BRITISH STANDARD

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Incorporating Amendment Nos. 1, 2 and 3

Precast concrete masonry units —

Part 1: Specification for precast concrete masonry units

ICS 91.100.30

BSI British Standards

Committees responsible for this British Standard

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Autoclaved Aerated Concrete Products Association
Brick Development Association
British Ceramic Research Ltd.
British Civil Engineering Test Equipment Manufacturers' Association
British Precast Concrete Federation Ltd.
Concrete Block Association
District Surveyors Association
Local Authority Organizations
Mortar Industry Association
National House-Building Council
Office of the Deputy Prime Minister — Building Regulations Division
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Stone Federation

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Foreword

This part of BS 6073 has been prepared by Subcommittee B/519/1, Masonry units. Together with Part 2, it supersedes BS 1180:1972 and BS 2028, 1364:1968, which are therefore withdrawn.

This part is a specification for precast concrete masonry units giving criteria for materials, minimum performance levels and maximum permissible dimensional deviations for solid, cellular or hollow units. BS 6073-2 is a method of specifying concrete masonry units, which gives guidance on items that should be considered when specifying precast concrete masonry units.

When revising BS 2028, 1364:1968, the committee carried out a survey of block sizes in common use. It was found that no particular thicknesses predominated and hence there was no possibility of specifying a standard range. Furthermore, forthcoming changes in legislation relating to energy conservation made it probable that new sizes of block would be developed in the near future. Similarly, no one strength was in general use. It also became clear that similar minimum performance criteria were also applicable to concrete bricks so the opportunity was taken to extend this revision to replace BS 1180:1972.

The former classification of blocks as types A, B and C in BS 2028, 1364 has not been perpetuated, as it has proved misleading. The alternative of classifying blocks by compressive strength was discussed but rejected in favour of specifying a minimum average compressive strength for all blocks not less than 75 mm in thickness and a minimum average transverse strength for blocks of thickness less than 75 mm.

The committee decided that the method of mortar capping blocks should continue to be used for verifying block strengths when required for independent testing. The fibre board method, which is suitable for routine quality control by the manufacturer, is described in Appendix B of BS 6073-2:1981.

The test procedures for determining drying shrinkage given in BS 2028, 1364 have been found to have certain drawbacks but have been included in Appendix D pending research by various organizations represented on the committee. If necessary, an amendment to Appendix D will be issued.

In the light of recent research, the specification given in BS 1180:1972 has been updated to include special purpose bricks, which have a specified minimum cement content and strength. The definitions of types of brick have been retained pending general agreement throughout industry on new definitions applicable to all British Standards for bricks.

The structural design and performance of brick and block masonry are covered by BS 5628-1 and BS 5628-3, which include guidance on use of blocks below damp-proof course and in other situations.

A common criterion for the permissible variation in compressive strength has replaced the different criteria for blocks, bricks and fixing units, which were taken from BS 2028, 1364 and BS 1180.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its 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 20, an inside back cover and a back cover.

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1 Scope

This part of BS 6073 specifies materials, tolerances and minimum performance levels for precast concrete masonry units. It covers solid (including autoclaved aerated concrete), cellular and hollow units not exceeding 650 mm in any work size dimension.

Units in which the height[1)] exceeds the length or six times the thickness are outside the scope of this standard.

Precast concrete paving blocks are outside the scope of this standard.

NOTE Reconstructed stone masonry units are covered by BS 6457.

2 References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3 Definitions

For the purposes of this part of BS 6073 the following definitions apply.

3.1 masonry unit

a block, a brick or a fixing unit

3.1.1
block
a masonry unit which when used in its normal aspect exceeds the length or width or height[1)] specified for bricks (see)

3.1.2
brick
a masonry unit not exceeding 337.5 mm in length, 225 mm in thickness[2)] or 112.5 mm in height[1)]

3.1.3
fixing unit
a masonry unit of the same dimensions as a brick which permits the easy driving of, and provides a good purchase for, nails or screws

3.2 Types of block

NOTE 1 Formed holes do not include transverse slots to facilitate cutting.

NOTE 2 Formed holes or cavities include those filled with structural insulant.

3.2.1
solid block
a block which contains no formed holes or cavities other than those inherent in the material

NOTE The definition of solid block covers autoclaved aerated blocks.

3.2.2
cellular block
a block which has one or more formed holes or cavities which do not wholly pass through the block

3.2.3
hollow block
a block which has one or more formed holes or cavities which pass through the block

1) The height is taken to be the vertical dimension perpendicular to the base when the unit is used in its normal aspect.
2) Termed width in BS 3921.

3.3 Types of brick

3.3.1
solid brick
a brick in which small holes passing through, or nearly through, the brick do not exceed 25 % of its volume, or in which frogs (depressions in the bed faces of a brick) do not exceed 20 % of its volume

NOTE For the purposes of this definition small holes are defined as being less than 20 mm wide or less than 500 mm^2 in area. Up to three larger holes, not exceeding 3 250 mm^2 each, may be incorporated as aids to handling, within the total of 25 %.

3.3.2
perforated brick
a brick in which small holes (as defined in the note to **3.3.1**) passing through the brick exceed 25 % of its volume. Up to three larger holes, not exceeding 3 250 mm^2 each, may be incorporated as aids to handling

3.3.3
hollow brick
a brick in which holes passing through the brick exceed 25 % of its volume and the holes are not small, as defined in the note to **3.3.1**

3.3.4
cellular brick
a brick in which holes closed at one end exceed 20 % of the volume of the brick

3.4 Sizes

3.4.1
co-ordinating size
the size of a co-ordinating space allocated to a masonry unit, including allowances for joints and tolerances

3.4.2
work size
the size of a masonry unit specified for its manufacture, to which its actual size should conform within specified permissible deviations

3.5
compressive strength
the average value of the crushing strengths of ten masonry units tested in accordance with Appendix B

4 Binders and binder constituents

Text deleted

5 Aggregates

Text deleted

6 Admixtures

Text deleted

7 Chloride content

The equivalent anhydrous calcium chloride content shall not exceed 0.2 % by mass of the masonry units when measured in accordance with the method given in BS 1881-6, except when it does not exceed 1.5 % by mass of the cement used in their manufacture.

8 External shell thickness of blocks

The minimum thickness of the external shell of hollow and cellular blocks, measured in accordance with **A.1.5**, shall be not less than 15 mm or 1.75 times the nominal maximum size of the aggregate, whichever is the greater.

9 Dimensional deviations

The maximum dimensional deviations for masonry units measured in accordance with Appendix A shall be as follows.

Dimension	Maximum dimensional deviation for blocks	Maximum dimensional deviation for bricks
Length	+3 mm –5 mm	+4 mm –2 mm
Height	+3 mm –5 mm	+2 mm –2 mm
Thickness	+2 mm –2 mm average	+2 mm –2 mm
	+4 mm –4 mm at any individual point	

Within these dimensional deviations the bedding surfaces and, for plain ended masonry units, the ends, shall be perpendicular to adjacent faces.

10 Strength

10.1 When sampled in accordance with Clause **13** and tested for compressive strength in accordance with Appendix B, the average crushing strength of 10 masonry units of thickness 75 mm or greater shall be:

a) not less than G;

and

b) not less than $0.9\,G + 0.62\,S$.

where

G = 2.8 N/mm^2 for blocks and fixing bricks or 7.0 N/mm^2 for bricks;

S is the standard deviation for the sample.

10.2 When sampled in accordance with Clause **13** and tested in accordance with Appendix C, the average transverse strength of five blocks of thickness less than 75 mm shall be not less than 0.65 N/mm^2.

11 Drying shrinkage

The average drying shrinkage of a sample of masonry units other than fixing units tested in accordance with Appendix D shall not exceed 0.06 %, except for autoclaved aerated concrete blocks, for which the maximum permissible value shall be 0.09 %.

NOTE In practice, the extremes of drying shrinkage given above do not occur in finished masonry. For guidance, see BS 5628-3.

12 Certificate of compliance

If requested, the manufacturer or supplier shall provide the purchaser with a certificate of compliance with the specification.

This certificate shall state that the manufacturer has made arrangements for his products to be sampled and tested at regular intervals.

13 Independent testing

13.1 Sampling

A representative sample of masonry units required for test purposes shall be selected to the mutual satisfaction of manufacturer, supplier and purchaser. (The number of masonry units required for each test is shown in Table 1.) The sample shall be taken, either immediately before delivery or as soon after delivery as convenient to all parties who are to be represented at the time of sampling. When the sample is taken from the stack, any units required for drying shrinkage tests shall be removed from positions away from the outside of the stack and shall be marked accordingly.

13.2 Identification and protection of samples

Each sample of masonry units shall be marked so as to identify the consignment and type of unit it represents. The date and place of sampling and, where known, the date of manufacture shall be recorded.

The masonry units shall be kept under cover and protected from extremes of conditions of temperature, relative humidity and wind exposure until they are required for test. The tests shall be carried out as soon as practicable after the sample has been taken.

Table 1 — Number of masonry units required for testing

Purpose	Appendix reference	Number of blocks required per consignment of 1 000 or part thereof		Number of bricks required per consignment of 10 000 or part thereof
Dimensional checks	A	Thickness ≥ 75 mm	Thickness <75 mm	10 (available for subsequent tests)
		10 (available for subsequent tests)	10 (available for subsequent tests)	
Compressive strength determination	B	10	—	10
Transverse strength determination	C	—	5	—
Drying shrinkage determination	D	4	4	4

14 Identification of masonry units

The following particulars relating to masonry units made in accordance with this standard shall be clearly indicated on the delivery note, invoice or supplier's certificate supplied with a consignment of units:

a) the name, trade mark or other means of identification of the manufacturer;

b) the number of this British Standard, i.e. BS 6073-1, followed by the strength of unit in N/mm^2; for example, BS 6073-1 (10) indicates a concrete masonry unit of strength 10 N/mm^2 complying with all the requirements of BS 6073-1;

c) the length, height and thickness of the masonry units;

d) the type of masonry unit, i.e. solid, cellular, hollow, or perforated.

NOTE 1 It is desirable to repeat the same details on any wrapping supplied with the consignment of units.

NOTE 2 Marking BS 6073-1 on or in relation to a product is a claim by the manufacturer that the product has been manufactured in accordance with the requirements of the standard. The accuracy of such a claim is therefore solely the manufacturer's responsibility. Enquiries as to the availability of third party certification to support such claims should be adressed to the Director, British Standards Institution, Maylands Avenue, Hemel Hempstead, Herts HP2 4SQ in the case of certification marks administered by BSI or to the appropriate authority for other certification marks.

Appendix A
Measurement of dimensions

A.1 Measurement of blocks

A.1.1 *Test specimens*

Take at random 10 blocks sampled in accordance with Clause **13**. Before measuring a block, remove any flashings with a carborundum stone

A.1.2 *Apparatus*

A.1.2.1 *GO/NOT GO gauges* as shown in Figure 1 and appropriate to the specified length and height of the block.

A.1.2.2 *External calipers* complying with the requirements of BS 3123.

A.1.2.3 *A rule* graduated to 1 mm, for use with the calipers.

A.1.3 *Height and length*

Check the compliance of each block for length at the four corners of the end faces, as shown in Figure 2(a), using a GO/NOT GO gauge. Ignore any tongue, as shown in Figure 2(d). Similarly, check the compliance of each block for height at the six positions shown in Figure 2(b).

Record each result as pass or fail.

A.1.4 *Thickness*

Measure the thickness of each block at the seven positions shown in Figure 2(c), using the calipers and the rule and measuring to the nearest millimetre.

Record each result.

Calculate the average of the seven results to the nearest millimetre.

A.1.5 *Minimum external shell thickness*

Measure the minimum external shell thickness of each block at four approximately symmetrical positions along the top edge of the block as cast, using the calipers and the rule and measuring to the nearest millimetre.

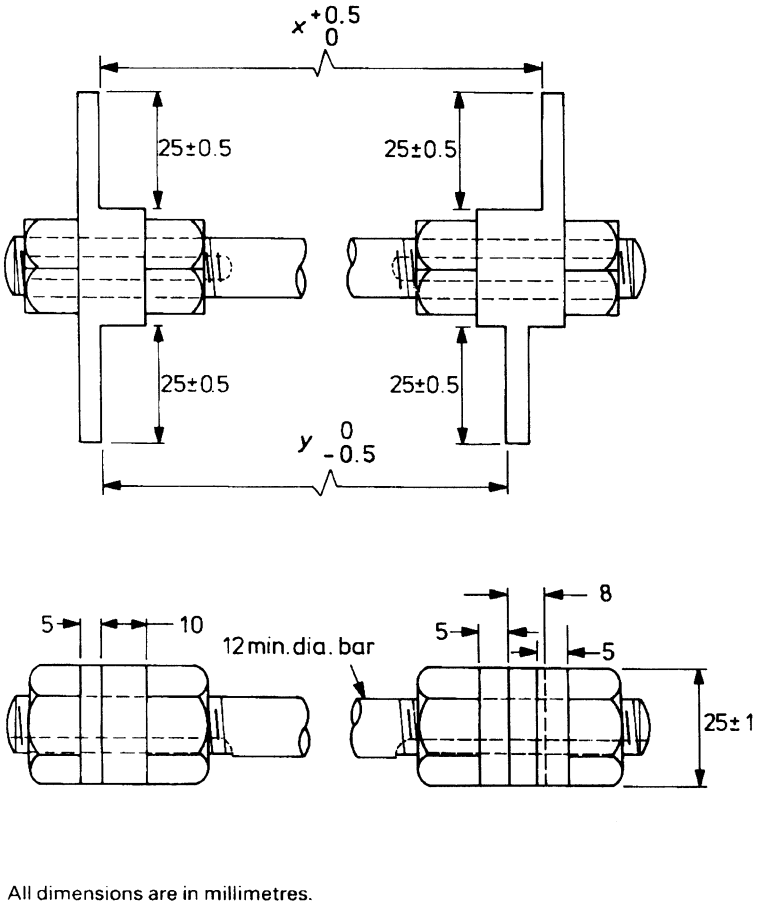
Record each result.

Calculate the average of the four results to the nearest millimetre.

A.2 Measurement of bricks

Take at random 10 bricks sampled in accordance with Clause **13**. Using the calipers (**A.1.2.2**) and the rule (**A.1.2.3**), measure each brick to the nearest millimetre.

Record the height, length and thickness of each brick. Calculate the average of the 10 results to the nearest millimetre.

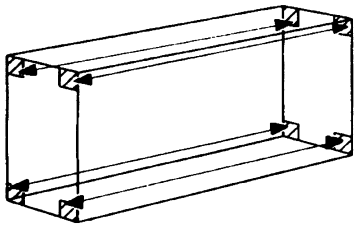


All dimensions are in millimetres.

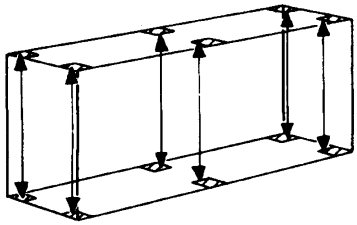
NOTE 1 x is the specified dimension of the block plus 3 mm, and y is the specified dimension of the block minus 5 mm.

NOTE 2 Keys are used for keeping fittings at both ends in the same plane.

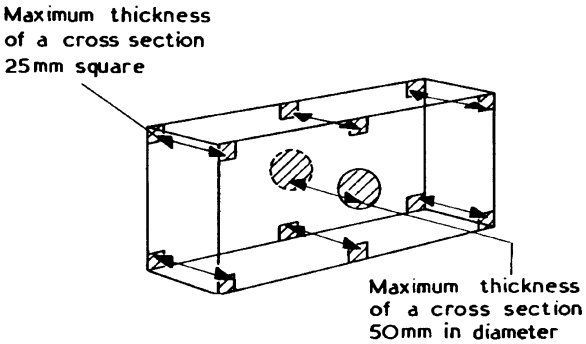
Figure 1 — GO/NOT GO gauges for checking length and height of blocks



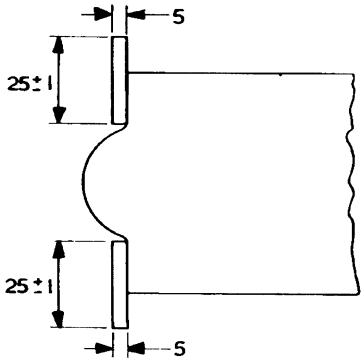
(a) Four positions for checking length of whole blocks



(b) Six positions for checking height of whole blocks



(c) Seven measurements of thickness



(d) Measurement of a tongued block

All dimensions are in millimetres.

Figure 2 — Checking and measuring dimensions of blocks

Appendix B
Determination of compressive strength

B.1 Compressive strength of blocks

B.1.1 *Apparatus*

B.1.1.1 *Capping plates*

B.1.1.1.1 When following the procedure described in **B.1.2.3.1**, a steel capping plate at least 25 mm longer and wider than the block to be capped, not less than 19 mm thick and complying with the requirements of BS 5078 or a sheet of glass at least 9 mm thick ground to a flatness tolerance of 0.1 mm on one side shall be used.

B.1.1.1.2 Alternatively, if the procedure described in **B.1.2.3.2** is followed, either a steel plate and a sheet of glass or two sheets of glass, all complying with the requirements for size and planeness given in **B.1.1.1.1** shall be used.

B.1.1.1.3 The steel plate described in **B.1.1.1.1** and **B.1.1.1.2** or the single sheet of glass described in **B.1.1.1.1** or the lower of the two sheets of glass described in **B.1.1.1.2** shall be adequately supported over most of its area (e.g. in a bed of mortar) to prevent excessive deflection.

B.1.1.2 *A square or a vertical level* complying with the requirements of BS 958.

B.1.1.3 *Testing machine.* A testing machine of sufficient capacity for the test and equipped with a means of providing the rate of loading specified in **B.1.3.3** and with a pacing device. The capacity of the machine shall be such that the expected ultimate load on a specimen is greater than one-fifth of the machine scale range. The accuracy of the machine shall comply with the requirements for grade A or B of BS 1610.

The testing machine shall be equipped with two permanent ferrous bearing platens which shall normally be as large as the bedding faces of the specimen being tested. Where the permanent platens of the testing machine are not as large as the specimen to be tested, auxiliary bearing platens having dimensions not less than those of the specimen shall be used. These shall not be fixed to the permanent platens, but shall be brought to bear in intimate contact, care being taken to exclude dirt from the interfaces. In no case, however, shall the auxiliary platen overhang the permanent platen by more than 75 mm.

The upper machine platen shall be able to align freely with the specimens as contact is made but the platens shall be restrained by friction or other means from tilting with respect to each other during loading.

The lower compression platen shall be a plain, non-tilting bearing block.

The auxiliary platen that will bear on the upper surface of the specimen shall be attached loosely to the testing machine by flexible wire or chain, to prevent it falling if the specimen collapses suddenly under load.

The testing face of the main platen and both faces of each auxiliary platen shall be hardened and shall have:

a) a flatness tolerance of 0.05 mm;

b) a parallelism tolerance for one face of each platen with respect to the other face as datum of 0.10 mm;

c) a surface texture not greater than 3.2 μm R_a, measured in accordance with BS 1134.

The testing faces, where case-hardened, shall have a Vickers hardness of at least 600 HV when tested in accordance with BS 427-1.

Where the platens are through-hardened, the steel shall be of grade 826M40Y as specified in BS 970-1 or any equivalent grade of steel.

The permanent platens shall be solid and not less than 50 mm thick, unless blocks of specified compressive strength of 7.0 N/mm^2 or more are to be tested, in which case the platens shall be not less than 75 mm thick.

Auxiliary platens shall be solid and have a thickness not less than two-thirds the amount by which they overhang the permanent platens unless blocks of specified compressive strength of 7.0 N/mm^2 or more are to be tested, in which case the thickness shall not be less than the overhang.

B.1.2 ***Preparation of specimens***

B.1.2.1 Immerse each specimen to be mortar capped in water at a temperature of between 10 °C and 25 °C for at least 16 h. Allow to drain on a stillage in a laboratory until the block stops dripping.

B.1.2.2 Prepare mortar for capping each block from one part by mass of ordinary or rapid-hardening Portland cement complying with the requirements of BS 12, or high alumina cement complying with the requirements of BS 915-2, to one part by mass of sand complying with the requirements of grading zones 2 or 3 of BS 882, but from which has been rejected material retained on a 2.36 mm fine mesh normal or special test sieve as specified in BS 410. Use a measured quantity of water sufficient to produce a mortar having a consistence value of not less than 6 mm and not more than 9 mm when measured by the test for the determination of consistence by the dropping ball method specified in BS 4551.

Make cubes from the mortar and test for compressive strength in accordance with the procedures given in BS 4551.

B.1.2.3 Bed each face with the mortar, using the appropriate method described in **B.1.2.3.1** or **B.1.2.3.2**.

B.1.2.3.1 Cover the machined face of the steel plate or the working face of the single sheet of plate glass (see **B.1.1.1.1**) with an appropriate release material (e.g. a film of oil or a sheet of absorbent paper) to prevent any mortar adhering to it. Support the plate with the working surface uppermost so that the surface is level.

Place a uniform layer of the mortar, about 5 mm thick, on the plate. Press the bed face that was not in contact with the stillage (see **B.1.2.1**) firmly into the layer of mortar so that the vertical axis of the specimen is perpendicular to the plane of the plate. Check this condition by using the square or vertical level held against each of the four vertical faces of the specimen in turn, making allowance for any taper of the block sides. Ensure that the thickness of the mortar bed is at least 3 mm over the whole area and that any cavity in the bed face, which is normally filled when the blocks are laid in the wall, is completely filled with mortar. Cavities which are formed in the block to produce a lightweight block shall not be filled. Trim off any surplus mortar flush with the sides of the block. Cover the specimen and mortar with a damp cloth. Ensure that the cloth is kept damp.

Allow the specimen to remain undisturbed for at least 16 h and then carefully remove the bedded specimen from the plate without damaging the mortar. Examine the mortar bed for defects such as lack of compaction, cracking and lack of adhesion to the block. If the bed is free from defects, bed the second bed face in the same way as the first, using mortar made with materials drawn from the same samples and with the same proportions of cement, sand and water as for the first bedding operation, and make cubes as before. After removing the specimen from the plate, check that the mortar bed is free from defects.

B.1.2.3.2 Cap each block by using either a steel plate and a sheet of plate glass or two sheets of plate glass (see **B.1.1.1.2**). Support the steel plate, or one of the two sheets of plate glass, so that the working face is horizontal and uppermost. Cover it with an appropriate release material, as described in **B.1.2.3.1**. Place a layer of mortar on this face and press a bed of the block into the mortar so that the vertical axis of the block is vertical.

Coat the working face of the remaining sheet of glass with a transparent release agent. Then place a uniform layer of the mortar, about 5 mm thick, on the upper bed face of the specimen, and place the sheet of glass, working face downwards, on to the bed of mortar. Work the plate, observing the condition of the mortar bed, until the mortar forms a horizontal bedding face and the bed is at least 3 mm thick over the whole area. Check the horizontal and vertical settings of the plates and blocks, using a spirit level, and trim off any surplus mortar flush with the sides of the block. Cover and allow to remain undisturbed and check as described in **B.1.2.3.1**.

After checking, immerse the block in water at a temperature of between 10 °C and 25 °C.

B.1.3 ***Test procedure***

B.1.3.1 When the mortar has reached a cube strength of at least 28 N/mm^2, remove each prepared mortar capped specimen about 30 min before it is to be tested and allow to drain under damp sacking, or similar material. Test the specimen whilst it is still in a wet condition.

B.1.3.2 Wipe the bearing surfaces of all the platens clean and remove any loose grit or other material from the surfaces of the specimen which are to be in contact with the platens. Place the mortar capped specimen in the machine without packing so that its centre of mass coincides with the axis of the machine. Where appropriate, set the zero of the machine with the ram slowly rising and the specimen in position, but without any platen in contact with the top of the specimen. If required, position the upper auxiliary platen on the specimen. Operate the machine to raise the ram to bring the auxiliary platen or specimen into contact with the machine platen.

B.1.3.3 Apply the load without shock and increase it continuously at a rate of 5 ± 0.5 N/mm^2 per minute, for blocks of specified strength less than or equal to 7 N/mm^2, or 10 ± 1 N/mm^2 per minute, for blocks of specified strength greater than 7 N/mm^2.

Maintain the appropriate loading rate, as far as possible, right up to failure.

B.1.3.4 Record the maximum load in newtons carried by the specimen during the test.

B.1.4 ***Calculation of compressive strength***

B.1.4.1 Calculate to the nearest millimetre the average value of the three top thicknesses and the average value of the three bottom thicknesses, measured in accordance with **A.1.4**, of each specimen.

B.1.4.2 Obtain the gross area of the specimen by multiplying the lesser of the two average thicknesses from **B.1.4.1** by the specified length.

B.1.4.3 Obtain the crushing strength of the specimen by dividing the maximum load from **B.1.3.4** by the gross area from **B.1.4.2**.

Record the crushing strength in N/mm^2 to the nearest 0.05 N/mm^2 for blocks of specified compressive strength of less than or equal to 7.0 N/mm^2 and to the nearest 0.1 N/mm^2 for blocks of specified compressive strength greater than 7.0 N/mm^2.

B.1.4.4 Calculate the average crushing strength (compressive strength) of the sample, using the same degree of accuracy as for the crushing strength in **B.1.4.3**.

B.1.4.5 Calculate the standard deviation, *S*, for the sample.

B.2 Compressive strength of bricks and fixing units

B.2.1 ***Apparatus***

Testing machine as described in **B.1.1.3**.

B.2.2 ***Preparation of specimens***

Immerse each specimen in water at a temperature of between 10 °C and 25 °C for at least 16 h.

B.2.3 ***Testing procedure***

B.2.3.1 Take each brick out of the water and place it with a bed face perpendicular to the direction of application of the load in the testing machine. To ensure a uniform bearing, place the brick between plywood sheets, not less than 2.4 mm thick and not more than 4.8 mm thick to take up irregularities. Ensure that the plywood extends beyond the faces of the brick all round the perimeter of each bed face. Use a fresh pair of plywood sheets for each test.

B.2.3.2 Apply the load axially, at the rate of 200 ± 20 kN/min for a frogged brick and 400 ± 40 kN/min for a brick with no frog until the brick has failed. For up to half of the anticipated maximum load, the rate of loading may be doubled.

B.2.3.3 Record the maximum load in newtons carried by the specimen during the test.

B.2.4 ***Calculation of compressive strength***

B.2.4.1 Where no frog or similar indentation is present, calculate the area of the smaller bed face of the specimen.

Where there is a frog, calculate the gross area of the bed face in which the frog lies and calculate the net area of application of the load as the gross area minus the area of the frog.

Where both bed faces contain frogs, calculate the area of the smaller net bed face as above.

For bricks having holes or perforations, calculate the gross area of the smaller bed face.

B.2.4.2 Obtain the crushing strength of each specimen by dividing the maximum load from **B.2.3.3** by the area of the bed face measured in **B.2.4.1**.

Record the crushing strength in N/mm^2 to the nearest 0.5 N/mm^2.

B.2.4.3 Calculate the average crushing strength (compressive strength) of the sample to the nearest 0.5 N/mm^2.

B.2.5 ***Calculation of standard deviation***

Calculate the standard deviation, S, for the sample.

B.2.5.1 Using the formula given below, calculate the coefficient of variation of compressive strength, K, from the crushing strengths of the specimens tested.

$$K = \frac{100}{\bar{x}} \sqrt{\frac{\Sigma(x-\bar{x})^2}{n-1}}$$

where

x is the individual crushing strength;

$\bar{x}$ is the average crushing strength;

n is the number of specimens in the sample tested;

$\Sigma(x-\bar{x})^2$ is the sum of the squares of the differences between the average crushing strength and each of the individual crushing strengths.

B.2.5.2 Record the value of K to the nearest 1 %.

Appendix C
Determination of transverse strength

C.1 Apparatus

A testing frame as shown in Figure 3. One of the support bearers and the load bearer shall be self aligning and the length of all bearers shall exceed the maximum height (i.e. the width in the testing position) of the block.

The vertical load shall be applied by a device the accuracy of which complies with the requirements for grade A or B of BS 1610. The capacity of the device shall be such that the expected ultimate load on a specimen is not less than one-fifth of the machine scale range.

C.2 Preparation of specimens

Immerse each specimen in water at a temperature of 10 °C to 25 °C for at least 16 h, and allow it to drain for about 30 min under damp sacking or similar material before it is to be tested.

C.3 Test procedure

C.3.1 Place each block centrally on the support bearers with the bedding faces perpendicular to the plane of the bearers. Apply the load without shock and increasing continuously at a rate such that the stress in the extreme fibres increases at approximately 1.5 N ± 0.2 N/mm^2 per minute.

C.3.2 Maintain the appropriate loading rate, as far as possible, right up to failure

C.3.3 Record the maximum load in newtons carried by the specimen during the test, to the nearest 25 N.

C.4 Calculation of transverse strength

C.4.1 Calculate to the nearest millimetre the average value of the thickness of the specimen in accordance with **A.1.4**.

C.4.2 Calculate to the nearest millimetre the mean height of the specimen, using the results obtained from **A.1.3**.

C.4.3 Obtain the transverse strength of the specimen from the following expression:

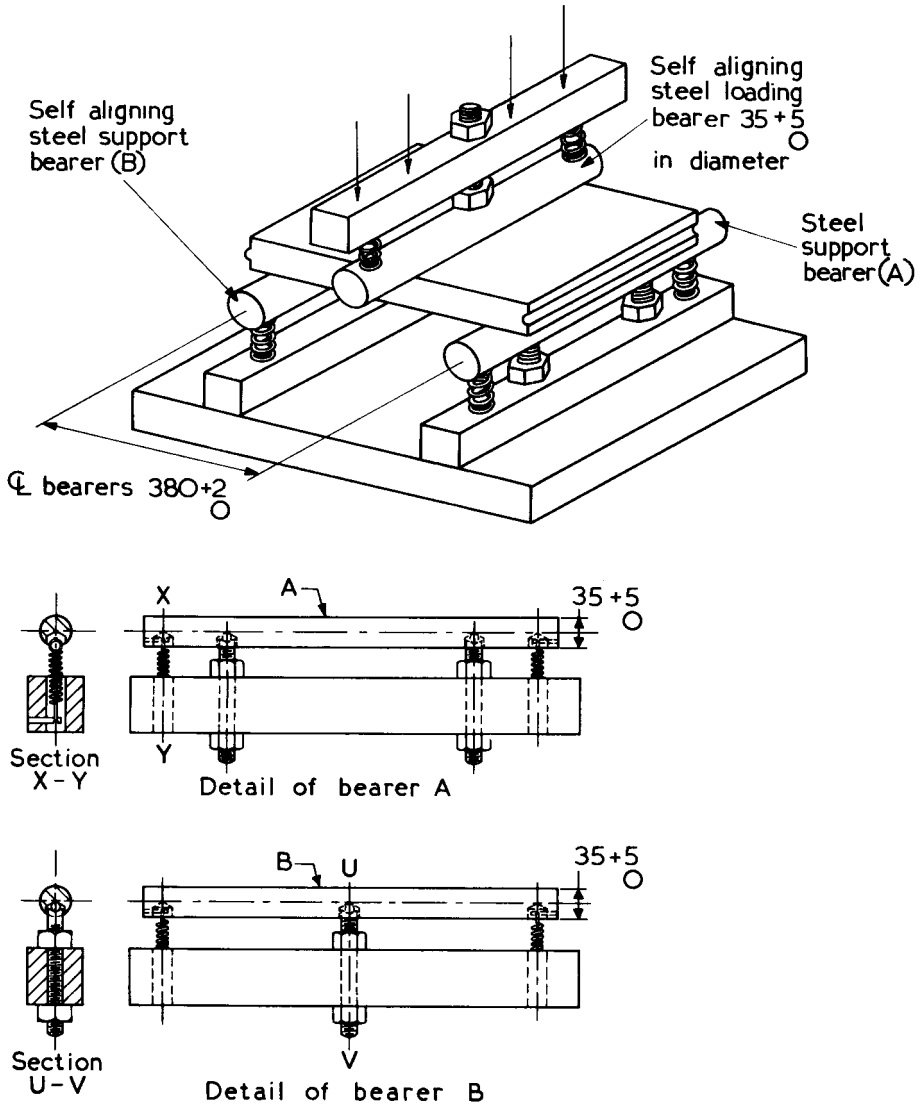
$$f = \frac{570P}{bt^2}$$

where

f is the transverse strength (in N/mm^2);
P is the recorded failure load of the specimen in newtons (from **C.3.3**);
b is the mean height of the block (in mm);
t is the mean thickness of the block (in mm).

Record the result, to the nearest 0.05 N/mm^2.

C.4.4 Calculate the average transverse strength of the sample, to the nearest 0.05 N/mm^2.



All dimensions are in millimetres.

Figure 3 — Apparatus for transverse strength test

Appendix D
Determination of drying shrinkage

D.1 Apparatus

D.1.1 *Measuring apparatus,* incorporating a micrometer gauge or a suitable dial gauge which reads accurately to 0.001 mm.

The gauge shall be rigidly mounted in a measuring frame and have a conical recessed end with 90° internal angle and a face diameter of 5.5 mm to 6.5 mm which can be located upon a 6.3 mm to 6.5 mm diameter stainless steel ball cemented in the specimen (as described in **D.2.3**). The lower end of the frame shall have a similar recessed seating which can be located upon the outer ball in the specimen. A steel reference rod shall be used as a standard length against which gauge readings can be tested. The rod shall have a negligible coefficient of expansion and shall be of a suitable length with hemispherical ends 6.3 mm to 6.5 mm in diameter or with 6.3 mm to 6.5 mm diameter stainless steel balls mounted in the ends. They shall be rotated at the seating and the minimum reading taken. This enables corrections to be made for any changes in the dimensions of the apparatus between successive measurements of a test specimen of different lengths. A convenient form of apparatus is shown in Figure 4.

D.1.2 ***Ovens***

D.1.2.1 *Conditioning oven*

D.1.2.1.1 *General*

The oven shall have an internal volume of not less than 0.05 m^3 or 6 times the total volume of the units to be dried at one time, whichever is the greater.

The oven shall be provided with a fan to keep the air circulating effectively during the drying of the specimens.

A partial immersion thermometer shall be so fitted that its bulb, and the part of the stem below the immersion line, are inside the oven, and the bulb is not less than 75 mm from the internal surface of the oven. The thermometer stem shall pass through a suitable bung in the wall or the top of the oven so that the temperature inside can be read from the outside.

The oven shall be capable of operating over a temperature range of 50 °C to 65 °C. The fluctuation of air temperature inside the oven at a setting of the thermostat in this range shall not be greater than 1 °C as specified in Clause **5** of BS 3718:1964. The relative humidity of the air inside the oven shall be controlled as described in **D.1.2.3** when the oven is empty and operating at a temperature of not less than 55 °C.

The oven shall be reasonably airtight.

NOTE 1 When a laboratory oven is to be used and it is not airtight this requirement may be met by adopting the following procedure:

a) correct any lack of airtightness in the oven lining;

b) seal the fan shaft access by a thin flexible sheet of impermeable material (e.g. polyethylene) sealed to the shaft and lightly pressed against the oven lining around the access hole (e.g. by cellular plastic fixed to the shaft);

c) seal any gap around, or holes in, the thermostat housing (e.g. with plasticine);

d) seal any ventilation holes completely;

e) provide an efficient door seal.

When the laboratory oven is sealed and airtight, a relief valve shall be provided which will operate at quite low pressures, e.g. 100 N/m^2 to 150 N/m^2, and enable the required rate of flow of air to be maintained through the auxiliary equipment (see **D.1.2.1.2**) by allowing the air to escape through a bubbler at a pressure of 150 N/m^2. The position of the outlet to the relief valve shall be chosen so as to be at a convenient point remote from the circulating fan.

NOTE 2 Laboratory humidity ovens (injection or non-injection types) complying with the requirements of, and used as recommended in, BS 3898 or BS 3718 respectively, with the atmosphere controlled by means of potassium acetate, may be used.

D.1.2.1.2 *Auxiliary equipment,* for providing saturated air for the oven.

D.1.2.1.2.1 *Air pump,* capable of delivering 35 litres of air per minute per cubic metre of oven capacity, i.e. approximately two air changes per hour.

D.1.2.1.2.2 *Flow meter,* for connection to the air pump to check the rate of flow of air.

D.1.2.1.2.3 *Equipment containing distilled or deionized water to produce saturated air at a fixed temperature,* consisting of a non-corrodible airtight container with the following features.

a) A means for controlling the average temperature of the water at 27 ± 1 °C with a fluctuation in temperature of not more than 1 °C as specified in Clause **5** of BS 3718:1964.

b) An air inlet pipe coiled below the surface of the water and terminating as an air diffuser near the bottom of the container.

c) An outlet tube with its inlet end well above the surface of the water and the opening screened from spray. The tube passes into the oven through a sealed opening (e.g. the top ventilator) and terminates inside the oven so that the saturated air is directed towards the inlet of the circulating fan.

d) A thermostat with sufficient length of stem for the bulb to be in the water and with the scale readable outside the equipment.

e) A pipe for replenishing the water in the equipment. The lower end should be below the surface of the water and the upper end should be connected to a funnel. If necessary, a pipe section may consist of glass tubing so that the level of the water in the container can be determined.

f) Lagging of the container, at least above the water level and above the outlet pipe connecting the equipment to the oven, to prevent condensation.

D.1.2.1.2.4 *By-pass tube,* with a two-way cock, such that the humidifying equipment (**D.1.2.1.3**) can be by-passed when not required without reducing the flow of air to the oven.

NOTE It is possible to construct this auxiliary equipment from standard chemical laboratory equipment but specially designed equipment may prove to be more efficient and robust.

D.1.2.1.3 *Control of relative humidity*

When the oven is empty and operating at a temperature of not less than 55 °C, the relative humidity of the air inside the oven shall be capable of being controlled as given in **D.1.2.3**.

D.1.2.2 *Controlled humidity room oven.* The volume, air circulation and temperature measuring arrangements of the oven shall be as specified in **D.1.2.1.1**.

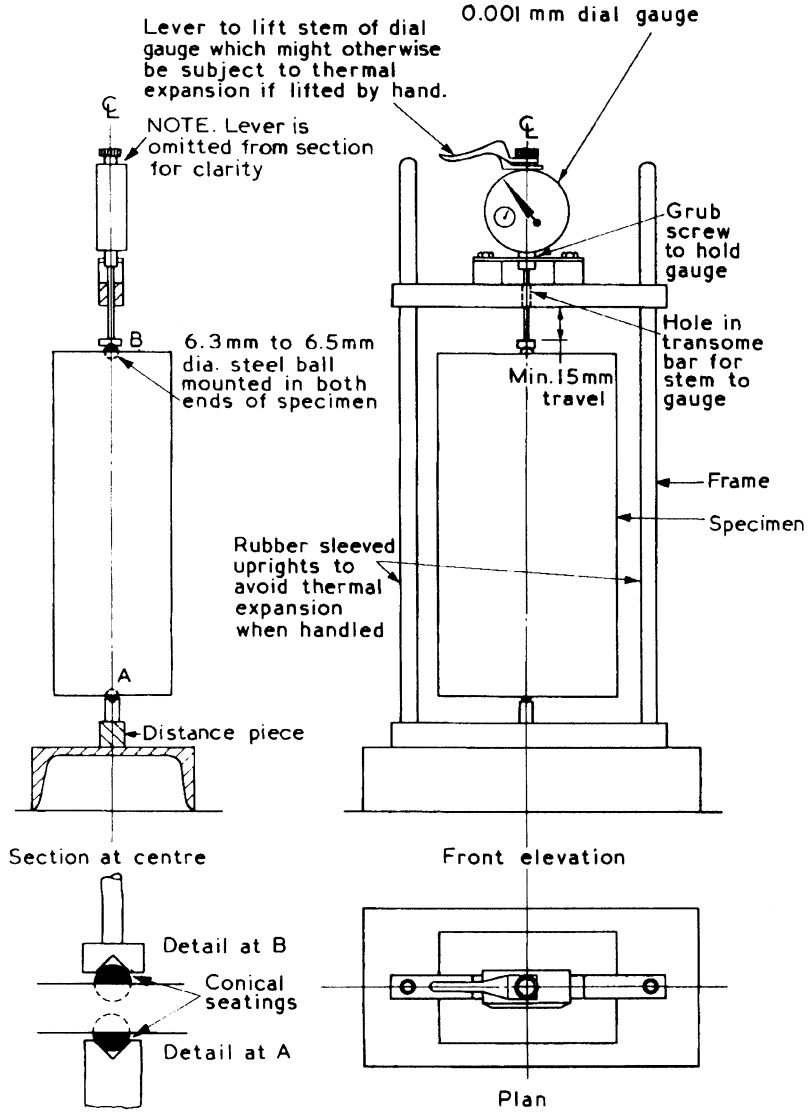


Figure 4 — Typical measuring apparatus for drying shrinkage

The oven shall be fitted with vents to allow movement of air in and out of the oven.

The room, when closed, shall be filled with moist air at a relative humidity of not less than 95 % and temperature controlled at 20 ± 2 °C. When access doors to the room are opened the volume of the room or the access arrangements shall be such that the air humidity and temperature within 1.5 m of the oven do not depart from the requirements.

D.1.2.3 *Adjustment and checking*

If using a conditioning oven, adjust the thermostat controlling the temperature of the water in the auxiliary equipment for sensitivity so that the water temperature will not fluctuate by more than 1 °C, as specified in Clause **5** of BS 3718:1964, and adjust the setting so that the average water temperature is 27 ± 1 °C.

Operate the auxiliary equipment so that saturated air at a temperature of 27 ± 1 °C is pumped into the oven. Set the oven control at a temperature between 55 °C and 60 °C and allow the conditions to stabilize with the oven empty. If the auxiliary equipment is supplying saturated air in sufficient quantity to make up for any losses of moisture to the atmosphere outside the oven, the average oven temperature, corresponding to an average water temperature of 27 °C, should be about 60 °C. If the average oven temperature required to provide the required test conditions inside the oven is less than 55 °C, re-examine the oven and auxiliary equipment to check adequate airtightness, air speed and air saturation.

If using a controlled humidity room oven, check the temperature and relative humidity in the conditioned room and set the oven to control at a temperature between 50 °C and 55 °C. Ensure that the vents are open.

Check either type of oven by sprinkling very small quantities of calcium chloride and potassium acetate, in the form of a dry fine powder, over separate clean warm watch glasses and immediately place them in the oven at positions approximating to those to be occupied by the test specimens. The oven conditions are appropriate for drying the specimens if, after at least 16 h, the calcium chloride is found to have picked up moisture but the potassium acetate has remained dry. Test the oven periodically by this method to check that it is functioning properly.

In early stages of determining the required average oven temperature the salts may be left for 2 h or 3 h and then examined. If both are wet raise the oven temperature. If both are dry, lower the oven temperature. If a salt is found to be wet, discard it. Clean, dry and warm the watch glass and use a new sprinkling of the salt. When the required oven temperature is approached leave the oven undisturbed for at least 6 h, and preferably overnight, before examining the salts.

D.1.3 *Cooling cabinet*

The cooling cabinet shall be capable of being effectively sealed. It may be either of metal or glass but metal is preferred owing to its superior properties of heat dissipation.

NOTE Internal air circulation in the cabinet is desirable but attention is drawn to the necessity for ensuring that no heat is introduced into the system. Thus, if a motor-driven fan is employed, it should be capable of operating effectively at low speed: the motor being placed outside the cabinet and driving the fan by means of a long shaft passing through a stuffing box which offers the minimum frictional resistance.

If the cabinet is metal, it shall be provided with a partial immersion thermometer so fitted that its bulb and the part of the stem below the immersion line is located inside the cabinet, and its stem passes through a suitable bung in the wall or lid of the cabinet so that the temperature registered can be read from the outside. If the cabinet is glass it shall be provided with a thermometer placed wholly inside it. The thermometer shall be placed so that its bulb is between the specimens or, alternatively, a screened bulb shall be used to avoid errors due to radiation effects.

D.2 Preparation of specimens

D.2.1 Take four masonry units at random.

D.2.2 Where blocks are being tested, saw one specimen from each of the blocks, with a length of not less than 150 mm and not more than 300 mm so that the cross section of the specimen has one dimension 50 ± 3 mm and the second dimension not less than 50 mm and the central area of the rectangle enclosing the cross section of the specimen is solid.

Where bricks are being tested, use each whole brick as the specimen.

D.2.3 Where practicable drill or cut into the centre of each end of each specimen a depression not more than 2 mm deep.

NOTE Where accurate drilling is difficult because of the hardness of the aggregate, or of the texture of the unit, the central area of the ends should be roughened, but the provision of a depression helps to give a more reliable fixing of the reference points.

Cement into each depression or on each end of the axis of the specimen a 6.3 mm to 6.5 mm diameter stainless steel ball with rapid-hardening Portland cement or high alumina cement or other suitable agent, such as synthetic resin, so that the ball is in close contact with the base of the hole and so that about half of the ball is exposed to provide a hemispherical bearing. After fixing, wipe the exposed hemisphere of the ball clean and dry and coat it with lubricating grease to prevent corrosion.

Where Portland or other hydraulic cements are used, store the specimens in moist air for at least 1 day. Where synthetic resins are used, keep the surface of the sample dry during hardening, unless otherwise recommended by the resin manufacturer. When the cement has hardened, clearly mark the four specimens, A, B, C and D respectively.

D.2.4 Completely immerse the specimens in water at room temperature for a minimum of 4 days and a maximum of 7 days and maintain the water at a temperature of 20 ± 1 °C for the final 4 h.

Measure each specimen to determine the distance over the steel balls to the nearest millimetre and take this distance minus 13 mm as the length.

D.3 Method of test

D.3.1 *Wet measurement of specimens*

Immediately after removal of the specimens from the water, wipe the grease from the steel balls and measure the length of each specimen to an accuracy of 0.001 mm by the apparatus described in **D.1.1**. Place the specimen between the recessed seating of the frame and the recessed end of the gauge. Rotate the specimen in the frame and observe the minimum reading. Then reverse the specimen end to end and measure in the same way. Record the average of the two readings and take this as the original wet measurement.

Before and after each set of specimens is measured check the length of the measuring apparatus against the reference rod. If the readings differ by more than 0.002 mm repeat the measurement of the specimens and the checking with the rod. Record the average of the two readings taken with the reference rod.

NOTE The measurement required is not the absolute length of the specimen but the difference in length between the specimen and the reference rod which are of approximately the same length.

D.3.2 *Drying, cooling and measuring of specimens*

Dry the specimens in either the conditioning oven (**D.1.2.1**) or in the controlled humidity room oven (**D.1.2.2**) which has been adjusted and checked as described in **D.1.2.3** and ensure that all surfaces of the specimen have free access to air. Do not place further wet specimens in an oven containing partly dried specimens.

For the first 24 h after placing the wet specimens in the oven, by-pass the apparatus for saturating the air in the oven (**D.1.2.1.2.3**) using the by-pass cock (**D.1.2.1.2.4**) to allow quicker removal of water from the specimens. At the end of the 24 h close the by-pass to maintain the required humidity.

Remove the specimens from the oven after 13 days from the day that they have been taken out of water and cool them in the cooling cabinet (**D.1.3**).

The room in which measurements are to be made should preferably be controlled at a temperature of 20 ± 2 °C; otherwise, make the measurements in a room free from draughts and rapid temperature changes. Place a thermometer near the measuring apparatus and leave the apparatus in position for an adequate period prior to use so that it attains the temperature of the surrounding air. The cabinet should preferably be placed in the same room.

Take readings from the cabinet thermometer from time to time and leave the specimens until the temperature does not change by more than 0.5 °C over a period of half an hour and until the temperature is within 3 °C of the temperature of the air at the place where the length of the specimen is to be measured.

NOTE At least 4 h will normally be required to attain a constant temperature.

Record the cabinet temperature at the time each individual specimen is removed from the cabinet and regard it as the temperature of the specimen at the time of measurement. If this temperature is other than 20 °C, reduce the measurement by 0.001 % of the length for each degree Celsius above 20 °C and vice versa.

Measure the length of each specimen as soon as possible after its removal from the cabinet and, in any event, within 15 min by the method described for determining the original wet measurement, including checking with the reference rod. Make a correction of the measurement of the length of the specimen for any apparent change in the length of the reference rod between measurements.

Replace the specimens in the oven and repeat the cooling and measuring procedure after 15 days from the day that they have been taken out of water. Calculate the average of the two sets of readings as the dry length of the specimen.

D.4 Calculation of results

Calculate the drying shrinkage for each specimen as the difference between the original wet measurement and the dry measurement, expressed as a percentage of the length measurement.

Should the value for drying shrinkage obtained with any one of the three specimens, A, B or C, differ from the average of the value for the same three specimens by more than 25 %, discard the excessively differing value of the individual specimen and substitute the value obtained from specimen D. Should one of the specimens A, B or C be so damaged that no value can be obtained, substitute the value obtained for D. Then recalculate average values for drying shrinkage. Report the average value of the drying shrinkage to the nearest 0.005 %.

If the value for D is also found to differ from the average of the value for the second set of three specimens by more than 25 % of this average, the result of the test shall be regarded as invalid. A re-test, either on specimens from the same four units or from a new sample of four units from the same consignment, may be carried out by agreement between the supplier and the purchaser.

Publications referred to

BS 12, *Specification for ordinary and rapid-hardening Portland cement.*

BS 146, *Portland-blastfurnace cement.*

BS 146-2, *Metric units.*

BS 410, *Specification for test sieves.*

BS 427, *Methods for Vickers hardness test.*

BS 427-1, *Testing of metals.*

BS 877, *Foamed or expanded blastfurnace slag lightweight aggregate for concrete.*

BS 877-2, *Metric units.*

BS 882, *Specification for aggregates from natural sources for concrete.*

BS 890, *Building limes.*

BS 915, *High alumina cement.*

BS 915-2, *Metric units.*

BS 958, *Spirit levels for use in precision engineering.*

BS 970, *Specification for wrought steels for mechanical and allied engineering purposes.*

BS 970-1, *General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels.*

BS 1014, *Pigments for Portland cement and Portland cement products.*

BS 1047, *Specification for air-cooled blastfurnace slag coarse aggregate for concrete.*

BS 1047-2, *Metric units.*[3)]

BS 1134, *Method for the assessment of surface texture.*

BS 1134-1, *Method and instrumentation.*

BS 1165, *Clinker aggregate for concrete.*

BS 1610, *Methods for load verification of testing machines.*

BS 1881, *Methods of testing concrete.*

BS 1881-5, *Methods of testing hardened concrete for other than strength.*[4)]

BS 1881-6, *Analysis of hardened concrete.*

BS 3123, *Spring calipers and spring dividers.*

BS 3587, *Calcium chloride (technical).*

BS 3718, *Laboratory humidity ovens (non-injection type).*

BS 3797, *Specification for lightweight aggregates for concrete.*

BS 3797-2, *Metric units.*

BS 3892, *Pulverized-fuel ash*

BS 3892-1, *Specification for pulverized-fuel ash for use as a cementitious component in structural concrete.*

BS 3892-2, *Specification for pulverized-fuel ash for use in concrete.*

BS 3898, *Laboratory humidity ovens (injection type).*

BS 3921, *Clay bricks and blocks.*

BS 4027, *Specification for sulphate-resisting Portland cement.*

BS 4550, *Methods of testing cement.*

BS 4550-2, *Chemical tests.*

BS 4551, *Methods of testing mortars and specification for mortar testing sand.*

BS 5075, *Concrete admixtures.*

[3)] To become BS 1047.
[4)] Referred to in the foreword only.

BS 5075-1, *Accelerating admixtures, retarding admixtures and water-reducing admixtures — Metric units.*

BS 5078, *Jig and fixture components.*

BS 5628, *Code of practice for use of masonry.*

BS 5628-1, *Unreinforced masonry.*[5)]

BS 5628-3, *Materials and components, design and workmanship.*

BS 6073, *Precast concrete masonry units.*

BS 6073-2, *Method for specifying precast concrete masonry units.*[5)]

BS 6457, *Specification for reconstructed stone masonry units.*

[5)] Referred to in the foreword only.

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