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Transport Infrastructure Ireland

TII Publications



The Design of Vehicle and Pedestrian Parapets

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For all documents that existed within the NRA DMRB or the NRA MCDRW prior to the launch of TII Publications, the NRA document reference used previously is listed above under 'historical reference'. The TII Publication Number also shown above now supersedes this historical reference. All historical references within this document are deemed to be replaced by the TII Publication Number. For the equivalent TII Publication Number for all other historical references contained within this document, please refer to the TII Publications website.

The Design of Vehicle and Pedestrian Parapets

January 2016

Summary:

This Standard sets out mandatory standards for the design of vehicle and pedestrian 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.

The Standard supersedes NRA BD 52/13, The Design of Road Bridge Parapets, dated March 2013.

Instructions for Use:

This is a new document to be incorporated into the Manual. It supersedes NRA BD 52/13.

1. Remove NRA BD 52/13 (dated March 2013).
2. Insert this new standard into the NRA DMRB.

**VOLUME 2 STRUCTURES: DESIGN
(SUBSTRUCTURES AND
SPECIAL STRUCTURES)
MATERIALS**

**SECTION 3 MATERIALS AND
COMPONENTS**

PART 3

NRA BD 52/16

**DESIGN OF VEHICLE AND PEDESTRIAN
PARAPETS**

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1. INTRODUCTION

General

- 1.1 This Standard sets out mandatory standards for the design of vehicle and pedestrian 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.
- 1.2 The Standard supersedes NRA BD 52/13, The Design of Road Bridge Parapets, dated March 2013.
- 1.3 Following the implementation of relevant parts of IS EN 1317, there is now a comprehensive suite of requirements for the testing and CE marking of vehicle parapets suitable for the majority of applications. It is a requirement of Transport Infrastructure Ireland that vehicle parapets used in connection with new national road structures shall be fully IS EN 1317 compliant. Where a Designer or Road Authority consider that it is necessary to provide a bespoke parapet on a new structure, the reasons for this, along with full details of the parapet proposed, shall be brought to the attention of Transport Infrastructure Ireland as early as possible during the Technical Acceptance of Structures process (ref NRA BD 02).
- 1.4 This standard is to be used, wherever appropriate, for the replacement of existing parapets on existing bridges, however, the Designer should agree with Transport Infrastructure Ireland 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 Transport Infrastructure Ireland.
- 1.5 Notwithstanding the requirements of 1.4 above, particular requirements for the replacement of parapets on existing masonry arch bridges are given in Paragraph 4.9 of this standard.

Scope

- 1.6 This Standard details the performance requirements and design criteria of vehicle and pedestrian 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 Transport Infrastructure Ireland in each case.
- 1.7 This Standard is concerned with the requirements for vehicle and pedestrian parapets and transitions to safety barriers, but excluding safety barriers remote from structures and also crash cushions. Safety barriers should be designed in accordance with NRA TD 19, Safety Barriers. Crash Cushions are not currently covered by NRA DMRB Standards.
- 1.8 Guidance is provided on pedestrian restraint at wingwalls, headwalls and buried structures.

Implementation

- 1.9 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 Transport Infrastructure Ireland, 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 Transport Infrastructure Ireland.
- 1.10 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.

2. DEFINITIONS

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

Transition: system for safely connecting two safety barriers of different designs and/or performance. For the purposes of this Standard, the term ‘transition’ is used to describe the means of connection between a safety barrier (as defined above) and a vehicle parapet;

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 intended to restrain pedestrians or other road users from stepping onto or crossing a road or other area likely to be hazardous including headwalls and wingwalls remote from the road;

Note: ‘other road users’ includes cyclists, equestrians, road maintenance personnel, emergency services personnel and cattle.

Bespoke parapet: A vehicle or pedestrian parapet which is not a product and thus not compliant with IS EN 1317, but which has been subject to a detailed design for a specific situation and set of circumstances;

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 aligned with 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.)**

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.

Except as noted above, where terms from IS EN 1317 are used in this standard (e.g. containment level, impact severity level, working width, etc), these terms shall have the meaning as defined in IS EN 1317.

3. GENERAL REQUIREMENTS FOR VEHICLE PARAPETS

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 Unless particular circumstances apply which require the use of a bespoke parapet, vehicle parapets shall be fully crash tested in accordance with IS EN 1317-2 and meet the acceptance criteria of IS EN 1317-2 for the performance requirements specified below. Any use of a bespoke parapet requires the written agreement of TII Structures Section.

Table 3/1: Minimum Parapet Containment Levels

Location	Minimum Parapet Containment Level
All structures not otherwise explicitly dealt with in this table	H2
Structures in urban areas where the legal speed limit is 60km/h or less, except where: <ul style="list-style-type: none"> • The structure crosses or adjoins a road or railway • The structure is on a horizontal curve and / or gradient and the radius and / or gradient does not comply with relevant desirable minimum standards. Relevant desirable minimum standards are described in NRA TD 9. All accommodation bridges serving a single landholding except accommodation bridges over the railway.	N2
All structures crossing or adjoining the railway	H4a

Containment Level

- 3.3 At the locations described in Table 3/1, the vehicle parapet shall have at least the Containment Level indicated. Vehicle parapets of containment level N1, T1, T2 or T3 shall not be used. Any proposal to use a vehicle parapet containment level less than H2 requires the written agreement of TII Structures Section.
- 3.4 The containment levels in Table 3/1 are minimum requirements only. The responsibility rests with the Designer to provide the appropriate containment level taking account of the following factors:
- a) The hazard formed by the parapet itself;
 - b) The risk to vehicles from penetrating the parapet and reaching the hazard below;
 - c) The risk to others (either on or below the structure) arising from a vehicle penetrating the parapet.

Where structures correspond to more than one location in Table 3/1, the highest relevant Containment Level shall be used.

- 3.5 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.
- 3.6 With the exception of bridges over the railway, vehicle parapets of Very High Containment Level (**H4a**) 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. Such cases should be considered (by the Designer) on their merits and submitted for consideration (by Transport Infrastructure Ireland) as part of the structure's Technical Acceptance process (ref NRA BD02).

Impact Severity Level

- 3.7 Vehicle parapets of Normal Containment Level (N2) should have Impact Severity Level **A**. Parapets of Higher or Very High Containment Level may have Impact Severity Level **B**.

Working Width

- 3.8 The Working Width shall be no greater than **W4**.
- 3.9 Notwithstanding 3.8 above, it remains the responsibility of the Designer to ensure that the parapet system chosen has been tested to circumstances similar to those in which the parapet is proposed to be used. In particular, the Designer shall ensure that no wheel of an errant vehicle can fall between the parapet edge beam and the deformed restraint system.

Height

- 3.10 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 structure in question:

1000mm	for structures carrying motorways or roads to motorway standard from which pedestrians, animals and cyclists are excluded by Order;
1250mm	for other road structures not otherwise explicitly dealt with in this Section 3.10;
1400mm	where a cycleway is adjacent to the parapet;
1500mm	for accommodation bridges;
1500mm	for Very High Containment Level applications except railway structures;
1800mm	for all structures over railways;
1800mm	for bridleway bridges.

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

- 3.11 Special conditions at particular sites may signify the need for higher parapets. Such cases should be considered (by the Designer) on their merits and submitted for consideration (by Transport Infrastructure Ireland) as part of the structure's Technical Acceptance process (ref NRA BD 02).

Form and Aesthetics

- 3.12 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).
- 3.13 Parapet posts shall be set out symmetrically with respect to bridge supports (piers and abutments) and any joints in the deck fascia.

Pedestrian Restraint on Vehicle Parapets

- 3.14 For all structures with vehicle parapets, except structures carrying motorways or roads to motorway standard from which pedestrians, animals and cyclists are excluded by law, the parapets shall restrain pedestrians as well as vehicles.
- 3.15 It is not practical to make vehicle parapets completely unclimbable but, where pedestrians have access, infilling shall be provided such that the parapet will not have footholds.
- 3.16 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.
- 3.17 Pedestrian restraint shall be provided as an integral part of the vehicle parapet. Separate vehicle and pedestrian parapets shall not be used.
- 3.18 Infilling on the traffic face of solid parapets shall conform to the following:
- a) Infilling shall comply with the loading and geometric requirements of SR CEN/TR 1317-6 Road Restraint Systems – Part 6: Pedestrian Restraint System – Pedestrian Parapets and this standard BD 52;
 - b) Infilling shall be securely fixed such that the use of power tools shall be required to detach it;
 - c) No reflective surfaces shall be used that might create a hazard for users of any road or railway;
 - d) Vertical bar infill shall only be considered on parapets of Normal Containment Level on roads with a mandatory speed limit of 50km/h or less.
- 3.19 Infills shall extend from not more than 25mm above the plinth at the traffic face to the full height of the parapet.
- 3.20 On road bridges where provision is made for other road users, such as cyclists, equestrians or livestock, pedestrian restraint in accordance with Paragraphs 3.14 to 3.19 shall be provided.
- 3.21 There may be a need for mesh infilling to part height on parapets with or 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 consideration (by Transport Infrastructure Ireland) as part of the structure's Technical Acceptance process (ref NRA BD02).
- 3.22 At locations subject to vandalism, there may be a need for a significant increase in height in the pedestrian restraint. Mesh screening should 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 consideration (by Transport Infrastructure Ireland) as part of the structure's Technical Acceptance process (ref NRA BD02).
- 3.23 On all bridges over or adjacent to railways, irrespective of whether pedestrians have access to the bridge, infill or other restraint for pedestrians or other road users will be required in accordance with Paragraphs 3.14 to 3.22 and with the following additional requirements:
- a) 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;

- b) 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;
- c) 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 of the parapet beam. The outer face sheeting shall deny access to the outer ledge and extend along the length of the parapet for the width of the railway tracks plus one parapet panel or 2.0m, whichever is the greater. In cases where overhead electrification equipment is present, the sheeting shall extend to at least 3.0m from the outside edge of the nearest rails or from any overhead electrification equipment, whichever is greater. It shall also be provided at the ends of the parapet for a distance of 2.0m. See Figure 3/1;

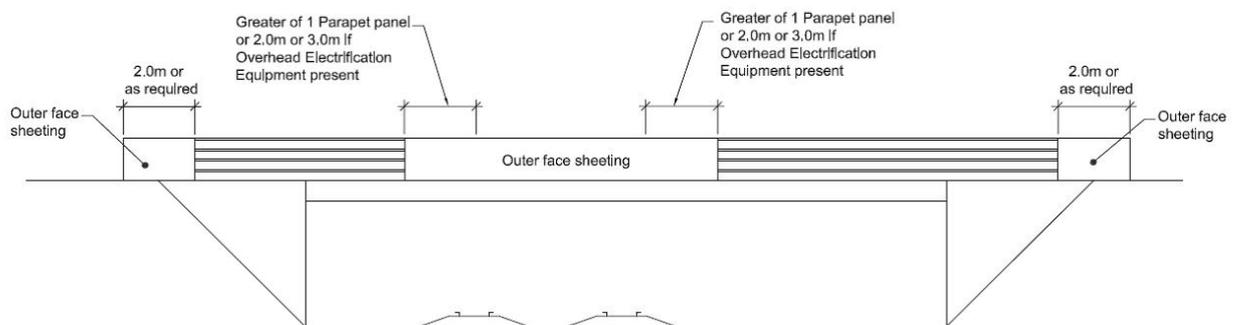


Figure 3/1: Metal Parapets over Railways

- d) 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;
- e) Any other method of denying access to the outer ledge of the parapet shall be subject to the agreement of Iarnród Éireann.

Paved Verge

3.24 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 minimum kerb height of not less than 75mm. 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 at a gradient no greater than 5% to the level of the road verge or footway on the bridge approaches.

Divided Structures

3.25 When designing a divided structure to carry a dual carriageway, the 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 appropriate bridge deck traffic loading in accordance with IS EN 1991-2 shall be provided. If the structure is over a railway, a grid is not permitted and a solid slab is required.

3.26 Where these provisions are impractical or the gap is greater than 2m, vehicle parapets shall be provided.

4. ADDITIONAL REQUIREMENTS FOR BESPOKE VEHICLE PARAPETS

General

- 4.1 As stated in Paragraph 3.2, vehicle parapets shall wherever possible be tested to and conform to the requirements of IS EN 1317-2. However, it is acknowledged that, in certain limited circumstances, suitable crash tested vehicle parapets may not be available and that a designed, non crash tested, bespoke vehicle parapet may be appropriate. This section provides specific requirements for bespoke parapets which are to be considered as additional to the general requirements for all parapets specified elsewhere in this standard.
- 4.2 The need for bespoke vehicle parapets may arise, inter alia, for bridges over the railway, where particular safety criteria apply, for heritage structures where particular aesthetic criteria may apply, or in urban areas where traffic speeds are low and aesthetic criteria may apply. Wherever possible road restraint systems tested in accordance with IS EN 1317 should be used in these circumstances and only as the last resort should a bespoke vehicle parapet be provided.
- 4.3 Design of bespoke vehicle parapets shall be in accordance with the relevant Part of BS 6779 as amended by this Standard. It will not be necessary for parapets designed to BS 6779 to be tested to demonstrate the Impact Severity Level.
- 4.4 Containment level N1 in IS EN 1317 shall be taken as equivalent to Low Level of Containment in BS 6779. Containment level N2 in IS EN 1317 shall be taken as equivalent to Normal Level of Containment in BS 6779. Containment level H4a in IS EN 1317 shall be taken as equivalent to High Level of Containment in BS 6779.
- 4.5 There is no containment level in BS 6779 equivalent to the H2 containment level specified in IS EN 1317. Where bespoke parapets of containment level H2 are required, these shall be designed from first principles for the vehicle impact criteria specified in IS EN 1317.
- 4.6 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.
- 4.7 Subject to paragraphs 4.1 and 4.2 above, bespoke vehicle parapets shall be provided on bridges and retaining walls at the locations described in Paragraph 3.1.

Materials

- 4.8 Bespoke 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.
- 4.9 Masonry vehicle parapets shall not be used on new bridges over, under or adjacent to national roads. However, where necessary to replace parapets on existing masonry bridges, reinforced or unreinforced masonry parapets may be used. Masonry parapets shall be designed in accordance with BS 6779: Highway Parapets for Bridges and Other Structures, Part 4: Specification for Parapets of Reinforced and Unreinforced Masonry Construction, as amended by this Standard. Designers shall also take account of the relevant guidance contained within the UK Department of Transport's 2012 document "Guidance on the Design, Assessment and Strengthening of Masonry Parapets on Highway Structures".

Vehicle Parapets of Metal Construction

- 4.10 Metal vehicle parapets of open frame design, such as post and rail or post and beam shall be designed in accordance with BS 6779: Highway Parapets for Bridges and Other Structures, Part 1: Specification for Vehicle Containment Parapets of Metal Construction Annex B, as amended by this Standard, for the relevant Containment Level.
- 4.11 Metal vehicle parapets of open frame design, such as post and rail or post and beam shall be designed for durability in accordance with BS 6779: Highway Parapets for Bridges and Other Structures, Part 1: Specification for Vehicle Containment Parapets of Metal Construction Section 6.4, as amended by this Standard.
- 4.12 Joints shall be provided in metal vehicle parapets in accordance with BS 6779: Highway Parapets for Bridges and Other Structures, Part 1: Specification for Vehicle Containment Parapets of Metal Construction Section 6.5, as amended by this Standard.
- 4.13 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 Low or Normal Levels of Containment and not less than 100mm or more than 200mm for High Level of Containment. The clear gap between longitudinal members and between the lowest longitudinal member and the top surface of the concrete plinth shall be not more than 300mm. For parapets on accommodation bridges, the clear gap may be increased to not more than 400mm.
- 4.14 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.
- 4.15 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.
- 4.16 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.
- 4.17 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.
- 4.18 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 High Level of Containment parapet, the post extensions to carry the non-effective rail shall be designed for this purpose only.

- 4.19 Bespoke metal parapets over the railway shall, in addition to the above requirements, comply with the requirements of Paragraph 3.23 of this Standard.
- 4.20 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.

Vehicle Parapets of Concrete Construction

- 4.21 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 and IS EN 1991-2.
- 4.22 Vehicle parapets of insitu reinforced concrete construction shall be designed in accordance with BS 6779: Part 2 as amended by this Standard and IS EN 1991-2
- 4.23 All reinforced concrete parapet panel walls shall have a minimum thickness of 180mm for Normal Level of Containment Level and 325mm at the critical design section for High Level of Containment.
- 4.24 All reinforced concrete parapet panel walls shall have a minimum panel length of 1.5m and a maximum panel length of $1/5^{\text{th}}$ span or 3.5m whichever is lesser.
- 4.25 γ_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.
- 4.26 Concrete parapets for Normal Level of Containment 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.
- 4.27 Concrete panel walls of parapets for Normal Level of Containment 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

- 4.28 Vehicle parapets of combined metal and 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.
- 4.29 γ_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.
- 4.30 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.
- 4.31 Concrete panel walls of parapets 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.
- 4.32 Bespoke parapets of combined metal and concrete construction over the railway shall, in addition to the above requirements, comply with the requirements of Paragraph 3.23 of this Standard.

Masonry Cladding

- 4.33 Where masonry cladding to concrete parapets is provided on new bridges the following criteria shall be satisfied:
- a) Fixings shall be spaced at not more than 450mm horizontally and 300mm vertically;
 - b) Fixings shall be in stainless steel and shall not be placed in contact with carbon steel reinforcement;
 - c) Uncoursed work will only be permitted where there is a low probability of detached masonry presenting a hazard to the public. Such cases should be considered (by the Designer) on their merits and submitted for consideration (by Transport Infrastructure Ireland) as part of the structure's Technical Acceptance process (ref NRA BD02).
- 4.34 Masonry cladding to the front face of a parapet will only be permitted in exceptional cases (based principally on aesthetic considerations). 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.
- 4.35 The requirements of Paragraphs 4.33 and 4.34 above do not apply to the replacement of existing masonry parapets on existing bridges.
- 4.36 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. SPECIFIC REQUIREMENTS FOR PEDESTRIAN PARAPETS AND GUARDRAILS

Scope

- 5.1 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.
- 5.2 The requirements in this Chapter for infill to pedestrian parapets are equally applicable to infill on vehicle parapets where pedestrian restraint is also required, subject to the requirements of Chapter 3 of this Standard.
- 5.3 This Chapter should be read in conjunction with SR CEN/TR 1317-6 Road Restraint Systems – Part 6: Pedestrian Restraint System – Pedestrian Parapets.

Height of Pedestrian Parapets

- 5.4 The height of pedestrian parapets (H_o) shall be measured above the adjoining pedestrian walking surface and shall not be less than the highest of the following criteria relevant to the bridge in question:

1250mm	for footbridges except over railways;
1450mm	for cycleway bridges except over railways;
1850mm	for bridleway bridges;
1850mm	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.

- 5.5 The height requirements given in 5.4 above shall include for a plinth of minimum height 50mm.

Pedestrian Parapets Design Criteria

- 5.6 Footbridges, cycleway bridges and bridleway bridges shall be provided with pedestrian parapets complying with the requirements of SR CEN/TR 1317-6.
- 5.7 The design working life for pedestrian parapets shall be as given in Series 400 of the TII Specification for Roadworks.
- 5.8 Pedestrian parapets shall be designed or tested to conform to the requirements of SR CEN/TR 1317-6. For designed parapets, horizontal uniformly distributed traffic loads shall be calculated in accordance with Method 2 in SR CEN/TR 1317-6. For all other traffic loads, the minimum values given in SR CEN/TR 1317-6 shall be used.
- 5.9 Pedestrian parapets of concrete construction shall be designed in accordance with IS EN 1992. The horizontal traffic loads in SR CEN/TR 1317-6 shall be assumed to act within 25mm of the top of the parapet.
- 5.10 Snow and wind loads on pedestrian parapets shall be in accordance with IS EN 1991-1-3 and IS EN 1991-1-4.
- 5.11 Pedestrian parapets shall be provided with infilling such that the parapet will not have footholds.

- 5.12 Infilling shall comply with the requirements of paragraphs 3.18 to 3.23 of this standard. Unless solid infilling is required to meet other requirements of this standard, the infilling shall contain spaces or voids with a maximum D_s equal to 30mm in accordance with SR CEN/TR 1317-6. Notwithstanding this, vertical bar infilling shall have a maximum D_s equal to 100mm.
- 5.13 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

- 5.14 Within the road boundary, retaining walls often support the slope of a cutting or embankment. Also present may be 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.
- 5.15 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 5/1 to 5/3 overleaf.
- 5.16 The type of pedestrian protective measure to be used will need to be determined for each specific location depending on the ease of pedestrian access to the hazard in question. It could be a pedestrian guardrail, a pedestrian parapet or an appropriate type of boundary fencing (in accordance with RCD/300/1). It will need to be in keeping with any structural, drainage, environmental and aesthetic considerations of the site in question. The choice of pedestrian protective measure shall be supported by a site specific risk assessment.

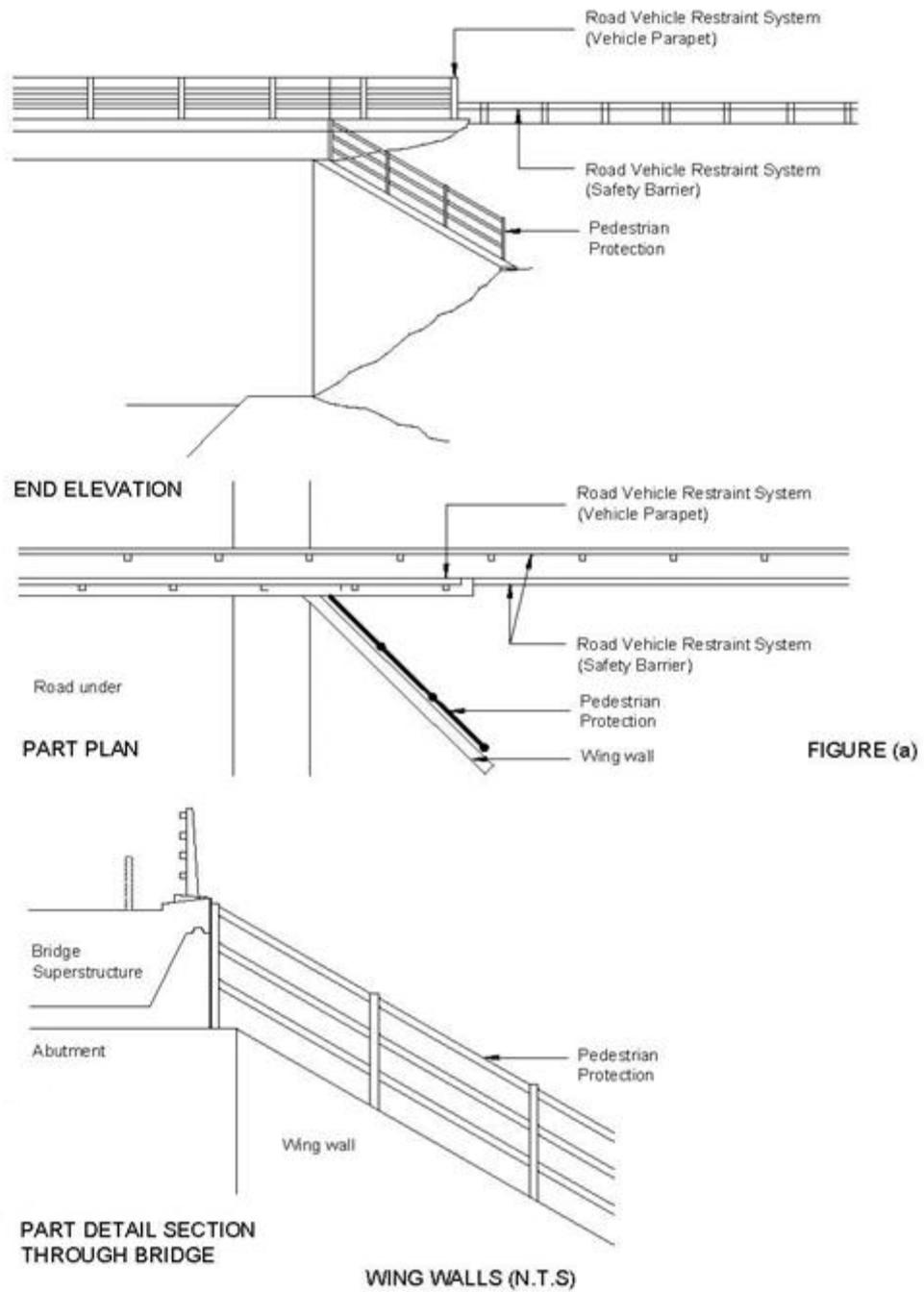


Figure 5/1: Typical Locations for Pedestrian Guardrailing/Protection

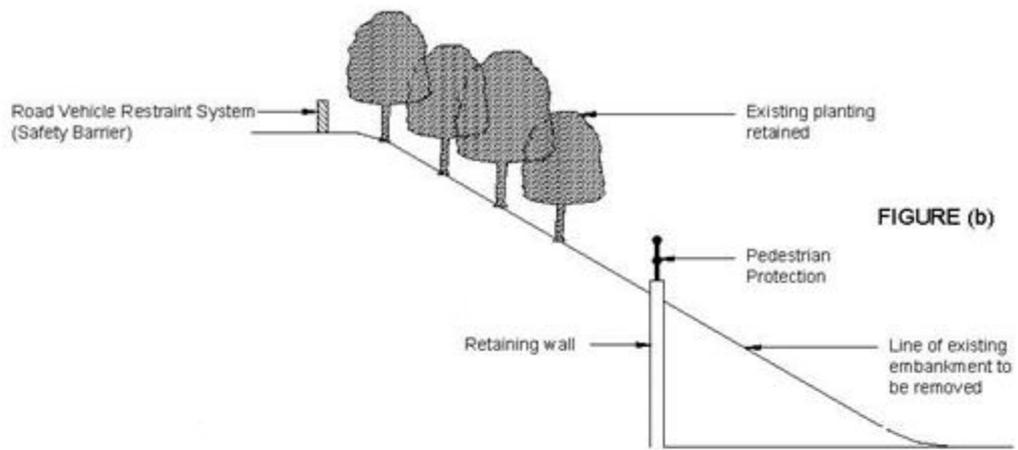


FIGURE (b)

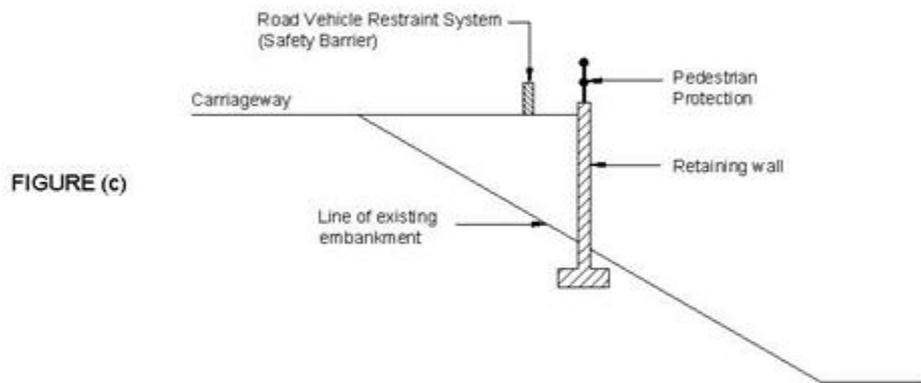


FIGURE (c)

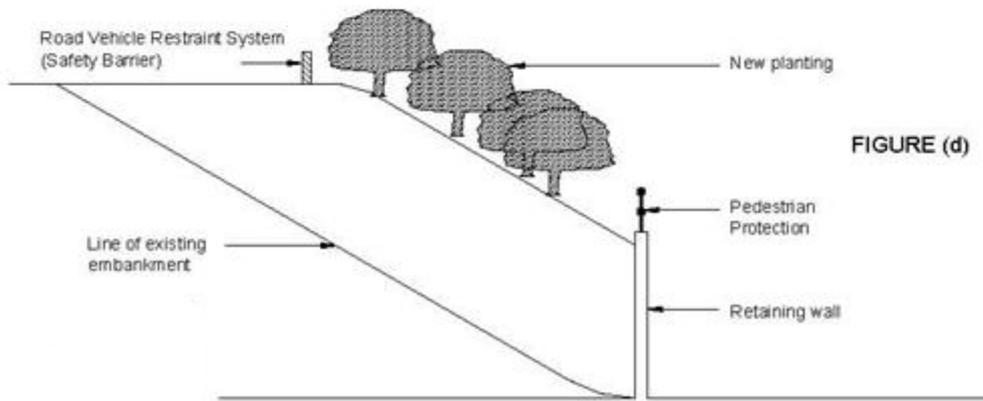


FIGURE (d)

RETAINING WALLS (N.T.S)

Figure 5/2: Typical Locations for Pedestrian Guardrailing/Protection

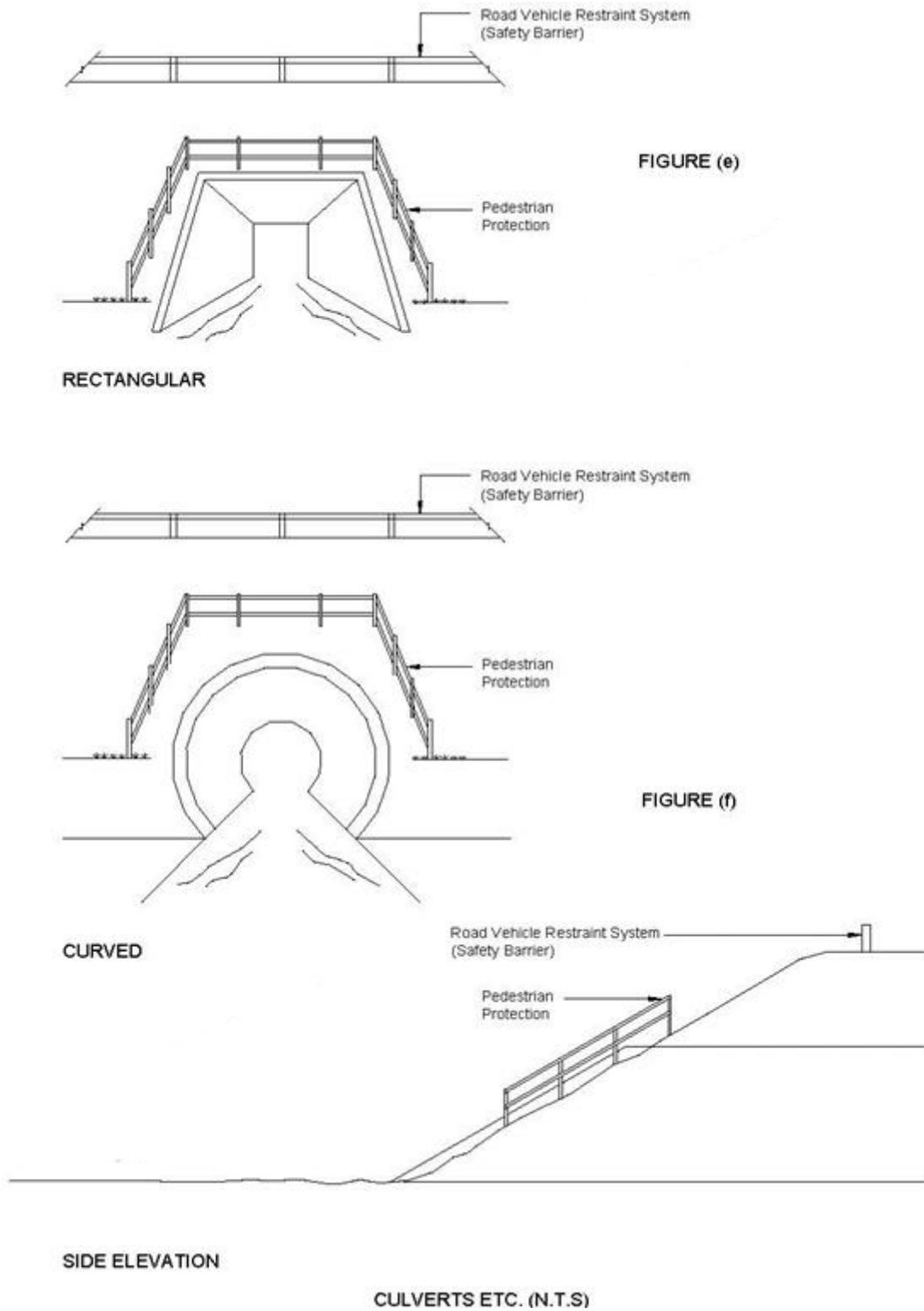


Figure 5/3: Typical Locations for Pedestrian Guardrailing/ Protection

6. DESIGN OF ANCHORAGES AND SUPPORTING MEMBERS FOR PARAPETS

Anchorage General

- 6.1 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.
- 6.2 Anchorages, attachment systems, bedding and plinths for metal parapets shall meet the requirements of the tested vehicle parapet system and, unless otherwise specified in this Standard or IS EN 1991-2, shall comply with the requirements of BS 6779: Part 1 Clause 6.6 as amended by this standard.
- 6.3 Anchorages and attachment systems for concrete parapets shall meet the requirements for the tested vehicle parapet system and unless otherwise specified in this Standard or IS EN 1991-2, shall comply with the requirements of BS 6779: Part 2 Clauses 6.2 and 10.
- 6.4 Reinforcement used to tie precast concrete parapets to the bridge deck or other supporting structure (e.g. kentledge slab) shall comply with one of the following:
- i) shall be stainless steel reinforcement Type 1.4301 to IS EN 10088 or
 - ii) shall be protected by bridge deck waterproofing system and the cover (cmin) to the face of all concrete forming part of the anchorage shall be in excess of 80mm.

Main Structure

- 6.5 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 and shall be as specified in IS EN 1991 Part 2 Traffic Loads on Bridges.
- 6.6 Where the Contractor has the facility to choose the vehicle parapet system to be used on a particular structure, the parapet system to be used will not be known at the time that the detailed bridge design is prepared. Accordingly, 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.
- 6.7 The Designer is responsible for assessing the condition and proving the strength sufficiency of an existing structure on which a new or replacement vehicle 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. 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 shall be included in the Appendices to the Specification to enable the Contractor to make an initial selection of the parapet and its anchorages.

Assessment of Existing Structures

- 6.8 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.
- 6.9 Approval to a proposed system will not be given by TII 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.
- 6.10 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 Transport Infrastructure Ireland.
- 6.11 The Designer will specify site tests which the Contractor has to carry out on anchors to demonstrate that they have been installed correctly.

7. APPROACHES AND TRANSITIONS

Approaches to Parapets

- 7.1 To prevent direct impact between a vehicle and the end of the vehicle parapet, a safety barrier shall be provided on each end of the parapet. The safety barrier shall 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.
- 7.2 On roads with a mandatory speed limit of 50km/h or less, the requirements for safety barriers, in accordance with Paragraph 7.1 may be relaxed subject to the approval of TII.
- 7.3 The Containment Level of the safety barrier on the approach to the parapet shall be at least equal to that of the parapet.
- 7.4 For bridges over railways the safety barrier requirements (given in 7.3 above) shall be subject to discussion/ agreement with Iarnród Éireann and shall be justified by means of a site specific risk analysis.

Transitions between Safety Barriers and Parapets

- 7.5 Where a safety barrier adjoins 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 and provide a gradual transition between the containment level and working width of the safety barrier and the parapet. Such connections shall be considered as Transitions.
- 7.6 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 greater than either of the two connected barriers or parapets.
- 7.7 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.
- 7.8 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.
- 7.9 All transitions shall comply with the requirements of the test acceptance criteria specified in IS ENV 1317-4 : 2001 Evidence of compliance shall be submitted to Transport Infrastructure Ireland in the form of a full test report. All transitions shall be connected to the same safety barrier and parapet system to which they are tested.
- 7.10 Pending finalisation of the European Standards on transitions, the use of non tested transitions will be considered, but will constitute a Departure from this Standard. Any application for a Departure from Standards for the use of a non tested transition shall contain the following information:
 - Evidence that both barriers (to be joined by the transition) have been successfully tested to the relevant parts of IS EN1317;
 - Details of appropriate calculations / simulations of the performance of both barriers which will have been prepared and validated using data from the actual crash testing of the barriers;

- Adequate demonstration that the proposed transition has been evaluated using these validated calculations / simulations and that the proposed transition meets the required performance criteria set out in IS ENV 1317 Part 4 : 2001;
- Adequate demonstration that the above calculations / simulations have been carried out and certified by a suitably qualified Chartered Engineer and clear identification of all design assumptions made.

7.11 Transitions between safety barriers and bespoke parapets provided in accordance with Section 4 of this Standard, shall be designed to meet the requirements of paragraph 7.5 above. The requirements of paragraphs 7.9 and 7.10 above do not apply in these circumstances.

8. REFERENCES

8.1 Irish and British Standards

IS EN 1317-1: 2010, Road Restraint Systems - Part 1: Terminology and General Criteria for Test Methods.

IS EN 1317-2: 2010, Road Restraint Systems - Part 2: Performance Classes, Impact Test Acceptance Criteria and Test Methods for Safety Barriers.

IS ENV 1317-4: 2001, Road Restraint Systems - Part 4: Performance Classes, Impact Test Acceptance Criteria and Test Methods for Terminals and Transitions of Safety Barriers.

IS EN 1317-5: 2007 (as amended), Road Restraint Systems – Part 5: Product Requirements and evaluation of conformity for vehicle restraint systems.

SR CEN/TR 1317-6: 2012, Road Restraint Systems – Part 6: Pedestrian Restraint System – Pedestrian Parapets.

BS 6779 Highway parapets for bridges and other structures - Part 1: Specification for vehicle containment parapets of metal construction.

BS 6779 Highway parapets for bridges and other structures - Part 2: Specification for vehicle containment parapets of concrete construction.

BS 6779 Highway parapets for bridges and other structures - Part 3: Specification for vehicle containment parapets of combined metal and concrete construction.

BS 6779 Highway parapets for bridges and other structures - Part 4: Specification for parapets of reinforced and unreinforced masonry construction.

IS EN 1991-1-3:2003 Eurocode 1: Actions on structures - Part 1-3: General Actions – Snow Loads (Including Irish National Annex).

IS EN 1991-1-4:2005 Eurocode 1: Actions on structures - Part 1-4: General Actions – Wind Actions (Including Irish National Annex).

IS EN 1991-2:2003 Eurocode 1: Actions on structures - Part 2: Traffic loads on bridges (Including Irish National Annex).

IS EN 1992-1-1:2005 Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings (Including Irish National Annex).

IS EN 1992-2:2005 Eurocode 2: Design of concrete structures – Concrete bridges – Design and detailing rules (Including Irish National Annex).

8.2 National Roads Authority Design Manual for Roads and Bridges

NRA BD 02: Technical Acceptance of Structures on Motorways and Other National Roads

NRA TD 27: Cross Sections and Headroom.

9. ENQUIRIES

- 9.1 All technical enquiries or comments on this document or any of the documents listed as forming part of the NRA DMRB should be sent by e-mail to infoDMRB@tii.ie, addressed to the following:

Director of Professional Services
Transport Infrastructure Ireland
Parkgate Business Centre
Parkgate St.
Dublin 8
D08 DK10
Ireland



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Helen Hughes
Director of Professional Services

APPENDIX A: (INFORMATIVE) – RELEVANT EXTRACTS FROM IS EN 1317

Summary of IS EN 1317 Performance Classes

- A.1. 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.
- A.2. IS EN 1317-2 defines various performance parameters for safety barriers and vehicle parapets as part reproduced in Tables A/1 to A/3 and Figure A/1 of this Standard.
- A.3. 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.
- A.4. Further details are available in IS EN 1317-5. Part 5 deals with the circumstances where a barrier is tested in one form but is subsequently (slightly) varied. It gives criteria which allows the modification without a further test certificate being required.

Containment Level

- A.5. Containment Level is an indication of the severity of impact – type, weight and speed of vehicle – which the safety barrier is designed to contain. Table A/1 below gives details of some of the more commonly used containment levels for bridge parapets.

Impact Severity Level

- A.6. Impact Severity Level is measured as a function of the Acceleration Severity Index (ASI) and the Theoretical Head Impact Velocity (THIV). IS EN 1317-2 defines these terms and describes how they should be measured. The three levels given in the Standard are shown in Table A/2.
- A.7. Impact Severity Level A affords a greater level of safety for vehicle occupants than Level B.

Table A/1: IS EN 1317 Containment Level Tests*

Containment Level	Vehicle Impact Test*				
	Test	Impact Speed (km/h)	Impact Angle (degrees)	Vehicle Mass (t)	Vehicle Type
Normal Containment					
N1	TB 31	80	20	1.5	Car
N2	TB 32	110	20	1.5	Car
Higher Containment					
H1	TB 42	70	15	10.0	Rigid HGV
H2	TB 51	70	20	13.0	Bus
H3	TB 61	80	20	16.0	Rigid HGV
Very High Containment					
H4a	TB 71	65	20	30.0	Rigid HGV
H4b	TB 81	65	20	38.0	Articulated HGV

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 A/2: IS EN 1317 Impact Severity Levels

Impact Severity Level	Index Values	
	ASI	THIV
A	≤ 1.0	≤ 33 km/h
B	≤ 1.4	≤ 33 km/h
C	≤ 1.9	≤ 33 km/h

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 impact severity level C may be adopted and installed.. (Source IS EN 1317-2)

Working Width

A.8. 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 A/1.

A.9. Working Width is generally specified as one of the classes listed in Table A/3.

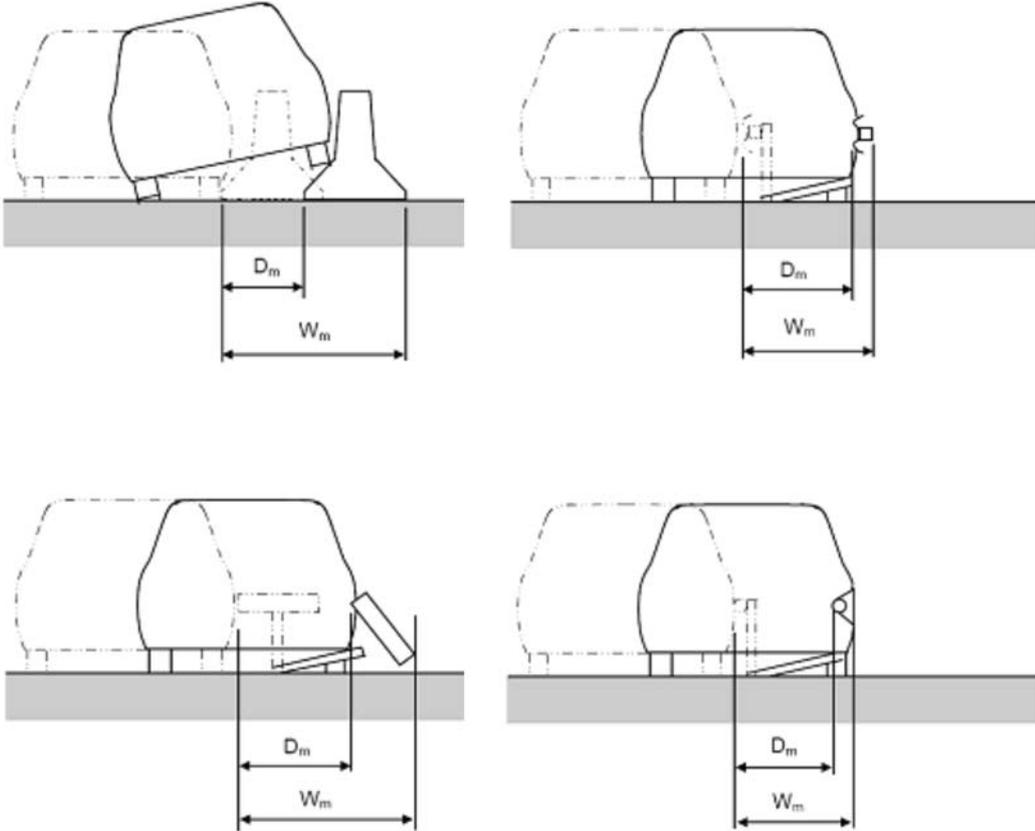
Table A/3: Working Width Classes

Class of Working Width	Level of Working Width
W1	≤ 0.6 m
W2	≤ 0.8 m
W3	≤ 1.0 m
W4	≤ 1.3 m
W5	≤ 1.7 m
W6	≤ 2.1 m
W7	≤ 2.5 m
W8	≤ 3.5 m

NOTE 1 In specific cases, a working width of less than W1 may be specified.

NOTE 2 The dynamic deflection, the working width and the vehicle intrusion 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 satisfactorily.

NOTE 3 The deformation depends on both the type of system and the impact test characteristics.
 (Source: IS EN 1317-2)



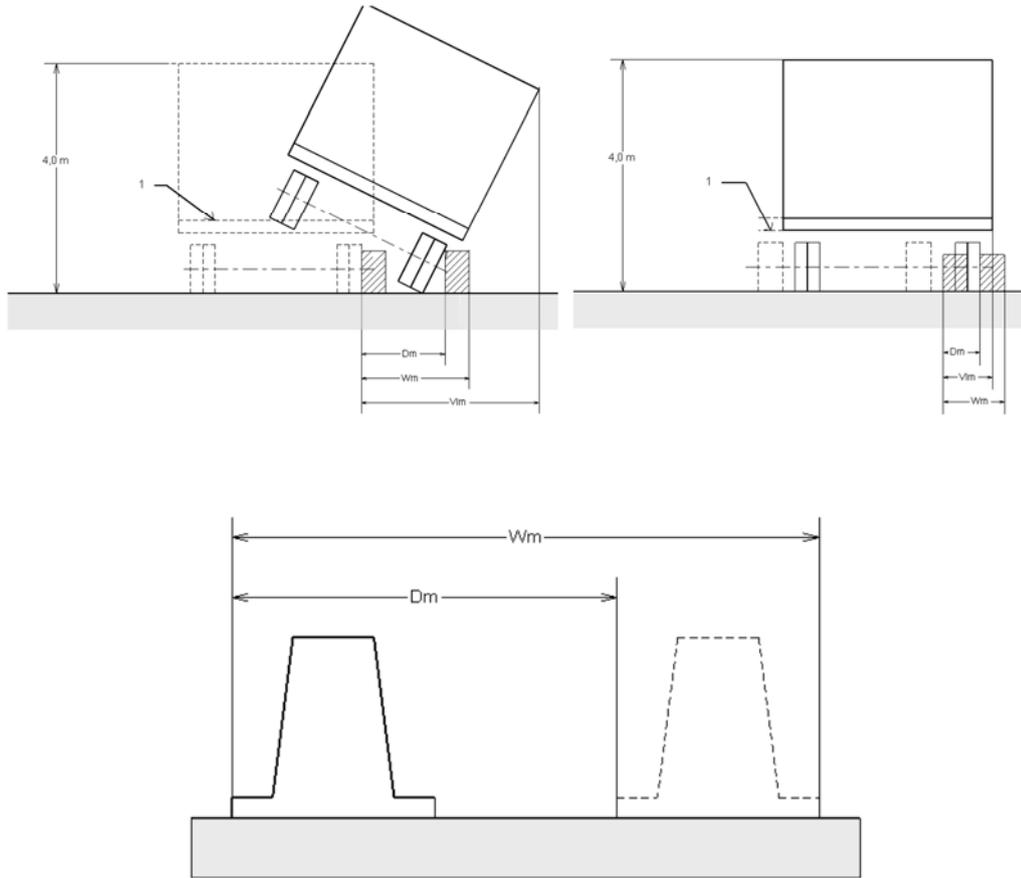


Figure A/1: Dynamic Deflection (D) and Working Width (W)

(Source: IS EN 1317-2)

APPENDIX B: (NORMATIVE) – AMENDMENTS AND ADDITIONS TO BS 6779

BS 6779-1: 1998 (Amd. No. 14290, 21 March 2003)

- (i) clause 2:
- (a) clause 2.1: first paragraph, third line delete “71” and replace with “65”.
- (iii) clause 6:
- (e) clause 6.6.2: Main structure: Replace “Department of Transport Standard BD 37/88” with “IS EN 1991-2”; and
- (f) clause 6.6.5: End of Note 1, delete last sentence and replace with: “The tensile strength of concrete shall be ignored in the calculation”.
- (iv) clause 7:
- (a) clause 7.1.2: Notch toughness: Replace “Department of Transport Standard BD 13/90” with “BD 13 (NRA DMRB 1.3)”;
- (b) Table 3 – Materials of construction for steel parapets: Delete and insert as follows:

Delete	Insert
BS 4848-2	IS EN 10210-2
BS 4848-4	IS EN 10056-1
BS 6363	IS EN 10219-2
BS EN 10113	IS EN 10025-1, IS EN 10025-3 and IS EN 10025-4
BS 1449-1	BS 1449-1.1
BS 1449-2	IS EN 10029, IS EN 10058, IS EN 10051, IS EN ISO 9445-1 and IS EN ISO 9445-2
BS 970-3	IS EN 10277-1 to IS EN 10277-5 (inclusive) and IS EN 10278
BS EN 24016	IS EN ISO 4016
BS EN 24018	IS EN ISO 4018
BS EN 24034	IS EN ISO 4034
BS EN 20898-1	IS EN ISO 898-1
BS EN 24014	IS EN ISO 4014
BS EN 24017	IS EN ISO 4017
BS EN 24032	IS EN ISO 4032
BS EN 24035	IS EN ISO 4035
BS EN 20898-1	IS EN ISO 898-1
BS 6105	IS EN ISO 3506-1 and IS EN ISO 3506-2

(c) Table 4 – Materials of construction for aluminium alloy parapets: Delete and insert as follows:

Delete	Insert
BS 1474:1987, Alloys 6061, 6063, 6082, 6005A and 6060	IS EN 515, IS EN 573-3, IS EN 755-1 to IS EN 755-9 (inclusive), IS EN 12020-1 and IS EN 12020-2, alloys EN AW-6061, EN AW-6063, EN AW-6082, EN AW-6005A and EN AW-6060
BS 1471:1972, Alloys 6061, 6063 and 6082	IS EN 515, IS EN 573-3, IS EN 754-1, IS EN 754-2, IS EN 754-7 and IS EN 754-8, alloys EN AW-6061, EN AW-6063 and EN AW-6082
BS 4300/1:1967, alloy 5251	IS EN 1592-1 to, IS EN 1592-4 (inclusive), alloy EN AW-5251
BS EN 485-1:1994	IS EN 485-1
BS 1490:1988, Alloys LM6 and LM25	IS EN 1559-1, IS EN 1559-4, IS EN 1676 and IS EN 1706, alloys EN AC-47000, EN AC-47100 and EN AC-47200
BS 1449-1	BS 1449-1.1
BS 1449-2: 1983, Grades 316 S 31 and 316 S33	IS EN 10029, IS EN 10048, IS EN 10051, IS EN ISO 9445-1, IS EN ISO 9445-2, Designation 1.4401 or 1.4436
BS EN 24016	IS EN ISO 4016
IS EN 24018	IS EN ISO 4018
BS EN 24034	IS EN ISO 4034
BS EN 20898-1	IS EN ISO 898-1
BS EN 24014	IS EN ISO 4014
BS EN 24017	IS EN ISO 4017
BS EN 24032	IS EN ISO 4032
BS EN 24035	IS EN ISO 4035
BS EN 20898-1	IS EN ISO 898-1
BS 6105	IS EN ISO 3506-1 and IS EN ISO 3506-2

BS 6779-2

- (i) clause 5:
 - (a) clause 5.2: NOTE, delete “British Rail” and insert “Iarnród Éireann”;
- (ii) clause 6:
 - (a) clause 6.3: Main structure: Replace “Department of Transport Standard BD 37/88” with “IS EN 1991-2”.
- (iii) clause 10:
 - (a) clause 10.1, a): NOTE replace “Department of Transport” with “National Roads Authority”; and
 - (b) clause 10.1 d): delete “BS 6105” and insert “IS EN 3506-1 and IS EN ISO 3506-2”, delete “BS 729” and insert “IS EN ISO 1461”.
- (iv) clause 11:

- (a) clause 11.3.5: delete “BS 6105” and insert:
“IS EN ISO 3506-1 and IS EN ISO 3506-2”, delete “BS 1449-2” and insert IS EN 10029, IS EN 10048, IS EN 10051, IS EN ISO 9445-1 and IS EN ISO 9445-2”; and

- (v) Table 4 - Values of f_k and γ_m :
 - (a) Anchorages and attachment system:
3rd column, delete “BS 6105” and insert IS EN ISO 3506-1 and IS EN ISO 3506-2”, delete “BS 1449-2” and insert “IS EN 10029, IS EN 10048, IS EN 10051, IS EN ISO 9445-1 and IS EN 9445-2”.

- (vi) Clause 13:
 - (a) Clause 13.2.1: Delete “NOTE For more information on safety fences see BS 6579”; and
 - (b) Clause 13.3.1: Delete “Note 1 and Note 2” completely.

- (vii) Figure 4: Top right hand side, delete “Grade 316 S 33 to BS 1449: Part 2” and insert “designation 1.4401 or 1.4436 to IS EN 10029, IS EN 10048, IS EN 10051, IS EN ISO 9445-1 and IS EN ISO 9445-2”.



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