



भारतीय मानक ब्यूरो

BUREAU OF INDIAN STANDARDS

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व्यापक परिचालन मसौदा

हमारा संदर्भ : सीईडी 05/ T-88

09 फरवरी 2024

तकनीकी समिति : फर्श, दीवार फिनिशिंग और छत अनुभागीय समिति सीईडी 05

प्राप्तकर्ता:

- 1) सिविल इंजीनियरी विभाग परिषद् के रूचि रखने वाले सदस्य
- 2) सीईडी 05 व उसकी सभी उपसमितियों के सभी सदस्य
- 3) रूचि रखने वाले अन्य निकाय

महोदय/महोदया,

निम्नलिखित मसौदा संलग्न है :

प्रलेख संख्या	शीर्षक
सीईडी 05 (24822) WC	प्रीकास्ट कंक्रीट पेविंग प्लैग - विशिष्टि का भारतीय मानक मसौदा (ICS 93.080.20)

कृपया इस मसौदे का अवलोकन करें और अपनी सम्मतियाँ यह बताते हुए भेजे कि यह मसौदा भारतीय मानक के रूप में प्रकाशित हो तो इस पर अमल करने में आपको व्यवसाय अथवा कारोबार में क्या कठिनाइयाँ आ सकती हैं।

सम्मतियाँ भेजने की अंतिम तिथि: **10 मार्च 2024.**

सम्मति यदि कोई हो तो कृपया अधोहस्ताक्षरी को संलग्न फॉर्मेट में, ced5@bis.gov.in पर ईमेल कर दें।

यदि कोई सम्मति प्राप्त नहीं होती है अथवा सम्मति में केवल भाषा संबंधी त्रुटि हुई तो उपरोक्त प्रलेख को यथावत अंतिम रूप दिया जाएगा। यदि सम्मति तकनीकी प्रकृति की हुई तो विषय समिति के अध्यक्ष के परामर्श से अथवा उनकी इच्छा पर आगे की कार्यवाही के लिए विषय समिति को भेजे जाने के बाद प्रलेखको अंतिम रूप दे दिया जाएगा।

यह प्रलेख भारतीय मानक ब्यूरो की वेबसाइट www.bis.gov.in पर भी उपलब्ध है।

धन्यवाद।

भवदीय

ह/-

(अरुण कुमार स.)

प्रमुख (सिविल इंजीनियरी)

संलग्न : उपरलिखित



भारतीय मानक ब्यूरो BUREAU OF INDIAN STANDARDS

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DRAFT IN WIDE CIRCULATION

Our Ref: CED 05/T-88

09 February 2024

Technical Committee: Flooring, Wall Finishing and Roofing Sectional Committee, CED 05

ADDRESSED TO:

- 1) All Interested Members of Civil Engineering Division Council, CEDC
- 2) All Members of CED 05 and its subcommittees,
- 3) All other interests.

Dear Sir/Madam,

Please find enclosed the following draft:

Doc No.	Title
CED 05 (24822)WC	Draft Indian Standard Precast Concrete Paving Flags – Specification (ICS 93.080.20)

Kindly examine the draft and forward your views stating any difficulties which you are likely to experience in your business or profession, if this is finally adopted as National Standards.

Last Date for Comments: 10 March 2024.

Comments, if any, may please be made in the format as enclosed and e-mailed to the undersigned at ced5@bis.gov.in in word format.

In case no comments are received or comments received are of editorial nature, you will kindly permit us to presume your approval for the above document as finalized. However, in case comments of technical nature are received, then this may be finalized either in consultation with the Chairman, Sectional Committee or referred to the Sectional Committee for further necessary action if so desired by the Chairman, Sectional Committee.

The document is also hosted on BIS website www.bis.gov.in.

Thanking you,

Yours faithfully,
Sd/-

(Arunkumar S.)
Head (Civil Engineering)

Encl: as above

FORMAT FOR SENDING COMMENTS ON BIS DOCUMENTS

(Please use A-4 size sheet of paper only and type within fields indicated. Comments on each clause/sub-clause/table/fig etc. be started on a fresh box. Information in column 3 should include reasons for the comments and suggestions for modified working of the clauses when the existing text is found not acceptable. Adherence to this format facilitates Secretariat's work) {Please e-mail your comments to ced5@bis.gov.in

DOC. NO.: CED 05 (24822)WC

Title: Draft Indian Standard Precast Concrete Paving Flags – Specification

LAST DATE OF COMMENTS: 10/03/2024

NAME OF THE COMMENTATOR/ORGANIZATION: _____

Sl. No.	Clause/Para/Table/ Figure No. Commented	Comments/Modified Wordings	Justification of the Proposed Change

BUREAU OF INDIAN STANDARD

DRAFT FOR COMMENTS ONLY

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Draft Indian Standard

Precast Concrete Paving Flags – Specification

Flooring, Wall Finishing and Roofing
Sectional Committee CED 05

Last date for Comment:
10/03/2024

FOREWORD

Concrete paver blocks were first introduced in Holland in the fifties as replacement of paver bricks which had become scarce due to the post-war building construction boom. These blocks were rectangular in shape and had more or less the same size as the bricks. During the past five decades, the block shape has steadily evolved from non-interlocking to partially interlocking to fully interlocking to multiply interlocking shapes.

Consequently, the pavements in which non-interlocking blocks are used are designated as 'Concrete Block Pavement (CBP)' or non-interlocking CBP, and those in which partially, fully or multiply interlocking blocks are used are designated as 'Interlocking Concrete Block Pavement (ICBP)'. BIS has published IS 15658 : 2021 'Precast concrete blocks for paving – Specification (*first revision*)' for interlocking paving blocks.

CBP/ICBP consists of a surface layer of small-element, solid un-reinforced pre-cast concrete paver blocks laid on a thin, compacted bedding material which is constructed over a properly profiled base course and is bounded by edge restraints/kerb stones, The block joints are filled using suitable fine material.

A properly designed and constructed CBP/ICBP gives excellent performance when applied at locations where conventional systems have lower service life due to a number of geological, traffic, environmental and operational constraints. Many number of such applications for light, medium, heavy and very heavy traffic conditions are currently in practice around the world.

In the formulation of this standard, assistance has been derived from the following publications:

BS EN 1339 : 2003 Concrete Paving Flags – Requirements and test methods

BS 7263 (Part 1) : 1994 Precast Concrete Flags, Kerbs, Channels, Edgings and Quadrants

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 : 2022 'Rules for rounding off numerical values (*second revision*)'. 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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Draft Indian Standard

Precast Concrete Paving Flags – Specification

Flooring, Wall Finishing and Roofing
Sectional Committee CED 05

Last date for Comment:
10/03/2024

1 SCOPE

This standard specifies materials, properties, requirements, and test methods for cement bound unreinforced concrete paving flags.

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 terms and definitions shall apply.

3.1 Arris - Part of a flag where two faces meet. It can be beveled, rounded, chamfered, parabolic or splayed.

3.2 Concrete Paving Flag - Precast concrete unit used as a surfacing material that satisfies the following conditions: its minimum thickness is 50mm, minimum plan area is 0.09 sq. m., its overall length does not exceed 1200 mm and its overall length divided by its thickness is greater than four.

3.4 Permeable Paving Flag - Flag intended, by its structure, to allow passage of water through the flag.

3.5 Overall Length - Longer side of the rectangle with the smallest area able to enclose the flag excluding any spacer nibs.

3.6 Overall Width - Shorter side of the rectangle with the smallest area able to enclose the flag excluding any spacer nibs.

3.7 Thickness - Distance between the upper face and the bed face of the flag.

3.8 Spacer Nibs - Small protruding profiles on a side face of a flag.

3.9 Upper Face - Surface intended to be seen when in use.

3.10 Bed Face - Surface generally parallel to the upper face and in contact with the bedding after laying.

3.11 Facing Layer - Layer of concrete on the upper face of a flag of different material and/or properties to the main body or backing layer of a flag.

NOTE - To be distinguished from wipe, being a fine cement mortar or slurry applied to the surface of the flag.

3.12 Draw - Intended angle of the side face from the vertical plane over the full height of a flag as shown in Fig. 1.

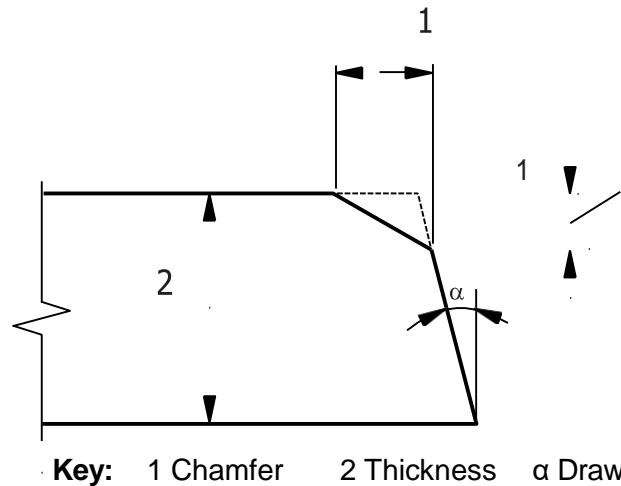


FIG. 1 EXAMPLE OF CHAMFER AND DRAW

3.13 Chamfer - Bevelled arris, as shown in Fig. 1

3.14 Nominal Size – Size which identifies the flag.

3.15 Secondary Processing - Manufacturing process to texture the whole flag or any surface, carried out after basic manufacture before or after hardening.

3.16 Work Size – The target size of the flag specified for its manufacture.

3.17 Chased Side Face - Side face of a concrete paving flag, having a recessed profile.

3.18 Format - Work dimensions of a flag specified in order of overall length, overall width and thickness.

3.19 Wipe - Fine cement mortar or slurry applied to the surface of the units.

4 MATERIAL

4.1 Cement

4.1.1 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.

3.2 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 and Part 2).
- b) Silica fume conforming to IS 15388.
- c) Ground granulated blast furnace slag conforming to IS 16714.
- d) Metakaolin conforming to IS 16354.
- e) Rice husk ash conforming to the requirements of IS 456.

4.2 Chemical Admixtures

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

4.3 Coarse and Fine Aggregates

4.3.1 Coarse Aggregates

- a) Coarse aggregates shall comply with the requirements of IS 383.
- b) The nominal maximum size of coarse aggregate used in production of paving flags 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 flags having thickness of 80 mm or above, and two-layer paving flags having thickness of backing layer of 80 mm or above.

4.3.2 Fine Aggregates

Fine aggregates shall conform to the requirements of IS 383.

4.4 Pigments

4.4.1 Pigments, if used either singly or in combination in the manufacture of paving flags, 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).

4.4.2 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.

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

4.5 Water

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

4.6 Where alkali activated concrete is used for manufacture, the constituent materials, mix design procedure and curing requirements shall be as per IS 17452.

5 REQUIREMENTS

5.1 General

5.1.1 Flags may be produced with a single concrete throughout or with different facing and backing layers.

5.1.2 When flags are produced with a facing layer this shall have a minimum thickness of 6 mm over that area claimed by the manufacturer to be faced, when measured in accordance with Annex B. Isolated particles of aggregate protruding into the facing layer shall be ignored. The facing layer shall be an integral part of the flag.

5.1.3 An arris described as square may be bevelled or rounded. The horizontal or vertical dimensions shall not exceed 2 mm.

5.1.4 A bevelled arris exceeding 2 mm shall be described as chamfered. Its dimensions shall be declared by the manufacturer.

5.1.5 Draw angle α shall not exceed 1° .

5.1.6 Flags may be produced with functional and/or decorative profiles, which shall not be included in the work dimensions of a flag.

5.1.7 The surface of flags may be textured, secondary processed or treated chemically; these finishes or treatments shall be described and declared by the manufacturer.

5.2 Dimensions

5.2.1 Sizes of flags shall be as given in Table 1.

Table 1 Concrete Paving Flags Sizes

Flag Type	Nominal Size mm	Work Size mm	Thickness mm
(1)	(2)	(3)	(4)
A	600 x 1200	598 x 1198	80
B	600 x 900	598 x 898	
C	600 x 750	598 x 748	
D	600 x 600	598 x 598	
E	600 x 450	598 x 448	
F	600 x 300	598 x 298	
G	500 x 500	498 x 498	
H	450 x 450	448 x 448	
I	400 x 400	398 x 398	
J	300 x 300	298 x 298	

NOTES

1 Flags, with size and thickness other than those specified above, may be manufactured when agreed between manufacturer and client, provided that the flags meet all other requirements of the standard.

2 Tactile Flags type TA are normally available in sizes of flag types F, G, H, I and J. Tactile flags are thus designated type TA/F, TA/G, TA/H, TA/I and TA/J depending on their size.

5.2.2 Applications

The choice of which flag to use in a particular location will depend on both its size and strength. The larger the flag, the higher its bending strength must be because it will have to carry more loads. The suitability of flags for various locations are given in Table 2.

Table 2 Suitability of Flags for Various Locations

SI NO.	Location and Use	Flag Type	Minimum Thickness mm
i)	No vehicles for example, pedestrian only streets; footpaths; railway platforms; walkways with bollards, benches, etc.;	C to J	50
ii)	Occasional use by cars and light mechanical sweepers, for example, footpaths/ walkways in no-parking areas or where over-run is not a problem	C to J	50
iii)	Footpaths/ walkways where vehicles cross sometimes, for example, to reach a house driveway	D, E, F, G, H, I, J	60
iv)	Footpaths and walkways where cars and occasional commercial light weight vehicles run over; unprotected pedestrian streets with about 25 vehicles each day/way for service or fire access	H, I, J	60
v)	Railway Platform + Fire Tender + Heavy Commercial Vehicle	A, B	80

5.2.3 Spacer nibs, draw or chased profiled side faces

Flags may be produced with spacer nibs, a draw or chased profiled side faces. When these are provided, the manufacturer shall declare their work dimensions.

NOTE – The size of the space allocated to the flag should include an allowance for joints and deviations.

5.2.4 Tolerances

The maximum dimensional deviations of any flag, measured in accordance with Annex B shall be as follows:

- a) *Thickness* : +/- 3 mm.
- b) *Dome height (tactile flags)*: +/- 1 mm.
- c) *Length and Width*: +/- 2 mm.
- d) *Squareness of plan (difference between diagonals)*:
 - i) Diagonal \leq 850mm: 2 mm
 - ii) Diagonal $>$ 850mm: 4 mm
- e) *Flatness and Straightness*: The deviations on flatness and straightness given in Table 3 shall apply to an upper face intended to be plane.

Table 3 Permissible Deviations in Flatness and Straightness

Sr. No.	Length of Gauge mm	Maximum Convex, mm	Maximum Concave, mm
(1)	(2)	(3)	(4)
i)	300	1.5	1.0
ii)	400	2.0	1.5
iii)	500	2.5	1.5
iv)	800	4.0	2.5
v)	1200	5.0	3.5

5.3 Physical and mechanical properties

5.3.1 General

The flags shall conform to the following requirements at the time they are declared suitable for use by the manufacturer.

All units shall be sound and free of cracks or other defects which interfere with the proper placing of the unit or impair the strength or performance of the construction. Minor chipping resulting from the customary methods of handling during delivery, shall not be deemed grounds for rejection. All angles of the units except for the angles resulting from the splayed or chamfered faces shall be true right angles.

In the case of two-layer flags there shall be no delamination or separation between the layers.

NOTE – When efflorescence occurs, it is not deleterious to the performance of the flags in use and is not considered significant.

5.3.2 Dimensions

The overall dimensions of the units when measured as given in Annex B shall be subject to the tolerances mentioned in **5.2.2**.

5.3.3 Bending strength

When sampled and tested according to the procedure laid down in Annex C, the bending strength shall be not less than the following values:

- a) Individual : 4.0 MPa
- b) Average : 5.0 MPa

5.3.4 Water Absorption

When tested according to the procedure laid down in Annex D, the average water absorption shall not exceed 6 percent.

5.3.5 Abrasion Resistant

When tested according to the procedure laid down in Annex E of IS 15658, the abrasion resistance (in mm³ per 5 000 mm²) shall not be more than the following values:

- a) Dry
 - i) Individual – 20 000
 - ii) Average – 18 000
- b) Wet
 - i) Individual - 22 000
 - ii) Average - 20 000

6 SAMPLING

6.1 All concrete paving flags of same type and thickness manufactured under identical condition from raw material of same source in a week shall constitute one batch.

6.2 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 flags shall be sampled from each batch of the consignment of blocks up to a quantity of 50 000 flags.

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

6.4 When the quantity of a partial batch is less than half of the quantities mentioned in **6.2** and **6.3**, that partial batch of the consignment shall be added to the previous full batch.

6.5 The sample of paving flags for inspection and testing shall be chosen from a batch at

random. For guidance in procedure of random selection, IS 4905 may be referred.

6.6 A sample of 4 flags shall be taken from each batch for each test. 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.

7 CRITERIA FOR CONFORMITY

7.1 The lot shall be considered as conforming to the requirements of the specification, if the conditions mentioned in **5.3.1** to **5.3.4** are satisfied.

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

8 RETESTS

8.1 Any test sample which fails to comply with the requirements of either of the tests specified in **5.3.1** to **5.3.4**, one set of test samples from the batch/lot comprising the same order shall be tested further.

8.2 If these further test samples fail to comply with the requirements of the tests, the whole of the batch/lot represented by the samples shall be rejected.

9 FACILITIES FOR SAMPLING AND TESTING

The purchaser or his representative shall, at all reasonable times, have access to the place where the units are manufactured or stored, for the purpose of examining and sampling the materials and the finished units, inspecting the process of manufacture, and testing and marking the units. The supplier/manufacturer shall, free of cost provide or make arrangements for the provision of every facility and all labour required for such examination, sampling, inspecting, testing and marking before delivery, and shall provide and maintain or make arrangements of providing and maintaining in good working order suitable, convenient and accurate apparatus for testing samples as hereinafter shall be provided.

10 MANUFACTURER'S CERTIFICATE

The manufacturer shall satisfy himself that the units, comply with the requirements of this Indian Standard and, if requested, shall forward a certificate to this effect to the purchaser or his representative. The manufacturer shall, if requested to do so, supply a certificate stating the date of manufacture of the units. 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. The tests shall be carried out in accordance with the standard on the written instructions of the purchaser or his representative in a testing laboratory mutually agreed upon by the purchaser and manufacturer.

11 MARKING

11.1 The following particulars relating to the units shall be made available on the invoice or on the manufacturer's certificate:

- a) Source of identification of the manufacturer.

- b) Designation of the unit; and
- c) Date of production and batch number.

11.2 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 the *Bureau of Indian Standards Act, 2016* and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

ANNEX A*(Clause 2)***LIST OF REFERRED STANDARDS**

<i>Standard No.</i>	<i>Title</i>
IS 44 : 1991	Iron Oxide Pigments for Paints — Specification (<i>second revision</i>)
IS 50 : 1980	Specification for Lead and Scarlet Chromes (<i>third revision</i>)
IS 54 : 1988	Specification for Green Oxide of Chromium for Paints (<i>second revision</i>)
IS 55 : 1970	Specification for Ultramarine Blue for Paints (<i>first revision</i>)
IS 56 : 1993	Prussian Blue (Iron Blue) for Paints — Specification (<i>second revision</i>)
IS 269 : 2015	Ordinary Portland Cement — Specification (<i>sixth revision</i>)
IS 383 : 2016	Coarse and Fine Aggregates for Concrete — Specification (<i>third revision</i>)
IS 411 : 2020	Titanium Dioxide, Anatase for Paints — Specification (<i>third revision</i>)
IS 455 : 2015	Portland Slag Cement — Specification (<i>fifth revision</i>)
IS 456 : 2000	Plain and Reinforced Concrete — Code of practice (<i>fourth revision</i>)
IS 516 : 1959	Method of Tests for Strength of Concrete
IS 1489	Portland Pozzolana Cement — Specification
(Part 1) : 2015	Fly Ash based (<i>fourth revision</i>)
(Part 2) : 2015	Calcined Clay based (<i>fourth revision</i>)
IS 2185	Concrete Masonry Units – Specification
Part 1 : 2005	Hollow and Solid Concrete Blocks (<i>third revision</i>)
IS 3574	Organic pigments for paints — Specification
Part 1 : 1965	AZO pigments
Part 2 : 2000	Phthalocyanines
IS 3812	Pulverized Fuel Ash — Specification
Part 1 : 2013	For Use as Pozzolona in Cement, Cement Mortar and Concrete (<i>Third Revision</i>)
Part 2 : 2013	For Use as Admixture in Cement Mortar and Concrete
IS 4905 : 2015	Random sampling and randomization procedures (<i>first revision</i>)
IS 8041 : 1990	Rapid Hardening Portland Cement — Specification (<i>second revision</i>)
IS 9103 : 1999	Concrete Admixtures — Specification (<i>first revision</i>)
IS 15388 : 2003	Silica Fume - Specification
IS 15658 : 2021	Concrete Paving Blocks - Specification (<i>first revision</i>)
IS 16354 : 2015	Metakaolin for use in cement, cement mortar and concrete — Specification
IS 16415 : 2015	Composite Cement — Specification
IS 16714 : 2018	Ground Granulated Blast Furnace Slag for Use In Cement, Mortar and Concrete

ANNEX B
(Clause 5.3.2)
MEASUREMENT OF DIMENSIONS

B-1 Alternative test methods, for example go and no-go gauges, may be used provided at least the same accuracy is achieved as in the following test method.

B-2 Preparation

Remove all flashings and burrs from the unit to be measured.

B-3 Dimensions

B-3.1 Thickness

Measure the thickness of each flag to the nearest millimetre using a calliper gauge having suitable jaws, 20 to 30mm from the edge of the flag and within 100 mm from each corner. From the four measurements obtained, calculate the average thickness of each flag to the nearest 1 mm.

B-3.2 Dome height (tactile flags)

Measure the thickness of each flag at a point where a dome occurs and at another point where there is no dome. Subtract one thickness from another to obtain the dome height.

B-3.3 Length and Width

Measure the length and width of each flag to the nearest 1 mm.

B-3.4 Squareness of Plan

Measure the two diagonals of each flag to the nearest 1 mm.

B-4 FLATNESS

Flatness of the flag upper surface is tested by means of a metal ruler, whose length is not less than the flag diagonal. For testing upper surfaces that are concave, the ruler is placed on the surface of the flag along one of the diagonals so that the ruler touches the flag at not less than two points. The largest gap is measured, and the test is repeated along the second diagonal. The larger gap is the amount of concavity. For testing upper surface that is convex, the ruler is placed on the surface of the flag along one of the diagonals so that the distances between the ruler and the flag, at the ends of the diagonal, are equal. The largest gap is measured between the ruler and flag and the test is repeated along the second diagonal. The larger gap is the amount of convexity.

B-5 STRAIGHTNESS

Two corners of the flag surface shall be connected with a fine thread alongside one of the edges and the largest gap between the thread and the plane is recorded. The test is repeated alongside each of the other edges.

ANNEX C
(Clause 5.3.3)
DETERMINATION OF BENDING STRENGTH

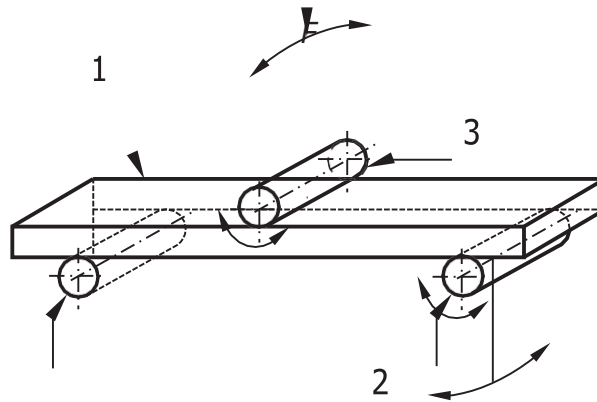
C-1 APPARATUS

The transverse testing machine shall have a scale with an accuracy of $\pm 3\%$ over the range of the anticipated test loads and be capable of increasing the load at specified rates. It shall be constructed in such a way that it can induce 3 point bending into the specimen without torsion.

The load inducing bar shall be equidistant between the supports.

The length of the supports and the load inducing bar shall be equal to the width of the sample to be tested (see Figure F.1). If not possible, sample may be cut to suit the apparatus.

The upper and lower bearers shall be parallel and rigid and round or rounded to a radius of (20 ± 1) mm. If plywood packing pieces are used their width shall not exceed 25 mm. Their thickness shall be (4 ± 1) mm and at least 10 mm longer than the size of the anticipated fracture plane.

**Key**

- 1 Specimen flag
- 2 Load bearing supports
- 3 Load inducing bar

FIG. 2 PRINCIPLE OF TESTING

C-2 PREPARATION

Use whole flags when their plan shape includes at least two parallel straight edges. In other cases use sawn specimens with the largest possible plan area which includes two parallel straight edges.

If necessary, remove any burrs, high spots, etc. Immerse the flags under water at (20 ± 5) °C for (24 ± 3) h, remove, wipe dry and test immediately.

A rough, textured or curved face shall be prepared by grinding or capping. Capping should be done by one of the methods described in **D-3.1** and **D-3.2** of Annex D of IS 2185 Part 1.

Other methods of preparation may be used for routine testing providing there is a correlation between the results of the two methods, for example, using unground rough, textured or curved flags instead of ground flags.

NOTE - Faces that are not rough, textured or curved may be prepared by grinding or capping

C-3 PROCEDURE

C-3.1 Place the flag in the testing machine. The distance between the load bearing supports and the edge of the flag shall be 50 mm, but if the span be less than three times the thickness, the distance between the load bearing supports and the edge of the flag shall be reduced to half the thickness of the flag. The span shall be within 0.5 percent of the specified span rounded to the nearest millimetre and recorded.

C-3.2 Place the specimen with its upper face uppermost, symmetrically on the load bearing supports of the testing machine and with its shorter side parallel to the load bearing supports.

C-3.3 Depending on the surface profile of the flag any one of the following shall be used at the discretion of the manufacturer:

- a) no packing;
- b) packing;

C-3.4 Apply the load without shock and increase the load uniformly so that the breaking load is reached within (45 ± 15) s. The maximum load applied shall be recorded to the nearest N.

C-4 CALCULATION

The Bending Strength of the specimen shall be calculated as follows:

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

where

F_b = bending strength, MPa;

P = breaking load, N;

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

b = width of the flag at the failure plane, mm; and

d = thickness of the flag at the failure plane, mm.

Record the individual result T and the breaking load P in kN.

C-5 REPORT

Report the individual and mean values of the bending strength, correct to the nearest 0.1 MPa and breaking load of the flag, correct to the nearest 0.1 kN.

ANNEX D
(Clause 5.3.4)
DETERMINATION OF TOTAL WATER ABSORPTION

D-1 APPARATUS

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

D-2 SPECIMENS

The paving flag specimens shall be selected as per the sampling procedure given in 6. If the flag weighs more than 5 kg, cut two square test pieces from diagonally opposite corners of the flags, of size 100mm x 100mm minimum and each weighing between 2.5 kg to 5.0 kg, cut from the full thickness of the flag and having two cut and two moulded edges.

D-3 PROCEDURE**D-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 *grams* to the nearest 1 g, W_w .

D-3.2 Drying

After 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 *grams* to the nearest 1 g.

D-4 CALCULATION

The percent water absorption shall be calculated as follows:

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

D-5 REPORT

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