F-Shape Concrete Safety Barrier - Permanent

Detail Sheet

December 2021

Abstract

This document provides the Department of Transport's (DoT's) conditions of use for F-Shape Concrete Safety Barriers.

Key Information

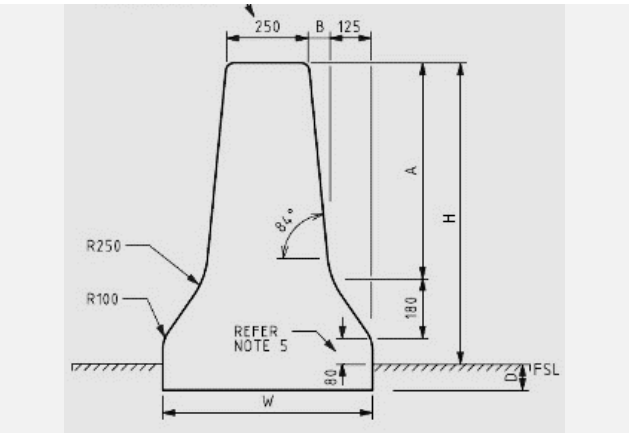
This document is intended to supplement Road Design Note 06-04 - Accepted Safety Barrier Products. Please refer to RDN 06-04 for the current acceptance status, information on the product assessment process and general acceptance conditions.

The technical conditions within this document have been extracted from crash test reports and available literature on concrete safety barriers. Where a departure from these requirements is required, users should understand the risks and document their engineering decisions.

Product Summary

Category	Permanent – Rigid Longitudinal Barriers
Test Level	MASH TL-3 MASH TL-4 MASH TL-5
Supplier	Public Domain
Description	F-Shape Concrete Safety Barrier is a permanent, rigid longitudinal barrier.

Product Image



Summary Conditions of Use

Accepted configuration	F-Shape Concrete Safety Barrier - Permanent
Variants	Verge barrier (single sided) Median barrier (double sided) Median barrier for split level carriageways (refer SD3901) Modification for sway protection (refer SD3901)
Deflection	0m
Working width	Based on test level and barrier height
Product manual	SD3901 - SD3907 and relevant Standard Sections
ASBAP issue	None

Conditions of use

Working width for concrete barriers

Concrete barrier height (mm)	MASH Test Level 3		MASH Test Level 4		MASH Test Level 5	
	2270 kg Pick-up truck		10000 kg Rigid truck		36000 kg semi-trailer	
	Cabin (mm)	Truck box (mm)	Cabin (mm)	Truck box (mm)	Cabin (mm)	Truck box (mm)
820	650	no box	*Not achievable*		*Not achievable*	
920	500	no box	1380	2300	*Not achievable*	
1100	System width	no box	1320	2200	1440	2400
1300			900	1500	900	1500
Source: Supplement to Austroads Guide to Road Design Part 6, Table V5.12a Notes: Refer notes below and RDN 06-16 for additional context and commentary.						

Standard installation configuration

Containment level	Barrier height (mm)	Point of Redirection (m)		Minimum length of barrier (m)	Maximum Anchor/Pin Spacing (m)	Minimum Embedment Depth	Working width (m)	Notes
		Leading	Trailing					
MASH TL-3	820	Entirely redirective		48	48	75mm	Refer above	Refer SD3902
MASH TL-4	920	Entirely redirective		48	48	75mm		Refer SD3902
MASH TL-5	1100	Entirely redirective		66	24	100mm		Refer SD3902
Note: While concrete barriers are entirely redirective, the transition length to achieve the desired height must be considered.								

Approved Terminals and Connections

Crash Cushions or Terminals must be fitted to both ends of a barrier	
Public Domain Products	
W-Beam Guardrail	Austroads transition permitted – Refer SD3951 to SD3956
Thrie-Beam Guardrail	Austroads transition permitted – Refer SD3951 to SD3956
Proprietary Products	
Refer to end treatment acceptance conditions for accepted connections. Some proprietary products may adopt the Austroads transition shown in SD3951 – SD3956.	

Design Guidance

System width (m)	TL-3 - 0.617 (Median variant) TL-4 - 0.638 (Median variant) TL-5 - 0.676 (Median variant)
Installation	This product must be manufactured and installed in accordance with SD3901, SD3902, SD3903, SD3904, SD3906 and SD3907
Slope limit	Side slope limit: 10 Horizontal to 1 Vertical (10%).
Systems conditions	Refer 'other consideration and comments'
Minimum installation distance from batter hinge point of the slope (m)	Concrete barrier must be suitably anchored. Minimum installation distance from barrier to batter hinge point depends on the embedment (or other restraint) detail. Refer SD3902.
Gore area use	Permitted
Pedestrian area use	Permitted
Cycleway use	Permitted
Frequent impact likely	Permitted
Remote location	Permitted
Median use	Permitted – Median barrier (double sided)

Foundation pavement conditions

Submitted Foundation Pavement Conditions					
Pavement	**Use**	**Accepted Speed (max)**	**Post/pin spacing (m)**	**Post/pin type**	**Pavement construction**
Concrete	Permitted	100 km/h	Project specific design required		
Deep lift asphalt	Permitted	100 km/h	Refer to standard drawing SD3902 for embedment depth and anchor spacing		
Asphalt over granular pavement					
Flush seal over granular pavement	Permitted	100 km/h	Project specific design required		
Unsealed compacted formation					
Natural surface					

Notes:

Deeper embedment or other anchorage methods will not affect performance and may be required to offset variations to the barrier height and or pavement conditions.

Where the specified embedment, minimum length, end anchors or intermediate anchors cannot be achieved in accordance with SD3902, then a specific anchorage must be designed and proposed. Some Australian states use a concrete foundation with dowels; others use a deeper embedment depth (250mm). Any design departures must demonstrate enough strength to resist the lateral loads and effective load heights in AS5100.2-Design Loads for a dynamic impact.

While relatively new to the industry, LS-DYNA may be used to simulate site conditions and justify the performance of an alternate anchorage. The Safe System Engineering team should be sought during this process.

Other considerations and comments:

Working Width

The working width for F-Shape concrete barriers will depend on the barrier height and the containment level. While taller concrete barriers will result in a lower vehicle roll allowance, they are often tested with larger vehicles.

The recommended working widths for concrete barrier and for vehicles that are 4.6 m high are listed in Table V5.12a of the Supplement to AGRD Part 6. This table has also been provided above for convenience.

For concrete barriers taller than 1300mm, working width should be determined using the 'point of contact' method. This method adopts a projected vehicle roll line that contacts the face of the barrier and is extended to a height of 4.6m above the pavement surface.

Refer to the Supplement to AGRD Part 6 and RDN 06-16 for additional context and commentary.

Standard Drawings

Standard Drawings 3901 to 3907 provide a set of standard requirements specific to F-Shape concrete barriers. These requirements have been based on several crash tested systems and other barrier designs used around the world.

Each drawing provides the standard requirements for a different component of the concrete barrier, allowing for compliance, departure and innovation to be managed.

These components include;

- Profile – SD3901,
- Installation – SD3902,
- Precast Manufacture – SD3903,
- Precast Connection – SD3904, and
- Delineation – SD3905.
- Slip Form Installation/Manufacture – SD3906
- Slip Form Terminals – SD3907

This information below provides important background info and commentary related to each concrete barrier standard drawing. It should be used when considering departures or possible alternatives.

F-Shape Profile

SD3901 outlines the shape requirements for achieving an F-Shape safety barrier. The F-Shape has been widely tested and is the preferred shape by DoT. Changes to any dimension should be carefully considered. The most common changes required are Height, Kerb Reveal and Sway Protection.

Height:

A minimum height of 820mm, 920mm and 1100mm, measured from pavement level, is needed to achieve MASH TL-3, TL-4 and TL-5 respectively. Height from pavement may vary across a single precast unit, provided the minimum requirement is met.

Taller heights are acceptable but may require additional anchorage. Taller barrier heights should extend the 84 degrees upper face as needed or include sway modification.

Lower heights will mean a lower level of containment. Over the life of a concrete barrier 25-50 years, pavement overlay may cause the barrier to reduce in overall height. The project will need to recognise this potential drop in containment level and may plan for it at the initial construction. While undesirable, DoT acknowledges some reduction in height will occur over the life of barrier, making the initial installation critical.

Kerb Reveal:

To maximise the performance of the F-Shape profile, the profile should have an 80mm maximum kerb reveal above the finished surface level. As such, 80mm (+0/-20mm) should be nominal – and values between 60-20mm should be justified to ensure the departure was minimised as much as possible. The absolute minimum allowable kerb reveal is 20mm, beyond which the effect to performance is considered unacceptable.

Other considerations of kerb reveal:

- Construction tolerances are reasonable in the range of +0/-20mm.
- Locations with complex road geometry may also affect the kerb reveal. The Designer must submit their planned approach if required to reduce the kerb reveal. Separator barriers, such as median barriers, could be an example of this. Affected barriers must still meet all minimum dimension requirements to meet the desired Test Level.
- Over the life of a concrete barrier 25-50 years, pavement overlay may cause the kerb reveal to decrease; while undesirable, this is a reasonable reduction.

Sway Modification:

When a typical passenger vehicle impacts the F-Shape, it mounts the kerb reveal and slides up the barrier before being redirected. Modifications to the upper profile may change the severity of the impact and should be avoided. The picture below is an unacceptable example; as this change in shape will negatively affect every vehicle that impacts the barrier, including those that impact before the modification and slide along the barrier.

DoT does acknowledge that sway modifications can reduce vehicle roll for trucks when hazards can't be relocated or moved further back. It is critical that the balance between reducing roll and effecting passenger vehicle impacts is managed. DoT requires the modification to begin 920mm (the TL-4 height) or more above the surface level to ensure the effects to smaller vehicles are reduced. DoT recommends a 30mm maximum protrusion to minimise snag and impact severity.

CEOS TIRTL

Modifications to the F-Shape profile may be required for the purpose of installing CEOS TIRTL devices. As such, all modifications must be undertaken in accordance with the product installation manual.

Installation:

SD3902 outlines the standard requirements to install a concrete barrier as a test level 'system'. Concrete barriers are designed to be fixed/rigid during an impact and although most concrete barriers have been crash tested using a slip-form construct, thereby making the entire barrier a single unit/system, the precast installation method in SD3902 has been designed as an equivalent.

Minimum length and embedment depth:

SD3902 provides a minimum embedment depth and installation length for the standard barrier heights (820mm, 920mm and 1100mm).

Where this restraint cannot be achieved through embedment or length, an equivalent (or suitable) restraint must be designed and approved.

Load transfer:

This barrier is designed to work as a 'self-sufficient system', where the impact energy is transferred along the barrier into adjacent barrier units or the terminal foundation. Where any potential impact load is being transferred into another asset, such as a retaining wall or structural foundation, then the system becomes a structural asset and must be designed in accordance with AS5100 and Bridge Technical Notes.

In-fill behind barrier:

This barrier system is designed to be fixed/rigid; therefore, an infill can be provided between the back of barrier and a cut batter. If the in-fill creates a potential energy transfer into another asset, then the system becomes a structural asset and must be designed in accordance with AS5100 and Bridge Technical Notes.

Split level carriageways:

Where the split-level carriageway is 600mm or less, the embedment method shown in SD3902 can be used. Where the split-level carriageway is greater than 600mm, the barrier stability is a concern and the system should be designed and anchored in accordance with AS5100; this is considered a structural asset.

Pre-Cast Connections:

This barrier is designed to work as a 'system', in which the impact energy is transferred along the barrier into adjacent barrier units or the terminal foundation. Given that most concrete barriers have been crash tested using a slip-form construct, the connections between precast units should provide an equivalence and must allow for load transfer into adjacent barrier units. It is extremely important that the connections are grouted to transfer longitudinal loads and connected to transfer lateral (and tipping) loads. Refer SD3904 – Pin & Loop for more information.

End Treatments:

The end of a concrete barrier is considered a hazard if it can be impacted head-on. It must be shielded with a crash cushion or transitioned into a thrie-beam or w-beam system in accordance with SD3951 to SD3956. The concrete profile shown in these drawings may be used with a 3.0m long x 250mm deep foundation where the installation conditions in SD3902 are achieved.

Lighting:

DoT does not currently provide standard drawings for lighting schemes; hence they must be designed for each project.

References

1. AS/NZS 3845.1:2015 – Road safety barrier systems
2. Austroads Guide to Road Design – Part 6 (2020)
3. DoT Road Design Note 06-04 – Accepted Safety Barrier Products
4. DoT Standard Drawings - SD3901, SD3902, SD3903, SD3904, SD3905, SD3906 and SD3907
5. DoT Standards Section 610 – Structural Concrete
6. DoT Standards Section 716 – Slip formed concrete barriers
7. DoT Supplement to Austroads Guide to Road Design – Part 6 (2021)

Revision History

Version	Date	Clause	Description of Change
1.0	Dec 2019	All	First version
2.0	Oct 2021	Various	• New DoT format • Updated working widths based on the Supplement to AGRD Part 6 (v4.0). • Additional notes on 'minimum length and embedment depth'. • Additional notes on the use of CEO TIRTL devices. • Additional notes on the use of Austroads' transition from guard fence to concrete barrier. Reference to SD3951 to SD3956 also added. Reference to SD4081 removed. • Reference to SD3906, SD3907 and Standard Section 716 added for slip form concrete barriers.

Contact Details

Manager – Road Design and Safe System Engineering
Road and Traffic Engineering, Department of Transport
60 Denmark St, Kew Vic 3101
Email: safesystemengineering@roads.vic.gov.au