bolt Tension % Fu (UTS)	Number of Tests*	(%Completed)	Number of Tests*	(%Completed)	Number of Tests	(%Completed)	Number of Tests	(%Completed)	Number of Tests	(%Completed)
1	Shear Key Anchor Bolts- Bottom (S1/S2)	96	3	0.70	TBD	-	TBD		TBD		TBD		TBD	
2	Shear Key Anchor Bolts- Bottom (S3/S4)	96	3	0.70	84	100%	Same Heat as ID 3	-	2	100%	2	have sample; fabrication in progress		
	Pier E2 Bearing Bolts- Bottom Housing (B1, B2, B3, B4)	96	3	0.70	54	100%		-	2	100%	2	have sample; fabrication in progress		
3	Shear Key Anchor Bolts-Top (S1/S2)	160	3	0.70	143	100%	6 (spares)	100%	2 (spares)	100%	Same Heat as ID 2	-		
	Shear Key Anchor Bolts-Top (S3/S4)	160	3	0.70	144	100%	6 (spares)	100%	2 (spares)	100%		-		
4	Pier E2 Bearing Bolts- Top Housing (B1,B2,B3,B4)	224	2	0.70	224	100%	7 (spares)	100%	2 (spares)	100%	1 (spare)	0% (have sample; fabrication in progress)		
5	Spherical Bearing Bushing Assembly Bolts	96	1	0.61	No Access	-	No Access	-	No Access	-	No Access	-		
6	Bearing Retainer Ring Plate Assembly Bolts	336	1	0.40	No Access	-	No Access	-	No Access	-	No Access	-		
7	PWS Strand Anchor Rods (Main Cable)	274	3-1/2	0.32	266 (Note 2)	100%	43	100%	1 (spare)	100%	4***	have sample; fabrication in progress		
8	Tower Saddle Tie Rods	25	4	0.68	19 (Note 3)	100%	2 (spare)	100%	1 (spare)	100%	1 (spare)	have sample; fabrication in progress		
9	Tower Saddle Turned Rods (@ Splices)	100	3	0.45	20	100%	2	100%	-	-	-	-		
	Tower Saddle Turned Rods (@ Splices)	8	3	0.10										
10	Tower Saddle Grillage Bolts	90	3	0.10	-	-	-	-	-	-	-	-		
11	Tower Outrigger	4	3	0.10	-	-	-	-	1 (spare)	100%	-	-		
12	Tower Anchorage Anchor Bolts (75 Dia. Anchor Bolts)	388	3	0.48	226	100%	6 (Note 5)	100%	1 (Note 7)	100%	1 (Note 7)	have sample; fabrication in progress		
13	Tower Anchorage Anchor Bolts (100 Dia. Anchor Bolts)	36	4	0.37	36	100%	3 (Note 5)	100%	-	-	-	-		
14	East Saddle Anchor Rods	32	2	0.10	16	100%	2 (Notes 4 &7)	100%	1 (spare)	100%	-	-		
15	East Saddle Tie Rods	18	3	0.20	8	100%	1	100%	-	-	-	-		
16	Cable Bracket Anchor Rods	24	3	0.16	12	100%	(Note 6)	-	(Note 6)	-	(Note 6)	-		
17	Bikepath Anchor Bolts at Pier W2	43	M30 (1-1/4)	0.10	9	0% (pending re-design)	1	0% (pending re-design)	-	-	-	-		

*Number of tests performed varies slightly from the number of tests planned. This column is adjusted to reflect testing performed.

*** 2 rolled thread samples &
2 cut thread samples

1. Test at least one sample from each heat for Test II
2. Cut-off drill and tap hole @ end for testing. Sample lengths to be provided in separate attachment.
3. Test top surface of hex @ end of rod.
4. No Charpy tests due to limited available rod stick-out.
5. Samples for lab test II shall be taken after tests I, III and IV are completed, except for some samples that can be taken earlier.
6. Same heat as PWS, no sampling necessary.
7. Sample already removed.

LIST OF TESTS

TEST I

Field Hardness Test (*in-situ*)

- Rockwell C Hardness

TEST II

Laboratory Test on Samples

- Rockwell C Hardness
- Chemistry
- Charpy (when available)

TEST III

Full Size Test

- Full Size Tension Test
- Coupon Tension Test
- Rockwell C Hardness
- Knoop Micro-Hardness
- Metallurgical Analysis
- Fracture Analysis
- Galvanization Chemistry

TEST IV

Stress Corrosion Test (Townsend)

- Time-Dependent Stress Corrosion Test
- Coupon Tension Test
- Rockwell C Hardness
- Knoop Micro-Hardness
- Metallurgical Analysis
- Fracture Analysis
- Galvanization Chemistry

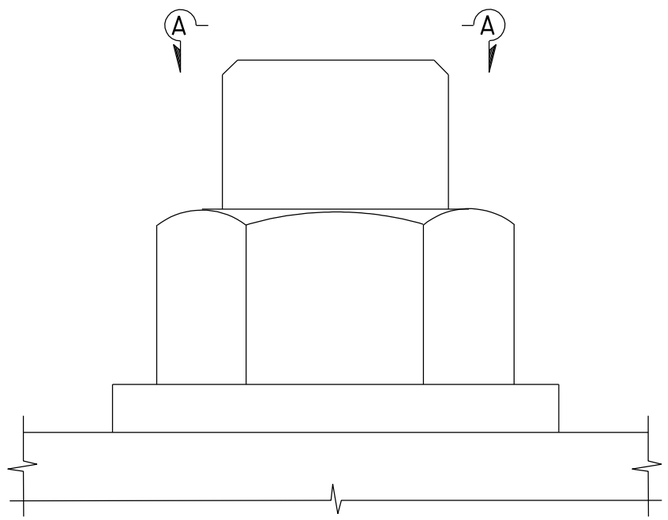
TEST V

Incremental Step Loading Technique

- Reduced Sample Size Tests
- HE threashold
- SCC threashold

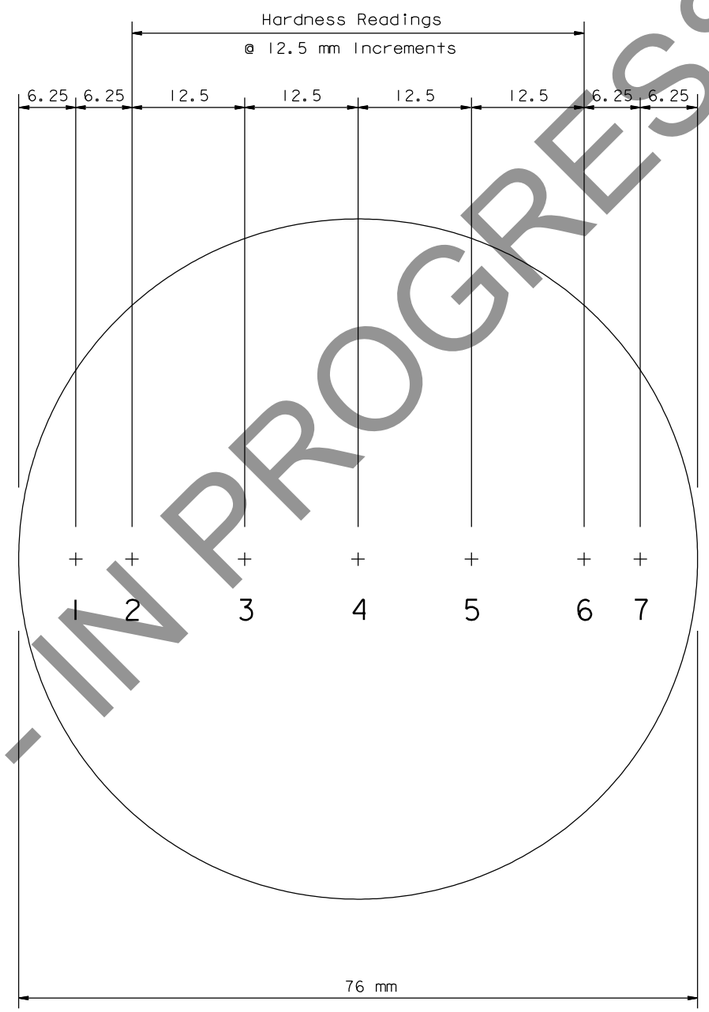
DRAFT - IN PROGRESS

TEST 1: FIELD HARDNESS TEST



(IN-SITU BOLT)

DETAIL 1
1:1



FIELD HARDNESS READINGS FOR 76 DIA ROD, TYP
(OTHER DIAMETERS SIMILAR)

SECTION A-A
1:1

GENERAL PROCEDURE:

1. The surface shall be free of oil, grease, rust, and surface coatings.
2. Grind galvanizing from the top surface of the rods.
3. After grinding, lightly sand surface to achieve a profile of 15 micro-m or less per ASTM A1038.
4. Verify surface roughness with a profile meter.
5. Take measurements with calibrated portable hardness equipment. Multiple readings at each point shall be taken and averaged to achieve consistent hardness values.
6. After measuring the hardness of each rod, the equipment readings shall be verified against a calibrated hardness reference block by taking two additional measurements.

GENERAL NOTES:

1. Field hardness equipment is subject to greater variability than lab equipment. In addition, factors including wind and difficult access conditions can contribute to such variability.
2. All dimensions are shown in millimeters.

Date: 2013-05-30
File Name: FIELD HARDNESS TEST (TP-01)

DRAFT - IN PROGRESS

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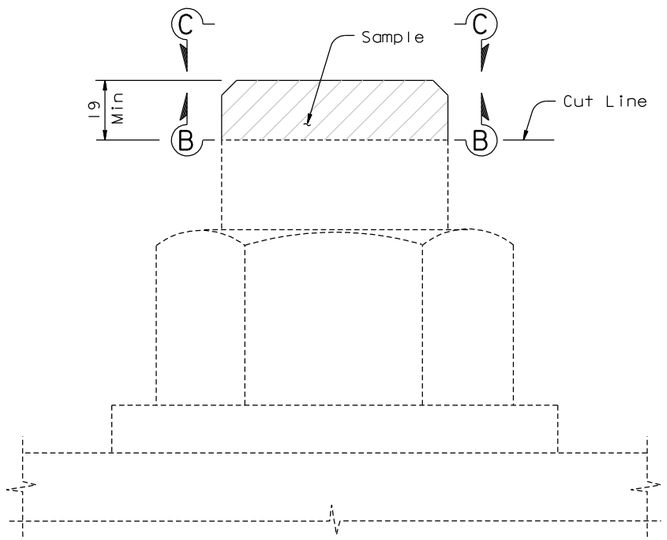
FILE => I:\bb\04-012001\sas\rfi updates\engineer update sketches\sh e2 shear keys retrofit\test program for 354bd\tp-01.dgn

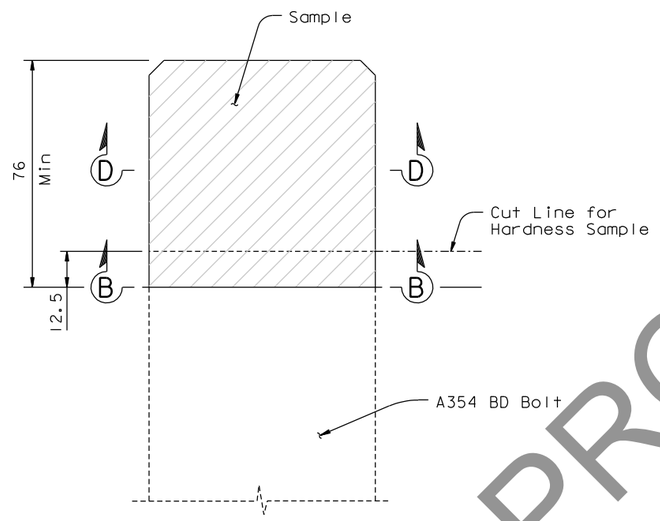
TEST II: LABORATORY TESTS



(HARDNESS & CHEMISTRY SAMPLE)

DETAIL 2

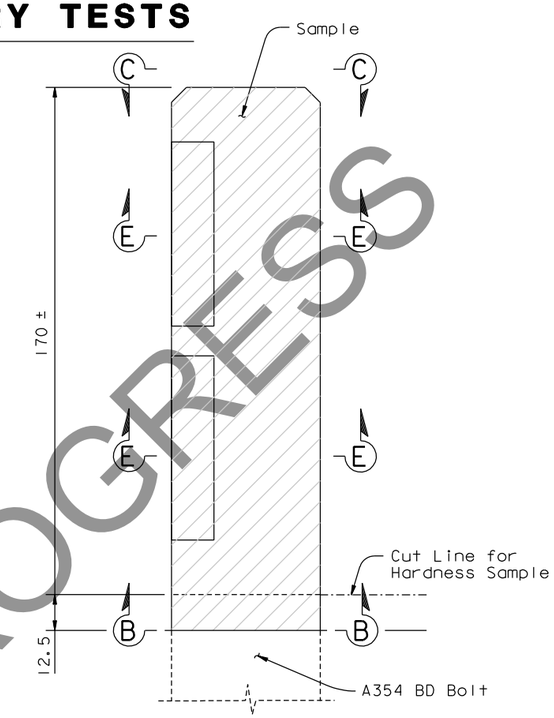
1:1



(HARDNESS, CHEMISTRY & CHARPY SAMPLE)

DETAIL 3 (OD ≥ 3")

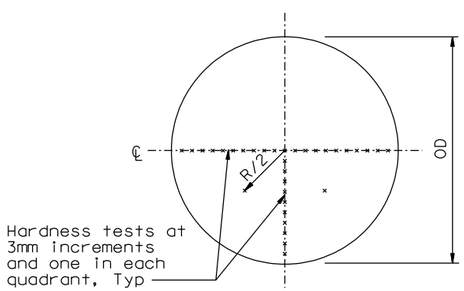
1:1



(HARDNESS, CHEMISTRY & CHARPY SAMPLE)

DETAIL 4 (OD = 2")

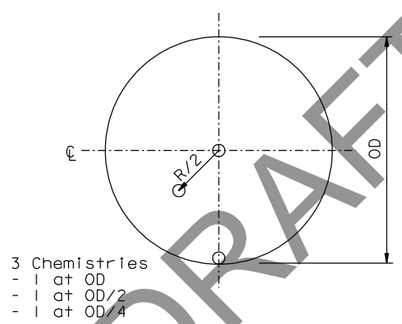
1:1



(ROCKWELL C HARDNESS)

SECTION B-B

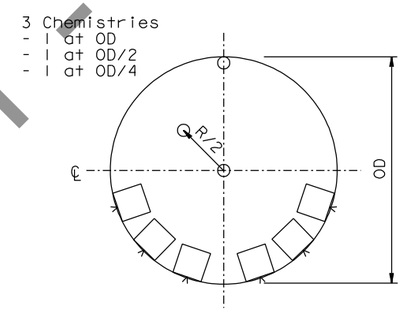
1:1



(CHEMISTRY)

SECTION C-C

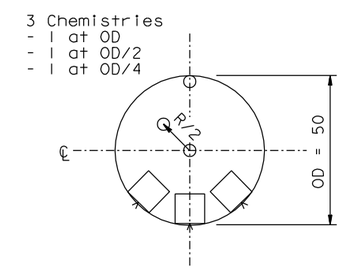
1:1



(HARDNESS, CHEMISTRY & CHARPY SAMPLES)

SECTION D-D (See Note 2)

1:1



SECTION E-E (See Note 3)

1:1

GENERAL PROCEDURE:

1. Cut sample from bolt in the field or from spare as shown in Detail 2 or Detail 3.
2. Where the test sample is per Detail 2, perform Rockwell C hardness per section B-B, and chemical analysis per Section C-C.
3. Where the test sample is per Detail 3, perform the following steps:
   a. Cut 12.5 mm sample for hardness testing first.
   b. Prepare hardness sample and perform Rockwell C hardness readings per Section B-B.
   c. Machine six (6) Charpy test samples as shown in Section D-D.
   d. Perform Charpy testing at 40F and 70F.
   e. After cutting the samples for Charpy tests, cut 12.5 mm sample for chemical analysis.
   f. Perform chemical analysis per Section D-D.

NOTES:

1. All dimensions shown in millimeters.
2. Required minimum sample length for Charpy test is 76 mm per Detail 3.
3. Required minimum sample length for Charpy test is 185 mm per Detail 4.

Date: 2013-06-05
File Name: LABORATORY TESTS (TP-02)

DRAFT - IN PROGRESS

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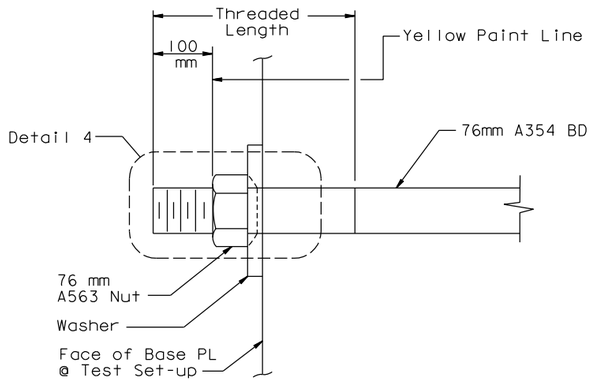
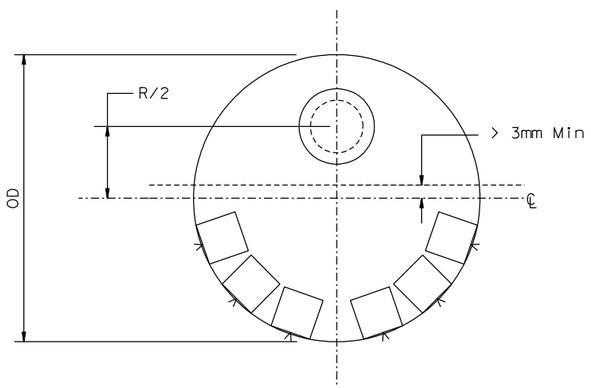
FILE => I:\bb\04-012001\sas\rfi updates\engineer update sketches\sh e2 shear keys retrofit\test program for 354bd\tp-02.dgn

TEST III: FULL SIZE TENSION TEST

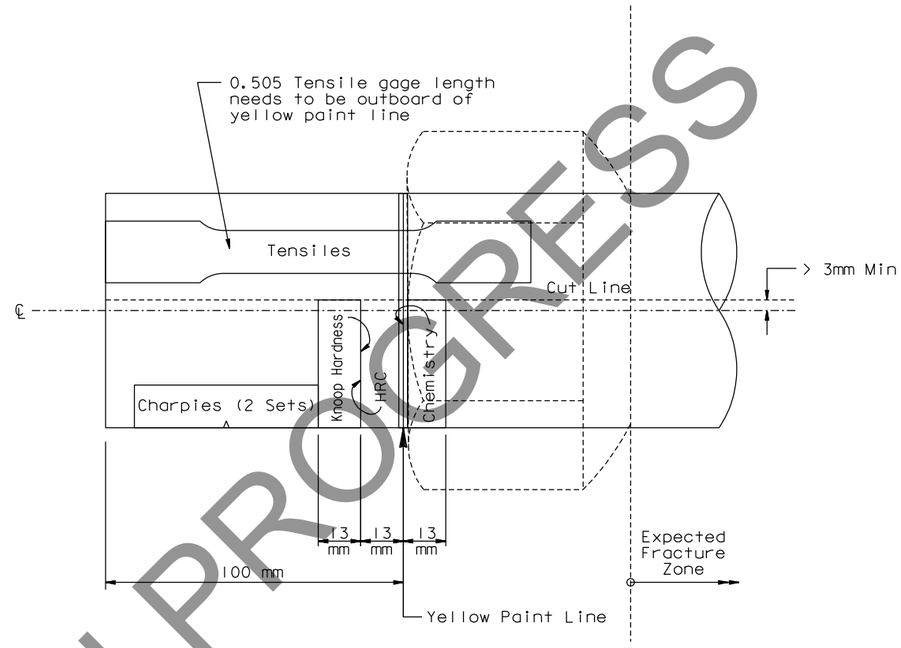


ANCHOR ROD

1:5

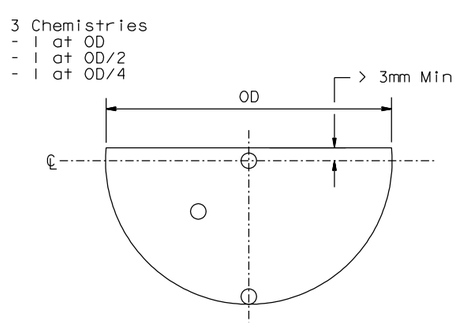


TENSILE AND CHARPY SAMPLES

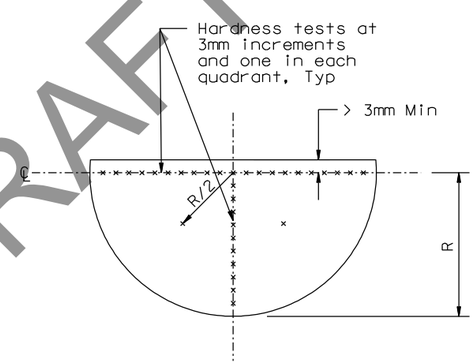


DETAIL 4

1:1



CHEMISTRY



ROCKWELL C HARDNESS

TESTING PROTOCOL

SAMPLE SELECTION:

1. Perform sample selection per sampling frequency on Table "SAS A354 BD Bolt Tests".

EXTENDED TESTING PROTOCOL

(Tests listed below to be performed at an independent testing laboratory accredited per ISO 17025 or approved by Caltrans).

1. Load full size sample to failure.
2. Perform Charpy V-Notch testing of broken rods at room temperature and at 40 degrees F.
3. Perform reduced section tensile tests (.505 diameter) of the broken rods as detailed in "Tensile and Charpy Samples" Section.
4. Perform hardness Testing (Rockwell C and Knoop Micro-hardness) of broken rods as detailed in "Rockwell C Hardness" Section.
5. Perform chemical analysis of broken rods as detailed in "Chemistry" Section.
6. Perform scanning electron microscopy - examination of fracture features on broken rods.
7. Perform Micro-structural examination of broken rods at the threaded area.
8. All dimensions shown in millimeters.
9. Perform Chemical analysis of galvanizing (provide tin and bismuth concentrations if any).

Date: 2013-05-31
File Name: FULL SIZE TENSION TEST (TP-03)

DRAFT - IN PROGRESS

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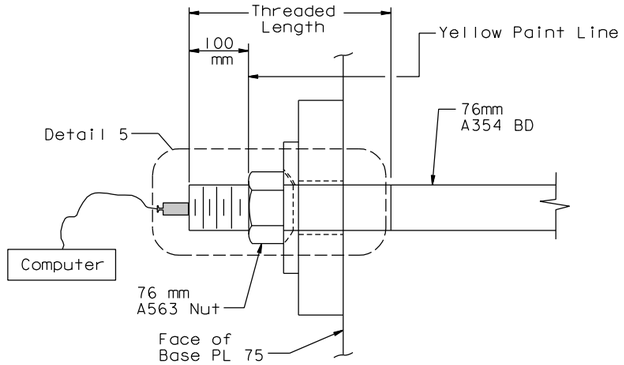
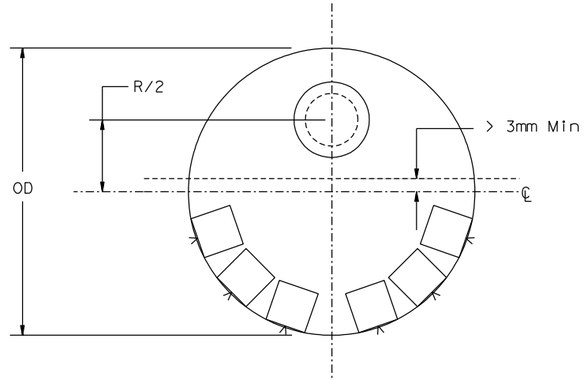
FILE => I:\bb\04-012001\sas\rfi updates\engineer update sketches\sh e2 shear keys retrofit\test program for 354bd\tp-03.dgn

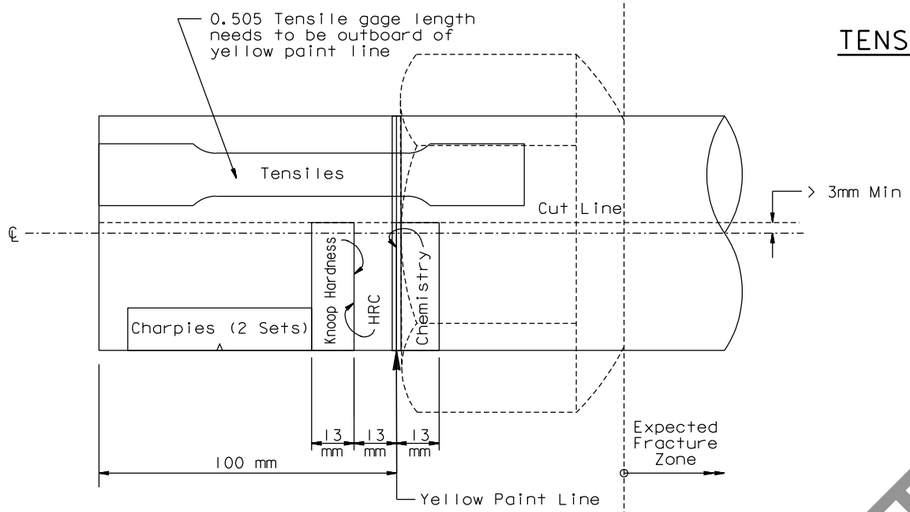
TEST IV: STRESS CORROSION (TOWNSEND) TEST



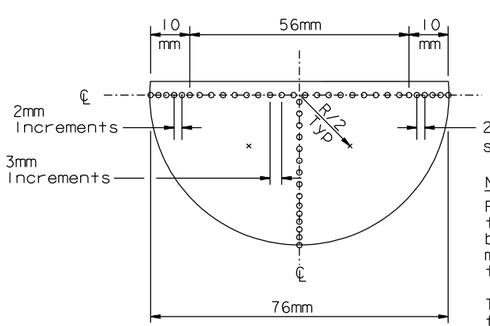
ANCHOR ROD
1:5



TENSILE AND CHARPY SAMPLES



DETAIL 5
1:1



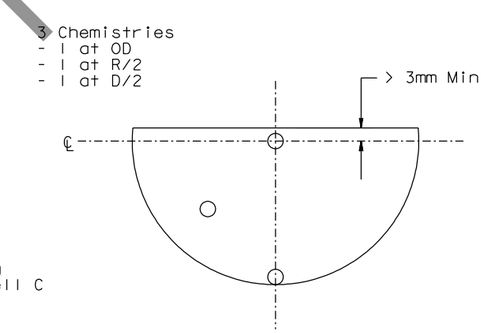
ROCKWELL C HARDNESS

Note:

Perform hardness tests along 2 traverses @ 90 degress. The spacing between the readings for the Rockwell C measurements shall be 3mm for the entire cross section.

The spacing between the readings for the Knoop measurements only shall be as follows:

- 2mm Increments for the first 10mm from the exterior
- 3mm Increments in between



CHEMISTRY

TEST PROTOCOL:

This testing protocol was developed with the assistance of Dr. Herb Townsend, PhD,PE, Dr. Karl Frank, PhD,PE; and Mr. Doug Williams, PE.

SAMPLE SELECTION: 4 rods will be tested.

1. Prior to extraction, ABFJV shall reload the selected rods up to 0.75Fu and maintain the load for 24 hours.
2. After 24 hours, the rods shall be extracted and nondestructively tested.
3. Rods shall be cleaned to remove all contaminants and lubricants from the threads.
4. The samples shall be transported to the selected testing facility where the slow loading tests in a 3.5% NaCl solution will be performed as follows:

%Fu	Load per Rod (Kips)	Time* (hr)
0.30	251	48
0.40	334	48
0.50	418	48
0.55	460	48
0.60	501	48
0.65	543	48
0.70	585	48
0.75	627	48
0.80	669	48
0.85	710	120

* Hold time at each load step

5. The testing facility shall record the strain using 3 strain gauges, spaced 120 degrees apart around the circumference of the rod. The following data shall be recorded against time from the start of test: load hydraulic pressure), displacement, confirmation that water level is above rod, water ph, reference electrode reading, strain gauge readings, relevant acoustic emission events. Data shall be recorded at the beginning and end of each load step and at intervals not exceeding 8 hours.
6. After maintaining the load at 0.85 Fu for 5 days (120 hours) as shown above, load the samples to failure.
7. Transport the fractured sections to the fracture analysis lab for further assessment.
8. Perform Charpy V-Notch testing of broken rods at room temperature and at 70 degrees, per "Tensile and Charpy Samples" Section.*
9. Perform reduced section tensile tests (.505 diameter) of the broken rods as close to the fracture surface as possible. Tensile tests to be performed as detailed in "Tensile and Charpy Samples" Section.
10. Perform Rockwell C hardness and Knoop (Micro-hardness) testing per "Rockwell C Hardness" Section, and no closer than 1 rod diameter from the ends of each rod.
11. Perform chemical analysis of broken rods at the threaded area and at the shank. Chemical tests to be performed as detailed in "Chemistry" Section.
12. Perform scanning electron microscopy - examination of fracture features on broken rods.
13. Perform Micro-structural examination of broken rods at the threaded area.
14. Perform Chemical analysis of galvanizing (provide tin and bismuth concentrations if any).

Date: 2013-05-31
File Name: STRESS CORROSION (TOWNSEND) TEST (TP-04)

DRAFT - IN PROGRESS

USERNAME => arivera DATE PLOTTED => 31 MAY 2013 TIME PLOTTED => 10:22:14
FILE => I:\bb\04-012001\sas\rfi updates\engineer update sketches\sh e2 shear keys retrofit\test program for 354bd\tp-04.dgn

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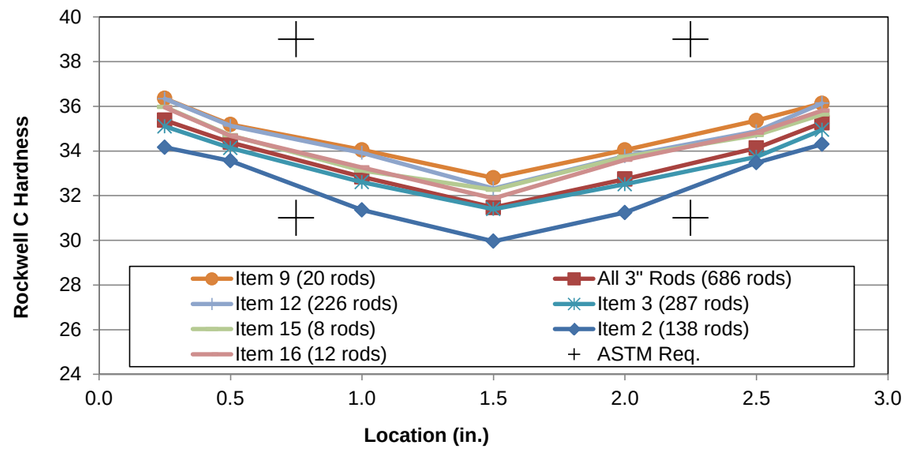
SUMMARY OF ALL TEST I

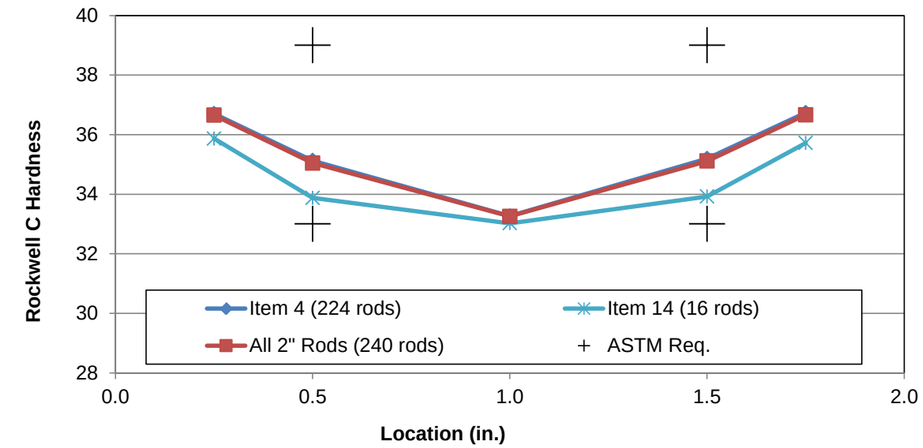
Average Hardness - 3" Rods

Average	35.4	34.4	32.8	31.5	32.7	34.1	35.3



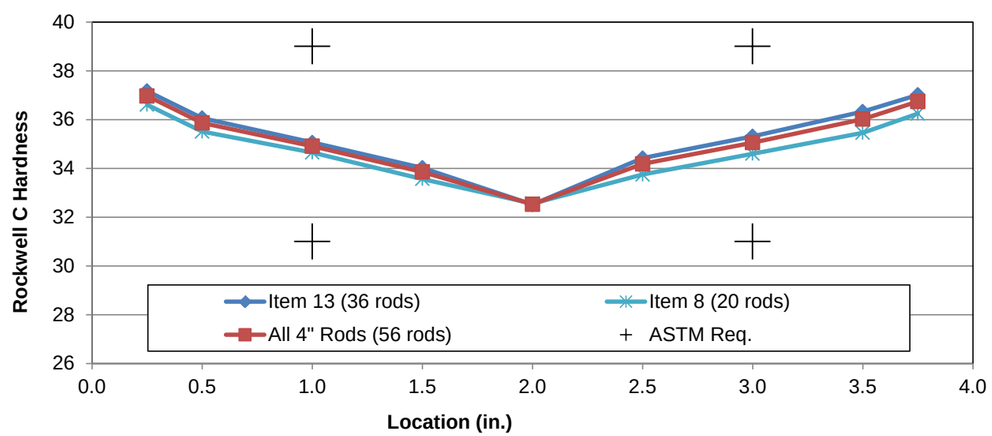
Average Hardness - 2" Rods

Average	36.7	35.0	33.3	35.1	36.7



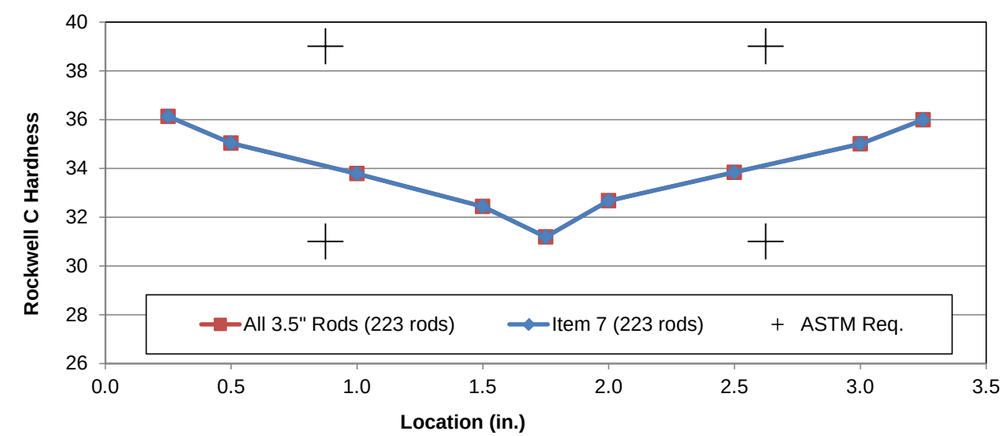
Average Hardness - 4" Rods

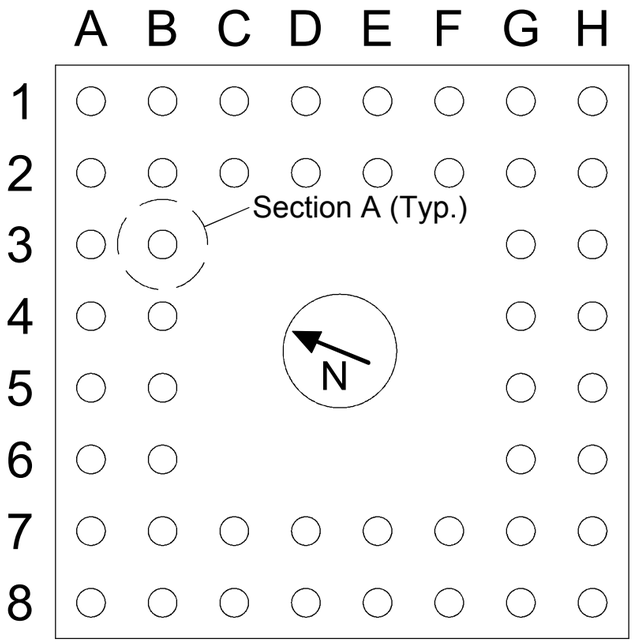
Average	37.0	35.9	34.9	33.9	32.5	34.2	35.1	36.0	36.7



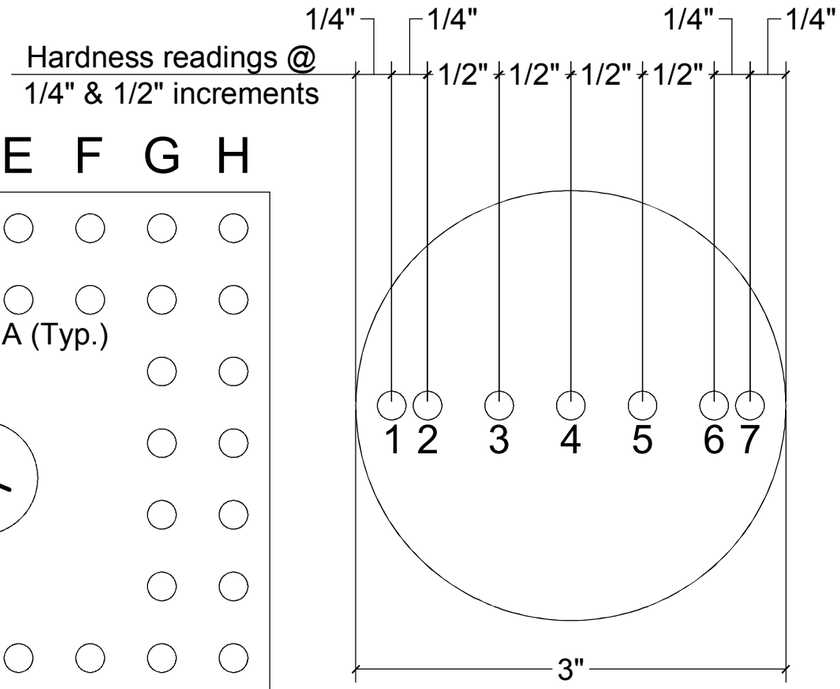
Average Hardness - 3.5" Rods

Average	36.1	35.0	33.8	32.4	31.2	32.7	33.8	35.0	36.0





SHEAR KEY ANCHOR ROD LAYOUT



Section A (Typ.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Revision No:	By:	Date:

SELF-ANCHORED SUSPENSION BRIDGE

E2 Shear Key Hardness Readings - 48 Rods (Fabricated in 2010)

Drawn By:	MH	SHEET NUMBER	2-I-S3-BOT
Date:	6/20/2013		

HARDNESS TEST RESULTS

	A		B		C		D		E		F		G		H	
1	1	31.6	1	34.8	1	35.9	1	35.7	1	35.7	1	35.4	1	37.3	1	36.3
	2	36.4	2	33.1	2	34.3	2	34.8	2	35.0	2	33.2	2	35.7	2	34.5
	3	36.6	3	32.1	3	33.5	3	33.1	3	33.1	3	33.0	3	34.7	3	31.4
	4	28.4	4	31.2	4	31.2	4	32.0	4	32.0	4	32.6	4	33.1	4	31.0
	5	30.6	5	32.4	5	33.1	5	32.6	5	33.8	5	33.3	5	32.8	5	30.8
	6	32.6	6	33.9	6	34.2	6	33.0	6	34.9	6	34.8	6	34.2	6	31.4
	7	32.4	7	34.5	7	35.2	7	34.0	7	36.3	7	36.9	7	34.6	7	34.3
2	1	37.3	1	34.0	1	34.9	1		1	34.7	1	33.0	1	36.1	1	35.3
	2	35.3	2	33.9	2	33.7	2		2	33.6	2	31.2	2	34.7	2	33.5
	3	33.8	3	32.7	3	32.5	3		3	31.2	3	30.0	3	33.0	3	32.1
	4	32.1	4	30.8	4	31.1	4		4	29.9	4	29.3	4	31.1	4	30.2
	5	33.7	5	32.8	5	32.4	5		5	31.2	5	30.4	5	30.8	5	32.8
	6	34.5	6	33.4	6	33.4	6		6	33.5	6	33.0	6	33.6	6	33.6
	7	35.1	7	34.8	7	34.3	7		7	36.5	7	36.7	7	34.4	7	36.1
3	1	36.4	1	34.6									1	35.1	1	35.6
	2	34.9	2	32.7									2	34.4	2	34.5
	3	33.3	3	31.1									3	33.5	3	34.2
	4	31.3	4	29.8									4	32.2	4	33.5
	5	30.7	5	30.3									5	34.5	5	34.1
	6	33.7	6	33.8									6	35.1	6	35.3
	7	34.6	7	34.8									7	35.6	7	35.6
4	1	35.6	1	34.2									1	36.3	1	33.4
	2	34.1	2	32.8									2	34.3	2	32.8
	3	33.2	3	30.8									3	32.4	3	31.5
	4	31.5	4	29.5									4	29.5	4	30.3
	5	32.2	5	30.6									5	33.7	5	28.6
	6	34.0	6	32.1									6	34.4	6	32.1
	7	35.3	7	34.5									7	35.8	7	33.9
5	1	34.9	1	35.2									1	34.6	1	34.9
	2	32.6	2	34.6									2	33.5	2	32.9
	3	31.2	3	33.4									3	32.7	3	31.6
	4	30.4	4	32.2									4	30.1	4	30.5
	5	33.7	5	32.8									5	31.5	5	31.0
	6	34.9	6	33.8									6	32.8	6	32.9
	7	36.2	7	35.8									7	34.3	7	33.3
6	1	34.4	1	34.6									1	35.2	1	36.1
	2	33.5	2	33.9									2	33.6	2	34.6
	3	32.6	3	33.4									3	32.9	3	33.9
	4	31.0	4	31.8									4	32.3	4	33.3
	5	33.4	5	29.5									5	33.0	5	32.9
	6	34.0	6	32.7									6	34.1	6	33.4
	7	34.8	7	35.0									7	35.5	7	35.2
7	1	36.8	1	36.8	1	34.6	1	35.0	1		1	36.1	1	36.2	1	35.4
	2	35.6	2	35.6	2	32.3	2	34.2	2		2	34.5	2	34.3	2	34.0
	3	34.6	3	33.4	3	31.6	3	33.1	3		3	33.3	3	32.2	3	33.6
	4	31.6	4	31.9	4	30.4	4	32.5	4		4	31.7	4	31.1	4	32.6
	5	33.5	5	33.7	5	32.2	5	33.3	5		5	33.9	5	32.6	5	33.4
	6	34.4	6	35.1	6	33.3	6	34.9	6		6	34.8	6	33.8	6	33.9
	7	36.0	7	35.9	7	34.5	7	36.1	7		7	35.0	7	34.4	7	34.6
8	1	36.7	1	36.6	1	36.8	1	36.5	1	35.3	1	36.5	1	35.4	1	36.9
	2	35.4	2	34.0	2	36.1	2	35.8	2	33.8	2	34.9	2	34.2	2	36.2
	3	35.1	3	33.6	3	33.9	3	33.2	3	33.3	3	34.2	3	33.8	3	34.9
	4	34.3	4	31.4	4	33.0	4	32.9	4	32.2	4	33.5	4	32.2	4	31.1
	5	33.2	5	32.7	5	34.7	5	34.0	5	34.0	5	34.2	5	31.7	5	32.4
	6	34.5	6	33.5	6	35.4	6	34.9	6	35.4	6	35.0	6	33.9	6	34.4
	7	36.5	7	35.0	7	36.9	7	35.5	7	36.0	7	36.1	7	35.7	7	36.5

Location: Shear Key S3

Average Field Hardness: 33.7 HRC

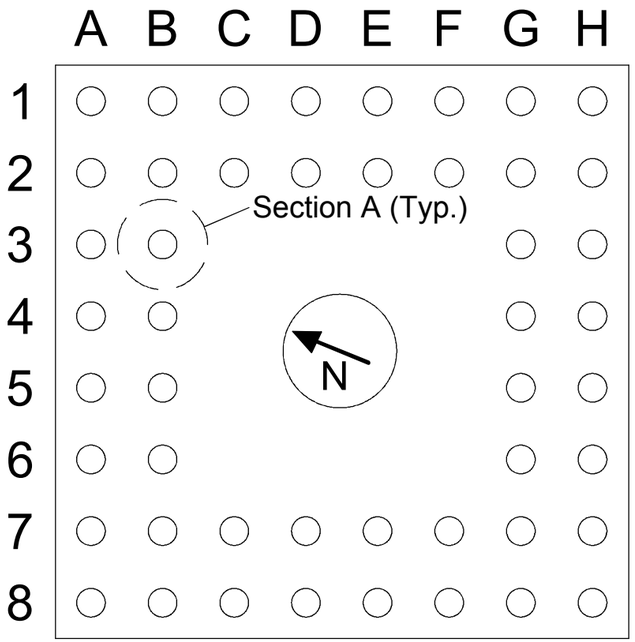
-Average Reading "1": 35.5 HRC
-Average Reading "2": 34.2 HRC
-Average Reading "3": 33.0 HRC
-Average Reading "4": 31.5 HRC
-Average Reading "5": 32.5 HRC
-Average Reading "6": 33.9 HRC
-Average Reading "7": 35.2 HRC

Average Surface Hardness Readings from 2010 MTR's: 35 HRC

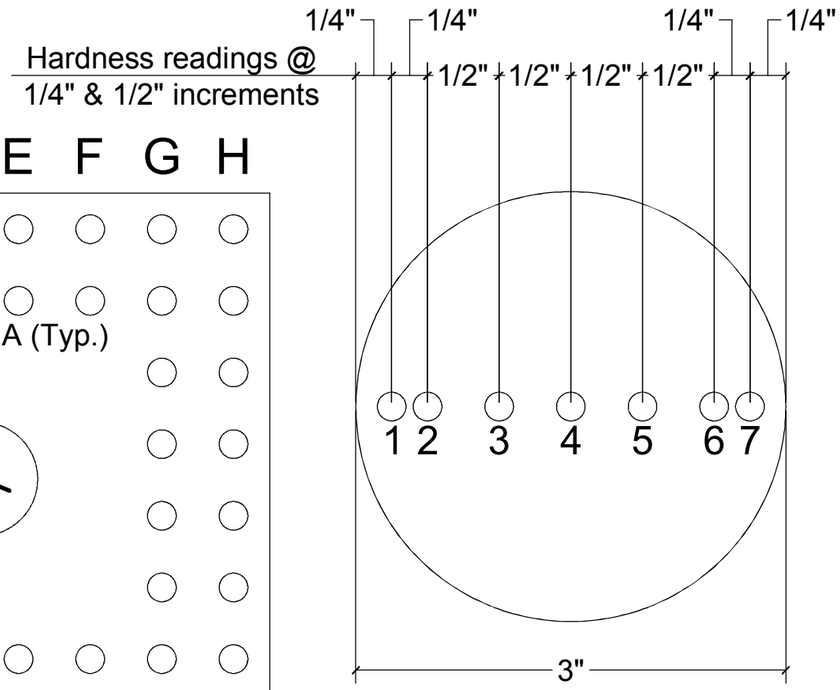
Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 68 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard



SHEAR KEY ANCHOR ROD LAYOUT



Section A (Typ.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

HARDNESS TEST RESULTS

	A		B		C		D		E		F		G		H	
1	1	33.0	1	34.1	1	33.1	1		1	31.5	1	34.0	1	32.7	1	33.6
	2	36.8	2	32.3	2	35.5	2		2	33.3	2	34.2	2	34.4	2	34.7
	3	31.6	3	29.6	3	31.1	3		3	30.9	3	33.2	3	30.7	3	31.8
	4	26.5	4	29.0	4	31.3	4		4	29.8	4	30.6	4	28.7	4	32.0
	5	28.5	5	33.7	5	32.5	5		5	32.3	5	30.9	5	29.6	5	31.3
	6	31.7	6	34.7	6	33.7	6		6	33.8	6	34.0	6	32.7	6	33.3
	7	33.3	7	32.9	7	31.4	7		7	31.5	7	34.2	7	31.9	7	32.8
2	1	34.1	1	33.5	1	33.5	1	33.3	1		1	34.6	1	36.2	1	
	2	32.2	2	33.9	2	34.0	2	33.0	2		2	33.0	2	33.2	2	
	3	32.2	3	30.7	3	32.4	3	29.9	3		3	31.8	3	32.3	3	
	4	29.0	4	31.2	4	27.9	4	28.1	4		4	28.0	4	28.4	4	
	5	31.9	5	30.7	5	32.6	5	30.5	5		5	31.2	5	32.0	5	
	6	33.5	6	33.2	6	34.3	6	33.0	6		6	32.5	6	33.7	6	
	7	32.3	7	34.0	7	32.9	7	34.0	7		7	33.6	7	34.9	7	
3	1	38.2	1	33.3									1	34.2	1	36.7
	2	33.9	2	34.0									2	35.5	2	33.4
	3	33.1	3	31.7									3	32.6	3	30.9
	4	34.0	4	30.2									4	30.3	4	30.9
	5	34.8	5	32.6									5	31.3	5	31.3
	6	35.0	6	34.3									6	34.7	6	33.9
	7	37.9	7	32.1									7	35.1	7	37.0
4	1	34.3	1	37.2									1		1	32.3
	2	34.0	2	32.4									2		2	34.1
	3	32.1	3	31.0									3		3	32.9
	4	28.9	4	27.1									4		4	31.6
	5	30.2	5	29.3									5		5	33.5
	6	32.7	6	36.9									6		6	34.7
	7	35.2	7	37.5									7		7	33.5
5	1	37.0	1										1		1	33.2
	2	34.9	2										2		2	36.2
	3	31.6	3										3		3	33.6
	4	31.3	4										4		4	31.2
	5	32.7	5										5		5	34.8
	6	33.5	6										6		6	36.1
	7	36.9	7										7		7	35.3
6	1	34.0	1	32.8									1	33.3	1	32.8
	2	33.1	2	33.9									2	32.9	2	33.2
	3	28.8	3	30.1									3	31.0	3	31.8
	4	27.8	4	26.1									4	29.6	4	30.0
	5	31.3	5	29.2									5	33.3	5	32.0
	6	34.5	6	33.6									6	34.1	6	34.2
	7	32.5	7	33.0									7	33.9	7	34.0
7	1		1	33.4	1	32.1	1		1	32.5	1	32.5	1		1	34.8
	2		2	34.9	2	35.9	2		2	34.0	2	35.0	2		2	32.6
	3		3	32.5	3	31.5	3		3	29.5	3	32.8	3		3	29.8
	4		4	29.3	4	30.5	4		4	27.0	4	28.6	4		4	27.2
	5		5	31.0	5	29.8	5		5	28.6	5	32.3	5		5	29.5
	6		6	32.6	6	32.8	6		6	32.7	6	34.2	6		6	30.6
	7		7	32.8	7	32.6	7		7	35.8	7	35.2	7		7	32.8
8	1	32.0	1	32.9	1	33.5	1	30.1	1	35.1	1	34.9	1		1	34.9
	2	33.3	2	32.5	2	33.4	2	34.0	2	33.3	2	34.0	2		2	31.9
	3	29.1	3	29.3	3	28.2	3	29.9	3	30.7	3	32.4	3		3	28.9
	4	27.6	4	29.1	4	30.2	4	32.6	4	26.7	4	30.5	4		4	26.6
	5	29.0	5	31.7	5	28.5	5	32.7	5	31.9	5	30.9	5		5	29.8
	6	31.8	6	32.3	6	32.9	6	33.7	6	32.2	6	31.8	6		6	30.8
	7	34.0	7	32.4	7	34.0	7	30.3	7	32.7	7	33.9	7		7	35.2

Location: Shear Key S4

Average Field Hardness: 32.4 HRC

-Average Reading "1": 33.8 HRC
-Average Reading "2": 33.9 HRC
-Average Reading "3": 31.2 HRC
-Average Reading "4": 29.4 HRC
-Average Reading "5": 31.3 HRC
-Average Reading "6": 33.4 HRC
-Average Reading "7": 33.8 HRC

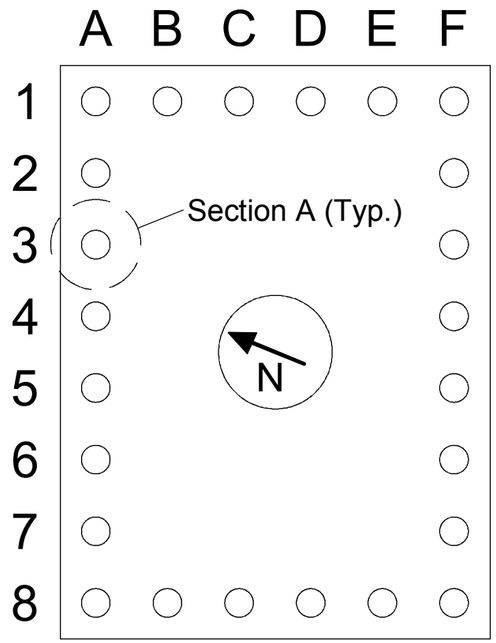
Average Surface Hardness Readings from 2010 MTR's: 35 HRC

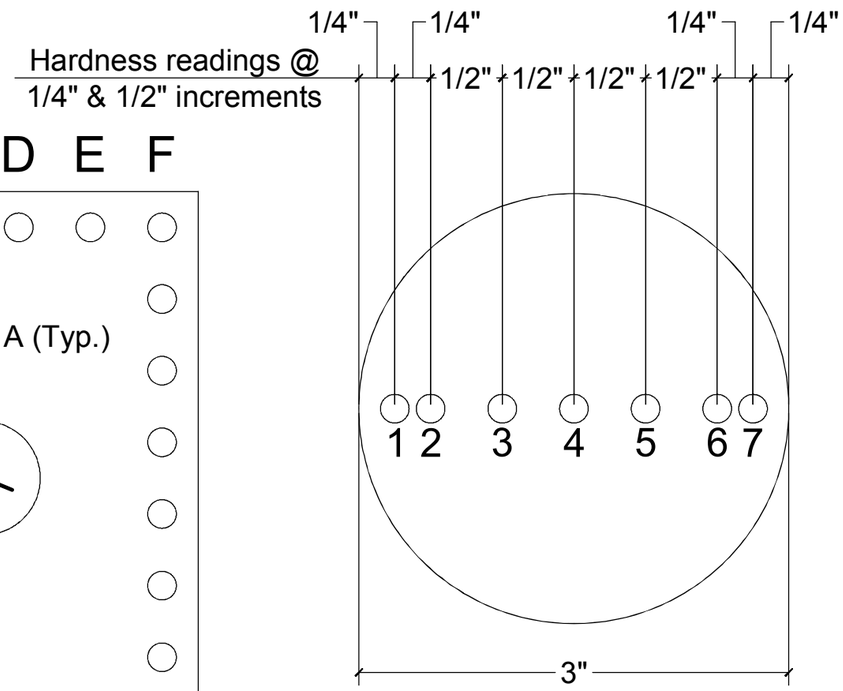
Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 68 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			E2 Shear Key Hardness Readings - 48 Rods (Fabricated in 2010)			
			Drawn By:	MH	SHEET NUMBER	2-I-S4-BOT
			Date:	5/21/2013		





Section A (Typ.)

BEARING ANCHOR ROD LAYOUT

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Revision No:	By:	Date:

SELF-ANCHORED SUSPENSION BRIDGE			
E2 Bearing Hardness Readings - 24 Rods (Fabricated in 2010)			
Drawn By:	MH	SHEET NUMBER	2-I-B1-BOT
Date:	5/21/2013		

HARDNESS TEST RESULTS

	A		B		C		D		E		F	
1	1	35.4	1	34.3	1	33.8	1	35.0	1	34.4	1	
	2	35.1	2	33.5	2	34.0	2	30.7	2	37.5	2	
	3	30.1	3	33.3	3	33.2	3	27.6	3	33.5	3	
	4	34.4	4	31.4	4	35.5	4	29.8	4	35.6	4	
	5	34.9	5	32.4	5	33.1	5	26.5	5	33.6	5	
	6	36.3	6	30.4	6	37.2	6	30.2	6	32.3	6	
	7	33.9	7	35.4	7	34.6	7	35.9	7	33.9	7	
2	1	37.6									1	34.3
	2	26.8									2	37.1
	3	27.3									3	30.1
	4	31.9									4	26.4
	5	32.0									5	27.7
	6	32.8									6	29.8
	7	38.0									7	35.0
3	Not Accessible										Not Accessible	
4												
5												
6												
7	1										1	32.5
	2										2	31.1
	3										3	23.0
	4										4	30.1
	5										5	27.7
	6										6	34.9
	7										7	32.6
8	1	33.4	1	31.1	1	36.1	1	33.8	1	32.7	1	34.4
	2	32.9	2	27.6	2	35.5	2	30.2	2	38.0	2	30.3
	3	31.4	3	29.4	3	33.5	3	24.2	3	27.7	3	26.8
	4	22.6	4	23.1	4	30.6	4	28.5	4	29.5	4	30.0
	5	31.7	5	32.2	5	32.8	5	32.2	5	26.4	5	33.4
	6	30.3	6	28.3	6	35.1	6	35.1	6	32.8	6	33.2
	7	33.3	7	32.8	7	35.3	7	33.3	7	34.9	7	35.0

Location: Bearing B1

Average Field Hardness: 32.1 HRC

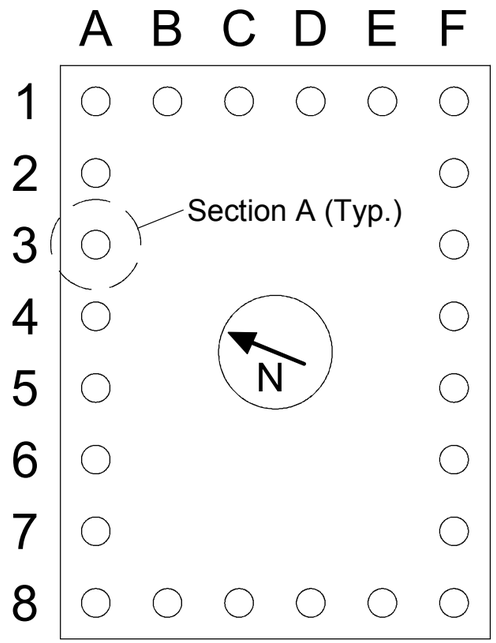
-Average Reading "1": 34.2 HRC
-Average Reading "2": 32.9 HRC
-Average Reading "3": 29.4 HRC
-Average Reading "4": 30.0 HRC
-Average Reading "5": 31.2 HRC
-Average Reading "6": 32.8 HRC
-Average Reading "7": 34.6 HRC

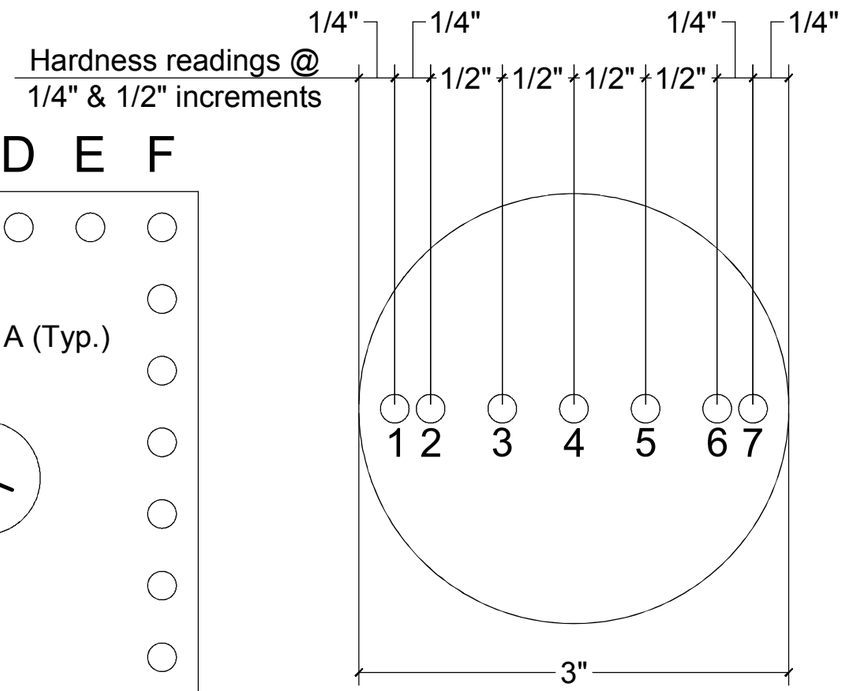
Average Surface Hardness Readings from 2010 MTR's: 35 HRC

Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 68 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard





Section A (Typ.)

BEARING ANCHOR ROD LAYOUT

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			E2 Bearing Hardness Readings - 24 Rods (Fabricated in 2010)			
			Drawn By:	MH	SHEET NUMBER	2-I-B2-BOT
			Date:	5/21/2013		

HARDNESS TEST RESULTS

	A		B		C		D		E		F	
1	1	29.0	1		1	33.9	1	34.9	1		1	35.3
	2	36.3	2		2	28.7	2	34.4	2		2	30.7
	3	32.2	3		3	31.0	3	29.7	3		3	35.0
	4	33.4	4		4	29.8	4	32.2	4		4	31.1
	5	27.8	5		5	33.8	5	33.5	5		5	33.6
	6	35.6	6		6	34.9	6	36.3	6		6	38.8
	7	32.6	7		7	32.9	7	35.4	7		7	36.6
2	1										1	33.2
	2										2	32.2
	3										3	31.6
	4										4	33.6
	5										5	30.2
	6										6	31.1
	7										7	33.5
3	Not Accessible										Not Accessible	
4												
5												
6												
7	1	32.5									1	35.7
	2	35.5									2	31.0
	3	35.4									3	36.2
	4	31.9									4	27.8
	5	26.6									5	31.0
	6	30.4									6	33.9
	7	35.4									7	35.3
8	1	33.1	1	35.2	1	36.2	1	34.5	1	37.3	1	33.8
	2	37.8	2	36.7	2	33.4	2	37.1	2	35.7	2	28.7
	3	33.4	3	29.1	3	32.9	3	32.5	3	26.9	3	27.4
	4	30.7	4	32.2	4	30.9	4	30.9	4	32.0	4	30.0
	5	31.8	5	32.8	5	27.1	5	29.6	5	29.5	5	35.1
	6	34.8	6	32.1	6	32.5	6	33.8	6	37.4	6	37.0
	7	36.9	7	33.4	7	35.0	7	33.0	7	36.5	7	34.3

Location: Bearing B2

Average Hardness: 33.0 HRC

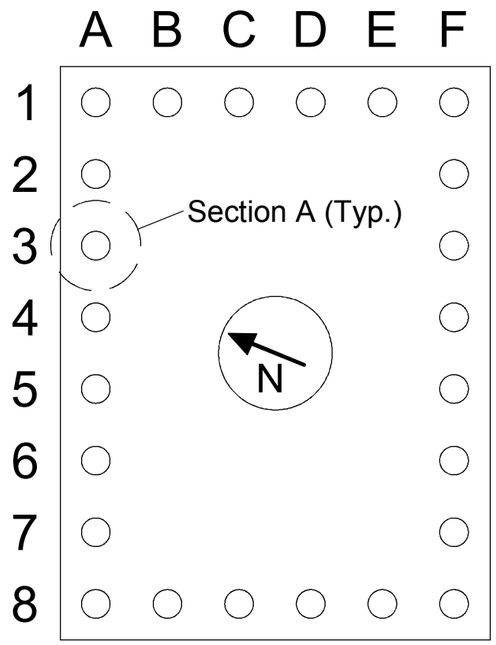
-Average Reading "1": 34.2 HRC
-Average Reading "2": 33.7 HRC
-Average Reading "3": 31.8 HRC
-Average Reading "4": 31.3 HRC
-Average Reading "5": 31.0 HRC
-Average Reading "6": 34.5 HRC
-Average Reading "7": 34.7 HRC

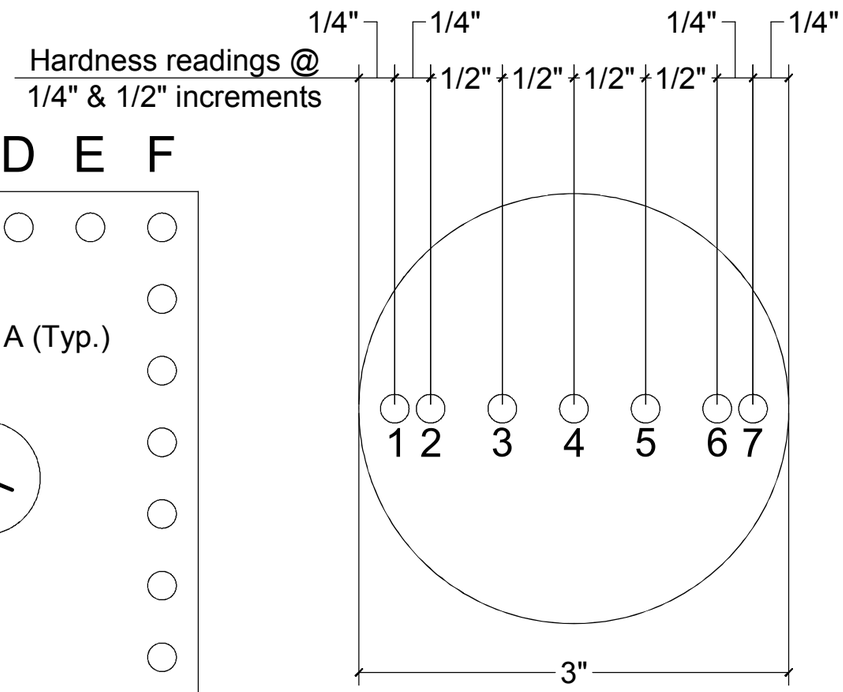
Average Surface Hardness Readings from 2010 MTR's: 35 HRC

Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 68 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard





Section A (Typ.)

BEARING ANCHOR ROD LAYOUT

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Revision No:	By:	Date:

SELF-ANCHORED SUSPENSION BRIDGE			
E2 Bearing Hardness Readings - 24 Rods (Fabricated in 2010)			
Drawn By:	MH	SHEET NUMBER	2-I-B3-BOT
Date:	5/23/2013		

HARDNESS TEST RESULTS

	A		B		C		D		E		F	
1	1	34.0	1	33.1	1	35.6	1	37.1	1	35.3	1	34.7
	2	33.1	2	32.4	2	33.5	2	35.6	2	32.6	2	32.9
	3	30.9	3	32.0	3	31.0	3	33.9	3	30.9	3	31.5
	4	29.9	4	30.4	4	31.1	4	30.9	4	30.0	4	30.6
	5	31.4	5	32.3	5	31.9	5	32.7	5	31.8	5	32.1
	6	33.4	6	33.9	6	33.8	6	35.0	6	34.8	6	33.5
	7	34.7	7	34.0	7	35.1	7	36.3	7	38.0	7	35.0
2	1										1	35.8
	2										2	33.6
	3										3	31.7
	4										4	29.8
	5										5	31.0
	6										6	32.8
	7										7	33.9
3	Not Accessible										Not Accessible	
4												
5												
6												
7	1	36.8									1	36.3
	2	33.4									2	34.2
	3	32.1									3	30.7
	4	28.7									4	26.9
	5	30.9									5	30.8
	6	33.6									6	33.4
	7	35.8									7	37.1
8	1	36.2	1	36.7	1	37.4	1	35.1	1	34.9	1	38.1
	2	34.1	2	34.1	2	35.1	2	34.9	2	34.0	2	34.8
	3	31.7	3	33.3	3	34.0	3	32.1	3	33.1	3	32.3
	4	30.4	4	31.7	4	32.9	4	31.9	4	30.8	4	30.3
	5	32.1	5	33.4	5	33.0	5	33.0	5	33.9	5	32.4
	6	35.2	6	33.9	6	34.5	6	34.0	6	35.0	6	33.9
	7	37.1	7	36.3	7	35.9	7	36.1	7	36.2	7	36.9

Location: Bearing B3

Average Field Hardness: 33.5 HRC

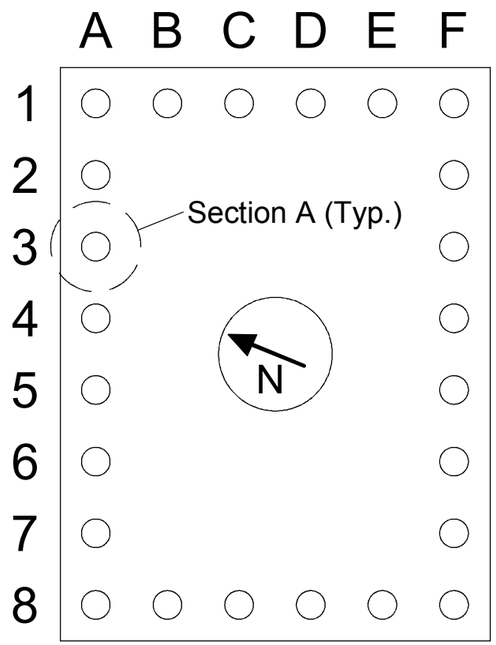
- Average Reading "1": 35.8 HRC
- Average Reading "2": 33.9 HRC
- Average Reading "3": 32.1 HRC
- Average Reading "4": 30.4 HRC
- Average Reading "5": 32.2 HRC
- Average Reading "6": 34.0 HRC
- Average Reading "7": 35.9 HRC

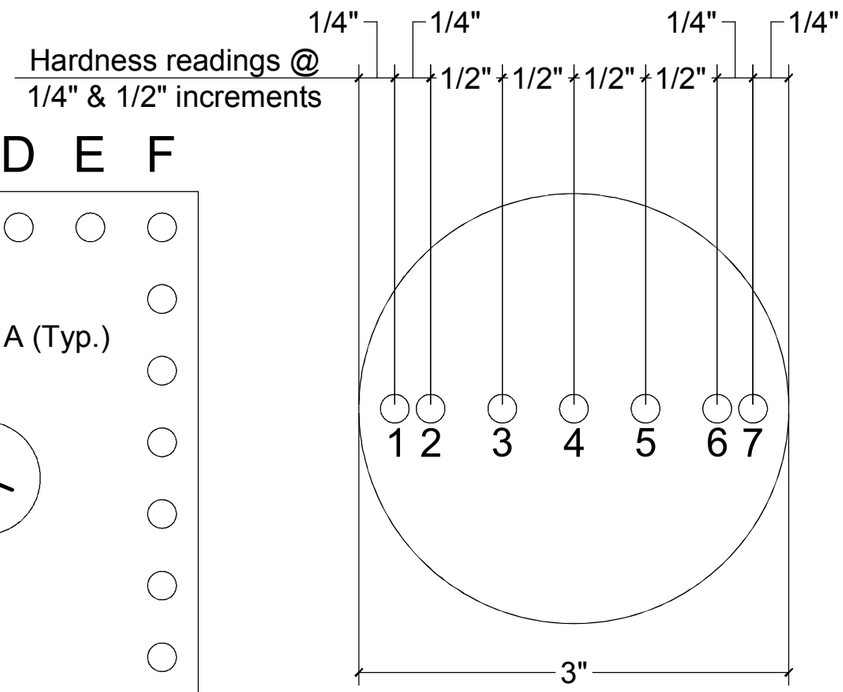
Average Surface Hardness Readings from 2010 MTR's: 35 HRC

Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 57 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard





Section A (Typ.)

BEARING ANCHOR ROD LAYOUT

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Revision No:	By:	Date:

SELF-ANCHORED SUSPENSION BRIDGE

E2 Bearing Hardness Readings - 24 Rods
(Fabricated in 2010)

Drawn By:	MH	SHEET NUMBER	2-I-B4-BOT
Date:	5/21/2013		

HARDNESS TEST RESULTS

	A		B		C		D		E		F	
1	1	33.7	1	37.9	1	35.0	1	36.2	1	39.1	1	34.7
	2	34.9	2	33.3	2	34.0	2	37.7	2	33.8	2	30.3
	3	33.7	3	31.7	3	33.5	3	33.0	3	33.5	3	27.4
	4	30.3	4	26.5	4	31.9	4	29.8	4	28.9	4	35.1
	5	32.4	5	29.7	5	34.0	5	31.6	5	31.8	5	29.7
	6	34.2	6	32.9	6	38.0	6	37.9	6	35.1	6	36.1
	7	35.7	7	39.3	7	36.7	7	35.8	7	36.9	7	35.3
2	1	36.3									1	
	2	31.9									2	
	3	30.4									3	
	4	33.7									4	
	5	31.9									5	
	6	34.2									6	
	7	33.8									7	
3	Not Accessible										Not Accessible	
4												
5												
6												
7	Rod Removed										1	33.3
											2	35.2
											3	33.1
											4	34.2
											5	32.2
											6	37.9
											7	32.2
8	1		1	33.2	1	33.6	1		1	33.2	1	33.2
	2		2	35.2	2	37.4	2		2	36.0	2	33.0
	3		3	33.8	3	34.0	3		3	35.6	3	29.9
	4		4	36.2	4	35.9	4		4	28.5	4	29.1
	5		5	37.8	5	32.8	5		5	24.2	5	33.7
	6		6	39.0	6	35.7	6		6	37.8	6	30.8
	7		7	36.1	7	35.4	7		7	34.6	7	33.1

Location: Bearing B4

Average Field Hardness: 33.8 HRC

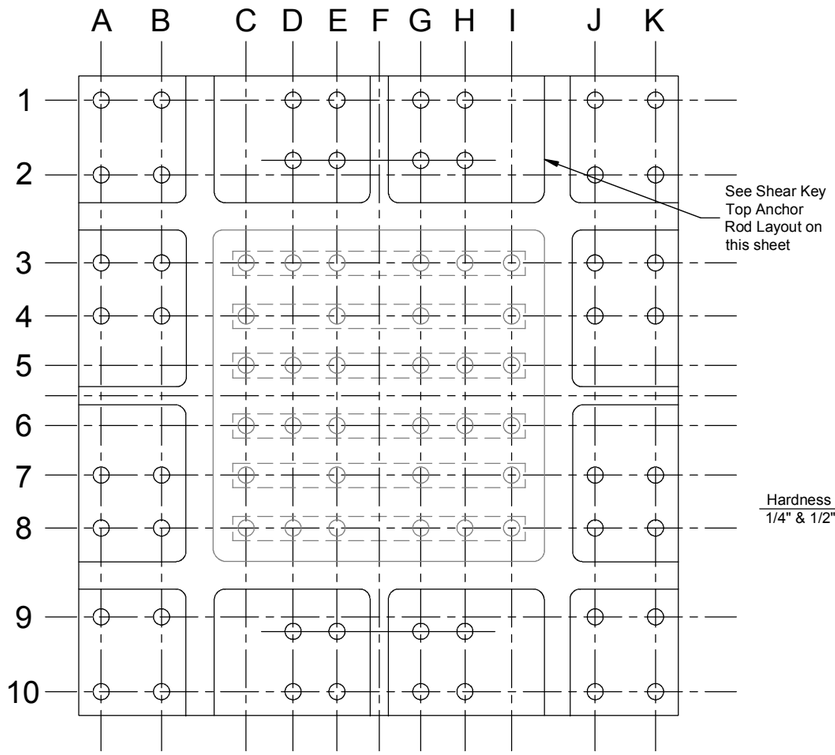
-Average Reading "1": 35.0 HRC
-Average Reading "2": 34.4 HRC
-Average Reading "3": 32.5 HRC
-Average Reading "4": 31.7 HRC
-Average Reading "5": 31.8 HRC
-Average Reading "6": 35.8 HRC
-Average Reading "7": 35.4 HRC

Average Surface Hardness Readings from 2010 MTR's: 35 HRC

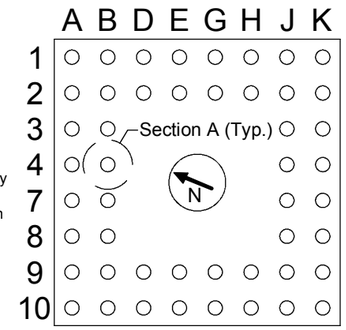
Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

MEASUREMENT LOGISTICS:

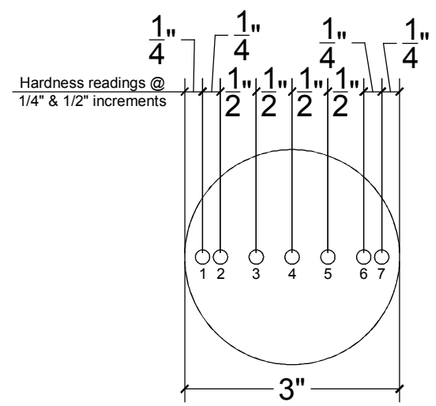
1) Recorded ambient temperature (Deg. F): 68 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard



SHEAR KEY HOUSING PLAN VIEW
NTS



SHEAR KEY TOP ANCHOR ROD LAYOUT



SECTION A (TYP.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

HARDNESS TEST RESULTS

	A		B		D		E		G		H		J		K	
1	1	34.3	1	37.4	1	32.4	1	36.5	1	36.9	1	37.3	1	34.3	1	34.0
	2	34.8	2	34.9	2	30.4	2	35.7	2	38.3	2	36.0	2	32.6	2	32.6
	3	33.2	3	32.8	3	30.5	3	31.9	3	36.0	3	35.1	3	32.0	3	32.1
	4	32.3	4	29.4	4	24.4	4	29.8	4	32.9	4	36.8	4	28.3	4	31.0
	5	32.9	5	34.6	5	27.9	5	34.6	5	34.4	5	34.4	5	29.6	5	30.0
	6	32.1	6	34.4	6	28.8	6	34.3	6	36.2	6	37.5	6	32.8	6	30.7
	7	34.7	7	35.9	7	32.8	7	36.8	7	37.0	7	36.1	7	33.9	7	32.8
2	1		1		1	32.9	1	34.2	1	36.8	1		1	31.8	1	35.6
	2		2		2	34.0	2	35.7	2	34.5	2		2	32.4	2	32.9
	3		3		3	31.8	3	33.0	3	34.1	3		3	30.0	3	31.2
	4		4		4	33.3	4	32.2	4	29.1	4		4	29.8	4	28.1
	5		5		5	32.2	5	31.7	5	32.1	5		5	32.5	5	29.9
	6		6		6	35.1	6	34.4	6	37.5	6		6	33.0	6	35.5
	7		7		7	34.1	7	35.0	7	35.7	7		7	33.3	7	36.0
3	1	33.2	1	38.8									1	34.7	1	34.0
	2	36.6	2	35.3									2	32.7	2	31.6
	3	34.4	3	35.5									3	33.0	3	32.0
	4	33.6	4	35.5									4	31.3	4	28.1
	5	32.4	5	34.7									5	31.8	5	27.9
	6	34.4	6	36.6									6	33.2	6	33.0
	7	32.2	7	38.4									7	35.5	7	34.3
4	1	37.0	1	38.8									1	33.4	1	
	2	35.3	2	37.4									2	33.4	2	
	3	32.2	3	33.3									3	31.8	3	
	4	35.1	4	34.0									4	31.4	4	
	5	35.4	5	36.2									5	32.6	5	
	6	35.9	6	35.3									6	32.8	6	
	7	36.8	7	37.9									7	33.3	7	
7	1	35.9	1	34.8									1		1	
	2	33.6	2	36.5									2		2	
	3	32.0	3	32.6									3		3	
	4	29.7	4	33.8									4		4	
	5	33.2	5	32.2									5		5	
	6	32.8	6	32.5									6		6	
	7	32.4	7	36.8									7		7	
8	1	32.2	1	32.8									1	34.3	1	33.0
	2	34.8	2	34.8									2	32.0	2	32.9
	3	33.0	3	33.3									3	30.5	3	30.9
	4	35.8	4	30.4									4	30.7	4	29.8
	5	36.0	5	32.6									5	28.8	5	31.7
	6	34.9	6	33.8									6	31.6	6	34.2
	7	36.5	7	34.7									7	33.9	7	34.2
9	1	36.1	1	35.1	1	34.8	1		1	31.5	1	32.8	1	32.7	1	33.6
	2	34.9	2	34.8	2	34.2	2		2	30.2	2	32.4	2	30.4	2	31.5
	3	30.8	3	32.6	3	32.9	3		3	29.3	3	28.6	3	30.0	3	28.8
	4	32.4	4	34.4	4	30.9	4		4	25.5	4	28.4	4	30.1	4	31.7
	5	35.1	5	35.0	5	31.7	5		5	29.4	5	31.9	5	32.8	5	32.9
	6	32.8	6	33.9	6	33.1	6		6	30.7	6	29.9	6	32.7	6	33.5
	7	32.7	7	37.3	7	34.5	7		7	31.0	7	33.4	7	33.5	7	33.9
10	1	36.5	1	37.2	1	32.7	1	33.4	1		1	34.4	1	33.6	1	
	2	37.5	2	36.8	2	31.5	2	31.8	2		2	31.7	2	31.8	2	
	3	35.2	3	31.7	3	32.5	3	30.7	3		3	31.6	3	29.1	3	
	4	30.2	4	33.1	4	31.9	4	29.7	4		4	30.0	4	30.1	4	
	5	32.4	5	32.3	5	32.9	5	30.9	5		5	29.0	5	29.9	5	
	6	34.1	6	36.8	6	33.1	6	31.5	6		6	31.6	6	31.1	6	
	7	32.6	7	36.5	7	32.7	7	32.9	7		7	35.5	7	35.6	7	

Location: Shear Key S1

Field Average Hardness: 33.2 HRC

-Average Reading "1": 34.5 HRC
-Average Reading "2": 33.9 HRC
-Average Reading "3": 32.1 HRC
-Average Reading "4": 31.2 HRC
-Average Reading "5": 32.3 HRC
-Average Reading "6": 33.5 HRC
-Average Reading "7": 34.7 HRC

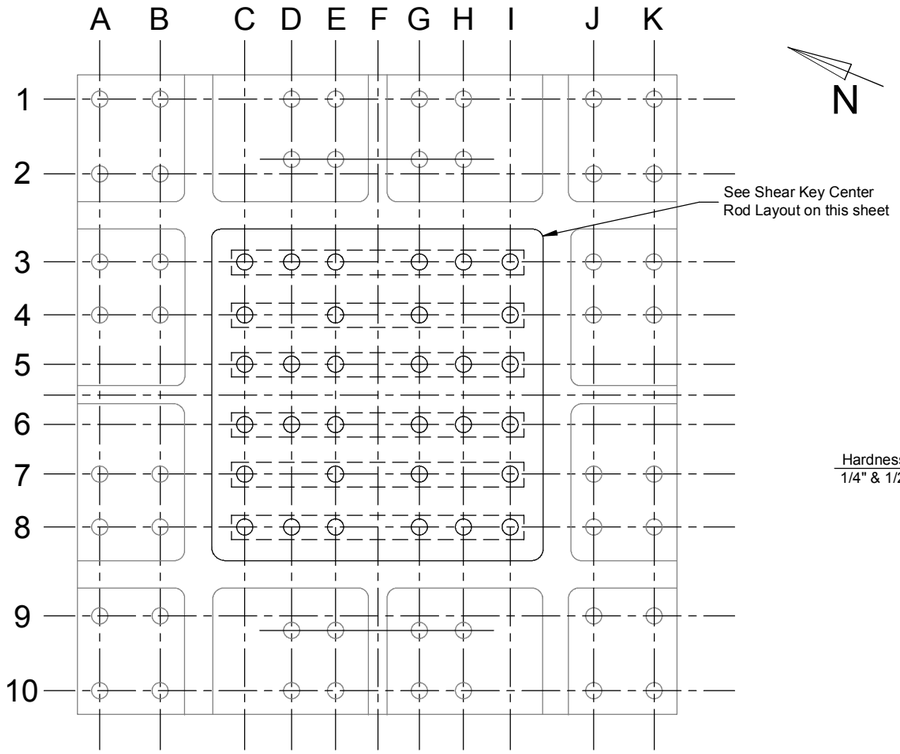
Average Surface Hardness Readings from 2010 MTR's: 35 HRC

Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

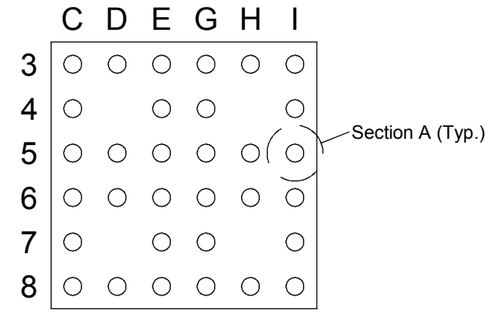
MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 68 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

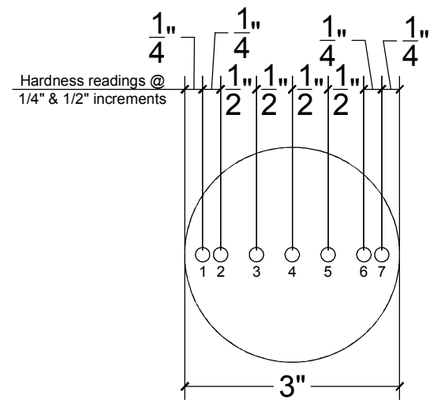
Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			E2 Shear Key Top Anchor Rods Hardness Readings			
			Drawn By:	MH	SHEET NUMBER	3-I-S1a-TOP
			Date:	5/21/2013		



SHEAR KEY HOUSING PLAN VIEW
NTS



SHEAR KEY CENTER ROD LAYOUT



SECTION A (TYP.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Location: Shear Key S1

Field Average Hardness: 34.4 HRC

- Average Reading "1": 36.2 HRC
- Average Reading "2": 34.8 HRC
- Average Reading "3": 33.5 HRC
- Average Reading "4": 32.4 HRC
- Average Reading "5": 33.5 HRC
- Average Reading "6": 34.6 HRC
- Average Reading "7": 36.0 HRC

Average Surface Hardness Readings from 2010 MTR's: 35 HRC

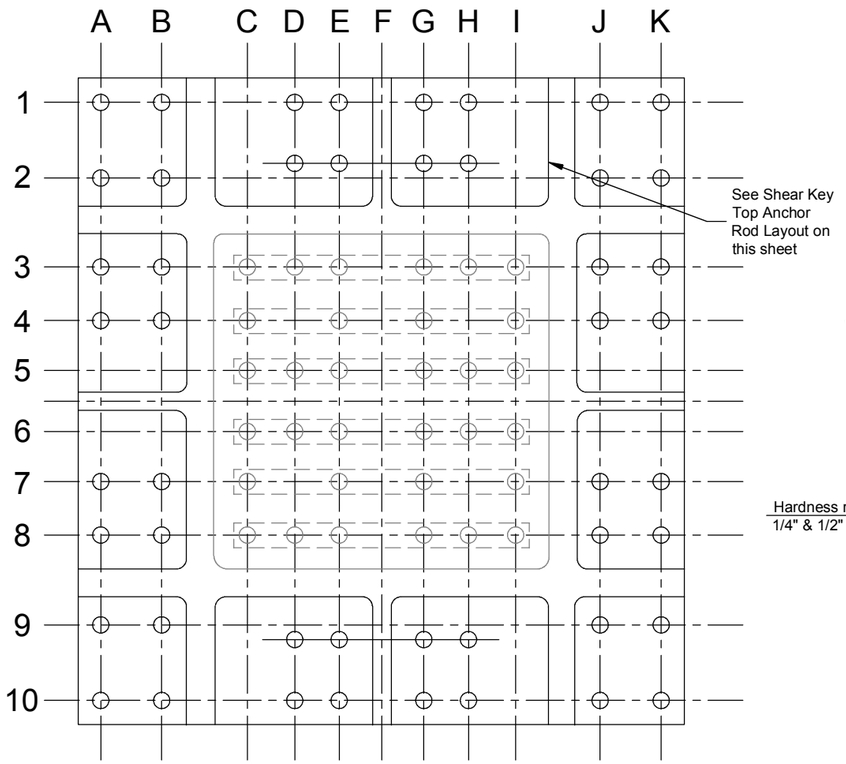
Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

HARDNESS TEST RESULTS

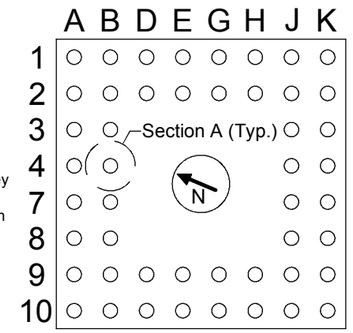
	C		D		E		G		H		I	
3	1	36.2	1	36.4	1	36.3	1	36.8	1	36.6	1	36.0
	2	35.1	2	35.4	2	35.8	2	36.1	2	35.2	2	35.2
	3	34.6	3	34.4	3	34.4	3	34.1	3	34.3	3	33.2
	4	33.3	4	33.0	4	33.7	4	33.6	4	33.1	4	32.8
	5	34.6	5	34.6	5	34.6	5	34.6	5	34.0	5	33.8
	6	35.1	6	35.8	6	35.8	6	35.2	6	35.5	6	34.5
	7	35.7	7	36.7	7	36.5	7	36.7	7	35.9	7	36.4
4	1	36.1			1	35.8	1	37.1			1	36.0
	2	34.9			2	33.6	2	35.7			2	34.9
	3	33.9			3	32.4	3	35.0			3	33.0
	4	33.2			4	31.8	4	33.1			4	31.5
	5	34.4			5	32.9	5	34.9			5	32.3
	6	35.6			6	33.5	6	36.3			6	33.5
	7	36.1			7	35.5	7	37.2			7	35.3
5	1	36.6	1	36.9	1	35.6	1	35.7	1	35.6	1	36.8
	2	34.4	2	36.3	2	34.5	2	34.7	2	33.3	2	36.1
	3	32.6	3	34.0	3	33.5	3	32.9	3	31.2	3	34.0
	4	31.8	4	33.3	4	31.4	4	31.1	4	30.4	4	33.0
	5	33.4	5	34.4	5	32.2	5	32.7	5	31.7	5	33.7
	6	34.6	6	35.0	6	34.2	6	33.7	6	33.4	6	35.2
	7	36.6	7	36.8	7	36.2	7	36.4	7	35.2	7	35.8
6	1	36.2	1	35.7	1	35.5	1	35.6	1	36.0	1	35.6
	2	34.3	2	33.7	2	34.3	2	34.3	2	35.2	2	34.1
	3	32.0	3	32.6	3	33.5	3	33.2	3	34.3	3	33.6
	4	31.0	4	31.7	4	31.8	4	32.5	4	33.3	4	32.9
	5	31.5	5	32.5	5	33.3	5	33.1	5	33.9	5	33.5
	6	33.2	6	34.8	6	34.2	6	34.3	6	34.7	6	34.2
	7	34.5	7	35.2	7	35.2	7	36.0	7	35.7	7	35.4
7	1	35.7			1	37.1	1	35.5			1	37.0
	2	34.2			2	35.7	2	34.6			2	35.1
	3	32.2			3	34.6	3	32.8			3	33.4
	4	31.3			4	33.7	4	32.0			4	31.6
	5	33.6			5	34.5	5	33.5			5	33.0
	6	34.4			6	35.5	6	34.3			6	34.2
	7	36.1			7	36.9	7	36.1			7	36.2
8	1	35.4	1	35.5	1	35.4	1	37.6	1	36.7	1	36.4
	2	34.3	2	34.5	2	33.7	2	35.2	2	35.6	2	34.0
	3	33.3	3	33.8	3	32.9	3	33.5	3	34.3	3	33.4
	4	35.1	4	31.7	4	31.8	4	31.5	4	33.3	4	31.0
	5	33.0	5	33.5	5	32.2	5	33.3	5	34.3	5	33.6
	6	34.8	6	34.1	6	34.4	6	34.2	6	34.9	6	34.0
	7	35.2	7	36.6	7	36.6	7	36.7	7	36.2	7	35.4

MEASUREMENT LOGISTICS:
1) Recorded ambient temperature (Deg. F): 68 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

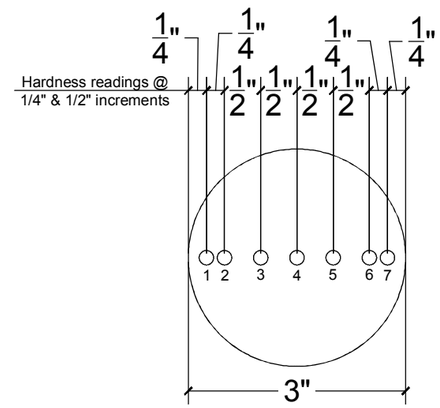
Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			E2 Shear Key Top Center Anchor Rods Hardness Readings			
			Drawn By:	MH	SHEET NUMBER	3-I-S1b-TOP
			Date:	6/11/2013		



SHEAR KEY HOUSING PLAN VIEW
NTS



SHEAR KEY TOP ANCHOR ROD LAYOUT



SECTION A (TYP.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

HARDNESS TEST RESULTS

	A		B		D		E		G		H		J		K	
1	1	36.9	1	37.8	1	35.0	1	35.3	1	37.1	1	36.5	1	35.4	1	34.6
	2	36.4	2	31.9	2	31.5	2	32.2	2	35.5	2	34.4	2	35.9	2	34.3
	3	35.6	3	32.5	3	26.4	3	31.2	3	35.0	3	31.6	3	34.6	3	31.0
	4	34.6	4	26.8	4	31.7	4	30.6	4	35.5	4	31.1	4	30.1	4	33.3
	5	34.3	5	33.0	5	30.1	5	34.1	5	30.6	5	33.7	5	34.9	5	36.3
	6	36.7	6	31.3	6	33.8	6	29.9	6	34.7	6	36.2	6	36.3	6	36.0
	7	38.4	7	30.3	7	33.8	7	36.2	7	37.8	7	34.2	7	31.2	7	36.2
2	1	35.5	1	36.3	1		1	33.8	1		1	35.5	1	31.3	1	
	2	32.8	2	37.0	2		2	34.5	2		2	32.8	2	32.3	2	
	3	32.5	3	30.8	3		3	31.6	3		3	31.5	3	30.0	3	
	4	32.2	4	31.6	4		4	34.2	4		4	29.1	4	25.3	4	
	5	27.2	5	34.9	5		5	32.4	5		5	30.4	5	31.5	5	
	6	33.0	6	34.1	6		6	32.8	6		6	32.9	6	29.7	6	
	7	34.1	7	36.2	7		7	37.5	7		7	32.4	7	32.5	7	
3	1	35.7	1	36.5									1	34.2	1	32.1
	2	30.6	2	35.6									2	34.9	2	26.2
	3	34.1	3	33.9									3	33.9	3	30.0
	4	33.2	4	29.5									4	37.7	4	31.2
	5	32.2	5	29.6									5	33.8	5	30.2
	6	32.1	6	35.0									6	35.2	6	33.4
	7	35.9	7	31.7									7	35.7	7	31.5
4	1	34.5	1										1	35.7	1	33.8
	2	32.7	2										2	34.6	2	29.5
	3	33.2	3										3	33.4	3	31.5
	4	32.1	4										4	31.4	4	25.6
	5	34.0	5										5	35.1	5	35.8
	6	29.2	6										6	35.6	6	34.9
	7	32.0	7										7	35.1	7	37.0
7	1		1	32.3									1	36.7	1	31.9
	2		2	35.5									2	33.9	2	33.8
	3		3	29.3									3	28.7	3	31.3
	4		4	38.1									4	27.6	4	27.9
	5		5	31.3									5	24.7	5	31.6
	6		6	27.3									6	29.3	6	31.7
	7		7	36.6									7	33.6	7	34.9
8	1	34.5	1	34.4									1	36.6	1	36.1
	2	35.8	2	35.0									2	35.7	2	34.9
	3	34.6	3	34.4									3	36.2	3	33.1
	4	32.8	4	29.2									4	32.7	4	30.8
	5	32.6	5	32.8									5	34.1	5	28.0
	6	34.7	6	34.7									6	34.0	6	28.6
	7	34.0	7	35.0									7	35.9	7	33.0
9	1	32.3	1	36.2	1		1	36.3	1	35.7	1	31.9	1		1	34.7
	2	30.5	2	35.1	2		2	30.1	2	33.9	2	30.0	2		2	31.6
	3	33.8	3	31.0	3		3	30.4	3	28.5	3	29.7	3		3	30.4
	4	31.1	4	35.5	4		4	35.1	4	29.2	4	24.3	4		4	23.3
	5	35.7	5	33.6	5		5	31.2	5	31.0	5	28.9	5		5	22.1
	6	32.8	6	33.5	6		6	34.1	6	35.1	6	29.1	6		6	30.3
	7	34.2	7	34.6	7		7	35.6	7	37.6	7	29.4	7		7	30.1
10	1	35.9	1	33.2	1	35.9	1	35.9	1	37.1	1	36.7	1		1	37.2
	2	36.0	2	36.3	2	36.2	2	36.6	2	35.1	2	37.4	2		2	35.1
	3	32.2	3	32.6	3	33.6	3	34.2	3	32.8	3	32.3	3		3	30.0
	4	30.8	4	33.8	4	29.9	4	33.1	4	31.7	4	32.8	4		4	33.9
	5	32.5	5	35.7	5	34.2	5	32.1	5	31.4	5	39.3	5		5	28.9
	6	35.1	6	33.8	6	36.4	6	36.2	6	34.1	6	32.6	6		6	32.2
	7	32.3	7	36.8	7	35.3	7	36.1	7	36.0	7	33.8	7		7	31.1

Location: Shear Key S2

Average Field Hardness: 33.1

-Average Reading "1": 35.1 HRC
-Average Reading "2": 33.9 HRC
-Average Reading "3": 32.1 HRC
-Average Reading "4": 31.3 HRC
-Average Reading "5": 32.1 HRC
-Average Reading "6": 33.2 HRC
-Average Reading "7": 34.4 HRC

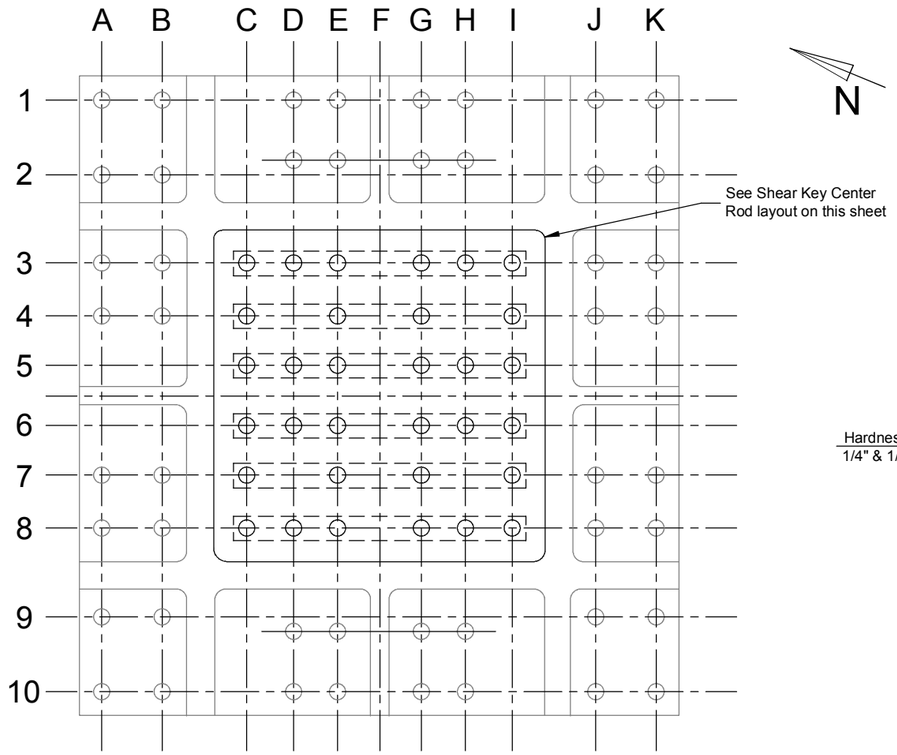
Average Surface Hardness Readings from 2010 MTR's: 35 HRC

Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

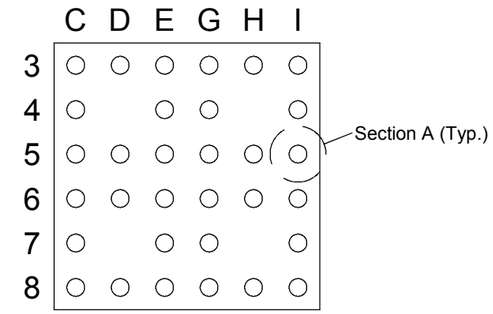
MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 68 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

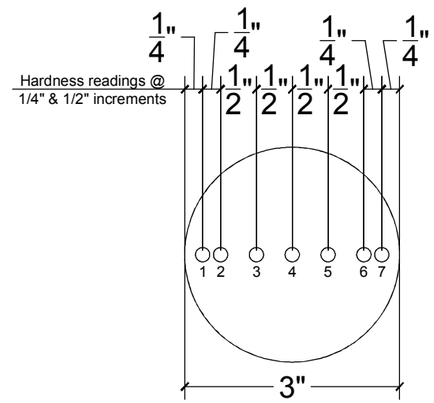
Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			E2 Shear Key Top Anchor Rods Hardness Readings			
			Drawn By:	MH	SHEET NUMBER	3-I-S2a-TOP
			Date:	5/21/2013		



SHEAR KEY HOUSING PLAN VIEW
NTS



SHEAR KEY CENTER ROD LAYOUT



SECTION A (TYP.)

Location: Shear Key S2

Field Average Hardness: 34.2 HRC

- Average Reading "1": 35.9 HRC
- Average Reading "2": 34.7 HRC
- Average Reading "3": 33.5 HRC
- Average Reading "4": 32.0 HRC
- Average Reading "5": 33.2 HRC
- Average Reading "6": 34.4 HRC
- Average Reading "7": 35.8 HRC

Average Surface Hardness Readings from 2010 MTR's: 35 HRC

Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

HARDNESS TEST RESULTS

	C		D		E		G		H		I	
3	1	34.5	1	36.4	1	35.4	1	36.4	1	35.9	1	36.2
	2	33.8	2	35.0	2	34.2	2	34.3	2	34.9	2	35.0
	3	32.9	3	34.0	3	33.3	3	32.9	3	34.1	3	33.7
	4	31.4	4	32.6	4	31.4	4	31.0	4	32.4	4	32.7
	5	32.3	5	33.3	5	32.7	5	33.5	5	33.8	5	33.9
	6	34.9	6	34.2	6	34.8	6	34.2	6	34.5	6	34.5
	7	35.8	7	35.0	7	36.3	7	35.9	7	36.6	7	35.2
4	1	35.1			1	36.9	1	35.8			1	36.1
	2	33.8			2	35.5	2	34.3			2	34.5
	3	32.8			3	34.5	3	33.4			3	33.4
	4	31.7			4	33.2	4	32.6			4	31.5
	5	33.5			5	34.5	5	33.7			5	32.6
	6	34.4			6	35.4	6	34.5			6	33.8
	7	35.4			7	36.5	7	35.7			7	35.6
5	1	35.2	1	37.1	1	36.1	1	36.0	1	36.1	1	36.7
	2	33.9	2	36.3	2	34.6	2	34.8	2	34.7	2	35.1
	3	32.4	3	35.4	3	32.9	3	34.1	3	33.4	3	34.0
	4	31.6	4	34.8	4	30.6	4	32.7	4	32.6	4	32.8
	5	32.4	5	35.4	5	32.7	5	33.8	5	33.7	5	33.7
	6	33.5	6	36.4	6	33.4	6	34.7	6	34.8	6	35.0
	7	35.1	7	37.1	7	35.2	7	35.8	7	36.2	7	36.1
6	1	36.0	1	35.5	1	36.0	1	35.8	1	35.9	1	35.1
	2	34.6	2	34.7	2	34.9	2	34.7	2	34.5	2	34.5
	3	33.6	3	33.2	3	33.1	3	33.3	3	33.3	3	33.1
	4	30.9	4	31.9	4	31.1	4	32.6	4	31.7	4	31.0
	5	31.9	5	32.4	5	32.7	5	33.2	5	32.2	5	32.7
	6	32.7	6	34.6	6	33.7	6	34.7	6	33.8	6	33.8
	7	36.6	7	35.4	7	35.9	7	36.4	7	35.1	7	35.3
7	1	35.6			1	36.4	1	36.1			1	35.9
	2	34.7			2	35.8	2	34.8			2	34.6
	3	32.5			3	34.1	3	32.8			3	33.7
	4	31.9			4	32.3	4	31.5			4	31.4
	5	33.3			5	33.3	5	32.7			5	32.7
	6	34.3			6	34.6	6	34.0			6	34.1
	7	36.5			7	36.0	7	35.4			7	35.8
8	1	35.5	1	35.6	1	36.0	1	35.7	1	36.0	1	35.7
	2	34.6	2	34.5	2	35.2	2	34.6	2	34.8	2	34.2
	3	33.3	3	33.8	3	33.5	3	33.0	3	33.8	3	33.6
	4	32.3	4	32.7	4	31.7	4	31.8	4	32.2	4	31.8
	5	33.7	5	33.8	5	33.2	5	32.8	5	33.5	5	33.2
	6	34.6	6	34.5	6	34.7	6	33.4	6	34.5	6	34.9
	7	35.3	7	36.1	7	35.4	7	34.7	7	35.7	7	35.6

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Revision No:	By:	Date:

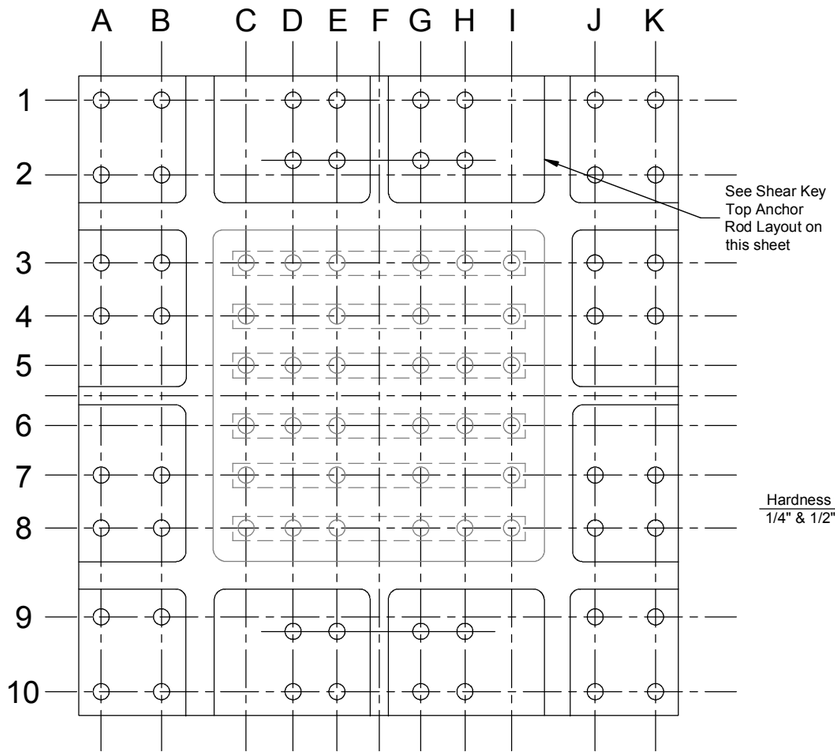
SELF-ANCHORED SUSPENSION BRIDGE

E2 Shear Key Top Center Anchor Rods
Hardness Readings

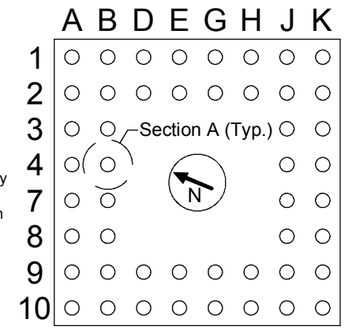
Drawn By:	MH	SHEET NUMBER	3-I-S2b-TOP
Date:	6/11/2013		

MEASUREMENT LOGISTICS:

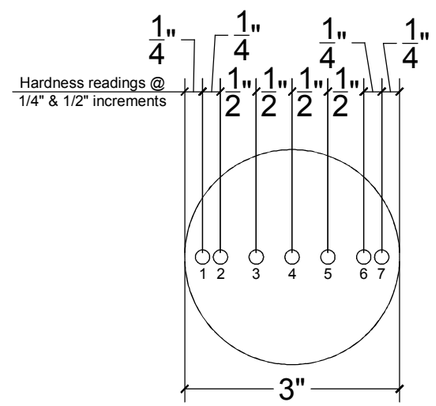
1) Recorded ambient temperature (Deg. F): 68 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard



SHEAR KEY HOUSING PLAN VIEW
NTS



SHEAR KEY TOP ANCHOR ROD LAYOUT



SECTION A (TYP.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

HARDNESS TEST RESULTS

	A		B		D		E		G		H		J		K	
1	1	34.1	1	37.5	1		1		1	31.6	1	37.4	1	36.8	1	35.9
	2	33.2	2	32.5	2		2		2	34.2	2	34.8	2	36.2	2	32.9
	3	30.8	3	34.6	3		3		3	31.7	3	30.8	3	33.9	3	30.4
	4	33.7	4	27.0	4		4		4	23.7	4	27.2	4	30.5	4	28.9
	5	31.2	5	26.1	5		5		5	32.9	5	32.0	5	32.7	5	30.8
	6	36.8	6	33.9	6		6		6	28.1	6	34.9	6	33.8	6	34.3
	7	33.0	7	32.5	7		7		7	33.6	7	35.8	7	30.8	7	32.7
2	1		1	33.1	1	34.9	1	30.0	1	37.1	1	30.8	1	36.4	1	37.2
	2		2	28.6	2	36.0	2	34.0	2	32.8	2	26.0	2	36.2	2	34.7
	3		3	29.9	3	31.9	3	32.1	3	29.2	3	27.0	3	36.0	3	32.2
	4		4	24.0	4	32.4	4	35.2	4	27.0	4	34.2	4	33.7	4	33.2
	5		5	29.6	5	29.9	5	31.2	5	30.8	5	34.4	5	33.3	5	33.6
	6		6	34.9	6	31.1	6	34.1	6	38.2	6	33.4	6	37.6	6	35.9
	7		7	32.1	7	36.0	7	31.8	7	38.0	7	31.8	7	36.5	7	33.1
3	1	34.2	1	31.2									1		1	35.6
	2	34.0	2	32.2									2		2	35.9
	3	26.7	3	32.1									3		3	30.8
	4	20.5	4	30.7									4		4	29.5
	5	30.3	5	29.3									5		5	32.5
	6	34.5	6	31.8									6		6	32.1
	7	37.7	7	32.7									7		7	34.1
4	1	31.8	1	35.2									1	31.9	1	31.2
	2	35.5	2	34.8									2	38.8	2	31.8
	3	35.6	3	29.9									3	34.0	3	30.5
	4	31.3	4	33.3									4	31.6	4	33.1
	5	34.3	5	30.7									5	36.2	5	31.0
	6	34.6	6	33.5									6	32.9	6	33.7
	7	33.5	7	33.3									7	32.0	7	31.3
7	1	31.3	1	33.0									1	33.4	1	34.9
	2	35.6	2	32.4									2	33.7	2	32.5
	3	32.2	3	33.9									3	36.6	3	33.7
	4	34.5	4	35.2									4	36.2	4	27.6
	5	28.7	5	34.4									5	37.2	5	32.2
	6	26.2	6	34.8									6	38.7	6	30.4
	7	32.9	7	34.7									7	35.1	7	32.1
8	1	37.9	1	34.1									1	37.0	1	34.4
	2	31.3	2	32.6									2	34.4	2	37.0
	3	25.9	3	33.7									3	32.3	3	33.0
	4	24.7	4	31.0									4	34.4	4	32.7
	5	29.2	5	34.1									5	34.8	5	31.4
	6	24.2	6	32.7									6	31.1	6	30.3
	7	32.8	7	34.5									7	32.9	7	33.9
9	1		1		1		1	35.1	1	32.4	1	30.4	1	35.2	1	31.5
	2		2		2		2	36.3	2	30.6	2	34.2	2	34.2	2	30.4
	3		3		3		3	34.1	3	31.6	3	33.6	3	31.8	3	30.9
	4		4		4		4	34.0	4	29.8	4	35.1	4	29.0	4	31.5
	5		5		5		5	30.6	5	30.5	5	34.3	5	33.0	5	30.0
	6		6		6		6	33.8	6	28.3	6	28.9	6	30.7	6	32.4
	7		7		7		7	34.9	7	31.7	7	31.0	7	34.7	7	32.8
10	1	34.7	1	34.7	1	33.3	1	38.4	1	31.7	1	33.3	1		1	34.9
	2	36.7	2	29.9	2	35.2	2	37.6	2	29.6	2	35.3	2		2	32.0
	3	33.5	3	31.4	3	35.5	3	32.6	3	33.2	3	29.4	3		3	28.9
	4	37.5	4	33.5	4	38.3	4	32.4	4	30.6	4	34.6	4		4	37.4
	5	35.7	5	33.2	5	32.3	5	32.1	5	27.8	5	34.2	5		5	36.5
	6	31.6	6	33.5	6	39.1	6	33.6	6	31.5	6	34.6	6		6	35.6
	7	34.9	7	32.4	7	36.5	7	33.3	7	35.0	7	35.3	7		7	36.8

Location: Shear Key S3

Average Field Hardness: 32.9 HRC

-Average Reading "1": 34.1 HRC
-Average Reading "2": 33.7 HRC
-Average Reading "3": 31.9 HRC
-Average Reading "4": 31.5 HRC
-Average Reading "5": 32.1 HRC
-Average Reading "6": 33.1 HRC
-Average Reading "7": 33.8 HRC

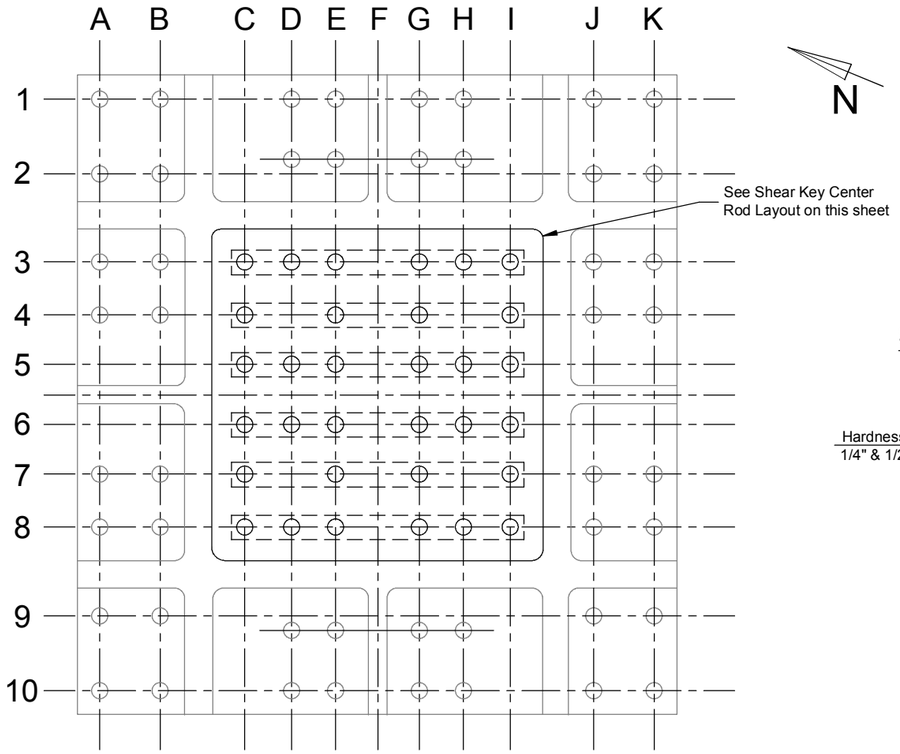
Average Surface Hardness Readings from 2010 MTR's: 35 HRC

Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

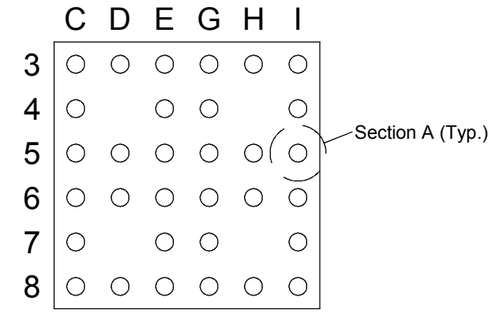
MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 68 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

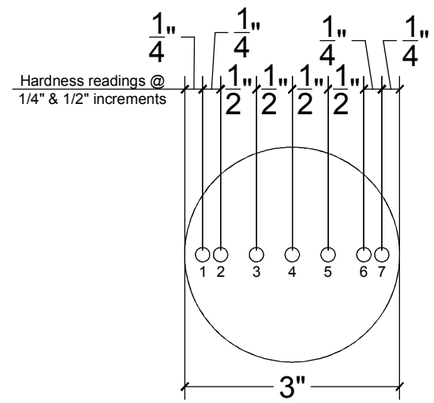
Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			E2 Shear Key Top Anchor Rods Hardness Readings			
			Drawn By:	MH	SHEET NUMBER	3-I-S3a-TOP
			Date:	5/21/2013		



SHEAR KEY HOUSING PLAN VIEW
NTS



SHEAR KEY CENTER ROD LAYOUT



SECTION A (TYP.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Location: Shear Key S3

Field Average Hardness: 34.3 HRC

- Average Reading "1": 36.0 HRC
- Average Reading "2": 34.8 HRC
- Average Reading "3": 33.4 HRC
- Average Reading "4": 32.0 HRC
- Average Reading "5": 33.3 HRC
- Average Reading "6": 34.6 HRC
- Average Reading "7": 36.1 HRC

Average Surface Hardness Readings from 2010 MTR's: 35 HRC

Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

HARDNESS TEST RESULTS

	C		D		E		G		H		I	
3	1	36.9	1	35.2	1	35.5	1	35.3	1	35.9	1	36.0
	2	35.4	2	33.7	2	33.6	2	34.4	2	34.5	2	35.1
	3	32.8	3	32.6	3	32.1	3	33.0	3	33.5	3	34.1
	4	31.6	4	30.6	4	31.5	4	31.0	4	31.7	4	33.2
	5	32.6	5	33.2	5	32.7	5	33.1	5	32.7	5	33.8
	6	34.6	6	34.7	6	33.4	6	34.5	6	33.2	6	34.4
	7	36.3	7	36.1	7	35.0	7	35.3	7	35.9	7	35.4
4	1	35.9			1	36.5	1	36.6			1	35.7
	2	34.6			2	34.6	2	35.2			2	34.9
	3	32.7			3	33.2	3	33.7			3	33.4
	4	31.7			4	31.0	4	30.8			4	31.4
	5	32.2			5	32.2	5	31.9			5	32.3
	6	34.8			6	34.2	6	33.3			6	34.7
	7	36.7			7	36.1	7	36.6			7	35.7
5	1	36.4	1	35.3	1	36.2	1	35.5	1	36.8	1	35.8
	2	34.3	2	34.2	2	34.2	2	34.6	2	36.1	2	35.1
	3	33.3	3	33.2	3	32.1	3	33.3	3	34.5	3	34.0
	4	32.9	4	32.8	4	31.0	4	30.9	4	32.4	4	33.0
	5	33.6	5	33.8	5	32.7	5	33.4	5	33.6	5	33.8
	6	34.5	6	34.9	6	33.7	6	34.7	6	35.7	6	35.5
	7	35.8	7	36.0	7	35.0	7	36.6	7	36.8	7	36.4
6	1	36.1	1	35.6	1	35.9	1	37.3	1	36.1	1	35.1
	2	34.8	2	35.0	2	35.3	2	35.0	2	35.4	2	33.8
	3	33.9	3	32.9	3	33.2	3	33.7	3	33.9	3	31.7
	4	32.6	4	31.6	4	32.1	4	33.3	4	32.3	4	31.1
	5	33.9	5	33.9	5	33.0	5	34.6	5	33.3	5	33.0
	6	35.1	6	34.0	6	34.8	6	35.2	6	34.6	6	35.3
	7	36.3	7	36.6	7	36.0	7	36.2	7	36.3	7	36.2
7	1	36.3			1	36.0	1	37.0			1	35.4
	2	35.4			2	35.2	2	36.6			2	34.7
	3	34.4			3	33.9	3	35.3			3	33.2
	4	32.0			4	31.6	4	33.8			4	31.3
	5	34.3			5	33.5	5	34.5			5	33.7
	6	35.3			6	34.1	6	35.1			6	34.3
	7	36.2			7	36.6	7	36.9			7	36.2
8	1	36.3	1	35.9	1	36.0	1	35.9	1	35.7	1	35.2
	2	34.7	2	34.8	2	35.3	2	34.0	2	34.8	2	34.8
	3	33.0	3	32.3	3	34.4	3	33.5	3	33.8	3	33.9
	4	31.8	4	31.6	4	34.1	4	32.1	4	31.4	4	32.9
	5	32.1	5	33.1	5	35.0	5	34.2	5	33.3	5	32.9
	6	33.5	6	34.9	6	35.3	6	35.6	6	34.0	6	34.6
	7	34.8	7	36.9	7	36.8	7	36.2	7	35.8	7	36.2

Revision No:	By:	Date:

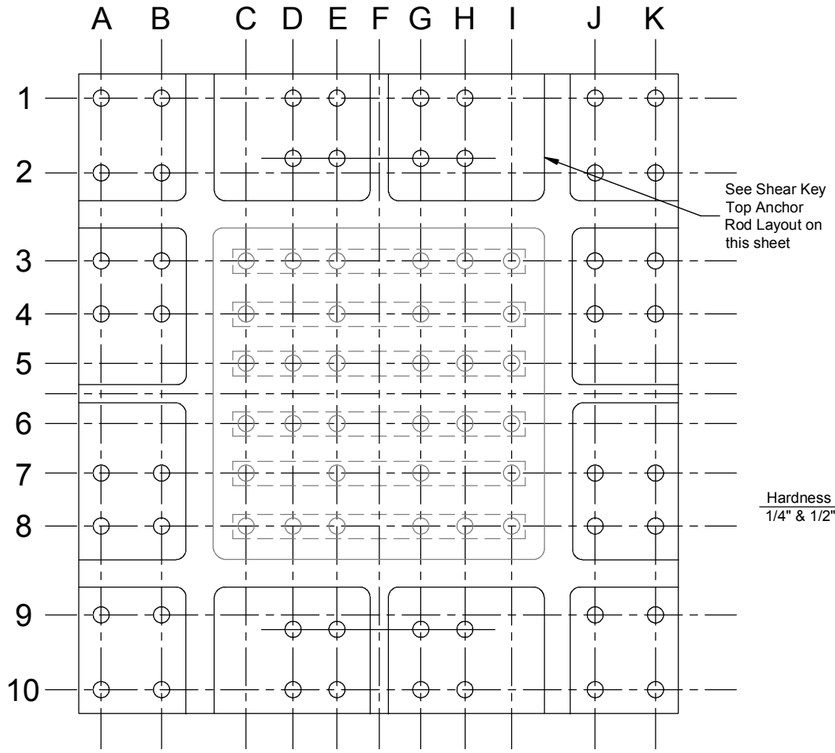
SELF-ANCHORED SUSPENSION BRIDGE

E2 Shear Key Top Center Anchor Rods Hardness Readings

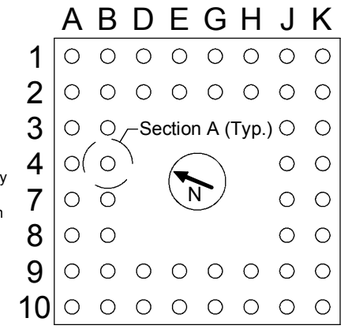
Drawn By:	MH	SHEET NUMBER	3-I-S3b-TOP
Date:	6/11/2013		

MEASUREMENT LOGISTICS:

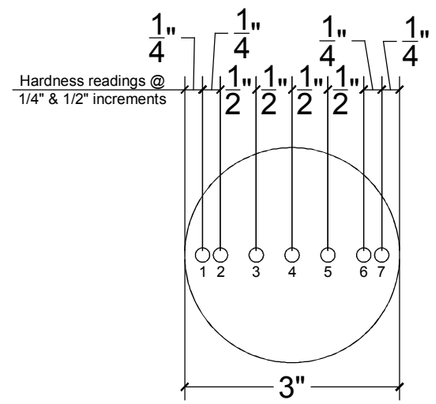
1) Recorded ambient temperature (Deg. F): 68 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard



SHEAR KEY HOUSING PLAN VIEW
NTS



SHEAR KEY TOP ANCHOR ROD LAYOUT



SECTION A (TYP.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

HARDNESS TEST RESULTS

	A		B		D		E		G		H		J		K	
1	1	34.0	1		1	33.7	1	33.3	1	33.4	1	32.5	1	32.8	1	38.2
	2	34.0	2		2	32.4	2	34.9	2	32.9	2	30.9	2	33.6	2	32.5
	3	31.6	3		3	30.8	3	34.3	3	32.7	3	30.4	3	28.5	3	29.7
	4	29.0	4		4	30.5	4	29.4	4	28.0	4	25.7	4	26.8	4	26.7
	5	28.6	5		5	30.2	5	30.2	5	28.7	5	26.5	5	27.0	5	29.3
	6	31.7	6		6	33.7	6	32.2	6	31.6	6	30.7	6	29.3	6	30.0
	7	32.0	7		7	34.4	7	32.9	7	32.9	7	38.8	7	33.8	7	36.7
2	1	33.0	1	33.9	1		1	34.8	1	34.3	1	31.9	1	31.2	1	31.3
	2	33.7	2	32.7	2		2	32.8	2	33.9	2	33.0	2	32.4	2	32.9
	3	33.5	3	30.7	3		3	30.3	3	30.0	3	33.2	3	32.0	3	30.4
	4	31.3	4	30.1	4		4	28.9	4	30.5	4	29.2	4	30.3	4	30.4
	5	31.6	5	26.9	5		5	30.6	5	31.7	5	30.0	5	31.7	5	30.7
	6	33.0	6	30.3	6		6	33.6	6	31.7	6	31.9	6	32.2	6	34.5
	7	32.0	7	33.6	7		7	34.0	7	33.1	7	33.6	7	33.7	7	30.3
3	1	31.9	1	33.9									1	34.1	1	
	2	35.0	2	33.4									2	32.0	2	
	3	33.1	3	33.5									3	31.4	3	
	4	32.4	4	30.6									4	26.1	4	
	5	31.0	5	38.6									5	31.0	5	
	6	31.8	6	35.4									6	33.4	6	
	7	35.3	7	33.6									7	32.2	7	
4	1	34.5	1										1	33.7	1	30.2
	2	31.2	2										2	32.1	2	33.5
	3	28.7	3										3	33.0	3	31.1
	4	28.2	4										4	31.9	4	30.6
	5	33.8	5										5	30.0	5	30.0
	6	35.8	6										6	31.6	6	33.1
	7	36.1	7										7	32.7	7	33.9
7	1	34.1	1										1	32.5	1	33.4
	2	34.2	2										2	32.6	2	32.0
	3	34.0	3										3	30.4	3	31.1
	4	29.6	4										4	30.1	4	27.6
	5	29.6	5										5	28.9	5	29.9
	6	29.5	6										6	32.4	6	31.1
	7	32.1	7										7	33.1	7	29.5
8	1		1	35.2									1	32.6	1	34.8
	2		2	32.3									2	32.9	2	31.5
	3		3	29.6									3	30.7	3	30.2
	4		4	26.6									4	29.8	4	28.3
	5		5	29.7									5	30.0	5	32.2
	6		6	30.2									6	32.1	6	32.9
	7		7	37.1									7	33.0	7	33.1
9	1	35.0	1	34.6	1	33.7	1	33.5	1	34.3	1	34.2	1	33.1	1	
	2	33.4	2	34.0	2	31.2	2	33.0	2	35.8	2	33.5	2	32.0	2	
	3	31.7	3	32.7	3	31.0	3	30.4	3	30.5	3	32.6	3	32.0	3	
	4	31.6	4	30.0	4	30.6	4	30.2	4	28.7	4	30.6	4	27.8	4	
	5	32.0	5	29.9	5	32.0	5	31.8	5	30.4	5	30.0	5	31.5	5	
	6	32.9	6	33.7	6	32.9	6	32.9	6	34.0	6	31.9	6	32.8	6	
	7	33.6	7	33.3	7	32.6	7	33.2	7	34.0	7	32.6	7	33.7	7	
10	1	33.3	1	33.6	1	34.4	1	33.3	1	34.6	1	33.1	1		1	32.8
	2	32.6	2	33.8	2	34.0	2	31.6	2	33.7	2	33.1	2		2	35.0
	3	30.2	3	31.5	3	31.8	3	30.9	3	31.6	3	32.5	3		3	32.7
	4	26.0	4	31.3	4	29.6	4	27.8	4	31.0	4	29.8	4		4	30.0
	5	29.9	5	32.1	5	32.8	5	30.3	5	31.0	5	32.8	5		5	33.5
	6	32.4	6	33.4	6	35.6	6	32.6	6	33.3	6	33.6	6		6	33.9
	7	34.5	7	33.1	7	34.4	7	32.6	7	34.2	7	33.0	7		7	31.9

Location: Shear Key S4

Average Field Hardness: 32.1 HRC
- -Average Reading "1": 33.6 HRC
- -Average Reading "2": 33.1 HRC
- -Average Reading "3": 31.5 HRC
- -Average Reading "4": 29.4 HRC
- -Average Reading "5": 30.8 HRC
- -Average Reading "6": 32.5 HRC
- -Average Reading "7": 33.6 HRC

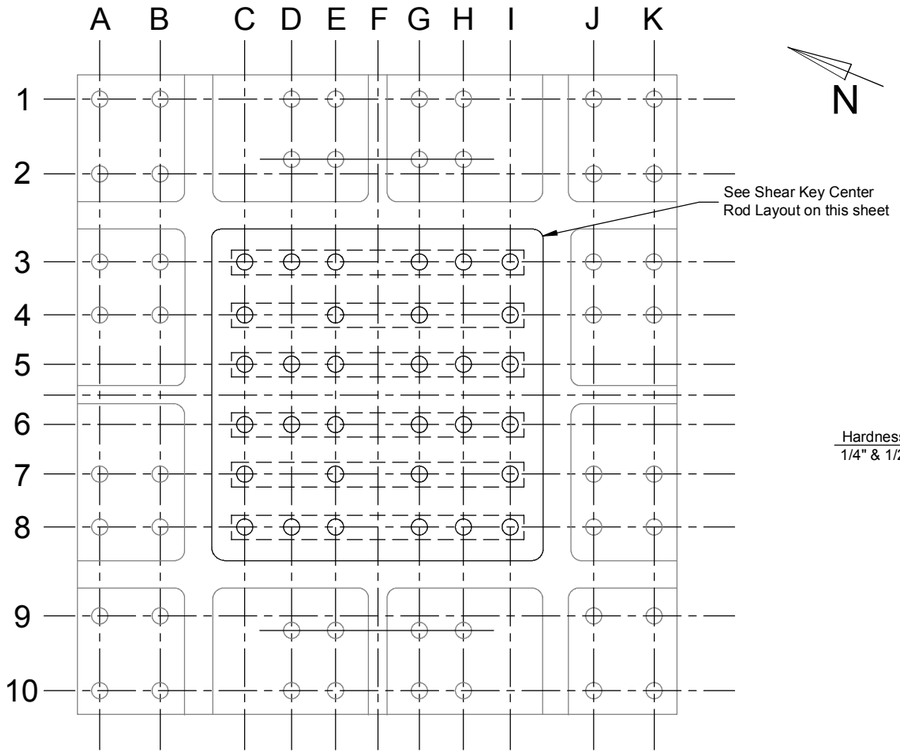
Average Surface Hardness Readings from 2010 MTR's: 35 HRC

Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

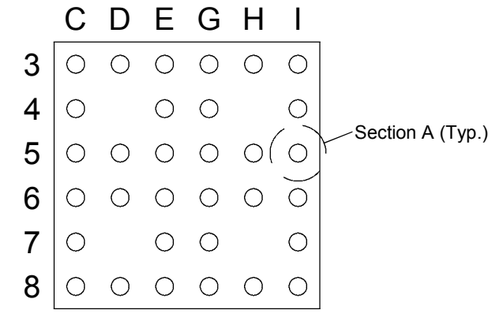
MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 68 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

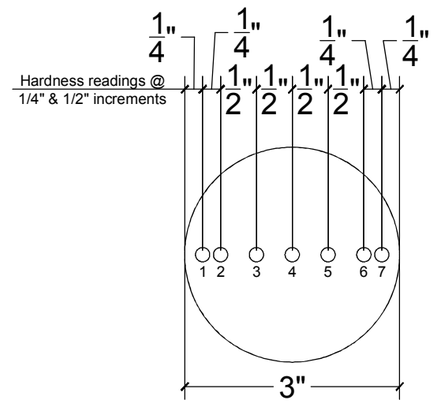
Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			E2 Shear Key Top Anchor Rods Hardness Readings			
			Drawn By:	MH	SHEET NUMBER	3-I-S4a-TOP
			Date:	5/21/2013		



SHEAR KEY HOUSING PLAN VIEW
NTS



SHEAR KEY CENTER ROD LAYOUT



SECTION A (TYP.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Location: Shear Key S4

Field Average Hardness: 34.4 HRC

- Average Reading "1": 36.2 HRC
- Average Reading "2": 34.8 HRC
- Average Reading "3": 33.5 HRC
- Average Reading "4": 32.0 HRC
- Average Reading "5": 33.4 HRC
- Average Reading "6": 34.7 HRC
- Average Reading "7": 36.1 HRC

Average Surface Hardness Readings from 2010 MTR's: 35 HRC

Average R/2 Hardness Readings from 2010 QC Reports: 33.9 HRC

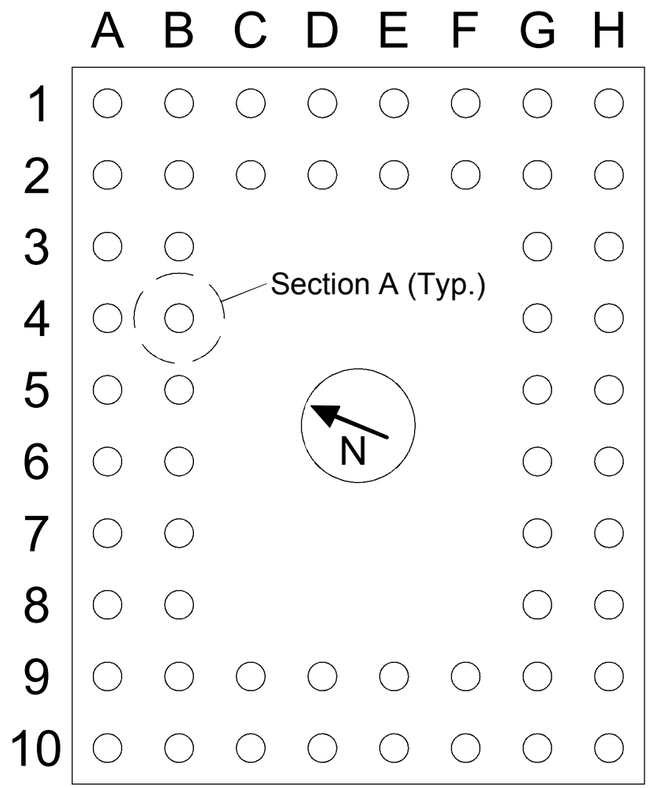
HARDNESS TEST RESULTS

	C		D		E		G		H		I	
3	1	35.5	1	35.1	1	36.7	1	36.4	1	36.5	1	36.0
	2	34.1	2	33.9	2	35.3	2	35.0	2	35.7	2	34.7
	3	32.7	3	33.4	3	33.8	3	32.5	3	33.1	3	33.2
	4	31.5	4	32.4	4	31.6	4	31.4	4	32.7	4	30.9
	5	33.5	5	33.8	5	33.0	5	33.7	5	33.0	5	33.2
	6	34.7	6	34.1	6	34.3	6	34.8	6	35.2	6	35.4
	7	35.3	7	36.6	7	35.8	7	35.4	7	36.6	7	36.6
4	1	35.6			1	36.5	1	36.7			1	36.6
	2	34.7			2	34.5	2	33.9			2	34.6
	3	33.8			3	33.9	3	32.0			3	33.0
	4	32.6			4	33.0	4	30.9			4	31.1
	5	33.6			5	34.1	5	33.0			5	33.3
	6	34.5			6	35.5	6	34.7			6	34.5
	7	35.9			7	36.6	7	35.0			7	36.6
5	1	35.5	1	36.6	1	35.9	1	35.5	1	36.2	1	36.5
	2	33.7	2	35.9	2	34.5	2	34.0	2	35.1	2	34.8
	3	33.1	3	33.7	3	32.5	3	32.4	3	33.9	3	33.7
	4	30.9	4	31.2	4	32.4	4	30.6	4	31.9	4	33.1
	5	31.7	5	32.2	5	32.0	5	32.0	5	32.5	5	34.4
	6	33.8	6	33.6	6	34.9	6	33.2	6	34.9	6	35.6
	7	34.7	7	36.6	7	36.9	7	35.5	7	36.2	7	36.7
6	1	35.9	1	36.0	1	36.1	1	36.5	1	35.7	1	36.6
	2	34.4	2	35.4	2	35.7	2	35.8	2	34.5	2	34.0
	3	34.0	3	34.4	3	33.2	3	34.3	3	33.1	3	33.6
	4	32.4	4	32.9	4	32.0	4	32.6	4	31.6	4	32.5
	5	33.7	5	33.3	5	34.5	5	33.5	5	33.5	5	33.9
	6	34.4	6	33.8	6	35.8	6	34.1	6	34.7	6	34.8
	7	35.3	7	35.7	7	36.9	7	35.6	7	36.9	7	36.2
7	1	35.9			1	36.0	1	36.6			1	36.7
	2	34.6			2	35.1	2	36.1			2	35.5
	3	33.9			3	33.4	3	35.6			3	34.4
	4	32.2			4	31.3	4	34.8			4	32.6
	5	33.7			5	32.3	5	35.6			5	33.5
	6	34.4			6	33.9	6	36.4			6	34.7
	7	35.2			7	36.1	7	37.0			7	35.9
8	1	36.7	1	36.8	1	36.8	1	35.6	1	36.5	1	35.5
	2	35.0	2	35.3	2	35.0	2	34.8	2	34.1	2	34.0
	3	33.8	3	33.9	3	34.6	3	33.6	3	33.4	3	33.5
	4	32.4	4	32.9	4	33.9	4	32.0	4	30.7	4	31.2
	5	33.9	5	34.2	5	34.9	5	34.8	5	32.6	5	32.9
	6	35.3	6	35.3	6	35.3	6	35.5	6	34.9	6	33.1
	7	36.5	7	36.6	7	36.3	7	36.2	7	35.6	7	35.5

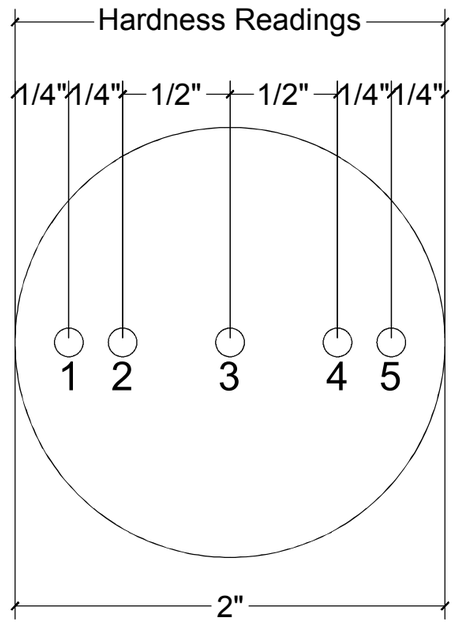
Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			E2 Shear Key Top Center Anchor Rods Hardness Readings			
			Drawn By:	MH	SHEET NUMBER	3-I-S4b-TOP
			Date:	6/11/2013		

MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 68 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard



BEARING TOP ANCHOR ROD LAYOUT



Section A (Typ.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

HARDNESS TEST RESULTS

	A		B		C		D		E		F		G		H	
1	1	37.0	1	37.1	1	36.2	1	37.1	1	36.4	1	36.6	1	36.3	1	36.4
	2	35.3	2	35.6	2	35.1	2	35.3	2	35.7	2	35.9	2	35.1	2	33.4
	3	33.0	3	32.4	3	34.5	3	32.9	3	33.4	3	31.3	3	31.4	3	31.7
	4	35.1	4	34.0	4	35.7	4	36.2	4	34.7	4	32.7	4	34.7	4	34.5
	5	36.1	5	37.0	5	38.6	5	37.1	5	37.1	5	34.5	5	34.7	5	35.5
2	1	36.9	1	36.3	1	36.3	1	36.3	1	38.1	1	37.3	1	34.7	1	34.5
	2	34.5	2	32.9	2	34.7	2	35.0	2	36.9	2	34.8	2	33.7	2	34.0
	3	31.9	3	32.0	3	32.0	3	32.0	3	33.2	3	33.6	3	32.0	3	33.3
	4	33.9	4	34.4	4	34.3	4	34.3	4	35.9	4	36.6	4	35.5	4	35.7
	5	35.5	5	36.1	5	35.1	5	35.6	5	37.7	5	37.5	5	38.0	5	38.0
3	1	35.1	1	37.0									1	38.0	1	37.3
	2	33.2	2	34.3									2	37.1	2	33.8
	3	31.9	3	31.7									3	36.0	3	33.0
	4	34.5	4	33.8									4	37.2	4	34.1
	5	35.5	5	35.5									5	36.9	5	36.8
4	1	35.7	1	36.2									1	36.8	1	35.2
	2	34.3	2	34.6									2	34.6	2	33.8
	3	32.5	3	32.3									3	32.7	3	32.9
	4	34.8	4	35.1									4	33.9	4	34.8
	5	37.9	5	36.8									5	35.4	5	37.5
5	1	36.8	1	37.1									1	37.4	1	36.1
	2	34.0	2	35.2									2	36.0	2	33.2
	3	31.1	3	33.9									3	35.2	3	33.0
	4	35.4	4	34.7									4	36.0	4	35.9
	5	36.5	5	36.8									5	37.1	5	38.0
6	1	36.7	1	36.7									1	35.0	1	37.1
	2	34.1	2	34.0									2	33.1	2	34.8
	3	33.4	3	31.5									3	33.0	3	31.8
	4	34.1	4	35.0									4	36.0	4	34.3
	5	36.3	5	36.5									5	37.7	5	35.0
7	1	37.3	1	37.0									1	36.6	1	36.6
	2	36.1	2	34.8									2	35.9	2	34.9
	3	34.0	3	33.3									3	32.1	3	31.0
	4	35.4	4	35.0									4	33.5	4	33.4
	5	37.3	5	36.4									5	37.1	5	34.6
8	1	35.0	1	36.4									1	36.3	1	37.2
	2	34.1	2	33.9									2	33.6	2	34.0
	3	33.2	3	32.4									3	32.9	3	33.7
	4	35.4	4	34.5									4	35.2	4	34.5
	5	36.3	5	35.9									5	36.3	5	36.7
9	1	36.5	1	36.8	1	37.6	1	36.7	1	37.0	1	37.1	1	36.5	1	36.9
	2	35.9	2	35.0	2	36.0	2	35.3	2	35.0	2	35.3	2	35.8	2	35.5
	3	34.4	3	33.7	3	35.8	3	32.0	3	33.9	3	33.9	3	32.2	3	33.8
	4	36.3	4	35.5	4	36.8	4	34.5	4	35.6	4	35.9	4	34.6	4	35.6
	5	37.1	5	36.5	5	37.7	5	35.8	5	37.5	5	36.4	5	37.7	5	37.9
10	1	37.2	1	37.7	1	35.1	1	35.3	1	36.5	1	36.2	1	37.2	1	36.1
	2	34.5	2	36.8	2	32.4	2	33.5	2	34.6	2	35.7	2	35.3	2	35.1
	3	31.2	3	33.1	3	31.5	3	31.9	3	33.8	3	34.3	3	33.8	3	32.6
	4	35.3	4	34.5	4	34.2	4	34.8	4	36.8	4	35.9	4	35.2	4	33.2
	5	36.9	5	36.9	5	37.0	5	35.4	5	37.7	5	36.2	5	37.6	5	37.0

Location: Bearing B1

Average Field Hardness: 35.2 HRC

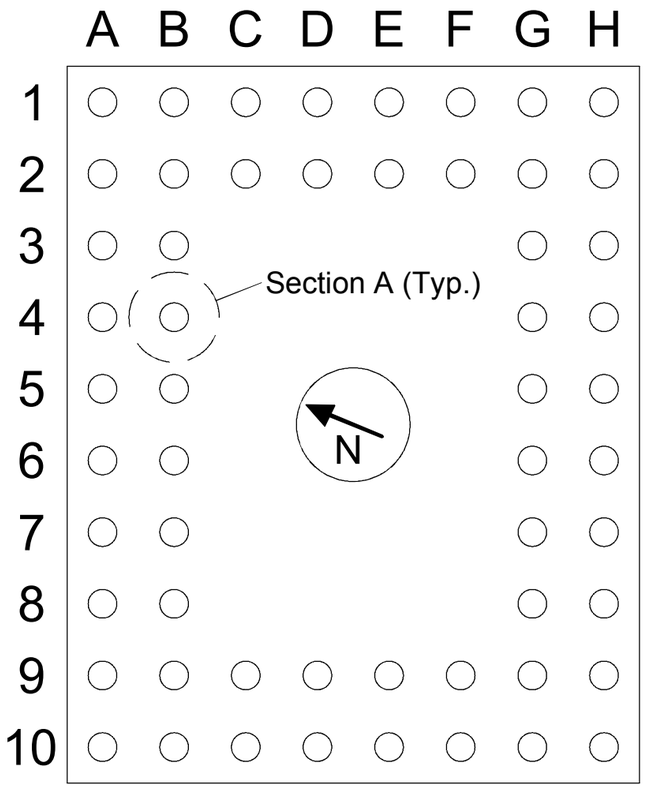
-Average Reading "1": 36.5 HRC
-Average Reading "2": 34.8 HRC
-Average Reading "3": 32.9 HRC
-Average Reading "4": 35.0 HRC
-Average Reading "5": 36.6 HRC

Average Hardness Readings from 2009 QC Report: 35.0 HRC

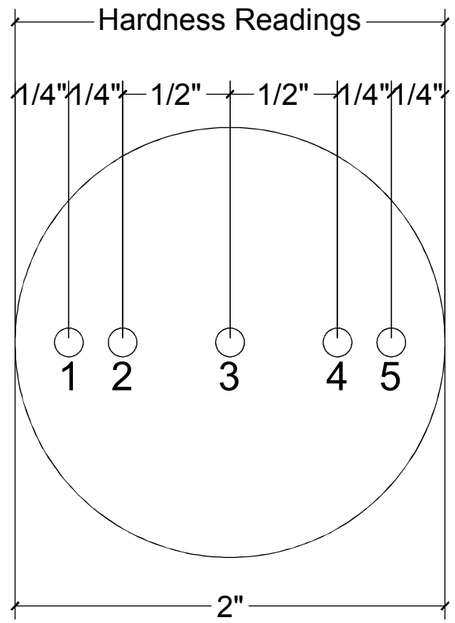
MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 60 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			E2 Bearing Top Anchor Rods Hardness Readings			
			Drawn By:	SK	SHEET NUMBER	4-I-B1-TOP
			Date:	5/23/2013		



BEARING TOP ANCHOR ROD LAYOUT



Section A (Typ.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

HARDNESS TEST RESULTS

	A		B		C		D		E		F		G		H	
1	1	34.2	1	35.0	1	33.7	1	37.4	1	36.7	1	37.5	1	37.0	1	36.3
	2	32.4	2	33.6	2	32.6	2	36.7	2	36.0	2	35.6	2	34.1	2	35.0
	3	32.1	3	31.5	3	32.3	3	33.6	3	35.0	3	31.3	3	33.7	3	32.5
	4	33.1	4	32.3	4	33.0	4	36.3	4	36.1	4	34.6	4	36.0	4	35.2
	5	33.9	5	34.2	5	34.6	5	37.5	5	37.1	5	37.0	5	37.4	5	36.9
2	1	36.6	1	37.0	1	36.4	1	37.2	1	36.4	1	36.0	1	37.0	1	35.9
	2	35.5	2	36.1	2	34.8	2	35.6	2	34.4	2	35.0	2	36.1	2	34.6
	3	33.3	3	33.9	3	34.2	3	35.2	3	32.1	3	33.8	3	35.6	3	33.1
	4	34.8	4	35.4	4	34.7	4	36.2	4	35.3	4	35.9	4	35.7	4	35.5
	5	36.9	5	37.1	5	36.7	5	36.8	5	36.1	5	36.3	5	37.1	5	36.3
3	1	35.7	1	36.2									1	37.0	1	36.2
	2	34.9	2	35.0									2	35.6	2	34.3
	3	33.5	3	33.0									3	34.7	3	32.7
	4	35.4	4	34.9									4	36.1	4	35.6
	5	36.0	5	35.7									5	36.4	5	36.5
4	1	37.0	1	36.4									1	36.4	1	36.1
	2	35.8	2	35.4									2	35.0	2	33.7
	3	34.4	3	32.4									3	33.7	3	32.5
	4	35.0	4	33.8									4	35.0	4	34.8
	5	36.3	5	36.4									5	36.8	5	36.9
5	1	36.9	1	36.6									1	36.8	1	36.8
	2	36.0	2	34.2									2	34.6	2	35.4
	3	34.4	3	31.9									3	33.5	3	32.6
	4	35.8	4	34.1									4	34.7	4	34.4
	5	38.0	5	36.1									5	36.0	5	37.0
6	1	37.0	1	36.8									1	33.9	1	36.2
	2	34.9	2	35.6									2	33.5	2	35.4
	3	33.9	3	34.0									3	31.7	3	33.5
	4	34.7	4	34.1									4	32.9	4	35.1
	5	36.3	5	36.0									5	34.4	5	36.2
7	1	36.8	1	37.3									1	35.1	1	35.4
	2	35.4	2	35.3									2	34.5	2	34.9
	3	34.1	3	34.1									3	33.3	3	30.9
	4	36.0	4	34.4									4	33.9	4	33.4
	5	37.0	5	36.6									5	36.0	5	35.5
8	1	37.6	1	36.8									1	33.9	1	35.0
	2	35.3	2	34.4									2	32.4	2	33.7
	3	33.5	3	33.1									3	30.1	3	33.1
	4	36.5	4	36.0									4	34.1	4	34.9
	5	37.0	5	37.3									5	35.9	5	35.7
9	1	37.0	1	36.7	1	37.0	1	36.3	1	37.8	1	37.0	1	35.3	1	34.9
	2	35.6	2	34.6	2	35.9	2	35.0	2	36.0	2	35.6	2	34.0	2	32.5
	3	35.2	3	33.3	3	33.2	3	33.3	3	34.0	3	33.7	3	32.0	3	32.1
	4	35.9	4	33.6	4	33.9	4	34.3	4	35.0	4	36.0	4	34.2	4	32.9
	5	36.2	5	35.0	5	36.5	5	36.8	5	36.5	5	37.3	5	35.5	5	35.0
10	1	35.7	1	36.1	1	36.6	1	36.9	1	37.0	1	35.1	1	34.6	1	36.3
	2	34.9	2	35.0	2	35.2	2	35.0	2	35.0	2	34.2	2	33.6	2	33.1
	3	32.9	3	32.8	3	34.8	3	34.5	3	34.6	3	33.0	3	31.6	3	31.3
	4	35.1	4	33.9	4	36.1	4	35.9	4	35.1	4	35.1	4	33.0	4	32.2
	5	36.2	5	35.9	5	36.8	5	36.8	5	36.3	5	36.0	5	36.0	5	33.9

Location: Bearing B2

Average Field Hardness: 35.1 HRC

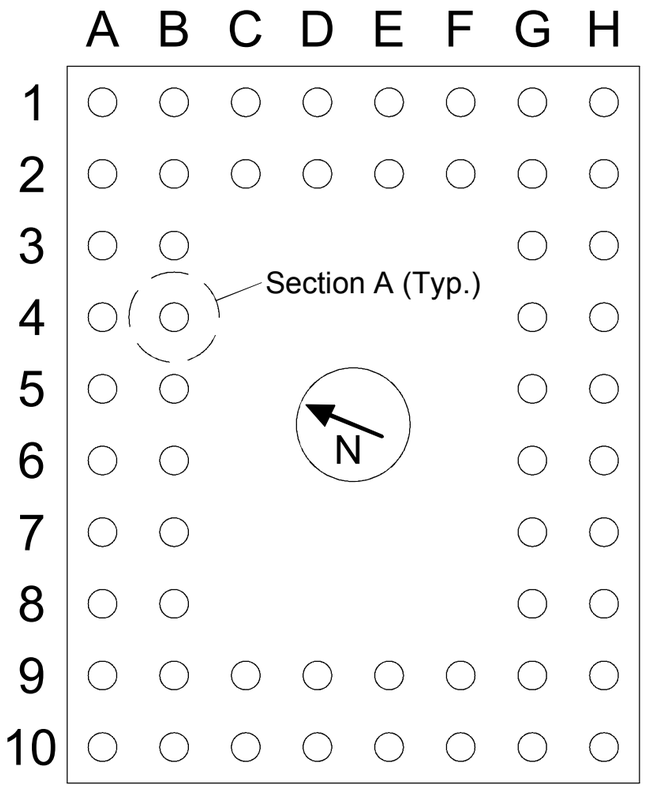
-Average Reading "1": 36.3 HRC
-Average Reading "2": 34.8 HRC
-Average Reading "3": 33.2 HRC
-Average Reading "4": 34.8 HRC
-Average Reading "5": 36.3 HRC

Average Hardness Readings from 2009 QC Report: 35.0 HRC

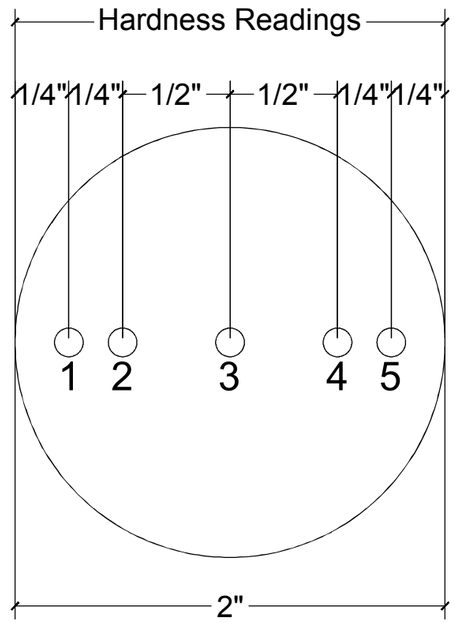
MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 57 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			E2 Bearing Top Anchor Rods Hardness Readings			
			Drawn By:	SK	SHEET NUMBER	4-I-B2-TOP
			Date:	5/23/2013		



BEARING TOP ANCHOR ROD LAYOUT



Section A (Typ.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

HARDNESS TEST RESULTS

	A		B		C		D		E		F		G		H	
1	1	36.1	1	38.1	1	36.6	1	36.4	1	36.0	1	37.5	1	37.7	1	37.2
	2	35.2	2	35.8	2	35.4	2	35.7	2	35.2	2	34.8	2	35.0	2	35.9
	3	32.3	3	33.0	3	32.8	3	34.0	3	31.9	3	34.4	3	33.6	3	34.9
	4	34.9	4	36.4	4	36.4	4	34.6	4	34.4	4	35.8	4	36.4	4	35.4
	5	37.1	5	37.3	5	37.7	5	36.3	5	36.0	5	36.9	5	37.5	5	36.2
2	1	36.1	1	36.2	1	38.2	1	36.4	1	36.8	1	37.3	1	36.7	1	36.2
	2	35.3	2	35.7	2	35.0	2	33.6	2	35.2	2	36.3	2	34.6	2	35.6
	3	33.6	3	33.7	3	31.6	3	30.2	3	32.3	3	35.4	3	32.5	3	34.8
	4	36.1	4	34.6	4	34.8	4	34.6	4	35.4	4	35.9	4	35.6	4	36.7
	5	37.2	5	35.9	5	37.4	5	36.5	5	36.7	5	36.4	5	38.1	5	38.2
3	1	38.4	1	36.7									1	36.8	1	36.9
	2	36.2	2	33.9									2	36.5	2	35.8
	3	35.7	3	32.0									3	31.8	3	34.4
	4	36.4	4	35.2									4	32.2	4	36.1
	5	38.6	5	36.2									5	34.0	5	37.1
4	1	36.3	1	38.1									1	37.8	1	36.8
	2	35.2	2	36.1									2	36.1	2	34.9
	3	33.8	3	32.4									3	34.8	3	33.8
	4	35.2	4	34.6									4	35.5	4	35.2
	5	36.2	5	35.2									5	37.5	5	36.0
5	1	38.1	1	37.6									1	36.0	1	36.8
	2	36.2	2	36.4									2	35.6	2	35.3
	3	34.2	3	35.0									3	32.2	3	33.2
	4	36.7	4	36.2									4	34.3	4	34.5
	5	38.0	5	37.4									5	35.0	5	36.8
6	1	36.2	1	38.2									1	38.4	1	36.2
	2	35.4	2	36.0									2	35.4	2	34.4
	3	32.1	3	34.3									3	32.6	3	33.8
	4	32.5	4	35.8									4	36.7	4	36.8
	5	37.2	5	38.5									5	38.3	5	38.4
7	1	37.6	1	38.4									1	36.0	1	37.7
	2	35.2	2	35.2									2	34.3	2	35.4
	3	34.0	3	32.1									3	31.8	3	34.8
	4	34.8	4	34.0									4	36.1	4	36.2
	5	37.8	5	35.2									5	36.4	5	37.6
8	1	36.6	1	36.5									1	37.9	1	37.7
	2	33.4	2	35.9									2	36.0	2	36.2
	3	33.1	3	32.9									3	31.9	3	35.5
	4	34.9	4	35.1									4	33.4	4	37.3
	5	36.1	5	36.3									5	35.3	5	37.9
9	1	37.3	1	36.0	1	36.5	1	37.1	1	37.8	1	36.2	1	37.3	1	36.4
	2	35.8	2	34.0	2	35.8	2	36.2	2	37.0	2	35.9	2	35.5	2	35.3
	3	31.6	3	33.2	3	33.2	3	34.3	3	36.4	3	34.2	3	32.5	3	33.3
	4	34.9	4	34.3	4	36.3	4	35.3	4	36.5	4	35.7	4	33.8	4	36.3
	5	36.6	5	36.9	5	38.6	5	38.6	5	37.3	5	36.7	5	35.5	5	38.3
10	1	36.1	1	36.2	1	38.4	1	37.4	1	36.0	1	37.2	1	37.6	1	36.1
	2	34.4	2	35.1	2	37.2	2	36.8	2	35.2	2	35.4	2	36.5	2	35.0
	3	32.9	3	33.2	3	33.0	3	33.1	3	33.2	3	32.1	3	33.5	3	32.7
	4	34.2	4	35.9	4	36.8	4	35.8	4	35.4	4	36.5	4	34.8	4	34.2
	5	37.8	5	36.3	5	38.2	5	38.6	5	36.3	5	37.8	5	36.3	5	36.5

Location: Bearing B3

Average Field Hardness: 35.6 HRC

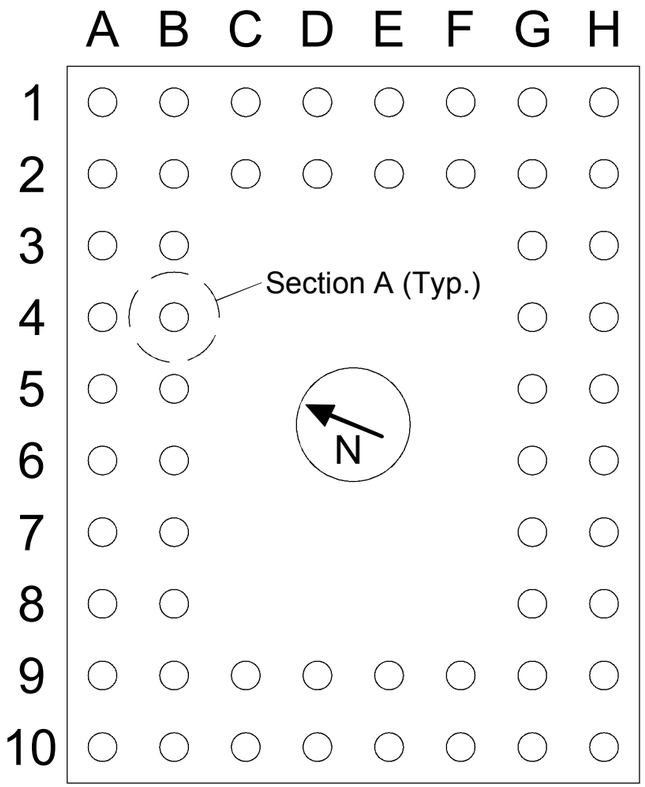
-Average Reading "1": 37.0 HRC
-Average Reading "2": 35.5 HRC
-Average Reading "3": 33.3 HRC
-Average Reading "4": 35.4 HRC
-Average Reading "5": 37.0 HRC

Average Hardness Readings from 2009 QC Report: 35.0 HRC

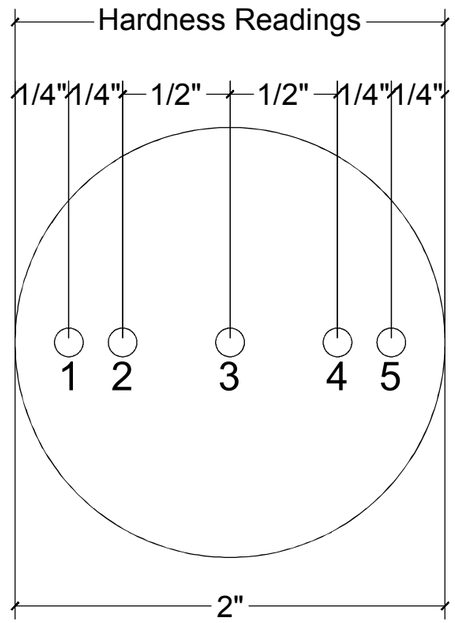
MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 54 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			E2 Bearing Top Anchor Rods Hardness Readings			
			Drawn By:	PH	SHEET NUMBER	4-I-B3-TOP
			Date:	5/24/2013		



BEARING TOP ANCHOR ROD LAYOUT



Section A (Typ.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

HARDNESS TEST RESULTS

	A		B		C		D		E		F		G		H	
1	1	36.8	1	36.7	1	36.5	1	36.3	1	36.6	1	38.0	1	36.3	1	37.9
	2	35.7	2	36.1	2	34.6	2	34.6	2	34.2	2	35.5	2	36.1	2	37.3
	3	32.7	3	34.3	3	33.6	3	32.2	3	33.5	3	34.4	3	34.5	3	36.2
	4	36.3	4	35.5	4	36.0	4	33.8	4	36.6	4	36.4	4	36.6	4	36.6
	5	36.9	5	36.7	5	37.4	5	36.0	5	37.6	5	37.7	5	37.2	5	37.8
2	1	36.6	1	37.2	1	37.1	1	36.8	1	37.9	1	37.5	1	37.4	1	36.3
	2	36.0	2	35.5	2	36.0	2	35.8	2	36.9	2	36.9	2	35.6	2	35.2
	3	33.3	3	33.5	3	33.4	3	33.1	3	33.1	3	35.5	3	32.5	3	33.7
	4	36.4	4	36.7	4	35.9	4	36.2	4	36.5	4	36.1	4	36.3	4	35.8
	5	37.1	5	36.9	5	36.1	5	37.1	5	38.1	5	38.0	5	37.5	5	37.4
3	1	37.1	1	36.6									1	35.1	1	37.5
	2	35.6	2	35.6									2	34.8	2	34.4
	3	32.1	3	33.7									3	31.5	3	32.5
	4	34.5	4	35.9									4	33.0	4	33.2
	5	36.6	5	37.1									5	37.8	5	35.0
4	1	36.7	1	38.0									1	37.2	1	36.4
	2	35.1	2	37.2									2	35.0	2	35.3
	3	33.7	3	35.3									3	33.8	3	33.1
	4	35.5	4	37.2									4	35.0	4	33.8
	5	36.6	5	38.0									5	36.7	5	35.2
5	1	36.0	1	37.4									1	36.4	1	36.6
	2	34.8	2	35.4									2	35.7	2	35.4
	3	33.2	3	34.9									3	32.3	3	32.0
	4	35.0	4	35.6									4	36.3	4	35.2
	5	36.9	5	36.6									5	37.5	5	35.7
6	1	37.2	1	37.4									1	36.9	1	37.8
	2	35.8	2	35.9									2	33.4	2	37.0
	3	35.0	3	34.1									3	32.1	3	34.3
	4	36.0	4	35.3									4	35.7	4	36.3
	5	37.7	5	37.6									5	38.1	5	37.8
7	1	36.5	1	36.9									1	36.7	1	37.2
	2	35.2	2	34.0									2	32.1	2	35.4
	3	33.2	3	33.7									3	32.0	3	32.7
	4	34.7	4	35.0									4	33.6	4	35.8
	5	37.4	5	35.8									5	34.4	5	37.9
8	1	37.3	1	36.6									1	38.1	1	36.6
	2	34.6	2	35.7									2	37.4	2	34.5
	3	33.2	3	33.4									3	36.3	3	33.0
	4	36.3	4	34.7									4	37.3	4	36.6
	5	37.5	5	35.7									5	37.9	5	37.0
9	1	37.3	1	36.8	1	36.1	1	37.3	1	37.2	1	36.3	1	37.5	1	37.0
	2	35.0	2	35.7	2	34.6	2	35.5	2	35.2	2	34.7	2	34.7	2	36.0
	3	32.6	3	34.0	3	33.4	3	34.3	3	34.1	3	33.8	3	33.8	3	34.3
	4	34.0	4	36.6	4	34.7	4	35.3	4	36.6	4	34.0	4	35.7	4	35.0
	5	36.8	5	37.2	5	37.0	5	36.3	5	37.9	5	36.5	5	36.9	5	36.7
10	1	36.1	1	37.6	1	38.0	1	36.7	1	37.1	1	37.5	1	38.3	1	37.8
	2	35.6	2	36.1	2	37.7	2	35.5	2	34.4	2	37.0	2	36.5	2	35.7
	3	31.8	3	35.3	3	34.6	3	34.3	3	33.2	3	35.1	3	34.2	3	34.9
	4	36.3	4	36.3	4	37.2	4	35.4	4	35.4	4	37.1	4	36.7	4	35.1
	5	38.1	5	37.2	5	38.3	5	37.1	5	36.7	5	37.3	5	36.8	5	38.3

Location: Bearing B4

Average Field Hardness: 35.8 HRC

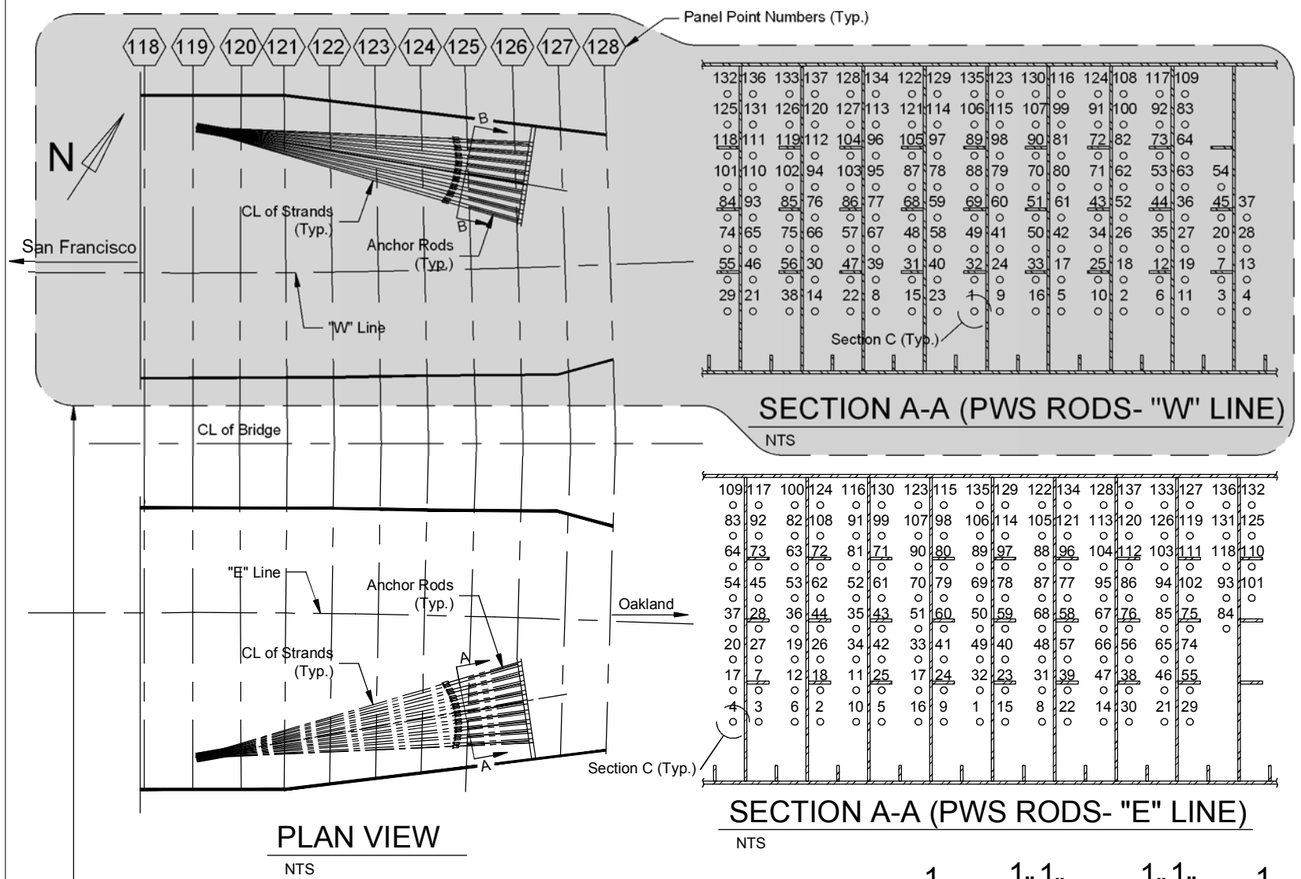
-Average Reading "1": 37.0 HRC
-Average Reading "2": 35.5 HRC
-Average Reading "3": 33.6 HRC
-Average Reading "4": 35.7 HRC
-Average Reading "5": 37.1 HRC

Average Hardness Readings from 2009 QC Report: 35.0 HRC

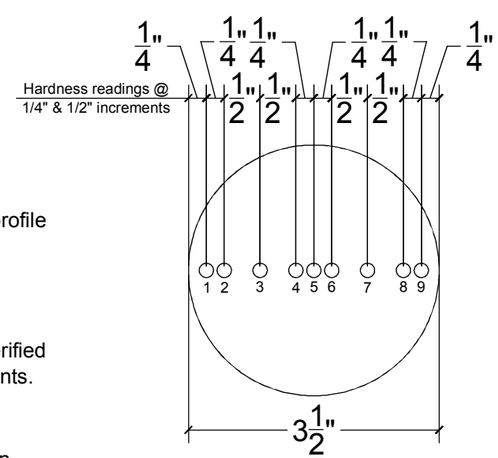
MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 65 F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			E2 Bearing Top Anchor Rods Hardness Readings			
			Drawn By:	PH	SHEET NUMBER	4-I-B4-TOP
			Date:	5/24/2013		



THIS DRAWING IS FOR THE HARDNESS TESTING READINGS FOR THE PWS STRAND ANCHOR RODS ON THE "W" LINE ONLY.



GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Revision No:	By:	Date:

SELF-ANCHORED SUSPENSION BRIDGE

PWS Strand Anchor Rods - "W" Line Hardness Readings

Drawn By:	MH	SHEET NUMBER	7-I-WEST
Date:	6/11/2013		

PWS Rod	Diam.	Hardness Readings for "W" Line PWS Rods								
		1	2	3	4	5	6	7	8	9
1	3 1/2"	36.8	36.3	34.2	32.2	31.4	33.7	34.1	35.2	35.7
2	3 1/2"	35.5	34.2	33.7	32.6	32.3	33.9	33.9	34.4	36.2
3	3 1/2"	35.6	33.5	31.9	30.4	29.7	31.6	31.7	32.0	34.9
4	3 1/2"	35.1	34.5	33.5	30.8	30.7	33.3	32.4	34.5	35.7
5	3 1/2"	36.4	34.6	33.7	32.8	30.5	32.6	33.6	33.1	35.6
6	3 1/2"	36.7	35.2	34.9	32.1	32.0	33.6	35.2	35.3	36.7
7	3 1/2"	36.2	35.1	34.0	33.6	30.9	31.7	32.2	34.2	36.0
8	3 1/2"	35.7	35.1	33.3	33.3	33.2	34.6	35.5	36.6	36.2
9	3 1/2"	36.5	36.1	34.4	32.3	30.4	32.6	34.2	36.9	37.0
10	3 1/2"	36.6	35.7	34.0	32.1	31.3	32.8	33.5	34.9	36.9
11	3 1/2"	37.4	35.3	33.6	30.9	29.7	32.1	33.4	34.7	38.3
12	3 1/2"	36.7	35.2	34.0	33.7	33.2	34.5	34.8	35.9	36.4
13	3 1/2"	36.4	35.8	33.3	30.8	30.3	31.5	34.3	35.9	36.0
14	3 1/2"	35.2	34.3	33.0	32.8	29.5	33.6	33.7	33.7	34.1
15	3 1/2"	37.1	35.4	33.4	33.0	30.9	33.1	34.7	35.2	34.9
16	3 1/2"	37.5	37.5	36.6	34.4	32.9	30.1	33.3	35.6	37.1
17	3 1/2"	37.1	36.6	35.3	33.3	31.0	32.7	34.7	35.4	36.6
18	3 1/2"	36.4	35.1	33.3	32.4	30.8	30.7	32.5	33.3	36.3
19	3 1/2"	35.7	35.0	33.5	32.6	30.7	33.8	34.8	36.3	36.5
20	3 1/2"	36.7	35.5	33.2	32.4	30.2	32.8	33.9	34.7	35.5
21	3 1/2"	36.2	35.5	34.6	34.1	33.8	34.9	35.2	36.4	37.1
22	3 1/2"	36.6	35.9	34.8	33.0	31.5	32.8	34.4	35.1	35.6
23	3 1/2"	36.8	35.8	34.5	34.1	33.9	34.6	34.8	35.2	36.4
24	3 1/2"	36.8	36.7	35.5	32.2	31.8	32.7	34.8	35.9	36.4
25	3 1/2"	36.4	36.1	34.8	32.6	30.8	31.2	33.9	35.1	36.6
26	3 1/2"	35.9	35.2	32.4	31.3	28.9	32.2	33.0	35.6	35.9
27	3 1/2"	36.8	36.0	33.7	32.9	31.5	32.2	34.8	35.4	36.3
28	3 1/2"	36.7	36.1	33.8	32.4	30.5	31.5	34.4	36.4	37.1
29	3 1/2"	-	-	-	-	-	-	-	-	-
30	3 1/2"	36.8	35.2	34.8	33.5	33.2	34.6	34.7	35.9	36.0
31	3 1/2"	35.0	34.5	33.1	32.7	31.6	32.7	33.8	33.8	34.8
32	3 1/2"	36.6	35.9	34.5	32.3	31.5	32.1	34.6	36.2	36.9
33	3 1/2"	36.1	35.9	34.3	32.8	30.5	33.0	34.4	35.3	35.7
34	3 1/2"	36.4	35.2	33.8	32.2	31.7	32.7	34.0	34.5	35.4
35	3 1/2"	35.3	34.6	33.6	31.8	31.6	32.1	32.7	34.4	35.3
36	3 1/2"	36.0	35.5	34.3	33.7	30.1	33.1	35.0	36.1	35.9
37	3 1/2"	35.9	35.3	34.6	31.0	30.5	30.8	34.1	36.0	36.3
38	3 1/2"	36.2	34.1	32.7	32.4	30.3	32.8	32.8	33.8	36.0
39	3 1/2"	-	-	-	-	-	-	-	-	-
40	3 1/2"	34.9	32.9	32.7	31.0	30.4	33.1	34.6	36.6	37.0
41	3 1/2"	-	-	-	-	-	-	-	-	-
42	3 1/2"	36.1	36.0	35.8	32.9	31.6	33.0	34.5	35.1	35.2
43	3 1/2"	34.9	34.7	32.8	32.4	32.5	33.1	33.9	34.1	35.6
44	3 1/2"	36.2	35.1	33.8	32.1	30.9	33.1	34.7	35.7	36.1
45	3 1/2"	36.1	35.9	33.8	32.0	31.5	33.4	35.5	36.3	36.8
46	3 1/2"	-	-	-	-	-	-	-	-	-
47	3 1/2"	35.8	34.3	33.2	32.4	31.5	32.8	33.2	34.8	36.0
48	3 1/2"	-	-	-	-	-	-	-	-	-
49	3 1/2"	-	-	-	-	-	-	-	-	-
50	3 1/2"	36.9	33.3	31.9	31.1	29.0	32.1	34.9	35.1	36.4
51	3 1/2"	36.9	36.1	34.2	32.0	30.0	33.5	34.1	35.7	36.8
52	3 1/2"	36.9	36.7	35.4	33.6	31.7	32.6	33.3	35.8	36.1
53	3 1/2"	35.7	33.4	31.8	31.8	32.1	33.5	34.6	34.9	35.3
54	3 1/2"	36.5	35.6	32.7	31.8	31.2	32.2	34.8	35.5	36.7
55	3 1/2"	35.2	33.4	32.1	31.8	27.9	28.8	32.2	34.8	35.6
56	3 1/2"	34.3	33.5	31.4	30.9	29.9	31.6	32.4	33.9	34.6
57	3 1/2"	35.7	33.4	33.2	30.3	30.3	33.5	34.0	34.1	35.0
58	3 1/2"	36.9	35.6	35.0	32.9	31.7	32.2	34.7	36.0	36.2
59	3 1/2"	-	-	-	-	-	-	-	-	-
60	3 1/2"	35.8	34.4	33.2	31.4	30.0	32.7	33.1	35.1	37.0
61	3 1/2"	35.5	33.8	32.8	32.5	32.4	33.4	34.1	35.0	36.1
62	3 1/2"	36.2	34.1	33.6	33.6	30.7	31.6	34.4	34.2	36.4
63	3 1/2"	36.0	35.1	33.9	32.9	31.1	33.0	34.5	35.7	35.8
64	3 1/2"	35.3	33.7	33.1	31.9	29.4	30.9	33.4	36.0	36.7
65	3 1/2"	36.5	35.4	34.0	32.3	31.9	33.1	33.0	34.9	36.6
66	3 1/2"	-	-	-	-	-	-	-	-	-
67	3 1/2"	36.9	35.8	35.0	33.5	30.7	33.8	35.1	36.5	36.6
68	3 1/2"	35.1	34.8	33.8	33.1	32.6	33.2	33.3	35.5	36.0
69	3 1/2"	-	-	-	-	-	-	-	-	-
70	3 1/2"	36.4	35.3	34.4	33.4	31.6	33.9	34.9	35.9	36.7

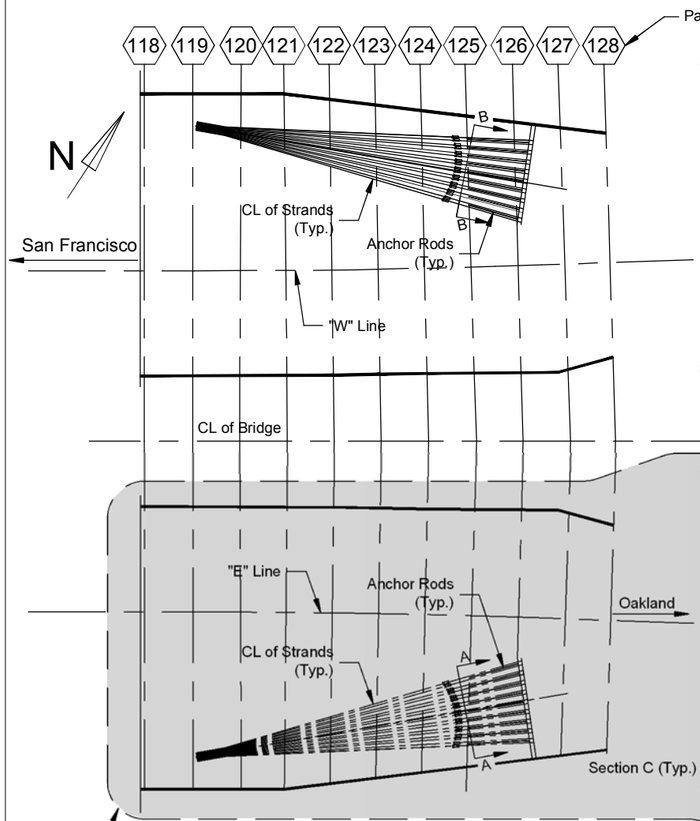
PWS Rod	Diam.	Hardness Readings for "W" Line PWS Rods								
		1	2	3	4	5	6	7	8	9
71	3 1/2"	37.2	36.2	33.4	31.8	30.4	32.1	33.6	34.8	35.6
72	3 1/2"	36.1	34.0	34.0	32.8	29.8	32.3	32.9	33.2	34.9
73	3 1/2"	-	-	-	-	-	-	-	-	-
74	3 1/2"	-	-	-	-	-	-	-	-	-
75	3 1/2"	35.4	35.3	33.8	31.0	29.8	32.1	33.0	34.4	36.4
76	3 1/2"	-	-	-	-	-	-	-	-	-
77	3 1/2"	37.9	37.2	35.0	33.2	31.0	32.7	33.5	36.8	37.3
78	3 1/2"	36.3	35.4	33.4	33.1	33.1	34.4	34.5	36.0	36.2
79	3 1/2"	36.0	35.4	33.8	33.0	32.7	32.9	34.4	35.9	36.7
80	3 1/2"	36.6	36.1	35.0	33.7	30.4	33.2	34.3	35.0	36.6
81	3 1/2"	36.0	34.0	33.0	30.0	30.0	32.1	33.6	34.3	35.2
82	3 1/2"	36.5	34.5	32.4	32.0	30.0	32.0	32.1	34.0	35.3
83	3 1/2"	37.0	36.5	34.9	32.2	32.0	33.1	34.4	35.2	36.8
84	3 1/2"	35.7	35.4	33.0	32.3	30.5	32.2	34.4	34.4	36.1
85	3 1/2"	36.4	35.9	34.8	32.4	31.2	31.3	34.9	36.2	36.3
86	3 1/2"	35.0	34.0	33.2	32.7	31.7	32.0	32.5	34.2	34.9
87	3 1/2"	35.2	34.9	32.8	31.3	30.5	32.3	34.2	35.6	35.7
88	3 1/2"	-	-	-	-	-	-	-	-	-
89	3 1/2"	36.4	35.9	34.1	32.7	32.3	32.9	33.2	34.6	35.1
90	3 1/2"	36.1	35.6	34.0	32.5	30.4	33.1	33.7	35.0	36.1
91	3 1/2"	36.8	35.5	33.9	32.5	32.0	33.8	34.4	35.5	37.2
92	3 1/2"	35.4	33.9	32.4	31.7	28.3	31.6	32.8	34.8	35.3
93	3 1/2"	35.4	34.3	32.2	31.1	29.6	31.7	32.1	34.3	34.9
94	3 1/2"	35.4	34.3	32.5	31.6	30.9	32.7	33.8	34.5	35.0
95	3 1/2"	35.3	33.6	32.4	30.0	29.8	33.3	33.5	34.3	35.9
96	3 1/2"	37.0	36.0	34.2	33.1	31.8	32.1	33.8	36.4	36.9
97	3 1/2"	34.8	33.8	32.9	32.1	32.0	32.6	33.2	33.4	35.9
98	3 1/2"	37.2	36.5	34.3	32.8	31.6	32.0	33.8	35.9	36.8
99	3 1/2"	36.6	34.2	33.3	32.1	31.5	33.9	33.7	34.1	34.9
100	3 1/2"	37.6	35.6	34.5	33.1	33.3	33.4	35.6	36.2	36.8
101	3 1/2"	36.1	34.0	32.8	31.6	30.1	32.1	33.3	34.1	36.4
102	3 1/2"	36.9	34.6	33.8	33.1	30.3	31.9	34.2	34.8	35.9
103	3 1/2"	35.7	34.4	33.4	31.6	31.4	31.2	31.9	32.8	36.7
104	3 1/2"	37.1	36.2	35.4	33.6	30.9	33.2	34.8	35.1	35.6
105	3 1/2"	37.5	37.2	35.4	34.5	33.5	34.1	35.0	36.6	37.4
106	3 1/2"	35.6	34.3	33.7	32.8	33.2	33.4	33.7	34.1	35.5
107	3 1/2"	36.4	35.2	33.2	33.7	32.1	34.2	34.5	34.9	35.8
108	3 1/2"	36.7	36.5	33.5	32.3	31.9	32.7	34.6	35.1	35.6
109	3 1/2"	-	-	-	-	-	-	-	-	-
110	3 1/2"	35.0	33.1	32.6	30.3	30.0	30.9	31.8	31.8	32.4
111	3 1/2"	-	-	-	-	-	-	-	-	-
112	3 1/2"	34.3	34.2	33.8	33.6	31.9	31.9	33.7	33.7	34.2
113	3 1/2"	36.5	35.5	34.9	34.7	32.1	32.5	33.6	33.9	35.1
114	3 1/2"	35.3	33.0	31.9	30.7	29.8	31.6	32.5	36.1	36.5
115	3 1/2"	36.2	34.8	33.6	32.1	29.4	32.5	33.3	34.8	37.4
116	3 1/2"	35.8	35.3	33.6	32.4	30.1	32.8	34.4	36.9	37.5
117	3 1/2"	35.7	35.2	33.5	31.9	31.3	32.3	34.2	35.7	35.9
118	3 1/2"	36.2	36.1	35.0	33.0	31.2	32.5	34.1	35.7	36.8
119	3 1/2"	37.1	36.5	35.2	32.1	31.5	31.7	32.4	36.5	36.9
120	3 1/2"	34.9	34.7	32.6	30.8	29.4	32.0	33.9	34.5	35.7
121	3 1/2"	36.4	34.4	33.9	32.2	30.2	30.5	32.6	34.6	34.8
122	3 1/2"	36.6	35.1	33.7	32.5	31.6	33.5	34.0	36.0	36.7
123	3 1/2"	35.5	33.1	32.4	29.9	28.8	33.1	33.1	34.4	34.9
124	3 1/2"	37.7	35.1	34.6	33.1	33.3	33.8	34.3	35.8	36.5
125	3 1/2"	35.2	34.0	34.4	34.3	31.8	34.8	35.0	35.1	35.1
126	3 1/2"	36.3	36.2	33.9	32.6	30.0	32.4	33.6	35.3	36.4
127	3 1/2"	36.9	36.6	34.5	32.3	30.6	32.6	34.5	35.3	35.7
128	3 1/2"	34.6	33.8	32.2	31.2	29.1	32.2	31.9	33.6	35.2
129	3 1/2"	-	-	-	-	-	-	-	-	-
130	3 1/2"	36.4	35.5	34.9	32.7	30.2	32.8	34.1	35.5	36.5
131	3 1/2"	34.5	34.0	33.1	30.1	31.2	32.1	33.1	34.2	35.7
132	3 1/2"	-	-	-	-	-	-	-	-	-
133	3 1/2"	-	-	-	-	-	-	-	-	-
134	3 1/2"	37.2	36.6	33.7	32.3	31.8	31.4	32.2	36.3	36.8
135	3 1/2"	36.8	36.3	33.8	32.2	31.0	33.5	34.5	35.7	36.4
136	3 1/2"	35.0	34.7	34.5	32.9	30.5	32.0	33.0	35.2	35.5
137	3 1/2"	33.8	32.1	31.7	31.8	30.6	31.9	32.0	32.2	32.7
AVERAGES	36.1	35.1	33.7	32.3	31.0	32.6	33.8	35.1	36.0	

Field Average Hardness: 34.0 HRC

Average Hardness Readings from 2011 MTR's: 35.5 HRC

MEASUREMENT LOGISTICS:

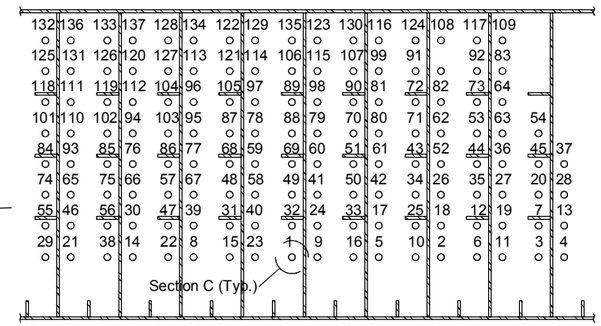
1) Recorded ambient temperature (Deg. F): 59 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard



PLAN VIEW

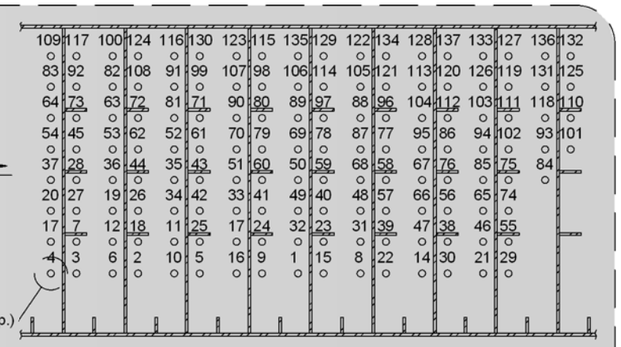
NTS

THIS DRAWING IS FOR THE HARDNESS TESTING READINGS FOR THE PWS STRAND ANCHOR RODS ON THE "E" LINE ONLY.



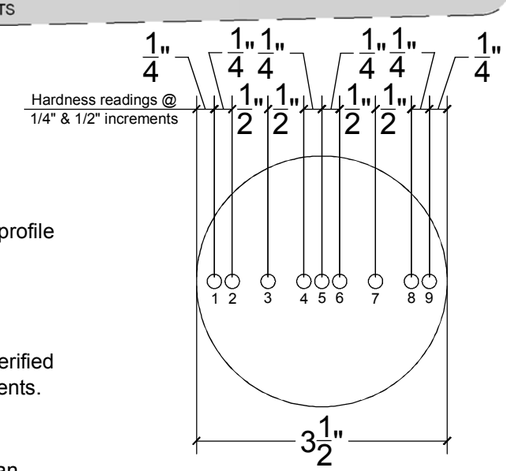
SECTION B-B (PWS RODS- "W" LINE)

NTS



SECTION A-A (PWS RODS- "E" LINE)

NTS



SECTION C (TYP.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Revision No:	By:	Date:

SELF-ANCHORED SUSPENSION BRIDGE

PWS Strand Anchor Rods - "E" Line Hardness Readings

Drawn By:	MH	SHEET NUMBER	7-I-EAST
Date:	6/11/2013		

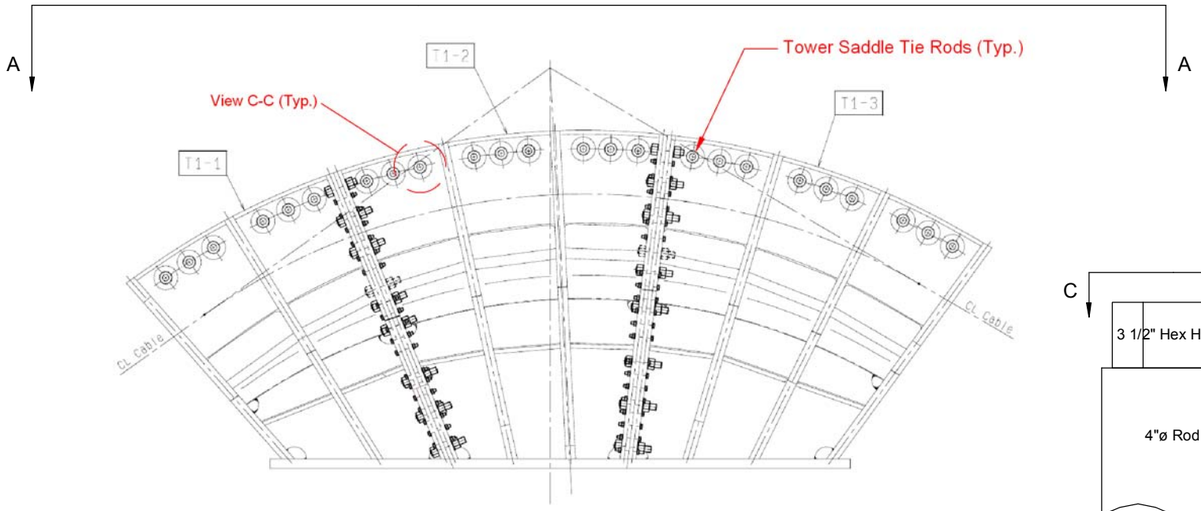
PWS Rod	Diam.	Hardness Readings for "E" Line PWS Rods								
		1	2	3	4	5	6	7	8	9
1	3 1/2"	35.9	35.6	35.1	33.4	33.0	34.0	34.1	35.7	36.0
2	3 1/2"	35.7	35.0	34.5	32.5	32.2	32.8	33.7	34.0	34.4
3	3 1/2"	35.6	34.8	34.1	33.6	32.7	33.1	34.7	35.4	36.4
4	3 1/2"	35.8	35.6	34.2	33.2	30.8	32.8	33.2	36.3	36.7
5	3 1/2"	36.1	35.3	34.8	33.6	31.2	33.3	34.3	35.2	36.4
6	3 1/2"	36.0	35.8	33.9	32.6	31.5	32.7	33.2	35.1	35.4
7	3 1/2"	35.8	34.4	33.3	32.0	30.0	32.0	33.1	33.1	35.2
8	3 1/2"	35.9	34.0	33.5	31.3	31.1	33.8	34.3	35.5	36.0
9	3 1/2"	36.4	35.1	34.0	33.4	32.6	33.5	34.3	34.9	35.9
10	3 1/2"	36.9	35.0	33.5	33.1	30.9	32.9	34.0	35.1	36.1
11	3 1/2"	35.9	34.9	34.6	33.4	31.3	33.0	34.3	36.1	36.3
12	3 1/2"	-	-	-	-	-	-	-	-	-
13	3 1/2"	36.5	35.7	34.5	32.1	30.7	33.2	34.6	35.2	35.5
14	3 1/2"	35.4	34.4	33.8	32.4	31.3	33.5	34.4	36.3	36.9
15	3 1/2"	35.5	35.0	33.9	32.5	29.2	32.6	34.4	35.6	36.0
16	3 1/2"	-	-	-	-	-	-	-	-	-
17	3 1/2"	35.3	32.8	32.6	31.8	31.4	33.1	33.5	33.9	35.5
18	3 1/2"	36.8	35.8	35.2	33.1	31.6	31.9	32.9	35.5	36.3
19	3 1/2"	35.5	34.9	33.5	31.4	30.5	32.2	33.6	34.2	35.2
20	3 1/2"	37.1	36.9	35.0	33.4	31.7	33.9	34.3	36.5	36.7
21	3 1/2"	-	-	-	-	-	-	-	-	-
22	3 1/2"	36.4	34.9	33.1	33.0	31.4	33.0	33.9	35.3	35.6
23	3 1/2"	36.9	35.6	35.4	35.2	32.2	34.0	35.6	36.0	36.4
24	3 1/2"	-	-	-	-	-	-	-	-	-
25	3 1/2"	36.9	35.9	34.8	33.7	30.2	31.2	33.9	35.0	36.6
26	3 1/2"	37.1	35.6	32.9	31.7	30.9	30.2	32.0	33.1	37.2
27	3 1/2"	-	-	-	-	-	-	-	-	-
28	3 1/2"	-	-	-	-	-	-	-	-	-
29	3 1/2"	36.7	35.2	34.1	32.3	31.1	32.5	33.4	33.5	34.8
30	3 1/2"	36.6	35.0	33.1	32.6	32.3	33.8	34.5	35.3	35.6
31	3 1/2"	36.6	34.3	32.0	30.7	29.5	31.1	33.3	34.4	36.2
32	3 1/2"	36.2	35.3	34.9	33.5	30.1	33.1	33.9	35.7	36.4
33	3 1/2"	35.3	33.9	33.5	32.6	32.8	34.4	35.3	35.7	36.3
34	3 1/2"	35.1	34.4	33.4	32.4	31.0	32.7	34.4	34.9	36.4
35	3 1/2"	36.6	34.6	33.7	32.7	32.8	33.3	35.0	34.8	35.8
36	3 1/2"	-	-	-	-	-	-	-	-	-
37	3 1/2"	33.6	33.5	33.5	32.1	31.4	31.3	32.0	33.4	34.8
38	3 1/2"	33.8	33.5	31.8	32.1	29.9	32.8	33.3	33.4	35.7
39	3 1/2"	35.3	34.8	33.4	32.4	32.2	33.1	34.8	34.8	35.2
40	3 1/2"	-	-	-	-	-	-	-	-	-
41	3 1/2"	36.0	35.8	34.2	33.0	31.6	34.0	34.9	35.1	36.6
42	3 1/2"	-	-	-	-	-	-	-	-	-
43	3 1/2"	35.7	34.4	33.2	31.5	30.2	33.5	33.6	33.8	34.3
44	3 1/2"	37.0	35.8	34.5	32.5	32.6	32.5	34.5	35.1	36.0
45	3 1/2"	-	-	-	-	-	-	-	-	-
46	3 1/2"	-	-	-	-	-	-	-	-	-
47	3 1/2"	37.0	36.2	35.4	33.1	35.0	35.9	35.7	36.1	37.1
48	3 1/2"	35.5	34.6	33.1	32.4	31.2	33.3	33.5	34.5	35.3
49	3 1/2"	34.9	34.6	33.9	32.1	31.6	31.0	33.8	33.8	35.9
50	3 1/2"	36.5	35.4	34.6	34.3	31.5	33.5	34.3	35.0	35.2
51	3 1/2"	37.2	37.1	34.5	33.3	31.5	33.3	34.4	35.6	36.3
52	3 1/2"	35.5	34.7	34.0	33.4	29.0	31.0	32.1	33.2	34.6
53	3 1/2"	-	-	-	-	-	-	-	-	-
54	3 1/2"	35.2	34.6	33.1	30.3	30.3	30.7	32.0	34.8	35.3
55	3 1/2"	35.9	35.6	35.5	35.1	33.5	33.2	34.4	34.9	35.7
56	3 1/2"	36.5	36.1	35.6	34.2	32.8	34.8	35.1	35.7	36.7
57	3 1/2"	36.2	35.0	34.2	32.2	30.6	32.3	33.8	35.0	36.7
58	3 1/2"	36.9	35.8	33.1	32.0	30.0	30.7	34.0	36.5	37.0
59	3 1/2"	37.1	33.0	32.5	31.8	31.8	33.0	33.2	34.5	36.6
60	3 1/2"	36.1	35.5	33.9	31.6	30.6	31.5	33.2	35.9	36.4
61	3 1/2"	36.2	35.4	34.2	33.1	32.6	32.1	34.5	35.3	36.6
62	3 1/2"	36.8	35.3	33.8	32.9	31.1	32.3	33.4	34.7	35.6
63	3 1/2"	36.4	35.3	34.3	33.6	32.2	33.8	34.8	35.9	36.8
64	3 1/2"	37.5	35.9	34.2	32.4	31.6	32.8	33.9	34.3	36.7
65	3 1/2"	36.8	35.8	34.6	33.2	31.3	31.7	34.8	35.0	36.0
66	3 1/2"	35.0	34.2	34.3	32.9	28.5	30.6	34.4	34.7	36.7
67	3 1/2"	36.3	35.9	33.0	31.9	29.5	32.0	34.3	36.3	37.0
68	3 1/2"	36.0	35.6	35.2	32.3	31.7	32.2	34.5	36.4	36.5
69	3 1/2"	36.9	35.5	33.5	32.3	31.6	32.6	33.2	33.8	36.9
70	3 1/2"	36.2	35.6	34.6	33.2	32.7	34.2	35.4	36.2	36.4

PWS Rod	Diam.	Hardness Readings for "E" Line PWS Rods								
		1	2	3	4	5	6	7	8	9
71	3 1/2"	35.8	34.8	32.9	30.9	29.6	31.8	33.5	36.0	36.6
72	3 1/2"	-	-	-	-	-	-	-	-	-
73	3 1/2"	35.0	35.3	33.0	31.1	31.4	33.5	33.3	34.7	36.1
74	3 1/2"	37.7	37.5	35.8	32.7	31.6	30.9	32.3	35.6	34.7
75	3 1/2"	-	-	-	-	-	-	-	-	-
76	3 1/2"	37.3	35.9	35.6	31.0	31.6	33.2	34.5	34.5	37.3
77	3 1/2"	36.6	35.0	34.6	34.3	33.4	34.4	35.0	35.9	36.9
78	3 1/2"	37.0	36.0	35.7	33.6	31.1	32.6	33.5	35.4	35.7
79	3 1/2"	36.9	35.1	34.3	32.3	32.0	33.3	33.3	35.9	37.0
80	3 1/2"	35.8	34.8	34.2	32.9	32.2	32.7	34.2	35.9	36.4
81	3 1/2"	36.5	35.2	33.9	32.5	31.4	33.1	34.4	35.7	37.0
82	3 1/2"	36.0	35.2	34.4	34.4	33.7	35.5	35.6	35.6	36.0
83	3 1/2"	35.5	33.6	33.0	32.6	32.1	32.2	33.9	34.2	36.6
84	3 1/2"	-	-	-	-	-	-	-	-	-
85	3 1/2"	35.5	34.7	33.8	32.2	31.0	32.9	33.6	35.0	35.4
86	3 1/2"	36.3	34.5	33.4	32.6	30.6	32.5	34.4	35.3	37.8
87	3 1/2"	36.4	35.0	34.7	33.9	30.8	33.1	34.1	35.1	36.0
88	3 1/2"	-	-	-	-	-	-	-	-	-
89	3 1/2"	35.5	32.8	32.0	31.8	29.6	32.2	32.3	32.7	35.8
90	3 1/2"	-	-	-	-	-	-	-	-	-
91	3 1/2"	36.1	34.9	33.6	32.5	31.9	33.7	34.3	35.5	35.7
92	3 1/2"	-	-	-	-	-	-	-	-	-
93	3 1/2"	-	-	-	-	-	-	-	-	-
94	3 1/2"	36.4	36.4	34.4	33.1	31.9	33.8	35.0	35.7	36.8
95	3 1/2"	35.7	35.1	33.9	31.6	31.6	32.2	33.0	35.0	35.9
96	3 1/2"	-	-	-	-	-	-	-	-	-
97	3 1/2"	37.2	36.2	35.1	33.8	31.0	32.8	33.7	35.5	35.9
98	3 1/2"	36.5	34.4	31.3	31.3	29.6	30.7	31.5	32.1	33.7
99	3 1/2"	37.0	36.5	35.3	31.8	31.9	33.0	34.1	35.7	36.2
100	3 1/2"	36.5	34.1	32.4	31.7	30.7	33.2	32.5	34.1	36.2
101	3 1/2"	36.7	35.9	34.9	33.1	33.0	33.7	35.3	36.1	37.1
102	3 1/2"	-	-	-	-	-	-	-	-	-
103	3 1/2"	36.8	35.4	34.4	32.0	31.0	32.3	34.2	36.0	36.2
104	3 1/2"	33.7	33.5	31.1	31.1	29.7	31.7	32.0	32.5	33.8
105	3 1/2"	36.5	33.7	32.8	32.2	32.1	32.2	34.9	34.8	35.8
106	3 1/2"	-	-	-	-	-	-	-	-	-
107	3 1/2"	36.1	35.7	34.0	33.2	31.5	33.6	34.9	35.3	35.5
108	3 1/2"	-	-	-	-	-	-	-	-	-
109	3 1/2"	36.1	35.0	34.6	33.7	33.7	33.5	35.0	35.1	36.3
110	3 1/2"	-	-	-	-	-	-	-	-	-
111	3 1/2"	-	-	-	-	-	-	-	-	-
112	3 1/2"	36.1	34.1	33.6	32.8	30.8	31.6	33.0	34.4	35.6
113	3 1/2"	36.8	35.4	34.6	32.3	31.3	33.4	34.1	36.1	36.6
114	3 1/2"	37.1	36.2	35.3	33.4	31.1	32.0	34.7	36.6	36.9
115	3 1/2"	35.5	34.9	34.4	33.3	33.0	34.1	34.7	35.9	36.6
116	3 1/2"	-	-	-	-	-	-	-	-	-
117	3 1/2"	-	-	-	-	-	-	-	-	-
118	3 1/2"	-	-	-	-	-	-	-	-	-
119	3 1/2"	35.7	34.2	33.3	31.3	29.2	32.9	33.9	34.0	36.0
120	3 1/2"	35.8	33.8	32.8	30.9	31.7	31.8	31.8	33.6	34.8
121	3 1/2"	-	-	-	-	-	-	-	-	-
122	3 1/2"	36.2	35.0	34.3	32.7	31.3	33.8	34.2	34.1	35.4
123	3 1/2"	36.5	33.7	32.0	30.7	30.0	30.6	32.7	33.6	36.9
124	3 1/2"	-	-	-	-	-	-	-	-	-
125	3 1/2"	36.7	35.4	33.7	31.5	30.8	31.1	32.0	33.9	34.7
126	3 1/2"	36.9	34.2	33.5	32.1	30.8	32.4	33.5	33.9	35.3
127	3 1/2"	-	-	-	-	-	-	-	-	-
128	3 1/2"	33.6	33.3	32.2	31.9	30.2	31.1	31.4	32.9	35.0
129	3 1/2"	35.9	35.3	34.3	33.2	31.9	33.0	34.4	35.2	35.6
130	3 1/2"	-	-	-	-	-	-	-	-	-
131	3 1/2"	36.9	36.4	35.3	34.3	33.5	34.7	35.3	35.4	36.8
132	3 1/2"	36.7	34.8	34.3	32.2	31.5	33.5	34.4	35.4	35.1
133	3 1/2"	36.1	35.4	33.3	31.0	30.6	31.1	32.0	32.4	33.0
134	3 1/2"	37.2	33.8	32.5	32.4	31.6	32.2	34.1	36.5	36.0
135	3 1/2"	-	-	-	-	-	-	-	-	-
136	3 1/2"	34.0	32.9	31.6	31.3	31.2	31.8	33.1	35.7	35.6
137	3 1/2"	35.2	33.1	32.4	32.0	31.3	30.8	31.6	32.6	34.0
AVERAGES		36.1	35.0	33.9	32.6	31.4	32.7	33.9	34.9	36.0

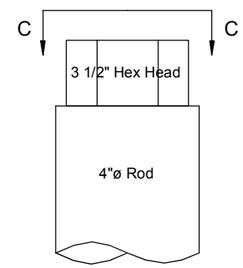
Field Average Hardness: 34.0 HRC
Average Hardness Readings from 2011 MTR's: 35.5 HRC

MEASUREMENT LOGISTICS:

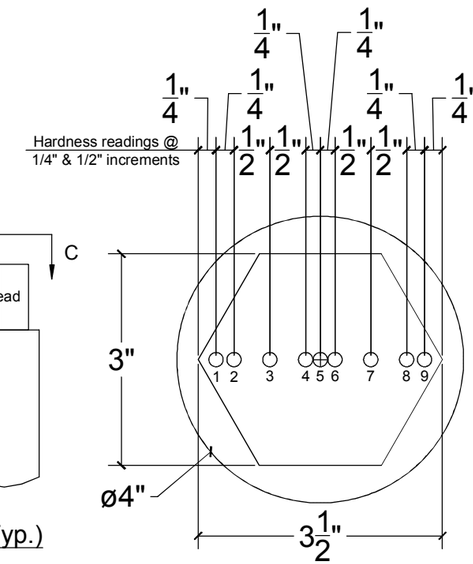
1) Recorded ambient temperature (Deg. F): 64 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard



ELEVATION
NTS



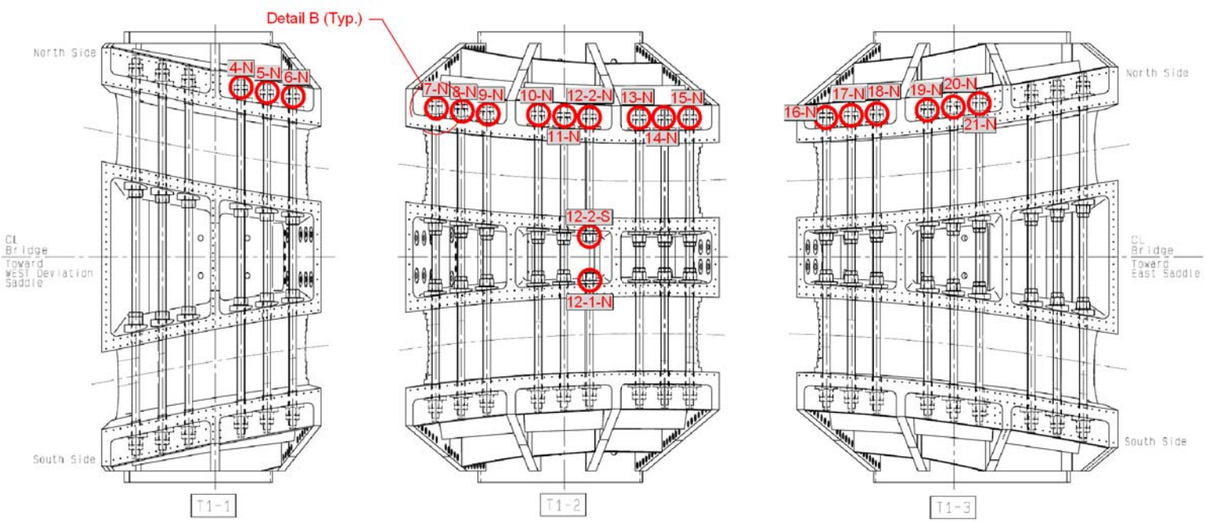
Detail B (Typ.)
NTS



View C-C (Typ.)
NTS

Tie Rod	Diameter	Hardness Readings for 3 1/2" Ø Tower Saddle Tie Rods								
		1	2	3	4	5	6	7	8	9
4-N	3 1/2"	36.6	34.7	34.4	33.6	33.2	33.2	34.7	35.2	36.1
5-N	3 1/2"	36.9	36.3	35.2	34.3	31.6	32.5	33.9	34.6	35.2
6-N	3 1/2"	36.4	35.1	34.8	33.3	33.3	34.6	35.9	36.1	37.1
7-N	3 1/2"	36.4	35.5	34.3	33.6	33.5	33.3	33.4	34.4	35.0
8-N	3 1/2"	36.0	35.4	34.6	33.7	32.6	33.9	34.4	34.4	36.4
9-N	3 1/2"	37.3	36.3	34.9	33.3	33.3	34.5	35.6	35.9	36.2
10N	3 1/2"	36.5	35.3	35.1	33.6	32.5	34.4	35.9	36.2	36.6
11N	3 1/2"	36.6	35.4	35.2	34.7	33.2	33.8	34.7	35.6	35.6
12-1-N	3 1/2"	36.8	36.1	35.2	34.3	32.2	33.3	33.7	36.0	37.1
12-2-N	3 1/2"	37.5	36.7	35.5	34.1	32.9	33.0	33.0	35.1	35.4
12-2-S	3 1/2"	36.3	35.8	33.9	33.7	33.8	34.9	35.6	35.6	36.6
13-N	3 1/2"	37.3	36.4	34.3	34.0	30.2	32.9	34.2	34.5	35.6
14-N	3 1/2"	36.6	35.3	33.3	32.6	31.7	33.8	33.9	35.5	35.5
15-N	3 1/2"	36.0	34.4	34.2	33.2	32.9	33.8	35.2	36.2	37.4
16-N	3 1/2"	36.6	36.0	34.4	32.9	32.0	34.0	34.6	35.0	36.4
17-N	3 1/2"	36.4	35.2	35.4	34.0	33.2	34.5	35.1	35.0	36.7
18-N	3 1/2"	37.5	35.1	34.6	33.4	31.4	32.2	34.3	35.7	36.4
19-N	3 1/2"	35.5	34.4	33.8	33.0	32.7	33.6	33.7	35.4	35.8
20-N	3 1/2"	36.3	35.2	35.2	32.4	32.4	34.9	35.6	35.8	37.6
21-N	3 1/2"	36.7	35.2	33.9	33.9	32.5	34.8	35.6	35.8	36.5
Averages		36.6	35.5	34.6	33.6	32.6	33.7	34.6	35.5	36.2

Overall Average for Tower Saddle Tie Rods = 34.8
Average Hardness Readings from 2010 QC Reports: 35.0 HRC



TOP VIEW A-A
NTS

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

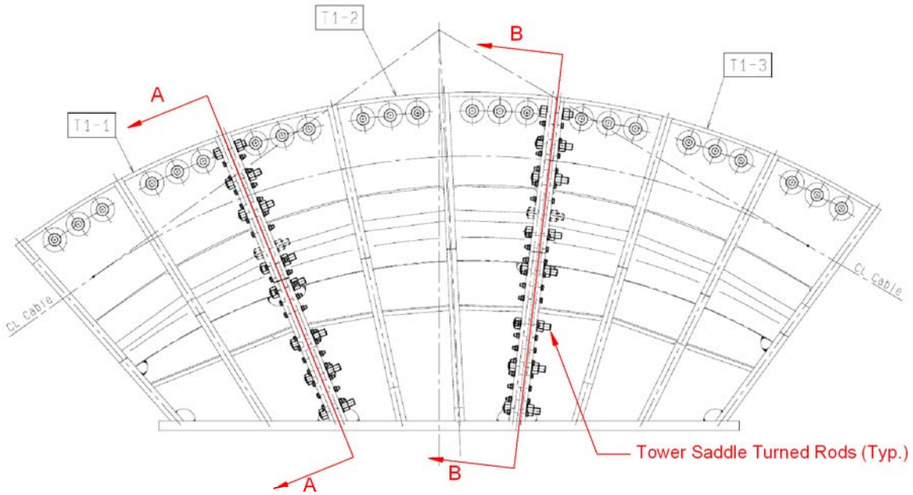
GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

MEASUREMENT LOGISTICS:

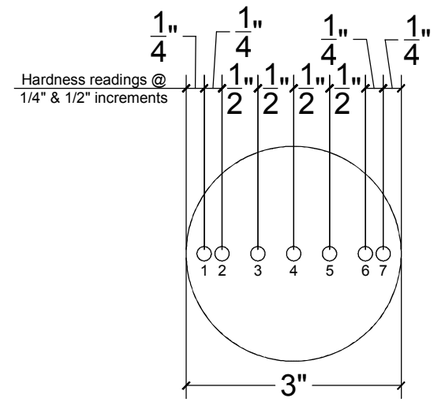
1) Recorded ambient temperature (Deg. F): 61 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			Tower Saddle Tie Rods Hardness Readings			
			Drawn By:	MH	SHEET NUMBER	8-I
			Date:	6/11/2013		



ELEVATION

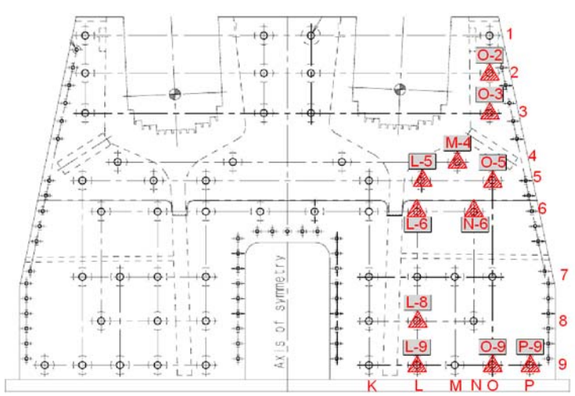
NTS



SECTION C (TYP.)

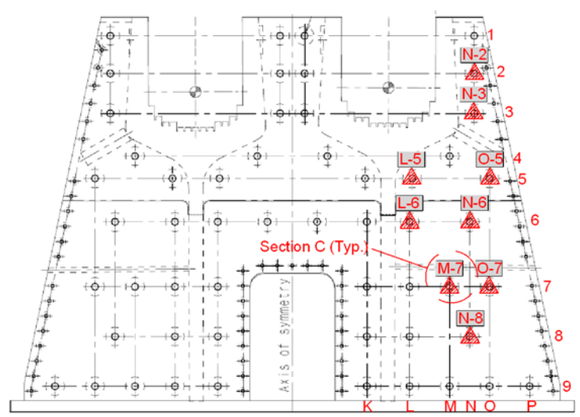
Saddle Splices	Turned Rod	Heat	Diameter	Hardness Readings for 3" Ø Rods						
				1	2	3	4	5	6	7
T1-T2	L5	NNF	3"	36.0	35.0	33.9	32.4	33.5	34.9	35.7
	L6	NNF	3"	36.9	35.4	33.7	31.6	32.6	34.0	34.8
	L8	NNF	3"	37.0	36.4	34.6	33.8	34.6	36.4	37.3
	L9	NNF	3"	35.9	34.9	34.0	33.6	34.6	35.2	36.5
	M4	NNF	3"	36.4	35.4	33.8	32.6	34.5	35.5	36.5
	N6	NNF	3"	35.7	33.3	32.5	31.4	33.7	35.9	36.2
	O2	NTA	3"	36.1	35.6	34.2	33.5	33.8	35.0	36.4
	O3	NNF	3"	37.6	36.2	35.5	34.7	35.9	36.2	36.9
	O5	NNF	3"	36.2	34.8	33.2	32.8	34.0	35.6	36.1
	O9	NNF	3"	36.8	35.9	34.2	33.3	34.0	35.7	35.0
	P9	NNF	3"	36.7	35.5	34.8	33.4	33.9	34.7	35.0
T2-T3	L5	NNF	3"	36.2	35.7	34.3	31.8	33.9	34.5	36.2
	L6	NNF	3"	36.6	35.7	33.2	31.3	33.4	35.9	36.2
	M7	NNF	3"	36.2	35.8	34.7	33.1	34.5	35.0	36.2
	N2	NTA	3"	35.0	34.2	33.4	31.8	32.9	35.8	35.7
	N3	NNF	3"	36.4	35.3	34.9	32.1	34.5	34.6	35.7
	N6	NNF	3"	36.7	34.4	33.9	33.2	34.8	35.4	36.8
	N8	NTA	3"	35.6	34.4	33.8	33.2	34.0	35.8	35.9
	O5	NNF	3"	36.9	35.4	34.5	33.5	34.8	35.4	35.8
	O7	NNF	3"	36.2	34.4	33.9	32.9	33.0	35.7	36.2
Averages				36.4	35.2	34.1	32.8	34.0	35.4	36.1

Field Average Hardness: 34.8 HRC
Average Hardness Readings from 2010 QC Reports: 35.1 HRC



SECTION A-A

NTS



SECTION B-B

NTS

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

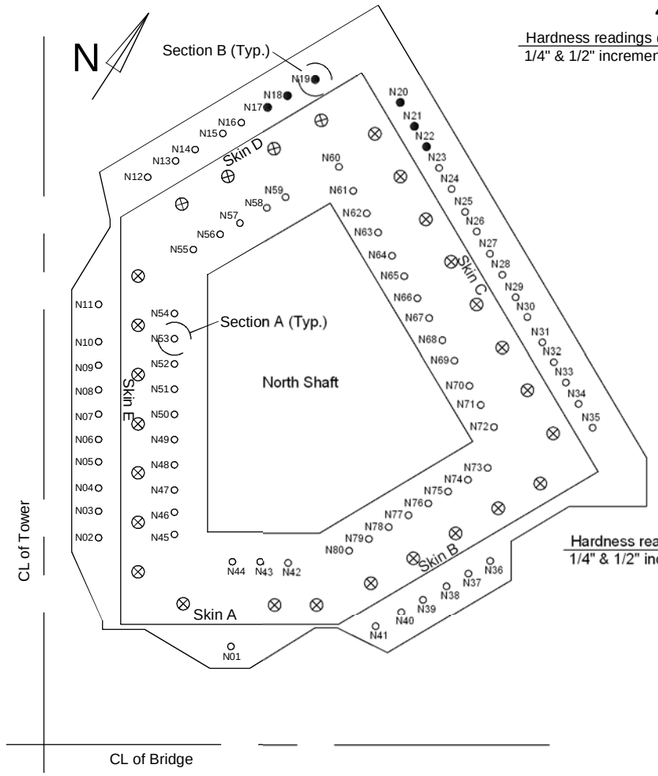
GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

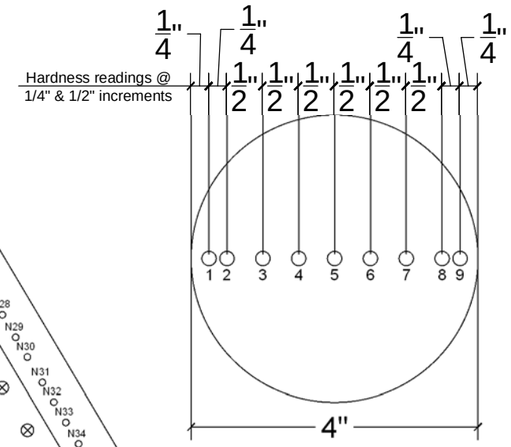
MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 65 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

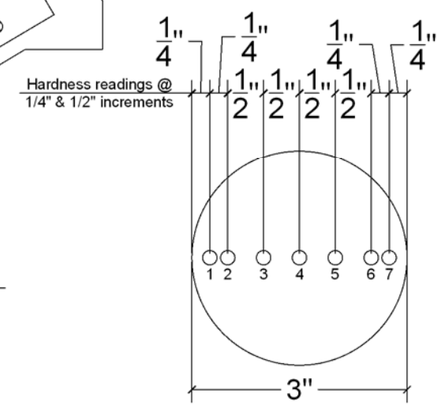
Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			Tower Saddle Turned Rods Hardness Readings			
			Drawn By:	MH	SHEET NUMBER	9-I
			Date:	6/10/2013		



PLAN VIEW
NTS



SECTION B (TYP.)



SECTION A (TYP.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Anchor Rod	Diameter	Hardness Readings for 3" Ø Rods						
		1	2	3	4	5	6	7
N01	3"	36.2	34.9	33.9	32.9	33.1	34.5	35.8
N02	3"	36.1	35.4	33.8	31.6	32.7	33.3	35.3
N03	3"	-	-	-	-	-	-	-
N04	3"	35.9	34.9	32.6	30.7	32.2	33.3	36.5
N05	3"	-	-	-	-	-	-	-
N06	3"	36.1	34.0	33.0	30.9	32.1	33.6	35.0
N07	3"	-	-	-	-	-	-	-
N08	3"	36.6	33.3	33.2	31.4	32.3	33.2	35.2
N09	3"	35.8	33.8	32.7	31.5	32.4	34.6	35.1
N10	3"	-	-	-	-	-	-	-
N11	3"	35.5	33.5	31.6	30.6	31.7	32.9	34.1
N12	3"	36.9	35.1	34.7	31.2	34.8	35.6	36.2
N13	3"	36.5	35.4	34.2	33.7	34.2	34.5	37.0
N14	3"	-	-	-	-	-	-	-
N15	3"	37.0	36.4	35.3	31.7	35.0	35.9	36.3
N16	3"	-	-	-	-	-	-	-
N23	3"	36.8	36.0	35.8	31.7	32.7	34.3	36.4
N24	3"	-	-	-	-	-	-	-
N25	3"	36.9	35.0	34.2	31.7	33.6	34.4	35.9
N26	3"	-	-	-	-	-	-	-
N27	3"	36.8	34.8	34.3	32.4	34.5	35.3	36.4
N28	3"	-	-	-	-	-	-	-
N29	3"	36.8	36.3	35.4	34.2	35.8	36.2	36.8
N30	3"	-	-	-	-	-	-	-
N31	3"	36.4	36.1	35.5	34.4	34.6	35.0	36.8
N32	3"	-	-	-	-	-	-	-
N33	3"	36.6	35.8	34.6	31.8	33.1	35.7	37.4
N34	3"	-	-	-	-	-	-	-
N35	3"	36.3	35.4	35.1	34.5	34.7	36.5	36.6
N36	3"	-	-	-	-	-	-	-
N37	3"	36.5	35.1	34.4	31.4	33.1	33.8	36.1
N38	3"	35.6	34.2	33.7	32.2	35.0	35.4	36.2
N39	3"	36.6	34.2	32.7	33.0	34.9	35.2	36.5
N40	3"	-	-	-	-	-	-	-
N41	3"	34.8	34.0	34.5	33.0	32.2	32.9	35.5
N42	3"	-	-	-	-	-	-	-
N43	3"	36.2	34.1	32.8	31.3	32.7	33.2	35.3

Anchor Rod	Diameter	Hardness Readings for 3" Ø Rods						
		1	2	3	4	5	6	7
N44	3"	36.9	35.2	33.9	33.3	34.3	35.4	36.4
N45	3"	36.6	36.4	34.4	33.9	34.6	34.9	36.2
N46	3"	-	-	-	-	-	-	-
N47	3"	35.9	35.3	34.4	32.5	33.7	34.2	36.0
N48	3"	-	-	-	-	-	-	-
N49	3"	36.8	34.2	33.2	31.9	34.6	35.0	35.9
N50	3"	-	-	-	-	-	-	-
N51	3"	36.9	35.8	33.7	32.9	33.8	34.2	36.1
N52	3"	36.8	36.4	35.1	33.2	34.6	35.4	36.7
N53	3"	-	-	-	-	-	-	-
N54	3"	36.8	36.6	34.8	32.7	33.7	35.8	37.5
N55	3"	36.1	34.3	33.4	33.1	34.4	35.1	36.1
N56	3"	-	-	-	-	-	-	-
N57	3"	36.8	34.8	33.3	30.0	32.9	33.3	35.9
N58	3"	-	-	-	-	-	-	-
N59	3"	36.6	34.5	33.5	31.7	32.0	34.0	34.9
N60	3"	-	-	-	-	-	-	-
N61	3"	36.1	34.6	32.8	31.7	31.8	34.0	35.7
N62	3"	-	-	-	-	-	-	-
N63	3"	36.6	35.9	34.1	30.4	33.9	34.8	36.7
N64	3"	-	-	-	-	-	-	-
N65	3"	36.5	35.4	33.5	30.1	32.4	33.0	35.4
N66	3"	-	-	-	-	-	-	-
N67	3"	35.8	34.1	33.7	30.9	33.9	34.7	36.4
N68	3"	-	-	-	-	-	-	-
N69	3"	36.6	34.6	34.3	32.0	35.0	35.7	36.4
N70	3"	37.1	35.5	35.1	34.7	34.8	35.3	36.6
N71	3"	-	-	-	-	-	-	-
N72	3"	36.1	35.8	35.4	32.0	34.1	35.7	36.2
N73	3"	36.4	35.1	34.1	31.3	33.5	35.4	36.9
N74	3"	-	-	-	-	-	-	-
N75	3"	36.3	35.9	34.1	31.3	33.8	34.8	36.8
N76	3"	-	-	-	-	-	-	-
N77	3"	36.6	35.5	33.7	30.7	33.6	35.4	35.8
N78	3"	-	-	-	-	-	-	-
N79	3"	36.2	35.5	34.9	32.2	34.4	35.0	36.3
N80	3"	36.8	36.4	35.9	34.4	35.4	36.1	36.4
Averages		36.4	35.1	34.1	32.2	33.7	34.7	36.1

Field Average for 3"ø Rods: 34.6 HRC
Average Hardness Readings from 2006 MTR's: 33.8 HRC

LEGEND:

- ● 4" diameter rod
- ○ 3" diameter rod
- ⊗ Dowel

Anchor Rod	Diameter	Hardness Readings for 4" Ø Rods								
		1	2	3	4	5	6	7	8	9
N17	4"	36.9	36.4	35.2	34.0	34.0	35.1	36.0	36.4	38.1
N18	4"	36.9	36.3	35.3	33.7	31.1	34.8	35.0	36.7	37.7
N19	4"	37.2	36.7	36.2	35.2	33.9	35.4	35.9	36.1	36.1
N20	4"	37.4	36.8	34.4	34.4	32.3	35.7	35.9	36.0	37.1
N21	4"	37.7	36.2	35.4	33.9	33.0	34.7	35.2	35.5	36.8
N22	4"	37.3	35.0	34.6	34.2	33.4	35.1	35.0	36.7	36.7
Averages		37.2	36.2	35.2	34.2	33.0	35.1	35.5	36.2	37.1

Field Average Hardness for 4"ø Rods: 35.5 HRC
Average Hardness Readings from 2006 MTR's: 33.2 HRC

MEASUREMENT LOGISTICS:

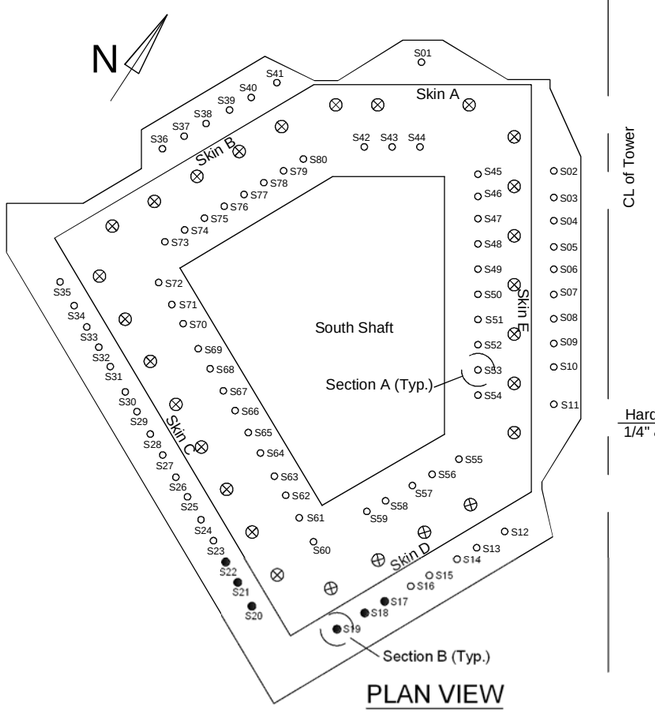
1) Recorded ambient temperature (Deg. F): 61 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

Revision No:	By:	Date:

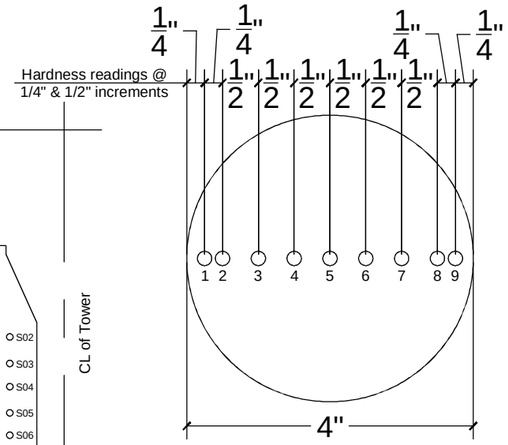
SELF-ANCHORED SUSPENSION BRIDGE

Tower Foundation Rods
Hardness Readings - North Shaft

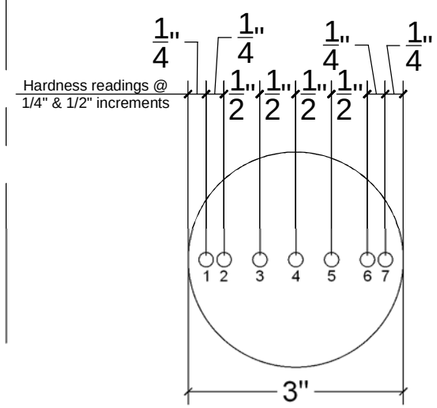
Drawn By:	MH	SHEET NUMBER	12/13-I-North
Date:	6/4/2013		



PLAN VIEW
NTS



SECTION B (TYP.)



SECTION A (TYP.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Anchor Rod	Diameter	Hardness Readings for 3" Ø Rods						
		1	2	3	4	5	6	7
S01	3"	36.6	35.7	33.6	32.9	33.9	35.1	36.2
S02	3"	36.7	35.0	33.8	31.2	33.6	35.1	36.9
S03	3"	36.4	35.9	33.2	30.2	31.2	33.3	34.8
S04	3"	-	-	-	-	-	-	-
S05	3"	36.6	35.4	34.4	33.1	34.8	35.3	36.9
S06	3"	-	-	-	-	-	-	-
S07	3"	36.9	35.2	34.1	30.2	32.9	35.4	35.7
S08	3"	-	-	-	-	-	-	-
S09	3"	36.7	35.7	34.5	31.6	34.7	35.4	36.1
S10	3"	-	-	-	-	-	-	-
S11	3"	35.7	34.6	33.7	30.7	32.7	34.2	35.5
S12	3"	36.3	35.8	34.0	33.0	33.4	35.5	35.9
S13	3"	-	-	-	-	-	-	-
S14	3"	35.5	35.1	33.9	31.5	35.0	35.7	37.3
S15	3"	-	-	-	-	-	-	-
S16	3"	37.3	35.9	33.5	34.9	35.5	37.1	37.4
S23	3"	37.3	35.3	34.6	31.7	33.8	34.5	36.6
S24	3"	-	-	-	-	-	-	-
S25	3"	37.6	35.9	33.9	33.0	35.1	36.6	37.0
S26	3"	-	-	-	-	-	-	-
S27	3"	36.8	35.9	35.7	34.4	35.2	35.8	37.0
S28	3"	-	-	-	-	-	-	-
S29	3"	36.9	35.7	34.8	33.1	33.4	35.1	35.3
S30	3"	-	-	-	-	-	-	-
S31	3"	37.0	35.7	35.3	33.1	33.6	35.0	36.1
S32	3"	-	-	-	-	-	-	-
S33	3"	36.2	35.9	35.0	32.0	34.7	35.8	37.1
S34	3"	-	-	-	-	-	-	-
S35	3"	36.1	35.3	32.4	33.3	35.3	35.8	36.8
S36	3"	-	-	-	-	-	-	-
S37	3"	35.9	35.2	34.5	33.4	35.0	35.5	36.1
S38	3"	35.9	35.0	33.4	32.0	33.3	34.2	35.4
S39	3"	35.3	34.6	33.1	32.8	33.0	34.5	36.2
S40	3"	-	-	-	-	-	-	-
S41	3"	36.0	35.0	34.2	32.9	33.2	33.7	35.8
S42	3"	36.3	35.8	33.7	32.4	34.4	34.8	36.3
S43	3"	35.7	35.1	33.5	33.1	33.2	34.9	36.1

Anchor Rod	Diameter	Hardness Readings for 3" Ø Rods						
		1	2	3	4	5	6	7
S44	3"	-	-	-	-	-	-	-
S45	3"	35.0	34.0	33.5	32.9	33.8	35.5	36.9
S46	3"	-	-	-	-	-	-	-
S47	3"	36.0	35.5	34.0	32.4	34.3	35.6	36.8
S48	3"	-	-	-	-	-	-	-
S49	3"	36.9	35.1	34.8	33.7	34.6	35.5	35.8
S50	3"	-	-	-	-	-	-	-
S51	3"	36.3	34.2	33.7	32.6	33.4	35.8	35.3
S52	3"	-	-	-	-	-	-	-
S53	3"	36.4	35.3	34.2	31.5	33.7	34.2	35.3
S54	3"	35.3	35.0	33.1	31.6	32.3	34.5	35.5
S55	3"	35.4	35.0	34.0	32.3	32.7	35.3	36.2
S56	3"	-	-	-	-	-	-	-
S57	3"	36.2	34.8	33.5	33.0	34.8	35.1	36.2
S58	3"	-	-	-	-	-	-	-
S59	3"	36.7	35.2	34.1	32.4	33.9	35.7	36.0
S60	3"	-	-	-	-	-	-	-
S61	3"	36.6	34.2	33.1	32.6	34.1	35.9	35.8
S62	3"	-	-	-	-	-	-	-
S63	3"	36.6	34.4	32.9	31.9	32.5	34.1	36.5
S64	3"	-	-	-	-	-	-	-
S65	3"	35.1	34.4	33.7	33.6	33.5	34.3	35.1
S66	3"	-	-	-	-	-	-	-
S67	3"	36.8	34.6	32.9	30.7	31.9	34.4	36.5
S68	3"	-	-	-	-	-	-	-
S69	3"	35.9	35.0	34.7	33.3	34.1	35.5	36.1
S70	3"	36.0	34.4	32.6	32.1	33.7	35.5	36.3
S71	3"	36.0	35.5	33.0	32.0	33.5	34.6	36.6
S72	3"	-	-	-	-	-	-	-
S73	3"	36.0	35.0	34.7	33.3	34.5	35.1	36.8
S74	3"	-	-	-	-	-	-	-
S75	3"	36.6	35.1	34.6	32.8	34.5	35.0	35.5
S76	3"	-	-	-	-	-	-	-
S77	3"	36.1	35.5	34.2	32.4	34.5	35.2	36.2
S78	3"	36.9	35.7	34.3	32.9	34.9	35.0	35.5
S79	3"	35.7	34.0	33.6	30.3	33.2	33.4	34.7
S80	3"	-	-	-	-	-	-	-
Averages		36.3	35.2	33.9	32.4	33.8	35.1	36.1

Field Average for 3"ø Rods: 34.7 HRC
Average Hardness Readings from 2006 MTR's: 33.8 HRC

LEGEND:

- ● 4" diameter rod
- ○ 3" diameter rod
- ⊗ Dowel

Anchor Rod	Diameter	Hardness Readings for 4" Ø Rods								
		1	2	3	4	5	6	7	8	9
S17	4"	37.4	36.6	34.6	33.9	32.7	35.0	35.7	37.3	37.6
S18	4"	37.2	35.9	35.0	32.6	31.7	34.2	35.6	36.5	36.1
S19	4"	36.3	35.3	34.6	33.4	34.6	32.8	35.8	36.1	36.6
S20	4"	36.6	34.4	33.7	32.0	31.8	34.8	35.4	35.6	36.0
S21	4"	38.3	37.0	36.5	35.2	34.1	35.3	36.2	36.4	37.1
S22	4"	37.5	35.7	35.1	33.1	32.6	35.5	35.6	36.9	37.4
Averages		37.2	35.8	34.9	33.4	32.9	34.6	35.7	36.5	36.8

Field Average Hardness for 4"ø Rods: 35.3 HRC
Average Hardness Readings from 2006 MTR's: 33.2 HRC

MEASUREMENT LOGISTICS:

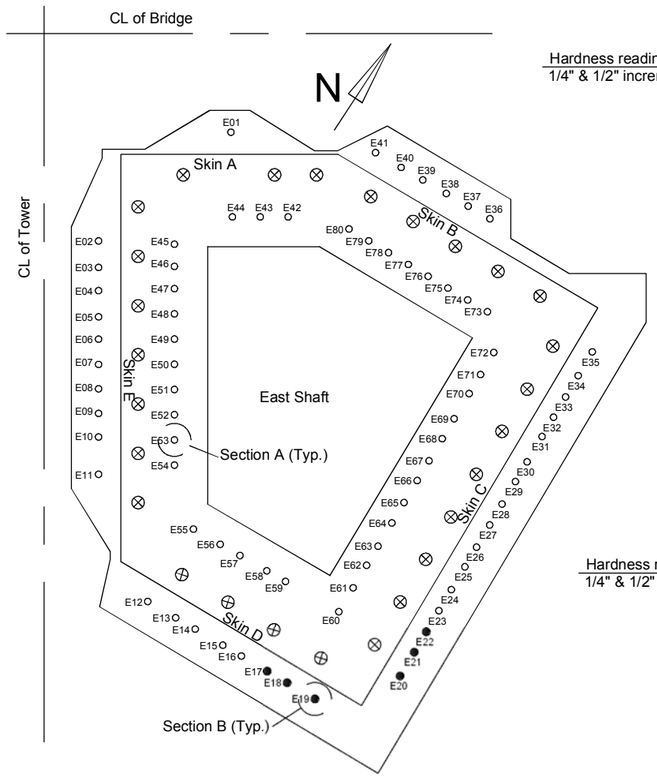
1) Recorded ambient temperature (Deg. F): 61 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

Revision No:	By:	Date:

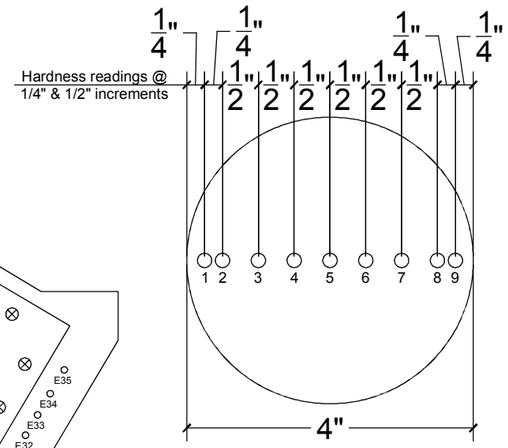
SELF-ANCHORED SUSPENSION BRIDGE

Tower Foundation Rods
Hardness Readings - South Shaft

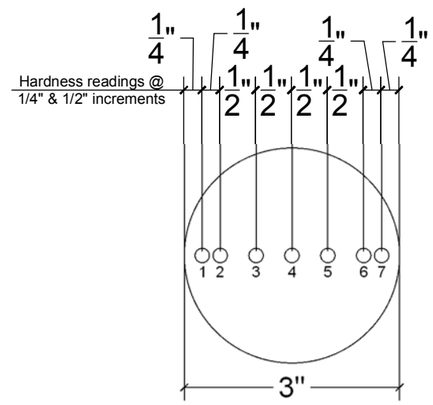
Drawn By:	MH	SHEET NUMBER	12/13-I-South
Date:	6/8/2013		



PLAN VIEW
NTS



SECTION B (TYP.)



SECTION A (TYP.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Anchor Rod	Diameter	Hardness Readings for 3" Ø Rods						
		1	2	3	4	5	6	7
E01	3"	36.0	35.2	34.6	33.3	33.9	34.6	35.4
E02	3"	36.2	35.5	33.4	32.2	33.8	34.9	36.3
E03	3"	35.0	33.6	34.0	32.0	32.1	33.6	35.7
E04	3"	-	-	-	-	-	-	-
E05	3"	35.0	34.5	32.2	32.0	33.6	34.4	35.0
E06	3"	-	-	-	-	-	-	-
E07	3"	-	-	-	-	-	-	-
E08	3"	35.2	33.5	32.6	33.2	34.8	35.5	36.2
E09	3"	36.6	35.1	34.6	33.0	34.1	35.0	35.5
E10	3"	-	-	-	-	-	-	-
E11	3"	35.8	34.9	33.6	30.6	33.6	34.8	35.3
E12	3"	36.6	34.8	33.0	31.7	34.5	35.8	36.1
E13	3"	-	-	-	-	-	-	-
E14	3"	35.9	34.3	33.7	31.7	33.1	35.5	36.5
E15	3"	-	-	-	-	-	-	-
E16	3"	36.9	35.5	34.4	32.0	33.5	35.6	36.1
E23	3"	-	-	-	-	-	-	-
E24	3"	36.1	35.9	35.7	32.6	34.6	35.1	36.0
E25	3"	-	-	-	-	-	-	-
E26	3"	36.4	36.3	35.8	31.6	33.7	35.1	35.5
E27	3"	-	-	-	-	-	-	-
E28	3"	36.5	35.9	33.0	31.4	31.7	33.3	35.9
E29	3"	-	-	-	-	-	-	-
E30	3"	37.3	36.3	35.0	33.3	34.6	35.9	36.9
E31	3"	-	-	-	-	-	-	-
E32	3"	36.4	35.1	33.5	32.5	35.0	35.8	36.1
E33	3"	-	-	-	-	-	-	-
E34	3"	35.1	33.6	33.4	33.1	34.8	35.9	36.3
E35	3"	36.8	35.1	34.6	34.4	35.0	35.1	36.0
E36	3"	36.1	34.3	33.9	30.7	32.0	34.4	35.0
E37	3"	36.4	36.1	35.5	32.8	32.9	33.6	36.5
E38	3"	-	-	-	-	-	-	-
E39	3"	37.0	36.0	34.9	33.7	34.0	35.5	36.9
E40	3"	-	-	-	-	-	-	-
E41	3"	37.2	35.3	35.0	31.7	32.3	34.1	35.4
E42	3"	36.6	34.2	32.7	32.6	34.5	34.9	36.6
E43	3"	-	-	-	-	-	-	-

Anchor Rod	Diameter	Hardness Readings for 3" Ø Rods						
		1	2	3	4	5	6	7
E44	3"	35.7	34.5	34.9	32.7	33.9	35.9	36.3
E45	3"	35.9	34.8	34.0	32.4	33.9	34.7	35.5
E46	3"	35.6	34.6	33.5	31.6	33.5	33.8	36.6
E47	3"	-	-	-	-	-	-	-
E48	3"	35.7	34.9	33.2	33.1	33.6	34.6	36.7
E49	3"	-	-	-	-	-	-	-
E50	3"	35.7	34.9	32.7	32.2	34.6	35.1	35.9
E51	3"	-	-	-	-	-	-	-
E52	3"	35.8	34.8	33.0	32.0	34.4	34.6	36.6
E53	3"	36.2	35.5	33.9	32.6	33.2	33.8	34.4
E54	3"	-	-	-	-	-	-	-
E55	3"	35.3	35.7	34.3	33.9	35.2	35.7	36.7
E56	3"	36.2	35.2	33.7	31.8	32.7	34.6	36.4
E57	3"	-	-	-	-	-	-	-
E58	3"	36.6	35.4	34.1	31.2	33.9	33.7	35.5
E59	3"	-	-	-	-	-	-	-
E60	3"	36.5	35.1	33.8	30.8	32.7	34.6	35.2
E61	3"	-	-	-	-	-	-	-
E62	3"	36.4	35.2	34.9	34.0	34.1	34.6	35.6
E63	3"	-	-	-	-	-	-	-
E64	3"	36.8	34.8	34.0	32.3	33.2	35.5	36.1
E65	3"	-	-	-	-	-	-	-
E66	3"	36.1	35.4	34.0	33.9	33.7	34.6	36.2
E67	3"	-	-	-	-	-	-	-
E68	3"	35.8	34.1	33.4	31.9	32.4	34.5	35.3
E69	3"	-	-	-	-	-	-	-
E70	3"	35.9	34.0	33.3	32.1	34.2	35.6	36.3
E71	3"	-	-	-	-	-	-	-
E72	3"	35.7	33.8	33.1	32.6	33.5	35.9	36.4
E73	3"	35.7	34.9	33.0	30.2	32.7	35.8	35.9
E74	3"	35.3	35.2	33.4	30.5	31.8	34.3	36.2
E75	3"	-	-	-	-	-	-	-
E76	3"	35.6	34.5	34.2	31.2	32.6	34.7	36.7
E77	3"	-	-	-	-	-	-	-
E78	3"	35.2	34.2	33.9	33.0	34.8	35.3	36.0
E79	3"	36.3	34.7	32.8	31.3	32.5	35.0	36.8
E80	3"	-	-	-	-	-	-	-
Averages		36.1	34.9	33.9	32.3	33.6	34.9	36.0

Field Average for 3"ø Rods: 34.5 HRC
Average Hardness Readings from 2006 MTR's: 33.8 HRC

LEGEND:

- ● 4" diameter rod
- ○ 3" diameter rod
- ⊗ Dowel

Anchor Rod	Diameter	Hardness Readings for 4" Ø Rods								
		1	2	3	4	5	6	7	8	9
E17	4"	37.8	36.7	36.4	34.5	33.1	33.8	34.6	34.8	35.6
E18	4"	37.8	36.2	35.1	34.7	31.8	34.4	35.6	36.8	37.2
E19	4"	37.7	36.5	36.5	36.1	32.7	35.7	36.4	37.0	37.3
E20	4"	37.1	36.9	35.3	34.3	30.0	32.4	33.0	35.3	35.7
E21	4"	36.9	35.4	33.8	32.2	32.5	34.8	35.6	36.8	37.3
E22	4"	36.9	35.2	34.4	33.1	30.8	32.2	34.1	35.9	36.3
Averages		37.4	36.2	35.3	34.2	31.8	33.9	34.9	36.1	36.6

Field Average Hardness for 4"ø Rods: 35.1 HRC
Average Hardness Readings from 2006 MTR's: 33.2 HRC

MEASUREMENT LOGISTICS:

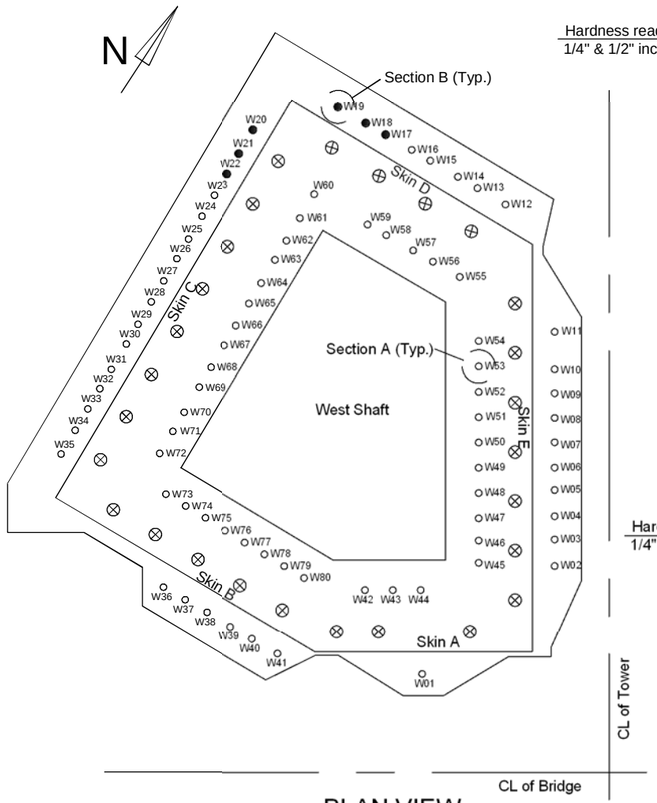
1) Recorded ambient temperature (Deg. F): 73 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

Revision No:	By:	Date:

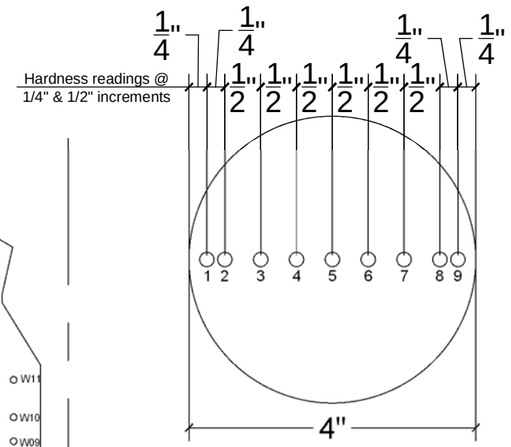
SELF-ANCHORED SUSPENSION BRIDGE

Tower Foundation Rods
Hardness Readings - East Shaft

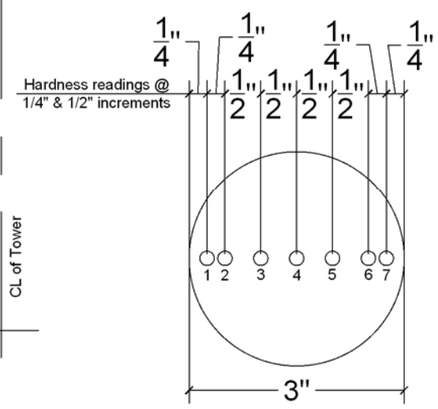
Drawn By:	MH	SHEET NUMBER	12/13-I-East
Date:	6/8/2013		



PLAN VIEW
NTS



SECTION B (TYP.)



SECTION A (TYP.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Anchor Rod	Diameter	Hardness Readings for 3" Ø Rods						
		1	2	3	4	5	6	7
W01	3"	36.2	34.0	32.8	31.1	32.4	34.2	35.7
W02	3"	36.3	34.7	33.2	31.4	32.2	34.2	35.9
W03	3"	36.0	34.6	33.8	31.9	33.7	34.3	35.1
W04	3"	-	-	-	-	-	-	-
W05	3"	35.8	34.3	32.5	31.5	32.9	33.9	35.7
W06	3"	-	-	-	-	-	-	-
W07	3"	36.4	34.8	32.7	31.3	32.3	33.1	36.4
W08	3"	-	-	-	-	-	-	-
W09	3"	36.1	35.3	33.3	31.4	32.0	33.3	34.8
W10	3"	-	-	-	-	-	-	-
W11	3"	36.1	35.5	34.1	32.1	33.3	34.1	35.5
W12	3"	-	-	-	-	-	-	-
W13	3"	36.2	34.4	32.2	31.6	33.3	35.3	36.8
W14	3"	36.0	35.7	35.5	32.1	33.4	35.4	36.5
W15	3"	-	-	-	-	-	-	-
W16	3"	36.9	34.9	33.8	31.8	33.9	35.4	37.3
W23	3"	-	-	-	-	-	-	-
W24	3"	37.3	35.0	33.9	29.7	34.4	34.6	36.4
W25	3"	-	-	-	-	-	-	-
W26	3"	36.6	35.2	34.8	31.8	33.3	35.4	36.4
W27	3"	-	-	-	-	-	-	-
W28	3"	38.1	35.3	34.0	33.4	35.8	36.3	36.9
W29	3"	-	-	-	-	-	-	-
W30	3"	37.3	36.8	35.0	33.2	34.4	36.4	37.6
W31	3"	-	-	-	-	-	-	-
W32	3"	37.8	36.7	35.7	34.1	36.0	36.9	37.5
W33	3"	-	-	-	-	-	-	-
W34	3"	38.4	37.0	34.5	34.2	34.3	35.5	36.6
W35	3"	37.3	36.6	34.8	31.3	34.5	36.4	36.2
W36	3"	-	-	-	-	-	-	-
W37	3"	36.6	34.7	33.4	33.4	35.4	35.8	36.2
W38	3"	35.9	34.5	33.4	33.3	34.6	35.8	36.6
W39	3"	35.9	34.5	33.6	31.0	33.3	35.0	35.3
W40	3"	-	-	-	-	-	-	-
W41	3"	36.1	35.3	33.8	33.7	34.6	35.6	35.5
W42	3"	36.2	35.3	34.3	32.7	34.3	35.7	36.5
W43	3"	-	-	-	-	-	-	-

Anchor Rod	Diameter	Hardness Readings for 3" Ø Rods						
		1	2	3	4	5	6	7
W44	3"	35.5	34.9	33.6	31.1	33.1	34.7	36.5
W45	3"	36.2	34.6	32.1	31.5	33.7	35.1	36.3
W46	3"	-	-	-	-	-	-	-
W47	3"	37.1	35.4	33.4	32.9	34.3	35.3	35.7
W48	3"	-	-	-	-	-	-	-
W49	3"	38.4	37.4	33.4	32.7	34.0	35.2	36.6
W50	3"	-	-	-	-	-	-	-
W51	3"	36.1	35.3	32.9	31.5	32.9	34.1	35.9
W52	3"	-	-	-	-	-	-	-
W53	3"	37.1	36.3	34.8	33.4	34.2	35.3	36.8
W54	3"	37.8	36.1	35.9	34.9	35.6	36.2	37.3
W55	3"	37.4	36.4	35.9	31.3	32.5	35.1	36.8
W56	3"	-	-	-	-	-	-	-
W57	3"	36.1	34.8	32.8	31.7	34.4	35.0	37.1
W58	3"	-	-	-	-	-	-	-
W59	3"	-	-	-	-	-	-	-
W60	3"	-	-	-	-	-	-	-
W61	3"	35.6	34.3	33.3	31.4	32.0	34.9	35.6
W62	3"	-	-	-	-	-	-	-
W63	3"	37.8	36.3	33.7	32.4	33.7	34.5	37.6
W64	3"	-	-	-	-	-	-	-
W65	3"	37.5	35.7	34.6	33.7	33.8	34.3	35.5
W66	3"	-	-	-	-	-	-	-
W67	3"	36.6	34.1	33.7	32.6	33.1	34.3	36.2
W68	3"	-	-	-	-	-	-	-
W69	3"	36.8	35.9	34.1	31.8	32.9	33.5	35.2
W70	3"	36.2	35.6	34.5	32.8	33.6	34.8	35.3
W71	3"	-	-	-	-	-	-	-
W72	3"	37.0	36.2	34.8	32.3	35.2	35.8	36.6
W73	3"	36.8	36.0	34.8	31.3	33.5	34.8	35.8
W74	3"	-	-	-	-	-	-	-
W75	3"	35.7	34.0	33.5	31.7	32.9	33.2	35.3
W76	3"	-	-	-	-	-	-	-
W77	3"	36.6	35.6	34.3	31.0	32.5	33.5	35.7
W78	3"	-	-	-	-	-	-	-
W79	3"	37.0	36.2	35.2	32.0	35.2	35.9	37.1
W80	3"	36.6	34.3	34.2	32.4	32.7	34.6	36.6
Averages		36.7	35.4	34.0	32.2	33.7	34.9	36.3

Field Average for 3"ø Rods: 34.7 HRC
Average Hardness Readings from 2006 MTR's: 33.8 HRC

LEGEND:

- ● 4" diameter rod
- ○ 3" diameter rod
- ⊗ Dowel

Anchor Rod	Diameter	Hardness Readings for 4" Ø Rods								
		1	2	3	4	5	6	7	8	9
W17	4"	37.6	36.6	36.0	34.8	31.5	34.4	34.6	36.9	37.9
W18	4"	37.3	36.2	35.1	34.9	31.4	32.2	34.0	35.6	37.7
W19	4"	38.4	36.9	35.8	35.4	32.5	34.8	35.9	37.0	37.7
W20	4"	38.0	37.4	36.9	35.6	33.4	34.6	36.7	36.8	37.6
W21	4"	38.0	35.6	33.9	33.6	33.5	35.2	35.6	37.0	37.2
W22	4"	36.7	35.5	34.5	33.3	33.1	34.5	34.8	36.0	37.5
Averages		37.7	36.4	35.4	34.6	32.6	34.3	35.3	36.6	37.6

Field Average Hardness for 4"ø Rods: 35.6 HRC
Average Hardness Readings from 2006 MTR's: 33.2 HRC

MEASUREMENT LOGISTICS:

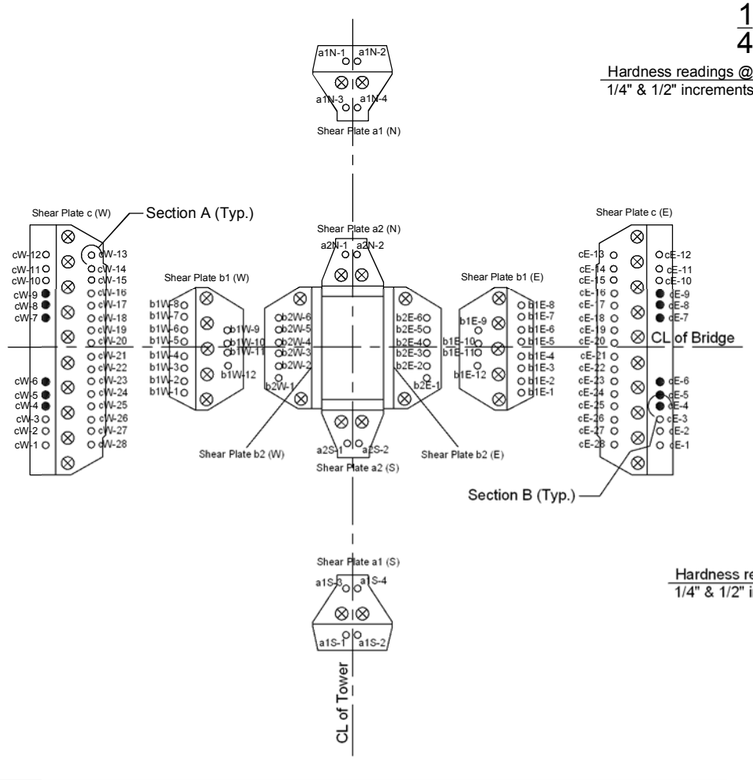
1) Recorded ambient temperature (Deg. F): 61 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

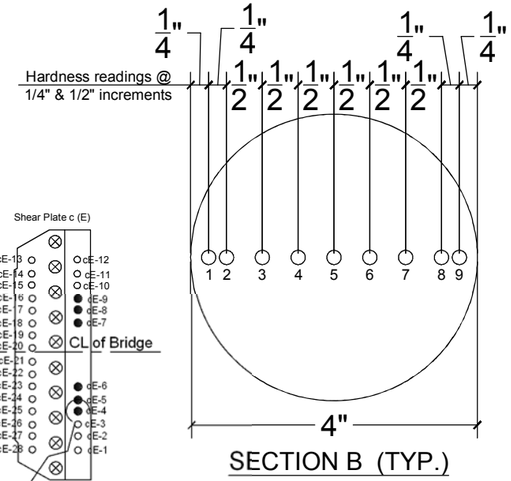
Revision No:	By:	Date:

SELF-ANCHORED SUSPENSION BRIDGE

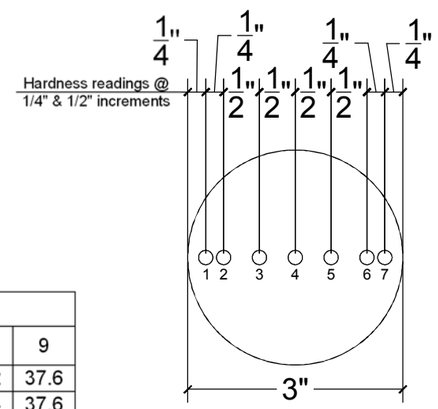
Tower Foundation Rods
Hardness Readings - West Shaft

Drawn By:	MH	SHEET NUMBER	12/13-I-West
Date:	6/8/2013		





SECTION B (TYP.)



SECTION A (TYP.)

Anchor Rod	Diameter	Hardness Readings for 4" Ø Rods								
		1	2	3	4	5	6	7	8	9
cE-4	4"	36.3	35.3	33.8	32.4	31.4	32.9	34.9	36.2	37.6
cE-5	4"	37.3	35.4	33.9	33.7	32.2	34.2	34.5	36.4	37.6
cE-6	4"	37.3	36.6	35.1	35.0	33.7	34.6	34.8	36.5	37.8
cE-7	4"	36.7	35.5	34.6	32.9	31.4	33.8	35.4	36.6	36.8
cE-8	4"	36.2	35.3	34.5	33.5	32.5	35.7	36.2	36.6	37.0
cE-9	4"	36.2	35.3	33.6	32.6	31.1	33.8	35.3	36.5	37.0
cW-4	4"	36.4	35.9	35.0	34.1	33.2	34.4	35.6	36.4	36.6
cW-5	4"	37.1	36.8	35.8	34.9	32.0	34.6	35.0	35.3	36.1
cW-6	4"	36.6	36.2	35.0	34.9	32.8	34.6	35.5	36.0	36.4
cW-7	4"	37.8	36.2	35.9	34.5	33.4	34.2	35.2	36.4	36.6
cW-8	4"	36.5	35.8	35.5	34.8	32.6	34.6	35.3	36.1	37.4
cW-9	4"	36.7	36.4	35.1	33.2	32.6	34.3	35.2	36.7	37.3
Averages		36.8	35.9	34.8	33.9	32.4	34.3	35.2	36.3	37.0

Field Average Hardness for 3"ø Rods: 34.6 HRC
Average Hardness Reading for 2006 MTR's: 33.8 HRC

Field Average Hardness for 4"ø Rods: 35.2 HRC
Average Hardness Reading for 2006 MTR's: 33.2 HRC

LEGEND:
- ● 4" diameter rod
- ○ 3" diameter rod
- ⊗ Dowel

MEASUREMENT LOGISTICS:
1) Recorded ambient temperature (Deg. F): 66 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

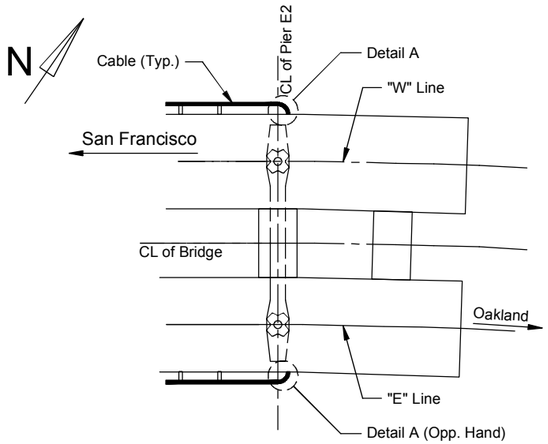
Anchor Rod	Diameter	Hardness Readings for 3" Ø Rods						
		1	2	3	4	5	6	7
a1N-1	3"	-	-	-	-	-	-	-
a1N-2	3"	36.3	36.0	34.5	33.1	34.6	35.5	36.1
a1N-3	3"	-	-	-	-	-	-	-
a1N-4	3"	36.2	34.3	32.9	31.7	32.8	33.3	35.7
a2N-1	3"	-	-	-	-	-	-	-
a2N-2	3"	36.6	35.7	34.3	31.6	33.2	33.1	36.2
a1S-1	3"	38.0	35.3	34.6	34.4	35.0	35.5	38.7
a1S-2	3"	-	-	-	-	-	-	-
a1S-3	3"	-	-	-	-	-	-	-
a1S-4	3"	35.7	34.8	33.6	31.9	33.2	34.2	36.2
a2S-1	3"	-	-	-	-	-	-	-
a2S-2	3"	35.8	34.2	33.1	31.4	34.9	35.6	36.0
b1E-1	3"	37.2	36.3	34.9	33.8	33.1	35.1	36.6
b1E-2	3"	-	-	-	-	-	-	-
b1E-3	3"	36.2	34.7	34.4	31.7	33.2	33.6	35.5
b1E-4	3"	-	-	-	-	-	-	-
b1E-5	3"	36.4	35.0	34.3	32.8	34.1	32.2	34.4
b1E-6	3"	-	-	-	-	-	-	-
b1E-7	3"	-	-	-	-	-	-	-
b1E-8	3"	36.5	34.7	34.2	32.9	34.7	34.4	35.6
b1E-9	3"	36.2	35.9	33.2	33.0	34.5	35.1	35.7
b1E-10	3"	-	-	-	-	-	-	-
b1E-11	3"	36.3	34.3	33.6	33.1	33.5	33.9	35.4
b1E-12	3"	-	-	-	-	-	-	-
b2E-1	3"	35.7	34.1	33.9	32.2	33.2	34.2	36.1
b2E-2	3"	-	-	-	-	-	-	-
b2E-3	3"	36.1	34.7	33.8	32.8	34.6	34.8	35.5
b2E-4	3"	35.5	33.7	33.2	33.0	34.8	35.0	36.4
b2E-5	3"	35.4	33.8	32.8	32.3	33.8	34.0	36.3
b2E-6	3"	-	-	-	-	-	-	-
b1W-1	3"	35.9	34.9	33.0	31.6	33.0	34.0	35.6
b1W-2	3"	-	-	-	-	-	-	-
b1W-3	3"	36.3	35.5	34.8	33.6	33.7	35.3	36.0
b1W-4	3"	-	-	-	-	-	-	-
b1W-5	3"	35.6	34.6	33.5	32.1	33.3	34.0	35.7
b1W-6	3"	-	-	-	-	-	-	-
b1W-7	3"	36.6	35.0	33.5	31.0	32.2	33.2	34.2
b1W-8	3"	-	-	-	-	-	-	-
b1W-9	3"	37.3	35.8	32.8	32.0	33.6	35.4	36.8
b1W-10	3"	-	-	-	-	-	-	-
b1W-11	3"	35.3	34.7	32.8	31.1	32.4	33.6	35.4
b1W-12	3"	-	-	-	-	-	-	-
b2W-1	3"	35.7	34.9	33.3	32.1	33.0	34.4	35.9
b2W-2	3"	-	-	-	-	-	-	-
b2W-3	3"	36.5	35.3	34.1	33.8	34.3	35.6	36.8
b2W-4	3"	-	-	-	-	-	-	-

Anchor Rod	Diameter	Hardness Readings for 3" Ø Rods						
		1	2	3	4	5	6	7
b2W-5	3"	36.1	34.7	33.6	30.9	33.9	34.3	35.9
b2W-6	3"	-	-	-	-	-	-	-
cE-1	3"	36.8	35.8	34.7	32.4	35.0	35.2	36.7
cE-2	3"	-	-	-	-	-	-	-
cE-3	3"	36.6	35.4	34.0	31.8	34.2	36.3	37.1
cE-10	3"	36.3	35.1	33.0	30.7	32.9	33.6	36.4
cE-11	3"	36.4	35.0	32.8	32.0	34.5	35.3	36.9
cE-12	3"	-	-	-	-	-	-	-
cE-13	3"	-	-	-	-	-	-	-
cE-14	3"	36.5	35.0	34.9	33.2	34.8	36.6	36.7
cE-15	3"	36.3	35.5	33.8	32.9	34.6	35.6	35.9
cE-16	3"	36.9	35.5	33.6	33.0	35.5	35.5	36.4
cE-17	3"	-	-	-	-	-	-	-
cE-18	3"	36.3	35.0	34.7	31.5	33.5	35.0	37.1
cE-19	3"	-	-	-	-	-	-	-
cE-20	3"	-	-	-	-	-	-	-
cE-21	3"	36.4	35.3	34.6	31.0	33.3	34.2	36.3
cE-22	3"	-	-	-	-	-	-	-
cE-23	3"	35.8	35.6	35.0	34.9	35.1	36.1	37.0
cE-24	3"	-	-	-	-	-	-	-
cE-25	3"	36.9	34.9	34.0	32.9	33.5	35.3	37.1
cE-26	3"	-	-	-	-	-	-	-
cE-27	3"	36.7	35.8	34.5	32.0	34.4	36.1	36.5
cE-28	3"	35.8	34.5	33.8	33.3	33.8	34.4	36.5
cW-1	3"	-	-	-	-	-	-	-
cW-2	3"	36.5	34.7	34.5	33.1	34.3	35.8	35.7
cW-3	3"	36.3	35.7	34.0	33.5	35.4	36.0	36.5
cW-10	3"	36.8	35.8	34.4	33.2	34.5	35.1	36.6
cW-11	3"	35.5	35.8	34.0	32.9	34.8	35.2	36.5
cW-12	3"	-	-	-	-	-	-	-
cW-13	3"	-	-	-	-	-	-	-
cW-14	3"	35.7	35.3	34.4	32.9	33.1	34.7	36.2
cW-15	3"	36.4	34.3	33.2	33.0	33.1	33.7	35.0
cW-16	3"	-	-	-	-	-	-	-
cW-17	3"	36.0	35.4	34.3	34.2	33.3	34.1	36.6
cW-18	3"	-	-	-	-	-	-	-
cW-19	3"	36.3	34.0	33.8	33.2	34.3	35.9	36.2
cW-20	3"	-	-	-	-	-	-	-
cW-21	3"	36.5	35.5	33.2	34.6	34.2	35.1	36.2
cW-22	3"	-	-	-	-	-	-	-
cW-23	3"	35.5	35.4	32.6	32.4	34.9	35.0	36.0
cW-24	3"	-	-	-	-	-	-	-
cW-25	3"	35.6	35.0	33.4	30.7	33.3	34.6	35.5
cW-26	3"	35.9	34.6	33.1	32.6	34.5	34.5	35.0
cW-27	3"	36.9	35.7	32.1	32.2	33.6	35.1	36.4
cW-28	3"	-	-	-	-	-	-	-
Averages		36.3	35.1	33.8	32.5	33.9	34.8	36.2

GENERAL PROCEDURE:
1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

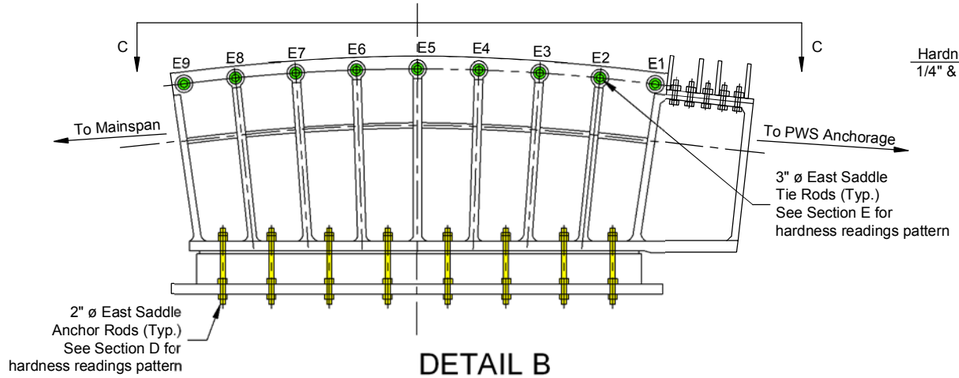
GENERAL NOTES:
Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			Tower Shear Base Plates Rods Hardness Readings			
			Drawn By:	MH	SHEET NUMBER	12/13-I-SBP
			Date:	6/8/2013		



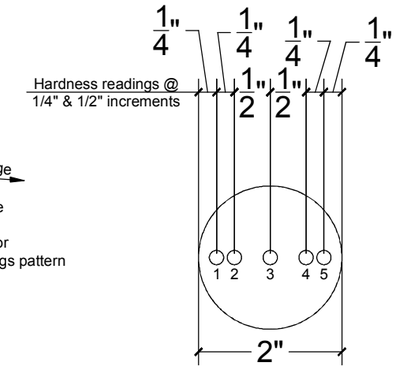
PLAN VIEW

NTS

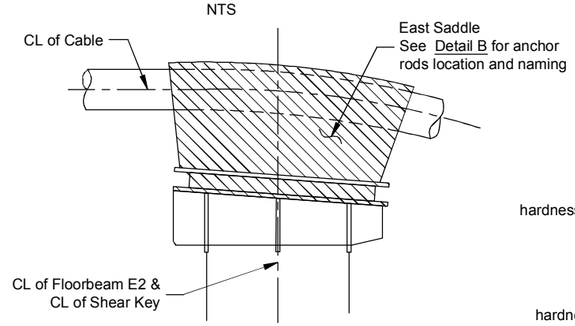


DETAIL B

NTS

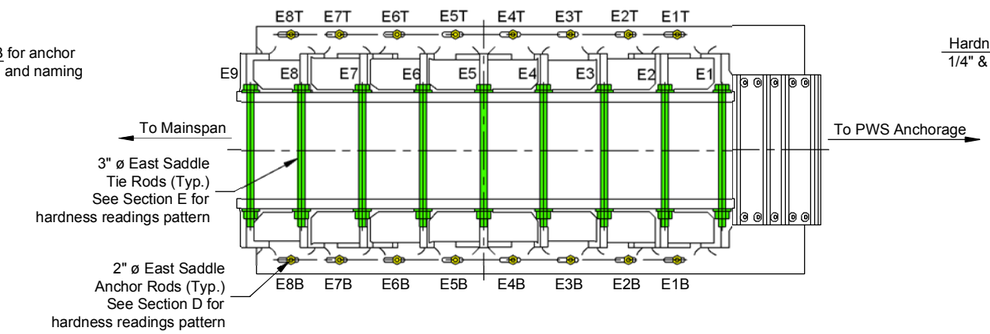


SECTION D (TYP.)



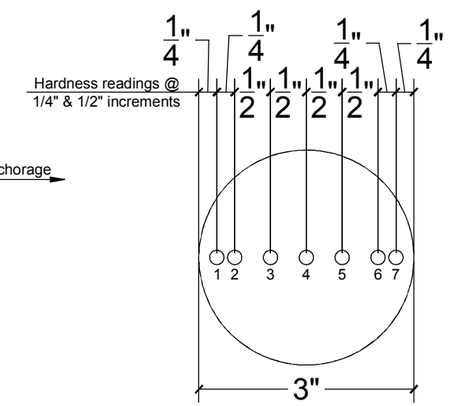
DETAIL A

NTS



TOP VIEW C-C

NTS



SECTION E (TYP.)

Anchor Rod	Diameter	Hardness Readings for 2" Ø Rods				
		1	2	3	4	5
E1T	2"	35.5	33.6	Machined dimple in center of rod	33.4	36.3
E2T	2"	35.5	33.5		33.3	35.2
E3T	2"	35.3	33.1		33.2	36.2
E4T	2"	35.4	33.2		33.6	35.4
E5T	2"	36.4	33.5		33.2	35.8
E6T	2"	35.5	33.1		33.4	36.7
E7T	2"	35.8	33.1		33.9	35.5
E8T	2"	36.4	33.3		33.0	35.8
E1B	2"	36.0	34.8	33.2	34.5	35.5
E2B	2"	37.0	34.7	33.9	35.3	36.4
E3B	2"	35.6	34.3	32.4	34.9	35.2
E4B	2"	35.9	34.9	32.4	33.1	35.2
E5B	2"	35.2	33.4	32.5	33.4	35.3
E6B	2"	36.5	34.3	32.7	34.3	35.7
E7B	2"	35.3	34.1	33.0	34.7	35.2
E8B	2"	36.6	35.1	34.1	35.5	36.1
Averages		35.9	33.9	33.0	33.9	35.7

Note: W-Line anchor rods were not tested for hardness readings.

Field Average Hardness for 2"ø Rods: 34.6 HRC
Average Hardness Readings from 2010 Certificate of Compliance: 36.6 HRC

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

LEGEND:

= 2"ø East Saddle Anchor rods

= 3"ø East Saddle Tie rods

MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 66 °F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

Tie Rod	Diameter	Hardness Readings for 3" Ø Rods						
		1	2	3	4	5	6	7
E1	3"	37.5	35.4	35.8	35.6	35.7	36.6	37.4
E2	3"	Adequate Surface Profile Could Not be Attained						
E3	3"	34.9	33.8	29.4	28.7	31.4	31.6	32.5
E4	3"	35.4	34.7	32.9	32.3	33.8	35.1	36.9
E5	3"	36.2	33.9	31.5	30.3	33.6	36.3	37.4
E6	3"	35.8	34.2	33.6	31.8	33.6	34.5	35.8
E7	3"	35.0	34.3	33.8	33.7	34.0	34.7	35.3
E8	3"	36.9	36.5	34.8	33.3	34.8	35.0	35.6
E9	3"	36.1	34.8	33.2	32.4	33.0	33.9	34.2
Averages		36.0	34.7	33.1	32.3	33.7	34.7	35.6

Note: W-Line tie rods were not tested for hardness Readings.

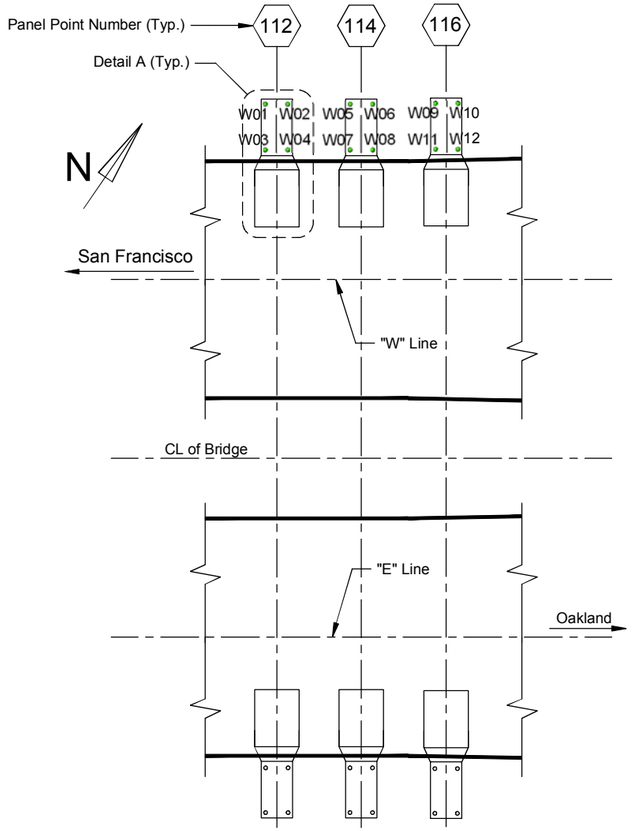
Field Average Hardness for 3"ø Rods: 34.3 HRC
Average Hardness Readings from 2010 QC Report: 33.6 HRC

Revision No:	By:	Date:

SELF-ANCHORED SUSPENSION BRIDGE

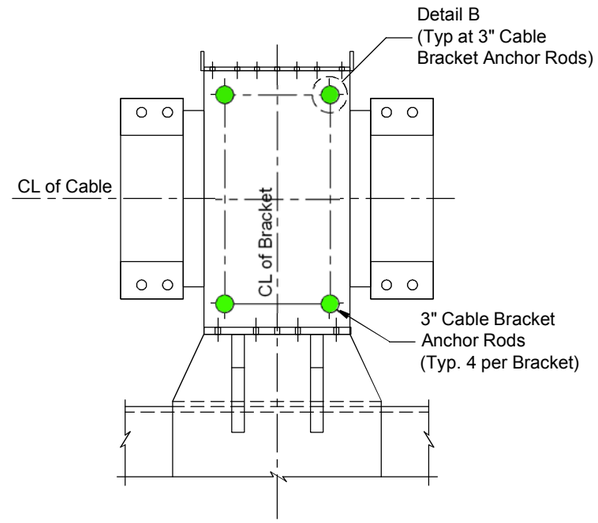
OBG Rods
East Saddle Anchor and Tie Rods

Drawn By:	MH	SHEET NUMBER	14/15-I-EAST
Date:	6/8/2013		



PLAN VIEW

NTS

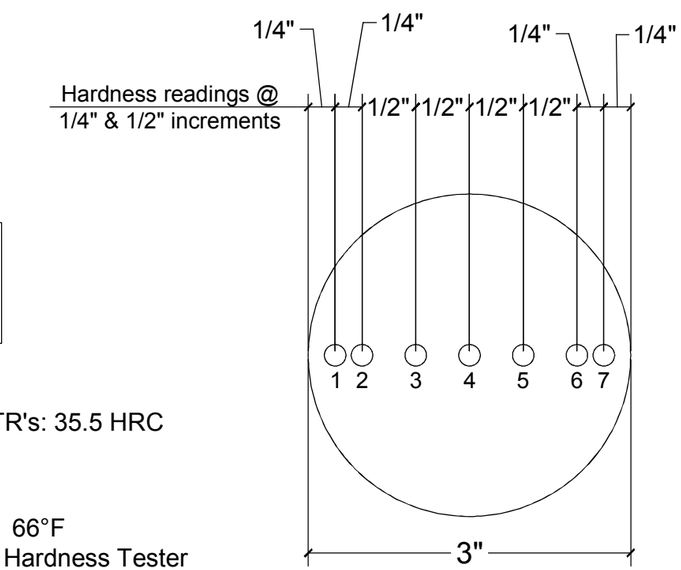


DETAIL A (Typ.)

NTS

Anchor Rod	Diameter	Hardness Readings for 3" Ø Rods						
		1	2	3	4	5	6	7
W01	3"	36.6	35.9	33.9	33.5	34.4	35.1	36.4
W02	3"	35.7	35.1	33.7	31.0	33.7	34.7	36.0
W03	3"	36.3	34.0	33.4	32.9	34.2	35.0	36.5
W04	3"	36.0	34.5	33.3	31.5	33.3	34.6	35.6
W05	3"	36.1	35.7	34.6	30.5	32.8	34.4	35.6
W06	3"	35.9	33.7	33.3	32.4	33.5	35.5	35.6
W07	3"	35.1	34.9	32.2	31.0	33.2	34.0	35.0
W08	3"	36.3	35.3	33.0	32.9	34.5	35.7	36.4
W09	3"	36.7	34.1	32.3	30.4	33.3	35.6	36.5
W10	3"	35.3	33.5	32.5	30.9	32.2	33.4	35.1
W11	3"	35.0	34.7	33.8	33.5	34.4	34.8	35.5
W12	3"	36.4	34.7	33.1	32.1	33.7	35.0	35.7
Averages		35.8	34.7	33.3	31.9	33.6	34.8	35.8

Note: E-Line anchor rods were not tested for hardness readings



Detail B (Typ.)

GENERAL PROCEDURE:

1) Galvanizing was ground off the top surface of the rods using a grinder.
2) Suitable sand paper was lightly applied after grinding to achieve a surface profile of 15 µm or less per ASTM A1038.
3) A profile meter was utilized to ensure surface roughness is acceptable.
4) The surface was free from oil, grease, dust, rust, and surface coatings.
5) Measurements were taken as shown on Section A above.
6) After measuring the hardness on each rod, the equipment readings were verified against a certified hardness reference block by taking 2 additional measurements.

GENERAL NOTES:

Note 1: Field hardness equipment is subject to greater variability than lab equipment. In addition,factors including wind and difficult access conditions can contribute to such variability.

LEGEND:

= 3"ø Cable Bracket Anchor Rods

Field Average Hardness: 34.3 HRC
Average Hardness Readings from 2011 MTR's: 35.5 HRC

MEASUREMENT LOGISTICS:

1) Recorded ambient temperature (Deg. F): 66°F
2) Equipment Utilized: Krautkramer MIC 10 Hardness Tester
3) Measurements Standard: Rockwell C standard

Revision No:	By:	Date:	SELF-ANCHORED SUSPENSION BRIDGE			
			Cable Bracket Anchor Rods			
			Drawn By:	MH	SHEET NUMBER	16-I-WEST
			Date:	6/8/2013		

TEST II
TABLE OF CONTENTS

Test II – Laboratory Tests

SHEAR KEY TOP ANCHOR RODS..... ITEM 3
PIER E2 BEARING TOP ANCHOR RODS..... ITEM 4
PWS STRAND ANCHOR RODS (MAIN CABLE)..... ITEM 7
TOWER SADDLE TIE RODS..... ITEM 8
TOWER SADDLE TURNED RODS..... ITEM 9
TOWER ANCHORAGE ANCHOR BOLTS (75 DIA.)..... ITEM 12
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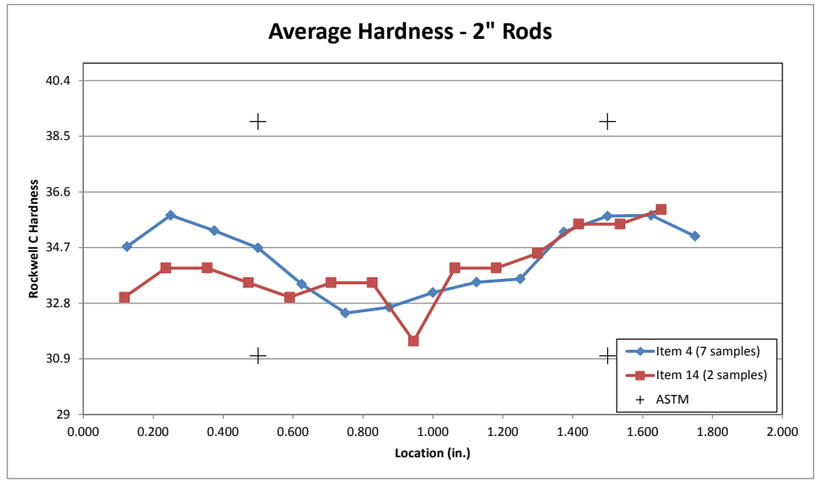
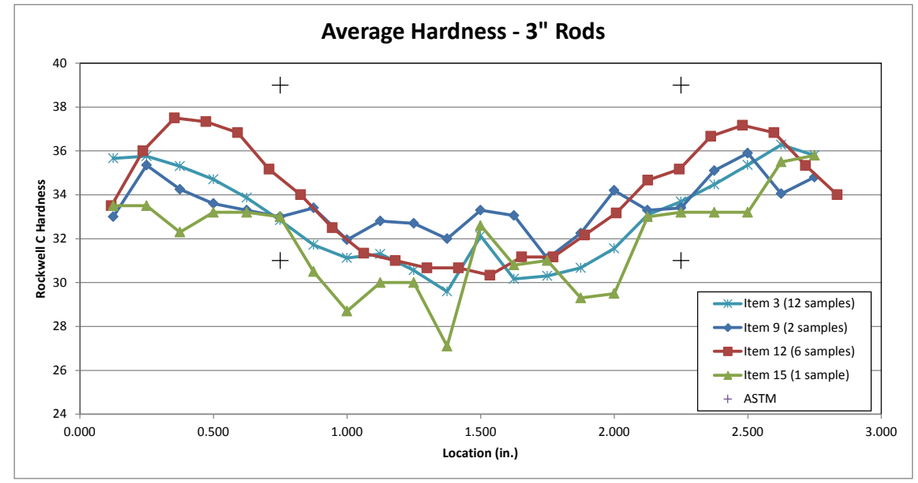
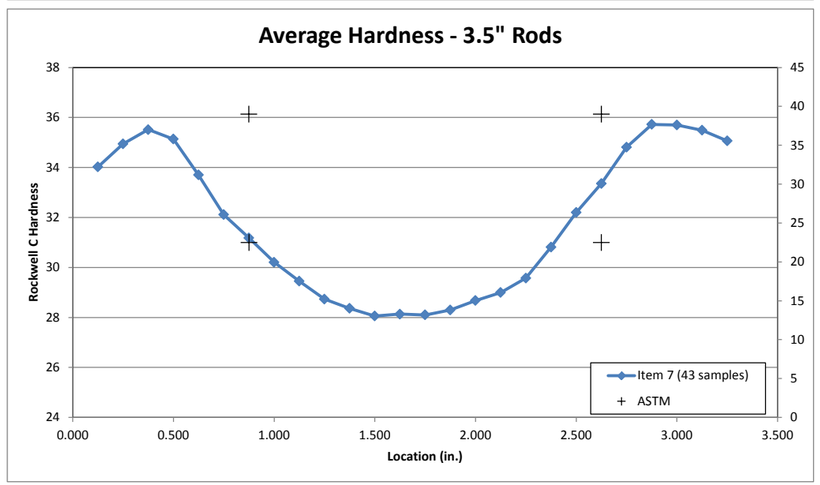
EAST SADDLE ANCHOR RODS..... ITEM 14
EAST SADDLE TIE RODS..... ITEM 15

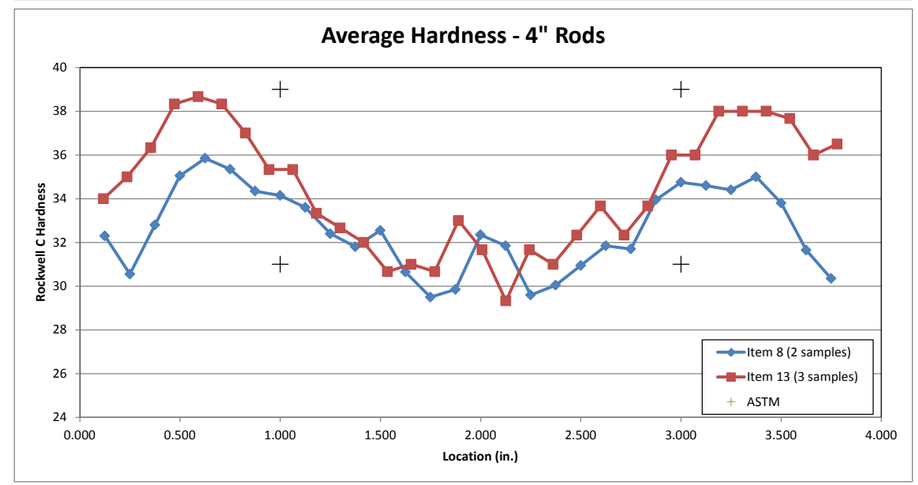
SUMMARY OF ALL TEST II

Average Readings







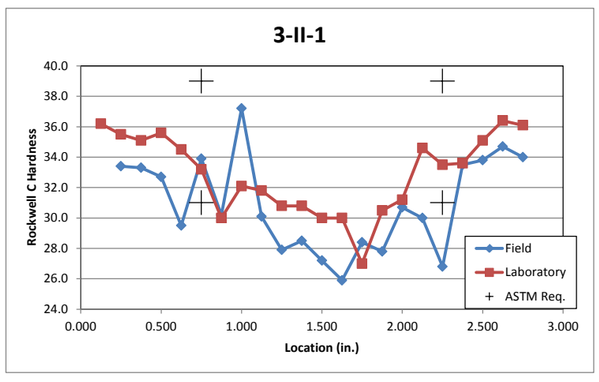


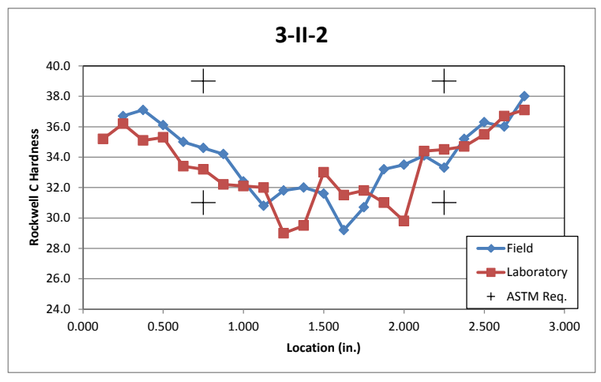
Item No.		Charpy	
		40°F	70°F
2		-	-
3		36.9	37.6
4		27.3	36.7
7		39.0	40.8
8		16.9	20.8
9	NNF	52.3	52.7
	NTA	13.0	16.0
11		-	-
12		39.1	41.8
13		31.7	36.3
14		-	-
15		17.8	23.7
16		-	-

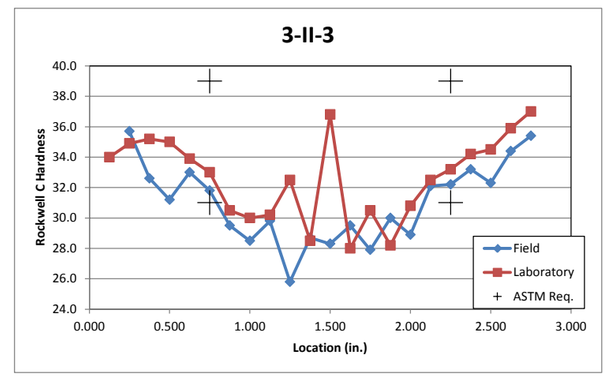
ITEMS 3. 3" SHEAR KEY TOP RODS - TEST II

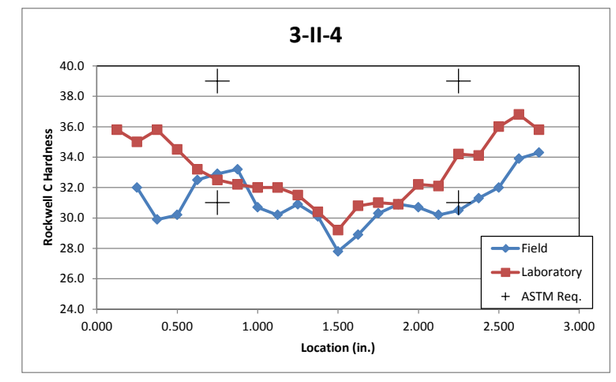
Rockwell Hardness Testing Comparison Across the Diameter

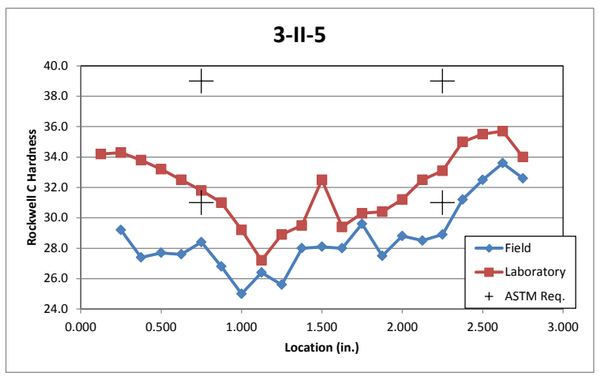
Location (in)	3-II-1		3-II-2		3-II-3		3-II-4		3-II-5		3-II-6		3-II-7		3-II-8		3-II-9		3-II-10		3-II-11		3-II-12		Average	
	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory
0.125	-	36.2	-	35.2	-	34.0	-	35.8	-	34.2	-	35.6	-	36.0	-	36.3	-	36.0	-	36.0	-	36.6	-	36.0	**-**	**35.7**
0.250	33.4	35.5	36.7	36.2	35.7	34.9	32.0	35.0	29.2	34.3	36.8	36.3	33.5	37.0	30.9	36.0	34.8	36.1	31.9	35.6	33.0	36.0	31.6	36.2	**33.3**	**35.8**
0.375	33.3	35.1	37.1	35.1	32.6	35.2	29.9	35.8	27.4	33.8	37.3	35.8	34.5	36.1	34.9	35.0	32.2	36.1	28.7	34.8	33.8	35.2	32.2	35.6	**32.8**	**35.3**
0.500	32.7	35.6	36.1	35.3	31.2	35.0	30.2	34.5	27.7	33.2	37.3	35.2	32.1	35.0	34.6	33.8	29.6	34.8	29.7	34.5	32.3	34.5	33.1	35.0	**32.2**	**34.7**
0.625	29.5	34.5	35.0	33.4	33.0	33.9	32.5	33.2	27.6	32.5	35.0	34.7	33.2	34.5	32.9	32.6	31.1	34.8	30.2	33.8	30.4	34.1	32.1	34.4	**31.9**	**33.9**
0.750	33.9	33.2	34.6	33.2	31.8	33.0	32.9	32.5	28.4	31.8	36.0	33.9	27.2	32.3	32.9	32.5	30.9	33.5	30.3	32.8	29.7	32.2	32.6	33.2	**31.8**	**32.8**
0.875	30.2	30.0	34.2	32.2	29.5	30.5	33.2	32.2	26.8	31.0	32.1	31.5	28.1	31.0	28.2	32.6	33.1	34.0	29.8	32.0	29.4	31.8	31.0	31.8	**30.5**	**31.7**
1.000	37.2	32.1	32.4	32.1	28.5	30.0	30.7	32.0	25.0	29.2	30.9	32.0	26.5	28.2	26.9	31.5	31.2	32.6	28.7	31.8	29.3	31.0	29.1	31.0	**29.7**	**31.1**
1.125	30.1	31.8	30.8	32.0	29.8	30.2	30.2	32.0	26.4	27.2	30.2	38.6	27.7	30.1	28.7	30.0	29.6	32.1	28.4	30.0	29.2	29.1	27.5	32.5	**29.1**	**31.3**
1.250	27.9	30.8	31.8	29.0	25.8	32.5	30.9	31.5	25.6	28.9	29.5	30.6	29.1	31.0	27.6	30.0	30.1	30.3	29.1	32.0	27.9	29.0	26.5	31.1	**28.5**	**30.6**
1.375	28.5	30.8	32.0	29.5	28.7	28.5	30.1	30.4	28.0	29.5	28.7	30.0	31.9	30.2	29.6	29.0	31.7	31.2	29.0	30.5	29.0	28.7	26.6	26.8	**29.5**	**29.6**
1.500	27.2	30.0	31.6	33.0	28.3	36.8	27.8	29.2	28.1	32.5	32.4	28.5	28.7	30.8	26.6	31.7	29.2	32.5	28.9	30.0	27.9	34.5	28.5	36.0	**28.8**	**32.1**
1.625	25.9	30.0	29.2	31.5	29.5	28.0	28.9	30.8	28.0	29.4	29.1	31.1	28.5	32.2	24.9	30.8	28.9	30.1	29.5	31.6	31.4	29.5	25.8	27.0	**28.3**	**30.2**
1.750	28.4	27.0	30.7	31.8	27.9	30.5	30.3	31.0	29.6	30.3	32.8	31.5	28.7	31.8	30.4	27.1	29.6	32.0	30.4	31.2	29.9	30.6	27.6	28.8	**29.7**	**30.3**
1.875	27.8	30.5	33.2	31.0	30.0	28.2	30.9	30.9	27.5	30.4	31.6	29.9	28.9	33.0	30.2	30.5	29.9	30.0	29.0	31.6	31.8	31.8	28.8	30.2	**30.0**	**30.7**
2.000	30.7	31.2	33.5	29.8	28.9	30.8	30.7	32.2	28.8	31.2	33.0	33.8	26.2	31.1	32.2	31.6	32.5	33.2	28.9	31.1	29.9	31.8	28.5	30.9	**30.3**	**31.6**
2.125	30.0	34.6	34.1	34.4	32.1	32.5	30.2	32.1	28.5	32.5	35.9	34.2	33.8	33.2	31.9	32.0	32.2	33.8	29.7	33.0	31.1	32.8	31.6	32.0	**31.8**	**33.1**
2.250	26.8	33.5	33.3	34.5	32.2	33.2	30.5	34.2	28.9	33.1	37.5	34.8	35.3	34.1	33.9	32.9	32.5	32.6	30.3	33.5	32.4	34.0	34.0	33.8	**32.3**	**33.7**
2.375	33.5	33.6	35.2	34.7	33.2	34.2	31.3	34.1	31.2	35.0	37.6	35.0	36.5	35.1	33.8	34.5	32.0	34.0	33.3	34.4	32.1	34.5	32.8	34.5	**33.5**	**34.5**
2.500	33.8	35.1	36.3	35.5	32.3	34.5	32.0	36.0	32.5	35.5	36.3	35.3	34.3	36.0	34.0	34.7	30.1	35.0	34.4	36.0	33.7	35.5	33.3	35.2	**33.6**	**35.4**
2.625	34.7	36.4	36.0	36.7	34.4	35.9	33.9	36.8	33.6	35.7	34.9	35.7	32.3	36.5	33.0	36.0	36.0	36.5	35.2	36.5	35.5	36.1	33.7	36.5	**34.4**	**36.3**
2.750	34.0	36.1	38.0	37.1	35.4	37.0	34.3	35.8	32.6	34.0	35.1	36.5	36.2	36.5	34.1	35.0	34.6	37.1	33.9	32.2	37.0	35.3	35.1	37.0	**35.0**	**35.8**

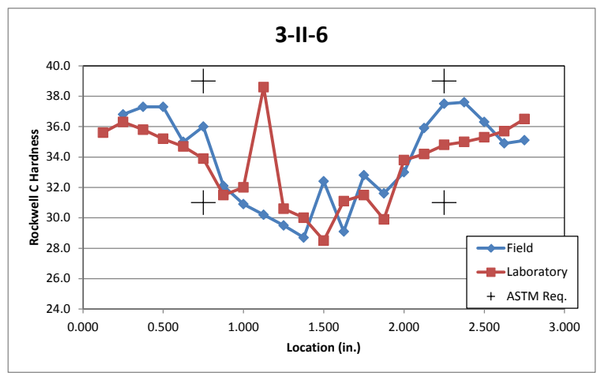


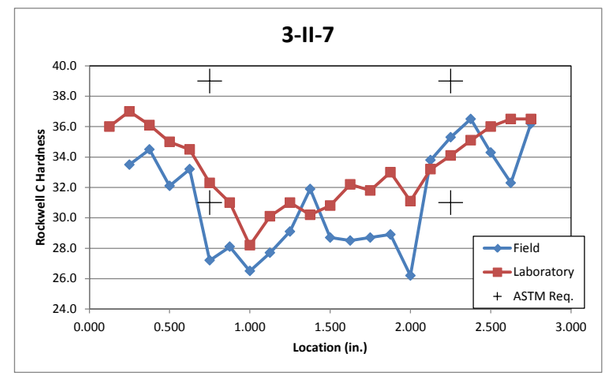


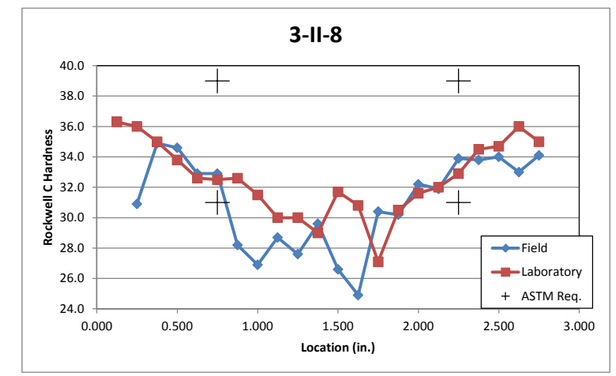


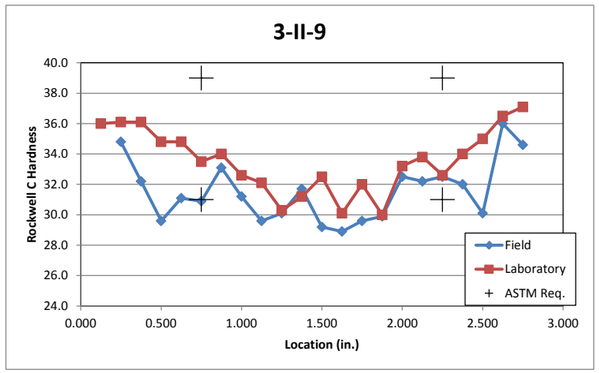


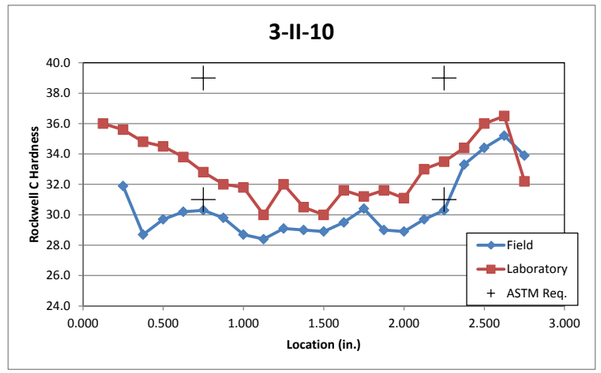


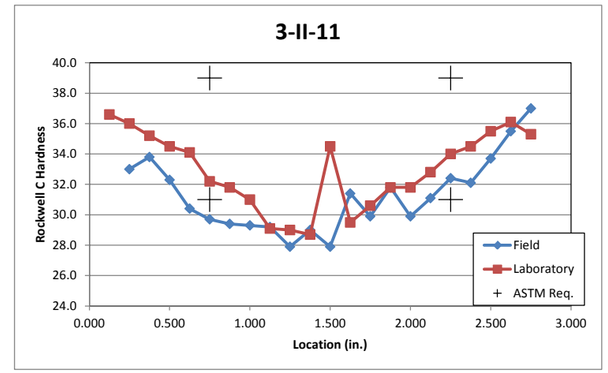


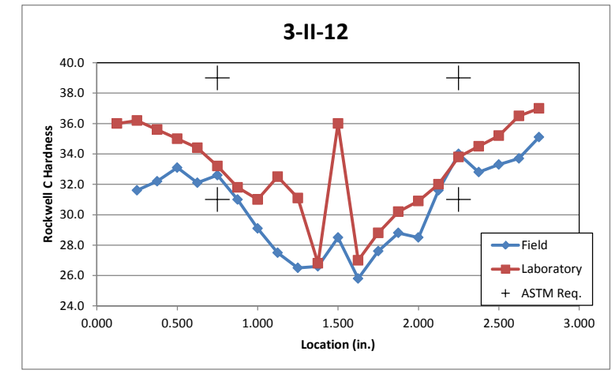


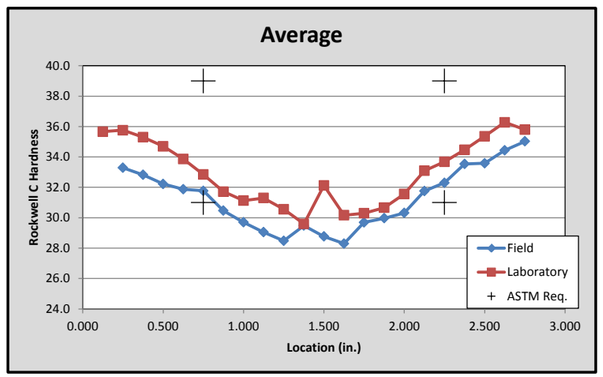






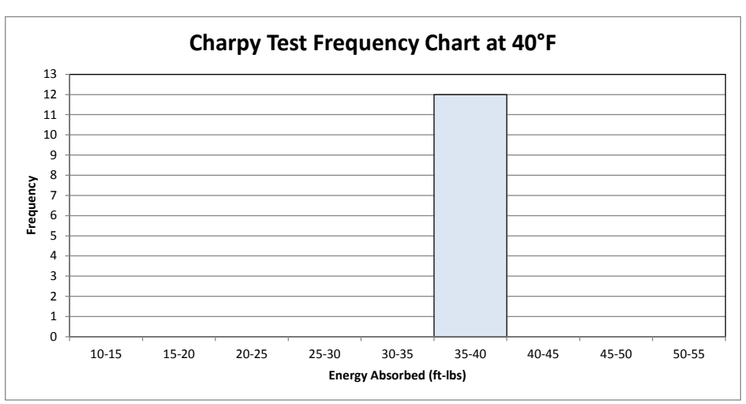


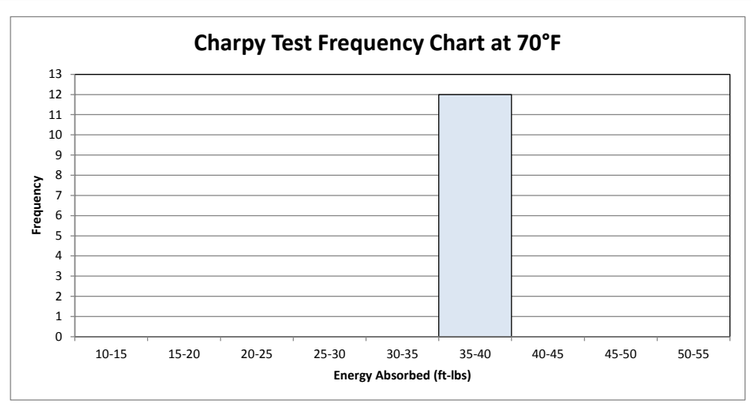




Charpy V-Notch Impact Test

Charpy V-Notch Impact Energy Results (ft-lb)																										
Identification	**3-II-1**		**3-II-2**		**3-II-3**		**3-II-4**		**3-II-5**		**3-II-6**		**3-II-7**		**3-II-8**		**3-II-9**		**3-II-10**		**3-II-11**		**3-II-12**		**Average**	
Temperature	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	**40°F**	**70°F**
Sample 1	39	39	36	37	37	38	36	36	38	38	37	37	36	36	38	39	37	37	37	38	38	38	36	37	**N/A**	**N/A**
Sample 2	39	38	35	37	37	36	37	37	39	38	36	37	36	39	36	36	36	37	37	38	37	37	36	36	**N/A**	**N/A**
Sample 3	38	39	36	38	36	38	36	37	38	40	37	38	36	38	37	37	37	37	37	38	38	38	36	38	**N/A**	**N/A**
Average	38.7	38.7	35.7	37.3	36.7	37.3	36.3	36.7	38.3	38.7	36.7	37.3	36.0	37.7	37.0	37.3	36.7	37.0	37.0	38.0	37.7	37.7	36.0	37.0	**36.9**	**37.6**





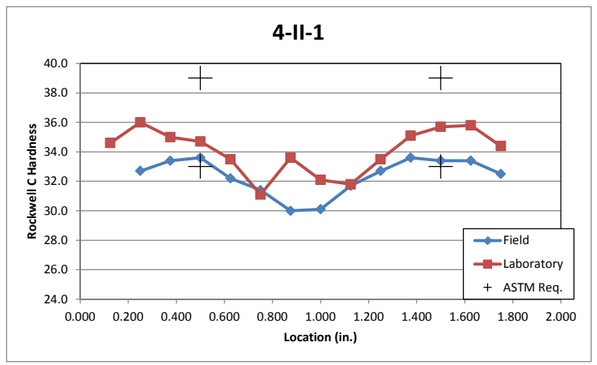
Spectrochemical Analysis

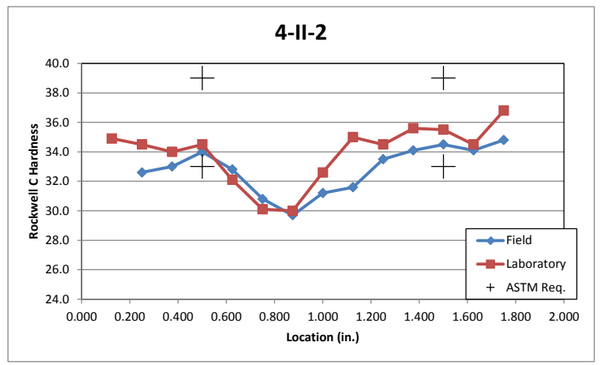
Spectrochemical Analysis (Reported as Wt. %)															
		3-II-1	3-II-2	3-II-3	3-II-4	3-II-5	3-II-6	3-II-7	3-II-8	3-II-9	3-II-10	3-II-11	3-II-12	Average	ASTM 354
Aluminum	Al	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	**0.02**	-
Carbon	C	0.43	0.42	0.42	0.42	0.43	0.43	0.43	0.42	0.42	0.43	0.43	0.43	**0.43**	0.33-0.55
Chromium	Cr	0.93	0.94	0.95	0.94	0.96	0.94	0.94	0.96	0.94	0.94	0.94	0.94	**0.94**	-
Cobalt	Co	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.01**	-
Columbium	Cb	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	**<0.005**	-
Copper	Cu	0.22	0.23	0.22	0.21	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	**0.22**	-
Manganese	Mn	0.86	0.86	0.86	0.87	0.88	0.85	0.85	0.88	0.86	0.86	0.85	0.85	**0.86**	0.57 min.
Molybdenum	Mo	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	**0.16**	-
Nickel	Ni	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	**0.14**	-
Phosporus	P	0.017	0.017	0.018	0.017	0.018	0.016	0.017	0.018	0.017	0.016	0.016	0.016	**0.017**	0.040 max.
Silicon	Si	0.28	0.28	0.27	0.28	0.27	0.28	0.28	0.27	0.28	0.28	0.28	0.28	**0.28**	-
Sulfur	S	0.035	0.034	0.037	0.034	0.037	0.035	0.034	0.038	0.034	0.035	0.034	0.036	**0.035**	0.045 max.
Titanium	Ti	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	**<0.005**	-
Vanadium	V	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.01**	-

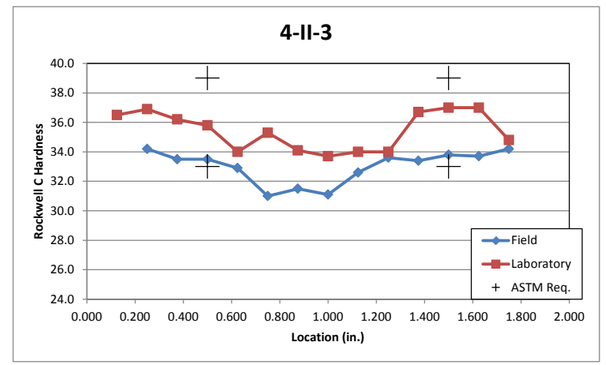
ITEM 4. 2" BEARING TOP RODS -TEST II

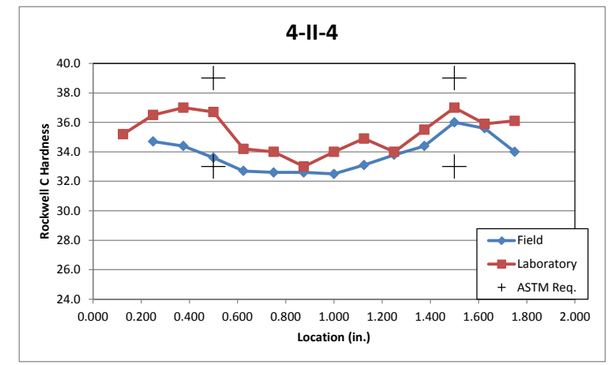
Rockwell Hardness Testing Comparison Across the Diameter

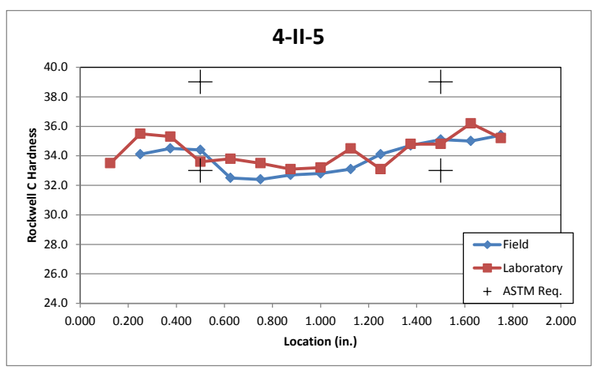
Location (in)	4-II-1		4-II-2		4-II-3		4-II-4		4-II-5		4-II-6		4-II-7		Average	
	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	**Field**	**Laboratory**
0.125	-	34.6	-	34.9	-	36.5	-	35.2	-	33.5	-	34.5	-	33.9	**-**	**34.7**
0.250	32.7	36.0	32.6	34.5	34.2	36.9	34.7	36.5	34.1	35.5	34.6	35.2	34.7	36.0	**33.9**	**35.8**
0.375	33.4	35.0	33.0	34.0	33.5	36.2	34.4	37.0	34.5	35.3	34.9	34.3	34.7	35.1	**34.1**	**35.3**
0.500	33.6	34.7	34.0	34.5	33.5	35.8	33.6	36.7	34.4	33.6	33.7	33.7	34.1	33.8	**33.8**	**34.7**
0.625	32.2	33.5	32.8	32.1	32.9	34.0	32.7	34.2	32.5	33.8	32.9	33.5	33.2	33.0	**32.7**	**33.4**
0.750	31.4	31.1	30.8	30.1	31.0	35.3	32.6	34.0	32.4	33.5	33.5	32.2	32.5	31.0	**32.0**	**32.5**
0.875	30.0	33.6	29.7	30.0	31.5	34.1	32.6	33.0	32.7	33.1	33.4	33.2	32.2	31.6	**31.7**	**32.7**
1.000	30.1	32.1	31.2	32.6	31.1	33.7	32.5	34.0	32.8	33.2	32.9	33.2	32.2	33.3	**31.8**	**33.2**
1.125	31.7	31.8	31.6	35.0	32.6	34.0	33.1	34.9	33.1	34.5	32.9	31.2	32.2	33.2	**32.5**	**33.5**
1.250	32.7	33.5	33.5	34.5	33.6	34.0	33.8	34.0	34.1	33.1	33.6	32.8	33.4	33.5	**33.5**	**33.6**
1.375	33.6	35.1	34.1	35.6	33.4	36.7	34.4	35.5	34.7	34.8	36.0	35.0	33.9	33.9	**34.3**	**35.2**
1.500	33.4	35.7	34.5	35.5	33.8	37.0	36.0	37.0	35.1	34.8	35.9	35.2	35.2	35.2	**34.8**	**35.8**
1.625	33.4	35.8	34.1	34.5	33.7	37.0	35.6	35.9	35.0	36.2	35.7	35.2	35.5	36.0	**34.7**	**35.8**
1.750	32.5	34.4	34.8	36.8	34.2	34.8	34.0	36.1	35.4	35.2	34.4	33.1	35.3	35.2	**34.4**	**35.1**

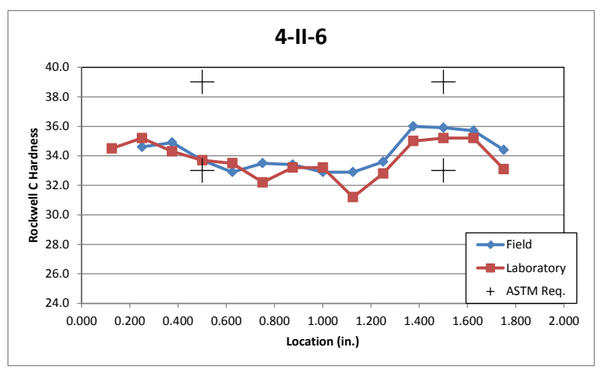


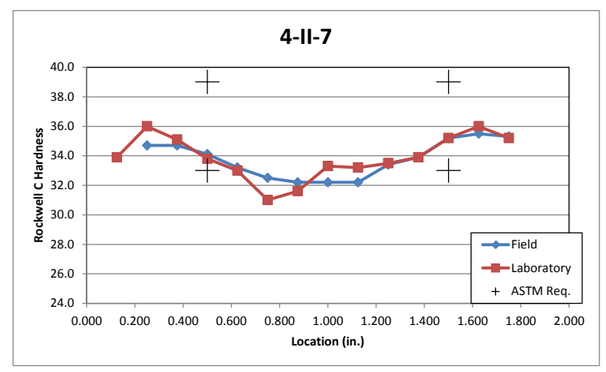


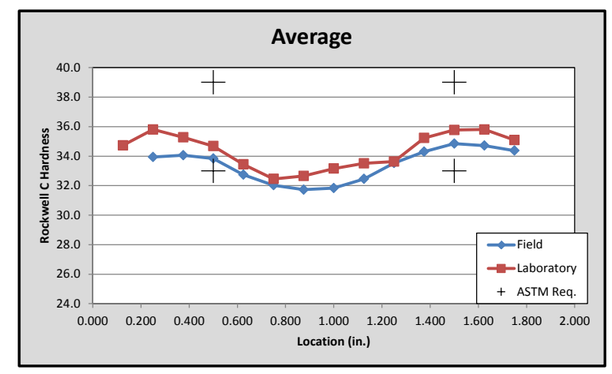






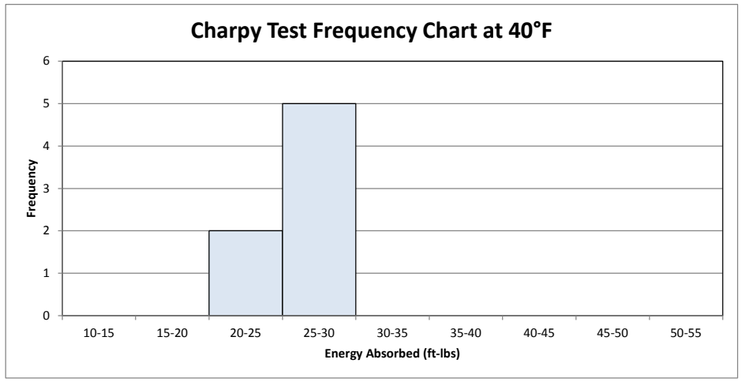


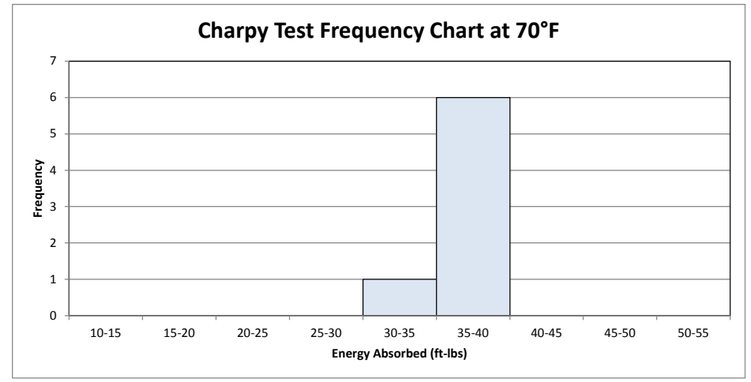




Charpy V-Notch Impact Test

Charpy V-Notch Impact Energy Results (ft-lb)																
Identification	**4-II-1**		**4-II-2**		**4-II-3**		**4-II-4**		**4-II-5**		**4-II-6**		**4-II-7**		**Average**	
Temperature	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	**40°F**	**70°F**
Sample 1	29	38	28	37	31	37	29	37	26	37	26	29	26	33	**N/A**	**N/A**
Sample 2	29	39	29	39	30	37.5	30	39	26	36	24	39	25	33	**N/A**	**N/A**
Sample 3	28	39.5	27	40	28	37	29	40	26	34	24	37	23	33	**N/A**	**N/A**
Average	28.7	38.8	28.0	38.7	29.7	37.2	29.3	38.7	26.0	35.7	24.7	35.0	24.7	33.0	**27.3**	**36.7**





Spectrochemical Analysis

Spectrochemical Analysis (Reported as Wt. %)										
		4-II-1	4-II-2	4-II-3	4-II-4	4-II-5	4-II-6	4-II-7	**Average**	ASTM 354
Aluminum	Al	0.02	0.02	0.02	0.02	0.02	0.02	0.02	**0.02**	-
Carbon	C	0.42	0.41	0.41	0.42	0.42	0.41	0.42	**0.42**	0.33-0.55
Chromium	Cr	0.93	0.93	0.93	0.94	0.94	0.94	0.94	**0.94**	-
Cobalt	Co	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.01**	-
Columbium	Cb	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	**<0.005**	-
Copper	Cu	0.21	0.21	0.21	0.21	0.21	0.21	0.21	**0.21**	-
Manganese	Mn	0.87	0.87	0.86	0.87	0.87	0.87	0.86	**0.87**	0.57 min.
Molybdenum	Mo	0.19	0.19	0.19	0.19	0.19	0.19	0.18	**0.19**	-
Nickel	Ni	0.09	0.09	0.09	0.09	0.09	0.09	0.09	**0.09**	-
Phosporus	P	0.024	0.024	0.024	0.024	0.024	0.024	0.024	**0.024**	0.040 max.
Silicon	Si	0.26	0.26	0.26	0.26	0.26	0.25	0.25	**0.26**	-
Sulfur	S	0.026	0.025	0.026	0.026	0.026	0.025	0.026	**0.03**	0.045 max.
Titanium	Ti	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	**<0.005**	-
Vanadium	V	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	**<0.005**	-

ITEM 7. 3.5" PWS ANCHOR RODS - TEST II

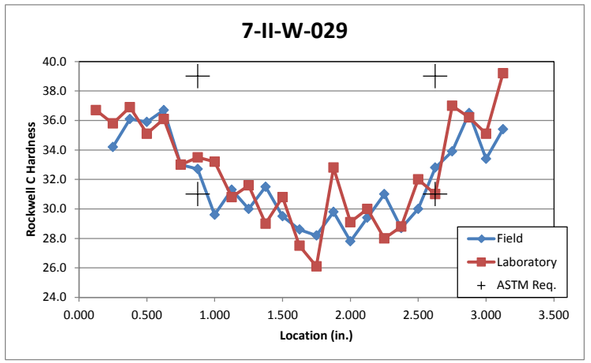
Rockwell Hardness Testing Comparison Across the Diameter

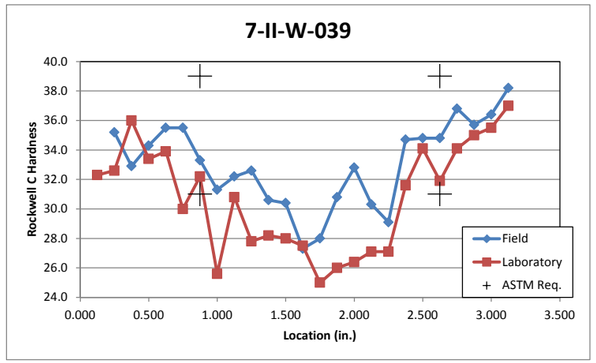
Location (in)	7-II-W-029		7-II-W-039		7-II-W-041		7-II-W-046		7-II-048		7-II-W-049		7-II-W-066		7-II-W-069		7-II-W-076		7-II-1W-109		7-II-W-111		7-II-W-129		7-II-W-132	
	OOH	Cut	OQY	Rolled	OYG	Rolled	OYH	Rolled	OQY	Rolled	OYM	Rolled	OYH	Rolled	OQY	Rolled	OYL	Rolled	OYK	Rolled	OYO	Rolled	OQY	Rolled	OYP	Rolled
	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory
0.125	-	36.7	-	32.3	-	33.8	-	36.0	-	37.1	-	30.0	-	32.1	-	35.2	-	28.5	-	32.0	-	29.8	-	34.2	-	29.5
0.250	34.2	35.8	35.2	32.6	38.2	34.3	33.0	32.1	33.2	36.6	27.4	33.8	34.7	31.8	36.5	37.0	31.5	26.7	33.9	33.6	33.8	31.2	32.8	33.1	35.5	32.9
0.375	36.1	36.9	32.9	36.0	37.2	35.5	32.7	32.9	34.3	35.9	30.9	33.5	39.8	35.3	35.7	37.1	32.2	32.0	34.1	33.5	32.7	33.2	30.8	35.2	35.0	33.6
0.500	35.9	35.1	34.3	33.4	35.0	35.1	33.6	36.8	33.4	37.5	28.9	33.5	42.7	33.8	33.9	36.7	33.1	31.7	33.7	32.0	32.3	32.0	32.4	34.2	33.9	31.8
0.625	36.7	36.1	35.5	33.9	35.4	35.2	31.4	32.1	34.3	34.5	27.7	31.1	40.4	34.1	35.2	36.1	31.6	31.0	35.8	32.0	30.7	30.6	32.2	30.4	33.6	29.7
0.750	33.0	33.0	35.5	30.0	34.6	34.8	33.5	29.9	29.5	34.5	29.1	31.0	40.7	33.7	30.3	34.1	32.6	27.5	32.9	32.9	31.6	32.1	32.6	31.5	33.6	29.5
0.875	32.7	33.5	33.3	32.2	34.9	32.5	29.3	29.9	33.3	26.5	29.6	27.1	37.8	35.0	32.3	32.8	31.9	28.8	33.0	30.9	30.6	29.8	28.8	31.8	32.4	27.8
1.000	29.6	33.2	31.3	25.6	33.7	31.0	28.9	29.0	33.4	28.0	26.9	26.9	34.9	33.1	31.1	30.8	30.1	31.8	32.0	30.0	30.5	28.5	30.7	27.5	33.0	26.1
1.125	31.3	30.8	32.2	30.8	32.8	29.6	28.1	26.6	29.6	30.0	29.7	28.2	33.6	34.8	30.8	29.3	31.0	26.9	29.4	29.8	28.3	29.3	28.8	29.8	31.3	28.5
1.250	30.0	31.6	32.6	27.8	32.7	25.0	26.8	28.1	27.5	30.0	26.6	27.5	30.6	32.2	30.5	28.2	30.1	25.6	29.4	28.9	30.7	26.1	27.7	26.7	33.0	26.8
1.375	31.5	29.0	30.6	28.2	33.1	29.0	26.5	32.6	29.9	30.7	24.0	26.1	26.8	29.0	30.4	29.0	24.5	25.2	30.2	28.9	27.6	26.0	30.2	26.7	27.9	30.5
1.500	29.5	30.8	30.4	28.0	31.7	29.4	28.2	28.5	27.9	26.9	25.7	26.8	27.4	30.1	29.6	28.0	25.3	28.8	26.3	28.2	26.7	25.5	28.7	25.2	30.4	27.5
1.625	28.6	27.5	27.3	27.5	31.9	30.8	26.9	32.7	28.2	28.5	28.2	25.8	27.6	27.2	29.3	27.1	24.2	23.5	25.9	28.0	25.3	27.8	28.4	26.5	29.5	25.9
1.750	28.2	26.1	28.0	25.0	29.9	28.0	28.5	26.8	27.9	29.9	28.0	27.0	27.9	31.3	29.5	29.2	25.5	25.0	24.1	28.2	26.2	25.1	30.5	27.0	29.6	27.0
1.875	29.8	32.8	30.8	26.0	30.5	28.1	27.6	26.5	28.2	29.8	25.8	26.0	28.7	28.0	28.7	27.1	27.6	24.5	27.6	29.3	27.0	25.8	27.5	28.9	31.2	27.5
2.000	27.8	29.1	32.8	26.4	31.6	28.8	29.6	28.7	27.9	27.0	27.1	25.5	28.5	31.2	30.4	27.1	28.6	25.2	27.9	28.5	29.0	27.2	29.3	29.0	32.1	26.5
2.125	29.4	30.0	30.3	27.1	33.0	27.5	30.1	29.2	29.6	26.5	30.1	29.3	28.1	30.1	30.2	30.0	29.7	28.1	30.4	28.0	27.6	30.2	30.1	28.5	31.1	28.0
2.250	31.0	28.0	29.1	27.1	32.3	30.1	28.9	29.5	29.3	29.8	26.7	27.9	29.6	28.5	29.9	25.8	28.4	25.9	26.3	28.8	29.2	28.8	27.6	26.8	32.5	30.3
2.375	28.7	28.8	34.7	31.6	33.2	30.8	30.9	30.1	30.4	32.8	27.3	31.1	27.8	28.5	32.1	28.1	27.1	27.1	27.4	31.1	31.3	27.5	29.7	31.2	31.7	28.8
2.500	30.0	32.0	34.8	34.1	33.9	31.1	32.2	33.1	30.4	29.9	29.5	30.5	36.7	31.0	32.0	31.8	27.7	28.2	28.8	33.8	29.8	29.2	32.2	29.0	33.5	33.5
2.625	32.8	31.0	34.8	31.9	34.4	33.8	32.3	34.4	32.1	33.6	28.8	33.0	37.4	32.1	33.5	31.8	30.2	29.3	33.3	30.6	32.0	32.7	33.9	31.2	33.4	33.0
2.750	33.9	37.0	36.8	34.1	34.5	33.4	32.0	34.8	32.8	34.0	30.3	33.0	38.0	34.0	32.3	34.2	27.8	32.2	33.2	32.5	27.5	29.8	32.4	30.6	34.4	35.3
2.875	36.5	36.2	35.7	35.0	35.5	34.6	33.2	34.4	37.2	38.5	31.5	33.8	36.5	36.0	35.5	35.6	30.9	30.8	35.3	35.0	32.1	33.8	32.4	34.5	35.9	33.5
3.000	33.4	35.1	36.4	35.5	35.5	34.4	33.1	34.5	33.0	37.0	30.2	34.6	36.6	35.1	34.7	36.1	32.4	31.5	32.3	33.5	31.8	33.5	32.8	35.2	33.7	31.5
3.125	35.4	39.2	38.2	37.0	35.4	34.2	32.4	31.5	34.7	39.0	29.0	33.0	32.7	34.0	35.2	37.8	30.3	29.0	33.6	30.5	32.6	33.2	35.6	36.8	35.2	35.0
3.250	-	-	-	-	-	-	-	-	-	-	-	-	38.0	30.8	34.6	36.8	32.1	31.0	-	-	36.4	29.1	35.4	34.1	-	-

Location (in)	7-II-W-133		7-II-E-012		7-II-E-016		7-II-E-021		7-II-E-024		7-II-E-027		7-II-E-028		7-II-E-040		7-II-E-042		7-II-E-045		7-II-E-046		7-II-E-053		7-II-072	
	OYL	Rolled	OTD	Cut	OQW	Rolled	OOH	Cut	OQX	Rolled	OTD	Rolled	OYJ	Rolled	OQX	Rolled	OQW	Rolled	OYM	Rolled	OYN	Rolled	OTD	Cut	OPY	Rolled
	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory
0.125	-	28.0	-	38.0	-	34.8	-	36.5	-	36.0	-	37.1	-	30.8	-	37.2	-	35.2	-	34.0	-	31.9	-	34.0	-	36.5
0.250	30.4	33.0	33.6	36.8	34.6	35.9	34.0	37.1	36.4	36.2	35.7	35.7	30.6	34.8	37.2	37.8	30.8	36.0	35.0	33.2	31.0	32.8	35.8	38.5	38.9	37.2
0.375	30.6	32.2	33.5	38.0	33.5	35.2	33.9	36.8	37.8	37.2	34.4	37.0	31.3	35.5	36.1	36.8	29.6	35.9	34.8	35.0	32.7	34.3	35.8	37.6	38.5	37.1
0.500	31.0	33.2	35.5	37.0	32.9	36.5	35.6	35.6	39.5	36.0	33.8	36.2	30.3	35.1	34.3	36.8	28.3	35.2	34.9	34.5	32.4	34.1	35.7	37.2	34.5	35.0
0.625	29.3	29.8	32.7	34.6	33.4	34.1	34.0	35.1	31.0	33.8	31.1	35.1	31.4	34.8	34.5	36.7	28.2	34.0	35.5	34.3	32.6	32.4	33.9	35.8	33.6	32.2
0.750	30.2	28.2	32.0	32.1	29.9	33.1	31.4	32.8	30.0	31.5	31.3	33.5	31.3	34.7	30.4	32.0	28.6	34.0	35.3	32.1	34.0	32.4	31.6	33.0	34.2	32.2
0.875	28.4	28.0	30.5	29.1	28.0	30.2	29.4	31.8	33.7	30.2	28.8	34.2	30.2	34.1	29.5	32.0	27.2	29.5	33.9	31.8	32.7	32.5	32.5	30.5	32.2	30.2
1.000	30.1	28.2	29.8	31.5	31.8	32.5	27.5	33.2	32.7	29.5	28.0	32.3	31.7	31.6	32.5	31.5	26.2	30.6	34.5	28.8	31.1	34.0	33.5	28.5	32.5	30.2
1.125	30.3	29.0	25.6	30.8	29.2	28.5	26.3	29.1	29.5	29.0	28.7	29.8	29.3	32.2	27.9	31.0	27.3	27.5	32.9	28.2	30.3	31.8	34.0	30.2	30.8	30.7
1.250	30.5	28.4	25.6	28.9	29.1	27.8	28.1	31.1	26.5	28.8	30.2	27.8	28.9	30.7	29.6	30.7	25.7	28.5	31.5	31.0	29.1	29.2	32.9	28.0	32.0	29.2
1.375	27.2	23.8	27.1	29.2	26.6	28.0	30.5	28.5	24.8	26.3	25.0	28.6	26.0	28.8	31.3	28.9	27.2	29.0	31.6	28.2	27.0	26.9	31.4	30.8	31.6	29.5
1.500	28.4	28.0	31.3	28.5	27.6	27.1	27.2	30.0	27.4	28.8	28.4	28.9	27.1	26.6	30.9	29.2	25.5	28.0	31.0	26.3	29.6	28.5	31.1	29.5	31.9	28.0
1.625	26.8	26.0	29.9	26.1	28.4	25.2	27.0	28.2	27.3	30.0	28.8	27.2	25.5	26.7	30.2	29.0	21.0	28.0	30.9	28.1	26.6	25.1	31.2	30.9	30.6	28.0
1.750	27.5	24.8	32.0	28.9	26.6	26.5	26.8	31.1	30.0	27.8	26.7	26.5	27.1	28.8	29.1	28.3	24.0	27.3	29.9	26.6	28.7	30.0	33.6	30.0	29.9	30.0
1.875	28.8	26.3	29.7	30.6	25.0	27.2	30.9	31.1	30.0	28.8	28.8	28.5	28.1	27.5	28.9	28.7	26.4	28.8	31.3	27.0	25.9	27.3	31.2	30.5	31.8	26.5
2.000	29.4	27.2	26.9	30.0	26.3	26.1	32.9	27.1	29.4	29.2	26.3	29.1	28.6	29.4	30.2	30.6	27.4	29.2	30.0	30.2	27.3	26.8	34.2	28.0	31.6	26.8
2.125	30.4	28.0	26.6	28.6	25.7	26.1	28.0	30.7	28.9	27.6	28.9	30.6	29.1	30.2	27.4	27.3	25.1	29.2	31.5	27.1	29.7	31.0	32.2	31.6	29.4	28.5
2.250	32.6	29.5	28.9	29.0	28.5	28.5	30.2	28.5	29.8	27.9	31.4	28.2	28.2	31.1	29.6	31.1	26.1	27.5	31.7	31.6	30.8	28.5	32.5	30.5	30.5	32.7
2.375	32.3	31.0	27.6	32.0	30.2	27.9	37.6	31.1	30.2	28.4	30.0	31.0	30.7	32.9	32.0	32.8	28.4	29.5	31.9	32.1	31.5	31.8	32.7	30.0	33.0	31.7
2.500	31.7	31.0	32.1	31.7	28.9	30.8	36.9	32.1	31.9	29.8	32.1	31.2	28.5	33.2	31.8	32.4	27.7	31.0	34.3	33.4	33.1	31.0	33.8	34.2	33.7	33.5
2.625	31.7	33.6	30.0	36.0	28.5	33.5	34.2	32.2	28.0	30.8	32.3	33.5	29.5	33.1	33.8	32.5	28.4	34.3	33.6	33.1	30.1	32.8	35.2	33.9	34.6	34.0
2.750	32.7	34.1	28.2	37.1	31.5	33.8	34.1	34.8	32.9	34.0	33.7	32.8	29.5	34.1	34.9	38.0	28.5	35.5	35.2	34.9	33.1	34.7	35.7	35.8	37.7	36.5
2.875	32.1	33.8	34.1	38.8	32.8	36.2	37.1	37.2	35.9	37.6	33.2	36.8	30.5	35.0	34.9	36.8	29.1	35.6	35.4	35.1	32.7	33.9	35.4	37.8	37.0	36.8
3.000	32.5	32.8	33.2	37.8	33.5	36.5	36.9	37.2	38.1	36.3	32.8	37.2	31.7	35.3	34.8	37.1	31.2	36.0	33.3	36.1	31.7	34.1	35.6	37.3	38.8	37.1
3.125	30.5	32.2	33.3	38.0	36.3	37.5	36.6	37.9	36.9	37.0	34.8	37.2	30.9	31.8	36.7	37.8	32.7	35.8	33.6	35.1	30.0	33.3	33.9	38.2	39.7	38.1
3.250	-	-	34.8	38.2	35.8	36.1	36.9	38.9	36.7	36.2	37.5	36.2	34.0	30.8	36.3	35.9	34.5	37.2	34.9	34.0	33.6	30.5	34.4	36.2	37.9	39.2

Location (in)	7-II-E-075		7-II-E-084		7-II-E-090		7-II-E-092		7-II-E-093		7-II-E-096		7-II-E-102		7-II-E-106		7-II-E-108		7-II-E-111		7-II-E-116		7-II-E-117		7-II-E-121	
	OYN	Rolled	OOF	Cut	OQX	Rolled	OYI	Rolled	OOF	Cut	OYI	Rolled	OYO	Rolled	OQX	Rolled	OPY	Rolled	OYP	Rolled	OPY	Rolled	OYG	Rolled	OPY	Rolled
	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory
0.125	-	33.8	-	38.0	-	35.8	-	31.1	-	37.7	-	28.2	-	32.1	-	36.3	-	35.0	-	33.2	-	38.8	-	31.5	-	35.0
0.250	36.0	35.5	34.3	37.5	37.0	37.8	33.2	34.2	35.3	37.0	32.4	33.2	34.0	34.0	34.7	36.5	35.1	36.2	32.7	34.4	33.9	37.5	34.6	35.0	35.4	35.1
0.375	35.4	34.0	35.1	36.3	39.0	38.4	30.9	34.8	35.2	37.1	32.7	34.5	31.2	34.8	35.8	36.5	32.3	35.8	33.1	33.8	35.7	37.0	35.5	36.0	36.2	36.2
0.500	33.5	35.6	32.1	37.0	38.3	38.0	31.1	34.8	35.1	37.0	34.0	34.5	31.3	33.8	38.3	36.6	32.5	35.8	32.0	33.0	34.7	36.8	35.1	35.7	37.3	35.9
0.625	34.4	35.6	30.3	33.8	36.4	33.5	32.9	33.5	33.1	32.0	32.6	34.2	32.6	33.8	35.8	32.5	32.5	34.3	33.6	34.5	34.2	37.0	33.2	34.0	34.9	34.2
0.750	32.7	33.5	30.4	32.5	35.6	34.2	33.5	33.8	32.7	31.6	33.0	32.0	30.2	31.2	31.7	31.8	30.7	30.0	31.6	32.0	33.0	32.5	33.6	35.2	33.2	31.9
0.875	32.9	31.3	28.0	31.1	34.1	30.1	31.2	31.1	31.1	32.1	33.0	32.2	30.7	34.1	30.7	34.1	31.8	31.1	29.2	30.0	33.0	34.7	32.6	32.2	29.9	31.0
1.000	31.2	30.9	29.3	30.9	30.3	30.0	30.8	30.8	31.5	29.5	32.4	30.8	30.9	32.2	28.8	30.0	30.5	29.2	28.0	26.5	34.5	32.0	32.1	32.8	30.0	32.1
1.125	31.6	30.7	27.3	30.0	30.7	30.5	30.8	29.7	31.5	30.1	31.7	29.2	28.4	28.5	27.3	28.0	30.5	29.5	26.1	26.2	32.8	31.8	31.7	30.2	24.6	28.9
1.250	31.0	30.0	28.0	29.2	27.1	29.0	31.4	26.1	31.3	28.2	31.8	30.1	29.8	30.1	30.5	28.3	29.0	29.5	27.3	28.1	30.9	30.5	31.6	28.2	29.0	27.3
1.375	30.5	32.8	25.2	29.8	31.2	29.3	28.0	26.8	31.3	29.0	31.1	27.5	26.3	27.2	27.5	28.2	29.2	29.8	26.4	26.1	29.8	29.0	31.1	27.0	28.5	29.0
1.500	29.6	30.0	25.6	27.4	31.1	29.0	31.0	28.1	30.8	26.5	29.0	27.5	25.2	26.8	26.5	27.5	28.8	28.8	26.4	27.8	30.1	30.0	31.7	26.7	28.2	29.0
1.625	28.6	30.1	26.2	28.5	32.2	29.5	29.6	33.5	31.2	31.3	30.1	29.5	25.9	28.8	26.5	27.8	29.6	28.2	25.4	27.8	31.7	29.2	31.9	28.2	28.0	30.0
1.750	29.7	28.0	26.2	30.2	31.6	28.7	29.6	27.0	29.6	32.8	30.3	27.4	26.3	25.8	28.9	29.5	26.8	27.5	26.2	25.8	30.8	31.1	31.0	29.0	28.4	29.6
1.875	30.4	30.2	26.5	28.7	30.4	30.0	28.8	28.3	29.4	29.2	30.9	29.2	26.5	28.0	28.1	30.0	27.8	29.0	28.1	26.0	30.3	29.0	31.7	28.0	30.2	29.4
2.000	31.9	29.5	27.0	31.8	31.6	29.0	30.1	31.4	31.2	27.3	31.4	31.6	28.9	26.8	27.8	31.1	31.8	30.8	26.4	28.2	31.2	29.5	30.1	30.0	28.4	30.0
2.125	33.3	30.9	29.1	30.0	29.7	30.8	32.4	31.1	32.0	29.8	31.7	30.0	29.2	26.3	29.3	30.0	28.5	28.5	26.7	26.2	33.9	29.2	29.6	29.7	28.9	29.0
2.250	31.1	31.1	28.3	30.1	32.7	30.3	32.8	34.5	32.3	29.6	31.8	31.7	26.9	27.8	28.1	30.1	28.0	30.5	28.2	29.3	32.5	32.3	31.4	29.8	30.4	30.5
2.375	30.4	29.5	29.0	33.0	35.1	31.9	33.8	35.0	32.9	35.0	32.5	34.5	31.6	31.2	30.4	31.7	29.9	31.0	30.1	27.5	32.1	31.0	32.0	32.1	31.9	30.0
2.500	32.9	31.8	31.1	33.1	33.6	32.8	34.1	34.1	32.7	35.5	31.3	35.0	29.4	30.5	32.2	33.0	29.5	32.5	32.0	32.0	32.3	33.8	33.2	32.8	35.4	33.0
2.625	35.3	34.9	33.4	35.0	34.1	34.0	33.1	34.8	33.6	32.6	32.7	34.5	30.8	31.5	37.8	34.9	30.6	36.6	32.0	31.0	34.6	34.1	32.5	34.5	37.2	36.0
2.750	35.2	34.5	34.5	37.8	39.0	37.5	34.4	34.7	35.1	37.2	33.3	35.0	33.2	33.0	35.3	37.0	30.1	36.8	33.4	33.0	37.2	37.1	33.3	35.2	37.8	36.8
2.875	35.0	37.0	35.1	36.9	35.7	37.5	35.2	34.8	36.3	36.4	34.4	36.0	32.5	34.8	36.6	36.8	31.2	36.8	34.4	33.2	35.0	37.1	35.5	34.8	36.9	36.0
3.000	35.4	36.5	36.0	38.0	38.2	37.5	35.2	35.6	35.3	37.5	33.1	35.5	32.1	34.2	36.8	37.2	34.0	36.5	33.3	33.7	36.0	37.5	34.3	34.4	36.4	36.8
3.125	35.0	36.1	37.6	38.2	39.9	37.3	33.0	35.5	35.7	38.0	31.4	35.5	34.1	31.9	35.9	36.2	35.0	35.5	32.1	34.1	34.7	37.1	33.1	32.2	34.6	35.7
3.250	35.0	34.0	36.5	38.0	39.0	37.2	35.4	37.1	36.2	37.1	33.5	33.0	38.0	35.0	37.0	40.2	35.1	39.0	31.9	31.5	33.6	36.1	33.9	35.0	33.2	23.2

Location (in)	7-II-E-124		7-II-E-127		7-II-E-130		7-II-E-135		Average	
	OPY	Rolled	OOH	Rolled	OYJ	Rolled	OQX	Rolled		
	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	**Field**	**Laboratory**
0.125	-	35.7	-	37.4	-	32.2	-	35.7	**-**	**34.0**
0.250	34.7	35.8	35.6	37.5	36.0	33.8	37.5	37.0	**34.3**	**34.9**
0.375	34.1	35.2	38.5	37.1	34.4	34.2	38.5	36.8	**34.4**	**35.5**
0.500	34.9	35.9	36.8	36.0	33.6	31.5	38.8	36.5	**34.2**	**35.1**
0.625	31.7	32.2	34.0	34.0	33.7	31.3	36.9	34.8	**33.4**	**33.7**
0.750	32.2	30.5	33.0	32.0	31.2	28.3	34.2	32.5	**32.4**	**32.1**
0.875	30.6	29.8	31.7	31.3	32.2	26.1	32.1	31.5	**31.4**	**31.2**
1.000	29.7	29.4	32.3	30.5	31.1	27.2	31.7	30.1	**31.0**	**30.2**
1.125	30.9	29.2	32.8	28.8	31.0	26.2	31.7	27.3	**30.0**	**29.5**
1.250	29.6	29.1	32.6	28.8	33.5	27.0	32.0	29.8	**29.9**	**28.7**
1.375	30.2	27.8	33.4	28.0	30.2	27.1	32.2	28.0	**28.9**	**28.4**
1.500	29.3	26.5	31.4	28.0	31.2	27.0	30.1	28.3	**28.9**	**28.1**
1.625	26.1	26.0	30.5	28.7	31.5	29.0	29.7	26.8	**28.4**	**28.1**
1.750	31.3	27.8	32.2	30.2	30.5	28.5	31.0	26.4	**28.7**	**28.1**
1.875	28.6	28.0	32.7	27.8	31.9	29.0	30.6	29.2	**29.1**	**28.3**
2.000	30.0	27.8	29.2	30.2	31.1	28.0	31.0	29.1	**29.6**	**28.7**
2.125	30.4	28.9	31.5	30.1	31.6	29.0	32.9	30.1	**29.8**	**29.0**
2.250	30.4	31.0	30.5	30.0	33.3	28.0	32.8	32.6	**30.1**	**29.6**
2.375	32.7	31.3	34.5	30.1	34.1	29.8	36.1	32.2	**31.4**	**30.8**
2.500	32.8	31.9	36.8	35.3	34.0	32.5	38.6	33.5	**32.3**	**32.2**
2.625	35.4	35.2	38.6	36.5	35.1	31.1	35.1	36.5	**33.0**	**33.4**
2.750	34.3	35.8	38.5	38.2	34.2	32.0	39.9	37.8	**33.8**	**34.8**
2.875	35.1	36.2	38.9	38.0	34.9	33.5	39.4	37.2	**34.7**	**35.7**
3.000	36.4	36.2	38.8	38.7	36.0	34.1	39.2	36.8	**34.6**	**35.7**
3.125	37.1	35.8	37.6	38.8	38.0	31.5	37.6	36.5	**34.6**	**35.5**
3.250	37.9	41.0	39.2	26.8	35.9	36.5	35.0	40.2	**35.6**	**35.1**


7-II-W-029
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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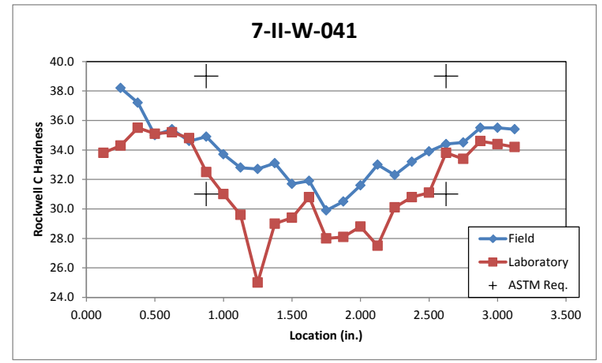
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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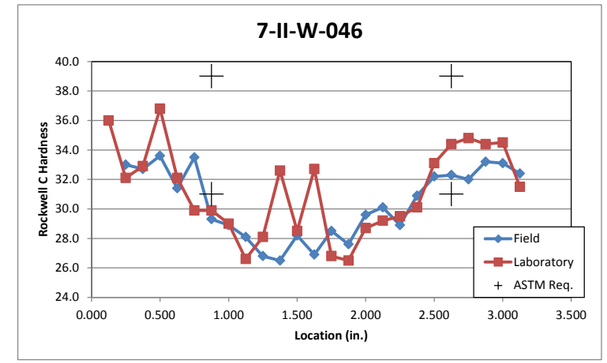
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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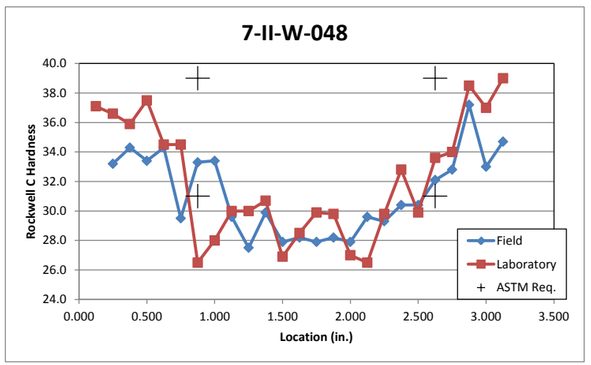
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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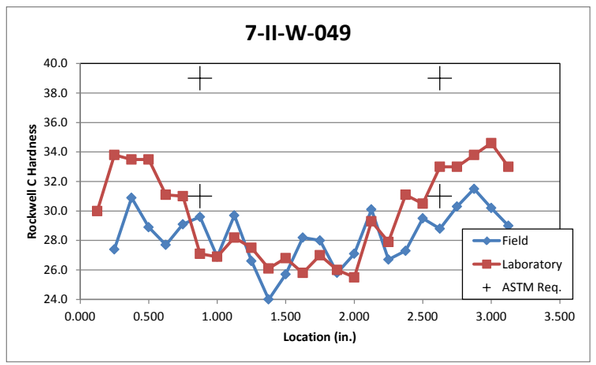
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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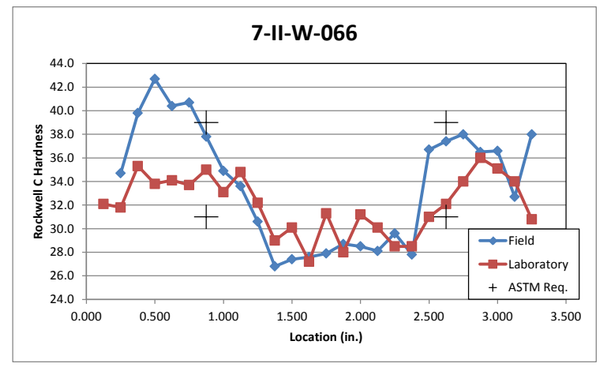
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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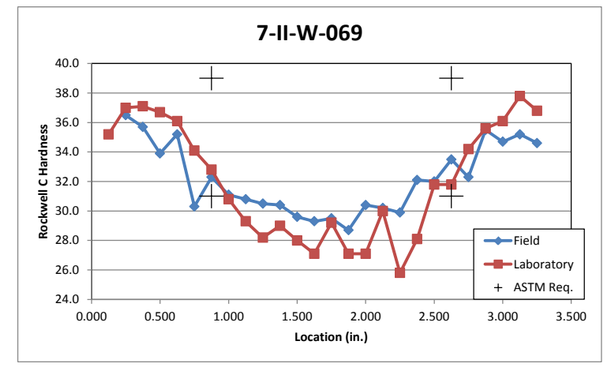
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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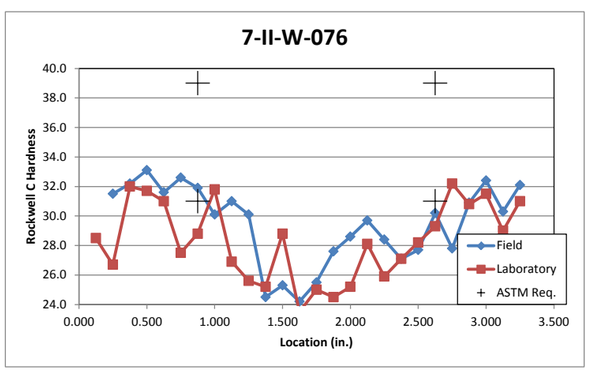
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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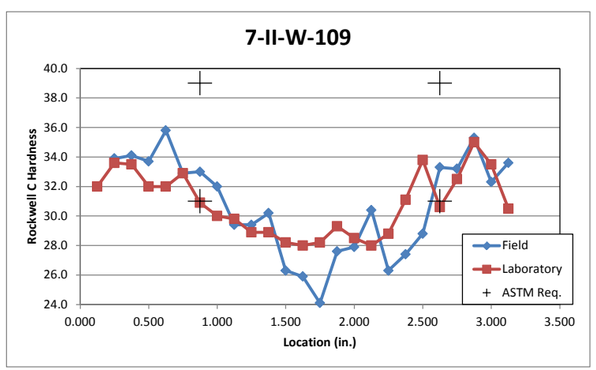
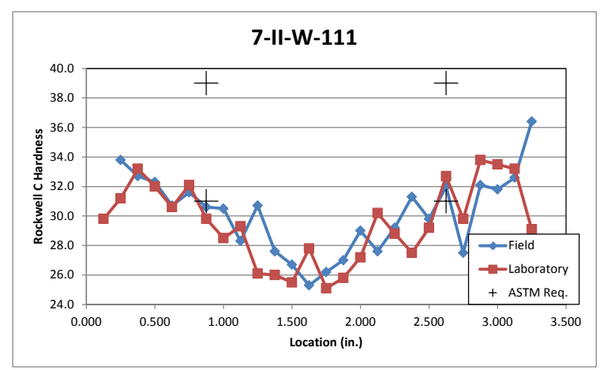
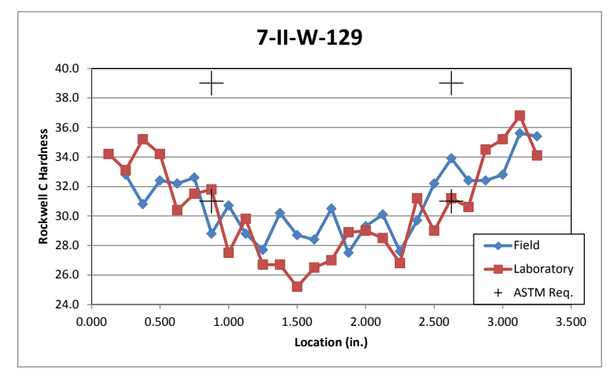
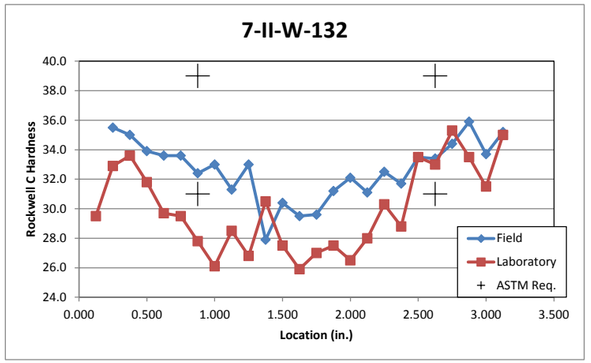
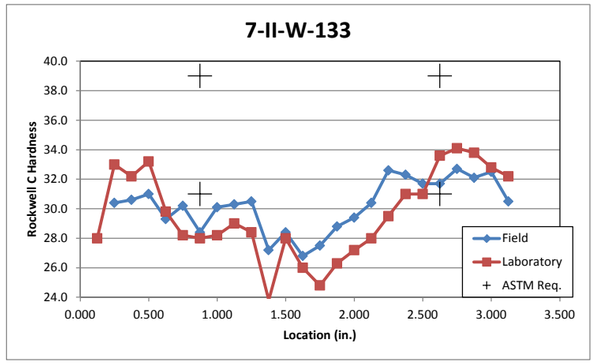
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.

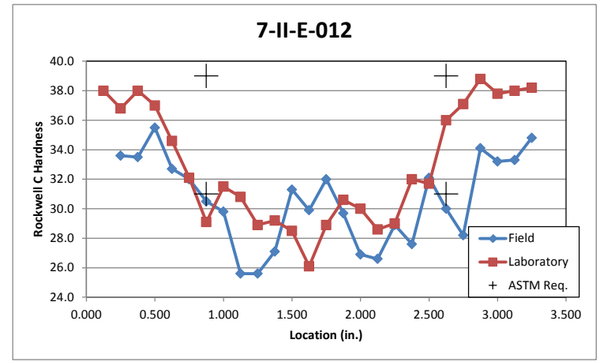

7-II-W-109
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.

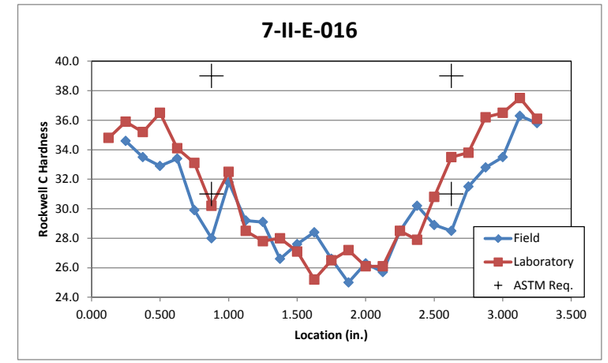

7-II-W-111
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.

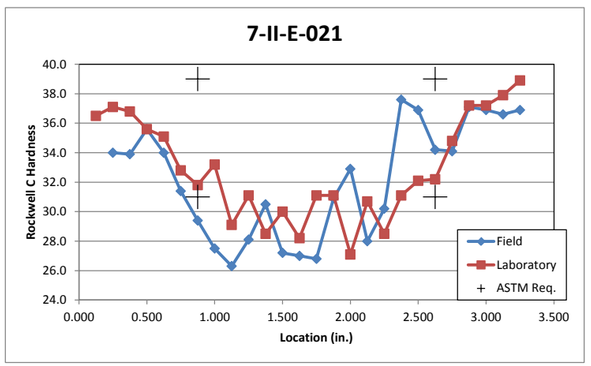

7-II-W-129
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.

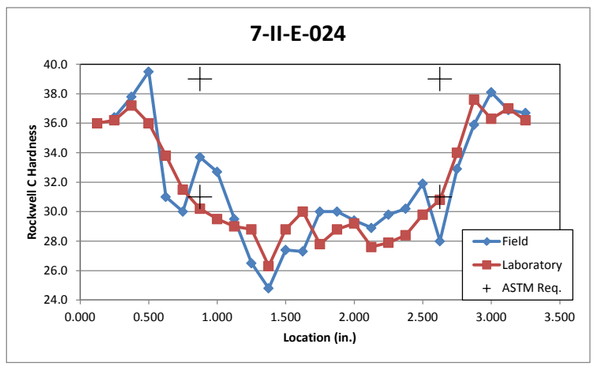

7-II-W-132
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.

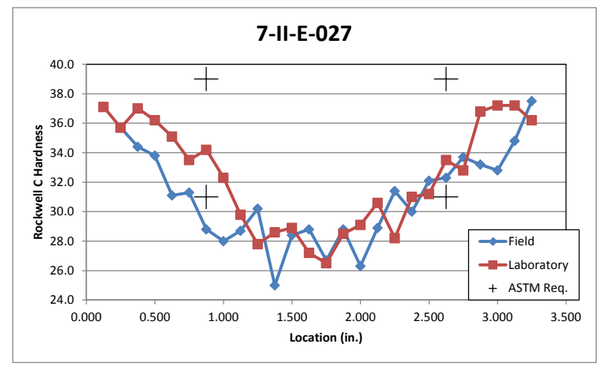

7-II-W-133
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.

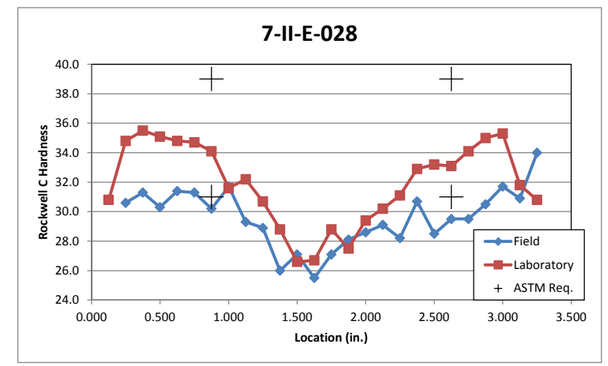

7-II-E-012
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.


7-II-E-016
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.


7-II-E-021
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.


7-II-E-024
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.


7-II-E-027
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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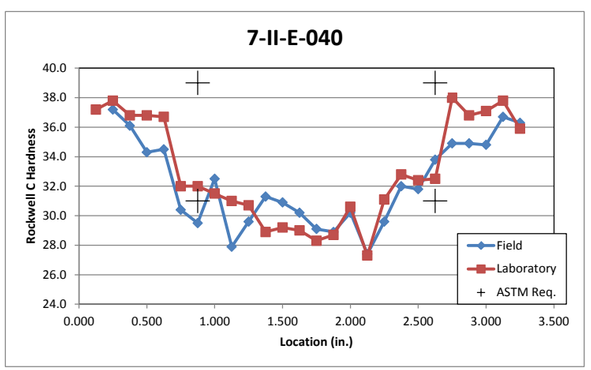
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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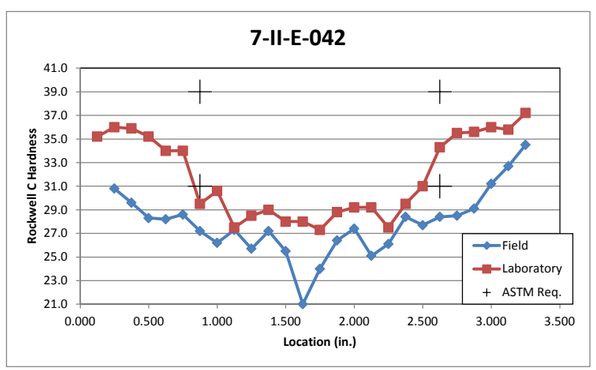
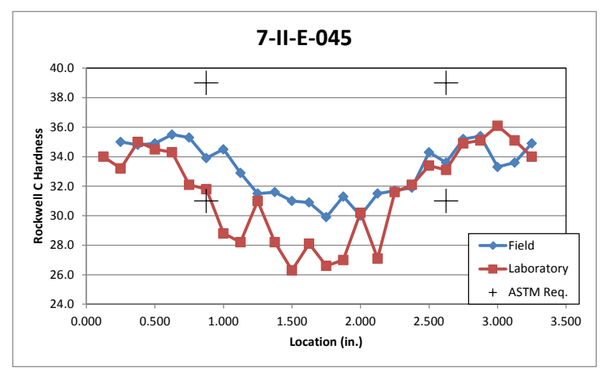
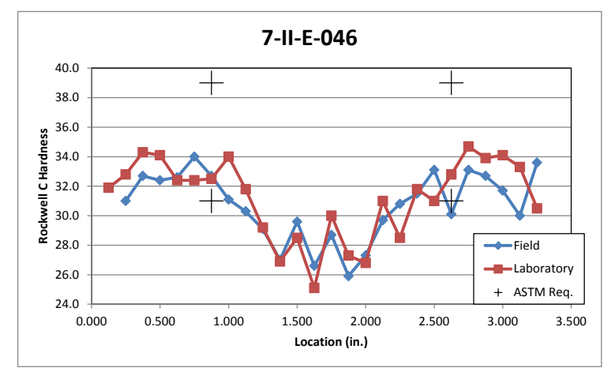
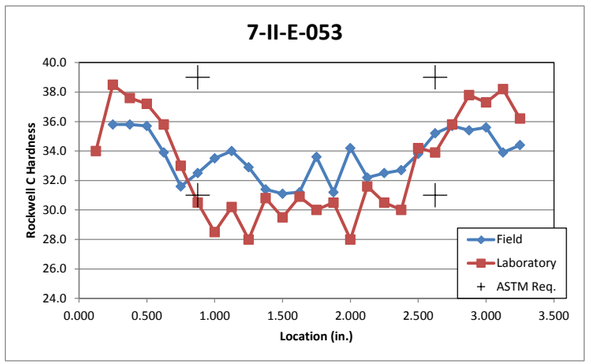
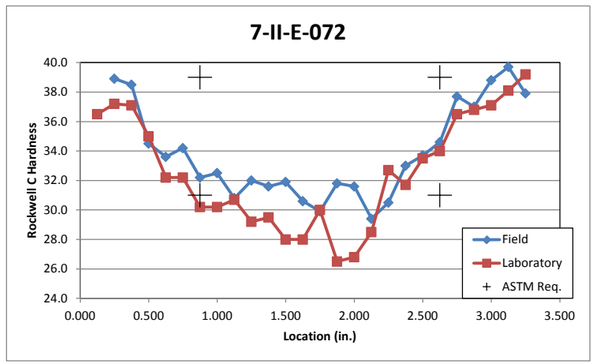
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.

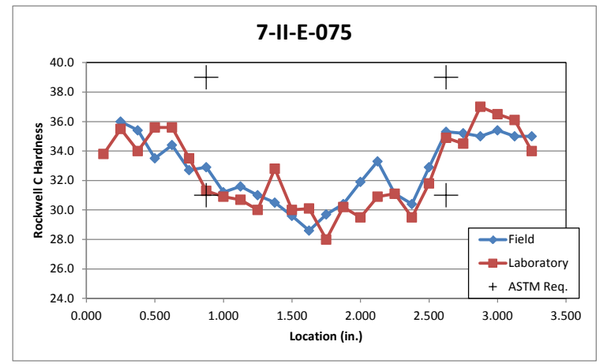

7-II-E-042
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.

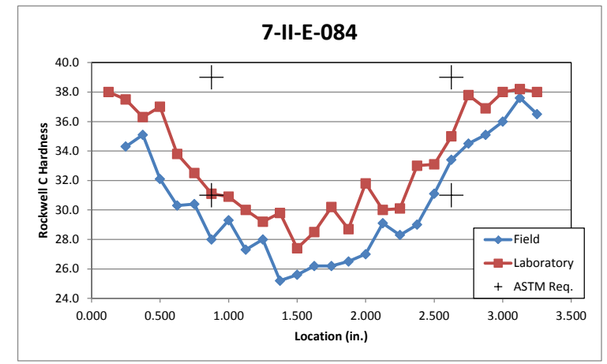

7-II-E-045
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.

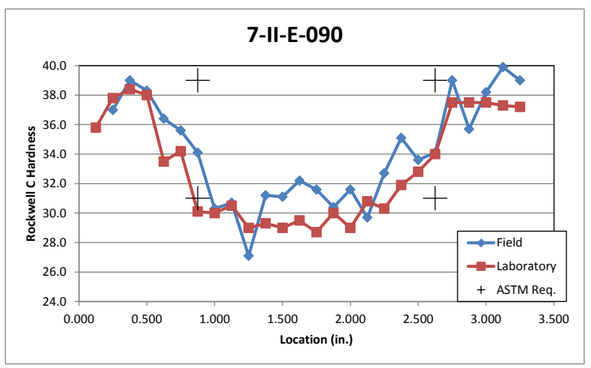

7-II-E-046
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.

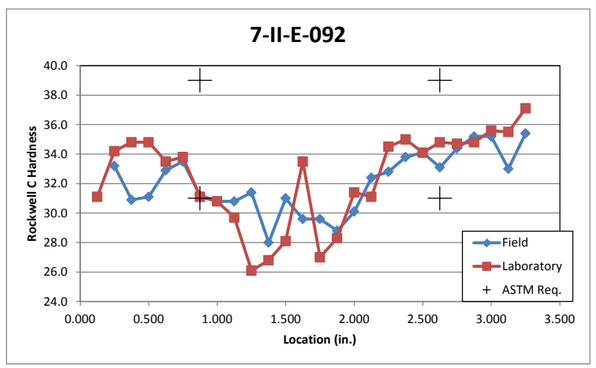

7-II-E-053
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.


7-II-E-072
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.


7-II-E-075
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.


7-II-E-084
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.


7-II-E-090
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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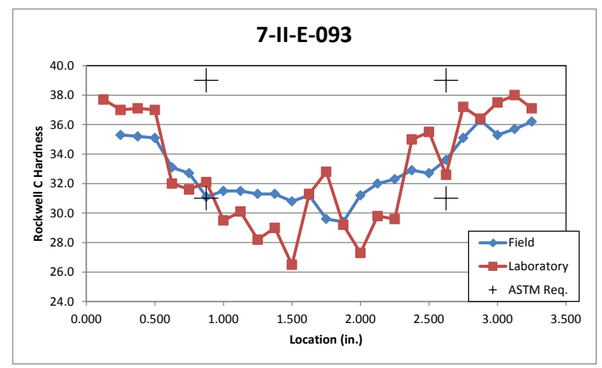
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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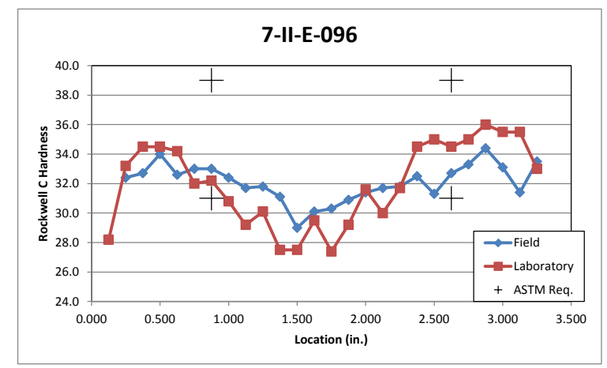
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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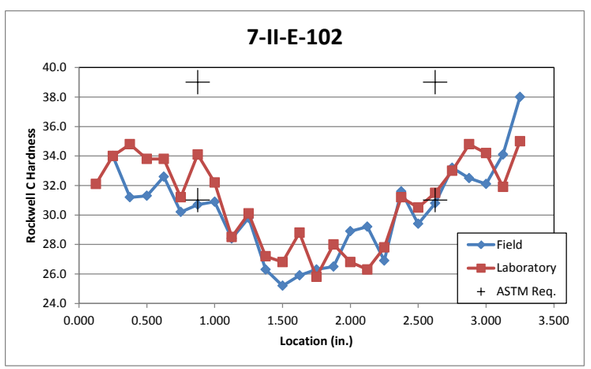
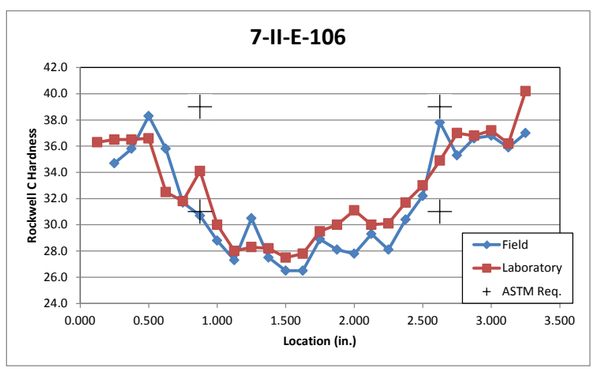
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.


7-II-E-102
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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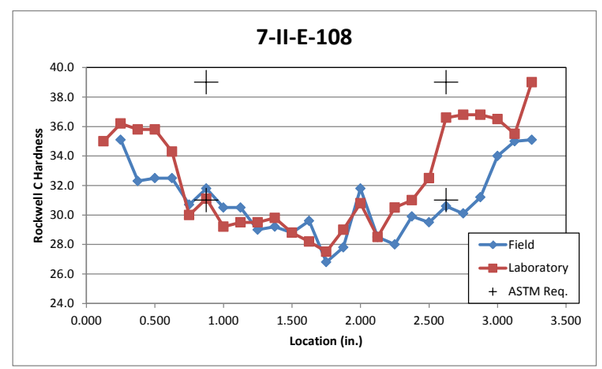
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.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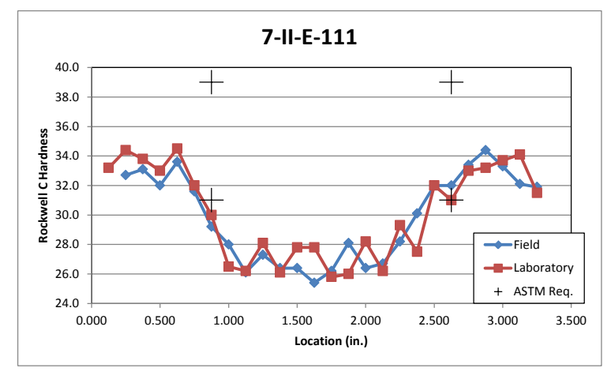
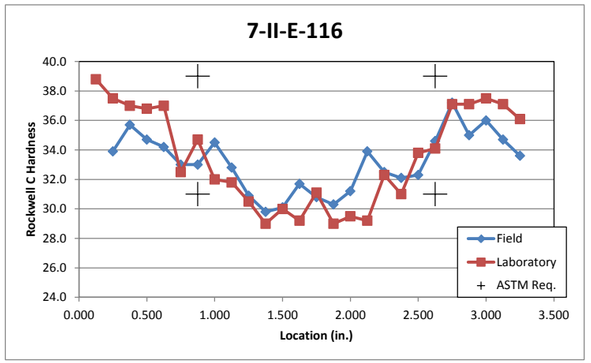
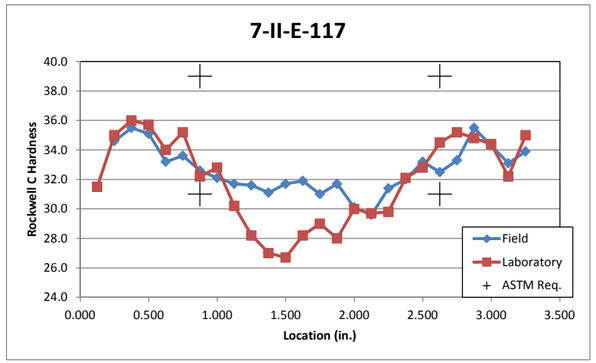
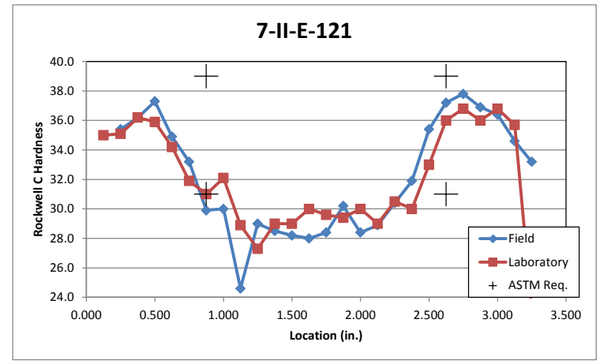
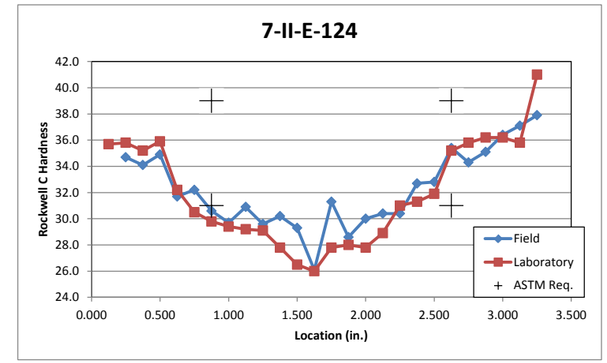
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.

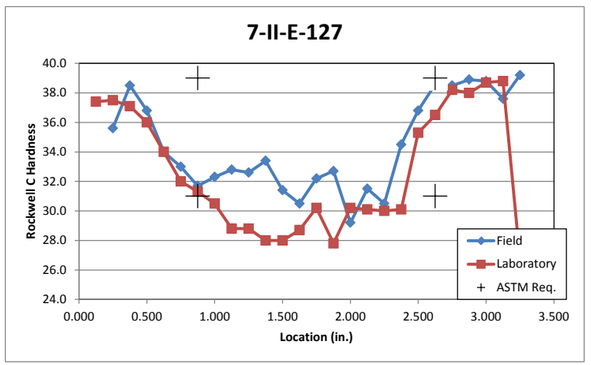

7-II-E-111
Rockwell C Hardness
Location (in.)
Field
Laboratory
ASTM Req.

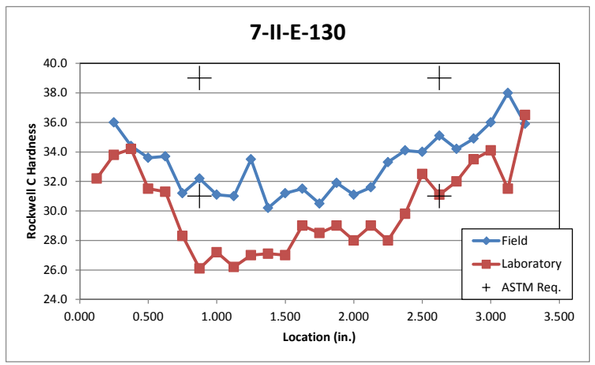


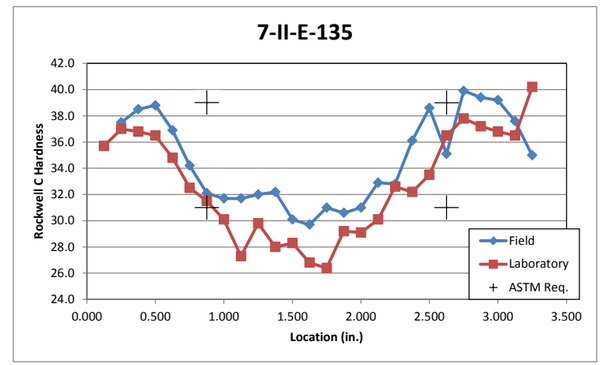


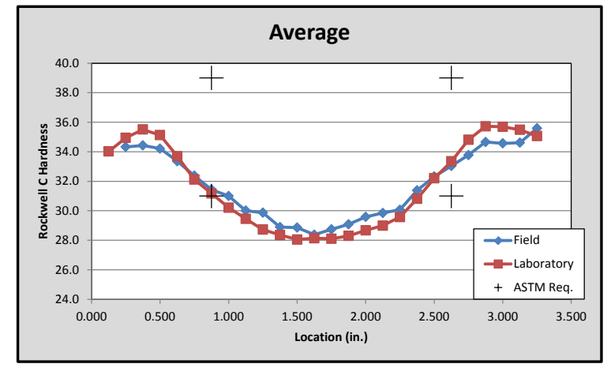












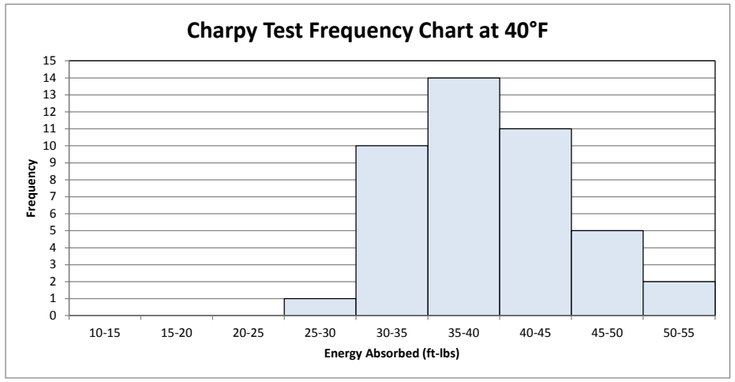
Charpy V-Notch Impact Test

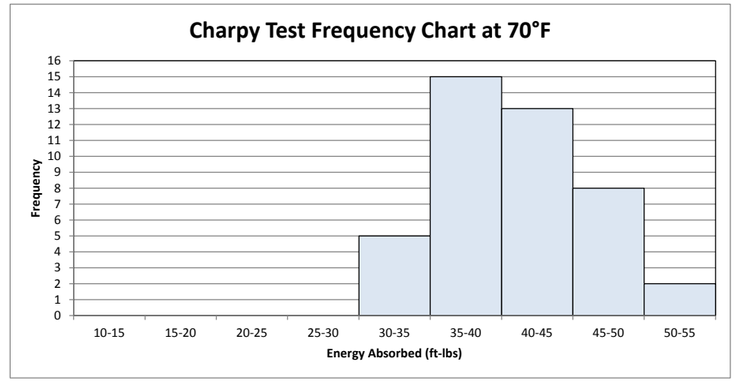
Charpy V-Notch Impact Energy Results (ft-lb)																								
Identification	**7-II-W-029**		**7-II-W-039**		**7-II-W-041**		**7-II-W-046**		**7-II-W-048**		**7-II-W-049**		**7-II-W-066**		**7-II-W-069**		**7-II-W-076**		**7-II-W-109**		**7-II-W-111**		**7-II-W-129**	
Temperature	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F
Sample 1	35	36.5	43	44.5	36	40	42	45	32	37	52	49	43	44	36	36	50	51	44	46	43	43	42	44
Sample 2	35.5	34	42	45	37	41	43	43	33	34	50	51	41	42	35	37	50	42	44	46	41	44	43	43
Sample 3	34	35	41	43	41	43	40	43	31	31	51	54	39	53	35	35	48	47	42	45	38	43	42	42
Average	34.8	35.2	42.0	44.2	38.0	41.3	41.7	43.7	32.0	34.0	51.0	51.3	41.0	46.3	35.3	36.0	49.3	46.7	43.3	45.7	40.7	43.3	42.3	43.0

Charpy V-Notch Impact Energy Results (ft-lb)																								
Identification	**7-II-W-132**		**7-II-W-133**		**7-II-E-012**		**7-II-E-016**		**7-II-E-021**		**7-II-E-024**		**7-II-E-027**		**7-II-E-028**		**7-II-E-040**		**7-II-E-042**		**7-II-E-045**		**7-II-E-046**	
Temperature	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F
Sample 1	51	50	47	48	32	32	37	37	35	36	40	41	39	39	37	43	36	38	38	40	29	38	45	46
Sample 2	49	48	45	50	32	33	34	37	33	36	41	43	40	39	37	40	35	38	40	37	28	40	44	46
Sample 3	53	50	47	50	32	32	34	39	31	36	39	40	40	41	39	42	35	36	38	39	30	37	41	46
Average	51.0	49.3	46.3	49.3	32.0	32.3	35.0	37.7	33.0	36.0	40.0	41.3	39.7	39.7	37.7	41.7	35.3	37.3	38.7	38.7	29.0	38.3	43.3	46.0

Charpy V-Notch Impact Energy Results (ft-lb)																								
Identification	**7-II-E-053**		**7-II-E-072**		**7-II-E-075**		**7-II-E-084**		**7-II-E-090**		**7-II-E-092**		**7-II-E-093**		**7-II-E-096**		**7-II-E-102**		**7-II-E-106**		**7-II-E-108**		**7-II-E-111**	
Temperature	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F
Sample 1	31	31	34	38	39	40	33	35	32	36	43	42	31	35	42	42	48	45	40	41	39	39	48	51
Sample 2	30	33	35	34	40	38	33	35	33	36	40	41	33	36	38	40	46	47	39	40	39	40	48	50
Sample 3	32	34	36	35	37	41	31	32	34	35	38	43	32	34	39	44	47	49	40	40	38	38	50	50
Average	31.0	32.7	35.0	35.7	38.7	39.7	32.3	34.0	33.0	35.7	40.3	42.0	32.0	35.0	39.7	42.0	47.0	47.0	39.7	40.3	38.7	39.0	48.7	50.3

Charpy V-Notch Impact Energy Results (ft-lb)																
Identification	**7-II-E-116**		**7-II-E-117**		**7-II-E-121**		**7-II-E-124**		**7-II-E-127**		**7-II-E-130**		**7-II-E-135**		**Average**	
Temperature	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	**40°F**	**70°F**
Sample 1	31	36	37	39	40	40	40	40	33	34	46	49	41	41	**N/A**	**N/A**
Sample 2	32	36	39	39	40	40	41	43	32	34	50	50	37	41	**N/A**	**N/A**
Sample 3	35	37	38	39	41	41	43	42	30	35	45	48	36	43	**N/A**	**N/A**
Average	32.7	36.3	38.0	39.0	40.3	40.3	41.3	41.7	31.7	34.3	47.0	49.0	38.0	41.7	**39.0**	**40.8**





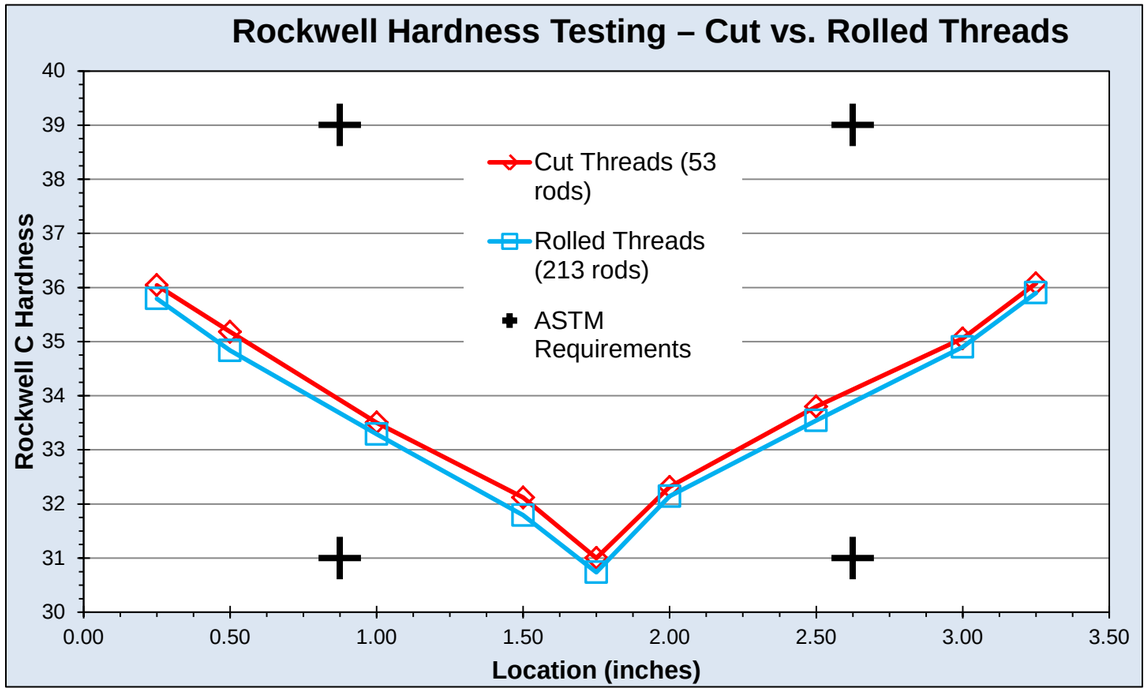
Spectrochemical Analysis

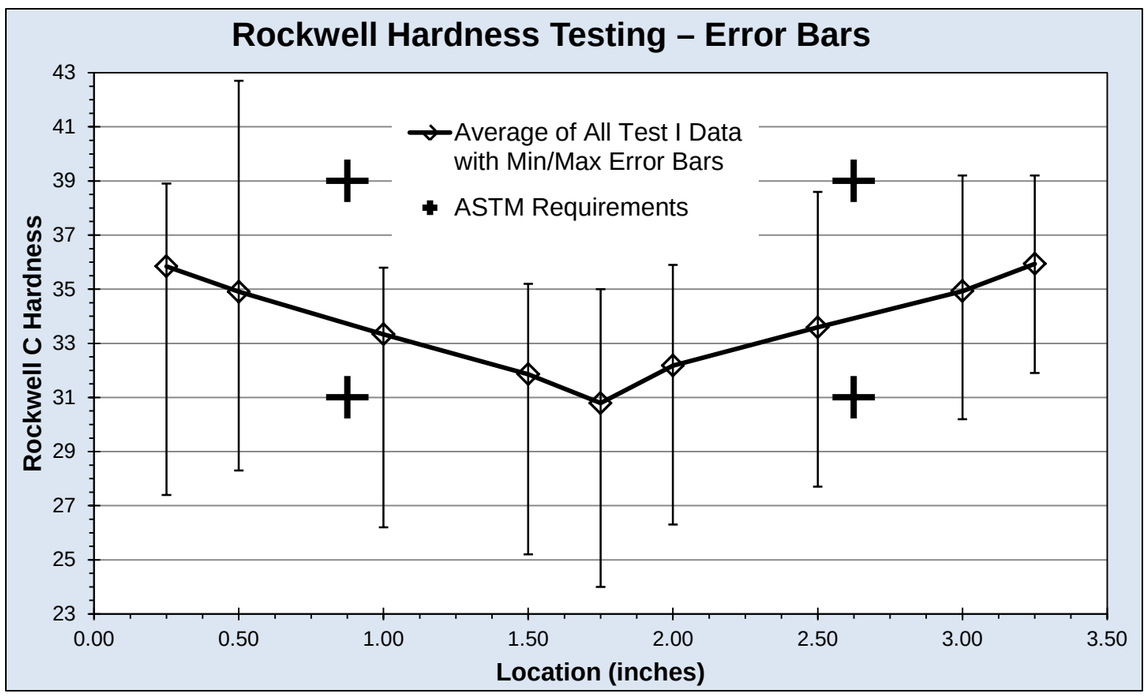
Spectrochemical Analysis (Reported as Wt. %)																											
		7-II-W-029	7-II-W-039	7-II-W-041	7-II-W-046	7-II-W-048	7-II-W-049	7-II-W-066	7-II-W-069	7-II-W-076	7-II-W-109	7-II-W-111	7-II-W-129	7-II-W-132	7-II-W-133	7-II-E-012	7-II-E-016	7-II-E-021	7-II-E-024	7-II-E-027	7-II-E-028	7-II-E-040	7-II-E-042	7-II-E-045	7-II-E-046	ASTM 354
Aluminum	Al	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-
Carbon	C	0.42	0.41	0.44	0.44	0.42	0.43	0.44	0.42	0.42	0.44	0.43	0.41	0.43	0.42	0.44	0.42	0.42	0.41	0.43	0.43	0.41	0.41	0.42	0.42	0.33-0.55
Chromium	Cr	1.06	1.06	1.02	1.02	1.07	1.02	1.03	1.08	1.03	1.01	1.02	1.08	1.02	1.03	1.06	1.08	1.07	1.07	1.06	1.02	1.08	1.07	1.01	1.01	-
Cobalt	Co	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-
Columbium	Cb	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.01	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Copper	Cu	0.18	0.17	0.19	0.19	0.17	0.18	0.18	0.17	0.18	0.17	0.17	0.17	0.17	0.18	0.19	0.18	0.19	0.16	0.18	0.16	0.16	0.17	0.17	0.17	-
Manganese	Mn	0.98	0.96	0.93	0.92	0.95	0.94	0.91	0.95	0.95	0.93	0.94	0.95	0.94	0.94	0.97	1.00	0.98	0.99	0.98	0.98	1.00	0.99	0.96	0.96	0.57 min.
Molybdenum	Mo	0.16	0.16	0.23	0.22	0.16	0.21	0.22	0.16	0.22	0.21	0.21	0.16	0.21	0.21	0.17	0.17	0.16	0.16	0.17	0.22	0.17	0.17	0.21	0.22	-
Nickel	Ni	0.09	0.08	0.12	0.13	0.08	0.06	0.15	0.08	0.06	0.06	0.06	0.08	0.06	0.06	0.09	0.09	0.09	0.08	0.09	0.06	0.08	0.10	0.06	0.06	-
Phosporus	P	0.014	0.014	0.010	0.010	0.013	0.009	0.010	0.014	0.010	0.009	0.009	0.014	0.009	0.009	0.012	0.013	0.013	0.014	0.015	0.010	0.014	0.013	0.009	0.009	0.040 max.
Silicon	Si	0.16	0.16	0.27	0.27	0.16	0.25	0.28	0.16	0.25	0.25	0.25	0.16	0.25	0.25	0.18	0.19	0.19	0.16	0.17	0.25	0.16	0.20	0.25	0.25	-
Sulfur	S	0.033	0.030	0.006	0.006	0.032	0.005	0.006	0.031	<0.005	<0.005	<0.005	0.030	<0.005	<0.005	0.033	0.031	0.031	0.031	0.034	<0.005	0.030	0.024	0.005	<0.005	0.045 max.
Titanium	Ti	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
Vanadium	V	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	-

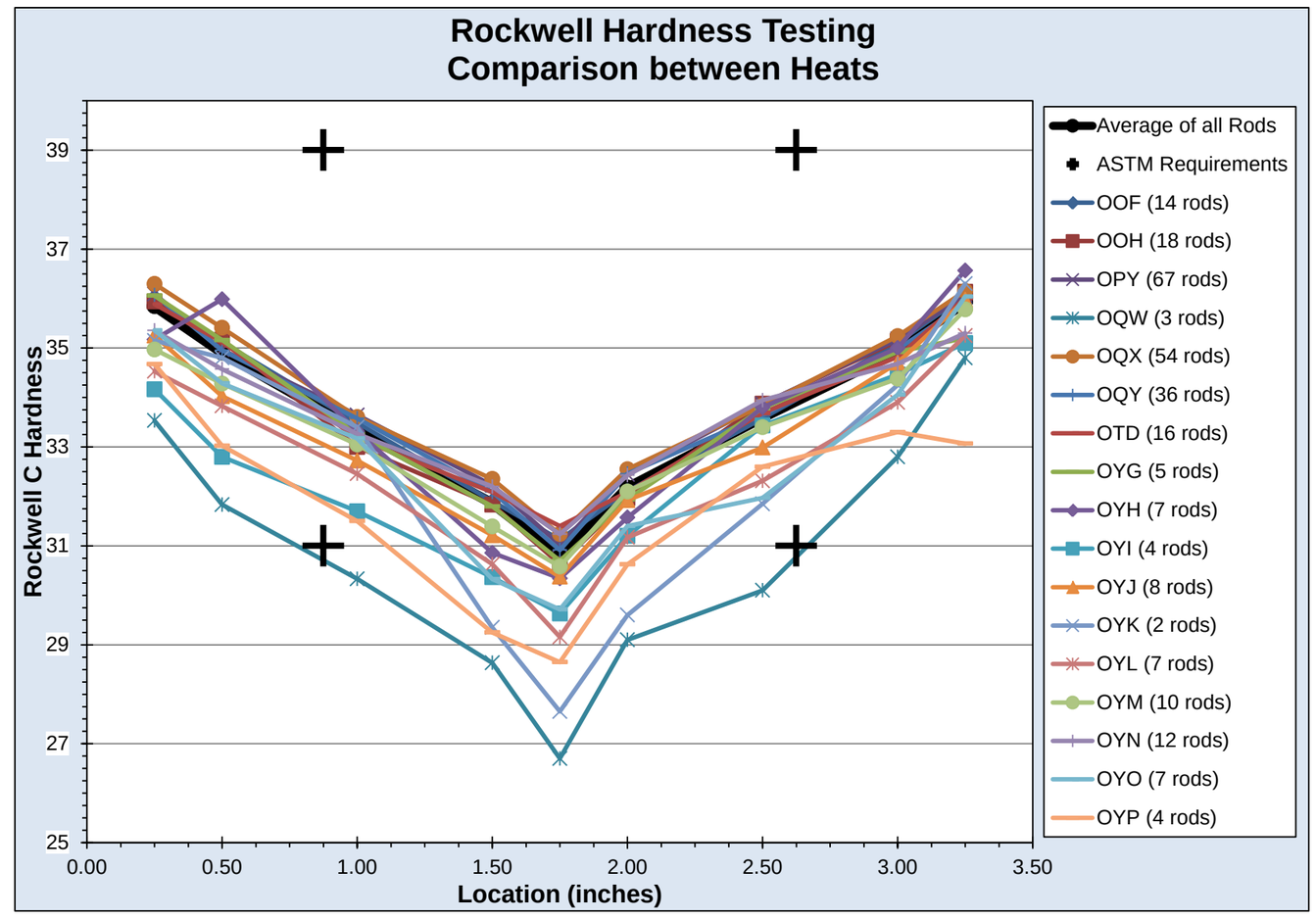
Spectrochemical Analysis (Reported as Wt. %)																							
		7-II-E-053	7-II-E-072	7-II-E-075	7-II-E-084	7-II-E-090	7-II-E-092	7-II-E-093	7-II-E-096	7-II-E-102	7-II-E-106	7-II-E-108	7-II-E-111	7-II-E-116	7-II-E-117	7-II-E-121	7-II-E-124	7-II-E-127	7-II-E-130	7-II-E-135	**Average**	ASTM 354
Aluminum	Al	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	**0.02**	-
Carbon	C	0.41	0.43	0.43	0.42	0.41	0.44	0.42	0.45	0.42	0.41	0.43	0.42	0.43	0.43	0.43	0.42	0.42	0.44	0.42	**0.42**	0.33-0.55
Chromium	Cr	1.07	1.06	1.03	1.07	1.08	1.03	1.07	1.03	1.02	1.08	1.07	1.02	1.01	1.03	1.07	1.07	1.06	1.02	1.08	**1.05**	-
Cobalt	Co	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	**0.01**	-
Columbium	Cb	<0.01	<0.01	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.001	<0.01	<0.005	**<0.01**	-
Copper	Cu	0.18	0.17	0.16	0.18	0.16	0.17	0.18	0.18	0.16	0.16	0.17	0.16	0.17	0.17	0.17	0.17	0.17	0.16	0.16	**0.17**	-
Manganese	Mn	0.98	0.99	0.97	0.98	0.98	0.94	0.97	0.94	0.97	1.02	1.02	0.99	1.01	0.96	1.00	1.01	1.00	0.97	1.00	**0.97**	0.57 min.
Molybdenum	Mo	0.16	0.17	0.21	0.17	0.16	0.22	0.16	0.23	0.21	0.16	0.16	0.21	0.16	0.22	0.16	0.16	0.16	0.20	0.16	**0.19**	-
Nickel	Ni	0.09	0.10	0.06	0.09	0.80	0.15	0.09	0.14	0.06	0.08	0.10	0.06	0.10	0.15	0.10	0.10	0.09	0.06	0.09	**0.10**	-
Phosporus	P	0.014	0.014	0.009	0.015	0.014	0.010	0.014	0.010	0.009	0.014	0.013	0.009	0.014	0.010	0.013	0.013	0.014	0.008	0.013	**0.012**	0.040 max.
Silicon	Si	0.17	0.21	0.25	0.17	0.16	0.27	0.18	0.27	0.25	0.16	0.20	0.26	0.20	0.27	0.20	0.20	0.18	0.26	0.17	**0.21**	-
Sulfur	S	0.033	0.032	<0.005	0.034	0.031	0.006	0.032	0.006	<0.005	0.030	0.034	<0.005	0.033	0.006	0.033	0.033	0.034	0.005	0.033	**0.025**	0.045 max.
Titanium	Ti	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	**<0.005**	-
Vanadium	V	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	**<0.005**	-

PWS Anchor Rod Summary

Item 7 – 3.5” Diameter



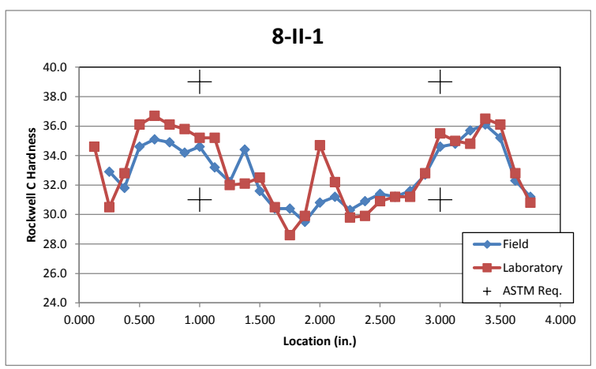


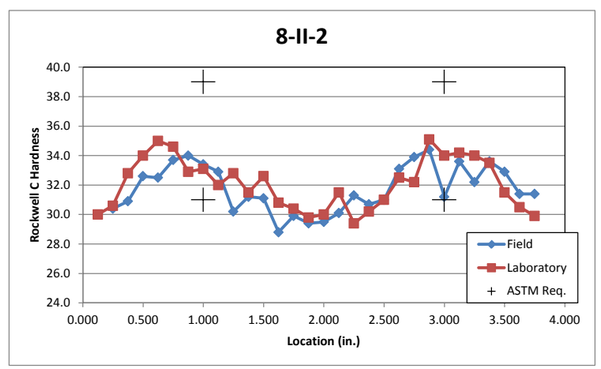


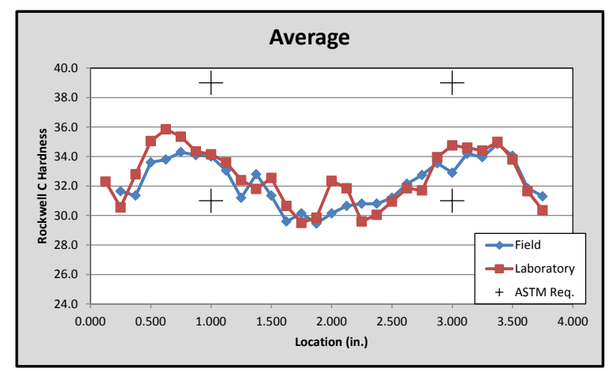
ITEM 8. 4" TOWER SADDLE TIE RODS - TEST II

Rockwell Hardness Testing Comparison Across the Diameter

Location (in)	8-II-1		8-II-2		Average	
	Field	Laboratory	Field	Laboratory	**Field**	**Laboratory**
0.125	-	34.6	-	30.0	**-**	**32.3**
0.250	32.9	30.5	30.4	30.6	**31.7**	**30.6**
0.375	31.8	32.8	30.9	32.8	**31.4**	**32.8**
0.500	34.6	36.1	32.6	34.0	**33.6**	**35.1**
0.625	35.1	36.7	32.5	35.0	**33.8**	**35.9**
0.750	34.9	36.1	33.7	34.6	**34.3**	**35.4**
0.875	34.2	35.8	34.0	32.9	**34.1**	**34.4**
1.000	34.6	35.2	33.4	33.1	**34.0**	**34.2**
1.125	33.2	35.2	32.9	32.0	**33.1**	**33.6**
1.250	32.2	32.0	30.2	32.8	**31.2**	**32.4**
1.375	34.4	32.1	31.2	31.5	**32.8**	**31.8**
1.500	31.6	32.5	31.1	32.6	**31.4**	**32.6**
1.625	30.4	30.5	28.8	30.8	**29.6**	**30.7**
1.750	30.4	28.6	29.9	30.4	**30.2**	**29.5**
1.875	29.5	29.9	29.4	29.8	**29.5**	**29.9**
2.000	30.8	34.7	29.5	30.0	**30.2**	**32.4**
2.125	31.2	32.2	30.1	31.5	**30.7**	**31.9**
2.250	30.3	29.8	31.3	29.4	**30.8**	**29.6**
2.375	30.9	29.9	30.7	30.2	**30.8**	**30.1**
2.500	31.4	30.9	31.0	31.0	**31.2**	**31.0**
2.625	31.2	31.2	33.1	32.5	**32.2**	**31.9**
2.750	31.6	31.2	33.9	32.2	**32.8**	**31.7**
2.875	32.7	32.8	34.4	35.1	**33.6**	**34.0**
3.000	34.6	35.5	31.2	34.0	**32.9**	**34.8**
3.125	34.8	35.0	33.6	34.2	**34.2**	**34.6**
3.250	35.7	34.8	32.2	34.0	**34.0**	**34.4**
3.375	36.1	36.5	33.6	33.5	**34.9**	**35.0**
3.500	35.2	36.1	32.9	31.5	**34.1**	**33.8**
3.625	32.3	32.8	31.4	30.5	**31.9**	**31.7**
3.750	31.2	30.8	31.4	29.9	**31.3**	**30.4**

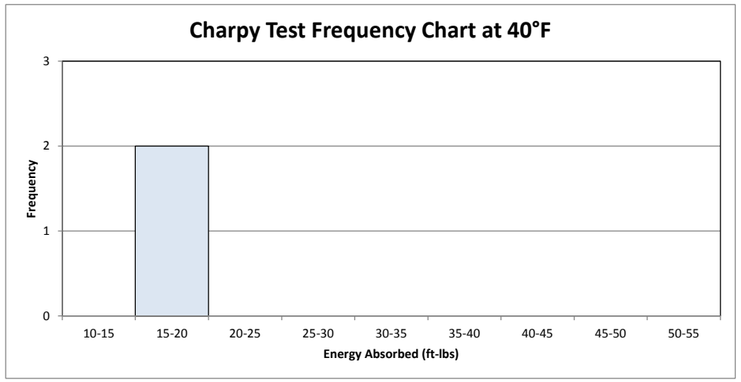


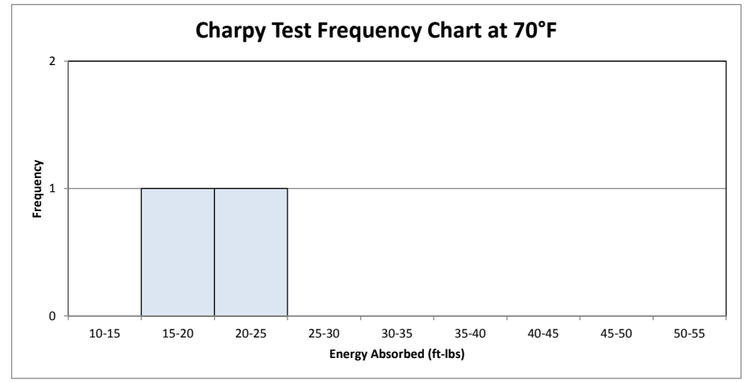




Charpy V-Notch Impact Test

Charpy V-Notch Impact Energy Results (ft-lb)						
Identification	8-II-1		8-II-2		Average	
Temperature	40°F	70°F	40°F	70°F	**40°F**	**70°F**
Sample 1	16.5	24	18.5	21	**N/A**	**N/A**
Sample 2	13	19	22	23	**N/A**	**N/A**
Sample 3	16.5	16	15	22	**N/A**	**N/A**
Average	15.3	19.7	18.5	22.0	**16.9**	**20.8**





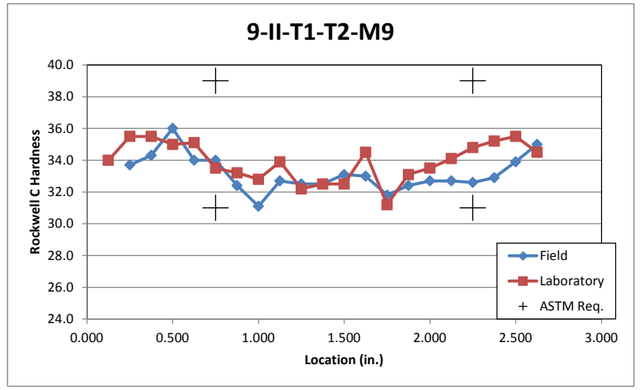
Spectrochemical Analysis

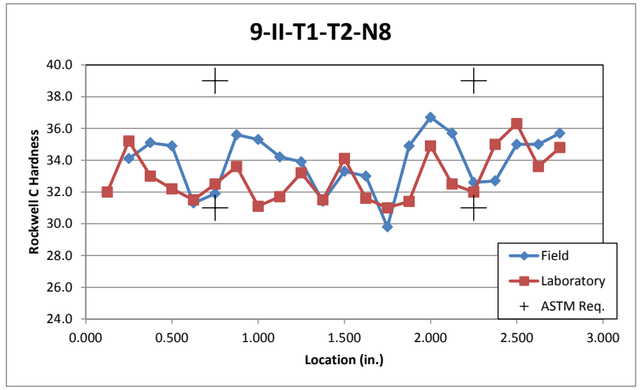
Spectrochemical Analysis (Reported as Wt. %)					
		8-II-1	8-II-2	**Average**	ASTM 354
Aluminum	Al	0.02	0.02	**0.02**	-
Carbon	C	0.42	0.43	**0.425**	0.33-0.55
Chromium	Cr	1.07	1.08	**1.075**	-
Cobalt	Co	0.01	0.01	**0.01**	-
Columbium	Cb	<0.01	<0.01	**<0.01**	-
Copper	Cu	0.18	0.18	**0.18**	-
Manganese	Mn	0.99	0.99	**0.99**	0.57 min.
Molybdenum	Mo	0.16	0.15	**0.155**	-
Nickel	Ni	0.14	0.14	**0.14**	-
Phosporus	P	0.008	0.008	**0.008**	0.040 max.
Silicon	Si	0.35	0.34	**0.345**	-
Sulfur	S	0.022	0.023	**0.0225**	0.045 max.
Titanium	Ti	<0.005	<0.006	**<0.006**	-
Vanadium	V	0.01	0.01	**0.01**	-

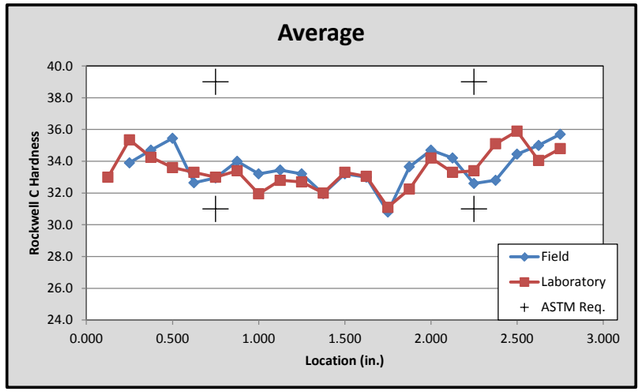
ITEM 9. TOWER SADDLE TURNED RODS - TEST II

Rockwell Hardness Testing Comparison Across the Diameter

Location (in)	9-II-T1-T2-M9		9-II-T1-T2-N8		Average	
	NNF	Cut	NTA	Cut		
	Field	Laboratory	Field	Laboratory	**Field**	**Laboratory**
0.125	-	34.0	-	32.0	**-**	**33.0**
0.250	33.7	35.5	34.1	35.2	**33.9**	**35.4**
0.375	34.3	35.5	35.1	33.0	**34.7**	**34.3**
0.500	36.0	35.0	34.9	32.2	**35.5**	**33.6**
0.625	34.0	35.1	31.3	31.5	**32.7**	**33.3**
0.750	34.0	33.5	31.9	32.5	**33.0**	**33.0**
0.875	32.4	33.2	35.6	33.6	**34.0**	**33.4**
1.000	31.1	32.8	35.3	31.1	**33.2**	**32.0**
1.125	32.7	33.9	34.2	31.7	**33.5**	**32.8**
1.250	32.5	32.2	33.9	33.2	**33.2**	**32.7**
1.375	32.5	32.5	31.4	31.5	**32.0**	**32.0**
1.500	33.1	32.5	33.3	34.1	**33.2**	**33.3**
1.625	33.0	34.5	33.0	31.6	**33.0**	**33.1**
1.750	31.8	31.2	29.8	31.0	**30.8**	**31.1**
1.875	32.4	33.1	34.9	31.4	**33.7**	**32.3**
2.000	32.7	33.5	36.7	34.9	**34.7**	**34.2**
2.125	32.7	34.1	35.7	32.5	**34.2**	**33.3**
2.250	32.6	34.8	32.6	32.0	**32.6**	**33.4**
2.375	32.9	35.2	32.7	35.0	**32.8**	**35.1**
2.500	33.9	35.5	35.0	36.3	**34.5**	**35.9**
2.625	35.0	34.5	35.0	33.6	**35.0**	**34.1**
2.750	-	-	35.7	34.8	**35.7**	**34.8**

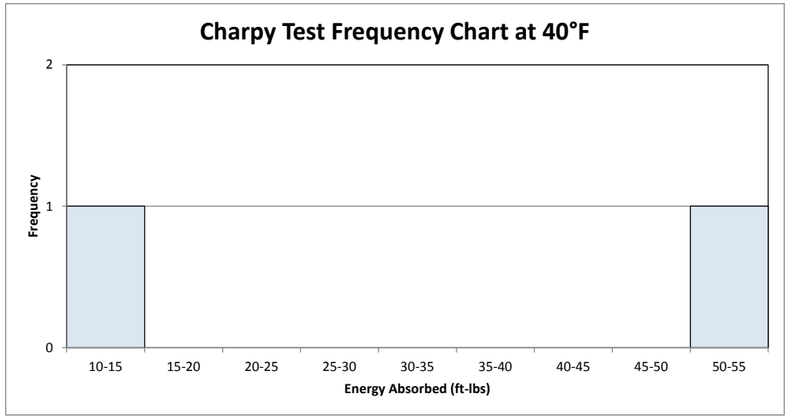


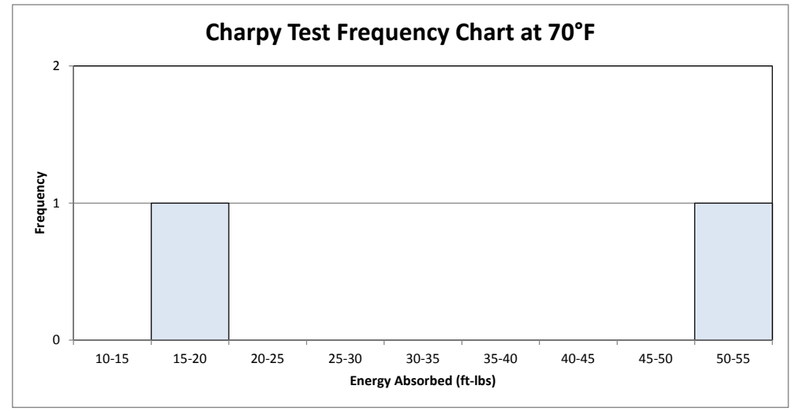




Charpy V-Notch Impact Test

Charpy V-Notch Impact Energy Results (ft-lb)						
Identification	9-II-T1-T2-M9		9-II-T1-T2-N8		Average	
	NNF		NTA			
Temperature	40°F	70°F	40°F	70°F	**40°F**	**70°F**
Sample 1	53	52	14	16	**N/A**	**N/A**
Sample 2	50	51	13.5	16	**N/A**	**N/A**
Sample 3	54	55	11.5	16	**N/A**	**N/A**
Average	52.3	52.7	13.0	16.0	**32.7**	**34.3**





* The two samples used to perform Test II were taken from two different heats. Heat NNF represents 100 of 108 Turned Rods, and is represented in Sample 9-II-T1-T2-M9. Heat NTA represents the last 8 turned rods and is represented in Sample 9-II-T1-T2-N8. Heat NTA is machined down from the same heat of material used to fabricate the Tower Saddle Tie Rods (Item 8).

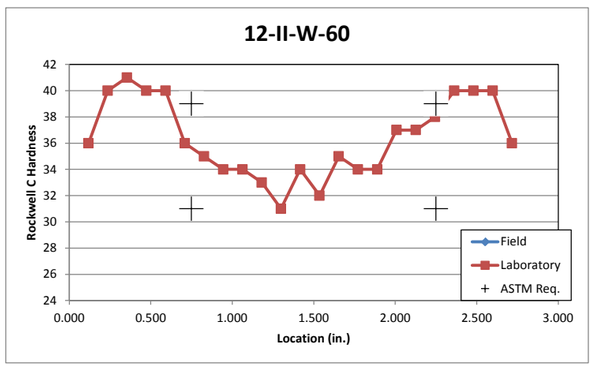
Spectrochemical Analysis

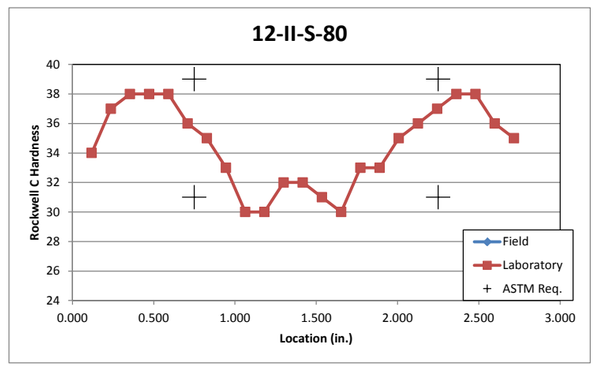
Spectrochemical Analysis (Reported as Wt. %)					
		9-II-T1-T2-M9	9-II-T1-T2-N8	**Average**	ASTM 354
Aluminum	Al	0.02	0.02	**0.02**	-
Carbon	C	0.45	0.41	**0.43**	0.33-0.55
Chromium	Cr	1.09	1.07	**1.08**	-
Cobalt	Co	<0.005	0.01	**0.01**	-
Columbium	Cb	<0.01	0.01	**0.01**	-
Copper	Cu	0.02	0.2	**0.11**	-
Manganese	Mn	0.96	0.97	**0.97**	0.57 min.
Molybdenum	Mo	0.23	0.16	**0.20**	-
Nickel	Ni	0.05	0.14	**0.10**	-
Phosporus	P	0.011	0.008	**0.010**	0.040 max.
Silicon	Si	0.33	0.36	**0.35**	-
Sulfur	S	0.020	0.021	**0.021**	0.045 max.
Titanium	Ti	<0.005	<0.005	**<0.005**	-
Vanadium	V	<0.005	<0.005	**<0.005**	-

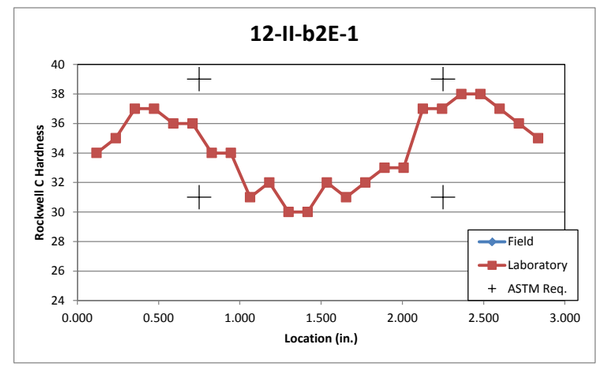
ITEM 12. 3" TOWER ANCHOR RODS - TEST II

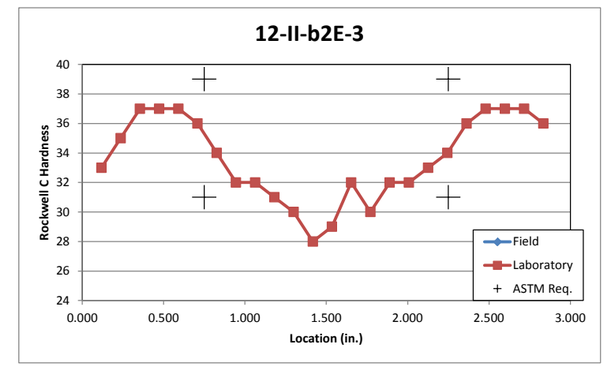
Rockwell Hardness Testing Comparison Across the Diameter

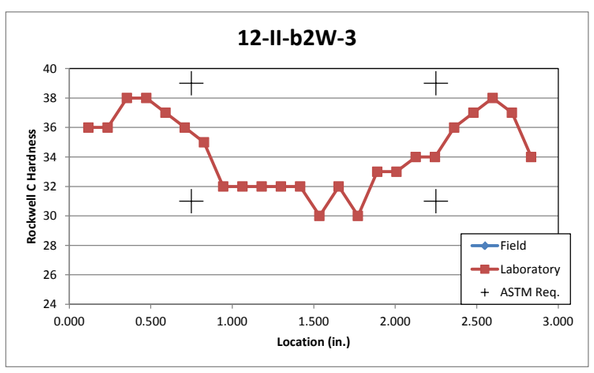
Location (in)	12-II-W-60		12-II-S-80		12-II-b2E-1		12-II-b2E-3		12-II-b2W-3		12-II-b2W-4		Average	
	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory	**Field**	**Laboratory**
0.118	-	36	-	34	-	34	-	33	-	36	-	28	**-**	**33.5**
0.236		40		37		35		35		36		33		**36.0**
0.354		41		38		37		37		38		34		**37.5**
0.472		40		38		37		37		38		34		**37.3**
0.591		40		38		36		37		37		33		**36.8**
0.709		36		36		36		36		36		31		**35.2**
0.827		35		35		34		34		35		31		**34.0**
0.945		34		33		34		32		32		30		**32.5**
1.063		34		30		31		32		32		29		**31.3**
1.181		33		30		32		31		32		28		**31.0**
1.299		31		32		30		30		32		29		**30.7**
1.417		34		32		30		28		32		28		**30.7**
1.535		32		31		32		29		30		28		**30.3**
1.654		35		30		31		32		32		27		**31.2**
1.772		34		33		32		30		30		28		**31.2**
1.890		34		33		33		32		33		28		**32.2**
2.008		37		35		33		32		33		29		**33.2**
2.126		37		36		37		33		34		31		**34.7**
2.244		38		37		37		34		34		31		**35.2**
2.362		40		38		38		36		36		32		**36.7**
2.480		40		38		38		37		37		33		**37.2**
2.598		40		36		37		37		38		33		**36.8**
2.717		36		35		36		37		37		31		**35.3**
2.835		-		-		35		36		34		31		**34.0**

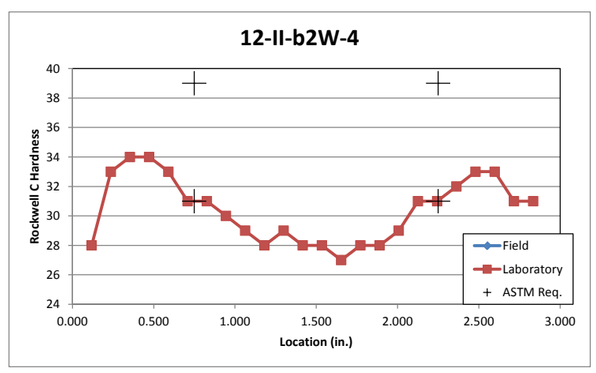


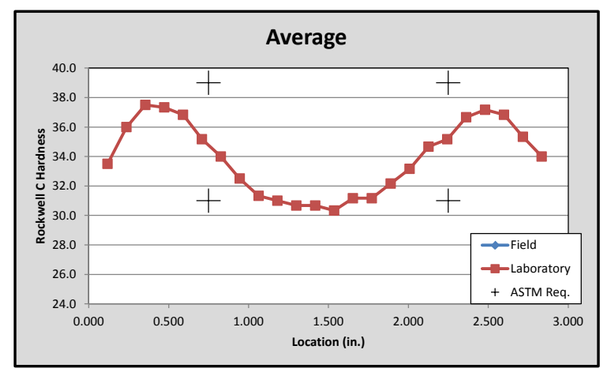






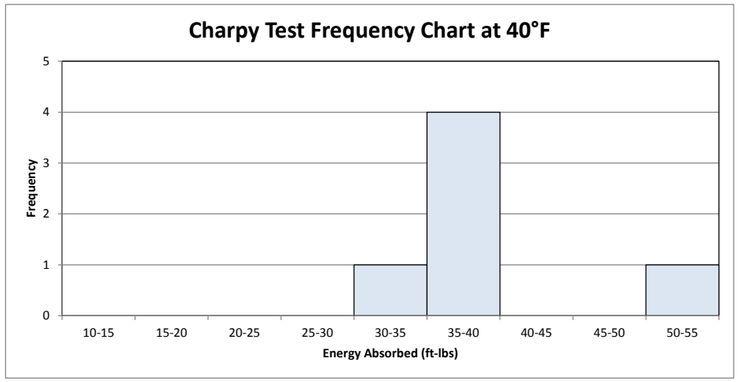


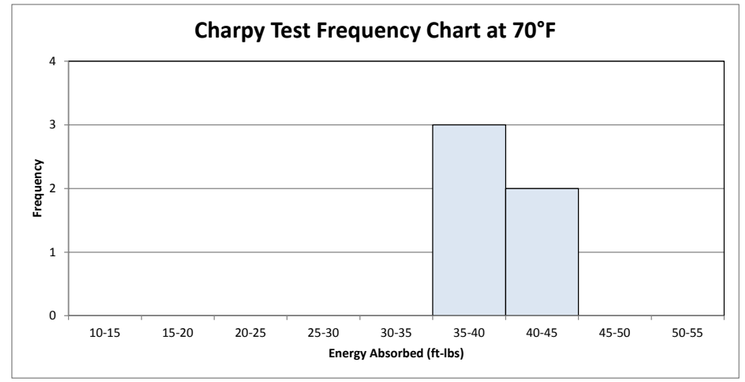




Charpy V-Notch Impact Test

Charpy V-Notch Impact Energy Results (ft-lb)														
Identification	**12-II-W-60**		**12-II-S-80**		**12-II-b2E-1**		**12-II-b2E-3**		**12-II-b2W-3**		**12-II-b2W-4**		**Average**	
Temperature	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F
Sample 1	38	38	32	38	36	41	36	36	34	40	52	56	N/A	N/A
Sample 2	39	41	39	40	37	40	32	40	36	40	56	56	N/A	N/A
Sample 3	40	38	34	38	40	42	34	35	35	40	54	53	N/A	N/A
Average	39.0	39.0	35.0	38.7	37.7	41.0	34.0	37.0	35.0	40.0	54.0	55.0	39.1	41.8





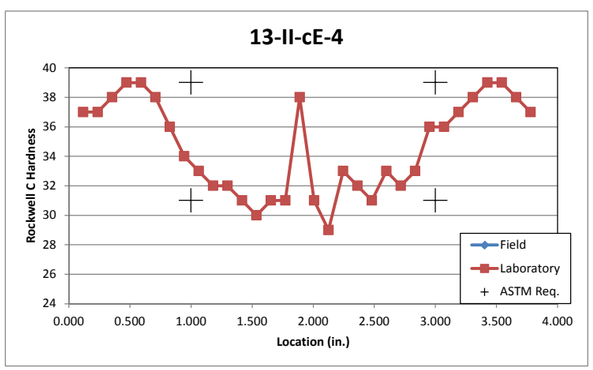
Spectrochemical Analysis

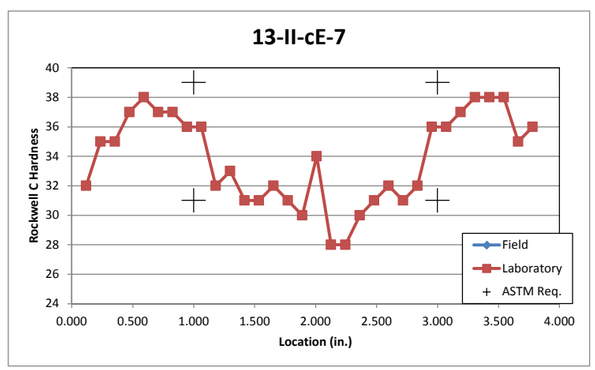
Spectrochemical Analysis (Reported as Wt. %)									
		12-II-W-60	12-II-S-80	12-II-b2E-1	12-II-b2E-3	12-II-b2W-3	12-II-b2W-4	**Average**	ASTM 354
Aluminum	Al	0.02	0.02	0.03	0.03	0.02	0.02	**0.02**	-
Carbon	C	0.38	0.40	0.37	0.37	0.38	0.37	**0.38**	0.33-0.55
Chromium	Cr	0.96	1.06	1.04	1.03	1.04	1.04	**1.03**	-
Cobalt	Co	0.01	0.05	0.05	0.05	0.05	0.05	**0.04**	-
Columbium	Cb	-	-	-	-	-	-	**-**	-
Copper	Cu	0.28	0.32	0.32	0.32	0.32	0.32	**0.31**	-
Manganese	Mn	0.85	0.98	0.95	0.93	0.94	0.94	**0.93**	0.57 min.
Molybdenum	Mo	0.16	0.17	0.16	0.16	0.16	0.16	**0.16**	-
Nickel	Ni	0.09	0.12	0.11	0.11	0.11	0.11	**0.11**	-
Phosporus	P	0.011	0.014	0.012	0.011	0.013	0.012	**0.012**	0.040 max.
Silicon	Si	0.28	0.27	0.26	0.26	0.26	0.26	**0.27**	-
Sulfur	S	0.018	0.023	0.019	0.020	0.021	0.020	**0.020**	0.045 max.
Titanium	Ti	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**<0.01**	-
Vanadium	V	<0.01	0.01	0.01	0.01	0.01	0.01	**0.01**	-

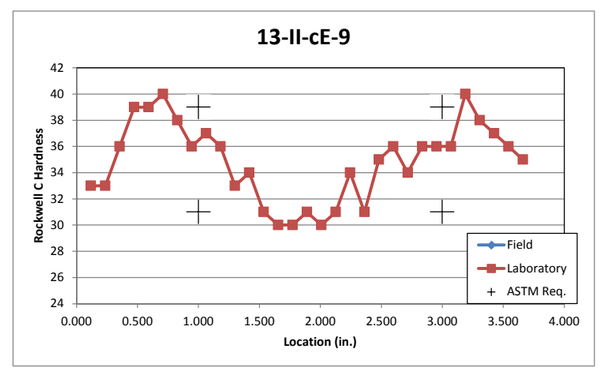
ITEM 13. 4" TOWER ANCHOR RODS - TEST II

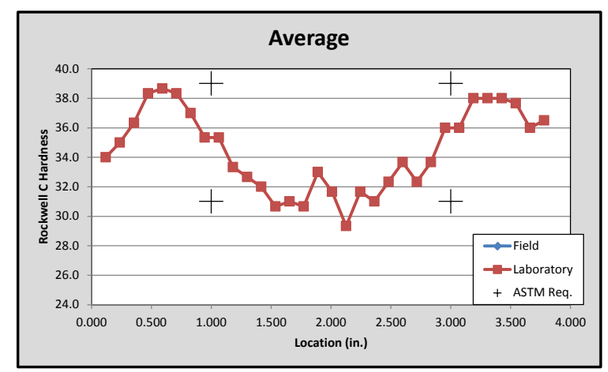
Rockwell Hardness Testing Comparison Across the Diameter

Location (in)	13-II-cE-4		13-II-cE-7		13-II-cE-9		Average	
	Field	Laboratory	Field	Laboratory	Field	Laboratory	Field	Laboratory
0.118	-	37	-	32	-	33	-	34.0
0.236		37		35		33		35.0
0.354		38		35		36		36.3
0.472		39		37		39		38.3
0.591		39		38		39		38.7
0.709		38		37		40		38.3
0.827		36		37		38		37.0
0.945		34		36		36		35.3
1.063		33		36		37		35.3
1.181		32		32		36		33.3
1.299		32		33		33		32.7
1.417		31		31		34		32.0
1.535		30		31		31		30.7
1.654		31		32		30		31.0
1.772		31		31		30		30.7
1.890		38		30		31		33.0
2.008		31		34		30		31.7
2.126		29		28		31		29.3
2.244		33		28		34		31.7
2.362		32		30		31		31.0
2.480		31		31		35		32.3
2.598		33		32		36		33.7
2.717		32		31		34		32.3
2.835		33		32		36		33.7
2.953		36		36		36		36.0
3.071		36		36		36		36.0
3.189		37		37		40		38.0
3.307		38		38		38		38.0
3.425		39		38		37		38.0
3.543		39		38		36		37.7
3.661		38		35		35		36.0
3.780		37		36		-		36.5



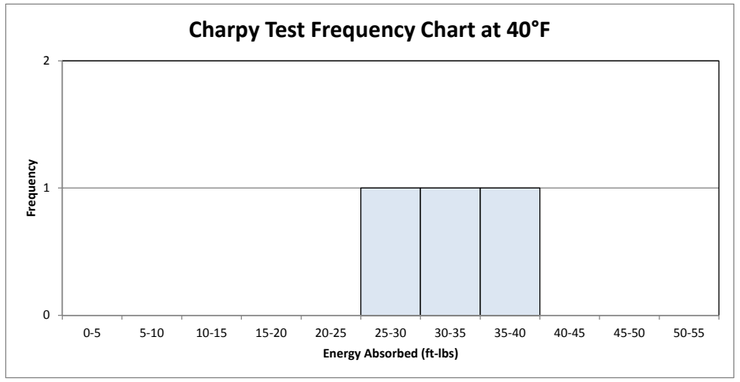


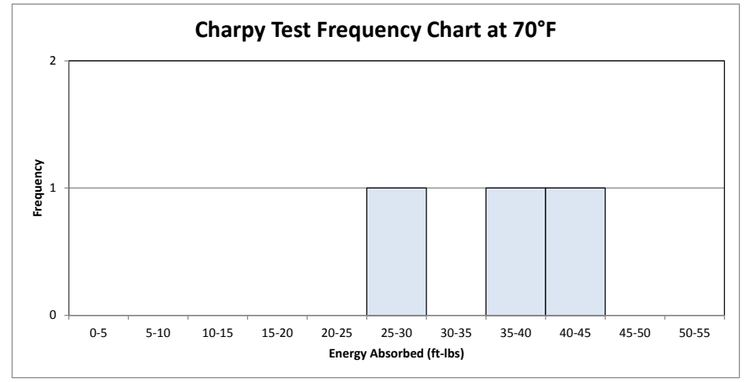




Charpy V-Notch Impact Test

Charpy V-Notch Impact Energy Results (ft-lb)								
Identification	13-II-cE-4		13-II-cE-7		13-II-cE-9		Average	
Temperature	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F
Sample 1	26	30	35	40	30	35	N/A	N/A
Sample 2	23	30	28	42	32	38	N/A	N/A
Sample 3	29	28	46	40	36	44	N/A	N/A
Average	26.0	29.3	36.3	40.7	32.7	39.0	31.7	36.3





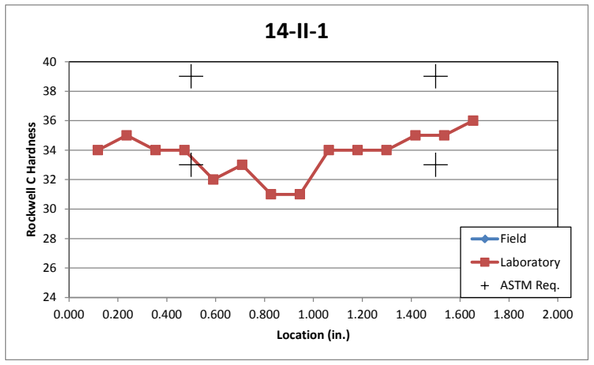
Spectrochemical Analysis

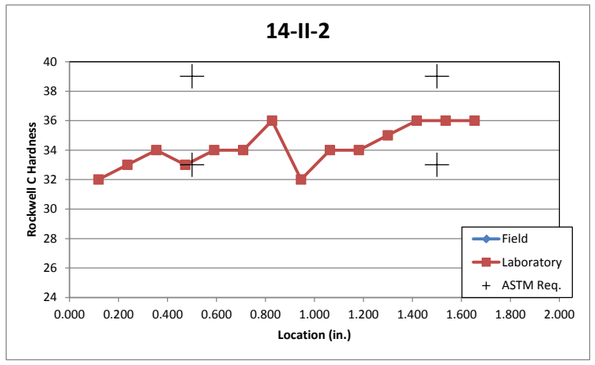
Spectrochemical Analysis (Reported as Wt. %)						
		13-II-cE-4	13-II-cE-4	13-II-cE-4	**Average**	ASTM 354
Aluminum	Al	0.02	0.02	0.02	**0.02**	-
Carbon	C	0.40	0.40	0.39	**0.40**	0.33-0.55
Chromium	Cr	0.98	0.98	0.96	**0.97**	-
Cobalt	Co	0.01	0.01	0.01	**0.01**	-
Columbium	Cb	-	-	-	**-**	-
Copper	Cu	0.28	0.26	0.25	**0.26**	-
Manganese	Mn	0.96	0.96	0.91	**0.94**	0.57 min.
Molybdenum	Mo	0.16	0.16	0.16	**0.16**	-
Nickel	Ni	0.11	0.11	0.13	**0.12**	-
Phosporus	P	0.011	0.010	0.011	**0.011**	0.040 max.
Silicon	Si	0.23	0.24	0.25	**0.24**	-
Sulfur	S	0.019	0.017	0.020	**0.019**	0.045 max.
Titanium	Ti	<0.01	<0.01	<0.01	**<0.01**	-
Vanadium	V	0.01	0.01	0.01	**0.01**	-

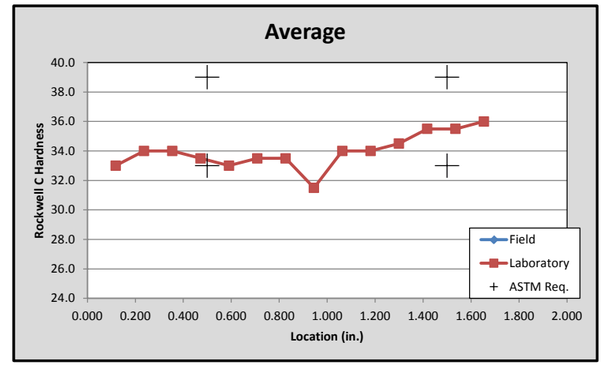
ITEM 14. 2" EAST SADDLE ANCHOR RODS - TEST II

Rockwell Hardness Testing Comparison Across the Diameter

Location (in)	14-II-1		14-II-2		Average	
	Field	Laboratory	Field	Laboratory	**Field**	**Laboratory**
0.118	-	34	-	32	**-**	**33.0**
0.236		35		33		**34.0**
0.354		34		34		**34.0**
0.472		34		33		**33.5**
0.591		32		34		**33.0**
0.709		33		34		**33.5**
0.827		31		36		**33.5**
0.945		31		32		**31.5**
1.063		34		34		**34.0**
1.181		34		34		**34.0**
1.299		34		35		**34.5**
1.417		35		36		**35.5**
1.535		35		36		**35.5**
1.654		36		36		**36.0**







Charpy V-Notch Impact Test

Test not performed because a large enough sample was not available.

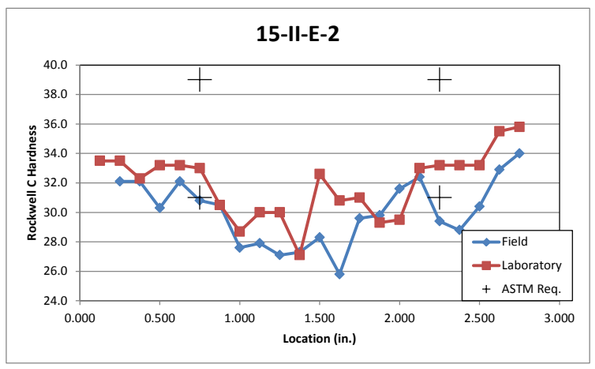
Spectrochemical Analysis

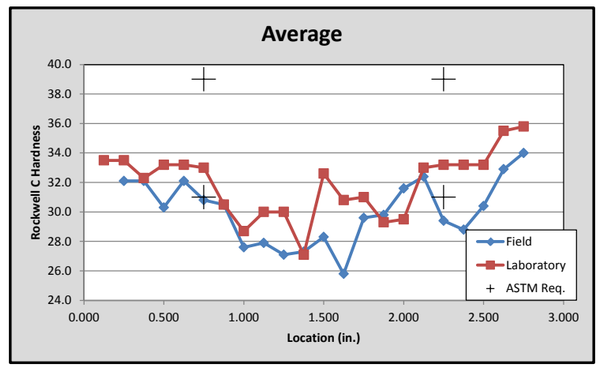
Spectrochemical Analysis (Reported as Wt. %)					
		14-II-1	14-II-2	**Average**	ASTM 354
Aluminum	Al	0.02	0.02	**0.02**	-
Carbon	C	0.4	0.4	**0.4**	0.33-0.55
Chromium	Cr	0.97	0.97	**0.97**	-
Cobalt	Co	0.01	0.01	**0.01**	-
Columbium	Cb	-	-	**-**	-
Copper	Cu	0.19	0.19	**0.19**	-
Manganese	Mn	0.89	0.89	**0.89**	0.57 min.
Molybdenum	Mo	0.16	0.16	**0.16**	-
Nickel	Ni	0.11	0.11	**0.11**	-
Phosporus	P	0.015	0.014	**0.0145**	0.040 max.
Silicon	Si	0.27	0.26	**0.265**	-
Sulfur	S	0.022	0.02	**0.021**	0.045 max.
Titanium	Ti	<0.01	<0.01	**<0.01**	-
Vanadium	V	0.01	0.01	**0.01**	-

ITEM 15. 3" EAST SADDLE TIE RODS - TEST II

Rockwell Hardness Testing Comparison Across the Diameter

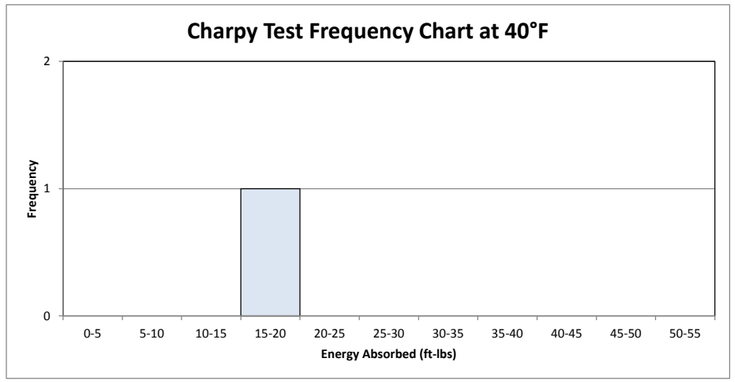
Location (in)	15-II-E-2		Average	
	Field	Laboratory	Field	Laboratory
0.125	-	33.5	-	33.5
0.250	32.1	33.5	32.1	33.5
0.375	32.1	32.3	32.1	32.3
0.500	30.3	33.2	30.3	33.2
0.625	32.1	33.2	32.1	33.2
0.750	30.8	33.0	30.8	33.0
0.875	30.5	30.5	30.5	30.5
1.000	27.6	28.7	27.6	28.7
1.125	27.9	30.0	27.9	30.0
1.250	27.1	30.0	27.1	30.0
1.375	27.3	27.1	27.3	27.1
1.500	28.3	32.6	28.3	32.6
1.625	25.8	30.8	25.8	30.8
1.750	29.6	31.0	29.6	31.0
1.875	29.8	29.3	29.8	29.3
2.000	31.6	29.5	31.6	29.5
2.125	32.4	33.0	32.4	33.0
2.250	29.4	33.2	29.4	33.2
2.375	28.8	33.2	28.8	33.2
2.500	30.4	33.2	30.4	33.2
2.625	32.9	35.5	32.9	35.5
2.750	34.0	35.8	34.0	35.8

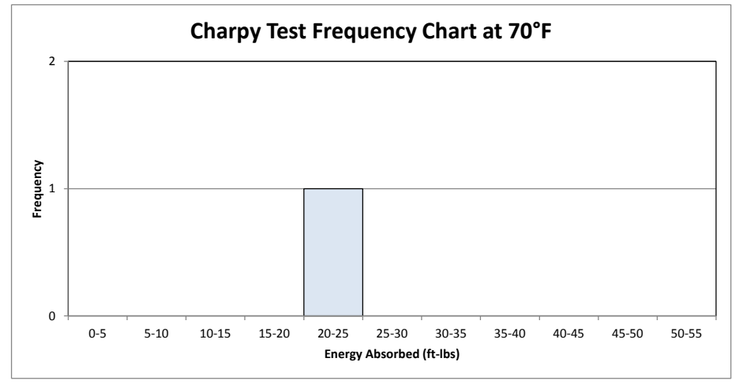




Charpy V-Notch Impact Test

Charpy V-Notch Impact Energy Results (ft-lb)				
Identification	15-II-E-2		Average	
Temperature	40°F	70°F	40°F	70°F
Sample 1	18	24	N/A	N/A
Sample 2	17	22	N/A	N/A
Sample 3	18.5	25	N/A	N/A
Average	17.8	23.7	17.8	23.7





Spectrochemical Analysis

Spectrochemical Analysis (Reported as Wt. %)				
		15-II-E-2	**Average**	ASTM 354
Aluminum	Al	0.02	**0.02**	-
Carbon	C	0.42	**0.42**	0.33-0.55
Chromium	Cr	0.96	**0.96**	-
Cobalt	Co	0.02	**0.02**	-
Columbium	Cb	0.01	**0.01**	-
Copper	Cu	0.20	**0.20**	-
Manganese	Mn	0.84	**0.84**	0.57 min.
Molybdenum	Mo	0.17	**0.17**	-
Nickel	Ni	0.14	**0.14**	-
Phosporus	P	0.012	**0.012**	0.040 max.
Silicon	Si	0.28	**0.28**	-
Sulfur	S	0.028	**0.028**	0.045 max.
Titanium	Ti	<0.005	**<0.005**	-
Vanadium	V	<0.005	**<0.005**	-

TEST III
TABLE OF CONTENTS

Test III – Full Size Tension Test

PIER E2 BEARING AND SHEAR KEY BOTTOM ANCHOR RODS…….. ITEM 2
SHEAR KEY TOP ANCHOR RODS…… ITEM 3
PIER E2 BEARING TOP ANCHOR RODS…….. ITEM 4
PWS STRAND ANCHOR RODS (MAIN CABLE)……... ITEM 7
TOWER SADDLE TIE RODS……. ITEM 8
TOWER OUTRIGGER…….. ITEM 11
TOWER ANCHORAGE ANCHOR BOLTS (75 DIA.)……... ITEM 12
EAST SADDLE ANCHOR RODS…….. ITEM 14

SAMPLE 2-III-1: 3" E2 BEARING ANCHOR RODS - TEST III

Full-Size Tensile Testing

Full Size Tensile Testing					
	2-III-B3-A2	2-III-S4-D7	2-III-S3-E7	2-III-B4-A7	ASTM A354 BD Requirements
Uitimate Load (kips)	945.4	945.2	942.6	945.8	835.8.0 min
Ultimate Tensile Strength (ksi)	158.3	158.3	157.9	158.4	140 min

Section (.505 Sample) Tensile Testing

.505 Sample Tensile Test Results					
Identification	2-III-B3-A2	2-III-S4-D7	2-III-S3-E7	2-III-B4-A7	ASTM A354 BD Requirements
Yield Strength (ksi)	143.0	138.0	139.0	143.1	115 min
Tensile Strength (ksi)	160.0	157.0	157.0	160.2	140 min
Elongation in 2" Gage (%)	17.0	19.0	17.5	16.8	14 min
Reduction of Area (%)	53.5	53.4	54	52.3	40 min

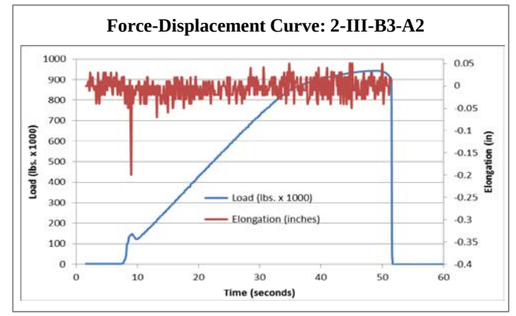
Charpy V-Notch Impact Test

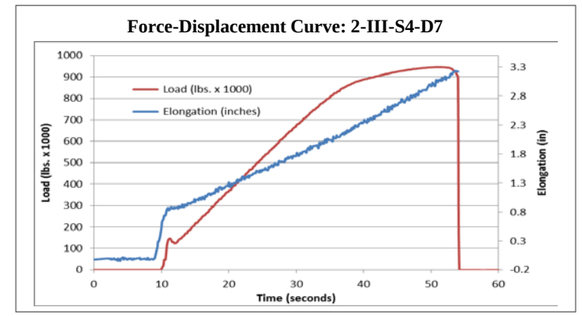
Charpy V-Notch Impact Energy Results (ft-lb)								
Identification	2-III-B3-A2		2-III-S4-D7		2-III-S3-E7		2-III-B4-A7	
Temperature	40°F	70°F	40°F	70°F	40°F	70°F	40°F	70°F
Sample 1	35.5	37	37	37	38	38	38.5	39
Sample 2	38	38	37	38	37	37	36	39
Sample 3	37	38	37.5	37	37	37	37.5	37
Average	36.8	37.7	37.2	37.3	37.3	37.3	37.3	38.3

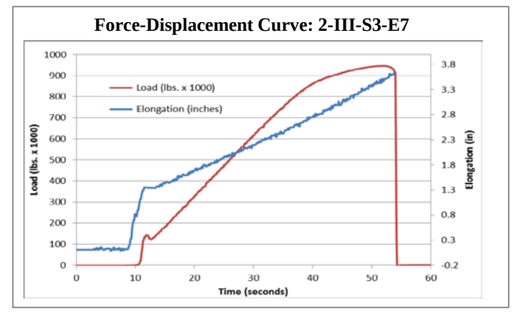
Hardness Testing Across the Diameter

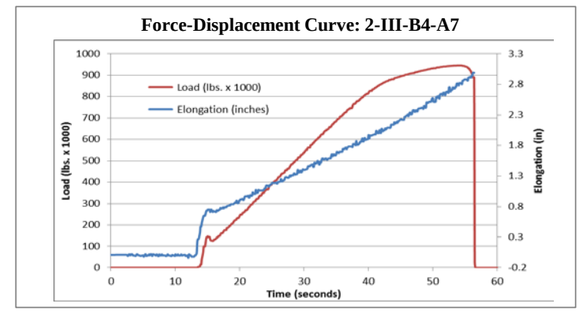
Location (in)	2-III-B3-A2	2-III-S4-D7	2-III-S3-E7	2-III-B4-A7
	HRC	HRC	HRC	HRC
0.125	36.5	36.2	37.0	35.1
0.250	37.0	36.9	37.2	36.0
0.375	36.8	37.0	36.2	35.4
0.500	36.1	36.3	36.0	34.5
0.625	35.2	35.8	35.6	33.7
0.750	34.3	34.8	34.1	33.2
0.875	33.6	34.0	32.7	31.5
1.000	32.0	33.1	32.8	31.3
1.125	32.6	33.1	31.4	31.8
1.250	30.3	31.9	32.1	31.0
1.375	26.5	31.0	32.5	33.3
1.500	26.0	31.8	30.4	36.0
1.625	29.5	32.0	31.0	31.8
1.750	31.9	30.8	32.1	31.7
1.875	33.0	32.5	27.2	32.3
2.000	33.6	32.5	32.8	33.0
2.125	34.0	34.2	34.8	33.4
2.250	35.0	34.8	35.0	34.1
2.375	36.0	35.6	36.2	34.8
2.500	37.0	36.5	37.0	35.6
2.625	37.1	37.2	36.9	36.1
2.750	37.8	36.1	36.7	35.7

Note: This testing was performed in April 2013 at Carpenter Rigging

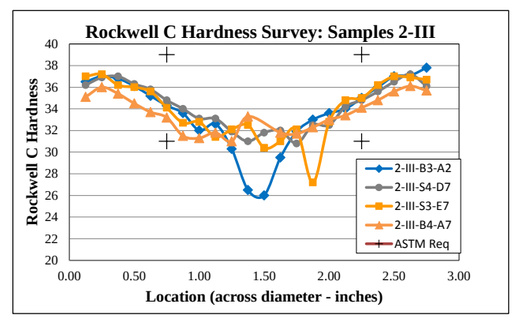








Invalid elongation reading for sample 2-II-B3-A2 due to error in placement of linear transducer.



Spectrochemical Analysis

Spectrochemical Analysis (Reported as Wt. %)						
		2-III-B3-A2	2-III-S4-D7	2-III-S3-E7	2-III-B4-A7	Requirement ASTM A354 Gr BD
Aluminum	Al	0.02	0.02	0.02	0.02	
Carbon	C	0.43	0.42	0.43	0.385	0.33 -0.55
Chromium	Cr	0.94	0.93	0.94	0.87	
Cobalt	Co	0.01	0.01	0.01	0.01	
Columbium	Cb	<0.005	<0.005	<0.005	NA	
Copper	Cu	0.2	0.2	0.2	0.23	
Manganese	Mn	0.88	0.87	0.88	0.89	0.57 min.
Molybdenum	Mo	0.16	0.16	0.16	0.17	
Nickel	Ni	0.14	0.14	0.14	0.13	
Phosphorus	P	0.017	0.017	0.017	0.2	0.040 max.
Silicon	Si	0.26	0.26	0.26	0.28	
Sulfur	S	0.034	0.33	0.031	0.35	0.045 max.
Titanium	Ti	<0.005	<0.005	<0.005	0.002	
Vanadium	V	0.01	0.01	0.01	0.01	

SAMPLE 3-III-1: 3" SHEAR KEY TOP BOLT - TEST III

Full-Size Tensile Testing

Full Size Tensile Testing		
	Sample 3-III-1 (47.6 in.)	ASTM A354 BD Requirements
Tensile Load (kips)	928.4	835.8 min
Tensile Strength (ksi)	156.3	140 min

Reduced Section (.505 Sample) Tensile Testing

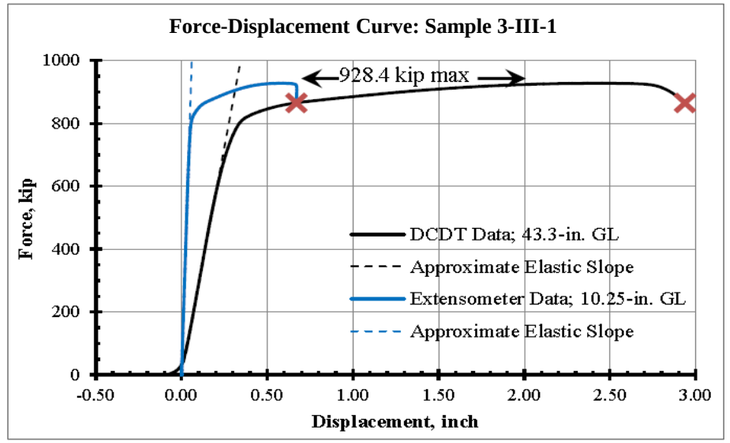
.505 Sample Tensile Test Results		
Identification	3-III-1	ASTM A354 BD Requirements
Yield Strength (ksi)	140.9	115 min
Tensile Strength (ksi)	158.3	140 min
Elongation in 2" Gage (%)	18.5	14 min
Reduction of Area (%)	54.3	40 min

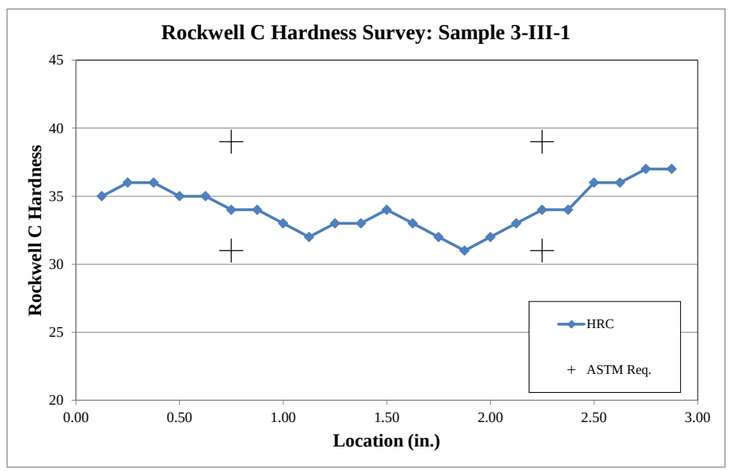
Charpy V-Notch Impact Test

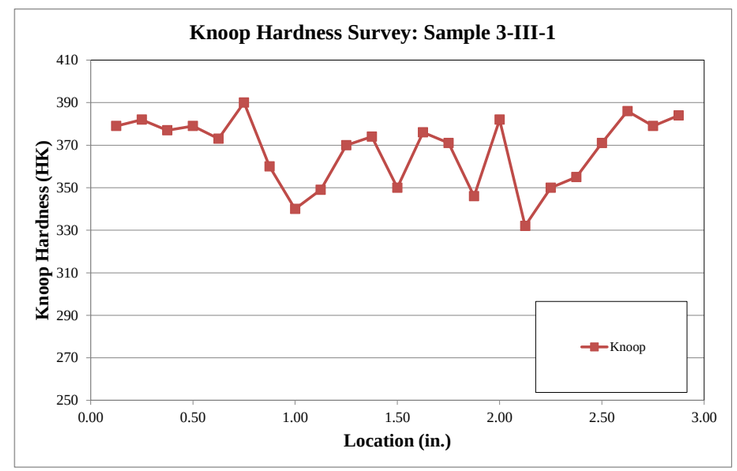
Charpy V-Notch Impact Energy Results (ft-lb)		
Identification	3-III-1	
Temperature	40°F	70°F
Sample 1	36	42
Sample 2	37	38
Sample 3	37	40
Average	36.7	40.0

Hardness Testing Across the Diameter

Location (in)	3-III-1	
	HRC	Knoop
0.125	35	379.0
0.250	36	382.0
0.375	36	377.0
0.500	35	379.0
0.625	35	373.0
0.750	34	390.0
0.875	34	360.0
1.000	33	340.0
1.125	32	349.0
1.250	33	370.0
1.375	33	374.0
1.500	34	350.0
1.625	33	376.0
1.750	32	371.0
1.875	31	346.0
2.000	32	382.0
2.125	33	332.0
2.250	34	350.0
2.375	34	355.0
2.500	36	371.0
2.625	36	386.0
2.750	37	379.0
2.875	37	384.0







Spectrochemical Analysis

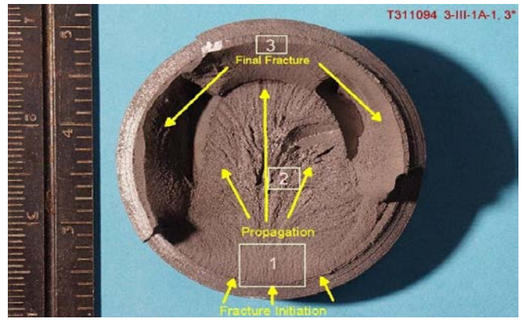
Spectrochemical Analysis (Reported as Wt. %)			
		3-III-1	ASTM A354
Aluminum	Al	0.02	
Carbon	C	0.44	0.33-0.55
Chromium	Cr	0.94	
Cobalt	Co	0.01	
Copper	Cu	0.20	
Manganese	Mn	0.90	0.57 min.
Molybdenum	Mo	0.18	
Nickel	Ni	0.15	
Phosporus	P	0.015	0.040 max.
Silicon	Si	0.27	
Sulfur	S	0.040	0.045 max.
Titanium	Ti	<0.01	
Vanadium	V	0.01	

Coating Chemical Analysis

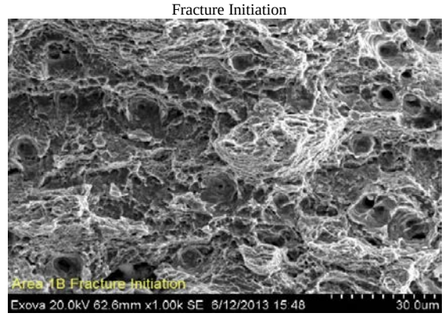
Coating Chemical Analysis (Reported as Wt. %)		
		3-III-1
Bismuth	Bi	0.006
Tin	Sn	0.012

Scanning Electron Microscopy

Overview

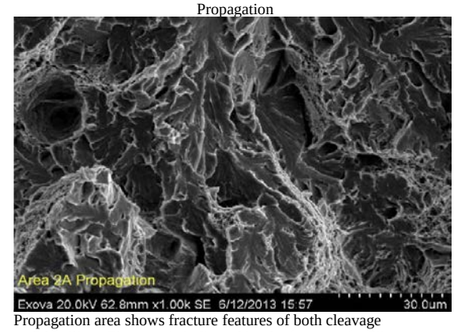


Fracture Initiation



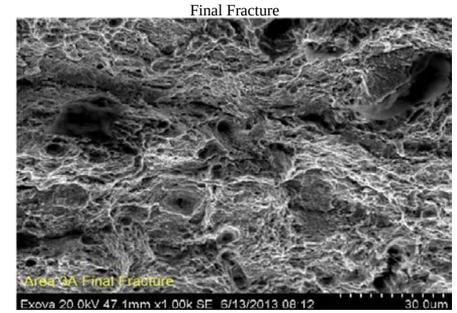
Fracture initiation area shows dimples or cup and cone features typical of ductile fracture. Ductile fractures in the origin area usually indicates tensile overload.

Propagation



Propagation area shows fracture features of both cleavage and ductility. Cleavage is indicated by the facets or fan like appearance. This is a common mode of propagation.

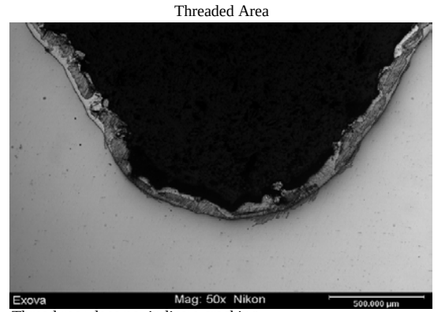
Final Fracture



Final fracture area shows dimpled ductile fracture features. Final fracture occurs when the remaining material is insufficient to sustain the load.

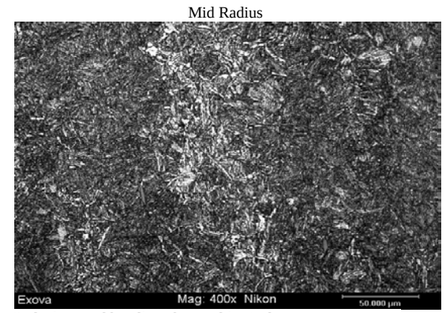
Micro-Structure Examination

Threaded Area



Thread root does not indicate cracking.

Mid Radius



Inclusions and banding observed in steel.
Essentially martensitic structure.

SAMPLE 3-III-2: 3" SHEAR KEY TOP BOLT - TEST III

Full-Size Tensile Testing

Full Size Tensile Testing		
	Sample 3-III-2 (47.6 in.)	ASTM A354 BD Requirements
Tensile Load (kips)	918.6	835.8 min
Tensile Strength (ksi)	153.9	140 min

Reduced Section (.505 Sample) Tensile Testing

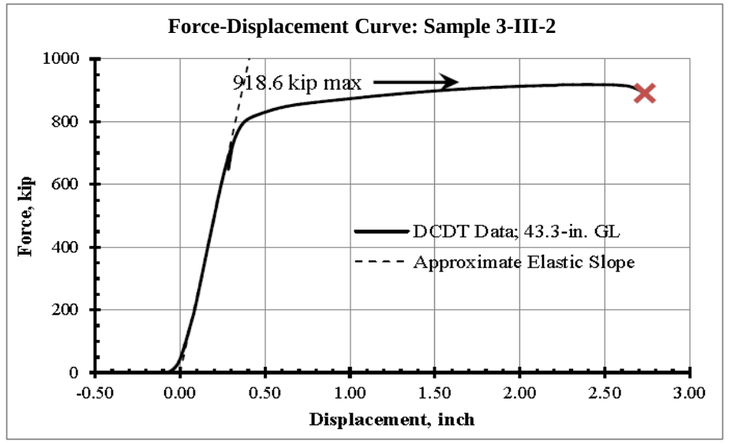
.505 Sample Tensile Test Results		
Identification	3-III-2	ASTM A354 BD Requirements
Yield Strength (ksi)	138.9	115 min
Tensile Strength (ksi)	157.6	140 min
Elongation in 2" Gage (%)	19.0	14 min
Reduction of Area (%)	54.6	40 min

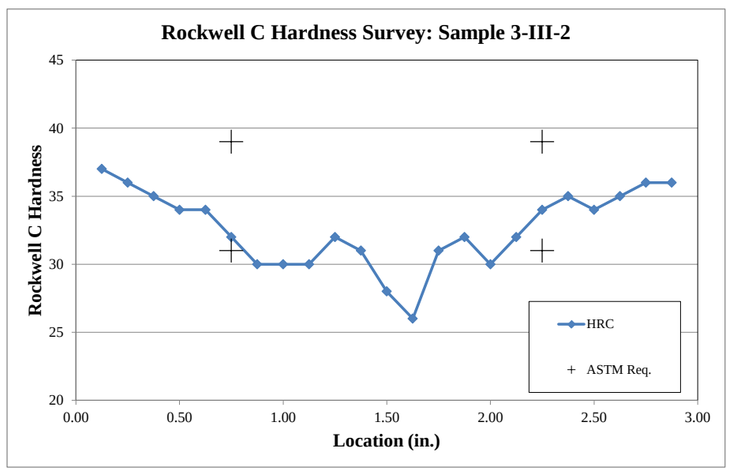
Charpy V-Notch Impact Test

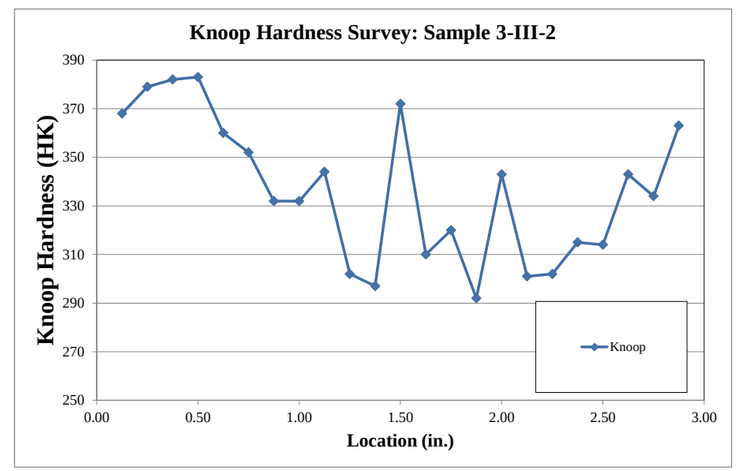
Charpy V-Notch Impact Energy Results (ft-lb)		
Identification	3-III-2	
Temperature	40°F	70°F
Sample 1	36	40
Sample 2	37	40
Sample 3	37	38
Average	36.7	39.3

Hardness Testing Across the Diameter

Location (in)	3-III-2	
	HRC	Knoop
0.125	37	368.0
0.250	36	379.0
0.375	35	382.0
0.500	34	383.0
0.625	34	360.0
0.750	32	352.0
0.875	30	332.0
1.000	30	332.0
1.125	30	344.0
1.250	32	302.0
1.375	31	297.0
1.500	28	372.0
1.625	26	310.0
1.750	31	320.0
1.875	32	292.0
2.000	30	343.0
2.125	32	301.0
2.250	34	302.0
2.375	35	315.0
2.500	34	314.0
2.625	35	343.0
2.750	36	334.0
2.875	36	363.0







Spectrochemical Analysis

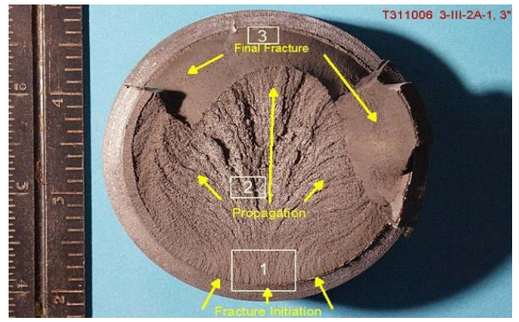
Spectrochemical Analysis (Reported as Wt. %)			
		3-III-2	ASTM A354
Aluminum	Al	0.02	
Carbon	C	0.41	0.33-0.55
Chromium	Cr	0.93	
Cobalt	Co	0.01	
Copper	Cu	0.20	
Manganese	Mn	0.88	0.57 min.
Molybdenum	Mo	0.17	
Nickel	Ni	0.15	
Phosporus	P	0.015	0.040 max.
Silicon	Si	0.26	
Sulfur	S	0.029	0.045 max.
Titanium	Ti	<0.01	
Vanadium	V	0.01	

Coating Chemical Analysis

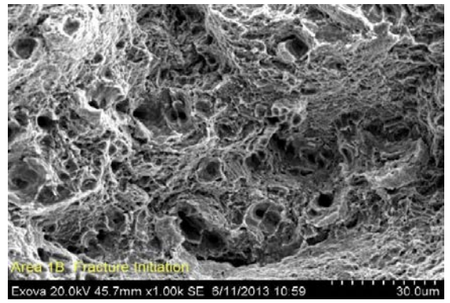
Coating Chemical Analysis (Reported as Wt. %)		
		3-III-2
Bismuth	Bi	0.006
Tin	Sn	0.011

Scanning Electron Microscopy

Overview

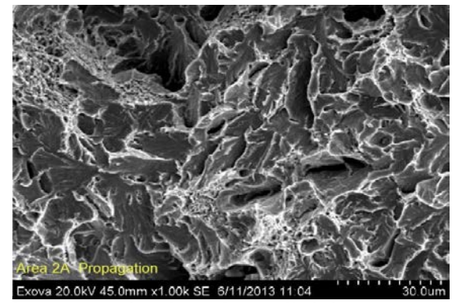


Fracture Initiation



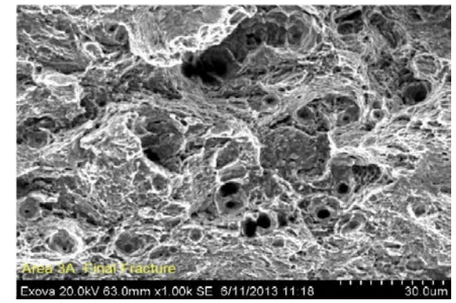
Fracture initiation area shows dimples or cup and cone features typical of ductile fracture. Ductile fractures in the origin area usually indicates tensile overload.

Propagation



Propagation area shows fracture features of both cleavage and ductility. Cleavage is indicated by the facets or fan like appearance. This is a common mode of propagation.

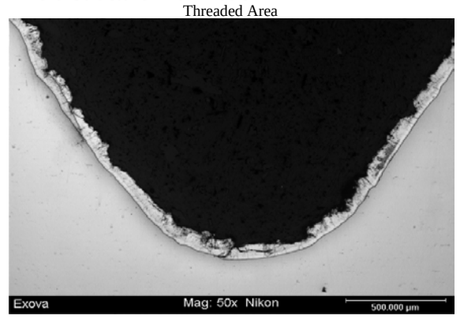
Final Fracture



Final fracture area shows dimpled ductile fracture features. Final fracture occurs when the remaining material is insufficient to sustain the load.

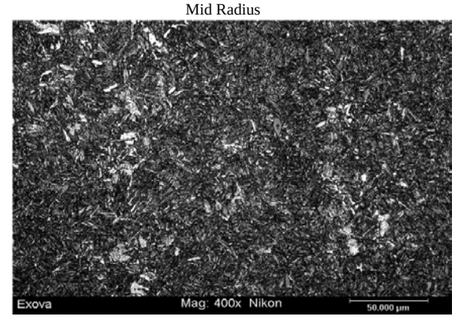
Micro-Structure Examination

Threaded Area



Thread root does not indicate cracking.

Mid Radius



Inclusions and banding observed in steel.
Essentially martensitic structure.

SAMPLE 3-III-3: 3" SHEAR KEY TOP BOLT - TEST III

Full-Size Tensile Testing

Full Size Tensile Testing		
	Sample 3-III-3 (47.6 in.)	ASTM A354 BD Requirements
Tensile Load (kips)	934.5	835.8 min
Tensile Strength (ksi)	156.5	140 min

Reduced Section (.505 Sample) Tensile Testing

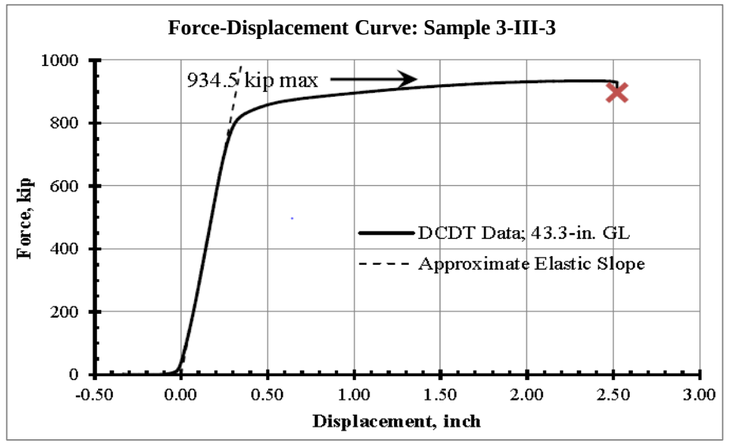
.505 Sample Tensile Test Results		
Identification	3-III-3	ASTM A354 BD Requirements
Yield Strength (ksi)	137.8	115 min
Tensile Strength (ksi)	156.4	140 min
Elongation in 2" Gage (%)	17.5	14 min
Reduction of Area (%)	53.9	40 min

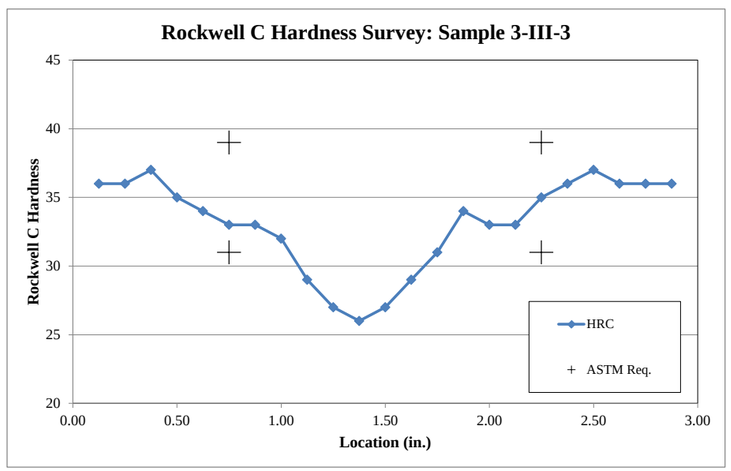
Charpy V-Notch Impact Test

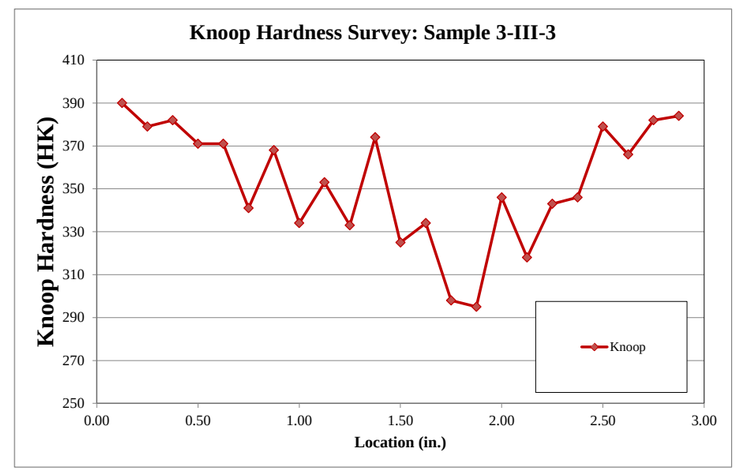
Charpy V-Notch Impact Energy Results (ft-lb)		
Identification	3-III-3	
Temperature	40°F	70°F
Sample 1	36	40
Sample 2	37	40
Sample 3	38	39
Average	37.0	39.7

Hardness Testing Across the Diameter

Location (in)	3-III-3	
	HRC	Knoop
0.125	36	390.0
0.250	36	379.0
0.375	37	382.0
0.500	35	371.0
0.625	34	371.0
0.750	33	341.0
0.875	33	368.0
1.000	32	334.0
1.125	29	353.0
1.250	27	333.0
1.375	26	374.0
1.500	27	325.0
1.625	29	334.0
1.750	31	298.0
1.875	34	295.0
2.000	33	346.0
2.125	33	318.0
2.250	35	343.0
2.375	36	346.0
2.500	37	379.0
2.625	36	366.0
2.750	36	382.0
2.875	36	384.0







Spectrochemical Analysis

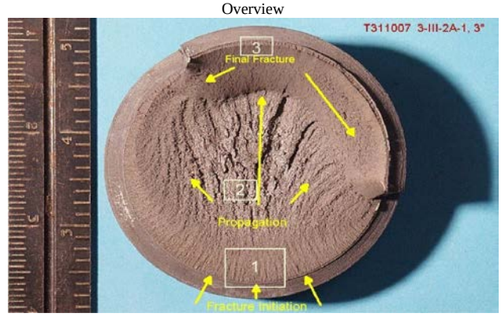
Spectrochemical Analysis (Reported as Wt. %)			
		3-III-3	ASTM A354
Aluminum	Al	0.02	
Carbon	C	0.42	0.33-0.55
Chromium	Cr	0.94	
Cobalt	Co	0.01	
Copper	Cu	0.20	
Manganese	Mn	0.89	0.57 min.
Molybdenum	Mo	0.17	
Nickel	Ni	0.15	
Phosporus	P	0.015	0.040 max.
Silicon	Si	0.27	
Sulfur	S	0.031	0.045 max.
Titanium	Ti	<0.01	
Vanadium	V	0.01	

Coating Chemical Analysis

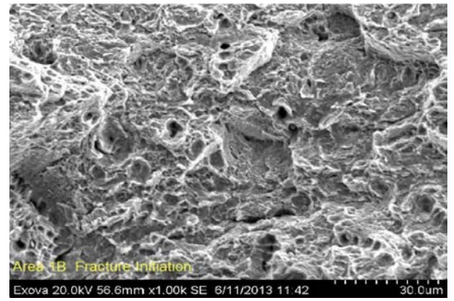
Coating Chemical Analysis (Reported as Wt. %)		
		3-III-3
Bismuth	Bi	0.007
Tin	Sn	0.012

Scanning Electron Microscopy

Overview

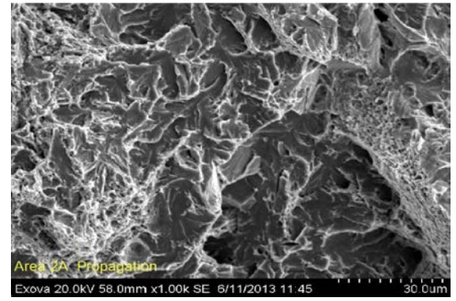


Fracture Initiation



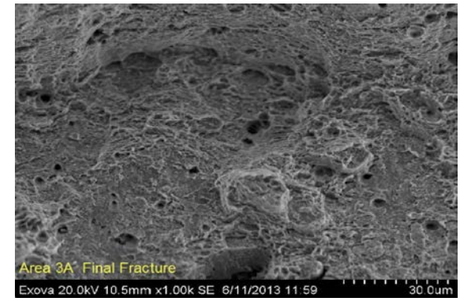
Fracture initiation area shows dimples or cup and cone features typical of ductile fracture. Ductile fractures in the origin area usually indicates tensile overload.

Propagation



Propagation area shows fracture features of both cleavage and ductility. Cleavage is indicated by the facets or fan like appearance. This is a common mode of propagation.

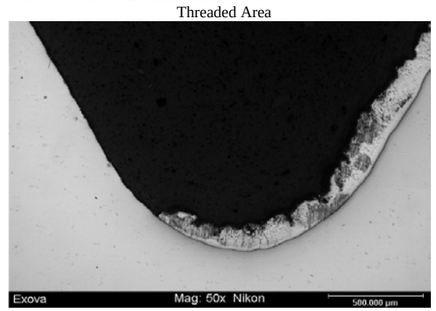
Final Fracture



Final fracture area shows dimpled ductile fracture features. Final fracture occurs when the remaining material is insufficient to sustain the load.

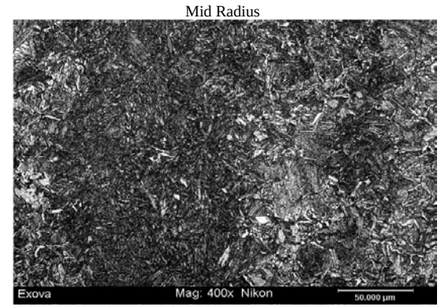
Micro-Structure Examination

Threaded Area



Thread root does not indicate cracking.

Mid Radius



Inclusions and banding observed in steel.
Essentially martensitic structure.

SAMPLE 3-III-4: 3" SHEAR KEY TOP BOLT - TEST III

Full-Size Tensile Testing

Full Size Tensile Testing		
	Sample 3-III-4 (47.6 in.)	ASTM A354 BD Requirements
Tensile Load (kips)	942.1	835.8 min
Tensile Strength (ksi)	157.8	140 min

Reduced Section (.505 Sample) Tensile Testing

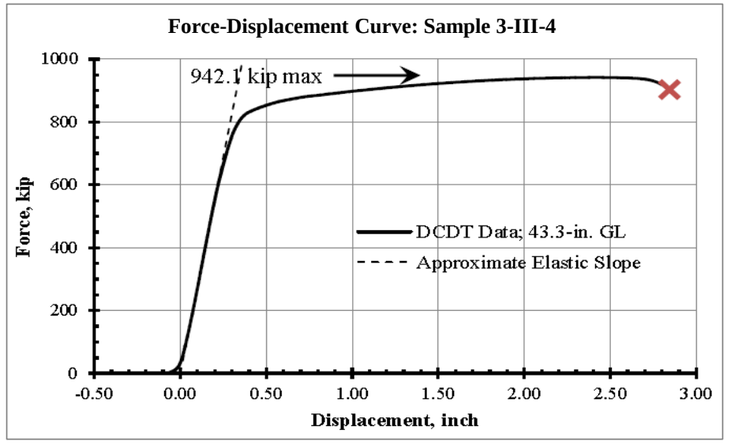
.505 Sample Tensile Test Results		
Identification	3-III-4	ASTM A354 BD Requirements
Yield Strength (ksi)	141.2	115 min
Tensile Strength (ksi)	159.1	140 min
Elongation in 2" Gage (%)	18.0	14 min
Reduction of Area (%)	53.0	40 min

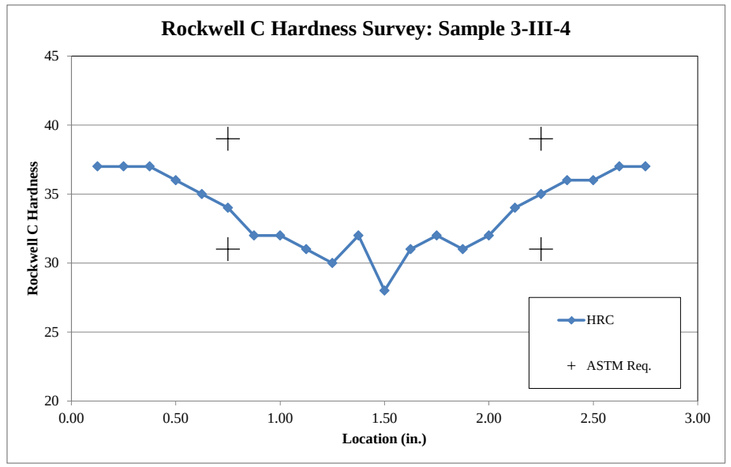
Charpy V-Notch Impact Test

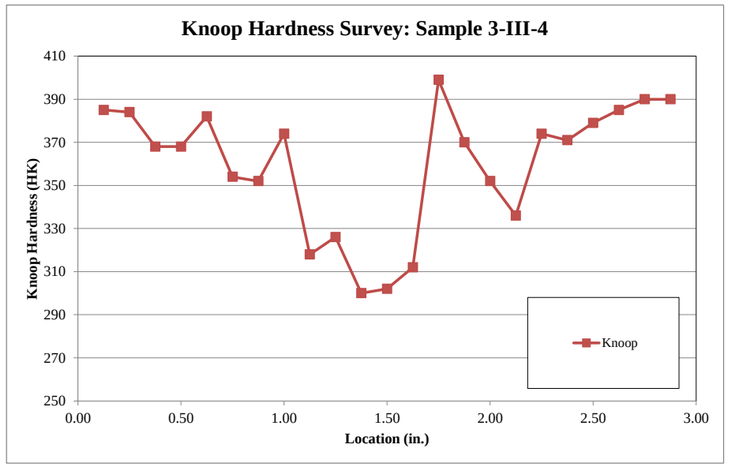
Charpy V-Notch Impact Energy Results (ft-lb)		
Identification	3-III-4	
Temperature	40°F	70°F
Sample 1	36	38
Sample 2	37	38
Sample 3	37	38
Average	36.7	38.0

Hardness Testing Across the Diameter

Location (in)	3-III-4	
	HRC	Knoop
0.125	37	385.0
0.250	37	384.0
0.375	37	368.0
0.500	36	368.0
0.625	35	382.0
0.750	34	354.0
0.875	32	352.0
1.000	32	374.0
1.125	31	318.0
1.250	30	326.0
1.375	32	300.0
1.500	28	302.0
1.625	31	312.0
1.750	32	399.0
1.875	31	370.0
2.000	32	352.0
2.125	34	336.0
2.250	35	374.0
2.375	36	371.0
2.500	36	379.0
2.625	37	385.0
2.750	37	390.0
2.875		390.0







Spectrochemical Analysis

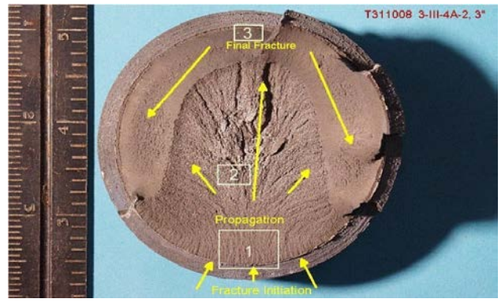
Spectrochemical Analysis (Reported as Wt. %)			
		3-III-4	ASTM A354
Aluminum	Al	0.02	
Carbon	C	0.42	0.33-0.55
Chromium	Cr	0.93	
Cobalt	Co	0.01	
Copper	Cu	0.20	
Manganese	Mn	0.89	0.57 min.
Molybdenum	Mo	0.17	
Nickel	Ni	0.15	
Phosporus	P	0.014	0.040 max.
Silicon	Si	0.26	
Sulfur	S	0.032	0.045 max.
Titanium	Ti	<0.01	
Vanadium	V	0.01	

Coating Chemical Analysis

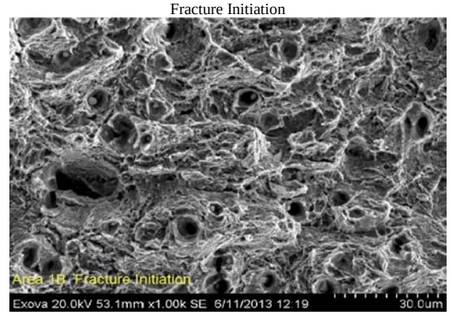
Coating Chemical Analysis (Reported as Wt. %)		
		3-III-4
Bismuth	Bi	0.006
Tin	Sn	0.011

Scanning Electron Microscopy

Overview

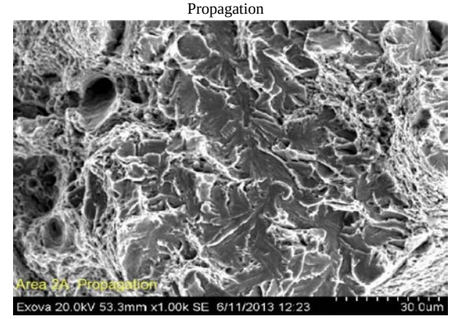


Fracture Initiation



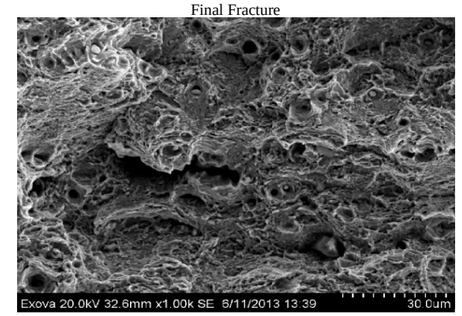
Fracture initiation area shows dimples or cup and cone features typical of ductile fracture. Ductile fractures in the origin area usually indicates tensile overload.

Propagation



Propagation area shows fracture features of both cleavage and ductility. Cleavage is indicated by the facets or fan like appearance. This is a common mode of propagation.

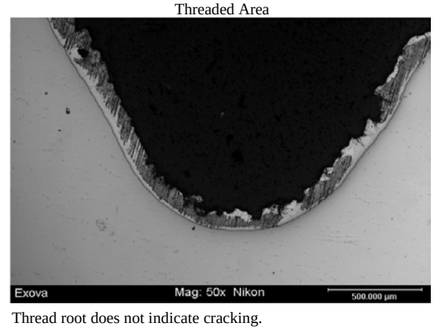
Final Fracture



Final fracture area shows dimpled ductile fracture features. Final fracture occurs when the remaining material is insufficient to sustain the load.

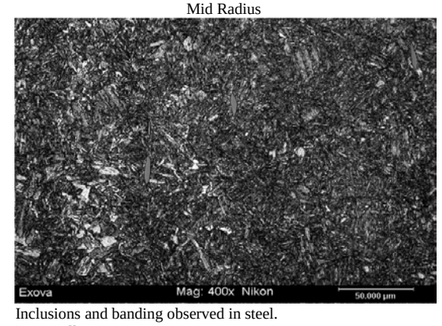
Micro-Structure Examination

Threaded Area



Thread root does not indicate cracking.

Mid Radius



Inclusions and banding observed in steel.
Essentially martensitic structure.

SAMPLE 4-III-1: 2" BEARING TOP BOLT - TEST III

Full-Size Tensile Testing

Full Size Tensile Testing		
	Sample 4-III-1 (43.5 in.)	ASTM A354 BD Requirements
Tensile Load (kips)	395.9	375.0 min
Tensile Strength (ksi)	158.4	140 min

Reduced Section (.505 Sample) Tensile Testing

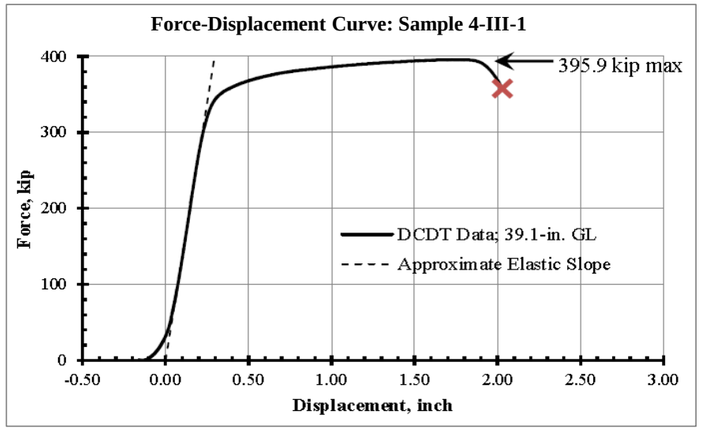
.505 Sample Tensile Test Results		
Identification	4-III-1	ASTM A354 BD Requirements
Yield Strength (ksi)	146.7	115 min
Tensile Strength (ksi)	159.9	140 min
Elongation in 2" Gage (%)	17.0	14 min
Reduction of Area (%)	50.4	40 min

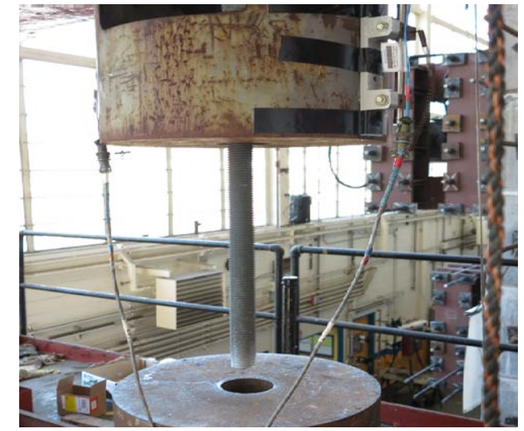
Charpy V-Notch Impact Test

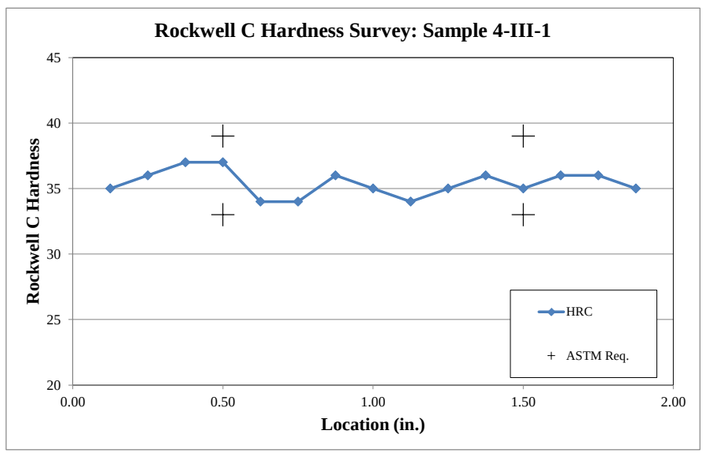
Charpy V-Notch Impact Energy Results (ft-lb)		
Identification	4-III-1	
Temperature	40°F	70°F
Sample 1	22	41
Sample 2	22	40
Sample 3	23	40
Average	22.3	40.3

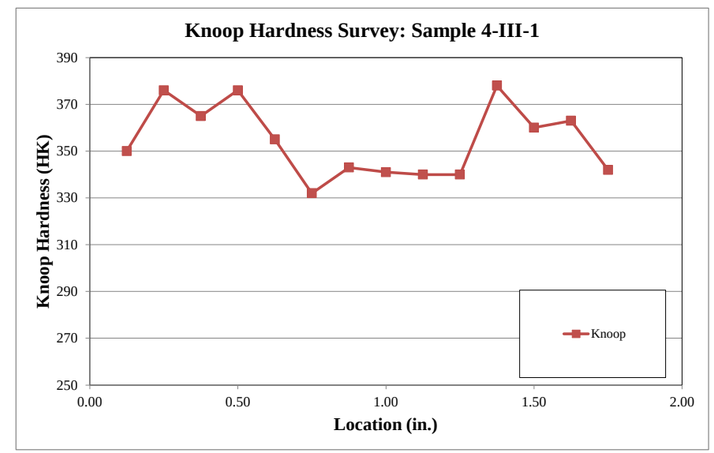
Hardness Testing Across the Diameter

Location (in)	4-III-1	
	HRC	Knoop
0.125	35	350
0.250	36	376
0.375	37	365
0.500	37	376
0.625	34	355
0.750	34	332
0.875	36	343
1.000	35	341
1.125	34	340
1.250	35	340
1.375	36	378
1.500	35	360
1.625	36	363
1.750	36	342
1.875	35	372









Spectrochemical Analysis

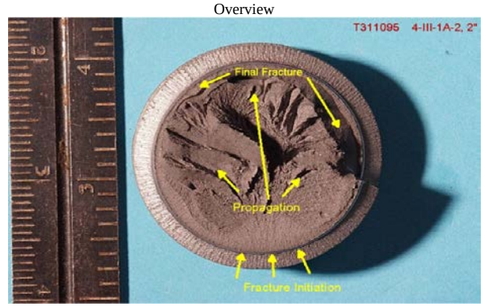
Spectrochemical Analysis (Reported as Wt. %)			
		4-III-1	ASTM A354
Aluminum	Al	0.02	
Carbon	C	0.4	0.33-0.55
Chromium	Cr	0.92	
Cobalt	Co	0.01	
Copper	Cu	0.21	
Manganese	Mn	0.86	0.57 min.
Molybdenum	Mo	0.20	
Nickel	Ni	0.10	
Phosporus	P	0.021	0.040 max.
Silicon	Si	0.25	
Sulfur	S	0.024	0.045 max.
Titanium	Ti	<0.01	
Vanadium	V	<0.01	

Coating Chemical Analysis

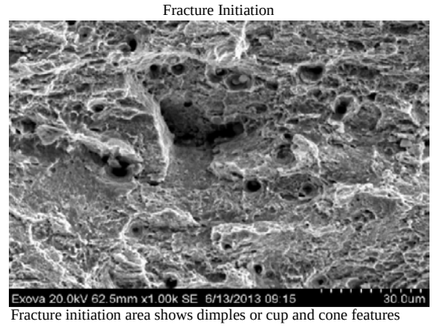
Coating Chemical Analysis (Reported as Wt. %)		
		4-III-1
Bismuth	Bi	0.006
Tin	Sn	0.012

Scanning Electron Microscopy

Overview

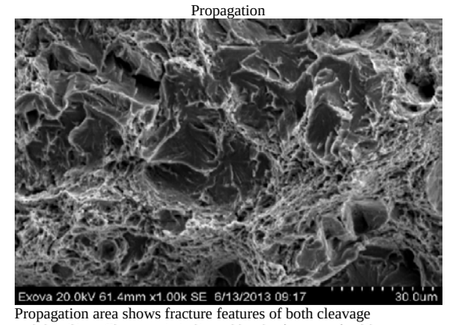


Fracture Initiation



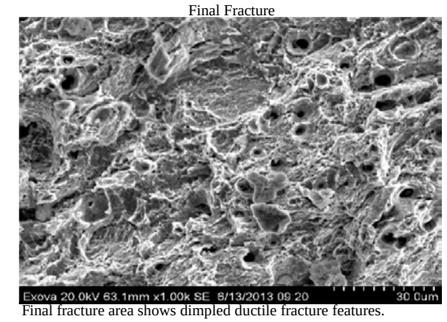
Fracture initiation area shows dimples or cup and cone features typical of ductile fracture. Ductile fractures in the origin area usually indicates tensile overload.

Propagation



Propagation area shows fracture features of both cleavage and ductility. Cleavage is indicated by the facets or fan like appearance. This is a common mode of propagation.

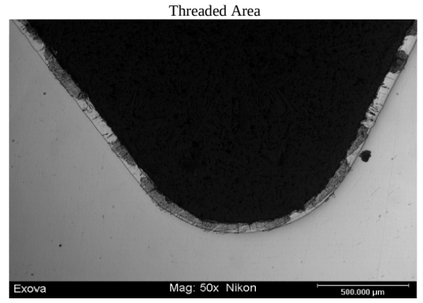
Final Fracture



Final fracture area shows dimpled ductile fracture features. Final fracture occurs when the remaining material is insufficient to sustain the load.

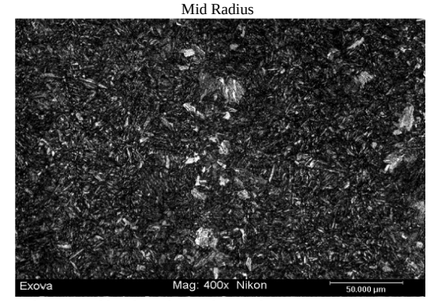
Micro-Structure Examination

Threaded Area



Thread root does not indicate cracking.

Mid Radius



Inclusions and banding observed in steel.
Essentially martensitic structure.

SAMPLE 4-III-2: 2" BEARING TOP BOLT - TEST III

Full-Size Tensile Testing

Full Size Tensile Testing		
	Sample 4-III-2 (35.5 in.)	ASTM A354 BD Requirements
Tensile Load (kips)	392.9	375.0 min
Tensile Strength (ksi)	157.2	140 min

Reduced Section (.505 Sample) Tensile Testing

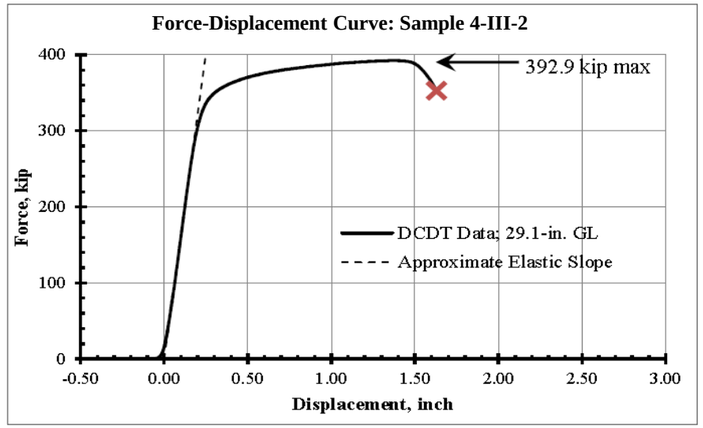
.505 Sample Tensile Test Results		
Identification	4-III-2	ASTM A354 BD Requirements
Yield Strength (ksi)	144.4	115 min
Tensile Strength (ksi)	156.6	140 min
Elongation in 2" Gage (%)	15.0	14 min
Reduction of Area (%)	46.6	40 min

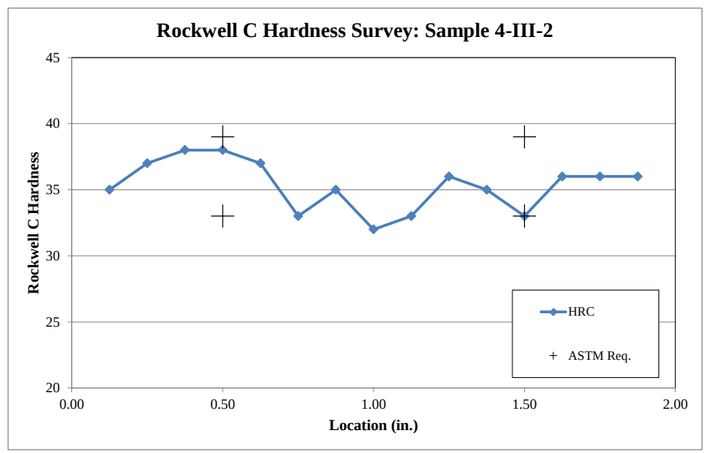
Charpy V-Notch Impact Test

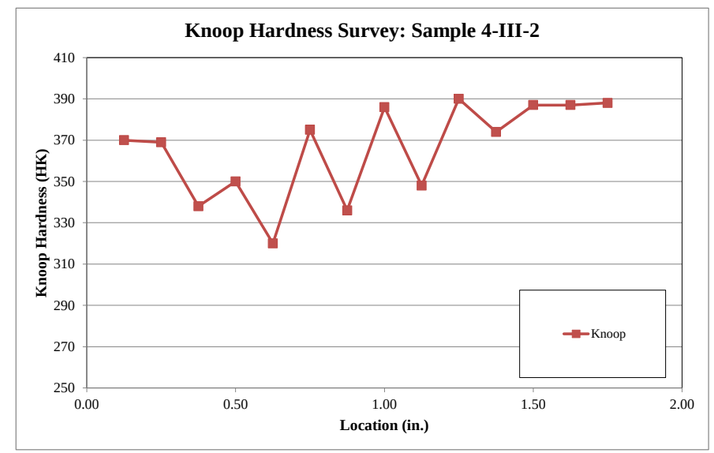
Charpy V-Notch Impact Energy Results (ft-lb)		
Identification	4-III-2	
Temperature	40°F	70°F
Sample 1	28	37
Sample 2	28	38
Sample 3	26	40
Average	27.3	38.3

Hardness Testing Across the Diameter

Location (in)	4-III-2	
	HRC	Knoop
0.125	35	370
0.250	37	369
0.375	38	338
0.500	38	350
0.625	37	320
0.750	33	375
0.875	35	336
1.000	32	386
1.125	33	348
1.250	36	390
1.375	35	374
1.500	33	387
1.625	36	387
1.750	36	388
1.875	36	410







Spectrochemical Analysis

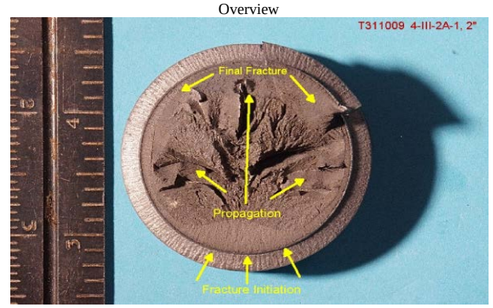
Spectrochemical Analysis (Reported as Wt. %)			
		4-III-2	ASTM A354
Aluminum	Al	0.02	
Carbon	C	0.40	0.33-0.55
Chromium	Cr	0.92	
Cobalt	Co	0.01	
Copper	Cu	0.21	
Manganese	Mn	86.00	0.57 min.
Molybdenum	Mo	0.20	
Nickel	Ni	0.09	
Phosporus	P	0.021	0.040 max.
Silicon	Si	0.25	
Sulfur	S	0.019	0.045 max.
Titanium	Ti	<0.01	
Vanadium	V	<0.01	

Coating Chemical Analysis

Coating Chemical Analysis (Reported as Wt. %)		
		4-III-2
Bismuth	Bi	0.006
Tin	Sn	0.010

Scanning Electron Microscopy

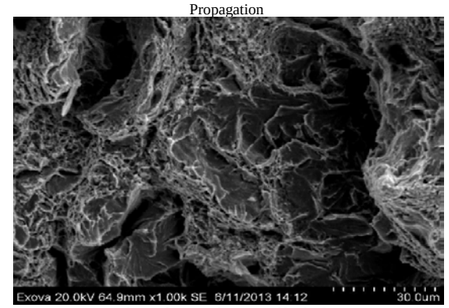
Overview



Fracture Initiation

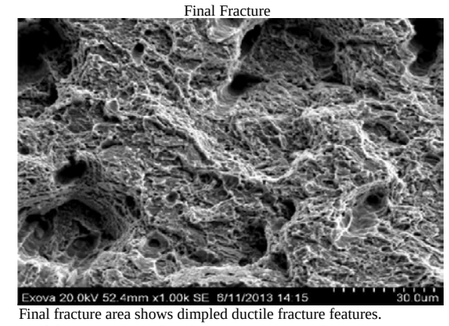
Fracture initiation area shows dimples or cup and cone features typical of ductile fracture. Ductile fractures in the origin area usually indicates tensile overload.

Propagation



Propagation area shows fracture features of both cleavage and ductility. Cleavage is indicated by the facets or fan like appearance. This is a common mode of propagation.

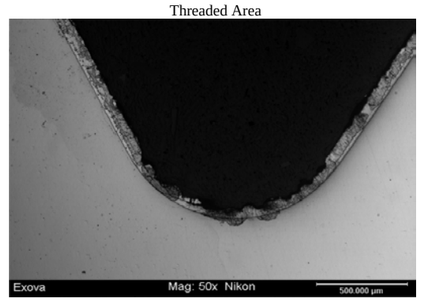
Final Fracture



Final fracture area shows dimpled ductile fracture features. Final fracture occurs when the remaining material is insufficient to sustain the load.

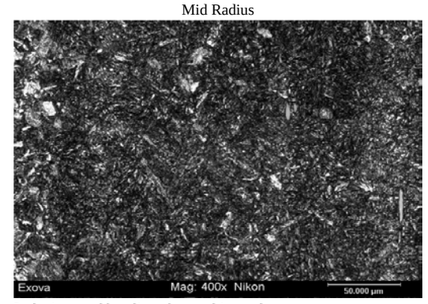
Micro-Structure Examination

Threaded Area



Thread root does not indicate cracking.

Mid Radius



Inclusions and banding observed in steel.
Essentially martensitic structure.

SAMPLE 7-III-1: 3.5" PWS STRAND ANCHOR ROD - TEST III

Full-Size Tensile Testing

Full Size Tensile Testing		
	Sample 7-III-1 (45.8 in.)	ASTM A354 BD Requirements
Tensile Load (kips)	1320.9	1166.2 min
Tensile Strength (ksi)	158.6	140 min

Reduced Section (.505 Sample) Tensile Testing

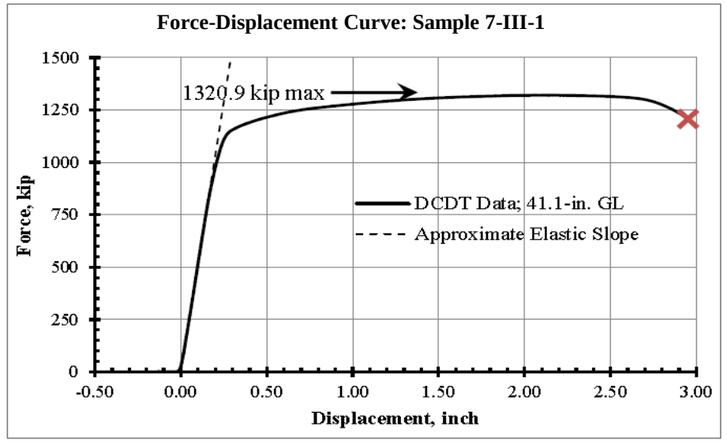
.505 Sample Tensile Test Results		
Identification	7-III-1	ASTM A354 BD Requirements
Yield Strength (ksi)	138.8	115 min
Tensile Strength (ksi)	158.3	140 min
Elongation in 2" Gage (%)	17.0	14 min
Reduction of Area (%)	53.1	40 min

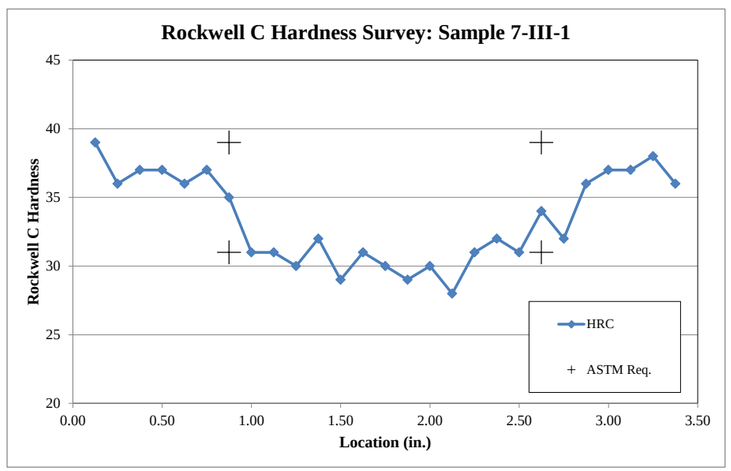
Charpy V-Notch Impact Test

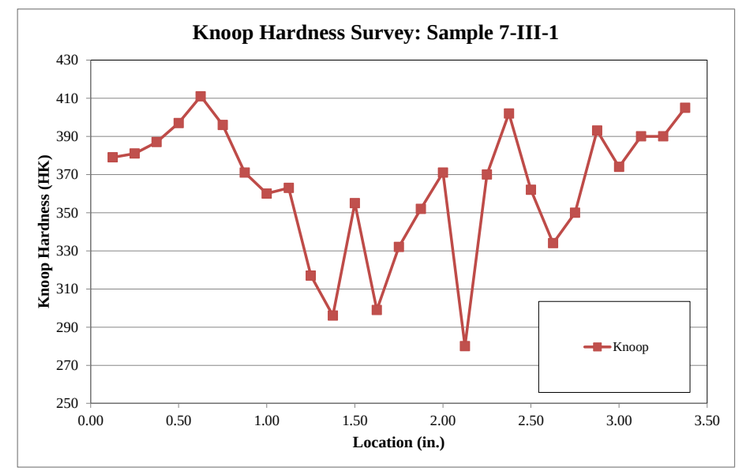
Charpy V-Notch Impact Energy Results (ft-lb)		
Identification	7-III-1	
Temperature	40°F	70°F
Sample 1	36	37
Sample 2	37	40
Sample 3	36	40
Average	36.3	39.0

Hardness Testing Across the Diameter

Location (in)	7-III-1	
	HRC	Knoop
0.125	39	379.0
0.250	36	381.0
0.375	37	387.0
0.500	37	397.0
0.625	36	411.0
0.750	37	396.0
0.875	35	371.0
1.000	31	360.0
1.125	31	363.0
1.250	30	317.0
1.375	32	296.0
1.500	29	355.0
1.625	31	299.0
1.750	30	332.0
1.875	29	352.0
2.000	30	371.0
2.125	28	280.0
2.250	31	370.0
2.375	32	402.0
2.500	31	362.0
2.625	34	334.0
2.750	32	350.0
2.875	36	393.0
3.000	37	374
3.125	37	390
3.250	38	390
3.375	36	405







Spectrochemical Analysis

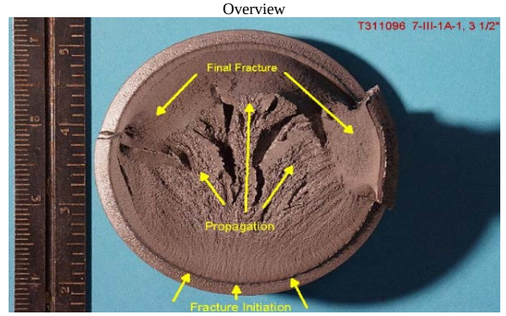
Spectrochemical Analysis (Reported as Wt. %)			
		7-III-1	ASTM A354
Aluminum	Al	0.03	
Carbon	C	0.37	0.33-0.55
Chromium	Cr	1.04	
Cobalt	Co	0.01	
Copper	Cu	0.17	
Manganese	Mn	0.98	0.57 min.
Molybdenum	Mo	0.18	
Nickel	Ni	0.09	
Phosporus	P	0.012	0.040 max.
Silicon	Si	0.20	
Sulfur	S	0.026	0.045 max.
Titanium	Ti	<0.01	
Vanadium	V	<0.01	

Coating Chemical Analysis

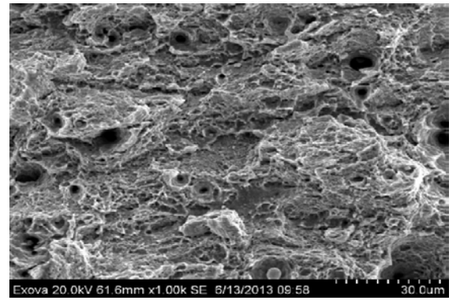
Coating Chemical Analysis (Reported as Wt. %)		
		7-III-1
Bismuth	Bi	0.006
Tin	Sn	0.014

Scanning Electron Microscopy

Overview

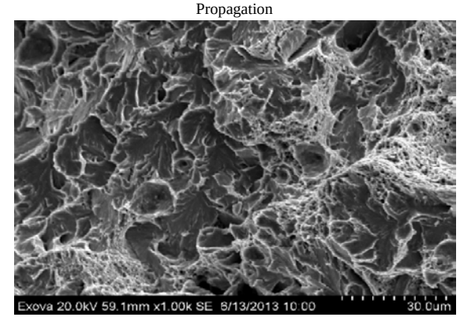


Fracture Initiation



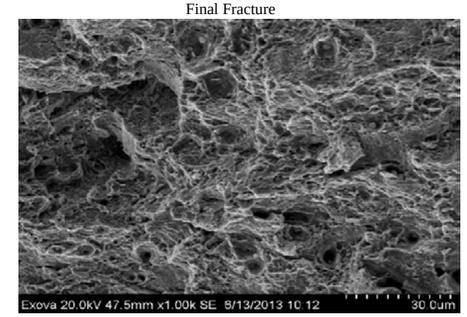
Fracture initiation area shows dimples or cup and cone features typical of ductile fracture. Ductile fractures in the origin area usually indicates tensile overload.

Propagation



Propagation area shows fracture features of both cleavage and ductility. Cleavage is indicated by the facets or fan like appearance. This is a common mode of propagation.

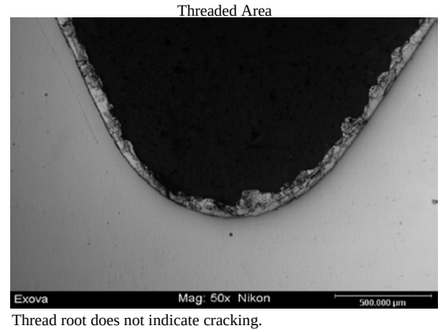
Final Fracture



Final fracture area shows dimpled ductile fracture features. Final fracture occurs when the remaining material is insufficient to sustain the load.

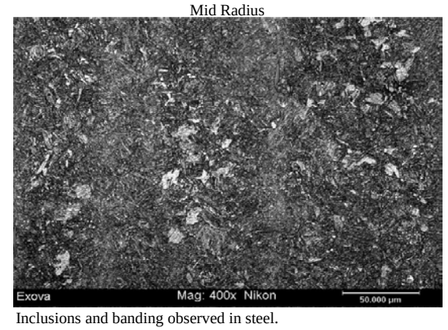
Micro-Structure Examination

Threaded Area



Thread root does not indicate cracking.

Mid Radius



Inclusions and banding observed in steel.
Essentially martensitic structure.

SAMPLE 8-III-1: 4" TOWER SADDLE TIE ROD - TEST III

Full-Size Tensile Testing

Full Size Tensile Testing		
	Sample 8-III-1 (25.5 in.)	ASTM A354 BD Requirements
Tensile Load (kips)	1676.0	1551.2 min
Tensile Strength (ksi)	151.3	140 min

Reduced Section (.505 Sample) Tensile Testing

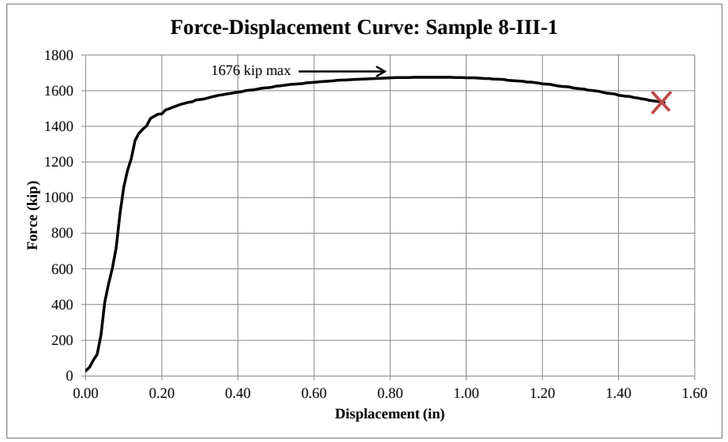
.505 Sample Tensile Test Results		
Identification	8-III-1	ASTM A354 BD Requirements
Yield Strength (ksi)	136.4	115 min
Tensile Strength (ksi)	161.5	140 min
Elongation in 2" Gage (%)	17.0	14 min
Reduction of Area (%)	49.3	40 min

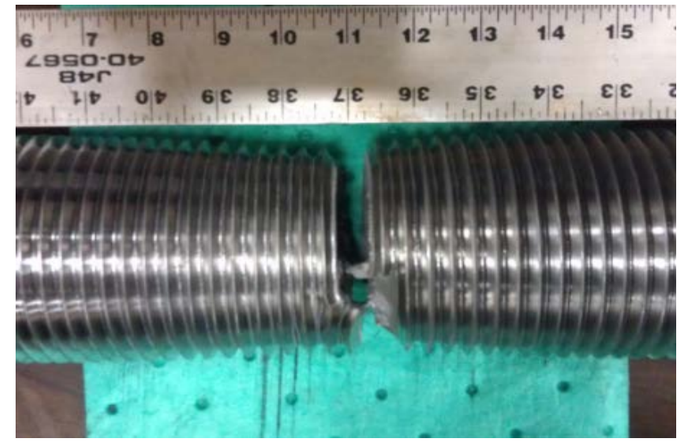
Charpy V-Notch Impact Test

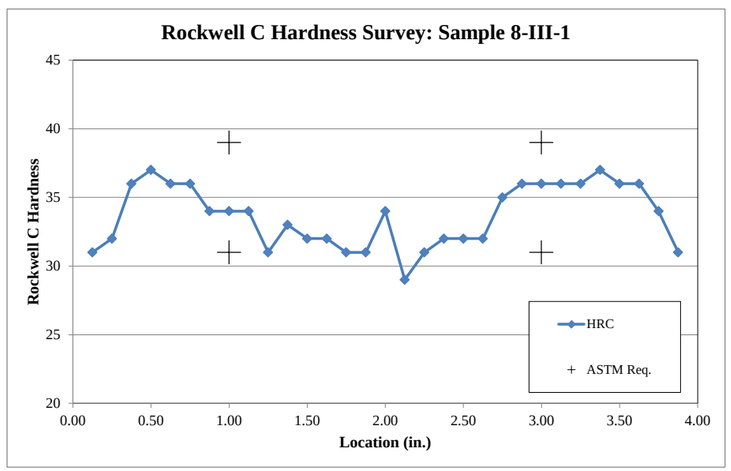
Charpy V-Notch Impact Energy Results (ft-lb)		
Identification	8-III-1	
Temperature	40°F	70°F
Sample 1	17	19
Sample 2	17	18
Sample 3	16	18
Average	16.7	18.3

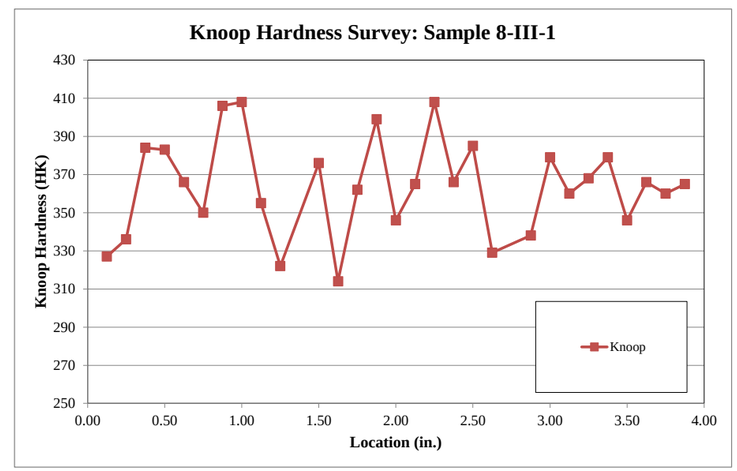
Hardness Testing Across the Diameter

Location (in)	8-III-1	
	HRC	Knoop
0.125	31	327
0.250	32	336
0.375	36	384
0.500	37	383
0.625	36	366
0.750	36	350
0.875	34	406
1.000	34	408
1.125	34	355
1.250	31	322
1.375	33	-
1.500	32	376
1.625	32	314
1.750	31	362
1.875	31	399
2.000	34	346
2.125	29	365
2.250	31	408
2.375	32	366
2.500	32	385
2.625	32	329
2.750	35	-
2.875	36	338
3.000	36	379
3.125	36	360
3.250	36	368
3.375	37	379
3.500	36	346
3.625	36	366
3.750	34	360
3.875	31	365









Spectrochemical Analysis

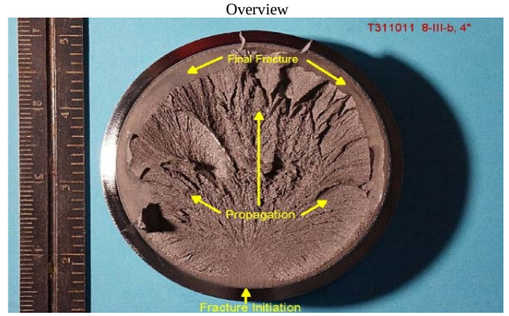
Spectrochemical Analysis (Reported as Wt. %)			
		8-III-1	ASTM A354
Aluminum	Al	0.02	
Carbon	C	0.38	0.33-0.55
Chromium	Cr	1.04	
Cobalt	Co	0.01	
Copper	Cu	0.18	
Manganese	Mn	0.98	0.57 min.
Molybdenum	Mo	0.17	
Nickel	Ni	0.14	
Phosporus	P	0.010	0.040 max.
Silicon	Si	0.32	
Sulfur	S	0.021	0.045 max.
Titanium	Ti	<0.01	
Vanadium	V	0.01	

Coating Chemical Analysis

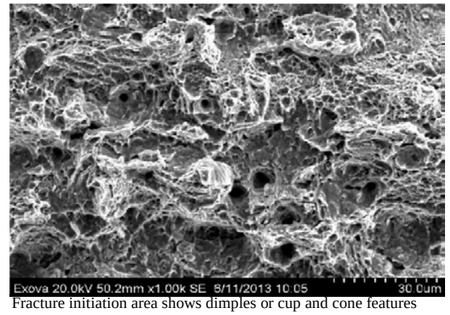
Coating Chemical Analysis (Reported as Wt. %)		
		8-III-1
Bismuth	Bi	0.007
Tin	Sn	0.009

Scanning Electron Microscopy

Overview

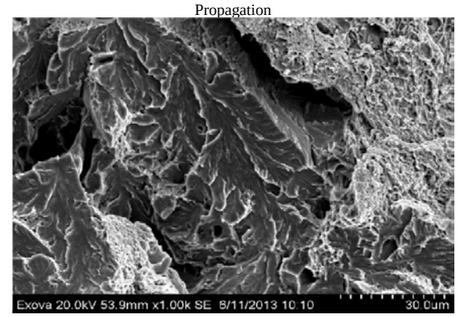


Fracture Initiation



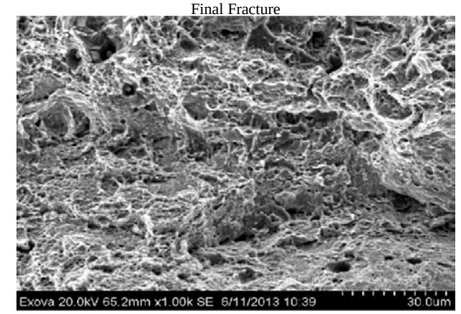
Fracture initiation area shows dimples or cup and cone features typical of ductile fracture. Ductile fractures in the origin area usually indicates tensile overload.

Propagation



Propagation area shows fracture features of both cleavage and ductility. Cleavage is indicated by the facets or fan like appearance. This is a common mode of propagation.

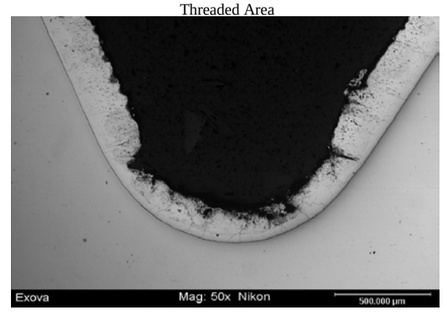
Final Fracture



Final fracture area shows dimpled ductile fracture features. Final fracture occurs when the remaining material is insufficient to sustain the load.

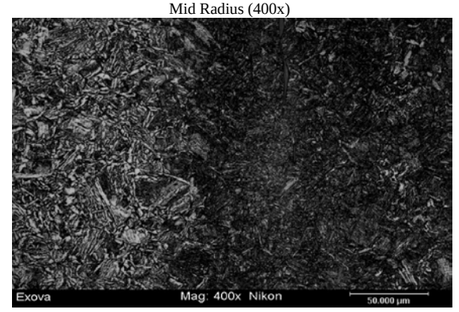
Micro-Structure Examination

Threaded Area



Thread root does not indicate cracking.

Mid Radius (400x)



Inclusions and banding observed in steel.
Essentially martensitic structure.

SAMPLE 11-III-1: 3" TOWER OUTRIGGER - TEST III

Full-Size Tensile Testing

Full Size Tensile Testing		
	Sample 11-III-1 (24.8 in.)	ASTM A354 BD Requirements
Tensile Load (kips)	996.9	835.8 min
Tensile Strength (ksi)	167.0	140 min

Reduced Section (.505 Sample) Tensile Testing

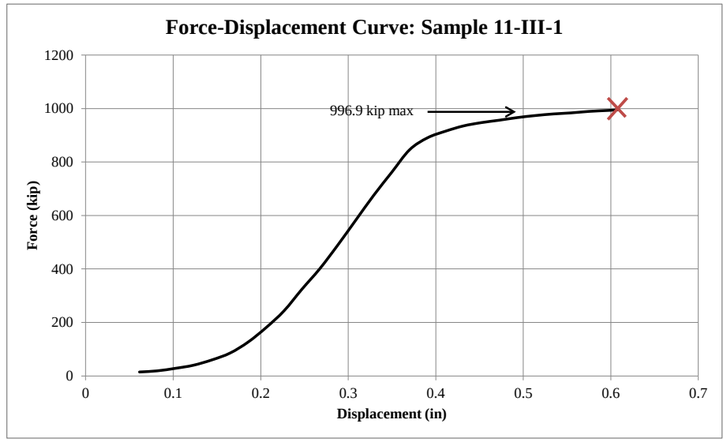
.505 Sample Tensile Test Results		
Identification	11-III-1	ASTM A354 BD Requirements
Yield Strength (ksi)	-	115 min
Tensile Strength (ksi)	-	140 min
Elongation in 2" Gage (%)	-	14 min
Reduction of Area (%)	-	40 min

Charpy V-Notch Impact Test

Charpy V-Notch Impact Energy Results (ft-lb)		
Identification	11-III-1	
Temperature	-	-
Sample 1	-	-
Sample 2	-	-
Sample 3	-	-
Average	-	-

Hardness Testing Across the Diameter

Location (in)	11-III-1	
	HRC	Knoop
0.125	-	-
0.250	-	-
0.375	-	-
0.500	-	-
0.625	-	-
0.750	-	-
0.875	-	-
1.000	-	-
1.125	-	-
1.250	-	-
1.375	-	-
1.500	-	-
1.625	-	-
1.750	-	-
1.875	-	-
2.000	-	-
2.125	-	-
2.250	-	-
2.375	-	-
2.500	-	-
2.625	-	-
2.750	-	-
2.875	-	-



Note:
There was not enough length in the non-strain hardened portion of this sample to perform reduced section analysis, Charpy V-Notch testing, hardness testing or spectrochemical analysis.

Spectrochemical Analysis

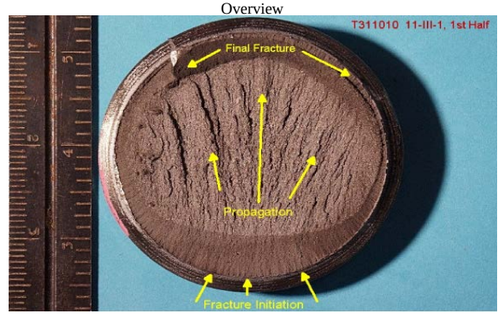
Spectrochemical Analysis (Reported as Wt. %)			
		11-III-1	ASTM A354
Aluminum	Al		
Carbon	C		0.33-0.55
Chromium	Cr		
Cobalt	Co		
Copper	Cu		
Manganese	Mn		0.57 min.
Molybdenum	Mo		
Nickel	Ni		
Phosporus	P		0.040 max.
Silicon	Si		
Sulfur	S		0.045 max.
Titanium	Ti		
Vanadium	V		

Coating Chemical Analysis

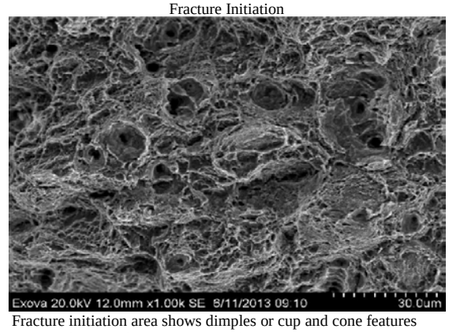
Coating Chemical Analysis (Reported as Wt. %)		
		11-III-1
Bismuth	Bi	0.007
Tin	Sn	0.017

Scanning Electron Microscopy

Overview

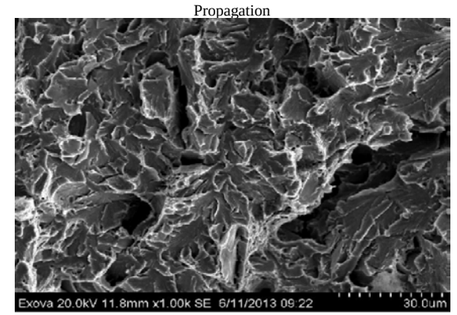


Fracture Initiation



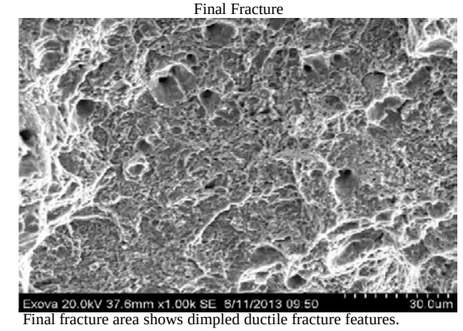
Fracture initiation area shows dimples or cup and cone features typical of ductile fracture. Ductile fractures in the origin area usually indicates tensile overload.

Propagation



Propagation area shows fracture features of both cleavage and ductility. Cleavage is indicated by the facets or fan like appearance. This is a common mode of propagation.

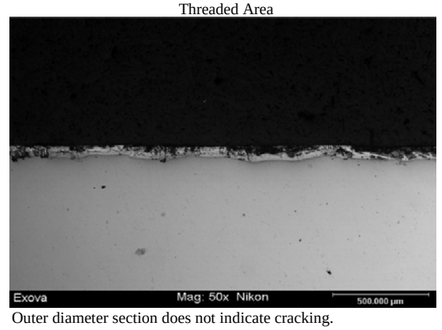
Final Fracture



Final fracture area shows dimpled ductile fracture features. Final fracture occurs when the remaining material is insufficient to sustain the load.

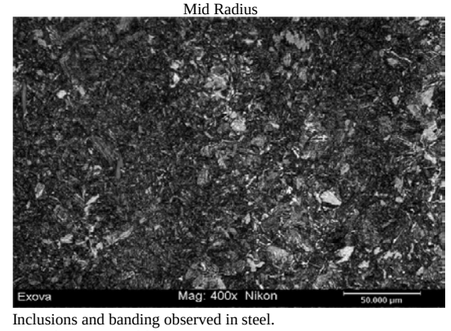
Micro-Structure Examination

Threaded Area



Outer diameter section does not indicate cracking.

Mid Radius



Inclusions and banding observed in steel.
Essentially martensitic structure.

SAMPLE 12-III-1: 3" TOWER ANCHORAGE ANCHOR BOLT - TEST III

Full-Size Tensile Testing

Full Size Tensile Testing			
	Sample 12-III-1 (Test 1 - 50.25 in.)	Sample 12-III-1 (Test 2 - 44.0 in.)	ASTM A354 BD Requirements
Tensile Load (kips)	924.6	972.0	835.8 min
Tensile Strength (ksi)	154.9	162.8	140 min

Reduced Section (.505 Sample) Tensile Testing

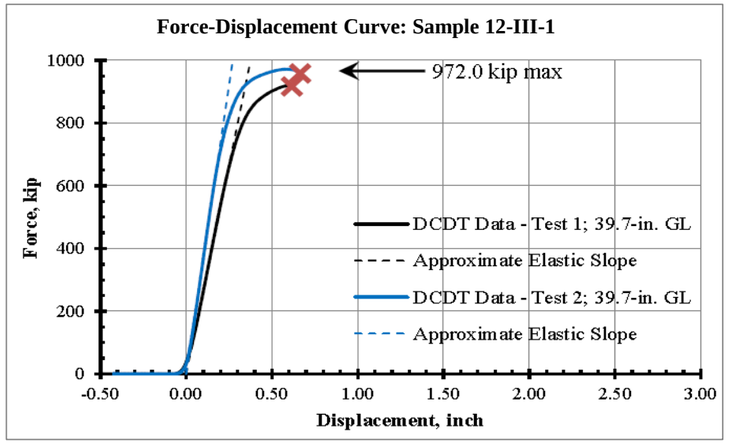
.505 Sample Tensile Test Results		
Identification	12-III-1	ASTM A354 BD Requirements
Yield Strength (ksi)	147.6	115 min
Tensile Strength (ksi)	163.3	140 min
Elongation in 2" Gage (%)	17.0	14 min
Reduction of Area (%)	54.8	40 min

Charpy V-Notch Impact Test

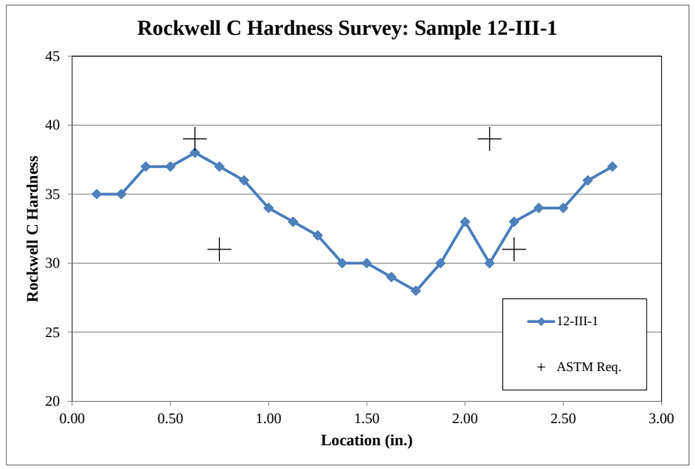
Charpy V-Notch Impact Energy Results (ft-lb)		
Identification	12-III-1	
Temperature	40°F	70°F
Sample 1	47	52
Sample 2	51	52
Sample 3	49	49
Average	49.0	51.0

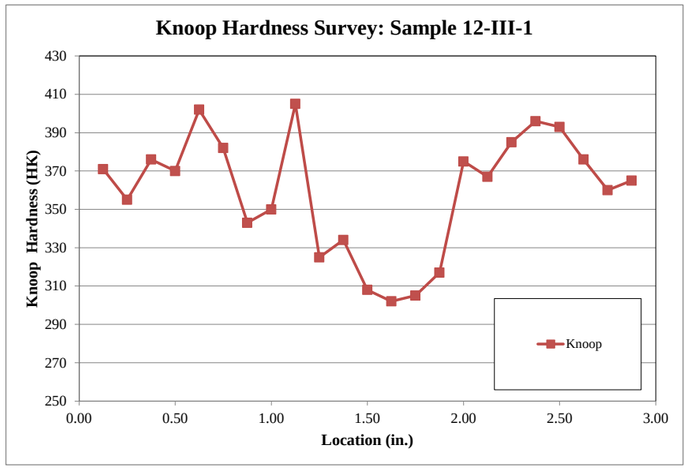
Hardness Testing Across the Diameter

Location (in)	12-III-1	
	HRC	Knoop
0.125	35	371.0
0.250	35	355.0
0.375	37	376.0
0.500	37	370.0
0.625	38	402.0
0.750	37	382.0
0.875	36	343.0
1.000	34	350.0
1.125	33	405.0
1.250	32	325.0
1.375	30	334.0
1.500	30	308.0
1.625	29	302.0
1.750	28	305.0
1.875	30	317.0
2.000	33	375.0
2.125	30	367.0
2.250	33	385.0
2.375	34	396.0
2.500	34	393.0
2.625	36	376.0
2.750	37	360.0
2.875	37	365.0



During the testing of sample 12-III-1, the bar reduction in area caused the threads to slide at a load larger than the ultimate requirement. The test was performed a second time in order to achieve a fracture across the diameter of the rod. The tabulated results and attached graph represent the first and second tests respectively. Note that the second test results are also affected by residual strains from the previous pull and the effects of work hardening.





Spectrochemical Analysis

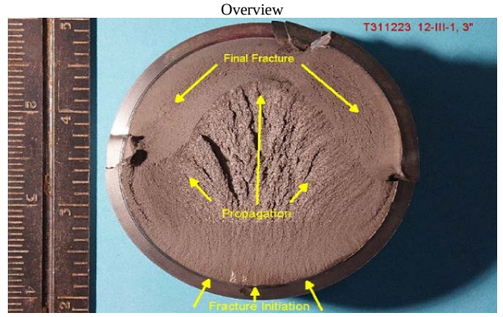
Spectrochemical Analysis (Reported as Wt. %)			
		12-III-1	ASTM A354
Aluminum	Al	0.02	
Carbon	C	0.38	0.33-0.55
Chromium	Cr	1.04	
Cobalt	Co	0.02	
Copper	Cu	0.21	
Manganese	Mn	0.90	0.57 min.
Molybdenum	Mo	0.17	
Nickel	Ni	0.08	
Phosporus	P	0.009	0.040 max.
Silicon	Si	0.27	
Sulfur	S	0.021	0.045 max.
Titanium	Ti	<0.01	
Vanadium	V	0.01	

Coating Chemical Analysis

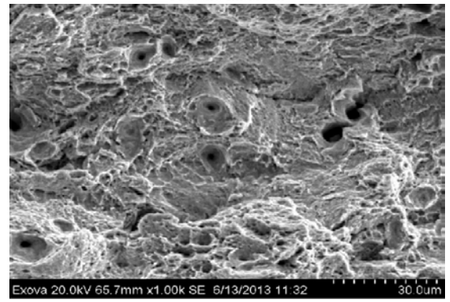
Coating Chemical Analysis (Reported as Wt. %)		
		12-III-1
Bismuth	Bi	0.030
Tin	Sn	0.012

Scanning Electron Microscopy

Overview

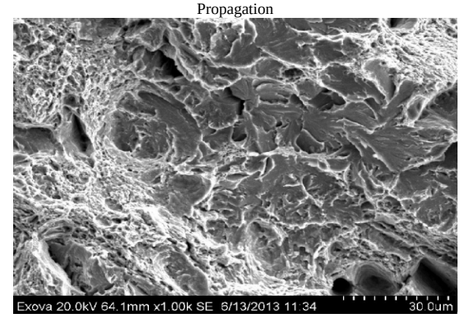


Fracture Initiation



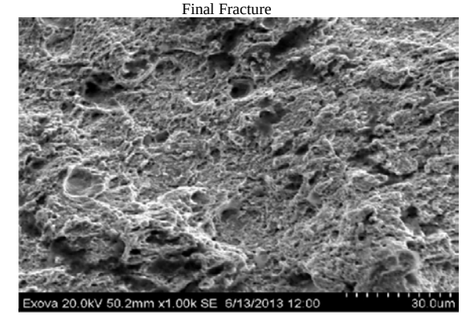
Fracture initiation area shows dimples or cup and cone features typical of ductile fracture. Ductile fractures in the origin area usually indicates tensile overload.

Propagation



Propagation area shows fracture features of both cleavage and ductility. Cleavage is indicated by the facets or fan like appearance. This is a common mode of propagation.

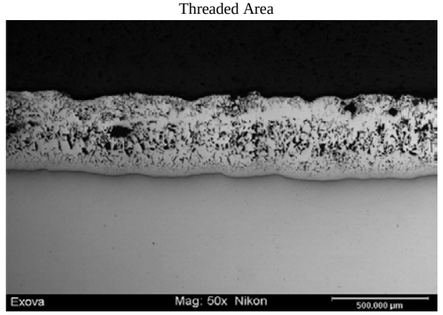
Final Fracture



Final fracture area shows dimpled ductile fracture features. Final fracture occurs when the remaining material is insufficient to sustain the load.

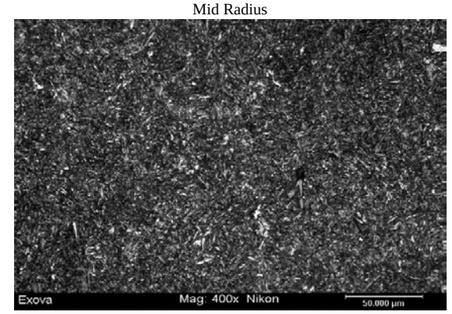
Micro-Structure Examination

Threaded Area



Thread root does not indicate cracking.

Mid Radius



Inclusions and banding observed in steel.
Essentially martensitic structure.

SAMPLE 14-III-1: 2" EAST SADDLE ANCHOR ROD - TEST III

Full-Size Tensile Testing

Full Size Tensile Testing		
	Sample 14-III-1 (31.5 in.)	ASTM A354 BD Requirements
Tensile Load (kips)	376.0	375.0 min
Tensile Strength (ksi)	150.4	140 min

Reduced Section (.505 Sample) Tensile Testing

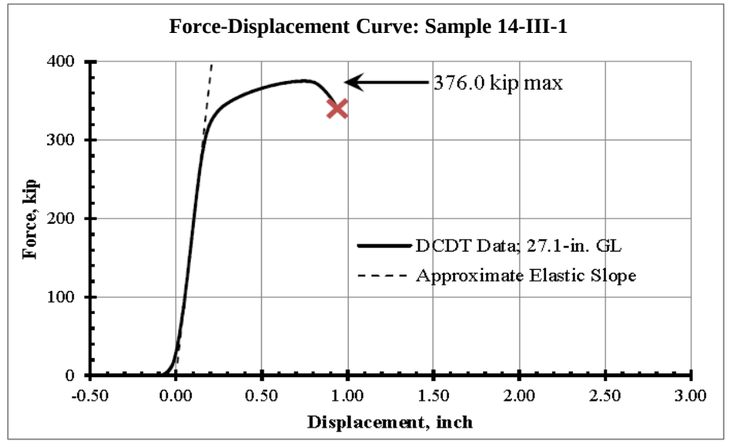
.505 Sample Tensile Test Results		
Identification	14-III-1	ASTM A354 BD Requirements
Yield Strength (ksi)	-	115 min
Tensile Strength (ksi)	-	140 min
Elongation in 2" Gage (%)	-	14 min
Reduction of Area (%)	-	40 min

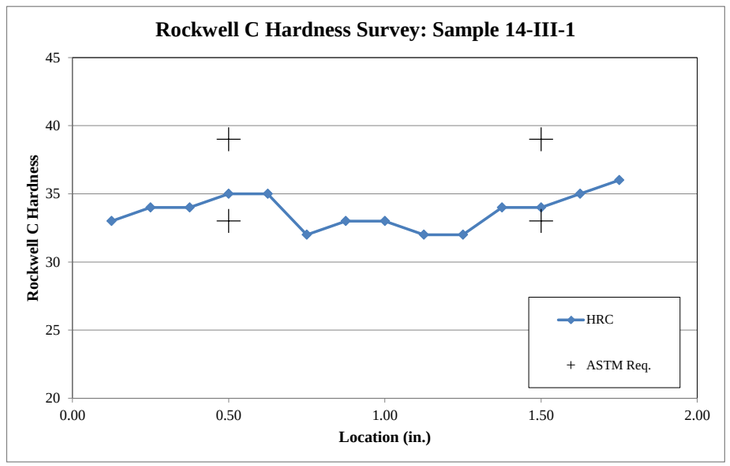
Charpy V-Notch Impact Test

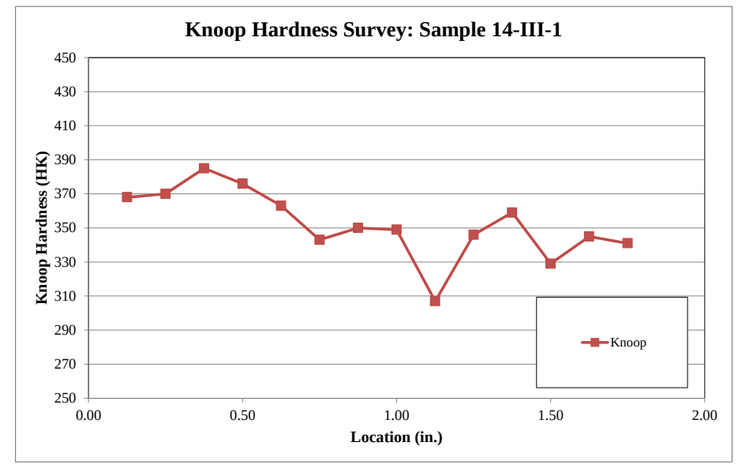
Charpy V-Notch Impact Energy Results (ft-lb)		
Identification	14-III-1	
Temperature	40°F	70°F
Sample 1	24	50
Sample 2	32	45
Sample 3	25	46
Average	27.0	47.0

Hardness Testing Across the Diameter

Location (in)	14-III-1	
	HRC	Knoop
0.125	33	368.0
0.250	34	370.0
0.375	34	385.0
0.500	35	376.0
0.625	35	363.0
0.750	32	343.0
0.875	33	350.0
1.000	33	349.0
1.125	32	307.0
1.250	32	346.0
1.375	34	359.0
1.500	34	329.0
1.625	35	345.0
1.750	36	341.0







Note: There was not enough length on this sample to perform reduced section analysis.

Spectrochemical Analysis

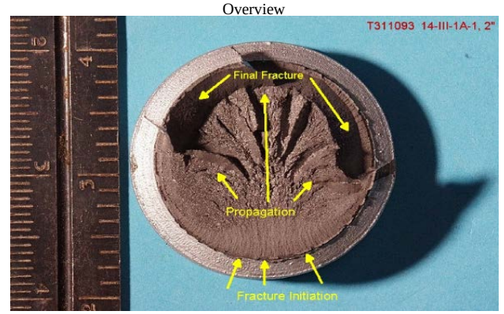
Spectrochemical Analysis (Reported as Wt. %)			
		14-III-1	ASTM A354
Aluminum	Al	0.02	
Carbon	C	0.40	0.33-0.55
Chromium	Cr	0.97	
Cobalt	Co	0.01	
Copper	Cu	0.19	
Manganese	Mn	0.90	0.57 min.
Molybdenum	Mo	0.16	
Nickel	Ni	0.10	
Phosporus	P	0.013	0.040 max.
Silicon	Si	0.27	
Sulfur	S	0.024	0.045 max.
Titanium	Ti	<0.01	
Vanadium	V	0.01	

Coating Chemical Analysis

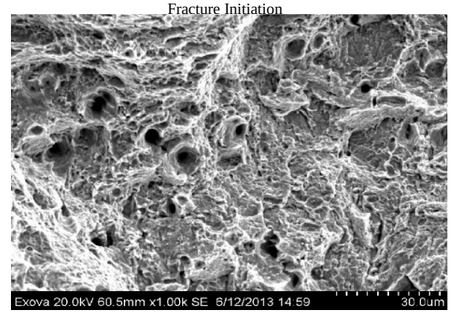
Coating Chemical Analysis (Reported as Wt. %)		
		14-III-1
Bismuth	Bi	0.003
Tin	Sn	0.005

Scanning Electron Microscopy

Overview

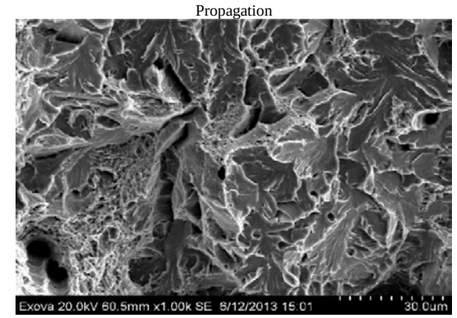


Fracture Initiation



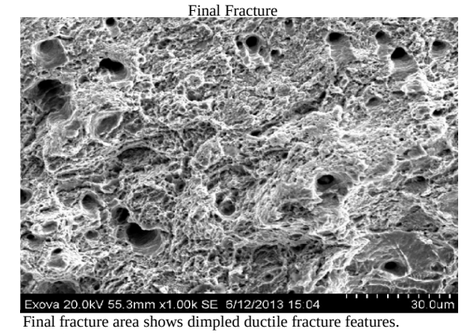
Fracture initiation area shows dimples or cup and cone features typical of ductile fracture. Ductile fractures in the origin area usually indicates tensile overload.

Propagation



Propagation area shows fracture features of both cleavage and ductility. Cleavage is indicated by the facets or fan like appearance. This is a common mode of propagation.

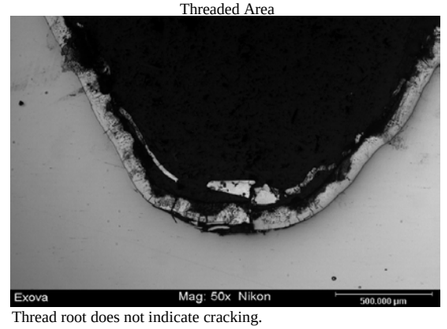
Final Fracture



Final fracture area shows dimpled ductile fracture features. Final fracture occurs when the remaining material is insufficient to sustain the load.

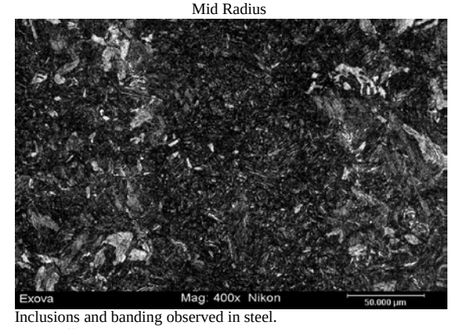
Micro-Structure Examination

Threaded Area



Thread root does not indicate cracking.

Mid Radius



Inclusions and banding observed in steel.
Essentially martensitic structure.