



U.S. Department
of Transportation
**Federal Highway
Administration**

February 22, 2021

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

In Reply Refer To:
HSST-1/B-355

Karla Lechtenberg
Midwest Roadside Safety Facility
130 Whittier Research Center
2200 Vine Street
Lincoln, NE 68583-0853
USA

Dear Ms. Lechtenberg:

This letter is in response to your October 30, 2020 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-355 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:

- Culvert-Mounted Strong-Post MGS

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: Culvert-Mounted Strong-Post MGS
Type of system: Longitudinal Barrier
Test Level: TL3
Testing conducted by: Midwest Roadside Safety Facility
Date of request: October 30, 2020

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

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-355 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: | October 30, 2020 | <input checked="" type="radio"/> New <input type="radio"/> Resubmission |
| | Name: | Karla Lechtenberg | |
| | Company: | Midwest Roadside Safety Facility | |
| | Address: | 130 Whittier Research Center, 2200 Vine Street, Lincoln, NE 68583-0853 | |
| | 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 | <input checked="" type="radio"/> Physical Crash Testing <input type="radio"/> Engineering Analysis | Culvert-Mounted, Strong-Post MGS | AASHTO MASH | TL3 |

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: | Karla Lechtenberg | Same as Submitter <input checked="" type="checkbox"/> |
| Company Name: | Midwest Roadside Safety Facility | Same as Submitter <input checked="" type="checkbox"/> |
| Address: | 130 Whittier Research Center, 2200 Vine Street, Lincoln, NE 68583-0853 | Same as Submitter <input checked="" type="checkbox"/> |
| Country: | USA | Same as Submitter <input checked="" type="checkbox"/> |

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

The Midwest Roadside Safety Facility (MwRSF) and its employees are requesting a letter of eligibility on behalf of the state departments of transportation participating in the Midwest States Pooled Fund Program.

MwRSF's financial interests are as follows:

- (i) No compensation, including wages, salaries, commissions, professional fees, or fees for business referrals;
- (ii) Consulting relationships consist of answering design and implementation questions;
- (iii) Research funding or other forms of research support include continuing to fund research projects with MwRSF;
- (iv) No patents, copyrights, or other intellectual property interests for this system;
- (v) No licenses or contractual relationships for this system; and
- (vi) No business ownership and investment interests for this system.

PRODUCT DESCRIPTION

Help

- New Hardware or Significant Modification
 Modification to Existing Hardware

The Culvert-Mounted, Strong-Post MGS consisted of a modified design of the Midwest Guardrail System (MGS) for installation on a low-fill culvert with a strong-post attachment to the culvert, half-post spacing, and a 12-in. offset from the back of the post to the culvert headwall. A 43 ft – 4 in. long, four-cell, concrete culvert was constructed at the center of the system. The maximum dimensions of the culvert’s top slab were 60 in. wide and 8 in. thick with a 10-in. wide x 9-in. high headwall positioned flush with the backside of the top slab.

The Midwest Guardrail System (MGS) consists of standard 12-gauge W-beam sections (RWM04a) installed with the top of the rail set at a nominal height of 31 inches. The rail is mounted on W6x9 ASTMA992 steel posts that are 40½ in. long and are anchored to the top of the concrete culvert using welded steel plates. A ½-in. thick x 8½-in. wide x 12-in. long ASTMA572 steel plate was welded to the bottom of each post. In order to fully develop the connection between the base plate and the W6x9 post sections, a special weld detail was utilized that incorporated a 3-pass, 5/16-in. fillet weld on the front flange of the post and a ¼-in. fillet weld on the web and back flange of the post. These posts anchored to the top concrete slab using four 1-in. diameter by 10½-in. long ASTMA307 hex head bolts were placed through each top base plate and the concrete deck and were held in place with 8½-in. wide x 12-in. long x ¼-in. thick steel washer plates below the top slab. Note that the one-piece washer plate below the top slab used for testing could be replaced by individual 3½-in. wide x 3½-in. long x ¼-in. square washer plates if desired.


The backside of the posts was positioned 12 in. away from the culvert’s headwall. The posts are set at 37½-in. centers and were embedded 9 in. in the soil. A 6-in. x 12-in. x 14½-in. wood blockout (PDB10a-b) is used to block the rail away from the front face of each steel post. The rails splices are located at mid-spans between adjacent posts. Standard guardrail bolts or ASTMA307 5/8-in. diameter x 14-in. long guardrail bolts and nuts (FBB06) are used to attach the rail to the posts. Galvanized ASTMA992 steel W6x8.5 sections measuring 72 in. long and embedded 40 in. were placed upstream and downstream of the culvert system. Five posts adjacent to the upstream end and six posts adjacent to the downstream end were set at half-post spacing. The remaining post on the upstream and downstream ends of the system are set at 75-in. centers.

For the transition from half-post spacing MGS to culvert-mounted MGS, a separate transition system is not necessary, because the resistance of the culvert-mounted posts and the posts embedded 40 in. in soil were found very similar through component-level bogie tests. For the transition from standard MGS to the culvert-mounted MGS, at least five posts embedded 40 in. in soil at half-post spacing are recommended to be installed both upstream and downstream from the culvert-mounted posts. For the transition from the standard MGS and half-post spacing MGS, no additional stiffness transition is required, as this transition has been successfully tested during a previous similar test, test no. MWTSP-2.

For further information on implementation guidance for culvert slab thicknesses, embedment of the posts attached to the culvert, offsets for the posts attached to the culvert, headwall height, placement adjacent to fill slopes, guardrail end terminals, and MGS trailing-end anchorages, see chapter 8 of MwRSF report no. TRP-03-383-20.

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: | Karla Lechtenberg | |
| Engineer Signature: |  Digitally signed by Karla Lechtenberg DN: cn=Karla Lechtenberg, o=MwRSF, ou, email=kpolivka@unl.edu, Date: 2020.11.02 11:15:29 -06'00' | |
| Address: | 130 Whittier Research Center, 2200 Vine Street, Lincoln, NE 68583-0853 | Same as Submitter <input checked="" type="checkbox"/> |
| Country: | USA | Same as Submitter <input checked="" type="checkbox"/> |

A brief description of each crash test and its result: [Help](#)

| Required Test Number | Narrative Description | Evaluation Results |
|----------------------|---|--------------------|
| 3-10 (1100C) | <p>The results of test no. CMGS-1 conducted on December 1, 2017 are found in MwRSF report no. TRP-03-383-20. A 2,428-lb small car with a simulated occupant seated in the right-front seat, impacted the culvert-mounted MGS system at a speed of 61.3 mph, an angle of 25.1 degrees, and at 92 in. upstream from post no. 19, thus resulting in an impact severity of 54.8 kip-ft. As the vehicle was redirected, a partial rail tear occurred through the lower hump of the W-beam rail at the downstream end of the rail splice at post no. 19. This tear did not rupture the rail nor compromise the integrity of the W-beam rail element. At 0.259 sec after impact, the vehicle became parallel to the system with a speed of 26.5 mph. At 0.464 sec, the vehicle existed the barrier at a speed of 24.7 mph and at an angle of 17.0 degrees. The vehicle was successfully contained and smoothly redirected.</p> <p>Exterior vehicle damage was moderate and the interior occupant compartment deformations were minimal, with a maximum of 3$\frac{3}{8}$ in., consequently not violating the limits established in MASH 2016. Damage to the barrier was moderate consisting of deformed guardrail posts, contact marks on guardrail sections, deformed W-beam rail, and slight tearing of W-beam rail. The maximum lateral dynamic barrier deflections was 12 inches. The working width of the system was 33.1 inches. All occupant risk measures were below recommended values. The test vehicle showed no tendency to rollover and did not penetrate or ride over the barrier. The vehicle trajectory did not violate the bounds of the exit box.</p> | PASS |

| Required Test Number | Narrative Description | Evaluation Results |
|----------------------|---|----------------------------------|
| 3-11 (2270P) | <p>The results of test no. CMGS-2 conducted on February 14, 2018 are found in MwRSF report no. TRP-03-383-20. A 5,013-lb pickup truck impacted the culvert-mounted MGS system at a speed of 62.8 mph, an angle of 25.7 degrees, and at a location of 129.1 in. upstream from post no. 19, thus resulting in an impact severity of 124.7 kip-ft. At 0.270 sec after impact, the vehicle became parallel to the system with a speed of 36.9 mph. At 0.520 sec, the vehicle exited the barrier at a speed of 33.1 mph and at an angle of 17.4 degrees. The vehicle was successfully contained and smoothly redirected.</p> <p>Exterior vehicle damage was moderate and the interior occupant compartment deformations were minimal, with a maximum of 1½ in., consequently not violating the limits established in MASH 2016. Damage to the barrier was moderate consisting of deformed guardrail posts, contact marks on guardrail sections, and deformed W-beam rail. The maximum lateral dynamic barrier deflections was 29.6 inches. The working width of the system was 50.8 inches. All occupant risk measures were below recommended values. The test vehicle showed no tendency to rollover and did not penetrate or ride over the barrier. The vehicle trajectory did not violate the bounds of the exit box.</p> | PASS |
| 3-20 (1100C) | Test no. 3-20 is not applicable for this type of system. | Non-Relevant Test, not conducted |
| 3-21 (2270P) | Test no. 3-21 is not applicable for this type of 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: | Midwest Roadside Safety Facility | |
| Laboratory Signature: |  | <small>DN: cn=Karla Lechtenberg, o=MwRSF, ou, email=kpolivka@unl.edu, c=US Digitally signed by Karla Lechtenberg Date: 2020.11.02 11:15:51 -06'00'</small> |
| Address: | 130 Whittier Research Center, 2200 Vine Street, Lincoln, NE 68583-0853 | Same as Submitter <input checked="" type="checkbox"/> |
| Country: | USA | Same as Submitter <input checked="" type="checkbox"/> |
| Accreditation Certificate Number and Dates of current Accreditation period : | A2LA Certificate Number: 2937.01, Valid to November 30, 2021 is current certificate. A2LA Certificate Number: 2937.01, Valid to November 30, 2017 was held during the testing phase of this project. | |

Submitter Signature*: **Karla
Lechtenberg**

Digitally signed by Karla Lechtenberg
DN: cn=Karla Lechtenberg, o=MWR/SF,
ou, email=kgottika@unit.edu, c=US
Date: 2020.11.02 11:42:32 -06'00'

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 |
| | | |



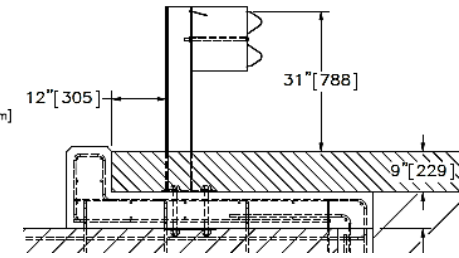
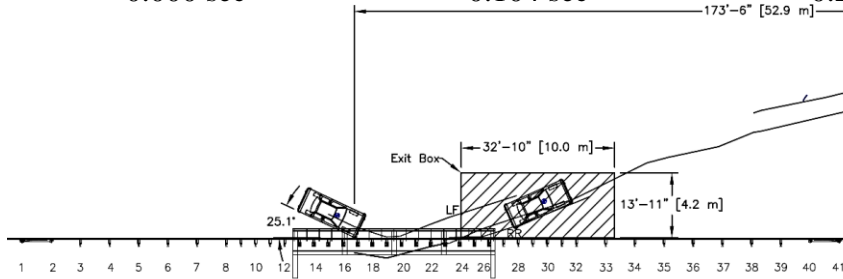
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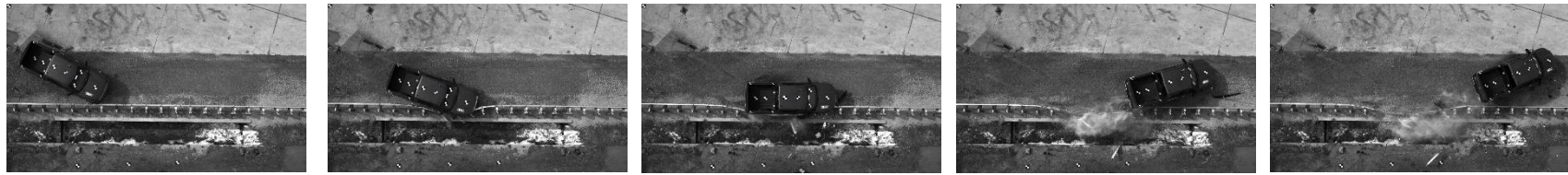
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- Test AgencyMwRSF
- Test Number..... CMGS-1
- Date..... 12/01/2017
- MASH Test Designation No.3-10
- Test Article..... Culvert-Mounted, Strong Post MGS
- Total Length 182.3 ft (55.6 m)
- Distance between Posts and Headwall 12 in. (305 mm)
- Key Component – MGS Rail
 - Thickness 12 gauge (2.7 mm)
 - Top Mounting Height..... 31 in. (787 mm)
- Key Component – Steel Posts
 - Post Type W6x9 by 40½ in. (1,029 mm)
 - Post Spacing..... 37½ in. (952 mm) on center
- Soil TypeCompacted, coarse, crushed limestone
- Vehicle Make /Model..... 2010 Hyundai Accent
- Curb.....2,471 lb (1,121 kg)
- Test Inertial.....2,428 lb (1,101 kg)
- Gross Static.....2,588 lb (1,174 kg)
- Impact Conditions
 - Speed61.3 mph (98.7 km/h)
 - Angle..... 25.1 deg
 - Impact Location..... 92 in. (2,337 mm) upstream from post no. 19
- Impact Severity 58.5 kip-ft (79.3 kJ) > 51 kip-ft (69.1 kJ) Limit from MASH
- Exit Conditions
 - Speed.....24.7 mph (39.8 km/h)
 - Angle..... 17 deg
- Exit Box Criterion.....Pass
- Vehicle Stability..... Satisfactory
- Vehicle Stopping Distance 173 ft - 6 in. (52.9 m) Downstream within the system

- Vehicle Damage..... Moderate
 - VDS [14] 1-RFQ-6
 - CDC [15]..... 1-RZAK-5
 - Maximum Interior Deformation 3¾ in. (86 mm)
- Test Article Damage Moderate
- Maximum Test Article Deflections
 - Dynamic..... 12.0 in. (305 mm)
 - Working Width..... 33.1 in. (842 mm)
 - Permanent Set 117% in. (302 mm)
- Transducer Data

| Evaluation Criteria | | Transducer | | MASH 2016 Limit |
|-------------------------------------|--------------|-------------------|----------------|-----------------|
| | | SLICE-1 (primary) | SLICE-2 | |
| OIV ft/s (m/s) | Longitudinal | -27.34 (-8.33) | -27.57 (-8.40) | ± 40 (12.2) |
| | Lateral | -20.01 (-6.10) | -19.49 (-5.94) | ± 40 (12.2) |
| ORA g's | Longitudinal | -16.96 | -15.45 | ± 20.49 |
| | Lateral | -11.51 | -11.18 | ± 20.49 |
| MAX ANGULAR DISPLACEMENT deg. | Roll | 15.2 | -11.4 | ±75 |
| | Pitch | -6.9 | -4.7 | ±75 |
| | Yaw | -53.4 | -53.7 | not required |
| THIV – ft/s (m/s) | | 33.47 (10.20) | 31.49 (9.60) | not required |
| PHD – g's | | 18.32 | 17.60 | not required |
| ASI | | 1.37 | 1.34 | not required |

Figure 73. Summary of Test Results and Sequential Photographs, Test No. CMGS-1



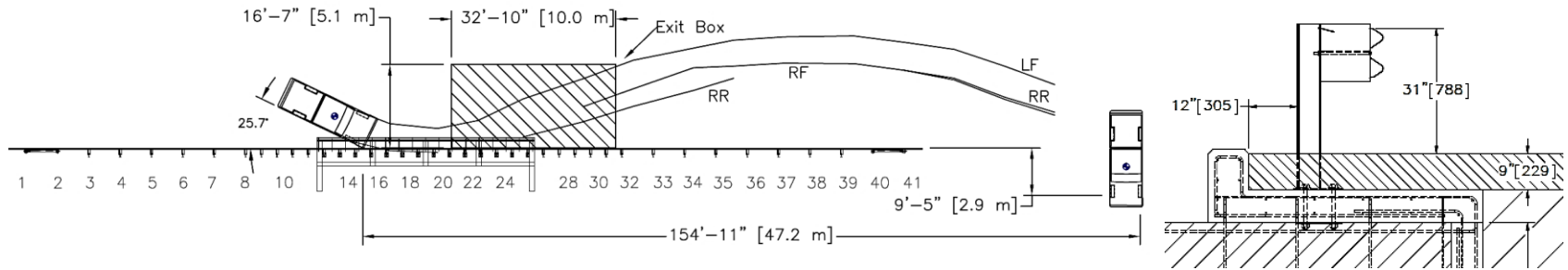
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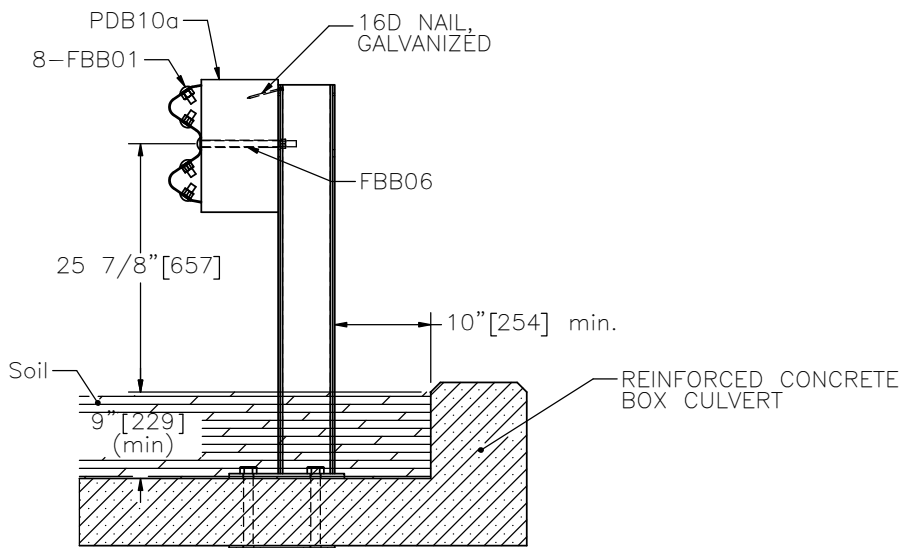
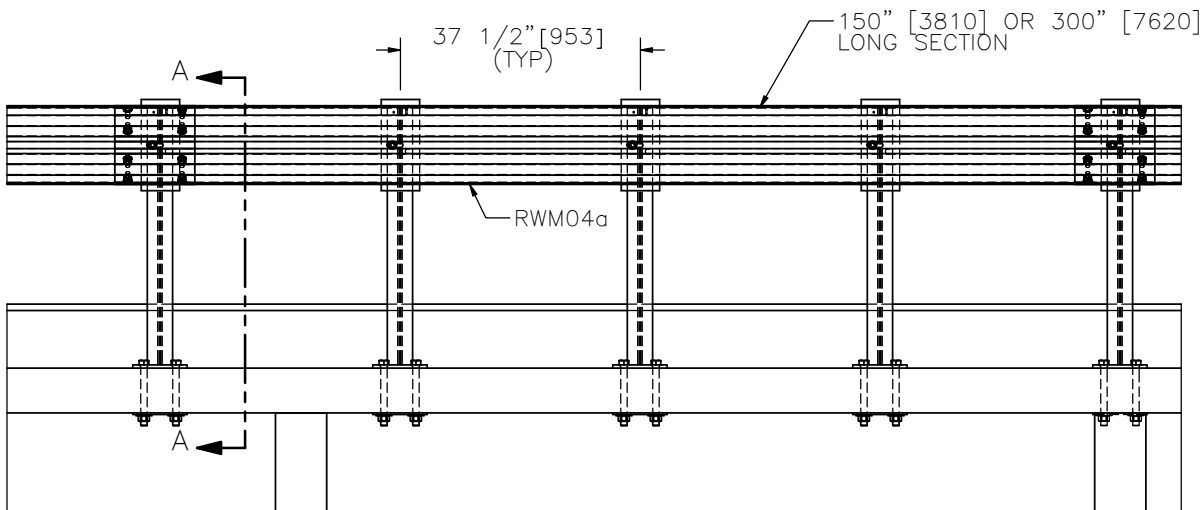
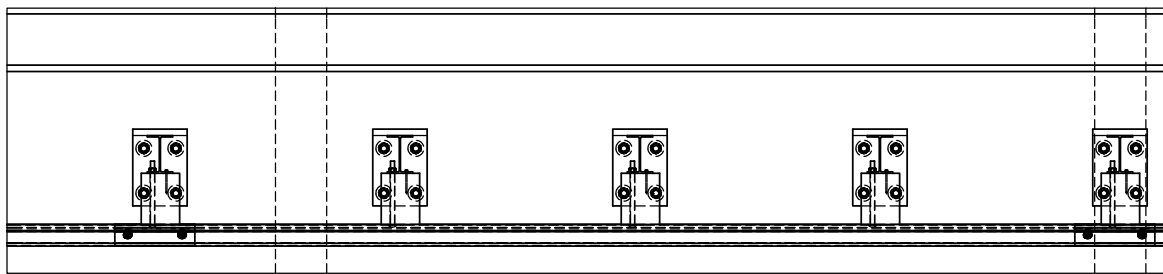


- Test AgencyMwRSF
- Test Number..... CMGS-2
- Date.....2/14/2018
- MASH Test Designation No.3-11
- Test Article.....Culvert-Mounted, Strong Post MGS
- Total Length 182.3 ft (55.6 m)
- Distance between Posts and Headwall 12 in. (305 mm)
- Key Component – MGS Rail
 - Thickness 12 gauge (2.7 mm)
 - Top Mounting Height..... 31 in. (787 mm)
- Key Component – Steel Posts
 - Post Type W6x9 by 40½ in. (1,029 mm)
 - Post Spacing 37½ in. (952 mm) on center
- Soil TypeCompacted, coarse, crushed limestone
- Vehicle Make /Model..... 2010 Dodge Ram
 - Curb.....5,292 lb (2,400 kg)
 - Test Inertial.....5,013 lb (2,274 kg)
 - Gross Static.....5,175 lb (2,347 kg)
- Impact Conditions
 - Speed.....62.8 mph (101.1 km/h)
 - Angle..... 25.7 deg
 - Impact Location..... 129.1 in. (3,279 mm) upstream from post no. 19
- Impact Severity 124.7 kip-ft (169.1 kJ) > 106 kip-ft (144 kJ) Limit from MASH
- Exit Conditions
 - Speed.....33.1 mph (53.2 km/h)
 - Angle 17.4 deg
- Exit Box Criterion.....Pass
- Vehicle Stability..... Satisfactory
- Vehicle Stopping Distance..... 173 ft - 6 in. (52.9 m) Downstream within the system
- Vehicle Damage.....Moderate

- VDS [14] 1-RFQ-6
- CDC [15]..... 1-RZAK-5
- Maximum Interior Deformation 1⅛ in. (29 mm)
- Test Article Damage Moderate
- Maximum Test Article Deflections
 - Dynamic.....29.6 in. (752 mm)
 - Working Width..... 50.8 in. (1,290 mm)
 - Permanent Set 15¾ in. (400 mm)
- Transducer Data

| Evaluation Criteria | | Transducer | | MASH 2016 Limit |
|-------------------------------------|--------------|-------------------|----------------|-----------------|
| | | SLICE-1 (primary) | SLICE-2 | |
| OIV ft/s (m/s) | Longitudinal | -21.86 (-6.66) | -19.60 (-5.97) | ± 40 (12.2) |
| | Lateral | -15.36 (-4.68) | -16.58 (-5.05) | ± 40 (12.2) |
| ORA g's | Longitudinal | -12.88 | -13.78 | ± 20.49 |
| | Lateral | -11.05 | -10.24 | ± 20.49 |
| MAX ANGULAR DISPLACEMENT deg. | Roll | 22.6 | 15.4 | ±75 |
| | Pitch | -7.9 | -9.5 | ±75 |
| | Yaw | -57.0 | -57.4 | not required |
| THIV – ft/s (m/s) | | 24.66 (7.52) | 23.68 (7.22) | not required |
| PHD – g's | | 16.11 | 16.22 | not required |
| ASI | | 1.02 | 0.96 | not required |

Figure 96. Summary of Test Results and Sequential Photographs, Test No. CMGS-2



CONDUITS MAY BE PLACED
IN DECK OR HOLES MAY
BE FIELD DRILLED, NOT TO
INTERFERE WITH REINFORCEMENT

SECTION A-A

Note: Either through bolt or epoxy anchor with minimum 8" [203] embedment and minimum 1,300 psi [9.0 MPa] bond strength.

REDUCED SPACING, W-BEAM GUARDRAIL ON CONCRETE BOX CULVERT



SGR25

SHEET NO.

DATE:

1 of 4

10/28/2020

INTENDED USE

Reduced Spacing, W-Beam Guardrail on Concrete Box Culvert (SGR25) should be used in locations where a maximum dynamic deflection of 12" [305] or less is acceptable and where a working width of 33 1/8" [842] is provided. W-Beam Guardrail on Concrete Box Culvert should be anchored and terminated using a suitable guardrail end treatment. W-Beam Guardrail on Concrete Box Culvert can be used with wide-flange steel posts as shown. Guardrail sections measuring 300" [7620] long can be used in lieu of the 150" [3810] long sections. This system is TL-3 NCHRP 350 and MASH accepted.

COMPONENTS

Unit Length = 150" [3810]

| DESIGNATOR | COMPONENT | SYSTEM | NUMBER |
|------------|---------------------------------|--------|--------|
| FBB01 | Guardrail Splice Bolts and Nuts | a-b | 8 |
| FBB06 | Guardrail Post Bolts and Nuts | a-b | 4 |
| PDB10 | Timber Blockout | a-b | 4 |
| RWM04a | W-beam Rail | a-b | 1 |
| ---- | Wide-flange Guardrail Post | a-b | 4 |
| ---- | 16D Nail, Galvanized | a-b | 4 |
| ---- | Base Plate | a-b | 4 |
| ---- | Washer Plate | a | 4 |
| FBX24a | Hex Bolt and Nut | a | 16 |
| FRS24a | Straight Anchor Stud and Nuts | b | 16 |

ACCEPTANCE

FHWA acceptance was not pursued.

REFERENCES

Polivka, K.A., Faller, R.K., Sicking, D.L., Rohde, J.R., Reid, J.D., and Holloway, J.C., NCHRP 350 Development and Testing of a Guardrail Connection to Low-Fill Culverts, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-114-02, Project No. SPR-3(017)-Year 10, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, November 1, 2002.

Polivka, K.A., Faller, R.K., Reid, J.D., Rohde, J.R., and Sicking, D.L., *Guardrail Connection for Low-Fill Culverts*, Paper No. 03-4421, Transportation Research Record No. 1851, Transportation Research Board, National Research Council Washington, Washington, D.C., January 2003. pp. 105-116.

Price, C.W., Rosenbaugh, S.K., Faller, R.K., Sicking, D.L., Reid, J.D., and Bielenberg, R.W., Post Weld and Epoxy Anchorage Variations for W-Beam Guardrail Attached to Low-Fill Culverts, Final Report to the Midwest States' Regional Pooled Fund Program, Transportation Research Report No. TRP-03-278-13, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, August 12, 2013.

Asadollahi Pajouh, M., Bielenberg, R.W., Rasmussen, J.D., Bai, F., Faller, R.K., and Holloway, J.C., Dynamic Testing and Evaluation of Culvert-Mounted, Strong-Post MGS to TL-3 Guidelines of MASH 2016, Final Report to the Wisconsin Department of Transportation, Transportation Research Report No. TRP-03-383-20, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, October 26, 2020.

CONTACT INFORMATION

Midwest Roadside Safety Facility
Nebraska Transportation Center
University of Nebraska-Lincoln
2200 Vine Street
130 Whittier Research Center
Lincoln, NE 68583-0965

REDUCED SPACING, W-BEAM GUARDRAIL ON CONCRETE BOX CULVERT



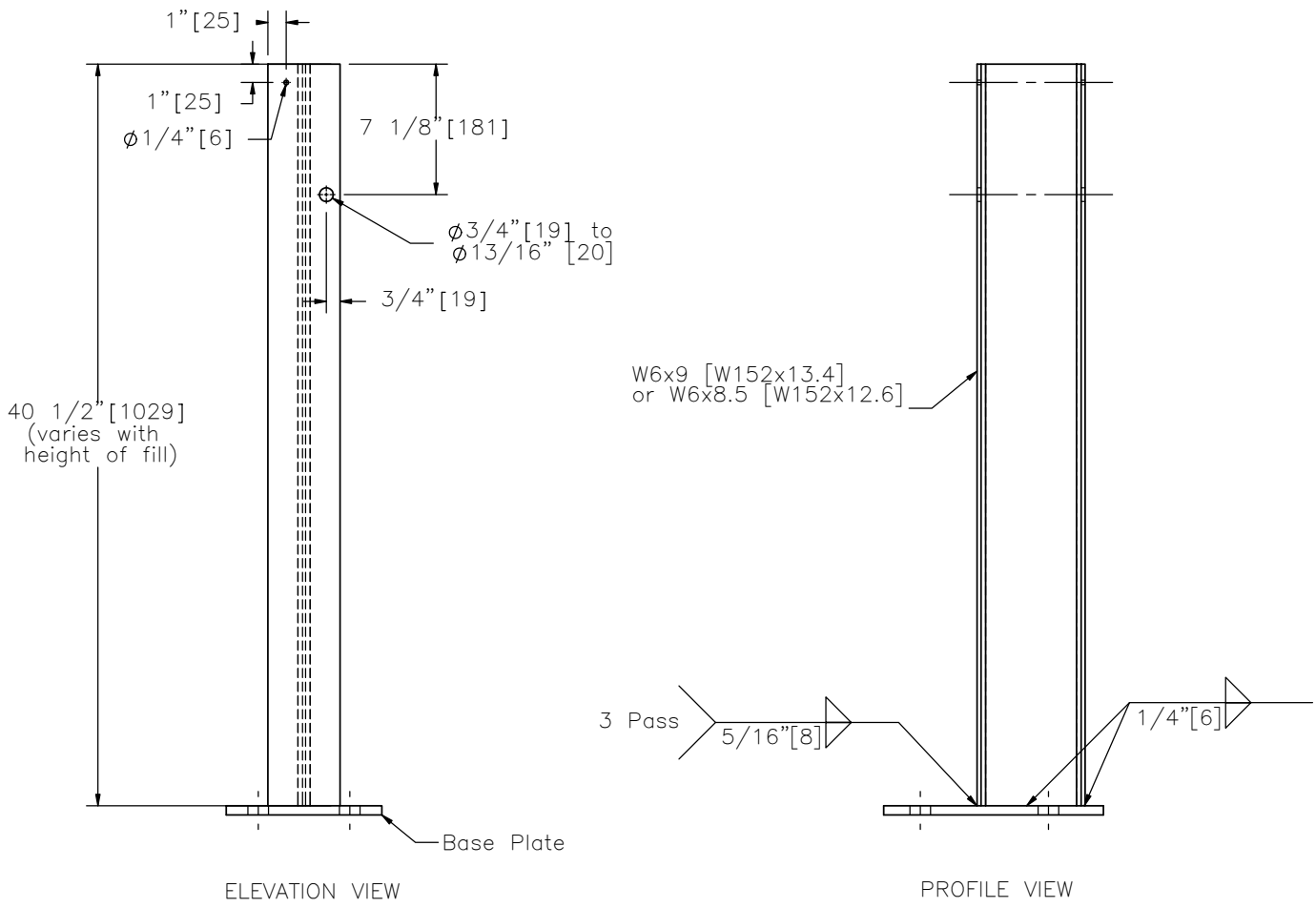
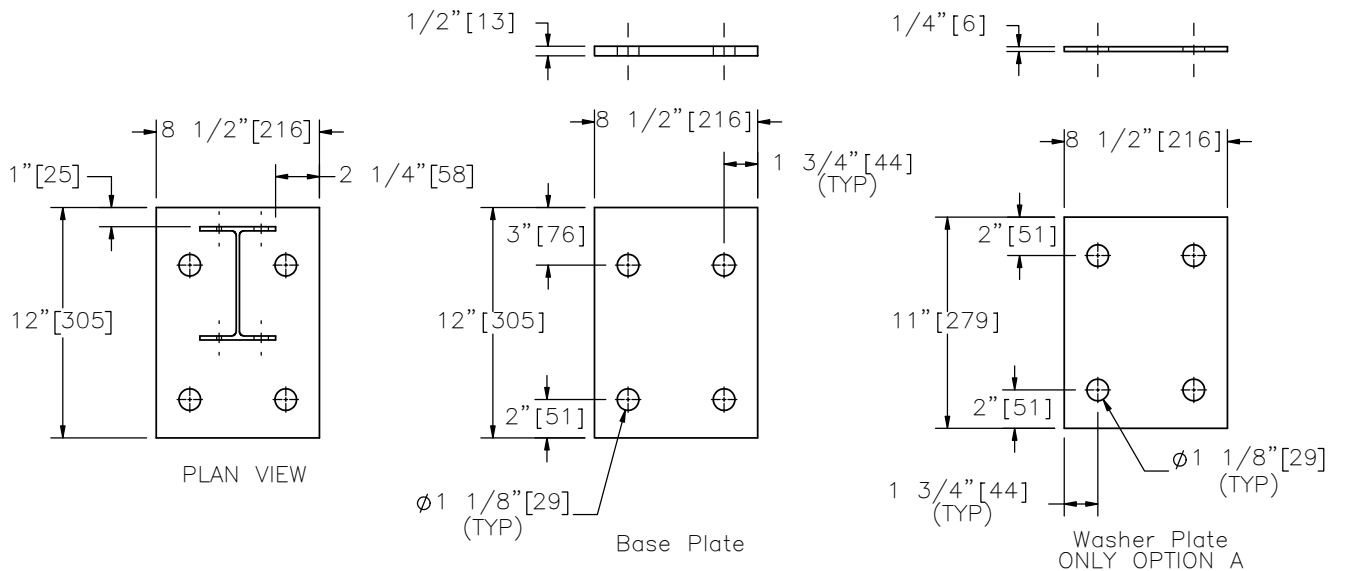
SGR25

SHEET NO.

DATE:

2 of 4

10/28/2020



REDUCED SPACING, W-BEAM GUARDRAIL ON CONCRETE BOX CULVERT



SGR25

| | |
|-----------|------------|
| SHEET NO. | DATE: |
| 3 of 4 | 10/28/2020 |

SPECIFICATIONS

The culvert-mounted guardrail post shall be manufactured using AASHTO M270M (ASTM A709M) Grade 250 steel or ASTM A992 unless corrosion resistant steel is required in which case the post shall be manufactured from AASHTO M270M (ASTM A709M) Grade 50W steel. The dimensions of the cross-section shall conform to a W6x9 [W152x13.4] section as defined in AASHTO M160M (ASTM A6M). W6x8.5 [W150x12.6] wide-flange posts are an acceptable alternative that is considered equivalent to the W6x9 [W152x13.4].

After the section is cut and all holes are drilled or punched, the component should be zinc-coated according to AASHTO M111 (ASTM A123) unless corrosion resistant steel is used. When corrosion resistant steel is used the portion of the post to be embedded in soil shall be zinc-coated according to AASHTO M111 (ASTM A123) and the portion above the soil shall not be zinc-coated, painted, or otherwise treated.

| DESIGNATOR | AREA in. ² [10 ³ mm ²] | I _x in. ⁴ [10 ⁶ mm ⁴] | I _y in. ⁴ [10 ⁶ mm ⁴] | S _x in. ³ [10 ³ mm ³] | S _y in. ³ [10 ³ mm ³] |
|-------------------------------|--|---|--|--|--|
| Wide-flange guardrail post | 2.68 [1.7] | 16.4 [6.83] | 2.20 [0.92] | 5.56 [91.1] | 1.11 [18.2] |

Dimensions tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance and accepted manufacturing practices.

REDUCED SPACING, W-BEAM GUARDRAIL ON CONCRETE BOX CULVERT



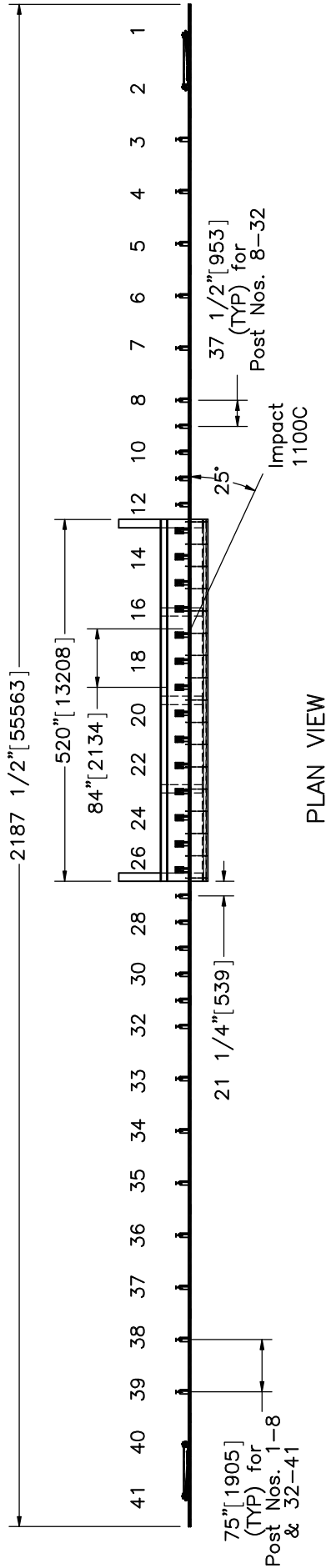
SGR25

SHEET NO.

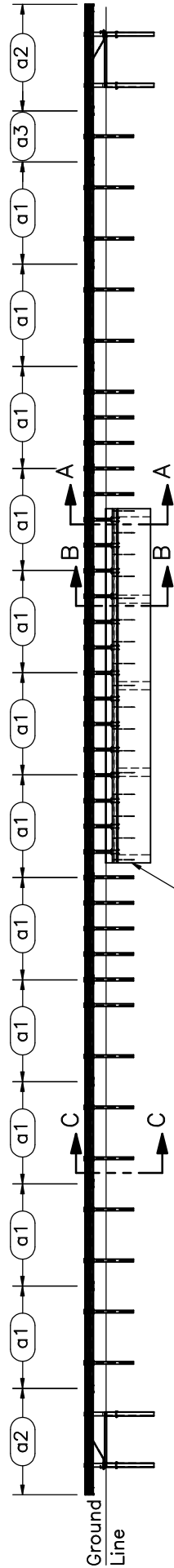
DATE:

4 of 4

10/28/2020



PLAN VIEW



ELEVATION VIEW

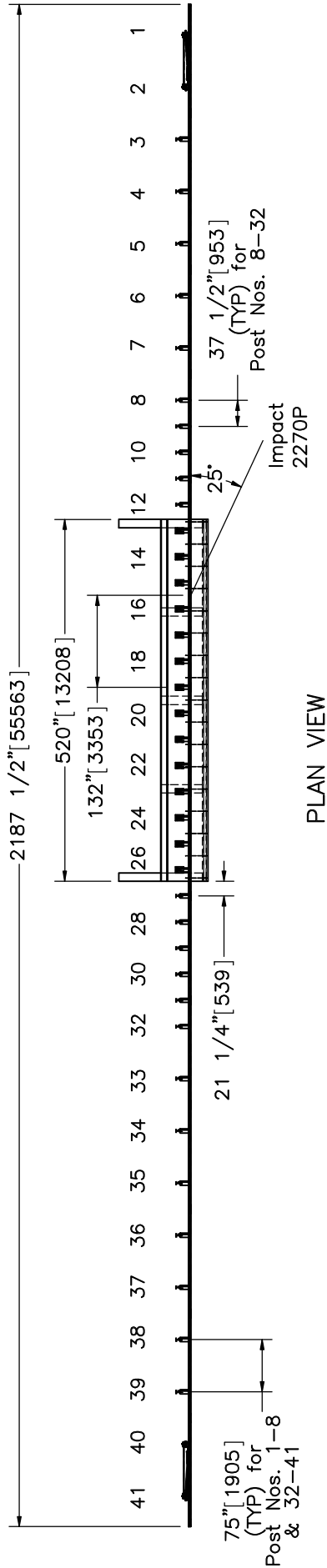
Concrete Culvert
(See WI_Culvert_Details
Drawing for details)

- Note: (1) Test shall be performed according to test designation no. 3-10 of MASH criteria.
 (2) The impact location is 84" [2,134] upstream of the splice at post no. 19.
 (3) BCT anchors are placed in $\phi 3'$ [914] holes, then backfilled and tamped with soil.
 (4) Critical region is between post nos. 13 and 29.

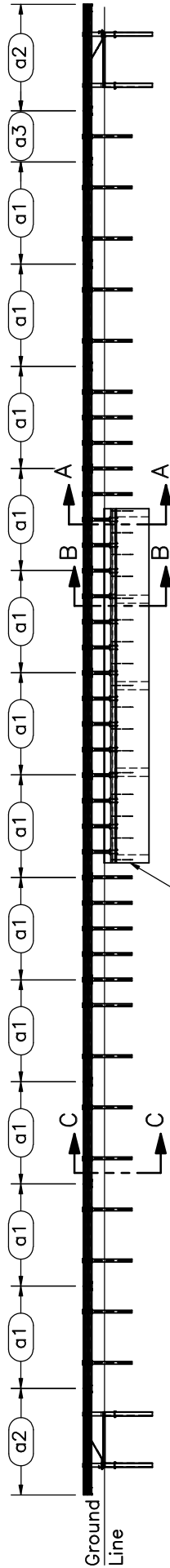


Midwest Roadside
Safety Facility

| | |
|---|--------------------------|
| MGS Strong Post on Culvert Test No. CMGS-1 System Layout | SHEET: 1 of 18 |
| | DATE: 11/22/2017 |
| DWG. NAME: WL_MGS_on_Culvert_R12 | DRAWN BY: MES/AEK/DTM |
| | REV. BY: JEK/RWB/KAL/JCH |
| SCALE: 1:230 | UNITS: in.[mm] |



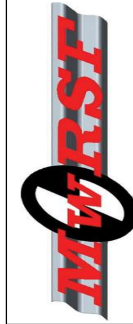
PLAN VIEW



ELEVATION VIEW

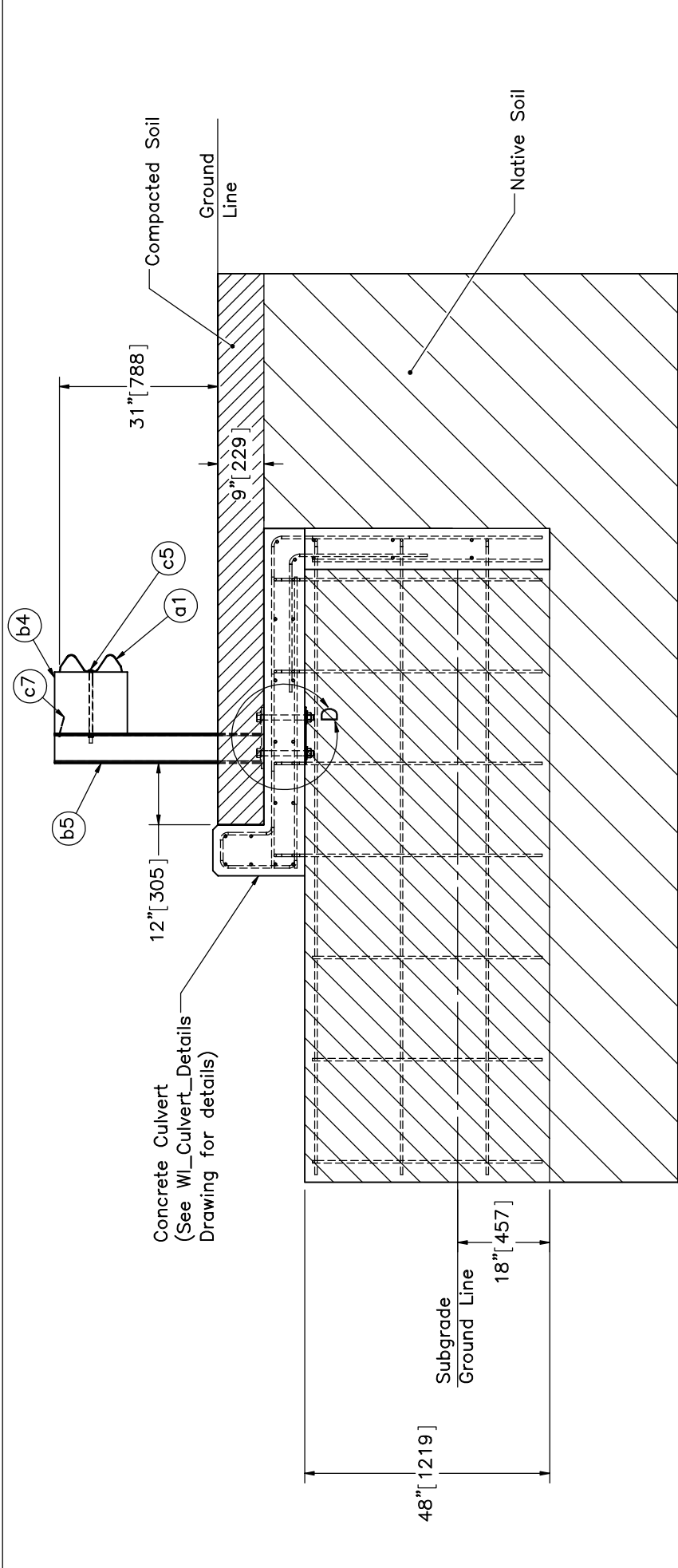
Concrete Culvert
(See WI_Culvert_Details
Drawing for details)

- Note: (1) Test shall be performed according to test designation no. 3-11 of MASH criteria.
 (2) The impact location is 132" [3,353] upstream of the splice at post no. 19.
 (3) BCT anchors are placed in ϕ 3' [914] holes, then backfilled and tamped with soil.
 (4) Critical region is between post nos. 13 and 29.



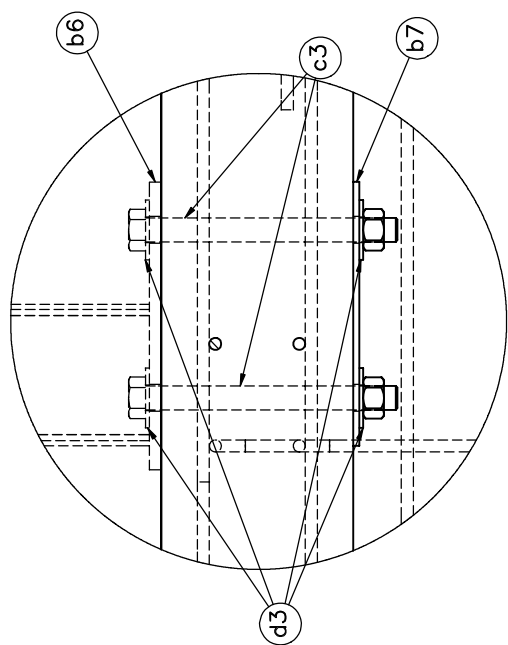
Midwest Roadside
Safety Facility

| | |
|---|------------------------------|
| MGS Strong Post on Culvert Test No. CMGS-2 System Layout | SHEET: 1 of 18 |
| | DATE: 11/22/2017 |
| DWG. NAME: WI_MGS_on_Culvert-2_R2 | DRAWN BY: MES/AEK/ DTM |
| | REV. BY: RWB |
| SCALE: 1:230 | UNITS: in.[mm] |




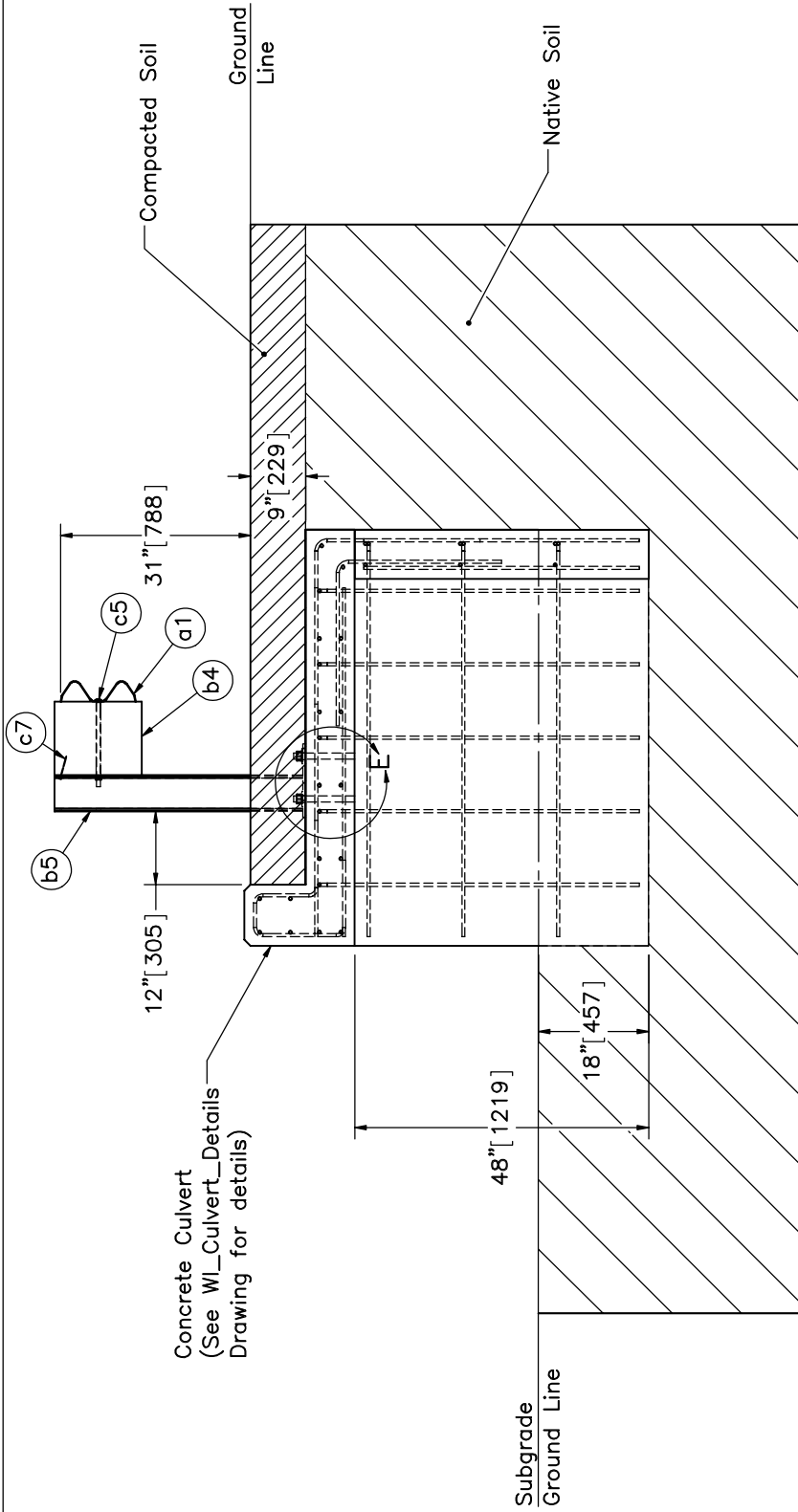
SECTION A-A
 Post Nos. 13-15, 17-22
 & 24-26

Note: (1) A 1" [25] dia., 12" [305] long threaded rod was substituted for bolt c3 at post nos. 14, 15, 17, 18, 21, 22, 24, and 25 to allow for proper installation in areas with deck sag.



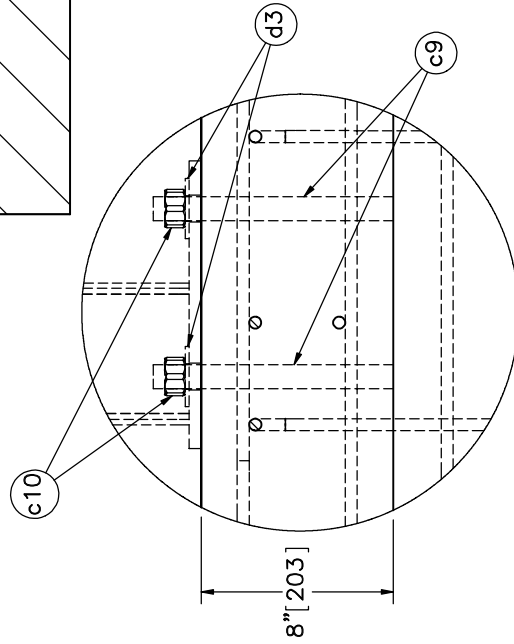
DETAIL D
 SCALE 1 : 8

| | | | |
|---|---|-------------------------------|---|
|  | MGS Strong Post on Culvert Test No. CMGS-1 | | SHEET: 2 of 18 |
| | Post Nos. 13-15, 17-22 & 24-26 Detail DWG. NAME: WL_MGS_on_Culvert_R12 | | DATE: 11/22/2017 |
| Midwest Roadside Safety Facility | | SCALE: 1:30 UNITS: in.[mm] | DRAWN BY: MES/AJK/ DTM REV. BY: JEK/RWB/ KAL/JCH |




SECTION B-B
Post Nos. 16 & 23

- Note: (1) Posts nos. 16 and 23 are epoxied in the concrete culvert at a depth of 8" [203] with Powers Fasteners AC100+ Gold epoxy or an equivalent epoxy with a minimum bond strength of 1,305 psi [9.0 MPa].
 (2) The holes for the 1" [25] threaded rods (part c9) that interface only with the 8" [203] concrete deck need to be taped on the bottom side of the deck to retain the epoxy in the hole.



DETAIL E
SCALE 1 : 8

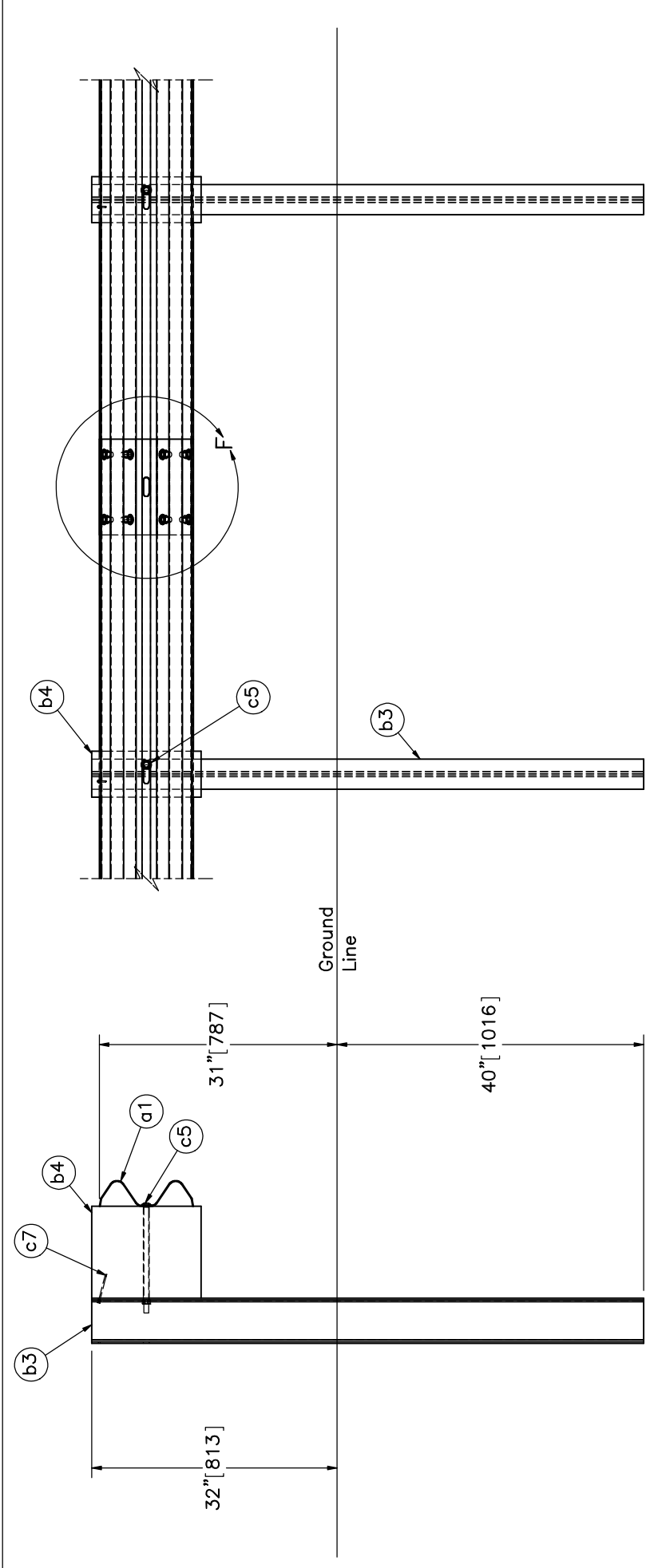
| | | |
|---|--|-----------------------------|
|  | MGS Strong Post on Culvert Test No. CMGS-1 | |
| | Post Nos. 16 & 23 Detail | |
| DWG. NAME: WL_MGS_on_Culvert_R12 | SCALE: 1:30 UNITS: in.[mm] | DRAWN BY: MES/AEK/DTM |
| | | REV. BY: JEK/RWB/KAL/JCH |

SHEET:
3 of 18

DATE:
11/22/2017


DRAWN BY:
MES/AEK/DTM

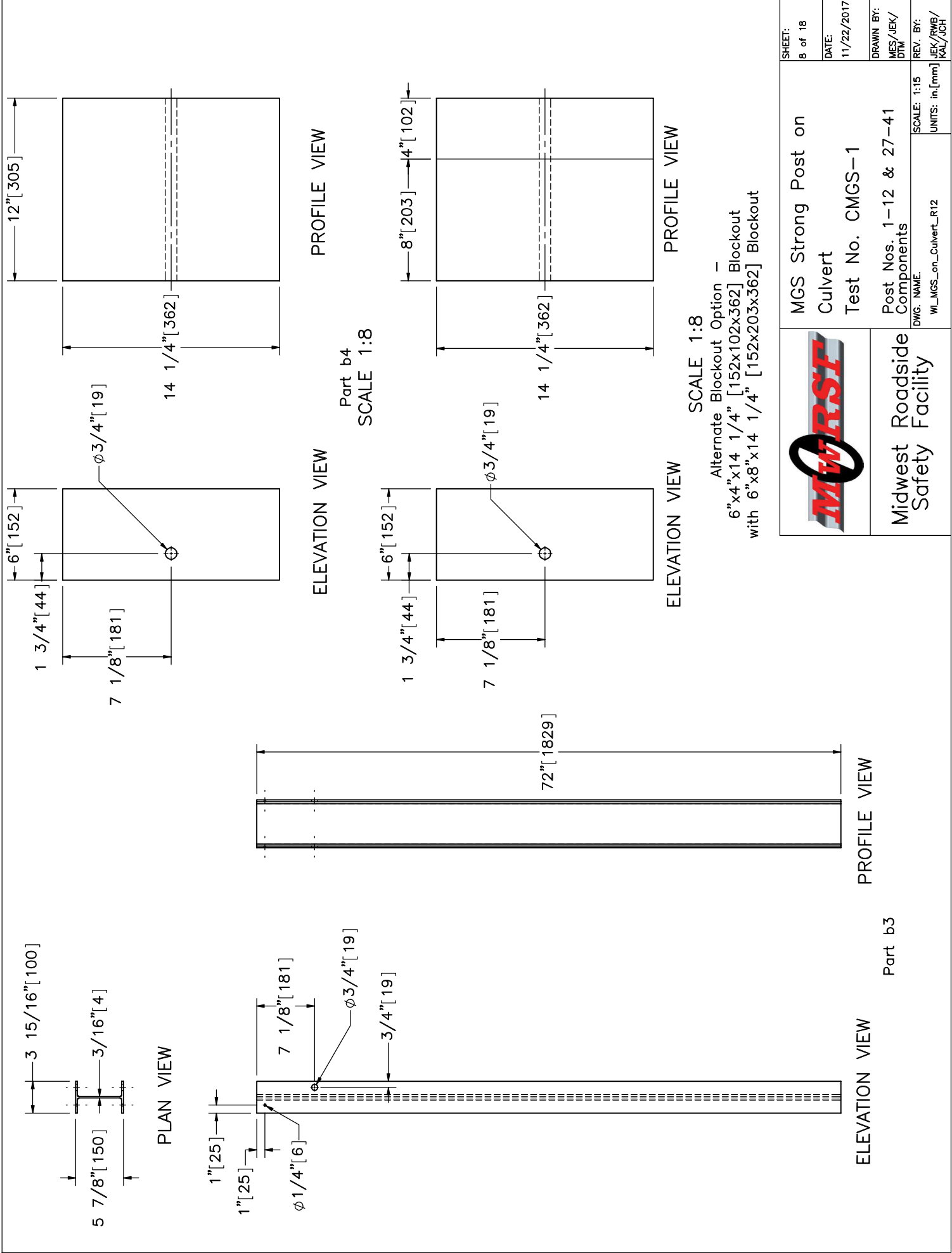
REV. BY:
JEK/RWB/KAL/JCH




SPLICE DETAIL
FRONT SIDE

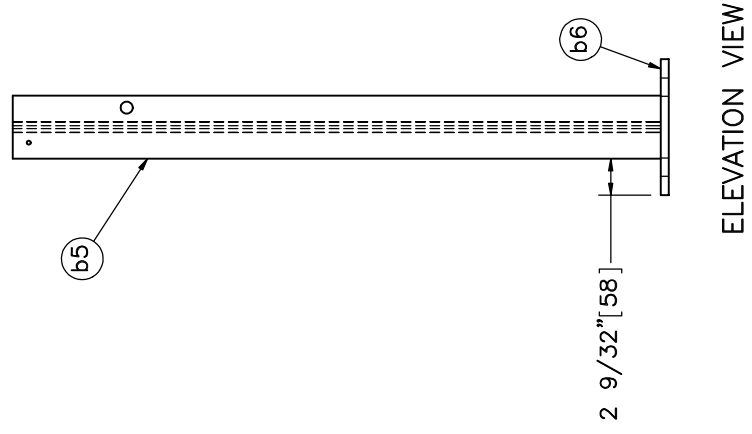
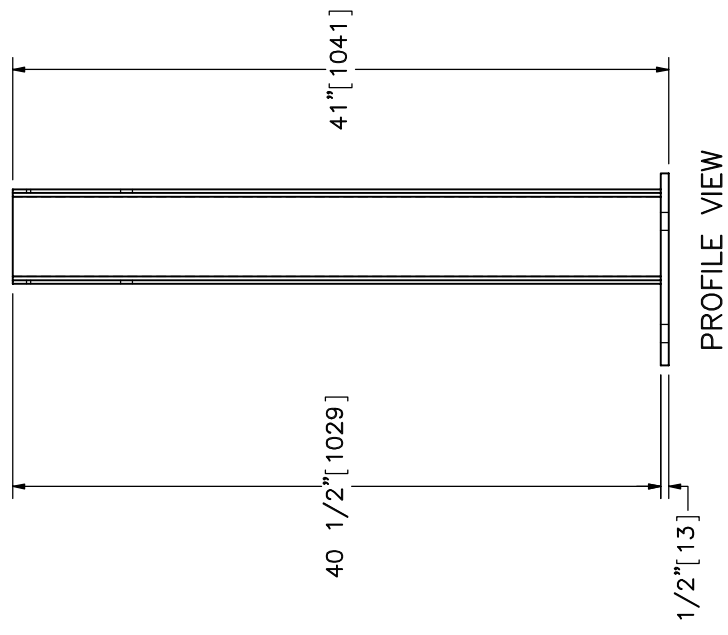
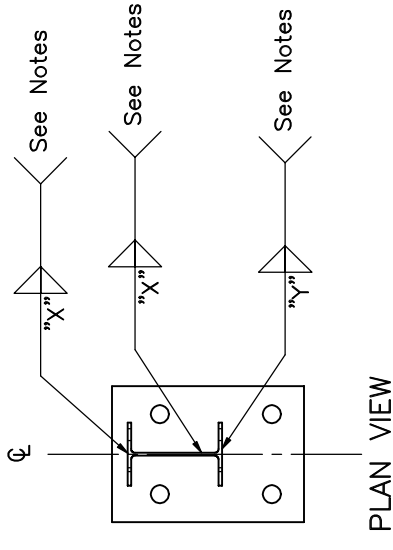
Note: (1) Guardrail bolts (part c5) on the upstream side of the web.


| | | | |
|---|--|--------------------------------|---------------------------------|
|  | MGS Strong Post on Culvert Test No. CMGS-1 Splice and Post Detail | | SHEET: 4 of 18 |
| | DWG. NAME: WL_MGS_on_Culvert_R12 | | DATE: 11/22/2017 |
| Midwest Roadside Safety Facility | | SCALE: 1:20 UNITS: in, [mm] | DRAWN BY: MES/AEK/ DTM |
| | | | REV. BY: JEK/RWB/ KAL/JCH |



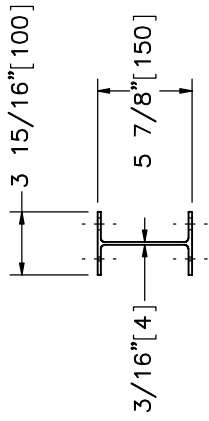
| | | |
|---|--------------------------------------|---------------------------------|
|  | MGS Strong Post on Culvert | SHEET: 8 of 18 |
| | Test No. CMGS-1 | DATE: 11/22/2017 |
| Midwest Roadside Safety Facility | Post Nos. 1-12 & 27-41 Components | DRAWN BY: MES/AEK/ DTM |
| | DWG. NAME: WL_MGS_on_Culvert_R12 | REV. BY: JEK/RWB/ KAL/JCH |
| | SCALE: 1:15 UNITS: in.[mm] | |

| | |
|------------------------|-------------------------|
| Weld, "X" in. [mm] | Weld, "Y" in. [mm] |
| 1/4" [6] - Single Pass | 5/16" [8] - Triple Pass |

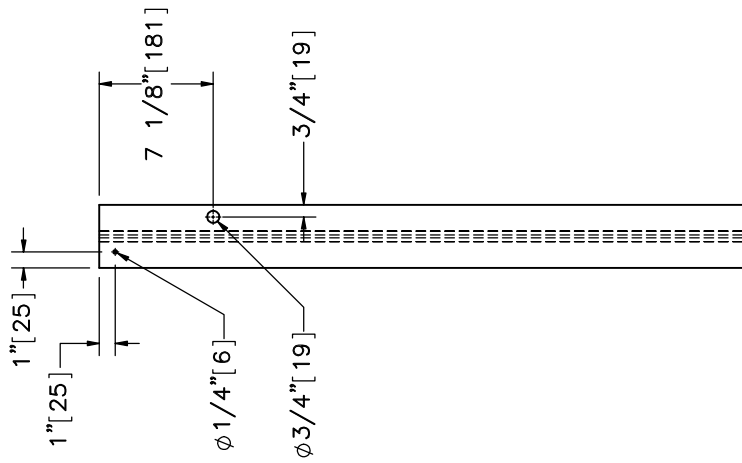


| | | |
|---|----------------------------------|--------------------------|
|  | MGS Strong Post on Culvert | SHEET: 9 of 18 |
| | Test No. CMGS-1 | DATE: 11/22/2017 |
| Midwest Roadside Safety Facility | Post Nos. 13-26 Assembly Details | DRAWN BY: MES/JEK/DTM |
| | DWG. NAME: WL_MGS_on_Culvert_R12 | REV. BY: JEK/RWB/KAL/JCH |
| | SCALE: 1:12 | UNITS: in. [mm] |

Notes: (1) Welding is to be completed using the Gas-Metal Arc Welding (GMAW) process with ER70S-3 welding wire and argon oxygen or CO2 cover gas.
 (2) Requires certified welder.

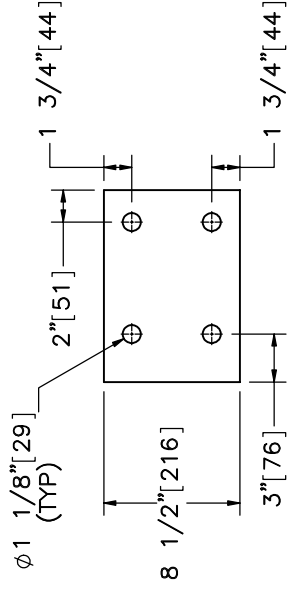


PLAN VIEW

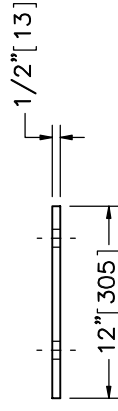


ELEVATION VIEW

Part b5

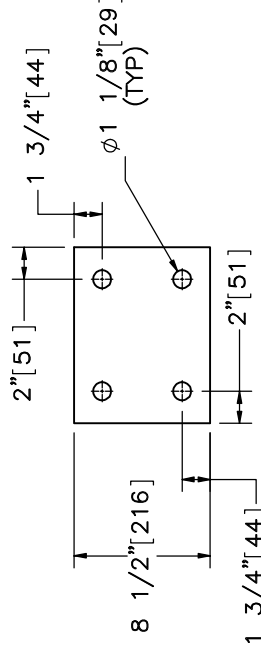


PLAN VIEW

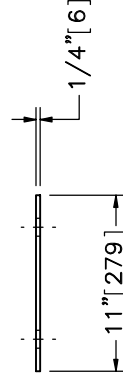


ELEVATION VIEW

Part b6

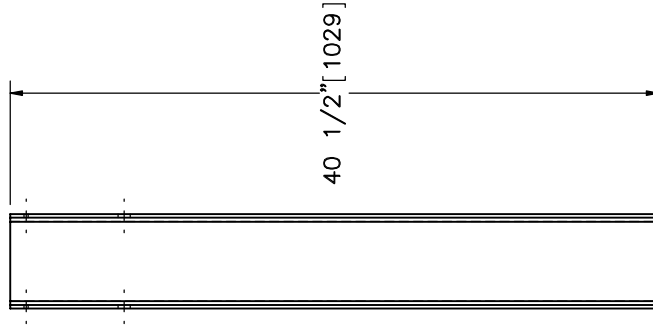


PLAN VIEW

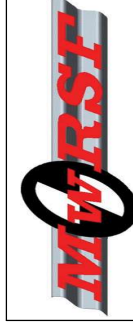


ELEVATION VIEW

Part b7



PROFILE VIEW



Midwest Roadside Safety Facility

MGS Strong Post on Culvert
Test No. CMGS-1

Pos Nos. 13-26 Component Details

DWG. NAME: WL_MGS_on_Culvert_R12
SCALE: 1:12
UNITS: in. [mm]

| | |
|-----------|-----------------|
| SHEET: | 10 of 18 |
| DATE: | 11/22/2017 |
| DRAWN BY: | MES/AJEK/DTM |
| REV. BY: | JEK/RWB/KAL/JCH |