U.S. Department of Transportation
Federal Highway Administration

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

May 4, 2012

In Reply Refer To:
HSST/ B-232

Brian Smith
Trinity Highway Products, LLC
2525 North Stemmons Freeway
Dallas, Texas 75207

Dear Mr. Smith:

This letter is in response to your request for the Federal Highway Administration (FHWA) to review a roadside safety system for eligibility for reimbursement under the Federal-aid highway program.

Name of system:	CASS S3 on 4H:1V slopes
Type of system:	Four rope cable median barrier
Test Level:	MASH Test Level 3
Testing conducted by:	Texas Transportation Institute
Task Force 13 Designator:	SGM36
Date of request:	July 14, 2011
Date initially acknowledged:	July 14, 2011
Date of completed package:	July 14, 2011

Decision:
The following device is eligible, with details provided in your enclosed July 14, 2011, letter which is considered an integral part of this finding:

- CASS using S3 posts on 4H:1V slopes four rope cable median barrier to MASH TL-3

Based on a review of crash test results submitted by the manufacturer certifying the device described herein meets the crash test and evaluation criteria of the American Association of State Highway and Transportation Officials' Manual for Assessing Safety Hardware (MASH), the device is eligible for reimbursement under the Federal-aid highway program. Eligibility for reimbursement under the Federal-aid highway program does not establish approval or endorsement by the FHWA for any particular purpose or use.

The FHWA, the Department of Transportation, and the United States Government do not endorse products or services and the issuance of a reimbursement eligibility letter is not an endorsement of any product or service.

Requirements
To be found eligible for Federal-aid funding, roadside safety devices should meet the crash test and evaluation criteria contained in the American Association of State Highway and

Transportation Officials' Manual for Assessing Safety Hardware (MASH).

Description and Crash Testing

The CASS four-rope cable median barrier, with S3 posts spaced at 10.5 feet, was tested on a 30-foot wide median with 4H:1V slopes. The barrier was placed four feet down from the slope break point, and subjected to MASH tests 3-10 and 3-11. The barrier system and tests are both described in your July 14, 2011, letter which is enclosed as an integral part of this finding. Also enclosed are the test data summary sheets of both tests, and drawings of the barrier.

Findings

Therefore, the system described and detailed in the attached letter is eligible for reimbursement and may be installed under the range of conditions tested when located no further than four feet from the 4H:1V slope break point.

Please note the following standard provisions that apply to FHWA eligibility letters:

- This letter provides a AASHTO/ARTBA/AGC Task Force 13 designator that should be used for the purpose of the creation of a new and/or the update of existing Task Force 13 drawing for posting on the on-line 'Guide to Standardized Highway Barrier Hardware' currently referenced in AASHTO Roadside Design Guide.
- This finding of eligibility does not cover other structural features of the systems, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may influence system conformance with MASH will require a new reimbursement eligibility letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals safety problems, or that the system is significantly different from the version that was crash tested, we reserve the right to modify or revoke this letter.
- You are expected to supply potential users with sufficient information on design and installation 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 the MASH.
- To prevent misunderstanding by others, this letter of eligibility is designated as number B-232 and 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 at our office 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. The finding of eligibility is limited to the crashworthiness characteristics of the candidate system, and the FHWA does not become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.
- The CASS barriers are patented products and considered 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.

- Although the barrier performed well under ideal test impact conditions with the two test vehicles, the likelihood of passenger car underrides of any cable system may increase as the post spacing increases, particularly when the barrier is installed on non-level or slightly irregular terrain and the cables are not restrained from lifting at each post. Consequently, some transportation agencies have limited post spacing to approximately 6m (20 feet) for cable barriers. The dynamic deflection of the barrier is likely to increase when it is installed along the convex sides of horizontal curves, and when distances between anchorages exceed the 195 meter (640-foot) test length.

Sincerely yours,

Michael S. Griffith
Director, Office of Safety Technologies

Enclosures

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Sincerely yours,

Michael S. Griffith

Michael S. Griffith
Director, Office of Safety Technologies

Enclosures

TRINITY HIGHWAY PRODUCTS, LLC

July 14, 2011

Mr. Nicholas Artimovich, II
Highway Engineer, Office of Safety Design
Federal Highway Administration HSSD
1200 New Jersey Avenue SE, Room E-71-322
Washington, DC 20590
Tel: 202-366-1331
Fax: 202-366-2249
e-mail: nick.artimovich@fhwa.dot.gov

Re: Request for FHWA Acceptance of CASS S3 MASH on 4H:1V Slopes per MASH Test Level 3.

Dear Mr. Artimovich:

Attached for your review are the test reports and videos of successful full-scale crash tests recently conducted by the Texas Transportation Institute (TTI) on Trinity's Cable Safety System (CASS S3 MASH) installed in a 9.1m (30 foot 0 inch) wide depressed median with 4H:1V side slopes on 3.2m (10 foot 6 inch) post spacing. Trinity Highway Products, LLC is seeking FHWA acceptance of CASS S3 MASH for use on the National Highway System (NHS).

CASS S3 MASH is a tensioned, four-cable barrier system that was tested with standard (non-prestretched) cables. The top two cables are positioned within a wave-shaped slot in the web of S75x8 (S3x5.7#) structural I-beam posts. The bottom two cables are supported on flanges of the I-beam post by 8mm (5/16 inch) hook bolts having the open end down, with the lowest cable located on the median-side flange and the next lowest cable located on the traffic-side flange.

The proprietary S75x8 (S3x5.7#) posts were installed in steel tube sleeves set in 305mm (12 inch) diameter x 762mm (30 inch) deep concrete footings. The cables within the wave-shaped slot are separated by a plastic spacer. A stainless steel strap is mounted on the outside of the post above the top cable.

The 19mm (3/4 inch) diameter standard (non-prestretched) cables were set at heights of 450mm, 755mm, 960 and 1070mm (17.75, 29.75, 37.875, and 42.125 inches) above the ground surface, measured to the center of each cable. Tension of the cables was set at 17.4 to 17.7 kN (3,914 to 3,985 pounds force) for the tests.

The 195m (640 foot) test installations were anchored by TTI Breakaway Cable Anchor Terminals, accepted by FHWA on August 29, 2002 (CC-76) and April 23, 2007 (B-157).

According to MASH, two crash tests are recommended to evaluate longitudinal barriers to TL-3. In the safety performance evaluation of CASS S3 MASH, and as per your March 15, 2010 e-mail concurrence, two full-scale crash tests were conducted. Trinity feels that safety performance verification of the proposed CASS S3 MASH can be concluded, as summarized below.

***MASH* Test Designation 3-10:** An 1100C (2425 lb) passenger car impacting the critical impact point (CIP) of the length of need (LON) of the barrier at a nominal impact speed and angle of 100 km/h (62 mi/h) and 25 degrees, respectively. This test investigates the barrier's ability to successfully contain and redirect a small passenger vehicle. CASS S3 MASH was installed on the backslope of the 9.1m (30 foot 0 inch) wide depressed median median with 4H:1V side slopes at 3.35m (11 feet 0 inch) from the median bottom.

Summary of results: CASS S3 MASH on the 4H:1V backslope contained and redirected the 1100C vehicle. The vehicle did not penetrate or underride the barrier. Both wheels on the left side overrode the lower cable of the installation. Maximum dynamic deflection of the cable barrier was 2.29 meters (7.5 feet). Although the cables separated from some of the posts, there were no detached elements, fragments or other debris to penetrate or show potential for penetrating the occupant compartment or to present undue hazard to others in the area.

Maximum occupant compartment deformation was 25mm (1.0 inch) in the driver's side instrument panel area. The 1100C vehicle remained upright during and after the collision event. Maximum roll was 22 degrees, and maximum pitch was 16 degrees. Occupant risk factors were within the limits specified for *MASH* test 3-10. The 1100C vehicle remained within the cable system. CASS S3 MASH performed acceptably according to the evaluation criteria of *MASH* test 3-10.

***MASH* Test Designation 3-11:** A 2270P (5000 lb) pickup truck impacting the critical impact point (CIP) of the length of need (LON) of the barrier at a nominal impact speed and angle of 100 km/h (62 mi/h) and 25 degrees, respectively. This is a strength test for test levels 1 through 3 to verify a barrier's performance for impacts involving light trucks and SUVs for all test levels. CASS S3 MASH was installed on the foreslope of a 9.1m (30 foot 0 inch) wide depressed median with 4H:1V side slopes at 1.22m (4 foot 0 inch) from the break point.

Summary of results: CASS S3 MASH on the 4H:1V foreslope contained and redirected the 2270P vehicle. The vehicle did not penetrate or underride. Only the left rear wheel overrode the two lower cables of the installation. Maximum dynamic deflection of the cable barrier was 2.9 meters (9.6 feet). Although the cables separated from some of the posts, there were no detached elements, fragments or other debris to penetrate or show potential for penetrating the occupant compartment or to present undue hazard to others in the area.

Maximum occupant compartment deformation was 25mm (0.25 inch) in the left lower kickpanel area. The 2270P vehicle remained upright during and after the collision event. Maximum roll was -4 degrees, and maximum pitch was 18 degrees. Occupant risk factors were within the limits specified for MASH test 3-11. The vehicle remained within the installation and did not exit the barrier, thus remaining within the exit box. CASS S3 MASH performed acceptably according to the evaluation criteria of MASH test 3-11.

Trinity respectfully requests FHWA acceptance of the CASS S3 MASH cable barrier for use on the National Highway System (NHS) as a MASH Test Level 3 compliant roadside or median barrier on the designated 4H:1V or flatter slopes when such use is acceptable to the contracting agency.

Although testing was conducted with standard (non-prestretched) cables, Trinity also requests FHWA acceptance of CASS S3 MASH with prestretched cables.

Thank you for your consideration. Should you have questions, we will be pleased to furnish or secure answers promptly.

Sincerely,
Brian Smith

Trinity Highway Products, LLC.

Enclosures: 4

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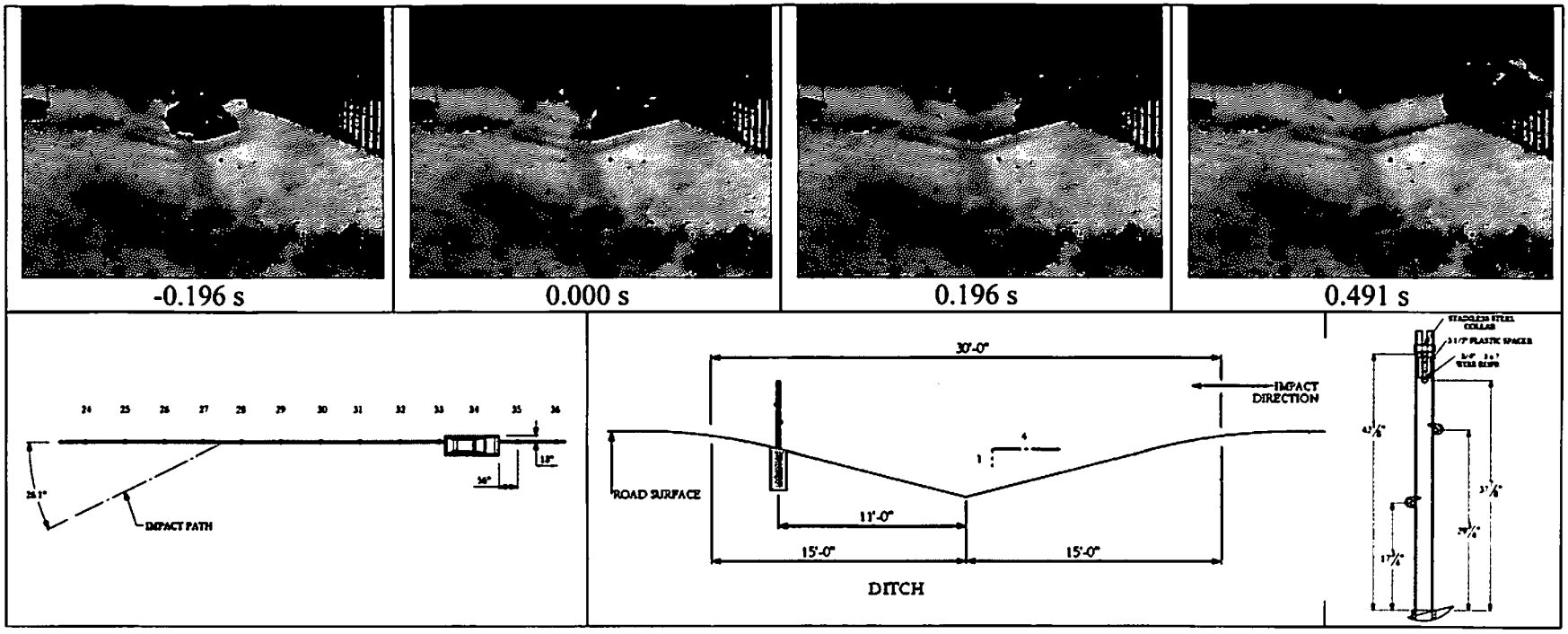


General Information
- Test Agency ..... Texas Transportation Institute
- Test Standard Test No. ..... *MASH* 3-10
- TTI Test No. 400001-TCR41
- Date 2010-06-02

Test Article
- Type ..... Cable Barrier
- Name ..... Trinity CASS on 4H:1V Backslope
- Installation Length ..... 640 ft
- Material or Key Elements ..... 4 wire ropes supported by slotted S3x5.7 support posts

Soil Type and Condition ..... MASH Standard Soil, dry

Test Vehicle
- Type/Designation 1100C
- Make and Model ..... 2004 Kia Rio
- Curb ..... 2394 lb
- Test Inertial ..... 2406 lb
- Dummy ..... 176 lb
- Gross Static ..... 2582 lb

Impact Conditions
- Speed entering ditch ..... 61.5 mi/h
- Angle entering ditch ..... 26.1 degrees
- Speed at wire rope ..... 46.2 mi/h
- Angle at wire rope ..... 26.1 degrees
- Location/Orientation ..... Midspan 27-28

Exit Conditions
- Speed ..... Not obtainable
- Angle ..... Not obtainable

Occupant Risk Values
- Impact Velocity
  - Longitudinal ..... 17.4 ft/s
  - Lateral ..... 0.3 ft/s
- Ridedown Accelerations
  - Longitudinal ..... -5.0 G
  - Lateral ..... 3.7 G
- THIV ..... 19.1 km/h
- PHD ..... 5.0 G
- ASI 0.72
- Max. 0.050-s Average
  - Longitudinal ..... -6.8 G
  - Lateral ..... 1.4 G
  - Vertical ..... -4.6 G

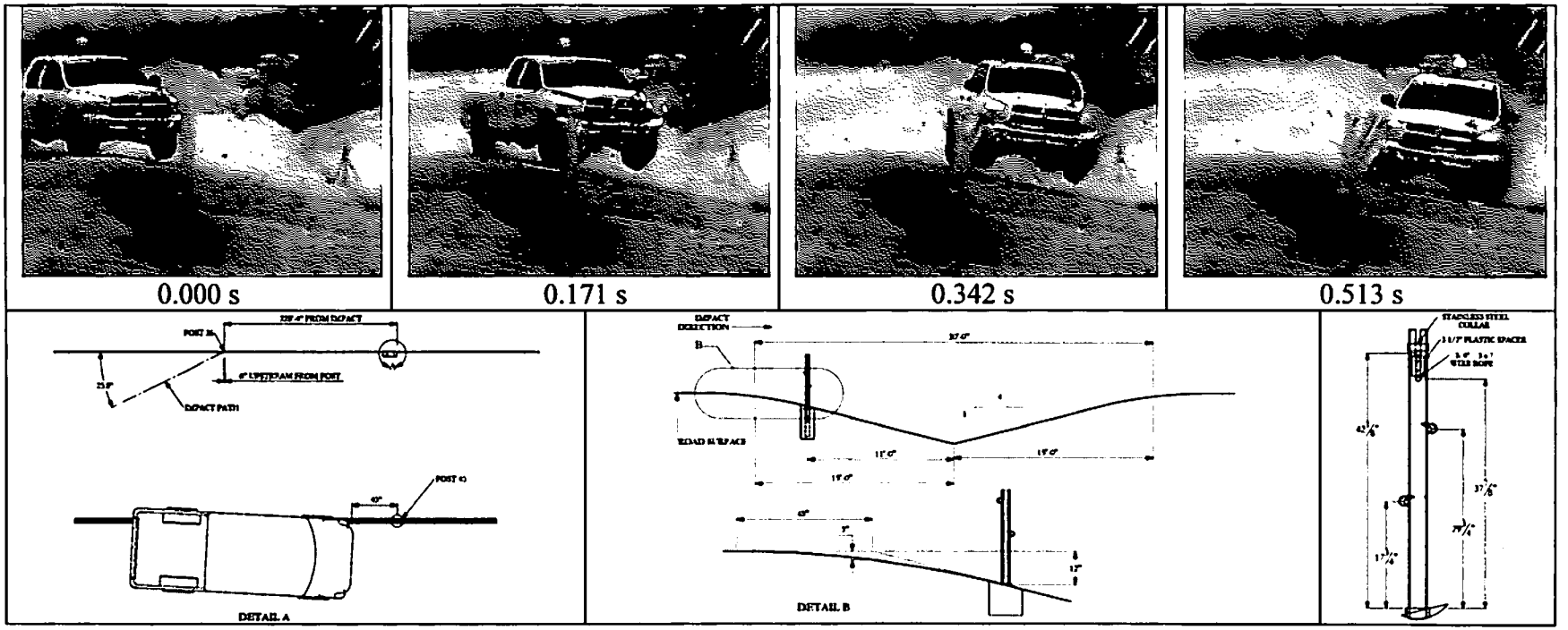
Post-Impact Trajectory
- Stopping Distance ..... 66.6 ft downstream

Vehicle Stability
- Maximum Yaw Angle ..... 22 degrees
- Maximum Pitch Angle ..... 16 degrees
- Maximum Roll Angle ..... 22 degrees
- Vehicle Snagging ..... No
- Vehicle Pocketing ..... No

Test Article Deflections
- Dynamic ..... 7.5 ft
- Permanent ..... 2.4 ft
- Working Width ..... 8.1 ft

Vehicle Damage
- VDS 11LFQ4
- CDC 11FLEW4
- Max. Exterior Deformation ..... 8.0 inches
- OCDI LF0000000
- Max. Occupant Compartment Deformation ..... 1.0 inch

Figure 5.7. Summary of results for *MASH* test 3-10 on the Trinity CASS on 4H:1V backslope.



General Information
- Test Agency ..... Texas Transportation Institute
- Test Standard Test No. ..... *MASH* 3-11
- TTI Test No. 400001-TCR40
- Date 2010-05-13

Test Article
- Type ..... Cable Barrier
- Name ..... Trinity CASS on 4H:1V Foreslope
- Installation Length ..... 640 ft
- Material or Key Elements ..... 4 wire ropes supported by slotted S3x5.7 support posts

Soil Type and Condition ..... MASH Standard Soil, dry

Test Vehicle
- Type/Designation 2270P
- Make and Model ..... 2005 Dodge Ram 1500 pickup
- Curb ..... 4724 lb
- Test Inertial ..... 5044 lb
- Dummy ..... No dummy
- Gross Static ..... 5044 lb

Impact Conditions
- Speed ..... 62.5 mi/h
- Angle ..... 25.8 degrees
- Location/Orientation .....

Exit Conditions
- Speed ..... Did not exit
- Angle ..... Did not exit

Occupant Risk Values
- Impact Velocity
  - Longitudinal ..... 10.8 ft/s
  - Lateral ..... 11.4 ft/s
- Ridedown Accelerations
  - Longitudinal ..... -4.8 G
  - Lateral ..... 4.5 G
- THIV ..... 15.7 km/h
- PHD ..... 6.0 G
- ASI 0.36
- Max. 0.050-s Average
  - Longitudinal ..... -3.1 G
  - Lateral ..... 2.9 G
  - Vertical ..... -2.1 G

Post-Impact Trajectory
- Stopping Distance ..... 231 ft

Vehicle Stability
- Maximum Yaw Angle ..... 32 degrees
- Maximum Pitch Angle ..... -4 degrees
- Maximum Roll Angle ..... 18 degrees
- Vehicle Snagging ..... No
- Vehicle Pocketing ..... No

Test Article Deflections
- Dynamic ..... 9.6 ft
- Permanent ..... 1.1 ft
- Working Width ..... 10.3 ft

Vehicle Damage
- VDS 11LFQ1
- CDC 11FLEW2
- Max. Exterior Deformation ..... 6.0 inches
- Max. Occupant Compartment Deformation ..... 0.25 inch

Figure 5.7. Summary of results for *MASH* test 3-11 on the Trinity CASS on 4H:1V foreslope.