



EZY-GUARD

INGAL CIVIL PRODUCTS

SMART

Product Manual



Release 04/15

www.ezyguard.com

1.0 Introduction

Introducing Ezy-Guard Smart, a member of the Ezy-Guard family, the next generation steel guardrail barrier providing superior motorist safety and more metres of barrier for your dollar.

Ezy-Guard Smart is crash tested to the latest performance standard distinguishing it from the existing Australian public domain guardrail barriers.

The Z-post profile shields post edges from vulnerable road users and provides sectional strength when driving through difficult conditions.

An Ezy-Carriage is used to secure the w-beam rails to the posts eliminating the requirement for blocking pieces and rail stiffening plates. This unique connection provides a soft ride-down for the occupants and smooth vehicle containment and redirection.

2.0 Specifications

Ezy-Guard Smart Z-Post Length: 1,600mm

Ezy-Guard Smart Z-Post Mass: 12.3kg

Ezy-Guard Smart System Mass: 18.6kg per metre

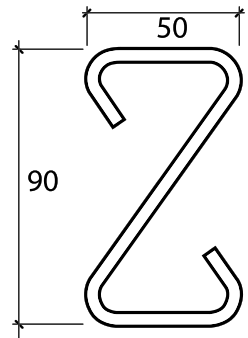
Rail Height Above Ground: 730mm

Z-Post Height Above Ground: 720mm

Post Spacing: 2,000mm

Ezy-Guard Smart System Width: 200mm

MASH TL3 Crash Test Deflection: 1.65m



Ezy-Guard Smart rails and Z-posts are manufactured from hot-rolled steel flat products in accordance with AS/NZS 1594. These items are hot dip galvanised in accordance with AS/NZS 4680 after fabrication leaving no surface untreated.



3.0 Crash Test Analysis

Crash test guidelines provide a minimum set of requirements that a roadside barrier has to meet in order to demonstrate its satisfactory impact performance.

Whilst crash test guidelines cannot include all possible impact conditions that may be experienced in the real world, the crash test matrix is selected to represent a "worst practical condition" for a roadside barrier impact.

Ezy-Guard Smart has been fully crash tested and evaluated according to the specifications for Test Level 3 (TL3) of the AASHTO Manual for Assessing Safety Hardware (MASH).

The MASH specification is an update to and supersedes NCHRP Report 350 for the purposes of evaluating new safety hardware devices.

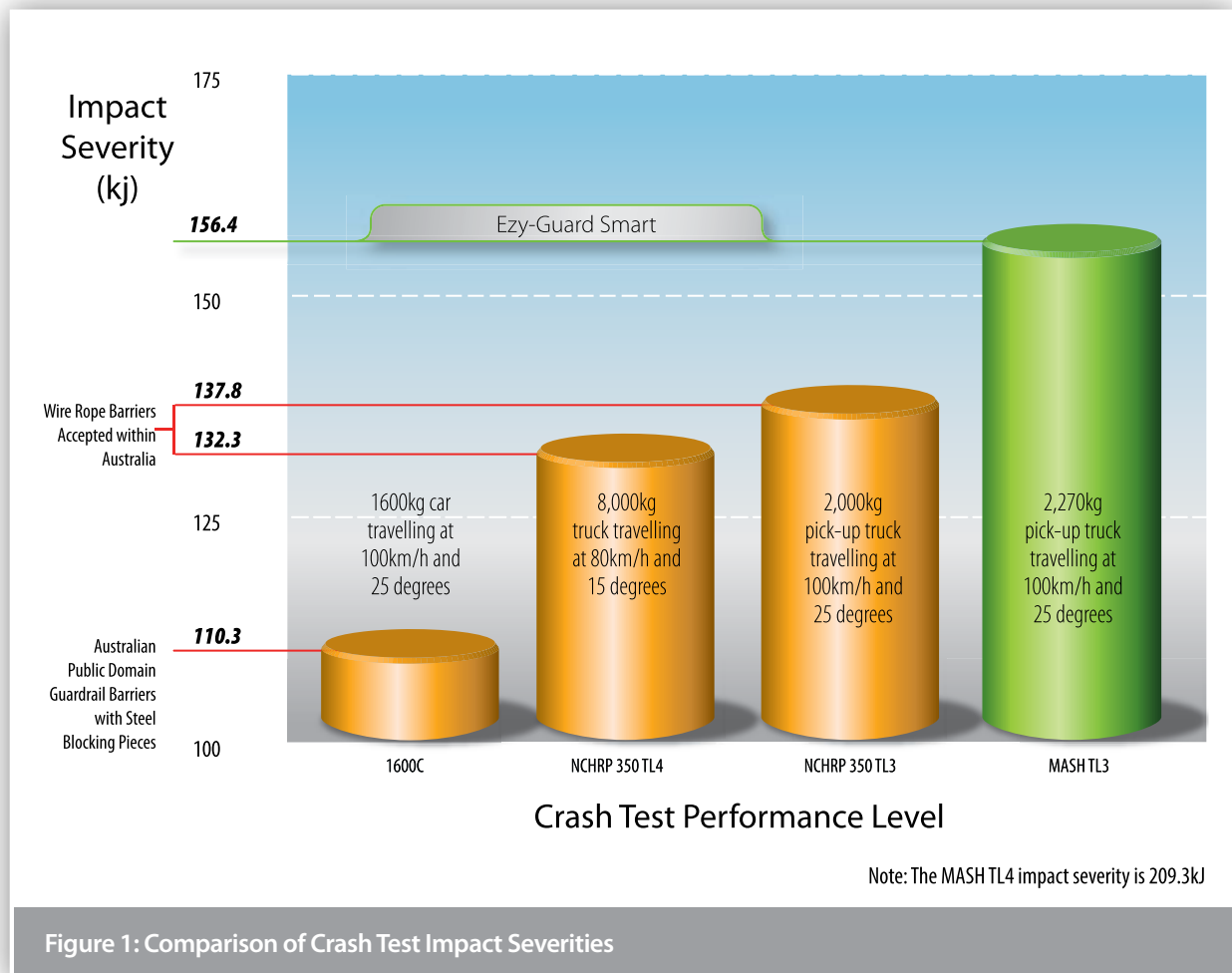
The MASH TL3 crash test matrix requires the following impacts;

- 1100kg car travelling at 100km/h and 25 degrees.
- 2270kg pick-up travelling at 100km/h and 25 degrees.

Crash test impact conditions are defined by the mass, speed, and angle of the impacting vehicle. Crash test standards and performance levels can be compared by calculating the impact severity (IS).

$$IS = \frac{1}{2} M (V \sin \theta)^2$$

Where IS is the impact severity in joules (J), M is the test inertial mass of the vehicle in kilograms (kg), V is the impact speed in metres/second (m/s) and θ is the impact angle in degrees.



4.0 Consideration for Vulnerable Road Users

Vulnerable road users include motorcyclists, pedestrians, cyclists and other road users. Ezy-Guard Smart has been designed to provide consideration to vulnerable road users as follows:

Rounded Post Corners.

The Z-post contains smooth, rounded post edges and corners mitigating the risk and severity of fractures and/or contusions.

Energy Absorbing, Ductile Z-Posts.

Unlike traditional guardrail posts, the Z-posts are designed to yield by bending near ground level. This bending action absorbs impact energy reducing the potential for post fracturing. A fractured or split guardrail post presents a significant laceration hazard to vulnerable road users.

The Ezy-Guard Smart design does not contain any elements that become projectiles and there are no aggressive edges.

Shielded Posts.

The revolutionary design of Ezy-Guard Smart shields the top of the supporting Z-posts by positioning the top of

the rail above the posts. This eliminates dangerous snag points, reducing the potential for the barrier to dismount motorcyclists or cyclists. This is a significant safety benefit compared to all guardrail and cable barrier designs currently used within Australia.

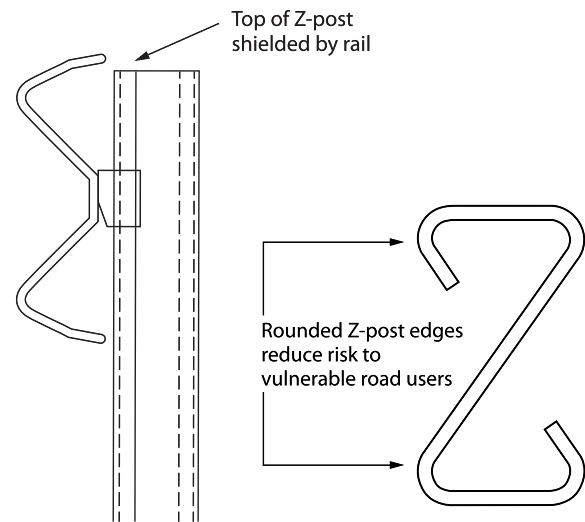


Figure 2: Ezy-Guard Smart Considerations for Vulnerable Road Users



5.0 Features and Benefits

5.1 Fully Compliant to MASH TL3

Ezy-Guard Smart, a member of the Ezy-Guard family, is Australia's only locally produced, fully compliant MASH TL3 guardrail barrier system.

The MASH TL3 test condition (2,270kg pickup travelling at 100km/h and 25 degrees) represents a 42% increase in impact energy when compared to the current Australian public domain guardrail systems using C-posts and steel blocking pieces, which has only demonstrated 1600C containment (1,600kg passenger car travelling at 100km/h and 25 degrees).

The MASH TL3 test condition also represents a 13% to 18% increase in energy when compared to the superseded NCHRP 350 Test Level 3 or Test Level 4 impacts.

MASH TL3 COMPLIANT

5.2 Rapid Installation & Repair

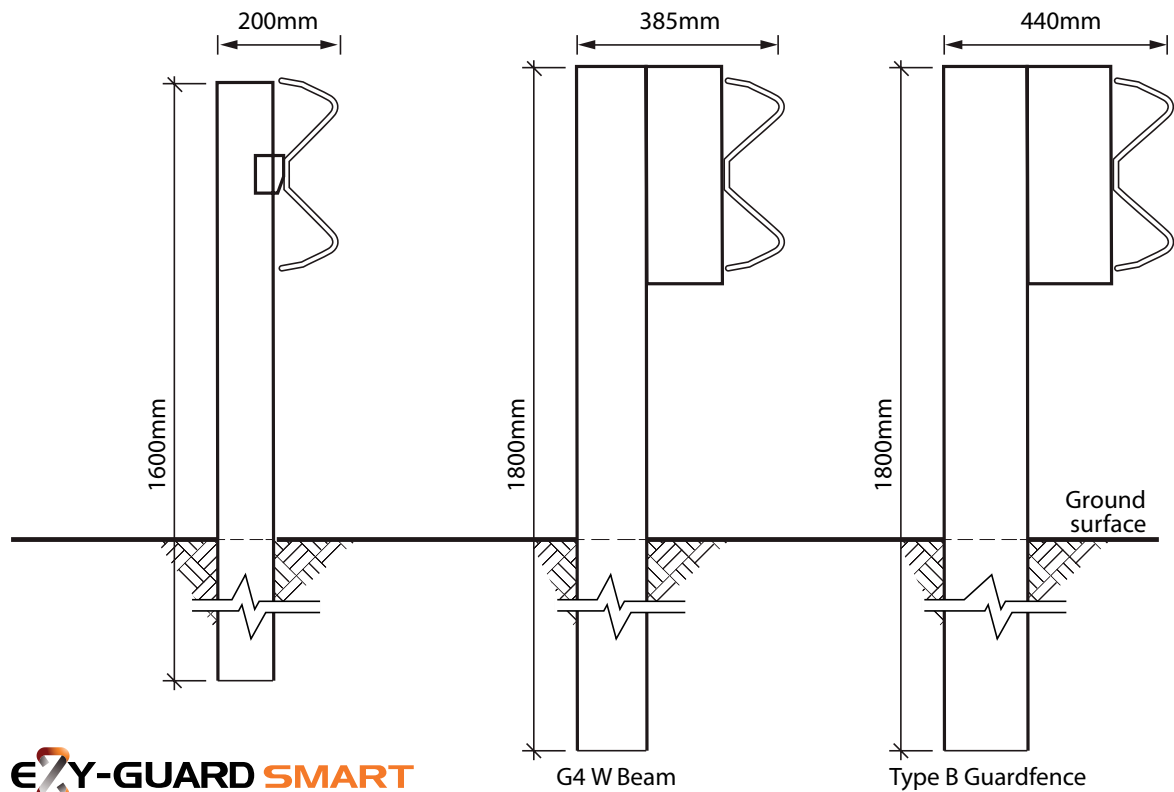
Ezy-Guard Smart installation can be up to twice as fast to install than conventional guardrail barriers and unlike cable barrier systems, no concrete is required.

The Ezy-Guard Smart design uses fewer components and features 1,600mm Z-posts that are rapidly driven into the ground. The Z-post embedment depth is just 880mm, a reduction of 20% when compared to traditional guardrail posts. This reduces installation time providing significant cost savings.

Since the Z-posts are designed to yield by bending near ground level, damaged posts can be removed easily which reduces the time spent by work crews on the roadside.

5.3 Narrow Width

With a system width of just 200mm, Ezy-Guard Smart is up to 55% narrower than the current public domain guardrail barrier systems. Ezy-Guard Smart conserves valuable formation width and allows a greater recovery width to be provided for errant vehicles.



EZY-GUARD SMART

Figure 3: Ezy-Guard Smart Width Comparison

5.4 Installation in Rock, Asphalt or Concrete Mowing Strips

The design of the Z-post differs from traditional posts in that it relies on the yielding of the post by bending near ground level rather than the yielding of the surrounding soil during a vehicle impact. This makes the Z-post suitable for installation in rock, asphalt or concrete mowing strips.

A traditional guardrail post is designed to absorb some crash energy through post rotation in the soil prior to post failure. Restraining these traditional posts by setting them in narrow holes drilled into solid rock, by setting them in thick asphalt layers or concrete, or by placing a mowing strip around the posts can lead to a failure of the system to safely contain and redirect the errant vehicle.

5.5 Manual Handling

Ezy-Guard Smart uses fewer components than the public domain guardrail systems. Z-posts weighing just 12.3kg are 50% lighter than traditional C-posts. The lightweight Z-post reduces manual lifting by installation crews.

The rounded edges of the Z-post provides a handlelike grip when lifting, reducing the possibility of hand lacerations. The Z-profile allows the installer to maintain a firm grip and facilitates correct lifting techniques.

5.6 Locally Designed & Produced

Ezy-Guard Smart is manufactured in Australia by Ingal Civil Products using steel manufactured by BlueScope Steel. Z-posts and rail are stamped providing traceability to material mechanical and chemical analysis certificates. Hot dip galvanising is performed



internally by Ingal and daily inspections ensure zinc thickness readings are in accordance with AS/NZS standards.



5.7 Environmentally Friendly

Using up to 30% less steel than conventional guardrail barriers, Ezy-Guard Smart provides an environmentally friendly alternative. Minimising steel content reduces energy consumption creating a smaller ecological footprint.



5.8 Soft Ride-Down Decelerations

The Ezy-Carriage controls the release of the w beam rail from the Z-posts. This controlled release reduces the potential for vehicle pocketing and provides a soft ridedown for vehicle occupants.



6.0 Performance

Ezy-Guard Smart provides protection from roadside hazards located close to the edge of the travelled way. The sectional strength of the 4 Z-post reduces lateral deflection whilst providing controlled containment and redirection.

Crash testing guidelines provide a set of requirements that is "worst practical conditions" in order to demonstrate the barriers impact performance. When the combined effects of vehicle mass, impact speed and angle of impact are considered, the testing criteria represents the extremes of impact conditions to be expected in real-world situations.

6.1 Deflection

The transverse deflection of a barrier during a crash is dependent upon the mass, speed, and impact angle of the errant vehicle.

Since crash testing typically represents the extremes of these parameters, a review of the proposed barrier location can be undertaken to assess the following;

- Maximum attainable impact angle;
- Design speed; and
- Design vehicle.

Figure 4 illustrates the vehicle trajectory when turned towards the barrier. The maximum attainable angle, ϕ is limited by the speed of the vehicle and the lateral offset, x to the barrier.

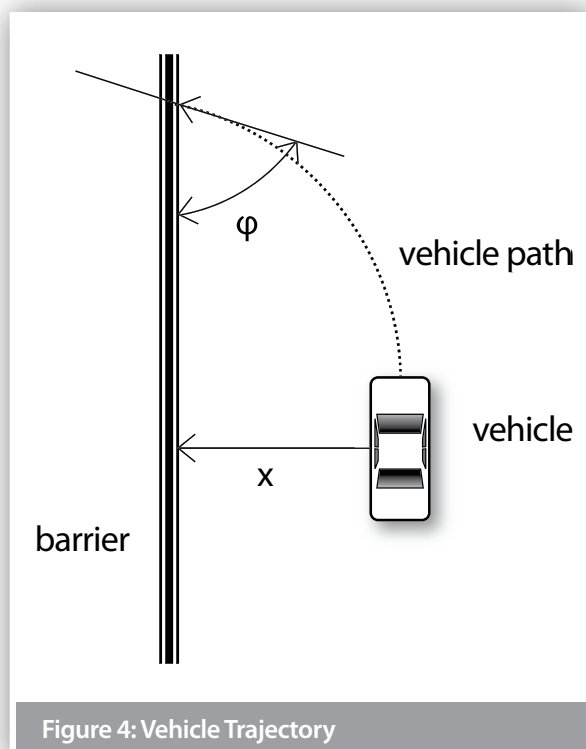


Figure 4: Vehicle Trajectory

The maximum attainable angle for various speeds and offsets is shown in Figure 6 and is derived using a point mass model and assumes maximum steering and a coefficient of friction of 0.7 (dry pavement). Once the angle of impact is determined, dynamic deflections for various design vehicles can be selected from Tables 1 to 3.

If the calculated deflection needs to be reduced due to the proximity of a road side hazard, this can be achieved by reducing the post spacing. Refer Table 2 for deflections with post spacing reduced to 1m. The reduced post spacing should be initiated 10m upstream and returned to standard spacing 10m downstream of the hazard.

Example:

A barrier is to be installed on a roadway with a posted speed of 90km/h. The lateral offset to the barrier is 5m.

Step 1: Using Figure 6, the maximum attainable impact is calculated as 20 degrees.

Step 2: The design vehicle is selected as 2,000kg or 2,270kg.

Step 3: The deflection value from the corresponding table is selected. This is as follows;

- 2,000kg design vehicle – 0.8m
- 2,270kg design vehicle – 0.9m

6.2 Slopes

The maximum cross fall for an installation of Ezy-Guard is 10H:1V (10%).

6.3 Batter Hinge Proximity

Ezy-Guard has been successfully crash tested where installed in close proximity to a hinge batter point with a gradient of 2:1, the minimum proximity to the hinge point is 300mm, refer Figure 5 for further detail.

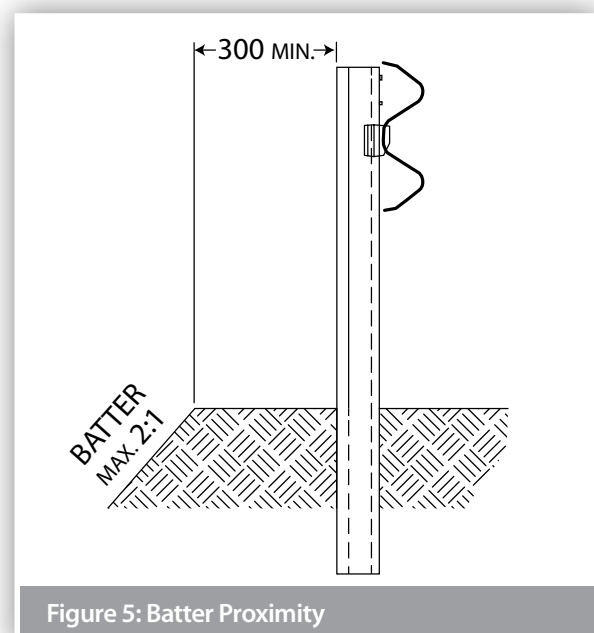
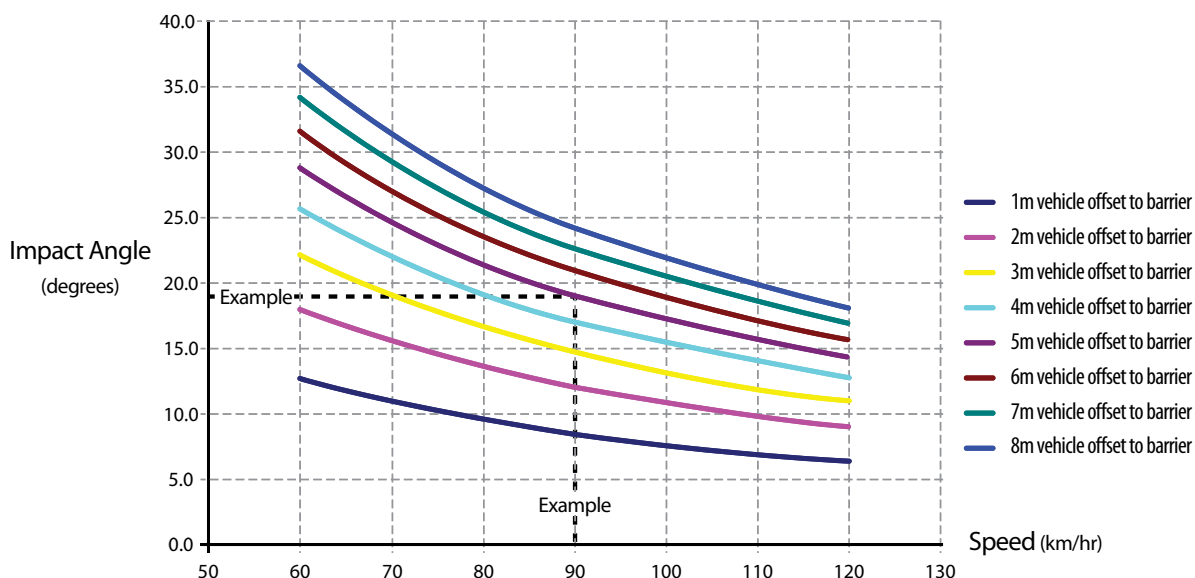


Figure 5: Batter Proximity


Table 1. Ezy-Guard Smart Deflections - 2,000kg Vehicle

Speed (km/h)	Dynamic Deflection (m)		
	15°	20°	25°
60	0.2	0.4	0.5
70	0.3	0.5	0.7
80	0.4	0.6	0.9
90	0.5	0.8	1.2
100	0.6	1.0	1.5
110	0.7	1.2	1.8

Table 2. Ezy-Guard Smart Deflections - 2,000kg Vehicle with post spacing reduced to 1m*

Speed (km/h)	Dynamic Deflection (m)		
	15°	20°	25°
70	0.3	0.4	0.5
80	0.4	0.5	0.7
100	0.4	0.7	1.04

* If further reduction of the deflection is required, please contact your local Ingal Civil Products representative.

Table 3. Ezy-Guard Smart Deflections - 2,270kg Vehicle

Speed (km/h)	Dynamic Deflection (m)		
	15°	20°	25°
60	0.2	0.4	0.6
70	0.3	0.5	0.8
80	0.4	0.7	1.1
90	0.5	0.9	1.4
100	0.6	1.1	1.7
110	0.8	1.3	2.0

7.0 Installation

7.1 Terminals

Guardrail end terminals are designed to provide a soft gating impact preventing the end rail from spearing an impacting vehicle. Terminals also introduce tensile and flexural strength necessary to ensure redirection performance of the length-of-need section.

Ezy-Guard Smart is installed at a system height of 730mm, measured to the top of the rail. This height is compatible with the ET2000 Plus and public domain terminals such as the MELT (NSW, Qld, SA) and Breakaway Cable Terminal (Vic, Tas).

Departure terminals should only be installed if they are located outside the clear zone of approaching traffic. See Figure 7. The clear zone is the horizontal width of space available for the safe use of an errant vehicle.

The clear zone is dependant upon the speed of the vehicle. Guidelines are contained with regulatory publications.

Terminals should be installed in accordance with the proprietor's drawings and specifications. Z-posts are not to be used in the terminals unless approved by the proprietor.

The installation of terminals will typically incorporate the use of blocking pieces positioned between the posts and rail. This will require the supporting posts to be offset from the set-out line used for the installation of the Z-posts which do not require blocking pieces.

In addition, the post spacing used in the terminals and transitions may vary from the 2m spacing used for installation of Ezy-Guard Smart. The required post spacing for terminals and transitions will be contained in the proprietor's drawings.

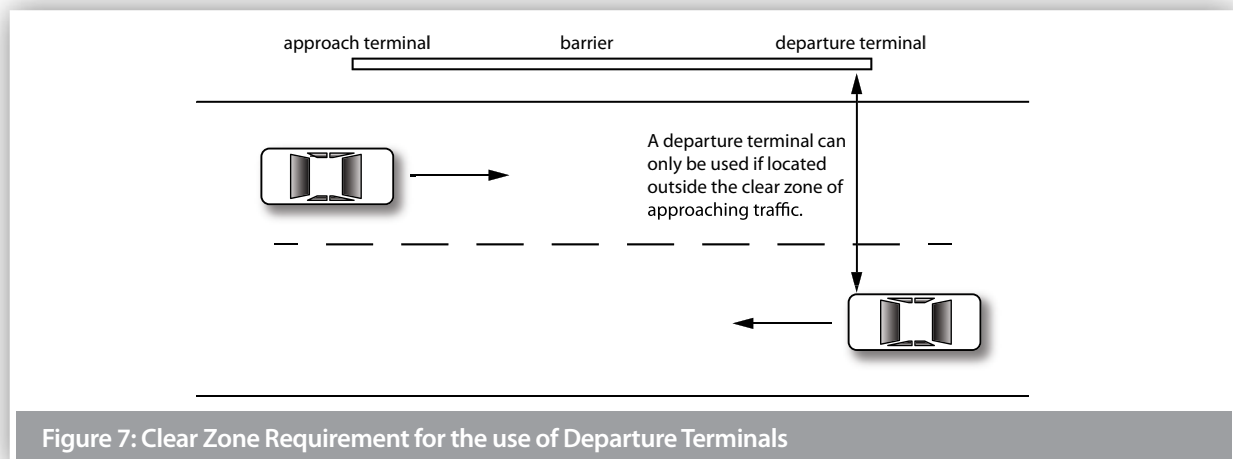


Figure 7: Clear Zone Requirement for the use of Departure Terminals



Figure 8: ET2000 Plus End Terminal

7.2 Minimum Length Requirements

The recommended minimum length of need for Ezy-Guard Smart is dependent on the posted speed environment. Refer to state road authority approval letter for local minimum length requirements.

Approach end terminals undergo a re-directive test in order to identify the terminal point-of-need. This is the location where the terminal is capable of re-directing an errant vehicle.

The TL3 ET2000 Plus (15.24m) is re-directive from post 3. This is a distance of 3.8m downstream from the nose of the device. The remaining 11.4m can be used in length-of-need calculations.

The recommended minimum installed length of Ezy-Guard Smart is;

- 34.5m for an installation on a two-way road where the end terminals are located within the clear zone of approaching traffic (refer Figure 7).

i.e. a 15.24m ET2000 Plus on both ends, plus 4m of Ezy-Guard Smart between both ET2000's. This will provide a length-of-need section measuring 26.8m.

- 29.2m for an installation on a road where the departure terminal is located outside the clear zone of approaching traffic (refer Figure 7).

i.e. a 15.24m ET2000 Plus, a 4m Trailing Terminal, plus 10m of Ezy-Guard Smart joining the two. This will provide a length-of-need section measuring 21.4m.

The recommended minimum installed lengths above are based upon crash test results conducted at 100km/h.

In areas where the posted speed is less than or equal to 70km/h an end terminal rated to NCHRP 350 Test Level 2 (TL2) may be considered. The TL2 ET2000 Plus is 7.62m long.

The TL2 ET2000 Plus point-of-need remains at post 3, a distance of 3.8m from the nose of the device. The remaining 3.8m can be used in length-of-need calculations.

The recommended minimum installed length using Ezy-Guard Smart where the posted speed is less than or equal to 70km/h is;

- 29.2m for an installation on a two-way road where the end terminals are located within the clear zone of approaching traffic (refer Figure 7).

i.e. a 7.62m ET2000 Plus on both ends, plus 14m of Ezy-Guard Smart between both ET2000's. This will provide a length-of-need section measuring 21.6m.

- 27.6m for an installation on a road where the departure terminal is located outside the clear zone of approaching traffic (refer Figure 7).

i.e. a 7.62m ET2000, a 4m Trailing Terminal, plus 16m of Ezy-Guard Smart joining the two. This will provide a length-of-need section measuring 19.8m.

7.3 Sequence of Work

Where Ezy-Guard Smart is being constructed on a road open to traffic, it is recommended that the work commence at the end closest to the approaching traffic. Leading terminals and transitions shall be commissioned at the earliest practical time.

7.4 Modifications

Ezy-Guard Smart shall be constructed in the configuration as detailed in Ingal Civil Products' drawings. This is the configuration in which the system has been crash tested. No modifications shall be made to the system unless verified by Ingal Civil Products.

Flame cutting of rails or posts is not permitted. Saw cutting and drilling is permitted in the event that a post is to be installed at an irregular spacing and/or rock is encountered and the post embedment depth has been modified in accordance with Table 4.

Any modification carried out after fabrication will require repair to the galvanized coating. This is undertaken by applying two coats of an organic zinc rich epoxy paint to the repair area.

7.5 Soil Requirements & Embedment Depth

The Z-post is designed to yield by bending near ground level during impact. Provided the post is embedded in material that allows this failure mechanism to be replicated, the Ezy-Guard Smart functionality will be retained. The Z-posts will provide lateral resistance until the impacting vehicle causes deformation of the posts. At this point the Ezy-Carriages will provide a controlled release of the rail from the Z-posts resulting in safe vehicle containment and redirection.

7.5.1 Standard Soil

Ezy-Guard Smart has been evaluated for installation in standard soil in accordance with AASHTO standard specifications for 'Materials for Aggregate and Soil Aggregate Subbase, Base and Surface Courses', designation M 147.

When installed in standard soil, the 880mm embedment depth of the Z-post is sufficient for installation up to 300mm from the rounding point on 2:1 embankment slopes, as detailed in Figure 5.

7.5.2 Weak Soil

Ezy-Guard Smart has been evaluated for installation in weak soil in accordance with AASHTO standard specification for 'Fine Aggregate for Hydraulic Cement Concrete', designation M 6.

When installed in weak soil, the 880mm embedment depth of the Z-post is sufficient for installation up to 500mm of the rounding point on 2:1 embankment slopes. If installation is required within 500mm of the rounding point, the post embedment depth is required to be increased to 1,050mm. A longer Z-post is available from Ingal for these applications.

7.6 Post Pullover Test

In the event that the soil type cannot be verified, the suitability of the post foundation can be established through a post pullover test.

This is undertaken by applying a 1kN load to the post, 700mm above ground level. The load is applied prior to the attachment of the rail. Displacement at the base of the post shall not exceed 1mm whilst the load is applied.

An alternative post pull over test can be achieved via a more destructive means, whereby a load of 1.2 tonnes is applied to the test post at a height of 700mm. This loading approximates the probable capacity of the post and should be able to be maintained with minimal rotation of the post in the soil. At the completion of the testing the post should be removed from the test location and should not be used in the installation.

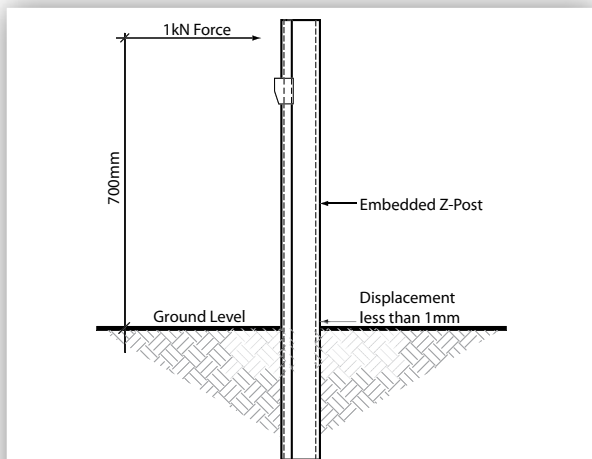


Figure 9: Z-Post Pullover Test

7.7 Posts on Base Plates

In the event that the Z-post cannot be installed to the required in-ground depth, the use of a base plate

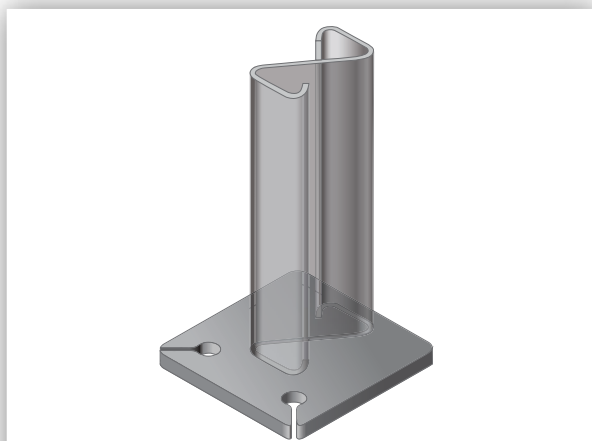


Figure 10: Z-Post on Base Plate

mounted on a suitable foundation can be adopted. Posts on base plates are typically used at culvert locations, and in areas where underground services restrict posts from being driven into the ground. Refer to Ingal Civil Products drawings for the installation of posts on base plates.

7.8 Z-Posts in Rock

Traditional guardrail posts are designed to yield in the surrounding soil and their placement in rock or concrete is problematic. Restraining the traditional posts by setting them in narrow holes drilled into rock, setting them in concrete or placing a mowing strip around the posts can lead to a failure of the system to safely contain and redirect the errant vehicle.

The specially engineered Z-post dissipates energy by yielding through bending near ground level. This means that typical recommendations for the installation of a traditional guardrail post in rock are not applicable to the Z-post. When rock is encountered, the installation guidelines as detailed in Table 3 are applied. If required the post may be cut onsite by a disc grinder or equivalent steel cutting tool. A corrosion resistant treatment will need to be applied to the freshly cut surface, ICP recommend a Zinc metal spray in accordance with ISO 2063 or AS/NZS 2312.

7.9 Non-Standard Post Spacing

Occasionally, a roadside hazard may prevent a post from being installed at the recommended spacing. In these instances it may be possible to stiffen the barrier with reduced post spacing on the approach and trailing side of the hazard, we would recommend you discuss these options with your local Ingal Civil Products representative.

7.10 Delineation

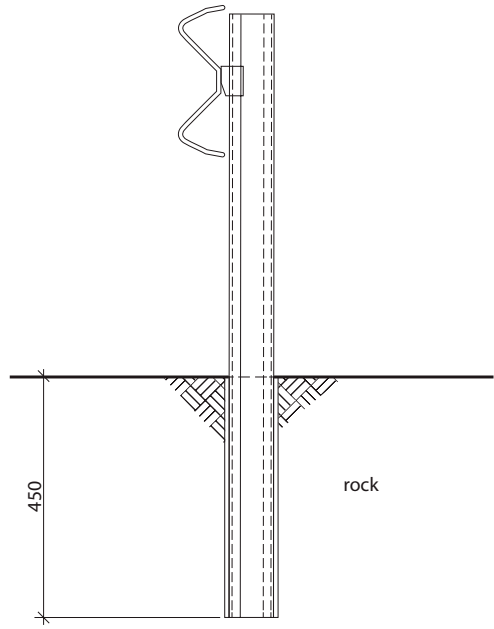
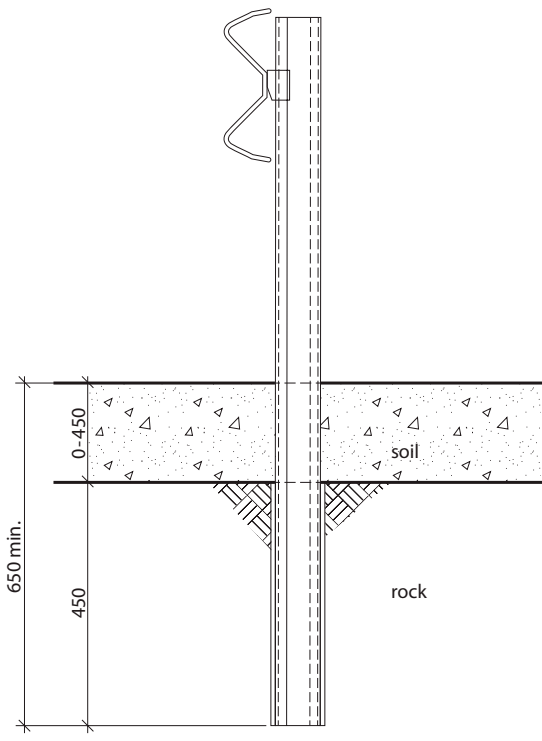
A specially designed delineator is attached to the Z-post. Typically, delineation is arranged so that drivers approaching from either direction will see only;

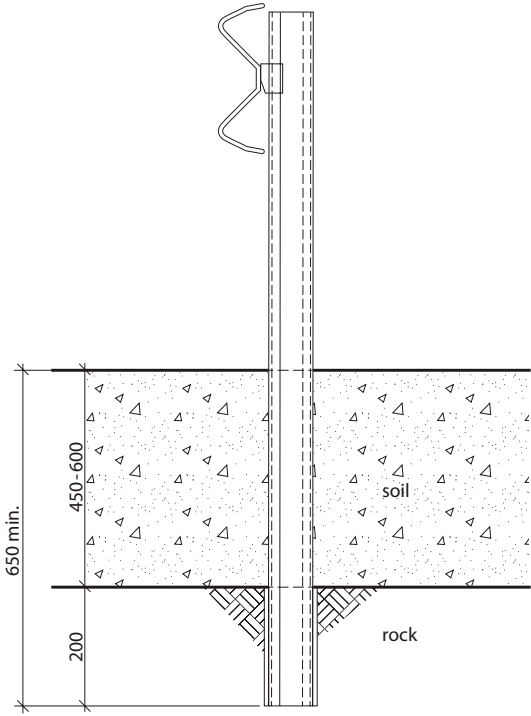
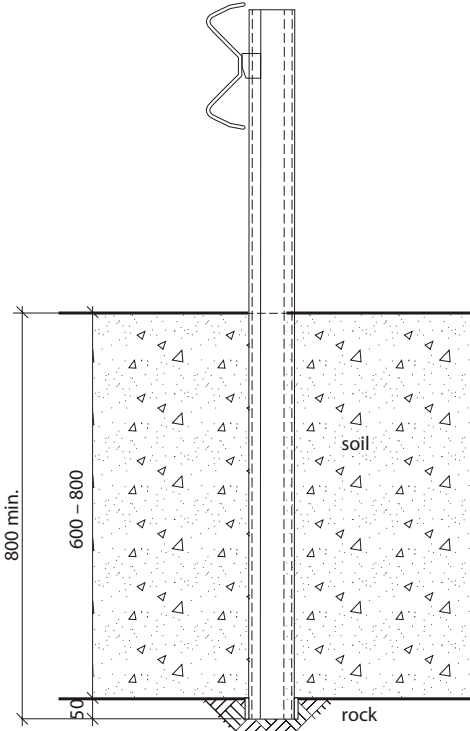
- Red retro-reflectors on their left;
- White retro-reflectors on their right on two-way carriageways; and
- Yellow retro-reflectors on their right on one-way carriageways and medians separating traffic in opposing directions

The spacing of delineators is dependant upon driver line of sight. As a general rule delineators are provided for installation every 20m on straight alignments. Installation on curves will require a closer spacing dependant upon the radius of the roadway.



Table 4: Installation of Ezy-Guard Smart Z-Posts in Rock

Site Condition	Installation Requirements	
Rock is encountered at the surface.	Drill a 110-300mm diameter hole to a depth of 450mm, install the post in the hole and backfill.	
Rock is encountered within 450mm of the surface.	Drill a 110-300mm diameter hole 450mm into the rock or to a minimum total post embedment depth of 650mm, whichever comes first, install the post and backfill.	

Site Condition	Installation Requirements	
<p>Rock is encountered 450mm to 600mm below ground.</p>	<p>Drill a 110-300mm diameter hole 200mm into the rock or to a minimum total post embedment depth of 650mm, whichever comes first, install the post and backfill.</p>	
<p>Rock is encountered 600mm to 800mm below ground.</p>	<p>Drill a 110-300mm diameter hole 50mm into the rock or to a minimum total post embedment depth of 800mm, whichever comes first, and install the post and backfill.</p>	

7.11 Curving of Rails

Guardrail used for the assembly of Ezy-Guard Smart may be shop curved to fit any radius from 25m to 45m Convex. Curves in excess of 45m do not require shop curving as the rail can be field installed to suit. Guardrail may be curved either concave or convex to the traffic face and can be part-curved along its length to suit site requirements.

7.11.1 Measuring Curvature

1. Mark along the arc of the curve at 4m intervals.
2. Measure the corresponding chord length (C) - refer to Figure 11.
3. Measure the corresponding centre offset (H) - refer to Figure 11.
4. Use the values for C & H to select the radius from Table 5.
5. Determine the curvature orientation from Figure 12.

7.11.2 Identification of Curved Rails

Where a rail has been factory curved by Ingal, the radius of curvature is marked on the rear face of the rail.

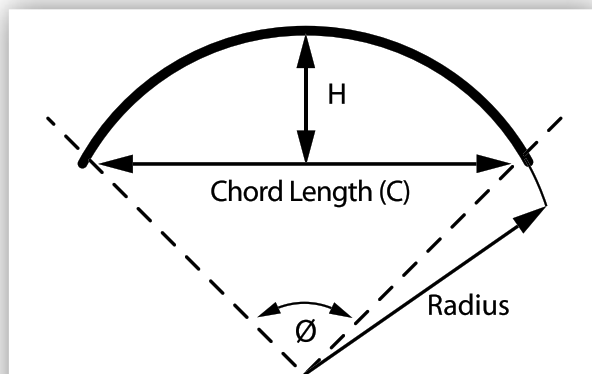


Figure 11: Curvature Measurements

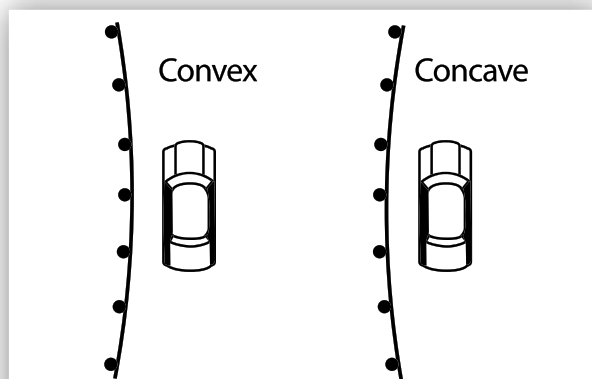


Figure 12: Curvature Orientation

Table 5: Rail Curvature Values

Radius (m)	Ø Degrees	C (mm)	H (mm)
2.4	95	3553	786
3	76	3710	642
4	57	3835	490
5	45	3894	395
6	28	3926	330
7	33	3946	284
8	29	3958	249
9	26	3967	221
10	23	3973	199
12	19	3982	166
14	16	3986	143
16	15	3990	125
20	12	3993	100
24	10	3995	83
28	8	3997	71
32	7	3997	62
35	7	3998	57
40	5	3998	50
45	5	3999	44



7.12 Installation Sequence

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

A generic Safe Work Method Statement is available from Ingal Civil Products to assist in the safe installation of Ezy-Guard Smart.

Only items purchased from Ingal Civil Products shall be used for the construction of Ezy-Guard Smart.

1. Ensure the area has been inspected for underground hazards and that suitable traffic control is in place.
2. Post locations are marked ensuring any fixed object hazard to be protected is located outside the expected dynamic deflection of the barrier.
3. The post in relation to the direction of traffic as per orientated as per Figure 13.

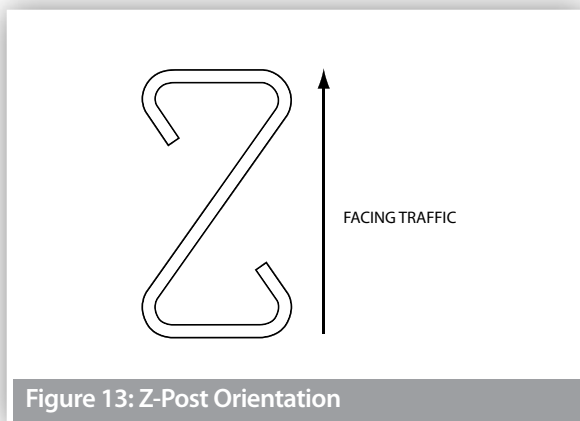


Figure 13: Z-Post Orientation

4. Posts are driven directly into the ground and should be vertical. The post installation process shall not cause damage to the post, such that it reduces the effective operation of the safety barrier or its design life, or introduces sharp tearing edges, nor shall it cause damage to pavement. If the Ezy-Carriage cannot freely move as it is attached to the post as a result of deformation of the post during installation, then the post shall be replaced.

The use of a vibrating post hammer will reduce deformation to the top of the post and install the post at a controlled rate.

5. Alternate to driving the posts, a minimum 110-300mm hole can be augured and the post placed in the hole. The posthole is then backfilled with the material that was excavated. If installing in soil, the material should be placed in layers of 150mm and suitably compacted to not less than the density of the surrounding layers.
6. The posts are spaced every 2m.

7. The height of the Z-post above ground level is 720mm.
8. The Ezy-Carriage is attached to the face of the post. The Ezy-Carriage will come to rest on the positioning lug fabricated on the Z-post.

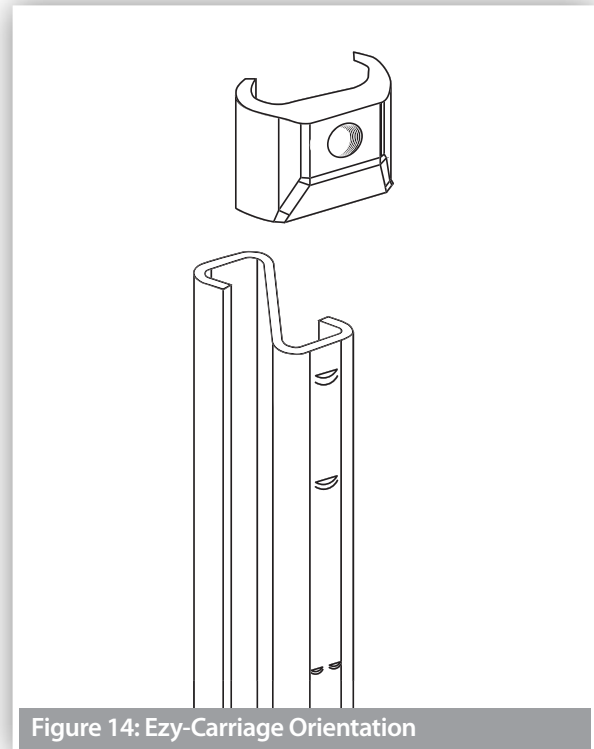


Figure 14: Ezy-Carriage Orientation

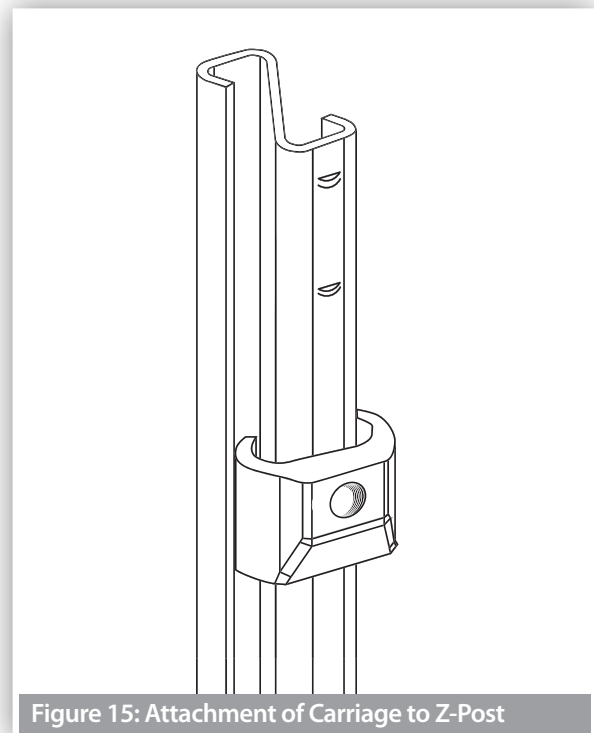


Figure 15: Attachment of Carriage to Z-Post

9. Rails are attached to the Ezy-Carriage using the M16x30mm post bolts. The post bolts are identified by the socket recess located in the head of the bolt. The bolts are tightened to snug tight using a 10mm hex. key.

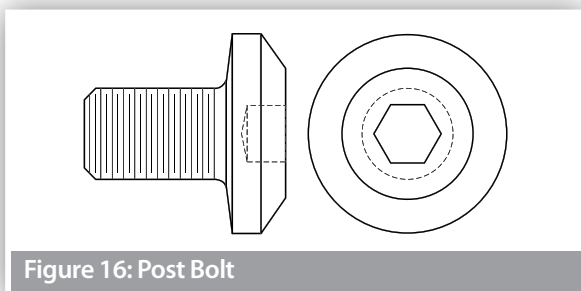


Figure 16: Post Bolt

10. Rails are spliced together at every second post using M16x32mm mushroom head bolts and oversized nuts. There are 8 bolts required per splice connection. A pinch bar may be used to assist in the alignment of splice holes. The use of a driving pin to elongate the slots is NOT to be used since this may cause tearing of the rail at the slot location. The bolts are tightened to snug tight.

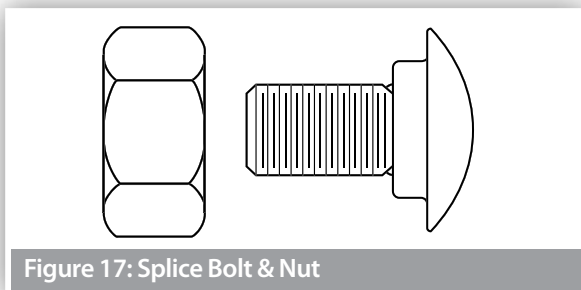


Figure 17: Splice Bolt & Nut

11. Rails are orientated so that no leading edge is presented to the traffic face as shown in Figure 18.

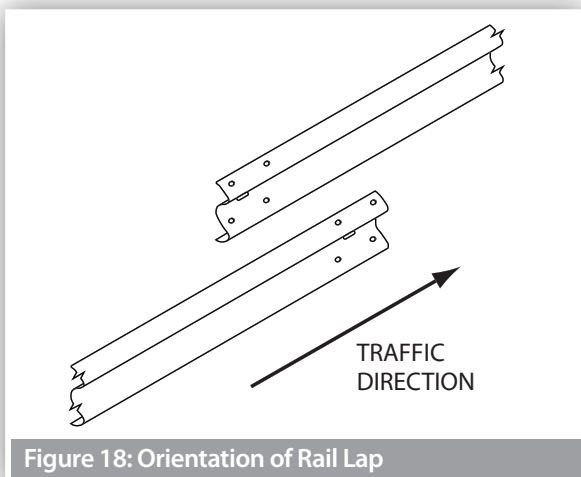


Figure 18: Orientation of Rail Lap

12. It is recommended that posts be installed only a few metres ahead of rail assembly to ensure correct post spacing and alignment. On curves, the rails can be used as a template and laid on the ground to determine post locations.
13. The construction of Ezy-Guard Smart shall form a smooth line vertically and horizontally when viewed along the line of the system, free from humps, sags or other irregularities.
14. The Ezy-Guard Smart components are to be free from splits, burrs or sharp edges after installation. Any minor damage is to be repaired by applying two coats of an organic zinc rich paint.
15. Any disturbed pavement or material around a post shall be left dense, tight, and smooth so that resistance to water penetration is similar to that of the adjacent surface.

7.13 Installation Tolerances

- The tolerance on height of the barrier shall be plus or minus 20mm.
- The tolerance for the line of the barrier shall be plus or minus 20mm in plan view.
- The tolerance for departure from the upright axis shall be plus or minus 15mm at the top of the barrier.
- The tolerance on post spacing shall be plus or minus 25mm.

8.0 Maintenance

It is recommended that annual inspections be performed to ensure the following;

- The system is appropriately delineated;
- Debris has not accumulated around the system that may impede the performance of the barrier or the trajectory of an impacting vehicle;
- The system is suitably anchored with appropriate terminals and/or transitions. If the system is anchored with terminals, the cable assembly shall be taut and tensioned to its recommended value; and
- All splice bolts and post bolts are snug tight.

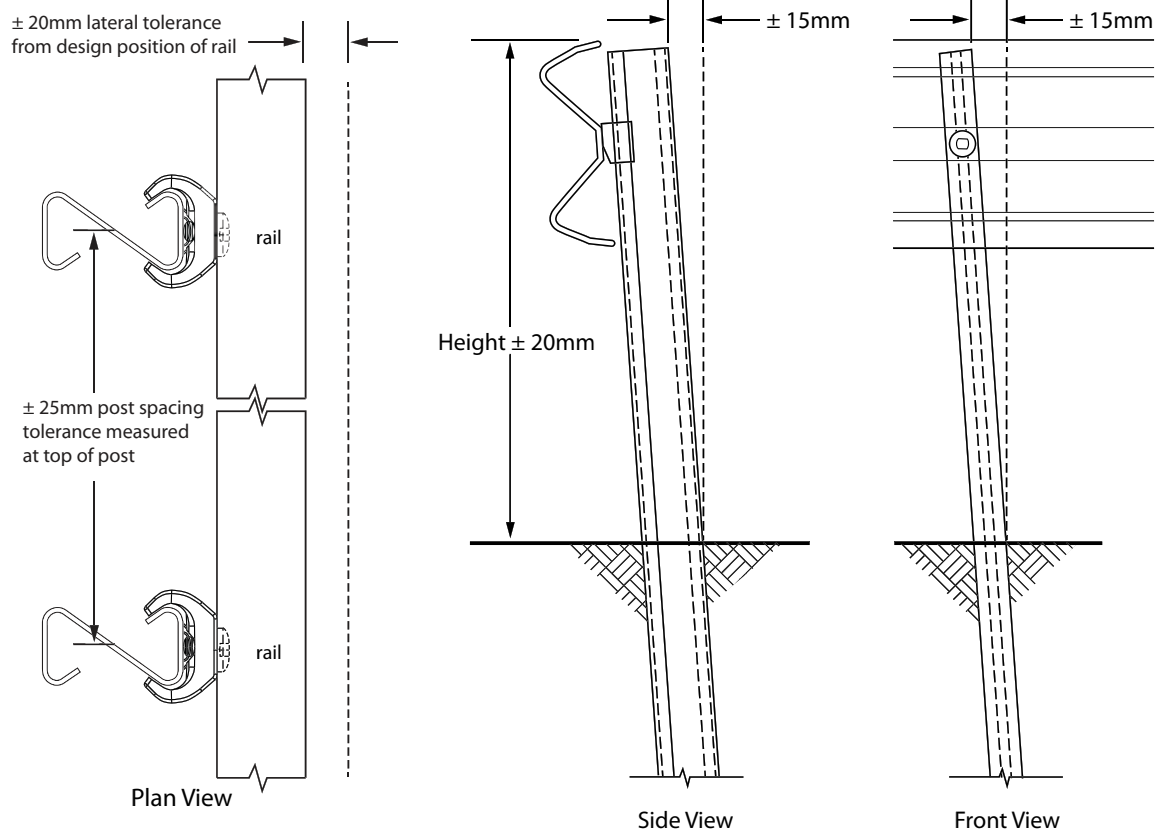


Figure 19: Ezy-Guard Smart Installation Tolerances

Ezy-Guard Smart Installation Checklist

Customer:

Project:

Barrier ID:

Barrier Length:

Checked By:

Signed:

Date

Have the Z-posts been positioned every 2m	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Have the Z-posts been correctly orientated in relation to the direction of traffic	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the construction of Ezy-Guard Smart within the allowable tolerances as detailed in Section 7.13	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Have the Ezy-Carriages been correctly orientated	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Have the rails been attached to the Ezy-Carriages using the post bolts with the socket recess	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Have the rails been spliced observing the correct lap	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Have the rails been spliced with M16x32mm mushroom head bolts	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are all splice bolts and post bolts snug tight	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is Ezy-Guard Smart appropriately delineated	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is Ezy-Guard Smart suitably anchored with approved terminals	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are the cables in the terminals tensioned to their nominated torque	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has any minor damage been repaired using two coats of an organic zinc rich paint	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Does the barrier form a smooth line vertically and horizontally when viewed along the system	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is the barrier system free from humps, sags or other irregularities	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Has the ground or pavement around the post been left dense, tight and smooth	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are the barrier components free from splits, burrs or sharp edges after installation	<input type="checkbox"/> Yes	<input type="checkbox"/> No

9.0 Repair

9.1 Bush Fire Damage

Ezy-Guard Smart does not contain any plastic, timber or rubber components that will burn.

The performance of galvanised coatings when subjected to fires depends upon a number of factors, such as flame duration, intensity and the characteristics of the galvanised coating.

Typical bushfire conditions may expose steel structures to an 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 temperature 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 also typically remain unaffected through a bushfire event. If the bushfire causes damage to the galvanized surface, then the item(s) shall be replaced.

9.2 Damage Assessment

In the event of a vehicle impact, damage to the barrier is to be assessed in accordance with Table 5.

A Safe Work Method Statement is available from Ingal Civil Products upon request to assist in the safe repair of Ezy-Guard Smart.

Any item that is replaced is to be reinstated observing the installation tolerances nominated in Section 7.13. Only items purchased from Ingal Civil Products shall be used for the repair of Ezy-Guard Smart.

9.2 Dismantling Sequence

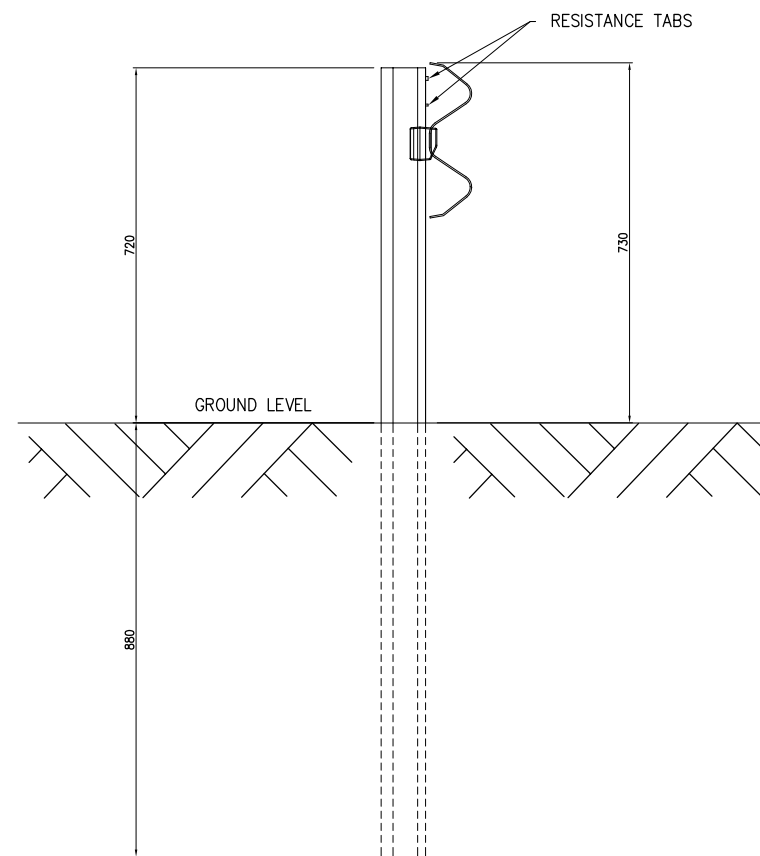
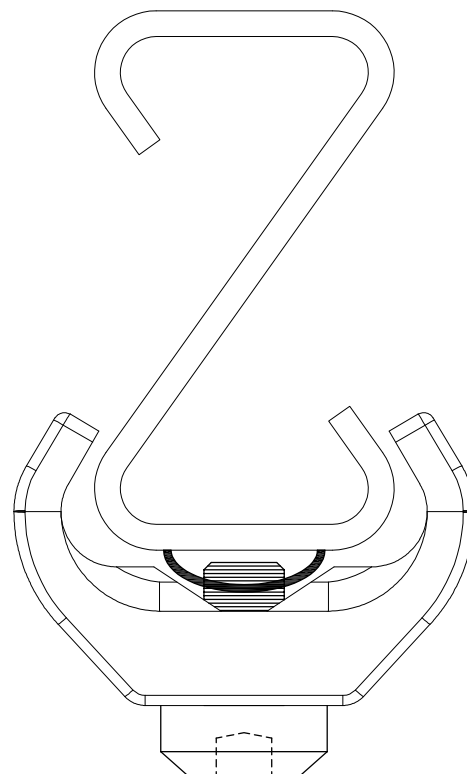
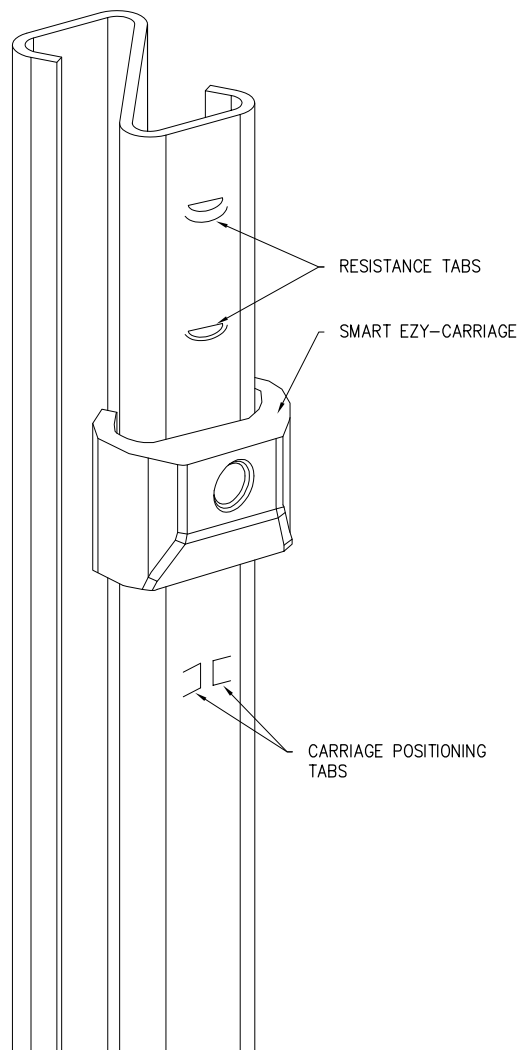
Prior to undertaking dismantling due to a vehicle impact, the area should be assessed for hazards. These include trip hazards, sharp edges and snag points.

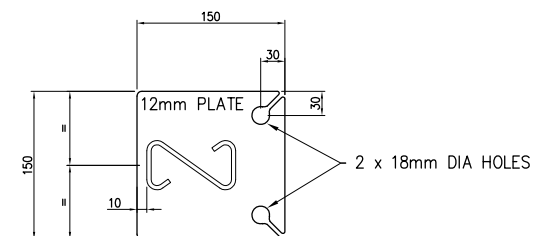
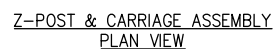
During a vehicle impact, the rail will disengage from the posts as they yield by bending at ground level. The recommended dismantling sequence is as follows;

1. Dismantle the rail splice by removing the M16x32mm mushroom head bolts and nuts. There are 8 bolts located at each splice location.
2. Rails that are still attached to posts outside the impact area are disconnected by removing the M16x30mm post bolts. A 10mm hex key is required.
3. Once the area is clear of damaged rail, the posts can be removed. Since the posts yield by bending near ground level, a sling or chain can be attached below the bent section.
4. The damaged post can be lifted using a backhoe or post extractor attachment.
5. Any disturbed pavement material shall be left dense, tight, and smooth prior to the installation of replacement posts.

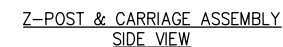
Table 6: Damage Assessment of Ezy-Guard Smart

Type of Defect	Description of the Defect	Action to be Taken
Galvanizing damage on Z-Posts.	The sum total of the damaged area does not exceed 35cm ² (0.5% of the total surface area). The sum total of the damaged area exceeds 35cm ²	An organic zinc rich epoxy paint is to be applied to the repair area in two coats. The Z-post is to be replaced.
Galvanizing damage on rails.	The sum total of the damaged area does not exceed 200cm ² (0.5% of the total surface area) and no individual damaged area does not exceed 40cm ² . The sum total of the damaged area exceeds 200cm ² (0.5% of the total surface area) and/or an individual damaged area exceeds 40cm ² .	An organic zinc rich epoxy paint is to be applied to the repair area in two coats. The rail is to be replaced.
Mechanical damage on Ezy-Carriages.	The Ezy-Carriage has chips or cracks.	The Ezy-Carriage is to be replaced.
Mechanical damage on Z-Posts.	The post is bent. The Ezy-Carriage cannot travel freely along the post due to distortion.	The post is to be replaced. The post is to be replaced.
Mechanical damage on rail.	The rail is dented, twisted or flattened. There are tears in any part of the rail. The slots in the rail are distorted.	The rail is to be replaced. The rail is to be replaced. The rail is to be replaced.
Mechanical damage on bolts.	The body of the bolt is distorted. The thread of the bolt is damaged.	The bolt is to be replaced. The bolt is to be replaced.
Disturbance of material around posts	The material around the post is loose or uncompacted.	Any disturbed pavement or material around a post shall be left dense, tight and smooth so that resistance to water penetration is similar to that of the adjacent surface.


[illegible]



Z-POST ON BASE PLATE
PLAN VIEW



- NOTES:
1. FIXING BOLTS TO BE M16 G8.8 THREADED RODS FIXED WITH HILTI RE-500 EPOXY
2. MINIMUM FIXING BOLT EMBEDMENT DEPTH = 210mm
3. MINIMUM CONCRETE SUBSTRATE THICKNESS = 270mm

REVISIONS						REFERENCES				NAME	DATE		INGAL CIVIL PRODUCTS 57-65 AIROS ROAD MINTO, N.S.W. AUSTRALIA 2566 PH. +61 2 9827 3333 FAX +61 2 9827 3300 www.ingalcivil.com.au	PROJECT EZY-GUARD SMART POSTS ON BASE PLATES	INGAL CIVIL PRODUCTS REFERENCE No.	
									DRAWN	DJB	04/04/2011					
									CHECKED	TC	04/04/2011					
	0	04/04/11	ISSUED FOR INFORMATION		DJB		TC				APPROVED					
REV	DATE	DESCRIPTION		DRAWN	CHECKED	APPROVED	DRAWING NUMBER	REFERENCE DRAWINGS	SCALE	NTS		DRAWING AND CONTENTS ARE COPYRIGHT TO INGAL CIVIL PRODUCTS AND CAN ONLY BE USED WITH PRIOR WRITTEN CONSENT FROM INGAL CIVIL PRODUCTS	TITLE ASSEMBLY DETAIL – SHEET 2 of 2	DRAWING No. EZY-SM-008		
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