# TRINITY CABLE SAFETY SYSTEM

**Final Report**
**January 2007**


**Wilson B. Brewer, Jr.**
**Project Manager**

**Jason Giebler, EIT**

**Daniel Myers, EIT**

**Ron Curb, P.E.**
**Engineering Manager**

**Planning and Research Division**
**Oklahoma Department of Transportation**
**200 N.E. 21st Street, Room 3A7**
**(405) 522-3207**
**FAX (405) 521-6917**

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Cable Safety System (CASS™) is being tested by the Oklahoma Department of Transportation (ODOT) along I-35 in McClain County. CASS™ will be compare with two other system approve by ODOT. Using C-shaped posts and tensioned cables, CASS™ is designed to assist in preventing head-on collisions by capturing and redirecting errant vehicles that would otherwise traverse the median of a roadway. The system consists of three 3/4 "x3x7 pre-stretched cables held by 4"x2"x8" gauge mild steel C-channel posts. The post spacing, however, varied with the product, the other products used approximately, 8 to 10 feet spacing, while the CASS™ was constructed with a tighter spacing of approximately 6 feet between posts. Since installation, no vehicles have passed through the barrier.


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# SI (METRIC)/ENGLISH CONVERSION FACTORS

## APPROXIMATE CONVERSIONS TO SI UNITS

| SYMBOL | WHEN YOU KNOW | MULTIPLY BY | TO FIND | SYMBOL |
|---|---|---|---|---|
| **LENGTH** | | | | |
| in | inches | 25.4 | millimeters | mm |
| ft | feet | 0.305 | meters | m |
| yd | yards | 0.914 | meters | m |
| mi | miles | 1.61 | kilometers | km |
| **AREA** | | | | |
| $in^2$ | square inches | 645.2 | square millimeters | $mm^2$ |
| $ft^2$ | square feet | 0.093 | square meters | $m^2$ |
| $yd^2$ | square yard | 0.836 | square meters | $m^2$ |
| ac | acres | 0.405 | hectares | ha |
| $mi^2$ | square miles | 2.59 | square kilometers | $km^2$ |
| **VOLUME** | | | | |
| fl oz | fluid ounces | 29.57 | milliliters | mL |
| gal | gallons | 3.785 | liters | L |
| $ft^3$ | cubic feet | 0.028 | cubic meters | $m^3$ |
| $yd^3$ | cubic yards | 0.765 | cubic meters | $m^3$ |
| **MASS** | | | | |
| oz | ounces | 28.35 | grams | g |
| lb | pounds | 0.454 | kilograms | kg |
| T | short tons (2000 lb) | 0.907 | megagrams | Mg |
| **TEMPERATURE (exact degrees)** | | | | |
| °F | Fahrenheit | (F-32)/1.8 | Celsius | °C |
| **FORCE and PRESSURE or STRESS** | | | | |
| lbf | poundforce | 4.45 | newtons | N |
| $lbf/in^2$ | poundforce per square inch | 6.89 | kilopascals | kPa |

## APPROXIMATE CONVERSIONS FROM SI UNITS

| SYMBOL | WHEN YOU KNOW | MULTIPLY BY | TO FIND | SYMBOL |
|---|---|---|---|---|
| **LENGTH** | | | | |
| mm | millimeters | 0.039 | inches | in |
| m | meters | 3.28 | feet | ft |
| m | meters | 1.09 | yards | yd |
| km | kilometers | 0.621 | miles | mi |
| **AREA** | | | | |
| $mm^2$ | square millimeters | 0.0016 | square inches | $in^2$ |
| $m^2$ | square meters | 10.764 | square feet | $ft^2$ |
| $m^2$ | square meters | 1.195 | square yards | $yd^2$ |
| ha | hectares | 2.47 | acres | ac |
| $km^2$ | square kilometers | 0.386 | square miles | $mi^2$ |
| **VOLUME** | | | | |
| mL | milliliters | 0.034 | fluid ounces | fl oz |
| L | liters | 0.264 | gallons | gal |
| $m^3$ | cubic meters | 35.314 | cubic feet | $ft^3$ |
| $m^3$ | cubic meters | 1.307 | cubic yards | $yd^3$ |
| **MASS** | | | | |
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.202 | pounds | lb |
| Mg | megagrams | 1.103 | short tons (2000 lb) | T |
| **TEMPERATURE (exact degrees)** | | | | |
| °C | Celsius | 1.8C+32 | Fahrenheit | °F |
| **FORCE and PRESSURE or STRESS** | | | | |
| N | newtons | 0.225 | poundforce | lbf |
| kPa | kilopascals | 0.145 | poundforce per square inch | $lbf/in^2$ |

# Trinity Cable Safety System

## Final Report

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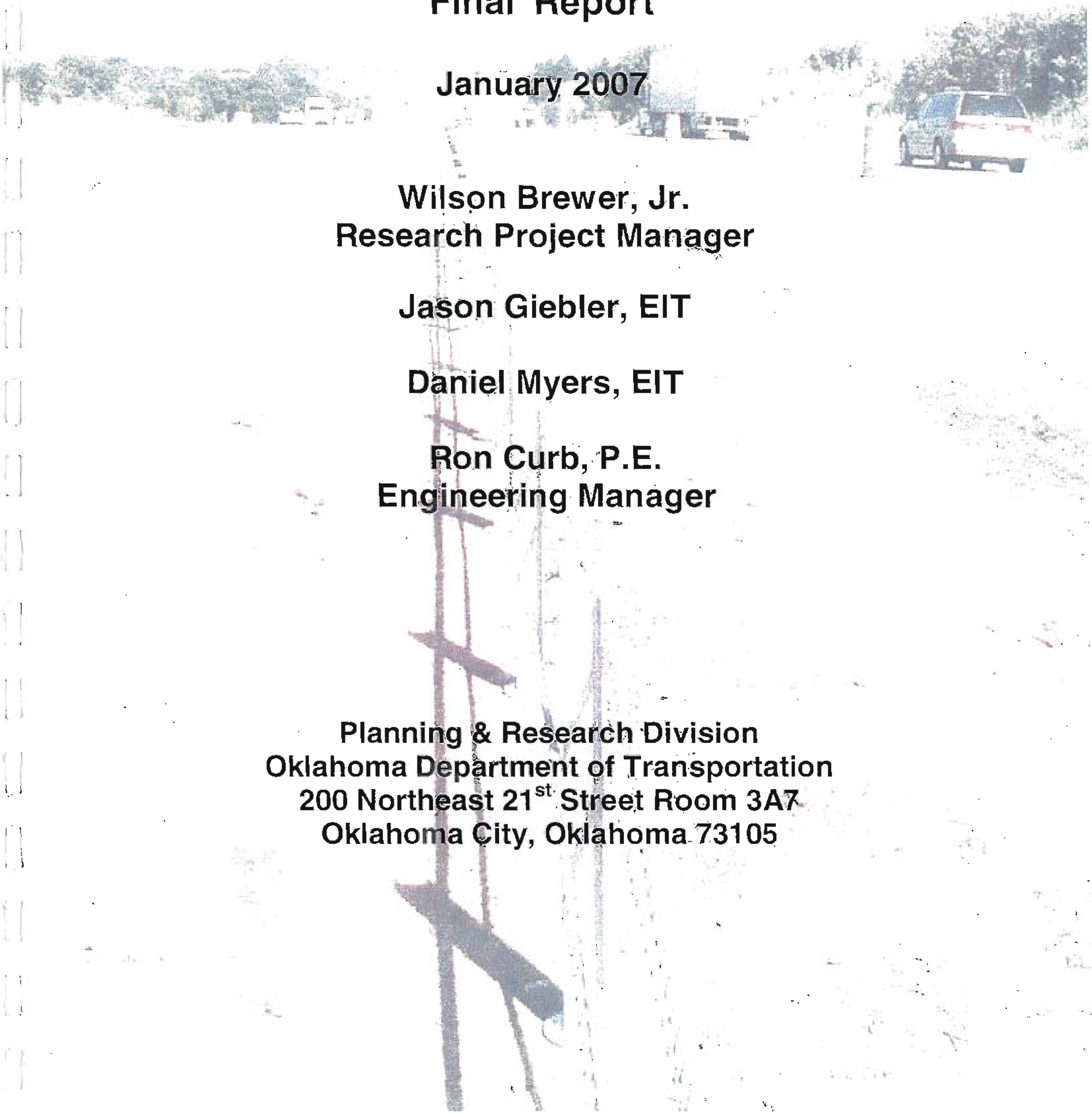
Wilson Brewer, Jr.
Research Project Manager

Jason Giebler, EIT

Daniel Myers, EIT

Ron Curb, P.E.
Engineering Manager

Planning & Research Division
Oklahoma Department of Transportation
200 Northeast 21st Street Room 3A7
Oklahoma City, Oklahoma 73105

# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# INTRODUCTION

Trinity Highway Safety Products, Inc. Cable Safety System (CASS™) is being tested by the Oklahoma Department of Transportation (ODOT) along I-35 in McClain County. The Federal Highway Administration (FHWA) requires that experimental products be evaluated prior to being used for federally funded projects. Since the CASS™ system is an experimental product to the State of Oklahoma, the Planning & Research Division was asked to conduct an evaluation of the CASS™ system's installation methods and performance. Trinity Industries, Inc. donated one mile (1.6 km) of their CASS™ system which was installed near mile marker 99 in McLain County for the necessary evaluation.

Trinity Highway Safety Products is based out of Dallas, and produces a large number of highway safety devices ranging from their Cable Safety System to highway guardrail and end treatments. CASS™ is NCHRP Report 350 TL-3 compliant. Trinity describes CASS™ thus:

> Using C-shaped posts and tensioned cables, CASS™ is designed to assist in preventing potential head-on collisions by capturing and redirecting errant vehicles that would otherwise traverse the median of a roadway. The specially designed post employs a proprietary wave-shaped slot which works in tandem with strategically positioned cables to increase the system's ability to restrain various types of vehicles.
>
> The proprietary shape of the post allows for lower deflections during crash tests by minimizing the length of unsupported cables. Additionally, the widened cable spread works to retain different types of vehicles. (Trinity, 2006)

# OBJECTIVES

The objectives of this project are as follows:

- Monitor construction and document procedures.
- Document specifications of the system.
- Compare system to proven products.
- Record crash and safety results.
- Complete a final report on construction and investigation results.

The Oklahoma Department of Transportation (ODOT) will compare CASS™ with two other systems, both of which have been approved to be constructed on Oklahoma's highway medians. CASS™ has different specifications and guidelines than the other systems, making it difficult to compare with them. Recommended guidelines for the cable CASS™ system will be established according to the practices and specifications of ODOT.

# CASS™ DESIGN DETAILS

The CASS™ barrier system consists of three ¾" (19 mm) 3x7 pre-stretched cables held by 4" x 2" x 8 gauge (100 x 50 x 4 mm) mild steel C-channel posts (Trinity, 2003). The cables are attached to the posts in a wave-shaped slot in the top of the post and kept separate at their specified heights by recycled plastic spacers, a plastic cap on top of the post, and a steel strap. The design spacing of the posts along the highway is governed by the desired deflection after impact. A feature of the CASS™ system is the ability to design it for a deflection between 4 and 10 feet (1.2 and 3.0 meters) by varying the spacing of the posts, a feature which allows for increased flexibility in different design situations. Trinity Highway Safety Products, Inc. barrier design plans for the CASS™ system are found in Appendix A.

Trinity Highway Safety Products, Inc. states that the CASS™ system is capable of being installed in 250 to 10,000 feet (75 to 3000 meter) sections in a variety of areas such as medians, shoulders, or slopes (Trinity, 2003). In addition, CASS™ offers different options for the post installation: driven into the soil, inserted into a steel sleeve in the asphalt, or set in a concrete post foundation. Due to issues like maintenance, each option deserves consideration for the application at hand.

CASS™ offers a unique design element in its wave-shaped slot which holds the cables in the post. The waves are said to create a longer period of friction before the cable comes out of the post during an impact. However, they still allow the cables to be released in the latter stages of impact. This prevents the cables from falling to the ground with the post, a situation which can permit the vehicle to cross the barrier.

**Figure 1: A post from Trinity Highway Safety Products, Inc. CASS™ Cable Safety System**

# FIELD TEST COMPARISON

In order to help prevent cross-over accidents, ODOT has looked into several proprietary cable barrier options: BRIFEN Wire Rope Safety Fence (WRSF) (Emamian, 2003), Safence Wire Rope Median Barrier by Blue Systems (Roper and Brewer, 2005), and the CASS™ system already in discussion. All of the systems consist of high-tension pre-stressed cables anchored at the ends with steel posts spaced in between to reduce the deflection of the cables during impact. However, each system has a unique design. The dimensions of the actual barrier designs used for each product during field testing with ODOT are presented in Table 1.

**Table 1: Comparison of geometry in ODOT Field Tests for cable barrier systems**

| | | | SAFENCE | BRIFEN WRSF | CASS |
|---|---|---|---|---|---|
| Manufacturer | | | Blue Systems AB | Brifen USA | Trinity Industries, Inc. |
| Height | | ft (m) | 2'-7" (0.8) | 2'-9.5" (0.9) | 2'-9" (0.8) |
| **CABLES** | | | | | |
| Cable Diameter | | in (mm) | 0.672 (17.1) | 0.701 (18.8) | 0.701 (18.8) |
| Number of Cables | | | 4 | 4 | 3 |
| Spacing Between Cables | Top | in (mm) | 2.0 (50.8) | 4.0 (101.6) | 4.0 (101.6) |
| | ↓ | | 3.5 (88.9) | 3.0 (76.2) | 4.5 (114.3) |
| | | | 3.5 (88.9) | 3.0 (76.2) | 4.0 (101.6) |
| | Bottom | | 3.0 (76.2) | 7 (177.8) | --- |
| Cable to Ground | | in (mm) | 20.0 (510) | 20.5 (520) | 22 (560) |
| **POSTS** | | | | | |
| Shape | | | I-Post | S-Post | C-Post |
| Post | Width | in (mm) | 1.672 (42.5) | 1.331 (33.8) | 2.065 (52.5) |
| | Length | | 3.314 (84.2) | 4.117 (104.6) | 4.104 (104.2) |
| Spacing | | ft (m) | 8'-0" (2.4) | 10'-6" (3.2) | 6'-6" (2.0) |

The CASS™ system is different from the other two barrier systems tested by ODOT in that it uses three cables while the other designs use four cables. The inner friction posts of the CASS™ system connect to the cables similarly to the Safence design with a slot at the top of the post and plastic retaining spacers. The Brifen system, however, uses a design for the lower cables that inter-weaves them between posts, and rests the cables on pegs on the side of the posts. The feature that differentiates the CASS™ system post design from that of Safence is the cable holding design of the wave-shaped slot.

All three barrier systems in the ODOT field test were comparable in their construction methods. Each design used a sleeve placed in a concrete foundation for the posts, allowing for quicker and easier post replacement after an impact. The post spacing, however, varied with the product: the Safence and Brifen models were constructed with approximately 8'-0" (2.4 m) and 10'-6" (3.2 m) post spacing, respectively, while the CASS™ system was constructed with a tighter spacing of approximately 6'-6" (2.0 m) between posts. A more detailed look into the CASS™ system construction may be found in Appendix C, which shows photographs of the installation procedure.

## *COLLISION REPORTS AND FINDINGS*

From December 25, 2000 until the installation of the CASS™ system in McClain County in 2005, a total of 7 cross-over collisions were reported, including three cases of property damage as well as one injury and three fatality accidents. Three fatalities and 6 injuries occurred due to these cross-overs.

Since the installation of the CASS™ system in August, 2005 through October, 2006, no vehicles have passed through the barrier. A total of 8 median barrier collisions were reported with no fatalities or injuries. As is graphically displayed in Figure 2, the presence of the barrier has reduced the likelihood of cross-over collisions dramatically. Since the installation, 100% of possible cross-over collisions have been associated with a fixed object (the cable barrier).

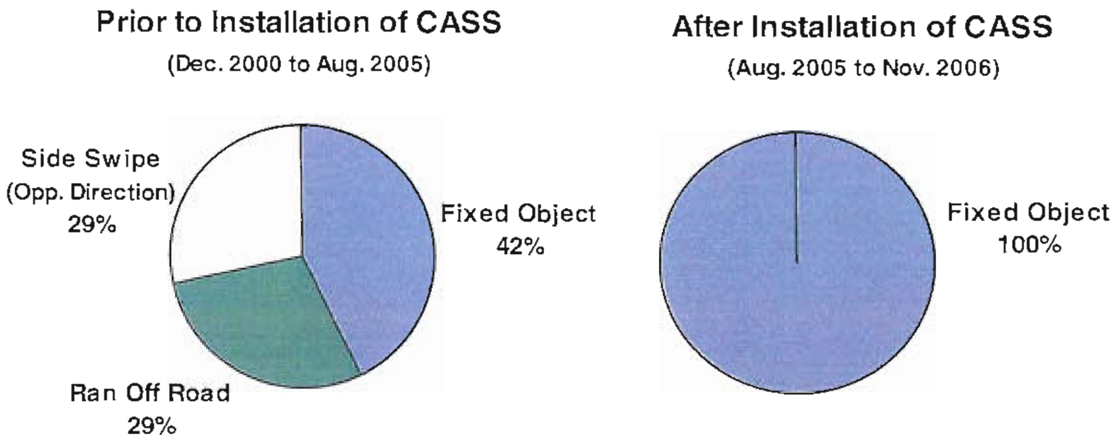



Figure 2: Cross-over collision types (CASS™ system)

Figure 3 displays some of the most important data of all: fatalities and injuries. The red bars in the figure represent the entire period prior to the barrier installation back through December, 2000. The blue bars represent the worst 15 month period in this time frame. The 15 month period was selected for comparison with the 15 month period of data available after the CASS™ was installed. Three fatalities and six injuries were reported due to cross-over accidents since December, 2000, but thus far, none have occurred with the CASS™ barrier system in place.

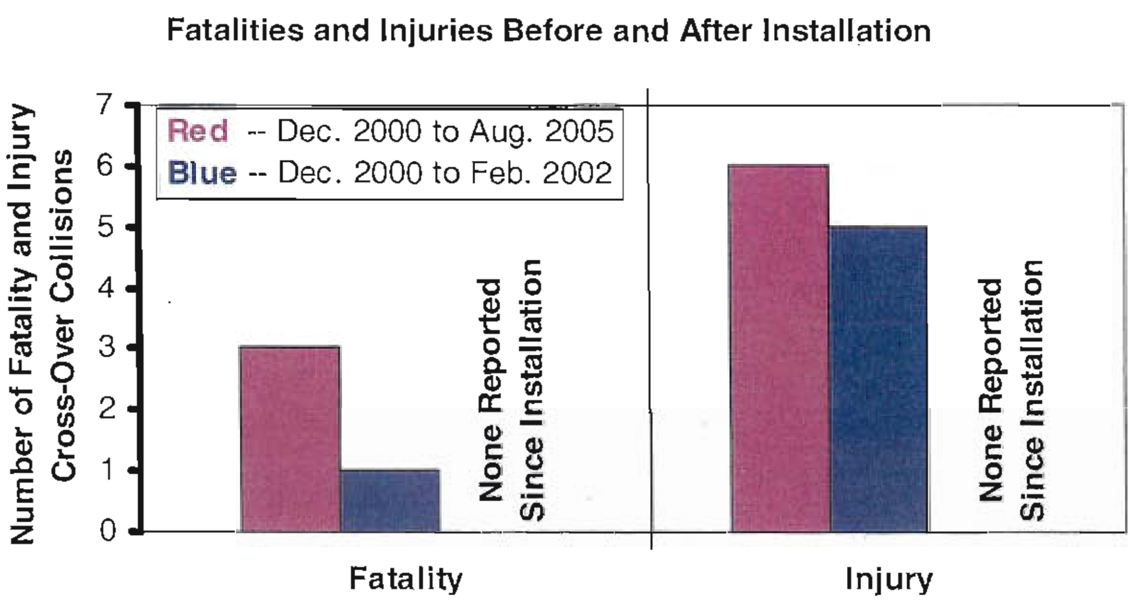



Figure 3: Fatalities and injuries before and after installation of CASS™ System

From the reported cross-over and barrier collision data, the estimated property damage time line and monthly average are displayed in Figures 4 and 5, respectively. These two figures show the data from December, 2000 up to the barrier installation in red, the data since installation in green, and the worst 15 month period before installation for comparison in blue.

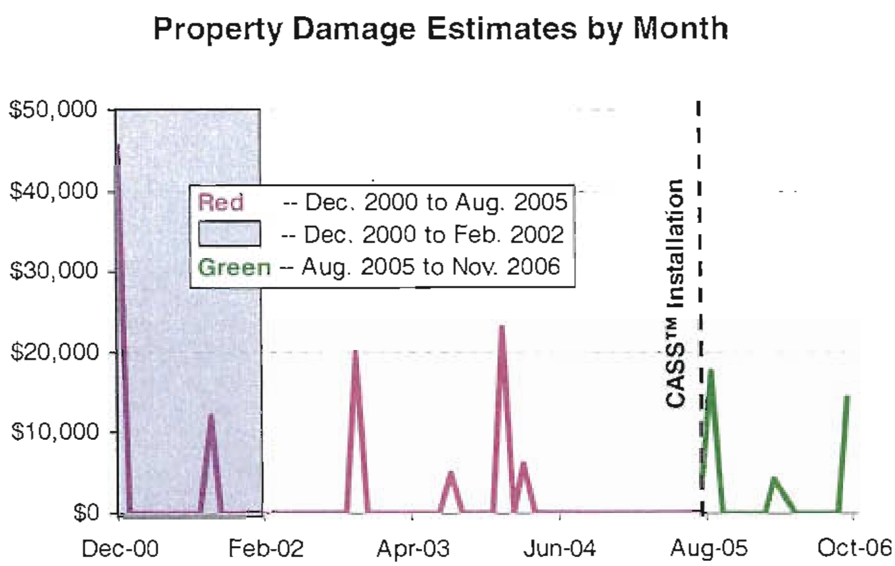



Figure 4: Property damage estimates by month (CASS™ system)

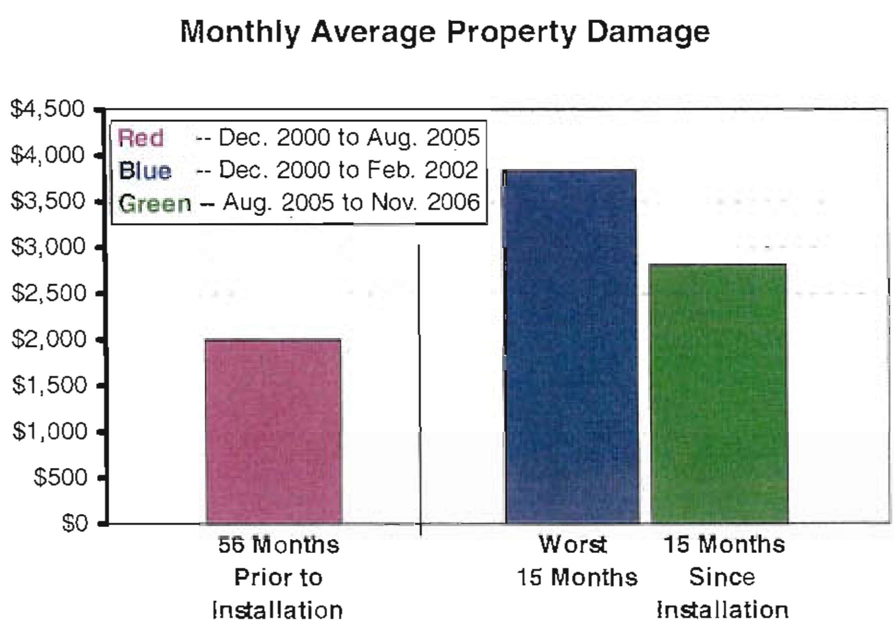



Figure 5: Monthly average property damage (CASS™ system)

Figures 4 and 5 show that property damage values have been at a high level since the installation of the cable barrier system. This is mainly due to the larger number of collisions occurring since the barrier installation. In the past, however, it is possible that accidents may not have been reported if little to no damage occurred to vehicles—for instance, when a car veered into the median but recovered successfully. The presence of the barrier has increased the likelihood of property damage, as well as reported collisions. On the other hand, associated with these increases is a notable absence of any fatalities or injuries.

At this time, it is not certain whether the increased number of collisions is simply a high property damage period or a trend that will continue. When comparing the worst 15 month period average with the 15 month period since installation, the worst period before installation of the barrier is significantly worse. However, it must be noted that the 56 month average property damage is only about 75% of that seen since the barrier was installed.

Table 2 compares the crash data from all three proprietary high-tension cable barrier systems tested by ODOT (Roper and Brewer, 2005). The Brifen data is from a section of I-35 not covered in the report by Emamian (2003), but because of its close proximity to the other two sections tested this segment was chosen for the crash comparison. All three barriers showed an increase in the number of collisions reported. Brifen and CASS™ both showed very large increases in the number of collisions. This can be traced to the likelihood that incidents of a car veering into the median, but recovering, would not have been reported before. Since the barriers were installed, such formerly minor incidents cause significant damage to the car and thus are reported.

All three barrier types also showed a large decrease in the number of cross-over injuries and fatalities. Safence and CASS™ had no injuries or fatalities since the installation of the barrier. Brifen was installed on a larger section in a busier area, and did show some injuries after installation. However, the number of fatalities dropped from 6 to none, and the number of injuries dropped from 32 to 13. All three of the fences were successful in their primary goals: preventing cross-over fatalities and injuries.

**Table 2: Comparison of cable barrier collision performance**

| | | SAFENCE | BRIFEN WRSF | CASS |
|---|---|---|---|---|
| Facility | | Interstate 35 | Interstate 35 | Interstate 35 |
| County | | McClain | Cleveland | McClain |
| 2005 AADT | | ~43,700 | ~70,000 | ~40,000 |
| Miles of Barrier | | 1.0 | 5.8 | 1.0 |
| Period of Study | Prior | 26 months | 27 months | 15 months * |
| | W/ Barrier | 26 months | 27 months | 15 months |
| **COLLISIONS** | **Prior** | **4** | **19** | **2** |
| | **Barrier** | **5** | **75** | **8** |
| Fatal | Prior | 0 | 5 | 1 |
| | Barrier | 0 | 0 | 0 |
| Injury | Prior | 3 | 10 | 1 |
| | Barrier | 0 | 12 | 0 |
| Property Damage | Prior | 1 | 4 | 0 |
| | Barrier | 5 | 63 | 8 |
| **PERSONS** | **Prior** | **6** | **38** | **6** |
| | **Barrier** | **0** | **13** | **0** |
| Fatal | Prior | 0 | 6 | 1 |
| | Barrier | 0 | 0 | 0 |
| Injury | Prior | 6 | 32 | 5 |
| | Barrier | 0 | 13 | 0 |

* Worst 15 month period chosen for comparison, as mentioned earlier in report

## USAGE IN OTHER STATES

According to the presentation on the NCHRP Project 20-7 (210) given by Alberson (2006), 29 states responded to a survey in that project on cable barriers (see Figure 6). Twenty-three out of twenty-eight (82%) reported that they use high-tension cable barrier systems with 100% of these being pre-stretched. In the surveyed states, it was found that approximately 1,047 miles (1,686 km) of high-tensioned barriers are currently in use.

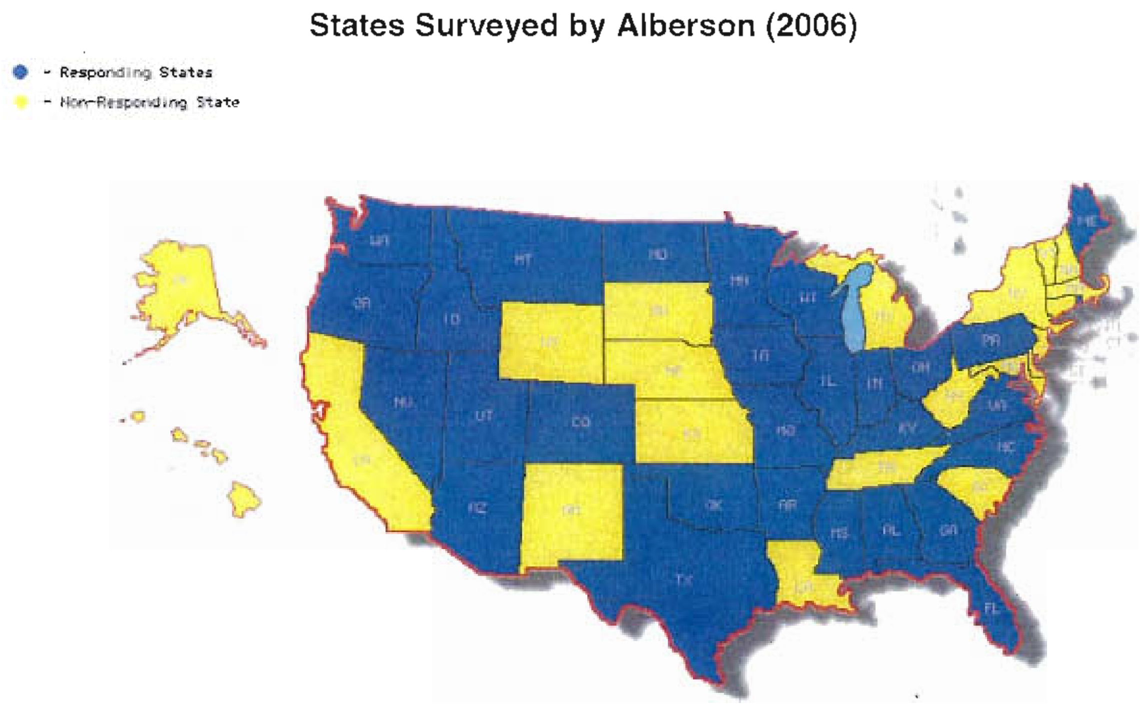



Figure 6: Surveyed states (Alberson, 2006)

As seen in Figure 7, the majority of the surveyed states are using systems from Trinity Industries, Inc. or Brifen USA. In addition, only 5% are currently using a Blue Systems barrier and 20% are using a system other than one of the three that have been field tested by ODOT.

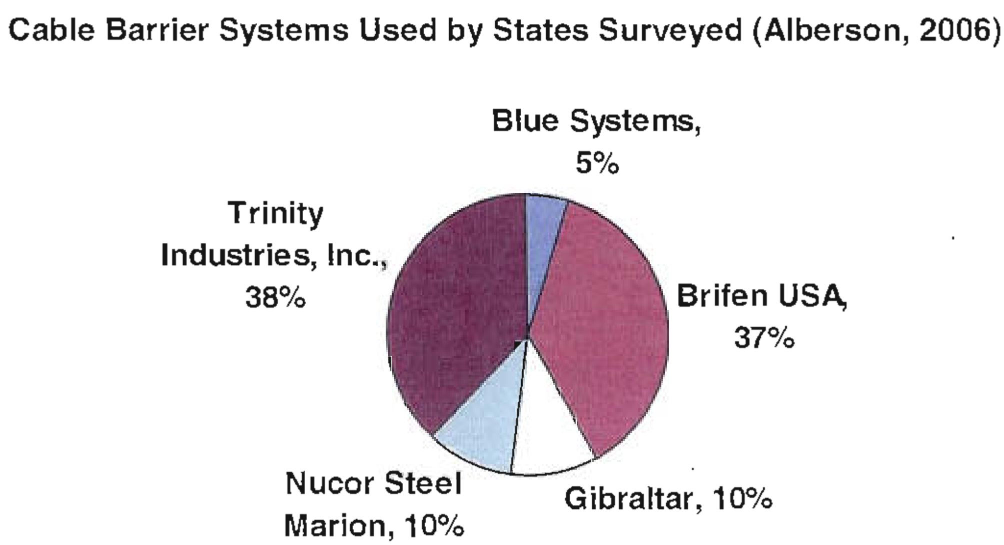



Figure 7: Types of high-tensioned barrier systems used by states surveyed (Alberson, 2006)

## *TEXAS EXPERIENCE*

Oklahoma is not the only state currently performing field investigations of high-tensioned barrier systems. The systems developed by Brifen USA and Trinity Industries, Inc. are being field tested in Texas as well (Medina and Benekohol, 2006). For these studies the Texas Department of Transportation (TXDOT) constructed 10.5 miles (16.9 km) of each of the barriers on stretches of I-20 and I-30 where 68,000 AADT were typical. At these testing areas, TXDOT found that both the Brifen system with a post spacing of 10'-6" (3.15 m) and the CASS™ system with a post spacing of 10 feet (3 m) performed to satisfaction, with no vehicles passing through either system.

In both barriers it was discovered that an average of 15 to 20 posts were required to be replaced after impact and sag could be seen in the cables after several significant impacts. In the Brifen system, as many as 30 posts or more have been required to be removed. The Brifen system has shown sag in the cables more commonly than CASS™, and there are reports of the Brifen cables being laid down after collisions.

Both the Brifen and CASS™ systems had the opportunity to be field tested with a hit from a large truck in the Texas study. In both cases the barriers performed their job in stopping the trucks from crossing over. A cable reportedly came loose from the barrier in the Brifen system: it was later determined that a shallowly threaded connection caused the failure and the problem was quickly fixed with a special fabricated splice piece.

As far as the damage to the barrier posts, TXDOT also reported that after impact some of the Brifen posts were hard to remove after being bent. Also, the Brifen plastic spacers were noticed to break off easily as well as the dust covers have been difficult to remove. Brifen has said that the post tolerances and dust cover chemistry have been changed to correct for these problems. TXDOT saw that the CASS™ system posts could sometimes be straightened, but Trinity Industries, Inc. does not recommend this. In addition, the plastic spacers in the CASS™ were often compressed or bent, the cables frequently became too tight to lift, and the tops of posts beyond the actual impact zone can be opened up during a collision.

Despite these issues with the usage of cable barrier systems, TXDOT was pleased with the barriers. The high-tension cable barrier systems have proven very effective in eliminating cross-over fatalities and injuries (Medina and Benekohol, 2006).

## ***UTAH EXPERIENCE***

Utah has also tested the Brifen and CASS™ cable barrier systems (Clayton, 2005). Utah has used the CASS™ system at three locations, and chose one as a case study. At that location, the AADT was 120,000, there were three lanes in each direction, a median width of 36 feet (11 m), and side slopes of 1:4 to 1:5. Eight miles (13 km) of cable barrier were installed.

After 16 months, 74 hits on the barrier had been logged. Of these, 32 were considered likely crossover cases (vehicle speeds above 50 mph (80 kph)). Only two serious injuries occurred, and both of these involved collisions with other vehicles before contact with the cable barrier. In addition to the reported cases, there were about four unreported cases per month, indicating insignificant damage to the vehicle. During the 16 month evaluation period, the barrier was penetrated three times.

As shown in Figure 8, the number of accidents rose significantly with the implementation of the CASS™ barrier system. However, the number of serious injuries and fatalities dropped dramatically. The average injury severity fell from 2.9 to 1.4. It is clear that this cable barrier system is very effective in reducing human injury.

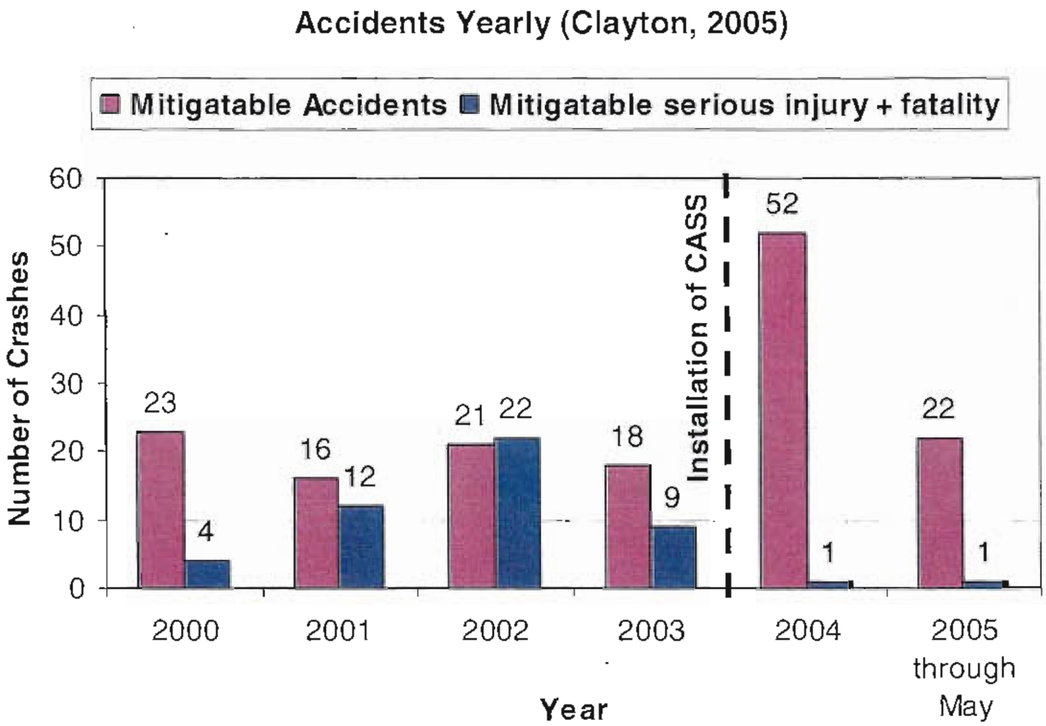



**Figure 8: Accidents yearly before and after installation of CASS™ (Clayton, 2005)**

Clayton lists several lessens Utah has learned. The CASS™ system is quite resilient, able to sustain a hit and remain effective even without repair. One instance is discussed where four cars hit the cable barrier in close proximity during a single hail storm, but the CASS™ system stayed effective throughout. Figure 9 shows the barrier after that event. The average repair consists of four to five posts replaced and 30 to 60 minutes repair time. Offsetting the barrier to one side of the median increased the accident rate from the lanes on that side (Clayton, 2005).

**Figure 9: Utah CASS™ system after four cars hit it (Clayton, 2005)**

## CONCLUSIONS

The CASS™ system from Trinity Highway Safety Products, inc. has performed well in the field. The primary goal of the high-tension cable barrier system is to prevent cross-over collisions. The CASS™ system accomplished this goal in ODOT field testing. No cross-over collisions occurred after the cable barrier was installed, though the barrier sustained a number of hits. Before the barrier was installed, several injury and fatality accidents took place; none occurred afterwards.

Because of the barrier, the total collision rate increased and property damage costs increased well above average for that stretch of interstate. This is likely because some accidents that without a barrier are recovered from without damage become barrier hits when the barrier is installed. This is unavoidable and commonly seen with cable barriers, but the benefits of eliminating human injuries and fatalities greatly outweigh the moderately increased property damage cost.

The CASS™ barrier system performed as well as the other two proprietary high-tension cable barrier systems used by ODOT. All three systems (CASS™, Brifen, and Safence) successfully reduced fatalities and injuries. No fatalities were seen with any of the systems in their ODOT field tests. CASS™ and Safence both had no injuries after installation; Brifen reduced injuries by about 65%. Since the primary objective of these fences is to eliminate cross-over collisions, all of the fences were successful.

Research on CASS™ by other states has found similar results. The number of injuries and fatalities are dramatically reduced, while the total number of incidents increases. The system has proven very resilient to multiple impacts, performing at least as well as other high-tension cable barrier types. Texas had some minor issues with the repair operations, but nevertheless was pleased with the CASS™ system's performance.

The version of CASS™ tested had a post spacing of two meters, so that is the spacing that could qualified for usage by ODOT. Since installation, no vehicles have passed through the barrier. CASS™ post spacing of three and five meters is also permitted by FHWA, but such spacing has not undergone the required testing by ODOT for usage in Oklahoma, it can not be permitted for bidding.

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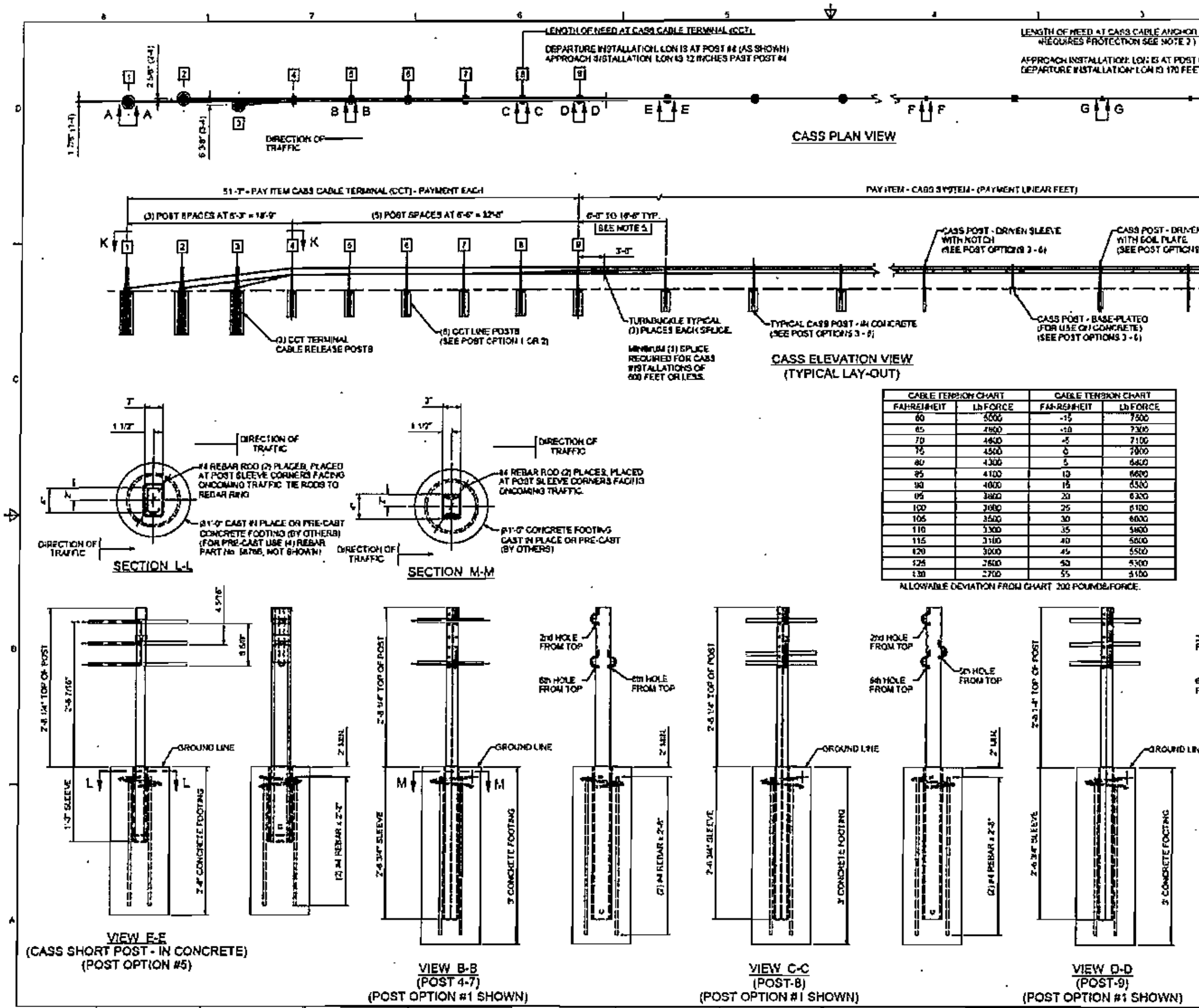
# APPENDIX

## ***Appendix A: Barrier Design Plans***




| CABLE TENSION CHART | | CABLE TENSION CHART | |
|---|---|---|---|
| FAHRENHEIT | Lb FORCE | FAHRENHEIT | Lb FORCE |
| 60 | 5000 | -15 | 7500 |
| 65 | 4800 | -10 | 7300 |
| 70 | 4600 | -5 | 7100 |
| 75 | 4500 | 0 | 7000 |
| 80 | 4300 | 5 | 6800 |
| 85 | 4100 | 10 | 6600 |
| 90 | 4000 | 15 | 6500 |
| 95 | 3800 | 20 | 6300 |
| 100 | 3600 | 25 | 6100 |
| 105 | 3500 | 30 | 6000 |
| 110 | 3300 | 35 | 5800 |
| 115 | 3100 | 40 | 5600 |
| 120 | 3000 | 45 | 5500 |
| 125 | 2800 | 50 | 5300 |
| 130 | 2700 | 55 | 5100 |

ALLOWABLE DEVIATION FROM CHART: 200 POUNDS/FORCE.

NOTES:

1. CASS HAS BEEN SUCCESSFULLY TESTED AT VARIOUS POST SPACING AND APPROVED TO NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM REPORT 350 TEST LEVEL 3 (NCHRP 350 TL-3). CASS CABLE TERMINAL (CCT) HAS BEEN SUCCESSFULLY TESTED AND APPROVED TO NCHRP 350 TL-3
2. IF CASS IS INSTALLED ON THE NATIONAL HIGHWAY SYSTEM (NHS) AN NCHRP 350 TL-3 APPROVED TERMINAL (CCT) SHALL BE USED ON APPROACH AND DEPARTURE TERMINATIONS; OR, A NON-NCHRP 350 TL-3 ANCHOR (CCA) MAY BE USED ON APPROACH AND DEPARTURE TERMINATIONS IF THE ANCHOR IS LOCATED OUTSIDE THE CLEAR ZONE OR PROTECTED BY OTHER MEANS (CRASHWORTHY BARRIER, TERMINALS, ETC.).
3. CASS SHALL BE INSTALLED ON SHOULDERS OR MEDIANS WITH SLOPES OF 6:1 OR FLATTER WITHOUT OBSTRUCTIONS, DEPRESSIONS, ETC. THAT MAY SIGNIFICANTLY AFFECT THE STABILITY AN ERRANT VEHICLE.
4. CASS POST SPACING MAY BE MODIFIED TO AVOID OBSTACLES THAT CONFLICT WITH THE INSTALLATION OF CASS LINE POSTS. NO POST SPACE CAN EXCEED THE MAXIMUM POST SPACE LIMIT OF 16'-6"
5. CASS POST SPACING VARIES DEPENDING UPON REQUIRED DEFLECTION
6. CASS POSTS SHALL BE ALTERNATELY ROTATED 180 DEGREES SO THAT EVERY OTHER POST IS FACING THE TRAFFIC FLOW. CASS MAY BE INSTALLED ON EITHER SIDE OF THE ROADWAY OR IN THE MEDIAN WITHOUT MODIFYING POST ORIENTATION.
7. CONSULT THE MANUFACTURER'S INSTALLATION MANUAL FOR ADDITIONAL INFORMATION

TRINITY HIGHWAY SAFETY PRODUCTS, INC.
2525 STEMMONS FREEWAY
DALLAS, TX 75207

EMAIL: PRODUCT.INFO@TRIN.NET
PHONE: (800) 644-7976

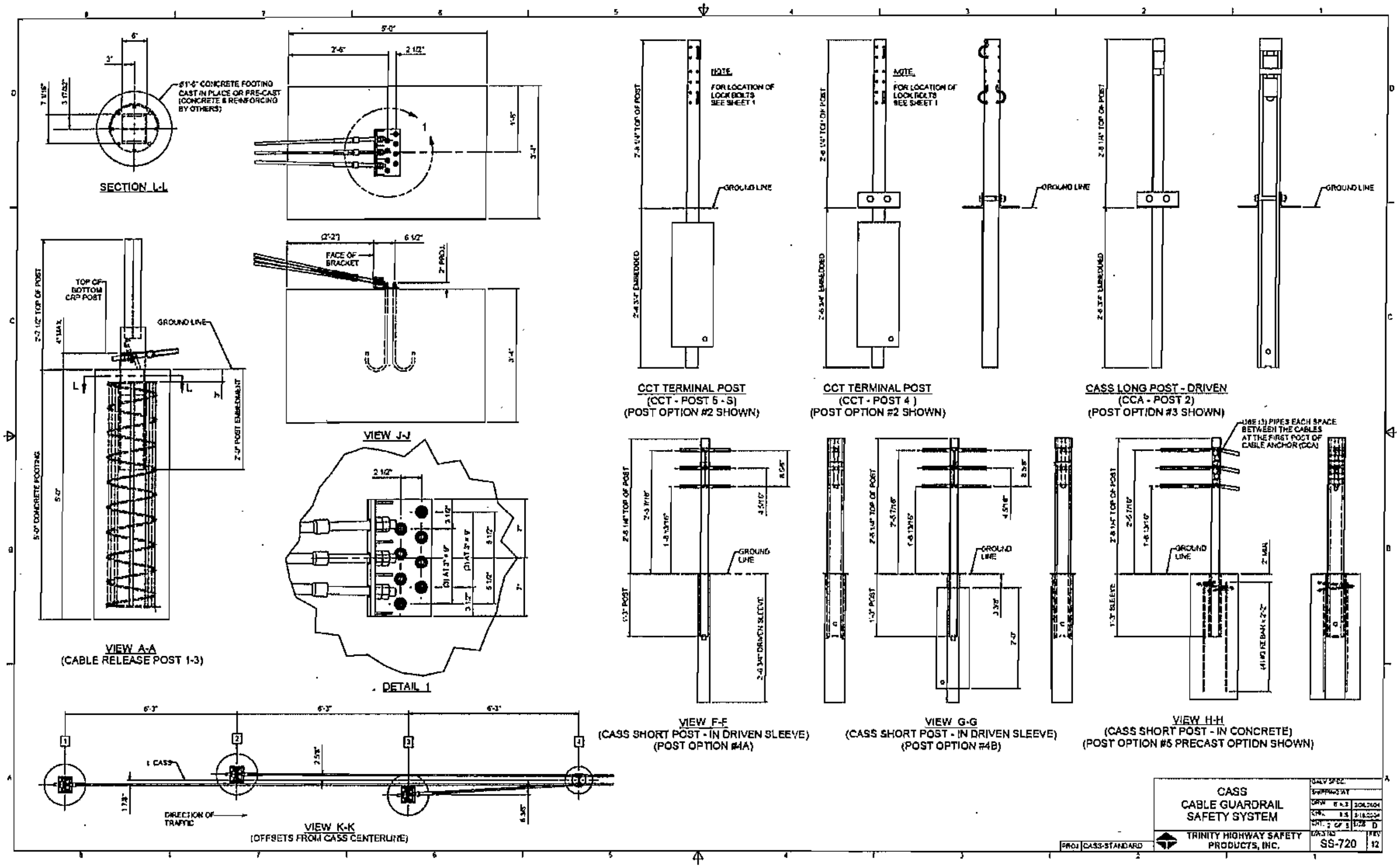
| No | CASS POST OPTIONS |
|---|---|
| 1 | CCT - TERMINAL POST 1 - 9 - IN CONCRETE |
| 2 | CCT - TERMINAL POST 1 - 9 - WITH SOIL PLATE |
| | |
| 3 | CASS POST - LONG - DRIVEN |
| 4 | CASS POST - SHORT - IN DRIVEN SLEEVE |
| | 4A - DRIVEN SLEEVE - WITH NOTCH |
| | 4B - DRIVEN SLEEVE - WITH SOIL PLATE |
| 5 | CASS POST - SHORT - IN CONCRETE |
| 6 | CASS POST - BASE-PLATED |

| REVISION HISTORY | | | |
|---|---|---|---|
| KEY | DESCRIPTION | DATE | BY |
| 3 | UPDATED HARDWARE SPECS | [illegible] | E.A.S. |
| 4 | ADDED PARTS, UPDATED DRAWING | [illegible] | E.A.S. |
| 5 | DELETED LONG POST IN DRIVEN SLEEVE | [illegible] | E.A.S. |
| 6 | REVISED CCA LENGTH | [illegible] | E.A.S. |
| 7 | ADDED REBAR REINFORCING RING | [illegible] | E.A.S. |
| 8 | MISC. UPDATES | [illegible] | E.A.S. |
| 9 | MISC. UPDATES | [illegible] | E.A.S. |
| 10 | REVISED TENSION CHART | [illegible] | E.A.S. |
| 11 | ADDED REBAR TERMINAL POST 4-9 | [illegible] | E.A.S. |
| 12 | REVISED NOTE ON REBAR RODS | [illegible] | E.A.S. |

CASS
CABLE GUARDRAIL
SAFETY SYSTEM

TRINITY HIGHWAY SAFETY PRODUCTS, INC.

PROJ: CASS-STANDARD | DWG NO: SS-720 | REV: 12 | SHT 1 OF 1 | SIZE D


SECTION L-L
Ø1'-6" CONCRETE FOOTING CAST IN PLACE OR PRE-CAST (CONCRETE & REINFORCING BY OTHERS)
VIEW J-J
DETAIL 1
VIEW A-A
(CABLE RELEASE POST 1-3)
GROUND LINE
CCT TERMINAL POST
(CCT - POST 5 - S)
(POST OPTION #2 SHOWN)
CCT TERMINAL POST
(CCT - POST 4 )
(POST OPTION #2 SHOWN)
CASS LONG POST - DRIVEN
(CCA - POST 2)
(POST OPTION #3 SHOWN)
VIEW F-F
(CASS SHORT POST - IN DRIVEN SLEEVE)
(POST OPTION #4A)
VIEW G-G
(CASS SHORT POST - IN DRIVEN SLEEVE)
(POST OPTION #4B)
VIEW H-H
(CASS SHORT POST - IN CONCRETE)
(POST OPTION #5 PRECAST OPTION SHOWN)
DIRECTION OF TRAFFIC
VIEW K-K
(OFFSETS FROM CASS CENTERLINE)
CASS
CABLE GUARDRAIL
SAFETY SYSTEM
TRINITY HIGHWAY SAFETY PRODUCTS, INC.
SS-720

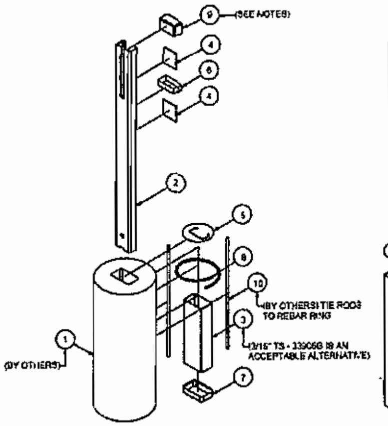
| PARTS LIST - CASS SHORT POST - #1 CONCRETE | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | | 1 | CONCRETE POST - CASS POST | 264.40 |
| 1 | 339033 | 2 | CASS SHORT POST | 18.75 |
| 1 | 339080 | 3 | POST SLEEVE - CONCRETE POST | 7.75 |
| 2 | 58229 | 4 | CASS CABLE SPACER | 0.09 |
| 1 | 58230 | 5 | SLEEVE COVER - CASS POST | 0.11 |
| 1 | 58241 | 6 | CASS POST STRAP | 0.19 |
| 1 | 58336 | 7 | SLEEVE CAP - CASS POST | 0.13 |
| 1 | 58340 | 8 | CONCRETE REINFORCING RING | 0.68 |
| 1 | 58380 | 9 | CASS CAP EXTERNAL BLACK | 0.13 |
| 2 | 58401R | 10 | #4 REBAR - SYSTEM POST | 1.45 |

| PARTS LIST - CASS SHORT POST - #1 DRIVEN SLEEVE - #4A | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | 339020 | 1 | CASS SHORT POST | 18.75 |
| 1 | 339500 | 2 | POST SLEEVE - DRIVEN SHORT POST | 15.00 |
| 2 | 58228 | 3 | CASS CABLE SPACER | 0.06 |
| 1 | 58238 | 4 | SLEEVE COVER - CASS POST | 0.11 |
| 1 | 58241 | 5 | CASS POST STRAP | 0.19 |
| 1 | 58389 | 6 | CASS CAP EXTERNAL BLACK | 0.13 |

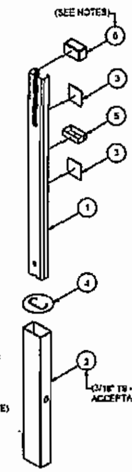
| PARTS LIST - CASS LONG POST - DRIVEN | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | 339010 | 1 | CASS LONG POST | 22.54 |
| 2 | 58228 | 2 | CASS CABLE SPACER | 0.09 |
| 1 | 58241 | 3 | CASS POST STRAP | 0.19 |
| 1 | 58388 | 4 | CASS CAP EXTERNAL BLACK | 0.13 |

| PARTS LIST - CASS POST - BASE PLATED | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | 339154 | 1 | CASS SHORT POST | 22.05 |
| 2 | 58229 | 2 | CASS CABLE SPACER | 0.09 |
| 1 | 58241 | 3 | CASS POST STRAP | 0.19 |
| 1 | 58388 | 4 | CASS CAP EXTERNAL BLACK | 0.13 |
| 4 | 67220 | 5 | 5/8 ALL THREADED ROD CHISEL POINT (A449) | 0.69 |
| 4 | 4372G | 6 | 5/8" FLAT WASHER (F436) | 0.00 |
| 4 | 3310G | 7 | 5/8 LOCK WASHER | 0.00 |
| 4 | 3361G | 8 | 5/8" HEX NUT (A563 GR DH) | 0.01 |

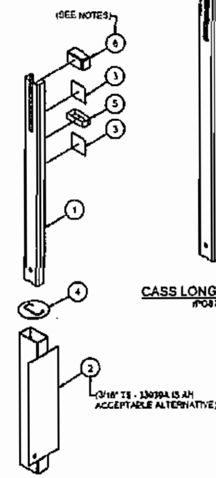
| PARTS LIST - CABLE ASSEMBLIES | | | | | | |
|---|---|---|---|---|---|---|
| QTY | PC NO | TITLE | LENGTH | TERM-1 | TERM-2 | Lbs / Each |
| 1 | 5817G | CCT CABLE ASSEMBLY-TOP | 54'-4" | R.H.T. | L.H.T. | 53.3 |
| 1 | 5818G | CCT CABLE ASSEMBLY-MID | 49'-1" | R.H.T. | L.H.T. | 52.3 |
| 1 | 5819G | CCT CABLE ASSEMBLY-BOT | 41'-10" | R.H.T. | L.H.T. | 40.3 |
| 1 | 5867G | CCA CABLE ASSEMBLY | 25'-0" | R.H.T. | L.H.T. | 30.9 |
| 1 | 5816G | CABLE ASSEMBLY-INTERIOR | 1000 | R.H.T. | L.H.T. | 967.0 |
| 1 | 5753G | CABLE FIELD SPLICE SECTION | 1025 | R.H.T. | NONE | 989.0 |
| 1 | 5752G | CABLE FIELD SPLICE SECTION | 1000 | R.H.T. | NONE | 965.0 |
| 1 | 5798G | CABLE FIELD SPLICE SECTION | 975 | R.H.T. | NONE | 940.9 |
| 1 | 5797G | CABLE FIELD SPLICE SECTION | 950 | R.H.T. | NONE | 916.9 |
| 1 | 5792G | CABLE FIELD SPLICE SECTION | 925 | R.H.T. | NONE | 892.8 |
| 1 | 5795G | CABLE FIELD SPLICE SECTION | 900 | R.H.T. | NONE | 868.8 |
| 1 | 5794G | CABLE FIELD SPLICE SECTION | 875 | R.H.T. | NONE | 844.7 |
| 1 | 5793G | CABLE FIELD SPLICE SECTION | 850 | R.H.T. | NONE | 820.7 |
| 1 | 5792G | CABLE FIELD SPLICE SECTION | 825 | R.H.T. | NONE | 796.6 |
| 1 | 5781G | CABLE FIELD SPLICE SECTION | 800 | R.H.T. | NONE | 772.6 |
| 1 | 5790G | CABLE FIELD SPLICE SECTION | 775 | R.H.T. | NONE | 748.5 |
| 1 | 5789G | CABLE FIELD SPLICE SECTION | 750 | R.H.T. | NONE | 724.5 |
| 1 | 5788G | CABLE FIELD SPLICE SECTION | 725 | R.H.T. | NONE | 700.4 |
| 1 | 5787G | CABLE FIELD SPLICE SECTION | 700 | R.H.T. | NONE | 676.4 |
| 1 | 5786G | CABLE FIELD SPLICE SECTION | 675 | R.H.T. | NONE | 652.3 |
| 1 | 5785G | CABLE FIELD SPLICE SECTION | 650 | R.H.T. | NONE | 628.3 |
| 1 | 5784G | CABLE FIELD SPLICE SECTION | 625 | R.H.T. | NONE | 604.2 |
| 1 | 5783G | CABLE FIELD SPLICE SECTION | 600 | R.H.T. | NONE | 580.2 |
| 1 | 5742G | CABLE FIELD SPLICE SECTION | 575 | R.H.T. | NONE | 556.1 |
| 1 | 5781G | CABLE FIELD SPLICE SECTION | 550 | R.H.T. | NONE | 532.1 |
| 1 | 5780G | CABLE FIELD SPLICE SECTION | 525 | R.H.T. | NONE | 508.0 |
| 1 | 5779G | CABLE FIELD SPLICE SECTION | 500 | R.H.T. | NONE | 484.0 |
| 1 | 5778G | CABLE FIELD SPLICE SECTION | 475 | R.H.T. | NONE | 459.9 |
| 1 | 5776G | CABLE FIELD SPLICE SECTION | 450 | R.H.T. | NONE | 435.9 |
| 1 | 5775G | CABLE FIELD SPLICE SECTION | 425 | R.H.T. | NONE | 411.8 |
| 1 | 5769G | CABLE FIELD SPLICE SECTION | 400 | R.H.T. | NONE | 387.8 |
| 1 | 5768G | CABLE FIELD SPLICE SECTION | 375 | R.H.T. | NONE | 363.7 |
| 1 | 5767G | CABLE FIELD SPLICE SECTION | 350 | R.H.T. | NONE | 339.7 |
| 1 | 5766G | CABLE FIELD SPLICE SECTION | 325 | R.H.T. | NONE | 315.7 |
| 1 | 5765G | CABLE FIELD SPLICE SECTION | 300 | R.H.T. | NONE | 291.6 |
| 1 | 5764G | CABLE FIELD SPLICE SECTION | 275 | R.H.T. | NONE | 267.6 |
| 1 | 5763G | CABLE FIELD SPLICE SECTION | 250 | R.H.T. | NONE | 243.5 |
| 1 | 5762G | CABLE FIELD SPLICE SECTION | 225 | R.H.T. | NONE | 219.5 |
| 1 | 5761G | CABLE FIELD SPLICE SECTION | 200 | R.H.T. | NONE | 195.4 |
| 1 | 5760G | CABLE FIELD SPLICE SECTION | 175 | R.H.T. | NONE | 171.4 |
| 1 | 5759G | CABLE FIELD SPLICE SECTION | 150 | R.H.T. | NONE | 147.3 |
| 1 | 5758G | CABLE FIELD SPLICE SECTION | 125 | R.H.T. | NONE | 123.3 |
| 1 | 5757G | CABLE FIELD SPLICE SECTION | 100 | R.H.T. | NONE | 99.2 |
| 1 | 5756G | CABLE FIELD SPLICE SECTION | 75 | R.H.T. | NONE | 75.2 |
| 1 | 5755G | CABLE FIELD SPLICE SECTION | 50 | R.H.T. | NONE | 51.1 |
| 1 | 5754G | CABLE FIELD SPLICE SECTION | 25 | R.H.T. | NONE | 27.1 |




CASS SHORT POST - IN CONCRETE
(POST OPTION #5 - CAST IN PLACE)

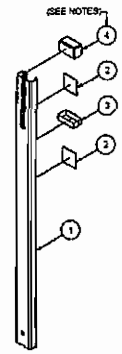



CASS SHORT POST - IN DRIVEN SLEEVE
(POST OPTION #4A)

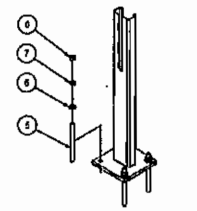



CASS SHORT POST - IN DRIVEN SLEEVE
(POST OPTION #4B)

| PARTS LIST - CASS SHORT POST - IN DRIVEN SLEEVE - #4B | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | 339020 | 1 | CASS SHORT POST | 18.75 |
| 1 | 339414 | 2 | CASS POST SLEEVE W/ SOIL PLATE | 39.53 |
| 2 | 58220 | 3 | CASS CABLE SPACER | 0.06 |
| 1 | 58238 | 4 | SLEEVE COVER - CASS POST | 0.11 |
| 1 | 58241 | 5 | CASS POST STRAP | 0.19 |
| 1 | 58320 | 6 | CASS CAP EXTERNAL BLACK | 0.13 |




CASS LONG POST - DRIVEN
(POST OPTION #2)



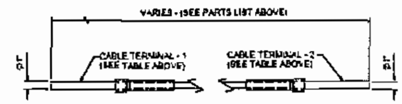
CASS POST - BASE-PLATED
(POST OPTION #3)

ANCHOR OPTIONS:
1. 5/8 x 6" ALL THREADED ROD (A449) WITH EPOXY
2. 5/8 MECHANICAL ANCHOR

MIN. EMBEDMENT IN CONCRETE = 6"
MIN. PULLOUT STRENGTH = 10,000 lbs.

NOTE

FOR THE STANDARD FIELD SPLICE SECTIONS ABOVE, SUPPLY (1) RIGHT HAND THREADED STUD ASSEMBLY 5815G EACH.



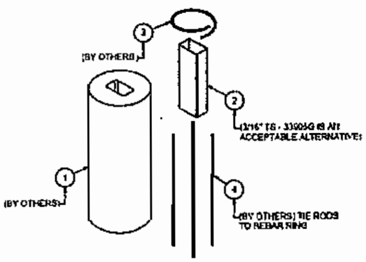

STANDARD CABLE ASSEMBLIES

NOTES

IN LIEU OF BLACK CAP 58389 SUPPLY YELLOW 58358 OR WHITE 58509 REFLECTIVE CAP. (AS REQUIRED PER PROJECT PLANS)
INTERNAL BLACK CAP 58218 AVAILABLE IN LIEU OF EXTERNAL BLACK CAP 58388

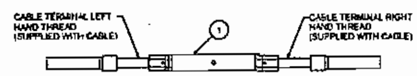
AT CASS POST LOCATION NEAREST TO A CABLE SPLICE, SUPPLY A SPLICE INTERFERENCE POST
LONG SPLICE POST 339110 IN LIEU OF LONG CASS POST 339010
SHORT SPLICE POST 319120 IN LIEU OF SHORT CASS POST 339020

IF REQUIRED PER PROJECT PLANS SUPPLY:
CABLE PULLING TOOL 58500
CABLE TENSIONING METER 68498



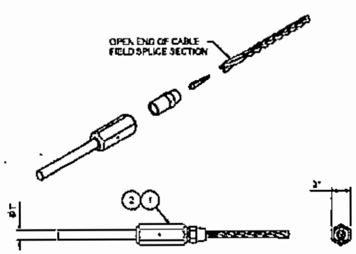

CONCRETE POST ASSEMBLY
(POST OPTION #5 - PRE-CAST OPTION)

| PARTS LIST - PRECAST CONCRETE POST | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | | 1 | CONCRETE POST - CASS POST | 264.40 |
| 1 | 339063 | 2 | POST SLEEVE - CONCRETE POST | 7.75 |
| 1 | 58300 | 3 | CONCRETE REINFORCING RING | 0.86 |
| 4 | 58708 | 4 | #3 REBAR - CONCRETE FOOTING | 0.42 |




CABLE SPLICE

| PARTS LIST - CABLE SPLICE | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | 5836G | 1 | CASS TURNBUCKLE | 4.61 |




STUD ASSEMBLY FOR FIELD SPLICE

| PARTS LIST - FOR FIELD SPLICE | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | 5814G | 1 | 3/4 STUD ASSEMBLY - LHT | Incompatible Units |
| | 4 | | 1 | 3 Error |
| 1 | 5815G | 2 | 3/4 STUD ASSEMBLY - RHT | Incompatible Units Error |

| | | |
|---|---|---|
| CASS<br>CABLE GUARDRAIL<br>SAFETY SYSTEM | DRW. EAS 2/26/2004 | |
| | CHK. SS 3/19/2004 | |
| | SHT. 5 OF 5 | SIZE D |
| TRINITY HIGHWAY SAFETY PRODUCTS, INC. | DWG NO. SS-720 | REV 12 |
| PROJ CASS-STANDARD | | |

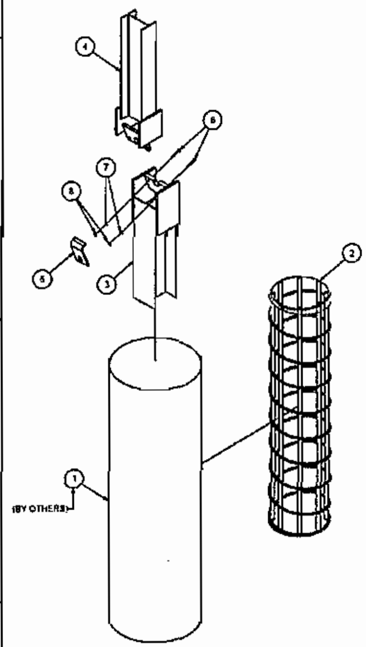
| PARTS LIST - CCT CABLE RELEASE POST - No. 1-3 - IN CONCRETE | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | | 1 | CONCRETE FOOTING - CRP POST | 1274.10 |
| 1 | 33916B | 2 | REINFORCING CAGE - CRP POST | 68.07 |
| 1 | 33934A | 3 | CRP - LOWER POST | 51.80 |
| 1 | 33935A | 4 | CRP - UPPER POST | 31.57 |
| 1 | 33909G | 5 | CASS CABLE BRACKET | 1.92 |
| 2 | 3248G | 6 | 5/16 HEX BOLT x 2" (SAE Gr.5) | 0.06 |
| 2 | 5831G | 7 | 5/16 FLAT WASHER (SAE Gr.5) | 0.00 |
| 2 | 6532G | 8 | 5/16 DIA. HEX NUT (SAE Gr 5) | 0.01 |

| PARTS LIST - CCT CABLE RELEASE POST - No. 1-3 - DRIVEN | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | 33934A | 1 | CRP - LOWER POST | 178.57 |
| 1 | 33935A | 2 | CRP - UPPER POST | 31.57 |
| 1 | 33920G | 3 | CASS CABLE BRACKET | 1.92 |
| 2 | 3248G | 4 | 5/16 HEX BOLT x 2" (SAE Gr 5) | 0.06 |
| 2 | 5831G | 5 | 5/16 FLAT WASHER (SAE Gr 5) | 0.00 |
| 2 | 6532G | 6 | 5/16 DIA. HEX NUT (SAE Gr 5) | 0.01 |

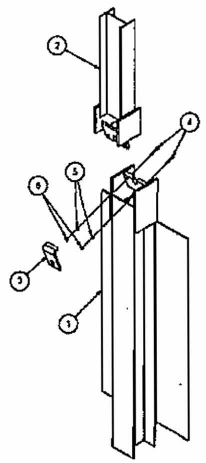
| PARTS LIST - CCT TERMINAL POST - IN CONCRETE - POSTS No. 4 - 9 | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | | 1 | CONCRETE FOOTING - LINE POST | 300.19 |
| 1 | 33906G | 2 | SLEEVE - TERMINAL LINE POST | 20.90 |
| 1 | 58250 | 3 | CONCRETE REINFORCING RING | 0.84 |
| 1 | 339103 | 4 | 350-TL3 TERMINAL POST | 28.63 |
| 1 | 58300 | 5 | SLEEVE COVER - B3 ANCHOR POST | 0.11 |
| 3 | 58350 | 6 | CABLE LOCK BOLT (A307) | 0.13 |
| 3 | 3245G | 7 | 5/16 DIA. HEX NUT (A563) | 0.01 |
| 2 | 69100 | 8 | #4 REBAR - TERMINAL POST | 1.78 |

| PARTS LIST - LONG POST - DRIVEN - POST No. 2 | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | 33901G | 1 | CASS LONG POST | 23.54 |
| 2 | 6021G | 2 | BEARING ANGLE (A36) | 3.81 |
| 2 | 5403G | 3 | 3/4 HEX BOLT x 5 1/2" (A325) | 0.11 |
| 2 | 3701G | 4 | 3/4 FLAT WASHER (F436) | 0.01 |
| 2 | 3711G | 5 | 3/4 HEX NUT (A194 2H) | 0.02 |
| 2 | [illegible] | 6 | CASS CABLE SPACER | 0.06 |
| 1 | 5824T | 7 | CASS POST STRAP | 0.19 |
| 1 | 58380 | 8 | CASS CAP EXTERNAL BLACK | 0.13 |

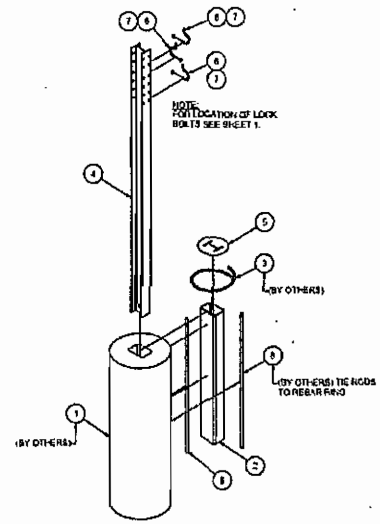
| PARTS LIST - CCT TERMINAL POST - WITH SOIL PLATE - POST No. 4 | | | | |
|---|---|---|---|---|
| QTY | PC NO. | ITEM | TITLE | Lbs / Each |
| 1 | 33903A | 1 | 350-TL3 TERMINAL POST w/ SOIL PLATE | 42.25 |
| 2 | 9021G | 2 | BEARING ANGLE (A36) | 3.81 |
| 2 | 4770G | 3 | 3/4 HEX BOLT x 4 1/2" (A325) | 0.09 |
| 2 | 3701G | 4 | 3/4 FLAT WASHER (F436) | 0.01 |
| 2 | 3711G | 5 | 3/4 HEX NUT (A194 2H) | 0.02 |
| 3 | 5825G | 6 | CABLE LOCK BOLT (A307) | 0.12 |
| 3 | 3245G | 7 | 5/16 DIA. HEX NUT (A563) | 0.01 |



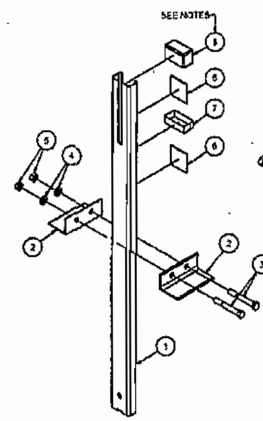

CRP TERMINAL POST - IN CONCRETE
(CCT TERMINAL POST 1 - 3)
(POST OPTION #1 SHOWN)



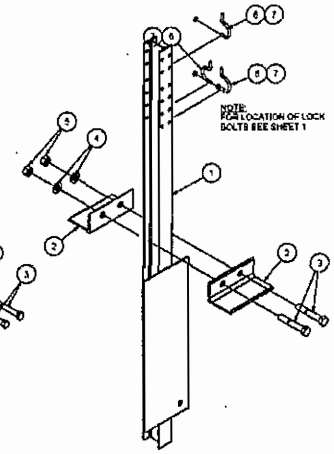
CRP TERMINAL POST - DRIVEN
(CCT TERMINAL POST 1 - 3)
(POST OPTION #3 SHOWN)




TERMINAL POST - IN CONCRETE
(CCT TERMINAL POST 4 - 9)
(POST OPTION #1 SHOWN)




ANCHOR LONG POST - DRIVEN
(CCA ANCHOR POST - 2)
(POST OPTION #3 SHOWN)




TERMINAL POST - WITH SOIL PLATE
(CCT TERMINAL POST - 4)
(POST OPTION #3 SHOWN)

NOTES:

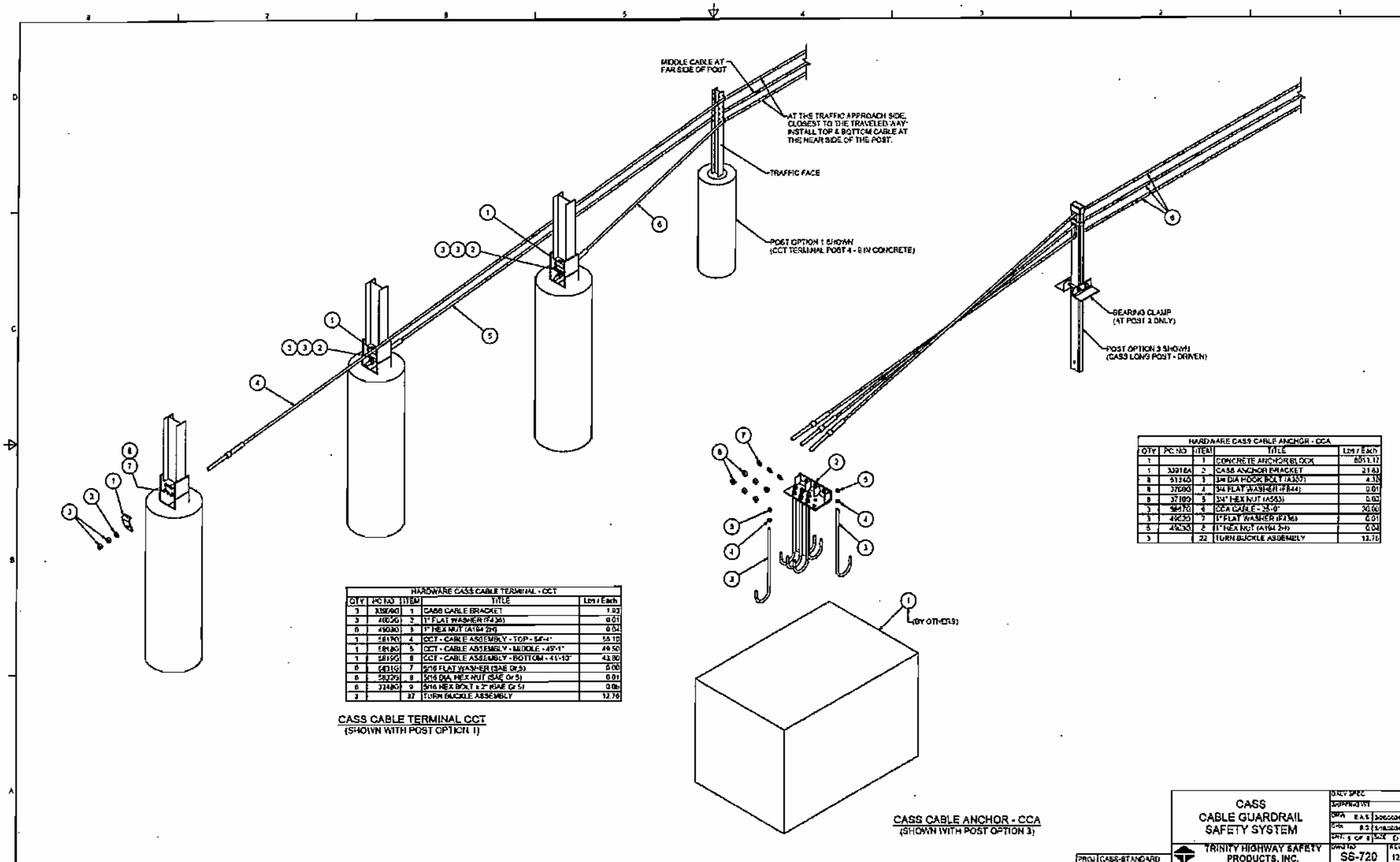
IN LIEU OF BLACK CAP 58380 SUPPLY YELLOW REFLECTIVE CAP 58350
(AS REQUIRED PER PROJECT PLANS)
INTERNAL BLACK CAP 58210 AVAILABLE IN LIEU OF EXTERNAL BLACK CAP 58380.

AT CASS POST LOCATION NEAREST TO A CABLE SPLICE, SUPPLY A SPLICE INTERFERENCE POST.
LONG SPLICE POST 339110 IN LIEU OF LONG CASS POST 339010
SHORT SPLICE POST 330120 IN LIEU OF SHORT CASS POST 339020

IF REQUIRED PER PROJECT PLANS SUPPLY:
CABLE PULLING TOOL 58500
CABLE TENSIONING METER 58460

| | | |
|---|---|---|
| CASS CABLE GUARDRAIL SAFETY SYSTEM | DRN. R.A.S. | 3/30/2004 |
| | CHK. B.B. | 3/18/2004 |
| | SHT. 4 OF 4 | SIZE D |
| TRINITY HIGHWAY SAFETY PRODUCTS, INC. | DWG NO. SS-720 | REV 12 |

PROJ CASS-STANDARD




| HARDWARE CASS CABLE TERMINAL - CCT | | | | |
|---|---|---|---|---|
| QTY | PC NO | ITEM | TITLE | Lbs / Each |
| 3 | 33000G | 1 | CASS CABLE BRACKET | 1.93 |
| 3 | 40020G | 2 | 1" FLAT WASHER (F436) | 0.01 |
| 6 | 49030G | 3 | 1" HEX NUT (A194 2H) | 0.04 |
| 1 | 58170G | 4 | CCT - CABLE ASSEMBLY - TOP - 54'-4" | 55.10 |
| 1 | 58180G | 5 | CCT - CABLE ASSEMBLY - MIDDLE - 45'-1" | 49.50 |
| 1 | 58190G | 6 | CCT - CABLE ASSEMBLY - BOTTOM - 41'-10" | 43.80 |
| 6 | 58310G | 7 | 5/16 FLAT WASHER (SAE Gr 5) | 0.00 |
| 6 | 58320G | 8 | 5/16 DIA. HEX NUT (SAE Gr 5) | 0.01 |
| 6 | 33480G | 9 | 5/16 HEX BOLT x 2" (SAE Gr 5) | 0.06 |
| 3 | | 22 | TURN BUCKLE ASSEMBLY | 12.76 |

CASS CABLE TERMINAL CCT
(SHOWN WITH POST OPTION 1)

| HARDWARE CASS CABLE ANCHOR - CCA | | | | |
|---|---|---|---|---|
| QTY | PC NO | ITEM | TITLE | Lbs / Each |
| 1 | | 1 | CONCRETE ANCHOR BLOCK | 8011.17 |
| 1 | 33018A | 2 | CASS ANCHOR BRACKET | 21.83 |
| 8 | 51340 | 3 | 3/4 DIA HOOK BOLT (A307) | 4.35 |
| 8 | 37000 | 4 | 3/4 FLAT WASHER (F844) | 0.01 |
| 8 | 37100 | 5 | 3/4" HEX NUT (A563) | 0.02 |
| 3 | 58170 | 6 | CCA CABLE - 25'-0" | 30.00 |
| 3 | 49020 | 7 | 1" FLAT WASHER (F436) | 0.01 |
| 6 | 49030 | 8 | 1" HEX NUT (A194 2H) | 0.04 |
| 3 | | 22 | TURN BUCKLE ASSEMBLY | 12.76 |

CASS CABLE ANCHOR - CCA
(SHOWN WITH POST OPTION 3)

CASS
CABLE GUARDRAIL
SAFETY SYSTEM

TRINITY HIGHWAY SAFETY PRODUCTS, INC.

PROJ CASS-STANDARD

DWG NO SS-720 REV 12

# ***Appendix B: FHWA Approval***

2 Meter Spacing

U.S. Department of Transportation
Federal Highway Administration

AUG 28 2003

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

Refer to: HSA-10/B-119B

Mr. Rodney A. Boyd
Trinity Highway Safety Products Division
P.O. Box 568887
Dallas, Texas 75356-8887

Dear Mr. Boyd:

In his August 15, letter to Mr. Richard Powers of my staff, your representative, Mr. Don Johnson, requested formal Federal Highway Administration acceptance of a third variation to your high-tension, wire rope traffic barrier called the Cable Safety System (CASS). Included with the letter were copies of a Texas Transportation Institute (TTI) report dated June 2003, entitled "National Highway Cooperative Research Program (NCHRP) Report 350 Test 3-11 of the TRINITY CASS System with 2 m Post Spacing with Concrete Footings and Sockets" and videotapes of the crash test. Previous acceptances were for the CASS System with 3-m and 5-m post spacings, respectively.

As with the previous two designs, the CASS barrier described in the test report consisted of three 19-mm diameter, pre-stretched 3 x 7 strand steel cables mounted 530 mm, 640 mm, and 750 mm above the ground. Each cable was tensioned to 24kN using turnbuckles attached to swaged threaded fittings on each end. These cables were supported by 1200-mm long, galvanized 100 x 50 x 4 mm C-channels inserted into socketed concrete foundations. The TS 125 mm x 75 mm x 3.2 mm sockets, 380-mm long, were cast inside 250-mm diameter concrete cylinders set 600 mm into augured holes. The upper central section of each post web was removed to accept the cables, which are kept separated in a vertical plane by the insertion of plastic spacer blocks, a stainless steel strap, and a plastic cap over the top of each post.

In test 3-11, the pickup truck impacted near the third-point of the 100 m test installation at 100.6 km/h at 25.6 degrees. The reported roll angle was 39.9 degrees, but all occupant risk values were well below Report 350 preferred limits. The cable rail deflected 2.06 meters in the test. Although the tested design met all Report 350 evaluation criteria, you requested acceptance of a stronger concrete foundation/steel socket to reduce repair costs after impacts. Specifically, you proposed increasing the concrete foundation diameter to 300 mm and its depth to 760 mm, and you increased the thickness of the steel sleeve from the tested 3.2 mm to 4.8 mm. These modifications are acceptable.

Although the posts in the test installation were set in steel sockets cast into concrete cylinders, you requested the use of posts set in driven steel tubes or posts driven directly into a strong soil as alternative designs. As long as the post failure mechanism remains essentially unchanged (i.e., post failure by bending at the ground line with minimal deflection below ground as in the test installation), these options are acceptable for any of the tested CASS post spacings. The CASS barrier should be introduced and ended with a crashworthy terminal such as the previously accepted TTI breakaway terminal for a high-tensioned cable barrier. If the TTI terminal is used, the first six posts beyond the third breakaway anchor post must be the same posts at the same spacing as were used in the terminal certification tests unless you repeat the appropriate tests using the CASS post at these locations. A non-crashworthy terminal may be used if both the upstream and downstream anchors are adequately shielded.

In summary, the CASS barrier, with posts set on 2-m centers, meets NCHRP Report 350 evaluation criteria as a test level 3 barrier and may be used on the National Highway System (NHS) as either a roadside or median barrier when such use is acceptable to the contracting agency. Since it is a proprietary product, the provisions of Title 23, Code of Federal Regulations, Section 635.411 apply to its use on Federally funded projects, except exempt non-NHS projects.

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

- This acceptance is limited to the crashworthiness characteristics of the CASS system and does not cover its long-term durability or maintenance requirements.
- Any design changes that may adversely influence the crashworthiness of the device may 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 device 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, and that they will meet the crashworthiness requirements of FHWA and NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance, designated as number B-119B, 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.

Sincerely yours,

Harry W. Taylor

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

## ***Appendix C: CASS™ Construction Operations***

## Construction Operations: Anchors

Figure A - 1: Anchor post base hole drilled to depth of 6 feet.

Figure A - 2: Construction of rebar cage for anchor post base.

**Figure A - 3: Insertion of rebar cage into drilled anchor base hole and concrete placement**

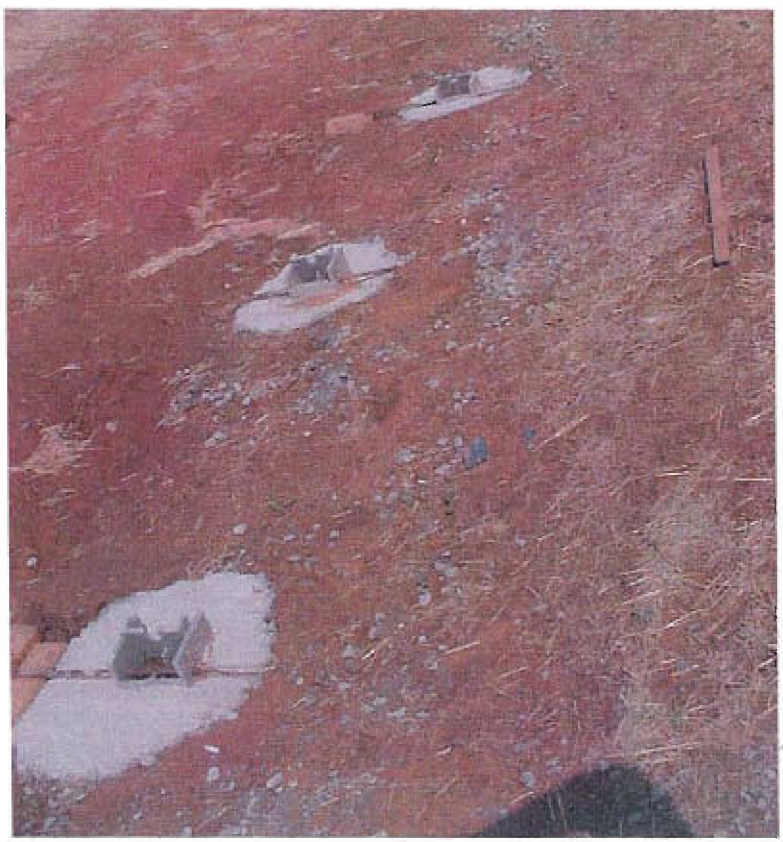


**Figure A - 4: Finished ancbor post bases.**

Figure A - 5: Anchor post installed

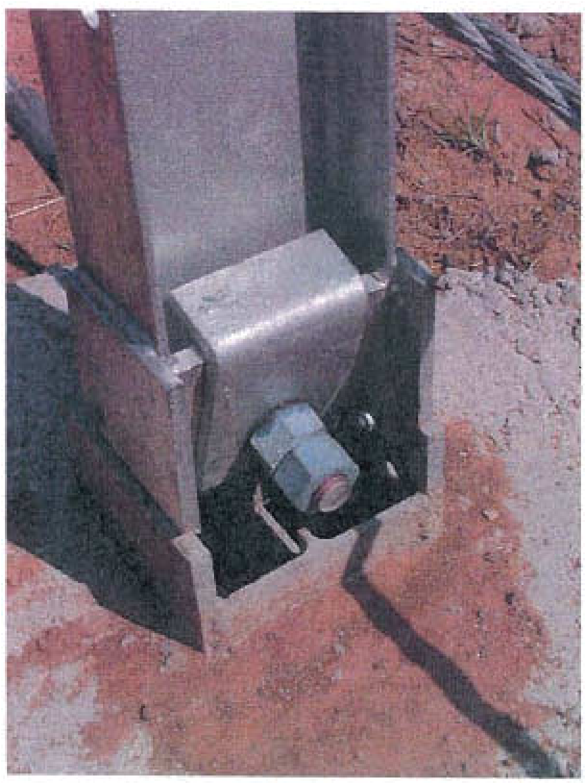


Figure A - 6: Anchor post end of cable connection

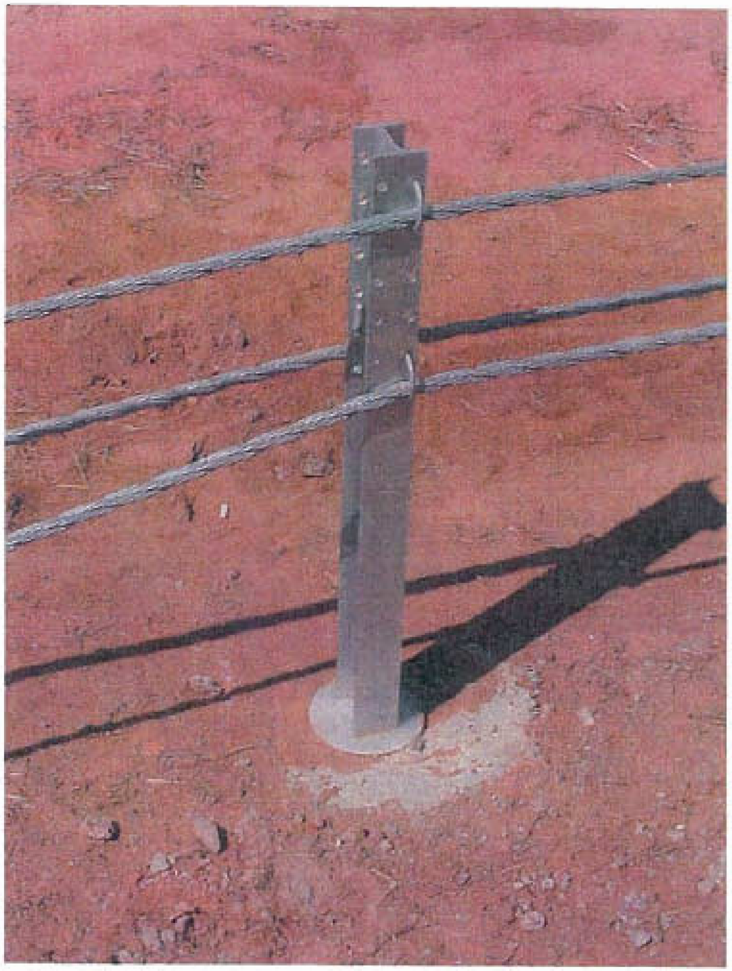


Figure A - 7: Installed post near anchors--note different cable-holding system

## Construction Operations: Barrier Posts

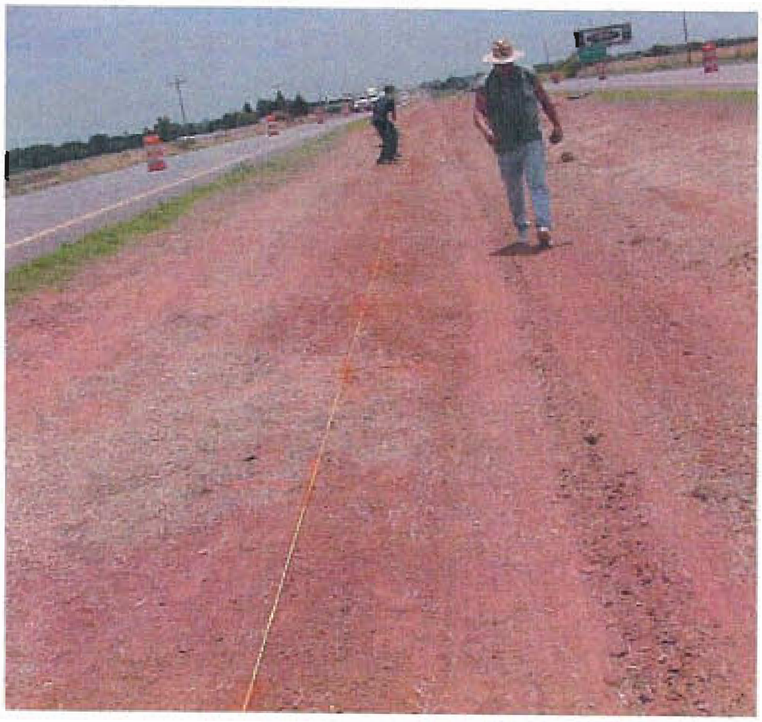


Figure A - 8: Laying out placement of barrier posts.

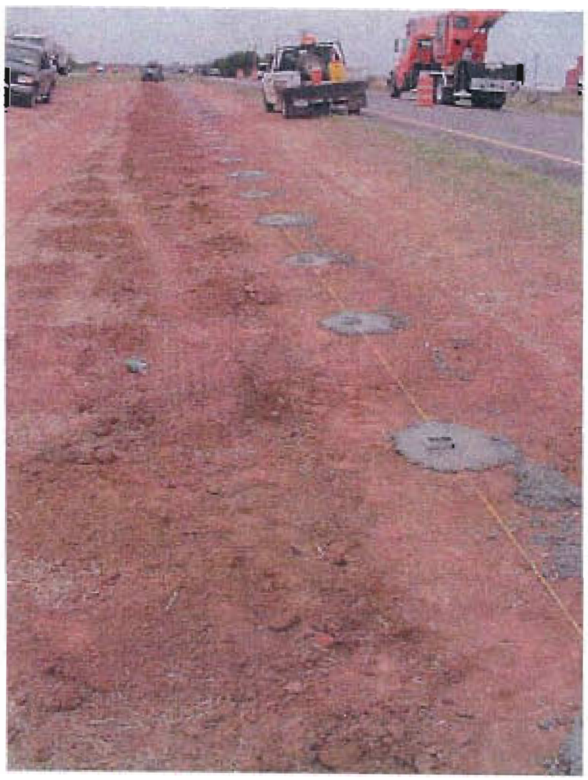


Figure A - 9: Completed barrier post bases.

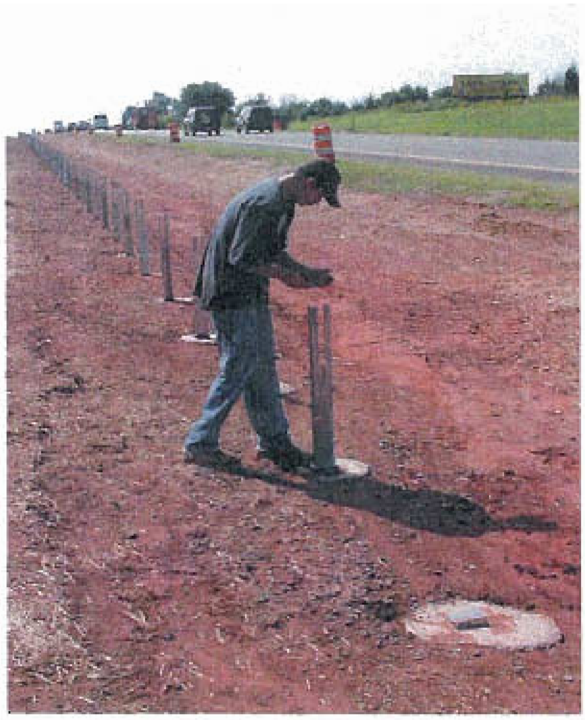


Figure A - 10: Installation of posts and base caps.

Figure A - 11: Finished cable barrier system.

## *Appendix D: CASS™ After Impact*

Figure A - 12: CASS™ system after impact.

Figure A - 13: Barrier post after impact.