RamShield®

MASH TL3 W-Beam Guardrail

SafeDirection
CRASH BARRIER SOLUTIONS

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Leading Safety

Successfully crash tested to MASH Test Level 3

Complies with AS/NZS 3845.1:2015 Road safety barrier systems and devices

Crash tested at rail heights of between 730mm and 820mm

Crash tested for bi-directional impacts

No debris from system on impact

Low Deflection

Lower deflection than cable barrier systems

Compatibility

Compatible with the MSKT and MAX-Tension guardrail end terminals

Standard 2m post spacing

Fast Assembly

Fewer parts

Simple rail to post bolt alignment

Stiff driving post

Narrow Geometry

Just 180mm system width

Motorcycle Friendly

Post is set lower than rail to eliminate snag point

No exposed edges on the post

Available with BikerShield™ Motorcycle Barrier

1.0 Introduction

RamShield® W-Beam is the latest innovation and advancement in guardrail barrier designs. Developed by Safe Direction, RamShield® has been full-scale crash tested to MASH Test Level 3.

Providing a forgiving roadside environment reduces the consequences for vehicles leaving the safe, travelled way. Hazards such as trees, utility poles, culverts and embankments are often located adjacent to roadways and relocating them is often impractical. In these instances, shielding with a longitudinal safety barrier, such as RamShield® W-Beam is the most appropriate solution.

W-beam barrier designs have developed over the years and are used to safely contain and re-direct errant vehicles away from nearby hazards. Safety barriers reduce the severity of run-off-the-road crashes and have made a significant contribution to the safety of our region's roads.

RamShield® W-Beam has significantly advanced the containment level of guardrail by introducing patented technology into the behaviour of the post during impact. This results in a safer barrier design with fewer components allowing more metres of barrier to be deployed per public dollar to protect Australian motorists.

2.0 Specifications

Compliance:	MASH Test Level 3
	AS/NZS 3845.1:2015
Standard post length:	1560mm
Post embedment depth:	810mm
System height:	800mm (see note)
System width:	180mm
Standard Post spacing:	2.0m centres
System mass:	19kg per metre
Post mass:	15kg
System deflection (MASH TL3):	1.56m
System Finish:	Hot dip galvanised to AS/NZS 4680

Note: RamShield® W-Beam has been crash tested in accordance with MASH Test Level 3 (TL3) at rail heights of between 730mm and 820mm above ground. An installed rail height of 800mm ± 20mm provides compatibility with MASH guardrail end terminals.

3.0 How RamShield® W-Beam Works

RamShield® W-Beam achieves a controlled redirection of errant vehicles by releasing the rail from the post at an optimal load to retain rail height, limit dynamic deflection and to allow the post to collapse without tripping the vehicle.

The separation of the rail from the post is achieved by a release tab incorporated into the post. The tab is designed to pull forward and tear from the post and remains connected to the rail to ensure there is no debris from the system that may otherwise present as a danger to other motorists.

RamShield® W-Beam uses standard guardrail and fasteners meaning there is very little risk of inadvertent use of non-compliant items.

The RamShield® posts have been designed to collapse upon impact yielding proximate to the ground surface. This distinguishes RamShield® W-Beam from heavier post systems which rely on the post rotating in the ground prior to collapse. The RamShield® post collapsing near the ground surface ensures more reliable performance that is not as dependent on soil conditions. Moreover, the collapse mechanism of the post makes RamShield® W-Beam suitable for use in concreted mowing strips and/or deep asphalt applications which are problematic to the performance of heavier post systems.

The working mechanism of RamShield® W-Beam is a patented concept designed and developed by Safe Direction. The concept is the latest innovation in guardrail design and sets a new benchmark in simplicity and performance.

4.0 Crash Test Performance

RamShield® W-Beam 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.

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 MASH TL3 crash test matrix requires the following impacts:

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

In addition, RamShield® W-Beam has been crash tested with a Commodore to reflect local driving conditions as follows:

- 1700kg car travelling at 110km/h and 25°.

This impact was performed using standard length posts positioned 200mm (measured from back of post) to a 2H:1V embankment representing a 'worst practical condition' for a roadside barrier impact.

5.0 Design Considerations

5.1 Advance Grading

It is recommended that the area in advance of RamShield® W-Beam be limited to a grading of 10H:1V to ensure that the vehicle's suspension is neither extended nor compressed at the moment of impact with the barrier.

5.2 Clearance to Hazards

The system should be installed with sufficient clearance behind the barrier to allow for the expected deflection of the system.

The MASH TL3 impact condition (2270kg pick-up truck travelling at 100km/h and 25 degrees) has been developed to represent 'worst case impact scenario'.

The MASH TL3 deflection of RamShield W-Beam with posts at 2.0m centres is 1.56m, measured from the face of the w-beam guardrail.

Please consult with Safe Direction for expected barrier deflection at varying vehicle speeds and impact angles.

5.3 Adjacent to Batter Slopes

Space in the road corridor is premium. In an effort to maximise space for other infrastructure and landscaping, the proximity of the guardrail post to the batter hinge point is often reduced without evidence or justification through crash testing.

Best practice ensures that the vehicle remains on the verge, that there is no damage to the batter following an impact and that the embankment provides adequate support to resist the impact loads.

State Road Agency guidelines typically require the distance from the hinge point be sufficient to accommodate the barrier's design deflection and provide adequate lateral support for the system.

Positioning the barrier closer to the hinge point:

- Increases the risk of the barrier failing if its lateral support is insufficient.
- Reduces the ease for the maintenance crews to inspect and reconstruct the barrier.
- Increases the risk that the vehicle will become unstable on the shoulder, or has a more unstable redirection; and
- Increase the possibility that the embankment slope will be damaged on impact and will be more difficult to repair.

However, moving the barrier closer to the road:

- Increases the potential for high-frequency impacts with the barrier.
- Reduces road shoulder width; and
- Increases centreline crowding and risk of head-on collision.

Therefore, on constrained sites, the barrier may be required to be positioned near or at the batter hinge point. At these locations, industry practice has been to install longer posts providing increased embedment depth and improved barrier lateral support.

Safe Direction has undertaken dynamic load impacts of the RamShield® post when installed adjacent to a weak soil embankment, studying the effects of increasing post embedment depth and comparing post yielding behaviour with flat terrain performance.

Please contact Safe Direction for guidance and recommendations for constrained site installations.

5.4 The Shy Line Offset

Drivers tend to reduce speed or laterally move their vehicles away from a road safety barrier if it is within close proximity to the edge of the travelled way.

The distance from the edge of the travelled way beyond which a safety barrier will not be perceived as an immediate hazard by the typical driver is known as the shy line offset. Recommendations for the shy line offset are contained in Table 1.

Table 1: Shy Line Offset

Design Speed (km/h)	Shy Line Offset (m)
50	1.1
60	1.4
70	1.7
80	2.0
90	2.2
100	2.4
110	2.8

Source: Austroads Design Guide 6.4

5.5 Flaring

Motorists are less likely to perceive roadside barriers to be a hazard if the barrier is introduced gradually to the roadside environment through the use of a 'flare'. The flare rate is the ratio of the length of the flared part of the barrier (measured parallel to the road) to the barrier offset.

Flaring the safety barrier system provides the following benefits:

- The end terminals can be positioned further from the travelled path reducing the potential for a head-on impact.
- The shy line effects where a hazard is close to the travelled path is minimised.
- Flaring provides a gradual transition to a major hazard close to the roadway (such as a bridge parapet or railing).

The maximum flare rates that should be used on an approach to a road safety barrier are shown in Table 2. Following the guidelines of Table 2 ensures that the flare does not significantly increase the opportunity for high-angle impacts with the barrier.

Table 2: Flare Rate

Design Speed (km/h)	Flare Rate (within Shy Line Offset)	Flare Rate (outside Shy Line Offset)
50	13:1	7:1
60	16:1	8:1
70	18:1	10:1
80	21:1	11:1
90	24:1	12:1
100	26:1	14:1
110	30:1	15:1

Source: Austroads Design Guide Table 6.5

The flare rate for end terminals may vary from those contained in Table 2. Please refer to specific Product Guides for allowable flare rates for end terminals.

5.6 System Installed Height

RamShield® W-Beam has been crash tested at an installed rail height of between 730mm and 820mm above pavement level.

A rail height of 800mm ± 20mm above pavement level provides compatibility with MASH compliant end terminals, including the MSKT.

5.7 Asphalt Overlay Consideration

When future asphalt overlays are expected the MASH TL3 working range of RamShield® W-Beam becomes an important design consideration.

By initially installing RamShield® W-Beam at a rail height of 820mm and positioning the bolt in the bottom of the post slot, the system can accommodate up to 138mm of asphalt overlay as shown in Figure 1.

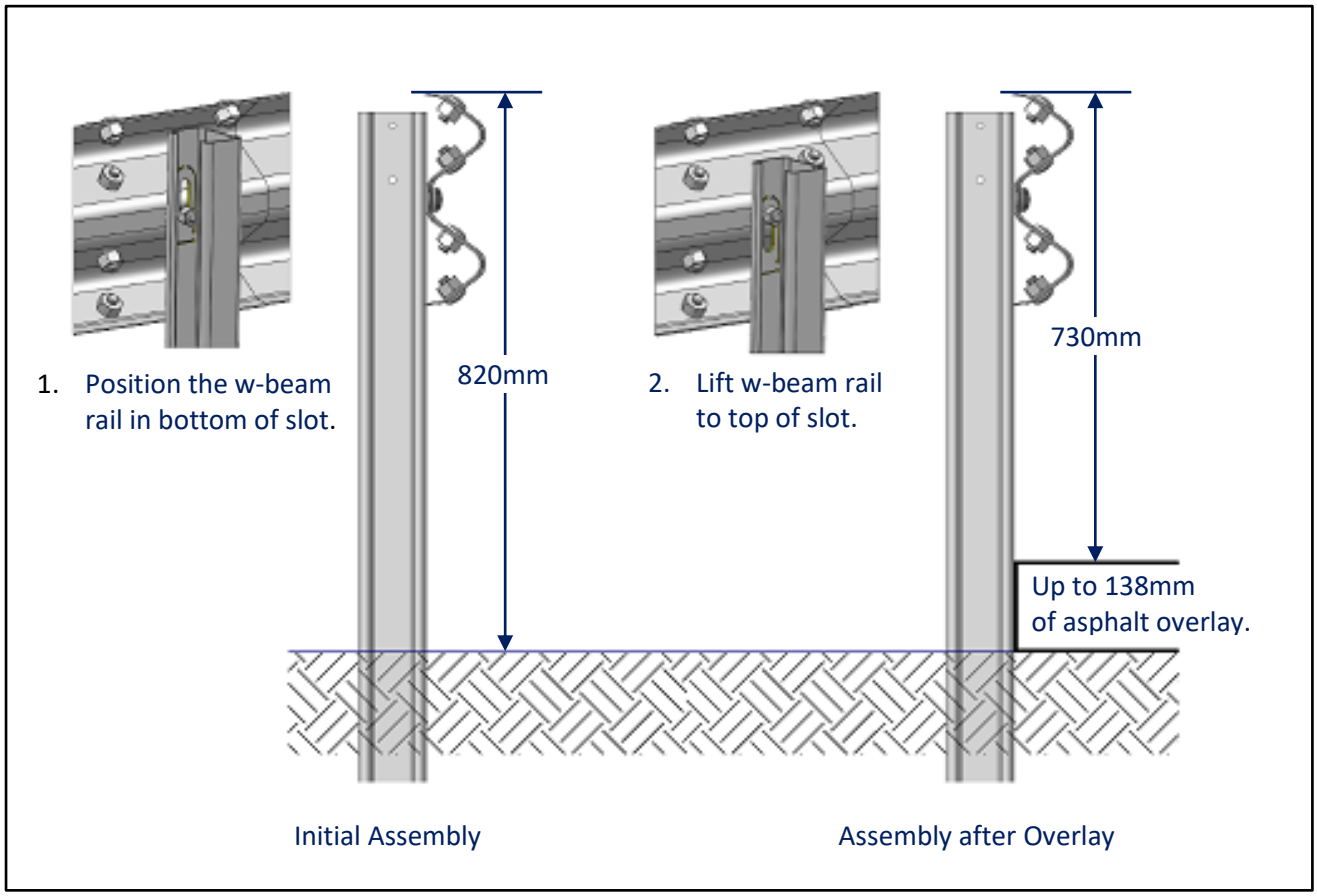

Figure 1: RamShield® W-Beam, Adjustment for Asphalt Overlays.

5.8 Kerbs

Crash testing is typically performed on level terrain. Whilst it is preferable that in-service installations replicate crash test conditions, it is often necessary to provide kerbing to facilitate drainage.

The installation of barriers behind kerbs may affect the vehicle trajectory and safe containment and redirection.

Current guidelines for installation behind kerbs have been developed through bumper trajectory analysis. This analysis may not thoroughly evaluate vehicle and barrier interaction including vehicle stability through the course of the impact and the potential for vehicles to under-ride or over-ride the barrier system.

Safe Direction has performed a series of MASH TL3 simulated impacts with RamShield® W-Beam installed immediately behind a mountable SF kerb. The SF kerb is widely used on the NSW classified road network and is regarded as the steepest of the mountable kerb types used throughout Australia thereby representing 'worst practical condition' to evaluate the potential for vehicle launching.

Two (2) RamShield® W-Beam configurations were evaluated for each vehicle type:

1. Measuring the 800mm height of w-beam rail from road level; and

2. Measuring the 800mm height of w-beam rail from top of kerb.

The results of the 2270kg pick-up truck impacts (MASH 3-11) demonstrated improved vehicle stability during containment and redirection when measuring the 800mm height of w-beam rail from top of kerb.

Therefore, Safe Direction recommends measuring the RamShield® W-Beam system height from top of kerb, regardless of the barrier offset behind the kerb as shown in Figure 2.

This methodology also ensures that the end terminals, which often feature posts with a frangible connection, are correctly installed with the post hinge positioned at the ground line.

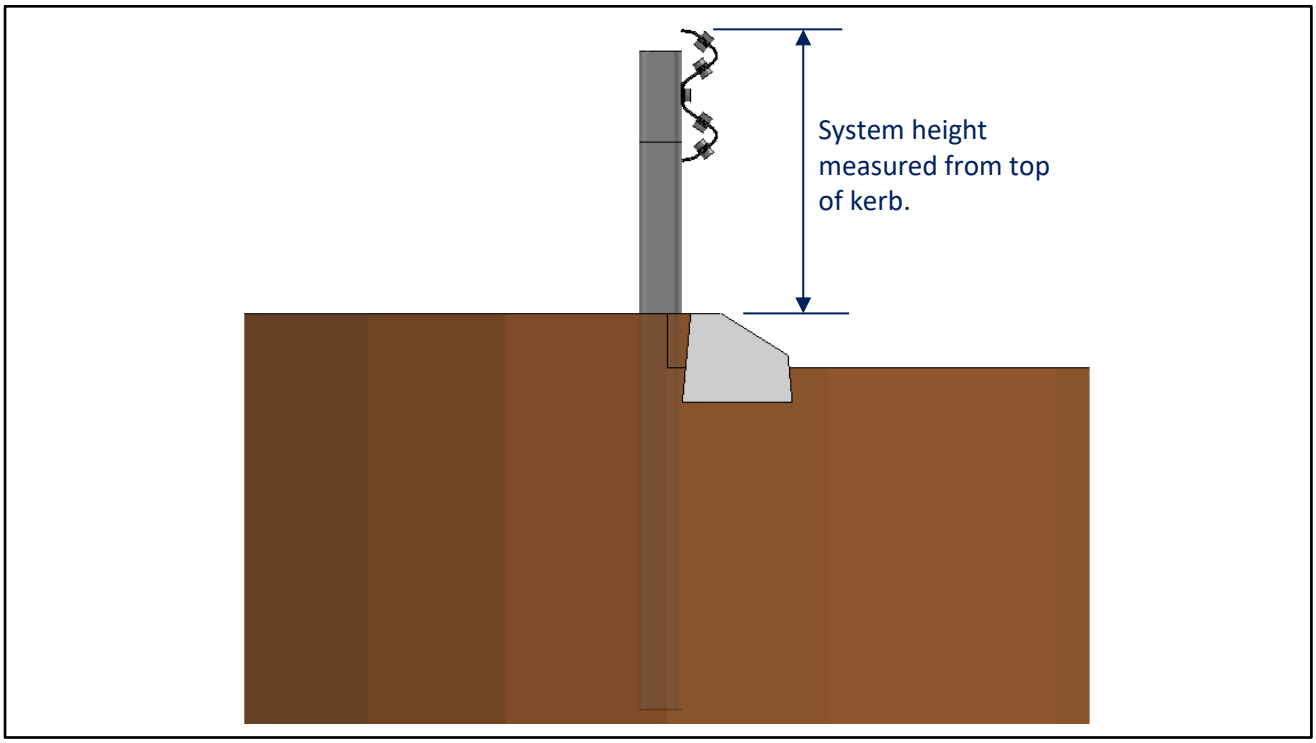

Figure 2: RamShield® W-Beam, Installation Behind a Mountable Kerb.

5.9 Placement in Rock or Deep Asphalt

The performance of RamShield W-Beam® differs from traditional barrier designs. Traditional posts will absorb some crash energy through post rotation in the surrounding soil prior to fully yielding. Setting these posts in deep lift asphalt or rock may compromise the performance of the system.

The patented RamShield® post tab regulates the forces required to release the w-beam rail from the post during a vehicle collision. The RamShield® post will typically yield by bending proximate to ground level.

Restraining the RamShield® post below ground level does not adversely affect the rail release mechanism.

Therefore, acceptable foundation pavement conditions for the installation of the RamShield® post includes the following:

- Narrow holes drilled into rock.
- Deep lift asphaltic concrete.
- Asphaltic concrete over granular pavement.
- Flush seal over granular pavement.
- Unsealed compacted formation.

Please consult with Safe Direction when rock is encountered, and full post embedment depth cannot be achieved.

5.10 6m Span without Posts

Underground services or obstructions may interfere with the regular 2.0m spacing of the RamShield W-Beam posts. In circumstances where the underground service cannot be relocated, or the barrier realigned to avoid the service then there is a need for the barrier to span the service location.

A conventional RamShield® W-Beam installation with posts spaced at 2.0m centres may be installed with up to two (2) posts omitted creating a maximum span of 6.0m between posts. The post spacing either side of the span shall be decreased to 1.0 metre intervals for the last three (3) posts.

Nesting of the w-beam guardrail is not required. This ensures the 6m span can be installed without the requirement for additional components.

Use of the 6m span should be limited to intervals not exceeding 20m for TL3 applications.

Note: Safe Direction w-beam guardrail is pre-punched at 1.0m centres, eliminating the requirement for onsite drilling to accommodate the reduced post spacing either side of the span.

Figure 3: RamShield® W-Beam, 6m Span without Posts.

5.11 Reduced Post Spacing

At constrained sites the available clearance between the barrier and hazard may be limited and insufficient to accommodate the barrier deflection at the standard 2.0m post spacing.

The post spacing of RamShield® W-Beam may be reduced to 1.0m, reducing the MASH TL3 deflection to 1.18m.

It is recommended that the reduction in post spacing commence 10m upstream of the hazard requiring shielding. If the roadway is undivided, the reduction in post spacing should also extend 10m downstream of the hazard.

Note: Safe Direction w-beam guardrail is pre-punched at 1.0m centres, eliminating the requirement for onsite drilling to accommodate the reduced post spacing.

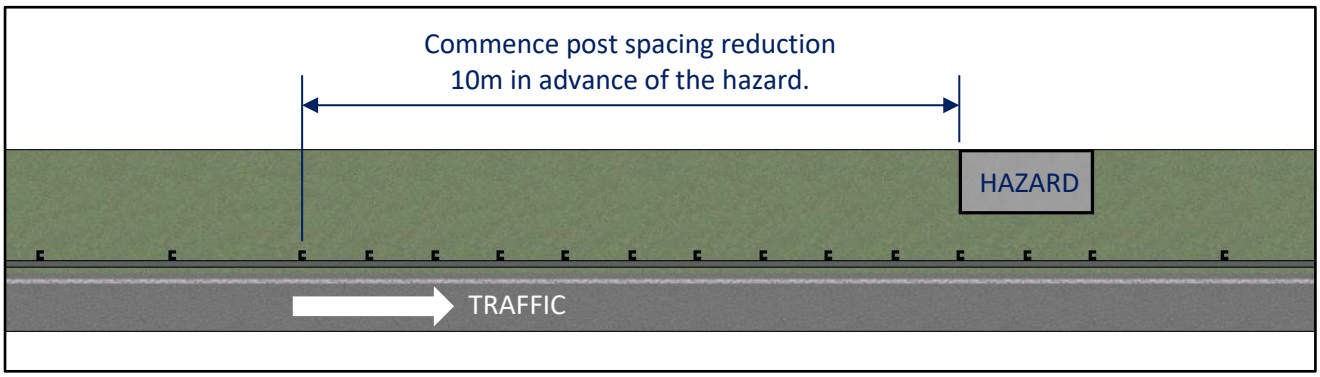

Figure 4: RamShield® W-Beam, Reduced Post Spacing

5.12 End Terminals

End terminals are designed to anchor the w-beam guardrail system and introduce the necessary tensile and flexural strength required for safe vehicle containment and re-direction throughout the length-of-need section.

Some guardrail end terminals also provide the additional feature of reducing the severity of an impact near or at the end of the system.

It is recommended that RamShield® W-Beam be anchored at the leading and trailing end of the installation with MASH compliant end terminals, such as the MSKT.

The MSKT is an energy-absorbing tangential end terminal, designed to minimise the severity of impacts occurring at the end of the safety barrier system.

5.13 The Point-of-Need

RamShield® W-Beam is designed to safely contain and re-direct errant vehicles away from roadside hazards. The point-of-need is the location where the barrier system becomes re-directive.

The point-of-need is typically dependent upon the end terminal selected to anchor the RamShield® W-Beam ® system.

The point-of-need of a MSKT terminal is post location 3, a distance of 3.81m downstream from the start of the terminal.

Figure 5: RamShield® W-Beam, Attachment to MSKT.

5.14 Transitioning to a Rigid Barrier

Wherever it is necessary to change from one type of barrier to another, or to physically join them together (e.g. a bridge barrier to a road barrier), the interface must be designed to ensure that the overall system will perform safely when impacted by a design vehicle.

The RamShield® Transition provides a smooth, snag-free connection between RamShield® W-Beam and rigid barriers, such as at bridge parapets. The RamShield® Transition gradually increases stiffness of the system reducing the potential for vehicle pocketing.

The RamShield® Transition has been fully crash tested and evaluated according to the specifications for MASH Test Level 3 and features thrie-beam guardrail with C-posts at reduced post spacings.

Connection of the RamShield® Transition to RamShield® W-Beam is achieved using an asymmetric transition which increases the rail height from 800mm to 1000mm.

The post spacing of RamShield® W-Beam is reduced to 1.0m centres over a distance of 4m prior to connecting to the asymmetric transition.

5.15 Installation on Curves

W-beam guardrail barriers perform well on the outside of curves, even those of relatively small radius, as the concave shape (in plan view) supports the development of tension in the w-beam rail.

In the field, straight sections of w-beam can be used to form a radius of 45m or greater. When a radius of less than 45m is required, the w-beam rails are required to be factory curved. For ordering purposes, the orientation of curvature (i.e. concave or convex) and the radius is required by the manufacturer.

Refer to Section 13.0 for guidance on measuring curvature.

5.16 Bi-Directional Impacts

Full-scale crash testing has demonstrated that the patented RamShield® post tab controls the release of the w-beam rail during a vehicle collision regardless of post orientation.

This makes RamShield® W-Beam a suitable solution for installations on undivided roadways where reverse direction impacts may occur.

Figure 6: RamShield® Transition, Connection to RamShield® W-Beam

5.17 Minimum Installation Length

The crash tested lengths of RamShield® W-Beam are not meant to reflect minimum installation lengths. It is a requirement under the MASH standard to crash test installation lengths that minimise the influence of the end terminal in providing safe containment and redirection. This is regarded as 'worst case impact scenario'.

MASH compliant end terminals, such as the MSKT are evaluated for re-directional impacts with a 2270kg pick-up travelling at 100km/h and 25 degrees. The MSKT demonstrated safe vehicle containment and redirection within the terminal section. Therefore, a minimum installation for a constrained site may comprise back-to-back guardrail terminals.

It is recommended, where space permits, to install continuous safety barrier rather than designing a barrier to shield a specific hazard. A continuous safety barrier aims to protect the entire roadside and prevent vehicles rolling, impacts with hazards or head-on collisions.

5.18 Connection to RamShield® HC

RamShield® High Containment (HC) is a MASH TL4 compliant barrier featuring thrie-beam guardrail supported by C-posts.

The use of an asymmetric transition is required to transition from thrie-beam to w-beam guardrail. The asymmetric transition panel is 1905mm long (nett laying length) and is available as an approach or departure configuration (viewed from the road centreline).

The asymmetric transition increases the height to top of the rail by 200mm. RamShield® HC posts are installed at each end of the asymmetric transition as shown in Figure 7.

Note: The 1905mm (6'3") nett laying length of the asymmetric transition differs from the standard 2m post spacing of RamShield® W-Beam.

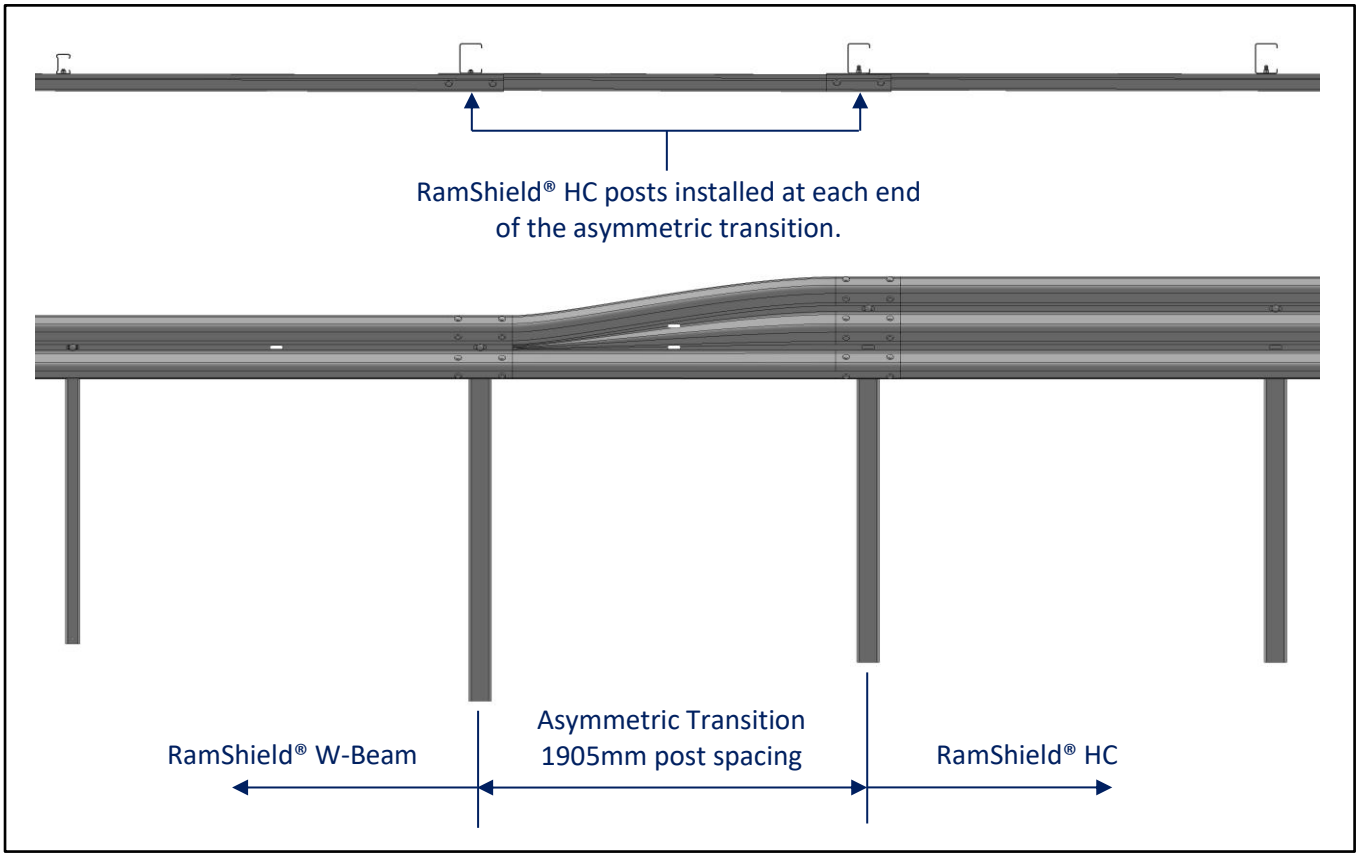

Figure 7: RamShield® W-Beam, Connection to RamShield® High Containment (HC).

5.19 Posts with Baseplates

Underground services and/or structures such as culverts may prevent the RamShield® W-Beam system from being installed with posts driven into the ground. In such circumstances the barrier is required to be installed on a concrete strip footing.

RamShield® W-Beam may be installed using posts on baseplates secured to a concrete strip footing. The post on baseplate design, anchor options and footing dimensions have been evaluated using a combination of pendulum and simulation impacts, analysing barrier and vehicle behaviour.

Simulation impacts have evaluated a minimum size footing, capable of resisting the torsional forces required for the barrier to provide safe vehicle containment and redirection. The footing design was evaluated with no soil behind the footing, relying upon the beam mass to resist movement and overturning forces. This is an important design consideration since onsite soil conditions and distances to the batter hinge point are often variable and unknown.

Impacts were performed with posts positioned at the front and rear of the footing assessing maximum applied overturning moments, shear loads and uplift forces. This assessment provides a working tolerance range for the position of the post on baseplate.

Anchor options for the attachment of the baseplate include:

a) Four (4) M20x187mm galvanised Fischer FBN II anchors. Minimum embedment depth of 145mm with each anchor torqued to 200Nm, or

b) Four (4) M20 galvanised threaded rods, class 8.8. Minimum embedment depth of 170mm with each anchor secured with Fischer SB 390 and torqued to 120Nm.

Table 3: Strip Footing Dimension Options

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

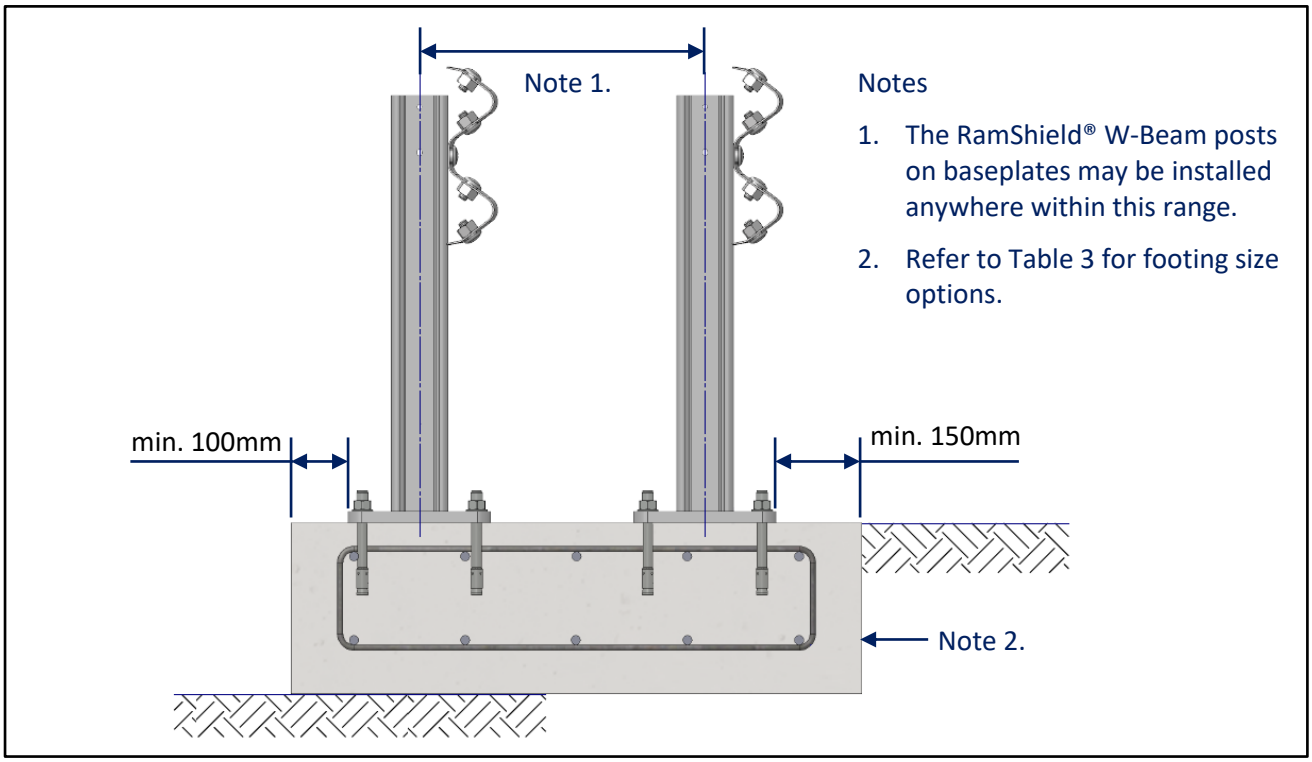

Figure 8: RamShield® W-Beam, Posts on Baseplates.

5.20 BikerShield™ Motorcycle Barrier

BikerShield™ is a motorcyclist safety barrier system designed to reduce the impact severity for riders when colliding with a roadside w-beam guardrail barrier.

BikerShield™ is positioned below the RamShield® W-Beam guardrail panel and prevents a dismounted motorcyclist from contacting the supporting posts of the guardrail barrier.

BikerShield™ provides safe rider containment and redirection through the combination of spring mounting brackets and lightweight, corrugated beams. The spring brackets attach directly to the w-beam guardrail mid-span between posts and absorbs the impact energy of the sliding rider.

The position of BikerShield™ beneath the w-beam guardrail prevents rider contact with the posts and provides forgiving containment and redirection.

The BikerShield™ mounting bracket position is an important design consideration as vertical alignment with the face of the w-beam guardrail reduces the potential for rider snagging.

BikerShield™ has been crash tested and evaluated in accordance with the European Technical Specification EN1317-8. This crash test procedure is nominated in AS/NZS 3845.1:2015 Road safety barrier systems and devices.

In addition, BikerShield™ has been crash tested in accordance with MASH (1100kg passenger vehicle at 100km/h and 25°) when attached to RamShield® W-Beam demonstrating that safe vehicle containment and redirection is unaffected when installed in combination with BikerShield™.

Note: Safe Direction w-beam guardrail is pre-punched at 1.0m centres to accommodate the attachment of the BikerShield™ mounting brackets mid-span between the RamShield® posts.

Figure 9: RamShield® W-Beam with BikerShield™

6.0 Component Identification

RamShield® Post

M16 x 32mm Bolt

M16 Standard Nut

M16 Oversize Nut

W-Beam Guardrail

Delineator

Note: *Safe Direction w-beam guardrail is pre-punched at 1.0m centres to accommodate the attachment of the BikerShield™ and facilitate the installation of reduced post spacing and the 6m span without posts.*

7.0 Tools Required

Tools required for the installation of RamShield® W-Beam are the same as those used for the installation of public domain guardrail. This includes:

- Post driving equipment or auger.
- Air compressor.
- Pneumatic drill driver with 32mm attachment.
- Hand socket with 24mm attachment.
- Metal snips.
- String line.
- Tape measure.
- Hammer.
- 12mm diameter pinch bar.
- Slings or chains.

7.1 Recommended PPE

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

- Safety footwear.
- Gloves.
- Hearing protection.
- High visibility clothing.
- PPE as required for the use of post driving equipment or auger.

8.0 Site Establishment

8.1 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.

8.2 Underground Services

The installation of RamShield® W-Beam requires the supporting posts to be embedded into the ground. Prior to the installation of posts an investigation for potential underground hazards is recommended.

8.3 Overhead Obstructions

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

8.4 Unloading Exclusion Zone

Only appropriate load-rated slings or chains should be used for safe unloading. 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.

9.0 Installation Sequence

The major steps in the installation of RamShield® W-Beam are as follows:

- Set-out.
- Installing the approach terminal.
- Installing the RamShield® posts.
- Attachment of the w-beam guardrail.
- Installing the departure terminal or transition.
- Attachment of delineation (if required).

10.0 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:

- RamShield® W-Beam does not use offset blocks. The width of the system is just 180mm.
- The standard post spacing of RamShield® W-Beam is 2.0m.
- The 2.0m post spacing of RamShield® may differ from the post spacing of the end terminals or transitions.
- The system width of RamShield® W-Beam may differ from the system width of the end terminals and transitions.
- The RamShield® W-Beam posts are not to be installed within the terminal or transition region.

11.0 Post Installation

Potential Hazards: *Use of post driving equipment or 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).*

The posts may be installed by:

- Driving with an appropriate driving head to the required depth, approximately 810mm, or
- Auguring a minimum 200mm diameter hole approximately 810mm deep, placing the post in the hole and backfilling. The backfill material is to be placed in 150mm lifts and compacted with tamping equipment.

Once installed, the top of the post should measure 750mm above ground level.

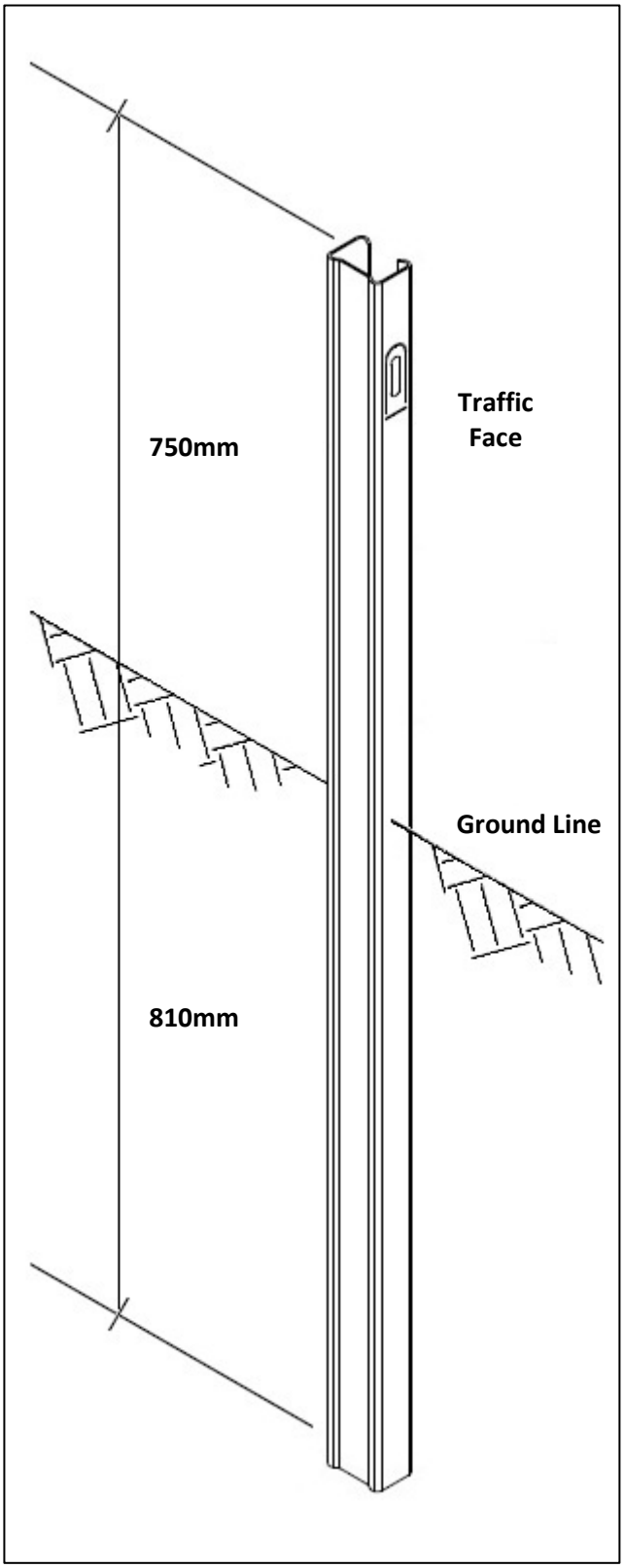

Figure 10: Post Installation.

11.1 Post Orientation

RamShield® W-Beam posts are installed with the release tab positioned on the traffic side of the barrier. The system has been crash tested for bi-directional impacts. When installed on an undivided roadway with 2-way traffic, the posts are orientated as shown in Figure 9.

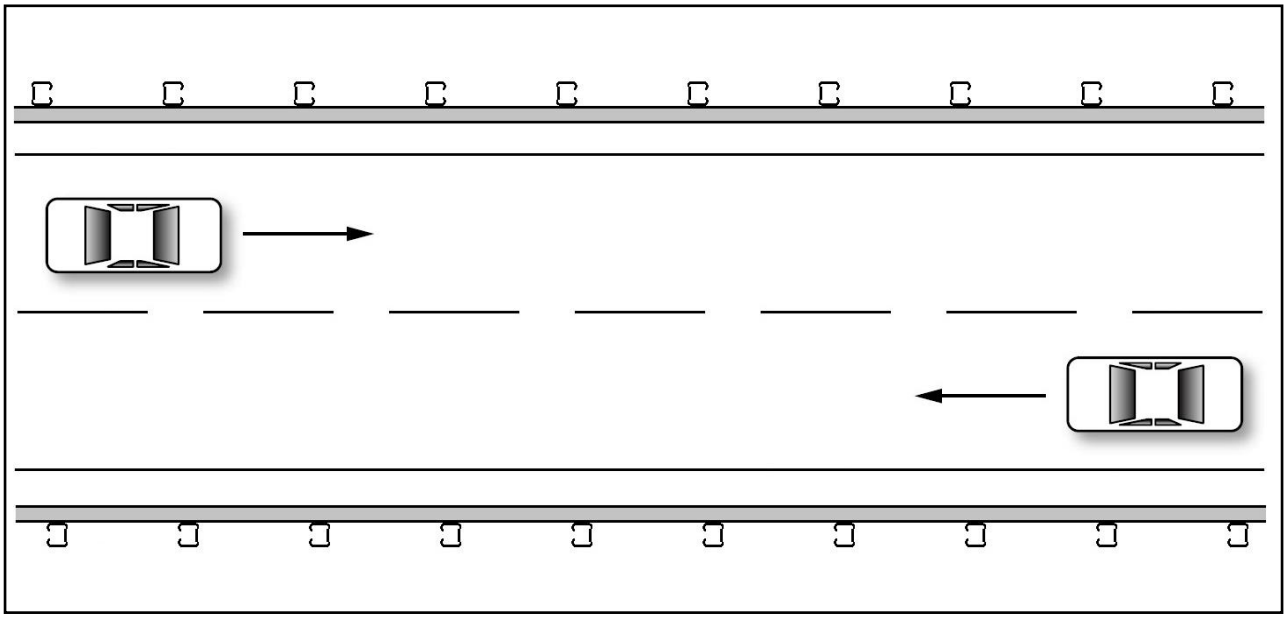

Figure 11: RamShield® W-Beam Post Orientation for 2-Way Traffic.

When the RamShield® W-Beam posts are installed on a divided roadway i.e. 1-way traffic, the posts are orientated as shown in Figure 10.

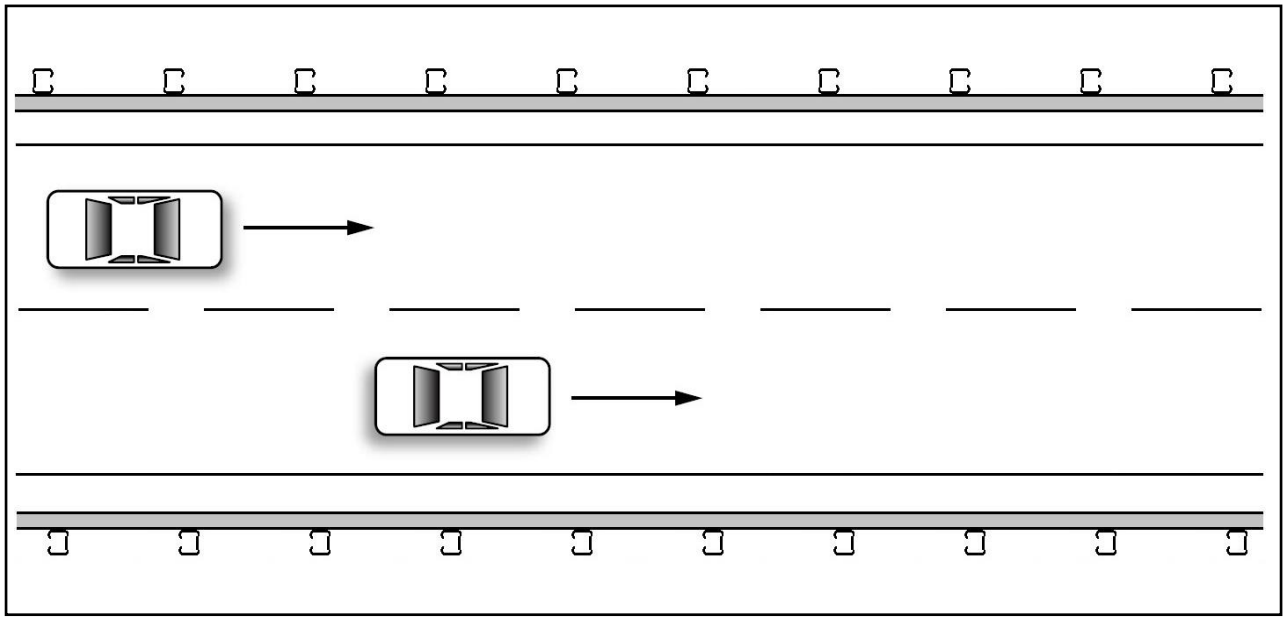

Figure 12: RamShield® W-Beam Post Orientation for 1-Way Traffic

12.0 Attaching the W-Beam Rails

Potential Hazards: *Injury from movements and posture, hand injury from pinch points, strain to wrists from tightening bolts and excessive noise from use of impact driver.*

Recommended Control Measures: *Observe correct techniques when lifting rails (bend at the knees), wear gloves, use a pinch bar to align holes, use an impact drill to tighten bolts and wear appropriate hearing protection.*

The standard 4m w-beam panels may be secured to the RamShield® posts using a M16 x 32mm or 50mm mushroom head bolt with a standard or oversize nut.

Safe Direction recommends the combination of a M16 x 32mm bolt with a standard nut providing maximum clearance within the post for tightening of the bolt.

The standard nut is tightened using a hand socket and 24mm attachment.

The guardrail lap is orientated so that the leading edge of the splice is shielded from the nearside approaching traffic. Rails are spliced together using eight (8) standard M16 x 32mm mushroom head bolts and oversize nuts. The oversize nuts are tightened using a pneumatic drill driver and 32mm attachment.

The use of a pinch bar will assist in aligning the splice holes as the bolts are inserted. The use of a driving pin to elongate the splice holes is NOT permitted.

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

Once secured to the posts, the finishing height of the guardrail will be approximately 50mm above the top of the posts.

Figure 13: Attachment of W-Beam.

13.0 Curving of W-Beam Rails

W-beam guardrail barriers perform well on the outside of curves, even those of relatively small radius, as the concave shape (in plan view) supports the development of tension in the w-beam rail.

In the field, straight sections of w-beam can be used to form a radius of 45m or greater. When a radius of less than 45m is required, the w-beam rails are required to be factory curved.

For ordering purposes, the orientation of curvature and radius is required. Alternately, providing the chord length (C), the height of rise (H) or angle (Ø) will allow Safe Direction to calculate the radius of curvature.

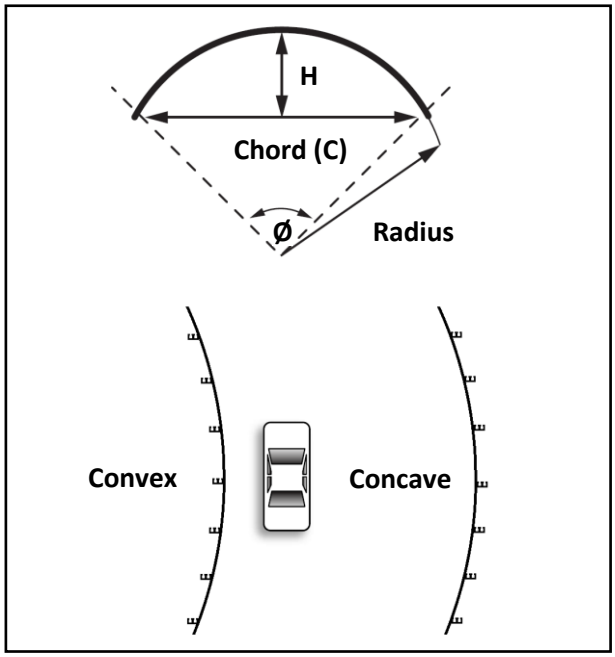

Figure 14: Curving Orientation

14.0 Recommended Installation Tolerances

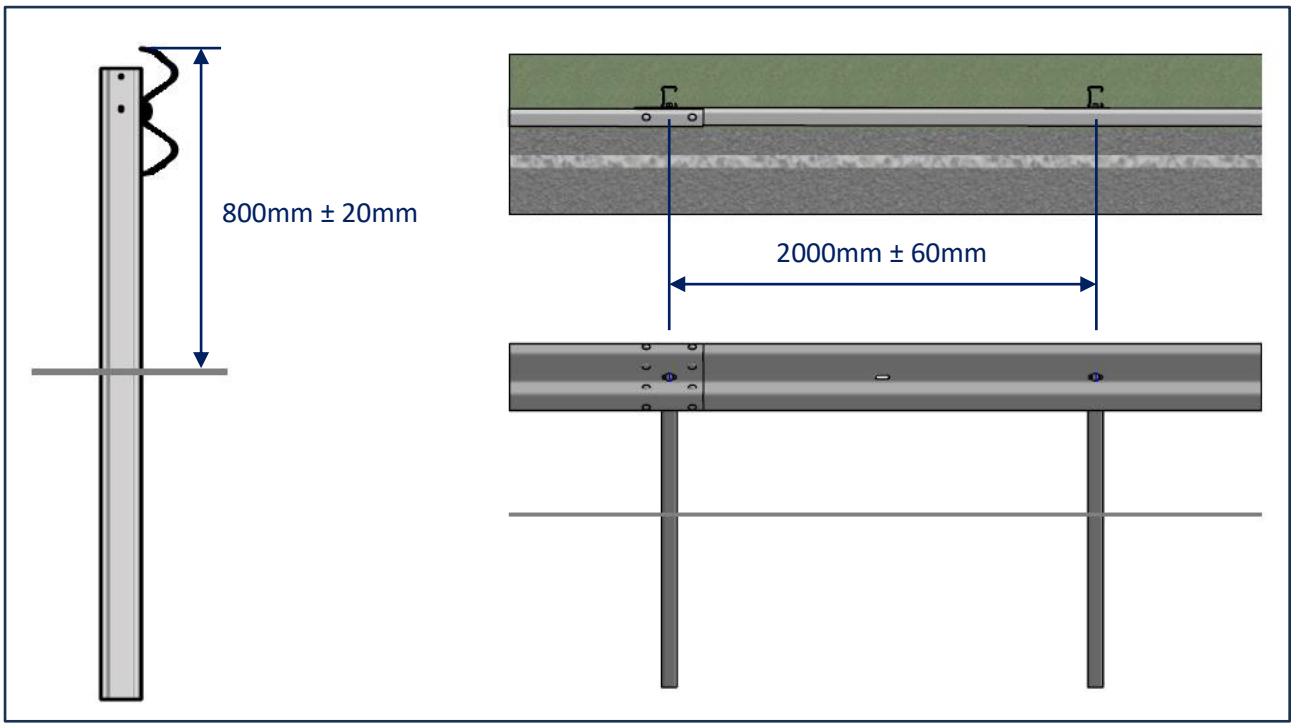

Figure 15: RamShield® W-Beam Recommended Installation Tolerances.

RamShield® W-Beam Inspection Form

Inspection Date	
Client	
Project Reference	
Name of Inspector	
Company	

❑ Yes ❑ No	The system is suitably anchored with approved state road agency end terminals.
❑ Yes ❑ No	The posts are spaced at maximum 2.0m centres.
❑ Yes ❑ No	The height measured to the top of the posts is 750mm ± 20mm.
❑ Yes ❑ No	The posts are correctly orientated with the release tab on the traffic side.
❑ Yes ❑ No	The height measured to the top of the rails is 800mm ± 20mm.
❑ Yes ❑ No	The rail is secured to each post with a M16 x 32mm (or 50mm) mushroom head bolt & standard nut.
❑ Yes ❑ No	The rails are spliced with eight (8) M16 x 32mm mushroom head bolt & oversized nuts.
❑ Yes ❑ No	The rail lap is orientated so that the leading edge of the splice is shielded from approaching traffic.
❑ Yes ❑ No	All bolts are tightened.
❑ Yes ❑ No	The fill material around the posts is suitably compacted.
❑ Yes ❑ No	Any minor damage to the galvanised finish is repaired using two coats of an organic zinc rich paint.
❑ Yes ❑ No	The barrier is appropriately delineated (if required).
❑ Yes ❑ No	The area around the barrier is free of debris.

RamShield® W-Beam has been crash tested in accordance with MASH Test Level 3 at rail heights of between 730mm and 820mm. An installed rail height of 800mm ± 20mm provides compatibility with MASH compliant guardrail end terminals.

Comments/Notes

15.0 Maintenance

RamShield® W-Beam is a low maintenance barrier. Except for repairs due to impacts, it is recommended that an annual inspection be undertaken to assess the following:

- The barrier is appropriately delineated (if required).
- Debris has not accumulated around the barrier which may impede the function of the barrier.
- Vegetation around the barrier is appropriately maintained.
- Nuisance impacts have not gone undetected.
- The anchor assembly at the end terminals is taut and the bearing plate is correctly aligned.

16.0 Repair

In the event of a vehicle impact, damage to the barrier is to be assessed in accordance with Table 4. Typically, impacts with RamShield® W-Beam will require replacement of damaged sections of rails and posts. It is also recommended that new bolts be used where rails and posts have been replaced.

Additional tools required for repair include:

- Acetylene torch to cut away damaged rail.
- Heavy duty chain to remove damaged posts.
- Sledgehammer.
- Post extractor.

Similar to the installation sequence, it is recommended that the guidelines contained in Section 8.0 be observed in the establishment of traffic control and an unloading exclusion zone in addition to investigation for underground services and overhead obstructions.

16.1 Removal of Damaged Posts

Potential Hazards: *Hand injury from pinch points, hand injury from damaged edges and injury from sudden movement as the posts are released.*

Recommended Control Measures: *Wear gloves and maintain an appropriate exclusion zone around the post until removed.*

Damaged posts should be removed using an appropriate post extractor. Once the damaged post is removed, the ground material should be suitably compacted before a replacement post is installed.

16.2 Removal of Damaged Rails

Potential Hazards: *hand injury from pinch points, hand injury from damaged edges, injury from sudden movement as rails are released and excessive noise from use of impact drill.*

Recommended Control Measures: *Wear gloves and wear appropriate hearing protection.*

Using an impact drill, remove the splice bolts at the rail connection. Rails that have twisted or bent during impact may need to be cut into manageable sections using an acetylene torch.

Table 4: Damage Assessment Guidelines

Type of Damage	Description of the Damage	Remedial Action
Damage to the galvanised coating on the posts.	The sum total of the damaged area does not exceed 40cm^2 (0.5% of the total surface area).	An organic zinc rich paint is to be applied to the repair area in two coats.
	The sum total of the damaged area exceeds 40cm^2 (0.5% of the total surface area).	The post is to be replaced.
Damage to the galvanised coating on the 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 exceeds 40cm^2.	An organic zinc rich paint is to be applied to the repair area in two coats.
	The sum total of the damaged area exceeds 200cm^2 (0.5% of the total surface area) or an individual damaged area exceeds 40cm^2.	The rail is to be replaced.
Damage to the posts.	The post is bent.	The post is to be replaced.
Damage to the post tab.	The post tab has pulled forward by breaking the top connection and/or there is tearing evident in either of the two bottom connections.	The post is to be replaced.
	The post tab has become detached from the post.	
Damage to the rails.	The rail is dented, twisted or flattened.	The rail is to be replaced.
	There are nicks in any part of the rail.	
	The slots in the rail are distorted.	
Damage to bolts.	The body of the bolt is distorted.	The bolt is to be replaced.
	The thread of the bolt is damaged.	
Disturbance of material around the posts.	The material around a post is loose.	The material is to be suitably compacted.

SafeDirection

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