RamShield®

MASH TL3 W-Beam Guardrail



SafeDirection
CRASH BARRIER SOLUTIONS

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Version	Date	Revisions
08	February 2026	Updated format, inclusion of Material Traceability & Design Life.

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 730 mm and 820 mm

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 2 m post spacing

Fast Assembly

Fewer parts

Simple rail to post bolt alignment

Stiff driving post

Narrow Geometry

Just 180 mm 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

Crash Test Compliance	MASH Test Level 3
MASH TL3 Dynamic Deflection	1.56 m
MASH TL3 Working Width	1.63 m
System Width	180 mm
System Height	800 mm, measured to top of w-beam *
System Mass	19 kg per metre
Standard Post Length	1560 mm
Standard Post Embedment Depth	810 mm
Standard Post Spacing	2.0 m centres
Post Mass	14.1 kg
System Finish	Hot dip galvanised in accordance with AS/NZS 4680

* RamShield® W-Beam has been crash tested in accordance with MASH Test Level 3 (TL3) at w-beam rail heights of between 730 mm and 820 mm above ground. An installed w-beam height of 800 mm ± 20 mm 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 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 introduction of MASH follows changes to the vehicle fleet, researching of real-life impact conditions and updated criteria for evaluating barrier performance.

RamShield® W-Beam has been assessed as a longitudinal barrier, designed to contain, redirect, and shield vehicles from roadside obstacles. The MASH TL3 crash test matrix for a longitudinal barrier requires the following impacts:

- 2270 kg pick-up travelling at 100 km/h and 25 degrees (156.4 kJ).
- 1100 kg passenger car travelling at 100 km/h and 25 degrees (75.8 kJ).

Impacts performed with the pick-up truck (2270P) evaluates barrier strength and the potential for the vehicle to override the crash barrier system or rollover during redirection.

Impacts performed with the passenger car (1100C) investigates the potential for the vehicle to underride the crash barrier system and wheel snag. This impact also assesses occupant risk, including impact velocities and head-slap.

An elective impact has also been performed with a 1700 kg passenger car travelling at 110 km/h and 25 degrees (141.7 kJ) to reflect Australian driving conditions.

This elective impact was performed using standard length RamShield® W-Beam posts positioned 200 mm (measured from back of post) to a 2H:1V embankment representing a ‘worst practical condition’ for a roadside barrier impact.



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 material used in the production of RamShield® W-Beam posts and guardrail to AS/NZS 1594.

Mill certificates and independent third-party laboratory test results are verified against Australian Standard guidelines recording the steel heat numbers, mechanical results and chemical composition. Safe Direction product is then stamped during manufacture with a 4-digit number providing industry-leading traceability to the steel heat number. The format for stamping w-beam guardrails is:

Example: SD 9419 350 27

Where: SD = product from Safe Direction
9419 = the last 4 digits of the heat no.
350 = steel grade (i.e. HA 350)
27 = base metal thickness (i.e 2.7 mm



TEST CERTIFICATE BLUESCOPE STEEL

CHEMICAL ANALYSIS

Percentage of element by mass (L=Cast, P=Product, -S=Soluble, -T=Total, CF=Chemical Formula, n=Min, x=Max)

Item No	Heat / Unit No	NATA Lab	L/P	C	P	Mn	Si	S	Ni	Cr	Mo	Cu	Al-T
0010	6709419	0632	L	.157	.019	.74	<.005	.015	.016	.035	.004	.042	.034

Item No	Heat / Unit No	NATA Lab	L/P	Ti	B-T	N	Nb	Sn	V	CF1	CF2	CF3
0010	6709419	0632	L	<.002	<.0003	.0045	.001	.002	<.003	.29	.10	.00

CF1=C+ (MN/6) + ((CR+MO+V)/5) + ((CU+NI)/15) CF2=NI + CR + CU + MO CF3=NB + TI + V

MECHANICAL TESTING

Tensile AS 1391

Item No	Heat No	Tested Unit	NATA Lab	Cat	Loc	THICK mm	ReH MPa	Rm MPa	Lo mm	ELONGN %
0010	6709419	1H1F9690	0631	B	LQF	2.70	420	520	80	25
0010	6709419	1H1F9845	0631	B	LQF	2.70	390	500	80	22

ITEMS COVERED BY THIS CERTIFICATE

Item No	Heat No	Ordered Dimensions (mm)	No of Units	Mass (Tonnes)	Unit Identities
0010	6709419	740.0X2.70XCOIL	6	24.030	1H1H9291AA 1H1H9291BA 1H1H9291CA 1H1H9291DA 1H1H9292AA 1H1H9292CA

6.0 Design Considerations

6.1 Offset from the Traffic Lane

Road safety barriers should be located (e.g. offset, lateral position) as far as possible from the edge of the traffic lane as site conditions permit but within the limits described below. This enables errant drivers to recover and regain control of the vehicle, minimising the frequency of barrier impacts. Wider offsets can reduce nuisance impacts on the barrier and enable disabled vehicles to be free of the traffic lanes on a high-speed road, therefore reducing the risk of secondary crashes.

Providing a consistent barrier offset is especially important for long lengths of continuous barrier. Consistent barrier design creates a uniform view, while frequent changes in barrier offset can mislead drivers and negatively impact decisions while driving, especially in adverse visibility conditions.

The offset is measured from the edge of the traffic lane to the face of the w beam barrier.

The offset needs to ensure that the available stopping sight distance and intersection sight distance are not impeded. Increased offsets allow vehicles to stand clear of the adjacent traffic lane after an impact if the vehicle is disabled and for maintenance activities. The practicality and costs of maintenance of a barrier and the areas on both sides of the barrier should be considered along with Occupational Health & Safety implications.

The recommended offsets to barriers are detailed in Table 1. It is recommended that barriers must not be closer than 0.5 m from traffic lanes on rural roads to minimise nuisance hits. Similarly, the minimum offset on urban roads is 0.3 m.

Table 1: Recommended Offset Distances. Source: Table 6.5 Austroads Guide to Road Design Part 6.

	Rural High Speed [1, 3]	Rural Low Speed	Urban Freeways [3]	Urban Roads [2]
Desirable	4.0 – 6.0 m	3.0 – 6.0 m	4.0 – 6.0 m	2.5 – 3.0 m
Minimum	3.0 m	2.5 m	3.0 m	1.0 m

Notes:

1. *Operating speed greater than or equal to 80 km/h.*
2. *The offset may be governed by the required offset to kerbs.*
3. *Adoption of widths less than 3 m shall include assessment of desired operating practices, including emergency response, maintenance and police enforcement.*

6.2 Flaring

Generally, there should be uniform clearance between traffic and roadside features, particularly in urban areas where there are many roadside features. Uniform alignment enhances road safety by providing the driver with a certain level of expectation, thus reducing driver concern for and reaction to the roadside features and barriers.

6.3 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.

6.4 Clearance to Hazards

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

Dynamic deflection is the maximum lateral displacement of the barrier during a vehicle impact. When a vehicle strikes a barrier, the dynamic deflection varies according to the characteristics of the impacting vehicle, including vehicle mass, impact speed, angle of impact and the characteristics of the barrier system.

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

Please consult with Safe Direction for calculated RamShield® W-Beam deflections at varying vehicle speeds and impact angles.

6.5 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, at 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® W-Beam 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.

6.6 Minimum Installation Length

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 head-on collisions.

At constrained sites where continuous barrier is not achievable, a shorter length barrier may be installed. In these circumstances it is recommended that the guidelines of *Austroads Safety Barrier Assessment Panel – Technical Advice SBTA 21-002* be referenced.



6.7 Placement in Rock or Asphaltic Concrete

The rail release mechanism and 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® tab regulates the forces required to release the w-beam rail during a vehicle collision. The RamShield® W-Beam posts will typically yield by bending proximate to ground level. Restraining the RamShield® W-Beam posts below ground level does not adversely affect the rail release mechanism.

Therefore, acceptable foundation pavement conditions for the installation of the RamShield® W-Beam posts 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.



6.8 System Installed Height

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

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

6.9 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 820 mm and positioning the bolt in the bottom of the post slot, the system can accommodate up to 138 mm of asphalt overlay as shown in Figure 1.

The lifting of the w-beam guardrail within the post slot leaves the RamShield® post undisturbed.

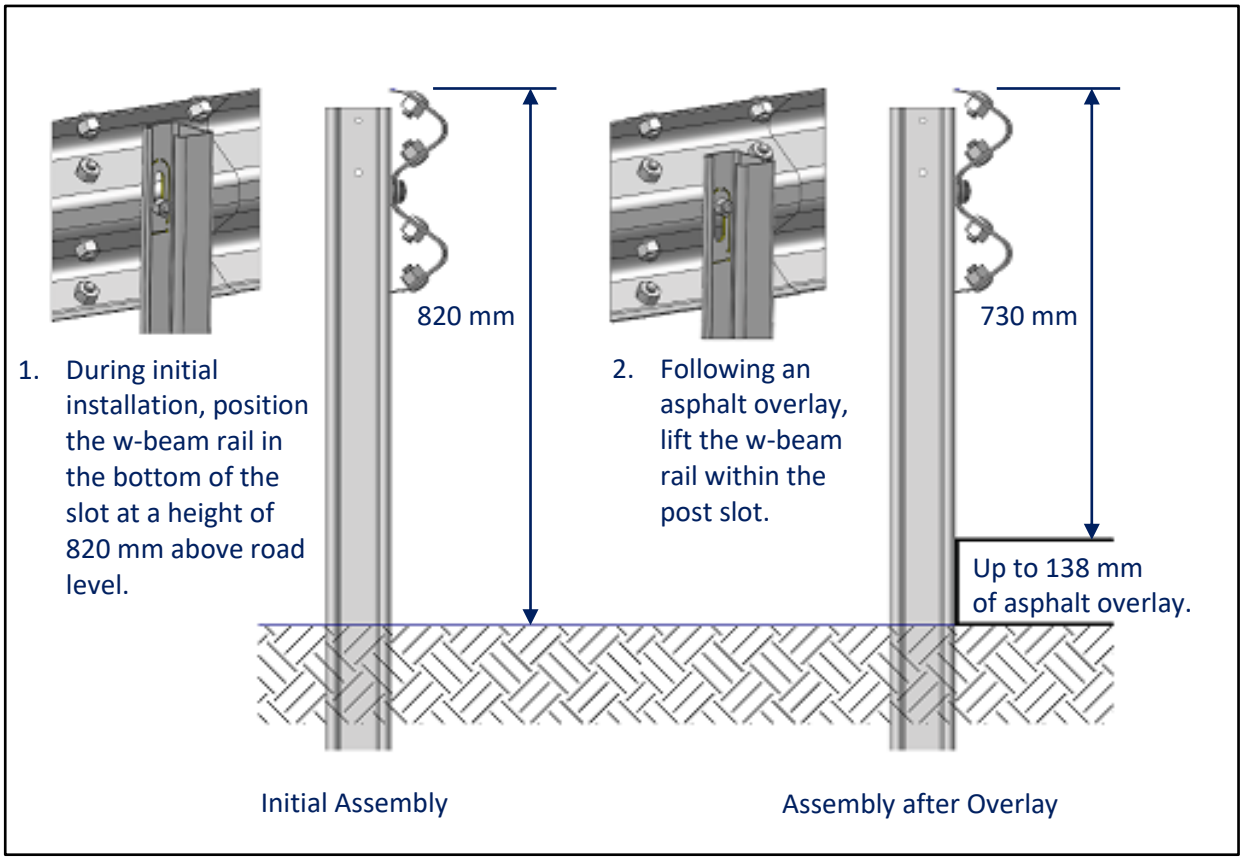


Figure 1: RamShield® W-Beam, Adjustment for Asphalt Overlays.

6.10 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 the 1100C and 2270P vehicles in accordance with MASH TL3:

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

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

The results of the 2270P impacts at 100 km/h and 25 degrees demonstrated improved vehicle stability during containment and redirection when measuring the 800 mm 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.

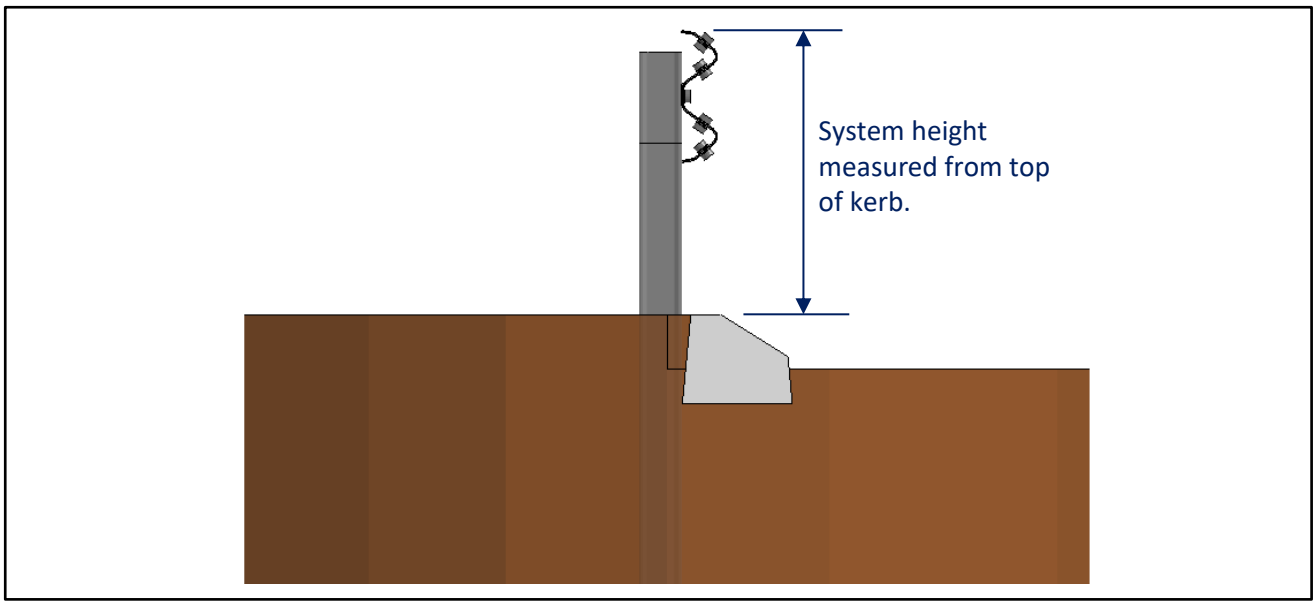


Figure 2: RamShield® W-Beam, Recommended Procedure for Installation Behind a Mountable Kerb.

6.11 6 m Span without Posts

Underground services or obstructions may interfere with the regular 2.0 m 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 2.0 m centres may be installed with up to two (2) posts omitted creating a maximum span of 6.0 m between posts. The post spacing either side of the span shall be decreased to 1.0 m intervals for the last three (3) posts.

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

Use of the 6 m span should be limited to intervals not exceeding 20 m for TL3 applications and sufficient clearance behind the 6 m span should be provided as per the upstream and downstream barrier configuration.

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



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

6.12 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 2.0 m post spacing.

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

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

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

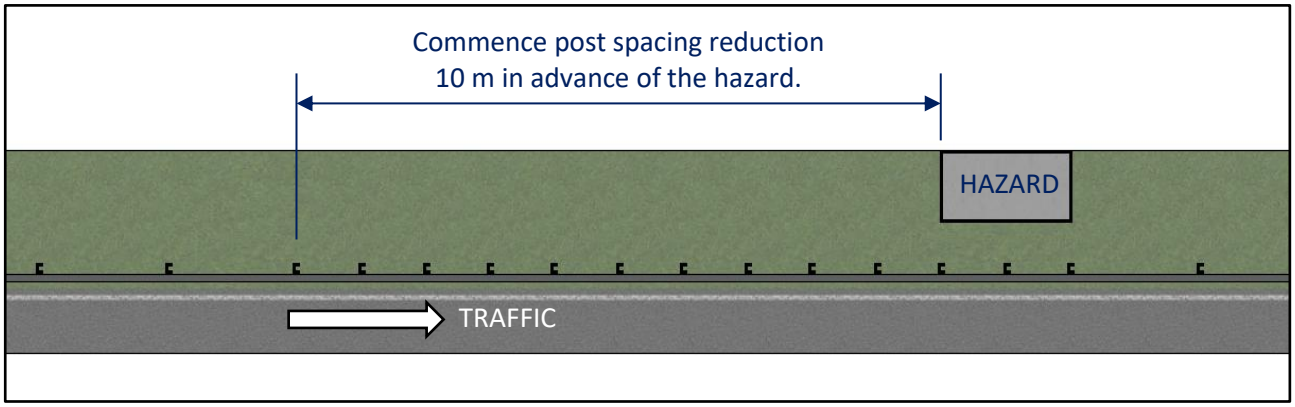


Figure 4: RamShield® W-Beam, Reduced Post Spacing.



6.13 Installation on Curves

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

There are no limitations regarding crest or sag vertical curves for the assembly of w-beam guardrail. Designers should refer to state road agency specifications for vertical alignment design guidelines. The minimum radius for crest vertical curvature is usually governed by sight distance requirements. Sag curves are generally designed as large as economically possible using the comfort criterion as a minimum.

6.14 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 or MAX-Tension.

6.15 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.

For example, the point-of-need of the MASH TL3 MSKT terminal is post location 3, a distance of 3.81 m downstream from the start of the terminal.



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

6.16 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.

6.17 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 800 mm to 1000 mm.

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



Figure 6: RamShield® Transition.

6.18 Connection to RamShield® High Containment

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 1905 mm 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 200 mm. RamShield® HC posts are installed at each end of the asymmetric transition as shown in Figure 7.

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

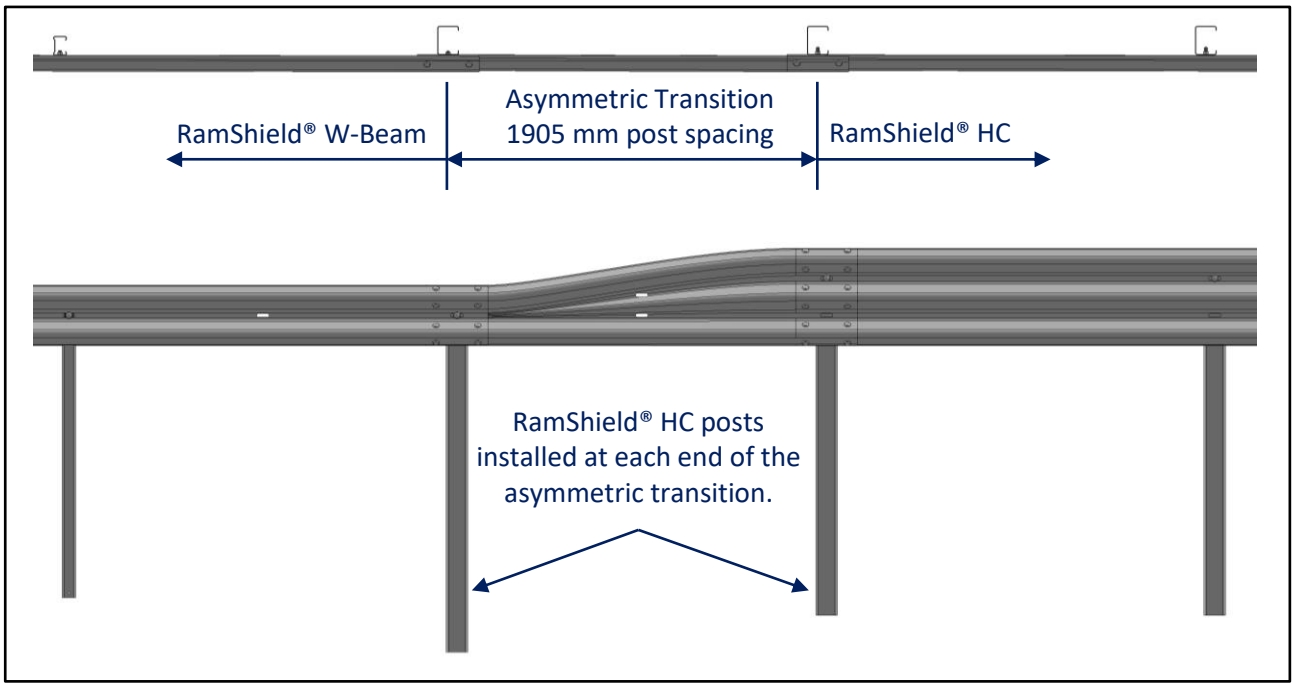


Figure 7: RamShield® W-Beam, Connection to RamShield® High Containment (HC).



6.19 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) M20 x 187 mm galvanised Fischer FBN II anchors. Minimum embedment depth of 125 mm with each anchor torqued to 200 Nm, or

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

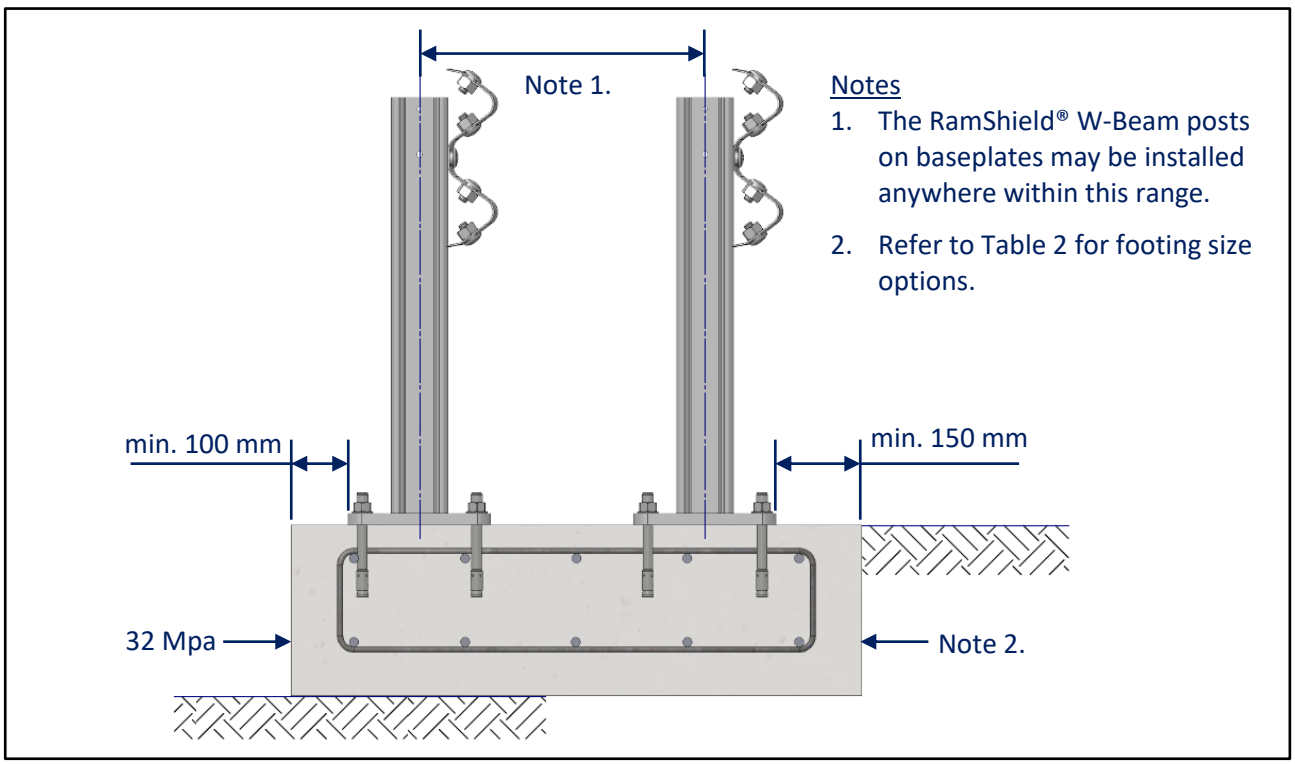


Figure 8: RamShield® W-Beam with Posts on Baseplates.

Table 2: RamShield® W-Beam with Posts on Baseplates, Strip Footing Sizing Options.

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



6.20 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.

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 absorb 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 3-10 (1100 kg passenger vehicle at 100 km/h and 25 degrees) 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 1.0 m centres to accommodate the attachment of the BikerShield™ mounting brackets mid-span between the RamShield® posts.



Figure 9: RamShield® W-Beam with BikerShield™.

6.21 Design Life

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. These estimates are based on average environmental conditions, and the actual lifespan of a galvanized coating will depend on the specific conditions it is exposed to.

Example: The RamShield® W-Beam post has a thickness of 4.5 mm. Hot dip galvanising will provide a minimum average coating thickness of 70 µm. When installed in a C3 environment, the coating will provide approximately 33 years until first maintenance.

Table 3: Coating Thicknesses, AS/NZS 4680.

Article Thickness, mm	Average Coating Thickness, µm	Average Coating Mass, g/m²
≤ 1.5	45	320
> 1.5 ≤ 3	55	390
> 3 ≤ 6	70	500
> 6	80	600

Table 4: Corrosivity Classifications, AS 4312.

Corrosivity Category	
CX	Severe Surf Shoreline
C5	Surf Seashore
C4	Calm Seashore
C3	Coastal
C2	Arid/Urban Inland
C1	Dry Indoors

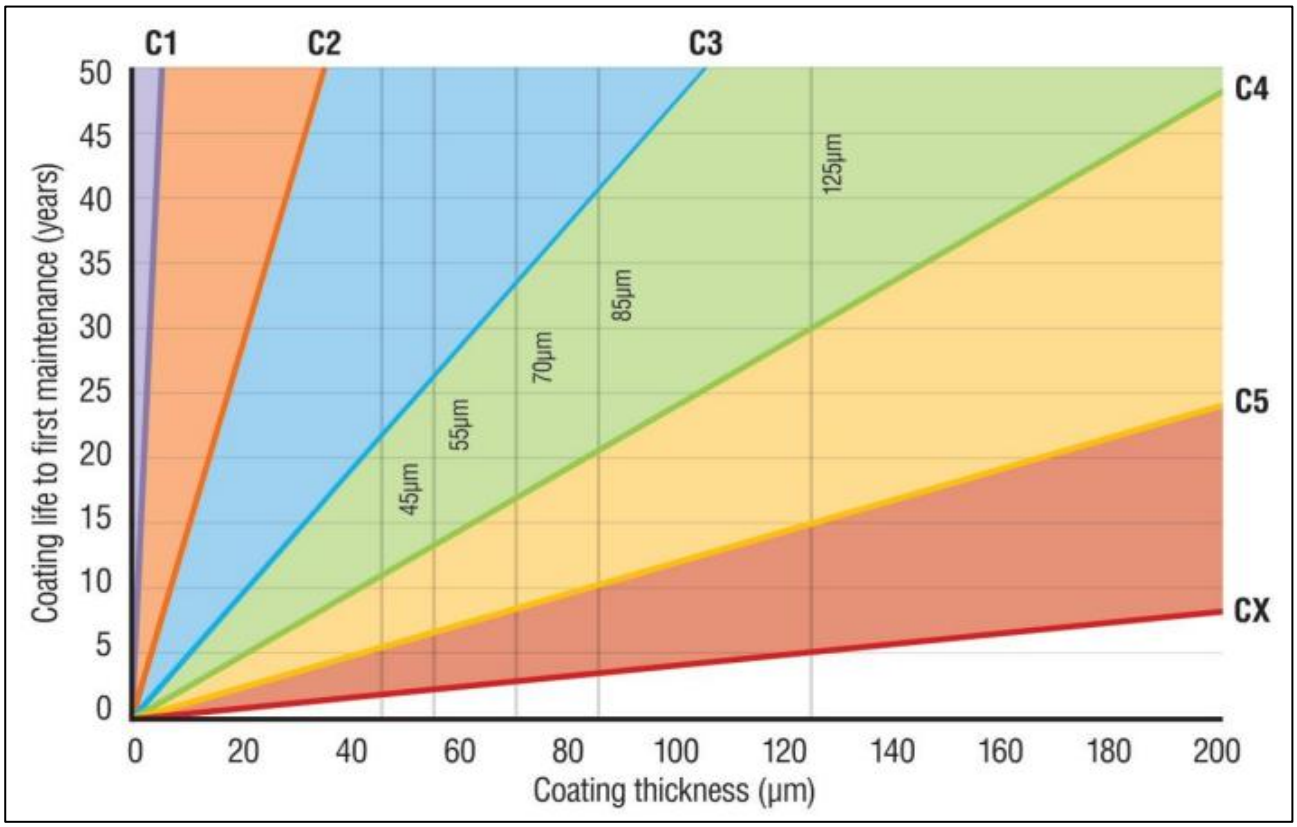


Figure 10: Calculated Corrosivity Rates for Hot Dip Galvanised Coatings, AS/NZS 2312.2.

7.0 Computer Simulation Analysis

Computer simulation analysis, also known as finite element analysis, has become an important tool in the development and assessment of crash barrier systems. Recent advances in computer hardware and finite element methodologies have given developers of crash barriers the ability to investigate complex dynamic problems involving vehicular impacts into safety barrier systems. Finite element analysis has been used extensively to evaluate both vehicle components and the crashworthiness of safety barriers and hardware.

Most computer simulation models use the LS-DYNA finite element code. LS-DYNA is a general-purpose, explicit finite element code and is widely used to solve nonlinear, dynamic response of three-dimensional problems and is capable of capturing complex interactions and dynamic load-time history responses that occur when a vehicle impacts a barrier system.

The MASH TL3 full-scale crash test results of RamShield® W-Beam have been numerically validated and verified in accordance with NCHRP Report 179 as required by the Austroads Safety Barrier Assessment Panel (ASBAP).

The RamShield® W-Beam simulation model has been used by safe Direction to evaluate incremental improvements including:

- Dynamic deflections and working widths at various impact speeds and impact angles.
- Omission of posts due to an underground service which cannot be relocated, or the barrier realigned to avoid the service.
- The behaviour of the concrete beam when supporting posts with baseplates.
- Reduced post spacing.

Computer simulation analysis is not used to substitute compliance crash testing, however it has become a useful tool to assist designers and understand the impact performance of non-standard installation configurations.

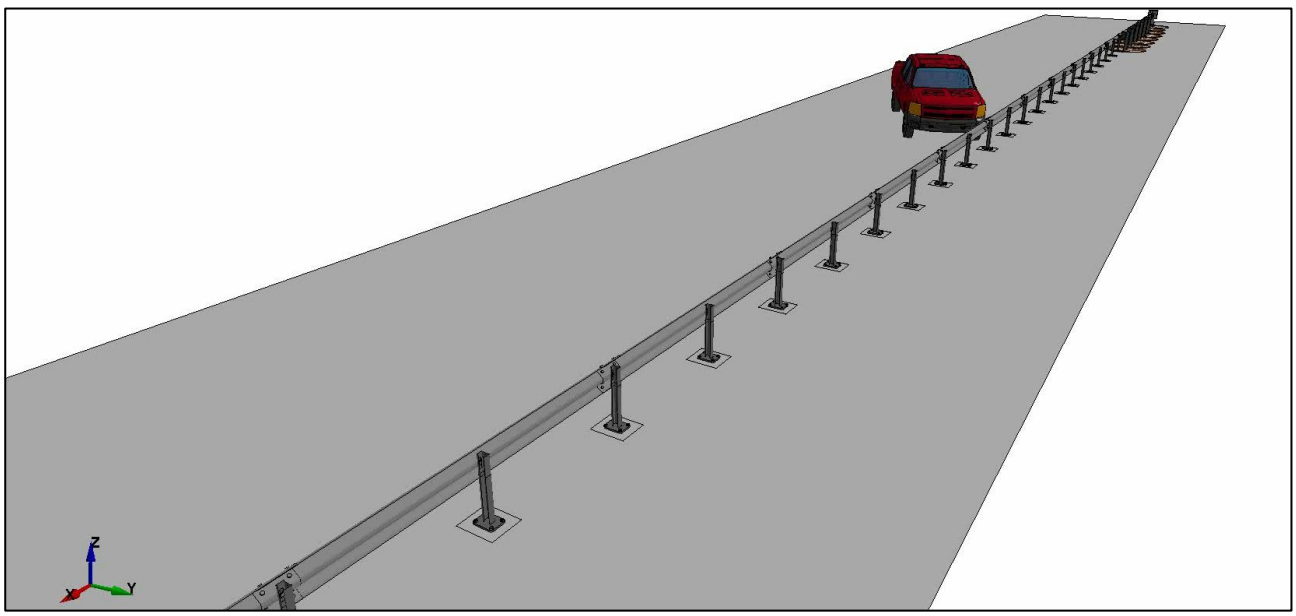
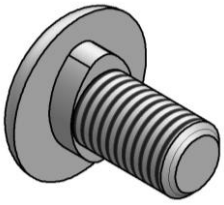


Figure 11: RamShield® W-Beam Simulation Analysis.

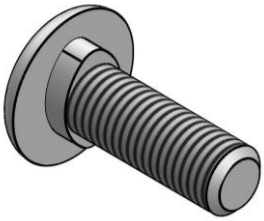
8.0 Component Identification (not to scale)



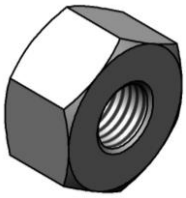
RamShield® W-Beam Post
15 kg



M16 x 32 mm
Mushroom Head Bolt



M16 x 50 mm
Mushroom Head Bolt

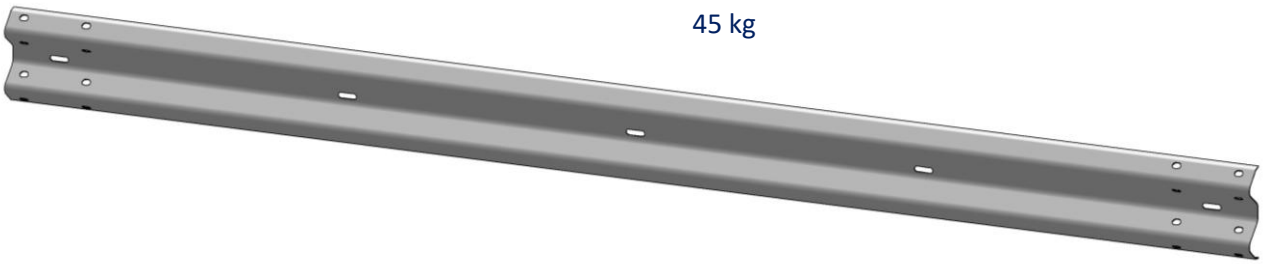


M16 Oversize Nut



M16 Standard Nut

4 m W-Beam Guardrail
45 kg



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

9.0 Tools Required

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

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

9.1 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.



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 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.

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 RamShield® W-Beam are as follows:

- Set-out.
- Installing the leading terminal.
- Installing the RamShield® W-Beam posts.
- Attachment of the w-beam guardrail.
- Installing the departure terminal.

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:

RamShield® W-Beam does not use offset blocks. The width of the system is just 180 mm.

The standard post spacing of RamShield® W-Beam is 2.0 m.

The 2.0 m 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.



11.2 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 C-posts may be installed by:

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

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

When a lateral force of 1 kN is applied in any direction within the top 200 mm of an installed post but before the rail is secured, the movement of the post at ground level must be not more than 1 mm.



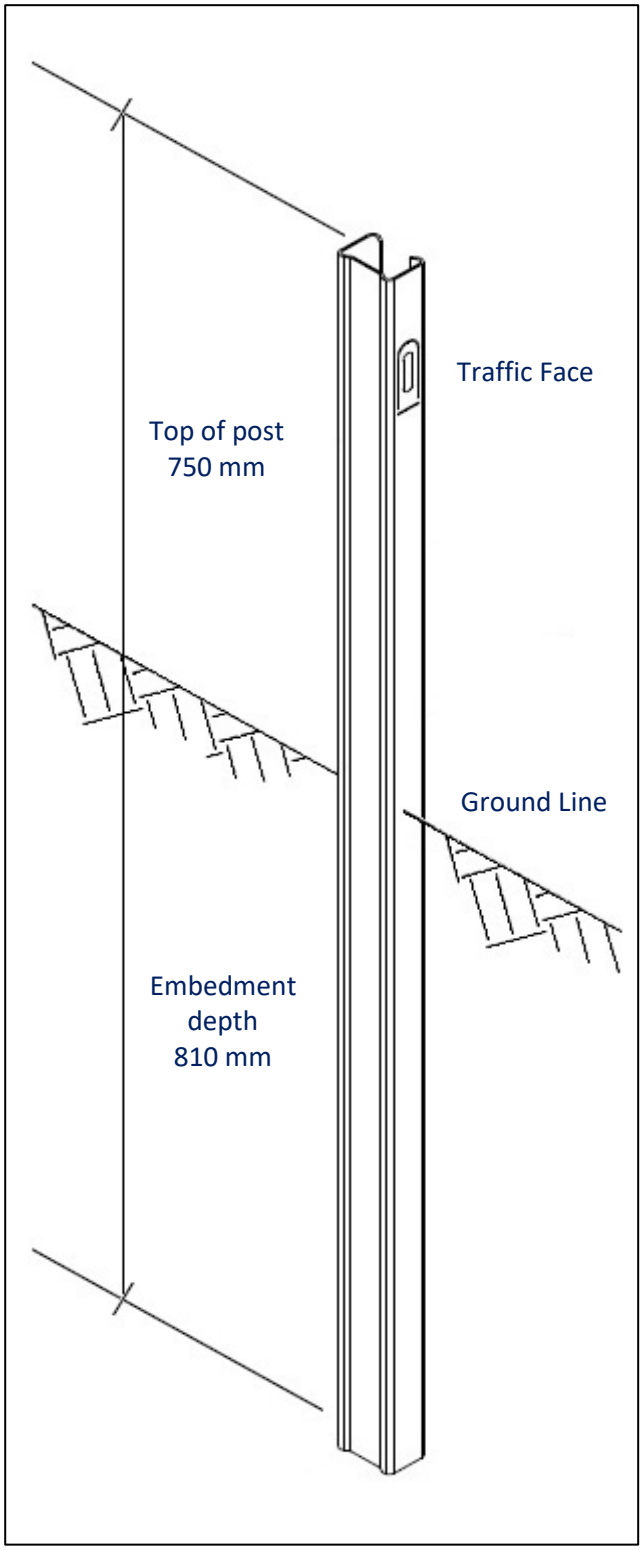


Figure 12: RamShield® W-Beam Post Installation.

11.3 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 13.

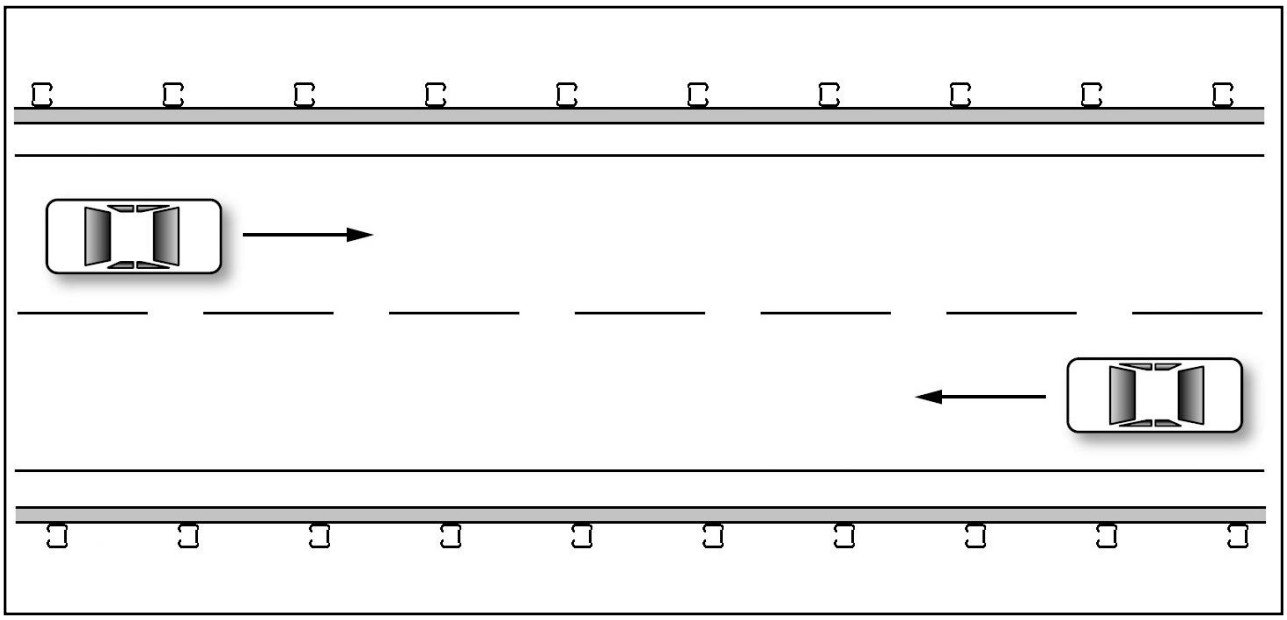


Figure 13: RamShield® W-Beam Post Orientation for 2-Way Traffic.

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 14.

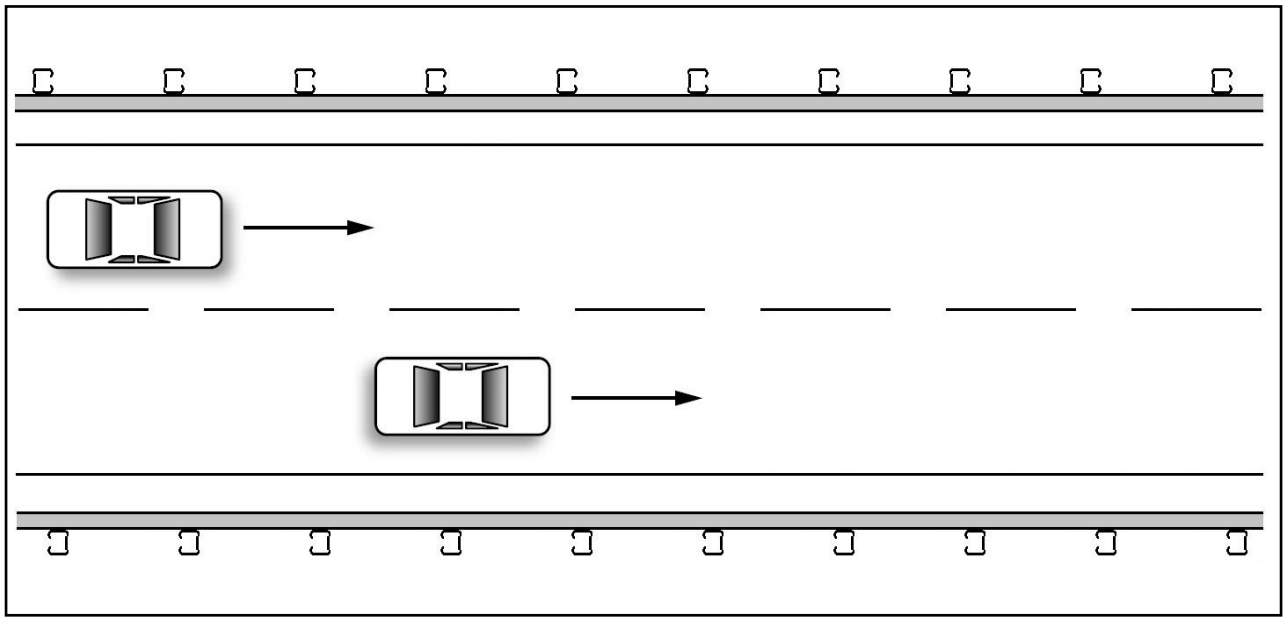


Figure 14: RamShield® W-Beam Post Orientation for 1-Way Traffic.

11.4 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 4 m w-beam panels may be secured to the RamShield® posts using a M1 6 x 32 mm or 50 mm mushroom head bolt with a standard or oversize nut.

Safe Direction recommends the combination of a M16 x 32 mm 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 24 mm 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 32 mm mushroom head bolts and oversize nuts. The oversize nuts are tightened using a pneumatic drill driver and 32 mm 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 50 mm above the top of the posts.



Figure 15: Attachment of the W-Beam Guardrail to the RamShield® Post.

12.0 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 45 m or greater. When a radius of less than 45 m 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.

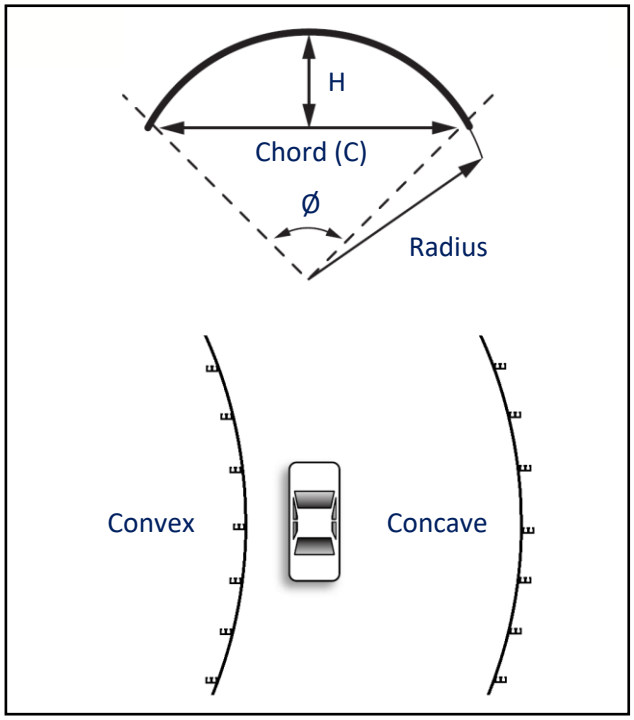


Figure 16: W-Beam Curving Orientation.



13.0 Recommended Installation Tolerances

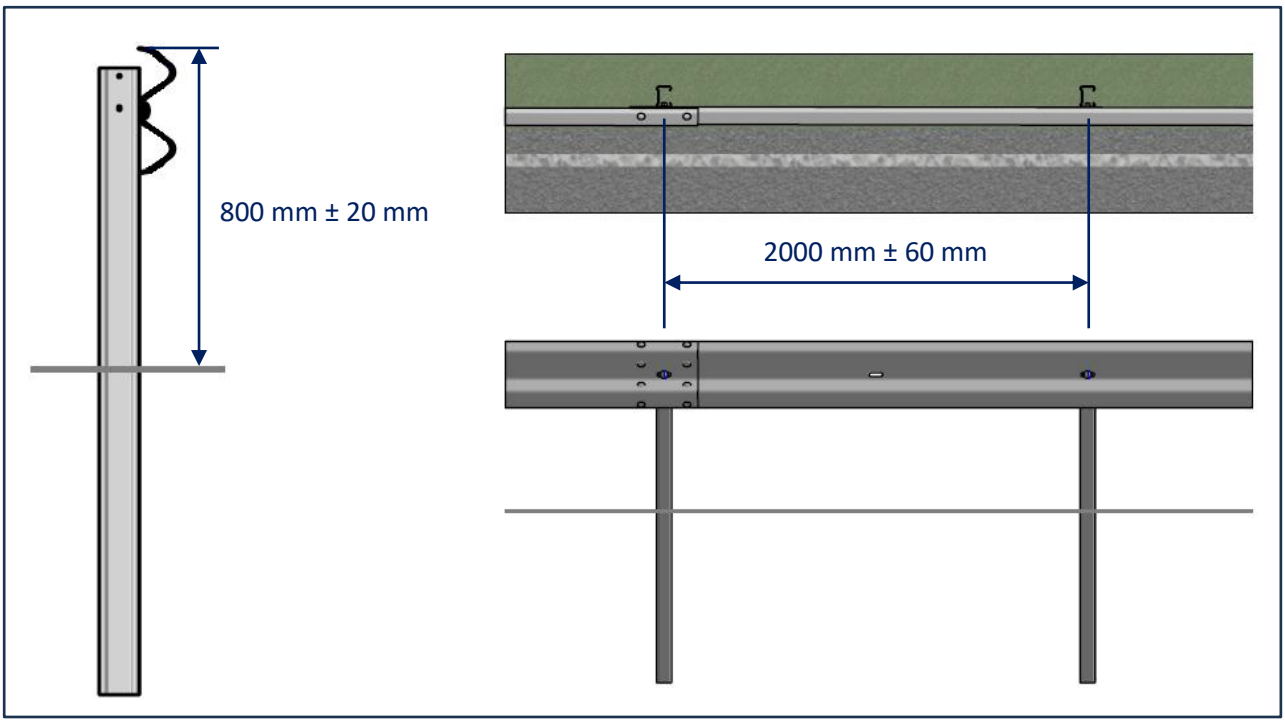


Figure 17: RamShield® W-Beam Recommended Installation Tolerances.



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 2.0 m centres.
❑ Yes ❑ No	The height measured to the top of the posts is 750 mm ± 20 mm.
❑ 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 800 mm ± 20 mm.
❑ Yes ❑ No	The rail is secured to each post with a M16 x 32 mm (or 50 mm) mushroom head bolt & standard nut.
❑ Yes ❑ No	The rails are spliced with eight (8) M16 x 32 mm 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 730 mm and 820 mm. An installed rail height of 800 mm ± 20 mm provides compatibility with MASH compliant guardrail end terminals.

Comments/Notes

14.0 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:

- 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 end terminals are free from damage.

14.1 Bushfire Damage

RamShield® W-Beam is constructed from hot dip galvanised steel components. The performance of hot dip galvanised components when subjected to a fire depends upon numerous factors such as flame duration, flame intensity and the characteristics of the galvanised finish.

Bushfires can produce high temperatures, however exposure of roadside structures to maximum flame intensity is generally for a short duration as the fire front moves forward. The combination of the reflectivity of the galvanised surface and the heat sink provided by the mass of the steel to which the hot dip galvanising is applied has shown galvanised steel to provide excellent performance during bushfires.

If it is observed that a bushfire has caused damage to the galvanised coating it is recommended that these item(s) be replaced.

15.0 Repair

In the event of a vehicle impact, damage to the barrier is to be assessed in accordance with Table 5. Typically, impacts with RamShield® W-Beam will require replacement of damaged sections of rails and posts. It is 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.
- Sledge hammer.
- Post extractor.

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 investigation for underground services and overhead obstructions.

15.1 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.

Upstream and downstream posts outside of the impact area should also be inspected for movement and the surrounding ground material recompacted if required.

15.2 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.

15.3 Material Disposal

RamShield® W-Beam features an all steel construction. Damaged items may be recycled.

15.4 Dismantling

RamShield® W-Beam is designed for permanent installations. Dismantling will only be required for permanent removal or following an impact.

The dismantling sequence should follow the installation sequence in reverse observing the same *Potential Hazards* and *Recommended Control Measures*.

When removing damaged posts, the ground material should be suitably compacted before a replacement post is installed.

Table 5: 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 40 cm^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 40 cm^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 200 cm^2 and no individual damaged area exceeds 40 cm^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 200 cm^2 or an individual damaged area exceeds 40 cm^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

CRASH BARRIER SOLUTIONS



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