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**DS/EN 1991-1-1:2025 DK NA:202x**

**National Annex to: Eurocode 1 - Actions on structures -  
Part 1-1: General actions - Densities, self-weight, imposed loads for buildings**

**National Anneks til: Eurocode 1 - Last på bærende konstruktioner -  
Del 1-1: Generelle laster – Densiteter, egenlast og nyttelast for bygninger**

## Foreword

Published [måned og år].

This National Annex (NA) to DS/EN 1991-1-1:2025 forms part of the Danish national annexes to the second generation of Eurocodes.

This NA supersedes DS/EN 1991-1-1:2007 DK NA:2024 upon its implementation in the Building Regulations (Bygningsreglementet 2018 – BR18) as an appendix.

During the transition period stated in the Building Regulations, both the first generation and the second generation of the Eurocodes and NAs may be applied.

This NA cannot be used in conjunction with the first generation of Eurocodes.

This NA lays down the conditions for the Danish implementation of DS/EN 1991-1-1:2025 for construction works in conformity with the Danish Building Regulations; Bygningsreglementet 2018 (BR18). Other parties may bring this NA into force by reference.

The Eurocodes establish the principle that certain parameters are left open for national determination. These parameters are referred to as *Nationally Determined Parameters* (NDP) and specifies the nationally applicable values, classes or methods. Furthermore, the NA may provide *Non-Contradictory, Complementary Information* (NCCI), i.e. additional guidance and alternative methods or values that support the application of the Eurocode without altering or contradicting its provisions.

Further, this National Annex includes NOTES. Notes have the status of guidance and provide additional information intended to assist the understanding or use of text of the national annex.

In conformity with the Danish Building regulations, the verbal forms used in this Eurocode and NA are to be understood as follows:

- “shall” expresses a requirement to be followed
- “should” expresses a recommendation. Alternative approaches could be used if technically justified
- “may” expresses permission within the limits of the Danish Building Regulations
- “can” expresses a possibility or capability
- “is/are” expresses a statement of certainty or a fact

This NA includes:

- Foreword;
- An overview of clauses with possible Nationally Determined Parameters (NDPs) and of Non-Contradictory Complementary Information (NCCI);
- National choice to national Determined Parameters (NDP), and Non-Contradictory Complementary Information (NCCI)

Valid versions of the NAs as well as previous versions, addenda can be found at [www.bygningsreglementet.dk](http://www.bygningsreglementet.dk).

## Overview of possible Nationally Determined Parameters (NDPs) and Non-Contradictory Complementary Information (NCCI)

The list below identifies the clauses where Nationally Determined Parameters (NDPs) are possible, and whether a national choice has been made, and if an informative annex is applicable or not applicable. Furthermore, clauses providing complementary information (NCCI) are identified in the list below.

| Clause                | Subject                                                 | Nationally Determined Parameter | Non-Contradictory Complementary Information |
|-----------------------|---------------------------------------------------------|---------------------------------|---------------------------------------------|
| 3.1.6                 | Partition                                               |                                 | Complementary information                   |
| 3.2.2                 | Latin lower-case symbols                                |                                 | Complementary information                   |
| 5.2(1) (2)            | Classification                                          |                                 | Complementary information                   |
| 5.3(1) (2)            | Representation of actions                               |                                 | Complementary information                   |
| 5.4.3(1)              | Additional provisions for bridges                       | Awaiting                        |                                             |
| 5.4.3(2)<br>2 choices | Additional provisions for bridges                       | Awaiting                        |                                             |
| 5.4.3(3)              | Additional provisions for bridges                       | National choice                 |                                             |
| 5.4.3(4)              | Additional provisions for bridges                       | National choice                 |                                             |
| 5.4.3(5)              | Additional provisions for bridges                       | Unchanged                       |                                             |
| 6.2.2(1)              | Additional provisions for dynamic actions               | National choice                 |                                             |
| 6.5.2(1)              | Categories of use and characteristic values, categories | National choice                 |                                             |
| 6.5.2(2)              | Categories of use and characteristic values, values     | National choice                 |                                             |
| 6.5.3.1(1)            | Partitions treated as imposed loads                     |                                 | Complementary information                   |
| 6.5.3.1(3)            | Partitions treated as imposed loads                     | National choice                 | Complementary information                   |
| 6.5.3.1(4)            | Partitions treated as imposed loads                     | National choice                 | Complementary information                   |

| Clause                                                                                                                                                                              | Subject                                                                                                                                             | Nationally Determined Parameter | Non-Contradictory Complementary Information |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|---------------------------------------------|
| 6.5.3.2(2)                                                                                                                                                                          | Reductions factors                                                                                                                                  | National choice                 |                                             |
| 6.5.3.2(4)                                                                                                                                                                          | Reductions factors                                                                                                                                  | National choice                 |                                             |
| 6.5.3.2(5)                                                                                                                                                                          | Reductions factors                                                                                                                                  | National choice                 |                                             |
| 6.5.3.2(6)                                                                                                                                                                          | Reductions factors                                                                                                                                  | National choice                 |                                             |
| 6.5.3.4(2)                                                                                                                                                                          | Grandstands and stages                                                                                                                              |                                 | Complementary information                   |
| 6.5.3.4(3)<br>3 choices                                                                                                                                                             | Grandstands and stages                                                                                                                              | Unchanged                       |                                             |
| 6.5.5(1)                                                                                                                                                                            | Garages and vehicle traffic areas excluding ordinary roads and bridges (categories F and G)                                                         |                                 | Complementary information                   |
| 6.5.6.1(1)                                                                                                                                                                          | Roofs (categories H to K) – general rules                                                                                                           | National choice                 |                                             |
| 6.5.6.2(1)<br>2 choices                                                                                                                                                             | Roofs not accessible except for normal maintenance and repair (category H)                                                                          | Unchanged                       |                                             |
| 6.5.6.3(1)                                                                                                                                                                          | Roofs accessible for special services (category K)                                                                                                  | Unchanged                       |                                             |
| 6.6.2(1)<br>2 choices                                                                                                                                                               | Barrier loadings - Horizontal loads                                                                                                                 | National choice                 |                                             |
| 6.6.2(2)                                                                                                                                                                            | Barrier loadings - Horizontal loads                                                                                                                 | Unchanged                       |                                             |
| 6.6.3(1)                                                                                                                                                                            | Barrier loadings - Vertical loads                                                                                                                   | Unchanged                       |                                             |
| Annex A                                                                                                                                                                             | Tables for mean values of specific weight of construction materials, and mean values of specific weight and angles of response for stored materials | Informative                     |                                             |
| Annex A,<br>Table A.6                                                                                                                                                               | Table A.6 Bridge materials and elements                                                                                                             |                                 | Complementary information                   |
| Annex B NA                                                                                                                                                                          | Dynamic load models for moving pedestrians and synchronised rhythmic movements of crowd                                                             | Normative                       |                                             |
| <p><b>NOTE</b><br/>           Unchanged: Recommendations in the Eurocode to be followed.<br/>           National choice: A National Determined Parameter is chosen and defined.</p> |                                                                                                                                                     |                                 |                                             |

| Clause | Subject | Nationally<br>Determined<br>Parameter | Non-<br>Contradictory<br>Complementary<br>Information                                                                                                                                                                                                                                                                                                       |
|--------|---------|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|        |         |                                       | <p>Complementary information: (Non-contradictory) complementary information on how to use the Eurocode.</p> <p>Normative: The Annex shall be used.</p> <p>Informative: The Annex may be used.</p> <p>Not applicable: The Annex cannot be used.</p> <p>No further information: The Eurocode allows further information. No further information is given.</p> |

## National Determined Parameter (NDP) and Non-contradictory complementary Information (NCCI)

### 3.1.6 Partition

(NCCI)

Partitions are non-loadbearing walls, which are regarded as either moveable partitions or non-moveable partitions.

Moveable partitions are those which can be re-built at another place without major measures.

Mobile partitions, also known as portable partitions, are temporary walls designed to divide spaces within a room or create separate areas quickly and easily, which are considered as movable partitions.

### 3.2.2 Latin lower-case symbols

(NCCI)

$c_s$  Factor related to the statistical influence of the number of storeys in the calculation of reduction factors  $\alpha_n$  (6.5.3.2).

### 5.2(1) (2) Classification

(NCCI)

Self-weight is divided into a 'non-variable' part, denoted  $G_{k,inf}$  and a 'variable part' denoted  $(G_{k,sup} - G_{k,inf})$ , see also Table A.1.8 NA in DS/EN 1990 DK NA.

The non-variable part,  $G_{k,inf}$ , includes self-weight of structural members and the minimum self-weight of elements other than structural. This part is classified as a permanent fixed action - assumed to be applied for the whole service life of the structure. Lower nominal values should be used for these load contributions.

The variable part,  $(G_{k,sup} - G_{k,inf})$ , includes the remaining self-weight from elements other than the non-variable part such as partitions, see NCCI for 6.5.3.1(1)(3)(4), installations, ceilings and remaining part of concrete overlayer. This part is classified as a 'variable' permanent action. Upper nominal values should be used for these load contributions.

### 5.3(1) (2) Representation of actions

(NCCI)

See NCCI for 5.2(1) (2) Classification.

### 5.4.3(1) Additional provisions for bridges

(NDP)

Awaiting.

### 5.4.3(2) Additional provisions for bridges

(NDP NOTE 1 and 2)

Awaiting.

### 5.4.3(3) Additional provisions for bridges

(NDP)

Nominal values may be used in cases where only minor deviations are expected, or in cases where deviations have only insignificant influence on the resulting design load effects.

### 5.4.3(4) Additional provisions for bridges

(NDP)

Mean values may be used as nominal values in cases where only minor deviations are expected, or in cases where deviations have only insignificant influence on the resulting design load effects.

### 6.2.2(1) Additional provisions for dynamic actions

(NDP)

Annex B NA applies when resonance effects from moving pedestrians and synchronised rhythmic crowd loads cannot be neglected.

### 6.5.2(1)(2) Categories of use and characteristic values

(NDP)

(1) The Categories and characteristic values are given in Table 6.1 NA.

(2) The characteristic values for  $q_k$  and  $Q_k$  are given in Table 6.1 NA.

**Table 6.1 NA — Categories of use and values for  $q_k$  and  $Q_k$**

| Category           | Specific use                                  | Sub-categories with examples                                                                                                                          | $q_k$<br>[ $\frac{\text{kN}}{\text{m}^2}$ ] | $Q_k^a$<br>[kN] |
|--------------------|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|-----------------|
| A                  | Areas for domestic and residential activities | <b>A1</b> Rooms in residential buildings and houses, including internal corridors                                                                     | 1,5                                         | 2,0             |
|                    |                                               | <b>A2</b> Bedrooms, wards, dormitories, private bathrooms, and toilets in hospitals, hotels, hostels, and other institutional residential occupancies | 1,5                                         | 2,0             |
|                    |                                               | <b>A3</b> Roof spaces <sup>b</sup>                                                                                                                    | 0,5                                         | 1,0             |
|                    |                                               | <b>A4</b> Attics <sup>c</sup>                                                                                                                         | 1,0                                         | 1,0             |
| B                  | Public areas (not susceptible to crowding)    | <b>B1</b> Offices areas for general use other than archive /storage areas (See category D2)                                                           | 2,5                                         | 2,5             |
|                    |                                               | <b>B2</b> Kitchens, communal bathrooms and toilets in hospitals, hotels, hostels and other institutional residential occupancies.                     | 3,0                                         | 3,0             |
| C <sup>d,e,f</sup> | Public areas where people                     | <b>C1</b> Areas with tables, etc. e.g. areas in schools, cafes, restaurants, dining halls, reading rooms, receptions.                                 | 2,5                                         | 3,0             |

| Category       | Specific use                                                                   | Sub-categories with examples                                                                                                                                                                                                             | $q_k$<br>[ $\frac{kN}{m^2}$ ] | $Q_k^a$<br>[kN] |
|----------------|--------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-----------------|
|                | can congregate<br>(with the exception of areas defined under category B and D) | <b>C2</b> Areas with fixed seats, e.g. areas in churches, theatres, cinemas, conference rooms, lecture halls, assembly halls, waiting rooms.                                                                                             | 4,0                           | 3,0             |
|                |                                                                                | <b>C3</b> Areas without obstacles for moving people, e.g. areas in museums, exhibition rooms, etc.                                                                                                                                       | 5,0                           | 4,0             |
|                |                                                                                | <b>C4</b> Areas with possible physical activities, e.g. dance halls, gymnastics rooms, stages.                                                                                                                                           | 5,0                           | 4,0             |
|                |                                                                                | <b>C5</b> Areas susceptible to large crowds, e.g. buildings for public events like concert halls, sports halls including grandstands, and railway platforms                                                                              | 5,0                           | 4,0             |
| D              | Shopping areas                                                                 | <b>D1</b> Areas in retail shops                                                                                                                                                                                                          | 4,0                           | 4,0             |
|                |                                                                                | <b>D2</b> Areas in department stores                                                                                                                                                                                                     | 5,0                           | 7,0             |
| A to D         | Access routes, stairs, and landings                                            | Category <b>A</b> , local access routes <sup>g</sup>                                                                                                                                                                                     | 3,0                           | 2,0             |
|                |                                                                                | Category <b>B-C1</b> , local access routes <sup>h</sup>                                                                                                                                                                                  | 3,0                           | 3,0             |
|                |                                                                                | Category <b>B-C1</b> , common access routes <sup>h</sup>                                                                                                                                                                                 | 5,0                           | 4,0             |
|                |                                                                                | Category <b>C2-D</b> , common access routes                                                                                                                                                                                              | 5,0                           | 4,0             |
| E              | Areas for archive, storage and industrial use <sup>i</sup>                     | <b>E1</b> Areas susceptible to accumulation of goods, including access areas <sup>j</sup>                                                                                                                                                | 7,5                           | 7,0             |
|                |                                                                                | <b>E2</b> Industrial use <sup>k</sup>                                                                                                                                                                                                    |                               |                 |
| F              | Garages and vehicle traffic areas (excluding ordinary roads and bridges)       | <u>Gross vehicle weight <math>\leq 35</math> kN<sup>l</sup></u><br><b>F1</b> Traffic and parking areas for light vehicles ( $\leq 8$ seats not including driver) e.g. garages; parking areas, parking halls.                             | 3,0                           | 20              |
| G              |                                                                                | <u><math>35</math> kN <math>\leq</math> Gross vehicle weight <math>\leq 160</math> kN:</u><br><b>G1</b> Traffic and parking areas for medium vehicles (on 2 axles) e.g. access routes, delivery zones, zones accessible to fire engines. | 5,0                           | 90              |
|                |                                                                                | <u>Gross vehicle weight <math>&gt; 160</math> kN:</u><br><b>G2</b> Traffic and parking areas for heavy vehicles <sup>m</sup>                                                                                                             |                               |                 |
| H <sup>1</sup> | Roofs not accessible except for normal maintenance and repair <sup>n</sup>     |                                                                                                                                                                                                                                          | 0                             | 1,5             |

| Category                                                                                                                                                 | Specific use                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Sub-categories with examples                                                     | $q_k$<br>[ $\frac{kN}{m^2}$ ] | $Q_k^a$<br>[kN] |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-------------------------------|-----------------|
| K                                                                                                                                                        | Roofs accessible for special services, such as classes HC for helicopter landing areas                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                  | 5,0                           | See Table 6.4   |
| T                                                                                                                                                        | Terraces and balconies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>T1</b> Roof terraces, access balconies, balconies, loggias, etc. <sup>o</sup> | 2,5                           | 2,0             |
| NOTE Specific imposed loading may be specified by the relevant authority or, where not specified, agreed for a specific project by the relevant parties. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                  |                               |                 |
| a                                                                                                                                                        | Typical dimension of the area loaded by $Q_k$ is in general $0,05 \times 0,05 \text{ m}^2$ except for category E, F, G, and K. For: <ul style="list-style-type: none"> <li>- Category E loaded area, can be assumed <math>0,05 \times 0,05 \text{ m}^2</math> unless specific provisions are implemented</li> <li>- Category F and G see 6.5.5</li> <li>- Category K see Table 6.4</li> </ul>                                                                                                                   |                                                                                  |                               |                 |
| b                                                                                                                                                        | Roof spaces include spaces above the top utilized floor that, due to low height and poor access conditions (without access), must be assumed to be affected by low loads (e.g. roof spaces above the base of lattice rafters).<br><br>For roof spaces with lattice rafters, the evenly distributed load can be set to 0 for that part of the roof space where the distance from the underlying ceiling (insulation or solid substrate) to the underside of the roof (rafters or insulation) is less than 50 cm. |                                                                                  |                               |                 |
| c                                                                                                                                                        | Attic spaces include spaces above the top floor that are only lightly loaded due to low height or poor access conditions (e.g. roof made with roof framing / attic trusses without stair access) or due to the use of the building.                                                                                                                                                                                                                                                                             |                                                                                  |                               |                 |
| d                                                                                                                                                        | Depending on their anticipated users, 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.                                                                                                                                                                                                                                                                                                             |                                                                                  |                               |                 |
| e                                                                                                                                                        | Attention is drawn to dynamic effects, see 6.5.2(4) and 6.2.2, in particular for C4 and C5.                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                  |                               |                 |
| f                                                                                                                                                        | For loadings on grandstands and stages, see 6.5.3.4.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                  |                               |                 |
| g                                                                                                                                                        | Local access routes include stairs, balconies, corridors, etc. that connect more than one housing unit.<br><br>Internal access routes within the individual housing unit include corridors, stairs, etc. within the individual housing unit see A1                                                                                                                                                                                                                                                              |                                                                                  |                               |                 |
| h                                                                                                                                                        | Common access routes include, for example, stairwells and stairwells throughout the building's height, as well as lobbies leading to these.<br><br>Other access routes are considered local. The load is given a $\psi$ -value that corresponds to the largest $\psi$ -value in the rooms served by the access route.                                                                                                                                                                                           |                                                                                  |                               |                 |
| i                                                                                                                                                        | For concentrated loads from storage racks or from lifting equipment, $Q_k$ should be determined for the individual case.                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                  |                               |                 |
| j                                                                                                                                                        | Loads for storage areas for books and other documents should be determined from the loaded area and height of the bookcases using appropriate values for density.<br><br>Presence of movable stands should be considered where relevant                                                                                                                                                                                                                                                                         |                                                                                  |                               |                 |

| Category | Specific use                                                                                                                                                                                                                                                                                                                                                                                   | Sub-categories with examples | $q_k$<br>[ $\frac{\text{kN}}{\text{m}^2}$ ] | $Q_k^a$<br>[kN] |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|---------------------------------------------|-----------------|
| k        | For industrial use, see also 6.5.4.<br>For actions induced by forklifts, see 6.5.4.2.<br>For actions induced by transport vehicles, see 6.5.4.3<br>For actions induced by special devices for maintenance, see 6.5.4.4.                                                                                                                                                                        |                              |                                             |                 |
| l        | Note that the limit value for category F differs from the value given in EN 1991-1-1, Table 6.1.                                                                                                                                                                                                                                                                                               |                              |                                             |                 |
| m        | For heavy vehicles, see EN-1991-2                                                                                                                                                                                                                                                                                                                                                              |                              |                                             |                 |
| n        | The characteristic values $Q_k$ and $q_k$ given in this table for roofs in category H are related to the projected 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.                                                                                                |                              |                                             |                 |
| o        | Terraces and balconies are assigned to the same category as the adjacent premises. However, at least loads corresponding to category T must be used.<br>The imposed load for terraces and balconies is calculated to include any simultaneous contribution from snow loads. Snow loads including drifting snow can lead to higher loads, in this combination from imposed load is disregarded. |                              |                                             |                 |

### 6.5.3.1(1)(3)(4) Partitions treated as imposed loads

(NCCI)

Loads induced by movable partitions are treated as imposed loads.

Loads induced by light partitions, which are not classified as moveable, may be taken into account as self-weight in the form of an equivalent uniformly distributed vertical load in accordance with 5.2(2).

Light partitions are non-structural walls which fulfil the following two conditions:

- The total load on the wall per  $\text{m}^2$  of the wall surface does not exceed  $1,5 \text{ kN/m}^2$ ;
- The total load on the wall per m of the wall length does not exceed  $4,0 \text{ kN/m}$ .

The characteristic value of the equivalent uniformly distributed load for light partitions shall be taken into account by the upper characteristic value and the lower characteristic value, respectively. As the upper characteristic value the largest of the following three values shall as a minimum be used:

- $0,5 \text{ kN/m}^2$ ;
- The load of the walls per  $\text{m}^2$  of the wall surface;
- The load of the weight of all light partitions on the considered floor area, divided by the floor area

The load due to heavier non-structural partitions is taken into account as self-weight on the basis of their actual locations and the structural form of the floor, in accordance with 5.2(2).

**Where the load cannot be assumed to be present during the lifetime of the building, the lower characteristic value, see 5.3(2),  $G_{k,inf}$ , of the load is taken as 0.6.5.3.1(3)(4) Partitions treated as imposed loads**

(NDP)

See previous section in DS/EN 1991-1-1:2025 DK NA:202x 6.5.3.1(1) (3) (4).

### 6.5.3.2(2) Reduction factors

(NDP)

The reduction factors  $\alpha_A$  and  $\alpha_n$  shall be combined as the product  $\alpha_A \times \alpha_n$ .

### 6.5.3.2(4) Reduction factors

(NDP)

The value of the reduction factor,  $\alpha_A$ , for imposed load on floors and accessible roofs shall be 1,0.

### 6.5.3.2(5) Reduction factors

(NDP)

In accordance with 6.4.2(3) and provided that the area is classified according to Table 6.1 in DS/EN 1991-1-1:2025 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 a reduction factor  $\alpha_n$ .

Different values of the reduction factor  $\alpha_n$  shall be applied for serviceability limit states and ultimate limit states respectively. The two factors shall not be combined.

For serviceability limit states the characteristic values of  $\alpha_{n,k}$  shall be calculated from Formula (6.a NA):

$$\alpha_{n,k} = \frac{1 + (n - 1) c_{s,k}}{n} \quad (6.a \text{ NA})$$

where the characteristic value  $c_{s,k}$  of  $c_s$  is 0,50.

For ultimate limit states for persistent and transient design situations the design values of  $\alpha_{n,d}$  shall be calculated from Formula (6.b NA):

$$\alpha_{n,d} = \frac{1 + (n - 1) c_{s,d}}{n} \quad (6.b \text{ NA})$$

where the characteristic value  $c_{s,d}$  of  $c_s$  is 0,45.

NOTE 1 The reduction factor  $\alpha_{n,k}$  corresponds to the reduction of the characteristic value of the accumulated load from  $n$  ( $n > 1$ ) storeys above the column or wall under consideration. Additionally,  $\alpha_{n,d}$  also takes into account the reduced uncertainty related to the design value of the accumulated load.

NOTE 2 The factor  $c_s$  accounts for the statistical reduction associated with the calculation of the accumulated reaction forces from imposed loads acting on two or more storeys.

NOTE 3 The expressions in Formula 6.a NA and 6.b NA can be interpreted as one storey being fully loaded and the remaining storeys in the group of storeys being loaded by a reduced load corresponding to factor  $c_s$ .

A multi-storey building shall be divided into groups of storeys according to the different categories of use in the building. A separate set of reduction factors  $\alpha_{n,k}$  and  $\alpha_{n,d}$  shall be applied to each group of storeys.

For each storey in a group, the reduction factors  $\alpha_n$  shall be calculated by considering the number of storeys  $n$  of the same category of use above the column or wall under consideration.

NOTE 1 Storeys belonging to the same group need not to be adjacent but can be distributed over the height of the building.

NOTE 2 When the tributary area varies from floor to floor, the storey with the biggest tributary area is assumed to being fully loaded and the remaining storeys are assumed to being loaded by a reduced load.

### 6.5.3.2(6) Reduction factors

(NDP)

When the imposed load is applied as an accompanying action in accordance with EN 1990, the design value of the action shall be determined using one of the following alternative approaches:

- either all imposed loads on floors are factored by the combination factor  $\psi_0$  (EN 1990:2023, Table A.1.7 NA); or
- the resulting imposed load on the vertical load-bearing element (column or wall) is reduced by applying  $\alpha_n$  in accordance with 6.5.3.2(5), as if the imposed load was the leading variable action.

The two factors  $\psi_0$  and  $\alpha_n$  cannot be combined.

### 6.5.3.4(2) Grandstands and stages

(NCCI)

For grandstands where the resonance effects can be neglected (see 6.2.1), the grandstand surface shall be designed to withstand a vertical static equivalent load in accordance with Table 6.1 NA and a simultaneous notional horizontal load of 10 % of the vertical load applied to the grandstand surface.

If there is risk of resonance or other significant dynamic response of the structure, the imposed load shall be considered as a dynamic action – See Annex B NA.

### 6.5.5(1) Garages and vehicle traffic areas excluding ordinary roads and bridges (categories F and G)

(NCCI)

The loaded area (see EN 1991-1-1, Figure 6.5) is defined as:

- For category F (see Table 6.1 NA):  $a \times a = 0,10 \times 0,10 \text{ m}^2$
- For category G (see Table 6.1 NA):  $a \times a = 0,20 \times 0,20 \text{ m}^2$

### 6.5.6.1(1) Roofs (categories H to K) – general rules

(NDP)

For roofs, the simultaneity of imposed loads in category H with climatic actions can be disregarded on the area which is covered by helicopter

### 6.6.2(1) Barrier loadings - Horizontal loads

(NDP, NOTE 1 and 2)

Imposed horizontal loads are divided into the subcategories; see Table 6.5 NA.

**Table 6.5 NA Horizontal loads on barriers (except guard rails for areas only accessible for maintenance and repair)**

| Category            | Specific Use                                                                                                                                                                                                                                                                                  | $q_k$<br>[kN/m]       |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A<br>B<br>C1        | Areas for domestic and residential activities<br>Public areas (not susceptible to crowding)<br>Areas with tables                                                                                                                                                                              | 0,5                   |
| C2<br>C3<br>C4<br>D | Areas with fixed seats<br>Areas without obstacles for moving people<br>Areas with possible physical activities<br>Shopping areas                                                                                                                                                              | 1,0 <sup>a</sup>      |
| C5                  | Areas susceptible to large crowds                                                                                                                                                                                                                                                             | 3,0                   |
| E                   | Areas for archive, storage and industrial use                                                                                                                                                                                                                                                 | 2,0 <sup>b</sup>      |
| F                   | Garages and vehicle traffic areas for gross vehicle weight ≤ 35 kN                                                                                                                                                                                                                            | See DS/EN 1991-1-7    |
| G                   | Garages and vehicle traffic areas for gross vehicle weight > 35 kN                                                                                                                                                                                                                            | See DS/EN 1991-1-7    |
| H                   | Roofs not accessible except for normal maintenance and repair                                                                                                                                                                                                                                 | 0,5                   |
| K                   | Roofs accessible for special services, such as classes HC for helicopter landing areas                                                                                                                                                                                                        | 1,0                   |
| A→D                 | Access routes, stairs and landings                                                                                                                                                                                                                                                            | See categories A to E |
| T                   | Terraces and balconies                                                                                                                                                                                                                                                                        |                       |
| NOTE                | The horizontal load is to be considered to act at the same time as the vertical load, if it is unfavourable. In this case the same $\psi$ value is to be applied for the horizontal load and for the vertical load. The horizontal load is assumed not to act at the same time as wind loads. |                       |
| a                   | For areas category C2-C4 and D 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.                                                    |                       |
| b                   | 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.                                                                            |                       |

NOTE In general, horizontal accidental concentrated loads on structures are defined in DS/EN 1991-1-7:2025.

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

**Table A.6 Bridge materials and elements**

(NCCI)

Awaiting.

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## Annex B NA: Dynamic load models for walking people and synchronised rhythmic movements of crowd

### B.1 Scope and field of application

(1) This Annex B NA is applicable when resonance effects from synchronised rhythmic crowd loads cannot be neglected, refer 6.2.2(1).

NOTE This annex can also be used for the assessment of comfort criteria for vibrations of structures caused by walking people.

(2) Rhythmic crowd loads shall be considered in both serviceability limit states, ultimate limit states (including accidental design situations) and fatigue limit states.

NOTE Rhythmic crowd loads include loads induced by coordinated jumping and stomping, e.g. by spectators on grandstands at sport events and rock concerts, or by people performing physical exercises in fitness centres.

(3) Rhythmic crowd loads shall always be considered when the movements of the individuals (dancing, jumping, rhythmical stomping, aerobics, etc.) are synchronised.

NOTE 1 Synchronised movements are typically connected to a distinct musical beat e.g. at rock concerts or aerobics, and they can also occur at certain sport events. Hence, the dynamic load is related to the musical beat or dance frequency, and it is periodic.

NOTE 2 The synchronised movements of people can generate both vertical and horizontal loads. The loads are determined by including the effects from the movements of the individuals, and at the same time taking into account the reduced correlation between the movements.

NOTE 3 Resonance occurs if the synchronised movements produce periodic load effects at the natural frequency of the structure. This can lead to significant amplification of the structural response and the load effects.

(4) Rhythmic crowd load shall be considered as a free action. As load combination factors,  $\psi_0 = 0$ ,  $\psi_1 = 0$  and  $\psi_2 = 0$  shall be used.

### B.2 Load model for resonant vibrations induced by walking people or synchronised rhythmic movement of crowd

(1) Regarding resonant vibrations, see also Table A.1.8.3 NA in DS/EN 1990 DK NA.

#### B.2.1 Load model

(1) Loads from walking people and rhythmic crowd loads should be modelled by harmonic load components at the movement frequency  $n_p$  and at frequencies equal to  $j n_p$  ( $j = 1, 2, 3, \dots$ ). For structures considered in B.1, load contributions where  $j > 3$  are disregarded. In this case the time-varying loads in the vertical direction,  $q_L$ , and in the horizontal direction,  $q_V$ , should be determined by:

$$q_L(t) = F_P \left[ 1 + \sum_{j=1,2,3} \alpha_j K_j \sin(2\pi j n_p t + \varphi_j) \right] \quad (\text{B.1 NA})$$

$$q_V(t) = F_P \sum_{j=1,2,3} \beta_j K_j \sin(2\pi j n_V t + \psi_j) \quad n_V = \frac{1}{2} n_p \quad (\text{B.2 NA})$$

where  $F_P$  is the mean static crowd load per  $\text{m}^2$  horizontal projection area. The average weight of each person can be estimated to be 70 kg;

|             |                                                                                                                                                                                                                                                                                               |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\alpha_j$  | is the amplitude factor for the $j$ 'th harmonic load component in the vertical direction;                                                                                                                                                                                                    |
| $\beta_j$   | is the amplitude factor for the $j$ 'th harmonic load component in the horizontal direction;                                                                                                                                                                                                  |
| $K_j$       | is the size reduction factor for the $j$ 'th harmonic load component. $K_j$ takes into account the reduced correlation between the movements of the individuals. When the deflections from crowd loads have the same sign for the entire structure, it is on the safe side to use $K_j = 1$ ; |
| $n_p$       | is the movement frequency for resonant vibrations;                                                                                                                                                                                                                                            |
| $t$         | is the time;                                                                                                                                                                                                                                                                                  |
| $\varphi_j$ | is the phase shift for the $j$ 'th harmonic load component in the vertical direction;                                                                                                                                                                                                         |
| $\psi_j$    | is the phase shift for the $j$ 'th harmonic load component in the horizontal direction.                                                                                                                                                                                                       |

NOTE The load model in (1) is a simplified description of the actual conditions. As examples, both correlations between the different phase shifts  $\varphi_j$  and  $\psi_j$ , and the fact that the movements of people do not all occur at one single frequency only but at several frequencies around the movement frequency  $n_p$ , have been disregarded.

(2) The design of the structure should be based on the most unfavourable values for the phase shifts  $\varphi_j$  and  $\psi_j$ .

NOTE As a consequence, these phase shifts are not explicitly included in the expressions given for determining the equivalent static load and acceleration of the structure in B.2.3 and B.2.4, respectively.

(3) The horizontal crowd load  $q_v$  shall be considered to act in any horizontal direction, and it shall be assumed to act at the same time as the vertical load  $q_L$ .

(4) The size reduction factor depends on the conditions governing the rhythmic activity. For the  $j$ 'th harmonic load component it should be calculated according to formula (B.3 NA), which is an approximation:

$$K_j = \sqrt{\rho_j + (1 - \rho_j) \frac{1}{n_e}} \quad (\text{B.3 NA})$$

$$n_e = n \frac{\left( \frac{1}{n} \sum_{i=1}^n \gamma_i \right)^2}{\frac{1}{n} \sum_{i=1}^n \gamma_i^2} \quad (\text{B.4 NA})$$

|       |          |                                                                                          |
|-------|----------|------------------------------------------------------------------------------------------|
| where | $\rho_j$ | is the correlation coefficient for the $j$ 'th harmonic load component, see Table B.1 NA |
|       | $n$      | is the number of people ( $n \geq 1$ )                                                   |
|       | $n_e$    | is the effective number of people                                                        |

$\gamma_i$  is the influence coefficient for the response due to the load from person no.  $i'$  on the structure.

$K_j$  is equal to 1 for  $n = 1$ .

NOTE 1 It is assumed that  $\gamma_i$  has the same sign for all  $n$  individuals. For a structure with a constant influence number for all individuals,  $n_e = n$  applies. For a simply supported beam with a uniformly distributed static load,  $n_e/n = 3/4$  applies for the bending moments of the beam and support reactions due to static loads, and  $n_e/n = 8/\pi^2$  applies for load components in resonance with the structure.

NOTE 2 Resonance occurs for load component no.  $j$ , when the frequency of the load component  $j n_p$  is equal to the natural frequency of the structure  $n_i$ .

(5) The characteristic rhythmic crowd load may be determined using the parameter values given in Table B.1 NA.

(6) The mean static crowd load,  $F_p$ , shall always be evaluated in the situation in question, and the limit state considered shall be included in this evaluation.  $\beta_j$  is assumed to be 10% of  $\alpha_j$ .

**Table B.1 NA — Parameters for determining the characteristic dynamic load from people**

| Activity                                                                                                                  | $F_p$<br>[kN/m <sup>2</sup> ] | $n_p$<br>[Hz] | $\alpha_1$ | $\alpha_2$                                   | $\alpha_3$ | $\rho_1$ | $\rho_2$ | $\rho_3$ |
|---------------------------------------------------------------------------------------------------------------------------|-------------------------------|---------------|------------|----------------------------------------------|------------|----------|----------|----------|
| A) Rhythmic crowd load. Possibility to move freely, e.g. grandstands and concert halls with standing people <sup>a</sup>  | 1,5-4,0                       | 0,5-3         | 1,6        | 1,0                                          | 0,2        | 1,0      | 0,3      | 0,03     |
| B) Rhythmic crowd load. Reduced possibility to move freely, e.g. on grandstands with seats <sup>b</sup>                   | 1,5-4,0                       | 0,5-3         | 0,4        | 0,25                                         | 0,05       | 1,0      | 0,1      | 0,01     |
| C) Rhythmic crowd load. Possibility to move freely, e.g. in fitness centres and similar <sup>a</sup>                      | 0,5-2,5                       | 0,5-3         | 1,6        | 1,0                                          | 0,2        | 1,0      | 0,3      | 0,03     |
| D) Walking on flat surface.                                                                                               | One person                    | 1,2-2,4       | 0,4        | 0,1                                          | 0,06       | 0        | 0        | 0        |
| E) Walking on monumental stairs                                                                                           | One person                    | 1,2-4,0       | 1,1        | 0,09 at 4 Hz<br>0,06 at 6 Hz<br>0,04 at 8 Hz | 0,03       | 0        | 0        | 0        |
| NOTE 1 For activity D and E, the values for walking loads refer to people not walking in step.                            |                               |               |            |                                              |            |          |          |          |
| NOTE 2 For activity E, linear interpolation can be used for intermediate values of the natural frequency for $\alpha_2$ . |                               |               |            |                                              |            |          |          |          |

- |   |                                                                                                                                                                                                                  |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| a | The load case shall be considered both in ultimate limit states and serviceability limit states. In ultimate limit states the value of $F_P$ will often be taken as greater than in serviceability limit states. |
| b | The amplitude factors shall only be applied in serviceability limit states, since the presence of seats does not guarantee that people are seated. In ultimate limit states, activity A should be assumed.       |

(7) For grandstands subject to horizontal movements caused by rhythmic crowd loads, the amplitude of the characteristic horizontal rhythmic crowd load shall be taken as at least 10% of the total characteristic imposed load in category C. The horizontal load shall be assumed to act at the same places as the rhythmic crowd load.

(8) Accidental actions caused by intentional excitation or other rhythmic activities shall be considered. The load shall be considered as a free action.

NOTE For balconies a load of one person per 5 m<sup>2</sup> can be assumed, with a minimum of 2 and a maximum of 5 persons on the balcony. The people are located at the critical position producing the most unfavourable effect.

### B.2.2 Calculation of load effects

(1) The load model referred to in B.2.1(1) defines the time history of the load. The effects of this load on the structure may be calculated in many ways depending on the complexity of the structure and the degree of accuracy required.

(2) An equivalent static load and the acceleration of the structure should be determined as described in B.2.3 and B.2.4 for structures where the following conditions are met:

- the deflections from static crowd loads have the same sign for the entire structure;
- only vibration contributions from a single vibration mode are taken into account;
- the vibration mode considered has essentially vertical components only, and these have the same sign over the entire structure;
- the vibration mode considered is not coupled with other vibration modes;
- the structure has a linear-elastic behaviour;
- 3 load harmonics are of importance.

### B.2.3 Equivalent static load

(1) The maximum effect of the vertical dynamic load should be determined as the effect of an equivalent static load,  $F_s$ , given as:

$$F_s = (1 + k_F) F_P \quad (\text{B.5 NA})$$

where  $k_F$  is the load response factor determined in (3)  
 $F_P$  is the mean static crowd load, see Table B.1 NA.

(2) The response from the  $j$ 'th load component depends on the frequency response factor of the structure,  $H_j$ , defined as follows:

$$H_j = \frac{1}{\sqrt{\left(1 - \left(\frac{jn_p}{n_i}\right)^2\right)^2 + \left(\frac{(\delta_s + \delta_p)}{\pi} \cdot \frac{jn_p}{n_i}\right)^2}} \quad (\text{B.6 NA})$$

where  $n_p$  is the movement frequency, see Table B.1

$n_i$  is the  $i$ 'th natural frequency of the structure;

$\delta_s$  is the structural damping expressed by the logarithmic decrement;

$\delta_p$  is a damping parameter which takes into account the fact that the crowd movements do not occur at one frequency only. For loads from walking people, the non-moving persons increase the damping. It is on the safe side to use  $\delta_p = 0,02$  in both cases.

NOTE For typical floor structures, lower bound values for the structural damping can be taken as:

Concrete or composite floors:  $\delta_s = 0,13$

Steel floors:  $\delta_s = 0,07$

Timber floors: See 9.3.1.1 in DS/EN 1995-1-1:2025

The damping values can alternatively be obtained by on-site testing.

(3) The load response factor  $k_F$  should be calculated as follows:

$$k_F = a \cdot \sqrt{\sum_{j=1}^3 (\alpha_j K_j H_j)^2} \quad (\text{B.7 NA})$$

where  $a$  is the response distribution factor depending on the number of dominant load harmonics. When the first or the second load harmonic component is in resonance with the structure,  $a = 1$  is assumed, and in other situations  $a = 1,5$  will be representative;

$\alpha_j$  is the amplitude factor for the  $j$ 'th harmonic load component, see Table B.1 NA;

$K_j$  is the size reduction factor, see B.2 (4);

$H_j$  is the structural frequency response factor, see (2).

(4) The load response factor,  $k_F$ , should be determined for the maximum frequency of the movement possible as specified in Table B.1 NA and for frequencies of movement where one of the load harmonic components is equal to the natural frequency of the structure ( $jn_p = n_i, j=1, 2 \text{ or } 3$ ).

#### B.2.4 Acceleration of the structure

(1) The standard deviation,  $\sigma_a$ , of the acceleration of the structure induced by the vertical dynamic load should be determined using formula (B.8 NA):

$$\sigma_a = k_a (2\pi n_p)^2 u_p \quad (\text{B.8 NA})$$

where  $k_a$  is the acceleration response factor determined in (2);

$n_p$  is the movement frequency in Hz;

$u_p$  is the static deflection from the mean static crowd load,  $F_p$ .

NOTE In the calculation of the standard deviation of the acceleration, the fact that the vibration source and the area where people are typically located do not necessarily coincide, can be taken into.

(2) The acceleration response factor,  $k_a$ , should be determined using formula (B.9 NA):

$$k_a = \sqrt{\frac{1}{2} \sum_{j=1}^3 (j^2 \alpha_j K_j H_j)^2} \quad (\text{B.9 NA})$$

where  $\alpha_j$  is the amplitude factor for the  $j$ 'th harmonic load component, see Table B.1 NA;

$K_j$  is the size reduction factor, see (B.3 Na);

$H_j$  is the structural frequency response factor, see (B.6 Na).

The acceleration response factor,  $k_a$ , should be determined for the maximum frequency of movement possible as specified in Table B.1 and for frequencies of movement where one of the load harmonic components is equal to the natural frequency of the structure ( $j n_p = n_i$ ,  $j=1, 2$  or  $3$ ).

### B.3 Load model for transient vibrations induced by walking people

(1) Regarding transient vibrations, see Table A.1.8.3 NA in DS/EN 1990 DK NA.

NOTE The load model for transient vibrations is based on the principles provided in DS/EN 1995-1-1:2025.

(2) For floors of open spaces and corridors, where a person can walk a distance of more than 10 m unobstructed in a single direction, a walking frequency  $n_p$  of 2,5 Hz should be assumed. For other cases a walking frequency of 2,0 Hz should be assumed.

(3) The mean modal impulse  $I_{\text{mod,mean}}$  should be taken as follows:

$$I_{\text{mod,mean}} = \frac{42 n_p^{1,43}}{n_i^{1,3}} [Ns] \quad (\text{B.10 NA})$$

where  $n_p$  is the walking frequency for transient vibrations as stated in (2), in Hz;

$n_i$  is the  $i$ 'th natural frequency of the floor, in Hz.

(4) The peak velocity response  $v_{\text{peak}}$  should be taken as follows:

$$v_{\text{peak}} = k_{\text{red}} \frac{I_{\text{mod,mean}}}{(M^* + 70)} \quad (\text{B.11 NA})$$

with the floor modal mass  $M^*$  in kg, taken as follows:

$$M^* = \varepsilon m l b \quad (\text{B.12 NA})$$

where  $k_{\text{red}}$  is the reduction factor which may be taken as  $k_{\text{red}} = 0,7$ ;

$\varepsilon$  is a ratio between modal mass and physical mass;

$m$  is the mass per unit area of the vibrating mass;

$l$  is the length of the vibrating mass;

$b$  is the width of the vibrating mass.

NOTE 1  $k_{\text{red}}$  is a factor accounting for the fact that the exciting source (a walking person) is usually at a distance from the person sensing the vibration. The upper threshold for this factor is 1 when the walking person and the sensing person are at the same location.

NOTE 2 For a floor supported along all four edges and with sufficient transverse stiffness to provide a plate like behaviour,  $\varepsilon = 1/4$ . For a floor supported along two edges on rigid supports, without any transverse connection to other parts of the structure along its unsupported edges,  $\varepsilon = 1/2$ . A more accurate modal mass can be calculated by means of a detailed analysis.

(5) If only one mode shape is considered within the range of natural frequencies for transient vibrations in DS/EN 1990 DK NA, formula (B.13 NA) should be used.

NOTE For other cases DS/EN 1995-1-1:2025 can be applied.

(6) For a single mode the root mean square velocity should be taken as follows:

$$v_{\text{rms}} = 0,95 \cdot (0,65 - 0,01n_i)(1,22 - 11,0\zeta) v_{\text{peak}} \quad (\text{B.13 NA})$$

where  $\zeta$  is the damping ratio.

NOTE Damping can be expressed either as the logarithmic decrement,  $\delta$ , or as the damping ratio,  $\zeta$ . For low levels of damping, the relationship can be approximated by  $\delta \approx 2\pi\zeta$ . Damping values are provided in B.2.3(2).