

EUROPEAN PRESTANDARD

ENV 1996-1-2

PRÉNORME EUROPÉENNE

EUROPÄISCHE VORNORM

July 1995

ICS 13.220.50; 91.080.30

Descriptors: buildings, construction, masonry work, building codes, computation, fire tests

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 Prestandard (ENV) was approved by CEN on 1994-06-10 as a prospective standard for provisional application. The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into an European Standard (EN).

CEN members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Ref. No. ENV 1996-1-2:1995 E

Page 2
ENV 1996-1-2:1995

Contents

	Page
Foreword	3
1 General	7
1.1 Scope	7
1.2 Normative references	7
1.3 Definitions	9
1.4 Symbols	10
1.5 Units	11
2 Basic principles	11
2.1 Performance requirements	11
2.2 Actions	12
2.3 Design values of material properties	12
2.4 Assessment methods	12
3 Fire resistance of masonry walls	13
3.1 General information on the design of walls	13
3.2 Materials for use in masonry walls	14
3.3 Additional requirements related to masonry walls	16
3.4 Assessment by testing	16
3.5 Assessment by tables	16
3.6 Assessment by calculation	17
Annexes	
A Testing the fire resistance of masonry walls	18
B Guidance on selection of fire resistance periods	19
C Assessment by tables	20

Foreword

Objectives of the Eurocodes

- (1) The Structural Eurocodes comprise a group of standards for the structural and geotechnical design of buildings and civil engineering works.
- (2) They cover execution and control only to the extent that it is necessary to indicate the quality of the construction products, and the standard of workmanship needed on and off site to comply with the assumptions of the design rules.
- (3) Until the necessary set of harmonized technical specifications for products and for the methods for testing their performance are available, some of the Structural Eurocodes cover some of these aspects in informative annexes.

Background of the Eurocode programme

- (4) The Commission of the European Communities (CEC) initiated the work of establishing a set of harmonized technical rules for the design of building and civil engineering works which would initially serve as an alternative to the different rules in force in the various member states and would ultimately replace them. These technical rules became known as the Structural Eurocodes.
- (5) In 1990, after consulting their respective Member States, the CEC transferred the work of further development, issue and updating of the Structural Eurocodes to CEN, and the EFTA secretariat agreed to support the CEN work.
- (6) CEN Technical Committee CEN/TC 250 is responsible for all Structural Eurocodes.

Eurocode programme

- (7) Work is in hand on the following Structural Eurocodes, each generally consisting of a number of parts:-

EN 1991 Eurocode 1 : Basis of design and 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.

EN 1995 Eurocode 5 : Design of timber structures.

EN 1996 Eurocode 6 : Design of masonry structures.

EN 1997 Eurocode 7 : Geotechnical design.

Page 4
ENV 1996-1-2:1995

EN 1998 Eurocode 8 : Design of structures for earthquake resistance.

EN 1999 Eurocode 9 : Design of aluminium alloy structures.

(8) Separate sub-committees have been formed by CEN/TC250 for the various Eurocodes listed above.

(9) This Part 1-2 of ENV 1996 is being published as a European Prestandard (ENV) with an initial life of three years.

(10) This prestandard is intended for experimental application and for the submission of comments.

(11) After approximately two years, CEN members will be invited to submit formal comments to be taken into account in determining future actions.

(12) Meanwhile feedback and comments on this prestandard should be sent to the Secretariat of CEN/TC 250/SC6 at the following address:-

DIN
Burggrafenstrasse 6
D-10787 Berlin
Germany

or to your national standards organization.

National Application Documents (NAD's)

(13) In view of the responsibilities of authorities in member countries for safety, health and other matters covered by the essential requirements of the Construction Products Directive (CPD), certain safety elements in this ENV have been assigned indicative values which are identified by ("boxed values"). The authorities in each member country are expected to review the "boxed values" and may substitute alternative definitive values for these safety elements for use in national application.

(14) Some of the supporting European or International standards may not be available by the time this prestandard is issued. It is therefore anticipated that a National Application Document (NAD) giving any substitute definitive values for safety elements, referencing compatible supporting standards and providing guidance on the national application of this prestandard, will be issued by each member country or its standards organisation.

(15) It is intended that this prestandard is used in conjunction with the NAD valid in the country where the building and civil engineering work is located.

Matters specific to this prestandard

(16) The scope of Eurocode 6 is defined in clause 1.1.1 of ENV 1996-1-1 and the scope of this Part of Eurocode 6 is defined in clause 1.1. Additional parts of Eurocode 6 which are planned are indicated in clause 1.1.3 of ENV 1996-1-1.

(17) 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.

(18) 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 capacity 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."

(19) According to the Interpretative Document "Safety in Case of Fire" the Essential Requirement may be observed by following various fire safety strategies, including passive and active fire protection measures.

(20) The Structural Eurocodes deal with specific aspects of passive fire protection in terms of designing structures and parts thereof for adequate load-bearing capacity and for limiting spread as relevant.

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

(22) This Part 1-2 of ENV 1996, together with ENV 1991-2-2, gives differences from or the supplements to ENV 1996-1-1 which are necessary so that structures designed according to this set of Structural Eurocodes may also comply with structural fire resistance requirements.

(23) 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

Page 6
ENV 1996-1-2:1995

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 a full analytical procedure is not available for masonry, but one is being developed.

(24) At the present time it is possible to undertake a 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.

(25) 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 the input to calculation methods for structural fire design. This prestandard therefore deals in the main with design for the standard fire resistance.

(26) Application of this Part of ENV 1996 with the thermal actions given in ENV 1991-2-2 is illustrated in table 1.

Table 1: Design procedure

Thermal actions given in ENV 1991-2-2	Design by prescriptive rules/tabulated data given in this Part of ENV 1996	Design by calculation methods given in this Part of ENV 1996
standard temperature-time curve	mainly from fire resistance tests	not yet applicable
other nominal temperature-time curves	not yet applicable	not yet applicable

1 General

1.1 Scope

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

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

(3) This Part 1-2 of ENV 1996-1 applies to elements of building structures which, for reasons of general fire safety, are required to fulfil certain functions in exposure to fire, in terms of:

- avoiding premature collapse of the structure (load-bearing function).
- limiting fire spread (flames, hot gases, excessive heat) and temperature rise beyond designated areas (separation failure).

(4) This Part gives Principles and Application Rules (see 1.2 in ENV 1996-1-1) for designing structures for specified requirements in respect of the aforementioned functions and levels of performance.

(5) This Part applies only to those masonry structures, or parts thereof, that are described in ENV 1996-1-1 and ENV 1996-2¹⁾ and are designed accordingly. This Part 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

(1) This European prestandard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the 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 prestandard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

¹⁾ ENV 1996-2 is in course of preparation.

Page 8**ENV 1996-1-2:1995**

- | | | |
|-----------|---|---|
| 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: Aerated concrete masonry units. |
| EN 771-4 | Specification for masonry units | Part 4: Aggregate concrete masonry units. |
| EN 771-5 | Specification for masonry units | Part 5: Manufactured stone masonry units. |
| EN 772-13 | Methods of test for masonry units | Part 13: Determination of net and gross dry density of masonry units. |
| EN 998-2 | Specification for mortar for masonry | Part 2: Masonry mortar. |
| EN 1364 | Fire resistance tests of non-loadbearing elements in buildings. | |
| | Part 1 | Partitions. |
| | Part 2a | External walls. |
| EN 1365 | Fire resistance tests of loadbearing elements in buildings. | |
| | Part 1 | Internal walls. |
| | Part 2 | External walls. |
| EN 1366 | Fire resistance tests of service installations in buildings. | |
| | Part 2 | Dampers. |
| | Part 3 | Penetration seals. |
| | Part 4 | Linear gap seals. |
| EN QQQ | Material properties. | |
| | Part 5 | Masonry. |
| ENV 1991 | Eurocode 1: Basis of design and actions on structures. | |
| | Part 2-2 | Actions on structures exposed to fire. |

ENV 1996 Eurocode 6: Design of masonry structures.

Part 1-1 General rules for buildings.
Rules for reinforced and unreinforced masonry.

Part 2 Design and selection of materials and use of masonry.

(2) Normative reference is made to the following ISO standard

ISO 1000 SI Units

1.3 Definitions

(1) In addition to those definitions given in ENV 1996-1-1, the following definitions are used (further definitions are given in ENV 1991-2-2):

- **Fire compartment:** An enclosed space in a building that is separated from other parts of the same building by enclosing construction having a specified period of fire resistance, within which a fire can be contained (or from which a fire can be excluded), without spreading to (or from) another part of the building.
- **Fire resistance:** The ability of an element of a building construction to fulfil for a stated period of time the required load-bearing function, integrity and/or thermal insulation specified in the standard fire resistance test.
- **Fire wall:** A wall separating two spaces (generally two buildings) which is designed for fire resistance and structural stability, including resistance to horizontal loading (Criterion M) such that, in case of fire and failure of the structure on one side of the wall, fire spread beyond the wall is avoided.

NOTE: In some countries 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 that more limited one.

- **Integrity criterion "E":** A criterion by which the ability of a separating member to prevent passage of flames and hot gases is assessed.
- **Loadbearing criterion "R":** A criterion by which the ability of a structure or member to sustain specified actions during the relevant fire is assessed.
- **Loadbearing wall:** 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.
- **Member analysis (for fire):** The thermal and mechanical analysis of a structural member exposed to fire in which the member is considered as isolated, with appropriate support and

boundary conditions. Indirect fire actions are not considered, except those resulting from thermal gradients.

- **Non-loadbearing wall:** Flat membrane-like building component that is loaded predominantly only by its dead weight and does not provide bracing for loadbearing walls; however, it may have to transfer horizontal loads acting on its surface to loadbearing building components such as walls or floors.
- **Non-separating wall:** Loadbearing wall exposed to fire on two or more sides.
- **Normal temperature design:** Ultimate limit state design for ambient temperatures according to ENV 1996-1-1 for the fundamental combination (see ENV 1991-1).
- **Separating function:** The ability of a separating member to prevent fire spread by passage of flames or hot gases (cf. integrity) or ignition beyond the exposed surface (cf. thermal insulation) during the relevant fire exposure.
- **Separating member:** Structural and non-structural member (wall or floor) forming the enclosure of a fire compartment.
- **Standard fire resistance:** The ability of a structure or part of it (usually only members) to fulfill required functions (loadbearing function, and/or separating function), for exposure to heating according to the standard temperature-time curve, for a stated period of time.
- **Structural failure of a wall in the fire situation:** When the wall loses its ability, calculated in accordance with ENV 1996-1-1, to carry a load up to a resistance of N_{Rd} divided by average γ_f after a certain period of time.
- **Temperature analysis:** The procedure of determining the temperature development in members on the basis of the thermal actions (net heat flux) and the thermal material properties of the members and of the protective surfaces, where relevant.
- **Thermal insulation criterion "I":** A Criterion by which the ability of a separating member to prevent excessive transmission of heat is assessed.

1.4 Symbols

(1) Supplementary to ENV 1996-1-1, the following units and symbols are used:

N_{Rd}	design load bearing capacity taking into account the effects of slenderness and eccentricity.
R 30	or R 60, . . . a member meeting the load bearing criterion for 30, or 60, minutes in standard fire exposure.

- E 30 or E 60, . . . a member meeting the integrity criterion for 30, or 60, minutes in standard fire exposure.
- I 30 or I 60, . . . a member meeting the thermal insulation criterion for 30, or 60, minutes in standard fire exposure.
- M 90 or M 120, . . . a member meeting the mechanical resistance criterion for 90, or 120, minutes in standard fire exposure.

average γ_f total characteristic load divided by total design load (see ENV 1991-1).

1.5 Units

- (1)P SI units shall be used in conformity with ISO 1000.
- (2) Supplementary to ENV 1996-1-1 the following units should be used in calculations.
- temperature: °C, K
 - specific heat: J/kgK
 - coefficient of heat transfer: W/m²K
 - coefficient of thermal conductivity: W/mK

2 Basic principles

2.1 Performance requirements

(1)P Where mechanical resistance in the case of fire is required, structures shall be designed and constructed in such a way that they maintain their loadbearing function during the relevant fire exposure - criterion R.

(2) Deformation criteria should only be used where the relevant product specifications for means of protection require consideration of the deformation of the loadbearing structure.

(3)P Where separation is required, the respective members shall be designed and constructed in such a way that they maintain their separating function during the relevant fire exposure ie:

- no integrity failure due to cracks, holes or other openings, which are large enough to cause fire penetration by hot gases or flame - criterion E.
- no insulation failure due to temperatures of the non-exposed surface exceeding permissible limits - criterion I.

(4)P The permissible average temperature rise at the non-exposed surface is limited to 140K and the maximum rise to 180K.

(5)P Members shall comply with criteria R, E, or I, M, as follows:

- loadbearing only: R
- loadbearing and separating: R, E and I
- separating only: E and I
- loadbearing, separating and mechanical impact: R, E, I and M
- separating and mechanical impact: E, I and M

2.2 Actions

(1)P Thermal and mechanical actions shall be obtained from ENV 1991-2-2.

(2) Where rules given in this Part 1-2 of ENV 1996 are only valid for the standard fire exposure, this is identified in the relevant clauses.

2.3 Design values of material properties

(1)P Design values of thermal and mechanical material properties shall be obtained according to the requirements of the calculation method²⁾.

2.4 Assessment methods

(1) Assessment of masonry walls with respect to the performance requirements in fire (see 2.1) may be by:

- testing structural members according to Annex A.
- sizing and detailing structural members according to tabulated data.
- calculation.

(2) In this Part, the means of protection against fire should be achieved by following the Principles and Application Rules in Section 3.

²⁾ No detailed method is given in this Part, and so no further information is given here.

3 Fire resistance of masonry walls

3.1 General information on the design of walls

3.1.1 General

(1) This Part applies to walls designed and built in accordance with Principles and Application Rules of ENV 1996-1-1 and ENV 1996-2³⁾.

3.1.2 Wall types, function

(1) From the point of view of fire protection, a distinction is made between non-loadbearing walls and loadbearing walls and between separating walls and non-separating walls.

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

(3) Examples of non-separating walls are walls within a fire compartment; they are loadbearing, but are subjected to fire on two or more sides.

(4) External walls may be separating walls, or non-separating walls as required. External separating walls less than 1,0m in length should be treated as non-separating walls.

(5) Fire walls are separating walls that additionally are required to resist mechanical impact, for example to separate buildings or fire compartments.

NOTE: See note to definition of fire walls.

3.1.3 Cavity walls

(1) The fire resistance of a cavity wall depends upon whether one or both leaves of the wall are loaded. When both leaves are loadbearing and carry approximately equal loads, or the two leaves are both loaded to their respective capacities N_{Rd} divided by average γ_f , 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.

(2) When only one leaf of a cavity wall is loadbearing, the resistance of the wall is usually enhanced over the fire resistance achieved for the loadbearing leaf when considered to act as a single leaf wall.

³⁾ ENV 1996-2 is in course of preparation.

NOTE: Table C.9 provides resistances for cavity walls. When tables C.1 and C.2 indicate that a higher fire resistance for the loaded leaf of the cavity wall acting as a single leaf wall is achieved over the figure given in table C.9, then this higher fire resistance rating may be taken as that appropriate to the cavity wall.

- (3) The fire resistance of a cavity wall comprising two non-loadbearing leaves may be taken as the sum of the fire resistances of the individual leaves.

3.1.4 Junctions, joints

- (1) This Part applies to walls that extend from one floor to the next floor or to the roof; it is assumed that those floors or the roof provide lateral support to the top and bottom of the wall, unless its stability under normal function is achieved 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 prevent fire spread and meet the fire resistance requirement of the wall.

- (3)P Insulating layers in movement joints shall consist of mineral fibres having a melting point of not less than 1 000°C; any cavities shall be tightly sealed. If other materials are to be used, it shall be shown by test that they will meet criteria E and I (see EN 1366: Part 4).

3.1.5 Fixtures, pipes and cables

- (1) Recesses and chases, that are permitted in ENV 1996-1-1 to be included 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 3.5. In non-loadbearing walls, chases and recesses should leave at least $\frac{1}{4}$ of the required minimum thickness of wall, including any applied relevant fire resistant finishes, but not less than 60mm, and be of width not greater than twice the required minimum thickness of the wall. Individual cables may pass through holes sealed with mortar. Non-combustible pipes may pass through holes, sealed with mortar (see footnote), if the conduction of heat through the pipes is not sufficient to infringe the temperature criterion I. Groups of cables and pipes of combustible material, or individual cables in holes not sealed with mortar, may pass through walls only if the method of sealing the penetration has been evaluated by testing according to EN 1366: Part 3⁴⁾.

3.2 Materials for use in masonry walls

- (1) The Tables referred to in 3.5 and Annex C apply to masonry built with units that comply with EN 771-1,2,3,4 and 5. Limitations as to strength and density of units are stated in the Tables. If units, eg. with unusual perforation patterns, not covered by EN 771-1,2,3,4 and 5, are to be used, evaluation by testing should be carried out.

- (2)P Masonry units shall be grouped as Group 1, 2a 2b or 3 for content of holes or

⁴⁾ If materials other than mortar are approved by CEN Standards, they may be substituted.

perforations as given in table 3.1.

Table 3.1: Requirements for grouping of masonry units.

	Group of masonry units			
	1	2a	2b	3
Volume of holes (% of the gross volume) (see note 1)	≤ 25	> 25-45 for clay units > 25-50 for concrete aggregate units	> 45-55 for clay units > 50-60 for concrete aggregate units (see note 2)	≤ 70
Volume of any hole (% of the gross volume)	$\leq 12,5$	$\leq 12,5$ for clay units ≤ 25 for concrete aggregate units	$\leq 12,5$ for clay units ≤ 25 for concrete aggregate units	Limited by area (see below)
Area of any hole	Limited by volume (see above)	Limited by volume (see above)	Limited by volume (see above)	$\leq 2\,800\text{mm}^2$ except for units with a single hole when the hole should be $\leq 18\,000\text{mm}^2$
Combined thickness (% of the overall width) (see note 3)	$\geq 37,5$	≥ 30	≥ 20	No requirement
<p>Notes:</p> <p>1. Holes may consist of formed vertical holes through the units or frogs or recesses.</p> <p>2. If there is national experience, based on tests, that confirms that the safety of the masonry is not reduced unacceptably when a higher proportion of holes is incorporated, the limit of 55 % for clay units and 60 % for concrete aggregate units may be increased for masonry units that are used in the country having the national experience.</p> <p>3. The combined thickness is the thickness of the webs and shells, measured horizontally across the unit at right angles to the face of the wall.</p>				

(3) For the purposes of the tables referred to in 3.5 and Annex C, some thicknesses of walls are further specified to be built in solid units; such units should not contain any perforations, but they may contain indentations, for example frogs, grip holes or grooves in the bed face, that will be filled with mortar in the finished wall.

(4) The tables referred to in 3.5 and Annex C apply to masonry built with general purpose, lightweight, or thin layer mortars complying with EN 998-2 or 1996-1-1, except that the mortar joint thickness is limited to a maximum of 3mm when mortars containing organic binders are used.

(5) Perforated masonry units should not be laid so that the perforations are at right angles to the face of the wall, i.e. the wall should not be penetrated by the perforations.

(6) Masonry having unfilled vertical joints less than 5mm wide, made with units that are designed to be used in that way, may be treated as being within the tables referred to in 3.5 and Annex C.

3.3 Additional requirements related to 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 or stiffened.

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

(3)P The tables referred to in 3.5 and Annex C shall not be used for walls either having a height to thickness ratio greater than the following:

- Loadbearing

27

- Non-loadbearing

40

or exceeding the relevant size limits given in ENV 1996-2⁵⁾.

3.4 Assessment by testing

(1) For all types of masonry walls the fire resistance may be obtained, using the test methods listed in Annex A.

3.5 Assessment by tables

(1) Assessment may be made by means of tables giving minimum thicknesses of masonry for stated periods of fire resistance.

Note: Such tables are not yet available. During the experimental ENV phase, it is intended to prepare such tables for the EN conversion. Models tables are given in Annex C.

⁵⁾ ENV 1996-2 is in course of preparation.

3.6 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, effects of thermal expansions and deformations.

(2) The calculation method may be:

- a global structure analysis for simulating the behaviour of structural members, subassemblies or the entire structure

or

- a simplified calculation model for specific types of member.

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

NOTE: A detailed calculation method is not yet available for masonry.

Annex A: (Normative)

Testing the fire resistance of masonry walls

- (1) In this Part 1-2 of ENV 1996 reference is made to the testing of:-
 - (a) masonry walls as building elements.
 - (b) service installation.
 - (c) linear gap seals.
- (2) The relevant test methods are
 - (a) EN 1364 Fire resistance tests of non-loadbearing elements in buildings.
 Part 1 Partitions.
 Part 2a External walls.
 - (b) EN 1365 Fire resistance tests of loadbearing elements in buildings.
 Part 1 Internal walls.
 Part 2 External walls.
 - (c) EN 1366 Fire resistance tests of service installations in buildings.
 Part 2 Dampers.
 Part 3 Penetration seals.
 Part 4 Linear gap seals.
- (3) Tests on masonry walls should be carried out if masonry units (perforation percentage or perforation type, density, dimension), types of mortar (general purpose mortar, lightweight or thin layer mortar) or the combination of units and mortar that are to be used are not covered in the tables referred to in 3.5 and Annex C.

ANNEX B: (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;
- the type of unit - solid or hollow (type of holes, percentage of holes), shell and web thickness;
- the type of mortar - general purpose, thin layer or lightweight mortar;
- the relationship of the applied load to the resistance of the wall;
- the slenderness of the wall;
- the density of units.

(2) In arriving at values to be inserted into tables C.1 to C.9 by 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 CEN/TC 127. In particular, allowance should be made for any difference from that required in the CEN/TC 127 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 system will also influence the test results and they should be evaluated against the system in the CEN/TC 127 method.

Annex C: (Informative)

Assessment by tables

(1) Tables C.1 to C.9 are models of tables which should give minimum thicknesses of masonry for the stated periods of fire resistance, made with units of:

- Clay complying with EN 771-1
- Calcium Silicate complying with EN 771-2
- Aggregate Concrete complying with EN 771-3
- Autoclaved Aerated Concrete complying with EN 771-4
- Manufactured stone in accordance with EN 771-5

Natural stone walls are not covered.

It has not been possible to tabulate the fire performance of such walls in this European prestandard.

(2) In these tables, the thicknesses referred to should be of the masonry itself, excluding finishes, if any. Row (a) is for walls without an applied finish or walls having a sand-cement rendered finish. Row (b) is for walls having an applied finish of gypsum plaster of minimum thickness 10mm.

(3) The symbol ρ is the gross density of the masonry units measured according to EN 772-13.

(4) In these tables, the minimum thickness of a wall for fire resistance purposes is to be given; the thickness required from consideration of ENV 1996-1-1, or other reasons, for example sound, may be greater and should then be used.

(5) The tables that apply to loadbearing walls are stated to cover, as appropriate, a load up to a resistance of N_{Rd} (or $0,6N_{Rd}$) divided by average γ_f , since this is the way in which the load has been traditionally determined when carrying out fire tests.

(6) The use of Tables C.3 and C.4 is limited to walls of length greater than 1,0m. For walls less than 1,0m in length, Tables C.6 and C.7 should be used.

**Table C.1: Loadbearing Walls Subject to Load up to a resistance
of $N_{Rd} \div \text{average } \gamma_f$
Separating Function REI**

Material	Minimum Masonry Thickness (mm) for Standard Fire Resistance (Minutes)					
	30	60	90	120	180	240
Clay: EN 771-1						
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
Group 1 solid units $\rho \geq 1200 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
Group 2a units $\rho \geq 700 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
Group 2b units $\rho \geq 700 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
or lightweight mortar						
Group 3 units laid in general	(a)					
purpose mortar	(b)					
Calcium Silicate: EN 771-2						
Laid in general purpose or thin layer mortar						
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$	(a)					
	(b)					
Group 1 solid units $\rho \geq 1600 \text{ kg/m}^3$	(a)					
	(b)					
Group 2 units $\rho \geq 500 \text{ kg/m}^3$	(a)					
	(b)					
Aerated Concrete Units:						
EN 771-4						
Group 1 units laid in general purpose or thin layer mortar						
$400 \leq \rho \leq 550 \text{ kg/m}^3$	(a)					
	(b)					
$\rho > 550 \text{ kg/m}^3$	(a)					
	(b)					
Aggregate Concrete Units						
Including Manufactured Stone						
EN 771-3 and 5						
Laid in general purpose, thin layer or lightweight mortar						
Group 1 units $500 \leq \rho \leq 1500 \text{ kg/m}^3$	(a)					
	(b)					
Group 1 units $\rho > 1500 \text{ kg/m}^3$	(a)					
	(b)					
Group 2 units $\rho \geq 800 \text{ kg/m}^3$	(a)					
	(b)					
Group 2 units $500 \leq \rho \leq 800 \text{ kg/m}^3$	(a)					
	(b)					

**Table C.2: Loadbearing Walls Subject to Load up to a resistance
of $0,6 N_{Rd} \div \text{average } \gamma_F$
Separating Function REI**

Material	Minimum Masonry Thickness (mm) for Standard Fire Resistance (Minutes)					
	30	60	90	120	180	240
Clay: EN 771-1						
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
Group 1 solid units $\rho \geq 1200 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
Group 2a units $\rho \geq 700 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
Group 2b units $\rho \geq 700 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
or lightweight mortar						
Group 3 units laid in general	(a)					
purpose mortar	(b)					
Calcium Silicate: EN 771-2						
Laid in general purpose or						
thin layer mortar						
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$	(a)					
	(b)					
Group 1 solid units $\rho \geq 1600 \text{ kg/m}^3$	(a)					
	(b)					
Group 2 units $\rho \geq 500 \text{ kg/m}^3$	(a)					
	(b)					
Aerated Concrete Units:						
EN 771-4						
Group 1 units laid in general						
purpose or thin layer mortar						
$400 \leq \rho \leq 550 \text{ kg/m}^3$	(a)					
	(b)					
$\rho > 550 \text{ kg/m}^3$	(a)					
	(b)					
Aggregate Concrete Units						
Including Manufactured Stone						
EN 771-3 and 5						
Laid in general purpose,						
thin layer or lightweight mortar						
Group 1 units $500 \leq \rho \leq 1500 \text{ kg/m}^3$	(a)					
	(b)					
Group 1 units $\rho > 1500 \text{ kg/m}^3$	(a)					
	(b)					
Group 2 units $\rho \geq 800 \text{ kg/m}^3$	(a)					
	(b)					
Group 2 units $500 \leq \rho \leq 800 \text{ kg/m}^3$	(a)					
	(b)					

**Table C.3: Loadbearing Walls Subject to Load up to a resistance
of $N_{Rd} \div \text{average } \gamma_F$
Non-Separating Function R**

Material	Minimum Masonry Thickness (mm) for Standard Fire Resistance (Minutes)					
	30	60	90	120	180	240
Clay: EN 771-1						
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$						(a)
laid in general purpose mortar						(b)
Group 1 solid units $\rho \geq 1200 \text{ kg/m}^3$						(a)
laid in general purpose mortar						(b)
Group 2a units $\rho \geq 700 \text{ kg/m}^3$						(a)
laid in general purpose mortar						(b)
Group 2b units $\rho \geq 700 \text{ kg/m}^3$						(a)
laid in general purpose mortar						(b)
or lightweight mortar						
Group 3 units laid in general						(a)
purpose mortar						(b)
Calcium Silicate: EN 771-2						
Laid in general purpose or						
thin layer mortar						
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$						(a)
						(b)
Group 1 solid units $\rho \geq 1600 \text{ kg/m}^3$						(a)
						(b)
Group 2 units $\rho \geq 500 \text{ kg/m}^3$						(a)
						(b)
Aerated Concrete Units:						
EN 771-4						
Group 1 units laid in general						
purpose or thin layer mortar						
$400 \leq \rho \leq 550 \text{ kg/m}^3$						(a)
						(b)
$\rho > 550 \text{ kg/m}^3$						(a)
						(b)
Aggregate Concrete Units						
Including Manufactured Stone						
EN 771-3 and 5						
Laid in general purpose,						
thin layer or lightweight mortar						
Group 1 units $500 \leq \rho \leq 1500 \text{ kg/m}^3$						(a)
						(b)
Group 1 units $\rho > 1500 \text{ kg/m}^3$						(a)
						(b)
Group 2 units $\rho \geq 800 \text{ kg/m}^3$						(a)
						(b)
Group 2 units $500 \leq \rho \leq 800 \text{ kg/m}^3$						(a)
						(b)

**Table C.4: Loadbearing Walls Subject to Load up to a resistance
of $0,6 N_{Rd} \div \text{average } \gamma_F$
Non-Separating Function R**

Material	Minimum Masonry Thickness (mm) for Standard Fire Resistance (Minutes)					
	30	60	90	120	180	240
Clay: EN 771-1						
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$						(a)
laid in general purpose mortar						(b)
Group 1 solid units $\rho \geq 1200 \text{ kg/m}^3$						(a)
laid in general purpose mortar						(b)
Group 2a units $\rho \geq 700 \text{ kg/m}^3$						(a)
laid in general purpose mortar						(b)
Group 2b units $\rho \geq 700 \text{ kg/m}^3$						(a)
laid in general purpose mortar						(b)
or lightweight mortar						
Group 3 units laid in general						(a)
purpose mortar						(b)
Calcium Silicate: EN 771-2						
Laid in general purpose or						
thin layer mortar						
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$						(a)
						(b)
Group 1 solid units $\rho \geq 1600 \text{ kg/m}^3$						(a)
						(b)
Group 2 units $\rho \geq 500 \text{ kg/m}^3$						(a)
						(b)
Aerated Concrete Units:						
EN 771-4						
Group 1 units laid in general						
purpose or thin layer mortar						
$400 \leq \rho \leq 550 \text{ kg/m}^3$						(a)
						(b)
$\rho > 550 \text{ kg/m}^3$						(a)
						(b)
Aggregate Concrete Units						
Including Manufactured Stone						
EN 771-3 and 5						
Laid in general purpose,						
thin layer or lightweight mortar						
Group 1 units $500 \leq \rho \leq 1500 \text{ kg/m}^3$						(a)
						(b)
Group 1 units $\rho > 1500 \text{ kg/m}^3$						(a)
						(b)
Group 2 units $\rho \geq 800 \text{ kg/m}^3$						(a)
						(b)
Group 2 units $500 \leq \rho \leq 800 \text{ kg/m}^3$						(a)
						(b)

**Table C.5: Non-Loadbearing Walls
Separating Function EI**

Material	Minimum Masonry Thickness (mm) for Standard Fire Resistance (Minutes)					
	30	60	90	120	180	240
Clay: EN 771-1						
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
Group 1 solid units $\rho \geq 1200 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
Group 2a units $\rho \geq 700 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
Group 2b units $\rho \geq 700 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
or lightweight mortar						
Group 3 units laid in general	(a)					
purpose mortar	(b)					
Calcium Silicate: EN 771-2						
Laid in general purpose or						
thin layer mortar						
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$	(a)					
	(b)					
Group 1 solid units $\rho \geq 1600 \text{ kg/m}^3$	(a)					
	(b)					
Group 2 units $\rho \geq 500 \text{ kg/m}^3$	(a)					
	(b)					
Aerated Concrete Units:						
EN 771-4						
Group 1 units laid in general						
purpose or thin layer mortar						
$400 \leq \rho \leq 550 \text{ kg/m}^3$	(a)					
	(b)					
$\rho > 550 \text{ kg/m}^3$	(a)					
	(b)					
Aggregate Concrete Units						
Including Manufactured Stone						
EN 771-3 and 5						
Laid in general purpose,						
thin layer or lightweight mortar						
Group 1 units $500 \leq \rho \leq 1500 \text{ kg/m}^3$	(a)					
	(b)					
Group 1 units $\rho > 1500 \text{ kg/m}^3$	(a)					
	(b)					
Group 2 units $\rho \geq 800 \text{ kg/m}^3$	(a)					
	(b)					
Group 2 units $500 \leq \rho \leq 800 \text{ kg/m}^3$	(a)					
	(b)					

Table C.6: Loadbearing Walls of Length < 1,0m
Subject to Load up to a resistance of $N_{Rd} \div \text{average } \gamma_f$
Non-Separating Function R

Material	Minimum Masonry Length (mm)						Thickness (mm)
	Standard Fire Resistance (Minutes)						
	30	60	90	120	180	240	
Clay: EN 771-1							
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$	(a)						
laid in general purpose mortar	(b)						
Group 1 solid units $\rho \geq 1200 \text{ kg/m}^3$	(a)						
laid in general purpose mortar	(b)						
Group 2a units $\rho \geq 700 \text{ kg/m}^3$	(a)						
laid in general purpose mortar	(b)						
Group 2b units $\rho \geq 700 \text{ kg/m}^3$	(a)						
laid in general purpose mortar	(b)						
or lightweight mortar							
Group 3 units laid in general	(a)						
purpose mortar	(b)						
Calcium Silicate: EN 771-2							
Laid in general purpose or							
thin layer mortar							
Group 1 or 2 units $\rho \geq 500 \text{ kg/m}^3$	(a)						
	(b)						
Aerated Concrete Units:							
EN 771-4							
Group 1 units laid in general							
purpose or thin layer mortar							
$\rho \geq 400 \text{ kg/m}^3$	(a)						
	(b)						
Aggregate Concrete Units							
Including Manufactured Stone							
EN 771-3 and 5							
Laid in general purpose,							
thin layer or lightweight mortar							
Group 1 or 2 units $\rho \geq 500 \text{ kg/m}^3$	(a)						
	(b)						

Table C.7: Loadbearing Walls of Length < 1,0m
Subject to Load up to a resistance of $0,6 N_{Rd} \div \text{average } \gamma_f$
Non-Separating Function R

Material	Minimum Masonry Length (mm)						Thickness (mm)
	Standard Fire Resistance (Minutes)						
	30	60	90	120	180	240	
Clay: EN 771-1							
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$							(a)
laid in general purpose mortar							(b)
Group 1 solid units $\rho \geq 1200 \text{ kg/m}^3$							(a)
laid in general purpose mortar							(b)
Group 2a units $\rho \geq 700 \text{ kg/m}^3$							(a)
laid in general purpose mortar							(b)
Group 2b units $\rho \geq 700 \text{ kg/m}^3$							(a)
laid in general purpose mortar							(b)
or lightweight mortar							
Group 3 units laid in general							(a)
purpose mortar							(b)
Calcium Silicate: EN 771-2							
Laid in general purpose or							
thin layer mortar							
Group 1 or 2 units $\rho \geq 500 \text{ kg/m}^3$							(a)
							(b)
Aerated Concrete Units:							
EN 771-4							
Group 1 units laid in general							
purpose or thin layer mortar							
$\rho \geq 400 \text{ kg/m}^3$							(a)
							(b)
Aggregate Concrete Units							
Including Manufactured Stone							
EN 771-3 and 5							
Laid in general purpose,							
thin layer or lightweight mortar							
Group 1 or 2 units $\rho \geq 500 \text{ kg/m}^3$							(a)
							(b)

**Table C.8: Fire Walls
Separating and Mechanical Impact Function REIM**

Material	Minimum Masonry Thickness (mm) for Standard Fire Resistance (Minutes)						Double Leaf 90
	30	60	90	120	180	240	
Clay: EN 771-1							
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$	(a)						
laid in general purpose mortar	(b)						
Group 1 solid units $\rho \geq 1200 \text{ kg/m}^3$	(a)						
laid in general purpose mortar	(b)						
Group 2a units $\rho \geq 700 \text{ kg/m}^3$	(a)						
laid in general purpose mortar	(b)						
Group 2b units $\rho \geq 700 \text{ kg/m}^3$	(a)						
laid in general purpose mortar	(b)						
or lightweight mortar							
Group 3 units laid in general	(a)						
purpose mortar	(b)						
Calcium Silicate: EN 771-2							
Laid in general purpose or							
thin layer mortar							
Group 1 or 2 units $\rho \geq 1300 \text{ kg/m}^3$	(a)						
	(b)						
Group 1 solid units $\rho \geq 1200 \text{ kg/m}^3$	(a)						
laid in thin layer mortar	(b)						
Group 2 units $\rho \geq 700 \text{ kg/m}^3$	(a)						
	(b)						
Aerated Concrete Units:							
EN 771-4							
Group 1 units laid in general							
purpose or thin layer mortar							
$400 \leq \rho \leq 550 \text{ kg/m}^3$	(a)						
laid in thin layer mortar	(b)						
$\rho > 550 \text{ kg/m}^3$	(a)						
laid in general purpose	(b)						
or thin layer mortar							
Aggregate Concrete Units							
Including Manufactured Stone							
EN 771-3 and 5							
Laid in general purpose,							
thin layer or lightweight mortar							
Group 1 or 2 units $\rho > 800 \text{ kg/m}^3$	(a)						
	(b)						
Group 1 or 2 units	(a)						
$500 \leq \rho \leq 800 \text{ kg/m}^3$	(b)						

Table C.9: Loadbearing Cavity Walls With Both Leaves Loaded Subject to Load up to a resistance of $N_{Rd} \div \text{average } \gamma_f$ Separating Function REI

Material	Minimum Masonry Thickness(mm) for the Loaded Leaf for Standard Fire Resistance (Minutes)					
	30	60	90	120	180	240
Clay: EN 771-1						
Group 1 units $\rho \geq 1200 \text{ kg/m}^3$	(a)					
laid in general purpose mortar	(b)					
Calcium Silicate: EN 771-2						
Group 1 units $\rho \geq 1000 \text{ kg/m}^3$	(a)					
Laid in general purpose mortar	(b)					
and lightweight mortar						
Aerated Concrete Units: EN 771-4						
Group 1 units laid in general purpose mortar and thin layer mortar						
$400 \leq \rho \leq 550 \text{ kg/m}^3$	(a)					
	(b)					
$\rho > 550 \text{ kg/m}^3$	(a)					
	(b)					
Aggregate Concrete Units Including Manufactured Stone EN 771-3 and 5. Group 1 Units						
Laid in general purpose, thin layer mortar and lightweight mortar						
$\rho \leq 800 \text{ kg/m}^3$	(a)					
	(b)					
$800 < \rho \leq 1600 \text{ kg/m}^3$	(a)					
	(b)					
$\rho > 1600 \text{ kg/m}^3$	(a)					
	(b)					