

UK National Annex to Eurocode 1: Actions on structures —

**Part 1-1: General actions — Densities,
self-weight, imposed loads for buildings**

ICS 91.010.30

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National Annex (informative) to BS EN 1991-1-1:2002, Eurocode 1: Actions on structures — Part 1-1: General actions — Densities, self-weight, imposed loads for buildings

Introduction

This National Annex has been prepared by BSI Subcommittee B/525/1, Actions (loadings) and basis of design. In the UK it is to be used in conjunction with BS EN 1991-1-1:2002.

NA.1 Scope

This National Annex gives:

a) the UK decisions for the Nationally Determined Parameters described in the following subclauses of BS EN 1991-1-1:2002:

- 2.2 (3)
- 5.2.3 (1) to 5.2.3 (5)
- 6.3.1.1 (Table 6.1)
- 6.3.1.2 (1)P (Table 6.2)
- 6.3.1.2 (10)
- 6.3.1.2 (11)
- 6.3.2.2 (1)P (Table 6.4)
- 6.3.3.2 (1) (Table 6.8)
- 6.3.4.2 (Table 6.10)
- 6.4 (1) (Table 6.12)

b) the UK decisions on the status of BS EN 1991-1-1:2002 informative annexes; and

c) references to non-contradictory complementary information for the following subclauses of BS EN 1991-1-1:2002:

- 6.3.2.2
- 6.3.4.2 (1)

NA.2 Nationally Determined Parameters

NA.2.1 Dynamically susceptible structures [BS EN 1991-1-1:2002, 2.2(3)]

NA.2.1.1 *General*

The procedure to be used for structures that are susceptible to dynamic excitation is outlined in NA.2.1.2, NA.2.1.3 and NA.2.1.4 for particular cases of dynamic loading conditions and structural types. In such cases, the design should take account of the load-structure interaction and dynamic characteristics of the structure, e.g. natural frequency, mass, damping and mode shapes. Furthermore, for structural design with oscillation or vibration as a serviceability criterion, separate consideration of their influence is necessary, e.g. on the operation of equipment in the building and/or on the comfort of the users and occupiers of the building.

In certain cases, e.g. structures intended primarily for providing spectator facilities, the relevant certifying authority may refer to specific guidance documents that are considered appropriate and sufficient for compliance with their requirements.

NA.2.1.2 *Synchronized rhythmical movements*

Structures with elements subject to dancing and jumping are liable 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. If a natural frequency of a structure matches the frequency of the synchronized movement, or an integer multiple of it, then resonance can occur that greatly amplifies the dynamic response.

The following three alternative procedures are recommended for such design situations.

- a) In addition to design using the dead and static imposed loads given for category C4 uses in Table NA.3, resonance of the structure should be avoided by limiting its 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.
- b) Structural elements subject to dancing and jumping should be designed to resist the anticipated dynamic loading. The deformation should not exceed limits appropriate to the structure type. Detailed design should be carried out accounting for dynamic response of the structure and a range of load frequencies and types, and with the help of specialist advice and specialist guidance documents, e.g. BRE Digest 426, *The response of structures to dynamic crowd loads* [1].
- c) Specific guidance, as required by the certifying authority for the type of structure under consideration, should be used.

NA.2.1.3 *Dynamic loads from machinery*

Dynamic effects caused by the operation of machinery depend on the type of machinery and the structural form. Designers should seek specialist guidance and consider dynamic loads and potential resonant excitation of such structures. Guidance on actions induced by cranes and machinery is given in BS EN 1991-3¹⁾.

NA.2.1.4 *Lightweight structures and long-span structures*

Where these structures are used as concourses and public spaces, they are likely to be subject 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 carried out with the help of specialist advice and specialist guidance documents.

NA.2.2 **Characteristic values of self-weight — Additional provisions specific to bridges** [BS EN 1991-1-1:2002, 5.2.3]

Additional provisions for bridges are given in BS EN 1991-1-1:2002, 5.2.3. The UK guidance on these provisions is given in Table NA.1.

NA.2.3 **Categories for residential, social, commercial and administration areas** [BS EN 1991-1-1:2002, 6.3.1.1]

The categories for residential, social, commercial and administration areas are given in BS EN 1991-1-1:2002, Table 6.1. These categories have been expanded in Table NA.2 to include additional sub-categories for the UK.

NA.2.4 **Imposed loads on floors, balconies and stairs in buildings** [BS EN 1991-1-1:2002, 6.3.1.2 (1)P]

Values for minimum imposed loads on floors, balconies and stairs in buildings should be taken from Table NA.3 (as a replacement for BS EN 1991-1-1:2002, Table 6.2) for the categories of residential, social, commercial and administration areas described in Table NA.2.

NA.2.5 **Reduction factor for imposed loads for floors and accessible roofs** [BS EN 1991-1-1:2002, 6.3.1.2 (10)]

The reduction factor α_A should be determined using Equation (NA.1) instead of BS EN 1991-1-1:2002, Equation (6.1):

$$\alpha_A = 1,0 - A/1\,000 \geq 0,75 \quad (\text{NA.1})$$

where

A is the area (m²) supported.

NOTE Loads that have been specifically determined from knowledge of the proposed use of the structure do not qualify for reduction.

¹⁾ In preparation.

Table NA.1 — Characteristic values of self-weight — UK guidance on additional provisions for bridges

BS EN 1991-1-1:2002 subclause	Nationally Determined Parameter
5.2.3 (1)	Self-weight of fill should be defined for the individual project depending on the estimated change with time due to consolidation, saturation, etc. and considering local conditions, type of soil, ground water variation and degree of consolidation. For ballast on railway bridges, unless otherwise specified by the competent authority, the upper characteristic value of the density of ballast should be taken as 21 kN/m³. This allows for dirty waterlogged ballast. For ballast on railway bridges, unless otherwise specified for the individual project, the lower characteristic value of the density of ballast should be taken as 17 kN/m³. This value allows for dry clean ballast and should be used especially when a dynamic analysis of the bridge is required by BS EN 1991-2 and a lower bound estimate of the mass of the bridge is being considered.
5.2.3 (2)	For determining the load effects on railway bridges, the nominal depth of ballast should be taken as 300 mm measured from the underside of the sleepers at the lowest rail to the top of the bridge deck unless the bridge carries a greater depth of ballast. In the latter case, the actual depth of ballast should be taken. In determining the upper and lower characteristic values of depth of ballast, the deviation of ±30 % should be applied only to the top 300 mm depth of ballast measured from the underside of the sleepers.
5.2.3 (3)	The deviation of the total thickness of waterproofing, surfacing and other coatings for bridges from the nominal value, or other specified values, should be ±40 % if a post-execution coating is included in the nominal value and between 55 % and –40 % if not.
5.2.3 (4)	Deviation from the mean value of self-weight should be ±20 %.
5.2.3 (5)	The characteristic values of self-weight of other non-structural elements should be taken to equal the nominal values.

NA.2.6 Reduction factors for imposed loads from several storeys **[BS EN 1991-1-1:2002, 6.3.1.2 (11)]**

The reduction factor α_n should be determined using Equation (NA.2) instead of BS EN 1991-1-1:2002, Equation (6.2):

$$\begin{aligned}
 \alpha_n &= 1,1 - n/10 && \text{for } 1 \leq n \leq 5 \\
 \alpha_n &= 0,6 && \text{for } 5 < n \leq 10 \\
 \alpha_n &= 0,5 && \text{for } n > 10
 \end{aligned}
 \tag{NA.2}$$

where

n is the number of storeys with loads qualifying for reduction (see Note).

Load reductions based on area in **NA.2.5** may be applied if $\alpha_A < \alpha_n$. However, the reductions given by Equation (NA.1) cannot be used in combination with those determined from Equation (NA.2).

NOTE Loads that have been specifically determined from knowledge of the proposed use of the structure do not qualify for reduction.

Table NA.2 — Categories for residential, social, commercial and administration areas including additional sub-categories for the UK

Category of loaded area	Specific use	Sub-category	Example
A	Areas for domestic and residential activities	A1	All usages within self-contained dwelling units (a unit occupied by a single family or a modular student accommodation unit with a secure door and comprising not more than six single bedrooms and an internal corridor) Communal areas (including kitchens) in blocks of flats with limited use (see Note 1). For communal areas in other blocks of flats, see A5, A6 and C3
		A2	Bedrooms and dormitories except those in self-contained single family dwelling units and in hotels and motels
		A3	Bedrooms in hotels and motels; hospital wards; toilet areas
		A4	Billiard/snooker rooms
		A5	Balconies in single family dwelling units and communal areas in blocks of flats with limited use (see Note 1)
		A6	Balconies in hostels, guest houses, residential clubs and communal areas in blocks of flats except those covered by Note 1
		A7	Balconies in hotels and motels
B	Office areas	B1	General use other than in B2
		B2	At or below ground floor level
C	Areas where people may congregate (with the exception of areas defined under category A, B and D)	C1	Areas with tables
		C11	Public, institutional and communal dining rooms and lounges, cafes and restaurants (see Note 2)
		C12	Reading rooms with no book storage
		C13	Classrooms
		C2	Areas with fixed seats
		C21	Assembly areas with fixed seating (see Note 3)
		C22	Places of worship
		C3	Areas without obstacles for moving people
		C31	Corridors, hallways, aisles in institutional type buildings not subjected to crowds or wheeled vehicles, hostels, guest houses, residential clubs, and communal areas in blocks of flats not covered by Note 1

Table NA.2 — Categories for residential, social, commercial and administration areas including additional sub-categories for the UK *(continued)*

Category of loaded area	Specific use	Sub-category	Example
		C32	Stairs, landings in institutional type buildings not subjected to crowds or wheeled vehicles, hostels, guest houses, residential clubs, and communal areas in blocks of flats not covered by Note 1
		C33	Corridors, hallways, aisles in all buildings not covered by C31 and C32, including hotels and motels and institutional buildings subjected to crowds
		C34	Corridors, hallways, aisles in all buildings not covered by C31 and C32, including hotels and motels and institutional buildings subjected to wheeled vehicles, including trolleys
		C35	Stairs, landings in all buildings not covered by C31 and C32, including hotels and motels and institutional buildings subjected to crowds
		C36	Walkways — Light duty (access suitable for one person, walkway width approx 600 mm)
		C37	Walkways — General duty (regular two-way pedestrian traffic)
		C38	Walkways — Heavy duty (high density pedestrian traffic including escape routes)
		C39	Museum floors and art galleries for exhibition purposes
		C4	Areas with possible physical activities
		C41	Dance halls and studios, gymnasia, stages (see Note 5)
		C42	Drill halls and drill rooms (see Note 5)
		C5	Areas susceptible to large crowds
		C51	Assembly areas without fixed seating, concert halls, bars and places of worship (see Note 4 and Note 5)
		C52	Stages in public assembly areas (see Note 5)
D	Shopping areas	D1	Areas in general retail shops
		D2	Areas in department stores

NOTE 1 Communal areas in blocks of flats with limited use are blocks of flats not more than three storeys in height and with not more than four self-contained dwelling units per floor accessible from one staircase.

NOTE 2 Where the areas described by C11 might 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 C4 or C5 as appropriate. Reference should also be made to Note 5.

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, reference should be made to the requirements of the appropriate certifying authority.

NOTE 5 For structures that might be susceptible to resonance effects, reference should be made to **NA.2.1**.

Table NA.3 — Imposed loads on floors, balconies and stairs in buildings

Category of loaded area		q_k kN/m ²	Q_k kN
Category A	A1	1,5	2,0
	A2	1,5	2,0
	A3	2,0	2,0
	A4	2,0	2,7
	A5	2,5	2,0
	A6	Same as the rooms to which they give access but with a minimum of 3,0	2,0 (concentrated at the outer edge)
	A7	Same as the rooms to which they give access but with a minimum of 4,0	2,0 (concentrated at the outer edge)
Category B	B1	2,5	2,7
	B2	3,0	2,7
Category C	C11	2,0	3,0
	C12	2,5	4,0
	C13	3,0	3,0
	C21	4,0	3,6
	C22	3,0	2,7
	C31	3,0	4,5
	C32	3,0	4,0
	C33	4,0	4,5
	C34	5,0	4,5
	C35	4,0	4,0
	C36	3,0	2,0
	C37	5,0	3,6
	C38	7,5	4,5
	C39	4,0	4,5
	C41	5,0	3,6
	C42	5,0	7,0
	C51	5,0	3,6
	C52	7,5	4,5
Category D	D1/D2	4,0	3,6

NA.2.7 Categories for storage and industrial areas [BS EN 1991-1-1:2002, 6.3.2.1 (1)P]

The categories for storage and industrial areas are given in BS EN 1991-1-1:2002, Table 6.3. These categories have been expanded in Table NA.4 to include additional sub-categories for the UK.

Table NA.4 — Categories for storage and industrial areas including additional sub-categories for the UK

Category of loaded area	Specific use	Sub-category	Examples
E1	Areas susceptible to accumulation of goods, including access areas	E11	General areas for static equipment not specified elsewhere (institutional and public buildings)
		E12	Reading rooms with book storage, e.g. libraries
		E13	General storage other than those specified (see Note)
		E14	File rooms, filing and storage space (offices)
		E15	Stack rooms (books)
		E16	Paper storage for printing plants and stationery stores
		E17	Dense mobile stacking (books) on mobile trolleys, in public and institutional buildings
		E18	Dense mobile stacking (books) on mobile trucks, in warehouses
		E19	Cold storage
E2	Industrial use	—	See PD 6688 for imposed loads on floors for areas of industrial use

NA.2.8 Imposed loads on floors due to storage [BS EN 1991-1-1:2002, 6.3.2.2 (1)P]

Values for imposed loads on floors due to storage should be taken from Table NA.5 (as a replacement for BS EN 1991-1-1:2002, Table 6.4) for the sub-categories of E1 described in Table NA.4.

Table NA.5 — Imposed floor loads due to storage

Category of loaded area	q_k kN/m ²	Q_k kN
E11	2,0	1,8
E12	4,0	4,5
E13	2,4 per metre of storage height	7,0
E14	5,0	4,5
E15	2,4 per metre of storage height but with a minimum of 6,5	7,0
E16	4,0 per metre of storage height	9,0
E17	4,8 per metre of storage height but with a minimum of 9,6	7,0
E18	4,8 per metre of storage height but with a minimum of 15,0	7,0
E19	5,0 per metre of storage height but with a minimum of 15,0	9,0

NOTE E13 is a general category, however, designers are encouraged to liaise with clients to determine more specific load values than the lower bound value given in this table.

NA.2.9 Imposed loads on garages and vehicle traffic areas [BS EN 1991-1-1:2002, 6.3.3.2 (1)]

Values for imposed loads on garages and vehicle traffic areas should be taken from Table NA.6 (as a replacement for BS EN 1991-1-1:2002, Table 6.8) for categories F and G described in BS EN 1991-1-1:2002, Table 6.7.

Table NA.6 — Imposed loads on garages and vehicle traffic areas

Categories of traffic areas	q_k kN/m ²	Q_k kN
Category F (gross vehicle weight ≤ 30 kN)	2,5	10,0
Category G ($30 \text{ kN} < \text{gross vehicle weight} \leq 160 \text{ kN}$)	5,0	To be determined for specific use
NOTE q_k and Q_k should not be applied simultaneously.		

NA.2.10 Imposed loads on roofs [BS EN 1991-1-1:2002, 6.3.4.2]

Values for imposed loads on roofs not accessible except for normal maintenance and repair should be taken from Table NA.7 (as a replacement for BS EN 1991-1-1:2002, Table 6.10) for category H described in BS EN 1991-1-1:2002, Table 6.9.

Table NA.7 — Imposed loads on roofs not accessible except for normal maintenance and repair

Roof slope, α degrees	q_k kN/m ²	Q_k kN
$\alpha < 30^\circ$	0,6	0,9
$30^\circ \leq \alpha < 60^\circ$	$0,6[(60 - \alpha)/30]$	
$\alpha \geq 60^\circ$	0	
NOTE 1 All roof slopes α are measured from the horizontal and all loads should be applied vertically.		
NOTE 2 In evaluating Table NA.7 for curved roofs the roofs should be divided into not less than five equal segments and the mean slope of each segment considered to be equivalent to the roof slope, α .		
NOTE 3 BS EN 1991-1-1:2002, Note 3 to Table 6.10 states that q_k may be assumed to act on an area A . It is recommended that the value of A should be the whole area of the roof.		

NA.2.11 Horizontal loads on parapets and partition walls acting as barriers [BS EN 1991-1-1:2002, 6.4 (1)]

Values for horizontal loads on parapets and partition walls acting as barriers should be taken from Table NA.8 (as a replacement for BS EN 1991-1-1:2002, Table 6.12) for the categories of loaded areas described in BS EN 1991-1-1:2002.

Table NA.8 — Horizontal loads on partition walls and parapets

Category of loaded area	Sub-category	Examples	q_k kN/m
A (including sub-categories in Table NA.2)	(i)	All areas within or serving exclusively one dwelling including stairs, landings etc. but excluding external balconies and edges of roofs [see (vii)]	0,36
	(ii)	Residential areas not covered by (i)	0,74
B and C1 (including sub-categories in Table NA.2)	(iii)	Areas not susceptible to overcrowding in office and institutional buildings, reading rooms and classrooms including stairs	0,74
	(iv)	Restaurants and cafes	1,5
C2, C3, C4 and D (including sub-categories in Table NA.2) ^a	(v)	Areas having fixed seating within 530 mm of the barrier, balustrade or parapet	1,5
	(vi)	Stairs, landings, balustrades, corridors and ramps	0,74
	(vii)	External balconies and edges of roofs Footways within building curtilage and adjacent to basement/sunken areas	0,74
	(viii)	All retail areas	1,5
C5 (including sub-categories in Table NA.2)	(ix)	Footways or pavements less than 3 m wide adjacent to sunken areas	1,5
	(x)	Theatres, cinemas, discotheques, bars, auditoria, shopping malls, assembly areas, studios Footways or pavements greater than 3 m wide adjacent to sunken areas	3,0
	(xi)	Grandstands and stadia	See requirements of the appropriate certifying authority
E (including sub-categories in Table NA.4)	(xii)	Industrial; and storage buildings except as given by (xiii) and (xiv)	0,74
	(xiii)	Light pedestrian traffic routes in industrial and storage buildings except designated escape routes	0,36
	(xiv)	Light access stairs and gangways not more than 600 mm wide	0,22
F and G	(xv)	Pedestrian areas in car parks including stairs, landings, ramps, edges or internal floors, footways, edges of roofs	1,5
	(xvi)	Horizontal loads imposed by vehicles	See BS EN 1991-1-1:2002, Annex B
^a For areas where large crowds might occur, see C5.			

NA.3 Decisions on the status of informative annexes

NA.3.1 Tables for nominal density of construction materials and nominal density and angles of repose for stored materials [BS EN 1991-1-1:2002, Annex A]

BS EN 1991-1-1:2002, Annex A may be used.

NA.3.2 Vehicle barriers and parapets for car parks [BS EN 1991-1-1:2002, Annex B]

BS EN 1991-1-1:2002, Annex B should be used.

NA.4 References to non-contradictory complementary information

NA.4.1 Imposed loads on industrial areas [BS EN 1991-1-1:2002, 6.3.2.2]

BS EN 1991-1-1 does not specify values for imposed loads on floors for areas of industrial use (i.e. category E2 from Table NA.4).

However, BS EN 1991-1-1:2002, **6.1** (4) does state that loads for heavy equipment (e.g. in communal kitchens, radiology rooms and boiler rooms) should be agreed between the client and/or the relevant authority.

In the absence of such agreement, the minimum imposed loads given in PD 6688 may be used for category E2 loaded areas.

NA.4.2 Imposed loads on roofs [BS EN 1991-1-1:2002, 6.3.4.2 (1)]

Imposed loads on roofs specified in BS EN 1991-1-1:2002, **6.3.4.2** (1) are for access for cleaning or maintenance only. Loads produced by climatic effects on all categories of roofs are specified in BS EN 1991-1-4 (wind loads), BS EN 1991-1-3 (snow loads) and BS EN 1991-1-5 (thermal actions).

Bibliography

Standards publications

BS EN 1991-1-3, *Eurocode 1: Actions on structures — Part 1-3: General actions — Snow loads*.

BS EN 1991-1-4, *Eurocode 1: Actions on structures — Part 1-4: General actions — Wind actions*.

BS EN 1991-1-5, *Eurocode 1: Actions on structures — Part 1-5: General actions — Thermal actions*.

BS EN 1991-2, *Eurocode 1: Actions on structures — Part 2: Traffic loads on bridges*.

BS EN 1991-3, *Eurocode 1: Actions on structures — Part 3: Actions induced by cranes and machinery*.

PD 6688, *Background paper to the UK National Annexes to BS EN 1991-1*.

Other publications

[1] BRE Digest 426, *The response of structures to dynamic crowd loads*. BRE: Watford, 2004.

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