BS EN 1052-2:2016

BSI Standards Publication

Methods of test for masonry

Part 2: Determination of flexural strength

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 1052-2:2016. It supersedes BS EN 1052-2:1999 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/519, Masonry and associated testing.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2016

ISBN 978 0 580 87726 1

ICS 91.080.30

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2016.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1052-2

March 2016

ICS 91.080.30

Supersedes EN 1052-2:1999

English Version

Methods of test for masonry - Part 2: Determination of flexural strength

Méthodes d'essai de la maçonnerie - Partie 2: Détermination de la résistance à la flexion

Prüfverfahren für Mauerwerk - Teil 2: Bestimmung der Biegezugfestigkeit

This European Standard was approved by CEN on 3 January 2016.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 1052-2:2016 E

Contents

Page

European foreword

This document (EN 1052-2:2016) 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 September 2016, and conflicting national standards shall be withdrawn at the latest by September 2016.

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

This document supersedes EN 1052-2:1999.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

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

1 Scope

This European standard specifies a method for determining the flexural strength of small masonry specimens for the two principal axes of loading. 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

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 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 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 mortar (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 masonary — Part 11: Determination of flexural and compressive strength of hardened mortar*

3 Principle

The flexural strength of masonry is derived from the strength of small specimens tested to destruction under four point loading. The maximum load achieved is recorded. The characteristic value, calculated from the maximum stresses achieved by the samples is considered to be the flexural strength of the masonry.

4 Terms, definitions and symbols

4.1 Terms and definitions

For the purposes of this document, 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
flexural strength of masonry
strength of masonry in pure bending assuming a linear stress distribution of internal stresses

4.2 Symbols

For the purposes of this document, the following symbols apply.

b is the height or width of a masonry specimen perpendicular to the direction of span, (mm)

$F_{i,\,max}$ is the maximum load applied to an individual masonry specimen, (N)

f_{mean} is the mean flexural strength of the masonry specimens, (N/mm^2)

f_{xi} is the flexural strength of an individual masonry specimen, (N/mm^2)

f_{xk} is the characteristic flexural strength of masonry, (N/mm^2)

h_u is the height of masonry unit, (mm)

k is the numerical factor

l_s is the length of a masonry specimen in the direction of span, (mm)

l_u is the length of masonry unit, (mm)

l_1 is the spacing of the outer bearings, (mm)

l_2 is the spacing of the inner bearings, (mm)

l_3 is the length of specimen outside the outer support ($1/2(l_s - l_1)$), (mm)

m is the mass of the sample, (kg)

n is the number of specimens

s is the standard deviation of the log values

t_u is the width of masonry unit, (mm)

x is the distance between the flexural crack in the specimen after testing and the nearer of the outer supports, (mm)

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 units prior to laying. Measure the moisture content by mass of autoclaved aerated concrete and calcium silicate masonry 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 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 to 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 prisms, 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 of the masonry specimens in accordance with EN 1015-11.

6 Apparatus

A testing machine complying with the requirements given in Table 1, and accommodating variations of plane. 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.

The bearings shall be designed to ensure that contact is provided over the full width of the masonry, for example by using a hollow rubber bolster of at least 7 mm wall thickness and a 10 mm bore containing an 8 mm diameter steel rod.

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 of specimens

7.1 Masonry specimens

For each of the two principal axes of loading use at least five specimens according to Figure 1 having the sizes given in Table 2. The size of the masonry specimens shall be chosen so that the distance between the inner and outer bearings shall be not less than the thickness of the masonry specimen. The thickness of the specimen shall be equal to t_u unless otherwise specified.

Table 2 — Specimen sizes for testing the flexural strength of masonry

Direction	h_u mm	b mm	Additional conditions
Flexural strength for a plane of failure parallel to the bed joints	any	≥ 400 and ≥ 1,5 l_u	minimum 2 bed joints within l_2
Flexural strength for a plane of failure perpendicular to the bed joints	≤ 250	≥ 240 and ≥ 3h_u	minimum 1 head joint every course within l_2
	> 250	≥ 1000	minimum 1 bed joint and minimum 1 head joint every course within l_2

7.2 Construction and curing of the specimens

Build the specimens within 30 min after completion of the conditioning of the units, using mortar mixed not more than one hour beforehand unless the mortar is designed to be used over a more prolonged period. Construct the specimens to the bond specified. Do not allow the work to be interrupted before completion.

Immediately after building, pre-compress each specimen using a uniformly distributed mass to give a vertical stress between $2,5 \times 10^{-3}$ 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, and determine the compressive strength of the mortar at the same age, following EN 1015-11. For lime-based mortars an alternative curing regime and period may be necessary and this should be specified.

8 Procedure

8.1 Placing the specimens in the testing equipment

Test the masonry specimen in the vertical attitude under four-point loading (see Figure 1). As an alternative, the specimen can be tested in a horizontal position. If the specimens are to be tested horizontally, weigh the mass m of each specimen to 0,1 kg. The distance between the outer bearings and the end of the specimen shall be greater than or equal to 15 mm. The distance between the inner bearings may be varied to suit the format of the masonry but shall be 0,4 times to 0,6 times the spacing of the outer bearings. The inner bearings shall be located so that they are, as far as practicable, midway between the nearest mortar joints which are parallel to the bearings.

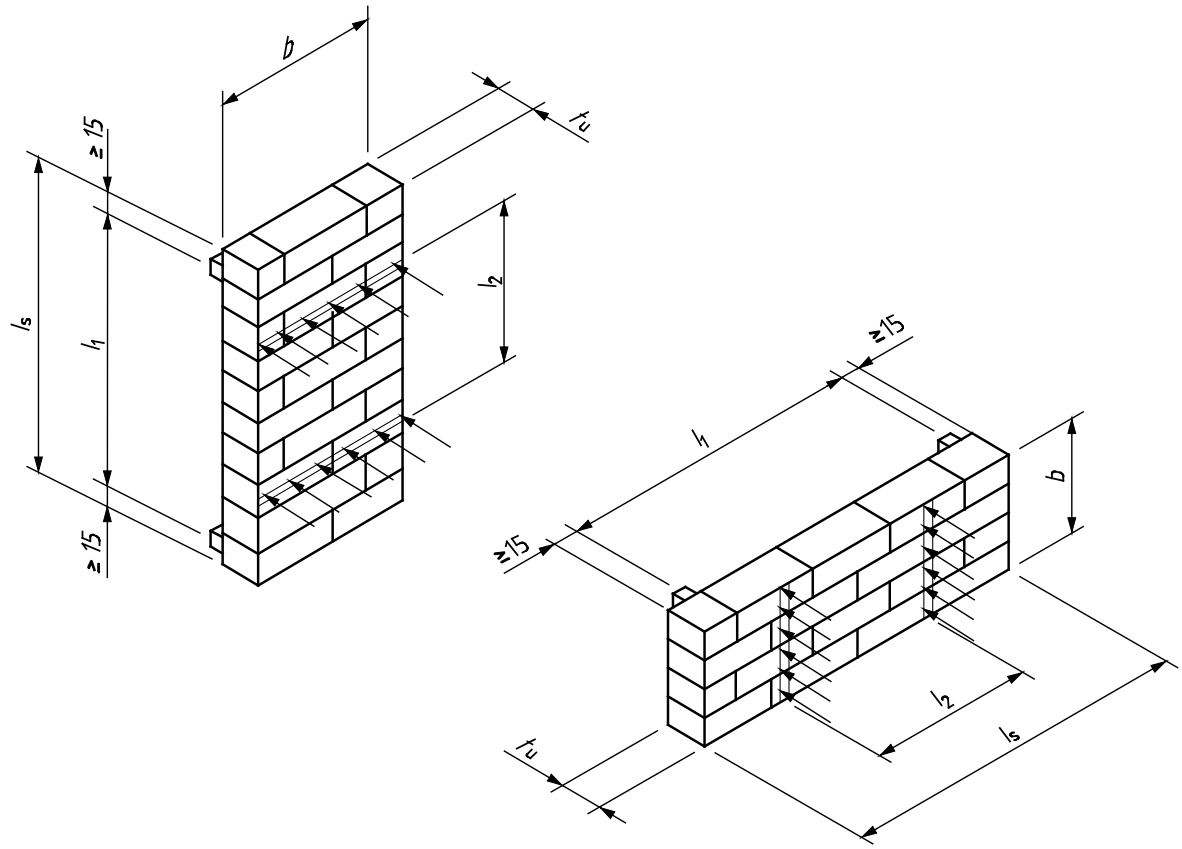
When testing in the vertical attitude ensure that the base of each masonry specimen is free from frictional restraint, for example by setting it on two layers of polytetrafluoroethylene with grease between them or on ball, needle or roller bearings.

When testing in the horizontal attitude care is needed, especially with masonry of low flexural strength, to avoid failures in handling and placing in the test machine. It may be necessary to build extra test specimens to ensure that five valid results can be achieved.

8.2 Loading

Increase the flexural stress at a rate between 0,03 $N/mm^2/min$ and 0,3 $N/mm^2/min$.

Dimensions in mm



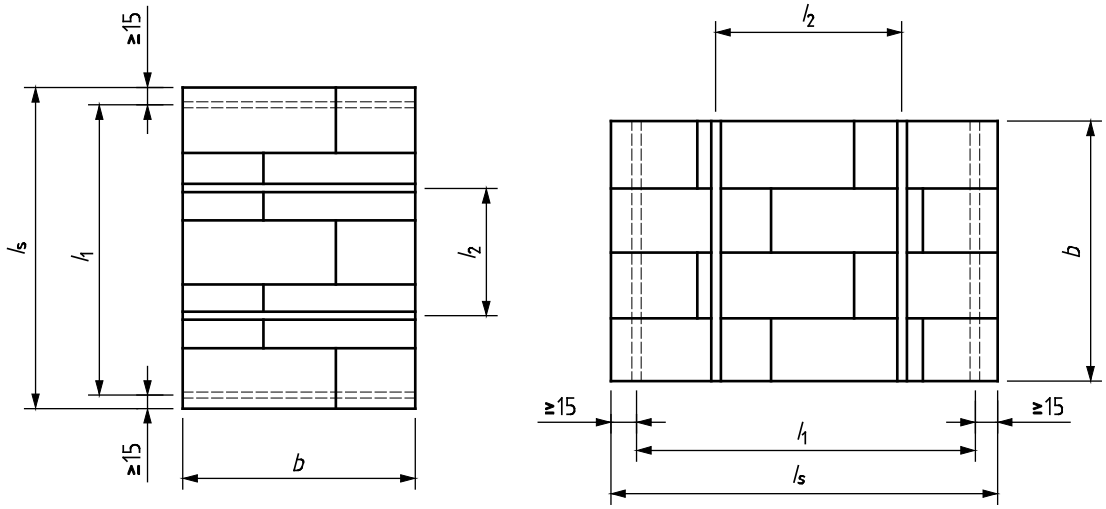
Key

b≈2l_u and b ≥ 400 mm and h_u ≤ 250 mm and more than two bed joints in l_2

b≈4h_u and b ≥ 240 mm and h_u ≤ 250 mm and a minimum of one head joint in l_2

Flexural strength for a plane of failure parallel to the bed joints

Flexural strength for a plane of failure perpendicular to the bed joints



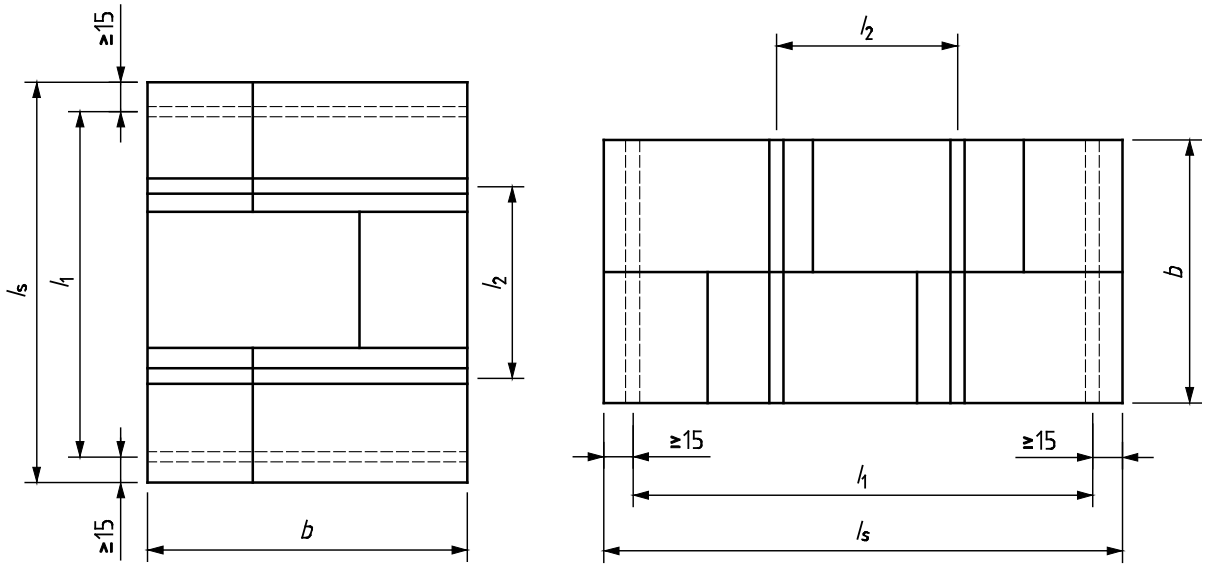
Key

b≈1,5l_u and b ≥ 400 mm and h_u ≤ 250 mm and two bed joints in l_2

b≈4h_u and b ≥ 240 mm and h_u ≤ 250 mm and a minimum of one head joint in l_2

Flexural strength for a plane of failure parallel to the bed joints

Flexural strength for a plane of failure perpendicular to the bed joints



Key

$b \approx 1{,}5 l_u$ and $b \geq 400$ mm and two bed joints in l_2

$b \geq 1000$ mm and $h > 250$ mm and one head joint and one bed joint in l_2

Flexural strength for a plane of failure parallel to the bed joints

Flexural strength for a plane of failure perpendicular to the bed joints

Figure 1 — Typical examples of masonry test specimens meeting the requirements of Table 2

8.3 Measurements and observations

Record the following:

a) age of non-autoclaved concrete units;

b) the dimensions of the cross-section of the specimen parallel to the bearings, to the nearest 1 mm;

c) the spacing of the outer and of the inner bearings, in mm;

d) the maximum load $F_{i,max}$ to the nearest 10 N. Discard any result where failure does not occur between the inner bearings;

e) the length of time from the start of loading until the maximum load is achieved;

f) crack patterns;

g) the distance x between the flexural crack and nearer of the outer bearings as marked on the specimen;

h) if the testing is carried out horizontally the mass of each specimen to the nearest 0,1 kg.

8.4 Replications

If less than five results are obtained in which failure occurs between the inner bearings, further tests shall be carried out until five valid results are obtained.

9 Calculations

Calculate the flexural strength of each specimen, to the nearest 0,01 N/mm², using the following formulae:

in case of vertical testing according:

$$f_{xi} = \frac{3F_{i,\max}(l_1 - l_2)}{2bt_u^2} \text{ N/mm}^2$$

in case of horizontal testing according:

$$f_{xi} = \frac{3F_{i,\max}(l_1 - l_2)}{2bt_u^2} + or - \frac{3m_i}{bt_u^2}\left\{x_i - \frac{(l_3 + x_i)^2}{l_s}\right\} \text{ N/mm}^2$$

Where the applied load acts in the same direction as the self-weight of the specimen, the plus sign is to be used. Where it is in the opposite direction, the negative sign is to be used.

Calculate the mean flexural strength (f_{mean}) to the nearest 0,01 N/mm².

10 Evaluation of results

Calculate the characteristic flexural strength to the nearest 0,01 N/mm² from a) or b)

a) $f_{xk} = f_{mean}/1{,}5$ for five specimens

b) $f_{x1}, f_{x2}, f_{x3}, \ldots f_{xn}$ for more than 5 specimens

calculate the values $y_1, y_2, y_3, \ldots y_n$, from $y_n = \log_{10} f_{xn}$, and y_{mean} from $y_{mean} = \sum y_n / n$.

Then $y_c = y_{mean} - k.s$,

where

s is the standard deviation for the n log values

k is a function of n, given in Table 3

n is the number of individual specimens

Table 3 — Relationship between *n* and *k*

n	***k***
6	2,18
7	2,08
8	2,01
9	1,96
10	1,92

Take the characteristic flexural strength to be:

$f_{xk} = anti\log_{10}(y_c)$ N/mm² to the nearest 0,01 N/mm².

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 tested in each direction;

d) date of building the specimens;

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

f) date of testing the specimens;

g) description of the specimens, including dimensions, number of courses, bonding pattern and spacing of the bearings;

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

i) age of non-autoclaved concrete units at the time of testing the masonry,

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

k) maximum load reached by the test specimens and the orientation of the test specimens, i.e. vertical or horizontal;

l) the length of time from the start of loading until the maximum load is achieved;

m) mean compressive strength of the masonry units in N/mm² to the nearest 0,01 N/mm² and the coefficient of variation;

n) mean compressive strength of the mortar in N/mm² to the nearest 0,01 N/mm² and the coefficient of variation, at 28 days ± 1 day;

o) individual values for the flexural strengths, of the masonry specimens in N/mm² to the nearest 0,01 N/mm², with notes on any unusual form of failure ;

p) mean and characteristic flexural strength of masonry in N/mm² to the nearest 0,01 N/mm²;

q) statistical treatment of the results where relevant;

r) crack patterns;

s) remarks, if any.

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

bsi.