# Safence

## Wire Rope Safety Barrier

NZ Edition

INGAL CIVIL PRODUCTS
A valmont COMPANY

***Product Manual***

Release 10/15



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## 1.0 Introduction

The superior design and clean lines of Safence Wire Rope Safety Barrier (WRSB) has seen it become the road safety industry's preferred wire rope barrier. Safence has gained popularity as a median barrier for the prevention of crossmedian accidents. Cross-median accidents are typically violent collisions with a high probability of multiple serious injuries and death. Thus, the design trend is towards providing positive vehicle containment in wider median applications for which barriers have not historically been warranted.

The straight alignment of the ropes allows for easy installation and tensioning. Post footings are typically concrete with a sleeve to form a recess. Once the anchors and footings are poured, the ropes are cut to length, stainless steel end fittings are machine swaged and the ropes are tensioned.

## 2.0 Configurations

### 2.1 Safence TL3

Safence TL3 is a 4-rope barrier assessed in accordance with NCHRP Report 350 Test Level 3 (TL3). The TL3 heavy vehicle impact is performed with a 2,000kg pick-up truck travelling at 100km/h and 25°.

In addition, Safence TL3 has been evaluated to the requirements of containment classes N2 and H1 as per the European EN1317-2 specification. This requires impacts with a 10,000kg rigid truck travelling at 70km/h and 15° (H1) and a 1,500kg passenger car travelling at 110km/h and 20° (N2).

### 2.2 Safence TL4

Safence TL4 is available as a 3-rope or 4-rope barrier and has been assessed in accordance with NCHRP Report 350 Test Level 4 (TL4).

The TL4 configuration requires the addition of a post stiffener plate and top rope hook. All other components are identical to the TL3 configuration. The 3 rope configuration is achieved by removing the 2nd from bottom cable.

The TL4 heavy vehicle impacts are performed with a 2,000kg pick-up truck travelling at 100km/h and 25° and an 8,000kg rigid truck travelling at 80km/h and 15°.

## 3.0 Specification

| | |
|---|---|
| **Material:** | |
| Steel Wire Rope: | Mass – 1.21kg/m<br>Ultimate Tensile Strength – 165.5kN |
| Sigma Posts: | Material to AS/NZS 1594 |
| Anchor Bracket: | Material to AS/NZS 1594 |
| Swage Fittings: | Stainless Steel, Grade 304 |
| Plastic Parts: | UV Stabilised Polypropylene |
| **Finish:** | |
| Steel Wire Rope: | Galvanised coating |
| Sigma Posts: | Galvanised to AS/NZS 4680 |
| Anchor Bracket: | Galvanised to AS/NZS 4680 |
| **Dimensions:** | |
| Steel Wire Rope: | Right Hand Lay, 19.0mm Diameter<br>3x7 strands (1x3.15mm + 6x3.0mm) |
| Sigma Posts: | 1230mm long |
| **Cable Heights:** | |
| Top: | 720mm |
| 2nd from Top: | 640mm |
| 2nd from Bottom: | 560mm (optional for Safence TL4) |
| Bottom: | 480mm |

Figure 1: Safence TL3

## 4.0 Technical Data

### 4.1 Safence Performance

Wire rope safety barriers are classified as flexible barriers and consideration must be given to the expected movement of the barrier when impacted.

The design of a WRSB should include an assessment of the mass of the impacting vehicle, its speed and angle of impact. Whilst rigorous crash testing is undertaken to evaluate the performance of roadside barriers, the deflection results obtained during testing should not be considered an exact distance, but rather as a single point within the range of deflections that can be expected.

### 4.2 Working Width

The working width is the maximum width that is required to prevent an impacting vehicle from colliding with an object behind a road safety barrier system. This includes the dynamic deflection and the extra width due to the roll of an impacting vehicle. The roll of a vehicle is an important consideration in shielding a fixed object hazard such as a utility pole or bridge support.

### 4.3 Dynamic Deflection

The dynamic deflection is defined as the largest transverse deflection of a road safety barrier system recorded during an actual crash or during a full-scale impact test.

If the available space between the hazard and the barrier is not adequate, then the barrier can be stiffened in advance of, and alongside the hazard by reducing the post spacing. Other factors that can have an influence on the deflection of the barrier include tension in the wire rope cables, horizontal curvature and installation length.

Safence crash test deflection results are listed on the Ingal drawings.

### 4.4 Footing Selection

Safence posts are supported by concrete footings containing a plastic sleeve. The footing provides lateral support to the post during impact ensuring the post yields by bending near ground level. The size of post footings is dependant upon the surrounding soil type and distance to the embankment rounding point.

Table 1 provides guidelines for the construction of post footings for varying site conditions.

**Table 1: Post Footing Selection Guide**

| Centre of Post Footing to Rounding Point | Standard Soil | | Weak Soil | |
|---|---|---|---|---|
| | Dia | Depth | Dia | Depth |
| Less than 0.5m | 300 | 600 | 300 | 750 |
| Greater than 0.5m | 300 | 600 | 300 | 600 |

The minimum concrete compressive strength at 28 days is 25Mpa.

In the event that the soil type cannot be verified, then a post pull-over test can be conducted to validate the structural capacity of the footing.

A pull-over test is conducted by applying a load to the top of the post whilst positioned in the proposed footing design. The footing is required to remain stable until the post yields. Once the post yields, the footing has been subjected to its maximum potential load.

### 4.5 Minimum Length

The recommended minimum length-of need for a Safence installation is 40m.

### 4.6 Maximum Length

The recommended maximum run length of a Safence installation is 1200m.

### 4.7 Point-of-Need

Safence is designed to contain and redirect errant vehicles away from road side hazards. The location along the barrier system that redirection occurs is known as the point-of-need.

The point-of need for both the Safence TL3 and TL4 configurations is 12.6m from the anchor point when using the TL3 End Terminal.

## 5.0 End Terminals

End terminals are used to anchor the system and provide a soft gating impact to prevent vehicles from launching or snagging upon impact with Safence.

### 5.1 TL3 Terminal

The TL3 Terminal has been crash tested to meet the requirements of NCHRP Report 350 TL3. It can be used on all new installations or retrofitted to existing Safence installations.

The TL3 Terminal gradually tapers the cables from full height to an anchor bracket located at ground level.

The TL3 Terminal has demonstrated an ability to provide a soft, gating impact without releasing the cables from the anchor point. This non-release feature allows the system to remain anchored following design impacts.

This important feature contrasts terminals that are designed to release the cables for end-on impacts. Once these terminals release the cables their ability to provide continued containment and redirection for errant vehicles is compromised.

### 5.2 Standard Terminal

The Standard Terminal is designed to provide the necessary tensile support to redirect errant vehicles that impact the wire rope barrier within the length-of-need section.

### 5.3 TL3 Terminal - Workzone Applications

If used in a temporary workzone, the hazard free area is to be 30m from anchor point, with a width of 6m running parallel with the system.

Figure 2: TL3 End Terminal

## 6.0 Installation

The following written instructions should be read in conjunction with Ingal Civil Products' drawings.

A Safe Work Method Statement is available upon request to assist in the safe assembly of Safence.

Tooling and equipment is provided by Ingal for the installation of Safence. This equipment is known as the Safence Tension Unit and Safence Swaging Unit. Please contact your nearest Ingal representative for the safe operating instructions for this equipment.

### 6.1 Site Preparation

The approach terrain to the barrier should be level, otherwise a maximum grading of 1V:10H is permitted. Steeper slopes may result in the vehicle impacting the barrier at other than the design height.

### 6.2 Horizontal and Vertical Alignment Criteria

The installation of wire rope barriers on horizontal curves may increase the dynamic deflection of the barrier. In addition, horizontal curves may place more lateral load on the post foundations. To calculate the effect of a curve on the deflection, multiply the deflections as detailed on the system arrangement drawings by the curve correction factor in Table 2, these correction factors only apply to convex curves.

The minimum allowable sag vertical curve for wire rope barriers is ≥ 30m. (K = length of VC in metres divided by the change in grade expressed as a percentage). There is no K value limit for crest curves.

**Table 2: Curve Correction Factors**

| Length (m) | Convex Curve Radius (m) | | | | | |
|---|---|---|---|---|---|---|
| | 200 - 400 | 400-600 | 600-800 | 800-1000 | 1000-1500 | 1500+ |
| 0-100 | 1.5 | 1.4 | 1.3 | 1.2 | 1.1 | 1.0 |
| 101-200 | 1.8 | 1.6 | 1.4 | 1.3 | 1.2 | 1.1 |
| 201-300 | 2.0 | 1.8 | 1.6 | 1.4 | 1.3 | 1.1 |
| 301-400 | 2.2 | 2.0 | 1.8 | 1.6 | 1.4 | 1.2 |
| 401-500 | 2.5 | 2.2 | 1.9 | 1.7 | 1.5 | 1.2 |
| 500+ | 2.5 | 2.2 | 2.0 | 1.8 | 1.5 | 1.2 |

### 6.3 End Anchor Site Preparation

The site should be inspected for the presence of underground utilities prior to any excavation. The site should be prepared free of obstructing vegetation and other hazards that may interfere with the installation or operational performance of the system. Some sites may require minor grading if installed beyond the edge of the pavement shoulder.

Vehicles impacting the end of the terminals will normally continue behind and beyond the barrier and may encounter non-traversable terrain or other roadside hazards. It is recommended that the guidelines as stated in AS/NZS 3845 for the installation of gating safety barrier end terminals be observed.

AS/NZS 3845 requires that a Hazard Free Zone 'immediately behind the terminal… should be reasonably traversable and free from fixed object hazards. If a clear runout is not possible, this area should be similar in character to adjacent unshielded roadside areas.'

### 6.4 Construction of Anchor Blocks

Safence is available with a variety of anchor block designs. These include;

1. Rectangular
2. Trapezoidal
3. Pier

The selection of a suitable design will depend upon soil type, road formation width and available installation equipment.

Typically, the alignment of the anchor block will follow the same alignment as the length of need section. If site conditions require the anchor block to be offset to the length of need section, a 200m radius can be introduced upstream from the end anchor until the desired offset angle is achieved. The fence can then be tapered at a constant rate to achieve the required offset distance.

The construction sequence is as follows;

1. Excavate the anchor hole in accordance with Ingal drawings.
2. If installing the rectangular anchor block, clip out several grids of the reomesh square to fit over the anchor bracket as shown in Ingal drawing WR-STD-62.

Figure 3: Clipping of Reomesh

3. Attach 3 off M20 x 550mm hook bolts to the base of the anchor bracket using 2 off M20 nuts per hook bolt. One M20 nut is used either side of the anchor bracket to secure each hook bolt.
4. Using formwork, suspend the anchor bracket and reomesh, ensuring the anchor bracket levelling plate is at the same longitudinal grade as the roadway. The position of the anchor bracket is to be in accordance with Ingal drawings.

Figure 4: Placement of Anchor Bracket

5. To prevent flotation or dislodgement during the concrete pour, drive a shortened star picket into the base or side of the excavation and use tie wire to secure the bracket.
6. Pour concrete into the excavation and vibrate. Ensure that the anchor bracket has remained secure.
7. Trowel the surface of the anchor block and shape to provide fall way from the anchor bracket.

Figure 5: Trowelling of the Anchor Block

### 6.5 Construction of Post Footings

1. Establish post spacing in accordance with expected dynamic deflections and excavate postholes to the dimensions in accordance with Table 1. Note that the height of the footing must be within 20mm of the design reference height.
2. Pour concrete into each hole.
3. Insert the post footing reinforcement ring to a depth providing 50mm of cover.

Figure 6: Pouring of Concrete

Figure 7: Insertion of the Post Reo Ring

4. Insert the Safence post into the plastic HDPE sleeve.
5. Push the Safence post and the plastic HDPE sleeve into the wet concrete so that the top of the plastic sleeve is at ground level. The posts are orientated so that the smooth face is towards the traffic face.
6. Trowel the surface of the post footings and shape to provide fall away from the post sleeve.

Figure 8: Trowelling of the Post Footing

### 6.6 Assembly Sequence

1. It is recommended that concrete used for the construction of anchor blocks and post footings be cured for a period of 7 days prior to tensioning.
2. Slide the ground covers over each Safence post.
3. Starting at the leading or high end of the fence, connect the bottom wire rope to the anchor using a temporary anchor connection and run out the wire through the post slots to the far anchor and cut the rope to length. When a reel is depleted, attach the end to the next reel by tying the cables together and continue to run out the cable.
4. Insert the plastic spreaders into the post slots.
5. Repeat these procedures with subsequent wire ropes. Ensure the stainless frame is inserted between the top two ropes.
6. When all the ropes have been installed, fit the plastic caps to the posts.

### 6.7 Assembly Sequence – Safence TL4

The installation of Safence TL4 requires the following additional procedures;

1. Prior to running out the wire, a reinforcement sleeve is inserted into each post. The post reinforcement will come to rest within the post sleeve at the ground level.

Figure 9: Attachment of Post Reinforcement

2. When all the ropes have been installed, a rope hook is attached through the pre-punched holes in the top of the posts.

Note. Ensure steel rope spreaders are used in the first full height post of the Safence TL3 Terminal. Refer post (k) on drawing WR-STD-050.


Figure 10: Attachment of Rope Hook


Figure 12: Securing of Fittings and Check Ropes

### 6.8 Installation of Tension Bays

Tension bays are located at 300m centres and not more than 150m from either anchor point.

For fences less than 600m;

1. Attach the safety check ropes to the wire ropes at the leading or high-end anchor. Swage the stainless steel end fittings onto all the cables and attach to the anchor bracket. The procedure for swaging is contained in the Safence Swaging Unit Safe Operating Procedure Manual The bottom rope is located nearest to the approaching traffic face. Each end fitting is secured at the anchor with one washer and two nuts.

   *Note: An inspection hole is drilled into each stainless steel end fitting to ensure the wire rope cables are properly inserted into the end fittings before swaging.*

2. Pull the slack out of the wire ropes toward the other anchor. This can be achieved by hand or by using a sling equipped with a lever claw clamp.


Figure 13: Attachment of Lever Claw Clamp


Figure 11: Anchor Block Fitting Arrangement

3. At locations where the wire rope reels have been temporarily joined, swage the end fittings onto the cables and install a tension fitting. End fittings should be positioned so that the end of the fitting is a minimum distance of 50mm from the post.
4. After the slack has been removed from the fence, attach the check ropes, machine swage the end fittings and attach to the trailing or low-end anchor.
5. Identify the tension bay location(s).
6. Mark and cut out an 800mm section from each cable. It may be necessary to attach temporary clamps one post back from the tension bay location prior to cutting in order to prevent the cables from retracting. End fittings should be positioned so that the end of the fitting is a minimum distance of 50mm from the post.


Figure 14: Attachment of Temporary Clamp

7. Swage the end fittings to each cable and attach the tension fittings. The procedure for swaging is contained in the Safence Swaging Unit Safe Operating Procedure Manual.
8. Attach the tensioning rig to the bottom cable and tension from the bottom up. The procedure for Tensioning is contained in the Safence Tension Unit Safe Operating Procedure Manual. Each rope is tensioned in accordance with Table 4.

**For fences greater than 600m**

1. Attach the safety check ropes and machine swage the cables at the leading or high-end anchor and attach to the anchor bracket.
2. Pull the slack out of the wire ropes towards the 1st tension bay location. This can be achieved by hand or by using a sling equipped with a lever claw clamp.
3. At the 1st tension bay location clamp the wire rope cable to a post. Repeat process for each cable, clamping each cable to a different post.
4. Cut the cables on the un-tensioned side of clamps and machine swage fittings. Assemble the tension fittings.
5. Relocate to the 2nd tension bay and repeat the above process. Continue until all the tension bays are completed.
6. Once the slack has been removed from the fence, attach the check ropes, swage the end fittings and attach to the trailing or low-end anchor.
7. Once the cables are attached at the anchor bracket, relocate to the centre tension bay.
8. Attach the tensioning rig and tension in accordance with Table 4 from the bottom up.
9. Relocate from the centre bay outwards repeating the tension process.
10. Once complete, relocate to the centre bay and repeat tensioning in this bay only.

Note: Upon completion of the installation the various tension bays shall not be more than 90% of their full extent so as to allow for further adjustment.

**Table 3: Construction Tolerances**

| Description | Recommended Tolerance |
|---|---|
| Rope Height | ± 20mm |
| Post Spacing | ± 30mm |
| Post Footing Dimensions | - 10mm |
| Anchor Block Dimensions | - 20mm |

**Table 4: Tension Unit Pressure Requirements**

| Ambient Temperature ºC | TL3 System (Bar) | TL4 System (Bar) |
|---|---|---|
| - 10 | (26kN) 278 | (38kN) 410 |
| 5 | (24kN) 263 | (36kN) 386 |
| 0 | (23kN) 247 | (34kN) 363 |
| 5 | (21kN) 231 | (32kN) 340 |
| 10 | (20kN) 215 | (29kN) 316 |
| 15 | (18kN) 200 | (27kN) 293 |
| 20 | (17kN) 184 | (25kN) 270 |
| 25 | (16kN) 168 | (23kN) 247 |
| 30 | (14kN) 152 | (21kN) 224 |
| 35 | (13kN) 137 | (19kN) 201 |
| 40 | (11kN) 121 | (17kN) 177 |

## 6.9 Clean-up and Waste Materials

Recycle, reuse or dispose of all surplus material, rubbish and other debris in accordance with the requirements of the local state based environmental protection specification.


Figure 15: Tension Bay

## 7.0 Safence Maintenance

Safence is a low maintenance roadside safety barrier. Except for repairs due to impacts, there is virtually no maintenance required for the system. It is recommended that regular drive-by inspections be performed to ensure the following;

1. Post caps have not dislodged. Delineation stickers are attached to the post caps and a loss of numerous caps could result in poor delineation.
2. Debris has not accumulated around the system. A clear zone, free of hazards should exist immediately behind the fence to accommodate for the expected dynamic deflection.
3. Safety check ropes should be secured to the anchor bracket.
4. Ropes have not dislodged from the posts as a result of minor impacts.

### 7.1 Cable Tension

Safence is supplied with pre-stretched wire rope. The pre-stretching process removes the constructional stretch in the wires as they 'bed-down'. Wire rope is essentially an elastic member and will not require retensioning after most impacts. For fences subjected to regular vehicle impacts or large seasonal temperature variations, it may be necessary to evaluate the rope tension annually. This can be undertaken using the Safence Tension Unit.

### 7.2 Bush Fire Damage [1]

The performance of galvanized coatings when subjected to bushfire depends on a number of factors, such as flame duration, intensity and the characteristics of the galvanized coating and the technology with which it is applied.

Typical bushfire conditions may expose steel structures to air temperature of 800°C for periods of up to 120 seconds, however zinc coatings are generally reflective and will not absorb heat at the same rate as an uncoated steel surface. Depending on the section thickness of the steel, the actual steel surface temperatures may not exceed 350°C.

Typically, the bushfire flame duration and intensity are not high enough to compromise the structural strength of the steel. The hot dip galvanized coating will thus remain largely unaffected through a bushfire event. If the bushfire causes damage to the galvanized surface, then the item(s) shall be replaced.

### 7.3 Damage Assessment

In the event of a vehicle impact, damage to the barrier is to be assessed in accordance with Table 5. In the event that the ropes are to be cut, they are NOT to be cut under tension.

A Safe Work Method Statement is available upon request to assist in the safe repair of Safence.

*[1] Information based upon testing conducted on behalf of BlueScope Steel by the CSIRO Manufacturing and Infrastructure Technology Bushfire CRC in 2005.*

**Table 5: Damage Assessment**

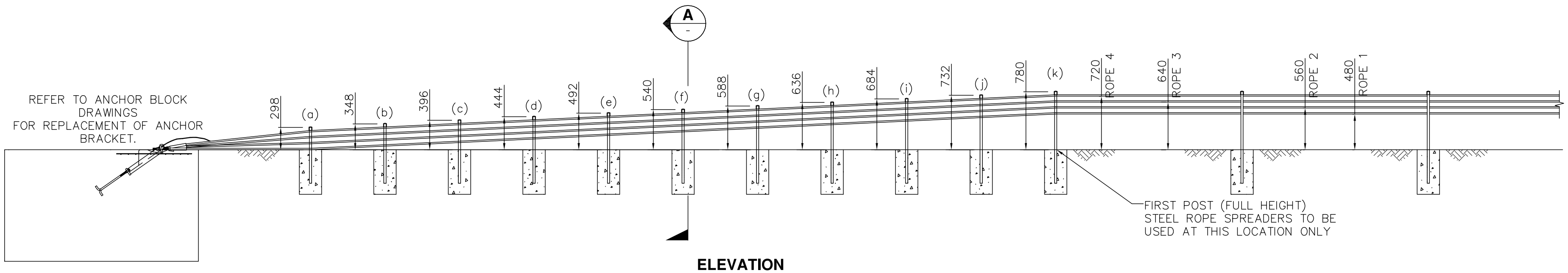
| Type of Defect | Description of the Defect | Action to be Taken |
|---|---|---|
| Galvanizing damage on Posts. | The sum total of the damaged or uncoated areas does not exceed $10cm^2$ (0.5% of the total surface area). | An organic zinc rich epoxy paint is to be applied to the repair areas in two coats. |
| | The sum total of the damaged or uncoated areas exceeds $10cm^2$ (0.5% of the total surface area). | The post is to be replaced. |
| Galvanizing Damage on Wire Rope Cable | The wire rope is nicked or gouged to less than 10% depth. | An organic zinc rich epoxy paint is to applied to the repair areas in two coats. |
| | The wire rope is nicked or gouged greater than 10% depth. | The wire rope section is to be replaced. |
| Mechanical Damage on Wire Rope Cable | Any rope length containing more than 1 broken wire. | The rope section is to be replaced. |
| | Any rope where the diameter is reduced by more than 10% by abrasion. | The rope section is to be replaced |
| | Any rope which has been crushed or flattened by more than 10% of its nominal diameter. | The rope section is to be replaced. |
| Mechanical damage on Posts. | The post is distorted. | The post is to be replaced. |
| Damaged End Fitting | There is damage to the thread of the fitting, however tension can be maintained in the wire rope system without relying on the fitting. | There is no requirement for immediate replacement. The location of the fitting should be noted and scheduled for replacement during routine maintenance. |
| | There is damage to the thread of the fitting and tension cannot be maintained in the wire rope system without relying on the fitting. | The fitting is to be replaced. |
| | The fitting is cracked. | The fitting is to be replaced. |
| | The body of the fitting is distorted. | The fitting is to be replaced. |
| Damaged Tension Fitting | The fitting is cracked. | The fitting is to be replaced. |
| | The body of the fitting is distorted. | The fitting is to be replaced. |

| Safence Tensioning Report And Checklist |
|---|
| Customer: |
| Project: |
| Fence ID: |
| Fence Length: |
| Ambient Temperature: |
| Tensioning Force: |
| Checked By: |
| Signed: |
| Date |

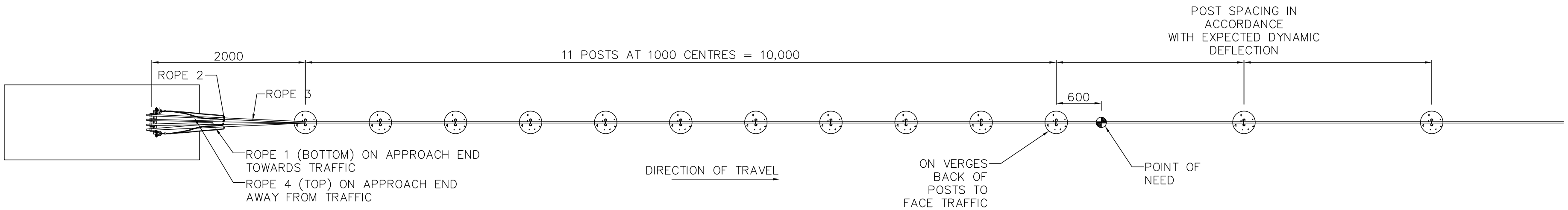
| | | |
|---|---|---|
| **End Anchors** | | |
| Is the anchor block dimensions in accordance with Ingal drawings | Yes | No |
| Has the anchor bracket been installed with the levelling plate at the same longitudinal grade as the roadway | Yes | No |
| Have safety check ropes been attached to the cables | Yes | No |
| Have the safety check ropes been attached to the anchor bracket | Yes | No |
| Has each end fitting been secured with one washer and two nuts | Yes | No |
| **Post Fittings** | | |
| Have the posts been installed at the correct spacing | Yes | No |
| Have the posts been installed with the correct orientation towards approaching traffic | Yes | No |
| Have ground covers been attached to the posts | Yes | No |
| Have plastic spacers been inserted between each cable | Yes | No |
| Has the stainless frame been inserted between the top and second from top cable | Yes | No |
| Have post caps been attached to the posts | Yes | No |
| Has delineation been attached to the post caps | Yes | No |
| **Post Fittings – TL4 System Only** | | |
| Has the post reinforcement sleeve been installed at each post location along the length of need section | Yes | No |
| Have rope hooks been attached to each post along the length of need section | Yes | No |
| **Tension Bays** | | |
| Have tension bays been installed at not more than 150m from the end anchors | Yes | No |
| Have tension Bays been installed at not more than 300m apart | Yes | No |

Figure 16: Safence TL4 (4 Rope)

Figure 17: Safence TL4 (4 Rope)

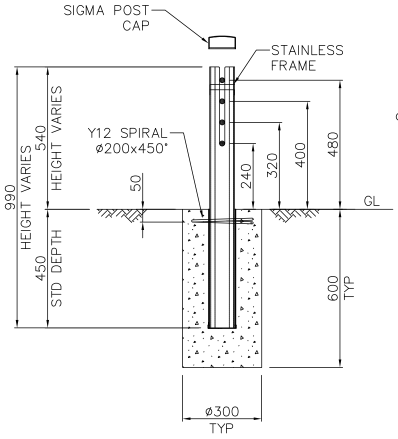



## ELEVATION

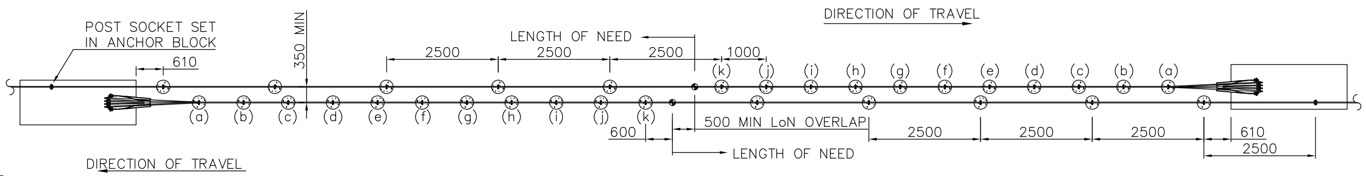



## PLAN

| ITEM No. | POST LENGTH |
|---|---|
| a | 748 |
| b | 798 |
| c | 846 |
| d | 894 |
| e | 942 |
| f | 990 |
| g | 1038 |
| h | 1086 |
| i | 1134 |
| j | 1182 |
| k | 1230 |




**SECTION A**
NTS




INTERMEDIATE ANCHOR GENERAL ARRANGEMENT

NOTES:

1. DIMENSIONS SHOWN ARE IN mm UNLESS OTHERWISE STATED.
2. THE FLEXFENCE TL3 TERMINAL HAS BEEN APPROVED BY THE US FEDERAL HIGHWAY ADMINISTRATION AS CONFORMING TO NCHRP REPORT 350 TEST LEVEL 3 (TL3) IN A 3 ROPE AND A 4 ROPE CONFIGURATION.
3. THE USE OF A 3 ROPE CONFIGURATION REQUIRES THE OMMITANCE OF THE SECOND FROM BOTTOM CABLE.
4. ICP DISTRIBUTE THIS WRSB SYSTEM UNDER THE PRODUCT NAME SAFENCE IN NEW ZEALAND. REFER NZTA APPROVAL LETTER FOR APPROVED CONFIGURATION.
5. LENGTH OF NEED OVERLAP FOR INTERMEDIATE ANCHOR TO BE 500mm FOR A FLEXFENCE INSTALLATION WITH A POST SPACING OF 2.5m, CONTACT YOUR ICP REPRESENTATIVE FOR OVERLAP WHEN USING A DIFFERENT POST SPACING.

REVISIONS

| REV | DATE | DESCRIPTION | DRAWN | CHECKED | APPROVED |
|---|---|---|---|---|---|
| 7 | 01/08/14 | STEEL ROPE SPREADERS ADDED | LG | LRB | LG |
| 6 | 15/04/13 | INTERMEDIATE ANCHOR DETAIL ADDED | LG | LRB | LG |
| 5 | 08/02/12 | SAFENCE NOTE ADDED | LG | SE | LRB |
| 4 | 02/11/11 | TITLE BLOCK UPDATED | DJB | TC | TC |
| 3 | 09/02/10 | DETAILS ADDED | MS | TC | TC |
| 2 | 28/01/97 | ANCHOR BLOCK DETAILS REMOVED | WSB | TC | TC |
| 1 | 01/10/96 | INITIAL ISSUE | WSB | TC | TC |

REFERENCES

| DRAWING NUMBER | REFERENCE DRAWINGS |
|---|---|

| | NAME | DATE |
|---|---|---|
| DRAWN | AUSTEC | 02/11/2011 |
| CHECKED | TC | 02/11/2011 |
| APPROVED | TC | 02/11/2011 |
| SCALE | NTS | |
| SIZE | A1 | |

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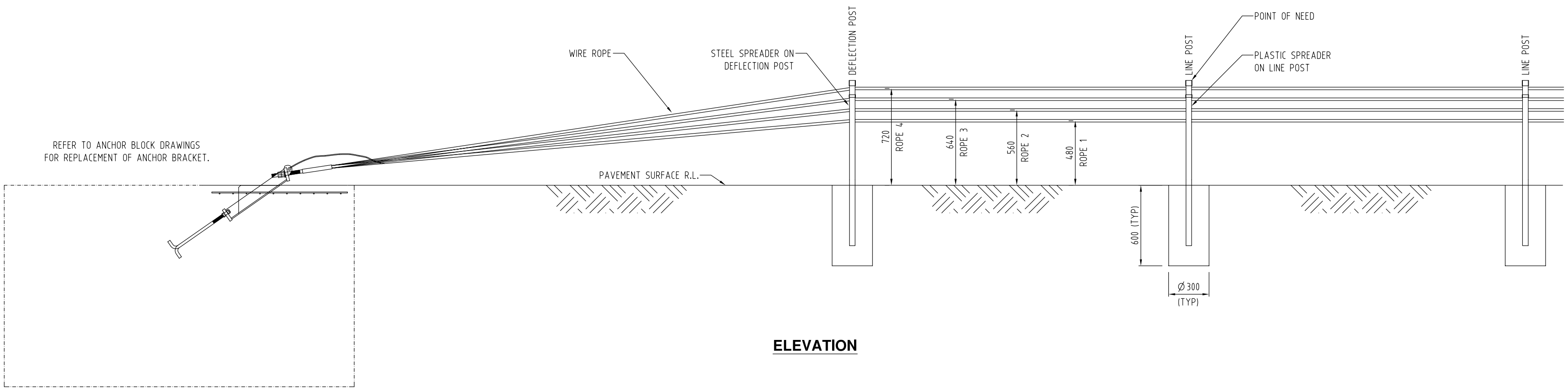
PROJECT
FLEXFENCE
WIRE ROPE SAFETY BARRIER

TITLE
TL3 END TERMINAL

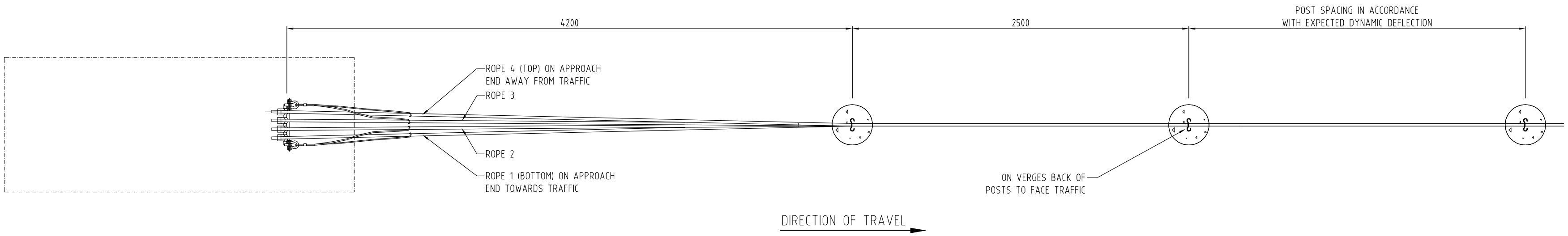
INGAL CIVIL PRODUCTS REFERENCE No.

DRAWING No.
WR–STD–050

REV. 7




**ELEVATION**




**PLAN**

Use of this terminal is limited to locations where geometric constraints limit use of TL3 Terminal. Please contact your local ICP representative for further advice prior to design or installation. Approval may be required from road controlling authority.

NOTES:
1. DIMENSIONS SHOWN ARE IN mm UNLESS OTHERWISE STATED.

REVISIONS

| REV | DATE | DESCRIPTION | DRAWN | CHECKED | APPROVED |
|---|---|---|---|---|---|
| 5 | 02/11/11 | TITLE BLOCK UPDATED | DJB | TC | TC |
| 4 | 08/02/10 | DETAILS UPDATED | MS | TC | TC |
| 3 | 24/04/07 | TITLE AMENDED | XX | TC | TC |
| 2 | 09/02/07 | NOTES AND TITLE AMENDED | AJP | TC | TC |
| 1 | 26/06/06 | INITIAL ISSUE | AJP | TC | TC |

REFERENCES

| DRAWING NUMBER | REFERENCE DRAWINGS |
|---|---|

| | NAME | DATE |
|---|---|---|
| DRAWN | AUSTEC | 2/11/2011 |
| CHECKED | TC | 2/11/2011 |
| APPROVED | TC | 2/11/2011 |
| SCALE | NTS | |
| SIZE | A1 | |

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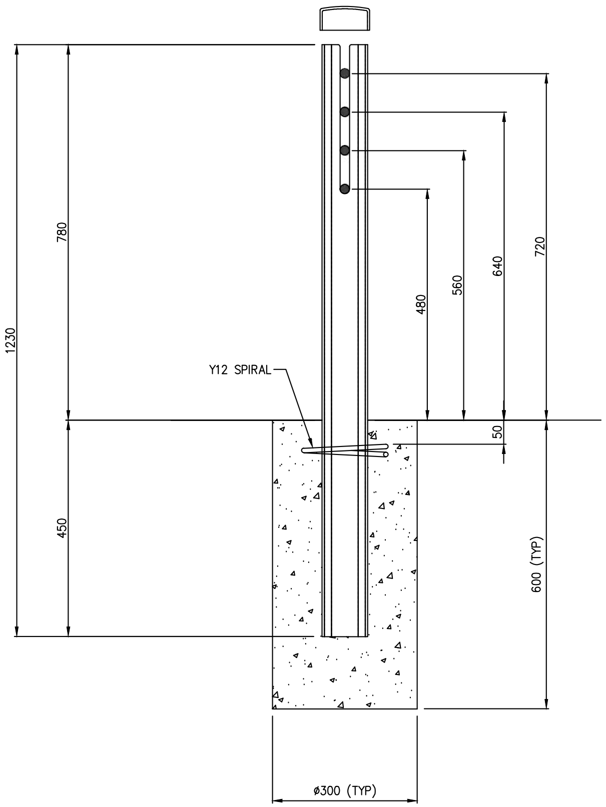
PROJECT
FLEXFENCE WIRE ROPE SAFETY BARRIER

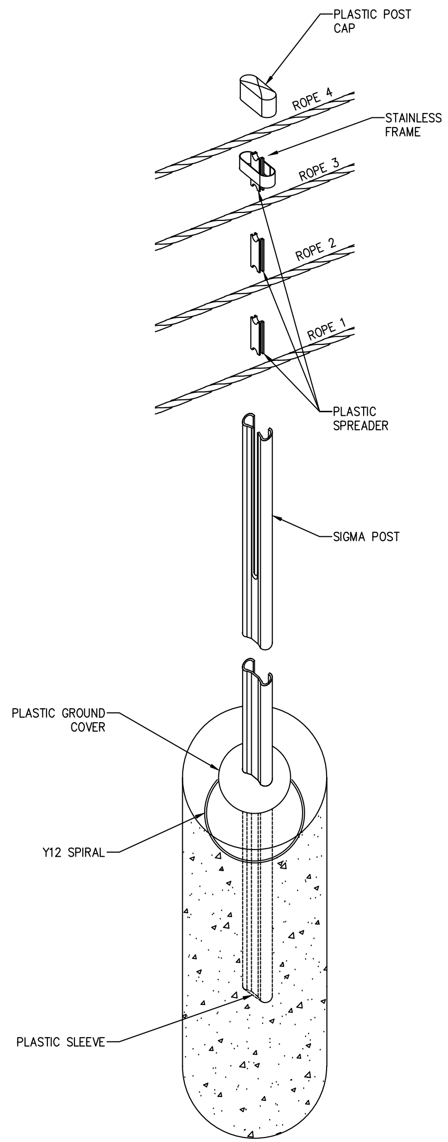
TITLE
STANDARD END TERMINAL
4-ROPE CONFIGURATION

INGAL CIVIL PRODUCTS REFERENCE No.

DRAWING No.
WR-STD-55

REV. 5




NOTES:

1. THE IMPACT CONDITIONS ARE DESCRIBED AS FOLLOWS:
   a) TL3 REFERS TO NCHRP REPORT 350 TEST LEVEL 3. THIS IS AN IMPACT WITH A 2,000KG PICK-UP TRUCK TRAVELING AT 100KM/H AND 25 DEGREES.
   b) N2 REFERS TO EN1317 CONTAINMENT LEVEL N2. THIS IS AN IMPACT WITH A 1,500KG VEHICLE TRAVELING AT 110KM/H AND 20 DEGREES.
   c) H1 REFERS TO EN1317 CONTAINMENT LEVEL H1. THIS IS AN IMPACT WITH A 10,000KG RIGID TRUCK TRAVELING AT 70KM/H AND 15 DEGREES.
2. THE DYNAMIC DEFLECTION VALUES SHOULD NOT BE CONSIDERED AN EXACT DISTANCE, BUT RATHER AS A SINGLE POINT WITHIN THE RANGE OF DEFLECTIONS THAT CAN BE EXPECTED.
3. STATE ROAD AUTHORITY SPECIFICATIONS SHOULD BE REFERENCED TO OBTAIN APPROVED POST SPACINGS AND RELEVANT MULTIPLYING FACTORS FOR INSTALLATIONS ON CURVES AND/OR VARIATIONS IN BARRIER LENGTHS (IF REQUIRED).
4. SIZES OF CONCRETE POST FOOTINGS ARE DEPENDANT UPON LOCAL GROUND CONDITIONS. REFER TO FLEXFENCE PRODUCT MANUAL FOR FOOTING SIZE OPTIONS.
5. DIMENSIONS SHOWN ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
6. NOMINAL ROPE TENSION AT 20°C IS 17kN

| | DYNAMIC DEFLECTION (M) | | |
|---|---|---|---|
| POST SPACING (M) | N2 | TL3 | H1 |
| 2.0 | 1.0 | 1.9 | 2.0 |
| 2.5 | 1.3 | 2.2 | 2.5 |
| 3.0 | 1.6 | 2.5 | 3.0 |

REVISIONS

| REV | DATE | DESCRIPTION | DRAWN | CHECKED | APPROVED |
|---|---|---|---|---|---|
| 6 | 26-06-2014 | NOTE 6 ADDED | LG | | |
| 5 | 02/11/11 | TITLE BLOCK UPDATED | DJB | TC | TC |
| 4 | 08/02/10 | NOTES AMENDED | MS | TC | TC |
| 3 | 24/03/09 | TITLE AMENDED | MS | TC | TC |
| 2 | 24/04/07 | TITLE AMENDED | AJP | TC | TC |
| 1 | 09/02/07 | NOTES AND TITLE AMENDED | AJP | TC | TC |
| 0 | 06/07/06 | INITIAL ISSUE | AJP | TC | TC |

REFERENCES

| DRAWING NUMBER | REFERENCE DRAWINGS |
|---|---|

| | NAME | DATE |
|---|---|---|
| DRAWN | AUSTEC | 2/11/2011 |
| CHECKED | TC | 2/11/2011 |
| APPROVED | TC | 2/11/2011 |
| SCALE | NTS | |
| SIZE | A1 | |

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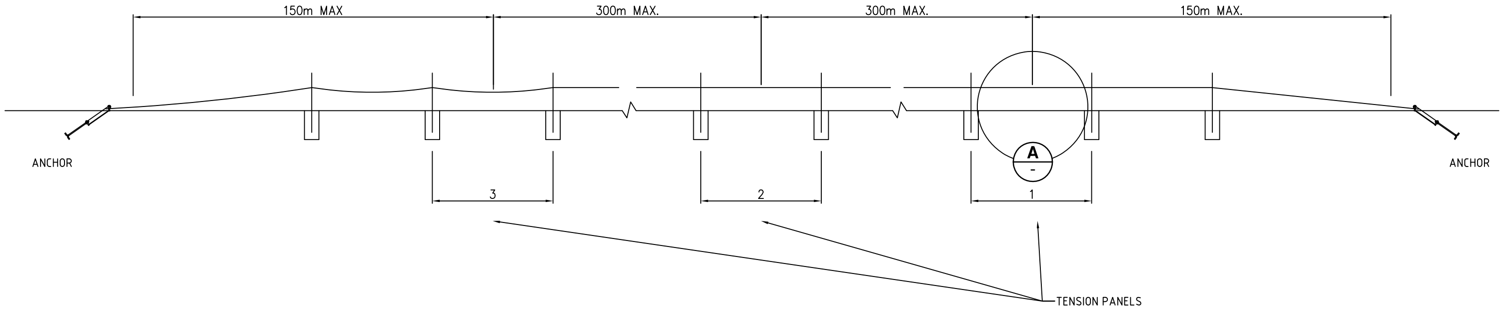
PROJECT
FLEXFENCE WIRE ROPE SAFETY BARRIER

TITLE
TL3 POST ARRANGEMENT

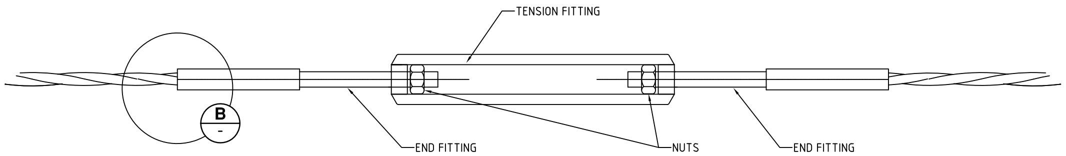
INGAL CIVIL PRODUCTS REFERENCE No.

DRAWING No.
WR-STD-57

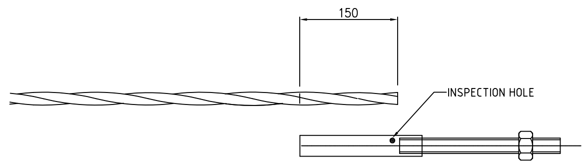
REV. 6




**TENSION PANEL LAYOUT**




**DETAIL** A -
NTS




**DETAIL** B -
NTS

NOTES:
1. ALL MEASUREMENTS ARE IN mm UNLESS STATED OTHERWISE.
2. ICP DISTRIBUTE THIS WRSB SYSTEM UNDER THE PRODUCT NAME SAFENCE IN NEW ZEALAND. REFER NZTA APPROVAL LETTER FOR APPROVED CONFIGURATION.

REVISIONS

| REV | DATE | DESCRIPTION | DRAWN | CHECKED | APPROVED |
|---|---|---|---|---|---|
| 4 | 08/02/13 | NOTES ADDED | LG | SE | LRB |
| 3 | 02/11/11 | TITLE BLOCK UPDATED | DJB | TC | TC |
| 2 | 25/02/10 | TITLE BLOCK UPDATED | MS | TC | TC |
| 1 | 13/07/06 | INITIAL ISSUE | AJP | TC | TC |

REFERENCES

| DRAWING NUMBER | REFERENCE DRAWINGS |
|---|---|

| | NAME | DATE |
|---|---|---|
| DRAWN | AUSTEC | 2/11/2011 |
| CHECKED | TC | 2/11/2011 |
| APPROVED | TC | 2/11/2011 |
| SCALE | NTS | |
| SIZE | A1 | |

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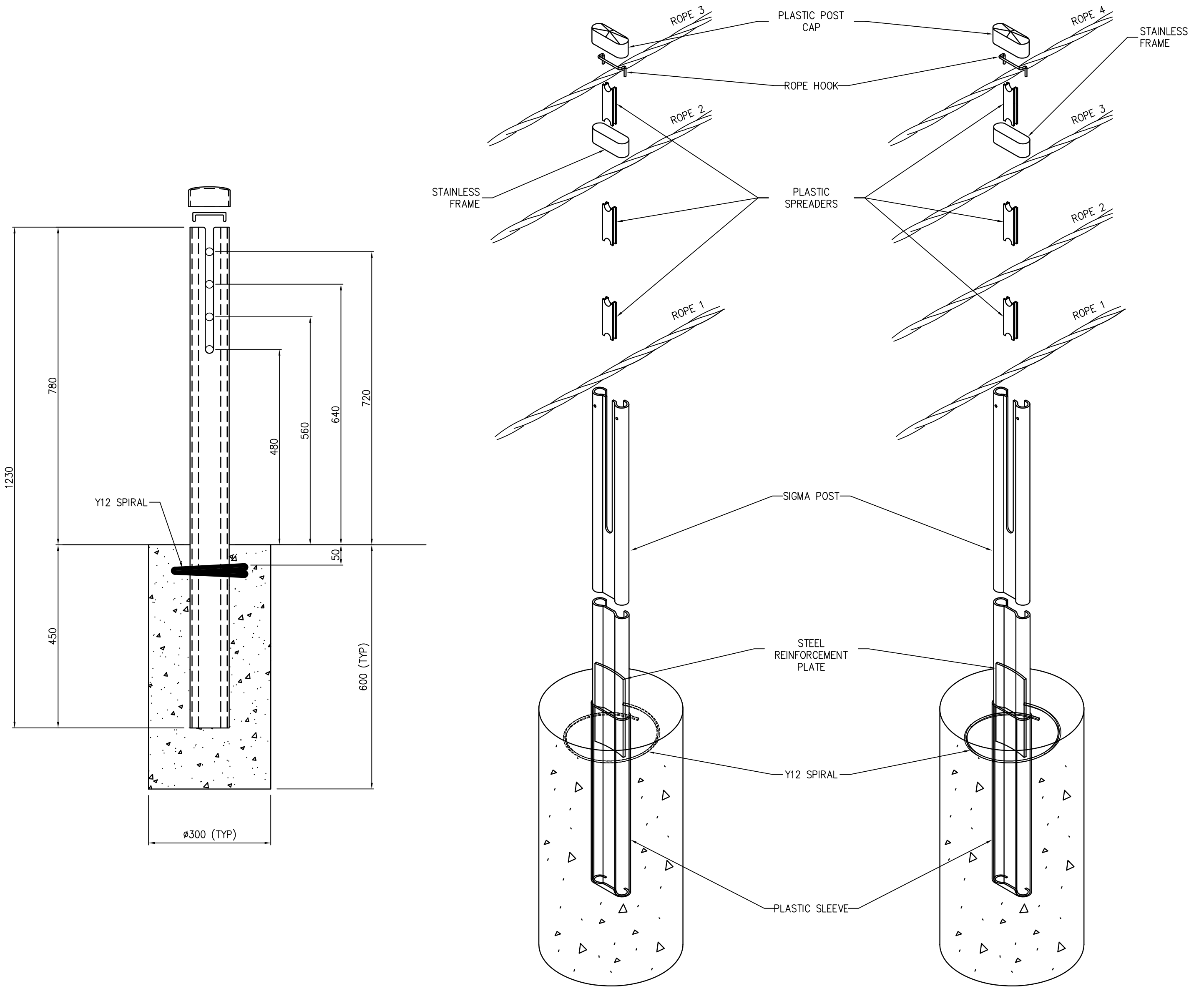
PROJECT
FLEXFENCE WIRE ROPE SAFETY BARRIER

TITLE
TENSION PANEL ARRANGEMENT

INGAL CIVIL PRODUCTS REFERENCE No.

DRAWING No.
WR–STD–59

REV. 4




3-ROPE OPTION

4-ROPE OPTION

NOTES:

1. THE IMPACT CONDITIONS ARE DESCRIBED AS FOLLOWS;
   a) TL3 REFERS TO NCHRP REPORT 350 TEST LEVEL 3. THIS IS AN IMPACT WITH A 2,000KG PICK-UP TRUCK TRAVELING AT 100KM/H AND 25 DEGREES.
   b) TL4 REFERS TO NCHRP REPORT 350 TEST LEVEL 4. THIS IS AN IMPACT WITH AN 8,000KG RIGID TRUCK TRAVELING AT 80KM/H AND 15 DEGREES. FLEXFENCE TL4 HAS BEEN APPROVED BY THE US FEDERAL HIGHWAY ADMINISTRATION AS A 3 ROPE OR 4 ROPE BARRIER.
2. THE DYNAMIC DEFLECTION VALUES SHOULD NOT BE CONSIDERED AN EXACT DISTANCE, BUT RATHER AS A SINGLE POINT WITHIN THE RANGE OF DEFLECTIONS THAT CAN BE EXPECTED.
3. STATE ROAD AUTHORITY SPECIFICATIONS SHOULD BE REFERENCED TO OBTAIN APPROVED POST SPACINGS AND RELEVANT MULTIPLYING FACTORS FOR INSTALLATIONS ON CURVES AND/OR VARIATIONS IN BARRIER LENGTHS (IF REQUIRED).
4. SIZES OF CONCRETE POST FOOTINGS ARE DEPENDANT UPON LOCAL GROUND CONDITIONS. REFER TO FLEXFENCE PRODUCT MANUAL FOR FOOTING SIZE OPTIONS.
5. DIMENSIONS SHOWN ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED
6. ICP DISTRIBUTE THIS WRSB SYSTEM UNDER THE PRODUCT NAME SAFENCE IN NEW ZEALAND. REFER NZTA APPROVAL LETTER FOR APPROVED CONFIGURATION.

| | DYNAMIC DEFLECTION (M) | |
|---|---|---|
| POST SPACING (M) | TL3* | TL4* |
| 2.0 | 1.3 | 1.1 |
| 2.5 | 1.4 | 1.2 |
| 3.0 | 1.6 | 1.3 |

* CABLE TENSION SET TO 25kN

REVISIONS

| REV | DATE | DESCRIPTION | DRAWN | CHECKED | APPROVED |
|---|---|---|---|---|---|
| 7 | 08/02/13 | SAFENCE NOTE ADDED & DEFLECTION UPDATED | LG | SE | LRB |
| 6 | 02/11/11 | TITLE BLOCK UPDATED | DJB | TC | TC |
| 5 | 04/05/10 | NOTES AMENDED | MS | TC | TC |
| 4 | 08/02/10 | NOTES AMENDED | MS | TC | TC |
| 3 | 28/07/09 | TITLE AMENDED | MS | TC | TC |
| 2 | 24/04/07 | TITLE AMENDED | AJP | TC | TC |
| 1 | 09/02/07 | NOTES AND TITLE AMENDED | AJP | TC | TC |
| 0 | 06/07/06 | INITIAL ISSUE | AJP | TC | TC |

REFERENCES

| DRAWING NUMBER | REFERENCE DRAWINGS |
|---|---|

| | NAME | DATE |
|---|---|---|
| DRAWN | AUSTEC | 2/11/2011 |
| CHECKED | TC | 2/11/2011 |
| APPROVED | TC | 2/11/2011 |
| SCALE | NTS | |
| SIZE | A1 | |

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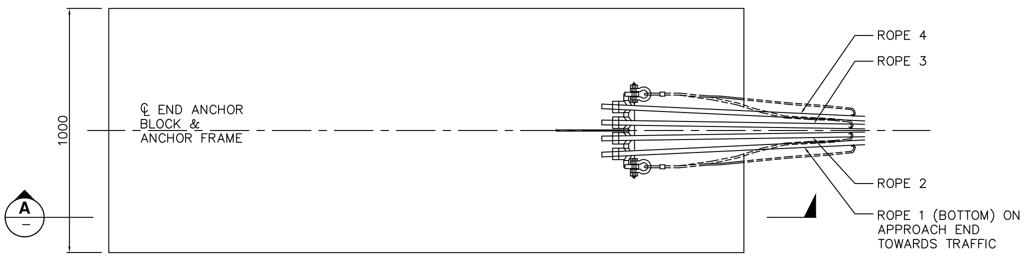
PROJECT
FLEXFENCE WIRE ROPE SAFETY BARRIER

TITLE
TL4 POST ARRANGEMENT

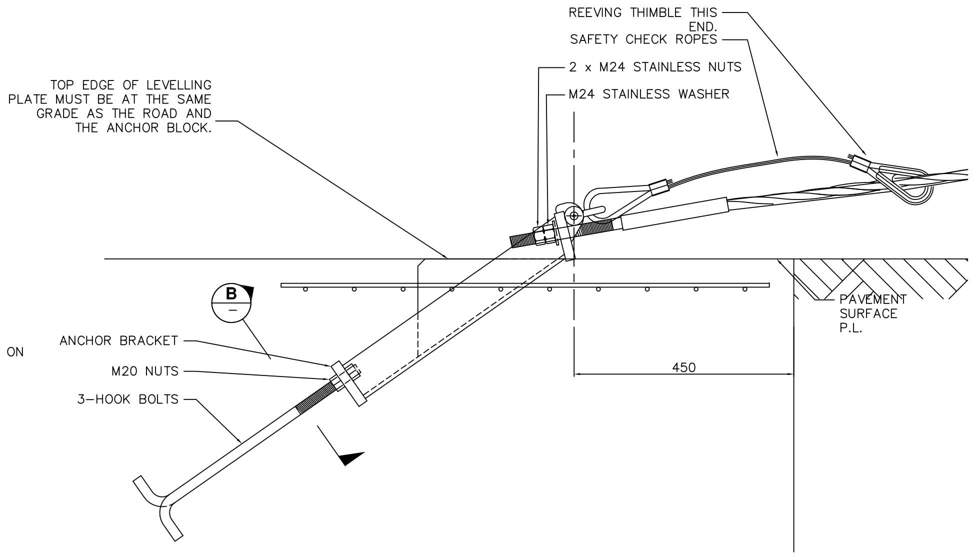
INGAL CIVIL PRODUCTS REFERENCE No.

DRAWING No.
WR-STD-60

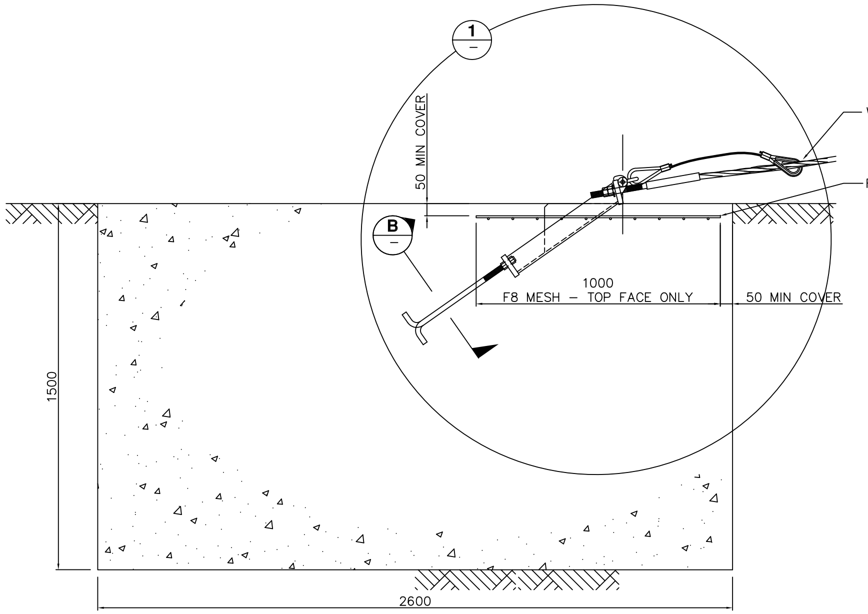
REV. 7



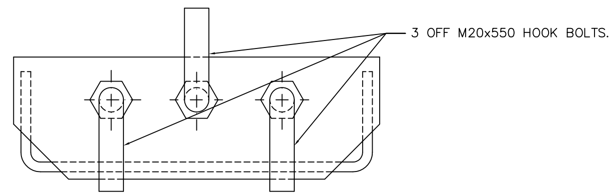

PLAN




DETAIL 1
NTS




SECTION A
NTS




SECTION B
NTS

NOTES:
1. COMPRESSIVE STRENGTH OF CONCRETE AT 28 DAYS SHALL BE 25MPa.
2. ALL MEASUREMENTS ARE IN mm UNLESS STATED OTHERWISE.
3. ICP DISTRIBUTE THIS WRSB SYSTEM UNDER THE PRODUCT NAME SAFENCE IN NEW ZEALAND. REFER NZTA APPROVAL LETTER FOR APPROVED CONFIGURATION.

REVISIONS

| REV | DATE | DESCRIPTION | DRAWN | CHECKED | APPROVED |
|---|---|---|---|---|---|
| 3 | 08/02/13 | SAFENCE NOTE ADDED | LG | SE | LRB |
| 2 | 02/11/11 | TITLE BLOCK UPDATED | DJB | TC | TC |
| 1 | 12/02/10 | INITIAL ISSUE | MS | TC | TC |

REFERENCES

| DRAWING NUMBER | REFERENCE DRAWINGS |
|---|---|

| | NAME | DATE |
|---|---|---|
| DRAWN | AUSTEC | 2/11/2011 |
| CHECKED | TC | 2/11/2011 |
| APPROVED | TC | 2/11/2011 |
| SCALE | NTS | |
| SIZE | A1 | |

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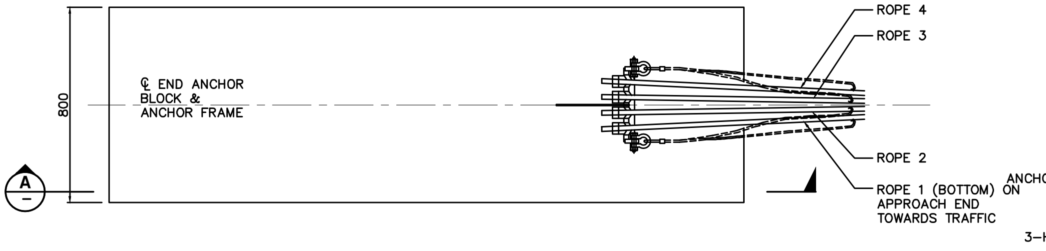
PROJECT
FLEXFENCE WIRE ROPE SAFETY BARRIER

INGAL CIVIL PRODUCTS REFERENCE No.

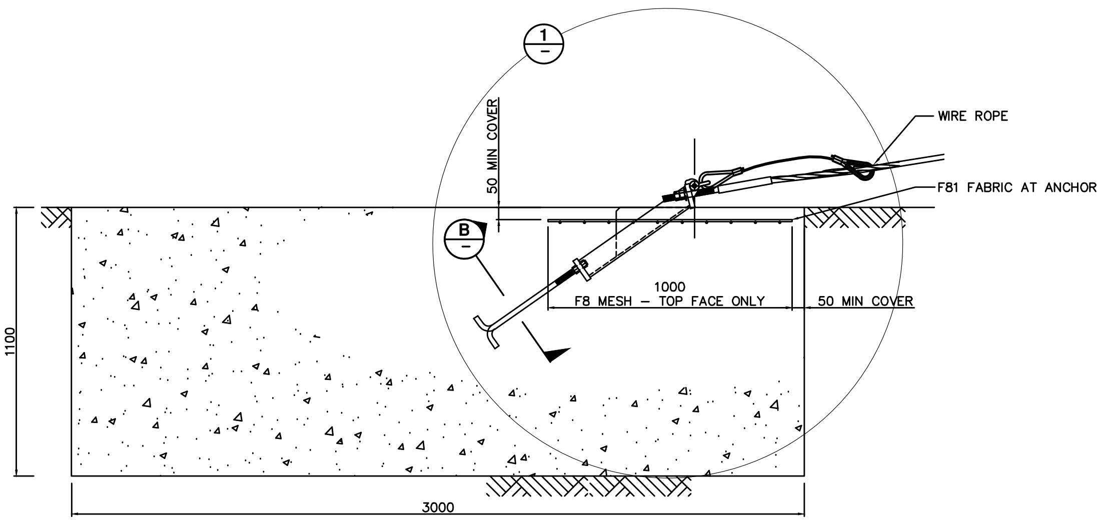
TITLE
RECTANGULAR (TYPE 1) ANCHOR BLOCK

DRAWING No.
WR-STD-62

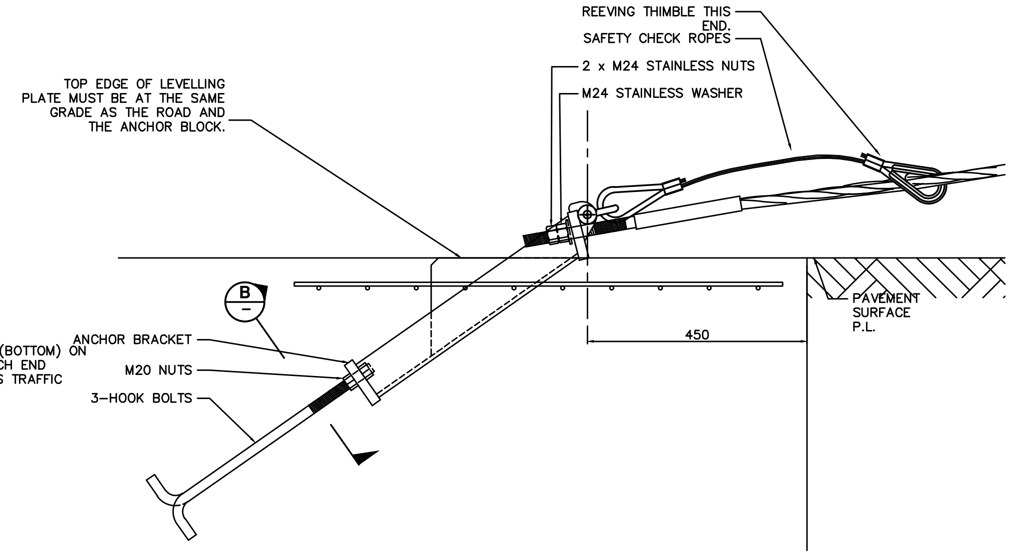
REV. 3



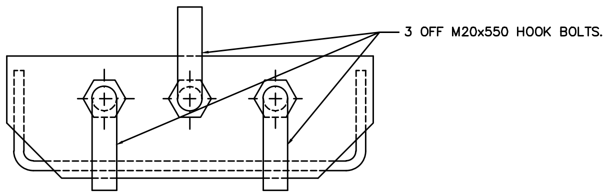

**PLAN**




**SECTION A**
NTS




**DETAIL 1**
NTS




**SECTION B**
NTS

NOTES:

1. COMPRESSIVE STRENGTH OF CONCRETE AT 28 DAYS SHALL BE 32MPa.
2. ALL MEASUREMENTS ARE IN mm UNLESS STATED OTHERWISE.
3. ASSUMED MATERIAL–INTERNAL ANGLE OF FRICTION $\phi = 30^\circ$
   $y = 19kN/m^3$
   or/
   $Cu = 50kPa$
4. INGAL CIVIL PRODUCTS MARKETS THIS SYSTEM UNDER THE TRADE NAME SAFENCE IN NEW ZEALAND.

REVISIONS

| REV | DATE | DESCRIPTION | DRAWN | CHECKED | APPROVED |
|---|---|---|---|---|---|
| 3 | 26/10/12 | NOTE 1 32MPa WAS 25MPa | D.K. | | |
| 2 | 02/11/11 | TITLE BLOCK UPDATED | DJB | TC | TC |
| 1 | 12/02/10 | INITIAL ISSUE | MS | TC | TC |

REFERENCES

| DRAWING NUMBER | REFERENCE DRAWINGS |
|---|---|

| | NAME | DATE |
|---|---|---|
| DRAWN | AUSTEC | 2/11/2011 |
| CHECKED | TC | 2/11/2011 |
| APPROVED | TC | 2/11/2011 |
| SCALE | NTS | |
| SIZE | A1 | |

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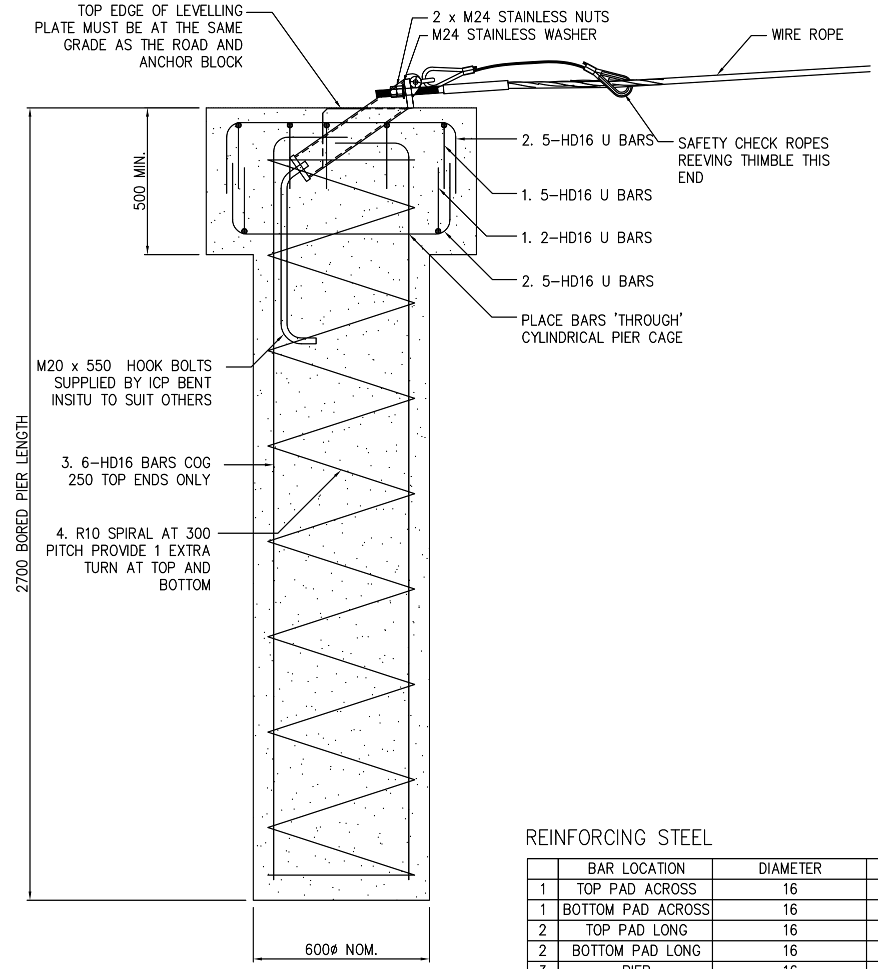
PROJECT
FLEXFENCE WIRE ROPE SAFETY BARRIER

TITLE
RECTANGULAR (TYPE 3) ANCHOR BLOCK

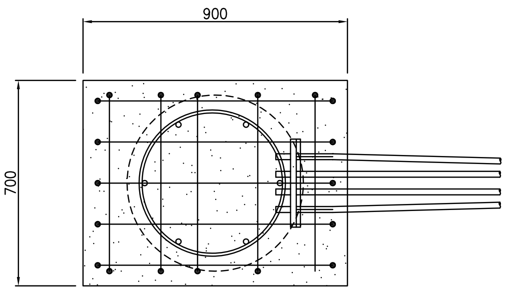
INGAL CIVIL PRODUCTS REFERENCE No.

DRAWING No.
WR–STD–64

REV. 3




SECTION




PLAN VIEW

NOTES:

1. CONCRETE TO BE 32MPa MINIMUM.
2. MINIMUM CLEAR COVER TO BE 75mm.
3. HD BAR DENOTES GRADE 500E TO AS/NZS 4671.
   R BAR DENOTES 300E TO AS/NZS 4671.
4. ASSUMED MATERIAL–INTERNAL ANGLE OF FRICTION $\phi = 30^\circ$, $\gamma = 19kN/m^3$
   or/ $Cu = 50kPa$
5. ICP DISTRIBUTE THIS WRSB SYSTEM UNDER THE PRODUCT NAME SAFENCE IN NEW ZEALAND. REFER NZTA APPROVAL LETTER FOR APPROVED CONFIGURATION.

REINFORCING STEEL

| | BAR LOCATION | DIAMETER | GRADE | No. OF BARS | STRAIGHT LENGTH | RETURNS/PITCH | TOTAL LENGTH | WEIGHT |
|---|---|---|---|---|---|---|---|---|
| 1 | TOP PAD ACROSS | 16 | 500E | 5 | 500 | 600 | 5.5 | 8.63kg |
| 1 | BOTTOM PAD ACROSS | 16 | 500E | 2 | 500 | 600 | 2.2 | 3.45kg |
| 2 | TOP PAD LONG | 16 | 500E | 5 | 600 | 600 | 6 | 9.41kg |
| 2 | BOTTOM PAD LONG | 16 | 500E | 5 | 600 | 600 | 6 | 9.41kg |
| 3 | PIER | 16 | 500E | 6 | 2600 | 250 | 17.1 | 26.82kg |
| 4 | SPIRAL | 10 | 500E | 1 | 15352 | 300 | 15.4 | 9.41kg |
| | | | | | | | | 67.1kg |

REVISIONS

| REV | DATE | DESCRIPTION | DRAWN | CHECKED | APPROVED |
|---|---|---|---|---|---|
| 2 | 08/02/13 | SAFENCE NOTE ADDED | LG | SE | LRB |
| 1 | 04/01/12 | INITIAL ISSUE | DJB | TC | TC |

REFERENCES

| DRAWING NUMBER | REFERENCE DRAWINGS |
|---|---|
| WR-STD-47 | PIER FOOTING IN ROCK (2005) |
| WR-STD-48 | PIER FOOTING IN MEDIUM CLAY (2005) |
| WR-STD-49 | PIER FOOTING IN DENSE SAND & GRAVEL (2005) |

| | NAME | DATE |
|---|---|---|
| DRAWN | AUSTEC | 04/01/2012 |
| CHECKED | TC | 04/01/2012 |
| APPROVED | TC | 04/01/2012 |
| SCALE | NTS | |
| SIZE | A1 | |

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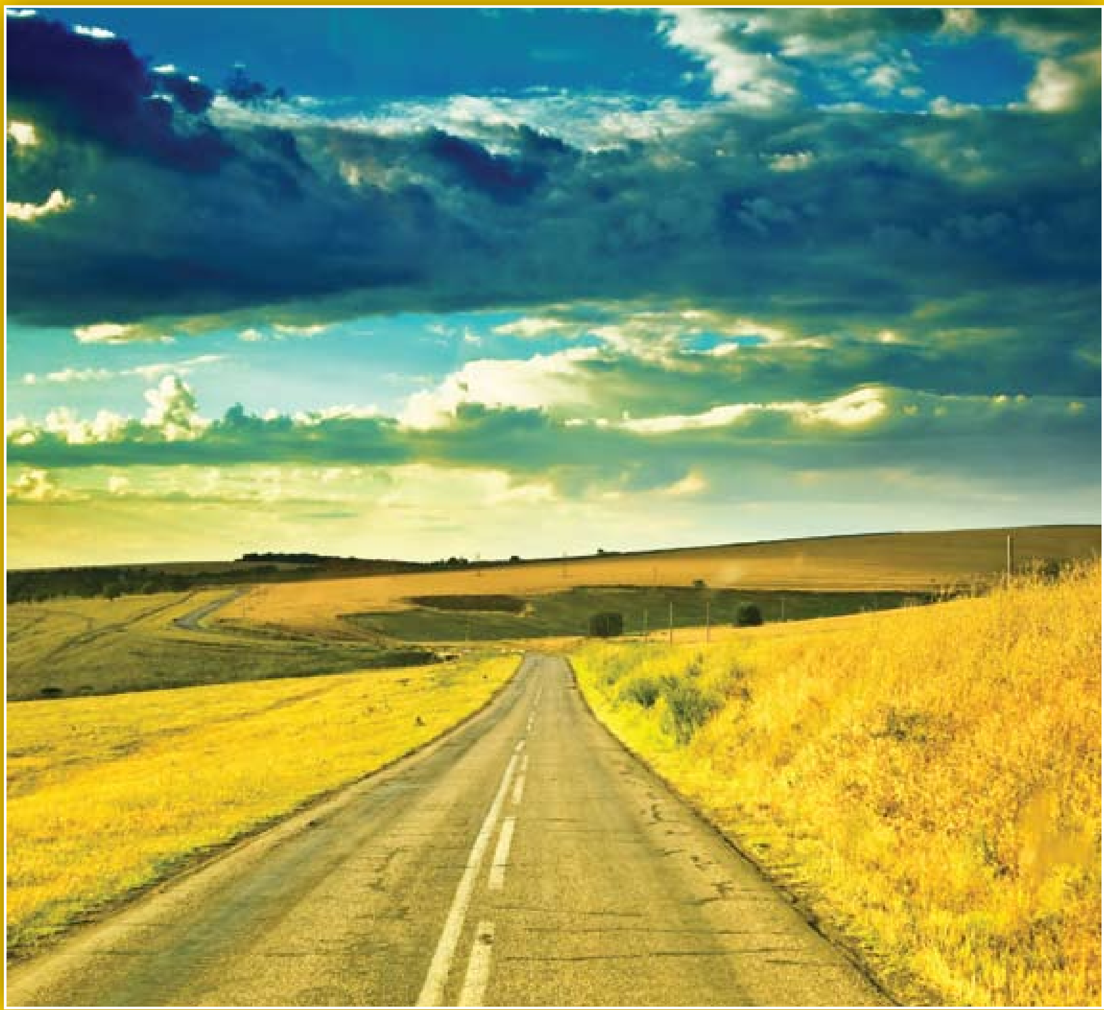
PROJECT
FLEXFENCE
WIRE ROPE SAFETY BARRIER

TITLE
PIER (TYPE 4) ANCHOR BLOCK

INGAL CIVIL PRODUCTS REFERENCE No.

DRAWING No.
WR–STD–82

REV. 2



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A valmont COMPANY

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