



# Loading for buildings —

## Part 1: Code of practice for dead and imposed loads

ICS 91.040

## Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee B/525, Building and civil engineering structures, to Subcommittee B/525/1, Actions (loadings) and basis of design, upon which the following bodies were represented:

British Constructional Steelwork Association Ltd.  
 British Iron and Steel Producers Association  
 British Masonry Society  
 Concrete Society  
 Department of the Environment (Building Research Establishment)  
 Department of the Environment (Property and Buildings Directorate)  
 Department of Transport (Highways Agency)  
 Institution of Structural Engineers  
 National House-building Council  
 Royal Institute of British Architects  
 Steel Construction Institute  
 Co-opted members

This British Standard, having been prepared under the direction of the Sector Board for Building and Civil Engineering, was published under the authority of the Standards Board and comes into effect on 15 September 1996

© BSI 11 October 2002

First published February 1984  
 Second edition September 1996

The following BSI references relate to the work on this standard:  
 Committee reference B/525/1  
 Draft for comment 95/100935 DC

ISBN 0 580 26239 1

### Amendments issued since publication

Amd. No.	Date	Comments
13669	11 October 2002	See national foreword

# Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
<hr/>	
1 Scope	1
2 References	1
3 Definitions	1
4 Dead loads	2
5 Imposed floor and ceiling loads	2
6 Reduction in total imposed floor loads	6
7 Imposed roof loads	7
8 Crane gantry girders	7
9 <i>Text deleted</i>	
10 Parapets, barriers and balustrades	7
11 Vehicle barriers for car parks	8
12 Accidental load on key or protected elements	9
<hr/>	
Annex A (informative) Examples of dynamic loading conditions for some specific structural types	10
<hr/>	
Table 1 — Minimum imposed floor loads	3
Table 2 — Reduction in total distributed imposed floor loads with number of storeys	7
Table 3 — Reduction in total distributed imposed floor loads on a supporting beam or girder with floor area	7
Table 4 — Minimum horizontal imposed loads for parapets, barriers and balustrades, etc.	9
List of references (see clause 2)	11
<hr/>	

## Foreword

This Part of BS 6399 has been prepared by Subcommittee B/525/1, Actions (loadings) and basis of design. It supersedes BS 6399-1:1984, which is withdrawn.

This edition of BS 6399-1, introduces technical changes, but it does not reflect a full revision of the standard which will be undertaken in due course.

The start and finish of text introduced or altered by Amendment No. 1 is indicated in the text by tags **A1** **A1**.

The principal change in this edition is the presentation of the imposed floor loads according to the type of activity/occupancy, rather than occupancy class as introduced in the 1984 edition. The weights of movable partitions which were redefined as imposed loads in the 1984 edition, retain their classification. The reductions in floor load with number of storeys and with area have also been clarified.

Table 1 and Table 4 have been revised by amendment to limit the guidance to types of buildings and structures appropriate to the scope of this standard. Consequently, loading information relevant to grandstands and designated stadia had been removed and reference is made to the requirements of the appropriate certifying authorities.

Clause 9, on dynamic loading, has been deleted and an amended version of the clause has been introduced as an informative Annex A. This was necessary in order to limit the guidance given in this standard to the types of buildings and structures covered in the scope of this Part of BS 6399 but at the same time provide references to specialist guidance for the design of structures susceptible to dynamic excitation. The deletion of Clause 9 has led to the removal of the normative Annex A on dynamic loads for dancing and jumping. That annex was intended to provide a rigorous approach to the evaluation of dynamic loading, which could only be applied in conjunction with specialist guidance, which is undergoing further development.

Clause 10 has been revised to give new recommendations for vertical loading on parapets, barriers and balustrades.

The basis of the loadings is historical and they agree, subject to comparatively minor variations, with international consensus of opinion.

The data on wind loads are given in BS 6399-2 and data on imposed roof loads are given in BS 6399-3.

In this edition of BS 6399-1, numerical values have been given in terms of SI units, details of which are to be found in BS 5555. Those concerned with the conversion and renovation of older buildings designed in terms of imperial units may find it useful to note that 1 N = 0.225 lbf and 1 kN/m<sup>2</sup> = 20.89 lbf/ft<sup>2</sup>.

A British Standard does not purport to include all the 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 11 and a back cover.

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

## 1 Scope

1.1 This Part of BS 6399 gives dead and minimum recommended imposed loads for use in designing buildings. It applies to:

- a) new buildings and new structures;
- b) alterations and additions to existing buildings and existing structures;
- c) existing construction on change of use.

It does not apply to the maintenance of, or the replacement of parts of, existing buildings and structures where there is no change of use.

1.2 This code of practice does  $\boxed{A_1}$  not give recommendations for  $\boxed{A_1}$ :

- a) loads on road and rail bridges, as these are dealt with in other British Standards, e.g. BS 5400;
- b) wind loads (see BS 6399-2);
- c) imposed roof loads (see BS 6399-3);
- d) snow loads (see BS 6399-3);
- e) loads on structures subject to internal pressures from their contents (e.g. bunkers, silos and water tanks), which have to be calculated individually;
- f)  $\boxed{A_1}$  loads on buildings and structures susceptible to dynamic excitation;

NOTE General guidance is given in Clause 5, Note 1, Note 2 and Note 3.  $\boxed{A_1}$

- g) loads due to lifts (see BS 2655);
- h) loads incidental to construction;
- i) test loads;
- j) loads for crane gantry girders (see BS 2573).

$\boxed{A_1}$  k) loads on grandstands and stadia

NOTE General guidance is given in Table 1, Note 4.  $\boxed{A_1}$

## 2 References

### 2.1 Normative references

This Part of BS 6399 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 the inside back cover. For dated references, only the edition cited applies, any subsequent amendments to or revisions of the cited publication apply to this Part of BS 6399 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.

### 2.2 Informative references

This Part of BS 6399 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.

## 3 Definitions

For the purposes of this code of practice the following definitions apply.

### 3.1

#### dead load

the load due to the weight of all walls, permanent partitions, floors, roofs, finishes and all other permanent construction including services of a permanent nature

### 3.2

#### imposed load

the load assumed to be produced by the intended occupancy or use, including the weight of movable partitions, distributed, concentrated, impact and inertia, loads, but excluding wind loads

**3.3****storage height**

the height of the space between a floor and a physical constraint to the height of storage formed by a ceiling, soffit of a floor, roof or other obstruction

**3.4****wind load**

the load due to the effect of wind pressure or suction

**3.5****accidental load on key or protected element**

the ultimate load assumed, during a single accidental loading event to apply to structural elements essential to the residual stability of the building

**4 Dead loads**

Dead loads are calculated from the unit weights given in BS 648 or from the actual known weights of the materials used. Where there is doubt as to the permanency of dead loads, such loads should be treated as imposed loads.

Where permanent partitions are indicated, their actual weights are included in the dead load.

The weights of tanks and other receptacles, and of their contents, are considered as dead loads. These loads should be calculated for the cases when a tank or receptacle is full and when it is empty.

**5 Imposed floor and ceiling loads**

**NOTE 1** The imposed loads given in this clause are intended to be treated as static loads. They include allowances for nominal dynamic effects expected for the type of occupancy or activity stated that are appropriate for the static load design of most buildings and structures.

However, static load design is not sufficient where dynamic loading occurs in buildings and structures that are susceptible to dynamic excitation. In such cases, the design should take account of the load-structure interaction and natural frequency, mass, damping and mode shape of the structure.

Furthermore, for structural design with oscillation or vibration as a serviceability criterion, separate considerations are necessary, e.g. the operation of equipment and the comfort of users and occupiers of a building.

**NOTE 2** For public buildings and structures, such as those intended for providing spectator facilities, the certifying authority may refer to specific guidance documents as appropriate for compliance with their requirements.

**NOTE 3** General advice on dynamic loading conditions for some specific structural types are given in Annex A. **A1**

**5.1 Floors****5.1.1 General**

The loads appropriate to the type of activity/occupancy for which the floor area will be used in service are given in Table 1. The loads in Table 1 should be treated as the unfactored or characteristic loads for design purposes.

They should be considered as the minimum values to be adopted.

Where higher values are considered more appropriate, based on a knowledge of the proposed use of the structure or proposed installation of equipment, machinery, stacking systems, etc., they should be used instead.

All floors should be designed to carry the uniformly distributed or concentrated load, whichever produces the greatest stresses (or where critical, deflection) in the part of the floor under consideration.

The categories adopted for types of activity/occupancy are:

- A Domestic and residential activities
- B Office and work areas not covered elsewhere
- C Areas where people may congregate
- D Shopping areas
- E Areas susceptible to the accumulation of goods
- F/G Vehicle and traffic areas

Table 1 — Minimum imposed floor loads







Type of activity/occupancy for part of the building or structure	Examples of specific use	Uniformly distributed load kN/m <sup>2</sup>	Concentrated load kN	
A Domestic and residential activities (Also see category C)	All usages within self-contained [A] single family [A] dwelling units Communal areas (including kitchens) in blocks of flats with limited use (See note 1) (For communal areas in other blocks of flats, see C3 and below)	1.5	1.4	
	Bedrooms and dormitories except those in [A] single family dwelling units and in [A] hotels and motels	1.5	1.8	
	Bedrooms in hotels and motels Hospital wards Toilet areas	2.0	1.8	
	Billiard rooms	2.0	2.7	
	Communal kitchens except in flats covered by note 1	3.0	4.5	
	Balconies	Single [A] family [A] dwelling units and communal areas in blocks of flats with limited use (See note 1)	1.5	1.4
		Guest houses, residential clubs and communal areas in blocks of flats except as covered by note 1	Same as rooms to which they give access but with a minimum of 3.0	1.5/m run concentrated at the outer edge
		Hotels and motels	Same as rooms to which they give access but with a minimum of 4.0	1.5/m run concentrated at the outer edge
	B Offices and work areas not covered elsewhere	Operating theatres, X-ray rooms, utility rooms	2.0	4.5
Work rooms (light industrial) without storage		2.5	1.8	
Offices for general use		2.5	2.7	
Banking halls		3.0	2.7	
Kitchens, laundries, laboratories		3.0	4.5	
Rooms with mainframe computers or similar equipment		3.5	4.5	
Machinery halls, circulation spaces therein		4.0	4.5	
Projection rooms		5.0	To be determined for specific use	
Factories, workshops and similar buildings (general industrial)		5.0	4.5	
Foundries		20.0	To be determined for specific use	
Catwalks		—	1.0 at 1 m centres	
Balconies		Same as rooms to which they give access but with a minimum of 4.0	1.5/m run concentrated at the outer edge	
Fly galleries		4.5 kN/m run distributed uniformly over width	—	
Ladders		—	1.5 rung load	



Table 1 — Minimum imposed floor loads (continued)

Type of activity/occupancy for part of the building or structure	Examples of specific use	Uniformly distributed load kN/m <sup>2</sup>	Concentrated load kN	
C Areas where people may congregate	Public, institutional and communal dining rooms and lounges, cafes and restaurants (See note 2)	2.0	2.7	
C1 Areas with tables	Reading rooms with no book storage	2.5	4.5	
	Classrooms	3.0	2.7	
C2 Areas with fixed seats	Assembly areas with fixed seating (See note 3)	4.0	3.6	
	Places of worship	3.0	2.7	
C3 Areas without obstacles for moving people	Corridors, hallways, aisles, stairs, landings etc. in institutional type buildings (not subject to crowds or wheeled vehicles), hostels, guest houses, residential clubs, and communal areas in blocks of flats not covered by note 1. (For communal areas in blocks of flats covered by note 1, see A)	Corridors, hallways, aisles etc. (foot traffic only)	3.0	4.5
		Stairs and landings (foot traffic only)	3.0	4.0
	Corridors, hallways, aisles, stairs, landings, etc. in all other buildings including hotels and motels and institutional buildings	Corridors, hallways, aisles, etc. (foot traffic only)	4.0	4.5
		Corridors, hallways, aisles, etc., subject to wheeled vehicles, trolleys etc.	5.0	4.5
		Stairs and landings (foot traffic only)	4.0	4.0
	Ⓐ Light duty walkways — (access suitable for one person, walkway width approximately 600 mm) Ⓐ	3.0	Ⓐ 2.0 Ⓐ	
	Ⓐ General duty walkways — (regular two-way pedestrian traffic) Ⓐ	5.0	Ⓐ 3.6 Ⓐ	
	Ⓐ Heavy duty walkways — (high density pedestrian traffic including escape routes) Ⓐ	7.5	4.5	
	Museum floors and art galleries for exhibition purposes	4.0	4.5	
	Balconies (except as specified in A)	Same as rooms to which they give access but with a minimum of 4.0	1.5/m run concentrated at the outer edge	
	Fly galleries	4.5 kN/m run distributed uniformly over width	—	
	C4 Areas with possible physical activities Ⓐ (See clause 5, Note 1, Note 2 and Note 3) Ⓐ	Dance halls and studios, gymnasia, stages	5.0	3.6
		Drill halls and drill rooms	5.0	9.0
C5 Areas susceptible to overcrowding Ⓐ (See clause 5, Note 1, Note 2 and Note 3) Ⓐ	Assembly areas without fixed seating, concert halls, bars Ⓐ and places of worship (See Note 4) Ⓐ	5.0	3.6	
	Stages in public assembly areas	7.5	4.5	
D Shopping areas	Shop floors for the sale and display of merchandise	4.0	3.6	

Table 1 — Minimum imposed floor loads (*concluded*)

Type of activity/occupancy for part of the building or structure	Examples of specific use	Uniformly distributed load kN/m <sup>2</sup>	Concentrated load kN
E Warehousing and storage areas. Areas subject to accumulation of goods. Areas for equipment and plant.	General areas for static equipment not specified elsewhere (institutional and public buildings)	2.0	1.8
	Reading rooms with book storage, e.g. libraries	4.0	4.5
	General storage other than those specified	2.4 for each metre of storage height	7.0
	File rooms, filing and storage space (offices)	5.0	4.5
	Stack rooms (books)	2.4 for each metre in storage height but with a minimum of 6.5	7.0
	Paper storage for printing plants and stationery stores	4.0 for each metre of storage height	9.0
	Dense mobile stacking (books) on mobile trolleys, in public and institutional buildings	4.8 for each metre of storage height but with a minimum of 9.6	7.0
	Dense mobile stacking (books) on mobile trucks, in warehouses	4.8 for each metre of storage height but with a minimum of 15.0	7.0
	Cold storage	5.0 for each metre of storage height but with a minimum of 15.0	9.0
	Plant rooms, boiler rooms, fan rooms, etc., including weight of machinery	7.5	4.5
Ladders	—	1.5 rung load	
F	Parking for cars, light vans, etc. not exceeding 2500 kg gross mass, including garages, driveways and ramps	2.5	9.0
G	Vehicles exceeding 2500 kg. Driveways, ramps, repair workshops, footpaths with vehicle access, and car parking	To be determined for specific use	
NOTE 1 Communal areas in blocks of flats with limited use refers to blocks of flats not more than three storeys in height and with not more than four self-contained  single family  dwelling units per floor accessible from one staircase.			
NOTE 2 Where these same areas may be subjected to loads due to physical activities or overcrowding, e.g. a hotel dining room used as a dance floor, imposed loads should be based on occupancy C4 or C5 as appropriate. Reference should also be made to  Clause 5, Note 1, Note 2 and Note 3. 			
NOTE 3 Fixed seating is seating where its removal and the use of the space for other purposes is improbable.			
 NOTE 4 For grandstands and stadia, see the requirements of the appropriate certifying authority. 			

### 5.1.2 Uniformly distributed loads

The uniformly distributed loads given in Table 1 are the uniformly distributed static loads per square metre of plan area and provide for the effects of normal use.

### 5.1.3 Concentrated loads

Concentrated loads should be assumed to act at points on the member to give the greatest moment, shear (or where critical, deflection). Concentrated loads should be applied to individual members and assumed to act on them unless there is evidence that adequate interaction exists to ensure that the load can be shared or spread.

When used for the calculation of local effects such as crushing and punching, the concentrated loads should be assumed to act at a position and over an area of application appropriate to their cause.

Where this cannot be foreseen, a square contact area with a 50 mm side should be assumed.

### 5.1.4 Partitions

When permanent partitions are indicated, their weight should be included in the dead load, acting at the given partition location.

In buildings where the use of other partitions is envisaged, an additional imposed load should be specified for the floor area. This may be taken as a uniformly distributed load of not less than one third of the load per metre run of the finished partitions. For floors of offices, this additional uniformly distributed partition load should not be less than 1.0 kN/m<sup>2</sup>.

## 5.2 Ceiling supports and similar structures

The following loads are appropriate for the design of frames and covering of access hatches (other than glazing), supports of ceilings and similar structures:

- a) without access: no imposed load; or
- b) with access: 0.25 kN/m<sup>2</sup> uniformly distributed over the whole area and a concentrated load of 0.9 kN so placed as to produce the maximum effect in the supporting members.

## 6 Reduction in total imposed floor loads

6.1 The following do not qualify for reduction:

- a) loads that have been specifically determined from a knowledge of the proposed use of the structure;
- b) loads due to plant or machinery;
- c) loads due to storage.

Otherwise, floors designed for activities described in categories A to D inclusive in Table 1 may qualify for the reductions specified in this clause to be applied to the uniformly distributed floor loads given in Table 1.

### 6.2 Reduction in loading on columns

The reductions given in Table 2 (based on the number of floors qualifying for load reduction carried by the member under consideration) may be applied to the total imposed floor load in the design of columns, piers, walls and their supports and foundations, except as provided in 6.1. The percentage reductions given apply to the total distributed imposed load (including the additional uniformly distributed imposed partition load, see 5.1.4) on all floors qualifying for reduction carried by the member under consideration.

Alternatively, the reductions based on area in 6.3 may be applied but the reductions given in Table 2 cannot be used in combination with those in Table 3.

NOTE The moments on a column should be determined from the load used to design the beams at the appropriate level and not reduced on the same basis as the axial load.

**Table 2 — Reduction in total distributed imposed floor loads with number of storeys**

Number of floors with loads qualifying for reduction carried by member under consideration	Reduction in total distributed imposed load on all floors carried by the member under consideration %
1	0
2	10
3	20
4	30
5 to 10	40
over 10	50 max.

### 6.3 Reduction in loading on beams

The loading on beams (including the additional uniformly distributed imposed partition load, see 5.1.4), may be reduced according to area supported by the percentage given in Table 3, except as provided in 6.1.

NOTE Beams supporting columns should be designed for the same load as that in the column being supported (being applied as appropriate), together with all other loads applied directly to the beam.

**Table 3 — Reduction in total distributed imposed floor loads on a supporting beam or girder with floor area**

Area supported (see note) m <sup>2</sup>	Reduction in total distributed imposed load %
0	0
50	5
100	10
150	15
200	20
above 250	25 max

NOTE Reductions for intermediate areas may be calculated by linear interpolation.

## 7 Imposed roof loads

For imposed roof loads refer to Part 3 of this standard.

## 8 Crane gantry girders

For loads due to cranes, see BS 2573.

Ⓐ) 9 Text deleted Ⓐ)

## 10 Parapets, barriers and balustrades

Table 4 specifies minimum horizontal imposed loads appropriate to the design of parapets, barriers, balustrades and other elements of a structure intended to retain, stop or guide people. The loads given in Table 4 should be treated as the unfactored or characteristic loads for design purposes. The uniformly distributed line load and the uniformly distributed and concentrated loads applicable to the infill are not additive and should be considered as three separate load cases. In design, the horizontal uniformly distributed line load should be considered to act at a height of 1.1 m above datum level, irrespective of the actual height of the element. For this purpose, the datum level should be taken as the finished level of the access platform, or the pitch line drawn through the nosings of the stair treads.

Ⓐ) For all types of activities given in Table 4, the parapets, barriers and balustrades should be designed for a vertical load. This vertical load should be either a concentrated load of 1 kN or a uniformly distributed load of 0.6 kN/m, whichever gives the worst design condition in combination with the recommended horizontal loading of Table 4. This combination of loads should be taken into account in the design of relevant elements of the structure that support the parapets, barriers and balustrades. Ⓐ)

## 11 Vehicle barriers for car parks

11.1 The horizontal force  $F$  (in kN), normal to and uniformly distributed over any length of 1.5 m of a barrier for a car park, required to withstand the impact of a vehicle is given by:

$$F = \frac{0.5mv^2}{\delta_c + \delta_b}$$

where

- $m$  is the gross mass of the vehicle (in kg);
- $v$  is the velocity of the vehicle (in m/s) normal to the barrier;
- $\delta_c$  is the deformation of the vehicle (in mm);
- $\delta_b$  is the deflection of the barrier (in mm).

11.2 Where the car park has been designed on the basis that the gross mass of the vehicles using it will not exceed 2500 kg the following values are used to determine the force  $F$ :

- $m$  = 1 500 kg<sup>1)</sup>;
- $v$  = 4.5 m/s;
- $\delta_c$  = 100 mm unless better evidence is available.

For a rigid barrier, for which  $\delta_b$  may be taken as zero, the force  $F$  appropriate to vehicles up to 2 500 kg gross mass is taken as 150 kN.

11.3 Where the car park has been designed for vehicles whose gross mass exceeds 2500 kg the following values are used to determine the force  $F$ :

- $m$  = the actual mass of the vehicle for which the car park is designed (in kg);
- $v$  = 4.5 m/s;
- $\delta_c$  = 100 mm unless better evidence is available.

11.4 The force determined as in 11.2 or 11.3 may be considered to act at bumper height. In the case of car parks intended for motor cars whose gross mass does not exceed 2 500 kg this height may be taken as 375 mm above the floor level.

11.5 Barriers to access ramps of car parks have to withstand one half of the force determined in 11.2 or 11.3 acting at a height of 610 mm above the ramp.

Opposite the ends of straight ramps intended for downward travel which exceed 20 m in length the barrier has to withstand twice the force determined in 11.2 or 11.3 acting at a height of 610 mm above the ramp.

<sup>1)</sup> The mass of 1 500 kg is taken as being more representative of the vehicle population than the extreme value of 2 500 kg.

## 12 Accidental load on key or protected elements

When an accidental load is required for a key or protected element approach to design,<sup>2)</sup> that load shall be taken as 34 kN/m<sup>2</sup>.

**Table 4 — Minimum horizontal imposed loads for parapets, barriers and balustrades, etc.**

Type of occupancy for part of the building or structure	Examples of specific use	Horizontal uniformly distributed line load (kN/m)	A uniformly distributed load applied to the infill (kN/m <sup>2</sup> )	A point load applied to part of the infill (kN)
A Domestic and residential activities	(i) All areas within or serving exclusively one <del>A1</del> single family <del>A1</del> dwelling including stairs, landings, etc. but excluding external balconies and edges of roofs (see C3 ix)	0.36	0.5	0.25
	(ii) Other residential, (but also see C)	0.74	1.0	0.5
B and E Offices and work areas not included elsewhere including storage areas	(iii) Light access stairs and gangways not more than 600 mm wide	0.22	N/A	N/A
	(iv) Light pedestrian traffic routes in industrial and storage buildings except designated escape routes	0.36	0.5	0.25
	(v) Areas not susceptible to overcrowding in office and institutional buildings also industrial and storage buildings except as given above	0.74	1.0	0.5
C Areas where people may congregate	(vi) Areas having fixed seating within 530 mm of the barrier, balustrade or parapet	1.5	1.5	1.5
C1/C2 Areas with tables or fixed seating	(vii) Restaurants and bars	1.5	1.5	1.5
C3 Areas without obstacles for moving people and not susceptible to overcrowding	(viii) Stairs, landings, corridors, ramps	0.74	1.0	0.5
	(ix) External balconies and edges of roofs. Footways and pavements within building curtilage adjacent to basement/sunken areas	0.74	1.0	0.5
C5 Areas susceptible to overcrowding	(x) Footways or pavements less than 3 m wide adjacent to sunken areas	1.5	1.5	1.5
	(xi) Theatres, cinemas, discotheques, bars, auditoria, shopping malls, assembly areas, studio. Footways or pavements greater than 3 m wide adjacent to sunken areas	3.0	1.5	1.5
	(xii) <del>A1</del> Grandstands and stadia <del>A1</del>	See requirements of the appropriate certifying authority		
D Retail areas	(xiii) All retail areas including public areas of banks/building societies or betting shops. For areas where overcrowding may occur, see C5	1.5	1.5	1.5
F/G Vehicular	(xiv) Pedestrian areas in car parks including stairs, landings, ramps, edges or internal floors, footways, edges of roofs	1.5	1.5	1.5
	(xv) Horizontal loads imposed by vehicles	See clause 11		
<del>A1</del> Note deleted. <del>A1</del>				

<sup>2)</sup> See appropriate material design code.

**Annex A (informative)****Examples of dynamic loading conditions for some specific structural types****A.1 Buildings and structures with areas subjected to dancing and jumping**

Buildings and structures with areas subjected to dancing and jumping are liable to be subjected to inadvertent or deliberate synchronized movement of occupants, sometimes accompanied by music with a strong beat, such as occurs at pop concerts and aerobics events. These activities generate dynamic effects that can result in enhanced vertical and horizontal loads on the structure. If, in addition, the synchronized movement is at a frequency that matches a harmonic of the natural frequency of the structure, or a part of it, resonance of the structure is liable to occur that greatly amplifies the dynamic response.

Two alternative approaches are recommended for such design situations:

a) Design to avoid resonance: In addition to design with dead and static imposed loads for buildings or structures with areas subjected to physical activities and overcrowding, as given in rows C4 and C5 of Table 1, resonance of the structure should be avoided. This is achieved by limiting structure's natural frequencies so that the vertical frequency is greater than 8.4 Hz and the horizontal frequency is greater than 4.0 Hz. These frequencies should be evaluated for the appropriate mode of vibration of an empty structure.


or

b) Design for dynamic loads: Buildings and structures with areas subjected to dancing and jumping should be designed to resist the anticipated dynamic loading. The deformation of the structural frame should not exceed limits appropriate to the building or structure type. Detailed design should be undertaken to account for the dynamic response of the structure and a range of load frequencies and types with the help of specialist advice and specialist guidance documents [1].

**A.2 Building with lightweight and long span structures**

Where lightweight and long span structures are used as concourses and public spaces, they are likely to be subjected to inadvertent or deliberate synchronized movement by people, causing dynamic excitation. The design provisions should take account of the nature and intended use of the structure, the potential number of people and their possible behaviour. Structural design should be undertaken with the help of specialist advice and specialist guidance documents, as required by the appropriate certifying authority.

**A.3 Buildings containing machinery**

The dynamic effects caused by the operation of machinery depend on the type of machinery and the form of the building structure. Designers should seek specialist guidance and consider the dynamic loads and the potential resonant excitation of the structures. 

## List of references (see clause 2)

### Normative references

#### BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 648:1964, *Schedule of weights of building materials.*

BS 2573, *Rules for the design of cranes.*

BS 2573-1:1983, *Specification for classification, stress calculations and design criteria for structures.*

### Informative references

#### BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 2655, *Specification for lifts, escalators, passenger conveyors and paternosters.*

BS 2655-4:1969, *General requirements for escalators, and passenger conveyors.*

BS 5400, *Steel, concrete and composite bridges.*

BS 5400-2:1978, *Specification for loads.*



BS 5555:1993, *Specification for SI units and recommendations for the use of their multiples and of certain other units.*

BS 6399, *Loading for buildings.*

BS 6399-2:1995, *Code of practice for wind loads.*

BS 6399-3:1988, *Code of practice for imposed roof loads.*

### Other references

[1]  BRE Digest 426, *The response of structures to dynamic crowd loads.* BRE, Watford, October 1997. 



---

---

## BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

### Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

### Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: [orders@bsi-global.com](mailto:orders@bsi-global.com). Standards are also available from the BSI website at <http://www.bsi-global.com>.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

### Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: [info@bsi-global.com](mailto:info@bsi-global.com).

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: [membership@bsi-global.com](mailto:membership@bsi-global.com).

Information regarding online access to British Standards via British Standards Online can be found at <http://www.bsi-global.com/bsonline>.

Further information about BSI is available on the BSI website at <http://www.bsi-global.com>.

### Copyright

Copyright subsists in all BSI publications. BSI also holds the copyright, in the UK, of the publications of the international standardization bodies. Except as permitted under the Copyright, Designs and Patents Act 1988 no extract may be reproduced, stored in a retrieval system or transmitted in any form or by any means – electronic, photocopying, recording or otherwise – without prior written permission from BSI.

This does not preclude the free use, in the course of implementing the standard, of necessary details such as symbols, and size, type or grade designations. If these details are to be used for any other purpose than implementation then the prior written permission of BSI must be obtained.

Details and advice can be obtained from the Copyright & Licensing Manager. Tel: +44 (0)20 8996 7070. Fax: +44 (0)20 8996 7553. Email: [copyright@bsi-global.com](mailto:copyright@bsi-global.com).

BSI  
389 Chiswick High Road  
London  
W4 4AL