BRITISH STANDARD

BS EN
1052-3:2002

Methods of test for masonry —

Part 3: Determination of initial shear strength

The European Standard EN 1052-3:2002 has the status of a British Standard

ICS 91.080.30

National foreword

This British Standard is the official English language version of EN 1052-3:2002.

EN 1052-3:2002 is the subject of transitional arrangements agreed under the European Commission mandate. The Member States have agreed a nominal transition period for the co-existence of the future "harmonized" European Standards and their corresponding national standard(s). It is intended that this period will comprise a nominal nine month period during which any required changes to national regulations are to be made, followed by a further nominal twelve month period for the implementation of CE marking. At the end of this co-existence period, the national standard(s) will be withdrawn. In the UK, there is no corresponding national standard.

Because EN 1052-3:2002 is a supporting standard to the forthcoming "harmonized" European product standard specification EN 998-2, *Specification for mortar for masonry — Masonry mortar*, the above-mentioned co-existence period will commence upon the date of availability (DOA) of EN 998-2. An estimation of the date of commencement of this period cannot yet be given.

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 international/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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This British Standard, having been prepared under the direction of the Building and Civil Engineering Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 13 August 2002

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Méthodes d'essai de la maçonnerie - Partie 3: Détermination de la résistance initiale au cisaillement

Prüfverfahren für Mauerwerk - Teil 3: Bestimmung der Anfangsscherfestigkeit (Haftscherfestigkeit)

This European Standard was approved by CEN on 11 April 2002.

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

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Foreword

This document EN 1052-3:2002 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 January 2003, and conflicting national standards shall be withdrawn at the latest by January 2003.

Annex A of this European Standard is informative.

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, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies a method for determining the in plane initial shear strength of horizontal bed joints in masonry using a specimen tested in shear.

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 (including amendments).

EN 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.*

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

EN 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 for masonry - Part 11: Determination of flexural and compressive strength of hardened mortar.*

3 Principle

The initial shear strength of masonry is derived from the strength of small masonry specimens tested to destruction. The specimens are tested in shear under four-point load, with precompression perpendicular to the bed joints.

Four different failure modes are considered to give valid results. The initial shear strength is defined by the linear regression curve to zero normal stress.

4 Terms, definitions and symbols

4.1 Terms and definitions

For the purpose of this European Standard, the following terms and definitions apply.

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

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

4.2 Symbols

A_i	is the cross-sectional area of a specimen parallel to the bed joints, in square millimetres (mm^2)
e	distance between centre lines of the mortar bed and the loading roller, in millimetres (mm)
f_{voi}	is the shear strength of an individual sample, in Newton per square millimetres (N/mm^2)
f_{pi}	is the precompressive stress of an individual sample, in Newton per square millimetres (N/mm^2)
f_{vo}	is the mean initial shear strength, in Newton per square millimetres (N/mm^2)
f_{vko}	is the characteristic initial shear strength, in Newton per square millimetres (N/mm^2)
F	is the representation of the force applied to the specimen, in Newton (N)
$F_{i,max}$	is the maximum shear load, in Newton (N)
F_{pi}	is the precompressive force, in Newton (N)
h_1 and h_2	are the heights of cut units, in millimetres (mm)
h_u	is the height of the units according to **EN 772-16**, in millimetres (mm)
l_s	is the length of specimen, in millimetres (mm)
l_u	is the length of the units according to **EN 772-16,** in millimetres (mm)
t_{bj}	is the thickness of the bed joint, in millimetres in millimetres (mm)
t_s	is the thickness of the steel loading plates, in millimetres (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:

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

5.1.2 Testing

Determine the compressive strength of a sample of masonry units, using the test method given in EN 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 EN 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 value in accordance with EN 1015-3 and to determine the air content in accordance with EN 1015-7. Use the prism specimens to determine the mean compressive strength at the time of testing the masonry specimens in accordance with EN 1015-11.

6 Apparatus

The testing machines used to apply the shear loads and precompression shall comply with the requirements given in Table 1.

The testing machine to apply the shear loads 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.

Table 1 - Requirements for testing machines

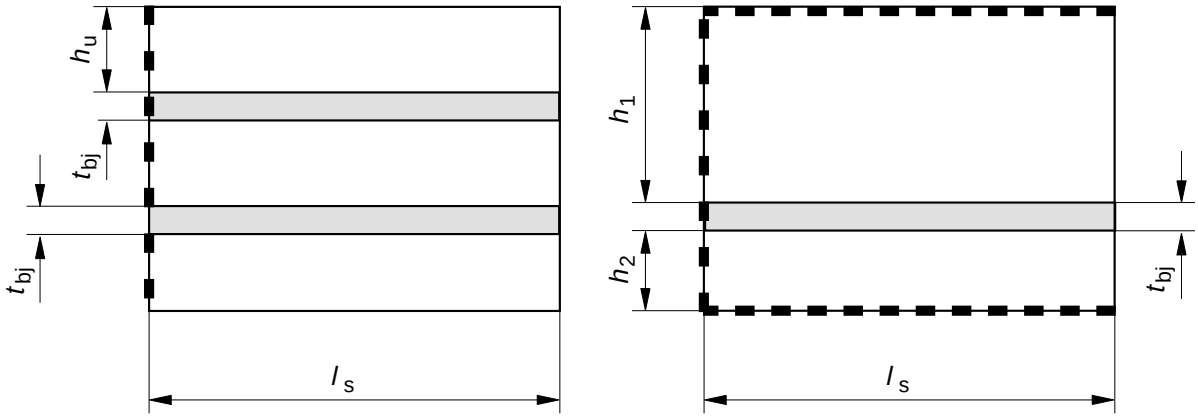
Maximum permissible repeatability of forces as percentage of indicated force	**Maximum permissible mean error of forces as percentage of indicated force**	**Maximum permissible error of zero force as percentage of maximum force of range**
2,0	± 2,0	± 0,4

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

7 Preparation and curing of specimens

7.1 Preparation of masonry specimens

Prepare at least nine specimens with dimensions according to Table 2 and to Figure 1, type A if $h_u \leq 200$ mm or according to Figure 1, type B if $h_u > 200$ mm.



Key

▪▪▪▪▪▪▪▪▪ Possible saw cuts

Figure 1 - Dimensions of shear test specimen

Table 2 - Dimensions and type of shear test specimens

Unit size		**Specimen type and dimensions**	
l_u **mm**	h_u **mm**	**Type according to Figure 1**	**Dimensions mm**
≤ 300	≤ 200	A	$l_s = l_u$
> 300	≤ 200	A	$l_s = 300$
≤ 300	> 200	B	$h_1 = 200$ $l_s = l_u$
> 300	> 200	B	$h_1 = 200$ $l_s = 300$

Build the specimens within 30 min after completion of the conditioning of the units. Use mortar mixed not more than 1 h beforehand unless it is designed to be used over a more prolonged period.

The bearing surfaces of the masonry units shall be wiped clean of any adherent dust. The lower unit shall be laid on a clean level surface. The next unit shall be laid so that a final mortar joint thickness of 8 mm to 15 mm, representative of masonry with conventional mortar joints, or of 1 mm to 3 mm, representative of masonry 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. In case of specimens according to Figure 1A, the procedure for the second unit shall be repeated for the top unit.

7.2 Curing and conditioning of the specimens

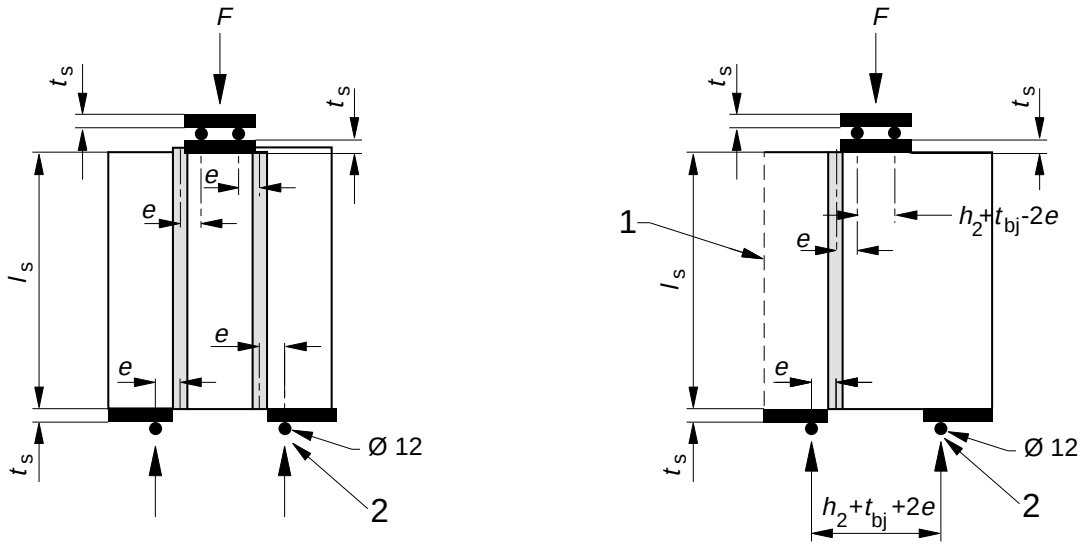
Immediately after building, pre-compress each specimen by an uniformly distributed mass to give a vertical stress between $2{,}0 \times 10^{-3}$ N/mm^2 and $5{,}0 \times 10^{-3}$ N/mm^2. Then cure the specimens and maintain them undisturbed until testing. For other than lime based mortars, prevent the 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 d ± 1 d, unless otherwise specified for lime based mortars, 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

Support the end units of each specimen in the test apparatus in accordance with Figure 2. For this, use pieces of steel at least 12 mm thick, with an appropriate capping if necessary, to ensure good contact. The diameter of the roller bearings shall be 12 mm with a length of at least t_u.

Apply the load through a ball hinge placed in the centre of the top central steel plate.

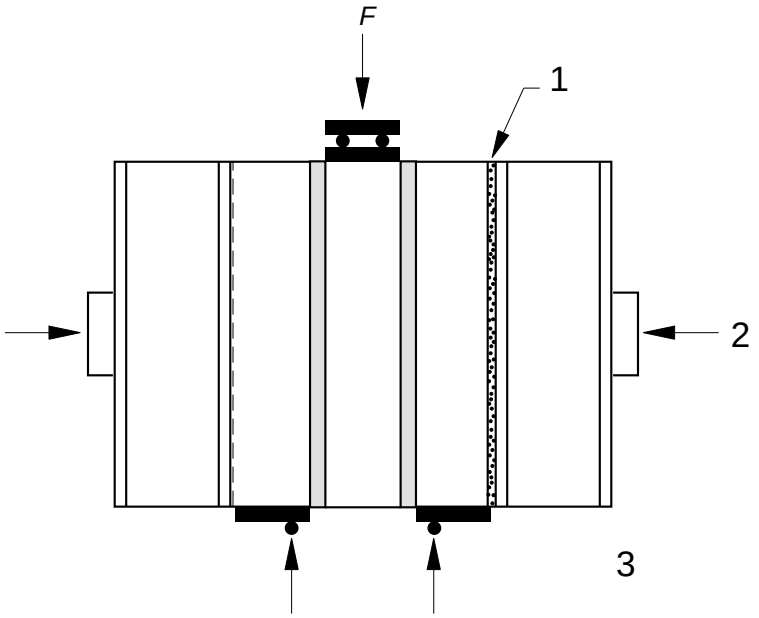


Key

1 Saw cut

2 Roller, fixed or positively located

Figure 2 - Loading of shear test specimen



Key

1 Strawboard/softboard/gypsum plaster

2 Precompression

3 Loading beam

Figure 3 - Precompression load

8.2 Loading

Test at least three specimens at each of three precompression loads. For units with compressive strengths greater than 10 N/mm^2, use precompression loads that give approximately 0,2 N/mm^2, 0,6 N/mm^2 and 1,0 N/mm^2. For units with compressive strength less than 10 N/mm^2 use precompression loads that give approximately 0,1 N/mm^2, 0,3 N/mm^2 and 0,5 N/mm^2. The precompression load shall be kept within ± 2 % of the initial value. The pre-compression shall be applied according to Figure 3.

The stiffness of the loading beams that are used for the precompression, shall be sufficient to ensure an equally distributed stress. If the platens of the machine are shorter than the length of the specimen $l_{u,}$ loading beams may be used. These shall have a length equal to the length of the specimen l_u and a depth greater than or equal to the length beyond the edge of the plate.

Increase the shear stress at a rate between 0,1 N/(mm^2 min) and 0,4 N/(mm^2 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 maximum load $F_{i,max}$

- the precompression load F_{pi}

- the type of failure (see annex A).

8.4 Replications

If failure is by:

- shear failure in the unit parallel with the bed joint (see Figure A.3) or;

- crushing or splitting of the units (see Figure A.4), then;

either

- further specimens may be tested until three shear failures of the types shown in Figure A.1 or Figure A.2 for each precompression level have been achieved or alternatively;

- the result may be used as a lower bound to the shear strength for each precompression level.

Lower bound results should not be used in the evaluation of results in clause 10. If necessary, an alternative precompression may be needed so that sufficient failures are achieved.

9 Calculations

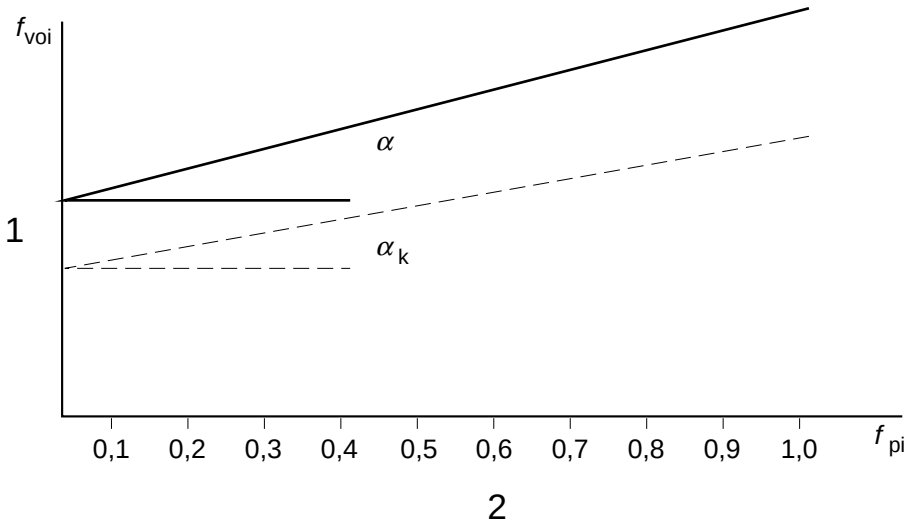
For each specimen calculate the shear strength and the precompression stress to the nearest 0,01 N/mm^2 using the following equations:

$$f_{voi} = F_{i,max} / 2A_i \quad \text{in N/mm}^2 \qquad (1)$$

$$f_{pi} = F_{pi} / A_i \quad \text{in N/mm}^2 \qquad (2)$$

10 Evaluation of results

Plot a graph of the individual shear strength f_{voi} against the normal compressive stress f_{pi} as shown in Figure 4. Plot the line determined from a linear regression of the points. Record the mean initial shear strength f_{vo} at zero normal stress to the nearest 0,01 N/mm^2. Obtain this from the intercept of the line with the vertical axis. Record also the angle of internal friction to the nearest degree, from the slope of the line.



Key

1 Shear strength (N/mm^2)

2 Precompressive stress (N/mm^2)

Figure 4 - Shear strength and angle of internal friction

The characteristic value of the initial shear strength is f_{vok} where $f_{vok} = 0{,}8 f_{vo}$ 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) the 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) description of the specimens including dimensions;

h) descriptions of the masonry units and the mortar, preferably consisting of the appropriate test reports, securely attached, or of extracts taken from these reports;

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

j) type of mortar and the mixing procedure of the mortar;

k) the method of conditioning the units prior to the time of laying and for autoclaved aerated concrete and calcium silicate units the moisture content by mass;

l) maximum load reached by the test specimens;

m) mean compressive strength of the masonry units in N/mm^2 to the nearest 0,01 N/mm^2 and the coefficient of variation;

n) mean compressive strength of the mortar in N/mm^2 to the nearest 0,01 N/mm^2 and the coefficient of variation, at 28 d ± 1 d;

o) individual values for the shear strength and 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.

Annex A

(informative)

Types of failure

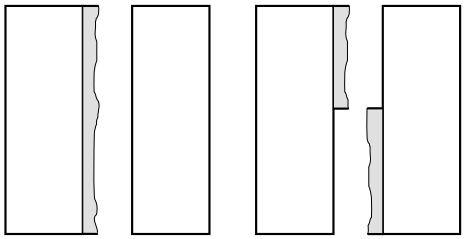


Figure A.1 - Shear failure in the unit/mortar bond area either on one or divided between two unit faces

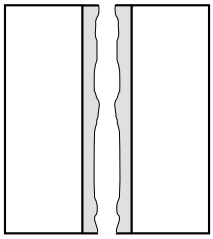


Figure A.2 - Shear failure only in the mortar

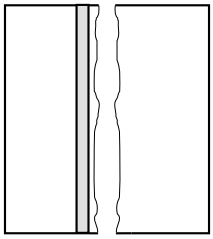


Figure A.3 - Shear failure in the unit

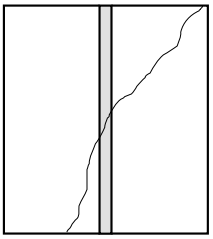


Figure A.4 - Crushing and or splitting failure in the units

Bibliography

EN 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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