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# CHAPTER 2
# ACTION ON STRUCTURES - DENSITIES, SELF-WEIGHT AND IMPOSED LOADS

## 2.1 GENERAL

### 2.1.1 Scope

(1) Design guidance and actions are provided for the structural design of buildings and civil engineering works including some geotechnical aspects for the following subjects:

(a) Densities of construction materials and stored materials;
(b) Self-weight of construction elements;
(c) Imposed loads

(2) Section 2.4 gives characteristic values for densities of specific building materials, and stored materials. In addition for specific materials, the angle of repose is provided.

(3) Section 2.5 provides methods for the assessment of the characteristic values of self-weight of construction elements.

(4) Section 2.6 gives characteristic values of imposed loads on floors and roofs in building structures.

(5) These characteristic values are defined according to category of use as follows:

(a) areas in dwellings, offices etc;
(b) garage and vehicle traffic areas;
(c) areas for storage and industrial activities;
(d) roofs

(6) The loads on traffic areas given in Section 2.6 refers to vehicles up to a gross weight of 160kN.

(7) For barriers or partition walls having the function of barriers, horizontal forces due to persons are given.

(8) Section 2.6 does not specify fatigue loads and dynamic loads causing vibrations or dynamic effects.

## 2.2 CLASSIFICATION OF ACTIONS

### 2.2.1 Self-Weight

(1) Self-weights of construction elements are classified as permanent actions and generally also are fixed actions (see Chapter 1).

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(2) Earth loads on roofs and terraces shall be considered as variable actions. Pressure on basement walls induced by earth loads shall however be considered a permanent action. Pore water pressure shall also be considered a permanent action.

(3) Loads due to ballast shall be considered as variable actions.

### 2.2.2 Imposed Loads

(1) Imposed loads are classified as variable and free actions (see Chapter 1).

(2) Imposed loads should be considered as static loads, non resonant dynamic effects being considered.

## 2.3 DESIGN SITUATIONS

### 2.3.1 General

(1) The relevant self-weights and imposed loads shall be determined for each design situation identified in accordance with Chapter 1.

### 2.3.2 Self-Weight

(1) Post-execution additional new coatings and/or distribution conduits should be considered in design situations.

(2) The source and moisture content of bulk materials should be considered in design situations of buildings used for storage purposes.

### 2.3.3 Imposed Loads

(1) For cases involving interaction with other types of load (e.g. wind), the total imposed load on a building shall be considered as a single action.

(2) Where the characteristic value of the imposed load is reduced by $\psi$ factors in combination with other actions, the loads shall be assumed in all storeys without reduction by the factor $\alpha_n$.

(3) This Chapter does not specify fatigue loads.

(4) In the case of production areas where the number of load variations or the effects of vibrations may cause fatigue, a fatigue load model shall be established for the particular case.

## 2.4 DENSITIES OF BUILDING MATERIALS AND STORED MATERIALS

### 2.4.1 Definitions

(1) The bulk weight density is the overall weight per unit volume of a material, including a normal distribution of voids and pores. In everyday usage this term is frequently abbreviated to 'density' (which is strictly mass per unit volume).

(2) The angle of repose is the angle which the natural slope of the sides of a heaped pile of loose material makes to the horizontal.

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### 2.4.2 Tables

(1) The densities and angles of repose provided in Tables 2.1 to 2.8 of some materials may vary from those indicated depending on moisture content, settlement and depth of storage.

**Table 2.1 Construction Materials**

| Materials | Density $\gamma$ [kN/m$^3$] |
|---|---|
| **concrete** | |
| lightweight | 9-20 |
| normal weight | 24* |
| heavyweight | >28 |
| reinforced and prestressed concrete | + 1 |
| unhardened concrete | + 1 |
| **mortar** | |
| cement mortar | 23 |
| gypsum mortar | 17 |
| lime mortar | 19 |
| **masonry units** | |
| basalt | 27 |
| limestone | 25 |
| granite | 27 |
| sandstone | 23 |
| Trachyte | 26 |
| **metals** | |
| aluminium | 27 |
| brass | 83 |
| bronze | 83 |
| copper | 87 |
| iron, cast | 71 |
| iron, wrought | 76 |
| lead | 112 |
| steel | 77 |
| zinc | 71 |

*density may be in the range 20-28 depending on local material

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Table 2.1 Construction Materials (cont'd)

| Material | Density $\gamma$ [kN/m$^3$] |
|---|---|
| **wood** | |
| Bahir Zaf (Eucalyptus Globulus Labill) | 8.5 |
| Kerero (Pouteria Ferrginea) | 6.5 |
| Sombo (Ekebergia Rueppeliana) | 6.5 |
| Tid (Juniperus Procera) | 7.5 |
| Zegba (Podacargus Gracilior) | 6.0 |
| **plywood:** | |
| raw plywood (softwood and birch) | 6 |
| laminboard and blockboard | 4 |
| **particleboards:** | |
| chipboard | 8 |
| cement-bonded particleboard | 12 |
| flakeboard, oriented strand board, waterboard | 7 |
| **fibre building board:** | |
| hardboard, standard and tempered | 10 |
| medium density fibreboard | 8 |
| softboard | 4 |
| **other materials** | |
| glass, in sheets | 25 |
| plastics: | |
| acrylic sheet | 12 |
| polystyrene, expanded,granules | 0.25 |
| slate | 29 |

**Table 2.2 Stored Materials - Building and Construction**

| Materials | Density $\gamma$ [kN/m$^3$] | Angle of repose $\phi$ [°] |
|---|---|---|
| **aggregates** | | |
| lightweight (pumice) | 7 | 30 |
| lightweight (scoria) | 12 | 30 |
| normal | 14 | 30 |
| **gravel** | 14 | 35 |
| **sand** | 14 | 30 |
| **brick sand,** crushed brick, broken bricks | 15 | - |
| **vermiculite** | | |
| exfoliated, aggregate for concrete | 1 | - |
| crude | 6 - 9 | - |
| **bentonite** | | |
| loose | 8 | 40 |
| **shaken** down | 11 | - |
| **cement** | | |
| in bulk | 16 | 28 |
| in bag | 15 | - |
| **fly ash** | 10 - 14 | 25 |
| **glass,** in sheets | 25 | - |
| **gypsum,** ground | 15 | 25 |
| **lignite filter ash** | 15 | 20 |
| **lime** | 13 | 25 |
| **limestone,** powder | 13 | 27 |
| **magnesite,** ground | 12 | - |
| **plastics,** | | |
| polyethylene, polystyrol granulated | 6.4 | - |
| polyvinylchloride, powder | 5.9 | - |
| polyester resin | 11.8 | - |
| glue resins | 13 | - |
| **water, fresh** | 10 | - |

**Table 2.3 Stored Materials - Agricultural**

| Materials | Density $\gamma$ [kN/m$^3$] | Angle of repose $\phi$ [°] |
|---|---|---|
| **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 - 12 | 25 |
| basic slag, crushed | 13.7 | 35 |
| phosphates, granulated | 10 - 16 | 30 |
| potassium sulphate | 12 - 16 | 28 |
| urea | 7 - 8 | 24 |
| **fodder,** green, loosely stacked | 3.5 - 4.5 | - |
| **grain** | | |
| whole ($\leq$ 14% moisture content unless indicated otherwise) | | |
| general | 7.8 | 30 |
| barley | 8.0 | 30 |
| beans | 7.0 | 30 |
| brewer's grain (wet) | 7.0 | 30 |
| coffee | 8.8 | 30 |
| herbage seeds | 8.0 | 30 |
| corn | 3.4 | 30 |
| maize in bulk | 7.4 | 30 |
| maize in bags | 8.0 | 30 |
| legumes | 5.0 | - |
| oats | 5.0 | 30 |
| oilseed rape | 8.0 | 30 |
| sorghum | 6.4 | 25 |
| rye | 9.0 | 25 |
| tef | 7.0 | 30 |
| wheat in bulk | 7.8 | 30 |
| wheat in bags | 7.5 | - |

Table 2.3 Stored Materials - Agricultural (contn'd)

| Material | Density $\gamma$ [kN/m$^3$] | Angle of repose $\phi$ [°] |
|---|---|---|
| **grass** cubes | 7.8 | 40 |
| hay | | |
| (baled) | 1 - 3 | - |
| (rolled bales) | 6 - 7 | - |
| **hides and skins** | 8 - 9 | 25 |
| **hops** | 1 - 2 | |
| **malt** | 4 - 6 | |
| **meal** | 7 | 45 |
| ground | 7 | 40 |
| cubes | 9.5 | - |
| **silage** | 5 - 10 | - |
| **straw** | | - |
| in bulk (dry) | 0.7 | - |
| baled | 1.5 | - |
| **tobacco** in bales | 3.5 - 5 | - |
| **wool** | | - |
| in bulk | 3 | - |
| baled | 7 - 13 | - |

**Table 2.4 Stored Materials - Foodstuffs**

| Materials | Density $\gamma$ [kN/m$^3$] | Angle of Repose $\phi$ [°] |
|---|---|---|
| butter | 9.5 | - |
| **eggs**, in stands | 4 - 5 | - |
| **flour** | | |
| bulk | 6 | 25 |
| bagged | 5 | - |
| **fruit** | | |
| loose | 8.3 | 30 |
| boxed | 6.5 | - |
| honey | 13 | - |
| milk | 10.5 | - |
| **sugar** | | - |
| bulk (loose) | 9.5 | 35 |
| sacks (compact) | 16.0 | - |
| **vegetables, green** | | |
| cabbages | 4 | - |
| lettuce | 5 | - |
| **vegetables, legumes** | | |
| beans | | |
| general | 8.1 | 35 |
| soya | 7.4 | - |
| peas | 7.8 | - |
| **vegetables, root** | | |
| general | 8.8 | - |
| beetroot | 7.4 | 40 |
| carrots | 7.8 | 35 |
| onions | 7 | 35 |
| **potatoes** | | |
| in bulk | 7 | 35 |
| in boxes | 4.4 | - |

Table 2.5 Stored Materials - Liquids

| Materials | Density $\gamma$ [kN/m$^3$] |
|---|---|
| **beverages** | |
| beer | 10.3 |
| milk | 10.1 |
| water, fresh | 9.8 |
| wine | 10 |
| **natural oils** | |
| castor oil | 9.3 |
| linseed oil | 9.2 |
| **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 (37% by weight) | 17.7 |
| turpentine, white spirit | 8.3 |
| **hydrocarbons** | |
| aniline | 9.8 |
| benzene (benzole) | 8.8 |
| coal tar | 10.8 - 12.8 |
| creosote | 10.8 |
| naphtha | 7.8 |
| paraffin (kerosene) | 8.3 |
| benzine (benzoline) | 6.9 |
| oil, crude (petroleum) | 9.8 - 12.8 |
| diesel | 8.3 |
| fuel | 7.8 - 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 2.6 Stored Materials - Solid Fuels**

| Materials | Density $\gamma$ [kN/m³] | Angle of Repose $\phi$ [°] |
|---|---|---|
| **charcoal** | | |
| air-filled | 4 | - |
| air-free | 15 | - |
| **firewood** | 5.4 | 45 |

**Table 2.7 Stored Materials - Industrial and General**

| Material | Density $\gamma$ [kN/m³] | Angle of Repose $\phi$ [°] |
|---|---|---|
| **books and documents** | | |
| books and documents | 6 | - |
| densely stored | 8.5 | - |
| **filing racks and cabinets** | 6 | - |
| **garments and rags,** bundled | 11 | - |
| **ice, lumps** | 8.5 | - |
| **leather,** piled | 10 | - |
| **paper** | | - |
| layers | 11.0 | - |
| rolls | 15.0 | - |
| **rubber** | 10 - 17 | 45 |
| **rock salt** | 22 | 40 |
| **salt** | 12 | |
| **sawdust** | | |
| dry, bagged | 3 | - |
| dry, loose | 2.5 | 45 |
| wet, loose | 5 | 45 |
| **tar, bitumen** | 14 | - |

**Table 2.8 Flooring and Walling**

| Materials | Density kN/m³ |
|---|---|
| **Flooring** | |
| clay tiling | 21 |
| Marble tiling | 27 |
| Parquet, timber board | 9 |
| PVC covering | 16 |
| Rubber covering | 17 |
| Granulithic, terrazzo paving | 23 |
| **Walling** | |
| Solid brick | 22 |
| Perfurated brick | 19 |
| Concrete hollow-block | |
| Stone aggregate | 14-20* |
| Lightweight (pumice) aggregate | 10-14* |
| Asoestos cement sheet | 17 |
| Fibrous plaster board | 10 |

*Lower values for smaller size thicknesses (100mm to 200mm)

## 2.5 SELF-WEIGHT OF CONSTRUCTION ELEMENTS

### 2.5.1 Representation of Actions

(1) Construction elements include structural and non-structural elements.

(2) For the purpose of this section, the self-weight of non-structural elements shall include the weight of fixed machinery.

(3) Non-structural elements include:

(a) roofing
(b) surfacing and coverings
(c) non-structural partition walls and linings
(d) hand rails, safety barriers, parapets and kerbs
(e) wall cladding
(f) suspended ceilings
(g) insulation
(h) fixed machinery
(i) earth and balast

(4) Fixed machinery includes:

(a) lifts and moving stairways
(b) heating, ventilating and air conditioning equipment
(c) electrical equipment
(d) pipes without their contents
(e) cable trunking and conduits.

(5) Loads due to movable partitions shall be treated as imposed loads (see Section 2.6).

(6) The self-weight of industrial equipment should be considered as an imposed load. Only the self-weights of equipment incorporated into the construction shall be classified as permanent actions.

(7) Where there is a reasonable likelihood that services will at some time be relocated within the building, loads due to these services shall be considered as imposed loads.

### 2.5.2 Load Arrangements

(1) In the case where the self-weight is classified as a fixed action it may be assumed that the variations of densities as well as the differences between nominal and actual dimensions of construction elements do not change within a given structure.

### 2.5.3 Self-Weight - Characteristic Values

#### 2.5.3.1 *Assessment of Self-Weight*

##### 2.5.3.1.1 *Characteristic Value*

(1) The weights of parts of structures and of non-structural elements shall be determined from the weights of the elements of which they are composed.

(2) Unless more reliable data are available (i.e. from product standards, the supplier or by direct weighing), the characteristics value of the weight of individual elements shall be estimated from nominal dimensions and the nominal densities of their constituent materials.

(3) However, in accordance with Chapter 1, it may be necessary to consider both upper and lower characteristic values for the self-weight. This may apply to thin concrete members or in cases of uncertainty about the precise value of self-weight, or where dimensional alternatives and the type of materials to be used remain open at the design stage.

##### 2.5.3.1.2 *Dimensions*

(1) In general nominal dimensions should be those as shown on the drawings.

(2) In general, where the weight of thin finishes is small in comparison in comparison with the weight of the elements to which they are applied, it is not necessary to consider variation in finish thickness. However variation in thickness may need to be considered when the thickness depends on the deflection of the structural component to which the finish is applied or when the maintenance of the finish may include the addition of further layers of material.

##### 2.5.3.1.3 *Densities*

(1) For the assessment of nominal densities Section 2.4 should be used.

(2) If the density of the material is likely to deviate significantly from the specified value, such deviation shall be considered.

(3) For structures where more accurate values are required, for example, where a design is likely to be particularly sensitive to variations in permanent load, a representative sample of the materials to

be used should be tested at representative moisture contents. Characteristic and representative values should then be determined according to Chapter 1.

(4) For some materials the bulk weight density has significant variability and may be dependent on the source and moisture content.

### 2.5.3.2 *Self-Weight for Buildings*

#### 2.5.3.2.1 *Floors and Walls and Partitions*

(1) For determining the effect of the self-weight due to partitions, an equivalent uniformly distributed load may be used.

(2) Account should be taken of voids made for the purpose of thermal insulation or for the reduction of weight.

(3) For suspended beam and block floors and beam and hollow-pot floors, data may be provided by the manufacturer. When the dimensions of thin concrete slabs are unlikely to be controlled to within ± 5% of their nominal values a range of values for the permanent load shall be taken into account and treated as indicated in Chapter 1.

(4) For determining the weight of unrendered masonry walls the weight of mortar shall be taken into account.

#### 2.5.3.2.2 *Roofs*

(1) The weights shall be calculated from the weight of the component materials and the geometry (e.g. pitch tiles/sq.metre etc).

(2) Information may be taken from documents provided by the manufacturer.

#### 2.5.3.2.3. *Claddings and Finishes*

(1) For the purpose of this section claddings shall be considered to include curtain walling (and fixings), overcladding (and fixings) and roof coverings.

(2) When designing individual structural elements the estimation of weight shall include the weight of claddings and finishes, unless alternative provision has been made (see Section 2.5.3.1). Finishes include in-situ finishes (such as plaster and screeds), prefabricated wall-panel finishes, and timber and other floor finishes.

## 2.6 IMPOSED LOADS ON BUILDINGS

### 2.6.1 Representation of Actions

(1) Imposed loads on buildings are those arising from occupancy. They may be caused by:

(a) normal use by persons;
(b) furniture and moveable objects (e.g.lightweight moveable partitions, storage, the contents of containers);
(c) machines and vehicles;

(d) exceptional use, such as exceptional concentrations of persons or of furniture, or the moving or stacking of commodities which may occur during reorganization or redecoration.

(2) The self-weight of structural and non-structural components and of fixed equipment shall be taken into account according to Section 2.5.

(3) Imposed loads are modelled by uniformly distributed loads or concentrated loads or combination of these loads.

(4) The characteristic values of the loads are determined for a reference period, ( See Chapter 1).

(5) The characteristic values of the loads are composed of long-term, medium-term and short-term components that, according to their duration, may have different effects on materials sensitive to time-dependent actions.

### 2.6.2 Load Arrangements

#### 2.6.2.1 *Horizontal Members*

(1) For the design of the elements of a floor structure within one storey the action shall be assumed as a free action on the most unfavourable tributary zone of the influence area. Where the loads on other floors are relevant, they may be assumed to be distributed uniformly (fixed actions).

(2) Imposed loads from a single occupancy may be reduced according to the tributary area by a reduction factor $\alpha_A$ according to Sections 2.6.3.1.2(3) and 2.6.2.2(4).

(3) To ensure a minimum local resistance of the floor structure a separate verification shall be performed with a concentrated load that, unless stated otherwise, shall not be combined with the uniformly distributed loads or other variable loads.

#### 2.6.2.2 *Vertical Members*

(1) For the design of columns or walls acting as vertical members, loaded from several storeys, the loads on the floor of each storey shall be assumed to distributed uniformly (fixed actions).

(2) Where the imposed loads from several storeys are relevant, the loads may be reduced by a reduction factor $\alpha_n$ according to Sections 2.6.1.2(4)

### 2.6.3 Imposed Loads - Characteristic Values

#### 2.6.3.1 *Residential, Social, Commercial and Administration Area*

##### 2.6.3.1.1 *Categories*

(1) Areas in residential, social, commercial and administration buildings are divided into five categories according to their specific uses shown in Table 2.9.

**Table 2.9 Categories of Building Areas**

| Category | Specific Use | Example |
|---|---|---|
| A | Area for domestic and residential activities | Rooms in residential buildings and houses; rooms and wards in hospitals; bedrooms in hotels and hostels; kitchens and toilets |
| B | Areas where people may congregate (with the exception of areas defined under category A,B,D, and E) | C1: Areas with tables, etc. e.g. areas in schools, cafes, restaurants, dining halls, reading rooms, receptions etc.<br><br>C2: Areas with fixed seats, e.g. areas in churches, theatres or cinemas, conference rooms, lecture halls, assembly halls, waiting rooms, etc.<br><br>C3: Areas without obstacles for moving people, e.g. areas in museums, exhibition rooms, etc and access areas in public and administration buildings, hotels, etc.<br><br>C4: Areas susceptible to overcrowding, e.g. dance halls, gymnastic rooms, stages, etc.<br><br>C5: Areas susceptible to overcrowding, e.g. in buildings for public-events like concert halls, sports halls including stands, terraces and access areas, etc. |
| D | Shopping areas | D1: Areas in general retail shops, e.g. areas in warehouses, stationery and office stores, etc. |
| E | Areas susceptible to accumulation of goods, including access areas | Areas for storage use including libraries. The loads defined in Table 2.10 shall be taken as minimum loads unless more appropriate loads are defined for the specific case. Further guidance is given in Table 2.7. |

**2.6.3.1.2** *Values of Actions*

(1) The characteristic values $q_k$ and $Q_k$ are given in Table 2.10.

(2) For local verifications a concentrated load $Q_k$ acting alone shall be taken into account. The characteristic values $Q_k$ are given in Table 2.9. Where concentrated loads from storage racks or from lifting equipment may be expected $Q_k$ shall be determined for the individual case (see Section 2.6.3.3).

The local concentrated load shall be considered to act at any point on the floor, balcony or stairs and to have an application area comprising a square with a 50mm side.

(3) The reduction factor $\alpha_A$ for categories A to E should be determined as follows:
With the restriction for categories C and D: $\alpha_A \geq 0.6$

$$\alpha_A = 5/7 \cdot \psi_o + \frac{A_o}{A} \leq 1.0 \qquad (2.1)$$

where $\psi_o$ is the factor according to Chapter 1.
$A_o$ $10.0m^2$
$A$ is the loaded area

(4) The reduction factor $\alpha_n$ for categories A to E should be determined as follows:

$$\alpha_n = \frac{2+(n-2)\ \psi_0}{n} \qquad (2.2)$$

where $n$ is the number of storeys ($>2$) above the loaded structural elements

**Table 2.10 Imposed Loads on Floors in Buildings**

| Loaded area | | $q_k$ (kN/m2) | $Q_k$ (kN) |
|---|---|---|---|
| **Category A** | - general | 2.0 | 2.0 |
| | - stairs | 3.0 | 2.0 |
| | - balconies | 4.0 | 2.0 |
| **Category B** | | 3.0 | 2.0 |
| **Category C** | - C1 | 3.0 | 4.0 |
| | - C2 | 4.0 | 4.0 |
| | - C3 | 5.0 | 4.9 |
| | - C4 | 5.0 | 7.0 |
| | - C5 | 5.0 | 4.0 |
| **Category D** | - D1 | 5.0 | 4.0 |
| | - D2 | 5.0 | 7.0 |
| **Category E** | | 6.0 | 7.0 |

### 2.6.3.2 *Garage and Vehicle Traffic Areas*

#### 2.6.3.2.1 *Categories*

(1) Traffic areas in buildings are divided into two categories according to their accessibility for vehicles as shown in Table 2.11.

**Table 2.11 Traffic Areas in Buildings**

| Category | Specific Use | Example |
|---|---|---|
| F | Traffic and parking areas for light vehicles (≤ 30 kN total weight and ≤ 8 seats not including driver) | e.g. garages; parking areas, parking halls |
| G | Traffic and parking areas for medium vehicles (>30 kN, ≤ 160 kN total weight, on 2 axles) | e.g. access routes; delivery zones; zones accessible to fire engines (≤ 160 kN total weight) |

(2) Access to areas designed to category F shall be limited by physical means built into the structure.

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

**2.6.3.2.2** ***Values of Actions***

(1) The characteristic values for the concentrated loads $Q_k$ representing a single axle with dimensions according to Fig. 2.1 and the distributed load $q_k$ are given in Table 2.12.

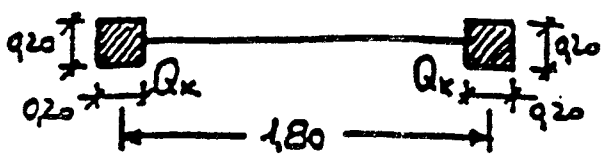



**Figure 2.1 Dimensions of Axle Load**

**Table 2.12 Imposed Loads on Garages and Vehicle Traffic Areas**

| Traffic areas | $q_k$ (kN/m2) | $Q_k$ (kN) |
|---|---|---|
| **Category F** vehicle weight: ≤30, ≤160 kN | 2.0 | 10 |
| **Category G** vehicle weight: >30, ≤160 kN | 5.0 | 45 |

(2) Both the concentrated load $Q_k$ and the uniformly distributed load $q_k$ shall be considered to act together.

(3) Each concentrated load shall be applied on a square surface with a 200mm side in the positions which will produce the most adverse effects.

(4) The reduction coefficient $\alpha_A$ for categories F and G shall be considered as follows:

$$\alpha_A = 1.0 \tag{2.3}$$

(5) The reduction coefficient $\alpha_n$ for categories F and G shall be considered as follows:

$$\alpha_n = 1.0 \tag{2.4}$$

**2.6.3.3** ***Areas for Storage and Industrial Activities***

(1) The characteristic value of the imposed load and also the loading arrangement (free or fixed actions) shall be defined, respectively, by the maximum value taking account of dynamic effects if appropriate and the most unfavourable condition allowed in use.

(2) The maximum permitted loads should be indicated by sings in the rooms concerned.

(3) The characteristic values of vertical loads in storage areas may be derived by taking the values given in Section 2.4 and upper design values for stacking heights. When stored material exerts horizontal forces on walls etc., the horizontal for may be determined from specialist literature. Any effects of filling and emptying shall be taken into account.

(4) Loads for storage areas for books and files shall be determined from the loaded area and the height of the book cases using the density values in Section 2.4.

(5) Loads on industrial areas may comprise machines, production units, heavy rolling engines that can have a defined lane, suspended cranes, etc. that cannot be modelled by uniformly distributed loads but need more detailed modelling.

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

**2.6.3.4** ***Roofs***

**2.6.3.4.1** ***Categories***

(1) Roofs are divided according to their accessibility into three categories as shown in Table 2.13.

**Table 2.13 Categorization of Roofs**

| Category | Specific Use |
|---|---|
| H | Roofs not accessible except for normal maintenance, repair, painting and minor repairs |
| I | Roofs accessible with occupancy according to categories A - G |
| K | Roofs accessible for special services, such as helicopter landings |

(2) Loads for roofs of category H are given in Table 2.13 Loads for roofs of category I are given in Table 2.10 and Table 2.12 according to the specific use. For roofs of category K the loads should be established for the particular case.

**2.6.3.4.2** *Values of Actions*

(1) The characteristic values $Q_k$ and $q_k$ are given in Table 2.14. They are related to the projected area of the roof under consideration.

**Table 2.14 Imposed Loads on Roofs**

| Roofs | | $q_k$ (kN/m²) | $Q_k$ (kN) |
|---|---|---|---|
| Category H | Flat roof | 0.5 | 1.0 |
| | Sloping roof | 0.25 | 1.0 |

(2) Separate verification shall be performed for the concentrated load $Q_k$ and the uniformly distributed load $q_k$, acting independently.

(3) For local checks the concentrated load $Q_k$ is given in Table 2.14. The application area of $Q_k$ comprises a square with a 50mm side.

(4) The reduction coefficient $\alpha_A$ for category H shall be considered as follows:

$$\alpha_A = 1.0 \tag{2.5}$$

(5) Access ladders and walkways shall be assumed to be loaded according to Table 2.2 for a roof slope $< 20°$. For walkways which are part of a designated escape route $q_k$ shall be assumed to be:

$$q_k = 3.0 \text{ kN/m}^2 \tag{2.6}$$

(6) The effects of water ponding on roofs should be considered.

### 2.6.4 Horizontal Loads on Partition Walls and Barriers due to Persons

(1) The characteristic values of the line load $q_k$ acting at the height of the hand rail but not higher than 1.20m are given in Table 2.15.

**Table 2.15 Horizontal Loads on Partition Walls and Barriers due to Persons**

| Loaded areas | $q_k$ (kN/m) |
|---|---|
| Category A | 0.5 |
| Category B and C1 | 1.0 |
| Categories C2 - C4 and D | 1.5 |
| Category C5 | 3.0 |

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

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