EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

DRAFT
prEN 1991-1-1

March 2023

ICS 91.010.30

Will supersede EN 1991-1-1:2002

English Version

Eurocode 1 - Actions on structures - Part 1-1: Specific weight of materials, self-weight of construction works and imposed loads on buildings

Eurocode 1 - Actions sur les structures - Partie 1-1 : Poids spécifique des matériaux, poids propre des ouvrages et charges d'exploitation des bâtiments

Eurocode 1 - Einwirkungen auf Tragwerke - Teil 1-1: Allgemeine Einwirkungen - Wichte von Baustoffen und Lagergütern, Eigengewicht von Bauwerken und Nutzlasten im Hochbau

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 250.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. prEN 1991-1-1:2023 E

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European foreword

This document (prEN 1991-1-1:2023) has been prepared by Technical Committee CEN/TC 250 “Structural Eurocodes”, the secretariat of which is held by BSI.

CEN/TC 250 is responsible for all Structural Eurocodes and has been assigned responsibility for structural and geotechnical design matters by CEN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 1991-1-1:2002.

The first generation of EN Eurocodes was published between 2002 and 2007. This document forms part of the second generation of the Eurocodes, which have been prepared under Mandate M/515 issued to CEN by the European Commission and the European Free Trade Association.

The Eurocodes have been drafted to be used in conjunction with relevant execution, material, product and test standards, and to identify requirements for execution, materials, products and testing that are relied upon by the Eurocodes.

The Eurocodes recognize the responsibility of each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level through the use of National Annexes.

Introduction

0.1 Introduction to the Eurocodes

The Structural Eurocodes comprise the following standards generally consisting of a number of Parts:

— EN 1990 Eurocode: Basis of structural and geotechnical design

— EN 1991 Eurocode 1: Actions on structures

— EN 1992 Eurocode 2: Design of concrete structures

— EN 1993 Eurocode 3: Design of steel structures

— EN 1994 Eurocode 4: Design of composite steel and concrete structures

— EN 1995 Eurocode 5: Design of timber structures

— EN 1996 Eurocode 6: Design of masonry structures

— EN 1997 Eurocode 7: Geotechnical design

— EN 1998 Eurocode 8: Design of structures for earthquake resistance

— EN 1999 Eurocode 9: Design of aluminium structures

— New parts are under development, e.g. Eurocode for design of structural glass

The Eurocodes are intended for use by designers, clients, manufacturers, constructors, relevant authorities (in exercising their duties in accordance with national or international regulations), educators, software developers, and committees drafting standards for related product, testing and execution standards.

NOTE Some aspects of design are most appropriately specified by relevant authorities or, where not specified, can be agreed on a project-specific basis between relevant parties such as designers and clients. The Eurocodes identify such aspects making explicit reference to relevant authorities and relevant parties.

0.2 Introduction to EN 1991 (all parts)

(1) EN 1991 specifies actions for the structural and geotechnical design of buildings, bridges and other civil engineering works, or parts thereof, including temporary structures, in conjunction with EN 1990 and the other Eurocodes.

(2) EN 1991 does not cover the specific requirements of actions for seismic design. Provisions related to such requirements are given in EN 1998 (all parts), which complement and are consistent with EN 1991.

(3) EN 1991 is also applicable to existing structures for:

— structural assessment,

— strengthening or repair,

— change of use.

NOTE In these cases additional or amended provisions can be necessary.

(4) EN 1991 is also applicable for the design of structures where materials or actions outside the scope of the other Eurocodes are involved.

NOTE In this case additional or amended provisions can be necessary.

0.3 Introduction to EN 1991-1-1

EN 1991-1-1 gives rules on the following aspects related to actions, which are relevant to the structural design of buildings and civil engineering works including some geotechnical aspects:

— specific weight of construction materials and stored materials;

— self-weight of construction works; and

— imposed loads for buildings.

0.4 Verbal forms used in the Eurocodes

The verb “shall” expresses a requirement strictly to be followed and from which no deviation is permitted in order to comply with the Eurocodes.

The verb “should” expresses a highly recommended choice or course of action. Subject to national regulation and/or any relevant contractual provisions, alternative approaches could be used/adopted where technically justified.

The verb “may” expresses a course of action permissible within the limits of the Eurocodes.

The verb “can” expresses possibility and capability; it is used for statements of fact and clarification of concepts.

0.5 National Annex for EN 1991-1-1

National choice is allowed in this standard where explicitly stated within notes. National choice includes the selection of values for Nationally Determined Parameters (NDPs).

The national standard implementing EN 1991-1-1 can have a National Annex containing all national choices to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

When no national choice is given, the default choice given in this standard is to be used.

When no national choice is made and no default is given in this standard, the choice can be specified by a relevant authority or, where not specified, agreed for a specific project by appropriate parties.

National choice is allowed in EN 1991-1-1 through the following clauses:

5.4.3 (1)	5.4.3 (2) – 2 choices	5.4.3 (3)	5.4.3 (4)
5.4.3 (5)	6.2.2 (2)	6.5.2 (1)	6.5.2 (2)
6.5.3.1 (2)	6.5.3.1 (3)	6.5.3.2 (2)	6.5.3.2 (5)
6.5.3.2 (6)	6.5.3.2 (7)	6.5.3.4 (3) – 3 choices	6.5.6.1 (1)
6.5.6.2 (1) – 2 choices	6.5.6.3 (1)	6.6.2 (1) – 2 choices	6.6.2 (2)

National choice is allowed in EN 1991-1-1 on the application of the following informative annexes:

— Annex A.

The National Annex can contain, directly or by reference, non-contradictory complementary information for ease of implementation, provided it does not alter any provisions of the Eurocodes.

1 Scope

1.1 Scope of EN 1991-1-1

(1) EN 1991-1-1 gives rules on the following aspects related to actions, which are relevant to the structural design of buildings and civil engineering works including some geotechnical aspects:

— specific weight of construction materials and stored materials;

— self-weight of construction works;

— imposed loads for buildings.

(2) Mean values for specific weight of specific construction materials, additional materials for bridges, stored materials and products are given. In addition, for specific materials and products the angle of repose is provided.

(3) Methods for the assessment of the characteristic values of self-weight of construction works are given.

(4) Characteristic values of imposed loads are given for the following areas in buildings according to the category of use:

— residential, social, commercial and administration areas;

— areas for archive, storage and industrial activities;

— garage and vehicle traffic areas (excluding bridges);

— roofs;

— stairs and landings;

— terraces and balconies.

NOTE The loads on traffic areas given in this standard refer to vehicles up to a gross vehicle weight of 160 kN. Further information can be obtained from prEN 1991-2:2021.

(5) Characteristic values of horizontal loads on parapets and partition walls acting as barriers are provided.

NOTE Forces due to vehicle impact are specified in EN 1991-1-7 and prEN 1991-2:2021.

1.2 Assumptions

(1) The general assumptions of FprEN 1990:2022 apply.

(2) EN 1991-1-1 is intended to be used with EN 1990, the other Parts of EN 1991 and the other Eurocode parts for the design of structures.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE See the Bibliography for a list of other documents cited that are not normative references, including those referenced as recommendations (i.e. in “should” clauses), permissions (“may” clauses), possibilities (“can” clauses), and in notes.

FprEN 1990:2022, *Eurocode — Basis of structural and geotechnical design*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions provided in EN 1990 and the following apply.

3.1.1
specific weight
overall weight per unit volume of a material, including a normal distribution of micro-voids, voids and pores

Note 1 to entry: In everyday usage this term is frequently called to “density” (which is strictly mass per unit volume).

3.1.2
angle of repose
angle which the natural slope of the sides of a heaped pile of loose material makes to the horizontal

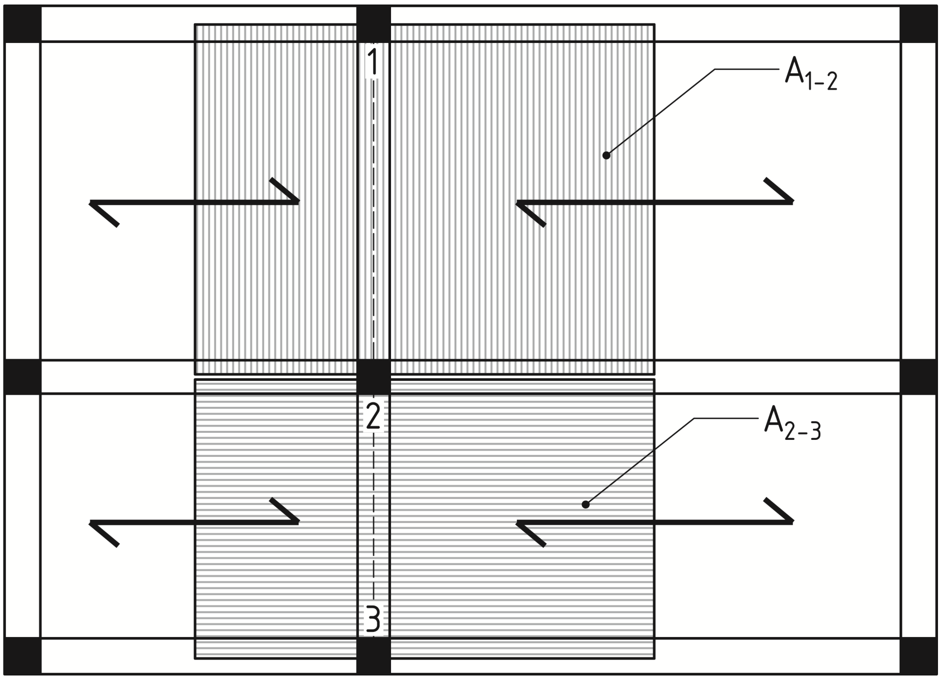
3.1.3
gross vehicle weight
self-weight of the vehicle together with the maximum weight of the goods it is permitted to carry

3.1.4
partitions
non-load bearing walls

3.1.5
tributary area
area whose loading is assumed to contribute to the loading on the structural member supporting that area

Note 1 to entry: The tributary area can change depending on the support conditions. An example of tributary areas for a beam supporting two single span one-way decks is given in Figure 3.1. An example of tributary areas for columns is given in Figure 3.2, which takes account of the continuity effects of the slab.

Note 2 to entry: On each floor, the sum of tributary areas equals the total area of the slab.

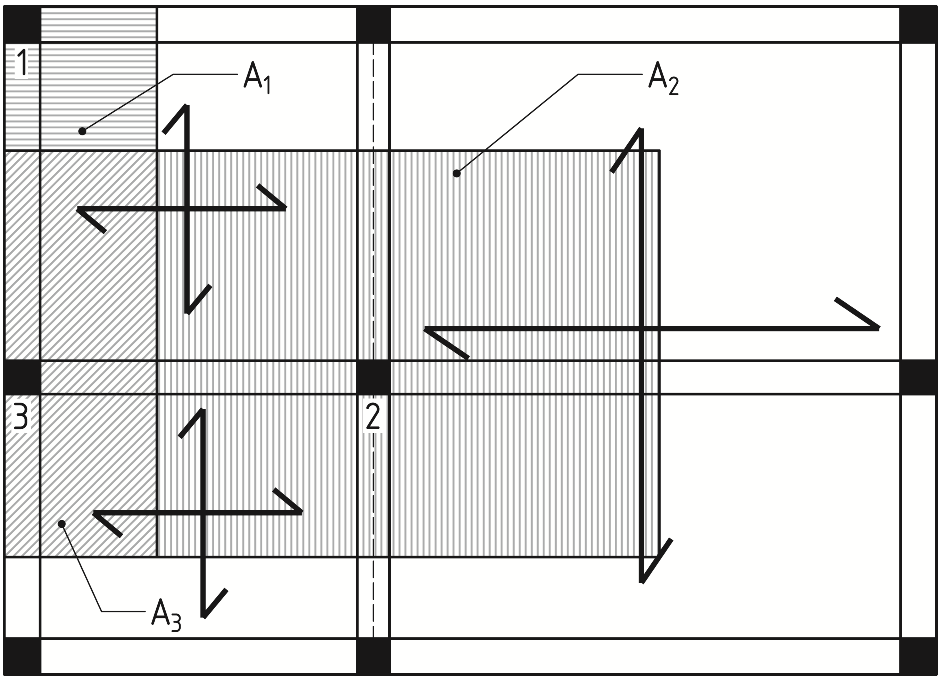


Key

$A_{1\text{-}2}$ tributary area related to beam 1-2

$A_{2\text{-}3}$ tributary area related to beam 2-3

Figure 3.1 — Example of tributary area related to a beam (slabs are only spanning over one bay)



Key

A_1 tributary area related to column 1

A_2 tributary area related to column 2

A_3 tributary area related to column 3

Figure 3.2 — Example of tributary area related to columns supporting a slab (two way spanning)

3.1.6
imposed loads on buildings
loads arising from occupancy

3.1.7
synchronised rhythmic crowd load
load induced by coordinated jumping and stamping, e.g. by spectators on grandstands at sporting events and concerts, coordinated jumping or dancing at fitness centres or similar

Note 1 to entry: 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.

3.1.8
grandstand
large, often roofed structure that can include standing and/or seated accommodation for spectators at sporting or other events

3.1.9
stage
structure that includes a performance area, which is used for a wide variety of functions at public and private events

3.2 Symbols and abbreviations

(1) For the purposes of this document, the following symbols apply.

3.2.1 Latin upper-case symbols

A	tributary area
A_{ref}	defined area for the application of q_{k} on roofs
$G_{\mathrm{k,inf}}$	lower characteristic value of a permanent action
$G_{\mathrm{k,\,sup}}$	upper characteristic value of a permanent action
Q_{k}	characteristic value of a variable concentrated action
$Q_{\mathrm{k,dyn}}$	characteristic value of a dynamic action
$Q_{\mathrm{k,p}}$	self-weight of movable partitions

3.2.2 Latin lower-case symbols

g_{k}	weight per unit area, or weight per unit length
l	overall length of a forklift
n	number of storeys
q_{k}	characteristic value of a uniformly distributed load, or line load
$q_{\mathrm{k,p}}$	characteristic value of the uniformly distributed load representing partitions
$w_{\mathrm{f,axle}}$	width of axle relevant to a forklift
$w_{\mathrm{f,overall}}$	overall width of a forklift

3.2.3 Greek lower-case symbols

α_A	reduction factor for imposed loads for floors and accessible roofs
α_n	reduction factor for imposed loads for columns and walls
γ	specific weight
φ	dynamic amplification factor
ψ_0	combination factor applied to a variable action to determine its combination value (see FprEN 1990:2022)
ϕ	angle of repose (degrees)

4 Specific weight of construction and stored materials

(1) Characteristic values of specific weight of construction and stored materials should be specified.

(2) Mean values should be used as characteristic values unless cases (4) and (5) occur.

NOTE Annex A gives mean values for specific weight and angles of repose for stored materials and products.

(3) When a range is given in Annex A, the selection of the appropriate mean values for specific weight and angles of repose may be as agreed for a specific project by the relevant parties.

NOTE When a range is given, it is assumed that the mean value will be highly dependent on the source of the material.

(4) For materials which are not covered by the Tables in Annex A (e.g. new and innovative materials), the characteristic value of the specific weight should be determined in accordance with FprEN 1990:2022, 6.1.2.2.

(5) Where materials are used with a significant scatter of specific weights e.g. due to their source, water content, the characteristic value of the specific weights should be assessed in accordance with FprEN 1990:2022, 6.1.2.2.

(6) Specific weights derived from direct measurements and tests may be used.

NOTE Further information about testing and statistical evaluations is given in FprEN 1990:2022, Annex D.

5 Self-weight of construction works

5.1 Design situations

(1) The self-weight of the structure or structural member shall be determined for each relevant design situation.

NOTE For the selection of design situations see FprEN 1990:2022, 5.2.

(2) Where elements other than structural are classified as permanent actions, the total self-weight (including both structural members and elements other than structural) should be treated as a single action when introducing relevant combinations of actions according to the single source principle.

NOTE 1 For the classification of self-weight of elements other than structural, see 5.2 (2).

NOTE 2 For the single source principle, see FprEN 1990:2022, 6.1.1.

(3) For areas where it is intended to remove, add or modify structural members or elements other than structural, the load-effect of the intended removal, modification or addition shall be incorporated in the load cases where applicable.

NOTE See EN 1991-1-6 for removals, modifications or additions during execution.

(4) When a water action is classified as permanent, the water level shall be taken into account for the relevant design situations.

NOTE See FprEN 1990:2022 for classification of water actions and EN 1997 (all parts) for additional information about treatment of groundwater.

(5) The moisture content of bulk materials should be considered where appropriate in design situations of buildings used for storage purposes.

NOTE The values for the specific weight provided in Annex A are for materials in the dry state.

(6) Variations in moisture content and variation in depth, which can be caused by uncontrolled accumulation during the design service life of the structure, should be considered when dealing with loads due to ballast and earth loads, see 4 (5).

NOTE For detailed information on earth pressures, see prEN 1997-3.

5.2 Classification

(1) The self-weight of structural members shall be classified as a permanent fixed action.

NOTE For the classification of actions, see FprEN 1990:2022, 6.1.1.

(2) The self-weight of elements other than structural should be classified as a permanent action, either fixed or free as relevant.

NOTE Elements other than structural are typically classified as permanent actions, but there can be cases where it is relevant to classify them as variable actions, see for 6.5.3.1 for a simplified approach for the treatment of partitions as imposed loads.

5.3 Representation of actions

(1) The self-weight of the construction works should in most cases be represented by a single characteristic value.

NOTE FprEN 1990:2022, 6.1.2.2 clarifies when a permanent action can be represented by a single characteristic value.

(2) According to FprEN 1990:2022, 6.1.2.2, if the uncertainty in the self-weight is not small, or if the structure is sensitive to variations in its value or spatial distribution, the self-weight should be represented by upper and lower characteristic values $G_{\mathrm{k,sup}}$ and $G_{\mathrm{k,inf}}$ respectively.

NOTE See 5.4.3 for cases where upper and lower characteristic values are to be used for bridges.

5.4 Characteristic values of self-weight

5.4.1 General

(1) The determination of the characteristic values of self-weight shall be in accordance with FprEN 1990:2022, 6.1.2.2.

(2) If the self-weight of the structure or structural member is represented by a single characteristic value (see 5.3 (1)), it may be calculated from the product of the nominal dimensions of the structure or structural member and the characteristic values of the specific weights.

NOTE Nominal dimensions are typically those specified in the design.

5.4.2 Additional provisions for buildings

(1) For manufactured elements such as flooring systems, facades and ceilings, lifts and equipment for buildings, data provided by the manufacturer on relevant characteristic values should be used when available.

5.4.3 Additional provisions for bridges

(1) The upper and lower characteristic values of specific weights for elements other than structural, such as ballast on railway bridges, or fill above buried structures such as culverts, should be taken into account if the material is expected to consolidate, become saturated or otherwise change its properties, during use.

NOTE Upper and lower characteristic values of specific weights for elements other than structural specific to bridges can be given in the National Annex.

(2) The nominal depth of ballast on railway bridges and the deviation from the nominal depth used to determine the upper and lower characteristic values of the depth of ballast should be specified where relevant.

NOTE 1 A suitable value of the depth of ballast on railway bridges can be given in the National Annex.

NOTE 2 The deviation from the nominal depth is ± 30 % unless the National Annex gives a different value.

(3) To determine the upper and lower characteristic values of self-weight of waterproofing, surfacing and other coatings for bridges, where the variability of their thickness can be high, a deviation of the total thickness from the nominal or other specified values should be taken into account.

NOTE The deviation of the total thickness from the nominal or other specified values is equal to ± 20 % if a post-execution coating is included in the nominal value, and to +40 % and –20 % if such a coating is not included, unless the National Annex gives a different value.

(4) To determine the upper and lower characteristic values of the self-weight of cables, pipes and service ducts, a deviation from the mean value of the self-weight should be taken into account.

NOTE The deviation from the mean value of the self-weight is ± 20 %, unless the National Annex gives a different value.

(5) For elements such as

— hand rails, safety barriers, parapets, kerbs and other bridge furniture;

— joints/fasteners;

— void formers.

the characteristic values of the self-weight should be specified where relevant.

NOTE The characteristic value for the self-weight of such elements is the nominal value unless the National Annex gives different rules.

(6) The filling of voids with water or other materials should be considered as relevant.

6 Imposed loads on buildings

6.1 Design situations

(1) The imposed loads shall be determined for each relevant design situation as relevant.

NOTE For the selection of design situations see FprEN 1990:2022, 5.2

(2) For areas which are intended to be subjected to different categories of imposed loads (i.e. multiple use), the most unfavourable category of loading which produces the highest effects of actions (e.g. forces or deflection) in the structural member under consideration shall be considered.

(3) In design situations when different imposed loads act simultaneously with other variable actions (e.g. actions induced by wind, snow, cranes or machinery), the imposed loads considered in the load case should be treated as a single action.

(4) Where the number of load variations or the effects of vibrations can cause fatigue, a fatigue load model should be established.

(5) For structural susceptible to vibrations, dynamic models of imposed loads should be considered where relevant.

NOTE 1 For dynamic actions, see FprEN 1990:2022 and the additional provisions given in 6.2.2.

NOTE 2 For dynamic loads caused by machinery, see EN 1991-3.

(6) The imposed loads to be considered for serviceability limit state verifications should be specified in accordance with the service conditions and the requirements concerning the performance of the structure.

6.2 Classification

6.2.1 General

(1) Imposed loads shall be classified as free variable actions, unless otherwise specified in this standard.

NOTE 1 For the classification of actions, see FprEN 1990:2022, 6.1.1.

NOTE 2 For imposed loads on bridges, see prEN 1991-2:2021.

NOTE 3 For accidental design situations where impact from vehicles or accidental loads from machines can be relevant, see EN 1991-1-7 and prEN 1991-2:2021.

(2) If there is no risk of resonance or other significant dynamic response of the structure, imposed loads may be taken into account as quasi-static actions (see FprEN 1990:2022, 3.1.3.17).

NOTE 1 For the treatment of the dynamic part of a quasi-static action, see FprEN 1990:2022, 7.1.3 (5).

NOTE 2 For synchronized rhythmic crowd loads, see 6.2.2.

(3) In cases of resonance or other significant dynamic response of the structure, imposed loads shall be classified as dynamic actions.

(4) Resonance effects may be neglected if the accelerations are lower than the acceleration limits relevant for user comfort and functionality.

NOTE According to FprEN 1990:2022, for specific types of structures or structural members having typical mass and damping properties, the acceleration limits can be assumed met when the natural frequency of vibrations is kept above appropriate values. For relevant limits and values, see FprEN 1990:2022, A.1.8.3.

6.2.2 Additional provisions for dynamic actions

(1) If resonance effects from synchronised rhythmic crowd loads cannot be neglected (see 6.2.1 (4)), a more refined analysis of the dynamic response of the structure should be performed according to FprEN 1990, the relevant parts of EN 1991 and the other Eurocodes.

NOTE 1 See also FprEN 1990:2022, A.1.8.3

NOTE 2 Further information on the procedure to be used for structures that are susceptible to dynamic excitation can be given in the National Annex.

(2) When considering forklifts and helicopters, the additional loadings due to masses and inertial forces caused by fluctuating effects should be considered.

NOTE 1 Fluctuating effects are taken into account by a dynamic amplification factor φ which is applied to the static load values, as shown in Formula (6.4).

NOTE 2 For forklifts, see 6.5.4.2. For helicopters, see 6.5.6.3.

6.3 Representation of actions

(1) For the determination of the imposed loads, floor and roof areas in buildings should be sub-divided into categories according to their use, see 6.5.2.

6.4 Load arrangements

6.4.1 Floors, beams and roofs

(1) For the design of a floor structure within one storey or a roof, the imposed load shall be taken into account as a free action applied at the most unfavourable part of the influence area of the action effects considered. For the other storeys, imposed loads may be assumed to be distributed uniformly (fixed actions) on the whole storey area.

NOTE 1 This is a simplified rule compared to the most critical ('chess board') loading arrangement.

NOTE 2 Characteristic values of uniformly distributed imposed loads are given in 6.5.

(2) To ensure a minimum local resistance of the floor structure, a separate verification shall be performed with a concentrated load. Unless stated otherwise, the combination of such concentrated load with the uniformly distributed loads or other variable actions may be neglected.

NOTE Characteristic values of concentrated loads are given in 6.5.

(3) Imposed loads acting on floors, beams and roofs may be reduced by a reduction factor α_A according to 6.5.3.2.

6.4.2 Columns and walls

(1) For the design of columns and walls, the imposed load should be placed at all unfavourable locations in order to calculate the most adverse (combination of) effects of actions.

(2) The maximum axial force may be calculated assuming the imposed loads on each storey to be uniformly distributed.

(3) Where imposed loads from several storeys act on columns and walls, the imposed loads may be reduced by a factor α_n according to 6.5.3.2.

6.5 Characteristic values of imposed loads

6.5.1 Field of application

(1) This clause covers values of imposed loads on buildings due to:

— normal use by persons;

— furniture and moveable objects (e.g. moveable partitions, storage, the contents of containers);

— vehicles;

— anticipating events, such as concentrations of persons or of furniture, or the moving or stacking of objects which may occur during reorganization or redecoration.

(2) The imposed loads specified in this part are modelled by uniformly distributed loads, line loads or concentrated loads or combinations of these loads.

(3) Heavy equipment (e.g. in communal kitchens, radiology rooms, boiler rooms, etc.) are not included in the loads given in this clause. Loads for heavy equipment should be specified by the relevant authority or, where not specified, agreed for a specific project by the relevant parties.

6.5.2 Categories of use and characteristic values

(1) Imposed loads on buildings shall be divided into categories according to the specific use of the area under consideration.

NOTE The categories are those given in Table 6.1 (NDP), unless the National Annex provides sub-categories and/or additional categories.

(2) Imposed loads shall be designed by using characteristic values q_{k} (uniformly distributed load) and/or Q_{k} (concentrated load).

NOTE 1 q_{k} is intended for determination of general effects. Q_{k} is intended for local effects and not expected to be combined with q_{k} unless otherwise stated, see also 6.4.1 (2) for local verifications.

NOTE 2 The values for qk and Qk are given in Table 6.1 (NDP), unless the National Annex gives different values.

NOTE 3 For specific provisions on the identified categories of use, see 6.5.3 to 6.5.5.

(3) The concentrated load Q_{k} shall be considered to act at any point on the floor, roof, balcony, terrace, staircase over an area with a shape which is appropriate to the use and form of the floor.

NOTE See Table 6.1 (NDP) for the dimension of the loaded area.

(4) Independent of this classification of areas, dynamic effects shall be considered where it is anticipated that the occupancy will cause significant dynamic effects.

NOTE See 6.2.2 for additional provisions on dynamic actions.

Table 6.1 — (NDP) Categories of use and values for q_k and Q_k

Category	Specific Use	Example	q_k [kN/m²]	Q_k [kN]	Typical dimension of the area loaded by Q_k expressed in (m × m)
A	Areas for domestic and residential activities	**A1** Rooms in residential buildings and houses, including corridors.	2,0	2,0	0,05 × 0,05
		A2 Bedrooms, wards, dormitories, private bathrooms and toilets in hospitals, hotels, hostels and other institutional residential occupancies.	2,0	2,0	0,05 × 0,05
B[a]	Public areas (not susceptible to crowding)	**B1** Office areas for general use including corridors other than archive / storage areas (see Category E)	3,0	3,0	0,05 × 0,05
		B2 Kitchens, communal bathrooms and toilets in hospitals, hotels, hostels and other institutional residential occupancies.	3,0	3,0	0,05 × 0,05
C[b,c,d]	Public areas where people may congregate (with the exception of areas defined under category A, B, and D)	**C1**: Areas with tables, etc. e.g. areas in schools, cafés, restaurants, dining halls, reading rooms, receptions.	3,0	4,0	0,05 × 0,05
		C2: Areas with fixed seats, e.g. areas in churches, theatres, cinemas, conference rooms, lecture halls, assembly halls, waiting rooms.	4,0	4,0	0,05 × 0,05
		C3: Areas without obstacles for moving people, e.g. areas in museums, exhibition rooms, etc. and corridors to areas not belonging to categories A1, B1 and C5.	5,0	4,0	0,05 × 0,05
		C4: Areas with possible physical activities, e.g. dance halls, gymnastic rooms, stages.	5,0	7,0	0,05 × 0,05
		C5: Areas susceptible to large crowds, e.g. in buildings for public events including corridors like concert halls, sports halls including stands, and railway platforms.	7,5	4,5	0,05 × 0,05

Category	Specific Use	Example	q_{k} [kN/m^2]	Q_{k} [kN]	Typical dimension of the area loaded by Q_{k} expressed in (m × m)
D	Shopping areas	**D1:** Areas in retail shops	4,0	4,0	0,05 × 0,05
		D2: Areas in department stores	5,0	7,0	0,05 × 0,05
E	Areas for archive, storage and industrial use[e]	**E1**: Areas susceptible to accumulation of goods, including access areas [f]	7,5	7,0	[a]
		E2: Industrial use [g,h,i,j]	[a]		
F	Garages and vehicle traffic areas (excluding ordinary roads and bridges)	Gross vehicle weight ≤ 30 kN: **F1** Traffic and parking areas for light vehicles (≤8 seats not including driver) e.g. garages; parking areas, parking halls	2,5	20	[a]
G		30 kN < Gross vehicle weight ≤ 160 kN: **G1** Traffic and parking areas for medium vehicles (on 2 axles) e.g. access routes, delivery zones, zones accessible to fire engines	5,0	90	0,2 × 0,2
		Gross vehicle weight > 160 kN: **G2** Traffic and parking areas for heavy vehicles [k]	[a]		
H [l]	Roofs not accessible except for normal maintenance and repair		0,4	1,0	0,05 × 0,05
I	Roofs accessible with occupancy according to categories A to G		See categories A to G		
K	Roofs accessible for special services, such as classes HC for helicopter landing areas		5,0	See Table 6.4	
S	Stairs and landings	**S1** Stairs and landings to areas belonging to category A1 and B1.	See categories A1 and B1		0,05 × 0,05
		S2 Stairs and landings for tribunes without fixed seats that are defined as escape ways.	7,5	3,0	0,05 × 0,05
		S3 Stairs and landings not belonging to category S1 or S2.	5,0	2,0	0,05 × 0,05
T	Terraces and balconies	**T1** Roof terraces, access balconies, balconies, loggias, etc.	3,0	2,0	0,05 × 0,05

Category	Specific Use	Example	q_k [kN/m²]	Q_k [kN]	Typical dimension of the area loaded by Q_k expressed in (m × m)

[a] Specific imposed loading and their impact area may be specified by the relevant authority or, where not specified, agreed for a specific project by the relevant parties.

[b] Depending on their anticipated uses, areas likely to be categorized as C2, C3, C4 may be categorized as C5 in the event of a large crowd as agreed for a specific project by the relevant parties.

[c] Attention is drawn to dynamic effects, see 6.5.2 (4) and 6.2.2, in particular for C4 and C5.

[d] For loadings on grandstands and stages, see 6.5.3.4.

[e] For concentrated loads from storage racks or from lifting equipment, Q_k should be determined for the individual case.

[f] Loads for storage areas for books and other documents should be determined from the loaded area and the height of the bookcases using the appropriate values for density. Presence of movable stands should be considered where relevant.

[g] For industrial use, see also 6.5.4.

[h] For actions induced by forklifts, see 6.5.4.2.

[i] For actions induced by transport vehicles, see 6.5.4.3.

[j] For actions induced by special devices for maintenance, see 6.5.4.4.

[k] For heavy vehicles, see also EN 1991-2.

[l] The characteristic values Q_k and q_k given in this table for roofs in category H are related to the projected area of the roof under consideration. They do not take into account uncontrolled accumulations of construction materials that can occur during maintenance, see also EN 1991-1-6.

6.5.3 Residential, social, commercial and administration areas (categories A to D)

6.5.3.1 Partitions treated as imposed loads

(1) The self-weight of partitions may be taken into account by introducing a uniformly distributed load $q_{k,p}$, provided that the following conditions are verified:

— the relevant floor allows a sufficient distribution of a line load orthogonal to the intended orientation of the partition, and

— the self-weight of the partition is $Q_{k,p} \leq 3{,}0$ kN/m wall length.

NOTE Partitions are elements other than structural; as such, according to 5.2 (2), they are expected to be classified as permanent actions, typically free for their spatial variation. The simplified approach provided in (1) only applies when the conditions defined above are verified. See (4) for heavier partitions.

(2) The uniformly distributed load $q_{k,p}$ defined in (1) should be added to the imposed loads of floors obtained from Table 6.1 (NDP).

(3) The value of this uniformly distributed load $q_{k,p}$ for partitions with a self-weight $Q_{k,p} \leq 3{,}0$ kN/m wall length should be based on the self-weight of the partitions.

NOTE In such a case, $q_{k,p}$ is derived from Formula (6.1) unless the National Annex gives different rules:

$$q_{k,p} = \max\{0{,}35 \text{ kN/m}^2;\ 0{,}4/\text{m}\ Q_{k,p}\} \tag{6.1}$$

with:

$Q_{k,p}$ expressed in kN/m wall length

$q_{k,p}$ expressed in kN/m^2

(4) The value of the uniformly distributed load $q_{k,p}$ for partitions with a self-weight $Q_{k,p}$ > 3,0 kN/m wall length should be determined taking account of:

— the locations and directions of the partitions;

— the structural form of the floors.

NOTE The National Annex can set specific rules to derive the value of the uniformly distributed load $q_{k,p}$ for partitions with a self-weight $Q_{k,p}$ > 3,0 kN/m wall length.

6.5.3.2 Reduction factors

(1) The reduction factors α_A and α_n specified in this clause, which are applicable to the q_k values for imposed loads, may be used unless otherwise specified by the relevant authority or agreed for a specific project by the relevant parties.

NOTE α_A is the reduction factor relevant to imposed loads on floors, beams and roofs; α_n is the reduction factor relevant to columns and walls depending on the number of storeys above such columns and walls.

(2) The reduction factors α_A and α_n may be mutually combined when dealing with multi-storey buildings.

NOTE The reduction factors α_A and α_n can be mutually combined provided that the product $\alpha_A \times \alpha_n$ is not less than 0,50, unless the National Annex gives different rules.

(3) The reduction factors α_A and α_n should not be applied for accidental and seismic design situations, including fire.

(4) In accordance with 6.4.1 (3) a reduction factor α_A may be applied to the q_k values for imposed loads for floors, beams and accessible roofs.

NOTE 1 The value for the reduction factor α_A for categories A, B, C, D and category I (accessible roofs) is determined from Formula (6.2) unless the National Annex gives an alternative method and/or specific rules for the use of the reduction factor α_A, including its application for partitions and for specific categories C and D, where the reduction factor could be inappropriate to use.

$$\alpha_A = 0,5 + \frac{10}{A} \leq 1,0 \qquad (6.2)$$

with the restriction for categories C and D: $\alpha_A \geq 0,6$

where:

A is the tributary area expressed in m^2.

NOTE 2 For continuous structures, the reduction factor α_A generally differs from span to span (see Figures 6.1 and 6.2). As a simplification, the same value can apply uniformly using the maximum of the α_A values calculated for different tributary areas (see Figure 6.3).

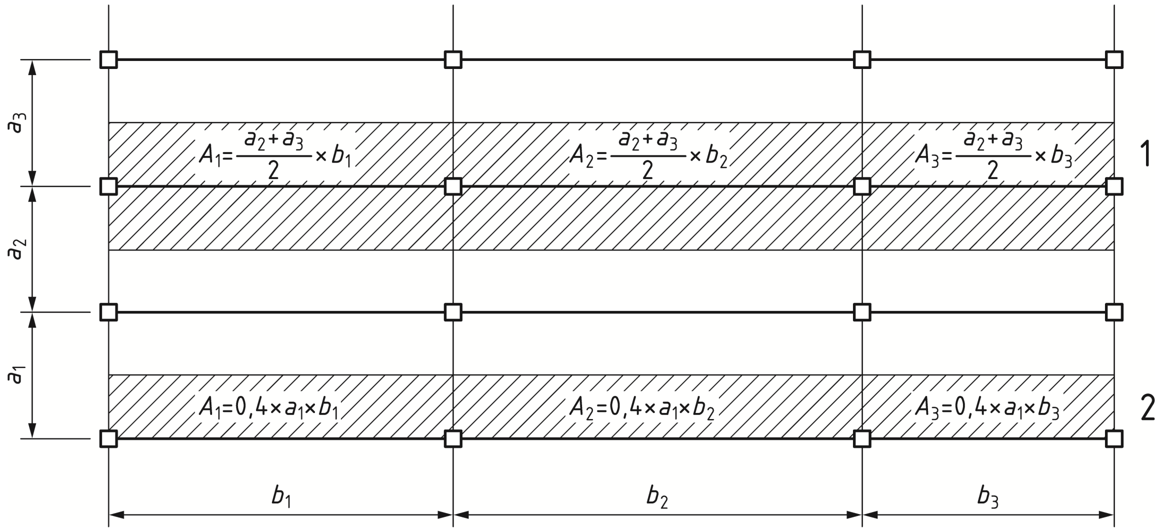


Figure 6.1 — Tributary areas relevant to mid-spans and end spans for one-way slabs (with A2 > A1 > A3) – example of continuous beams supporting continuous slabs

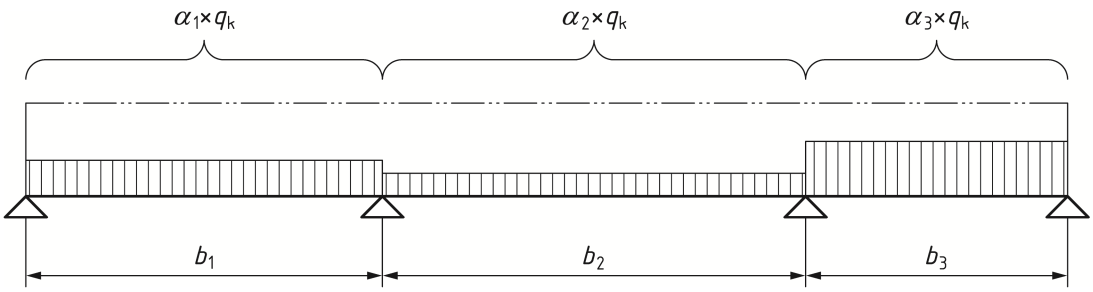


Figure 6.2 — Load reduction with α_i values differing from span to span (with $\alpha_3 > \alpha_1 > \alpha_2$)

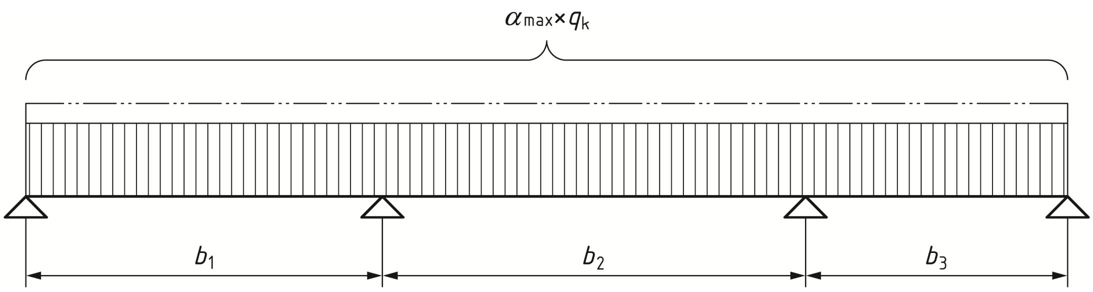


Figure 6.3 — Load reduction with uniform α_i values (simplified so that $\alpha_{max} = \alpha_3$)

(6) In accordance with 6.4.2 (3) and provided that the area is classified according to Table 6.1 (NDP) into the categories A to D and T, for columns and walls the imposed loads on the floors supported by the column or wall under consideration may be multiplied by the reduction factor α_n.

NOTE The values for α_n can be calculated from Formula (6.3) unless the National Annex gives an alternative method.

$$\alpha_n = 0,7 + \frac{0,6}{n} \leq 1,0 \tag{6.3}$$

where α_n is calculated for each floor considering the number of floors n above the column or wall under consideration.

(7) When the imposed load is considered as an accompanying action in accordance with EN 1990, the combination of the factors ψ (FprEN 1990:2022, Table A.1.7) and α_n may be considered.

NOTE The two factors ψ and α_n can be combined, unless the National Annex gives different rules.

6.5.3.3 Actions induced by forklifts

(1) The vertical loads on floors due to traffic of forklifts shall be taken into account according to 6.5.4.2.

6.5.3.4 Grandstands and stages

(1) Loadings on grandstands should take account of loads from spectators, fixed and movable equipment, and any dynamic loads caused by people dancing, jumping or moving in a synchronized manner.

NOTE For barrier and handrail loadings for grandstands, see 6.6.

(2) Specific loading requirements may be specified by the relevant authority, or, where not specified, agreed for a specific project by the relevant parties.

(3) For stage structures where the resonance effects can be neglected (see 6.2.1), the stage surface should be designed to withstand a minimum vertical static equivalent load and a simultaneous notional horizontal load applied to the stage surface at the node joints where vertical imposed loads are transferred to the vertical members.

NOTE 1 The minimum vertical static equivalent load is 5 kN/m^2 unless the National Annex gives a different value.

NOTE 2 The minimum notional horizontal load is 5 % of the design vertical imposed load applied to the area of stage floor on which the activity takes place, unless the National Annex gives different values taking account of the anticipated activity on the stage surface.

NOTE 3 The minimum notional horizontal load is 2,5 % of the design vertical imposed load for other parts of the stage floor (for example areas used for workers and equipment) unless the National Annex gives a different value.

NOTE 4 The notional horizontal loads are typically applied in combination with wind loads and not combined with horizontal loads that take account of the geometric imperfections of frames.

6.5.4 Areas for archive, storage and industrial activities (category E)

6.5.4.1 Load model

(1) The characteristic value of the imposed load in areas for storage and industrial activities shall be the maximum value taking account of the dynamic effects if appropriate. The loading arrangement shall be defined so that it produces the most unfavourable conditions allowed in use.

NOTE For transient design situations due to installation and reinstallation of machines, production units, etc. guidance is given in EN 1991-1-6.

(2) Any effects of filling and emptying should be taken into account.

(3) The characteristic values of vertical loads in storage areas (category E1 in Table 6.1 (NDP)) should be derived by taking into account the specific weight and the upper design values for stacking heights. When stored material exerts horizontal forces on walls, etc. the horizontal force should be determined in accordance with EN 1991-4.

NOTE See Annex A for specific weights.

(4) Loads in industrial areas should be assessed considering the intended use and the equipment which is to be installed. Where equipment such as cranes, moving machinery, etc. are to be installed the effects on the structure should be determined in accordance with EN 1991-3.

(5) Actions due to forklifts and transport vehicles should be considered as concentrated loads acting together with the appropriate imposed distributed loads given in Table 6.1 (NDP), see 6.5.4.2 and 6.5.4.3.

6.5.4.2 Actions induced by forklifts

(1) Forklifts should be classified in six classes FL 1 to FL 6 depending on net weight, dimensions and hoisting loads, see Table 6.2 and Figure 6.4.

Table 6.2 — Dimensions of forklift according to classes FL

Class of Forklift	**Net weight** [kN]	**Hoisting load** [kN]	**Width of axle** $w_{f,axle}$ [m]	**Overall width** $w_{f,overall}$ [m]	**Overall length** l [m]
FL 1	21	10	0,85	1,00	2,60
FL 2	31	15	0,95	1,10	3,00
FL 3	44	25	1,00	1,20	3,30
FL 4	60	40	1,20	1,40	4,00
FL 5	90	60	1,50	1,90	4,60
FL 6	110	80	1,80	2,30	5,10

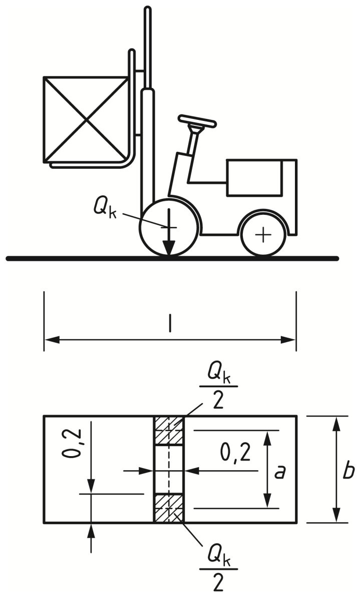


Figure 6.4 — Dimensions of forklifts

(2) The static characteristic value of the vertical axle load Q_k of a forklift should be obtained from Table 6.3 depending on the forklift classes.

Table 6.3 — Axle loads of forklifts

Class of forklifts	Axle load Q_k [kN]
FL 1	26
FL 2	40
FL 3	63
FL 4	90
FL 5	140
FL 6	170

(3) The static characteristic value of the vertical axle load Q_k should be increased by the dynamic amplification factor φ using Formula (6.4) to derive the characteristic value of the dynamic action $Q_{k,dyn}$:

$$Q_{k,dyn} = \varphi \, Q_k \tag{6.4}$$

NOTE The dynamic amplification factor φ for forklifts takes into account the inertial effects caused by acceleration and deceleration of the hoisting load.

(4) The dynamic factor φ for forklifts should be taken as:

φ = 1,40 for pneumatic tyres,

φ = 2,00 for solid tyres.

(5) For forklifts having a net weight greater than 110 kN the loads should be defined by a more accurate analysis.

(6) The vertical axle load Q_k and $Q_{k,dyn}$ of a forklift should be arranged according to Figure 6.4.

(7) Horizontal loads due to acceleration or deceleration of forklifts may be taken as 30 % of the vertical axle loads Q_k. Dynamic factors may be neglected.

6.5.4.3 Actions induced by transport vehicles

(1) The actions from transport vehicles that move on floors freely or guided by rails should be determined by a pattern of wheel loads.

(2) The static values of the vertical wheel loads should be given in terms of permanent weights and pay loads. Their spectra should be used to define combination factors and fatigue loads.

(3) The vertical and horizontal wheel loads should be determined for the specific case.

(4) The load arrangement including the dimensions relevant for the design should be determined for the specific case.

NOTE Where relevant, see traffic load models from prEN 1991-2:2021.

6.5.4.4 Actions induced by special devices for maintenance

(1) Special devices for maintenance should be modelled as loads from transportation vehicles, see 6.5.4.3.

(2) The load arrangements including the dimensions relevant for the design should be determined for the specific case.

6.5.5 Garages and vehicle traffic areas excluding ordinary roads and bridges (categories F and G)

(1) The load model which should be used for garages and vehicle traffic areas (excluding ordinary roads and bridges) is a single axle with a load Q_k with dimensions according to Figure 6.5 and/or a uniformly distributed load q_k.

NOTE The characteristic values for q_k and Q_k and the impact area are given in Table 6.1 (NDP).

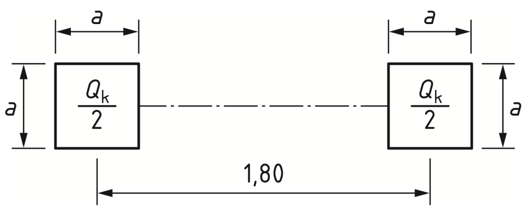


Figure 6.5 — Dimensions of axle load

(2) The axle load Q_k should be in the possible positions which will produce the most adverse effects of the action.

(3) Areas designed to categories F and G should be posted with the appropriate warning signs.

(4) Access to areas designed to category F should be limited by physical means built into the structure, which prevent access to vehicles heavier than category F.

6.5.6 Roofs (categories H to K)

6.5.6.1 General rules

(1) For roofs, the combination of imposed loads with climatic actions should be considered where appropriate.

NOTE The National Annex can set specific rules for combination of imposed loads with climatic actions (particularly for category H roofs).

6.5.6.2 Roofs not accessible except for normal maintenance and repair (category H)

(1) For roofs of category H, the characteristic value q_k shall be applied on a defined area A_{ref} of the roof at the most unfavourable position of the influence area of the action effects considered (see 6.4 for load arrangements).

NOTE 1 For category H, q_k can be varied by the National Annex dependent upon the roof slope.

NOTE 2 The area A_{ref} is equal to 10 m^2 unless the National Annex gives a different value and specific rules to consider the maintenance and repair conditions that are expected.

6.5.6.3 Roofs accessible for special services (category K)

(1) For roofs of category K, which are accessible for special services such as classes HC helicopter landing areas, to take account of dynamic effects during take-off and landing, the concentrated actions from helicopters on landing areas should be determined using Formula (6.4) and the dynamic amplification factor φ = 1,40.

NOTE 1 The dynamic amplification factor φ = 1,40 excludes accidental loadings, which are covered in EN 1991-1-7.

NOTE 2 Q_k is taken from Table 6.4 (NDP) according to the class of the helicopter, unless the National Annex gives different values.

Table 6.4 — Imposed loads on roofs of category K for helicopters

Class of helicopter	Take-off load Q of helicopter	Take-off load Q_k	Dimension of the loaded area (m × m)
HC1	$Q \leq 20$ kN	$Q_k = 20$ kN	0,2 × 0,2
HC2	20 kN < $Q \leq 60$ kN	$Q_k = 60$ kN	0,3 × 0,3
HC3	60 kN < $Q \leq 120$ kN	$Q_k = 120$ kN	0,3 × 0,3

6.5.6.4 Access ladders and walkways

(1) Access ladders and walkways should be assumed to be loaded according to category H for a roof slope < 20°.

(2) For walkways which are part of a designated escape route, q_k should be according to categories A to D as relevant.

(3) For walkways for service, a minimum characteristic value Q_k of 1,5 kN should be taken.

6.5.6.5 Frames and coverings of access hatches, supports of ceilings

(1) The following loads should be used for the design of frames and coverings of access hatches (other than glazing), the supports of ceilings and similar structures:

— without access: no imposed load;

— with access: 0,25 kN/m^2 distributed over the whole area or the area supported, and the concentrated load of 0,9 kN so placed so as to produce maximum stresses in the affected member.

6.5.7 Stairs and landings (category S)

(1) The characteristic values for q_k and Q_k that are given in Table 6.1 (NDP) should not be lower than the values of the adjacent areas, which give access to the stairs and landings under consideration.

6.5.8 Terraces and balconies (category T)

(1) The characteristic values for q_k and Q_k are given in Table 6.1 (NDP) should not be lower than the values of the adjacent areas, which give access to the terrace / balcony under consideration.

NOTE Imposed loads on terraces and balconies are usually not combined with snow loads, see also 6.5.6.1 for combination of imposed loads and climatic actions.

6.6 Parapets, partition walls acting as barriers, balustrades and guard rails

6.6.1 General

(1) Parapets, partition walls acting as barriers, balustrades and guard rails should be designed for both horizontal and vertical loads.

6.6.2 Horizontal loads

(1) The characteristic values of the line load q_k shall be applied at the height of the parapets, partition walls acting as barriers and balustrades but not higher than 1,2 m.

NOTE 1 The characteristic values of the line load q_k are given in Table 6.5 (NDP), unless the National Annex gives different values.

NOTE 2 The National Annex can prescribe additional concentrated loads Q_k and related loaded area, and/or hard or soft body impact specifications for analytical or experimental verification.

Table 6.5 — (NDP) Horizontal loads on partition walls and parapets

Category	**Specific Use**	q_k [kN/m]
A B C1	Areas for domestic and residential activities Office areas Areas with tables	0,8
C2 C3 C4 D	Areas with fixed seats Areas without obstacles for moving people Areas with possible physical activities Shopping areas	1,0
C5	Areas susceptible to large crowds	3,0
E[a]	Storage and industrial use	2,0
F	Garages and vehicle traffic areas in buildings, for gross vehicle weight ≤ 30 kN	See EN 1991-1-7
G	Garages and vehicle traffic areas in buildings, for gross vehicle weight > 30 kN	See EN 1991-1-7
S	Stairs and landings	See categories A to G
T	Balconies and terraces	

[a] For areas of category E, the horizontal loads depend on the occupancy. Therefore the value of q_k is defined as a minimum value and should be checked for the specific occupancy and actual storage conditions.

(2) Guard rails should be designed to resist a local horizontal load Q_k at any point.

NOTE The value of Q_k is 0,3 kN unless a different value is given in the National Annex.

(3) For areas susceptible to significant overcrowding associated with public events e.g. for sports stadiums, stands, stages, assembly halls or conference rooms, the line load should be taken according to category C5.

(4) Barrier and handrail loadings for grandstands should be designed considering: the geometric arrangement of the structure; typical movements of spectators in a direction parallel or perpendicular to the guardrail; and specific areas of grandstands like the front row, the rear of the stand, adjacent to the guard rail and the standing area.

6.6.3 Vertical loads

(1) The vertical load is 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 horizontal loading given in 6.6.2.

Annex A
(informative)

Tables for mean values of specific weight of construction materials, and mean values of specific weight and angles of repose for stored materials

A.1 Use of this Annex

(1) This Informative Annex provides supplementary guidance to that given in Clause 4 for mean values of specific weight of construction materials, and mean values of specific weight and angles of repose for stored materials.

NOTE National choice on the application of this Informative Annex is given in the National Annex. If the National Annex contains no information on the application of this informative annex, it can be used.

A.2 Scope and field of application

(1) This Informative Annex applies to construction and stored materials, including bridge materials.

A.3 Construction materials

(1) Mean values for the following construction materials are provided in Tables A.1 to A.6:

— concrete and mortar;

— masonry;

— wood;

— metals;

— other materials;

— bridge materials.

Table A.1 — Construction materials-concrete and mortar

Materials	*Specific weight* γ [kN/m^3]
concrete (see EN 206)	
lightweight	
density class D1,0	8,0 to 10,0[a b]
density class D1,2	10,0 to 12,0[a b]
density class D1,4	12,0 to 14,0[a b]
density class D1,6	14,0 to 16,0[a b]
density class D1,8	16,0 to 18,0[a b]
density class D2,0	18,0 to 20,0[a b]
normal weight	24,0[a b]
heavy weight	>26,0[a b]
mortar	
cement mortar	19,0 to 23,0
gypsum mortar	12,0 to 18,0
lime-cement mortar	18,0 to 20,0
lime mortar	12,0 to 18,0

[a] Increase by 1kN/m^3 for normal percentage of reinforcing and pre-stressing steel

[b] Increase by 1kN/m^3 for unhardened concrete

Table A.2 — Construction materials-masonry

Materials	*Specific weight* γ [kN/m³]
masonry units	
clay masonry units	see EN 771-1
calcium silicate masonry units	see EN 771-2
aggregate concrete masonry units	see EN 771-3
autoclaved aerated masonry units	see EN 771-4
manufactured stone masonry units	see EN 771-5
glass blocks, hollow	see EN 1051-2
terra cotta	21,0
natural stones, see EN 771-6	
granite, syenite, porphyry	27,0 to 30,0
basalt, diorite, gabbro	27,0 to 31,0
tachylyte	26,0
basaltic lava	24,0
gray wacke, sandstone	21,0 to 27,0
dense limestone	20,0 to 29,0
other limestone	20,0
volcanic tuff	20,0
gneiss	30,0
slate	28,0

Table A.3 — Construction materials-wood

Materials	*Specific weight* γ [kN/m³]
wood (see EN 1991 for timber strength classes)	
timber strength class C14	3,5
timber strength class C16	3,7
timber strength class C18	3,8
timber strength class C22	4,1
timber strength class C24	4,2
timber strength class C27	4,5

Materials	*Specific weight* γ [kN/m³]
timber strength class C30	4,6
timber strength class C35	4,8
timber strength class C40	5,0
timber strength class D30	6,4
timber strength class D35	6,7
timber strength class D40	7,0
timber strength class D50	7,8
timber strength class D60	8,4
timber strength class D70	10,8
glued laminated timber (see EN 14080 for Timber strength classes)	
homogenious glulam GL24h	3,7
homogenious glulam GL28h	4,0
homogenious glulam GL32h	4,2
homogenious glulam GL36h	4,4
combined glulam GL24c	3,5
combined glulam GL28c	3,7
combined glulam GL32c	4,0
combined glulam GL36c	4,2
plywood	
softwood plywood	5,0
birch plywood	7,0
laminboard and blockboard	4,5
particle boards	
chipboard	7,0 to 8,0
cement-bonded particle board	12,0
flake board, oriented strand board, wafer board	7,0
fibre building board	
hardboard, standard and tempered	10,0
medium density fibreboard	8,0
softboard	4,0

Table A.4 — Construction materials-metals

Materials	*Specific weight* γ [kN/m^3]
metals	
aluminium	27,0
brass	83,0 to 85,0
bronze	83,0 to 85,0
copper	87,0 to 89,0
iron, cast	71,0 to 72,5
iron, wrought	76,0
lead	112,0 to 114,0
steel	77,0 to 78,5
zinc	71,0 to 72,0

Table A.5 — Construction materials- other materials

Materials	*Specific weight* γ [kN/m^3]
other materials	
glass, broken	22,0
glass, in sheets	25,0
plastics	
acrylic sheet	12,0
polystyrene, expanded, granules	0,3
foam glass	1,4

Table A.6 — Bridge materials

Materials	*Specific weight* γ [kN/m³]
pavement of road bridges	
gussasphalt and asphaltic concrete	24,0 to 25,0
mastic asphalt	18,0 to 22,0
hot rolled asphalt	23,0
infills for bridges	
sand (dry)	15,0 to 16,0[a]
ballast, gravel (loose)	15,0 to 16,0[a]
hardcore	18,5 to 19,5
crushed slag	13,5 to 14,5[a]
packed stone rubble	20,5 to 21,5
puddle clay	18,5 to 19,5
pavement of rail bridges	
concrete protective layer	25,0
normal ballast (e.g. granite, gneiss, etc.)	20,0
basaltic ballast	26
	Weight per unit bed length[b c] g_k [kN/m]
structures with ballasted bed	
2 rails UIC 60	1,2
prestressed concrete sleeper with track fastenings	4,8
concrete sleepers with metal angle braces	-
timber sleepers with track fastenings	1,9
structures without ballasted bed	
2 rails UIC 60 with track fastenings	1,7
2 rails UIC 60 with track fastenings, bridge beam and guard rails	4,9

[a] Given in other tables as stored materials

[b] Excludes an allowance for ballast

[c] Assumes a spacing of 600 mm

NOTE The values for track are also applicable outside railway bridges.

A.4 Stored materials

(1) Mean values for the following stored materials are provided in Tables A.7 to A.12:

— building and construction;

— agricultural;

— foodstuffs;

— liquids;

— solid fuels;

— industrial and general.

Table A.7 — Stored materials — building and construction

Materials	*Specific weight* γ [kN/m^3]	**Angle of repose** ϕ [°]
aggregates (see EN 206)		30
lightweight	8,0 to 20,0[a]	30
normal	20,0 to 30,0	30
heavyweight	> 30,0	35
gravel and sand, bulked	15,0 to 20,0	30
sand	14,0 to 19,0	
blast furnace slag		
lumps	17,0	40
granules	12,0	30
crushed foamed	9,0	35
brick sand, crushed brick, broken bricks	15,0	35
vermiculite		
exfoliated, aggregate for concrete	1,0	-
crude	6,0 to 9,0	-
bentonite		
loose	8,0	40
shaken down	11,0	-
cement		
in bulk	16,0	28
in bag	15,0	-
fly ash	10,0 to 14,0	25
glass, in sheets	25,0	-
gypsum, ground	15,0	25
lignite filter ash	15,0	20
lime	13,0	25
limestone, powder	13,0	25 to 27
magnesite, ground	12,0	-
plastics,		
polyethylene, polystyrol granulated	6,4	30
polyvinylchloride, powder	5,9	40
polyester resin	11,8	-
glue resins	13,0	-
water, fresh	10,0	

[a] See table A.1 for density classes of lightweight concrete

Table A.8 — Stored products — agricultural

Products	*Specific weight* γ [kN/m³]	**Angle of repose** ϕ [°]
farmyard		
manure (minimum 60 % solids)	7,8	-
manure (with dry straw)	9,3	45
dry chicken manure	6,9	45
slurry (maximum 20 % solids)	10,8	-
fertiliser, artificial		
NPK, granulated	8,0 to 12,0	25
basic slag, crushed	13,7	35
phosphates, granulated	10,0 to 16,0	30
potassium sulphate	12,0 to 16,0	28
urea	7,0 to 8,0	24
fodder, green, loosely stacked	3,5 to 4,5	-
grain		
whole (≤ 14 % moisture content unless indicated otherwise)	7,8	30
general	7,0	30
barley	8,8	-
brewer’s grain (wet)	3,4	30
herbage seeds	7,4	30
maize in bulk	5,0	-
maize in bags	5,0	30
oats	6,4	25
oilseed rape	7,0	30
rye	7,8	30
wheat in bulk	7,5	-
wheat in bags	7,8	40
grass cubes		
hay		
(baled)	1,0 to 3,0	-
(rolled bales)	6,0 to 7,0	-
hides and skins	8,0 to 9,0	-
hops	1,0 to 2,0	25
malt	4,0 to 6,0	20
meal		
ground	7,0	45
cubes	7,0	40
peat		
dry, loose, shaken down	1,0	35

Products	*Specific weight* γ [kN/m³]	**Angle of repose** ϕ [°]
dry, compressed in bales	5,0	-
wet	9,5	-
silage	5,0 to 10,0	-
straw		-
in bulk (dry)	0,7	-
baled	1,5	-
tobacco in bales	3,5 to 5,0	-
wool		
in bulk	3,0	-
baled	7,0 to 13,0	-

Table A.9 — Stored products — foodstuffs

Products	*Specific weight* γ [kN/m³]	**Angle of repose** ϕ [°]
eggs, in stands	4,0 to 5,0	-
flour		
bulk	6,0	25
bagged	5,0	-
fruit		
apples		
- loose	8,3	30
- boxed	6,5	-
cherries	7,8	-
pears	5,9	-
raspberries, in trays	2,0	-
strawberries, in trays	1,2	-
tomatoes	6,8	-
sugar		
loose, piled	7,5 to 10,0	35
dense and bagged	16,0	
vegetables, green		
cabbages	4,0	-
lettuce	5,0	-
vegetables, legumes		
beans		
- general	8,1	35
- soya	7,4	30
peas	7,8	-

Products	*Specific weight* γ [kN/m³]	Angle of repose ϕ [°]
vegetables, root		
general	8,8	-
beetroot	7,4	40
carrots	7,8	35
onions	7	35
turnips	7	35
potatoes		
in bulk	7,6	35
in boxes	4,4	-
sugarbeet,		
dried and chopped	2,9	35
raw	7,6	-
wet shreds	10,0	-

Table A.10 — Stored products — liquids

Products	*Specific weight* γ [kN/m³]
beverages	
beer	10,0
milk	10,0
water, fresh	10,0
wine	10,0
natural oils	
castor oil	9,3
glycerol (glycerine)	12,3
linseed oil	9,2
olive oil	8,8
organic liquids and acids	
alcohol	7,8
ether	7,4
hydrochloric acid (40 % by weight)	11,8
methylated spirit	7,8
nitric acid (91 % by weight)	14,7
sulphuric acid (30 % by weight)	13,7
sulphuric acid (87 % by weight)	17,7

Products	*Specific weight* γ [kN/m^3]
turpentine, white spirit	8,3
hydrocarbons	
aniline	9,8
benzene (benzol)	8,8
coal tar	10,8 to 12,8
creosote	10,8
naphtha	7,8
paraffin (kerosene)	8,3
benzine (benzoline)	6,9
oil, crude (petroleum)	9,8 to 12,8
diesel	8,3
fuel	7,8 to 9,8
heavy	12,3
lubricating	8,8
petrol (gasolene, gasoline)	7,4
liquid gas	
butane	5,7
propane	5,0
other liquids	
mercury	133
red lead paint	59
white lead, in oil	38
sludge, over 50 % by volume water	10,8

Table A.11 — Stored products – solid fuels

Products	*Specific weight* γ [kN/m³]	**Angle of repose** ϕ [°]
charcoal		
air-filled	4	-
air-free	15	-
coal		
block briquettes, tipped	8	35
block briquettes, stacked	13	-
egg briquettes	8,3	30
coal, raw from pit	10	35
coal in washing pools	12	-
coal dust	7	25
coke	4,0 to 6,5	35 to 45
middlings in the quarry	12,3	35
waste washing tips in colliery	13,7	35
all other kinds of coal	8,3	30 to 35
firewood	5,4	45
lignite/brown coal		
briquettes, tipped	7,8	30
briquettes, stacked	12,8	-
damp	9,8	30 to 40
dry	7,8	35
dust	4,9	25 to 40
low-temperature coke	9,8	40
peat		
black, dried, firmly packed	6 to 9	-
black, dried, loosely tipped	3 to 6	45

Table A.12 — Stored products — industrial and general

Products	*Specific weight* γ [kN/m³]	**Angle of repose** ϕ[°]
books and documents		
books and documents,	6,0	-
densely stored	8,5	-
		-
filing racks and cabinets	6,0	-
garments and rags, bundled	11,0	-
ice, lumps	8,5	-
leather, piled	10,0	-
paper		
in rolls	15,0	-
piled	11,0	-
rubber	10,0 to 17,0	-
rock salt	22,0	45
salt	12,0	40
sawdust		
dry, bagged	3,0	-
dry, loose	2,5	45
wet, loose	5,0	45
tar, bitumen	14,0	-

Bibliography

References contained in recommendations (i.e. "should" clauses)

The following documents are referred to in the text in such a way that some or all of their content constitutes highly recommended choices or course of action of this document. Subject to national regulation and/or any relevant contractual provisions, alternative documents could be used/adopted where technically justified. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1991-4, *Eurocode 1 — Actions on structures — Part 4: Silos and tanks*

References given in permissions (i.e. "may" clauses)

The following documents are referred to in the text in such a way that some or all of their content expresses a course of action permissible within the limits of the Eurocodes. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

None.

References contained in permissions (i.e. "can" clauses) and notes

The following documents are cited informatively in the document, for example in "can" clauses and in notes.

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