U.S. Department of Transportation
Federal Highway Administration

June 29, 2021

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

In Reply Refer To:
HSST-1/B-359

Mr. Tekeste Amare
Maryland Transportation Authority
300 Authority Drive
Baltimore MD 21222
USA

Dear Mr. Amare:

This letter is in response to your April 1, 2021 request for the Federal Highway Administration (FHWA) to review a roadside safety device, hardware, or system for eligibility for reimbursement under the Federal-aid highway program. This FHWA letter of eligibility is assigned FHWA control number B-359 and is valid until a subsequent letter is issued by FHWA that expressly references this device.

Decision

The following device is eligible within the length-of-need, with details provided in the form which is attached as an integral part of this letter:

- MDTA Chesapeake Bay Bridge Steel Rail System

Scope of this Letter

To be found eligible for Federal-aid funding, new roadside safety devices should meet the crash test and evaluation criteria contained in the American Association of State Highway and Transportation Officials'(AASHTO) Manual for Assessing Safety Hardware (MASH). However, the FHWA, the Department of Transportation, and the United States Government do not regulate the manufacture of roadside safety devices. Eligibility for reimbursement under the Federal-aid highway program does not establish approval, certification or endorsement of the device for any particular purpose or use.

This letter is not a determination by the FHWA, the Department of Transportation, or the United States Government that a vehicle crash involving the device will result in any particular outcome, nor is it a guarantee of the in-service performance of this device. Proper manufacturing, installation, and maintenance are required in order for this device to function as tested.

This finding of eligibility is limited to the crashworthiness of the system and does not cover other structural features, nor conformity with the Manual on Uniform Traffic Control Devices.

Eligibility for Reimbursement

Based solely on a review of crash test results and certifications submitted by the manufacturer, and the crash test laboratory, FHWA agrees that the device described herein meets the crash test and evaluation criteria of the AASHTO's MASH. Therefore, the device is eligible for reimbursement under the Federal-aid highway program if installed under the range of tested conditions.

- Name of system: MDTA Chesapeake Bay Bridge Steel Rail System
  Type of system: Longitudinal Barrier
  Test Level: Test Level 5
  Testing conducted by: Texas A&M Transportation Institute (TTI)
  Date of request: April 1, 2021

FHWA concurs with the recommendation of the accredited crash testing laboratory on the attached form.

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". A test report included in with the submittal documents that Test 5-12 shows the right fuel tank was damaged.

Full Description of the Eligible Device

The device and supporting documentation, including reports of the crash tests or other testing done, videos of any crash testing, and/or drawings of the device, are described in the attached form.

Notice

This eligibility letter is issued for the subject device as tested. Modifications made to the device are not covered by this letter. Any modifications to this device should be submitted to the user (i.e., state DOT) as per their requirements.

You are expected to supply potential users with sufficient information on design, installation and maintenance requirements to ensure proper performance.

You are expected to certify to potential users that the hardware furnished has the same chemistry, mechanical properties, and geometry as that submitted for review, and that it will meet the test and evaluation criteria of AASHTO's MASH.

Issuance of this letter does not convey property rights of any sort or any exclusive privilege. This letter is based on the premise that information and reports submitted by you are accurate and correct. We reserve the right to modify or revoke this letter if: (1) there are any inaccuracies in the information submitted in support of your request for this letter, (2) the qualification testing was flawed, (3) in-service performance or other information reveals safety problems, (4) the system is significantly different from the version that was crash tested, or (5) any other information indicates that the letter was issued in error or otherwise does not reflect full and complete information about the crashworthiness of the system.

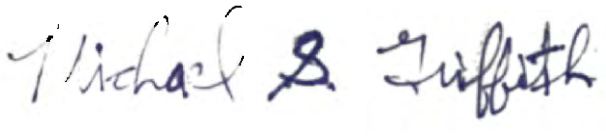
Standard Provisions

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number B-359 shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed upon request.

- This letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder.

- This FHWA eligibility letter is not an expression of any Agency view, position, or determination of validity, scope, or ownership of any intellectual property rights to a specific device or design. Further, this letter does not impute any distribution or licensing rights to the requester. This FHWA eligibility letter determination is made based solely on the crash-testing information submitted by the requester. The FHWA reserves the right to review and revoke an earlier eligibility determination after receipt of subsequent information related to crash testing.

Sincerely,



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:	April 01, 2021	◉ New ○ Resubmission
	Name:	Tekeste Amare	
	Company:	Maryland Transportation Authority	
	Address:	300 Authority Drive, Baltimore, MD 21222	
	Country:	United States of America	
	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	MDTA Chesapeake Bay Bridge Steel Rail System	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:	Tekeste Amare	Same as Submitter ☒
Company Name:	Maryland Transportation Authority	Same as Submitter ☒
Address:	300 Authority Drive, Baltimore, MD 21222	Same as Submitter ☒
Country:	United States of America	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 Modjeski and Masters, Inc. (M&M) vis-a'-vis the Maryland Transportation Authority (MDTA) to perform full-scale crash testing of the MDTA Chesapeake Bay Bridge Steel Rail System. There are no shared financial interests in the MDTA Chesapeake Bay Bridge Steel Rail System by TTI, or between/among M&M / MDTA and TTI, other than costs involved in the actual crash tests and reports for this submission to FHWA.

612861-02

PRODUCT DESCRIPTION

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

The MDTA Chesapeake Bay Bridge Steel Rail system consists of four 40-ft 8-inch long and one 42-3/16-inch long steel parapet assembly sections, which are supported and anchored to the bridge floor system by nine floor beam assemblies, evenly spaced at 20-ft-5-inches. The parapet assembly is anchored to the floor beam 7½ inches below grade and extends up to 32 inches above grade. A steel rail system is mounted on top of the parapet; it consists of an 8-inch x 4⅞-inch elliptical tube and intermediate short posts, with the top of the tube located 50 inches above grade. Both the parapet and rail contain 2-inch-wide longitudinal expansion joints between each assembly section.

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:	William F. Williams	
Engineer Signature:	William Williams Digitally signed by William Williams Date: 2021.04.01 08:27:47 -05'00'	
Address:	1254 Avenue A, Bldg 7091, Bryan, Texas 77807	Same as Submitter ☐
Country:	United States of America	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 and target angle of 25°. The target CIP for the right corner of the front bumper was 3.6 ft upstream of the centerline of the steel rail joint between posts 6 & 7. The results of the test conducted on May 26, 2020, are found in TTI Test Report No. 612861-02. The test vehicle was traveling at an impact speed of 62.6 mi/h as it made contact with the MDTA Chesapeake Bay Bridge Steel Rail System 3.9 ft upstream of the centerline of the steel rail joint between posts 6 & 7 and at an impact angle of 25.0°. After loss of contact with the barrier, the vehicle came to rest 174 ft downstream of the impact point and in line with the bridge rail. The MDTA Chesapeake Bay Bridge Steel Rail System contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. The vehicle exited within the exit box criteria defined in MASH. Maximum dynamic deflection during the test was 1.5 inches. Maximum permanent deformation was 0.25 inch. Working width was 25.0 inches. No detached elements, fragments, or other debris were present to penetrate, or to show potential for penetrating, the occupant compartment, or to present undue hazard for others in the area. The 1100C vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 18° and 14°, respectively. Longitudinal OIV was 20.3 ft/s and lateral OIV was 29.2 ft/s. Maximum longitudinal occupant ridedown acceleration was 4.8 g, and maximum lateral occupant ridedown acceleration was 6.5 g. Occupant risk factors were within the preferred limits specified in MASH. Maximum exterior crush to the vehicle was 10.0 inches in the front plane at the right front corner at bumper height. Maximum occupant compartment deformations were 6.5 inches in the right-side kick panel; 6.5 inches in the right-side diagonal direction of the windshield; 3.0 inches in the right-side firewall; and 2.0 inches in the floor pan. No fuel tank damage was observed. The MDTA Chesapeake Bay Bridge Steel Rail System 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 and target angle of 25°. The target CIP for the right corner of the front bumper was 4.3 ft upstream of the centerline of the joint in the steel rail between posts 6 & 7. The results of the test conducted on May 21, 2020, are found in TTI Test Report No. 612861-02. The test vehicle was traveling at an impact speed of 62.2 mi/h as it made contact with the MDTA Chesapeake Bay Bridge Steel Rail System 5.1 ft upstream of the centerline of the joint in the steel rail between posts 6 & 7 and at an impact angle of 25.0°. After loss of contact with the barrier, the vehicle came to rest 151 ft downstream of the impact point and 4 ft toward the field side. The MDTA Chesapeake Bay Bridge Steel Rail System contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. The vehicle exited within the exit box criteria defined in MASH. Maximum dynamic deflection during the test was 2.6 inches. Maximum permanent deformation was 1.1 inches. Working width was 20.1 inches. No detached elements, fragments, or other debris were present to penetrate, or to show potential for penetrating, the occupant compartment, or to present undue hazard for others in the area. The 2270P vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 16° and 10°, respectively. Longitudinal OIV was 21.0 ft/s and lateral OIV was 31.2 ft/s. Maximum longitudinal occupant ridedown acceleration was 6.1 g and maximum lateral occupant ridedown acceleration was 9.8 g. Occupant risk factors were within the preferred limits specified in MASH. Maximum exterior crush to the vehicle was 12.0 inches in the side plane at the right front corner at bumper height. Maximum occupant compartment deformation was 2.5 inches in the right front firewall area. No fuel tank damage was observed. The MDTA Chesapeake Bay Bridge Steel Rail System 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 and target angle of 15°. The target CIP for the right corner of the cab's front bumper was 7.0 ft upstream of the centerline of post 3. The results of the test conducted on May 29, 2020, are found in TTI Test Report No. 612861-02. The test vehicle was traveling at an impact speed of 49.9 mi/h as it made contact with the MDTA Chesapeake Bay Bridge Steel Rail System 6.9 ft upstream of the centerline of post 3 and at an impact angle of 15.0°. After loss of contact with the barrier, the vehicle came to rest 309 ft downstream of the impact point and 104 ft toward the field side. The MDTA Chesapeake Bay Bridge Steel Rail System contained and redirected the 36000V vehicle. The vehicle did not penetrate, underride, or override the installation. The vehicle exited within the exit box criteria defined in MASH. Maximum dynamic deflection during the test was 3.0 inches. Permanent deformation was unmeasurable due to rail separation. Working width was 60.9 inches. No detached elements, fragments, or other debris were present to penetrate or to show potential for penetrating the occupant compartment, or to present undue hazard for others in the area. The 36000V vehicle remained upright during and after the collision event, although the trailer severed 5 feet behind the bulkhead. Maximum roll and pitch angles were 6° and 4°, respectively. Longitudinal OIV was 3.3 ft/s, and lateral OIV was 14.8 ft/s. Maximum longitudinal occupant ridedown acceleration was 12.4 g, and maximum lateral occupant ridedown acceleration was 12.5 g. Maximum exterior crush to the vehicle cab was 19.0 inches in the front plane at the right front corner of the cab at bumper height. Maximum occupant compartment deformation was 4.5 inches in the right floor pan. The MDTA Chesapeake Bay Bridge Steel Rail System performed acceptably for MASH test 5-12.	PASS
5-20 (1100C)	Test for transition is not applicable for this bridge barrier system	Non-Relevant Test, not conducted

5-21 (2270P)	Test for transition is not applicable for this bridge barrier system	Non-Relevant Test, not conducted
5-22 (36000V)	Test for transition is not applicable for this bridge barrier 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 A&M Transportation Institute Proving Ground	
Laboratory Signature:	Digitally signed by Darrell L. Kuhn 'Date: 2021.03.29 16:36:35 -05'00	
Address:	1254 Avenue A, Bldg 7091, Bryan, Texas 77807	Same as Submitter ☐
Country:	United States of America	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, 2021	

Submitter Signature*: Tekeste Amare, P.E. Digitally signed by Tekeste Amare, P.E. Date: 2021.04.08 12:18:34 -04'00'

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

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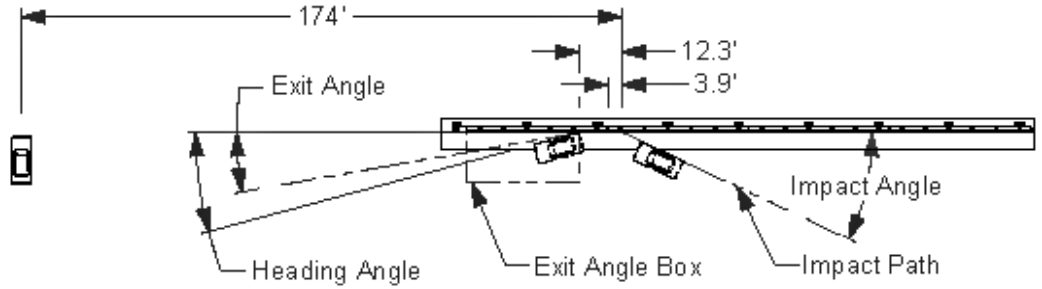
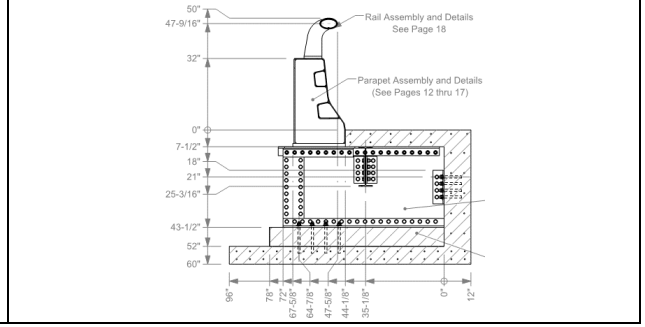
0.400 s





General Information
- Test Agency ..... Texas A&M Transportation Institute (TTI)
- Test Standard Test No. ..... MASH Test 5-10
- TTI Test No. 612861-02-3
- Test Date 2020-05-26

Test Article
- Type ..... Longitudinal Barrier—Bridge Rail
- Name ..... MDTA Chesapeake Bay Bridge Steel Rail
- Installation Length ..... System
- Material or Key Elements ... 171 ft 7 inches × $22^{3}/_{13}$ inches Four 40-ft 8-inch parapet assembly sections with rail assembly of 8-inch × 4⅞-inch elliptical tube held by short posts

Soil Type and Condition ..... 50⅝ inches above the pavement

Test Vehicle ..... Concrete bridge deck, dry
- Type/Designation .....
- Make and Model 1100C
- Curb ..... 2014 Nissan Versa
- Test Inertial ..... 2402 lb
- Dummy ..... 2429 lb
- Gross Static ..... 165 lb 2594 lb

Impact Conditions
- Speed ..... 62.6 mi/h
- Angle ..... 25.0°
- Location/Orientation ..... 3.9 ft upstream of joint btw posts 6-7

Impact Severity ..... 59 kip-ft

Exit Conditions
- Speed ..... 45.7 mi/h
- Trajectory/Heading Angle ... 5.5°/18.7°

Occupant Risk Values
- Longitudinal OIV ..... 20.3 ft/s
- Lateral OIV ..... 29.2 ft/s
- Longitudinal Ridedown ..... 4.8 g
- Lateral Ridedown ..... 6.5 g
- THIV ..... 10.8 m/s
- ASI 2.3

Max. 0.050-s Average
- Longitudinal ..... −10.9 g
- Lateral ..... −17.4 g
- Vertical ..... −2.4 g

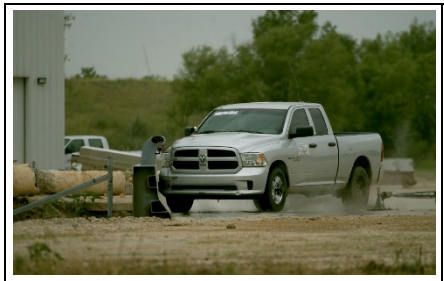
Post-Impact Trajectory
- Stopping Distance ..... 174 ft downstream in line

Vehicle Stability
- Maximum Yaw Angle ..... 50°
- Maximum Pitch Angle ..... 14°
- Maximum Roll Angle ..... 18°
- Vehicle Snagging ..... No
- Vehicle Pocketing ..... No

Test Article Deflections
- Dynamic ..... 1.5 inches
- Permanent ..... 0.25 inch
- Working Width ..... 25.0 inches
- Height of Working Width ..... 32.6 inches

Vehicle Damage
- VDS 01RFQ6
- CDC 01FREW5
- Max. Exterior Deformation ..... 10 inches
- OCDI FR1111000
- Max. Occupant Compartment Deformation ..... 6.5 inches

Figure 7.6. Summary of Results for *MASH* Test 5-10 on MDTA Chesapeake Bay Bridge Steel Rail System.



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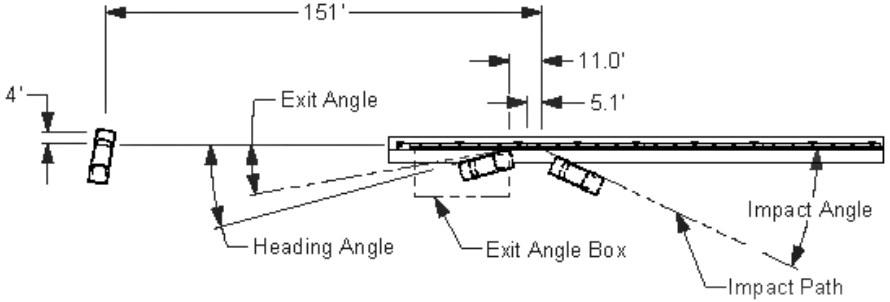

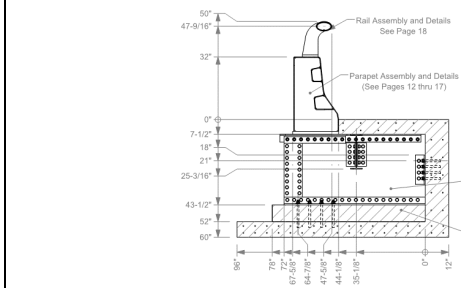

General Information
- Test Agency ..... Texas A&M Transportation Institute (TTI)
- Test Standard Test No. ..... MASH Test 5-11
- TTI Test No. 612861-02-2
- Test Date 2020-05-21

Test Article
- Type ..... Longitudinal Barrier—Bridge Rail
- Name ..... MDTA Chesapeake Bay Bridge Steel Rail
- Installation Length ..... System
- Material or Key Elements ... 171 ft 7 inches × $22^{3}/_{13}$ inches Four 40-ft 8-inch parapet assembly sections with rail assembly of 8-inch × 4⅞-inch elliptical tube held by short posts

Soil Type and Condition ..... 50⅝ inches above the pavement

Test Vehicle ..... Concrete bridge deck, dry
- Type/Designation .....
- Make and Model 2270P
- Curb ..... 2015 RAM 1500 Pickup
- Test Inertial ..... 4995 lb
- Dummy ..... 5045 lb
- Gross Static ..... 165 lb 5210 lb

Impact Conditions
- Speed ..... 62.2 mi/h
- Angle ..... 25.0°
- Location/Orientation ..... 5.1 ft upstream of joint btw posts 6-7

Impact Severity ..... 117 kip-ft

Exit Conditions
- Speed ..... 48.5 mi/h
- Trajectory/Heading Angle ... 9.1°/8.9°

Occupant Risk Values
- Longitudinal OIV ..... 21.0 ft/s
- Lateral OIV ..... 31.2 ft/s
- Longitudinal Ridedown ..... 6.1 g
- Lateral Ridedown ..... 9.8 g
- THIV ..... 11.4 m/s
- ASI 2.22

Max. 0.050-s Average
- Longitudinal ..... −10.9 g
- Lateral ..... −17.6 g
- Vertical ..... 3.8 g

Post-Impact Trajectory
- Stopping Distance ..... 151 ft downstream 4 ft twd field side

Vehicle Stability
- Maximum Yaw Angle ..... 38°
- Maximum Pitch Angle ..... 10°
- Maximum Roll Angle ..... 16°
- Vehicle Snagging ..... No
- Vehicle Pocketing ..... No

Test Article Deflections
- Dynamic ..... 2.6 inches
- Permanent ..... 1.1 inches
- Working Width ..... 20.1 inches
- Height of Working Width ..... 32.6 inches

Vehicle Damage
- VDS 01RFQ5
- CDC 01FREW4
- Max. Exterior Deformation ..... 12.0 inches
- OCDI RF0010000
- Max. Occupant Compartment Deformation ..... 2.5 inches

Figure 6.6. Summary of Results for *MASH* Test 5-11 on MDTA Chesapeake Bay Bridge Steel Rail System.

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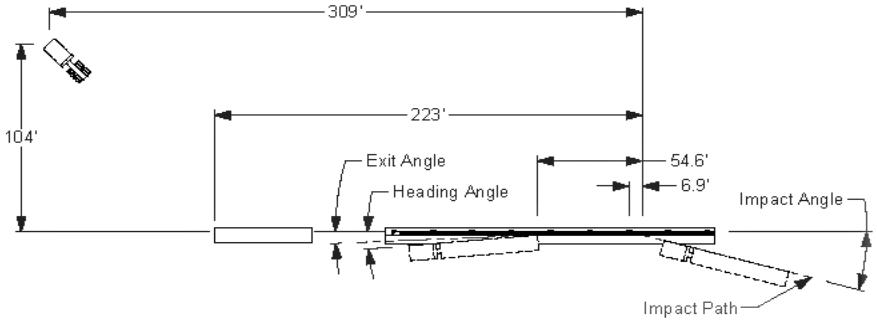
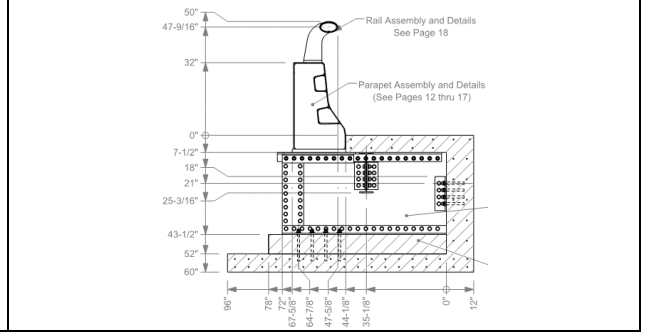




General Information
- Test Agency ..... Texas A&M Transportation Institute (TTI)
- Test Standard Test No. ..... MASH Test 5-12
- TTI Test No. 612861-02-4
- Test Date 2020-05-29

Test Article
- Type ..... Longitudinal Barrier—Bridge Rail
- Name ..... MDTA Chesapeake Bay Bridge Steel Rail
- Installation Length ..... System
- Material or Key Elements ... 171 ft 7 inches × $22^{3}/_{13}$ inches Four 40-ft 8-inch parapet assembly sections with rail assembly of 8-inch × 4⅞-inch elliptical tube held by short posts

Soil Type and Condition ..... 50⅝ inches above the pavement

Test Vehicle ..... Concrete bridge deck, dry
- Type/Designation .....
- Make and Model ..... 36000V 2013 International 8600 SBA6X4 with
- Curb ..... 1983 Lufkin 7FV-IPST trailer
- Test Inertial ..... 30,370 lb
- Dummy ..... 79,510 lb
- Gross Static ..... No dummy 79,510 lb

Impact Conditions
- Speed ..... 49.9 mi/h
- Angle ..... 15.0°
- Location/Orientation ..... 6.9 ft upstream of post 3

Impact Severity ..... 443 kip-ft

Exit Conditions
- Speed ..... Not attainable
- Trajectory/Heading Angle ... Along bridge rail

Occupant Risk Values
- Longitudinal OIV ..... 3.3 ft/s
- Lateral OIV ..... 14.8 ft/s
- Longitudinal Ridedown ..... 12.4 g
- Lateral Ridedown ..... 12.5 g
- THIV ..... 4.6 m/s
- ASI 1.0

Max. 0.050-s Average
- Longitudinal ..... −5.8 g
- Lateral ..... −6.8 g
- Vertical ..... 10.0 g

Post-Impact Trajectory
- Stopping Distance ..... 309 ft downstream 104 ft twd field side

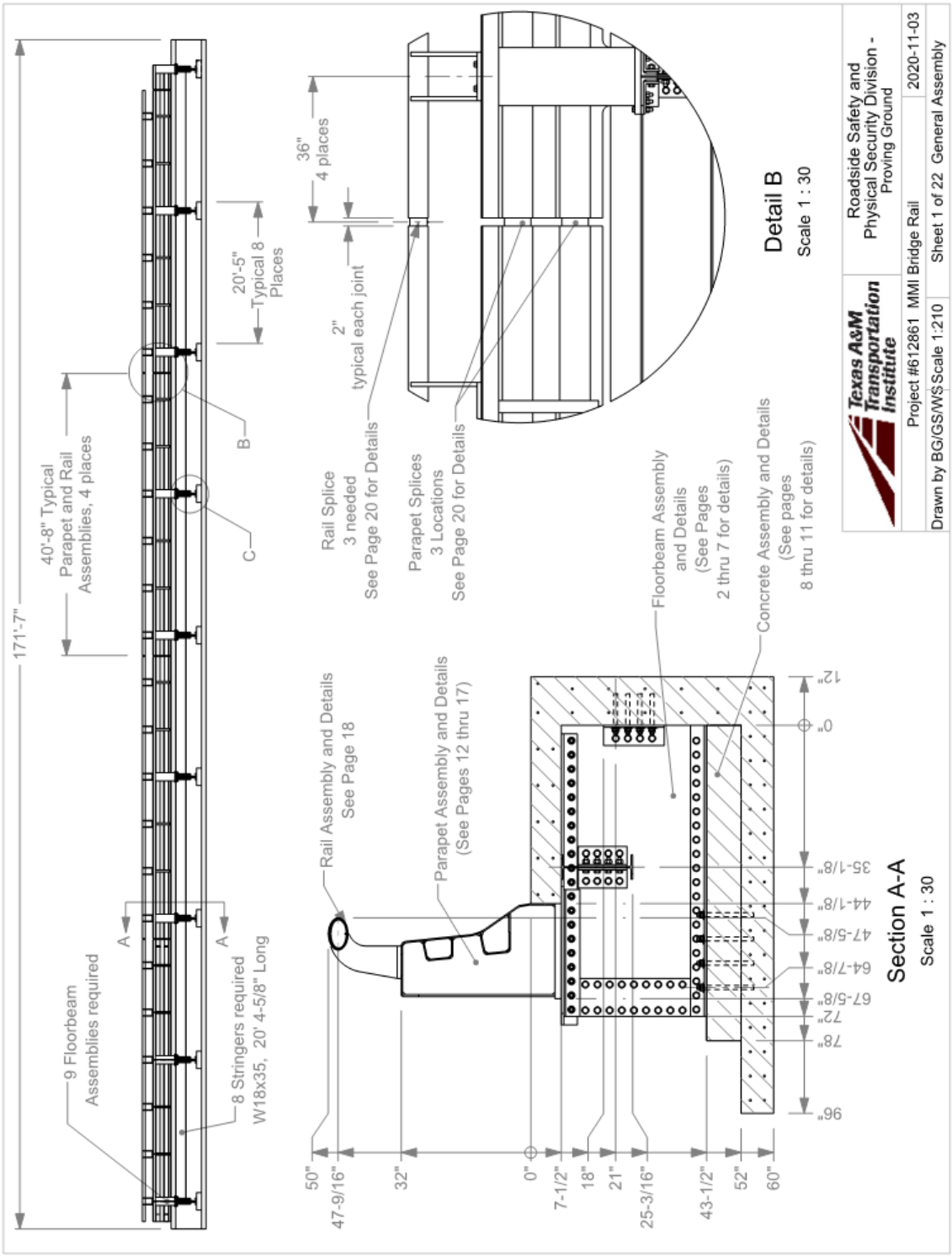
Vehicle Stability
- Maximum Yaw Angle ..... 20°
- Maximum Pitch Angle ..... 4°
- Maximum Roll Angle ..... 6°
- Vehicle Snagging ..... No
- Vehicle Pocketing ..... No

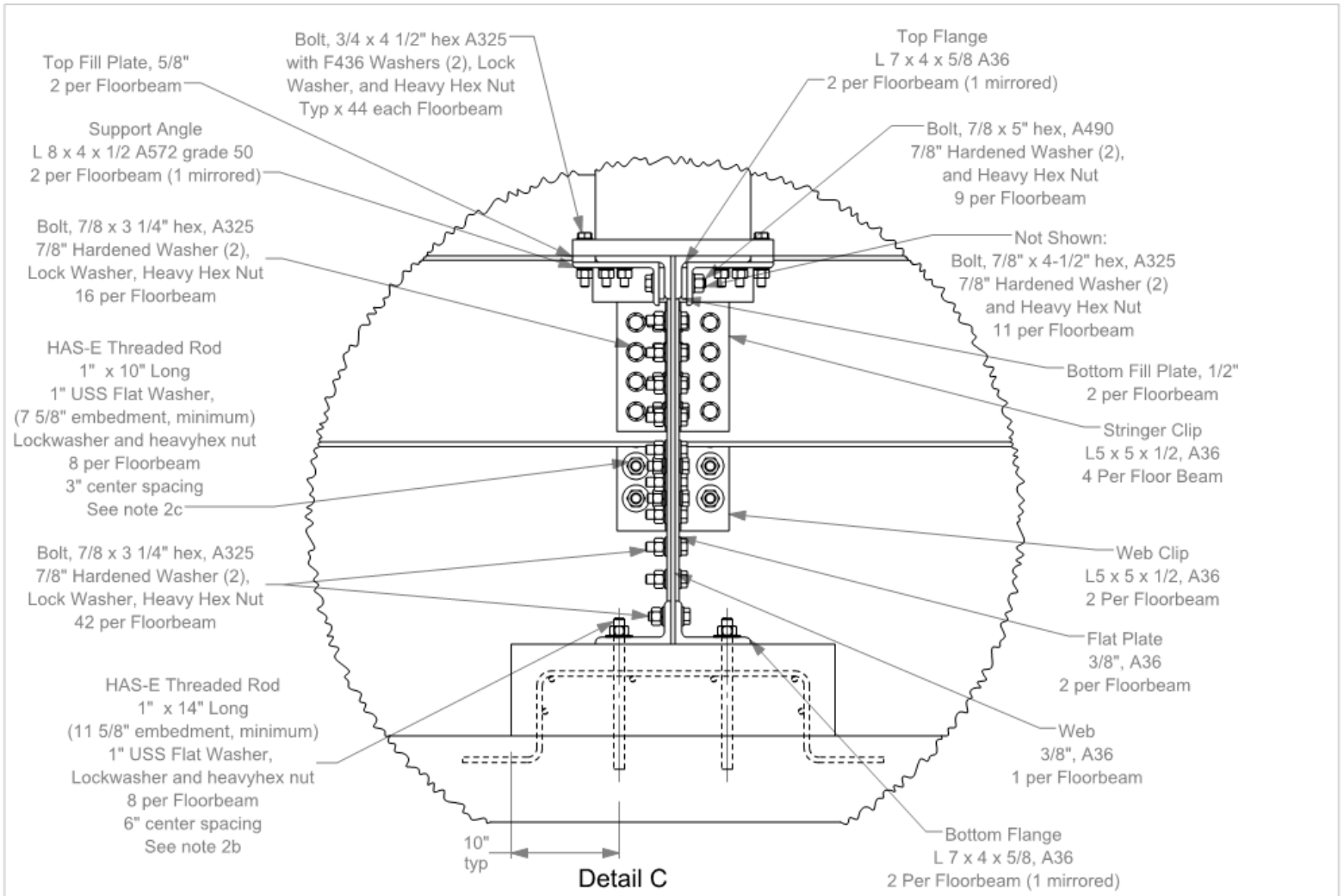
Test Article Deflections
- Dynamic ..... 3.0 inches
- Permanent ..... None measurable
- Working Width ..... 60.9 inches
- Height of Working Width ..... 138.3 inches

Vehicle Damage
- VDS ..... N/A
- CDC ..... N/A
- Max. Exterior Deformation ..... 19.0 inches
- OCDI ..... N/A
- Max. Occupant Compartment Deformation ..... 4.5 inches

Figure 8.8. Summary of Results for *MASH* Test 5-12 on MDTA Chesapeake Bay Bridge Steel Rail System.

APPENDIX A. DETAILS OF MDTA CHESAPEAKE BAY BRIDGE STEEL RAIL SYSTEM




Bolt, 3/4 x 4 1/2" hex A325
with F436 Washers (2), Lock
Washer, and Heavy Hex Nut
Typ x 44 each Floorbeam
Top Fill Plate, 5/8"
2 per Floorbeam
Top Flange
L 7 x 4 x 5/8 A36
2 per Floorbeam (1 mirrored)
Support Angle
L 8 x 4 x 1/2 A572 grade 50
2 per Floorbeam (1 mirrored)
Bolt, 7/8 x 5" hex, A490
7/8" Hardened Washer (2),
and Heavy Hex Nut
9 per Floorbeam
Bolt, 7/8 x 3 1/4" hex, A325
7/8" Hardened Washer (2),
Lock Washer, Heavy Hex Nut
16 per Floorbeam
Not Shown:
Bolt, 7/8" x 4-1/2" hex, A325
7/8" Hardened Washer (2)
and Heavy Hex Nut
11 per Floorbeam
HAS-E Threaded Rod
1" x 10" Long
1" USS Flat Washer,
(7 5/8" embedment, minimum)
Lockwasher and heavyhex nut
8 per Floorbeam
3" center spacing
See note 2c
Bottom Fill Plate, 1/2"
2 per Floorbeam
Stringer Clip
L5 x 5 x 1/2, A36
4 Per Floor Beam
Bolt, 7/8 x 3 1/4" hex, A325
7/8" Hardened Washer (2),
Lock Washer, Heavy Hex Nut
42 per Floorbeam
Web Clip
L5 x 5 x 1/2, A36
2 Per Floorbeam
Flat Plate
3/8", A36
2 per Floorbeam
HAS-E Threaded Rod
1" x 14" Long
(11 5/8" embedment, minimum)
1" USS Flat Washer,
Lockwasher and heavyhex nut
8 per Floorbeam
6" center spacing
See note 2b
Web
3/8", A36
1 per Floorbeam
10"
typ
Bottom Flange
L 7 x 4 x 5/8, A36
2 Per Floorbeam (1 mirrored)
Detail C
Floorbeam, 9 required
2a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted
2b. All Anchors in concrete to be epoxied in using HIT-RE 500 V3, with Hilti instructions.
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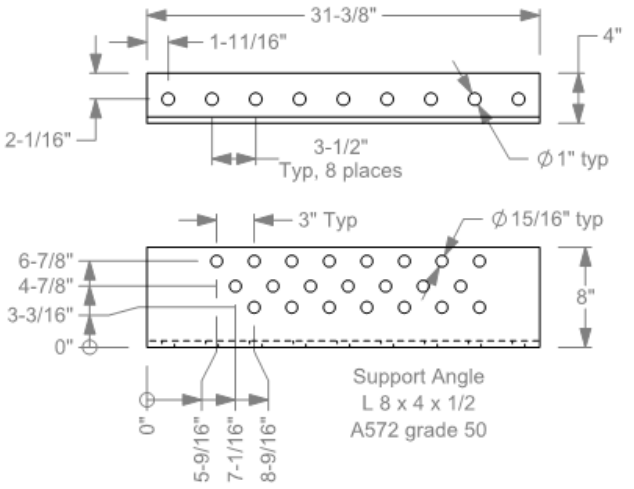
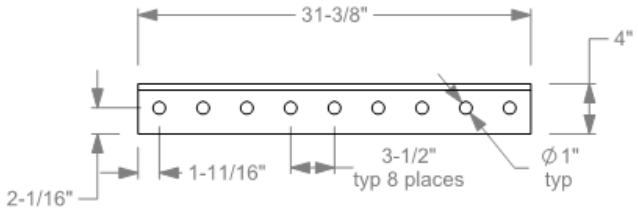
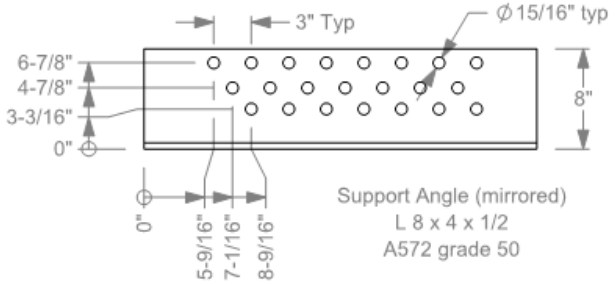
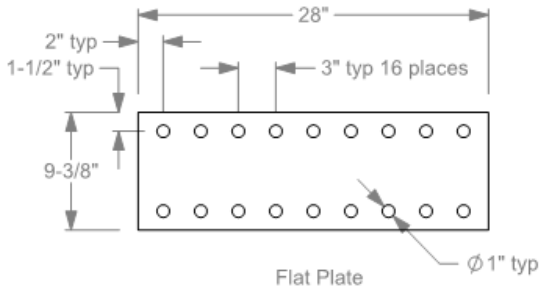
Drawn by BG/GS/WS
Scale 1:12
Sheet 2 of 22 Floorbeam Assembly

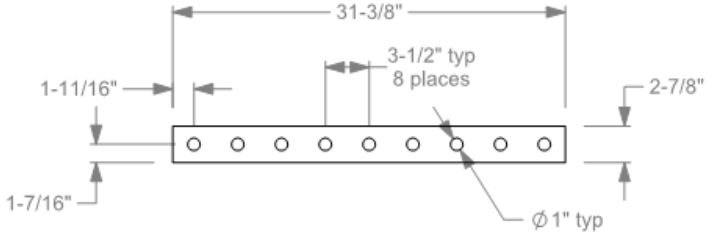




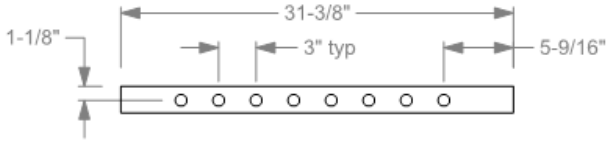




Flat Plate
3/8", A36
2 Needed per Floorbeam



Bottom Fill Plate, 1/2"
A709 grade 50
2 Needed per Floorbeam



Top Fill Plate, 2 1/8" x 5/8"
A709 grade 50
2 Needed per Floorbeam

3a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted

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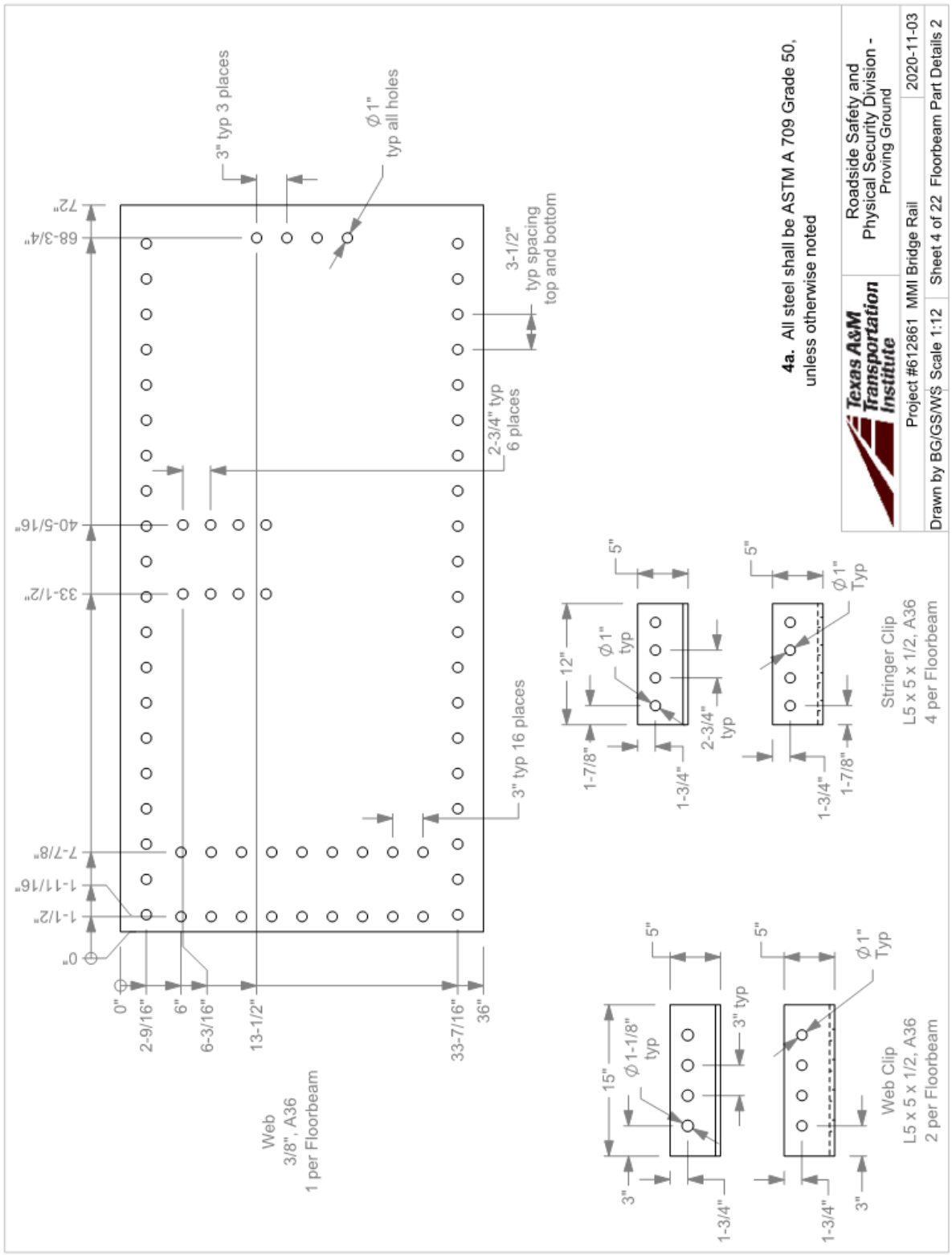
4a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted
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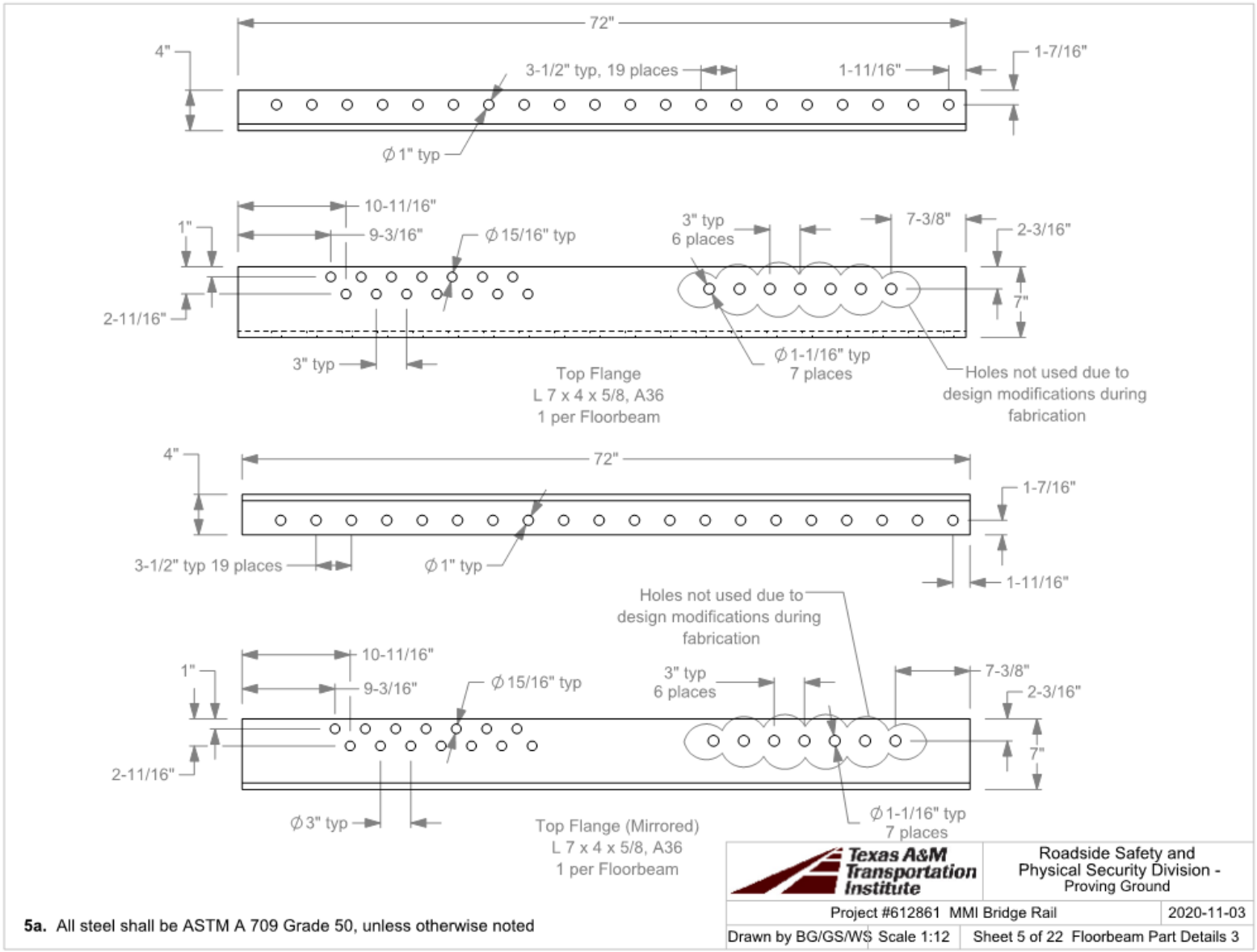
Drawn by BG/GS/WS Scale 1:12
Sheet 4 of 22 Floorbeam Part Details 2
3" typ 3 places
Ø 1" typ all holes
3-1/2" typ spacing top and bottom
2-3/4" typ 6 places
3" typ 16 places
72"
68-3/4"
40-5/16"
33-1/2"
7-7/8"
1-11/16"
1-1/2"
0"
0"
2-9/16"
6"
6-3/16"
13-1/2"
33-7/16"
36"
Web 3/8", A36 1 per Floorbeam
12"
Ø 1" typ
5"
1-7/8"
1-3/4"
2-3/4" typ
Ø 1" Typ
Stringer Clip L5 x 5 x 1/2, A36 4 per Floorbeam
15"
Ø 1-1/8" typ
3" typ
3"
Web Clip L5 x 5 x 1/2, A36 2 per Floorbeam


72"
4"
3-1/2" typ, 19 places
1-11/16"
1-7/16"
Ø1" typ
10-11/16"
1"
9-3/16"
Ø15/16" typ
3" typ
6 places
7-3/8"
2-3/16"
2-11/16"
7"
3" typ
Ø1-1/16" typ
7 places
Top Flange
L 7 x 4 x 5/8, A36
1 per Floorbeam
Holes not used due to
design modifications during
fabrication
4"
72"
1-7/16"
3-1/2" typ 19 places
Ø1" typ
1-11/16"
Holes not used due to
design modifications during
fabrication
10-11/16"
1"
9-3/16"
Ø15/16" typ
3" typ
6 places
7-3/8"
2-3/16"
2-11/16"
7"
Ø3" typ
Ø1-1/16" typ
7 places
Top Flange (Mirrored)
L 7 x 4 x 5/8, A36
1 per Floorbeam
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Physical Security Division -
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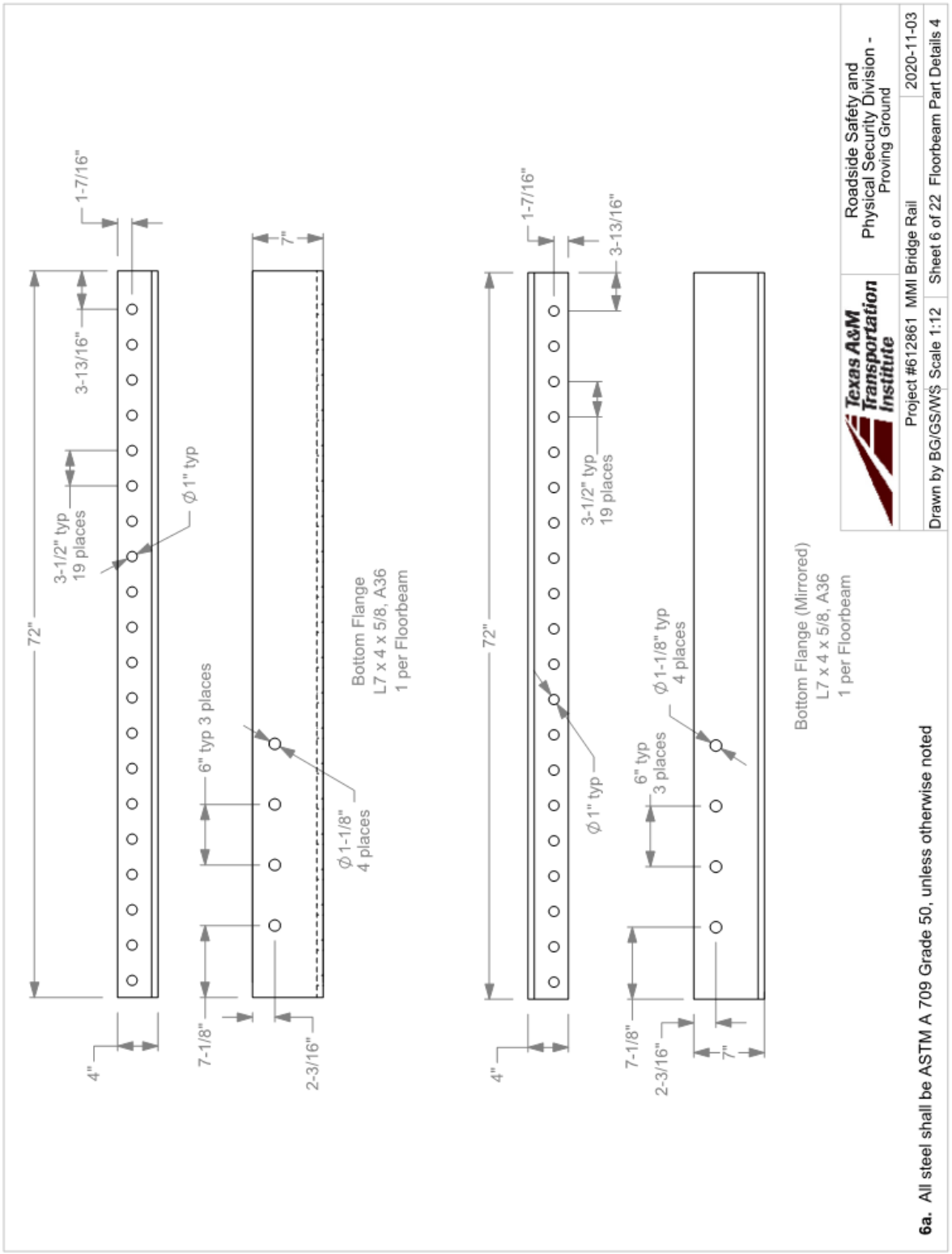
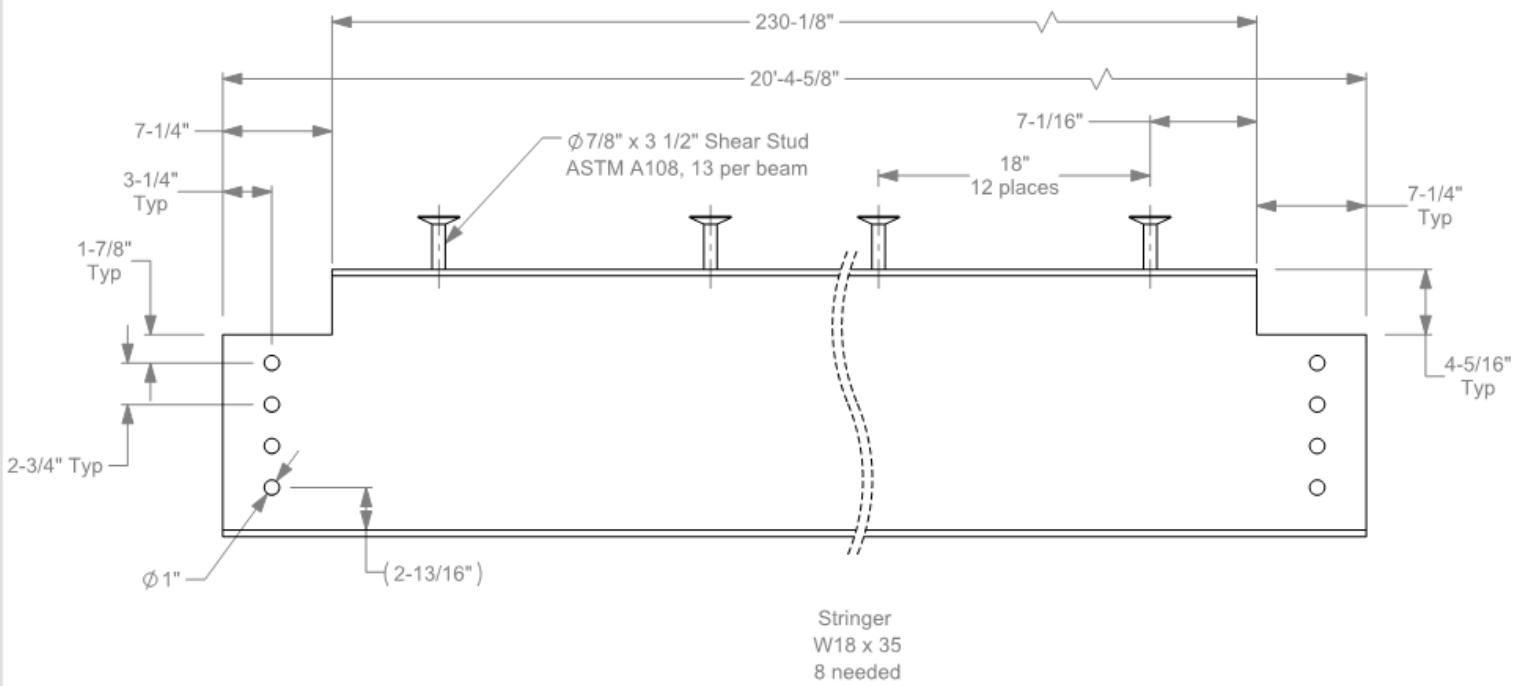
Drawn by BG/GS/WS Scale 1:12
Sheet 5 of 22 Floorbeam Part Details 3
5a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted



6a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted

Stringer Detail



7a. All steel shall be ASTM A572 Grade 50, unless otherwise noted

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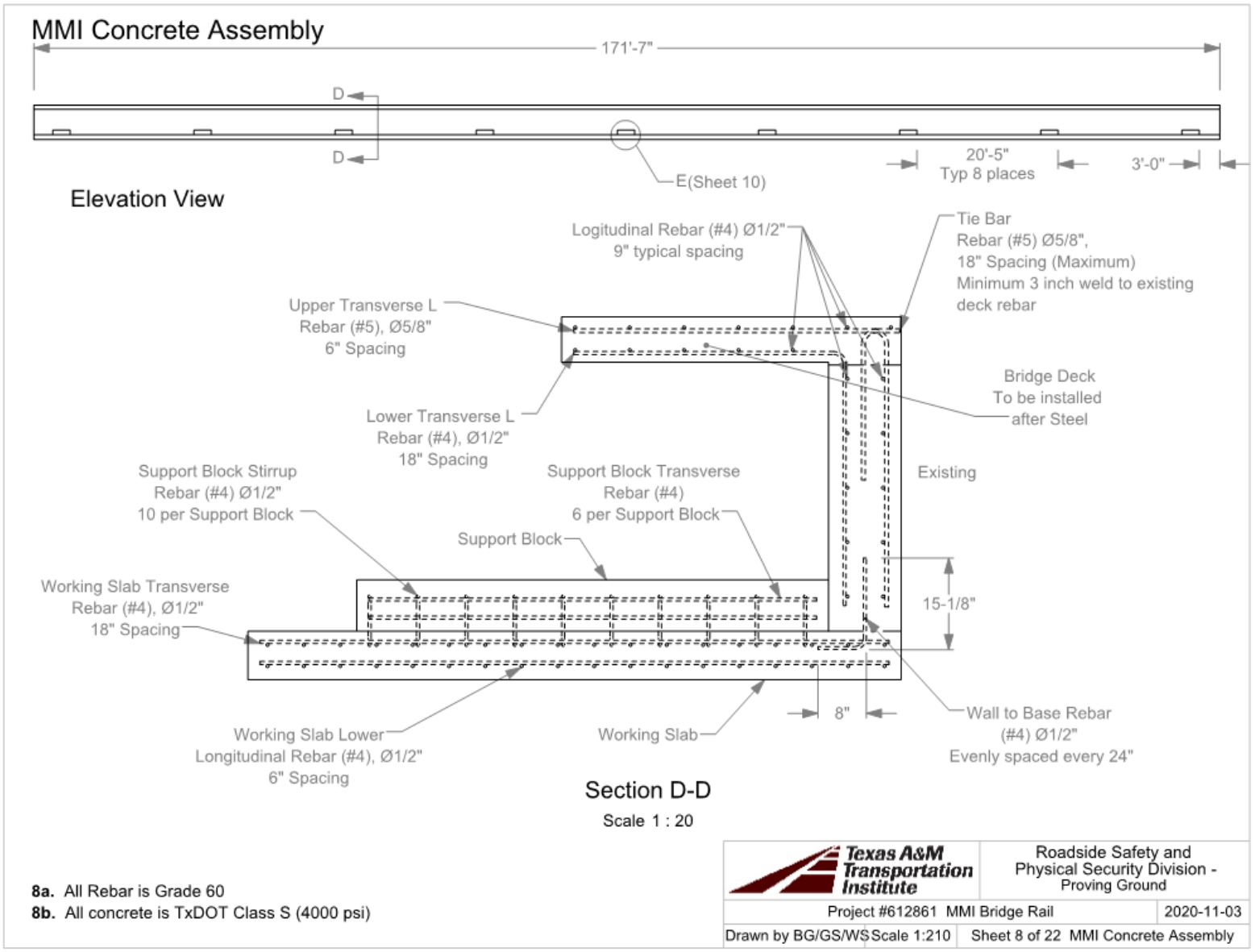
Drawn by BG/GS/WS Scale 1:10	Sheet 7 of 22 Stringer Detail	



8a. All Rebar is Grade 60
8b. All concrete is TxDOT Class S (4000 psi)

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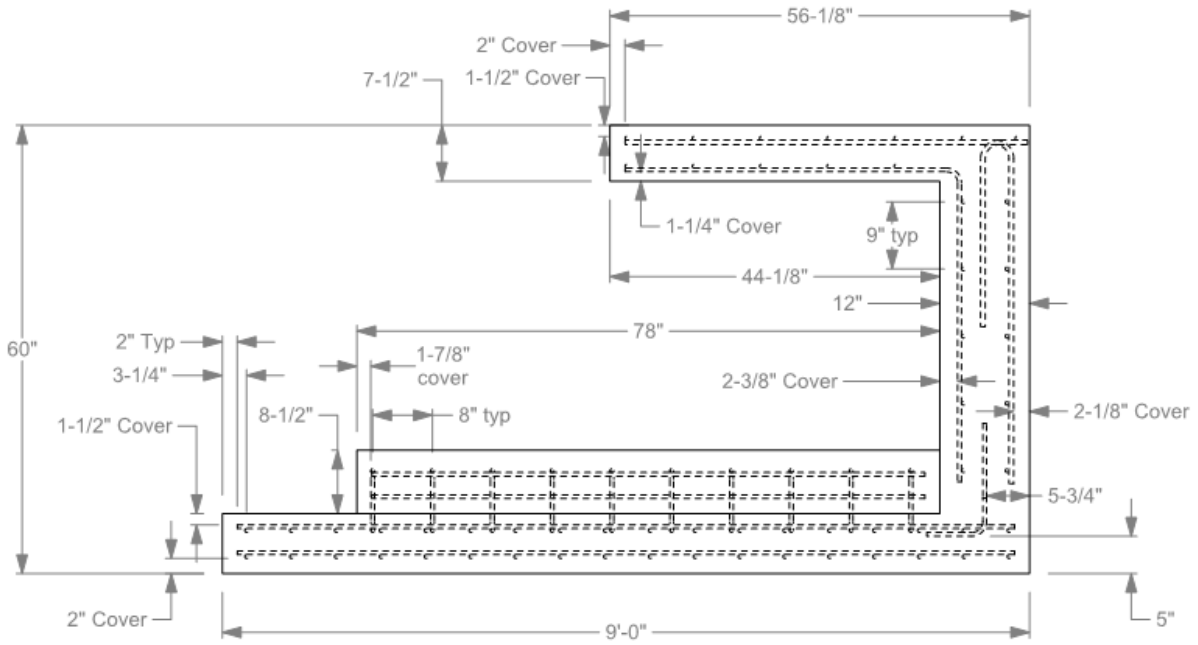
Drawn by BG/GS/WS	Scale 1:210	Sheet 8 of 22 MMI Concrete Assembly

Concrete Dimensional Details



9a. All Rebar is Grade 60
9b. All concrete is TxDOT Class S (4000 psi)

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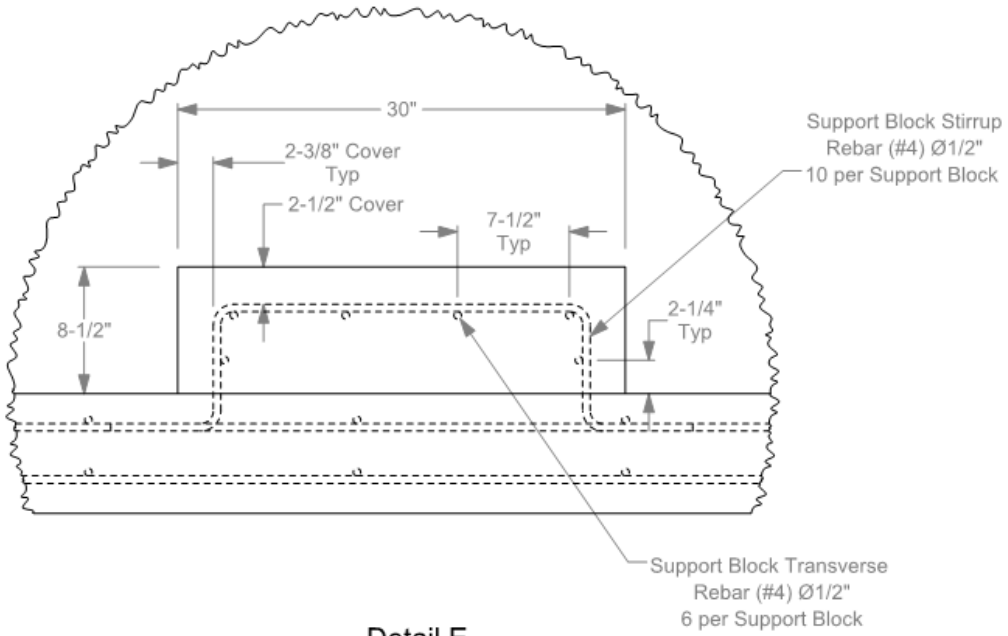
Drawn by BG/GS/WS	Scale 1:20	Sheet 9 of 22 Concrete Dim. Details

Support Block Detail



Detail E
Support Block Detail
Typical 9 locations

10a. All Rebar is Grade 60
10b. All concrete is TxDOT Class S (4000 psi)

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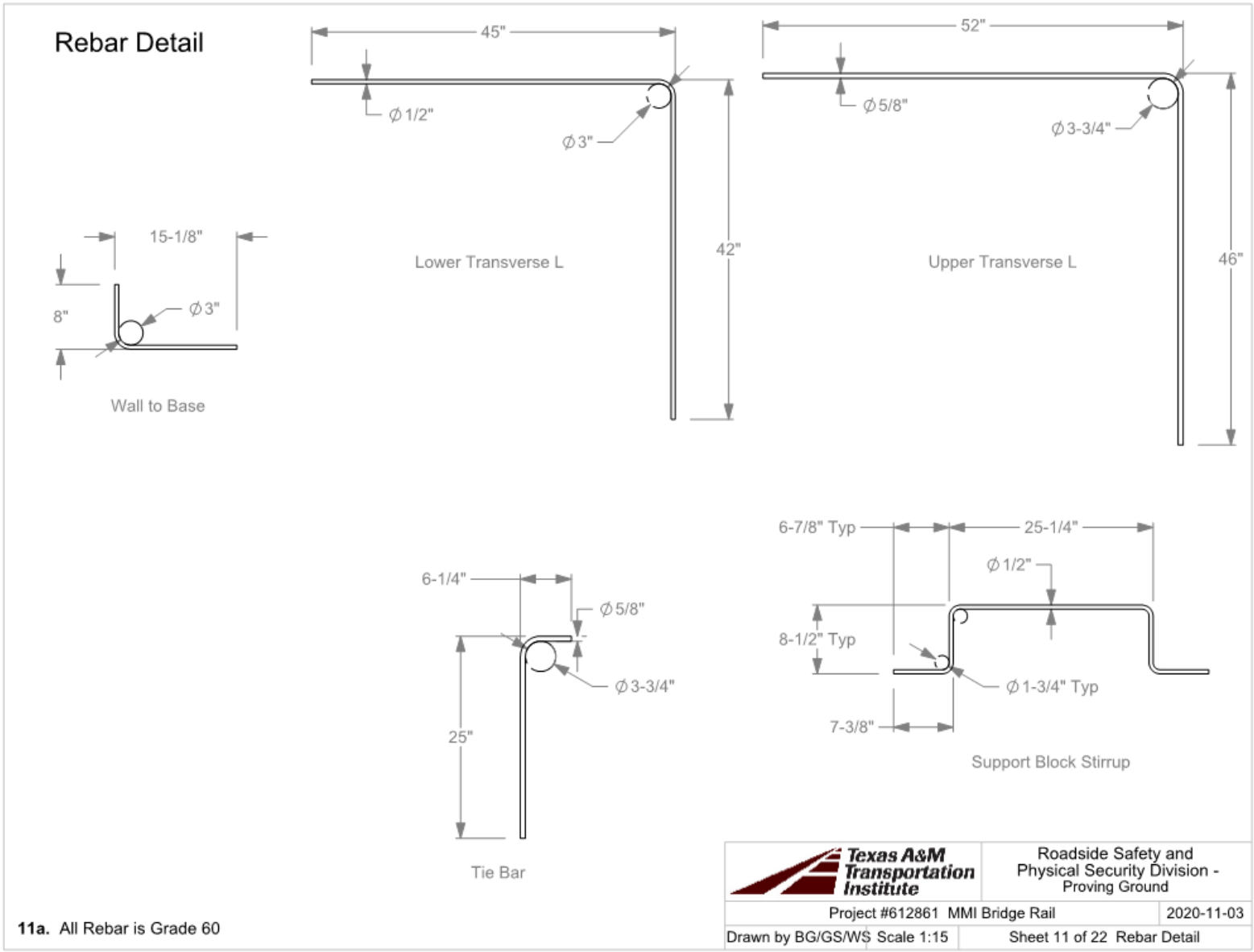
Drawn by BG/GS/WS	Scale 1:10	Sheet 10 of 22 Support Block Detail


Rebar Detail
45"
Ø1/2"
Ø3"
42"
Lower Transverse L
52"
Ø5/8"
Ø3-3/4"
46"
Upper Transverse L
15-1/8"
8"
Ø3"
Wall to Base
6-1/4"
Ø5/8"
Ø3-3/4"
25"
Tie Bar
6-7/8" Typ
25-1/4"
Ø1/2"
8-1/2" Typ
Ø1-3/4" Typ
7-3/8"
Support Block Stirrup
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Roadside Safety and Physical Security Division - Proving Ground
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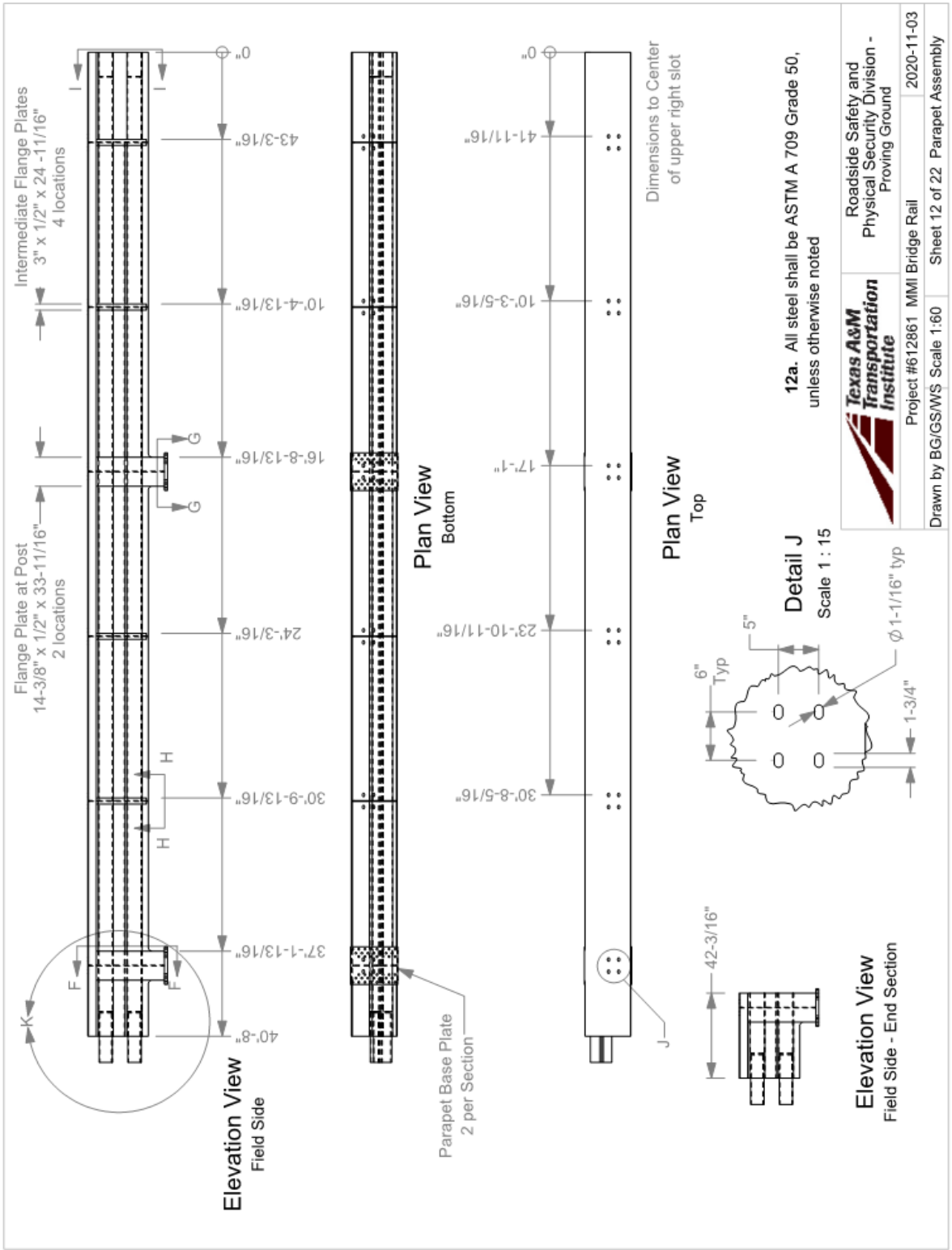
Drawn by BG/GS/WS Scale 1:15
Sheet 11 of 22 Rebar Detail
11a. All Rebar is Grade 60


Intermediate Flange Plates
3" x 1/2" x 24 -11/16"
4 locations
Flange Plate at Post
14-3/8" x 1/2" x 33-11/16"
2 locations
0"
43-3/16"
10'-4-13/16"
16'-8-13/16"
24'-3/16"
30'-9-13/16"
37'-1-13/16"
40'-8"
Elevation View
Field Side
Plan View
Bottom
Parapet Base Plate
2 per Section
Plan View
Top
Dimensions to Center
of upper right slot
41-11/16"
10'-3-5/16"
17'-1"
23'-10-11/16"
30'-8-5/16"
J
42-3/16"
Elevation View
Field Side - End Section
Detail J
Scale 1 : 15
6" Typ
5"
Ø 1-1/16" typ
1-3/4"
12a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted
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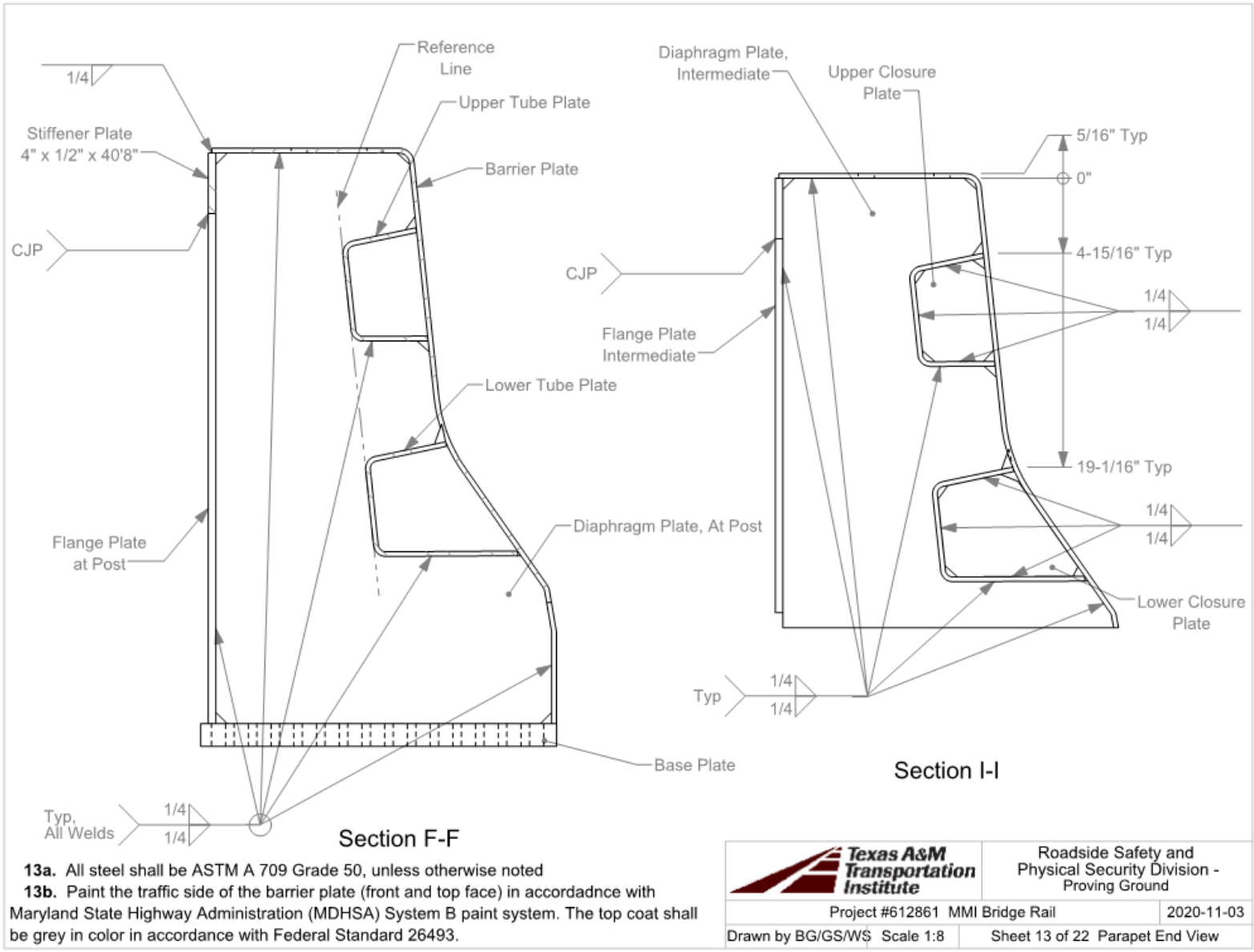
Drawn by BG/GS/WS Scale 1:60
Sheet 12 of 22 Parapet Assembly



13a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted

13b. Paint the traffic side of the barrier plate (front and top face) in accordadnce with Maryland State Highway Administration (MDHSA) System B paint system. The top coat shall be grey in color in accordance with Federal Standard 26493.

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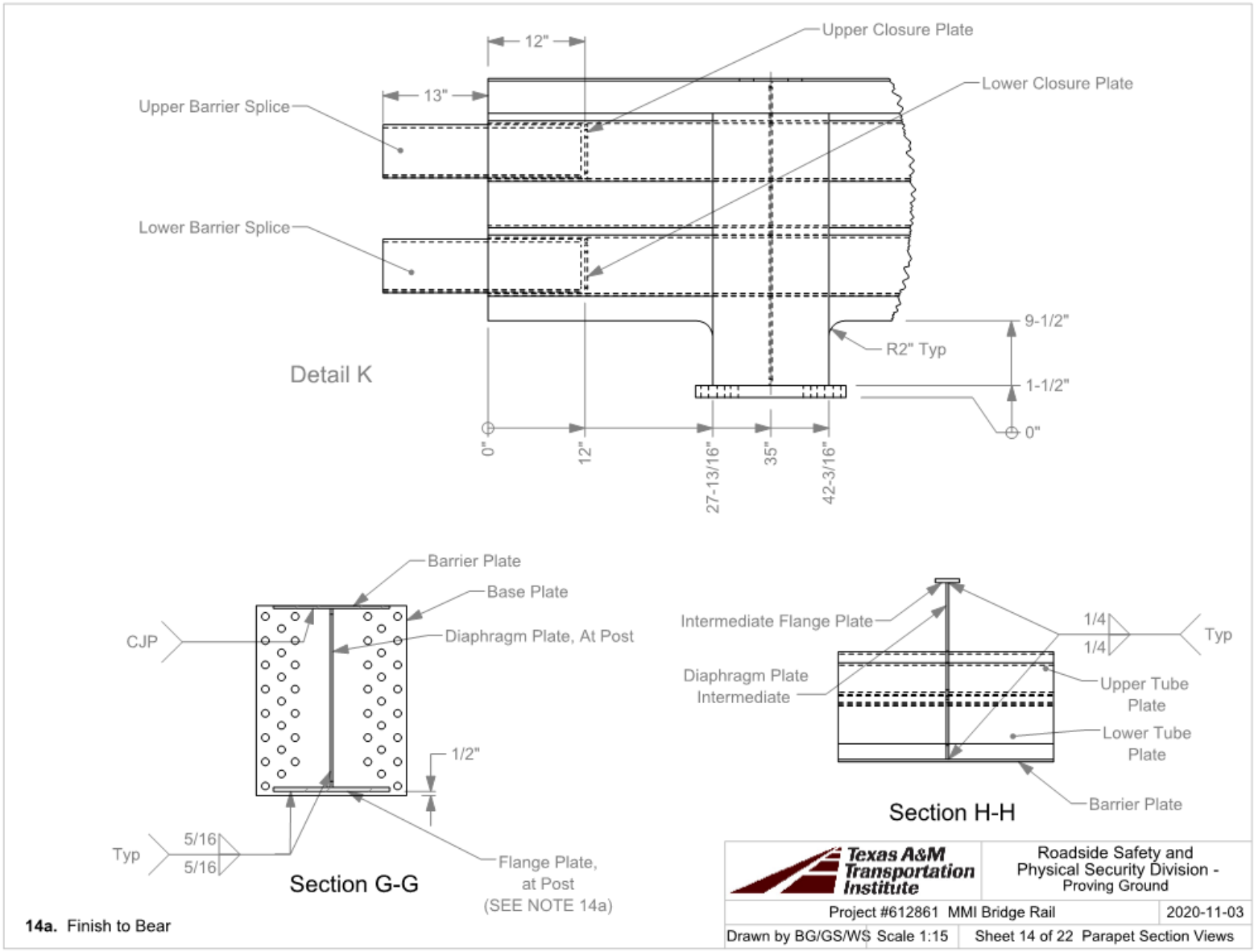
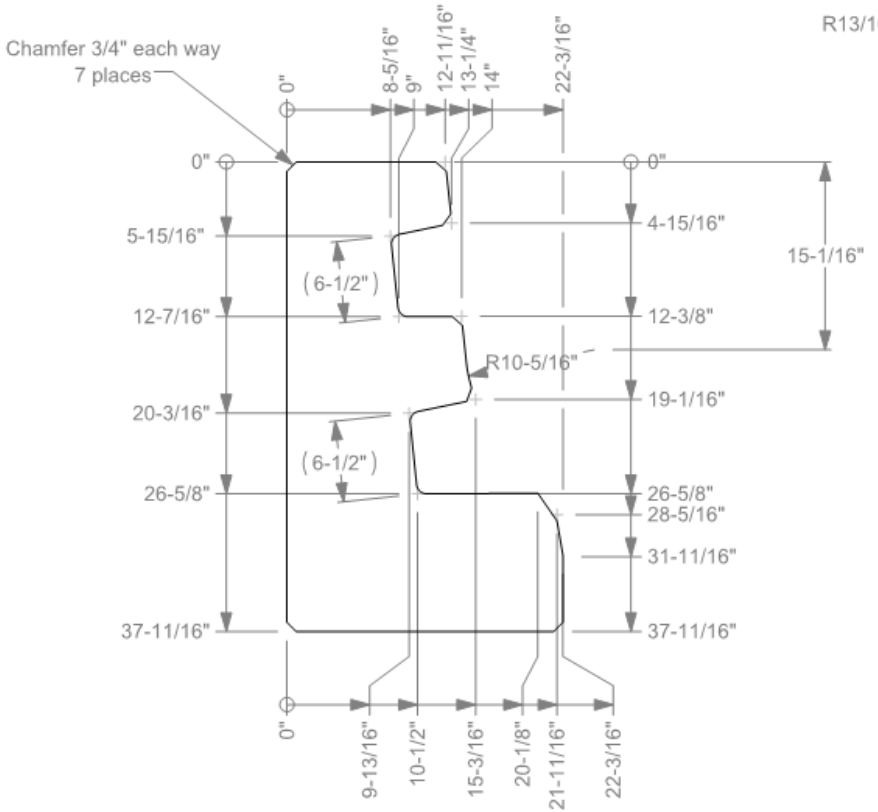
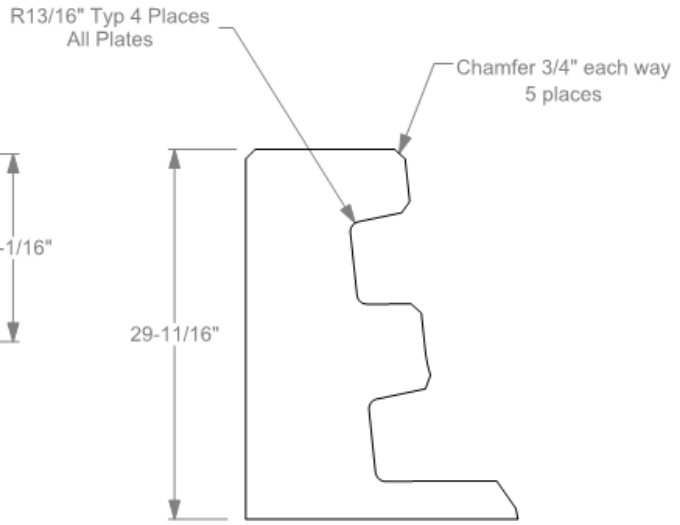
Drawn by BG/GS/W$ Scale 1:8	Sheet 13 of 22 Parapet End View	



14a. Finish to Bear



Diaphragm Plate at Post
3/8" Plate, 2 Per Section



Diaphragm Plate, Intermediate
3/8" Plate, 4 Per Section

See Note 15b

15a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted
15b. See Diaphragm at Post for Dimensional details

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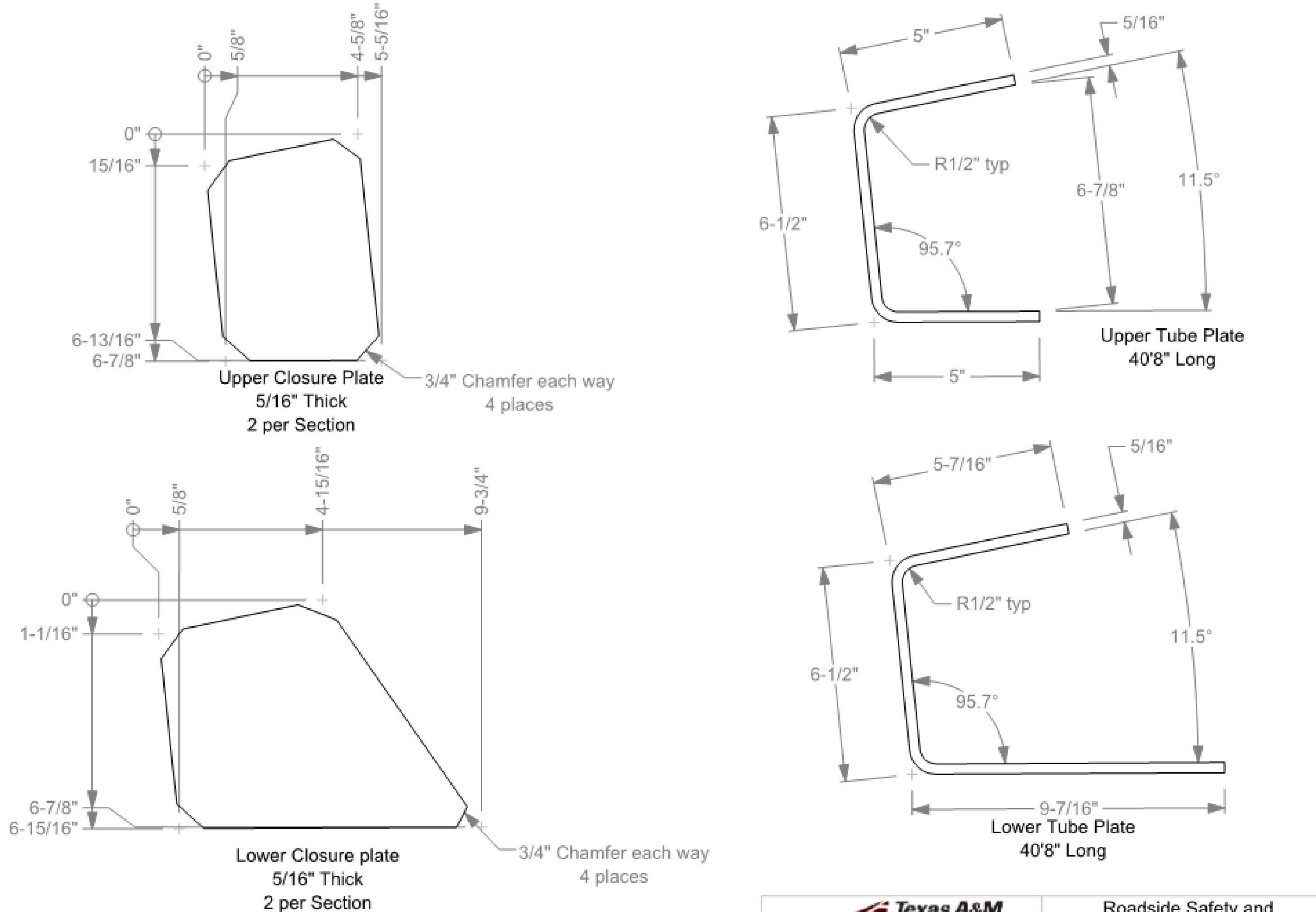
Drawn by BG/GS/WS	Scale 1:12	Sheet 15 of 22 Parapet Part Details 1



16a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted

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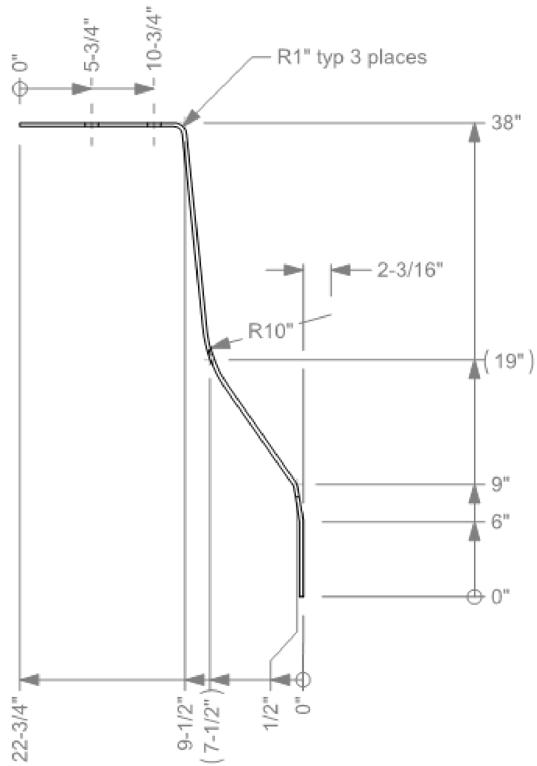
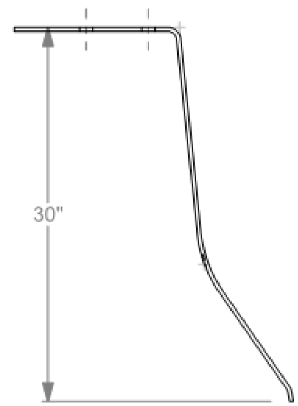
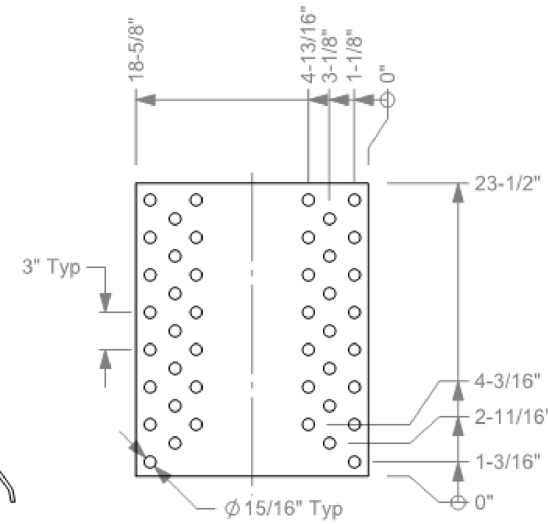


Barrier Plate, at Post
5/16" Thick
40' 8" long



Barrier Plate, away from posts
5/16" Thick, Dimensions identical
to those of Barrier Plate at Post
Unless noted otherwise



Base Plate
Plate, 18 5/8" x 1 1/2"
A709 grade 50
2 per Section

17a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted

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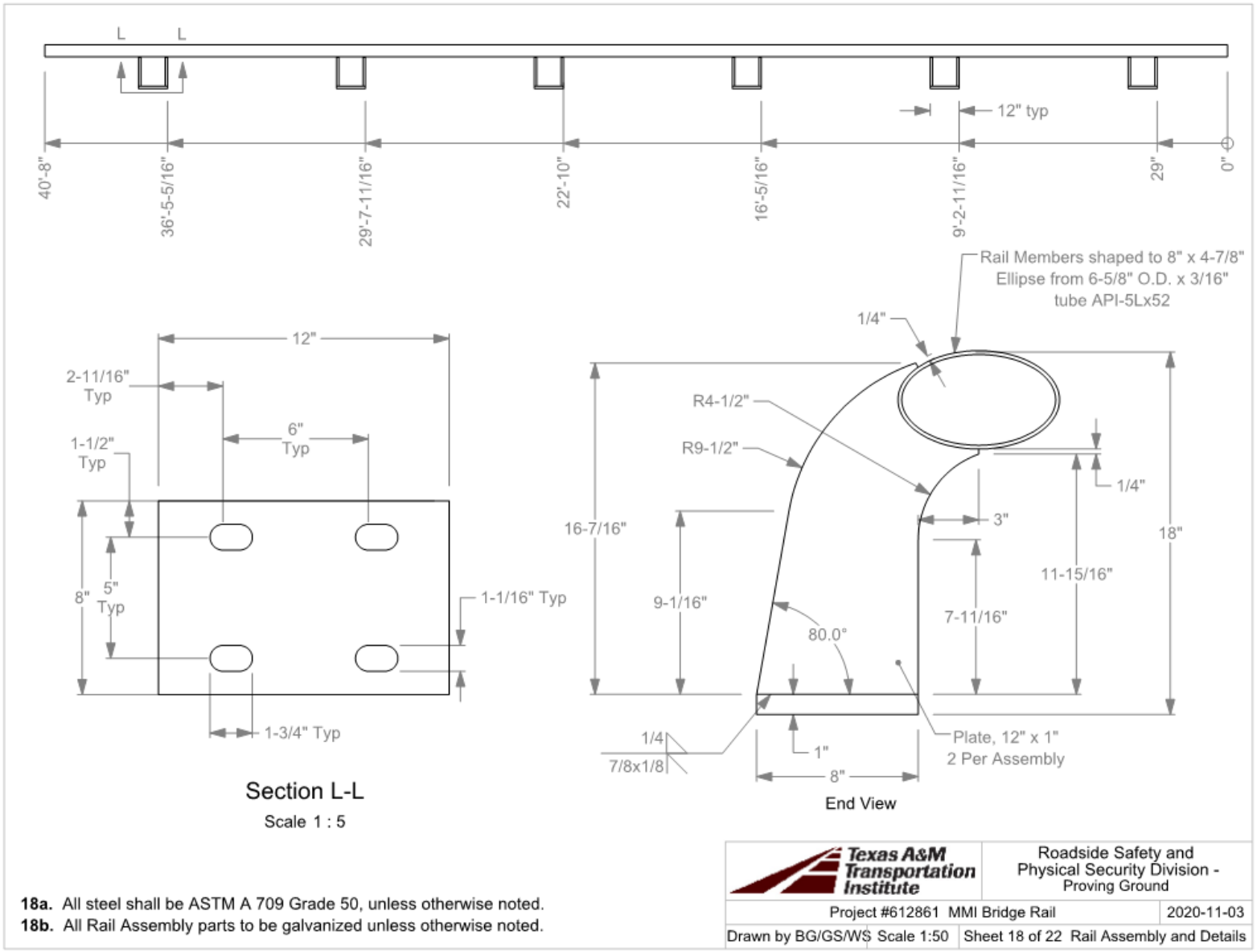
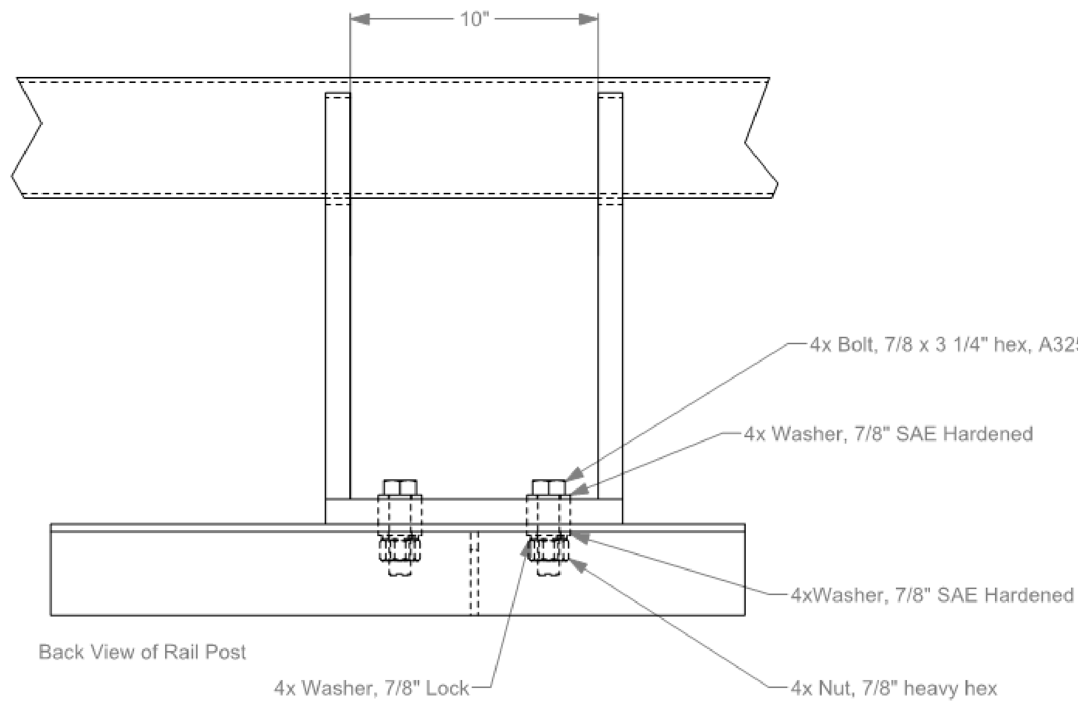


18a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.
18b. All Rail Assembly parts to be galvanized unless otherwise noted.



Back View of Rail Post

19a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.
19b. All Rail Assembly parts to be galvanized unless otherwise noted.

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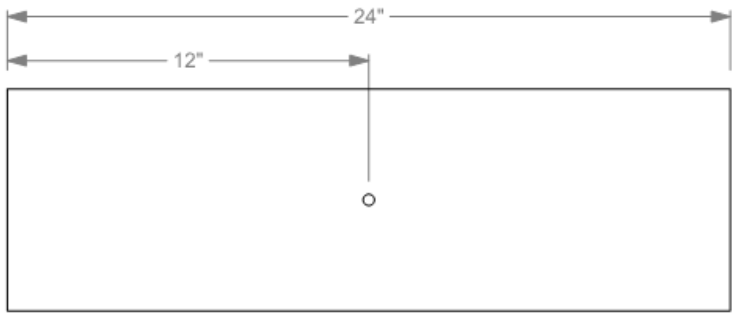
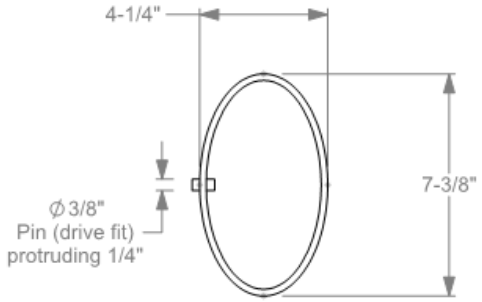
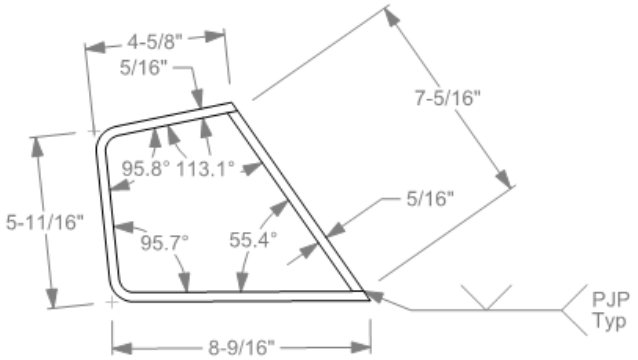
Drawn by BG/GS/WS	Scale 1:6	Sheet 19 of 22 Rail Post details



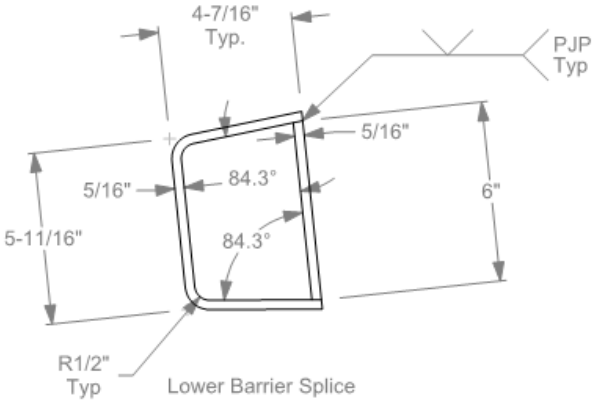
Rail Splice
3/16" tube API-5Lx52, galvanized
1 required per joint



End View



Upper Barrier Splice
24" Long
1 required per joint



Lower Barrier Splice
24" Long
1 required per joint

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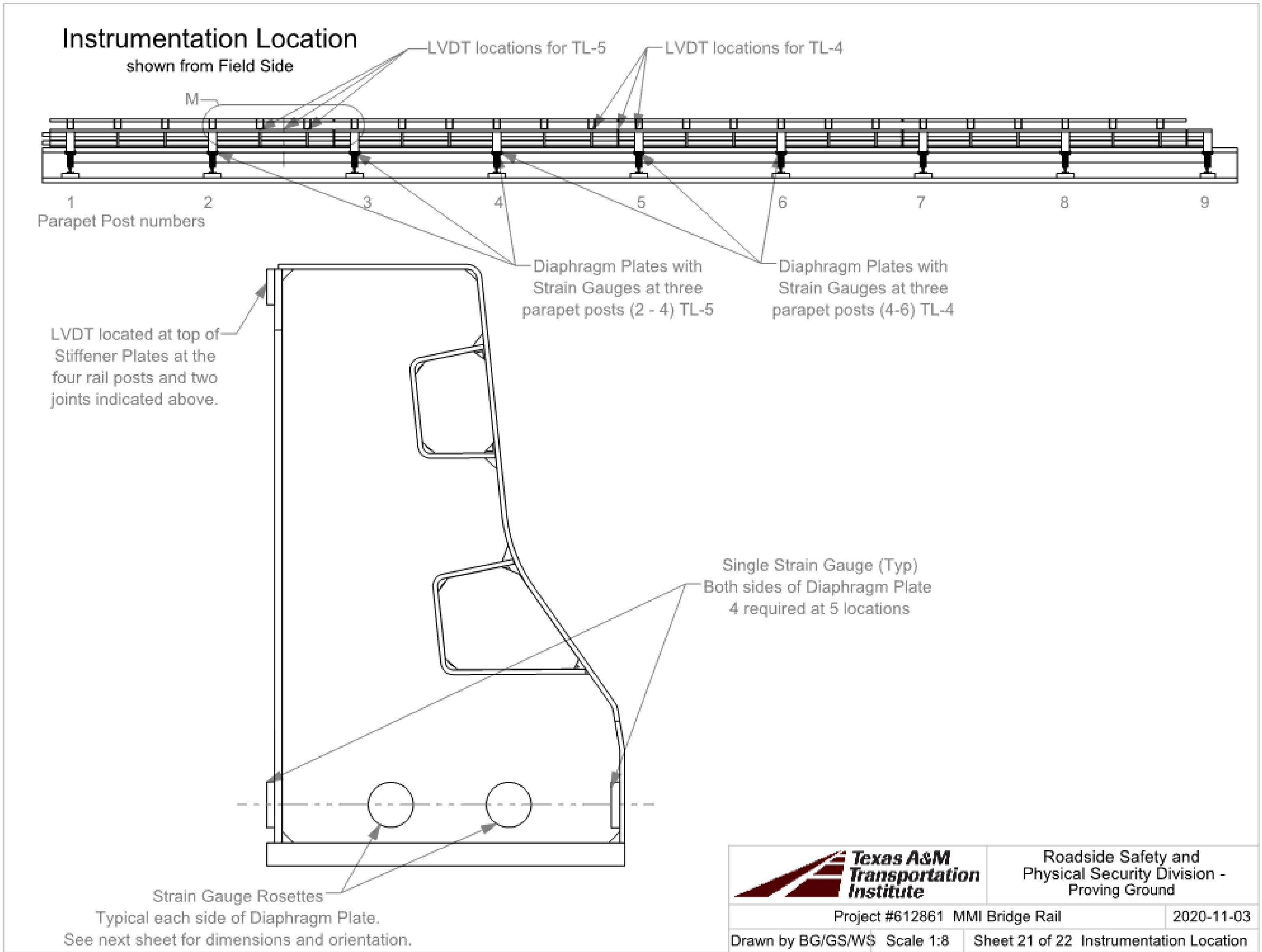
20a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted


Instrumentation Location
shown from Field Side
LVDT locations for TL-5
LVDT locations for TL-4
M
1
2
3
4
5
6
7
8
9
Parapet Post numbers
Diaphragm Plates with Strain Gauges at three parapet posts (2 - 4) TL-5
Diaphragm Plates with Strain Gauges at three parapet posts (4-6) TL-4
LVDT located at top of Stiffener Plates at the four rail posts and two joints indicated above.
Single Strain Gauge (Typ) Both sides of Diaphragm Plate 4 required at 5 locations
Strain Gauge Rosettes Typical each side of Diaphragm Plate. See next sheet for dimensions and orientation.
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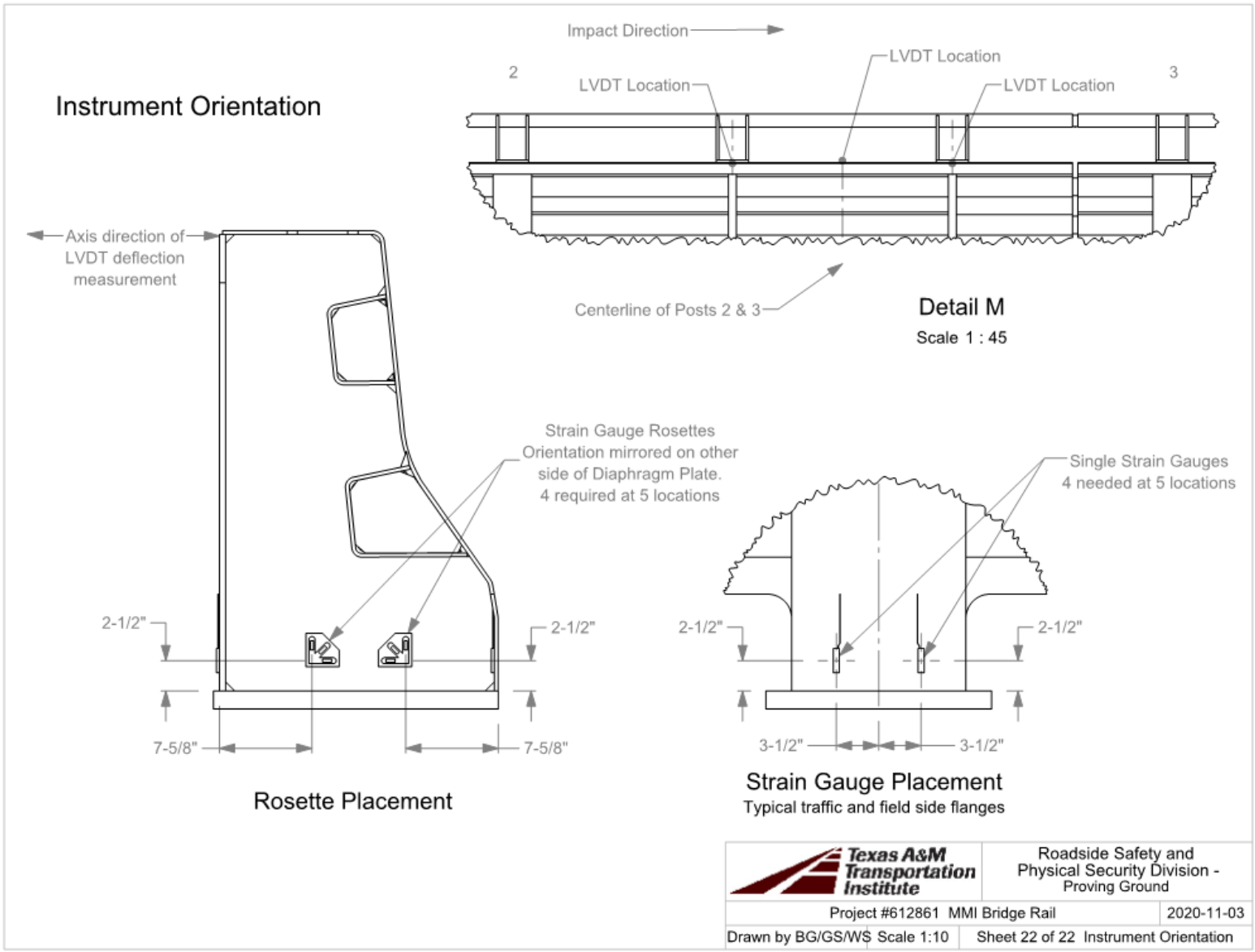
Scale 1:8
Sheet 21 of 22 Instrumentation Location


Instrument Orientation
Impact Direction
2
3
LVDT Location
LVDT Location
LVDT Location
Centerline of Posts 2 & 3
Detail M
Scale 1 : 45
Axis direction of LVDT deflection measurement
Strain Gauge Rosettes Orientation mirrored on other side of Diaphragm Plate. 4 required at 5 locations
2-1/2"
2-1/2"
7-5/8"
7-5/8"
Rosette Placement
Single Strain Gauges 4 needed at 5 locations
2-1/2"
2-1/2"
3-1/2"
3-1/2"
Strain Gauge Placement
Typical traffic and field side flanges
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Project #612861 MMI Bridge Rail
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Drawn by BG/GS/WS Scale 1:10
Sheet 22 of 22 Instrument Orientation