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IS 5816 (1999): Method of Test Splitting Tensile Strength of Concrete [CED 2: Cement and Concrete]



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IS 5816 : 1999

भारतीय मानक  
कंक्रीट की खंडित तनन सामर्थ्य – परीक्षण पद्धति  
( पहला पुनरीक्षण )

*Indian Standard*

SPLITTING TENSILE STRENGTH OF CONCRETE —  
METHOD OF TEST

*( First Revision )*

ICS 91.100.30

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**BUREAU OF INDIAN STANDARDS**  
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July 1999

Price Group 4

## FOREWORD

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

Tensile strength is one of the basic and important properties of concrete. A knowledge of its value is required for the design of concrete structural elements subject to transverse shear, torsion, shrinkage and temperature effects. Its value is also used in the design of prestressed concrete structures, liquid retaining structures, roadways and runway slabs. Direct tensile strength of concrete is difficult to determine; recourse is often taken to the determination of flexural strength or the splitting tensile strength and computing the direct tensile. The usefulness of the splitting cube test for assessing the tensile strength of concrete in the laboratory is widely accepted and the usefulness of the above test for control purposes in the field is under investigation. The standard has been prepared with a view to unifying the testing procedure for this type of test for tensile strength of concrete.

This standard was first published in 1970. In this first revision test on cube specimen has also been incorporated as it was felt that cube specimens, being used for compression testing, would be convenient to use.

In this revision assistance has been derived from BS 1881 (Part 117) : 1983 'Method for determination of tensile splitting strength'. Assistance has also been rendered by conducting test and supplying valuable data by the following:

National Council for Cement and Building Material, Ballabgarh and Gujrat Ambuja Cement, Ahmedabad.

In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

The composition of the technical committee responsible for the formulation of this standard is given at Annex A.

## *Indian Standard*

# SPLITTING TENSILE STRENGTH OF CONCRETE— METHOD OF TEST

*( First Revision )*

### 1 SCOPE

This standard covers the procedure for determining the splitting tensile strength of moulded concrete cubes and cylinders.

### 2 NORMATIVE REFERENCES

The Indian Standards listed below contain provisions, which through reference in this standard, constitute provision of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
516 : 1959	Method of test for strength of concrete
1500 : 1983	Method for Brinell hardness test for metallic materials ( <i>second revision</i> )
1658 : 1977	Fibre hardboards ( <i>second revision</i> )

### 3 TEST SPECIMENS

#### 3.1 Cube

Cube specimen shall be of size not less than four times the maximum size of the coarse aggregate and not less than 150 mm.

#### 3.2 Cylinder

The cylindrical specimen shall have diameter not less than four times the maximum size of the coarse aggregate and not less than 150 mm. The length of the specimens shall not be less than the diameter and not more than twice the diameter. For routine testing and comparison of results, unless otherwise specified the specimens shall be cylinder 150 mm in diameter and 300 mm long.

#### 3.3 Making and Curing Test Specimen

The procedure of making and curing tension test specimen in respect of sampling of materials,

preparation of materials, proportioning, weighing, mixing, workability, moulds, compacting and curing shall comply in all respects with the requirements given in IS 516.

### 4 APPARATUS

#### 4.1 Testing Machine

Any compression machine of reliable type, of sufficient capacity for the tests and capable of applying the load at the rate specified in 7.5 shall be used. It shall comply with the requirements given in IS 516 as far as applicable except that the bearing faces of both platens shall provide a minimum loading area of 12 mm  $\times$  the length of the cylinder or cube, as the case may be so that the load is applied over the entire length of the specimen. If necessary, a supplementary bearing bar or plate of machined steel may be used.

#### 4.2 Jigs

Either jig shown in Fig. 1 for splitting cylindrical and cubic specimen or alternatively jig shown in Fig. 2 for cubic specimen shall be used.

##### 4.2.1 Components of Jigs shown in Fig. 1

4.2.1.1 Two packing strips of tempered hardboard of nominal thickness 4 mm conforming to IS 1658 having following dimensions of the test specimen shall be used only once:

Width	15 $\pm$ 2 mm
Nominal thickness	4 mm
Length	Greater than the length of the line of content of the test specimen

##### 4.2.1.2 Steel loading strips

A steel loading plate having minimum hardness value, when tested in accordance with IS 1500 shall be used between the platen of the machine and the hardboard packing strips. The piece shall not be shorter than the specimen. For cylindrical specimens it shall be of rectangular cross section. For cubic specimens, it shall be a section of a cylinder, with a radius of 75 mm, so

that the load is applied along a line on the surface of the specimen (*see* Fig. 1A and 1B). This loading piece can be incorporated within the jig.

550 when tested in accordance with IS 1500, shall be auxiliary platens incorporating steel strips with the following dimensions:

4.2.2 Components of Jigs shown in Fig. 2

4.2.2.1 Steel loading pieces

Steel loading pieces having a minimum hardness of

Width	6 ± 1 mm for 150 mm size
Thickness	4 ± 1 mm
Length	Not less than the length of the line of contact with the test specimen

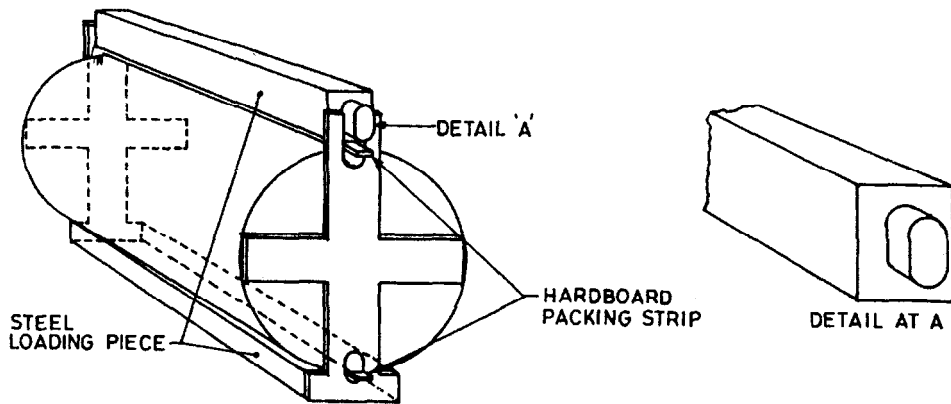


FIG. 1A APPARATUS FOR SPLITTING CYLINDERS

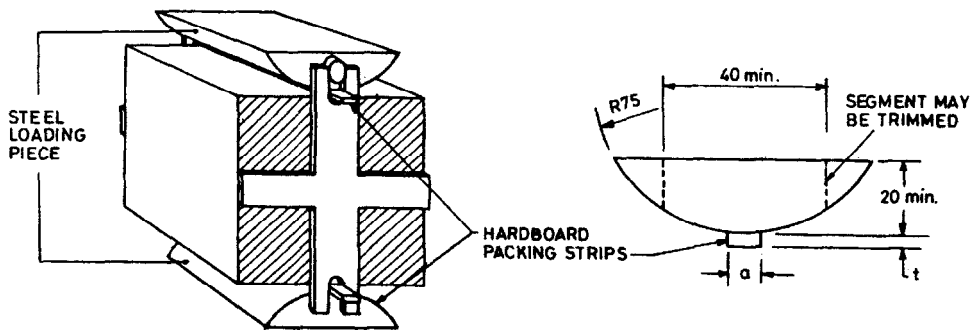


FIG. 1B APPARATUS FOR SPLITTING CYLINDER AND CUBE

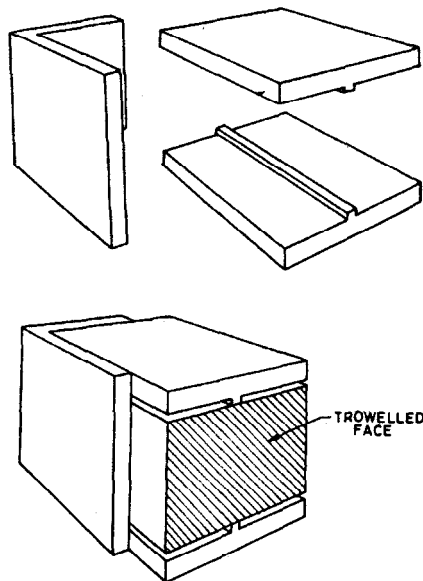


FIG. 2 ALTERNATE APPARATUS FOR SPLITTING CUBES

### 4.3 Tolerances

The steel loading pieces specified in 4.2.1.2 and 4.2.2.2 shall have flatness, squareness parallelism and surface requirements along the length of the strips within the tolerances given below:

- a) *Flatness* — 0.03 mm for each contact face.
- b) *Squareness* — for each edge of the piece with respect to the adjacent edge as datum shall be 0.06 mm.
- c) *Parallelism* — one contact face with respect to the other face as datum shall be 0.06 mm.
- d) Ra value for the surface texture of the contact faces — 0.04  $\mu$ m and 3.2  $\mu$ m.

The steel loading pieces shall be replaced when the dimensions are out of tolerance or they are seriously damaged or pitted along the contact face.

## 5 AGE AT TEST

Tests shall be made at the recognized ages of the test specimens, the most usual being 7 and 28 days. Tests at any other age at which the tensile strength is desired may be made, if so required. The ages shall be calculated from the time of the addition of water to the dry ingredients. The age at test shall be reported along with the results.

## 6 NUMBER OF SPECIMENS

At least three specimens shall be tested for each age of tests.

## 7 PROCEDURE

**7.1 Specimens when received dry shall be kept in water for 24 h before they are taken for testing.** Unless other conditions are required for specific laboratory investigation specimen shall be tested immediately on removal from the water whilst they are still wet. Surface water and grit shall be wiped off the specimens and any projecting fins removed from the surfaces which are to be in contact with the packing strips.

### 7.2 Marking

Central lines shall be drawn on the two opposite faces of the cube using any suitable procedure and device that will ensure that they are in the same axial plane.

### 7.3 Measurement

The mass and dimensions of the specimen shall be noted before testing. The sides of the specimen, lying

in the plane of the pre-marked lines, shall be measured near the ends and the middle of the specimen and the average taken to the nearest 0.2 mm. The length of the specimen shall be taken to the nearest 0.2 mm by averaging the two lengths measured in the plane containing the pre-marked lines.

## 7.4 Placing of the Specimen in the Testing Machine

The bearing surfaces of the testing machine and of the loading strips shall be wiped clean.

### 7.4.1 Positioning

The test specimen shall be placed in the centring jig with packing strip and/or loading pieces carefully positioning along the top and bottom of the plane of loading of the specimen. The jig shall then be placed in the machine so that the specimen is located centrally. In the case of cubic specimens, the load shall be applied on the moulded faces in such a way that the fracture plane will cross the trowelled surface.

For cylindrical specimen it shall be ensured that the upper platen is parallel with the lower platen.

## 7.5 Rate of Loading

The load shall be applied without shock and increased continuously at a nominal rate within the range 1.2 N/(mm<sup>2</sup>/min) to 2.4 N/(mm<sup>2</sup>/min). Maintain the rate, once adjusted, until failure. On manually controlled machines as failure is approached the loading rate will decrease; at this stage the controls shall be operated to maintain as far as possible the specified loading rate. The maximum load applied shall then be recorded. The appearance of concrete and any unusual features in the type of failure shall also be noted.

The rate of increase of load may be calculated from the formula:

$$(1.2 \text{ to } 2.4) \times \pi/2 \times l \times d \text{ N/min}$$

## 8 CALCULATION

**8.1** The measured splitting tensile strength  $f_{ct}$  of the specimen shall be calculated to the nearest 0.05 N/mm<sup>2</sup> using the following formula :

$$f_{ct} = \frac{2P}{\pi Id}$$

where

$P$  = maximum load in Newtons applied to the specimen,



- $l$  = length of the specimen as shown in Fig. 3 (in mm), and
- $d$  = cross sectional dimension of the specimen as shown in Fig. 3 (in mm).

## 9 REPORT

9.1 The following information shall be included in the report on each specimen:

- a) Date of test,
- b) Identification mark, shape and size of the specimen in mm,

- c) Age of specimen at date of test when known,
- d) Curing history,
- e) Weight of specimen in Newtons,
- f) Type of fracture and the appearance of concrete on the fractured face if these are unusual,
- g) Splitting tensile strength to the nearest 0.05 N/mm<sup>2</sup> on the lower side, and
- h) Estimate of the proportion of coarse aggregate fractured during test.

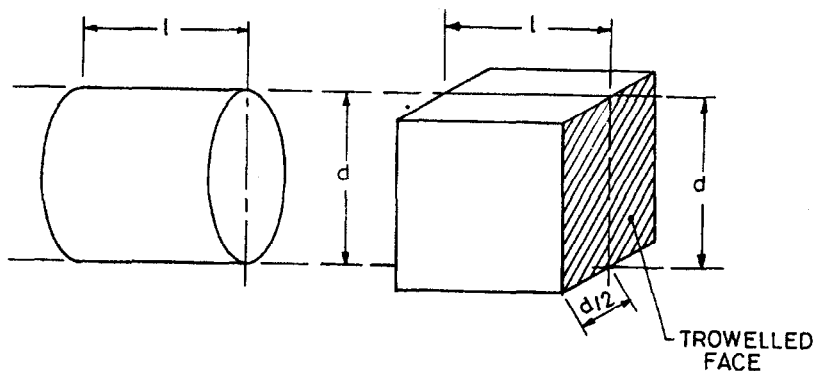


FIG. 3 PLANE OF LOADING

**ANNEX A**  
**(Foreword)**  
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### Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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