

UNIVERSAL ARMORWIRE™ TERMINAL END Product Manual

Release 06/17



Anchoring for 3 & 4 Cable Barriers



TABLE OF CONTENTS

1.0	Universal A.T.E. Introduction	3
2.0	System Overview	3
3.0	Limitations and Warnings	3
4.0	Before Installation	4
5.0	Safety Statements	4
6.0	Geotechnical Warning.....	4
7.0	Design Considerations.....	5
8.0	System Design.....	5
9.0	Parts Identification	8
10.0	Installation Preparation.	9
11.0	Bill of Materials.....	9
12.0	Installation Instructions	10
13.0	Installation Examples.....	15
14.0	Installation Checklist	16
15.0	Frequently Asked Questions	17



APPENDIX – TECHNICAL DRAWINGS

16.0	Universal A.T.E. - Overlap.....	18
17.0	Universal A.T.E. - 3 & 4 Cable Line Post Set Up.....	18
18.0	Universal A.T.E. - Clearzone	19
19.0	Universal A.T.E. – Foundation Options.....	20
20.0	Universal A.T.E. (3 Cable).....	21
21.0	Universal A.T.E. (4 Cable).....	22



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1.0 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.

2.0 SYSTEM OVERVIEW

The Universal A.T.E. is designed and constructed to provide acceptable structural adequacy, minimal occupant risk and safe trajectory as set forth in NCHRP 350 for cable barrier terminal ends.

When impacted with an 820kg and 2000kg vehicle at speeds of 100kph, due to the immediate loss of cable tension, the errant vehicle remains on its wheels at all times without vaulting or rolling which is common on terminal ends where cables remain tensioned during impact.

When the 'trigger' post is impacted all cables disconnect causing the system to be de-tensioned immediately. During end on impacts the vehicle pushes the anchor cables down and out of the 'trigger' post. While during re-directive or reverse angle impacts, the cables disconnect out from the top of the 'trigger' post.

The Length of Need (LoN) of the Universal A.T.E. is 8m downstream from the 'trigger' post. The first 4 line posts after the 'trigger' post are always at 2m spacing.

3.0 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.



4.0 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.



5.0 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.

6.0 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.

7.0 DESIGN CONSIDERATIONS

7.1 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.

7.2 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.

7.3 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).

7.4 Tension

The Universal A.T.E. is designed to anchor 3 and 4 high tensioned cable barriers. Please refer to the relevant literature for instructions on how to tension the barrier that is being installed.

Note: Do NOT tension a barrier for 7 days after the foundation piles have been cast.

7.5 Line Posts

The 4 line posts (posts #2 - #5 where post #1 is the 'trigger' post) that make up the remainder of the Universal A.T.E. are to be installed as per manufacturers' instructions. The spacing of these posts must ALWAYS be at 2m spacing.

8.0 SYSTEM DESIGN

8.1 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. distributor 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.

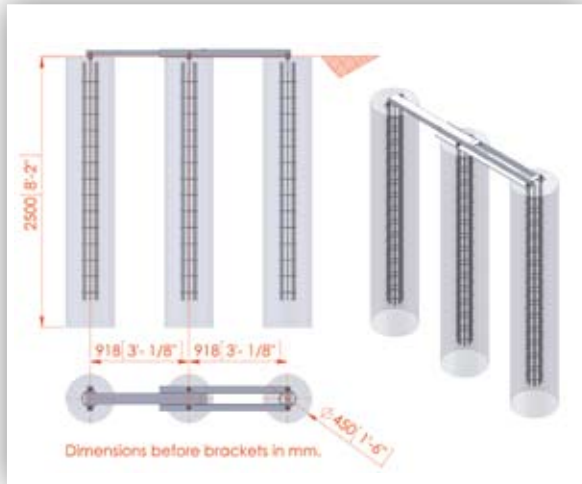


Figure A

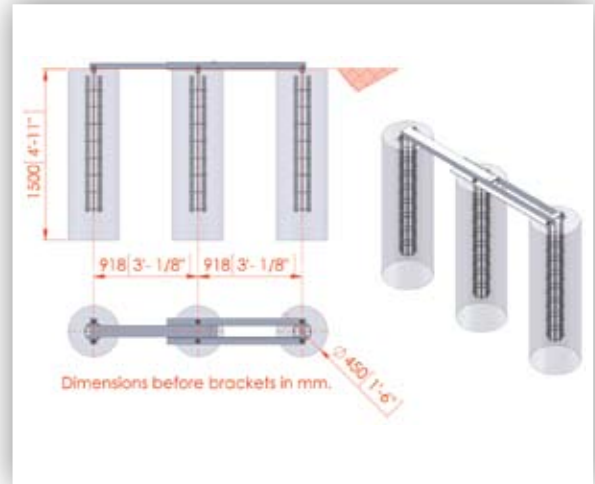


Figure B

OPTION 1



To use Option 1 the tested soil condition must meet or exceed the strength detailed in Table 1 below.

TABLE 1

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

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

OPTION 2



To use Option 2 the tested soil condition must meet or exceed the strength detailed in Table 2 below.

TABLE 2

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.

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).

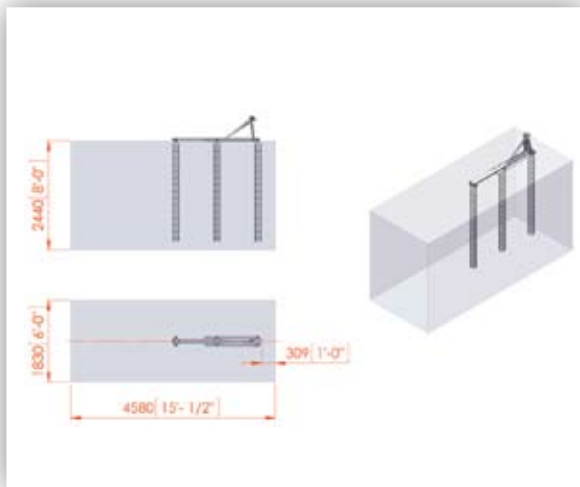


Figure C

OPTION 3



Option 3 is for use in extremely poor soil. To use the conditions on site must match the below description and assumptions:

- 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)

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).

8.2 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.

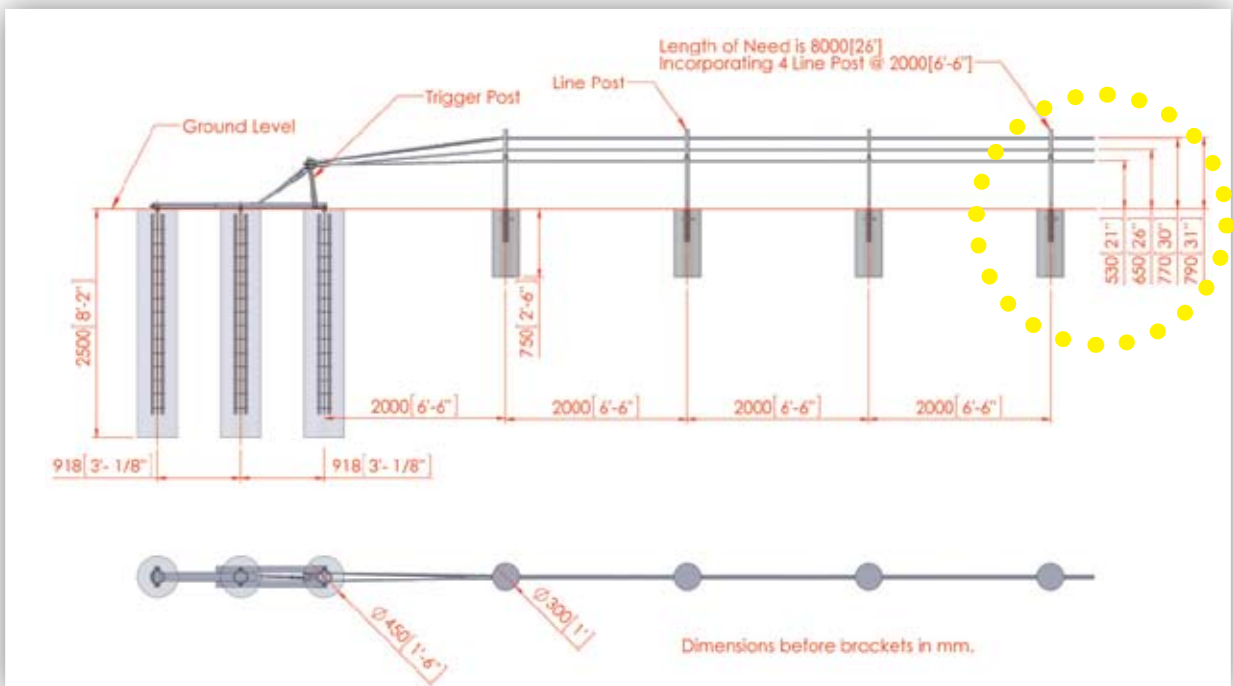


Figure D

9.0 UNIVERSAL A.T.E. - PARTS IDENTIFICATION



Ground Strut



Rebar Cages

* Type of cage shown for visual representation only



Anchor Cables



Washers & Nuts



Trigger Post



Cable Grips* for 3 Barrier



Cable Grips* for 4 Barrier

*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, except the rebar cages which are cast into the concrete piles.

10.0 UNIVERSAL A.T.E. INSTALLATION PREPARATION

10.1 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.

10.2 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.

10.3 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. It is extremely important that the Universal A.T.E. has the required strength to anchor the cable barrier.

Refer to the Foundation Options in the System Design section in this manual for more information.

It is recommended that soil tests are carried out at the location the Universal A.T.E. is to be installed.



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.

10.4 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

11.0 UNIVERSAL A.T.E. BILL OF MATERIALS

Universal A.T.E. (connected to a 4 Cable barrier)

- 1x Ground Strut
- 3x Rebar Cages (c/w 12x M24 nuts)
- 1x Trigger Post
- 2x Anchor Cables (c/w 4 x M24 nuts)
- 1x 10mm thick Rectangular Steel Washer
- 1x 6mm thick Rectangular Steel Washer
- 1x 3mm thick Rectangular Polyethylene Washer
- 4x 3mm thick Square Polyethylene Washers
- 4x 6mm thick 50mm ø Steel washers

Universal A.T.E. (connected to a 3 Cable Barrier)

- 1x Ground Strut
- 3x Rebar Cages (c/w 12x M24 nuts)
- 1x Trigger Post
- 2x Anchor Cables (c/w 4 x M24 nuts)
- 1x 10mm (thick) Rectangular Steel Washer
- 1x 6mm (thick) Rectangular Steel Washer
- 1x 3mm (thick) Rectangular Polyethylene Washer
- 3x 3mm (thick) Square Polyethylene Washer
- 3x 6mm thick 50mm ø Steel washers

12.0 UNIVERSAL A.T.E. INSTALLATION INSTRUCTIONS

12.1 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.

12.2 Step 2 – Installing the Ground Strut

12.2a 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.



Figure 1*

12.2b 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.



Figure 2*



Figure 3*

12.2c 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).

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.



Figure 4*

12.3 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 5*

* Pile Foundation Option shown for visual representation only.

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*

12.4 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*

* Pile Foundation Option shown for visual representation only.

12.5 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 12*



Figure 11*



Figure 13*



Make sure the anchor cables are fully housed within the 'trigger' post.

* Pile Foundation Option shown for visual representation only.

12.6b Step 6 – Connecting to a 4 Cable Barrier

Place the top 2 cables from the cable barrier 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 14 & 15).

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.



Do not tension the barrier until at least 7 days after the anchor foundations have been cast.

12.7 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.



Figure 14*



Figure 15*

* Pile Foundation Option shown for visual representation only.

13.0 ARMORWIRE – INSTALLATION EXAMPLES



Universal A.T.E. connected to a 3 cable barrier*



Universal A.T.E. connected to a 4 cable barrier*

14.0 Installation Checklist for Armorwire Cable Barriers

Location:

Installed By:

Date:

Signed:

Inspected By:

Date:

Signed:

General

The ground strut does not protrude more than 100mm when measured using a 1500mm cord along its centreline.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
The M24 nuts holding the ground strut to the foundation are spanner tight.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
The 10mm thick steel rectangular washer has been used to fix the anchor cables to the upstream end of the ground strut.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
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).	<input type="checkbox"/> Yes	<input type="checkbox"/> No
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.	<input type="checkbox"/> Yes	<input type="checkbox"/> No

Connected to a 3 Cable Barrier

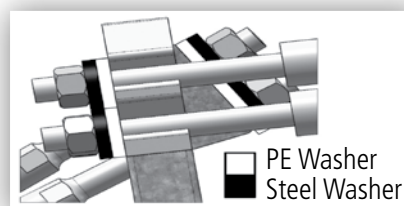
The top cable of the cable barrier is positioned in the top slot on the 'trigger' post.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
The two bottom cables are positioned on either side of the 'trigger' post in the bottom slots.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
The 3mm thick square polyethylene washer is between the 6mm round steel washer and the 'trigger' post for all three cables (see diagram below).	<input type="checkbox"/> Yes	<input type="checkbox"/> No

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.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
The two bottom cables are positioned on either side of the 'trigger' post in the bottom slots.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
The 3mm thick square polyethylene washer is between the 6mm round steel washer and the 'trigger' post for all four cables (see diagram below).	<input type="checkbox"/> Yes	<input type="checkbox"/> No

Disclaimer:

Important Note: The conformity of the installation is the responsibility of the installation contractor, and Valmont Highway accepts no liability for or in connection with any installation that is outside of the specifications of this manual or the Road Controlling Authority. For more information, please refer to our Standard Terms and Conditions of Sale available on our website: www.ingalcivil.com.au.



15.0 UNIVERSAL A.T.E.: FREQUENTLY ASKED QUESTIONS

1. What type of equipment is required to install the Universal A.T.E.?

Standard tools required include a wrench, measuring tape, string line and trowel. Machinery suitable for drilling or excavating the foundations.

2) How much concrete is required to install the concrete foundations on a Universal A.T.E. and what strength does it need to be?

The volume will vary depending on the type of foundation being used. There are three foundation options contained in this manual and the corresponding theoretical volumes are:

Option 1 = 1.39m³

Option 2 = 0.92m³

Option 3 = 20.65m³ (includes 4 line post footings)

The concrete used must be 25mpa. (Due to the drilling and removing spoil the actual amount may be larger than this).



Other foundation sizes and types might be required due to on site soil conditions. Concrete volume requirements will vary accordingly.

3. Is there a curing period for the concrete before the barrier can be tensioned?

Yes, do not tension until at least 7 days after the concrete footings have been poured.

4. Does your company provide spare parts? What is the lead-time for supply?

It is important to fix a damaged cable barrier as soon as possible because it most probably won't perform as required when damaged. For this reason it is recommended that spares are held by Maintenance Contractors (the concrete footings and ground strut assembly are very unlikely to be damaged).

5. On average, how long does it take to install a Universal A.T.E.?

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

6. What about vandalism, can the Universal A.T.E. be easily damaged?

No, once the system has been tensioned it is an extremely rigid system and tampering without the use of heavy duty tools or machinery is very unlikely to damage or affect the performance of the system.

7. How easily can the Universal A.T.E. and Armorwire Cable Barrier be restored after impact?

Armorwire is the simplest cable barrier to fix on the market and including the Universal A.T.E., the system is easily repaired after impact. Damaged line posts can be removed using a crow bar and new ones positioned in the sockets before the cables and caps are repositioned. It is recommended that the cable tension is checked after impact.

If the system has been de-tensioned due to damage to the 'trigger' post, a hydraulic tension machine and trained personnel will be required to re-tension the system after the 'trigger' post is replaced. The foundation piles and ground strut should not be damaged in anyway.

8. What maintenance does the Universal A.T.E. require?

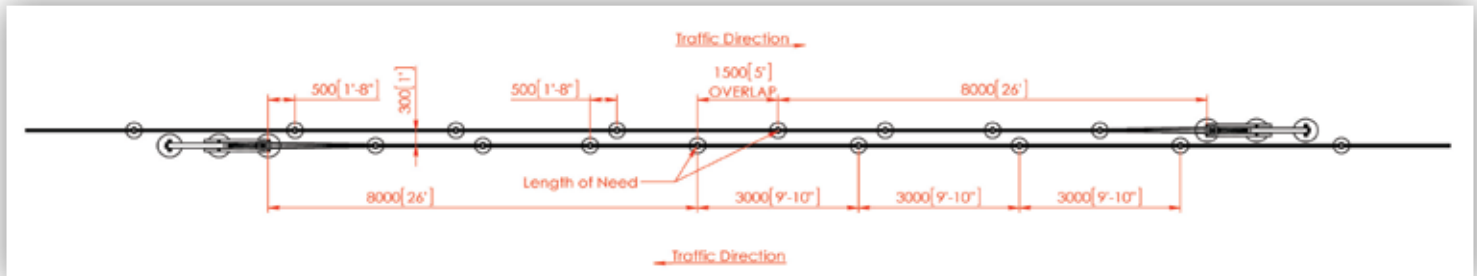
The Universal A.T.E. terminal end is maintenance free as the anchor cables used are pre-stretched. Refer to the relevant Armorwire Product Manual for recommendations on maintenance for the cable barrier itself which includes cable tension checking.

9. Apart from the configuration of the cables from the cable barrier onto the 'trigger' post, are there any other differences between installing a 3 or 4 cable barrier to a Universal A.T.E.?

No, the setup of the Universal A.T.E. terminal end apart from how the cables connect to the 'trigger' post is always the same. (N.B. Foundations required are site specific)

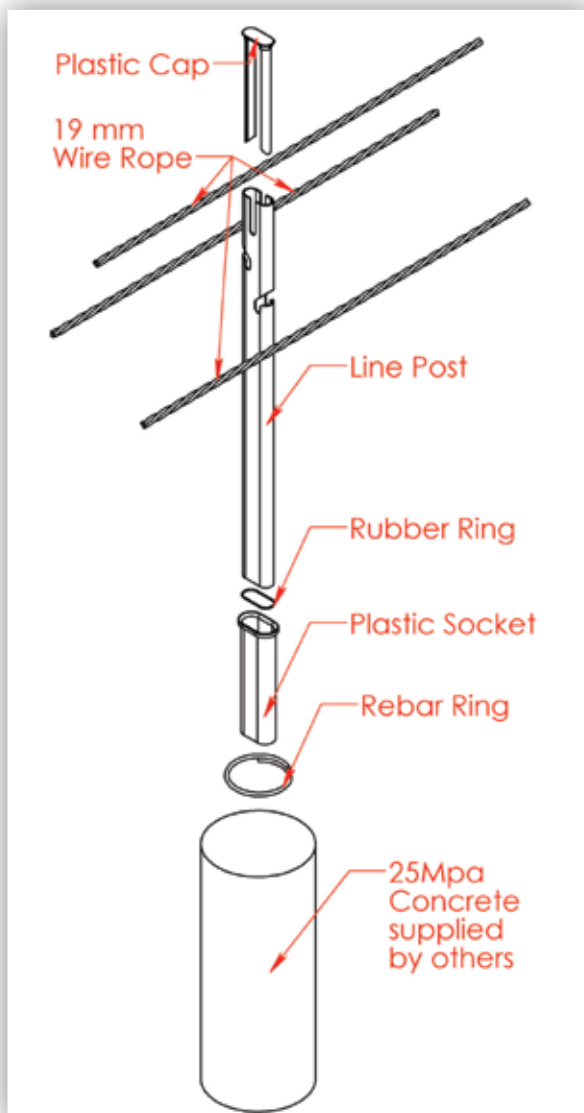
Universal ARMORWIRE™ Terminal End

16.0 UNIVERSAL A.T.E. - OVERLAP

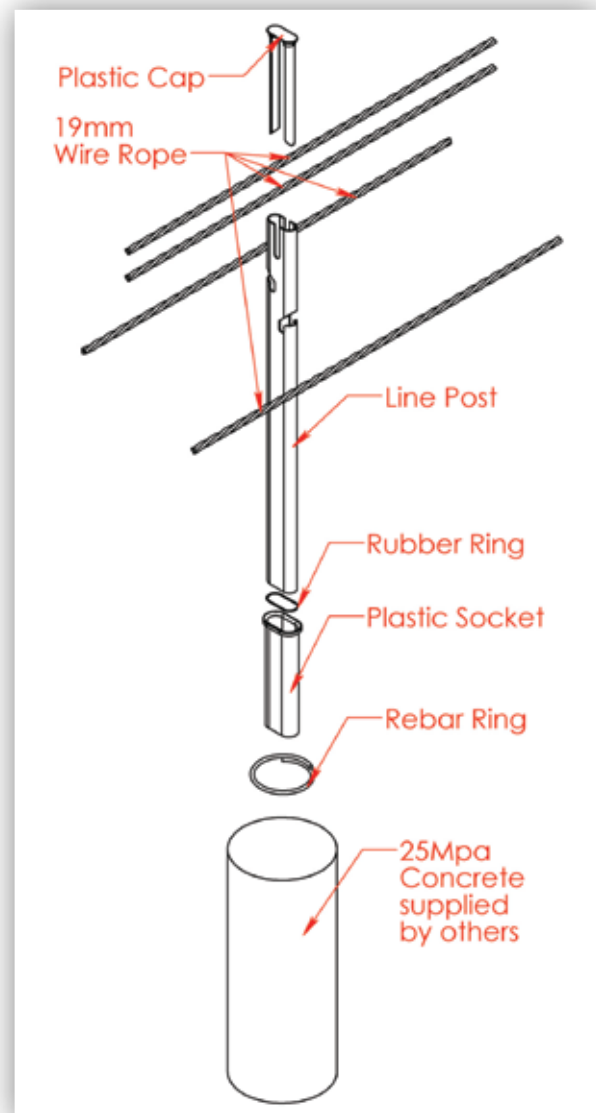


Universal A.T.E. – Overlap

17.0 UNIVERSAL A.T.E. - 3 & 4 CABLE LINE POST SET UP



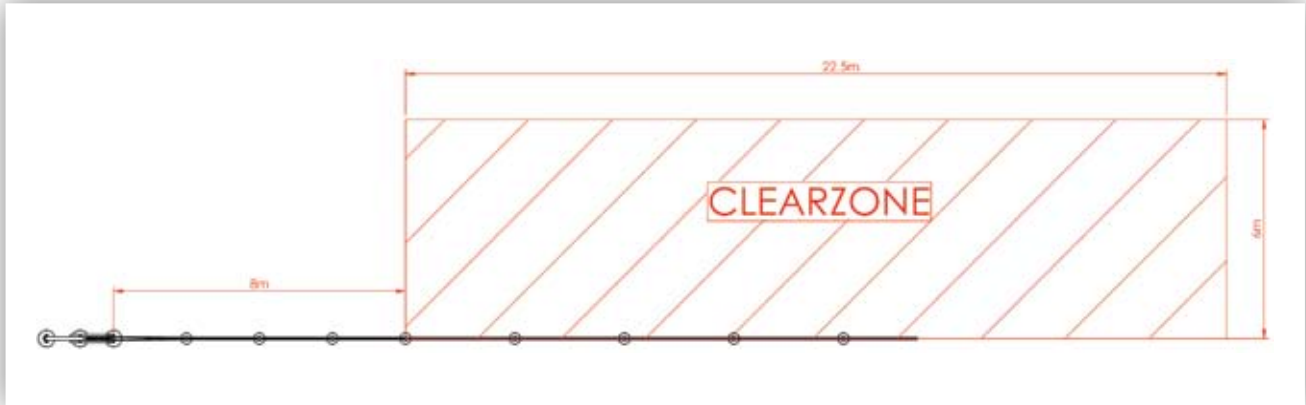
3 Cables Line Post Set Up*



4 Cables Line Post Set Up*

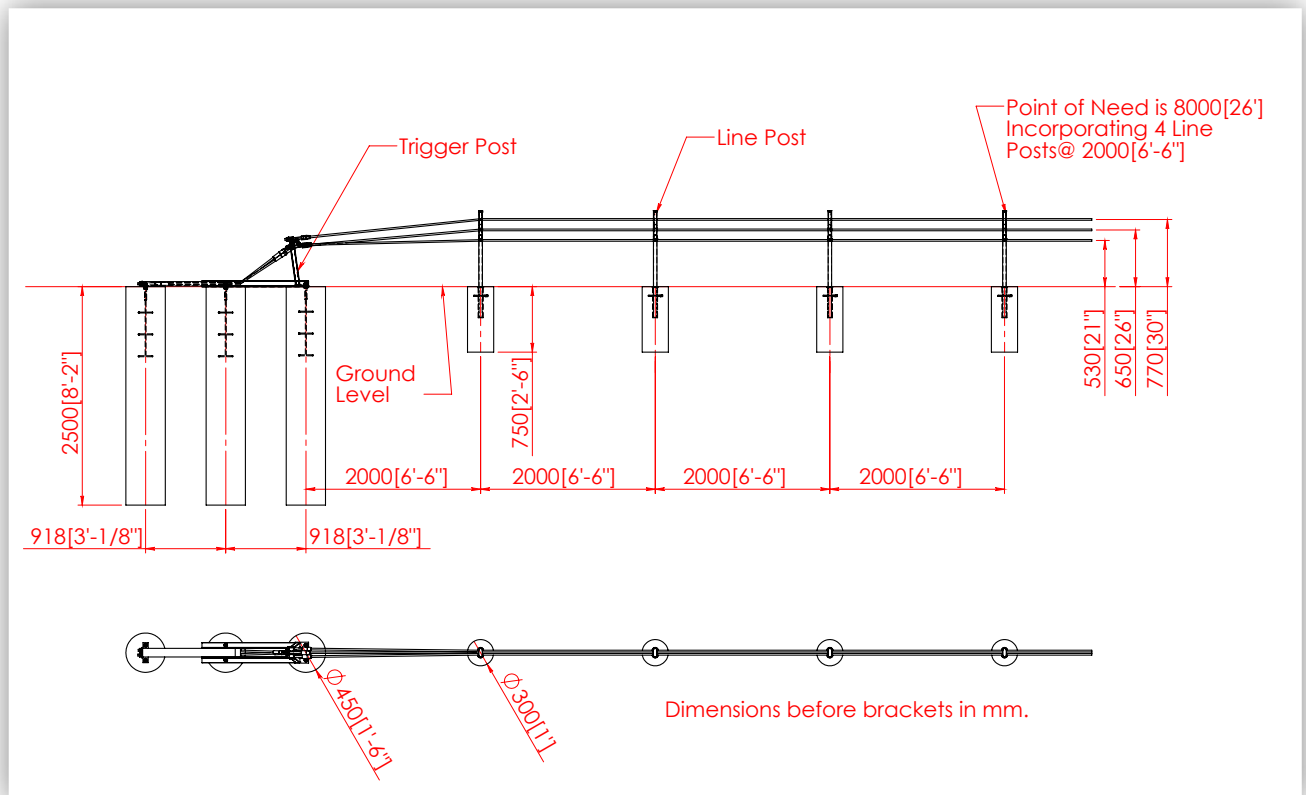
*Pile Foundation Option shown for visual representation only.

18.0 UNIVERSAL A.T.E. - CLEARZONE



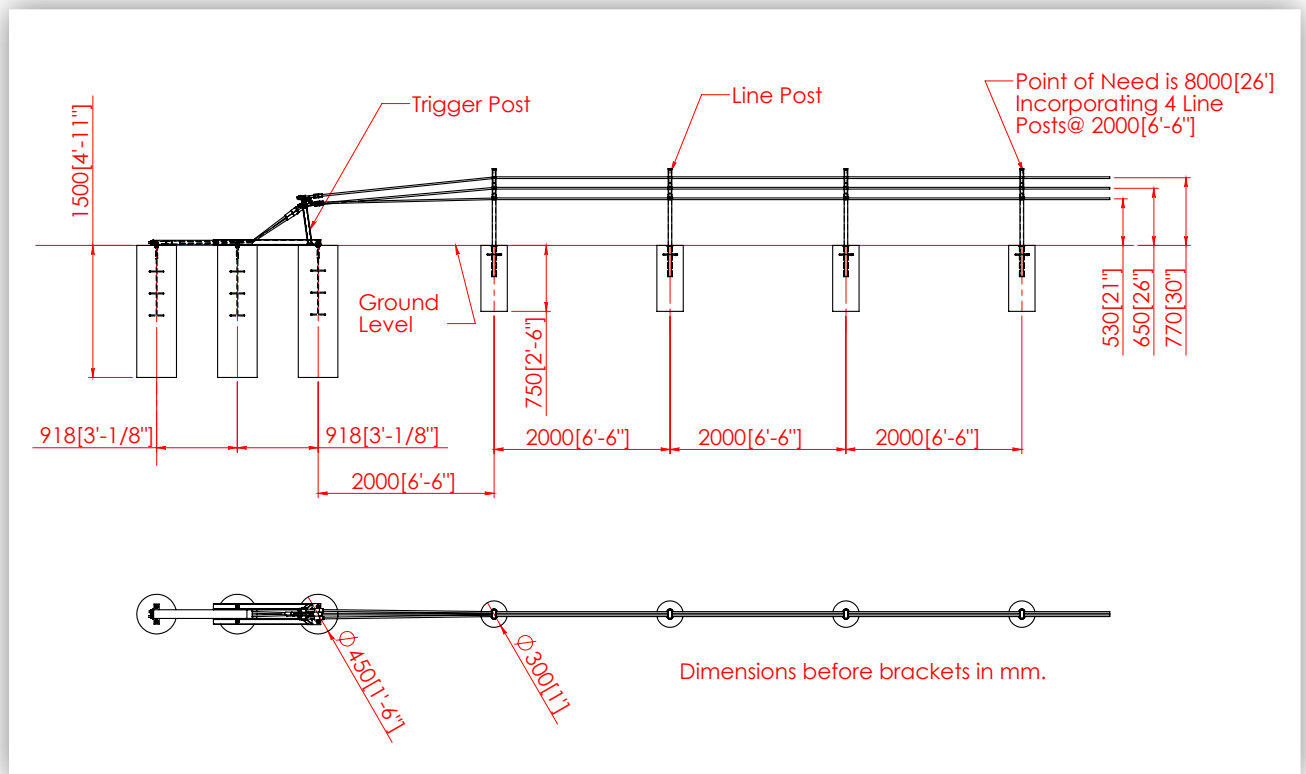
Universal A.T.E. – Clearzone*

19.0 UNIVERSAL A.T.E. – FOUNDATION OPTIONS

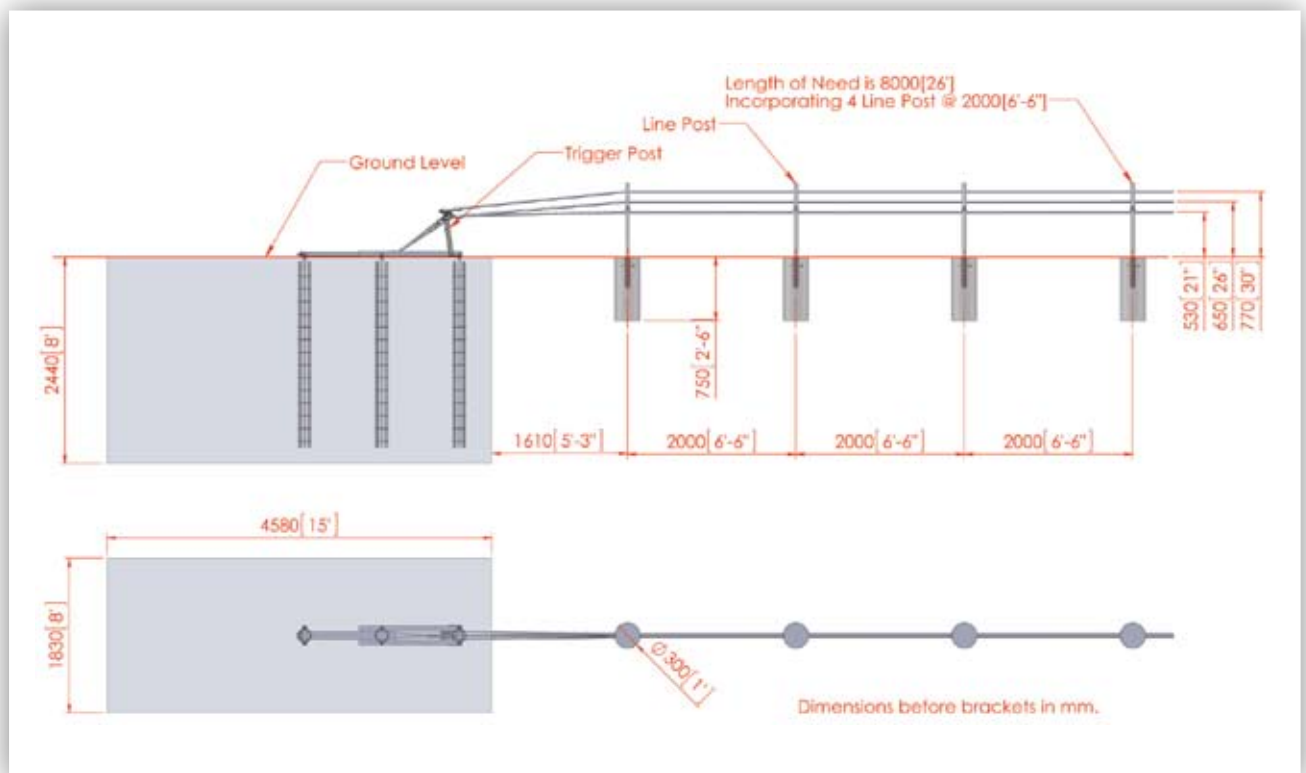


Universal A.T.E. – Set-up (Option 1)

*Pile Foundation Option shown for visual representation only.



Universal A.T.E. – Set-up (Option 2)

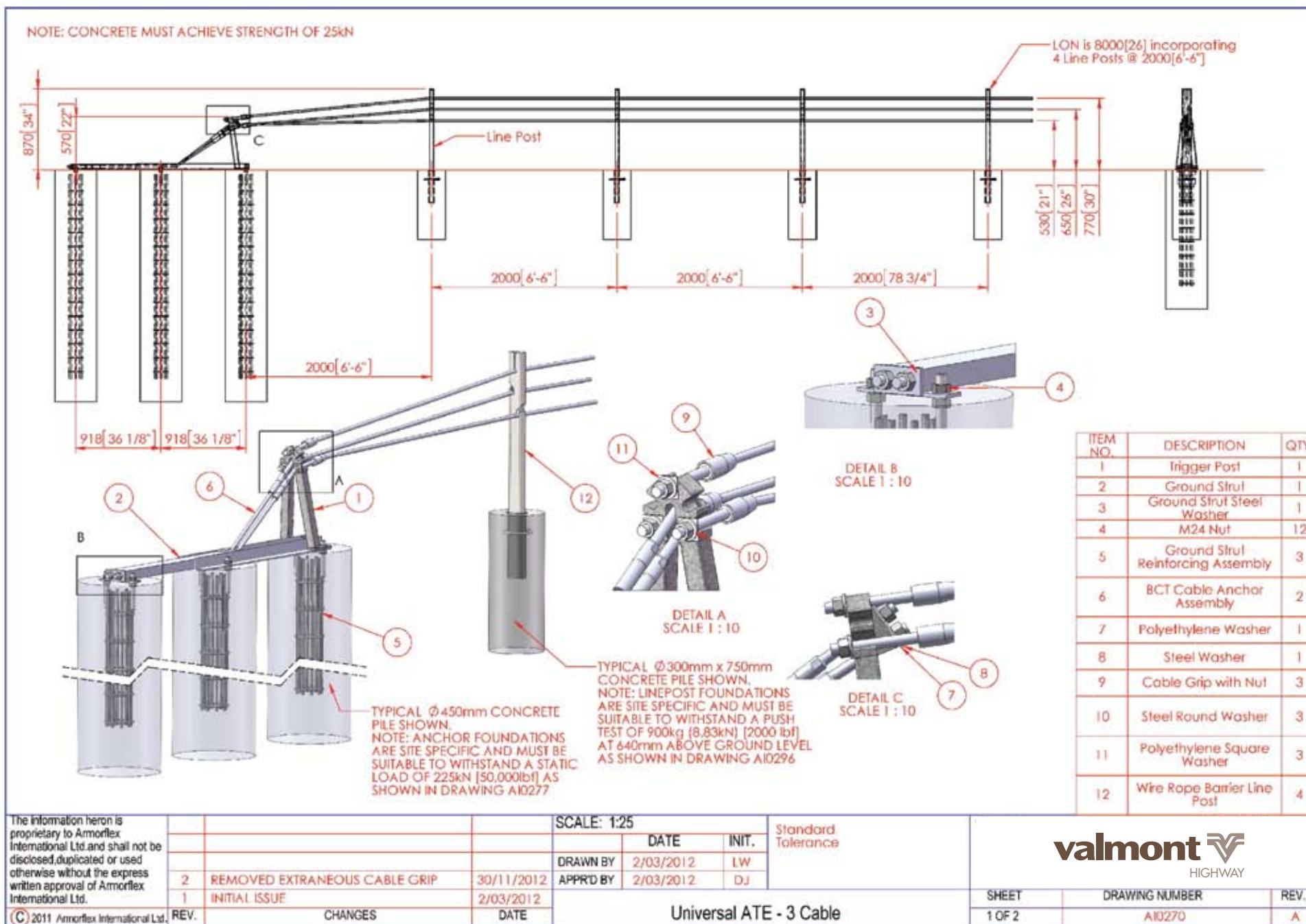


Universal A.T.E. – Set-up (Option 3)

*Pile Foundation Option shown for visual representation only.

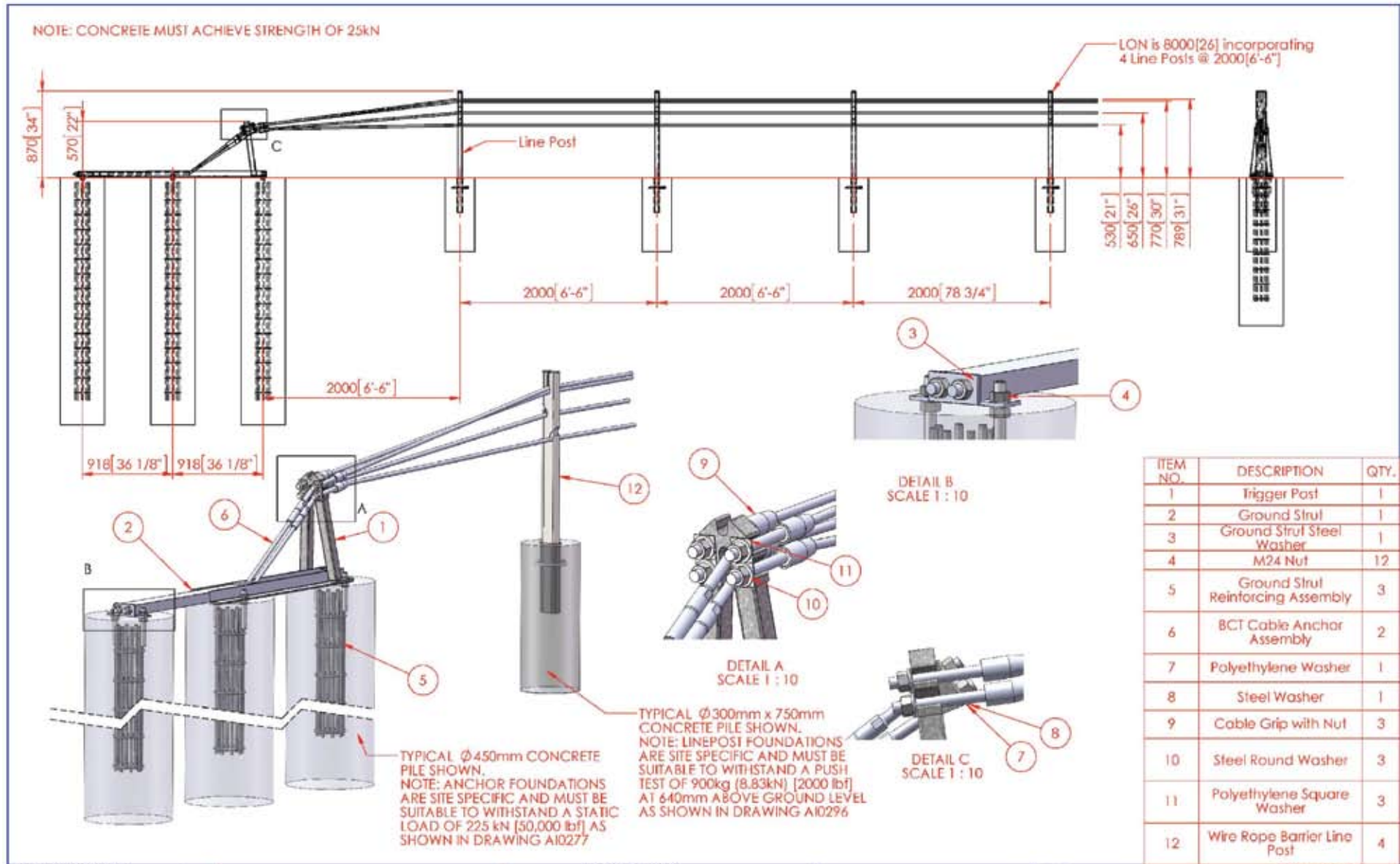
20.0 UNIVERSAL A.T.E. (3 CABLE)

*Pile Foundation Option shown for visual representation only.



21.0 UNIVERSAL A.T.E. (4 CABLE)

*Pile Foundation Option shown for visual representation only.



The information herein is proprietary to Amortflex International Ltd and shall not be disclosed, duplicated or used otherwise without the express written approval of Amortflex International Ltd.

REV.	CHANGES	DATE
2	REMOVED EXTRANEOUS CABLE GRIP	30/11/2012
1	INITIAL ISSUE	2/03/2012

SCALE: 1:25		
DRAWN BY	DATE	INIT.
APPRD BY	2/03/2012	LW
	2/03/2012	DJ

Standard Tolerance

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HIGHWAY

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