The Design of Road Bridge Parapets
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Summary:

This Standard sets out mandatory standards for the design of roadside parapets on bridges, retaining walls and similar structures where there is a need for parapets to prevent vehicles, equestrians, livestock or pedestrians from falling off the edge of the structure.

Instructions for Use:

This is a new document to be incorporated into the Manual. It supersedes BD 52/93.

1. Remove NRA Amendment to BD 52/93 (dated December 2000).
2. Remove all reference to HA BD 52/93 (which shall now be considered as not adopted in Ireland).
3. Insert this new standard into the Irish DMRB.

Published by National Roads Authority, July 2007
PART 3

NRA BD 52/07

DESIGN OF ROAD BRIDGE PARAPETS

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1. INTRODUCTION

General

1.1 This Standard gives the requirements for the design of roadside Parapets on bridges, retaining walls and similar structures where there is a need for parapets to prevent vehicles, equestrians, livestock or pedestrians from falling off the edge of the structure.


1.3 The Standard adopts the design performance requirements of:

   a) IS EN 1317-1, Road Restraint Systems - Part 1: Terminology and General Criteria for Test Methods;


   d) EN 1317-5, Road Restraint Systems – Part 5: Product Requirements, Durability and evaluation of conformity.


Scope

1.4 This Standard details the performance requirements and design criteria of parapets in common situations on the verge and central reserve of bridges, retaining walls and similar structures. Requirements for vehicles, pedestrians and other road users are included. The requirements for exceptional circumstances which are not encompassed by this Standard shall be agreed with the National Roads Authority in each case.

1.5 This Standard is concerned with the requirements for roadside parapets and transitions to safety barriers, but excluding safety barriers away from structures and also crash cushions. Safety barriers should be designed in accordance with NRA TD 19.

1.6 Guidance is provided on pedestrian restraint at wingwalls, headwalls and buried structures.

1.7 Further guidance on pedestrian protection at headwalls, wing walls and retaining walls is also given in UK HA Advice Note BA 48/93.

Implementation

1.8 This Standard shall be used forthwith for all schemes for the construction and/or improvement of National Roads. The Standard shall be applied to the design of schemes already being prepared unless, in the opinion of the National Roads Authority, application would result in significant additional expense or delay progress. In such cases, Designers should confirm the non-application of this Standard to particular schemes with the National Roads Authority.

1.9 If this Standard is to be used for the design of Local Road schemes (non-national roads), the Designer should agree with the relevant Road Authority the extent to which the document is appropriate in any particular situation.

1.10 If this standard is to be used for the replacement of existing parapets on existing bridges, the Designer should agree with the National Roads Authority the extent to which the document is appropriate in any particular situation. Where compliance with the containment levels in this standard would give rise to undue cost implications, a risk based approach (including a cost benefit analysis) for identifying the appropriate containment level shall be used. The criteria for this risk based approach shall be agreed with the National Roads Authority.
1.11 In situations of exceptional difficulty it may be necessary to apply for a Departure from Standards in respect of the provisions of this Standard. Proposals to adopt Departures from Standards must be submitted to the National Roads Authority for approval before incorporation into a design layout to ensure that safety is not significantly reduced.
2. DEFINITIONS

IS EN 1317 Definitions

2.1 For the purposes of this Standard, the following terms, as defined in IS EN 1317-1, apply:

Safety barrier: system to provide restraint to an errant road vehicle, installed on the central reserve of or alongside a road;

Transition: connection of two safety barriers of different designs and/or performance;

Vehicle parapet: safety barrier on the edge of a bridge or on a retaining wall or similar structure where there is a vertical drop, and which may include additional protection and restraint for pedestrians or other road users;

Pedestrian parapet: restraint system for pedestrians or other road users along a bridge or on top of a retaining wall or similar structure which is not intended to act as a road vehicle restraint system;

Pedestrian guardrail: restraint system for pedestrians or other road users along the edge of a footway or footpath intended to restrain pedestrians or other road users from stepping onto or crossing a road or other area likely to be hazardous.

Note: ‘other road users’ includes cyclists, equestrians and cattle.

2.2 Under the terminology of IS EN 1317, the term ‘safety barrier’ is defined as ‘a road vehicle restraint system installed alongside, or on the central reserve, of a road’. The term is used to describe both deformable and rigid barriers as well as vehicle parapets. However, for the purposes of this Standard, the term ‘safety barrier’ is used to describe a road vehicle restraint system other than a vehicle parapet.

Other Definitions

2.3 The following terms are also defined for the purposes of this Standard:

Effective longitudinal member: those longitudinal members of a post and rail type parapet that become effective in restraining a vehicle in an impact;

Front face: the face of a parapet or member nearest to the vehicular traffic;

Outer face: the face of a parapet or member remote from the vehicular traffic;

Traffic face: a vertical plane containing the front face of the main longitudinal member or the bottom of a concrete parapet or plinth;

Adjoining paved surface: the paved area on the traffic side of a parapet immediately adjacent to the plinth or base of the parapet;

Designer: the person or organisation responsible for the design of a proposed bridge, or for the inspection/assessment of an existing bridge, onto which the parapet is to be installed. (It is the designer who will be required to confirm the ability of the existing/proposed bridge to meet the loading requirements imposed by the parapet system since the designer will retain responsibility for the sufficiency following the installation.)

2.4 Where reference is made in this Standard to bridges, the meaning should be taken to include retaining walls and other structures as appropriate. Similarly, where reference is made to a road, the meaning should be taken to include tracks or other areas with vehicular access.

Summary of IS EN 1317 Performance Classes

2.5 IS EN 1317 designates road restraint systems, on the basis of design to specified performance levels of containment, to redirect errant vehicles. The standard identifies impact test tolerances and vehicle behaviour criteria that need to be met to gain approval.

In the context of this Standard IS EN 1317 shall be used to identify loading criteria to be adopted in the design. In situ testing of a parapet may not be appropriate because of:
2.6 IS EN 1317-2 defines various performance parameters for safety barriers and vehicle parapets as part reproduced in Tables 2/1 to 2/3 and Figure 2/1 of this Standard.

2.7 Within IS EN 1317 the performance parameters for a particular design of restraint system are established empirically by full-scale testing of representative samples. Details of the tests are specified in IS EN 1317-2 and IS ENV 1317-4. (Refer to Clause 2.5 above).

2.8 Further details are available in EN 1317-5 and prEN 1317-6. At the time of issue of this Standard these are in draft form. Part 5 deals with the circumstances where a barrier is tested in one form but is subsequently (slightly) varied. It gives criteria which allow the modification without a further test certificate being required. Part 6 relates to pedestrian guardrails and is thus of less relevance. Specific approval should be sought (from the NRA) before adoption of the requirements of either of these Parts whilst they are still in draft form.

**Containment Level**

2.9 Containment Level is an indication of the severity of impact – type, weight and speed of vehicle – which the safety barrier is designed to contain. The standard levels stipulated in IS EN 1317-2, which are adopted in Ireland, are as shown in Table 2/1.

**Impact Severity Level**

2.10 Impact Severity Level is measured as a function of the Acceleration Severity Index (ASI), the Theoretical Head Impact Velocity (THIV) and the Post-impact Head Deceleration (PHD). IS EN 1317-2 defines these terms and describes how they should be measured. The two levels given in the Standard are shown in Table 2/2.

2.11 Impact Severity Level A affords a greater level of safety for vehicle occupants than Level B.

**Design/ Installation of the Parapet**

2.12 The restraint system (parapet) will be designed and installed so as to meet the specified design criteria taking full account of, and not be limited by, the strength of the member/ structure onto which it is to be (directly) fixed. See also Designer responsibilities in paragraph 2.3.
### Table 2/1: IS EN 1317 Containment Level Tests*

<table>
<thead>
<tr>
<th>Containment Level</th>
<th>Test</th>
<th>Impact Speed (km/h)</th>
<th>Impact Angle (degrees)</th>
<th>Vehicle Mass (t)</th>
<th>Vehicle Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Angle Containment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>TB 21</td>
<td>100</td>
<td>20</td>
<td>0.9</td>
<td>Car</td>
</tr>
<tr>
<td>T2</td>
<td>TB 22</td>
<td>80</td>
<td>8</td>
<td>1.3</td>
<td>Car</td>
</tr>
<tr>
<td>T3</td>
<td>TB 21 &amp; TB41</td>
<td>80</td>
<td>15</td>
<td>1.3</td>
<td>Car</td>
</tr>
<tr>
<td>Normal Containment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N1</td>
<td>TB 31</td>
<td>80</td>
<td>20</td>
<td>1.5</td>
<td>Car</td>
</tr>
<tr>
<td>N2</td>
<td>TB 32</td>
<td>110</td>
<td>20</td>
<td>1.5</td>
<td>Car</td>
</tr>
<tr>
<td>Higher Containment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H1</td>
<td>TB 42</td>
<td>70</td>
<td>15</td>
<td>10.0</td>
<td>Rigid HCV</td>
</tr>
<tr>
<td>H2</td>
<td>TB 51</td>
<td>70</td>
<td>20</td>
<td>13.0</td>
<td>Bus</td>
</tr>
<tr>
<td>H3</td>
<td>TB 61</td>
<td>80</td>
<td>20</td>
<td>16.0</td>
<td>Rigid HCV</td>
</tr>
<tr>
<td>Very High Containment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4a</td>
<td>TB 71</td>
<td>65</td>
<td>20</td>
<td>30.0</td>
<td>Rigid HCV</td>
</tr>
<tr>
<td>H4b</td>
<td>TB 81</td>
<td>65</td>
<td>20</td>
<td>38.0</td>
<td>Articulated HCV</td>
</tr>
</tbody>
</table>

Note: Parapets or barriers with a Containment Level of N2 or higher shall also be subjected to Test TB 11, using a light vehicle (900kg), in order to verify that satisfactory attainment of the maximum level is also compatible for a light vehicle.

* Attention is drawn to the fact that parapets will be tested off site and the above criteria are to be used solely as criteria for the design of the parapet.

(Source: IS EN 1317-2)

### Table 2/2: IS EN 1317 Impact Severity Levels

<table>
<thead>
<tr>
<th>Impact Severity Level</th>
<th>Index Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASI</td>
</tr>
<tr>
<td>A</td>
<td>≤ 1.0</td>
</tr>
<tr>
<td>B</td>
<td>≤ 1.4</td>
</tr>
</tbody>
</table>

NOTE 1   Impact severity level A affords a greater level of safety for the occupants of an errant vehicle than level B and is preferred when other considerations are the same.

NOTE 2   At specific hazardous locations where the containment of an errant vehicle (such as a heavy commercial vehicle) is the prime consideration, a vehicle restraint system with no specific impact severity level may be adopted and installed. The index values recorded in the test of the restraint system shall, however, be quoted in the test report.

(Source IS EN 1317-2)

2.13 Reference should be made to BS 6779 as regards the classification to be adopted in specifying types of parapets, with the exception that the Containment Level should be as specified in Table 2/1 above and not as set out in BS 6779.

**Working Width**

2.14 Working Width (W) is the distance between the side facing the traffic before impact of the parapet or safety barrier and the maximum dynamic lateral position under test of any major part of the system. If the vehicle body deforms around the parapet or safety barrier, the maximum lateral position of any part of the vehicle shall be taken as an alternative. Examples of Working Width are illustrated in Figure 2/1.

2.15 Working Width is generally specified as one of the classes listed in Table 2/3.
Table 2/3: Working Width Classes

<table>
<thead>
<tr>
<th>Class of Working Width</th>
<th>Level of Working Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1</td>
<td>≤ 0.6 m</td>
</tr>
<tr>
<td>W2</td>
<td>≤ 0.8 m</td>
</tr>
<tr>
<td>W3</td>
<td>≤ 1.0 m</td>
</tr>
<tr>
<td>W4</td>
<td>≤ 1.3 m</td>
</tr>
<tr>
<td>W5</td>
<td>≤ 1.7 m</td>
</tr>
<tr>
<td>W6</td>
<td>≤ 2.1 m</td>
</tr>
<tr>
<td>W7</td>
<td>≤ 2.5 m</td>
</tr>
<tr>
<td>W8</td>
<td>≤ 3.5 m</td>
</tr>
</tbody>
</table>

NOTE 1  A working width of less than W1 may be specified.

NOTE 2  The dynamic deflection and the working width allow determination of the conditions for installation of each restraint system and also define the distances needed in front of obstacles (and any vertical drop) to permit the system to perform safely.

NOTE 3  The deformation will depend on both the type of system and the impact test characteristics.

(Source: IS EN 1317-2)
Figure 2/1: Dynamic Deflection (D) and Working Width (W)

(Source: IS EN 1317-2)
3. CONTAINMENT REQUIREMENTS

Vehicle Parapets

3.1 Vehicle parapets are required on the edges of all bridges where there is a vertical drop and the bridge is designed to carry vehicular traffic. Vehicle parapets are also required on the edges of retaining walls or similar structures where there is a vertical drop in excess of 1m and there is access for vehicles adjacent to the top of the wall.

3.2 Design of vehicle parapets shall be based on the test acceptance criteria of IS EN 1317-2 for the performance requirements specified below.

Containment Level

3.3 At the locations described, the vehicle parapet shall have at least the Containment Level indicated:

a) Bridge (other than over a railway) carrying a road, normally only used by cars, with a maximum weight of 1.3 tonnes and with a Design Speed or mandatory speed limit less than 85km/h: \( T_2/T_3 \);

b) Bridge (other than over a railway) carrying a road with a Design Speed or mandatory speed limit less than 85km/h: \( N_1 \);

c) Bridge carrying a road with a Design Speed or mandatory speed limit equal to or greater than 85km/h: \( N_2 \);

d) Bridge carrying any road over a railway: Normal requirement – \( H_4a \).*

*The Designer is required to obtain the agreement of Iarnród Éireann to any proposed vehicle restraint system either over or alongside an existing (or proposed) railway.

3.4 With the exception of bridges over the railway, vehicle parapets of Very High Containment Level (\( H_4a \)) shall only be considered in high risk locations where the consequences of parapet penetration are judged to outweigh the hazards to vehicle occupants or other road users resulting from the effects of the very high containment barrier. However, each case shall be considered on its merits and the

Containment Level decided only after consultation with the relevant authorities. The decision shall be subject to the approval of the National Roads Authority.

3.5 At certain locations the nature of the area below the bridge may justify the use of \( H_4a \) parapets, while at other sites both the circumstances below and on the structure (or its approaches) need to be considered.

3.6 At a bridge over a busy road, the use of Very High Containment Level parapets will normally be justified (subject to NRA approval) where the following conditions occur on or adjacent to the bridge:

a) Inferior horizontal or vertical alignment permitted as a Departure from Standards; or

b) Reduced clearance between the carriageway and parapets permitted as a Departure from Standards; or

c) A complex interchange where driver error is more likely; or

d) Where road junctions are very close to the bridge; or

e) Existing sites which have a record of accidents and where the bridge structure can accommodate the forces specified for a Very High Containment parapet.

Impact Severity Level

3.7 Vehicle parapets of Normal Containment Level (\( N_1 \) or \( N_2 \)) should have Impact Severity Level A. Parapets of Very High Containment Level (\( H_4a \)) shall have Impact Severity Level B. The use of \( N_1 \) or \( N_2 \) parapets with Impact Severity Level B shall constitute a relaxation for which justification will be required.

Working Width

3.8 The Working Width shall normally be no greater than \( W_4 \). The use of a larger Working Width will constitute a departure in standard for which approval from the National Roads Authority would be required.
Authority will be required and will require evidence that an errant vehicle can not pass between the parapet edge beam and the deformed restraint system.

**Vehicle Parapets of Concrete Construction**

3.9 Design loading criteria (for specific containment criteria) for all parapets of concrete construction shall be in accordance with the requirements of Table 2/1 above.

3.10 Vehicle parapets of precast reinforced concrete construction shall be designed in accordance with BS 6779: Highway Parapets for Bridges and Other Structures, Part 2: Specification for Vehicle Containment Parapets of Concrete Construction, as amended by this Standard for the relevant Containment Level. Very High Containment Level is designated ‘high level of containment’ in BS 6779 Part 2.

3.11 Vehicle parapets of insitu reinforced concrete construction shall be designed in accordance with BS 6779: Part 2 as amended by this Standard for the relevant Containment Level. Very High Containment Level is designated ‘high level of containment’ in BS 6779 Part 2.

3.12 Reinforced concrete parapet panel walls shall have a minimum thickness of 180mm for Normal Containment Level and 325mm at the critical design section for Very High Containment Level.

3.13 Reinforced concrete parapet panel walls shall have a minimum panel length of 1.5m and a maximum panel length of 1/5th span or 3.5m whichever is greater.

3.14 $\gamma_m$ for the reinforcement in the in-situ and precast parapet panel wall shall be 1.0, not 0.8 as given in Table 4 of BS 6779: Part 2.

3.15 Concrete parapets for Normal Containment Level shall be designed for an equivalent static nominal load (for calculating panel nominal bending moment) of 100kN over 1.0m, not 50kN over 1.0m as given in Table 2 of BS 6779: Part 2.

3.16 Concrete panel walls of parapets for Normal Containment Level shall be designed with shear transfer provision between panels. An equivalent static nominal load of 50kN shall be transferred between panels within the top 0.5m of the panels.

**Vehicle Parapets of Combined Metal and Concrete Construction**

3.17 With the exception of performance classes, impact test acceptance criteria and test methods for safety barriers, which shall be in accordance with IS EN 1317-2, vehicle parapets of combined metal and precast concrete construction shall be designed in accordance with BS 6779: Highway Parapets for Bridges and Other Structures, Part 3: Specification for Vehicle Containment Parapets of Combined Metal and Concrete Construction, as amended by this Standard for the relevant Containment Level. Very High Containment Level is designated ‘high level of containment’ in BS 6779 Part 3.

3.18 Vehicle parapets of combined metal and insitu concrete construction shall be designed in accordance with BS 6779: Part 3 as amended by the relevant Containment Level. However, the impact test acceptance criteria and test methods shall be in accordance with IS EN 1317-2. Very High Containment Level is designated ‘high level of containment’ in BS 6779 Part 3. It will not be necessary for parapets designed entirely to BS 6779: Part 3 to be tested to demonstrate the Impact Severity Level.

3.19 $\gamma_m$ for the reinforcement in the in-situ and precast parapet panel wall shall be 1.0, not 0.8 as given in Table 6 of BS 6779: Part 3.

3.20 In addition to the requirements of BS 6779: Part 3, concrete panel walls and bases for vehicle parapets of combined metal and concrete construction for Normal Containment Level (or more severe) shall have a capacity not less than that required to satisfy BS 6779: Part 2, as modified by this Standard, for a vehicle parapet of equivalent overall height.

3.21 Concrete panel walls of parapets for Normal Containment Level (or more severe) shall be designed with shear transfer provision between panels. An equivalent static nominal load of 50kN shall be transferred between panels within the top 0.5m of the panels.
Pedestrian Parapets

3.22 Footbridges, cycleway bridges and bridleway bridges without vehicular access shall be provided with pedestrian parapets complying with the performance requirements of BS 7818, Specification for Pedestrian Restraint Systems in Metal.
4. DESIGN CRITERIA FOR VEHICLE PARAPETS

General

4.1 Vehicle parapets shall be provided on bridges and retaining walls at the locations described in Paragraph 3.1. The parapets shall be designed for the relevant performance requirements specified in Chapter 3 and for the other criteria set out below.

4.2 Design of vehicle parapets shall be based on the test acceptance criteria of IS EN 1317-2 for the performance requirements specified. Thereafter, the vehicle parapets shall be designed in accordance with BS 6779 as amended by this Standard.

4.3 The design requirements given in this Standard for vehicle parapets are based on cantilever action from the bridge deck. Main structural members of bridges shall not be designed to act as vehicle parapets.

Aesthetics

4.4 Parapets form an important feature of the appearance of a structure. The aesthetic effects of the vehicle parapet, including its details, shall be considered at the initial stage of the design of the structure and also during development of the design. The aesthetic effects of the vehicle parapet would include both the appearance (and detailing) of the vehicle parapet itself as well as the inter relationship of the parapet with the main structure (e.g. the setting out of the parapet posts with respect to bridge supports and/or joints in deck fascia etc)

Height

4.5 The height of the parapet shall be measured above the adjoining paved surface and shall not be less than the highest of the following criteria relevant to the bridge in question:

- 1000mm for bridges carrying motorways or roads to motorway standard from which pedestrians, animals and cyclists are excluded by Order;
- 1250mm for other road bridges;
- 1400mm for cycleways adjacent to the parapet;
- 1500mm for accommodation bridges;
- 1500mm for Very High Containment Level applications;
- 1800mm for all bridges over railways;
- 1800mm for bridleway bridges.

Notwithstanding the above, the heights of parapets over railways shall be subject to the approval of Iarnród Éireann.

4.6 Special conditions at particular sites may signify the need for higher parapets: these cases will be considered (by the NRA) and modified requirements issued to designers.

Materials

4.7 Vehicle parapets may be of steel or aluminium, reinforced concrete (precast or in-situ) or a combination of these. Where it is necessary to harmonise with local conditions, the outer face of concrete vehicle parapets may be clad in masonry provided the cladding is securely fixed to the concrete.

4.8 Masonry vehicle parapets shall not be used on bridges over, under or adjacent to national roads except with the specific (prior) agreement of the National Roads Authority.

Metal (steel/ aluminium) Parapets on Non Railway Bridges

4.9 Metal vehicle parapets of open frame design, such as post and rail or post and beam, on non-railway bridges shall be designed in accordance with the additional requirements of Paragraphs 4.10 to 4.14.

4.10 The parapet shall consist of at least two effective longitudinal members. The overall depth of each longitudinal member, measured as the depth of its projection onto a vertical plane, shall be not less than 50mm or more than 150mm for Normal Containment Level and not less than 100mm or more than 200mm for Very High Containment Level. The clear gap between longitudinal members and between the lowest longitudinal member and the top surface of the base of the parapet or the concrete plinth shall be not more than 300mm. For parapets on
accommodation bridges, the clear gap may be increased to no more than 400mm.

4.11 Parapets shall incorporate a reinforced concrete plinth (of height 50-100mm) and the front faces of the effective metal longitudinal members shall be in the vertical plane containing the top edge of the front face of the reinforced concrete plinth.

4.12 Metal rails or beams shall present smooth surfaces on the traffic face and on the top and bottom faces and be free from sharp edges or corners on the front face.

4.13 Projections or depressions on the front, top and bottom faces shall only be allowed at joints in rails and at connections to posts and shall be within the following limits:

   a) *Front face and top and bottom faces within 15mm of the front face*: a maximum of 15mm including the heads of any fastenings, which shall be of a well rounded shape.

   b) *Top and bottom faces beyond 15mm from the front face*: a maximum of 25mm including the heads of any fastenings.

   c) *Tops of posts*, including any caps or straps, shall not project above the level of the top of the top rail by more than 16mm and the heads of any fastenings to the top of the posts shall not project above the top face of the top rail by more than 35mm, making allowance for sloping rails.

4.14 On roads with a mandatory speed limit not greater than 50km/h, the vehicle parapet may, as an alternative, be a design incorporating two longitudinal members and closely spaced vertical members. The clear space between adjacent vertical members shall not exceed 100mm.

**Pedestrian Restraint**

4.15 On all bridges with vehicle parapets, except bridges carrying motorways or roads to motorway standard from which pedestrians, animals and cyclists are excluded by Order, the parapets shall restrain pedestrians as well as vehicles. For parapets of an open design, some form of (specified) infill will be required. Where wire mesh or expanded metal infill is specified it shall generally (ie except as below) have apertures with a perimeter not exceeding 200mm. The minimum metal thickness shall be 3mm for aluminium or steel and 2mm for stainless steel and the maximum metal thickness shall not exceed the required minimum by more than 1.5mm.

All expanded metal sheet infill shall be supplied in a deburred and flattened condition.

Wire mesh infill for railway applications shall have apertures not exceeding 25mm x 25mm. Expanded metal sheet shall have openings not exceeding 45mm x 20mm and shall be fixed with the long dimension horizontal. In all other respects the requirements shall be as above.

4.16 It is not practical to make vehicle parapets completely unclimbable but, where pedestrians have access, infilling shall be provided and the parapet should not have footholds.

4.17 Since pedestrians are excluded, infilling will not normally be required on motorway underbridges or structures adjacent to motorway carriageways, except where they cross or are adjacent to railways.

4.18 Pedestrian restraint shall be provided as an integral part of the vehicle parapet. Separate vehicle and pedestrian parapets will not be permitted.

4.19 Infilling, additional members or the traffic face of solid parapets shall conform to the following:

   a) Infills shall be fixed closely to the traffic faces of the parapet;

   b) Heads of fixings shall not project more than 10mm forward of the traffic face and shall be of a well rounded shape;

   c) There shall be no footholds or projections exceeding the dimensions permitted in Paragraph 4.13 on the traffic face;

   d) All cladding shall be securely fixed and shall not easily be detached;

   e) No reflective surfaces shall be used that might create a hazard for users of any road or railway.
4.20 Infills of vertical bars, wire mesh, expanded metal or solid panels shall comply with the requirements of BS 6779: Part 1 Clause 8.2. Wire mesh, expanded metal or solid panel infill shall extend from not more than 25mm above the plinth at the traffic face to the full height of the parapet. Vertical bar infill shall only be considered on parapets of Normal (or Low) Containment Level on roads with a mandatory speed limit of 50km/h or less.

Restraint for Other Users

4.21 On bridges where provision is made for other road users, such as cyclists, equestrians or livestock, pedestrian restraint in accordance with Paragraphs 4.15 to 4.20 shall be provided for the full height of the parapet.

4.22 On post and rail type parapets with an overall height of 1.5m or more, the top rail may be a ‘non-effective longitudinal member’. Such a member shall be designed to withstand a horizontal ultimate load of at least 1.4kN/m and the parapet posts shall be designed to ensure that they are capable of providing support for the consequential effects. This loading need not be considered co-existent with the loading required for vehicle containment. In the case of an application of such a rail to a Very High Containment Level parapet, the post extensions to carry the non-effective rail shall be designed for this purpose only.

4.23 There may be a need for mesh infilling to part height on parapets without pedestrian restraint, in order to prevent loose debris, stones or snow from falling onto the area beneath the bridge. Similarly, there may be a need for solid infill in order to prevent splash, reduce noise, screen railway electrification equipment or, on accommodation bridges, to avoid frightening livestock crossing the bridge. Such cases should be considered (by the Designer) on their merits and submitted for approval (by the National Roads Authority) within the Preliminary Design Report.

4.24 At locations subject to vandalism, there may be a need for a major increase in height in the pedestrian restraint. Mesh screening could be inclined away from the traffic and positioned such that it cannot be struck by an errant vehicle. Also, at some bridges the parapet may need to incorporate environmental barriers. Such cases should be considered (by the Designer) on their merits and submitted for approval (by the National Roads Authority) within the Preliminary Design Report.

Parapets Over or Adjacent to Railways

4.25 On bridges over railways, infill or other restraint for pedestrians or other road users will be required in accordance with Paragraphs 4.15 to 4.24 and with the following additional requirements.

4.26 On all bridges over railways, solid infill shall be provided over the full height of the traffic face of the parapet. Infill shall extend so as to be no more than 3mm above the plinth at the traffic face. Metal infill panels shall be of a type approved by Iarnród Éireann and shall be at least 3mm in thickness.

4.27 On post and rail type parapets with an overall height of 1.5m or more over railways, the top rail shall be of the same section as the main longitudinal members of the parapet. Where a small extension in height is required, consideration may be given to the provision of a steeple coping profile continuously attached to the top rail.

4.28 In order to discourage walking on top of the parapet, either the overall width of the top of the parapet shall be no greater than 100mm or the top shall have a steeply inclined face at an angle not less than 45 degrees to the horizontal.

4.29 Metal parapets over railways shall also be provided with solid sheeting or mesh on the outer face of the parapet, extending to the full height of the parapet and with the lower part shaped to cover the outer ledge. The outer face sheeting shall deny access to the outer ledge and extend horizontally for the width of the railway tracks plus one parapet panel or 2.0m, whichever is the greater. It shall be fitted at the ends of the parapet or on both sides of the railway tracks. In all cases, the distance from the inner face of the sheeting shall be at least 3.0m from the outside edge of the nearest rails or from any live overhead electrification equipment.
4.30 The outer face sheeting at the ends of the parapet shall be extended in length in locations where the outer ledge is deemed to be readily accessible from any area adjacent to the bridge.

4.31 Any other method of denying access to the outer ledge of the parapet shall be subject to the agreement of Iarnród Éireann.

**Paved Verge**

4.32 In order to discourage the stationing of vehicles with their wheels close to the vehicle parapet, a raised verge shall be provided between the parapet and the edge of hard shoulder, hard strip or carriageway. The raised verge shall have a minimum width of 600mm and be edged with a kerb not less than 75mm high. The Designer is responsible for assessing whether the kerb height impacts on the performance of the parapet. The paved surface of the verge shall fall towards the top of the kerb. At the ends of the bridge the kerb and verge shall slope down gradually to the level of the paved surface on the bridge approaches.

**Divided Structures**

4.33 When designing a divided structure to carry a dual carriageway, the longitudinal gap between the two structures should be narrow (<100mm) and present no danger to pedestrians or vehicles. If a wider gap of between 100mm and 2.0m is unavoidable, a horizontal grid or slab designed to carry HA loading shall be provided. If the structure is over a railway, a solid slab to HA loading is required.

4.34 Where these provisions are impractical, vehicle parapets shall be provided.

**Masonry Cladding**

4.35 Where masonry cladding to concrete parapets is provided the following criteria shall be satisfied:

a) Fixings shall be spaced at not more than 450mm horizontally and 300mm vertically. Brick reinforcing mesh shall also be incorporated into the bedding joint beneath each row of fixings;

b) Fixings and brick reinforcing mesh shall be in stainless steel and shall not be placed in contact with carbon steel reinforcement;

c) Uncoursed work, where it is impracticable to provide brick reinforcing mesh, will only be permitted where there is a low probability (as confirmed by the NRA) of detached masonry presenting a hazard to the public.

4.36 Masonry cladding to the front face of a parapet will only be permitted in exceptional cases (based principally on aesthetic considerations - see Cl 4.4). Where it is permitted, stone shall normally be of the form of close jointed ashlar or generally smooth blocks. Uncoursed work will not be permitted. Bricks shall have a reasonably smooth surface. Pointing shall be flush. Masonry on the front face may have an irregular surface subject to the maximum amplitude of the steps and undulations in the surface not exceeding 30mm when measured with respect to a plane through the peaks. The plane shall be flat for straight parapets and curved to follow the nominal parapet curvature for parapets which are curved on plan.

4.37 Stone or precast concrete copings may only be used with vehicle parapets of concrete construction where the permitted speed is 50km/h or less. Such copings shall be fixed to the concrete core by fixings capable of resisting, at the ultimate limit state, a horizontal force of 33kN per metre of coping.
5. DESIGN OF ANCHORAGES AND SUPPORTING MEMBERS FOR PARAPETS

Contract Documentation

5.1 Contracts based on the NRA Specification for Road Works involving metal vehicle parapets on bridges should normally allow the Contractor to choose any metal parapet that meets the required design criteria, in combination with any approved anchors which meet the design requirements for the chosen parapet. If the parapet system to be used is not known at the time that the detailed bridge design is prepared, it will not be possible to design fully the corresponding anchor requirements, nor to specify the requirements in terms of either the design resistance or the characteristic resistance. The Designer will, therefore, need to check the adequacy of the selected anchors after the Contractor’s proposals are known.

5.2 The Designer is responsible for assessing the condition and proving the strength sufficiency of an existing structure on which a new or replacement parapet is to be erected and for evaluating the factors to be used in determining the design resistance value of the Contractor’s chosen anchorage. Since the parapet system to be used may not be known at the time of preparing the design, the Designer will be required to make assumptions relating to the loads applied to the supporting structure. If these loads are incapable of being carried by the structure then it will be necessary for the Contractor to propose an alternative parapet design so as to not exceed the limitations of the structure. (See also 5.6-5.8 below). Any limitations (emanating from this assessment) to the design of the parapet will be made clear to the Contractor as soon as they are known. Information will be included in the Appendices to the Specification to enable the Contractor to make an initial selection of the parapet and its anchorages.

Anchorages

5.3 Anchorages for metal parapets, together with their attachment system and the main structure, shall be designed to resist without damage all the loads which the parapet is theoretically capable of transmitting, up to and including failure, in any mode that may be induced by vehicular impact. The design of parapet attachment systems and anchorages shall be such that:

- removal and replacement of damaged sections may be achieved readily;
- under no loading conditions (including the event of a failure) is damage sustained by any part of the bridge.

5.4 Anchorages, attachment systems, bedding and plinths for metal parapets shall comply with the requirements of BS 6779: Part 1 Clause 6.6.

Main Structure

5.5 The local and global effects of vehicular collision with the parapets is to be considered in the design of elements of the main structure and on the superstructure; bearings and substructure of the bridge shall be as specified in BD 37, Loads for Highway Bridges.

Assessment of Existing Structures

5.6 Because of the interaction of the proposed restraint system with the existing structure it will be necessary for the Designer to undertake a bridge inspection/assessment to determine whether the proposed containment level/parapet system is appropriate to the (limitations of the) structure.

5.7 Approval to a proposed system will not be given by the NRA until the results of the above bridge inspection/assessment are known and the Contractor has verified suitability of his proposed system. In the event of failure to meet the specified criteria the Contractor will be required to consider (and submit for approval) an alternative which maintains the specified containment level.

5.8 In the event that no alternative system (meeting the specified containment level) is available/viable, a risk based approach (including a cost benefit analysis) for identifying the appropriate containment level shall be used. The
criteria for this risk based approach shall be agreed with the National Roads Authority.

5.9 The Designer will specify site tests which the Contractor has to carry out on anchors to demonstrate that they have been installed correctly.
6. APPROACHES AND TRANSITIONS

Approaches to Parapets

6.1 To prevent direct impact between a vehicle and the end of the vehicle parapet, a safety barrier shall be provided wherever possible on each end of the parapet. The safety barrier should be at least 30m long at full height in advance of the approach end and at least 15m long at full height after the departure end and should continue the line of the traffic face of the parapet. The safety barriers and their terminals shall be designed in accordance with NRA TD 19.

6.2 On roads with a mandatory speed limit of 50km/h or less, the requirements for safety barriers, in accordance with Paragraph 6.1 may be relaxed subject to the approval of the NRA.

6.3 For safety barriers adjacent to parapets of Normal Containment Level, the adjacent safety barrier shall have a Containment Level not less than that of the parapet. For safety barriers adjacent to parapets of Very High Containment Level, the adjacent safety barrier shall have a Containment Level not less than H2 for at least the relevant distance stated in Paragraph 6.1.

6.4 For bridges over railways the safety barrier requirements (given in 6.3 above) shall be subject to discussion/agreement with Iarnród Éireann and shall be justified by means of a site specific risk analysis.

Safety Barrier Connections to Vehicle Parapets

6.5 Where a safety barrier is provided adjacent to a vehicle parapet, a connection shall be provided between the parapet and the safety barrier. The connection shall be capable of maintaining the continuity of the Containment Level of the safety barrier. Such connections shall be considered as Transitions.

6.6 Where such a connection is not practicable, a full height anchorage of the safety barrier shall be provided close to the vehicle parapet. A connection capable of resisting an ultimate tensile force of not less than 50kN shall also be made with the vehicle parapet.

Transitions

6.7 Where a Very High Containment vehicle parapet is provided on part of a structure and a Normal Containment parapet on the remainder, a transition shall be provided at all changes in Containment Level. Where a change from a Normal Containment (N1) parapet to a Very High Containment (H4a) parapet is required, the end section of N1 parapet shall be strengthened to Normal Containment Level (N2).

6.8 The Containment Level for the transition shall not be lower than the lower containment level, nor higher than the higher, of the two connected barriers or parapets. The Working Width of the transition shall not be larger than the larger working width of the two connected barriers or parapets.

6.9 The design of transitions should be such that changes in Working Width and Containment Level are introduced gradually and evenly along the length of the transition. Additionally the length of the transition should be sufficient to ensure that no significant changes in the dynamic deflection occur over short lengths: a length of at least 10 to 12 times the change in Working Width should normally be provided.

6.10 Where a transition is composed of posts and rails, the maximum change in height at any point shall be 450mm. The projecting end of any terminated upper rail shall be treated so as to avoid the possibility of an errant vehicle impacting directly with it.

6.11 All transitions shall comply with the requirements of the test acceptance criteria specified in IS ENV 1317-4. Evidence of compliance shall be submitted to the National Roads Authority in the form of a full test report. To avoid any further doubt: all transitions shall be connected to the same safety barrier and parapet system to which they are tested.
7. PEDESTRIAN PARAPETS AND GUARDRAILS

Scope

7.1 This Chapter gives requirements and guidance on parapets for pedestrians, cyclists and equestrians on bridges without vehicular traffic and also on pedestrian guardrails to provide pedestrian restraint at structures. It does not provide guidance on the use of pedestrian guardrails at locations away from structures.

Height

7.2 The height of the parapet shall be measured above the adjoining paved surface and shall not be less than the highest of the following criteria relevant to the bridge in question:

- 1150mm for footbridges except over railways;
- 1400mm for cycleway bridges except over railways;
- 1800mm for bridleway bridges;
- 1800mm for all non-vehicular bridges over railways.

Notwithstanding the above, the heights of parapets over railways shall be subject to the approval of Iarnród Éireann.

Pedestrian Parapets

7.3 Footbridges, cycleway bridges and bridleway bridges shall be provided with pedestrian parapets complying with the requirements of BS 7818. Pedestrian parapets of concrete construction shall be designed in accordance with NRA BD 24 and BS 5400: Part 4 and be capable of resisting the relevant loads specified in BS 7818 Table 2.

7.4 Pedestrian parapets should be of framed construction with suitable infill (in accordance with paragraphs 4.15 to 4.20) or solid construction or a combination of these. Pedestrian parapets may (subject to NRA approval) incorporate materials other than metal or reinforced concrete provided it has adequate strength and resistance to weathering and vandalism.

7.5 On bridleway bridges over a road, a solid infill panel at least 600mm high shall be provided at the bottom of the parapet in order to obstruct the animals’ view of the road below.

7.6 On bridges over railways, solid infill shall be provided for the full height of the front face of pedestrian parapets in accordance with the requirements of Paragraphs 4.26 to 4.28. Infill panels shall also be provided on the outer face of pedestrian parapets at the ends of railway spans, to deny access to the outer ledge, as detailed in Paragraphs 4.29 to 4.31.

7.7 The design load for metal pedestrian parapets shall generally be to BS 7818; Class 3 (Table 2) with the nominal load for the infill at Class C (Table 3). In exceptional situations, where above normal loading is anticipated, pedestrian parapets of Class 4 and/or with Class D infill may be specified. The use of high strength pedestrian parapets shall be agreed with the National Roads Authority.

7.8 Pedestrian parapets of solid construction shall be designed to resist the more severe of a nominal load of 1,400N/m applied transversely at the level of the top of the parapet or wind loading in accordance with BD 37. $\gamma_L$ shall be taken as 1.5 for live load and 1.4 for wind load at the ultimate limit state or 1.0 for both at the serviceability limit state.

7.9 Framed pedestrian parapets of concrete construction shall be designed to resist the loads specified in BS 7818 for metal parapets.

7.10 The strength of infill panels may be proven for a prototype design by test loading with the loads in the most adverse positions. The minimum overload factor shall be taken as equal to the product of the partial safety factors used for ultimate limit state design. When the appropriate design document is not to limit state format, a 50% overload shall be assumed.

7.11 Stone or precast copings used with pedestrian parapets should be secured to the concrete backing by fixings capable of resisting a
horizontal force of 10kN at the ultimate limit state per metre of coping.

Pedestrian Restraint at Head Walls, Wingwalls and Retaining Walls

7.12 Within the road boundary, retaining walls often support the slope of a cutting or embankment. Also there are head walls and wingwalls at underbridges, underpasses, subways and culverts. On motorways and some other rural national roads, pedestrians are not normally expected to be present near these walls. However, drivers and passengers of broken down or damaged vehicles, maintenance staff, emergency services personnel and others may on occasion walk near them.

7.13 Where it is considered necessary, by the NRA, suitable protective barriers or pedestrian guardrails should be provided at these locations in accordance with the following:

- Where a structure such as a retaining wall, head wall or wingwall presents a vertical or near vertical face 1.5m or more in height and it would be possible for a person to gain access to the upper edge of the structure, a pedestrian restraint system such as a protective barrier or guardrail should be installed close to or on top of the structure.

- Consideration should also be given to installing a pedestrian protective barrier or guardrail at walls less than 1.5m high if a particular hazard, such as a watercourse or road, is in close proximity.

- Examples of locations where pedestrian measures would generally be necessary are shown in Figures 7/1 to 7/3 overleaf.

7.14 The type of pedestrian protective measure to be used will need to be determined for each specific location and could be pedestrian guardrail, pedestrian parapet or an appropriate type of boundary fencing. It will need to be in keeping (as approved by the NRA) with any structural, drainage, environmental and aesthetic considerations.
Figure 7/1: Typical Locations for Pedestrian Guardrailing/Protection
Figure 7/2: Typical Locations for Pedestrian Guardrailing/ Protection
Figure 7/3: Typical Locations for Pedestrian Guardrailing/Protection
8. **ENQUIRIES**

8.1 All technical enquiries or comments on this Standard should be sent in writing to:

Head of Engineering Operations  
National Roads Authority  
St Martin’s House  
Waterloo Road  
Dublin 4”.

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E O’CONNOR  
Head of Engineering Operations