VALTIR

CASS® S3 4:1

With CASS® End Terminal (CET™)

PRODUCT MANUAL

PN 119836B
MAY 2025

CASS® S3 4:1
Cable Safety System
With CASS® End Terminal

The CASS® S3 4:1 Cable Safety System ("CASS® S3") has been tested to National Cooperative Highway Research Program ("NCHRP") Report 350 criteria and to American Association of State and Highway Transportation Officials ("AASHTO") Manual for Assessing Safety Hardware ("MASH"), 1st Edition-2009 criteria, has been deemed eligible for Federal-aid reimbursement on the National Highway System ("NHS") by the Federal Highway Administration ("FHWA"). See information within this manual on specific post spacings and slope requirements.

CASS® End Terminal ("CET™") has been tested to AASHTO MASH, 2nd Edition-2016 with 2020 Errata criteria, has been submitted to the FHWA for an Eligibility Letter for Federal-aid reimbursement for use on the NHS.

Production Description
Assembly Manual

VALTIR

15601 Dallas Parkway
Suite 525
Addison, Texas 75001

Warning: The state/specifying agency, distributors, owners, and contractors are RESPONSIBLE for the assembly, maintenance, and repair of the CASS® S3. Failure to fulfill these RESPONSIBILITIES with respect to the assembly, maintenance, and repair of the CASS® S3 could result in serious injury or death.

Important: These instructions are for standard assembly specified by the state/specifying agency. **In the event the specified system assembly, maintenance, or repair would require a deviation from standard assembly parameters, contact a Valtir, LLC ("Valtir") representative.** This system has been submitted to the FHWA for a Eligibility Letter for Federal-aid reimbursement for use on the NHS under strict criteria utilized by that agency.

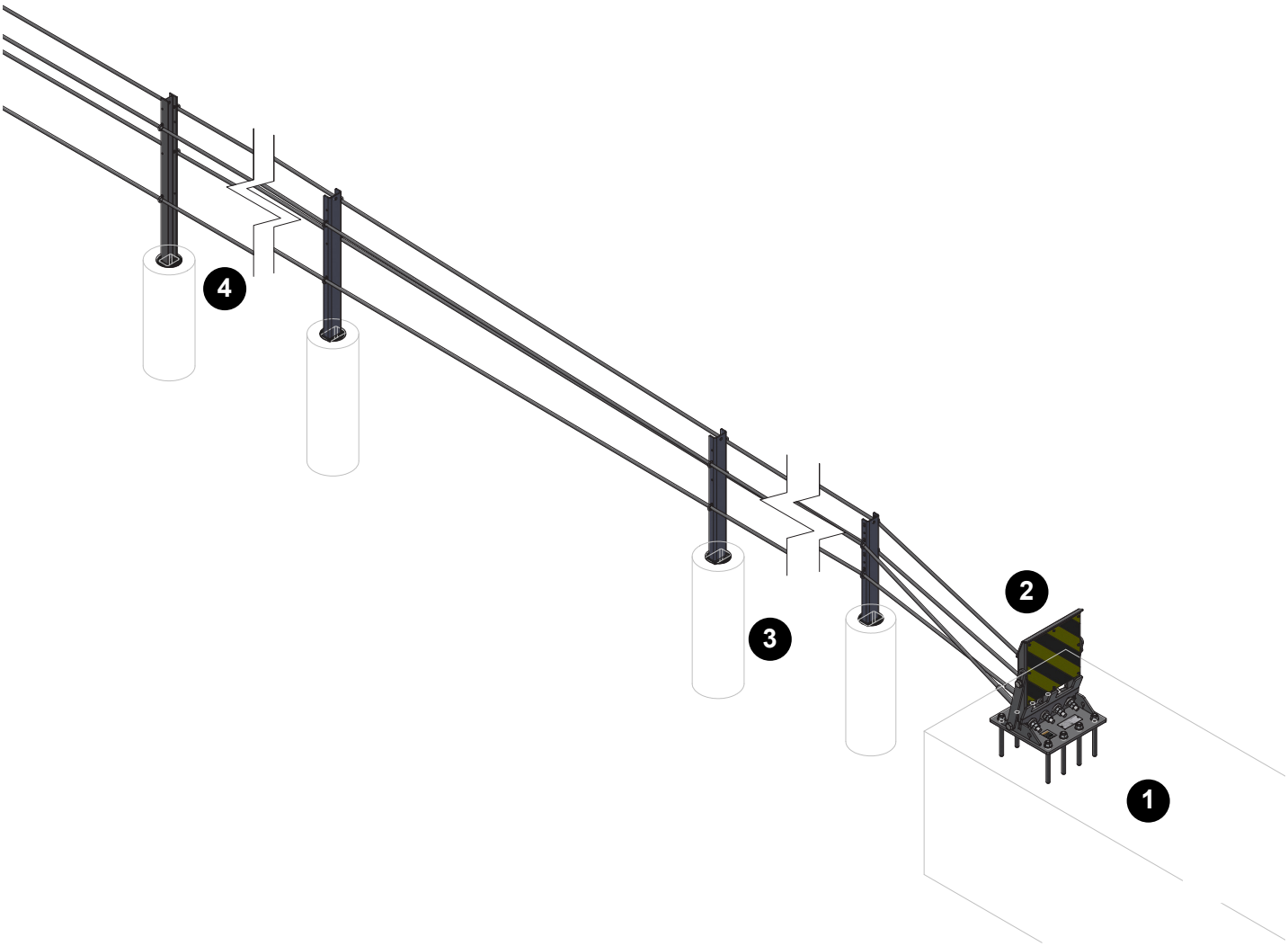
This manual must be available to the worker overseeing and/or assembling the product at all times. For additional copies, contact Valtir at (888) 356-2363 or visit Valtir.com.

The information contained in this manual supersede all previous versions. The instructions, illustrations, and specifications are based on the latest CASS® S3 information available to Valtir at publication. We reserve the right to make changes at any time. Please visit Valtir.com to confirm the latest revision.

Part No. 119836B

Revision - | May 2025

REFERENCE DRAWING: SS 2380



1	CET™ Foundation Block
2	CET™ Anchor Assembly
3	CET™ U-Shaped Posts One through Four
4	CET™ S3 SYT® Posts Five though Ten

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CASS® S3 ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
CASS® S3	The CASS® S3 4:1 Cable Safety System
CBOD	Cable Barrier Overlap Distance
CCA	CASS® Cable Anchor
CET™	CASS® End Terminal
CFR	Code of Federal Regulation
FHWA	Federal Highway Administration
MASH	Manual for Assessing Safety Hardware
MPH	Miles Per Hour
MSC	Minimum Strength Concrete
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
NHS	National Highway System
OSHA	Occupational Safety & Health Administration
PN	Valtir Product Number
PPE	Personal Protective Equipment
RDG	ROADSIDE DESIGN GUIDE 4th Edition 2011, or Latest Version
SYT®	Steel Yielding Terminal
TL-3 or TL-4	Test Level 3 or Test Level 4
VPD	Vehicles Per Day
Valtir	Valtir, LLC
1V:”x”H	Slope Measurement-1 Foot Vertical Distance to “x” Foot Horizontal Distance

Customer Service Contacts

Valtir is committed to the highest level of customer service. Feedback regarding CASS® S3, its assembly procedures, supporting documentation, and performance is always welcome. Additional information can be obtained from the contact information below:

Valtir

Telephone	(888) 356-2363 (USA) +1 214 589 8140 (International)
Contact Link	Valtir.com
Website:	Valtir.com

Valtir, LLC
15601 Dallas Parkway
Suite 525
Addison, TX 75001

Important Introductory Notes

Proper assembly of CASS® S3 and CET™ is essential to achieve the performance that has been evaluated and submitted to the FHWA for a Eligibility Letter for Federal-aid reimbursement by the FHWA per NCHRP Report 350 and to AASHTO MASH. These instructions are to be read in their entirety and understood before assembling CASS® S3 and CET™. These instructions are to be used only in conjunction with standard CASS® S3 assemblies specified by the state/specifying agency. **If you need additional information, or have questions about CASS® S3 and CET™, please contact the state/specifying agency that has planned and specified this assembly and, if needed, contact Valtir Customer Service.** This product must be assembled in the location specified by the state/specifying agency. If there are deviations, alterations, or departures from the assembly instructions specified in this manual, the device may not perform as tested.

Note: The Metric conversion from Imperial in this manual uses a soft conversion.

A set of product and project shop drawings can be supplied by Valtir. These drawings and other materials are to be reviewed and studied thoroughly by a qualified individual who is skilled in interpreting them.

Limitations and Warnings

Valtir, in compliance with NCHRP Report 350 and MASH, contracts with ISO 17025 A2LA accredited testing laboratories to perform crash tests, evaluate tests, and submit the test results to the FHWA for review.

CASS® S3 has been deemed eligible by FHWA as meeting the requirements and guidelines of NCHRP Report 350 and MASH, Test Level 3 ("TL-3") and Test Level 4 ("TL-4") as a flexible longitudinal barrier. These tests typically evaluate product performance defined by NCHRP Report 350 and MASH involving a range of vehicles on roadways. Specific details of these tests, performance and conditions can be located within the associated FHWA Eligibility Letters for CASS S3 – which are B-141F, B-232, B-232A, B-232B and B-232C. The TL-3 speed for NCHRP Report 350 and MASH is approximately 100 kph [62 mph]. The TL-4 speed for NCHRP Report 350 is approximately 80 kph [45 mph] and 90 kph [56 mph] for MASH.

The CET™ has been submitted to the FHWA in April 2025 for an eligibility letter confirming it meets the requirements and guidelines of MASH TL-3, for an end terminal. These tests typically evaluate product performance defined by MASH involving a range of vehicles on roadways, (approximately 1,100kg [2,420 lb.]) and full-size pickup trucks (approximately 2,270 kg [5,000 lb.]) at 100 kph [62 mph].

There is no matrix within MASH or NCHRP Report 350 for TL-4 End Terminals. The FHWA/AASHTO tests are not intended to represent the performance of systems when impacted by every vehicle type or in every impact condition existing on the roadway. Every departure from the roadway is a unique event.

- CASS® S3 is tested pursuant to the test matrix criteria of MASH as designated by AASHTO and FHWA and NCHRP Report 350 as designated by FHWA.
- CET™ is tested pursuant to the test matrix criteria of MASH as designated by AASHTO.

Valtir expressly disclaims any warranty or liability for injury or damage to persons or property resulting from any impact, collision or harmful contact with its products, other vehicles, or nearby hazards or objects by any vehicle, object or person, whether or not the products were assembled in consultation with Valtir or by third parties.

CASS® S3 and CET™ is intended to be assembled, delineated, and maintained within specific state and federal guidelines. It is important for the state/specifying agency the use of a highway product to select the most appropriate product configuration for site specifications.

The state/specifying agency's careful evaluation of the site layout, vehicle population type and speed, traffic direction, and visibility are some of the elements that require evaluation in the selection of a highway product. **For example, curbs could cause an untested effect on an impacting vehicle.**

After an impact with the system, all debris must be removed from the area immediately in compliance with the most applicable agency policy. The specified CASS® S3 and CET™ must be evaluated and restored to its original specified condition or replaced as the state/specifying agency determines/requires, as soon as possible. Product selection, approval, proper installation, and maintenance of any highway product is the sole responsibility of the state/specifying agency.

Safety Alert Symbols appear throughout this manual and indicate Danger, Warning, Caution or Important statements. Failure to read and follow these warnings could result in serious injury or death in the event of a vehicle impact with the system.

WARNING: Do not assemble, maintain, or repair CASS® S3 and CET™ until you have read this manual thoroughly and completely understand it. Ensure that all Danger, Warning, Caution, and Important statements within the manual are completely followed. Please call Valtir at (888) 356-2363 if you have any questions about instructions in this manual.

WARNING: Safety measures incorporating appropriate traffic control devices and personal protective equipment ("PPE") specified by the state/specifying agency must be used to protect all personnel while at the assembly, maintenance, or repair site.

WARNING: Ensure the assembly site meets all appropriate Manual on Uniform Traffic Control Devices ("MUTCD") and local standards.

WARNING: Only Valtir parts that are specified herein can be used for assembly, maintenance, or repair on CASS® S3 and CET™. Do not utilize or otherwise commingle parts from other systems, even if those systems are other Valtir 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 in the event of a vehicle impact with such an UNACCEPTED system.

WARNING: Do NOT modify the CASS® S3 and CET™ in any way.

IMPORTANT: Valtir makes no recommendation whether use or reuse of any part of CASS® S3 and CET™ is appropriate or acceptable after system impact. It is the responsibility of the state/specifying agency and its engineers to make that determination.

IMPORTANT: It is the responsibility of the owner, state/specifying agency to inspect CASS® S3 and CET™ after assembly is complete to ensure the instructions provided in this manual have been strictly followed.

Danger: It is critical that the CASS® S3 and CET™ posts are placed in suitable soil that will allow the system to fully perform in accordance with design specifications. Should you have any questions about this, please contact the state/specifying agency that specified these products at this particular location for guidance. Valtir is available for consultation with that agency.

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 in the event of a vehicle impact with the system.

Warning: It is imperative, before assembly, that the assembler/installer contact a Valtir representative and state/specifying agency engineer for special criteria for soils which do not meet or exceed MASH (or NCHRP Report 350) soil conditions. It is also recommended that you consult your own soils or structural engineer.

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: When drilling rock and/or concrete, it is the responsibility of the installer to consult Occupational Safety & Health Administration (“OSHA”) silica respiratory standard 29 Code of Federal Regulation (“CFR”) 1910.134 for debris removal and ensure compliance.

Warning: Ensure that all delineation used meets all federal, state/specifying agency specifications.

Warning: CASS® S3 shall be placed on a median or roadside 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.

To address assembly in rock, see Appendix C: Encountering Rock.

Note: Based on soil conditions at the site, ANY or ALL foundations may need larger/deeper concrete footings or larger soil plates (for driven applications) as determined by soil analysis.

General CASS® S3 Information

CASS® S3 is a 4-Cable Barrier consisting of galvanized steel S3 x 5.7# [S75 x 8kg] posts and four (4) pre-stretched 3/4” [19 mm] wire rope cables. The posts can be driven, placed in a driven sleeve, placed in a sleeve and concrete footing, placed in a sleeve in a mow strip, or base plated. A 1" [25 mm] or 3/4” [19 mm] fitting hardware can be used. The NCHRP Report 350 and MASH CASS® S3 TL-3 system can be placed on slopes 1V:4H or flatter. The NCHRP Report 350 CASS® S3 TL-4 system can be placed on slopes 1V:6H or flatter. The MASH CASS® S3 TL-4 can be placed on slopes 10:1 or flatter

The bottom two (2) cables are retained by a cable hook bolt. The top two cables are placed in a slot at the top of the post and separated with a plastic spacer. Cable heights are approximately 17.4” [440 mm], 29.5” [750 mm], 38.1” [970 mm], and 41.7” [1060 mm]. A stainless steel strap is placed around the post over the top cable.

The post spacing will be in accordance to the contract plans. The barrier is terminated either with a CET™", or a CASS® Cable Anchor (CCA). **Only use the CCA when not on the NHS or when it cannot be impacted in either direction.**

For 1V:6H or flatter slopes, a 12” [300 mm] diameter x 30” [762 mm] minimum depth concrete footing is used. For slopes steeper than 1V:6H, the footing depth is increased by 6” [150 mm]. The footing depths can be increased if the soils do not meet or exceed the NCHRP Report 350 soil conditions. Contact Valtir for these designs.

NCHRP Report 350 CASS® S3 TL-3 Applications

- Can be installed anywhere on slopes 1V:10H or flatter
- Per the AASHTO Roadside Guide (“RDG”), for slopes between 1V:6H to steeper than 1V:10H, the system cannot be placed within 1’ to 8’ [0.3 m to 2.4 m] from the ditch line.
- Per the FHWA Eligibility Letter, for slopes 1V:4H to steeper than 1V:6H, it must be installed 0’ to 4’ [0 m to 1.2 m] from the break point.
- Per the FHWA Eligibility Letter, for back slope applications, for slopes 1V:4H to steeper than 1V:6H, the installation must be a minimum of 11” [3.3 m] from the V-ditch center.
- Minimum post spacing is 10’-6” [3.15 m]; Maximum post spacing is 21’ [6.3 m].

NCHRP Report 350 CASS® S3 TL- 4 Applications

- Can be installed anywhere on slopes 1V:10H or flatter
- Per the AASHTO Roadside Guide (“RDG”), for slopes between 1V:6H to steeper than 1V:10H, the system cannot be placed within 1’ to 8’ [0.3 m to 2.4 m] from the ditch line.
- Has not been tested on slopes steeper than 1V:10H.
- Minimum post spacing is 10’-6” [3.15 m]; Maximum post spacing is 21’ [6.3 m].

MASH CASS® S3 TL-3 Applications

- Can be installed anywhere on slopes 1V:10H or flatter
- Per the FHWA Eligibility Letter, for slopes 1V:4H to steeper that 1V:10H, it must be installed 0’ to 4’ [0 m to 1.2 m] from the break point.
- Per the FHWA Eligibility Letter, for back slope applications, for slopes 1V:4H to steeper than 1V:10H, the installation must be a minimum of 11’ [3.3 m] from the v-ditch center.
- Tested post spacing 10’-6” [3.2 m].

MASH CASS® S3 TL-4 Applications

- Has not been tested on slopes steeper than 1V:10H.
- Tested post spacing 10’-6” [3.2 m].

General CET™ Information

When installed/assembled the entire CET™ system length is 99'-6" [33m], measured from the center of the CET™ Lower Anchor to the center of CET™ Post Ten. At Post Ten the nominal CET™ heights are 42" [1.07m], 38" [0.97m], 29 3/4" [0.76m], and 17 3/4" [0.45m] measured from finished grade with all four (4) 3x7" Pre-Stretched, High-Tension ¾" Highway Guard cables terminating into the CET™ Upper/Lower Anchor through the use of 1" High Strength Cable Fitting(s) which pass through both the Upper and Lower Anchor assembly and are fastened with the use of two (2) 1" High Strength Nuts and one (1) special CET™ Washer, per cable.

The main components of the CET™ include four (4) CET™ U-Shaped Posts (locations One through Four, inserted into tube sleeves encased in concrete footings) and six (6) CET™ S3x5.7# [S75x8kg] Modified SYT® Posts (locations Five through Ten, inserted into tube sleeves encased in concrete footings), four (4) tension cables and the aforementioned CET™ Upper and Lower Anchor. The CET™ Lower Anchor is anchored to a concrete foundation block, as detailed. The Upper and Lower Anchor are connected together utilizing two (2) ¼" Shear bolts and two (2) CET™ Anchor Links. Each CET™ Anchor Link utilizes two (2) 1" High Grade Hex Bolts allowing the CET™ Upper Anchor to rotate and release from the CET™ Bottom Anchor when impacted.

All 5/16" fasteners utilized within the CET™ to attach the cables are attached to the outside of the Posts (One through Ten), on one side or the other, as detailed in the drawings. Note that the side that the cable attaches to does NOT change within the CET™. Post One and Post Four utilize four (4) each 5/16" Cable Lock Bolts with nuts. Post Two and Post Three as well as Posts Five through Post Ten utilize four (4) each 5/16" Cable J-Bolts with Shoulder with nuts. The four (4) 5/16" J-Bolts with Shoulder located at Post Two and Post Three face "up" on the top two (2) cables and face "down" on the bottom two (2) cables. At post locations Five through Ten the four (4) 5/16" J-Bolts with Shoulder face "down" on all four (4) ¾" cables attached to the CET™ Modified SYT® Posts.

The post spacing between the CET™ Anchor Post assembly and Post One is 5'-0" [1.52m] on center and the post spacings between the other posts (One through Ten) are all 10' 6'' [3.20m], on center.

Adhesive-backed delineation is typically attached to a 1/16" x 18" x 18" piece of aluminum which is secured to the CET™ Upper Anchor utilizing standard #12 Self-Tapping Screws. For shipments within the United States of America all hardware/fasteners will be provided per imperial standard/specification.

MASH CET™ TL-3 Applications

- Has been tested on slopes 1V:10H or flatter.
- Tested post spacing 10'-6" [3.2 m].

Minimum Concrete Strength

The Minimum Strength Concrete ("MSC") for all concrete components of the CASS® S3 and CET™ is 3,000 psi [21 MPa] or greater to meet the agency's specifications.

Macro synthetic fibers conforming to ASTM C1116/C1116M Type III dosed at 4 lb/yd^3 of concrete was utilized in the CET™ crash testing matrix as reinforcement, in order to verify the structural capacity of the various foundations. These fibers may be used in the line post foundations, anchor block foundations and/or concrete mow strips. As of the date of this manual issuance/revision some commonly available macro synthetic fibers which meet or exceed ASTM C1116/C1116M and are appropriate for the CASS® S3 and CET™ applications are Strux by Chryso, MasterFiber MAC 100 or MAC 360FF by MasterBuilders, Forta-Ferro by Forta Concrete Fiber, Tuf-Strand by Euclid, SikFibermesh 650 or SikaFiber 800 Stealth by Sika – HOWEVER, ANY OTHER MACRO SYNTHETIC FIBERS MEETING OR EXCEEDING THE ASTM SPECIFICATION ARE ALLOWABLE, without Valtir approval.

A rebar reinforcing cage can be utilized instead of macro synthetic fibers, see Figure 2 for the minimum rebar reinforcing cage design, placed with a minimum of 3" [75 mm] clearance on all sides. The connections can be tack welded or tie wired, as desired by the assembler/installer or specifying agency.

CASS® S3 & CET™ Components

Below is a pictorial of components for **CASS® S3 and CET™** Hardware. Please see **Valtir drawings** for specific lists of quantities. All Valtir Part Numbers ("PN") are provided for standard parts only.

Note: The following components are not shown to scale.

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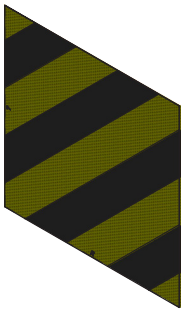	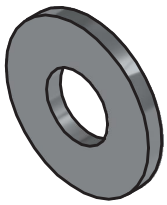	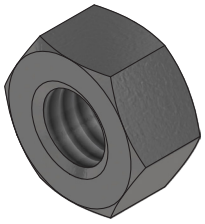
18" x 18" Reflective Sheeting Yellow/Black	5/16" Flat Washer (F844)	5/16" Hex Nut (A563)

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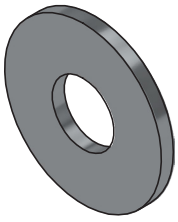
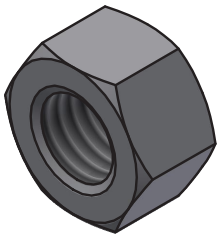
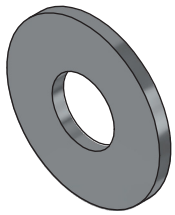
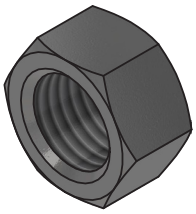
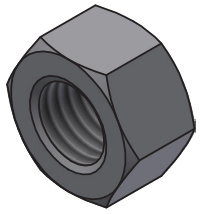
		
5/8" Flat Washer (F844)	5/8" Lock Washer	5/8" Hex Nut

PN: 003536G	PN: 003537G	PN: 003700G
		
1” Stud Flattened-RHT	1” Stud Flattened-LHT	3/4” Flat Washer (F844)

PN: 003701G	PN: 003710G	PN: 003711G
		
3/4” Flat Washer (F436)	3/4” Hex Nut (A563)	3/4” Hex Nut (A194 2H)

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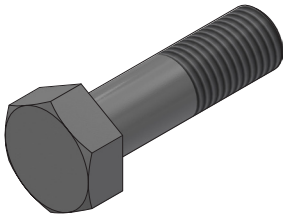
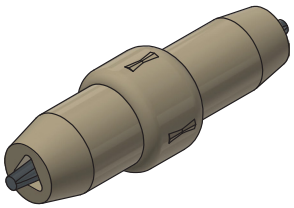
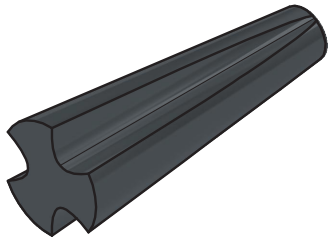
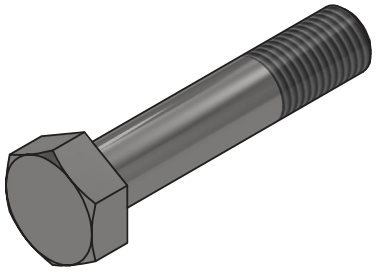
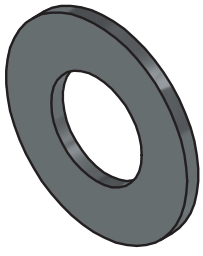
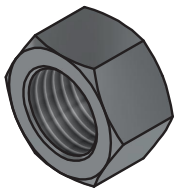
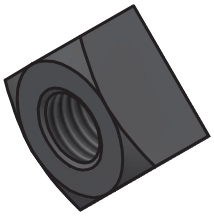
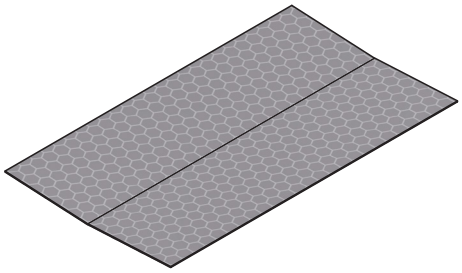
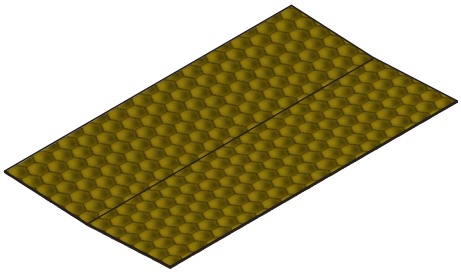
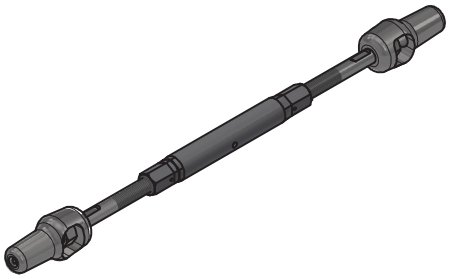
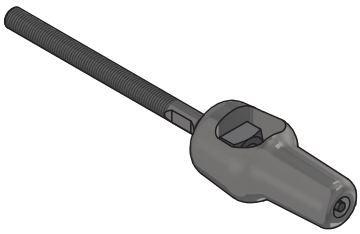
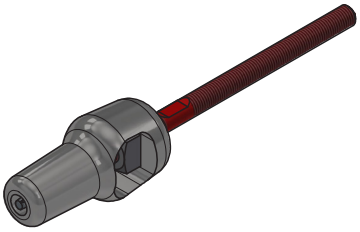
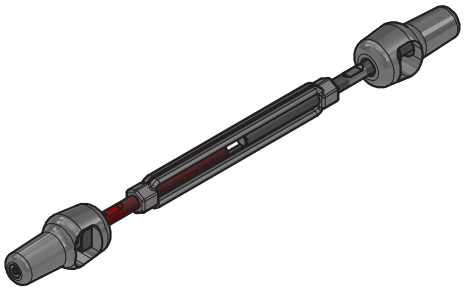
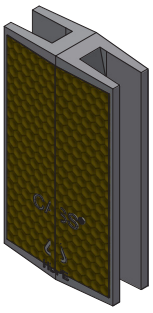
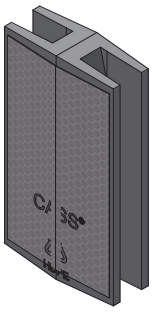
		
1” x 3 1/2” Hex Bolt (A325)	Torpedo Cable Splice	3/4” Cable Wedge (3 x 7)

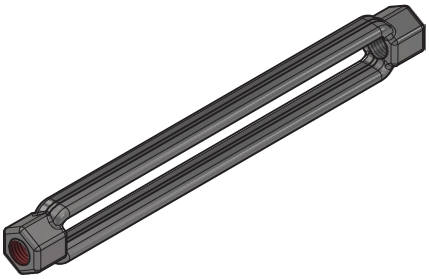
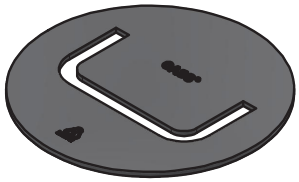
PN: 004225G	PN: 004486G	PN: 004902G
		
Cable Hook Bolt (A307)	1” x 5” Hex Bolt (A325)	1” Flat Washer (F436)

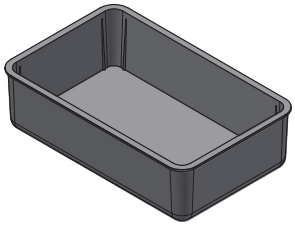
PN: 004903G	PN: 004959G	PN: 005225G
		
1” Hex Nut (A194 2H)	3/4” Heavy Square Nut	5/8” x 7 1/2” Rod (A193 B7)

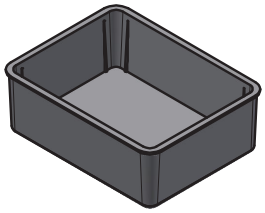
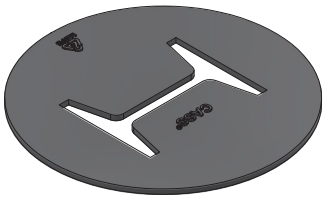
PN: 005589B	PN: 005590B	PN: 005633G
		
1 7/8” x 3 1/4” Reflective Sheeting, White	1 7/8” x 3 1/4” Reflective Sheeting, Yellow	Assembled 1” Cable Splice

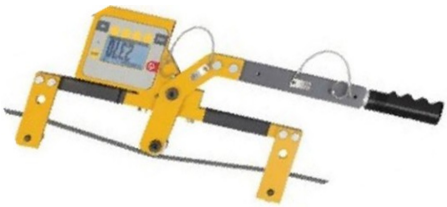
PN: 005634G	PN: 005635G	PN: 005698G
		
3/4” Cable Field Splice Left	3/4” Cable Field Splice Right	Assembled 3/4” Cable Splice

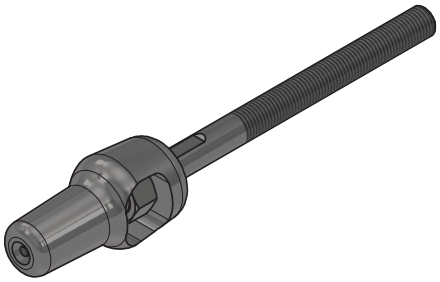
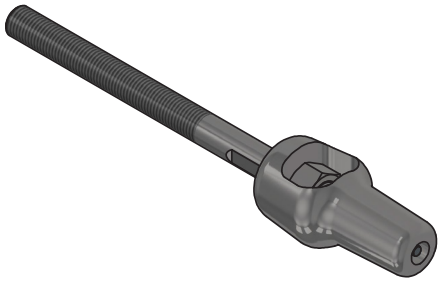
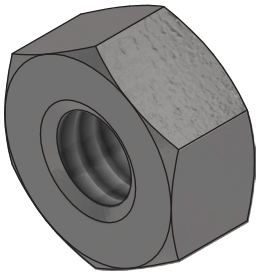
PN: 005700B	PN: 005701B	PN: 005702B
		
4” Cable Spacer w/o Reflector	4” Cable Reflector Spacer Yellow	4” Cable Reflector Spacer White

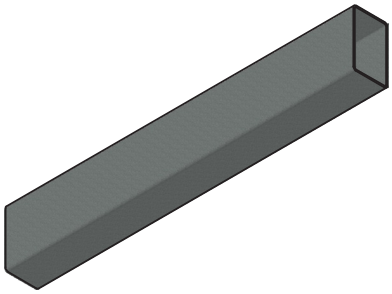
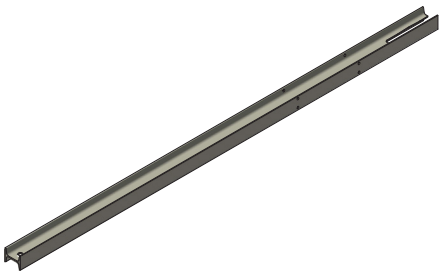
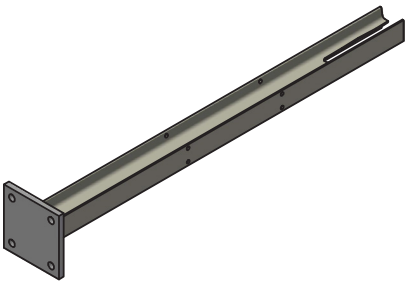
PN: 005709B	PN: 005711G	PN: 005823B
		
Infrared Thermometer	3/4” Turnbuckle Open Body	CASS® C Post Sleeve Cover

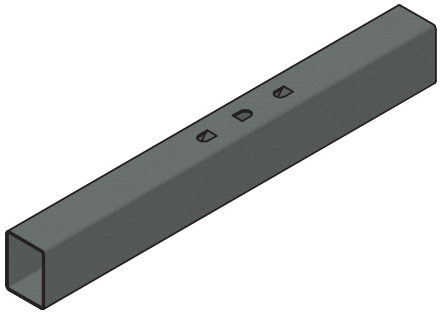
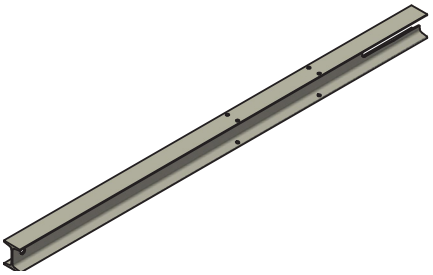
PN: 005825G	PN: 005826G	PN: 005833B
		
Cable Lock Bolt (A307)	1” Turnbuckle Closed Body	C Post Sleeve Cap Bottom

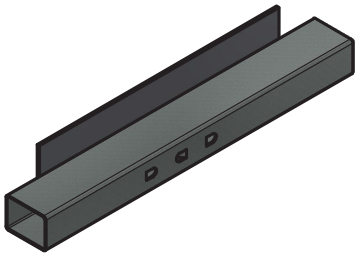
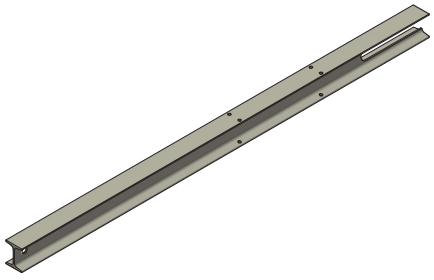
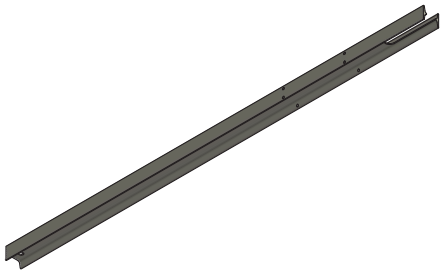
PN: 005836B	PN: 005837B	PN: 005839B
		
8” Concrete Reinforcing Ring	S3 Sleeve Cap Bottom	S3 Sleeve Post Cover

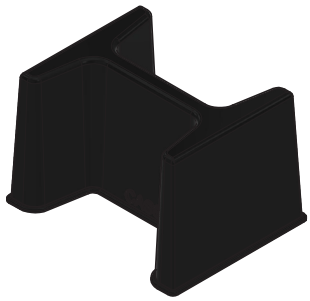
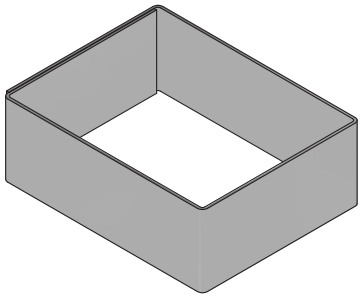
PN: 005840G	PN: 005850B	PN: 005878B
		
5’-0” Cable Field Repair Section	CASS® Cable Pulling Tool	CASS® Tension Meter

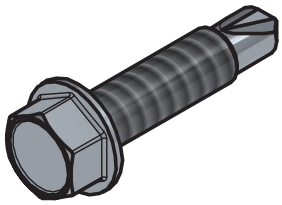
PN: 005909G	PN: 005910G	PN: 006401G
		
1” Field Wedge Open Left	1” Field Wedge Open Right	1/4” Hex Nut A563

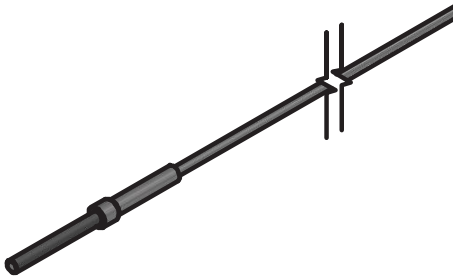
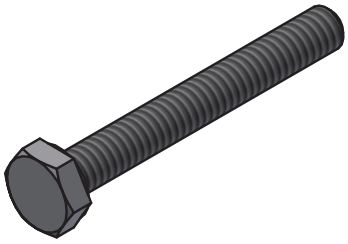
PN: 033588G	PN: 034036G	PN: 034037A
		
TS 5 x 3 x 11 GA x 2'-6 3/4" (CET™ Post Sleeve)	S3 Post-Driven	S3 Base Plated Post

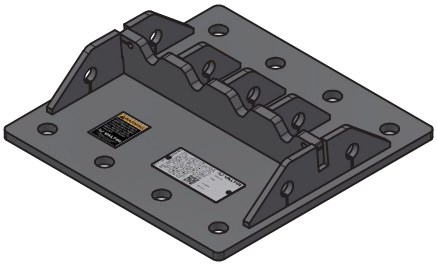
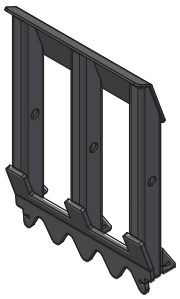
PN: 034038G	PN: 034039G	PN: 034045G
		
TS 4 x 3 x 11 GA x 2'-3" (S3/CET™ Post Sleeve-Concrete Footing)	S3 27” Driven Sleeve	S3 Post-Concrete Footing

PN: 034047A	PN: 034049G	PN: 034061G
		
S3 Driven Sleeve w/soil Plate Post-30 3/4”	S3 Standard Splice Post in Sleeve	CASS®-S3 SPL PST X 6'-10"

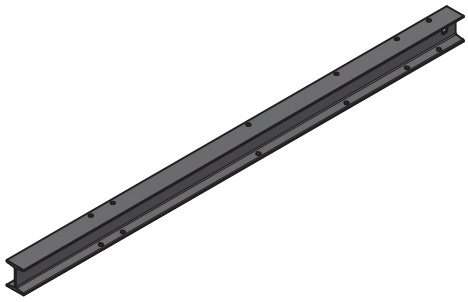
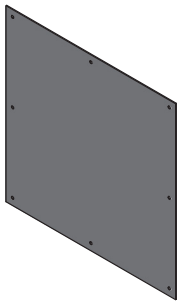
PN: 105201B	PN: 105202T	PN: 105204G
		
S3 Post Cap	S3 Post Strap	3/4” Stud Flattened-LHT

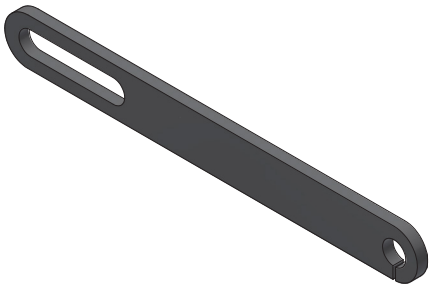
PN: 105204G	PN: 116884G	PN: 118352G
		
3/4” Stud Flattened-RHT	#12 x 1” Self Tapping Screw	1” x 12” Threaded Rod

PN: 118710B	PN: 119672G	PN: 119824G
		
Hilti HY200, 330 Adhesive	CET™ 105' Cable Assy, RHT	1/4” x 2” Hex Bolt A307

PN: 131665B	PN: 131670G	PN: 131671G
		
CET™ Lower Anchor	CET™ Upper Anchor	CET™ U-Shaped Post One: 60.5”

PN: 131672G	PN: 131673G	PN: 131676G
		
CET™ U-Shaped Post Two: 65.5”	CET™ U-Shaped Post Three: 70.5”	CET™ U-Shaped Post Four: 75.5”

PN: 131675G	PN: 131676G	PN: 131677B
		
CET™ S3 SYT® Terminal Line Posts Five through Ten	CET™ Cable Washer	CET™ Reflective Sheet Panel 18" x 18"

PN: 131678G	PN: 211297B	PN: 211299B
	**Picture Not Available**	**Picture Not Available**
CET™ Anchor Link	Tape, Refl, DG3, 12, Amber (Yellow)	Tape, Refl, DG3, 24, Amber (Yellow)

Bill of Materials

Warning: Use only Valtir parts on the CET™ System for assembly, maintenance, or repair. The assembly or comingling of unauthorized parts is strictly PROHIBITED. Failure to follow this warning could result in serious injury or death in the event of a vehicle impact with a system.

CET™ COMPONENTS	PN	QTY
TS 5 x 3 x 11 GA x 2'-6 3/4"	033588G	4
TS 4 x 3 x 11 GA x 2'-3"	034038G	6
CET™ LOWER ANCHOR W/DECAL	131665B	1
CET™ UPPER ANCHOR	131670G	1
CET™ U-SHAPED POST ONE: 60 1/2	131671G	1
CET™ U-SHAPED POST TWO: 65 1/2	131672G	1
CET™ U-SHAPED POST THREE: 70 1/2	131673G	1
CET™ U-SHAPED POST FOUR: 75 1/2	131674G	1
CET™ POST FIVE THROUGH TEN, S3, SYT®	131675G	6
CET™ REFL SHT PNL,18X18	131677B	1
CET™ ANCHOR LINK	131678G	2
CET™ HARDWARE BUCKET (MANUAL INCLUDED)	**119831B**	**1**
CET™ HDWR BAG 1 (ANCHOR) – TO INCLUDE:	**119837B**	**1**
WASHER,FLAT,5/16 W,TY A,G	003240G	4
1"X3.5" HEX BOLT A325	003914G	2
1"X5" HEX BOLT A325	004486G	2
1" ROUND WASHER F436	004902G	10
1" HEX NUT A194 2H	004903G	20
1/4" HEX NUT A563	006401G	2
SCREW,HWH,#12X1,SELF TAPPING,P	116884G	8
ROD,THREADED,1X12,B7,G	118352G	8
BOLT,HX,1/4X2,AT,A307	119824G	2
CET™ CABLE WASHER	131676G	4
CET™ HDWR BAG 2 (U-SHAPED POSTS ONE THROUGH FOUR) – TO INCLUDE:	**119838B**	**1**
5/16" HEX NUT A563	003245G	16
5/16"X1.75"HOOK BLT/SHLDR	004225G	8
CABLE LOCK BOLT 5/16	005825G	8
CET™ HDWR BAG 3 (S3 SYT® POSTS FIVE THROUGH TEN) – TO INCLUDE:	**119839B**	**1**
5/16" HEX NUT A563	003245G	24
5/16"X1.75"HOOK BLT/SHLDR	004225G	24

CET™ LOOSE MATERIALS IN BUCKET – TO INCLUDE:		
CASS®,SLEEVE COVER,C POST	005823B	4
CASS®,SLVCVRBTM,5X3,C	005833B	4
CASS®,SLEEVE COVER,BOTTOM,4X3	005837B	6
CASS®,SLEEVE COVER,S3 POST	005839B	6
ADHESIVE,HY200,330,HILTI	118710B	6
CASS® S3 4:1 WITH CASS® END TERMINAL PRODUCT MANUAL	119836B	1
CET™ OPTIONAL COMPONENTS – SEE SPECIFICATIONS		
REFLECTIVE SHEET 18X18 YELLOW/BLACK	003177B	1
REFLECTIVE SHEET 1 7/8 X 3 1/4,WHITE	005589B	5
REFLECTIVE SHEET 1 7/8 X 3 1/4,YELLOW	005590B	5
CASS® CBL TURNBUCKLE ASS'Y-1"	005633G	4
CASS® #3 REBAR 8" OD	005836B	10
1” CABLE FIELD SPLICE – R.H.T.	005910G	4
CET™ CBL 105', R.H.T, ASSY	119672G	4
TAPE,REFL,DG3,12,AMBER (YELLOW)	211297B	3 LF
TAPE,REFL,DG3,24,AMBER (YELLOW)	211299B	2 LF

Recommended Tools

Documentation

- Manufacturer's CASS® S3 4:1 With CASS® End Terminal Product Manual (PN: 119836)
- CET™ Drawing SS-2380 and CASS® S3 4:1

Personal Protective Equipment (PPE)

- Eye Protection
- Work Gloves
- Back Protection
- Safety-Toe Shoes
- Reflective Vest
- Apron
- Hard Hat

Wrenches

- Pipe Wrenches
- Adjustable Spanner
- Adjustable Jaw Wrenches
- Imperial and/or Metric Wrenches

Concrete Equipment

- Concrete Vibrator
- Concrete Tools

Cable/Miscellaneous Equipment

- Traffic Control Equipment and Plan per local standards and the MUTCD
- Cable Tension Meter (PN: 005878B)
- Infrared Thermometer (PN: 005709B)
- Abrasive Cutoff Blade/Saw
- C-Clamps
- CASS® Cable Pulling Tool (PN: 005850B)
- Locking Pliers
- Duct tape
- Pry Bars
- Line/String
- Plumb Line
- Straight Edge
- Level
- Tape Measure
- Come-along/Lever chain hoist (3 ton minimum capacity)
- Backhoe
- Chain (5 ton minimum capacity) of appropriate length for tensioning equipment
- Marking Paint
- Post Pounder
- Auger
- Drift Pin
- Pneumatic/Impact Drill with 1 1/8" concrete bit
- Drill with 7/32" metal bit (reflective sheet application)
- Hilti HY200, 330 adhesive or equivalent, Hilti 1-1/8" brush, Hilti dispensing tool, and Hilti handle

Note: The provided list of tools is a general recommendation and should not be considered an extensive list. Depending on specific site conditions and the complexity of the assembly specified by the appropriate agency, the required tools may vary. Decisions as to what tools are needed to perform the job are entirely the responsibility of the specifying agency and the agency's selected contractor performing the assembly of the system at the agency's specified assembly site.

Ground Preparation and Barrier Alignment

The CASS® S3 and CET™ shall be placed on a median or roadside 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. To address assembly in rock, see Appendix C: Encountering Rock.

Warning: It is imperative, before assembly, that the assembler/installer contact a Valtir representative and state/specifying agency engineer for special criteria for soils which do not meet or exceed MASH (or NCHRP Report 350) soil conditions. It is also recommended that you consult your own soils or structural engineer.

Note: Based on soil conditions at the site, ANY or ALL foundations may need larger/deeper concrete footings or larger soil plates (for driven CASS® S3 applications) as determined by soil analysis.

Ground Preparation

When CASS® S3 or CET™ is placed in a median, use the following criteria:

When the NCHRP Report 350 CASS® S3 is placed on a ditch section and the side slope is 1V:4H or flatter; but, steeper than 1V:6H, the maximum offset from the hinge point is 4’ [1.3 m] and minimum offset from the bottom of the ditch is 11’ [3.3 m]. According to FHWA and AASHTO, on side slopes steeper than 1V:10H, the cable median barrier (including CASS® S3) cannot be placed within 1’ to 8’ [0.3m to 2.4 m] from the ditch line. When the side slope is 1V:10H or flatter, CASS® S3 can be placed anywhere in the median.

When the MASH CASS® S3 is placed on a ditch section and the side slope is 1V:4H or flatter; but steeper than 1V:10H, the maximum offset from the hinge point is 4’ [1.3 m] and minimum offset from the bottom of the ditch is 11’ [3.3 m]. When the side slope is 1V:10H or flatter, CASS® S3 can be placed anywhere in the median.

The CET™ was tested on 1V:10H or flatter slopes.

Barrier Alignment

Follow all procedures in the placement of the footing and/or post to ensure proper alignment. It is suggested that a string line or other means be used to provide a consistent horizontal and vertical alignment that meets specifications. See “Assembly on a Curve” Section.

CASS® S3 can be placed on the roadside in front of slopes 1V:2H or flatter. Use a minimum distance of 2’ [0.6 m] in front of the hinge point to the center of the post.

Use the state/specifying agency or agency’s guardrail terminal standards, policy or guidance for grading and widening for the CET™.

There may be instances where a break will be required in the cable run. In these circumstances proper overlap of the cable barrier system is required in order to prevent a vehicle from passing through the break area. For a break that occurs at the approach end of an installation, use Cable Barrier Overlap A. For a break that occurs at the trailing end of an installation, use Cable Barrier Overlap B. See Appendix B for recommended minimum Cable Barrier Overlaps.

Important: A flare rate of 30:1 or flatter is required if the barrier must be flared, transverse across the median, or if CASS® S3 must change in direction (See Appendix A). No flaring within the CET™ is allowed.

CASS® S3 Assembly on a Curve (not applicable to the CET™)

Horizontal 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.
2. Weak soil conditions may necessitate a larger/deeper footing for the line posts, based on the radius of the curve.
3. When placing posts on a curve, use the table below to adjust the spacing as required:

Curve Radius	Post Spacing (NCHRP Report 350)	Post Spacing (MASH)
0 to 650' [0 to 198 m]	CASS® S3 is not recommended	CASS® S3 is not recommended
651' to 1,300' [198 m to 396 m]	10'-6" [3.2 m] post spacing or less (as specified by state/specifying agency)	10'-6" [3.2 m] post spacing or less (as specified by state/specifying agency)
Greater than 1,301' [396 m]	21' [6.4 m] post spacing or less (as specified by state/specifying agency)	10'-6" [3.2 m] 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 contract specifications, use the contract specification post spacing.

Vertical Curve

For a sag vertical curve, the recommended minimum K value is 100 [30]. There is no K value limit for crest vertical curves.

K= L / (g1-g2)

L = length of vertical curve in feet [meters] between the two tangents

g1 = grade of tangent in

g2 = grade of tangent out

When the minimum sag vertical curve value is not met, the use of CET™ terminals at the low point of the sag curve is recommended to minimize the cables from rising beyond the allowable height tolerance relative to grade.

Line 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 state/specifying agency immediately! NEVER attempt to place posts if these assembly instructions cannot be complied with.

Post Alignment

Lay out the post alignment and post spacing according to the contract specifications. For the NCHRP Report 350 CASS® S3 the minimum post spacing is 10’-6” [3.15 m] and maximum post spacing is 21’-0” [6.4 m]. The post spacing for MASH CASS® S3 is 10’-6” [3.2 m].

CASS® S3 Driven Foundation Sleeve With and Without Soil Plate

Complete the following Steps for a driven foundation sleeve assembly.

1. Drive the foundation sleeve (PN: 034039G) or foundation sleeve with soil plate (PN: 034047A) with an appropriate driving head. During the driving process ensure that the sleeve is aligned, properly oriented (with interior tabs 15” [375 mm] from the top of the tube sleeve and the 3” [75 mm] side parallel to the roadway), soil is prevented from coming up into the sleeve, and the sleeve is not damaged.

CASS® S3 Sleeve in Poured Concrete Footing

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

1. Place a plastic cap (PN: 005837B) on the bottom of the foundation sleeve (PN: 034038G) or tape the bottom end of the foundation sleeve to prevent the concrete from coming into the tube.
2. Punch or auger a minimum 12” [300 mm] diameter x 30” [762 mm] deep hole for the concrete footing.
3. Place the MSC in the hole with the top of the footing flush with the finish grade. The MSC can be reinforced with either macro synthetic fiber (4 lbs./yd^3) or a re-bar ring.
4. Place the foundation sleeve in the poured concrete footing. Ensure that the sleeve is positioned plumb, flush with the top of the footing, a minimum of 3” [75 mm] from the edge of the footing, properly oriented (with interior tabs 15” [375 mm] from the top of the tube sleeve and the 3” [75 mm] side parallel to the roadway) and in alignment. Consolidate the concrete to remove air pockets in compliance with applicable state specifications for similar applications.
5. If the MSC is not reinforced with the macro synthetic fiber, place a re-bar ring (PN: 005836B) around the top of the sleeve 2” to 3” [50 mm to 75 mm] from the top of the footing.
6. Smooth off the top of the concrete footing with a slight crown from the sleeve.
7. Allow the footing to attain the required concrete strength before disturbing the foundations, including the placement of posts.

Sleeve in a Mow Strip

Valtir may allow the use of an alternate line post footing if the system is installed with an acceptable mow strip application. Please contact Valtir for additional details. If the mow strip is not acceptable, follow the Steps in “Sleeve in Poured Concrete Footing” section.

Precast Concrete Footings

The precast concrete footings will be made in forms and fabricated the same as if placed in an augured or punched hole. The hole shall be backfilled as needed and compacted per state/specificly agency applicable state specifications for similar applications.

CASS® S3 Post Placement

Posts

The CASS® S3 posts can be driven, placed in a driven sleeve with or without a soil plate, placed in a sleeve in a concrete footing (poured or precast), or mounted to a concrete surface.

Driven Posts

Complete the following Steps for a driven post assembly.

1. Lay out the post alignment and post spacing according to contract specifications and drive the post (PN: 034036G) with an appropriate driving head equipment.
2. The height from the finished grade to the top of the post is approximately 3’-10” [1.2 m]

Posts in Sleeve

Complete the following Steps for a post in the sleeve assembly

1. Place the post sleeve cover (PN: 005823B) on the bottom end of the CASS® S3 post (PN: 034045G).
2. Place the post in the sleeve so it rests on the first tab in the sleeve or bottom of the sleeve and the sleeve cover is located at the top of the sleeve.
3. The height from the finished grade to the top of the post is approximately 3’-10” [1.2 m].

Base Plated Post

For Base Plated Post Assembly, see Appendix D

CASS® S3 Cable End Treatments

The CASS® S3 is terminated with either a CET™ or a CCA.

CET™

The CET™ system consists of an CET™ Foundation (Concrete Anchor Block, 30” Cylindrical Anchor, or 36” Cylindrical Anchor) with CET™ Lower and Upper Anchor, four (4) CET™ U-Shaped Posts and six (6) CET™ S3 SYT® Line Post. The cables are terminated at the CET™ Anchor. The CET™ U-Shaped Posts and CET™ S3 SYT® Line Posts are placed with a sleeve in a concrete footing.

See Figure 1 for the foundation and footing location and spacing.

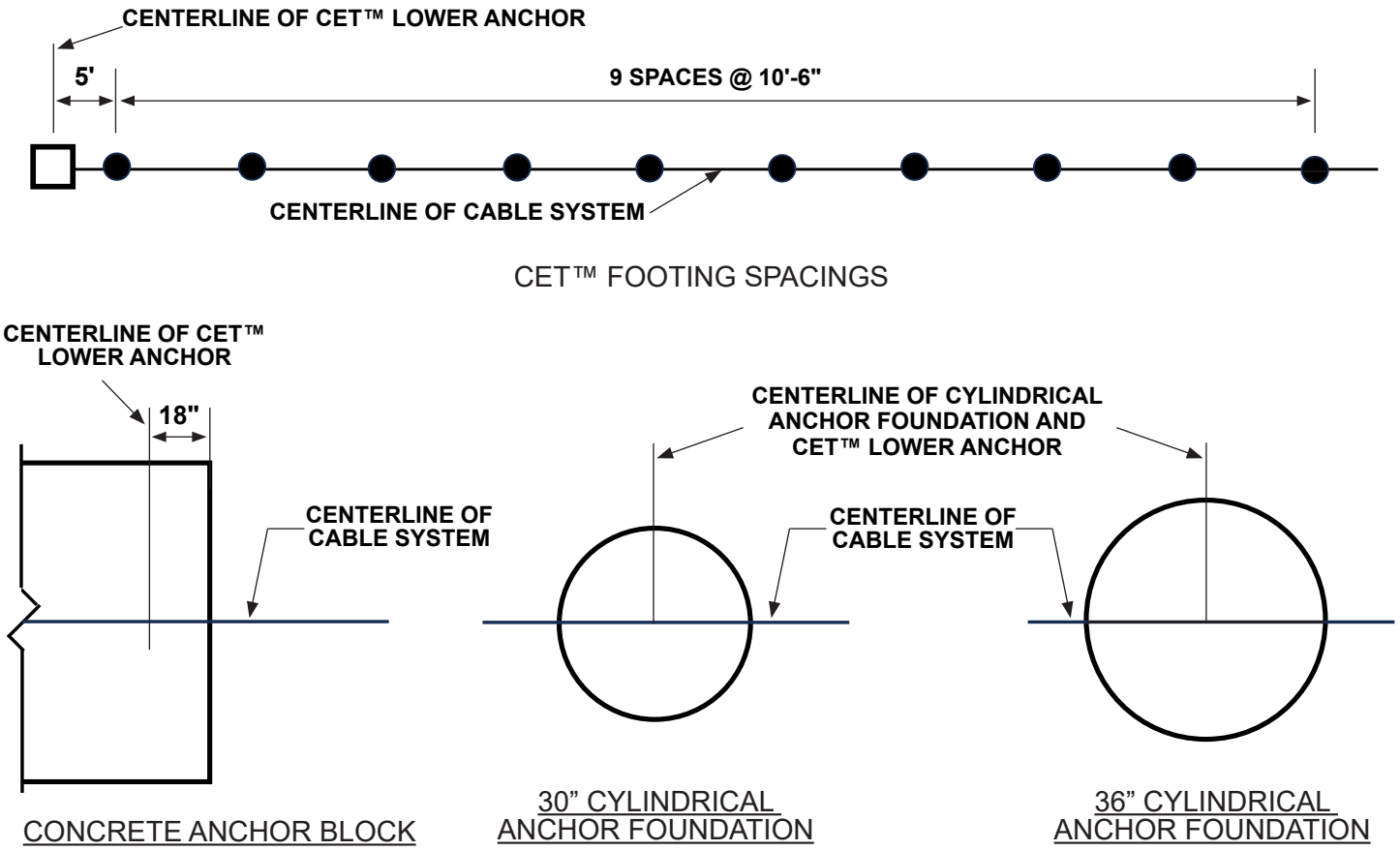


Figure 1
CET™ FOOTING LAYOUT

CET™ Anchor Foundations

The CET™ Anchor Foundation consists of a CET™ Concrete Anchor Block; **or** CET™ 30" [762 mm] Diameter x 9' [2.7 m] deep concrete cylindrical anchor foundation; **or** CET™ 36" [914 mm] Diameter x 8' [2.4 m] deep concrete cylindrical anchor foundation.

Based on soil conditions at the site, the CET™ may need larger/deeper concrete anchors as determined through soil analysis.

CET™ Concrete Anchor Block

1. Place the CET™ concrete anchor block as shown in the CET™ Layout in Figure 1. The anchor block is 4' [1.2 m] wide, 3.5' [1.1 m] deep and 12' [3.7 m] long.
2. The CET™ Anchor Block is reinforced with concrete containing macro synthetic fibers (4 lbs./yd^3).
3. If macro synthetic fibers are not used, a rebar cage can be utilized for reinforcement instead, see Figure 2. The rebar cage is placed with a minimum of 3" [75 mm] clearance on all sides and can be tack welded or tie wired.
4. Consolidate the concrete to remove air pockets in compliance with applicable state specifications for similar applications.
5. Allow the block to attain the required concrete strength before disturbing the foundations, including the placement of CET™ Lower Anchor.

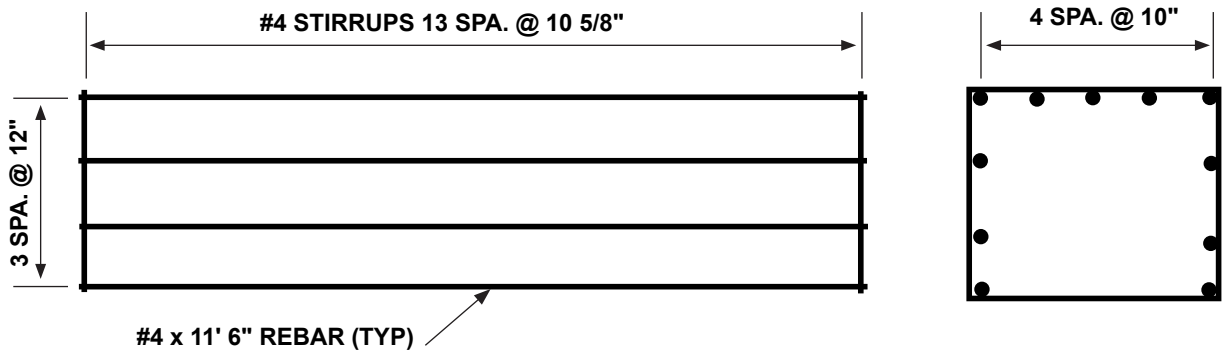


Figure 2
CET™ Concrete Anchor Block Rebar Cage

CET™ 30” [762 mm] Diameter x 9’ [2.7 m] Deep Cylindrical Anchor Foundation

1. At anchor foundation location, punch or auger a 30” [762 mm] diameter x 9’ [2.7 m] deep hole for the concrete cylindrical anchor foundation.
2. In the hole, place MSC with a 24” [610 mm] diameter rebar cage. See Figure 3 for the rebar cage. The rebar cage consists of eight (8) #9 Grade 60 reinforcing bars and 24” [600 mm] diameter, #4 stirrups spaced at 10” [250 mm] on center. The connections can be tack welded or tie wired, as desired by the assembler/installer or specifying agency. The rebar cage is placed with a minimum of 3” [75 mm] clearance on all sides. If the specifying agency requires a deeper footing, the length on the rebar cage will be increased by the amount for the extra depth of the footing.
3. Consolidate the concrete to remove air pockets in compliance with applicable state specifications for similar applications.
4. Allow the concrete cylindrical anchor foundation to attain the required concrete strength before disturbing it, including the placement of the CET™ Lower Anchor.

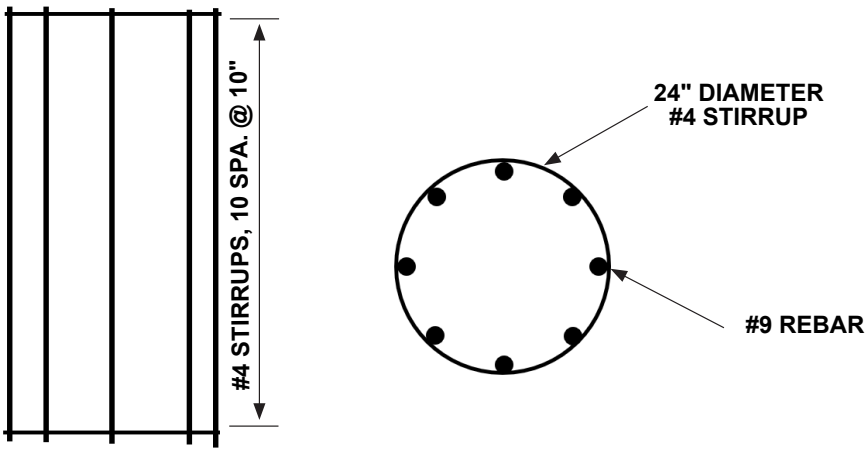


Figure 3
24” [610 mm] Diameter Rebar Cage

CET™ 36” [915 mm] Diameter x 8’ [2.4m] Deep Cylindrical Anchor Foundation

1. At anchor foundation location, punch or auger a 36” [915 mm] diameter x 8’ [2.4 m] deep hole for the concrete footing.
2. In the hole, place MSC reinforced with a 30” [762 mm] diameter rebar cage. See Figure 4 for the rebar cage. The rebar cage consists of eight (8) #10 Grade 60 reinforcing bars and 30” [750 mm] diameter stirrups spaced at 10” [250 mm] on center. The connections can be tack welded or tie wired, as desired by the assembler/ installer or specifying agency. The rebar cage is placed with a minimum of 3” [75 mm] clearance on all sides. If the specifying agency requires a deeper footing, the length on the rebar cage will be increased by the amount for the extra depth of the footing.
3. Consolidate the concrete to remove air pockets in compliance with applicable state specifications for similar applications.
4. Allow the concrete cylindrical anchor foundation to attain the required concrete strength before disturbing it including the placement of the CET™ Lower Anchor.

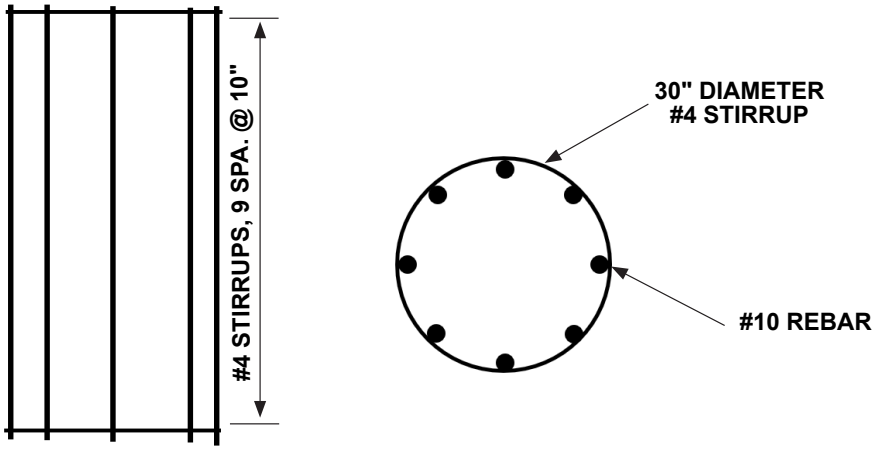


Figure 4
30” [762 mm] Diameter Rebar Cage

CET™ Line Post Footings

Lay out the post alignment and post spacing. See Figure 1. Starting at Post One, post spacing for Post One to Post Ten is 10’-6” [3.20 m]. The centerline of the post will be on the center line of the cable assembly.

Based on soil conditions at the site, the CET™ may need larger/deeper concrete footings as determined through soil analysis.

CET™ Line Concrete Footings – Post One To Post Ten

1. At locations Post One to Post Four, punch or auger a 12” [300 mm] diameter x 36” [915 mm] deep hole for the concrete footing. At locations Post Five to Post Ten, punch or auger a 12” [300 mm] diameter x 30” [762 mm] deep hole for the concrete footing.
2. Place the end cap (PN: 005833B) on the end of the U-Shaped Post Sleeve (PN: 033588G) and end cap (PN: 005837B) on the end of the SYT® Post Sleeve (PN: 034038G). Secure the end cap or seal the sleeve to prevent the MSC from entering the sleeve.
3. Place the MSC in the hole with the top of the footing flush with the finish grade. The MSC can be reinforced with either macro synthetic fiber (4 lbs./yd^3) or a re-bar ring around the top of the sleeve. See the Concrete Strength section for acceptable manufacturers.

4. Place the appropriate foundation sleeve (PN: 033558G) for Post One to Post Four and foundation sleeve (PN: 034038G) for Post Five to Post Ten in the poured concrete footing. The sleeves are to be positioned relatively plumb, flush with the top of the footing, a minimum of 3” [75 mm] from the edge of the footing, and in alignment. Consolidate the concrete to remove air pockets in compliance with applicable state specifications for similar applications.

Note: The U-Shaped Post sleeves are different than the SYT® Post/standard line post sleeves.

5. If the MSC is not reinforced with the macro synthetic fiber, place a re-bar ring (PN: 005836B) around the top of the sleeve 2” to 3” [50 mm to 75 mm] from the top of the footing.
6. Smooth off the top of the footing with a slight crown.
7. Allow the footing to attain the required concrete strength per manufacturer's recommendation before disturbing the foundations, including the placement of posts.

CET™ Line Precast Concrete Footings – Post One To Post Ten

The precast concrete footings will be made in forms and fabricated the same as if placed in an augured hole. The precast footing will be placed in a punched or augured hole. The hole shall be backfilled as needed and compacted per state/specificly agency applicable state specifications for similar applications.

CET™ Anchor Assembly

CET™ Lower Anchor

Attach the CET™ Lower Anchor to the anchor block or concrete cylindrical anchor foundations.

1. Locate the eight (8) holes to anchor the CET™ Lower Anchor (PN: 131665B) to the anchor block or concrete cylindrical anchor foundation by using the CET™ Lower Anchor holes as a template.

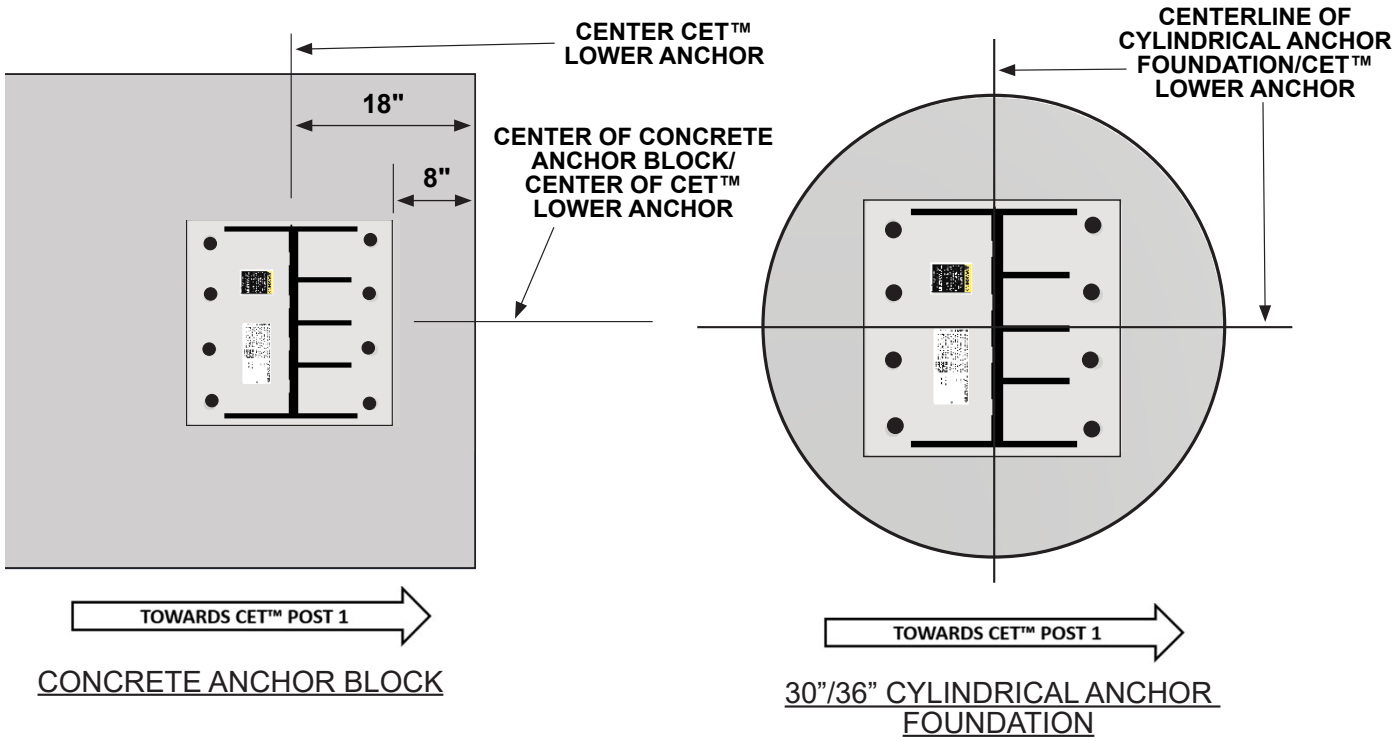


Figure 5
Orientation of CET™ Lower Anchor

2. Place the CET™ Lower Anchor on the anchor Block or concrete cylindrical anchor foundation as shown in Figure 5.
3. Leaving the CET™ Lower Anchor in place, drill the eight (8) 1 1/8” [29 mm] diameter x 10” [234 mm] deep holes for the threaded anchor rods (PN: 118352G).
4. Blow the concrete dust from the borehole using oil-free compressed air. Thoroughly brush it with a 1 1/8” diameter steel bristle tube brush and then blow it out again. If the borehole is wet, completely flush it with water while brushing and then blow it clean to remove all water using oil-free compressed air.

NOTE: Use of an appropriate vacuum drill is authorized to replace the blowing and brushing requirement of this Step.

5. Leaving the CET™ Lower Anchor in place on the anchor block or concrete cylindrical anchor foundation, fill the holes using the Hilti HY200, 330 Adhesive (PN: 118710B) or equivalent. Ensure the threaded anchor rods are inserted, with a twisting motion, and the adhesive comes out of the hole. Follow the manufacturers’ recommendations. Ensure the rods extend **only** 2 inches [50 mm] (+1/4”, -0”) [+6 mm, -0 mm] above the concrete surface.
6. After the adhesive has reached strength, secure the CET™ Lower Anchor to the anchor block or concrete cylindrical anchor foundation with a flat washer (PN: 004902G) and nut (PN: 004903G). Tighten all threaded hardware to a snug position with a minimum of two threads protruding beyond the nut.

CET™ Upper Anchor

1. Orientation of the CET™ Upper Anchor (PN: 131670G) to the CET™ Lower Anchor is shown in Figure 6A.
2. Secure the CET™ Upper Anchor to the CET™ Lower Anchor with two (2) 1/4” x 2” Hex Bolts (PN: 119824G) and 1/4” Nut (PN: 006401G). Place a 5/16” Flat Washer (PN: 003240G) under the Bolt Head and the Nut. See Figure 6B and 6C. Hand tighten at this time.
3. Secure the two (2) CET™ Anchor Links (PN: 131678G) to the CET™ Lower Anchor. Using the round hole in the CET™ Anchor Links and the hole in the CET™ Lower Anchor towards Post One, secure with a 1” x 3 1/2” Hex Bolt (PN: 003914G) and the nut (PN: 004903G). See Figure 6D, note orientation of bolts. The slit in the bottom hole of the CET™ Anchor Links can be orientated in either upstream or downstream direction. Tighten all threaded hardware to a snug position with a minimum of two threads protruding beyond the nut. The length of the shank on the bolt is designed to prevent a tight connection between the CET™ Anchor Links and the CET™ Lower Anchor. See Figure 6E, note orientation of bolts.
4. Secure the slot end of the CET™ Anchor Link to the CET™ Upper Anchor with a 1” x 5” Hex Bolt (PN: 004486G) and 1” Washer (PN: 004902G) under the bolt head and nut (PN: 004903G). Tighten all threaded hardware to a snug position with a minimum of two threads protruding beyond the nut. The length of the shank on the bolt is designed to prevent a tight connection between the CET™ Anchor Links and the CET™ Upper Anchor. See Figure 6E, note orientation of bolts.
5. Apply the 18” x 18” [457 mm x 457 mm] Reflective Sheeting (PN: 003177B, 211297B, 211299B, or state approved alternative) to the 18” x 18” [457 mm x 457 mm] CET™ Reflective Sheet Panel (PN: 131677B).
6. Using the holes in the CET™ Reflective Sheet Panel mark the location on the CET™ Upper Anchor and drill a minimum of four (4) 7/32” [5.5 mm] diameter holes at the corner locations. Secure the CET™ Reflective Sheet Panel to the CET™ Upper Anchor using #12 x 1” Self-Tapping Screws (PN: 116884G).
7. After the cables have been tensioned in accordance with the CASS® S3 System Temperature/Tension chart, tighten the ¼” hardware that was hand tightened in Step 2 to a snug position with a minimum of two threads protruding beyond the nut.

Figure 6A
Orientation of the CET™ Upper Anchor

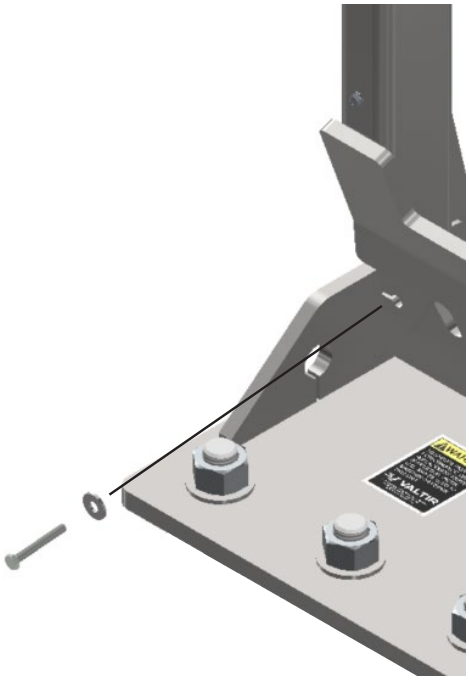


Figure 6B
Bolt and Washer Assembly of the CET™ Upper Anchor to CET™ Lower Anchor

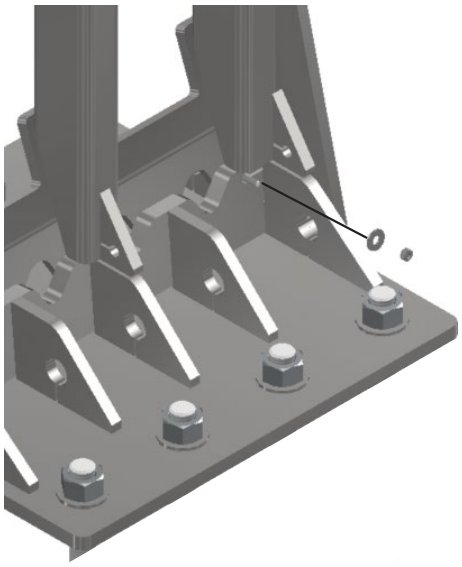


Figure 6C
Nut and Washer Assembly of the CET™ Upper Anchor to CET™ Lower Anchor

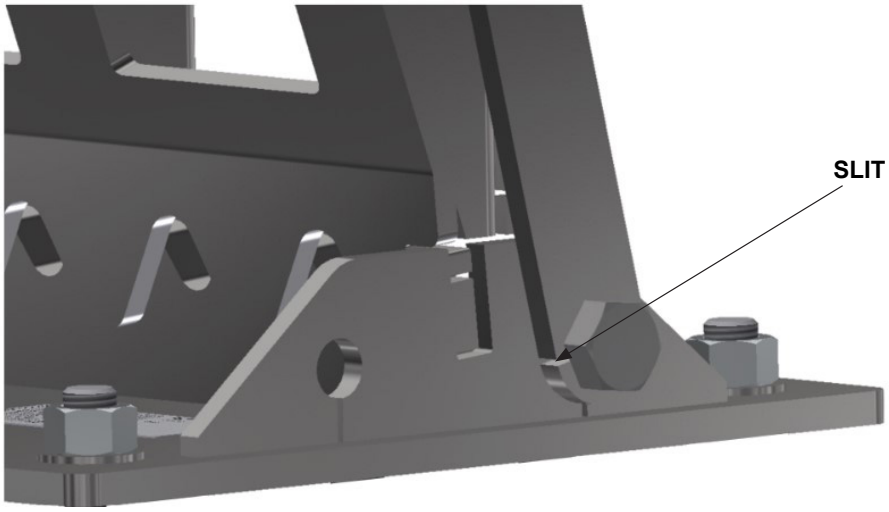


Figure 6D
Assembly of the CET™ Anchor Link to the CET™ Lower Anchor

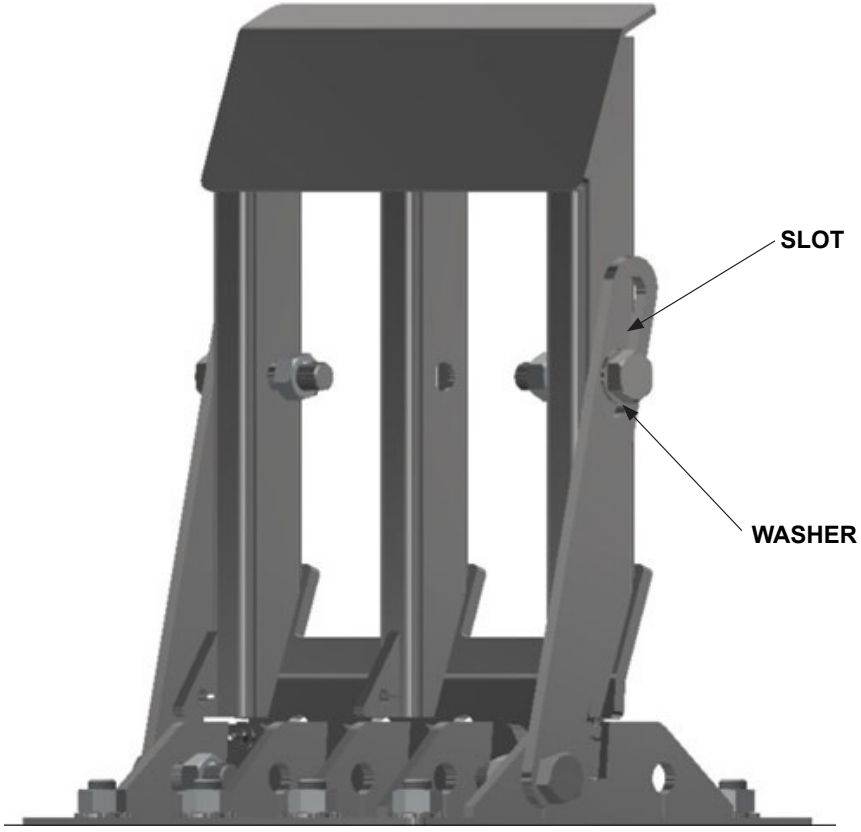


Figure 6E
Assembly of the CET™ Anchor Link

CET™ Terminal Post Assembly

Terminal Posts

The CET™ Terminal Posts consist of four (4) CET™ U-Shaped Posts and six (6) CET™ S3 SYT® Line Posts.

1. Place the post sleeve cover (PN: 005823B) on the bottom end of the CET™ U-Shaped Post.
2. Insert the CET™ U-Shaped Posts in sleeves: Post One (PN:131671G); Post Two (PN: 131672G); Post Three (PN:131673G); and Post Four (PN: 131674G). The post sleeve cover should cover the sleeve. **See Figure 7 for the orientation of the posts.**

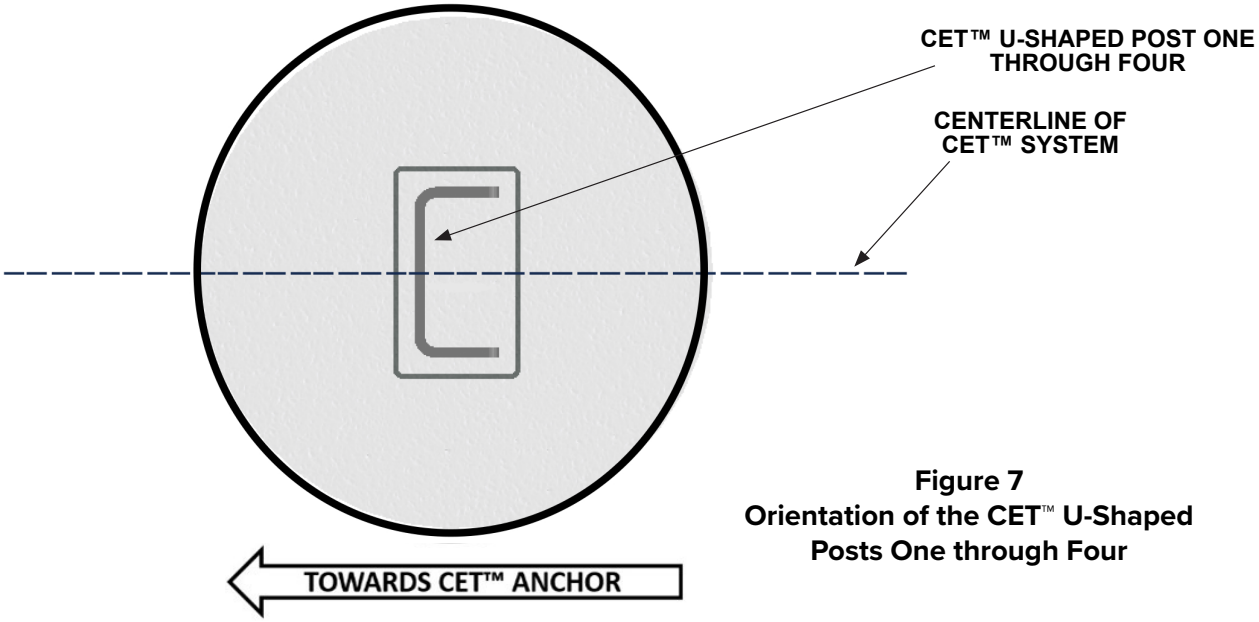


Figure 7
Orientation of the CET™ U-Shaped Posts One through Four

3. Place the post sleeve cover (PN: 005839B) on the bottom end of the CET™ S3 SYT® Line Posts (PN: 131675G).
4. Insert the CET™ S3 SYT® Line Post in the sleeves, Post Five to Post Ten. The post sleeve cover should cover the sleeve.
5. Check to ensure the CET™ U-Shaped Posts and CET™ S3 SYT® Terminal Line Posts are at the correct height. (See drawing)

Terminal Cables (Options)

Option 1: Four (4) precut pre-stretched cables (PN: 119672G) with 1” factory applied right-handed threaded fitting on one end. The precut cable lengths are 105’ [32 m].

Option 2: Four (4) pre-stretched cables with 1” field applied right-handed threaded fitting on one end, minimum length 105’ [32 m], maximum 2,000’ [610 m].

Complete the following Steps for placing the CET™ cables:

Installing the Terminal Cables to the CET™ Anchor Assembly

The CET™ Terminal Posts consist of four (4) CET™ U-Shaped Posts and six (6) CET™ S3 SYT® Line Posts.

1. Lay out the four (4) x 105’ [32 m] precut cables. The right-hand threaded end of the cables will be attached to the CET™ Anchor Assembly. See Figure 8 for the orientation of the cables for the approach end to the nearest traffic and departure end to the nearest traffic.
2. Cable 1 (top cable) shall always be attached to the CET™ Anchor hole nearest to the adjacent traffic.

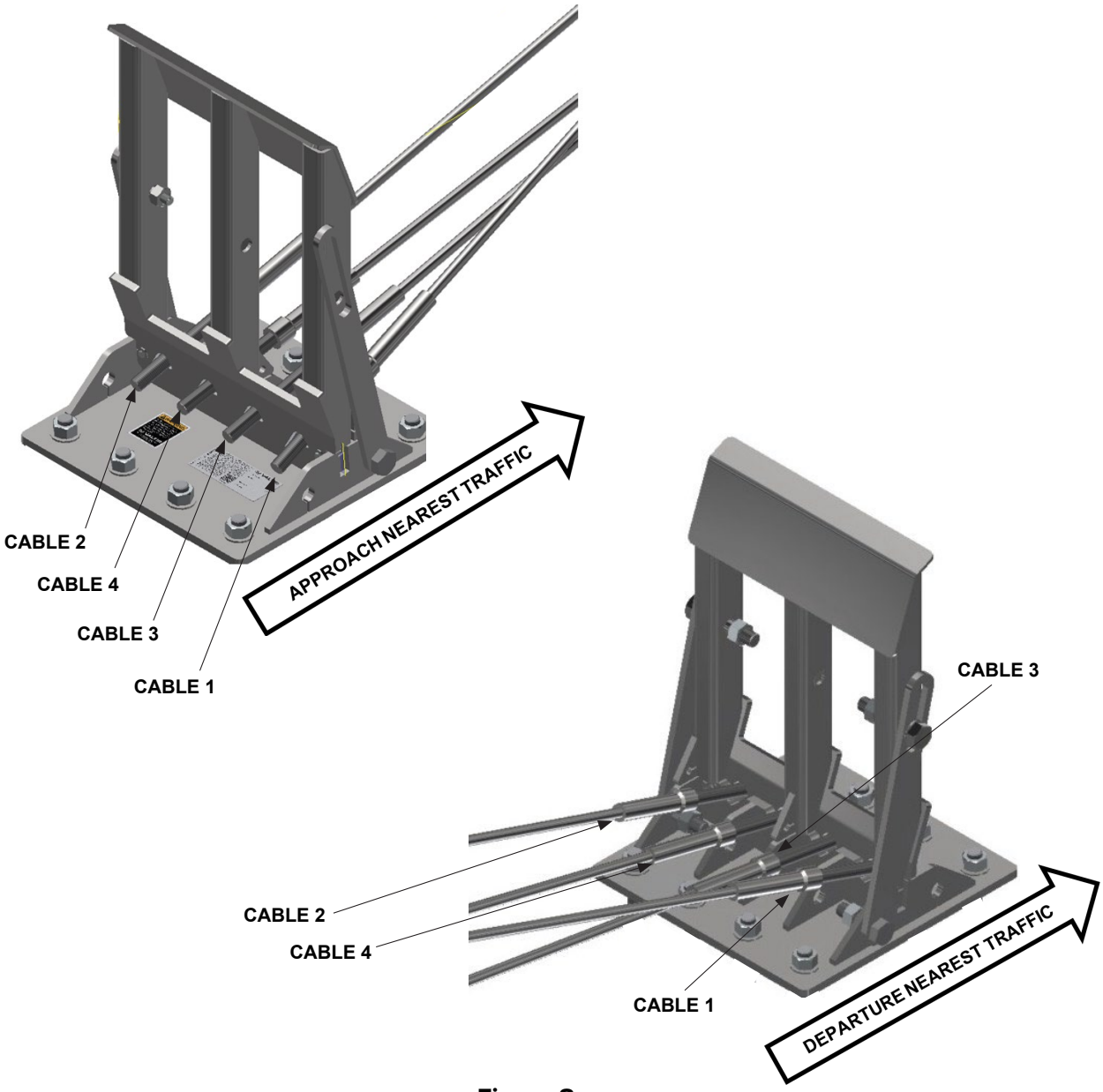


Figure 8
Orientation of Cables

3. Place the threaded end of the fitting through the opening formed by the Lower and Upper CET™ Anchors.
4. Place a CET™ Cable Washer (PN: 131676G) and a hex nut (PN: 004903G) on the cable threaded fitting. Thread the nut approximately 1 1/2” on to the 1” threaded end. Place on the 1” threaded end a second hex nut (PN: 004903G) up against the first nut. Ensure a minimum of two threads protrude beyond the nut and the threaded end is not in contact with the CET™ Lower Anchor or anchor nuts.
5. On the other end of the cable, a Turnbuckle will be used to connect the CASS® S3, assemble Left-Handed fitting to the cable end. See the Field Applied Fittings with Turnbuckle Section for assembly instruction.
6. For cables 2, 3 and 4, perform Step 3 to Step 5.

Warning: Only 1” fittings are to be utilized for the connection to the CET™ Anchor Assembly

Installing the Cables to the Line Terminal Posts (CET™ U-Shaped Posts One through Four)

CET™ U-Shaped Post One

Note: Ensure that the open side of the U-Shaped Post is facing away from the CET™ anchor assembly.

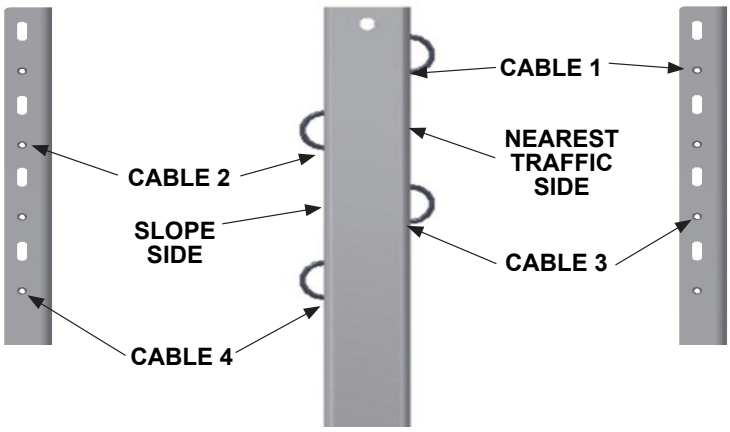


Figure 9
CET™ U-Shaped Post One Cable Lock Bolt Locations
(View Towards Direction of Nearest Traffic)

1. Locate the holes for the Cable Lock Bolts for each cable on the CET™ U-Shaped Post One. See Figure 9.

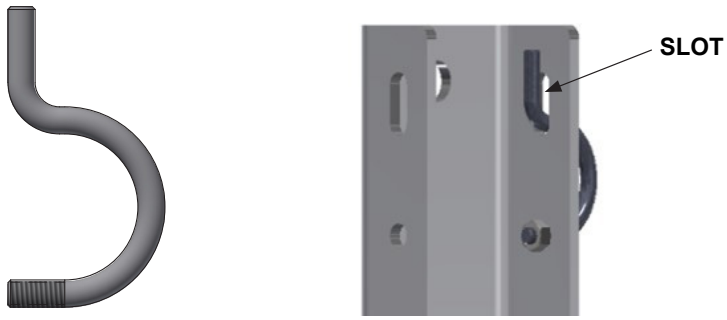


Figure 10
Cable Lock Bolt Assembly

2. Assemble the cables to the post using Cable Lock Bolt (PN: 005825G). The tail of the Cable Lock Bolt must be installed in the slot. See Figure 10.
3. Secure the Cable Lock Bolt to the post with a 5/16” nut (PN: 003245G). Tighten all threaded hardware with only

two (2) to three (3) threads protruding beyond the nut, allowing the cables to be free to move within the Cable Lock Bolt.

CET™ U-Shaped Posts Two and Three

Note: Ensure that the open side of the U-shaped post is facing away from the CET™ anchor assembly.

1. Locate the holes for the Cable Hook Bolts on CET™ U-Shaped Posts Two and Three. See Figures 11 and 12.
2. Assemble the cables to the post using 5/16” Cable Hook Bolt (PN: 004225G) and 5/16” nut (PN: 003245G).

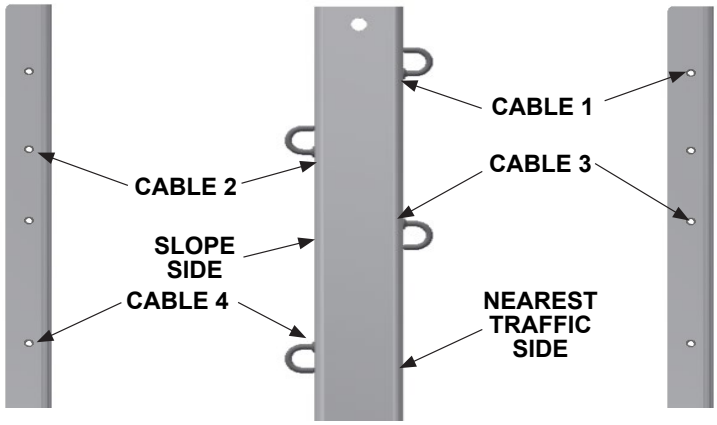


Figure 11
CET™ U-Shaped Post Two Cable Hook Bolt Locations
(View Towards Direction of Nearest Traffic)

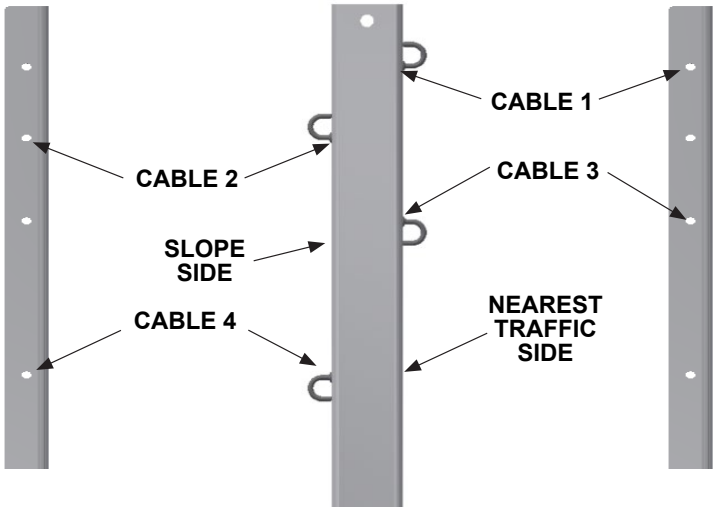


Figure 12
CET™ U-Shaped Post Three Cable Hook Bolt Locations
(View Towards Direction of Nearest Traffic)

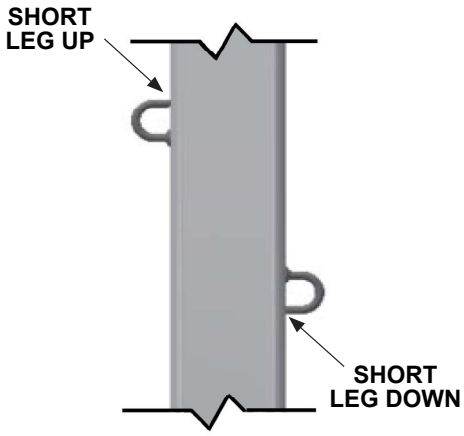


Figure 13
Cable Hook Bolt Assembly

Assemble the top two (2) bolts with short leg up and the bottom two (2) with the short leg down. See Figure 13.

3. Tighten all threaded hardware to a snug position with a minimum of two threads protruding beyond the nut

CET™ U-Shaped Post Four

1. Locate the cables on CET™ U-Shaped Post Four as shown in Figure 14.
2. Assemble the cables to the post using Cable Lock Bolt. See Figure 10.

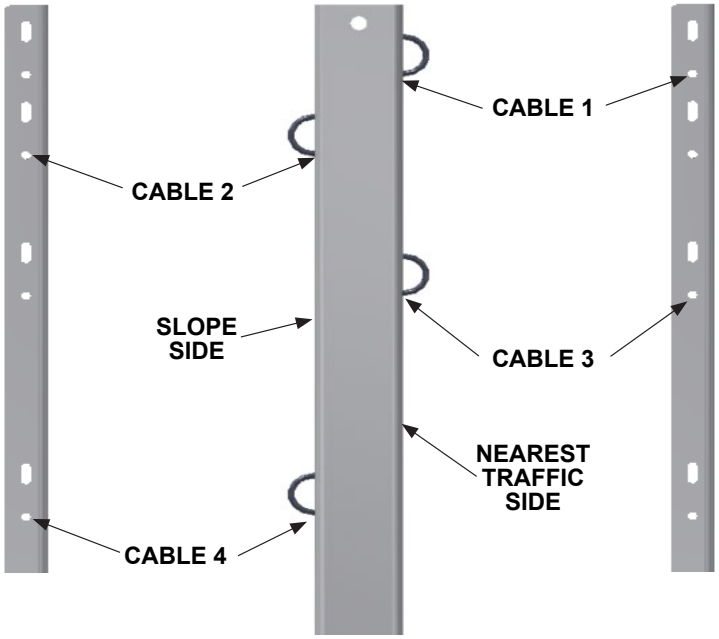


Figure 14
CET™ U-Shaped Post Four Cable Lock Bolt Locations
(View Towards Direction of Nearest Traffic)

3. Secure the Cable Lock Bolt to the post with a 5/16” nut (PN: 003245G). Tighten all threaded hardware with only two (2) to three (3) threads protruding beyond the nut, allowing the cables to be free to move within the Cable Lock Bolt.

CET™ S3 SYT® Line Post Five to Post Ten

1. Locate the cables on CET™ S3 SYT® Line Post Five to Post Ten as shown in Figure 15.
2. Assemble the cables to the post using 5/16” Hook Bolt (PN: 004225G) and 5/6” nut (PN: 003245G). Assemble the hook bolts with the short leg down. (See Figure 13)
3. Tighten all threaded hardware to a snug position with a minimum of two threads protruding beyond the nut.

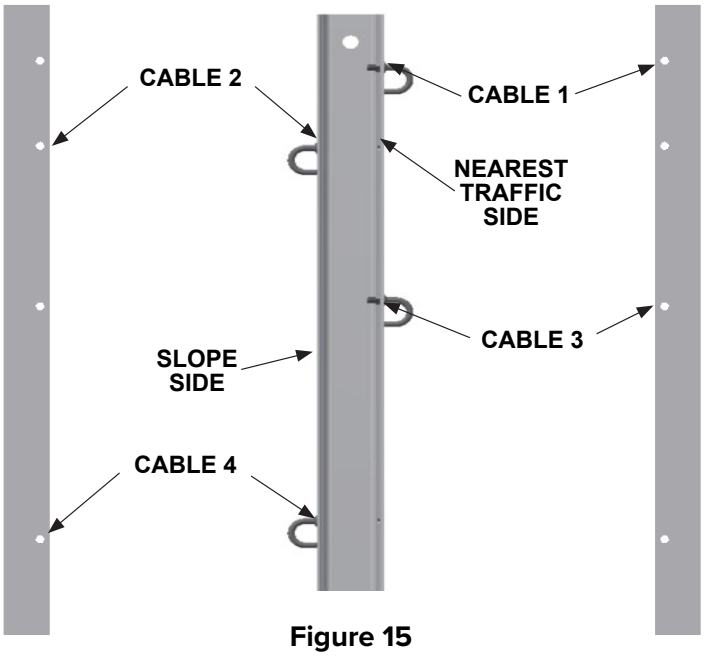


Figure 15
CET™ S3 SYT® Post Five to Post Ten Cable Bolt Locations
(View Towards Direction of Nearest Traffic)

CASS® S3 Line Cables

The cables used in the CASS® S3 System are pre-stretched. They are supplied on reels, either precut with factory applied fittings (in 1,000’ [305 m] increments) or continuous length to be cut in the field and field applied fittings attached. The reels can be supplied with 2,000’ to 3,000’ [610 m to 914 m] of cable on each reel. The precut cable has a right-hand fitting on one end and left-hand fitting on the other end. The cables are placed on the reel with the left-hand fitting placed on the reel first. The right-hand fitting end for the cable must come off first and the end is painted red for identification. When there is more than one cable on the reel, the last cable placed on the reel will have the right- hand fitting painted red and also a yellow mark. This will be the first cable removed from the reel.

Lengths less than 1,000’ [305 m] can be supplied with a factory applied fitting (right–hand fitting) on one end, or the lengths can be cut from a continuous reel and a field applied fitting placed on both ends.

Cable Splices

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

- Factory applied fittings with a turnbuckle (1” hardware only).
- Field applied fittings with a turnbuckle (3/4” and 1” hardware).
- Torpedo fitting.

1” Factory Applied Fittings with Turnbuckle

1. To attach the turnbuckle, 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” [38 mm] from the end of each fitting. On the right-handed threaded fitting place right-handed threaded end of the turnbuckle (PN: 005826G) where it is only held on the threaded end by a couple of threads.
2. Place the left-handed threaded end in the left-handed end of the turnbuckle.
3. While rotating the turnbuckle, prevent the two threaded ends from rotating. Rotate the turnbuckle until both of the threaded ends can be seen through the sight holes at the end of the turnbuckle or both threaded ends are into the turnbuckle beyond the 1 1/2” [38 mm] mark. See Figure 16 for the complete assembly.

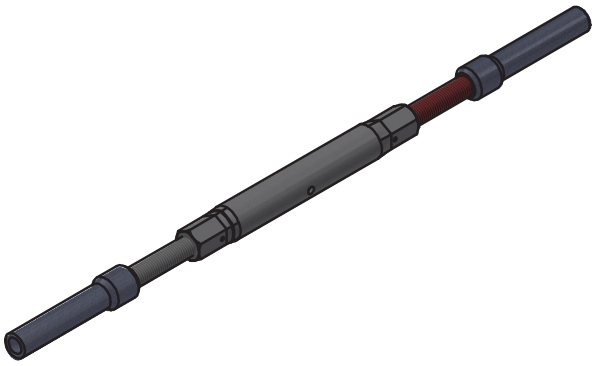


Figure 16
1” Factory Applied Fitting with Turnbuckle

Field Applied Fittings with Turnbuckle

Perform the following Steps to utilize a field applied fitting and a turnbuckle:

1. Ensure that the cable has a clean square cut by using a saw with an abrasive blade tool or an electric band saw.
2. Insert the cut end of the cable into the casting (PN: 004190G) through the triangular end.
3. With the cable inside the casting, separate the cable with two flathead screwdrivers for insertion of the tapered triangular wedge (PN: 004199B) between the three strands of cable.
4. Insert the wedge into the cable with the smaller diameter end towards the triangular hole. Ensure that the wedge is pushed 1/2” [13 mm] beyond the end of the cable (plus or minus 1/8” [3 mm].

Note: All three strands 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 (or other appropriate tool) to seat the wedge by hitting on the exposed end of the casting. Ensure the wedge is seated. Once the wedge has been seated, check to make sure the heavy hex nut (PN: 004903G for 1” fitting) or heavy square nut (PN: 004959G for 3/4” fitting will fit inside the casting. If it will not, reseat the wedge.
6. Insert the appropriate hex nut in the housing.
7. Place the left-handed threaded stud (PN: 003537G for 1” fitting or PN: 105204G for 3/4” fitting) or right-handed threaded stud (PN: 003536G for 1” fitting or PN: 105205G for 3/4” fitting) in the casting and into the nut. Rotate the stud into the nut until it will not go any further. A minimum of two (2) threads of the stud must show beyond the nut.
8. To attach the turnbuckle, place a mark 1 1/2” [38 mm] from the end of each fitting. On the right-handed threaded fitting place right-handed threaded end of the turnbuckle where it is only held on the threaded end by a couple of threads.
9. Place the left-handed threaded end in the left-handed end of the turnbuckle.

While rotating the turnbuckle, prevent the two threaded ends from rotating. Rotate the turnbuckle until both of the threaded ends can be seen through the sight holes (for 1” turnbuckles) or in the open section (3/4” turnbuckle) at the end of the turnbuckle or both threaded ends are into the turnbuckle beyond the 1 1/2” [38 mm] mark. See Figure 17a for a 1” Cable Splice (PN: 005633G) and Figure 17b for 3/4” Cable Splice (PN: 005698G).

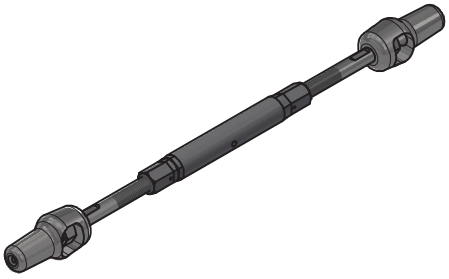


Figure 17a
1” Cable Splice with Turnbuckle

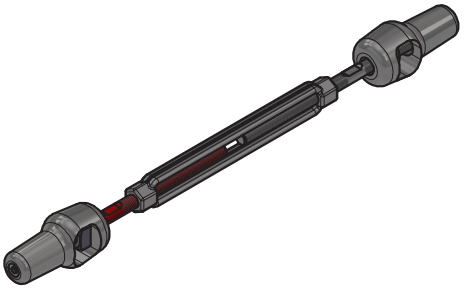


Figure 17b
3/4” Cable Splice with Turnbuckle

Torpedo Cable Splice

When two cable ends are spliced together other than where a spliced with a turnbuckle, a Torpedo Cable Splice can be used. The Torpedo Cable Splice (PN: 004099G) is made up of two (2) housings, one of which has threads on it, a threaded ring, and two (2) triangular wedges. See Figure 18.

Warning: The distance from the torpedo splice to any other fitting must be 100’ [30 m] or greater.

Perform the following Steps to complete a splice:

1. Ensure that the cables have 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 threaded Torpedo fitting.
3. Separate one of the wires from the others by bending it out of the way.
4. Cut the remaining twenty (20) of the twenty-one (21) wires off about 1/2” to 3/4” (13 mm to 19 mm) from the end of the cable. Care should be taken to not nick the separated wire.
5. With the wires cut off, separate the cable with two flathead screwdrivers so the tapered triangular wedge (PN: 004199B) can be inserted.
6. With the wedge inserted into the cable, drive the wedge into the casting until the twenty (20) wire strands are flush with the end of the casting.
7. Bend the one (1) extended wire of the cable over the end of the wedge.
8. On the other cable, place the threaded ring on it so the threads inside the ring are towards the end of the cable.
9. On this same cable, follow Steps 1-7 to assemble the cable in the fitting.
10. 10. Place the two Torpedo Cable splice assemblies together and connect them with the threaded ring. Tighten the connection with a pipe wrench(s), **ensuring no more than two threads are shown after the connection.**

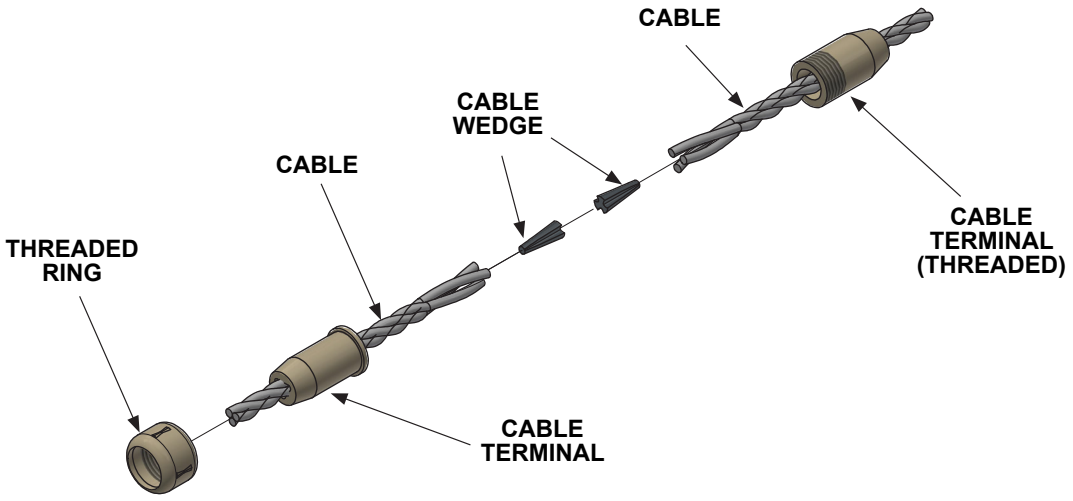


Figure 18
Torpedo Cable Splice

Laying Out the Cable/Attaching the Cables to the Posts

The cable can 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 (1) cable at a time or multiple at the same time. The Valtir Shop Drawings supplied for the project are used to determine where to place each cable. The cables are identified as Cable 1 (top), Cable 2, Cable 3, and Cable 4 (bottom).

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

1. Using the Valtir 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 or Anchor cables. Use the factory applied fitting with a turnbuckle method or field-applied fittings with a turnbuckle to make the connection. Ensure that Cables 1, 2, 3 and 4 are identified.
3. Place Cable 4 (bottom) cable on the embankment (slope) side of the post. On the nearest traffic side of the post, place Cable 3. See Figure 19. The cables are attached to the post with a cable hook bolt (PN: 004225G). Cable 4 is attached to the post using the bottom hole in the post and Cable 3 is attached using the top hole. The cable hook bolt is placed around the cable with the short leg down. See Figure 13. Secure the bolt to the post with a hex nut (PN: 003245G) and tighten until snug with a minimum of two threads beyond the nut.
4. Place Cable 2 in the notch at top of the post (See Figure 20). Place a spacer (PN: 005700B (black), PN: 005701B (yellow) or PN: 005702B (white)) on top of the cable.
5. Place Cable 1 (top) of the spacer. Place a post strap (PN: 105202T) on top of the cable. See Figure 21.

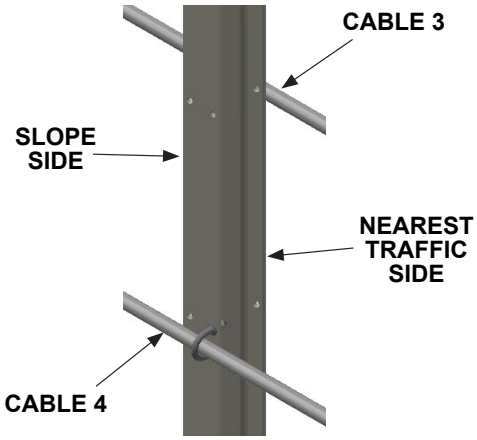


Figure 19
Cables 3 and 4 Installed

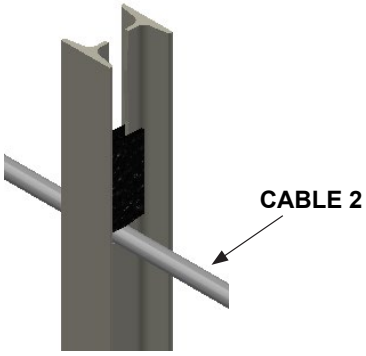


Figure 20
Cable 2 Installed

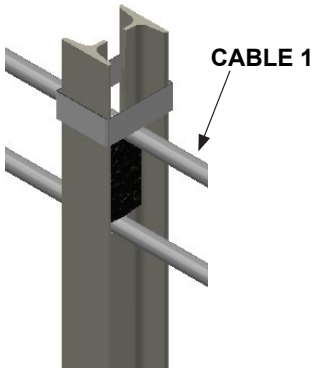


Figure 21
Cable 1 Installed

It is recommended before tensioning that for runs of cable greater than 5,000' [1,525 m], to pull the cable at intervals of 3,000' [915 m] to remove excess slack. Remove any post(s) or cables from the post where turnbuckles or torpedo splices will interfere with the posts during the tensioning.

Important: For long runs of cable, check the turnbuckles at every location to ensure the cable has not unthreaded during the laying out or slack pulling process. Ensure the threaded rod can be seen through the holes on each end of the turnbuckle or the 1 1/2" [38 mm] mark cannot be seen.

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 cable temperature at the time of tensioning. The tension meter shall be set for pre-stretched cable. An infrared thermometer is to be on-site at the point of tensioning to obtain the correct cable temperature. If an infrared thermometer is not available, obtain the air temperature from a reliable source in the immediate area and not influenced by other factors. See the CASS® S3 Temperature and Tension Chart for the tension requirements at the back of this manual.

Note: Due to frictional forces, it is recommended to start tensioning from the bottom cable, working upwards to the top cable.

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

Important: Completely review the manufacturer's manual included with the CASS® S3 tensioning meter prior to tensioning of the cable.

Important: Ensure that the tension meter is set for pre-stretched cable.

Important: Completely review the infrared thermometer manufacturer's manual prior to tensioning of the cable.

Warning: Infrared light is harmful if shined into the eyes.

Warning: Read and understand the directions provided for the CASS® cable pulling tool.

Warning: Extreme care should be taken to ensure that the CASS® cable pulling tool is attached to the cable in such a location that if it slips, the chain or CASS® cable pulling tool will not hit anyone. It is suggested that the pulling equipment be placed between the workers and the CASS® cable pulling tool. Read the directions and ensure the tool is clean, dry and the "teeth" of the tool is not worn.

Complete the following Steps to tension the cables:

1. Check the cable run to see if any of the turnbuckles or torpedo cable splice 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 taken at a location no closer than 500' [167 m] from the end that has not been connected to the CET™ Anchor Cables. Always take cable tension readings in tangential sections.

3. For cable runs greater than 5,000’ [1,525 m], it is recommended the cable be pulled every 3,000’ [915 m] to remove the slack from the cable.
4. With the required tension on the cable, place a mark on the cable where it meets the threaded end of the CET™ Anchor Cable.
5. Release the tension on the cable. Go back approximately 28” [0.71 m] from the mark and cut the cable.
6. Place a right-hand field applied fitting using the procedures in the Field Applied Fittings with a Turnbuckle section.
7. On the CET™ Anchor Cable end, place a turnbuckle (PN: 005826G for 1” fitting; PN: 005711G for 3/4” fitting) on the fitting by only a couple of threads. Pull the cable until the cables are connected to the turnbuckle. With both fittings inserted in the turnbuckle, the turnbuckle will be turned until the threaded ends can be seen through the peek hole at the end of the turnbuckle or both threaded ends are into the turnbuckle beyond the 1 1/2” [38 mm] mark.
8. With the cables connected, release the cable pulling tool from the cable. Check the tension on the cable. If a higher tension is needed, rotate the turnbuckle while the cables are restrained to prevent twisting.
9. Replace any posts removed during the tensioning process. If a turnbuckle or torpedo cable splice falls where there is a post, or if the turnbuckle or torpedo cable splice is 1’ [300 mm] from the post, replace the post with a splice interference post (PN: 034049G/post in sleeve or PN: 034061G/driven post).
10. **After the cables have been tensioned, tighten the two 1/4” nuts that were hand tightened in Step 2 of the “CET™ Upper Anchor” to a snug position with a minimum of two threads protruding beyond the nut.**
11. Two (2) or three (3) days after tensioning, check and record the tension values, at the same locations as taken in Step 2. If adjustment is needed to meet the tension on the tension chart, the turnbuckles can be adjusted. After adjustment, ensure the threaded rod is no more than 4” [100 mm] into the turnbuckle. It is suggested that the tension recorded be set approximately 800 lbf. [3.6 kN] above the value on the tension chart.
12. **It is highly recommended that approximately two (2) to three (3) weeks after checking the cable tensioning in Step 11, the cable tension is checked again against the tension chart. Make any adjustments necessary to meet the appropriate tension.**

Delineation

The specifying agency will establish the criteria for delineation of the CASS® line posts. The delineation is typically provided on the spacer used to separate the cables; but, can be placed in other locations including the cable itself.

Valtir provides optional reflective sheeting (PN: 005989B, White or PN: 005990B, Yellow) to install on the CET™ Terminal Posts.

Adhesive-backed delineation is typically attached to a 1/16" x 18" x 18" piece of aluminum which is secured to the CET™ Upper Anchor. Valtir makes no guarantees the reflectivity meets the minimum specifications, complies with MUTCD requirements or complies with state/specifying agency requirements.

Repairs

After an impact, the system will require repair. Full scale crash testing conducted in conformance with NCHRP Report 350 or MASH indicates that the cable will typically remain close to its original height depending on the number of posts damaged. 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 visually appears broken, frayed, torn, and/or damaged must be replaced. Additional specific parts of the CASS® S3 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 CET™ 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 outside of the testing parameters that the cable be checked to determine if re-tensioning is required.

Important: Valtir makes no recommendation whether use or reuse of any part of the system is appropriate or acceptable following an impact. It is the sole responsibility of the state/ specifying agency and its engineers or its agent to make that determination. It is critical that you inspect this product after assembly is complete to make certain that the instructions provided in this manual have been strictly followed.

Repair for CASS® S3 Impact (CET™ Upper Anchor Not Impacted)

If an impact occurs and a CET™ Upper Anchor is not involved, usually only the line or terminal posts will have to be replaced and the cables re-inserted in the posts or attached to the post. Follow the Steps below in making this repair:

1. Inspect the damaged system and determine what components will be required to correct and repair the CASS® S3 to originally specified working condition.
2. Remove the damaged posts. 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. With approval from the State specifying agency, 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 work gloves and eye protection during post removal. If the posts are driven, they will have to be pulled out of the ground.
3. Replace any damaged posts.
4. Replace the cables. For the line cables, see the "**Laying Out the Cable/Attaching the Cables to the Post**" section. For the CET™ cables, see the "**Terminal Cables**" section.

Depending on the severity of the impact, after the repair, the cable may need to be re-tensioned, Valtir recommends the tension of the cable be checked with the CASS® tension meter. If the tension is not in accordance with the CASS® S3 System Temperature/Tension chart, adjust turnbuckles to bring the cable to the correct tension. See the "**Tensioning and Tension Meter**" section to make any tension adjustments.

Note: The reflective sheeting may be placed on the spacer for CASS® S3 based on the agency's specification.

Repair for System Impact (CET™ Anchor Assembly Involved)

When the system has been impacted and CET™ Anchor Assembly is involved, follow the Steps below:

1. Inspect the damaged system and determine what material will be required to make the repairs.
2. Replace any visually damaged components. For any other components that have been damaged, follow the criteria in the "**Repair for CASS® S3 Impact (CET™ Upper Anchor Not Impacted)**" section.
3. Attach any detached cables and re-tension the cable.

Emergency Repairs

There is a possibility that an accident could cause significant traffic congestion, or the cable can be entangled with the vehicle. When 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. The following suggestions may help to get traffic moving and 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. PPE equipment such as protective gloves, safety goggles, and mask must always be used. **Keep personnel out of the area upstream and/or downstream from the point of the cut. In life threatening or emergency situations the cable can be cut.**

If the cable was put under additional tension due to the accident, the tension can be reduced at the turnbuckles closest to the impact. The turnbuckle can be backed off; however, **it is critical that the fittings remain engaged within the turnbuckle a minimum of 3/4" [19mm] when the cable is under tension.**

To reduce the amount of the cable damage during cutting and limit fraying, tape must be wrapped around the cable and the cut made through the tape. **Some agencies have also cut through the turnbuckle itself.** This may reduce the maintenance/repair efforts and costs. When cutting through a turnbuckle, ensure that all posts, both upstream and downstream for a distance of 50'-0" [15 m], are removed in order to prevent turnbuckle or fitting interference.

If time permits, the tension can be released by pushing over one or more of the CET™ Upper Anchor(s) with a piece of equipment.

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 must 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 CET™ end, it is possible to reduce tension by loosening the two large nuts on the terminal cable end. The nuts can be backed off to the end of the fitting.

WARNING: DO NOT COMPLETELY REMOVE EITHER OF 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. The length of the cable must be 50’-0” [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 infrared thermometer cable temperature reading and the values on the CASS® S3 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 follow the procedures in the “Tension and Tension Meter” Section. 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’-0” [1.5 m] Section

A second method to reconnect the cables is to use a 5’-0” [1.5 m] Cable Field Repair Section (PN: 005840G) of cable with a factory applied fitting 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 approximately 9’-8” [2.9 m] of cable from the cut cable.
2. Connect the threaded fittings and the cable ends connections per the “**Factory Applied Fittings with Turnbuckle” Section**.

Method 3 – Other Than 5’-0” [1.5 m] Cable

When using a cable length other than 5’-0” [1.5 m], the amount of cable removed from the cut cable is to be adjusted based on the cable length removed.

1. To help 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.
2. If the length of cable used is less than 5’-0” [1.5 m], remove less than 9’-8” [2.9 m] of cable from the cut cable.
3. If more than 5’-0” [1.5 m] of cable is used, remove more than 9’-8” [2.9 m] of cable 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. 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 cable temperature and the values on the CASS® S3 and CET™ Temperature/Tension Chart.

After completing one (1) of the four (4) methods above, 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 cable temperature and the values on CASS® S3 and CET™ Temperature/Tension Chart and complete the CASS® S3 and CET™ Assembly/Repair Checklist.

Cable Tension Inspection Program

Valtir recommends the cable tension be checked at least once a year. The tension value is established based on the cable temperature, which can be taken using an infrared thermometer for the cable temperature. If an infrared thermometer is not available, obtain the air temperature from a reliable source in the immediate area and not influenced by other factors. See CASS® S3 and CET™ Temperature/Tension Chart.

CASS® S3 & CET™ Assembly/Repair Checklist

(File With Project/Maintenance Records)

Performed by:_____

Date:_____

Location:_____

- ☐ 1. Ensure required traffic control is in place to conduct assembly/repair. (p. 6)
- ☐ 2. Ensure only Valtir CASS® S3 and CET™ parts are used for the assembly/repair and that all parts are free of damage. (pp. 7, 10)
- ☐ 3. Ensure site grading for the **CET™** complies with state/specifying agency guidelines, policies and/or the AASHTO Roadside Design Guide (whichever is more stringent), for guardrail terminals. (p. 20)
- ☐ 4. Ensure slope grading for the **CASS® S3** complies with state/specifying agency guidelines, policies and/or the AASHTO Roadside Design Guide, whichever is more stringent. (p. 20)
- ☐ 5. Ensure the Sleeve Cover is placed on the post and is flush with the top of the Post Sleeve. (pp. 23, 31)
- ☐ 6. Ensure the CET™ Line Post spacings are 10'-6". (p. 26)
- ☐ 7. Ensure the CET™ Lower Anchor is on the centerline and the center is 18" from the front edge of the anchor block. For concrete cylindrical anchor foundation foundations ensure the CET™ Lower Anchor is on the longitudinal and lateral centerline. (p. 27)
- ☐ 8. Ensure the CET™ Lower Anchor is oriented correctly and is secured using eight (8) 1" (25 mm) diameter threaded anchor rods. (pp. 27, 28)
- ☐ 9. Ensure the CET™ Anchor Link is oriented correctly and all threads on the bolt are engaged. (p. 28)
- ☐ 10. Ensure the CET™ U-Shaped Posts (One through Four) are oriented with the open side away from the CET™ Anchor. (p. 31)
- ☐ 11. Ensure the CET™ S3 SYT® Line Posts are in post locations Five through Ten. (p. 31)
- ☐ 12. Ensure the CET™ Cable 1 (top cable) and Cable 3 are located on the traffic side of the post and CET™ Cable 2 and Cable 4 (bottom cable) are located on the slope side of the post. Ensure the CASS® S3 Cable 3 is located on the traffic side of the post and CASS® Cable 4 is located on the slope side of the post. (pp. 31, 33)
- ☐ 13. Ensure that all CET™ Anchor cables are correctly placed in the CET™ Anchor Assembly. (pp. 31, 32)
- ☐ 14. Ensure two (2) 1" Hex Nuts have been placed on each of the ends of the anchor cable fittings, with a Minimum of two threads protruding beyond the second nut. Ensure the threaded rod is not in contact with the CET™ Lower Anchor or anchor nuts. (p. 32)
- ☐ 15. Ensure the Cable Hook Bolts and the Cable Lock Bolts are assembled correctly. (p. 33)
- ☐ 16. Ensure the Turnbuckle Fittings are a minimum of 1 1/2" [38 mm], with a recommendation of a maximum of 4" [100 mm] into the turnbuckle. (p. 38)
- ☐ 17. Ensure CASS® S3 Cable Spacer is placed between the top two (2) cables for the CASS® S3 system. (p. 40)
- ☐ 18. Ensure the CASS® S3 Post Strap is placed above the top cable of the CASS® S3 system. (p. 40)
- ☐ 19. Ensure the CASS® S3 reflector spacers are placed per the contract plans. (p. 42)
- ☐ 20. Ensure there are no damaged/frayed/bent cables. (p. 43)
- ☐ 21. Ensure the Tension on all cables are as specified in the "CASS® S3 & CET™ Temperature/Tension Chart". (pp. 41, 49)

CASS® S3 & CET™ Routine Inspection Checklist

(File With Project/Maintenance Records)

Performed by:_____

Date:_____

Location:_____

Valtir recommends the state/specifying agency develop and administer their own end terminal inspection program, based on location of unit, volume of traffic and impact history.

Important: CASS® S3 & CET™ and all of its components shall be inspected for damage after every impact. **Repair using only Valtir parts that are specified for use within the CASS® S3 4:1 with CET™ Product Manual, latest edition.**

If no CASS® S3 or Cable Barrier inspection program exists, Valtir recommends visual drive-by inspections at least once every month and walk-up inspections at least once every year. These inspections shall, at a minimum, consist of:

Visual Drive-By Inspections (Recommended Frequency: Monthly)

- ☐ Check for damage caused by vehicle impacts.
- ☐ Check for damage caused by impacts from snowplow, mowing or roadway operations.
- ☐ Check for misalignment.
- ☐ Check for missing system components.
- ☐ Check for vandalism.
- ☐ Check for damage caused by adverse weather conditions (i.e. erosion, weight of snow, UV).

Walk-Up Inspections (Recommended Frequency: Yearly)

Walk-Up Inspections include ALL Visual Drive-By Inspection items (listed above) as well as the items listed below.

- ☐ Ensure required traffic control is in place to conduct walk-up inspection.
- ☐ Check and record the tension per the manufacturer's recommendation.
- ☐ Clear and dispose of any debris or trash found on the CASS® S3 & CET™ or interfere with the performance of CASS® S3 & CET™.
- ☐ Check for erosion to the site grading around the system.
- ☐ Check all fasteners to ensure they are tight.

If any of the above items are identified during the inspection process as being deficient, swift action shall be taken to correct and repair the CASS® S3 and/or CET™ to working condition as outlined in the **CASS® S3 4:1 With CASS® End Terminal (CET™)** Product Manual, latest edition.

CASS® S3 & CET™ Temperature/Tension Chart

Pre-Stretched Cable			
°F	**Tension (lbf)***	**°C**	**kN**
-15	7500	-26	33.3
-10	7300	-23	32.5
-5	7100	-21	31.6
0	7000	-18	31.1
5	6800	-15	30.3
10	6600	-12	29.4
15	6500	-9	28.9
20	6300	-7	28.0
25	6100	-4	27.1
30	6000	-1	26.7
35	5800	2	25.8
40	5600	4	24.9
45	5500	7	24.4
50	5300	10	23.6
55	5100	13	22.7
60	5000	16	22.2
65	4800	18	21.4
70	4600	21	20.5
75	4500	24	20.0
80	4300	27	19.1
85	4100	29	18.2
90	4000	32	17.8
95	3800	35	16.9
100	3600	38	16.0
105	3500	41	15.6
110	3300	43	14.7
115	3100	46	13.8
120	3000	49	13.3
125	2800	52	12.5
130	2700	54	12.0
135	2600	57	11.6
140	2500	60	11.1
145	2400	63	10.7
150	2300	65	10.2
160	2100	71	9.3
170	1900	77	8.5
180	1700	82	7.6
190	1500	88	6.7
200	1300	93	5.8

*** Tolerance: –200 to + 800 pounds force [-0.9 to + 3.6 kN]**

Tension Log

Cable Safety System™

Project Owner:____

Project Number:__________________ **Project Description:**__________________

Date Checked:____________________ **Valtir Drawing #:**______________________

IR Temperature of Steel:______________ **Corresponding Chart Lbf. Tension:**__________

By: Company/Agency:__________________

ALWAYS check tension in a tangential (NON-radii) section of the cable installation, a minimum of 500 LF from CET™

Run # _______ **STA:** _________ **to STA:** ________ **LF of Run:** ______

Loc: ________	**Actual Lbf.**	**Loc:** ________	**Actual Lbf.**	**Loc:** ________	**Actual Lbf.**
Cable 1	________________	Cable 1	________________	Cable 1	________________
Cable 2	________________	Cable 2	________________	Cable 2	________________
Cable 3	________________	Cable 3	________________	Cable 3	________________
Cable 4	________________	Cable 4	________________	Cable 4	________________

Loc: ________	**Actual Lbf.**	**Loc:** ________	**Actual Lbf.**	**Loc:** ________	**Actual Lbf.**
Cable 1	________________	Cable 1	________________	Cable 1	________________
Cable 2	________________	Cable 2	________________	Cable 2	________________
Cable 3	________________	Cable 3	________________	Cable 3	________________
Cable 4	________________	Cable 4	________________	Cable 4	________________

Loc: ________	**Actual Lbf.**	**Loc:** ________	**Actual Lbf.**	**Loc:** ________	**Actual Lbf.**
Cable 1	________________	Cable 1	________________	Cable 1	________________
Cable 2	________________	Cable 2	________________	Cable 2	________________
Cable 3	________________	Cable 3	________________	Cable 3	________________
Cable 4	________________	Cable 4	________________	Cable 4	________________

Loc: ________	**Actual Lbf.**	**Loc:** ________	**Actual Lbf.**	**Loc:** ________	**Actual Lbf.**
Cable 1	________________	Cable 1	________________	Cable 1	________________
Cable 2	________________	Cable 2	________________	Cable 2	________________
Cable 3	________________	Cable 3	________________	Cable 3	________________
Cable 4	________________	Cable 4	________________	Cable 4	________________

In all cases Cable 1 is the top cable and Cable 4 is the bottom cable.

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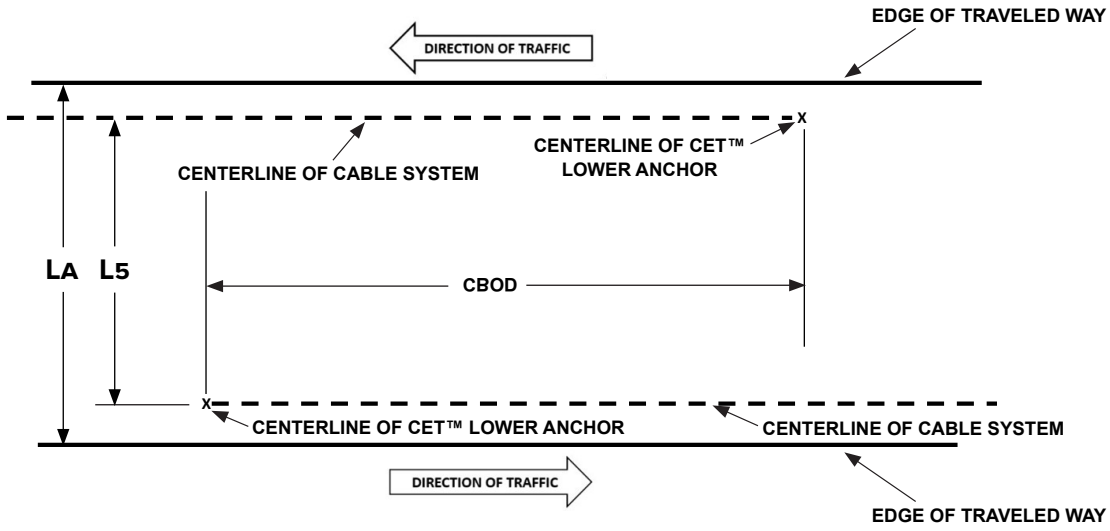
Appendix A: Flare Assemblies 30:1 Flare

Appendix B: Cable Barrier Overlaps



CBOD= CABLE BARRIER OVERLAP DISTANCE = 157' + (L5 x LR) / LA

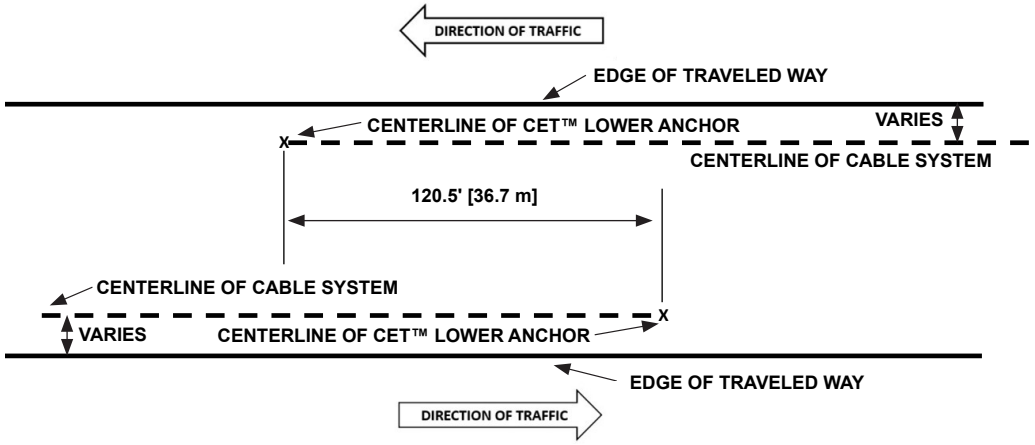
LA= MEDIAN WIDTH
L5 = DISTANCE BETWEEN THE TWO CABLE BARRIER SYSTEMS
LR = RUNOUT LENGTH BASED ON THE RDG

EXAMPLE:

GIVEN: MEDIAN WIDTH = 48'; DESIGN SPEED = 70 MPH; ADT = 8200VPD; LA = 48'; L5 = 30' FROM THE RDG, LR = 330'

CBOD = 157' + (30' x 330') / 48' = 363'

Cable Barrier Overlap A (Approach)



Cable Barrier Overlap B (Trailing)

Appendix C: Encountering Rock

Assembling CASS® Foundation Tubes or Posts

CASS® S3 Foundation Tubes

Complete the following Steps to assemble CASS® Foundation Tubes when encountering rock:

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” [225 mm] or less of the full-length foundation tube remains to be embedded. Install the full length foundation tube (Option A) or as shown below (Option B).

A. Drill a 12” to 16” [300 mm to 400 mm] diameter hole into the rock.

B. Drill the hole 3” [75 mm] deeper than the required embedment depth.

C. Place the MSC in the hole with the top of the footing flush with the finish grade. The MSC can be reinforced with either macro synthetic fiber (4 lbs./yd^3) or a re-bar ring.

D. Place the foundation tube per the “Sleeve in a Concrete Footing (Poured Footing)” section.

Option B - If rock is encountered and more than 9” [225 mm] of the full-length foundation tube remains to be embedded.

A. Drill a 12” to 16” [300 mm to 400 mm] diameter hole into the rock. The minimum depth to the bottom of the hole from the ground line shall be 21” [525 mm]. The 21” [525 mm] includes 3” [75 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. Follow the Steps in C and D in “Option A” above.

CASS® S3 Foundation Tubes with Soil Plates

For Foundation with Tubes with Soil Plates, remove the soil plate from the sleeve and follow the “Foundation Tube” Steps above.

CASS® S3 Driven Posts

For Driven Posts, it is recommended that the post be installed with a Foundation Tube. Follow the Foundation Tube Steps above.

Assembling CET™ Foundation Tubes

CET™ Foundation Tubes

Complete the following Steps to assemble the CET™ U-Shaped foundation tube and CET™ S3 SYT® Line foundation tube when encountering rock.

CET™ U-Shaped Foundation Tube (Post One to Post Four)

If rock is encountered and a full-length CET™ U-Shaped foundation tube cannot be embedded.

A. Drill a 12” to 16” [300 mm to 400 mm] diameter hole into the rock for full length embedded.

B. Drill the hole 3” [75 mm] deeper than the required embedment depth.

C. Place the MSC in the hole with the top of the footing flush with the finish grade. The MSC can be reinforced with either macro synthetic fiber (4 lbs./yd^3) or a re-bar ring.

D. Place the foundation tube per the "CET™ Line Concrete Footings – Post One to Post Ten" section.

CET™ S3 SYT® Line Foundation Tubes (Post Five to Post Ten)

Complete the following Steps to assemble CASS® S3 SYT® Line Foundation Tubes when encountering rock:

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" [225 mm] or less of the full-length foundation tube remains to be embedded.

A. Drill a 12" to 16" [300 mm to 400 mm] diameter hole into the rock.

B. Drill the hole 3" [75 mm] deeper than the required embedment depth.

C. Place the MSC in the hole with the top of the footing flush with the finish grade. The MSC can be reinforced with either macro synthetic fiber (4 lbs./yd^3) or a re-bar ring.

D. Place the foundation tube per the "CET™ Line Concrete Footings – Post One to Post Ten section.

Option B - If rock is encountered and more than 9" [225 mm] of the full length foundation tube remains to be embedded. Install the full-length foundation tube (Option A) or as shown below (Option B).

A. Drill a 12" to 16" [300 mm to 400 mm] diameter hole into the rock. The minimum depth to the bottom of the hole from the ground line shall be 21" [525 mm]. The 21" [525 mm] includes 3" [75 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. Follow the Steps C and D in "Option A" above.

Appendix D: Base Plated Post Assembly within CASS® S3

The base plated post (PN: 034037A) must be placed on a concrete surface 6” [150 mm] or more in depth (See Figure 21). The post length varies per concrete elevation.

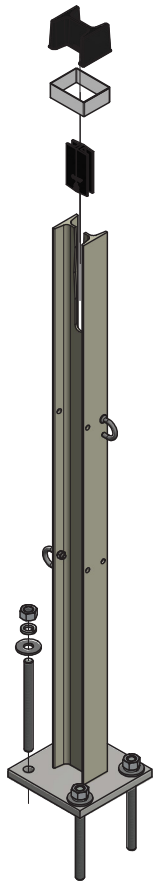


Figure 22
Base Plated Post

Complete the following Steps for the base plated post assembly

1. Drill four (4) 3/4” [19 mm] holes, 6” [150 mm] deep for the rod (PN: 005225G or PN: 006722G).
2. Blow the concrete dust from the borehole using oil-free compressed air. Thoroughly brush it with a steel bristle tube brush and then blow it out again. If the borehole is wet, completely flush it with water while brushing and then blow it clean to remove all water using oil-free compressed air.
3. Fill the holes using the Hilti HY200, 330 Adhesive (PN: 118710B) or equivalent. Ensure the threaded anchor rods are inserted, with a twisting motion, and the adhesive comes out of the hole. Follow the manufacturers’ recommendations. Ensure the rods extend **a maximum of** 2 inches [50 mm] above the concrete surface.
4. Allow the adhesive to cure according to the manufacturer’s recommendations.
5. Place the base plated post on the rods.
6. Place flat washer (PN: 003300G) and lock washer (PN: 003310G) between the hex nut (PN: 003361G) and the plate (See Figure 22).
7. Tighten the nuts to a snug position with an appropriately sized wrench or socket and the lock washer is flat with a minimum of two threads beyond the nut.

Note: A 5/8” [16 mm] mechanical anchor with a pullout strength of 10,000 lbs. [4536 kg] can also be used.

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