NATIONAL BUILDING CODE OF FINLAND

Strength and stability of structures

Masonry structures

Ympäristöministeriö
Miljöministeriet
Ministry of the Environment

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Foreword

The Ministry of the Environment publishes the recommendations for strength and stability related to the design of masonry structures in the National Building Code of Finland. The instruction contains a compilation of all the National Annexes concerning the design of masonry structures.

The beginning of each National Annex presents those clauses in the standard where national choice is permitted, and where such a choice has been made.

Helsinki, 20 December 2016

Head of the Buildings and Construction unit
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Contents

1. Scope

These instructions provide additional information when applying the Ministry of Environment Decree on load-bearing structures in the design and execution of masonry structures. A solution pursuant to these instructions is considered to meet the requirements set for load-bearing structures.

These instructions are applied when masonry structures are designed and executed pursuant to standards SFS-EN 1996 and their National Annexes.

2. Design of structures

2.1 Execution documents

Standard SFS-EN 1996-2 and its National Annex provide instructions regarding the drawing up of the execution documents for masonry structures.

Usually, the execution documents include, at a minimum, the following:
a) construction drawings
b) the designer's written requirements and instructions for the structure, such as the work specification
c) other documents to be adhered to or references to other documents.

2.2 Content of the structural designs

Usually, the structural designs for masonry structures present, at a minimum, the following to the extent applicable to the design task:
a) consequence class
b) environmental condition class and the planned service life of the structure
c) the R/E/I/M fire resistance class for the structural components
d) the adopted characteristic loads and load class
e) complete information on the dimensions and location of the structures
f) permissible deviations
g) the identifying information for the masonry units and mortar and the reinforcement steel and reinforcement elements
h) the number, diameter, length, form and bending radius of the reinforcement bars and their location and extensions

i) for prestressing reinforcements, the number, diameter, length, form, bending radii, location and extensions of the cords/bars, the tendon type and the location of the grouting pipes and auxiliary pipes
j) the mortar/concrete cover of the reinforcement
k) overlap of bricks/blocks
l) joint type, joint thickness and joint width in walls with shell bedded units
m) type, material, shape, number and placement of brick ties
n) water and damp proofing and water drainage
o) movement joints, their location and details
p) supporting of walls
q) recesses, chases, indentations and holes
r) holes for execution and construction joints
s) additional instructions concerning special conditions, such as bricklaying in winter
t) loads and supports during work.

2.3 Durability and design working life

The environmental condition class of the structure is defined in order to achieve the design working life. The environmental condition class is used to determine the requirements for the masonry units, mortar, concrete fill, reinforcement and the steel parts supplementing the masonry:

- the environmental condition classes are presented in standard SFS-EN 1996-2
- information related to the durability of the masonry units, mortar and supplementary steel parts is given in standard SFS 7001
- the concrete cover and the design of the structure are presented in standard SFS-EN 1996-1-1 and its National Annex
- instructions concerning the durability of the concrete fill are presented in standard SFS-EN 206 and its supplementary standard SFS 7022.

3. Execution

3.1 Execution planning

The work plans for the execution of masonry structures are drawn up on the basis of the execution documents in adherence with standard SFS-EN 1996-2 and its National Annex.

Usually, the work plans for the execution of masonry structures present, at a minimum, the following to the extent applicable to the design task:

- the required execution drawings

- the work phase plans pursuant to standard SFS-EN 1996-2 and its National Annex, as required by the execution documents
- quality plans pursuant to standard SFS-EN 1996-2 and its National Annex.

3.2 Construction products

The characteristics of the building products, materials and supplies used in masonry structures are demonstrated by means of the CE marking if they are covered by the scope of the harmonised product standard or if the manufacturer has acquired the European Technical Approval/Assessment for its product. Otherwise, they are demonstrated according to the Act on the Type Approval of Certain Construction Products (954/2012).

The characteristics of the following products are central in terms of the reliability of the masonry structures:
- masonry units
- mortar
- reinforcing steel and reinforcement
- masonry ties and other steel parts
- lintels and other elements made from masonry units.

The strength properties of the masonry structure are determined by means of advance tests, when using:
- masonry units that differ from European harmonised product standards
- masonry units pursuant to European product standards for which design values are not given in the National Annex to standard SFS-EN 1996-1-1
- mortars or mortar additives whose properties are not known.

If necessary, the other properties of the masonry structure, such as weather resistance and moisture performance, should be determined in advance. Advance tests concerning strength are done by applying the European test standards and advance tests concerning durability by applying standard SFS 7001. The test samples for advance testing are taken from the batch which is intended to use in construction. If necessary, the advance tests are supplemented by tests performed during construction.

All design values have not been presented for masonry units pursuant to standards SFS-EN 771-5 and SFS-EN 771-6; these need to be determined for each project.

A semi-structural lintel pursuant to standard SFS-EN 845-2 made of prefabricated steel, autoclaved aerated concrete masonry, manufactured stone, concrete, clay masonry, calcium silicate masonry, natural stone or a combination thereof with a span not more than 4.5 m may be used only for supporting the self-weight of masonry wall above.

4. Execution supervision and the conformity of structures

4.1 Execution supervision

The inspections related to the supervision of the execution of masonry structures are drawn up within the scope required by the execution documents in adherence with standard SFS-EN 1996-2.

During the execution of the structures, the responsible work supervisor or a separately appointed specialist work supervisor will supervise that the plans and instructions concerning the manufacture of masonry structures are followed and that the appropriate documents are prepared of the work.

If it is observed during the execution that a structure or detail does not meet the requirements laid down in the execution documents, the occurrence locations and causes of the deviations are analysed. In this case, it should be determine whether the deviation can be approved without a repair. If necessary, calculations are used to demonstrate that the safety level required by standards SFS-EN 1996 and their National Annexes is achieved. If it cannot be demonstrated that the deviation is acceptable without a repair, the repair will be carried out to the necessary extent. The deviation and corrective action will be recorded in the quality control archive.

The quality control material is documented and compiled into a single entity.

4.2 Conformity of structures

When applying these instructions, the conformity of structures is based on that the masonry structures are designed appropriately pursuant to standards SFS-EN 1996 and their National Annexes and are executed and inspected pursuant to the execution documents.

5. References

If the version of a reference has not been specified, the latest edition of the reference (with amendments) is applied.

SFS-EN 206 Concrete. Specification, performance, production and conformity

SFS-EN 771-5 Specification for masonry units. Part 5: Manufactured stone masonry units

SFS-EN 771-6 Specification for masonry units. Part 6: Natural stone masonry units

SFS-EN 845-2 Specification for ancillary components for masonry. Part 2: Lintels

SFS-EN 1996-1-1 Eurocode 6: Design of masonry structures. Part 1-1: General rules for reinforced and unreinforced masonry structures

SFS-EN 1996-1-2 Eurocode 6: Design of masonry structures. Part 1-2: General rules. Structural fire design

SFS-EN 1996-2 Eurocode 6: Design of masonry structures. Part 2: Design considerations, selection of materials and execution of masonry

SFS 7001 Properties required from masonry products at different locations and the requirement levels set for them
(In Finnish)

SFS 7022 Concrete. Use of standard SFS-EN 206 in Finland
(In Finnish)

6. National annexes to Eurocodes SFS-EN 1996

National Annex to standard SFS-EN 1996-1-1 Part 1-1: General rules for reinforced and unreinforced masonry structures

As regards standard SFS-EN 1996-1-1, the recommended values set forth in standard SFS-EN 1996-1-1 and all the annexes to standard SFS-EN 1996-1-1 are followed unless otherwise stated in this National Annex.

The Non-Contradictory Complementary Information (NCCI) is presented in italics.

National choice is permitted in the following clauses of standard SFS-EN 1996-1-1:

- • 2.4.3(1)P
- – 2.4.4(1)
- – 3.2.2(1)
- • 3.6.1.2(1)
- • 3.6.2(3)
- • 3.6.2 (4)
- • 3.6.2 (6)
- • 3.6.3(3)
- • 3.7.2(2)
- • 3.7.4(2)
- • 4.3.3(3)
- • 4.3.3(4)
- • 5.5.1.3(3)
- • 6.1.2.2(2)
- • 8.1.2(2)
- • 8.5.2.2(2)
- • 8.5.2.3(2)
- • 8.6.2(1)
- • 8.6.3(1).

A national choice has been made in the clauses marked ●.

Ultimate limit states

2.4.3(1)P

The values of partial factor γ_M in the persistent design situation are presented in the following Table 1. In an accidental design situation, the value of symbol γ_M is 1.0.

Table 1. Values for partial factor γ_M

	γ_M (persistent design situation)
Masonry structure with: - category I masonry units and designed mortar [a] - category I masonry units and prescribed mortar [b] - category II masonry units and any mortar [a,b,d]	 1.8 2.4 2.5
Reinforcement anchorage	1.8
Reinforcing steel and pre-stressing steel	1.15
Masonry ties, tension straps, brackets and hangrs pursuant to standard SFS-EN 845-1 and lintels pursuant to standard SFS-EN 845-2 [c], the manufacturer does not declare the failure type. The manufacturer may declare the failure type of the product. The partial factor to be used may be calculated as follows. Failure occurs: - in concrete, timber or masonry or their interface - in steel, aluminium or reinforcing steel γ_{M1} is the partial factor pursuant to the National Annex of the Eurocode part corresponding to the material in question (parts EN 1992, EN 1993, EN 1995, EN 1996, EN 1999)	3.2 1.35 γ_{M1} 1.10 γ_{M1}
[a] The requirements for designed mortars are given in standards SFS-EN 998-2 and SFS-EN 1996-2. Mortars used in Finland are designed mortars. In this case, the manufacturer declares the characteristics of the mortar. [b] The requirements for prescribed mortar are given in standards SFS-EN 998-2 and SFS-EN 1996-2 [c] The declared resistances are mean values. [d] When the coefficient of variation for category II masonry units is not greater than 25%.	

Characteristic compressive strength of masonry

3.6.1.2(1)

The compression strength of masonry is determined by means of a test pursuant to standard SFS-EN 1052-1, or with method (i) using expression (3.1) in standard SFS-EN 1996-1-1.

The following values are used for the powers α and β in expression (3.1) of standard SFS-EN 1996-1-1:

When using general purpose mortar:	$\alpha = 0.65$	$\beta = 0.25$
When using lightweight mortar	$\alpha = 0.65$	$\beta = 0.25$
When using thin layer mortar:		
for the following masonry units:	$\alpha = 0.85$	$\beta = 0$

- clay masonry, Groups 1 and 4
- calcium silicate masonry
- aggregate concrete masonry (lightweight and dense aggregate)
- autoclaved aerated concrete units

for the following masonry units: $\alpha = 0.7$ $\beta = 0$

- clay masonry, Groups 2 and 3

Table 2. Values for factor *K* in expression (3.1) of standard SFS-EN 1996-1-1 when using general purpose mortars, thin layer mortars and lightweight mortars

Masonry unit		General purpose mortar	Thin layer mortar (0,5 mm ≤ bed joint ≤ 3 mm)	Lightweight mortar, density	
				$600 \le \rho_d \le 800$ kg/m^3	$800 \le \rho_d \le 1300$ kg/m^3
Clay masonry	Group 1	0.60	0.75	0.35	0.45
	Group 2	0.50	0.70	0.30	0.35
	Group 3	0.40	0.50	0.25	0.30
	Group 4	0.35	0.35	0.20	0.25
Calcium silicate masonry	Group 1	0.60	0.80	-	-
	Group 2	0.50	0.65	-	-
Aggregate concrete masonry (lightweight and dense aggregate)	Group 1	0.65	0.85	0.50	0.50
	Group 2	0.55	0.70	0.50	0.50
	Group 3	0.50	0.55	-	-
	Group 4	0.45	-	-	-
Autoclaved aerated concrete masonry	Group 1	0.65	0.85	0.50	0.50

When using factor *K* from Table 2, the requirement is that the following conditions are met:

- the detailed design of the masonry has been performed pursuant to Chapter 8 of standard SFS-EN 1996-1-1
- all joints may be considered full according to the requirements of clauses 8.1.5(1) and (3) of standard SFS-EN 1996-1-1
- f_b is not greater than 75 N/mm^2 when the units are laid with general purpose mortar
- f_b is not greater than 50 N/mm^2 when the units are laid with thin layer mortar
- f_m is not greater than 20 N/mm^2 and at most 2 f_b when the units are laid with general purpose mortar
- f_b is not greater than 10 N/mm^2 when the units are laid with lightweight mortar
- the thickness of the masonry is equal to the width or length of the masonry units so that there is no longitudinal mortar joint along the entire length of the wall or a part thereof
- the coefficient of variation of the strength of the masonry units is not greater than 25%.

When action effects are in the direction of the horizontal joints, the characteristic value for compression strength may also be determined from the expressions (3.2), (3.3) or (3.4) in standard SFS-EN 1996-1-1 by using a value for the normalised compression strength of the masonry unit f_b received from tests where the direction of application of the load to the test specimen is the same as the direction of the action effect in the masonry. However, the value of factor δ presented in standard SFS-EN 772-1 must not be assumed to be higher than 1.0.

Alternatively, the normalised compression strength in the direction of the horizontal joints may be determined by means of calculation from the normalised compression strength perpendicular to the horizontal joint by using the following expression for masonry units in Groups 1, 2 and 3 when the voids run through the masonry unit:

$$f_{b1} = f_b \, ct/(1 - V_h) \qquad (1.1)$$

where

f_{b1}	*is the normalised compression strength of the masonry unit in the direction of the horizontal joint*
f_b	*is the normalised compression strength of the masonry unit in the direction perpendicular to the horizontal joint*
ct	*is the ratio of the combined thickness of the shells and webs of the masonry unit to the overall width. The value is reported by the manufacturer or it is selected according to the minimum value for the Group from Table 3.1 of standard SFS-EN 1996-1-1*
V_h	*is the ratio of the volumes of all voids to the gross volume. The value is declared by the manufacturer or it is selected according to the minimum value for the Group from Table 3.1 of standard SFS-EN 1996-1-1.*

For reinforced masonry structures with a tension distribution pursuant to Figure 6.4 of standard SFS-EN 1996-1-1, the normalised compression strength of the compressed part may be adopted for the normalised compression strength in the direction of the horizontal joint instead of the normalised compression strength in the direction of the horizontal joint of the entire masonry unit. In this case, the vertical joints shall have mortar across the entire compressed section. If necessary, the manufacturer may declare the normalised compression strength for the compressed part mentioned above (= mean value of the mass compression strength).

Characteristic shear strength of masonry

3.6.2(3)
The upper limit f_{vlt} for the characteristic initial shear strength f_{vlt} is calculated with the expressions below:

When the normalised compression strength of the masonry unit f_b is ≤ 5 N/mm^2:

$$f_{vlt} = 0,45 f_{bt} \sqrt{1 + \frac{\sigma_d}{f_{bt}}} \leq f_b - \sigma_d \tag{1.2}$$

where

σ_d is the design value for compression stress that acts perpendicular to the shearing plane within the examined structural member (calculated with a combination of actions corresponding to a shear analysis), based on the mean compression stress on the compressed part of the structural member

$$f_{bt} = 0,15 f_b ct \tag{1.3}$$

where

f_{bt} is the tensile strength of the masonry unit

f_b is the normalised compression strength of the masonry unit in the direction perpendicular to the horizontal joint

ct is the ratio of the combined thickness of the shells and webs of the masonry unit to the overall width. The value is declared by the manufacturer or it is selected according to the minimum value for Group considered from Table 3.1 of standard SFS-EN 1996-1-1.

When the normalised compression strength of the masonry unit f_b is > 5 N/mm^2:

$$f_{vlt} = 0,065 f_b \leq 1 \text{ N/mm}^2$$

3.6.2(4)

The upper limit f_{vlt} for the characteristic value the shearing strength for masonry without mortar in the vertical joints, f_{vk}, is calculated with the expressions below:

When the normalised compression strength of the masonry unit f_b is ≤ 5 N/mm^2:

$$f_{vlt} = 0,45 f_{bt} \sqrt{1 + \frac{\sigma_d}{f_{bt}}} \leq 0,7\left(f_b - \sigma_d \right) \tag{1.4}$$

where

σ_d is defined above in clause 3.6.2(3)

$$f_{bt} = 0,15 f_b ct \quad (1.5)$$

where

f_{bt}	is the tensile strength of the masonry unit
f_b	is the normalised compression strength of the masonry unit in the direction perpendicular to the horizontal joint
ct	is the ratio of the combined thickness of the shells and webs of the masonry unit to the overall width. The value is declared by the manufacturer or it is selected according to the minimum value for Group considered from Table 3.1 of standard SFS-EN 1996-1-1.

When the normalised compression strength of the masonry unit f_b is > 5 N/mm^2:

$$f_{vlt} = 0,045 f_b \leq 1 \text{ N/mm}^2$$

3.6.2(6)

The basic value for the characteristic shearing strength of a masonry structure f_{vko} is determined on the basis of initial shearing strength tests performed on the masonry, in which case the basic value adopted for nominal shearing strength is the basic value acquired by testing that is reported in the performance level declaration by the manufacturer of the masonry unit or the mortar.

Characteristic flexural strength of masonry

3.6.3(3)

Tables 3 and 4 below present the characteristic values of flexural strength f_{xk1} and f_{xk2} for clay masonry and calcium silicate masonry. In the design of structures with aggregate concrete masonry (dense and lightweight aggregate) and autoclaved aerated concrete masonry the characteristic values for flexural strength declared in the manufacturer's Declaration of Performace (DoP) are used.

Table 3. Characteristic values for the flexural strength f_{xk1} for clay masonry and calcium silicate masonry for plane of failure parallel to bed joints

Strength of masonry unit	f_{xk1} (N/mm^2)	
	General purpose mortar and thin layer mortar	
	$f_m \leq 5$ N/mm^2	$f_m \geq 10$ N/mm^2
$f_b \leq 20$ N/mm^2	0.15	0.20
$f_b = 25$ N/mm^2	0.20	0.25
$f_b \geq 35$ N/mm^2	0.20	0.35
Note 1. Intermediate values can be interpolated. Note 2. For other mortar types, the characteristic value of flexural strength f_{xk1} is determined for each project.		

Table 4. Characteristic values for the flexural strength f_{xk2} for clay masonry and calcium silicate masonry for plane of failure perpendicular to the bed joints

Strength of masonry unit	f_{xk2} (N/mm^2)	
	General purpose mortar and thin layer mortar	
	$f_m \leq 5$ N/mm^2	$f_m \geq 10$ N/mm^2
$f_b \leq 20$ N/mm^2	0.45	0.60
$f_b = 25$ N/mm^2	0.45	0.75
$f_b \geq 35$ N/mm^2	0.60	1.05
Note 1. Intermediate values can be interpolated. Note 2. If no mortar is used in the vertical joints, the values presented in the table are multiplied by a reduction factor of 0.7. Note 3. For other mortar types, the value of flexural strength f_{xk2} is determined for each project.		

Characteristic anchorage strength of reinforcement

3.6.4(1)P

The characteristic values for the anchorage strength of reinforcement steel are given in Table 5.

Table 5. *Characteristic value for anchorage strength of reinforcement in mortar, f_{bok}*

Mortar	*M2 – M7*	*M7.5 – M20*
f_{bok} for ribbed steel bars whose relative rib area meets the minimum requirements of standard SFS 1300	*1.8 N/mm^2*	*2.7 N/mm^2*

Modulus of elasticity

3.7.2(2)

The modulus of elasticity to be used in Annex G of standard SFS-EN 1996-1-1 should be calculated as quasi-permanent value where the permanent action is assumed to account for one half of the overall load.

Values of K_E for the modulus of elasticity needed in Annex G (the factor includes the effects of creep):

Clay masonry K_E =500
Calcium silicate masonry K_E =400
Concrete (dense aggregate) K_E =650
Concrete (lightweight aggregate) K_E =700
Autoclaved aerated concrete masonry K_E =700.

The values of factor K_E for the calculation of the secant modulus of elasticity for different masonry units:

Clay masonry	K_E =700
Calcium silicate masonry	K_E =700
Concrete (dense aggregate)	K_E =1000
Concrete (lightweight aggregate)	K_E =1400
Autoclaved aerated concrete masonry	K_E =1100.

For other masonry units, the values are determined for each project.

Creep, moisture expansion or shrinkage and thermal expansion

3.7.4(2)

The deformation properties used in Finland are given in Table 6.

Table 6. Creep, shrinkage and thermal elongation coefficients for masonry structures

Type of masonry unit	Final creep coefficient φ_∞	Long-term shrinkage coefficient[a], mm/m	Thermal elongation coefficient α_t, 10^{-6}/K
Clay masonry	0.75	- 0.1	6
Calcium silicate masonry	1.5	- 0.2	8
Concrete (dense aggregate)	1	- 0.6	10
Concrete (lightweight aggregate)	2	- 0.6	6
Autoclaved aerated concrete masonry	1	- 0.2	8
Note 1: For other masonry units, the values are determined for each project. a Negative value refers to shrinkage			

Reinforcing steel

4.3.3(3)

The selection of reinforcement steel in terms of durability is performed pursuant to Tables 7 and 8 below.

Table 7. Selection of reinforcement; clay masonry and calcium silicate masonry

Exposure class[a]	Minimum protection for reinforcement	
	Located in mortar	Located in concrete when the cover is less than required in clause (4)
MX1	Unprotected carbon steel	-
MX2	Stainless steel 1.4301[b]	Stainless steel 1.4301[b]
	Galvanised carbon steel[c]	
MX3	Stainless steel 1.4301[b]	Stainless steel 1.4301[b]
	Galvanised carbon steel[c]	
MX4	Stainless steel 1.4301[b,d]	Stainless steel 1.4301[b,d]
	Galvanised carbon steel[e]	
MX5	Stainless steel[f]	Stainless steel[f]

[a] See standard SFS-EN 1996-2 [b] See standard SFS-EN 10088-1
[c] Carbon steel is galvanised with a zinc coating of 600 g/m^2 (corresponds to class Zn E in SFS 1266).
[d] In very aggressive environment use of steel grades 1.4436, 1.4429 or 1.4462 pursuant to SFS-EN 10088-1 is recommended.
[e] Carbon steel is galvanised with a zinc coating of 1,350 g/m^2 (corresponds to class Zn B in SFS 1266).
[f] The steel grade is selected for each project on the basis of the environment.

Table 8. Selection of reinforcement; concrete (dense and lightweight aggregate) and autoclaved aerated concrete masonry

Exposure class[a]	Minimum protection for reinforcement	
	Located in mortar	Located in concrete when the cover is less than required in clause (4)
MX1	Unprotected carbon steel	-
MX2	Unprotected carbon steel[c]	Stainless steel 1.4301[b]
MX3	Unprotected carbon steel[c]	Stainless steel 1.4301[b]
MX4	Stainless steel 1.4301[b,d]	Stainless steel 1.4301[b,d]
	Galvanised carbon steel[e]	
MX5	Stainless steel[f]	Stainless steel[f]

[a] See standard SFS-EN 1996-2 [b] See standard SFS-EN 10088-1
[c] The mortar is a general purpose mortar or thin layer mortar of class M7.5 at a minimum, the protective cover pursuant to Figure 8.2 of standard SFS-EN 1996-1-1 is increased to 30 mm.
[d] In very aggressive environment use of steel grades 1.4436, 1.4429 or 1.4462 pursuant to SFS-EN 10088-1 is recommended.
[e] Carbon steel is galvanised with a zinc coating of 1,350 g/m^2 (corresponds to class Zn B in SFS 1266).
[f] The steel grade is selected for each project on the basis of the environment.

4.3.3(4)

The thickness of concrete cover c_{nom} is calculated by adding the allowance in design for deviation of the reinforcement to the concrete cover minimum value $c_{min,dur}$ given in Table 2 of the National Annex to standard SFS-EN 1992-1-1. Unless special measures are taken, the allowance in design for deviation is 10 mm.

The exposure classes according to the classification of concrete structures are presented in the design documents, in which case the required minimum strength, minimum amount of cement and the water/cement ratio are determined on the basis of standards SFS-EN 206 and SFS 7022.

The exposure classes of the masonry structure and the corresponding concrete exposure classes:
MX1=X0
MX2=XC4
MX3=XC4, XF1
MX4=XC4, XD1, XS1, XF2
MX5=XA3

Concrete cover may be reduced if the concrete is cast inside the masonry unit and the masonry unit is able to protect the reinforcement steel. The protection effect of the masonry unit should be demonstrated by means of a reliable analysis. However, the minimum distance between the reinforcing steel and the masonry unit is 5 mm.

When the masonry units act as the mould, in exposure classes MX2 and MX3 the concrete may be mixed from a factory-made dry mix with a minimum strength of not less than C25/30 and frost resistance pursuant to the exposure classes.

Effective thickness of masonry walls

5.5.1.3(3)

The value of k_{tef} is determined from the ratio E_1/E_2. However, the maximum value of k_{tef} is 2.

Reduction factor for slenderness and eccentricity

6.1.2.2(2)

The eccentricity e_k caused by creep may be assumed to be zero for walls with a maximum slenderness ratio λ_c of 27.
Creep is accounted for in the modulus of elasticity that is used for the calculation of the reduction factor for the wall compression resistance.

Minimum wall thickness

8.1.2(2)

The minimum thickness of a load-bearing wall, t_{min}, is 100 mm. The minimum thickness does not apply to outer leaf of cavity wall.

Cavity and veneer walls

8.5.2.2(2)

For cavity and veneer walls, the minimum number of ties n_{tmin} is 2 per square metre. If the inner and outer leaves are required to work together, the minimum number of ties n_{tmin} is 4 per square metre.

In insulated block structures where the outer leaf is attached to the inner leaf by means of insulation, the provided minimum number of ties does not need to be followed in the wind load design. In this case, the anchorage strength between the insulation and block must be at least 10 kN/m^2. If the interaction between the leaves is utilised in the design for vertical loads, the minimum number of ties n_{tmin} is 4 per square metre.

Double –leaf walls

8.5.2.3(2)

The number of ties *j* connecting together the leaves of a double wall is 2 per square metre. If the leaves are required to work together, the minimum number of ties *j* is 4 per square metre.

Vertical chases and recesses

8.6.2(1)

The allowed dimensions for vertical chase and recesses in the masonry allowed without calculations are given in Table 9.

Table 9. Allowed dimensions for vertical chases and recesses in the masonry allowed without calculations

Wall thickness mm	Chases and recesses on the wall surface		Chases inside the wall	
	maximum depth mm	maximum width mm	minimum thickness of remaining wall mm	maximum width mm
85	30	100	55	300
115	30	125	75	300
175	30	150	115	300
225	30	175	150	300
≥ 300	30	200	200	300

Note 1. The effects of chases and recesses in reinforced structures and near load concentrations (such as the support of beams) and on walls designed as 2-way slabs for horizontal actions must be verified.
Note 2. Intermediate values for different wall thicknesses should be interpolated.
Note 3. The maximum depth of the indentation or chase includes the depth of the hole of masonry unit that is uncovered when the indentation or chase is created.
Note 4. Indentations with a maximum height x width of 300 mm x 120 mm may be created in walls for electrical and HVAC installations.
Note 5. Vertical chases that do not extend above a floor by more than one third of the storey height may have a maximum depth of 80 mm and a maximum width of 120 mm if the wall has a minimum thickness of 225 mm.
Note 6. The horizontal distance between adjacent chases or a chase and a recess should be not less than 225 mm.
Note 7. The horizontal distance between any two adjacent recesses, whether they occur on the same side or on opposite sides of the wall, or between a recess and an opening, should not be less than twice the width of the wider of the two recesses.
Note 8. The cumulative width of vertical chases and recesses should not exceed 0,13 times the length of the wall.

Horizontal and inclined chases

8.6.3(1)
The allowed dimensions for horizontal or diagonal chases and recesses allowed in masonry structures without calculations are given in Table 10.

Table 10. Allowed dimensions for horizontal or diagonal chases made in masonry structures without calculations

Wall thickness mm	Maximum depth mm
	length ≤ 500 mm
85–115	0
116–175	30
176–225	30
226–300	30
over 300	30

Note 1. The effects of chases made on reinforced structures and near load concentrations (such as the support of beams) must be verified
Note 2. The dimensions of the holes exposed when creating the chase should be included when the maximum depth of the chase measured.
Note 3. Indentations with a maximum height x width of 120 mm x 300 mm may be created in walls for electrical and HVAC installations.
Note 4. The horizontal distance between an opening and a chase or a recess should be not less than 500 mm.
Note 5. The horizontal distance between adjacent chases of limited length, whether they occur on the same side or on opposite sides of the wall, should be not less than twice the length of the longest chase.
Note 6. In walls of thickness greater than 175 mm, the permitted depth of the chase may be increased by10 mm if the chase is machine cut accurately to the required depth. If machine cuts are used, chases up to 10 mm deep may be cut in both sides of walls of thickness not less than 225 mm.
Note 7. The width of chase should not exceed half the residual thickness of the wall.

Annex A
Considering of partial factors relating to Execution

Annex A is not used

Annex C
A simplified method for calculating the out-of-plane eccentricity of loading on walls

Annex C is not used

Annex E
Bending moment coefficients α_2 in a single leaf laterally loaded wall panels of thickness less than or equal to 250 mm

Annex E may also be applied to walls with a thickness above 250 mm.

Annex J
Reinforced masonry members subjected to shear loading: enhancement of f_{vd}

Annex J is not used.

National Annex to standard SFS-EN 1996-1-2 Part 1-2: General rules. Structural fire design

As regards standard SFS-EN 1996-1-2, the recommended values set forth in standard SFS-EN 1996-1-2 and all the annexes to standard SFS-EN 1996-1-2 are followed unless otherwise stated in this National Annex.

The Non-Contradictory Complementary Information (NCCI) is presented in italics.

National choice is permitted in the following clauses of standard SFS-EN 1996-1-2:

- 2.1.3(2)
- • 2.2(2)
- – 2.3(2)P
- • 3.3.3.1(1)
- • 3.3.3.2(1), Note 2
- • 3.3.3.3(1), Note 2
- • 4.5(3)
- • B(5), Note 4
- – C.2.4.

A national choice has been made in the clauses marked •.

Actions

2.2(2)
A value of ε_m = 0.7 is used for the emissivity of a masonry surface .

Member analysis

2.4.2(3), Note 1
When using standard SFS-EN 1990 and the partial factors from the Ministry of Environment Decree 3/16 concerning its application, the Figure in clause 2.4.2(3) of standard SFS-EN 1996-1-2 will change as presented in Figure 1.

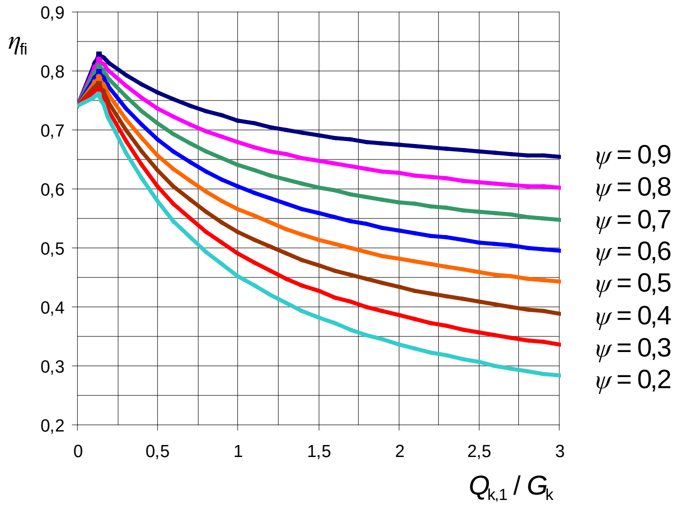

Figure 1. *The variation of the reduction factor η_{fi} as a function of the load ratio of the characteristic values of leading variable action and permanent action $Q_{k,1} / G_k$ according to the load combination rules presented in the Ministry of Environment Decree 3/16 concerning the application of standard SFS-EN 1990.*

2.4.2(3), Note 2

Approximate values are not used.

Thermal elongation

3.3.3.1(1)

The following values are used for the thermal elongation factor of a masonry structure:

Clay masonry:

Density range 900–2,000 kg/m^3

Thermal elongation factor $\alpha(\theta) = 6 \times 10^{-6}$

Calcium silicate masonry:

Density range 1500–2,000 kg/m^3

Thermal elongation factor $\alpha(\theta) = 8 \times 10^{-6}$

Concrete masonry (lightweight aggregate):

The thermal elongation of lightweight aggregate concrete masonry with a density range of 600–1,000 kg/m^3 and a strength of 4–6 N/mm^2 is given in Figure 2.

Autoclaved aerated concrete blocks:

The thermal elongation for autoclaved aerated concrete blocks with a density range of 300–700 kg/m^3 is given in Figure 2.

Aggregate concrete masonry:
The thermal elongation of concretes containing quartziferous and calciferous aggregates is given in Figure 2.

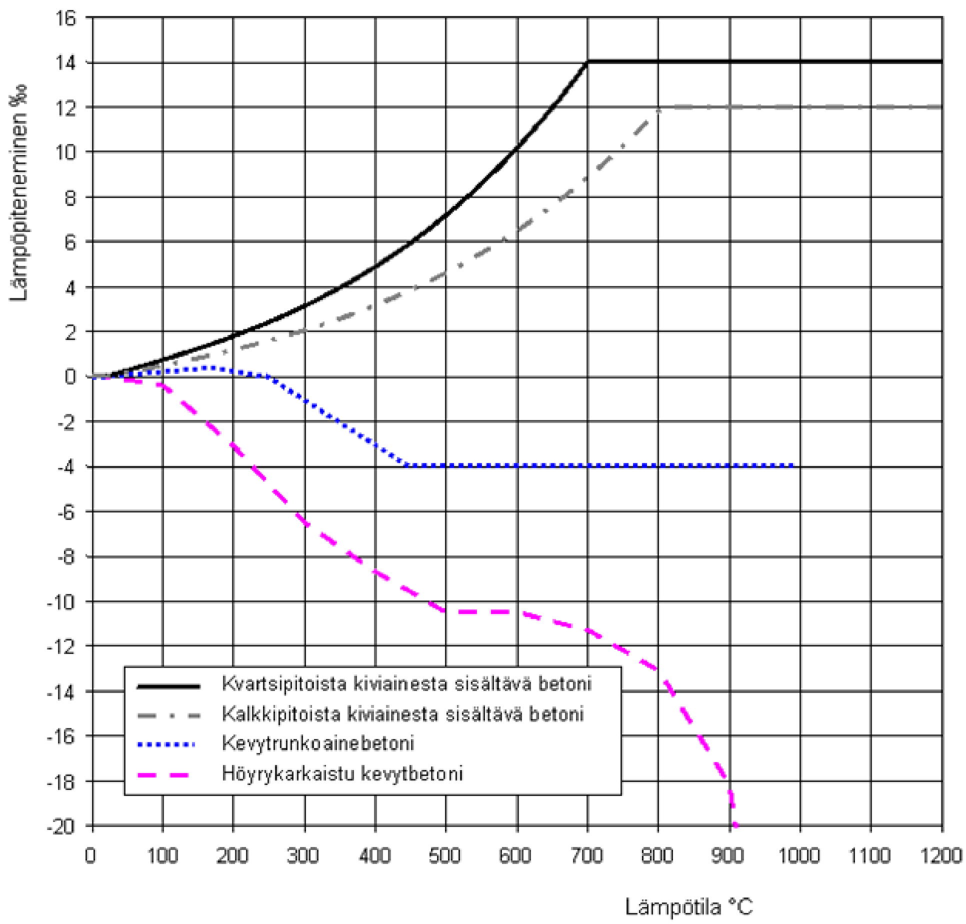

Figure 2. *Thermal elongation of different masonry units*

Specific heat capacity

3.3.3.2(1), Note 2
The following values are used for the specific heat capacity of a masonry structure:

Clay masonry:
Density range 900–1,200 kg/m^3, specific heat capacity c_a = 600 J/kgK
Density range 1200–2,000 kg/m^3, specific heat capacity c_a = 900 J/kgK

Calcium silicate masonry:
Density range 1500–2,000 kg/m^3
Specific heat capacity c_a = 1,000 J/kgK

Concrete masonry (lightweight aggregate):
Density range 600–1,000 kg/m^3
Specific heat capacity c_a = 1,000 J/kgK

Autoclaved aerated concrete blocks:
Density range 300–700 kg/m^3
Specific heat capacity c_a = 1,050 J/kgK

Concrete masonry (dense aggregate):
Density range 1,000–2,500 kg/m^3
Specific heat capacity c_a = 900 J/kgK at normal temperature

Figure 3 presents the dependency between the characteristic specific heat of concrete $c_p(\theta)$ (corresponds to c_a) and temperature and concrete moisture content *u*.

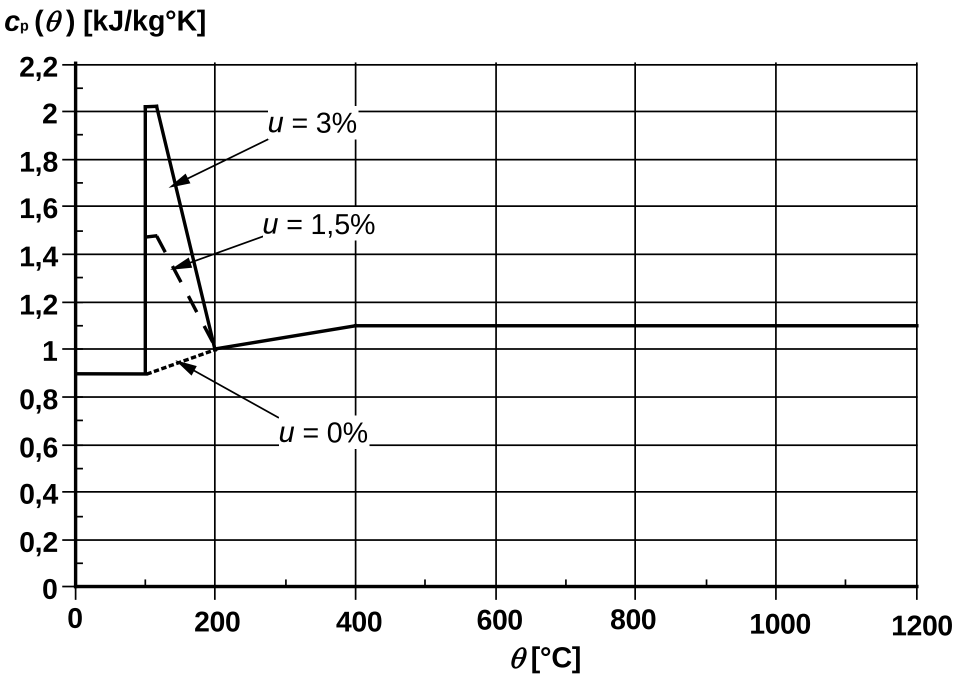

Figure 3. *Specific heat $c_p(\theta)$ of concrete containing quartziferous aggregate at three different moisture concentrations (0%, 1.5% and 3%)*

Thermal conductivity

3.3.3.3(1), Note 2
The following, generally conservative values for thermal conductivity may be adopted in the fire design of masonry structures.

Clay masonry:
Density range 1,200–1,400 kg/m^3
Thermal conductivity λ_a = 0.35 W/mK

Calcium silicate masonry:
Density range 1500–2,000 kg/m^3
Thermal conductivity λ_a = 0.95 W/mK

Concrete masonry (lightweight aggregate):
Density range 600–1,000 kg/m^3
Thermal conductivity λ_a = 0.25 W/mK

Autoclaved aerated concrete blocks:
Table 1 presents the thermal conductivity λ_a (W/mK) at different temperatures for autoclaved aerated concrete with a density of 300, 500 and 600 kg/m^3.

Table 1. Thermal conductivity λ_a (W/mK) for autoclaved aerated concrete at different temperatures

Temperature	Density		
	300 kg/m^3	500 kg/m^3	600 kg/m^3
20°C	0.10	0.14	0.15
300°C	0.12	0.16	0.17
600°C	0.19	0.20	0.21
900°C	0.28	0.28	0.29

Concrete (dense aggregate) masonry:
A value pursuant to curve 2 in Figure 4 is adopted for the thermal conductivity of concrete λ_a.

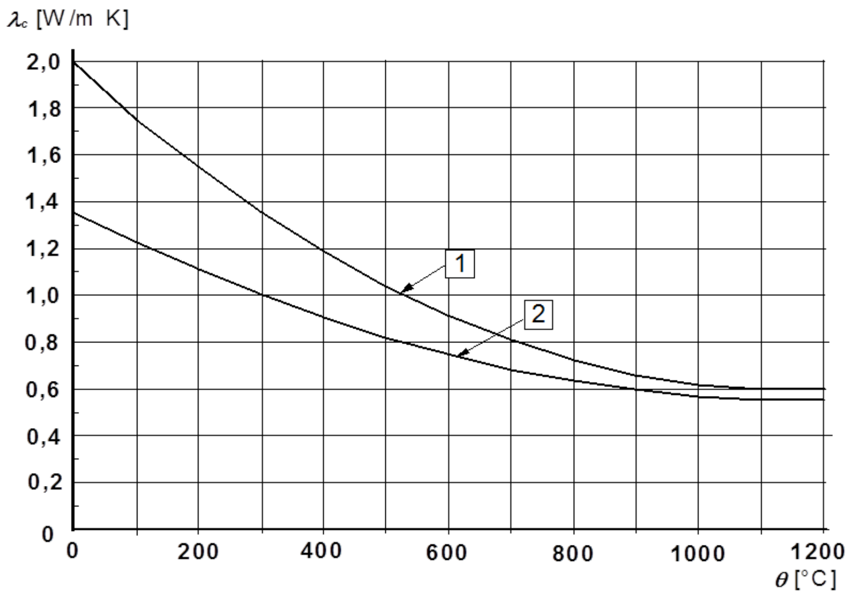

Figure 4. *Thermal conductivity of concrete*

Cavity walls and untied walls comprising independent leaves

4.1.2(2)

The minimum inner leaf thickness of a cavity wall is determined similarly to a simple wall, if the outer leaf is thinner than the inner leaf or the gap between the leaves contains combustible material.

Assessment by tabulated data

4.5(3)

A value of 2.4 is adopted for the term γ_{Glo}.

Annex A
Guidance on the selection of fire resistance periods

Annex A is not used.

Annex B
Tabulated fire resistance of masonry walls

B(5), Note 4

Clay masonry pursuant to standard EN 771-1

Table 2. Minimum thickness of non-load-bearing separating walls (criterion EI) made of clay masonry in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class EI at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1.	**Masonry units in Groups 1S and 1**						
1.1	general purpose, thin layer or lightweight mortar 800 ≤ ρ ≤ 2400						
1.1.1		70	85	100	115	130	180
2.	**Masonry units in Group 2**						
2.1	general purpose, thin layer or lightweight mortar 650 ≤ ρ ≤ 2400						
2.1.1		100	120	140	175	210	235

Table 3. Minimum thickness of load-bearing separating simple walls (criterion REI) made of clay masonry in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class REI at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1S	**Masonry units in Group 1S**						
1S.1	general purpose or thin layer mortar $1000 \le \rho \le 2400$						
1S.1.1	$\alpha \le 1.0$	100	100	100	120	180	200
1	**Masonry units in Group 1**						
1.1	general purpose or thin layer mortar $800 < \rho \le 2400$						
1.1.1	$\alpha \le 1.0$	100	100	120	150	190	220
2	**Masonry units in Group 2**						
2.1	general purpose or thin layer mortar $650 < \rho \le 2200$						
2.1.1	$\alpha \le 1.0$	100	130	160	190	210	235

Table 4. Minimum thickness of load-bearing non-separating simple walls (criterion R) made of clay masonry and with a minimum length of 1 m in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class R at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1S	**Masonry units in Group 1S**						
1S.1	general purpose or thin layer mortar $1000 \le \rho \le 2400$						
1S.1.1	$\alpha \le 1.0$	100	120	135	200	235	300
1	**Masonry units in Group 1**						
1.1	general purpose or thin layer mortar $800 < \rho \le 2400$						
1.1.1	$\alpha \le 1.0$	100	120	135	200	235	300
2	**Masonry units in Group 2**						
2.1	general purpose or thin layer mortar $650 < \rho \le 2200$						
2.1.1	$\alpha \le 1.0$	100	150	235	365	490	-

Table 5. Minimum thickness of load-bearing non-separating simple walls (criterion R) made of clay masonry and with a length of less than 1 m in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	wall thick-ness [mm]	Minimum wall length l_F (mm) fire resistance class R at different fire resistance times $t_{fi,d}$ (min)					
			30	60	90	120	180	240
1	**Masonry units in Groups 1S and 1**							
1.1	general purpose or thin layer mortar $800 \leq \rho \leq 2400$							
1.1.1	$\alpha \leq 1.0$	130	600	900	-	-	-	-
1.1.2		200	365	490	600	1000	-	-
1.1.3		235	300	365	490	600	1000	-
1.1.4		300	235	300	365	490	600	1000

Table 6. Minimum thickness of load-bearing and non-load-bearing separating simple walls (criterion REI-M and EI-M) made of clay masonry in different fire resistance clas-ses

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class REI-M and EI-M at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1S	**Masonry units in Group 1S**						
1S.1	general purpose or thin layer mortar $1000 \leq \rho \leq 2400$						
1S.1.1	$\alpha \leq 1.0$	235	235	235	300	350	-
1	**Masonry units in Group 1**						
1.2	general purpose or thin layer mortar $800 \leq \rho \leq 2400$						
1.1.1	$\alpha \leq 1.0$	235	235	235	300	350	-

Table 7. Minimum thickness in different fire resistance classes for both leaves of load-bearing separating cavity walls (criterion REI) made of clay masonry with only one leaf of the wall loaded

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class REI at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1S	**Masonry units in Group 1S**						
1S.1	general purpose or thin layer mortar 1000 ≤ ρ ≤ 2400						
1S.1.1	α ≤ 1.0	85	85	85	105	-	-
1	**Masonry units in Group 1**						
1.1	general purpose or thin layer mortar 800 < ρ ≤ 2400						
1.1.1	α ≤ 1.0	85	85	105	130	-	-
2	**Masonry units in Group 2**						
2.1	general purpose or thin layer mortar 650 < ρ ≤ 2200						
2.1.1	α ≤ 1.0	90	115	135	170	-	-

Calcium silicate masonry pursuant to standard EN 771-2

Table 8. Minimum thickness of non-load-bearing separating walls (criterion EI) made of calcium silicate masonry in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class EI at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1.	**Masonry units in Groups 1S and 1**						
1.1	general purpose, thin layer or lightweight mortar 1,400 ≤ ρ ≤ 2,400						
1.1.1		70	85	100	110	130	160
2.	**Masonry units in Group 2**						
2.1	general purpose, thin layer or lightweight mortar 650 ≤ ρ ≤ 2,400						
2.1.1		100	120	140	175	210	235

Table 9. Minimum thickness of load-bearing separating walls (criterion REI) made of calcium silicate masonry in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class REI at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1S	**Masonry units in Group 1S**						
1S.1	general purpose or thin layer mortar 1,700 ≤ ρ ≤ 2,400						
1S.1.1	α ≤ 1.0	100	100	100	120	180	200
1	**Masonry units in Group 1**						
1.1	general purpose or thin layer mortar 1,400 < ρ ≤ 2,400						
1.1.1	α ≤ 1.0	100	100	120	150	190	220
2	**Masonry units in Group 2**						
2.1	general purpose or thin layer mortar 650 < ρ ≤ 1,600						
2.1.1	α ≤ 1.0	100	130	160	190	210	235

Table 10. Minimum thickness of load-bearing non-separating simple walls (criterion R) made of calcium silicate masonry and with a minimum length of 1 m in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class R at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1S	**Masonry units in Group 1S**						
1S.1	general purpose or thin layer mortar 1,700 ≤ ρ ≤ 2,400						
1S.1.1	α ≤ 1.0	100	120	135	200	235	300
1	**Masonry units in Group 1**						
1.1	general purpose or thin layer mortar 1,400 < ρ ≤ 2,400						
1.1.1	α ≤ 1.0	100	120	135	200	235	300
2	**Masonry units in Group 2**						
2.1	general purpose or thin layer mortar 650 < ρ ≤ 1,600						
2.1.1	α ≤ 1.0	100	150	235	365	490	-

Table 11. Minimum thickness of load-bearing non-separating simple walls (criterion R) made of calcium silicate masonry and with a length below 1 m in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Wall thickness [mm]	Minimum wall length l_F (mm) fire resistance class R at different fire resistance times $t_{fi,d}$ (min)					
			30	60	90	120	180	240
1	**Masonry units in Groups 1S and 1**							
1.1	general purpose or thin layer mortar 1,400 < ρ ≤ 2,400							
1.1.1		130	490	900	-	-	-	-
1.1.2		200	365	490	600	1000	-	-
1.1.3		235	300	365	490	600	1000	-
1.1.4		300	235	300	365	490	600	1,000
1.1.5		365	200	235	300	365	490	600

Table 12. Minimum thickness of load-bearing and non-load-bearing separating simple walls (criterion REI-M and EI-M) made of calcium silicate masonry in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class REI-M and EI-M at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1S	**Masonry units in Group 1S**						
1S.1	general purpose or thin layer mortar 1,700 ≤ ρ ≤ 2,400						
1S.1.1	α ≤ 1.0	235	235	235	300	350	-
1	**Masonry units in Group 1**						
1.1	general purpose or thin layer mortar 1,400 < ρ ≤ 2,400						
1.1.1	α ≤ 1.0	235	235	235	300	350	-

Table 13. Minimum thickness in different fire resistance classes for both leaves of load-bearing separating cavity walls (criterion REI) made of calcium silicate masonry with only one leaf of the wall loaded

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class REI at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1S	**Masonry units in Group 1S**						
1S.1	general purpose or thin layer mortar 1,700 ≤ ρ ≤ 2,400						
1S.1.1	α ≤ 1.0	85	85	85	105	-	-
1	**Masonry units in Group 1**						
1.1	general purpose or thin layer mortar 1,400 < ρ ≤ 2,400						
1.1.1	α ≤ 1.0	85	85	105	130	-	-
2	**Masonry units in Group 2**						
2.1	general purpose or thin layer mortar 650 < ρ ≤ 1,600						
2.1.1	α ≤ 1.0	90	115	135	170	-	-

Concrete masonry with dense and lightweight aggregate pursuant to standard EN 771-3

Table 14. Minimum thickness of non-load-bearing separating walls (criterion EI) made of concrete masonry (dense and lightweight aggregate) in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class EI at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1	**Masonry units in Group 1** general purpose, thin layer or lightweight mortar						
1.1	lightweight aggregate 400 < ρ ≤ 1,600						
1.1.1		70	70	100	100	120	150
1.2	dense aggregate 1,200 < ρ ≤ 2,400						
1.2.1		70	80	100	120	150	175
2	**Masonry units in Group 2** general purpose, thin layer or lightweight mortar						
2.1	lightweight aggregate 240 < ρ ≤ 1,200						
2.1.1		70	100	100	120	150	170
2.2	dense aggregate 720 < ρ ≤ 1,650						
2.2.1		70	100	120	150	175	200

Table 15. Minimum thickness of load-bearing separating walls (criterion REI) made of concrete masonry (dense and lightweight aggregate) in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m^3]	Minimum wall thickness t_F (mm) fire resistance class REI at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1	**Masonry units in Group 1** general purpose, thin layer or lightweight mortar						
1.1	lightweight aggregate 400 < ρ ≤ 1,600						
1.1.1	α ≤ 1.0	100	100	120	150	200	200
1.2	dense aggregate 1,200 < ρ ≤ 2,400						
1.2.1	α ≤ 1.0	120	130	140	160	210	270
2	**Masonry units in Group 2** general purpose, thin layer or lightweight mortar						
2.1	lightweight aggregate 240 < ρ ≤ 1,200						
2.1.1	α ≤ 1.0	100	100	120	150	200	200
2.2	dense aggregate 720 < ρ ≤ 1,650						
2.2.1	α ≤ 1.0	120	130	140	160	210	270

Table 16. Minimum thickness of load-bearing non-separating simple walls (criterion R) made of concrete masonry (dense and lightweight aggregate) and with a minimum length of 1 m in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m^3]	Minimum wall thickness t_F (mm) fire resistance class R at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1	**Masonry units in Group 1** general purpose, thin layer or lightweight mortar						
1.1	lightweight aggregate 400 < ρ ≤ 1,600						
1.1.1	α ≤ 1.0	100	125	150	200	240	290
1.2	dense aggregate 1,200 < ρ ≤ 2,400						
1.2.1	α ≤ 1.0	120	140	170	220	270	350
2	**Masonry units in Group 2** general purpose, thin layer or lightweight mortar						
2.1	lightweight aggregate 240 < ρ ≤ 1,200						
2.1.1	α ≤ 1.0	100	125	150	200	240	290
2.2	dense aggregate 720 < ρ ≤ 1,650						
2.2.1	α ≤ 1.0	120	140	170	220	270	350

Table 17. Minimum thickness of load-bearing non-separating simple walls (criterion R) made of concrete masonry (lightweight aggregate) and with a length of less than 1 m in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m^3]	Wall thickness [mm]	Minimum wall length l_F (mm) fire resistance class R at different fire resistance times $t_{fi,d}$ (min)					
			30	60	90	120	180	240
1	**Masonry units in Groups 1 and 2** general purpose, thin layer or lightweight mortar							
1.1	lightweight aggregate 240 < ρ ≤ 1,600							
1.1.1	α ≤ 1.0	150	600	800	1,000	-	-	-
1.1.2		200	290	490	600	1,000	-	-
1.1.3		240	240	300	490	600	1,000	-
1.1.4		290	200	240	300	365	490	1,000

Table 18. Minimum thickness of load-bearing and non-load-bearing separating simple walls (criterion REI-M and EI-M) made of concrete masonry (dense and lightweight aggregate) in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class REI-M and EI-M at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1	**Masonry units in Group 1** general purpose, thin layer or lightweight mortar						
1.1	lightweight aggregate 400 < ρ ≤ 1,600						
1.1.1	α ≤ 1.0	240	240	300	300	350	-
1.2	dense aggregate 1,200 < ρ ≤ 2,400						
1.2.1	α ≤ 1.0	200	200	240	300	350	-

Table 19. Minimum thickness in different fire resistance classes for both leaves of load-bearing separating cavity walls (criterion REI) made of concrete masonry (dense and lightweight aggregate) with only one leaf of the wall loaded

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class REI at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1	**Masonry units in Group 1** general purpose, thin layer or lightweight mortar						
1.1	lightweight aggregate 400 < ρ ≤ 1,600						
1.1.1	α ≤ 1.0	90	90	110	140	-	-
2	**Masonry units in Group 2** general purpose, thin layer or lightweight mortar						
2.1	lightweight aggregate 240 < ρ ≤ 1,650						
2.1.1	α ≤ 1.0	90	90	110	140	-	-

Autoclaved aerated concrete masonry pursuant to standard EN 771-4

Table 20. Minimum thickness of non-load-bearing separating walls (criterion EI) made of autoclaved aerated concrete masonry in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class EI at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1	**Masonry units in Groups 1 and 1S**						
1.1	general purpose or thin layer mortar						
1.1.1	350 < ρ ≤ 450	68	80	100	120	140	170
1.1.2	450 < ρ ≤ 1,000	68	68	88	100	120	150

Table 21. Minimum thickness of load-bearing separating walls (criterion REI) made of autoclaved aerated concrete masonry in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class REI at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1	**Masonry units in Groups 1 and 1S**						
1.1	general purpose or thin layer mortar 350 < ρ ≤ 450						
1.1.1	α ≤ 1.0	100	100	120	150	200	250
1.2	general purpose or thin layer mortar 450 < ρ ≤ 1,000						
1.2.1	α ≤ 1.0	100	100	100	150	175	200

Table 22. Minimum thickness of load-bearing non-separating simple walls (criterion R) made of autoclaved aerated concrete and with a minimum length of 1 m in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class R at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1	**Masonry units in Groups 1 and 1S**						
1.1	general purpose or thin layer mortar 350 < ρ ≤ 450						
1.1.1	α ≤ 1.0	120	150	175	225	275	325
1.2	general purpose or thin layer mortar 450 < ρ ≤ 1,000						
1.2.1	α ≤ 1.0	100	125	150	200	240	290

Table 23. Minimum thickness of load-bearing non-separating simple walls (criterion R) made of autoclaved aerated concrete and with a length of less than 1 m in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Wall thickness [mm]	Minimum wall length l_F (mm) fire resistance class R at different fire resistance times $t_{fi,d}$ (min)					
			30	60	90	120	180	240
1	**Masonry units in Groups 1 and 1S**							
1.1	general purpose or thin layer mortar 350 ≤ ρ ≤ 450							
1.1.1	α ≤ 1,0	150	800	1000	-	-	-	-
1.1.2		175	490	600	1000	-	-	-
1.1.3		200	365	490	800	-	-	-
1.1.4		240	300	365	600	730	-	-
1.1.5		300	240	300	490	600	730	-
1.1.6		365	200	240	365	490	600	730
1.2	general purpose or thin layer mortar 450 ≤ ρ ≤ 1,000							
1.2.1	α ≤ 1.0	150	600	800	1000	-	-	-
1.2.2		175	365	490	800	-	-	-
1.2.3		200	300	365	600	730	-	-
1.2.4		240	240	300	490	600	730	-
1.2.5		300	200	240	365	490	600	730
1.2.6		365	170	200	300	365	490	600

Table 24. Minimum thickness of load-bearing and non-load-bearing separating simple walls (criterion REI-M and EI-M) made of autoclaved aerated concrete masonry in different fire resistance classes

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class REI-M and EI-M at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1	**Masonry units in Groups 1 and 1S**						
1.1	thin layer mortar, mortar in the vertical and horizontal joints 350 < ρ ≤ 450						
1.1.1	α ≤ 1.0	300	300	300	325	375	-
1.2	thin layer mortar, mortar in the vertical and horizontal joints 450 < ρ ≤ 1,000						
1.2.1	α ≤ 1.0	240	240	240	300	350	-

Table 25. Minimum thickness in different fire resistance classes for both leaves of load-bearing separating cavity walls (criterion REI) made of autoclaved aerated concrete masonry with only one leaf of the wall loaded

Row number	Material properties: gross dry density ρ [kg/m³]	Minimum wall thickness t_F (mm) fire resistance class REI at different fire resistance times $t_{fi,d}$ (min)					
		30	60	90	120	180	240
1	**Masonry units in Groups 1 and 1S**						
1.1	general purpose or thin layer mortar $350 < \rho \leq 450$						
1.1.1	$\alpha \leq 1.0$	90	100	110	140	175	200
1.2	general purpose or thin layer mortar $450 < \rho \leq 1{,}000$						
1.2.1	$\alpha \leq 1.0$	90	90	100	125	150	175

Annex C
Simplified calculation model

Annex C is not used.

Annex D
Advanced calculation method

Annex D is not used.

Annex E
Examples of connections that meet the requirements of Section 5

Annex E is not used.

National Annex to standard SFS-EN 1996-2 Part 2: Design considerations, selection of materials and execution of masonry

As regards standard SFS-EN 1996-2, the recommended values set forth in standard SFS-EN 1996-2 and all the annexes to standard SFS-EN 1996-2 are followed unless otherwise stated in this National Annex.

The Non-Contradictory Complementary Information (NCCI) is presented in italics.
National choice is permitted in the following clauses of standard SFS-EN 1996-2:

- 2.3.4.2(2)
- 3.5.3.1(1)

A national choice has been made in the clauses marked ●.

General

2.2.1(3)
Construction products that are CE marked pursuant to a harmonised product standard or the European Technical Approval/assessment (ETA) are used in masonry structures. If CE marking is not possible, qualification of used construction products should be verified pursuant to Act 954/2012.

Masonry movement

2.3.3(4)
Non-movement-tolerant ties may be used in cavity walls less than 6 m in height. In cavity walls higher than this, the movement caused by moisture expansion and temperature variation between the leaves should be calculated and a tie with sufficient movement capability should be used. The tie manufacturer should declare the movement range of the tie according to standard SFS-EN 845-1.

Spacing of movement joints

2.3.4.2(2)
The horizontal distance between movement joints in unreinforced, non-load-bearing external walls l_m, shall generally not exceed the values given in Table 1. The values apply to a structure 3 m high without openings. With lower masonry walls, the spacing of movement joints must be made shorter; with masonry walls more than 3 m high, the spacing of movement joints may be increased. The effect of the openings on the spacing of movement joints must be determined separately case by case.

Table 1. Horizontal distance l_m between movement joints in unreinforced non-load-bearing outside walls

Type of masonry	l_m (m)
Clay masonry[a]	15
Calcium silicate masonry[a]	10
Aggregate concrete masonry (lightweight aggregate)[b]	6
Aggregate concrete masonry (dense aggregate)[b]	6
Autoclaved aerated concrete masonry[b]	6

[a] Values apply to external leaf of cavity wall or external walls in unheated structures
[b] Usually, reinforcement fulfilling the requirements given in SFS-EN 1996-1-1 clause 8.2.3(3) is used in external walls, and for this reason the spacing of movement joints may be larger. The spacing of movement joints for such external walls is determined according to the manufacturer's instructions.

The spacing of movement joints for masonry made from other materials must be determined on a project basis.

Permissible deviations

3.4(3)
The permissible deviations to be used are given in Table 2.

Table 2. The permissible deviations of masonry structures compared to the designed location

Position	*Maximum deviation*
Inclination	
measured from the straight reference line between the centre points of the top and bottom of the wall/column	*0.5%, but no more than 30 mm*
for the entire height of a building of at least three storeys, measured from the straight reference line between the centre points of the top and bottom of the wall/column *tolerance from the planned centre line*	*± 50 mm* *± 8 mm*
Curvature	
measured from the straight reference line between the centre points of the top and bottom of the wall/column	*0.4%*
Thickness	
thickness of one leaf of the wall[a] *distance between the wall leaves*	*± 5% of the thickness of one leaf of the wall* *± 15 mm*
[a]Excluding walls whose width or length is equal to a single masonry unit, where the dimensional tolerances of the masonry unit govern the deviations.	

If no values for deviations are provided in the design documents, clause 3.4(3) of SFS-EN 1996-2 states that the stricter of the deviations pursuant to Table 3.1 of SFS-EN 1996-2 and Table 2 of the National Annex shall be used.

Pointing

3.5.3.1(1)
With non-load-bearing walls, the unhardened mortar should be raked out to a depth of at least d_p = 15 mm for joints to be pointed.

Pointing is not recommended in load-bearing structures.

Protection against freeze/thaw cycling

3.6.3(1)
Winter conditions are considered to be prevalent when the air temperature falls below 0°C, even intermittently. If this is the case, special attention must be paid to the choice of mortar, the execution of the work, the storage of construction products and materials,

the organising of the work and the protection of the masonry structure. Masonry units should not be wet and they should be free from ice and snow. If necessary, the masonry units may be heated. The mortar must be free from ice and from any icy substances.

Execution of masonry under winter conditions can be performed by using mortar developed to winter conditions, or by using heated normal mortars and masonry-laying techniques suitable for winter conditions.

Execution using mortars developed for winter conditions:

The execution is done according to the mortar manufacturer's instructions and following the operating temperature limits and protective measures set for the mortar.

Execution using normal mortar under winter conditions:

Execution is done with normal mortar. The mortar is heated by using heated mixing water. When using heated mortars, it is necessary to take into account the faster setting of the mortar. However, the temperature of the mortar should not exceed +40°C and the temperature of the water used in mixing the mortar should not exceed +60°C.

Execution and the protection of the masonry structure under winter conditions should be performed so that the temperature of the mortar in the joints stays above 0°C for a sufficiently long time in order to prevent the freezing of the water from damaging the adhesion between the mortar and the masonry unit. Where necessary, heaters may be used to keep the masonry warm enough.

The mortar may be allowed to freeze only after the water absorption in the masonry units has reduced the water content of the mortar to an acceptable level, or when the mortar has cured for a sufficiently long time for it to reach an acceptable strength before freezing.

When using lime cement mortars with at least 65% by weight of Portland cement as binding material or masonry cement mortars, the value for acceptable low water content from the point of view of freezing is 6% by weight. The absorption of water from the mortar into the masonry units is determined experimentally or in another reliable way. The strength of the masonry structure should be assumed to be no more than 40% of the design strength when it thaws.

When using lime cement mortars with at least 65% by weight of Portland cement as binding material or masonry cement mortars with clay and calcium silicate masonry units, masonry can be considered to have reached acceptable strength from the point of view of freezing when masonry has cured for at least 48 hours at a temperature above

0°C. The temperature of the mortar should be monitored in a reliable way. The strength of the masonry structure should be assumed to be no more than 60% of the design strength when it thaws.

When using masonry cement mortars with lightweight aggregate concrete and autoclaved aerated concrete masonry units, masonry can be considered to have reached acceptable strength from the point of view of freezing when masonry has cured for at least 72 hours at a temperature above 0°C. The temperature of the mortar should be monitored in a reliable way. The strength of the masonry structure should be assumed to be no more than 60% of the design strength when it thaws.

Execution of reinforced masonry should be performed so that the temperature in the masonry structure stays above 0°C for at least 48 hours.

Annex A
Classification of micro conditions of exposure of completed masonry

There is no need to use the subdivisions of the basic classification in Finland when determining the exposure class for the masonry structure.

Annex B
Acceptable specifications of masonry units and mortar for durable masonry under various exposure conditions

Annex B is not used

Standard SFS 7001 presents durability information for masonry units and mortars.

Annex C
Selection of materials and corrosion protection specifications for ancillary components according to exposure class

Annex C is not used

Durability information for ancillary components concerning materials and corrosion protection is presented in standard SFS 7001.