December 7, 2020

Shawn Yu, Standards Engineer
Colorado Department of Transportation
2829 W. Howard Place, Room 309p
Denver, CO 80204

Dear Mr. Yu:

This letter is in response to your October 12, 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-351 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:

- Colorado Type 10 Bridge Rail

**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: Colorado Type 10 Bridge Rail
Type of system: Longitudinal Barrier
Test Level: TL4
Testing conducted by: Texas A&M Transportation Institute
Date of request: October 12, 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-351 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

Date of Request: October 12, 2020
New

Name: Roger Bligh

Company: Texas A&M Transportation Institute

Address: 1254 Avenue A, Bldg 7091, Bryan, Texas 77807

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**

<table>
<thead>
<tr>
<th>System Type</th>
<th>Submission Type</th>
<th>Device Name / Variant</th>
<th>Testing Criterion</th>
<th>Test Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>'B': Rigid/Semi-Rigid Barriers</td>
<td>Physical Crash Testing</td>
<td>Colorado Type 10 Bridge Rail</td>
<td>AASHTO MASH</td>
<td>TL4</td>
</tr>
</tbody>
</table>

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:** Shawn Yu, Standards Engineer
- **Company Name:** Colorado Department of Transportation
- **Address:** 2829 W. Howard Pl., Room 309p, Denver, CO 80204
- **Country:** U.S.A.

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

Texas A&M Transportation Institute (TTI) was contracted by Colorado Department of Transportation to perform full-scale crash testing of the Colorado Type 10 Bridge Rail. There are no shared financial interests in the Colorado Type 10 Bridge Rail by TTI, or between Colorado Department of Transportation and TTI, other than costs involved in the actual crash tests and reports for this submission to FHWA.

609761-01-3.4.5
PRODUCT DESCRIPTION

New Hardware or Modification to Existing Hardware

The Type 10 Bridge Rail installation consists of two tubular steel rails attached to steel posts mounted on a concrete parapet. The concrete parapet is 18 inches wide at the bottom, tapering up on the traffic side to a top width of 16¾ inches. In the tested configurations, a 3-inch thick lift of asphalt covered the bottom 3 inches of the concrete parapet, which extends 10 inches above grade. W6x20 steel posts are mounted on top of the concrete parapet at a 10 ft spacing. Two HSS6×6×¼ steel rails are attached to the posts at heights of 25 inches and 40 inches above the road surface. The rails are spliced using 5¼-inch square, 5/16-inch thick, 36-inch long fabricated steel tubular sections with a 6 inch distance between the adjacent rail sections.

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 Bligh

Engineer Signature: Digitally signed by Roger Bligh 2020.10.09 13:43:03 -05'00'

Address: 1254 Avenue A, Bldg 7091, Bryan, Texas 77807

Country: U.S.A.

A brief description of each crash test and its result:

<table>
<thead>
<tr>
<th>Required Test Number</th>
<th>Narrative Description</th>
<th>Evaluation Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-10 (1100C)</td>
<td>The results of test 609761-01-5 conducted on May 15, 2020 are found in TTIReport No. 609761-01-3-5. The Type 10 bridge rail successfully contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or to present undue hazard to others in the area. Maximum dynamic lateral deflection of the rail during the test was 2.2 inches. The vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 7° and 4°, respectively. Occupant risk indices (occupant impact velocity and ridedown accelerations) were below the preferred values of MASH. Maximum occupant compartment deformation was 4.0 inches in the kick panel area. The test satisfied all relevant MASH criteria.</td>
<td>PASS</td>
</tr>
<tr>
<td>Required Test Number</td>
<td>Narrative Description</td>
<td>Evaluation Results</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>4-11 (2270P)</td>
<td>The results of test 609761-01-4 conducted on May 13, 2020 are found in TTIReport No. 609761-01-3-5. The Type 10 bridge rail successfully contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or to present undue hazard to others in the area. Maximum dynamic lateral deflection of the rail during the test was 6.0 inches. The vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 50° and 15°, respectively. Occupant risk indices (occupant impact velocity and ridedown accelerations) were below the preferred values of MASH. Maximum occupant compartment deformation was 3.0 inches in the firewall area. The test satisfied all relevant MASH criteria.</td>
<td>PASS</td>
</tr>
<tr>
<td>4-12 (10000S)</td>
<td>The results of test 609761-01-3 conducted on May 11, 2020 are found in TTIReport No. 609761-01-3-5. The Type 10 bridge rail successfully contained and redirected the 10000S vehicle. The vehicle did not penetrate, underride, or override the installation. No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or to present undue hazard to others in the area. Maximum dynamic lateral deflection of the rail during the test was 2.9 inches. The vehicle remained upright during and after the collision event. Maximum occupant compartment deformation was 5.75 inches in the floor pan. The test satisfied all relevant MASH criteria.</td>
<td>PASS</td>
</tr>
<tr>
<td>4-20 (1100C)</td>
<td>MASH2016 Test Designation 4-20 evaluates transitions. The Colorado DOT Type 10 bridge rail is not a transition; therefore, this test is not relevant.</td>
<td>Non-Relevant Test, not conducted</td>
</tr>
<tr>
<td>4-21 (2270P)</td>
<td>MASH2016 Test Designation 4-21 evaluates transitions. The Colorado DOT Type 10 bridge rail is not a transition; therefore, this test is not relevant.</td>
<td>Non-Relevant Test, not conducted</td>
</tr>
<tr>
<td>4-22 (10000S)</td>
<td>MASH2016 Test Designation 4-22 evaluates transitions. The Colorado DOT Type 10 bridge rail is not a transition; therefore, this test is not relevant.</td>
<td>Non-Relevant Test, not conducted</td>
</tr>
</tbody>
</table>
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):

<table>
<thead>
<tr>
<th>Laboratory Name:</th>
<th>Texas A&amp;M Transportation Insitute</th>
</tr>
</thead>
</table>
| LaboratorySignature: | Digitally signed by Darrell L. Kuhn  
Date: 2020.10.09 17:33:30-05'00 |
| Address: | 1254 Avenue A, Bldg 7091, Bryan, Texas 77807  
Same asSubmitter |
| Country: | U.S.A.  
Same asSubmitter |
| Accreditation Certificate Number and Dates of current Accreditation period: | ISO 17025-2017 Laboratory A2LACertificate Number: 2821.01  
Valid To: April 30, 2021 |

SubmitterSignature*: Roger Bligh  
Digitally signed by Roger Bligh  
Date: 2020.10.09 13:43:28-05'00 |

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:

<table>
<thead>
<tr>
<th>Eligibility Letter</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Date</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 5.7. Summary of Results for MASH Test 4-12 on Type 10 Bridge Rail.
General Information
Test Agency........................................ Texas A&M Transportation Institute (TTI)
Test Standard Test No................... MASH Test 4-11
TTI Test No................................. 609761-01-4
Test Date........................................ 2020-05-13

Test Article
Type ............................................ Longitudinal Barrier—Bridge Rail
Name ............................................ Type 10 Bridge Rail
Installation Length ..................... 139 ft 6 inches
Material or Key Elements ........ Bridge rail with two 6"x6"x1/4" tubular steel rails attached to W6x20 steel posts mounted on a concrete parapet
Soil Type and Condition ......... Concrete bridge deck, dry

Test Vehicle
Type/Designation....................... 2270P
Make and Model ......................... 2014 RAM 1500 Pickup
Curb ......................................... 4941 lb
Test Inertial .............................. 5061 lb
Dummy ..................................... 165 lb
Gross Static ............................... 5226 lb

Impact Conditions
Speed .......................................... 61.3 mph
Angle ......................................... 24.5°
Location/Orientation .............. 4.3 ft upstream of post 8

Impact Severity
Exit Conditions
Speed .......................................... 47.2 mi/h
Trajectory/Heading Angle ....... 7.0°/6.5°

Occupant Risk Values
Longitudinal OIV .......................... 17.7 ft/s
Lateral OIV ................................. 26.2 ft/s
Longitudinal Ridedown ............. 4.4 g
Lateral Ridedown ....................... 13.2 g
THIV ........................................ 9.8 m/s
ASI ............................................ 1.8

Max. 0.050-s Average
Longitudinal ............................ −9.3 g
Lateral ..................................... 13.3 g
Vertical ................................... 3.1 g

Post-Impact Trajectory
Stopping Distance ... 225 ft downstream
60 ft twd traffic

Vehicle Stability
Maximum Yaw Angle .................. 113°
Maximum Pitch Angle ............. 15°
Maximum Roll Angle ................ 50°
Vehicle Snagging .......................... No
Vehicle Pocketing ......................... No

Test Article Deflections
Dynamic ........................................ 6.0 inches
Permanent ................................. 0.5 inch
Working Width ........................... 19.3 inches
Height of Working Width ......... 37.8 inches

Vehicle Damage
VDS ........................................... 11LF06
CDC ........................................... 11FLEW5
Max. Exterior Deformation ...... 14.0 inches
OCDI ........................................ LF0010000
Max. Occupant Compartment Deformation ........ 3.0 inches

Figure 6.6. Summary of Results for MASH Test 4-11 on Type 10 Bridge Rail.
Figure 7.6. Summary of Results for MASH Test 4-10 on Type 10 Bridge Rail.
1a. All rail components, including Rails, Posts, and Hardware, shall be galvanized.

1b. Bolts with Lock Washers shall be tightened to snug only.
Plan View

Detail C
Scale 1:15
Typical 3 places

30'-0"
30" 10'-0" Typ
70'-0"
110'-0"
135'-0"
30" 30'-0"
20"
6"
65.0°
1"

Roadside Safety and Physical Security Division - Proving Ground

Project #609761 3-5 Colorado Type 10 TL-4 Bridge Rail 2020-02-11
Drawn by GES  Scale 1:10  Sheet 2 of 8  Plan View
3a. All welding must be performed by certified welders using industry standard practices.
3b. Galvanize all components after fabrication is complete.
4a. All welding must be performed by certified welders using industry standard practices.
4b. Galvanize all components after fabrication is complete.
4c. Detail D is typical both Rail Sections, both ends. Section E-E is typical both Rail Sections.
**Rail Splice Details**

*Alternate Fabrication Option*  
Slots now shown  

*After fabrication this sheet will be edited to show only the fabrication method used.*

---

**Plan View**

- Plate, 4 5/8" x 5/16" x 36"  
  ASTM A572 Grade 50  
  Typ x 4

- Plate, 36" x 5/16" x 9 3/8"  
  ASTM A572 Grade 50  
  Typ x 2, bent as shown

**Elevation View**

**Isometric View**
Concrete Details
Elevation View

Three Joints in Curb and Deck. See next sheet. See sheet 2 for locations.

135'-0"

Elevation View

6a. Concrete is 4500 psi for Deck and Curb.

6b. Minimum rebar lap is 22" for #3 stainless steel bars, and 18-3/4" for #5 bars.

6c. All rebar dimensions are to center of bar unless otherwise indicated by "cvr" (cover).

6d. R1" fillet traffic side top edge of Curb. Chamfer 3/4" field side edges of Deck and Curb as shown.

6e. Top Transverse L-Bars: #4 @ 7" throughout. A #4 straight bar bundled with every other L-Bar only within 18' each side of joint. See section View H-H, next sheet.

6f. Secure each Tie Bar to existing rebar (not shown here) protruding from the runway with a minimum 3" weld. Maximum spacing is 18".

Existing Working Slab

Section G-G
Rebar Details
Scale 1 : 15

Roadside Safety and Physical Security Division - Proving Ground

Project #609761 3-5 Colorado Type 10 TL-4 Bridge Rail 2020-02-11

Drawn by GES Scale 1:200 Sheet 6 of 8 Concrete Details
Section H-H
Typical at each Joint

Curb Stirrups @ 6"
See 7b

10'-0"
9'-3"
25-1/2"
0"
9"

2" cvr
6"

Anchor Bolts

1" joint
2" cvr

6" Typ, bottom transverse bars
7" Typ, top transverse bars
14" Typ, Bundled straight bars

Rebar, Ø1/2" x 66" Grade 60
See 7a

7a. Ø1/2" straight bars bundled with every other top transverse L-bar for 18’ each side of each joint.

7b. Adjust spacing of Stirrups as needed to avoid interference with Anchor Bolts.
#4 L-bar
Ø1/2" Grade 60 Rebar

#3 L-bar
Ø3/8" Grade 60 Rebar

Tie Bar
Ø5/8" Grade 60 Rebar

Curb Stirrup
Ø3/8" Grade 2304 Stainless Steel Rebar