Installation Manual

ArmorWire™ Cable Barrier

TL-3 & TL-4 Systems

valmont HIGHWAY

VHD (v2)

300914

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ArmorWire™ Introduction

ArmorWire™ is a high tension cable barrier consisting of unique 'oval' shaped steel posts. Slots within the posts house the barrier cables at the required height and each post has a concrete footing.

The system has been designed and tested to meet the evaluation criteria of NCHRP 350 Test Level 3 and 4 (TL-3 & TL-4) for a longitudinal barrier.

It is recommended that the ***ArmorWire™*** barrier is anchored using the ***Universal ArmorWire™ Terminal End (A.T.E)*** which has been accepted to NCHRP 350 TL-3.

Limitations and Warnings Features

ArmorWire™ cable barriers have been rigorously tested and evaluated per the evaluation criteria in the NCHRP 350 guidelines for a longitudinal barrier. The impact conditions recommended in NCHRP 350 are intended to address typical in-service collisions.

ArmorWire™ barriers allow an impacting vehicle to be re-directed 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 longitudinal barriers 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 ***ArmorWire™*** 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, post spacing and conditions on site, installation and assembly of the system should take a 3 person crew less than 4 hours to cast the piles, install the posts and place the cables for a 100m section.

ArmorWire™ 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 system.

Design Considerations

Curves

Horizontal – If temperatures can reach as low as zero degrees Celsius, the minimum allowable curve is 200m radius.

Note: Post spacing and concrete footings sizes will need to be determined to accommodate a radius this tight. For all further assistance contact your nearest ***ArmorWire™*** distributor.

Vertical – Minimum allowable vertical sag radius is 2400m. This maximum does not apply to crests of hills.

Slopes

A maximum slope of 10:1 is preferable. On slopes greater than this, advice should be followed from the Road Controlling Authority's guidelines.

Curbs

As with all road side safety hardware, ***ArmorWire™*** has been designed and tested so the centre of gravity of the impacting vehicle is 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 barrier 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.

Ditches

If the slope of the ditch is greater than 10:1 then follow the Road Controlling Authority's guidelines.

Soil Conditions

The ***ArmorWire™*** line post foundation pile has been designed to have sufficient strength to withstand multiple vehicle impacts and support the post from the horizontal load exerted by the cables on tight radius. Therefore it is extremely important that the soil conditions on site have the adequate bearing capacity to support the ***ArmorWire™*** foundation pile 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 21 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

Median and Roadside Applications

The ***ArmorWire™*** cable barrier can be impacted from either side of the post with no difference in performance. Therefore the barrier can be used in both median and roadside situations in either orientation as long as the slot arrangement is consistent.

Barrier Length

Minimum – Is 25m and represents the distance between the upstream and downstream Length of Need (LoN) of the terminal ends. i.e. excludes the 8m of Universal ***ArmorWire™*** terminal end cable at either end.

Note: A shorter barrier may not have sufficient length to fully re-direct an errant vehicle.

Maximum – No theoretical limit if the barrier is essentially straight in both horizontal and vertical alignment and tensioned as required. However, when a barrier is impacted, the ability of the barrier to resist subsequent impacts before repair is not guaranteed. For this reason, ***ArmorWire™*** is recommended to be limited to a maximum of 1000m between terminal ends.

For all further assistance on how to tension long installations correctly, contact your nearest ***ArmorWire™*** distributor.

Flare Rate

The maximum flare rate allowed is 30:1 measured from the tangent.

Terminal End Treatments

The ***ArmorWire™*** cable barrier is terminated using the ***ArmorWire™*** terminal end. For further details consult the ***ArmorWire™ Terminal End (ATE) Product Manual.***

Transitions

Transitions from ***ArmorWire™*** to other types of barriers are possible and details are available on request. Please contact your nearest ***ArmorWire™*** distributor.

Intermediate Anchors

It is recommended that an ***ArmorWire™*** barrier is limited to 1000m in length and that intermediate anchor set-ups are utilised when a barrier greater than 1000m is required.

To create an intermediate anchor, simply overlap one ***ArmorWire™*** barrier run with the next. A minimum 300mm gap between the barriers is required. The Length of Need (LoN) of each barrier must be as per the ***ATE Overlap*** drawing. (See ***Appendix*** section of this manual)

Batter Hinge Point

NCHRP 350 recommends that the lateral extent of the soil, outside an envelope of the embedded portion of the test article, be approximately 1.3 times the embedment length. This is so that the foundations have sufficient support during impact to resist movement.

*ie: If the **ArmorWire™** footing is 300mm ϕ by 750mm deep, it will requiring a minimum of 1 metre supporting soil outside the line of posts.(shown in Figure A)*

If the batter hinge point is reduced to only 600mm, the 300mm ϕ pile will need to increase to a depth of 1000mm. (shown in Figure B) (MGL 15 Sept 2006 – Post Foundation Under Later Load)

Note: These are examples only and based on a particular soil type. It may be required that a specific foundation will need to be designed by a local geotechnical engineer.

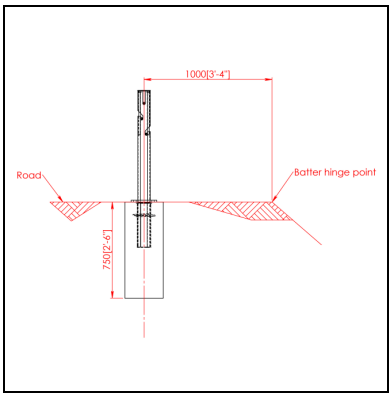

Figure A*.

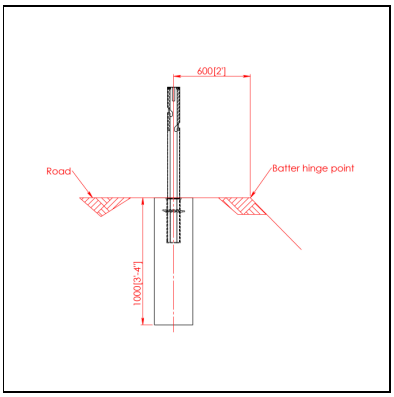

Figure B*.

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.

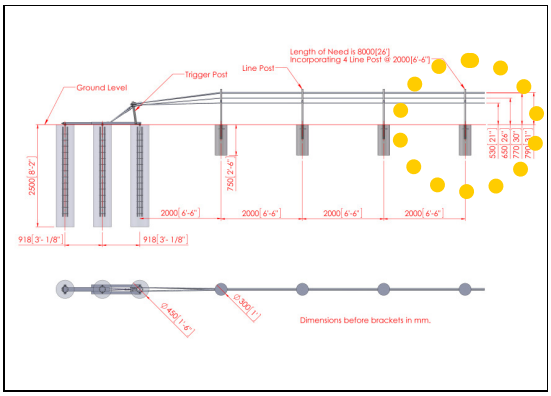

Figure C*.

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

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Line Post Foundation Piles

For the line post foundation pile to provide the required support to the post during vehicle impact, and have sufficient strength to resist movement, 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 foundation and accordingly ArmorWire™ 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 ones can be used.

Note: Foundation piles can be pre-cast but special attention must be made that adequate soil compaction is achieved after placement. For further information contact your nearest ***ArmorWire™*** distributor.

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	50 - 75	300mm ø x 900mm
Cohesionless Soils		
Soil Type	**Description Phi (0)**	**Foundation Pile Depth**
Dense - Medium Dense	30 - 41	300mm ø x 900mm

(G&A 24 Feb 2011 # 0778202901/10L)

The post socket and rebar ring must be cast into concrete foundation piles with the following dimensions. The augured holes for this option are 300mm diameter by 900mm deep and filled with 25mpa concrete. (Theoretical volume 0.064m³)

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**
Stiff – Very Stiff	75 - 125	300mm ø x 750mm
Cohesionless Soils		
Soil Type	**Description Phi (0)**	**Foundation Pile Depth**
Very Dense	> 41	300mm ø x 750mm

(G&A 24 Feb 2011 # 0778202901/10L)

Option 2 continued:

The post socket and rebar ring must be cast into concrete foundation piles with the following dimensions. The augured holes for this option are 300mm diameter by 750mm deep and filled with 25mpa concrete. (Theoretical volume 0.053m³)

Option 3:

TO USE OPTION 3 THE TESTED SOIL CONDITION MUST MEET OR EXCEED THE STRENGTH DETAILED IN TABLE 3 BELOW

Cohesive Soils		
Soil Type	**Description Su (kpa)**	**Foundation Pile Depth**
Very Stiff	101 - 125	450mm ø x 600mm
Cohesionless Soils		
Soil Type	**Description Phi (0)**	**Foundation Pile Depth**
Very Dense	> 41	450mm ø x 600mm

(G&A 24 Feb 2011 # 0778202901/10L)

The post socket and rebar ring must be cast into concrete foundation piles with the following dimensions. The augured holes for this option are 450mm diameter by 600mm deep and filled with 25mpa concrete. (Theoretical volume 0.95m³)

Tension Bays

Tension Bays are required every 450m, or as often as is necessary to correctly tension the system. When positioning the strong back brackets, care must be taken to cut the cables mid-span between the posts so that they are offset to each other.

Note: Do not place two strong backs within 30m of each other when on the same cable.

Tension

It is important that when tensioning the ***ArmorWire™*** that the tension machine is set to make allowance for the temperature at the time of installation.

A tension machine is usually pre-set so advice should be sought on all installations from your ***ArmorWire™*** distributor.

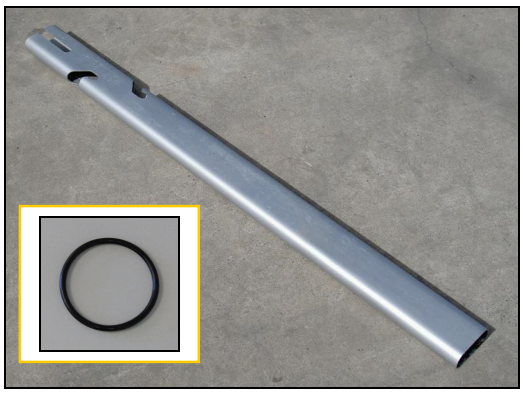
Note: Temperature refers to air temperature.

Temp (ºC)	0-3	4-9	10-14	15-20	21-26	26-32	33-37	38-43	44-49	50-54
Tension (kN's)	32	30.5	28.5	26.5	25	23.2	21.5	19.5	18.2	16.8

NOTE: DO NOT TENSION A BARRIER FOR AT LEAST 7 DAYS AFTER THE FOUNDATION PILES HAVE BEEN CAST.

Note: As with all cable barrier systems it is recommended that 2 weeks after the barrier is tensioned for the first time, it should be re-tensioned to remove 'construction creep'. It is also recommended that the tension on the cables is checked after impacts.

ArmorWire™ - Parts Identification



Line Post & 'O' Ring

Cable Grip

Post Cap

Strong Back Bracket

Post Socket

3 Cable Barrier

4 Cable Barrier

Rebar Ring

All steel components used in the ArmorWire™ system are hot dipped galvanized. (<u>except</u> the rebar ring which are cast into the concrete piles)

ArmorWire™ - Installation Preparation

Getting Started

ArmorWire™ cable barrier is designed so that the TL-3 and TL-4 systems have the same post. For all installations, whether median or edge of road locations, start from the last post of the terminal end. The 4 line posts between the terminal end 'trigger' post and the ***ArmorWire™*** cable barrier must always be at 2m spacing.

Preparation

Before installing an ***ArmorWire™*** cable barrier, ensure that all components required for the system are on site and have been identified. The ***ArmorWire™*** 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 ***Parts Identification*** and ***Bill of Materials*** section in this manual for more information.

Ensure that the area where the ***ArmorWire™*** is to be installed is flat enough so that the ground conditions will not significantly alter the height of the vehicle in relation to the height of the barrier's cables.

Minor site grading may be required.

Geotechnical Warning

The ***ArmorWire™™*** line post 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 tools required to install the ArmorWire™ cable barrier are:

- Drilling or excavating machinery suitable for foundation design
- Concrete trowel or float
- String line, measuring tape and marker pen
- Machinery capable of lifting the cable reel and a single axle spindle
- Cut off saw (generator)
- Tensioning Machine

ArmorWire™ - Installation Instructions

Step 1 – Site Preparation

It is preferred that the ***ArmorWire™*** is installed on flat, level ground with sufficient distance behind the foundation piles as described in the ***Batter Hinge Point*** section. The ***ArmorWire™*** barrier starts at post #5 (where post #1 is the 'trigger' post of the ***Universal A.T.E***) with post spacing as described in the construction drawings.

Note: The ***ArmorWire™*** cable barrier is a continuation of the ***Universal A.T.E*** should be installed in a tangent position. The maximum flare rate allowed is 30:1 measured from the tangent.

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 authorised 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)

ArmorWire™ Safety Statements

- All installers must be well clear of drilling or excavating machinery operating.
- The cable and reel are extremely heavy so it is recommended that the cable is run out from a single axis spindle. Do not place hands or fingers in or around moving parts.
- Only trained personnel can use the tensioning machine. All installers must be extremely careful they are clear of moving parts when the machine is being operated.

Step 2 – Foundation Construction

Excavate or drill the area that the ArmorWire™ posts are to be located as per the foundation option required. (shown in Figure 1 and 2)

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

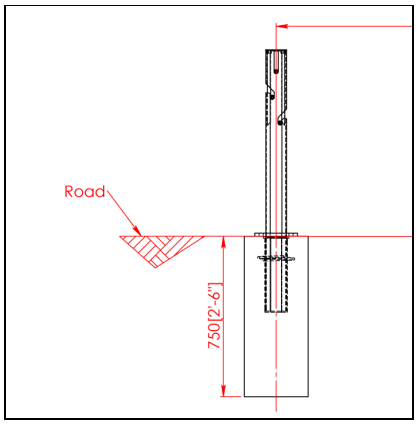


Figure 1*.

Figure 2*.

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

Step 3 – Construction of a foundation pile

COMPLETE ALL OF STEP 3 BEFORE MOVING TO NEXT FOOTING

Fill the hole to no closer than 100mm from the top with concrete (25mpa), place the rebar ring in the centre. (shown in Figure 3)

Fill the remainder of the hole with concrete immediately. (shown in Figure 4)

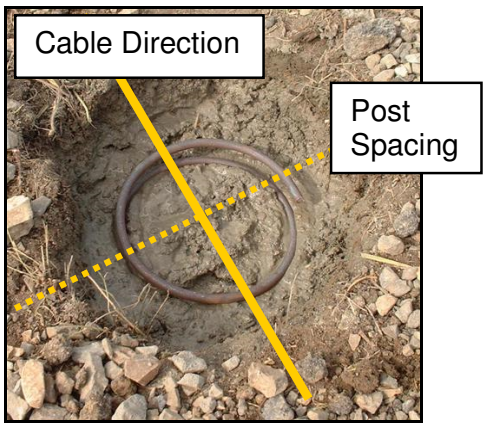


Figure 3*.

Figure 4*.

Immediately push the socket ('flat' side perpendicular to direction of barrier) into the centre of the footing until the top edge is flush with the concrete. (shown in Figure 5)

Using string lines and levels will aid in correct positioning of the rebar ring and socket.

Note: To prevent the possibility of a socket 'floating' use a stiff mix of concrete or place a post in the socket to ensure the final position will remain as intended. (shown in Figure 6)

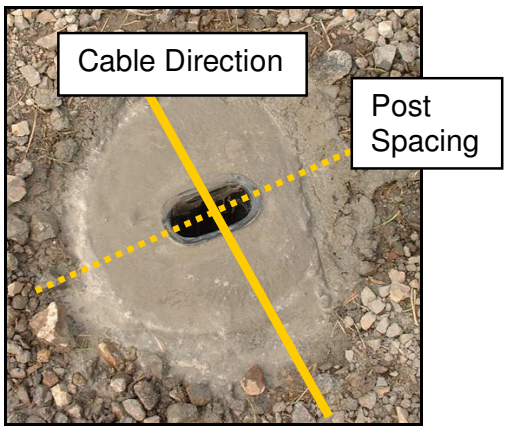


Figure 5*.

Figure 6*.

At this stage extreme care must be taken to ensure that the sockets will be at the correct height. This guarantees that when the barrier cable are installed, the cable heights will be within the construction tolerance as required in the manufacturer's specification.

Note: Diagrams showing cable heights can be found in the ***Appendix*** of this manual.

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

Step 4 - Installing the Posts

Push the rubber 'o' ring onto the bottom of the post approximately 350mm. (shown in Figure 7)

This will prevent debris from building up in the socket which can make removal difficult.

Slide a post into the socket once the concrete has set and adjust the 'o' ring so that it fills the gap between the post and post socket. (shown in Figure 8)

Figure 7*.

Figure 8*.

Ensure that the posts are aligned so that the orientation of the two slots located on the side of the post are consistent. (shown in Figure 9)

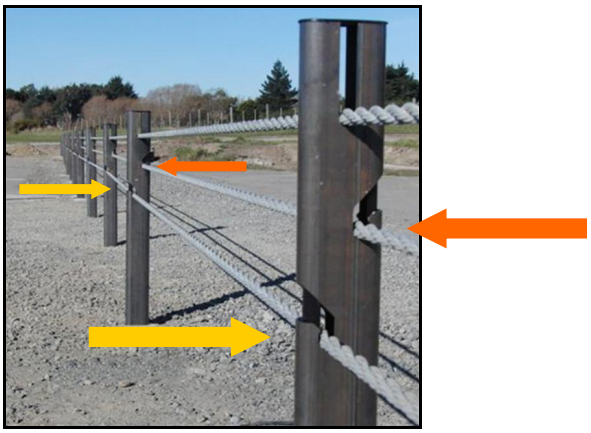


Figure 9.

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

Step 5 - Installing the Cables

Using a truck or trailer fitted with a cable reel frame, run the cables out to the desired length with cables on either side of the posts. (shown in Figures 10 & 11)

One or more of the cables may be run out at the same time depending on the installer's equipment. (shown in Figures 10 & 11)

Figure 10.

Figure 11.

For a 3 cable system place the bottom 2 cables into the bottom slots on either side of the post and the top cable into the top slot. (shown in Figure 12)

For a 4 cable system place the bottom 2 cables into the bottom slots on either side of the post and the top 2 cables into the top slot. (shown in Figure 13)

Ensure that the cables are pushed fully down to the bottom of their respective slots.

Figure 12.

Figure 13.

Step 6 – Placing the Post Caps

Slide the cap down the inside of the post and push down until cap is 'hard home' onto the top of the post. (shown in Figure 14)

If using a mallet or similar, make sure that the cap is not damaged in any way.

Ensure that the cap sleeves are on the outside of the 2 cables in the bottom slots. (shown in Figure 15)

Figure 14.

Figure 15.

Step 7 – Connecting to the Cable Barrier Terminal End

Connect the cables to the terminal end as per the manufacturer's instructions.

The ***ArmorWire™*** Terminal End is the recommended terminal end for ***ArmorWire™*** Cable Barrier. (shown in Figure 16)

Figure 16*.

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

Step 8 – Connecting the Cable Grips

At the desired location, cut the cable using a cut off wheel in a grinder.

Note: Make sure that the cut end of the cable is not frayed.

The cut end of the cable should be then coated with a zinc containing paint and then the last 100mm cleaned with a 'rag' with methylated spirits to remove any oily residue.

Mark the cable with a marker pen 75mm from the cut end. (shown in Figure 17 & 18)

Push the end of the cable into the cable grip and 'work in' a few times until hard home and the pen mark is in line with the mouth of the fitting. (shown in Figure 19)

Note: It is acceptable for the cable to ease out of the Cable Grip up to 10mm when tensioned. (shown in Figure 20)

IF THE CABLE PULLS OUT OF THE CABLE GRIP BY MORE THAN 10MM AFTER TENSIONING, DETENSION THE CABLE AND REFIT THE CABLE GRIP CORRECTLY AND REPEAT THE PROCESS.

Figure 17.

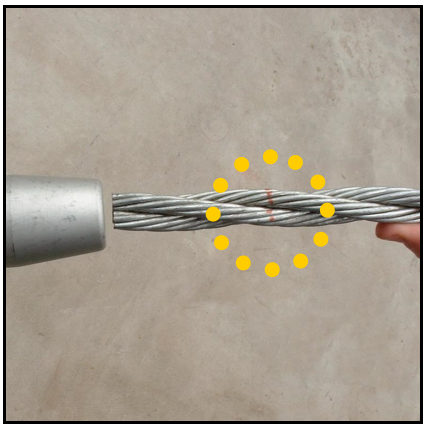


Figure 18.

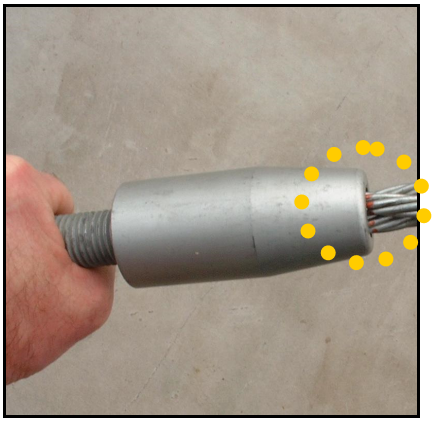


Figure 19.

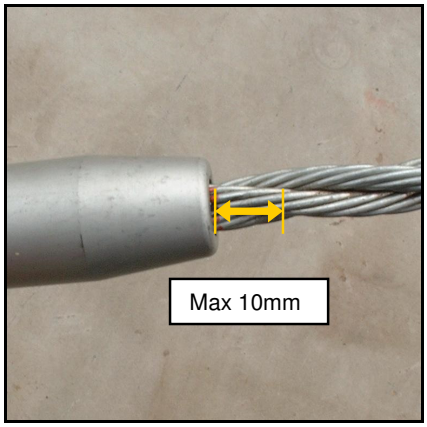


Figure 20.

Step 9 – Tensioning the Barrier

Tensioning the barrier is achieved by pulling the cable grips attached to the ends of the cable together using a hydraulic machine. The cable grips can then be secured to the strong back bracket which will hold the tensioned cables together when the machine is released.

ENSURE FULL TENSION MACHINE TRAINING, INCLUDING SAFE USE, HAS BEEN COMPLETED BEFORE OPERATING A TENSION MACHINE.

Tension Machine and associated training is available from your local ***ArmorWire™*** distributor.

Place cable grips and strong back bracket into the tension machine ensuring that the cable is held by the safety catches. Once all personnel's hands are clear activate the machine so that it extends and pulls the cable grips together. (shown in Figure 21.)

Note: The tension machine may be pre-set to stop at tension; therefore it may be necessary to adjust the settings on the machine. Refer to ***Tension*** in the ***System Design*** section in this manual or contact your ***ArmorWire™*** distributer for more information.

Run nuts along the threaded section of the cable grips inside the strong back bracket using a ring spanner until secure. (shown in Figure 22)

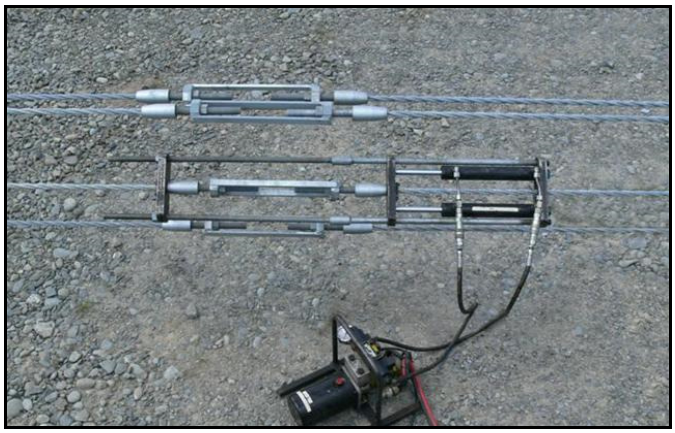


Figure 21.

Figure 22.

Activate the tension machine so it contracts and the machine can be lifted from the cable. Repeat Step 9 until all the cables are tensioned.

KEEP HANDS AND FINGERS CLEAR OF MOVING COMPONENTS

Step 10 – 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

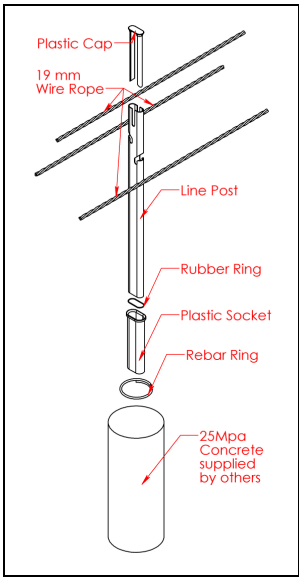
ArmorWire™ Cable Barriers

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

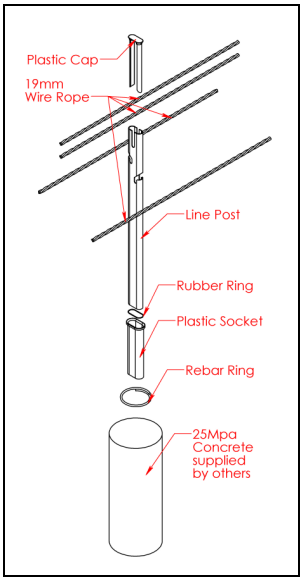
	Y/N	***N/A***
TL-3 - 3 Cable Barrier • **Ground is level** and the top of the pile is flush. • The plastic socket is cast in correctly and a rebar ring is positioned **100mm down from the top**. • If installed near a steep slope, **there is sufficient** supporting soil outside the line of the posts in relation to the foundation size. • Posts are spaced as per the **Construction Drawings**. (1m-9m) • Posts are installed with **slot orientation consistent** for the entire length of the barrier. • Top cable is positioned in the **top slot** while the bottom 2 cables sit at the **bottom of the slots** on either side of the post. • An 'o' ring seal is positioned on all posts at the **top of the socket**. • **All posts** have a plastic cap inserted in the top. (make sure each cap sleeve is on the outside of the bottom cables) • **Cable heights**, 530mm, 650mm and 770mm. (± 25mm) • Each of the 3 cables has been **tensioned correctly**.		
TL-4 - 4 Cable Barrier • **Ground is level** and the top of the pile is flush. • The plastic socket is cast in correctly and a rebar ring is positioned **100mm down from the top**. • If installed near a steep slope, **there is sufficient** supporting soil outside the line of the posts in relation to the foundation size. • Posts are spaced as per the **Construction Drawings**. (1m-3m) • Posts are installed with **slot orientation consistent** for the entire length of the barrier. • Top 2 cables are positioned in the **top slot** while the bottom 2 cables sit at the **bottom of the slots** on either side of the post. • An 'o' ring seal is positioned on all posts at the **top of the socket**. • **All posts** have a plastic cap inserted in the top. (make sure each cap sleeve is on the outside of the bottom cables) • **Cable heights,** 530mm, 650mm, 770mm and 790mm. (± 25mm) • Each of the 4 cables has been **tensioned correctly**.		

Comments:

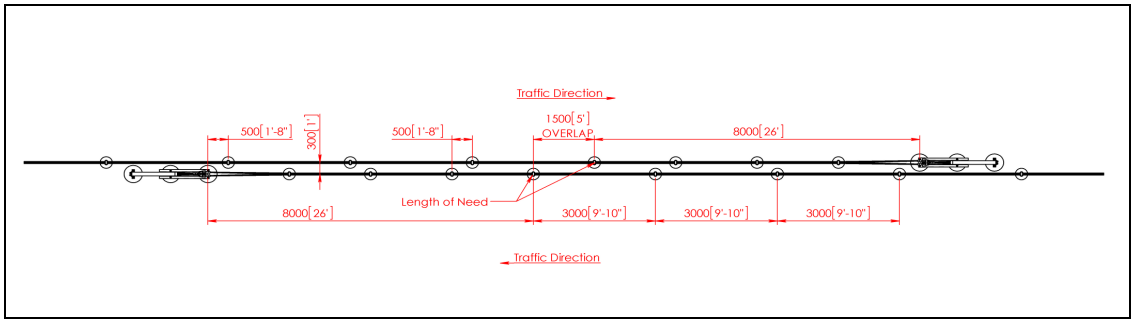
APPENDIX – Technical Drawings



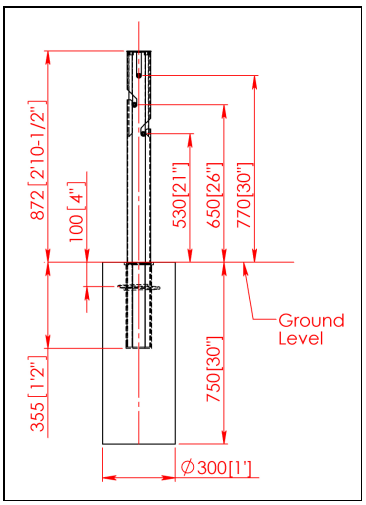
3 Cables Line Post Set Up*



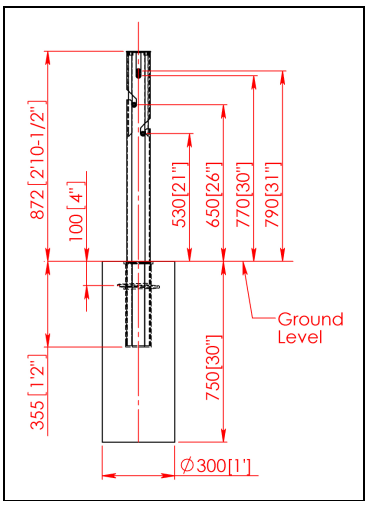
4 Cables Line Post Set Up*



ArmorWire™ Terminal End – Overlap*



TL-3 – Cable Heights*

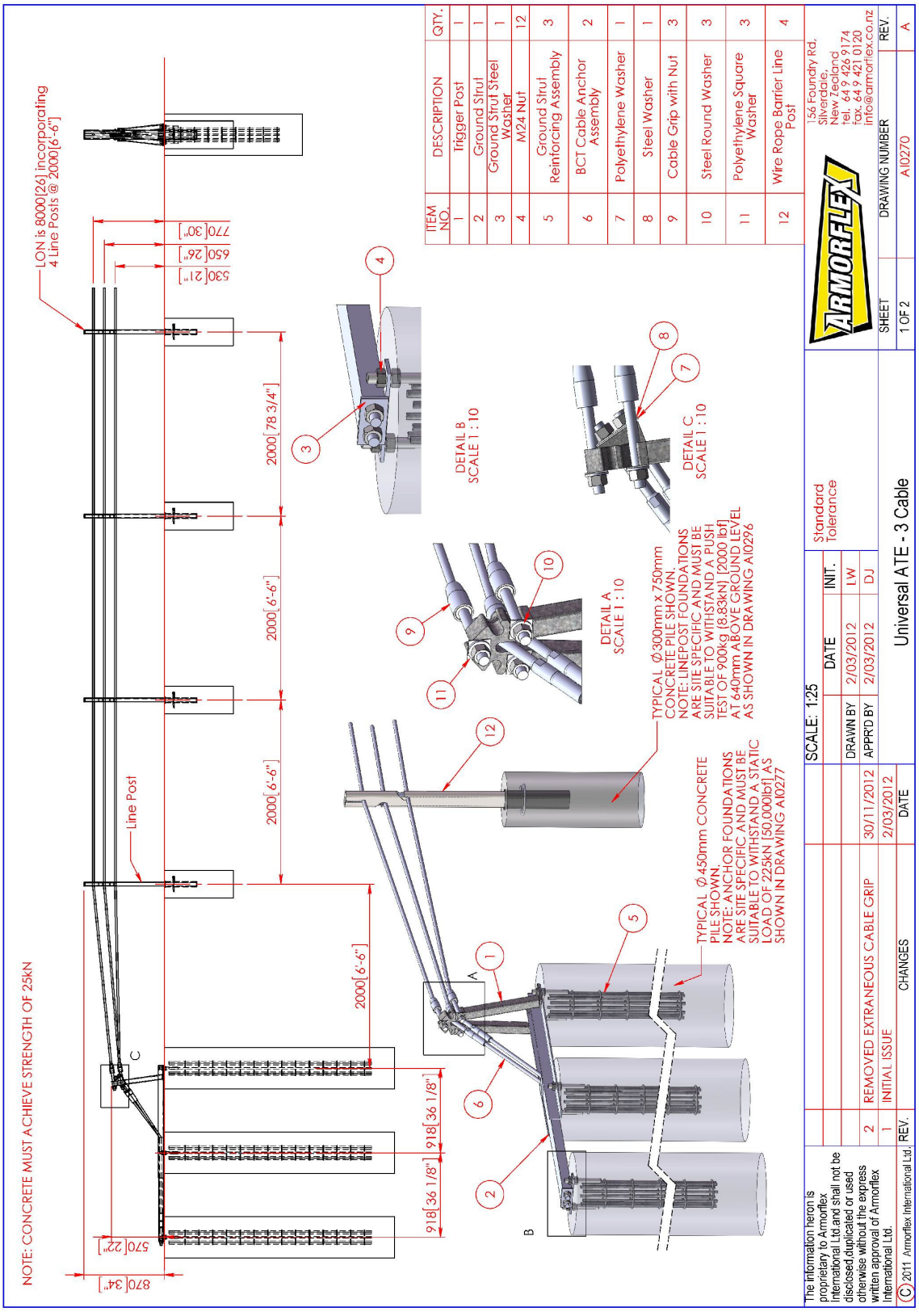


TL-4 – Cable Heights*

(measured in mm to the centre of the cable, tolerance ± 25mm)

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

valmont HIGHWAY



Universal ArmorWire™ Terminal End - 3 Cable Connection*

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