

CASS™ S3 4:1

Product Description Assembly Manual

Part No. 620005B

Revision E August 2012



CASS™ S3 4:1

Product Description Assembly Manual



Important: These instructions are to be used only in conjunction with the assembly, maintenance, and repair of the Cable Safety System (CASS™) S3 4:1. These instructions are for standard assembly specified by the appropriate highway authority only. In the event the specified system assembly, maintenance, or repair would require a deviation from standard assembly parameters, contact the appropriate highway authority engineer. This system has been determined to meet the criteria for eligibility for reimbursement by the Federal Highway Administration for use on the national highway system under strict criteria utilized by that agency. A Trinity Highway Products, LLC representative is available for consultation if required.

This Manual must be available to the worker overseeing and/or assembling the product at all times. For additional copies, contact Trinity Highway Products, LLC at (888) 323-6374 or download from websites below.

The instructions contained in this Manual supersede all previous information and Manuals. All information, illustrations, and specifications in this Manual are based on the latest CASS™ system information available to Trinity Highway Products at the time of printing. We reserve the right to make changes at any time. Please contact Trinity Highway Products to confirm that you are referring to the most current instructions.

Table of Contents

Customer Service Contacts	3
Important Introductory Notes	3
Recommended Safety Rules for Assembly	4
Safety Symbols	5
Warnings and Cautions.....	5
Important Introductory Notes	6
General CASS™ System Information	6
System Overview	7
Ground Preparation and Barrier Alignment.....	8
Layout – Aligning the CASS™	9
Post Spacing on a Curve	9
Post Foundation Placement.....	10
Post Foundations (Line Post).....	10
Driven Foundation Tube With and Without Soil Plate	10
Sleeve in Poured Concrete Footing	11
Precast Concrete Footings.....	11
Post Placement.....	11
Base Plated Post Assembly	12
Cable Barrier End Treatments	13
CASS™ Terminal Line Footings	15
CASS™ Terminal Post Assembly	16
CASS™ Cable Anchor (CCA)	19
CASS™ Transition to W-Beam (CTW).....	22
CASS™ Transition to Thrie-Beam (CTT) Thrie-beam rail panels	22
Assembling Foundation Tubes or Posts when Encountering Rock	23
Driven Posts.....	25
Cables.....	26
Cable Splices	26
Torpedo Cable Splice.....	28
Tensioning and Tension Meter	31
Delineation	32
Repairs.....	33
Repair for System Impact (CCT Not Damaged).....	33
Repair for CCT Impact (CRP not Involved).....	34
Repair for CCT Impact (CRP Involved).....	34
Repair for Cable Transition to W-Beam (CTW) or Rail Elements	34
Emergency Repairs	36
Road Blocked Due to an Accident	36
Removing Entangled Cable from a Vehicle	36
Repairing a Cut or Damaged Cable.....	37
CASS™ System Temperature and Tension Chart (A)	40
CASS™ System Temperature and Tension Chart (B)	41
Appendix – Drawings	42
Cable Flare Assemblies	44
Cable Barrier Overlap	45
Table of Figures	46

Customer Service Contacts

Trinity Highway Products, LLC is committed to the highest level of customer service. Feedback regarding the CASS™ system, its assembly procedures, supporting documentation, and performance is always welcome. Additional information can be obtained from the contact information below:

Trinity Highway Products, LLC:

Telephone:	(888) 323-6374 (USA Only) +1 (214) 589-8140 (International Calls)
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Centerville, Utah	(800) 772-7976
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Girard, Ohio	(800) 321-2755
Orangeburg, South Carolina	(800) 835-9307
Canada	(800) 835-6051

Important Introductory Notes

Proper assembly of the CASS™ is essential to achieve performance of the system under appropriate federal and state criteria. These instructions should be read in their entirety and understood before assembling the CASS™. These instructions are to be used only in conjunction with the assembly of the CASS™ and are for standard assemblies only as specified by the applicable highway authority. In the event your system assembly requires or involves deviation from standard parameters or, during the assembly process a question arises, please contact the appropriate highway authority that specified this system at this particular location for guidance. Trinity Highway Products, LLC is available for consultation with that agency. These instructions are intended for an individual who is qualified to both read and accurately interpret them as written. They are intended for the individual who is experienced and skilled in the assembly of highway products which are specified and selected by the highway authority.

A set of product and project shop drawings will be supplied by Trinity Highway Products, LLC. The shop drawings will be for each section of the assembly. These drawings should be reviewed and studied thoroughly by a qualified individual who is skilled in interpreting them before the start of any assembly.



Important: Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the CASS™ system. Failure to follow this warning can result in serious injury or death to workers and/or bystanders. It further compromises the acceptance of this system by the FHWA. Please keep these instructions for later use.



Warning: Ensure that all of the CASS™ system Warnings, Cautions, and Important Statements within the CASS™ Manual are completely followed. Failure to follow this warning could result in serious injury or death in the event of a collision.

Recommended Safety Rules for Assembly

*** Important Safety Instructions ***

This Manual must be kept in a location where it is readily available to persons who are skilled and experienced in the assembly, maintenance, or repair of the CASS™ system. Additional copies of this Manual are immediately available from Trinity Highway Products, LLC by calling (888) 323-6374 or by email at CASSTL3.info@trin.net. This Manual may also be downloaded directly from the websites indicated below. Please contact Trinity Highway Products, LLC if you have any questions concerning the information in this Manual or about the CASS™ system.

Always use appropriate safety precautions when operating power equipment and when moving heavy equipment or the CASS™ components. Gloves, safety goggles, steel toe boots, and back protection should be used.

Safety measures incorporating traffic control devices specified by the highway authority must be used to provide safety for personnel while at the assembly, maintenance, or repair site.

Safety Symbols

This section describes the safety symbols that appear in this CASS™ Manual. Read the Manual for complete safety, assembly, operating, maintenance, repair, and service information.

<u>Symbol</u>	<u>Meaning</u>
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Safety Alert Symbol: Indicates Danger, Warning, or Caution. Failure to read and follow the Danger, Warning, Safety, or Caution indicators could result in serious injury or death to the workers and/or bystanders.

Warnings and Cautions

Read all instructions before assembling, maintaining, or repairing the CASS™ system.



Warning: Do not assemble, maintain, or repair the CASS™ system until you have read this Manual thoroughly and completely understand it. Ensure that all Warnings, Cautions and Important statements within the Manual are completely followed. Please call Trinity Highway Products at (888) 323-6374 if you do not understand these instructions. Failure to follow this warning could result in serious injury or death.



Warning: Safety measures incorporating appropriate traffic control devices specified by the highway authority must be used to protect all personnel while at the assembly, maintenance, or repair site. Failure to follow this warning could result in serious injury or death.



Warning: Use only Trinity Highway Products, LLC parts that are specified herein for the CASS™ for assembling, maintaining, or repairing the CASS™ system. Do not utilize or otherwise commingle parts from other systems even if those systems are other Trinity Highway Products, LLC or Trinity systems. Such configurations have not been tested, nor have they been approved for use. Assembly, maintenance, or repairs using unspecified parts or accessories is strictly prohibited. Failure to follow this warning could result in serious injury or death.



Warning: Do NOT modify the CASS™ system in any way. Failure to follow this warning could result in serious injury or death.



Warning: Ensure that the CASS™ system and delineation used meet all federal, state, specifying agency, and local specifications. Failure to follow this warning could result in serious injury or death.



Warning: Ensure that your assembly meets all appropriate Manual on Uniform Traffic Control Devices (MUTCD) and local standards. Failure to follow this warning could result in serious injury or death.



Warning: Be aware of hazards of using compressed air (small objects may become projectiles). Failure to follow this warning can result in serious injury or death to the workers and/or bystanders.



Warning: Do not allow pedestrians or workers to stand near this system, when under tension, in circumstances where the cable may be impacted or cut. Failure to follow this warning can result in serious injury or death to the workers, bystanders and/or pedestrians.

Important Introductory Notes

These instructions are to be used only in conjunction with the assembly of the CASS™ System for a NCHRP-350 Report TL-3 or TL-4 assembly.

Proper deployment and maintenance of the CASS™ system is critical to achieve performance under appropriate state and federal guidelines. Take the time to review this Manual including the Limitations and Warnings section thoroughly before performing the necessary work. Do not attempt to assemble any CASS™ system without the proper plans and assembly Manual from the manufacturer.

In the event your system assembly requires or involves special circumstances or, if during the assembly process, a question arises regarding a particular assembly step, contact a Trinity Highway Products, LLC representative before proceeding.

If you require additional information, or have questions about the CASS™, please contact Trinity Highway Products, LLC Customer Service Department. See Customer Service Contacts on Page 3 of this Manual.

General CASS™ System Information

Pre-Stretched Cable

For pre-stretched cable, the cable tension should be checked at least **once** a year. The tension value is established based on either the ambient air temperature or the cable temperature, which can be taken using a thermometer for the air temperature or an infrared thermometer for the cable temperature. See the CASS™ System Temperature / Tension Chart for the tension values.

Standard Cable

For standard cable, the cable tension should be checked at least **twice** a year. The tension value is established based on either the ambient air temperature or the cable temperature, which can be taken using a thermometer for the air temperature or an infrared thermometer for the cable temperature. See the CASS™ System Temperature / Tension Chart for the tension values.

System Overview

The CASS™ system is a 4-Cable Barrier System that can be used as a Test Level 3 system on 4:1 (1:4) or flatter slopes and as a Test Level 4 System on 6:1(1:6) or flatter slopes. The CASS™ system consists of Steel Yielding Cable Posts (SYCP™) and four pre-stretched 3/4" (19mm) cables or four standard 3/4" (19mm) cables. The posts can be driven, placed in a driven sleeve, placed in a sleeve and concrete footing, or base plated.

The maximum post spacing is 21 feet (6.4 m). The 12 inches (304 mm) diameter x 30 inches (762 mm) minimum depth concrete footing is used for the system with slopes 6:1(1:6) or flatter. For slopes steeper than 6:1(1:6), the footing depths should be increased by 6 inches (152 mm). The footing depths can be increased if the soil characteristics do not meet the NCHRP 350 standard soils. Contact Trinity Highway Products for these designs.

The SYCP™ is an S3 x 5.7 (S75 x 8) post. The bottom two cables are retained by a hook bolt. The top two cables are placed in a slot at the top of the post and are separated with a plastic spacer. Cable heights are 17.4 inches (440mm), 29.5 inches (750mm), 38.1 inches (970mm) and 41.7 inches (1060mm). A stainless steel strap is placed around the post over the top cable.

The post spacing will be according to the contract plans. The barrier is terminated either with a CASS™ Cable Terminal (CCT), a CASS™ Cable Anchor (CCA), a CASS™ Transition to W-Beam (CTW) or Thrie Beam (CTT), a CASS™ Transition to Box Beam (CTB), a CASS™ Transition to a Colorado 3F, or a Bracket connected to a barrier (CB).

Ground Preparation and Barrier Alignment

The CASS™ System shall be placed on shoulders or medians without obstructions, depressions, etc. that may significantly affect the stability of an errant vehicle. Grading of the site and/or appropriate fill materials may be required. The assembler shall “flatten” or “round” various topographical inconsistencies that could interfere with the ability to consistently maintain the design height (in relation to the terrain) of the cables.

When used as a Test Level 3 System on a 4:1(1:4) to 6:1(1:6) slope, the system can be placed no further than 4 feet (1.2 m) from the shoulder hinge point on the fore slope and no closer than 11 feet (3.3 m) on the back slope from the bottom of the ditch.

When used as a Test Level 3 or Test Level 4 system in a median, use the following criteria for locating the system: According to Federal Highway Administration (FHWA) and American Association of State Highway and Transportation Officials (AASHTO), a cable should not be placed 1 to 8 feet from the ditch line when on a slope that is 6:1 (1:6) to 10:1(1:10). When the slope is 10:1 (1:10) or flatter, the cable can be placed anywhere in the median.

The CASS™ System can be placed in front of slopes 2:1 (1:2) or flatter. The distance in front of the hinge point to the center of the post should be 2 feet (.6 m), with 1 foot (.3 m) minimum.

When a curb is used with the CASS™ System, the height of the curb should not be higher than 4 inches (100 mm) and, on high-speed roadways, the CASS™ System should not be placed behind the curb in an area from 1.5 to 8 feet (.5 to 2.4 m). When the CASS™ System needs to be placed on roadways with a speed of 40 mph (65 km/h) or less, and a curb is present, contact the appropriate highway authority representative before proceeding. Trinity Highway Products representatives are available to consult with the highway authority or agency.

If the barrier must be flared, the flare rate is 30:1 or flatter. See the Drawing Section for the placement.

The appropriate highway authority or agency's standards for grading and widening for guardrail terminals should be used for the CASS™ Cable Terminal.

Layout – Aligning the CASS™

Follow all procedures in placing the footing and/or post to insure proper alignment. To achieve this, it is suggested that a string line or other means be used to provide a consistent horizontal and vertical alignment that meets specifications.

Post Spacing on a Curve

Complete the following Steps to Place the posts or post foundations along a curve.

1. When the cable is placed on a curve, post spacing may need to be reduced based on the radius.

Note: The post spacing criteria for a curve will be the same for both pre-stretched and standard cable.

2. Weak soil conditions may necessitate a larger footing for the line posts, based on the radius of the curve.

Note: For weak soil conditions it is imperative before assembly that you contact a Trinity Highway Products Representative and highway authority engineer for special criteria. It is also recommended that you consult your own soils or structural engineer.

3. When placing posts on a curve, use the table below to adjust the spacing as required:

Curve Radius	Post Spacing
Less than 650' (198.1 m)	Contact a Trinity Highway Products representative and appropriate highway authority representative
650' to 1300' (198.1 m to 396.2 m)	10' (3.05 m) post spacing or less (as specified by state specifying agency)
1301' to 2250' (396.5 m to 685.8 m)	16.5' (5.03 m) post spacing or less (as specified by state specifying agency)
Greater than 2250' (685.8 m)	Project post spacing or less (as specified by state specifying agency)

Note: If any of the post spacing for a particular radii grouping is larger than the project post spacing, the project post spacing should be used.

Post Foundation Placement



WARNING: If the post cannot be placed, pursuant to these assembly instructions, because of soil conditions, or any other environmental factor, please contact the appropriate specifying highway authority immediately! NEVER attempt to place posts if these assembly instructions cannot be complied with.

Post Foundations (Line Post)

The driven sleeves are 31 inches (787 mm) in length and the sleeves placed in a concrete footing are 27 inches [686 mm] long (See Figure 1).

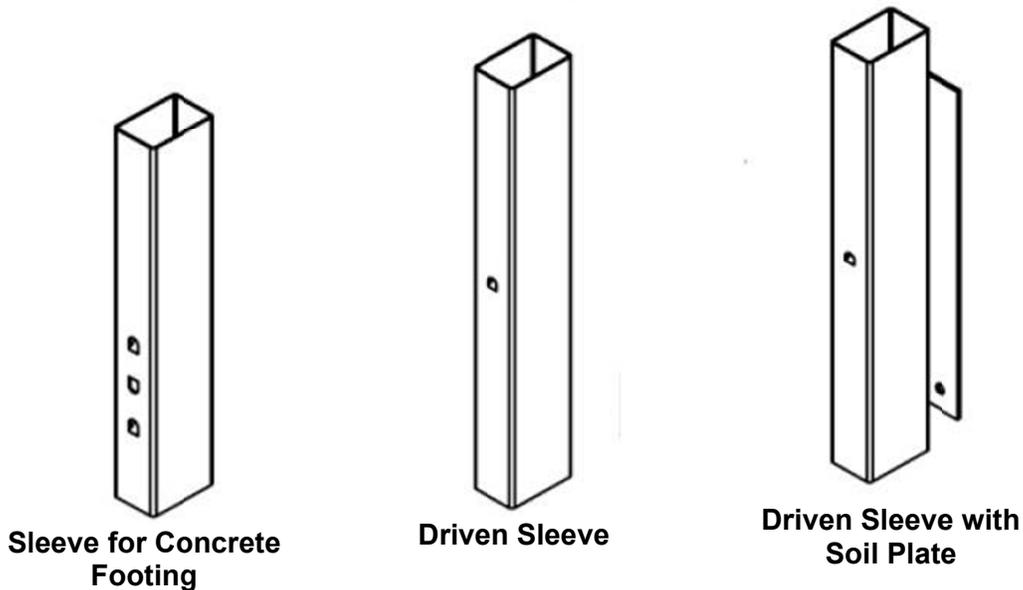


Figure 1 Post Sleeves

The following actions should be followed for the assembly of foundation line posts.

Driven Foundation Tube With and Without Soil Plate

Complete the following steps for a driven foundation tube assembly.

1. Lay out the post alignment and post spacing according to the contract specifications. Maximum post spacing is 21 feet (6.4 m).
2. Drive the foundation tube (PN-34039G) or foundation tube with soil plate (PN-34047A) with an appropriate driving head. The driving head needs to keep the tube oriented in the proper alignment and prevent soil from coming up into the tube so the post can be deployed.

Sleeve in Poured Concrete Footing

Complete the following steps for placing a sleeve in a poured concrete footing.

1. Lay out the post alignment and post spacing according to contract specifications. Maximum post spacing is 21 feet (6.4 m).
2. Punch or auger a 12 inches (25 mm) hole x 30 inches (762 mm) deep hole for the concrete footing.
3. Pour the concrete in the hole. The top of the footing needs to be flush with the finished grade.

Note: The minimum concrete strength is 3000 psi (21 MPa) or greater to meet the agency's specifications

4. Place a plastic cap on the bottom of the foundation sleeve (PN-5839B) or tape the bottom end of the foundation sleeve to prevent the concrete from coming into the tube.
5. Place the foundation sleeve in the center of the poured concrete footing. The sleeve needs to be positioned plumb and on alignment. The top of the sleeve should be arranged so the top end is flush with the top of the concrete footing.
6. Place a #3 rebar ring around the top of the sleeve 2 to 3 inches (51 mm to 76 mm) from the top of the footing.
7. Smooth off the top of the footing.
8. Allow the footing to attain the required concrete strength before post placement.

Precast Concrete Footings

The precast concrete footings will be made in forms and should be fabricated the same as if placed in an augered hole. The precast footing will be placed in a punched or augered hole.

Post Placement

Post

The CASS™ System posts can be driven, placed in a driven sleeve, placed in a sleeve in a concrete footing (poured or precast), or mounted to a concrete surface. Driven CASS™ System posts are 6'4" (1.93 m) long. For posts placed in a sleeve, the posts are 5'1" (1.55 m). For posts mounted to a concrete surface, the post is approximately 3'10" (1.17 m) long.

Driven Posts

Complete the following steps for a driven post assembly.

1. Lay out the post alignment and post spacing according to contract specifications. Maximum post spacing is 21'0" (6.4 m).
2. Drive the post (PN-35045G) with an appropriate driving head.

Posts in Sleeve

Complete the following steps for a post in the sleeve assembly

1. Place the post sleeve cover (PN-5839B) Figure 2 on the bottom end of the CASS™ System post (PN-34045G).
2. Place the post in the sleeve. The post should rest on the first tab in the sleeve. The post sleeve cover should be located at the top of the sleeve.



Figure 2 Post Sleeve Cover

Base Plated Post Assembly

The base plated post must be placed on a concrete surface 6 inches or more in depth. The base plate is 8X8X5/8" (203 mm x 203 mm x 16 mm) (See Figure 3).

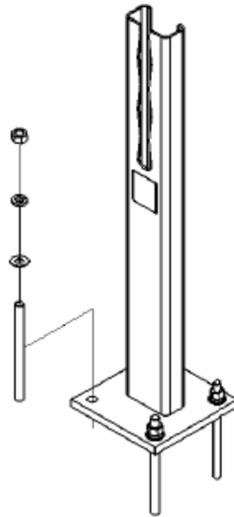


Figure 3 Plate Mounted Post

Complete the following steps for the base plated post assembly.

1. Drill four 3/4 inch (19 mm) holes, 6 inches (152 mm) deep for the 5/8 inch (16 mm) diameter X 8 inches (203 mm) long all threaded chisel point, A-449 rod.
2. Clean the holes according to the adhesive manufacturer's recommendation.
3. Place the bolts and adhesive in the holes according to the manufacturer's recommendations.

Note: A 5/8" mechanical anchor with a pull out strength of 10,000 lbs. (4536 kg) can also be used.

4. Allow the adhesive to cure according to the manufacturer's recommendations.

5. Place the base plated post (PN 34037A) on the rods.
6. Place a 5/8 inch (19 mm) flat washer (PN-3300G) and lock washer (PN-3310G) between the 5/8 inch (19 mm) hex nut (PN-3361G) and the plate (See Figure 2).
7. Tighten the nut so the lock washer is flat.

Cable Barrier End Treatments

The CASS™ Barrier is terminated with one of the following methods:

- CASS™ Cable Terminal (CCT)
- CASS™ Cable Anchor (CCA)
- CASS™ Transition to W-Beam (CTW)
- CASS™ Transition to Thrie Beam (CTT)
- CASS™ Transition to Box Beam (CTB)
- Transition to Colorado 3F
- CASS™ Bracket (CB).

CASS™ Cable Terminal (CCT)

The CASS™ Cable Terminal (CCT), National Cooperative Highway Research Program (NCHRP) 350 approved, consists of four (4) Cable Release Posts (CRP) and six (6) S3 x 5.7 (S75 x 8) terminal line posts. The CRP is a two-part post system (stub post or bottom post with soil plate and upper post). The cables are terminated at the CRP posts, one at each post. The terminal line posts are emplaced with sleeve in a concrete footing, a sleeve with a soil plate, or a driven post with a soil plate.

CASS™ Cable Terminal (CCT) Bottom Post with Concrete Footings

CASS™ Terminal CRP Footings

The CRP is a two-part post system (stub post and upper post). The stub post (W6 x 15) (W150 x 21) is 2'0" (0.61 m) in length. The upper post (W6 x 8.5) (W150 x 12) is 32 inches (813 mm) in length. The post stub should be placed in an 18 inches (457 mm) diameter x 5 foot (1.5 m) deep reinforced concrete footing. The concrete strength shall be 3000 psi (21 MPa) or greater if necessary to meet an agency's specifications. The footing is reinforced with a spiral rebar cage.

Complete the following steps for the placement of the CRP stub post in the concrete footing:

1. Lay out the four footings. See Figure 4 for the footing locations and spacing.
2. Punch or auger an 18 inch (457 mm) hole x 5 feet (1.52 m) deep hole for the concrete footing.
3. Fabricate the spiral rebar cage (PN-33916B) (See Figure 5). The spiral is made of #3 rebar (10M), 4' 6" long (1.3 m), with a 6" (152 mm) pitch and one turn flat on each end. Eight #6 x 4' 6" (19M x 1.3 m) long rebar are equally spaced and wire tied or tack welded to the inside of the spiral cage. An alternate to the spiral cage is a rebar cage made of #3 rebar rings spaced 6" (152 mm) on center and wire tied or tack welded together with eight #6 x 4' 6" (19M x 1.3m) rebar.
4. Place the spiral rebar cage in the footing hole. The cage should be centered in the hole and secured so the top of the cage is 3 inches (75 mm) from the top of the footing (finished grade). The cage should be secured so that the stub post and concrete can be placed in the hole.

- Place the stub post (PN-33934A) in the footing hole. See Figure 4 for the orientation of the stub. The weldment at the top of the stub should not be more than 4 inches above the finished grade.
- Place the concrete in the hole. The concrete strength shall be 3000 psi (20.7 MPa) or greater if necessary to meet an agency's specifications.

Note: The concrete needs to be vibrated.

- Smooth off the top of the footing.
- Allow the footing to attain the required concrete strength before tensioning the cables.

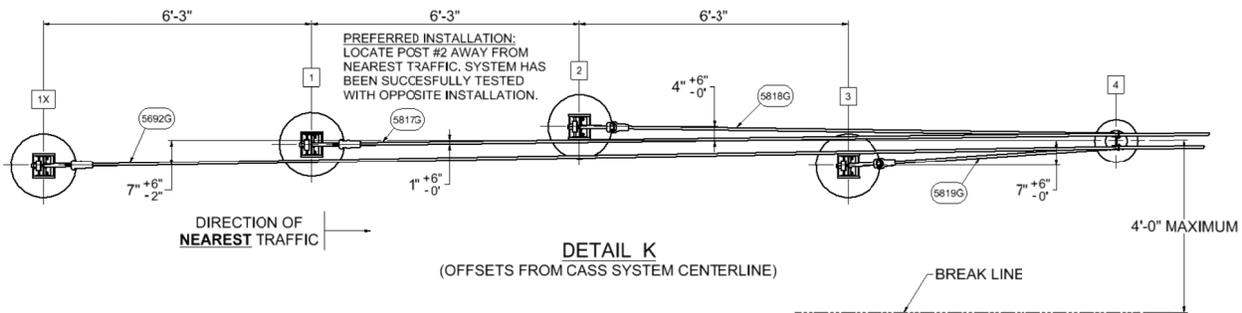


Figure 4 CRP Layout

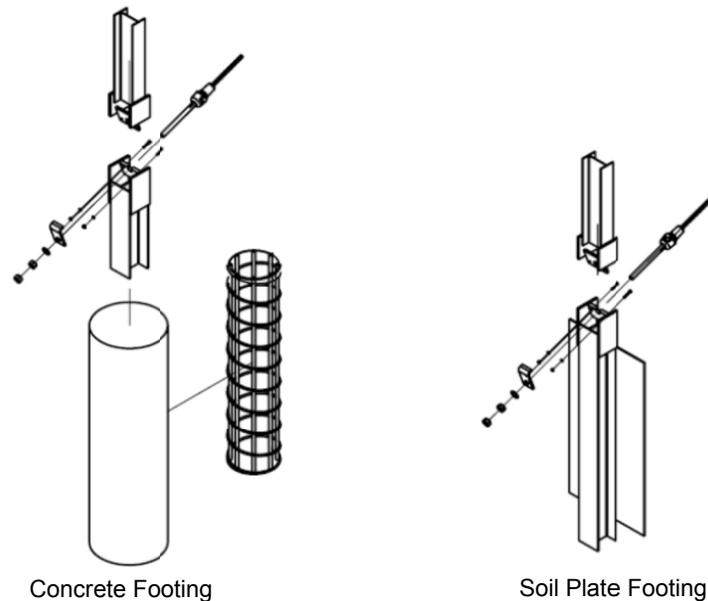


Figure 5 CRP Footing Detail

CASS™ Cable Terminal (CCT) Bottom Post with Soil Plate

For a soil plate assembly, a 5'0" (1.52 m) bottom post with a 24 x 48 inch (610 x 1219 mm) soil plate can be driven or placed in an augured hole. The soil plate can be either welded or bolted to the bottom CRP (See Figure 5).

Complete the following steps for assembling the CCT Bottom Post with Soil Plate:

- Lay out the four footings. See Figure 4 for the footing locations and spacing.

2. Punch or auger a hole approximately 4 feet (1.92 m) deep for the bottom post with soil plate (PN-33936A) if the post is not completely driven.
3. Place the post with soil plate in the hole. The post should be aligned so that the soil plate is on the downstream side of the post. Drive the post so that the weldment at the top end of the post is not more than 4 inches (100 mm) above the ground.
4. Compact the material placed back in the hole with a mechanical device.

CASS™ Terminal Line Footings

Terminal Line Sleeve in a Poured Concrete Footing – Posts 4 through 9

Complete the following steps for placing a line terminal sleeve in a poured concrete footing:

1. Lay out the post alignment and post spacing. Starting at post 4 (See Figure 4), post spacing for posts 4 through 9 is 6'3" (1.905m). The posts will be on the center line of the cable assembly.
2. Punch or auger a 12 inch (305 mm) hole x 36 inches (914 mm) deep hole for the concrete footing.
3. Pour the concrete in the hole. The top of the footing needs to be flush with the finished grade.

Note: The minimum concrete strength is 3000 psi (20.7 MPa) or greater to meet the agency's specifications.

4. Place the end cap (PN-5837B) on the bottom of the foundation sleeve (PN-33908G) to prevent the concrete from coming into the tube.
5. Place the foundation sleeve in the center of the poured concrete footing. The sleeve needs to be placed plumb and on alignment. The top of the sleeve should be placed so the top end is flush with the top of the concrete footing.

Note: The concrete needs to be vibrated.

6. Place two #4 (13M) rebar (PN-5919B) x 32 inches (813 mm) vertically at the corner of the sleeve approaching traffic. Place a #3 (10M) rebar ring (PN-5836B) around the top of the sleeve 2 to 3 inches (51 to 76 mm) from the top of the footing.
7. Smooth off the top of the footing.
8. Allow the footing to attain the required concrete strength before placing posts.

Terminal Line Precast Concrete Footings-Posts 4 through 9

The precast concrete footings will be made in forms and should be fabricated the same as if placed in an augured hole. The precast footing will be placed in a punched or augured hole.

Terminal Line Driven Foundation Tube with a Soil Plate

Complete the following steps for placement of a driven foundation tube with a soil plate.

1. Lay out the post alignment and post spacing. Starting at post 4 (See Figure 4), post spacing for posts 4 through 9 is 6'3" (1.9 m). The posts will be on the center line of the cable assembly.
2. Drive the foundation tube with soil plate (PN-33903A) with an appropriate driving head. The driving head needs to keep the tube orientated in the proper alignment and prevent soil from coming up into the tube so the post can be placed.

CASS™ Terminal Post Assembly

Terminal Posts

The CASS™ Terminal (CCT) consists of four Cable Release Posts (CRP) and six (6) S3 x 5.7 (S75 x 21) terminal line posts (positioned in a sleeve or a driven post).

Cable Release Post (CRP) – Post 1X to Post 3

Complete the following steps for the placement of the Cable Release Post (CRP):

1. Place the top Cable Release Post (CRP) (PN-33935A) on the assembled bottom CRP.
2. Place a 5/16 inch x 2 inches (8 mm x 51 mm) bolt (PN-4211G) in the two holes of the sloping plates of the top and bottom CRP.
3. Place a 5/16 inch (8 mm) washer (PN-3240G) and 5/16 inch (8 mm) nut (PN-3245G) on each of the bolts.
4. Tighten the nuts.

Terminal Line Posts in Sleeve – Posts 4 through 9

Complete the following steps for the placement of the terminal line posts in the sleeve:

1. Place the post sleeve cover (PN-5839B) (See Figure 2) on the bottom end of the terminal line post (PN-33910G or PN-33955G).
2. Place post (PN-33910G) in sleeves 4 to 7. Place post (PN-33955G) in the sleeves 8 and 9. The post should go to bottom of the sleeve. The post sleeve cover should be located at the top of the sleeve.

Terminal Line Driven Post with Soil Plate – Posts 4 through 9

Complete the following steps for the placement of a driven post with a soil plate:

1. Lay out the post alignment and post spacing. Starting at post 4 (See Figure 4), post spacing for posts 4 through 9 is 6'3" (1.9m). The posts will be on the center line of the cable assembly.
2. Drive posts (PN-33903A) at post locations 4 through 7 and posts (PN-33989A) at post locations 8 and 9 with an appropriate driving head.
3. Place a bearing angle (PN-9021G) on each side of the post 4 at the ground line (See Figure 6).
4. Place two 3/4 inch (19 mm) hex head bolts (PN-4779G) through the two bearing angles. Place a 3/4 inch (19 mm) flat washer (PN-3701G) on the bolt under the nut. Place a 3/4 inch (19 mm) hex head nut (PN-3711G) on the bolt. Tighten the nuts.

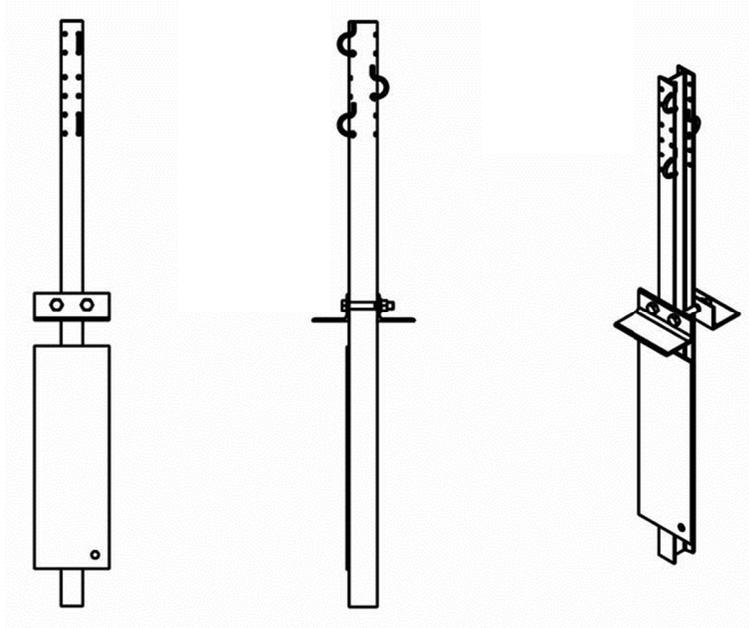


Figure 6 Bearing Angles for Post

Terminal Cables

The CASS™ Cable Terminal (CCT) consists of four (4) cables that are precut with factory applied fittings on each end; or they can be field cut from cable taken from a reel of cable. The cable lengths are 41'9" (12.73 m), 48'0" (16.63 m), 54'3" (16.54 m) and 60'6" (18.44 m).

Complete the following steps for placing the CCT cables:

1. Use Option A to lay out the precut cables or Option B to lay out cables cut from a cable reel. See Figure 4 CRP Layout for the CR Post locations.

Option A

- A. Lay out the four precut cables. The right threaded end of the cables will be attached to the CR Posts. The 60'6" (18.4 m) cable (PN-5692G) starts at CR Post 1X and is placed on the front side (traffic side) of the line terminal posts; the 54'3" (16.5 m) cable (PN-5817G) starts at CR Post 1 and is placed on the back side (away from traffic) of the line terminal posts; the 48'0" (14.6 m) cable (PN-5818G) starts at CR Post 2 and is placed on the back side of the line terminal posts; and the 41'9" (12.7 m) cable (PN5819G) starts at CR Post 3 and is placed on the front side of the line terminal posts.
- B. Place the threaded end of the cable through the hole formed by the top and bottom CR Posts.
- C. Place the CASS™ cable bracket (PN-33909G) on the threaded end. The angle end of the bracket is placed up (See Figure 5).
- D. Place a 1 inch (25 mm) flat washer (PN-4903G) on the threaded end.
- E. Place a 1 inch (25 mm) hex nut (PN-4902G) on the threaded rod. Thread the nut approximately halfway on to it. Place a second 1 inch (25 mm) hex nut on the rod up against the first nut.

Option B

- A. Cut four (4) lengths of cable from the cable reel. The cable lengths are 60'6" (18.4 m), 54'3" (16.5 m), 48'0" (14.6 m), and 41'9" (12.7 m).
 - B. Place a right-hand and left-hand field fitting on the end of the cables. See the Field Splice section for assembling the fittings.
 - C. Lay out the four field-cut cables. The right threaded end of the cables will be attached to the CR Posts. The 60'6" (18.4 m) cable (PN-5692G) starts at CR Post 1X and is placed on the front side (traffic side) of the line terminal posts; the 54'3" (16.5 m) cable (PN-5817G) starts at CR Post 1 and is placed on the back side (away from traffic) of the line terminal posts; the 48'0" (14.6 m) cable (PN-5818G) starts at CR Post 2 and is placed on the back side of the line terminal posts; and the 41'9" (12.7 m) cable (PN5819G) starts at CR Post 3 and is placed on the front side of the line terminal posts.
 - D. Place the threaded end of the cable through the hole formed by the top and bottom CR Posts.
 - E. Place the CASS™ cable bracket (PN-33909G) on the threaded end. The angle end of the bracket is placed up. (See Figure 5).
 - F. Place a 1 inch (25 mm) flat washer (PN-4903G) on the threaded end.
 - G. Place a 1 inch (25 mm) hex nut (PN-4902G) on the threaded rod. Thread the nut about half way on. Place a second 1" hex nut on the rod up against the first nut.
2. The CRP 1X cable will use the middle two holes of the line terminal posts 4 through 8. At post 9, the third and fourth holes from the top will be used.
 3. The CRP 1 cable will use the top two holes of the line terminal posts 4 through 7 and post 9. At post 8, the third and fourth holes from the top will be used.
 4. The CRP 2 cable will use the bottom two holes of the line terminal posts 4 through 9.
 5. The CRP 3 cable will use the bottom two holes of the line terminal posts 4 through 7. At post 8, the seventh and eighth holes from the top will be used. At post 9, the middle two holes will be used.
 6. The cables are attached to the posts using cable lock bolts (PN-5825G) (See Figure 7).
 7. With the threaded end of the bolt placed in the hole of the post, place a 5/16" (8 mm) hex head nut on the bolt. Only a couple of threads need to be shown beyond the nut for proper assembly.

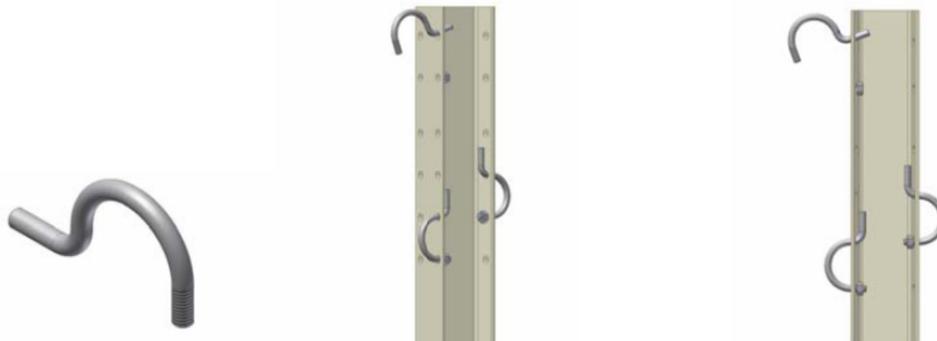


Figure 7 Placement of the Cable Lock Bolt

CASS™ Cable Anchor (CCA)

The CASS™ Cable Anchor (CCA) consists of an anchor block, a bracket to secure the cable to the anchor, two (2) CCT posts, and four 25 foot (7.62 m) lengths of cable.

The anchor block can either be precast or cast in place. It is 10 feet (3 m) long, 5 feet (1.5 m) wide, and 5 feet (1.5 m) deep (See Figure 8 on Page 20). The appropriate highway authority's standards may require a larger footing.

CASS™ Anchor Footing-Poured in Place

Complete the following assembly steps for a poured in place CASS™ anchor footing:

1. Lay out the anchor footing and post spacing. The footing and posts will be on the center line of the cable assembly. The two posts will be 10' (3.05 m) on center, starting from the center of the footing.
2. Form a footing to the dimensions shown in Figure 8.
3. To secure the anchor bracket to the footing, use Option A or Option B.

Option A. Secure ten (10) 3/4" (19 mm) "J" hooks (PN-5134G) for the anchor bracket. See Figure 8 CASS™ Cable Anchor (CCA) for the location and orientation of the bolts.

4. Pour the concrete in the form or hole. The top of the footing needs to be flush with the finished grade. The concrete needs to be vibrated.

Option B. After the footing has reached strength, drill ten (10) 1" (25 mm) X 12" (305 mm) holes in the footing for the anchor studs. See Figure 8 for the location and orientation of the holes. Place a 3/4" (19 mm) anchor stud in each hole with an appropriate adhesive. Place according to the adhesive manufacturer's recommendation.

5. Allow the footing to attain the required concrete strength before the placement of the anchor bracket. Remove the forms and compact the material around the footing with a mechanical tamper.
6. Place the anchor brackets (PN-33918A) on the anchor bolts.
7. Place a 3/4 inch (19 mm) flat washer (PN-3700G) and a 3/4 inch (19 mm) hex head nut (PN-3710G) on the anchor bolts.
8. Tighten the nuts.

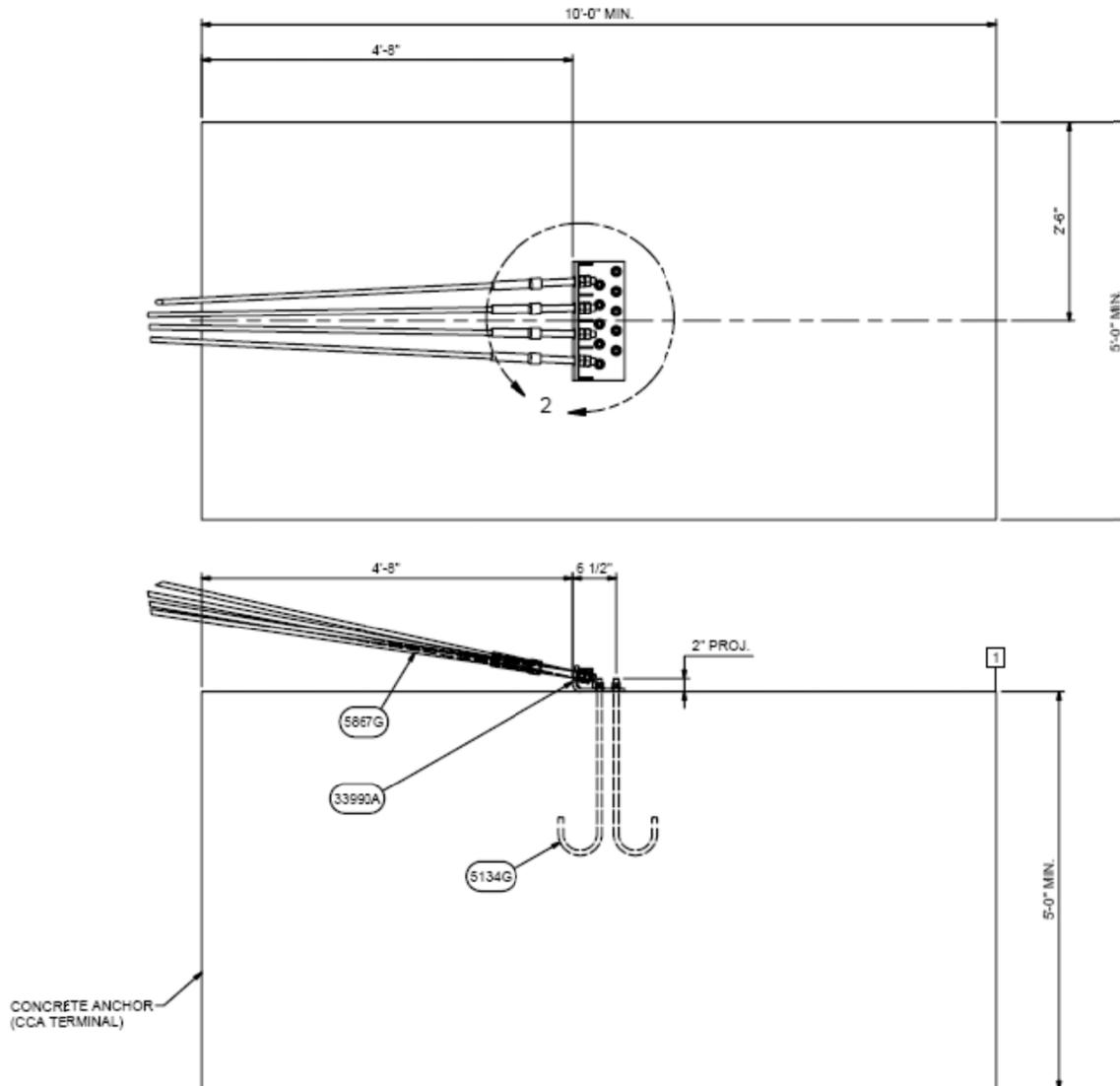


Figure 8 CASS™ Cable Anchor (CCA)

CASS™ Anchor Footing-Precast Footing

Complete the following steps for assembling the CASS™ anchor footing-precaster footing:

1. Lay out the anchor footing and post spacing. The footing and posts will be on the center line of the cable assembly. The two (2) posts will be 10 feet (3 m) on center, starting from the center of the footing.
2. Excavate a hole large enough for the precast footing.
3. Fabricate the footing using the same steps for in the CASS™ Anchor Footing Poured in Place Footing section.
4. Place the precast footing in the excavated hole. Compact the footing with a mechanical tamper.
5. Allow the footing to attain the required concrete strength before assembling the anchor bracket.

6. Place the anchor brackets (PN-33918A) on the anchor bolts.
7. Place a 3/4 inch (19 mm) flat washer (PN-3700G) and a 3/4 inch (19 mm) hex head nut (PN-3710G) on the anchor bolts.
8. Tighten the nuts.

CASS™ Anchor Foundations and Posts

The post foundations and post assembly should be according to the CASS™ Terminal Line Footings section and the CASS™ Terminal Post Assembly section.

Bearing Bracket Assembly – Post 1

Complete the following steps to assembly the bearing brackets:

1. Place a bearing angle (PN-9021G) on each side of Post 1 at the ground line (See Figure 6).
2. Place two (2) hex head 3/4 inch (19 mm) bolts (PN-4779G) through the two (2) bearing angles. Place a 3/4 inch (19 mm) flat washer (PN-3701G) on the bolt. Place a 3/4 inch (19 mm) hex head nut (PN-3711G) on the bolt.
3. Tighten the bolts.

Anchor Cables

Complete the following steps for the assembly of the anchor cables:

1. Place the right-handed treaded end of the 25 foot (7.62 m) anchor cable (PN-5867) in one of the four holes of the anchor bracket.
2. Place on the end of each cable a 1 inch (25 mm) flat washer (PN-4902G) and two 1 inch (25 mm) hex nuts (PN-4903G).
3. At Post 1 (PN-33910G), place four (4) cable lock bolts (PN-5825G) in the bottom two sets of holes on each side of the post.
4. Place the top and bottom cables on back side of the post and the middle two cables on the front side of the post.
5. At Post 2 (PN-33955G), place four (4) cable lock bolts (PN-5825G) in the middle two sets of holes on each side of the post.
6. With the threaded end of the bolt inserted in the hole of the post, place a 5/16 inch (8 mm) hex head bolt (PN-3245G) on the bolt. Only a couple of threads need to show beyond the nut for proper assembly.

CASS™ Transition to W-Beam (CTW)

The CASS™ Transition to W-Beam (CTW) connects the cable barrier directly to W-beam rail panels. The system requires reduced cable post spacing, slotted 10-gauge W-beam or nested 12-gauge W-beam, anchor brackets, and a flared guardrail terminal.

Complete the following steps to transition the cables to W-Beam (CTW):

1. Assemble the two (2) W-Beam rail panels (PN-33920G) including the terminal. See the Drawing Section for guardrail layout.
2. Place a 5/8 inch (16 mm) flat washer (PN-3711G) on the 5/8 inch (16 mm) x 1 1/2 inch (38 mm) hex bolt (PN-3380G).
3. Place the bolt through the anchor bracket holes in the guardrail; eight (8) bolts for each bracket. The washer will be between the bolt head and the face of the guardrail.
4. Place the anchor brackets (PN-700A) to the backside of the rail panel; one (1) bracket at the end of each slot.
5. Place a 5/8 inch (16 mm) hex nut (PN-3350G) on the end of each nut.
6. Tighten the nut.
7. Place the CASS™ posts or footings and posts. This will be based on the project line post assembly. See the Shop Drawing for the post spacing.
8. Place the right end threaded cable ends through the slot in the rail. The longest cable will be in the slot furthest away; the shortest cable in the closest slot.
9. Run the cable end through the hole in the anchor bracket. Place a 1 inch (25 mm) round washer (PN-4902G) and two (2) hex head nuts (PN-4903G). Leave 3 inches (75 mm) of the stud beyond the nuts.
10. Place the cable in the posts the same as the line cable except the spacers for the first post are metal round spacers, or 1 inch (25 mm) diameter PVC spacers, or approved alternate (not standard spacers).

CASS™ Transition to Thrie-Beam (CTT) Thrie-beam rail panels

The system requires reduced cable post spacing, slotted 10 gauge Thrie-beam rail panels or nested 12-gauge Thrie-beam rail panels, anchor brackets, and a flared guardrail terminal.

Complete the following steps to transition the cables to Thrie-Beam (CTT):

1. Assemble the Thrie beam rail panel (PN-33922G) including the terminal. See the Drawing Section for guardrail layout.
2. Place a 5/8 inch (16 mm) flat washer (PN-3711G) on the 5/8 inch (16 mm) x 1 1/2 inches (38 mm) hex bolt (PN-3380G).
3. Place the bolt through the anchor bracket holes in the guardrail; eight (8) bolts for each bracket. The washer will be between the bolt head and the face of the guardrail.
4. Place the anchor brackets (PN-700A) to the backside of the rail panel; one bracket at the end of each slot.
5. Place a 5/8" (16 mm) hex nut (PN-3350G) on the end of each nut.
6. Tighten the nut.

7. Place the CASS™ posts or footings and posts. This will be based on the project line post assembly. See the Shop Drawing for the post spacing.
8. Place the right end threaded cable ends through the slot in the rail. The longest cable will be in the slot furthest away; the shortest cable in the closest slot.
9. Run the cable end through the hole in the anchor bracket. Place a 1 inch (25 mm) round washer (PN-4902G) and two (2) hex head nuts (PN-4903G). Leave 3 inches (75 mm) of the stud beyond the nuts.
10. Place the cable in the posts the same as for the line cable, except the spacers for the first post are metal round spacers, or 1 inch (25 mm) diameter PVC spacers, or approved alternate (not standard spacers).

CASS™ Transition to Box Beam (CTB)

Contact Trinity Highway Products for assembly instructions.

CASS™ Transition to Colorado 3F

This assembly is the same as for the Transition to W-beam.

CASS™ Bracket (CB)

The CASS™ Bracket provides a direct cable connection to a rigid barrier or wall. Contact Trinity Highway Products for assembly instructions.

Assembling Foundation Tubes or Posts when Encountering Rock

Foundation Tubes

Complete the following steps to assemble foundation tubes when encountering rock:

1. Select Option A or Option B below when encountering rock, unless there is a more restrictive state or specifying agency specification.

Option A - If rock is encountered and 9 inches (229 mm) or less of the full length foundation tube remains to be embedded.

- A. Drill a 12 to 16 inch (300 mm to 400 mm) diameter hole into the rock.
- B. Drill the hole 3 inches (75 mm) deeper than the required embedment depth.
- C. Fill the hole with 3000 psi (21 MPa) concrete.
- D. Place the foundation tube and rebar ring per the “Sleeve in a Concrete Footing (Poured Footing)” section.

Option B - If rock is encountered and more than 9 inches (229 mm) of the full length foundation tube remains to be embedded.

- A. Drill a 12 to 16 inch (300 to 400 mm) diameter hole into the rock. The minimum depth to the bottom of the hole from the ground line shall be 21 inches (533 mm). The 21 inches (533 mm) includes 3 inches (76 mm) below the tube.
- B. Cut off the bottom end of the foundation tube so the top of the tube will be flush with finished ground.
- C. Fill the hole with 3000 psi (21 MPa) concrete.
- D. Place the foundation tube and rebar ring per the “Sleeve in a Concrete Footing (Poured Footing)” section.

Foundation Tubes with Soil Plates

Complete the following steps to place foundation tubes with soil plates when encountering rock:

1. Select Option A or Option B below when encountering rock, unless there is a more restrictive state or specifying agency specification. For each option, remove the soil plate from the sleeve or deploy a sleeve without a soil plate.

Option A - If rock is encountered and 9 inches (229 mm) or less of the full length foundation tube remains to be embedded.

- A. Drill a 12 to 16 inches (300 to 400 mm) diameter hole into the rock.
- B. Drill the hole 3 inches (76 mm) deeper than the required embedment depth.
- C. Fill the hole with 3000 psi (21 MPa) concrete.
- D. Place the foundation tube and rebar ring per the "Sleeve in a Concrete Footing (Poured Footing)" section.

Option B - If rock is encountered and more than 9 inches (229 mm) of the full length foundation tube remains to be embedded.

- A. Drill a 12 to 16 inches (300 to 400 mm) diameter hole into the rock. The minimum depth to the bottom of the hole from the ground line shall be 21 inches (533 mm). The 21 inches (533 mm) include 3 inches (76 mm) below the tube.
- B. Cut off the bottom end of the foundation tube so the top of the tube will be flush with finished ground.
- C. Fill the hole with 3000 psi (21 MPa) concrete.
- D. Place the foundation tube and rebar ring per the "Sleeve in a Concrete Footing (Poured Footing)" section.

Driven Posts

Complete the following steps to place foundation tubes with soil plates when encountering rock:

1. Select Option A or Option B below when encountering rock, unless there is a more restrictive state or specifying agency specification. For each option, remove the soil plate from the sleeve or deploy a sleeve without a soil plate.

Option A - If rock is encountered and 9 inches (229 mm) or less of the full length foundation tube remains to be embedded.

- A. Drill a 6 to 8 inches (152 to 203 mm) diameter hole into the rock.
- B. Drill the hole deep enough so that the height of the deployed post is 3'10" (1 m) from the finished grade.
- C. Place the post into the hole. Backfill the hole with compactable materials in 6 inch (150 mm) lifts and compact with pneumatic equipment to optimum compaction.

Note: If compactable, the material removed from the hole may be used for backfill.

Option B - If rock is encountered and more than 9 inches (229 mm) of the full length foundation tube remains to be embedded.

- A. Drill a 6 to 8 inch (152 to 203 mm) diameter hole 18 inches (229 mm) into the rock.
- B. Cut off the bottom end of the post so the top of the post above grade is 3'10" (1 m) from the finished grade.
- C. Place the post into the hole. Backfill the hole with compactable materials in 6 inch (150 mm) lifts and compact with pneumatic equipment to optimum compaction.

Note: If compactable, the material removed from the hole may be used for backfill.

CRP Stub Posts (1X to 3)

Complete the following steps to place foundation tubes when encountering rock:

1. Select Option A or Option B below when encountering rock, unless there is a more restrictive state or specifying agency specification.

Option A - If rock is encountered and 30 inches (762 mm) or less depth is required to complete the assembly of the full hole (60 inches deep (1524 mm)):

- A. Drill an 18 inch (457 mm) diameter hole into the rock.
- B. Place the rebar cage and bottom CRP stud. See the CASS™ Cable Terminal (CCT)/Concrete Footing section for the placement of the rebar cage and the CRP stud.
- C. Fill the hole with 3000 (21 MPa) psi concrete.

Option B - If rock is encountered and more than 30 inches (762 mm) is required to complete the placement of the full rebar cage:

- A. Drill an 18 inch (457 mm) diameter hole 33 inches (838 mm) into the rock.
- B. Cut off the rebar cage so there will be 3 inches (75 mm) of concrete below the cage. See the CASS™ Cable Terminal (CCT)/Concrete Footing section for the placement of the rebar cage and the CRP stud.
- C. Fill the hole with 3000 (21 MPa) psi concrete.

Cables

The cables used in the CASS™ systems are pre-stretched or standard. They are supplied on reels, either precut with factory applied fittings or continuous length to be cut in the field with field applied fittings attached. The reels can be supplied with 2000 to 3000 feet (610 to 914 m) of cable on each reel.

Pre-stretched cables require a turnbuckle every 1000 feet (305 m) or less, and standard cables require a turnbuckle every 750 feet (229 m) or less.

The precut cables have a factory applied fitting on each end. One end has a right-hand fitting and the other end has a left-hand fitting. The cables are placed on the reel with the left-hand fitting placed on the reel first. The right-hand fitting ends are painted red and should be the first end removed from the reel. There will usually be more than one cable length to a reel, so the first right-hand fitting end (painted red) removed from the reel will have a yellow mark on it.



Caution: It is important that the end with the yellow mark be removed first.

For cable runs longer than 1000 feet (305 m) (pre-stretched cable) or 750 feet (229 m) (standard cable); a short length of cable will be required to complete the system. These lengths can be precut with a factory applied fitting (right-hand fitting) on one end, or the lengths can be cut from a continuous reel and field applied fitting attached to one end.

Cable Splices

There are three types of cable splices that can be made.

- Shop applied fittings with a turnbuckle.
- Field applied fittings with a turnbuckle.
- Shop applied fitting/field applied fitting with a turnbuckle.
- Cable splice with no turnbuckles.

Shop Applied Fittings with Turnbuckle

1. To make a shop applied splice, one of the two cable ends must have a fitting with right-handed threads and the other cable must have a fitting with left-handed threads. Place a mark 1 1/2 inch (37 mm) from the end of each fitting. On one threaded end place a 1 inch (25 mm) turnbuckle (PN-5826G). The turnbuckle should be attached where it is held on the threaded end by only a couple of threads.
2. Place the other threaded end in the turnbuckle.
3. Prevent the two threaded ends from rotating while turning the turnbuckle so that the threaded ends are into the turnbuckle beyond the 1.5 inch (37 mm) mark. Before tensioning, the turnbuckles should be checked to make sure no marks are showing. See Figure 9 for the completed assembly.



Figure 9 Cable Splice with Turnbuckle

Field Applied Fittings with Turnbuckle

There are two situations where a field applied fitting will be used: either when a fitting is required to complete an assembly; or when no shop applied fittings are used and field applied fittings are needed to make all of the cable connections.

Perform the following steps to complete a splice using a field applied fitting and a turnbuckle:

1. Make sure that the cable has a clean square cut by using a saw with an abrasive blade or an electric band saw.
2. Insert the cut end of the cable into the field casting (PN-3022G) through the triangular end.
3. With the cable inside the casting, separate the cable with two flathead screwdrivers so the tapered triangular wedge (PN-4199B) can be inserted.
4. Insert the wedge into the cable with the smaller diameter end towards the triangular hole. Make sure the wedge is pushed 1/2 inch (13 mm) beyond the end of the cable (plus or minus 1/8 inch (3 mm)).

Note: All three bundles of the cable are to be located in the appropriate grooves of the wedge.

5. Once the wedge is inserted, use a hammer and drift pin to seat the wedge by hitting on the triangular end of the casting. Several hits should be made to seat the wedge.
6. A 1 inch (25 mm) heavy hex nut (PN-3908G) has to fit inside the housing. Once the wedge has been seated, check to make sure the nut will fit. If it will not, reseal the wedge.
7. After the wedge is properly seated, one (1) wire of the cable must be bent over the end of the wedge.
8. Insert the 1 inch (25 mm) heavy hex nut in the housing.
9. Place the left-hand threaded stud (PN-5909G) or right-hand threaded stud (PN-5910G) in the housing and into the nut. Screw the stud into the nut until it will not go any further. Several threads of the stud must show beyond the nut.
10. With the field applied fitting attached, follow the steps for a shop applied fitting to connect the two cables with a turnbuckle.

Torpedo Cable Splice

When two cable ends need to be spliced together other than where a splice with a turnbuckle is required, a Torpedo Cable Splice would be required. The Torpedo Cable Splice (PN-4099G) is made up of two Cable Terminal Pieces, one of which has threads on it, a threaded ring, and two triangular wedges.

Perform the following steps to complete a splice:

1. Make sure that the cable has a clean square cut by using a saw with an abrasive blade or an electric band saw.
2. Insert the cut end of the cable through the triangular end of the Cable Terminal Piece with the threads.
3. With the cable through the casting, separate the cable with two flathead screwdrivers so the tapered triangular wedge (PN-4199B) can be inserted.
4. Insert the wedge into the cable with the smaller diameter end towards the triangular hole. Drive the wedge into the Cable Terminal Piece so it is just inside the housing and the cables extended 1/2 inch to 3/4 inch (13 mm to 19 mm) beyond the end of the housing.
5. Bend one (1) wire of the cable over the end of the wedge.
6. Using the edge of the housing as a guide, cut off the remaining twenty (20) wires.

Note: Care should be taken to not nick the bent wire.

7. Place the threaded ring on the other cut cable with the threads facing the end of the cable.
8. Insert the cut end of the cable through the triangular end of the other Cable Terminal Piece.
9. With the cable through the casting, separate the cable with two flathead screwdrivers so the tapered triangular wedge (PN-4199B) can be inserted.
10. Insert the wedge into the cable with the smaller diameter end towards the triangular hole. Drive the wedge into the Cable Terminal Piece so it is just inside the housing and the cables extended 1/2 inch to 3/4 inch (13 mm to 19 mm) beyond the end of the housing.
11. Bend one (1) wire of the cable over the end of the wedge.
12. Using the edge of the housing as a guide, cut off the remaining twenty (20) wires.

Note: Care should be taken to not nick the bent wire.

13. Place the two Cable Terminal Pieces together and connect them together with the threaded ring. Tighten the connection with a pipe wrench.

Note: No more than two threads should be shown after the connection.

Laying Out the Cable / Attaching the Cables to the Posts

The cable will be either precut lengths or length from a cable reel. The method of laying out the cable will be determined by the contractor. The cables can be laid out one cable at a time or all four at the same time. The Trinity Highway Products Shop Drawings should be used to determine what cables need to be used.

Complete the following steps for laying out the cable and attaching the cables to the posts:

1. Using the Trinity Highway Products Shop Drawings for the cable run to select the cable needed to complete the assembly.
2. Attach the right threaded end of the cable to the terminal, CWT or Anchor cables. Use the shop-applied fitting with a turnbuckle method or field-applied fittings with a turnbuckle to make the connection. Make sure the top, middle two and bottom cables are identified.
3. Place the bottom cable on the back side of the post. The cable is attached to the post with cable lock bolt (PN-4225G). The cable lock bolt is placed around the cable, with the opening of the bolt down. Insert the bolt in the hole in the post. Secure the bolt to the post with a hex nut (PN-3245G).
4. Place the bottom middle cable on the front side of the post. The cable is attached to the post with cable lock bolt (PN-4225G). The cable lock bolt is placed around the cable, with the opening of the bolt down. Insert the bolt in the hole in the post. Secure the bolt to the post with a hex nut (PN-3245G).
5. Place the top middle cable in the post slot. Before placing the top cable, place a black spacer (PN-5700B) or reflective spacer (PN-5701B yellow or PN-5702B white) on top of the cable (See Figure 11).
6. Place the top cable on top of the spacer. Place a post strap (PN-105202T) on the post (See Figure 12).

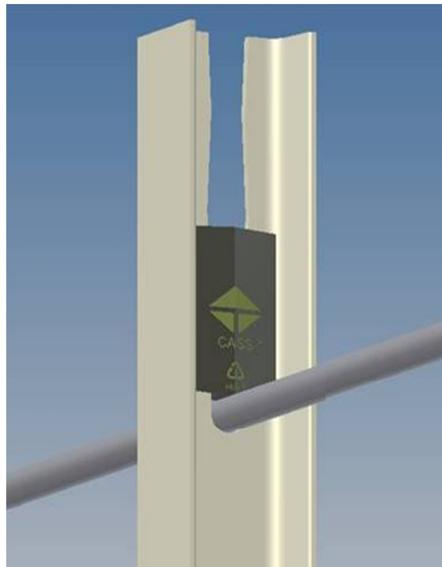


Figure 10 Bottom Cable and Spacer Assembled



Figure 11 Top Cable, Spacer, and post Steel Strap Assembled

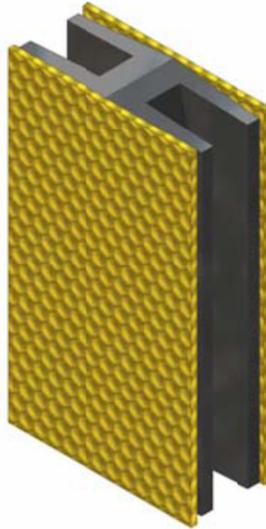


Figure 12 Reflective Sheeting on Spacer

Tensioning and Tension Meter

After all of the cables have been placed in the posts, tensioning can take place. The tension placed on the cables is to be determined by the air temperature or cable temperature at the time of tensioning. An accurate thermometer needs to be on-site at the point of tensioning to obtain the correct air temperature. If there is a reason to believe that the cable temperature will be different than the air temperature, the temperature of the cable should be obtained by infrared means and the cable temperature used. See the CASS™ Temperature and Tension Chart for the tension requirements.

The means of placing tension on the cable will be determined by the contractor. Whatever means is chosen, it should assure that the anticipated tension from tension chart can be obtained.



Important: Review completely the manufacturer's manual included with the tensioning meter prior to tensioning of the cable

Completed the following steps to tension the cables:

1. Check the cable run to see if any of the turnbuckles will pass from one side of the post to the other during the tensioning process. If they will, pull the post for the tensioning process. Also check the fitting marks at each turnbuckle to make sure no marks are showing.
2. The tensioning of the cable will be at the end that has not been connected to the CCT, CTW, or Anchor Cables.
3. For cable runs of 3000 feet (914 m), the cable should be pulled every 3000 feet (914 m) to remove the slack from the cable.

Note: Start tensioning from the bottom cable to the top cable

4. The cable is pulled using the means selected by the contractor, a cable gripper to hold the cable, and the required tension from the tension chart.



Warning: Extreme care should be taken to ensure that the cable gripper is attached to the cable in such a location that if it slips, the chain or gripper will not hit the workers. It is suggested that the pulling equipment is placed between the workers and the cable gripper

5. With the required tension on the cable, place a mark on the cable where it meets the threaded end of the CCT, CTW, or Anchor cable.
6. Release the tension on the cable. Go back approximately 28 inches (711 mm) from the mark and cut the cable.
7. Place a field applied fitting using the procedures in the Field Applied Fittings with a Turnbuckle section. The threaded rod used will need to have right-handed threads.
8. On the CCT, CTW, or Anchor cable end, place a 1 inch (25 mm) turnbuckle (PN-5826G). The turnbuckle should be attached where it is held on the threaded end by only a couple of threads.
9. Place tension back on the cable. The cable should be pulled until the second cable is connected to the turnbuckle. With both cables inserted in the turnbuckle, the turnbuckle should be turned until the ends of both threaded rods can be seen in the sight holes of the turnbuckle.
10. With the cables connected, release the cable gripper from the cable. The tension of the cable should be checked. If a higher tension is needed, the turnbuckle should be rotated while the cables are restrained from twisting.
11. Replace any posts removed during the tensioning process. If a turnbuckle falls where there is a post, or if the turnbuckle is 1 foot (304 mm) from the post, replace the post with a straight cut notch post (PN-34049G).
12. Two to three days after this tensioning, the cable tension should be checked and recorded at each turnbuckle. If adjustment is needed to meet the tension on the tension chart, the turnbuckle(s) should be adjusted. It is suggested that the tension recorded be set between 600 to 800 lbs. (272 to 363 kg) above the tension on the tension chart.

Delineation

The specifying agency should establish the criteria as to delineation of the posts. The delineation will be provided on the spacer used to separate the cables.

It is suggested for the terminal CRP that reflective sheeting be affixed to delineate them, which could help to reduce some accident impacts. It is recommended that all of the posts be delineated. The minimum is to delineate the four (4) CRP on the approach side of the approach terminal and CRP-3 on the approach side of the departing terminal.

Repairs

After an impact, the system will require repair. Impact testing conducted in conformance with NCHRP Report 350 indicates that the cable will typically maintain its original height and may be able to withstand additional hits. Even with this capability, it is recommended that the system be repaired as soon as possible by the appropriate state or specifying agency.

After most impacts, the system can be repaired in a relatively short period of time. Any part or parts which appear broken, worn, torn, and/or damaged must be replaced. Additional specific parts of the CASS™ system, which must be replaced in order to bring the system back into full service, is a decision that must be made by the appropriate state or specifying agency.

An impact that encounters a CASS™ Cable Terminal (CCT) may require re-tensioning of the entire run of cable. After repairing the cable, the tension throughout the system should be checked.

It is recommended that for impacts with vehicles larger than those used in the NCHRP Test Level 3 or Test Level 4 be checked to determine if it needs to be re-tensioned.

Repair for System Impact (CCT Not Damaged)

If an impact occurs and the CASS™ Cable Terminal (CCT) is not involved, usually only the posts will have to be replaced and the cables re-inserted in the posts. The following steps should be followed in making this repair:

Depending on the severity of the impact, after the repair, the cable might have to be re-tensioned. If the cable is standard and has been attached less than two years, the tension on the cable should be checked with the tension meter and adjustments made at the turnbuckles to bring the cable to the correct tension based on either the ambient air temperature and values on the CASS™ System Temperature / Tension chart.

1. Inspect the damaged system and determine what material will be required to make the repairs.
2. Remove the damaged posts. They should come out of the sockets easily. During very cold weather and in Northern climates, the post may become frozen into the socket. Successful means of extraction have utilized propane torches or a hammer drill to break-up the ice. Calcium chloride (a common deicing chemical) can also be mounded over the top of the ice for 24 hours prior to removal of the post. As always, wear appropriate safety equipment such as gloves and safety goggles during post removal. If the posts are driven, they will have to be pulled out of the ground.
3. Place new posts in place of damaged ones.
4. Place the bottom cable on the back side of the post. Attach the cable to the post with the appropriate “J” bolt and nut. The “J” part of the bolt needs to be pointed down.
5. Place the next cable up from the bottom on the traffic side of the post. Attach the cable to the post with the appropriate “J” bolt and nut. The “J” part of the bolt needs to be pointed down.
6. Place the next cable in the post slot.
7. Place the CASS™ system spacer above the cable.
8. Place the top cable in the post slot.
9. Place the stainless steel strap on the post above the top cable.

Note: The reflective sheeting may be placed on the spacer for the CASS™ system based on the agency’s specification.

Repair for CCT Impact (CRP not Involved)

When the cable has been impacted and the Controlled Released Posts (CRP) of the CCT are not involved, the following steps should be followed:

1. Remove the damaged posts.
2. Replace new terminal line post(s) that need to be replaced.
3. Attach the cables to the new terminal line posts. Refer to the Cables Section for the replacement of cables.
4. Check the cable tension at turnbuckle downstream from the CCT to ensure that the tension is within tolerances.

Repair for CCT Impact (CRP Involved)

When the cable has been impacted and the Controlled Release Posts (CRP) of the CCT are involved, the following steps should be followed:

1. For the CRPs that have been impacted, inspect the top and bottom post for damage. Repair or replace any damaged posts.
2. Remove the turnbuckles that connect the terminal cables to the line cables that have been released from the CR posts.
3. Bolt the top CRP with the bottom CRP. Refer to the CASS™ Cable Terminal (CCT) section for the replacement of the CRP.
4. Replace new terminal line posts that are damaged.
5. Attach the cable to the CRP and terminal line posts. Refer to the Terminal Cables Section for the replacement of cables.
6. The CCT cables and line cables released in Step 2 should be reconnected. The cables can be connected by the use of a backhoe, come-along, or other mechanical means.
7. Check the cable tension at the CCT turnbuckle and downstream from the CCT to ensure that the tension is within tolerances.

Repair for Cable Transition to W-Beam (CTW) or Rail Elements

When an impact occurs with rail elements that have a Cable Transition to W-Beam (CTW) connected to them and the impact is more than 200 feet (61 m) from the transition, the damaged guardrail system can be repaired by completing the normal guardrail procedures.

When the impact occurs within 200 feet (61 m) of the transition and only posts are damaged and need to be replaced, the repair procedures below should be followed:

1. Before the rail splice bolts are removed, secure the guardrail system to prevent the posts from leaning over when the panels are removed. This may be done by the use of a come-along or other mechanical means.
2. Once the posts are secured, the rail panels or posts can be removed and replaced by following the normal guardrail procedures for guardrail repair.
3. After the rail panels are replaced, the devices used to secure the guardrail system can be loosened and removed.

If the rail panels of the CWT are damaged, the repair procedures below should be followed:

1. Place a mark on the fittings at the end of the turnbuckles and at the anchor bracket cable end.
2. Release the tension on the cables at the turnbuckle and remove the cable from the anchor brackets.
3. Replace the rail panels and posts as needed.
4. Place the cables in the brackets and replace the removed nuts. The nuts placed on the fittings should be located on the mark made before removing them.
5. The cables should be re-tensioned by connecting the cable fittings to the turnbuckles. Insert fittings into the turnbuckles to the mark before doing the un-tensioning.
6. Re-check the tension at each turnbuckle as necessary.

Emergency Repairs

There could be an occasion when an accident could cause significant traffic congestion, or the cable can be entangled with the vehicle. Whenever a vehicle is entangled in the cable, the first step that must be undertaken is to move or drive the vehicle as close to the centerline of the cable system as a feasible, in order to reduce tension. Here are some suggestions on how to get traffic moving or the cable untangled:

Road Blocked Due to an Accident

To resume traffic flow after an accident or to get emergency vehicles access to the accident site, crossover access through the cable may be necessary. To provide this access, remove cables from several posts upstream and downstream of the desired opening. The opening width can be adjusted by removing posts from the ground sleeves. The cable can be held down and the traffic or emergency vehicles can pass over it.

In life threatening or emergency situations the cable can be cut. If the cable was put under addition tension due to the accident, the tension can be reduced at the turnbuckles closest to the impact. The threads outside of the turnbuckle must be marked, and the turnbuckle backed off no more than 3/4 inch (17 mm).

To reduce the amount of the cable damage during cutting, duct tape must be wrapped around the cable and the cut made through the tape. Some agencies have also cut through the turnbuckle itself. This will reduce the maintenance/repair effort. When cutting through a turnbuckle, make sure that all posts, both upstream and downstream for a distance of 50' (15 m), are removed in order to prevent turnbuckle or fitting interference.

The cut cable will back away a short distance from the person doing the cutting. Safety measures such as protective gloves, safety goggles, and mask must always be used. No personnel must be standing either upstream or downstream from the point of the cut.

Removing Entangled Cable from a Vehicle

When the cable is entangled with a vehicle that must be towed away, remove the entangled cable by lifting one or more of the cables up over the vehicle. During this operation, if any of the line posts entangled with the cable start to lift up out of the sleeves, the lifting should be stopped and the posts removed from the cable. Once the posts are removed, the cable can be lifted up over the vehicle.

In addition, if the entangled vehicle is located near the CASS™ Cable Terminal end, it is possible to reduce tension by backing off the two large 1 inch (25 mm) nuts on the terminal cable end.

DO NOT REMOVE THE NUTS!

Repairing a Cut or Damaged Cable

Following are various methods to repair cables that have been cut or damaged:

Method 1 – Splicing the Cable

Splicing the cable may be necessary if a cable is cut or damaged during an impact, which is rare. The length of the cable must be 50 feet (15 m) or longer to make the splice.

1. Re-cut the ends of the cable to ensure the ends are clean and smooth.
2. Refer to the Cable Splices Section when making a cable splice connection.
3. If an accurate length of cable is used for the splice section, two cable splice connectors will be required to connect the cables together.
4. Connect one end of the splice cable to one end of the cut cable with a connector.
5. Apply another connector to the other end of the splice cable and the end of the cut cable.
6. Assemble the cable splice connector using a backhoe or other mechanical means.
7. Check the tension on the cable with the tension meter and adjust the turnbuckles to bring the cable to the correct tension based on the ambient air temperature or the cable temperature and the values on the CASS™ System Temperature / Tension Chart.

Note: If the cable splice has been cut accurately, the tension may be obtained by turning the turnbuckles at each side of the cut.

If the tension cannot be obtained at the turnbuckles at each side of the splice, it may be necessary to re-tension the cable at the end of the cable run where the field splice was made. The field splice should be removed, cable measured, cut, and re-connected with the correct tension. Follow the procedures in the Tension and Tension Meter Section when re-tensioning. Some assemblies may have field splices at all locations. If this is the case, the measuring, cutting, and re-connecting can be done at any location.

Method 2 – 5-Foot (1.5 m) Section

A second method to reconnect the cables is to use a 5 foot (1.5 m) section of cable with factory applied fittings on each end. This method will also require two turnbuckles and a left-hand and right-hand threaded fitting to complete the connection.

1. Remove 9'8" (2.9 m) of cable from the cut cable.
2. Connect the threaded fittings and the cable ends connections per the Shop Applied Fittings with Turnbuckle Section.

Method 3 – Other Than 5 Foot (1.5 m) Cable

When using a cable length other than 5 feet, the amount of cable removed from the cut cable should be adjusted based on the cable length removed.

1. If the length of cable used is less than 5 feet (1.5 m), remove less than 9'8" (2.9 m) of cable from the cut cable.
2. If more than 5 feet (1.5 m) of cable is used, remove more than 9'8" (2.9 m) of cable from the cut cable.
3. To help to determine the amount of cable to be removed, after the threaded fittings are placed on the piece of splice cable, take a measurement from end-of-fitting to end-of fitting. Take this measurement and add 4'6" (1.3 m) and this will be the amount of cable to be removed from the cut cable.

Method 4 – Use of Fitting Connections Only

If the damaged cable, after cutting, is less than a total of 4'6" (1.3 m), the connection can be made with a left and right threaded fitting and a turnbuckle.

1. Remove 4'6" (1.3 m) of cable from the cable run.
2. Place a left-hand threaded fitting on one end of the cut cable and right-hand threaded fitting on the other end of the cut cable.
3. Follow the procedures in the Field Applied Fittings with Turnbuckle Section.
4. Check the tension on the cable with the tension meter and adjust the turnbuckles to bring the cable to the correct tension based on the ambient air temperature or the cable temperature and the values on the CASS™ System Temperature / Tension Chart.

Trinity Highway Products, LLC
 Cable Safety System (CASS™)
CASS™ TENSIONING LOG FORM

PROJECT NAME: _____

RUN: _____ WEATHER: _____

STA. _____ TO STA. _____

INITIAL TENSION

TENSION RECHECK

DATE: _____

DATE: _____

TURNBUCKLE STATION: _____

CABLE	CABLE TEMP	CHART LOAD	MEASURED LOAD	CABLE TEMP	CHART LOAD	MEASURED LOAD
B	_____	_____	_____	_____	_____	_____
MB	_____	_____	_____	_____	_____	_____
MT	_____	_____	_____	_____	_____	_____
T	_____	_____	_____	_____	_____	_____

TURNBUCKLE STATION: _____

CABLE	CABLE TEMP	CHART LOAD	MEASURED LOAD	CABLE TEMP	CHART LOAD	MEASURED LOAD
B	_____	_____	_____	_____	_____	_____
MB	_____	_____	_____	_____	_____	_____
MT	_____	_____	_____	_____	_____	_____
T	_____	_____	_____	_____	_____	_____

RECORDED BY: _____ RECORDED BY: _____

CASS™ System Temperature and Tension Chart (A)

Pre-Stretched Cable		Standard Cable	
°F	Tension (lbs)*	°F	Tension (lbs)
-15	7500	-15	8800
-10	7300	-10	8600
-5	7100	-5	8400
0	7000	0	8200
5	6800	5	8000
10	6600	10	7800
15	6500	15	7600
20	6300	20	7400
25	6100	25	7200
30	6000	30	7000
35	5800	35	6800
40	5600	40	6600
45	5500	40	6400
50	5300	50	6200
55	5100	55	6000
60	5000	60	5800
65	4800	65	5600
70	4600	70	5400
75	4500	75	5200
80	4300	60	5000
85	4100	85	4800
90	4000	90	4600
95	3800	95	4400
100	3600	100	4200
105	3500	105	4000
110	3300	110	3800
115	3100	115	3600
120	3000	120	3400
125	2800	125	3200
130	2700	130	3000
135	2600	135	2900
140	2500	140	2700
145	2400	145	2500
150	2300	150	2400
160	2100	160	2200
170	1900	170	2000
180	1700	180	1800
190	1500	190	1600
200	1300	200	1400

- Tolerance: -200 to + 800 pounds

CASS™ System Temperature and Tension Chart (B)

Pre-Stretched Cable		Standard Cable	
°C	Tension (kg)*	°C	Tension (kg)
-26	3402	-26	3992
-23	3311	-23	3901
-21	3220	-21	3810
-18	3175	-18	3719
-15	3084	-15	3629
-12	2994	-12	3538
-9	2948	-9	3447
-7	2858	-7	3357
-4	2767	-4	3266
-1	2722	-1	3175
2	2631	2	3084
4	2540	4	2994
7	2495	7	2903
10	2404	10	2812
13	2313	13	2722
16	2268	16	2631
18	2177	18	2540
21	2087	21	2449
24	2041	24	2359
27	1950	27	2268
29	1860	29	2177
32	1814	32	2087
35	1724	35	1996
38	1633	38	1905
41	1588	41	1814
43	1497	43	1724
46	1406	46	1633
49	1361	49	1542
52	1270	52	1451
54	1225	54	1361
57	1179	57	1315
60	1134	60	1225
63	1089	63	1134
66	1043	66	1089
71	953	71	998
77	862	77	907
82	771	82	816
88	680	88	726
93	590	93	635

- Tolerance: -91 to + 363 kilograms

Appendix – Drawings

<u>Drawing</u>	<u>Page</u>
Shop Drawing	43
Cable Flare Assembly 30:1 Flare	44
Cable Barrier Overlap	45

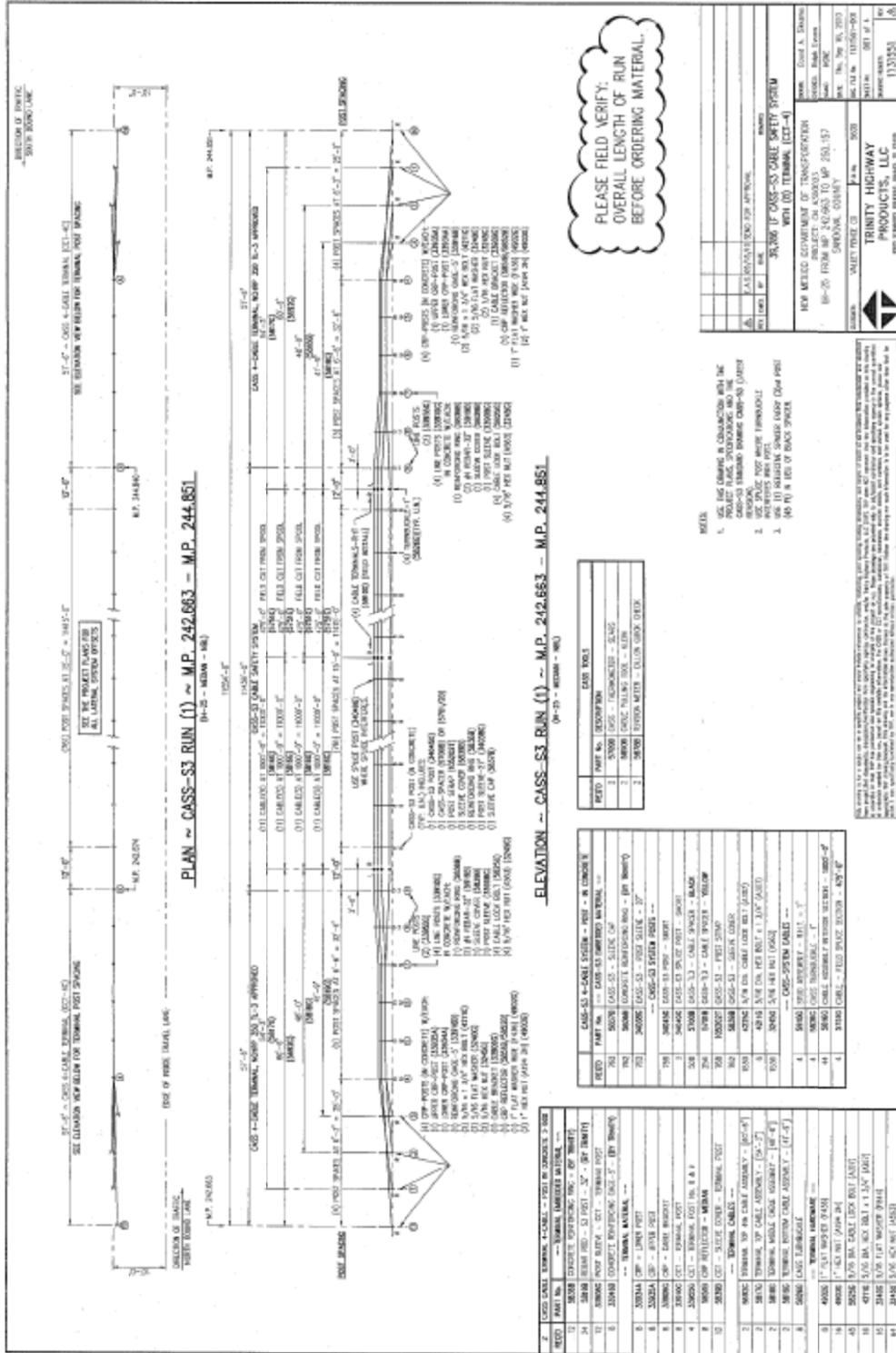
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Please download the updated drawings from the Trinity Highway Products website at: <http://www.highwayguardrail.com>.

Contact your Trinity Highway Products Representative for Drawings

<u>CASS™ Terminal, Anchor, and Transition Drawings</u>	<u>Drawing No.</u>
Terminal (CASS™)	CCT
CASS™ Anchor (CASS™)	CCA
Approach Transition-Cable to W-Beam (CTW CASS™)	CTWA
Departure Transition-Cable to W-Beam (CTW CASS™)	CTWD
Approach Transition-Cable to Thrie Beam (CTW CASS™)	CTTA
Departure Transition-Cable to Thrie Beam (CTT CASS™)	CTTD
Approach Transition-Cable to Box Beam-New (CTB CASS™)	CTBAN
Approach Transition-Cable to Box Beam-Existing (CTB CASS™)	CTBAE
Departure Transition-Cable to Box Beam (CTB CASS™)	CTBD
Cable Bracket (CB CASS™)	CB
Approach Transition-Cable to Colorado 3F (CTC3F)	CTC3FA

Shop Drawings

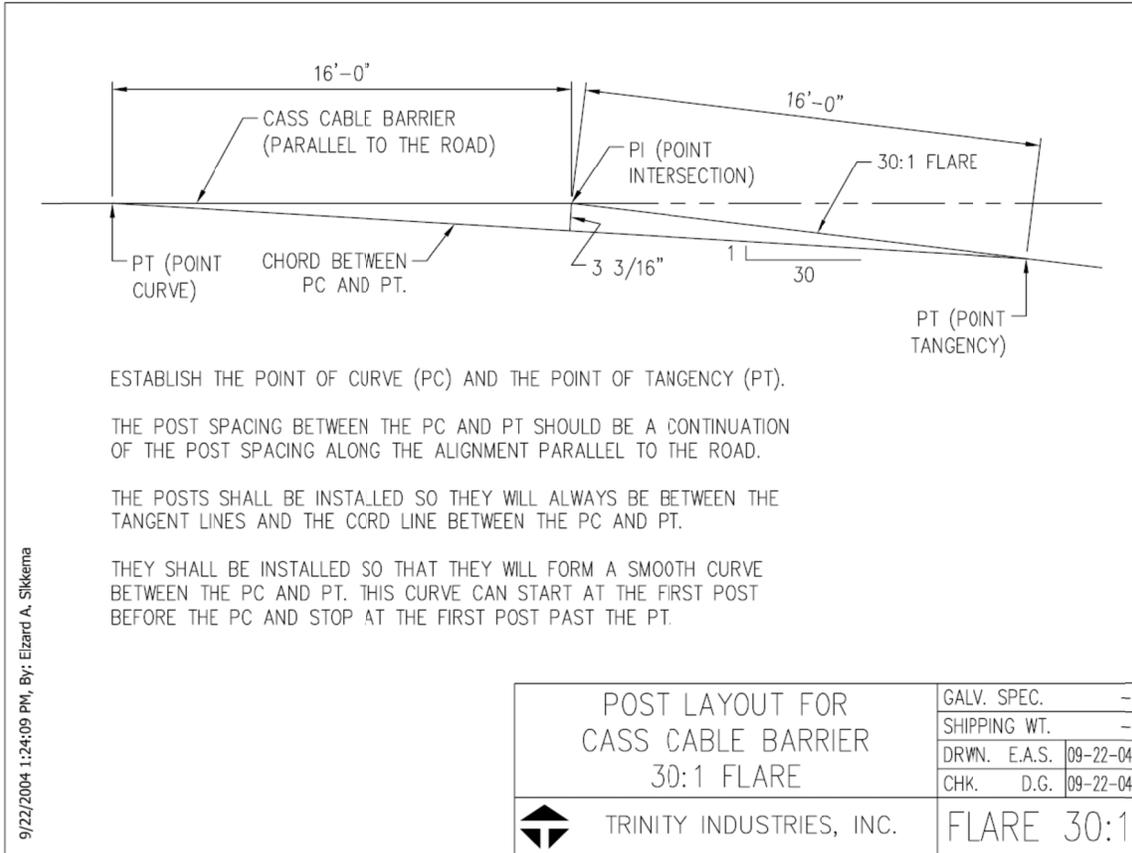


DWG 1537554

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Cable Flare Assemblies

30:1 Flare



Cable Barrier Overlap

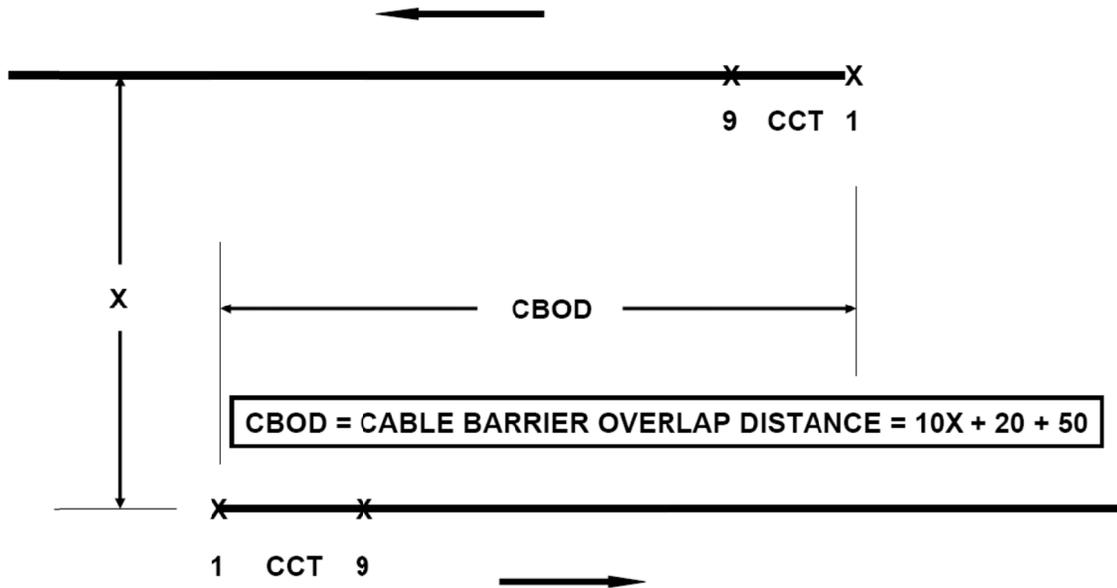


Figure 13 Cable Barrier Overlap

Use the cable barrier overlap distance calculated by the use of the CBOD formula.

If the CBOD is greater than 370' (112.8 m), use 370' (112.8 m).

Table of Figures

Figure 1 Post Sleeves.....	10
Figure 2 Post Sleeve Cover.....	12
Figure 3 Plate Mounted Post.....	12
Figure 4 CRP Layout.....	14
Figure 5 CRP Footing Detail.....	14
Figure 6 Bearing Angles for Post.....	17
Figure 7 Placement of the Cable Lock Bolt.....	18
Figure 8 CASS™ Cable Anchor (CCA).....	20
Figure 9 Cable Splice with Turnbuckle.....	27
Figure 10 Bottom Cable and Spacer Assembled.....	30
Figure 11 Top Cable, Spacer, and post Steel Strap Assembled.....	30
Figure 12 Reflective Sheeting on Spacer.....	31
Figure 13 Cable Barrier Overlap.....	45



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