ДСТУ EN 1015-11:2022
(EN 1015-11:2019, IDT)
Методи випробування розчину для кладки.
Частина 11. Визначення міцності на
згин і стиск затверділого розчину

EUROPEAN STANDARD

NORME EUROPÉENNE

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Methods of test for mortar for masonry - Part 11: Determination of flexural and compressive strength of hardened mortar

Méthodes d'essai des mortiers pour maçonnerie - Partie 11: Détermination de la résistance en flexion et en compression du mortier durci

Prüfverfahren für Mörtel für Mauerwerk - Teil 11: Bestimmung der Biegezug- und Druckfestigkeit von Festmörtel

This European Standard was approved by CEN on 16 September 2019.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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Contents

European foreword

This document (EN 1015-11:2019) has been prepared by Technical Committee CEN/TC 125 "Masonry", 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of an identical text or by endorsement, at the latest by May 2020, and conflicting national standards shall be withdrawn at the latest by May 2020.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1015-11:1999.

The following main changes made to the previous edition include:

— Editorial revision (inversion Clauses 3 and 4, Clause 3, 5.1);

— Clause 6 has changed; time of starting and ending are indicated;

— 7.2.3: An additional type of compaction has been added;

— The storage condition different for air lime mortars and air lime-cement mortars with cement not exceeding 50 % of the total binder mass (Table 1 and Table 2);

— 9.1.2: Tolerance for plate width added.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This document specifies a method for determining the flexural and compressive strength of moulded mortar specimens. This document is applicable to cement/air-lime mortars, air-lime mortars, mortars with hydraulic binders and retarded mortars.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 196-1, *Methods of testing cement — Part 1: Determination of strength*

EN 998 (all parts), *Specification for mortar for masonry*

EN 1015-2, *Methods of test for mortar for masonry — Part 2: Bulk sampling of mortars and preparation of test mortars*

EN 1015-3, *Methods of test for mortar for masonry — Part 3: Determination of consistence of fresh mortar (by flow table)*

EN ISO 5436-1, *Geometrical Product Specifications (GPS) — Surface texture: Profile method; Measurement standards — Part 1: Material measures (ISO 5436-1)*

EN ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method (ISO 6507-1)*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
air-lime
limes mainly consisting of calcium oxide or hydroxide which slowly harden in air by reacting with atmospheric carbon dioxide and generally do not harden under water as they have no hydraulic properties

Note 1 to entry: The definition of air-lime comprises an English translation of a term used in most European countries.

3.2 Symbols

F is the maximum load applied to the specimen, in newtons (N).

l is the distance between the axes of the support rollers, in millimetres (mm).

b is the width of specimen, in millimetres (mm).

d is the depth of the specimen, in millimetres (mm).

4 Principle

The flexural strength of mortar is determined by three point loading of hardened moulded mortar specimens to failure. The compressive strength of the mortar is determined on the two parts resulting from the flexural strength test. Where the flexural strength is not required, the parts for compressive strength testing can be produced from the specimens in any way which does not lead to these parts being damaged.

5 Apparatus

5.1 Metal moulds consisting of an open frame of removable walls forming three compartments when assembled (see Figure 1 for typical design and Annex A for a detailed description).

5.1.1 Metal moulds for use with mortars with hydraulic binders and air-lime mortars with mass of air-lime not exceeding 50 % of total binder mass; a typical mould is given in EN 196-1.

5.1.2 Metal moulds for use with mortars based on air-lime/cement with cement mass not exceeding 50 % of total binder mass.

5.2 Tamper consisting of a rigid, non-absorptive rod of square cross-section, each side of which is (12 ± 1) mm. The tamping face is flat and at right angles to the length of the tamper. The mass of the tamper is (50 ± 1) g.

5.3 Storage chamber capable of maintaining a temperature of 20 °C (+3 °C/-2 °C) and a relative humidity of (95 ± 5) % or (65 ± 5) %.

5.4 White cotton gauze, four sheets each with a size of approximately 150 mm x 175 mm.

5.5 Absorbent filter paper with a specific mass of (200 ± 20) g/m² and water absorption capacity of (160 ± 20) g/m²; twelve sheets each with a size of approximately 150 mm x 175 mm.

The number of filter paper sheets may be increased or decreased to account for lower or higher water absorption capacity.

5.6 Polyethylene bags capable of containing the metal moulds.

5.7 Non-absorptive plates of sufficient area to cover the metal mould and which can support a mass of 5 kg.

5.8 Palette knife, or similar metal straight edge.

5.9 Metal grid, providing support for storing and curing the specimens.

5.10 Trowel.

Additional apparatus is described in 8.1 and 9.1.

Dimensions in millimetres

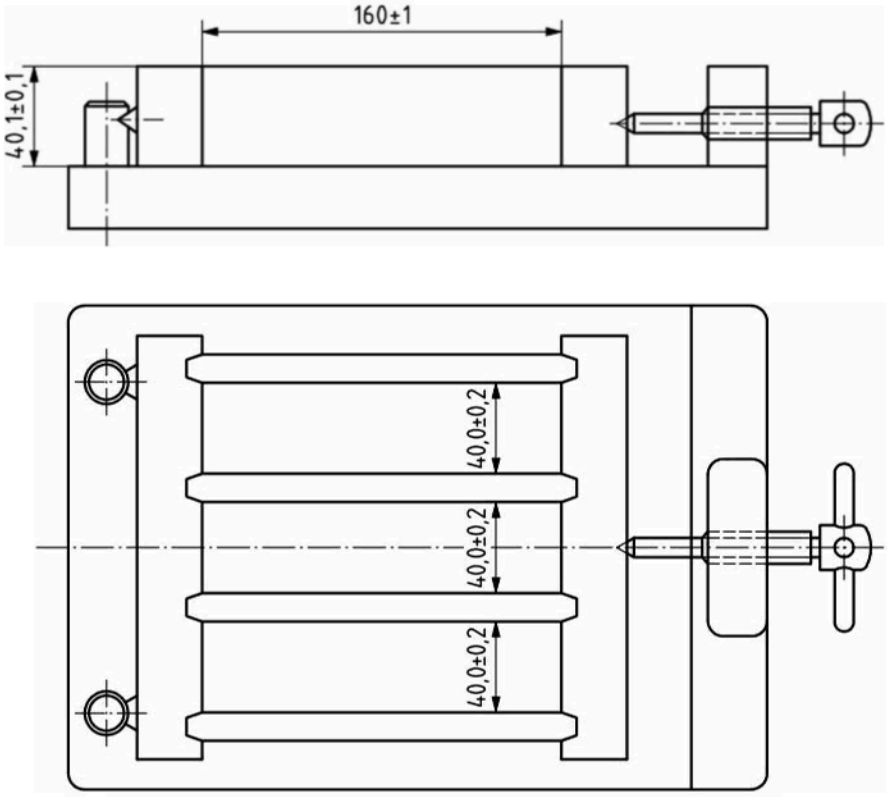


Figure 1 — Typical mould for forming test specimens

6 Sampling

6.1 General

The fresh mortar for this test shall have a minimum volume of 1,5 l or at least 1,5 times the quantity needed to perform the test, whichever is the greater, and shall either be obtained by reduction of the bulk test sample (see EN 1015-2) using a simple divider or by quartering or by preparation from water and the other constituents in the laboratory. Two test samples shall be prepared.

6.2 Laboratory prepared mortars

The length of the mixing period shall be measured from the moment all the constituents are introduced into the mixer. The mortar shall be brought to a defined flow value as specified in EN 1015-2 determined in accordance with EN 1015-3 or EN 1015-4 and reported. The test procedure shall start after mixing but shall be concluded within the specified workable life of the mortar (preferably within 30 min after completion of mixing). Before testing, the batch shall be gently stirred by hand using a trowel or palette knife in 5 s to 10 s to counteract any false setting, etc., but without any additional mixing of the batch.

6.3 Mortars, other than laboratory prepared mortars

Ready to use mortars (factory-made wet mortars which are retarded), and pre-batched air-lime/sand wet mortars when not gauged with hydraulic binders, shall be used for specimen preparation within their specified workable life.

Before testing the batch shall be gently stirred by hand using a trowel or palette knife for 5 s to 10 s to counteract any false setting, etc., but without any additional mixing of the batch.

The flow value of the mortar in the bulk test sample shall be determined in accordance with EN 1015-3 and reported.

7 Preparation and storage of test specimens

7.1 General

The test specimens shall be specimens 160 mm x 40 mm x 40 mm. Three specimens shall be provided. For the compressive strength test, break the specimens into two halves to provide six half specimens.

7.2 Preparation

7.2.1 General

Prepare mortars based on hydraulic binders (retarded or not retarded), and air-lime/cement mortars with mass of air-lime not exceeding 50 % of the total binder mass, in accordance with 7.2.2.

Prepare mortars based on air-lime, and air-lime/cement mortars with cement mass not exceeding 50 % of the total binder mass, in accordance with 7.2.3.

Prepare mortars of unknown composition according to the manufacturer's instructions, in accordance with either 7.2.2 or 7.2.3.

Preparation and storage conditions are given in Tables 1 and 2.

Prepare at least three specimens for testing at an age of 28 d, or more if retarding agents are incorporated in the mortar, unless otherwise specified.

Clean the moulds and lubricate the internal faces of the assembled moulds with a thin layer of mineral based oil that does not affect setting of mortars, to prevent adhesion of the mortar.

7.2.2 Mortars with hydraulic binders, and air-lime/cement mortars with mass of air-lime not exceeding 50 % of the total binder mass

Fill the mould with mortar in two approximately equal layers, each layer being compacted by 25 strokes of the tamper. Alternatively, the mould may be tilted through approximately 30° and tapped ten times, returned to the horizontal and then tilted and tapped a further ten times. The method of compaction shall be reported.

Skim off the excess mortar with a palette knife, or similar metal straight edge, leaving the mortar surface plane and level with the top of the mould. Then store the mould as described in 7.3.

7.2.3 Mortars based on air-lime, and air-lime/cement mortars with cement mass not exceeding 50 % of the total binder mass

Place the assembled mould frame, clamped together at right angles, on a non-absorptive plate on which two layers of dry white cotton gauze have been placed. Fill the mould with mortar in two approximately equal layers, each layer being compacted by 25 strokes of the tamper. Alternatively the mould may be tilted through approximately 30° and tapped ten times, returned to the horizontal and then tilted and tapped a further ten times. The method of compaction shall be reported.

Skim off the excess mortar with a palette knife, or metal sharp edge leaving the mortar surface plane and level with the top of the mould.

Place two layers of white cotton gauze tightly on the mortar surface. Place six layers of absorbent filter paper on top of the gauze.

Cover the absorbent filter paper with a non-absorptive plate and turn the mould upside down keeping the non-absorptive plates at the bottom and top firmly attached to the mould.

Carefully remove the non-absorptive plate from the top of the inverted mould, place six layers of absorbent filter paper on the exposed gauze and re-cover with the non-absorptive plate on top.

Re-invert the mould back to its upright position and place it on a fixed table and load with mass of approximately 5 kg.

After 3 h remove the load and the non-absorptive plate. Discard the absorbent filter paper and the gauze on top of the mould, and recover with the non-absorptive plate on top. Invert the mould, keeping the non-absorptive plates at the bottom and the top firmly attached to the mould. Remove the non-absorptive plate from the top of the inverted mould and discard the absorbent filter paper and the gauze. Then store the mould as described in 7.3.

7.3 Storage and curing conditions

7.3.1 Mortars with hydraulic binders, and air-lime/cement mortars with mass of air-lime not exceeding 50 % of the total binder mass.

Place the mould in the storage chamber or in sealed polyethylene bags. Then after the period given in Table 1 remove the specimens from the mould and subsequently store them on a metal grid under the conditions described in Table 1.

7.3.2 Mortars based on air-lime, and air-lime/cement mortars with cement mass not exceeding 50 % of the total binder mass.

Place the mould in the storage chamber. Then after five days remove the specimens from the mould and subsequently store them on a metal grid under the conditions described in Table 2.

Table 1 — Preparation and conditions of storing specimens for mortars in accordance with 7.3.1

Type of mortar	Preparation	Storage time at a temperature of 20 °C (+3 °C/-2 °C) in days		
		Relative humidity		
		95 % ± 5 % or in polyethylene bag		65 % ± 5 %
		in the mould	with the mould removed	with the mould removed
Cement and air-lime/cement mortars with mass of air-lime not exceeding 50 % of the total binder mass	7.2.2	1-3	Until a total of 7 d in the storage chamber or polyethylene bags	21
Mortar with hydraulic binders	7.2.2	1-3		21
Retarded mortars	7.2.2	7	-	21

Table 2 — Preparation and conditions of storing specimens for mortars in accordance with 7.3.2

Type of mortar	Preparation	Storage time at a temperature of 20 °C (+3 °C/-2 °C) in days		
		Relative humidity		
		95 % ± 5 % or in polyethylene bag		65 % ± 5 %
		in the mould	with the mould removed	with the mould removed
Air-lime mortars	7.2.3	5	2	21
Air-lime/cement mortars with cement mass not exceeding 50 % of the total binder mass	7.2.3	5	2	21

Additionally, testing can be performed after an extended 90 day cure under the conditions defined in Table 2 (7 d at 95 % relative humidity followed by 83 d at 65 % relative humidity). The alternative curing period shall be clearly identified.

8 Determination of flexural strength

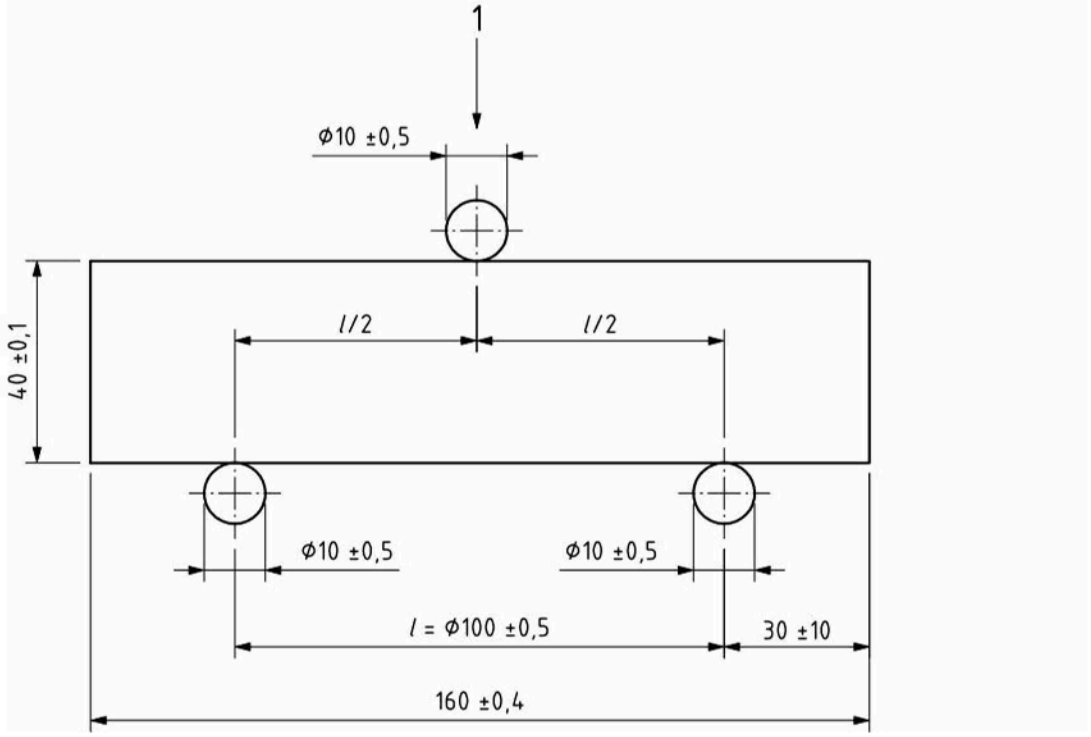
8.1 Apparatus

A testing machine capable of applying the load at a rate specified in 8.2. The machine shall comply with the requirements in Table 3. The machine shall have two steel supporting rollers of length between 45 mm and 50 mm and (10 ± 0,5) mm diameter, spaced (100,0 ± 0,5) mm apart, and a third steel roller of the same length and diameter located centrally between the support rollers (see Figure 2). The three vertical planes through the axes of the three rollers shall be parallel and remain parallel, equidistant and normal to the direction of the specimen under test. One of the supporting rollers and the loading roller shall be capable of tilting slightly to allow a uniform distribution of the load over the width of the specimen without subjecting it to any torsional stresses.

Table 3 — Requirements for testing machines

Maximum permissible repeatability of forces as percentage of nominal force	Maximum permissible mean error of force as percentage of nominal force	Maximum permissible error of zero force as percentage of maximum force of range
%	%	%
±2,0	±2,0	±0,4

Dimensions in millimetres



Key

1 load

l See 3.2.

Figure 2 — Flexural strength test

8.2 Procedure

8.2.1 Preparation

Test the specimen at 28 d after casting, or more if retarding agents are incorporated in the mortar, unless otherwise specified, and immediately after removing from the storage atmosphere. Wipe the bearing surfaces of the rollers and the sides of specimen with a clean cloth to remove any loose grit or other material. Place the specimen with one of its faces (which has been cast against the steel of the mould) on the supporting rollers.

8.2.2 Loading

Apply the load without shock at a uniform rate in the range 10 N/s to 50 N/s so that failure occurs within a period of 30 s to 90 s.

NOTE A loading rate at the lower end of the permitted range may need to be used for the lower strength mortars.

Record the maximum load applied, in N. Return the broken specimen to the storage chamber and keep it there if required, for compressive strength measurements.

8.3 Calculation and expression of results

Calculate the flexural strength, f, in N/mm² using the following formula:

$$f = 1,5\frac{F \cdot l}{b \cdot d^2}$$

where

F is the maximum load applied to the specimen, in newtons (3.2);

l is the distance between the support rollers, in millimetres (3.2);

b is the width of specimen, in millimetres (3.2);

d is the depth of the specimen, in millimetres (3.2).

b and d may be taken from the mould dimensions.

Record the flexural strength of each specimen to the nearest 0,05 N/mm². Calculate the mean to the nearest 0,1 N/mm².

Record age of test specimen and age at demoulding.

9 Determination of compressive strength

9.1 Apparatus

9.1.1 Testing machine capable of applying the load at a rate specified in 9.2.2.

The machine shall comply with the requirements in Table 3. The upper machine platen shall be able to align freely as contact is made with the specimen, but the platens shall be restrained from tilting with respect to one another during loading.

9.1.2 Two bearing plates made of tungsten carbide or of steel of surface hardness at least 600 HV Vickers hardness value in accordance with EN ISO 6507-1.

The plates shall be 40,0 mm ± 0,1 mm long x 40,0 mm ± 0,1 mm wide and 10,0 mm ± 0,1 mm thick. The dimensional tolerance for the width shall be based on the average of four symmetrically placed measurements. The flatness tolerance for the contact faces shall be 0,01 mm.

9.2 Procedure

9.2.1 Preparation

a) Test the specimen at 28 d after casting, or more if retarding agents are incorporated in the mortar, unless otherwise specified, and immediately on removing from the storage atmosphere or after the flexural strength test. Remove any loose grit or other material from the sides of the specimen as cast. Wipe the bearing surface of the testing machine, with a clean cloth and place the specimen in the machine in such a manner that the load is applied to one of its faces (which has been cast against the steel of the mould).

b) Arrange the specimen so that the cast end is 16,0 mm ± 0,1 mm from the nearer edge of the platens or bearing plates. Discard any specimens that do not provide a cube of solid material between the top and bottom platens or bearing plates. Carefully align the specimen so that the load is being applied to the whole width of the faces in contact with the platens.

9.2.2 Loading

a) Apply the load without shock and increase it continuously until failure occurs. As a guide suggested loading rates are given for the different classes of masonry and rendering mortars in Annex B.

b) Record the maximum load applied, in N, during the test.

9.3 Calculation and expression of results

a) Calculate the strength as the maximum load carried by the specimen divided by its cross-sectional area of the bearing plate (nominally 1 600 mm^2).

b) Record the strength of each specimen to the nearest 0,05 N/mm^2. Calculate the mean to the nearest 0,1 N/mm^2.

c) Record the age of specimens and the age at de-moulding.

10 Test report

The test report shall include the following information:

a) the number, title and date of issue of this document;

b) the place, date and time of taking the bulk test sample[1)]:

NOTE This is the sample taken from the bulk supply that is to be used for all of the tests in the EN 1015 series.

c) the method used for taking the bulk test sample (if known) and the name of the organization that took it;

d) the type, origin and designation of the mortar by reference to the relevant part of the EN 998 series;

e) the date of testing;

f) preparation (mixing, casting, type of mould, method of compaction) and storage (curing) conditions;

g) the date and time of preparing samples for test (i.e. date and time of any mixing, casting, moulding, or demoulding procedure, if appropriate);

h) the flow value of the test mortar determined in accordance with EN 1015-3;

i) age of mortar when tested;

j) test results (individual values of flexural strength, if required, and of the compressive strength of mortar stated to the nearest 0,05 N/mm^2, and corresponding mean value stated to the nearest 0,1 N/mm^2);

k) remarks, if any.

1) This information is contained on the certificate of sampling (see EN 1015-2).

Annex A
(normative)

Description of metal moulds for specimen preparation

The compartment walls are at least 8 mm thick and rigid enough to prevent distortion or damage to specimens on removal.

The assembled mould frame is firmly attached to a rigid base plate by means of a fixing screw arrangement thus giving a water-resistant joint when greased (see 7.2.2), or it may be held together at right angles by means of a clamp and firmly placed on a loose non-absorptive plate thus forming the bottom of the mould (see 7.2.3).

A typical mould design for specimens is shown in Figure 1.

The assembled moulds conform to the following requirements:

a) Dimensions. For each compartment, the internal dimensions are: length 160 mm ± 1 mm; depth 40,0 mm ± 0,1 mm and width 40,0 mm ± 0,2 mm.

b) Flatness. The surface of each internal face lies between two parallel planes 0,03 mm apart. The joints between the sections of the mould and between the bottom surface of the mould and the top surface of the base plate shall lie between two parallel planes 0,06 mm apart.

c) Squareness. The surface of each internal face lies between two parallel planes 0,50 mm apart, which are perpendicular to the bottom surface of the mould and also to the adjacent internal faces.

d) Parallelism. The top surface of the mould lies between two parallel planes 1,0 mm apart and is parallel to the bottom surface.

e) Surface texture. The surface texture of each internal surface shall be not greater than 3,2 µm R_a measured in accordance with EN ISO 5436-1.

Annex B
(informative)

Suggested loading rates for different classes of masonry and rendering mortars

Suggested loading rates for different classes of masonry and rendering mortars, in N/s, are given in Table B.1. These loading rates relate only to compressive strength.

Table B.1 — Suggested loading rates

Masonry mortars		Rendering mortars	
Category	Loading rate (N/s)	Category	Loading rate (N/s)
M 1	50	CS I	50
M 2,5	100	CS II	100
M 5	200	CS III	200
M 10	400	CS IV	400
M 15	400		
M 20	400		

Bibliography

[1] EN 1015 (all parts), *Methods of test for mortar for masonry*