
ताजा कंक्रीट — नमूने लेना, परीक्षण
एवं विश्लेषण पद्धतियाँ

भाग 6 स्वतः संगहनित कंक्रीट का परीक्षण
(पहला पुनरीक्षण)

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

Part 6 Tests on Fresh Self Compacting Concrete

(*First Revision*)

ICS 91.100.30

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www.bis.org.in www.standardsbis.in

December 2018

Price Group 7

FOREWORD

This Indian Standard (Part 6) (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 shall be simple, direct and convenient to apply. This standard was formulated 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 'Methods of sampling and analysis of concrete', have been revised. The revision of this standard has been 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 complete in all respects, and rendering it a comprehensive source of provisions for testing of concrete and reference in other Indian Standards.

In this revision, IS 1199 has been split into nine parts. The other parts in the series are:

- Part 1 Sampling of fresh concrete
- Part 2 Determination of consistency 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 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 6) covers the procedures for testing of fresh self-compacting concrete.

This standard (Part 6) has been based on the latest literature on this topic as well as latest research data. Significant provisions in this revision are highlighted below:

- a) These are newly introduced test methods for self compacting concrete (SCC).
- b) Test methods for the determination of consistency, viscosity, passing ability and segregation resistance have been included.
- c) For consistency determination of SCC, the flowability is evaluated by measuring the maximum spreading diameter (d_{max}) and the time the concrete takes to reach the spreading diameter of 500 mm (t_{500}).
- d) For viscosity determination, the V-funnel test for determining the flow time of SCC has been included. This test also gives the filling ability of the concrete.
- e) For passing ability determination of SCC, the L box test is specified, which measures the passing ability

(Continued on third cover)

*Indian Standard*FRESH CONCRETE — METHODS OF SAMPLING,
TESTING AND ANALYSIS

PART 6 TESTS ON FRESH SELF COMPACTING CONCRETE

*(First Revision)***1 SCOPE**

This standard (Part 6) specifies procedures for testing of fresh self-compacting concrete. It specifies the following test methods: determination of consistency (slump flow test), V-funnel test, L-box test, and sieve segregation test.

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 shall be apply.

3.1 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.

3.2 Passing Ability — Ability of fresh concrete to flow through tight openings such as spaces between steel reinforcing bars.

3.3 Powder Content — Powder content includes the materials of particle size smaller than 0.125 mm. It includes this size fraction in the cement, mineral admixtures and aggregate.

3.4 Segregation Resistance — The ability of concrete to remain homogeneous in composition while in its fresh state.

3.5 Slump Flow — The mean diameter of the spread of fresh concrete using conventional slump cone.

**SECTION 1 SLUMP-FLOW TEST AND
 t_{500} TEST**

4.0 This test specifies the procedure for determining the slump-flow and t_{500} time for self-compacting

concrete. The test is not suitable when the maximum size of the aggregate exceeds 40 mm.

4 PRINCIPLE

The slump-flow test is an indication of the flowability of self-compacting concrete in the absence of obstructions. It is based on the slump test described in IS 1199 (Part 2). The flowability is evaluated by measuring the maximum spreading diameter (d_{max}) and the time it reaches the spreading diameter of 500 mm (t_{500}). The d_{max} of spreading is a measure of the self-compacting concrete flow range when subjected to load from its own weight. It is an indication of the yield stress of the self-compacting concrete. The t_{500} time is a measure of the speed of flow and an indication of the relative viscosity of the self-compacting concrete. The result is an indication of the filling ability of self-compacting concrete.

The fresh concrete is poured into a cone as used for the IS 1199 (Part 2) slump test. When the cone is withdrawn upwards the time from commencing upward movement of the cone to when the concrete has flowed to a diameter of 500 mm is measured; this is the t_{500} time. The largest diameter of the flow spread of the concrete and the diameter of the spread at right angles to it are then measured and the mean diameter is the slump-flow.

5 APPARATUS

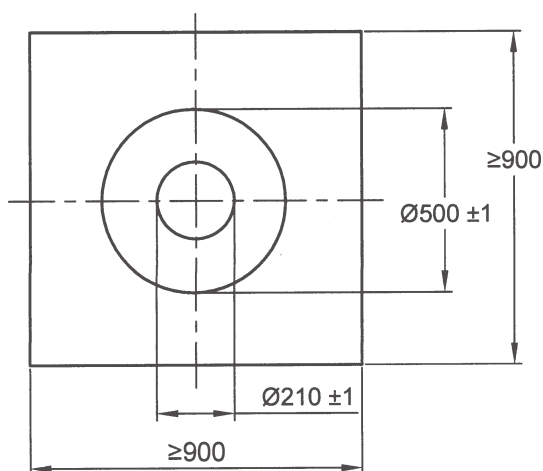
The apparatus shall be in accordance with IS 1199 (Part 2) except as detailed below.

5.1 Base Plate, made from a flat steel plate, with a plan area of at least 900 mm × 900 mm on which concrete can be placed.

The plate shall have a flat, smooth surface. The surface shall not be readily attacked by cement paste or be liable to rusting. The construction of the plate shall be such as to prevent distortion. The deviation from flatness shall not exceed 3 mm at any point when a straight edge is placed between opposite sides and corners.

The centre of the plate shall be scribed with a cross, the lines of which run parallel to the edges of the plate

and with circles of 210 ± 1 mm diameter and 500 ± 1 mm diameter having their centers coincident with the centre point of the plate (See Fig. 1). All lines to be of maximum of 2.0 mm wide and 1.0 mm deep.



All dimensions in millimetres.

FIG. 1 BASE PLATE

5.2 Rule or Measuring Tape, of minimum length 1 000 mm and having sub-divisions not greater than 5 mm along its entire length.

5.3 Stop Watch, capable of measuring to 0.1 s.

5.4 Spirit Level, for checking horizontality of base plate prior to commencing the test.

5.5 Container, to hold the test sample and having a volume of at least 10 litre.

6 TEST SAMPLE

About 6 litre of concrete is needed to perform the test. The sample shall be obtained in accordance with IS 1199 (Part 1).

7 PROCEDURE

Place the base plate on a flat and horizontal surface free from external vibration or shock. Check the top surface for horizontality using the spirit level. Clean the table and the cone and dampen immediately prior to testing, but keep free from excess moisture.

Place the cone centrally within the 210 mm circle on the base plate and hold in position firmly, ensuring that no concrete can leak from under the cone.

Fill the cone in one operation without any agitation or mechanical compaction, and strike off surplus from the top of the cone. Allow the filled cone to stand for not more than 30s; during this time remove any spilled concrete from the base plate.

Lift the cone vertically in 1s to 3s in one movement without interfering with the flow of concrete. If the t_{500}

time has been requested, start the stop watch immediately when the cone ceases to be in contact with the base plate and record the time taken to the nearest 0.1 s for the concrete to first touch the 500 mm circle

After the flow of concrete has stabilized without disturbing the base plate or concrete, measure the largest diameter of the flow spread and record as d_1 , to the nearest 10 mm. Then measure the diameter of the flow spread at right angles to d_1 , and record as d_2 , to the nearest 10 mm. If the difference between d_1 and d_2 is greater than 50 mm another sample shall be taken and the procedure repeated.

If two consecutive tests show the difference between d_1 and d_2 to be greater than 50 mm, the concrete lacks the necessary flowability for the slump-flow test to be suitable.

Check the concrete spread for signs of segregation and report under 9(g) in a qualitative way, for example, no indication of segregation, strong indication of segregation, etc (Signs of segregation include a ring of cement paste/mortar and segregated coarse aggregate in the central area.).

NOTE — When carrying out this test, 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.

8 TEST RESULT

The slump-flow (SF) is the mean of d_1 and d_2 , expressed to the nearest 10 mm, given by the following equation:

$$SF = (d_1 + d_2) / 2$$

where

SF = slump-flow, in millimetres;

d_1 = largest diameter of flow spread, in millimetres; and

d_2 = flow spread at 90° to d_1 , in millimetres.

The t_{500} time is reported to the nearest 0.1 s.

9 TEST REPORT

The test report shall include the following:

- Identification of the test sample;
- Location where the test was performed;
- Date and time of test;
- Ambient temperature;
- Slump-flow, SF , to the nearest 10 mm;
- t_{500} time, to the nearest 0.1 s (when requested);
- Any indication of segregation of the concrete, for example, no indication of segregation or strong indication of segregation (see Note under 7);

- h) Any deviation from the standard test method; and
- j) Declaration by the person technically responsible for the test that it was carried out in accordance with this standard, except as noted in 9(h).
- k) The report may also include,
 - 1) temperature of the concrete at the time of test; and
 - 2) time between completion of mixing and performance of the tests.

SECTION 2 V-FUNNEL TEST

10 INTRODUCTION

This test specifies the procedure for determining the V-funnel flow time for self-compacting concrete. The test is not suitable when the maximum size of the aggregate exceeds 20 mm. The V-funnel test is used to assess the viscosity and filling ability of self-compacting concrete.

11 PRINCIPLE

A V shaped funnel is filled with fresh concrete and the time taken for the concrete to flow out of the funnel is measured and recorded as the V-funnel flow time.

12 APPARATUS

12.1 V-funnel, made to the internal dimensions and tolerances as in Fig. 2, fitted with a quick release, watertight hinged or sliding gate at its base and supported by a frame so that the top of the funnel is horizontal with sufficient clearance beneath the gate to place the container underneath. The V-funnel shall be

made from metal or fibre glass; the surfaces shall be smooth, and not be readily attacked by cement paste or be liable to rusting.

12.2 Container, to hold the test sample and having a volume larger than the volume of the funnel and not less than 12 litre.

12.3 Stop Watch, capable of measuring to 0.1 s.

12.4 Straight Edge, for striking off concrete level with the top of the funnel.

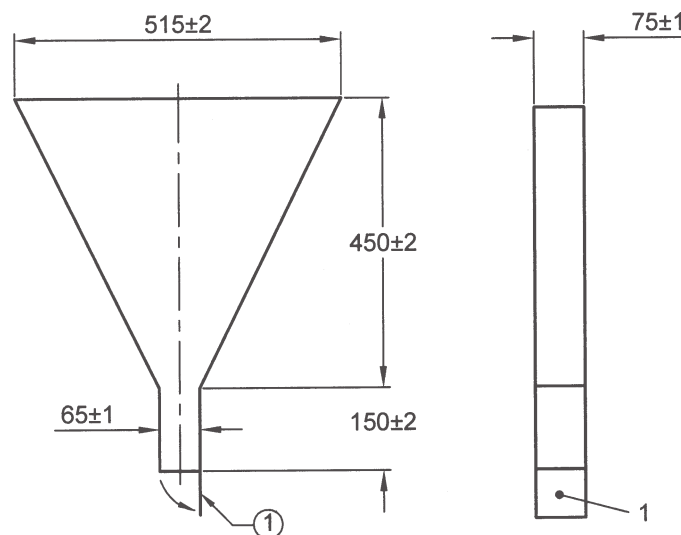
13 TEST SAMPLE

A sample of at least 12 litre shall be obtained in accordance with IS 1199 (Part 1).

14 PROCEDURE

Clean the funnel and bottom gate, then dampen all the inside surface including the gate. Close the gate and pour the sample of concrete into the funnel in one operation, without any agitation or mechanical compaction, then strike off the top with the straight edge so that the concrete is level with the top of the funnel. Place the container under the funnel in order to collect the concrete. After a delay of 10 ± 2 s from filling the funnel, open the gate quickly and measure the time t_v , to 0.1 s, from the time of opening the gate to when it is possible to see vertically through the funnel into the container below for the first time. The time t_v is the V-funnel flow time.

The flow of concrete from the funnel shall be continuous. If a blockage occurs the test shall be repeated. If a second blockage occurs the concrete lacks the necessary viscosity. Report, if a blockage has occurred.



KEY

1 Hinged or Sliding Gate

All dimensions in millimetres.

FIG. 2 V-FUNNEL

15 TEST REPORT

The test report shall include the following:

- Identification of the test sample;
- Location where the test was performed;
- Date when test performed;
- Ambient temperature;
- V-funnel flow time (t_v) to the nearest 0.1s;
- Any deviation from the standard test method;
- Declaration by the person technically responsible for the test that it was carried out in accordance with this standard, except as noted in (f).
- The report may include,
 - temperature of the concrete at the time of test; and
 - time between completion of mixing and performance of the tests.

SECTION 3 L-BOX TEST

16 INTRODUCTION

The L-box test is used to assess the passing ability of self-compacting concrete to flow through tight openings including spaces between reinforcing bars and other obstructions without segregation or blocking.

17 PRINCIPLE

The L-box test is used to assess the passing ability of

self-compacting concrete. There are two variations; the two bar test and the three bar test. Only the three bar test is covered in this section, as it simulates more congested reinforcement.

A measured volume of fresh concrete is allowed to flow horizontally through the gaps between vertical, smooth reinforcing bars. The heights of the concrete in the vertical section (H_1) and at the end of the horizontal section (H_2) (see Fig. 3), are measured and the ratio H_2/H_1 determined. This ratio is a measure of the passing or blocking behaviour of self-compacting concrete.

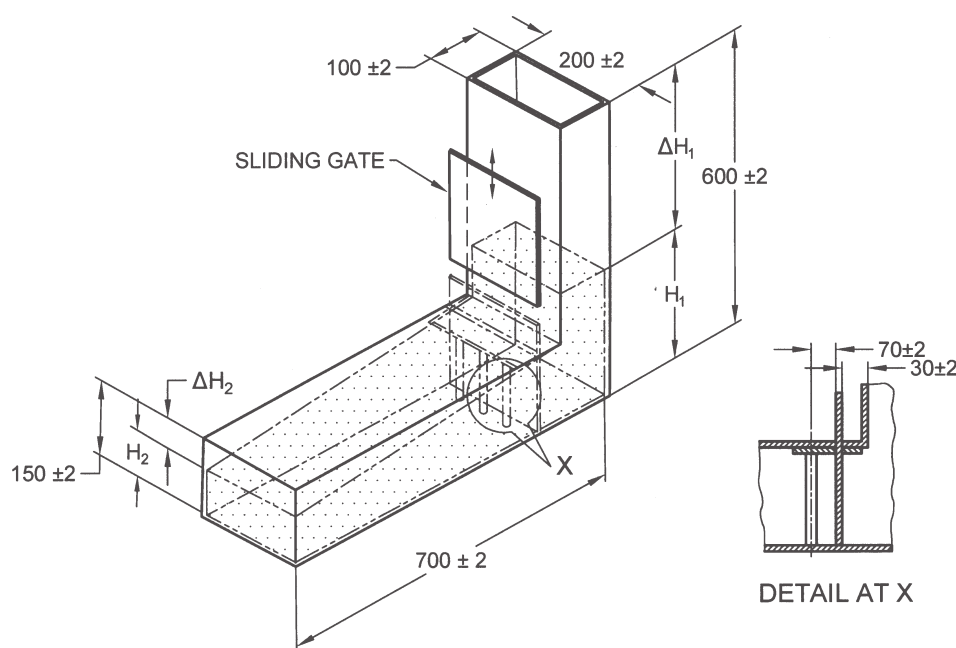
18 APPARATUS

18.1 L-Box, having the general arrangement and internal dimensions as shown in Fig. 3.

The L-box shall be of rigid construction with surfaces that are smooth, flat and not readily attacked by cement paste or be liable to rusting. The vertical hopper may be removable for ease of cleaning.

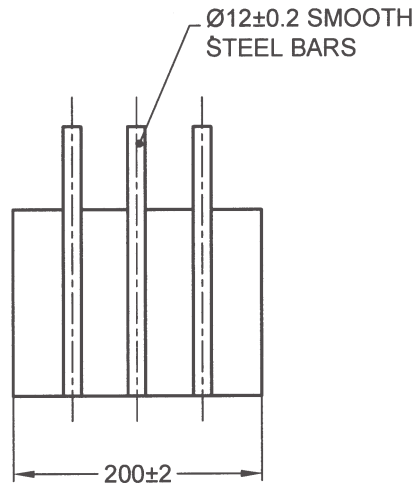
The bar positioning system shall be such that three smooth steel bars of 12 ± 0.2 mm diameter will provide a gap of 41 ± 1 mm. The system shall locate the bars in the L-box so that they are vertical and equidistant across the width of the box, as shown in Fig. 4.

The surface of any material used in the assemblies shall not be readily attacked by cement paste or be liable to rusting.



All dimensions in millimetres.

FIG. 3 TYPICAL GENERAL ASSEMBLY OF L-BOX SHOWING REQUIRED DIMENSIONS



Clear bar space 41 ± 1

All dimensions in millimetres.

FIG. 4 BAR POSITIONS IN L- BOX

18.2 Rule or Measuring Tape, of minimum length 500 mm and graduated at intervals not exceeding 1 mm, the zero mark being at the extreme end of the rule or measuring tape.

18.3 Containers, to hold the sample and having a total volume not less than 12 litre.

18.4 Spirit Level, for checking horizontality of base of L-box base prior to commencing the test.

18.5 Straight Edge, for striking off concrete level with the top of the L-box.

19 TEST SAMPLE

A sample of at least 12 litre shall be obtained in accordance with IS 1199 (Part 1).

20 TEST PROCEDURE

Support the L-box on a level base and check for horizontality using the spirit level. Clean the L-box and dampen immediately prior to testing, but keep free from excess moisture. Close the gate between the vertical and horizontal sections. Pour the concrete from the container(s) into the filling hopper of the L-box, without any agitation or mechanical compaction, then strike off the top with the straight edge so that the concrete is level with the top of the vertical section of the L-box and allow to stand for 60 ± 10 s. Check the concrete for signs of segregation before and after filling of the L-box and report under 22(f) in a qualitative way, for example, no indication of segregation, strong indication of segregation, etc.

Fully open the sliding gate in a smooth continuous action to allow the concrete to flow into the horizontal

section. When movement has ceased, measure the drop in height of the level of concrete ΔH_1 to the nearest 1 mm in the vertical section on the gate side of the box at three positions equally spaced across the width of the box. The mean depth of the concrete H_1 is the difference between the height of vertical section and the average of the three readings of ΔH_1 . Record H_1 to the nearest 1 mm. The same procedure is used to calculate the mean depth of the concrete at the end of the horizontal section of the L-box, H_2 from the difference with the height of the horizontal section and the average of the three readings of ΔH_2 . Record H_2 to the nearest 1 mm.

NOTE — Signs of segregation include a layer of cement paste/mortar and segregated coarse aggregate at the top.

21 TEST RESULT

The passing ability ratio P_L , as measured by the L-box test, is calculated to the nearest 0.01 from the following equation:

$$P_L = \frac{H_2}{H_1}$$

where

P_L = passing ability ratio measured by the L-box test;

H_1 = mean depth of concrete in the vertical section of the box, in millimetres; and

H_2 = mean depth of concrete at the end of the horizontal section of the box, in millimetres.

22 TEST REPORT

The test report shall include the following:

- a) Identification of the test sample;
- b) Location where the test was performed;
- c) Date and time of test;
- d) Ambient temperature,
- e) Passing ability ratio, P_L , to the nearest 0.05;
- f) Any segregation or bleeding observed during filling of the L-box, for example, no indication of segregation/bleeding or strong indication of segregation/bleeding (*see* Note under **20**);
- g) Any deviation from the standard test method;
- h) Declaration by the person technically responsible for the test that it was carried out in accordance with this standard, except as noted in (g).
- j) The report may include,
 - 1) temperature of the concrete at the time of test; and
 - 2) time between completion of mixing and performance of the tests

SECTION 4 SIEVE SEGREGATION RESISTANCE TEST

23 INTRODUCTION

This test specifies the procedure for determining the sieve segregation resistance of self-compacting concrete.

24 PRINCIPLE

The sieve segregation resistance test is used to assess the resistance of self-compacting concrete to segregation. After sampling, the fresh concrete is allowed to stand for 15 min and any separation of bleed water is noted. A known weight of the sample is then poured into a sieve with 4.75 mm² apertures. After 2 min the weight of material which has passed through the sieve is recorded. The segregation ratio is then calculated as the proportion of the sample passing through the sieve.

25 APPARATUS

25.1 Perforated Plate Sieve, having 4.75 mm square apertures, frame diameter 300 mm and height 40 mm, conforming to IS 460 (Part 2) complete with a receiver from which the sieve can be easily removed by lifting vertically.

25.2 Weighing Machine, having a flat platform which can accommodate the sieve receiver and having a capacity of at least 10 kg, calibrated in increments of not more than 20 g.

25.3 Sample Container, a rigid container made from a non-absorbent material and having a minimum

internal diameter of 200 mm and a capacity of at least 11 litre with a 10 litre point indicated on the inside of the container.

25.4 Timer, capable of measuring to 1 s.

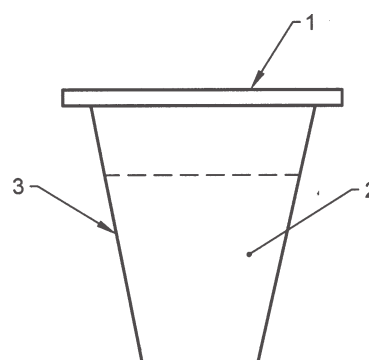
25.5 Thermometer, capable of measuring to 1 °C.

26 TEST SAMPLE

A sample which fills the sample container to be obtained in accordance with IS 1199 (Part 1).

27 PROCEDURE

Take and record the temperature of the concrete to the nearest 1°C by using the thermometer. Place 10 ± 0.5 litre of concrete in the sample container and cover to prevent evaporation (*see* Fig. 5).



KEY

- 1 Cover
- 2 Concrete
- 3 Sample Container

FIG. 5 SAMPLE CONTAINER AND COVER

Allow to stand in a level position without disturbance, for 15 ± 0.5 min.

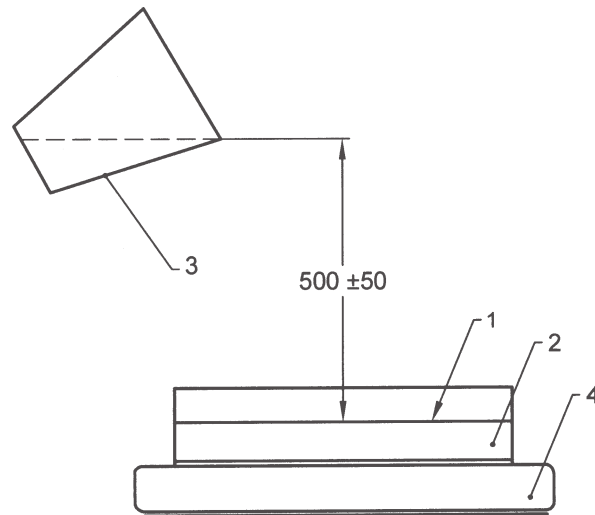
Ensure the balance is level and free from vibration. Place the sieve receiver on the balance and record its mass, m_p in g. Then place the dry sieve on the receiver and again record the mass or zero the balance.

At the end of the standing period remove the cover from the sample container and record whether any bleed water has appeared on the surface of the concrete.

With the sieve and receiver still on the balance, and with the top of the sample container 500 ± 50 mm above the sieve, steadily and carefully pour 4.8 ± 0.2 kg of concrete (including any bleed water) onto the center of the sieve (*see* Fig. 6) in one operation. Record the actual mass of concrete m_c in g on the sieve.

Allow the concrete to stand in the sieve for 120 ± 5 s and then remove the sieve vertically without agitation.

Record the mass of the receiver, including the material that has passed through the sieve, m_{ps} in g.



KEY

- 1 Sieve
- 2 Sieve Receiver
- 3 Sample Container
- 4 Balance

All dimensions in millimetres.

FIG. 6 MEASUREMENT OF SEGREGATED PORTION

28 TEST RESULT

The segregated portion SR is calculated from the following equation and reported to the nearest 1 percent.

$$SR = \frac{(m_{ps} - m_p) \times 100}{m_c}$$

where

SR = segregated portion in percent;

m_{ps} = mass of sieve receiver plus passed material, in g;

m_p = mass of the sieve receiver, in g; and

m_c = initial mass of concrete placed onto the sieve, in grams.

29 TEST REPORT

The test report shall include the following:

- a) Identification of the test sample;
- b) Location where the test was performed;
- c) Date and time of test;
- d) Ambient temperature;
- e) Segregated portion SR , to the nearest 1 percent;
- f) Presence of bleed water, if any, after standing for 15 min;
- g) Any deviation from the standard test method;
- h) Declaration by the person technically responsible for the test that it was carried out in accordance with this standard, except as noted in (g).
- j) The report may include,
 - 1) temperature of the concrete at the time of test; and
 - 2) time between completion of mixing and performance of the tests.

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>)	(Part 1) : 2018	Sampling of fresh concrete (<i>first revision</i>)
1199	Fresh concrete — Methods of sampling, testing and analysis :	(Part 2) : 2018	Properties of fresh concrete (<i>first revision</i>)

ANNEX B

(Foreword)

COMMITTEE COMPOSITION

Cement and Concrete Sectional Committee, CED 02

<i>Organization</i>	<i>Representative(s)</i>
In Personal Capacity (14A, Summer Breeze, Kuravankonam, Kowdiar, Thiruvananthapuram 695 003)	SHRI JOSE KURIAN (Chairman)
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Indian Institute of Technology Delhi, New Delhi	REPRESENTATIVE
Indian Institute of Technology Madras, Chennai	PROF DEVDAS MENON DR MANU SANTHANAM (<i>Alternate</i>)

IS 1199 (Part 6) : 2018

<i>Organization</i>	<i>Representative(s)</i>
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The India Cements Limited, Chennai	DR D. VENKATESWARAN
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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)

of self-compacting concrete to flow through tight openings including spaces between reinforcing bars and other obstructions without segregation or blocking.

- f) For assessing the segregation resistance of SCC, the sieve segregation resistance test is specified. A known weight of the sample, kept stagnant for 15 min, is poured into a sieve, and the segregation ratio is then calculated as the proportion of the sample passing through the sieve.

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

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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This Indian Standard has been developed from Doc No.: CED 02 (10896).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Published by BIS, New Delhi