U.S. Department of Transportation
Federal Highway Administration

1200 New Jersey Ave., SE
Washington, D.C. 20590

August 5, 2022

In Reply Refer To:
HSST-1/B-366

Thomas Cho
Triborough Bridge and Tunnel Authority (TBTA)
Engineering and Construction, Room 215,
Robert Mosses Building, Randall's Island,
New York City, NY 10035
USA

Dear Mr. Cho:

We received your correspondence of October 26, 2021 requesting issuance of a reimbursement eligibility letter under the Federal-aid highway program for the roadside safety system, device, design, product, or hardware (collectively "device") described below. This letter is assigned Federal Highway Administration (FHWA) control number B-366.

ELIGIBILITY LETTERS

The FHWA issues Federal-aid reimbursement eligibility letters for new roadside safety devices that are crash tested in accordance with the industry standard of the American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH).

FHWA, the Department of Transportation, and the United States (government) do not regulate roadside safety devices, crash test facilities, or the manufacturing industry. Issuance of eligibility letters is discretionary and provided only as a service to the states. FHWA may, at its discretion, decline to issue, revise, or rescind an eligibility letter. Eligibility letters are only issued by the FHWA headquarters Office of Safety.

Eligibility letters are issued only as notice to the states that a device is eligible for reimbursement under the Federal-aid highway program. They do not establish approval or certification for any other purpose. Issuance of an eligibility letter is not a prerequisite or requirement for state transportation agencies seeking to use Federal-aid funds for roadside safety devices. State agencies may use a device for which an eligibility letter has not been issued and seek Federal-aid reimbursement.

FEDERAL-AID REIMBURSEMENT

The request for issuance of this letter certified the device was crash tested in accordance with the industry standard of AASHTO's MASH. This eligibility letter is based on that certification and the material offered in support of its issuance. The device described below is eligible for reimbursement under the Federal-aid highway program.

Name of system: RK-19 Bridge Rail
Type of system: Bridge Rail
Test Level: Test Level 5
Testing conducted by: Texas A&M Transportation Institute
Date of request: October 26, 2021

Information about the device, including material such as the eligibility request, crash test reports, drawings, or images are included in one or more attachment(s) to this letter.

In accordance with FHWA's Memo "Federal-aid Reimbursement Eligibility Process for Safety Hardware Devices" dated November 12, 2015, FHWA will make note of any reported damage to a test vehicle's fuel tank, oil pan, or other feature that might serve as a surrogate of the fuel tank. AASHTO's MASH states "Although not a specific factor in assessing test results, integrity of a test vehicle's fuel tank is a potential concern. It is preferable that the fuel tank remains intact and not be punctured. Damage or rupture of the fuel tank, oil pan, or other feature that might serve as a surrogate of the fuel tank should be reported". The test report included in this submittal states right fuel tank was damaged in Test 5-12.

Eligibility letter B-366 is inapplicable to devices, optional equipment, alternate materials, or other features that were not crash tested in accordance with AASHTO's MASH.

This letter is issued only for the subject device as crash tested under AASHTO's MASH. Later modification(s) of the device are not eligible for Federal-aid reimbursement under this letter. Notice of later modification(s) should be given to transportation agencies, facility owners, and operators (collectively "agencies").

Agencies should be provided appropriate information about the device's design, installation, maintenance, materials, and mechanical properties.

Issuance of this letter is discretionary, and it may be revised or rescinded at FHWA's discretion. This letter is not a determination of compliance with the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) or ownership of any intellectual property rights.

This eligibility letter is not a determination by the government that a crash involving the subject device will result in any particular outcome. It is limited to only the device's eligibility for Federal-aid reimbursement.

INTELLECTUAL PROPERTY

Issuance of this eligibility letter does not convey property rights of any sort nor any exclusive privilege. This letter is not authorization or consent by the government for the use, manufacture, or sale of any patented or proprietary system, device, design, product, or hardware for which the requester is not the patent owner. Eligibility letters are not an expression of any view, position, or determination by the government as to the validity, scope, or ownership of any intellectual property rights to a specific device. These letters do not grant, impute, suggest, or otherwise establish any ownership, distribution, or licensing rights to the requester. The government expresses no opinion about the intellectual property rights relating to any device for which this or any other eligibility letter is issued.

PUBLIC DISCLOSURE

To prevent any misunderstanding, and as discussed above, this eligibility letter is assigned FHWA control number B-366. It should only be reproduced in full with its attachment(s). This letter and the material offered by the requester supporting its issuance is public information. All eligibility letters and supporting material are subject to public disclosure under the Freedom of Information Act (FOIA). Eligibility letters are available to the public at https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/.

If you have any questions please contact Aimee Zhang at Aimee.Zhang@dot.gov.

Sincerely,

Michael S. Griffith

Michael S. Griffith
Director, Office of Safety Technologies
Office of Safety

Enclosures

Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware

Submitter		
Date of Request:	October 26, 2021	(•) New ( ) Resubmission
Name:	Thomas Cho	
Company:	Triborough Bridge and Tunnel Authority (TBTA)	
Address:	Engineering and Construction, Room 215, Robert Mosses Building, Randall's Island, New York, NY 10035	
Country:	USA	
To:	Michael S. Griffith, Director FHWA, Office of Safety Technologies	

I request the following devices be considered eligible for reimbursement under the Federal-aid highway program.

Device & Testing Criterion - Enter from right to left starting with Test Level

!-!-!

System Type	Submission Type	Device Name / Variant	Testing Criterion	Test Level
'B': Rigid/Semi-Rigid Barriers (Roadside, Median, Bridge Railings)	(•) Physical Crash Testing ( ) Engineering Analysis	RK-19 Bridge Rail	AASHTO MASH	TL5

By submitting this request for review and evaluation by the Federal Highway Administration, I certify that the product(s) was (were) tested in conformity with the AASHTO Manual for Assessing Safety Hardware and that the evaluation results meet the appropriate evaluation criteria in the MASH.

Individual or Organization responsible for the product:

Contact Name:	Thomas Cho	Same as Submitter ☒
Company Name:	Triborough Bridge and Tunnel Authority (TBTA)	Same as Submitter ☒
Address:	Engineering and Construction, Room 215, Robert Mosses	Same as Submitter ☒
Country:	USA	Same as Submitter ☒

Enter below all disclosures of financial interests as required by the FHWA `Federal-Aid Reimbursement Eligibility Process for Safety Hardware Devices' document.

Texas A&M Transportation Institute (TTI) was contracted by Ammann & Whitney / WSP on behalf of TBTA to perform full-scale crash testing of the RK-19 Bridge Rail. There are no shared financial interests in the RK-19 Bridge Rail by TTI, or between Ammann & Whitney / WSP and TTI, other than costs involved in the actual crash tests and reports for this submission to FHWA.

614911-01-1, -2, -3

PRODUCT DESCRIPTION

(●) New Hardware or Significant Modification	( ) Modification to Existing Hardware

The installation consisted of a steel bridge rail system mounted to a 1ft-10 inches thick orthotropic steel bridge deck, with a 3/8-inch-thick overlay. The bridge deck was 9 ft wide, and 50 ft-9 inches long, starting 1 ft-8½ inches upstream of post 3 and ending 1 ft-8½ inches downstream of post 11. Steel W8×28 posts, which supported 1 rectangular and 3 square steel rails, were evenly spaced at 5 ft-11 inches center-to-center for a total length of 130 ft-2 inches. The top rail (HSS 6×6×½ inch) was mounted to the posts at 44-1/8 inches from the roadway to the top of the rail, the preceding two rails (HSS 6×6×5/16 inch) were mounted below with 5 inches between each rail, and the bottom rail (HSS 5×3×⅜ inch) was mounted 6 inches below the rail above.

CRASH TESTING

By signature below, the Engineer affiliated with the testing laboratory, agrees in support of this submission that all of the critical and relevant crash tests for this device listed above were conducted to meet the MASH test criteria. The Engineer has determined that no other crash tests are necessary to determine the device meets the MASH criteria.

Engineer Name:		
Engineer Signature:	William Williams Digitally signed by William Williams Date: 2021.10.26 10:08:01 -05'00'	
Address:	1254 Avenue A, Bldg 7091, Bryan, Texas 77807 USA	Same as Submitter ☐
Country:		Same as Submitter ☐

A brief description of each crash test and its result:

Required Test Number	Narrative Description	Evaluation Results
5-10 (1100C)	Test 5-10 involves an 1100C vehicle impacting the test article at a target impact speed of 62 mi/h ±2.5 mi/h and a target impact angle of 25° ±1.5°. The target CIP was for the right corner of the front bumper to impact 3.6 ft upstream of the centerline of the rail splice between posts 6 and 7. The results of the test conducted on April 27, 2021, are found in TTI Test Report number 614911-01. The test vehicle was traveling at an impact speed of 62.4 mi/h as it made contact with the rail 3.5 ft upstream of the centerline of the rail splice between posts 6 and 7 at an impact angle of 25.0°. After loss of contact with the barrier, the vehicle came to rest 201 ft downstream of the impact point and 40 ft towards the traffic side. The bridge rail contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. The 1100C vehicle exited within the exit box criteria. Working width was 17.5 inches. Maximum dynamic deflection was 1.3 inches during the test. No permanent deformation was observed afterwards. No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or present hazard to others in the area. Maximum exterior crush to the vehicle was 10.0 inches in the front and side planes at the right front corner at and above bumper height. Maximum occupant compartment deformation was 3.0 inches in the right front firewall/toe pan area. The 1100C vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 8° and 4°, respectively. Longitudinal OIV was 21.5 ft/s, and lateral OIV was 34.6 ft/s. Longitudinal occupant ridedown acceleration was 3.4 g, and lateral occupant ridedown acceleration 11.2 g. The occupant risk factors were within the MASH allowable limits. The RK-19 Bridge Rail performed acceptably for MASH test 5-10.	PASS

Required Test Number	Narrative Description	Evaluation Results
5-11 (2270P)	Test 5-11 involves a 2270P vehicle impacting the test article at a target impact speed of 62 mi/h ±2.5 mi/h and a target impact angle of 25° ±1.5°. The target CIP was for the right corner of the front bumper to impact at 4.3 ft upstream of the centerline of the rail splice between posts 6 and 7. The results of the test conducted on April 29, 2021 are found in TTI Test Report number 614911-01. The test vehicle was traveling at an impact speed of 64.0 mi/h as it made contact with the barrier 4.1 ft upstream of the centerline of the rail splice between posts 6 and 7 at an angle of 25.1°. After loss of contact with the barrier, the vehicle came to rest 241 ft downstream of the impact point and 31 ft towards the traffic side. The bridge rail contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. The 2270P vehicle exited within the exit box criteria. Working width was 17.5-inches. Maximum dynamic deflection during the test was 1.5 inches. No permanent deformation was observed afterwards. No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or present hazard to others in the area. Maximum exterior crush to the vehicle was 11.0 inches in the side plane at the right front corner above bumper height. Maximum occupant compartment deformation 1.0 inch in the right front fire wall/toe pan area and the right front kickpanel. The 2270P vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 9° and 7°, respectively. Longitudinal OIV was 16.2 ft/s, and lateral OIV was 31.7 ft/s. Longitudinal occupant ridedown acceleration was 6.7 g, and lateral occupant ridedown acceleration 15.2 g. The occupant risk factors were within the MASH allowable limits. The RK-19 Bridge Rail performed acceptably for MASH test 5-11.	PASS

5-12 (36000V)	Test 5-12 involves a 36000V vehicle impacting the test article at a target impact speed of 50 mi/h ±2.5 mi/h and a target impact angle of 15° ±1.5°. The target CIP was for the right corner of the front bumper to impact at 1 ft downstream of the centerline of the rail splice between posts 6 and 7. The results of the test conducted on May 7, 2021 are found in TTI Test Report number 614911-01. The test vehicle was traveling at an impact speed of 51.8 mi/h as it made contact with the barrier 0.9 ft downstream of the centerline of the rail splice between posts 6 and 7 at an angle of 15.9°. After loss of contact with the barrier, the vehicle came to rest 233 ft downstream of the impact point and 91 ft towards the traffic side. The bridge rail contained and redirected the 36000V vehicle. The vehicle did not penetrate, underride, or override the installation. The 36000V vehicle exited within the exit box criteria. Working width was 46.5 inches. Maximum dynamic deflection during the test was 2.8 inches. The maximum permanent deformation was 1.0 inch No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or present hazard to others in the area Maximum exterior crush to the vehicle was 10.0 inches at the right front corner at bumper height. Maximum occupant compartment deformation was 4.0 inches in the right front floor pan. The 36000V vehicle remained upright during and after the collision event. . Maximum roll and pitch angles were 19° and 50°, respectively. Longitudinal OIV was 1.2 ft/s, and lateral OIV was 18.6 ft/s. Longitudinal occupant ridedown acceleration was 15.4 g, and lateral occupant ridedown acceleration 38.2 g. The RK-19 Bridge Rail performed acceptably for MASH test 5-12.	PASS
5-20 (1100C)	This bridge rail is not a transition system.	Non-Relevant Test, not conducted
5-21 (2270P)	This bridge rail is not a transition system.	Non-Relevant Test, not conducted
5-22 (36000V)	This bridge rail is not a transition system.	Non-Relevant Test, not conducted

Full Scale Crash Testing was done in compliance with MASH by the following accredited crash test laboratory (cite the laboratory's accreditation status as noted in the crash test reports.):

Laboratory Name:	Texas AM Transportation Institute	
Laboratory Signature:	Digitally signed by Darrell L. Kuhn 'Date: 2021.10.26 09:46:42 -05'00	
Address:	1254 Avenue A, Bldg 7091, Bryan, Texas 77807 USA	Same as Submitter ☐
Country:	USA	Same as Submitter ☐
Accreditation Certificate Number and Dates of current Accreditation period :	ISO 17025-2017 Laboratory A2LA Certificate Number: 2821.01 Valid To: April 30, 2023	

Submitter Signature*: Thomas Cho Digitally signed by Thomas Cho DN: cn=Thomas Cho, o=MTA Construction & Development, ou=Engineering, email=thomas.cho@mtacd.org, c=US Date: 2022.01.20 16:01:28 -05'00'

Submit Form

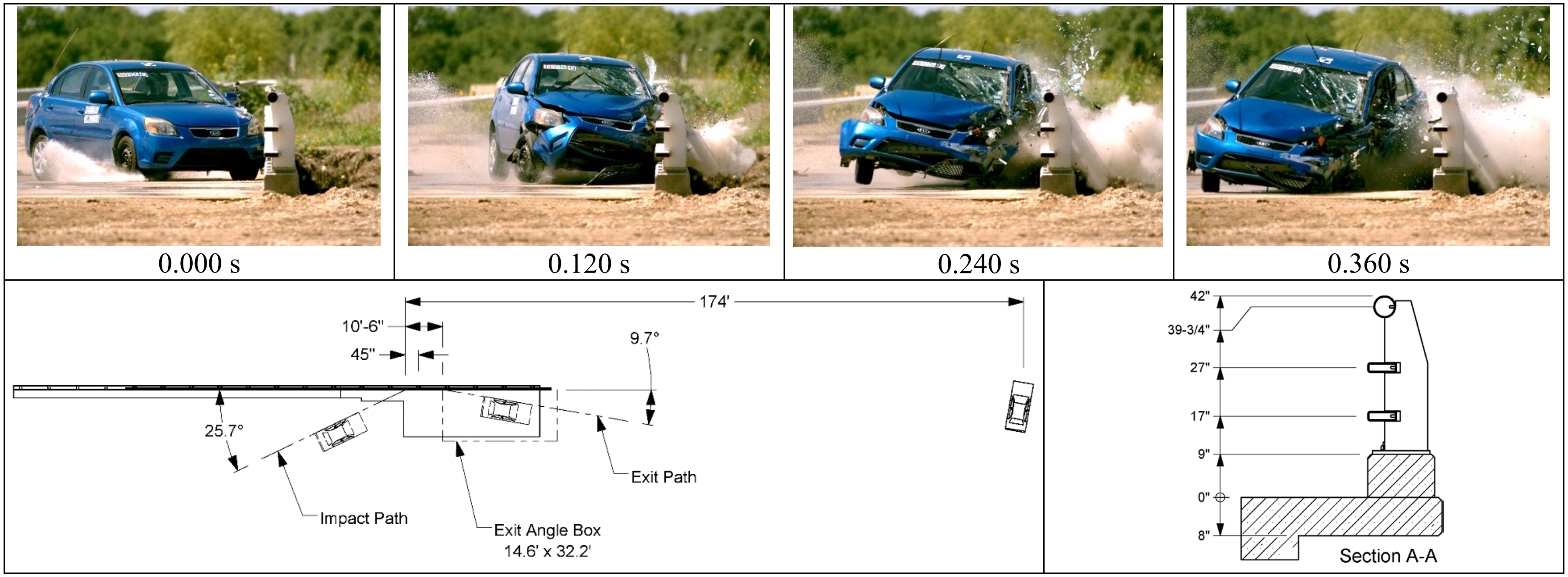
ATTACHMENTS

Attach to this form:

1) Additional disclosures of related financial interest as indicated above.
2) A copy of the full test report, video, and a Test Data Summary Sheet for each test conducted in support of this request.
3) A drawing or drawings of the device(s) that conform to the Task Force-13 Drawing Specifications [Hardware Guide Drawing Standards]. For proprietary products, a single isometric line drawing is usually acceptable to illustrate the product, with detailed specifications, intended use, and contact information provided on the reverse. Additional drawings (not in TF-13 format) showing details that are relevant to understanding the dimensions and performance of the device should also be submitted to facilitate our review.

FHWA Official Business Only:

Eligibility Letter		
Number	Date	Key Words

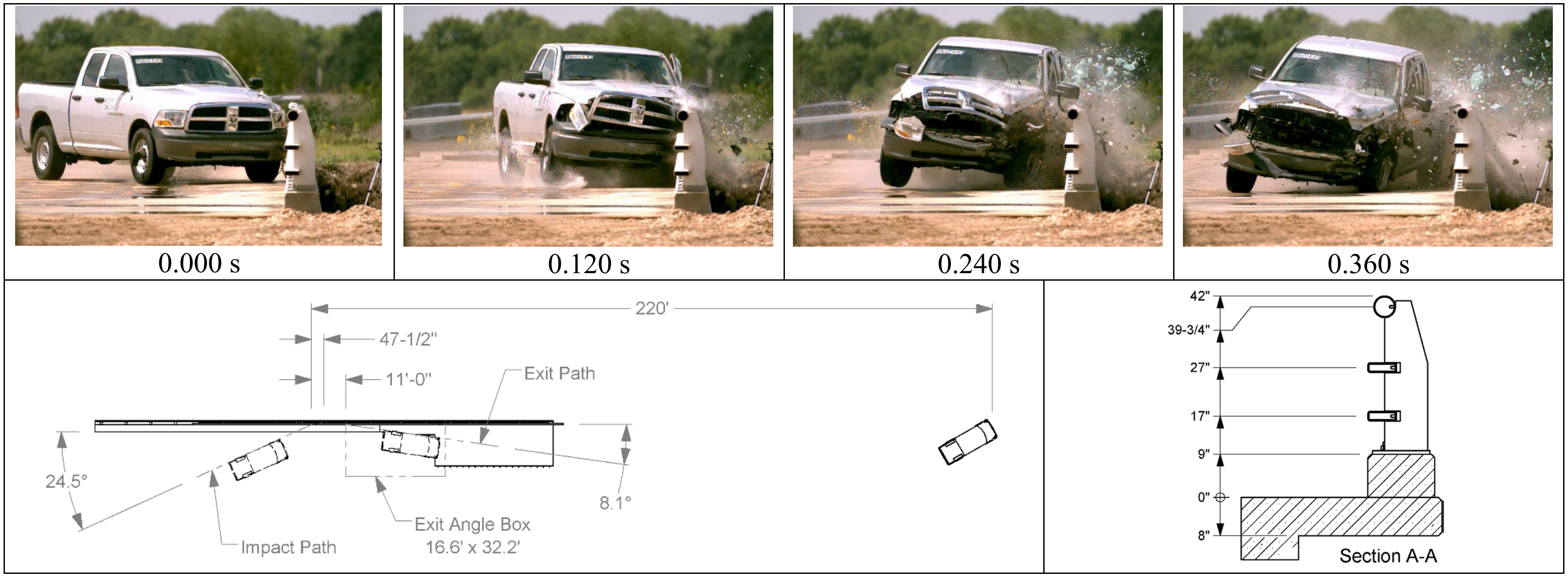


General Information	
Test Agency	Texas A&M Transportation Institute (TTI)
Test Standard Test No.	MASH Test 4-10
TTI Test No.	490026-4-1
Test Date	2016-07-20
Test Article	
Type	Bridge Rail
Name	TxDOT Type C2P Bridge Rail
Installation Length	112 ft Rail Post-to-Post
Material or Key Elements	Three steel rails supported on fabricated steel posts mounted on concrete curb and deck
Soil Type and Condition	Concrete Bridge Deck, Dry
Test Vehicle	
Type/Designation	1100C
Make and Model	2010 Kia Rio
Curb	2493 lb
Test Inertial	2433 lb
Dummy	165 lb
Gross Static	2598 lb

Impact Conditions	
Speed	63.0 mi/h
Angle	25.7 degrees
Location/Orientation	45 inches upstream of post 11
Impact Severity	60 kip-ft
Exit Conditions	
Speed	49.5 mi/h
Angle	9.7 degrees
Occupant Risk Values	
Longitudinal OIV	26.2 ft/s
Lateral OIV	33.1 ft/s
Longitudinal Ridedown	2.8 g
Lateral Ridedown	8.2 g
THIV	46.0 km/h
PHD	8.5 g
ASI	2.81
Max. 0.050-s Average	
Longitudinal	−14.9 g
Lateral	19.7 g
Vertical	−3.8 g

Post-Impact Trajectory	
Stopping Distance	174 ft downstream 2 ft twd field side
Vehicle Stability	
Maximum Yaw Angle	52 degrees
Maximum Pitch Angle	5 degrees
Maximum Roll Angle	6 degrees
Vehicle Snagging	No
Vehicle Pocketing	No
Test Article Deflections	
Dynamic	0.8 inch
Permanent	None noted
Working Width	14.0 inches
Vehicle Damage	
VDS	11LFQ5
CDC	11FLEW4
Max. Exterior Deformation	13.0 inches
OCDI	LF0033000
Max. Occupant Compartment Deformation	4.0 inches Driver's side toe pan

Figure 5-1. Summary of Results for *MASH* Test 4-10 on TxDOT Type C2P Bridge Rail.



General Information
- Test Agency: Texas A&M Transportation Institute (TTI)
- Test Standard Test No.: MASH Test 4-11
- TTI Test No.: 490026-4-2
- Test Date: 2016-07-13

Test Article
- Type: Bridge Rail
- Name: TxDOT Type C2P Bridge Rail
- Installation Length: 112 ft Rail Post-to-Post
- Material or Key Elements: Three steel rails supported on fabricated steel posts mounted on concrete curb and deck

Soil Type and Condition: Concrete Bridge Deck, Dry

Test Vehicle
- Type/Designation: 2270P
- Make and Model: 2011 Dodge RAM 1500
- Curb: 4911 lb
- Test Inertial: 5048 lb
- Dummy: 165 lb
- Gross Static: 5213 lb

Impact Conditions
- Speed: 62.9 mi/h
- Angle: 24.5 degrees
- Location/Orientation: 47½ inches upstream of post 6

Impact Severity: 115 kip-ft

Exit Conditions
- Speed: 50.5 mi/h
- Angle: 8.1 degrees

Occupant Risk Values
- Longitudinal OIV: 18.4 ft/s
- Lateral OIV: 29.5 ft/s
- Longitudinal Ridedown: 3.0 g
- Lateral Ridedown: 9.5 g
- THIV: 38.7 km/h
- PHD: 9.9 g
- ASI: 2.03

Max. 0.050-s Average
- Longitudinal: −9.9 g
- Lateral: 15.3 g
- Vertical: −2.5 g

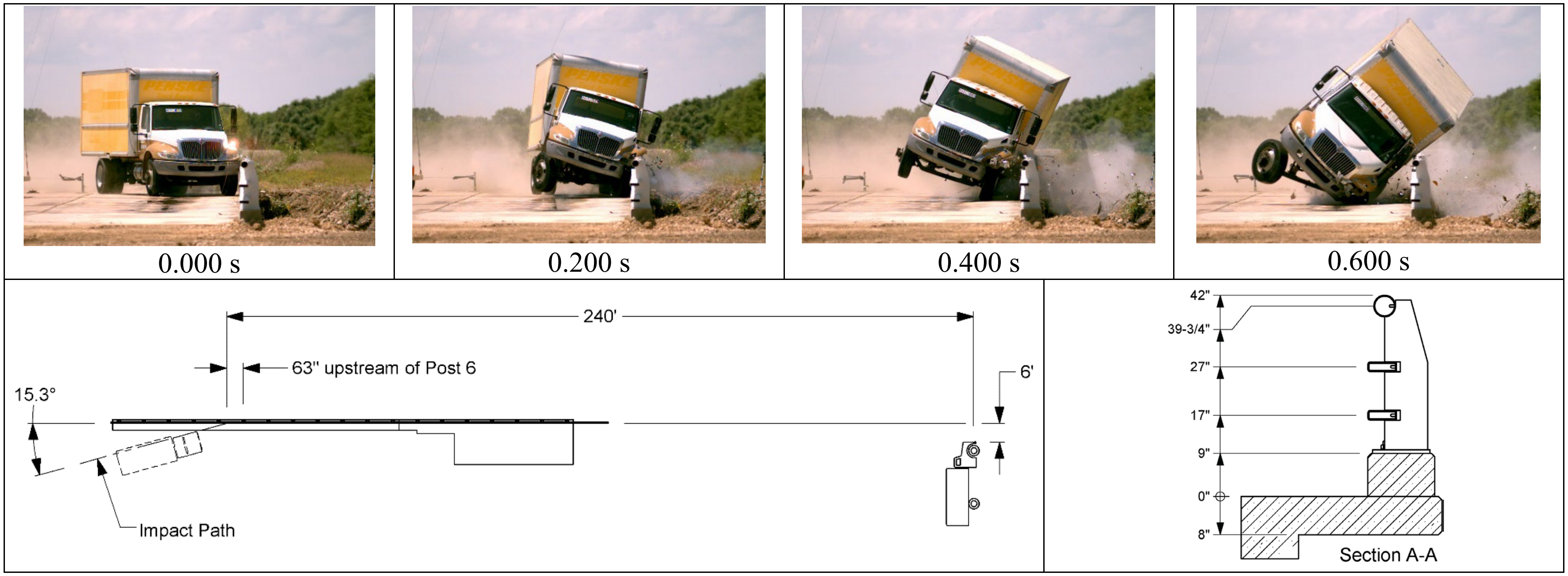
Post-Impact Trajectory
- Stopping Distance: 220 ft downstream, 1 ft twd traffic lanes

Vehicle Stability
- Maximum Yaw Angle: 37 degrees
- Maximum Pitch Angle: 4 degrees
- Maximum Roll Angle: 5 degrees
- Vehicle Snagging: No
- Vehicle Pocketing: No

Test Article Deflections
- Dynamic: 2.5 inches
- Permanent: 1.4 inches
- Working Width: 14.0 inches

Vehicle Damage
- VDS: 11LFQ4
- CDC: 11FLEW3
- Max. Exterior Deformation: 13.0 inches
- OCDI: LF0000000
- Max. Occupant Compartment Deformation: 2.25 inches driver side dash.

Figure 6-2. Summary of Results for *MASH* Test 4-11 on TxDOT Type C2P Bridge Rail.



General Information
- Test Agency .... Texas A&M Transportation Institute (TTI)
- Test Standard Test No. .... MASH Test 4-12
- TTI Test No. 490026-4-3
- Test Date 2016-06-27

Test Article
- Type .... Bridge Rail
- Name .... TxDOT Type C2P Bridge Rail
- Installation Length .... 144 ft Rail Post-to-Post
- Material or Key Elements .... Three steel rails supported on fabricated steel posts mounted on concrete curb and deck

Soil Type and Condition .... Concrete Bridge Deck, Dry

Test Vehicle
- Type/Designation 10000S
- Make and Model .... 2004 International 4200 single-unit box van truck
- Curb .... 12,360 lb
- Ballast 10,287
- Test Inertial .... 22,220 lb
- Gross Static .... 23,385 lb

Impact Conditions
- Speed .... 58.4 mi/h
- Angle .... 15.3 degrees
- Location/Orientation .... 63 inches upstream of post 6

Impact Severity .... 176 kip-ft

Exit Conditions
- Speed .... 54.1 mi/h
- Angle .... Not obtainable

Occupant Risk Values
- Longitudinal OIV .... 6.2 ft/s
- Lateral OIV .... 15.1 ft/s
- Longitudinal Ridedown .... 3.6 g
- Lateral Ridedown .... 8.0 g
- THIV .... 17.8 km/h
- PHD .... 8.0 g
- ASI 0.61

Max. 0.050-s Average
- Longitudinal .... -1.8 g
- Lateral .... 5.4 g
- Vertical .... -2.5 g

Post-Impact Trajectory
- Stopping Distance .... 240 ft dwnstrm 6 ft twd traffic

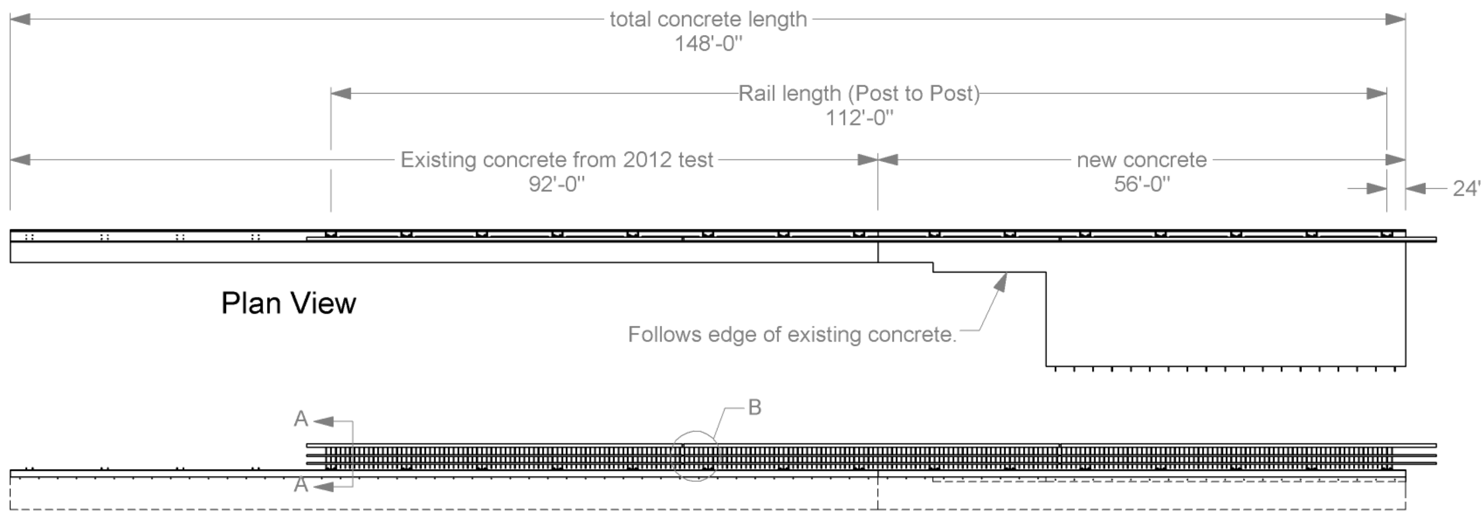
Vehicle Stability
- Maximum Yaw Angle .... 29 degrees
- Maximum Pitch Angle .... 10 degrees
- Maximum Roll Angle .... 89 degrees
- Vehicle Snagging .... No
- Vehicle Pocketing .... No

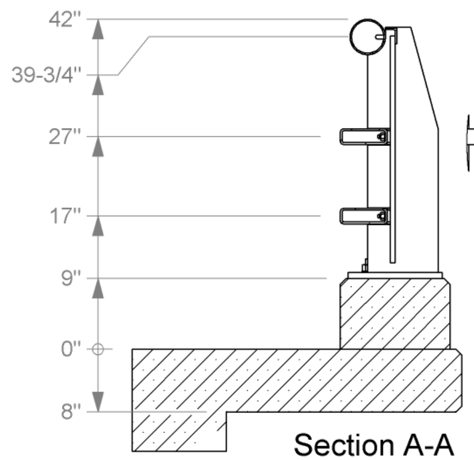
Test Article Deflections
- Dynamic .... 11.4 inches
- Permanent .... 7.25 inches
- Working Width .... 62.3 inches

Vehicle Damage
- VDS .... NA
- CDC 11FLEW5
- Max. Exterior Deformation .... 14.0 inches
- OCDI LF0000000
- Max. Occupant Compartment Deformation .... None

Figure 7-3. Summary of Results for *MASH* Test 4-12 on TxDOT Type C2P Bridge Rail.

Test Installation

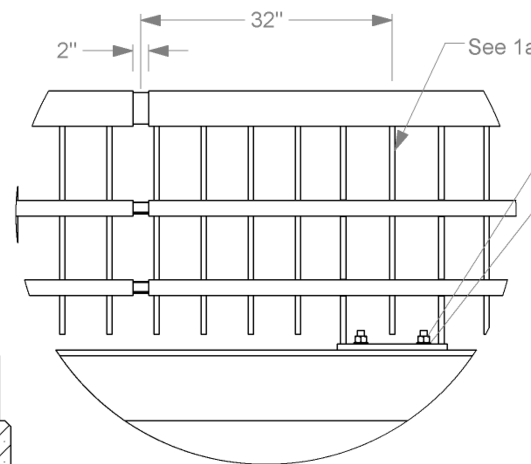




Section A-A

Scale 1 : 20

(some dims rounded to nearest 1/8")



Detail B

Scale 1 : 20

Typical each joint

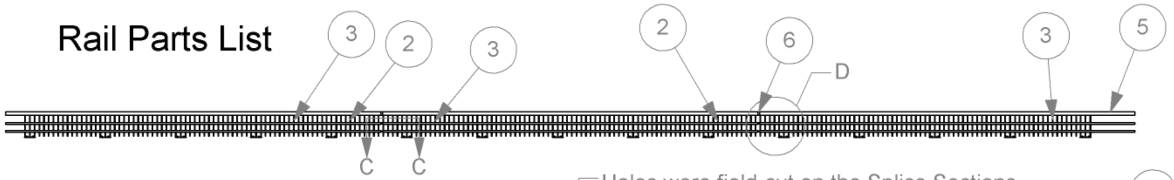
1a. Place Picket Panels with slots at Rail splice locations. Picket Panels with round holes go at all other locations.

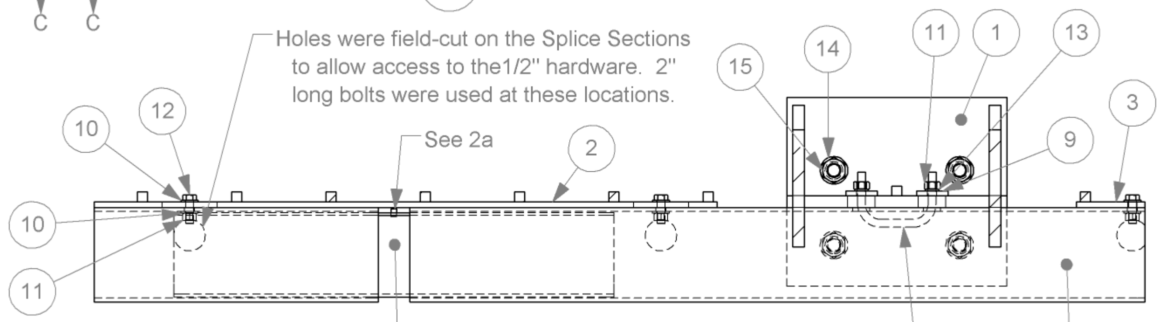
1b. Tolerance on all fabricated parts is ±1/8" unless otherwise indicated.

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project 490026-4 / 1-2 42" Picket Rail			2016-07-18
Drawn By GES	Scale1:200	Sheet 1 of 14	Test Installation

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

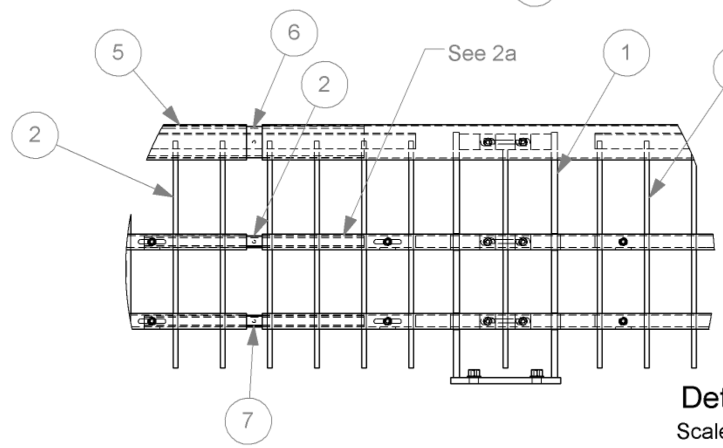
Rail Parts List





Section C-C
Scale 1 : 10

Rail Parts		
#	Part Name	Qty.
1	Post for 42" Picket Rail	15
2	Picket Rail Panel, with slots	2
3	Picket Rail Panel, with holes	12
4	Rectangular Rail	6
5	Round Rail	3
6	Splice Section for Round Rail	2
7	Splice Section for Rectangular Rail	4
8	U-bolt for Picket Rail	45
9	Plate Washer for U-bolt	90
10	Washer, 1/2 SAE Hardened	168
11	Nut, 1/2 heavy hex	174
12	Bolt, 1/2" x 1 1/2" hex	84
13	Washer, 1/2 Lock	90
14	Washer, 7/8 SAE Hardened	60
15	Nut, 7/8 heavy hex	60



Detail D
Scale 1 : 20

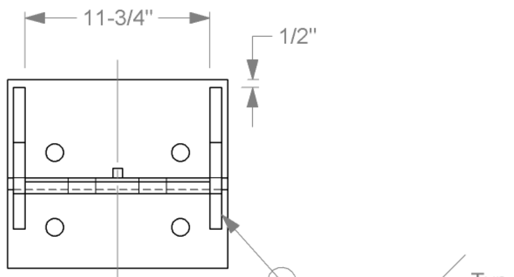
2a. Place Splice Sections with Pins on Field Side.
2b. Ø1/2" Bolts are ASTM A325. Ø7/8" Bolts are ASTM A449.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground		
Project 490026-4 / 1-2	42" Picket Rail		2016-07-18
Drawn By GES	Scale1:200	Sheet 2 of 14	Rail Parts List

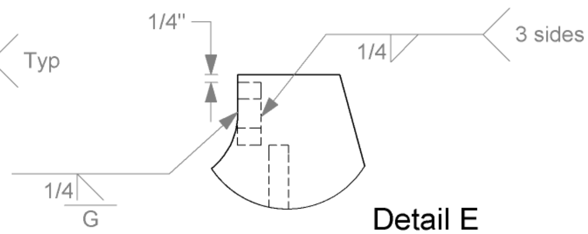
T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

Post

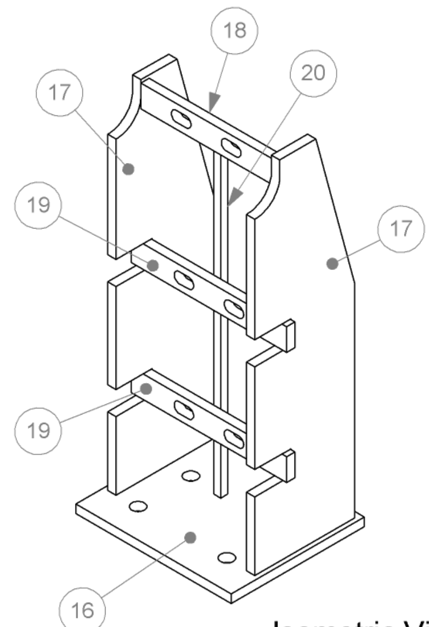
Post Parts					
#	Body Name	Description	Length	MATERIAL	Qty
16	Base Plate	Plate, 12" x 3/4"	14"	ASTM A572 Grade 50	1
17	Side Plate	Plate, 9" x 3/4"	31 1/4"	ASTM A572 Grade 50	2
18	Rail Plate, Top	Plate, 2" x 3/4"	11 3/4"	ASTM A36 Steel	1
19	Rail Plate, Bot and Mid	Plate, 2" x 3/4"	14"	ASTM A36 Steel	2
20	Picket	Plate, 5/8" x 5/8"	27 3/4"	ASTM A36 Steel	1



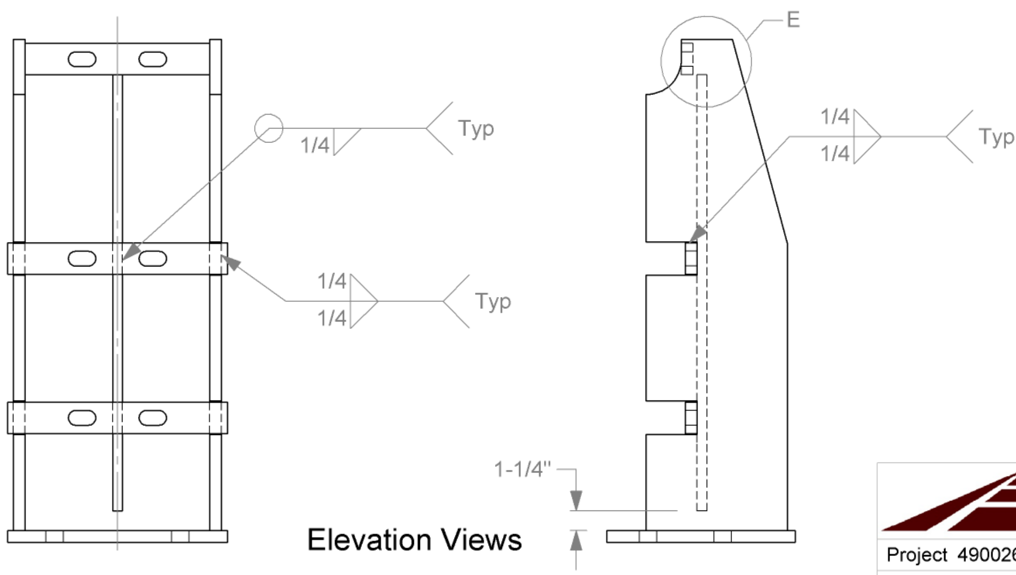
Plan View



Detail E
Scale 1 : 5



Isometric View



Elevation Views

Texas A&M Transportation Institute

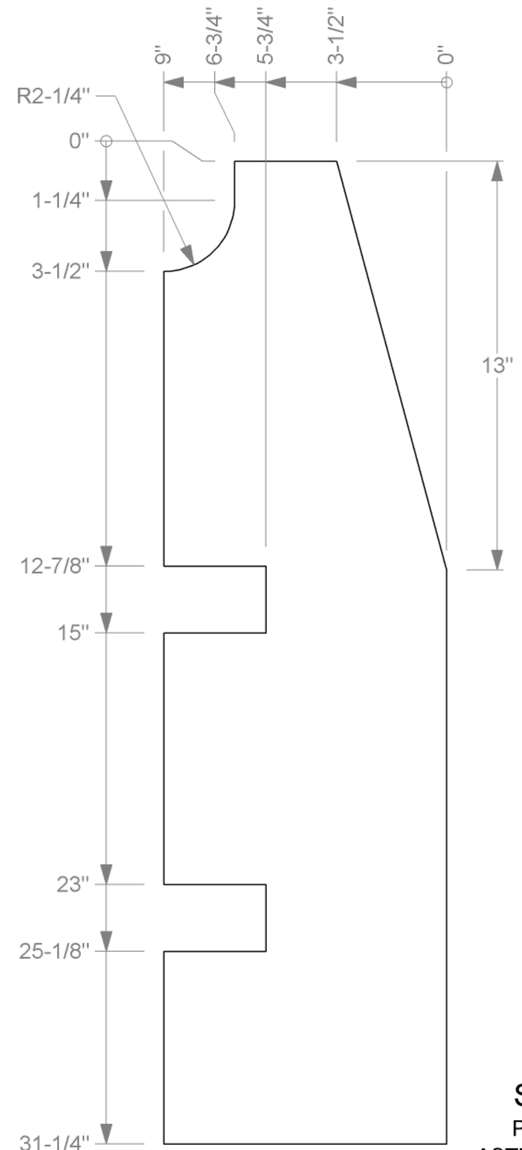
Roadside Safety and Physical Security Division - Proving Ground

Project 490026-4 / 1-2	42" Picket Rail		2016-07-18
Drawn By GES	Scale1:500	Sheet 3 of 14	Post

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

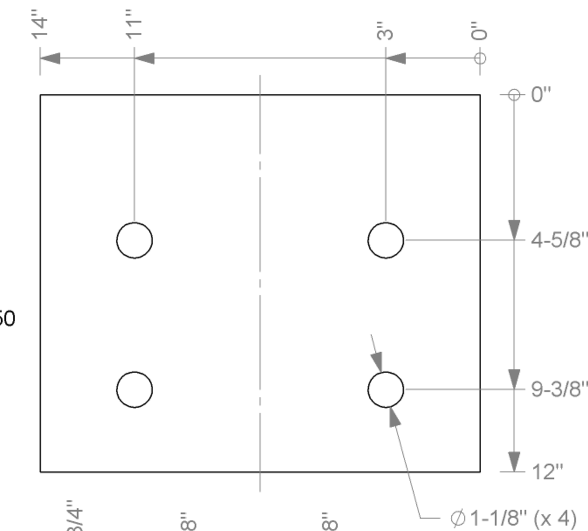
Post Parts

(See Table, previous sheet, for Picket details)



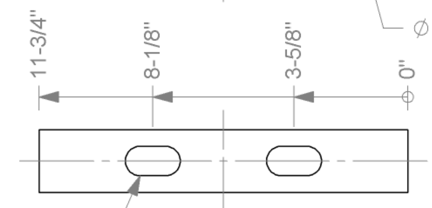
Side Plate

Plate, 9" x 3/4"
ASTM A572 Grade 50



Base Plate

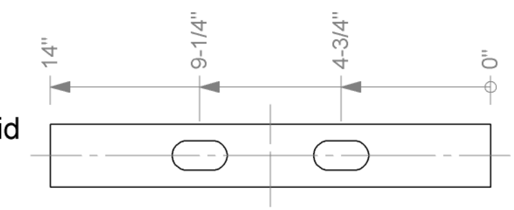
Plate, 12" x 3/4"
ASTM A572 Grade 50



Rail Plate, Top

Plate, 2" x 3/4"
ASTM A36 Steel

Slots, 15/16" x 1-3/4"
Typical both Rail Plates

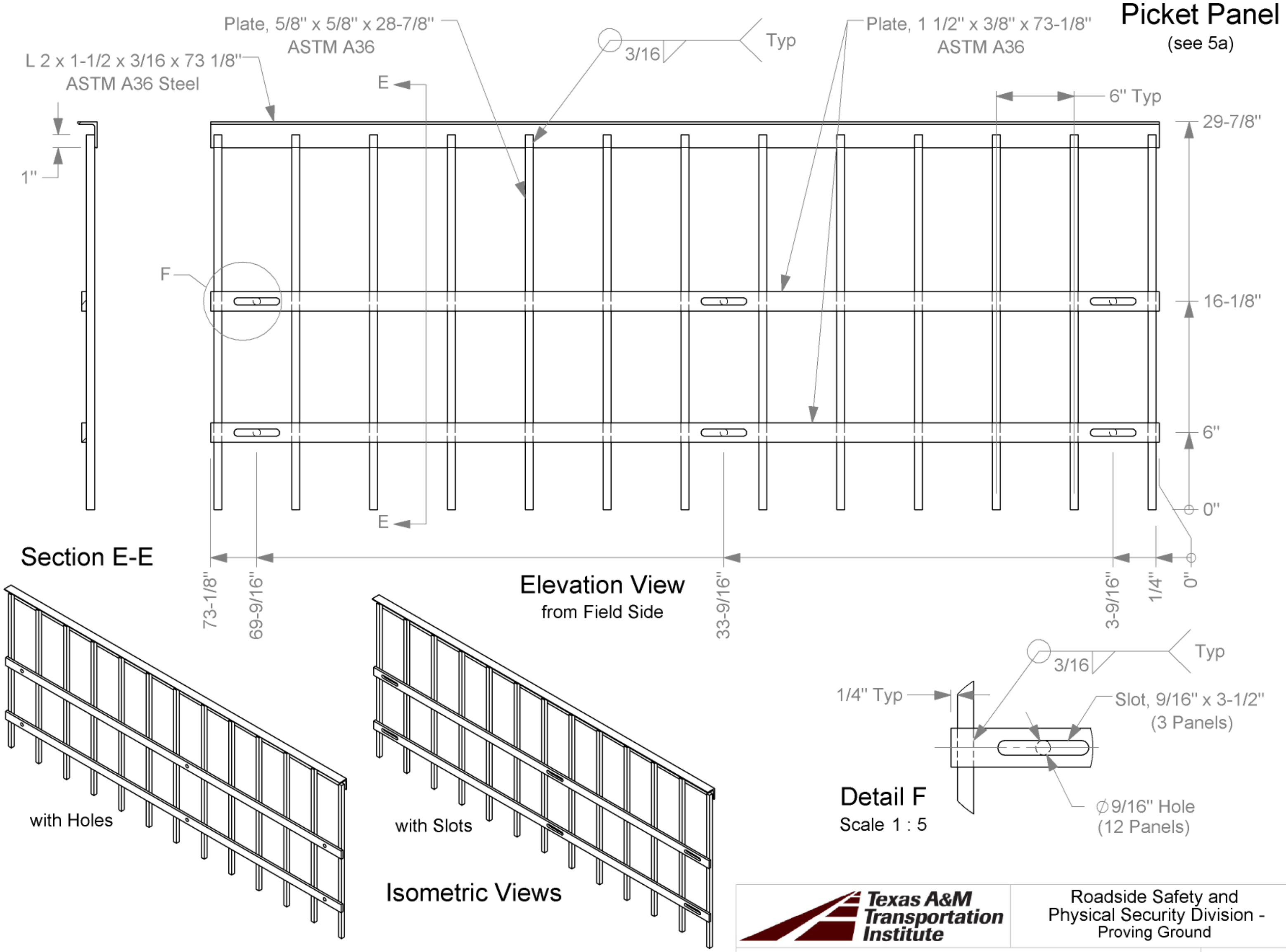


Rail Plate, Bot and Mid

Plate, 2" x 3/4"
ASTM A36 Steel

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project 490026-4 / 1-2	42" Picket Rail	2016-07-18
Drawn By GES	Scale 1:5	Sheet 4 of 14 Post Parts

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

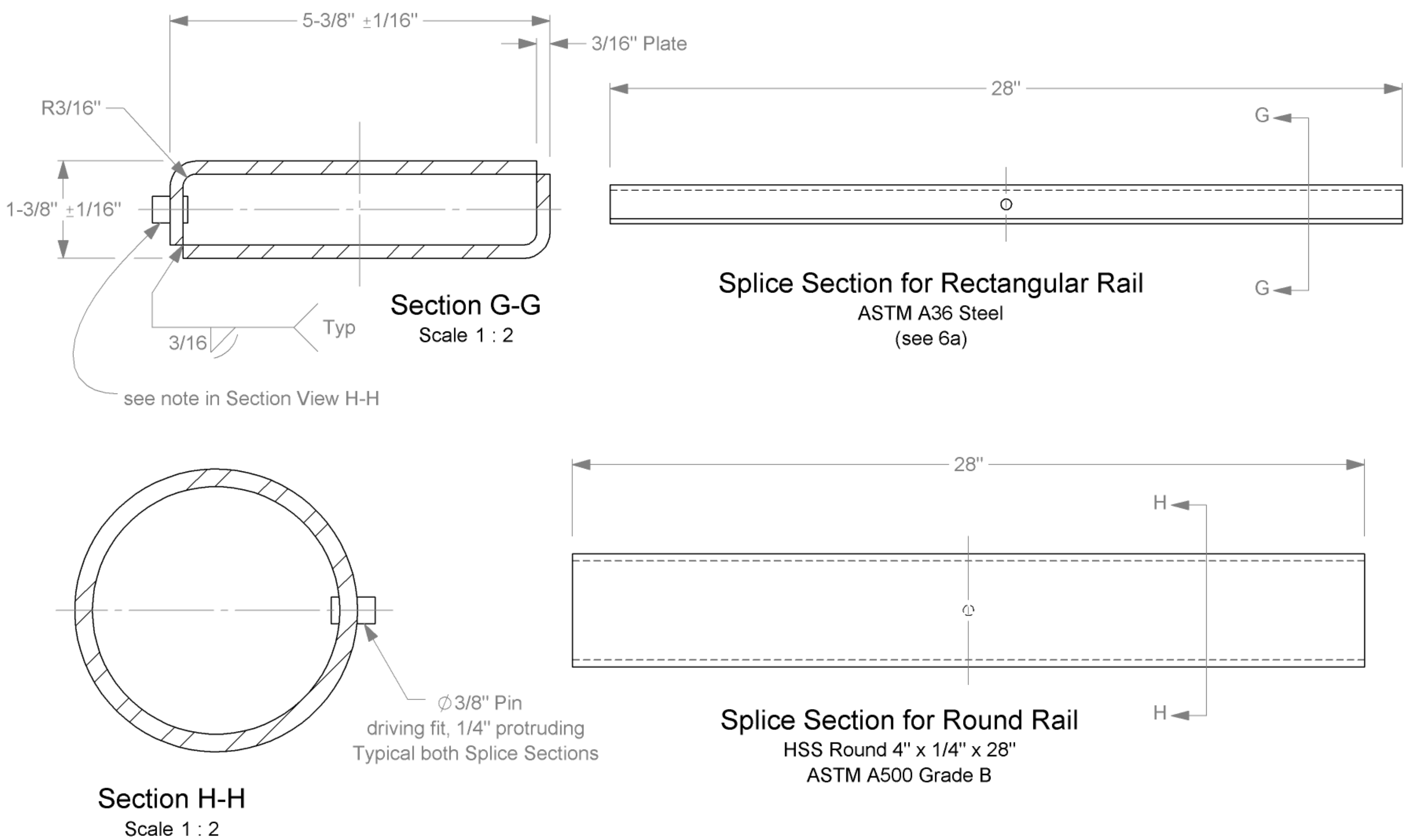


5a. Need 18 Panels total, 3 with Slots and 15 with holes at same location.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project 490026-4 / 1-2	42" Picket Rail	2016-07-18
Drawn By GES	Scale 1:10	Sheet 5 of 14 Picket Panel

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

Splice Sections



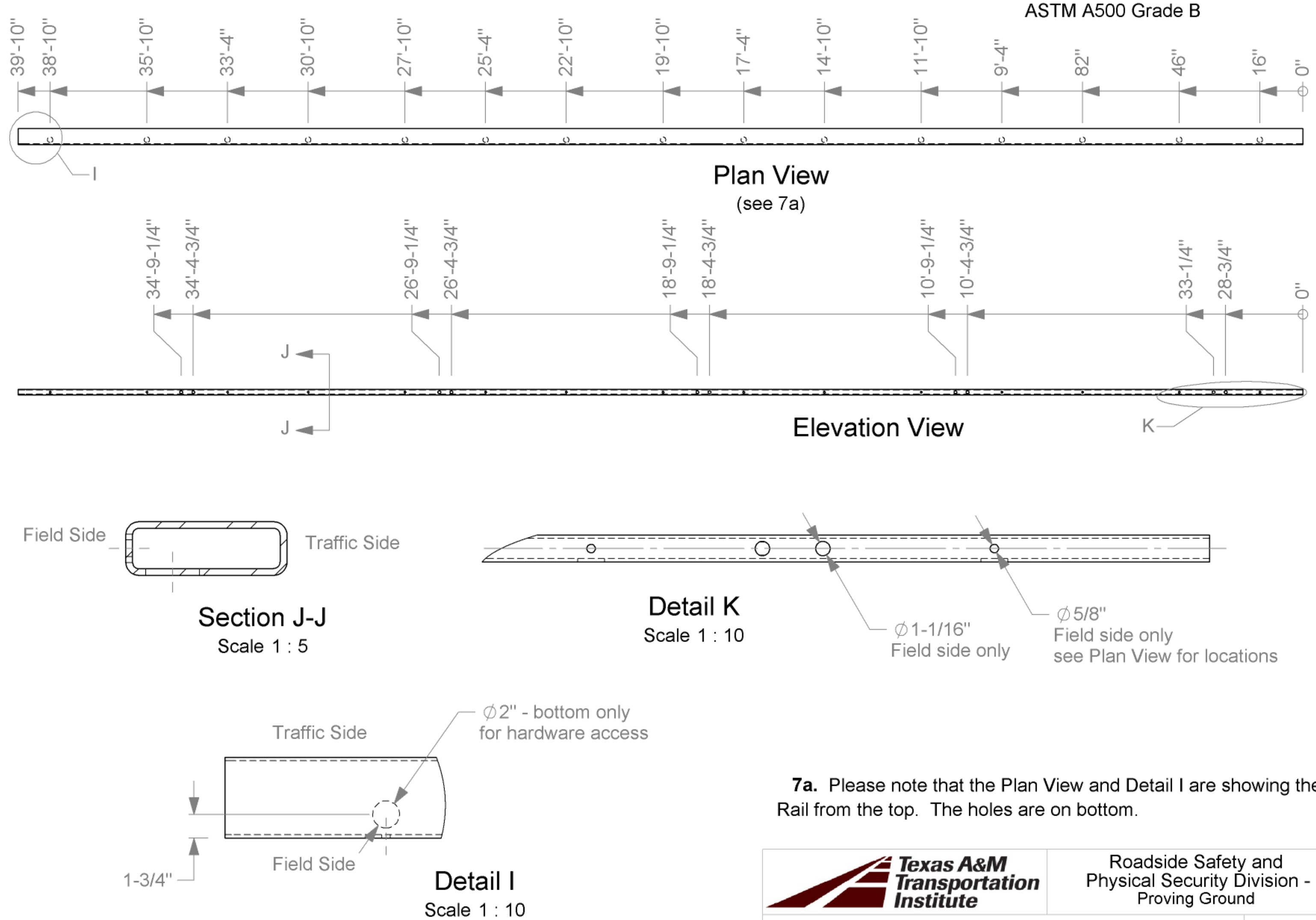
6a. Check Splice Sleeve for Rectangular Rail for loose fit in Rectangular Rail after fabrication is completed.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground		
Project 490026-4 / 1-2	42" Picket Rail		2016-07-18
Drawn By GES	Scale 1:5	Sheet 6 of 14	Splice Sections

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

Rectangular Rail

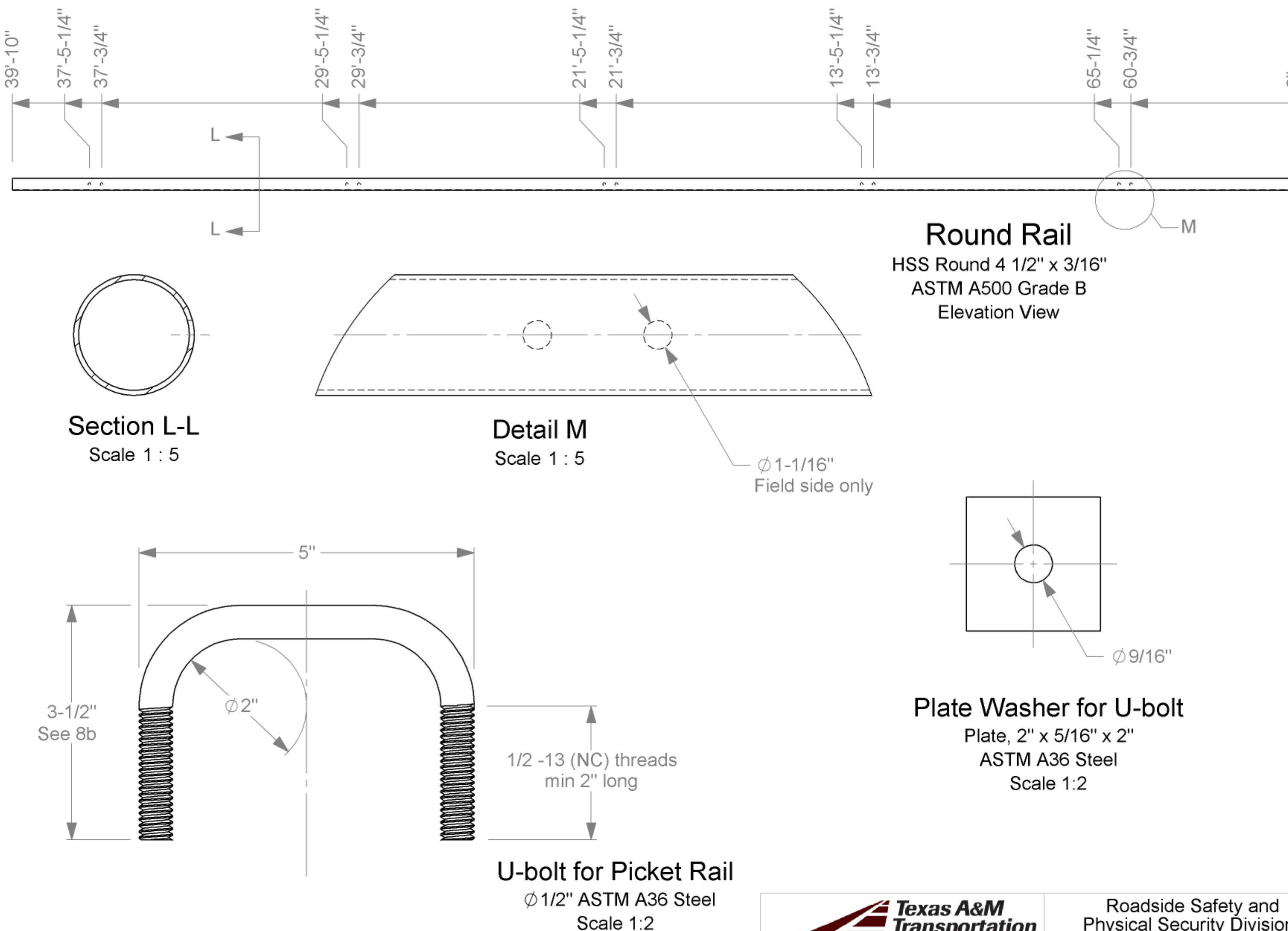
HSS 6" x 2" x 1/4"
ASTM A500 Grade B



7a. Please note that the Plan View and Detail I are showing the Rail from the top. The holes are on bottom.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground		
Project 490026-4 / 1-2	42" Picket Rail		2016-07-18
Drawn By GES	Scale 1:50	Sheet 7 of 14	Rectangular Rail

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

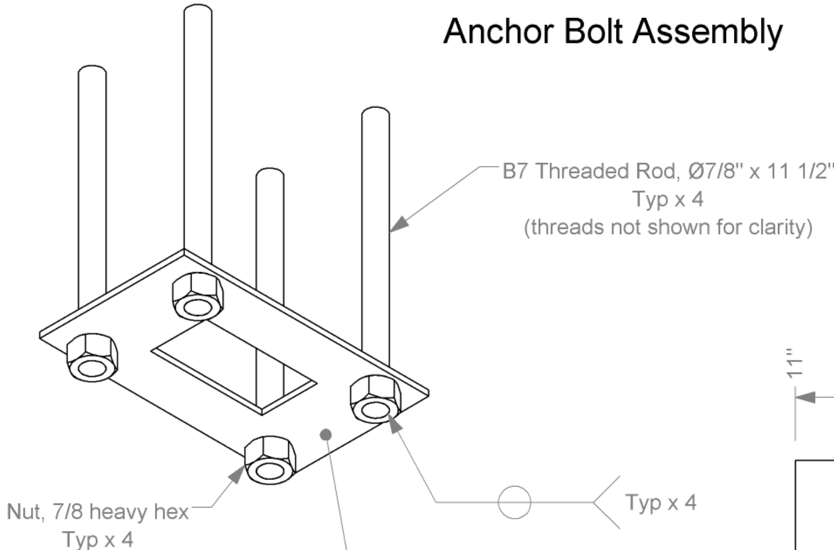


8a. Dimension is approximate. Rod is 10" long before bending.

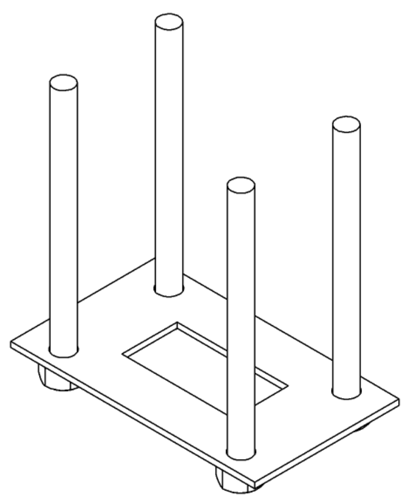
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground		
Project 490026-4-3	42" Picket Rail		2016-07-20
Drawn By GES	Scale 1:50	Sheet 8 of 14	Round Rail, etc.

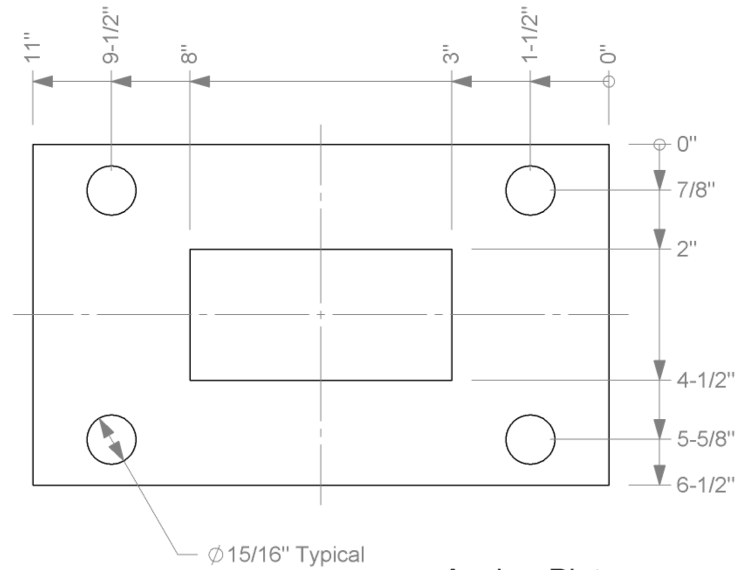
T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-3\Drafting\490026-4-3 Drawing

Anchor Bolt Assembly



Isometric Views





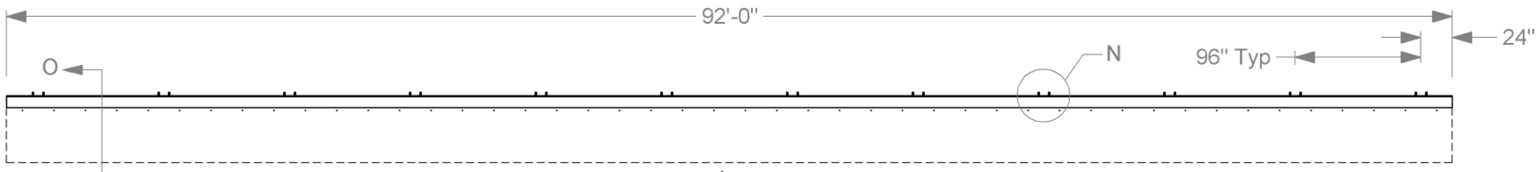
Anchor Plate

Plate, 6 1/2" x 1/4" x 11"
ASTM A36 Steel

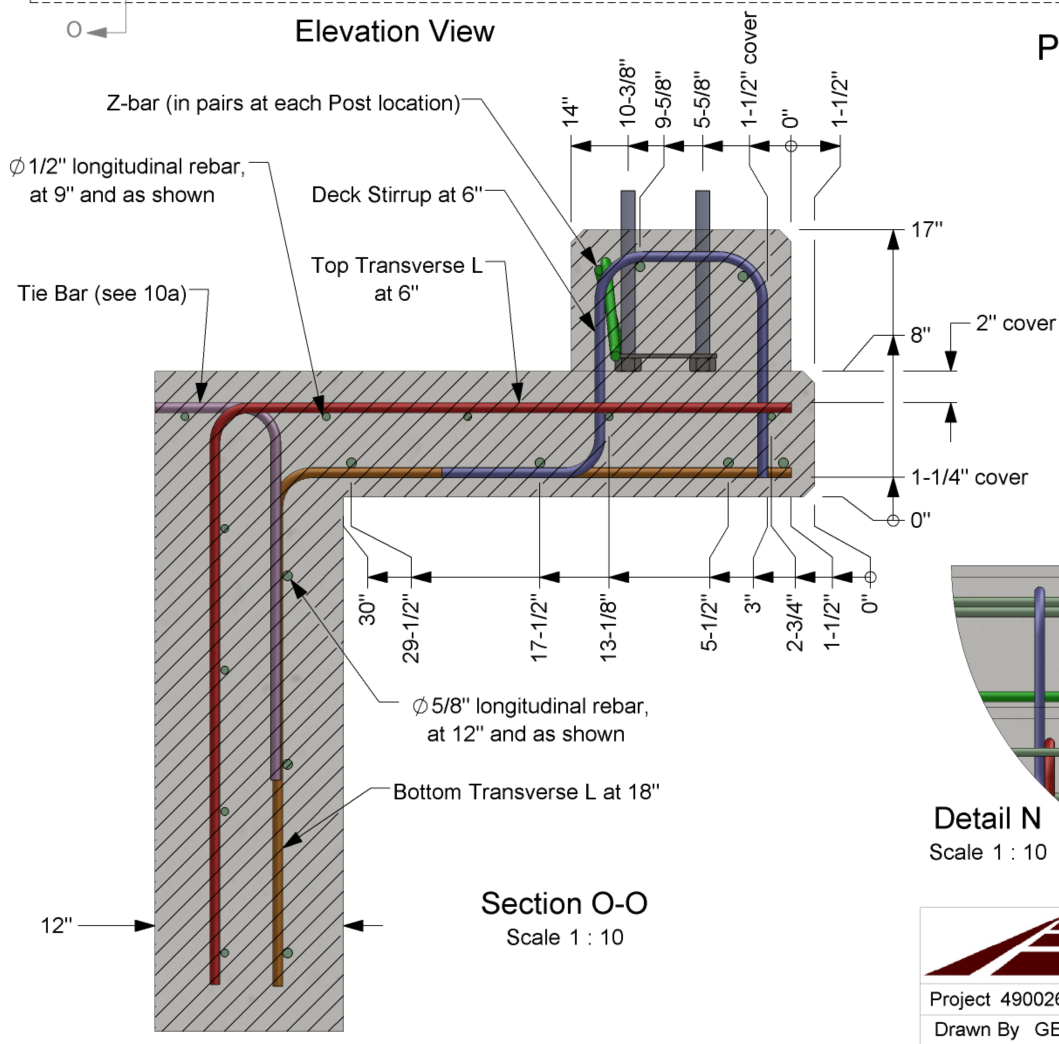
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground		
Project 490026-4-3	42" Picket Rail		2016-07-20
Drawn By GES	Scale 1:3	Sheet 9 of 14	Anchor Bolt Assembly

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-3\Drafting\490026-4-3 Drawing

Previous Concrete



Elevation View

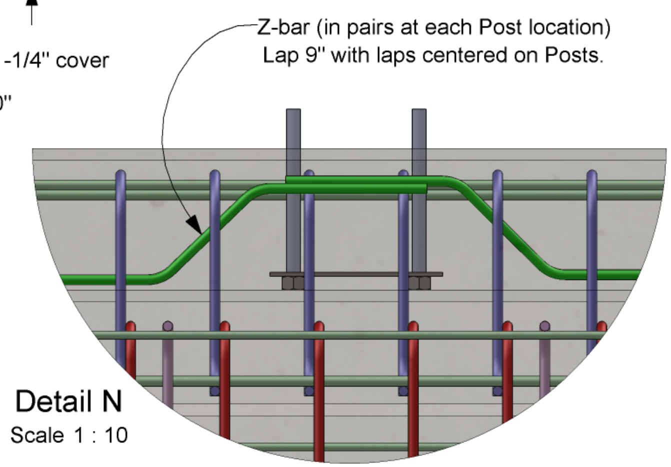


Section O-O
Scale 1 : 10

10a. Tie Bars spaced at 24", and welded to existing rebar protruding from the runway (not shown here).

10b. All Rebar is grade 60. Minimum lap distance is 17" for Ø1/2" bars and 21" for Ø5/8" bars.

10b. Concrete is TxDOT Class S (4000 psi). Chamfer edges of Deck and Curb 3/4" as shown.

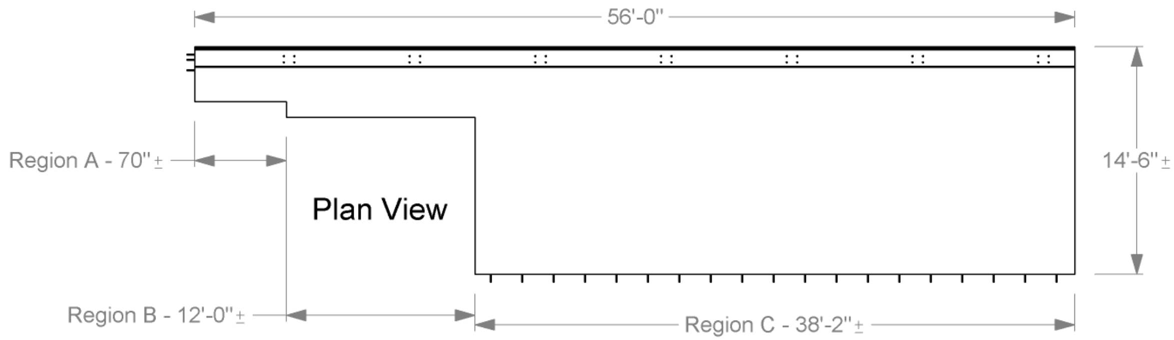


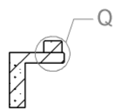
Detail N
Scale 1 : 10

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground
Project 490026-4-3	42" Picket Rail	2016-07-20
Drawn By GES	Scale1:120	Sheet 10 of 14 Previous Concrete

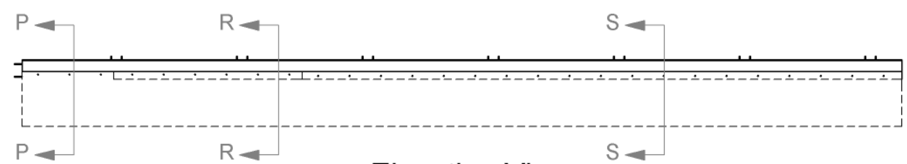
T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-3\Drafting\490026-4-3 Drawing

New Concrete

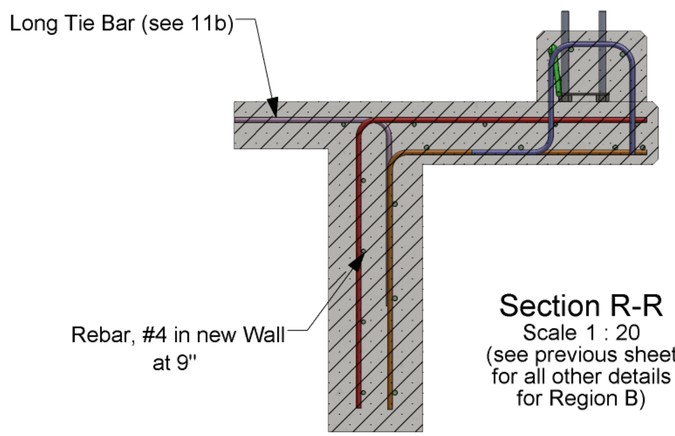




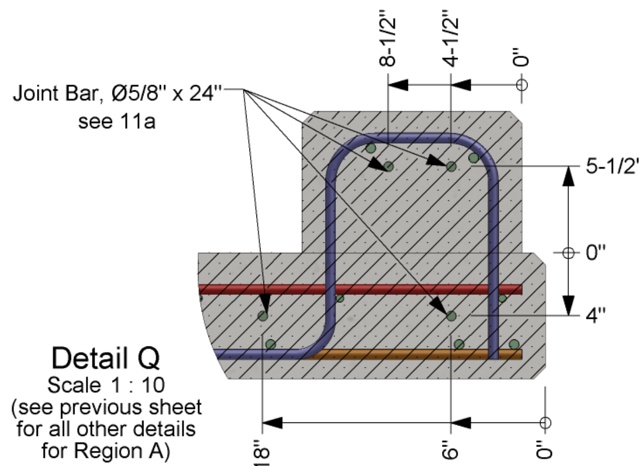
Section P-P



Elevation View



Section R-R
Scale 1 : 20
(see previous sheet for all other details for Region B)



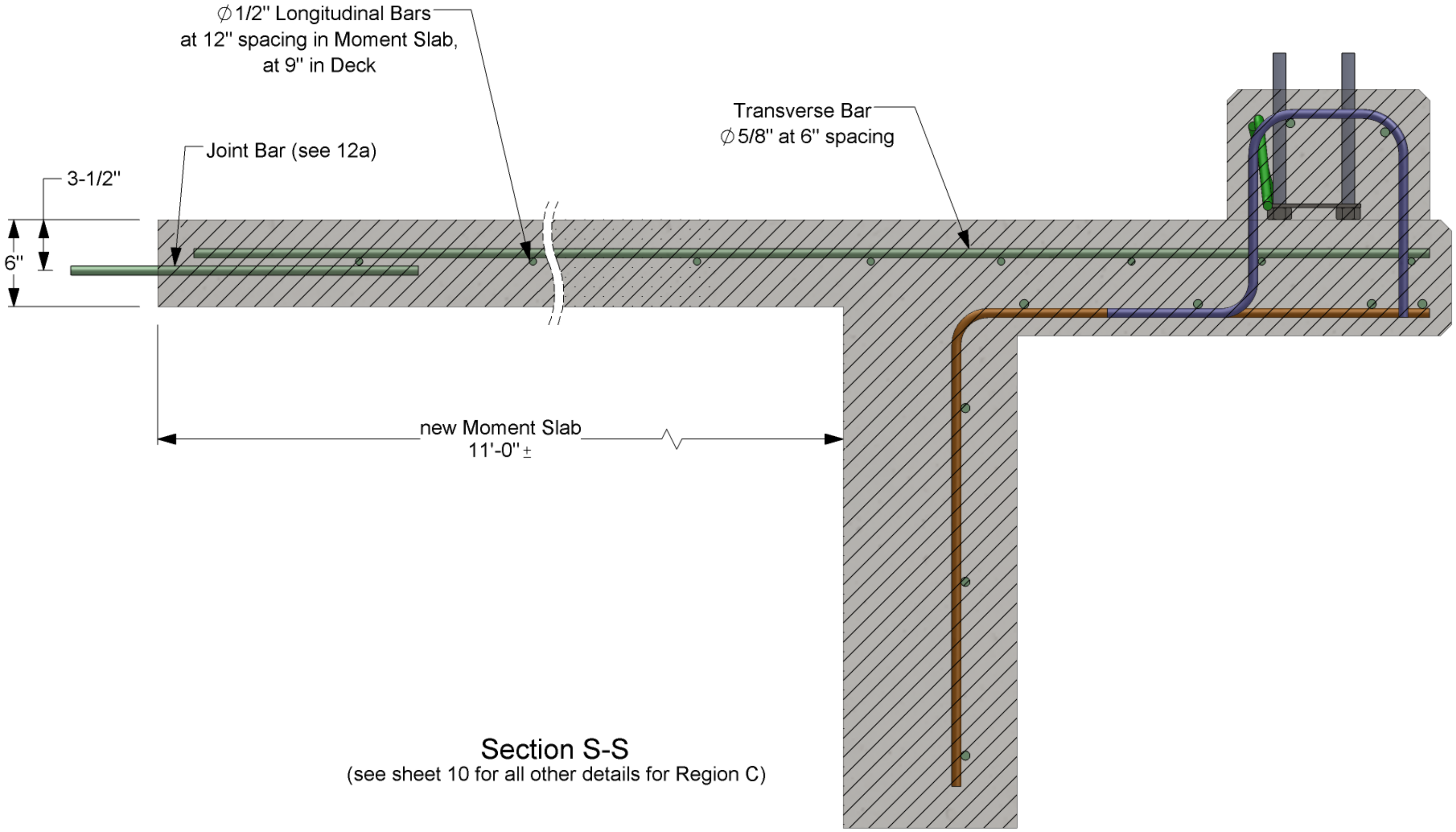
Detail Q
Scale 1 : 10
(see previous sheet for all other details for Region A)

11a. Drill minimum 6" into existing concrete and secure Joint Bars with Hilti RE-500 epoxy, according to manufacturer's instructions.

11b. Long Tie Bars spaced at 24" and welded to existing rebar protruding from the runway (not shown here).

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project 490026-4-3	42" Picket Rail		2016-07-20
Drawn By GES	Scale1:120	Sheet 11 of 14	New Concrete

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-3\Drafting\490026-4-3 Drawing



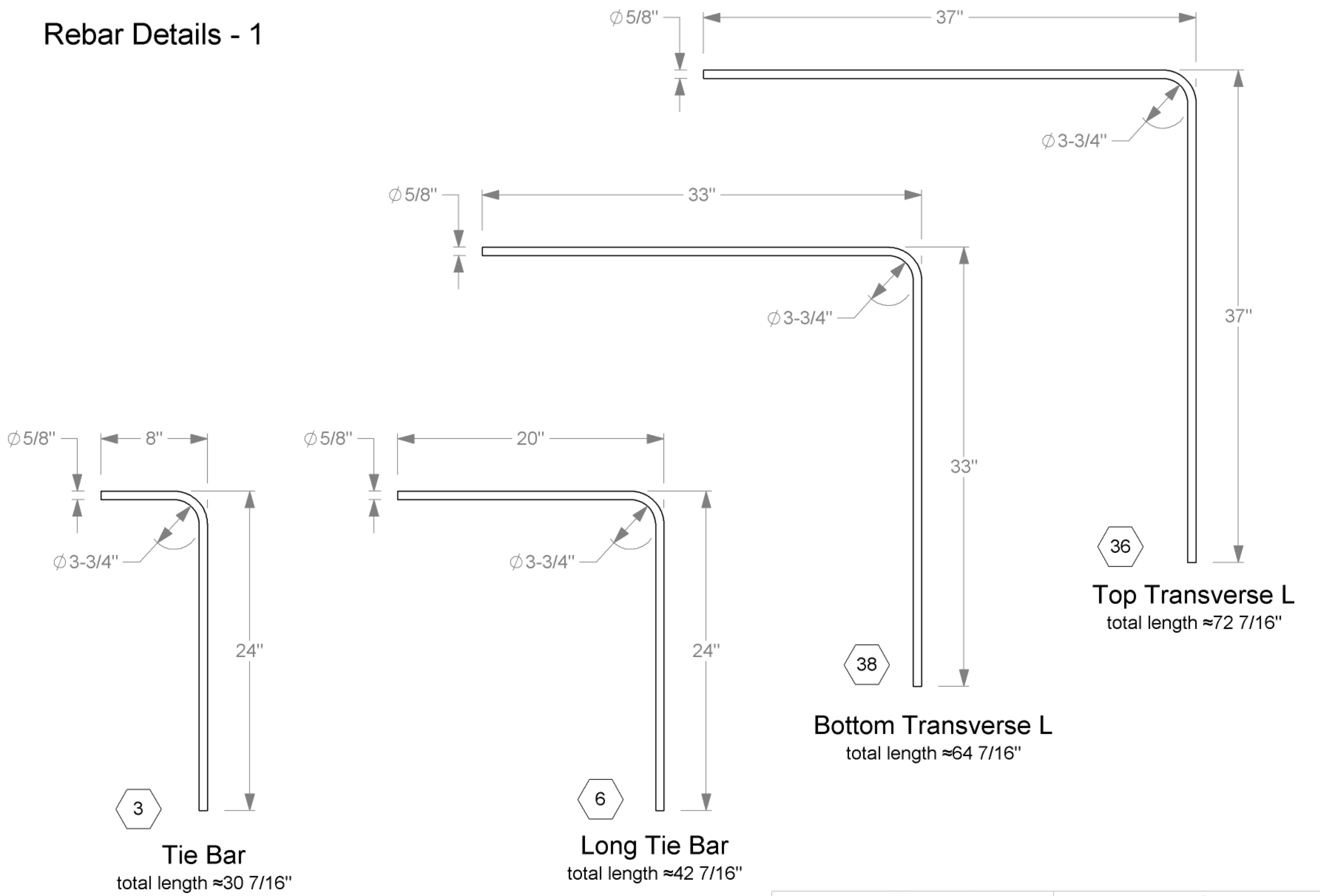
Section S-S
(see sheet 10 for all other details for Region C)

12a. Drill minimum 6" into existing concrete and secure Joint Bars with Hilti RE-500 epoxy, according to manufacturer's instructions. Space at 24".

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project 490026-4-3	42" Picket Rail	2016-07-20
Drawn By GES	Scale 1:10	Sheet 12 of 14 Section View

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-3\Drafting\490026-4-3 Drawing

Rebar Details - 1

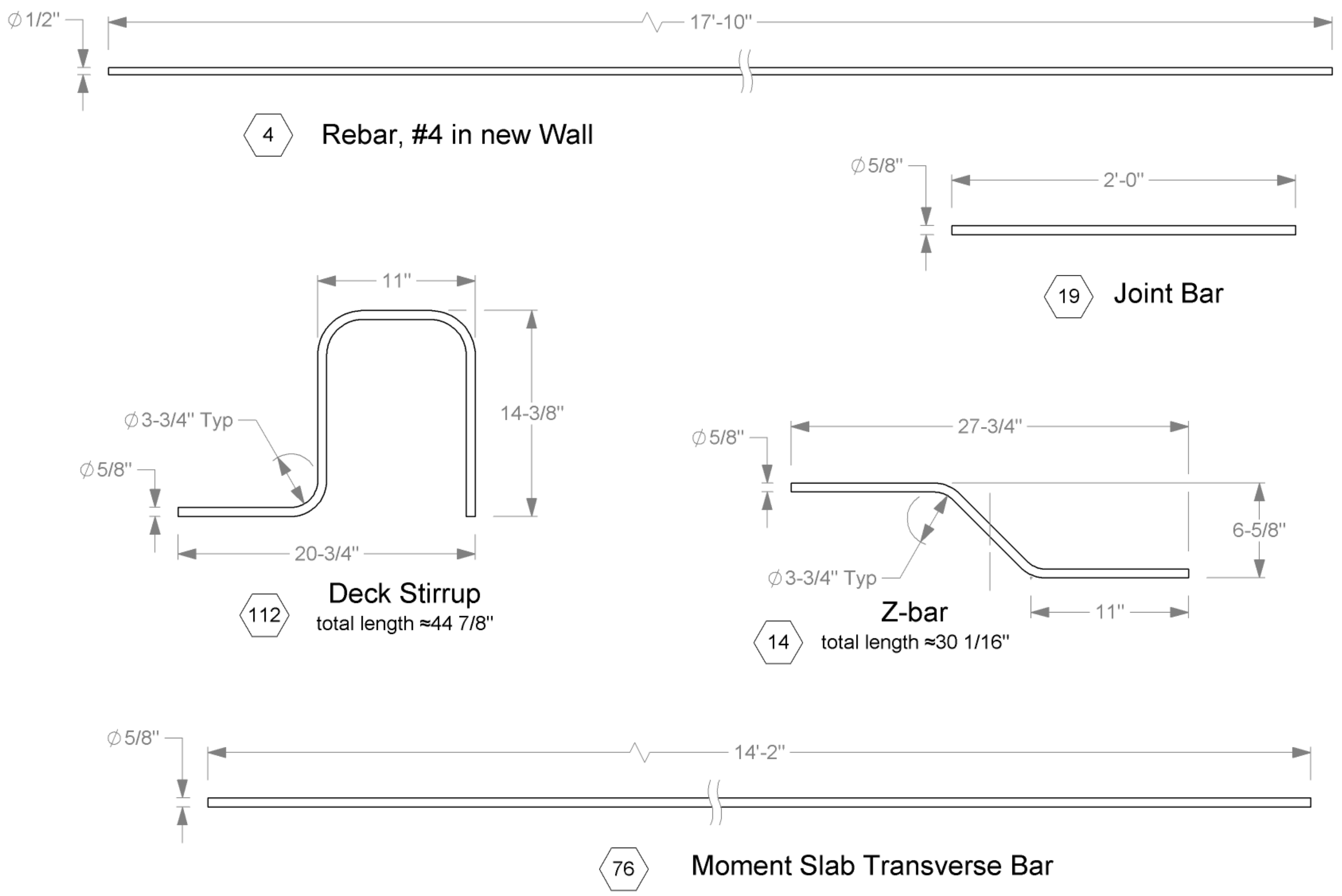


13a. The numeral in the hexagon denotes the quantity needed for each Bar.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground		
Project 490026-4-3	42" Picket Rail		2016-07-20
Drawn By GES	Scale 1:10	Sheet 13 of 14	Rebar Details - 1

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-3\Drafting\490026-4-3 Drawing

Rebar Details - 2

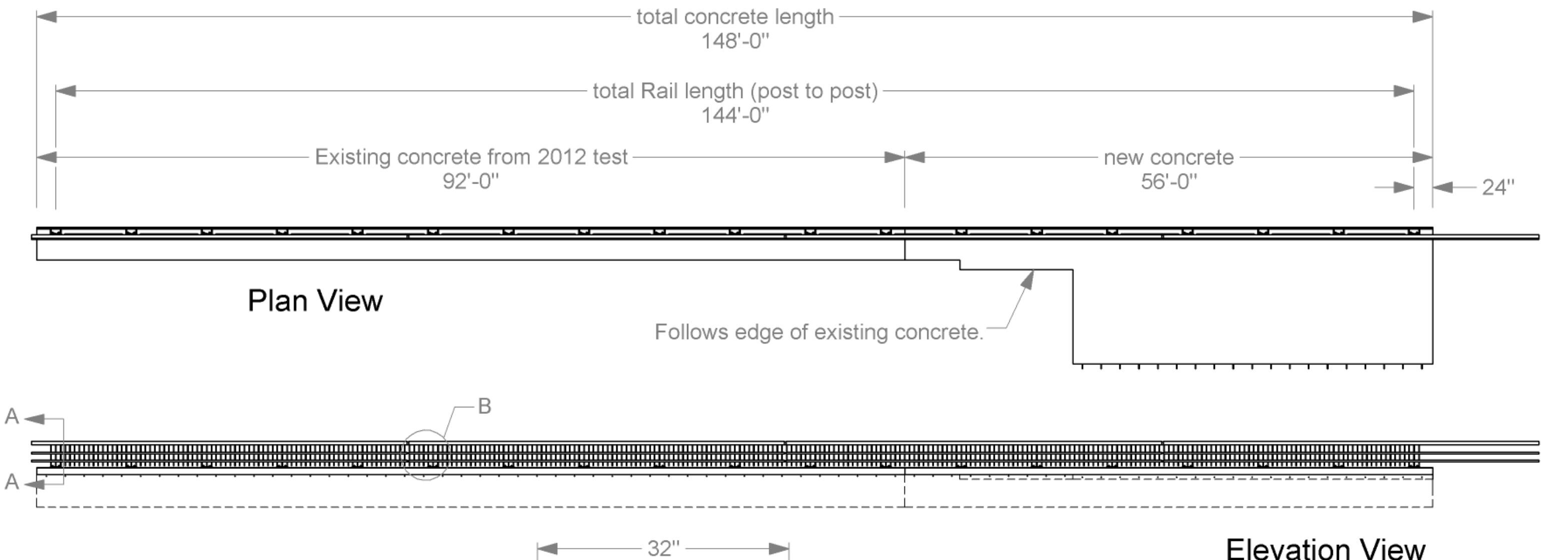


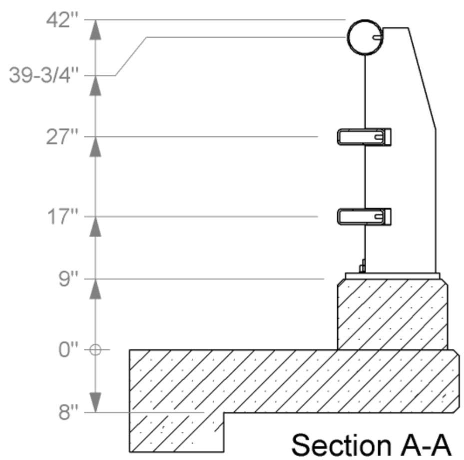
14a. The numeral in the hexagon denotes the quantity needed for each Bar.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground		
Project 490026-4-3	42" Picket Rail		2016-07-20
Drawn By GES	Scale 1:10	Sheet 14 of 14	Rebar Details - 2

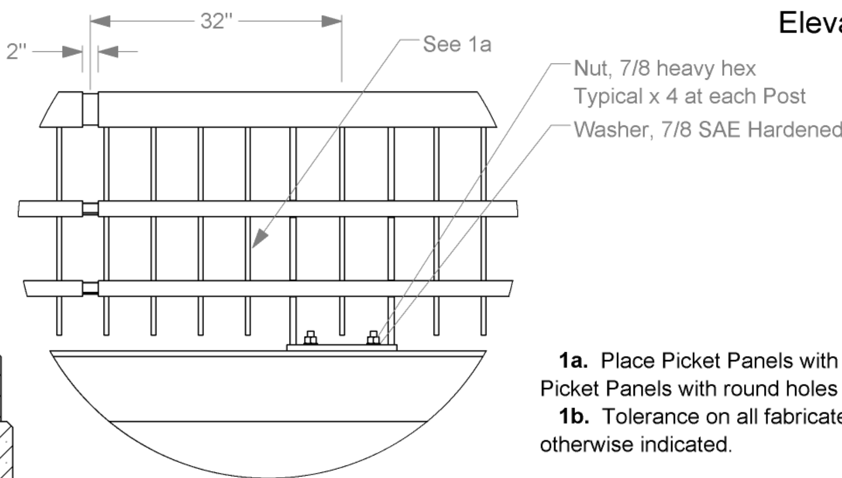
T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-3\Drafting\490026-4-3 Drawing

Test Installation





Section A-A
Scale 1 : 20
(some dims rounded to nearest 1/8")



Detail B
Scale 1 : 20
Typical each joint

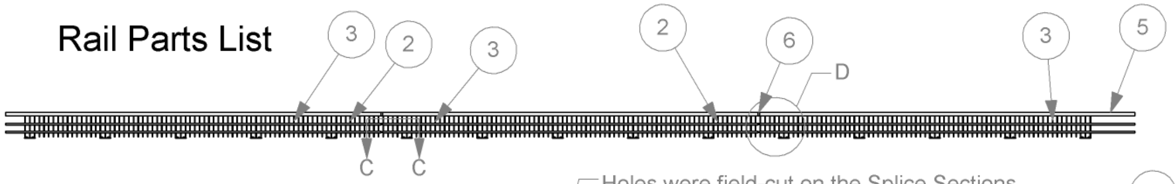
1a. Place Picket Panels with slots at Rail splice locations. Picket Panels with round holes go at all other locations.

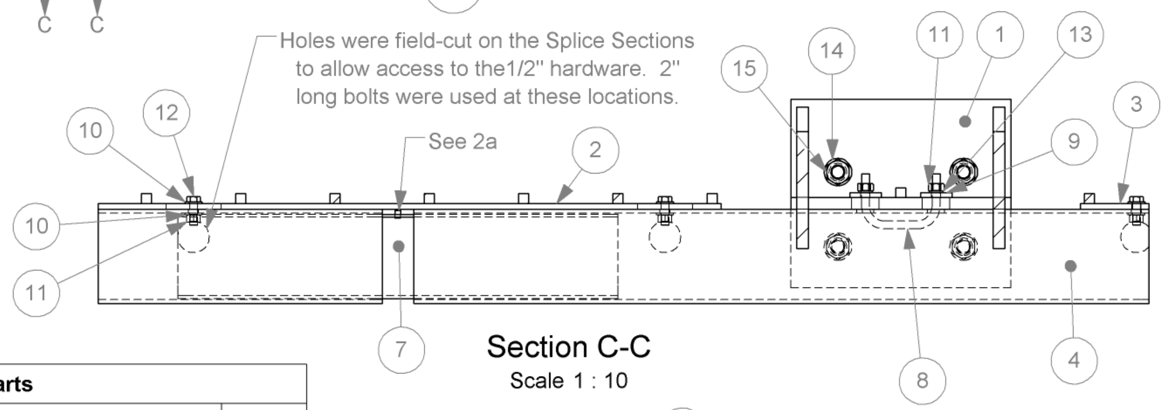
1b. Tolerance on all fabricated parts is ±1/8" unless otherwise indicated.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground		
Project 490026-4-3	42" Picket Rail		2016-07-20
Drawn By GES	Scale1:200	Sheet 1 of 14	Test Installation

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-3\Drafting\490026-4-3 Drawing

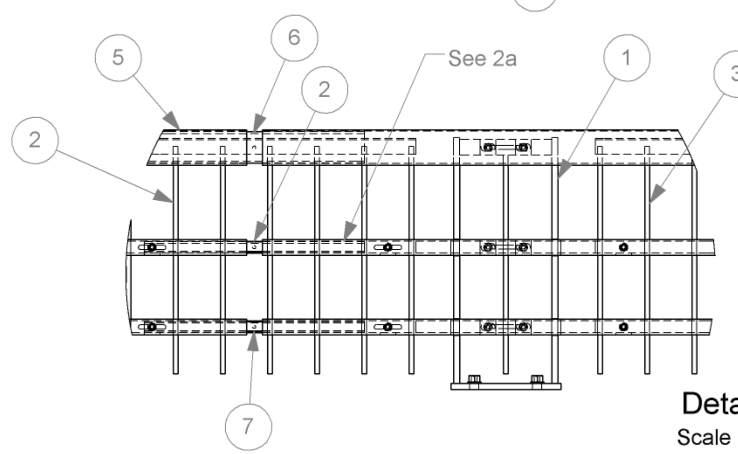
Rail Parts List





Section C-C
Scale 1 : 10

Rail Parts		
#	Part Name	Qty.
1	Post for 42" Picket Rail	15
2	Picket Rail Panel, with slots	2
3	Picket Rail Panel, with holes	12
4	Rectangular Rail	6
5	Round Rail	3
6	Splice Section for Round Rail	2
7	Splice Section for Rectangular Rail	4
8	U-bolt for Picket Rail	45
9	Plate Washer for U-bolt	90
10	Washer, 1/2 SAE Hardened	168
11	Nut, 1/2 heavy hex	174
12	Bolt, 1/2" x 1 1/2" hex	84
13	Washer, 1/2 Lock	90
14	Washer, 7/8 SAE Hardened	60
15	Nut, 7/8 heavy hex	60



Detail D
Scale 1 : 20

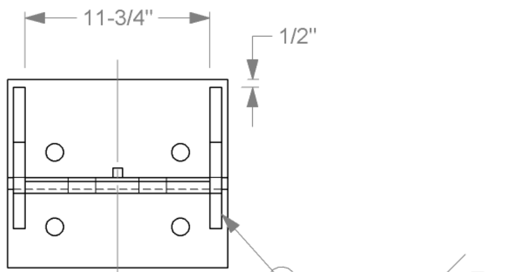
2a. Place Splice Sections with Pins on Field Side.
2b. Ø1/2" Bolts are ASTM A325. Ø7/8" Bolts are ASTM A449.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground		
Project 490026-4 / 1-2	42" Picket Rail		2016-07-18
Drawn By GES	Scale1:200	Sheet 2 of 14	Rail Parts List

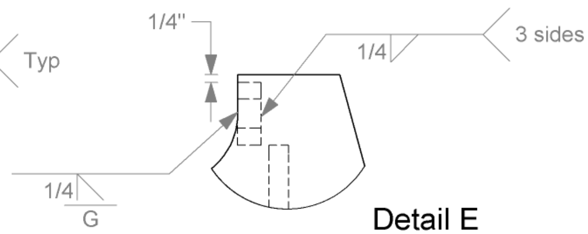
T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

Post

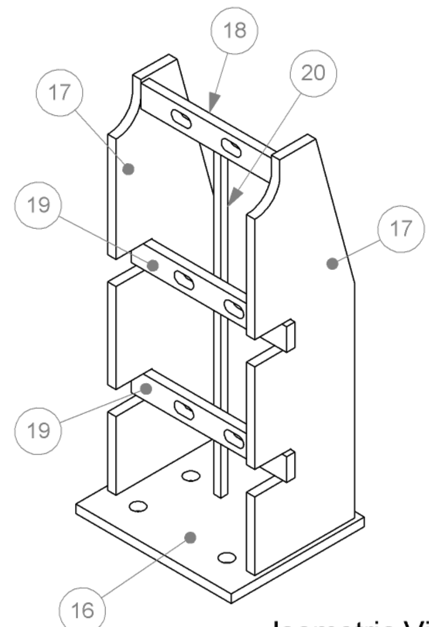
Post Parts					
#	Body Name	Description	Length	MATERIAL	Qty
16	Base Plate	Plate, 12" x 3/4"	14"	ASTM A572 Grade 50	1
17	Side Plate	Plate, 9" x 3/4"	31 1/4"	ASTM A572 Grade 50	2
18	Rail Plate, Top	Plate, 2" x 3/4"	11 3/4"	ASTM A36 Steel	1
19	Rail Plate, Bot and Mid	Plate, 2" x 3/4"	14"	ASTM A36 Steel	2
20	Picket	Plate, 5/8" x 5/8"	27 3/4"	ASTM A36 Steel	1



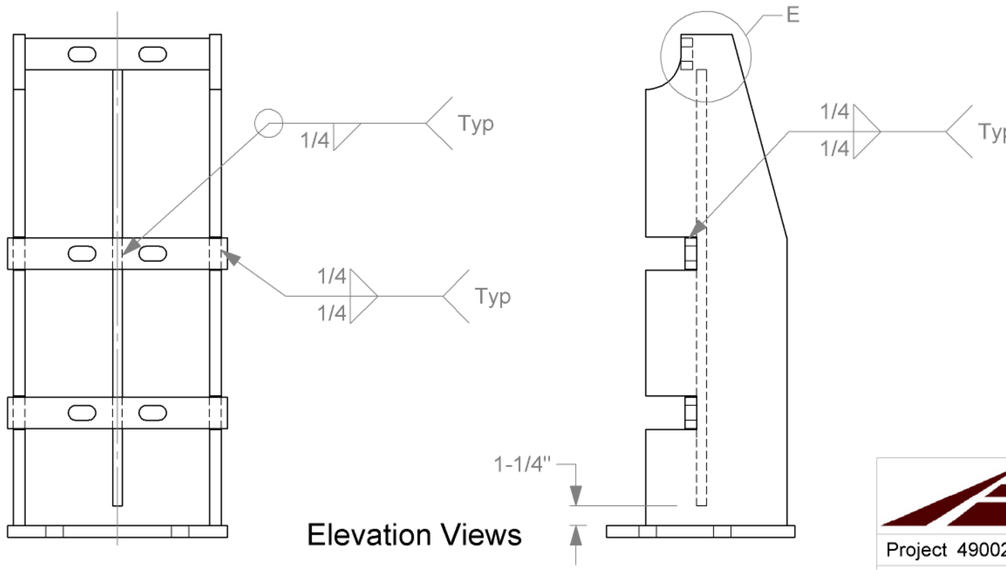
Plan View



Detail E
Scale 1 : 5



Isometric View



Elevation Views

Texas A&M Transportation Institute

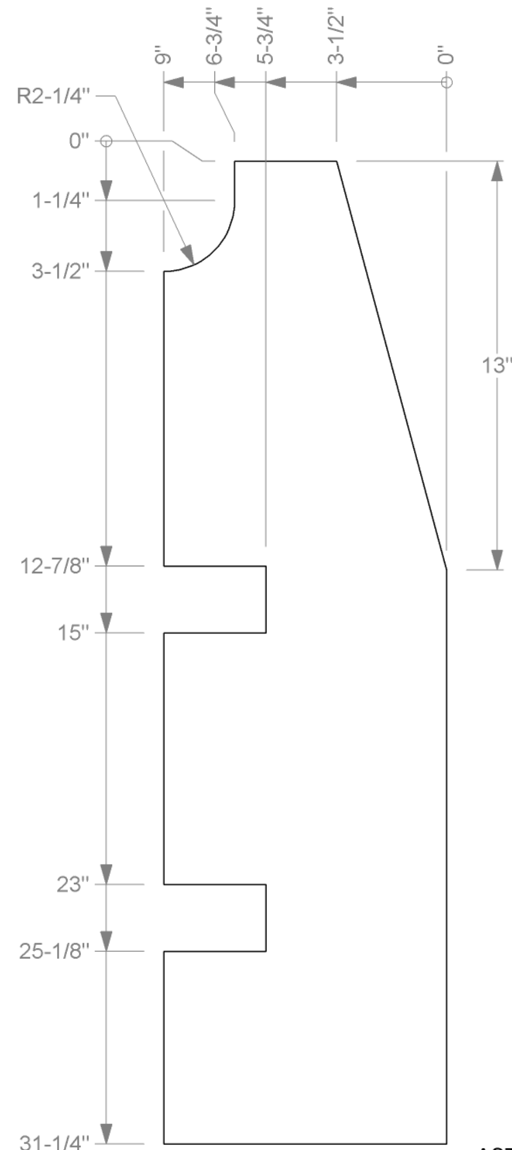
Roadside Safety and Physical Security Division - Proving Ground

Project 490026-4 / 1-2	42" Picket Rail	2016-07-18
Drawn By GES	Scale1:500	Sheet 3 of 14 Post

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

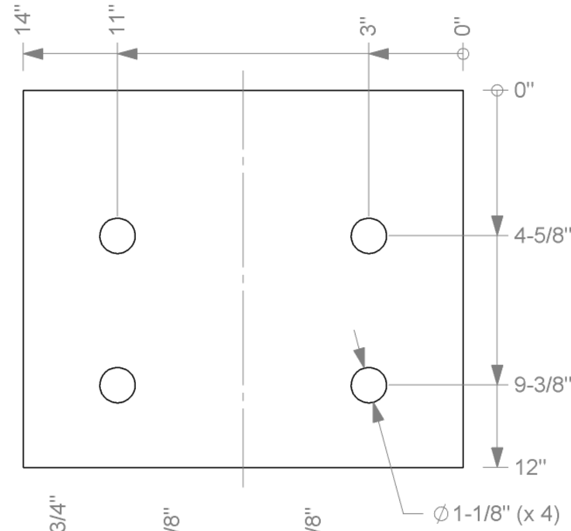
Post Parts

(See Table, previous sheet, for Picket details)



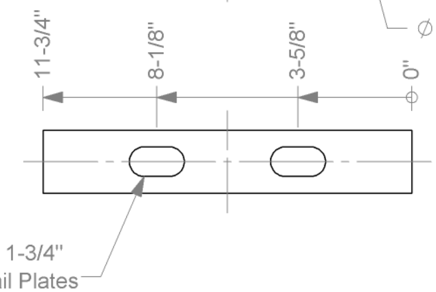
Side Plate

Plate, 9" x 3/4"
ASTM A572 Grade 50



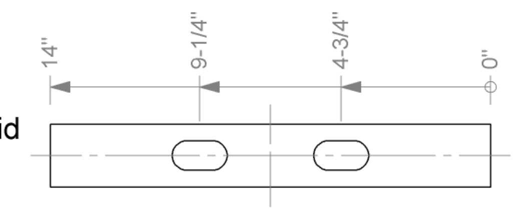
Base Plate

Plate, 12" x 3/4"
ASTM A572 Grade 50



Rail Plate, Top

Plate, 2" x 3/4"
ASTM A36 Steel



Rail Plate, Bot and Mid

Plate, 2" x 3/4"
ASTM A36 Steel

Texas A&M Transportation Institute | Roadside Safety and Physical Security Division - Proving Ground

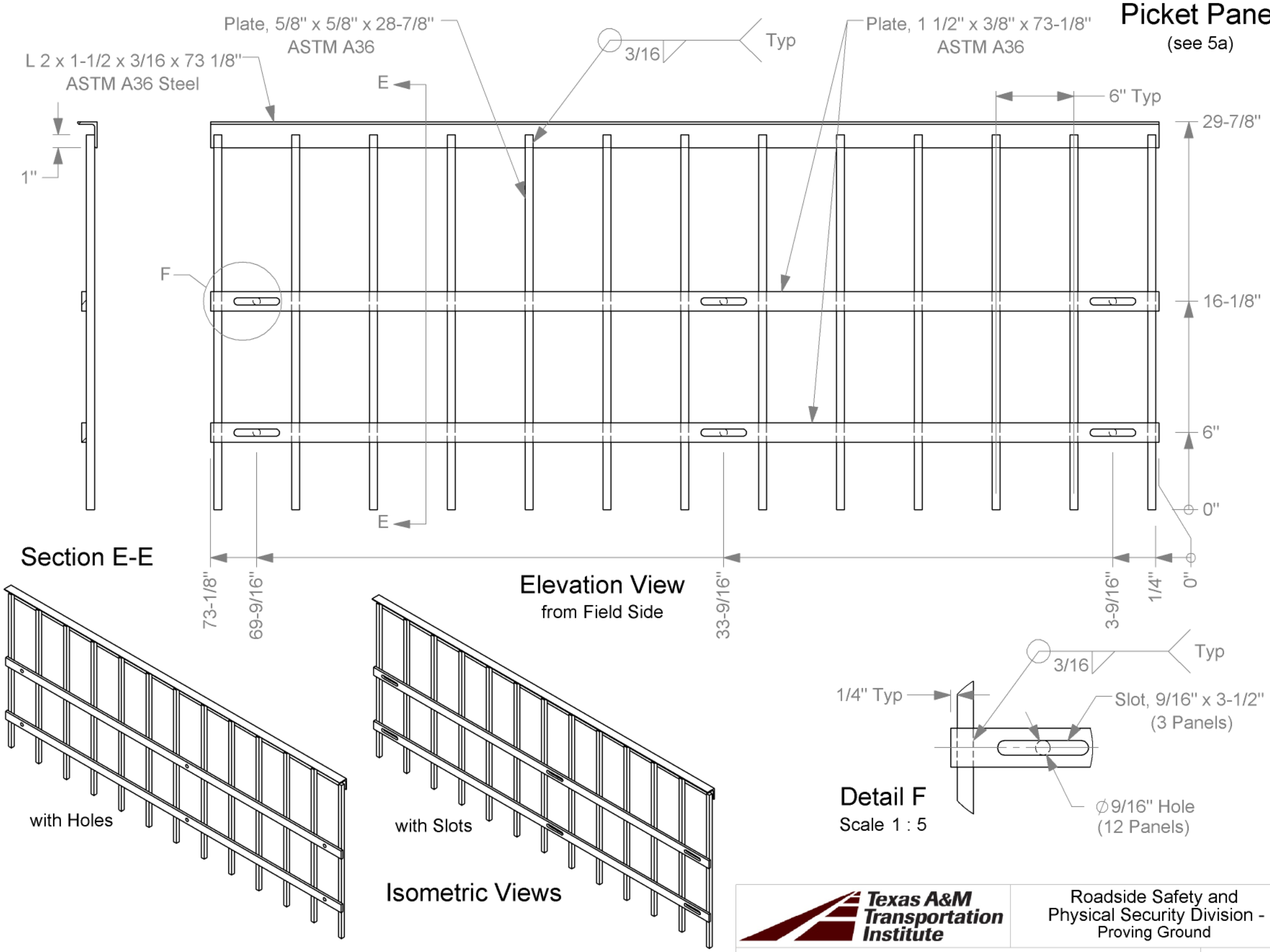
Project 490026-4 / 1-2 | 42" Picket Rail | 2016-07-18

Drawn By GES | Scale 1:5 | Sheet 4 of 14 | Post Parts

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

Picket Panel

(see 5a)



5a. Need 18 Panels total, 3 with Slots and 15 with holes at same location.

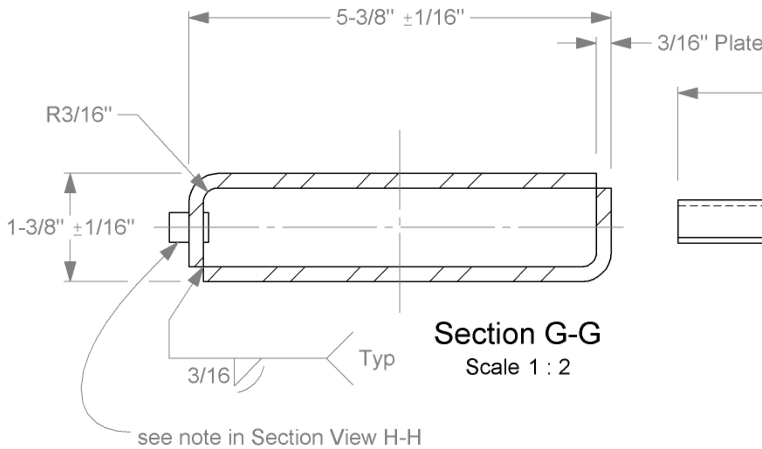
Texas A&M Transportation Institute

Roadside Safety and Physical Security Division - Proving Ground

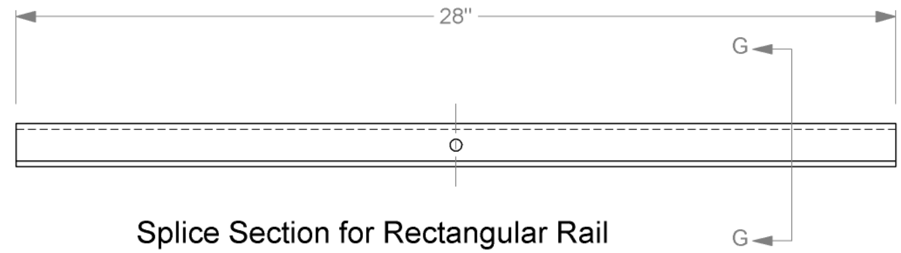
Project 490026-4 / 1-2	42" Picket Rail	2016-07-18
Drawn By GES	Scale 1:10	Sheet 5 of 14 Picket Panel

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

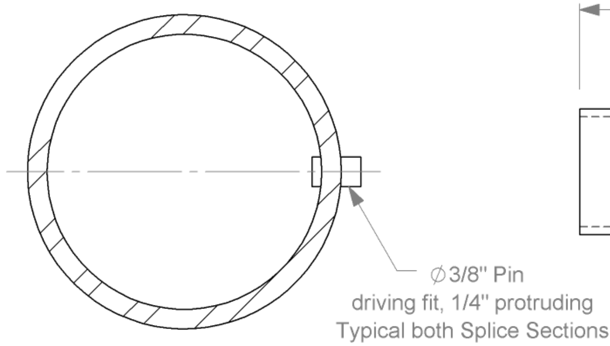
Splice Sections



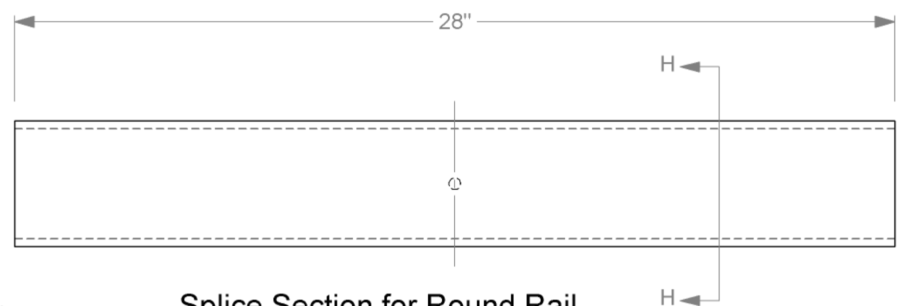
Section G-G
Scale 1 : 2



Splice Section for Rectangular Rail
ASTM A36 Steel
(see 6a)



Section H-H
Scale 1 : 2



Splice Section for Round Rail
HSS Round 4" x 1/4" x 28"
ASTM A500 Grade B

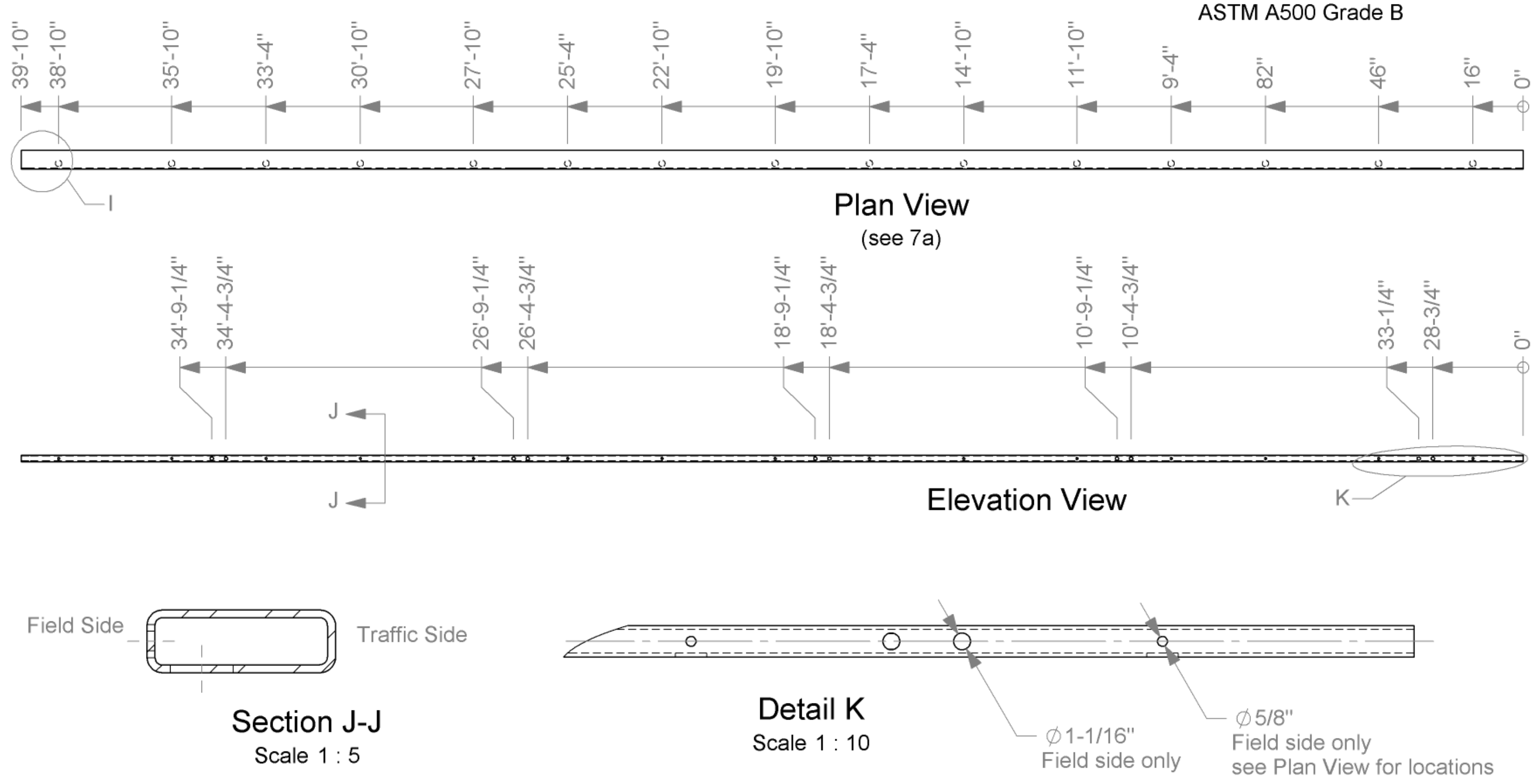
6a. Check Splice Sleeve for Rectangular Rail for loose fit in Rectangular Rail after fabrication is completed.

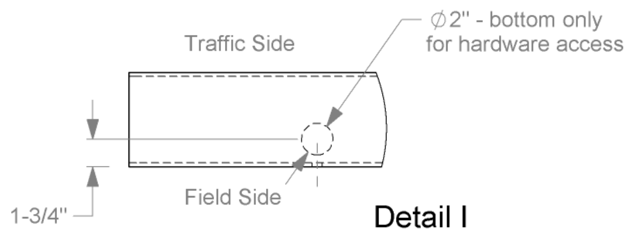
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground		
Project 490026-4 / 1-2	42" Picket Rail		2016-07-18
Drawn By GES	Scale 1:5	Sheet 6 of 14	Splice Sections

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

Rectangular Rail

HSS 6" x 2" x 1/4"
ASTM A500 Grade B

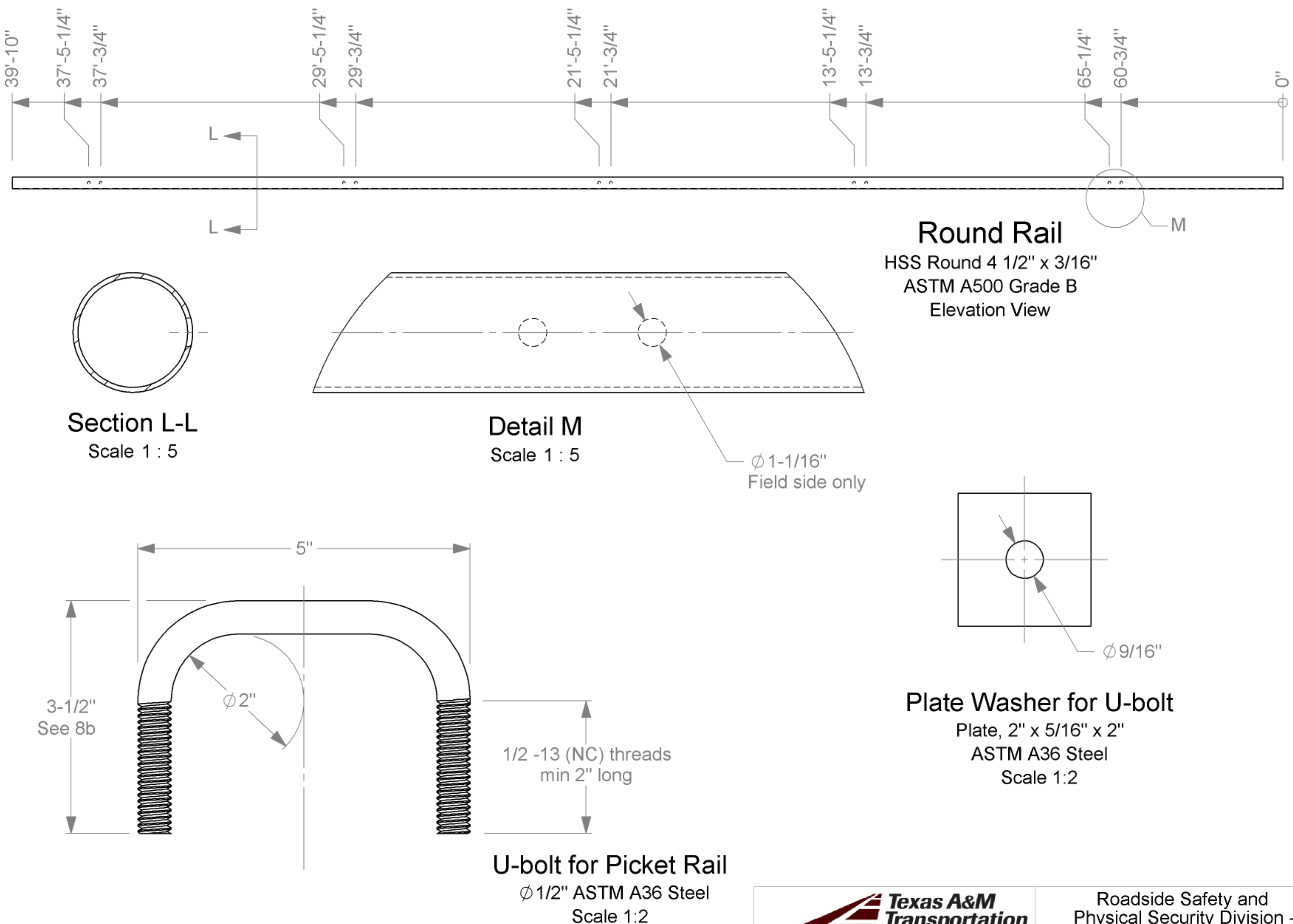




Detail I
Scale 1 : 10

7a. Please note that the Plan View and Detail I are showing the Rail from the top. The holes are on bottom.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground
Project 490026-4 / 1-2 42" Picket Rail	2016-07-18
Drawn By GES Scale 1:50	Sheet 7 of 14 Rectangular Rail

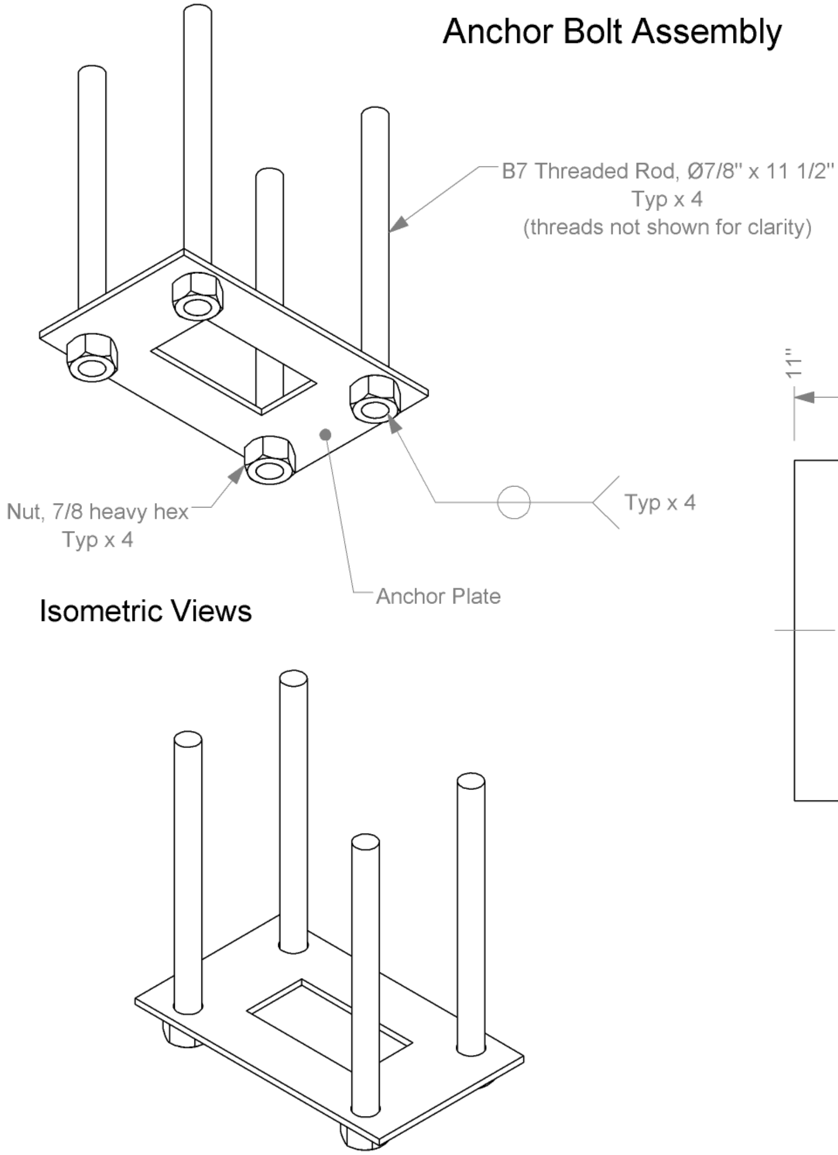


8a. Dimension is approximate. Rod is 10" long before bending.

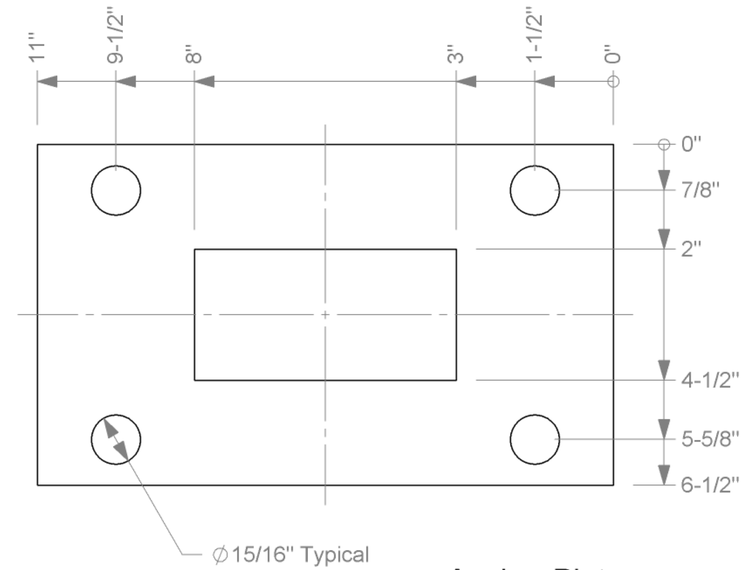
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project 490026-4 / 1-2	42" Picket Rail	2016-07-18
Drawn By GES	Scale 1:50	Sheet 8 of 14 Round Rail, etc.

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

Anchor Bolt Assembly



Isometric Views

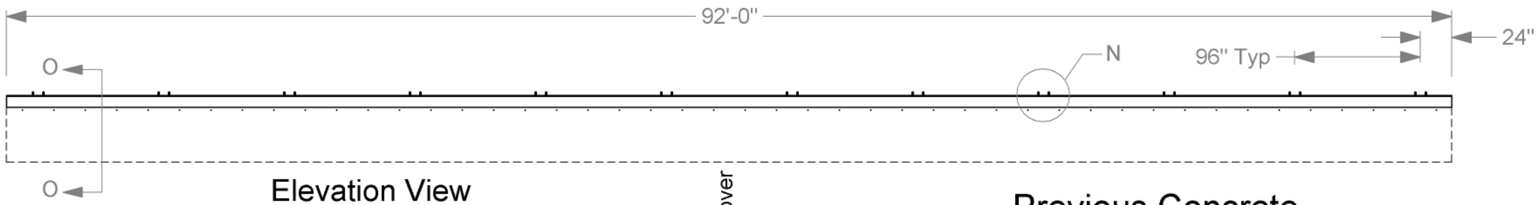


Anchor Plate

Plate, 6 1/2" x 1/4" x 11"
ASTM A36 Steel

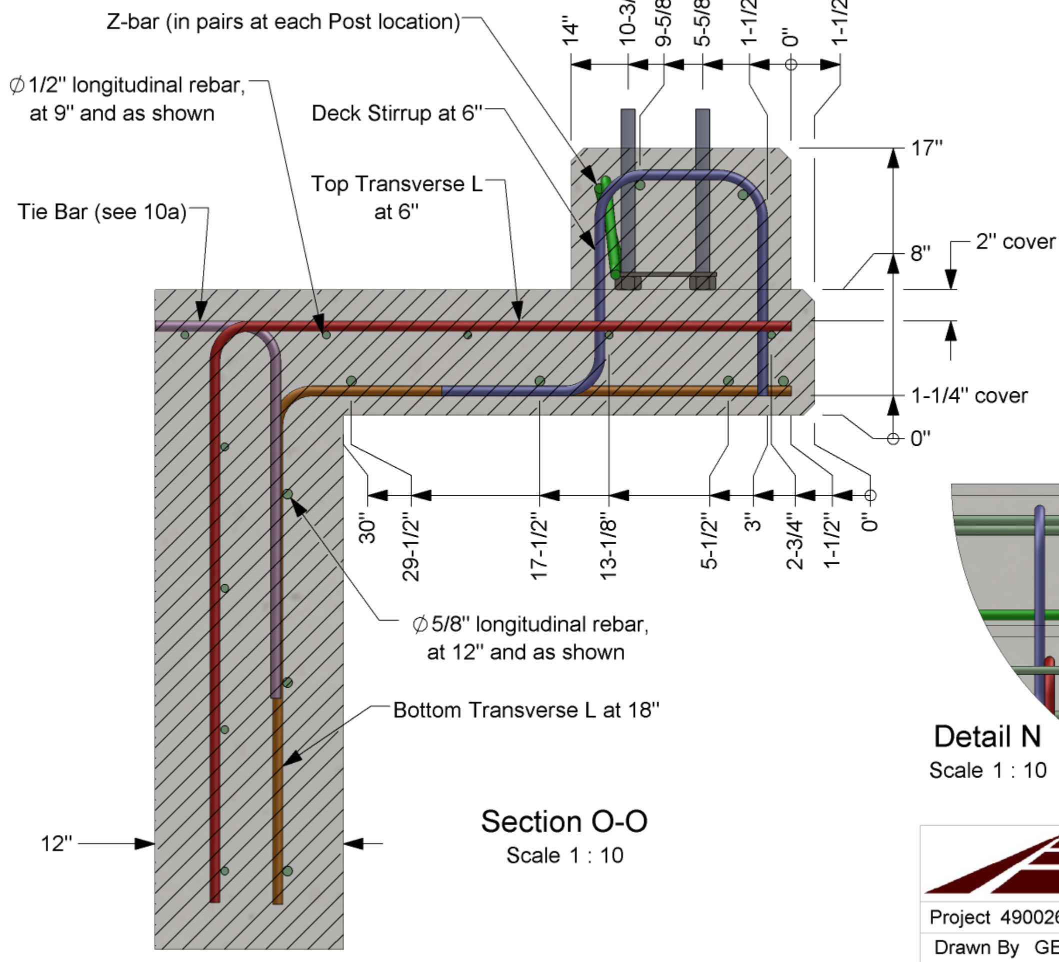
Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project 490026-4 / 1-2	42" Picket Rail		2016-07-18
Drawn By GES	Scale 1:3	Sheet 9 of 14	Anchor Bolt Assembly

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing



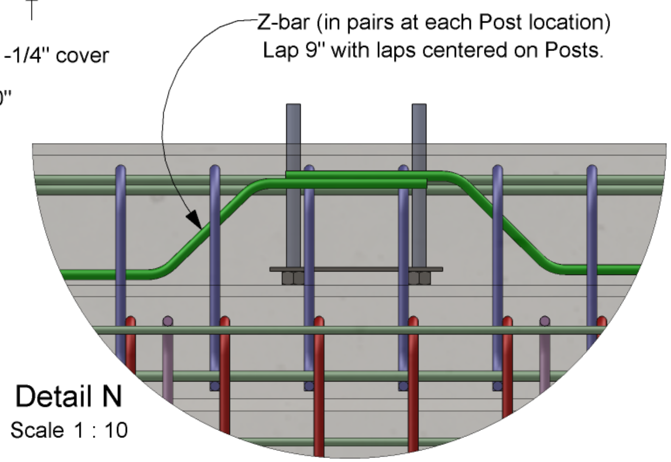
Elevation View

Previous Concrete



Section O-O
Scale 1 : 10

10a. Tie Bars spaced at 24", and welded to existing rebar protruding from the runway (not shown here).
10b. All Rebar is grade 60. Minimum lap distance is 17" for Ø1/2" bars and 21" for Ø5/8" bars.
10b. Concrete is TxDOT Class S (4000 psi). Chamfer edges of Deck and Curb 3/4" as shown.



Detail N
Scale 1 : 10

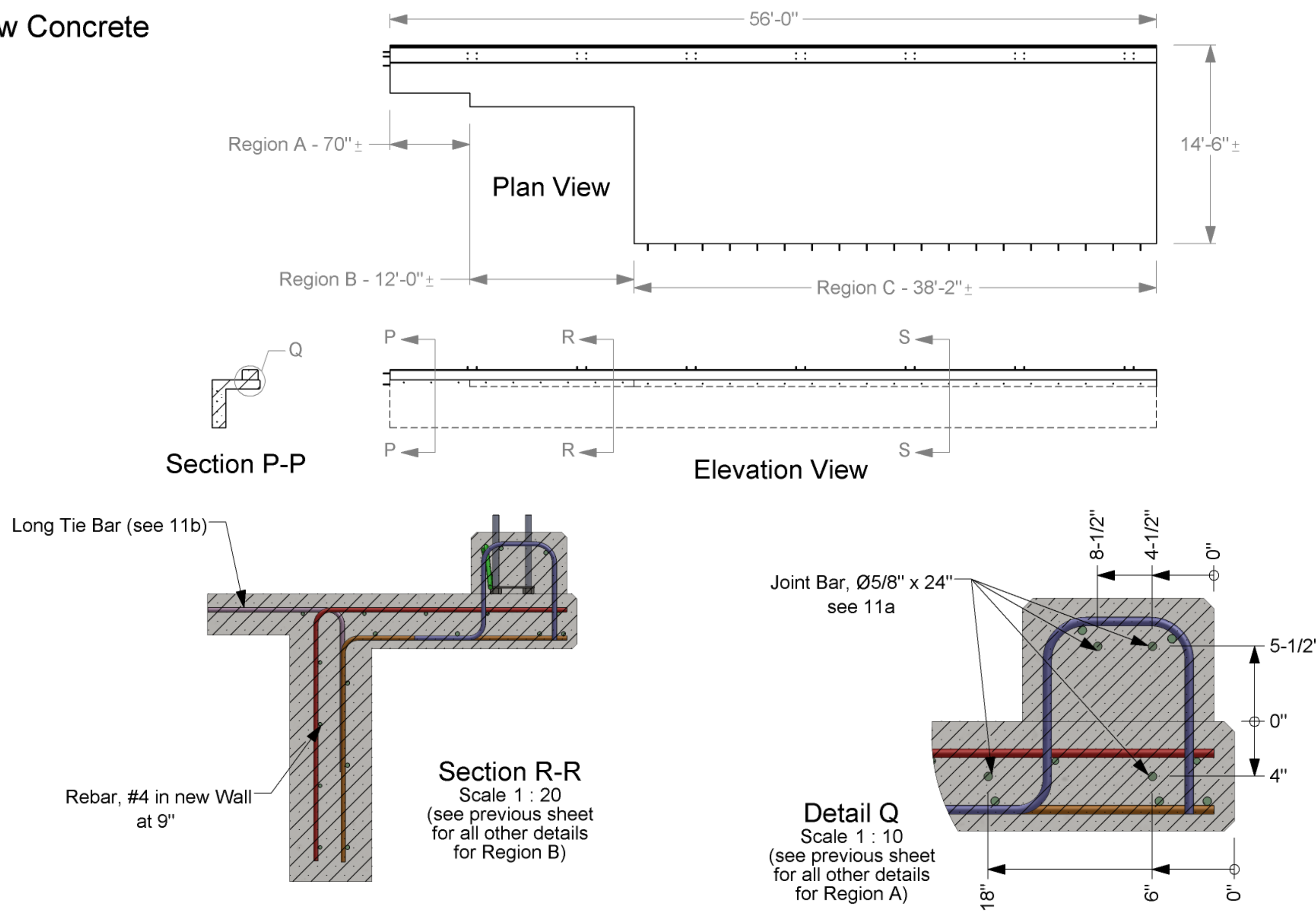
Texas A&M Transportation Institute

Roadside Safety and Physical Security Division - Proving Ground

Project 490026-4 / 1-2	42" Picket Rail		2016-07-18
Drawn By GES	Scale1:120	Sheet 10 of 14	Previous Concrete

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

New Concrete

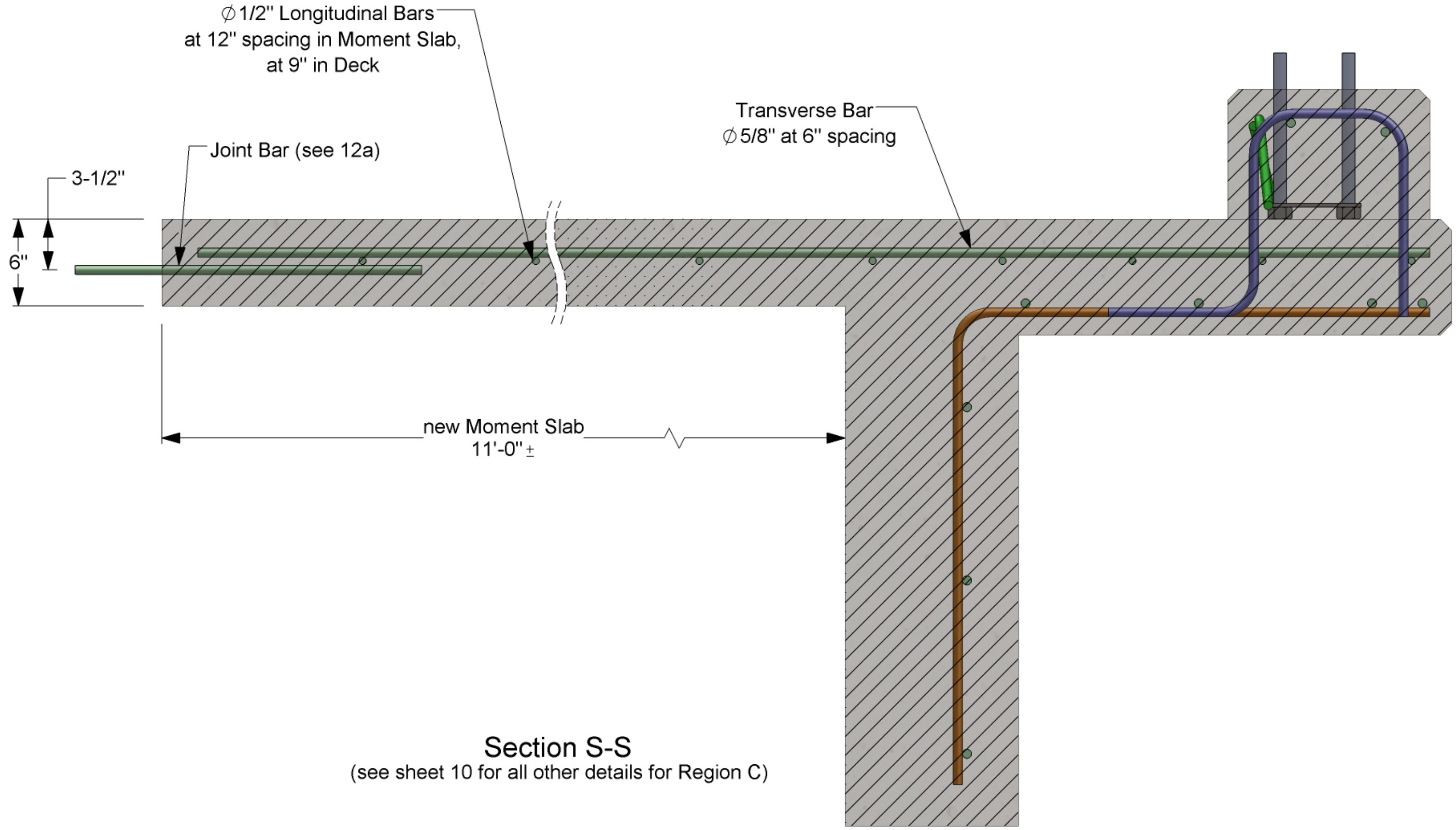


11a. Drill minimum 6" into existing concrete and secure Joint Bars with Hilti RE-500 epoxy, according to manufacturer's instructions.

11b. Long Tie Bars spaced at 24" and welded to existing rebar protruding from the runway (not shown here).

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project 490026-4 / 1-2	42" Picket Rail		2016-07-18
Drawn By GES	Scale1:120	Sheet 11 of 14	New Concrete

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing



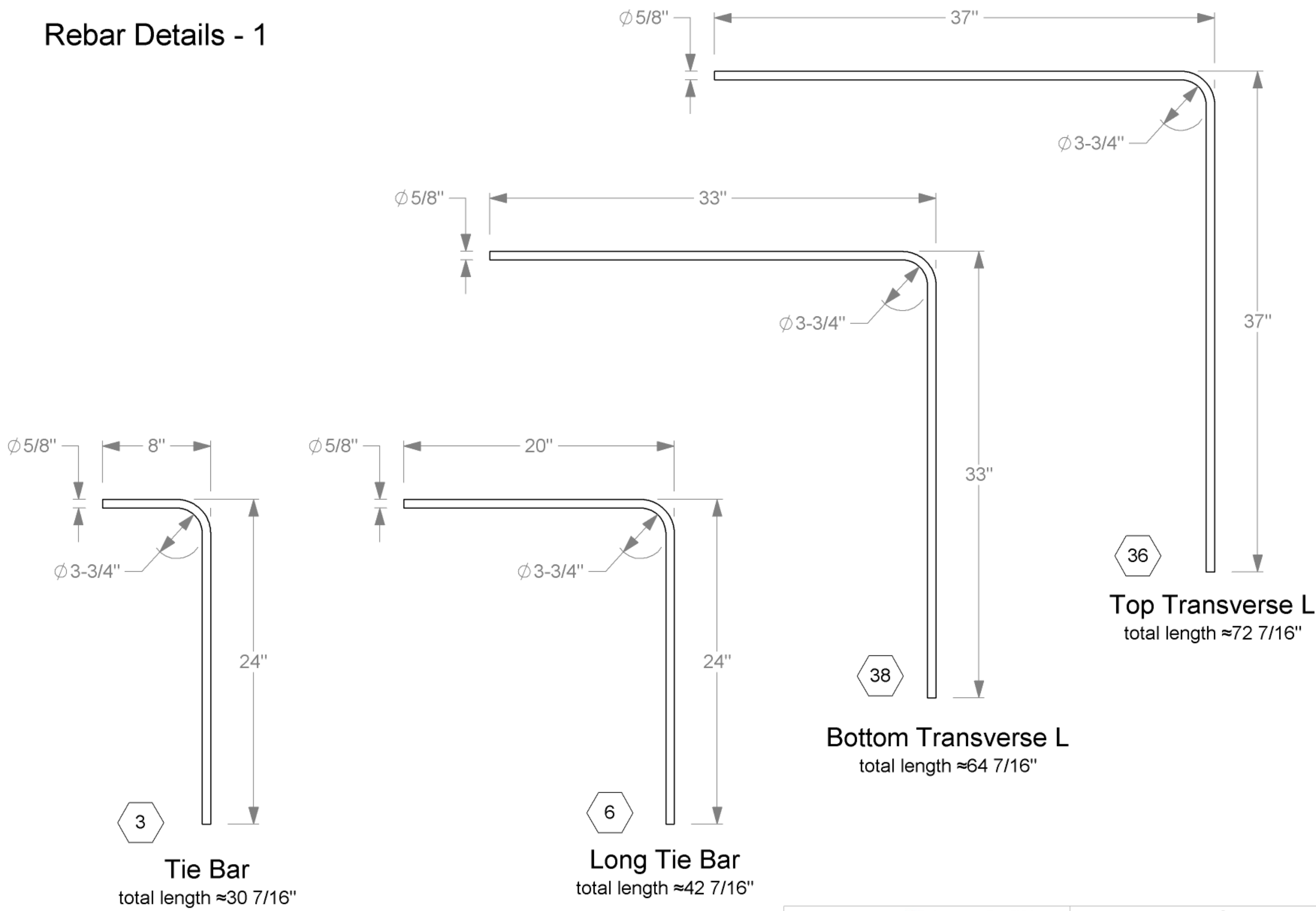
Section S-S
(see sheet 10 for all other details for Region C)

12a. Drill minimum 6" into existing concrete and secure Joint Bars with Hilti RE-500 epoxy, according to manufacturer's instructions. Space at 24".

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project 490026-4 / 1-2	42" Picket Rail	2016-07-18
Drawn By GES	Scale 1:10	Sheet 12 of 14 Section View

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

Rebar Details - 1

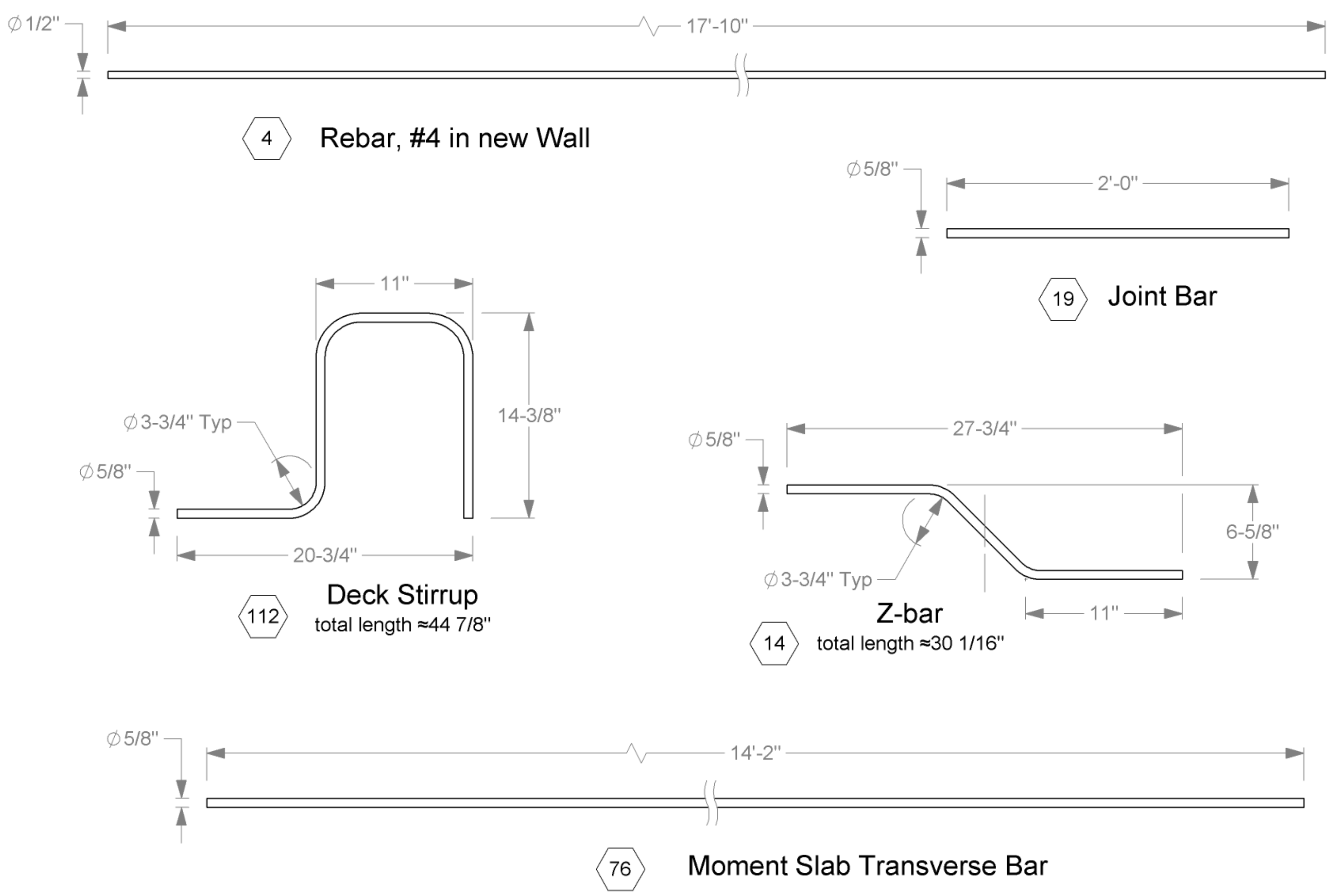


13a. The numeral in the hexagon denotes the quantity needed for each Bar.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground		
Project 490026-4 / 1-2	42" Picket Rail		2016-07-18
Drawn By GES	Scale 1:10	Sheet 13 of 14	Rebar Details - 1

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing

Rebar Details - 2



14a. The numeral in the hexagon denotes the quantity needed for each Bar.

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project 490026-4 / 1-2	42" Picket Rail		2016-07-18
Drawn By GES	Scale 1:10	Sheet 14 of 14	Rebar Details - 2

T:\1-ProjectFiles\490026-TxDOT\-4 - 42 inch Picket Rail - Williams\4-2\Drafting\490026-4-2 Drawing