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

400 Seventh St., S.W.
Washington, D.C. 20590

November 17, 2005

In Reply Refer To: HSA-10/B-141

Mr. Stephen L. Brown
President
Trinity Highway Safety Products, Inc.
P.O. Box 568887
Dallas, Texas 75356-8887

Dear Mr. Brown:

In two separate letters to Mr. Richard Powers, both dated November 15, Mr. Brian Smith requested the Federal Highway Administration (FHWA) acceptance of modified designs of your CASS cable barrier, one at test level 3 (TL-3) and one at TL-4. Both designs use S4 x 7.7 structural steel posts to support the high-tensioned cables in lieu of the original CASS C-channel posts. For the TL-3 design, the 3/4-inch diameter cables were set at heights of 21.0, 25.2, and 29.5 inches above the ground surface, measured to the center of each cable. The slot design was also modified and the 47.25-inch long posts were weakened by the addition of two 11/16-inch diameter holes through each flange at ground line. These details are shown in Enclosure 1.

To verify the crashworthiness of the modified CASS design, two initial tests were conducted on a prototype TL-3 design at the Southwest Research Institute in San Antonio, details of which were contained in that agency's September 1, final report entitled "Full-Scale Crash Evaluation of a Tensioned Safety System (TESS) Cable Barrier System – NCHRP Report 350 Tests 3-10 and 3-11". For these tests, the weakening holes in each line post were 9/16-inch diameter and the posts were set on 16'-8" centers. The wire ropes were pretensioned to 5600 pounds. As seen on the test summary sheets (Enclosure 2a and 2b), both tests met the National Cooperative Highway Research Program (NCHRP) Report 350 evaluation criteria, but there was more damage to the small car and more post-crash instability with the pickup truck than normally seen in cable barrier tests. You subsequently increased the hole size to 11/16 inch and increased the post spacing to 20 feet. This final design was tested at the Texas Transportation Institute (TTI) with the pickup truck as described in that agency's November 2005 report, "NCHRP Report 350 Test 3-11 of the Trinity CASS-TL3 Spaced at 6.1 m in Concrete Footings and Sockets with Non-Pre-Stretched Cable". These test results, shown in

Enclosure 3, were a significant improvement over the first 3-11 test, and I agree that test 3-10 need not be run on the final "softer" design. The design deflection for the 100-m long test installation was 7.7 feet. All line posts were set into 5-inch x 3-inch x 11 gauge sockets encased in 12-inch diameter x 30-inch deep reinforced concrete foundations.

The TTI also tested the modified CASS with a single-unit truck under TL-4 impact conditions and reported the successful results in its November 2005 report entitled, "NCHRP Report 350 Test 4-12 of the Trinity CASS-TL4 Spaced at 6.1 m in Concrete Footings and Sockets with Non-Pre-Stretched Cable". Enclosure 4 is the summary sheet for this test. The support posts were lengthened to approximately 56 inches and the cable heights were set at 21.0, 29.5, and 38.0 inches. Thus, the bottom cable height remained the same as in the TL-3 design, and the middle cable was the same height as the upper cable in the TL-3 design. Since only the top cable was raised, it is reasonable to assume that the TL-4 design would perform acceptably in tests 3-10 and 3-11, both of which can be waived. The CASS TL-4 uses the same TL-3 anchor developed for the original CASS barrier (FHWA acceptance letter CC-76), and is identical through post 7. Two longer posts are then added to transition the cables gradually to the higher CASS TL-4 cable heights. This design is shown in Enclosure 5. Finally, since the design deflection of longitudinal barrier systems is based on the pickup truck test, which was waived for the CASS TL-4, its dynamic deflection can be assumed to be the same as the CASS TL-3, i.e., 7.7 feet. As with all roadside safety features, the field performance of both designs should be closely monitored to verify acceptable performance under varied field conditions.

The CASS TL-3 and CASS TL-4 designs described above may be used as either a roadside or median barrier on the National Highway System (NHS) when such use is acceptable to the contracting agency. Although the cables used in the test were not pre-stretched, this acceptance is also valid if and when pre-stretched cables are used, assuming that the recommended post-tensioning is applied to the barrier. You also asked about the acceptability of an alternative post embedment detail, specifically direct-driven posts or posts set in driven sockets. While longer posts embedded directly into the ground or posts in sockets without concrete foundations would probably perform satisfactorily, there is currently no way to predict barrier deflection with different embedment designs. To determine the design deflections for alternative post designs, testing would need to be done.

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

- Our acceptance is limited to the crashworthiness characteristics of the CASS TL-3 and TL-4 designs and does not cover their structural features, durability, or maintenance characteristics.
- Any design or material changes that may adversely affect the crashworthiness of the barrier 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 barrier being marketed is significantly different from the version that was crash tested, it reserves the right to modify or revoke its 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.
- To prevent misunderstanding by others, this letter of acceptance, designated as number B-141 shall not be reproduced except in full. This letter, and the test documentation upon which this letter is based, is public information. All such letters and documentation may be reviewed at our office upon request.
- The CASS Cable Barrier includes patented components and is considered proprietary. When proprietary devices are *specified by a highway agency* for use on Federal-aid projects, except exempt, non-NHS projects, they: (a) must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with 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 yours,

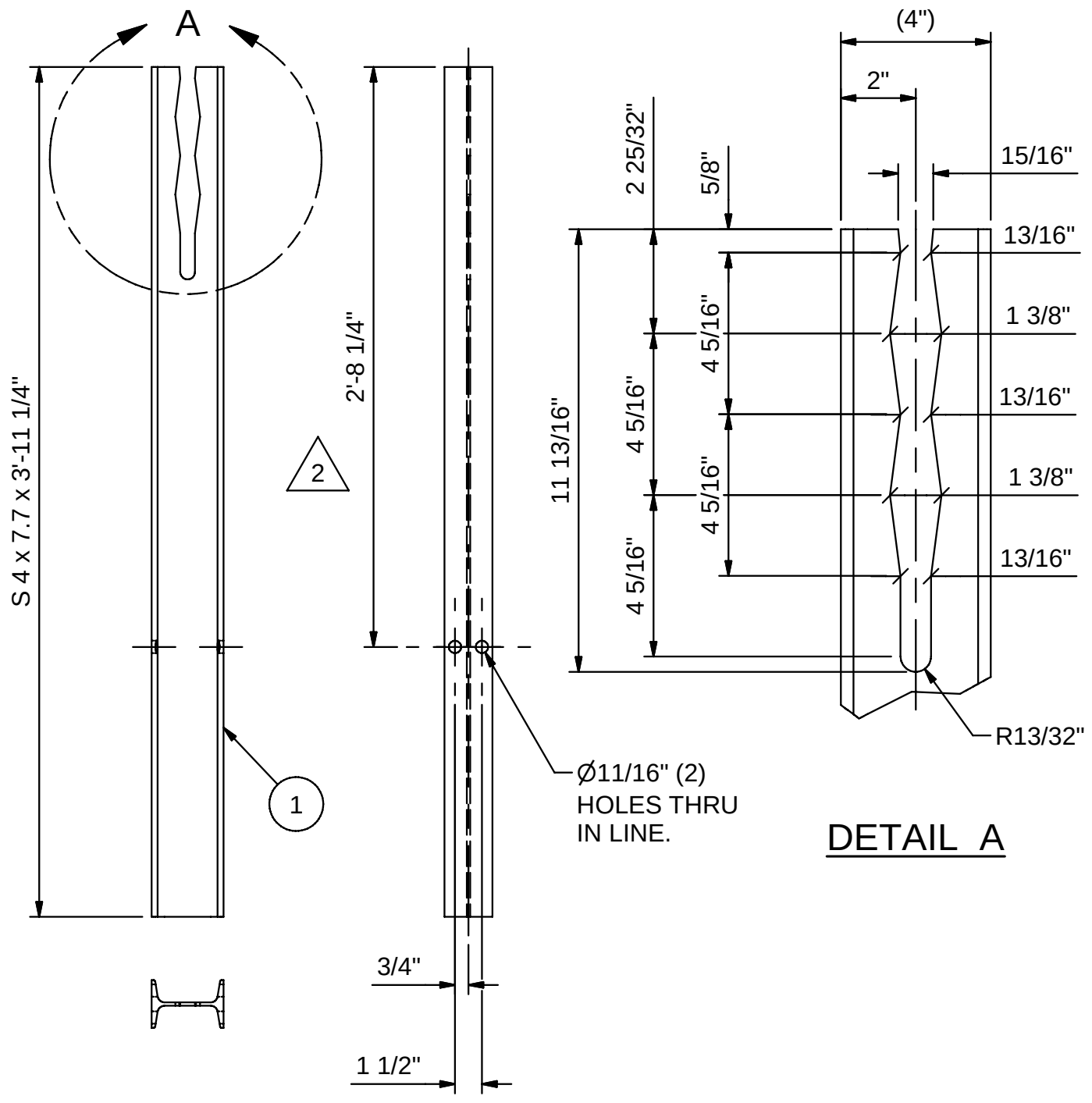
***/original signed by George Ed. Rice, Jr./***

***~for~***

John R. Baxter, P.E.
Director, Office of Safety Design
Office of Safety

5 Enclosures

| BILL OF MATERIAL | | | | | | |
|---|---|---|---|---|---|---|
| QTY | PART No | ITEM | DESCRIPTION | LENGTH | Lbs / Each | MATERIAL |
| 1 | | 1 | S 4 x 7.7 | 3'-11 1/4" | 29.54 | A36 |




DETAIL A

# CASS-TL3 - SHORT POST 3'-11 1/4" - (IN CONCRETE OR IN DRIVEN SLEEVE)

| | |
|---|---|
| GALV SPEC: | A123 |
| SHIPPING WT: | 31.3 lb |
| DRW: E.A.S | 7/16/2005 |
| CHK: R.M.H. | 7/18/2005 |

**TRINITY INDUSTRIES, INC.**
HIGHWAY SAFETY DIVISION

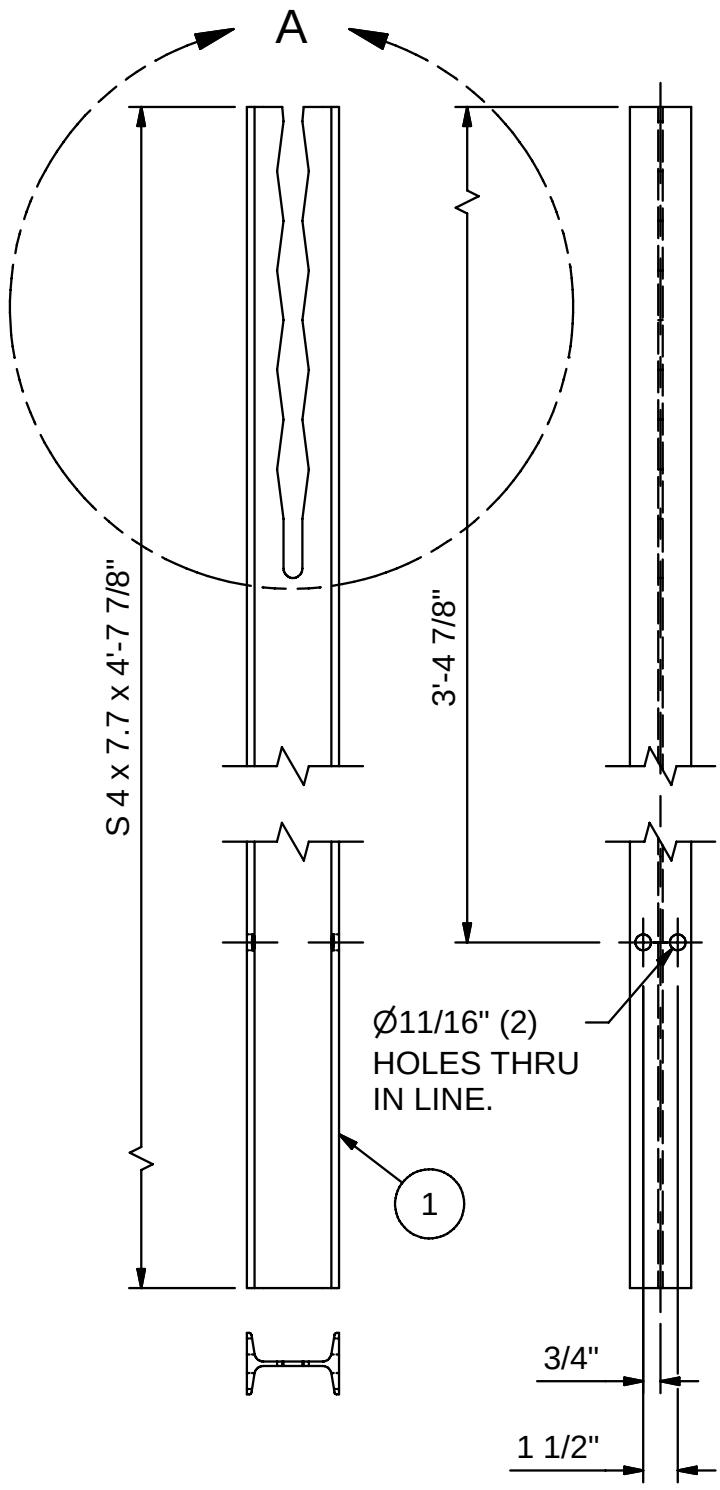
DWG NO: TL3-S11

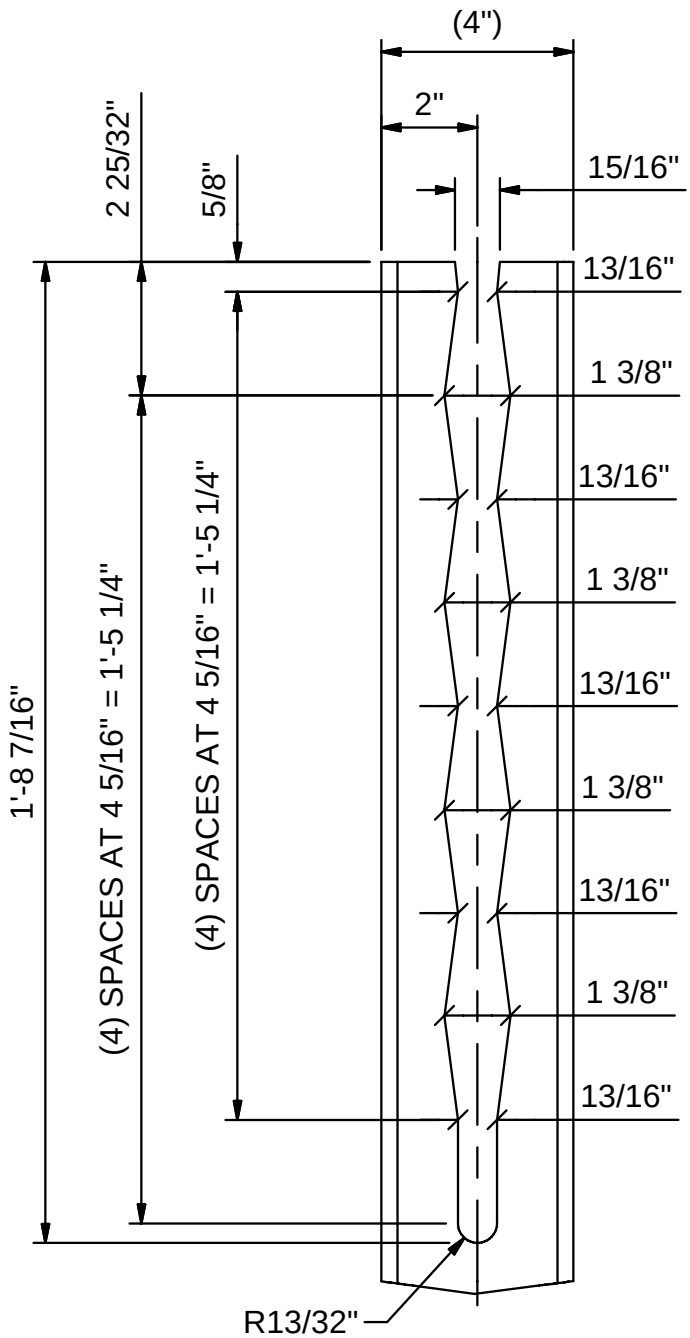
REV: 0

PROJ. CASS-TL3

BILL OF MATERIAL

| QTY | PC NO. | ITEM | DESCRIPTION | LENGTH | Lbs / Each | MATERIAL |
|---|---|---|---|---|---|---|
| 1 | | 1 | S 4 x 7.7 | 4'-7 7/8" | 34.56 | A36 |




DETAIL A

# CASS-TL4 - SHORT POST 4'-7 7/8" - (IN CONCRETE OR IN DRIVEN SLEEVE)

| | |
|---|---|
| GALV SPEC: | A123 |
| SHIPPING WT: | 36.6 lb |
| DRW: E.A.S | 10/14/2005 |
| CHK: B.S. | 10/14/2005 |

**TRINITY HIGHWAY SAFETY PRODUCTS, INC.**

DWG NO: TL4-S11

REV: 0

PROJ. CASS-TL4

**Table D.1 – Test CASS-2 Summary Report**

Test Summary Report

General Information

| | |
|---|---|
| Test Agency: | Southwest Research Institute |
| Test Number: | CASS-2 |
| Test Date: | 08/17/05 |
| Test Article: | TESS Cable Barrier |

Test Vehicle

| | |
|---|---|
| Description: | 2000 Suzuki Swift |
| Test Inertial Mass: | 907 kg |
| Gross Static Mass: | 907 kg |

Impact Conditions

| | |
|---|---|
| Speed: | 100.0 km/hr |
| Angle: | 20.0 degrees |

Occupant Risk Factors

Impact Velocity (m/s) at 0.1820 seconds on left side of interior

| | |
|---|---|
| x-direction | 3.4 |
| y-direction | -4.5 |

| | |
|---|---|
| THIV (km/hr): | 24.6 at 0.1919 seconds on left side of interior |
| THIV (m/s): | 6.8 |

Ridedown Accelerations (g's)

| | | |
|---|---|---|
| x-direction | -6.2 | (0.2722 - 0.2822 seconds) |
| y-direction | 6.8 | (0.1817 - 0.1917 seconds) |

| | | |
|---|---|---|
| PHD (g's): | 7.0 | (0.2722 - 0.2822 seconds) |
| ASI: | 0.64 | (0.1617 - 0.2117 seconds) |

Max. 50msec Moving Avg. Accelerations (g's)

| | | |
|---|---|---|
| x-direction | -3.9 | (0.2574 - 0.3074 seconds) |
| y-direction | 5.3 | (0.1617 - 0.2117 seconds) |
| z-direction | -1.9 | (0.1742 - 0.2242 seconds) |

Max Roll, Pitch, and Yaw Angles (degrees)

| | | |
|---|---|---|
| Roll | -5.1 | (0.2038 seconds) |
| Pitch | -7.1 | (0.3884 seconds) |
| Yaw | -15.8 | (0.3318 seconds) |

## Table C.1 – Test CASS-1 Summary Report

General Information

| | |
|---|---|
| Test Agency: | Southwest Research Institute |
| Test Number: | CASS-1 |
| Test Date: | 08/16/05 |
| Test Article: | TESS Cable Barrier |

Test Vehicle

| | |
|---|---|
| Description: | 3/4 Ton Chevrolet Pickup |
| Test Inertial Mass: | 2000 kg |
| Gross Static Mass: | 2000 kg |

Impact Conditions

| | |
|---|---|
| Speed: | 100.0 km/hr |
| Angle: | 25.0 degrees |

Occupant Risk Factors

Impact Velocity (m/s) at 0.2023 seconds on right side of interior

| | | |
|---|---|---|
| x-direction | 2.2 | |
| y-direction | 3.5 | |

| | | |
|---|---|---|
| THIV (km/hr): | 16.8 at 0.2106 seconds on right side of interior | |
| THIV (m/s): | 4.7 | |

Ridedown Accelerations (g's)

| | | |
|---|---|---|
| x-direction | -3.3 | (0.2092 - 0.2192 seconds) |
| y-direction | -7.6 | (0.3611 - 0.3711 seconds) |

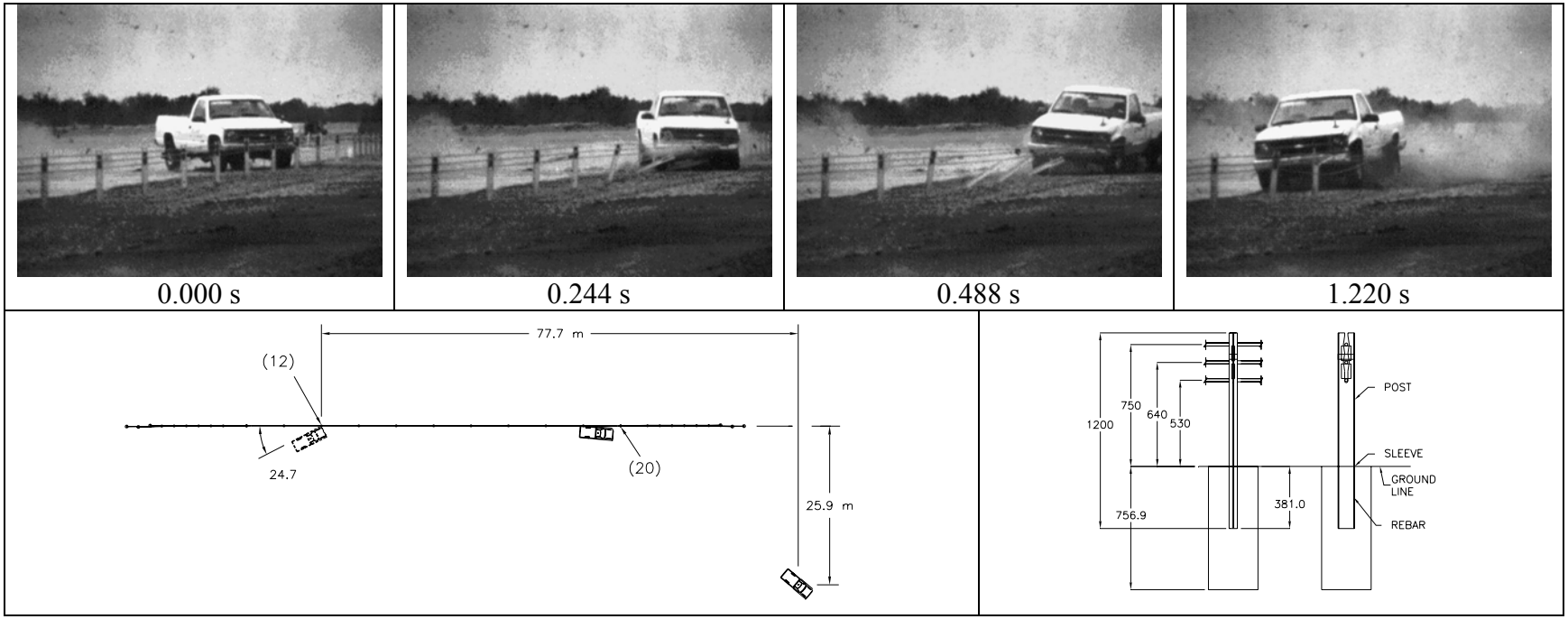
| | | |
|---|---|---|
| PHD (g's): | 7.7 | (0.3611 - 0.3711 seconds) |
| ASI: | 0.49 | (0.3437 - 0.3937 seconds) |

Max. 50msec Moving Avg. Accelerations (g's)

| | | |
|---|---|---|
| x-direction | -1.9 | (0.1892 - 0.2392 seconds) |
| y-direction | -4.4 | (0.3432 - 0.3932 seconds) |
| z-direction | 2.0 | (0.5184 - 0.5684 seconds) |

Max Roll, Pitch, and Yaw Angles (degrees)

| | | |
|---|---|---|
| Roll | -26.9 | (0.7841 seconds) |
| Pitch | 10.9 | (0.5694 seconds) |
| Yaw | 30.7 | (0.4670 seconds) |




**General Information**

| | |
|---|---|
| Test Agency | Texas Transportation Institute |
| Test No. | 400001-TCR8 |
| Date | 10-07-2005 |

**Test Article**

| | |
|---|---|
| Type | Cable Guardrail |
| Name | Trinity CASS-TL3 |
| Installation Length (m) | 101.9 |
| Material or Key Elements | 3 Wire Ropes With S4x7.7# I-Beam Posts In Concrete Socketed Footings Spaced at 6.1 m |
| **Soil Type and Condition** | Standard Soil, Dry |

**Test Vehicle**

| | |
|---|---|
| Type | Production |
| Designation | 20000P |
| Model | 1999 Chevrolet C2500 |
| Mass (kg) | |
| Curb | 2223 |
| Test Inertial | 2106 |
| Dummy | N/A |
| Gross Static | 2106 |

**Impact Conditions**

| | |
|---|---|
| Speed (km/h) | 96.5 |
| Angle (deg) | 24.7 |

**Exit Conditions**

| | |
|---|---|
| Speed (km/h) | N/A |
| Angle (deg) | N/A |

**Occupant Risk Values**

| | |
|---|---|
| Impact Velocity (m/s) | |
| Longitudinal | 2.1 |
| Lateral | 3.4 |
| THIV (km/h) | 13.1 |
| Ridedown Accelerations (g's) | |
| Longitudinal | -3.5 |
| Lateral | 7.6 |
| PHD (g's) | 7.6 |
| ASI | 0.45 |
| Max. 0.050-s Average (g's) | |
| Longitudinal | -1.6 |
| Lateral | 4.1 |
| Vertical | 2.2 |

**Test Article Deflections (m)**

| | |
|---|---|
| Dynamic | 2.36 |
| Permanent | 0.05 |
| Working Width | 2.94 |

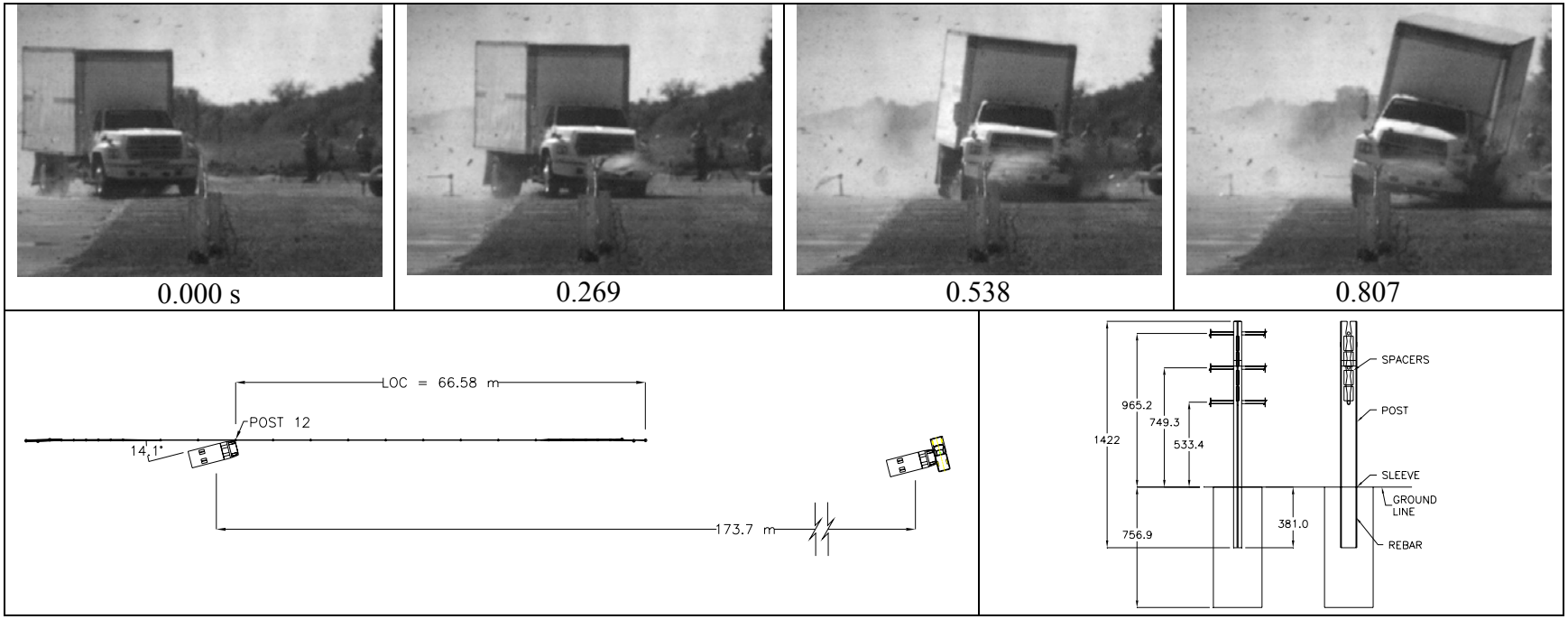
**Vehicle Damage**

| | |
|---|---|
| Exterior | |
| VDS | 11LFQ1 |
| CDC | 11FLEW1 |
| Max. Exterior | |
| Vehicle Crush (mm) | 80 |
| Interior | |
| OCDI | LF0000000 |
| Max. Occupant Compartment | |
| Deformation (mm) | 0 |

**Post-Impact Behavior**

| | |
|---|---|
| (during 1.0 sec after impact) | |
| Max. Yaw Angle (deg) | 35 |
| Max. Pitch Angle (deg) | -3 |
| Max. Roll Angle (deg) | 9 |

Figure 15. Summary of results for *NCHRP Report 350* test 3-11 on the Trinity CASS-TL3 at 6.1 m spacing.




**General Information**

| | |
|---|---|
| Test Agency | Texas Transportation Institute |
| Test No. | 400001-TCR9 |
| Date | 10-26-2005 |

**Test Article**

| | |
|---|---|
| Type | Cable Guardrail |
| Name | Trinity CASS-TL4 |
| Installation Length (m) | 101.9 |
| Material or Key Elements | 3 Wire Ropes With S4x7.7# I-Beam Posts In Concrete Socketed Footings Spaced at 6.1 m |
| **Soil Type and Condition** | Standard Soil, Dry |

**Test Vehicle**

| | |
|---|---|
| Type | Production |
| Designation | 8000S |
| Model | 1991 Ford F-700 |
| Mass (kg) | |
| Curb | 5602 |
| Test Inertial | 8196 |
| Dummy | N/A |
| Gross Static | 8196 |

**Impact Conditions**

| | |
|---|---|
| Speed (km/h) | 82.5 |
| Angle (deg) | 14.1 |

**Exit Conditions**

| | |
|---|---|
| Speed (km/h) | N/A |
| Angle (deg) | N/A |

**Occupant Risk Values**

| | |
|---|---|
| Impact Velocity (m/s) | |
| Longitudinal | 1.3 |
| Lateral | 2.0 |
| THIV (km/h) | 8.2 |
| Ridedown Accelerations (g's) | |
| Longitudinal | -1.1 |
| Lateral | 1.8 |
| PHD (g's) | 2.1 |
| ASI | 0.14 |
| Max. 0.050-s Average (g's) | |
| Longitudinal | -0.7 |
| Lateral | 1.3 |
| Vertical | 0.8 |

**Test Article Deflections (m)**

| | |
|---|---|
| Dynamic | 2.205 |
| Permanent | N/A |
| Working Width | 3.869 |

**Vehicle Damage**

| | |
|---|---|
| Exterior | |
| CDC | 11FLEW1 |
| Max. Exterior Vehicle Crush (mm) | 356 |
| Interior | |
| Max. Occupant Compartment Deformation (mm) | 0 |

**Post-Impact Behavior**

| | |
|---|---|
| (during 1.0 sec after impact) | |
| Max. Yaw Angle (deg) | 23 |
| Max. Pitch Angle (deg) | -1 |
| Max. Roll Angle (deg) | -15 |

Figure 16. Summary of results for *NCHRP Report 350* test 4-12 on the Trinity CASS-TL4 spaced at 6.1.

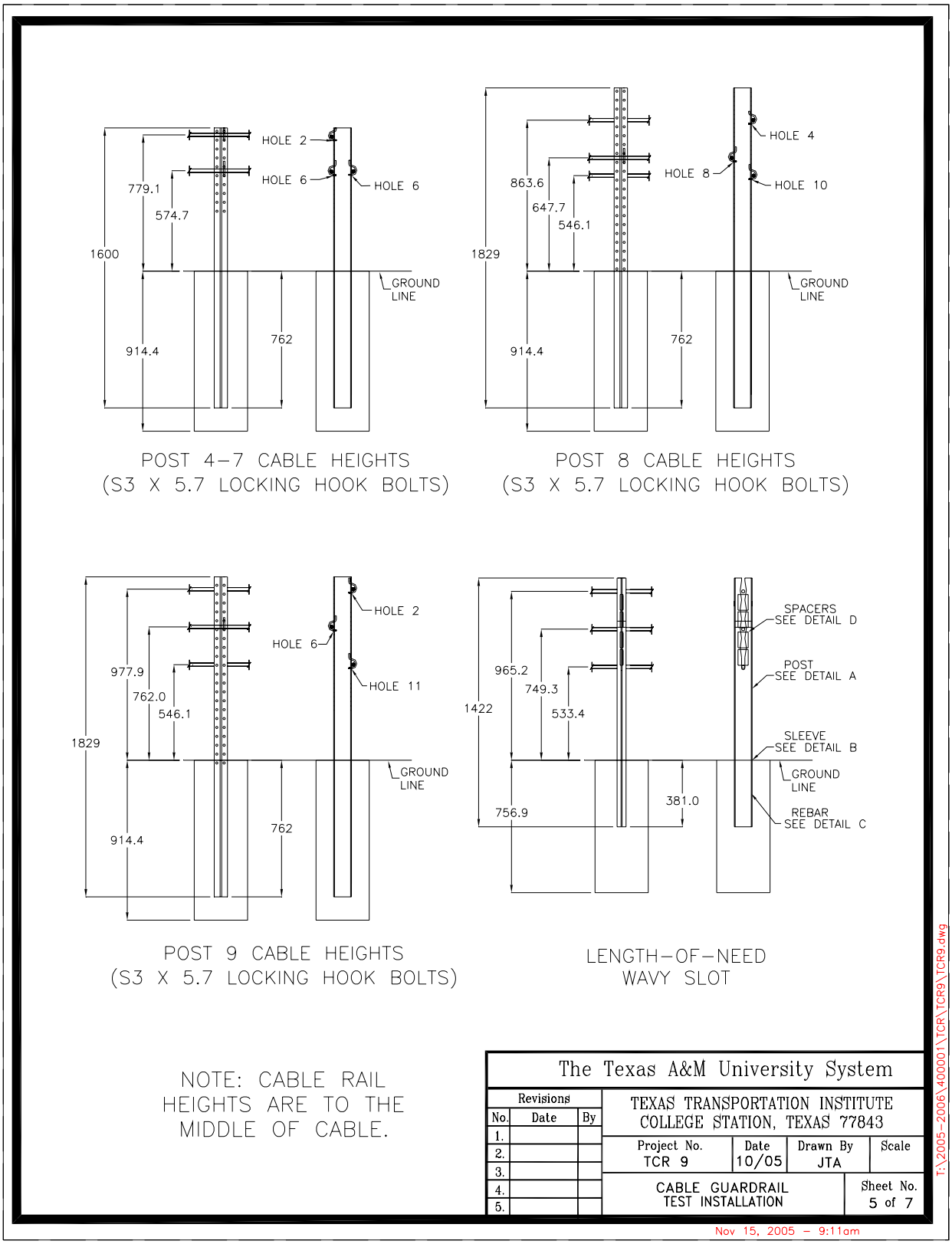



Figure 5. Post details.