RamShield®

High Containment

MASH TL4 Compliant Thrie-Beam Barrier

SafeDirection
CRASH BARRIER SOLUTIONS

safedirection.com.au

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Leading Safety

Successfully crash tested to MASH Test Level 3 & 4

Approved by the Austroads Safety Barrier Assessment Panel (ASBAP)

Complies with AS/NZS 3845.1:2015 Road Safety Barrier Systems and Devices

Low Deflection & Working Width

Shields roadside hazards close to the travelled way

Stable vehicle containment and redirection

Reduced distance between the barrier and a fixed hazard

Approved Connections

MSKT Guardrail End Terminal – RamShield® Transition – RamShield® W-Beam – RamShield® Edge – BikerShield™ Motorcycle Barrier

Fast Assembly

Standard 2m post spacing

Same fasteners as public domain systems

Fewer parts

Simple rail to post bolt alignment

Stiff driving C-post

Narrow Geometry

Just 230mm system width

Local

Designed and manufactured in Australia

1.0 Introduction

RamShield® High Containment (HC) is the latest innovation and advancement in thrie-beam guardrail barrier designs. Developed by Safe Direction, RamShield® HC has been full-scale crash tested to MASH Test Level 3 & Test Level 4.

Thrie-beam guardrail is a stronger version of the w-beam guardrail systems. The additional corrugation in the rail combined with the higher mounting height, stiffens the barrier and improves its ability to contain larger vehicles.

RamShield® HC has advanced the containment level of public domain thrie-beam guardrail by introducing patented technology into the thrie-beam guardrail release mechanism. This results in a safer barrier design with fewer components allowing more metres of barrier to be deployed per public dollar to protect Australian motorists.

2.0 Specifications

Compliance: MASH Test Level 3

MASH Test Level 4

AS/NZS 3845.1:2015

Standard post length: 1860mm

System width: 230mm

Standard post spacing: 2.0m centres

System Finish: Hot dip galvanised to AS/NZS 4680

Compliance	Deflection	Working Width
MASH TL3	1.0m	1.1m
MASH TL4	1.1m	2.2m

3.0 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® HC posts and thrie-beam 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 thrie-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 2.7mm)

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

4.0 How RamShield® HC Works

RamShield® HC achieves a controlled redirection of errant vehicles by releasing the thrie-beam guardrail 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 controls the release of the rail within the impact zone providing stable vehicle containment and redirection with minimal vehicle roll.

RamShield® HC uses standard thrie-beam guardrail and standard fasteners meaning there is minimal risk of inadvertent use of non-compliant items.

Upon release of the thrie-beam rail, the C-posts collapse upon impact yielding proximate to the ground surface. This release and collapse mechanism makes RamShield® HC suitable for use in stiff soils and deep asphalt applications.

The sectional strength of the C-post limits barrier deflection, an important design consideration when shielding roadside hazards.

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

5.0 Crash Test Performance

RamShield® HC has been fully crash tested and evaluated according to the specifications for Test Level (TL) 4 and 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.

The MASH TL4 crash test matrix requires the following three (3) impacts:

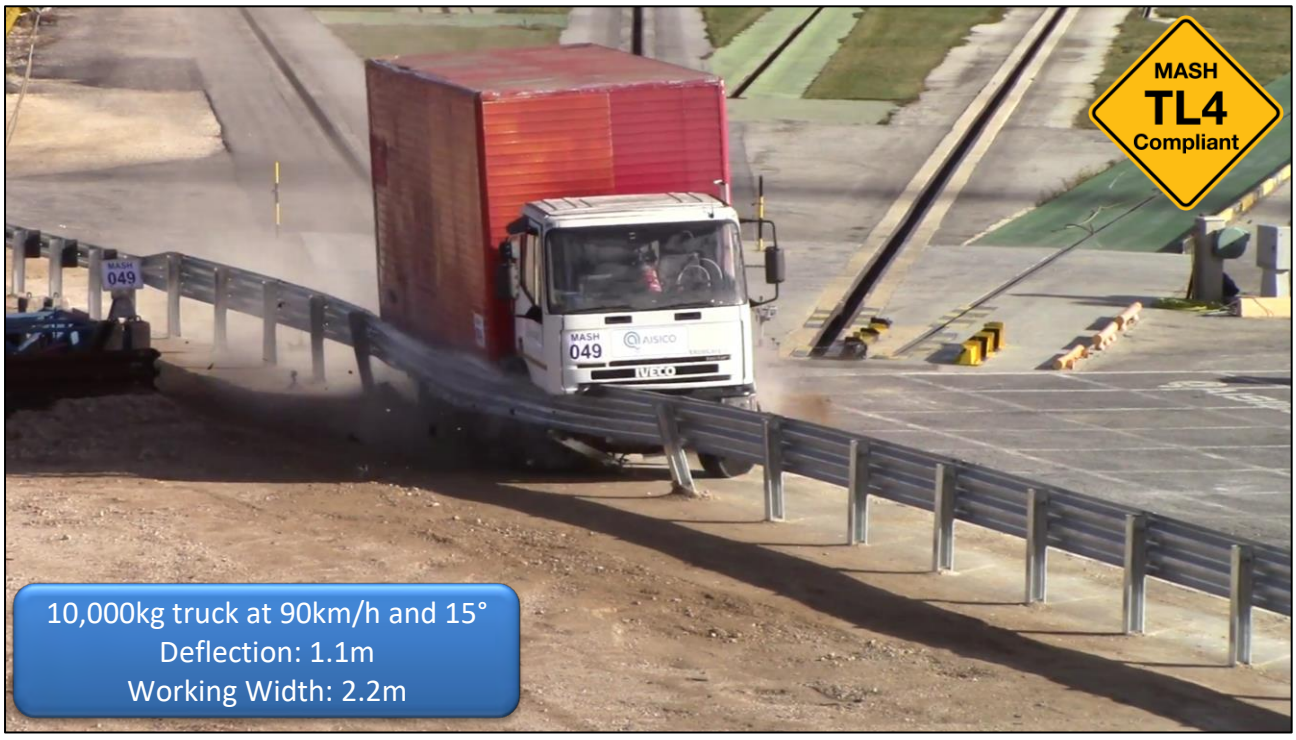
- 10,000kg rigid truck travelling at 90km/h and 15°.
- 2270kg pick-up truck travelling at 100km/h and 25°.
- 1100kg passenger car travelling at 100km/h and 25°.

6.0 RamShield® HC Crash Test Results

Vehicle Type	Impact Condition	Impact Energy	Barrier Deflection	Working Width
	1100kg small car travelling at 100km/h and 25 degrees	75.8 kJ	0.8m	1.0m
	2270kg pick-up truck travelling at 100km/h and 25 degrees	156.4 kJ	1.0m	1.1m
	10,000kg rigid truck travelling at 90km/h and 15 degrees	209.3 kJ	1. 1m	2.2m


MASH
TL3
Compliant
1100kg car at 100km/h and 25°
Deflection: 0.8m
Working Width: 1.0m


MASH
TL3
Compliant
2270kg pick-up at 100km/h and 25°
Deflection: 1.0m
Working Width: 1.1m


MASH
TL4
Compliant
10,000kg truck at 90km/h and 15°
Deflection: 1.1m
Working Width: 2.2m

7.0 Design Considerations

7.1 Barrier Deflection

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.

Sufficient dynamic clearance should be provided between the face of a barrier and a hazard to accommodate the appropriate dynamic deflection. The crash test deflection results of RamShield® HC provide a linear relationship between impact energy and dynamic deflection indicating predictable barrier behaviour.

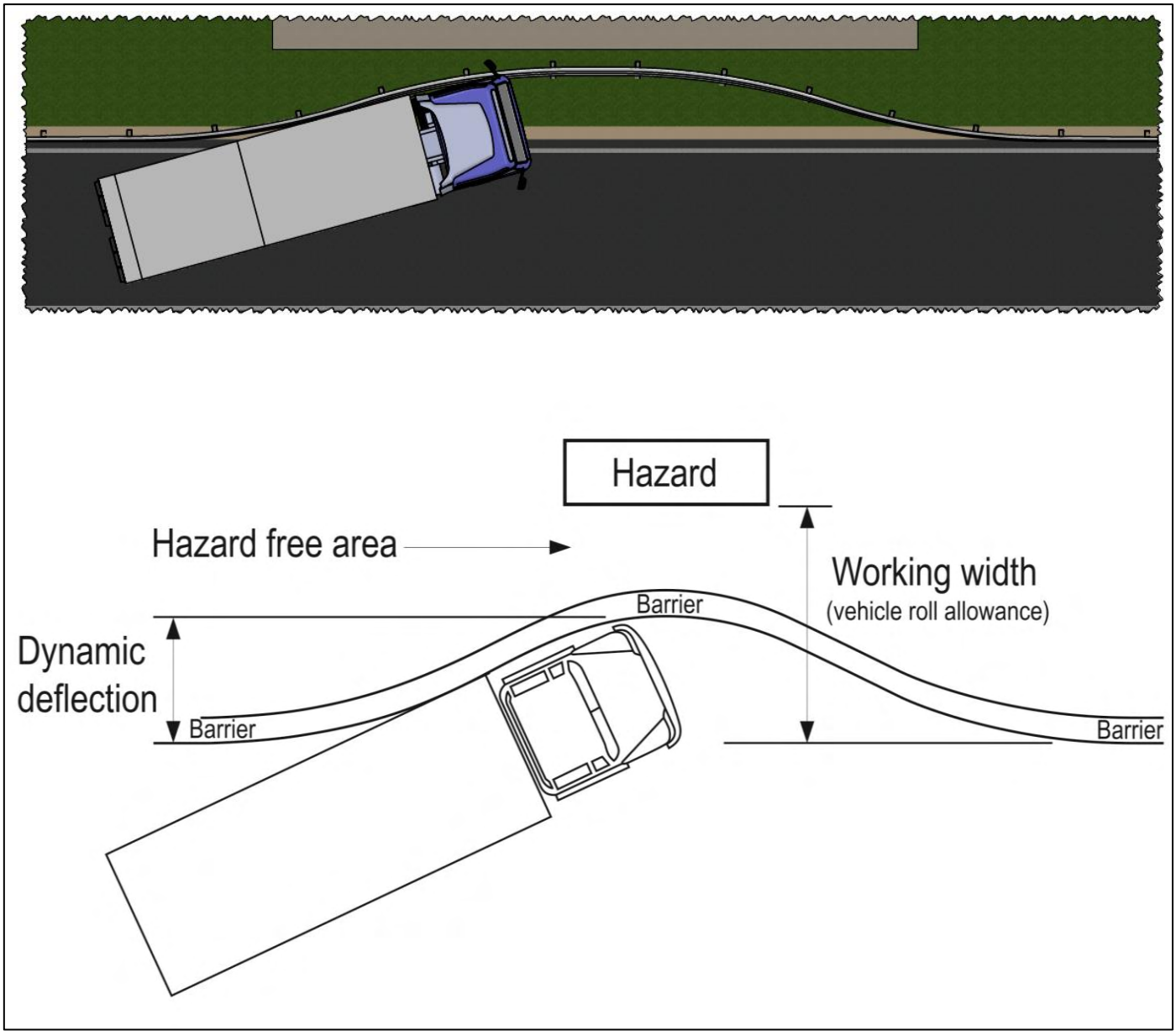


Figure 1: Dynamic Deflection Terminology

7.2 Working Width

The working width is the minimum distance required to prevent an impacting design vehicle from colliding with an object behind a barrier system. This includes both the dynamic deflection of the barrier and the extra width to allow for the roll (vertical rotation) of an impacting vehicle.

Working width is an important design consideration when shielding above-ground fixed hazards such as trees, sign supports or bridge piers.

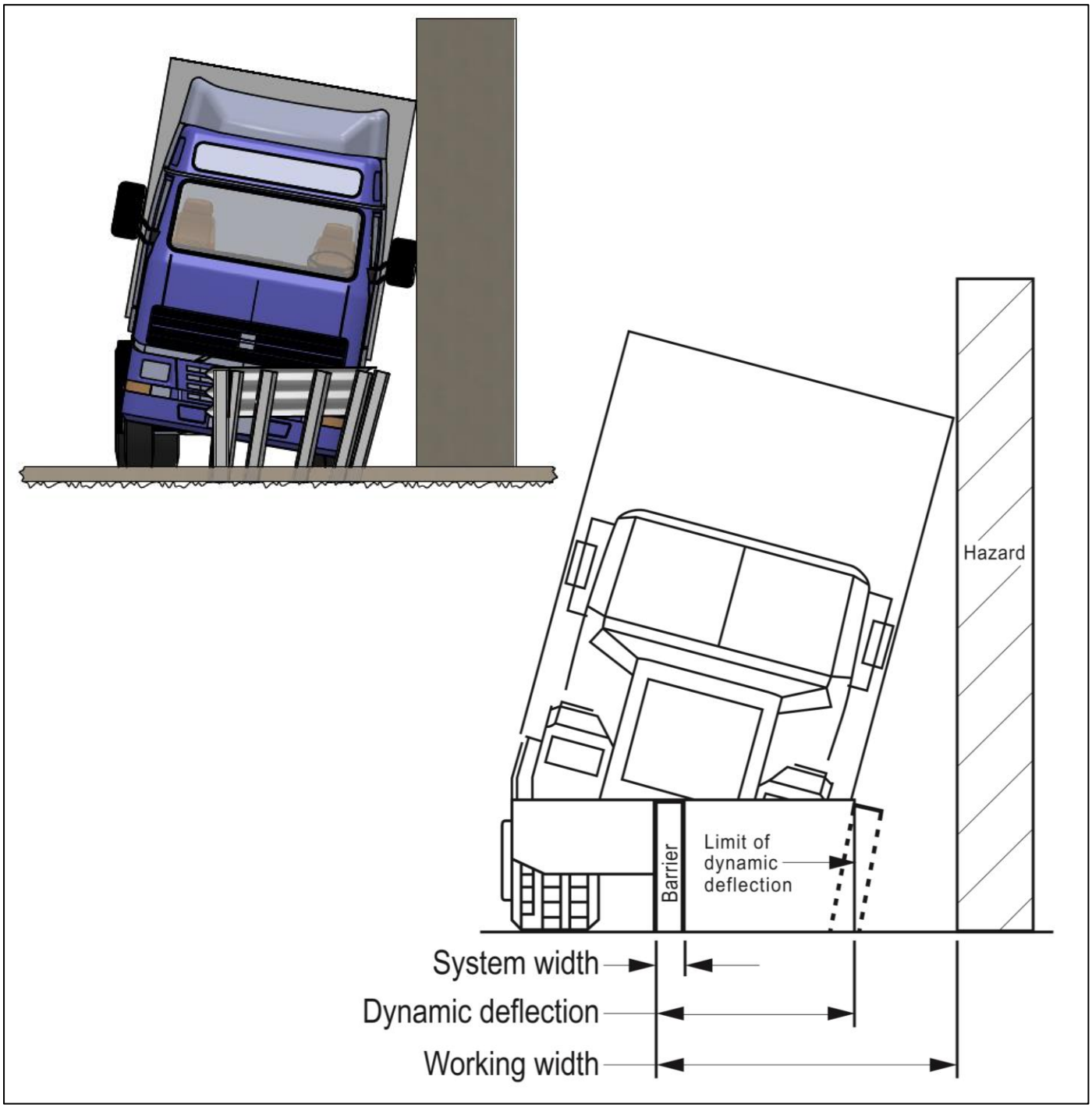


Figure 2: Working Width Terminology

7.3 Shy Line Offset

When safety barriers are located too close to traffic, drivers in the adjacent traffic lane tend to reduce speed, drive off-centre in the lane, or move into another lane.

Generally, there should be uniform clearance between traffic and 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.

The distance from the edge of the traffic lane beyond which a roadside feature will not be perceived as an obstacle and result in motorists reducing speed or changing lanes on the road is called the shy-line offset.

Where long continuous lengths of barrier are used, this shy-line effect is not so critical, especially if the commencement of the barrier can be gradually transitioned from beyond the shy-line.

Recommendations for the shy line offset are contained in Table 1.

Table 1: Shy Line Offset

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

Source: Austroads Guide to Road Design Part 6

7.4 Flaring

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

Flaring the safety barrier system provides the following benefits:

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

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

Table 2: Flare Rate

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

Source: Austroads Guide to Road Design Part 6

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

7.5 Advance Grading

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

7.6 Reduced Post Spacing

The proximity of hazards behind the barrier system may encroach within the standard deflection zone.

In these circumstances the post spacing of RamShield® HC may be decreased, reducing the expected deflection of the system during a vehicle impact.

The use of reduced post spacing should be limited to constrained sites where it is not possible to reposition the barrier or remove the hazard. It is recommended that the reduction in post spacing commence 10m in advance of the hazard. If the roadway is undivided and the barrier may be impacted from either traffic direction, the reduced post spacing should extend 10m beyond the hazard.

Please contact Safe Direction for reduced post spacing deflection values.

7.7 Proximity to Batter Hinge Points

Space in the road corridor is premium. In an effort to maximise space for other infrastructure and landscaping, the proximity of the post to the batter hinge point is often reduced during the design process, 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.

The Austroads Safety Barrier Assessment Panel's preference is for the distance to the hinge point be sufficient to accommodate the barrier's design deflection and provide adequate lateral support for the system.

On constrained sites, please consult with Safe Direction for guidance on minimum distances, post spacing and post embedment depth, noting that recommendations need to consider available distance to the hinge point, soil conditions and batter slope.

RamShield® Edge provides an engineered solution for installations on the hinge point of weak soil embankments. Please refer to Section 9.

7.8 System Installed Height

RamShield® HC has been crash tested with the top of the thrie-beam guardrail 1000mm above ground level.

The thrie-beam guardrail is positioned approximately 30mm above the top of post. This is an important design consideration for vulnerable road users.

The post mounting slot provides 45mm of height adjustment. The tolerance on system height is ± 20mm.

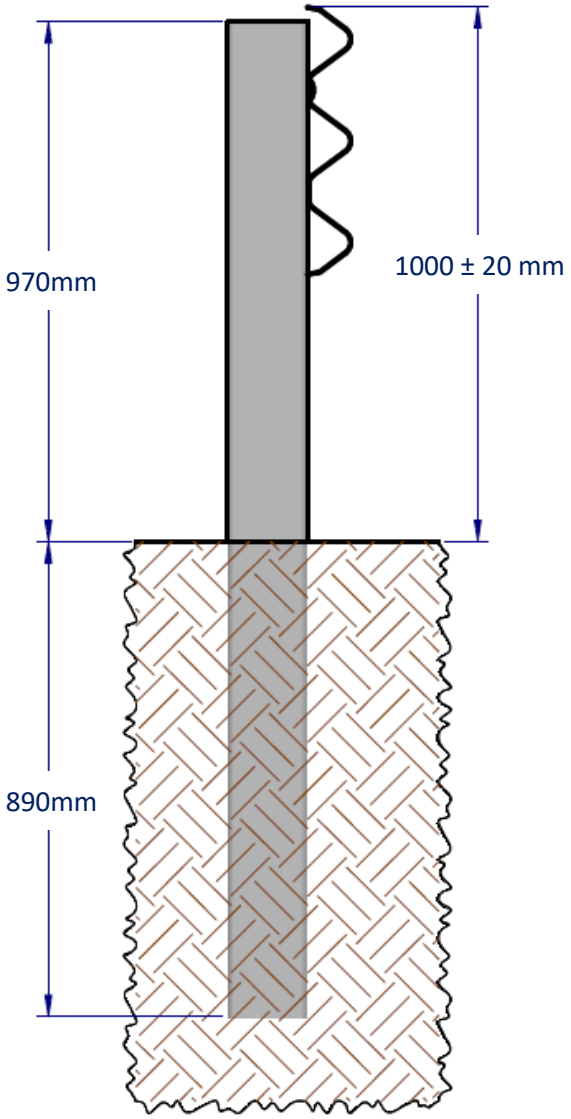


Figure 3: RamShield® HC Post Embedment Depth

7.9 The Point-of-Need

The point-of-need (PON) is the location along the barrier system where containment and redirection of errant vehicles commences. The distance between the leading and trailing points of need is referred to as the length of need.

Where the test level of a barrier is determined by the level of performance required for a specific hazard, the same level of performance should be provided over the whole length of need associated with that hazard. For example, where a hazard requires a MASH TL4 barrier, a barrier successfully tested to TL4 must be provided over the full length of need associated with that hazard.

The MASH TL3 point-of-need provides containment of a 2270kg pick-up truck travelling at 100km/h and 25 degrees. When anchored with MSKT terminals the MASH TL3 PON is the 3rd post of the end terminal.

The MASH TL4 point-of-need provides containment of a 10,000kg rigid truck travelling at 90km/h and 15 degrees.

The MASH TL4 leading point-of-need for RamShield® HC is 9.5m downstream of the asymmetric transition as shown in Figure 5.

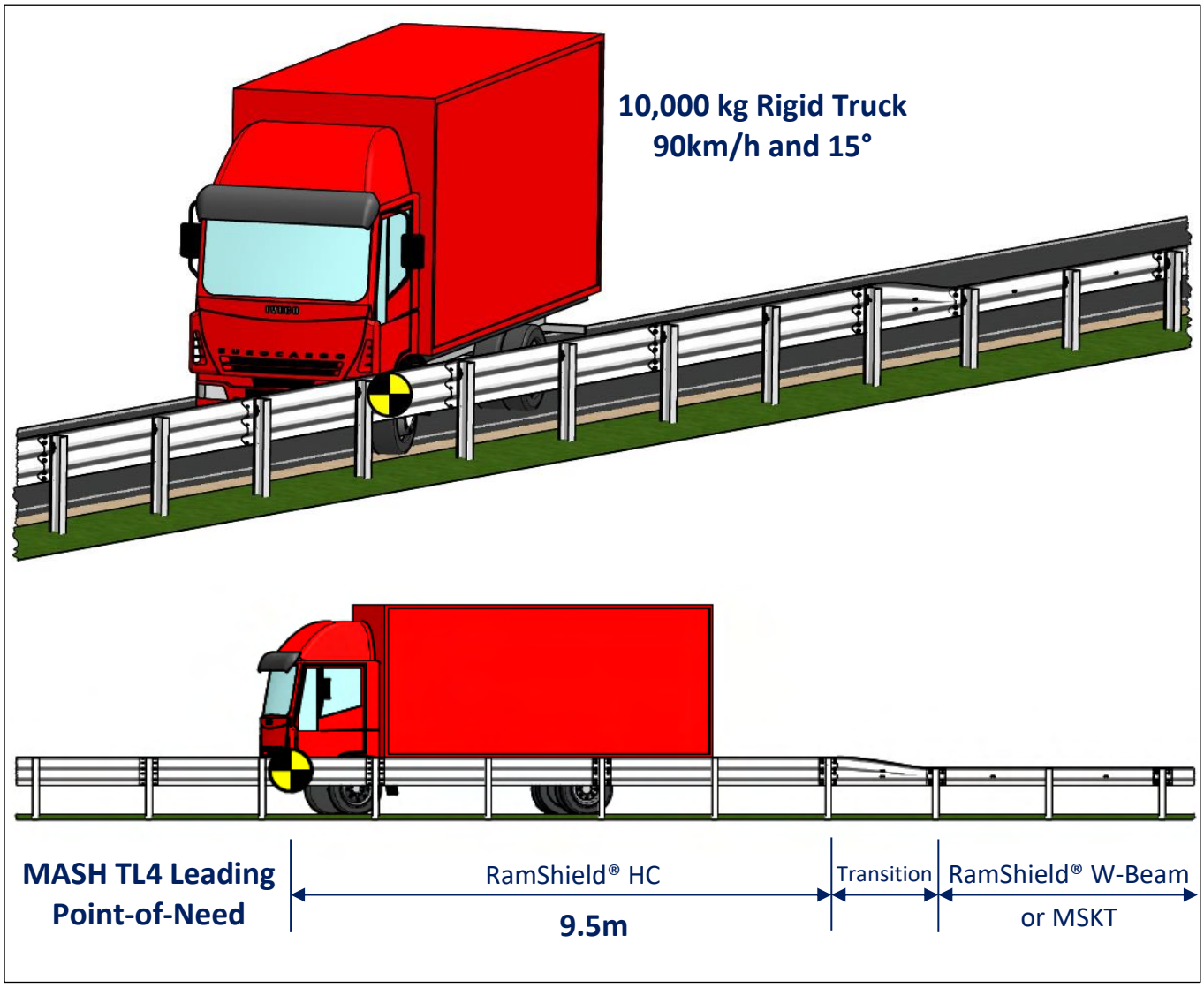


Figure 4: RamShield® HC MASH TL4 Point-of-Need

7.10 Minimum Installation Length

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

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

Where site conditions do not permit the use of long barrier sections, the recorded contact lengths with RamShield® HC providing safe vehicle containment and redirection were 12m for a MASH TL3 impact and 20m for a MASH TL4 impact.

7.11 Installation on Curves

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 thrie-beam rail.

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

Refer to Section 14.0 for guidance on measuring curvature.

7.12 Posts on Baseplates

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

The RamShield® post on baseplate is secured with four (4) M20 anchors. Chemical and mechanical fixing options are available. The thrie-beam rail to post connection and thrie-beam rail height above road level are the same as adopted for driven post installation.

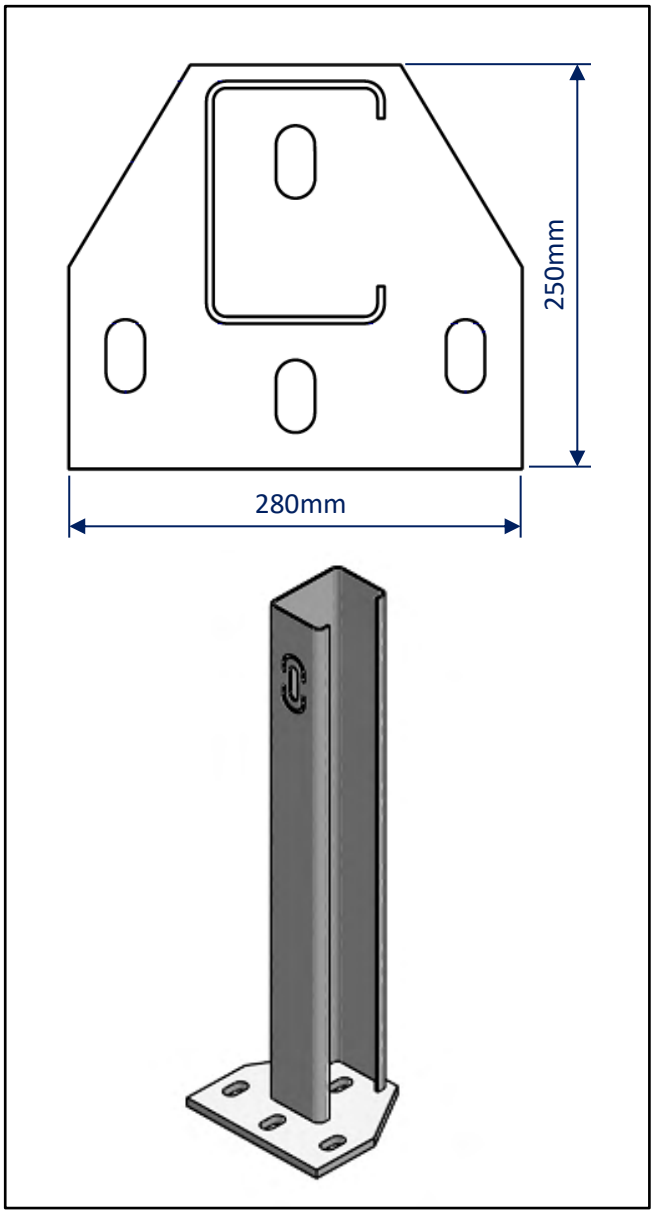


Figure 5: RamShield® HC Post on Baseplate

8.0 Connections & Attachments

8.1 Connection to RamShield® W-Beam

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

The asymmetric transition lowers the height to top of the rail by 200mm, making it compatible for use with RamShield® W-Beam guardrail which is installed with a rail height of 800mm above ground level.

When connecting to RamShield® W-Beam, RamShield® HC posts are installed at each end of the asymmetric transition as shown in Figure 6.

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

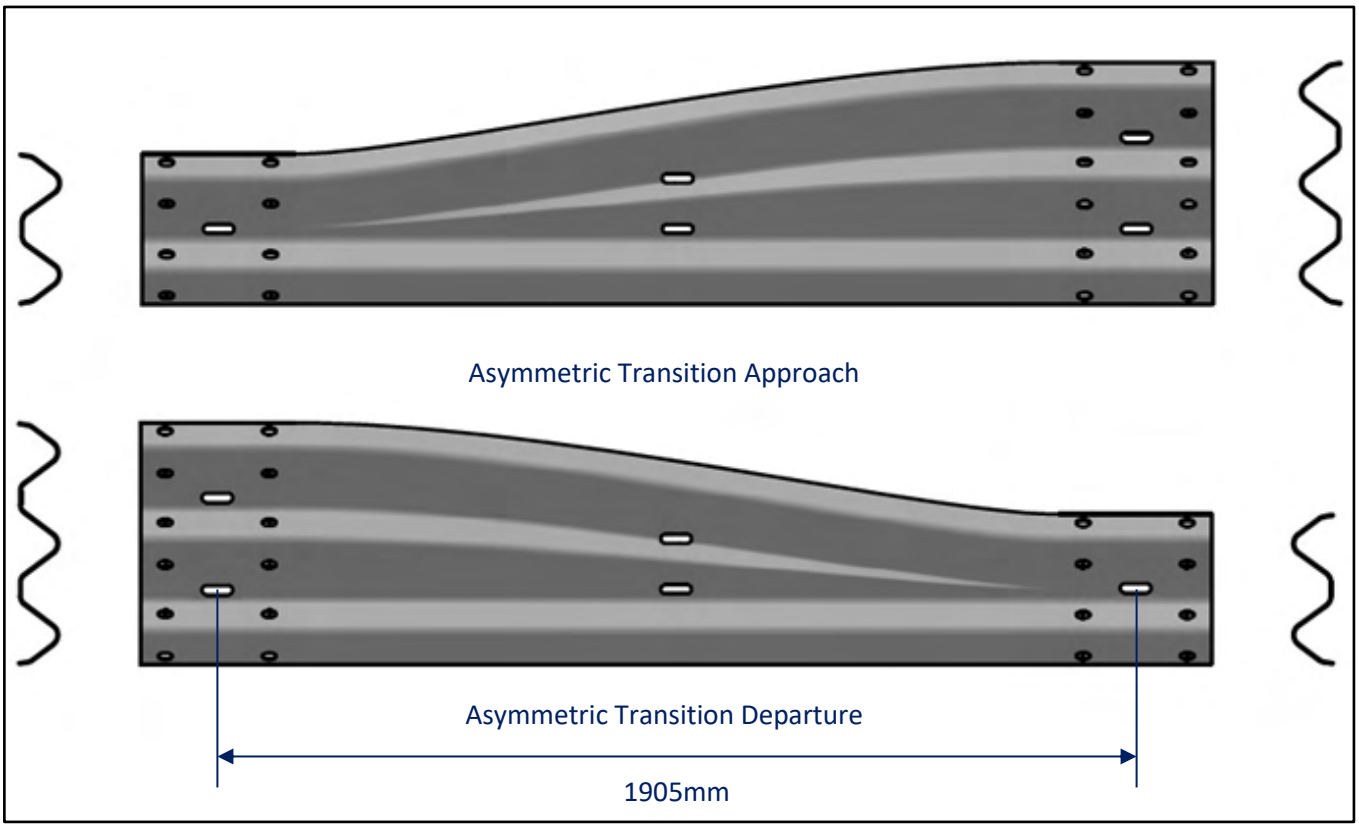


Figure 6: Asymmetric Transitions

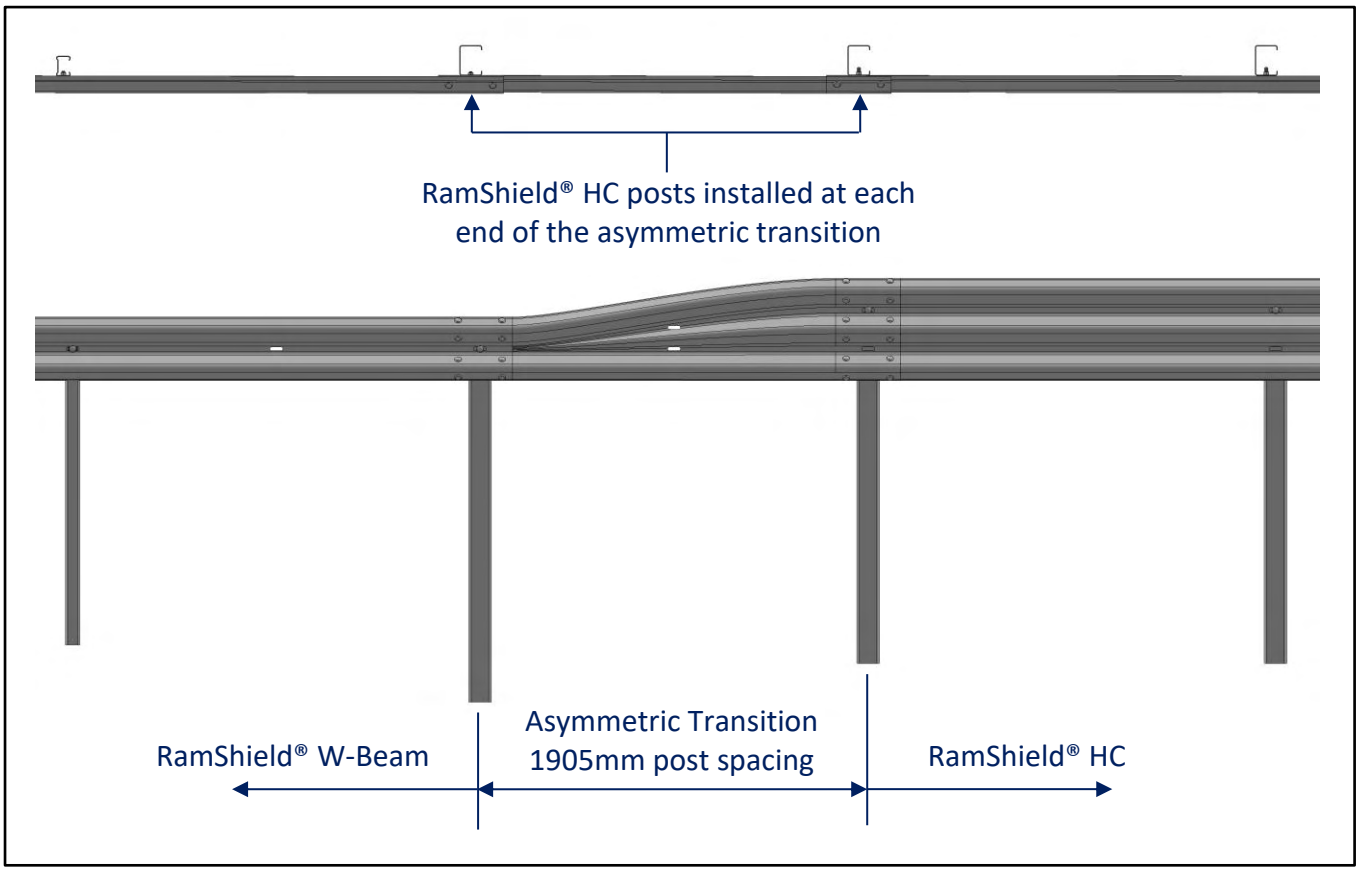


Figure 7: Installation of the Asymmetric Transition

8.2 Connection to the MSKT Terminal

The MSKT is a MASH TL3 compliant, energy-absorbing tangential guardrail end terminal, designed to minimise the severity of impacts occurring at the end of the safety barrier system.

The MSKT also anchors the safety barrier system and introduce the necessary tensile and flexural strength required for safe vehicle containment and re-direction throughout the length-of-need section.

It is recommended that RamShield® HC be anchored at the leading and trailing end of the installation with MSKT guardrail end terminals.

The MSKT guardrail end terminal is installed using w-beam guardrail, therefore it is necessary to transition from thrie-beam using an asymmetric transition, as described in Section 8.1, before commencing installation of the MSKT end terminal. Thrie-beam cannot be used within the MSKT end terminal section.

The w-beam rail height of the MSKT terminal is 800mm, therefore the MSKT can connect directly to the the asymmetric transition.

Note: The upper limit for the crash test assessment of guardrail end terminals is MASH Test Level 3.

8.3 Connection to a Rigid Barrier

Wherever it is necessary join RamShield® HC to a rigid 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® HC and rigid barriers, including concrete abutments and the CrocGuard® Bridge & Culvert Barrier. The RamShield® Transition gradually increases stiffness of the system reducing the potential for vehicle pocketing.

The RamShield® Transition features 3.5mm thick thrie-beam guardrail supported by RamShield® HC posts at reduced spacings. The RamShield® Transition adopts the same system height as RamShield® HC, simplifying connection between the two systems.

The RamShield® Transition is compliant with MASH TL3 and accepted for use by the Austroads Safety Barrier Assessment Panel (ASBAP).

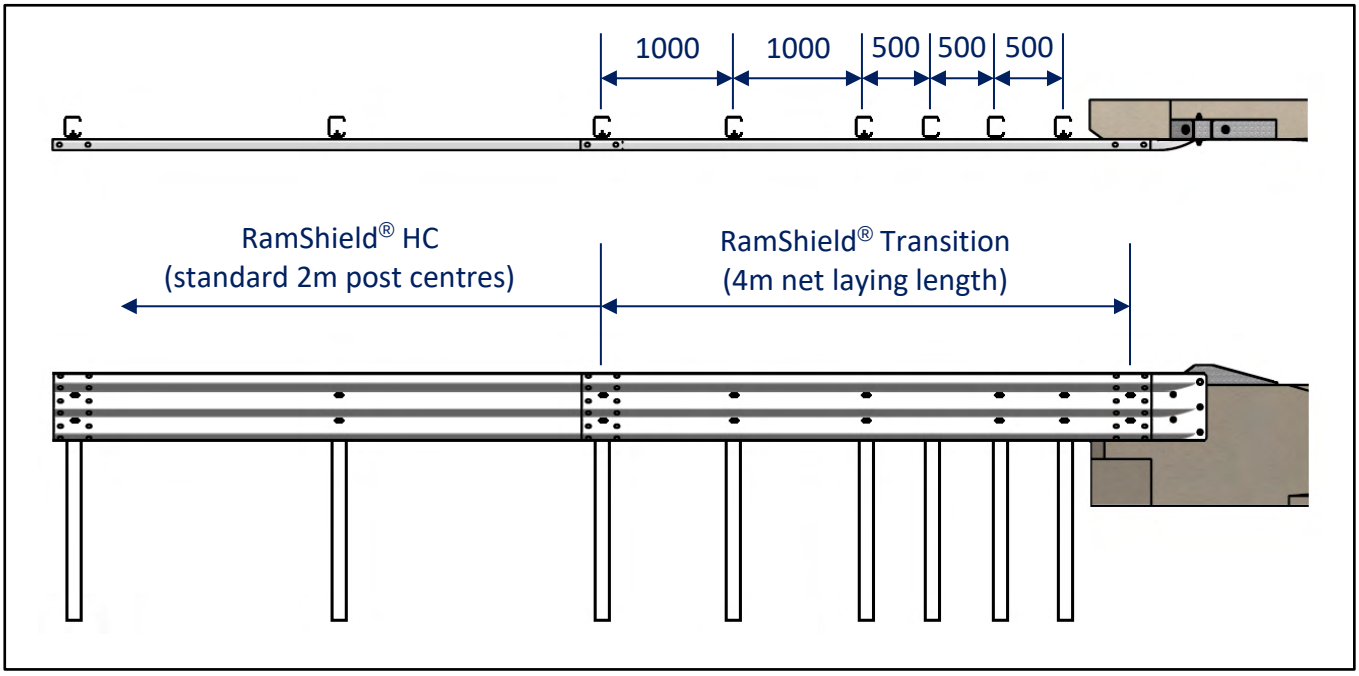


Figure 8: RamShield® HC Connection to a Concrete Abutment using the RamShield® Transition

8.4 Attachment of BikerShield™

BikerShield™ is a motorcyclist safety barrier system designed to reduce the impact severity for riders when colliding with a roadside guardrail barrier. BikerShield™ is positioned below the guardrail beam and prevents a dismounted motorcyclist from contacting the supporting posts of the guardrail barrier system.

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

The position of BikerShield™ beneath the guardrail beam 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 guardrail beam reduces the potential for rider snagging.

Since the BikerShield™ mounting brackets are secured to the rear of the guardrail beam mid-span between posts, thrie-beam rails manufactured by Safe Direction are pre-punched at 1m centres to facilitate ease of installation.

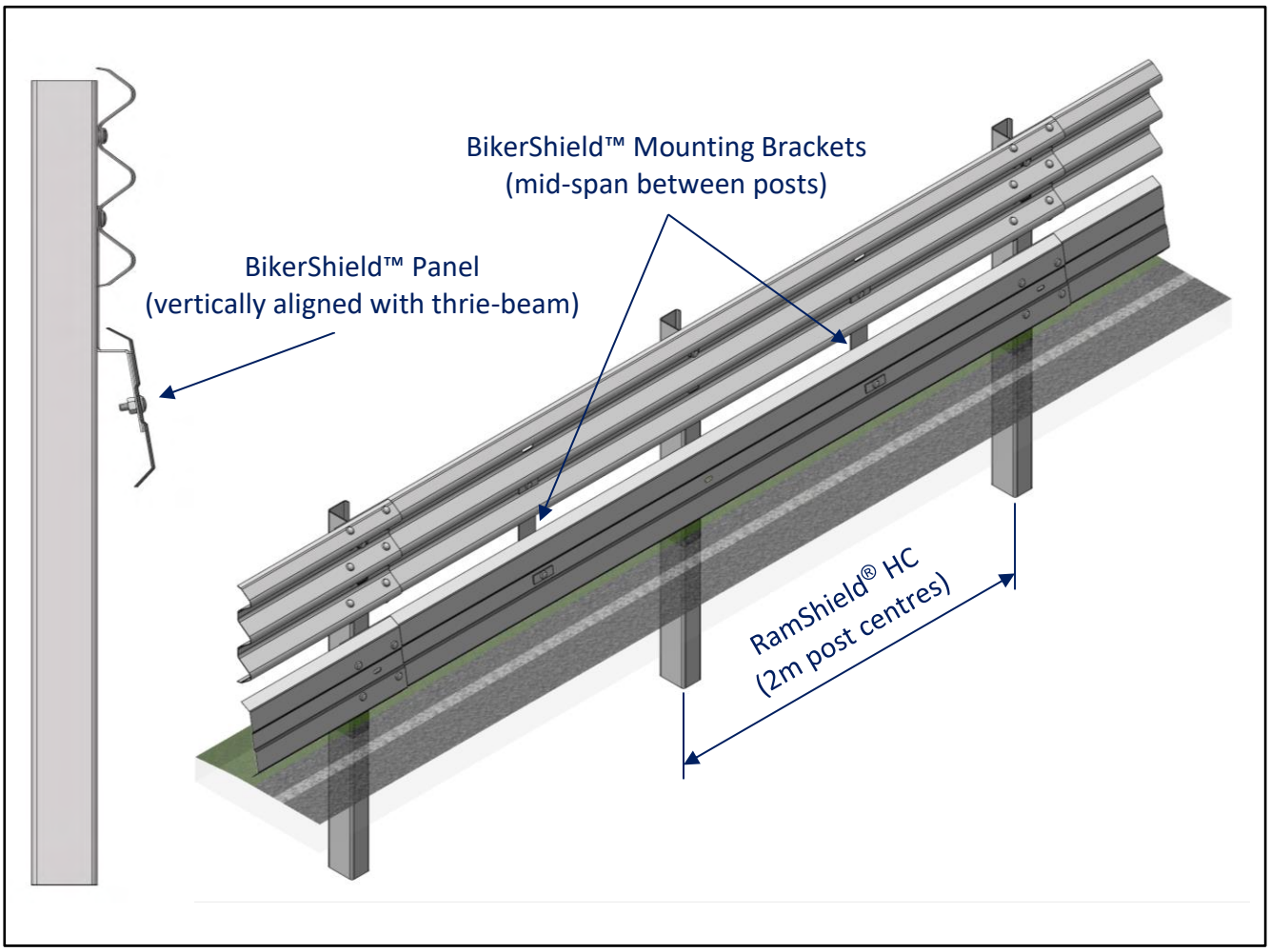


Figure 9: RamShield® HC with BikerShield™

9.0 RamShield® Edge

RamShield® Edge is a variation to RamShield® HC providing MASH TL4 compliance for installations on the hinge point of a 1:1 weak soil embankment.

RamShield® Edge restrains the RamShield® HC posts by using a pin that is driven back into the road formation at approximately 45° and is clamped to the post just below ground level. The RamShield® Edge pin is anchored in front of the barrier system therefore not relying upon lateral support behind the post. This restraint mechanism is independent of soil type, compaction level or batter geometry behind the post.

The RamShield® Edge pin prevents below-ground post movement allowing the post to yield by bending at ground level, replicating post behaviour in flat, well-compacted terrain. RamShield® Edge prevents the post from rotating through the back of the embankment, limits barrier deflection and facilitates safe vehicle containment and redirection.

The RamShield® Edge pins remained anchored into the road formation and were reused during full-scale crash testing. The restraint capacity of the RamShield® Edge pins can be validated on-site using the mobile THOR apparatus which performs a high-energy, dynamic impact.

RamShield® Edge is an economical alternative to expensive shoulder widening and embankment stabilisation. Positioning the barrier on the hinge batter conserves valuable vehicle lane width and retains important recovery space between the edge of the travelled way and the barrier.

Thrie-beam system provides numerous performance advantages when compared with a w-beam system when installed near embankments. A thrie-beam system provides lower dynamic deflection, a wider lateral catching area and deeper post embedment when compared with w-beam systems. Furthermore, a higher rail height provides improved stability for high-centre-of-gravity vehicles and thrie-beam systems are less prone to vehicles under-riding the system.

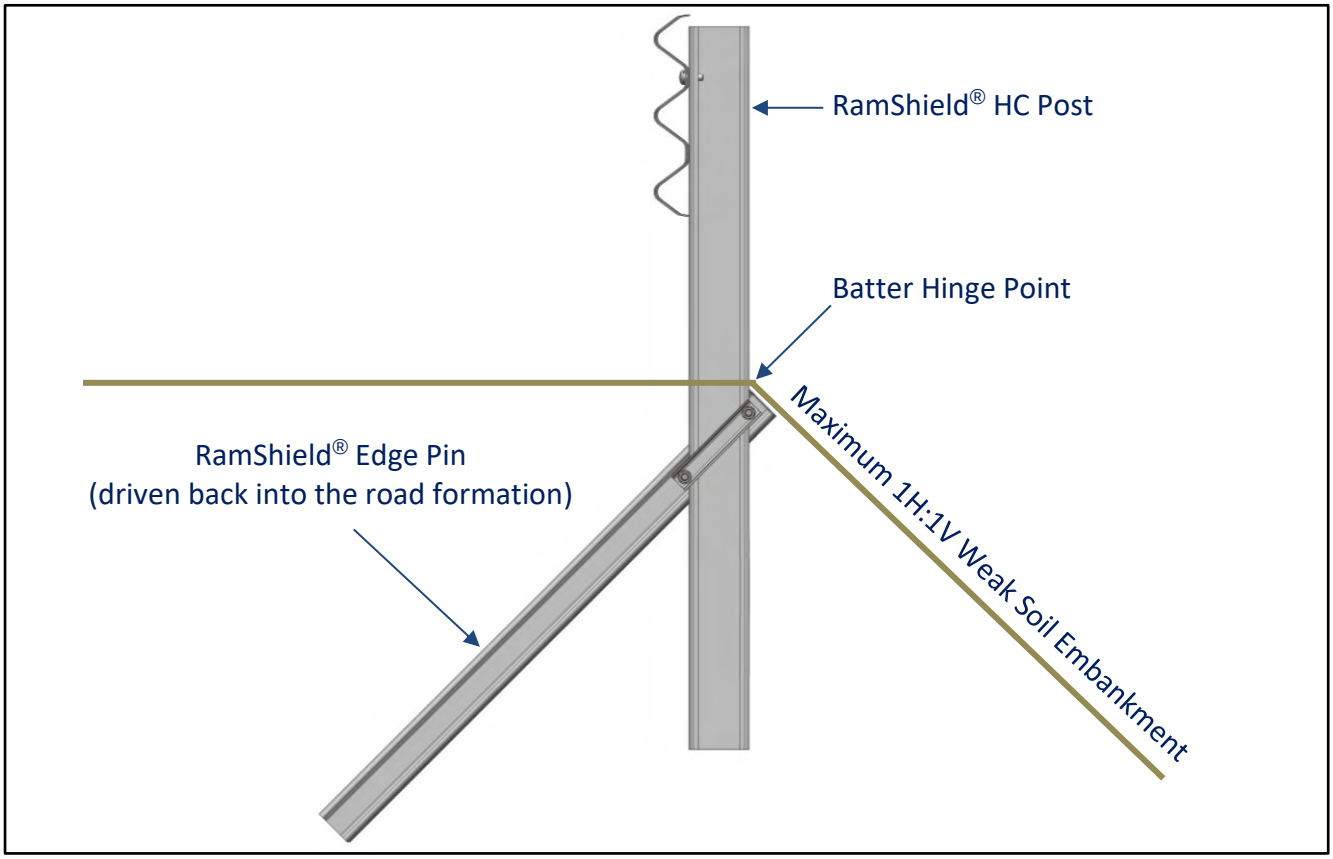


Figure 10: RamShield® Edge Pin Attachment

Figure 11: Dynamic Impacts with Mobile THOR Apparatus

Figure 12: RamShield® Edge Pins

Figure 13: Installation of RamShield® Edge on the Hinge Point of a 1:1 Weak Soil Embankment

10.0 RamShield® HC Component Identification

M16 x 32mm Splice Bolt

M16 Oversize Nut

M16 x 50mm Post Bolt

Delineator

1860mm RamShield® HC Post
(24 kg each)

4m Thrie-Beam Guardrail
(72kg each)

1.9m Asymmetric Transitions
(32kg each)

11.0 Tools Required

Tools required for the installation of RamShield® HC are the same as those used for the installation of public domain thrie-beam barriers. This includes:

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

11.1 Recommended PPE

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

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

12.0 Site Establishment

12.1 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.

12.2 Underground Services

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

12.3 Overhead Obstructions

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

12.4 Unloading Exclusion Zone

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

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

13.0 RamShield® HC Installation

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

- Set-out.
- Installing the C-posts.
- Attachment of the thrie-beam guardrail.
- Installing the trailing terminal and asymmetric transition.

13.1 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® HC does not use offset blocks. The width of the system is just 230mm.
- The standard post spacing of RamShield® is 2.0m.
- The post spacing of the asymmetric transitions and MSKT terminals is 1.905m.
- The system width of RamShield® HC differs from the system width of RamShield® W-Beam, MSKT terminals and bridge transitions.
- The RamShield® HC posts are not to be installed within the end terminal or w-beam region.

13.2 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 posts may be installed by:

- Driving with an appropriate driving head to the required depth, approximately 890mm, or
- Auguring a minimum 200mm diameter hole approximately 890mm deep, placing the post in the hole and backfilling. The backfill material is to be placed in 150mm lifts and compacted with tamping equipment.

Once installed, the top of the post should measure 970mm above ground level.

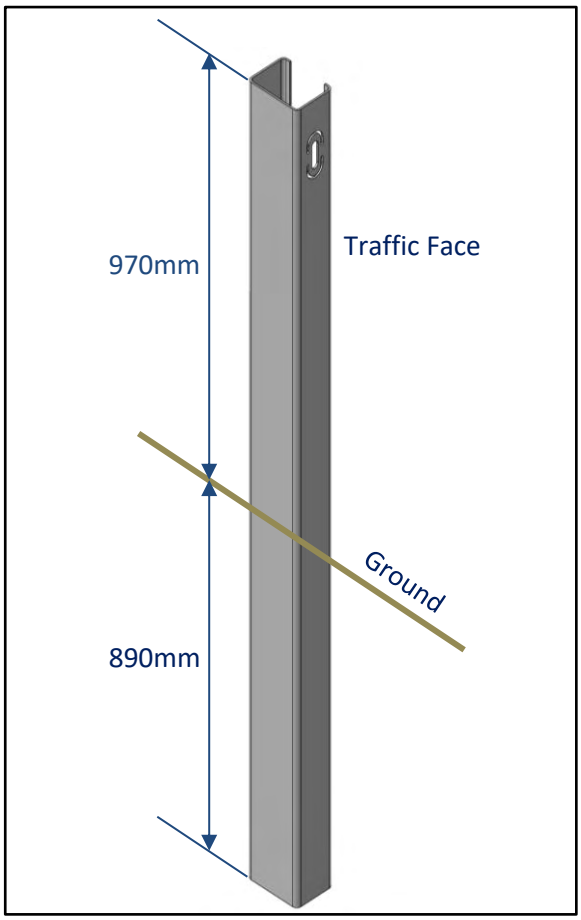


Figure 14: RamShield® HC Post Installation

13.3 Attaching the Thrie-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.*

Standard 4m thrie-beam guardrails are used throughout the RamShield® HC system. The rails are secured to the posts using a M16 x 50mm mushroom head bolt and oversize nut. The bolt passes through the upper slot in the thrie-beam rail.

The thrie-beam lap is orientated so that the leading edge of the splice is shielded from the nearside approaching traffic. Rails are spliced together using twelve (12) standard M16 x 32mm mushroom head bolts and oversize nuts. The oversize nuts are tightened using a drill driver and 32mm attachment.

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

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

Once secured to the posts, the finishing height of the thrie-beam will be approximately 30mm above the top of the posts.

Figure 15: Post to Rail and Splice Arrangement

13.4 Delineation

The RamShield® HC delineator is positioned on the top corrugation of the thrie-beam panel and secured with a splice bolt. The use of delineators is project specific and considers driver line-of-sight and barrier offset.

Figure 16: RamShield® HC Delineation

14.0 Curving of Thrie-Beam Rails

Thrie-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 thrie-beam can be used to form a radius of 45m or greater. When a radius of less than 45m is required, the thrie-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.

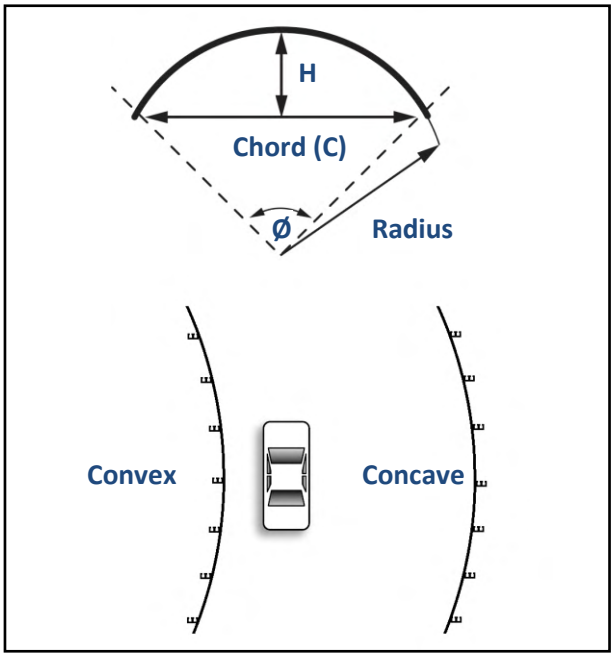


Figure 17: Curving Orientation

15.0 Installation Tolerances

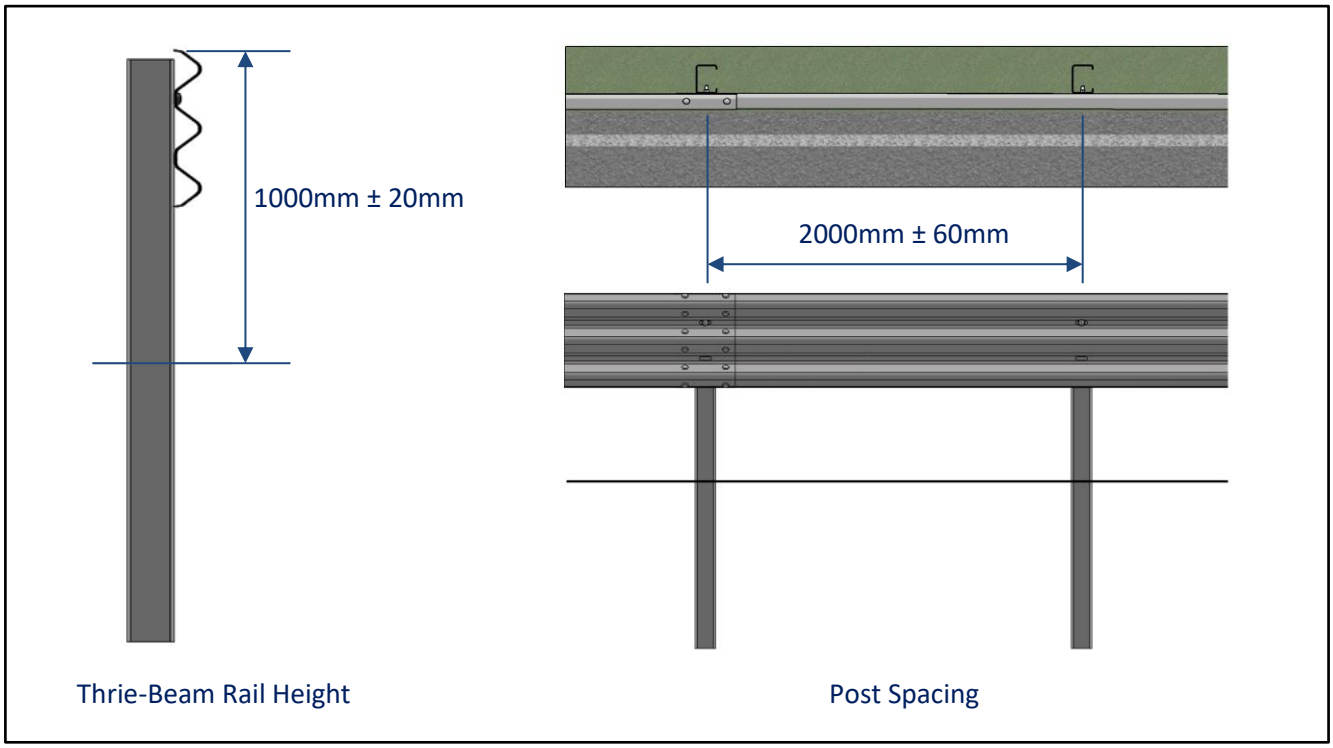


Figure 18: RamShield® HC Installation Tolerances

RamShield® HC 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	Asymmetric transitions are used to connect to w-beam guardrail.
❑ Yes ❑ No	The posts are spaced at maximum 2.0m centres.
❑ Yes ❑ No	The height measured to the top of the posts is 970mm ± 20mm.
❑ Yes ❑ No	The posts are correctly orientated with the release tab on the traffic side.
❑ Yes ❑ No	The height measured to the top of the rails is 1000mm ± 20mm.
❑ Yes ❑ No	The thrie-beam rail is secured to each post with one (1) M16 x 50mm mushroom head bolt & oversize nut.
❑ Yes ❑ No	The thrie-beam rails are spliced with twelve (12) M16 x 32mm mushroom head bolt & oversized nuts.
❑ Yes ❑ No	The rail lap is orientated so that the leading edge of the splice is shielded from approaching traffic.
❑ Yes ❑ No	All bolts are tightened.
❑ Yes ❑ No	The fill material around the posts is suitably compacted.
❑ Yes ❑ No	Any minor damage to the galvanised finish is repaired using two coats of an organic zinc rich paint.
❑ Yes ❑ No	The area around the barrier is free of debris.
Comments/Notes	

16.0 Maintenance

RamShield® HC 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 anchor assembly at the end terminals is taut and the bearing plate is correctly aligned.

17.0 Repair

In the event of a vehicle impact, damage to the barrier is to be assessed in accordance with Table 3. Typically, impacts with RamShield® HC will require replacement of damaged sections of rails and posts. It is also recommended that new bolts be used where rails and posts have been replaced.

Additional tools required for repair include:

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

Similar to the installation sequence, it is recommended that the guidelines contained in Section 12.0 be observed in the establishment of traffic control and an unloading exclusion zone in addition to investigation for underground services and overhead obstructions.

17.1 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.

17.2 Removal of Damaged Rails

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

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

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

Table 3: 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 70cm^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 70cm^2 (0.5% of the total surface area) or an individual damaged area exceeds 40cm2.	The post is to be replaced.
Damage to the galvanised coating on the rails.	The sum total of the damaged area does not exceed 250cm^2 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 250cm^2 or an individual damaged area exceeds 40cm^2.	The rail is to be replaced.
Damage to the posts.	The post is bent.	The post is to be replaced.
Damage to the post tab.	The post tab has distorted and released the post bolt.	The post 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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