British Standard

BRITISH STANDARD

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1052-4:2000

Methods of test for masonry —

Part 4: Determination of shear strength including damp proof course

The European Standard EN 1052-4:2000 has the status of a British Standard

ICS 91.080.30

National foreword

This British Standard is the official English language version of EN 1052-4:2000.

The UK participation in its preparation was entrusted by Technical Committee B/519, Masonry and associated tests, to Subcommittee B/519/4, Tests, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 12, an inside back cover and a back cover.

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Methods of test for masonry - Part 4: Determination of shear strength including damp proof course

Méthodes d'essai de la maçonnerie - Partie 4: Détermination de la résistance au cisaillement, en tenant compte de la couche de coupure de capillarité

Prüfverfahren für Mauerwerk - Teil 4: Bestimmung der Scherfestigkeit bei einer Feuchtesperrschicht

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Foreword

This European Standard 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of an identical text or by endorsement, at the latest by November 2000, and conflicting national standards shall be withdrawn at the latest by November 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies a method for determining the in plane shear strength of horizontal bed joints in masonry incorporating sheet damp proof course material using a specimen tested in double shear with load applied perpendicular to the bed joints.

Guidance is given on the preparation of the specimens, the conditioning required before testing, the testing machine, the method of test, the method of calculation and the contents of the test report.

2 Normative references

This European Standard 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 Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

prEN 772-1 Methods of test for masonry units - Part 1: Determination of compressive strength.

EN 772-10 Methods of test for masonry units - Part 10: Determination of moisture content of calcium silicate and autoclaved aerated concrete units.

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

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

EN 1015-7 Methods of test for mortar for masonry - Part 7: Determination of air content of fresh mortar.

EN 1015-11 Methods of test for mortar - Part 11: Determination of flexural and compressive strength of hardened mortar.

3 Principle

The shear strength of masonry incorporating sheet damp proof course material is derived from the strength of small masonry specimens tested to destruction. The specimens are tested in double shear under three-point load with precompression perpendicular to the bedjoints. The shear strength is defined by the initial shear strength and the coefficient of friction.

4 Definitions and symbols

4.1 Definitions

For the purposes of this standard, the following definitions apply:

4.1.1 masonry: an assemblage of masonry units laid in a specified pattern and jointed together with mortar

4.1.2 shear strength of masonry: the strength of masonry subjected to shear forces

4.2 Symbols

A_i is the cross-sectional area of the masonry specimen parallel to the bed joints, (mm^2)

$F_{i,max}$ is the maximum shear load withstood by an individual masonry specimen, (N)

f_{vi} is the shear strength of an individual masonry specimen at a particular precompressive stress, (N/mm^2)

f_{pi} is the precompressive stress, (N/mm^2)

F_{pi} is the precompressive load, (N)

f_{vim} is the mean shear strength of the three masonry specimens tested at a particular precompressive stress, (N/mm^2)

f_{vo} is the mean value of shear strength at zero precompressive load, (N/mm^2)

f_{vck} is the characteristic value of shear strength, (N/mm^2)

l is the length of the specimen, in mm

h is the height of the specimen, in mm

w is the width of the specimen, in mm

α is the angle of internal friction, in degrees

α_k is the characteristic angle of internal friction, in degrees

5 Materials

5.1 Masonry units

5.1.1 Conditioning of the units

The conditioning of masonry units shall be as specified.

Measure the moisture content by mass of autoclaved aerated concrete and calcium silicate masonry units in accordance with **EN 772-10**. For other types of masonry unit record the method of conditioning the units prior to laying. Record the age of non-autoclaved concrete units at the time of testing the masonry specimens.

5.1.2 Determination of the compressive strength of the masonry units

Determine the compressive strength of a sample of masonry units, using the test method given in **prEN 772-1**. For non-autoclaved concrete units determine the compressive strength at the time of testing the masonry specimens.

5.2 Mortar

The mortar, its mixing procedure and its flow value shall conform with the requirements of **prEN 998-2**, unless otherwise specified, and these shall be reported in the test report.

Take representative samples of fresh mortar from the mason's board to make mortar prism specimens, to determine the flow valve in accordance with **prEN 1015-3** and to determine the air content in accordance with **prEN 1015-7**. Use the prism specimens to determine the mean compressive strength at the time of testing the masonry specimens in accordance with **prEN 1015-11**.

6 Apparatus

6.1 The testing machine used to apply the shear loads and precompression shall comply with the requirements given in **Table 1**. The testing machine shall have adequate capacity but the scale used shall be such, that the ultimate load on the specimen exceeds one fifth of the full scale reading. The machine shall be provided with a load pacer or equivalent means to enable the load to be applied at the rate specified.

6.2 Apparatus capable of measuring the cross-sectional area of the specimens to an accuracy of 1 %.

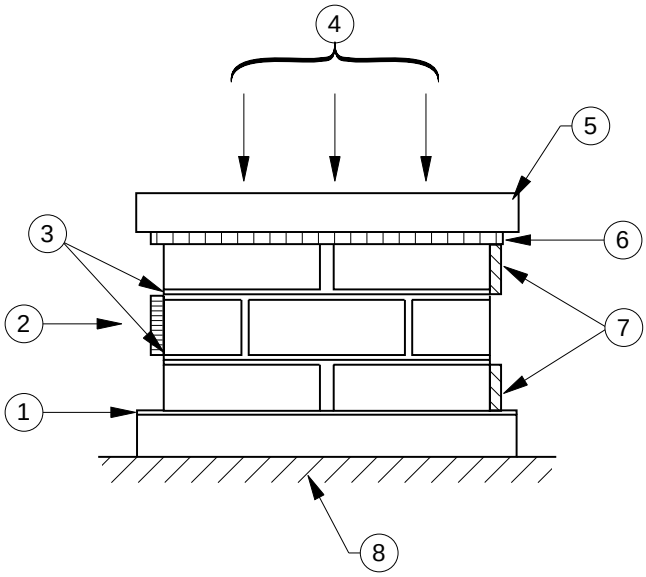
Table 1 - Requirements for testing machines

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

7 Preparation and curing of specimens

7.1 Preparation of masonry specimens

Prepare at least nine specimens in the format shown in **Figure 1**. The length of the specimens shall be greater than 400 mm and less than 700 mm. The height to width ratio (*h/w*) shall be greater than 2 and there should be at least one vertical joint per course.



Key					
3	Damp proof courses	1	Straw-board	2	Shear load
6	Load spreading material	4	Compressive load	5	Upper platen
		7	Rigid abutments to restrain top and bottom courses (adjustable to allow for minor variations in masonry)	8	Lower platen

Figure 1 - Testing arrangement

The damp proof course shall be sandwiched between layers of mortar. Frogs and perforations shall not be exposed at the end of the specimen but turned in.

Build the specimens on a flat horizontal surface. The units shall be laid so that a final mortar joint thickness of 8 mm to 15 mm representative of masonry with conventional mortar joints, of 1 mm to 3 mm representative of masonry made with thin layer mortar joints is attained. The masonry unit shall be checked for linear alignment and level using a set-square and spirit level. Excess mortar shall then be struck off with a trowel. The procedure shall be repeated for the top unit(s).

7.2 Curing and conditioning of the specimens

Immediately after building, pre-compress each specimen using a uniformly distributed mass to give vertical stress between $2{,}0 \times 10^{-3}$ N/mm^2 and $5{,}0 \times 10^{-3}$ N/mm^2 then cure the specimens and maintain them undisturbed until testing. For other than lime-based mortar, prevent the test specimens from drying out during the curing period by close covering with polyethylene sheet, and maintain the specimens undisturbed until testing unless otherwise specified. Test each specimen at an age of 28 days ± 1 day, unless otherwise specified for lime-based mortar, and determine the compressive strength of the mortar at the same age, following **EN 1015-11**.

8 Procedure

8.1 Placing the specimens in the testing machine

Place the specimens in the testing machine and apply the compressive load and the shear load as shown in **Figure 1**.

The faces of the masonry units where the shear load is to be applied shall be plane and perpendicular to the direction of the shear load.

8.2 Loading

Test at least three specimens at each of three precompression loads. Use precompression loads that give stresses of approximately 0,2 N/mm^2, 0,6 N/mm^2 and 1,0 N/mm^2. The precompression load shall be kept within ±2% of the initial value. Increase the shear stress at a rate between 0,1 N/mm^2 and 0,4 N/mm^2 per min.

8.3 Measurements and observations

Record the following:

- the age of non-autoclaved concrete units;

- the cross-sectional area A_i of the specimens parallel to the shear force with an accuracy of 1 %;

- the precompression load F_{pi};

- the load $F_{i,max}$ where failure of one of the bed joints occurs;

- the mode of failure, e.g. slipping along damp proof course or material failure within the damp proof course.

8.4 Replications

If failure is by shear failure in the unit parallel with the bed joint or crushing or splitting of the units, then either further specimens may be tested until three shear failures for each precompression level have been achieved or alternatively the result may be used as a lower bound to the shear strength. However, circumstances may be such that the use of an alternative unit is appropriate.

9 Calculations

For each specimen at each compressive stress calculate the shear strength to the nearest 0,01 N/mm^2 using the following formula:

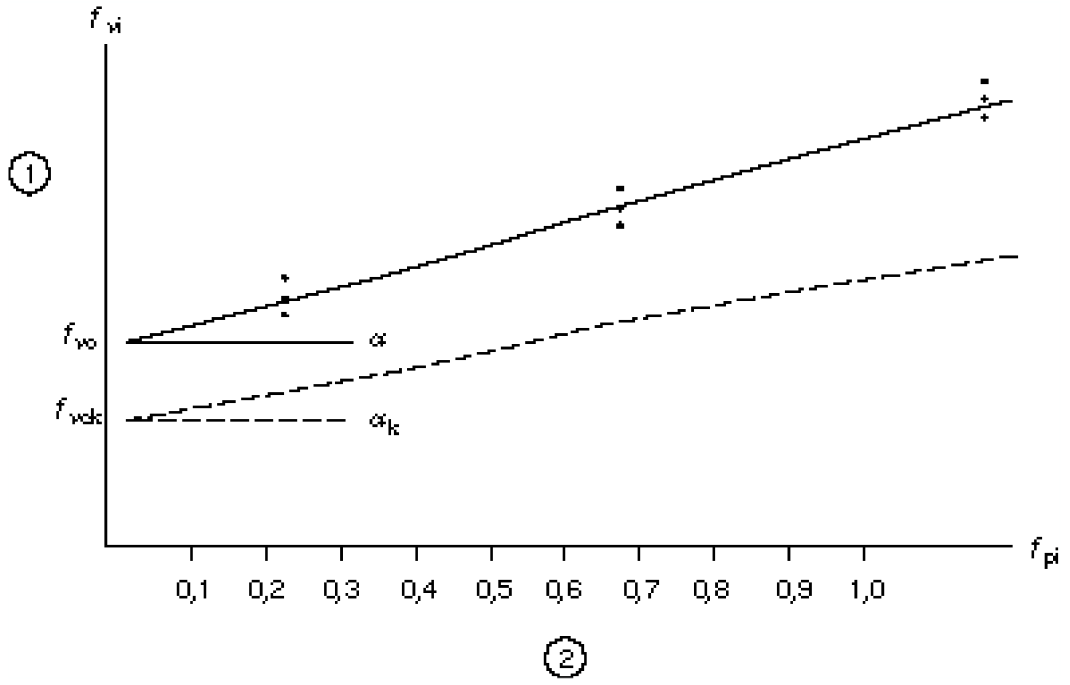
$$f_{\mathrm{vi}} = \frac{F_{\mathrm{i,max}}}{2A_{\mathrm{i}}} \mathrm{N/mm}^2$$

Calculate the precompressive stress at each precompression load as:

$$f_{\mathrm{pi}} = \frac{F_{\mathrm{pi}}}{A_{\mathrm{i}}} \mathrm{N/mm}^2$$

10 Evaluation of results

Plot a graph of the individual shear strength f_{vi} against the normal compressive stress f_{pi} as shown in **Figure 2**. Plot the line determined from a linear regression of the points. Record the mean initial shear strength f_{vo} and the angle of internal friction α to the nearest degree, from the slope of the line.



Key
1 Shear strength (N/mm^2) 2 Precompressive stress (N/mm^2)

Figure 2 - Shear strength and angle of internal friction

The characteristic value of the initial shear strength with damp proof course is f_{vck} where $f_{vck} = 0{,}8\,f_{vo}$ and the characteristic angle of internal friction from $\tan \alpha_k = 0{,}8 \tan \alpha$.

11 Test report

The test report shall contain the following information:

a) number, title and date of issue of this European Standard;

b) name of the testing laboratory;

c) number of specimens;

d) date of building the specimens;

e) curing conditions (e.g. time, temperature, humidity);

f) date of testing the specimens;

g) laboratory temperature range during test period;

h) description of the specimens including dimensions;

i) description of the masonry units and the mortar (to include also details of the mortar mixing procedure and flow value, air content and compressive strength), preferably consisting of the appropriate test reports, or of extracts taken from these reports;

j) description of damp proof course materials (test certifications);

k) age of non-autoclaved concrete units at the time of testing the specimens;

l) moisture content by mass of autoclaved aerated concrete and calcium silicate units at the time of laying or, for other types of unit, the method of conditioning prior to the time of laying;

m) compressive load at the beginning of testing and at the moment of failure;

n) maximum shear load reached by the test specimens;

o) individual values for the shear strength a precompression stress for each specimen in N/mm^2 to the nearest 0,01 N/mm^2 and the description of the failure mechanism of each specimen;

p) mean and characteristic initial shear strength in N/mm^2 to the nearest 0,01 N/mm^2;

q) angle of internal friction and characteristic angle of internal friction;

r) remarks, if any.

Bibliography

prEN 772-16 Methods of test for masonry units - Part 16: Determination of dimensions.

prEN 772-20 Methods of test for masonry units - Part 20: Determination of flatness of faces of aggregate concrete, manufactured stone and natural stone masonry units.

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