
ताजा कंक्रीट — नमूने लेना, परीक्षण
एवं विश्लेषण पद्धतियाँ

भाग 2 ताजा कंक्रीट की गाढ़ता निर्धारण
(पहला पुनरीक्षण)

**Fresh Concrete — Methods of
Sampling, Testing and Analysis**

Part 2 Determination of Consistency of Fresh Concrete
(*First Revision*)

ICS 91.100.30

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भारतीय मानक ब्यूरो

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FOREWORD

This Indian Standard (Part 2) (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.

Testing plays an important role in controlling the quality of cement concrete work. Systematic testing of the raw materials, the fresh concrete and the hardened concrete, is an inseparable part of any quality control programme for concrete. This helps achieve a higher efficiency of the materials used and greater assurance of the performance of the concrete, in regard to workability, strength and durability. The test methods used should be simple, direct and convenient to apply. This standard was prepared with this objective in view.

This standard was first published in 1959. In this revision, it was decided to review and update the various existing test methods of fresh concrete taking into consideration the latest international practices and developments in this field in the country, and also introduced certain new test methods wherever required. In the process, the various existing test methods covered in IS 1199 : 1959 'Method of sampling and analysis of concrete', have been revised. The revision of the standard is being brought out taking into consideration primarily the corresponding ISO standards while also examining the other best practices world over and in the country. In addition, test methods for determination of properties of new types of concrete like self compacting concrete have been included, covering tests such as consistency, viscosity, passing ability and segregation resistance. Also, for better understanding and implementation, some of the other test methods which were spread over in other Indian standards have been brought together under the fold of IS 1199 as its various parts, such as the setting time of concrete by penetration method and, water soluble and acid soluble chlorides in mortar and concrete. This is with a view to making the standard comprehensive in all respects, and rendering it a comprehensive source of provisions for testing of concrete and reference in other Indian Standards.

This standard has been split into nine parts. The other parts in the series are:

- Part 1 Sampling of fresh concrete
- Part 3 Determination of density of fresh concrete
- Part 4 Determination of air content of fresh concrete
- Part 5 Making and curing of test specimens
- Part 6 Tests on fresh self compacting concrete
- Part 7 Determination of setting time of concrete by penetration resistance
- Part 8 Determination of water soluble and acid soluble chlorides in mortar and concrete
- Part 9 Analysis of freshly mixed concrete

This standard (Part 2) covers the procedures for the determination of consistency of fresh concrete. The consistency tests as per this standard may be treated as synonymous to workability tests.

These test methods shall be applicable as and when published in place of the corresponding provisions given in IS 1199 : 1959. IS 1199 : 1959 shall be superseded after the publication of all the parts of the standard. The flow table test formerly covered in IS 9103:1999 has been updated and included in this standard, and the flow test referred in IS 9103 shall be superseded and may be conducted as per this standard.

(Continued on third cover)

*Indian Standard***FRESH CONCRETE — METHODS OF SAMPLING,
TESTING AND ANALYSIS****PART 2 DETERMINATION OF CONSISTENCY OF FRESH CONCRETE***(First Revision)***1 SCOPE**

This standard (Part 2) specifies procedures for determination of consistency of fresh concrete. It specifies the following test methods:

- a) Slump test,
- b) Vee bee consistometer test (modified Vee bee consistometer test also included in Annex B),
- c) Compacting factor test,
- d) Degree of compactability,
- e) Flow table test (not applicable for SCC), and
- f) Slump flow test for high fluidity concrete and self compacting concrete [see IS 1199 (Part 6)].

NOTES

1 When carrying out these tests, prevent skin contact with fresh concrete by wearing suitable protective clothing, gloves and footwear. If wet cement or concrete enters the eye, immediately wash it out thoroughly with clean water and seek medical treatment without delay. Wash fresh concrete off the skin immediately.

2 The use of vibrating equipment, such as vibrating tables, can cause damage to joints and loss of sensation due to nerve damage. Moulds, etc, should be clamped to the table and not held in position using one's hand while they are being vibrated.

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 definitions given in IS 4845 and IS 6461 (Parts 1 to 12) and the following shall also apply.

3.1 Roller Compacted Concrete — It is a stiff mix with zero slump but yet cohesive and can be compacted by vibratory roller. The concrete in its unhardened state will support a roller while being compacted.

3.2 Self Compacting Concrete (SCC) — SCC is an innovative concrete that does not normally require

vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, without segregation, even in the presence of congested reinforcement.

4 DETERMINATION OF CONSISTENCY**4.1 General**

The consistency of the concrete can be determined by any of the following tests:

- a) Slump test,
- b) Vee bee test,
- c) Compacting factor test,
- d) Degree of compactability,
- e) Flow table test, and
- f) Slump flow test for high fluidity concrete.

Above mentioned tests are not applicable for foam concrete, no fines concrete, or where the nominal maximum aggregate size exceeds 40 mm. If the concrete contains coarse aggregate with size larger than 40 mm, the concrete shall be wet-sieved through 40 mm screen to exclude aggregate particles bigger than 40mm.

4.2 Sampling

Samples for the test shall be obtained as per IS 1199 (Part 1). Each sample shall be remixed before carrying out the tests.

4.3 Slump Test**4.3.1 Principle**

The fresh concrete is compacted into a mould in the shape of a frustum of a cone. When the cone is withdrawn upwards, the distance that the concrete has slumped provides a measure of the consistency of the concrete.

The slump test is applicable to a range of consistency of concrete that corresponds to slumps between 10 mm and 210 mm. Outside this range, other method of determination of consistency should be considered which are described elsewhere in this standard.

4.3.2 Apparatus

4.3.2.1 Mould, suitable of forming the test specimen,

IS 1199 (Part 2) : 2018

shall be made of metal, not readily attacked by cement paste and having at least 1.6 mm thickness. The mould shall have a smooth internal surface and free from dents. The mould shall be in the form of a hollow frustum of a cone and shall have the following internal dimensions:

- a) Diameter of base : 200 ± 2 mm
- b) Diameter of top : 100 ± 2 mm
- c) Height : 300 ± 2 mm

The base and the top shall be open and parallel to each other and at right angle to the axis of the cone. The mould shall be provided, on the upper portion, with two handles at two-thirds of the height, and at the bottom with fixing clamps or foot pieces to hold it steady. A sketch of a typical mould without guide is included in Fig. 1.

The mould shall be visually inspected prior to each use to ensure that the interior is clean and free from concrete deposits.

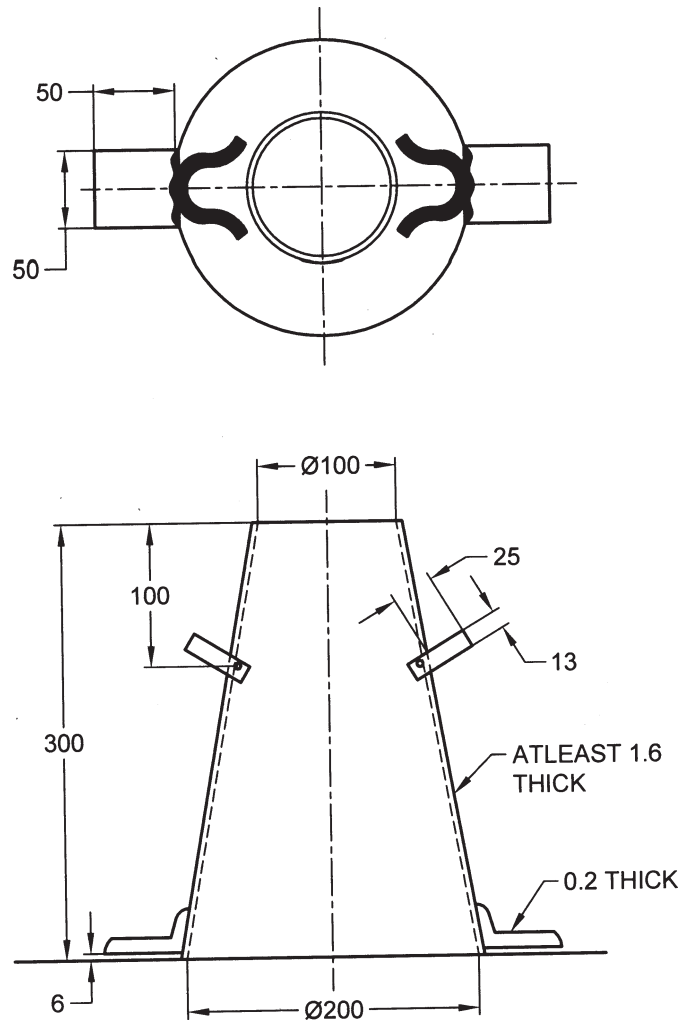
4.3.2.1.1 Calibration of the mould

The mould shall be checked annually to ensure that its dimensions and condition remain within specified tolerances.

4.3.2.2 Tamping rod

The tamping rod shall be made of steel, having a circular cross-section with a diameter of 16 ± 1 mm, 600 ± 5 mm in length and with rounded ends. The rod may be extended with a handle of plastic conduit, provided that the overall length does not exceed 1 000 mm.

The tamping rod shall be checked annually to ensure



All dimensions in millimetres.

NOTE — To facilitate the lifting of the mould in a vertical direction, it is recommended that suitable guide attachments may be provided. Any rivets used in the construction of the mould shall be countersunk flush on the inside of the cone. Attachments shall be preferably welded to the mould.

FIG. 1 TYPICAL MOULD FOR SLUMP TEST

that its dimensions and condition remain within the tolerances.

4.3.2.3 Funnel (optional)

It shall be made of non-absorbent material, not readily attacked by cement paste.

The funnel shall consist of two coaxial conical frustums having a common diameter of 100 ± 2 mm, the ends being of greater diameter, one frustum to act as a filling funnel and the other as a collar to enable the funnel to be located on the outer surface of the mould.

The funnel shall be checked annually to ensure that its dimensions and condition remain within tolerances.

4.3.2.4 Rule

It shall be graduated from 0 mm to 300 mm, at intervals not exceeding 5 mm, with zero point being at extreme end of the rule.

4.3.2.5 Base plate/surface

It shall be rigid, flat, non-absorbent and smooth plate on which the mould is to be placed.

4.3.2.6 Shovel

It shall have a square blade.

4.3.2.7 Re-mixing tray

It shall be of good construction and fabricated from a non-absorbent material, not readily attacked by cement paste. It shall be of appropriate dimensions such that the concrete can be thoroughly remixed, using the square bladed shovel.

4.3.2.8 Scoop

It shall be of adequate size.

4.3.2.9 Timer

It shall allow time measurement accurate to 1s. The timer shall be calibrated at suitable frequency.

4.3.3 Procedure

- a) Dampen the mould and base plate with a moist cloth. Wipe any excessive water from the surfaces using an absorbent cloth. Place the mould on the surface of the rigid horizontal base plate free from extraneous vibration and shock.
- b) Immediately after obtaining the sample in accordance with 4.2, fill the mould in three layers, each approximately one-third of the height of the mould when compacted. During filling, clamp or hold the mould firmly in place by standing on the two foot pieces.
- c) When filling the mould, ensure that the

concrete is distributed symmetrically around the mould.

- d) Tamp each layer with 25 strokes of the tamping rod.
- e) The strokes shall be distributed in an uniform manner over the cross-section area of the mould. For the bottom layer, this will necessitate inclining the rod slightly and positioning approximately half the strokes spirally towards centre.
- f) Tamp the second layer and top layer each throughout its depth, so that the strokes just penetrate into the underlying layer.
- g) In filling and tamping the top layer, heap the concrete above the mould before the tamping is started.
- h) If the tamping operation of the top layer results in subsidence of the concrete below the top edge of the mould, add more concrete to keep an excess above the top of the mould at all times. Also ensure that the addition of concrete to the top layer does not provide extra compaction of the concrete.
- j) After the top layer has been tamped, scrap off the surface of the concrete level with the top of the mould by means of a sawing and rolling motion of the tamping rod. Remove spilled concrete from the base plate/surface.
- k) Remove the mould in 5 ± 2 s by a straight upward push with no lateral or torsional motion being imparted to the concrete.
- m) The entire operation from the start of the filling to the removal of the mould shall be carried out without interruption and shall be completed within 180 s.
- n) Immediately after removal of the mould, determine the slump, h , by measuring the difference between the height of the mould and the highest point of the slumped concrete (see Fig. 2).
- p) Measure slump to the nearest 5 mm.

4.3.4 Test Results

The test is valid only if it yields a true slump, this being a slump in which the concrete remains substantially intact and symmetrical as shown in Fig. 3A. If a specimen shears as shown in Fig. 3B or collapses as shown in Fig. 3C, take another sample and repeat the entire procedure as described above.

Record the true slump, to the nearest 5 mm.

If two consecutive test show portion of concrete shearing of from the mass of the test specimen or

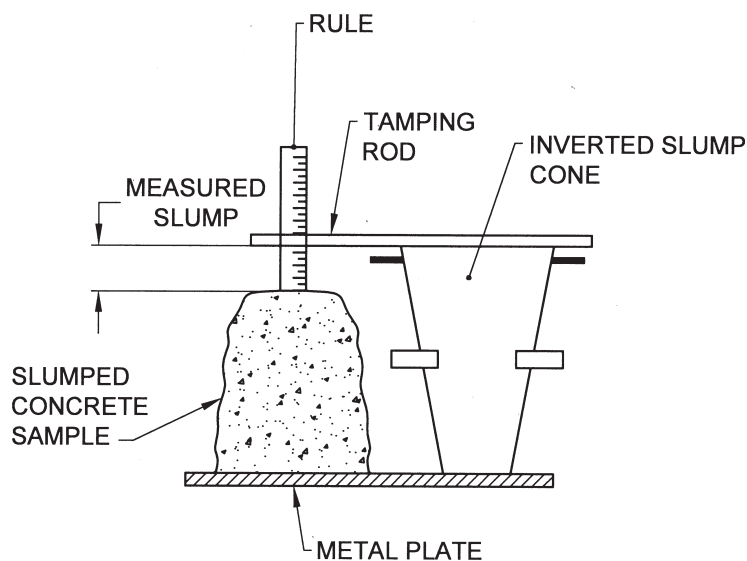


FIG. 2 SLUMP MEASUREMENT

collapsing, report the test as being invalid as the concrete lacks the necessary plasticity and cohesiveness for the slump test to be suitable.

4.3.5 Test Report

In addition to the information required in 5, the test report shall include the following:

- a) Slump, if there is a true slump, measured to the nearest 5 mm; or
- b) A notation that the test gave a sheared/collapsed slump.

4.4 Vee Bee Consistometer Test

4.4.1 Principle

The Vee bee consistometer test determines the time required for transforming, by vibration, a concrete specimen in the shape of a conical frustum into a cylinder.

The fresh concrete is compacted into a slump mould. The mould (cone) is lifted of the concrete and a transparent disc is swung over the top of the concrete and carefully lowered until it comes in contact with the concrete. The slump of the concrete is recorded. The vibrating table is started and the time taken for the lower surface of the transparent disc to be fully in contact with cement paste of the concrete is measured.

If the Vee bee time is less than 5 s or more than 30 s, the use of the test method to determine consistency may be unsuitable and other methods should be considered for this purpose (see Annex B for modified Vee bee consistometer test for testing of very stiff dry concretes such as roller compacted concrete. This method also covers the method for determining the density of such concretes).

4.4.2 Apparatus

4.4.2.1 *Consistometer (Vee bee meter)*, consists of the following items as shown in Fig. 4.

- a) *Container* (see 1 in Fig. 4) — It is cylindrical in shape, having an internal diameter of 240 ± 5 mm and a height of 200 ± 2 mm and made of a metal, not readily attacked by cement paste. The thickness of wall shall be 3 mm and that of the base 7 mm. The container shall be watertight and of sufficient rigidity to retain its shape under rough usage. It shall be fitted with handles and protected from corrosion. The container shall be provided with suitable foot pieces to enable it to be securely clamped to the top of the vibrating table (see 7 in Fig. 4) by means of wing nuts (see 8 in Fig. 4).
- b) *Mould* (see 2 in Fig. 4), as described in 4.3.2.1, except that the fixing clamps or foot pieces are not required. The mould shall be visually checked prior to each use to ensure that it is clean and not damaged or dented.
- c) *Disc* (see 3 in Fig. 4) — A transparent and horizontal disc attached to a rod (see 9 in Fig. 4) that slides vertically through a guide sleeve (see 5 in Fig. 4) mounted on swivel arm (see 13 in Fig. 4) and which can be fixed in a position by a screw (see 15 in Fig. 4). The swivel arm also supports a funnel (see 4 in Fig. 4), the bottom of which coincides with the top of the conical mould when the latter is positioned concentrically in the container. The swivel arm is located by a hold (see 12 in Fig. 4) and can be fixed in a position by set screw

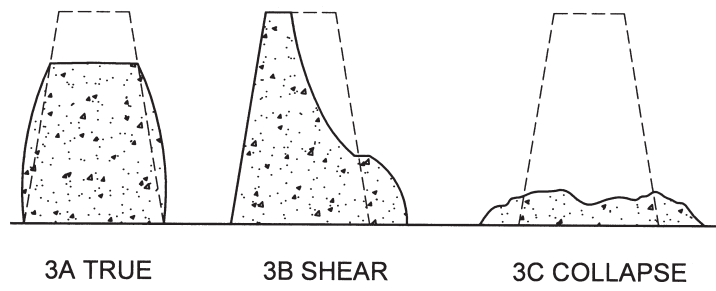
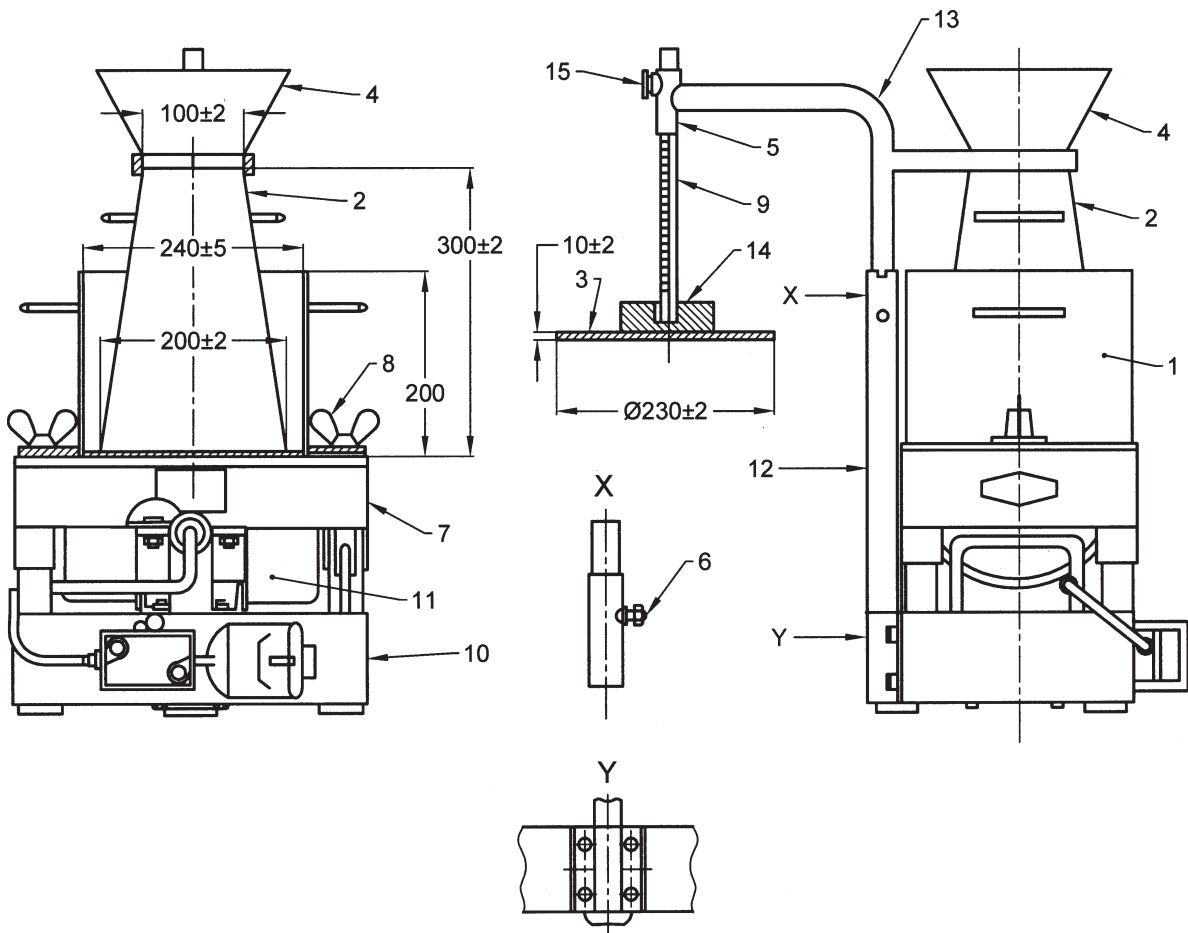


FIG. 3 TYPES OF SLUMP



Key		
1 container	6 set-screw	11 vibrator unit
2 mould	7 vibrating table	12 holder
3 transparent disc	8 wing nuts	13 swivel arm
4 funnel	9 rod	14 weight
5 guide sleeve	10 base for vibrator	15 screw

All dimensions in millimetres.

FIG. 4 VEE BEE CONSISTOMETER

(see 15 in Fig. 4). When in the proper position, the axes of the rod and of the funnel shall be coincident with the axis of the container.

The transparent disc shall be 230 ± 2 mm in diameter and 10 ± 2 mm in thickness. A weight placed directly above the disc shall be provided such that the moving assembly consisting of the rod, the disc and the weight has a mass of $2\,750 \pm 50$ g. The rod shall be provided with a scale graduated to at least 5 mm intervals to record the slump of the concrete.

- d) *Vibrating table* — It shall be 380 ± 3 mm in length and 260 ± 3 mm in width, supported on four rubber shock absorbers.

A vibrator unit (see 11 in Fig. 4), carried on a base resting on three rubber feet, shall be securely fixed beneath it. The vibrator shall operate at a frequency of 55 ± 5.5 Hz and the vertical amplitude of vibration of the table with empty container on the top of it shall be approximately 0.5 ± 0.02 mm.

The vibrating table shall be checked annually to ensure that the frequency and the vertical amplitude remain within tolerances. All the elements of the vibration table shall be checked annually to ensure that their dimensions remain within tolerances.

4.4.2.2 Tamping rod — It is a straight rod, made of steel or other suitable material, of circular cross-section, having a diameter of 16 ± 1 mm, 600 ± 5 mm in length, and with rounded ends.

4.4.2.3 Stopwatch or clock, capable of recording time to an accuracy of 1 s.

4.4.2.4 Remixing container — It is of rigid construction, made from non-absorbent material not readily attacked by cement paste.

4.4.2.5 Scoop, of adequate size.

4.4.3 Procedure

- a) Place the Vee bee meter (consistometer) on a rigid horizontal base free from extraneous vibration and shock. Make sure that the container is firmly fixed to the vibrating table by means of wing nuts. Dampen the inside of the mould with a moist cloth and place it in the container. Swing the funnel into position over the mould and lower the funnel on the mould. Tighten the screw so that the mould cannot rise from the bottom of the container. During the subsequent operations ensure that the mould does not rise or move until it is manually raised and ensure that concrete has not fallen into the container. From the sample of concrete obtained in

accordance with 4.2, immediately fill the mould in three layers, each approximately one-third of the height of the mould when compacted. When adding the concrete, ensure that it is distributed symmetrically around the mould.

- b) Tamp each layer with 25 strokes of the tamping rod. The strokes shall be distributed in a uniform manner over the cross-section area of the mould. For the bottom layer, this will necessitate inclining the rod slightly and positioning approximately half the strokes spirally towards centre. Tamp the second layer and top layer each throughout its depth, so that the strokes just penetrate into the underlying layer. In filling and tamping the top layer, heap the concrete above the mould before tamping is started. If necessary, add further concrete to maintain excess above the top of the mould throughout the tamping operation. After the top layer has been tamped, loosen the screw, raise and swing the funnel through 90° and tighten the screw. Scrape off the concrete level with the top of the mould with a sawing and rolling motion of the tamping rod. Lift the mould from the concrete by raising it carefully in a vertical direction, using the handles. The operation of raising the mould shall be performed in 7 ± 2 s by a steady upward lift with no lateral or torsional motion being imparted to the concrete. If the concrete shears, collapses or slumps to the extent that it touches the wall of the container, this information shall be recorded. Swing the transparent disc over the top of the concrete, loosen the screw and very carefully lower the disc until it just comes in contact with the concrete. When the disc just touches the highest point of the concrete without disturbing it, tighten the screw. When there is a true slump, the value of the slump shall be read from the scale and the value recorded. The screw shall be loosened to allow the disc to follow the concrete as it settles under the subsequent vibration. Simultaneously, start the vibration of the table and the timer. Observe through the transparent disc how the concrete is being re-moulded. As soon as the lower surface of the disc is fully in contact with cement paste of the concrete, stop the timer and switch off the vibrating table. Record the time taken to the nearest second. Complete the procedure within a period of 5 min from the start of filling.

The consistency of the concrete mix changes with the time due to hydration of the cement and possibly, loss

of moisture. Tests on different samples should, therefore, be carried out at a constant time interval after mixing, if strictly comparable results are to be obtained.

4.4.4 Test Result

Record the time read from the stopwatch to the nearest second. This is the Vee bee time which indicates the consistency of the concrete under test.

4.4.5 Test Report

In addition to the information required in 5, the test report shall include the following:

- a) Time from completion of mixing of the concrete until the time of removal of the mould; and
- b) Vee bee time, in second.

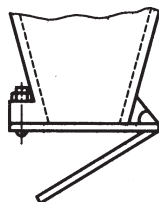
4.5 Compacting Factor Test

4.5.1 This clause specifies a procedure for determining the workability of concrete, where the nominal maximum size of the aggregate does not exceed 40 mm. The test is designed primarily for use in the laboratory, but if circumstances permit, it may also be used in the field. It is more precise and sensitive than the slump test and is particularly useful for concrete mixes of very low workability.

4.5.2 Apparatus

A diagram of the apparatus is shown in Fig. 5. It shall consist of the two conical hoppers (A and B) mounted above a cylindrical mould (C).

4.5.3 The essential dimensions of the hoppers and mould and distances between them shall be as shown in



VIEW OF TRAP-DOOR PARTLY OPEN

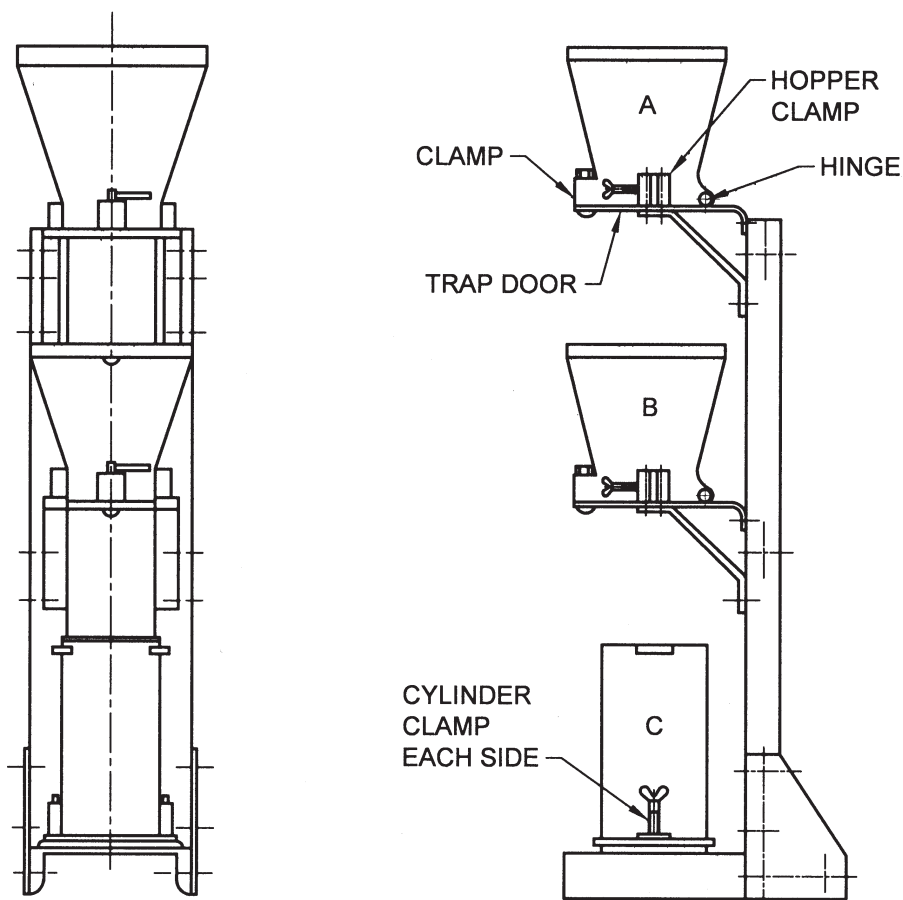


FIG. 5 COMPACTION FACTOR APPARATUS

Table 1. The hopper and cylinder shall be of rigid construction, true to shape and smooth inside. They shall preferably be made of cast brass or bronze, but stout sheet brass or steel may also be considered satisfactory provided the inside surfaces of the joints are smooth and flush. The lower ends of the hoppers shall be closed with tightly fitting hinged trap-doors having quick release catches. Metal plate 3 mm thick is suitable for the doors. The frame in which the hoppers and cylinder are mounted shall be of rigid construction and shall firmly locate them in the relative positions indicated in Table 1. The cylinder and hoppers shall be easily detachable from the frame. The apparatus shall also include two ordinary trowels, one scoop of adequate size, a tamping rod made of steel, having a circular cross-section with a diameter of 16 ± 1 mm, 600 ± 5 mm in length and with rounded ends, and scales (or a balance) to weigh up to 50 kg, with an accuracy to the nearest 10 g.

4.5.4 Sampling

The sample shall be taken as per 4.2. In the case of concrete containing aggregate of maximum size more than 40 mm, the concrete shall be wet sieved through 40 mm screen to exclude aggregate particles bigger than 40 mm.

Table 1 Essential Dimensions of the Compacting Factor Apparatus for Use with Aggregate Not Exceeding 40 mm Nominal Maximum Size

(Clause 4.5.3)

Sl No.	Detail (see Fig. 6)	Dimension mm
(1)	(2)	(3)
i)	Upper hopper, A:	
	a) Top internal diameter	250
	b) Bottom internal diameter	125
	c) Internal height	280
ii)	Lower hopper, B:	
	a) Top internal diameter	230
	b) Bottom internal diameter	125
	c) Internal height	230
iii)	Cylinder, C:	
	a) Internal diameter	150
	b) Internal height	300
iv)	Distance between bottom of upper hopper and top of lower hopper	200
v)	Distance between bottom of lower hopper and top of cylinder	200

4.5.5 Procedure

Dampen the inside of the hopper and cylinder with a moist cloth before its use. The sample of concrete to be tested shall be placed gently in the upper hopper, using the scoop. The hopper shall be filled level with its brim and the trap-door shall be opened so that the

concrete falls into the lower hopper. Certain mixes have a tendency to stick in one or both of the hoppers. If this occurs, the concrete may be helped through by pushing the rod gently into the concrete from the top. During this process, the cylinder shall be covered by the trowels. Immediately after the concrete has come to rest, the cylinder shall be uncovered, the trap-door of the lower hopper opened, and the concrete allowed to fall into the cylinder. The excess of concrete remaining above the level of the top of the cylinder shall then be cut off by holding a trowel in each hand, with the plane of the blades horizontal, and moving them simultaneously one from each side across the top of the cylinder, at the same time keeping them pressed on the top edge of the cylinder. The outside of the cylinder shall then be wiped clean. The above operation shall be carried out at a place free from vibration or shock. The weight of the concrete in the cylinder shall then be determined to the nearest 50 g. This weight shall be known as the weight of partially compacted concrete. The cylinder shall be refilled with concrete from the same sample in layers approximately 5 cm deep, the layers being heavily rammed or preferably vibrated so as to obtain full compaction. The top surface of the fully compacted concrete shall be carefully struck off level with the top of the cylinder. The outside of the cylinder shall then be wiped clean. The weight of the concrete in the cylinder shall then be determined to the nearest 50 g. This weight shall be known as the weight of fully compacted concrete.

NOTE — The test is sufficiently sensitive to enable differences in workability arising from the initial processes in the hydration of the cement to be measured. Each test, therefore, should be carried out at a constant time interval after the mixing is completed, if strictly comparable results are to be obtained.

4.5.6 Calculation

The compacting factor is defined as the ratio of the weight of partially compacted concrete to the weight of fully compacted concrete. It shall normally be stated to the nearest second decimal place.

4.5.7 Test Report

In addition to the information required in 5, the test report shall include the compacting factor value, expressed to the nearest two decimal places.

4.6 Degree of Compactability

4.6.1 Principle

The fresh concrete is uniformly placed with trowel in a container avoiding any compaction while filling. When the container is full, the top surface is scraped off level with the top of the container. The concrete is compacted and the distance from the surface of the compacted concrete to the upper edge of the container is used to define the degree of compactability.

The degree of compactability test is valid for a range of values lying between 1.04 and 1.46. If the degree of compactability is less than 1.04 or more than 1.46, this test is not suitable.

4.6.2 Apparatus

4.6.2.1 Container — A container with parallel sides and shape as shown in Fig. 6, made of metal not readily attacked by cement paste and having following internal dimensions:

- Base : $200 \pm 2 \text{ mm} \times 200 \pm 2 \text{ mm}$
- Height : $400 \pm 2 \text{ mm}$
- Thickness of the base and walls shall be at least 1.5 mm.

The dimensions and condition of the container shall be checked at the time of test to ensure that they are within the tolerances.

4.6.2.2 Trowel — A trowel with a flat blade or equivalent (see Fig. 7).

4.6.2.3 Concrete compaction — The means of compacting concrete shall consist of one of the following:

- Internal vibrator*, with a minimum frequency of 120 Hz (7 200 cycles per minute). The diameter of the vibrating head shall not exceed one-quarter of the smallest dimension of the container. The vibrator shall meet the requirements of IS 2505.
- Vibrating table*, with a minimum frequency of 50 Hz (3 000 cycles per minute). The vibrating table shall meet the requirements of IS 2514.

4.6.2.4 Mixing tray — This shall be of a rigid construction, made from a non absorbent material not

readily attacked by the cement paste.

4.6.2.5 Straight edge scrapper — It shall have a length greater than 200 mm.

4.6.2.6 Rule — It shall have a length greater than 400 mm, having 1 mm sub-divisions along its entire length with the zero point being at the extreme end of the rule.

4.6.3 Procedure

- Clean the container and dampen the inner surfaces using a moist cloth.
- Fill the container without tamping it, by tilting the trowel sideways from all four upper edges of the container in turn. When the container is full, remove all concrete above upper edges, using straight edged scrapper with a sawing action, in such a way as to avoid any compaction.
- Compact the concrete by means of vibrating table (reference method) or by the use of internal vibrator, until no further reduction in volume is determinable. During compaction, avoid loss of concrete through splashing or leakage.
- After compaction, measure to the nearest millimetre, the distance between the surface of the compacted concrete and the upper edge of the container at the middle of each side of the container.
- Determine the mean value of the four measurements.

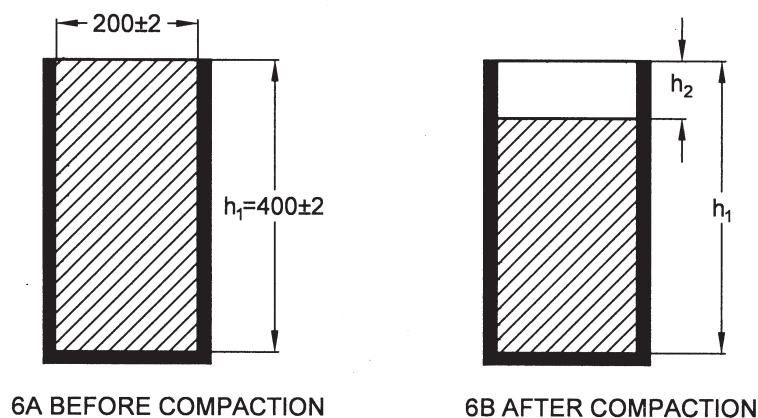
4.6.4 Test Results

The degree of compactability is given by equation:

$$c = h_1 / (h_1 - h_2)$$

where

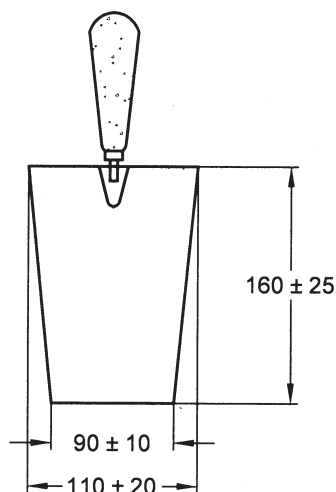
c = degree of compactability;



All dimensions in millimetres.

FIG. 6 CONCRETE IN CONTAINER

- h_1 = internal height of the container; and
 h_2 = mean value, to the nearest millimetre, of the distance from the surface of the compacted concrete to the upper edge of the container.



All dimensions in millimetres.

FIG. 7 TROWEL

4.6.5 Test Report

In addition to the information required in 5, the test report shall include the degree of compactability, expressed to nearest two decimal places.

4.7 Flow Table Test

4.7.1 Principle

This test determines the consistency of fresh concrete by measuring the spread of concrete on a flat plate subject to jolting.

The flow test is applicable to a range of consistency of concrete that corresponds to flow values between 340 mm and 620 mm. Outside this range, the measurement of flow may be unsuitable and other methods of determining the consistency should be considered. If the concrete segregates during the test, this test is not suitable.

NOTE — This test is applicable only for high workability concrete and not for SCC. This test is generally a laboratory test.

4.7.2 Apparatus

4.7.2.1 Flow-table — The flow-table shall be constructed in accordance with Fig. 8. It shall consist of a flat plate with a plan area of $700 \pm 2 \text{ mm} \times 700 \pm 2 \text{ mm}$, on which concrete can be placed, hinged to a rigid base onto which it can fall from a fixed height.

The flow-table top shall have a metal surface with a minimum thickness of 2 mm and it shall not be readily attacked by cement paste or be liable to rusting. This moving part shall have a mass of $16 \pm 0.5 \text{ kg}$ and may be attached using a pin hinge to allow the weight to be

checked. The construction of the plate shall be such as to prevent distortion of the upper surface. The table top shall be hinged to the base in such a way that no aggregate can get trapped easily between the hinged surfaces.

The centre of the table shall be scribed with a cross, the lines of which run parallel to the edges of the plate and with a central circle with a diameter of $210 \pm 1 \text{ mm}$.

At the front corners of the plate, two hard, rigid blocks shall be firmly attached to the underside. They should be non-absorbent and should not deform when wet. These stops shall transfer the load of the tabletop to the base without distorting the table. The base frame shall be so constructed that this load is then transferred directly to the surface on which the apparatus is placed, so that there is minimal tendency for the tabletop to bounce, when allowed to fall freely.

Footrest shall be provided to assist in stabilizing the table when in use.

The total height of the tabletop, measured at the centre line of the front edge of the top place, shall be limited to $40 \pm 1 \text{ mm}$ by means of one or more stops.

A handle or lifting mechanism shall be provided for lifting the tabletop to ensure that the top is lifted without jerking and allowed to fall freely over the entire lifting height.

4.7.2.2 Mould — The mould of slump cone shall be made of metal, not readily attacked by cement paste or liable to rust and with a minimum thickness of 1.5 mm (see Fig. 9). The interior of the mould shall be smooth and free from projections, such as protruding rivets and shall be free from dents. The mould shall be in the form of hollow frustum of a cone having the following internal dimensions:

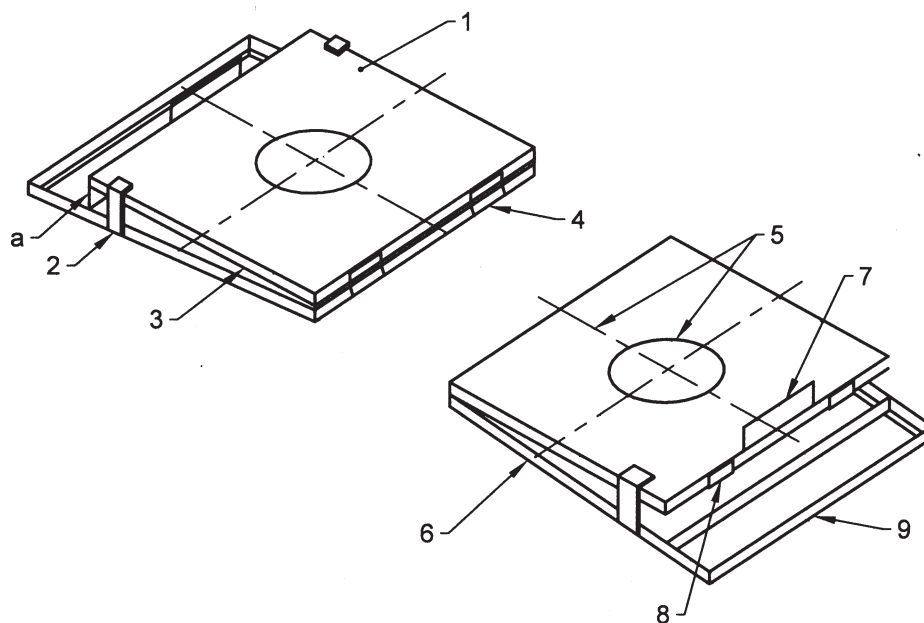
- a) Diameter of base : $200 \pm 2 \text{ mm}$
- b) Diameter of top : $130 \pm 2 \text{ mm}$
- c) Height : $200 \pm 2 \text{ mm}$

The base and the top shall be open and parallel to each other and at right angles to the axis of the cone. The mould shall be provided with two metal foot pieces at the bottom and two handles above them (see Fig. 9). This mould may be clamped to the table provided it is releasable without movement of the mould.

4.7.2.3 Tamping bar — It shall be made of hardwood or other non-absorbing hard material having a square section of $40 \pm 1 \text{ mm}$ and a length of at least 200 mm. A further 120 mm to 150 mm shall be extended to a circular section to form a handle to the bar (see Fig. 10).

4.7.2.4 Scoop, of adequate size.

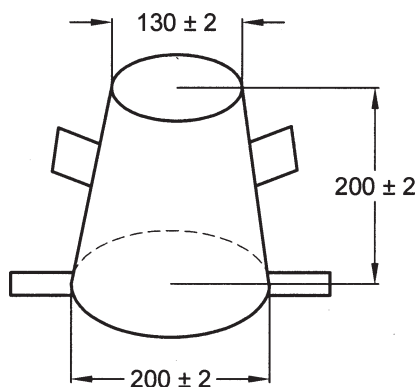
4.7.2.5 Sampling tray, with minimum dimensions



KEY

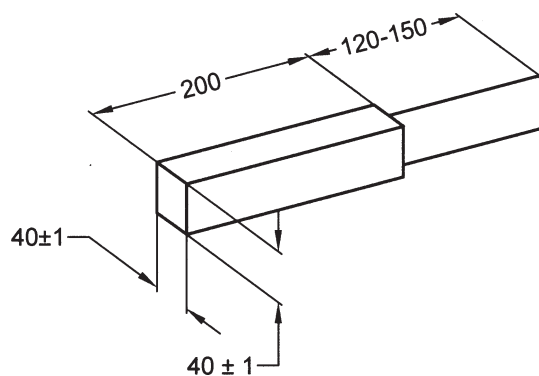
- | | | |
|-------------------|--------------|--------------|
| 1 metal plate | 2 upper stop | 3 tabletop |
| 4 external hinges | 5 markings | 6 base frame |
| 7 lifting handle | 8 lower stop | 9 toe-board |

FIG. 8 FLOW-TABLE APPARATUS



All dimensions in millimetres.

FIG. 9 CONCRETE MOULD WITH TYPICAL DIMENSIONS



All dimensions in millimetres.

FIG. 10 TAMPING BAR

900 mm × 900 mm × 50 mm deep, of rigid construction and made from non-absorbent material not readily attacked by cement paste.

4.7.2.6 *Shovel*, with a square blade.

4.7.2.7 *Rule*, with a minimum length of 700 mm, having at least 5 mm subdivisions along its entire length.

4.7.2.8 *Timer*, with accuracy up to 1 s.

4.7.3 Procedure

- a) Place the flow-table on a flat horizontal surface free from external vibration or shock. Ensure that the hinged top of the table can be lifted to the correct limit of its travel and is then free to fall to the lower stop. Check that the table is supported such that, when the top of the table falls to lower stop, there is a minimal tendency for the top to bounce.

- b) Clean the table and mould and dampen immediately prior to testing, but keep them free from excessive moisture. Ensure that the contact blocks are clean.
- c) Place the mould centrally on the tabletop and hold it in position by standing on the two foot pieces, or by the use of magnets.
- d) Fill the mould with the concrete in two equal layers using scoop, and tamp each layer lightly 10 times with the tamping bar. If necessary, add more concrete to the second layer to maintain an excess above the top of the mould.
- e) With the tamping bar, scrap off the concrete level with the upper edge of the mould and clean any excess concrete off the free area of the tabletop.
- f) Wait 30 s after scraping of the concrete, then slowly raise the mould vertically by the handle over a period of 5 ± 2 s. While the operator stabilizes the flow-table by standing on the toe board at the front of the table, slowly raise the tabletop until it reaches to the upper stop in such a manner that the tabletop does not impact hard against the upper stop.
- g) Then allow the tabletop to fall freely to the lower stop. Repeat this cycle to give a total of 15 drops, each cycle taking not less than 1 s nor more than 3 s.
- h) Measure with the rule the maximum dimension of the concrete spread in the two perpendicular directions, d_1 and d_2 , parallel to the table edges and record each measurement to the nearest 10 mm.
- j) Check the concrete spread for segregation. The cement paste can segregate from the coarse aggregate to give a ring of paste extending several millimetres beyond the coarse aggregate. Report that segregation has

occurred and the concrete was therefore unsatisfactory.

4.7.4 Test Results

Determine the flow value $(d_1 + d_2)/2$ and record to the nearest 10 mm.

4.7.5 Test Report

In addition to the information required in 5, the test report shall include the following:

- a) Jolting time for 15 jolts, in seconds;
- b) Dimension d_1 , in millimetres;
- c) Dimension d_2 , in millimetres;
- d) Test result $(d_1 + d_2)/2$, in millimetres; and
- e) Statement on any segregation identified.

5 TEST REPORT

In addition to the specifics required for each test method, the report shall include the following information:

- a) Identification of the test sample;
- b) Location of performance of test;
- c) Date and time of performance of test;
- d) Ambient temperature;
- e) Temperature of the remixed sample (optional);
- f) Method of compaction (wherever required to be mentioned):
 - 1) for mechanical compaction, the duration,
 - 2) for hand compaction, the number of strokes;
- g) Name of person carrying out the test or part of the test;
- h) Any deviation from standard test method; and
- j) Declaration by the person carrying out the test that it was carried out in accordance with this standard, except as noted in (h).

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
460 (Part 2) : 1985	Test sieves: Part 2 Perforated plate test sieves (<i>third revision</i>)	6461	Glossary of terms relating to cement concrete
1199	Fresh concrete — Methods of sampling, testing and analysis	(Part 1) : 1972	Concrete aggregates
(Part 1) : 2018	Sampling and fresh concrete (<i>first revision</i>)	(Part 2) : 1972	Materials (other than cement and aggregate)
(Part 3) : 2018	Determination of density of fresh concrete (<i>first revision</i>)	(Part 3) : 1972	Concrete reinforcement
(Part 5) : 2018	Making and curing of test specimens (<i>first revision</i>)	(Part 4) : 1972	Types of concrete
(Part 6) : 2018	Tests on fresh self compacting concrete (<i>first revision</i>)	(Part 5) : 1972	Formwork for concrete
2505 : 1992	Concrete vibrators immersion type — General requirements (<i>third revision</i>)	(Part 6) : 1972	Equipment, tools and plant
2514 : 1963	Specification for concrete vibrating tables	(Part 7) : 1973	Mixing, laying, compaction, curing and other construction aspects
4845 : 1968	Definitions and terminology relating to hydraulic cement	(Part 8) : 1973	Properties of concrete
		(Part 9) : 1973	Structural aspects
		(Part 10) : 1973	Tests and testing apparatus
		(Part 11) : 1973	Prestressed concrete
		(Part 12) : 1973	Miscellaneous

ANNEX B

(Clause 4.4.1)

DETERMINATION OF THE CONSISTENCY AND DENSITY USING MODIFIED VEE BEE CONSISTOMETER

B-1 GENERAL

This procedure describes the methods for measuring the consistency and density of freshly prepared concrete, both in laboratory and in field and having a nominal maximum size of 40 mm aggregate. For concretes containing aggregates with nominal maximum size greater than 40 mm, the concrete passing 40 mm can be screened and testing in accordance with the prescribed methods in this standard. In cases, where screening over 40 mm is used, cautious interpretation by experienced professionals is essential.

The test methods prescribed herein are primarily intended for use in testing of very stiff, drier, non-slump or near-zero and/or zero slump concretes such as dry lean concrete (DLC), roller compacted concrete, no-slump concrete, dry cast concrete, cement treated

aggregates (used in pavements) and mixtures of similar types.

The measurements made using this method can be reliably interpreted for applications if the Vee bee time ranges between 5 and 30 s. Readings beyond these need a cautious and experienced judgment while applying for practical purposes.

Because of the characteristic nature and response of stiff to extremely dry concrete mixtures, the standard Vee bee test method of rodding the specimen in a slump cone is being substituted by a method with surcharge weight (WS). For the test method, if the mix is very stiff, a surcharge mass of 12.5 ± 0.05 kg is placed over the transparent acrylic disc. In case of roller compacted concrete which is extremely dry, a surcharge of 22.7 ± 0.05 kg is placed over the transparent acrylic disc. The

concrete mix is then vibrated to get the cover disc in full contact with cement paste.

This test method provides a measure of the consistency of concrete having zero-slump or no measurable slump. The consistency is measured as the time required for a given mass of concrete to be consolidated by external vibration in a cylindrical mould. Under the application of external vibration, the paste in the concrete rises to the surface. This test method uses this as the principle, wherein a measured volume of concrete is allowed to compact under a pre-defined surcharge weight and vibration until a uniform layer of cement slurry rises to the top.

NOTE — The surcharge weights mentioned here are only for guidance and the Engineer-in-Charge may decide the surcharge weight to be used in a particular case.

B-2 APPARATUS

B-2.1 Cylindrical Mould — A watertight, rigid cylindrical mould made of non-corrosive material (preferably steel) shall have an internal diameter of 240 ± 5 mm, and a height of 200 ± 2 mm. The mould shall be capable of being rigidly clamped to the Vee bee vibrating table. The thickness of the wall of the mould shall be 3 ± 0.05 mm, while the base plate thickness shall be 7 ± 0.05 mm. The top rim of the mould shall be smooth, plane, and parallel to the bottom of the mould and shall be capable of providing an air and watertight seal when an acrylic or plastic plate is placed on the top rim.

B-2.2 Guide Sleeve with Swivel Arm — A metal guide sleeve with a clamp assembly or other suitable holding device mounted on a swivel arm shall be provided. The guide sleeve shall be made of non-corroding metal and shall be provided with clamp capable of holding a steel rod attached to the surcharge in a position perpendicular to the vibrating table, and centred over the sample, which will allow the rod to slide freely when the clamp is released. The swivel arm shall be capable of maintaining the guide sleeve in a locked position directly over the centre of the vibrating surface and capable of being rotated away from the centre of the table. The inside diameter of the guide sleeve shall be adequately larger than the diameter of the metal shaft of the surcharge to allow for a free movement while maintaining the concentricity.

B-2.3 Surcharge — The surcharge shall have a transparent, circular acrylic plate rigidly attached to its base and the steel rod at least 450 mm length attached perpendicularly to the plate and positioned through the centre of the surcharge. The transparent acrylic plate shall have a diameter of 230 ± 2 mm and shall be 10 ± 2 mm in thickness. The total surcharge weight including the complete assembly of weight, acrylic plate and the

holding rod shall be 12.5 ± 0.05 kg for stiff mixes and 22.7 ± 0.05 kg for extremely dry mixes, like roller compacted concrete.

NOTE — The surcharge weights mentioned here are only for guidance and the Engineer-in-charge may decide the surcharge weight to be used in a particular case.

B-2.4 Weigh Balance — The weigh balance shall be of sufficient capacity to determine the total mass of the sample and mould, and have sufficient accuracy so that the mass of the concrete sample may be determined to the nearest 0.5 percent or 0.5 g, whichever is lesser.

B-2.5 Vee bee Vibrating Table — A vibrating table, as per 4.4.2.1 (d) may be utilized.

B-2.6 Strike-off Plate — A flat square metal plate at least 6 mm thick shall be provided for striking off excessive concrete.

B-2.7 Sieve — A 40 mm sieve conforming to IS 460 (Part 2) shall be used for screening concrete with nominal maximum size of aggregate greater than 40 mm.

B-2.8 Stop-Watch or Timing Device — A stopwatch or a timing device capable of recording time intervals of at least 3 min to the nearest 0.5 s shall be used for recording the Vee bee time.

B-2.9 Miscellaneous Equipment — A square ended shovel, scoop of adequate size, slump test rod, flashlight and wrench, may also be required.

B-3 SAMPLING

B-3.1 Fresh concrete samples shall be obtained in accordance with IS 1199 (Part 1). Care shall be exercised in drawing a uniform sample without segregation.

B-3.2 Concretes with higher than 40 mm nominal maximum size of aggregate shall be wet sieved over 40 mm sieve according to the procedure given in IS 1199 (Part 5).

B-4 CALIBRATION

Calibration of the vibrating table and the container for holding concrete are essential. Usually with the age, handling and storage of equipment, the frequency of the vibrator may change, hence periodic calibration of the same is essential. Due to frequent use and cleaning, the container may also show some changes in its volume, thus necessitating calibration.

B-4.1 Vibrating Table

The vibrating table, shall produce a vibratory motion with a frequency of 55 ± 5 Hz and a vertical double amplitude of vibration of 0.5 ± 0.02 mm when the surcharge is bolted to the centre of the table.

The frequency of such calibration should be at least once per year or depending on the usage and/or post repairs or when in doubt.

B-4.2 Cylindrical Mould/Container

B-4.2.1 Determine the volume of the cylindrical mould (V_c) using a glass plate. Procedure shall remain the same as is in the case of calibration of the density containers, as per IS 1199 (Part 3). Verify the volume of the mould monthly during times of regular use and annually when used infrequently.

B-4.2.2 If this cylindrical mould is used in estimating the density, determine the mass of the cylindrical mould to the nearest 5 g. Record this mass as (W_1).

B-5 PROCEDURE

B-5.1 Vee Bee Consistency

Place the Vee bee consistometer on a rigid horizontal base free from extraneous vibration and shock. Make sure that the container is firmly fixed to the vibrating table by means of wing nuts. Ensure that the container is fairly levelled and acrylic plate would be able to concentrically move while retaining a practically horizontal plane during the testing. Without causing any segregation (especially of coarse aggregate), obtain a representative sample according to IS 1199 (Part 1). Dampen the inside of the mould with a moist cloth and place it in the container. Tighten the screw so that mould cannot rise from the bottom of the container. Gradually, without introducing any intentional compaction, using scoop fill the container with concrete till the top edge. Distribute the concrete evenly thus minimizing segregation and rock pockets. Level the surface of the concrete while ensuring that there is neither an overfilling nor under filling of concrete. Gently slide the shaft of the surcharge mass through the guide sleeve, and rotate the surcharge (with the transparent disc) in such a manner that it is centred over the mould filled with concrete specimen.

Ensure that there is no additional pressure applied to the concrete by any means. Simultaneously start the vibrator and stopwatch. This may require some practice and/or prior experience. As the concrete is vibrated, the concrete will start settling down and an annular mortar ring will be gradually formed around the acrylic plate. Keep observing the mortar ring around until it covers the perimeter completely. When the perimeter is completely filled around the acrylic plate, stop the vibrator and the stop-watch and record the time as the

Vee bee time (t_{vb}). If the container or the acrylic plate tilts or the wing nuts loosen during the testing, then repeat the test. If the complete ring is not formed within 120 s, then stop the test and record the condition of the test specimen. If the ring has formed all around the plate, except for a small length or due to rock pocket, repeat the test.

NOTE — The surcharge may be handled with caution so as to avoid any injuries during the conduction of the test.

B-5.2 Vee Bee Density

Subsequent to recording the Vee bee time (t_{vb}), remove the surcharge weight and vibrate the specimen for a total of 120 s (including t_{vb}), while taking precaution for not letting any concrete fly off. Remove the mould from the vibrating table and place it on a leveled ground or surface. Using an acrylic or glass plate, cover it and measure the weight of the cylindrical mould plus the compacted concrete specimen and the acrylic/ glass plate. Record this weight as (W_2). Remove the acrylic/ glass plate and gently pour water onto the concrete specimen, until it reaches the top of the mould. Now gently slide the glass plate and keep pouring water and completely cover the cylinder with the acrylic/glass plate, while ensuring no air bubbles trapped in. Gently pick this assembly and record its mass as (W_3). Compute the weight of the compacted concrete (W_{CC}) as ($W_2 - W_1 - W_{AP}$), W_{AP} is the weight of the acrylic plate. Compute the volume of water (V_w) over the compacted concrete as ($W_3 - W_2$)/1 000 and the volume of compacted concrete (V_{CC}) will be ($V_c - V_w$). The Vee bee density (VB_D) shall be computed as W_{CC} / V_{CC} .

B-6 TEST REPORT

In addition to the information required in 5, the test report shall include the following:

- Temperature of concrete and the ambient temperature;
- Surcharge used for the test;
- Whether the test is carried out in the laboratory or in the field;
- Vee bee consistency time, in second;
- Vee bee density, in kg/m^3 ; and if the ring of mortar does not form after 120 s of vibration, record the cause of the delay. The delay could be caused due to excessively dry consistency of concrete or an aggregate coming just below the acrylic plate, uneven level of the vibrating table or acrylic plate resulting in uneven mortar ring formation.

ANNEX C

(Foreword)

COMMITTEE COMPOSITION

Cement and Concrete Sectional Committee, CED 02

<i>Organization</i>	<i>Representative(s)</i>
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Indian Institute of Technology Madras, Chennai	PROF DEVDAS MENON DR MANU SANTHANAM (<i>Alternate</i>)

<i>Organization</i>	<i>Representative(s)</i>
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The Indian Hume Pipe Company Limited, Mumbai	SHRI P. R. BHAT SHRI S. J. SHAH (<i>Alternate</i>)
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Ultra Tech Cement Ltd, Mumbai	SHRI SURYA VALLURI DR M. R. KALGAL (<i>Alternate</i>)
Voluntary Organization in Interest of Consumer Education, New Delhi	SHRI M. A. U. KHAN SHRI B. MUKHOPADHYAY (<i>Alternate</i>)
In personal capacity [B-806, Oberoi Exquisite, Oberoi Garden City, Goregaon (East), Mumbai]	SHRI A. K. JAIN
In personal capacity (36, Old Sneh Nagar, Wardha Road, Nagpur)	SHRI L. K. JAIN
In personal capacity (EA-92, Maya Enclave, Hari Nagar, New Delhi)	SHRI R. C. WASON
In personal capacity (E-1, 402, White House Apartments, R. T. Nagar, Bengaluru)	SHRI S. A. REDDI
BIS Directorate General	SHRI SANJAY PANT, Scientist 'F' and Head (Civil Engg) [Representing Director General (<i>Ex-officio</i>)]

Member Secretary
SHRIMATI DIVYA S.
Scientist 'B' (Civil Engg), BIS

Concrete Sub-committee, CED 2:2

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Association of Consulting Civil Engineers (India), Bengaluru	SHRI AVINASH D. SHIRODE SHRI K. K. MEGHASHYAM (<i>Alternate</i>)

IS 1199 (Part 2) : 2018

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Panel for Revision of Indian Standards on Test Methods for Concrete, CED 2:2/P7

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(Continued from second cover)

This revision has been taken up to incorporate the modifications found necessary in the light of experience gained in its use and also to bring it in line with the latest development on the subject. Significant provisions in this revision are highlighted below:

- a) The slump test has been elaborated by including figures on slump measurement and different types of slumps.
- b) The filling procedure for the concrete in slump test has been modified to three layers in place of four layers, as per international practice. This may result in slightly higher slump values and if required, may be suitably adjusted.
- c) An revised flow table test, in line with the international practices, has been incorporated.
- d) A new test for determining consistency of concrete, that is, the degree of compactability has been included. This test is similar to compacting factor test but is easier to perform. At the present revision, both the tests, (degree of compactability and compacting factor test) have been included. But once the sufficient data of correlation between the two tests is available, the compacting factor test may be withdrawn, in order to align with the international practices.
- e) Modified Vee bee consistometer test has been included for the determination of consistency and density. The test method is prescribed for use in testing of very stiff, dry, non-slump or near-zero and/or zero slump concretes such as dry lean concrete (DLC), roller compacted concrete, no-slump concrete, dry cast concrete, cement treated aggregates (used in pavements) and mixtures of similar types.

In the formulation of this standard, assistance has also derived from ISO 1920-2 : 2016 ‘Testing of concrete — Part 2 : Properties of fresh concrete’.

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

In reporting the result of a test or analysis 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*)’.

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