



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

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

October 1, 2010

In Reply Refer To:
HSSD/B-141F

Mr. Brian Smith
Trinity Highway Products, LLC
P.O. Box 568887
Dallas, TX 75356-8887

Dear Mr. Smith:

This letter is in response to your request for the Federal Highway Administration (FHWA) acceptance of modifications to your CASS cable barrier safety system for use on the National Highway System (NHS).

Name of system:	Trinity's Cable Safety System (CASS S3 4:1)
Type of system:	Four cable median and roadside barrier system
Test Levels:	NCHRP Report 350: Test Level 3 on 1:4 slopes or flatter Test Level 4 on 1:6 slopes or flatter
Testing conducted by:	Texas Transportation Institute
Date of request:	March 5, 2010

You requested that we find this system acceptable for use on the NHS under the provisions of National Cooperative Highway Research Program (NCHRP) Report 350 "Recommended Procedures for the Safety Performance Evaluation of Highway Features."

Requirements

Roadside safety systems should meet the guidelines contained in the NCHRP Report 350. The FHWA memorandum "Identifying Acceptable Highway Safety Features" of July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers.

Description

The CASS S3 4:1 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 S75 x 8 (S3 x 5.7 in English units) structural I-beam posts. The bottom two cables are



FHWA:HSSD:NArtimovich:tb:61331:9/20/10

File: s://directoryfolder/nartimovich/B-141F CASS S3 4-1 FINAL.doc
cc: HSSD (Reader, HSA; Chron File, HSSD; NArtimovich, HSSD;
JCheung, HSSD)

supported on flanges of the I-beam post by an 8-mm (5/16-inch) hook bolt with 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 S75 x 8 (S3 x 5.7) posts were installed in steel tube sleeves set in 305-mm (12-inch) diameter x 762-mm (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 3/4-inch diameter standard (non-pre-stretched) 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 24.9 kN (5,600 pounds force) for the tests.

The 104.7-m (343-foot, 6-inch) test installations were anchored by Texas Transportation Institute (TTI) Breakaway Cable Anchor Terminals which were accepted by the FHWA on August 29, 2002.

Four tests were conducted with the CASS S3 4:1 system installed in a 9.1m (30 foot 0 inch) wide depressed median with 1V: 4H side slopes, and one test with the CASS S3 4:1 system installed on level terrain:

1. The NCHRP Report 350 Test 3-11 (modified) - 2270P at 102.6 km/hour (63.7 mph) with a 25.4 degree impact angle. The test article was the CASS S3 4:1 with 3.2-m (10-foot, 6-inch) post spacing installed on the foreslope of a 9.1-m (30-foot, 0-inch) wide depressed median with 1V: 4H side slopes at 1.22m (4 foot, 0 inch) from the break point.

The CASS S3 4:1 on 1V:4H foreslope contained and redirected the 2270P vehicle. The vehicle did not penetrate, under ride, or override the installation. Dynamic deflection in Test 3-11 (modified) with 3.2-m (10-foot, 6-inch) post spacing was reported by TTI to be 2.16m (7.1 feet).

2. The NCHRP Report 350 Test 3-10 - 820C at 102.1 km/hour (63.4 mph) with a 20.8 degree impact angle. The test article was the CASS S3 4:1 with 6.1-m (20-foot, 0-inch) post spacing installed on the backslope of the 9.1-m (30-foot, 0-inch) wide depressed median at 3.35m (11 feet 0 inch) from the median bottom. The test vehicle crossed the median bottom and traveled up the backslope before impacting CASS S3 4:1.

The CASS S3 4:1 on 1V:4H backslope contained the 820C vehicle, which then sideslipped along the system until loss of contact. The vehicle did not penetrate, under ride, or override the installation. Dynamic deflection in Test 3-10 (backslope) with 6.1-m (20-foot, 0-inch) post spacing was reported by TTI to be 1.34m (4.4 feet).

3. The NCHRP Report 350 Test 3-10 - 820C at 97.3 km/hour (60.4 mph) with a 19.5 degree impact angle. The test article was the CASS S3 4:1 with 3.2-m (10-foot, 6-inch) post spacing installed on the foreslope of a 9.1-m (30-foot, 0-inch) wide depressed median with 1V: 4H side slopes at 1.22m (4 foot, 0 inch) from the break point.

The CASS S3 4:1 on 1V:4H foreslope contained and redirected the 820C vehicle. The vehicle did not penetrate, under ride, or override the installation. Dynamic deflection in Test 3-10 with 3.2-m (10-foot, 6-inch) post spacing was reported by TTI to be 1.04m (3.4 feet).

4. The NCHRP Report 350 Test 3-11 (modified) - 2270P at 102.4 km/hour (63.6 mph) with a 25.4 degree impact angle. The test article was the CASS S3 4:1 with 6.4-m (21-foot, 0-inch) post spacing installed on the foreslope of a 9.1-m (30-foot, 0-inch) wide depressed median with 1V: 4H side slopes at 1.22m (4 foot, 0 inch) from the break point.

The CASS S3 4:1 on 1V:4H foreslope contained and redirected the 2270P vehicle. The vehicle did not penetrate, under ride, or override the installation. Dynamic deflection in Test 3-11 (modified) with 6.4-m (21-foot, 0-inch) post spacing was reported by TTI to be 2.59m (8.5 feet).

5. The NCHRP Report 350 Test 4-12 - 8000S at 79.9 km/hour (49.6 mph) with a 13.6 degree impact angle. The test article was the CASS S3 4:1 with 3.2-m (10-foot, 6-inch) post spacing installed on level terrain.

The CASS S3 4:1 on flat ground contained and redirected the 8000S vehicle. The vehicle did not penetrate, under ride, or override the installation. Dynamic deflection in Test 4-12 with 3.2-m (10-foot, 6-inch) post spacing was reported by TTI to be 2.42m (8.0 feet).

The deflections reported above for 3-11 Tests were using a Manual for Assessing Safety Hardware vehicle (2270P). Based on reduced mass, the deflections for an NCHRP-350 vehicle (2000P) are estimated to be 1.91m (6.26 feet) for 3.2-m (10-foot, 6-inch) post spacing and 2.28m (7.49 feet) for 6.4-m (21-foot, 0-inch) post spacing.

Findings

The 4-cable barrier systems described above are acceptable for use on the designated 1V:4H or flatter slopes under NCHRP Report 350 Test Level 3 or 4 conditions as noted. The systems are detailed in the enclosed drawings and are acceptable for use on the NHS when such use is acceptable to a highway agency.

Although the barrier performed well under idealized test impact conditions, 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 104.7-m (343-foot, 6-inch) test length.

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

- This acceptance is limited to the crashworthiness characteristics of the systems and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may adversely influence the crashworthiness of the system will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the system being marketed is significantly different from the version that was crash tested, we reserve the right to modify or revoke our acceptance.
- You will be expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that it will meet the crashworthiness require of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number B-141F 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.
- The CASS barriers are patented products and considered proprietary. If proprietary systems are specified by a highway agency for use on Federal-aid projects, except exempt, non-NHS 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.
- This acceptance 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 acceptance letter is limited to the crashworthiness characteristics of the candidate system and the FHWA is neither prepared nor required to become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,

David A. Nicol, P.E.
Director, Office of Safety Design

Enclosures



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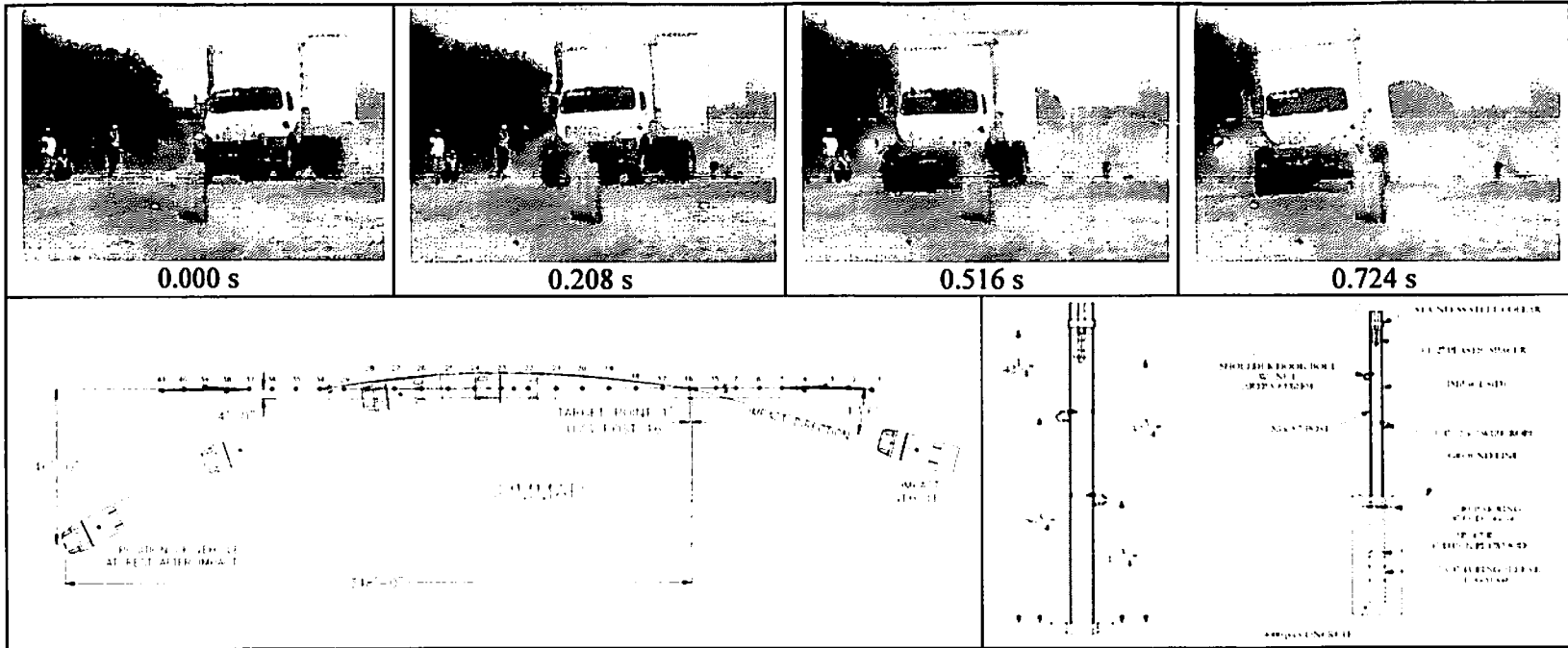
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Sincerely yours,

A handwritten signature in black ink, appearing to read "David A. Nicol". The signature is fluid and cursive, written over a light gray rectangular background.

David A. Nicol, P.E.
Director, Office of Safety Design

Enclosures



23

General Information

Test Agency..... Texas Transportation Institute
 Test No. 400001-TCR33
 Date 2009-09-04
Test Article
 Type..... Longitudinal Barrier
 Name Trinity CASS
 Installation Length 343.5 ft
 Material or Key Elements 4 wire ropes supported by slotted S3x5.7 support posts spaced at 10 ft-6 inches

Soil Type and Condition..... Concrete footings in crushed limestone, dry

Test Vehicle

Type/Designation..... 8000S
 Make and Model 1994 International NaviStar 4700
 Curb 12,400 lb
 Test Inertial..... 17,710 lb
 Dummy No dummy
 Gross Static 17,710 lb

Impact Conditions

Speed49.6 mi/h
 Angle13.6 degrees
 Location/Orientation1 ft upstream

Exit Conditions Post 16

SpeedNot obtainable
 AngleNot obtainable

Occupant Risk Values

Impact Velocity
 Longitudinal3.6 ft/s
 Lateral4.9 ft/s
Ridedown Accelerations
 Longitudinal-1.4 G
 Lateral-1.3 G
 THIV6.4 km/h
 PHD0.12

Max. 0.050-s Average

Longitudinal-0.6 g
 Lateral-1.1 G
 Vertical 0.4 G

Post-Impact Trajectory

Stopping Distance 348 ft downstrm
 46 ft twd traffic

Vehicle Stability

Maximum Yaw Angle.....-23 degrees
 Maximum Pitch Angle..... -3 degrees
 Maximum Roll Angle..... 1 degrees
 Vehicle Snagging..... No
 Vehicle Pocketing No

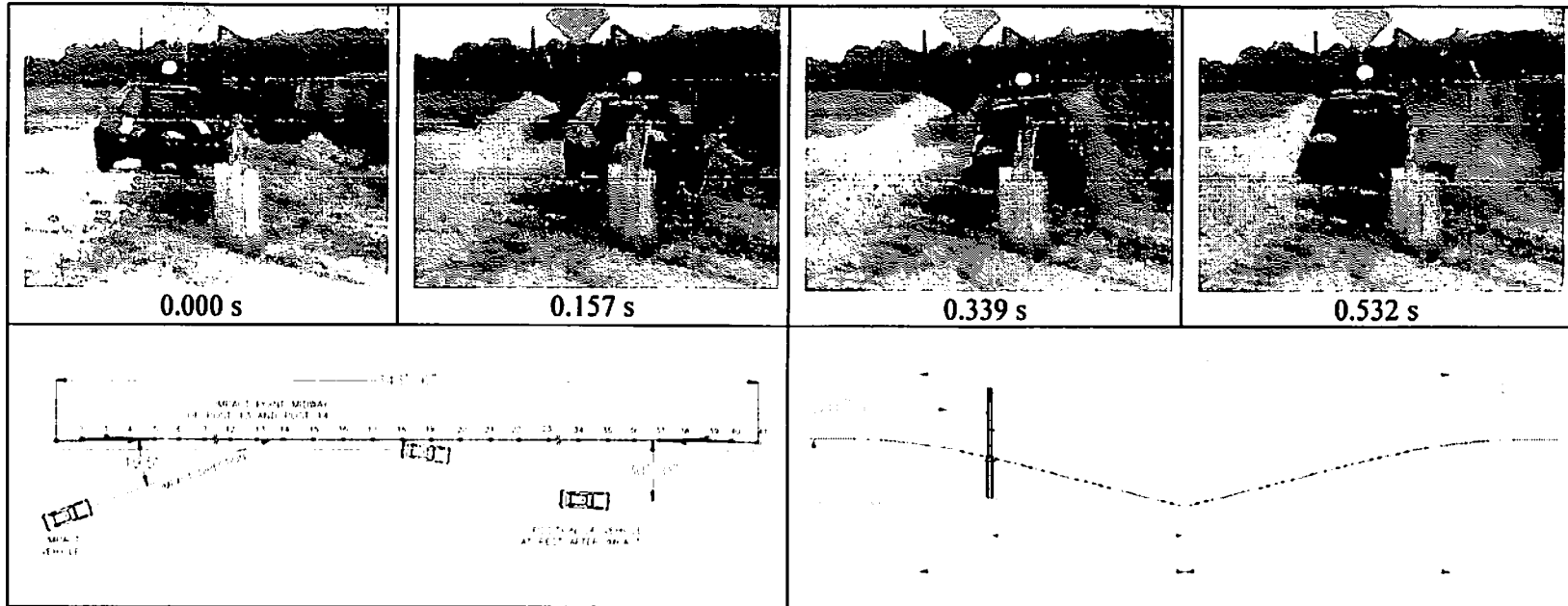
Test Article Deflections

Dynamic.....~8 ft
 Permanent0.9 ft
 Working Width9.1 ft

Vehicle Damage

VDS01RFQ1
 CDC01RFEW1
 Max. Exterior Deformation..... 1.5 inches
 Max. Occupant Compartment Deformation.....0

Figure 15. Summary of results for NCHRP Report 350 test 4-12 on the Trinity CASS on level ground.



23

General Information

Test Agency..... Texas Transportation Institute
 Test No. 400001TCR35
 Date 2009-10-08

Test Article

Type..... Cable Barrier
 Name Trinity CASS
 Installation Length 343.5 ft
 Material or Key Elements CASS with S3x5.7 posts installed on 4H:1V foreslope

Soil Type and Condition..... Concrete Footings in Standard Soil, Damp

Test Vehicle

Type/Designation..... 820C
 Make and Model..... 1995 Suzuki Swift
 Curb 1861 lb
 Test Inertial..... 1850 lb
 Dummy 167 lb
 Gross Static..... 2017 lb

Impact Conditions

Speed60.4 mi/h
 Angle19.5 degrees
 Location/OrientationMidspan btw posts 15&16
Exit Conditions posts 15&16
 SpeedNot obtainable
 Angle~3.6 degrees

Occupant Risk Values

Impact Velocity
 Longitudinal12.8 ft/s
 Lateral12.8 ft/s
Ridedown Accelerations
 Longitudinal-5.3 G
 Lateral 6.3 G
 THIV18.2 km/h
 PHD7.5 G
Max. 0.050-s Average
 Longitudinal-2.9 G
 Lateral 4.3 G
 Vertical 3.7 G

Post-Impact Trajectory

Stopping Distance 214 ft dwnstrm
 30 ft twd traffic

Vehicle Stability

Maximum Yaw Angle..... 32 degrees
 Maximum Pitch Angle..... 9 degrees
 Maximum Roll Angle..... 14 degrees
 Vehicle Snagging..... No
 Vehicle Pocketing No

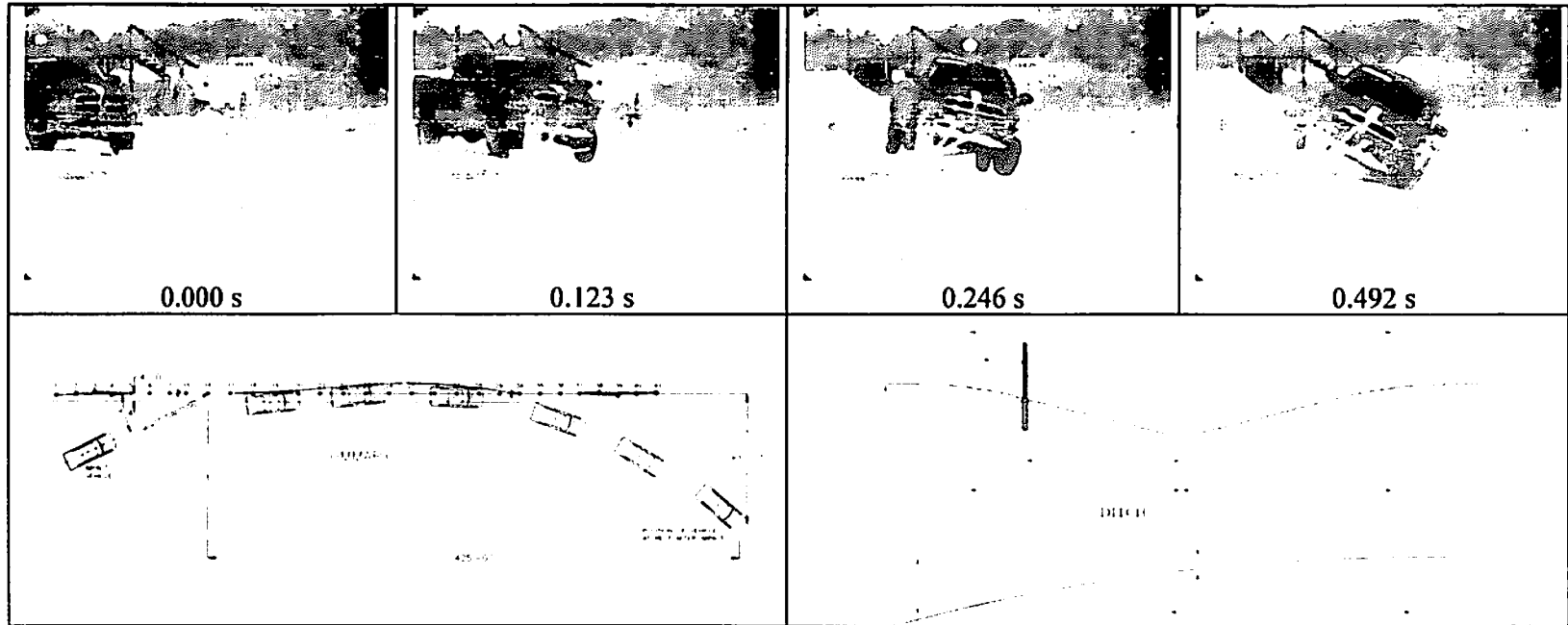
Test Article Deflections

Dynamic..... 3.4 ft
 Permanent0.1 ft
 Working Width 4.2 ft

Vehicle Damage

VDS 11LFQ3
 CDC..... 11FDEW3
 Max. Exterior Deformation..... 10.6 inches
 Max. Occupant Compartment Deformation..... 0.6 inch

Figure 16. Summary of results for NCHRP Report 350 test 3-10 on the Trinity CASS with S3x5.7 posts installed on a 4H:1V foreslope.



General Information

Test Agency..... Texas Transportation Institute
 Test No. 400001-TCR32
 Date 2009-08-12

Test Article

Type..... Longitudinal Barrier
 Name CASS on 4H:1V Slope
 Installation Length 343.5 ft
 Material or Key Elements CASS with S3x5.7 posts spaced at 10 ft-6 inches on 4V:H1 foreslope

Soil Type and Condition

Crush Limestone, Dry

Test Vehicle

Type/Designation..... 2270P
 Make and Model..... 2003 Dodge 1500 Quad
 Curb..... 4871
 Test Inertial..... 5007
 Dummy No dummy
 Gross Static..... 5007

Impact Conditions

Speed63.7 mi/h
 Angle25.4 degrees
 Location/OrientationAt post 16

Exit Conditions

SpeedOut of view
 AngleNot obtainable

Occupant Risk Values

Impact Velocity
 Longitudinal..... 8.2 ft/s
 Lateral13.4 ft/s

Ridedown Accelerations

Longitudinal.....-3.5 G
 Lateral 4.3 G
 THIV15.9 km/h
 PHD5.0 G

Max. 0.050-s Average

Longitudinal.....-2.0 G
 Lateral 3.5 G
 Vertical-2.9 G

Post-Impact Trajectory

Stopping Distance 425 ft downstrm
 83 ft twd traffic

Vehicle Stability

Maximum Yaw Angle..... 39 degrees
 Maximum Pitch Angle.....-6 degrees
 Maximum Roll Angle.....28 degrees
 Vehicle Snagging.....No
 Vehicle Pocketing..... Yes

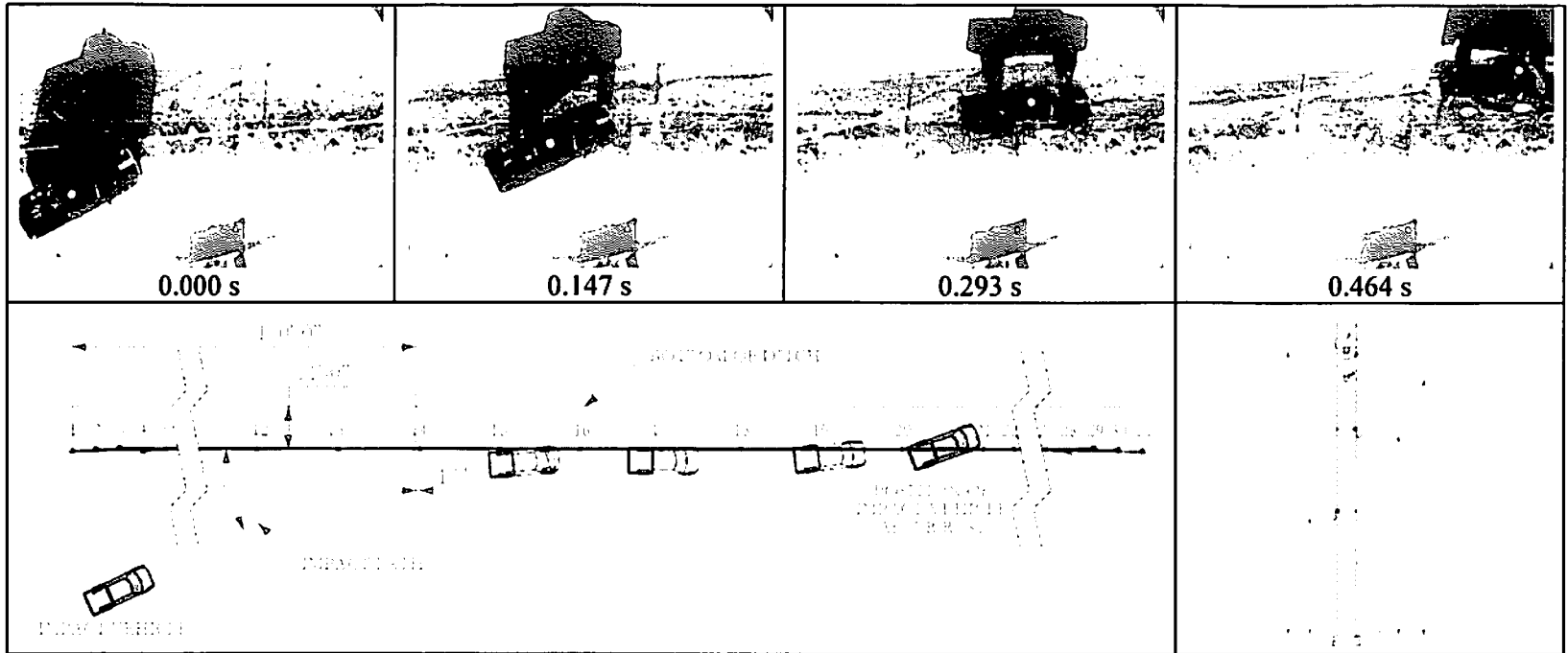
Test Article Deflections

Dynamic..... 7.1 ft
 Permanent..... 0.5 ft
 Working Width 8.2 ft

Vehicle Damage

VDS 11LFQ1
 CDC 11LFEW2
 Max. Exterior Deformation..... 9.0 inches
 Max. Occupant Compartment Deformation..... 0

Figure 11. Summary of results for NCHRP Report 350 test 3-11 on CASS with S3x5.7 posts on 4H:1V foreslope.



General Information

Test Agency..... Texas Transportation Institute
 Test No. 400001-TCR36
 Date 2009-11-06

Test Article

Type..... Wire Rope Barrier
 Name CASS with S3x5.7 posts/4H:1V foreslope
 Installation Length 343.5 ft
 Material or Key Elements CASS with S3x5.7 posts installed on 4H:1V foreslope

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

Test Vehicle

Type/Designation..... 2270P
 Make and Model..... 2004 Dodge Ram 1500 Quad-Cab
 Curb 4772 lb
 Test Inertial..... 5026 lb
 Dummy No dummy
 Gross Static..... 5026 lb

Impact Conditions

Speed63.6 mi/h
 Angle25.4 degrees
 Location/OrientationAt post 13

Exit Conditions

SpeedOut of view
 AngleOut of view

Occupant Risk Values

Impact Velocity
 Longitudinal.....8.8 ft/s
 Lateral12.5 ft/s
 Ridedown Accelerations
 Longitudinal-4.1 G
 Lateral 5.9 G
 THIV15.2 km/h
 PHD6.1 G
 Max. 0.050-s Average
 Longitudinal-2.0 G
 Lateral 3.6 G
 Vertical-1.8 G

Post-Impact Trajectory

Stopping Distance 73.5 ft downstrm
 Within cables

Vehicle Stability

Maximum Yaw Angle..... 33 degrees
 Maximum Pitch Angle.....-12 degrees
 Maximum Roll Angle.....-57 degrees
 Vehicle Snagging..... No
 Vehicle Pocketing No

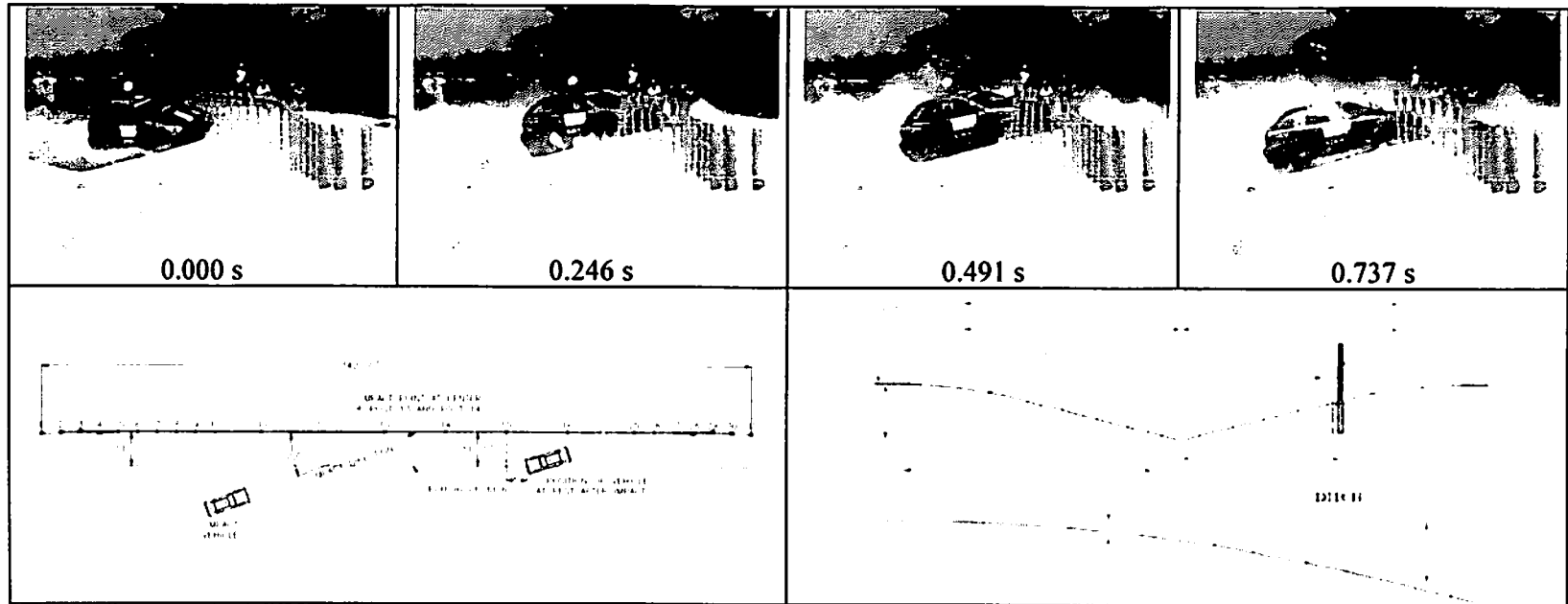
Test Article Deflections

Dynamic..... 8.5 ft
 Permanent3.0 ft
 Working Width9.8 ft

Vehicle Damage

VDS 11LFQ2
 CDC..... 11LDEW2
 Max. Exterior Deformation..... 7.5 inches
 Max. Occupant Compartment Deformation..... 0

Figure 16. Summary of results for NCHRP Report 350 test 3-11 on the CASS with S3x5.7 posts on 4H:1V foreslope.



General Information

Test Agency..... Texas Transportation Institute
 Test No. 400001-TCR34
 Date 2009-10-02

Test Article

Type..... Median Barrier
 Name Trinity CASS
 Installation Length 342 ft
 Material or Key Elements S3x5.7 posts installed on a 4H:1V
 backslope

Soil Type and Condition..... Concrete footings in standard soil, damp

Test Vehicle

Type/Designation..... 820C
 Make and Model..... 1997 Geo Metro
 Curb 1797 lb
 Test Inertial..... 1861 lb
 Dummy 165 lb
 Gross Static 2026 lb

Impact Conditions

Speed entering ditch.....63.4 mi/h
 Angle entering ditch.....20.8 degrees
 Speed at wire rope60.8 mi/h
 Angle at wire rope.....24.0 degrees
 Location/OrientationMispan 13-14

Exit Conditions

SpeedOut of view
 AngleOut of view

Occupant Risk Values

Impact Velocity
 Longitudinal18.7 ft/s
 Lateral 2.3 ft/s
Ridedown Accelerations
 Longitudinal-8.9 G
 Lateral-8.6 G
 THIV19.2 km/h
 PHD11.9 G
Max. 0.050-s Average
 Longitudinal-7.8 G
 Lateral-4.4 G
 Vertical-5.4 G

Post-Impact Trajectory

Stopping Distance 35 ft dnwstr
 11 ft field side

Vehicle Stability

Maximum Yaw Angle.....-172 degrees
 Maximum Pitch Angle..... 26 degrees
 Maximum Roll Angle.....-34 degrees
 Vehicle Snagging..... Yes
 Vehicle Pocketing..... No

Test Article Deflections

Dynamic.....4.4 ft
 Permanent 1.9 ft
 Working Width 5.2 ft

Vehicle Damage

VDS 11LFQ4
 CDC 11FLEW3
 Max. Exterior Deformation..... 9.8 inches
 Max. Occupant Compartment
 Deformation..... 1.2 inches

Figure 15. Summary of results for NCHRP Report 350 test 3-10 on the Trinity CASS with S3x5.7 posts installed on a 4H:1V backslope.