

BS EN 15080-12:2011



BSI Standards Publication

# Extended application of results from fire resistance tests

## Part 12: Loadbearing masonry walls

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## Extended application of results from fire resistance tests - Part 12: Loadbearing masonry walls

Application étendue des résultats des essais de résistance  
au feu - Partie 12: Murs porteurs en maçonnerie

Erweiterter Anwendungsbereich der Ergebnisse aus  
Feuerwiderstandsprüfungen - Teil 12: Tragende  
Mauerwerkswände

This European Standard was approved by CEN on 11 December 2010.

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## Contents

Page

Foreword.....	3
1 Scope .....	4
2 Normative references .....	4
3 Terms and definitions .....	5
4 General principles.....	5
4.1 General.....	5
4.2 Classifications.....	6
4.3 Necessary additional information .....	6
5 Rules for extended application .....	7
5.1 Units .....	7
5.2 Masonry mortars and joints.....	9
5.3 Plaster, rendering or external covering.....	9
5.4 Load Level .....	10
5.5 Geometrical parameters.....	10
6 Report of the extended application analysis .....	10
Annex A (informative) Examples of extended applications for loadbearing masonry walls.....	12
A.1 Basis for the Definition: Test report according to EN 1365-1 (add photo) .....	12
A.2 Material Properties from Report:.....	12
A.2.1 Units .....	12
A.2.2 Mortar .....	12
A.2.3 Plaster or rendering.....	12
A.3 Load .....	12
A.3.1 Centric application of the load .....	12
A.4 Test results:.....	13
A.5 Possible applications according to EN 15080-12 .....	13
A.5.1 Units .....	13
A.5.2 Masonry mortar:.....	14
A.5.3 Plaster or rendering.....	14
A.5.4 Load level .....	14
A.5.5 Geometrical parameters.....	14
Annex B (informative) Recommendations for the installation .....	15
B.1 Connection systems for REI walls .....	15
B.2 Recesses and chases.....	15
Bibliography .....	16

## Foreword

This document (EN 15080-12:2011) has been prepared by Technical Committee CEN/TC 127 “Fire safety in buildings”, 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of an identical text or by endorsement, at the latest by July 2011, and conflicting national standards shall be withdrawn at the latest by July 2011.

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## 1 Scope

This European Standard provides guidance, and where appropriate defines procedures, for variations of certain parameters and factors associated with the design of internal and external loadbearing walls that have been tested in accordance with EN 1365-1.

Data from historic standard fire resistance tests may be used as supporting information.

Manufactured stone masonry units according to EN 771-5 and natural stone units according to EN 771-6 are not covered.

This European Standard is not valid for reinforced masonry.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 771-1, *Specification for masonry units — Part 1: Clay masonry units*

EN 771-3, *Specification for masonry units — Part 3: Aggregate concrete masonry units (Dense and light-weight aggregates)*

EN 772-1, *Methods of test for masonry units — Part 1: Determination of compressive strength*

EN 772-16, *Methods of test for masonry units — Part 16: Determination of dimensions*

EN 998-1:2010, *Specification for mortar for masonry — Part 1: Rendering and plastering mortar*

EN 1363-1, *Fire resistance tests — Part 1: General requirements*

EN 1363-2, *Fire resistance tests — Part 2: Alternative and additional procedures*

EN 1365-1, *Fire resistance tests for loadbearing elements — Part 1: Walls*

EN 1996-1-1, *Eurocode 6 — Design of masonry structures — Part 1-1: General rules for reinforced and unreinforced masonry structures*

EN 1996-1-2:2005, *Eurocode 6 — Design of masonry structures — Part 1-2: General rules — Structural fire design*

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

EN 1996-3:2006, *Eurocode 6 — Design of masonry structures — Part 3: Simplified calculation methods for unreinforced masonry structures*

EN 13501-2, *Fire classification of construction products and buildings elements — Part 2 Classification using data from fire resistance tests, excluding ventilation services*



### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1996-1-2:2005 and the following apply.

#### 3.1

##### **unit grouping**

is defined in EN 1996-1-1

#### 3.2

##### **unfilled perpend joint**

vertical plain joint or joint with tongue and groove, not filled with mortar or adhesive

#### 3.3

##### **utilisation factor**

relation between the applied load on the test specimen and the design resistance without partial safety factors

NOTE For design resistance see EN 1996-1-1 or EN 1996-3.

#### 3.4

##### **historical test data**

test data generated by fire resistance tests that have been undertaken by a Notified Test Laboratory in accordance with European and/or former and in accordance with standards

NOTE 1 Previously existing test data is acceptable even though the test may not have been carried out using the plate thermometer as long as the necessary additional information, (see 4.3) is available. This data can only be used as described in this European Standard.

NOTE 2 The temperature-time curve used is based on the one specified in EN 1363-1, which is also defined in ISO 834.

#### 3.5

##### **moisture content of units**

difference between the density of the units at the beginning of the fire test and the gross dry density of the units, related to the gross dry density of the units, in percent by mass

### 4 General principles

#### 4.1 General

(1) The fire behaviour of load bearing masonry mainly depends on:

- the masonry unit material - clay, calcium silicate, autoclaved aerated concrete, dense/lightweight aggregate concrete;
- the type of unit - solid or hollow (type of holes, percentage and direction of holes), shell and web thickness;
- the unit dimensions;
- the unit gross density;
- the unit compressive strength;
- the type of mortar - general purpose, thin layer or lightweight mortar;



- the type of perpend joint – filled or unfilled perpend joint, especially for unplastered walls;
- the use of finishes;
- the geometrical slenderness of the wall as defined in EN 1996-1-1;
- the level of the applied load;
- eccentricities;
- fire exposure of separating/non separating elements.

(2) For the determination of values by consideration of test results, the interpretation of any existing fire test results has to be based on the requirements for the relevant test method from EN 1363-1, EN 1363-2 and EN 1365-1.

(3) For the evaluation of use of previously existing data, differences between the test methods, have to be considered.

NOTE Differences to be considered are for example material properties, specimen dimensions, utilisation factor based on maximum loading, eccentricities, etc.

(4) To establish the extended application, the rules given in Clause 5 shall be followed for each of the given parameters.

(5) Extrapolations exceeding the rules of this European Standard are possible, provided that tests give evidence to do so. Such extrapolations have to be specified in the report, see Clause 6.

## 4.2 Classifications

(1) All the given rules are always valid for the same classification.

(2) Extrapolation is possible for different wall thicknesses and geometries, different unit densities, compressive strengths, perforation patterns and sizes, different types of masonry mortar, different types of external covering, different load levels and eccentricities.

(3) An extrapolation for higher fire resistances or from REI tests to REI-M or R is not possible.

NOTE 1 In some cases, there are different extended application rules given for the classifications R, REI and REI-M.

NOTE 2 In addition, the rules given in this European Standard for REI tests also apply for RE and REW tests.

## 4.3 Necessary additional information

For the classification according to these extended application rules additional information on material properties and additional measurements during the test procedure according to EN 1363-1, EN 1365-1 and EN 1363-2 or historic standard fire test methods are necessary:

- measurement of the deflection of the test specimen at least in mid height, to allow for an extrapolation for height, see 5.5 (1);
- gross density, compressive strength and moisture content of the units;
- percentage of voids, web and shell thickness and combined thickness for perforated units;
- gross density and compressive strength of the mortar;



- thickness of unfilled perpend joints in unplastered or unrendered walls;
- thickness and type of plaster or render in rendered walls;
- measurement of applied load on the test specimens;
- determination of the utilisation factor.

NOTE The measurement of the temperature within the test specimen at least in mid-height across the wall thickness is advised to allow for a future calculation of fire resistances according to EN 1996-1-2. Thermocouples should be placed at least in depths of 10 mm, 30 mm and 50 mm from the exposed side and then every 50 mm.

## 5 Rules for extended application

### 5.1 Units

(1) Extrapolations are only possible within the same type of material – e.g. tests on clay unit masonry with units according to EN 771-1 can only be used for extrapolations for clay unit masonry. For lightweight aggregate concrete units according to EN 771-3 extrapolations are only possible within lightweight aggregate concrete units.

(2) The test results are valid for the tested type of unit. If solid units, i.e. group 1 units according to EN 1996-1-1 are tested, the results are only valid for group 1 units with the same or a smaller percentage of voids.

(3) For vertically perforated units (group 1, 2 and group 3 according to EN 1996-1-1), the test results can be applied for units with the same or a smaller percentage of voids. If the difference between the tested percentage of voids and the upper limit of the group in EN 1996-1-1 is less than 5 % of the overall surface of the unit, test results are valid for all percentages of voids within that group. The tested percentage of voids can be rounded up to the next multiple of 5 %.

(4) For vertically perforated units, the test results can be applied for units with the same or a higher thickness of webs and shells and for the same or higher values of the combined thickness. The value of the combined thickness can be rounded down to the next multiple of 10 mm/m.

(5) Test results for vertically perforated units can be applied for solid units.

(6) For the classification REI and R the test results are valid for the tested size of the unit and units larger in height, length and width.

(7) For units with a length between 200 mm and 1000 mm, test results for a unit length from that range are valid for the whole range of unit lengths between 200 mm and 1000 mm.

(8) For the classification REI-M, test results are valid for the tested length and width and units larger in length and width. It is not possible to extrapolate from tests on masonry walls with unit heights equal or smaller than 250 mm to units with greater heights.

(9) For tested wall thicknesses up to 140 mm, the test results are valid for masonry with units with the same or a higher declared value of the gross density of the units within the following ranges.

- unit density between 300 kg/m<sup>3</sup> and 999 kg/m<sup>3</sup>: Tested density and densities up to 800 kg/m<sup>3</sup> higher than the tested density up to a maximum gross dry density of 1600 kg/m<sup>3</sup>.
- unit density between 1000 kg/m<sup>3</sup> and 2200 kg/m<sup>3</sup>: Tested density and densities up to 600 kg/m<sup>3</sup> higher than the tested density up to a maximum gross dry density of 2200 kg/m<sup>3</sup>.

NOTE 1 Extrapolations for lightweight aggregate concrete units are limited to net dry densities 20 % higher than tested.



(10) For wall thicknesses greater than 140 mm, the test results are valid for masonry units with a higher declared value of the gross density of units.

NOTE 2 Extrapolations for lightweight aggregate concrete units are limited to net dry densities 20 % higher than tested.

(11) The tested density can be rounded down within the following ranges:

- for unit densities between 300 kg/m<sup>3</sup> and 999 kg/m<sup>3</sup> to the next multiple of 50 kg/m<sup>3</sup>;
- for unit densities between 1000 kg/m<sup>3</sup> and 2200 kg/m<sup>3</sup> to the next multiple of 200 kg/m<sup>3</sup>.

(12) The test results are valid for masonry with the same or a higher declared value of the compressive strength of units tested according to EN 772-1 within the ranges given in Table 1 and with the same or lower utilisation factor. The tested compressive strength can be rounded down to:

- the next multiple of 1 N/mm<sup>2</sup> for compressive strengths up to 7 N/mm<sup>2</sup>;
- the next multiple of 2 N/mm<sup>2</sup> for compressive strengths between 7,1 N/mm<sup>2</sup> and 16 N/mm<sup>2</sup>;
- the next multiple of 5 N/mm<sup>2</sup> for compressive strengths greater than 16,1 N/mm<sup>2</sup>.

**Table 1 — Ranges of unit compressive strength for extrapolation**

Row Number	Type of unit	Unit compressive strength $f_b$ in the test	Permissible range of unit strengths for extrapolation
1	Calcium silicate units, clay units, aggregate concrete units	2 to 50 N/mm <sup>2</sup>	Tested strength up to 50 N/mm <sup>2</sup> or 110 % of the tested strength, the greater value applies
	autoclaved aerated concrete units	1,5 to 10 N/mm <sup>2</sup>	Tested strength up to 10 N/mm <sup>2</sup> or 110 % of the tested strength, the greater value applies
2	Calcium silicate units, clay units, aggregate concrete units	50 to 75 N/mm <sup>2</sup>	Tested strength up to 75 N/mm <sup>2</sup> or 110 % of the tested strength, the greater value applies
3	Clay units	75 to 150 N/mm <sup>2</sup>	Tested strength up to 150 N/mm <sup>2</sup> or 110 % of the tested strength, the greater value applies



## 5.2 Masonry mortars and joints

- (1) For all types of masonry mortar – general purpose mortar, lightweight mortar, thin layer mortar – the test results are valid for mortar compressive strengths equal or higher than tested.
- (2) Test results for walls with lightweight mortar with a gross density up to 800 kg/m<sup>3</sup> tested are also valid for walls with lightweight mortars with a density higher than tested and for general purpose mortar with a bond strength classification equal or greater than M5 according to EN 998-1:2010.
- (3) Test results for walls with lightweight mortar with a gross density > 800 kg/m<sup>3</sup> are also valid for general purpose mortar with a bond strength classification equal or greater than M5 according to EN 998-1:2010.
- (4) Test results for walls with thin layer mortar are valid for all types of thin layer mortar and general purpose mortar with a bond strength classification equal or greater than M5 according to EN 998-1:2010.
- (5) Test results for walls with lightweight mortar and general purpose mortar are valid for walls with thin layer mortar, if the utilisation factor does not exceed the relation between the load in the test and the design resistance for walls with thin layer mortar.
- (6) Test results for unplastered or unrendered walls with unfilled perpend joints are valid for walls with a maximum perpend joint thickness equal or smaller than tested.
- (7) Test results for unplastered or unrendered walls with filled perpend joints are valid independent of the perpend joint thickness.
- (8) Test results for unplastered walls with unfilled plain perpend joints are valid for all types of perpend joints executed according to EN 1996-2.
- (9) Test results for unplastered walls with vertical tongue and groove joints are only valid for walls with tongue and groove joints or with filled perpend joints.
- (10) Test results for plastered or rendered walls are valid for all types of perpend joints executed according to EN 1996-2 independent on the perpend joint thickness.
- (11) For the classification REI-M an extrapolation is possible within one type of mortar and from:
  - general purpose mortar to thin layer mortar;
  - lightweight mortar to thin layer mortar;
  - lightweight mortar to general purpose mortar with a strength equal or greater M5 according to EN 998-1:2010;
  - thin layer mortar to general purpose mortar with a strength equal or greater M10;if the applied load on the wall does not exceed the load in the test.

## 5.3 Plaster, rendering or external covering

- (1) If plaster or rendering based on sand cement is tested, the test result is valid for all types and the same or higher thickness of plaster or rendering.
- (2) If plasters or renders based on gypsum binder or renders LW and T according to EN 998-1 are used, the result is valid for the tested type of plaster or rendering with the same or higher thickness.
- (3) If a wall is tested without plaster or rendering the test result is also valid for plastered or rendered walls.



(4) Rendering for external walls can be replaced by a second leaf of masonry or a thermal insulation with non combustible insulation material of at least the same thickness than the rendering.

(5) Test results for walls covered with gypsum plaster are also valid for walls covered with LW or T renders.

(6) Test results for walls covered with LW or T renders are also valid for walls covered with gypsum plaster.

## 5.4 Load Level

(1) For the ranges of compressive strengths given in the rows of Table 1, an extrapolation is possible for utilisation factors up to the utilisation factor applied in the test.

(2) Test results for units from row number 1 in Table 1 are also valid for units in rows 2 and 3 if the applied load on the wall does not exceed the load in the test.

(3) Test results for units from row number 2 in Table 1 are also valid for units in row 3 if the applied load on the wall does not exceed the load in the test.

(4) An extrapolation from tests with eccentric loading ( $e \leq t/6$  from the centre) is possible to walls loaded with the same or a lower eccentricity.

(5) An extrapolation from tests with centric loads is possible for walls with eccentric loading ( $e \leq t/6$  from the centre).

(6) An extrapolation for higher utilisation factors for a reduced fire resistance period is possible if a sufficient number of test results give evidence about the load-deflection behaviour of the tested specimen.

## 5.5 Geometrical parameters

(1) If the wall is tested with at least 3 m height, the height for REI and R systems can be extrapolated up to a slenderness (effective height ratio  $h_{ef}/t$ ) of 25 or a maximum height of 8 m, the lower value applying, if the deflection of the tested specimen is smaller than half of the thickness of the wall.

(2) If the wall is tested with at least 3 m height, the height for REI-M systems can be extrapolated up to a slenderness (effective height ratio  $h_{ef}/t$ ) of 25 or a maximum height of 5 m, the lower value applying, if the deflection of the tested specimen is smaller than half of the thickness of the wall.

NOTE See example in Annex A.

(3) The length of a wall ( $l$ ) is unlimited but depending on the static calculation and stiffeners according to EN 1996-1-1 or EN 1996-3.

(4) Test results are valid for the tested thickness of the wall ( $t$ ) and wall thicknesses equal or greater than tested. These limits cannot exceed those given in the design for the ultimate and service limit state according to EN 1996.

(5) The presence of one layer of units with a lower unit height at the bottom and/or at the top of the wall does not change the fire performance of the wall.

## 6 Report of the extended application analysis

The Extended Application report shall be used in conjunction with the classification document as specified in EN 13501-2 (based on tests according to EN 1365-1 or historic data) and shall contain the following:

- 1) name of the applicant;

- 2) name of the notified body which has performed the extended application;
- 3) type of the tested walls.

This shall include a general description and any trade names of all the products involved.

- 4) scope of the extended application;
- 5) summary of the report(s) of the reference test(s) and previously granted extended applications, if available;

NOTE This is a specially prepared summary and not necessary the brief summary sometimes given as part of the test report or as a separate document. Alternatively, it is acceptable to append full copies of the relevant reports of the reference test(s).

- 6) analysis of the extended application, writing including:
  - the source of any calculation model used;
  - a justification of the use of the calculation model for this particular extended application;
  - a list of any assumptions made, together with a justification for those assumptions;
  - any supporting information and test references from other fire resistance tests or from historic fire resistance tests or from ad hoc or small-scale tests;
- 7) the conclusion of the analysis, including the new classification of the fire resistance (EI, EI-M, R, REI or REI-M as appropriate).



## Annex A (informative)

### Examples of extended applications for loadbearing masonry walls

#### A.1 Basis for the Definition: Test report according to EN 1365-1 (add photo)

#### A.2 Material Properties from Report:

##### A.2.1 Units

Clay unit according to EN 771-1

Compressive strength of unit  $f_b = 9,2 \text{ N/mm}^2$

Density  $\rho = 770 \text{ kg/m}^3$

Percentage of voids  $V = 49 \%$

Thickness of webs  $w = 6 \text{ mm}$

Thickness of shells  $s = 10 \text{ mm}$

Combined thickness according to EN 772-16  $ct = 188 \text{ mm/m}$

Unit size:  $l \times t \times h$ ;  $373 \text{ mm} \times 115 \text{ mm} \times 238 \text{ mm}$

##### A.2.2 Mortar

General purpose mortar M5 according to EN 998-1:2010

##### A.2.3 Plaster or rendering

Plaster:  $15 \text{ mm}$  lime-gypsum according to EN 998-1:2010 on both sides

#### A.3 Load

A.3.1 Centric application of the load

A.3.2 Applied load  $27,6 \text{ kN/m} = 0,24 \text{ N/mm}^2$

A.3.3 Utilisation factor  $u$

A.3.3.1 General purpose mortar:

related to  $f_k$  from EN 1996-3:2006, Annex D;  $f_k = 3,1 \text{ N/mm}^2$

reduction factor  $\phi = 0,347$  from EN 1996-3:2006, 4.2.2.3;

$$\phi \times f_k = 1,07 \text{ N/mm}^2$$

$$u = 0,24/1,07 = 0,223$$

#### A.3.3.2 Thin layer mortar:

related to  $f_k$  from EN 1996-3:2006, Annex D;  $f_k = 3,0 \text{ N/mm}^2$

as the characteristic load is smaller than for general purpose mortar, the same utilisation factor can be applied

$$u = 0,223$$

### A.4 Test results:

A.4.1 Performance REI 180 (196 Minutes Fire Resistance)

A.4.2 Maximum deflection in mid-height: 43 mm

A.4.3 Maximum temperature change: 104 K

A.4.4 Mean temperature change: 75 K

A.4.5 Temperatures in the specimen determined: YES

### A.5 Possible applications according to EN 15080-12

#### A.5.1 Units

#### Relevant subclause

A.5.1.1 Compressive strength greater than  $8 \text{ N/mm}^2$

5.1 (12)

NOTE 1 The compressive strength of  $9,2 \text{ N/mm}^2$  lies between  $7,1 \text{ N/mm}^2$  and  $16 \text{ N/mm}^2$  and can be rounded down to the next multiple of  $2 \text{ N/mm}^2$ .

NOTE 2 For a unit with a tested compressive strength of  $19,2 \text{ N/mm}^2$  (greater than  $16,1 \text{ N/mm}^2$ ) the compressive strength could be rounded down to the next multiple of  $5 \text{ N/mm}^2$ , i.e.  $15 \text{ N/mm}^2$ .

A.5.1.2 Density greater than  $750 \text{ kg/m}^3$ , but not greater than  $1570 \text{ kg/m}^3$

5.1 (9)

NOTE 1 The tested density of  $770 \text{ kg/m}^3$  lies between  $300 \text{ kg/m}^3$  and  $999 \text{ kg/m}^3$  and can be rounded down to the next multiple of  $50 \text{ kg/m}^3$  (lower boundary). The upper limit of the range of permissible densities is  $1570 \text{ kg/m}^3$  ( $770 + 800$ ).

NOTE 2 For a unit with a tested density of  $1770 \text{ kg/m}^3$  (lies between  $1000 \text{ kg/m}^3$  and  $2200 \text{ kg/m}^3$ ) the density can be rounded down to the next multiple of  $200 \text{ kg/m}^3$  (i.e.  $1600 \text{ kg/m}^3$ ; lower boundary). The upper limit of the range of permissible densities is  $2200 \text{ kg/m}^3$ .

A.5.1.3 Percentage of voids  $V \leq 50 \%$

5.1 (3)

A.5.1.4 Thickness of webs  $t_w \geq 6 \text{ mm}$

5.1 (4)

Thickness of shells  $t_s \geq 10 \text{ mm}$

5.1 (4)



Combined thickness  $ct \geq 180 \text{ mm/m}$  5.1 (4)

#### A.5.1.5 Unit size:

Length  $l \geq 200 \text{ mm}$  5.1 (6,7)

Thickness  $t \geq 115 \text{ mm}$  5.1 (6)

Height  $h \geq 238 \text{ mm}$  5.1 (6)

#### A.5.2 Masonry mortar:

Possible mortars are:

A.5.2.1 General purpose mortar  $\geq M5$  5.2 (1)

A.5.2.2 Thin layer mortar (utilisation factor  $u \leq 0,223$ ) 5.2 (5)

#### A.5.3 Plaster or rendering

A.5.3.1 Thickness  $\geq 15 \text{ mm}$  5.3 (2)

A.5.3.2 Possible type of plaster or rendering:

Gypsum plaster 5.3 (2)

Lightweight plaster T or LW 5.3 (5)

#### A.5.4 Load level

A.5.4.1 Centric and eccentric ( $e \leq t/6$ ) load 5.4 (5)

A.5.4.2 Utilisation factor  $u \leq 0,223$  for unit compressive strengths  
up to  $50 \text{ N/mm}^2$ , i.e.  $122,8 \text{ kN/m}$  5.4 (1)

Maximum applied load  $\leq 122,8 \text{ kN/m}$  for  
unit compressive strengths greater  $50 \text{ N/mm}^2$  5.4 (2)

#### A.5.5 Geometrical parameters

A.5.5.1 Maximum height of wall

Boundary conditions:

$h_{\text{eff}} = 0,75 \times h$  (EN 1996-3)

Where  $h_{\text{eff}}$  is effective height

$h = 25 \times 0,115/0,75 = 3,83 \text{ m}$ ; max.  $h = 8 \text{ m}$

Extrapolation is possible up to a height of  $3,83 \text{ m}$  5.5 (1)

## **Annex B** (informative)

### **Recommendations for the installation**

#### **B.1 Connection systems for REI walls**

Extrapolation is possible for the connection systems defined in EN 1996-1-2:2005, Annex E. Examples are:

- a) the masonry wall located between metal angles with a mineral wool infill;
- b) the masonry wall located between metal channels with a mineral wool infill;
- c) the masonry wall located within a pocket in the adjacent floor or wall with a mineral wool infill;
- d) the gap between the masonry wall and the wall or floor is filled with mineral wool or mortar. The joint may be capped with sealant material;
- e) the masonry wall is tied to the adjacent wall and the gap between the walls is filled with mineral wool or mortar. The joint may be capped with sealant material.

Connection systems for REI-M walls

- The rules for REI systems apply.
- If the 3<sup>rd</sup> impact (impact on the unloaded wall) according to EN 1365-1 was carried out with an upper fixation of the wall, the REI-M classification requires a fixation on site, e.g. a ring-beam.

#### **B.2 Recesses and chases**

The rules of EN 1996-1-2 apply.

For recesses and chases in REI and R systems with an area of less than 100 mm x 100 mm, the required remaining minimum wall thickness is 50 mm.

For recesses and chases with an area of more than 0,01 m<sup>2</sup>, the remaining wall thickness has to meet the criterion REI for the required period of fire resistance.

For any recesses and chases in REI-M systems, the remaining wall thickness behind recesses shall be the minimum REI thickness required for the required period of fire resistance.



## Bibliography

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

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 masonry units*

EN 998-2, *Specification for mortar for masonry — Part 2: Masonry mortar*

EN 1991-1-2, *Eurocode 1: Actions on structures — Part 1-2: General actions — Actions on structures exposed to fire*





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