ANNEX 37

NATIONAL ANNEX

TO STANDARD

SFS-EN 1991-1-7 EUROCODE 1: ACTIONS ON STRUCTURES

Part 1-7: General actions – Accidental actions

Preface

This National Annex is used together with the Standard SFS-EN 1991-1-7: 2006.

This National Annex sets out:

a) the national parameters for the following paragraphs in Standard SFS-EN 1991-1-7 where national selection is permitted:

- 2(2)
- 3.1(2) Note 4
- 3.2(1) Note 3
- 3.3(2) Note 1, 2 and 3
- 3.4(1) Note 4
- 3.4(2)
- 4.1(1) Note 3
- 4.3.1(1) Note 1, 2 and 3
- 4.3.1(2)
- 4.3.1(3)
- 4.3.2(1) Note 1 and 3
- 4.4(1)
- 4.5.1.2 Note 1 and 2
- 4.5.1.4(2)
- 4.5.1.4(3)
- 4.5.1.4(4)
- 4.5.1.4(5)
- 4.5.1.5(1)
- 5.3(1)P

b) Guidance for the use of informative annexes A, B, C and D.

Section 2 Classification of actions

2(2)

An accidental action may also be considered as a fixed action in those cases where the load is evenly distributed on the entire structure (for example pressure load from an explosion).

Section 3 Design situations

3.1 General

3.1(2) Note 4

Without permission from relevant authorities, it is not allowed by the client to give permission to use lower values for accidental actions in individual projects other than those set down in SFS-EN 1991-1-7 and its National Annex.

3.2 Accidental design situations – strategies for identified accidental actions

3.2(1) Note 3

Levels of acceptable risks are not set down.

3.3 Accidental design situations – strategies for limiting the extent of localised failure

3.3(2) Note 1

The design value for load A_d is 50 kN. Load A_d acts to the horizontal direction in the centre of clear floor height. Point loads are used for columns and in walls A_d is distributed as a horizontal line load over 3 meters.

3.3(2) Note 2

The acceptable limit of "localised failure" depends on the building type:

<u>Multi-storey buildings</u>

The local damage should not exceed 15% of the floor area or 100 m^2 in one storey. The damage may occur in two adjacent storeys.

<u>Hall-type buildings</u>

If a column is damaged, the acceptable area of local damage is the length of the main girders supported by the column multiplied by two times the distance between main girders. If the main girders are on the external wall line, the acceptable local damage area is half of the area above. The damage may occur on one storey only.

If a main girder is damaged, the acceptable area of local damage is the length of the main girder multiplied by two times the distance between main girders. If the main girders are on the external wall line, the acceptable local damage area may be half of the area above. The damage may occur on one storey only.

3.3(2) Note 3

The procedures are presented in the document "The design for the consequences of localised failure in buildings from unspecified cause" which is published as non-contradictory complementary information NCCI. A building is able to sustain an extent of localised failure from an unspecified cause without disproportionate collapse when it is designed according to above procedures. The same document also contains the rules for tying forces for different consequences classes, the nominal section lengths of the load-bearing wall, as well as other necessary guidance.

3.4 Accidental design situations – use of consequences classes

3.4(1) Note 4

The classification of buildings according to consequences classes will be presented in the document “The design for the consequences of localised failure in buildings from unspecified cause” which is published as non-contradictory complementary information NCCI.

3.4(2)

No design approaches are given.

Section 4 Impact

4.1 Field of application

4.1(1) Note 3

No guidance on issues concerning the transmission of impact forces to the foundations is given.

4.3.1 Impact on supporting substructures

4.3.1(1) Note 1

In Finland the values given in Table 4.1 (FI) are used except in areas which are not accessible to vehicles

Table 4.1 (FI) Indicative equivalent static design forces due to vehicular impact on members supporting structures over or adjacent to roadways

.

Category of traffic	Force F_{dx} [a] [kN]	Force F_{dy} [a] [kN]
Motorways and country national and main roads	1000	500
Country roads in rural area	750	375
Roads in urban areas	500	250
Courtyards and parking garages with access to:		
– Cars[b]	25	25
– Lorries[c]	75	75

[a] x = direction of normal travel, y = perpendicular to the direction of normal travel.

[b] If the horizontal distance from the structure to the edge of the courtyard area planned to vehicular traffic is at least 2,0 m, it is not necessary to design the structure for vehicular impact.

[c] The term "lorry" refers to vehicles with maximum gross weight greater than 3,5 tonnes.

4.3.1(1) Note 2

The design forces for building structures given in Table 4.1 (FI) for the category of traffic *Roads in urban area* can be multiplied by a reduction factor taken from Figure 4.1(FI) as a function of the distance d and the maximum allowed speed of the vehicle v_0. The distance d is measured from the centreline of the nearest trafficked lane to the structural member. However, the design forces must not be lower than those given in Table 4.1 (FI) for lorries in the category of traffic *Courtyards and parking garages*. The reduction factors for speeds between 40 km/h and 80 km/h are interpolated linearly. The reduction factors given in Figure 4.1(FI) can be applied when the downward slope between the centreline of the nearest trafficked lane and the point of impact, measured perpendicularly to the lane, is not more than 1:5. The effect of slopes steeper than this and the effect of upward slopes as well as the effect of rails and other measures to avoid impact are to be specified separately for each individual project.

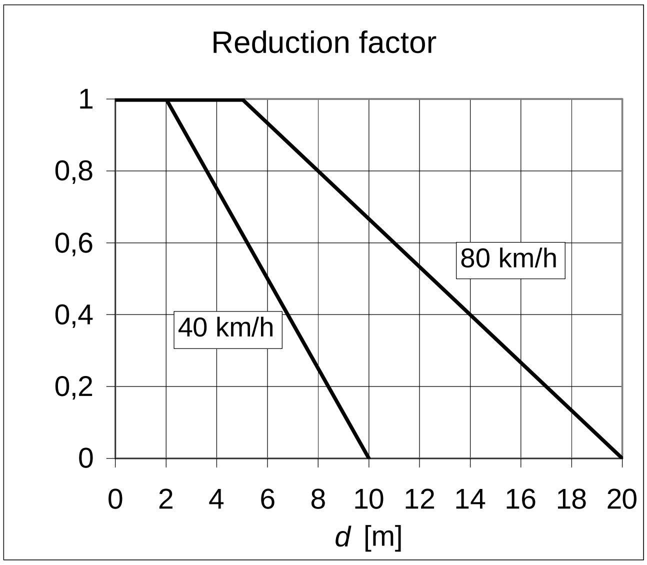


Figure 4.1(FI) Reduction factor for design forces on building structures in the category of traffic *Roads in urban area.*

4.3.1(1) Note 3

It is not necessary to consider vehicular impact for building structures in Consequences class CC1.

4.3.1(2)

When designing building structures near to roadways, it is assumed that F_{dx} ja F_{dy} do not act simultaneously.

4.3.1(3)

The impact area is determined according to the recommendations.

4.3.2 Impact on superstructures

4.3.2(1) Note 1

For building structures, the clearance to avoid impact is 6,0 m. For smaller clearances the equivalent static design forces given in Table 4.2 (FI) for impact loads are used.

Table 4.2 (FI) Indicative equivalent static design forces due to impact on superstructures of building structures

Category of traffic	Equivalent static design force F_{dx} [a] [kN]
Motorways and country national and main roads	500
Country roads in rural area	375
Roads in urban area	250
Courtyards and parking garages	75
[a] x = direction of normal travel	

4.3.2(1) Note 3

The recommended values are used for the reduction factor r_F as well as for distances h_0 and h_1 except in the category of traffic *Courtyards and parking garages* where the reduction factor r_F is not used.

4.4(1)

Unless a more accurate method is applied, the value of F to be used is the sum of the net weight and the hoisting load of a loaded forklift truck, acting at a height of 0,75 m above the floor level.

4.5.1.2 Classification of structures

4.5.1.2(1) Note 1

The structures to be included in Classes A or B are not specified separately.

4.5.1.2(1) Note 2

Temporary structures are not classified.

4.5.1.4 Class A structures

4.5.1.4(2)

Reductions are not given.

4.5.1.4(3)

The recommended value is used.

4.5.1.4(4)

The recommended value is used.

4.5.1.4(5)

$F_{dx} = F_{dy} = 0$ when d > 20 m. In other cases the values are determined separately for each individual project.

4.5.1.5 Class B structures

4.5.1.5(1)

If the distance *d* is greater than 5 m, no requirements are specified. In other cases the requirements are specified separately for each individual project.

5.3 Principles for design

5.3(1)P

No guidance is given in addition to Annex D.

Annex A
Design for consequences of localised failure in buildings from an unspecified cause

Annex A is not used. In Finland the NCCI document "The design for the consequences of localised failure in buildings from unspecified cause" is used instead of Annex A. If the building is designed according to this NCCI document, building will sustain an extent of localised failure from an unspecified cause without disproportionate collapse.

Annex B
Information on risk assessment

Annex B may be used

Annex C
Dynamic design for impact

Annex C may be used

Annex D
Internal explosions

Annex D may be used.

End of National Annex

The design for the consequences of localised failure in buildings from unspecified cause

1 Scope

(1) This NCCI document gives rules and methods for designing buildings to sustain an extent of localised failure from an unspecified cause without disproportionate collapse. If the design is carried out according to this document, it is ensured that a structure has adequate robustness based on its consequences class (see SFS-EN 1991-1-7, clause 3.4).

2 Introduction

(1) According to SFS-EN 1991-1-7, section 3, it is accepted that a structure is allowed to design in such a way that in accidental situations local damages may occur. Local damage may neither cause the whole structure nor a significant part of it to collapse. Adopting this strategy should provide a building with sufficient robustness to survive a reasonable range of undefined accidental actions.

(2) The minimum period that a building needs to survive following an accident should be that period needed to facilitate the safe evacuation and rescue of personnel from the building and its surroundings.
Longer periods of survival may be required for buildings used for handling hazardous materials, provision of essential services, or for national security reasons.

3 Consequences classes of buildings

(1) The categorisation of building types to different consequences classes in accidental situations is presented in Table 1. This categorisation is based on the low, medium and high consequences classes given in SFS-EN 1991-1-7 clause 3.4 (1).

Table 1 – Categorisation of consequences classes in accidental design situations

Consequences class	Categorisation of building type and occupancy
1	1- or 2-storey buildings, which are occupied by people only occasionally (for example warehouses)
2a Lower risk group	Buildings with no more than four above-ground storeys[1)] or buildings which height from ground level does not exceed 16 m
2b Upper risk group	All other buildings and structures that do not fall into consequences classes 1, 2a or 3
3a	9-15 storey[2)] residential, office, commercial buildings and other 9-15 storey buildings that are similar with regard to intended purpose of use and structural system
3b	Other type of buildings with more than 8 storeys[2)] Concert halls, theatres, sports and exhibitions halls, spectator stands (more than 1000 peoples) Heavily loaded buildings or buildings with long spans Special structures according to a case-by-case assessment

[1)] Residential buildings with no more than two above-ground storeys may be designed according to consequences class 1 for accidental situations.

[2)] With basement storeys.

4 Recommended strategies

(1) Adoption of the following recommended strategies should provide a building with an acceptable level of robustness to sustain localised failure without a disproportionate level of collapse.

a) For buildings in Consequences class 1:

Provided a building has been designed and constructed in accordance with the rules given in EN 1990 to EN 1999 for satisfying stability in normal use, no further specific consideration is necessary with regard to accidental actions from unidentified causes.

b) For buildings in Consequences class 2a (Lower Group):

In addition to the recommended strategies for Consequences class 1, horizontal ties should be provided or anchorage of horizontal structures to walls should be provided. Clause 5.1 provides rules for horizontal ties and clause 5.2 for anchoring vertical structures to floors.

NOTE 1 In SFS-EN 1992-1-1 it is required that in buildings with a complete concrete frame, horizontal ties should be used and vertical structures should be anchored to horizontal structures.

c) For buildings in Consequences class 2b (Upper Group):

In addition to the procedures for Consequences class 1, either one of the following strategies should be used:

– in horizontal structures horizontal ties as defined in clause 5.1 and vertical ties in all load-bearing columns and walls as defined in clause 6 and anchorage of vertical structures to horizontal structures as defined in clause 5.2 should be used
– the building should be checked to ensure that upon the notional removal of each supporting column and each beam supporting a column, or any nominal section of load-bearing wall as defined in clause 7 (one at a time in each storey of the building) the building remains stable and that any local damage does not exceed the acceptable limit.

Where the notional removal of such columns and sections of walls would result in an extent of damage in excess of the acceptable limit (see clause 9), then such elements should be designed as a "key element" (see clause 8).

d) For buildings in Consequences class 3a:

In addition to the procedures for Consequences class 1, either one of the following strategies should be used::

– in horizontal structures horizontal ties as defined in clause 5.1 and vertical ties in all load-bearing columns and walls as defined in clause 6 and anchorage of vertical structures to the horizontal structures as defined in clause 5.2 should be used
– the building should be checked to ensure that upon the notional removal of each supporting column and each beam supporting a column, or any nominal section of load-bearing wall as defined in clause 7 (one at a time in each storey of the building) the building remains stable and that any local damage does not exceed the acceptable limit.

Where the notional removal of such columns and sections of walls would result in an extent of damage in excess of the acceptable limit (see clause 9), then such elements should be designed as a "key element" (see clause 8).

e) For buildings in Consequences class 3b:

A systematic risk assessment of the building should be undertaken taking into account both foreseeable and unforeseeable hazards. Regardless of the result of the risk assessment, the building should still meet the following requirements.

– the building should be checked to ensure that upon the notional removal of each supporting column and each beam supporting a column, or any nominal section of load-bearing wall as defined in clause 7 (one at a time in each storey of the building) the building remains stable and that any local damage does not exceed the acceptable limit.

Where the notional removal of such columns and sections of walls would result in an extent of damage in excess of the acceptable limit (see clause 9), then such elements should be designed as a "key element" (see clause 8).

NOTE 2 Guidance on risk analysis is provided in the Finnish Building Code, Part A1 and in Annex B of SFS-EN 1991-1-7.

5 Horizontal ties

5.1 Peripheral and internal ties

(1) Horizontal peripheral and internal ties should be provided around the perimeter of each floor and roof level and internally in two right angle directions. The ties should be continuous and be arranged as closely as practicable to the edges of floors and lines of columns and walls. At least 30 % of the ties should be located within the close vicinity of the grid lines of the columns and the walls.

(2) Horizontal ties may comprise timber sections, steel or aluminium sections, steel bar reinforcement in concrete slabs, or steel mesh reinforcement and profiled steel sheeting in composite steel/concrete floors (if directly connected to the steel beams with shear connectors). The ties may consist of a combination of the above types.

(3) Each continuous tie, including its end connections, should be capable of sustaining a design tensile force for the accidental limit state, equal to the following values:

Consequences class 2

The tie forces are based on the characteristic value of the permanent actions g_k for the horizontal structure.

Peripheral and internal ties:

When the characteristic value of the permanent actions for the horizontal structure is $g_k \geq 2,0$ kN/m^2

$T_i = s \cdot 20 kN/m$ or 70 kN, whichever is greater (1)

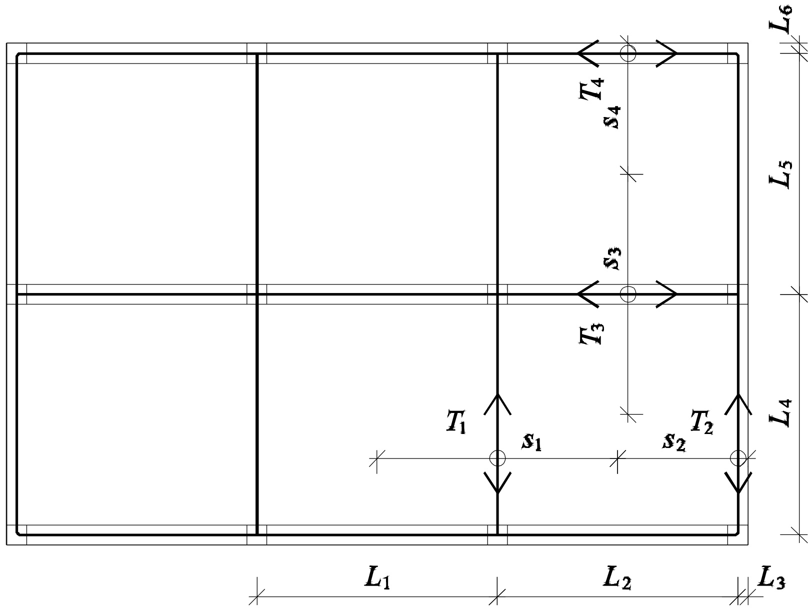
When the characteristic value of the permanent actions for the horizontal structure is $g_k \leq 1,0$ kN/m^2

$T_i = s \cdot 3 kN/m$ or 10 kN, whichever is greater (2)

where:

s is for internal ties, the distance between ties from centre to centre, and for peripheral ties, the distance between the peripheral tie and the closest internal tie divided by two plus the distance to the edge of the building (see Fig. 1).

When the characteristic value g_k of the permanent actions for the horizontal structure is between 1,0 and 2,0 kN/m^2, the values for the tie forces can be obtained by interpolation.



Key

Tie forces:

T_1: $s_1=(L_1+L_2)/2$ T_2: $s_2=L_3+L_2/2$ T_3: $s_3=(L_4+L_5)/2$ T_4: $s_4=L_6+L_5/2$

Figure 1 – Determination of the distance *s* when calculating horizontal tie forces

Consequences class 3a

The tie forces are based on the characteristic value of the permanent actions g_k for the horizontal structure. In the Consequences class 3a the characteristic value for the permanent actions g_k is usually greater than 2,0 kN/m^2. If the characteristic value of the permanent actions g_k is smaller than this value, then the tie forces may be defined on a project basis.

Peripheral and internal ties:

When the characteristic value of the permanent actions for the horizontal structure is $g_k \geq 2{,}0$ kN/m^2:

$$T_i = \frac{F_t \cdot 0{,}8 \cdot (g_k + \sum \psi_i q_k)}{6 \frac{kN}{m^2}} \frac{z}{5m} \cdot s \text{ or } T_i = F_t \cdot s \text{, whichever is greater} \tag{3}$$

where:

F_t is 48 kN/m or $(16 + 2{,}1 n_s)$ kN/m, whichever is smaller

g_k is the characteristic value of the permanent actions for the horizontal structure

ψ_i is the combination factor for a variable load in accidental limit state

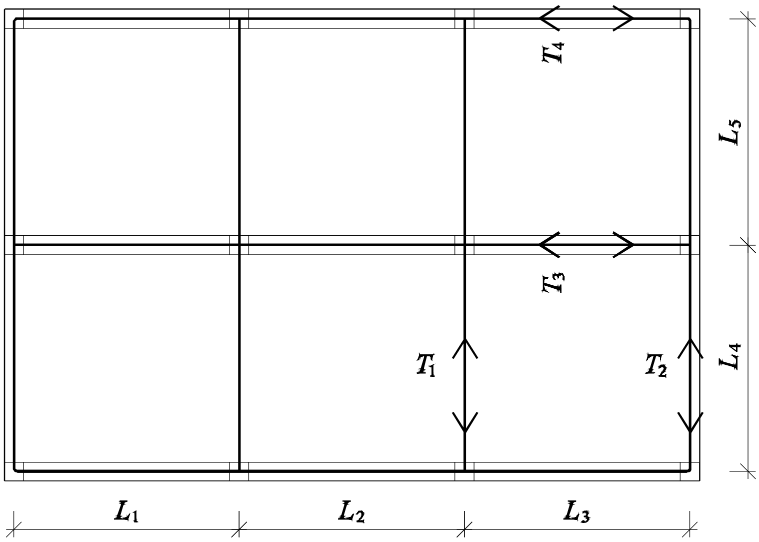
q_k is the characteristic value of the variable action for the horizontal structure

s is for internal ties, the distance between ties from centre to centre, and for peripheral ties, the distance between the peripheral tie and the closest internal tie divided by two plus the distance to the edge of the building (see Fig. 1)

n_s is the number of storeys (see table 1)

z is the distance between column or wall centre lines in the direction of the tie, or if the tie is in the direction of a load-bearing wall, it is the nominal length of the notationally removed section defined in clause 7 divided by two (z is the assumed to be a safe value of half of the span when utilising catenary action, see Fig. 2).

a)

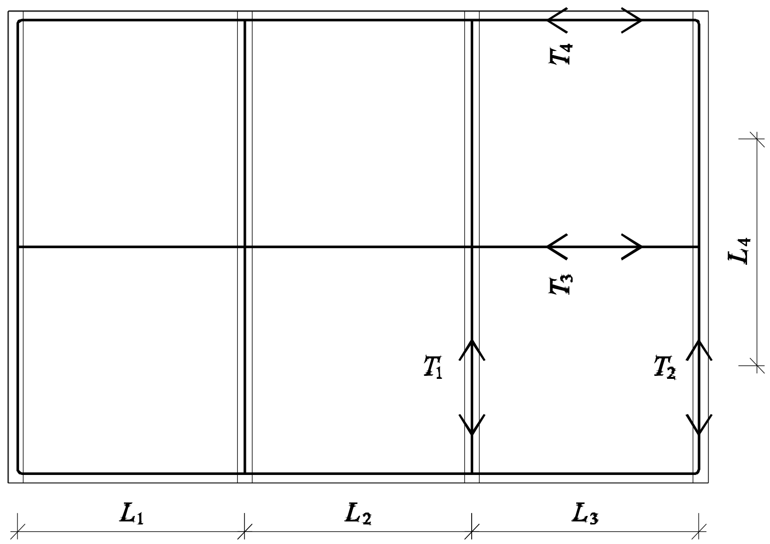


Key

Tie forces in a framed structure:

T_1 and T_2: $z = \max(L_4, L_5)$ T_3 and T_4: $z = \max(L_1, L_2, L_3)$

b)



Key

Tie forces in a load-bearing wall construction:

T_1 and T_2: $z = L_4/2$, where L_4 the nominal length of the load-bearing wall section (see clause 7)
T_3 and T_4: $z = \max(L_1, L_2, L_3)$

Figure 2 – Determination of the distance *z* when calculating horizontal tie forces

(4) Members used for sustaining actions other than accidental actions may be utilised as the above ties.

5.2 Horizontal ties to columns and walls

(1) Edge columns and walls should be tied to every floor and roof. The tie forces are based on the characteristic value of the permanent actions g_k for the horizontal structure. The ties should be capable of sustaining the following forces in accidental limit state:

<u>Consequences class 2</u>

$F_{tie} = 20\frac{kN}{m}\cdot s$ when the characteristic value of the permanent actions for the horizontal structure is $g_k \geq 2{,}0$ kN/m^2 (4)

$F_{tie} = 3\frac{kN}{m}\cdot s$ when the characteristic value of the permanent actions for the horizontal structure is $g_k \leq 1{,}0$ kN/m2 (5)

but no more than $F_{tie} = 150kN$

where:

s is the calculation width of the tie force, which is measured from centre to centre of the clear distance of vertical structures or to the edge of the building when the vertical structures are located in the outer corner (see Fig. 3),.

When the characteristic value g_k of the permanent actions for the horizontal structure is between 1,0 and 2,0 kN/m^2, the values for the tie forces can be obtained by interpolation.

Consequences class 3a

The tie forces are based on the characteristic value of the permanent actions g_k for the horizontal structure. If the characteristic value of the permanent actions of the horizontal structure is $g_k \geq 2,0$ kN/m^2, the equation (6) may be applied. If the characteristic value of the permanent actions g_k is smaller than this value, the tie forces may be defined on a project basis.

$$F_{tie} = F_t \cdot \frac{h}{2,5m} \cdot s \text{ or } F_{tie} = 2 \cdot F_t \cdot s \text{, whichever is smaller} \qquad (6)$$

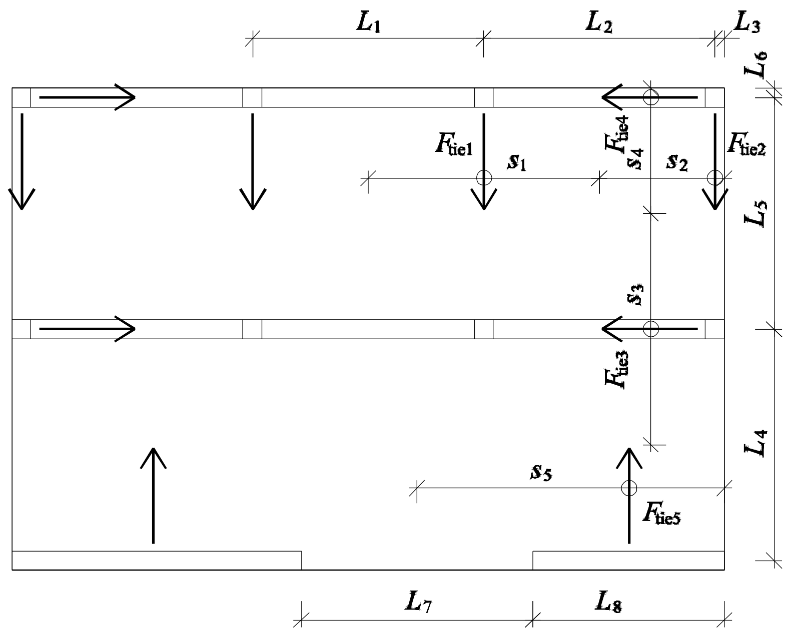
where:

F_t is 48 kN/m or $(16 + 2,1n_s)$ kN/m, whichever is smaller

h is the storey height

s is the calculation width of the tie force, which is measured from centre to centre of the clear distance of vertical structures or to the edge of the building when the vertical structures are located in the outer corner, (see Fig. 3)

n_s is the number of storeys (see Table 1).



Key

Tie forces:

F_{tie1}: $s_1=(L_1+L_2)/2$ F_{tie2}: $s_2=L_3+L_2/2$ F_{tie3}: $s_3=(L_4+L_5)/2$ F_{tie4}: $s_4=L_6+L_5/2$

F_{tie5}: $s_5=L_8+L_7/2$

Figure 3 – Determination of the distance *s* when calculating wall and column tying forces

(2) Corner columns should be tied in both directions

(3) Peripheral or internal ties may be used for tying columns if the reinforcement is anchored to the columns.

6 Vertical ties

(1) Each column and wall should be tied continuously from the foundations to the roof level.

(2) The columns and walls carrying vertical actions should be capable of resisting an accidental design tensile force equal to the largest design vertical permanent and variable load reaction applied to the column from any one storey. The tensile force should be anchored to the upper floor.

(3) The vertical ties are grouped at 6 m maximum centres along the wall and occur no greater than 3 m from an unrestrained end of the wall.

7 Nominal section of load-bearing wall

(1) The nominal length of load-bearing wall construction referred to in clauses 4(1) c, d and e should be taken as follows:

– for a concrete wall, a length not exceeding 2,25H,

– for an external masonry, or timber or metal stud wall, the length measured between lateral supports provided by other vertical building components (e.g. columns or transverse partition walls),

– for an internal masonry, or timber or metal stud wall, a length not exceeding 2,25H

where:

H is the storey height in metres.

8 Key elements

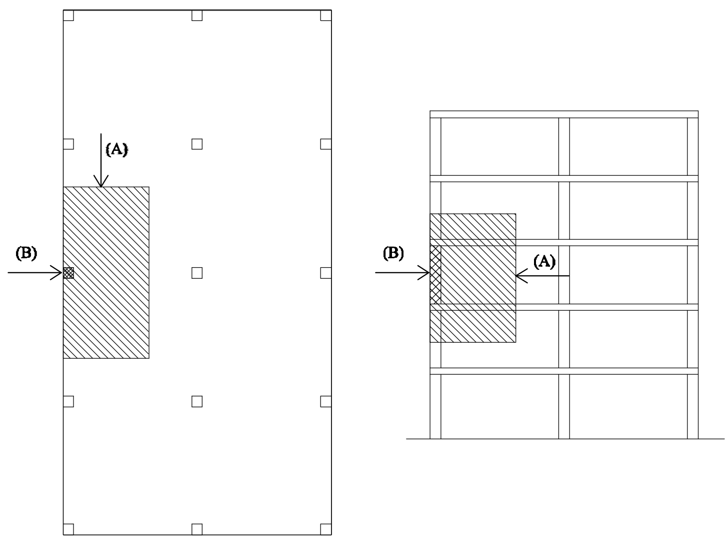
(1) In accordance with 3.3(1)P of SFS-EN 1991-1-7, for building structures a "key element" should be capable of sustaining an accidental action of A_d. The design value for load A_d is 50 kN. The action A_d acts horizontally in the centre of the clear storey height. Point loads are used for columns and A_d is distributed as a line load over 3 meters for walls.

9 Acceptable limit of local failure

(1) The acceptable limit of "localised failure" depends on the building type:

9.1 Multi-storey buildings

(1) The local damage should not exceed 15% of the floor area or 100 m^2 in one storey. The damage may occur in two adjacent storeys (see Fig. 4).



a) Plan b) Section

Key

(A) Local damage

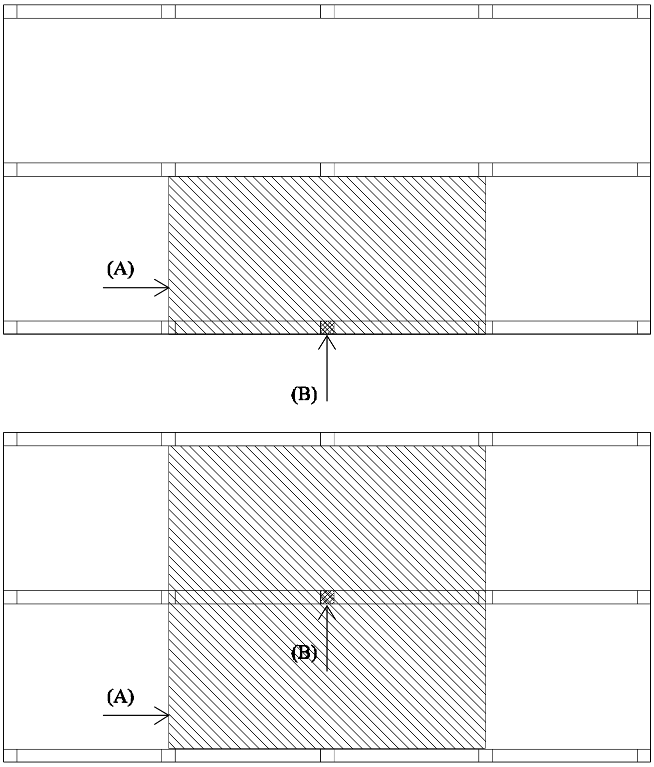
(B) Notional column to be removed

Figure 4 – Acceptable limit of local failure in multi-storey buildings

9.2 Hall-type buildings

(1) If a column is damaged, the acceptable area of local damage is the length of the main girders supported by the column multiplied by two times the distance between main girders. If the main girders are on the

external wall line, the acceptable local damage area is half of the area above (see Fig. 5). The damage may occur on one storey only.



Key

(A) Local damage

(B) Notional column to be removed

Figure 5 – Acceptable limit of local failure in hall-type buildings

(2) If a main girder is damaged, the acceptable area of local damage is the length of the main girder multiplied by two times the distance between main girders. If the main girders are on the external wall line, the acceptable local damage area may be half of the area above. The damage may occur on one storey only.