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Indian Standard

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खड़ंजे के लिए कंक्रीट ब्लॉक — विशिष्टि

(पहला पुनरीक्षण)

Concrete Paving Blocks — Specification

(First Revision)

FOR BIS INTERNAL USE. TO BE USED FOR STANDARDS DEVELOPMENT PURPOSE ONLY

ICS 93.080.20

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Flooring, Wall Finishing and Roofing Sectional Committee had been approved by the Civil Engineering Division Council.

This standard specifies the requirements and test methods for solid un-reinforced cement concrete blocks used for paving applications. This standard was first formulated in 2006 to provide guidance regarding requisite quality and consequent longevity of pavements made using these blocks. This revision has been brought out to take care the experience gained since the publication of the first version of the standard.

Following are the major modifications incorporated in this revision:

a) Title of the standard has been modified from 'Precast concrete blocks for paving — Specification' to 'Concrete paving blocks — Specification'.

b) Definition of spacer nibs has been revised to include dimensional aspect.

c) Minimum thickness for M 55 grade has been revised to 100 mm.

d) Clause on materials has been updated covering use of all relevant materials along with reference to their latest Indian Standards.

e) Use of lead pigments has been disallowed.

f) A new clause on manufacturing of paving blocks has been introduced.

g) Requirement of compressive strength has been modified.

h) Requirement for wet/saturated specimen for abrasion resistance has been modified.

j) Limiting values of splitting tensile strength has been revised for higher grades of concrete.

l) A test method for measuring thickness of wearing layer has been introduced.

m) Hardness values of packing pieces used in splitting tensile strength have been specified replacing the existing punching test.

n) 'Specimens' clause in method for determination of flexural strength has been modified.

p) All the amendments issued to the first version of the standard have been absorbed, and the text of the standard has been suitably modified to make it more user friendly.

The composition of the Committee responsible for the formulation of this standard is given in Annex J.

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

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Indian Standard

CONCRETE PAVING BLOCKS — SPECIFICATION

(First Revision)

1 SCOPE

1.1 This standard specifies requirements and test methods for solid un-reinforced precast cement concrete blocks and complementary blocks used for paving applications.

1.2 The standard does not cover concrete masonry units, cellular (hollow) concrete blocks, fly ash masonry blocks, permeable concrete blocks, grid blocks, grass stones and cement concrete flooring tiles.

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

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

3.1 Actual Dimension — Measured dimensions of a paving block.

3.2 Arris — Part of a block where two faces meet which can be bevelled, rounded, chamfered, or splayed, as shown in Fig. 1.

3.3 Aspect Ratio — The ratio of length to thickness of a paving block.

3.4 Backing Layer — Layer of concrete on the lower face of a two layer paving block, made of material same as or different from that used in the wearing layer of the block.

3.5 Bed Face — The surface of a paving block which, when paved, comes in direct contact with the bedding material.

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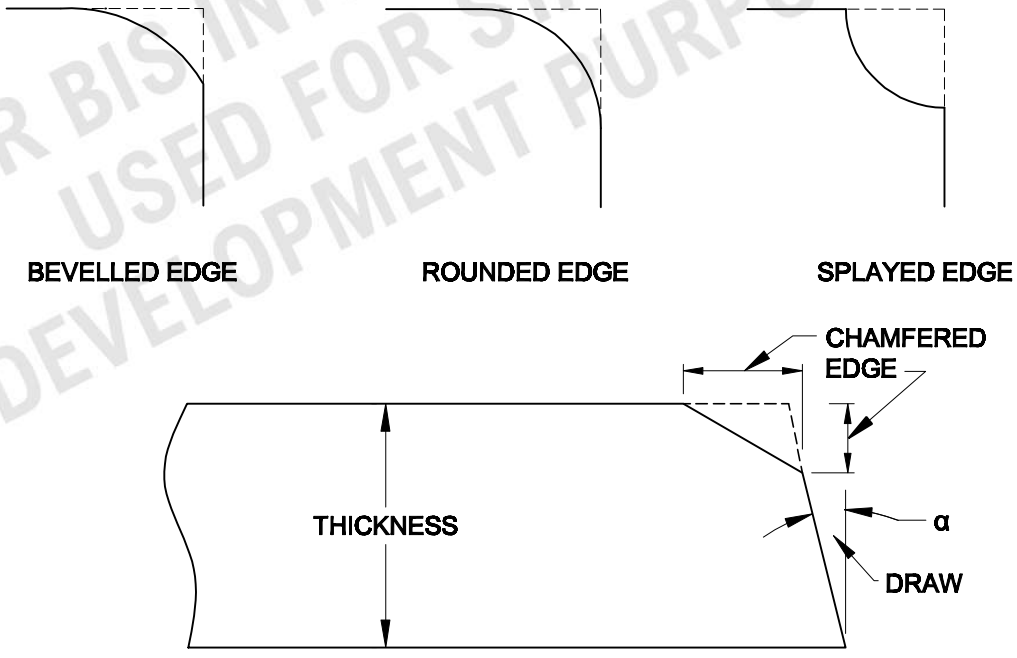


FIG. 1 EXAMPLES OF ARRIS (BEVELED, ROUNDED, CHAMFERED), CHASED SIDE FACE AND DRAW

3.6 Chamfer — Bevelled arris, as shown in Fig.1.

3.7 Chased Side Face — The side face of a paving block, having a recessed profile, as shown in Fig. 1.

3.8 Complementary Block — A block usually of the shape of part of a block, used for fitting into gaps remaining in a block-paved area, for complete coverage of paved surface.

3.9 Draw — Intended angle of the side face from the vertical plane over the full height of a paving block, as shown in Fig.1.

3.10 False Joints/Grooves — Regularly shaped depressions on the wearing layer of a paving block.

3.11 Format — Work dimensions of a paving block, specified in the order of overall length, overall width and thickness.

3.12 Interlocking Mechanism — The mechanism which allows adjacently paved blocks to key into one another and facilitates the sharing of shear, bending and thrust forces between adjacent blocks in a paved system.

3.13 Interlocking/ Dentated/ Inter-connected Paving Blocks — Paving blocks which key into one another on some or all vertical faces, when paved in any pattern.

3.14 Length — Shortest distance between farthest opposite vertical faces of a parallelepiped enclosing a paving block, excluding the dimensions due to any spacer nibs.

3.15 Overall Length — The length of the longer side of a rectangle with the smallest area enclosing a paving block excluding any spacer nibs.

3.16 Overall Width — The length of the shorter side of a rectangle with the smallest area enclosing a paving block excluding any spacer nibs.

3.17 Plan Area — Horizontal area bounded by the vertical faces of a paving block, excluding the area due to any spacer nibs.

3.18 Paving Block — Solid un-reinforced precast cement concrete paving units used in the surface course of pavements, with minimum horizontal cross section of 50 mm from any edge in any direction, having aspect ratio not more than four, except for complementary blocks.

3.19 Side Face — That face of a paving block which is generally in the vertical direction when paved and which faces adjacent block.

3.20 Spacer Nibs — Small protruding profiles on the vertical face of a paving block, having height more than 60 percent of that of the block and width such that the nib is of fully compacted concrete, used as a device for keeping minimum joint gap while paving blocks.

3.21 Thickness — Vertical distance between the upper face and bed face of a paving block.

3.22 Wearing Layer — Layer of concrete or mortar on the upper face of a two- layer paving block, made of material same as or different from that used in the backing layer of the block.

3.23 Wearing Face — The surface of a paving block which, when paved, faces the atmosphere and is directly subjected to vehicular or pedestrian traffic.

3.24 Wearing Face Area — Horizontal area bounded by the vertical faces of a paving block, minus the area reduced due to the presence of arris.

3.25 Width — Shortest distance between nearest opposite vertical faces or corners of a paving block.

4 CLASSIFICATION

The grades of paving blocks to be used for construction of pavements having different traffic categories are given in Table 1.

5 RAW MATERIAL

5.1 Cement

5.1.1 Cement used in the manufacture of paving blocks shall be any of the following:

a) Ordinary Portland cement conforming to IS 269.
b) Portland slag cement conforming to IS 455.
c) Portland pozzolana cement (fly ash based) conforming to IS 1489 (Part 1).
d) Portland pozzolana cement (calcined clay based) conforming to IS 1489 (Part 2).
e) Rapid hardening Portland cement conforming to IS 8041.
f) Composite cement conforming to IS 16415.

5.2 Mineral Admixtures

Mineral admixtures may be used as a part replacement of ordinary Portland cement in the manufacture of paving blocks, provided uniform blending with cement is ensured. They shall be any of the following:

a) Pulverized fuel ash conforming to IS 3812 (Part 1).
b) Pulverized fuel ash conforming to IS 3812 (Part 2).
c) Silica fume conforming to IS 15388.
d) Ground Granulated Blast Furnace Slag conforming to IS 16714.
e) Metakaolin conforming to IS 16354.
f) Rice husk ash conforming to the requirements of IS 456.

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Table 1 Grades of Paving Blocks for Different Traffic Categories

(*Clause* 4, *and Table* 2 *and* 3)

Sl No.	Grade Designation	Compressive Strength at 28 Days, f_{ck} MPa	Traffic Category	Minimum Thickness, mm	Traffic Examples of Application
(1)	(2)	(3)	(4)	(5)	(6)
i)	M 30	30	Non-traffic	50	Building premises, monument premises, landscapes, public gardens/parks, domestic drives, paths and patios, embankment slopes, sand stabilization area, etc
ii)	M 35	35	Light-traffic	60	Pedestrian plazas, shopping complexes ramps, car parks, office driveways, housing colonies, rural roads with low volume traffic, farm houses, beach sites, tourist resorts local authority footways residential roads, etc
iii)	M 40	40	Medium-traffic	80	City streets, small and medium market roads, low volume roads, utility cuts on arterial roads, etc
iv)	M 50	50	Heavy-traffic	100	Bus terminals, industrial complexes, mandi houses, roads on expansive soils factory floor, service stations, industrial pavements, etc
v)	M 55	55	Very heavy-traffic	100	Container terminals, ports docks, yards, mine access roads, bulk cargo handling areas, airports pavements, etc

NOTES

1 Non-traffic areas are defined as areas where no vehicular traffic occurs.

2 Light-traffic is defined as daily traffic up to 150 commercial vehicles exceeding 30 kN laden weight, or an equivalent up to 0.5 million standard axles (MSA) for a design life of 20 years (A standard axle is defined as a single axle load of 81.6 kN).

3 Medium-traffic is defined as a daily traffic of 150 - 450 commercial vehicles exceeding 30 kN laden weight, or an equivalent of 0.5 to 2.0 MSA for a design life of 20 years.

4 Heavy-traffic is defined as a daily traffic of 450 - 1 500 commercial vehicles exceeding 30 kN laden weight, or an equivalent of 0.5 to 2.0 MSA for a design life of 20 years.

5 Very heavy-traffic is defined as daily traffic of more than 1 500 commercial vehicles exceeding 30 kN laden weight, or an equivalent of more than 5.0 MSA for a design life of 20 years.

5.3 Chemical Admixtures

Chemical admixtures, if used in the manufacture of paving blocks, shall conform to IS 9103.

5.4 Coarse and Fine Aggregates

5.4.1 *Coarse Aggregates*

5.4.1.1 Coarse aggregates shall comply with the requirements of IS 383.

5.4.1.2 The nominal maximum size of coarse aggregate used in production of paving blocks shall be 12.5 mm. However, the nominal maximum size of the coarse aggregate may be increased up to 20 mm in case of single layer paving blocks having thickness of 80 mm or above, and two-layer paving blocks having thickness of backing layer of 80 mm or above.

5.4.2 *Fine Aggregates*

Fine aggregates shall conform to the requirements of IS 383.

5.5 Pigments

5.5.1 Pigments, if used either singly or in combination in the manufacture of paving blocks, shall have durable colour and free from matters detrimental to concrete. They shall be any of the following:

a) Black or red or brown pigment conforming to IS 44.

b) Green pigment conforming to IS 54.

c) Blue pigment conforming to IS 55 or IS 56 or IS 3574 (Part 2).

d) White pigment conforming to IS 411.

e) Yellow pigment conforming to IS 50 or IS 3574 (Part 1).

5.5.2 Pigment quantity shall be restricted to a maximum of 9 percent by weight of cement content. The fineness of pigment should be more than the fineness of cement.

5.5.3 The pigments shall not contain zinc compounds or organic dyes. Lead pigments shall not be used.

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5.6 Water

Water used in the manufacture of concrete blocks for paving shall conform to the requirements of IS 456.

6 MANUFACTURE

6.1 Concrete shall be mixed in a mechanical mixer and mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency. The concrete, so obtained, shall be filled to slightly overfill the suitable moulds, compacted by hydraulic or vibration machine and struck off level with a trowel, if required. The proportioning of the various mix constituents used, mentioned in **5**, shall be so carried out as to obtain concrete having zero slump (in case hydraulic machine is used), or slump as low as possible (in case vibration equipment is used) and required compressive strength at 28 days in accordance with this standard.

6.2 The paving blocks, on removal from the moulds, shall be kept in moist condition continuously for such a period that would ensure their conformity to the requirements of this standard.

6.3 The paving blocks may be manufactured in single layer or two layers. When two-layer paving blocks are manufactured, there shall be proper bonding and demarcation between the two layers. There shall be no delamination between the two layers.

7 REQUIREMENTS

7.1 General Quality and Finish

7.1.1 *General Quality*

All paving blocks shall be sound and free of cracks or other visual defects which interfere with the proper paving of the unit or impair the strength or performance of the pavement paved with the paving blocks.

When paving blocks with false joints, surface reliefs or projections are supplied, the same shall be specified. Also, the surface features shall be well formed and be devoid of any defects.

7.1.2 *Visual Inspection*

Visual inspection of quality of paving blocks shall be carried out in natural daylight, prior to the tests for other properties. The blocks shall then be laid out on a level floor in any desired paving pattern, approximately covering a square area of 1 m^2. Any visual defects of paving blocks, including cracks and flaking, shall be recorded by observing the paved blocks from a distance of approximately 2 m from each edge of the paved area.

7.1.3 *Colour and Texture*

The colour and texture of the pigmented paving blocks shall be matched with the standard specimens, as mutually agreed between manufacturer and the purchaser.

7.2 Dimensions and Tolerances

The paving blocks shall comply with the dimensions and tolerance requirements given in Table 2, when tested in accordance with the methods given in Annex B.

Table 2 Dimensions and Tolerances

(*Clause* 7.2)

Sl No.	Dimensions	Requirement	Tolerances	
			Thickness < 100 mm	Thickness ≥ 100 mm
(1)	(2)	(3)	(4)	(5)
i)	Width, *W*, mm	*see* Note 1	± 2	± 3
ii)	Length, *L*, mm	*see* Note 1	± 2	± 3
iii)	Thickness, *T*h, mm	50 to 120, *see* Notes 2 and 3	± 3	± 4
iv)	Aspect ratio, *L*/*T*h, *Max*	4		
v)	Arris/chamfer, mm:			
	a) Minimum	5	± 1	± 1
	b) Maximum	7		
vi)	Thickness of wearing layer, mm, *Min*	6		
vii)	Plan area, A_{sp}, m^2 (*optional*)	*see* Note 1	+ 0.001	+ 0.001
viii)	Ratio of wearing face area and plan area, A_{sw}/A_{sp}, *Min*	0.75	- 0.01	- 0.01
ix)	Deviation from squareness, mm	NIL	± 2	± 3

NOTES

1 The value shall be decided by mutual agreement between the manufacturer and the purchaser.

2 The thickness shall also meet the requirements for various grades of paving blocks as given in Table 1.

3 When agreed between the manufacturer and the purchaser, blocks having thickness more than 120 mm may also be manufactured. For such blocks, the tolerance on width and length shall be ± 4 mm.

7.3 Paving blocks shall comply with the physical requirements given in Table 3.

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Table 3 Physical Requirements for Paving Blocks

(*Clauses* 7.3 *and* 9.1.4)

Sl No.	Characteristic	Requirement	Method of Test, Ref to
(1)	(2)	(3)	(4)
i)	Water absorption, percent, *Max*:		Annex C
	a) Individual	7	
	b) Average	6	
ii)	Compressive strength, MPa, *Min*:		Annex D
	a) Individual	f_{ck} - 3 (*see* Note 1)	
	b) Average	f_{ck} + 0.825 × established standard deviation (rounded off to nearest 0.5 MPa) or f_{ck} + 3, whichever is greater (*see* Note 2)	
iii)	Abrasion resistance, mm^3 per 5 000 mm^2, *Max:*		Annex E
	a) Dry:		
	i) Individual	20 000	
	ii) Average	18 000	
	b) Wet:		
	i) Individual	22 000	
	ii) Average	20 000	
iv)	Tensile splitting strength, MPa, *Min*:		Annex F
	a) Individual	0.08 f_{ck} for grades < M 40 3.0 MPa for grades ≥ M 40	
	b) Average	0.085 f_{ck} for grades < M 40 3.6 MPa for grades ≥ M 40	
v)	Flexural strength, MPa, *Min*:		Annex G
	a) Individual	0.10 f_{ck}	
	b) Average	0.11 f_{ck}	
vi)	Freeze thaw durability (*optional*)	*see* Note 3	Annex H

NOTES

1 The value of f_{ck} is given in col 3 of Table 1.

2 In the absence of established value of standard deviation, it may be assumed as 5, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.

3 The value shall be decided by mutual agreement between the manufacturer and the purchaser.

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8 SAMPLING

8.1 All concrete paving blocks of same size/shape and grade manufactured under identical condition from raw material of same source in a week shall constitute one batch.

8.2 When the product has been submitted to an assessment of conformity by a third party, acceptance testing is not required, except in case of dispute between the purchaser and manufacturer, when acceptance testing may be carried out. In such cases, depending upon the circumstances of the case in dispute, the required number of blocks shall be sampled from each batch of the consignment of blocks up to a quantity of 50 000 blocks.

8.3 When the product has not been submitted to an assessment of conformity by a third party, the required number of blocks shall be sampled from each batch of the consignment of blocks up to a quantity of 25 000 blocks.

8.4 When the quantity of a partial batch is less than half of the quantities mentioned in **8.2** and **8.3**, that partial batch of the consignment shall be added to the previous full batch.

8.5 The sample of paving blocks for inspection and testing shall be chosen from a batch at random. For guidance in procedure of random selection, IS 4905 may be referred.

Table 4 Sampling Requirements

(*Clause* 8.6)

Sl No.	Property	Ref to Clause No.	Number of Paving Blocks for Test	
			Quality Assurance by Third Party	Quality Assurance by Manufacturer/ Purchaser (*see* Note 1)
(1)	(2)		(3)	(4)
i)	Visual inspection	7.1	8	4 (16)
ii)	Dimensions	7.2	8	4 (16)
iii)	Water absorption	7.3	3	3
iv)	Compressive strength	7.3	8	4 (16)
v)	Tensile splitting strength	7.3	8	4 (16)
vi)	Flexural strength	7.3	8	4 (16)
vii)	Abrasion resistance:	7.3		
	a) Dry		3	3
	b) Wet		3	3
viii)	Freeze-thaw durability	7.3	3	3

NOTE — The number within brackets is the number to be sampled to avoid secondary sampling from the batch of on the basis of the conformity criteria, additional blocks are required to be tested to assess conformity.

8.6 The number of blocks to be sampled from each batch for each test shall be as given in Table 4. If the samples drawn for testing one characteristic can be utilized for testing any other characteristic, without introducing any prejudice in the test results of the latter, it would not be necessary to take fresh samples for the latter characteristics.

9 ACCEPTANCE CRITERIA

9.1 Mandatory Requirements

9.1.1 The batch shall be considered as conforming to the requirements of this specification if the conditions mentioned in **9.1.2** to **9.1.4** are satisfied.

9.1.2 Blocks with visual defects in the sample lot shall not be more than one.

9.1.3 The sample lot shall meet the dimension and tolerance requirements given in Table 2.

9.1.4 The sample lot shall meet the physical requirements given in Table 3.

9.2 Optional Requirements

The lot shall be considered conforming when samples tested for optional requirements, if and as agreed to between the purchaser and the manufacturer, meet the requirements given in Table 2 and Table 3.

10 MARKING

10.1 Concrete paving block/package shall be marked with the following information suitably:

a) Name of the manufacturer or his trade-mark;

b) Brand name, if any;

c) Grade of paving blocks; and

d) Identification in code or otherwise, to enable to trace back the date of manufacture, batch number to factory records.

10.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

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ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
44 : 1991	Iron oxide pigments for paints — Specification (*second revision*)
50 : 1980	Specification for lead and scarlet chromes (*third revision*)
54 : 1988	Specification for green oxide of chromium for paints (*second revision*)
55 : 1970	Specification for ultramarine blue for paints (*first revision*)
56 : 1993	Prussian blue (iron blue) for paints — Specification (*second revision*)
269 : 2015	Ordinary portland cement — Specification (*sixth revision*)
383 : 2016	Coarse and fine aggregates for concrete — Specification (*third revision*)
411 : 2020	Titanium dioxide, anatase for paints — Specification (*fourth revision*)
455 : 2015	Portland slag cement — Specification (*fifth revision*)
456 : 2000	Plain and reinforced concrete — Code of practice (*fourth revision*)
516 : 1959	Method of tests for strength of concrete
1237 : 2012	Cement concrete flooring tiles — Specification (*second revision*)
1489	Portland pozzolana cement — Specification
(Part 1) : 2015	Fly ash based (*fourth revision*)
(Part 2) : 2015	Calcined clay based (*fourth revision*)
2185 (Part 1) : 2005	Concrete masonry units — Specification: Part 1 Hollow and solid concrete blocks (*third revision*)
3574	Organic pigments for paints — Specification
(Part 1) : 1965	AZO pigments (toluidine red; chlorinated – nitroaniline red; arylamide yellows; and para red)
(Part 2) : 2000	Phthalocyanines
3812	Pulverized fuel ash — Specification
(Part 1) : 2013	For use as pozzolona in cement, cement mortar and concrete (*third revision*)
(Part 2) : 2013	For use as admixture in cement mortar and concrete
4905 : 2015	Random sampling and randomization procedures (*first revision*)
8041 : 1990	Rapid hardening portland cement — Specification *(second revision)*
9103 : 1999	Concrete admixtures — Specification (*first revision*)
15388 : 2003	Silica fume — Specification
16354 : 2015	Metakaolin for use in cement, cement mortar and concrete — Specification
16415 : 2015	Composite cement — Specification
16714 : 2018	Ground granulated blast furnace slag for use in cement, mortar and concrete — Specification

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ANNEX B

(*Clause* 7.2)

METHOD FOR DETERMINATION OF VARIOUS DIMENSION REQUIREMENTS

B-1 LENGTH, WIDTH, THICKNESS AND ASPECT RATIO

B-1.1 Apparatus

The apparatus shall comprise the following:

a) Steel calipers; and

b) Steel rule capable of measuring up to 300 mm to an accuracy of 0.5 mm

B-1.2 Specimens

The paving block specimens shall be selected as per the sampling procedure given in **8** and the number as per Table 4.

B-1.3 Procedure

B-1.3.1 *Length, L and Width, W*

The length and width of the specimen (*see* Fig. 2) shall be measured across two opposite faces by using the steel calipers or steel rule. Two representative positions shall be used for measurement of length and three for measurement of width. The mean values of length and width for the block shall be noted to the nearest 1 mm.

B-1.3.2 *Thickness, T*h

The thickness of the specimen (*see* Fig. 2) shall be measured at four different positions. The mean value of the thickness of the block shall be noted to the nearest 1 mm.

B-1.3.3 *Aspect Ratio*

The aspect ratio of the specimen shall be calculated by dividing the mean length by the mean depth as determined by the procedures in **B-1.3.1** and **B-1.3.2** and shall be noted to the nearest 0.1.

B-2 ARRIS

B-2.1 Apparatus

The apparatus shall comprise of steel calipers.

B-2.2 Specimens

The paving block specimens shall be selected as per the sampling procedure given in **8** and the number as per Table 4.

B-2.3 Procedure

The depth and width of arris of the specimen (*see* Fig. 2) shall be measured across two opposite faces, to the nearest 0.1 mm, by using the steel calipers. Four representative positions shall be used for measurement of depth and width. The mean values of depth and width of arris for the block shall be noted to the nearest 0.1 mm.

B-3 PLAN AREA AND WEARING FACE AREA

B-3.1 Apparatus

The apparatus shall comprise the following:

a) Balance capable of weighing 1 N to an accuracy of 0.000 1 N;

b) Sheets of thin cardboard of uniform thickness;

c) Sharp pencil;

d) Odd-leg marking gauge (*see* Fig. 3);

e) Sharp scissors; and

f) Steel rule marked with graduations of 0.5 mm.

B-3.2 Specimens

The paving block specimens shall be selected as per the sampling procedure given in **8** and the number as per Table 4.

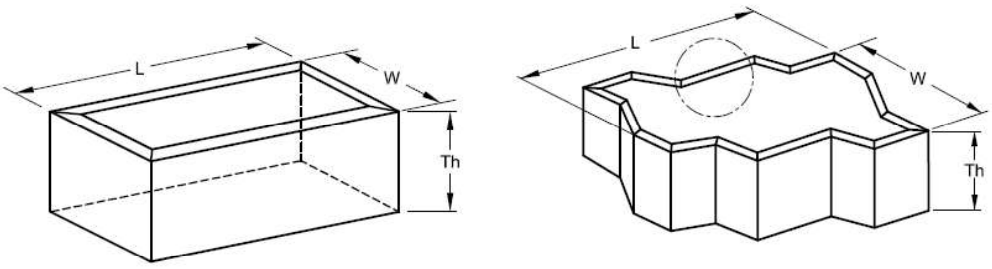


FIG. 2 LENGTH (*L*), WIDTH (*W*) AND THICKNESS (*Th*) OF PAVING BLOCKS

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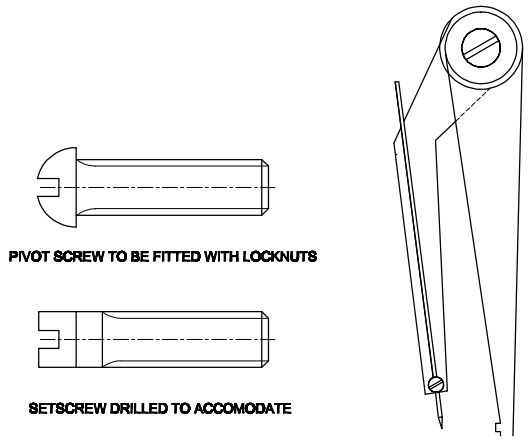


FIG. 3 ODD-LEG MARKING GAUGE

B-3.3 Procedure

B-3.3.1 *Plan Area, A_{sp} (Method 1)*

The test specimen shall then be weighed, while suspended by a metal wire, and completely submerged in water, and the weight shall be recorded in *N* to the nearest 0.01 N, W_a. They shall be removed from the water and allowed to drain for 1 min by placing them on a 10 mm or coarser wire mesh. Visible water on the specimen shall be removed with a damp cloth. The specimen shall then be immediately weighed and the weight for each specimen noted in *N* to the nearest 0.01 N, W_w. The volume of the specimen shall be calculated as follows:

$$\text{Volume} = (W_w - W_a)\ 10^{-3}\ \text{m}^3$$

The thickness of the specimen in mm shall be determined as per **B-1.3.2**. The volume shall be divided by thickness to obtain plan area, in mm^2.

In the case of rectangular specimens, the plan area may also be calculated by multiplying the length by the width, as determined by the procedure in **B-1.3.1**.

B-3.3.2 *Plan Area, A_{sp} (Method 2)*

The specimen shall be placed, wearing face facing up, on the cardboard and its perimeter traced with the pencil. The shape shall be cut out accurately with the scissors and weighed to the nearest 0.0001 N, and the result recorded as mass, m_{sp}. A rectangle measuring 200 mm × 100 mm, accurately cut out from the same cardboard, shall also be weighed to the nearest 0.0001 N, and the result recorded as mass, m_{std}. The plan area for the block shall be calculated from the formula:

$$A_{sp} = 20\ 000\ m_{sp}/m_{std}\ \text{mm}^2$$

B-3.3.3 *Wearing Face Area, A_{sw}*

The width of the arris of the block shall be measured at four different locations and their mean value determined. A ballpoint pen refill shall be fixed to the odd-leg marking gauge and the gauge shall be set to the measured mean value of width of the arris. The gauge so set shall be used to draw a line, indicating the width of the arris, along the periphery of the cardboard shape of the plan area of the block with mass, m_{sp}, as obtained in **B-3.3.2**. The marked arris width on the cardboard shall be neatly cut away with the scissors, and the cardboard shall be weighed to the nearest 0.0001 N and the result recorded as mass, m_{sw}. The wearing face area for the block shall be calculated from the formula:

$$A_{sw} = 20\ 000\ m_{sw}/m_{std}\ \text{mm}^2$$

B-4 DEVIATION FROM SQUARENESS

B-4.1 Apparatus

The apparatus shall comprise the following:

a) Engineer's square or a profiled template; and
b) Feeler gauges.

B-4.2 Specimens

The paving block specimens shall be selected as per the sampling procedure given in **8** and the number as per Table 4.

B-4.3 Procedure

With the stock of the square or profiled template in contact with the top or bottom surface of the block, the blade shall be brought into contact with the vertical face of the block. The clearance, if any, between the square or profiled template and the vertical face of the block shall be measured to the nearest 0.1 mm with the feeler gauge at points 10 mm inside each top and bottom edge of the block. This measurement shall be repeated at six sensibly different locations around the block, and the average of the feeler gauge measurement noted as the deviation from squareness for the block, which shall be noted to the nearest 0.1 mm.

B-5 THICKNESS OF WEARING LAYER

The thickness of the wearing layer for two-layer paving blocks shall be measured at several points along the fracture line of the paving block that was tested for tensile splitting strength in accordance with Annex F. The thickness of the wearing layer shall not be measured on the chamfer. The mean of the two measurements which yielded the lowest value shall be the minimum thickness of the wearing layer.

B-6 REPORT

Report the individual and mean values of measured dimensions, arris, aspect ratio, plan area, wearing face area, deviation from squareness and thickness of wearing layer.

FOR BIS INTERNAL USE TO BE USED FOR STANDARDS DEVELOPMENT ONLY

ANNEX C

(*Clause* 7.3)

METHOD FOR DETERMINATION OF WATER ABSORPTION

C-1 APPARATUS

The balance used shall be sensitive to within one percent of the mass of the smallest specimen tested.

C-2 SPECIMENS

The paving block specimens shall be selected as per the sampling procedure given in **8** and the number as per Table 4.

C-3 PROCEDURE

C-3.1 Saturation

The test specimen shall be completely immersed in water at room temperature for 24 ± 2 h. The specimen then shall be removed from the water and allowed to drain for 1 min by placing them on a 10 mm or coarser wire mesh. Visible water on the specimens shall be removed with a damp cloth. The specimen shall be immediately weighed and the weight for each specimen noted in *N* to the nearest 0.01 *N*, W_w.

C-3.2 Drying

Subsequent to saturation, the specimens shall be placed at a distance of 15 mm from each other and subsequently dried in a ventilated oven at 105 ± 5 ° C for not less than 24 h and until two successive weighing at intervals of 2 h show an increment of loss not greater than 0.2 percent of the previously determined mass of the specimen. The dry weight of each specimen, W_d shall be recorded in N to the nearest 0.01 N.

C-4 CALCULATION

The percent water absorption shall be calculated as follows:

$$W \text{ percent} = (W_w — W_d)/ W_d \times 100$$

C-5 REPORT

Report the individual and mean values of water absorption of specimens tested as per **C-1** to **C-4**, correct to 0.1 percent.

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ANNEX D

(*Clause* 7.3)

METHOD FOR DETERMINATION OF COMPRESSIVE STRENGTH

D-1 APPARATUS

D-1.1 Compression Testing Machine

The apparatus shall comprise of compression testing machine which shall be equipped with two steel bearing blocks for holding the specimen. It is desirable that the blocks have a minimum hardness of 60 HRC and a minimum thickness of 25 mm. The block on top through which load is transmitted to the specimen shall be spherically seated. The block below on which the specimen is placed shall be rigidly fitted. When the bearing area of the steel blocks is not sufficient to cover the bearing area of the paving block specimen, two steel bearing plates meeting the requirements of **D-1.2** shall be placed between the steel bearing blocks fitted on the machine and the specimen.

D-1.2 Steel Bearing Blocks and Plates

The surfaces of the steel bearing blocks and plates shall not depart from the plane by more than 0.025 mm in any 15 mm dimension. The center of the sphere of the spherically seated upper bearing block shall coincide with the center of the bearing surface. If bearing plate is used, the center of the sphere of the upper bearing block shall be 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 150 mm. When steel plates are employed between the steel bearing blocks and the specimen, the plates shall have a thickness equal to at least one-third 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 SPECIMENS

The paving block specimens shall be selected as per the sampling procedure given in **8** and the number as per Table 4.

D-3 CAPPING OF SPECIMENS

D-3.1 The bearing surfaces of the specimens shall be capped by one of the methods described in **D-3.1** and **D-3.2** of Annex D of IS 2185 (Part 1).

D-3.2 Alternatively, 3 mm thick plywood sheets of size larger than the specimens by a margin of at least 5 mm from all edges of the specimen shall be used for capping the specimens.

D-3.3 When specimen with surface projections or surface relief features has to be tested, its bearing surfaces shall be made plain by suitable capping, such as by using sulphur or gypsum, before testing.

D-4 PROCEDURE

D-4.1 The dimensions and plan areas of the specimens shall be determined as described in Annex B. The blocks shall be stored for 24 ± 4 h in water maintained at a temperature of 27 ± 2° C. The bearing plates of the testing machine shall be wiped clean. The specimens are aligned with those of the bearing plates.

D-4.2 The load shall be applied without shock and increased continuously at a rate of 15 ± 3 MPa/min until no greater load can be sustained by the specimen or delamination occurs. The maximum load applied to the specimen shall be noted in N.

D-5 CALCULATION

The apparent compressive strength of individual specimen shall be calculated by dividing the maximum load (in N) by the plan area (in mm^2). The corrected compressive strength shall be calculated by multiplying the apparent compressive strength by the appropriate correction factor from Table 5. The strength shall be expressed to the nearest 0.1 MPa.

For other thickness of paving blocks between 50 mm and 120 mm, linear extrapolation of correction factor shall be made.

Table 5 Correction Factors for Thickness and Arris/Chamfer of Paving Block for Calculation of Compressive Strength

(*Clause* D-5)

Sl No.	Paving Block Thickness	Correction Factor for	
	mm	Plain Block	Arrised/Chamfered Block
(1)	(2)	(3)	(4)
i)	50	0.96	1.03
ii)	60	1.00	1.06
iii)	80	1.12	1.18
iv)	100	1.18	1.24
v)	120	1.28	1.34

D-6 REPORT

Report the individual and mean compressive strength of the specimens, correct to the nearest 0.1 MPa.

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ANNEX E

(*Clause* 7.3)

METHOD FOR DETERMINATION OF ABRASION RESISTANCE

E-1 APPARATUS

The abrasion testing machine shall be the same as described in Annex G of IS 1237 (*see* Fig. 4).

E-2 SPECIMENS

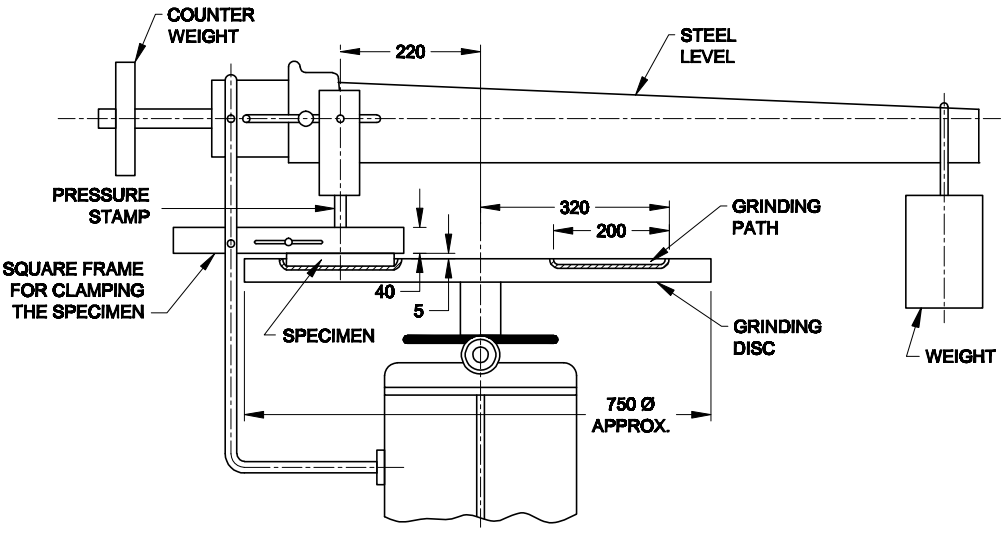
E-2.1 Square-shaped specimens measuring 71.0 ± 0.5 mm shall be cut from the block specimens selected as per the sampling procedure in **8** and as per the number of specimens mentioned in Table 4. The contact face and the opposite face of the specimen shall be parallel and flat. For determining the reduction in thickness as described in **E-4**, the opposite face shall, if appropriate, be ground parallel or otherwise machined so as to be parallel.

E-2.2 For testing dry specimens, the specimens shall be dried to constant mass at a temperature of 105 ± 5 °C.

E-2.3 For testing wet/saturated specimens; the specimens shall be immersed in water for 7 days and wiped with a damp artificial sponge prior to each weighing (*see* **E-3**) so that all specimens appear equally damp.

E-3 PROCEDURE

E-3.1 The mass of the specimen, *PR* shall be determined nearest to 0.1 g/mm^3. The mass of the specimen shall be noted to nearest 0.1 g both prior to the abrasion test and after every four cycles. (*see* **E-4**)



All dimensions in millimetres.

FIG. 4 TYPICAL ABRASION TESTING MACHINE

E-3.2 In the case of two-layer specimens, the density of specimens taken separately from the wearing layer shall be determined.

E-3.3 The grinding path of the disc of the abrasion testing machine shall be evenly strewn with 20 g of the standard abrasive powder as per **G-3** of IS 1237. The specimen shall be fixed in the holding device such that the testing surface faces the grinding disc. The specimen shall be centrally loaded with 294 ± 3 N.

E-3.4 The grinding disc shall be run at a speed of 30 rpm. The disc shall be stopped after one cycle of 22 revolutions. The disc and contact face of the specimen shall be cleaned of abrasive powder and debris. The specimen shall be turned 90° in the clockwise direction and 20 g of abrasive powder shall be evenly strewn on the testing track before starting the next cycle.

E-3.5 When testing wet/saturated specimens, prior to each cycle, the track shall be wiped with a lightly damp artificial sponge and moistened before being strewn with the abrasive powder. From the start of the test, arrangement shall be made for drip-wetting of the central portion of the track, about 30 mm from the specimen (opposite to the direction of motion of the disc), by supplying water drops at the rate of 180 to 200 drops (13 ml) per minute. During this test, it should be ensured that the abrasive powder continuously returns to the effective area of the track.

E-3.6 The test cycle shall be repeated 16 times, the specimen being turned 90° in the clockwise direction and spreading of 20 g of abrasive powder on the testing track after each cycle.

E-4 CALCULATION

The abrasive wear of the specimen after 16 cycles of testing shall be calculated as the mean loss in specimen volume, ΔV, from the equation:

$$\Delta V = \Delta m / PR$$

where

ΔV = loss in volume after 16 cycle, mm^3;

Δm = loss in mass after 16 cycles, g; and

PR = Density of the specimen, or in the case of two-layer specimens, the density of the wearing layer, g/mm^3.

E- 5 REPORT

Report the individual and mean values of the abrasion resistance, as loss in volume, to the nearest whole number of 1 000 mm^3 per 5 000 mm^2.

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ANNEX F

(*Clause* 7.3)

METHOD FOR DETERMINATION OF TENSILE SPLITTING STRENGTH

F-1 APPARATUS

The testing machine shall have a scale with an accuracy of ± 3 percent over the range of the anticipated test loads and be capable of increasing the load at specified rates. The machine shall be equipped with a device composed of two rigid bearers (*see* Fig. 5) whose contact surface has a radius of 75 ± 5 mm. The two bearers shall be held in the same vertical plane with a tolerance of ± 1 mm at the bearers' end. The upper bearer shall be able to rotate in its transverse axis. The two packing pieces shall be 15 ± 1 mm wide (*see* '*b*' in Fig. 5), 4 ± 1 mm thick (*see* '*a*' in Fig. 5) and at least 10 mm longer than the anticipated fracture plane. The packing pieces shall be made of a material having hardness between 55 HRC and 60 HRC.

F-2 SPECIMENS

The paving block specimens shall be selected as per the sampling procedure given in **8** and the number as per Table 4.

F-3 PREPARATION

Whole specimens shall be used and any burrs, high spots, etc. shall be removed. In case a face is rough, textured or curved, it shall be prepared by grinding or capping. The least amount of material shall be removed to obtain a flat face. The specimens shall be immersed in water at 27 ± 2 °C for 24 ± 3 h, removed, wiped dry and immediately tested. Other methods of preparation may be used for routine testing, provided there is a correlation between the two methods, for example, using ungrounded rough textured or curved specimens instead of ground specimens.

F-4 PROCEDURE

F-4.1 The specimen shall be placed on the testing machine with the packing pieces on the upper face and the bed face, in contact with the bearers. It shall be ensured that the packing pieces and the axes of the bearers are in line with the splitting section of the specimen. The splitting section shall be chosen according to the following order of priority:

a) The test is carried out along the longest splitting section of the specimen, parallel and symmetrical to the edges, in such a way that the distance of the splitting section to any side face is at least 0.5 times the thickness of the specimen over at least 75 percent of splitting section area.

b) If the condition in (a) cannot be met, the test is carried out along two splitting sections, chosen in such a way that the distance from one splitting section to the other splitting section or to any side face of the specimen is at least 0.5 times the thickness of the specimen over at least 75 percent of the splitting section length considered.

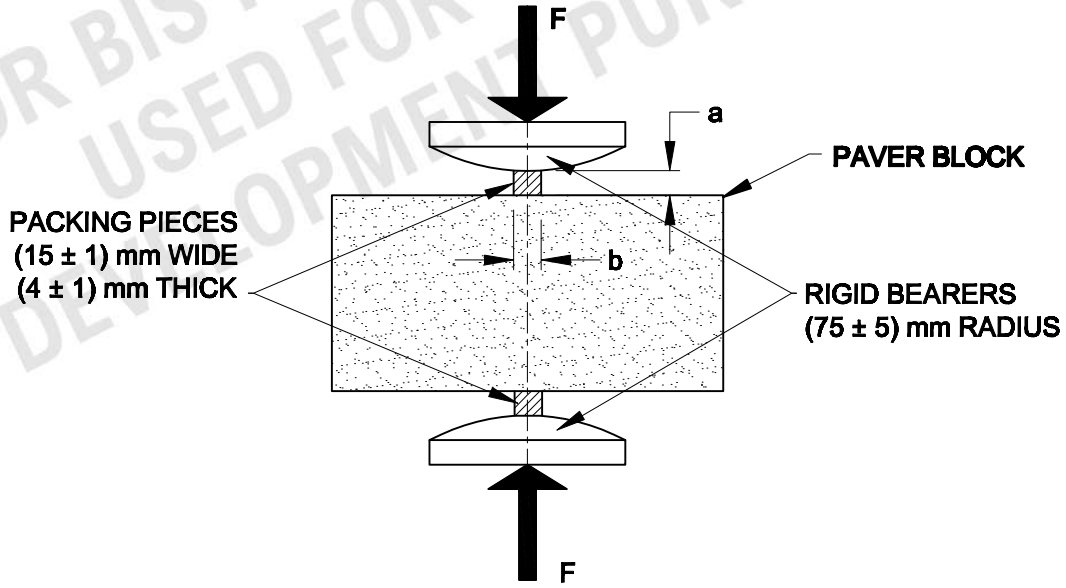


FIG. 5 TYPICAL TENSILE SPLITTING STRENGTH TEST SETUP

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c) If neither of the conditions in (a) or (b) can be met, the splitting section shall be chosen in such a way that the greatest total proportional section length satisfying the distance requirement is obtained.

d) In case the section of the specimen is square, hexagonal or circular in plan, the splitting section shall be chosen in such a way that it is the shortest length passing through the center of the plan area.

F-4.2 The load is smoothly and progressively applied at a rate which corresponds to an increase in stress of 0.05 ± 0.01 MPa/s. The failure load (P) is recorded in N, to the nearest 0.01 N.

F-5 CALCULATION

F-5.1 The area of the failure plane(s) of the specimen tested are calculated from the equation given below:

$$S = I \times t$$

where

S = area of the failure, mm^2;

I = mean of two measurements of the failure length, one at the top and one at the bottom of the specimen, mm; and

t = mean of three measurements of thickness at the failure plane, one in the middle and one at either end, mm.

F-5.2 The tensile splitting strength of the test specimen is calculated from the equation given below:

$$T = 0.637 \times k \times (P/S)$$

where

T = tensile splitting strength, MPa; and

P = failure load, N.

k = correction factor for block thickness, as given below:

T (mm)	50	60	80	100	120
k	0.79	0.87	1.00	1.11	1.19

NOTE — For intermediate values of wall thickness, the value of k shall be interpolated and for thickness greater than 120 mm, the value of k shall be extrapolated.

F-5.3 The failure load per unit length of the specimen is calculated for the equation:

$$F = P/I$$

where

F = failure load, in N/mm.

F-5.4 If testing is conducted along two transverse sections of the same specimen, the splitting tensile strength of the specimen is the mean of the two individual results.

F-6 REPORT

Report the individual and mean values of the following:

a) T, the tensile splitting strength of the specimen to the nearest 0.1 MPa; and

b) F, the failure load per unit length of the specimen to the nearest 10 N/mm.

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ANNEX G

(*Clause* 7.3)

METHOD FOR DETERMINATION OF FLEXURAL STRENGTH

G-1 APPARATUS

The apparatus for the test shall be the same as in **8** of IS 516, with the following modifications:

a) The supporting and loading rollers shall have diameter in the range of 25 to 40 mm. They shall extend on both sides beyond the dimensions of the specimens by at least 10 mm;

b) The distance from centre to centre of the two supporting rollers shall be adjustable to the overall length of the specimen minus 50 mm; and

c) The loading roller shall be arranged for application of load from the top of the specimen along the vertical centerline between the supporting rollers.

G-2 SPECIMENS

The longest rectangular slice having width of at least 40 mm, in case nominal maximum size of coarse aggregate is 12.5 mm or 60 mm, in case nominal maximum size of coarse aggregate is 20 mm shall be cut from the block specimens selected as per the sampling procedure in **8** and as per the number of specimens mentioned in Table 4.

G-3 CAPPING OF SPECIMENS

G-3.1 The test specimens shall be capped by one of the methods described in **D-3** of Annex D.

G-3.2 When specimen with surface projections or surface relief features has to be tested, its upper face shall be made plain by suitable capping, such as by using sulphur or gypsum before testing.

G-4 PROCEDURE

The test procedure shall be the same as in **8** of IS 516, with the following modifications:

a) The load shall be applied from the top of the specimen in the form of a simple beam loading through a roller placed midway between the supporting rollers, as shown in Fig. 6. Loading of irregular-shaped specimens shall be as shown in Fig. 7.

b) The load shall be applied without shock and increased continuously at a uniform rate of 6 ± 0.6 kN/min.

c) The load shall be increased until the specimen fails, and the maximum load applied shall be recorded to the nearest N.

G-5 CALCULATION

The flexural strength of the specimen shall be calculated as follows:

$$F_b = 3Pl / 2bd^2$$

where

F_b = flexural strength, MPa;

P = maximum load, N;

l = distance between central lines of supporting rollers, mm;

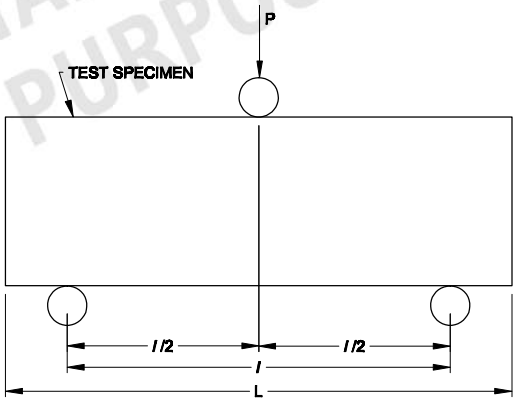
b = average width of block, measured from both faces of the specimen, mm; and

d = average thickness, measured from both ends of the fracture line, mm.

The maximum load P shall be reported as the breaking load, nearest to 1 *N*.

G-6 REPORT

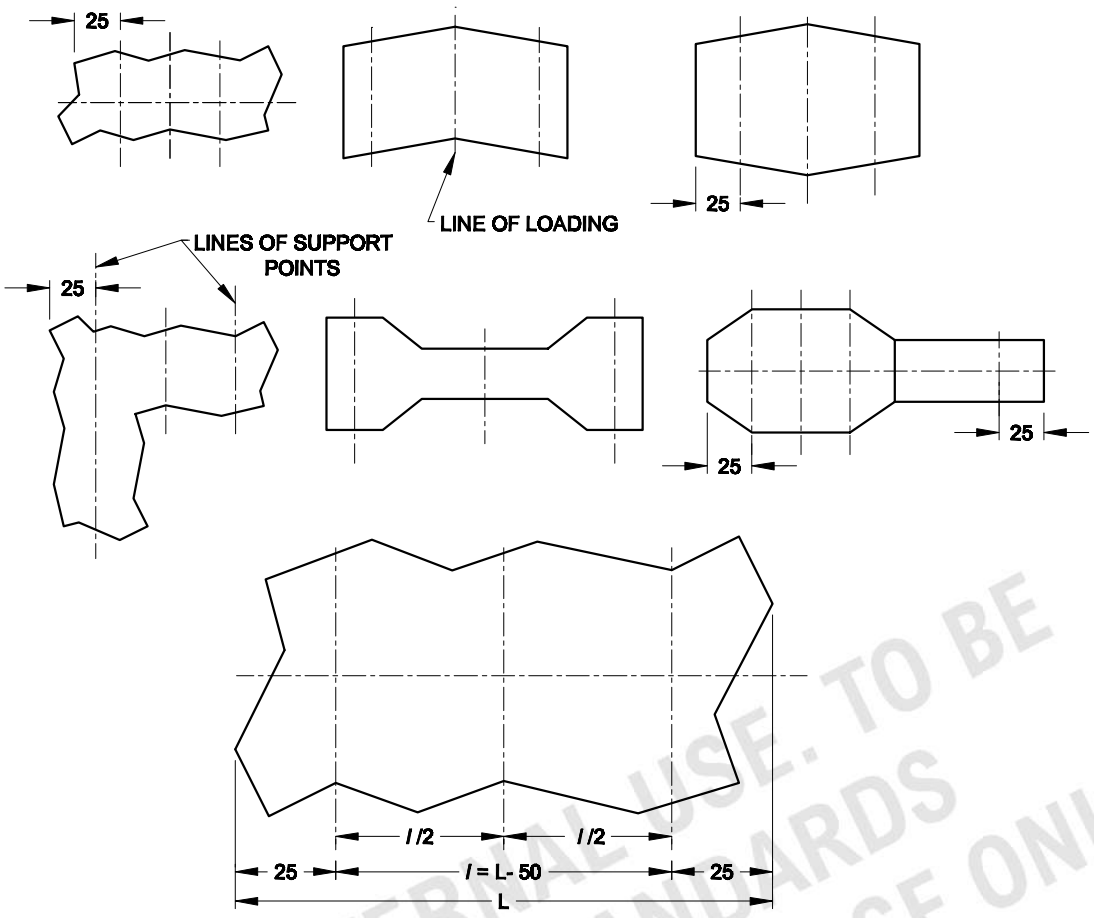
Report the individual and mean values of the flexural strength, correct to the nearest 0.1 MPa and breaking load, correct to the nearest 1 N.



(L = Overall length of the specimen parallel to the longitudinal axis, l = centre-to-centre distance between the two rollers, P = Load)

FIG. 6 TYPICAL LOADING ARRANGEMENT OF TEST SPECIMEN FOR FLEXURAL STRENGTH

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All dimensions in millimetres.

FIG. 7 LOADING OF COMMON IRREGULAR SHAPES OF FLEXURAL STRENGTH

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ANNEX H

(*Clauses* 7.3)

METHOD OF DETERMINATION OF FREEZE-THAW DURABILITY

H-1 SCOPE

This method covers the determination of the resistance of concrete paving blocks to repeated cycles of freezing and thawing when fully submerged in 3 percent sodium chloride solution.

H-2 APPARATUS

H-2.1 The freezing apparatus shall consist of a suitable cabinet or cold room with controls to reach and maintain an air temperature of -15 ± 2° C within 1 h of the introduction of specimens.

H-2.2 The thawing chamber (cabinet or room) shall be suitable to maintain a controlled air temperature of 27 ± 2 °C.

H-2.3 The moist chamber (cabinet or room) shall be suitable to maintain a controlled air temperature of 27 ± 2° C and a relative humidity of 90 percent. If storage in water is desirable, a saturated lime solution shall be used, and the temperature shall be maintained at 27 ± 2° C.

H-2.4 For measuring fine spalled material, a balance having a capacity of not less than 500 g sensitive to 0.1 g shall be used. For measuring the dry weight of paving blocks, a balance having a capacity of not less than 5 000 g sensitive to 1 g shall be used.

H-2.5 The drying oven shall be capable of being maintained at 110 ± 5°C, and the rate of evaporation shall average at least 25 g per hour. This rate shall be determined by the loss of water from 1 l Griffin low-form beakers, each containing 500 g of water at a temperature of 27 ± 2°C, placed at each corner and at the center of each shelf of the oven, and heated for at least 4 h, during which period the doors of the oven shall be kept closed.

H-2.6 The containers shall be made of non-corroding material and have such dimensions as to permit complete submersion of the specimens in the saline solution.

H-3 SPECIMENS

The paving block specimens shall be selected as per the sampling procedure given in **8** and the number as per Table 4.

H-4 PROCEDURE

H-4.1 The specimens shall be oven dried for not less than 24 h and until two successive weighing at intervals of 2 h show an increment of loss of not greater than 0.2 percent of the last previously determined weight of the specimen.

H-4.2 One freeze-thaw cycle shall be completed every 24 h. The cycle shall consist of 16 ± 1 h of freezing, followed by 8 ± 1 h of thawing. If for any reason a thaw period cannot commence at the specified time, the specimens shall remain in a frozen condition until conditions are suitable for resumption of the test.

H-4.3 Following the completion of the oven drying and cooling to room temperature, the specimens shall be placed in individual containers with the bottom surface of the specimens resting on the glass, stainless steel, ceramic, or plastic spacers (approximately 3 mm high) to ensure exposure of at least 95 percent of the bottom surfaces to the saline solution.

H-4.4 The containers shall be filled with a 3 percent sodium chloride solution at a temperature of 27 ± 2°C for 24 h. The level of the solution shall be at least 2 mm above the surface of the specimens, but excess volume of solution shall be avoided in order to ensure rapid freezing of the specimens.

H-4.5 Following the 24 h saturation period, the specimens shall be subjected to continuous freeze-thaw cycles as outlined in **H-4.2**.

H-4.6 After 10, 25 and 50 cycles the specimens shall be washed with 3 percent sodium chloride solution to remove all loose particles. These particles and spalled material, collected at the bottom of the containers, shall be washed, stained through a filter, and dried to constant weight. This residue shall be defined as weight loss, and expressed as a percent of the initial dry weight of the specimens. The residue shall be cumulatively weighed after 10, 25 and 50 cycles.

H-4.7 A new solution of 3 percent sodium chloride shall be used following each weight loss determination. The 24 h pre-soaking period shall be waived at 10 and 25 cycles, provided that the specimens are maintained in a saturated condition during weight determinations.

H-5 CALCULATION

H-5.1 The weight loss shall be calculated to the nearest 0.01 percent.

H-5.2 The test shall continue until 50 freeze thaw cycles have been completed unless the test specimens have disintegrated or lost more than 1.0 percent of their original dry weight. If, because of high spalling

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losses or disintegration, testing of the specimen has to be terminated prematurely, the weight loss shall be determined (*see* **H-4.6**) and added to the previous lost weight.

H-6 REPORT

The report shall include the following:

a) Identification of specimens;

b) Dimensions;

c) Weight losses of the specimens and the average results after 10, 25 and 50 cycles or at the time of termination of the test;

d) Number of cycles at termination time;

e) Visual rating of the specimens after 10, 25 and 50 cycles in accordance with the following scale:

   1) 0 : no scaling;

   2) 1 : very slight scaling (3 mm depth maximum. No coarse aggregate visible);

   3) 2 : slight to moderate scaling;

   4) 3 : moderate scaling (some coarse aggregates visible on 50 percent of the surface);

   5) 4 : moderate to severe scaling (some coarse aggregates visible on 75 percent of the surface); and

   6) 5 : severe scaling (coarse aggregates visible on 100 percent of the surface).

f) Description of the damages suffered by the specimens, and photographs where possible;

H-7 GUIDE FOR DURABILITY CHARACTERISTICS

H-7.1 As a guide to the purchaser, the durability characteristics given in **H-7.2** may be adopted.

H-7.2 When tested in accordance with this method, the average weight loss of three paving blocks, after having been subjected to 50 freeze-thaw cycles while totally immersed in a 3 percent sodium chloride solution, shall not exceed 1 percent of the initial constant dry weight of the specimens.

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ANNEX J

(*Foreword*)

COMMITTEE COMPOSITION

Flooring, Wall finishing and Roofing Sectional Committee, CED 05

Organization	*Representative(s)*
In Personal Capacity (*L/109, Sarita Vihar, New Delhi*)	Shri Ashok Khurana (***Chairman***)
Ardex Endura India Pvt Ltd, Bengaluru	Shri K. P. Paulson Shri Gopinath Krishnan (*Alternate*)
ACC Limited, Mumbai	Representative
Ahluwalia Contracts India Limited, Mumbai	Representative
Building Materials & Technology Promotion Council, New Delhi	Shri S. K. Gupta Shri Pankaj Gupta (*Alternate*)
Carborundum Universal Ltd, Chennai	Shri Ranji Varghese Shri V. G. Rajendran (*Alternate*)
Central Public Works Department, New Delhi	Shri Rajesh Kumar Kaushal Shri Arun Kumar Tyagi (*Alternate*)
Choksi Laboratories Limited, Indore	Shri R. D. Mathur Shri Vyangesh Choksi (*Alternate*)
Construction Chemicals Manufacturers Association, Navi Mumbai	Shri Upen Patel Shri Samir Surlaker (*Alternate*)
Construction Industry Development Council, New Delhi	Shri P. R. Swarup Shri Ravi Jain (*Alternate*)
CSIR-Central Building Research Institute, Roorkee	Shri S. K. Singh Dr Achal Kumar Mittal (*Alternate*)
CSIR-Central Glass and Ceramic Research Institute, Kolkata	Dr Satyendra Nath Misra
CSIR-Central Road Research Institute, New Delhi	Dr Rakesh Kumar
Delhi Development Authority, New Delhi	Chief Engineer (DWK) Superintending Engineer (P) (*Alternate*)
Directorate General Border Roads, New Delhi	Shri A. K. Agarwal
Engineers India Limited, New Delhi	Shri Samir Das Shri Akhilesh Maurya (*Alternate*)
H. R. Johnson (India) Limited, Dewas	Shri Arun Rao Shri Subhashish Mukhopadhyay (*Alternate*)
Indian Council of Ceramic Tiles & Sanitaryware, Mumbai	Shri Arun Rao Shri P. K. Sharma (*Alternate*)
Larsen & Toubro Ltd, Mumbai	Representative
Lloyd Insulation (India) Pvt Limited, New Delhi	Shri Mohit Khanna Shri K. K. Mitra (*Alternate*)
MAPEI Construction Products India Pvt Ltd, Bengaluru	Dr G. S. Ravi Shankar Abhijit Dutta (*Alternate*)
Military Engineer Services, Engineer-in- Chief's Branch, Integrated HQ of MoD (Army), New Delhi	Shrimati Rivoo Mahendru Shrimati Remika Sharma (*Alternate*)

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Organization	*Representative(s)*
Modern Tiles & Marble, New Delhi	Shri Subhash Kapoor E. R. Padma Kumar (*Alternate*)
Morbi Dhuva Glaze Tiles Association, Morbi	Shri Nilesh Jetparia Shri Jeram Madhav Kavar (*Alternate*)
MYK Laticrete India, Hyderabad	Dr P. Arjunan Shri N. Radhakanth (*Alternate*)
National Council for Cement and Building Materials, Ballabgarh	Shri Amit Trivedi Shri Nitin Chowdhary (*Alternate*)
National Test House, Kolkata	Shri Somit Neogi Shri Animesh Das (*Alternate*)
NTC Tiles LLP, Panchkula	Shri Prem Chand Gupta Shri Sushant Gupta (*Alternate*)
New Delhi Municipal Council, New Delhi	Representative
North Delhi Municipal Corporation, New Delhi	Dr S. Ramesh
Paver and Block Manufacturers, Association, Mumbai	Shri Mehul Jain Shri Ishan Sehgal (*Alternate*)
Plastindia Foundation, Mumbai	Representative
Premier Polyfilm Ltd, Ghaziabad	Shri Praveen Kumar Shri Harendra Kumar (*Alternate*)
Research, Designs and Standards Organization, Lucknow	Executive Director (Works) Shri Ashutosh Kumar (*Alternate*)
Responsive Industries Ltd, Mumbai	Shri Rishabh Agarwal Shri Abhishek Agarwal (*Alternate*)
RMG Polyvinyl India Limited, Ghaziabad	Representative
Shriram Institute of Industrial Research, New Delhi	Dr Mukesh Garg Shri Raman Dhyani (*Alternate*)
Somany Ceramics Ltd, Bahadurgarh	Shri G. G. Trivedi Shri Abhishek Agarwal (*Alternate*)
Super Tiles & Marble Pvt Ltd, Mumbai	Shri Sudhakar Mody
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