

EUROPEAN STANDARD

EN 1996-1-2

NORME EUROPÉENNE

EUROPÄISCHE NORM

May 2005

ICS 13.220.50; 91.010.30; 91.080.30

Supersedes ENV 1996-1-2:1995

English version

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

Eurocode 6 - Calcul des ouvrages en maçonnerie - Partie 1-2: Règles générales - Calcul du comportement au feu

Eurocode 6 - Bemessung und Konstruktion von Mauerwerksbauten - Teil 1-2: Allgemeine Regeln - Tragwerksbemessung für den Brandfall

This European Standard was approved by CEN on 4 November 2004.

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Foreword

This document (EN 1996-1-2:2005) has been prepared by Technical Committee CEN/TC 250 "Structural Eurocodes", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2005 and conflicting national standards shall be withdrawn at the latest by March 2010.

This document supersedes ENV 1996-1-2:1995.

CEN/TC 250 is responsible for all Structural Eurocodes.

Background of the Eurocode programme

In 1975, the Commission of the European Community decided on an action programme in the field of construction, based on article 95 of the Treaty. The objective of the programme was the elimination of technical obstacles to trade and the harmonisation of technical specifications.

Within this action programme, the Commission took the initiative to establish a set of harmonised technical rules for the design of construction works which, in a first stage, would serve as an alternative to the national rules in force in the Member States and, ultimately, would replace them.

For fifteen years, the Commission, with the help of a Steering Committee with Representatives of Member States, conducted the development of the Eurocodes programme, which led to the first generation of European codes in the 1980's.

In 1989, the Commission and the Member States of the EU and EFTA decided, on the basis of an agreement¹ between the Commission and CEN, to transfer the preparation and the publication of the Eurocodes to the CEN through a series of Mandates, in order to provide them with a future status of European Standard (EN). This links *de facto* the Eurocodes with the provisions of all the Council's Directives and/or Commission's Decisions dealing with European standards (e.g. the Council Directive 89/106/EEC on construction products - CPD - and Council Directives 93/37/EEC, 92/50/EEC and 89/440/EEC on public works and services and equivalent EFTA Directives initiated in pursuit of setting up the internal market).

The Structural Eurocode programme comprises the following standards generally consisting of a number of Parts:

EN 1990	Eurocode :	Basis of Structural Design
EN 1991	Eurocode 1:	Actions on structures
EN 1992	Eurocode 2:	Design of concrete structures
EN 1993	Eurocode 3:	Design of steel structures
EN 1994	Eurocode 4:	Design of composite steel and concrete structures

¹ Agreement between the Commission of the European Communities and the European Committee for Standardisation (CEN) concerning the work on EUROCODES for the design of building and civil engineering works (BC/CEN/03/89).

EN 1995	Eurocode 5:	Design of timber structures
EN 1996	Eurocode 6:	Design of masonry structures
EN 1997	Eurocode 7:	Geotechnical design
EN 1998	Eurocode 8:	Design of structures for earthquake resistance
EN 1999	Eurocode 9:	Design of aluminium structures

Eurocode standards recognise the responsibility of regulatory authorities in each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level where these continue to vary from State to State.

Status and field of application of Eurocodes

The Member States of the EU and EFTA recognise that EUROCODES serve as reference documents for the following purposes:

- as a means to prove compliance of building and civil engineering works with the essential requirements of Council Directive 89/106/EEC, particularly Essential Requirement N°1 – Mechanical resistance and stability – and Essential Requirement N°2 – Safety in case of fire;
- as a basis for specifying contracts for construction works and related engineering services;
- as a framework for drawing up harmonised technical specifications for construction products (ENs and ETAs)

The Eurocodes, as far as they concern the construction works themselves, have a direct relationship with the Interpretative Documents² referred to in Article 12 of the CPD, although they are of a different nature from harmonised product standards³. Therefore, technical aspects arising from the Eurocodes work need to be adequately considered by CEN Technical Committees and/or EOTA Working Groups working on product standards with a view to achieving full compatibility of these technical specifications with the Eurocodes.

The Eurocode standards provide common structural design rules for everyday use for the design of whole structures and component products of both a traditional and an innovative nature. Unusual forms of construction or design conditions are not specifically covered and additional expert consideration will be required by the designer in such cases.

² According to Art. 3.3 of the CPD, the essential requirements (ERs) shall be given concrete form in interpretative documents for the creation of the necessary links between the essential requirements and the mandates for harmonised ENs and ETAGs/ETAs.

³ According to Art. 12 of the CPD the interpretative documents shall :

- a) give concrete form to the essential requirements by harmonising the terminology and the technical bases and indicating classes or levels for each requirement where necessary ;
- b) indicate methods of correlating these classes or levels of requirement with the technical specifications, e.g. methods of calculation and of proof, technical rules for project design, etc. ;
- c) serve as a reference for the establishment of harmonised standards and guidelines for European technical approvals.

The Eurocodes, *de facto*, play a similar role in the field of the ER 1 and a part of ER 2.

EN1996-1-2:2005**National Standards implementing Eurocodes**

The National Standards implementing Eurocodes will comprise the full text of the Eurocode (including any annexes), as published by CEN, which may be preceded by a National title page and National foreword, and may be followed by a National Annex.

The National Annex may only contain information on those parameters which are left open in the Eurocode for national choice, known as Nationally Determined Parameters, to be used for the design of buildings and civil engineering works to be constructed in the country concerned, *i.e.* :

- values and/or classes where alternatives are given in the Eurocode,
- values to be used where a symbol only is given in the Eurocode,
- country specific data (geographical, climatic, etc.), e.g. snow map,
- the procedure to be used where alternative procedures are given in the Eurocode,

and it may also contain

- decisions on the application of informative annexes,
- references to non-contradictory complementary information to assist the user to apply the Eurocode.

Links between Eurocodes and products harmonised technical specifications (ENs and ETAs)

There is a need for consistency between the harmonised technical specifications for construction products and the technical rules for works⁴. Furthermore, all the information accompanying the CE Marking of the construction products which refer to Eurocodes should clearly mention which Nationally Determined Parameters have been taken into account.

This European Standard is part of EN 1996 which comprises the following parts:

EN 1996-1-1: Common rules for reinforced and unreinforced masonry structures.

EN 1996-1-2: General Rules - Structural Fire Design.

EN 1996-2: Design, Selection of materials and execution of masonry

EN 1996-3: Simplified calculation methods and simple rules for masonry structures

EN 1996-1-2 is intended to be used together with EN 1990, EN 1991-1-2, EN 1996-1-1, EN 1996-2 and EN 1996-3

⁴ see Art.3.3 and Art.12 of the CPD, as well as clauses 4.2, 4.3.1, 4.3.2 and 5.2 of ID 1.

Additional information specific to EN 1996-1-2

The general objectives of fire protection are to limit risks with respect to the individual and society, neighbouring property, and where required, directly exposed property, in the case of fire.

The Construction Products Directive 89/106/EEC gives the following essential requirement for the limitation of fire risks:

"The construction works must be designed and built in such a way that, in the event of an outbreak of fire

- the load bearing resistance of the construction can be assumed for a specified period of time
- the generation and spread of fire and smoke within the works are limited
- the spread of fire to neighbouring construction works is limited
- the occupants can leave the works or can be rescued by other means
- the safety of rescue teams is taken into consideration".

According to the Interpretative Document No 2 "Safety in Case of Fire" the essential requirement may be observed by following various possibilities for fire safety strategies prevailing in the Member States like conventional fire scenarios (nominal fires) or 'natural' (parametric) fire scenarios, including passive and/or active fire protection measures.

The fire parts of Structural Eurocodes deal with specific aspects of passive fire protection in terms of designing structures and parts thereof for adequate load bearing resistance that could be needed for safe evacuation of occupants and fire rescue operations and for limiting fire spread as relevant.

Required functions and levels of performance are generally specified by the national authorities - mostly in terms of a standard fire resistance rating. Where fire safety engineering for assessing passive and active measures is acceptable, requirements by authorities will be less prescriptive and may allow for alternative strategies.

This Part 1-2, together with EN 1991-1-2, Actions on structures exposed to fire, supplements EN 1996-1-1, so that the design of masonry structures can comply with normal and fire requirements.

Supplementary requirements concerning, for example

- the possible installation and maintenance of sprinkler systems
- conditions on occupancy of building or fire compartment
- the use of approved insulation and coating materials, including their maintenance

are not given in this document, as they are subject to specification by the competent authority.

A full analytical procedure for structural fire design would take into account the behaviour of the structural system at elevated temperatures, the potential heat exposure and the beneficial effects of active fire protection systems, together with the uncertainties associated with these three features and the importance of the structure (consequences of failure).

At the present time it is possible to perform a calculation procedure for determining adequate performance which incorporates some, if not all, of these parameters and to demonstrate that the structure, or its components, will give adequate performance in a real building fire. However the principal current procedure in European countries is one based on results from standard fire resistance tests. The grading system in regulations, which call for specific periods of fire resistance, takes into account (though not explicitly), the features and uncertainties described above.

Due to the limitations of the test method, further tests or analyses may be used. Nevertheless, the results of standard fire tests form the bulk of input for calculation procedures for structural fire design. This standard therefore deals principally with the design for the standard fire resistance.

Application of this Part 1-2 of Eurocode 6 with the thermal actions given in EN 1991-1-2, is illustrated in figure 0.1. For design according to this part, EN 1991-1-2 is required for the determination of temperature fields in structural elements, or when using general calculation models for the analysis of the structural response.

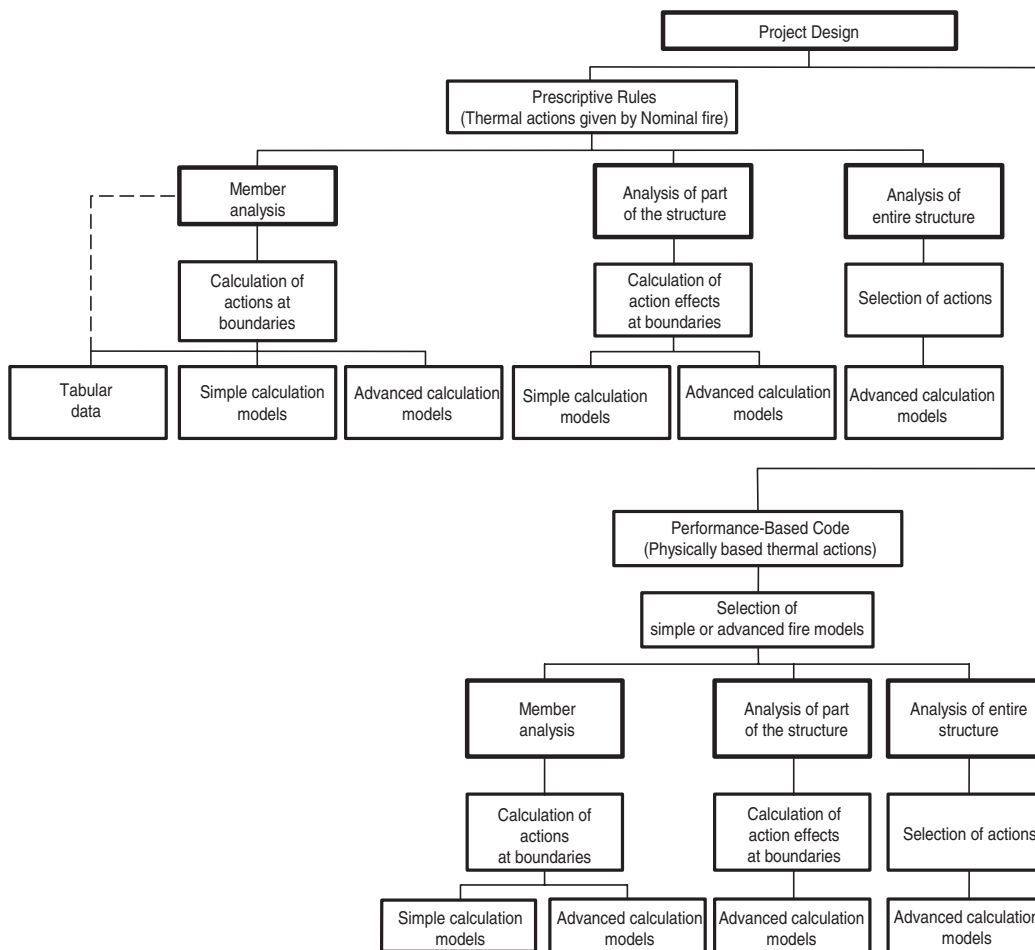


Figure 0.1 : Design procedures

Where simple calculation models are not available, the Eurocode fire parts give design solutions in terms of tabular data (based on tests or general calculation models), which may be used within the specified limits of validity.

National Annex for EN 1996-1-2

This standard gives alternative procedures, values and recommendations for classes, with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1996-1-2 should include a National annex which contains all Nationally Determined Parameters to be used for the design of buildings and civil engineering works constructed in the relevant country.

National choice is allowed in EN 1996-1-2 through clauses:

- 2.2 (2) Actions;
- 2.3 (2) Design values of material properties;
- 2.4.2 (3) Member analysis;
- 3.3.3.1(1) Thermal elongation;
- 3.3.3.2 (1) Specific heat;
- 3.3.3.3 Thermal conductivity;
- 4.5(3) Value of γ_{Glo} ;
- Annex B Tabulated values of fire resistance of masonry walls;
- Annex C Values of constant c.

Section 1. General

1.1 Scope

(1)P This Part 1-2 of EN 1996 deals with the design of masonry structures for the accidental situation of fire exposure, and is intended to be used in conjunction with EN 1996-1-1, EN 1996-2, 1996-3 and EN 1991-1-2. This part 1-2 only identifies differences from, or supplements to, normal temperature design.

(2)P This Part 1-2 deals only with passive methods of fire protection. Active methods are not covered.

(3)P This Part 1-2 applies to masonry structures which, for reasons of general fire safety, are required to fulfil certain functions when exposed to fire, in terms of:

- avoiding premature collapse of the structure (load bearing function)
- limiting fire spread (flames, hot gases, excessive heat) beyond designated areas (separating function)

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(4)P This Part 1-2 gives principles and application rules for designing structures for specified requirements in respect of the aforementioned functions and levels of performance.

(5)P This Part 1-2 applies to structures, or parts of structures, that are within the scope of EN 1996-1-1, EN 1996-2 and EN 1996-3 and are designed accordingly.

(6)P This Part 1-2 does not cover masonry built with Natural Stone units to EN771-6

(7)P This Part 1-2 deals with the following:

- non-loadbearing internal walls.
- non-loadbearing external walls.
- loadbearing internal walls with separating or non-separating functions.
- loadbearing external walls with separating or non-separating functions.

1.2 Normative references

This European standard incorporates by dated or undated references, provisions from other publications. These Normative references are cited at appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of, any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies (including amendments).

EN 771-1 Specification for masonry units - Part 1: Clay masonry units.

EN 771-2 Specification for masonry units - Part 2: Calcium silicate masonry units

EN 771-3 Specification for masonry units - Part 3: Aggregate concrete masonry units (dense and light-weight aggregates)

EN 771-4 Specification for masonry units - Part 4: Autoclaved aerated concrete masonry units

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

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

EN 772-13 Methods of test for masonry units - Part 13: Determination of net and gross dry density of masonry units (except for natural stone)

EN 998-1 Specification for mortar for masonry - Part 1: Rendering and plastering mortar

EN 998-2 Specification for mortar for masonry - Part 2: Masonry mortar.

EN 1363 Fire resistance
Part 1: General requirements
Part 2: Alternative and additional requirements

- EN 1364 Fire resistance tests of non-loadbearing elements.
Part 1 Walls
- EN 1365 Fire resistance tests of loadbearing elements.
Part 1 Walls
- EN 1365 Fire resistance tests of loadbearing elements.
Part 4 Columns
- EN 1366 Fire resistance tests for service installations.

Part 3 Penetration seals
- EN 1990 Basis of design for Structural Eurocodes
- EN 1991 Basis of design and actions on structures:
Part 1-1: General actions - Densities, self-weight, imposed loads for buildings
Part 1-2: Actions on structures exposed to fire;
- EN 1996 Design of masonry structures:
Part 1.1: Common rules for reinforced and unreinforced masonry structures
Part 2: Design, selection of materials and execution of masonry
Part 3: Simplified and simple rules for masonry structures
- prEN 12602 Prefabricated reinforced components of autoclaved aerated concrete
Annex C – Resistance to fire design of AAC components and structures
- EN 13279-1 Gypsum and gypsum-based building plaster - Part 1: Definitions and requirements

1.3 Assumptions

- (1) P In addition to the general assumptions of EN 1990 the following assumptions apply:
- Any passive fire protection systems taken into account in the design will be adequately maintained.
 - The choice of the relevant design fire scenario is made by appropriately qualified and experienced personnel.

1.4 Distinction between Principles and application Rules

- (1) The rules given in EN 1990 clause 1.4 apply.

1.5 Definitions

For the purposes of this Part 1-2 of EN 1996, the definitions of EN 1990 and of EN 1991-1-2 apply with the following additional definitions:

EN1996-1-2:2005**1.5.1 Special terms relating to fire design in general****1.5.1.1****Fire protection material**

Any material or combination of materials applied to a structural member for the purpose of increasing its fire resistance

1.5.1.2**Fire wall**

A wall separating two spaces (generally two fire compartments or buildings) which is designed for fire resistance and structural stability, including resistance to mechanical impact (Criterion M) such that, in the case of fire and failure of the structure on one side of the wall, fire spread beyond the wall is avoided (so that a Fire wall is designated REI-M or EI-M)

NOTE: In some countries a fire wall has been defined as a separating wall between fire compartments without a requirement for resistance to mechanical impact; the definition above should not be confused with this more limited one. Fire walls may have to fulfil additional requirements not given in this part 1-2, these being given in the regulations of each country

1.5.1.3**Loadbearing wall**

A flat, membrane-like component predominantly subjected to compressive stress, for supporting vertical loads, for example floor loads, and also for supporting horizontal loads, for example wind loads.

1.5.1.4**Non-loadbearing wall**

A flat membrane-like building component loaded predominantly only by its dead weight, and which does not provide bracing for loadbearing walls. It may however, be required to transfer horizontal loads acting on its surface to loadbearing building components such as walls or floors.

1.5.1.5**Separating wall**

A wall exposed to fire on one side only.

1.5.1.6**Non-separating wall**

A loadbearing wall exposed to fire on two or more sides.

1.5.1.7**Normal temperature design**

The ultimate limit state design for ambient temperatures in accordance with Part 1-1 of EN 1992 to 1996 or ENV 1999

1.5.1.8**Part of structure**

The isolated part of an entire structure with appropriate support and boundary conditions.

1.5.2 Special terms relating to calculation methods

1.5.2.1

Ineffective cross section

The area of a cross section that is assumed to become ineffective for fire resistance purposes.

1.5.2.2.

Effective cross section

The cross section of a member used in structural fire design, obtained by removing parts of the cross section with assumed zero strength and stiffness.

1.5.2.3.

Residual cross section

That part of the cross section of the original member which is assumed to remain after deduction of the thickness which is ineffective for fire-resistance purposes.

1.5.2.4

Structural failure of a wall in the fire situation

When the wall loses its ability to carry a specified load after a certain period of time

1.5.2.5

Maximum stress level

For a given temperature, the stress level at which the stress-strain relationship of masonry is truncated to a yield plateau.

1.6 Symbols

For the purpose of this Part 1-2, the following symbols apply, in addition to those given in EN 1991-1-1 and EN 1991-1-2:

E 30 or E 60, . . . , member meeting the integrity criterion, E, for 30, or 60 .. minutes in standard fire exposure.

I 30 or I 60, . . . , member meeting the thermal insulation criterion, I, for 30, or 60 .. minutes in standard fire exposure.

M 90 or M 120, . . . , member meeting the mechanical resistance criterion, M, for 90, or 120 .. minutes after standard fire exposure when mechanical impact applied .

R 30 or R 60, . . . , member meeting the load bearing criterion, R, for 30, or 60 .. minutes in standard fire exposure,

A total area of masonry

A_m surface area of a member per unit length;

A_p area of the inner surface of the fire protection material per unit length of the member;

A_{θ_1} area of masonry up to temperature θ_1 ;

A_{θ_2} area of masonry between temperatures θ_1 and θ_2 ;

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c	constant obtained from stress strain tests at elevated temperature (with subscripts)
c_a	specific heat capacity of masonry;
ct	combined thickness of webs and shells (given as a percentage of the width of a unit)
$e_{\Delta\theta}$	eccentricity due to variation of temperature across masonry;
f_b	characteristic unit strength
$f_{d\theta_1}$	design compressive strength of masonry at less than or equal to θ_1 ;
$f_{d\theta_2}$	design strength of masonry in compression between θ_1 and $\theta_2^\circ\text{C}$
h_{ef}	effective height of the wall
l	length at 20°C ;
l_F	length of a wall for a period of fire resistance
N_{Ed}	design value of the vertical load;
$N_{Rd,fi\theta_2}$	design value of the resistance in fire;
N_{Rk}	characteristic value of vertical resistance of masonry wall or column;
nvg	no value given
t_F	thickness of a wall for a period of fire resistance
$t_{fi,d}$	time of fire classification (eg 30 minutes) for a standard fire in accordance with EN 1363;
t_{Fr}	thickness of the cross-section whose temperature does not exceed θ_2
α	proportion of load on a wall;
α_t	coefficient of thermal expansion of masonry
ε_T	thermal strain
γ_{Glo}	a safety factor for use in fire tests;
Δt	time interval;
η_{fi}	reduction factor for design load level in the fire situation;
θ_1	temperature up to which the cold strength of masonry may be used;
θ_2	temperature above which any residual masonry strength is ignored;
λ_a	thermal conductivity;

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(2) Criterion R is assumed to be satisfied when the load bearing function is maintained throughout the required time of fire exposure.

(3) Criterion I is assumed to be satisfied when the mean temperature of the unexposed face does not rise by more 140 °K, and the maximum temperature rise at any point of that surface does not exceed 180 °K

(4) Criterion E is assumed to be satisfied when the passage of flames and hot gases through the member is prevented.

(5) Where a vertical separating element, with or without a load-bearing function, is required to comply with an impact resistance requirement, (criterion M), the element should resist the application of the horizontal concentrated load specified in EN 1363 Part 2.

(6) With the external fire exposure curve the same criteria as (1)P should apply, however the reference to this specific curve should be identified by the letters “ef”.

2.1.3 Parametric fire exposure

(1) The load-bearing function is satisfied when collapse is prevented for the complete duration of the fire, including the decay phase, or for a prescribed period of time.

(2) The separating function, with respect to insulation, is satisfied when the following criteria are met:

- the mean temperature rise over the whole of the non-exposed surface does not exceed 140°K and the maximum temperature rise of that surface at any point does not exceed 180°K, at the time of the maximum gas temperature,

- the mean temperature rise over the whole of the non-exposed surface does not exceed 180°K, and the maximum temperature rise at any point of that surface does not exceed 220°K during the decay phase of the fire or up to a required period of time.

2.2 Actions

(1)P The thermal and mechanical actions shall be obtained from EN 1991-1-2.

(2) The emissivity of a masonry surface should be taken as ϵ_m .

NOTE: The value to be ascribed to ϵ_m in a Country may be found in its National Annex. The value will depend on the material of the masonry.

2.3 Design values of material properties

(1)P Design values of the mechanical (material strength and deformation) properties, $X_{d,fi}$, are defined as follows:

$$X_{d,fi} = k_{\theta} X_k / \gamma_{M,fi} \quad (2.1)$$

where:

X_k is the characteristic value of the strength or deformation property of the material (eg f_k) for normal temperature design to EN 1996-1-1;

k_{θ} is the reduction factor for the strength or deformation property ($X_{k,\theta} / X_k$), dependent on the material temperature;

$\gamma_{M,fi}$ is the partial safety factor for the relevant material property, for the fire situation.

(2)P Design values of the thermal properties, $X_{d,fi}$, of materials are defined as follows:

(i) if an increase of the property is favourable for safety:

$$X_{d,fi} = X_{k,\theta} / \gamma_{M,fi} \quad (2.2a)$$

or

(ii) if an increase of the property is unfavourable for safety:

$$X_{d,fi} = \gamma_{M,fi} X_{k,\theta} \quad (2.2b)$$

where:

$X_{k,\theta}$ is the value of the material property in fire design, generally dependent on the material temperature, (see section 3);

NOTE: The value of $\gamma_{M,fi}$ to be ascribed in a Country may be found in its National Annex. For thermal properties of masonry the recommended value of the partial safety factor $\gamma_{M,fi}$ for the fire situation is 1,0. For mechanical properties of masonry, the recommended value of the partial safety factor $\gamma_{M,fi}$ for the fire situation is 1,0.

2.4 Assessment methods

2.4.1 General

(1)P The model of the structural system adopted for design in the fire situation shall reflect the expected performance of the structure in fire.

(2)P The analysis for the fire situation may be carried out using one of the following:

- testing the structure
- tabulated data
- member analysis
- analysis of part of the structure
- global structural analysis

(3)P It shall be verified for the relevant duration of fire exposure that

$$E_{fi,d} \leq R_{fi,t,d} \quad (2.3)$$

Where

$E_{fi,d}$ is the design effect of actions for the fire situation, determined in accordance with EN 1991-1-2, including the effects of thermal expansion and deformation

$R_{fi,t,d}$ is the corresponding design resistance in the fire situation.

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(4) The structural analysis for the normal situation should be carried out in accordance with EN 1990 5.1.4(2).

(5) In order to verify standard fire resistance requirements, a member analysis is sufficient.

(6) Where application rules given in this Part 1-2 are only valid for the standard temperature-time curve, this is identified in the relevant clauses

(7)P Tabulated data given in this part is based on the standard temperature-time curve in accordance with EN 1363.

(8)P As an alternative to design by calculation, fire resistance may be based on the results of fire tests, or on fire tests in combination with calculation (see EN1990 5.2).

2.4.2 Member analysis

(1) The effect of actions should be determined for time $t=0$ using combination factors $\psi_{1,1}$ or $\psi_{2,1}$ according to EN 1991-1-2.

(2) As a simplification to (1), the effect of $\psi_{2,1}$ on actions $E_{d,fi}$ may be obtained from a structural analysis for normal temperature design as:

$$E_{d,fi} = \eta_{fi} E_d \quad (2.4)$$

where:

E_d is the design value of the corresponding force or moment for normal temperature design, for a fundamental combination of actions (see EN 1990);

η_{fi} is the reduction factor for the design load level for the fire situation.

(3) The reduction factor η_{fi} for load combination (6.10) in EN 1990 should be taken as:

$$\eta_{fi} = \frac{G_k + \psi_{fi} Q_{k,1}}{\gamma_G G_k + \gamma_{Q,1} Q_{k,1}} \quad (2.5)$$

or for load combinations (6.10a) and (6.10b) in EN 1990 as the smaller value given by the two following expressions:

$$\eta_{fi} = \frac{G_k + \psi_{fi} Q_{k,1}}{\gamma_G G_k + \gamma_{Q,1} \psi_{0,1} Q_{k,1}} \quad (2.5a)$$

$$\eta_{fi} = \frac{G_k + \psi_{fi} Q_{k,1}}{\xi \gamma_G G_k + \gamma_{Q,1} Q_{k,1}} \quad (2.5b)$$

where:

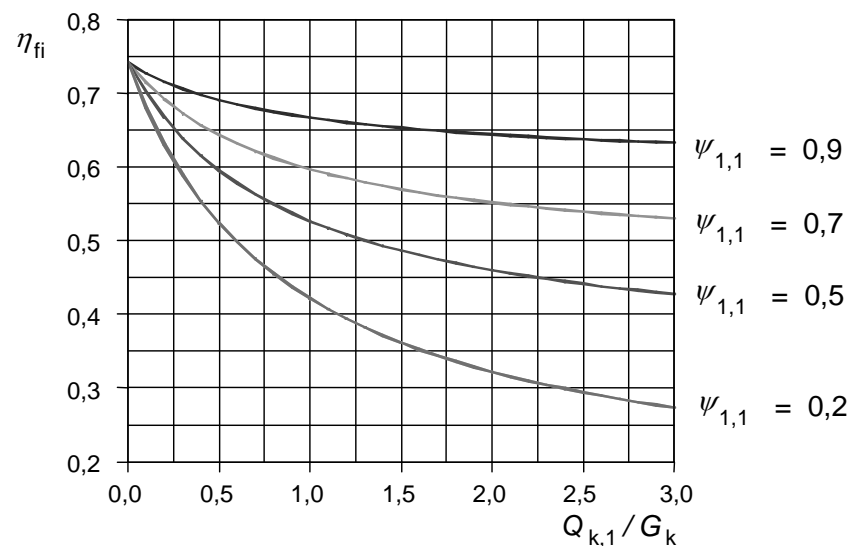
$Q_{k,1}$ is the principal variable load;

G_k is the characteristic value of a permanent action;

- γ_G is the partial factor for permanent actions;
- $\gamma_{Q,1}$ is the partial factor for variable action 1;
- ψ_{fi} is the combination factor for frequent values, given either by $\psi_{1,1}$ or $\psi_{2,1}$
- ξ is a reduction factor for unfavourable permanent actions G .

NOTE 1: An example of the variation of the reduction factor η_{fi} versus the load ratio $Q_{k,1}/G_k$ for different values of the combination factor $\psi_{fi} = \psi_{1,1}$ according to expression (2.5) is shown in the figure to this note with the following assumptions: $\gamma_{GA} = 1,0$, $\gamma_G = 1,35$ and $\gamma_Q = 1,5$. Use of expressions (2.5a) and (2.5b) will give figures slightly higher than those in the figure.

The values of partial factors for use in a Country may be found in its National Annex. Recommended values are given in EN 1990. The choice of expression (6.10) or (6.10)a and (6.10)b may also be found in the National Annex.



Variation of the reduction factor η_{fi} with the load ratio $Q_{k,1}/G_k$

NOTE 2: As a simplification the recommended value of $\eta_{fi} = 0,65$ may be used, except for imposed load category E as given in EN 1990 (areas for storage and industrial activity) for which the recommended value is 0,7.

(4) Only the effects of thermal deformations resulting from thermal gradients across the cross-section need to be considered. The effects of axial or in-plane thermal expansions may be neglected.

(5) The boundary conditions at supports and ends of a member may be assumed to remain unchanged throughout the fire exposure.

(6) Tabulated data, simplified or advanced calculation methods are suitable for verifying members under fire conditions.

NOTE: Annexes B, C and D give information on tabulated data, simplified and advanced calculation methods.

EN1996-1-2:2005**2.4.3 Analysis of part of the structure**

- (1) The effect of actions should be determined for time $t=0$ using combination factors $\psi_{1,1}$ or $\psi_{2,1}$ according to EN 1991-1-2.
- (2) As an alternative to carrying out a structural analysis for the fire situation at time $t = 0$, the reactions at supports and internal forces and moments at boundaries of part of the structure may be obtained from a structural analysis for normal temperature as given in 2.4.1(4)
- (3) The part of the structure to be analysed should be specified on the basis of the potential thermal expansions and deformations, such that their interaction with other parts of the structure can be approximated by time-independent support and boundary conditions during fire exposure.
- (4)P Within the part of the structure to be analysed, the relevant failure mode in fire exposure, the temperature-dependent material properties and member stiffnesses, effects of thermal expansions and deformations (indirect fire actions) shall be taken into account
- (5) The boundary conditions at supports and forces and moments at boundaries of part of the structure may be assumed to remain unchanged throughout the fire exposure.

2.4.4 Global structural analysis

- (1)P When global structural analysis for the fire situation is carried out, the relevant failure mode in fire exposure, the temperature-dependent material properties and member stiffness, effects of thermal expansions and deformations (indirect fire actions) shall be taken into account.

Section 3. Materials**3.1 Units**

- (1) The requirements for masonry units given in EN 1996-1-1 apply to this Part with the following addition:
- Group 1S: Units containing less than 5% of formed voids by volume; additionally, they may contain indentations, for example frogs, grip holes or grooves in the bed face, if such indentations will be filled with mortar in the finished wall.

3.2 Mortar

- (1) The requirements for mortar given in EN 1996-1-1 apply to this Part.

3.3 Mechanical properties of masonry**3.3.1 Mechanical properties of masonry at normal temperature**

- (1)P The mechanical properties of masonry at 20°C shall be taken as those given in EN 1996-1-1 for normal temperature design.

3.3.2 Strength and deformation properties of masonry at elevated temperature

3.3.2.1 General

(1) The strength and deformation properties of masonry at elevated temperatures may be obtained from the stress-strain relationship obtained by tests for a project or from a database.

NOTE: Stress-strain relationships for some materials are given in Annex D. These stress-strain relationships are valid for heating rates between 2 and 50 K/min.

3.3.2.2 Unit mass

(1) The unit mass of masonry may be considered to be independent of the masonry temperature. The density of masonry can be obtained from the density of the masonry materials, as given in EN 1991-1-1.

NOTE: The density of masonry units and mortar should be declared by the manufacturer in accordance with ENs 771-1 to 5 and EN 998-2.

3.3.3 Thermal properties

3.3.3.1 Thermal elongation

(1) The thermal elongation of masonry should be determined from tests or from a database.

NOTE: The variation of the thermal elongation with temperature for some materials is given in Annex D; values may be found in the National Annex.

3.3.3.2 Specific heat capacity

(1) The specific heat capacity of masonry, c_a , should be determined from tests or from a database.

NOTE 1: The variation of the specific heat capacity with temperature for some materials is given in Annex D

NOTE 2: The value of c_a to be used in a Country may be found in its National Annex.

3.3.3.3 Thermal conductivity

(1) The thermal conductivity, λ_a , should be determined from tests or from a database.

NOTE 1: The variation of the thermal conductivity with temperature for some materials is given in Annex D

NOTE 2: The value of λ_a to be used in a Country may be found in its National Annex.

Section 4. Design Procedures for obtaining fire resistance of masonry walls

4.1 General information on the design of walls

4.1.1 Wall types by function

(1) For fire protection, a distinction is made between non-loadbearing walls and loadbearing walls, and between separating walls and non-separating walls.

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(2) Separating walls serve to prevent fire propagation from one place to another, and are exposed to fire on one side only. Examples are walls along escape ways, walls of stair wells, separating walls of a fire compartment.

(3) Non-separating loadbearing walls are subjected to fire on two or more sides. Examples are walls within a fire compartment.

(4) External walls may be separating walls, or non-separating walls as required.

NOTE: External separating walls less than 1,0 m in length should be treated as non-separating walls for the purposes of fire design, depending on the adjacent construction.

(5) Walls which include lintels above openings should have at least the same fire resistance as if there was no lintel in the wall.

(6) Fire walls are separating walls that are required to resist mechanical impact in addition to actions REI, or EI, as relevant.

NOTE: Examples of fire walls are walls separating buildings or fire compartments.

(7) Stiffening elements, such as cross walls, floors, beams, columns or frames, should have at least the same fire resistance as the wall.

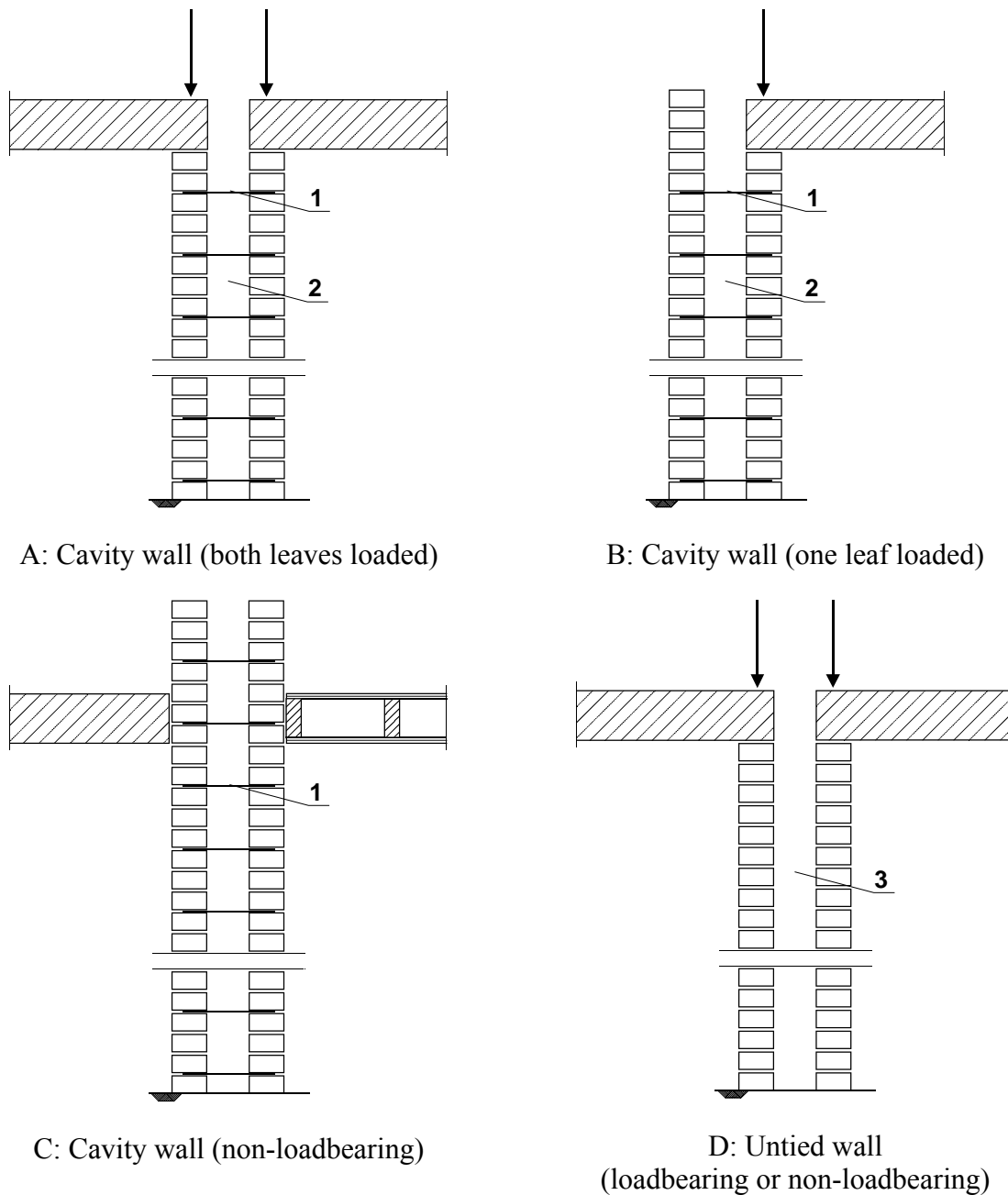
NOTE: If assessment shows that the failure of the stiffening elements on one side of a fire wall would not lead to a failure of the fire wall the stiffening elements do not need fire resistance.

(8) Additional factors to be considered for fire design are:

- the use of non-combustible materials
- the effect on a fire wall from thermal reaction or expansion of an adjacent construction situated close to the fire wall.
- the effect on a wall of displacement, in a fire, of columns and beams close to the wall.

4.1.2 Cavity walls and untied walls comprising independent leaves

(1) When both leaves of a cavity wall are loadbearing and carry approximately equal loads, the fire resistance of a cavity wall with leaves of approximately equal thickness is defined as the fire resistance of an equivalent single leaf wall of thickness equal to the sum of the thicknesses of the two leaves, (see figure 4.1, A), providing that no combustible material is included in the cavity.



Key

- 1: Wall ties or bed joint reinforcement
- 2: Cavity unfilled or partially filled;
- 3: Untied wall

Figure 4.1: Illustration of cavity walls and double leaf walls

(2) When only one leaf of a cavity wall is loadbearing, the resistance of the cavity wall is usually greater than the fire resistance achieved for the loadbearing leaf when considered to act as a single leaf wall, (see figure 4.1, B).

(3) The fire resistance of a cavity wall comprising two non-loadbearing leaves (Figure 4.1, C) may be taken as the sum of the fire resistances of the individual leaves, limited to a maximum of 240 min when fire resistance is determined by this Part of EN1996-1-2.

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(4) For untied walls comprising independent leaves, the fire resistance of the wall is determined by reference to the appropriate loadbearing or non-loadbearing table in Annex B for the single leaf wall (see figure 4.1, D) which is to be assessed as being exposed to fire.

4.2 Surface finishes

(1) The fire resistance of masonry walls may be increased by the application of a layer of a suitable surface finish, for example:

- gypsum premixed plaster in accordance with EN 13279-1
- plaster type LW or T in accordance with EN 998-1

For cavity and untied walls, the surface finish is only needed on the outside faces of the leaves, and not between the two leaves.

(2) An additional masonry leaf or masonry cladding may be used to increase the fire resistance of a wall.

4.3 Additional requirements for masonry walls

(1)P Any supporting, or stiffening, part of a structure shall have at least the same fire resistance as the structure being supported.

(2) Combustible thin damp proof materials incorporated into a wall may be ignored in assessing fire resistance.

(3) Masonry units containing holes through the unit should not be laid so that the holes are at right angles to the face of the wall, i.e. the wall should not be penetrated by the holes of the masonry units.

(4) When thermal insulation systems made of insulation and plaster are used on single leaf external walls, it should be noted that:

- insulation layers made of combustible materials do not enhance fire resistance,
- insulation layers made of non-combustible materials, e.g. mineral wool or foamed glass, can be used instead of a suitable surface finish. [Rob, deleted render, as it is not considered to be a suitable finish!]

4.4 Assessment by testing

(1) For all types of masonry walls the fire resistance may be obtained from tests made in accordance with the relevant ENs (see 1.2 for a list of test methods). Guidance on selection of fire resistance periods is given in Annex A.

(2) Tests on masonry walls should be carried out if the fire resistance of the masonry to be used (masonry units, percentage of holes, density, dimension), type of mortar (general purpose mortar, lightweight or thin layer mortar) or the combination of units and mortar is not available already.

NOTE: Values of fire resistance may be available in a database.

4.5 Assessment by tabulated data

(1) Assessment of masonry walls may be carried out using the tables, in Annex B, which give the minimum thickness of masonry required, for the relevant criterion, to achieve the stated period of fire resistance, when constructed using units of the material, Group and density given.

(2) In the tables, the minimum wall thickness given is for fire resistance purposes only. The thickness required for other considerations as defined in EN 1996-1-1, or which is needed to meet other requirements, for example acoustic performance, is not taken into account.

(3) The tabulated values for loadbearing walls are valid for a total characteristic vertical load of $(\alpha N_{Rk})/\gamma_{Glo}$ where α , the ratio of the applied design load on the wall to the design resistance of the wall, is 1,0 or 0,6 and where N_{Rk} is taken as Φf_{kt} (see EN 1996-1-1).

NOTE: The value of γ_{Glo} to be used in a Country may be found in its National Annex. The tables in the NOTE to Annex B have been obtained from the consideration of test results wherein γ_{Glo} was 3 to 5; fire tests, before the advent of partial factor design, were subjected to the permissible load, which was, approximately, the characteristic strength divided by the global factor $\gamma_F \times \gamma_M$, where γ_F and γ_M are partial factors for actions and materials respectively (see EN 1990 and EN 1996-1-1).

4.6 Assessment by calculation

(1) The fire resistance of masonry walls may be assessed by calculation, taking into account the relevant failure mode in fire exposure, the temperature dependent material properties, the slenderness ratio and the effects of thermal expansions and deformations.

(2) The calculation method may be:

- a model for specific types of member

or

- a global structural analysis simulating the behaviour of structural members, part of a skeleton or the entire structure.

(3) The validity of calculation methods should be assessed by comparison of calculated fire resistance with the results of tests.

NOTE 1: A simplified method of calculation for walls is given in Annex C.

NOTE 2: An advanced method of calculation for walls is given in Annex D.

Section 5. Detailing

5.1 General

(1)P The detailing of masonry in a structure shall not reduce the fire resistance of the construction.

5.2 Junctions and joints

(1)P Floors or the roof shall provide lateral support to the top and bottom of the wall, unless stability under normal conditions is provided by other means, for example buttresses or special ties.

(2)P Joints, including movement joints, in walls, or between walls and other fire separating members, shall be designed and constructed so as to achieve the fire resistance requirement of the walls.

(3)P Where fire insulating layers are required in movement joints, they shall consist of mineral based materials having a melting point of not less than 1000⁰C. Any joints shall be tightly sealed so that movement of the wall shall not adversely affect the fire resistance. If other materials are to be used, it shall be shown by test that they meet criteria E and I (see EN 1366: Part 4).

(4) Connections between non-loadbearing masonry walls should be built according to EN 1996-2 or to other suitable details.

NOTE: Examples of suitable details are given in Annex E.

(5) Connections of loadbearing masonry walls may be built according to EN 1996-1-1 or to other suitable details.

NOTE: Examples of suitable details are given in Annex E.

(6) Connection of fire walls to reinforced, unreinforced concrete and masonry structures which are required to fulfil mechanical requirements (i.e. connections which are required to fulfil the mechanical impact requirements in accordance with EN 1363-2) should be constructed with joints that are filled completely with mortar or concrete or they should be constructed with properly protected mechanical fixings. Where connections are not required to provide mechanical resistance they may be built in accordance with (4) or (5) as appropriate.

5.3 Fixtures, pipes and cables

(1) The presence of recesses and chases, as permitted by EN 1996-1-1 in loadbearing walls without the need for separate calculation, can be assumed not to reduce the period of fire resistance given in the tables referred to in 4.5.

(2) For non-loadbearing walls, vertical chases and recesses should leave at least 2/3 of the required minimum thickness of the wall, but not less than 60mm, including any integrally applied fire resistance finishes such as plaster.

(3) Horizontal and inclined chases and recesses in non-loadbearing walls should leave at least 5/6 of the required minimum thickness of the wall, but not less than 60 mm, including any integrally applied fire resistant finishes such as plaster. Horizontal and inclined chases and recesses should not be positioned within the middle one-third height of the wall. The width of individual chases and recesses in non-loadbearing walls should be not greater than twice the required minimum thickness of the wall, including any integrally applied fire resistant finishes such as plaster.

(4) The fire resistance of non-loadbearing walls having chases or recesses not complying with (2) and (3) should be evaluated from tests according to EN 1364.

(5) Individual cables may pass through holes sealed with mortar. Additionally, non-combustible pipes up to 100 mm diameter may pass through non combustibly sealed holes, if the effects of heat conduction through the pipes do not infringe the criteria E and I, and any expansion does not impair fire resistance performance.

NOTE: Materials other than mortar may be used provided they conform to CEN Standards..

(6) Groups of cables and pipes of combustible materials, or individual cables in holes not sealed with mortar, may pass through walls if either:

- the method of sealing has been evaluated by testing in accordance with EN 1366: Part 3 or
- guidance based on satisfactory experience in use is followed.

Annex A (Informative)

Guidance on selection of fire resistance periods

(1) The fire behaviour of a masonry wall depends on

- the masonry unit material - clay, calcium silicate, autoclaved aerated concrete or dense/lightweight aggregate concrete, manufactured stone;
- the type of unit - solid or hollow (type of holes, percentage of formed voids), shell and web thickness;
- the type of mortar - general purpose, thin layer or lightweight mortar;
- the relationship of the design load to the design resistance of the wall;
- the slenderness of the wall;
- the eccentricity of loading
- the density of units.
- the type of wall construction
- the type and nature of any applied surface finishes

(2) In arriving at values of fire resistance from consideration of test results, it is important to base the interpretation of any existing fire test results on the requirements for the relevant test method from EN 1363, EN 1364-1, EN 1365-1, EN 1365-4. In particular, allowance should be made for any difference from that required in the above mentioned test method in the loading system used in the fire test on loadbearing walls, for example fixed ends, free ends or one fixed end and one partly free end.

(3) In non-loadbearing walls, the restraint method will also influence the test results and it should be evaluated against the system in EN 1364-1 .

Annex B
(Normative)

Tabulated fire resistance of masonry walls

(1) The thickness of a masonry wall, t_F , to give a period of fire resistance $t_{fi,d}$, may be taken from the tables B1, B2, B3, B4, B5 and B6 for the relevant wall and loading situation.

(2) The tables are valid only for walls complying with EN 1996-1-1, EN 1996-2 and EN 1996-3, as appropriate to the type of wall and its function (for example, non-loadbearing).

(3) In the tables the thickness referred to is that of the masonry itself, excluding finishes, if any. The first row of pairs of rows defines the resistance for walls without a suitable surface finish (see 4.2(1)). Values in brackets () in the second row of pairs of rows are for walls having an applied finish in accordance with 4.2(1), of minimum thickness 10mm on both faces of a single leaf wall, or on the fire-exposed face of a cavity wall. [deleted rendering or plaster again, ref to 4.2(1) is enough]

NOTE 1: A sand cement render does not normally increase the fire resistance of a masonry wall to the extent given in the second row of pairs of rows of the tables unless national experience indicates otherwise

NOTE 2: pairs of rows are, for example 1.1.1 and 1.1.2 in table N.B.1

(4) Masonry made with units having high precision dimensions and having unfilled vertical joints more than 2 mm, but less than 5mm, wide, may be assessed using the tables providing render or plaster of at least 1 mm thickness is used on at least one side. In such cases, the fire resistance periods are those given for walls without a layer of surface finish. For walls having vertical joints with a thickness less than or equal to 2 mm, no additional finish is required in order to be able to use the Tables appropriate to walls with no applied finish.

(5) Masonry made with tongued and grooved masonry units and having unfilled vertical joints less than 5 mm, wide, may be assessed using the tables appropriate to walls without a layer of surface finish.

Table B.1 Minimum thickness of non-loadbearing separating walls (Criteria EI) for fire resistance classifications

Material of wall	Minimum wall thickness (mm) t_F for fire resistance classification EI for time (minutes) $t_{fi,d}$									
	15	20	30	45	60	90	120	180	240	360
Type of units, mortar, grouping of units, including combined thickness if required, and density	Wall thickness t_F									

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Table B.2 Minimum thickness of separating loadbearing single-leaf walls (Criteria REI) for fire resistance classifications

Material of wall Loading level	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$									
	15	20	30	45	60	90	120	180	240	360
Type of units, mortar, grouping of units, density Loading level $\alpha \leq 1,0$ and $\alpha \leq 0,6$	Wall thickness t_F									

Table B.3 Minimum thickness of non-separating loadbearing single-leaf walls $\geq 1,0\text{m}$ in length (Criterion R) for fire resistance classifications

Material of wall Loading level	Minimum wall thickness (mm) t_F for fire resistance classification R for time (minutes) $t_{fi,d}$									
	15	20	30	45	60	90	120	180	240	360
Type of units, mortar, grouping of units, density Loading level $\alpha \leq 1,0$ and $\alpha \leq 0,6$	Wall thickness t_F									

Table B.4 Minimum length of non-separating loadbearing single-leaf walls $< 1,0\text{m}$ in length (Criterion R) for fire resistance classifications

Material of wall Loading level	Minimum wall thickness (mm)	Minimum wall length (mm) l_F for fire resistance classification R for time (minutes) $t_{fi,d}$									
		15	20	30	45	60	90	120	180	240	360
Type of units, mortar, grouping of units, density Loading level $\alpha \leq 1,0$ and $\alpha \leq 0,6$	t_F	Wall length l_F									

Table B.5 Minimum thickness of separating loadbearing and non-loadbearing single and double leaf fire walls (Criteria REI-M and EI-M) for fire resistance classifications

Material of wall Loading level	Minimum wall thickness (mm) t_F for fire resistance classification REI-M and EI-M for time (minutes) $t_{fi,d}$									
	15	20	30	45	60	90	120	180	240	360
Type of units, mortar, grouping of units, density Loading level $\alpha \leq 1,0$ and $\alpha \leq 0,6$	Wall thickness t_F									

Table B.6 Minimum thickness of separating loadbearing cavity walls with one leaf loaded (Criteria REI) for fire resistance classifications

Material of wall Loading level	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$									
	15	20	30	45	60	90	120	180	240	360
Type of units, mortar, grouping of units, density Loading level $\alpha \leq 1,0$ and $\alpha \leq 0,6$	Wall thickness t_F									

NOTE 1: The periods of fire resistance, from 15 to 360 minutes, given in Table B.1 to B.6 cover the whole range given in the Commission Decision of 3rd May 2000 in the Official Journal L133/26 dated 6.6.2000. It is stated, there, that the performance level for all or some classes or one class needs to be given. A Country may choose how many of the periods of fire resistance shown in Tables B.1 to B.6 will be given in its National Annex, and for what range of materials and loading conditions.

NOTE 2: Walls that include bed-joint reinforcement, according to EN 845-3, may be considered as covered by these tables.

NOTE 3: Thicknesses of walls given in tables for non-loadbearing masonry, ie classification EI or EI-M, are only valid for walls having a height to thickness ratio less than 40

NOTE 4: In respect to tables B.1 to B.6 above, the values of t_F or l_F in mm, as appropriate, for use in a Country may be found in its National Annex. The materials, that is units, grouping, density, mortar and load levels should be tabulated for the required periods of fire resistance, for example 30, 60, 90, 120, 240 minutes. For loadbearing walls, the level of loading applicable to the wall should be given. Recommended values of t_F or l_F for the commonly used range of units, grouping, mortar density and load levels are given in tables N.B.1 to N.B.5, below. For fire walls the thickness given in the tables is for a single leaf wall; if a country wishes to distinguish between single and double leaf walls, it may do so by introducing additional lines in the National Annex, increasing the total thickness for double leaf walls if required. Throughout the tables, where two thicknesses with a slash between, eg 90/100, are given this is a range, ie the thickness recommended is from 90 to 100. In arriving at the values to be inserted in the National Annex, a Country should have regard to the available test results, the loading that was applied to the test walls, the masonry characteristics and the partial factors that will be used in that Country.

- N.B.1.1 - N.B.1.6 Clay masonry
- N.B.2.1 - N.B.2.6 Calcium silicate masonry
- N.B.3.1 - N.B.3.6 Dense and lightweight aggregate concrete masonry
- N.B.4.1 - N.B.4.6 Autoclaved aerated concrete masonry
- N.B.5.1 - N.B.5.2 Manufactured stone masonry

N.B.1 Clay masonry

Clay units conforming to EN 771-1

Table N.B.1.1 Clay Masonry Minimum thickness of separating non-loadbearing walls (Criterion EI) for fire resistance classifications

row number	material properties: gross dry density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification EI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1.	Group 1S, 1, 2, 3 and 4							
1.1	mortar : general purpose, thin layer, lightweight $500 \leq \rho \leq 2\ 400$							
1.1.1		60/100	90/100	90/100	100/140	100/170	160/190	190/210
1.1.2		(50/70)	(50/70)	(60/70)	(70/100)	(90/140)	(110/140)	(170)

Table N.B.1.2 Clay masonry minimum thickness of separating loadbearing single-leaf walls
(Criteria REI) for fire resistance classifications

row number	material properties: unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes)						
		$t_{F,d}$						
		30	45	60	90	120	180	240
1S	Group 1S units							
1S.1	$5 \leq f_b \leq 75$ general purpose mortar $5 \leq f_b \leq 50$ thin layer mortar $1\ 000 \leq \rho \leq 2\ 400$							
1S.1.1	$\alpha \leq 1,0$	90 (70/90)	90 (70/90)	90 (70/90)	100 (70/90)	100/140 (90/140)	170/190 (110/140)	170/190 (170/190)
1S.1.2								
1S.1.3	$\alpha \leq 0,6$	90 (70/90)	90 (70/90)	90 (70/90)	100 (70/90)	100/140 (100/140)	170 (110/140)	170 (140/170)
1S.1.4								
1	Group 1 units mortar: general purpose, thin layer							
1..2	$5 \leq f_b \leq 75$ $800 < \rho \leq 2\ 400$							
1.2.1	$\alpha \leq 1,0$	90/100 (70/90)	90/100 (70/90)	90/100 (70/90)	100/170 (70/90)	140/170 (100/140)	170/190 (110/170)	190/210 (170/190)
1.2.2								
1.2.3	$\alpha \leq 0,6$	90/100 (70/90)	90/100 (70/90)	90/100 (70/90)	100/140 (70/90)	140/170 (100/140)	140/170 (110/170)	190/200 (170/190)
1.2.4								
1.3	$5 \leq f_b \leq 25$ $500 \leq \rho \leq 800$							
1.3.1	$\alpha \leq 1,0$	100 (100)	200 (170)	200 (170)	200 (170)	200/365 (200/300)	200/365 (200/300)	300/370 (300/370)
1.3.2								
1.3.3	$\alpha \leq 0,6$	100 (100)	170 (140)	170 (140)	200 (170)	200/365 (200/300)	200/365 (200/300)	300/370 (300/370)
1.3.4								
2	Group 2 units							
2.1	Mortar: general purpose, thin layer $5 \leq f_b \leq 35$ $800 < \rho \leq 2\ 200$ $ct \geq 25\%$							
2.1.1	$\alpha \leq 1,0$	90/100 (90/100)	90/100 (90/100)	90/100 (90/100)	100/170 (100/140)	140/240 (140)	190/240 (190/240)	190/240 (190/240)
2.1.2								
2.1.3	$\alpha \leq 0,6$	90/100 (90)	90/100 (90)	90/100 (90/100)	100/140 (100/140)	190/240 (100/140)	190/240 (140/190)	190/240 (190)
2.1.4								
2.2	Mortar: general purpose, thin layer and lightweight $5 \leq f_b \leq 25$ $700 \leq \rho \leq 800$ $ct \geq 25\%$							
2.2.1	$\alpha \leq 1,0$	nvg (100)	nvg (100)	nvg (90/170)	nvg (100/240)	nvg (140/300)	nvg (170/365)	nvg
2.2.2								
2.2.3	$\alpha \leq 0,6$	nvg (100)	nvg (100)	nvg (90/140)	nvg (100/170)	nvg (100/300)	nvg (170/300)	nvg (190/300)
2.2.4								
2.3	mortar: general purpose, thin layer and lightweight $5 \leq f_b \leq 25$ $500 < \rho \leq 900$ $16\% \leq ct < 25\%$							
2.3.1	$\alpha \leq 1,0$	nvg (100)	nvg (170)	nvg (90/170)	nvg (140/240)	nvg (140/300)	nvg (365)	nvg
2.3.2								
2.3.3	$\alpha \leq 0,6$	nvg (100)	nvg (140)	nvg (90/140)	nvg (100/170)	nvg (140/300)	nvg (300)	190
2.3.4								nvg

row number	material properties: unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes)						
		$t_{fi,d}$						
		30	45	60	90	120	180	240
3	Group 3 units mortar: general purpose, thin layer and lightweight							
3.1	$5 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$ $ct \geq 12\%$							
3.1.1	$\alpha \leq 1,0$	nvg (100)	nvg (200)	nvg (240)	nvg (300)	nvg (365)	nvg (425)	nvg
3.1.2								
3.1.3	$\alpha \leq 0,6$	300/365 (300/365)	300/365 (300/365)	300/365 (300/365)	300/365 (300/365)	300/365 (300/365)	300/365 (300/365)	365 (365)
3.1.4								
4	Walls in which holes in units are filled with mortar or concrete mortar: general purpose, thin layer							
4.1	$10 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$ $ct \geq 10\%$							
4.1.1	$\alpha \leq 1,0$	90/100 (100)	90/100 (100)	90/100 (100)	140/170 (100)	140/240 (140)	170/240 (170/190)	190/240 (190)
4.1.2								
4.1.3	$\alpha \leq 0,6$	90/100 (90/100)	90/100 (100)	90/100 (90/100)	100/140 (100/140)	100/170 (100/140)	140/240 (140/190)	190/240 (190)
4.1.4								
5	Group 4 units mortar: general purpose, thin layer and lightweight							
5.1	$5 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$							
5.1.1	$\alpha \leq 1,0$	nvg (200/240)	nvg (200/240)	nvg (200/240)	nvg (300)	nvg (365)	nvg (425)	nvg
5.1.2								
5.1.3	$\alpha \leq 0,6$	nvg (200/240)	nvg (200/240)	nvg (200/240)	nvg (240)	nvg (300)	nvg (365)	nvg
5.1.4								

Table N.B.1.3 Clay masonry minimum thickness of non-separating loadbearing single-leaf walls $\geq 1,0\text{m}$ in length
(Criterion R) for fire resistance classifications

row number	material properties: unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	Minimum wall thickness or length (mm) t_F for fire resistance classification R for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1S	Group 1S units							
1S.1	$5 \leq f_b \leq 75$ general purpose mortar $5 \leq f_b \leq 50$ thin layer mortar $1\ 000 \leq \rho \leq 2\ 400$							
1S.1.1	$\alpha \leq 1,0$	100 (100)	100 (100)	100 (100)	240 (100)	365 (170)	490 (240)	nvg
1S.1.2								
1S.1.3	$\alpha \leq 0,6$	100 (100)	100 (100)	100 (100)	170 (100)	240 (100)	300 (200)	nvg
1S.1.4								
1	Group 1 units							
1.1	mortar: general purpose, thin layer $5 \leq f_b \leq 75$ $800 \leq \rho \leq 2\ 400$							
1.1.1	$\alpha \leq 1,0$	100 (100)	100 (100)	100 (100)	240 (100)	365 (170)	490 (240)	nvg
1.1.2								
1.1.3	$\alpha \leq 0,6$	100 (100)	100 (100)	100 (100)	170 (100)	240 (100)	300 (200)	nvg
1.1.4								

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row number	material properties: unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	Minimum wall thickness or length (mm) t_F for fire resistance classification R for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1.2	$5 \leq f_b \leq 25$ $500 \leq \rho \leq 800$							
1.2.1	$\alpha \leq 1,0$	100	100	100	240	365	490	nvg
1.2.2	$f < 5$ N/mm ²	(100)	(100)	(100)	(100)	(170)	(240)	
1.2.3	$\alpha \leq 0,6$	100	100	100	170	240	300	nvg
1.2.4	$f < 3$ N/mm ²	(100)	(100)	(100)	(100)	(100)	(200)	
2	Group 2 units							
2.1	mortar: general purpose, thin layer $5 \leq f_b \leq 35$ $800 \leq \rho \leq 2\ 200$ $ct \geq 25\%$							
2.1.1	$\alpha \leq 1,0$	100	100	100	240	365	490	nvg
2.1.2		(100)	(100)	(100)	(100)	(170)	(240)	
2.1.3	$\alpha \leq 0,6$	100	100	100	170	240	300	nvg
2.1.4		(100)	(100)	(100)	(100)	(100)	(200)	
2.2	$5 \leq f_b \leq 25$ $700 \leq \rho \leq 800$ $ct \geq 25\%$							
2.2.1	$\alpha \leq 1,0$	100	100	100	240	365	490	nvg
2.2.2		(100/240)	(100/240)	(100/240)	(100/240)	(170/300)	(240/365)	
2.2.3	$\alpha \leq 0,6$	100	100	100	170	240	300	nvg
2.2.4		(100/170)	(100/170)	(100/170)	(100/240)	(100/240)	(200/300)	
2.3	mortar: general purpose, thin layer and lightweight $5 \leq f_b \leq 25$ $500 \leq \rho \leq 900$ $16\% \leq ct < 25\%$							
2.3.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
2.3.2		(100/240)	(100/240)	(100/240)	(100/240)	(170/300)	(240/365)	
2.3.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
2.3.4		(100/170)	(100/170)	(100/170)	(100/240)	(100/240)	(200/300)	
3	Group 3 units							
3.1	mortar: general purpose, thin layer and lightweight $5 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$ $ct \geq 12\%$							
3.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.1.2		(100)	(170)	(240)	(300)	(365)	(425)	
3.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.1.4		(100)	(140)	(170)	(240)	(300)	(365)	
4	Walls in which holes in units are filled with mortar or concrete							
4.1	mortar: general purpose, thin layer $10 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$ $ct \geq 10\%$							
4.1.1	$\alpha \leq 1,0$	100	100	100	240	365	490	nvg
4.1.2		(100)	(100)	(100)	(100)	(170)	(240)	
4.1.3	$\alpha \leq 0,6$	100	100	100	170	240	300	nvg
4.1.4		(100)	(100)	(100)	(100)	(100)	(200)	

row number	material properties: unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	Minimum wall thickness or length (mm) t_F for fire resistance classification R for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
5	Group 4 units							
5.1	mortar: general purpose, thin layer and lightweight $5 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$							
5.1.1	$\alpha \leq 1,0$	nvg (100)	nvg (170)	nvg (240)	nvg (300)	nvg (365)	nvg (425)	nvg
5.1.2								
5.1.3	$\alpha \leq 0,6$	nvg (100)	nvg (140)	nvg (170)	nvg (240)	nvg (300)	nvg (365)	nvg
5.1.4								

Table N.B.1.4 Clay masonry minimum length of non-separating loadbearing single-leaf walls <1,0m in length (Criterion R) for fire resistance classifications

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	wall thickness [mm]	Minimum wall length (mm) l_F for fire resistance classification R for time (minutes) $t_{fi,d}$						
			30	45	60	90	120	180	240
1s	Group 1S units								
1S.1	5 $\leq f_b \leq 75$ general purpose mortar 5 $\leq f_b \leq 50$ thin layer mortar 1 000 $\leq \rho \leq 2\ 400$								
1S.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg	nvg
1S.1.2									
1S.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg	Nvg
1S.1.4									
1	Group 1 units								
1.1	mortar : general purpose, thin layer 5 $\leq f_b \leq 75$ 800 $\leq \rho \leq 2\ 400$								
1.1.1	$\alpha \leq 1,0$	100	990 (490)	990 (600)	990 (600)	nvg (730)	nvg	nvg	nvg
1.1.2									
1.1.3		170	600 (240)	730 (240)	730 (240)	990 (365)	nvg (365)	nvg	nvg Nvg
1.1.4									
1.1.5		240	365 (170)	490 (170)	490 (170)	600 (240)	nvg (240)	nvg (365)	nvg Nvg
1.1.6									
1.1.7		300	300 (170)	365 (170)	365 (170)	490 (200)	nvg (240)	nvg (300)	nvg Nvg
1.1.8									
1.1.9	$\alpha \leq 0,6$	100	600 (365)	730 (490)	730 (490)	990 (600)	nvg (730)	nvg	nvg Nvg
1.1.10									
1.1.11		170	490 (240)	600 (240)	600 (240)	730 (240)	990 (300)	nvg	nvg Nvg
1.1.12									
1.1.13		240	200 (170)	240 (170)	240 (170)	300 (170)	365 (240)	490 (300)	nvg Nvg
1.1.14									
1.1.15		300	200 (170)	200 (170)	200 (170)	240 (170)	365 (170)	490 (240)	nvg Nvg
1.1.16									

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row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	wall thickness [mm]	Minimum wall length (mm) l_F for fire resistance classification R for time (minutes) $t_{fi,d}$						
			30	45	60	90	120	180	240
1.2	mortar : general purpose, thin layer $5 \leq f_b \leq 25$ $500 \leq \rho \leq 800$								
1.2.1	$\alpha \leq 1,0$	100	990	990	990	nvg	nvg	nvg	nvg
1.2.2			(490)	(600)	(600)	(730)		nvg	nvg
1.2.3		170	600	730	730	990	nvg	nvg	nvg
1.2.4			(240)	(240)	(240)	(365)	(365)	nvg	nvg
1.2.5		240	365	490	490	600	nvg	nvg	nvg
1.2.6			(170)	(170)	(170)	(240)	(240)	(365)	nvg
1.2.7		300	300	365	365	490	nvg	nvg	nvg
1.2.8			(170)	(170)	(170)	(200)	(240)	(300)	nvg
1.2.9	$\alpha \leq 0,6$	100	600	730	730	990	nvg	nvg	nvg
1.2.10			(365)	(490)	(490)	(600)	(730)	nvg	nvg
1.2.11		170	490	600	600	730	990	nvg	nvg
1.2.12			(240)	(240)	(240)	(240)	(300)	nvg	nvg
1.2.13		240	200	240	240	300	365	490	nvg
1.2.14			(170)	(170)	(170)	(170)	(170)	(240)	nvg
1.2.15		300	200	200	200	240	365	490	nvg
1.2.16			(170)	(170)	(170)	(170)	(170)	(240)	nvg
2	Group 2 units								
2.1	mortar : general purpose, thin layer $5,0 \leq f_b \leq 35$ $800 < \rho \leq 2\ 200$ $ct \geq 25\%$								
2.1.1	$\alpha \leq 1,0$	100	990	990	990	nvg	nvg	nvg	nvg
2.1.2			(490)	(600)	(600)	(730)		nvg	nvg
2.1.3		170	600	730	730	990	nvg	nvg	nvg
2.1.4			(240)	(240)	(240)	(365)	(365)	nvg	nvg
2.1.5		240	365	490	490	600	nvg	nvg	nvg
2.1.6			(170)	(170)	(170)	(240)	(240)	(365)	nvg
2.1.7		300	300	365	365	490	nvg	nvg	nvg
2.1.8			(170)	(170)	(170)	(200)	(240)	(300)	nvg
2.1.9	$\alpha \leq 0,6$	100	600	730	730	990	nvg	nvg	nvg
2.1.10			(365)	(490)	(490)	(600)	(730)	nvg	nvg
2.1.11		170	490	600	600	730	990	nvg	nvg
2.1.12			(240)	(240)	(240)	(240)	(300)	nvg	nvg
2.1.13		240	200	240	240	300	365	490	nvg
2.1.14			(170)	(170)	(170)	(170)	(240)	(300)	nvg
2.1.15		300	200	200	200	240	365	490	nvg
2.1.16			(170)	(170)	(170)	(170)	(170)	(240)	nvg

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	wall thickness [mm]	Minimum wall length (mm) l_F for fire resistance classification R for time (minutes) $t_{fi,d}$						
			30	45	60	90	120	180	240
2.2	$5 \leq f_b \leq 25$ $700 \leq \rho \leq 800$ $ct \geq 25\%$								
2.2.1	$\alpha \leq 1,0$	100	990	990	990	nvg	nvg	nvg	nvg
2.2.2			(490)	(600)	(600)	(730)	nvg	nvg	Nvg
2.2.3		170	600	730	730	990	nvg	nvg	nvg
2.2.4			(240)	(240)	(240)	(365)	(365)	nvg	Nvg
2.2.5		240	365	490	490	600	nvg	nvg	nvg
2.2.6			(170)	(170)	(170)	(240)	(240)	(365)	Nvg
2.2.7		300	300	365	365	490	nvg	nvg	nvg
2.2.8			(170)	(170)	(170)	(200)	(240)	(300)	Nvg
2.2.9	$\alpha \leq 0,6$	100	600	730	730	990	nvg	nvg	nvg
2.2.10			(365)	(490)	(490)	(600)	(730)	nvg	Nvg
2.2.11		170	490	600	600	730	990	nvg	nvg
2.2.12			(240)	(240)	(240)	(240)	(300)	nvg	Nvg
2.2.13		240	200	240	240	300	365	490	nvg
2.2.14			(170)	(170)	(170)	(170)	(240)	(300)	Nvg
2.2.15		300	200	200	200	240	365	490	nvg
2.2.16			(170)	(170)	(170)	(170)	(170)	(240)	Nvg
2.3	$5 \leq f_b \leq 25$ $500 \leq \rho \leq 900$ $16\% < ct \leq 25\%$								
2.3.1	$\alpha \leq 1,0$	100		nvg	nvg	nvg	nvg	nvg	nvg
2.3.2			(490)	(600)	(600)	(730)	nvg	nvg	nvg
2.3.3		170		nvg	nvg	nvg	nvg	nvg	nvg
2.3.4			(240)	(240)	(240)	(240)	(365)	(365)	nvg
2.3.5		240		nvg	nvg	nvg	nvg	nvg	nvg
2.3.6			(170)	(170)	(170)	(240)	(240)	(365)	nvg
2.3.7		300		nvg	nvg	nvg	nvg	nvg	nvg
2.3.8			(170)	(170)	(170)	(200)	(240)	(300)	nvg
2.3.9	$\alpha \leq 0,6$	100		nvg	nvg	nvg	nvg	nvg	nvg
2.3.10			(365)	(490)	(490)	(600)	(730)	nvg	nvg
2.3.11		170		nvg	nvg	nvg	nvg	nvg	nvg
2.3.12			(240)	(240)	(240)	(240)	(300)	nvg	nvg
2.3.13		240		nvg	nvg	nvg	nvg	nvg	nvg
2.3.14			(170)	(170)	(170)	(170)	(240)	(300)	nvg
2.3.15		300		nvg	nvg	nvg	nvg	nvg	nvg
2.3.16			(170)	(170)	(170)	(170)	(170)	(240)	nvg
2.3.17	365		nvg	nvg	nvg	nvg	nvg	nvg	
2.3.18		(100)	(170)	(170)	(170)	(170)	(240)	(240)	nvg

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row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	wall thickness [mm]	Minimum wall length (mm) l_F for fire resistance classification R for time (minutes) $t_{fi,d}$						
			30	45	60	90	120	180	240
3	Group 3 units								
3.1	mortar: general purpose and lightweight $5 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$ $ct \geq 12\%$								
3.1.1	$\alpha \leq 1,0$	240		nvg	nvg	nvg	nvg	nvg	nvg
3.1.2			(240)	(240)	(240)	(300)	(300)	(365)	nvg
3.1.3		300		nvg	nvg	nvg	nvg	nvg	nvg
3.1.4			(240)	(240)	(240)	(240)	(240)	(300)	nvg
3.1.5		365		nvg	nvg	nvg	nvg	nvg	nvg
3.1.6			(240)	(240)	(240)	(240)	(240)	(240)	nvg
3.1.7	$\alpha \leq 0,6$	240		nvg	nvg	nvg	nvg	nvg	nvg
3.1.8			(240)	(240)	(240)	(240)	(240)	(365)	nvg
3.1.9		300		nvg	nvg	nvg	nvg	nvg	nvg
3.1.10			(170)	(170)	(170)	(170)	(240)	(240)	nvg
3.1.11		365		nvg	nvg	nvg	nvg	nvg	nvg
3.1.12			(170)	(170)	(170)	(170)	(240)	(240)	nvg
4	Walls in which holes in units are filled with mortar or concrete								
4.1	mortar: general purpose and thin layer $10 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$ $ct \geq 10\%$								
4.1.1	$\alpha \leq 1,0$	100	990	990	990	nvg	nvg	nvg	nvg
4.1.2			(490)	(600)	(600)	(730)	nvg	nvg	Nvg
4.1.3		170	600	730	730	990	nvg	nvg	nvg
4.1.4			(240)	(240)	(240)	(365)	(365)	nvg	Nvg
4.1.5		240	365	490	490	600	nvg	nvg	nvg
4.1.6			(240)	(170)	(170)	(240)	(240)	(365)	Nvg
4.1.7	300	300	365	365	490	nvg	nvg	nvg	
4.1.8		(170)	(170)	(170)	(200)	(240)	(300)	Nvg	
4.1.9	$\alpha \leq 0,6$	100	600	730	730	990	nvg	nvg	nvg
4.1.10			(365)	(490)	(490)	(600)	(730)	nvg	Nvg
4.1.11		170	490	600	600	730	990	nvg	nvg
4.1.12			(240)	(240)	(240)	(240)	(300)	nvg	Nvg
4.1.13		240	200	240	240	300	365	490	nvg
4.1.14			(170)	(170)	(170)	(170)	(240)	(300)	Nvg
4.1.15	300	200	200	200	240	365	490	nvg	
4.1.16		(170)	(170)	(170)	(170)	(170)	(240)	Nvg	
5	Group 4 units								
5.1	mortar: general purpose and lightweight $5 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$								
5.1.1	$\alpha \leq 1,0$	240	nvg	nvg	nvg	nvg	nvg	nvg	nvg
5.1.2				nvg	nvg	nvg	nvg	nvg	nvg
5.1.3		300	nvg	nvg	nvg	nvg	nvg	nvg	nvg
5.1.4				nvg	nvg	nvg	nvg	nvg	nvg
5.1.5		365	nvg	nvg	nvg	nvg	nvg	nvg	nvg
5.1.6				nvg	nvg	nvg	nvg	nvg	nvg
5.1.7	$\alpha \leq 0,6$	240	nvg	nvg	nvg	nvg	nvg	nvg	nvg
5.1.8				nvg	nvg	nvg	nvg	nvg	nvg
5.1.9		300	nvg	nvg	nvg	nvg	nvg	nvg	nvg
5.1.10				nvg	nvg	nvg	nvg	nvg	nvg
5.1.11		365	nvg	nvg	nvg	nvg	nvg	nvg	nvg
5.1.12				nvg	nvg	nvg	nvg	nvg	Nvg

**Table N.B.1.5 Clay masonry minimum thickness of separating loadbearing and non-loadbearing single and double leaf fire walls
(Criteria REI-M and EI-M) for fire resistance classifications**

Row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	Minimum wall thickness (mm) t_F for fire resistance classification						
		REI-M and EI-M for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1S	Group 1S units							
1S.1	5 ≤ f_b ≤ 75 general purpose mortar 5 ≤ f_b ≤ 50 thin layer mortar 1 000 ≤ ρ ≤ 2 400							
1S.1.1	$\alpha \leq 1,0$	240	240	240	240	365	365	nvg
1S.1.2		(170)	(170)	(170)	(170)	(365)	(365)	nvg
1S.1.3	$\alpha \leq 0,6$	240	240	240	240	365	365	nvg
1S.1.4		(170)	(170)	(170)	(170)	(365)	(365)	nvg
1	Group 1 units							
1.1	5 ≤ f_b ≤ 75 800 ≤ ρ ≤ 2 400							
1.1.1	$\alpha \leq 1,0$	240	240	240	240	365	365	nvg
1.1.2		(170)	(170)	(170)	(170)	(365)	(365)	
1.1.3	$\alpha \leq 0,6$	240	240	240	240	365	365	nvg
1.1.4		(170)	(170)	(170)	(170)	(365)	(365)	
1.2	5 ≤ f_b ≤ 25 500 ≤ ρ ≤ 800							
1.2.1	$\alpha \leq 1,0$	240	240	240	240/300	365	365	nvg
1.2.2		(170)	(170)	(170)	(170/240)	(365)	(365)	
1.2.3	$\alpha \leq 0,6$	240	240	240	240/300	365	365	Nvg
1.2.4		(170)	(170)	(170)	(170/240)	(365)	(365)	
2	Group 2 units							
2.1	mortar : general purpose, thin layer 5 ≤ f_b ≤ 35 800 < ρ ≤ 2 200 $ct \geq 25\%$							
2.1.1	$\alpha \leq 1,0$	240	240	240	240	365	365	Nvg
2.1.2		(170)	(170)	(170)	(170)	(365)	(365)	
2.1.3	$\alpha \leq 0,6$	240	240	240	240	365	365	Nvg
2.1.4		(170)	(170)	(170)	(170)	(365)	(365)	
2.2	mortar : general purpose, thin layer and lightweight 5 ≤ f_b ≤ 25 700 ≤ ρ ≤ 800 $ct \geq 25\%$							
2.2.1	$\alpha \leq 1,0$	240/365	240/365	240/365	240/365	365	365	nvg
2.2.2		(170/240)	(170/240)	(170/240)	(170/300)	(365)	(365)	
2.2.3	$\alpha \leq 0,6$	240/365	240/365	240/365	240/365	365	365	nvg
2.2.4		(170/240)	(170/240)	(170/240)	(170/240)	(365)	(365)	
2.3	mortar: general purpose, thin layer and lightweight 5 ≤ f_b ≤ 25 500 ≤ ρ ≤ 900 16% ≤ ct < 25%							
2.3.1	$\alpha \leq 1,0$	365	365	365	365	nvg	nvg	nvg
2.3.2		(170)	(170)	(170)	(170/365)	(365)	(365)	
2.3.3	$\alpha \leq 0,6$	365	365	365	365	nvg	nvg	nvg
2.3.4		(170)	(170)	(170)	(170/300)	(365)	(365)	

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Row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	Minimum wall thickness (mm) t_F for fire resistance classification REI-M and EI-M for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
3	Group 3 units							
3.1	mortar : general purpose, lightweight, thin layer, vertical perforation $5 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$ $ct \geq 12\%$							
3.1.1	$\alpha \leq 1,0$	nvg (365)	nvg (365)	nvg (365)	nvg (365)	nvg	nvg	nvg
3.1.2								
3.1.3	$\alpha \leq 0,6$	nvg (365)	nvg (365)	nvg (365)	nvg (365)	nvg	nvg	nvg
3.1.4								
4	Walls in which holes in units are filled with mortar or concrete							
4.1	mortar : general purpose, thin layer, $5 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$ $ct \geq 10\%$							
4.1.1	$\alpha \leq 1,0$	240 (170)	240 (170)	240 (170)	240 (170)	nvg	nvg	nvg
4.1.2								
4.1.3	$\alpha \leq 0,6$	240 (170)	240 (170)	240 (170)	240 (170)	nvg	nvg	nvg
4.1.4								
5	Group 4 units							
5.1	mortar : general purpose, lightweight, thin layer, $5 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$ $ct \geq 12\%$							
5.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
5.1.2								
5.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	Nvg
5.1.4								

Table N.B.1.6 Clay masonry minimum thickness of each leaf of separating loadbearing cavity walls with one leaf loaded (Criteria REI) for fire resistance classifications

row number	material properties: unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1S	Group 1S units							
1S.1	$5 \leq f_b \leq 75$ general purpose mortar $5 \leq f_b \leq 50$ thin layer mortar $1\ 000 \leq \rho \leq 2\ 400$							
1S.1.1	$\alpha \leq 1,0$	90 (90)	90 (90)	90 (90)	100 (90)	100 (100)	nvg	nvg
1S.1.2								
1S.1.3	$\alpha \leq 0,6$	90 (90)	90 (90)	90 (90)	100 (90)	100 (100)	nvg	nvg
1S.1.4								
1	Group 1 units							
1.1	mortar : general purpose, thin layer $5 \leq f_b \leq 75$ $800 \leq \rho \leq 2\ 400$							
1.1.1	$\alpha \leq 1,0$	90 (90)	90 (90)	90 (90)	100 (90/100)	100/170 (100)	nvg	nvg
1.1.2								
1.1.3	$\alpha \leq 0,6$	90 (90)	90 (90)	90 (90)	100 (90)	100/140 (100)	nvg	nvg
1.1.4								

row number	material properties: unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1.2	mortar : general purpose, thin layer $5 \leq f_b \leq 25$ $500 \leq \rho \leq 800$							
1.2.1	$\alpha \leq 1,0$	100	170	170	240	365	nvg	nvg
1.2.2		(100)	(140)	(140)	(200)	(300)		
1.2.3	$\alpha \leq 0,6$	100	140	170	200	300	nvg	nvg
1.2.4		(100)	(140)	(140)	(170)	(300)		
2	Group 2 units							
2.1	mortar: general purpose, thin layer, $5 \leq f_b \leq 35$ $800 < \rho \leq 2\ 200$ $ct \geq 25\%$							
2.1.1	$\alpha \leq 1,0$	100	100	100	140/170	170/240	nvg	nvg
2.1.2		(100)	(100)	(100)	(100)	(100/140)		
2.1.3	$\alpha \leq 0,6$	100	100	100	100/140	170	nvg	nvg
2.1.4		(100)	(100)	(100)	(100)	(100/140)		
2.2	$15 \leq f_b \leq 25$ $700 \leq \rho \leq 800$ $ct \geq 25\%$							
2.2.1	$\alpha \leq 1,0$	100	100	100	170	240	nvg	nvg
2.2.2		(100)	(100)	(100)	(100)	(140)		
2.2.3	$\alpha \leq 0,6$	100	100	100	140	170	nvg	nvg
2.2.4		(100)	(100)	(100)	(100)	(100)		
2.3	mortar: general purpose, thin layer and lightweight $5 \leq f_b \leq 25$ $500 \leq \rho \leq 900$ $16\% \leq ct < 25\%$							
2.3.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
2.3.2		(100)	(100)	(100/170)	(100/240)	(140/300)		
2.3.3	$\alpha \leq 0,6$	100	100	100	140	170	nvg	nvg
2.3.4		(100)	(100)	(100/140)	(100/170)	(100/300)		
3	Group 3 units							
3.1	mortar: general purpose, thin layer and lightweight $5 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$ $ct \geq 12\%$							
3.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.1.2		(100)	(170)	(240)	(300)	(365)		
3.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.1.4		(100)	(140)	(170)	(240)	(300)		
4	Walls in which holes in units are filled with mortar or concrete							
4.1	mortar: general purpose and thin layer $10 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$ $ct \geq 10\%$							
4.1.1	$\alpha \leq 1,0$	100	100	100	170	240	nvg	nvg
4.1.2		(100)	(100)	(100)	(100)	(140)		
4.1.3	$\alpha \leq 0,6$	100	100	100	140	170	nvg	nvg
4.1.4		(100)	(100)	(100)	(100)	(100)		

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row number	material properties: unit strength f_b [N/mm ²] gross density ρ [kg/m ³] combined thickness ct % of wall thickness	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
5	Group 4 units							
5.1	mortar: general purpose, thin layer and lightweight $5 \leq f_b \leq 35$ $500 \leq \rho \leq 1\ 200$							
5.1.1	$\alpha \leq 1,0$	nvg (100)	nvg (170)	nvg (240)	nvg (300)	nvg (365)	nvg	nvg
5.1.2								
5.1.3	$\alpha \leq 0,6$	nvg (100)	nvg (140)	nvg (170)	nvg (240)	nvg (300)	nvg	nvg
5.1.4								

N.B.2 Calcium silicate masonry

Calcium silicate units conforming to EN 771-2

**Table N.B.2.1 Calcium silicate masonry minimum thickness of separating non-loadbearing separating walls
(Criteria EI) for fire resistance classifications**

row number	material properties: gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification EI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1	Group 1S, 1, 2 and 3							
1.1	mortar : general purpose, $600 \leq \rho \leq 2\ 400$							
1.1.1		70	70/90	70/90	100	100/140	140/170	140/200
1.1.2		(50)	(70)	(70)	(90)	(90/140)	(140)	(170)
1.2	mortar : thin layer $600 \leq \rho \leq 2\ 400$							
1.2.1		70	70/90	70/90	100	100/140	140/170	140/200
1.2.2		(50)	(70)	(70)	(100)	(100/140)	(140)	(170)

**Table N.B.2.2 Calcium silicate masonry minimum thickness of separating loadbearing single-leaf walls
(Criteria REI) for fire resistance classifications**

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{R,d}$						
		30	45	60	90	120	180	240
1S	Group 1S units							
1S.1	mortar: general purpose $12 \leq f_b \leq 15$ $1\ 700 \leq \rho \leq 2\ 400$							
1S.1.1	$\alpha \leq 1,0$	90	90	90	100	100/170	170	140/190
1S.1.2		(90)	(90)	(90)	(90/100)	(100/140)	(170)	(140/190)
1S.1.3	$\alpha \leq 0,6$	90	90	90	100	100/10	170	140/190
1S.1.4		(90)	(90)	(90)	(90/100)	(100/140)	(170)	(140/190)
1S.2	mortar: thin layer $12 \leq f_b \leq 15$ $1\ 700 \leq \rho \leq 2\ 400$							
1S.2.1	$\alpha \leq 1,0$	90	90	90	100	100/170	170	140/190
1S.2.2		(90)	(90)	(90)	(90/100)	(100/140)	(170)	(140/190)
1S.2.3	$\alpha \leq 0,6$	90	90	90	100	100/10	170	140/190
1S.2.4		(90)	(90)	(90)	(90/100)	(100/140)	(170)	(140/190)
1	Group 1 units							
1.1	mortar: general purpose $12 \leq f_b \leq 75$ $1\ 400 \leq \rho \leq 2\ 400$							
1.1.1	$\alpha \leq 1,0$	90 / 100	90 / 100	90 / 100	100	140 / 200	190 / 240	190/240
1.1.2		(90 / 100)	(90 / 100)	(90 / 100)	(90/100)	(140)	(170 / 190)	(140)
1.1.3	$\alpha \leq 0,6$	90 / 100	90 / 100	90 / 100	100	120/40	170 / 200	190/200
1.1.4		(90 / 100)	(90 / 100)	(90 / 100)	(100)	(100)	(140)	(140)
1.2	mortar: thin layer $12 \leq f_b \leq 75$ $1\ 400 \leq \rho \leq 2\ 400$							
1.2.1	$\alpha \leq 1,0$	90 / 100	90 / 100	90 / 100	100	140 / 200	190 / 240	190/240
1.2.2		(90 / 100)	(90 / 100)	(90 / 100)	(90/100)	(140)	(170 / 190)	(140)
1.2.3	$\alpha \leq 0,6$	90 / 100	90 / 100	90 / 100	100	120/40	170 / 200	190/200
1.2.4		(90 / 100)	(90 / 100)	(90 / 100)	(100)	(100)	(140)	(140)
2	Group 2 units							
2.1	mortar: general purpose $6 \leq f_b \leq 35$ $700 \leq \rho \leq 1\ 600$							
2.1.1	$\alpha \leq 1,0$	100	100	100	100/140	200	240	nvg
2.1.2		(100)	(100)	(100)	(100)	(170)	(190)	
2.1.3	$\alpha \leq 0,6$	100	100	100	100	140	200	nvg
2.1.4		(100)	(100)	(100)	(100)	(100)	(140)	
2.1	mortar: thin layer $6 \leq f_b \leq 35$ $700 \leq \rho \leq 1\ 600$							
2.1.1	$\alpha \leq 1,0$	100	100	100	100/140	200	240	nvg
2.1.2		(100)	(100)	(100)	(100)	(170)	(190)	
2.1.3	$\alpha \leq 0,6$	100	100	100	100	140	200	nvg
2.1.4		(100)	(100)	(100)	(100)	(100)	(140)	

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Table N.B.2.3 Calcium silicate masonry minimum thickness of non-separating loadbearing single-leaf walls $\geq 1,0\text{m}$ in length (Criterion R) for fire resistance classifications

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness or length (mm) t_F for fire resistance classification R for time (minutes)						
		$t_{R,d}$						
		30	45	60	90	120	180	240
1S	Group 1S units							
1S.1	mortar: general purpose $15 \leq f_b \leq 75$ $1\,700 \leq \rho \leq 2\,400$							
1S.1.1	$\alpha \leq 1,0$	100	100	100	100/140	200	240	nvg
1S.1.2		(100)	(100)	(100)	(100)	(170)	(190)	
1S.1.3	$\alpha \leq 0,6$	100	100	100	100/140	170	200	nvg
1S.1.4		(100)	(100)	(100)	(100)	(170)	(170)	
1S.1	mortar: thin layer $15 \leq f_b \leq 75$ $1\,700 \leq \rho \leq 2\,400$							
1S.1.1	$\alpha \leq 1,0$	100	100	100	100/140	200	240	nvg
1S.1.2		(100)	(100)	(100)	(100)	(170)	(190)	
1S.1.3	$\alpha \leq 0,6$	100	100	100	100/140	170	200	nvg
1S.1.4		(100)	(100)	(100)	(100)	(170)	(170)	
1	Group 1 units							
1.1	mortar : general purpose $12 \leq f_b \leq 75$ $1\,400 \leq \rho \leq 2\,400$							
1.1.1	$\alpha \leq 1,0$	100	100	100	140	200	240	nvg
1.1.2		(100)	(100)	(100)	(100)	(170)	(190)	
1.1.3	$\alpha \leq 0,6$	100	100	100	100/140	170	200	nvg
1.1.4		(100)	(100)	(100)	(100)	(100)	(170)	
1.2	mortar : thin layer $12 \leq f_b \leq 75$ $1\,400 \leq \rho \leq 2\,400$							
1.2.1	$\alpha \leq 1,0$	100	100	100	100/140	200	240	nvg
1.2.2		(100)	(100)	(100)	(100)	(170)	(190)	
1.2.3	$\alpha \leq 0,6$	100	100	100	100/140	170	200	nvg
1.2.4		(100)	(100)	(100)	(100)	(100)	(170)	
2	Group 2 units							
2.1	mortar : general purpose, $6 \leq f_b \leq 35$ $700 \leq \rho \leq 1\,600$							
2.1.1	$\alpha \leq 1,0$	100	100	100	140	200	240	nvg
2.1.2		(100)	(100)	(100)	(100)	(170)	(200)	
2.1.3	$\alpha \leq 0,6$	100	100	100	140	170	200	nvg
2.1.4		(100)	(100)	(100)	(100)	(100)	(170)	
2.2	mortar : thin layer $6 \leq f_b \leq 35$ $700 \leq \rho \leq 1\,600$							
2.2.1	$\alpha \leq 1,0$	100	100	100	140	200	240	nvg
2.2.2		(100)	(100)	(100)	(100)	(170)	(200)	
2.2.3	$\alpha \leq 0,6$	100	100	100	140	170	200	nvg
2.2.4		(100)	(100)	(100)	(100)	(100)	(170)	

Table N.B.2.4 Calcium silicate masonry minimum length of non-separating loadbearing single-leaf walls <1,0m in length (Criterion R) for fire resistance classifications

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	wall thick- ness [mm]	Minimum wall length (mm) l_F for fire resistance classification R for time (minutes) $t_{F,d}$						
			30	45	60	90	120	180	240
1	Group 1 and Group 2 units								
1.1	mortar: general purpose, thin layer $15 \leq f_b \leq 75$ $1\ 700 \leq \rho \leq 2\ 400$								
1.1.1	$\alpha \leq 1,0$	100	490	630	630	990	1 000	1 000	1 000
1.1.2			(365)	(490)	(490)	(730)	(990)	nvg	nvg
1.1.3		140	365	490	490	730	990	1 000	1 000
1.1.4			(300)	(365)	(365)	(630)	(730)	nvg	nvg
1.1.3		150	365	490	490	730	990	1 000	1 000
1.1.4			(300)	(365)	(365)	(630)	(730)	nvg	nvg
1.1.5		170	240	240	240	300	300	490	nvg
1.1.6			(240)	(240)	(240)	(240)	(240)	(300)	
1.1.7		200	240	240	240	300	300	490	nvg
1.1.8			(240)	(240)	(240)	(240)	(240)	(300)	
1.1.9		240	170	170	170	240	240	365	nvg
1.1.10			(nvg)	(nvg)	(nvg)	(170)	(170)	nvg	
1.1.11		300	170	170	170	170	170	300	nvg
1.1.12								(200)	
1.1.13	365	nvg	170	170	170	170	240	nvg	
1.1.14		(100)	(nvg)	(nvg)	(nvg)	(nvg)	(nvg)		
1.1.15	$\alpha \leq 0,6$	100	365	490	490	730	1 000	1 000	Nvg
1.1.16			(300)	(365)	(365)	(615)	(990)	nvg	
1.1.17		140	300	300	300	615	730	990	nvg
1.1.18			(240)	(300)	(300)	(490)	(615)	(730)	
1.1.17		150	300	300	300	615	730	990	nvg
1.1.18			(240)	(300)	(300)	(490)	(615)	(730)	
1.1.19		170	240	240	240	240	240	365	nvg
1.1.20			(240)	(240)	(240)	(240)	(240)	(365)	
1.1.21		200	240	240	240	240	240	365	nvg
1.1.22			(240)	(240)	(240)	(240)	(240)	(365)	
1.1.23		240	170	170	170	170	170	300	nvg
1.1.24									
1.1.25		300	170	170	170	170	170	240	nvg
1.1.26									
1.1.27	365	170	170	170	170	170	170	nvg	
1.1.28									

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**Table N.B.2.5 Calcium silicate masonry minimum thickness of separating loadbearing and non-loadbearing single and double leaf fire walls
(Criteria REI-M and EI-M) for fire resistance classifications**

row number	material properties: unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_f for fire resistance classification						
		REI-M and EI-M for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
IS	Group IS units							
IS.1	mortar: general purpose $12,5 \leq f_b \leq 35$ $1\ 700 \leq \rho \leq 2\ 400$							
IS.1.1	$\alpha \leq 1,0$	170/240	170/240	170/240	170/240	240/300	240/300	nvg
IS.1.2								
IS.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
IS.1.4					(170)			
IS.2	mortar: thin layer $12,5 \leq f_b \leq 35$ $1\ 700 \leq \rho \leq 2\ 400$							
IS.2.1	$\alpha \leq 1,0$	170/240	170/240	170/240	170/240	240/300	240/300	nvg
IS.2.2								
IS.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
IS.2.4					(170)			
1	Group 1 units							
1.1	mortar: general purpose $12,5 \leq f_b \leq 35$ $1\ 400 \leq \rho \leq 2\ 400$							
1.1.1	$\alpha \leq 1,0$	240	240	240	240	300	300/365	nvg
1.1.2								
1.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	170	nvg	240	nvg
1.1.4								
1.2	mortar: thin layer $12,5 \leq f_b \leq 35$ $1\ 400 \leq \rho \leq 2\ 400$							
1.2.1	$\alpha \leq 1,0$	240	240	240	240	300	300/365	nvg
1.2.2								
1.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	170	nvg	240	nvg
1.2.4								
2	Group 2 units							
2.1	mortar: general purpose $6 \leq f_b \leq 35$ $700 \leq \rho \leq 1\ 600$							
2.1.1	$\alpha \leq 1,0$	300	300	300	300	300/365	365/490	nvg
2.1.2								
2.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
2.1.4								
2.2	mortar: thin layer $6 \leq f_b \leq 35$ $700 \leq \rho \leq 1\ 600$							
2.2.1	$\alpha \leq 1,0$	300	300	300	300	300/365	365/490	nvg
2.2.2								
2.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
2.2.4								

Table N.B.2.6 Calcium silicate masonry minimum thickness of each leaf of separating loadbearing cavity walls with one leaf loaded (Criteria REI) for fire resistance classifications

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1S	Group 1S units							
1S.1	mortar: general purposer $12 \leq f_b \leq 35$ $1\ 700 \leq \rho \leq 2\ 400$							
1S.1.1	$\alpha \leq 1,0$	90 (90)	90 (90)	90 (90)	100 (90/100)	140/170 (100/140)	170 (170)	190 (190)
1S.1.2	$\alpha \leq 0,6$	90 (90)	90 (90)	90 (90)	100 (90/100)	140/170 (100/140)	170 (170)	190 (190)
1S.1.3	$\alpha \leq 1,0$	90 (90)	90 (90)	90 (90)	100 (90/100)	140/170 (100/140)	170 (170)	190 (190)
1S.1.4	$\alpha \leq 0,6$	90 (90)	90 (90)	90 (90)	100 (90/100)	140/170 (100/140)	170 (170)	190 (190)
1S.2	mortar: thin layer $12 \leq f_b \leq 35$ $1\ 700 \leq \rho \leq 2\ 400$							
1S.2.1	$\alpha \leq 1,0$	90 (90)	90 (90)	90 (90)	100 (90/100)	140/170 (100/140)	170 (170)	190 (190)
1S.2.2	$\alpha \leq 0,6$	90 (90)	90 (90)	90 (90)	100 (90/100)	140/170 (100/140)	170 (170)	190 (190)
1S.2.3	$\alpha \leq 1,0$	90 (90)	90 (90)	90 (90)	100 (90/100)	140/170 (100/140)	170 (170)	190 (190)
1S.2.4	$\alpha \leq 0,6$	90 (90)	90 (90)	90 (90)	100 (90/100)	140/170 (100/140)	170 (170)	190 (190)
1	Group 1 units							
1.1	mortar: general purpose $8 \leq f_b \leq 48$ $1\ 400 \leq \rho \leq 2\ 400$							
1.1.1	$\alpha \leq 1,0$	90/100 (90/100)	90/100 (90/100)	90/100 (90/100)	100 (90/100)	140/200 (140)	190/240 (170/190)	190/240
1.1.2	$\alpha \leq 0,6$	90/100 (90/100)	90/100 (90/100)	90/100 (90/100)	100 (100)	140 (100)	170/200 (140)	190/200
1.1.3	$\alpha \leq 1,0$	90/100 (90/100)	90/100 (90/100)	90/100 (90/100)	100 (90/100)	140/200 (140)	190/240 (170/190)	190/240
1.1.4	$\alpha \leq 0,6$	90/100 (90/100)	90/100 (90/100)	90/100 (90/100)	100 (100)	140 (100)	170/200 (140)	190/200
1.2	mortar: thin layer $8 \leq f_b \leq 48$ $1\ 400 \leq \rho \leq 2\ 400$							
1.2.1	$\alpha \leq 1,0$	90/100 (90/100)	90/100 (90/100)	90/100 (90/100)	100 (90/100)	140/200 (140)	190/240 (170/190)	190/240
1.2.2	$\alpha \leq 0,6$	90/100 (90/100)	90/100 (90/100)	90/100 (90/100)	100 (100)	120/140 (100)	170/200 (140)	190/200
1.2.3	$\alpha \leq 1,0$	90/100 (90/100)	90/100 (90/100)	90/100 (90/100)	100 (90/100)	140/200 (140)	190/240 (170/190)	190/240
1.2.4	$\alpha \leq 0,6$	90/100 (90/100)	90/100 (90/100)	90/100 (90/100)	100 (100)	120/140 (100)	170/200 (140)	190/200
2	Group 2 units							
2.1	mortar: general purpose $6 \leq f_b \leq 35$ $700 \leq \rho \leq 1\ 000$							
2.1.1	$\alpha \leq 1,0$	100 (100)	100 (100)	100 (100)	100 (100)	200 (170)	240 (190)	nvg
2.1.2	$\alpha \leq 0,6$	100 (100)	100 (100)	100 (100)	100 (100)	140 (100)	200 (140)	nvg
2.1.3	$\alpha \leq 1,0$	100 (100)	100 (100)	100 (100)	100 (100)	200 (170)	240 (190)	nvg
2.1.4	$\alpha \leq 0,6$	100 (100)	100 (100)	100 (100)	100 (100)	140 (100)	200 (140)	nvg
2.2	mortar: thin layer $6 \leq f_b \leq 35$ $700 \leq \rho \leq 1\ 000$							
2.2.1	$\alpha \leq 1,0$	100 (100)	100 (100)	100 (100)	100 (100)	200 (170)	240 (190)	nvg
2.2.2	$\alpha \leq 0,6$	100 (100)	100 (100)	100 (100)	100 (100)	140 (100)	200 (140)	nvg
2.2.3	$\alpha \leq 1,0$	100 (100)	100 (100)	100 (100)	100 (100)	200 (170)	240 (190)	nvg
2.2.4	$\alpha \leq 0,6$	100 (100)	100 (100)	100 (100)	100 (100)	140 (100)	200 (140)	nvg

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N.B.3 Dense and lightweight aggregate concrete masonry

Dense and lightweight aggregate concrete units conforming to EN 771-3

Table N.B.3.1 Dense and lightweight aggregate concrete masonry minimum thickness of separating non-loadbearing separating walls (Criteria EI) for fire resistance classifications

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification EI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1	Group 1 units mortar: general purpose, thin layer, lightweight							
1.1	lightweight aggregate $2 \leq f_b \leq 15$ $400 \leq \rho \leq 1\ 600$							
1.1.1		50	70	70 / 90	70 / 140	70 / 140	90 / 140	100 / 190
1.1.2		(50)	(50)	(50/70)	(60/70)	(70 / 140)	(70 / 140)	(70 / 170)
1.2	dense aggregate $6 \leq f_b \leq 35$ $1\ 200 \leq \rho \leq 2\ 400$							
1.2.1		50	70	70 / 90	90/140	90 / 140	100/190	100 / 190
1.2.2		(50)	(50)	(50 / 70)	(70)	(70/ 90)	(90 / 100)	(100 / 170)
2	Group 2 units mortar: general purpose, thin layer, lightweight							
2.1	lightweight aggregate $2 \leq f_b \leq 15$ $240 \leq \rho \leq 1\ 200$							
2.1.1		50	70	70 / 100	70 / 90	100 / 140	100 / 200	140/200
2.1.2		(50)	(50)	(50/90)	(70)	(70/140)	(90 / 100)	(100 / 200)
2.2	dense aggregate $6 \leq f_b \leq 35$ $720 \leq \rho \leq 1\ 650$							
2.2.1		50	70	70 / 100	70 / 90	90 / 200	100 / 200	125 / 200
2.2.2		(50)	(50)	(50 / 70)	(70)	(90/140)	(90 / 140)	(100/ 200)
3	Group 3 units mortar: general purpose, thin layer, lightweight							
3.1	lightweight aggregate $2 \leq f_b \leq 10$ $160 \leq \rho \leq 1\ 000$							
3.1.1		nvg	nvg	nvg	nvg	nvg	nvg	Nvg
3.1.2								
3.2	dense aggregate $6 \leq f_b \leq 20$ $480 \leq \rho \leq 1\ 000$							
3.2.1		100	nvg	150	200	nvg	nvg	Nvg
3.2.2								
4	Walls in which holes in units are filled with mortar or concrete mortar: general purpose and thin layer							
4.1	lightweight aggregate $2 \leq f_b \leq 10$ $160 \leq \rho \leq 1\ 000$							
4.1.1		nvg	nvg	nvg	nvg	nvg	nvg	Nvg
4.1.2								
4.2	dense aggregate $6 \leq f_b \leq 20$ $480 \leq \rho \leq 1\ 000$							
4.2.1		nvg	nvg	nvg	nvg	nvg	nvg	Nvg
4.2.2								

Table N.B.3.2 Dense and lightweight aggregate concrete masonry minimum thickness of separating loadbearing single-leaf walls (Criteria REI) for fire resistance classifications

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1	Group 1 units mortar: general purpose, thin layer, lightweight							
1.1	lightweight aggregate $2 \leq f_b \leq 15$ $400 \leq \rho \leq 1\ 600$							
1.1.1		90 / 170	90 / 170	90 / 170	100 / 170	100 / 190	140 / 240	150 / 300
1.1.2	$\alpha \leq 1,0$	(90 / 140)	(90 / 140)	(90 / 140)	(90 / 140)	(90 / 170)	(100 / 190)	(100 / 240)
1.1.3		70 / 140	70 / 140	70 / 140	90 / 170	90 / 170	100 / 190	100 / 240
1.1.4	$\alpha \leq 0,6$	(60 / 100)	(60 / 100)	(60 / 100)	(70 / 100)	(70 / 140)	(90 / 170)	(90 / 190)
1.2	dense aggregate $6 \leq f_b \leq 35$ $1\ 200 \leq \rho \leq 2\ 400$							
1.2.1		90 / 170	90 / 170	90 / 170	90 / 170	100 / 190	140 / 240	150 / 300
1.2.2	$\alpha \leq 1,0$	(90/140)	(100/140)	(90/140)	(90/140)	(90/170)	(100/190)	(100/240)
1.2.3		70 / 140	90 / 140	70 / 140	90 / 170	90 / 170	100 / 190	140 / 240
1.2.4	$\alpha \leq 0,6$	(60 / 100)	(70 / 100)	(70 / 100)	(70 / 100)	(70 / 140)	(90 / 170)	(100 / 190)
2	Group 2 units mortar: general purpose, thin layer, lightweight							
2.1	lightweight aggregate $2 \leq f_b \leq 15$ $240 \leq \rho \leq 1\ 200$							
2.1.1		90 / 170	100 / 170	100 / 170	100 / 170	100 / 190	140 / 240	150 / 300
2.1.2	$\alpha \leq 1,0$	(90 / 140)	(90 / 140)	(90 / 140)	(90/140)	(100/170)	(140/190)	(140/240)
2.1.3		70/140	70/140	90/140	90/170	100/170	125/190	140/240
2.1.4	$\alpha \leq 0,6$	(70/100)	(70/100)	(70/100)	(70/100)	(90/140)	(100/170)	(125/190)
2.2	dense aggregate $6 \leq f_b \leq 35$ $720 \leq \rho \leq 1\ 650$							
2.2.1		90 / 170	100 / 170	100 / 170	100 / 170	100 / 190	140 / 240	150 / 300
2.2.2	$\alpha \leq 1,0$	(90 / 140)	(90 / 140)	(90 / 140)	(100/140)	(100/170)	(140/190)	(150/240)
2.2.3		90/140	90/140	100/140	100/170	100/170	140/190	150/240
2.2.4	$\alpha \leq 0,6$	(70/100)	(90/100)	(90/100)	(90/100)	(100/140)	(125/170)	(140/190)
3	Group 3 units mortar: general purpose, thin layer, lightweight							
3.1	lightweight aggregate $2 \leq f_b \leq 10$ $160 \leq \rho \leq 1\ 000$							
3.1.1		nvg	nvg	nvg	nvg	nvg	nvg	Nvg
3.1.2	$\alpha \leq 1,0$							
3.1.3		nvg	nvg	nvg	nvg	nvg	nvg	Nvg
3.1.4	$\alpha \leq 0,6$							
3.2	dense aggregate $6 \leq f_b \leq 20$ $480 \leq \rho \leq 1\ 000$							
3.2.1		nvg	nvg	nvg	140	140/200	200	Nvg
3.2.2	$\alpha \leq 1,0$							
3.2.3		nvg	nvg	nvg	nvg	nvg	nvg	Nvg
3.2.4	$\alpha \leq 0,6$							

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row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
4	Walls in which holes in units are filled with mortar or concrete mortar: general purpose and thin layer							
4.1	lightweight aggregate $2 \leq f_b \leq 10$ $160 \leq \rho \leq 1\,000$							
4.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.1.2								
4.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.1.4								
4.2	dense aggregate $6 \leq f_b \leq 20$ $480 \leq \rho \leq 1\,000$							
4.2.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.2.2								
4.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.2.4								

Table N.B.3.3 Dense and lightweight aggregate concrete masonry minimum thickness of non-separating loadbearing single-leaf walls $\geq 1,0m$ in length (Criterion R) for fire resistance classifications

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness or length (mm) t_F for fire resistance classification R for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1	Group 1 units mortar: general purpose, thin layer, lightweight							
1.1	lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\,400$							
1.1.1	$\alpha \leq 1,0$	170	170	170	240	300	300	365
1.1.2		(170)	(170)	(170)	(170)	(240)	(240)	(300)
1.1.3	$\alpha \leq 0,6$	170	170	170	190	240	240	300
1.1.4		(140)	(140)	(140)	(170)	(190)	(240)	(240)
1.2	dense aggregate $6 \leq f_b \leq 20$ $1\,400 \leq \rho \leq 2\,000$							
1.2.1	$\alpha \leq 1,0$	170	170	170	240	300	300	365
1.2.2		(170)	(170)	(170)	(170)	(240)	(240)	(300)
1.2.3	$\alpha \leq 0,6$	170	170	170	190	240	240	300
1.2.4		(140)	(140)	(140)	(170)	(190)	(240)	(240)
2	Group 2 units mortar: general purpose, thin layer, lightweight							
2.1	lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\,400$							
2.1.1	$\alpha \leq 1,0$	170	170	170	240	300	300	365
2.1.2		(170)	(170)	(170)	(170)	(240)	(240)	(300)
2.1.3	$\alpha \leq 0,6$	170	170	170	190	240	240	300
2.1.4		(140)	(170)	(140)	(170)	(190)	(240)	(240)
2.2	dense aggregate $6 \leq f_b \leq 20$ $1\,400 \leq \rho \leq 2\,000$							
2.2.1	$\alpha \leq 1,0$	170	170	170	240	300	300	365
2.2.2		(170)	(170)	(170)	(170)	(240)	(240)	(300)
2.2.3	$\alpha \leq 0,6$	170	170	170	190	240	240	300
2.2.4		(140)	(170)	(140)	(170)	(190)	(240)	(240)

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness or length (mm) t_F for fire resistance classification R for time (minutes) $t_{f,d}$						
		30	45	60	90	120	180	240
3	Group 3 units mortar: general purpose, thin layer, lightweight							
3.1	lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\,400$							
3.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.1.2								
3.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.1.4								
3.2	dense aggregate $6 \leq f_b \leq 20$ $1\,400 \leq \rho \leq 2\,000$							
3.2.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.2.2								
3.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.2.4								
4	Walls in which holes in units are filled with mortar or concrete mortar: general purpose and thin layer							
4.1	lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\,400$							
4.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.1.2								
4.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.1.4								
4.2	dense aggregate $6 \leq f_b \leq 20$ $1\,400 \leq \rho \leq 2\,000$							
4.2.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.2.2								
4.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.2.4								

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Table N.B.3.4 Dense and lightweight aggregate concrete masonry minimum length of non-separating loadbearing single-leaf walls <1,0m in length (Criterion R) for fire resistance classifications

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	wall thickness [mm]	Minimum wall length (mm) l_F for fire resistance classification R for time (minutes) $t_{fi,d}$							
			30	45	60	90	120	180	240	
1	Group 1 mortar: general purpose, thin layer, lightweight									
1.1	lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\,400$									
1.1.1	$\alpha \leq 1,0$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg	
1.1.2		170	365/490	490	490	1 000	1 000	1 000	1 000	
1.1.3			(365)	(490)						
1.1.4			240	240	300	300	365	1 000	1 000	nvg
1.1.5			300	240	240	240	300	365	490	nvg
1.1.6	$\alpha \leq 0,6$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg	
1.1.7		170	240	365	365	490	1 000	1 000	nvg	
1.1.8			240	170	240	240	300	365	365	nvg
1.1.9			300	170	240	240	240	300	300	nvg
1.1.10			300	170	240	240	240	300	300	nvg
1.1.11	$\alpha \leq 1,0$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg	
1.1.12		170	300/365	nvg	490	365/1 000	1 000	1 000	nvg	
1.1.13			(240)	(300)	(365)	(490)				
1.1.14			240	240	300	300	365	1 000	1 000	nvg
1.1.15			300	240	240	240	300	365	490	nvg
1.1.16	$\alpha \leq 0,6$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg	
1.2.1		170	240	nvg	nvg	300	365	490	nvg	
1.2.2			(240)	(300)	(365)	(490)				
1.2.3			240	170	240	240	300	365	490	nvg
1.2.4			300	170	240	240	240	300	365	nvg
1.2.5	$\alpha \leq 1,0$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg	
1.2.6		170	240	nvg	nvg	300	365	490	nvg	
1.2.7			(240)	(300)	(365)	(490)				
1.2.8			240	170	240	240	300	365	490	nvg
1.2.9			300	170	240	240	240	300	365	nvg
1.2.10	$\alpha \leq 0,6$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg	
1.2.11		170	240	nvg	nvg	300	365	490	nvg	
1.2.12			(240)	(300)	(365)	(490)				
1.2.13			240	170	240	240	300	365	490	nvg
1.2.14			300	170	240	240	240	300	365	nvg
1.2.15	$\alpha \leq 1,0$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg	
1.2.16		170	240	nvg	nvg	300	365	490	nvg	
1.2.17			(240)	(300)	(365)	(490)				
1.2.18			240	170	240	240	300	365	490	nvg
1.2.19			300	170	240	240	240	300	365	nvg
1.2.20	$\alpha \leq 0,6$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg	
1.2.21		170	240	nvg	nvg	300	365	490	nvg	
1.2.22			(240)	(300)	(365)	(490)				
1.2.23			240	170	240	240	300	365	490	nvg
1.2.24			300	170	240	240	240	300	365	nvg

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	wall thickness [mm]	Minimum wall length (mm) l_F for fire resistance classification R for time (minutes) $t_{fi,d}$								
			30	45	60	90	120	180	240		
2	Group 2 units mortar: general purpose, thin layer, lightweight										
2.1	lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\ 400$										
2.1.1	$\alpha \leq 1,0$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg		
2.1.2		170	365/490 (365)	490	490	1 000 (490)	1 000	1 000	nvg		
2.1.3			240	240	300	300	365	1 000	1 000	nvg	
2.1.4			300	240	240	240	300	365	490	nvg	
2.1.5				100	nvg	nvg	nvg	nvg	nvg	nvg	
2.1.6				$\alpha \leq 0,6$	170	240	365	365	490	1 000	1 000
2.1.7	240	170	240		240	300	365	490	nvg		
2.1.8	300	170	240		240	240	300	365	nvg		
2.1.9		170	240		240	240	300	365	nvg		
2.1.10	$\alpha \leq 0,6$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg		
2.1.11		170	240	365	365	490	1 000	1 000	nvg		
2.1.12			240	170	240	240	300	365	490	nvg	
2.1.13			300	170	240	240	240	300	365	nvg	
2.1.14				100	nvg	nvg	nvg	nvg	nvg	nvg	
2.1.15				$\alpha \leq 0,6$	170	240	240	240	300	365	nvg
2.1.16	170	240	240		240	300	365	nvg			
2.2	dense aggregate $6 \leq f_b \leq 20$ $1\ 400 \leq \rho \leq 2\ 000$										
2.2.1	$\alpha \leq 1,0$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg		
2.2.2		170	300/365 (240)	nvg	490	365/1 000 (300)	1 000 (365)	1 000 (490)	nvg		
2.2.3			240	240	300	300	365	1 000	1 000	nvg	
2.2.4			300	240	240	240	300	365	490	nvg	
2.2.5				$\alpha \leq 0,6$	100	nvg	nvg	nvg	nvg	nvg	nvg
2.2.6					170	240	nvg	nvg	300 (240)	365 (300)	490 (365)
2.2.7	240	170	240			240	300	365	490	nvg	
2.2.8	300	170	240			240	240	300	365	nvg	
2.2.9		170	240	240	240	300	365	nvg			
2.2.10	$\alpha \leq 0,6$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg		
2.2.11		170	240	nvg	nvg	300 (240)	365 (300)	490 (365)	nvg		
2.2.12			240	170	240	240	300	365	490	nvg	
2.2.13			300	170	240	240	240	300	365	nvg	
2.2.14				$\alpha \leq 0,6$	100	nvg	nvg	nvg	nvg	nvg	nvg
2.2.15					170	240	nvg	nvg	300 (240)	365 (300)	490 (365)
2.2.16	170	240	240	240		300	365	nvg			
3	Group 3 units mortar: general purpose, thin layer, lightweight										
3.1	Lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\ 400$										
3.1.1	$\alpha \leq 1,0$	240	nvg	nvg	nvg	nvg	nvg	nvg	nvg		
3.1.2		300	365	nvg	nvg	nvg	nvg	nvg	nvg		
3.1.3			240	nvg	nvg	nvg	nvg	nvg	nvg		
3.1.4			365	240	nvg	nvg	nvg	nvg	nvg	nvg	
3.1.5				$\alpha \leq 0,6$	240	nvg	nvg	nvg	nvg	nvg	nvg
3.1.6					300	240	nvg	nvg	nvg	nvg	nvg
3.1.7	365	240	nvg			nvg	nvg	nvg	nvg		
3.1.8		240	nvg			nvg	nvg	nvg	nvg	nvg	
3.1.9	$\alpha \leq 0,6$	240	nvg	nvg	nvg	nvg	nvg	nvg			
3.1.10		300	240	nvg	nvg	nvg	nvg	nvg			
3.1.11			365	nvg	nvg	nvg	nvg	nvg	nvg		
3.1.12	$\alpha \leq 0,6$	240	nvg	nvg	nvg	nvg	nvg	nvg			
3.1.12		365	nvg	nvg	nvg	nvg	nvg	nvg			

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row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	wall thickness [mm]	Minimum wall length (mm) l_F for fire resistance classification R for time (minutes) $t_{fi,d}$						
			30	45	60	90	120	180	240
3.2	dense aggregate $6 \leq f_b \leq 20$ $1\ 400 \leq \rho \leq 2\ 000$								
3.2.1	$\alpha \leq 1,0$	240	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.2.2		300	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.2.3			365	nvg	nvg	nvg	nvg	nvg	nvg
3.2.4				nvg	nvg	nvg	nvg	nvg	nvg
3.2.5		$\alpha \leq 0,6$	240	nvg	nvg	nvg	nvg	nvg	nvg
3.2.6			300	nvg	nvg	nvg	nvg	nvg	nvg
3.2.7	365			nvg	nvg	nvg	nvg	nvg	
3.2.8				nvg	nvg	nvg	nvg	nvg	
3.2.9	300		nvg	nvg	nvg	nvg	nvg	nvg	
3.2.10			365	nvg	nvg	nvg	nvg	nvg	
3.2.11		nvg		nvg	nvg	nvg	nvg		
3.2.12									
4	Walls in which holes in units are filled with mortar or concrete mortar: general purpose and thin layer								
4.1	lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\ 400$								
4.1.1	$\alpha \leq 1,0$	240	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.1.2		300	nvg	nvg	nvg	nvg	nvg	nvg	
4.1.3			365	nvg	nvg	nvg	nvg	nvg	
4.1.4				nvg	nvg	nvg	nvg	nvg	
4.1.5		$\alpha \leq 0,6$	240	nvg	nvg	nvg	nvg	nvg	nvg
4.1.6			300	nvg	nvg	nvg	nvg	nvg	nvg
4.1.7	365			nvg	nvg	nvg	nvg	nvg	
4.1.8				nvg	nvg	nvg	nvg	nvg	
4.1.9	300		nvg	nvg	nvg	nvg	nvg	nvg	
4.1.10			365	nvg	nvg	nvg	nvg	nvg	
4.1.11		nvg		nvg	nvg	nvg	nvg		
4.1.12									
4.2	dense aggregate $6 \leq f_b \leq 20$ $1\ 400 \leq \rho \leq 2\ 000$								
4.2.1	$\alpha \leq 1,0$	240	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.2.2		300	nvg	nvg	nvg	nvg	nvg	nvg	
4.2.3			365	nvg	nvg	nvg	nvg	nvg	
4.2.4				nvg	nvg	nvg	nvg	nvg	
4.2.5		$\alpha \leq 0,6$	240	nvg	nvg	nvg	nvg	nvg	nvg
4.2.6			300	nvg	nvg	nvg	nvg	nvg	nvg
4.2.7	365			nvg	nvg	nvg	nvg	nvg	
4.2.8				nvg	nvg	nvg	nvg	nvg	
4.2.9	300		nvg	nvg	nvg	nvg	nvg	nvg	
4.2.10			365	nvg	nvg	nvg	nvg	nvg	
4.2.11		nvg		nvg	nvg	nvg	nvg		
4.2.12									

Table N.B.3.5 Dense and lightweight aggregate concrete masonry minimum thickness of separating loadbearing and non-loadbearing single and double leaf fire walls (Criteria REI-M and EI-M) for fire resistance classifications

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_f for fire resistance classification REI-M and EI-M for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1	Group 1 units mortar: general purpose, thin layer, lightweight							
1.1	lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\,400$							
1.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	300 (240)	nvg	nvg	nvg
1.1.2								
1.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
1.1.4								
1.2	dense aggregate $6 \leq f_b \leq 20$ $1\,400 \leq \rho \leq 2\,000$							
1.2.1	$\alpha \leq 1,0$	nvg	nvg	nvg	240 (170)	nvg	nvg	nvg
1.2.2								
1.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
1.2.4								
2	Group 2 units mortar: general purpose, thin layer, lightweight							
2.1	lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\,400$							
2.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	300 (240)	nvg	nvg	nvg
2.1.2								
2.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
2.1.4								
2.2	dense aggregate $6 \leq f_b \leq 20$ $1\,400 \leq \rho \leq 2\,000$							
2.2.1	$\alpha \leq 1,0$	nvg	nvg	nvg	240 (170)	nvg	nvg	nvg
2.2.2								
2.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
2.2.4								
3	Group 3 units mortar: general purpose, thin layer, lightweight							
3.1	lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\,400$							
3.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.1.2								
3.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.1.4								
3.2	dense aggregate $6 \leq f_b \leq 20$ $1\,400 \leq \rho \leq 2\,000$							
3.2.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.2.2								
3.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.2.4								

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row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification REI-M and EI-M for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
4	Walls in which holes in units are filled with mortar or concrete mortar: general purpose and thin layer							
4.1	lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\,400$							
4.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.1.2								
4.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.1.4								
4.2	dense aggregate $6 \leq f_b \leq 20$ $1\,400 \leq \rho \leq 2\,000$							
4.2.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.2.2								
4.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.2.4								

Table N.B.3.6 Dense and lightweight aggregate concrete masonry minimum thickness of each leaf of separating loadbearing cavity walls with one leaf loaded (Criteria REI) for fire resistance classifications

row number	material properties: unit strength f_b [N/mm ²] density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1	Group 1 units mortar : general purpose, thin layer, lightweight							
1.1	lightweight aggregate $2 \leq f_b \leq 15$ $400 \leq \rho \leq 1\,600$							
1.1.1	$\alpha \leq 1,0$	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 100/240 (2 x 90/170)	2 x 100/240 (2 x 90/170)	nvg	nvg
1.1.2								
1.1.3	$\alpha \leq 0,6$	2 x 70 (2 x 60)	2 x 70 (2 x 60)	2 x 70 (2 x 60)	2 x 90 (2 x 70)	2 x 90 (2 x 70)	nvg	nvg
1.1.4								
1.2	dense aggregate $6 \leq f_b \leq 20$ $1\,200 \leq \rho \leq 2\,200$							
1.2.1	$\alpha \leq 1,0$	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 90/170 (2 x 90/170)	2 x 100/170 (2 x 90/170)	nvg	nvg
1.2.2								
1.2.3	$\alpha \leq 0,6$	2 x 70 (2 x 60)	2 x 70 (2 x 70)	2 x 70 (2 x 70)	2 x 90 (2 x 70)	2 x 90 (2 x 70)	nvg	nvg
1.2.4								
2	Group 2 units mortar : general purpose, thin layer, lightweight							
2.1	lightweight aggregate $2 \leq f_b \leq 8$ $400 \leq \rho \leq 1\,400$							
2.1.1	$\alpha \leq 1,0$	2 x 90 (2 x 90)	2 x 100 (2 x 90)	2 x 100 (2 x 90)	2 x 100/240 (2 x 90/170)	2 x 100/240 (2 x 100/240)	nvg	nvg
2.1.2								
2.1.3	$\alpha \leq 0,6$	2 x 70 (2 x 70)	2 x 70 (2 x 70)	2 x 90 (2 x 70)	2 x 90 (2 x 70)	2 x 100 (2 x 90)	nvg	nvg
2.1.4								
2.2	dense aggregate $6 \leq f_b \leq 35$ $1\,400 \leq \rho \leq 2\,000$							
2.2.1	$\alpha \leq 1,0$	2 x 90 (2 x 90)	2 x 100 (2 x 90)	2 x 100 (2 x 90)	2 x 100/170 (2 x 100/170)	2 x 100/170 (2 x 100/170)	nvg	nvg
2.2.2								
2.2.3	$\alpha \leq 0,6$	2 x 90 (2 x 70)	2 x 100 (2 x 90)	2 x 100 (2 x 90)	2 x 100 (2 x 90)	2 x 100/170 (2 x 100)	nvg	nvg
2.2.4								

row number	material properties: unit strength f_b [N/mm ²] density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
3	Group 3 units mortar: general purpose, thin layer, lightweight							
3.1	lightweight aggregate $2 \leq f_b \leq 10$ $400 \leq \rho \leq 1\,400$							
3.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.1.2								
3.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.1.4								
3.2	dense aggregate $6 \leq f_b \leq 20$ $1\,400 \leq \rho \leq 2\,000$							
3.2.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.2.2								
3.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
3.2.4								
4	Walls in which holes in units are filled with mortar or concrete mortar: general purpose and thin layer							
4.1	lightweight aggregate $2 \leq f_b \leq 15$ $400 \leq \rho \leq 1\,400$							
4.1.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.1.2								
4.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.1.4								
4.2	dense aggregate $6 \leq f_b \leq 20$ $1\,400 \leq \rho \leq 2\,000$							
4.2.1	$\alpha \leq 1,0$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.2.2								
4.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg	nvg
4.2.4								

N.B.4 Autoclaved aerated concrete masonry

Autoclaved aerated concrete units conforming to EN 771-4

Table N.B.4.1 Autoclaved aerated concrete masonry minimum thickness of separating non-loadbearing walls (Criteria EI) for fire resistance classifications

Row number	material properties: unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification EI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1	Group 1 and IS units							
1.1	Mortar : general purpose, thin layer							
1.1.1	$350 \leq \rho \leq 500$	50/70	60/65	60/75	60/100	70/100	90/150	100 / 190
1.1.2		(50)	(60/65)	(60/75)	(60/70)	(70/90)	(90/115)	(100/190)
1.1.3	$500 \leq \rho \leq 1\,000$	50/70	60	60	60/100	60 / 100	90/150	100 / 190
1.1.4		(50)	(50/60)	(50/60)	(50 / 60)	(60 / 90)	(90/100)	(100/190)

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Table N.B.4.2 Autoclaved aerated concrete masonry minimum thickness of separating loadbearing single-leaf walls (Criteria REI) for fire resistance classifications

row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1	Group 1 and 1S units							
1.1	mortar: general purpose, thin layer $2 \leq f_b \leq 4$ $350 \leq \rho \leq 500$							
1.1.1	$\alpha \leq 1,0$	90/115	90/115	90/140	90/200	90/225	140/300	150/300
1.1.2		(90/115)	(90/115)	(90/115)	(90/200)	(90/225)	(140/240)	(150/300)
1.1.3	$\alpha \leq 0,6$	90/115	90/115	90/115	100/150	90/175	140/200	150/200
1.1.4		(90/115)	(90/115)	(90/115)	(90/115)	(90/150)	(140/200)	(150/200)
1.2	mortar: general purpose, thin layer $4 < f_b \leq 8$ $500 \leq \rho \leq 1\ 000$							
1.2.1	$\alpha \leq 1,0$	90/100	90/100	90/150	90/170	90/200	125/240	150/300
1.2.2		(90/100)	(90/100)	(90/100)	(90/150)	(90/170)	(100/200)	(100/240)
1.2.3	$\alpha \leq 0,6$	90/100	90/100	90/100	90/150	90/170	125/140	150/240
1.2.4		(90/100)	(90/100)	(90/100)	(90/100)	(90/125)	(125/140)	(150/200)

Table N.B.4.3 Autoclaved aerated concrete masonry minimum thickness of non-separating loadbearing single-leaf walls $\geq 1,0$ m in length (Criterion R) for fire resistance classifications

Row number	material properties: unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness or length (mm) t_F for fire resistance classification R for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1	Group 1 and 1S units							
1.1	mortar: general purpose, thin layer $2 \leq f_b \leq 4$ $350 \leq \rho \leq 500$							
1.1.1	$\alpha \leq 1,0$	170	170	170/200	240	240/300	300	300
1.1.2		(150)	(150)	(150)	(170)	(240)	(240)	(300)
1.1.3	$\alpha \leq 0,6$	125	150	150/170	170	170	240	300
1.1.3		(100)	(125)	(125/150)	(150)	(150)	(170)	(200)
1.2	mortar: general purpose, thin layer $4 < f_b \leq 8$ $500 \leq \rho \leq 1\ 000$							
1.2.1	$\alpha \leq 1,0$	125	125	150/170	170	240	240	240
1.2.2		(100)	(100)	(125/150)	(150)	(170)	(170)	(240)
1.2.3	$\alpha \leq 0,6$	100	100	125/150	150	150	170	240
1.2.4		(100)	(100)	(100/125)	(125)	(125)	(150)	(170)

Table N.B.4.4 Autoclaved aerated concrete masonry minimum length of non-separating loadbearing single-leaf walls <1,0m in length (Criterion R) for fire resistance classifications

Row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	wall thickness [mm]	Minimum wall length (mm) l_F for fire resistance classification R for time (minutes) $t_{fi,d}$							
			30	45	60	90	120	180	240	
1	Group 1 and 1S units									
1.1	mortar: general purpose, thin layer $2 \leq f_b \leq 4$ $350 \leq \rho \leq 500$									
1.1.1	$\alpha \leq 1,0$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg	
1.1.2		125	nvg	nvg	nvg	nvg	nvg	nvg	nvg	
1.1.3		150	nvg	nvg	nvg	nvg	nvg	nvg	nvg	
1.1.4		170	490	490	490	1000	1000	1000	1000	
1.1.5		200	365	490	490	1000	1000	1000	1000	
1.1.6		240	300	365	365	615	730	730	730/990	
1.1.7		300	240	300	300	490	490	615	615/730	
1.1.8		365	200	240	240	365	490	615	615/730	
1.1.9		$\alpha \leq 0,6$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg
1.1.10			125	nvg	nvg	nvg	nvg	nvg	nvg	nvg
1.1.11			150	nvg	nvg	nvg	nvg	nvg	nvg	nvg
1.1.12			170	365	365	365	490	490	490/615	1 000
1.1.13			200	240	365	365	365	490	490/615	1 000
1.1.14			240	240	240	240	300	365	365/615	730
1.1.15			300	240	240	240	240	300	300/490	615
1.1.16			365	170	170	170	240	240	240/365	615/490
1.1.17										
1.1.18										
1.1.19										
1.1.20										
1.1.21										
1.1.22										
1.1.23										
1.1.24										
1.1.25										
1.1.26										
1.1.27										
1.1.28										
1.1.29										
1.1.30										
1.1.31										
1.1.32										

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Row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	wall thickness [mm]	Minimum wall length (mm) l_F for fire resistance classification R for time (minutes) $t_{fi,d}$							
			30	45	60	90	120	180	240	
1.2	mortar: general purpose, thin layer $4 < f_b \leq 8$ $500 \leq \rho \leq 1\ 000$									
1.2.1	$\alpha \leq 0,0$	100	nvg	Nvg	nvg	nvg	nvg	nvg	nvg	
1.2.2		125	nvg	Nvg	nvg	nvg	nvg	nvg	nvg	
1.2.3		150	nvg	Nvg	nvg	nvg	nvg	nvg	nvg	
1.2.4		170	365/490	365/490	365/490	730	1000	1000	1000	
1.2.5		200	240/365	365	365/490	615	730	730	730/990	
1.2.6		240	240/300	300	240/365	490/615	615/730	615/730	615/730	
1.2.7		300	200/240	240	240/300	365/490	365/490	490/615	490/615	
1.2.8		365	170/200	200	175/240	300/365	365/490	490/615	365/615	
1.2.9		$\alpha \leq 0,6$	100	nvg	nvg	nvg	nvg	nvg	nvg	nvg
1.2.10			125	nvg	nvg	nvg	nvg	nvg	nvg	nvg
1.2.11	150		nvg	nvg	nvg	nvg	nvg	nvg	nvg	
1.2.12	170		300/365	300	300/365	365/490	365/490	490/615	615	
1.2.13	200		200/240	300	300/365	300/365	365/490	490/615	615	
1.2.14	240		200/240	200	200/240	240/300	300/365	490/615	615	
1.2.15	300		200/240	200	200/240	200/240	240/300	365/490	490	
1.2.16	365		150/240	150	150/240	200/240	200/240	300/365	365	
1.2.17										
1.2.18										
1.2.19										
1.2.20										
1.2.21										
1.2.22										
1.2.23										
1.2.24										
1.2.25										
1.2.26										
1.2.27										
1.2.28										
1.2.29										
1.2.30										
1.2.31										
1.2.32										

Table N.B.4.5 Autoclaved aerated concrete masonry minimum thickness of separating loadbearing and non-loadbearing single and double leaf fire walls (Criteria REI-M and EI-M) for fire resistance classifications

Row number	material properties unit strength f_b [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification REI-M and EI-M for time (minutes) $t_{fi,d}$					
		30	60	90	120	180	240
1	Group 1 and 1S units						
1.1	mortar: general purpose, thin layer $2 \leq f_b \leq 4$ $350 \leq \rho \leq 500$						
1.1.1	$\alpha \leq 1,0$	300	300	300	365	365	nvg
1.1.2							
1.1.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg
1.1.4							
1.2	mortar: general purpose, thin layer $4 < f_b \leq 8$ $500 \leq \rho \leq 1\ 000$						
1.2.1	$\alpha \leq 1,0$	300/240	300/240	300/240	365/300	365/300	nvg
1.2.2							
1.2.3	$\alpha \leq 0,6$	nvg	nvg	nvg	nvg	nvg	nvg
1.2.4							

Table N.B.4.6 Autoclaved aerated concrete masonry minimum thickness of each leaf of separating loadbearing cavity walls with one leaf loaded (Criteria REI) for fire resistance classifications

row number	material properties: unit strength f_b [N/mm ²] density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$						
		30	45	60	90	120	180	240
1	Group 1 and 1S units							
1.1	mortar: general purpose, thin layer $2 \leq f_b \leq 4$ $350 \leq \rho \leq 500$							
1.1.2*)	$\alpha \leq 1,0$	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 100 (2 x 100)	2 x 100 (2 x 100)	2 x 150/170	2 x 150/225
1.1.3	$\alpha \leq 0,6$	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 90/125 (2 x 90/125)	2 x 150 (2 x 150)	2 x 150/200 (2 x 150/200)
1.1.4								
1.2	mortar: general purpose, thin layer $4 < f_b \leq 8$ $500 \leq \rho \leq 1\ 000$							
1.2.1**)	$\alpha \leq 1,0$	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 100 (2 x 100)	2 x 100 (2 x 100)	2 x 125/240 (2x 100/200)	2 x 150/240 (2x 100/200)
1.2.2								
1.2.3	$\alpha \leq 0,6$	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 90 (2 x 90)	2 x 100 (2 x 100)	2 x 100 (2 x 100)	2 x 125 (2 x 125)	2 x 150 (2 x 150)
1.2.4								

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N.B.5 Manufactured stone masonry

Manufactured stone units conforming to EN 771-5

Table N.B.5.1 Manufactured stone masonry minimum thickness of separating non-loadbearing separating walls (Criteria EI) for fire resistance classifications

Row number	material properties normalized strength [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification EI for time (minutes) $t_{fi,d}$					
		30	60	90	120	180	240
1	Group 1 units						
1.1	Mortar: general purpose, thin layer, lightweight $1\,200 \leq \rho \leq 2\,200$						
1.1.1		50	70 / 90	90	90 / 100	100	100/170
1.1.2		(50)	(50/70)	(70)	(70 / 90)	(90/100)	(100/140)

Table N.B.5.2 Manufactured stone masonry minimum thickness of separating loadbearing single-leaf walls (Criteria REI) for fire resistance classifications

row number	material properties normalized strength [N/mm ²] gross density ρ [kg/m ³]	Minimum wall thickness (mm) t_F for fire resistance classification REI for time (minutes) $t_{fi,d}$					
		30	60	90	120	180	240
1	Group 1 units						
1.2	Mortar: general purpose, thin layer, lightweight $1\,200 \leq \rho \leq 2\,200$						
1.2.1		90/170	90/170	90/170	100/190	140/240	150/300
1.2.2	$\alpha \leq 1,0$	(90/140)	90/140	(90/140)	(90/170)	(100/190)	(100/240)
1.2.3		70/140	70/140	90/170	90/170	100/190	140/240
1.2.4	$\alpha \leq 0,6$	(60/100)	(70/100)	(70/100)	(70/140)	(90/170)	(100/190)

END OF NOTES

Annex C (Informative)

Simplified calculation model

C.1 General

(1) In the simplified calculation method the loadbearing capacity is determined by boundary conditions on the residual cross section of the masonry for stated periods of fire exposure using the load at normal temperature.

(2) The simplified method is valid for masonry walls and columns under standard fire exposure built with the following units and mortar combinations:

- clay units: group 1S and Group 1, unit strength f_b 10 - 40 N/mm², gross density 1 000 – 2 000 kg/m³, general purpose mortar
- calcium silicate units: group 1S and Group 1, unit strength f_b 10 - 40 N/mm², gross density 1 500 - 2 000 kg/m³, thin layer mortar
- dense aggregate concrete: group 1, unit strength f_b 10 - 40 N/mm², gross density 1 500 - 2 000 kg/m³, general purpose mortar
- lightweight aggregate concrete: group 1S and Group 1, unit strength f_b 4 - 8 N/mm², gross density 600 – (pumice)1 000 kg/m³, lightweight mortar,
- autoclaved aerated concrete: group 1, unit strength f_b 2 - 6 N/mm², gross density 400-700 kg/m³, general purpose mortar, thin layer

NOTE The limits given above relate to the results of the Simplified method having been calibrated against the results of tests. The list is not intended as a list of limits for other reasons. The principle of the method can be used if calibration results are available for units not covered by the list above.

(3) In simple calculation models the relationship between thermal elongation and masonry temperature may be considered to be constant. In this case the elongation may be determined from 3.3.3.1(1).

C.2 Procedure

(1) Determine the temperature profile of the cross-section, the structurally ineffective section and the residual cross-section, calculate the load-bearing capacity at the ultimate limit state with the residual cross-section (see figure C.1), check that this load-bearing capacity is greater than that required with the relevant load combination of actions (see (2) below).

(2) At the limit state for the fire situation, the design value of vertical load applied to a wall or column should be less than or equal to the design value of the vertical resistance of the wall or column such that:

$$N_{Ed} \leq N_{Rd,fi(0i)} \quad (C1)$$

(3) The design value of the vertical resistance of the wall or column is given by:

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$$N_{Rd,fi(\theta_i)} = \Phi (f_{d\theta_1} A_{\theta_1} + f_{d\theta_2} A_{\theta_2}) \quad (C2)$$

where

A	total area of masonry
A_{θ_1}	area of masonry up to θ_1 ;
A_{θ_2}	area of masonry between θ_1 and θ_2 ;
θ_1	temperature up to which the cold strength of masonry may be used;
θ_2	temperature above which the material has no residual strength
N_{Ed}	design value of the vertical load;
$N_{Rd,fi\theta_2}$	design value of the resistance in fire
$f_{d\theta_1}$	design compressive strength of masonry up to θ_1 ;
$f_{d\theta_2}$	design strength of masonry in compression between θ_1 and θ_2 °C, taken as $cf_{d\theta_1}$
c	constant obtained from stress strain tests at elevated temperature (with subscripts)
Φ	capacity reduction factor in the middle of the wall obtained from 6.1.2.2. of EN 1996-1-1, taking into account additionally the eccentricity $e_{\Delta\theta}$.
$e_{\Delta\theta}$	eccentricity due to variation of temperature across masonry.

(4) The temperature distribution across a masonry section and the temperature at which the masonry becomes ineffective, as a function of the time of fire exposure, should be obtained from the results of tests or from a data base of test results. In the absence of test results or a database the Figures C.3(a) to (d) may be used. For autoclaved aerated concrete masonry, reference should be made to prEN 12602.

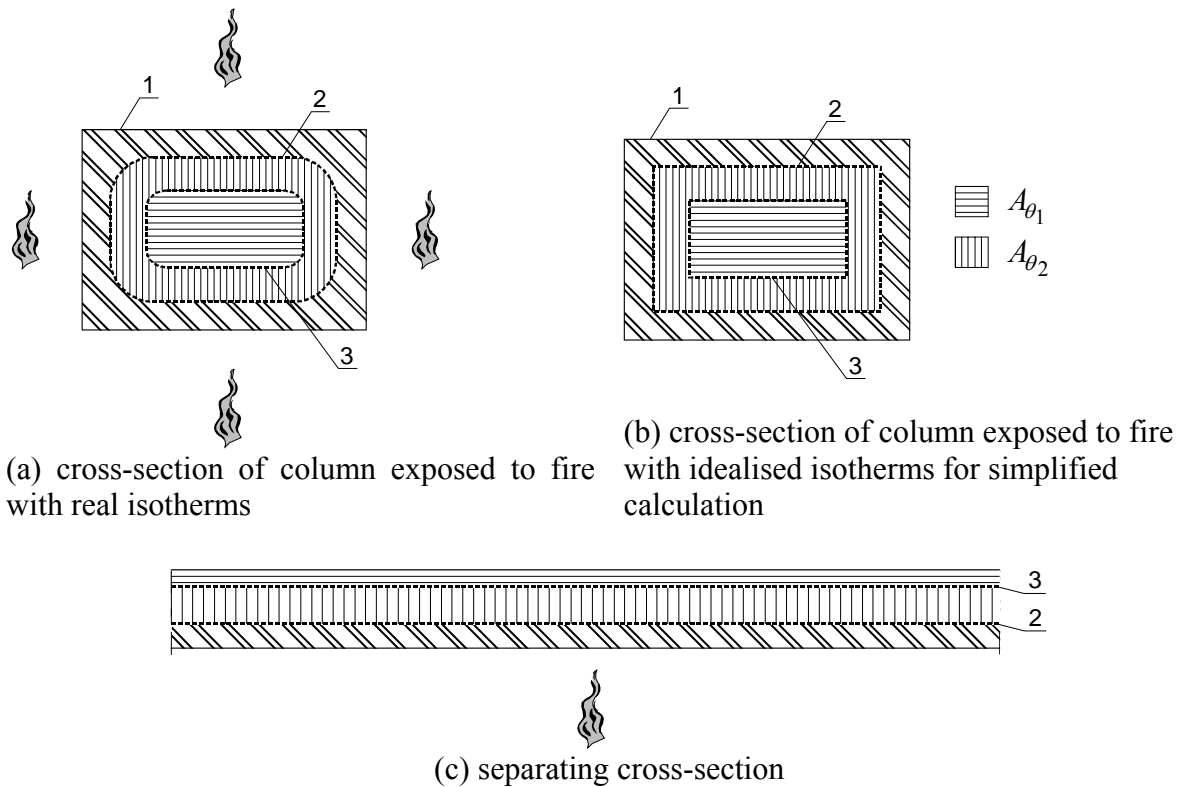


Figure C.1 Illustration of areas of masonry at temperatures up to θ_1 , between θ_1 and θ_2 , and structurally ineffective areas (over θ_2)

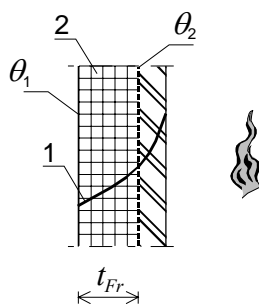
The eccentricity, $e_{\Delta\theta}$, due to the fire load, for use in this simplified calculation method may be obtained from test results or from equation (C3a or b) (see also figure C.2):

$$e_{\Delta\theta} = \frac{1}{8} h_{ef}^2 \frac{\alpha_t (\theta_2 - 20)}{t_{Fr}} \leq h_{ef} / 20 \tag{C3a}$$

$$e_{\Delta\theta} = 0 \text{ when the fire is all around} \tag{C3b}$$

where:

- h_{ef} effective height of the wall
- α_t coefficient of thermal expansion of masonry according to 3.7.4 of EN 1996-1-1
- 20°C temperature assumed on the cold side
- t_{Fr} thickness of the cross-section whose temperature does not exceed θ_2



Key

- 1 temperature distribution from Figures C.3
- 2 residual area of the cross section with strength ($A_{\theta_1} + A_{\theta_2}$)

Figure C.2 Vertical section on masonry

NOTE: The value of c_{cl} , c_{cs} , c_{la} , c_{da} and c_{aac} to be used in a Country may be found in its National Annex

Values of constant, c , and temperature θ_1 and θ_2 by masonry material

Masonry units and mortar (surface unprotected) according to 1.1 (2)	Values of constant c	Temperature °C	
		θ_2	θ_1
Clay units with general purpose mortar	c_{cl}	600	100
Calcium silicate units with thin layer mortar	c_{cs}	500	100
Lightweight aggregate units (pumice) with general purpose mortar	c_{la}	400	100
Dense aggregate units with general purpose mortar	c_{da}	500	100
Autoclaved aerated units with thin layer mortar	c_{aac}	700	200

END OF NOTE.

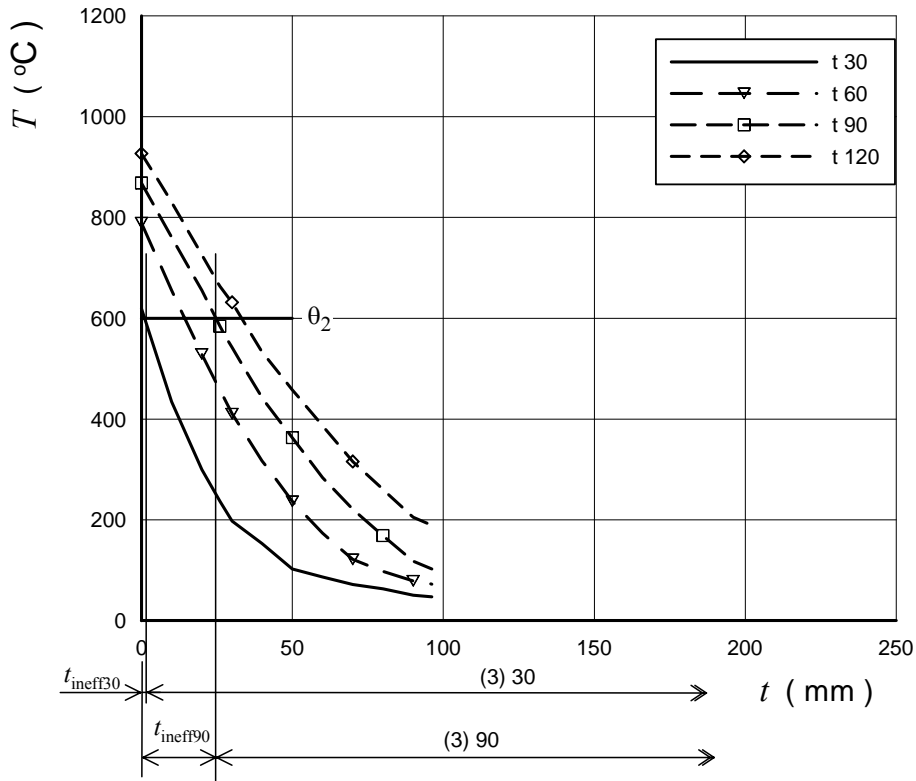


Figure C.3(a): Clay masonry, gross density 1 000 – 2000 kg/m³

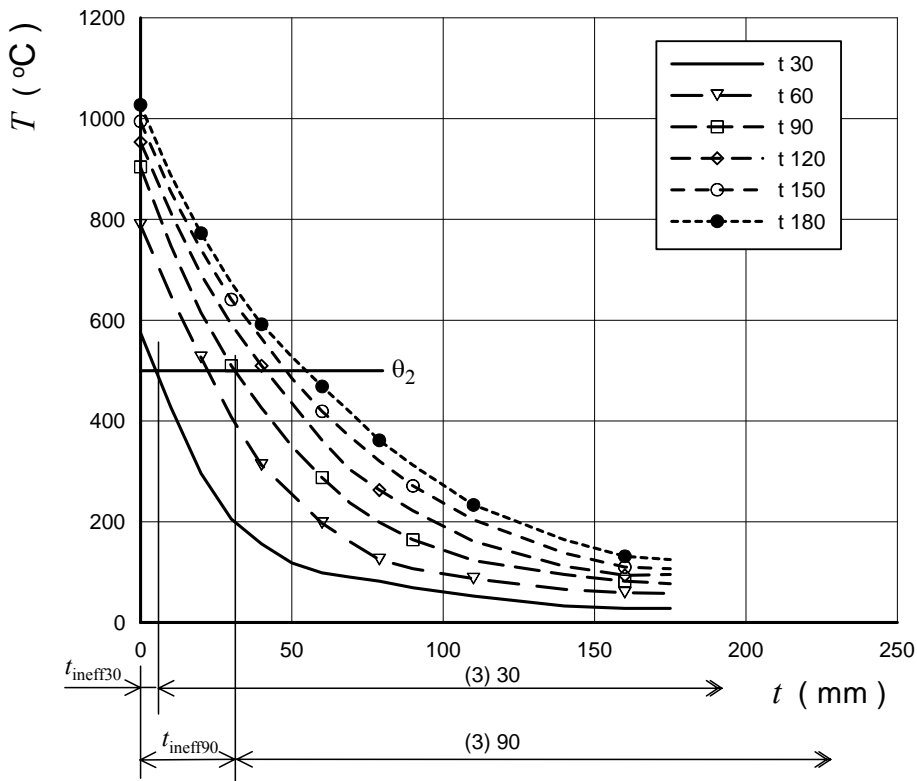


Figure C.3(b): Calcium silicate masonry, gross density 1 500 - 2 000 kg/m³

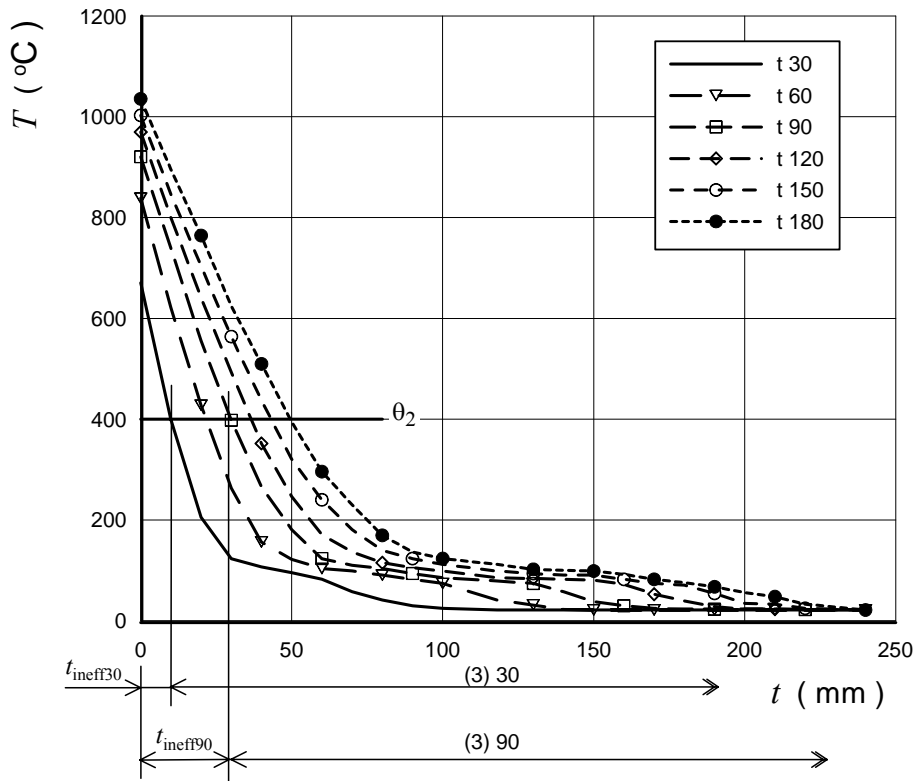


Figure C.3(c): Lightweight aggregate concrete (pumice) masonry, gross density 600 - 1 000 kg/m^3

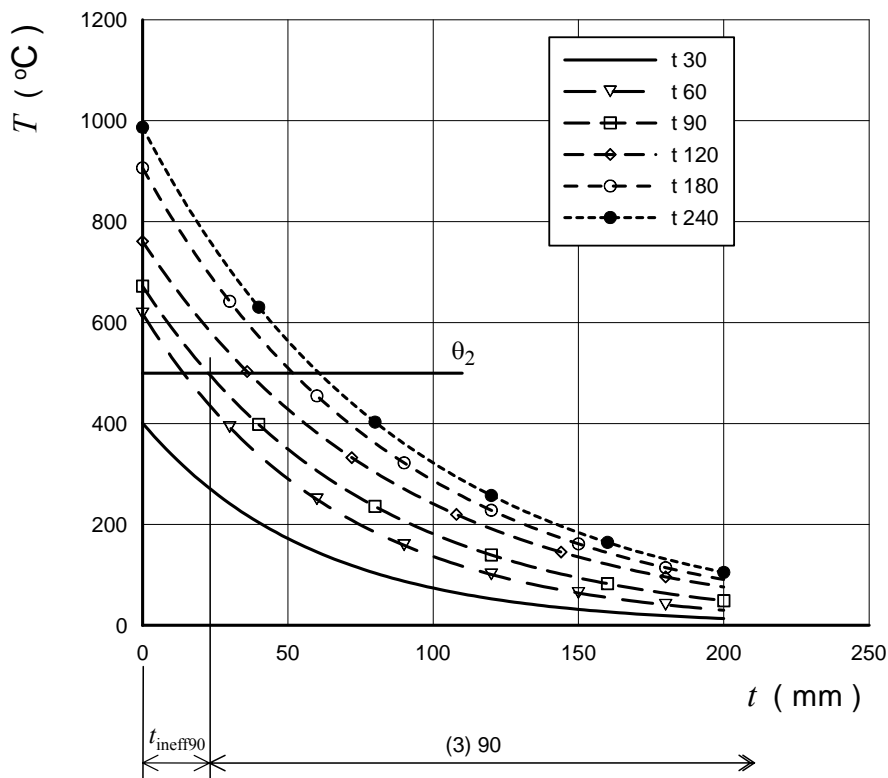


Figure C.3(d): Dense aggregate concrete masonry, gross density 1 500 - 2 000 kg/m^3

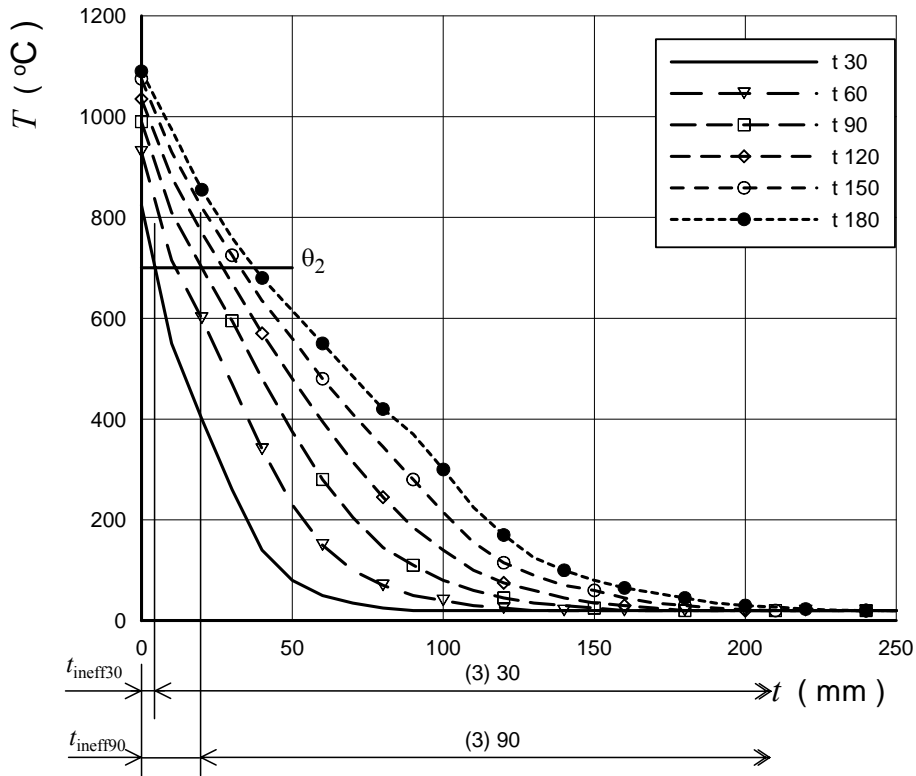


Figure C.3(e): Autoclaved aerated concrete masonry, gross density 400 kg/m^3

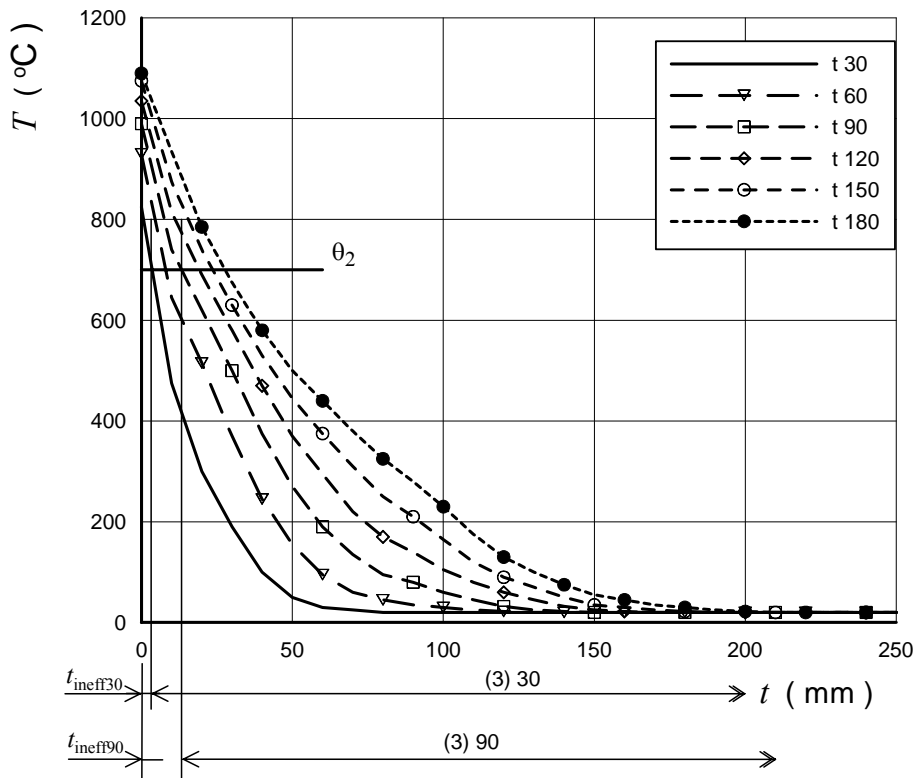


Figure C.3(f): Autoclaved aerated concrete masonry, gross density 500 kg/m^3

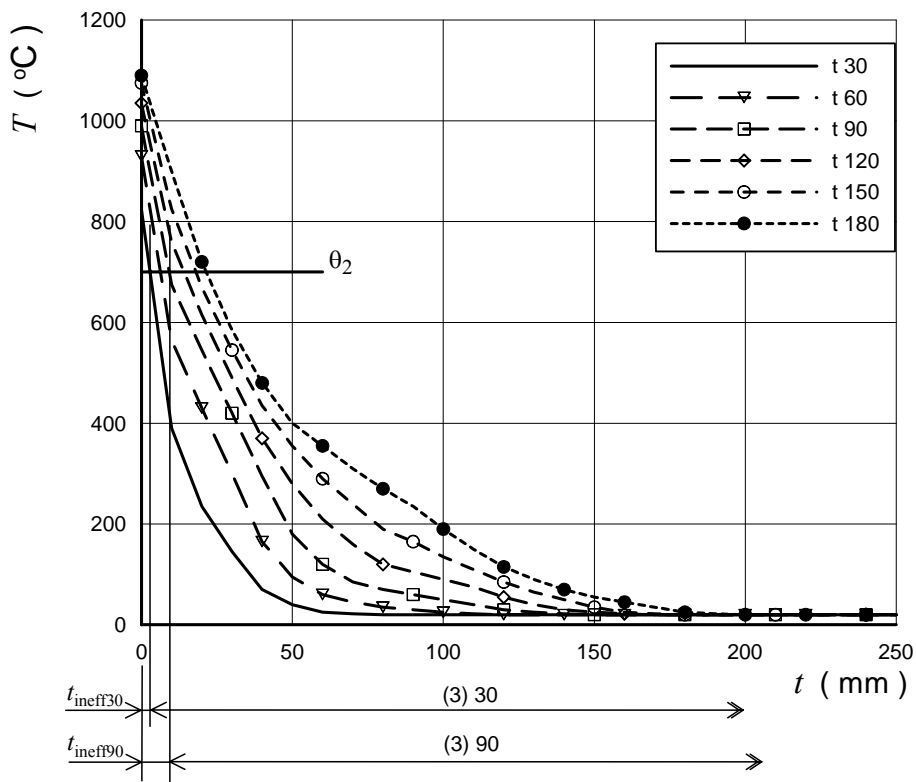


Figure C.3(g): Autoclaved aerated concrete masonry, gross density 600 kg/m³

Key

$t_{ineff\ 30}$ is thickness of wall that has become ineffective in 30 minutes

$t_{ineff\ 90}$ is thickness of wall that has become ineffective in 90 minutes

θ_2 is the temperature above which masonry is structurally ineffective

T Temperature (°C)

t Masonry thickness (mm)

3 Residual section with number in minutes

t 30	30 minutes	t 120	120 minutes
t 60	60 minutes	t 150	150 minutes
t 90	90 minutes	t 180	180 minutes
t 240	240 minutes		

Figure C.3 Temperature distribution across masonry section and temperature at which masonry is structurally ineffective

Annex D (Informative)

Advanced calculation method

D.1 General

(1)P Advanced calculation methods shall be based on fundamental physical behaviour leading to a reliable approximation of the expected behaviour of the structural component under fire conditions.

(2) Advanced calculation methods should include calculation models for the determination of:

- the development and distribution of the temperature within structural members (thermal response model);
- the mechanical behaviour of the structure or of any part of it (mechanical response model).

(3) Advanced calculation methods may be used in association with any heating curve provided that the material properties are known for the relevant temperature range and the relevant rate of heating.

D.2 Thermal response

(1) Advanced calculation methods for thermal response should be based on the acknowledged principles and assumptions of the theory of heat transfer.

(2) The thermal response model should include consideration of:

- the relevant thermal actions specified in 1991-1-2;
- the temperature dependent thermal properties of the materials.

(3) The influence of moisture content and of migration of the moisture within masonry may conservatively be neglected.

(4) The effect of non-uniform thermal exposure and of heat transfer to adjacent building components may be included where appropriate.

D.3 Mechanical response

(1) Advanced calculation methods for mechanical response should be based on the acknowledged principles and assumptions of the theory of structural mechanics, taking into account the changes of mechanical properties with temperature.

(2) The effects of thermally induced strains and stresses both due to temperature rise and due to temperature differentials, should be considered. The figures D.1(a) to (d) and D.2(a) to (f) give relevant information.

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NOTE For autoclaved aerated concrete masonry, reference may be made to prEN 12602. For other materials reference can be made to other authoritative publications.

(3) The deformation at ultimate limit state implied by the calculation methods should be limited as necessary to ensure that compatibility is maintained between all parts of the structure.

(4) Where relevant, the mechanical response of the model should also take account of geometrical non-linear effects.

(5) In the analysis of individual members or sub-assemblies the boundary conditions should be checked and detailed in order to avoid failure due to the loss of adequate support for the members.

(6) It should be verified that

$$E_{fi,d}(t) \leq R_{fi,t,d}$$

In which:

$E_{fi,d}$ is the design effect of actions for the fire situation, determined in accordance with EN 1991-1-2, including effects of thermal expansions and deformations

$R_{fi,t,d}$ is the corresponding design resistance in the fire situation

t is the designed duration of fire impact

(7) In the calculation of load-bearing structures, the way in which the structure collapses under fire impact, temperature-dependant material properties including stiffness as well as the effect of thermal strain and deformation (indirect fire impact) should be assessed.

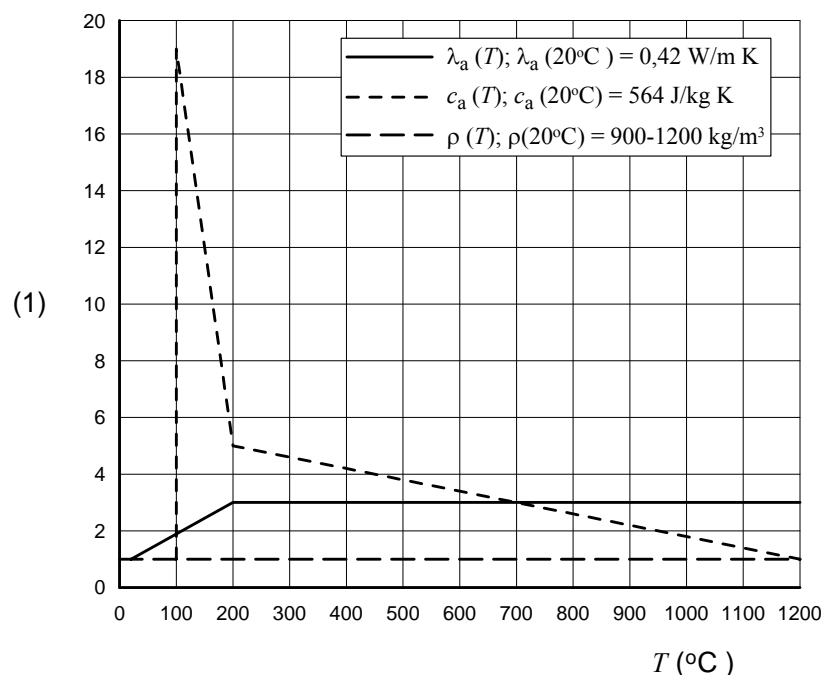


Figure D.1.(a): calculation values of temperature-dependant material properties of clay units with a density range of 900 – 1 200 kg/m³

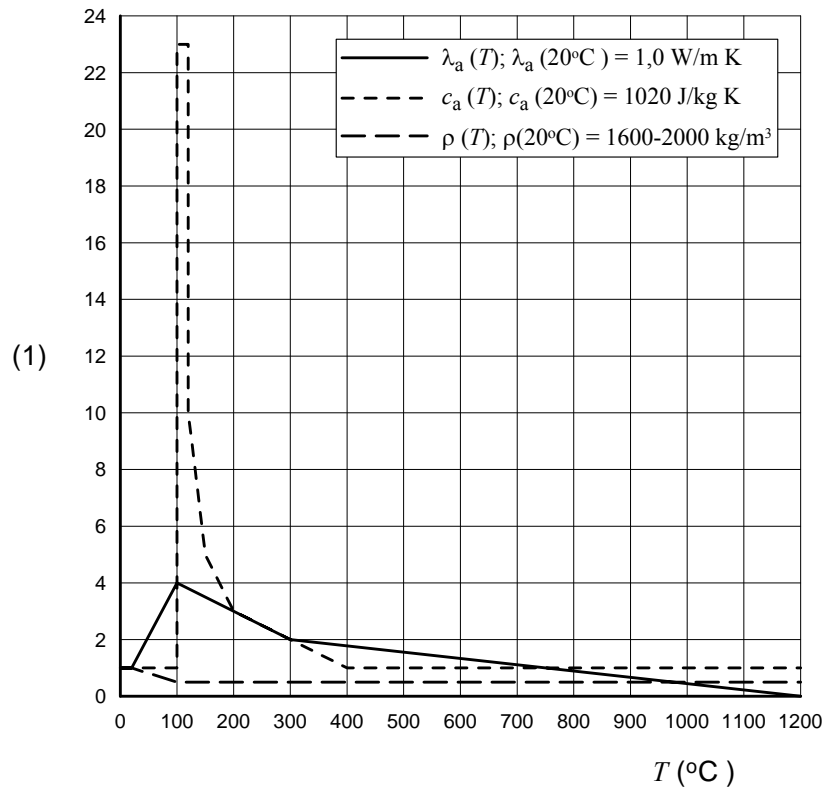


Figure D.1.(b): calculation values of temperature-dependant material-properties calcium silicate units with a density range of 1 600 – 2 000 kg/m³

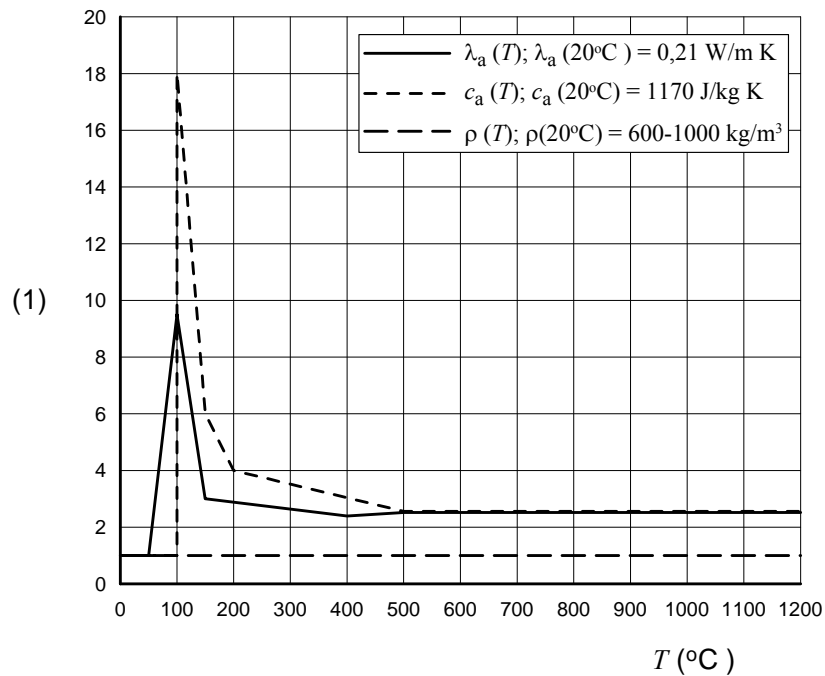


Figure D.1.(c): calculation values of temperature-dependant material properties of lightweight aggregate concrete units (pumice) with a density range of 600 – 1 000kg/m³

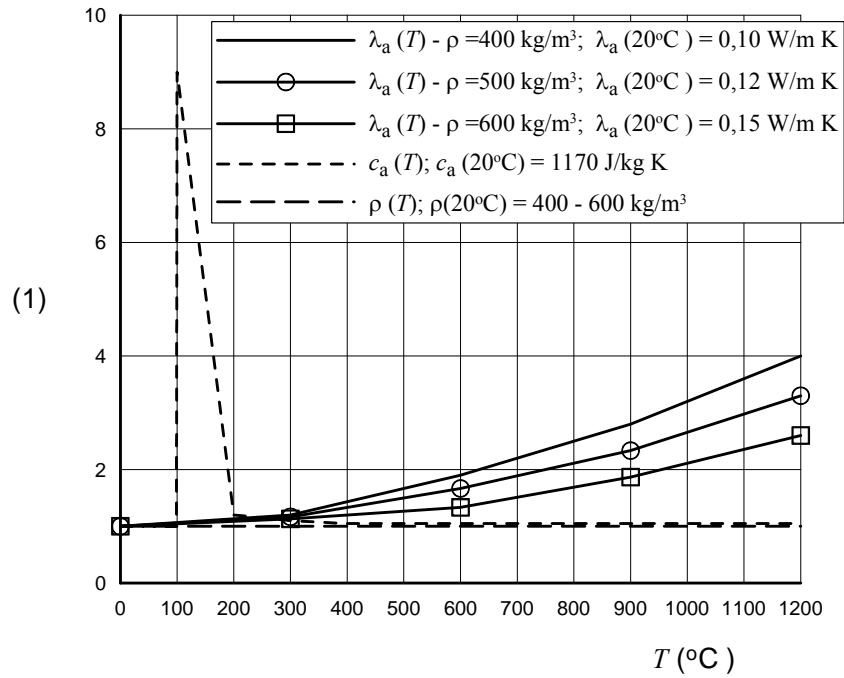


Figure D.1(d): Calculation values of temperature-dependant material properties of autoclaved aerated concrete units with a density range of 400 - 600 kg/m³

Key

T (°C) temperature

λ_a heat conductivity

c_a specific heat capacity

ρ density kg/m³

1 Ratio of value at temperature T to that at 20°C

Figure D.1 Thermal analysis

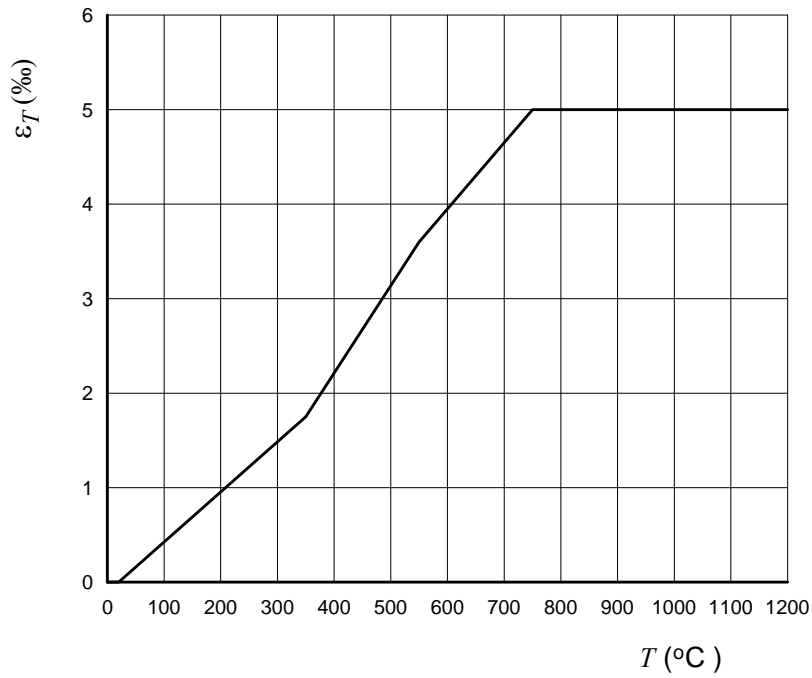


Figure D.2(a): Calculation values of thermal strain ϵ_T of clay units (group 1) with unit strength 12 – 20 N/mm² and units with a density range of 900 – 1 200 kg/m³

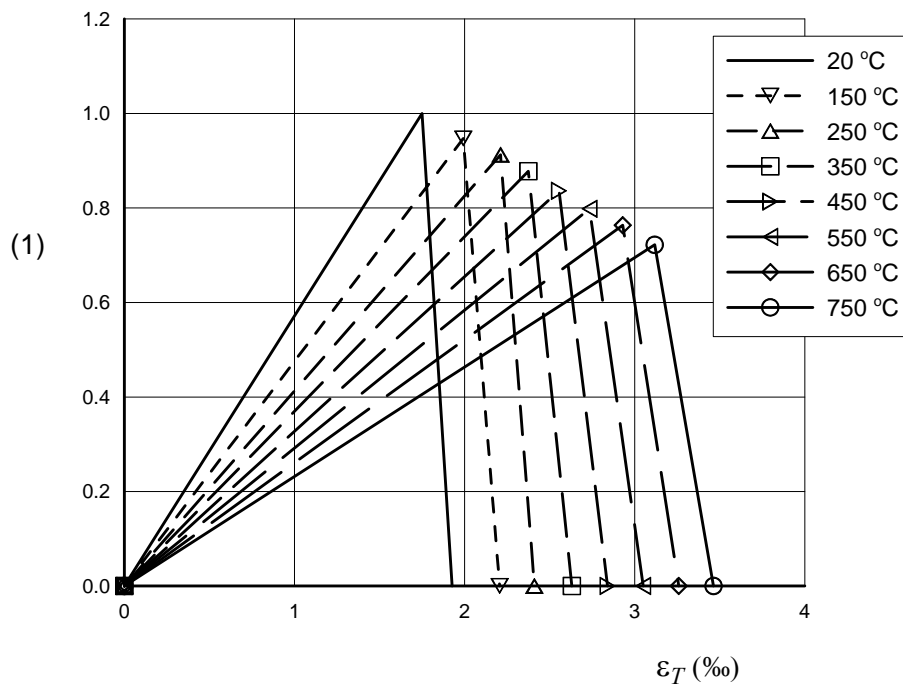


Figure D.2(b): Calculation values of temperature-dependant stress-strain diagrams of clay units (group 1) with unit strength 12 – 20 N/mm² and with a density range of 900 – 1 200 kg/m³

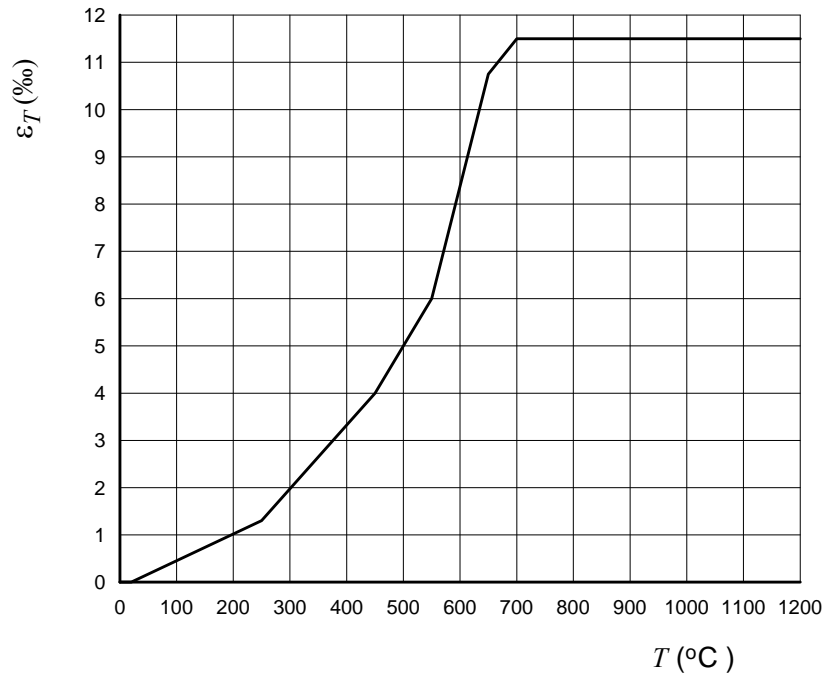


Figure D.2(c): Calculation values of thermal strain ϵ_T of calcium silicate units (solid) with unit strength 12 – 20 N/mm² and with a density range of 1 600 – 2 000 kg/m³

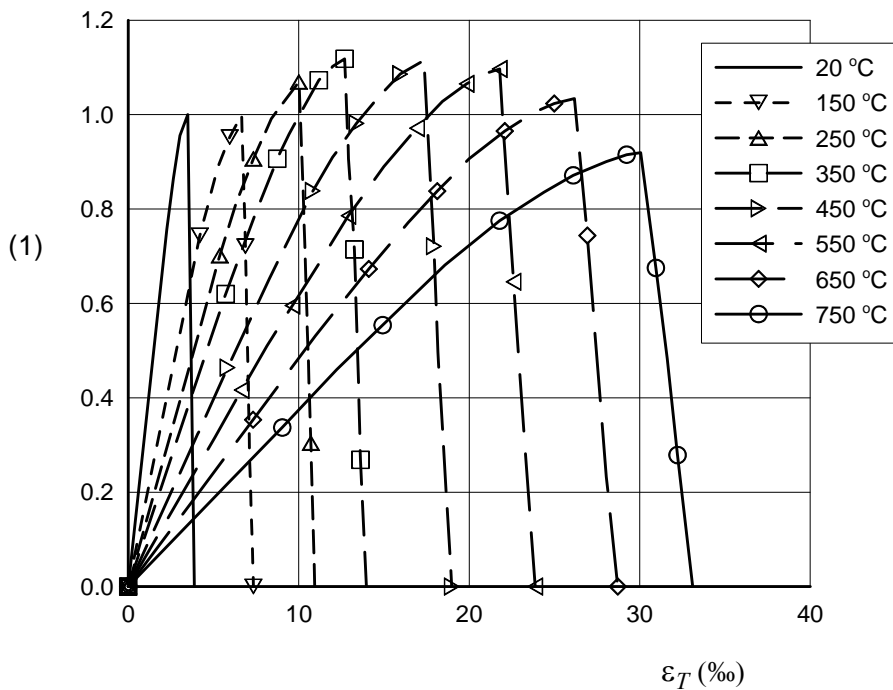


Figure D.2(d): Calculation values of thermal stress- strain diagrams for calcium silicate units (solid) with unit strength 12 – 20 N/mm² and with a density range of 1 600 – 2 000 kg/m³

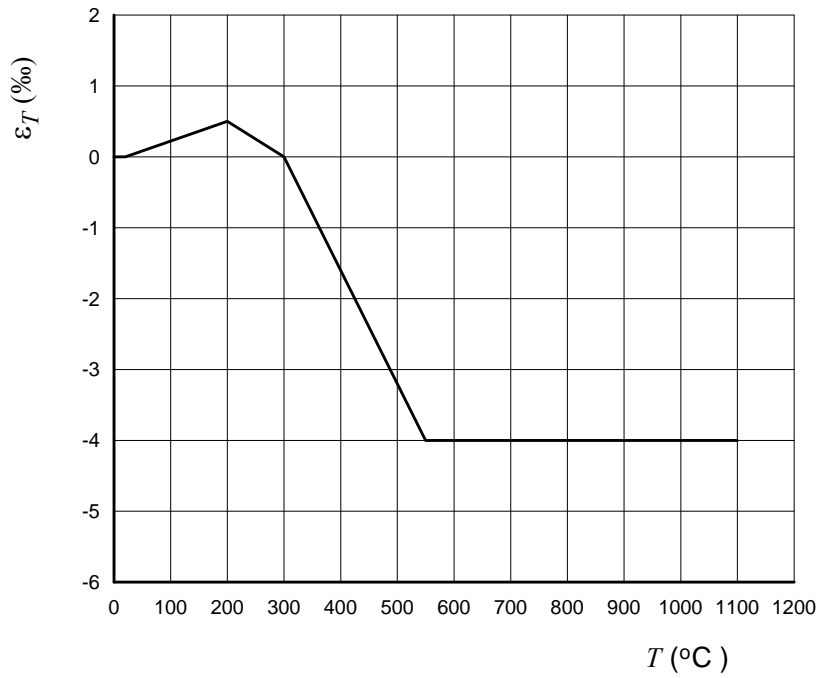


Figure D.2(e): Calculation values of thermal strain ϵ_T for lightweight aggregate concrete units (pumice) with unit strength 4 – 6 N/mm² and with a density range of 600 – 1 000 kg/m³

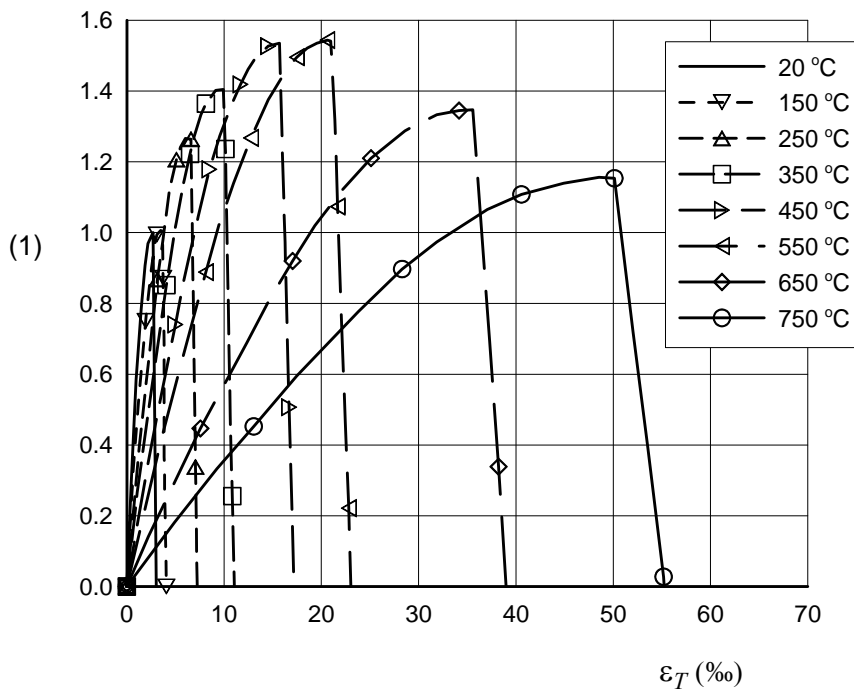


Figure D.2(f): Calculation values of temperature-dependent stress-strain diagrams for lightweight aggregate concrete units (pumice) with unit strength 4 – 6 N/mm² and with a density range of 600 – 1 000 kg/m³

Key

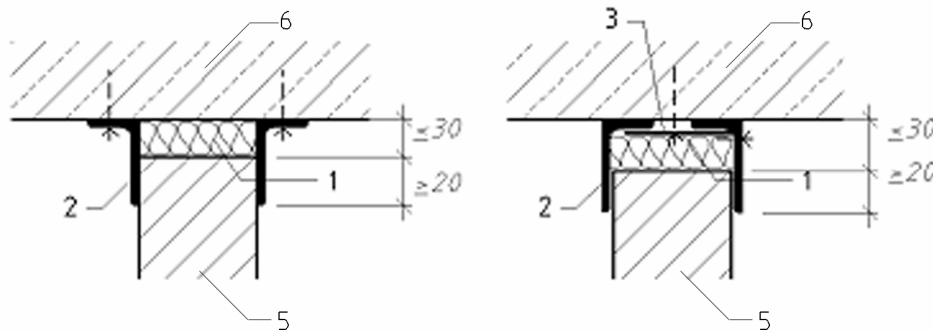
$T(^{\circ}\text{C})$ temperature

1 Ratio of strength at temperature T to that at 20°C

Figure D.2 Mechanical Analysis

Annex E
(Informative)

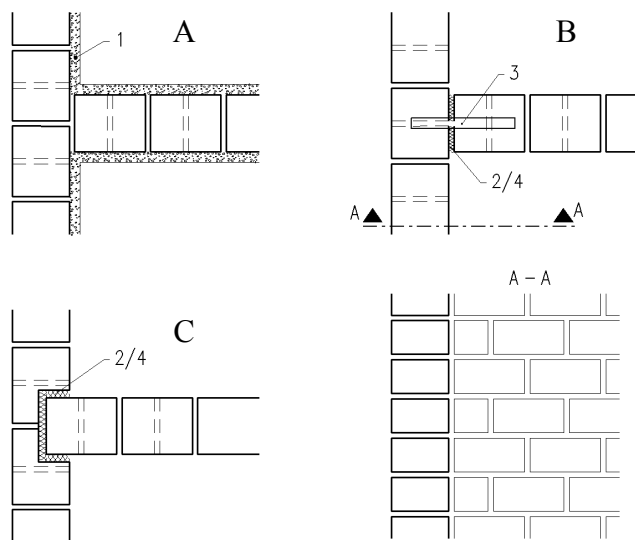
Examples of connections that meet the requirements of Section 5



Key

- 1 Insulating layer - mineral wool, material class A (noncombustible), melting point $\geq 1000^{\circ}\text{C}$
- 2 Steel angle
- 3 Flat steel 65x5mm, $a > 600\text{mm}$
- 5. Masonry
- 6. Concrete

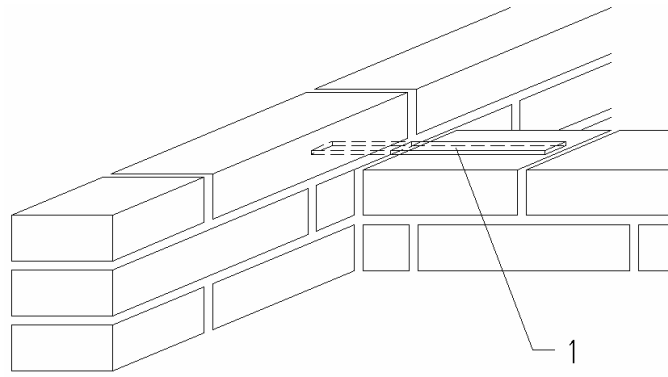
Figure E.1: Cross-section of connections, wall to floor or roof, of non-loadbearing masonry walls



Key

- A Connection through plaster work,
- B Connections through anchor
- C Connection through dovetail joint, insulating layer or mortar
- 1 Plaster
- 2 Insulating layer - mineral wool, material class A (noncombustible), melting point $\geq 1000^{\circ}\text{C}$
- 3 Anchor made of flat steel, spacing according to structural requirements
- 4 Mortar

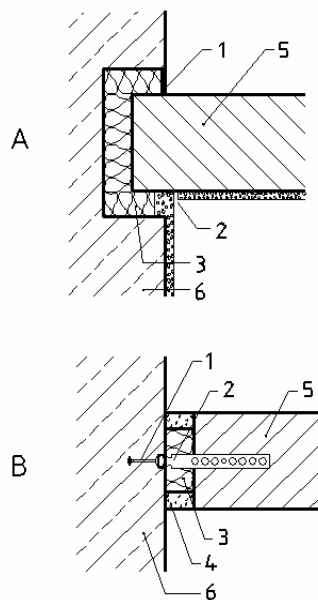
Figure E.2: Plan cross-section of connections wall (column) to wall



Key

- 1 Anchor made of flat steel , spacing according to structural requirements,

Figure E.3: Connection wall to wall of loadbearing masonry walls



Key

A

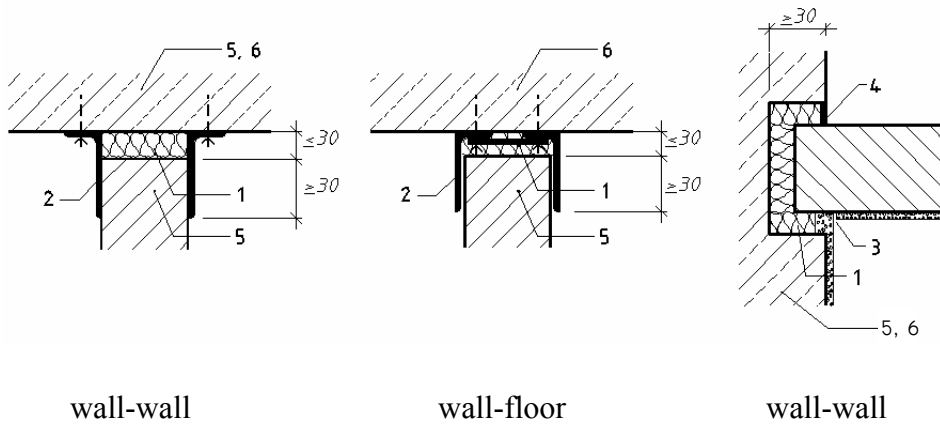
- 1 Joint seal
- 2 Trowel cut or plaster cut (optional)
- 3 Insulating layer - mineral wool, material class A (noncombustible), melting point $\geq 1000^{\circ}\text{C}$
- 5. Masonry
- 6. Concrete

B

- 1 Anchor
- 2 Vertical sliding anchor
- 3 Insulating layer - mineral wool, material class A (noncombustible), melting point $\geq 1000^{\circ}\text{C}$, or mortar
- 4 Joint seal
- 5. Masonry
- 6. Concrete

Figure E.4: Movement connection of wall (column) to wall of concrete

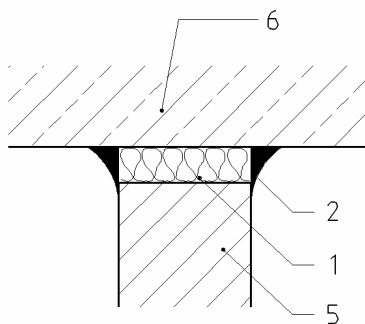
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Key

- 1 Insulating layer - mineral wool, material class A (noncombustible), melting point $\geq 1000^{\circ}\text{C}$, or mortar
- 2 Steel angle
- 3 Trowel cut or plaster cut (optional)
- 4 Joint seal
- 5 Masonry
- 6 Concrete

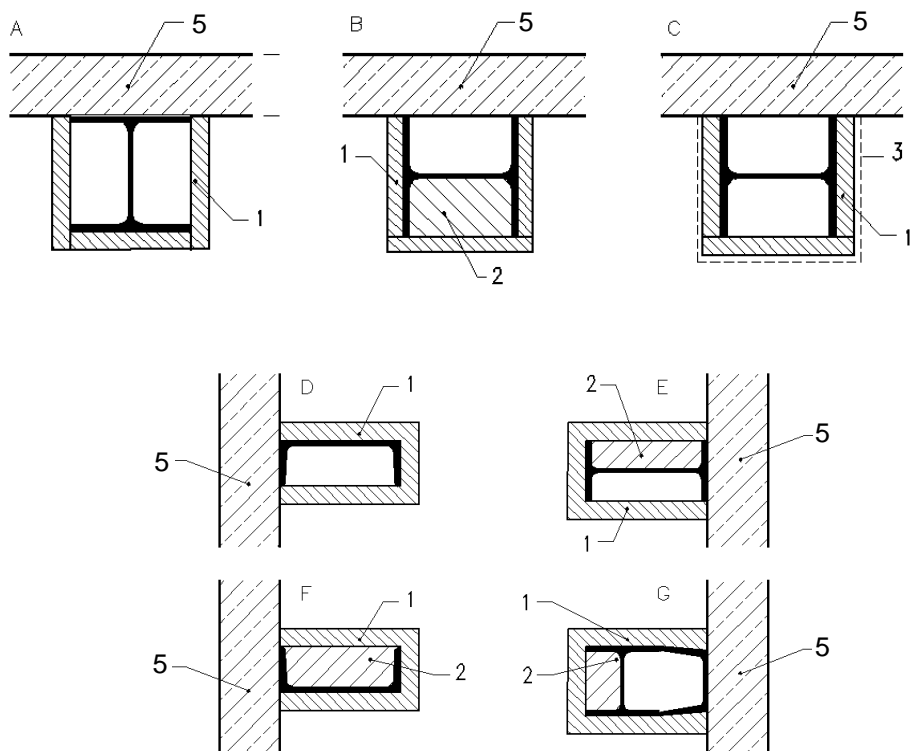
Figure E.5: Structural connections of fire walls to walls and floors



Key

- 1 Insulating layer - mineral wool, material class A (noncombustible), melting point $\geq 1000^{\circ}\text{C}$, or mortar
- 2 Joint seal (optional)
- 5. Masonry
- 6. Concrete

Figure E.6: Connection with no structural requirements.



Key

- 1 Cladding corresponding to fire resistance class
- 2 Masonry or concrete
- 3 Sheet metal encasement
- 5. Masonry

A-C Steel column

D-G Steel beam

Figure E.7: Connections of fire walls to steel structures