BRITISH STANDARD

BS 7818:1995

Incorporating Corrigenda Nos. 1 and 2

Specification for pedestrian restraint systems in metal

ICS 93.080.30

BSI British Standards

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee B/509, Road equipment, to Subcommittee B/509/11, Pedestrian restraint systems, upon which the following bodies were represented:

Aluminium Federation

Association of County Councils

British Railways Board

British Steel Industry

County Surveyors' Society

Department of Transport (Highways Agency)

Department of Transport (Transport Research Laboratory)

Fencing Industry Association

Institution of Civil Engineers

Institution of Highways and Transportation

Royal Society for the Prevention of Accidents

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Amd. No.	Date	Comments
15047 Corrigendum No. 1	10 May 2004	Correction to Figure 4a), Figure 4b), Figure 4c) and Figure 5
16540 Corrigendum No. 2	29 September 2006	Correction to Figure 4a) and its title

Contents

Foreword

This British Standard has been prepared under the direction of Technical Committee B/509 and supersedes BS 3049:1976 which is withdrawn.

BS 3049:1976 provided a useful guide for the manufacture and installation of metal guard rails for highway situations. The need to provide a new standard has been recognized for some time and in 1992 B/509 made the decision to proceed with a pedestrian restraint systems standard which required the inclusion of pedestrian bridge parapets (not vehicle bridge parapets which are covered by the vehicle restraint systems standards).

Pedestrian restraint systems protect pedestrians when walking near the edge of high retaining walls/bridge parapets and prevent them from walking/running onto a carriageway. The design of the system should have regard to overall safety, be strong enough to withstand envisaged loading, avoid creating a visibility hazard and not become disconnected on impact and cause a major hazard for highway users.

As compared with BS 3049:1976, this British Standard covers the following:

a) pedestrian parapets;

b) illustrations of some types of pedestrian restraint systems;

c) the encouragement of the designers or specifiers to look at the overall issues of both road safety and environment by recognizing the need for particular designs in specific locations e.g. sites where increased visibility through the system is desired or where it may be necessary to extend the existing pedestrian restraint systems in historic locations;

d) additional loading requirements in recognition of the need to withstand increased crowd loadings in critical situations such as outside sports grounds.

This British Standard deals with pedestrian restraint systems of metal construction. It is hoped to extend the scope to other materials in due course but, pending the publication of such further standards, designers and specifiers wishing to use materials other than metal should ensure that the performance of those materials meets the loading requirements of this standard.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 37 and a back cover.

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Section 1. General

Introduction

Pedestrian restraint systems may take one of the following forms:

a) *Parapets* are generally installed on bridges, retaining walls or other structures where vehicular traffic is excluded but where pedestrians, equestrians or cyclists may be carried (see Figure 1).

b) *Guard rails* are installed to control pedestrians, cyclists and equestrians such as on footways, bridleways, footpaths, cycleways, but are not used on structures (see Figure 2 and Figure 3).

The main objectives of pedestrian restraint systems are:

1) to sustain the specified design loadings;

2) to protect and provide guidance for pedestrians and other non-vehicular highway users taking full account of the needs of the disabled;

3) where they are placed adjacent to a carriageway, elements should not become easily detached on impact.

The type, design and layout of a pedestrian restraint system should take account of the needs, safety and visibility of all highway users and maintenance personnel.

NOTE Any system should meet the requirements of the safety audits imposed by the relevant authorities including highway, road and rail.

1.1 Scope

1.1.1 This British Standard specifies requirements for the design, materials, workmanship and construction (including storage, transportation and installation) and testing of components for steel and aluminium alloy pedestrian restraint systems.

Other materials such as cast iron, timber, masonry, brickwork or plastics are not at present covered by this standard.

Systems covered by this standard are not designed to protect pedestrians by containing vehicle impact and if this is required reference should be made to BS 6579-1 to BS 6579-8 and BS 6779-1 and BS 6779-2.

1.1.2 Annex A and Annex B provide information on the layout of pedestrian restraint systems and visibility and inter visibility respectively.

NOTE For barriers in and about buildings see BS 6180. For general fencing see BS 1722. For steel, aluminium and concrete vehicle and vehicle/pedestrian parapets see BS 6779-1 and BS 6779-2. For vehicle safety fences and safety barriers see BS 6579-1 to BS 6579-8.

1.2 References

1.2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 35. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

1.2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

1.3 Definitions

For the purposes of this British Standard the following definitions apply.

1.3.1
road restraint system
generic name for road vehicle restraint system and pedestrian restraint system

1.3.2
vehicle restraint system
a system installed on the road to provide a level of containment for an errant vehicle; it may be used to limit damage or injury to road users and others in the vicinity

1.3.3
pedestrian restraint system
a system installed to provide restraint and guidance for pedestrians, cyclists and equestrians

1.3.4
safety barrier
a road vehicle restraint system installed alongside or on the central reserve of a road

1.3.5
vehicle parapet
a road vehicle restraint system installed on the edge of a bridge or on a retaining wall or similar structure which may include additional protection and restraint for pedestrians and other road users

1.3.6
pedestrian parapet
a pedestrian restraint system installed on the edge of a bridge or on a retaining wall or similar structure (see Figure 1)

NOTE It is not suitable for restraining vehicles.

1.3.7
vehicle/pedestrian parapet
vehicle parapet with additional safety provisions for pedestrians and/or other users

1.3.8
pedestrian guard rail
a pedestrian restraint system installed along the edge of a footway intended to restrain pedestrians from stepping onto or crossing a road or other area likely to be hazardous (see Figure 2, Figure 3 and Figure 4)

NOTE It is not suitable for restraining vehicles.

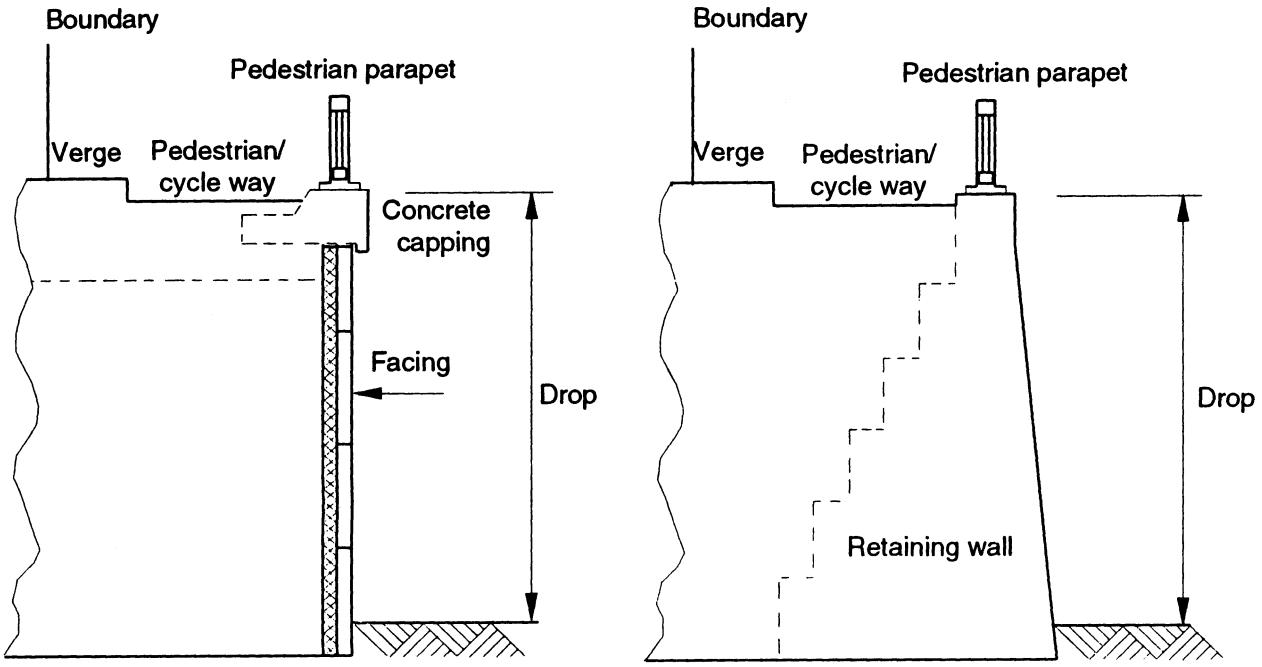
1.3.9
embankment slope
sloping ground which either forms part of the highway or road or immediately adjoins it

NOTE Pedestrian restraint systems may be necessary to protect pedestrians where the gradient is greater than 1 in 4.

1.3.10
pedestrians
persons on foot

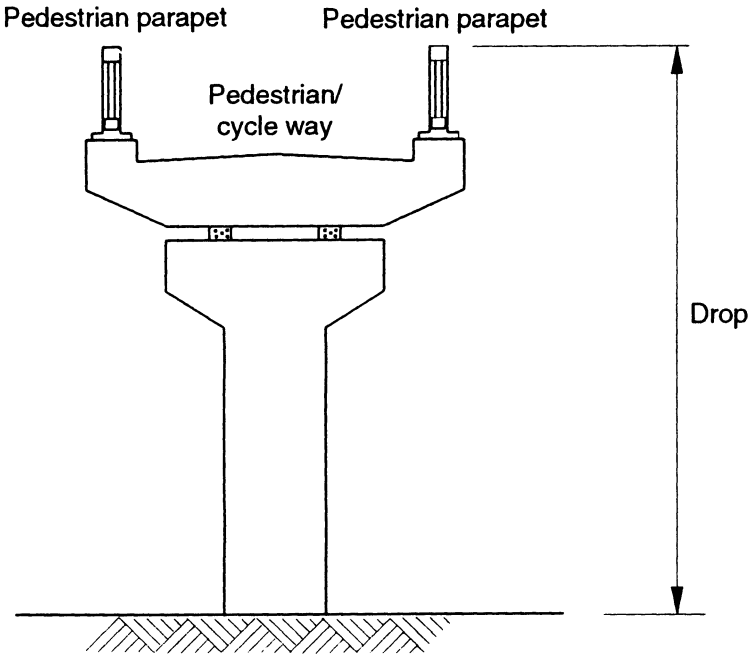
1.3.11
other users
cyclists and equestrians

1.3.12
front face of a pedestrian restraint system
the face nearest to the pedestrian traffic



a) Retaining wall

b) Reinforced earth



c) Footbridge edge beams

Figure 1 — Typical cross sections showing use of pedestrian parapets

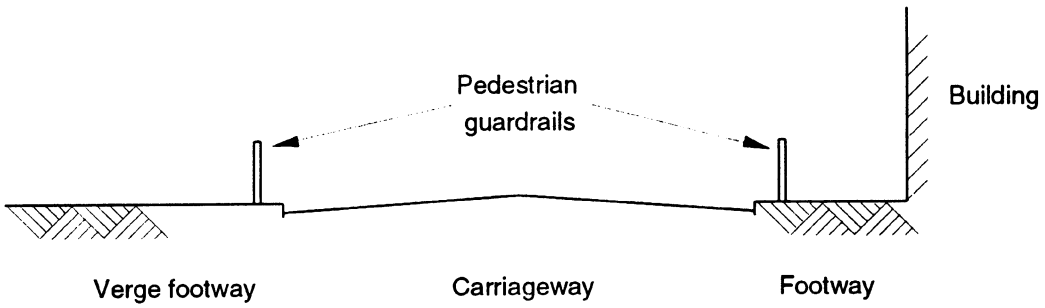


Figure 2 — Typical cross section showing carriageway, footway and guard rail arrangement

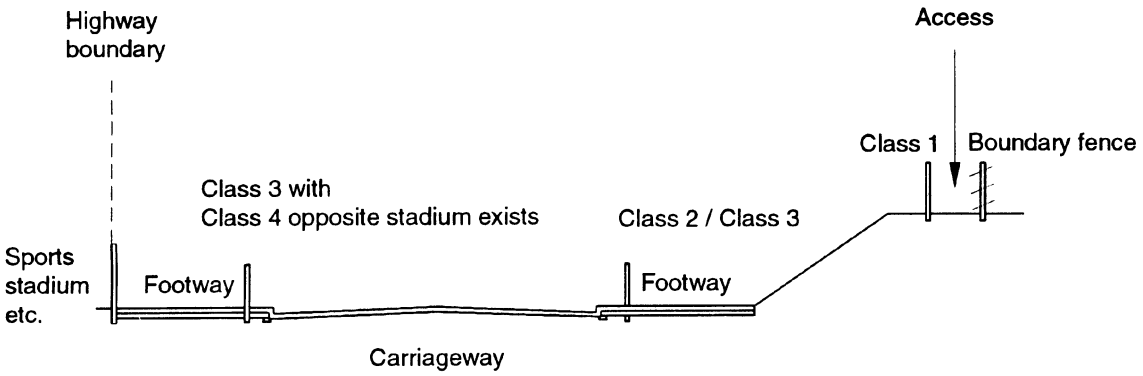
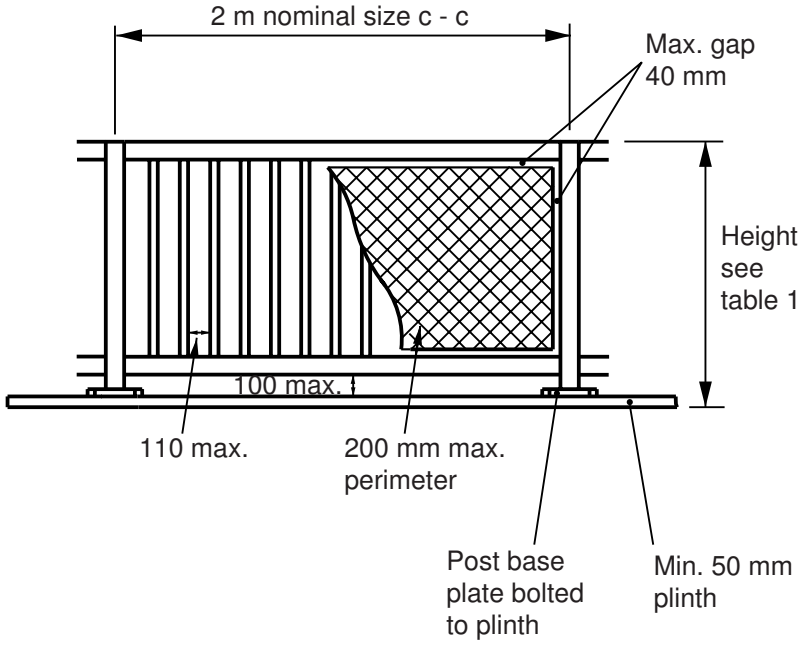


Figure 3 — Typical uses of the various classes of pedestrian guard rail



a) Typical pedestrian parapet

NOTE For special requirements for railways see text.

Figure 4 — Typical details of restraint systems

1.3.13
surface over which the user passes
the area in front of the face of a pedestrian restraint system, usually paved, immediately adjacent to any plinth or base

1.3.14
datum for height consideration
the highest level of footway, verge, carriageway or any other part of the highway or road construction within 1.5 m of, and on a line at right angles to, the front face of the pedestrian restraint system but excluding plinths and dwarf walls (see Annex A and Figure 5)

NOTE This will normally be the adjoining paved surface.

1.3.15
ground level
the final level of the surface above which the system is erected

1.3.16
plinth
a continuous upstand on the edge of a structure or set into the ground upon which the pedestrian restraint system is mounted

1.3.17
main structure
any part of a bridge, retaining wall or similar structure upon which a pedestrian parapet is mounted which may include a plinth

1.3.18
attachment system
the means of attachment of the pedestrian restraint system to the anchorage, usually consisting of holding-down bolts, or posts concreted into holes

NOTE Pedestrian parapets normally have base plates and attachment systems/anchorages. Spigots or cast-in posts are not allowed on structures. Cast-in posts can be used for pedestrian guard rails.

1.3.19
anchorage
that part contained within the main structure to which the pedestrian restraint system is fixed by means of the attachment system

1.3.20
infill
material which occupies the spaces between rails and adjacent posts

1.3.21
infill panel
a panel used to cover the spaces between members. It may provide restraint, or splash protection

1.3.22
vertical infill/bar
vertical members set at close centres between longitudinal members to provide protection to pedestrians and animals. The vertical members may be fixed or adjustable for gradient

1.3.23
rails
longitudinal members connecting two or more posts

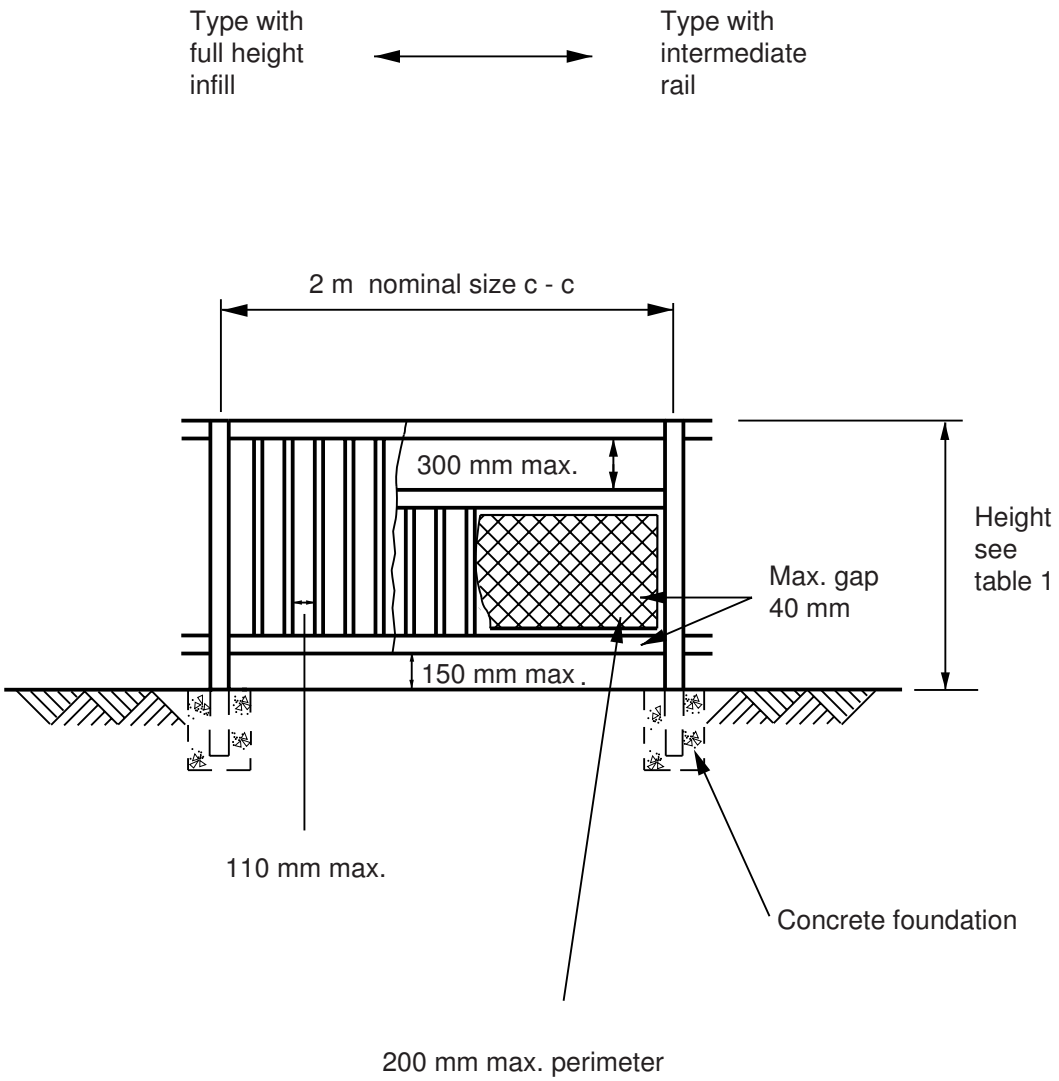
1.3.24
post
a structural member mounted in the ground or on the main structure, supporting rails and/or infill.

1.3.25
design load [see Table 2a) and Table 2b)]
Design load = nominal load × γ_{fl}

1.3.26
intervisibility
visibility through a pedestrian restraint system (see Figure 6)

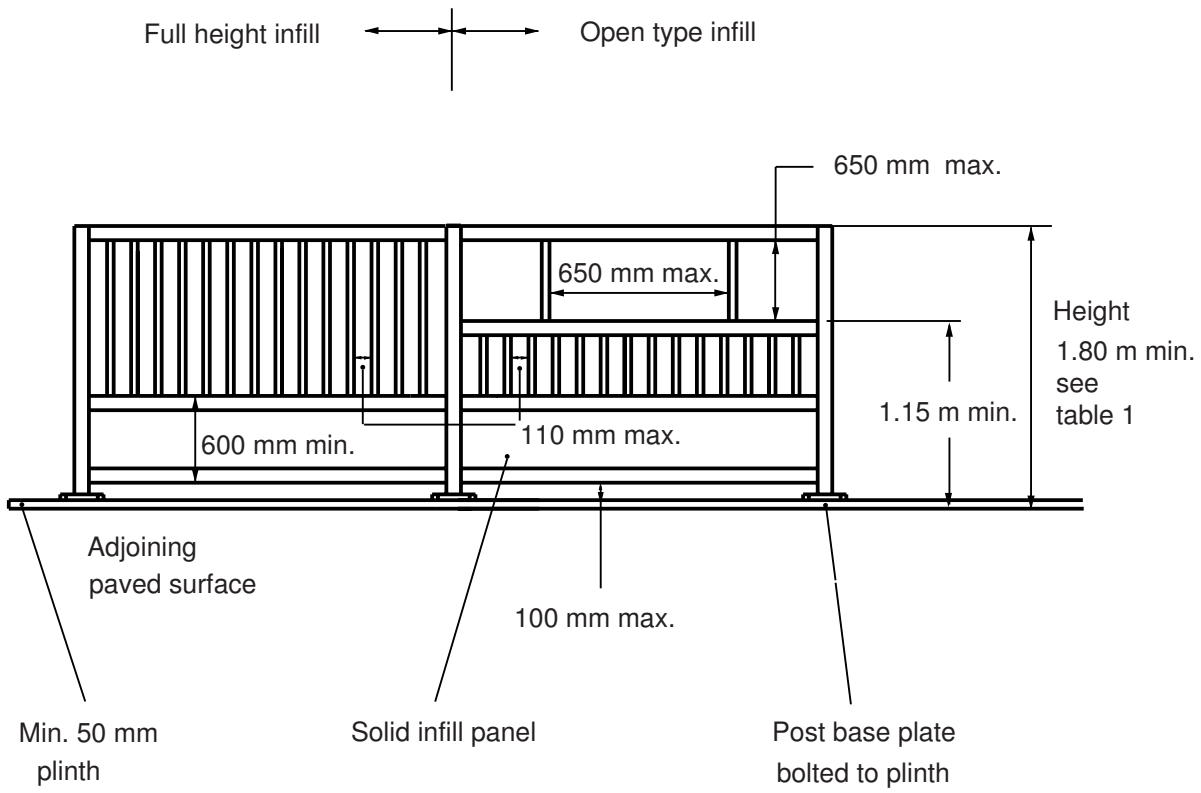
NOTE At points of emergence drivers and pedestrians should be able to see each other from a safe distance and important sight lines between drivers should not be obscured.

1.3.27
gate
a movable portion of the pedestrian restraint system provided to give access, e.g. for loading goods



b) Typical pedestrian guard rail

Figure 4 — Typical details of restraint systems (*continued*)



c) Typical equestrain parapet

NOTE Solid infill panel may be extended to the bottom of the upper intermediate rail in the design involving an open top section.

Figure 4 — Typical details of restraint systems (*concluded*)

1.4 Symbols

The following is a list of symbols used in this British Standard to represent variables. Other symbols may be found in the tables and diagrams.

$\tilde{D}$ Nominal bolt diameters (mm)

σ_{ub} Minimum ultimate tensile strength of bolt material (N/mm^2)

γ_{fl} Load factor relevant to loading

σ_{γ} Minimum yield strength of anchorage material (N/mm^2)

1.5 Layout consideration

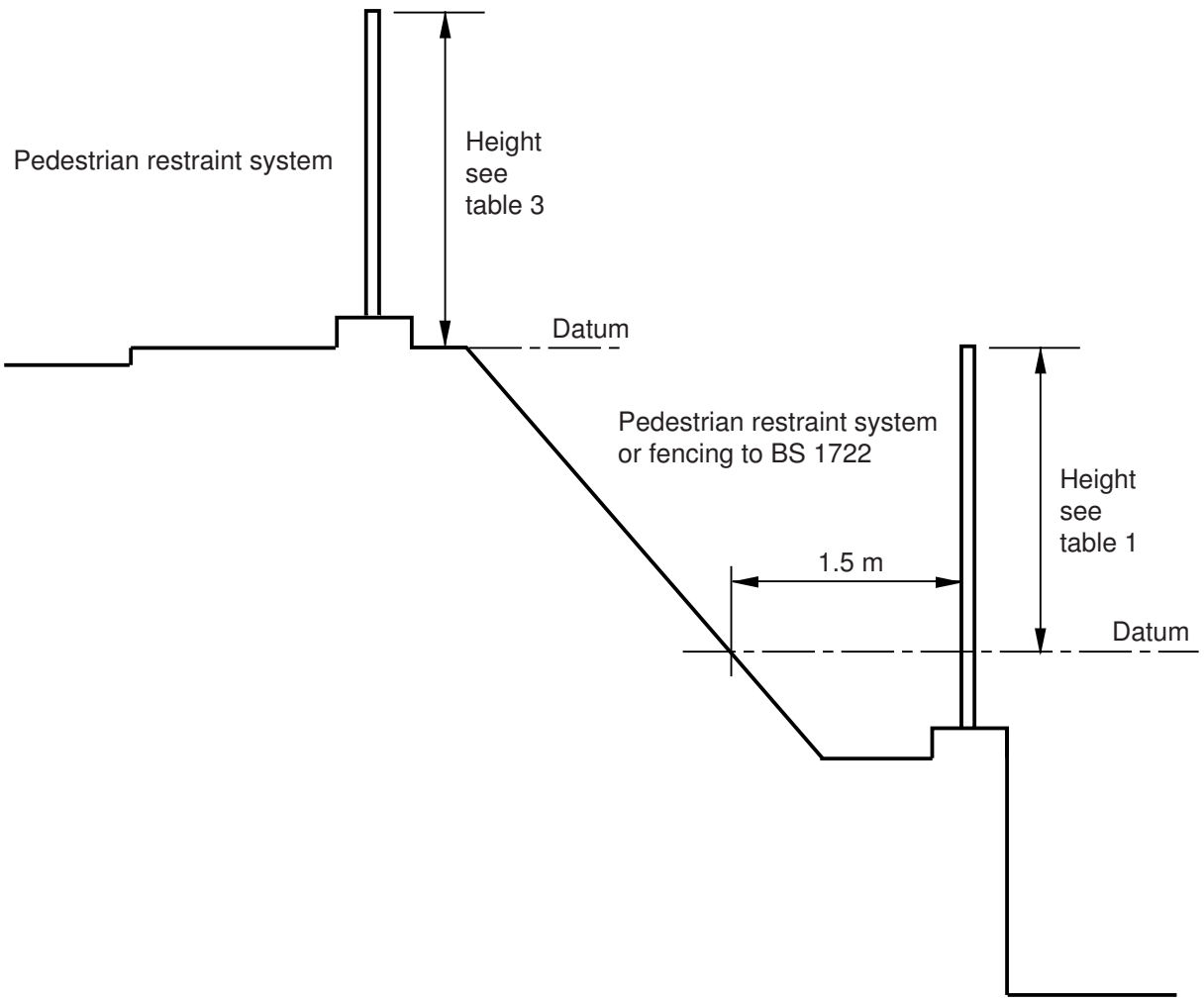
1.5.1 An accurate topographical survey of the proposed site shall be used for the overall design of the system and the following shall be considered (see Figure 6):

a) the visibility requirements between drivers and other drivers, and between drivers and pedestrians, equestrians and cyclists;

b) the minimum stopping sight distance;

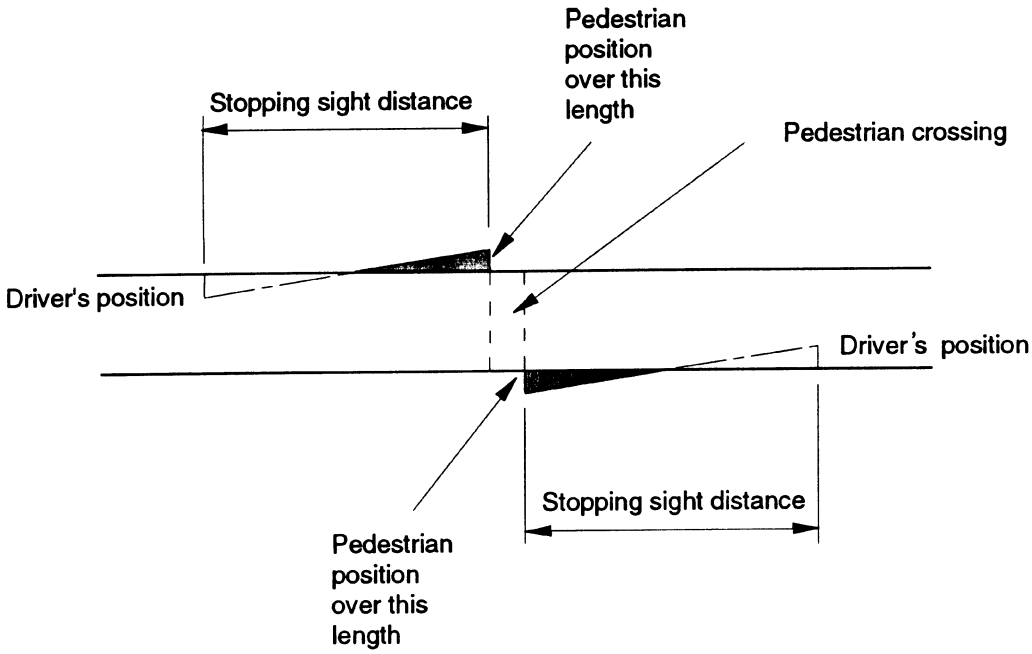
c) any special conditions to be met such as loading/unloading requirements;

d) the location of movement joints in structures.

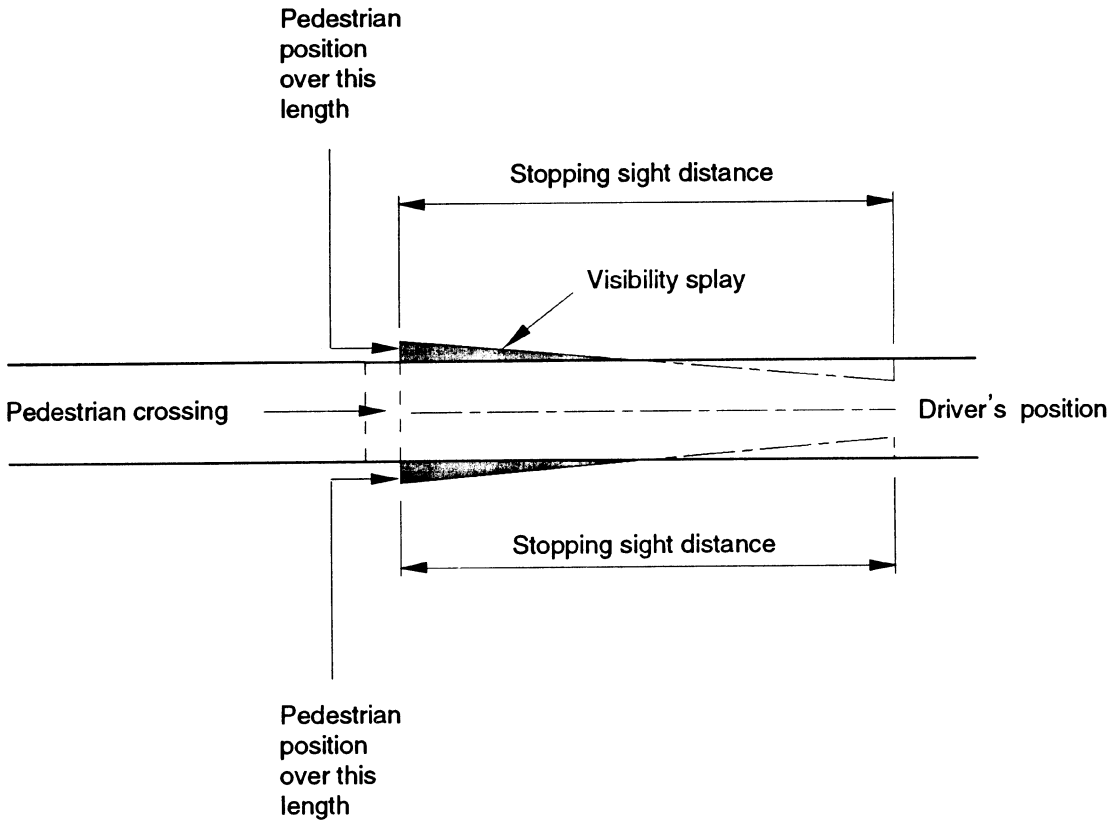


NOTE The purpose of the arrangement is to prevent pedestrians from using the adjoining slope to climb the rail and will normally be required only when there is a possibility of unauthorized pedestrian access, i.e. where the installation is on a desire line and the alternatives involves a major detour. In normal circumstances a restraint system at the top of the slope should be sufficient.

Figure 5 — Datum for height consideration



a) Two - way roads



b) One - way roads

NOTE 1 Stopping sight distances should be related to traffic speeds and may be obtained from the relevant highway/route authority design code requirements.

NOTE 2 Where space allows, the guardrail should be sited clear of visibility splay. Otherwise guardrails which provide increased visibility between road users may be necessary (see Annex B).

NOTE 3 The driver's position should be taken as the centreline of the traffic lane adjacent to the system.

Figure 6 — Typical arrangement of pedestrian crossing showing desirable visibility splays

1.5.2 Having ascertained the requirements of the system the design shall specify the system characteristics taking into account the factors listed below.

a) Design loading class (see **2.1** and advice on conditions of use in Annex A) for the following:

1) Class 1: light duty guard rail;

2) Class 2: normal duty guard rail;

3) Class 3: normal requirement for parapet and heavy duty guard rail;

4) Class 4: special duty.

b) Infill classes (see **2.1.4.3**) for the following:

1) Class A: light duty;

2) Class B: normal duty (excluding parapet);

3) Class C: normal duty (parapet);

4) Class D: special duty.

NOTE The loading requirements are given in Table 3.

c) Infill types for the following (see Figure 4):

1) vertical infill: full height;

2) vertical infill: part height;

3) mesh panel;

4) none.

d) The height shall be in accordance with Table 1 and is measured from the datum (see Figure 5).

Table 1 — Minimum heights in millimetres of pedestrian restraint systems

Use	Guard rail	Parapets	
		Not over railway	Over railway
Pedestrian	1 000	1 150	1 500
Cyclist	1 000	1 400	1 500
Equestrian	1 800	1 800	1 800

NOTE Substantial increase or decrease in the height of the pedestrian guard rail may be necessary in some situations, for example:

a) if a pedestrian restraint system blocks a direct path for pedestrians, and necessitates a considerable detour;

b) if the height above ground level is greater on one side than the other;

c) if a pedestrian restraint system is on top of a wall or bottom of an embankment.

Section 2. Design and performance

2.1 Design

2.1.1 General

This section describes the methods to be used when verifying the structural design of a pedestrian restraint system by calculation. Where calculations are not provided it is an acceptable alternative to verify the design by test (see **2.1.4**).

2.1.2 Design procedures

Pedestrian restraint systems shall be designed to resist the loadings given in **2.1.3** distributed to the components of the system as given in **2.1.4**. In addition, the effects of overall bridge loadings shall be taken into account. Limit state design procedures shall be used. The partial safety factors for loads shall be as in Table 2b). The partial factors on material strength shall be those normally applicable to the ultimate strength as recommended by the appropriate standards.

NOTE The appropriate standards for design of guard rail in steel are either BS 5950-1, BS 5950-2 and BS 5950-5 or BS 5400-3 and BS 5400-6.

Steel pedestrian parapets shall be designed to BS 5400-3 and BS 5400-6. Design in aluminium for all systems shall be to BS 8118-1.

2.1.3 Design loads

2.1.3.1 *Dead and live loads*

Design loads for rails and posts shall be determined from the nominal loads given in Table 2a).

In addition to other loadings, through-type girder footbridges and similar structures shall be designed for a nominal load of 1 400 N/m applied horizontally to the top edge of the parapet girder.

Design loads for bar, sheet or mesh infill shall be determined from the nominal loads given in Table 3.

NOTE In all cases design load = nominal load × γ_{fi} where γ_{fi} is taken from Table 2b).

Design loads shall be applied to the components of the system as specified in **2.1.4**.

Table 2 — Design loads for framed and post and rail pedestrian restraint systems

a) Nominal live loads

Class (see Annex A)	Longitudinal members (rails)	Posts and frame vertical members	
		Transverse load	Longitudinal load
	N/m	N	N
1	500	500L	250L
2	700	700L	350L
3	1 400	1 400L[a]	700L[a]
4	2 800	2 800L[a]	2 800L

b) Values of γ_{fi} for ultimate limit state

Class (see Annex A)	Loading combination	Load	γ_{fi}
All	Dead and wind	Dead	1.0
		Wind	1.4
	Live load	Live	1.5
	Live and wind load	Live	1.25
		Wind	1.4

NOTE 1 Design load = Nominal load γ_{fi}.

NOTE 2 L = Post spacing in metres for intermediate posts, or post spacing/2 in metres for end and corner posts.

NOTE 3 Loads on posts shall be applied at top rail position. Post and rail loadings are not co-existent.

NOTE 4 Class 3 is suitable for equestrian use.

NOTE 5 All parapet loadings are independent of bridge design loadings (main structural actions).

[a] With a minimum value of 1 000 N.

Table 3 — Nominal loads for bar, sheet or mesh infill

Bar, sheet or mesh infill class	Nominal load N
A	500
B	1 000
C	1 000
D	1 500
NOTE For γ_{fl} values see Table 2b).	

2.1.3.2 *Wind loads*

Wind loading shall be considered where appropriate and shall be derived from BS 5400-2.

NOTE Where large areas of solid sheeting (e.g. railway applications and environmental barriers) are fixed to or form part of the system, the effect of wind may be critical.

2.1.4 Design of components

2.1.4.1 *Rails*

All rails and their connections to posts shall be designed to carry the uniformly distributed load specified in **2.1.3** for the class specified when applied separately in the horizontal and vertical directions.

NOTE Where appropriate the strength of the infill and any vertical members providing frame restraint may be taken into account in assessing the strength of the rails.

2.1.4.2 *Posts*

Posts shall be designed to carry the minimum concentrated load given in **2.1.3** appropriate to the class specified and the type of post. The load shall be applied at the height of the top rail separately parallel to and normal to the line of the rail.

2.1.4.3 *Infill*

Infill and connections shall be designed to carry the load given in **2.1.3** for the class specified.

a) Classes A and B. The loading shall be applied normal to the plane of the infill, at any position over a single contact area of 125 mm × 125 mm for mesh or sheet and for vertical bars loads shall be applied over any 125 mm length and in any direction normal to the bar.

b) Classes C and D. The loading for mesh or sheet infill shall be applied normal to the plane of the infill over the areas and lengths specified for classes A and B (125 mm × 125 mm) on a 700 mm × 700 mm grid.

For vertical infill bars the loading shall be applied at 700 mm centres over individual, distributed lengths each of 125 mm in any direction normal to the bar.

NOTE Loads or combinations of loads should be applied to produce the most adverse effects for classes A to D.

2.1.4.4 *Deflection*

The maximum deflection of the system at any point below 1 m height shall not exceed the values given in Table 4 when subjected to a horizontal load applied to the top rail equal to the longitudinal member nominal live load derived from Table 2a) and using a γ_{fl} of 1.0 for serviceability.

Table 4 — Maximum deflection of the system

Loading class	Maximum deflection mm
1 and 2	50
3 and 4	40

2.1.5 Performance verification by test

2.1.5.1 *Static loading*

The tests shall be carried out on an actual pedestrian restraint system.

Prior to the acceptance test, a preliminary settling down of the structure shall be accomplished by applying 25 % of the value of the live load specified in Table 2 and Table 3 as appropriate. These shall remain in place for a minimum of 15 min and be removed before the static acceptance tests begins.

2.1.5.2 *Static acceptance test*

The nominal live load given in Table 2a) or Table 3 as appropriate shall be multiplied by a partial safety factor γ_{fl} of 1.2 (the test load) and this shall be applied to the system or infill in at least five approximately equal increments. Each increment of test live load shall remain in place long enough to enable measurement of deflection to be taken at critical points of the pedestrian restraint system, and to permit examinations for damage. The final increment of loading shall remain in place for at least 15 min before the measurements and inspection required for acceptance are made.

2.1.5.3 *Integrity of the test pedestrian restraint system*

The acceptance test shall be considered satisfactory if:

a) the recovery of deformation 15 min after removal of the test load defined in **2.1.5.2** is at least 95 %;

b) the deflection at any point in the system below 1 m height meets the requirements of **2.1.4.4**.

NOTE Where the system fails to meet these requirements the system will be acceptable if on repetition of the test the deformation and recovery of deformation meet the acceptance criteria in a) and b).

Failure at the second test shall be deemed failure of the system.

2.2 Gradients

For a pedestrian restraint system erected on a slope, all performance requirements of this standard shall be met whether the posts are vertical or normal to the slope and whether the rails are horizontal or parallel to the slope.

2.3 Post spacing and curves

2.3.1 Post spacing

The distance between the centres of adjacent posts shall be nominally 2 m but this may be amended provided that the system satisfies the appropriate design criteria specified in **2.1** and to accommodate expansion joints, wing walls etc. on structures. The post centres shall not exceed 3.8 m.

2.3.2 Curves

Pedestrian guard rails shall be capable of being erected to suit curves with a minimum radius of 10 m.

NOTE Where tighter curves are required shorter length panels may be used.

2.3.3 Minimum section thickness

The minimum thickness of section of all metal parts shall be in accordance with Table 5.

2.4 Infill

2.4.1 General

Where the use of infill is specified the space contained within the top rail (or the intermediate rails, if used), the bottom rail and the posts shall be filled with vertical infill bars, mesh, sheet or other material as agreed between the specifier and the supplier. The infill and its connections shall meet all requirements specified (see **2.1.4.3**). See Figure 4 for typical details.

2.4.2 Vertical infill

Where infill comprises vertical infill bars (or tubes) there shall be no horizontal gap between the bars or between the bars and posts in excess of 110 mm.

2.4.3 Mesh or solid sheet infill (excluding applications over railways)

Where infill comprises mesh, apertures in the infill shall have no perimeter in excess of 200 mm except for the gap between the top and the intermediate rail which may be up to 300 min.

NOTE Solid sheeting should only be provided in special cases as this type may have detrimental aesthetic effects.

2.4.4 Solid sheet infill: railway applications

The sheet shall present a smooth surface to the front face. Joint gaps shall not exceed 3 mm. The sheet shall extend to the full height of the parapet.

The gap between ground level or plinth and the sheet shall not exceed 3 mm.

NOTE 1 A grit blasted finish or a patterned surface with maximum depth of 1 mm may be used on solid panels to offset the risk of dazzle.

NOTE 2 Solid infill may also be used for anti-splash or anti-dazzle purposes.

2.4.5 Mesh infill: railway applications

2.4.5.1 Wire and expanded metal sheet shall be used as infill over the full height of the parapet.

Any gaps between the edge of the mesh and posts, rails and ground level or plinth shall not exceed 25 mm.

2.4.5.2 Wire mesh infill shall have apertures not exceeding 25 mm × 25 mm.

Table 5 — Minimum thickness of member, infill panels and other components

Material	Section	Minimum thickness mm						
		Primary load carrying members		Non-load carrying members and secondary elements of load carrying		Infill panels, bars and mesh		Clips, covers fixings etc.
		class 1 and class 2	class 3 and class 4	class 1 and class 2	class 3 and class 4	class 1 and class 2	class 3 and class 4	All classes
Steel	Hollow sections galvanized inside and outside	2	3	2	3	2	3	3
	All other sections	4	4	3	3	3	3	3
Aluminium alloy	All Sections	2	3	1.5	2	1.5	2	1.5
Stainless steel	All sections	2	2	1	1	1.5	2	0.5

2.4.5.3 Expanded metal sheet shall have openings not exceeding 30 mm × 20 mm and shall be fixed vertically with the long direction horizontal, and shall be supplied in a deburred and flattened condition so that the strands are in the same plane as the sheet. The mesh shall be fixed to provide a flush, smooth front face.

2.4.5.4 Mesh infill shall not be used over electrified lines.

2.4.6 Specific requirements for equestrian applications

Where equestrian parapets are provided, solid infill panels at least 600 mm high at the bottom of the parapet shall be provided in order to obstruct the horse's view of the road below. Infill over 1 150 mm above datum shall have a gap not exceeding 650 mm in any direction. The gap below the panel shall not exceed 100 mm (see Figure 4c)).

2.4.7 Other requirements

2.4.7.1 When erected, the gap between the bottom rail and plinth or ground level shall not exceed the following:

Guard rail	150 mm
Parapet	100 mm

2.4.7.2 When an intermediate rail is used in the guard rail, the gap between the top and intermediate rail shall not exceed 300 mm.

2.4.7.3 On faces where pedestrians have access there shall be no footholds or projections above the bottom rail level and regard shall be paid to the following principles:

a) children should not be able to get heads/limbs trapped in gaps;

b) pedestrians shall be discouraged from climbing over or through the system.

2.4.7.4 All infill and connections shall be securely fixed and shall not be easily detachable.

2.4.7.5 No reflective surfaces shall be used that create a hazard for, or may mislead or misinform any road or railway user.

2.5 Gates

2.5.1 Where gates are required in a pedestrian restraint system they shall, when closed and secured, conform to the specification for the adjoining system. Gates or opening rails, or any part of them, shall not at any time project, or be capable of projecting, into the carriageway. They shall be provided with key operated locks and appropriate arrangements for retaining them open when in use. Gates should preferably be self-closing and self-locking and when opened be capable of folding back against the adjoining section of the restraint system.

2.6 Hazards

NOTE Pedestrian guard rails are usually intended for installation near the edge of the carriageway and, as such the risk of their components presenting a hazard to the occupants of impacting vehicles or pedestrians when struck should be minimized. They are not intended to act as safety fences or safety barriers and restrain impacting vehicles.

It is impractical to design a pedestrian guard rail which creates no risk after vehicle impact. However, good design can alleviate two specific hazards:

a) detachment of horizontal rails, particularly at the end of guard rails, which could impale vehicles;

b) detachment of infill bars or other components, which could become dangerous projectiles.

2.6.1 The posts at the end of a pedestrian guard rail on an unlit road shall be installed with reflectors.

2.6.2 The whole pedestrian restraint system shall be free from burrs and sharp edges.

2.7 Materials

2.7.1 Steel

Steel used for pedestrian restraint systems shall conform to the appropriate British Standard listed in Table 6.

Table 6 — Materials of construction for steel pedestrian restraint systems

Form of material	Current BS specification	Requirements specified
Hot rolled sections	BS 4-1 BS EN 10034	Dimensions, sectional properties and tolerances on shape
Hot rolled hollow sections	BS 4848-2	
Equal and unequal sections	BS 4848-4 BS EN 10056-2	
General purpose tubes	BS 1387	
Cold formed rolled hollow sections	BS 6363	Physical properties, chemical composition, dimensions and sectional properties, tolerances
Weldable structural steel (includes appropriate requirements for items above)	BS EN 10025 BS EN 10113-1 to BS EN 10113-3 BS EN 10210-1	Technical delivery requirements, physical properties, chemical composition
Plate, sheet and strip		
carbon steel	BS 1449-1 BS EN 10130 BS EN 10131	Physical properties, chemical composition, material condition and dimensional tolerances
stainless steel	BS 1449-2 BS EN 10051	
Bars and rods	BS 970-1 BS 970-3 BS EN 10083-1 BS EN 10083-2	Physical properties and chemical composition
Welded wire mesh	BS 4483	General requirements
Expanded metal	As for plate sheet and strip	Physical properties, chemical composition, material condition and dimensional tolerances
Fasteners (see note)		Dimensions, sizes, physical, properties, chemical compositions, grades, tolerances and marking
ISO metric black hexagon bolts, screws and nuts	BS 4190	
ISO metric precision hexagon bolts, screws and nuts	BS 3692	
Metric washers	BS 4320	
Metric spring washers	BS 4464	
Corrosion-resistant stainless steel fasteners	BS 6105	
High strength friction grip bolts, nuts and washers	BS 4395-1	

NOTE The standards listed in this table relating to the form of fasteners do not cover special bolts, nuts, screws etc. which may be used for particular fixings where it is not possible to incorporate bolts, screws etc. of standard dimensions or where special fixings are required to resist vandalism.

2.7.2 Aluminium alloy

Aluminium alloys used for pedestrian restraint systems shall conform to the appropriate British Standards listed in Table 7.

2.7.3 Fasteners

Structural fasteners shall conform to the relevant British Standards (see notes to Table 6 and Table 7).

Table 7 — Materials of construction for aluminium pedestrian restraint systems

Form of material	Current BS specification		Draft of new BS specification		Requirements specified
	Alloy designation	BS specification	Alloy designation	BS EN specifications	
Extruded sections	6060		EN AW 6060	BS EN 515	Alloy designation, chemical composition, temper designation, mechanical properties, tolerances
	6061	BS 1474	EN AW 6061	BS EN 573-1, BS EN 573-3 and BS EN 573-4	
	6063		EN AW 6063	BS EN 755-2 to BS EN 755-9	
	6082		EN AW 6082		
Drawn tube	6061		EN AW 6061	BS EN 515	Alloy designation, chemical composition, temper designation mechanical properties tolerances
	6063	BS 1472	EN AW 6063	BS EN 573-1, BS EN 573-3 and BS EN 573-4	
	6082		EN AW 6082	BS EN 754-1 to BS EN 754-8	
Seam welded tube	5251	BS 4300/1	EN AW 5251	BS EN 515	Alloy designation, chemical composition, temper designation, mechanical properties tolerances
				BS EN 573-1, BS EN 573- 3 and BS EN 573-4	
Sheet and plate	1200		EN AW 1200	BS EN 515	Alloy designation, chemical composition, temper designation, mechanical properties tolerances
	3103		EN AW 3103	BS EN 573-1, BS EN 573-3 and BS EN 573-4	
	3105		EN AW 3105	BS EN 485-1 to BS EN 485-4	
	5083	BS 1470	EN AW 5083		Alloy designation, chemical composition, temper designation, mechanical properties, tolerances
	5251		EN AW 5251		
	6082		ENAW 6082		
	stainless steel	BS 1449-2			
Rivets	5154A	BS 1473	EN AW 5154A	BS EN 515	Alloy designation, chemical composition, temper designation, mechanical properties, tolerances, dimensions and materials for blind rivets with break mandrel
	6082	BS 1473	EN AW 6082	BS EN 573-1, BS EN 573-3 and BS EN 573-4	
	5056A	BS 1474	EN AW 5056A	BS EN 755-2 to BS EN 755-9	

Table 7 — Materials of construction for aluminium pedestrian restraint systems (*concluded*)

Form of material	Current BS specification		Draft of new BS specification		Requirements specified
	Alloy designation	BS specification	Alloy designation	BS EN specifications	
Castings	LM6 and LM25	BS 1490	EN AC 44100 EN AC 42000	BS EN 515 BS EN 573-1, BS EN 573-3 and BS EN 573-4	Alloy designation, chemical composition, temper designation, mechanical properties, tolerances
Welding filler rods and wire		BS 2901-4			Chemical composition, properties, diameters and tolerances
Welded wire mesh		BS 4483			General requirements
Expanded metal:					
aluminium alloy		BS 1470			Properties, chemical composition, material condition and dimensional tolerances
carbon steel		BS 1449-1			
stainless steel	Grades 316S31 and 316S31	BS 1449-2			
Fasteners:[a]					
ISO metric black hexagon bolts, screws and nuts		BS 4190			Dimensions, sizes and tolerances
ISO metric precision hexagon bolts, screws and nuts		BS 3692			
washers		BS 4320			
spring washers		BS 4464			
corrosion resistant stainless steel fasteners	Grade A4	BS 6105			Chemical composition and physical properties
high strength friction grip bolts		BS 4395-1			

NOTE The physical properties of aluminium alloys may be modified by welding. A method of dealing with this effect for design purposes is given in BS 8118-1.

[a] The standards listed in this table relating to the form of fasteners do not cover special bolts, screws etc. Which may be used for particular fixings where it is not possible to incorporate bolts, screws etc. of standard dimensions or where special fixings are required to resist vandalism.

2.8 Durability and protection

2.8.1 General

Pedestrian restraint systems shall be manufactured and finished in such a way that they can be expected to have a useful life appropriate to the situation in which they are to be used taking into account winter maintenance considerations. The design of the system shall ensure that water traps are avoided.

NOTE 1 This assumes that regular inspection and maintenance will be undertaken.

NOTE 2 Pedestrian guard rail systems should have a minimum serviceable life of 15 years.

NOTE 3 Pedestrian parapets should have a minimum serviceable life of 60 years.

2.8.2 Protection

NOTE For aluminium alloy pedestrian restraint systems no additional corrosion protection is normally required where natural rain washing occurs.

2.8.2.1 Steel parapets shall be galvanized to BS 729 and treated with a suitable protective system in accordance with the intended environment and life requirements.

2.8.2.2 Steel guard rails shall be galvanized to BS 729.

2.8.3 Mixing different materials

2.8.3.1 *Metals*

Metal-to-metal contact between dissimilar metals shall be avoided by the use of non-metallic sleeves, washers or coatings (but see **2.10.3**). This requirement shall not preclude galvanized steel mesh being used on aluminium alloy systems, nor the use of stainless steel fasteners and fittings with aluminium alloy systems.

2.8.3.2 *Aluminium in contact with concrete*

Aluminium alloys which are to be in contact with concrete or cement mortar shall be protected in accordance with **2.10.3**.

2.8.4 Drainage of hollow sections

Hollow sections shall be drained to prevent corrosion and damage occurring due to the freezing of water which may otherwise accumulate inside them.

Holes for galvanizing and drainage shall have a diameter not greater than one-twelfth of the circumference of the members, with a minimum diameter of 8 mm and a maximum diameter of 15 mm prior to galvanizing. Holes in any member shall not be spaced closer than 700 mm if they are to be left open to the atmosphere.

NOTE 1 Consideration should be given to the effect of the holes and their location on the strength of members.

NOTE 2 Moisture can collect in a section not open to direct penetration by condensation of water vapour, drawn in by the breathing effect caused by changes in air temperature and pressure.

2.8.5 Vandalism

The pedestrian restraint system shall be resistant to vandalism. It shall be ensured that fixings and fasteners cannot be loosened so as to allow parts of the system to be wilfully removed, simply and quickly using minimal tools, or to be damaged, for example by blows.

2.9 Identification marking

2.9.1 When a pedestrian restraint system is manufactured as a unit comprised of posts, rails and infill, an easily legible and durable plate or marking shall be applied to and located on each panel or installation. The identification plate or marking shall be easily visible.

2.9.2 When separate components are assembled on site to form a complete panel, an easily legible and durable plate or marking shall be applied, and located on the top or intermediate rail in a position which is easily visible, following erection.

2.9.3 The marking shall have lettering not less than 5 mm high and include the following information (see Figure 7)

a) the name and/or trademark of the manufacturer;

b) the number of this British Standard[1)];

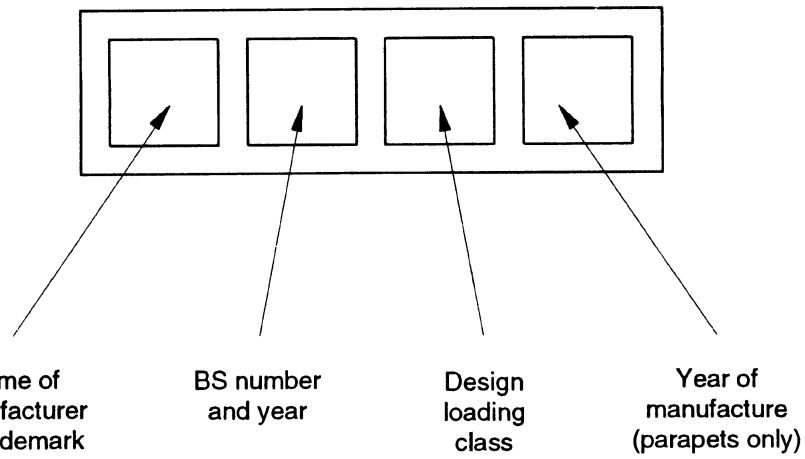
c) the design loading class;

d) for parapets only, the year of manufacture.

2.9.4 Requirements at movement joints

Joints providing continuity between lengths of rails or across expansion or rotational joints shall be designed to resist the maximum design loads that are to be applied to the rail or joint.

NOTE Normally a discontinuity joint in the parapet using suitable infill between the posts is used (see Figure 8 and Figure 9).



NOTE Lettering to be legible and durable and of 5 mm minimum length.

Figure 7 — Detail of typical identification plate

[1)] Marking BS 7818:1995 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

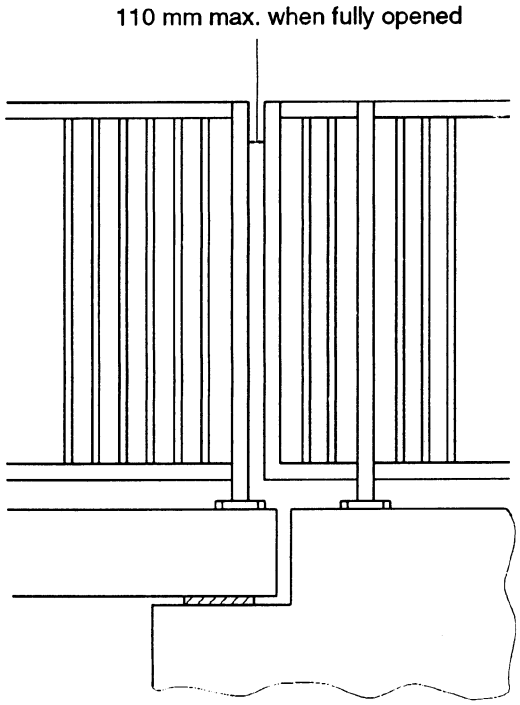


Figure 8 — Typical detail of parapet at movement joint to accommodate small movements up to 100 mm

2.10 Foundations, attachment systems and bedding

2.10.1 Pedestrian guard rails

The foundation or attachment system shall be designed to withstand loads 50 % greater than the design load in Table 2.

Where posts are set into excavated holes a concrete foundation shall be cast for each post, and the surrounding soil fully compacted.

NOTE Possible minimum dimensions for the concrete foundation are given in Table 8. These should be amended as necessary to suit actual ground conditions.

Table 8 — Possible minimum dimensions for concrete foundations

Guard rail height	Up to and including 1 000 mm	Over 1000 mm and up to 1 500 mm	1 500 mm and above (including cyclist and equestrian use)
Suggested minimum dimensions	300 mm × 300 mm × 400 mm deep	300 mm × 300 mm × 600 mm deep	500 mm × 500 mm × 600 mm deep

2.10.2 Pedestrian parapets

2.10.2.1 *General*

Parapets that use baseplates shall be fixed to the main structure by stainless steel holding down bolts engaging with an anchorage.

Anchorages in concrete shall be either cast-in cradle anchorages, (see Figure 10) or individual anchorage systems that are of purpose design or of proprietary manufacture. It shall be ensured that they will provide the necessary resistance taking into account the effect of possible overlap of stress cones from individual fixings and any bursting forces from expanding type anchorages.

NOTE 1 The concrete of the main structure may need additional local reinforcement to resist without damage the forces that may be transmitted from the parapet.

NOTE 2 Static testing of the proposed assembly may be considered advisable if other evidence is not available covering the particular application.

Any voids in anchorages, such as those around bolts in holes drilled for individual anchorages, shall be completely filled with grout or with a non-setting passive filler to prevent the collection of water which may cause corrosion or freeze and engender bursting stresses.

The holding-down bolts and anchorages shall be capable of resisting loads at least 30 % greater than the maximum fully plastic moment of the post. The calculated load in the holding-down bolts shall not exceed the product of the yield stress or 0.2 % proof stress of the bolt material multiplied by the tensile stress area of the bolt.

2.10.2.2 *Engagement of holding-down bolts*

Each holding-down bolt shall have a length of engagement into the anchorage of not less than that given by the following expression:

$$0.7 \times \frac{\sigma_{ub}}{\sigma_{ya}} \times D$$

where

σ_{ub} is the minimum ultimate tensile strength of bolt material (in N/mm^2);

σ_{ya} is the minimum yield strength of the anchorage material (in N/mm^2);

D is the nominal bolt diameter (in mm).

NOTE 1 This is to ensure that bolt failure occurs prior to anchorage thread failure.

NOTE 2 If the type of holding-down bolts used require an initial torque to be effective, the torque should be specified.

2.10.2.3 *Bedding mortar*

Any bedding mortar used between the baseplates and the plinth shall be capable of permanently transmitting the loads involved, without undue deformation or cracking. The nominal bearing stresses developed in the bedding shall not exceed 20 N/mm^2.

2.10.2.4 *Plinth*

Where the main structure is of concrete, the parapet shall be mounted on a plinth having an upstand above datum of not less than 50 mm at the front face and not more than 100 mm above datum at any point on the cross section.

2.10.3 Resistance to corrosion at base and base plates

The following requirements shall be observed in addition to the general requirements.

a) Aluminium which is to be in contact with the concrete or mortar shall be coated with at least two applications of a bituminous coating solution in accordance with BS 3416 or with hot-dip bitumen, applied to a clean, degreased surface.

b) Metal-to-metal contact between dissimilar materials shall be avoided by the use of non-metallic sleeves or washers. Coatings are not permitted on pedestrian parapets.

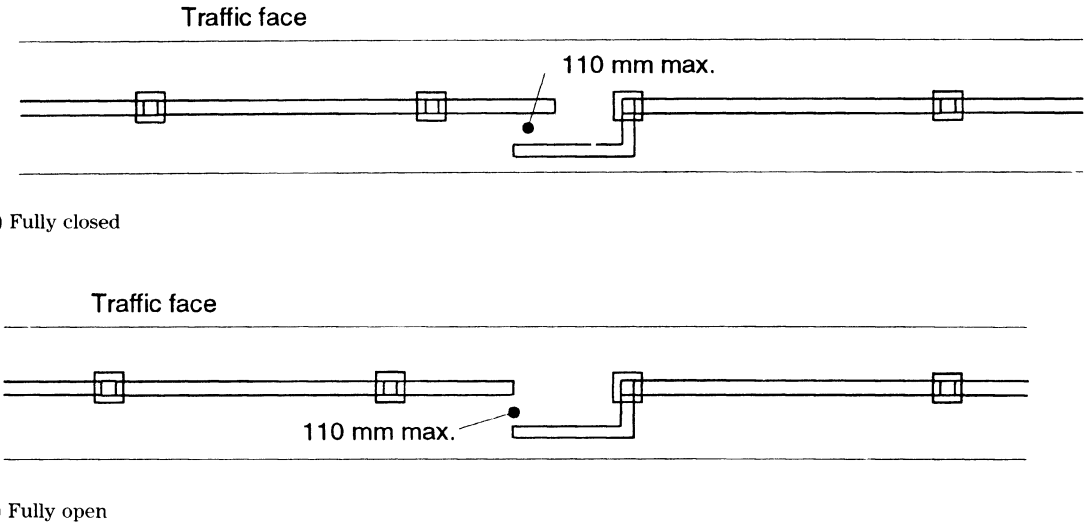
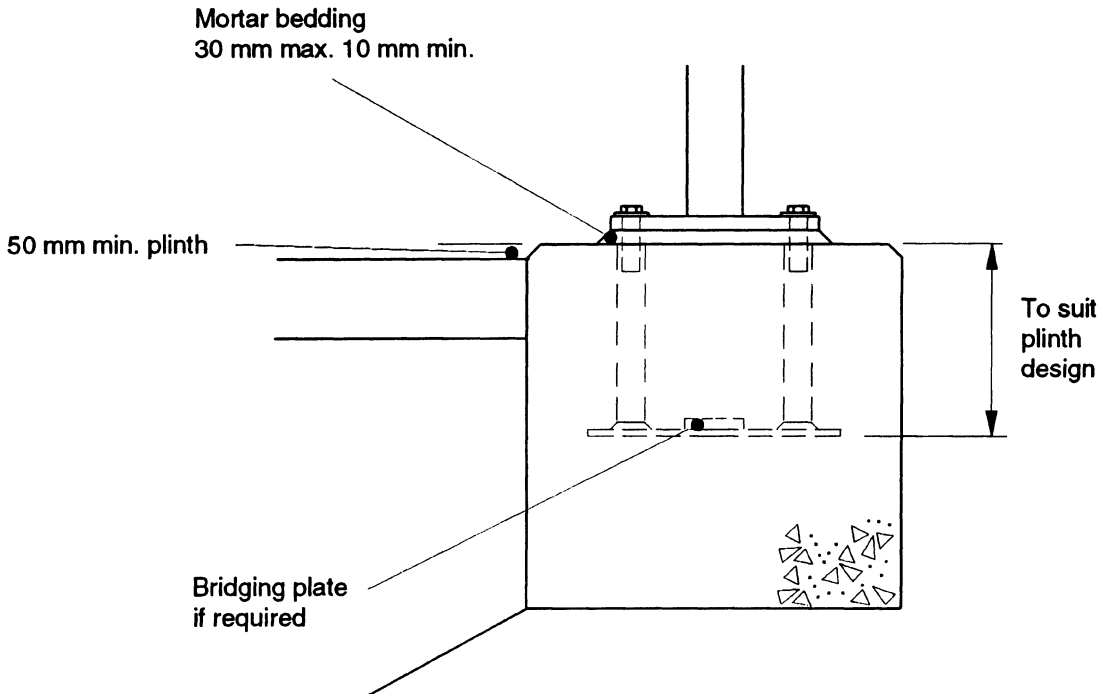


Figure 9 — Typical plan of parapet at movement joint to accommodate large movements



NOTE Individual anchorage fixings may be used as an alternative to cast-in cradles

Figure 10 — Typical detail of parapet fixing to concrete structure

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Section 3. Construction of steel and aluminium pedestrian restraint systems

3.1 Workmanship, inspection and testing

3.1.1 General: steel

3.1.1.1 Steel base plates shall not have lamination defects exceeding those specified in BS EN 10021.

3.1.1.2

a) Holes may be punched full size in cleats and brackets where the material thickness does not exceed 15 mm, and the fabrication is not subject to repeated stresses. Slotted holes may be flame cut or punched full size.

b) Flame cut surfaces on steel components shall be smooth and free from deep gutters.

c) The faces of posts and rails shall present a surface free from burrs and sharp edges.

3.1.2 General: aluminium

Workmanship in aluminium alloy shall be in accordance with BS 8118-2 except as modified by **3.2**.

3.2 Welding

3.2.1 General

Arc welding of carbon manganese steels shall conform to BS 5135. Arc welding of aluminium alloys shall be in accordance with BS 3019 or BS 3571 as appropriate. Processes other than arc welding shall be to the approval of the engineer. Welding of stainless steel anchorages shall be in accordance with BS 7475.

All approved written procedures, where required for automatic and robotic welding, shall be to BS 4870-4.

3.2.2 Welding approval scheme for pedestrian parapets to classes 3 and 4

3.2.2.1 ***Procedures***

The supplier shall produce and work in conformity with written approved procedures, confirmed by testing, in accordance with BS EN 288-1,BS EN 288-2 and BS EN 288-3 for steel and BS EN 288-1, BS EN 288-2 and BS EN 288-4 for aluminium alloys for all production and repair welds. These shall be subject to re-approval after a period of seven years. When applying BS EN 288-1, BS EN 288-2 and BS EN 288-3, the welding consumable and procedures used shall be such that the mechanical properties of deposited weld metal will not be less than the respective minimum specified values of the parent metal being welded.

Approval shall be by an independent inspecting authority using Registered Welding Engineers, Registered Welding Quality Engineers or equivalent.

3.2.2.2 ***Welder qualifications***

All welders shall hold certificates of approval to BS EN 287-1 for steel and BS EN 287-2 for aluminium alloys, obtained within the previous two year period, for all weld types which they produce.

Certificates of approval shall be from an independent inspection authority using personnel certified by the Certification Scheme for Welding Inspection Personnel (CSWIP) carried out by a laboratory accredited by the National Measurement Accreditation Service (NAMAS) for weld testing.

3.2.2.3 ***Production inspection and testing***

3.2.2.3.1 *Inspection personnel*

The supplier shall provide suitable personnel to carry out inspection of production welds. Personnel conducting visual inspection shall have a nationally recognized certificate of competence appropriate to the type of welding being inspected. Personnel conducting non-destructive testing (NDT) shall be certified according to a nationally recognized certification scheme appropriate to the equipment used and the weld groups inspected. Evidence of training and qualification shall be retained and made available for examination when required.

3.2.2.3.2 *Visual inspection of welds*

All production welds shall be subject to visual inspection after cleaning prior to any NDT and protective treatment. The relevant techniques in BS 5289 shall be applied as appropriate. Weld surfaces shall be free of slag residues, sharp edges, cracks, lack of fusion including overlap. All surfaces shall be free of excessive weld spatter, arc strikes and contaminants. The apparent throat dimensions of butt welds and the apparent leg length and apparent throat dimensions of fillet welds, as measured by a welding gauge and taking into account lack of fit, shall not be less than those specified, except that local shortfalls up to 1 mm are acceptable, provided the average dimensions over any 50 mm length is not less than the specified dimension. The toe angle shall not be less than 90º.

NOTE Isolated surface breaking discontinuous porosity may be accepted provided it is not detrimental to the protective treatment.

Undercut shall not result in a section loss of more than 5 % over any 50 mm length of joint, nor shall its depth exceed 0.5 mm or 10 % of the thickness, whichever is less.

3.2.2.3.3 *Magnetic particle inspection (MPI) and liquid penetrant inspection (LPI)*

MPI shall be applied in accordance with BS 6072 to joints in steel parapets selected in accordance with **3.2.2.5.1**. Liquid penetrant inspection in accordance with BS 6443 shall be applied to transverse welds in aluminium alloy post welds between posts, any gussets and base plates as selected in accordance with **3.2.2.5.1**.

NOTE To aid inspection the profile of the joint may be dressed by burr grinding provided that the specified throat size and leg length is maintained.

The surface of the weld shall be free of cracks, lack of fusion and slag.

3.2.2.3.4 *Frequency of magnetic particle inspection (MPI) and liquid penetrant inspection (LPI)*

Where on visual examination the presence of cracking or lack of fusion is suspected in an item, 100 % MPI or LPI shall be carried out on that item.

Where in a welded joint any of the material thicknesses exceed 20 mm, 10 % of the welds in these joints shall be inspected by MPI or LPI. If non-conformances are found, the scope of the testing shall be doubled. If further non-conformances are found, the whole batch shall be tested.

3.2.2.4 ***Reporting***

Inspection records for production welds shall be retained by the manufacturer for three years and those covering the production periods relating to the components supplied shall be made available for examination.

3.2.2.5 ***Destructive testing of pedestrian parapets to classes 3 and 4 of this standard***

3.2.2.5.1 *Supply of test components*

The supplier shall provide complete components or sample joints cut from components for destructive testing. The basis of selection shall be as follows:

a) for orders containing one post to 150 posts: one complete post for each type, unless successful destructive testing has been carried out within the last 6 weeks on a post of that type, where the post to be tested was selected by the engineer to another contract;

b) for orders of 151 posts to 300 posts: one complete post for each type;

c) for orders exceeding 300 posts: two complete posts for each type;

d) for orders containing 1 to 200 intermediate shop or site welded rail splices: one shop splice and one site splice, as appropriate, for each order;

e) for orders containing more than 200 intermediate shop or site welded rail splices: two shop splices and two site splices as appropriate for each order;

f) for all other welded components, including post anchorages: one component for each type, unless successful destructive testing has been carried out within the last 6 months on a component of that type, where the component to be tested was selected by the purchaser for another contract.

3.2.2.5.2 *Testing*

Where required by the purchaser the following testing shall be carried out by the supplier on the components supplied under **3.2.2.5.1**.

a) Posts shall be subjected to destructive static load testing generally in accordance with **2.1.5.1** and **2.1.5.2**. Posts shall subsequently be loaded to failure.

b) Shop or site welded rail splices and base plate to post welds shall be sectioned through the weld on each face of the section to check the material thicknesses, thickness and true throat and leg weld dimensions and weld quality.

c) Other welded components shall be sectioned through the welds to check thicknesses, thickness and true throat and leg weld dimensions and weld quality.

3.2.2.5.3 *Acceptance criteria*

The acceptance criteria for any testing carried out by the purchaser on the components supplied under **3.2.2.5.1** shall be as given below.

a) Posts tested up to the test load of 1.2 times the nominal load shall meet the acceptance criteria given in **2.1.5.1.3** and the welds shall show no signs of distress.

For steel posts failure shall not be of the post to base plate weld or the adjacent heat affected zone.

b) Sections through shop or site welded rail splices and base plate to post welds shall demonstrate that the material thicknesses and weld sizes meet those specified in the design, and the weld quality meets the requirements of **3.2.2.3.2**

c) Sections through other welded components shall demonstrate that the material thicknesses and weld sizes meet those specified in the design, and the weld quality meets the requirements of **3.2.2.3.2**.

Where failure occurs the batch shall be rejected.

3.2.2.5.4 *Non-conformance*

In the event that there is a non-conformance arising from a serious deviation in materials, preparation, assembly or welding procedure, the batch concerned shall be rejected and further production of the components affected, stopped until such time as the fault has been corrected. A minor non-conformance shall only be accepted on the basis that further sampling and testing shows that the fault is not repetitive and will not in that instance impair structural integrity.

If the problem can be traced to a particular manufacturing period, operator, piece of equipment or batch of materials and if proper traceability to individual batches of components can be assured, only those batches affected shall be subject to rejection.

3.2.2.5.5 *Test reports*

The destructive test reports shall be retained by the supplier and recorded in a register for a period of three years. The destructive test specimens shall be retained for a period of 18 months. These shall be made available for examination on future contracts.

NOTE Purchasers may carry out such testing as they require, e.g. macro sectioning, nick break tests, and for steel, hardness surveys. Purchasers may return the samples to the supplier after their tests are complete if so requested.

3.2.2.6 ***Remedial work***

Welds which do not conform to the specification shall be repaired to an approved procedure, as described in **3.2.2**. Welds in aluminium alloys shall not be repaired more than once.

3.3 Tolerances

3.3.1 General

3.3.1.1 ***Components fabricated in aluminium or steel***

Components fabricated in either aluminium alloy or steel shall be assembled so that they are not twisted or otherwise damaged and shall be so prepared that the specified inclinations, if any, are provided. Shims and packings shall not be used except under the post base plate (see **3.5.3**).

3.3.1.2 *Fit of mating components*

The design strength requirements shall be maintained allowing for the fit of mating components and practical site assembly.

3.3.1.3 *Rail fixings*

The tolerance on the position of rail fixings on posts shall be within ± 3 mm of the specified dimension.

3.3.1.4 *Tolerances of holes other than in base plates*

The diameter of holes or the width of slots shall be up to 2 mm larger than the nominal size of the associated fastener. Where the material is to be galvanized, the diameter of the hole or width of slot may be increased by up to an additional 2 mm or 15 % of the nominal diameter of the fastener, whichever is the greater.

3.3.1.5 *Tolerances of holes in base plates*

Holes or slots in base plates shall be up to a total of 50 % larger or wider than the nominal size of the holding-down bolt including galvanizing allowance.

3.3.1.6 *Washers*

Where the allowances specified in **3.3.1.4** and **3.3.1.5** are used, washers of sufficient bridging strength shall be provided.

3.3.2 Sections, plate and sheet

Tolerances shall be in accordance with **2.7**.

3.4 Storage and transportation

3.4.1 Handling and stacking

Pedestrian restraint systems shall be handled and stacked in such a manner that permanent damage to components and to any temporary or permanent protective treatment is avoided. Any damage sustained shall be made good.

Where cranage is required fabric slings or equivalent shall be used to avoid damage.

Pedestrian restraint system components shall be stored clear of the ground in such a way that contact with standing water, soil, cement or ash, or any other deleterious substance, is prevented.

Pedestrian restraint systems components shall not be stored in contact with other materials. Suitable packings shall be placed between the components to prevent contact, to allow the free circulation of air and to allow the dispersion of any water. Means shall be provided to prevent the accumulation of water on any surface.

NOTE Particular care in this respect should be taken to prevent white rust forming on galvanized sections or those painted with zinc-rich priming paints and exposed to weathering before the surface is sealed with a finishing paint coating.

3.4.2 Packing and transportation

Pedestrian restraint systems shall be protected from damage during transportation. Means shall be provided to prevent distortion of the fabrications and any machined or unprotected surface shall be coated with a suitable temporary protective system.

All bolts, screws, nuts and washers and any small loose components shall be suitably packed, protected and identified.

3.5 Installation and site workmanship

3.5.1 The supplier of the pedestrian restraint systems shall produce a statement of method of erection and site work to completion, and where necessary, layout drawings detailing anchorage positions.

Particular attention shall be given to bolt torque, weld gaps, the gap setting at expansion or bridge movement joints, protection of the underside of aluminium post base plates (see **2.8.3.2** and **2.10.3**), avoidance of contact between dissimilar metals (see **2.8.3.1** and **2.10.3**) and holding-down bolt engagement (see **2.10.2.2**).

3.5.2 Pedestrian restraint systems shall be set true to line and level, within the tolerances set for bedding, throughout their length to give a smooth flowing line to the finished pedestrian restraint system. Where the plinth has cross and/or longitudinal fall, the maximum thickness of bedding to the underside of the base plate shall be 30 mm plus an amount sufficient to allow for the effect of these falls over the area under the base plate.

NOTE 1 Infill panels when fitted should present a uniform and smooth appearance after fixing.

NOTE 2 The installer should be aware of site conditions including traffic management and site safety requirements.

3.5.3 Pedestrian restraint systems shall be securely held in their correct final position until the anchorages and bedding have attained the required strength.

Permanent packers or washers shall be of corrosion resistant material compatible with the metal of the base plate.

NOTE 1 Only stainless steel washers should be used for pedestrian parapets. Suitable materials for central packs are plastics, stainless steel or mortar blocks. These should not be so large as to reduce the bearing capacity of the bedding.

The bedding shall completely fill the space between the base plate and the plinth and shall not project above the underside of the base plate.

NOTE 2 Where extra bedding thickness is allowed (see **3.5.2**), it may be necessary to increase the length of the holding-down bolts to satisfy **2.10.2.2**.

NOTE 3 Where pedestrian restraint systems are erected directly onto steelwork, bedding may not be necessary.

3.5.4 Damaged areas of protective coatings shall be made good after completion of the erection.

NOTE The completed pedestrian restraint systems may need protection from damage or contamination by the activities of other trades.

3.6 Non-destructive production inspection

Where required by the purchaser, components for production posts and all completed production posts shall be subject to visual and dimensional inspection by the representative of the purchaser at the place of fabrication.

Annex A (informative)
Layout of pedestrian restraint systems

A.1 General

A.1.1 *Inclusion of pedestrian restraint systems*

Pedestrian restraint systems are designed to safeguard pedestrians and other users by keeping them away from hazardous areas and by guiding them to safe crossing places. This can be achieved by careful design of the layout and by giving attention to a large number of factors, many of which will be site specific. Advice on the more common of these is set out in this annex. It is important that decisions are taken about the inclusion of restraint systems early in the design process so that where necessary, provision can be made to accommodate them by increasing the widths of footways or by relocating the footways to provide, for instance, appropriate visibility between drivers, pedestrians and other users (see Figure 2 and Figure 3).

A.1.2 *Parapets*

Pedestrian parapets forming part of pedestrian restraint systems are designed to guide pedestrians or other users, and prevent them from falling off the edge of structures such as bridges or retaining walls. Many of the design factors will be site specific and need to be related to the site conditions such as location and height of fall (see Figure 1).

A.2 Factors influencing layout

A.2.1 *Installation length*

There are four principal reasons for erecting a pedestrian restraint system:

a) to safeguard a drop from a structure or an embankment slope;

b) to contain or protect pedestrians from road traffic;

c) to guide pedestrians and other users to a safe crossing point on the highway or road;

d) to prevent pedestrians and other users from moving directly into the carriageway from an adjoining footpath.

In the case of a) above, the installation length will be dictated by the details of the structure, but the pedestrian parapet could join into a pedestrian guard rail at either end if necessary.

In the case of b) above, the length of the system will correspond to the length of the section of road which is hazardous. It should be recognized, however, that long lengths will be likely to inconvenience pedestrians and encourage climbing or even damage to the installation. Particular attention should be given to the termination points as pedestrians will be concentrated at these by virtue of the presence of the restraint system. It may be necessary to provide a restraint system as in the case of a staggered pedestrian crossing with a central reserve on a divided carriageway.

In the case of c) above, if a restraint system is to be employed, it should be installed on both sides of the road and should extend a minimum distance of 20 m in either direction from the crossing:

1) to discourage diagonal crossing; and

2) to keep pedestrians off the crossing approaches as these are the most dangerous sections of the road for pedestrians.

In the case of d) above, the principle should be followed of making the pedestrian deviate by at least 45° from the straight line route to reach the point of emergence.

A.2.2 *Installation set-back from kerb*

Pedestrian and other road users should be discouraged from using the area between the kerb and the pedestrian restraint system. To achieve this it may be necessary to use a pedestrian resistant surface.

A.2.3 *Loading gaps and gates*

Particular attention should be given to loading gaps and gates. The reasonable requirements of adjacent business should be considered. Moreover, the presence of stationary goods vehicles in relation to the flow of traffic and the use of gaps by pedestrians in relation to their safety should also be taken into account. For the former reason, such facilities should be kept as far as possible from junctions and pedestrian crossings, and for the latter reason, gates should always be provided in preference to gaps wherever possible.

A.2.4 *Intervisibility*

Where it is not possible to provide adequate visibility due to physical constraints, consideration can be given to employing a special type of restraint system which allows a requisite degree of intervisibility through the installation at very acute angles. Guidance is given in Annex B.

A.3 Factors influencing choice of design class (see Table 3 and Figure 1, Figure 2 and Figure 3)

The design of a new pedestrian system should have regard to the location in that it may be necessary to complement an adjoining existing system which has provided satisfactory service for a number of years. General requirements for design classes are set out below but the designer may wish to vary these to suit a particular location. For example, whilst class 3 is generally the minimum requirement for pedestrian parapets there may be instances where a lower class could suffice having regard to location.

a) *Class 1* is a light duty guard rail design which is suitable only for situations where pedestrian traffic is very light and there is no likelihood of vandalism. Typical uses would be to provide guidance and restraint for workmen in situations, such as the tops of cuttings, and where the public normally have no access. It should not, however, be employed in normal traffic situations.

b) *Class 2* is for a normal duty guard rail and may be employed for all purposes except where crowd loading is anticipated or where the risk of vandalism is severe.

c) *Class 3* is the minimum requirement for pedestrian parapets and for guard rails where class 2 is likely to be inadequate such as where crowd loading is anticipated or much vandalism is likely.

d) *Class 4* is for special duty and should be employed only for very severe loading conditions.

Annex B (informative)
Visibility and intervisibility

B.1 General

Intervisibility is defined in **1.3.26**. There are two main circumstances to be considered: the road junction and the pedestrian crossing. The latter may be a formal crossing, a gap in the railing, or a point where the rail terminates. In all these cases, it is desirable for drivers and pedestrians to be aware of each other. In general, the appropriate visibility requirement should be built in to the design in the new roads or major reconstructions. Where that is not possible because of site constraints, special designs of restraint system are available which will provide varying degrees of intervisibility. Guidance on the various options available is given in **B.2**.

B.2 Detailed considerations

B.2.1 *Junctions*

Junctions fall into two main types: those controlled by traffic signals and those which depend on some sort of priority arrangement. Traffic signal controlled junction visibility requirements will be limited to the pedestrian crossing points usually located on each approach. Priority junctions require visibility splays appropriate to the speed value of the road and it is necessary to ensure that any guard rail is located either behind the splay or below the critical visibility height which is normally 1.05 m above the road surface level at the end points of the splay. A 1 m high guard rail mounted on the footway behind a kerb may not conform to the height criteria, particularly if the junction is not planar. In such cases, a rail design having a gap between the top rail and an intermediate rail may solve the problem.

B.2.2 *Pedestrian crossing points* (see Figure 6)

At pedestrian crossing points, which may be formal crossings, gaps or points of termination of the rail, full visibility is desirable between drivers in the adjacent traffic lane and pedestrians and small animals who might otherwise emerge without warning. Where the restraint system is located so that a clear view of the point of emergence is available to the driver over a distance of 2 m measured from the kerb and at right angles to it with the driver at a distance representing the minimum stopping sight distance for the speed of traffic using the road, intervisibility requirements are deemed to be satisfied. Where the restraint system is located immediately behind the kerb, special guard rail designs may be necessary to provide satisfactory visibility.

B.2.3 *Designs with no infill*

These can give a very good standard of visibility provided the posts are not too deep in section. However, they should not be employed where children congregate or where there is a likelihood of pedestrians climbing over them to avoid a long detour. This type of system can be useful where environmental considerations are important.

B.2.4 *Designs with a gap between the top rail and an intermediate rail*

These can be useful for junctions, as noted above. It should be borne in mind, however, that at pedestrian crossing points, very small children may be concealed behind the lower, infilled part of the installation.

B.2.5 *Design with special Infill*

Specially designed guard rails which may assist vision are available and may be used whenever visibility is important e.g. adjacent to junctions or pedestrian crossings.

In a two-way road, special treatment is generally required on the nearside approach only. In a one-way road, special treatment may be required on both sides, and it should be noted that in the latter case the driver's point of vision may be closer to the guard rail on the off-side because of his/her position in the vehicle (see Figure 6 for asymmetrical visibility splay).

Annex C (informative)
Information to be provided by the purchaser

The information listed in Table C.1 should be provided by the purchaser.

Where purchasers indicate alternatives or do not specify a particular requirement, suppliers should state what they intend to provide.

Table C.1 — Information to be supplied by the purchaser

Information to be supplied	Example of information required
Material	Steel or aluminium alloy including grade
Surface protection	For steel the preparation and protective system
Designation	The loading class (see Table 1)
Infill material (if infill required) and protection	Steel or aluminium alloy: whether galvanized etc; expanded metal, welded mesh or solid; fixing method, non-effective member. Special requirements, such as environmental barrier or visibility requirements. The loading class (see Table 2)
Type of holding-down bolts (if required)	Normal; expanding; cast-in resin etc. Any torque or static testing requirements. Passive filler (see **2.10.2.1**)
Detailed layout	Relevant details such as horizontal and vertical dimensions and alignment joints required, giving details of position and movement and any special features such as vertical movements etc.
Details of attachment to any safety fence/transition	Type of fence to be attached to
Availability of storage at site etc.	Position; area; type of surface
Erection requirements	Relevant details including the following information: dates required; access to site and availability; availability to cranage; other operations in progress; special conditions, e.g. proximity or traffic, site welding hazards
Method of securing attachments against vandalism	High torque, spot welding, punch locking
Production testing requirements	Posts; number per order; number per batch; not greater than 100; none; etc.
Weld defect levels for acceptance	A quality regime, production testing of posts and visual inspection are envisaged. Levels of visual defects allowed, such as porosity or changes or cross section etc. may need to be given
Gates	Dimensions; opening arrangements
Foundations method of fixing	Type to be used

blank

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