

Barriers in and about buildings — Code of practice

ICS 91.060.99

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

BSI
Documents



Document Sharing Hub

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Subcommittee B/209/2, upon which the following bodies were represented:

- Aluminium Federation
- Association of Building Engineers
- Brick Development Association
- British Parking Association
- British Plastics Federation
- British Steel Industry
- Building Research Establishment
- Construction Confederation
- Consumer Policy Committee of BSI
- Department of the Environment, Transport and the Regions (DETR)
- District Surveyors Association
- Flat Glass Manufacturers' Association
- Galvanizers Association
- Glass and Glazing Federation
- Health and Safety Executive
- Institution of Structural Engineers
- Royal Institute of British Architects
- Railtrack
- Scottish Office

This British Standard, having been prepared under the direction of the Sector Committee for Building and Civil Engineering, was published under the authority of the Standards Committee and comes into effect on 15 December 1999

© 28 September 2001

First published September 1982
Second edition January 1995
Third edition December 1999

The following BSI references relate to the work on this standard:
Committee reference B/209/2
Draft for comment 97/107180 DC

ISBN 0 580 33051 6

Amendments issued since publication

Amd. No.	Date	Comments
13292	28 September 2001	Amendment to 6.4.1

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Materials, components and methods of design and construction	4
5 Preliminary considerations	4
6 Design criteria	4
7 Concrete	6
8 Glass	7
9 Masonry	10
10 Metals	10
11 Plastics	16
12 Timber	18
13 Composites	19
14 Installation	19
Annex A (normative) Vehicle impact on barriers	20
Annex B (informative) Bolt fixing of glass in barriers	23
Bibliography	25
Index	26
Figure 1 — Datum, barrier height and design height	3
Figure 2 — Height and width of barriers in front of fixed seating	7
Figure 3 — Preferred minimum hot bending radius for rectangular hollow steel sections	14
Figure 4 — Typical site fixing details for steel barriers	15
Figure A.1 — Impact forces for vehicles impacting at right angles to a barrier	21
Figure A.2 — Typical impact forces for vehicles impacting at 20° to a barrier, at 10 mile/h	22
Figure B.1 — Alternative bolt fixing arrangement for thick toughened glass infill panels	23
Figure B.2 — Typical clamping systems for free-standing toughened glass balustrades	24
Table 1 — Minimum barrier heights	4
Table 2 — Sizes of fully framed single glass panes in accordance with the design criteria given in BS 6399-1:1996	9
Table 3 — Recommended coating thickness and applications	11
Table 4 — Preferred minimum hot bending radius for rectangular hollow steel sections	13

Foreword

This revision of BS 6180 has been prepared by Subcommittee B/209/2. It supersedes BS 6180:1995, which is withdrawn.

The changes incorporated, provide clarification on the design of barriers to satisfy safety criteria given in this code of practice, relative to the type of occupancy and risks to building users. The principal change in this revision, following publication of revised loading data in BS 6399-1:1996, is the withdrawal of the information on building-use categories and barrier loadings which appeared in annex A of the 1995 edition.

In view of the variety of materials available for barrier construction and the wide range of possible uses for barriers, this code does not attempt to standardize methods of design but refers instead to existing structural design codes. Clause 4 allows users freedom to choose materials and methods of design and construction not specifically mentioned in this code, subject to the provision of research data and test results.

The safety factors implicit in this code provide adequate levels of protection in the circumstances given. However, in the case of multifunction buildings, for example, the recommendations should be considered with reasoned judgement to provide a suitable design.

Annex A is normative. Annex B is informative.

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Attention is drawn to the fact that statutory legislation such as the Building Regulations 1991 [1] (applicable to England and Wales), the Building Standards Scotland 1990 [2], the Building Regulations (Northern Ireland) 1994 [3], and the Safety at Sports Ground Act 1975 [4] may impose more stringent requirements in certain circumstances.

A British Standard does not purport to include all necessary provisions of a contract. Users of British Standards are responsible for their 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 and ii, pages 1 to 26, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

1 Scope

This British Standard gives recommendations for the design and construction of temporary and permanent barriers to be provided in and about buildings and places of assembly, such barriers being positioned and designed to protect persons from various hazards and to restrict or control the movement of persons or vehicles. This British Standard applies to:

- a) barriers that indicate routes;
- b) barriers capable of stopping or diverting moving vehicles up to 2 500 kg within areas where vehicle speed is restricted to a maximum of 16 km/h (4.44 m/s, 10 mile/h);
- c) walls, glazing and other elements of buildings or structures where such elements act as protective barriers.

This British Standard does not apply to:

- barriers for resisting impact from vehicles travelling at speeds greater than 16 km/h, for example, bridge parapets beyond the curtilage of a building, or highway safety barriers (see BS 6779);
- barriers used in building operations and works of engineering construction;
- safety barriers, with or without opening gate features, for the protection of children up to 24 months, where the safety requirement is covered by a specific safety standard, e.g. BS 4125.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 449-2, *Specification for the use of structural steel in building — Part 2: Metric units.*

BS 476-7:1997, *Fire tests on building materials and structures — Part 7: Method of test to determine the classification of the surface spread of flame of products.*

BS 639, *Specification for covered carbon and carbon manganese steel electrodes for manual metal-arc welding.*

BS 970 (all parts), *Specification for wrought steels for mechanical and allied engineering purposes.*

BS 1449-1 (all parts), *Steel plate, sheet and strip — Carbon and carbon-manganese plate, sheet and strip.*

BS 1965-1, *Specification for butt-welding pipe fittings for pressure purposes — Part 1: Carbon steel.*

BS 3416:1991, *Specification for bitumen-based coatings for cold application, suitable for use in contact with potable water.*

BS 3605-1, *Austenitic stainless steel pipes and tubes for pressure purposes — Part 1: Specification for seamless tubes.*

BS 3605-2, *Austenitic stainless steel pipes and tubes for pressure purposes — Specification for longitudinally welded tubes.*

BS 4641, *Method for specifying electroplated coatings of chromium for engineering purposes.*

BS 4921:1988, *Specification for sherardized coatings on iron or steel.*

BS 5135, *Specification for arc welding of carbon and carbon manganese steels.*

BS 5268-2, *Structural use of timber — Part 2: Code of practice for permissible stress design, materials and workmanship.*

BS 5268-5, *Structural use of timber — Part 5: Code of practice for the preservative treatment of structural timber.*

BS 5400-6, *Steel, concrete and composite bridges — Part 6: Specification for materials and workmanship, steel.*

BS 5628-1, *Code of practice for use of masonry — Part 1: Structural use of unreinforced masonry.*

BS 5628-2, *Code of practice for use of masonry — Part 2: Structural use of reinforced and prestressed masonry.*

BS 5628-3, *Code of practice for use of masonry — Part 3: Materials and components, design and workmanship.*

BS 5400-6, *Steel, concrete and composite bridges — Part 6: Specification for materials and workmanship, steel.*

BS 5950-1, *Structural use of steelwork in building — Part 1: Code of practice for design in simple and continuous construction: hot rolled sections.*

BS 5950-2, *Structural use of steelwork in building — Part 2: Specification for materials, fabrication and erection: hot rolled sections.*

BS 5950-5, *Structural use of steelwork in building — Part 5: Code of practice for design of cold formed thin gauge sections.*

BS 6100 (all parts), *Glossary of building and civil engineering terms.*

BS 6206:1981, *Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings.*

BS 6262, *Code of practice for glazing for buildings.*

BS 6262-4, *Glazing for buildings — Part 4: Safety related to human impact.*

BS 6323 (all parts), *Specification for seamless and welded steel tubes for automobile, mechanical and general engineering purposes.*



Documents

Document Sharing Hub

BS 6270-4, *Code of practice for cleaning and surface repair of buildings — Part 4: Surface repair of natural stone, brick and terracotta.*

BS 6270-5, *Code of practice for cleaning and surface repair of buildings — Part 5: Cleaning of natural stone, brick, terracotta and concrete.*

BS 6399-1:1996, *Loading for buildings — Part 1: Code of practice for dead and imposed loads.*

BS 6399-2, *Loading for buildings — Part 2: Code of practice for wind loads.*

BS 6446, *Specification for manufacture of glued structural components of timber and wood based panels.*

BS 7668, *Specification for weldable structural steels. Hot finished structural hollow sections in weather resistant steels.*

BS 8110-1, *Structural use of concrete — Part 1: Code of practice for design and construction.*

BS 8110-2, *Structural use of concrete — Part 2: Code of practice for special circumstances.*

BS 8118-1, *Structural use of aluminium — Part 1: Code of practice for design.*

BS 8118-2, *Structural use of aluminium — Part 2: Specification for materials, workmanship and protection.*

BS EN 1982, *Copper and copper alloys — Ingots and castings.*

BS EN 10025, *Hot rolled products of non-alloy structural steels — Technical delivery conditions.*

BS EN 10029, *Specification for tolerances on dimensions, shape and mass for hot rolled steel plates 3 mm thick or above.*

BS EN 10088-2, *Stainless steels — Part 2: Technical delivery conditions for sheet/plate and strip for general purposes.*

BS EN 10088-3, *Stainless steels — Part 3: Technical delivery conditions for semi-finished products, bars, rods and sections for general purposes.*

BS EN 10113 (all parts), *Hot-rolled products in weldable fine grain structural steels.*

BS EN 10137 (all parts), *Plates and wide flats made of high yield strength structural steels in the quenched and tempered or precipitation hardened conditions.*

BS EN 10143, *Continuously hot-dip metal coated steel sheet and strip — Tolerances on dimensions and shape.*

BS EN 10155, *Structural steels with improved atmospheric corrosion resistance — Technical delivery conditions.*

BS EN 10210 (all parts), *Hot finished structural hollow sections of non-alloy and fine grain structural steels.*

BS EN 10219-1, *Cold formed welded structural sections of non-alloy and fine grain steels — Part 1: Technical delivery requirements.*

BS EN 10219-2, *Cold formed welded structural sections of non-alloy and fine grain steels — Part 2: Tolerances, dimensions and sectional properties.*

BS EN 12163, *Copper and copper alloys — Rod for general purposes.*

BS EN 12164, *Copper and copper alloys — Rod for free machining purposes.*

BS EN 12167, *Copper and copper alloys — Profiles and rectangular bar for general purposes.*

BS EN 22063, *Metallic and other inorganic coatings — Thermal spraying — Zinc, aluminium and their alloys.*

BS EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods.*

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS 6100 and the following apply.

3.1

barrier

any element of building or structure, permanent or temporary, intended to prevent persons from falling and to retain, stop or guide persons or vehicles

3.2

datum

finished level on which people may stand on a floor, roof, wide parapet, balcony, ramp, pitch line of stairs, etc. (see Figure 1)

3.3

design level

level at which the horizontal force on the barrier is assumed to act for the purposes of design (see Figure 1)

3.4

safety glass/plastics material

glass or plastics sheet material which remains unbroken or breaks safely under the test specified in BS 6206

3.5

manifestation

any technique for enhancing a person's awareness of the presence of transparent glass areas

3.6

top rail

structural rail which may also act as a handrail

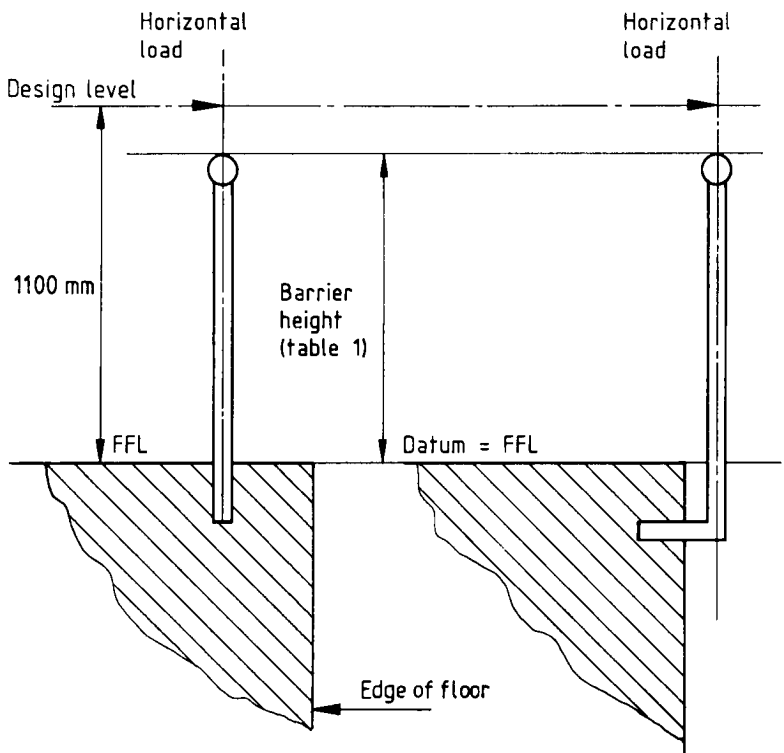
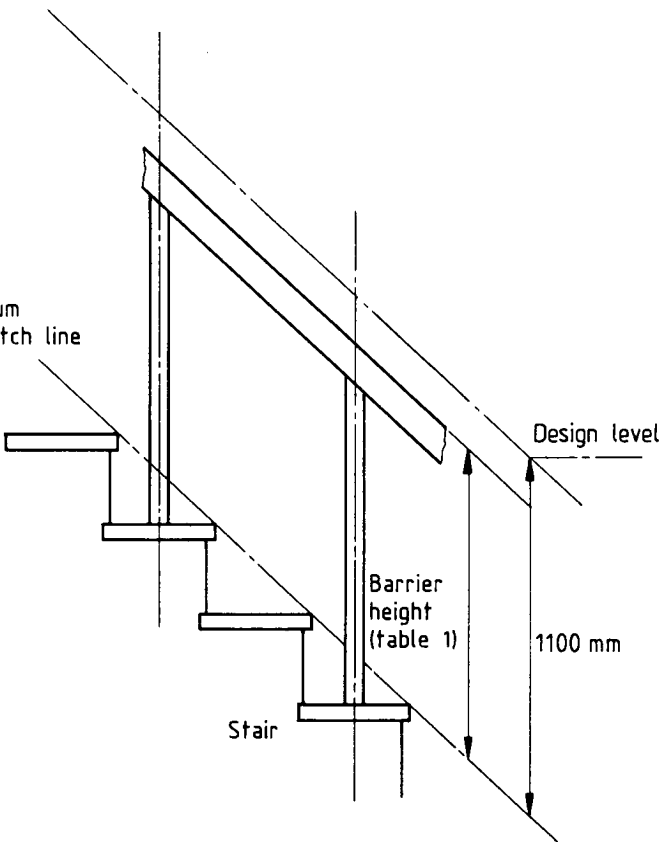


Figure 1 — Datum, barrier height and design height

4 Materials, components and methods of design and construction

Recommendations for the detailed design and construction of barriers using various materials, components and methods are given in clauses 7 to 13. Where materials, components and methods of design and construction are not specifically covered by these clauses or by any other British Standard, the designer should be satisfied that the materials and methods to be employed are such as to ensure durability, integrity and a level of performance at least equal to that recommended in this code, subject to the provision of research data and test results.

Alternatively, a test assembly should be built to test the material, component or method under consideration. The test assembly should be representative, as to materials, workmanship and details, of the design and construction for which approval is desired, and should be built under conditions truly representative of the conditions in the actual building construction or curtilage involved.

In areas used by children, special attention should be paid to the toxicity of finishes.

5 Preliminary considerations

5.1 In the assessment of the need for a barrier and the type of barrier to be provided, the designer should give consideration to the likely hazards, the building use and the risks to building users.

Where, in a building, more than one use of the building is anticipated, either the barrier design should be chosen to suit the worst case, or more than one type of barrier should be provided, as appropriate, to the location.

Where the hazard is a change in level pedestrian guarding is recommended in dwellings where the difference in adjacent levels is greater than 600 mm. Guarding is recommended in buildings other than dwellings where there is a difference of 380 mm, to take account of the greater number of building users and their possible lack of familiarity with the layout.

NOTE Guarding is covered by the Building Regulations and the appropriate technical documents for England and Wales [5], Scotland [6] and Northern Ireland [7] should be consulted.

5.2 Where walls, glazing or other elements of buildings or structures perform the functions of barriers, the designer should either:

- a) ensure that these elements satisfy the criteria given in this code of practice; or
- b) provide additional barriers designed in accordance with this code of practice.

5.3 The barrier adopted should be designed so as to minimize the risk of persons falling, rolling, sliding or slipping through gaps in the barrier.

In dwellings and other buildings which cater for children under the age of 5 (e.g. public assembly buildings), gaps in a barrier or infill should not be

large enough to permit a sphere of 100 mm diameter to pass through, making due allowance for deflection under load. Except inside dwellings, this does not apply to the triangular opening formed by the tread, a riser and the bottom edge of the barrier or infill, if that bottom edge is not more than 50 mm above the pitch line. The barrier and infill should also be constructed so that a child cannot easily climb it. Manifestation should also be applied, to clear glass barriers or in-fill panels that reach the floor (or nearly reach the floor), at an appropriate height to make them visible to children whose eye level is below the top of the barrier (see 8.1.1). These recommendations also apply to barriers for stairs and landings which give access to the building.

NOTE Where a high standard of protection is thought necessary, consideration should be given to the requirements of EN 1930.

5.4 The designer should consider the use of barriers to protect critical structural elements where there is a risk that vehicle impact could cause structural damage, e.g. around any cast iron column. This is particularly important in buildings where pallet or fork lift trucks are used.

6 Design criteria

6.1 Introduction

Barriers should be designed to resist the most unfavourable likely imposed and wind loads (see 6.3) without unacceptable deflections or distortions (see 6.4).

In some situations (e.g. sports grounds) the spacing of barriers may be critical. In the case of sports grounds guidance may be obtained from a number of nationally recognized documents such as the *Guide to Safety at Sports Grounds* [8].

Barrier heights are also covered by the Building Regulations [5], [6], [7]. The barrier height above datum is defined in Figure 1. Table 1 gives minimum heights for each barrier location.

NOTE The height of barriers installed on top of low parapet walls should be measured from the top of the parapet and not at walk level.

Table 1 — Minimum barrier heights

Use	Position	Height
Single family dwelling	a) Barriers in front of a window	800 mm
	b) Stairs, landings, ramps, edges of internal floors	900 mm
	c) External balconies, edges of roofs	1 100 mm
All other uses	d) Barrier in front of a window	800 mm
	e) Stairs	900 mm
	f) Balconies and stands, etc. having fixed seating within 530 mm of the barrier	800 mm ^a
	g) Other positions	1 100 mm

^a See also 6.8 on sight lines.

6.2 Design procedures

For barriers other than vehicle barriers, either permissible stress or limit state design procedures may be used, according to the recommended procedure given in the British Standard appropriate for the material to be used, treating the loads given in BS 6399-1 as:

- a) working loads, for permissible stress design;
- b) characteristic loads, for limit state design.

When using limit state design, the partial safety factors for loads and materials should be those recommended by the appropriate British Standard for the relevant material. The strength of the barrier should be designed as ultimate limit state (ULS) and the deflection as serviceability limit state.

In designing barriers to resist equivalent static loads, such as those due to vehicular impact (see **6.3.2** and **6.4.2**), the permissible stress procedure should not be used. In such cases, it is essential to use a limit state approach based on the partial safety factors for load and materials appropriate to accidental damage or misuse. Where a code of practice makes no specific provision for design against impact loads, decisions should be made regarding the possible reduction of the overall factor of safety, according to the relative influence of dynamic loads compared with static loads on the properties of the material.

The designer should also be aware that the equivalent static force concept is related to an assumed mean deceleration. Validation tests on barriers constructed from the materials normally used in vehicle barriers, such as steel, aluminium, or reinforced concrete, show good correlation with calculated values. However, the performance of barriers constructed from other materials needs to be established in order to determine the equivalent static force against which they should be designed.

NOTE Information on the forces resulting from vehicle impact into yielding barriers is available from research papers published by the Transport Research Laboratory, Crowthorne [9].

6.3 Loading

6.3.1 General

Minimum horizontal imposed loads appropriate to the design of parapets, barriers, balustrades and other elements of structure intended to retain, stop or guide people, should be determined in accordance with BS 6399-1:1996, clause **10**, which specifies a uniformly distributed line load for the barrier and a uniformly distributed and point load applied to the infill. These are not additive and should be considered as three separate load cases; all loads being determined according to the type of occupancy which reflects the possible in-service conditions.

NOTE Additional recommendations for glazing in barriers are given in clause **8**.

For clarity, the design level (the level at which the horizontal uniformly distributed line load should be considered to act) is shown in Figure 1. The point load applied to part of the infill should be applied in a position which gives the most onerous requirement. Where the infill consists of successive balusters, each baluster should be designed to resist half the concentrated load to the infill given in BS 6399-1, applied at mid-height.

6.3.2 Imposed loading due to vehicles

When designing barriers to resist vehicular impact, an estimate of the characteristic mass, m , of the vehicle should be made. Ideally, this should be determined statistically; if this is not possible, the characteristic mass should be taken to be equal to the maximum mass anticipated.

Annex A should be used to estimate the equivalent static force F for a given characteristic mass and displacement.

Simplified design recommendations for car parks are given in BS 6399-1. Loadings can be calculated in accordance with BS 6399-1:1996, clause **11** which allows for a characteristic mass of 1.5 t to be taken for car parks designed for vehicles not exceeding 2.5 t in mass. (A graphic interpretation derived from these recommendations is given in annex A.)

NOTE 1 Further information to enable the designer to derive equivalent static forces for cases where different parameters apply is given in annex A.

The anticipated area and position of contact should be used in calculating the ultimate strength of the barrier if the pattern of vehicle or barrier deformation can be reliably predicted.

The assumed distribution of the impact force and the design level at which it is applied should be related to the likely area and position of initial contact.

Angular impacts may give rise to additional forces directed along the line of the barrier. Where the construction of the barrier is such that frictional contact between it and the vehicle is likely to be high, or such that projections may restrain the vehicle, these additional forces can reach three times the lateral applied forces.

NOTE 2 Annex A provides data for vehicles impacting at 20° to a barrier.

6.3.3 Wind loads

External barriers should be designed to resist the wind loads given in BS 6399-2.

6.4 Deflection

6.4.1 Barriers for the protection of people

Barriers for the protection of people should be of adequate strength and stiffness to sustain the applied loads given in BS 6399, without permanent deflection or distortion.

In addition, a barrier that is structurally safe should not possess sufficient flexibility to alarm building users when subject to normal service conditions. Therefore, for serviceability considerations, the limiting condition for deflection appropriate for a barrier for the protection of people is that the total horizontal displacement of the barrier at any point from its original unloaded position should not exceed the deflection limits determined from the relevant structural design code for the material used or 25 mm, whichever is the smaller.

Where a glass component of a barrier is subjected to imposed loads given in BS 6399-1, or if appropriate BS 6399-2, the displacement of any point of the glass component, relative to its fixings, should not exceed $L/65$ or 25 mm, whichever is the smaller where L is given in 8.3, 8.4 or 8.5.

Where the infill panel is a plastics material, as given in 11.4, the displacement of any point of the infill panel should not exceed $L/80$ or 25 mm, whichever is the smaller, when subjected to infill imposed loads given in BS 6399-1 or, if appropriate, the wind loads given in BS 6399-2 (where L is the clear span of the infill panel between supports).

6.4.2 Vehicle barriers

Barriers designed to resist vehicular impacts may be distorted by such impacts but should remain substantially in place.

6.5 Fixings, attachments and anchorage

Care should be taken to ensure that the strength of fixings, attachments and anchorage securing the barrier to a substrate is adequate to sustain a loading greater than that to which the barrier will be subjected. All joints should be designed to provide the full strength of the members being joined. To that end, where any uncertainty exists with regard to the strength of any component in the fixing, the design loading factors should be increased by 50 %.

It is essential that fixing design takes particular account of the material into which the fixing is placed, the spacing between fixings, the edge distance, and where the substrate is concrete, the position of reinforcement. Reliance on the pull-out capacity of a single fixing should be avoided.

NOTE 1 The recommendation of an additional load factor of 1.5 is intended to ensure that under an extreme load condition, barriers will give an indication of failure by deflection distortion and not by total collapse, as would be brought about by a failure of the fixing, attachment or anchorage system.

NOTE 2 Where the design strength of a proposed system of fixing to an existing substrate cannot be determined with reasonable accuracy by theoretical consideration, load testing should be used to validate the design. A factor greater than 1.5 on barrier load design may also be appropriate.

6.6 Safety details

6.6.1 General

The finished barrier should have no sharp edges or projections that may cause injury to persons or damage to clothing.

Infill panels and balusters are intended to provide support and protection to the user, and should be designed to restrain people without causing additional injury from sharp edges, thin sections, open ended tubes, projecting details, etc.

The ends of barriers on unlit access roads should be provided with reflectors or reflective markings.

The designer should be aware of the need to provide maintenance of the barrier to sustain levels of safety and performance. Consideration should be given in the design of the barrier to the possibility of tampering or vandalism.

6.6.2 Vehicle barriers

The designer should, wherever possible, avoid introducing projections on the vehicular face of the barrier and should also consider ways of redirecting vehicles in such a way as to cause minimum damage after impact.

6.7 Support from adjacent construction

The designer should ensure that any construction or structure acting as support for barriers is of adequate strength and stability to sustain all applied loads safely without excessive stress, deflection or distortion.

6.8 Sight lines

It is essential to consider sight lines as well as safety aspects when designing barriers in places such as theatres, cinemas and concert halls. This applies particularly to barriers protecting balconies or parts of balconies having fixed seating within 530 mm of the barrier. The relationship between the height and width of a barrier affects both sight lines and safety. A lower, wider barrier may provide the same degree of protection as a higher, narrower barrier. The minimum height for a narrow barrier given in Table 1 is 800 mm, however this height may be reduced to a minimum of 750 mm provided the sum of the barrier width and the barrier height is greater than 975 mm (see Figure 2).

NOTE It should be noted that where the barrier is not in front of fixed seating (e.g. at the end of the gangway) the normal design criteria apply.