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*Indian Standard*  
SPECIFICATION FOR  
CONCRETE MASONRY UNITS  
PART II HOLLOW AND SOLID LIGHTWEIGHT  
CONCRETE BLOCKS  
  
( *First Revision* )

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**BUREAU OF INDIAN STANDARDS**  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

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# *Indian Standard*

## SPECIFICATION FOR CONCRETE MASONRY UNITS

### PART II HOLLOW AND SOLID LIGHTWEIGHT CONCRETE BLOCKS

#### *( First Revision )*

#### 0. FOREWORD

**0.1** This Indian Standard ( Part II ) ( First Revision ) was adopted by the Indian Standards Institution on 28 February 1983, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Civil Engineering Division Council.

**0.2** This standard was first published in 1966 as ' IS : 3500-1966 Specification for load bearing lightweight concrete blocks'. The first revision is being issued under the modified title ' Specification for concrete masonry units: Part II Hollow and solid lightweight concrete blocks' and supercedes IS : 3590-1966. Part I of this standard covers hollow and solid concrete blocks of normal weight. This modification in title is intended for facilitating the co-ordination of requirements of various types of concrete masonry units, covered under various Indian Standards.

**0.2.1** This standard incorporates significant modifications especially with regard to the classification of the blocks and physical requirements such as dimensions, compressive strength values, water absorption and drying shrinkage. Also this revision covers hollow blocks of closed cavity type apart from hollow blocks of open cavity. The requirements of load bearing and non-load bearing blocks have been separately given in this standard to the extent possible.

**0.3** Concrete masonry, already extensively used in building construction abroad, is likely to make very considerable headway in this country because of the many advantages, such as durability, strength and structural stability, fire resistance, insulation, and sound absorption it possesses. Concrete masonry construction is also economical because of the following aspects:

- a) the units are relatively large and true in size and shape. This insures rapid construction so that more wall is laid per man-hour than in other types of wall construction;

- b) fewer joints result in a considerable saving in mortar as compared to normal masonry construction; and
- c) the true plane surface obtained does not require plaster. Even when plaster is used for any reason, the quantity required for satisfactory coverage is significantly small.

**0.3.1** Concrete masonry has an attractive appearance and is readily adaptable to any style of architecture. It lends itself to a wide variety of surface finishes for both exterior and interior walls. It may also be finished with cement plaster, gauged with lime or a plasticizer. Concrete masonry units provide a strong mechanical key, uniting the concrete masonry backing and the plaster finish in a strong permanent bond.

**0.4** Concrete masonry units are used for both load-bearing and non-load bearing walls, for partitions and panel walls, as backing for other types of facing material, for piers; pilasters and columns, for retaining walls, garden walls, chimneys and fire places, as fillers in concrete joist floor construction, and as shuttering for beams and lintels.

**0.4.1** Concrete masonry units manufactured from lightweight aggregate concrete are used for both load bearing and non-load bearing internal walls, partition and panel walls, inner leaf of cavity walls or as backing to brick masonry and for external load bearing walls as well as panel walls in steel or reinforced concrete frame construction when protected from weather by rendering or by some other efficient treatment.

**0.5** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960\*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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## **1. SCOPE**

**1.1** This standard ( Part II ) covers the following lightweight concrete masonry building units which are used in the construction of load-bearing and non-load bearing walls:

- a) Hollow ( open and closed cavity ) load bearing concrete blocks,
- b) Hollow ( open and closed cavity ) non-load bearing concrete blocks,

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\*Rules for rounding off numerical values ( revised ).

- c) Solid load-bearing concrete blocks, and
- d) Solid non-load bearing concrete blocks.

NOTE — The requirements of cellular ( aerated ) concrete blocks are covered in IS : 5482-1969\*.

## 2. TERMINOLOGY

**2.0** For the purpose of this standard, the following definitions shall apply.

**2.1 Block** — A concrete masonry unit, either hollow ( open or closed cavity ), or solid or cellular ( other than units used for bonding, such as a half block ), any one of the external dimensions of which is greater than the corresponding dimension of a brick as specified in IS : 3952-1978†, and of such size and mass as to permit it to be handled by one man. Furthermore, to avoid confusion with slabs and panels, the height of the block shall not exceed either its length or six times its width.

**2.2 Block Density** — The density calculated by dividing the mass of a block by the overall volume, including holes or cavities and end recesses.

**2.3 Drying Shrinkage** — The difference between the length of specimen which has been immersed in water and subsequently dried to constant length, all under specified conditions; expressed as a percentage of the dry length of the specimen.

**2.4 Face Shells** — The two outer plates of the hollow concrete block. These are connected together by webs.

**2.5 Gross Area** — The total area occupied by a block on its bedding face, including areas of cores and end recesses.

**2.6 Height** — The vertical dimension of the exposed face of a block, excluding any tongue or other device designed to provide mechanical keying.

**2.7 Hollow ( Open or Closed Cavity ) Concrete Block** — A block having one or more large holes or cavities which either pass through the block ( open cavity ) or do not effectively pass through the block ( closed cavity ) and having the solid material between 50 and 75 percent of the total volume of the block calculated from the overall dimensions.

**2.8 Length** — The horizontal dimension of the exposed face of block, excluding any tongue or other device designed to provide mechanical keying.

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\*Specification for autoclaved cellular concrete blocks.

†Specification for burnt clay hollow blocks for walls and partitions ( *first revision* ).

**2.9 Moisture Movement** — The difference between the length of the specimen when dried to constant length and when subsequently immersed in water, all under specified conditions, expressed as a percentage of the dry length of the specimen.

**2.10 Solid Block** — A block which has solid material not less than 75 percent of the total volume of the block calculated from the overall dimensions.

**2.11 Webs** — The solid sections of the hollow concrete blocks which connect the face shells.

**2.12 Width** — The external dimension of a block at the bedding plane, measured at right angles to the length and height of the block.

### **3. DIMENSIONS AND TOLERANCES**

**3.1 Concrete masonry building units** shall be made in sizes and shapes to fit different construction needs. They include stretcher, corner, double corner or pier, jamb, header, bull nose, and partition block, and concrete floor units.

**3.2 Concrete Block** — Concrete block, hollow ( open or closed cavity ) or solid shall be referred to by its nominal dimensions. The term ' nominal ' means that the dimension includes the thickness of the mortar joint. Actual dimensions shall be 10 mm short of the nominal dimensions ( or 6 mm short in special cases where finer jointing is specified ).

**3.2.1** The nominal dimensions of concrete block shall be as follows:

Length	400, 500 or 600 mm
Height	100 or 200 mm
Width	50, 75, 100, 150, 200, 250 or 300 mm

In addition, block shall be manufactured in half lengths of 200, 250 or 300 mm to correspond to the full lengths.

The nominal dimensions of the units are so designed that taking account of the thickness of mortar joints, they will produce wall lengths and heights which will conform to the principles of modular co-ordination.

**3.2.2** Blocks of nominal dimensions other than those specified in **3.2.1** may also be used by mutual agreement between purchaser and supplier. In the case of special concrete masonry units such as jallie or screen wall block and ornamental block, the specified sizes shall not necessarily apply.

**3.2.3** The maximum variation in the length of units shall not be more than  $\pm 5$  mm and maximum variation in height and width of unit, not more than  $\pm 3$  mm.

**3.2.4** Hollow concrete blocks shall be made either with two cores or three cores. Stretchers in the 200, 250 and 300 mm widths shall generally have concave ends, each end flange being grooved or plain. All 100 and 150 mm wide units shall generally be made with plain ends.

**3.2.5** Face shells and webs shall increase in thickness from the bottom to the top of the unit. Depending upon the core moulds used, the face shells and webs shall be flared and tapered or straight tapered, the former providing a wider surface for mortar. The minimum thickness of the face shell and web shall be not less than 20 mm. However, for the top face shell of the closed cavity units, the minimum thickness may be less than 20 mm, but not less than 15 mm.

**3.3** Subject to the tolerances specified in **3.2.3** and the provisions of **3.4** the faces of masonry units shall be flat and rectangular, opposite faces shall be parallel, and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the blocks.

**3.4 Blocks with Special Faces** — Blocks with special faces shall be manufactured and supplied as agreed upon between the supplier and the purchaser.

## 4. CLASSIFICATION

**4.1** Load bearing lightweight concrete masonry units hollow ( open and closed cavity ) or solid shall conform to the following two grades:

- a) *Grade A* — These are used below and above ground level in damp-proof course, in exterior walls that may or may not be treated with a suitable weather-protective coating and for interior walls.
- b) *Grade B*—These are used above ground level in damp-proof course, in exterior walls that are treated with a suitable weather-protective coating and for internal walls.

**4.2** Non-load bearing lightweight concrete masonry units, hollow ( open and closed cavity ) or solid shall be used in interior walls, partitions, panels and for exterior panel walls in steel or reinforced concrete frame construction when protected from weather by rendering or by some other efficient treatment.

## 5. MATERIALS

**5.1 Cement** — Cement complying with any of the following Indian Standards may be used at the discretion of the manufacturer:

IS : 269-1976 Specification for ordinary and low heat Portland cement ( *third revision* )

IS : 455-1976 Specification for Portland slag cement ( *third revision* )



IS : 1489-1976 Specification for Portland pozzolana cement ( *second revision* )

IS : 6909-1973 Specification for supersulphated cement

IS : 8041-1978 Specification for rapid hardening Portland cement ( *first revision* )

IS : 8042-1978 Specification for white Portland cement ( *first revision* )

IS : 8043-1978 Specification for hydrophobic Portland cement ( *first revision* )

**5.1.1** When cement conforming to IS : 269-1976\* is used, replacement of cement by fly ash conforming to IS : 3812-1981† may be permitted up to a limit of 20 percent. However, it shall be ensured that blending of fly ash with cement is as intimate as possible, to achieve maximum uniformity.

## 5.2 Lightweight Aggregates

**5.2.1** The lightweight aggregates shall conform to IS : 9142-1979‡. The type of aggregate shall be approved by the purchaser. The purchaser may also specify the use of a particular aggregate or a particular combination of aggregates.

**5.2.2** The dry loose bulk density of the lightweight aggregates shall be as follows:

Fine aggregate	1120 kg/m <sup>3</sup> , max
Coarse aggregate	880 kg/m <sup>3</sup> , max
Combined aggregate	1100 kg/m <sup>3</sup> , max

**5.3 Water** — The water used in the manufacture of concrete masonry units shall be free from matter harmful to concrete or reinforcement, or matter likely to cause efflorescence in the units. It shall conform to 4.3 of IS : 456-1978§.

**5.4 Additives or Admixtures** — Additives or admixtures may be added either as additives to the cement during manufacture, or as admixtures to the concrete mix. Additives or admixtures used in the manufacture of concrete masonry units may be:

- a) accelerating, water-reducing and air-entraining admixtures conforming to IS : 9103-1979||,
- b) colouring pigments,

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\*Specification for ordinary and low heat Portland cement ( *third revision* ).

†Specification for fly ash for use as pozzolana and admixture ( *first revision* ).

‡Specification for artificial lightweight aggregates for concrete masonry units.

§Code of practice for plain and reinforced concrete ( *third revision* ).

||Specification for admixtures for concrete.

- c) fly ash conforming to IS : 3812-1981\*, and
- d) waterproofing agents conforming to IS : 2645-1975†

Where no Indian Standards apply, the additives or admixtures shall be shown by test or experience to be not detrimental to the durability of the concrete.

## 6. MANUFACTURE

**6.1 Mix** — The concrete mix used for blocks shall not be richer than one part by volume of cement to 6 parts of combined fine and coarse aggregates as specified in 5.2. Allowance shall be made for bulking of materials, if necessary.

**6.2 Mixing** — Concrete shall normally be mixed in a mechanical mixer.

**6.2.1** Mixing shall be continued until there is a uniform distribution of the materials, and the mass is uniform in colour and consistency.

**6.2.2** When hand mixing is permitted by the engineer-in-charge, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency.

### 6.3 Placing and Compaction

**6.3.1** In the case of hand-operated machine, the mixture shall be placed into the mould in layers of about 50 to 75 mm and each layer thoroughly tamped with suitable tampers until the whole mould is filled up and struck off level with a trowel.

**6.3.2** In the case of mechanically operated machine, the mould shall be filled up to a height above the mould appropriate to the machine used, vibrated or mechanically tamped and struck off level.

**6.3.3** Immediately the block is made, it shall be released from the mould and removed with the pallet to a covered shed, to protect it against sun and strong winds. The blocks shall be stored in the shed until they are sufficiently hardened to permit handling without damage but in no case shall this period be less than 12 hours.

### 6.4 Curing

**6.4.1** The blocks hardened in accordance with 6.3.3 shall then be removed from the pallets and placed in a curing water tank or taken to the curing yard ( see Note ), where these shall be kept continuously

\*Specification for fly ash for use as pozzolana and admixture ( first revision ).

†Specification for integral cement waterproofing compounds ( first revision ).

moist for at least 21 days. When the blocks are cured in an immersion tank, the water of the tank shall be changed at least every 4 days.

**NOTE** — The curing yard is a paved yard subdivided by shallow drains into 4 to 5 m square platforms which are provided with water fountains in the centre. The blocks are stacked on the platforms around the fountains, which work continuously. The fountains are connected to an elevated water storage tank.

**6.4.2** Steam curing of blocks hardened in accordance with **6.3.3** may be adopted instead of method specified in **6.4.1** provided the requirements of pressure or non-pressure steam curing are fulfilled. For non-pressure steam curing, the blocks shall be subjected to the action of thoroughly saturated steam at a temperature of 38° to 54°C for a period of not less than 24 hours; or when necessary, for such additional time as may be necessary to enable the blocks to meet the physical requirements specified in this standard.

**6.5 Drying** — After curing the blocks shall be dried under shade for a period of 4 weeks before being used on the work. They shall be stacked with voids horizontal to facilitate through passage of air. The blocks shall be allowed to complete their initial shrinkage before they are laid in a wall.

## **7. SURFACE TEXTURE AND FINISH**

**7.1** Concrete masonry building units can be given a variety of surface textures ranging from a very fine close texture to a coarse open texture by proper selection, grading and proportioning of the aggregates at the time of manufacture. Textures may also be developed by treating the face of the units while still green by wire brushing or combing, by slightly eroding the surface by playing a fine spray of water upon it, and by splitting ( split block ). Colour may be introduced by incorporating non-fading mineral pigments in the facing concrete, or by applying a coloured Portland cement grout or paint to the face of the units soon after they are removed from the moulds. Selected coloured aggregates may also be used in the facing and exposed by washing with water or dilute hydrochloric acid.

**7.2** Concrete masonry units used in constructing exposed walls shall be free from stains and discolouration, blemishes or defects which detract the desired appearance of the finished wall.

## **8. PHYSICAL REQUIREMENTS**

**8.1 General** — All units shall be sound and free of cracks or other defects which interfere with the proper placing of the unit or impair the strength or performance of the construction. Minor chipping resulting from the customary methods of handling during delivery, shall not be deemed grounds for rejection.

**8.1.1** Where units are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks, or other imperfections, except that if not more than 5 percent of a consignment contains slight cracks or small chippings not larger than 25 mm, this shall not be deemed grounds for rejection.

**8.2 Dimensions** — The overall dimensions of the units when measured as given in Appendix A shall be in accordance with 3 subject to the tolerances mentioned therein.

**8.3 Block Density** — The block density, when determined as in Appendix B, shall not exceed 1 600 kg/m<sup>3</sup>.

**8.4 Compressive Strength** — The minimum compressive strength, being the average of eight units, and the minimum compressive strength of individual units, when tested in the manner described in Appendix C, shall be as prescribed in Table 1.

**5.8 Water Absorption** — The water absorption, being the average of three units, when determined in the manner prescribed in Appendix D, shall be as prescribed in Table 1.

**TABLE 1 PHYSICAL REQUIREMENTS**

TYPE AND GRADE	MINIMUM COMPRESSIVE STRENGTH		MAXIMUM AVERAGE WATER ABSORPTION, WITH OVEN-DRY MASS OF CONCRETE	
	Average of 8 units, <i>Min</i>	Individual unit, <i>Min</i>	Less than 1 360	Less than 1 600
(1)	(2)	(3)	(4)	(5)
	N/mm <sup>2</sup>	N/mm <sup>2</sup>	kg/m <sup>3</sup>	kg/m <sup>3</sup>
Hollow, load bearing				
Grade A	7.0	5.5	—	290
Grade B	5.0	4.0	320	—
Hollow, non-load bearing	4.0	3.5	—	—
Solid, load-bearing				
Grade A	12.5	10.8	—	290
Grade B	8.5	7.0	320	—

**8.6 Drying Shrinkage** — The drying shrinkage of the units when unrestrained being the average of three units, shall be determined in the manner described in Appendix E, and shall be as follows:

- a) Load-bearing light-weight concrete masonry units, hollow ( open or closed cavity ) or solid,

Grade A — 0.08 percent, *max*; and

Grade B — 0.09 percent, *max*

- b) Non-load bearing light weight—0.09 percent, *max*  
concrete masonry units

**8.7 Moisture Movement** — The moisture movement of the dried blocks on immersion in water, being the average of three units, when determined in the manner described in Appendix F, shall be less than the drying shrinkage specified in 8.6 by at least 0.01.

## 9. TESTS

**9.1** Tests as described in Appendix A to F shall be conducted on samples of units selected according to the sampling procedure given in 10 to ensure conformity with the physical requirements laid down in 8.

## 10. SAMPLING

**10.1** The blocks required for carrying out the tests laid down in this standard shall be taken by one of the methods given in 10.2 and 10.3. In either case, a sample of 20 blocks shall be taken from every consignment of 5 000 blocks or part thereof of the same size and same batch of manufacture. From these samples, the blocks shall be taken at random for conducting the tests.

**10.2 Sampling Blocks in Motion** — Whenever practicable, samples of blocks shall be taken when the blocks are being moved as in the case of loading, unloading, etc. The batch from where samples are to be drawn shall be divided into a number of convenient portions such that when one sample is drawn from each of these portions the minimum number of blocks specified under 10.1 is provided.

**10.3 Sampling Blocks from a Stack** — The number of blocks required for the test shall be taken at random from across the top of the stacks, the sides accessible and from the interior of the stacks by opening trenches from the top.

### 10.4 Number of Tests

**10.4.1** All the 20 blocks shall be checked for dimensions and inspected for visual defects ( *see* 8.1 and 8.2 ).

**10.4.2** Out of the 20 blocks, 3 blocks shall be subjected to the test for blocks density ( *see* 8.3 ), 8 blocks to the test for compressive strength ( *see* 8.4 ), 3 blocks to the test for water absorption ( *see* 8.5 ) and 3 blocks to the test for drying shrinkage ( *see* 8.6 ) and later to the test for moisture movement. The remaining 3 blocks shall be reserved for retest for drying shrinkage and moisture movement if a need arises.

## 11. CRITERIA FOR CONFORMITY

**11.1** The lot shall be considered as conforming to the requirements of the specification if the conditions mentioned in **11.2** to **11.5** are satisfied.

**11.2** The number of blocks with dimensions outside the tolerance limit and/or with visual defects, among these inspected shall be not more than two.

**11.3** For block density, the mean value determined shall not be greater than the maximum limit specified in **8.3**.

**11.4** For compressive strength, the mean value determined shall be greater than or equal to the minimum limit specified in **8.4**.

**11.5** For drying shrinkage and moisture movement, all the test specimens shall satisfy the requirements of the test. If one or more specimens fail to satisfy the requirements, the remaining 3 blocks shall be subjected to these tests. All these blocks shall satisfy the requirements.

**11.6** For water absorption, the mean value determined shall be equal or less than maximum limit specified in **8.5**.

## 12. MANUFACTURER'S CERTIFICATE

**12.1** The manufacturer shall satisfy himself that the masonry units conform to the requirements of this specification and, if requested, shall supply a certificate to this effect to the purchaser or his representative.

## 13. INDEPENDENT TESTS

**13.1** If the purchaser or his representative requires independent tests, the samples shall be taken before or immediately after delivery, at the option of the purchaser or his representative and the tests shall be carried out in accordance with this specification.

**13.2** The manufacturers shall supply free of charge the units required for testing.

**13.3 Cost of Testing** — Unless otherwise specified in the enquiry or order, the cost of the tests shall be borne as follows:

- a) By the manufacturer in the event of the results showing that the blocks do not conform to this specification, or
- b) By the purchaser in the event of the results showing that the blocks conform to this specification.

## 14. MARKING

14.1 Concrete masonry units manufactured in accordance with this specification shall be marked permanently with the following information:

- a) The identification of the manufacturer;
- b) The grade of the unit; and
- c) The year of manufacture, if required by the purchaser.

14.1.1 Each block may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution ( Certification Marks ) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

## A P P E N D I X A

( *Clauses 8.2 and 9.1* )

### MEASUREMENT OF DIMENSIONS

#### A-1. APPARATUS

A-1.1 Overall dimensions shall be measured with a steel scale graduated in 1 mm divisions. Face shell and web thickness shall be measured with a caliper rule graduated in 0.5 mm divisions and having parallel jaws not less than 15 mm nor more than 25 mm in length.

#### A-2. SPECIMENS

A-2.1 Twenty full size units shall be measured for length, width and height. Cored units shall also be measured for minimum thickness of face shells and webs.

NOTE — These specimens shall be used for other tests also.

#### A-3. MEASUREMENTS AND REPORT

A-3.1 Individual measurements of the dimensions of each unit shall be read to the nearest division of the scale or caliper and the average recorded.

**A-3.2** Length shall be measured on the longitudinal centre line of each face, width across the top and bottom bearing surfaces at midlength, and height on both faces at midlength. Face-shell thickness and web thickness shall be measured at the thinnest point of each such element 15 mm above the mortar-bed plane. Where opposite face shells differ in thickness by less than 3 mm, their measurements shall be averaged. Sash grooves, dummy joints, and similar details shall be disregarded in the measurements.

**A-3.3** The report shall show the average length, width, and height of each specimen, and the minimum face-shell and web thickness and total web thickness in 200 mm length of walling per course as an average for the 20 specimens.

## APPENDIX B

( Clauses 8.3 and 9.1 )

### METHOD FOR THE DETERMINATION OF BLOCK DENSITY

#### B-1. PROCEDURE

**B-1.1** Three blocks taken at random from the samples selected in accordance with 10, shall be dried to a constant mass in a suitable oven heated to approximately 100°C. After cooling the blocks to room temperature, the dimensions of each block shall be measured in centimetres ( to the nearest millimetre ) and the overall volume computed in cubic centimetres. The blocks shall then be weighed in kilograms ( to the nearest 10 g ) and the density of each block calculated as follows:

$$\text{Density} = \frac{\text{Mass of block in kg}}{\text{Volume of specimen in cm}^3} \times 10^6 \text{ kg/m}^3$$

**B-1.2** The average for the three blocks shall be taken as the average density.

## APPENDIX C

( Clauses 8.4 and 9.1 )

### METHOD FOR THE DETERMINATION OF COMPRESSIVE STRENGTH

#### C-1. APPARATUS

**C-1.1 Testing Machine** — The testing machine shall be equipped with two steel bearing blocks ( see Note ) one of which is a spherically



seated block that will transmit load to the upper surface of the masonry specimen, and the other a plane rigid block on which the specimen will rest. When the bearing area of the steel blocks is not sufficient to cover the bearing area of the masonry specimen, steel bearing plates meeting the requirements of **C-1.2** shall be placed between the bearing blocks and the capped specimen after the centroid of the masonry bearing surface has been aligned with the centre of thrust of the bearing blocks ( *see C-4.1* ).

**NOTE** — It is desirable that the bearing faces of blocks and plates used for compression testing of concrete masonry have a hardness of not less than 60 ( *HRC* ).

**C-1.2 Steel Bearing Blocks and Plates** — The surfaces of the steel bearing blocks and plates shall not depart from a plane by more than 0.025 mm in any 15 mm dimension. The centre of the sphere of the spherically seated upper bearing block shall coincide with the centre of its bearing face. If a bearing plate is used, the centre of the sphere of the spherically seated bearing block shall lie on a line passing vertically through the centroid of the specimen bearing face. The spherically seated block shall be held closely in its seat, but shall be free to turn in any direction. The diameter of the face of the bearing blocks shall be at least 15 cm. When steel plates are employed between the steel bearing blocks and the masonry specimen ( *see C-4.1* ) the plates shall have a thickness equal to at least one-third of the distance from the edge of the bearing block to the most distant corner of the specimen. In no case shall the plate thickness be less than 12 mm.

## **C-2. TEST SPECIMENS**

**C-2.1** Eight full size units shall be tested within 72 hours after delivery to the laboratory, during which time they shall be stored continuously in normal room air.

**C-2.2** Units of unusual size, shape, or strength may be sawed into segments, some or all of which shall be tested individually in the same manner as prescribed for full-size units. The strength of the full-size units shall be considered as that which is calculated from the average measured strength of the segments.

**C-2.3** For the purpose of acceptance, age of testing the specimens shall be 28 days. The age shall be reckoned from the time of the addition of water to the dry ingredients.

## **C-3. CAPPING TEST SPECIMEN**

**C-3.0** Bearing surfaces of units shall be capped by one of the methods described in **C-3.1** and **C-3.2**.

**C-3.1 Sulphur and Granular Materials** — Proprietary or laboratory prepared mixtures of 40 to 60 percent sulphur ( by mass ), the remainder

being ground fire clay or other suitable inert material passing 150-micron IS sieve with or without a plasticizer, shall be spread evenly on a non-absorbent surface that has been lightly coated with oil ( *see* Note ). The sulphur mixture shall be heated in a thermostatically controlled heating pot to a temperature sufficient to maintain fluidity for a reasonable period of time after contact with the capping surface. Care shall be exercised to prevent overheating, and the liquid shall be stirred in the pot just before use. The capping surface shall be plane within 0.075 mm in 40 cm and shall be sufficiently rigid and so supported as not to be measurably deflected during the capping operation. Four 25 mm square steel bars shall be placed on the surface plate to form a rectangular mould approximately 12 mm greater in either inside dimension than the masonry unit. The mould shall be filled to a depth of 6 mm with molten sulphur material. The surface of the unit to be capped shall quickly be brought into contact with the liquid, and the specimen, held so that its axis is at right angles to the surface of the capping liquid, shall be inserted. The unit shall be allowed to remain undisturbed until solidification is complete. The caps shall be allowed to cool for a minimum of 2 hours before the specimens are tested. Patching of caps, shall not be permitted. Imperfect caps shall be removed and replaced with new ones.

NOTE — The use of oil on capping plates may be omitted if it is found that plate and unit can be separated without damaging the cap.

**C-3.2 Gypsum Plaster Capping** — A neat paste of special high-strength plaster ( *see* Note under C-4.1 ) and water shall be spread evenly on a non-absorbent surface that has been lightly coated with oil. Such gypsum plaster, when gauged with water at the capping consistency, shall have a compressive strength at a 2-hour age of not less than 25 N/mm<sup>2</sup>, when tested as 50 mm cubes. The coating surface plate shall conform to the requirements described in C-3.1. The surface of the unit to be capped shall be brought into contact with the capping paste; the specimen which is held with its axis at right angles to the capping surface, shall be firmly pressed down with a single motion. The average thickness of the cap shall be not more than 3 mm. Patching of caps shall not be permitted. Imperfect caps shall be removed and replaced with new ones. The caps shall be aged for at least 2 hours before the specimens are tested.

## C-4. PROCEDURE

**C-4.1 Position of Specimens** — Specimens shall be tested with the centroid of their bearing surfaces aligned vertically with the centre of thrust of the spherically seated steel bearing block of the testing machine ( *see* Note ). Except for special units intended for use with their cores in a horizontal direction, all hollow concrete masonry units shall be tested with their cores in vertical direction. Masonry units that are 100

percent solid and special hollow units intended for use with their hollow cores in a horizontal direction may be tested in the same direction as in service.

NOTE — For homogenous materials, the centroid of the bearing surface shall be considered to be vertically above the centre of gravity of the masonry unit.

**C-4.2 Speed of Testing** — The load up to one-half of the expected maximum load may be applied at any convenient rate, after which the control of the machine shall be adjusted as required to give a uniform rate of travel of the moving head such that the remaining load is applied in not less than one nor more than two minutes.

## **C-5. CALCULATION AND REPORT**

**C-5.1** The compressive strength of a concrete masonry unit shall be taken as the maximum load in Newtons divided by the gross cross-sectional area of the unit in square millimetres. The gross area of a unit is the total area of a section perpendicular to the direction of the load, including areas within cells and within re-entrant spaces unless these spaces are to be occupied in the masonry by portions of adjacent masonry.

**C-5.2** Report the results to the nearest 0.1 N/mm<sup>2</sup> separately for each unit and as the average for the 8 units.

## **A P P E N D I X D**

( *Clauses 8.5 and 9.1* )

### **METHOD FOR THE DETERMINATION OF WATER ABSORPTION**

#### **D-1. APPARATUS**

**D-1.1** The balance used shall be sensitive to within 0.5 percent of the mass of the smallest specimen tested.

**D-1.2** Three full-size units shall be used.

#### **D-2. PROCEDURE**

**D-2.1 Saturation** — The test specimens shall be completely immersed in water at room temperature for 24 hours. The specimens shall then be weighed, while suspended by a metal wire and completely submerged in water. They shall be removed from the water and allowed to drain for one minute by placing them on a 10 mm or coarser wire mesh, visible surface water being removed with a damp cloth, and immediately weighed.

**D-2.2 Drying** — Subsequent to saturation, all specimens shall be dried in a ventilated oven at 100 to 115°C for not less than 24 hours and until two successive weighings at intervals of 2 hours show an increment of loss not greater than 0.2 percent of the last previously determined mass of the specimen.

### D-3. CALCULATION AND REPORT

**D-3.1 Absorption** — Calculate the absorption as follows:

$$\text{Absorption, kg/m}^3 = \frac{A - B}{A - C} \times 1\,000$$

$$\text{Absorption, percent} = \frac{A - B}{B} \times 100$$

where

*A* = wet mass of unit in kg,

*B* = dry mass of unit in kg, and

*C* = suspended immersed mass of unit in kg.

**D-3.2 Report** — Report the results as the average for the three units.

## A P P E N D I X E

( *Clauses 8.6 and 9.1* )

### METHOD FOR THE DETERMINATION OF DRYING SHRINKAGE

#### E-1. NUMBER OF TESTS

**E-1.1** Of the samples selected in accordance with 10, three shall be tested for drying shrinkage. Three more blocks shall be set aside and stored in air-tight containers at normal room temperature so as to be available for duplicate tests if they are required at a later stage ( *see Note* ).

**NOTE** — In order to facilitate storage, instead of blocks, sections cut from these additional blocks may be stored until necessary in separate air-tight containers at normal room temperature.

#### E-2. APPARATUS

**E-2.1 Measuring Apparatus** — A measuring apparatus shall be used which incorporates a micrometer gauge or a suitable dial gauge reading accurately to 0.0025 mm. This gauge shall be rigidly mounted in a

measuring frame and have a recessed end which may be located upon a 5-mm diameter ball or other reference point cemented on the specimens. The other end of the frame shall have a similar recessed seating which may be located upon the other ball or reference point in the specimen. An Invar steel rod of suitable length with 5-mm diameter hemispherical ends or with 5-mm diameter steel balls mounted on the ends, shall be used as a standard of length against which readings of the gauge may be checked, thus enabling corrections to be made for any change in the dimensions of the apparatus between successive measurements of a test specimen. The apparatus shall preferably be adjusted for specimens of different lengths and Invar rod of lengths near to those of the specimens to be tested shall be available.

**E-2.2 Drying Oven** — The drying oven shall comply with the following requirements:

- a) It shall have an internal volume equivalent to not less than 8 litres per specimen, with a minimum total volume of 50 litres.
- b) It shall be reasonably air-tight and shall be provided with a fan to keep the air circulating effectively during the drying of the specimen.
- c) It shall be capable of maintaining a constant temperature of  $50 \pm 1^{\circ}\text{C}$ .
- d) The relative humidity of the air in the oven shall be controlled at approximately 17 percent by means of saturated calcium chloride solution. Suitable dishes or trays containing this solution shall be provided to give an exposed area of solution not less than  $10 \text{ cm}^2$  for each litre of volume of the oven. The dishes or trays shall contain sufficient solid calcium chloride to show above the surface of the solution throughout the test.

### **E-3. PREPARATION OF SPECIMENS**

**E-3.1** One sample shall be cut from each of the blocks such that the length of each specimen is not less than 15 cm and the cross-section is as near to  $7.5 \times 7.5 \text{ cm}$  as practicable in the case of solid blocks and  $7.5 \text{ cm} \times$  thickness of the wall in the case of other blocks. Two reference points consisting of 5 mm diameter steel balls or other suitable reference points providing a hemispherical bearing shall be cemented with neat rapid-hardening Portland cement or other suitable cementing material at the centre of each end of each specimen after drilling or cutting a shallow depression. After fixing, the surface of the steel balls shall be wiped clean of cement, and dried and coated with lubricating grease to prevent corrosion. The specimens shall then be completely immersed in water for 4 days, the temperature being maintained at  $27 \pm 2^{\circ}\text{C}$  at least for the last 4 hours.

#### E-4. PROCEDURE FOR TESTING

**E-4.1** Immediately after removal of the specimens from the water, the grease shall be wiped from the steel balls and the length of each specimen measured to an accuracy of 0.0025 mm by the apparatus described in E-2.1. This shall be taken as the original wet measurement.

NOTE — The instrument reading required is not the absolute length of the specimen but the difference in length between the specimens and an Invar rod of approximately the same length.

**E-4.2** The specimens shall then be dried for at least 44 hours in an oven of the type described in E-2.2, at the specified temperature and humidity. The specimens shall then be removed from the oven and cooled for at least 4 hours in a desiccator containing solid calcium chloride or a saturated solution of calcium chloride. Each specimen shall then be measured as described in E-4.1, at a temperature of  $27 \pm 2^\circ\text{C}$ .

**E-4.3** The cycle of drying, cooling and measuring shall be repeated until constant length is attained, that is, when the difference between consecutive readings separated by a period of drying of at least 44 hours followed by cooling for at least 4 hours, is less than 0.005 mm for a 15 cm specimen and *pro rata* for a larger specimen. The final reading shall be taken as the dry measurement.

**E-4.4** During the above drying process further wet specimen shall not be placed in the same oven and there shall be free access of air to all surfaces of the specimen.

**E-4.5** After the dry measurement has been taken, the length of the specimen shall be measured, adjacent to the steel balls, to the nearest millimetre and this shall be taken as the 'dry length'.

#### E-5. CALCULATION OF RESULTS

**E-5.1** The 'drying shrinkage' shall be calculated for each specimen as the difference between the 'original wet measurement' and the 'dry measurement' expressed as a percentage of the 'dry length'.

**E-5.2** Report all results separately for each unit.

## A P P E N D I X F

( *Clauses 8.7 and 9.1* )

### METHOD FOR THE DETERMINATION OF MOISTURE MOVEMENT

#### F-1. PROCEDURE

**F-1.1** The specimens which have previously been used for the drying shrinkage test ( *see* Appendix E ) shall after the completion of that test, be immersed in water for 4 days, the temperature being maintained at  $27 \pm 2^{\circ}\text{C}$  for at least 4 hours prior to the removal of the specimens and the wet length measured. The moisture movement shall be determined as the difference between the dry and wet lengths and expressed as a percentage of the dry length for each specimen.

**F-1.2** Should the value obtained with any one of the three specimens tested be greater than the limit specified in **8.7**, the test shall be repeated on the further three blocks which were set aside. In repeating the moisture movement test, the drying shrinkage test shall be repeated if the previous specimens have failed on that test also; otherwise, the drying shrinkage test may be omitted. The three new specimens, in that event, shall be dried to constant length at  $50 \pm 1^{\circ}\text{C}$  measured after cooling and the moisture movement test carried out as described in **F-1.1**.

( Continued from page 2 )

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