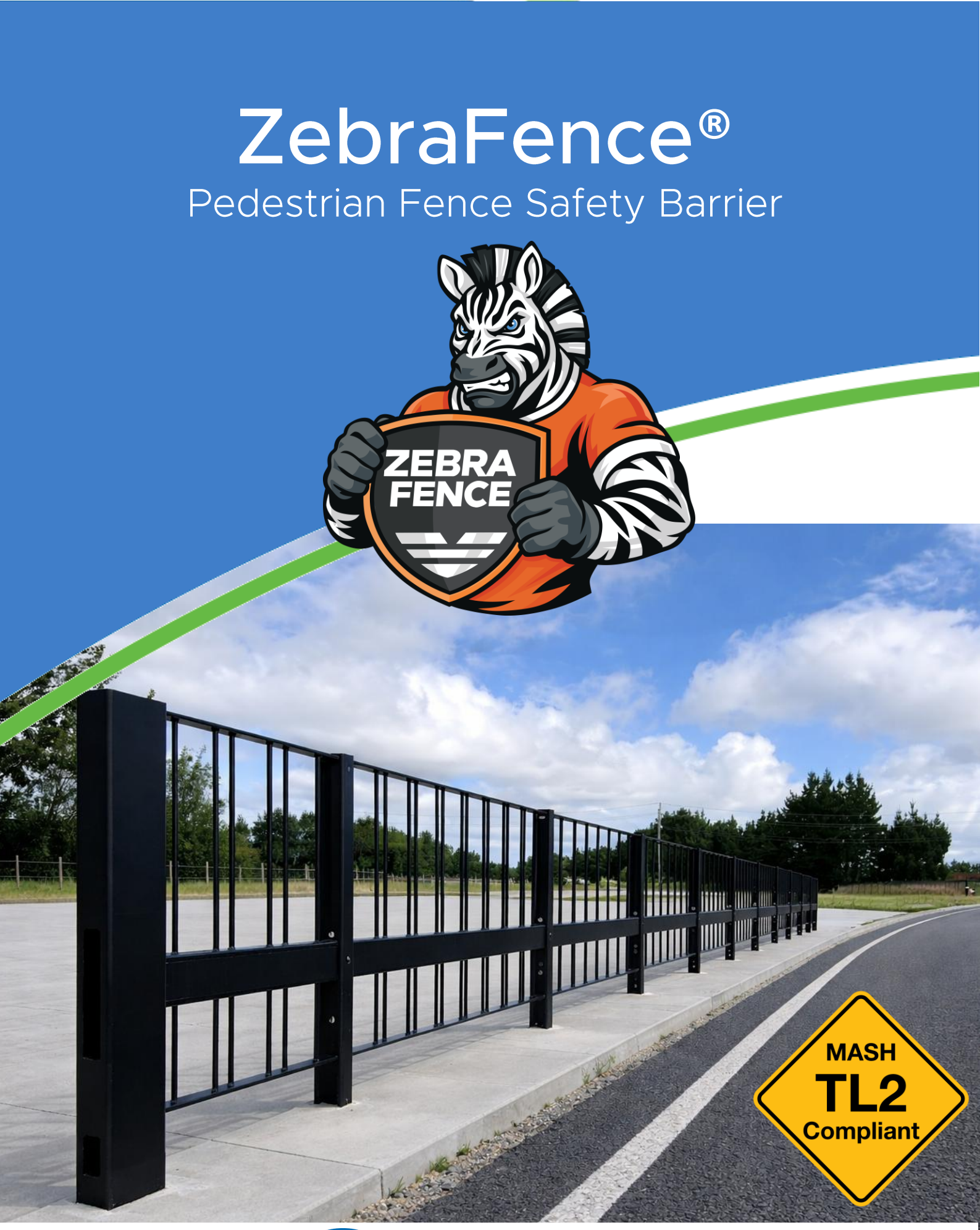
ZebraFence®

Pedestrian Fence Safety Barrier



SafeDirection
CRASH BARRIER SOLUTIONS

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Version	Date	Revisions
01	May 2026	Initial Issue
02	July 2026	Inclusion of 90-Degree Impacts
03	September 2026	Inclusion of Repair Guidelines and Field Curvature
04	November 2026	Inclusion of Posts with Baseplates



SafeDirection
CRASH BARRIER SOLUTIONS

Leading Safety

Crash tested to MASH Test Level 2

Crash tested to withstand a 90-degree impact from a 2000 kg vehicle travelling at 40 km/h

Shields vulnerable road users

Designed to contain and arrest errant vehicles

Demonstrated secondary vehicle impact capability

Low dynamic deflection

Evaluated on flat ground and behind a kerb & gutter

Pedestrian Friendly Considerations

Offset vertical balusters provide line of sight for pedestrians and motorists

The system height discourages climbing of the fence

The gap between balusters prevents children climbing through

No sharp edges

No protrusions that could snag a cyclist

Narrow system width of just 100 mm

Simplified Installation

Standard 2 m post spacing

Available with inground or baseplate posts

Panels can be stepped in 50 mm increments up to a maximum 100 mm

Inground posts are concreted into the ground

Designed for Australian Conditions

Considers the Safe System philosophy by shielding vulnerable road users

All steel construction with hot dip galvanised components

Can be powder coated to suit site requirements

1.0 Introduction

The *Austroads Guide to Road Safety Part 2: Safe Roads* reports that crashes involving vulnerable road users are responsible for 36 % of all high-severity road trauma.

Safe System-aligned measures for pedestrians require either full separation of pedestrians from vehicles or, where this cannot practically be achieved, low-risk travel speeds, typically not exceeding 30 km/h. Many of the most commonly encountered treatments for pedestrians cannot be considered to be Safe System-aligned, largely because they are designed in a way that allows crashes to occur at speeds outside the Safe System boundary conditions for unprotected road users.

Developed by Safe Direction, ZebraFence® is a steel pedestrian safety barrier system, designed to shield vulnerable road users within close proximity to the edge of the travelled way. Unlike public domain pedestrian fencing designs currently installed on Australian road corridors, ZebraFence® is a crash tested safety barrier demonstrating containment of errant vehicles travelling up to 80 km/h.

2.0 Specifications

Crash Test Capacity	MASH Test Level 2*
MASH TL2 Dynamic Deflection	680 mm
Standard Post Spacing	2 m centres
System Width	100 mm
System Height	1185 mm, measured to top of the panel
System Finish	Hot dip galvanised in accordance with AS/NZS 4680

** The ZebraFence® end treatment is not a MASH compliant end terminal. Since pedestrians gather near the end of the system to cross the road, the end treatment has been designed to prioritise pedestrian protection by restraining an errant vehicle. For design and site-specific risk assessment, the ZebraFence end treatment should be considered a rigid hazard to vehicle occupants when determining the overall safety benefit of a ZebraFence® installation.*

3.0 ZebraFence® Description

ZebraFence® is a steel fencing system comprising intermediate posts at 2 m centres. Each panel features vertical balusters and a horizontal RHS cross tube providing lateral resistance during a vehicle collision. The connection of the RHS cross tube to each post resists vehicle impact forces creating a robust longitudinal safety barrier system. The height of ZebraFence® is 1185 mm above pavement level, measured to the top of the panels.

The intermediate posts measure 1900 mm long and are placed 695 mm into 800 mm deep footings. The footing diameter measures 150 mm when installed in a concrete pavement or 200 mm when installed in soil.

The intermediate posts provide three (3) mounting slot positions allowing the panels to be stepped up to a maximum of 100 mm between panels. The upper portion of each intermediate post is tapered and features

a laser cut zig zag pattern within the post web. This design weakens the upper portion of the post and reduces the potential for vehicle snagging.

The ZebraFence® end treatment comprises an end post measuring 2100 mm long placed 895 mm into a minimum 20 MPa concrete footing measuring 1000 mm deep and 250 mm diameter. The end post is positioned 900 mm from the first/last intermediate post and supports the end panel. The end panel features vertical balusters and a slotted horizontal RHS cross tube, designed to crush and absorb the energy of a vehicle during an end-on impact.

4.0 Crash Test Performance

4.1 Redirective Impacts

ZebraFence® has been crash tested and evaluated according to the specifications for Test Level 2 (TL2) 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.

MASH is also the basis of testing procedures for road safety systems as stated in *AS/NZS 3845.1: 2015 Road Safety Barrier System and Devices.* The introduction of MASH follows changes to the vehicle fleet, researching of real-life impact conditions and updated criteria for evaluating barrier performance.

The primary objective in the development of ZebraFence® is to shield pedestrians by redirecting or arresting errant vehicles.

In addition to impacts complying with MASH Test Level 2, elective impacts have been performed to thoroughly evaluate the various ZebraFence® installation configurations and to represent real-life impact scenarios. In total, five (5) length-of-need impacts have been performed as follows:

- 1100 kg passenger car travelling at 70 km/h and 25 degrees,
- 2000 kg SUV travelling at 80 km/h and 15 degrees,
- 2270 kg pick-up truck travelling at 60 km/h and 25 degrees, and
- 2270 kg pick-up truck travelling at 70 km/h and 25 degrees (2 off).

The heavy vehicle impacts evaluate barrier strength and the potential for the vehicle to override the crash barrier system or rollover during redirection.

The small car impacts investigate the potential for the vehicle to underride the crash barrier system and wheel snag. This impact condition also assesses occupant risk, including impact velocities and head-slap.

The ZebraFence® end panel features a slotted horizontal RHS beam designed to crush and absorb the energy of an impacting vehicle during an end-on collision. The end post has been impacted with a 2270 kg pick-up truck travelling at 50 km/h and 5 degrees demonstrating an ability to arrest the vehicle and prevent penetration into the pedestrian are behind the barrier.

4.2 90-Degree Impacts

The installation of ZebraFence® to shield vulnerable road users congregating at intersections and adjacent to parking areas creates the possibility for high-angle vehicle impacts. The crash test evaluation of ZebraFence® included 90-degree impacts as follows:

- 2000 kg dual cab utility travelling at 20 km/h with the posts concreted into soil.
- 2000 kg dual cab utility travelling at 40 km/h with the posts concreted behind a kerb and gutter.

In both impacts the errant vehicle was contained and occupant impact velocities were within MASH limits.



Figure 1: Impact behaviour of ZebraFence®, 2000 kg dual cab utility travelling at 40 km/h and 90-degrees.

5.0 Material Traceability

Safe Direction operates a quality management system, independently certified to the requirements of ISO 9001:2015. A multi-stepped procedure is used by Safe Direction to verify the compliance of the steel used in the production of ZebraFence® matches the material specification as crash tested.

6.0 Limitations of Current Barrier Designs in Pedestrian Areas

6.1 Public Domain Fencing

Public domain pedestrian fencing systems are used to assist with the safe movement of roadside users. They act as a physical barrier and are used to direct pedestrians to safe crossing areas, preventing them from inadvertently accessing areas of the road corridor where they may interact with vehicular traffic in an uncontrolled manner. These public domain fencing systems **are not** road safety barriers and cannot be relied upon to arrest or redirect an errant vehicle or to prevent injury to pedestrians by errant vehicles.

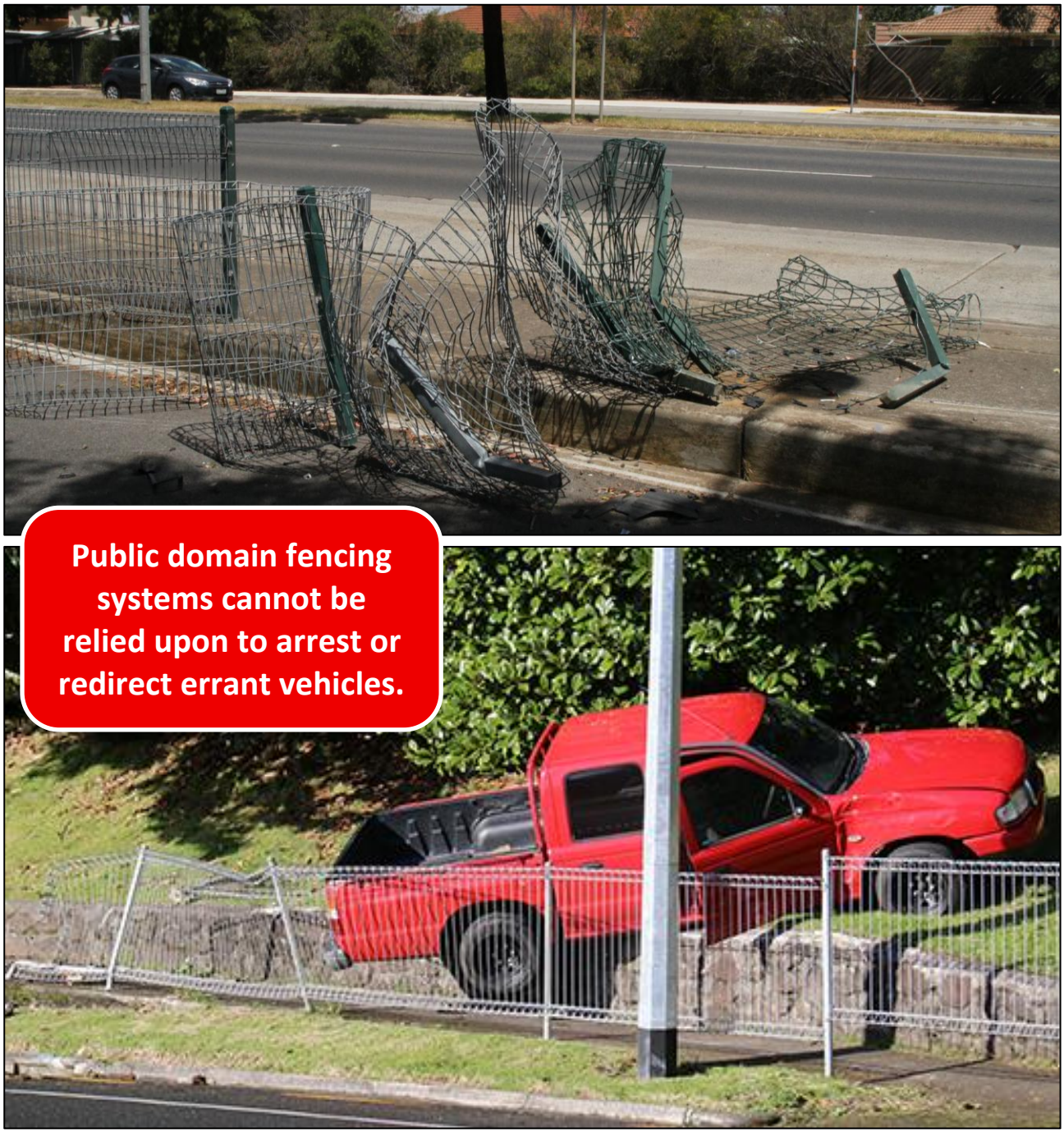


Figure 2: Impact behaviour of public domain fencing systems.

6.2 Guardrail Barriers

Guardrail barriers redirect errant vehicles away from roadside hazards including trees, power poles or bridge abutments. Guardrails are designed to provide vehicle stability during impact and mitigate the risk to vehicle occupants. Industry guidelines typically recommend the installation of continuous guardrail barriers, shielding long sections of the road corridor.

The installation of guardrail barriers for the protection of pedestrians is problematic as follows:

- There is often insufficient space behind the guardrail barrier to accommodate system dynamic deflection.
- Short lengths of guardrail barriers may not provide vehicle containment or redirection.
- The height of guardrail barriers cannot be relied upon to restrict pedestrian movements.
- The width of a guardrail system may encroach into the pedestrian area.
- The edges and corners of guardrail systems may present risk to pedestrians and cyclists.

Designers often modify guardrail barriers installed in pedestrian areas by attaching backing rails to mitigate snagging risk. However, these attachments are not crash tested and may present risk to vulnerable road users if they become detached during a vehicle collision.



Figure 3: Pedestrian attachments to guardrail barriers can become hazardous during a vehicle collision.

7.0 ZebraFence® Design Features

7.1 Pedestrian Considerations

The design of ZebraFence® considers the following:

- The height of ZebraFence® discourages pedestrians from climbing over the fence.
- The gap between the vertical balusters prevents children from climbing through.
- The system does not contain sharp edges which could be a danger to those who use the railing for support or guidance.
- The system does not have protrusions that could snag cyclists or the pedals of cycles as they pass.
- The balusters are offset facilitating line of sight for pedestrians and motorists.
- The narrow system width minimises encroachment into the pedestrian area.

7.2 Low Dynamic Deflection

In urban areas, pedestrian pathways are located immediately adjacent to the roadway. A large clear zone behind a barrier cannot be maintained due to the movement of pedestrians and the need to utilise pavement width for alfresco dining, transit stops and intersection crossing. It is therefore desirable to minimise dynamic deflection, reducing encroachment into the pedestrian area.

A dynamic deflection of just 680 mm was recorded for the ZebraFence® when impacted by a 2270 kg pick-up truck travelling at 70 km/h and 25 degrees.

7.3 Secondary Vehicle Impact Capability

Pedestrian fencing is typically installed in urban environments with high traffic volumes. Due to installation within close proximity to the edge of the travelled way, nuisance impacts are common. Therefore, an important design consideration is the ability of the pedestrian fence system to continue to contain and redirect an errant vehicle while awaiting repair.

Two (2) length-of-need vehicle impacts were performed on previously impacted ZebraFence® installations. There were no repairs undertaken between the tests.

During all ZebraFence® crash testing, including the secondary impacts, the connection between the panels and posts was unbreakable. This robust construction ensures the system provides secondary vehicle impact capability.

7.4 ZebraFence® End Treatment

Crash test evaluation of the ZebraFence® end post has been undertaken with a 2270 kg pick-up truck travelling at 50 km/h and 5 degrees. At sites where a high-speed vehicle collision with the end post is considered likely, a risk assessment should be undertaken to consider other treatment options including a crash cushion or the installation of a guardrail barrier in combination with MASH compliant end terminals.

The ZebraFence® end treatment features a slotted RHS cross tube designed to deform when impacted by a heavy passenger vehicle during an end-on collision.



Figure 4: Crash testing of the ZebraFence® end treatment.

7.5 Post Placement in Natural Ground or a Concrete Pavement

The crash test evaluation of ZebraFence® included the posts concreted into natural ground and concrete pavement. The intermediate posts measure 1900 mm long and are placed 695 mm into a minimum 20 MPa concrete footing. The footing diameter measures 150 mm when installed in a concrete pavement or 200 mm when installed in soil. The end posts measure 2100 mm long and are placed 895 mm into a minimum 20 MPa concrete footing measuring 1000 mm deep and 250 mm diameter for all pavement conditions.

7.6 Point of Need

ZebraFence® has demonstrated containment and redirection of a 2270 kg pick-up truck travelling at 60 km/h and 25 degrees impacting 0.3 m upstream of the 3rd post. This is a distance of 2.6 m, measured from the centre of the end post.

This impact was performed with a step of 100 mm between panels and with the system installed behind a kerb and gutter creating maximum potential for vehicle instability during containment and redirection.

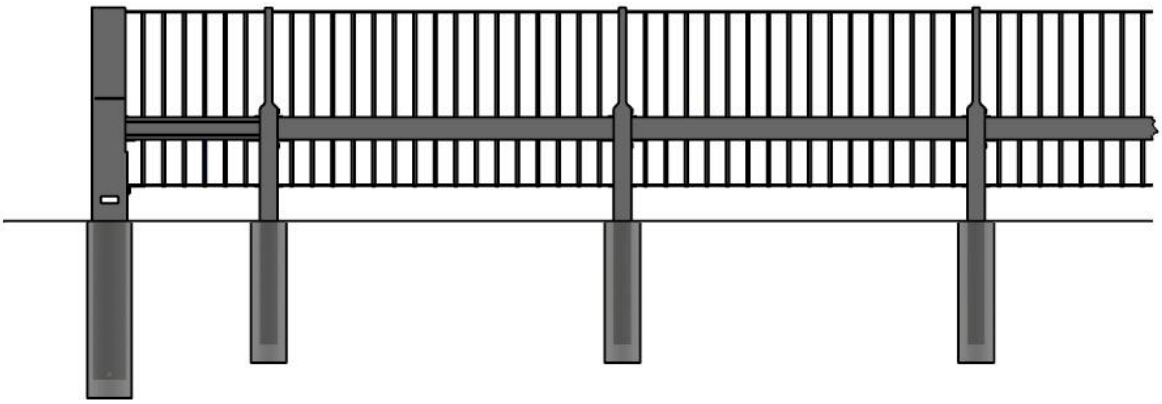
7.7 Minimum Installation Length

Where space permits, it is recommended to install a minimum length of 20 m replicating the ZebraFence® crash test installation lengths. At constrained sites a shorter length system could be installed subject to a risk assessment that considers the danger(s) to vulnerable road users.

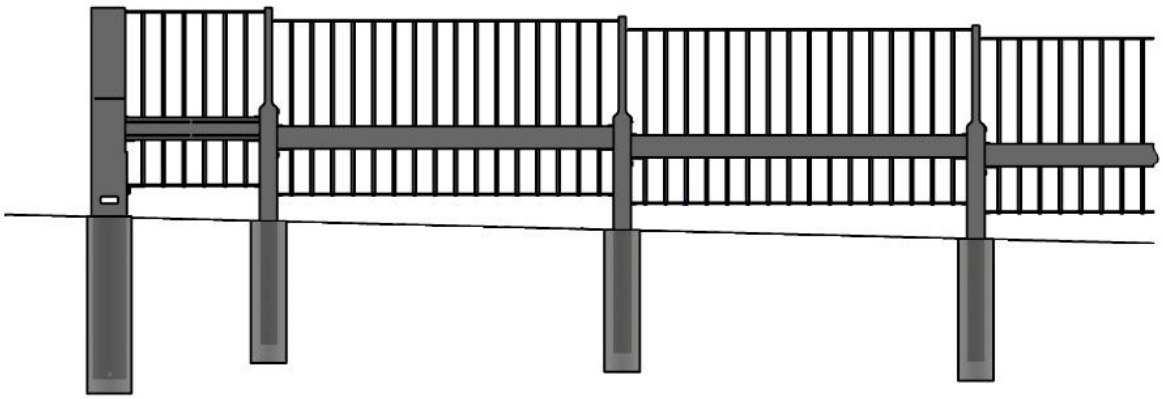
7.8 Stepping of Panels

The installation of ZebraFence® requires the panels to remain level while the ground slopes. Therefore, the use of stepped panels maintains a consistent system height relative to ground level.

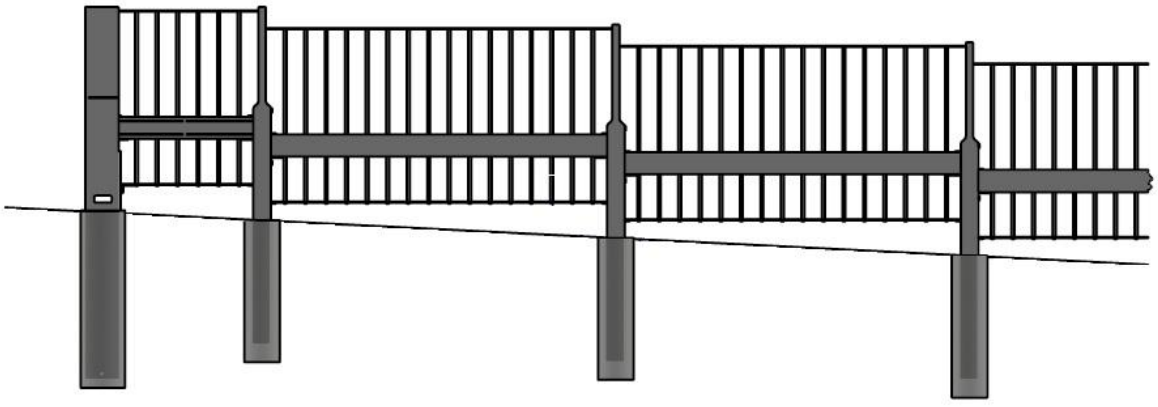
The ZebraFence® intermediate posts provide several mounting hole locations allowing the panels to be stepped in 50 mm increments up to a maximum step of 100 mm.



No step between panels



50 mm step between panels



100 mm step between panels

Figure 5: Stepping of ZebraFence® panels.

7.9 Installation behind Kerb & Gutter

Urban roadways typically feature kerbs and gutters. Crash testing of ZebraFence® included impacts with the system installed behind a type SA kerb as widely used throughout NSW in pedestrian areas. In all crash tests the errant vehicle was prevented from entering the pedestrian area behind the ZebraFence® installation.

When installed behind a kerb and gutter the height of the ZebraFence® system is measured from pavement level at the base of the posts as shown in Figure 6.

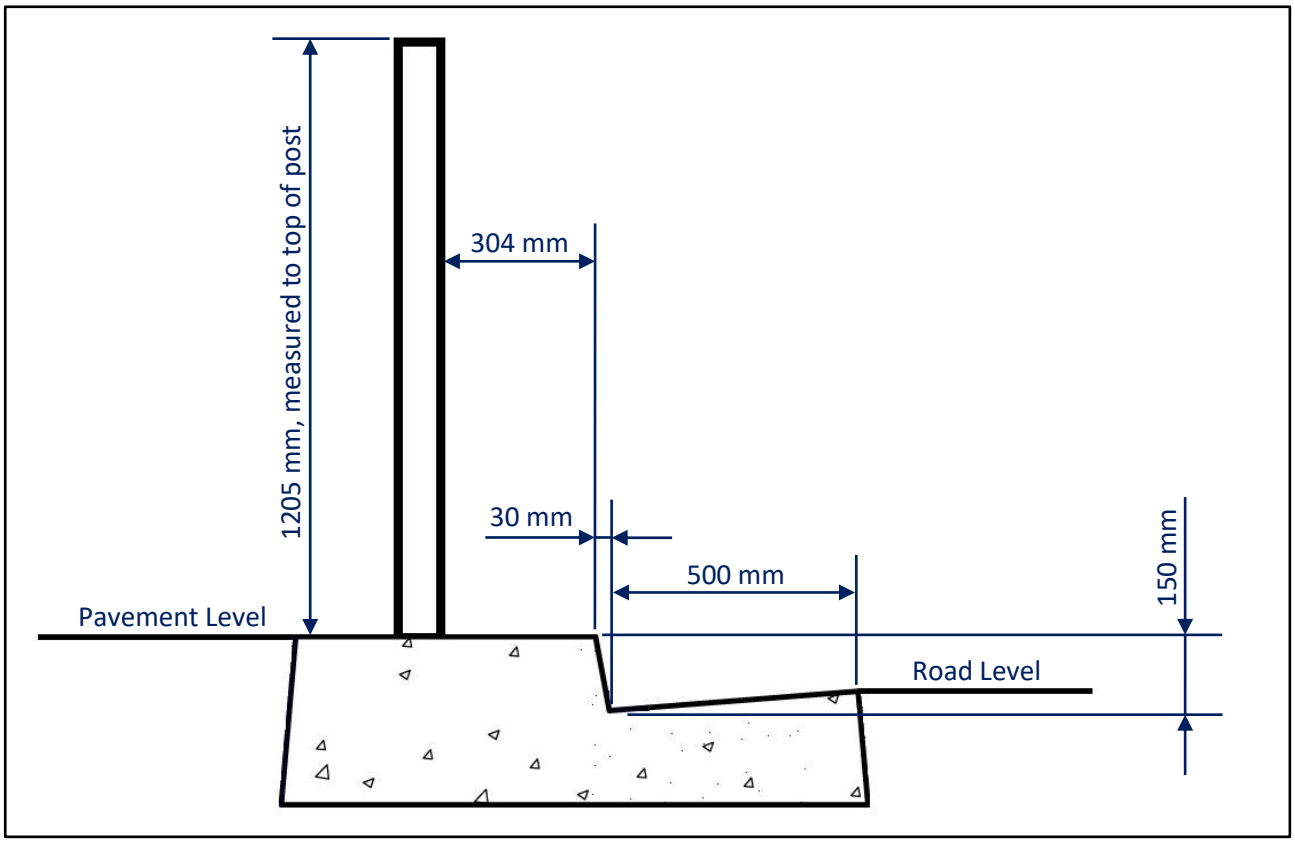


Figure 6: Crash test evaluation of ZebraFence® behind a kerb and gutter.

7.10 Field Curvature

ZebraFence® panels are supplied in straight sections. The standard assembly of ZebraFence® secures the panels to the posts with M24 x 75 mm structural bolts. At sites where a horizontal radius is required, the panels may be secured with M24 x 90 mm structural bolts which will facilitate a minimum horizontal radius of 10.5 m.

7.11 Design Life

ZebraFence® is an all-steel construction with all components hot dip galvanised after fabrication.

The durability of the finished hot dip galvanized coating is a function of the environment to which the article is exposed. According to industry standards, hot-dip galvanized coatings can last up to 50 years in rural environments and up to 25 years in more corrosive environments, such as coastal regions.

7.12 Posts with Baseplates

Underground services may prevent ZebraFence® from being installed with inground posts. In these circumstances ZebraFence® may be installed with posts on baseplates secured to the top of a rigid kerb or concrete strip footing.

The baseplate posts may be secured using mechanical or chemical anchor options as follows:

a) M16 x 220 mm galvanised Fischer FBN II anchors. Minimum embedment depth of 180 mm with each anchor torqued to 70 Nm, or

b) M16 galvanised threaded rods, class 8.8. Minimum embedment depth of 180 mm with each anchor secured with Fischer SB 390 and torqued to 60 Nm.

Table 1: Strip Footing Sizing

Depth (mm)	Width (mm)	min. Length (m)
250	1200	10
300	1000	10
400	800	12
500	600	17

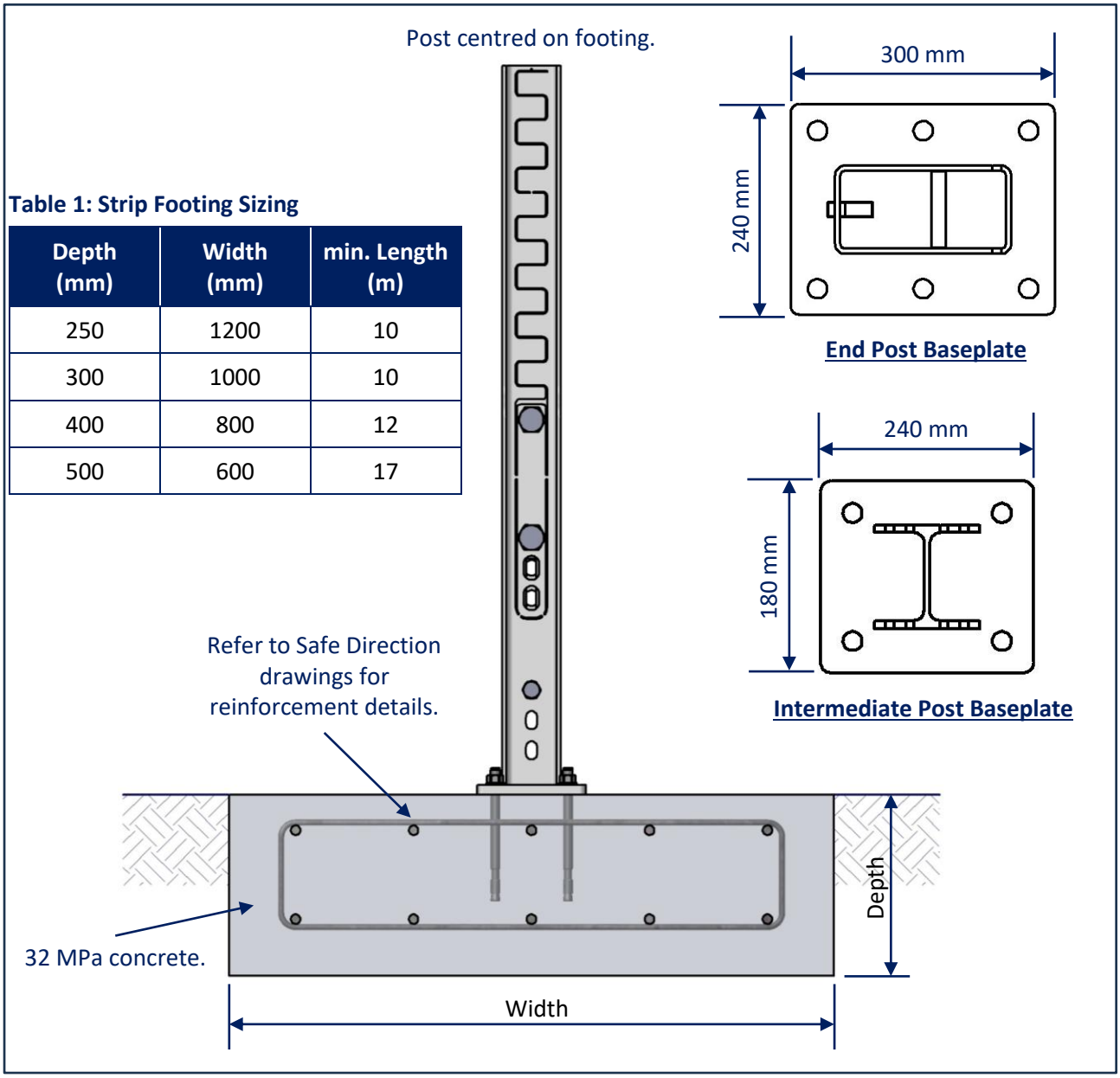
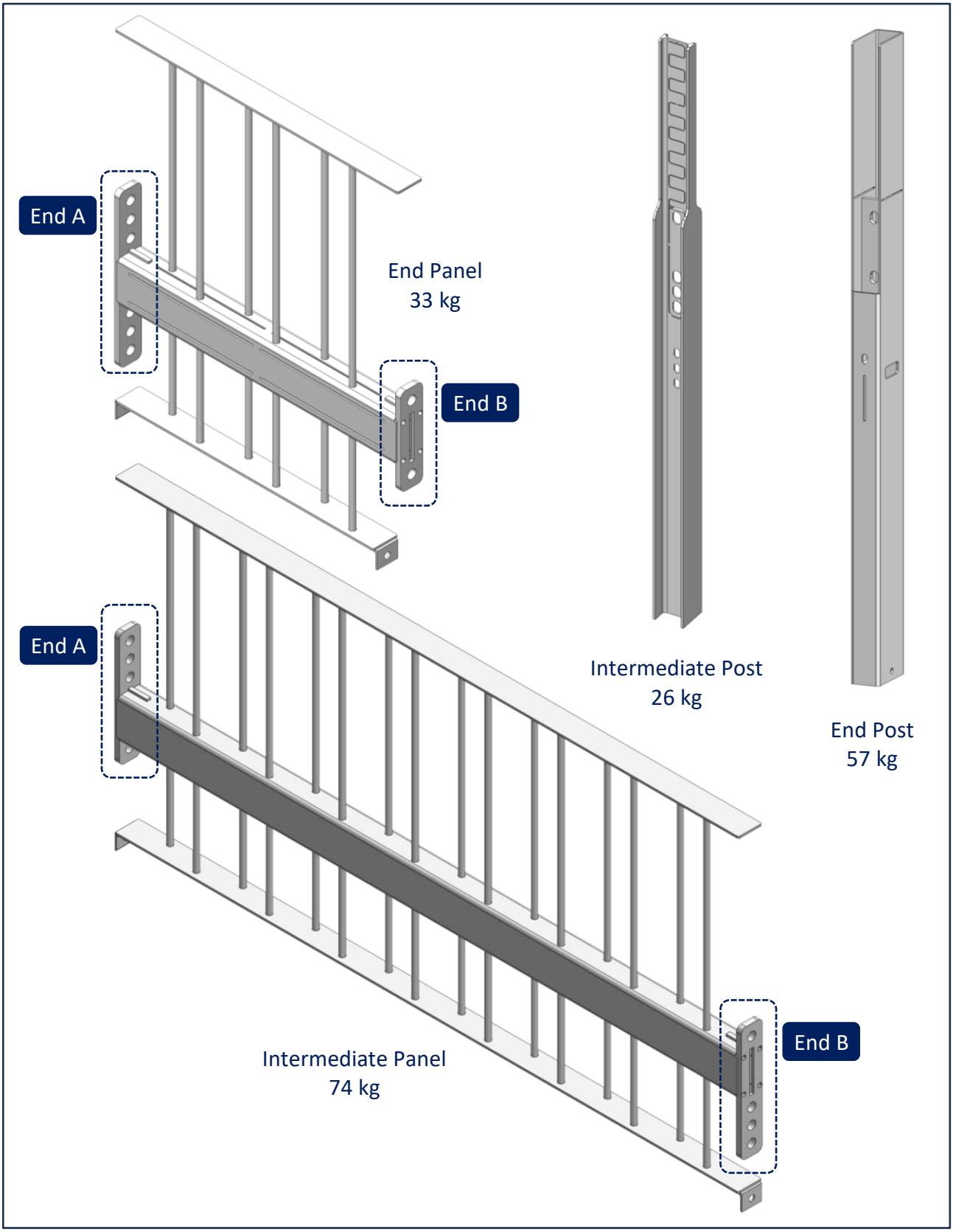


Figure 7: ZebraFence® posts with baseplates.

8.0 Component Identification (not to scale)



9.0 Tools Required

Tools required for the installation of ZebraFence® includes:

- 250 mm diameter auger for the end post installation.
- 200 mm diameter auger (placement in soil) or 150 mm auger (placement in a concrete pavement) for the intermediate post installation.
- String line.
- Hand socket with 36 mm and 24 mm attachment.
- Tape measure.
- Spirit level.
- Shovels.
- Finishing trowel.
- Steel tamping rod.
- 200 mm high timber blocks.
- Timber bracing.

9.1 Recommended PPE

It is recommended that the following personal protective equipment (PPE) be provided for the safe installation of ZebraFence®:

- Safety footwear.
- Gloves.
- Hearing protection.
- High visibility clothing.
- PPE as required for the use of an auger.



10.0 Site Establishment

10.1 Traffic Control

Prior to the commencement of any work, the site should be evaluated for risks to workers, pedestrians and other road users. The establishment of traffic control should provide safe travel for passing vehicles and/or pedestrians and appropriately protect workers near the roadside.

10.2 Underground Services

The installation of ZebraFence® requires the supporting posts to be concreted into the ground. Prior to the installation of posts an investigation for potential underground hazards is recommended.

10.3 Overhead Obstructions

The site should be evaluated for potential overhead instructions that may present a risk during the installation process. These obstructions typically include power lines, signage or trees.

10.4 Unloading Exclusion Zone

Only appropriate load-rated slings and chains should be used for the safe unloading of product. It is recommended that an exclusion zone be maintained around the unloading process. This provides distance between moving machinery and workers in the event that goods or the machinery move unexpectedly.

Unloading and the storing of the product on a level surface is recommended. Storing product adjacent to the installation area eliminates the requirement for workers to carry items over long distances.

11.0 Installation Sequence

The major steps in the installation of the ZebraFence® are as follows:

- Set-out.
- Auguring the post holes.
- Assembling and supporting the system.
- Concreting the post holes.
- Removing timber supports.

It is recommended that the ZebraFence® system be assembled prior to pouring concrete. The use of timber blocks can be placed under the fencing panels to establish the correct system height. Timber braces should be placed on each side of the fence as required.

11.1 Set-Out

It is recommended that a string line be used to establish the alignment of the post locations. When establishing the post locations, take care to note the following:

- The intermediate posts are spaced at 2 m centres.
- The centre of the end post is 900 mm from the centre of the first/last intermediate post.
- The overall distance from the centre of the first/last intermediate post to the outer edge of the end post is 1 m.

11.2 Auguring of End Post Footings

Potential Hazards: *Use of auger, contact with underground hazards, excessive noise, hand injury from pinch points and injury from movements and posture.*

Recommended Control Measures: *Observe the safe work instructions as per machinery requirements, ensure the area has been inspected for underground hazards, wear appropriate hearing protection, wear gloves and observe correct techniques when lifting (bend at the knees).*

Using a 250 mm diameter auger drill the end post footing to a depth of 1000 mm. These dimensions are applicable for the end post installation in soil or a concrete pavement.

Ensure the removed material is disposed as per site environmental requirements.

11.3 Auguring of Intermediate Post Footings

Potential Hazards: *Use of auger, contact with underground hazards, excessive noise, hand injury from pinch points and injury from movements and posture.*

Recommended Control Measures: *Observe the safe work instructions as per machinery requirements, ensure the area has been inspected for underground hazards, wear appropriate hearing protection, wear gloves and observe correct techniques when lifting (bend at the knees).*

When installing into soil, use a 200 mm diameter auger and drill the post footing to a depth of 800 mm. When installing into a concrete pavement, use a 150 mm diameter auger and drill the post footing to a depth of 800 mm.

Ensure the removed material is disposed as per site environmental requirements.

11.4 ZebraFence® Assembly – Flat Ground Installation

Potential Hazards: *Injury from movements and posture, hand injury from pinch points, strain to wrists from tightening bolts.*

Recommended Control Measures: *Observe correct techniques when lifting (bend at the knees), wear gloves, use a socket to tighten bolts.*

The end panel is orientated with End B (refer to Section 8.0) attaching to the end post. The end panel is secured to the end post with three (3) fasteners. The connection bracket is secured to the end post at two

(2) positions with a M24 x 75 mm structural bolt, nut and washer. The washer is positioned under each nut. The nuts are tightened using a hand socket and 36 mm attachment.

The bottom plate of the end panel is secured to the end post with a M16 x 50 mm structural bolt, nut and washer. The washer is positioned under the nut. The nut is tightened using a hand socket and 24 mm attachment.

There is no torque requirement for the tightening of the bolts. They should be tightened to a snug position.

A 200 mm timber block should be placed under the panel, raising the fence to the correct height.

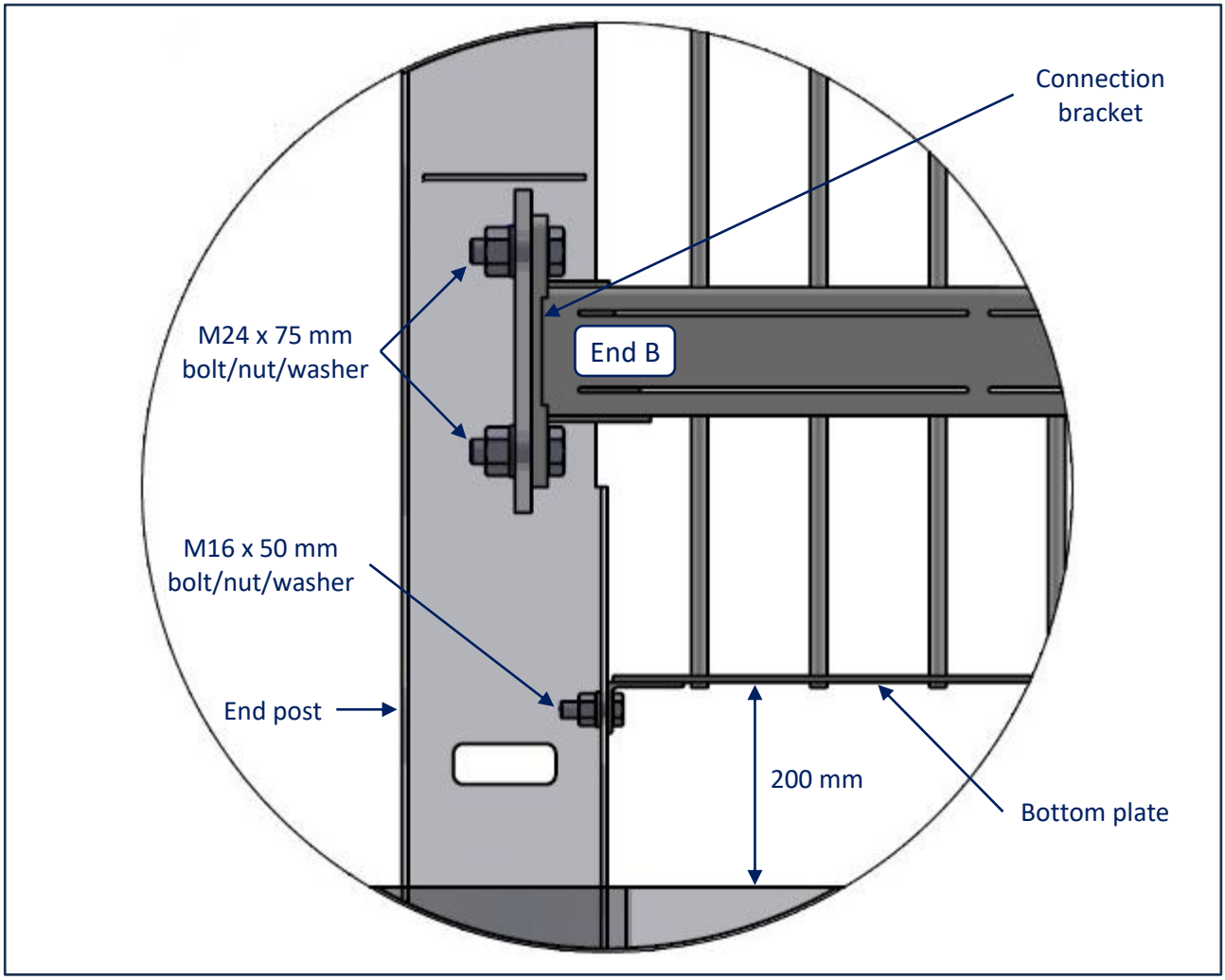


Figure 8: Attachment of the end panel to the end post.

Each intermediate panel is secured to the intermediate posts with three (3) fasteners. The connection bracket is secured at two (2) positions with a M24 x 75 mm structural bolt, nut and washer. The washer is positioned under each nut. The nuts are tightened using a hand socket and 36 mm attachment.

The bottom plate of each end of the intermediate panels is secured to each intermediate post with a M16 x 50 mm structural bolt, nut and washer. The washer is positioned under the nut. The nut is tightened using a hand socket and 24 mm attachment.

There is no torque requirement for the tightening of the bolts. They should be tightened to a snug position.

A 200 mm timber block should be placed under the panels, raising the fence to the correct height.

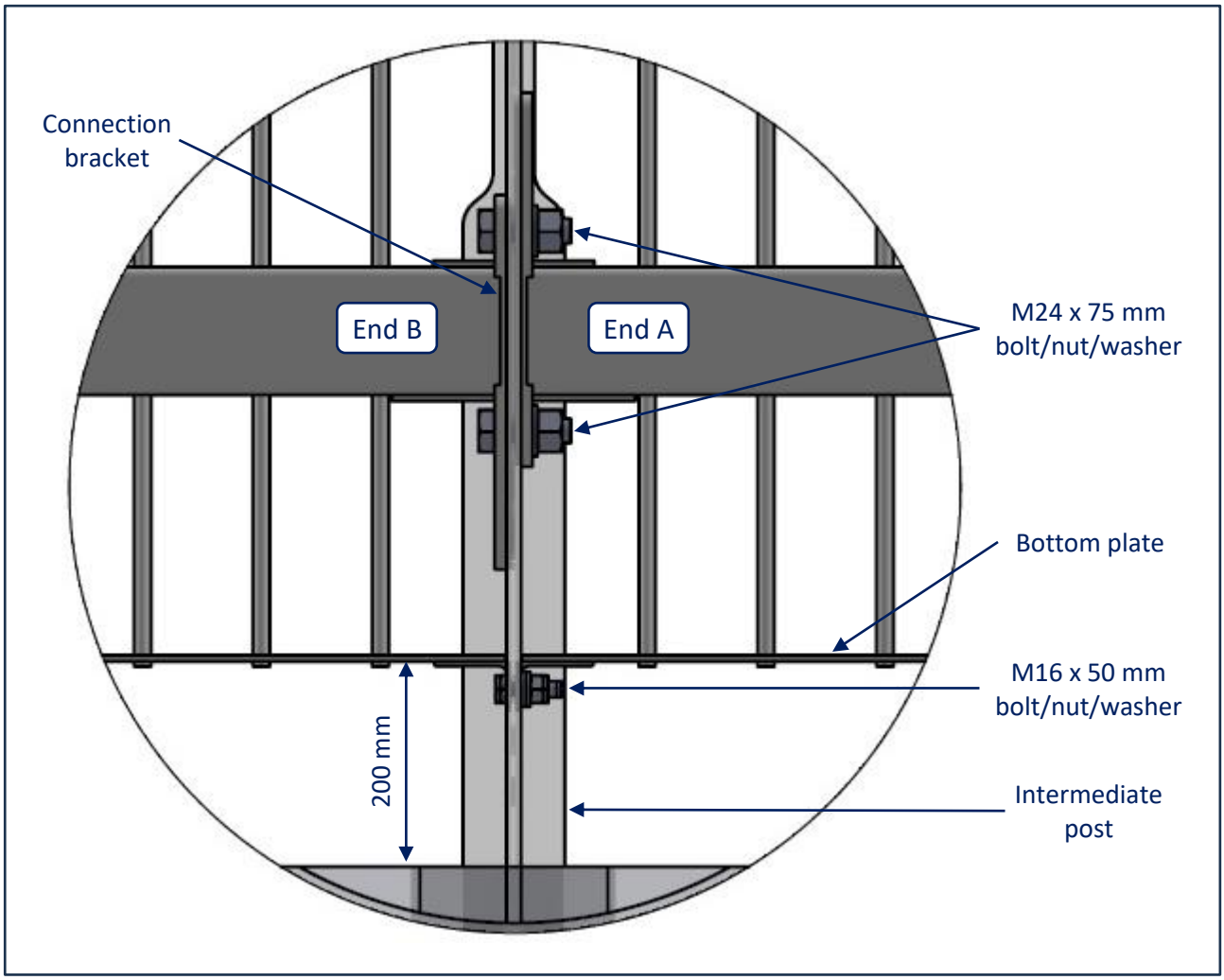


Figure 9: Attachment of panels to intermediate posts – flat ground installation.

11.5 ZebraFence® Assembly – Sloping Ground Installation

Potential Hazards: *Injury from movements and posture, hand injury from pinch points, strain to wrists from tightening bolts.*

Recommended Control Measures: *Observe correct techniques when lifting (bend at the knees), wear gloves, use a socket to tighten bolts.*

Each intermediate post is punched to provide several mounting hole locations allowing the panels to be stepped in 50 mm increments up to a maximum step of 100 mm.

It is recommended that a stepped assembly commence from the low end of the slope.

The end panel is orientated with End B (refer to Section 8.0) attaching to the end post. Place a 200 mm timer block under End B and secure to the end post as described in Section 11.4 and Figure 7.

To determine the step required, place a spirit level on top of the end panel and secure the bottom plate of End A to the first intermediate post with a M16 x 50 mm structural bolt, nut and washer, ensuring the panel is level. The washer is positioned under the nut. The nut is tightened using a hand socket and 24 mm attachment.

The first intermediate panel is orientated with End B (refer to Section 8.0) attaching to the first intermediate post. Place a 200 mm timer block under End B and secure the bottom plate to the intermediate post with a M16 x 50 mm structural bolt, nut and washer. The washer is positioned under the nut. The nut is tightened using a hand socket and 24 mm attachment.

Secure the adjacent panels to the intermediate post at two (2) positions with a M24 x 75 mm structural bolt, nut and washer. The washer is positioned under each nut. The nuts are tightened using a hand socket and 36 mm attachment.

There is no torque requirement for the tightening of the bolts. They should be tightened to a snug position.

This sequence is repeated at each intermediate post though to the end post at the high end of the slope. It will be necessary to brace and support the system as subsequent panels and posts are assembled.

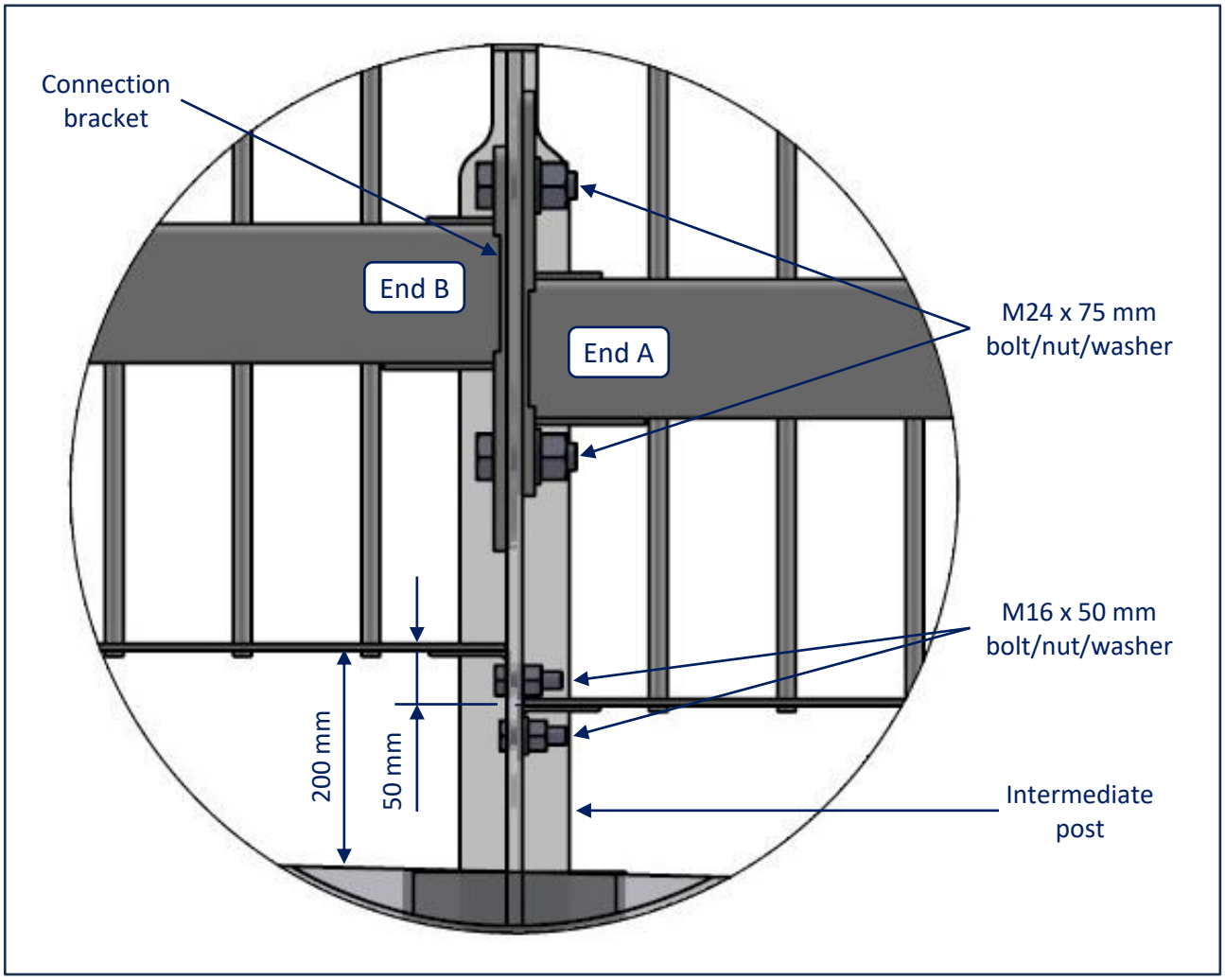


Figure 10: Attachment of panels to intermediate posts – 50 mm step.

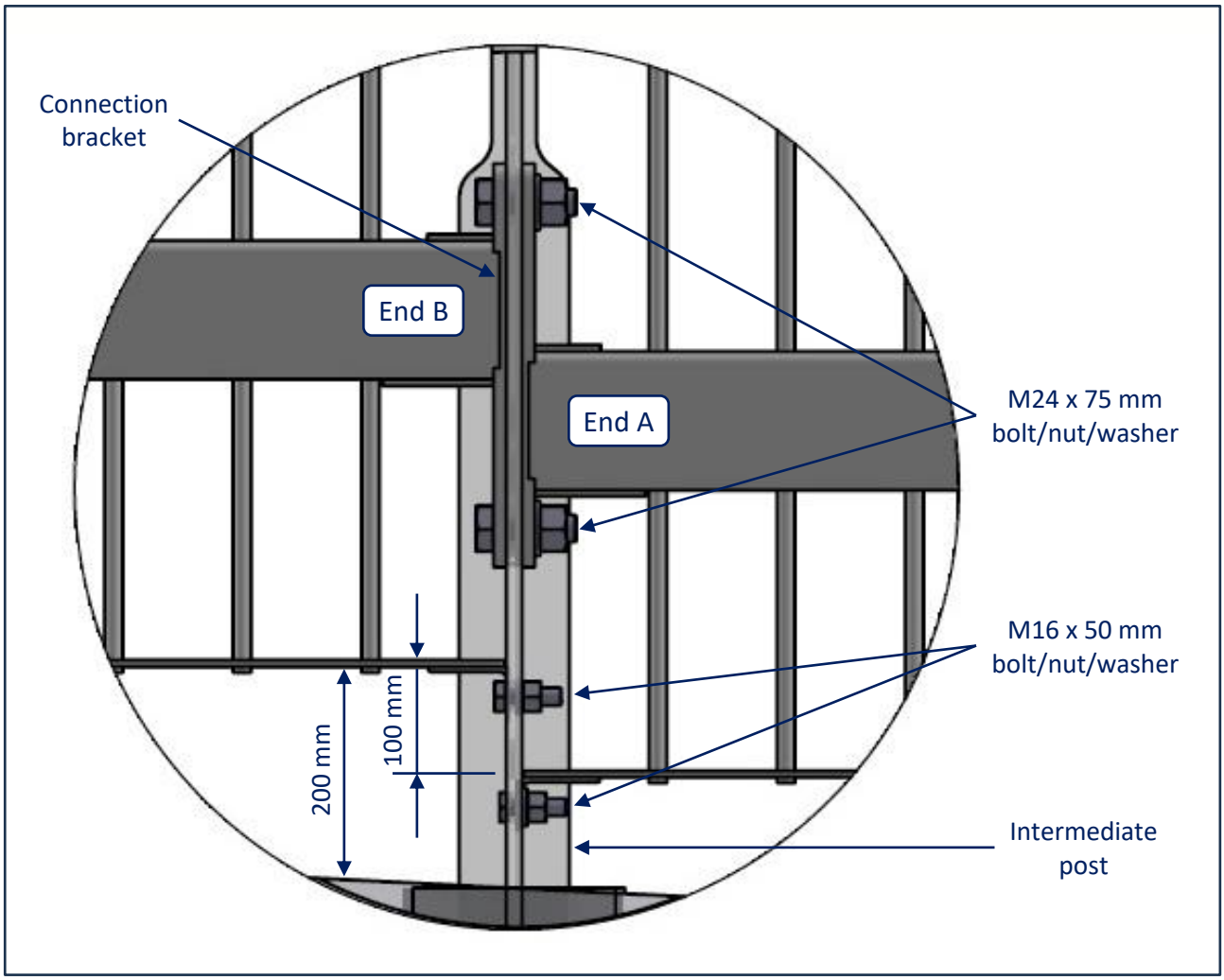


Figure 11: Attachment of panels to intermediate posts – 100 mm step.

11.6 Concreting of Posts

Potential Hazards: *Injury from movements and posture, exposure to open excavations, movement of concrete truck.*

Recommended Control Measures: *Observe correct techniques when bending and shovelling concrete, remain aware of surroundings.*

Pour minimum 20 MPa concrete into each post hole and use a steel rod to tamp and remove air voids. Once the concrete reaches the top of the hole check the vertical alignment of the posts and adjust if necessary.

Wipe any spilled concrete from the fencing system and use a trowel to finish the surface of each post hole footing. It is recommended that the support stands remain for 24 hours to allow the concrete to cure.

11.7 Delineation

ZebraFence® may be delineated by attaching reflective tape to the posts as required.

ZebraFence® Inspection Form

Inspection Date	
Client	
Project Reference	
Name of Inspector	
Company	

❑ Yes ❑ No	End posts have been installed at each end of the system.
❑ Yes ❑ No	End panels have been installed at each end of the system.
❑ Yes ❑ No	The end panel connection bracket (both ends) is secured to the end post and first/last intermediate post with two (2) M24 x 75 mm structural bolts/nuts/washers.
❑ Yes ❑ No	The end panel bottom plate (both ends) is secured to the end post and first/last intermediate with one (1) M16 x 50 mm structural bolt/nut/washer.
❑ Yes ❑ No	The intermediate panel connection bracket (both ends) is secured to the intermediate posts with two (2) M24 x 75 mm structural bolts/nuts/washers. *Note: for curved installations M24 x 90 mm structural bolts are permitted.*
❑ Yes ❑ No	The intermediate panel bottom plate (both ends) is secured to the intermediate posts with one (1) M16 x 50 mm structural bolt/nut/washer.
❑ Yes ❑ No ❑ n/a	When installed behind a kerb and gutter, the system height has been measured from pavement level at the base of each post.
❑ Yes ❑ No	The measurement from ground or pavement level to the top of the end posts is 1205 mm ± 30 mm.
❑ Yes ❑ No	The measurement from ground or pavement level to the top of the panels is 1185 mm ± 30 mm.
❑ Yes ❑ No	The maximum gap under each panel does not exceed 200 mm.
❑ Yes ❑ No ❑ n/a	The top of each concrete footing has been trowelled providing a smooth finish with the surrounding ground/pavement.
❑ Yes ❑ No ❑ n/a	Intermediate posts on baseplates have been secured with four (4) anchor bolts as per Safe Direction drawings.
❑ Yes ❑ No ❑ n/a	End posts on baseplates have been secured with six (6) anchor bolts as per Safe Direction drawings.
❑ Yes ❑ No	All fasteners are tightened.
❑ Yes ❑ No ❑ n/a	Concrete spillage has been removed from posts and panels.

Comments/Notes

12.0 Maintenance

ZebraFence® is a robust fencing system designed to withstand vehicle collisions. The crash test evaluation of ZebraFence® has demonstrated an ability to provide secondary impact capability while awaiting repairs.

Except for repairs due to impacts, it is recommended that regular inspections be undertaken to ensure that vegetation around the barrier is appropriately maintained and that debris has not accumulated around the barrier.

13.0 Repair

In the event of a vehicle impact, damage to the barrier is to be assessed in accordance with Table 2. Impacts with ZebraFence® will require replacement of damaged panels and posts. Additional tools required for repair may include an angle grinder to cut away damaged panels and concrete core drilling equipment.

Similar to the installation sequence, it is recommended that the guidelines contained in Section 10.0 be observed in the establishment of traffic control and an unloading exclusion zone in addition to an investigation for underground services and overhead obstructions.

13.1 Removing Damaged Panels

Potential Hazards: *Use of angle grinder, excessive noise, injury from movements and posture, hand injury from twisted steel, strain to wrists from loosening bolts.*

Recommended Control Measures: *Observe correct techniques when lifting panels (bend at the knees), wear gloves, hearing protection and eye protection, and use appropriately sized sockets for loosening bolts.*

Prior to the dismantling of the system following a vehicle collision, it may be necessary to cut away damaged posts using an angle grinder.

During all performed crash test impacts the M24 bolted connection between the panels and posts was unbroken. Damaged panels may be removed by releasing all fasteners.



Figure 12: Unbroken M24 structural bolts.

13.2 Removing Damaged Posts

Potential Hazards: *Use of concrete core drill, use of angle grinder, excessive noise, hand injury from twisted steel and injury from movements and posture.*

Recommended Control Measures: *Observe the safe work instructions as per machinery requirements, wear appropriate hearing protection, wear gloves and observe correct techniques when lifting (bend at the knees).*

The upper portion of the web of each ZebraFence intermediate post features a zig zag pattern designed to weaken the post and reduce the potential for vehicle snagging. During high-energy vehicle impacts the post web will open as shown in Figure 12.

It is recommended that these post sections be cut away with an angle grinder before cutting the damaged post at its base. Use a concrete core drill to remove the post footing.



Figure 13: Damaged intermediate post.

13.3 Material Disposal

ZebraFence® features an all-steel construction. Damaged items may be recycled.

Table 2: Damage Assessment Guidelines.

Type of Damage	Description of the Damage	Remedial Action
Damage to the galvanised coating	There is minor scratching from the result of handling during transport or installation.	An organic zinc rich paint is to be applied to the repair area in two coats.
Damage to the powder coating finish.	There is minor scratching or peeling from the result of handling during transport or installation.	Scrape away any flaking or chipped coating, lightly sand the damaged area and apply two coats of a matching powder coat touch up spray.
Damage to the panels	There is damage to the connection bracket preventing attachment to the support posts.	The panel is to be replaced.
	There is breaking of any weld.	
	There is breaking of any steel section.	
	The RHS cross tube is bent.	
	There is excessive bending of the balusters.	
Damage to the posts	The zig zag pattern of the post web has separated and protrudes beyond the edge of the fence	The post is to be replaced.
	There is breaking of any weld.	
	There is breaking of any steel section.	
Damage to bolts.	The body of the bolt is distorted.	The bolt is to be replaced.
	The thread of the bolt is damaged.	
Damage to the concrete post footings.	The post footing has cracked and there is movement of the post.	The post and footing are to be replaced.

SafeDirection

CRASH BARRIER SOLUTIONS



☎ 1300 063 220 sales@safedirection.com.au

ABN 53 156 459 684

safedirection.com.au