

Specification for Clay bricks

UDC 666.71/.72:691.421.2

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW



Document Sharing Hub

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Clay Products Standards Committee (CLB/-) to Technical Committee CLB/7 upon which the following bodies were represented:

- Brick Development Association
- British Aggregate Construction Materials Industries
- British Ceramic Research Association
- British Engineering Brick Association
- Building Employers' Confederation
- Calcium Silicate Brick Association Limited
- Consumer Standards Advisory Committee of BSI
- Department of Education and Science
- Department of the Environment (Building Research Establishment)
- Department of the Environment (Housing and Construction Industries)
- Department of the Environment (Property Services Agency)
- Department of Finance Northern Ireland
- Greater London Council
- Institution of Civil Engineers
- Institution of Structural Engineers
- National House-building Council
- North of Ireland Brickmakers' Association
- Royal Institute of British Architects
- Scottish Employers' Council for the Clay Industries
- Society of Chemical Industry
- Society of Chief Architects of Local Authorities

The following were also represented in the drafting of the standard, through sub-committees and panels:

Coopted members

This British Standard, having been prepared under the direction of the Clay Products Standards Committee, was published under the authority of the Board of BSI and comes into effect on 29 November 1985

© BSI 12-1998

First published July 1965
First revision May 1974
Second revision
The following BSI references relate to the work on this standard:
Committee reference CLB/7
Draft for comment 83/10329 DC

ISBN 0 580 14642 1

Amendments issued since publication

Amd. No.	Date of issue	Comments
8946	December 1995	Indicated by the sideline in the margin

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
0 Introduction	1
1 Scope	2
2 Definitions	2
3 Sizes	2
4 Dimensional deviations	3
5 Durability	3
6 Efflorescence	4
7 Compressive strength	4
8 Water absorption	4
9 Sampling for tests	4
10 Marking	6
Appendix A Measurement of dimensions	7
Appendix B Determination of soluble salt content	7
Appendix C <i>Appendix deleted</i>	11
Appendix D Determination of compressive strength	11
Appendix E Determination of water absorption	13
Appendix F Appearance	13
Appendix G Check-list for ordering bricks	14
Appendix H Determination of initial rate of suction	15
Appendix J Recommendations for quality control	15
Figure 1 — Arrangement of bricks for the measurement of dimensions	8
Figure 2 — <i>Figure deleted</i>	11
Figure 3 — Example of control charts for the quality control scheme for compressive strength	17
Table 1 — Sizes	2
Table 2 — Limits of size	3
Table 3 — Durability designations	4
Table 4 — Classification of bricks by compressive strength and water absorption	5
Table 5 — Number of bricks required for testing	5
Table 6 — Limits for the dimensions measured when using the gauge board	22
Publications referred to	Inside back cover

Foreword

This revision of BS 3921 has been prepared under the direction of the Clay Products Standards Committee and supersedes BS 3921:1974 which is therefore withdrawn.

In this revision the committee have attempted to specify more closely, and to quantify where possible, those properties of fired-clay bricks which are most critical in use, with particular regard to durability.

The main changes from the previous edition are as follows.

Requirements for clay blocks have not been included, since they are no longer manufactured.

The anomaly whereby bricks with holes forming up to 25 % of the gross volume were designated "solid" has been removed.

NOTE This does not affect recommendations in other documents that a perforated brick should be treated as solid, for example in respect of its behaviour under compressive loading and in fire resistance tables.

The method of overall measurement of 24 bricks has been retained. However, a limit on the maximum size of any brick has been added to ensure that the limits of tolerance have been met.

The 225 mm × 112.5 mm × 75 mm format has been retained as the only format in this standard. However, a new standard, BS 6649, has been published which specifies a single format, namely 200 mm × 100 mm × 75 mm, selected by the Department of Education and Science, Royal Institute of British Architects and Society of Chief Architects of Local Authorities as the most promising of the four formats listed in DD 34 and DD 59 which are withdrawn. It is intended for users requiring bricks having dimensionally coordinated sizes.

The decision to cover these two brick formats in separate standards was taken to allow for any possible future development and to obviate confusion when ordering bricks. Other formats are available and will be covered in the forthcoming revision of BS 4729. (At present BS 4729 covers only special shapes.)

Limits for the soluble salts content for all bricks have now been specified. Accordingly the liability to efflorescence test has been deleted as its function was to safeguard against the use of bricks with excessive quantities of very soluble salts. The test was originally intended to predict the liability of the bricks to damage from magnesium sulphate and to a lesser extent potassium sulphate crystallisation. It was not intended to indicate the liability of brickwork to exhibit the visual effects to water soluble efflorescence as is commonly supposed. It has proved difficult to relate the result of the test to the liability of the brickwork to produce efflorescence, although this is in part explained by the fact that some efflorescence arises from causes other than the water soluble salts content of the bricks. Alkalies derived from the mortar constituents and salts present in ground water are typical examples.

Experience also suggests that efflorescence is mainly a short term problem and the risk is minimized where the brickwork is constructed in accordance with the recommendations in BS 5628 *Code of Practice for Use of Masonry Part 3. Materials and Components, Design and Workmanship*.

Pending further research, it is now a requirement to state the frost resistance of bricks, classifying them into one of three categories (see clause 5). As a consequence, the distinction between ordinary and special quality is no longer required. As soon as sufficient evidence is available to set appropriate performance levels, a test method for frost resistance will be included in the standard. It is also the intention to develop some form of index for assessing the effect of sulphate content on performance of brickwork in buildings.

It has not yet been found possible to specify an overall limit for soluble salt content for all bricks. In the meantime, a requirement that bricks do not show an efflorescence worse than Moderate has been included to exclude bricks that have excessive quantities of very soluble salts.

The loadbearing classification of bricks in BS 3921:1974 has been omitted from this standard.

It is now a requirement to state the water absorption of bricks. Experimental work has shown that there is no simple relationship between the values for the water absorption determined by the 5 h boil and vacuum methods. Only the 5 h boil method is, therefore, now specified in the standard, although the vacuum or the 24 h soak methods still may be used for works quality control.

The committee has been unable to recommend a satisfactory test for the irreversible moisture expansion which affects all fired-clay products, especially in their early life. However, research in this field is continuing.

In view of the wide range of appearance which gives the many varieties of bricks or individual facing bricks their aesthetic appeal, it is not practicable to establish a numerical system of classification. However, a guide to assessment of visual acceptability for facing bricks has been included (see appendix F).

A check-list for ordering bricks has been added (see appendix G).

A suction rate test has been added (see appendix H) because in highly stressed masonry structures the initial rate of suction of the bricks may need to be specified or adjusted by wetting to some predetermined level.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 22, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Introduction

0.1 Water absorption

As a consequence of extensive research into the structural performance of fired-clay masonry, the importance of water absorption as a determinant of its behaviour in flexure is now recognized.

BS 5628-1 relates three levels of water absorption (less than 7 %; between 7 % and 12 %; over 12 %) to the characteristic flexural strengths to be used in design.

A low water absorption figure is used to classify engineering bricks and bricks for damp-proof courses but water absorption, like strength, is not a general index of durability. With many clays, the more durable bricks of a given type absorb less water than those of the same type that are not so durable.

0.2 Durability

Much research has been carried out to develop a reliable test for frost resistance. The British Ceramic Research Association has devised a panel freezing test¹⁾ for testing samples of clay brickwork rather than individual bricks, which has the merit of reproducing the type of failure found in practice. In this test the brickwork panel is maintained in a saturated condition and subjected to 100 cycles of freezing and thawing. It is thus a very severe test and bricks which withstand 100 cycles may be expected to be frost resistant (class F as defined in 5.1). Work is in progress to develop a single pan-European frost resistance test for clay masonry units. Natural exposure tests are being carried out to get more information. Where the test is not appropriate, the manufacturer should provide evidence that bricks of the quality to be offered have been in service under conditions of exposure at least as severe as those proposed for not less than 3 years in the situation in which their use is to be considered and that their performance has been shown by inspection to be satisfactory.

It should be noted that the durability of fired-clay brickwork depends not only upon the properties of the bricks but also on other material in contact with them, the exposure conditions and the degree of protection from the effects of weather, particularly moisture penetration. For guidance see BS 5628-3.

0.3 Tolerances

The average size of the bricks in a batch should not vary greatly from the average size in the sample of 24 bricks tested, although average size may occasionally alter sufficiently from one batch to the next for the effect to be noticeable in the finished brickwork. Individual bricks, on the other hand, may show a greater deviation due to differences cancelling one another in the test. These variabilities are a natural characteristic of fired clay bricks.

Accuracy can become critical where very short lengths of brickwork are involved and insufficient joints are available to absorb variability in the individual bricks without excessive variation in joint width. It is also important where, in a larger area of work, a poor appearance might result from a change in the average size (and hence joint width) due to differences between batches. In such cases the designer should consider carefully the character of the particular bricks specified.

At any one time, variations in the manufacturing, drying and firing conditions will cause variations in the size of the bricks. This is the usual cause of variation in the batch (consignment). The magnitude of the variation in the batch is influenced by the type of clay and the manufacturing process.

In addition, the batch average can deviate from the target or work size due to gradual changes in raw materials. This is the usual cause of variation between batches, for which the manufacturer has to make periodic adjustment.

It is the combined effect of the variations in and between batches which affects the user. The method of overall measurement of 24 bricks takes into account both variations but is influenced more by the latter.

It is however, the deviation from the work size which is of concern to the user. The overall measurement of 24 bricks is based on the prediction that individual brick dimensions should not differ from the work size by more than 6.4 mm on length and 4 mm on width and height. This is a compromise between the requirements of the manufacturer and the user. Batches with less than 1 % of individual brick dimensions outside these tolerances have a chance of rejection of approximately 1 in 1 000 whilst batches containing more than 12 % of individual brick dimensions outside these tolerances have a chance of acceptance of approximately 1 in 200.

¹⁾ See *Transactions and Journal of the British Ceramic Society*, Vol. 83 (1984), available from the British Ceramic Research Association, Queens Road, Penkhull, Stoke-on-Trent ST4 7LQ.

It was apparent from the evidence of control charts made available to the committee responsible for drafting BS 3921:1974 that some types of brick (e.g. handmade and stock bricks) had some difficulty in meeting the dimensional requirement. Other types of brick could meet a more stringent requirement, although not consistently; manufacturers have sometimes supplied these bricks with smaller tolerances by special arrangement with the user. The committee has therefore felt it desirable to retain tolerances similar to those in BS 657²⁾, and to suggest that smaller tolerances should be agreed between the manufacturer and the user.

1 Scope

This British Standard specifies requirements for dimensions, compressive strength, water absorption, soluble salts content, efflorescence and sampling for bricks manufactured from clay for use in walling. It also gives methods of classification. The bricks are intended to be laid on a bed of mortar, following the recommendations in BS 5628-3.

Sizes and tolerances given in this standard apply only to the 225 mm × 125 mm × 75 mm format (see 0.3). Requirements for a 200 mm × 100 mm × 75 mm format are given in BS 6649 and requirements for special bricks are given in BS 4729.

- NOTE 1 In view of the wide variety of bricks available, there are no requirements for appearance, but general guidance is given in appendix F as well as a guide to the assessment of the visual acceptability of consignments of facing bricks using a reference panel.
- NOTE 2 Some types of bricks may also be suitable for use in paving.
- NOTE 3 A check-list for ordering bricks is given in appendix G. A suction rate test is given in appendix H.
- NOTE 4 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the definitions given in BS 6100-5.3 apply, together with the following.

2.1 compressive strength

the average value of the crushing strengths of ten bricks sampled in accordance with clause 9 and tested in accordance with appendix D

2.2 water absorption

the average value of the water absorptions of ten bricks sampled in accordance with clause 9 and tested in accordance with appendix E

2.3 coordinating size

the size of a coordinating space allocated to a brick, including allowances for joints and tolerances

2.4 work size

the size of a brick specified for its manufacture, to which its actual size should conform within specified permissible deviations

3 Sizes

3.1 External sizes

Bricks shall be designated in terms of their coordinating sizes. The coordinating sizes and work sizes for bricks shall be as given in Table 1.

Table 1 — Sizes

Coordinating size			Work size		
Length	Width	Height	Length	Width	Height
mm	mm	mm	mm	mm	mm
225	112.5	75	215	102.5	65
NOTE The work sizes are derived from the corresponding coordinating sizes by the subtraction of a nominal thickness of 10 mm for the mortar joint.					

²⁾ BS 657:1950 “Dimensions of common clay building bricks” was withdrawn in 1974 when the previous edition of BS 3921 superseded it.

3.2 Sizes of voids

Solid bricks shall not have holes, cavities³⁾ or depressions.

Cellular bricks shall not have holes, but may have frogs or cavities³⁾ exceeding 20 % of the gross volume of the brick.

Perforated bricks shall have holes not exceeding 25 % of the gross volume of the brick. The holes shall be so disposed that the aggregate thickness of solid material, measured horizontally across the width of the unit at right angles to the face, is nowhere less than 30 % of the overall width of the brick. The area of any one hole shall not exceed 10 % of the gross area of the brick.

Frogged bricks shall have depressions in one or more bed faces but their total volume shall not exceed 20 % of the gross volume of the brick.

4 Dimensional deviations

The overall measurements of 24 bricks sampled in accordance with clause 9 and measured as described in appendix A shall not fall outside the limits given in Table 2. In addition, the size of any individual brick in the sample shall not exceed the coordinating size given in Table 1.

Table 2 — Limits of size

Work size (see Table 1)	Overall measurement of 24 bricks	
	Maximum	Minimum
mm	mm	mm
215	5235	5085
102.5	2505	2415
65	1605	1515
NOTE Where for special reasons closer limits of size are required, this can best be achieved by agreement between the specifier and the supplier.		

5 Durability

NOTE The classification of bricks by frost resistance (see 5.1) and by soluble salts content (see 5.2) may be used to distinguish different designations of durability as given in Table 3.

The word “designation” has been used rather than “level” to avoid any implication that bricks of one particular frost resistance and soluble salts content are of better quality than bricks of any other frost resistance and/or soluble salts content.

5.1 Frost resistance

The bricks shall be classified into one of the following categories.

Frost resistant (F). Bricks durable in all building situations including those where they are in a saturated condition and subjected to repeated freezing and thawing.

Moderately frost resistant (M). Bricks durable except when in a saturated condition and subjected to repeated freezing and thawing.

Not frost resistant (O). Bricks liable to be damaged by freezing and thawing if not protected as recommended in BS 5628-3 during construction and afterwards, e.g. by an impermeable cladding. Such units may be suitable for internal use.

5.2 Soluble salts content

The bricks shall be classified into one of the following categories.

Low (L). The percentage by mass of soluble ions, measured as described in appendix B, shall not exceed the following.

magnesium	0.030 %
potassium	0.030 %

³⁾ A cavity is a hole closed at one end.