

PARTICULAR SPECIFICATION

APPENDIX M

**CONCRETE SAFETY BARRIERS – GUIDE FOR PROPER
SELECTION AND INSTALLATION**

1. Overview of the common types of concrete safety barriers used in Singapore



(A) Precast Concrete Safety Barrier using pin-and-loop assembly



(B) Precast Concrete Safety Barrier using tongue-and-groove connection



(C) Cast-in-situ concrete safety barrier



(D) P1-2 bridge parapet wall

This is not a design standard. The Contractor shall apply, and rely upon their own professional skills and judgement to the particular issue which they are considering, based on relevant design standards. LTA does not accept responsibility for any consequence arising from the use of the information contained in this guide.

2. Details of Precast Concrete Safety Barrier using pin-and-loop assembly



Design features

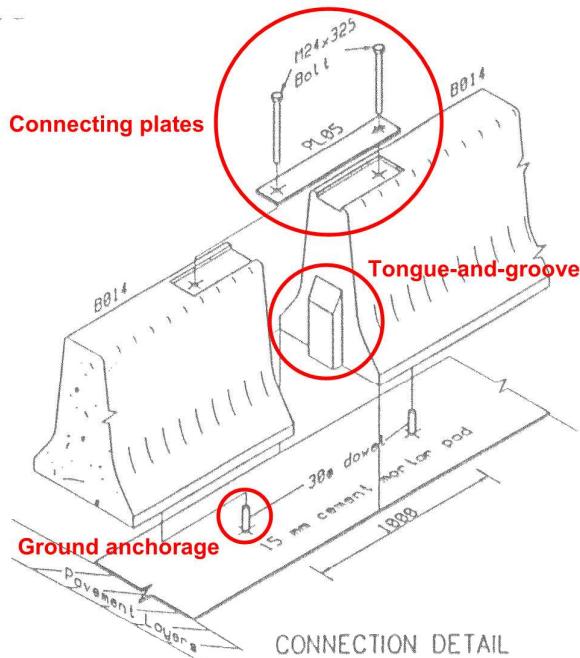
- The design is based on the Oregon F-shaped precast concrete safety barrier.
- Individual segments are connected using pin-and-loop assembly.
- The precast barriers can also be anchored to the ground.

Application

- **Using pin-and-loop assembly only :** This arrangement is particularly suitable if the temporary traffic schemes will be implemented over a number of stages where the carriageway alignment has to be shifted frequently. As the barriers are not anchored to the ground, the barriers may move backwards when impacted. Based on an impact speed of 100 km/hr by a 2000 kg vehicle at an angle of 25 degrees, the barrier deflected by 760mm. Therefore, where only pin-and-loop assembly is used, it is necessary to ensure that there is sufficient space behind the barrier for deflection.
- **Using pin-and-loop assembly and ground anchor :** This arrangement is required where there is insufficient space behind the barrier for it to deflect when hit by an errant vehicle. Such locations include centre divider and work zone where excavation works are being carried out.

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3. Details of Precast Concrete Safety Barrier using tongue-and-groove connection



Design features

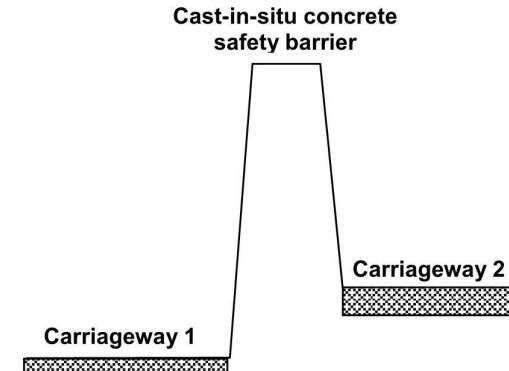
- The design is based on the Roads and Traffic Authority, New South Wales, Australia, Type F precast concrete safety barrier.
- Individual segments are connected using :
 - Tongue and groove,
 - Connecting metal plates, and
 - Ground anchorage.

Application

- The specified connection details are required, in addition to the ground anchorage, to ensure that vehicles will not penetrate the safety barrier when impacted.
- As compared to Type 1 portable concrete safety barrier, due to the need to use ground anchorage, Type 2 barrier is relatively less suitable if the temporary traffic schemes will be implemented over a number of stages where the carriageway alignment has to be shifted frequently.
- The use of metal connecting plates may also make it more difficult to use at locations with tight horizontal road bends.

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4. Details of Cast-In-Situ Concrete Safety Barrier



Schematic example of cast-in-situ concrete safety barrier which can be used to cater to the level difference on both sides of the barrier

Design features

- The design is based on the vertical-shaped concrete safety barrier.
- The traffic face of the barrier is inclined at an angle of 3 degrees.

Application

- The barrier is generally used for permanent installation.
- Primarily used where there is insufficient space behind the barrier for it to deflect when hit by an errant vehicle.
- For temporary traffic diversion schemes, the barrier is particularly suitable to be used along a centre divider where there is a level difference between both sides of the centre divider. This is because, the safety barrier can be fabricated on site to suit the terrain and site conditions.

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5. Details of P1-2 Bridge Parapet Wall



Design features

- The total height of the barrier is 1.5m.
- The barrier consists of a 800mm concrete wall and a 700mm metal railings.

Application

- The barrier is generally used for permanent installation.
- Primarily used along bridge structures for height protection.
- For temporary traffic diversion schemes, the barrier can be used to provide height protection, where required, in compliance with LTA Design Criteria.

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6. Deflection zone and delineation for portable concrete safety barrier



(A) Deflection zone for portable concrete safety barrier

For temporary portable concrete safety barriers which are not anchored to the ground (e.g. those using pin-and-loop connection), the safety barriers will deflect backwards when impacted by an errant vehicle. Therefore, there should be sufficient lateral set-back of the safety barrier away from the roadside hazards to provide the required deflection zone. The required set-back will depend on the type of the portable concrete barrier, and this can be obtained from the design specifications.

If there is insufficient space along the centre divider or sidetable to provide the required setback, the portable concrete safety barriers have to be anchored to the ground.

(B) Delineation for portable concrete safety barrier

Retro-reflective discs are mounted on top of the concrete safety barrier to provide adequate delineation during adverse weather conditions.

7. Provision of edge line and lateral offset of safety barrier from traffic lanes



Motorists tend to “shy away” from traveling too close to the edge of the traffic lane where there are physical devices or structures such temporary safety barriers, water-filled safety barricades etc. Therefore sufficient lateral offset has to be provided between the safety barriers and the edge of the traffic lane.

Based on the Code of Practice for Traffic Control at Work Zone, the required lateral offset for expressways and non-expressways are 500mm and 300mm respectively.

If the concrete safety barriers are located along the outer radius of a road bend, the lateral offset should be increased to guide motorists from traveling too close to the concrete safety barriers as they negotiate the road bend.

8. End treatment for concrete safety barriers : Use of crash-cushion

Examples of crash cushion that can be used for temporary road works :



ACZ-350 (Energy Absorption)

Absorb 350 (Barrier System)

Description :

A proper end treatment is required to shield the leading terminal of the concrete safety barrier to reduce the severity of impact if it is hit by an on-coming vehicle.

Crash cushions are typically used to shield the leading terminal of safety barriers along high speed road environment (≥ 70 km/hr). However, the use of a crash cushion may also be warranted at lower speed environment if there is a risk of vehicles veering off the carriageway and impacting the leading terminal of the safety barriers. Such locations include the gore area of an exit, carriageway bifurcation and road bends. As site conditions vary from site to site, a proper risk assessment should be undertaken to determine the required hazard management measures.

Similar to the main section of the safety barrier, the crash cushion must also be certified to comply with the crash-test evaluation standards for roadside devices, such as NCHRP 350 or BSEN 1317, as specified in the Code of Practice for Traffic Control at Work Zone.

As a crash cushion is typically a proprietary product, the contractor has to engage the Manufacturer Certified Installer to design and certify the installation to ensure that the system will be able to perform as intended.

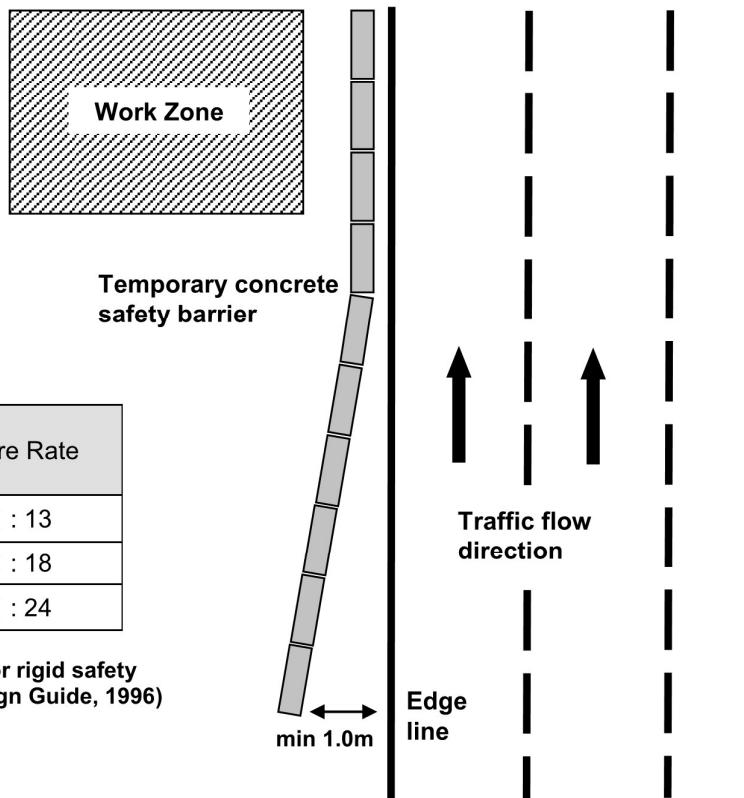
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9. End treatment for concrete safety barriers : Flaring of leading terminal

(Drawings are not to scale)

85th percentile speed (km/hr)	Flare Rate
50	1 : 13
70	1 : 18
90	1 : 24

Recommended flare rate for rigid safety barriers (AASHTO Road Design Guide, 1996)



Description :

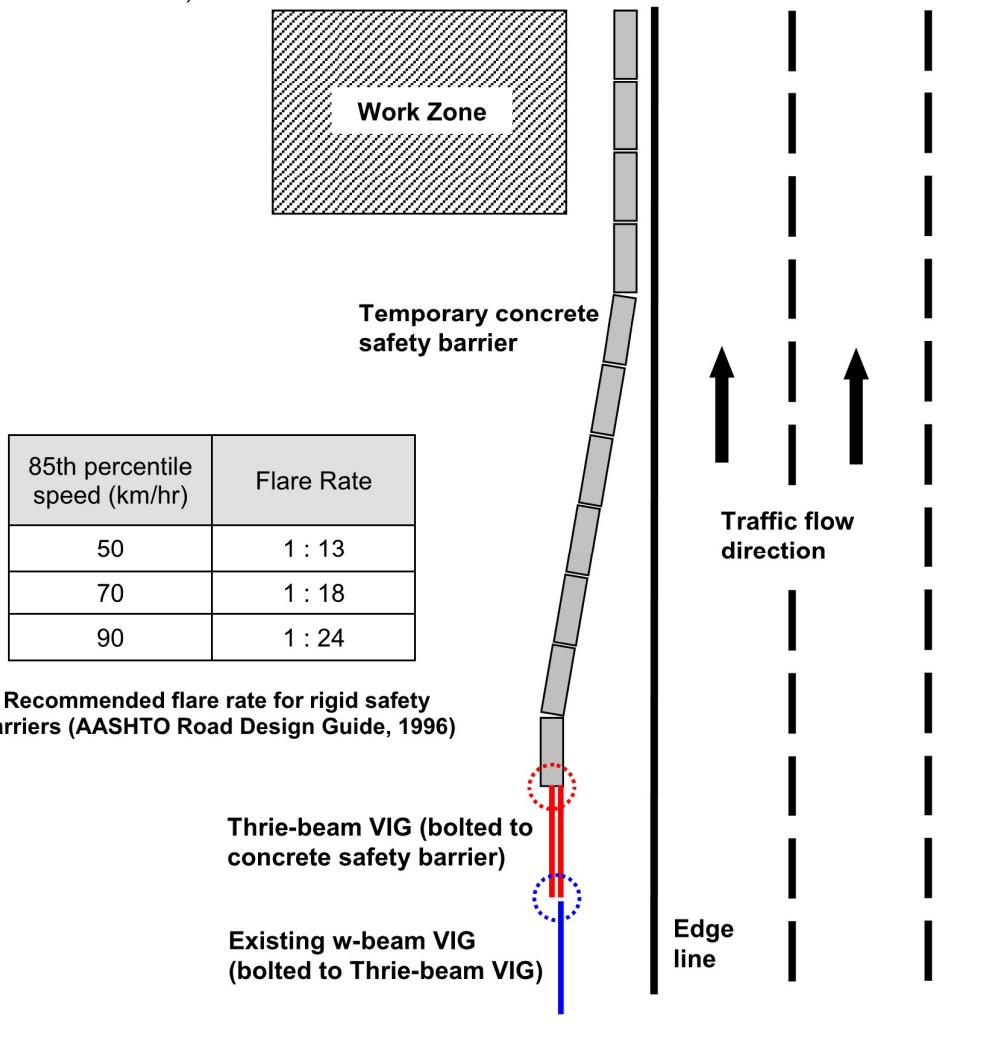
If a vehicle strikes the leading terminal of the temporary precast concrete safety barrier, it will result in a severe collision. Therefore it is essential that the leading terminal of the precast concrete safety barrier be properly treated using a typed-approved end treatment.

At low speed environment (< 50 km/hr), the leading section of the temporary precast concrete safety barrier can be flared away (at a controlled rate) from the direction of on-coming vehicles at a minimum offset of 1.0m (see above illustration).

This arrangement can only be applied if there is a low risk of vehicles veering off the carriageway and impacting the leading terminal of the safety barrier. As site conditions vary from site to site, a proper risk assessment should be undertaken to determine the required hazard management measures. If this type of end treatment is not suitable, then the use of a crash cushion has to be considered.

10. End Treatment for concrete safety barriers : Transition to existing safety barrier

(Drawings are not to scale)



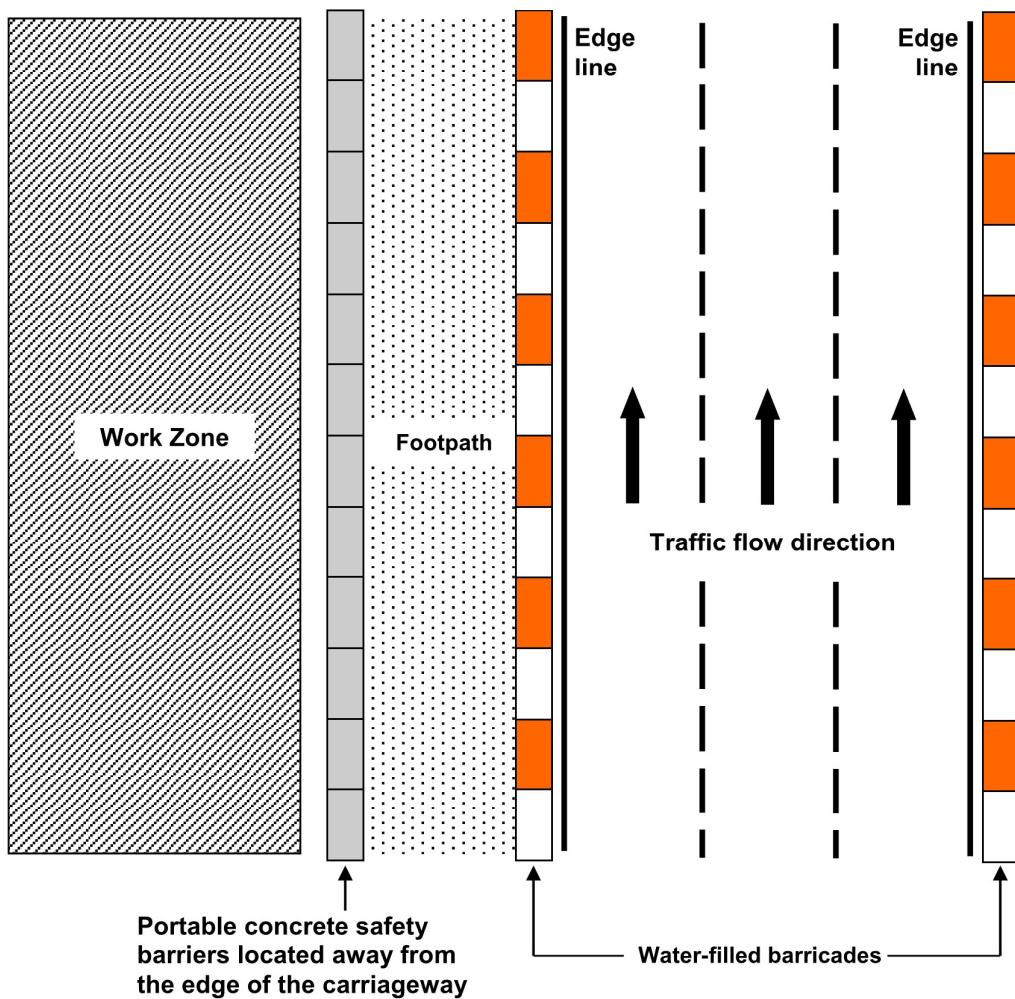
If the road works are carried along the main section of the carriageway, the temporary concrete safety barriers can be connected to the existing safety barriers.

For example, the temporary concrete safety barriers can be connected to the existing w-beam VIG by using a Thrie-beam transition section (see above illustration).

If the existing w-beam VIG is not aligned with the temporary concrete safety barriers parallel to the carriageway, a flare rate appropriate to the operating speed of the carriageway has to be applied to the temporary concrete safety barriers.

11. Placement of concrete safety barrier along an existing footpath

(Drawings are not to scale)



Description :

At locations where the existing footpath is along the edge of the carriageway, the concrete safety barriers can be located along the inner side of the sidetable. Water-filled barricades can be installed at the edge of the carriageway for delineation purposes.

If the safety barrier has to be located at the edge of the carriageway, a proper layout and type of end treatment should be provided to reduce the likelihood and severity of a collision at the leading terminal of the safety barrier.