THE HIGHWAYS AGENCY BD 52/93

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

THE WELSH OFFICE
Y SWYDDFA GYMREIG

THE DEPARTMENT OF THE ENVIRONMENT
FOR NORTHERN IRELAND



# The Design of Highway Bridge Parapets

**Summary:** This Standard updates design requirements for highway bridge parapets as an interim measure pending completion of a new British Standard.

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# FOREWORD

Reference in the Specification for Highway Works (December 1991) and in Appendix 22/1 of the Specification, to `Department of Transport Technical Memorandum (Bridges) BE 5' shall be taken to mean a reference to this Standard.

Reference to `BE 5 Clause 205 c ii and Clause 206' shall be taken to mean a reference to BD 52/93 paragraphs 8.9 to 8.13 and Chapter 9.



This Standard provides specification requirements for use in public purchasing contracts. It does not lay down legislative requirements for products and materials used in highway construction in the United Kingdom.

## REGISTRATION OF AMENDMENTS

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VOLUME 2 HIGHWAY STRUCTURES: DESIGN (SUBSTRUCTURES AND SPECIAL STRUCTURES), MATERIALS

SECTION 3 MATERIALS AND COMPONENTS

# PART 3

# BD 52/93

# THE DESIGN OF HIGHWAY BRIDGE PARAPETS

**Contents**

Chapter





**April 1993**

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# 1. INTRODUCTION

1.1 The British Standards Institution is a present working towards completion of a British Standard (BS 6779) for vehicle containment parapets on highways. This work is currently taking place and when completed the various other parts of BS 6779 (excluding Part 1) will be brought into effect by the Overseeing Department in a revision to this Standard. Meanwhile there is an urgent need, as an interim measure, to carry out a minimal amendment to BE 5, which is now reissued as BD 52/93. The main changes are as follows:-

i. Implementation of the use of BS 6779: Part 1 for vehicle and vehicle/pedestrian parapets in metal.

ii. Clarification of the requirements for dealing with the ends of P6 parapets where the present document may mislead.

iii. Revision of the cross section for concrete P6 and the concrete plinths for P1, P2 and P5 parapets because the present cross section has on test been found to cause cars to corkscrew and roll over on impact.

iv. Allowing the use of P6 parapet in steel which has been proven by dynamic testing.

v. Removal of reference to out of date documents.

vi. Revision of bridge deck loading from P6 parapets.

vii. Amended special requirements at railways as agreed with the Railway Inspectorate.

viii. Deletion of lists of acceptable parapets and anchorages.

1.2 For convenience, these amendments and additions have been incorporated into the text of BE 5, and the whole document has been reprinted as BD 52/93.

**Scope**

1.3 This Standard covers parapets of vehicle, vehicle/pedestrian and pedestrian types for use on bridges and other structures including those crossing railways. Three containment levels are used for vehicle parapets, P1 and P2 (113) for normal containment, P2 (80) for low containment and P6 (high containment).

**Implementation**

1.4 This Standard should be used forthwith for all schemes currently being prepared provided that, in the opinion of the Overseeing Department, this would not result in significant additional expense or delay progress. Design Organisations should confirm its application to particular schemes with the Overseeing Department.

1.5 Where existing P6 high containment parapets have not been provided with suitable transitions, action shall be taken to install transitions in accordance with this Standard. In order to minimise disruption to traffic, this work should be programmed where possible to coincide with other work in the vicinity. The programme for this work shall be agreed with the Overseeing Department.

# 2. GENERAL REQUIREMENTS FOR HIGHWAY BRIDGE PARAPETS

**Definitions**

2.1 For the purposes of this Standard the following definitions apply:

**a. Safety Fence**

A continuous structure intended to redirect an errant vehicle along the line of the fence.

**b. Parapet**

A protective fence or wall at the edge of a bridge or similar structure.

**c. Vehicle Parapet**

A parapet designed to contain vehicles on a structure from which pedestrians, animals and cyclists are excluded by Order.

**d. Pedestrian Parapet**

A parapet designed to safeguard pedestrians, but not intended to contain vehicles.

**e. Vehicle/Pedestrian Parapet**

A parapet designed to contain vehicles and to safeguard pedestrians.

**f. Adjoining Paved Surface**

The paved area of a bridge deck, on the traffic side of a parapet, immediately adjacent to the base of the plinth of a metal parapet, or to the base of a concrete parapet.

**g. Main Longitudinal Member**

The member whose centre line is between 535mm and 685mm above the adjoining paved surface, in a parapet which contains longitudinal members. Not all parapets have a main longitudinal member.

**h. Traffic Face of a Parapet (see Annex A, Figs 1-5)**

A vertical plane containing the front face of the main longitudinal member or the bottom edge of a concrete parapet or plinth.

**i. Front Face**

The face nearest to the traffic.

**j. Outer Face**

The face remote from the traffic.

**k. Effective Longitudinal Member**

Those members of the parapet which become effective in restraining a vehicle in an impact.

**Design Criteria**

2.2 Parapets are intended to protect pedestrians and/or errant vehicles. In addition they may be required to protect the area below. In special circumstances they may be required to be solid, eg to prevent splash, reduce noise or screen railway electrification equipment. Although this Standard applies essentially to the design of bridge parapets the use of the document can be extended, as and where applicable, to parapets for other special locations eg top of retaining walls, separation of adjacent traffic at different levels, protection of adjacent vulnerable installations etc. (See also Note ii to Table I.)

2.3 The aesthetic effects of the parapet construction including its details should be considered at the initial stage of the design of the structure.

2.4 When designing a divided structure to carry a dual carriageway, the longitudinal gap between the two bridge decks should be narrow and present no danger to pedestrians or vehicles thus avoiding the need for parapets in the central reserve. If the hazard of a wider gap is unavoidable a horizontal grid designed to carry HA loading shall be provided. If the structure is over a railway, it must be infilled by a horizontal slab designed to HA loading. Where these options are impractical, parapets shall be provided.

2.5 It is not practicable to make parapets completely unclimbable but, where pedestrians have access, the parapet should not have footholds. Children

must not be able to pass through the parapet.

2.6 For the purpose of this Standard, parapets have been divided into five groups, designated P1, P2, P4, P5 and P6.

2.7 In general, a P2 parapet is intended to have half the strength of a P1 parapet. These strengths are approximately proportional to the square of the speed of the vehicle to be contained.

2.8 Application and containment requirements for various groups of parapets are given in Table I. The containment standard for full height metal vehicle and vehicle/pedestrian parapets, other than those for accommodation bridges, shall be proved by full scale dynamic testing in accordance with BS 6779: Part 1. The full scale dynamic test shall be performed using a test vehicle acceptable to the Overseeing Department. The testing shall be undertaken by a body or laboratory in a member state of the European Community offering suitable and satisfactory guarantees of technical and professional competence and independence. The Overseeing Department is likely to require to examine the full record of testing.

2.9 When using BS 6779: Part 1 the parapet group designation as given in this Standard for vehicle and vehicle/pedestrian parapets shall be taken to have the following equivalent level of containment as defined in BS 6779:

P1 & P2 (113): Normal level of containment
P2 (80): Low level of containment
P5 (excluding footbridges): Normal level of containment
P6: High level of containment

2.10 Reinforced concrete parapets or metal parapets with plinths may be used for all vehicle or vehicle/pedestrian applications.

2.11 All P5 vehicle and vehicle/pedestrian parapets are to have the containment standard of a P1 parapet.

2.12 P6 High Containment parapets shall be constructed in suitable materials. Criteria for design in reinforced concrete are given herein and criteria for construction in metal in BS 6779: Part 1.

2.13 For vehicle and vehicle/pedestrian parapets, the forces and their effects given in this document are the ultimate design values, ie they need not be multiplied by any partial safety factors. For footbridge and bridleway bridge parapets, the forces given in this document are nominal values, ie they are to be multiplied by appropriate partial safety factors for limit state design.

2.14 The design requirements given in this Standard for the vehicle and vehicle/pedestrian parapets in concrete are based on a cantilever action from the bridge deck. Main structural bridge members shall not be designed to act as vehicle or vehicle/pedestrian parapets.

2.15 Where bridge parapets are procured through a contract incorporating the Specification for Highway Works (MCHW 1) products conforming to equivalent standards or specifications of other member states of the European Community and equivalent sampling and testing undertaken in other member states will be acceptable in accordance with the terms of the 104 and 105 Series of Clauses of the Specification. Any contract not containing these Clauses must contain a suitable clause of mutual recognition having the same effect, regarding which advice should be sought.

**Materials**

2.16 All parapets may be constructed of metal or reinforced concrete or structural brickwork or masonry or a combination of these materials. When it is necessary to harmonise with local conditions, the outer face of reinforced concrete P1, P2 and P5 parapets and plinths and both faces of P4 parapets, may be clad in masonry or brickwork provided that the cladding is securely fixed to the concrete core. The front face of reinforced concrete P1, P2 and P5 parapets and plinths may also be clad, but only if the speed is below 48 km/h. Stone or precast concrete copings may only be used with reinforced concrete P4 parapets and P1, P2 and P5 parapets where the permitted speed is less than 48 km/h.

2.17 Metal parapets shall be provided with the name, trade mark or any other means of identification of the proprietary parapet system, group designation and type or mark number. An acceptable method of fixing cladding shall be by means of steel reinforcement located at every third horizontal bed course. An acceptable proprietary wire type of reinforcement to BS 4482 shall consist of 2 no. longitudinal 3.5mm diameter wires spaced at 155mm with 2.5mm diameter transverse ties at 304mm centres. Alternative proprietary reinforcement systems eg expanded metal meshes, may be used provided they are of comparable strength. The reinforcement shall have a cover of 25mm. It shall extend into the concrete backing for the same depth as the projection for the fixing of the cladding. Cladding

reinforcement shall be galvanised generally in accordance with the requirements of BS 729 or shall be of stainless steel. Care shall be taken to ensure that there is no direct contact between galvanised and non-galvanised reinforcement in order to prevent galvanic action. Stone or precast concrete copings should be secured to the concrete backing by fixings capable of resisting at yield a horizontal force of 33kN per metre of coping.

2.18 Pedestrian parapets may incorporate material other than metal or reinforced concrete provided that it has adequate strength and resistance to weathering and vandalism.

**Height**

2.19 The height of parapets shall be measured above the adjoining paved surface and shall not be less than the following:

| | |
|---|---|
| 1000 mm | for vehicle and vehicle/pedestrian parapets except as below |
| 1150 mm | for footbridges except over railways (para 7.1) |
| 1250 mm or 1500 mm | for all bridges over railways (para 8.3) |
| 1400 mm | for cycle ways |
| 1500 mm | for accommodation bridges (para 6.5) |
| 1500 mm | for High Containment applications (para 9.5) |
| 1800 mm | for bridleways (para 7.8) |

Special conditions at particular sites may require higher parapets; these cases should be considered on their merits.

**Freedom From Projections**

2.20 Metal parapets shall comply with BS 6779: Part 1: 1992, Clause 9 and for the vehicle and vehicle/pedestrian parapets have the longitudinal members placed in front of their supporting posts. Concrete parapets shall have a smooth finish.

**Safety Fences**

2.21 To prevent direct impact between a vehicle and the end of the vehicle parapet or vehicle/pedestrian parapet facing the traffic on the nearside, a safety fence shall be provided on each approach end of the parapet.

A safety fence shall be provided on the departure end where considered necessary. The safety fence shall be at least 30m long and shall continue the line of the traffic face of the parapet.

2.22 The connection between a safety fence and a vehicle or vehicle/pedestrian parapet shall conform to the current Overseeing Department requirements given in the Highway Construction Details (MCHW 3).

2.23 The end of the safety fence facing the traffic shall be sloped down, flared back away from the traffic face and secured to a buried anchorage. At the end adjacent to the bridge, the safety fence should normally be made continuous with the vehicle parapet or vehicle/pedestrian parapet by a connection capable of resisting a minimum ultimate tensile force of 330 kN.

2.24 Where a vehicle or vehicle/pedestrian parapet is required on the offside adjacent to the fast lane, it shall be protected by a safety fence similar to that described in paragraph 2.21 above.

2.25 Where safety fencing has to be provided on a motorway near cattle creeps or culverts for other safety requirements then the fencing shall be continued across these structures. In addition a pedestrian type of parapet should be provided on the headwall of the buried structures when considered necessary for the safety of the highway maintenance personnel.

**TABLE I - APPLICATION AND CONTAINMENT REQUIREMENTS FOR PARAPETS**

| PARAPET GROUP DESIGNATION | APPLICATION | CONTAINMENT FOR WHICH DESIGNED |
|---|---|---|
| P1 | Vehicle parapets for bridges carrying motorways or roads to motorway standards* (excluding motorway bridges over railways and high risk locations) | 1.5t vehicle at 113 km/h and 20° angle of impact |
| P2 | Vehicle/pedestrian parapets for bridges carrying all purpose roads and for accommodation bridges (excluding bridges over railways and high risk locations) | 1.5t vehicle at 113 and 80 km/h and 20° angle of impact (see also para 6.1) |
| P4 | Pedestrian parapets for use on footbridges and bridges carrying bridleways (excluding bridges over railways) | See para 7.9 and 7.10 |
| P5 | Parapets for use over railways (excluding use on bridges at high risk railway locations) | |
| | i. on bridges carrying motorways or roads to motorways or roads to motorway standards* | As for P1 |
| | ii. on bridges carrying all purpose roads | As for P1 |
| | iii. on footbridges | As for P4 |
| P6 | High Containment vehicle and vehicle/pedestrian parapets at high risk locations (excluding accommodation bridges) | 30t vehicle at 64 km/h and 20° angle of impact |

Notes:-

i. Where reference * is made to roads to motorway standards, this means roads from which pedestrians, animals, pedal cycles and vehicles drawn by animals are excluded by Order.

ii. In addition to their application on bridges, P6 parapets are also required for use on other structures close to and alongside railway lines (see Chapter 9 and Annex B)

# 3. REQUIREMENTS FOR METAL PARAPETS

3.1 The strength requirements given in paragraphs 3.7 to 3.12 and 3.21 apply only to metal members for vehicle and vehicle pedestrian parapets. Reference shall be made to Chapter 7 for the particular P4 requirements.

**Elongation**

3.2 The metal shall normally have a minimum elongation of 7%, but where the base of a post is a casting it must be so constructed that the casting will not fail before the post yields.

**Minimum Thickness and Protection Against Corrosion**

3.3 All hollow sections should be sealed where possible. Unsealed sections are liable to collect water due to condensation etc and where this may be trapped, drain holes shall be provided.

3.4 Steel members shall have a minimum thickness as follows:-

| | |
|---|---|
| Sealed hollow sections | 3 mm |
| Unsealed sections | 4 mm |

All exposed surfaces shall be protected against corrosion.

3.5 The thickness of non-ferrous members shall be determined by the strength requirement, subject to a minimum thickness of 3mm. Satisfactory proof of their resistance to corrosion must be obtained. The protection of non-ferrous metal members of a parapet must be considered in relation to the alloy of which the members are made. The possibility of fatigue caused by vibration and wind loading over a very long period should also be examined.

**Maximum Distance Between Posts Supporting Longitudinal Members**

3.6 For vehicle and vehicle pedestrian parapets the maximum span of a continuous metal longitudinal member between supporting posts shall be 3800mm. The maximum spacing of posts for P4 parapets shall not exceed 2000mm.

**Strength of Effective Longitudinal Members**

3.7 The product of the plastic modulus about the vertical axis and the minimum guaranteed yield stress or 0.2% proof stress of each effective longitudinal member of a parapet, at mid span and at the supports, shall be not less than the values given in Table II. The plastic bending strength of the member about the horizontal axis shall be not less than 50% of that about the vertical axis.

**Continuity of Strength of Longitudinal Members**

3.8 Longitudinal members shall be structurally continuous over the whole length of the bridge, except where it is necessary to provide for expansion. An expansion joint in a member shall maintain the minimum required strength of the member in bending at all times, and not less than 60% of the full strength of the member in tension when the limit of the allowable movement is reached. Where the allowable movement is 50mm or more "end posts" complying with paragraph 3.12 are to be provided on either side of the expansion joint. The joint in the longitudinal members between these posts need not be designed to transmit tension.

**Strength of Supporting Posts Under Transverse Loading**

3.9 The product of the nominal yield stress of 0.2% proof stress and the plastic modulus of any post about an axis parallel to the line of the parapet, shall be not less than the moment induced by the transverse force F, given in Table II, applied equally between the `n' number effective longitudinal members. The forces F/n shall be applied at the centroid of the effective longitudinal members.

3.10 Special attention is drawn to the importance of good fabrication, workmanship and inspection of welding which must comply with the requirements of the Overseeing Department given in Series 2200 of the Specification for Highway Works (MCHW 1).

**Strength of Supporting Posts Under Longitudinal Loading**

3.11 The product of the minimum guaranteed yield stress or 0.2% proof stress and the plastic modulus of an intermediate post, about an axis at right angles to the line of the parapet, shall be not less than 12.5% of that in the transverse direction.

3.12 The longitudinal strength of an end post shall be equal to its transverse strength, unless it is connected to a safety fence, as described in paragraph 2.11 when its longitudinal strength may be equal to that of an intermediate post.

**Strength and Description of Post Fixings**

3.13 The attachment of a post to baseplate shall be as strong as the post in bending and shear.

3.14 The fixing of the post to the bridge shall be by means of a baseplate secured by separate bolts with individual anchorages or by bolts attached to a cradle anchorage for better spread of the impact force and greater resistance against pull out. The holding down bolts (attachment system) and anchorages shall be capable of developing a moment of resistance about either axis at least 50% and 80% respectively greater than the appropriate maximum fully plastic moment of the post.

3.15 The calculated load in the holding down bolts shall not exceed the product of the guaranteed yield stress or 0.2% proof stress of the bolt material and the net cross sectional area of the bolt at the root of the thread. The bearing stress in the concrete, which shall be calculated elastically, shall not exceed 20 N/mm².

3.16 Where holding down bolts or anchorages are fitted into holes in the concrete, satisfactory evidence based on the results of tests must be provided to show that they can sustain the calculated load with negligible pull-out. Conditions of forming the hole and installing the bolt or anchorage for the tests should simulate those met with in practice.

3.17 Fixings must be treated to withstand corrosion especially due to de-icing salts. Metal to metal contact between stainless steel holding down bolts and aluminium or steel base-plates should be avoided by the use of suitable non-metallic sleeves and washers or a coating which is effective in preventing galvanic corrosion.

3.18 The supporting concrete must be additionally reinforced against the bursting associated with any internal forces eg those generated by expanding anchorages. See also paragraph 4.8.

3.19 The bedding between base plates and plinths shall be capable of permanently transmitting, safely and without undue deformation, all the loads involved. The thickness of the bedding may vary between 10mm minimum to 30mm maximum where the plinth surface is horizontal. Where the plinth surface has a cross and/or longitudinal fall, the latter dimension may be increased by an amount sufficient to allow for the effect of these falls over the area below the baseplate. It may be necessary to adjust the lengths of holding down bolts as a consequence of this increase. Where permanent shims are used to align posts they shall take the form of slotted washers, placed round the shanks of the bolts, or centre packings.

3.20 A procedure trial to assess the method and satisfactory placing of the bedding material shall be carried out to the approval of the Engineer. It should be ensured that the bedding has completely filled the space between the top of the plinth and the underside of the post baseplate over its entire area.

**Fixing Longitudinal Members to Supporting Posts**

3.21 The fixing of the longitudinal members to their supporting posts shall develop not less than the longitudinal strength requirement of the post.

TABLE II STRENGTH CRITERIA FOR METAL MEMBERS AND SUPPORTING POSTS

| PARAPET GROUP | LONGITUDINAL MEMBERS | SUPPORTING POSTS |
|---|---|---|
| | Product of plastic modulus and yield stress of 0.2% proof stress (See para 3.7) kNm | Transverse force F, to be applied (See para 3.9) kN |
| P1<br>P2 (113) | $\frac{8.3\ L}{n}$ | 50 |
| P2 (80) | $\frac{4.15\ L}{n}$ | 25 |

Notes:-

i. "L" equals the distance between centre line of supports, in metres.

ii. "n" is the number of effective longitudinal members.

iii. A plinth which complies with paragraph 4.9 may be considered as one effective longitudinal member.

iv. In the forms of parapet described in Figs 1 and 3 of Annex A, no metal longitudinal member whose centre line is at a height of less than 300mm above the adjoining paved surface, shall be regarded as an effective member.

v. In the form of parapet described in Fig 4 of Annex A, the upper and lower longitudinal members shall both be regarded as being equally effective, although the centre line of the lower member, in this case, is less them 300mm above the adjoining paved surface.

vi. For pedestrian parapets (P4) and parapets on bridges over railways (P5), see Chapters 7 and 8.

# 4. REQUIREMENTS FOR REINFORCED CONCRETE PARAPETS AND PLINTHS

**Minimum Concrete Strength**

4.1 The concrete shall have a minimum 28 day works cube strength of 40 N/mm² or 50 N/mm² and over. For grade 40 the concrete shall be air entrained.

**Design Requirements for Reinforced Concrete, In Situ and Precast Parapets (P1, P2, P4 and P5)**

4.2 The vehicle and vehicle/pedestrian parapets shall be of the form shown in Annex A, Fig 5. For P4 parapets the front face of the parapets shall always be vertical. Generally the shaping of the top of the parapet should be as shown in Annex A, Fig 5 to prevent anybody walking on top of these walls, but for parapets on bridges carrying motorways, or roads to motorway standards from which pedestrians are excluded by order, such shaping is not essential.

4.3 For vehicle and vehicle/pedestrian parapets the minimum length of each of the precast reinforced concrete panels shall be 1200mm.

4.4 For the design requirements for these parapets see Table III and the notes given below.

**Design Requirements for Reinforced Concrete, In Situ and Precast Plinths (P1, P2, P4 and P5)**

4.5 The requirements given in paragraphs 4.7, 4.9 and 4.10 apply only to plinths for vehicle and vehicle pedestrian parapets. Reference shall be made to Chapter 7 for the particular P4 requirements.

**Height**

4.6 A reinforced concrete plinth shall always be provided under a metal parapet. The plinth height for vehicle and vehicle/pedestrian parapets, measured above the adjoining paved surface shall (1) either be not less than 50mm, and not greater than 100mm, or (2) shall be at least 800mm. Where the permitted traffic speed does not exceed 80 km/h the above limitation (2) on plinth height may be reduced to 700mm. The plinth height for P4 parapets shall comply with the requirements of paragraphs 7.2 to 7.8.

**Form**

4.7 The bottom edge of a reinforced concrete plinth shall lie in the plane of the traffic face of the parapet. For plinth height equal to, or exceeding 700m, the front face of the plinth shall be as shown in Annex A, Fig 2.

**Strength**

4.8 The strength of the plinth shall be sufficient to withstand the moment and shear developed by the fixing of the parapet posts (see paragraphs 3.13 to 3.20).

**Plinth as an Effective Longitudinal Member**

4.9 A plinth may be considered as an effective longitudinal member provided its height is at least 700mm above the adjoining paved surface, and that it can support a horizontal transverse force of F/n kN, applied as a point load to its top edge, in addition to the forces induced by the posts. ("F" being the appropriate force given in Table II, and "n" the number of effective longitudinal members.) If the derived ultimate moments of resistance at any point for the plinth are less than the appropriate moments given in Table III, the values as specified in the table shall be used.

**Precast Sections**

4.10 Where a plinth is built of precast concrete sections, they shall be not less than 1200mm long. The fixing moment of the section of the plinth to the deck shall be not less than the holding down moment of the post fixing, plus 1.5 times the moment induced by F/n where appropriate (see paragraph 4.9 above and paragraph 3.14). If the derived ultimate fixing moment is less than the moment given in item 3 of Table III, the value as specified in the table shall by used.

4.11 When a precast concrete plinth acts as an effective longitudinal member, the vertical joints shall be provided with shear keys or dowels which will transfer the appropriate load in item 4 of Table III.

TABLE III DESIGN REQUIREMENTS FOR REINFORCED CONCRETE PARAPETS

| Item No. | Requirement | Parapet Group | |
|---|---|---|---|
| | | P1 | P2 |
| 1 | Minimum ultimate moment of resistance, at the base of wall (see Note i) for bending in the vertical plane, with reinforcement adjacent to the traffic face (see Note ii) | 25 kNm/m | 12.5 kNm/m |
| 2 | Minimum ultimate moment of resistance for bending in the horizontal plane, with reinforcement adjacent to outer face (see Note ii) | 12.5 kNm/m | 6.25 kNm/m |
| 3 | Minimum ultimate moment of resistance of anchorage at the base of a precast reinforced concrete panel | 37.5 kNm/m | 18.7 kNm/m |
| 4 | Minimum ultimate transverse shear resistance at vertical joints between precast panels, or at vertical joints made between lengths of in situ parapet | 65.5 kN/m of joint | 32.5 kN/m of joint |
| 5 | Minimum thickness of RC wall | 180 mm | 150 mm |

Notes:

i. The base of wall refers to horizontal sections of the parapet within 300mm above the adjoining paved surface level. The minimum ultimate moments of resistance shall reduce linearly from the base of wall value to zero at top of the parapet.

ii. In addition to the main reinforcement, in items 1 and 2 above, distribution steel equal to 50% of the main reinforcement shall be provided in the respective faces.

iii. For P4 pedestrian parapets and P5 parapets for bridges over railways, see Chapters 7 and 8.

TABLE IV DESIGN REQUIREMENTS FOR HIGH CONTAINMENT IN SITU REINFORCED CONCRETE PARAPETS

| ITEM NO | REQUIREMENT | |
|---|---|---|
| 1 | Minimum ultimate moment of resistance at base of wall (see Note i) for bending in the vertical plane with reinforcement adjacent to traffic face (see Note ii) | |
| | For end sections ) (see Note iii) | 165 kNm/m |
| | For intermediate sections ) | 125 kNm/m |
| 2 | Minimum ultimate moment of resistance for bendng in the horizontal plane, with reinforcement adjacent to outer face (see Note ii). | 62.5 kNm/m |
| 3 | Minimum ultimate horizontal transverse shear resistance | 220 kN/m |
| 4 | Minimum ultimate transverse shear load to be transferred at vertical joints made between lengths of in situ parapets (see Note iv) | 165 kN |
| 5 | Minimum thickness of RC wall at top | 250mm |

Notes:

i. The base of wall refers to horizontal sections of the parapet within 300mm above or below the adjoining paved surface level. The minimum ultimate moment of resistance shall reduce linearly from the base of wall value to zero at top of the parapet.

ii. In addition to the main reinforcement in items 1 and 2 above, distribution steel equal to 50% of the main reinforcement shall be provided in the respective faces.

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

iv. The minimum ultimate transverse shear load may be reduced to 50kN if the 3.0m longitudinal lengths adjacent and either side of the joint are designed as end sections. The shear load shall be assumed to be uniformly distributed over the joint length.

**Design Requirements for High Containment In Situ Reinforced Concrete Parapets (P6)**

4.12 The design requirements for these parapets are given in Table IV and the notes below. Parapets which are jointed to the supporting structure at a level deeper than 300mm below the adjoining paved surface level, shall also comply with the requirements of Table V and Note given below.

**Design Requirements for High Containment Precast Reinforced Concrete Parapets (P6)**

4.13 The design requirements for these parapets are given in Table VI and the notes below.

**Effects on Bridge Structure**

4.14 The effects of vehicle collision with parapets shall be considered locally in the design of the elements of the structure supporting parapets and globally on bridge superstructure, bearings and substructure. The vehicle collision loads with the parapets shall be as specified in BD 37 (DMRB 1.3).

TABLE V ADDITIONAL DESIGN REQUIREMENT FOR HIGH CONTAINMENT IN SITU REINFORCED CONCRETE PARAPETS

| ITEM NO | ADDITIONAL REQUIREMENTS |
|---|---|
| 1(a) | Minimum ultimate moment of resistance, at level d (metres) below the adjoining paved surface level, for bending in the vertical plane with reinforcement adjacent to traffic face<br><br>For end sections ) 165 + 48 (d−0.3) kNm/m<br>For intermediate ) See Note i<br>section ) 125 + 12 (d−0.3) kNm/m |

Note:

i. For design purposes the parapet shall be divided into end sections extending a distance not greater than 3.0 + 3 (d−0.3) metres from ends of the parapet and intermediate sections extending along the remainder of the parapet.

TABLE VI DESIGN REQUIREMENTS FOR HIGH CONTAINMENT PRECAST REINFORCED CONCRETE PARAPETS

| LOADING NO | REQUIREMENT |
|---|---|
| | The minimum ultimate moment of resistance and horizontal transverse shear resistance of the precast panels (see Note i) shall be sufficient to withstand the more severe of the following ultimate design forces:- |
| 1 | A transverse force of 330 kN applied to each panel over a horizontal length of 1.5m at a height of 0.85m above the adjoining paved surface |
| 2 | A transverse force of 330 kN applied over a horizontal length of 3.0m at the top of parapet. |

Notes:

i. If the ultimate moment and shear resistances derived from Table VI are less than the values given in Table IV and V (items 1 and 1(a) end sections, item 2 and item 3), the Table IV and V values shall be used.

ii. The minimum ultimate moment of resistance and horizontal transverse shear resistance of the precast panel anchorages shall be 1.5 times the values calculated at the base of the precast panels.

iii. The minimum ultimate transverse shear resistance at vertical joints between precast panels shall be 110kN. The effect of shear transfer between adjacent panels shall be ignored when applying the above requirements.

iv. The requirement for minimum thickness given under item 5 of Table IV shall apply to precast panels. The minimum length of panels shall be 1500mm.

# 5. GROUP P1 VEHICLE PARAPETS FOR MOTORWAY UNDERBRIDGES

**General**

5.1 P1 vehicle parapets shall be provided except as described in paragraph 5.15.

5.2 In order to discourage the stationing of vehicles with their wheels close to the vehicle parapet, a 75mm splayed kerb shall be provided behind the edge of hardshoulder or hard strip. The "adjoining paved surface" shall fall towards the top of the kerb. At the ends of the bridge the kerb shall slope down gradually to the level of the paved surface on the bridge approaches.

**Form**

5.3 A P1 parapet may consist of a reinforced concrete wall, or precast reinforced concrete panels, as described in Chapter 4.

5.4 Alternatively it may consist of at least two effective longitudinal members constructed in accordance with the appropriate provisions of Chapters 3 and 4 and the limiting dimensions given in paragraphs 5.5 to 5.10 below.

**Dimensions of P1 Parapets Consisting of at Least Two Effective Longitudinal Members (see Annex A Figs 1 and 2)**

5.5 The minimum depth of each longitudinal member, as the depth of its projection onto a vertical plane, shall be 50mm, and the clear gap between longitudinal members shall be not more than 300mm. Sufficient clearance shall be provided around metal members to allow for maintenance.

5.6 For parapets which do not incorporate reinforced concrete plinths the front face of a supporting post at its base shall be not less than 150mm behind the traffic face of the parapet. This shall apply at whatever height the base may be. The front faces of effective metal longitudinal members should preferably be in the plane of the traffic face and, in no case, may depart from it by more than 25mm. Below the main longitudinal member, the departure may be only away from the traffic.

5.7 For parapets which incorporate reinforced concrete plinths the front faces of the effective metal longitudinal members shall be in the vertical plane containing the top edge of the concrete plinth front face. For the front face of the reinforced concrete plinth, see paragraph 4.7. The minimum width of plinths, not greater than 100mm in height, shall be 450mm.

5.8 No longitudinal member, other than the plinth, shall have its centre line at a height of less than 300mm above the adjoining paved surface.

5.9 Supporting posts may be straight or curved, vertical or inclined. When inclined, they shall slope towards the carriageway.

5.10 Consideration regarding the provision of mesh infilling, (see paragraphs 6.6 to 6.11) to part height of parapet in order to prevent loose debris, stones or snow from falling to the area below the bridge, should be given and agreed with the appropriate TAA.

# 6. GROUP P2 VEHICLE/PEDESTRIAN PARAPETS FOR BRIDGES CARRYING ALL PURPOSE ROADS AND FOR ACCOMMODATION BRIDGES



**General**

6.1 Where the bridge carries a road on which speeds over 80 km/h and up to 113 km/h are permitted parapets shall comply with the requirements for P1, but parapets of the form and dimensions of paragraphs 5.4 and 5.5 to 5.10 shall be provided with mesh infilling as described in paragraphs 6.6 to 6.11.

6.2 Vertical or half-battered kerbs, not less than 75mm high shall be provided over the bridge deck immediately behind the carriageway or hard strip. Where necessary these kerbs shall be sloped down gradually at the ends of the bridge to the level of the kerbs, if any, or to the level of the paved surface on the bridge approaches.

6.3 Where safety fencing has to be provided on the all-purpose road near cattle creeps or culverts for other safety requirements then the fencing shall be continued across these structures. In addition a pedestrian type of parapet should be provided on the headwall of the buried structures when considered necessary for the safety of the pedestrians.

**Form**

6.4 A P2 parapet may consist of:

i. A reinforced concrete wall, or precast reinforced concrete panels.

ii. At least two effective longitudinal members constructed in accordance with the appropriate provisions of Chapters 3 and 4 and the limiting dimensions given in paragraphs 6.5 to 6.11 below. For accommodation bridge parapets, only one longitudinal member need be added to achieve the increased parapet height. This additional longitudinal member shall be designed to contain a horizontal load of 1400 N/m but this loading need not be considered co-existent with the loading required under paragraph 3.9 and Table II. Mesh panels shall be mounted on or flush with the traffic face of the longitudinal members. The mesh infilling may be omitted where pedestrians are discouraged, eg on an urban flyover where, to gain access, they would have to cross a slip road.

iii. Closely spaced vertical members, secured top and bottom to effective longitudinal members, mounted on the traffic side of the supporting posts. (For effective members, in this case, see Note v. to Table II.) This form of parapet possesses aesthetic advantages but because of inferior redirectional capabilities it shall not be used for highway bridges where the permitted traffic speed of the road carried exceeds 48 km/h.

**Dimensions of Reinforced Concrete Parapets**

6.5 The factors governing the dimensions of reinforced concrete parapets are given in Chapter 4 and Table III.

**Dimensions of Parapets with Longitudinal Members and Mesh Infilling (see Annex A Figs 2 and 3)**

6.6 The minimum overall depth of each longitudinal member, measured as the depth of its projection on to a vertical plane, shall be 50mm and the clear gap between longitudinal members shall be not more than 300mm. For accommodation bridge parapets the above gap may be increased to 400mm. Sufficient clearance shall be allowed around metal members for maintenance.

6.7 For parapets which do not incorporate reinforced concrete plinths the front face of a supporting post at its base shall be not less than 100mm behind the traffic face of the parapet. This shall apply at whatever height the base may be. The front faces of all metal longitudinal members shall be in the plane of the traffic face of the parapet.

6.8 For parapets which incorporate reinforced concrete plinths the front faces of effective metal longitudinal members shall be in the vertical plane containing the top edge of the concrete plinth front face.

For the front face of the reinforced concrete plinth, see paragraph 4.7. The minimum width of plinths, not greater than 100mm in height, shall be 450mm.

6.9 The supporting posts may be straight or curved, vertical or inclined. When inclined they shall slope towards the carriageway.

6.10 The mesh infilling panels shall completely fill the area between the longitudinal members and the gap above the plinth shall not exceed 25mm. The mesh shall be made of round wire not less than 3mm diameter and the gaps in the mesh shall be contained within a parallelogram having a perimeter not greater than 200mm. Expanded metal sheeting may be used in place of mesh provided the thickness of the sheeting is not less than 3mm and it meets the other requirements for mesh in this Chapter.

6.11 Due regard shall be paid to the problem of maintenance.

**Dimensions of Metal Parapets with Two Longitudinal Members and Closely Spaced Vertical Members (see Annex A Fig 4)**

6.12 The front face of a supporting post, at its base, shall be not less than 100mm behind the traffic face of the parapet which, in this case, shall be the vertical plane through the front faces of the two effective metal longitudinal members and the bottom edge of the plinth.

6.13 The height of the plinth above the adjoining paved surface shall lie between the limits of 50mm and 100mm. In other respects, the plinth shall comply with the requirements of paragraphs 4.5 to 4.11.

6.14 The minimum overall depth of the projection of each longitudinal member on a vertical plane shall be not less then 50mm.

6.15 Sufficient clearance shall be allowed around metal members to allow for maintenance.

6.16 The vertical members forming the in-filling in this form of parapet shall be either solid bars of square or circular section, having a minimum sectional area of 480mm² in mild steel Grade 43C to BS 4360 or other sections of equivalent plastic bending strength, ie 0.63 kNm longitudinally and transversely, in steel or other metals. Each end connection shall develop at least half the strength of the bar in bending and in tension acting simultaneously and also the strength of the bar in shear acting separately.

6.17 The clear space between adjacent vertical members shall not exceed 100mm.

6.18 The front face of the vertical infill members shall be not more than 50mm behind the traffic face of the parapet.

# 7. GROUP P4 PEDESTRIAN PARAPETS FOR FOOTBRIDGES, OTHER THAN FOOTBRIDGES OVER RAILWAYS, AND BRIDGES CARRYING BRIDLEWAYS



**General**

7.1 Footbridges (other than footbridges over railways) and bridleway bridges, shall be provided with P4 pedestrian parapets. For footbridges over railways, see Chapter 8.

**Form**

7.2 The parapet should be of framed construction with suitable infilling, solid construction or a combination of both of these forms.

7.3 Framed parapets consisting of posts and longitudinal members shall be mounted on a plinth, or have an upstand, at least 50mm in height above the adjoining paved surface. Upstands consisting of discrete metal plates shall be continuously connected to the deck.

7.4 The clear distance between the top of the plinth or upstand and any bottom longitudinal member shall not exceed 100mm. To prevent footholds, parapets with plinths or upstands greater than 100mm in height shall be provided with infill panels placed immediately above and located in the same vertical plane as the front face of the plinth or upstand.

7.5 Infilling for framed parapets shall extend up to the full height of the parapet and shall be in the form of vertical infill members or panels of wire mesh, expanded metal sheeting or solid sheeting. Solid sheeting shall only be provided in special cases as this form of infilling has detrimental aesthetic effects and imposes additional wind loading on supporting members.

7.6 Vertical infill members shall only be used where the distance between the top of the parapet to the top of an intermediate rail, or to the top of solid infilling, is greater than 800mm. The clear space between the vertical infill members shall not exceed 100mm.

7.7 The minimum thickness for all forms of infill panels shall be 3mm. The wire mesh and expanded metal sheeting shall conform to the geometric requirements given in paragraphs 6.6 to 6.11.

7.8 On footbridges frequently used by equestrians the height of the parapet from the adjacent paved surface may be increased to 1800mm. All bridleway bridges and footbridges with 1800mm high parapets shall have 600mm high infill panels at the bottom of the parapet in order to obstruct the horse's view of the road below.

**Strength**

7.9 All parapet members shall be designed in accordance with the relevant documents contained in the current Technical Approval Schedule (TAS) in BD 2 (DMRB 1.1), for the worst condition using either the loading specified in Table VII or the wind pressures as given in the current Standard for Bridge Loading. All loadings given are nominal loads.

7.10 The strength of infilling panels may be proved for a prototype design by test loading with the loads situated 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 given in the TAS is not to limit state format a 50% overload shall be assumed.

**TABLE VII NOMINAL LOADING FOR GROUP P4 PEDESTRIAN PARAPETS**

| Parapet Construction | Parapet Component | Design Load | Application | Remarks |
|---|---|---|---|---|
| Framed Construction | Longitudinal member | 1400 N/m | Acting separately in transverse and vertical directions | Where appropriate the strength of the infilling when acting as a framework may be taken into account, and the nominal load in the vertical direction shared between longitudinal members |
| | Post (the greater effect of the following loads) | 1400s* N and 700s* N<br><br>or 1000 N | Acting separately: in transverse direction<br><br>in longitudinal direction<br><br>Acting separately: in transverse and longitudinal directions | Loads to be applied at the level of the longitudinal members which will give the most adverse effect on the post |
| | Infill panel and fixings | 1000 N forces acting on a 700 x 700 mm grid | Loads applied in any position normal to face of the parapet | The contact area of the loads shall be taken as 125 x 125 mm.<br><br>Bracing of large panels may be necessary |
| | Vertical infill member & fixings | 1000 N forces at 700mm centres | Loads applied in any position or direction normal to the bar | The contact length of the loads shall be taken as 125mm |
| Solid Construction | N/A | 1400 N/m | Acting separately at top of parapet in transverse and vertical directions | |

* Note: s = post spacing in metres

# 8. GROUP P5 PARAPETS OVER RAILWAYS

**General**

8.1 The statutory requirements for parapets on bridges over railways have been incorporated, where necessary, in the text of this Chapter. Where reference is made in this document to a programmed overhead electrification this shall denote electrification included in the British Railways Board Investment Programme at the time of the design of the bridge.

8.2 Where no effective alternative arrangements exist to prevent a vehicle from leaving the bridge approach and falling onto the railway below, a safety fence shall be provided on each approach end of the parapet and on the departure end where considered necessary, as stated in Clauses 2.21 to 2.25.

**Height**

8.3 On bridges over railways the minimum height of a parapet above the adjoining paved surface shall be:-

i. For bridges carrying motorways, or roads to motorway standards, from which pedestrians, animals, cycles and vehicles drawn by animals are excluded by order 1250 mm

ii. For all other bridges 1500 mm

**Form on Motorway Over Railway**

8.4 On bridges carrying a motorway over a railway, vehicle parapets shall comply with all the requirements for a P1 parapet, as described in this Standard, subject to paragraphs 8.3 and 8.5 to 8.8.

8.5 On bridges over railways with existing or programmed overhead electrification, parapets consisting of a plinth surmounted by metal posts and horizontal rails shall be provided with solid or open infill panels immediately above the top of the plinth up to the full height of the parapet. On bridges over railways without existing or programmed overhead electrification this form of parapet shall be similarly provided with infill panels up to a height of not less than 600mm above the adjoining paved surface.

8.6 The solid infill shall consist of metal panels at least 3mm in thickness, and shall be subject to the approval of the Railway Inspectorate.

8.7 The open infill panels shall be made either of metal wire mesh not less than 3mm diameter with apertures not exceeding 25mm x 25mm or of expanded metal sheet not less than 3mm thick having openings not exceeding 20mm x 30mm. Expanded metal must be fixed vertically with the long dimension of the aperture horizontal. As a result of the manufacturing process the mesh strands are at an angle to the plane of the sheet and when installing the mesh the panels should be orientated so that on the traffic side of the parapet the sheared surfaces of the strands face downward towards the adjoining paved surface. This reduces as far as possible the risk of objects passing through the mesh. It is recommended that mesh panels and their surrounds be heavily galvanised and suitably painted to keep maintenance to a minimum.

8.8 Since pedestrians are excluded, footholds on the traffic side are not objectionable. The panels may therefore be fixed behind the horizontal members, where they are less liable to become entangled with an errant vehicle.

**Form on All Purpose Road Over Railway**

8.9 When the road is an all purpose road, of whatever class the road may be, vehicle/pedestrian parapets shall comply with the requirements for Group P1, but parapets of the form and dimension of paragraphs 5.4 and 5.5 to 5.10 shall also comply with the following:-

i. The maximum clear gap between the two upper longitudinal members may be increased to 450mm.

ii. The traffic face shall be smooth and without hand or footholds.

iii. Solid infill metal panels approved by the Railway Inspectorate and at least 3mm in thickness shall be provided immediately above the top of the plinth up to the full height of the parapet irrespective of whether the railway is electrified or not. This requirement may be relaxed with the agreement of the Railway Authority where there is no programmed overhead electrification.

8.10 Metal parapets for bridges over railways carrying roads where pedestrians have access shall be provided with additional solid or mesh sheeting on the outer face of the parapet extending to its full height with the lower part shaped to cover the outer ledge.

8.11 The sheeting shall deny access to the outer ledge and extend horizontally for a length of one parapet panel or 2m whichever is the greater. It shall be fitted at the ends of the parapet or on both sides of railway tracks. In all cases the distance from the outer end of the sheeting away from the railway tracks shall be at least 3m from the outer limits of any railway tracks or any live overhead electrification equipment (see Annex D Fig 10).

8.12 The outer sheeting at ends of parapet shall be extended in length for situations where the outer ledge is deemed to be readily accessible from any area adjacent to the bridge.

8.13 Any other method of denying access to the outer ledge of the parapet shall be subject to the agreement of the Railway Authority and the Railway Inspectorate.

**Form on Footbridge Over Railway**

8.14 Footbridges over a railway shall be provided with pedestrian parapets which comply with the requirements for a P4 parapet as described in this Standard. The parapets must be so arranged that no footholds or projections are provided on the inside face and, if made of steel, it is recommended that all metal parts be galvanised after fabrication generally to BS 729.

8.15 The parapets shall also comply with the following particular requirements:-

i. The minimum height of parapets on footbridges over railways shall be as specified in paragraph 8.3.

ii. For footbridges used frequently by equestrians the height may be increased to 1800mm.

iii. The parapets shall be solid or shall have solid infill panels, approved by the Railway Inspectorate, on the inside face. This requirement may be relaxed by agreement with the Railway Authority where there is no programmed overhead electrification.

iv. The requirements for the provision of panels on the outer face or barriers at the ends of the railway span, given in paragraphs 8.9 to 8.13 shall also apply to metal parapets on footbridges over railways.

# 9. GROUP P6 HIGH CONTAINMENT PARAPETS

**General**

9.1 High Containment parapets shall be provided at certain high risk locations where the likelihood of parapet impacts and consequential dangers resulting from parapet penetration are judged to outweigh the hazards resulting from the containment of errant vehicles of widely different weights and dimensions, and their redirection within the traffic stream. At certain locations, the nature of the area below the bridge may alone justify High Containment parapets. At other sites, both the circumstances below and on the bridge (or its approaches) will need to be taken into account.

9.2 Annex B lists a number of conditions where High Containment parapets shall be considered. Each case, however, shall be considered on its merits, and a High Containment parapet shall only be provided after consultation with the responsible Authorities and subject to a prior approval of the Technical Approval Authority. In the event of disagreement between Highway and Railway Authorities about the need for High Containment parapets on any structure over or close to a railway line, the Railway Inspectorate shall arbitrate.

9.3 Kerbs shall be provided in accordance with paragraph 5.2 or 6.2 as appropriate.

9.4 The requirements of paragraph 8.1 shall also apply to P6 parapets at high risk railway locations.

**Height**

9.5 The minimum height of all P6 parapets shall be 1500mm.

**Form**

9.6 High Containment parapets consisting of a reinforced in situ concrete wall, or precast reinforced concrete panels, shall be designed in accordance with paragraphs 4.12 to 4.14. Masonry or brickwork cladding and stone or precast concrete copings shall not be permitted. The requirements for P6 parapets in steel are given in BS 6779: Part 1.

9.7 The front face of the concrete parapet shall be as shown in Annex A, Fig 5.

9.8 Generally the shaping of the top of the concrete parapet should be as shown in Annex A, Fig 5 to prevent anybody walking on top of these walls, but for parapets on bridges carrying motorways, or roads to motorway standards from which pedestrians are excluded by order, such shaping is not essential.

9.9 For P6 parapets in steel for motorway underbridges, not over or adjacent to railways, the provision of mesh infilling shall be considered in accordance with paragraph 5.10. For P6 parapets in steel for bridges carrying all purpose roads and for accommodation bridges, not over or adjacent to railways, mesh infilling shall be provided in accordance with paragraphs 6.6 to 6.11.

**Ends of Parapets**

9.10 A transition shall be provided at the approach ends of P6 parapets. At the departure end transitions shall be provided where safety fences are provided additionally on single carriageway roads and situations where it is considered necessary, for example due to road alignment and locations where contraflow will arise.

9.11 The transition shall comply with the following requirements:-

i. The transition when metal shall be a minimum of 4 bays long.

ii. The length of the transition shall be a minimum of 9m.

iii. The structural components of the transition shall be designed to give a progressive change of stiffness.

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

v. Sharp corners of concrete parapets are to be avoided and the use of chamfers adopted where appropriate.

NOTE: Four outline designs complying with the above criteria are given in Annex C which gives an indication of the possible types of transition.

9.12 Where the transition is used to connect the ends of P6 and P2 parapets, the end bay of P2 parapet shall be strengthened to P1 parapet strength. This may be achieved by the use of an additional parapet post at mid-span of end bay. This modification shall not be considered as part of the transition in i. and ii. of paragraph 9.11 above.

9.13 A total length of not less than 30m of safety fence and transition shall be provided on the approach to the bridge.

# 10. REFERENCES

1. Design Manual for Roads and Bridges

Volume 1: Section 1 Approval Procedures

BD 2 - Technical Approval of Highway Structures on Motorways and Other Trunk Roads Part 1: General Procedures (DMRB 1.1).

Volume 1: Section 3 General Design

BD 37 - Loads for Highway Bridges (DMRB 1.3).

2. Manual of Contract Documents for Highway Works

Volume 1: Specification for Highway Works (December 1991): HMSO (MCHW 1)

Volume 3: Highway Construction Details (December 1991/April 1992) HMSO (MCHW 3)

3. British Standards

BS 729: 1971 - Hot dip galvanized coatings on iron and steel articles.

BS 4360: 1986 - Specification for weldable structural steels.

BS 4482: 1969 - Hard drawn mild steel wire for the reinforcement of concrete.

BS 6779: Part 1: 1992 - Parapets for vehicle containment on highways - Specification for parapets of metal construction.

# 11. ENQUIRIES

All technical enquiries or comments on this Standard should be sent in writing as appropriate to:-

Chief Highway Engineer
The Department of Transport
St Christopher House
Southwark Street
London SE1 OTE

T A ROCHESTER
Chief Highway Engineer

The Deputy Chief Engineer
The Scottish Office Industry Department
Roads Directorate
New St Andrew's House
Edinburgh EH1 3TG

J INNES
Deputy Chief Engineer

The Director of Highways
Welsh Office
Y Swyddfa Gymreig
Government Buildings
Ty Glas Road
Llanishen
Cardiff CF4 5PL

K J THOMAS
Director of Highways

Chief Engineer - Roads Service
Dept. of the Environment for
Northern Ireland
Commonwealth House
Castle Street
Belfast BT1 1GU

W J McCOUBREY
Chief Engineer - Roads Service

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BRIDGES CARRYING MOTORWAYS
(MOTORWAY UNDERBRIDGES)

For shape of posts
see para 5.9

Diagrammatic
Sketch - not
to scale

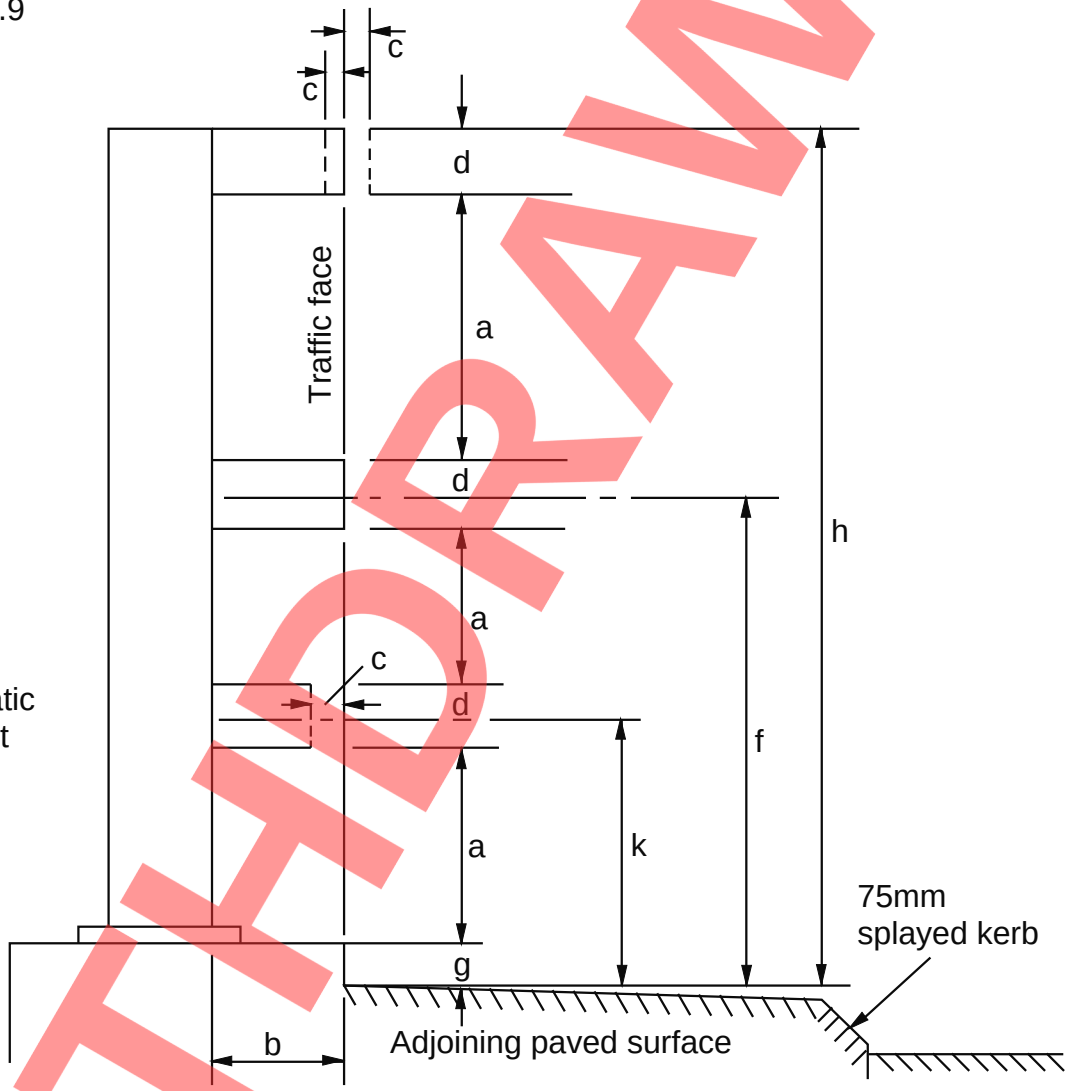


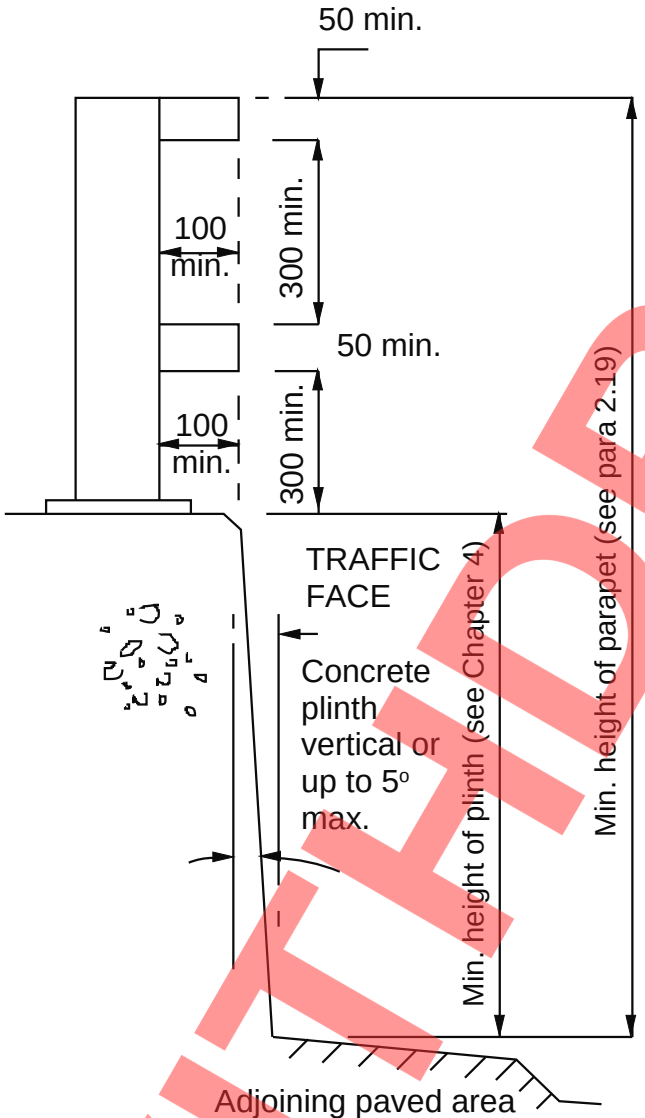

FIGURE 1

DIMENSIONS OF P1 & P2 (113) VEHICLE PARAPET WHERE HEIGHT OF PLINTH IS LESS THAN 700mm

TABLE TO FIGURE 1

| DIMENSION | DESCRIPTION | MAX | MIN |
|---|---|---|---|
| a. | Clear distance between longitudinal members, or between top of plinth and the longitudinal member above. The dimension is not necessarily constant within the barrier | 300 mm | see para 5.5 |
| b. | The distance between the traffic face of the parapet and the front face of supporting post at its base, at whatever height the base may be | - | 150 mm |
| c. | Distance between the front face of a metal longitudinal member, or the top edge of a plinth, and the traffic face of the parapet:- | | |
| | i. Above the main longitudinal member | ± 25 mm | - |
| | ii. Below the main longitudinal member (+= towards the carriageway – = away from the carriageway) | – 25 mm | - |
| d. | The overall depth of a longitudinal member | - | 50 mm |
| f. | The height of the centre line of the main longitudinal member above the adjoining paved surface | 685 mm | 535 mm |
| g. | Height of plinth, for which this diagram applies, above the adjoining paved surface | 100 mm | 50 mm |
| h. | Height of top of upper longitudinal member above the adjoining paved surface. See also para 2.20 | - | 1000 mm |
| k. | Height of the centre line of the lowest longitudinal member, other then the plinth, above the adjoining paved surface | to comply with "a" | 300 mm |

BRIDGES CARRYING MOTORWAYS




1. All dimensions are in mm
2. No. of longitudinal members to suit overall height required
3. Figure not to scale
4. Infill, shown as dashed line, required for P2 and P5 applications (see para 6.6 to 6.11 and 8.4 to 8.15)

FIGURE 2

CONCRETE PLINTH PARAPETS

BRIDGES CARRYING ALL PURPOSE ROADS



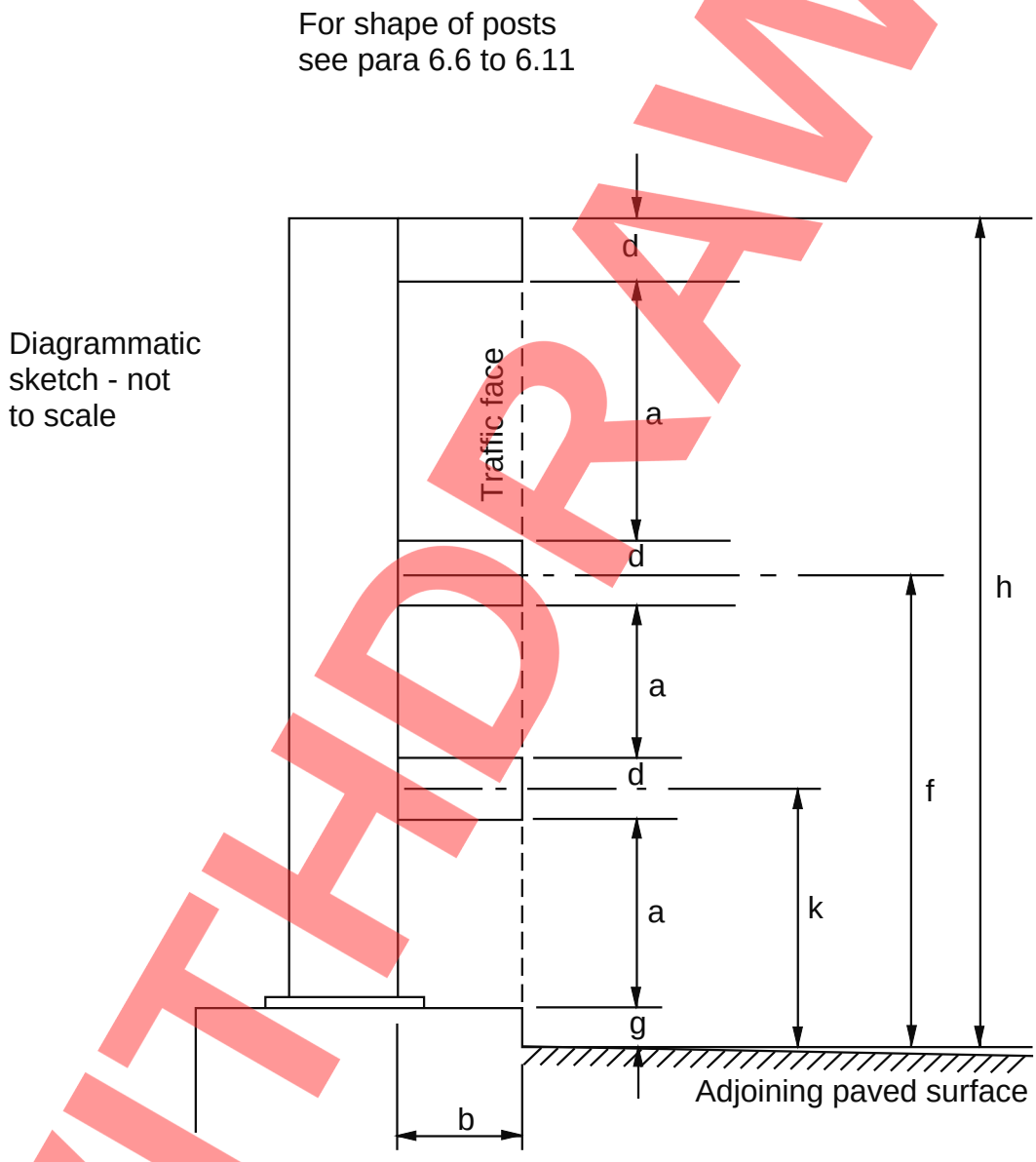



FIGURE 3

DIMENSIONS OF P2 (80) VEHICLE PEDESTRIAN PARAPET

TABLE TO FIGURE 3

| DIMENSION | DESCRIPTION | MAX | MIN |
|---|---|---|---|
| a. | Clear distance between longitudinal members, or between top of plinth and the longitudinal member above | 300 mm (400 mm for accommodation bridge parapets only) | see para 6.6 to 6.11 |
| b. | Distance between the traffic face of the parapet and the front face of supporting post at its base, at whatever height the base may be | - | 100 mm |
| d. | Overall depth of a longitudinal member | - | 50 mm |
| f. | Height of the centre line of the main member above the adjoining paved surface | 685 mm | 535 mm |
| g. | Height of the plinth above the adjoining paved surface | 100 mm | 50 mm |
| h. | Height of top of upper longitudinal member above the adjoining paved surface See also para 2.20 | - | 1000 mm |
| k. | Height of the centre line of the lowest effective member | to comply with "a" | 300 mm |

BRIDGES CARRYING ALL PURPOSE ROADS

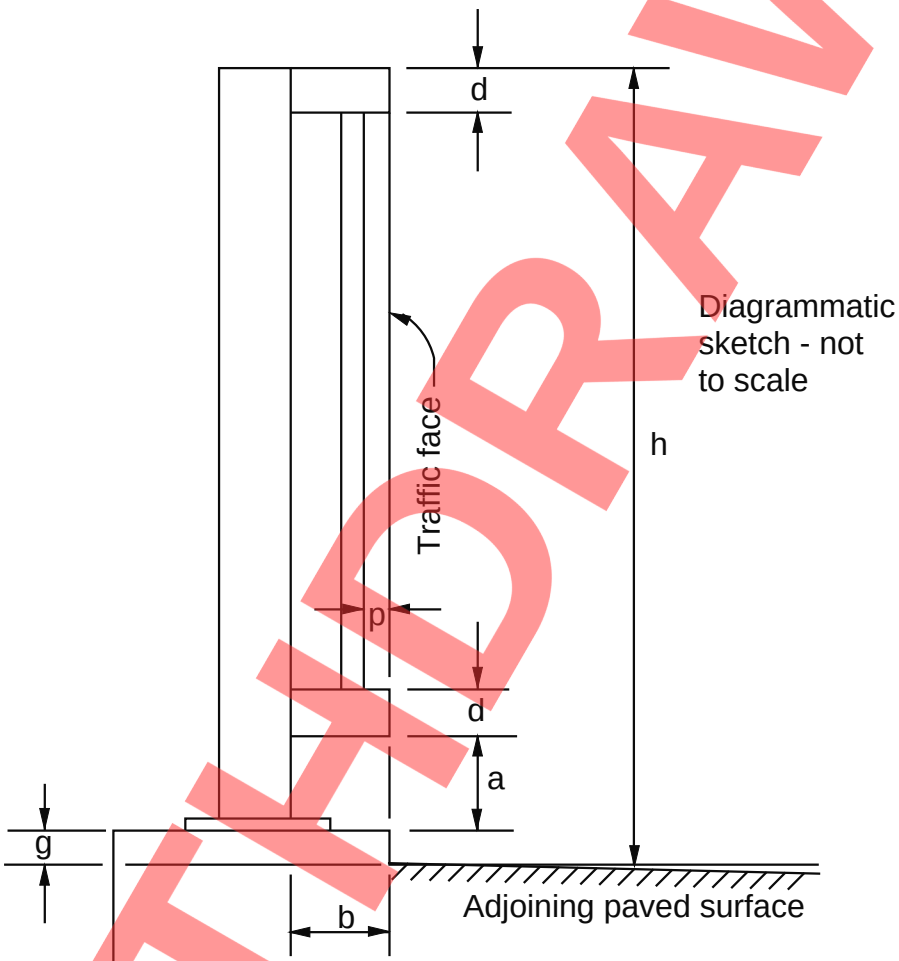


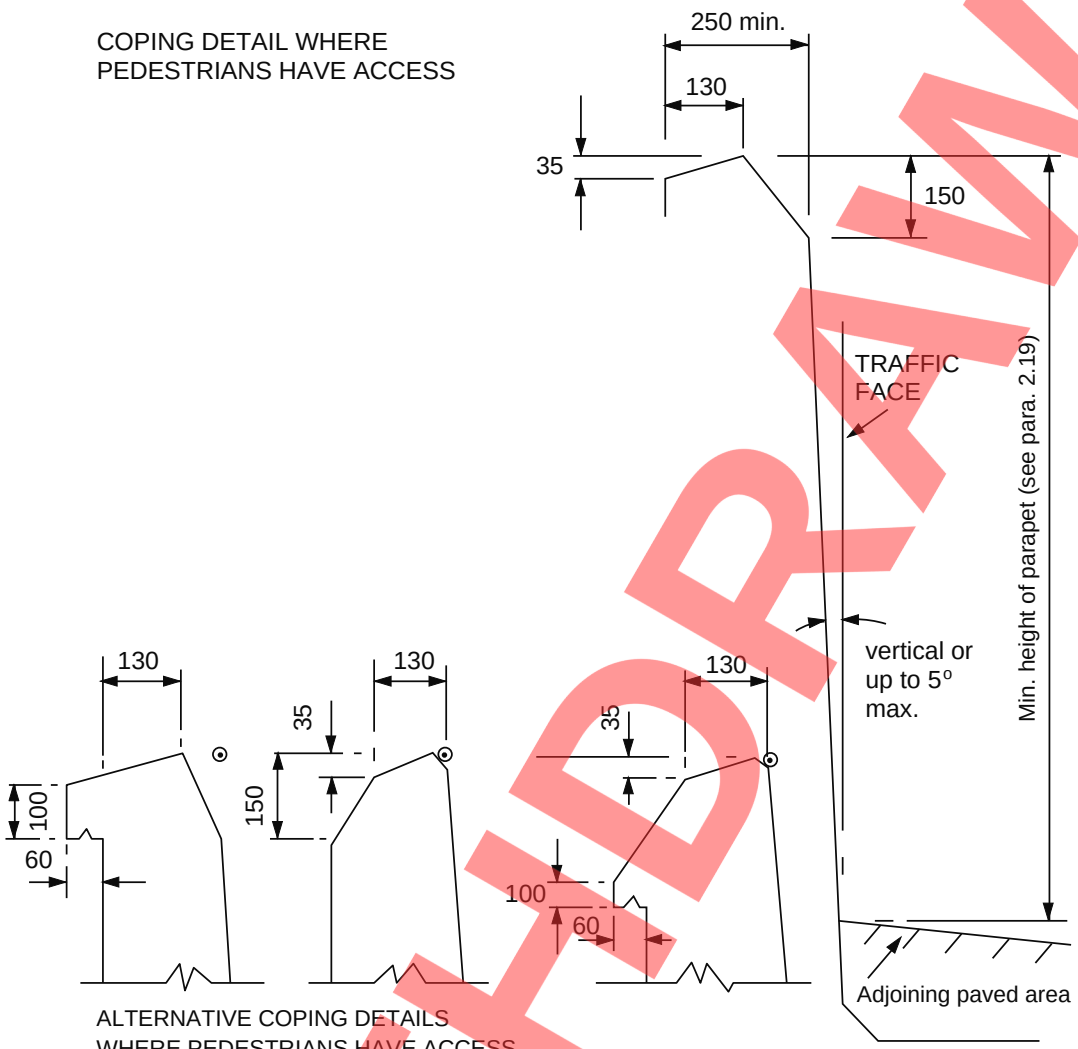

FIGURE 4
DIMENSIONS OF P2 (80) VEHICLE/PEDESTRIAN PARAPET

(only to be used where speed restricted
to a maximum of 48 km/h)

TABLE TO FIGURE 4

| DIMENSION | DESCRIPTION | MAX | MIN |
|---|---|---|---|
| a. | Clear distance between top of plinth and lower longitudinal member | 100 mm | see para 6.12 to 6.18 |
| b. | The distance between the traffic face of the parapet and the front face of the supporting post at its base, at whatever height the base may be | - | 100 mm |
| d. | Overall depth of a longitudinal member | - | 50 mm |
| g. | Height of plinth above the adjoining paved surface | 100 mm | 50 mm |
| h. | Height of top of upper longitudinal member above the adjoining paved surface | - | 1000 mm |
| p. | Distance between front faces of the vertical in-fill members and longitudinal members | 50 mm | 0 mm |

COPING DETAIL WHERE
PEDESTRIANS HAVE ACCESS




ALTERNATIVE COPING DETAILS
WHERE PEDESTRIANS HAVE ACCESS

Notes:

1. Dimensions are in mm
2. Figure not to scale
3. Outer face may be inclined with plain or featured finish

FIGURE 5
TYPICAL CROSS-SECTION OF CONCRETE PARAPET



Volume 2 home page

APPLICATION OF GROUP P6 HIGH CONTAINMENT PARAPETS

Conditions for the selection of High Containment parapets are listed in the table below. Group A conditons (ie items 1 and 2) related solely to the situation below the structure while Group B conditions (ie items 3 and 4) refer to the combination of below and on the structure.

APPLICATION OF HIGH CONTAINMENT PARAPETS

| GROUP | ITEM | Conditions for Selection | |
|---|---|---|---|
| | | Below Structure | On Structure |
| A | 1 | a. High speed railway line (over 160 km/h); or<br><br>b. Busy railway line (with peak intensity of more than 6 trains an hour each way); or<br><br>c. Any railway line carrying more than 6 trains per week conveying more than 1 wagon containing any of the following hazardous substances:-<br><br>i. FLAMMABLE GASES (Class 2(a))<br><br>ii. TOXIC GASES (Class 2(c)) ANHYDROUS HYDROGEN CYANIDE (HYDROCYANIC ACID (HCN) or similar products (Class 6.1(a)); or<br><br>d. Any railway line carrying more than 6 "Block" trains per week conveying FLAMMABLE LIQUIDS with a flash point below 21°C (Class 3(a)); or<br><br>e. Any railway line running close alongside when the rail level is more than 1m below the carriageway surface | Any condition |
| | 2 | Area in immediate vicinity of bridge occupied by people or valuable installations, or used for storage of hazardous materials | |

| GROUP | ITEM | Conditions for Selection<br>Below Structure | On Structure |
|---|---|---|---|
| B | 3 | Any railway line | a. Inferior horizontal or vertical road alignment permitted as a departure from current Standards<br>or;<br>b. Reduced clearance between carriageway and parapets permitted as a departure from Standards<br>or; |
| | 4 | Exceptionally busy road with maximum speed limit eg:-<br>a. Motorway or dual three lane all purpose road with permitted traffic speed of 113 km/h<br>b. Urban primary distributor with permitted traffic speed of 80 km/h | c. Complex interchanges where divers' error is more likely<br>or;<br>d. Where road junctions are very close to the bridge or its approaches<br>or;<br>e. Existing sites which have a record of accidents and where the supporting deck and sub-structure can accommodate the forces specified for High Containment parapet |

Note 1. The classifications for hazardous substances are defined in Part 3 of the Working Manual for Rail Staff and shall be agreed with the Department of Transport Railway Inspectorate.

Note 2. "Empty" wagons which have contained any of the hazardous substances mentioned in this Annex should be regarded as "full" unless the wagon has been purged after discharging the load.

Note 3. Explosives or radioactive substances, because of the way they are transported are not regarded as "hazardous goods" in the context of this Annex.

Note 4. A "Block" train is one in which the complete train is made up of wagons carrying the same substance.

TRANSITIONS AT ENDS OF GROUP P6 PARAPETS

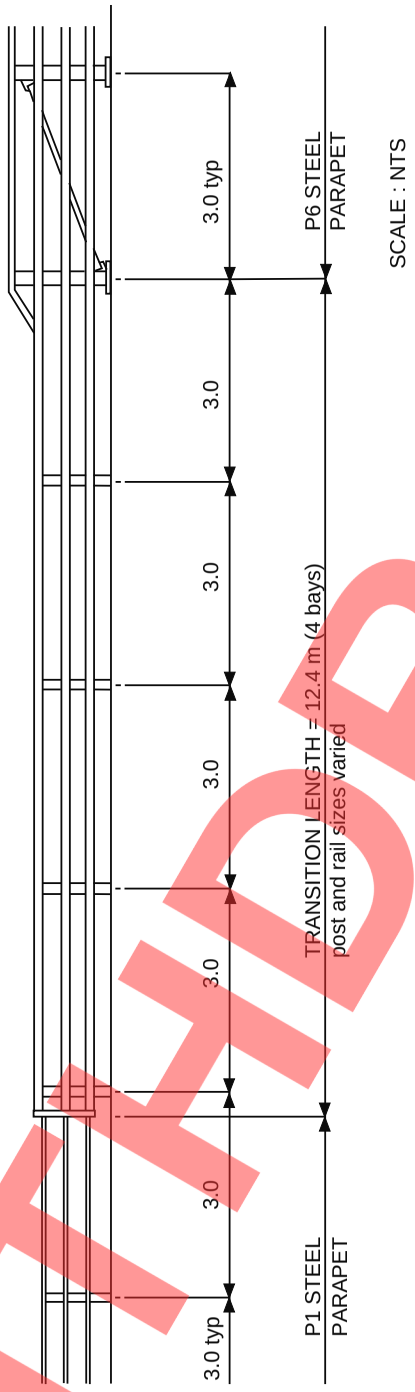



FIGURE 6

P6 STEEL PARAPET/P1 STEEL PARAPET (12.4m)

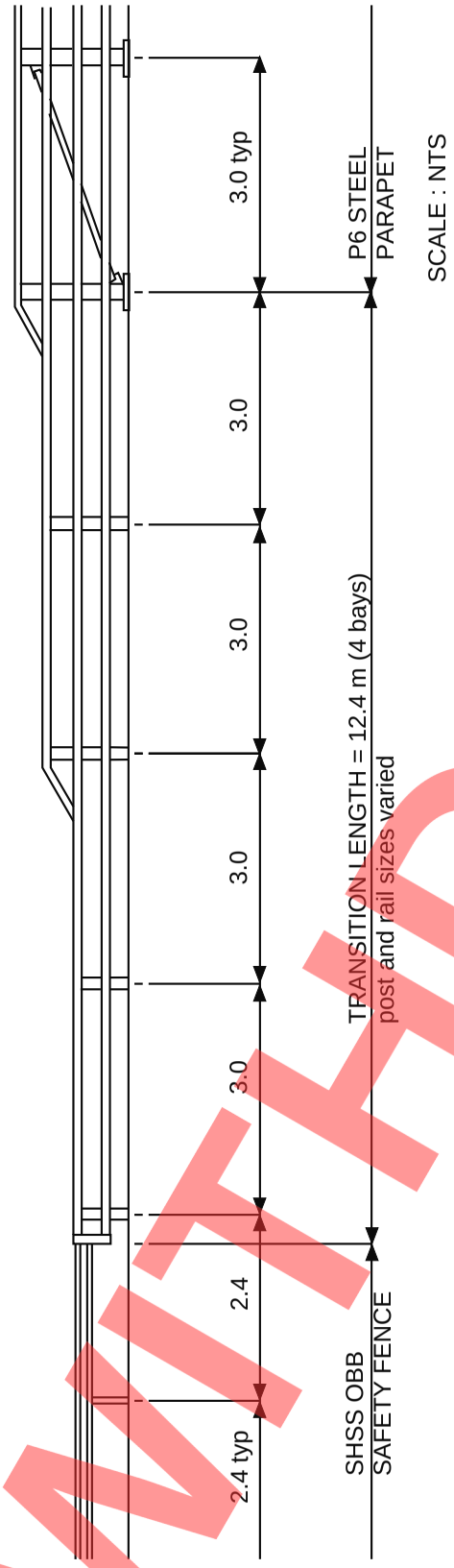



FIGURE 7

P6 STEEL PARAPET/OBB SAFETY FENCE (12.4m)



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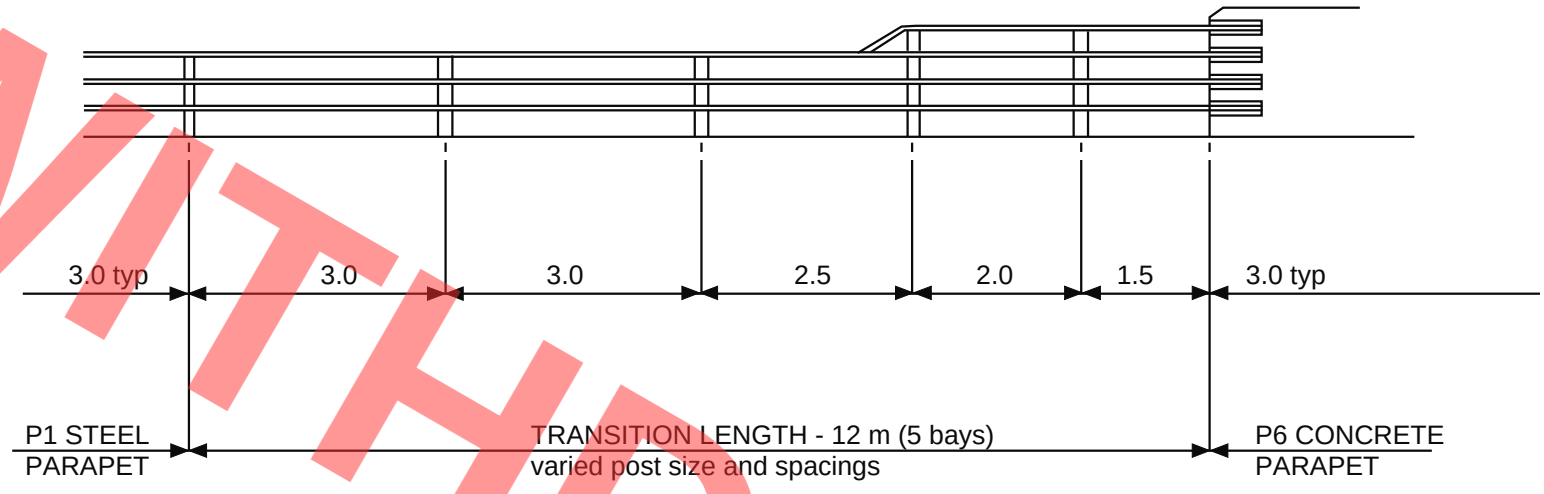


SCALE : NTS

FIGURE 8

P6 CONCRETE PARAPET/STEEL PARAPET (12m)





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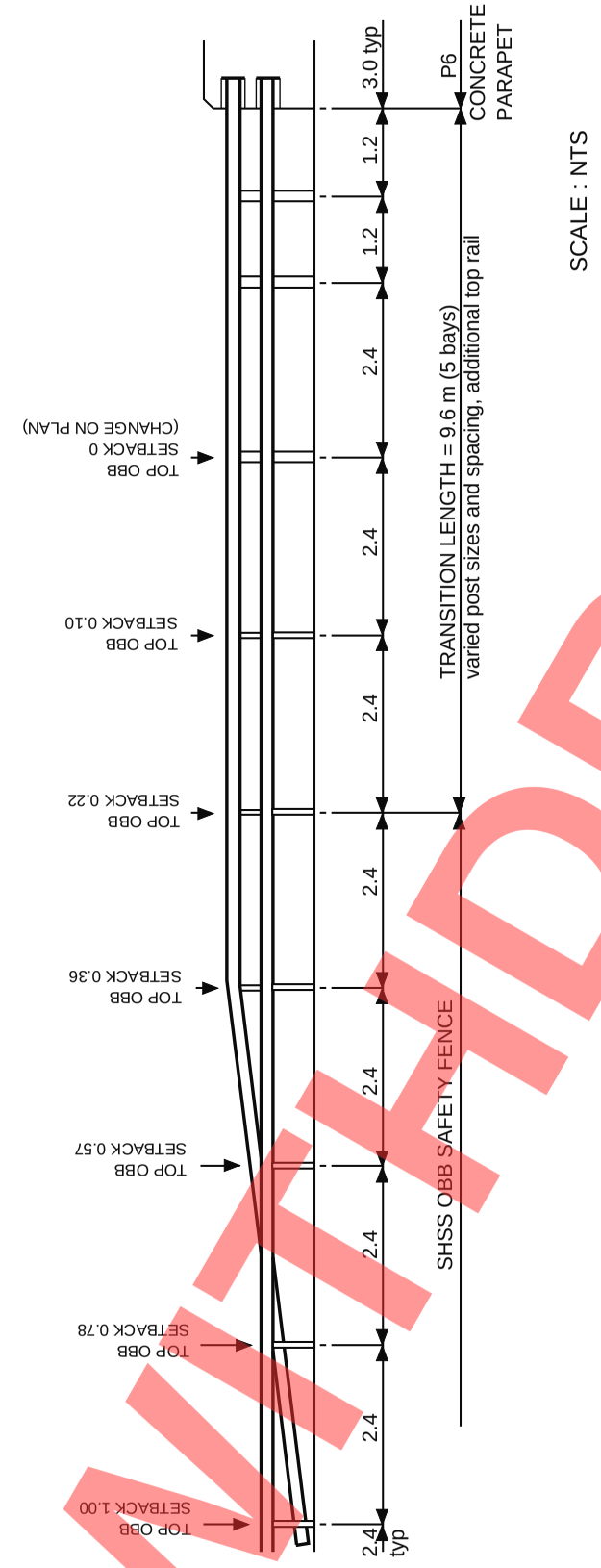


SCALE : NTS

FIGURE 9

P6 CONCRETE PARAPET/OBB SAFETY FENCE (9.6m)



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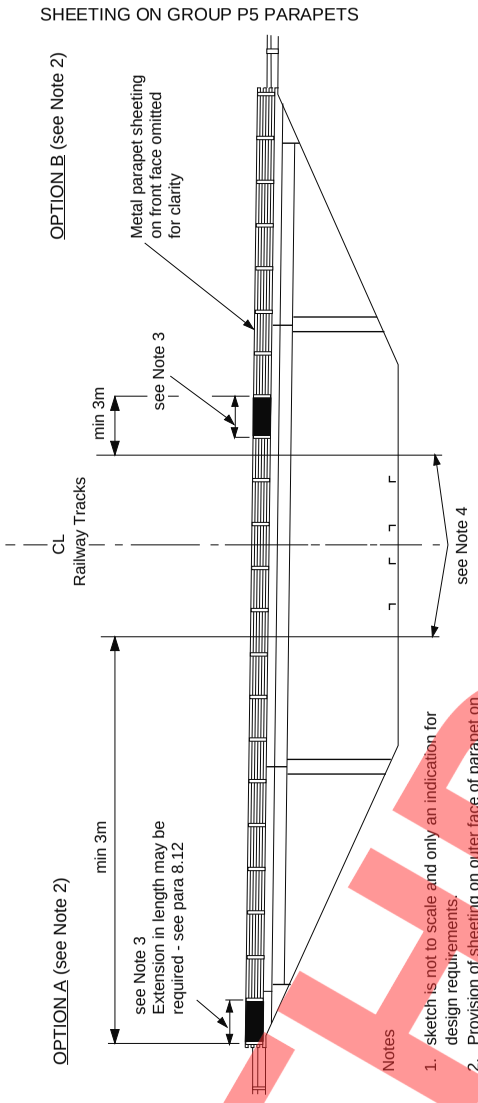


Notes

1. Sketch is not to scale and only an indication for design requirements.
2. Provision of sheeting on outer face of parapet on other side of centreline of railway track to be similar but handed.
3. Solid or mesh sheeting in accordance with para 8.10 and 8.11 on the outer face of the parapet to be fitted for a length of one parapet panel or 2m whichever is the greater.
4. The line denotes the outer limit of any railway tracks or any line overhead electrification equipment (to be determined by railway authority).

FIGURE 10

REQUIREMENTS FOR SHEETING ON OUTER FACE OF PARAPET OF BRIDGES CARRYING ALL PURPOSE ROAD OVER RAILWAY



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