(Draft)

Guidelines and Design Specifications

For

Crash Barriers, Pedestrian Railings and Dividers

(For Public Observations/ Suggestions)
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1. Introduction

With an exponential growth of vehicular traffic, the pedestrians in the city are often exposed to accidents and are marginalized in the mobility network. The pedestrians are invariably channelised on the narrow footpaths which sometimes are encroached. They are expected to use the pedestrian underpasses or foot-over bridges to cross the high volume traffic roads. With the increasing flyovers and speeds, the frequency of accidents involving the pedestrians has increased.

With the objective to ensure the entitlements of the pedestrians in terms of mobility, safety and convenience, slow and fast vehicular traffic crash barriers, dividers and pedestrian’s railings on the central verge are often provided, together with Foot Over Bridges (FOB), sub-ways etc. Many times the FOB’s and sub-ways are underused as they cause inconvenience and insecurity to the users. As a result, the pedestrians are seen jaywalking and climbing over the barriers and railings in order to cross the high intensity, high speed roads and flyovers. As such, it is necessary to provide wide and safer pedestrian corridors. In the areas/ roads with high pedestrian traffic, it may be necessary to provide pedestrian corridors at grade while the motorised vehicles move up and down.

This may be possible by raising the carriageway of the road by about 2.4 meters, so that pedestrians keep moving freely at the ground level for crossing the roads. Such facility should be provided in front of the Railway Stations, Metro Stations, ISBT, Exhibition Ground, large commercial center and office complexes (such as ITO, RK Puram, Central Secretariat, etc.)

2. Definitions

2.1 Crash Barrier

Crash barriers are designed to withstand the impact of vehicles of certain weights at certain angle while traveling at the specified speed. They are expected to guide the vehicle back on the road while keeping the level of damage to vehicle as well as to the barriers within acceptable limits.

2.2 Pedestrian Railing between Footpath and Carriageway/ Central Verge

Where considerable pedestrian traffic is expected, railing in the median of the road and reinforced concrete crash barrier is provided separating the vehicular and pedestrian traffic. For rigid railing, the strength should be equivalent to that of rigid RCC type. For areas of low intensity of pedestrian traffic, semi-rigid type of railings, such as concrete, steel, etc. can be adopted.

2.3 Dividers

Dividers are usually provided to earmark the segregated movement of a particular type/category of traffic, such as, segregating through carriageway from a service road for local traffic, segregating light and heavy traffic, segregating through traffic from turning traffic and dedicated BRT corridor and corridors for non-motorised transport (cycles, rickshaws etc.). The dividers can be within form of low height central verge, curb, railing, etc. which can be either permanent (steel, concrete etc) or flexible/ movable, shiftable such as rubberised cones, precast curbs and electrically/ mechanically operated shiftable divider railings.
3. **Guiding Principles**

3.1 To ensure and safeguard pedestrian Right of Way, safety and accessibility, including wheelchairs.
3.2 To ensure vehicle and driver’s safety
3.3 To promote segregated traffic movement for various types of traffic and categories of vehicles
3.4 To offer the flexibility for adjustment of central verge/ barrier/ railing according to directional volume of traffic.
3.5 To synchronise design with the road users/ pedestrians behavior and needs
3.6 To evolve design with sensitivity to the aspects of aesthetics, sight lines, streetscape, lighting and heritage.
3.7 To consider the cost/ economy factors
3.8 Ease of maintenance

4. **Crash Barrier**

Ideally a crash barrier should present a continuous smooth face to an impacting vehicle, so that the vehicle is redirected, without overturning, to a course that is nearly parallel to the barrier face and with a lateral deceleration, which is tolerable to the motorist. To achieve these aims the vehicle must be redirected without rotation about both its horizontal or vertical axis (that is, without 'spinning out' or overturning), and the rate of lateral deceleration must be such as to cause the minimum risk of injury to the passengers.

4.1 **Objectives**

   a) Reducing the likelihood of a vehicle crossing the central reserve and reaching the opposite carriageway.
   b) Minimising the damage to a barrier and vehicle, following vehicle strike and also reducing the risk to the workforce and work related congestion.
   c) Being maintenance-free and having a life of 25 to 50 years.

4.2 **Types of Crash Barriers**

In view of the above factors, various options should be considered in evolving the need, location and design of the crash barriers, central railings and dividers.

   i. No provision, vehicular carriageway raised for pedestrian walkway at grade.
   ii. 15 cm to 30 cm high curb stone.
   iii. Flexible/ removable/ sinking divider or railing.
   iv. Water filled plastic jerry can safety barrier.
   v. Reinforced Glass/ Plastic/ Rubber railing.
   vi. Jersey Barriers (concrete) and its variations (constant slope, F shape, Jali, etc).
   vii. Steel concrete barriers, Railings, Fencing etc.
   viii. Hybrid combining two or more options
According to IRC, following are the categories of crash barriers:

<table>
<thead>
<tr>
<th>Category</th>
<th>Application</th>
<th>Containment for</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-1: Normal Containment</td>
<td>Bridges carrying expressway, or equivalent</td>
<td>15 kN vehicle at 110 km/h, and 20 degree angle of impact</td>
</tr>
<tr>
<td>P-2: Low Containment</td>
<td>All other bridges except bridge over railways</td>
<td>15 kN vehicle at 80 km/h, and 20 degree angle of impact</td>
</tr>
<tr>
<td>P-3: High Containment</td>
<td>At hazardous and high risk locations, over busy railway lines, complex interchanges, etc.</td>
<td>30 kN vehicle at 60 km/h, and 20 degree angle of impact</td>
</tr>
</tbody>
</table>

According to the IRC (6-2000) the crash barriers shall be provided at the following locations:

i. For bridges without foot paths, concrete crash barriers shall be provided at the edge of the carriageway.

ii. The type design for the crash barriers may be adopted as per IRC:5. The design loading for the barriers shall be as per Clause 209.7 of IRC:6.

iii. For bridges with foot paths, pedestrian railing shall be provided on the outer side of footpath.

iv. The railings of existing bridges shall be replaced by crash barriers, where specified in Schedule-B of the Concession Agreement.

v. Parapets/ Railings of the existing bridges/ culverts to be repaired/ replaced shall be specified in Schedule-B of the Concession Agreement.

In the urban environment traffic barriers are needed on urban motorways and primary distributors, where speeds are high and dangerous.

Traffic barriers should be erected on both sides of roads on embankments 6m high or more and on the outer edge of the roads where the radius is 850m or less and the embankment height 3m or more.

Barriers may also be needed on an embankment where there is road, railway or river at the foot, on bridges with lightly built parapets or to protect bridge piers or other obstruction on the central reserve or verges.

Fig 1: Barrier Placement

![Barrier Placement Diagram](source: IRC: SP: 73-2007)
Crash barriers can be rigid type, using cast-in-situ precast reinforced concrete panels, or of flexible type constructed using metallic cold-rolled and/or hot-rolled sections, the metallic type, called semi-rigid type, suffer large dynamic deflection of the order of 0.9 to 1.2m, or on impact, whereas, the 'rigid' concrete type suffer comparatively negligible deflection. The efficacy of the two types of barriers is established on the basis of full size tests carried out by the laboratories specializing in such testing. Due to the complexities of the structural action the value of impact force cannot be quantified.

Fig 3: Barrier cast-in-situ design
A certificate from such laboratory can be the only basis of acceptance of the semi-rigid type, in which case all the design details and construction details tested by the laboratory are to be followed in to without modifications, and without changing relative strengths and positions of any of the connections and elements.

Fig 4: Barrier cast-in-situ design

Source: IRC: SP: 73-2007

Fig 5: Barrier cast-in-situ design

Notes:
Concrete Compressive Strength
4,000 PSI @ 28 days
Weight 2000 Lbs

Note:-
1. Concrete M. 30.
2. Place on 25 mm grout bed.
3. High Yield Strength Deformed (HYSD) reinforcement.
4. All dimensions are in mm.
4.3 Crash Barriers need to be provided at the following locations:

Crash/ Safety barrier of rigid, flexible or semi rigid type, in accordance with MOSRT&H guidelines/ circular shall be provided at following locations:

i. Where height of embankment is 3m or more,
ii. Where height of embankment is retained by a retaining structure,
iii. Where median is depressed, flushed or having the width less than 4.5 m. the barriers shall be for both directions of travel,
iv. On valley side of highway in mountainous and steep terrain.
v. Between main carriageway and footpath in bridges.
vi. At hazardous location identified in Schedule B or through safety audit.

4.4 Design Requirements

According to IRC 6-2000, the below table states the minimum requirement for design of the crash barriers:

<table>
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<th>Item</th>
<th>Requirement</th>
<th>Parapet Type</th>
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<tbody>
<tr>
<td>1</td>
<td>Shape</td>
<td>Shape on traffic side to be as per IRC:5, or New Jersey Type of 'F' Shape designated thus by AASTHO</td>
</tr>
<tr>
<td>2</td>
<td>Minimum grade of concrete</td>
<td>M-40</td>
</tr>
<tr>
<td>3</td>
<td>Minimum thickness of RCC wall (at top)</td>
<td>175 mm</td>
</tr>
<tr>
<td>4</td>
<td>Minimum moment of resistance at base of the wall [see note (i)] for bending in vertical plane with reinforcement adjacent to the traffic face [see note (ii)].</td>
<td>15 kNm/m</td>
</tr>
<tr>
<td>5</td>
<td>Minimum moment of resistance for bending in horizontal plane with reinforcement adjacent to outer face [see note (ii)].</td>
<td>7.5 kNm/m</td>
</tr>
<tr>
<td>6</td>
<td>Minimum moment of resistance of anchorage at the base of a pre-cast reinforced concrete panel.</td>
<td>22.5 kNm/m</td>
</tr>
<tr>
<td>7</td>
<td>Minimum transverse shear resistance at vertical joints between precast panels or at vertical joints made between lengths or in-situ parapet.</td>
<td>44 kNm/m</td>
</tr>
<tr>
<td>8</td>
<td>Minimum height</td>
<td>900 mm</td>
</tr>
</tbody>
</table>

Source: IRC 6-2000

Notes:

i. The base of wall refers to horizontal sections of the parapet within 300 mm above the adjoining paved surface level. The minimum moments of resistance shall reduce linearly from the base of wall value to zero at top of the parapet.
ii. In addition to the main reinforcement, in items 4 and 5 above, distribution steel equal to 50 per cent of the main reinforcement shall be provided in the respective faces.

iii. For design purpose the parapet Type P3 shall be divided into end sections extending a distance not greater than 3.0 m from ends of the parapet and intermediate sections extending along remainder of the parapet.

iv. If concrete barrier is used as a median divider, the steel is required to be placed on the both sides.

v. In case of P3, In-situ type, a minimum horizontal transverse shear resistance of 135 kNm/m shall be provided.

5. Pedestrian Railings/ Guard-rails

5.1 Objectives

Pedestrian guard-rails in the vicinity of zebra crossing should be of sufficient length to deter pedestrians from crossing the road at any arbitrary point along the road. Night time visibility of zebra crossing is of vital importance and this can be achieved through proper lighting of the intersection area. A typical layout of zebra crossing at an intersection controlled by channelisation is given below:

Fig 6: Design type – Four arm channelised intersection
Type design of four arm channelised intersection showing arrangement of zebra crossing

Source: IRC: 103-1988
As the guard-rails would confine the movement of pedestrians to the footpath, it is obligatory that sufficient width of footpath be made available for the use of pedestrians.

5.2 Location
Use of pedestrian guard-rails could be considered under the following situations:

a) Hazardous locations on straight stretches
In particularly busy reaches where the road is congested and vehicles move at a fast pace, guard-rails should be provided on both sides of the carriageway so as to channelise the pedestrians on to the planned crossing locations.

b) At Junctions/Intersections
Railing barriers should be provided to prevent people from crossing the junctions diagonally at signalized intersections. The barrier must open only at planned crossing facility (at the zebra crossing). At unsignalised junctions they should be provided for sufficient length to guide the pedestrians to the nearest planned pedestrian crossing.

c) Schools
Provision of guard-rails near schools where children would otherwise run straight into the road is essential. If there is a pedestrian crossing or a school crossing patrol nearby, the guard-rails must be extended up to it.

d) Bus Stations/stops, Metro Railway Stations, etc.
Provision of guard-rails along side-walks with suitable access at bus stops, railway stations and other areas of heavy pedestrian activity such as cinema houses, stadiums, etc. are recommended for guiding pedestrian's safety in such areas.

Fig 7: Pedestrian Crossing at Grade

e) Overpass Subway, etc.
Guard-rails may be necessary at these locations in order to complete the pedestrians to use the facilities provided for them.

f) Central reserves
Where there is a central reserve or a median, guard-rails can be erected within it to deter the pedestrians from attempting a crossing.
5.3 Design Requirements and Options

The design of railings/ guard rails should be consistent for a particular corridor/ area. It should be as far as possible uniform and relate with the boundary walls, urban character and street furniture. The design of guard-rails should be neat, simple in appearance and, as far as possible, vandal proof. Two aspects which need special consideration are the height of hand-rail and the obstruction to visibility. The height should be sufficient so as to deter people from climbing over it. The visibility of the approaching vehicles by the pedestrians as well as the visibility of the pedestrians by the drivers of the approaching vehicles should be adequate. The railings should not, therefore, have any thick horizontal member, other than the baluster to achieve the desired objective. The guard-rails should be of sturdy but slender design. A tapered and thick base/ ends to support the railing will prevent the pedestrians to climb over the railing to cross the road.

Pedestrian guard-rails in reinforced cement concrete have also been found to be generally suitable in urban situations. Iron tubes, steel channeled sections and pipes may also be adopted so as to fit in with the environment or for better aesthetics. These can, however, be costly and may also need higher level of maintenance. Long lengths of guard rails give any environment an undue effect of severe confinement and regimentation.

When pedestrian and vehicle separation is desirable, thought should be given to possible alternatives rather than specifying guard rails as a matter of course. Continuous central refuges, small aqueducts, planters, bollards, trees, are all ways in which pedestrians can be screened from vehicles, and are infinitely preferable to the usual guard rails which seem to be springing up everywhere. If there is absolutely no alternative, guard rails should be erected at points of particular danger to pedestrians. The height of the pedestrian railing and divider should be such that it is a deterrent for pedestrian to climb over and jaywalking. The dividers/ central verge should be so designed to make it impossible for the pedestrians to walk over it.

Occasionally, gaps in guard-rails may have to be provided to accommodate trees, pillar boxes, sign posts, electrical control boxes etc. located near the side-walk. However, these should be suitably designed to prevent pedestrians or little children from squeezing through to cross the carriageway. Preferably, the guard-rails should be set back from edge of the carriageway by at least 150 mm.

Central dividers on wide roads ensure that vehicles confine their movements only to the correct carriageway, thus avoiding any conflict with traffic from the opposite direction. The rails over central dividers can be provided to ensure that pedestrians do not cross erratically or spill over the carriageway.
Fig 8: Pedestrian at Grade
A 10 to 15 meter wide pedestrian underpass created by raising the vehicular carriageway by 1.5 to 2.0 M and dipping the pedestrian passage by 0.5 to 1.0M.

Fig 9: Typical RCC pedestrian ‘Guardrail’

Source: IRC: 103-1988
Fig 10: Typical RCC pedestrian ‘Guardrail’

Source: IRC: 103-1988

Fig 11: Steel Guardrails

Source: GLC

Fig 12: Concrete Screening
Fig 13: Steel Barriers, Railing & Fencing

Source: GLC

Fig 14: Steel Barriers, Railing & Fencing
Fig 15: Existing MS Railing at Lodhi Road

Fig 16: Existing MS Railing at Aurobindo Marg
6. Dividers

6.1 Objectives

Central dividers on wide roads ensure that vehicles confine their movements only to the correct carriageway, thus avoiding any conflict with traffic from the opposite direction. The rails over central dividers can be provided to ensure that pedestrians do not cross erratically or spill over the carriageway.

6.2 Types of Dividers

6.2.1 Central Verge/ Concrete Curb/ Parabolic Divider

Usually wide central verge are provided as dividers within right of way. This encourages unrestricted and dangerous movement and crossing pedestrians. This also restrict the effective carriageway.

In certain areas where wide space is not available for central verge, narrow concrete curb is provided. The concrete curb is usually in the shape of parabolic divider.

Parabolic dividers and flower-beds which have a height of nearly 1 meter ensure pedestrian discipline. As the railings in the middle of roads are very vulnerable to accidents, parabolic dividers and flower-beds serve the same purpose more efficiently, besides improving the environment. A typical parabolic divider is shown in the Fig. 19. Traffic cones can be used for temporary segregation of traffic.

Fig 17: Parabolic Divider

![Parabolic Divider Diagram](source: IRC)
6.2.2 Railing over concrete curb

With view to discourage the pedestrians from jaywalking and crossing the central verge, railings are provided over a narrow concrete curb. The height and width of the concrete curb is kept which does not allow pedestrians to walk and climb the railing. This also saves the valuable carriage way.

Fig 18: Kerb Stone

6.2.3 Temporary arrangements such as Plastic/ Fibre cones, etc.

It is often witnessed as that in Delhi to cope up with segregated movement of traffic various temporary arrangements are put up such as plastic/ fibre cones, steel panels, plastic jerry canes, etc. as traffic dividers. These offer a temporary solution, which need to be considered together with pedestrian safety, infrastructure proper arrangement and aesthetics.

Fig 19: Type design for reflective traffic cone

Traffic cones
Rubber or flexible plastic

Fig 20: High density traffic Barrier/ divider

Source: IRC
6.2.4 Shiftable/Moveable Divider

Keeping in view the centrifugal/centripetal pattern of Delhi traffic, where there is a wide variations in traffic flow during the peak hours, shiftable dividers can provide a greater efficiency and capacity enhancement of the carriage way within the existing right of ways. Such dividers can be manually placed in the form of modular steel units or electrically/mechanically operated systems installed under the road, which facilitate sinking of the dividers within the road for dividing the lanes as per the traffic volume requirements (Fig: 21).

Fig 21: Design of a movable central divider

6.3 Placement/Location of Dividers

The location and placement of dividers is important to provide at wide pedestrian corridors in the areas/roads with high pedestrian traffic, in order to secure pedestrians.

This may be possible by raising the carriageway of the road by about 2.4 meters, so that pedestrians keep moving freely at the ground level for crossing the roads. Such facility should be provided in front of the Railway Stations, Metro Stations, ISBT, Exhibition Ground, large commercial center and office complexes (such as ITO, RK Puram, Central Secretariat, etc.)
7. Concluding Recommendations

1. In the areas/ roads with high pedestrian traffic, it may be necessary to provide wide pedestrian corridors in the areas/ roads with high pedestrian traffic. This may be possible by raising the carriageway of the road by about 2.4 meters, so that pedestrians keep moving freely at the ground level for crossing the roads. Such facility should be provided in front of the Railway Stations, Metro Stations, ISBT, Exhibition Ground, large commercial center and office complexes (such as ITO, RK Puram, Central Secretariat, etc.)

2. Flexible/ Shiftable Road Dividers installed over thin curbs, which can be operated manually/ electrically should be adopted for capacity improvement of existing roads, which can be stopped during peak hours.

3. Traffic Safety is the most important issue as it implies to the pedestrians largely. The separate right of way for the pedestrians is required for the safe movement.

4. It is also important to integrate the following infrastructure along with the crash barriers, pedestrian railing and dividers-
   - Road markings
   - Three dimensional/ electronic Signages
   - Signals and lighting
   - High visibility paint and suitable plantation may be considered for Crash barrier, railings and anti-glaring measure.
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