F-Shape Concrete Safety Barrier (rigid) – Permanent

Product summary

<table>
<thead>
<tr>
<th>Status</th>
<th>Accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Permanent – Rigid Longitudinal Barriers</td>
</tr>
<tr>
<td>Test Level</td>
<td>MASH TL-3, MASH TL-4, MASH TL-5</td>
</tr>
<tr>
<td>Supplier</td>
<td>Public Domain</td>
</tr>
<tr>
<td>Description</td>
<td>F-Shape Concrete Safety Barrier is a permanent, rigid longitudinal barrier.</td>
</tr>
</tbody>
</table>

Introduction and purpose

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

The technical details 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.

For more detailed product information, refer to VicRoads Standard Drawings.

Technical information

The F-Shape Concrete Safety Barrier should be designed, installed and maintained in accordance with the following VicRoads conditions for use.

These conditions for use have been based on crash test reports and available literature on concrete safety barriers.

Summary Conditions for Use

<table>
<thead>
<tr>
<th>Accepted configuration</th>
<th>F-Shape Concrete Safety Barrier (rigid) - Permanent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variants</td>
<td>Verge barrier (single sided)</td>
</tr>
<tr>
<td></td>
<td>Median barrier (double sided)</td>
</tr>
<tr>
<td></td>
<td>Median barrier for split level carriageways (refer SD3901)</td>
</tr>
<tr>
<td></td>
<td>Modification for sway protection (refer SD3901)</td>
</tr>
<tr>
<td>Deflection</td>
<td>0m</td>
</tr>
<tr>
<td>Working width</td>
<td>Based on test level and barrier height</td>
</tr>
<tr>
<td>Product manual reviewed</td>
<td>N/A</td>
</tr>
<tr>
<td>ASBAP issue</td>
<td>None</td>
</tr>
</tbody>
</table>

Refer VicRoads conditions for use (below).
VicRoads Conditions for Use

Tested design requirements

<table>
<thead>
<tr>
<th>Containment level</th>
<th>Vehicle mass (kg)</th>
<th>Point of Redirection (m)</th>
<th>Minimum length of barrier (m)</th>
<th>Maximum Anchor/Pin Spacing (m)</th>
<th>Minimum Embedment Depth (m)</th>
<th>Dynamic deflection (m)</th>
<th>Working width (m)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Leading</td>
<td>Trailing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MASH TL-3</td>
<td>2270</td>
<td>48</td>
<td>48</td>
<td></td>
<td>0.075</td>
<td>0</td>
<td>0.617</td>
<td>Minimum 820mm high</td>
</tr>
<tr>
<td>MASH TL-4</td>
<td>10000</td>
<td>8</td>
<td>8</td>
<td>48</td>
<td>48</td>
<td>0.075</td>
<td>0</td>
<td>Minimum 920mm high</td>
</tr>
<tr>
<td>MASH TL-5</td>
<td>36000</td>
<td>30</td>
<td>30</td>
<td>66</td>
<td>24</td>
<td>0.1</td>
<td>0</td>
<td>Minimum 1100mm high</td>
</tr>
</tbody>
</table>

Approved Terminals and Connections

- **Crash Cushions or Terminals must be fitted to both ends of a barrier**

Public Domain Products
- W-Beam Guardrail: Permitted – Refer SD4801
- Thrie-Beam Guardrail: Not permitted

Proprietary Products
- Refer to end treatment acceptance conditions for accepted connections

Design Guidance

- **System width (m)**
  - TL-3: 0.617 (Median)
  - TL-4: 0.638 (Median)
  - TL-5: 0.676 (Median)

- **Installation**
  - This product must be manufactured and installed in accordance with VicRoads SD3901, SD3902, SD3903 and SD3904.

- **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)**
  - 1.5 – 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

<table>
<thead>
<tr>
<th>Pavement</th>
<th>Use</th>
<th>Accepted Speed (max)</th>
<th>Post/pin spacing (m)</th>
<th>Post/pin type</th>
<th>Pavement construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>Permitted</td>
<td>100 km/h</td>
<td></td>
<td></td>
<td>Project specific design required</td>
</tr>
<tr>
<td>Deep lift asphaltic concrete</td>
<td>Permitted</td>
<td>100 km/h</td>
<td></td>
<td></td>
<td>Refer to standard drawing SD3902 for embedment depth and anchor spacing</td>
</tr>
<tr>
<td>Asphaltic concrete over granular pavement</td>
<td>Permitted</td>
<td>100 km/h</td>
<td></td>
<td></td>
<td>Not Permitted</td>
</tr>
<tr>
<td>Flush seal over granular pavement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unsealed compacted formation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- Deeper embedment 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 selected. While taller concrete barriers will result in a lower vehicle roll allowance, they are often tested with larger vehicles.

For TL-3 (820mm high), the barrier is tested with a 2270kg passenger vehicle and the working width is equal to dynamic deflection (0m) plus system width (0.617m).

For TL-4 and TL-5 (920mm-1100mm high), the barriers are tested with larger vehicles (10T and 36T) and vehicle roll must be determined based on the barrier height.

The vehicle roll allowance must be determined using the barrier “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 4.0-4.6m above the pavement surface.

Please note; the DoT (formerly VicRoads) is currently reviewing the “Zone of Intrusion” (ZOI) concept, as described in Section 5.5.2 of the AASHTO Roadside Design Guide 2011, which may eventually supersede the point of contact method above.

### VicRoads Standard Drawings:

Standard Drawings 3901 to 3905 provide a set of requirements specific to F-Shape concrete barriers. These requirements have been based on several crash tested systems and other barrier designs being used around the world.

Each drawing provides the 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,
- Manufacture (Precast) – SD3903,
- Connection (Precast) – SD3904, and
- Delineation – SD3905.

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 VicRoads. 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. Taller barrier heights should extend the 84 degrees upper face as needed or include sway modification. Heights above 1100mm may require additional anchorage.

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, VicRoads 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. 80mm (+0/-20mm) should be nominal - values between 60-20mm should justify reasons for departing and that 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; 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.

VicRoads 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. VicRoads 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. VicRoads recommends a 30mm maximum protrusion to minimise snag and impact severity.

Lighting:
We do not currently provide standard drawings for lighting schemes; hence they must be designed for each project.

Installation:
SD3902 outlines the requirements to install a concrete barrier as a ‘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.

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 600m 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 guard fence system in accordance with SD4081. The concrete profile shown in SD4081 may be used with a 3.0m long x 250mm deep foundation to anchor the concrete barrier.

References
- VicRoads Road Design Note 06-04 Accepted Safety Barrier Products.
- VicRoads Commentary Note (internal) on Concrete Barriers – Test Level.
- VicRoads Standard Drawings – SD3901, SD3902, SD3903, SD3904, SD3905.

Detail Sheet – Update Summary

<table>
<thead>
<tr>
<th>Issue</th>
<th>Approved</th>
<th>Amendment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 2019</td>
<td>M-SSD</td>
<td>First edition</td>
</tr>
</tbody>
</table>