IS 2185-1 (2005): Concrete masonry units, Part 1: Hollow and solid concrete blocks [CED 53: Cement Matrix Products]

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भारतीय मानक

कंक्रीट की चिनाई वाली इकाइयाँ — विशिष्टि

भाग 1 खोखले एवं ठोस कंक्रीट ब्लाक

(तीसरा पुनरीक्षण)

Indian Standard

CONCRETE MASONRY UNITS — SPECIFICATION

PART 1 HOLLOW AND SOLID CONCRETE BLOCKS

(Third Revision)

ICS 91.080.30; 91.100.30

BUREAU OF INDIAN STANDARDS
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Price Group 5

FOREWORD

This Indian Standard (Part 1) (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Cement Matrix Products Sectional Committee had been approved by the Civil Engineering Division Council.

This standard was first published in 1962 and subsequently revised in 1967 and 1979. The second revision was published under the modified title 'Specification for concrete masonry units: Part 1 Hollow and solid concrete blocks'. Also Part 2 and Part 3 were brought out, Part 2 covering lightweight concrete masonry units as revision of IS 3590 : 1966 'Specification for load bearing lightweight concrete blocks' and Part 3 covering aerated concrete masonry units as revision of IS 5482 : 1969 'Specification for autoclaved cellular concrete blocks'. In the second revision apart from covering, hollow blocks of open cavity type, hollow blocks of closed cavity type were covered. Another distinct feature in that revision was that concrete masonry units of load bearing and non-load bearing category were separately treated to the extent possible. This revision incorporates modifications found necessary as a result of experience gained with the use of the standard and to bring the standard in line with present practices being followed. The principal modifications in this revision are as follows:

a) Provisions for reduced time period of drying of steam cured blocks has been incorporated.

b) Higher grades of concrete blocks of 8.5 N/mm^2 to 15.0 N/mm^2 has been included.

c) Provision for the use of 43 and 53 grade ordinary Portland cement has also been kept apart from all other type of cements already recommended in the standard.

Concrete masonry, already extensively used in building construction abroad, is likely to make very considerable headway in this country because of 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 ensures rapid construction so that more wall is laid per man-hour than in other types of wall construction;

b) Fewer joints result in considerable saving in mortar as compared to normal masonry constructions, and also in increasing the strength of the wall; and

c) The true plane surfaces obtained obviate necessity of plaster for unimportant buildings situated in low rainfall areas; even when plaster is used for any reason, the quantity of mortar required for satisfactory coverage is significantly small.

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.

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

The hollow (open and closed cavity) and solid concrete masonry units covered by this standard are made with normal weight aggregates and are known as normal weight units. The hollow load-bearing concrete block of standard 400 mm × 200 mm × 200 mm size will weigh between 17 kg and 26 kg when made with normal weight aggregates. Normal weight units are made with such aggregates as sand, crushed stones and air-cooled slag.

(*Continued on third cover*)

Indian Standard

CONCRETE MASONRY UNITS — SPECIFICATION

PART 1 HOLLOW AND SOLID CONCRETE BLOCKS

(Third Revision)

1 SCOPE

This standard (Part 1) covers the following concrete masonry building units which are used in the construction of load-bearing and partition walls:

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

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

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

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

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

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

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

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

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

3.5 Gross Area — The total area occupied by a block on its bedding face, including areas of the cavities and end recesses.

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

3.7 Hollow (Open or Closed Cavity) 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.

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

3.9 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.

3.10 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.

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

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

4 DIMENSIONS AND TOLERANCES

4.1 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.

4.2 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 (length and depth only) shall be 10 mm short of the nominal dimensions.

4.2.1 The nominal dimensions of concrete block shall be as follows:

Length : 400, 500 or 600 mm
Height : 200 or 100 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. Full length and half length U-blocks may also be manufactured for the purposes of band and lintels.

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

4.2.2 Blocks of sizes other than those specified in **4.2.1** may also be used by mutual agreement between the purchaser and the supplier. In the case of special concrete masonry units such as jallie wall blocks and ornamental blocks, the specified sizes may not necessarily apply.

4.2.3 The variation in the length of the units shall not be more than ± 5 mm and variation in height and width of units, not more than ± 3 mm.

4.2.4 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 thickness of the face shell and web shall be not less than the values given in Table 1.

Table 1 Minimum Face Shell and Web Thickness

(*Clause* 4.2.4)

All dimensions in millimetres.

Sl No.	Nominal Block Width	Face Shell Thickness	Thickness of Web	Total Web Thickness per Course in Any 200 mm Length of Wall
		Min	*Min*	*Min*
(1)	(2)	(3)	(4)	(5)
i)	100 or less	25	25	25
ii)	100-150	25	25	30
iii)	150-200	30	25	30
iv)	Over 200	35	30	38

4.3 Subject to the tolerances specified in **4.2.3** and provisions of **4.4** the faces of masonry units shall be flat and rectangular, opposite faces shall be parallel, and all angles shall be square. The bedding surfaces shall be at right angles to the faces of the blocks.

4.4 Blocks with Special Faces

Blocks with special faces shall be manufactured and supplied as agreed upon between the supplier and the purchaser.

5 CLASSIFICATION

5.1 Hollow (Open and Closed Cavity) Concrete Block

The hollow (open and closed cavity) concrete blocks shall conform to the following three grades:

a) *Grade A* — These are used as load bearing units and shall have a minimum block density of 1 500 kg/m^3. These shall be manufactured for minimum average compressive strengths of 3.5, 4.5, 5.5, 7.0, 8.5, 10.0, 12.5 and 15.0 N/mm^2 respectively at 28 days (*see* Table 2).

b) *Grade B* — These are also used as load bearing units and shall have a block density between 1 100 kg/m^3 and 1 500 kg/m^3. These shall be manufactured for minimum average compressive strengths of 3.5 and 5.0 N/mm^2 respectively at 28 days (*see* Table 2).

5.2 Solid Concrete Block — Grade C

The solid concrete blocks are used as load bearing units and shall have a block density not less than 1 800 kg/m^3. These shall be manufactured for minimum average compressive strength of 4.0 and 5.0 N/mm^2 respectively (*see* Table 2).

6 MATERIALS

6.1 Cement

Cement complying with any of the following Indian Standards may be used:

a) 33 grade ordinary Portland cement, conforming to IS 269,

b) 43 grade ordinary Portland cement, conforming to IS 8112,

c) Portland slag cement conforming to IS 455,

d) Portland pozzolana cement, fly ash based conforming to IS 1484 (Part 1),

e) Portland pozzolana cement, calcined clay based conforming to IS 1484 (Part 2),

f) Supersulphated cement conforming to IS 6909,

g) Rapid hardening Portland cement conforming to IS 8041,

h) White Portland cement conforming to IS 8042,

j) Hydrophobic Portland cement conforming to IS 8043, and

k) 53 grade ordinary Portland cement conforming to IS 12269.

6.1.1 When cement conforming to IS 269 or IS 8112 or IS 12269 is used, replacement of cement by fly ash conforming to IS 3812 (Part 1) may be permitted up to a limit of 25 percent. However, it shall be ensured that blending of fly ash with cement is as intimate as possible, to achieve maximum uniformity.

6.2 Aggregates

The aggregates used in the manufacture of blocks at the mixer or the mixing platform shall be clean and free from deleterious matter and shall conform to the requirements of IS 383.

6.2.1 The grading of the combined aggregates shall conform as near as possible to the requirements indicated in IS 383.

6.2.2 *Fly Ash*

Fly ash conforming to IS 3812 (Part 2) may be used for part replacement of fine aggregate upto a limit of 20 percent (*see also* **6.1.1**).

6.3 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 and shall conform to the requirements of IS 456.

6.4 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, air-entraining and super plasticizer conforming to IS 9103,

b) Waterproofing agents conforming to IS 2645, and

c) Colouring pigments.

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.

7 MANUFACTURE

7.1 Mix

7.1.1 The concrete mix used for blocks shall not be richer than one part by volume of cement to 6 parts by volume of combined aggregates before mixing.

7.1.2 In machine-moulded blocks, the web markings on the units as they come from the machine give a good indication as to whether the proper consistency of concrete has been used. In addition to the grading of the aggregate and the quantity of the cement, the amount of water required for mix will depend to an extent on the type of machine on which blocks are produced. The amount of water required for mix should be electronically measured and controlled in the mixing drum.

7.2 Mixing

7.2.1 Batching of the ingredients should be done accurately and concrete mixing shall be done in a mixer to achieve homogenous mix.

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

7.3 Placing and Compaction

7.3.1 The block should be compacted by vibro-compaction and finished to proper size without broken edges.

7.3.2 After ejection demoulding, the blocks shall be handled carefully to avoid damage. The blocks shall be protected until they are sufficiently hardened before starting curing.

7.4 Curing

7.4.1 The blocks hardened in accordance with **7.3.2** shall then be cured as per **13.5** of IS 456 or by mist curing so as to deliver the specified strength of block.

7.4.2 The blocks hardened in accordance with **7.3.2** may alternatively be cured by steam.

7.5 Drying

After curing the blocks in accordance with **7.4.1**, they shall be dried for a period of 4 weeks before being used on the work. In case of curing as per **7.4.2**, once low pressure steam curing has been done, the blocks shall be dried at ambient temperature for a period of seven days. The blocks shall then be stacked with voids horizontal to facilitate through passage of air. It shall be ensured that the blocks have been thoroughly dried and allowed to complete their initial drying shrinkage before supply to the work-site.

8 SURFACE TEXTURE AND FINISH

8.1 Concrete masonry units can be given a variety of surface textures ranging from a very fine close texture to a coarse open texture by the proper selection, grading, and proportioning of 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, 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 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 followed by thorough washing with water to ensure no traces of acid are left on the surface.

8.2 Well made concrete masonry may not require plaster in case of unimportant buildings in low rainfall areas; two or three coats of a cement paint being sufficient to render it resistant to rain water. If, however, it is intended to plaster concrete masonry, the block shall have a sufficiently rough surface to afford a good key to the plaster. Water proofing admixtures may be used for preparing the plaster.

9 PHYSICAL REQUIREMENTS

9.1 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 chiping resulting from the customery methods of handling during delivery, shall not be deemed grounds for rejection.

9.1.1 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.

9.2 Dimensions

The overall dimensions of the units when measured as given in Annex B shall in accordance with **4** subject to the tolerances mentioned therein.

9.3 Blocks Density

The block density when determined as in Annex C shall conform to the requirement given in **5**.

9.4 Compressive Strength

The minimum compressive strength at 28 days being the average of eight units, and the minimum compressive strength at 28 days of individual units, when tested in the manner described in Annex D shall be as prescribed in Table 2.

9.5 Water Absorption

The water absorption, being the average of three units, when determined in the manner prescribed in Annex E shall not be more than 10 percent by mass.

9.6 Drying Shrinkage

The drying shrinkage of the units when unrestrained being the average of three units, shall be determined in the manner described in Annex F and shall not exceed 0.06 percent.

9.7 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 Annex G, shall not exceed 0.09 percent.

Table 2 Physical Requirements

(*Clauses* 5.1, 5.2 *and* 9.4)

Type	Grade	Density of Block kg/m^2	Minimum Average Compressive Strength of Units N/mm^2	Minimum Compressive Strength of Individual Units, N/mm^2
(1)	(2)	(3)	(4)	(5)
Hollow (open and closed cavity) load bearing unit	A(3.5)	Not less than 1 500	3.5	2.8
	A(4.5)		4.5	3.6
	A(5.5)		5.5	4.4
	A(7.0)		7.0	5.6
	A(8.5)		8.5	7.0
	A(10.0)		10.0	8.0
	A(12.5)		12.5	10.0
	A(15.0)		15.0	12.0
	B(3.5)	Less than 1 500 but not less than 1 100	3.5	2.8
	B(5.0)		5.0	4.0
Solid load bearing unit	C(5.0)	Not less than 1 800	5.0	4.0
	C(4.0)		4.0	3.2

10 TESTS

Tests as described in Annex B to Annex G shall be conducted on samples of units selected according to the sampling procedure given in **11**, to ensure conformity with the physical requirements laid down in **9**.

11 SAMPLING

11.1 The blocks required for carrying out the tests laid down in this standard shall be taken by one of the methods given in **11.2** and **11.3**. In either case, a sample of 20 blocks shall be taken from every lot/consignment of 5 000 blocks or part thereof from the same grade, size and same batch of manufacture.

11.2 The required number of blocks shall be taken at regular intervals during the loading of the vehicle or the unloading of the vehicle depending on whether sample is to be taken before delivery or after delivery. When this is not practicable, the sample shall be taken from the stack in which case the required number of blocks 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.

11.3 The sample of blocks shall be marked for future identification of the consignment it represents. The blocks shall be kept under cover and protected from extreme conditions of temperature, relative humidity and wind until they are required for test. The tests shall be undertaken as soon as practicable after the sample has been taken.

11.4 Number of Tests

11.4.1 All the 20 blocks shall be checked for dimensions and inspected for visual defects (*see* **9.1** and **9.2**).

11.4.2 Out of the 20 blocks, 3 blocks shall be subjected to the test for block density (*see* **9.3**), 8 blocks to the test for compressive strength (*see* **9.4**), 3 blocks to the test for water absorption (*see* **9.5**), and 3 blocks to the test for drying shrinkage (*see* **9.6**) and later to the test for moisture movement (*see* **9.7**). The remaining 3 blocks shall be reserved for retest for drying shrinkage and moisture movement, if a need arises.

12 CRITERIA FOR CONFORMITY

12.1 The lot shall be considered as conforming to the requirements of the specification if the conditions mentioned in **12.2** to **12.5** are satisfied.

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

12.3 For block density, the mean value determined shall be greater than or equal to the minimum limit specified in **9.3**. For compressive strength, the average value and minimum individual value determined shall be greater than or equal to the value specified in **9.4**.

12.4 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.

12.5 For water absorption, the mean value determined shall be equal or less than maximum limit specified in **9.5**.

13 MANUFACTURER'S CERTIFICATE

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

14 INDEPENDENT TESTS

14.1 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 standard.

14.2 The manufacturer shall supply free of charge the units required for testing.

14.3 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.

15 MARKING

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

a) Identification of the manufacturer;

b) Grade of the unit [for example A(7.0)]; and

c) Year of manufacture, if required by the purchaser.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
269 : 1989	Specification for 33 grade ordinary Portland cement (*fourth revision*)
383 : 1970	Specification for coarse and fine aggregates from natural sources for concrete (*second revision*)
455 : 1989	Specification for Portland slag cement (*fourth revision*)
456 : 2000	Code of practice for plain and reinforced concrete (*fourth revision*)
1489	Specification for Portland pozzolana cement:
(Part 1) : 1991	Fly ash based (*third revision*)
(Part 2) : 1991	Calcined clay based (*third revision*)
2645 : 1975	Integral cement water proofing compounds for cement mortar and concrete (*second revision*)
3812	Pulverized fuel ash — Specification:
(Part 1) : 2003	For use as pozzolana in cement, cement mortar and concrete (*second revision*)
(Part 2) : 2003	For use as admixture in cement mortar and concrete (*second revision*)
3952 : 1988	Specification for burnt clay hollow bricks for walls and partitions (*second revision*)
6909 : 1990	Specification for supersulphated cement
8041 : 1990	Specification for rapid hardening Portland cement (*second revision*)
8042 : 1989	Specification for white Portland cement (*second revision*)
8043 : 1989	Specification for hydrophobic Portland cement (*second revision*)
8112 : 1989	Specification for 43 grade ordinary Portland cement (*first revision*)
9103 : 1999	Specification for admixtures for concrete (*first revision*)
12269 : 1087	Specification for 53 grade ordinary Portland cement

ANNEX B

(*Clauses* 9.2 *and* 10)

MEASUREMENT OF DIMENSIONS

B-1 APPARATUS

B-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 and not more than 25 mm in length.

B-2 SPECIMENS

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 test also.

B-3 MEASUREMENTS AND REPORT

B-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.

B-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.

B-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.

ANNEX C

(*Clauses* 9.3 *and* 10)

METHOD FOR THE DETERMINATION OF BLOCK DENSITY

C-1 PROCEDURE

C-1.1 Three blocks taken at random from the samples selected in accordance with **10**, shall be dried to 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 block shall then be weighed in kilograms (to the nearest 10 g) and the density of each block calculated as follows:

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

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

ANNEX D

(*Clauses* 9.4 *and* 10)

METHOD FOR THE DETERMINATION OF COMPRESSIVE STRENGTH

D-1 APPARATUS

D-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 **D-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* **D-4.1**).

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

D-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 masonry specimen (*see* **D-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.

D-2 TEST SPECIMENS

D-2.1 Each full size units shall be tested within 72 h after delivery to the laboratory, during which time they shall be stored continuously in normal room air.

D-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.

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

D-3 CAPPING TEST SPECIMEN

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

D-3.1 Sulphur and Granular Materials

Proprietry 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 thermostatistically 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 exercized 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 units. The mould shall be filled to a depth of 6 mm with molten sulphur material. The surface of the units 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 units shall be allowed to remain undisturbed until solidification is complete. The caps shall be allowed to cool for a minimum of 2 h before the specimens are tested. Patching of caps shall not be permitted. Imperfect caps shall be removed and be 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.

D-3.2 Gypsum Plaster Capping

A neat paste of special high-strength plaster (*see* Note under **D-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 h age of not less than 25 N/mm^2, when tested on 50 mm cubes. The casting surface plate shall conform to the requirements described in **D-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 h before the specimens are tested.

D-4 PROCEDURE

D-4.1 Positioning of Specimens

Specimens shall be tested with the centroid of their bearing surfaces aligned vertically with the centre of thrust of the spherically seated 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 a vertical direction. Masonry units that are hundred 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 homogeneous materials, the centroid of the bearing surface shall be considered to be vertically above the centre of gravity of the masonry units.

D-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.

D-5 CALCULATION AND REPORT

D-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.

D-5.2 Report be results to the nearest 0.1 N/mm^2 separately for each unit and is the average for the 8 units.

ANNEX E

(Clauses 9.5 and 10)

METHOD FOR THE DETERMINATION OF WATER ABSORPTION

E-1 APPARATUS

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

E-1.2 Three full-size units shall be used.

E-2 PROCEDURE

E-2.1 Saturation

The test specimens shall be completely immersed in water at room temperature for 24 h. 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.

E-2.2 Drying

Subsequent to saturation, all specimens shall be dried

in a ventilated oven at 100°C to 115°C for not less than 24 h and until two successive weighings at intervals of 2 h show an increment of loss not greater than 0.2 percent of the last previously determined mass of the specimen.

E-3 CALCULATION AND REPORT

E-3.1 Water Absorption

Calculate the water absorption as follows:

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

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

where

A = wet mass of units, in kg;
B = dry mass of units, in kg; and
C = suspended immersed mass of units, in kg.

E-3.2 Report

Report all results seperately for each unit and as the average for the three units.

ANNEX F

(Clauses 9.6 and 10)

METHOD FOR THE DETERMINATION OF DRYING SHRINKAGE

F-1 NUMBER OF TESTS

Of the samples selected in accordance with **11**, 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.

F-2 APPARATUS

F-2.1 Measuring Apparatus

A measuring apparatus shall be used which incorporates a micrometre gauge or a suitable dial gauge reading accurately to 0.002 5 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 specimen. The other end of the frame shall have a similar recessed seating which may be located upon the 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 tests specimen. The apparatus shall preferably be adjusted for specimens of different lengths and Invar rods of length near to those of the specimens to be tested shall be available.

F-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 litre per specimen, with a minimum total volume of 50 litre.
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 ± 1°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 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.

F-3 PREPARATION OF SPECIMENS

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 cm × 7.5 cm as practicable in case of solid blocks and 7.5 cm × 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 ± 2°C at least for the last 4 h.

F-4 PROCEDURE FOR TESTING

F-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 0.002 5 mm by the apparatus described in **F-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 area of approximately the same length.

F-4.2 The specimen shall then be dried for atleast 44 h in an oven of the type described in **F-2.2**, at the specified temperature and humidity. The specimens shall then be removed from the oven and cooled for at least 4 h in a desiccator containing solid calcium chloride or a saturated solution of calcium chloride. Each specimen shall then be measured as described in **F-4.1**, at a temperature of 27 ± 2°C.

F-4.3 The cycle drying cooling and measuring shall be repeated until constant length is attained that is when difference between consecutive readings separated by a period of drying of at least 44 h followed by cooling for at least 4 h, 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.

F-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.

F-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.

F-5 CALCULATION OF RESULT

F-5.1 The drying shrinkage shall be calculated as the difference between the original wet measurement and dry measurement expressed as a percentage of the dry length.

F-5.2 Report all results separately for each unit.

ANNEX G

(*Clauses* 9.7 *and* 10)

METHOD FOR THE DETERMINATION OF MOISTURE MOVEMENT

G-1 PROCEDURE

G-1.1 The specimens which have previously been used for the drying shrinkage test (*see* Annex F) shall after the completion of that test, be immersed in water for 4 days, the temperature being maintained at 27 ± 2°C for at least 4 h prior to the removal of the specimen 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.

G-1.2 Should the value obtained with any one of the three specimens tested be greater than the limit specified in **9.7**, the test shall be repeated on the further three blocks which were set aside. In repeating the moisture movement test, the 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 ± 1°C measured after cooling and the moisture movement test carried out as described in **G-1.1**.

(*Continued from second cover*)

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, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. 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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