



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

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

December 19, 2017

In Reply Refer To:
HSST-1/CC-140

Mr. Gregory A. Neece
Trinity Highway Products, LLC
2525 N. Stemmons Fwy
Dallas, TX 75204

Dear Mr. Neece:

This letter is in response to your October 17, 2017 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 CC-140 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:

- Slotted Rail Terminal (SRT)-MASH 2016

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: Slotted Rail Terminal (SRT)-MASH 2016

Type of system: Terminal

Test Level: MASH Test Level 3 (TL3)

Testing conducted by: Texas A&M Transportation Institute

Date of request: October 19, 2017

Date initially acknowledged: October 20, 2017

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 CC-140 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.
- If the subject device is a patented product it may be considered to be proprietary. If proprietary systems are specified by a highway agency for use on Federal-aid projects: (a) they must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with the existing highway facilities or that no equally suitable alternative exists; or (c) they must be used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes. Our regulations concerning proprietary products are contained in Title 23, Code of Federal Regulations, Section 635.411.

Sincerely,

A handwritten signature in blue ink, reading "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 17, 2017	<input checked="" type="radio"/> New <input type="radio"/> Resubmission
	Name:	Roger Bligh	
	Company:	Texas A&M Transportation Institute	
	Address:	3135 TAMU, College Station, TX 77843-3135	
	Country:	U.S.A.	
	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
'CC': Crash Cushions, Attenuators, & Terminals	<input checked="" type="radio"/> Physical Crash Testing <input type="radio"/> Engineering Analysis	Slotted Rail Terminal (SRT)-MASH 2016	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:	Gregory A. Neece	Same as Submitter <input type="checkbox"/>
Company Name:	Trinity Highway Products, LLC	Same as Submitter <input type="checkbox"/>
Address:	2525 N. Stemmons Fwy, Dallas, TX 75204	Same as Submitter <input type="checkbox"/>
Country:	U.S.A.	Same as Submitter <input 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 SRT-MASH 2016 system technology is covered by patents that were applied for by The Texas A&M University System (TAMUS). Trinity Highway Products, LLC (THP) has a license agreement to manufacture and sell SRT systems, which are commercial embodiments of those patents.

The tests were performed by the Texas A&M Transportation Institute (TTI) Proving Ground. TTI Proving Ground is an International Standards Organization ("ISO") 17025 accredited laboratory with American Association for Laboratory Accreditation (A2LA) Mechanical Testing certificate 2821.01.

The SRT systems were designed and developed by engineers who are currently or were previously employed by TTI. The associated United States Patent Office patent numbers are assigned to TAMUS. The patent holders of record for the associated patents are listed below:

Cable Release Anchor - US Patent Number 6,729,607: Dean C. Alberson, D. Lance Bullard, Jr., Roger P. Bligh, C. Eugene Buth

Steel Yielding Guardrail Support Post - US Patent Number 6,902,150: Dean C. Alberson, D. Lance Bullard, Jr., Roger P. Bligh, C. Eugene Buth

Slot Guard for Slotted Rail Terminal - US Patent Number 6,435,761: Roger P. Bligh, King K. Mak, Hayes E. Ross, Jr.

Slotted Rail Terminal - US Patent Number 5,547,309 (expired): Dean L. Sicking, Roger P. Bligh, King K. Mak, Hayes E. Ross, Jr.

THP pays royalties to TAMUS for sales of the SRT systems and parts, pursuant to an executed license agreement.

PRODUCT DESCRIPTION

- ☒ New Hardware or Significant Modification
 ☐ Modification to Existing Hardware

The SRT-MASH terminal became eligible via letter CC-100B dated December 5, 2012. With the publication of MASH 2016, the test matrix for W-beam guardrail terminals was modified to include Test 3-37b. This test involves an 1100C vehicle impacting the terminal at the critical impact point in the reverse direction at a speed of 62 mph and an angle of 25 degrees. Additional testing was performed in accordance with MASH 2016 to develop the SRT-MASH 2016 system.

The SRT-MASH 2016 terminal has a linear flare with a 4-ft offset over a length of 37.5 ft. The anchor post (post 1) is a cable release post (CRP) embedded 6 ft-6 inches below grade. Steel yielding terminal posts (SYTPs) are used for post 2 through post 10. The SYTPs are 6 ft long and embedded 40 inches below grade. Post 1 and post 2 are spaced 75 inches on center and connected at the ground line with a 3-inch x 3-inch x 1/4-inch angle strut. The spacing between post 2 and post 3 is 56.25 inches. Post 3 through post 10 are spaced at 37.5 inches. The last post spacing in the terminal between post 10 and post 11 (the first standard line post) is 56.25 inches. Slotted 12 gauge W-beam rail is used in the first 25 ft of the SRT-MASH 2016 system. A single 3/4-inch x 13 1/2-inch long slot is in the rail at post 1. Two sets of slots are located in the first 12 ft-6 inches of rail between post 1 and post 3. Each set of slots consists of three slots that are 1/2-inch wide x 27-inches long. The next 12 ft-6 inches of rail contains two additional sets of slots located between post 4 and post 7. These sets of three slots are 1/2-inch wide x 12-inch long. Slot guards are bolted to the field side of the slotted rail at the downstream end of each set of slots with the raised, narrow portion of the slot guard oriented towards post 1.

Posts 4 through 10 are offset from the rail using nominal 6-inch x 8-inch x 14-inch routed wood offset blocks. No offset blocks are used on posts 1, 2 and 3. Posts 2 through 7 are not bolted to the slotted W-beam rail panels. A shelf angle fabricated from 1/2-inch steel plate is used at post 2 to provide vertical reaction for the cable anchor system. W-beam flange protectors are used at posts 2 through 7 to provide additional vertical support to the slotted W-beam rail sections. A cable anchor bracket is bolted to the slotted rail panel between post 1 and post 2. A 9 1/4-inch long section of 1 1/4-inch diameter schedule 40 pipe is positioned inside the cable anchor bracket against the downstream bearing plate. The pipe insert positions the swaged fitting against the end of the cable anchor bracket where it turns down to post 1.

The SRT-MASH 2016 incorporates a deflector bracket upstream of post 2 that is attached to the back of the W-beam rail using four of the anchor bracket attachment bolts. This deflector bracket eliminates contact between post 2 and the anchor cable assembly when the terminal is impacted in the reverse direction as in Test 3-37b. The SRT-MASH 2016 also incorporates post 1 deflector plates on the downstream side of the flanges of the post 1 stub. When the terminal is impacted in the reverse direction as in Test 3-37b, the post 1 deflector plates permit the undercarriage of the vehicle to slide up and across the post 1 stub after the release of the top of the CRP post. This mitigates snagging potential between the vehicle and post 1 stub.

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:	Roger P. Bligh, Ph.D., P.E.	
Engineer Signature:	Bligh, Roger P	Digitally signed by Bligh, Roger P DN: postalCode=77843, o=TAMU-SIGN, street=Texas A&M University, st=TX, l=College Station, c=US, cn=Bligh, Roger P, email=rbligh@tamu.edu Date: 2017.10.16 16:40:57 -05'00'
Address:	3135 TAMU, College Station, TX 77843-3135	Same as Submitter <input type="checkbox"/>
Country:	U.S.A.	Same as Submitter <input type="checkbox"/>

A brief description of each crash test and its result:

Required Test Number	Narrative Description	Evaluation Results
3-30 (1100C)	<p>TTI Test Report No. 400001-SRT6, "MASH Test 3-30 on the SRT-MASH."</p> <p>The 1100C, traveling at an impact speed of 61.4 mi/h, impacted the nose of the SRT-MASH 2016 at 1.2 degrees with the left quarterpoint aligned with the center of post 1. The SRT-MASH 2016 activated as designed, slowed the 1100C vehicle, and permitted its controlled penetration behind the test article. The SRT-MASH 2016 performed acceptably according to the evaluation criteria for MASH 2016 Test 3-30.</p>	PASS
3-31 (2270P)	<p>TTI Test Report No. 400001-SRT5, "MASH Test 3-31 on the SRT-MASH."</p> <p>The 2270P vehicle, traveling at an impact speed of 61.0 mi/h, impacted the nose of the SRT-MASH 2016 at 0.6 degrees with the center of the vehicle aligned with the center of post 1. The SRT-MASH 2016 activated as designed, slowed the 2270P vehicle, and permitted its controlled penetration behind the test article. The SRT-MASH 2016 performed acceptably according to the evaluation criteria for MASH 2016 Test 3-31.</p>	PASS
3-32 (1100C)	<p>TTI Test Report No. 400001-SRT8, "MASH Test 3-32 on the SRT-MASH."</p> <p>The 1100C, traveling at an impact speed of 61.5 mi/h, contacted the nose of the SRT-MASH 2016 at post 1 at an impact angle of 5.4 degrees. The SRT-MASH 2016 activated as designed and permitted controlled gating of the 1100C. The SRT-MASH 2016 performed acceptably according to the evaluation criteria for MASH 2016 Test 3-32.</p>	PASS
3-33 (2270P)	<p>TTI Test Report No. 690900-SRT9, "MASH Test 3-33 on the SRT M10."</p> <p>The 2270P, traveling at an impact speed of 63.2 mi/h, contacted the nose of the SRT-MASH 2016 with the centerline of the vehicle aligned with the centerline of post 1 at an impact angle of 4.2 degrees. The SRT-MASH 2016 activated as designed and permitted controlled gating of the 2270P vehicle. The SRT-MASH 2016 performed acceptably according to the evaluation criteria for MASH 2016 Test 3-33.</p>	PASS

Required Test Number	Narrative Description	Evaluation Results
3-34 (1100C)	<p>TTI Test Report No. 400001-SRT4, "MASH Test 3-34 on the SRT-MASH."</p> <p>The 1100C, traveling at an impact speed of 62.2 mi/h, impacted the SRT-MASH 2016 24 inches downstream of post 1 at an impact angle of 14.5 degrees. The SRT-MASH 2016 contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. The SRT-MASH 2016 performed acceptably according to the evaluation criteria for MASH 2016 Test 3-34.</p>	PASS
3-35 (2270P)	<p>TTI Report No. 403371-SRT3, "MASH Test 3-35 on SRT-MASH."</p> <p>The 2270P, traveling at an impact speed of 62.4 mi/h, impacted the SRT-MASH 2016 6.8 inches downstream of post 4 at an impact angle of 24.3 degrees. The SRT-MASH 2016 contained and redirected the 2270P vehicle. The vehicle did not penetrate or override the installation. The SRT-MASH performed acceptably according to the evaluation criteria for MASH 2016 Test 3-35.</p>	PASS
3-36 (2270P)	<p>MASH 2016 Test Designation 3-36 is designed to examine the behavior of terminals and redirective crash cushions attached to a rigid barrier or backup structure. As a W-beam guardrail terminal, the SRT-MASH 2016 is not attached directly to a stiff barrier or backup structure. Therefore, Test 3-36 is not relevant.</p>	Non-Relevant Test, not conducted
3-37b (1100C)	<p>TTI Test Report No. 190140-SRT12, "MASH Test 3-37b on the SRT M10."</p> <p>The 1100C, traveling at an impact speed of 61.7 mi/h, impacted the SRT-MASH 2016 15 ft-6 3/4 inches upstream of the downstream anchor post in the reverse direction at an impact angle of 25.2 degrees. The SRT-MASH 2016 slowed the 1100C vehicle and permitted the vehicle to gate through the system in a controlled manner. The SRT-MASH 2016 performed acceptably according to the evaluation criteria for MASH 2016 Test 3-37b.</p>	PASS

3-38 (1500A)	MASH 2016 Test Designation 3-38 is designed to evaluate the performance of staged energy-absorbing attenuators and end terminals when impacted by a mid-size vehicle. The SRT-MASH 2016 is not a staged energy absorbing device. The slots of the slotted rail sections buckle at a prescribed level of force and is not dependent on vehicle mass. Therefore, Test 3-38 is not relevant.	Non-Relevant Test, not conducted
3-40 (1100C)	MASH 2016 Test Designation 3-40 evaluates non-redirective crash cushions. The SRT-MASH 2016 is not a non-redirective crash cushion and, therefore, Test 3-40 is not relevant.	Non-Relevant Test, not conducted
3-41 (2270P)	MASH 2016 Test Designation 3-41 evaluates non-redirective crash cushions. The SRT-MASH 2016 is not a non-redirective crash cushion and, therefore, Test 3-41 is not relevant.	Non-Relevant Test, not conducted
3-42 (1100C)	MASH 2016 Test Designation 3-42 evaluates non-redirective crash cushions. The SRT-MASH 2016 is not a non-redirective crash cushion and, therefore, Test 3-42 is not relevant.	Non-Relevant Test, not conducted
3-43 (2270P)	MASH 2016 Test Designation 3-43 evaluates non-redirective crash cushions. The SRT-MASH 2016 is not a non-redirective crash cushion and, therefore, Test 3-43 is not relevant.	Non-Relevant Test, not conducted
3-44 (2270P)	MASH 2016 Test Designation 3-44 evaluates non-redirective crash cushions. The SRT-MASH 2016 is not a non-redirective crash cushion and, therefore, Test 3-44 is not relevant.	Non-Relevant Test, not conducted
3-45 (1500A)	MASH 2016 Test Designation 3-45 evaluates non-redirective crash cushions. The SRT-MASH 2016 is not a non-redirective crash cushion and, therefore, Test 3-45 is not relevant.	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:	Darrell L. Kuhn	Darrell L. Kuhn 2017.10.16 16:54:30 -05'00'
Address:	3135 TAMU, College Station, TX 77843-3135	Same as Submitter <input type="checkbox"/>
Country:	USA	Same as Submitter <input type="checkbox"/>
Accreditation Certificate Number and Dates of current Accreditation period :	A2LA Certificate No. 2821.01, April 30, 2019	

Submitter Signature*: Bligh, Roger P

Digitally signed by Bligh, Roger P
DN: postalCode=77863, o=KAMU-S&GK, street=Texas
A&M University, st=TX, c=College Station, c=US,
cn=Bligh, Roger P, email=rogerbligh@tamus.edu
Date: 2017.10.19 10:03:42 -0500**Submit Form**

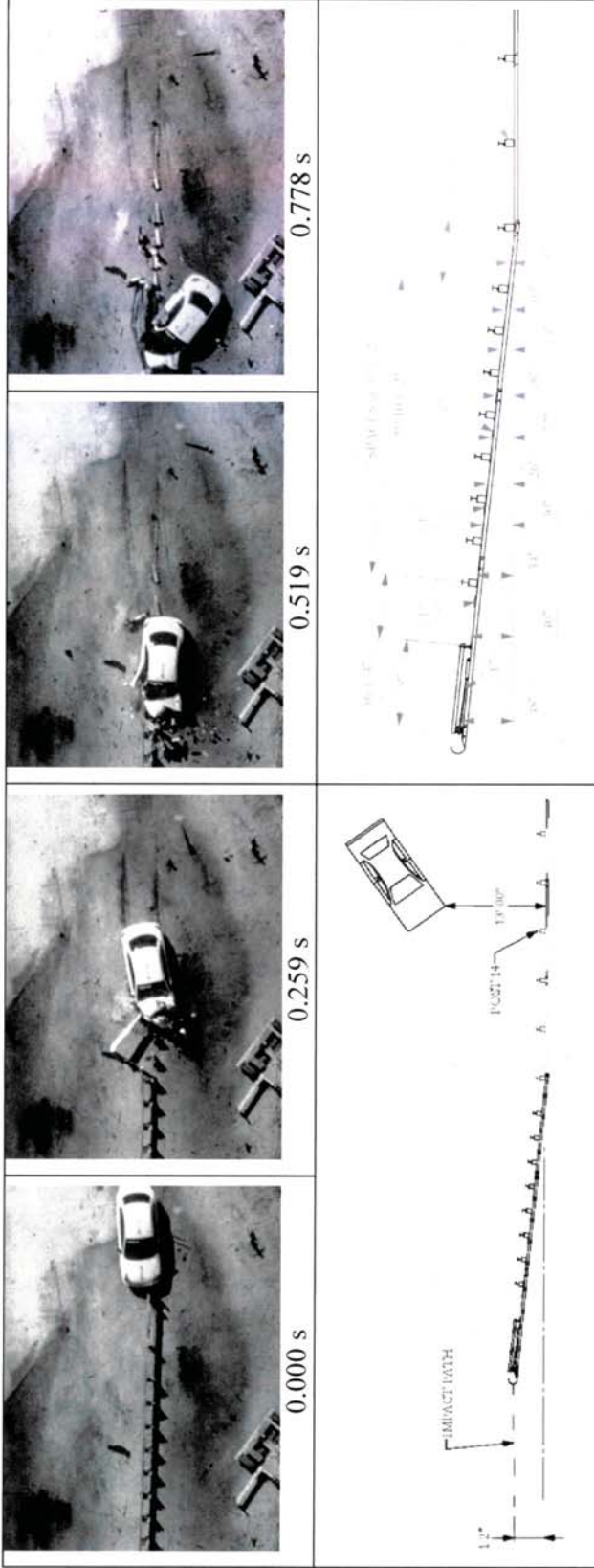
ATTACHMENTS

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 Transportation Institute (TTI)
Test Standard Test No..... MASH Test 3-30
TTI Test No..... 400001-SRT6
Date..... October 29, 2010
Test Article
Type..... Terminal
Name..... SRT-MASH
Installation Length..... 131 ft-3 inches
Material or Key Elements..... Slotted rail, CRP post 1, SYTP, anchor bracket and cable
Soil Type and Condition..... Standard Soil, Dry

Test Vehicle

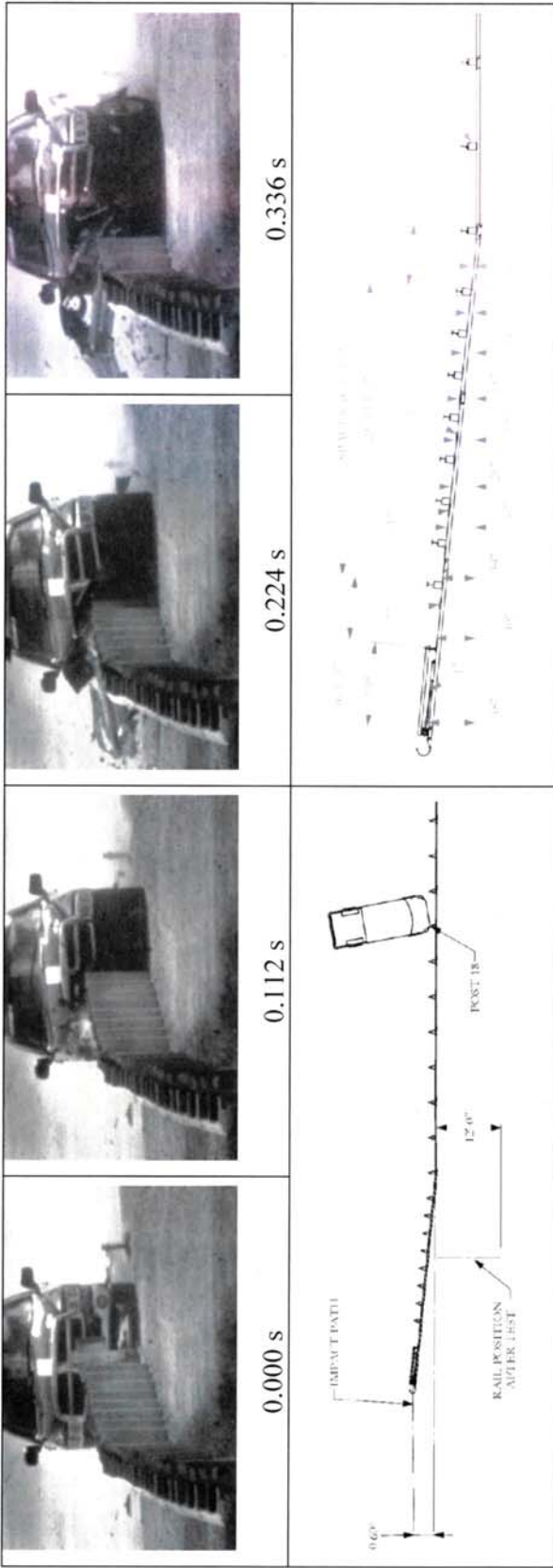
Type/Designation..... 1100C
Make and Model..... 2005 Kia Rio
Curb..... 2385 lb
Test Inertial..... 2423 lb
Dummy..... 178 lb
Gross Static..... 2601 lb

Impact Conditions

Speed..... 61.4 mi/h
Angle..... 1.2 degrees
Location/Orientation..... Nose
Kinetic Energy
Exit Conditions..... 305 kip-ft
Speed..... 12.0 mi/h
Angle..... 45.4 degrees
Occupant Risk Values
Impact Velocity..... 24.3 ft/s
Longitudinal..... 1.0 ft/s
Lateral..... 10.9 g
Ride-down Accelerations..... 6.6 g
Longitudinal..... 26.9 km/h
Lateral..... 11.4 g
THIV..... 0.66
PHD..... -7.6 g
ASI..... -1.9 g
Max. 0.050-s Average..... -3.1 g
Longitudinal.....
Lateral.....
Vertical.....

Post-Impact Trajectory

Stopping Distance..... 43.75 ft downstrm
26.3 ft twd field side
Vehicle Stability
Maximum Yaw Angle..... 151 degrees
Maximum Pitch Angle..... -10 degrees
Maximum Roll Angle..... 10 degrees
Vehicle Snagging..... No
Vehicle Pocketing..... No
Test Article Deflections
Dynamic..... 5.3 ft
Permanent..... 5.3 ft
Vehicle Damage
VDS..... 12RFO6
CDC..... 12FREW4
Max. Extensor Deformation..... 12.0 inches
OCDI..... RF1000100
Max. Occupant Compartment Deformation..... 6.25 inches



General Information

Test Agency Texas Transportation Institute (TTI)
 Test Standard Test No. MASH 3-31
 TTI Test No. 400001-SRT5
 Date October 21, 2010
 Test Article
 Type Terminal
 Name SRT-MASH
 Installation Length 131 ft-3 inches
 Material or Key Elements Slotted rail, CRP post 1, SYTP, anchor bracket and cable
 Soil Type and Condition Standard Soil, Dry

Test Vehicle

Type/Designation 2270P
 Make and Model 2003 Dodge Ram 1500 Pickup Truck
 Curb 4774 lb
 Test Inertial 5021 lb
 Dummy No dummy
 Gross Static 5021 lb

Impact Conditions

Speed 61.0 mi/h
 Angle 0.6 degrees
 Location/Orientation Nose
 Kinetic Energy 624 kip-ft
 Exit Conditions
 Speed Not obtainable
 Angle Not obtainable
 Occupant Risk Values
 Impact Velocity
 Longitudinal 18.0 ft/s
 Lateral 2.0 ft/s
 Ridedown Accelerations
 Longitudinal 11.8 G
 Lateral 7.6 G
 THIV 20.0 km/h
 ASI 0.50
 Max. 0.050-s Average
 Longitudinal 4.7 G
 Lateral 1.5 G
 Vertical -3.0 G

Post-Impact Trajectory

Stopping Distance 81.0 ft downstrm
 Against field side

Vehicle Stability

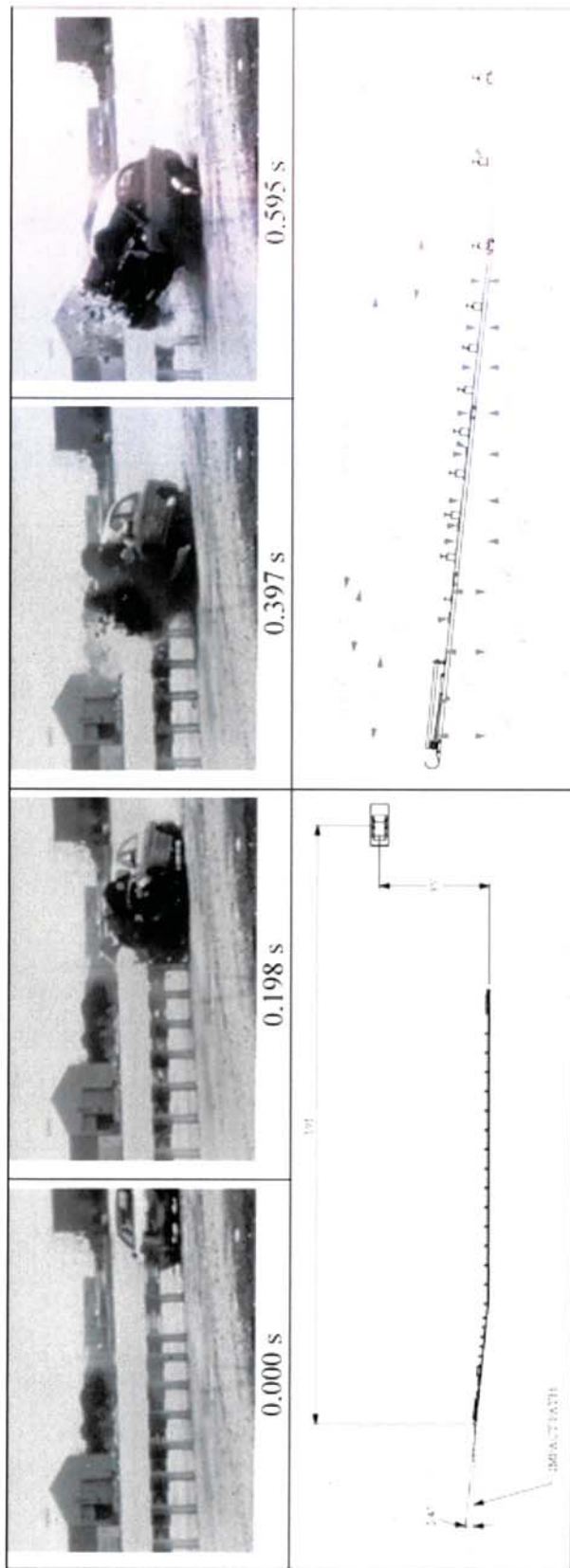
Maximum Yaw Angle 72 degrees
 Maximum Pitch Angle 5 degrees
 Maximum Roll Angle 7 degrees
 Vehicle Snagging No
 Vehicle Pocketing No

Test Article Deflections

Dynamic 13.3 ft
 Permanent 12.5 ft
 Working Width 20.25 ft

Vehicle Damage

VDS 12FC4
 CDC 12FCEW4
 Max. Exterior Deformation 17.0 inches
 OCDI FS0000000
 Max. Occupant Compartment Deformation 0



* Corrected 2015-11-17

General Information

Test Agency Texas Transportation Institute (TTI)
 Test Standard Test No. MASH Test 3-32
 TTI Test No. 400001-SRT8
 Date January 21, 2011

Test Article

Type Terminal
 Name SRT-MASH
 Installation Length 125 ft
 Material or Key Elements Slotted rail, CRP post 1, SYTP, anchor bracket and cable
 Standard Soil, Dry

Soil Type and Condition

Type/Designation 1100C
 Make and Model 2005 Kia Rio
 Curb 2385 lb
 Test Inertial 2412 lb
 Dummy 172 lb
 Gross Static 2584 lb

Impact Conditions

Speed 61.5 mi/h
 Angle 5.4 degrees
 Location/Orientation Nose
 Kinetic Energy 305 kip-ft*
 Exit Conditions
 Speed 40.0 mi/h
 Angle 2.0 degrees
 Occupant Risk Values
 Longitudinal OIV 24.6 ft/s
 Lateral OIV 3.3 ft/s
 Longitudinal RDA 5.0 g
 Lateral RDA 5.6 g
 THIV 27.3 km/h
 PHD 7.4 g
 ASI 0.64
 Max. 0.050-s Average
 Longitudinal -6.7 g
 Lateral 1.8 g
 Vertical -5.2 g

Post-Impact Trajectory

Stopping Distance 191 ft downstrm
 35 ft twd field side

Vehicle Stability

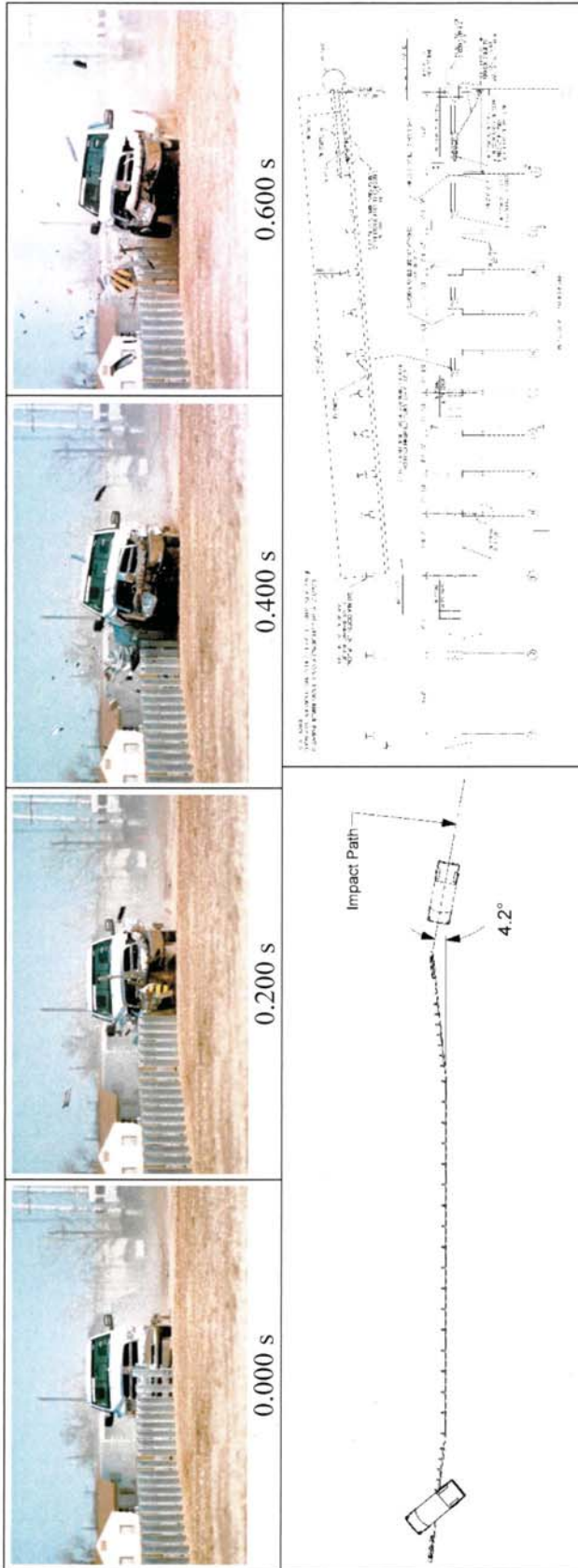
Maximum Yaw Angle -8 degrees
 Maximum Pitch Angle 14 degrees
 Maximum Roll Angle -32 degrees
 Vehicle Snagging No
 Vehicle Pocketing No

Test Article Deflections

Dynamic 4.0 ft
 Permanent 4.0 ft
 Working Width NA

Vehicle Damage

VDS 12FD6
 CDC 12FDEW4
 Max. Exterior Deformation 7.0 inches
 OCDI FS0000000
 Max. Occupant Compartment Deformation 0



General Information

Test Agency..... Texas A&M Transportation Institute (TTI)
 Test Standard Test No..... MASH Test 3-33
 TTI Test No..... 690900-SRT9
 Test Date..... 2017-02-09

Test Article

Type..... Terminal
 Name..... SRT M10
 Installation Length..... 181 ft-3 inches
 Material or Key Elements..... 37 ft-6-inch long SRT M10 terminal with steel posts and 8-inch deep routed wood offset blocks
 Soil Type and Condition..... AASHTO M147-65(2004), grading B Soil (crushed limestone), damp

Test Vehicle

Type/Designation..... 2270P
 Make and Model..... 2012 Dodge RAM 1500
 Curb..... 4934 lb
 Test Inertial..... 5040 lb
 Dummy..... No dummy
 Gross Static..... 5040 lb

Impact Conditions

Speed..... 63.2 mi/h
 Angle Relative to LON..... 4.2 degrees
 Location/Orientation..... Post 1

Impact Severity

Exit Conditions
 Speed..... 51.5 mi/h
 Angle Relative to LON..... 4.9 degrees

Occupant Risk Values

Longitudinal OIV..... 14.1 ft/s
 Lateral OIV..... 3.0 ft/s
 Longitudinal Ridedown..... 6.9 g
 Lateral Ridedown..... 6.5 g
 THIV..... 15.9 km/h
 PHD..... 7.6 g
 ASI..... 0.30
 Max. 0.050-s Average
 Longitudinal..... -3.8 g
 Lateral..... -1.9 g
 Vertical..... -2.1 g

Post-Impact Trajectory

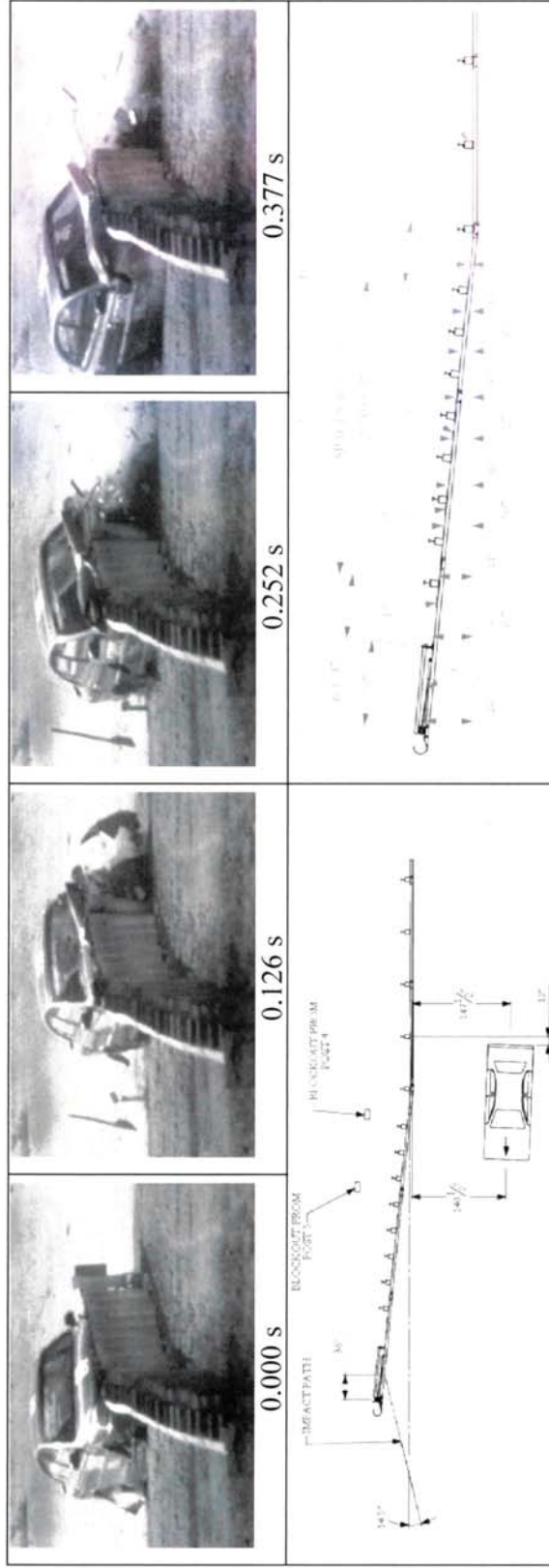
Stopping Distance..... 173 ft downstrm
 10 ft twd traffic side

Vehicle Stability

Maximum Yaw Angle..... 27 degrees
 Maximum Pitch Angle..... 3 degrees
 Maximum Roll Angle..... 11 degrees
 Vehicle Snagging..... No
 Vehicle Pocketing..... No

Vehicle Damage

VDS..... 01RFQ6
 CDC..... 01RFEW4
 Max. Exterior Deformation..... 16.0 inches
 OCDI..... FS0000000
 Max. Occupant Compartment Deformation..... None



General Information

Test Agency Texas Transportation Institute (TTI)
 Test Standard Test No. MASH 3-34
 TTI Test No. 400001-SRT4
 Date October 19, 2010
 Test Article
 Type Terminal
 Name SRT-MASH
 Installation Length 131 ft-3 inches
 Material or Key Elements Slotted rail, CRP post 1, SYTP, anchor bracket and cable
 Soil Type and Condition Standard Soil, Dry

Test Vehicle

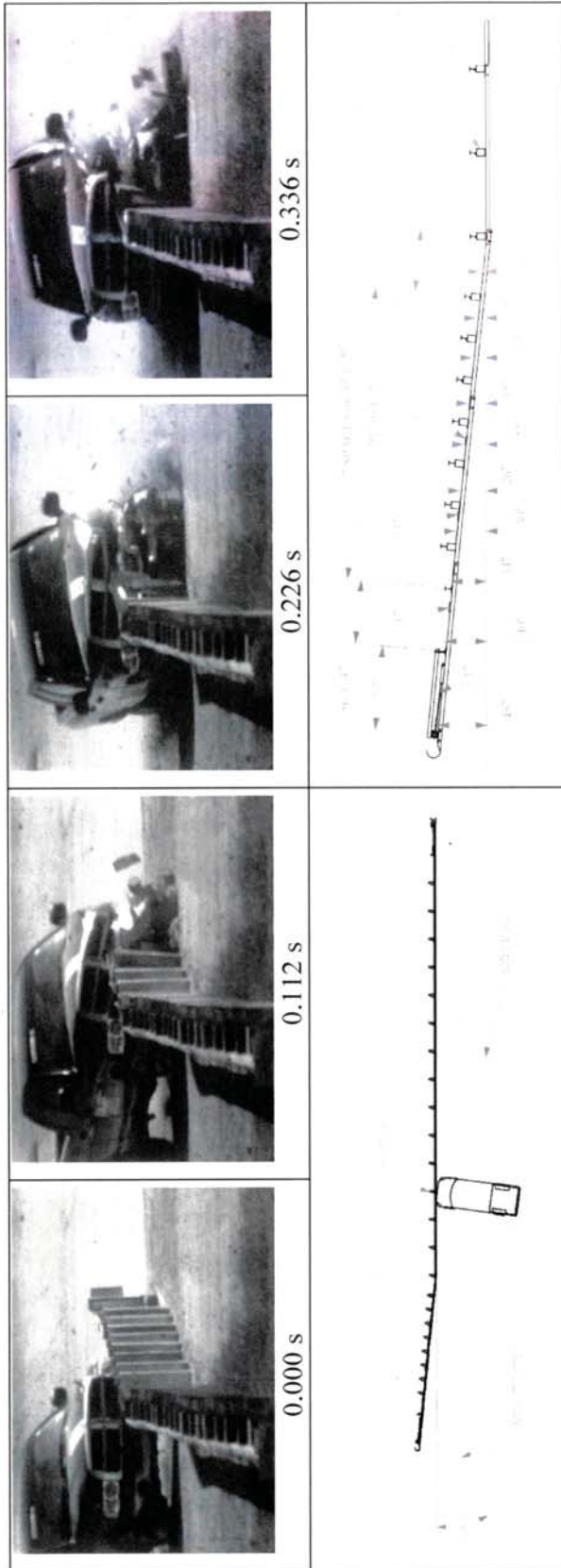
Type/Designation 1100C
 Make and Model 2004 Kia Rio
 Curb 2428 lb
 Test Inertial 2431 lb
 Dummy 174 lb
 Gross Static 2605 lb

Impact Conditions

Speed 62.2 mi/h
 Angle 14.5 degrees
 Location/Orientation 24 inches
 Impact Severity 19 kip-ft, downstream post 1
 Exit Conditions
 Speed 13.3 mi/h
 Angle 64.6 degrees
 Occupant Risk Values
 Impact Velocity
 Longitudinal 34.8 ft/s
 Lateral 13.4 ft/s
 Ridedown Accelerations
 Longitudinal 12.0 g
 Lateral 5.4 g
 THIV 41.1 km/h
 PHD 13.0 g
 ASI 1.08
 Max. 0.050-s Average
 Longitudinal -11.9 g
 Lateral 3.9 g
 Vertical 3.0 g

Post-Impact Trajectory

Stopping Distance 43.8 ft
 Vehicle Stability
 Maximum Yaw Angle -166 degrees
 Maximum Pitch Angle 2 degrees
 Maximum Roll Angle 11 degrees
 Vehicle Snagging No
 Vehicle Pocketing No
 Test Article Deflections
 Dynamic 2.62 ft
 Permanent 2.62 ft
 Working Width 2.62 ft
 Vehicle Damage
 VDS 11LFO6
 CDC 11FLEW4
 Max. Exterior Deformation 15.5 inches
 OCDI FS0000000
 Max. Occupant Compartment Deformation 0



General Information

Test Agency..... Texas Transportation Institute (TTI)

Test Standard Test No..... MASH Test 3-35

TTI Test No..... 403371-SRT3

Date..... 2010-10-04

Test Article

Type..... Terminal

Name..... SRT-MASH

Installation Length..... 137 ft-6 inches

Material or Key Elements..... Slotted rail, CRP post 1, SYTP, anchor bracket and cable

Soil Type and Condition..... Standard Soil, Dry

Test Vehicle

Type/Designation..... 2270P

Make and Model..... 2003 Dodge Ram 1500 Pickup

Curb..... 4712 lb

Test Inertial..... 4948 lb

Dummy..... No dummy

Gross Static..... 4948 lb

Impact Conditions

Speed..... 62.4 mi/h

Angle..... 24.3 degrees

Location/Orientation..... Post 4

Impact Severity..... 3507 kip-ft (-4.9%)

Exit Conditions

Speed..... Not obtainable

Angle..... Not obtainable

Occupant Risk Values

Impact Velocity

Longitudinal..... 21.6 ft/s

Lateral..... 16.7 ft/s

Ridedown Accelerations

Longitudinal..... 8.1 G

Lateral..... 5.2 G

THIV..... 29.5 km/h

PHD..... 9.4 G

ASI..... 0.77

Max. 0.050-s Average

Longitudinal..... -6.7 G

Lateral..... 5.1 G

Vertical..... 1.6 G

Post-Impact Trajectory

Stopping Distance..... 81.3 ft

Vehicle Stability

Maximum Yaw Angle..... -43 degrees

Maximum Pitch Angle..... -5 degrees

Maximum Roll Angle..... 9 degrees

Vehicle Snagging..... No

Vehicle Pocketing..... No

Test Article Deflections

Dynamic..... 3.8 ft

Permanent..... 3.8 ft

Working Width..... 4.0 ft

Vehicle Damage

VDS..... 11LFQ5

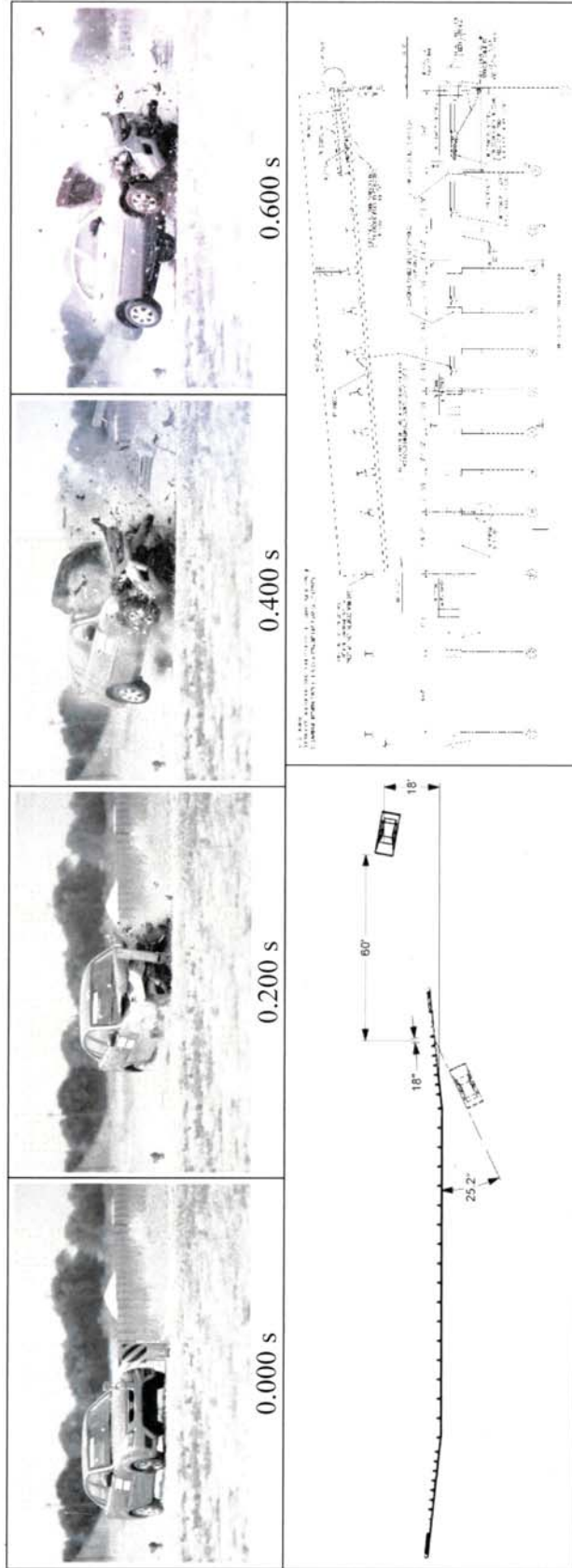
CDC..... 11FLEW4

Max. Exterior Deformation..... 16.0 inches

OCDI..... LF0000000

Max. Occupant Compartment

Deformation..... 1.5 inches



General Information

Test Agency..... Texas A&M Transportation Institute (TTI)
Test Standard Test No..... MASH Test 3-37b
TTI Test No..... 190140-SRT12
Test Date..... 2017-06-21

Test Article
Type..... Terminal
Name..... SRT M10
Installation Length..... 181 ft 3 inches
Material or Key Elements..... 37 ft-6-inch long, 31-inch tall, SRT M10 terminal with steel posts and 8-inch deep routed wood offset blocks

Soil Type and Condition..... AASHTO M147-65(2004), grading B Soil (crushed limestone), damp

Test Vehicle
Type/Designation..... 1100C
Make and Model..... 2011 Kia Rio
Curb..... 2470 lb
Test Inertial..... 2432 lb
Dummy..... 165 lb
Gross Static..... 2597 lb

Impact Conditions

Speed..... 61.7 mi/h
Angle Relative to LON..... 25.2 degrees
Location/Orientation..... 15 ft 6 3/4 inches upstream end
Rev Direction..... 54 kip-ft

Exit Conditions
Speed..... 30.8 mi/h
Angle Relative to LON..... 0.1 degrees

Occupant Risk Values
Longitudinal OIV..... 18.7 ft/s
Lateral OIV..... 14.8 ft/s
Longitudinal Ridedown..... 12.9 g
Lateral Ridedown..... 7.4 g
THIV..... 25.7 km/h
PHD..... 13.0 g
ASI..... 0.85
Max. 0.050-s Average
Longitudinal..... -9.3 g
Lateral..... 6.0 g
Vertical..... -4.5 g

Post-Impact Trajectory

Stopping Distance..... 60 ft downstream
18 ft twd field side

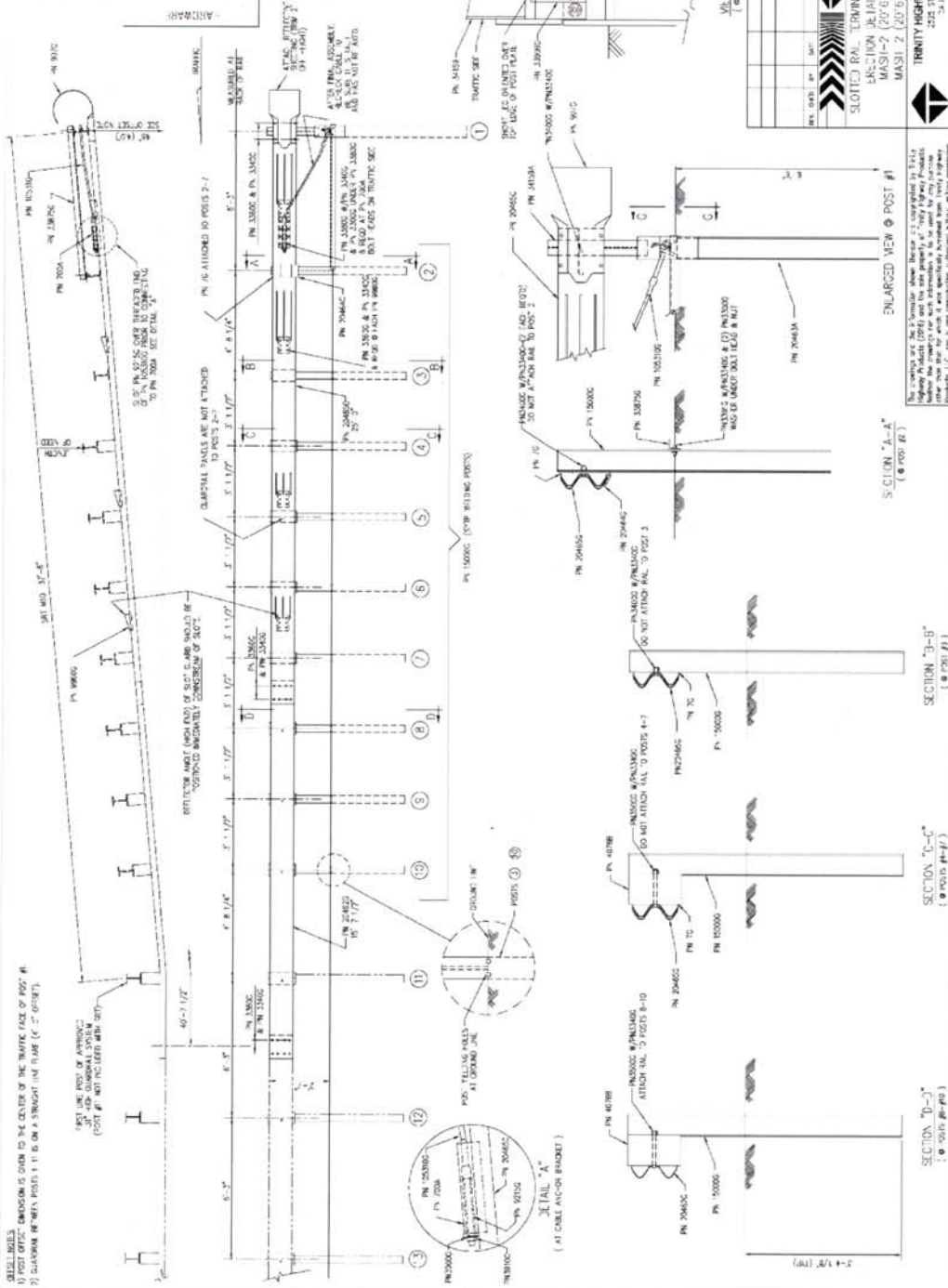
Vehicle Stability

Maximum Yaw Angle..... 115 degrees
Maximum Pitch Angle..... 6 degrees
Maximum Roll Angle..... 13 degrees
Vehicle Snagging..... No
Vehicle Pocketing..... No

Vehicle Damage

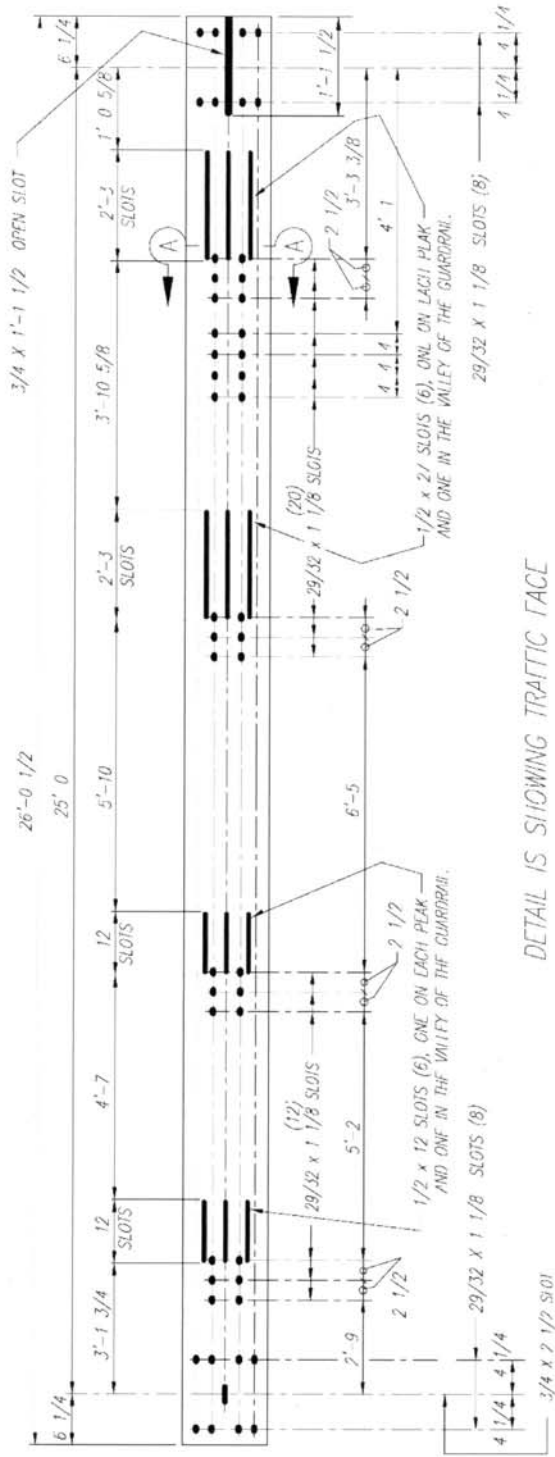
VDS..... 11LFQ3
CDC..... 11LFEW2
Max. Exterior Deformation..... 12.0 inches
OCDI..... LF0000000
Max. Occupant Compartment Deformation..... 0.5 inch

EN	Q ¹	Q ²	Q ³	Q ⁴	Q ⁵	Q ⁶	Q ⁷	Q ⁸	Q ⁹	Q ¹⁰	Q ¹¹	Q ¹²	Q ¹³	Q ¹⁴	Q ¹⁵	Q ¹⁶	Q ¹⁷	Q ¹⁸	Q ¹⁹	Q ²⁰	Q ²¹	Q ²²	Q ²³	Q ²⁴	Q ²⁵	Q ²⁶	Q ²⁷	Q ²⁸	Q ²⁹	Q ³⁰	Q ³¹	Q ³²	Q ³³	Q ³⁴	Q ³⁵	Q ³⁶	Q ³⁷	Q ³⁸	Q ³⁹	Q ⁴⁰	Q ⁴¹	Q ⁴²	Q ⁴³	Q ⁴⁴	Q ⁴⁵	Q ⁴⁶	Q ⁴⁷	Q ⁴⁸	Q ⁴⁹	Q ⁵⁰	Q ⁵¹	Q ⁵²	Q ⁵³	Q ⁵⁴	Q ⁵⁵	Q ⁵⁶	Q ⁵⁷	Q ⁵⁸	Q ⁵⁹	Q ⁶⁰	Q ⁶¹	Q ⁶²	Q ⁶³	Q ⁶⁴	Q ⁶⁵	Q ⁶⁶	Q ⁶⁷	Q ⁶⁸	Q ⁶⁹	Q ⁷⁰	Q ⁷¹	Q ⁷²	Q ⁷³	Q ⁷⁴	Q ⁷⁵	Q ⁷⁶	Q ⁷⁷	Q ⁷⁸	Q ⁷⁹	Q ⁸⁰	Q ⁸¹	Q ⁸²	Q ⁸³	Q ⁸⁴	Q ⁸⁵	Q ⁸⁶	Q ⁸⁷	Q ⁸⁸	Q ⁸⁹	Q ⁹⁰	Q ⁹¹	Q ⁹²	Q ⁹³	Q ⁹⁴	Q ⁹⁵	Q ⁹⁶	Q ⁹⁷	Q ⁹⁸	Q ⁹⁹	Q ¹⁰⁰	Q ¹⁰¹	Q ¹⁰²	Q ¹⁰³	Q ¹⁰⁴	Q ¹⁰⁵	Q ¹⁰⁶	Q ¹⁰⁷	Q ¹⁰⁸	Q ¹⁰⁹	Q ¹¹⁰	Q ¹¹¹	Q ¹¹²	Q ¹¹³	Q ¹¹⁴	Q ¹¹⁵	Q ¹¹⁶	Q ¹¹⁷	Q ¹¹⁸	Q ¹¹⁹	Q ¹²⁰	Q ¹²¹	Q ¹²²	Q ¹²³	Q ¹²⁴	Q ¹²⁵	Q ¹²⁶	Q ¹²⁷	Q ¹²⁸	Q ¹²⁹	Q ¹³⁰	Q ¹³¹	Q ¹³²	Q ¹³³	Q ¹³⁴	Q ¹³⁵	Q ¹³⁶	Q ¹³⁷	Q ¹³⁸	Q ¹³⁹	Q ¹⁴⁰	Q ¹⁴¹	Q ¹⁴²	Q ¹⁴³	Q ¹⁴⁴	Q ¹⁴⁵	Q ¹⁴⁶	Q ¹⁴⁷	Q ¹⁴⁸	Q ¹⁴⁹	Q ¹⁵⁰	Q ¹⁵¹	Q ¹⁵²	Q ¹⁵³	Q ¹⁵⁴	Q ¹⁵⁵	Q ¹⁵⁶	Q ¹⁵⁷	Q ¹⁵⁸	Q ¹⁵⁹	Q ¹⁶⁰	Q ¹⁶¹	Q ¹⁶²	Q ¹⁶³	Q ¹⁶⁴	Q ¹⁶⁵	Q ¹⁶⁶	Q ¹⁶⁷	Q ¹⁶⁸	Q ¹⁶⁹	Q ¹⁷⁰	Q ¹⁷¹	Q ¹⁷²	Q ¹⁷³	Q ¹⁷⁴	Q ¹⁷⁵	Q ¹⁷⁶	Q ¹⁷⁷	Q ¹⁷⁸	Q ¹⁷⁹	Q ¹⁸⁰	Q ¹⁸¹	Q ¹⁸²	Q ¹⁸³	Q ¹⁸⁴	Q ¹⁸⁵	Q ¹⁸⁶	Q ¹⁸⁷	Q ¹⁸⁸	Q ¹⁸⁹	Q ¹⁹⁰	Q ¹⁹¹	Q ¹⁹²	Q ¹⁹³	Q ¹⁹⁴	Q ¹⁹⁵	Q ¹⁹⁶	Q ¹⁹⁷	Q ¹⁹⁸	Q ¹⁹⁹	Q ²⁰⁰	Q ²⁰¹	Q ²⁰²	Q ²⁰³	Q ²⁰⁴	Q ²⁰⁵	Q ²⁰⁶	Q ²⁰⁷	Q ²⁰⁸	Q ²⁰⁹	Q ²¹⁰	Q ²¹¹	Q ²¹²	Q ²¹³	Q ²¹⁴	Q ²¹⁵	Q ²¹⁶	Q ²¹⁷	Q ²¹⁸	Q ²¹⁹	Q ²²⁰	Q ²²¹	Q ²²²	Q ²²³	Q ²²⁴	Q ²²⁵	Q ²²⁶	Q ²²⁷	Q ²²⁸	Q ²²⁹	Q ²³⁰	Q ²³¹	Q ²³²	Q ²³³	Q ²³⁴	Q ²³⁵	Q ²³⁶	Q ²³⁷	Q ²³⁸	Q ²³⁹	Q ²⁴⁰	Q ²⁴¹	Q ²⁴²	Q ²⁴³	Q ²⁴⁴	Q ²⁴⁵	Q ²⁴⁶	Q ²⁴⁷	Q ²⁴⁸	Q ²⁴⁹	Q ²⁵⁰	Q ²⁵¹	Q ²⁵²	Q ²⁵³	Q ²⁵⁴	Q ²⁵⁵	Q ²⁵⁶	Q ²⁵⁷	Q ²⁵⁸	Q ²⁵⁹	Q ²⁶⁰	Q ²⁶¹	Q ²⁶²	Q ²⁶³	Q ²⁶⁴	Q ²⁶⁵	Q ²⁶⁶	Q ²⁶⁷	Q ²⁶⁸	Q ²⁶⁹	Q ²⁷⁰	Q ²⁷¹	Q ²⁷²	Q ²⁷³	Q ²⁷⁴	Q ²⁷⁵	Q ²⁷⁶	Q ²⁷⁷	Q ²⁷⁸	Q ²⁷⁹
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REV.	DATE	BY	DATE
			
SLOTTED RAIL "CONFORM SPT M10 (31") (1)"			
PRE-CONC. 2" JARS TYP 1-3/32;			
MASH-2 (20'6") TEST 3-3/32;			
MASH 1 (20'6") 1/32 5/7			
THINNY HANDED PRODUCTS, L.L.C.			
2250 N. 10TH AVE. SUITE 200			
MINNAPOLIS, MN 55412-7000			

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DETAIL IS SHOWING TRAFFIC FACE



SECTION A - A

This part combines SRT M10 Rails #1 & #2, (PN 20460 & 20461)

VAL: BAL: AASH TO M 180 (12 Co.) FINISH M-180

TRINITY HIGHWAY PRODUCTS, LLC.

225 STAMPS TRUCKWAY

12/25'-0"/SPECIAL/S

SR - MASH

RAIL #1 & #2 COMBINED

SCALE: N. S.

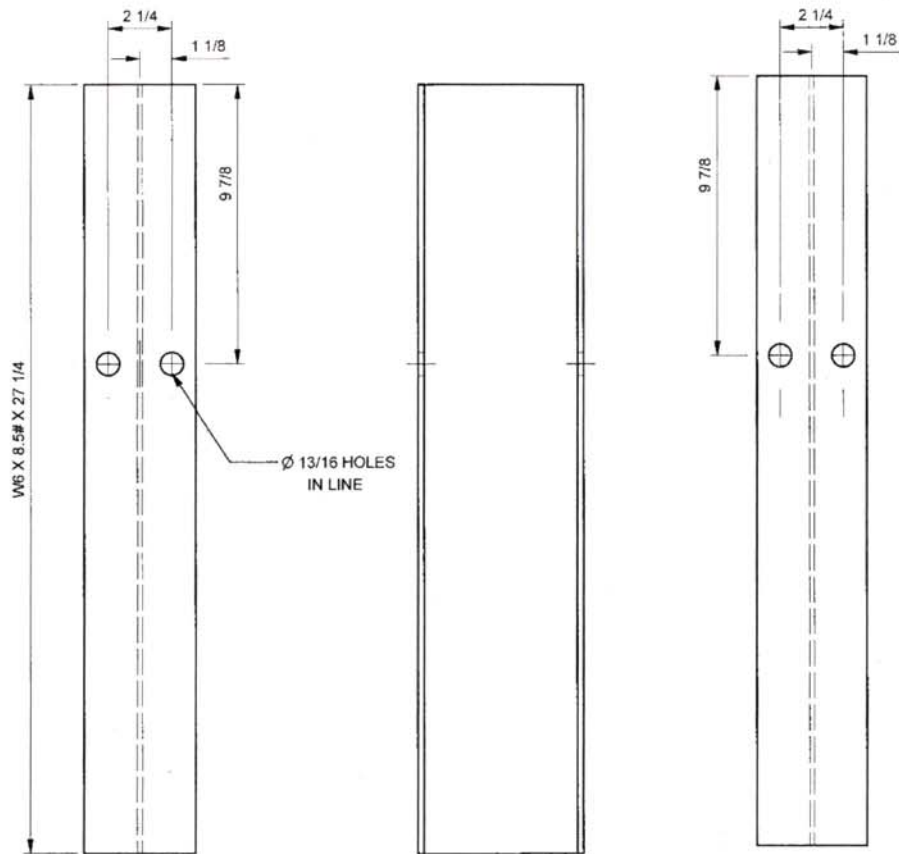
DATE: 2-2-9

REV: 0

APPROX. SH-PG. W-1, 185#

MR	BY	DATE	REVISION

F:\R\Share\Engineering\SS\WIP\SRT MASH\20465 Corbado Rail.dwg



MATERIAL
ASTM A36

FINISH
GALVANIZE, ASTM A123

EST UNFINISHED WT: 20.3 lbs

DRAWN: cortesc DATE: 9/9/2016
CHECKED: BT DATE: 9-9-16

UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE IN INCHES
DIMENSIONS ACCORDING TO ASME Y14.5M AND CEMC-THP-SF-003
UNLESS OTHERWISE SPECIFIED

Revision

NOTES:

1. FINISH AND GENERAL WORKMANSHIP PER CEMC-THP-SF-004, UNLESS OTHERWISE SPECIFIED.

TOLERANCES PER
CEMC-THP-SF-001, UNLESS
OTHERWISE SPECIFIED.

DO NOT SCALE DRAWING

ECO Date Rev By Chk.

W6 x 8.5X 2' -31/4"

PROTOTYPE FOR TEST



034158 TST

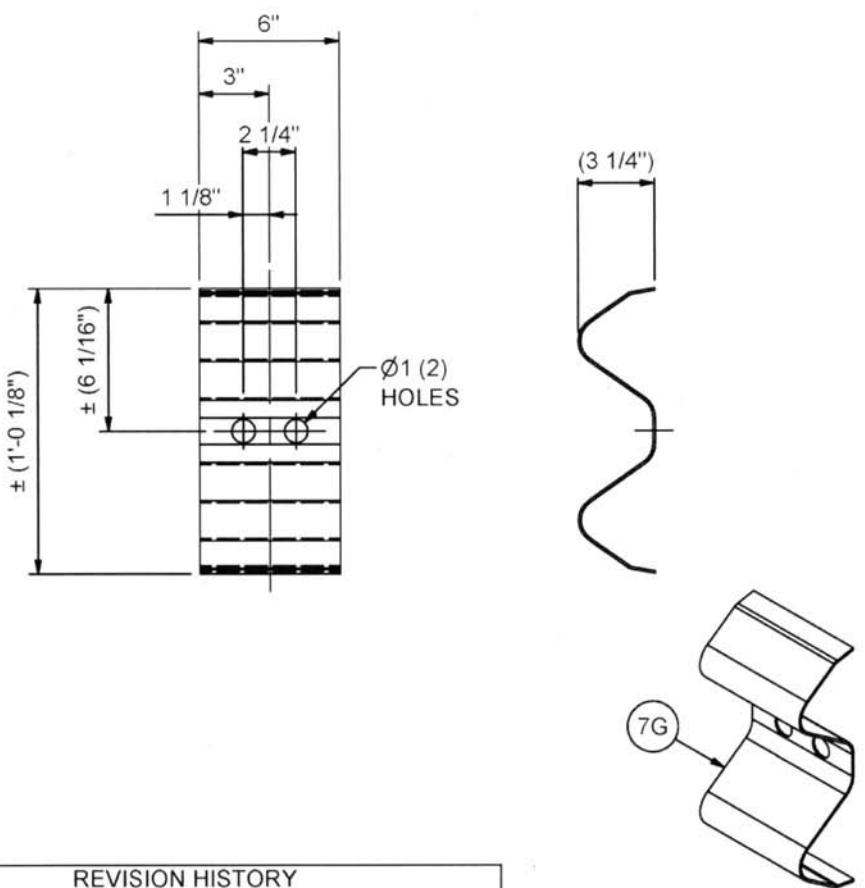

REV

SHEET

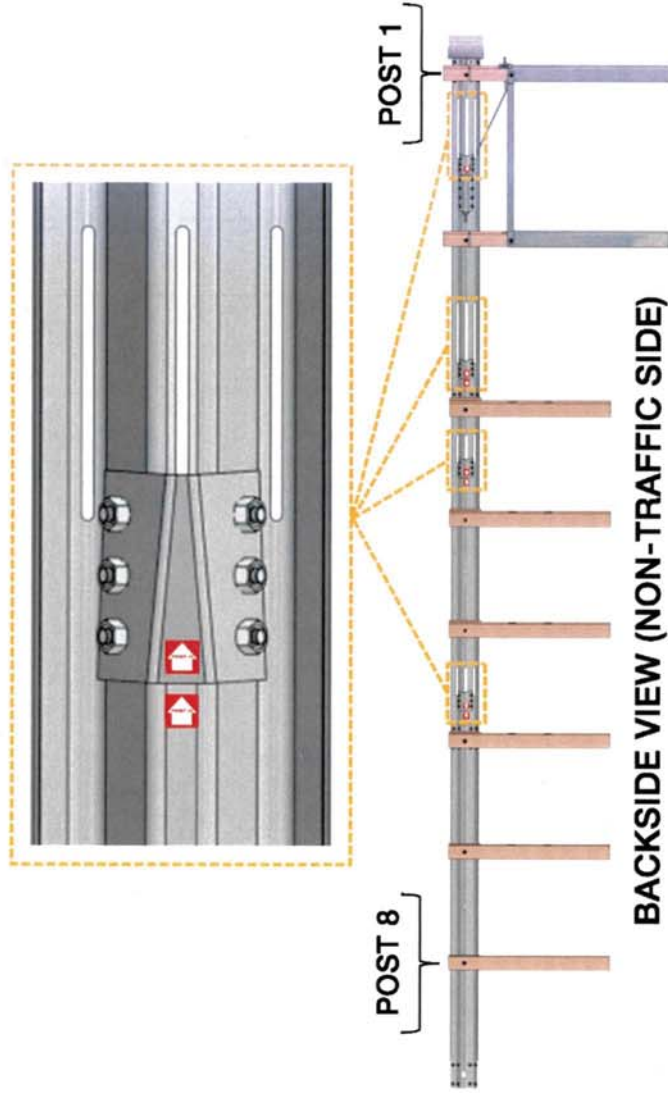
1 of 1

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CEMC-THP-FE-004 Rev E, 1/22/2018

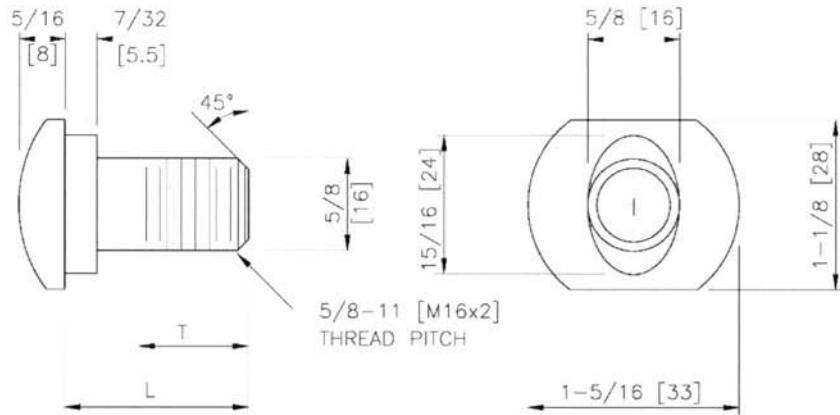
BILL OF MATERIAL				
QTY	PART No	DESCRIPTION	Lbs / Each	MATERIAL
1	7G	12 GA W-BEAM GUARDRAIL x 6"	3.32	M180
<div style="display: flex; justify-content: space-around; align-items: center;">  </div>				
REVISION HISTORY				
REV	DESCRIPTION	DATE	BY	
1	HOLES FROM 13/16 TO 1"	7/13/2006	E.A.S.	
<p>All material must be melted and manufactured in the U.S.A. Original raw material producing mill test reports are required. All mill test reports must be signed by an authorized representative of the producing mill. All material must have full traceability from all sources. All receipts must be identified by quantity, either in pounds or pieces, by heat number. All welding shall be in accordance with ANSI/AWS D1.1 section 5 and D1.5 section 3.</p>				
<p>The drawings and the information shown thereon are copyrighted by TRINITY HIGHWAY PRODUCTS, LLC. (2013) and the sole property of TRINITY HIGHWAY PRODUCTS, LLC. Neither the drawings nor such information is to be used for any purpose other than that for which it was specifically furnished from TRINITY HIGHWAY PRODUCTS, LLC, nor is any reproduction authorized without written permission.</p>		<p>FLANGE PROTECTOR T31 & T39 GUARDRAIL SYSTEM - 12 GA W-BEAM x 6"</p>		<p>SPEC: A123</p>
				<p>SHIP WT: 3.52 lb</p>
				<p>DRW: E.A.S. 5/21/2006</p>
				<p>CHK: B.S. 5/22/2006</p>
				<p>SHT: 1 OF 1 SIZE: A</p>
				<p>DWG NO: 000007</p>
				<p>REV 1</p>
<p>PROJ. T31 & T39 SYSTEM</p>		<p> TRINITY HIGHWAY PRODUCTS, LLC</p>		

000007.iss

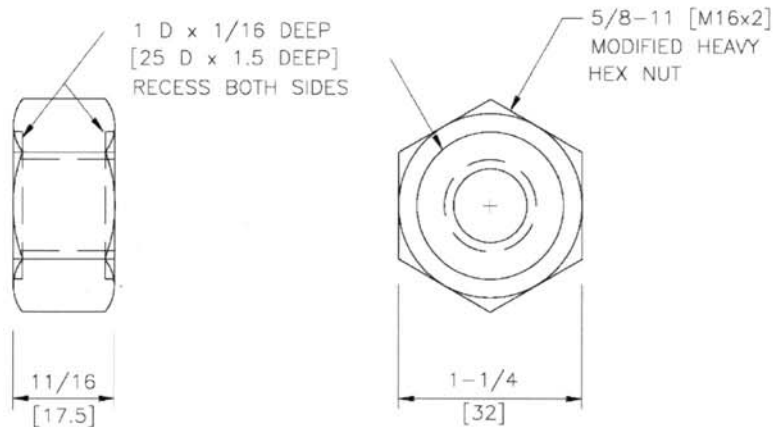


NOTE: APPLIES TO BOTH WOOD & STEEL POST SRT CONFIGURATIONS.

- NOTES:**
1. ALL FILLETS SHALL HAVE A MINIMUM RADIUS OF 1/16 [2].
 2. IF THE BOLT EXTENDS MORE THAN 1/4 [6] FROM THE NUT THE BOLT SHOULD BE TRIMMED BACK.



DESIGNATOR	L	T (MIN)
FBB01	1-1/4 [35]	1-1/8 [30]
FBB02	2 [50]	1-3/4 [45]
FBB03	10 [255]	4 [100]
FBB04	18 [460]	4 [100]
FBB05	25 [640]	4 [100]



1976

GUARDRAIL BOLT AND RECESSED NUT

FBB01-05

SHEET NO.	DATE:
1 of 2	6/30/2005

SPECIFICATIONS

The geometry and material specifications for this oval shoulder button-headed bolt and hex nut are found in AASHTO M 180. The bolt shall have 5/8-11 [M16x2] threads as defined in ANSI B1.1 [ANSI B1.13M] for Class 2A [6g] tolerances. Bolt material shall conform to ASTM A307 Grade A [ASTM F 568M Class 4.6], with a tensile strength of 60 ksi [400 MPa] and yield strength of 36 ksi [240 MPa]. Material for corrosion-resistant bolts shall conform to ASTM A325 Type 3 [ASTM F 568M Class 8.8.3], with tensile strength of 120 ksi [830 MPa] and yield strength of 92 ksi [660 MPa]. This bolt material has corrosion resistance comparable to ASTM A588 steels. Metric zinc-coated bolt heads shall be marked as specified in ASTM F 568 Section 9 with the symbol "4.6."

Nuts shall have ANSI B1.1 Class 2B [ANSI B1.13M Class 6h] 5/8-11 [M16x2] threads. The geometry of the nuts, with the exception of the recess shown in the drawing, shall conform to ANSI B18.2.2 [ANSI B18.2.4.1M Style 1] for zinc-coated hex nuts (shown in drawing) and ANSI B18.2.2 [ANSI B18.2.4.6M] for heavy hex corrosion-resistant nuts (not shown in drawing). Material for zinc-coated nuts shall conform to the requirements of AASHTO M 291 (ASTM A 563) Grade A [AASHTO M 291M (ASTM A 563M) Class 5], and material for corrosion-resistant nuts shall conform to the requirements of AASHTO M 291 (ASTM A 563) Grade C3 [AASHTO M 291M (ASTM A 563M) Class 8S3].

When zinc-coated bolts and nuts are required, the coating shall conform to either AASHTO M 232 (ASTM A 153/A 153M) for Class C or AASHTO M 298 (ASTM B 695) for Class 50. Zinc-coated nuts shall be tapped over-size as specified in AASHTO M 291 (ASTM A 563) [AASHTO M 291M (ASTM A 563M)], except that a diametrical allowance of 0.020 inch [0.510 mm] shall be used instead of 0.016 inches [0.420 mm].

Designator	Stress Area of Threaded Bolt Shank (in ² [mm ²])	Min. Bolt Tensile Strength (kips [kN])
FBB01-05	0.226 [157.0]	13.6 [62.8]

Dimensional 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.

INTENDED USE

These bolts and nuts are used in numerous guardrail and median barrier designs.

GUARDRAIL BOLT AND RECESSED NUT

FBB01-05

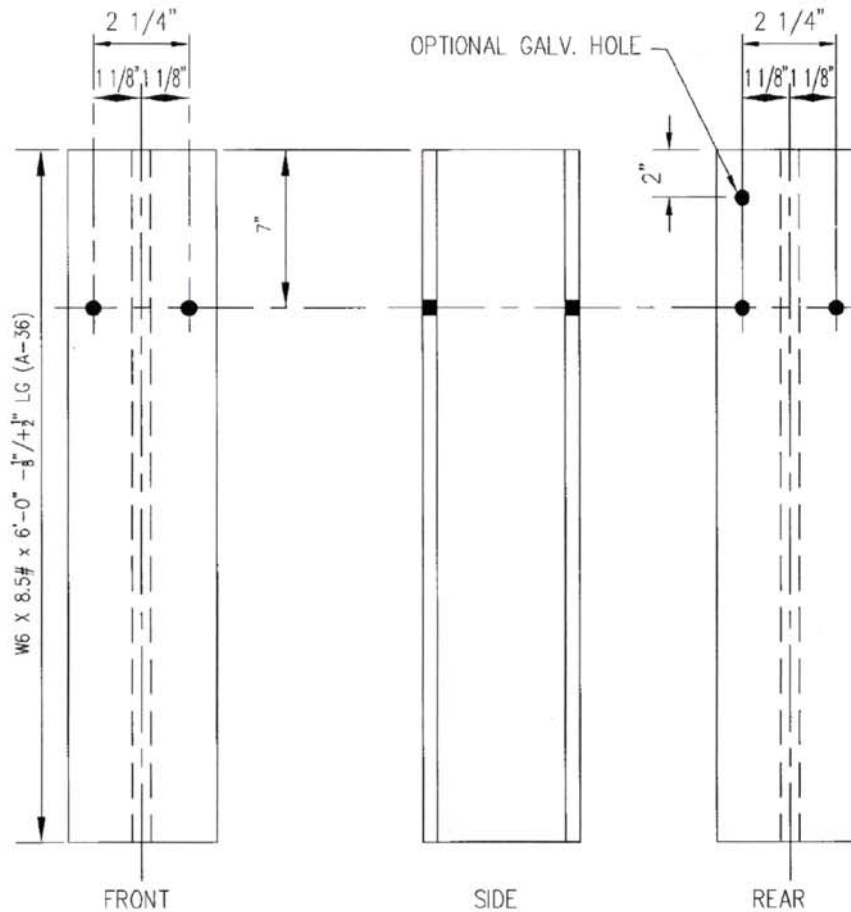
SHEET NO.	DATE
2 of 2	6/30/2005

BILL OF MATERIAL						
TOTAL REQ'D	PIECE MARK	MATERIAL	LENGTH		WEIGHT	REMARKS
			FEET	INCHES		
1		12 GA. DP. BM. GUARDRAIL	25	0	192	M180

SECTION A-A

△ REVISED FORMAT ONLY

USED ON								
	A/R STANDARD							
REVISION				GUARDRAIL, W-BEAM -			GALV. SPEC. A123	
#	BY	DATE	CHK.	12 GA X 25'-0 WITH			SHIPPING WT. 192	
△	D.B.W.	2-3-93	J.L.S.	INTERMITTENT HOLES @ 3'-1 1/2			DRWN. E.S. 9-25-89	
							CHK. J.L.S. 9-26-89	
							SK REFERENCE 1534	
				TRINITY INDUSTRIES, INC.			61 △	



ALL HOLES 13/16" Ø DIA.

STATE:

APPROX. SHPG. WT.; 54 #

3	LH	4/24/09	ADDED OPTIONAL GALV HOLE
2	SAR	3/11/05	ADDED TOLERANCE TO LENGTH
1	LH	01/09/02	REDRAWN W/O CHANGE
MK	BY	DATE	REVISION

ITEM CLASS:			
MATERIAL: A-36		FINISH A-123	
 TRINITY HIGHWAY PRODUCTS, LLC. 2525 STEMMONS FREEWAY DALLAS, TX 75207			
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6'-0" POST/W6X8.5# DDR			
DRAWN: L.R.	CHKD: T.P.	SCALE: N.T.S.	DATE: 09/26/05
DRAWING NO:	533		REV. 3



TRINITY
HIGHWAY

MATERIAL SPECIFICATION

Doc: ENG-FE-018 Page 1 of 1

Rev: 4 By: ENG-TM

Doc Type: Form App'd:

Part Number: **003300**

Description: **5/8" WASHER F844 A/W**

Specification:

WASHER, STEEL FLAT, 0.656" ID X 1.750" OD X 0.100" THK.
WASHER DIMENSIONS TO BE PER ANSI-B18.22.1 - TYPE A, SERIES W.

003300G - SHALL BE HOT DIPPED GALVANIZED PER ASTM-A153 CLASS C, OR MECHANICALLY GALVANIZED PER ASTM-B695 CLASS 50.

003300C - WASHER, (CORTEN - WEATHERING) STEEL FLAT, SPECIFICATION ASTM-F844.

☒ Apply: ☐ Does Not Apply:

ALL STEEL AND/OR IRON MUST BE MELTED AND MANUFACTURED IN THE USA, IN COMPLIANCE WITH THE FEDERAL HIGHWAY ADMINISTRATION BUY AMERICA REQUIREMENTS. ORIGINAL RAW MATERIAL PRODUCING MILL TEST REPORTS ARE REQUIRED. ALL MATERIAL MUST HAVE FULL TRACEABILITY BY HEAT NUMBER FROM ALL SOURCES, INCLUDING 3RD PARTY PROCESSORS AND GALVANIZERS. ALL RECEIPTS MUST BE IDENTIFIED BY QUANTITY, EITHER IN POUNDS OR PIECES, BY HEAT NUMBER.

☐ Approved Manufacturer(s):

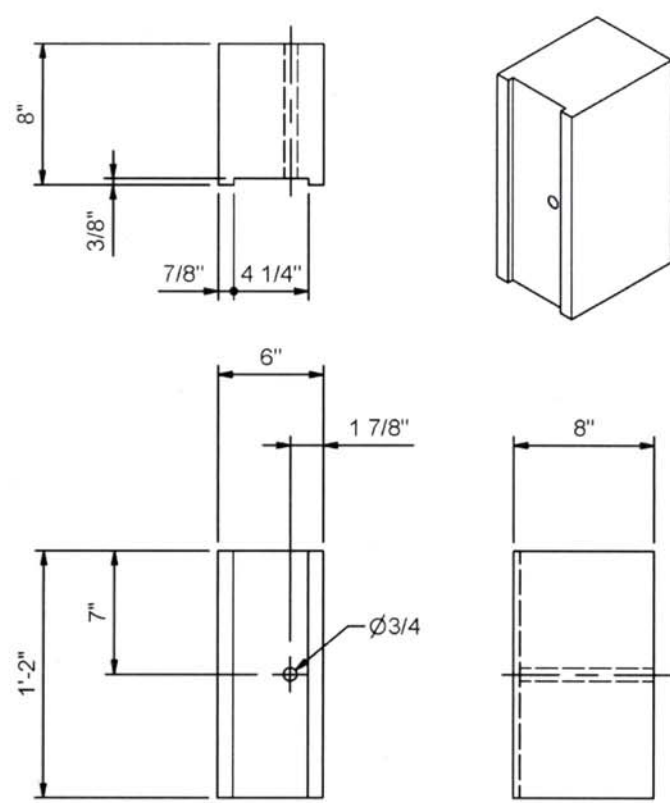

☐ Vendor Reference:

Prepared: R. VENZON 09/25/14

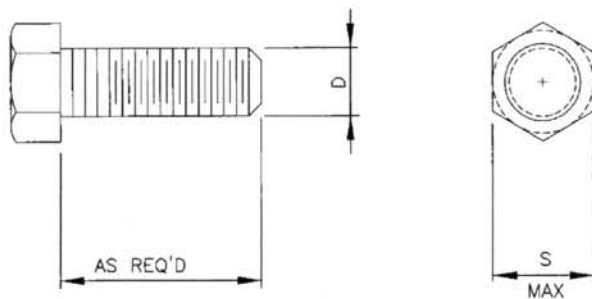
Engineer: C. BACKHAUS 10/15/14

Purchasing: S. Brasher 10/17/14

Revision Description	ECO	Rev	By	Date	Eng	Pur
Rev B to match Romacs	-	B	-	-	-	-

BILL OF MATERIAL						
QTY	PART No	DESCRIPTION	Lbs / Each	REMARKS		
1	4076B	WOOD BLOCK 6 x 8 x 1'-2"	17.06	AASHTO M168		
						
NOTES: SUPPLY WOOD BLOCKS PER AASHTO M168. TREAT WITH PRESERVATIVE PER AASHTO M133.						
REVISION HISTORY						
REV	REVISION		ECO	DATE	BY	APPR. AP. DATE
1	REDRAWN IN INVENTOR			6/30/2014	EAS	6/30/2014
<small>All material must be melted and manufactured in the U.S.A. Original raw material producing mill test reports are required. Mill test reports must be signed by an authorized representative of the producing mill. Material must have full traceability from all sources. Receipts must be identified by quantity, either in pounds or pieces, by heat number. Welding shall be in accordance with ANSI/AWS D1.1 section 5 and D1.5 section 3. Tolerances per QMS-SF-001 (U.N.O.). Finish and general workmanship per QMS-SF-004 (U.N.O.).</small>						
<small>The drawings and the information shown thereon are copyrighted by TRINITY HIGHWAY PRODUCTS, LLC, and the sole property of TRINITY HIGHWAY PRODUCTS, LLC. Neither the drawings nor such information is to be used for any purpose other than that for which it was specifically furnished from TRINITY HIGHWAY PRODUCTS, LLC, nor is any reproduction authorized without written permission.</small>			WOOD BLOCK - WBEAM RECESSED FOR USE W/ STEEL POST ONLY WD BLK RTD 6X8X14		SPEC: SHIP WT: 17.1 lb DRW: RMH 8/27/1998 CHK: EAS 8/27/1998 SHT: 1 OF 1 SIZE: A DWG NO: 4076 REV: 1	
PROJ. _____						

004076.rdw



DESIGNATOR	ANSI SIZE	D	M	S
FBX06a	1/4-20 [M6x1]	5/16 [6]	1 3/64 [5.2]	2 5/64 [10.0]
FBX08a	5/16-18 [M8x1.25]	5/16 [8]	1 7/64 [6.8]	3 3/64 [13.0]
FBX10a	3/8-16 [M10x1.5]	5/16 [10]	2 1/64 [8.4]	4 0/64 [16.0]
FBX12a	7/16-14 [M12x1.75]	5/8 [12]	2 7/64 [10.8]	4 5/64 [18.0]
FBX14a	1/2-13 [M14x2]	9/16 [14]	3 3/64 [12.8]	5 3/64 [21.0]
FBX16a	5/8-11 [M16x2]	1 0/16 [16]	3 7/64 [14.8]	6 0/64 [24.0]
FBX20a	3/4-10 [M20x2.5]	1 1/2 [20]	4 5/64 [18.0]	1 1/64 [30.0]
FBX24a	1-8 [M24x3]	1 5/8 [24]	5 1/64 [21.5]	1 26/64 [36.0]



CLASS 4.6 HEX BOLT & NUT

FBX06a-24a

SHEET NO. 1 OF 2
DATE: 2006

SPECIFICATIONS

Class 4.6 bolts shall be manufactured according to the geometric specifications included in ANSI B18.2.3.5M. Threads shall conform to ANSI B1.13M for Class 6g threads. Material for zinc-coated bolts shall conform to ASTM F568 for Class 4.6 (400 MPa tensile strength and 240 MPa yield strength). Material for corrosion resistant bolts shall conform to ASTM F568 for Class 8.8.3 (830 MPa tensile strength and 660 MPa yield strength). Bolt heads shall be marked as specified in ASTM F568 Section 9 with the manufacturer's identification symbol and the symbol "4.6" if zinc-coated and "8.8.3" if corrosion resistant steel is used. ASTM F569 Class 4.6 bolts are essentially equivalent to SAE J429 Grade 2 bolts.

Zinc-coated nuts shall be manufactured according to the dimensions and tolerances in ANSI B18.2.4.1M for metric Style 1 hex nuts (shown in drawing). Corrosion resistant nuts shall be manufactured according to the dimensions and tolerances in ANSI B18.2.4.6M for heavy hex nuts (not shown in drawing). Threads shall conform to ANSI B1.13M for Class 6H. Zinc-coated nuts shall conform to the requirements of AASHTO M291M (ASTM A563M) for Class 5 nuts. Corrosion resistant nuts shall conform to the requirements of AASHTO M291M (ASTM A563M) for Class 8S3 nuts.

Zinc-coated bolts and nuts shall be treated according to either AASHTO M232 (ASTM A153) or AASHTO M298 (ASTM B695) for Class 50.

Designator	Stress Area of Threaded Bolt Shank (mm ²)	Minimum Bolt Strength (kN)
FBX06a	20.1	8.0
FBX08a	36.6	14.6
FBX10a	58.0	23.2
FBX12a	84.3	33.7
FBX14a	115.0	46.0
FBX16a	157.0	62.8
FBX20a	245.0	98.0
FBX24a	353.0	141.0

Dimensional 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.

INTENDED USE

These bolts and nuts are used in various sign systems.

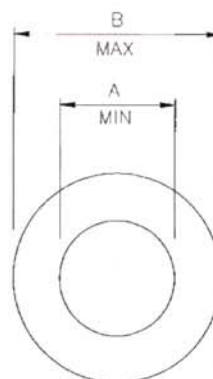
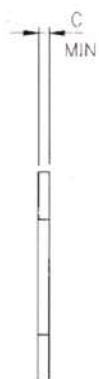
CLASS 4.6 HEX BOLT AND NUT

FBX06a-24a

SHEET NO.

DATE

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DESIGNATOR	A MIN	B MAX	C MIN	ANSI SIZE
FWC12b	15/32 [14.0]	61/64 [27.0]	0.051 [3.1]	7/16 [12]
FWC14b	17/32 [16.0]	1-3/32 [30.0]	0.097 [3.1]	1/2 [14]
FWC16b	11/16 [18.0]	1-11/32 [34.0]	0.122 [3.1]	5/8 [16]
FWC20b	13/16 [22.0]	1-1/2 [42.0]	0.122 [3.1]	3/4 [20]
FWC22b	15/16 [24.0]	1-25/32 [44.0]	0.136 [3.4]	7/8 [22]
FWC24b	1-1/8 [26.0]	2-1/32 [50.0]	0.136 [3.4]	1 [24]
FWC27b	1-1/4 [30.0]	2-9/32 [56.0]	0.136 [3.4]	1-1/8 [27]
FWC30b	1-3/8 [33.0]	2-17/32 [60.0]	0.136 [3.4]	1-1/4 [30]
FWC36b	1-1/2 [39.0]	2-25/32 [72.0]	0.136 [3.4]	1-3/8 [36]

HARDENED ROUND WASHER

FWC12b-36b

SHEET NO.

DATE:

1 of 2

7/14/2005

SPECIFICATIONS

Hardened steel washers shall be manufactured according to the requirements of AASHTO M 293 (ASTM F 436) [AASHTO M 293M (ASTM F 436M)]. If galvanized washers are required, they shall be treated according to either AASHTO M 232 (ASTM A153) for Class D or AASHTO M 298 (ASTM B695) for Class 50.

Dimensional 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.

INTENDED USE

Hardened steel washers are used in a variety of applications in several barrier systems. These washers are generally used with high-strength structural bolts and high-strength heavy hex nuts as shown in this guide for FBX16b-36b.

HARDENED ROUND WASHER

FWC12b-36b

SHEET NO.

DATE

2 of 2

7/14/2005



DESIGNATOR	ANSI SIZE	D	M MAX	S MAX
FNX06a	1/4-20 [M6x1]	1/4 [6]	7/32 [5.2]	7/16 [10.0]
FNX08a	5/16-18 [M8x1.25]	5/16 [8]	17/64 [6.8]	1/2 [13.0]
FNX10a	3/8-16 [M10x1.5]	3/8 [10]	21/64 [8.4]	9/16 [16.0]
FNX12a	7/16-14 [M12x1.75]	7/16 [12]	3/8 [10.8]	11/16 [18.0]
FNX14a	1/2-13 [M14x2]	1/2 [14]	7/16 [12.8]	3/4 [21.0]
FNX16a	5/8-11 [M16x2]	5/8 [16]	35/64 [14.8]	15/16 [24.0]
FNX20a	3/4-10 [M20x2.5]	3/4 [20]	41/64 [18.0]	1-1/8 [30.0]
FNX24a	1-8 [M24x3]	1 [24]	55/64 [21.5]	1-1/2 [36.0]
FNX30a	1-1/4-7 [M30x3.5]	1-1/4 [30]	1-1/16 [25.6]	1-7/8 [46.0]
FNX36a	1-3/8-6 [M36x4]	1-3/8 [36]	1-11/64 [31.0]	2-1/16 [55.0]

HEX NUTS

FNX06a-36a

SHEET NO.

DATE:

1 of 2

8/18/2005

SPECIFICATIONS

Zinc-coated nuts shall be manufactured according to the dimensions and tolerances in ANSI B18.2.2 [ANSI B18.2.4.1M Style 1] for hex nuts (shown in drawing). Corrosion-resistant nuts shall be manufactured according to the dimensions and tolerances in ANSI B18.2.2 [ANSI B18.2.4.6M] for heavy hex nuts (not shown in drawing). Nuts shall conform to the requirements of AASHTO M 291 (ASTM A 563) Grade A [AASHTO M 291M (ASTM A 563M) Class 5]. Corrosion-resistant nuts shall have geometric properties defined in ANSI B18.2.2 [ANSI B18.2.4.1M] but shall have mechanical and material properties conforming to AASHTO M 291 (ASTM A 563) Grade C3 [AASHTO M 291M (ASTM A 563M) Class 8S3]. Threads shall conform to ANSI B1.1 Class 2B [ANSI B1.13M Class 6h]. Zinc-coated nuts shall be treated according to either AASHTO M 232 (ASTM A 153/A 153M) for Class C or AASHTO M 298 (ASTM B 695) for Class 50.

Dimensional 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.

INTENDED USE

These nuts are used in numerous barrier designs.

HEX NUT

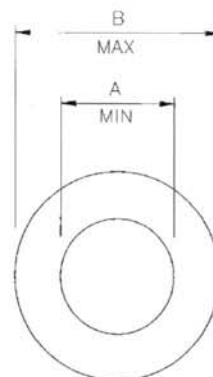
FNX06a-36a

SHEET NO.

DATE

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8/18/2005



DESIGNATOR	A MIN		B MAX		C MIN		ANSI SIZE
FWC06a	0.276	[6.65]	0.749	[18.80]	0.056	[1.20]	1/4 [6]
FWC08a	0.339	[8.90]	0.890	[25.40]	0.056	[1.60]	5/16 [8]
FWC10a	0.401	[10.85]	1.015	[28.00]	0.056	[2.00]	3/8 [10]
FWC12a	0.526	[13.30]	1.280	[34.00]	0.090	[2.50]	1/2 [12]
FWC14a	0.589	[15.25]	1.499	[39.00]	0.090	[2.50]	9/16 [14]
FWC16a	0.649	[17.25]	1.780	[44.00]	0.090	[3.00]	5/8 [16]
FWC20a	0.805	[21.80]	2.030	[50.00]	0.090	[3.50]	3/4 [20]
FWC24a	1.055	[25.60]	2.530	[56.00]	0.146	[4.00]	1 [24]
FWC30a	1.305	[32.40]	3.030	[72.00]	0.146	[4.50]	1-1/4 [30]
FWC36a	1.552	[38.30]	3.545	[90.00]	0.234	[5.00]	1-1/2 [36]

PLAIN ROUND WASHER

FWC06a-36a

SHEET NO.

DATE:

1 of 2

6/27/2005

SPECIFICATIONS

Plain round steel washers shall be manufactured according to the dimensions and tolerances in ANSI B18.22 [B18.22M] for regular (Type B) series washers. Unless corrosion-resistant steel is used, washers shall be zinc-coated according to AASHTO M 232 (ASTM A153) for Class D or AASHTO M 298 (ASTM B695) for Class 50.

Dimensional 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.

INTENDED USE

Plain round steel washers are used in a variety of applications in several barrier systems. These washers are usually used with standard-strength bolts and nuts as shown in this guide for FBX06a-36a.

PLAIN ROUND WASHER

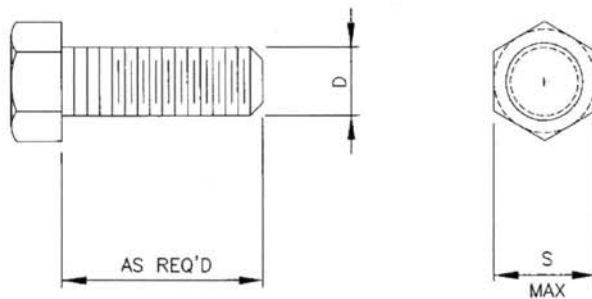
FWC06a-36a

SHEET NO.

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6/27/2005



DESIGNATOR	ANSI SIZE	D	M	S
FBX16b	$\frac{5}{8}$ -11 [M16x2]	$1\frac{1}{8}$ [16]	$4\frac{3}{4}$ [17.1]	$1\frac{1}{4}$ [27.0]
FBX20b	$\frac{3}{4}$ -10 [M20x2.5]	$1\frac{1}{2}$ [20]	$5\frac{1}{4}$ [20.7]	$1\frac{1}{2}$ [34.0]
FBX22b	$\frac{7}{8}$ -9 [M22x2.5]	$1\frac{3}{4}$ [22]	$6\frac{1}{4}$ [23.6]	$1\frac{3}{4}$ [36.0]
FBX24b	1-8 [M24x3]	$1\frac{5}{8}$ [24]	$6\frac{1}{2}$ [24.2]	$1\frac{3}{4}$ [41.0]
FBX27b	$1\frac{1}{8}$ -7 [M27x3]	$1\frac{7}{8}$ [27]	$1\frac{3}{4}$ [27.6]	$1\frac{5}{8}$ [46.0]
FBX30b	$1\frac{1}{4}$ -7 [M30x3.5]	$1\frac{3}{4}$ [30]	$1\frac{13}{16}$ [30.7]	$1\frac{6}{8}$ [50.0]
FBX36b	$1\frac{3}{8}$ -6 [M36x4]	$1\frac{5}{8}$ [36]	$1\frac{28}{16}$ [36.6]	$2\frac{2}{8}$ [60.0]



STRUCTURAL HEX BOLT & NUT

FBX16b-36b

SHEET NO.	DATE:
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INTENDED USE

High-strength heavy hex structural bolts shall conform to the requirements of AASHTO M164M (ASTM A325M) and shall be manufactured according to the geometric specifications included in ANSI B18.2.3.7M. Threads shall conform to ANSI B1.13M for Class 6g. Material for zinc-coated bolts shall conform to AASHTO M164M (ASTM A325M) for Type 1 bolts (800 MPa tensile strength and 660 MPa yield strength) and shall bear the head identification marking "8S" and "A-325M." Material for corrosion resistant bolts shall conform to AASHTO M164M (ASTM A325M) Type 3 bolts and shall bear the head identification marks "8S3", "A 325M", and a symbol identifying the manufacturer.

Heavy hex nuts shall be manufactured according to AASHTO M291M (ASTM A563M) using the geometry of ANSI B18.2.4.6M. Threads shall conform to ANSI B1.13M for class 6H threads. Zinc-coated nuts shall conform to AASHTO M291M (ASTM A563M) for Class 10s nuts and shall bear the identification mark "10Sn, and the manufacturer's identification symbol. Corrosion resistant nuts shall comply to AASHTO M291M (ASTM A563M) for Class 8S3 nuts and shall bear the identification mark "8S3" and the manufacturer's identification symbol.

Zinc-coated bolts and nuts shall be treated according to either AASHTO M232 (ASTM A153) for Class C or AASHTO M298 (ASTM B695) for Class 50, Type 1.

Designator	Stress Area of Threaded Bolt Shank (mm ²)	Minimum Bolt Strength (kN)
FBX16b	157.0	130.0
FBX20b	245.0	203.0
FBX22b	303.0	251.0
FBX24b	353.0	293.0
FBX27b	459.0	381.0
FBX30b	561.0	466.0
FBX36b	817.0	678.0

Dimensional 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.

INTENDED USE

These bolts and nuts are used in various sign systems.

HIGH-STRENGTH STRUCTURAL HEX BOLT & NUT

FBX16b-36b

SHEET NO.

DATE

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