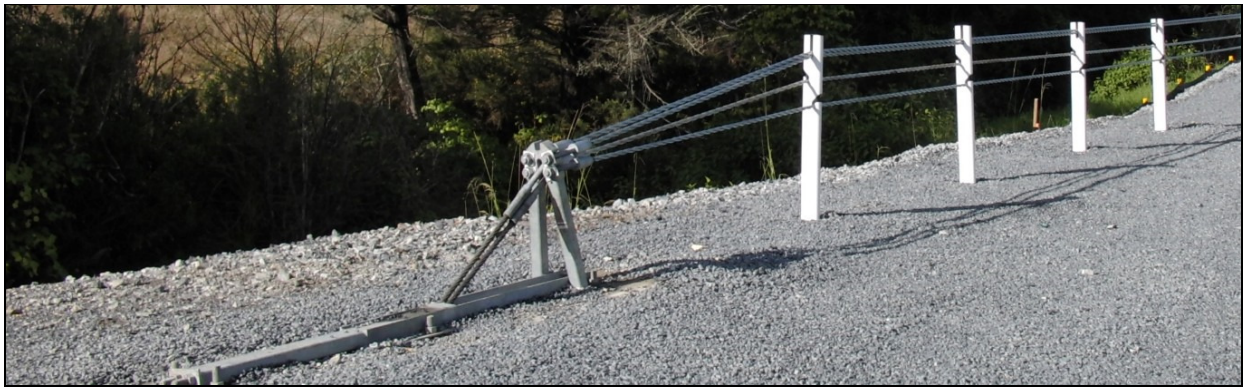
Installation Manual

Universal Armorwire Terminal End™



Anchoring for 3 & 4 Cable Barriers

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Universal Armorwire Terminal End™ Introduction

Introduction

The ***Universal Armorwire Terminal End™ (A.T.E)*** is used to anchor high tensioned 3 or 4 cable barriers. All cables connect to the unique 'trigger' post which is attached to the ground strut, while concrete foundations and rebar cages complete the anchor set-up.

The ***Universal A.T.E™*** has been designed and tested to meet the evaluation criteria of NCHRP 350 Test Level 3 (TL-3) for a cable barrier terminal end.

It is recommended that the ***Universal A.T.E™*** is used to anchor ***Armorwire™*** cable barriers which have been accepted to NCHRP 350 TL-3 and TL-4.

Limitations and Warnings

The ***Universal A.T.E™*** has been rigorously tested and evaluated per the evaluation criteria in the NCHRP 350 guidelines for gating, re-directive cable barrier terminal end. The impact conditions recommended in NCHRP 350 are intended to address typical in-service collisions.

The ***Universal A.T.E™*** allows an impacting vehicle to remain on its wheels in a safe and predictable manner under the NCHRP 350 impact conditions. It is imperative that the system is installed as per manufacturers' specification.

Vehicle impacts that vary from the NCHRP 350 impact conditions described for cable barrier terminal ends may result in significantly different results than those experienced in testing. Vehicle impact characteristics different than, or in excess of, those encountered in NCHRP 350 testing (weight, speed and angle) may result in system performance that may not meet the NCHRP 350 evaluation criteria.

Before Installation

Design, selection and placement of the ***Universal A.T.E™*** must be in accordance with the Road Controlling Authority's guidelines and the details shown in the construction drawings. Installation must be in accordance with the installation instructions supplied for this product.

Note: Concrete foundations will have to be designed by a local geotechnical engineer if soil conditions on site do not meet the required level described in the manual.

Depending on the application and circumstances at the site, installation and assembly of the system should take one person less than 15mins once the concrete foundation piles are poured and set.

The ***Universal A.T.E™*** is a highly engineered safety device made up of a relatively small number of parts. Before starting installation ensure that one is familiar with the make up of the terminal end.

Design Considerations

Curbs

As with all road side safety hardware, the ***Universal A.T.E™*** has been designed and tested so that the centre of gravity of the impacting vehicle is at a constant height in relation to the system. For this reason, it is preferred that curbs or channels are not in front or behind the terminal end as they will result in altering the height of the vehicle at impact. If there is no option but to install near a curb advice should be followed from the Road Controlling Authority's guidelines.

Undulating Ground Conditions

Site specific grading may be necessary to ensure that there are no 'humps' or 'hollows' that may significantly alter the impacting vehicles stability or substantially alter the cable heights in relation to the ground. The ground strut is required to lay flush with the foundation piles and must not protrude more than 100mm from ground level, when measured using a 1500mm cord pulled along the centreline of the anchor assembly.

Flare Rate

The preference is to not flare the system. If this is unavoidable then the maximum flare rate should be 30:1 over the entire length of the terminal end.

Clearzone

The ***Universal A.T.E™*** is a gating, non-energy absorbing terminal end and therefore requires a clearzone directly behind as recommended by Road Controlling Authority guidelines. The minimum size of the clearzone should be an area 22.5m long by 6m wide, reasonably traversable and free from fixed object hazards.
(See drawing in Appendix)

Soil Conditions

The ***Universal A.T.E™*** foundation pile options contained in this manual have been designed to withstand a constant static load and dynamic impact load that can be exerted on it from the tensioned barrier cables. Therefore it is extremely important that the soil conditions on site have the adequate bearing capacity to support the ***Universal A.T.E™*** foundations and is recommended that soil tests are carried out on site.

SOIL CONDITIONS ON SITE MUST MEET OR EXCEED THE REQUIRED STRENGTH AS DETAILED IN THE SYSTEM DRAWING ON PAGE 17 OF THIS MANUAL.

IF SOIL CONDITIONS ON SITE DO NOT MEET OR EXCEED THE REQUIRED STRENGTH DETAILED IN THIS MANUAL, SITE SPECIFIC FOUNDATIONS MUST BE DESIGNED BY A LOCAL GEOTECHNICAL ENGINEER

System Design

Foundation Options

For the ***Universal A.T.E™*** to provide sufficient anchoring strength to the cable barrier it relies on the design of the concrete foundation and the surrounding soil conditions on site. Soil conditions have different characteristics that will affect the strength of the concrete foundations and accordingly the ***Universal A.T.E™*** has a range of foundations options which allow for economical construction, while still maintaining the performance levels required.

IF SOIL CONDITIONS ON SITE DO NOT MEET OR EXCEED THE REQUIRED STRENGTH DETAILED IN THIS MANUAL, SITE SPECIFIC FOUNDATIONS MUST BE DESIGNED BY A LOCAL GEOTECHNICAL ENGINEER

Note: All technical information required to assist in designing a site specific foundation is available from your ***Universal A.T.E™*** distributer as a ***Foundation Assistance Package***.

Three foundation options are available in this manual; the soil conditions that exist on site will determine which one can be used.

Option 1:

TO USE OPTION 1 THE TESTED SOIL CONDITION MUST MEET OR EXCEED THE STRENGTH DETAILED IN TABLE 1 BELOW

Cohesive Soils		
Soil Type	Description Su (kpa)	Foundation Pile Depth
Firm - Stiff	51 - 100	450mm ø x 2500mm
Cohesionless Soils		
Soil Type	Description Phi (0)	Foundation Pile Depth
Dense - Medium Dense	30 - 41	450mm ø x 2500mm

* G&A 24 Sept 2009 # 077812115/06 Rev 1.

Table 1.

The ground strut and 2000mm long rebar cage assembly must be cast into concrete foundation piles with the following dimensions. The augured holes for this option are 450mm diameter by 2500mm deep and filled with 25mpa concrete. The rebar cages are located centrally in the foundation piles. (shown in Figure A)

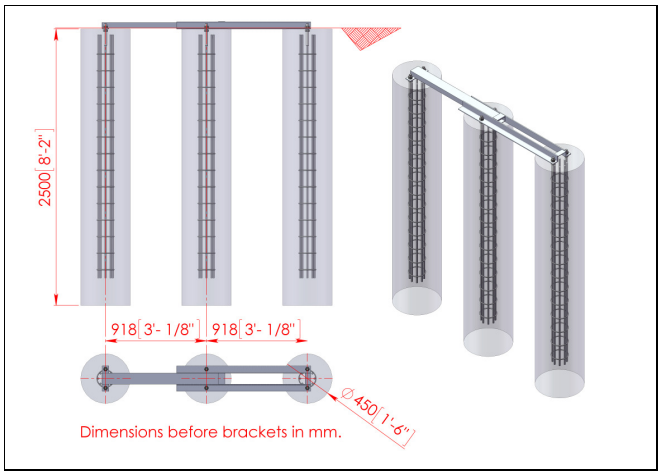


Figure A.

Option 2:

TO USE OPTION 2 THE TESTED SOIL CONDITION MUST MEET OR EXCEED THE STRENGTH DETAILED IN TABLE 2 BELOW

Cohesive Soils		
Soil Type	Description Su (kpa)	Foundation Pile Depth
Very Stiff	101 - 125	450mm ø x 1500mm

* G&A 24 Sept 2009 # 077812115/06 Rev 1.

Table 2.

The ground strut and 1200mm long rebar cage assembly must be cast into concrete foundation piles with the following dimensions. The augured holes for this option are 450mm diameter by 1500mm deep filled with 25mpa concrete. The rebar cages are located centrally in the foundation piles. (shown in Figure B)

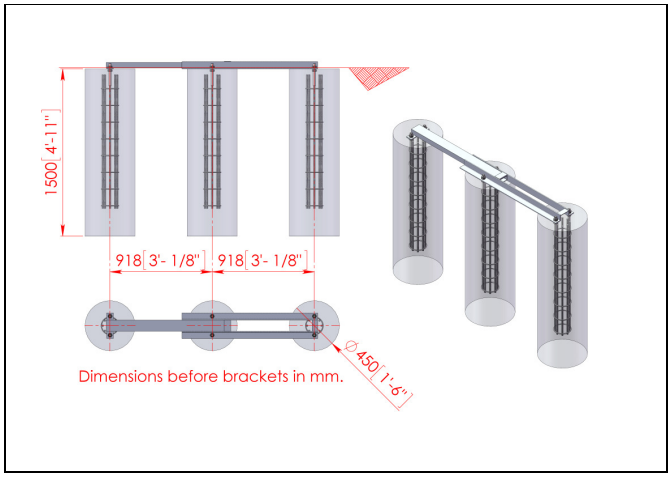


Figure B.

Option 3:

OPTION 3 IS FOR USE IN EXTREMELY POOR SOIL. TO USE THE CONDITIONS ON SITE MUST MATCH THE BELOW DESCRIPTION

- WATER TABLE IS AT GROUND SURFACE
- COHESION IS ZERO
- 'ANGLE OF INTERNAL FRICTION' IS A MINIMUM OF 30 DEGREES

Assumptions - Saturated unit weight of soil 1800 kg/m³ (112 lbs/ft³)
- Effective unit weight of soil 800 kg/m³ (50 lbs/ft³)
- Unit weight of concrete in air 2550 kg/m³ (159 lbs/ft³)
- Effective unit weight of concrete submerged 1550 kg/m³ (97 lbs/ft³)

* G&A 27 May 2009 # 077812115/10

(Continued over page)

Option 3 continued:

The ground strut and 2000mm long rebar cage assembly must be cast into a concrete block with the following dimensions. The excavated hole for this option is 1830mm wide by 4580mm wide and 2440mm deep filled with 25mpa concrete. The rebar cages are located in the centre widthways but offset lengthways at 300mm from the trigger post end of the ground strut assembly. (shown in Figure C)

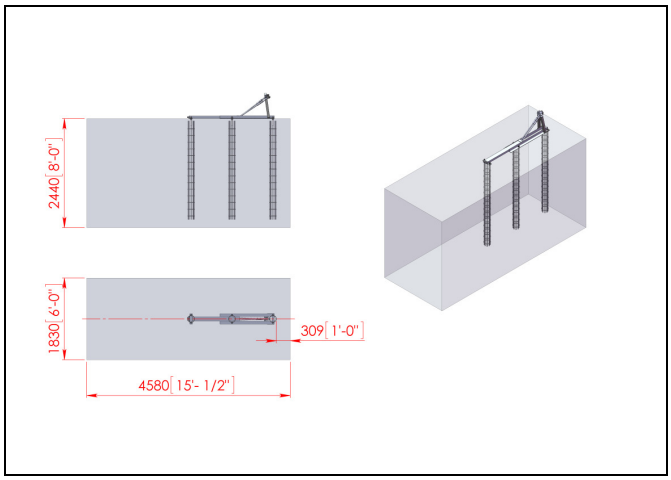


Figure C.

Length of Need (LoN)

The Length of Need (LoN) for an ***Armorwire™*** cable barrier connected to a ***Universal A.T.E™*** is at post #5, where post #1 is the 'trigger' post. Posts #2 - #5 are always at 2m spacing; therefore the LoN is 8m from the 'trigger' post. (shown in Figure D)

Note: As per the LoN design section of the Road Controlling Authority's guidelines, care must be taken when calculating the actual length of the barrier required versus the theoretical length of the LoN. The physical placement of the ***Universal A.T.E™*** must be with post #5 positioned at the LoN.

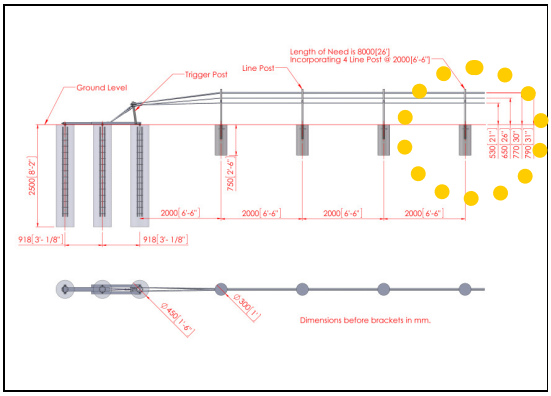
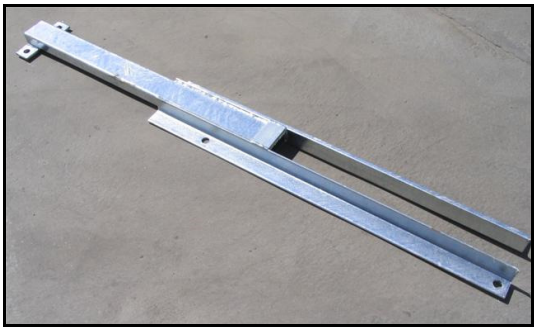


Figure D*.

*** Pile Foundation Option shown for visual representation only.**

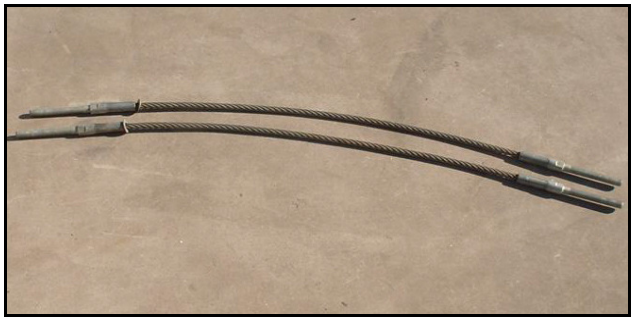
Universal A.T.E™ - Parts Identification



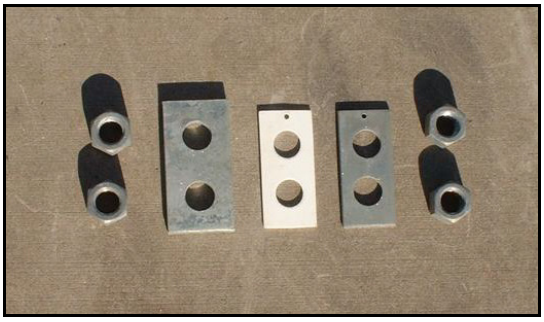
Ground Strut

* Type of cage shown for visual representation only.

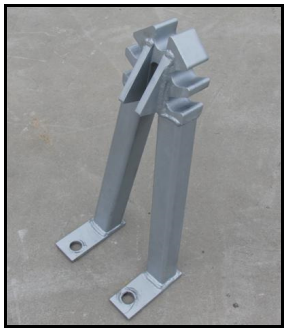
Rebar Cages



Anchor Cables



Washers & Nuts



Trigger Post

Cable Grips*

Cable Grips*

* For each cable grip a M24 steel nut, 3mm thick polyethylene square washer and a 6mm thick steel round washer is also required. Shown above are the cable grip and fitting requirements for a 3 and 4 cable barrier respectively.

All steel components used in the Universal A.T.E™ are hot dipped galvanized, <u>except</u> the rebar cages which are cast into the concrete piles.

Universal A.T.E™ - Installation Preparation

Getting Started

The ***Universal A.T.E™*** is a cable barrier terminal end designed to anchor either 3 or 4 cable barriers. For all installations, whether median or edge of road locations, start from the last post of the cable barrier. The 4 line posts between the end of the cable barrier and the ***Universal A.T.E™*** 'trigger' post must always be at 2m spacing.

Preparation

Before installing a ***Universal A.T.E™***, ensure that all components required for the system are on site and have been identified. The ***Universal A.T.E™*** is a highly engineered safety device made up of relatively small number of parts. Before starting installation ensure that one is familiar with the make up of the system. Refer to the ***Bill of Materials*** and ***Parts Identification*** sections in this manual for more information.

Ensure that the area where the ***Universal A.T.E™*** is to be installed is flat enough so that the ground strut will not protrude more than 100mm from ground level, when measured using a 1500mm cord pulled along the centreline of the anchor assembly.

Minor site grading may be required.

Geotechnical Warning

The ***Universal A.T.E™*** concrete foundations require sufficient strength from the supporting soil and guidelines contained within this manual on foundation sizes relate specifically to the corresponding soil strength. If it is determined that soil conditions on site do not meet or exceed these requirements, alternative size foundations must be designed by a local geotechnical engineer for use at that location.

Tools Required

The same tools required to install the cable barrier will also install a ***Universal A.T.E™***:

- Drilling or excavating machinery suitable for foundation design
- Concrete trowel or float
- 300mm Wrench
- Measuring tape
- String line

Universal A.T.E™ - Installation Instructions

Step 1 – Site Preparation

It is preferred that the ***Universal A.T.E™*** be installed on flat, level ground. The ***Universal A.T.E™*** starts at the last post of the cable barrier and the setup is always the same configuration over its 10m length.

The ***Universal A.T.E™*** is a continuation of the cable barrier and should be installed in a tangent position. If this is not possible, a maximum flare rate of 30:1 is accepted.

The 4 line posts between the ***Universal A.T.E™*** 'trigger' post and the cable barrier must always be at 2m spacing.

BEFORE DRILLING OR EXCAVATION ALWAYS ENSURE THAT THE AREA IS CLEAR OF UNDERGROUND SERVICES

Safety Statements

General Safety

- All required traffic safety precautions should be complied with. All workers should wear required safety clothing. (Examples, and not limited to, include: high visibility vests, steel capped footwear, gloves etc.)
- Only authorized trained personnel should operate any machinery. Where overhead machinery is used, care must be taken to avoid any overhead hazards.
- Before drilling or excavation always ensure that the area is clear of underground services. (The appropriate service providers may need to be contacted)

Universal A.T.E™ Safety Statements

- All installers must be well clear of drilling or excavating machinery operating.
- The components are not heavy enough to require specialised lifting equipment, but due to the dimensions and bulky nature, care should be taken when lifting the larger components into position. If the ground strut and rebar cage assembly is assembled prior to installation, suitable lifting equipment will be required.
- Avoid placing hands or fingers in and around moving machine parts when components are being lifted and manoeuvred into place.

Step 2 – Installing the Ground Strut

Foundation Construction

Excavate or drill the area that the Universal A.T.E™ is to be located as per the foundation option required. (shown in Figure 1)

All technical information on the 3 foundation options available, or for guidance on site specific foundations design, is located in the ***System Design*** section in this manual under ***Foundation Options.***

DO NOT PROCEED PAST THIS POINT IF THE TYPE OF FOUNDATION REQUIRED HAS NOT BEEN ESTABLISHED

Ground Strut and Rebar Cage Assembly

Attach each rebar cage to the ground strut using M24 nuts, one below and one above the ground strut. (shown in Figure 2)

At least 15mm of thread above the top nut must be showing on ALL threads.

Note: This assembly can take place either pre-installation or in position on site. Depending on type of rebar cages used, suitable lifting equipment will be required.

Construction

The foundation can be constructed in two ways. Either fill the foundation excavation to the top with concrete and insert the rebar cage assembly, or manoeuvre the rebar cage assembly into the foundation excavation and then fill with concrete. (shown in Figure 3)

Which technique to use will be dependent on the foundation used and type of rebar cage. Position of the rebar cage assembly must be in accordance with the foundation design.

Note: The hollow RHS end of the ground strut is always at the end furthest from the cable barrier and needs to be flush with the concrete level. (shown in Figure 3)

Figure 1*.

Figure 2*.

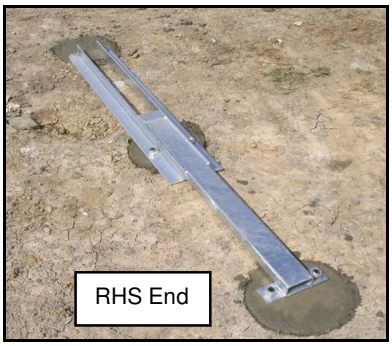


Figure 3*.

Note: Due to the drilling and removing spoil the actual amount of concrete required is likely to be larger than the theoretical volume. Concrete must be 25mpa.

*** Pile Foundation Option shown for visual representation only.**

Step 3 – Installing the Anchor Cables

Once the concrete has had sufficient time to harden, the anchor cables can be connected to the ground strut. (shown in Figure 4)

Hold both anchor cables at once and slot down through the RHS end of the ground strut.

The 10mm thick rectangular steel washer is placed onto the threads at the upstream end of the ground strut and the M24 nuts can be then wound on. (shown in Figure 5)

Note: Only wind on by 1 or 2 threads at this stage, they are fully tightened later in **Step 5**.

Figure 4*.

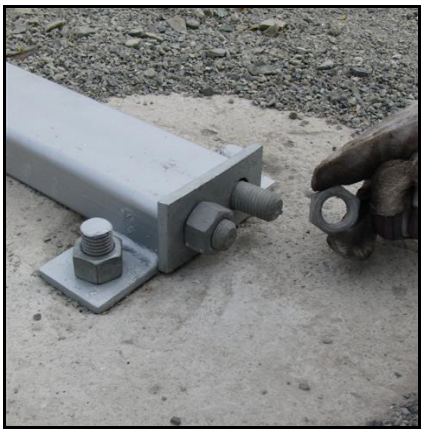


Figure 5*.

At the other end of the anchor cables the 3mm thick polyethylene rectangular washer is placed onto the threads first, followed by the 6mm thick steel rectangular washer. The M24 nuts can then be wound on. (shown in Figures 6 & 7)

Note: Only wind on by 1 or 2 threads so there is sufficient room in the 'trigger' post to house the cable grips.

Figure 6*.

Figure 7*.

*** Pile Foundation Option shown for visual representation only.**

Universal A.T.E™ - Installation Instructions

Step 4 – Connecting the Trigger Post

Remove the two M24 nuts on the top side of the downstream end of the ground strut. The 'trigger' post can then be placed on the exposed threads and the nuts re-attached and tightened with a wrench. (shown in Figures 8 & 9)

Note: At least one thread must be wound through the nuts when re-attached.

Figure 8*.

Figure 9*.

Step 5 – Connecting the Anchor Cables to the Trigger Post

The anchor cables with washers are positioned onto the triangular wedges on the 'trigger' post. The anchor cables are then tightened with a wrench by turning the nuts at the upstream end of the ground strut until taut. (shown in Figures 10 & 11)

Note: An open end wrench may be required due to space constraints.

Figure 10*.

Figure 11*.

MAKE SURE THE ANCHOR CABLES ARE FULLY HOUSED WITHIN THE 'TRIGGER' POST.

*** Pile Foundation Option shown for visual representation only.**

valmont HIGHWAY

Step 6 – Connecting to the Cable Barrier

For the 3 cable barrier place top cable in the top slot of the 'trigger' post and the bottom two cables on either side in the bottom slots. (shown in Figures 12)

For the 4 cable barrier place the top 2 cables in the top slots on either side of the 'trigger' post and the bottom two cables on either side in the bottom slots. (shown in Figures 13)

Make sure that the 3mm thick polyethylene square washer is positioned between the 6mm thick steel round washer and the 'trigger' post on each cable.

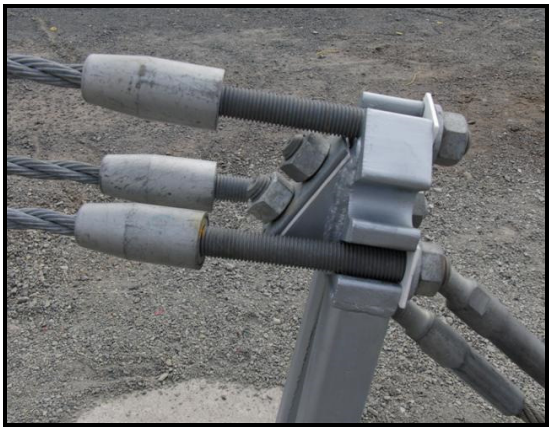


Figure 12*.

Figure 13*.

NOTE: DO NOT TENSION THE BARRIER UNTIL AT LEAST 7 DAYS AFTER THE ANCHOR FOUNDATIONS HAVE BEEN CAST.

*** Pile Foundation Option shown for visual representation only.**

Step 7 – Delineation

Delineation may be required as per the Road Controlling Authority guidelines.

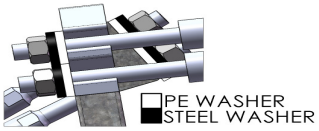
For further details including type, location and placement contact your nearest ***Armorwire*** distributor.

INSTALLATION CHECKLIST FOR THE
Universal A.T.E™

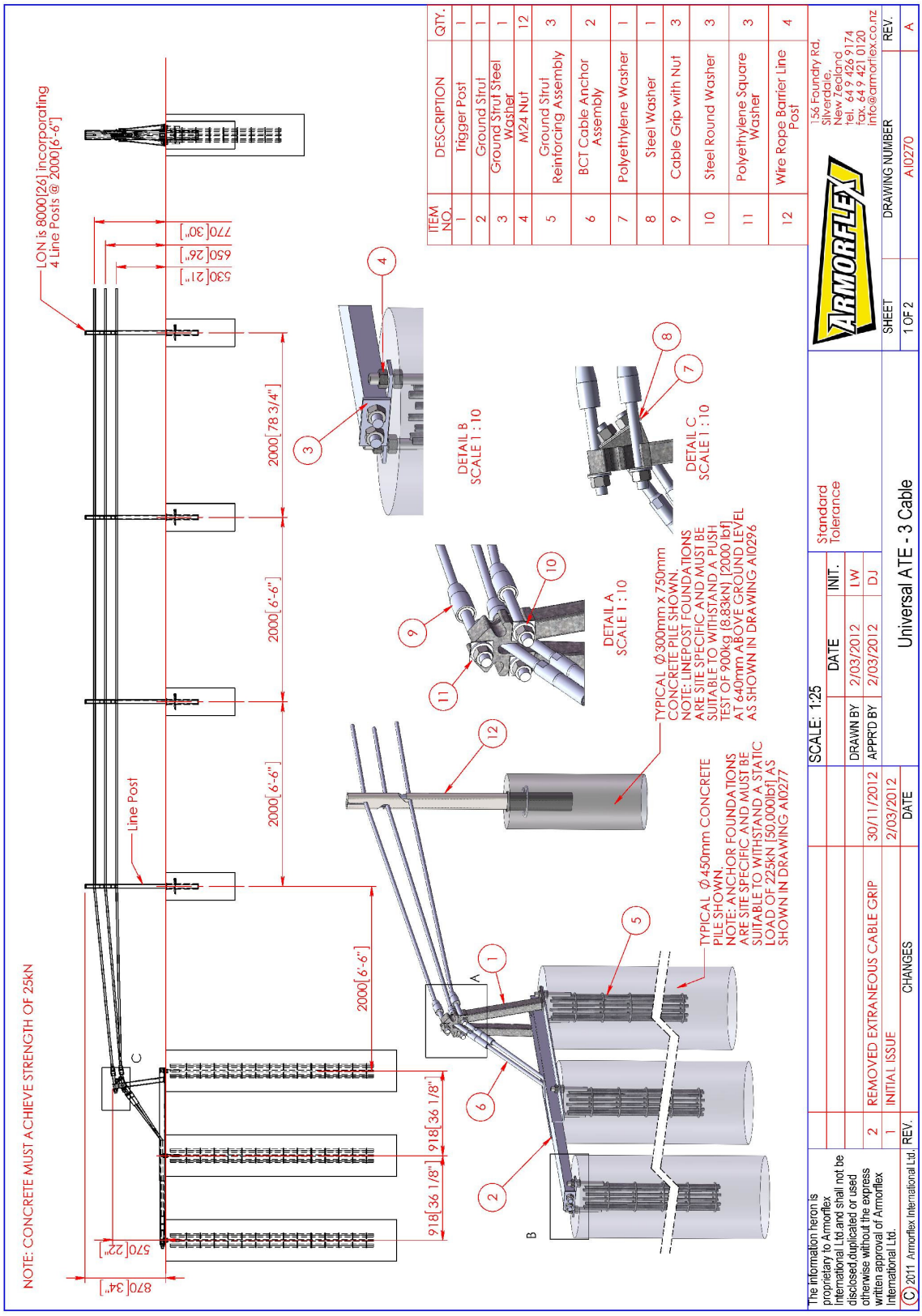
Location			
Installed By		***Date***	
Inspected By		***Date***	

	Y/N	***N/A***
General • The ground strut **does not protrude more than 100mm** when measured using a 1500mm cord along its centreline. • The M24 nuts holding the ground strut to the foundation are **spanner tight.** • The 10mm thick steel rectangular washer has been used to fix the anchor cables to the **upstream end** of the ground strut. • The 3mm thick polyethylene rectangular washer and 6mm thick steel rectangular washer are used to fix the **anchor cables to the 'trigger' post** (see diagram below). • The **anchor cables are firmly held** in the body of the triangular wedges on the 'trigger' post and the M24 nuts at the upstream end of the ground strut are **spanner tight**. **Connected to a 3 Cable Barrier** • The **top cable** of the cable barrier is positioned in the **top slot** on the 'trigger' post. • The **two bottom cables** are positioned on either side of the 'trigger' post in the **bottom slots**. • The 3mm thick square polyethylene washer **is between** the 6mm round steel washer and the 'trigger' post for all three cables. (see diagram below) **Connected to a 4 Cable Barrier** • The **two top cables** of the cable barrier are positioned on either side of the 'trigger' post in the **top slots**. • The **two bottom cables** are positioned on either side of the 'trigger' post in the **bottom slots**. • The 3mm thick square polyethylene washer **is between** the 6mm round steel washer and the 'trigger' post for all four cables. (see diagram below)		

Comments:

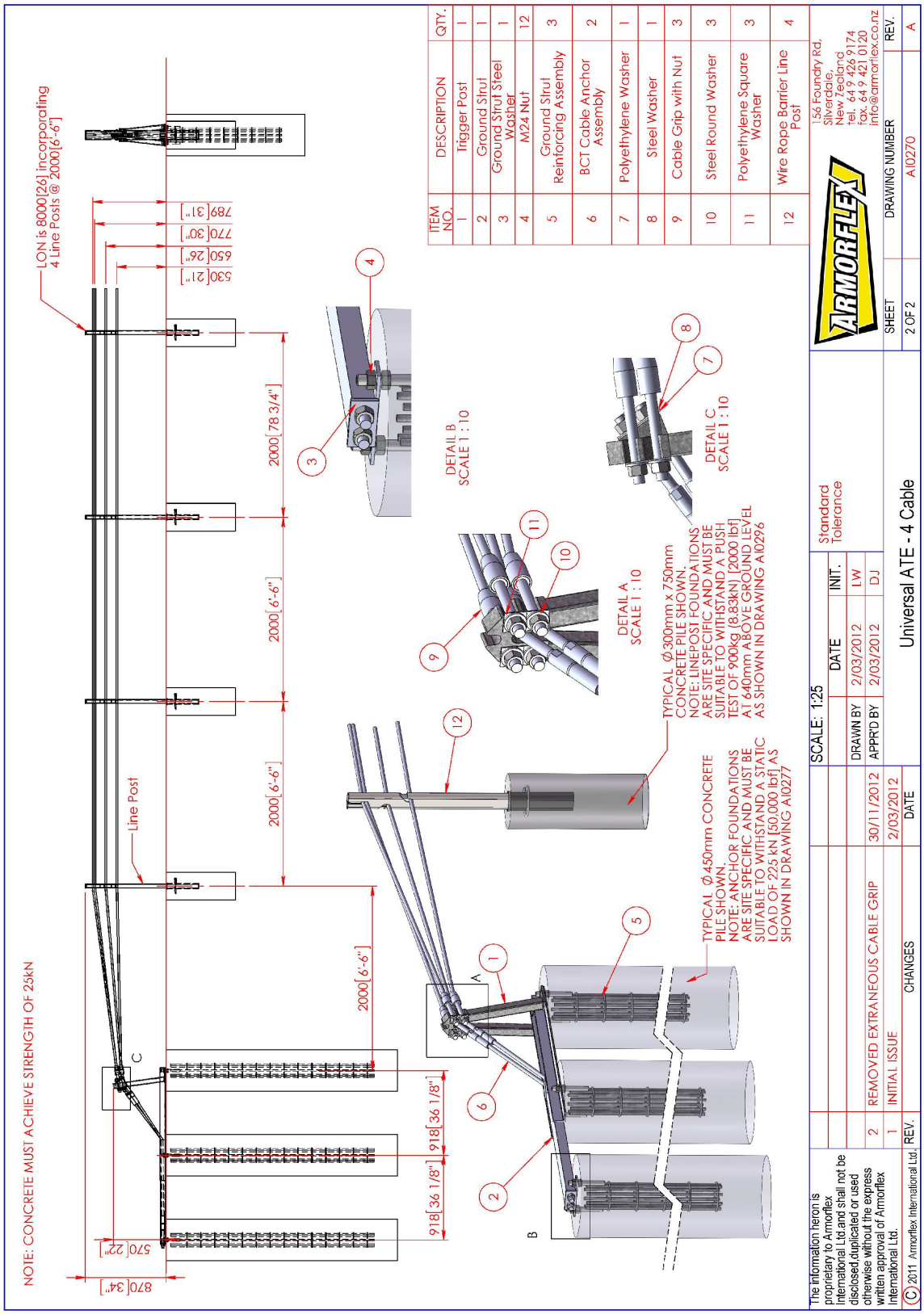


APPENDIX – Technical Drawings



Universal Armorwire Terminal End™ - 3 Cable Connection*

*** Pile Foundation Option shown for visual representation only.**



Universal Armorwire Terminal End™ - 4 Cable Connection*

*** Pile Foundation Option shown for visual representation only.**