RamShield®
Low Deflection

MASH TL3 Compliant Barrier

SafeDirection
CRASH BARRIER SOLUTIONS

Table of Contents

Version	Date	Revisions
04	February 2026	Updated format, inclusion of Variable Width Blocking Pieces

Leading Safety

Successfully crash tested to MASH Test Level 3

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

Superior Design

Simple rail to post assembly

Available with the RamBloc®, providing an offset between the w-beam rail and C-post

Same C-post profile as used in public domain systems

Reduced post embedment depth when compared with public domain systems

Rails splices positioned mid-span between posts

Low Deflection

Shields roadside hazards close to the travelled way

Stable containment and redirection

Reduced distance between the barrier and a fixed hazard

Compatibility

Features standard w-beam manufactured by Safe Direction

Compatible with the MSKT guardrail end terminal

Standard 2 m post spacing

Fast Assembly

Fewer parts

Stiff driving C-post

1.0 Introduction

RamShield® Low Deflection is the latest innovation and advancement in w-beam guardrail barrier designs. Developed by Safe Direction, RamShield® Low Deflection 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® Low Deflection 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® Low Deflection reduces the clearance required between barrier and hazard, an important design consideration for installation on narrow formations.

2.0 Specifications

Crash Test Compliance	MASH Test Level 3
MASH TL3 Dynamic Deflection (without blocking pieces)	1.1 m
MASH TL3 Dynamic Deflection (with 150 mm RamBlocs®)	1.2 m
System Width (without blocking pieces)	235 mm
RamBloc® Width Options	150 mm, 200 mm, 250mm or 300 mm
System Height	800 mm, measured to top of w-beam
System Mass (without blocking pieces)	22 kg per metre
Standard Post Length	1660 mm
Standard Post Embedment Depth	890 mm
Standard Post Spacing	2.0 m centres
Post Mass	21.2 kg
System Finish	Hot dip galvanised in accordance with AS/NZS 4680

3.0 How RamShield® Low Deflection Works

RamShield® Low Deflection achieves a controlled redirection of errant vehicles by regulating the force to release the rail throughout the impact zone, limiting dynamic deflection and to allow the C-post to collapse without tripping the vehicle.

The separation of the w-beam rail during a vehicle collision is achieved by a release tab. This allows the rail to be disengaged at an optimal load, facilitating safe vehicle containment and redirection.

RamShield® Low Deflection uses standard w-beam guardrail and standard fasteners meaning there is very little risk of inadvertent use of non-compliant items. The w-beam rails are spliced mid-span between C-posts, facilitating ease of access during installation.

RamShield® Low Deflection features C-posts designed to collapse upon impact, yielding proximate to the ground following the controlled release of the rail. This release and collapse mechanism makes the RamShield® Low Deflection C-post suitable for use in stiff soils and deep asphalt applications.

The sectional strength of the C-post limits barrier deflection, an important design consideration for shielding roadside hazards and steep embankments located within close proximity to the edge of the travelled way.

The working mechanism of RamShield® Low Deflection 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® Low Deflection 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® Low Deflection has been assessed as a longitudinal barrier, designed to contain, redirect, and shield vehicles from roadside obstacles. The heavy vehicle MASH TL3 crash test impact is performed with a 2270 kg pick-up travelling at 100 km/h and 25 degrees.

RamShield® Low Deflection has been crash tested with direct connection of the w-beam guardrail to the C-post and with 150 mm wide RamBlocs®, providing an offset between the w-beam rail and post.

Table 1: RamShield® Low Deflection Crash Test Results

MASH TL3 Dynamic Deflection (without blocking pieces)	1.1 m
MASH TL3 Dynamic Deflection (with 150 mm wide blocking pieces)	1.2 m

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® Low Deflection 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 Installation without Blocks

RamShield® Low Deflection may be installed with the w-beam rail connected directly to the C-post, reducing the width of the system. This is an important design consideration for sites with a narrow formation.

The separation of the w-beam rail during a vehicle collision is achieved by a release tab punched in to the face of the C-post. This allows the rail to be disengaged at an optimal load, facilitating safe vehicle containment and redirection.

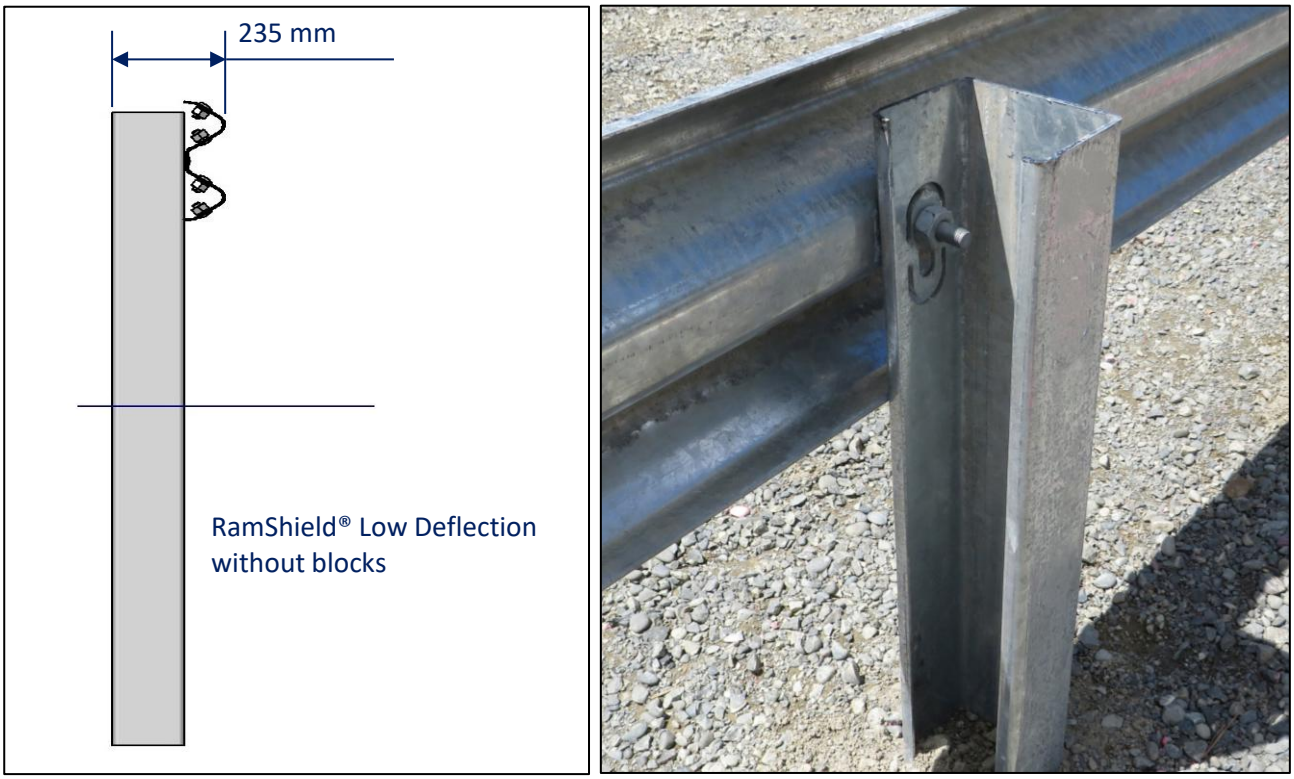


Figure 1: RamShield® Low Deflection Installation without Blocks.

6.2 Installation with RamBlocs®

RamShield® Low Deflection may be installed with the RamBloc®, a steel RHS spacer positioned between the C-post and w-beam guardrail. The RamBloc® allows the face of rail to be offset from the C-post, an important design consideration when accommodating the alignment of drainage or asphalt beneath the barrier system.

The standard width of the RamBloc® is 150 mm. For constrained sites where a larger offset between the face of w-beam and the alignment of the C-posts is required, RamBlocs® may be supplied in larger widths of 200 mm, 250 mm or 300 mm, Please contact Safe Direction for installation recommendations.

The separation of the w-beam rail during a vehicle collision is achieved by a release tab punched in to the face of each RamBloc®. This allows the rail to be disengaged at an optimal load, facilitating safe vehicle containment and redirection.

Figure 2: RamShield® Low Deflection Installation with RamBlocs®.

6.3 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 2. 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 2: 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.*

6.4 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.

6.5 Advance Grading

It is recommended that the area in advance of RamShield® Low Deflection 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.

6.6 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® Low Deflection deflections at varying vehicle speeds and impact angles.

6.7 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
- Increases 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 on the RamShield® Low Deflection C-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.

6.8 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.

6.9 Placement in Rock or Asphaltic Concrete

The rail release mechanism and performance of RamShield® Low Deflection 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® Low Deflection posts will typically yield by bending proximate to ground level. Restraining the RamShield® Low Deflection C-posts below ground level does not adversely affect the rail release mechanism.

Therefore, acceptable foundation pavement conditions for the installation of the RamShield® Low Defection C-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.

6.10 System Installed Height

RamShield® Low Deflection has been crash tested at a rail height of 800 mm ± 20 mm above ground level providing compatibility with MASH compliant end terminals, including the MSKT and MAX-Tension.

6.11 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 on RamShield® variants 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) W-Beam configurations were evaluated for each vehicle type:

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 system height of all RamShield® w-beam variants from top of kerb, regardless of the barrier offset behind the kerb as shown in Figure 3.

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.

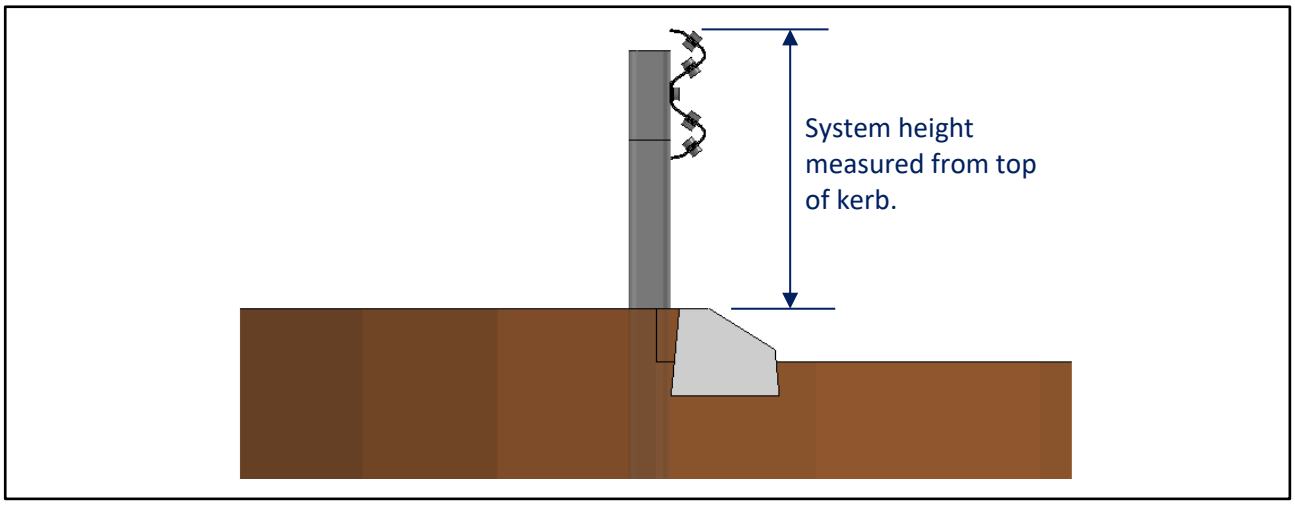


Figure 3: Recommended Procedure for RamShield® Low Deflection Installation Behind a Mountable Kerb.

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 2.0m post spacing.

The post spacing of RamShield® Low Deflection without blocking pieces may be reduced to 1.0 m, reducing the MASH TL3 deflection to 0.73 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.

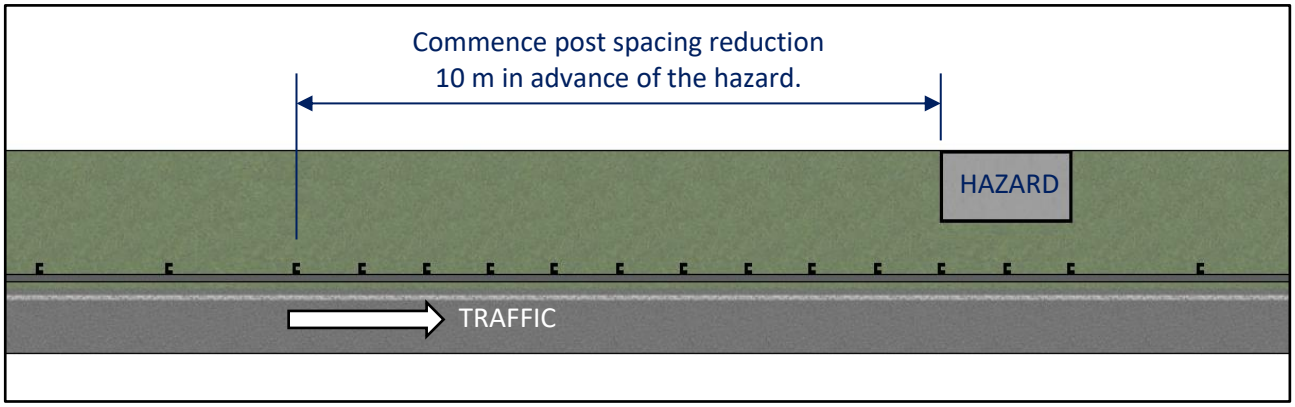


Figure 4: RamShield® Low Deflection, Reduced Post Spacing.

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® Low Deflection 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® Low Deflection 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® Low Deflection 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: MSKT Terminal Connection to RamShield® Low Deflection.

6.16 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® Low Deflection is achieved using an asymmetric transition which increases the rail height from 800 mm to 1000 mm.

Figure 6: RamShield® Transition.

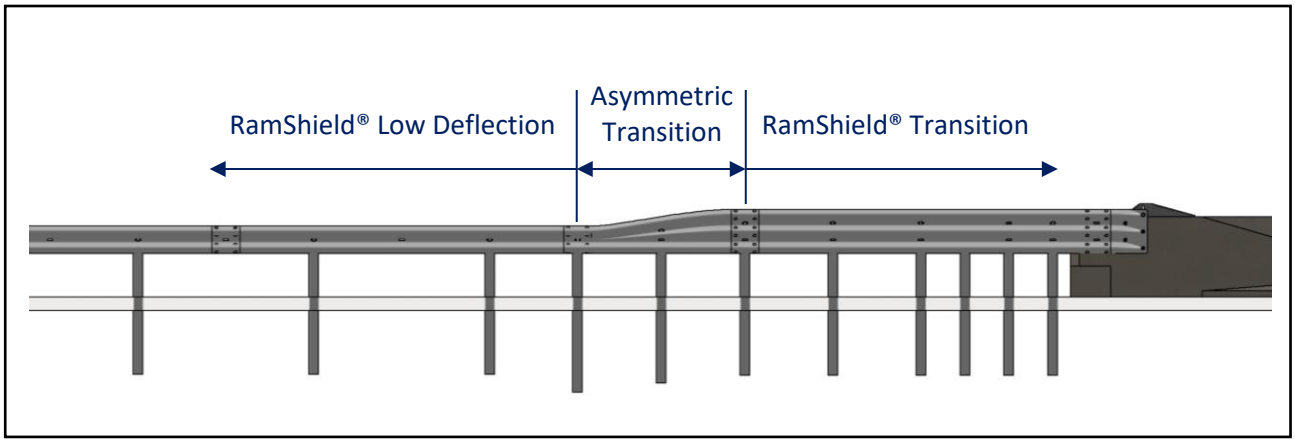


Figure 7: RamShield® Low Deflection, Connection to the RamShield® Transition.

6.17 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 6.

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

6.18 Connection to RamShield® W-Beam

At sites where an isolated hazard is located within close proximity to the edge of the travelled way, RamShield® Low Deflection may be used in conjunction with RamShield® W-Beam to stiffen the barrier system in advance and adjacent to the hazard.

It is recommended that the installation of RamShield® Low Deflection commences 10 m upstream of the hazard requiring shielding. If the roadway is undivided, the installation of RamShield® Low Deflection should also extend 10 m downstream f the hazard.

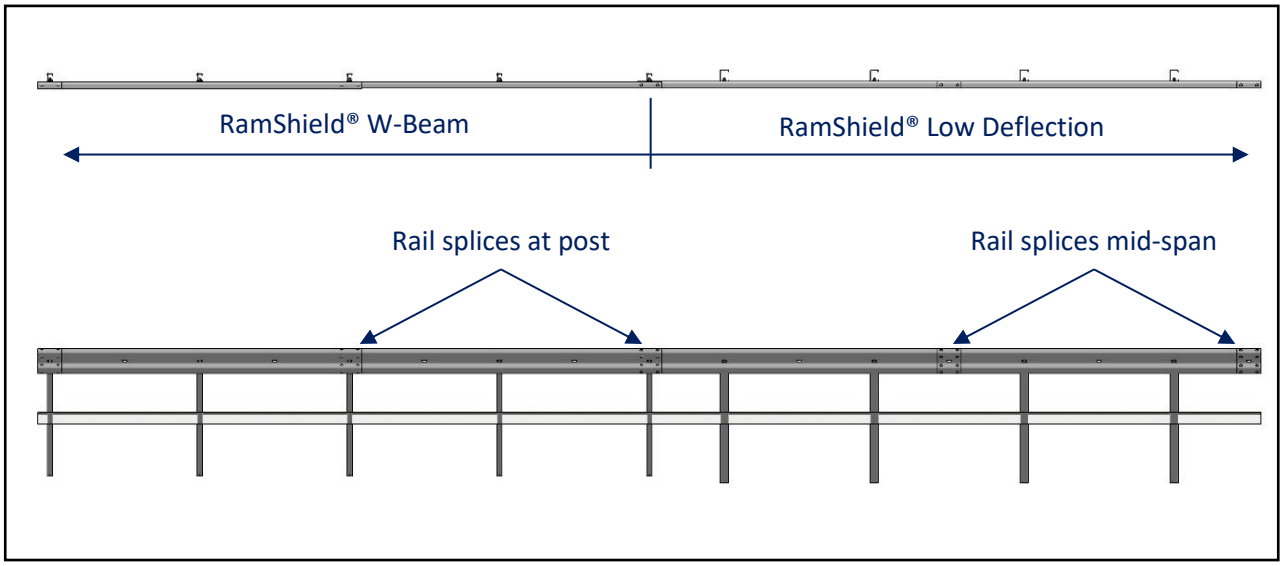


Figure 8: RamShield® Low Deflection, Connection to RamShield® W-Beam.

6.19 Posts with Baseplates

Underground services and/or structures such as culverts may prevent RamShield® Low Deflection from being installed with posts driven into the ground. In these circumstances RamShield® Low Deflection may be installed with posts on baseplates secured to a concrete strip footing.

The RamShield® Low Deflection concrete footing was modelled with no soil behind the beam and therefore relies upon the beam mass to resist movement and overturning forces. This concept provides an important differentiation from footing designs that rely upon soil resistance since onsite soil properties are often unknown.

In addition, the RamShield® Low Deflection concrete footing has been assessed with posts positioned at the front and rear of the beam. This methodology assesses the maximum applied overturning moment, shear load and uplift force acting on the concrete beam and provides designers with a working tolerance range for the positioning of the posts.

The safe vehicle containment of the simulated impacts demonstrates appropriate footing and beam mass. Safe Direction provides various footing size options providing equivalent beam mass as adopted for the simulation impacts. In addition, mechanical or chemical anchor options are provided. Please refer to Safe Direction drawings. 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.

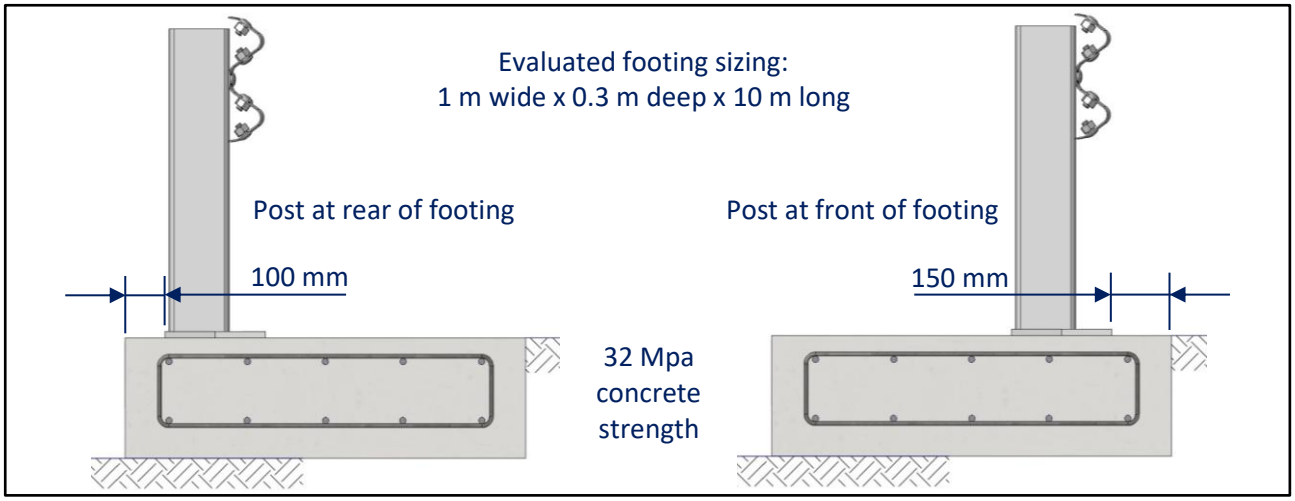


Figure 9: Assessment of RamShield® Low Deflection Posts with Baseplates.

To further assist designers in circumstances when the post on baseplate will be secured to an existing footing or structure, Safe Direction has undertaken RamShield® Low Deflection post capacity analysis using LS-Dyna.

Analysis was undertaken using four (4) load conditions as shown in Figure 10 to identify the maximum loading condition.

Table 3: 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

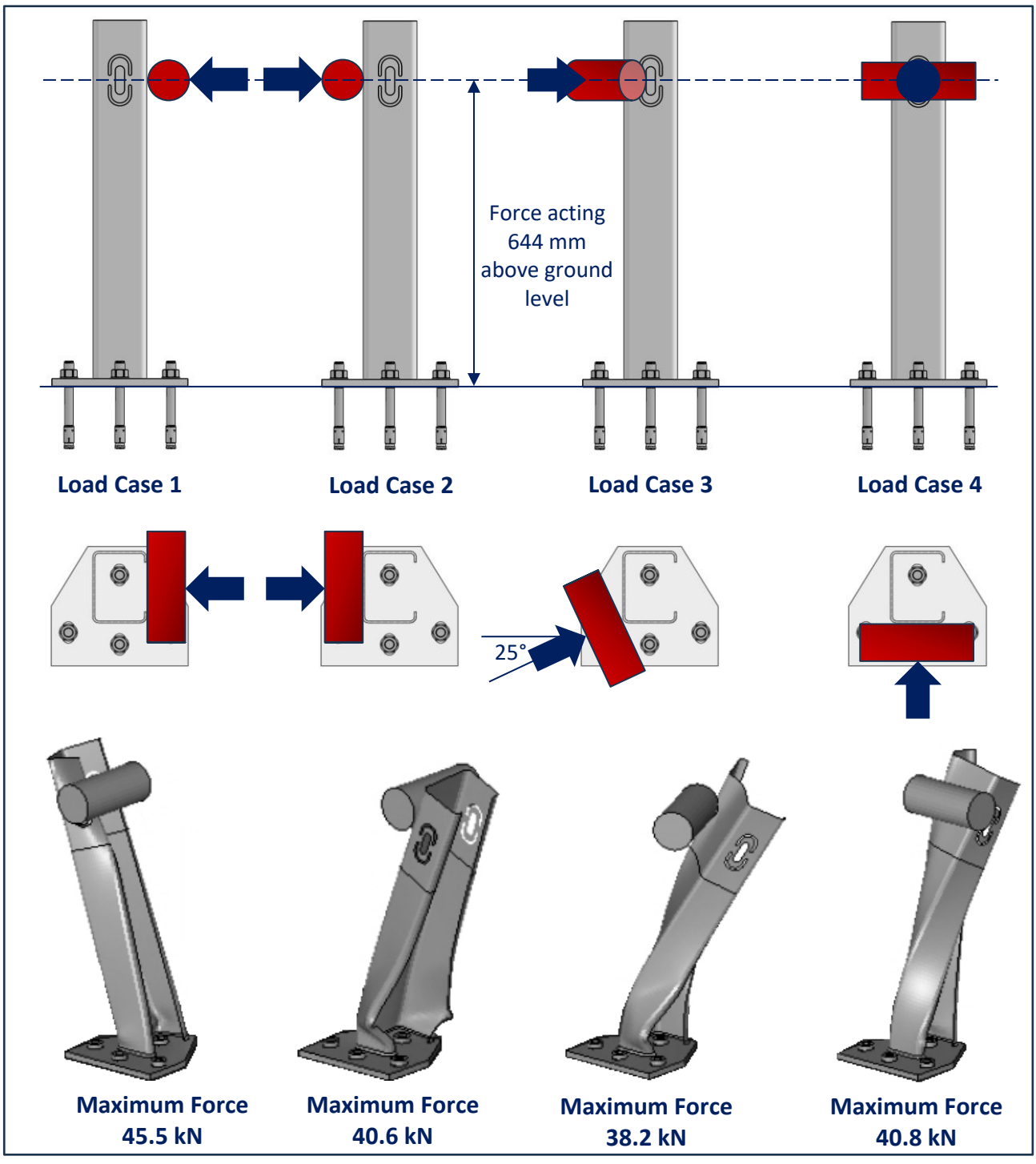


Figure 10: Load Analysis of RamShield® Low Deflection Posts with Baseplates.

6.20 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® Low Deflection C-post has a thickness of 4.3 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 4: 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 5: 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

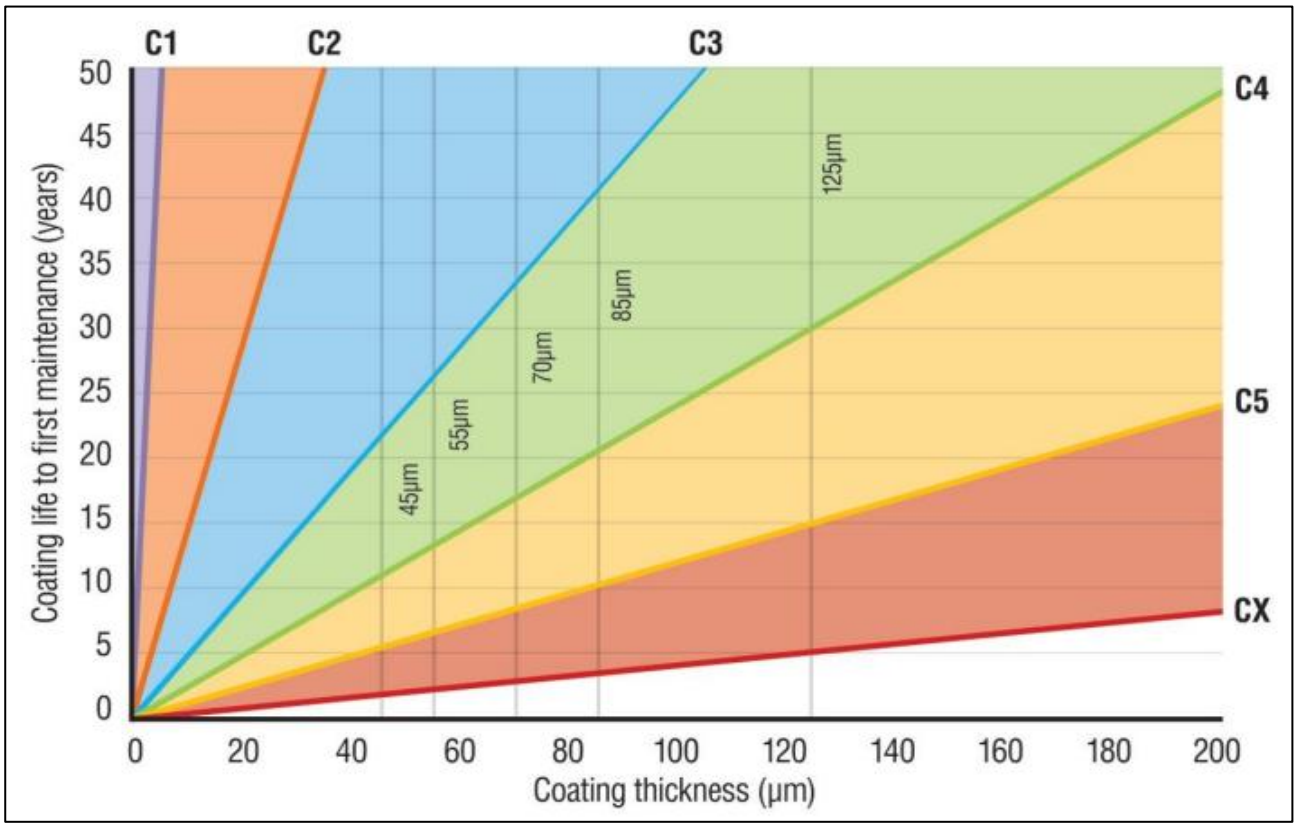


Figure 11: Calculated Corrosivity Rates for Hot Dip Galvanised Coatings, AS/NZS 2312.2.

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® Low Deflection have been numerically validated and verified in accordance with NCHRP Report 179 as required by the Austroads Safety Barrier Assessment Panel (ASBAP).

The RamShield® Low Deflection 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.

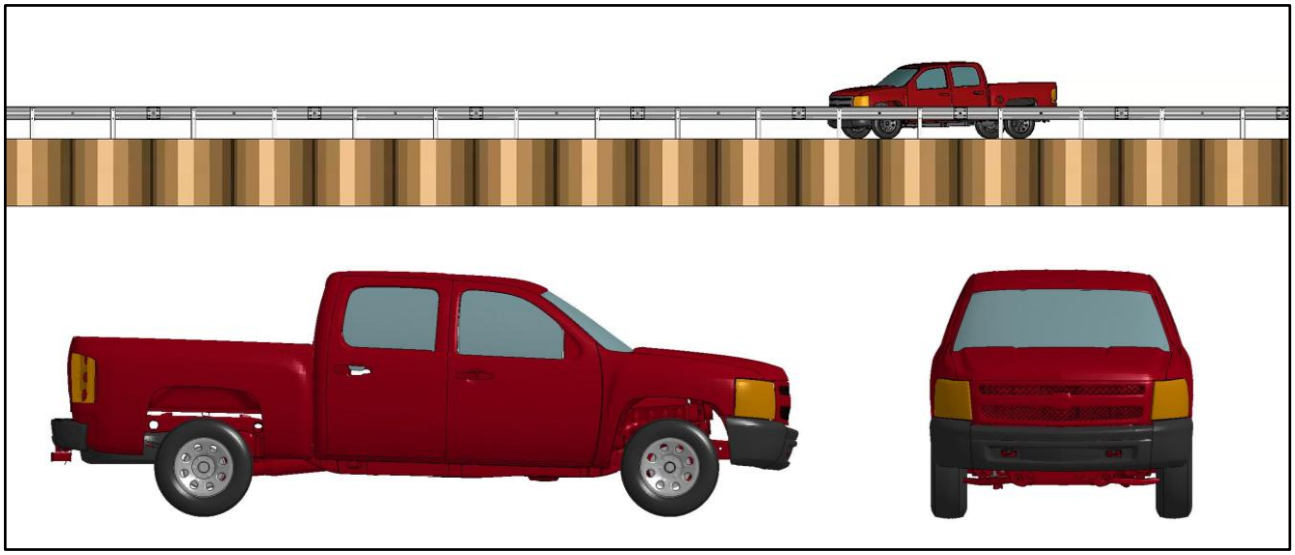
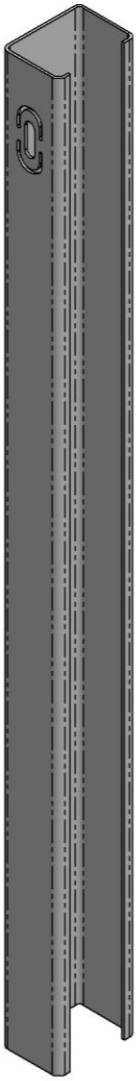


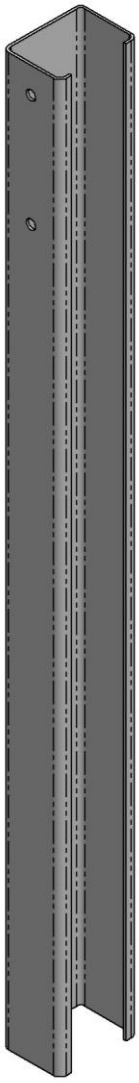
Figure 12: RamShield® Low Deflection Simulation Analysis.

8.0 Component Identification (not to scale)

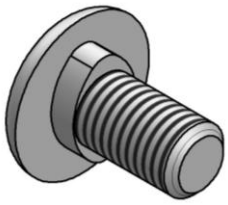


RamShield® C-Post
(punching for direct
connection of w-beam)
21 kg

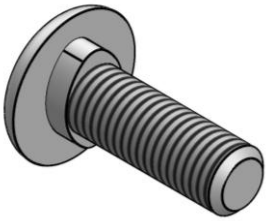
150 mm Wide
RamBloc®
5 kg



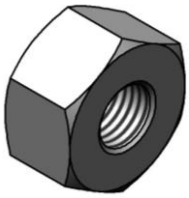
RamShield® C-Post
(punching for use with
RamBloc®)
21 kg



M16 x 32 mm
Mushroom Head Bolt

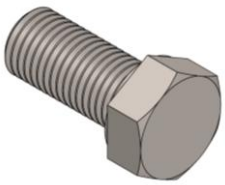


M16 x 50 mm
Mushroom Head Bolt

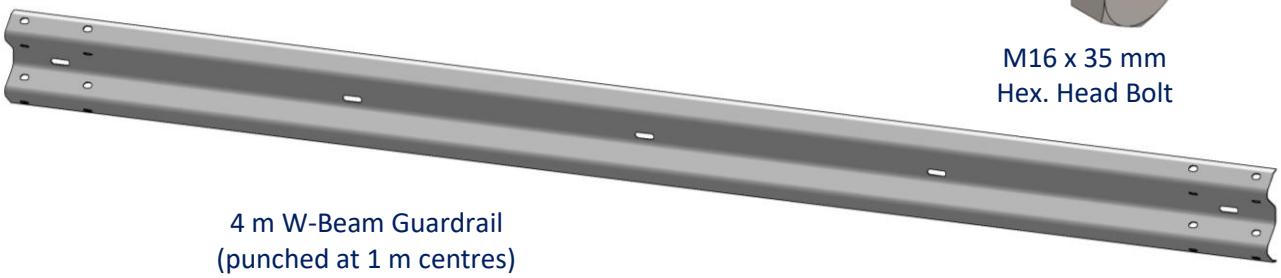


M16 Oversize Nut

M16 Standard Nut



M16 x 35 mm
Hex. Head Bolt



4 m W-Beam Guardrail
(punched at 1 m centres)
45 kg

9.0 Tools Required

Tools required for the installation of RamShield® Low Deflection 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® Low Deflection:

- 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® Low Deflection 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® Low Deflection are as follows:

- Set-out.
- Installing the approach terminal.
- Installing the RamShield® Low Deflection C-posts.
- Installing the RamBlocs® (optional)
- Attachment of the w-beam guardrail.
- Installing the departure terminal or transition to rigid barrier.
- Attachment of delineation (if 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 rail splice locations of RamShield® Low Deflection are mid-span between C-posts.
- RamShield® Low Deflection may be installed with or without RamBlocs®.
- The standard post spacing of RamShield® Low Deflection is 2.0 m.
- The 2.0 m post spacing of RamShield® Low Deflection may differ from the post spacing of the end terminals or transitions.
- The system width of RamShield® Low Deflection may differ from the system width of the end terminals and transitions.
- The RamShield® Low Deflection C-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 890 mm, or
- Auguring a minimum 200 mm diameter hole approximately 890 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 C-post should measure 770 mm above ground level.

11.3 Attaching RamBlocs®

Potential Hazards: *Hand injury from pinch points and injury from movements and posture.*

Recommended Control Measures: *Wear gloves and observe correct posture.*

The use of RamBlocs® is optional and considers whether an offset between the face of the rail and the alignment of the posts is desirable.

The standard width RamBloc® is manufactured from 150 x 150 mm SHS. Each RamBloc® is secured to the C-post with two (2) M16 x 35 mm hex head bolts and standard nuts. The standard nut is tightened using a hand socket and 24 mm attachment.

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.*

W-beam guardrails manufactured by Safe Direction are punched at 1 m centres providing compatibility for all RamShield® variants. The rails should be positioned ensuring the rail splice is located mid-span between C-posts.

The rails are secured to the C-posts (or optional RamBlocs®) using a M16 x 50 mm mushroom head bolt and oversize nut. The oversize nut is tightened using a hand socket and 32 mm attachment.

The guardrail lap is orientated so that the leading edge of the splice is shielded from nearside approaching traffic. Rails are spliced together mid-span between C-posts using eight (8) standard M16 x 32 mm mushroom head bolts and oversize nuts. The oversize nuts are tightened with a 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 C-posts, the finishing height of the guardrail will be approximately 30 mm above the top of the C-posts (or optional RamBlocs®).

Note: *A M16 x 32 mm mushroom head bolt may be used as an alternative to secure the rails to the posts (or optional RamBlocs®).*

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.

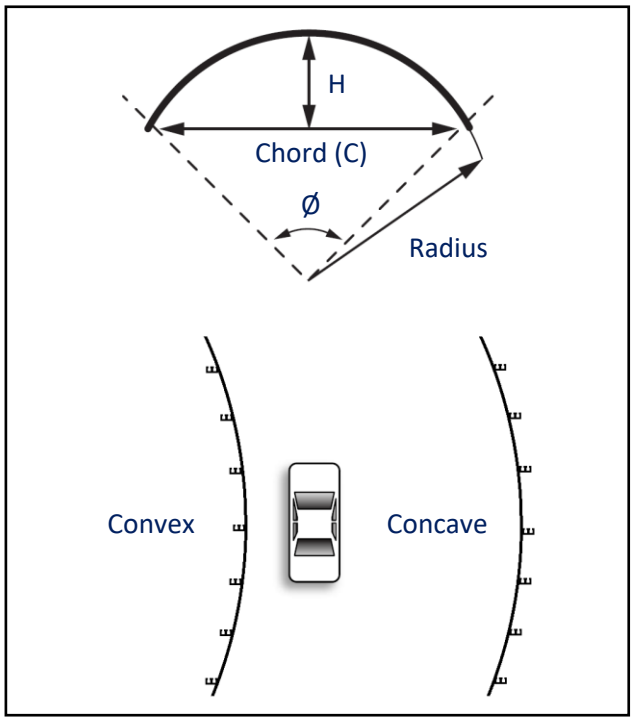


Figure 13: W-Beam Curving Orientation.

13.0 Recommended Tolerances

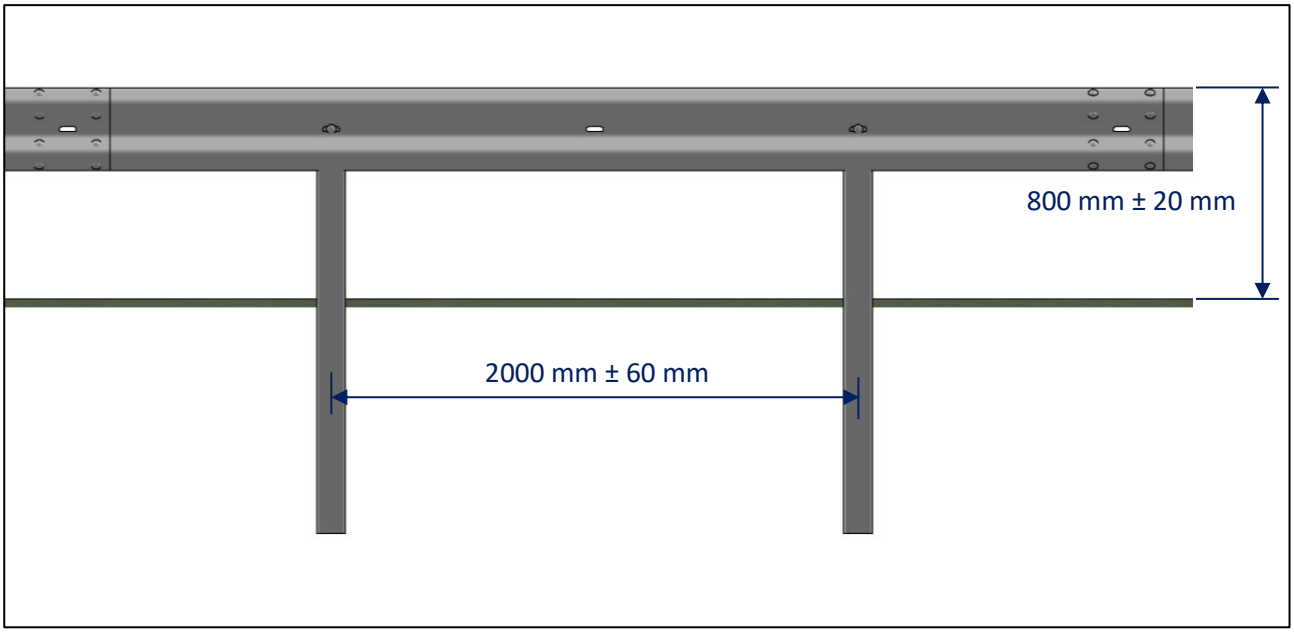


Figure 14: Recommended Installation Tolerances.

Inspection Form

System Type	**RamShield® Low Deflection**
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 C-posts are spaced at maximum 2.0 m centres.
❑ Yes ❑ No	The height measured to the top of the C-posts (or optional RamBlocs®) is approximately 770 mm.
❑ Yes ❑ No	If RamBlocs® are installed, they are secured to each post with two (2) M16 x 35 mm hexagonal head bolts & standard nuts.
❑ Yes ❑ No	The height measured to the top of the w-beam rails is 800 mm ± 20 mm.
❑ Yes ❑ No	The rail is secured to each C-post (or optional RamBloc®) with a M16 x 50 mm (or 32 mm) mushroom head bolt & oversize nut.
❑ Yes ❑ No	The rails are spliced mid-span between C-posts 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.

Comments/Notes

14.0 Maintenance

RamShield® Low Deflection 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.

14.1 Bushfire Damage

RamShield® Low Deflection 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 7. Typically, impacts with RamShield® Low Deflection will require replacement of damaged sections of rails, C-posts and RamBlocs® (if fitted). It is also recommended that new bolts be used where rails, C-posts and RamBlocs® (if fitted) have been replaced.

RamShield® Low Deflection components are all-steel and may be recycled when 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 an investigation for underground services and overhead obstructions.

15.1 Removing the W-Beam Rails

Potential Hazards: *Injury from movements and posture, hand injury from pinch points, strain to wrists from loosening 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 an impact drill to loosen bolts and wear appropriate hearing protection.*

Using a battery drill driver and 32 mm attachment, loosen the eight (8) M16 oversize nuts and remove the M16 x 32 mm mushroom head splice bolts.

Remove the M16 x 50 mm mushroom head bolt and oversize nut securing the w-beam rail to the C-posts (or optional RamBlocs®).

15.2 Removing the RamBlocs®

Potential Hazards: *Hand injury from pinch points and injury from movements and posture.*

Recommended Control Measures: *Wear gloves and observe correct posture.*

The use of RamBlocs® is optional and considers whether an offset between the face of the rail and the alignment of the posts is desirable.

The RamBlocs are removed by loosening the two (2) M16 x 35 mm hex head bolts and standard nuts.

15.3 Removing the C-Posts

Potential Hazards: *Use of post extracting 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).*

Posts should be removed using an appropriate post extractor. Once the post is removed, the ground material should be suitably compacted.

15.4 Material Disposal

RamShield® Low Deflection features an all steel construction. Damaged items may be recycled.

Figure 15: Damaged C-Post.

16.0 Dismantling

Should RamShield® Low Deflection require dismantling, it is recommended that the guidelines contained in Section 10.0 be observed in the establishment of traffic control in addition to an investigation for underground services and overhead obstructions.

Table 7: Damage Assessment Guidelines

Type of Damage	Description of the Damage	Remedial Action
Damage to the galvanised coating on the C-posts.	The sum total of the damaged area does not exceed 60 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 60 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 (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 200 cm^2 (0.5 % of the total surface area) or an individual damaged area exceeds 40 cm^2.	The rail is to be replaced.
Damage to the C-posts.	The C-post is bent.	The C-post is to be replaced.
Damage to the RamBlocs® (if fitted).	The shape of the RamBloc® is distorted.	The RamBloc® is to be replaced.
Damage to the release tab.	The tab has distorted and released the post bolt.	The C-post or RamBloc® (if fitted) is to be replaced.
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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