भारतीय मानक ब्यूरो
(उपभोक्ता मामले, खाद्य एवं सार्वजनिक वितरण मंत्रालय, भारत सरकार)
BUREAU OF INDIAN STANDARDS
*(Ministry of Consumer Affairs, Food & Public Distribution, Govt. of India)*

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## व्यापक परिचालन मसौदा

**हमारा संदर्भ : सीईडी 02:2/टी-16** **01 अगस्त 2025**
**तकनीकी समिति : सीमेंट और कंक्रीट अनुभागीय समिति , सीईडी 02**

**प्राप्तकर्ता :**
1. **सिविल अभियांत्रिकी विभाग परिषद, सीईडीसी के सभी सदस्य**
2. **सीमेंट और कंक्रीट अनुभागीय समिति , सीईडी 02**
3. **सीईडी 02 की उपसमितियों और अन्य कार्यदल के सभी सदस्य**
4. **रुचि रखने वाले अन्य निकाय।**

महोदय/महोदया,

निम्नलिखित मानक का मसौदा संलग्न है:

| प्रलेख संख्या | शीर्षक |
|---|---|
| **सीईडी 2 (28016)WC** | **कंक्रीट के लिए मिलावा के लिए परीक्षण की पद्धति**<br>**भाग 1 भौतिक गुणों का निर्धारण का भारतीय मानक मसौदा**<br>(आईएस 2386 का पहला पुनरीक्षण)<br>(ICS 91.100.30) |

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

**सम्मतियाँ भेजने की अंतिम तिथि: 30 सितम्बर 2025**

सम्मति यदि कोई हो तो कृपया अधोहस्ताक्षरी को ई-मेल द्वारा ced2@bis.gov.in पर या उपरलिखित पते पर, संलग्न फोर्मेट में भेजें। सम्मतियाँ बीआईएस ई-गवर्नेंस पोर्टल, www.manakonline.in के माध्यम से ऑनलाइन भी भेजी जा सकती हैं।

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यह प्रालेख भारतीय मानक ब्यूरो की वेबसाइट www.bis.gov.in पर भी उपलब्ध हैं।

धन्यवाद।

**भवदीय**
ह-/
**द्वैपायन भद्र**
**वैज्ञानिक ई एवं प्रमुख**
**सिविल अभियांत्रिकी विभाग**

**संलग्न: उपरलिखित**

भारतीय मानक ब्यूरो
(उपभोक्ता मामले, खाद्य एवं सार्वजनिक वितरण मंत्रालय, भारत सरकार)
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## WIDE CIRCULATION DRAFT

**Our Reference: CED 02:2/T-16** **01 August 2025**

**TECHNICAL COMMITTEE:CEMENT AND CONCRETE SECTIONAL COMMITTEE, CED 02**

**ADDRESSED TO:**

1. All Members of Civil Engineering Division Council, CEDC
2. All Members of Cement and Concrete Sectional Committee, CED 02 and its Subcommittees
3. All Members of Subcommittees, Panels and Working Groups under CED 02
4. All others interested.

Dear Sir/Madam,

Please find enclosed the following draft:

| Doc No. | Title |
|---|---|
| **CED 2 (28016)WC** | **Draft Indian Standard Methods of Test for Aggregates for Concrete Part 1 Determination of Physical Properties**<br>(*first revision* of IS 2386) (ICS 91.100.30) |

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

**Last Date for comments: 30 September 2025**

Comments if any, may please be made in the enclosed format and emailed at ced2@bis.gov.in or sent at the above address. Additionally, comments may be sent online through the BIS e-governance portal, www.manakonline.in.

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

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

Thanking you,

Yours faithfully,
Sd/-
Dwaipayan Bhadra
Scientist 'E' & Head
Civil Engineering Department

**Encl: As above**

**FORMAT FOR SENDING COMMENTS ON THE DOCUMENT**

[Please use A4 size sheet of paper only and type within fields indicated. Comments on each clause/sub-clause/ table/figure, etc, be stated on a fresh row. Information/comments should include reasons for comments, technical references and suggestions for modified wordings of the clause. Comments through e-mail to **ced2@bis.gov.in** shall be appreciated.]

**Doc. No.**: CED 02(28016)WC

**BIS Letter Ref**: CED 02:2/T-16

**Title: Draft Indian Standard Methods of Test for Aggregates for Concrete: Part 1 Determination of Physical Properties** (*first revision of IS 2386*) (ICS 91.100.30)

**Last date of comments:** 30 September 2025

**Name of the Commentator/ Organization**: ________________________________________

| Sl No. | Clause/ Para/ Table/ Figure No. commented | Type of Comment (General/ Technical/ Editorial) | Comments/ Modified Wordings | Justification of Proposed Change |
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*NOTE- Kindly insert more rows as necessary for each clause/table, etc*

## BUREAU OF INDIAN STANDARDS

## DRAFT STANDARD FOR COMMENTS ONLY

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*Draft Indian Standard*

# METHODS OF TEST FOR AGGREGATES FOR CONCRETE

## Part 1 Determination of Physical Properties

(*First revision of* IS 2386)

| | |
|---|---|
| Cement and Concrete | Last Date for Comments: |
| Sectional Committee, CED 02 | **30 September 2025** |

Cement and Concrete Sectional Committee, CED 02

## FOREWORD

(*Formal clauses to be added later*)

One of the major contributing factors to the quality of concrete is the quality of aggregates used therein. The test methods given in this standard are intended to assist in assessing the quality of aggregates. In a given situation, for a particular aggregate, it may not be necessary to assess all the qualities and therefore it is necessary to determine beforehand the purpose for which concrete is being used and the qualities of the aggregate which require to be assessed. Accordingly, the relevant test methods may be chosen from amongst the various tests covered in this standard. This standard was first published in 1963 as ‘Indian Standard Methods of Test for Aggregates for Concrete’ in eight parts as given below.

Part 1 Particle size and shape
Part 2 Estimation of deleterious materials and organic impurities
Part 3 Specific gravity, density, voids, absorption and bulking
Part 4 Mechanical properties
Part 5 Soundness
Part 6 Measuring mortar making properties of fine aggregate
Part 7 Alkali aggregate reactivity
Part 8 Petrographic examination

In this revision, the Committee decided to group the different test methods based upon properties of the aggregates under the following five parts for the convenience of the users. Also, the test methods given in this standard have been harmonized with the ongoing revision of IS 383.

| | |
|---|---|
| Part 1 | Determination of Physical Properties |
| Part 2 | Determination of Mechanical Properties |
| Part 3 | Determination of Durability Properties |
| Part 4 | Determination of Chemical requirements and Hazardous Substances |

Part 5 Petrographic examination of aggregates

The Sectional Committee responsible for the preparation of this standard has taken into consideration the views of the concrete specialists, testing authorities, consumers and technologists and has related the standard to the practices followed in this country. Further the need for international co-ordination among standards prevailing in different countries of the world has also been recognized.

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

EN 933 (Part 9): 2022 Determination of Methylene Blue Value, European Organization

BS 812 (Part 106): 1985 Determination of Shell Content, British Standards Institution

This standard contributes to the United Nations Sustainable Development Goal 9: ‘Industry, Innovation and Infrastructure' towards building resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

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

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2: 2022 Rules for Rounding Off Numerical values (*second revision*). The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

**BUREAU OF INDIAN STANDARDS**

*Draft Indian Standard*

# METHODS OF TEST FOR AGGREGATES FOR CONCRETE

## Part 1 Determination of Physical Properties

(*First revision of* IS 2386)

| | |
|---|---|
| Cement and Concrete | Last Date for Comments: |
| Sectional Committee, CED 02 | **30 September 2025** |

## 1 SCOPE

This standard (Part 1) covers the following tests for determining the physical properties of aggregates for the purpose of mix design, production and quality control of concrete:

a) Determination of specific gravity and water absorption
b) Determination of bulk density and voids
c) Sieve analysis and fineness modulus
d) Determination of materials finer than 75 micron
e) Determination of sand equivalent value
f) Determination of methylene blue value
g) Determination of flakiness index, elongation index and combined flakiness index and elongation index
h) Determination of shell content
j) Determination of shale content
k) Determination of clay lumps
m) Determination of clay, fine silt and fine dust (*Sedimentation Method*)
n) Determination of light weight pieces (*Coal and Lignite*)
p) Determination of soft particles
q) Determination of organic impurities
r) Determination of angularity number
s) Determination of necessary adjustment for bulking of fine aggregates (*Field Method*)
t) Determination of surface moisture in fine aggregates (*Field Method*)
u) Measuring mortar making properties of fine aggregate

## 2 REFERENCES

The standards given 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 given in Annex A.

## 3 DETERMINATION OF SPECIFIC GRAVITY AND WATER ABSORPTION

**3.1** This test covers the procedures for determining the specific gravity, apparent specific gravity and water absorption of aggregates.

**3.2** Three main methods are specified for use according to whether the size of the aggregate is larger than 40 mm (Method I), between 40 mm and 10 mm (Method I or II may be used); or smaller than 10 mm (Method III). An alternate method (Method IV) is also permitted.

**3.2.1** *Method I — Aggregate larger than 40 mm and between 40 mm to 10 mm*

**3.2.1.1** *Apparatus* — The apparatus shall consist of the following:

a) *Balance* — A balance or scale of capacity not less than 3 kg, readable and accurate to 0.5 g and of such a type and shape as to permit the basket containing the sample to be suspended from the beam and weighed in water.
b) *Oven* — a Well-ventilated oven, thermostatically controlled, to maintain a temperature of 100°C to 110°C.
c) A wire basket of not more than 6.3 mm mesh or a perforated container of convenient size, preferably chromium plated and polished, with wire hangers not thicker than one millimetre for suspending it from the balance.
d) A stout watertight container in which the basket may be freely suspended.
e) Two dry soft absorbent/microfibre cloths each not less than 75 cm × 45 cm.
f) A shallow tray of area not less than 650 $cm^2$.
g) An airtight container of capacity similar to that of the basket.
h) Thermometer having temp. range 0ºC to 50ºC readable upto 0.5ºC accuracy.

**3.2.1.2** *Sample* — A sample of not less than 2 000 g of the aggregate shall be tested. Aggregates which have been artificially heated shall not normally be used. If such material is used the fact shall be stated in report. Two tests shall be made, and it is recommended that the two samples should not be tested concurrently.

**3.2.1.3** *Test procedure*

a) The sample shall be thoroughly washed to remove finer particles and dust, drained and then placed in the wire basket and immersed in distilled water at a temperature between 22°C and 32°C with a cover of at least 5 cm of water above the top of the basket.

b) Immediately after immersion the entrapped air shall be removed from the sample by lifting the basket containing it 25 mm above the base of the tank and allowing it to drop 25 times at the rate of about one drop per second. The basket and aggregate shall remain completely immersed during the operation and for a period of 24 ± ½ hours afterwards.

c) The basket and the sample shall then be jolted and weighed in water at a temperature of 22 °C to 32°C also record the temperature. If it is necessary for them to be transferred to a different tank for weighing, they shall be jolted 25 times as described above in the new tank before weighing (Weight $A_1$ and Temp. $t_1$).

d) The basket and the aggregate shall then be removed from the water and allowed to drain for a few minutes, after which the aggregate shall be gently emptied from the basket on to one of the dry clothes, and the empty basket shall be returned to the water, jolted 25 times and weighed in water (Weight $A_2$).

e) The aggregate placed on the dry cloth shall be gently surface dried with the cloth, transferring it to the second dry cloth when the first will remove no further moisture. It shall then be spread out not more than one stone deep on the second cloth, and lest exposed to the atmosphere away from direct sunlight or any other source of heat for not less than 10 minutes, or until it appears to be completely surface dry (which with some aggregates may take an hour or more). The aggregate shall be turned over at least once during this period and a gentle current of unheated air may be used after the first ten minutes to accelerate the drying of difficult aggregates. The aggregate shall then be weighed (Weight B).

NOTE – If the apparent specific gravity only is required, the operations described in **3.2.1.3** (f) may be omitted.

f) The aggregate shall then be placed in the oven in the shallow tray, at a temperature of 100°C to 110°C and maintained at this temperature for 24 ± ½ hours. It shall then be removed from the oven, cooled in the airtight container up to $t_1 \pm 2^\circ C$ and weighed (Weight C).

**3.2.1.4** *Calculations*

Specific gravity, specific gravity based on saturated surface dry weight (*see* Note), apparent specific gravity and water absorption shall be calculated as follows:

Specific gravity based on dry aggregate (dry bulk specific gravity) = $\frac{C}{B-A}$

Specific gravity based on saturated surface dry weight (SSD bulk specific gravity) = $\frac{B}{B-A}$

Apparent specific gravity = $\frac{C}{C-A}$

Water absorption (percent of dry weight) = $\frac{100\,(B-C)}{C}$

where,

A = weight of the saturated aggregate in water ($A_1 - A_2$), in g;
B = weight of the saturated surface dry aggregate in air, in g; and
C = weight of oven dried aggregate in air, in g.

NOTE — This value of specific gravity based on SSD condition may be adopted for calculations for mix design as per IS 10262.

**3.2.1.5** *Reporting of results* – The individual and mean results shall be reported to an accuracy of 0.01, at temperature $t_1$. The size of the aggregate tested shall be stated, and whether it has been artificially heated.

**3.2.2** *Method II — Aggregate between 40 mm and 10 mm*

**3.2.2.1** *Apparatus* — The apparatus shall consist of the following:

a) *Balance* — A balance or scale of capacity not less than 3 kg, readable and accurate to 0.5 g, and of such a type as to permit the weighing of the vessel containing the aggregate and water.
b) *Oven* — A well ventilated oven, thermostatically controlled to maintain a temperature of 100°C to 110°C
c) *Glass Vessel or Jar*, referred as pycnometer — A wide-mouthed glass vessel such as a jar of minimum 1.5 litres capacity, with a flat ground lip and a plane ground disc of plate glass to cover it, giving a virtually watertight fit.
d) *Cloths* — Two dry soft absorbent cloths, each not less than 75 cm × 45 cm.
e) *Tray* — A shallow tray of area not less than 325 $cm^2$.
f) *Container* — An airtight container large enough to take the sample.
g) Thermometer having temp. range 0ºC to 50ºC readable up to 0.5º C accuracy.

**3.2.2.2** *Sample* — A sample of about one kilogram of the aggregate shall be used. Aggregate which has been artificially heated shall not normally be used; if such material is used, the fact shall be stated in the report.

Two tests shall be made, and it is recommended that the two samples should not be tested concurrently.

**3.2.2.3** *Test procedure*

a) The sample shall be screened on a 10 mm IS sieve, thoroughly washed to remove fine particles of dust, and immersed in distilled water in the glass vessel; it shall remain immersed at a temperature of 22° C to 32°C for 24 h ± 1 h. Soon after immersion and again at the end of the soaking period, air entrapped in or bubbles on the surface of the aggregate shall be removed by gentle agitation. This may be achieved by rapid clockwise and anticlockwise rotation of the vessel between the operator's hands.

b) The vessel shall be overfilled by adding distilled water and the plane ground-glass disc slid over the mouth so as to ensure that no air is trapped in the vessel. The vessel shall be dried on the outside and weighed and temp. recorded (Weight A and Temp. $t_1$).

c) The vessel shall be emptied and the aggregate allowed to drain. Refill the vessel with distilled water. Slide the glass disc in position as before. The vessel shall be dried on the outside and weighed and temp. recorded (Weight B and Temp. $t_2$).

d) The difference in the temperature of water in the vessel $t_1$ and $t_2$ during the first and second weighing shall not exceed 2°C.

e) The aggregate shall be placed on a dry cloth and gently surface dried with the cloth, transferring it to a second dry cloth when the first will remove no further moisture. It shall then be spread out not more than one stone deep on the second cloth, and left exposed to the atmosphere away from direct sunlight or any other source of heat for not less than 10 minutes or until it appears to be completely surface dry (which with some aggregates may take an hour or more) The aggregate shall be turned over at least once during this period and a gentle current of unheated air may be used after the first ten minutes to accelerate the drying of difficult aggregates. The aggregate shall then be weighed (Weight C).

NOTE– If the apparent specific gravity only is required, the operations described in **3.2.2.3**(f) may be omitted.

f) The aggregate shall be placed in the oven in the shallow tray, at a temperature of 100° C to 110° C for 24 ± ½ hours. It shall then be cooled in airtight container and weighed (Weight D).

**3.2.2.4** *Calculations* — Specific gravity, specific gravity based on saturated surface dry weight (*see* Note), apparent specific gravity and water absorption shall be calculated as follow:

Specific gravity based on dry aggregate (dry bulk specific gravity) = $\frac{D}{C-(A-B)}$

Specific gravity based on saturated surface dry weight (SSD bulk specific gravity) = $\frac{C}{C-(A-B)}$

Apparent specific gravity = $\frac{D}{D-(A-B)}$

Water absorption (percentage of dry weight) = $\frac{100(C-D)}{D}$

where,

A = weight of the vessel containing sample and filled with distilled water, in g;
B = weight of the vessel filled with distilled water only, in g;
C = weight of the saturated surface-dry sample, in g, and
D = weight of oven-dry sample, in g.

NOTE — This value of specific gravity based on SSD condition may be adopted for calculations for mix design as per IS 10262.

**3.2.2.5** *Reporting of results* – The individual and mean results shall be reported to an accuracy of 0.01 at temperature ($t_1$). The grading of aggregate tested shall be stated, and whether it has been artificially heated.

**3.2.3** *Method III — Aggregate smaller than 10 mm*

**3.2.3.1** *Apparatus* — The apparatus shall consist of the following:

a) *Balance* — A balance or scale of capacity not less than 3 kg, roadable and accurate to 0.5 g, and of such a type as to permit the weighing of the vessel containing the aggregate and water.

b) *Oven* — A well ventilated oven, thermostatically controlled, to maintain a temperature of 100°C to 110°C.
c) *Vessel* — Any form of vessel capable of holding 0.5 to 1 kg of material up to 10 mm in size and capable of being filled with water to a constant volume with an accuracy of ± 0.5 ml. Either of the two following vessels is suitable:

   1) A glass vessel, referred to later as a pycnometer, of about one litre capacity having a metal conical screw top with a 6 mm diameter hole at its apex. The screw top shall be watertight when it is screwed on to the jar, and, if necessary, a rubber or fibre washer shall be inserted in the joint. If such a washer is used, a mark shall be made on the jar to correspond with a mark on the screw top so that the screw is tightened to the same position every time and the volume contained by the jar is constant throughout the test. A suitable vessel can be made from a 1 kg fruit preserving jar in which the glass lid normally used is replaced by a sheet metal cone as shown in Fig. 1; or.

   2) A wide-mouthed glass vessel, such as a gas jar, of about 1.25 litres capacity, with a flat ground lip and a plane ground disc of plate glass to cover it, giving a virtually watertight fit.

d) A means of supplying a current of warm air, such as a hair drier.
e) A tray of area not less than 325 $cm^2$.
f) An airtight container large enough to take the sample.
g) Thermometer having temp. range 0 ° C to 50° C readable upto 0.5° C accuracy.

**3.2.3.2** *Test procedure*

a) *Using the pycnometer* — A sample of about 1 kg for 10 mm to 4.75 mm or 500 g if finer than 4.75 mm, shall be placed in the tray and covered with distilled water at a temperature of 22°C to 32°C. Soon after immersion, air entrapped in or bubbles on the surface of the aggregate shall be removed by gentle agitation with a rod. The sample shall remain immersed for 24 h ± 1 h.

   The water shall then be carefully drained from the sample, by decantation through a filter paper, any material retained being returned to the sample. The aggregate including any solid matter retained on the filter paper shall be exposed to a gentle current of warm air to evaporate surface moisture and shall be stirred at frequent intervals to ensure uniform drying until no free surface moisture can be seen and the material just attains a 'free-running' condition. Care shall be taken to ensure that this stage is not passed. The saturated and surface-dry sample shall be weighed (Weight A).

   NOTE — If the apparent specific gravity only is required, the operations described in paragraph 5 may he omitted, although for material finer than 4.75 mm some surface drying may be desirable to facilitate handling.

   The aggregate shall then be placed in the pycnometer which shall be filled with distilled water. Any trapped air shall be eliminated by rotating the pycnometer on its side, the hole in the apex of the cone being covered with a finger. The pycnometer shall be topped up with distilled water to remove any froth from the surface, so that the surface of the water in the hole is flat. The pycnometer shall be dried on the outside and weighed (Weight B) and temperature recorded (Temp. $t_1$).

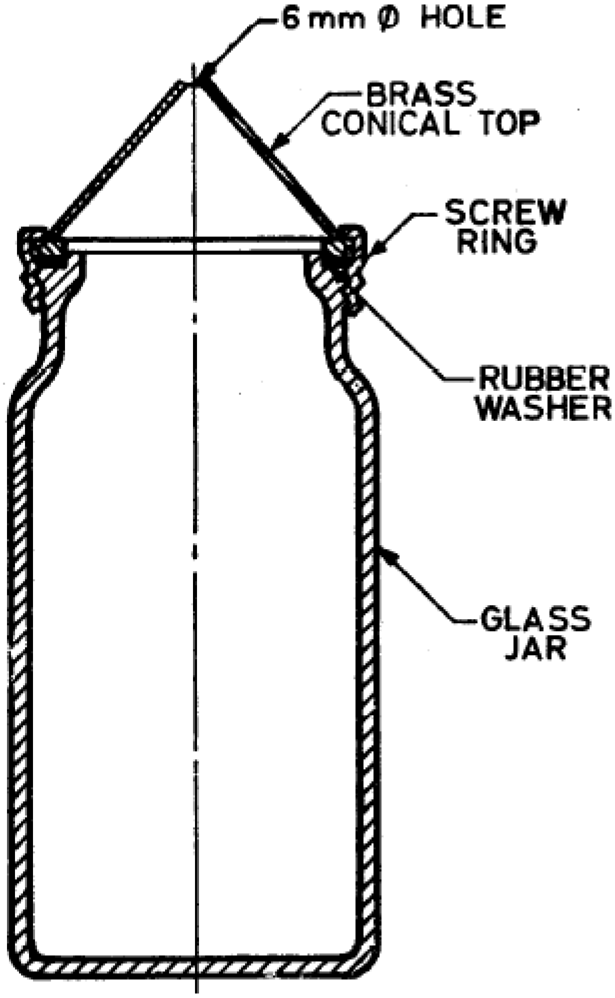


FIG.1 SECTION OF PYCNOMETER MADE FROM FRUIT JAR

The contents of the pycnometer shall be emptied into the tray, care being taken to ensure that all the aggregate is transferred. The pycnometer shall be refilled with distilled water to the same level as before, dried on the outside and weighed and temperature recorded (Weight C and Temp. $t_2$). The difference in the temperature of the water $t_1$ and $t_2$ in the pycnometer during the first and second weightings shall not exceed 2°C.

The water shall then be carefully drained from the sample by decantation through a filter paper and any material retained returned to the sample. The sample shall be placed in the oven in the tray at a temperature of 100°C to 110°C for 24±1/2 hours, during which period it shall be stirred occasionally to facilitate drying. It shall be cooled in the air-tight container and weighed (Weight D).

Two tests shall be made.

b) Using the second (glass jar) apparatus described in **3.2.3.1(c)**, the procedure shall be the same except that in filling the jar with water it shall be filled just to overflowing and the glass plate slid over it to exclude any air bubbles.

**3.2.3.3** *Calculations*

Specific gravity, specific gravity based on saturated surface dry weight (*see* Note), apparent specific gravity and water absorption shall be calculated as follows:

Specific gravity based on dry aggregate (dry bulk specific gravity) = $\frac{D}{A-(B-C)}$

Specific gravity based on saturated surface dry weight (SSD bulk specific gravity) = $\frac{A}{A-(B-C)}$

Apparent specific gravity = $\frac{D}{D-(B-C)}$

Water absorption (percentage of dry weight) = $\frac{100(A-D)}{D}$

where,

A = weight of the saturated surface-dry sample, in g;
B = weight of the pycnometer or gas jar containing sample and filled with distilled water, in g,
C = weight of the pycnometer or gas jar filled with distilled water only; and
D = weight of oven-dry sample, in g.

NOTE — This value of specific gravity based on SSD condition may be adopted for calculations for mix design as per IS 10262'

**3.2.3.4** *Reporting of results* – The individual and mean results shall be reported to an accuracy of 0.01 at temperature $t_1$ and the grading of the aggregate shall be stated.

**3.2.4** *Method IV — Alternate Method*

**3.2.4.1** When testing aggregate between 40 mm and 10 mm the procedure shall be as described in **3.2.1** substituting the bucket for the wire basket and stirring with a rod instead of jolting to remove air from the sample.

**3.2.4.2** When testing aggregate smaller than 10 mm the apparatus shall be used in the same way as above, but the sequence of operations shall be as given in **3.2.3**. After transferring the sample to the bucket, water shall be added to cover the aggregate by at least 25 mm and the sample stirred to remove air. The bucket shall then be filled with water and the level of water in the tank raised slowly to avoid, as far as possible, the loss of fine particles from the sample in the bucket to the tank.

## 4 DETERMINATION OF BULK DENSITY AND VOIDS

**4.1** This method of test covers the procedure for determining unit weight or bulk density and void of aggregates.

NOTES

**1** The bulk density is the weight of material in given volume, and for the purpose of this standard it is measured in kilograms per litre. The bulk density of an aggregate is affected by several factors, including the amount of moisture present and the amount of effort introduced in filling the measures.

**2** It is emphasized that this is a laboratory test intended for comparing properties of different aggregates. It is not generally suitable for use as a basis for quoting mix design conversion factors.

**3** Considerably more compactive effort is used in the determination of angularity number as given in **17** than in this test, and hence the values for bulk density and voids are different.

## 4.2 Apparatus

The apparatus shall consist of the following:

a) *Balance* — A balance sensitive to 0.1 percent of the weight of the sample to be weighed.

b) *Cylindrical Metal Measure* — The measure shall preferably be machined to accurate internal dimensions and shall be provided with handles. It shall also be watertight, and of sufficient rigidity to retain its form under rough usage and should be protected against corrosion.
The measure shall be of 3, 15 or 30 litres capacity, according to the maximum nominal size of the coarsest particles of aggregate and shall comply with the requirements given in Table 1.

c) *Tamping Rod* — A straight metal tamping rod of cylindrical cross-section 16 mm in diameter and 60 cm long, rounded at one end.

**Table 1 Size of Container for Bulk Density Test**
[*Clause* 4.2 (b)]

| **Sl. No.** | **Size of largest Particular** | **Nominal Capacity (litre)** | **Inside Diameter (cm)** | **Inside height (cm)** | **Thickness of metals, *Min* (mm)** |
|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) |
| i) | 4.75 mm and under | 3 | 15 | 17 | 3.15 |
| ii) | Over 4.75 mm to 40 mm | 15 | 25 | 30 | 4.00 |
| iii) | Over 40 mm | 30 | 35 | 31 | 5.00 |

**4.3 Calibration** — The measure shall be calibrated by determining the weight of water at 27 °C required to fill it such that no meniscus is present above the rim of the container. The capacity in litres shall be obtained by dividing the weight of water in kilograms required to fill the container at 27 °C by the weight of water in one litre at 27 °C, which may be taken as one kilogram.

### 4.4 Procedure

**4.4.1** *Condition of Specimen* — The test shall normally be carried out on dry material when determining the voids, but when bulking tests are required material with a given percentage of moisture may be used.

**4.4.2** *Rodded or Compacted Weight* — The measure shall be filled about one-third full with thoroughly mixed aggregate and tamped with 25 strokes of the rounded end of the tamping rod. A further similar quantity of aggregate shall be added and a further tamping of 25 strokes given. The measure shall finally be filled to over-flowing, tamped 25 times and the surplus aggregate struck off, using the tamping rod as a straightedge. The net weight of the aggregate in the measure shall be determined and the bulk density calculated in kilograms per litre.

**4.4.3** *Loose Weight* — The measure shall be filled to overflowing by means of a shovel or scoop, the aggregate being discharged from a height not exceeding 5 cm above the top of the measure. Care shall be taken to prevent, as far as possible, segregation of the particle sizes of which the sample is composed. The surface of the aggregate shall be levelled with straightedge. The net weight of the aggregate in the measure shall then be determined and the bulk density calculated in kilogram per litre.

### 4.5 Calculation of Voids

The percentage of voids shall be calculated as follows:

$$\text{Percentage of voids} = \frac{G_2-\gamma}{G_2} \times 100$$

where,
$G_2$ = specific gravity of the aggregate, and
$\gamma$ = bulk density in kg/litre

### 4.6 Reporting of Results

**4.6.1** The bulk density shall be reported in kg/litre to the nearest 0.01 kg/ltr.

**4.6.2** The voids shall be reported as a percentage to the nearest whole number.

**4.6.3** The condition of aggregate at the time of test shall be stated, that is (a) oven dry, (b) statured and surface dry, or (c) with a given percentage of moisture.

## 5 SIEVE ANALYSIS AND DETERMINATION OF FINENESS MODULUS OF AGGREGATE

**5.1** This method covers the procedure for the determination of particle size distribution of fine, coarse and all-in-aggregates by sieving or screening.

### 5.2 Apparatus

**5.2.1** *Sieves* — Sieves of the sizes given in Table 2, conforming to IS 460 (Part 1) and IS 460 (Part 2) shall be used.

**Table 2 IS Sieves for Sieve Analysis of Aggregate for Concrete**

(*Clause* 5.2.1)

| Sl. No. | Type | IS Sieve |
|---|---|---|
| (1) | (2) | (3) |
| i) | Square hole, perforated plate | 80 mm, 63 mm, 50 mm, 40 mm, 31.5 mm,<br>25 mm, 20 mm, 16 mm, 12’5 mm, 10 mm,<br>6.3 mm, 4.75 mm |
| ii) | Fine mesh, wire cloth | 3.35 mm, 2.36 mm, 1.18 mm, 600 micron, 300 micron, 150 micron, 75 micron |

**5.2.2** *Balance* — The balance or scale shall be such that it is readable and accurate to 0.1 percent of the weight of the test sample.

### 5.3 Sample

The weight of sample available shall be not less than the weight given in Table 3. The sample for sieving (*see* Table 5) shall be prepared from the larger sample either by quartering or by means of a sample divider.

**Table 3 Minimum Weights for Sampling**
(*Clause* 5.3)

| Sl. No. | Maximum Size of aggregates | Minimum weight of sample despatched for testing |
|---|---|---|
| | (mm) | (kg) |
| (1) | (2) | (3) |
| i) | 63 | 150 |
| ii) | 50 | 100 |
| iii) | 40 | 50 |
| iv) | 25 | 50 |
| v) | 20 | 25 |
| vi) | 16 | 25 |
| vii) | 12.5 | 12 |
| viii) | 10.0 | 6 |
| ix) | 6.3 | 3 |

### 5.4 Test Procedure for Coarse and Fine Aggregate

**5.4.1** The sample shall be brought to dry condition before weighing and sieving. This may be achieved either by drying at room temperature or by heating at a temperature of 100°C to 110°C. The air-dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest. Care shall be taken to ensure that the sieves are clean before use.

**5.4.2** Each sieve shall be shaken separately over a clean tray until not more than a trace passes, but in any case for a period of not less than two minutes. The shaking shall be done with a varied motion, backwards and forwards, left to right, circular clockwise and anticlockwise, and with frequent jarring, so that the material is kept moving over the sieve surface in frequently changing directions. Material shall not be forced through the sieve by hand pressure, but on sieves coarser than 20 mm, placing of particles is permitted. Lumps of fine material, if present, may be broken by gentle pressure with fingers against the side of the sieve. Light brushing with a soft brush on the under side of the sieve may be used to clear the sieve openings.

**5.4.3** Light brushing with a fine camel hair brush may be used on the 150 micron and 75 micron IS Sieves to prevent aggregation of powder and blinding of apertures. Stiff or worn out brushes shall not be used for this purpose and pressure shall not be applied to the surface of the sieve to force particles through the mesh.

**5.4.3.1** On completion of sieving, the material retained on each sieve, together with any material cleaned from the mesh, shall be weighed.

**5.4.4** In order to prevent binding of the sieve apertures by overloading, the amount of aggregate placed on each sieve shall be such that the weight of the aggregate retained on the sieve at completion of the operation is not greater than the value given for that sieve in Table 4. Sample weights given in Table 4 will thus normally require several operations on each sieve.

NOTES

1 For many routine purpose mechanical sieving is advantageous but if this method is used, care should be taken to ensure that the sieving is complete.

2 The following alternatives procedure is permissible where it is required to determine only the cumulative percentage figures:
The weighed sample shall be passed through the largest of the appropriate sieves as described above. The fraction which passes the sieve shall be weighed and then passed through the next smaller sieve, the fraction which passes shall be weighed
The cumulative weight passing each sieve shall be calculated as a percentage of the total sample weight. and

3 If sieving is carried out with a nest of sieves on a machine, not less than 10 minutes sieving will be required for each test.

### 5.5 Test Procedure for All- in-Aggregate, or Mixed Coarse and Fine Aggregates

The weight of sample available shall not be less than the weight given in Table 3. The sample for sieving (*see* Table 5) shall be prepared from the larger sample either by quartering or by means of a sample divider. It shall be brought to air-dry condition before weighing and sieving. This may be achieved either by drying at room temperature or by heating at a temperature or by heating at a temperature of 100°C to 110°C.

### Table 4 Maximum Weight to be Retained at the Completion of Sieving

(*Clauses* 5.4.4 *and* 5.5.2)

| **Sl. No.** | **Coarse Aggregate** | | | **Fine Aggregate** | |
|---|---|---|---|---|---|
| | **IS Sieve** | **Maximum Weight for** | | **IS Sieve** | **Maximum Weight for** |
| | | 45 cm dia Sieve | 30 cm dia Sieve | | 20 cm dia Sieve |
| | | (kg) | (kg) | | (g) |
| (1) | (2) | (3) | (4) | (5) | (6) |
| i) | 50 mm | 10 | 4.5 | 2.36 mm | 200 |
| ii) | 40 mm | 8 | 3.5 | 1.18 mm | 100 |
| iii) | 31.5 mm or 25 mm | 6 | 2.5 | | |
| iv) | 20 mm | 4 | 2.0 | 600 micron | 75 |
| v) | 16 mm or 12.5 mm | 3 | 1.5 | 300 micron | 50 |
| vi) | 10 mm | 2 | 1.0 | | |
| vii) | 6.3 mm | 1.5 | 0.75 | 150 micron | 40 |
| viii) | 4.75 mm | 1.0 | 0.50 | 75 micron | 25 |
| ix) | 3.35 mm | – | 0.30 | | |

### Table 5 Minimum Weight of Sample for Sieve Analysis

(*Clauses* 5.3 *and* 5.5)

| **Sl. No.** | **Maximum Size of aggregate** | **Minimum weight of sample to be taken for sieving** |
|---|---|---|
| | (mm) | (kg) |
| (1) | (2) | (3) |
| i) | 63 | 50 |
| ii) | 50 | 35 |
| iii) | 40 or 31.5 | 15 |
| iv) | 25 | 5 |
| v) | 20 or 16 | 2 |
| vi) | 12.5 | 1 |
| vii) | 10 | 0.5 |
| viii) | 6.3 | 0.2 |
| ix) | 4.75 | 0.2 |
| x) | 2.36 | 0.1 |

**5.5.1** In some cases the sieve analysis of all-in-aggregate can be carried out in accordance with the procedure given in **5.4**. Frequently, however, this will result in heavy overloading of the finer sieves. In such cases it will be necessary to make a preliminary separation of the all-in-aggregate into two fractions, coarse and fine, using for this purpose a convenient sieve for example, 3.35 mm or 4.75 mm IS Sieve.

**5.5.2** If the amount of either the coarse or fine aggregate obtained as above is substantially less than that required for testing in accordance with Table 4, another sample shall be taken which is sufficiently large to produce an adequate sample of both the coarse and the fine aggregate. If the amount of either the coarse or the fine aggregate thus obtained is substantially greater than that required for testing, it shall be reduced by quartering or by means of a sample divider.

### 5.6 Determination of Fineness Modulus of the Aggregate

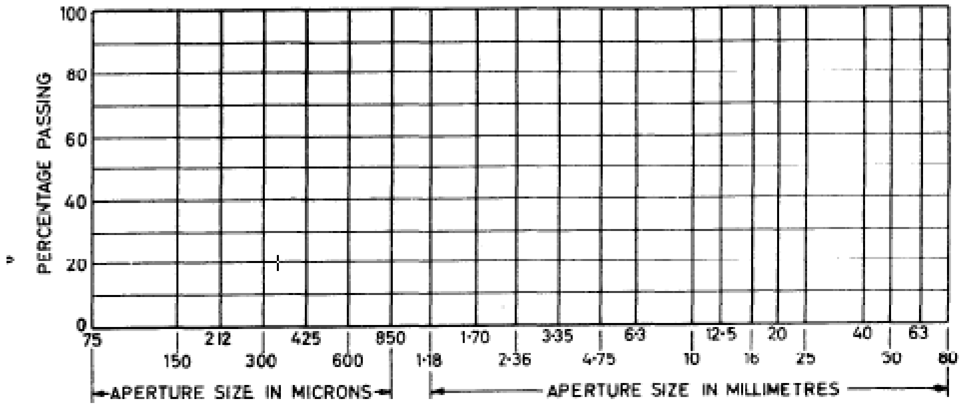
The fineness modulus (FM) is obtained by adding the total percentage of the sample of an aggregate retained on each of a specified test sieves and dividing the sum by 100.

### 5.7 Reporting of Results

The results shall be calculated and reported as:

a) the cumulative percentage by weight of the total sample passing each of the sieves, to the nearest whole number; or
b) the percentage by weight of the total sample passing one sieve and retained on the next smaller sieve, to the nearest 0.1 percent.
c) Fineness Modulus to the nearest 0.01.

**5.7.1** *Graphical Method of Recording Results* — The results of sieve analysis may be recorded graphically on the chart for recording sieve analysis shown in Fig. 2.



NOTE — The vertical scale of this chart is an arithmetic scale and the horizontal scale is logarithmic.

FIG. 2 CHART FOR RECORDING SIEVE ANALYSIS RESULTS

NOTE — It is recommended that cumulative percentage figures should be used for comparison with specification requirements, or for reporting results graphically.

## 6 DETERMINATION OF MATERIALS FINER THAN 75 MICRON

**6.1** This method of test deals with the procedure for determining the total quantity of material finer than 75 micron IS Sieve in aggregates by washing.

NOTE — Clay particles that are dispersed by wash water as well as water soluble materials will be removed from the aggregate during the test.

### 6.2 Apparatus

The apparatus shall consist of the following:

a) *Balance* — The balance or scale shall be of sufficient capacity and sensitivity (*see* **6.3.1** and **6.4.1**) and shall have an accuracy of 0.1 percent of the weight of the test sample.

b) *Sieve* — A nest of two sieves, the lower being 75 micron IS Sieve and the upper approximately 1.18 mm IS Sieve (*see* IS 460).

c) *Container* — A pan or vessel of a size sufficient to contain the sample covered with water and to permit of vigorous agitation without inadvertent loss of any part of the sample or water.

d) *Oven* — An oven of sufficient size capable of maintaining a uniform temperature of 110°C ± 5°C.

### 6.3 Sample

The test sample shall be selected from material which has been thoroughly mixed, and which contains sufficient moisture to prevent segregation. A representative sample, sufficient to yield not less than the appropriate weight of dried material, as shown in Table 6, shall be selected:

**Table 6 Minimum Weight of Representative Sample**
(*Clause* 6.3)

| **Maximum Nominal Size of Aggregate** | **Approximate Minimum Weight of Sample** |
|---|---|
| (mm) | (g) |
| (1) | (2) |
| 4.75 | 500 |
| 10.0 | 2 000 |
| 20 | 2 500 |
| 40 or over | 5 000 |

### 6.4 Procedure

**6.4.1** The test sample shall be dried to constant weight at a temperature of 110°C ± 5°C and weighed to the nearest 0.1 percent.

**6.4.2** The test sample after being dried and weighed shall be placed in the container and sufficient water added to cover it. The contents of the container shall be agitated vigorously.

**6.4.3** The agitation shall be sufficiently vigorous to result in the complete separation from the coarse particles of all particles finer than 75 micron and bring the fine material into suspension. Care shall be taken to avoid, as much as possible, the decantation of the coarse particles of the sample. The operation shall be repeated until the wash water is clear.

**6.4.4** The wash water containing the suspended and dissolved solids shall be immediately poured over the nested sieves arranged with the coarser sieve on the top.

**6.4.5** All material retained on the nested sieves shall be returned to the washed sample. The washed aggregate shall be dried to constant weight at a temperature not exceeding 110°C and weighed to the nearest 0.1 percent such that two successive weights after 2 h of further drying do not differ by 0.1 percent.

### 6.5 Calculation

The amount of material passing the 75 micron IS Sieve shall be calculated as follows:

$$A = \frac{B - C}{B} \times 100$$

where,

$A$ = percentage of material finer than 75 micron
$B$ = original dry weight, and
$C$ = dry weight after washing.

### 6.6 Reporting of Results

The results shall be calculated and reported to nearest 0.1 percent.

## 7 DETERMINATION OF SAND EQUIVALENT VALUE

**7.1** This test covers the method for the determination of sand equivalent value of fine aggregate. This indicates, under standard conditions, the relative proportions of fine aggregate like clay or plastic fines and dusts that pass 4.75 mm IS Sieve. This method is intended to serve as a rapid field-correlation test.

### 7.2 General Precautions

**7.2.1** Maintain the temperature of the working solution at 27°C ± 3°C during the performance of this test.

**7.2.1.1** If field conditions preclude the maintenance of the temperature range, frequent referee samples should be submitted to a laboratory where proper temperature control is possible. It is also possible to establish temperature correction curves for each material being tested where proper temperature control is not possible. However, no general correction curve should be utilized for several materials even within a narrow range of sand equivalent values. Samples that meet the minimum sand equivalent requirement at a working solution temperature below the recommended range need not be subjected to referee testing.

**7.2.2** Perform the test at a location free from vibration.  Excessive vibration may cause the suspended material to settle at a greater rate than normal.

**7.2.3** Do not expose the plastic cylinders to direct sunlight any more than is necessary.

**7.2.4** Occasionally it may be necessary to remove a fungus growth from the working calcium chloride solution container and from the inside of the flexible tubing and irrigator tube. This fungus can easily be seen as a slimy substance in the solution.

**7.2.4.1** To remove this growth, prepare a cleaning solvent by diluting sodium hypochlorite solution (household chlorine bleach) with an equal quantity of water.

**7.2.4.2** Fill the solution container with the prepared cleaning solvent, allow about 1 litre of the cleaning solvent to flow through the siphon assembly and irrigator tube, then place the pinch clamp on the end of the tubing to cut off the flow of solvent and to hold the solvent in the tube. Refill the container and allow to stand overnight.

**7.2.4.3** After soaking, allow the cleaning solvent to flow out through the siphon assembly and irrigator tube.

**7.2.4.4** Remove the siphon assembly from the solution container and rinse both with clear water. The irrigator tube and siphon assembly can be rinsed easily by attaching a hose between the tip of the irrigator tube and water faucet and backwashing fresh water through the tube.

**7.2.5** Occasionally the holes in the tip of the irrigator tube may become clogged by a particle of sand. If the obstruction cannot be freed by any other method, use a pin or other sharp object to force it out using extreme care not to enlarge the size of the opening.

### 7.3 Apparatus

**7.3.1** Graduated cylinder of transparent acrylic plastic as shown in Fig. 3 having an inside diameter of 32 mm, a height of 430 mm, graduations up to 380 mm at 2 mm intervals, beginning at the bottom, and a rubber stopper to fit in mouth of the cylinder.

**7.3.2** Irrigator tube as shown in Fig. 3, made of 6.4 mm outside diameter stainless steel tubing with one end closed to form a wedge-shaped point. Two holes of 1 mm diameter are drilled laterally through the flat side of the wedge near the point.

**7.3.3** Siphon assembly as shown in Fig. 3, consisting of a 4 litre bottle, a 5 mm outside diameter copper bent tube 410 mm long, 1 220 mm of 3 mm inside diameter rubber tubing (pure gum or equal) with pinch clamp, a blow tube consisting of 50 mm of

5 mm diameter copper tube and 50 mm of 3 mm inside diameter rubber tube (blow hose), and a 2 hole rubber stopper to fit the graduated cylinder specified in **7.3.1.**

**7.3.4** Weighted foot assembly as shown in Figure 3, consisting of a 6 mm diameter brass rod 445 mm long, threaded on both ends, a brass hexagonal foot of 17.5 mm side by 14 mm diameter, a cylindrical weight of 50 mm diameter and 53 mm height of cold-rolled steel and a nylon sand reading indicator of 28 mm diameter and 15 mm height. The weight is attached to the top end of the rod to give the assembly of the weight, rod and foot a total mass of 1 000 g ± 5 g. The foot is attached to the lower end of the rod.

**7.3.5** *Measuring Can* — 90 ± 5 ml capacity.

**7.3.6** Sieve 4.75 mm IS Sieve, conforming to IS 460 (Part 1).

**7.3.7** *Funnel* — wide mouth, for transferring soil into the cylinder.

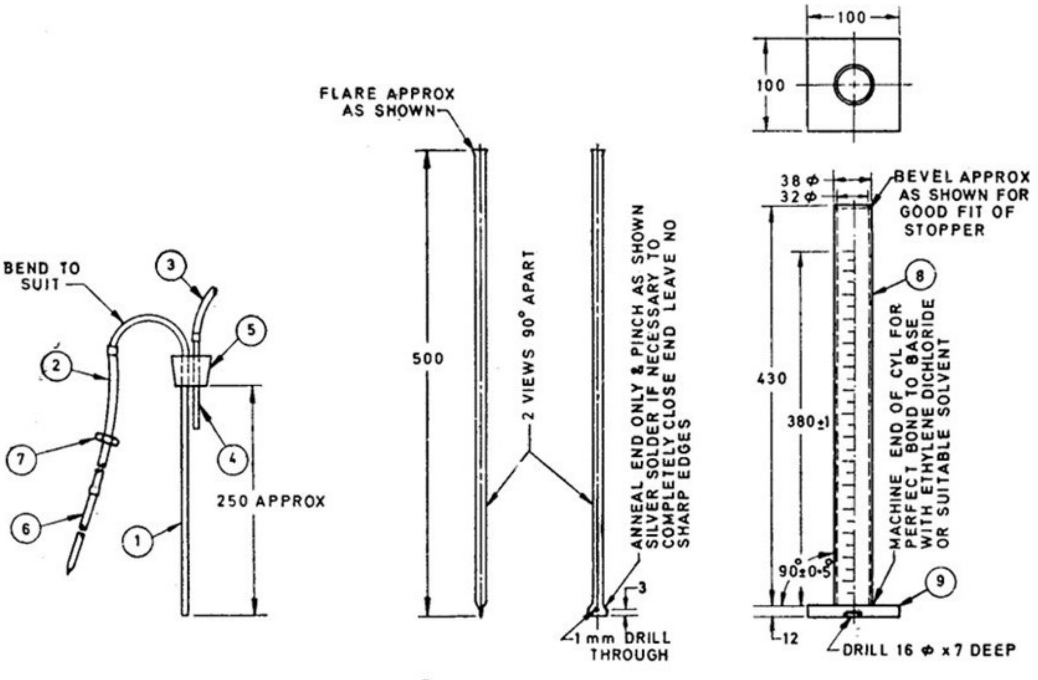
**7.3.8** *4-Litre bottles* — two, to store stock solution and working solution.

**7.3.9** *Flat pan* — for mixing.

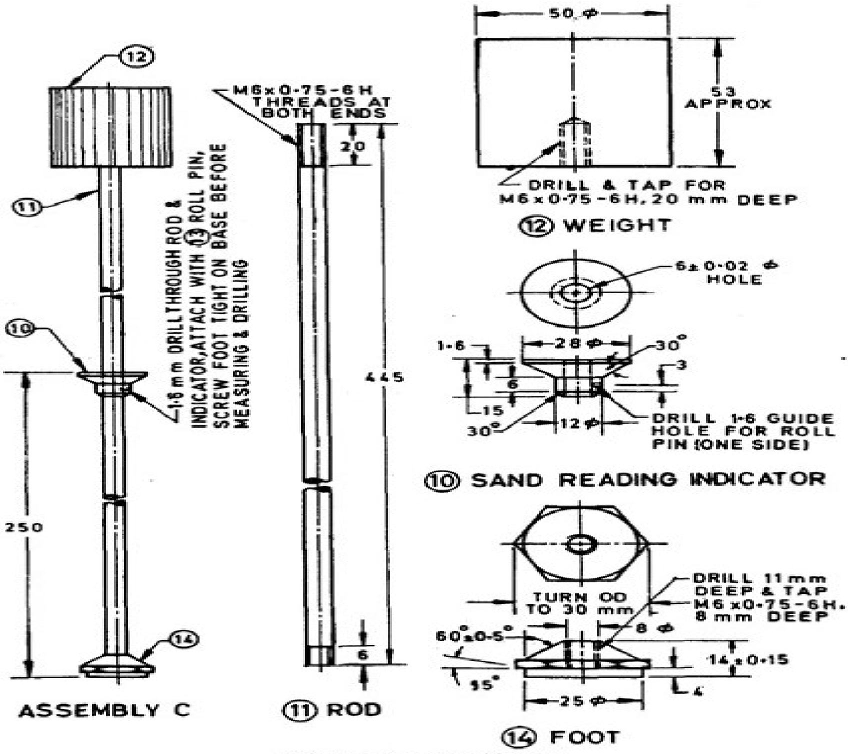
**7.3.10** *Timing device* — reading in minutes and seconds.

**7.3.11** *Sand Equivalent Shaker* — mechanical or manually operated.

**7.3.11.1** *Mechanical* — having a throw of 200 mm ± 1 mm and operating at 175 ± 2 cycles per minute



All dimensions in millimetres.



All dimensions in millimetres.

FIG. 3 SAND EQUIVALENT TEST APPARATUS

**Table 7 Material Used for Sand Equivalent Test Apparatus**
(*Clause* 7.4)

| List of materials | | | | |
|---|---|---|---|---|
| **Assembly** | **Part No.** | **Description** | **Stock Size, mm** | **Material** |
| (1) | (2) | (3) | (4) | (5) |
| **A** | **Siphon Assembly** | | | |
| | 1 | Siphon Tube | 5 diameter, 410 length | Copper tube (may be plated) |
| | 2 | Siphon hose | 3 1D, 1 220 length | Rubber tube, pure gum or equivalent |
| | 3 | Blow hose | 3 1D, 50 length | Rubber tube, pure gum or equivalent |
| | 4 | Blow tube | 5 diameter, 50 length | Copper tube (may be plated) |
| | 5 | 2-hole stopper | To fit 4 litres bottle | Rubber |
| | 6 | Irrigator tube | 6.4 OD wall, 500 length | Stainless steel tube |
| | 7 | Clamp | A suitable pinchcock | - |
| **B** | **Graduate Assembly** | | | |
| | 8 | Tube | 38 OD, 450 Length | Transparent acrylic plastic |

| | | | | |
|---|---|---|---|---|
| | 9 | Base | 12 X 100 X 100 | Transparent acrylic plastic |
| **C** | **Weighted Foot Assembly** | | | |
| | 10 | Sand reading indicator | 28 diameter, 15 height | Nylon |
| | 11 | Rod | 6 diameter,445 height | Brass (May be plated) |
| | 12 | Weight | 50 diameter, 53 height | Cold rolled steel (may be plated) |
| | 13 | Roll pin | 1.6 diameter, 12 height | Corrosion-resistant metal |
| | 14 | Foot | 17.5 hex, 14 height | Brass (may be plated) |
| | 15 | Solid stopper | To suit graduated cylinder | Rubber |

NOTE

**1** Assembly C — weighted foot assembly should weigh 1 000 ± 5 g.

**2** Graduations on graduate to be in mm. Centimetre marks should be numerically designated.

**3** Accuracy of scale — ± 0.02 mm

**7.3.11.2** Manually Operated capable of producing an oscillating motion at a rate of 100 complete cycles in 45 ± 5 seconds, with a hand-assisted half stroke length of 125 + 5 mm.

**7.4 Materials**

**7.4.1** Stock Calcium Chloride Solution The materials listed below will be required (also see Table 7).

a) 480.4 g of technical grade anhydrous calcium chloride conforming to IS 1314.
b) 2179 g of glycerine (technical grade) conforming to IS 1796.
c) 49.7 g of formaldehyde (40 percent by volume solution) conforming to IS 3321.

**7.4.1.1** Dissolve the 480.4 g of calcium chloride in 2 litres of distilled water. Cool and filter through ready pleated rapid filtering filter paper. Add 2 179 g of glycerine and the 49.7 g of formaldehyde to the filtered solution, mix well and dilute to 4 litres.

**7.4.2** Prepare the working calcium chloride solution by diluting 90 ml of the stock calcium chloride solution to 4 litres with water. Use distilled or demineralized water for the normal preparation of the working solution. However, if it is determined that the local tap water is of such purity that it does not affect the test results, it is permissible to use it instead of distilled or demineralized water.

NOTE — The effect of local tap water on sand equivalent test results may be determined by comparing the results of three sand equivalent tests using distilled water with the results of three sand equivalent tests using the local tap water. The six test specimens required for this comparison shall be prepared from the same sample of material and oven-dried as prescribed in this method.

### 7.5 Sample Preparation

**7.5.1** Obtain at least 1 500 g of material passing 4.75 mm IS Sieve in the manner specified below.

**7.5.1.1** Separate the sample on the 4.75 mm IS Sieve by means of a lateral and vertical motion of the sieve, accompanied by a jarring action so as to keep the sample moving continuously over the surface of the sieve. Continue the sieving until not more than one percent by mass of the residue passes the sieve during one minute. The sieving operation may be performed either by hand or by a mechanical apparatus. When thoroughness of mechanical sieving is being determined, test by the hand method described above using a single layer of material on the sieve.

**7.5.1.2** Breakdown any lumps of material in the coarse fraction to pass the 4.75 mm IS Sieve. A mortar and rubber-covered pestle or any other means that will not cause appreciable degradation of the aggregate may be used.

**7.5.1.3** Remove any coatings of fines adhering to the coarse aggregate. These fines may be removed by surface-drying the coarse aggregate, then rubbing between the hands over a flat pan.

**7.5.1.4** Add the material passing the sieve as obtained in **7.5.1.2** and **7.5.1.3** to the separated fine portion of the sample.

**7.5.2** Prepare test specimens from the material passing 4.75 mm IS Sieve portion of the sample by the procedure described in either **7.5.2.1** or **7.5.2.2**.

> NOTE — Experiments show that as the amount of material being reduced by splitting or quartering is decreased, the accuracy of providing representative portions is decreased. For this reason, it is imperative that extreme care be exercised when preparing the test specimens.

**7.5.2.1** Split or quarter enough material to fill four can measures to the brim or slightly rounded above the brim in the manner specified below.

a) If it appears necessary, dampen the material to avoid segregation or loss of fines during the splitting or quartering operations. Use care in adding water to the sample to retain a free-flowing condition of the material.

b) Using the measuring can, dip out four of these measures from the sample. Each time a measure full of the material is dipped from the sample, tap the bottom edge of the measure on a work table or other hard surface at least four times and jog it slightly to produce a measure of consolidated material level (full or slightly rounded) above the brim.

c) Determine and record the amount of material contained in these four measures either by mass or by volume in a dry plastic cylinder.

d) Return this material back to the sample and proceed to split or quarter the material making the necessary adjustments to obtain this predetermined mass or volume. When this mass or volume is obtained, two successive splitting or quartering operations without adjustment should provide the proper amount of material to fill the measure.

e) Dry each test specimen to constant mass at 105°C ± 5°C and cool to room temperature before testing.

NOTE – Sand equivalent results on test specimens that have not been dried will generally be lower than the results obtained on identical test specimens that have been dried. As a time-saving expedient, it is permissible to test most materials without drying when the sand equivalent value is used to determine compliance with a specification giving a minimum acceptable test value. If the resulting test value is lower than that specified, however, it will be necessary to rerun the test on a dried test specimen. If the sand equivalent, determined from a test on one dried test specimen, is below the minimum specification limit, it will be necessary to perform two additional tests on dried test specimens from the same sample. The sand equivalent for a sample shall be determined in accordance with clause **7.8**

**7.5.2.2** Prepare the desired number of test specimens from the sample as follows.

a) Maintaining a free-flowing condition, dampen the material sufficiently to prevent segregation or loss of fines.

b) Split or quarter out 1 000 to 1 500 g of the material. Mix thoroughly with a hand trowel in a circular pan by scoping toward the middle of the pan while rotating it horizontally. Mixing or remixing should be continued for at least 1 minute to achieve uniformity. Check the material for the necessary moisture condition by tightly squeezing a small portion of the thoroughly mixed sample in the palm of the hand. If a cast is formed that permits careful handling without breaking, the correct moisture range has been obtained. If the material is too dry, the cast will crumble, and it will be necessary to add water and remix and retest until the material forms a cast. If the material shows any free water, it is too wet to test and should be drained and air-dried, mixing it frequently to ensure uniformity. This overly wet material will form a good cast when checked initially, so the drying process should continue until a squeeze check on the drying material gives a cast which is more fragile and delicate to handle than the original. If the ‘as received’ water content is within the limits described above, the sample may be run immediately. If the water content is altered to meet these limits, the sample should be put in a pan, covered with a lid or with a damp trowel that does not touch the material, and allowed to stand for a minimum of 15 minutes.

c) After the minimum curing time, remix for 1 minute without water. When thoroughly mixed, form the material into a cone with a trowel.

d) Take the can measure in one hand and push it directly through the base of the pile while holding the free hand firmly against the pile opposite the measure.

e) As the can travels through the pile and emerges, apply enough hand pressure to cause the material to fill the can to overflowing. Press firmly with the palm of the hand, compacting the material until it consolidates in the can. The excess material should be struck off level with the top of the can, moving the edge of the trowel in a sawing motion across the brim.

f) To obtain additional test specimens, repeat the procedures in **7.5.2.2**(c) to **7.5.2.2**(e).

### 7.6 Preparation of Apparatus

**7.6.1** Fit the siphon assembly to a 4 litres bottle of working calcium chloride solution. Place the bottle on a shelf 915 mm ± 25 mm above the work surface.

NOTE — Instead of the 4 litre bottle, a glass or plastic vat having a larger capacity may be used provided the liquid level of the working solution is maintained between 915 mm and 115 mm above the work surface.

**7.6.2** Start the siphon by blowing into the top of the solution bottle through a short piece of tubing while the pinch clamp is open.

**7.6.3** When using either the mechanical or the manually operated sand equivalent shaker, fasten the apparatus to a firm and level mount.

NOTE — If only a few sand equivalent tests are to be performed at one location, it is possible to hold the manually operated shaker by hand on a firm mount.

### 7.7 Procedure

**7.7.1** Siphon 100 mm + 2 mm (indicated on the graduated cylinder) of working calcium chloride solution into the graduated cylinder.

**7.7.2** Pour one of the test specimens into the graduated cylinder using the funnel to avoid spillage.

**7.7.3** Tap the bottom of the cylinder sharply on the palm of the hand several times to release air bubbles and to promote thorough wetting of the specimen.

**7.7.4** Allow the wetted specimen and cylinder to stand undisturbed for 10 min ± 1 min.

**7.7.5** At the end of the 10 minute soaking period, stopper the cylinder; then loosen the material from the bottom by partially inverting the cylinder and shaking it simultaneously.

**7.7.6** After loosening the material from the bottom of the cylinder, shake the cylinder and contents by any one of the following three methods.

**7.7.6.1** Mechanical Shaker Method Place the stoppered cylinder in the mechanical sand equivalent shaker, set the time, and allow the machine to shake the cylinder and the contents for 45 sec ± 1 sec.

**7.7.6.2** Manual Shaker Method Secure the stoppered cylinder to the shaker and shake for 100 strokes, with half stroke length of 125 mm ± 5 mm.

**7.7.6.3** *Hand method*

a) Hold the cylinder in a horizontal position and shake it vigorously in a horizontal linear motion from end to end.

b) Shake the cylinder 90 cycles in approximately 30 seconds using a throw of 230 mm ± 25 mm. A cycle is defined as a complete back and forth motion. To shake the cylinder at this speed properly, it will be necessary for the operator to shake with the forearms only, relaxing the body and shoulders.

**7.7.7** Following the shaking operation, set the cylinder upright on the work table and remove the stopper.

**7.7.8** *Irrigation Procedure*

**7.7.8.1** During the irrigation procedure, keep the cylinder vertical and the base in contact with the work surface. Insert the irrigator tube in the top of the cylinder, remove the spring clamp from the hose, and rinse the material from the cylinder walls as the irrigator is lowered. Force the irrigator through the material to the bottom of the cylinder by applying a gentle stabbing and twisting action while the working solution flows from the irrigator tip. This flushes the fine material into suspension above the coarser sand particles.

**7.7.8.2** Continue to apply a stabbing and twisting action while flushing the fines upward until the cylinder is filled to the 380 mm graduation. Then raise the irrigator tube slowly without shutting off the flow so that the liquid level is maintained at about the 380 mm graduation while the irrigator tube is being withdrawn. Regulate the flow just before the irrigator tube is entirely withdrawn and adjust the final level to the 380 mm graduation.

**7.7.9** Allow the cylinder and contents to stand undisturbed for 20 min ± 15 sec. Start the timing immediately after withdrawing the irrigator tube.

**7.7.10** At the end of the 20 minute sedimentation period, read and record the level of the top of the clay suspension as prescribed in **7.7.12**. This is referred to as the ‘clay reading’. If no clear line of demarcation has formed at the end of the specified 20 minute sedimentation period, allow the sample to stand undisturbed until a clay reading can be obtained; then immediately read and record the level of the top of the clay suspension and the total sedimentation time. If the total sedimentation time exceeds 30 minutes, rerun the test using three individual specimens of the same material. Record the clay column height for the sample requiring the shortest sedimentation period as the clay reading.

**7.7.11** *Sand Reading Determination*

**7.7.11.1** After the clay reading has been taken, place the weighted foot assembly over the cylinder and gently lower the assembly until it comes to rest on the sand. Do not allow the indicator to hit the mouth of the cylinder as the assembly is being lowered.

**7.7.11.2** As the weighted foot comes to rest on the sand, tip the assembly towards the graduations on the cylinder until the indicator touches the in-side of the cylinder. Subtract 250 mm from the level indicated by the extreme top edge of the indicator and record this value as the 'sand reading'.

**7.7.11.3** When taking the sand reading, take care not to press down on the weighted foot assembly since this could give an erroneous reading.

**7.7.12** If clay or sand readings fall between 2 mm graduations, record the level of the higher graduation as the reading.

### 7.8 Calculations

**7.8.1** Calculate the sand equivalent (SE) to the nearest 0.1 using the following formula:

$SE = (S_r/C_r) \times 100$
where $S_r$= sand reading (see **7.7.11**)
$C_r$= clay reading (see **7.7.11**)

**7.8.2** When the result of this calculation is not a whole number, the sand equivalent (SE) shall be the next higher whole number.

Example: $SE = (84/204) \times 100 = 41.2 = 42$

## 8 DETERMINATION OF THE METHYLENE BLUE VALUE

### 8.1 Objective

The purpose of this standard is to identify the presence of harmful clays and organic matter present in fine aggregate of the 75 µm passing material and to provide an indication of the surface activity of the aggregate. A high methylene blue value indicates a large amount of clay or organic material present in the sample.

### 8.2 Principle

Increments of a solution of methylene blue are added successively to a suspension of the test portion (material finer than 75µm) in water. The adsorption of dye solution by the test portion is checked after each addition of solution by carrying out a stain test on filter paper to detect the presence of free dye. When the presence of free dye is confirmed the methylene blue value (MB) is calculated and expressed as grams of dye adsorbed per kilogram of the size fraction tested.

### 8.3 Reagents

**8.3.1** Methylene blue, reagent grade and stored for no more than four months in a brown bottle wrapped with foil in a dark cabinet at lab temperature.

Note — One gram of Methylene blue is dissolved in enough distilled water to produce 200 ml of solution, with each 1 ml of solution containing 5 mg of Methylene blue.

**8.3.2** *Distilled or Demineralized Water*

### 8.4 Apparatus

a) Burette of at least 50 ml capacity with 0.1 ml graduations.
b) Suitable stirrer/Magnetic mixer with stir bar.
c) Balance, accurate to 0.01 g.
d) Glass rod of approximately 250 mm (10 in.) length and approximately 8 mm (0.3 in.) diameter.
e) Timer or stopwatch.
f) Test sieve, 75 µ with guard sieve.
g) Volumetric flask of 1 000 ml capacity.
h) Whatman No. 40/42 filter paper of 8 µm retention
j) Three 500 ml beakers.
k) Oven capable of maintaining a temperature of 110°C ± 5°C.

### 8.5 Preparation of test portions

This test shall be performed on a sample of material passing the 75 µm test sieve, taken from the washed portion of a representative sample of individual or combined material (as required). The material shall be washed through the 75 µm sieve and collected in a clean container. Material transferred to a smaller container and dried for testing. The collected material is mixed thoroughly prior to testing. The minimum oven-dry mass of the collected material shall be at least 30 g to ensure enough material for a possible retest.

### 8.6 Procedure

a) Place 10.0 g (± 0.05 g) of the material as prepared above in a 500 ml beaker.
b) Add 30 ml of distilled water and stir with the mixer to make a slurry.
c) With the slurry still mixing, fill the burette with the methylene blue solution, add 0.5 ml of the solution to the slurry, and stir for 1 min.
d) Remove a drop of the slurry, using the glass stirring rod, and place on the filter paper.
e) Observe the appearance of the drop on the filter paper. The end point is indicated by the formation of a light blue halo around the drop. Continue adding the Methylene Blue solution to the slurry in 0.5 ml increments stirring for 1 min after each addition, then testing, until the end point is reached. Record the total volume of dye solution V1 added to produce a halo that persists for 5 min, to the nearest 1 ml.

### 8.7 Calculation and expression of results

The methylene blue value, MB, expressed in grams of dye per kilogram of the 0 µm to 75 µm, fraction is given by the following equation:

$$MB = CV/W$$

where,
MB = methylene blue value to the nearest 0.1 gm/kg

C = mg of methylene blue per ml of solution.
V = methylene blue solution required for titration in ml

### 8.8 Reporting

a) Identification and source of fine aggregate (if provided).
b) Methylene blue value to nearest 0.1 g/kg

## 9 DETERMINATION OF COMBINED FLAKINESS INDEX AND ELONGATION INDEX

### 9.1 Determination of Flakiness Index

**9.1.1** *Objective*

This method of test lays down the procedure for determining the flakiness index of coarse aggregate.

NOTE — The flakiness index of an aggregate is the percentage by weight of particles in it whose least dimension (thickness) is less than three-fifths of their mean dimension. The test is not applicable to sizes smaller than 6.3 mm.

**9.1.2** *Apparatus*

The apparatus shall consist of the following:

a) *Balance* — The balance shall be of sufficient capacity and shall have an accuracy of 0.1 percent of the weight of the test sample.
b) *Metal Gauge* — The metal thickness gauge shall be of the pattern shown in Fig. 4 with elongated slots of dimensions indicated in Fig. 4 the tolerance on dimensions shall be ± 0.20 mm for dimensions equal to or more than 50 mm and ± 0.10 mm for dimensions less than 50 mm.
c) *Sieves* — IS Sieves of sizes shown in Table 8**.**

**9.1.3** *Sample*

A quantity of aggregate shall be taken sufficient to provide the minimum number of 200 pieces of any fraction to be tested.

**9.1.4** *Procedure*

**9.1.4.1** *Sieving* — The sample shall be sieved in accordance with the sieves specified in Table 8.

**9.1.4.2** *Separation of flaky material* — Each fraction shall be gauged in turn for thickness on a metal gauge of the pattern shown in Fig. 4 or in bulk on sieves having elongated slots. The width of the slot used in the gauge or sieve shall be of the dimensions specified in col 3 of Table 8 for the appropriate size of material.

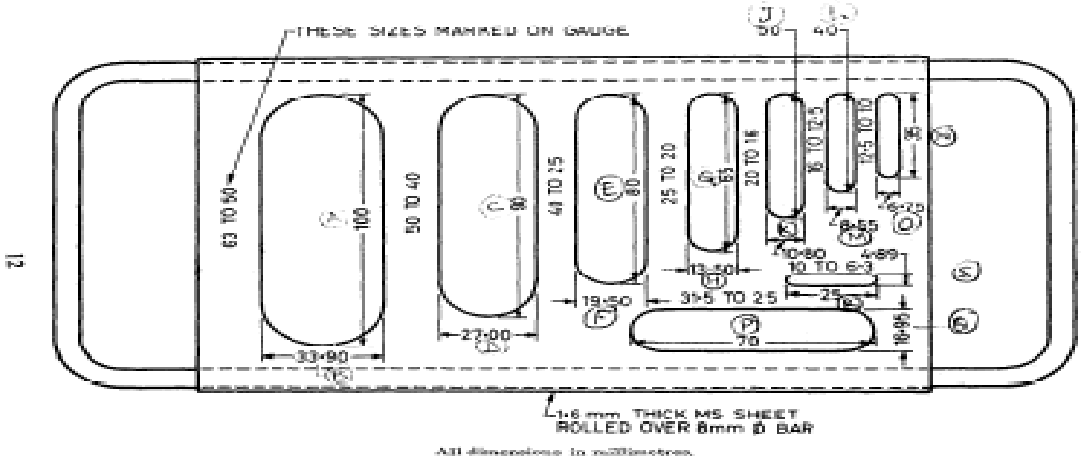


FIG. 4 THICKNESS GAUGE

(As per amendment no. 2 in Fig. 4 –substitute 40 to 31.5 for 40 to 25)
(As per amendment no 3 – substitute 21.50 for 19.50.)

**Table 8 Dimensions of Thickness and Length Gauges According to Sieve Sizes to be Used in Determination of Flakiness Index and Elongation Index**
(*Clauses* 9.1.4 *and* 9.2.4)

| Sl. No. | Size of Aggregate | | Thickness Gauge* | Length Gauge$ |
|---|---|---|---|---|
| | Passing Through IS Sieve | Retained on IS Sieve | | |
| (1) | (2) | (3) | (4) | (5) |
| i) | 63 mm | 50 mm | 33.90 | – |
| ii) | 50 mm | 40 mm | 27.00 | 81.0 |
| iii) | 40 mm | 31.5 mm | 21.50 | 64.4 |
| iv) | 31.5 mm | 25 mm | 16.95 | – |
| v) | 25 mm | 20 mm | 13.50 | 40.5 |
| vi) | 20 mm | 16 mm | 10.80 | 32.4 |
| vii) | 16 mm | 12.5mm | 8.55 | 25.6 |
| viii) | 12.5 mm | 10 mm | 6.75 | 20.2 |
| ix) | 10 mm | 6.3 mm | 4.89 | 14.7 |

NOTES

* This dimension is equal to 0.6 times the mean sieve size
$ This dimension is equal to 1.8 times the mean sieve size.

**9.1.4.3** The number of pieces passing the appropriate gauge in each size fraction shall be counted separately. The total mass of each size fraction of the sample also shall be determined**.**

**9.1.5** *Calculation and Reporting of Results*

**9.1.5.1** The mass of pieces passing the appropriate gauge in each sieve fraction shall be calculated as a percentage of mass of the total number of pieces selected in each / fraction (x). The mass of total number of pieces in each sieve shall then be calculated as a percentage of the total mass of the whole sample that is the sample which is retained on 6.3 mm sieve (y). The weighted percentage of the mass of the pieces passing the appropriate gauge in each sieve fraction shall then be calculated by multiplying ‘x’ by ‘y’.

**9.1.5.2** The flakiness index shall be expressed as the sum of weighted percentages of the material passing the appropriate gauge in each sieve fraction.

### 9.2 Determination of Elongation Index

**9.2.1** *Objective*

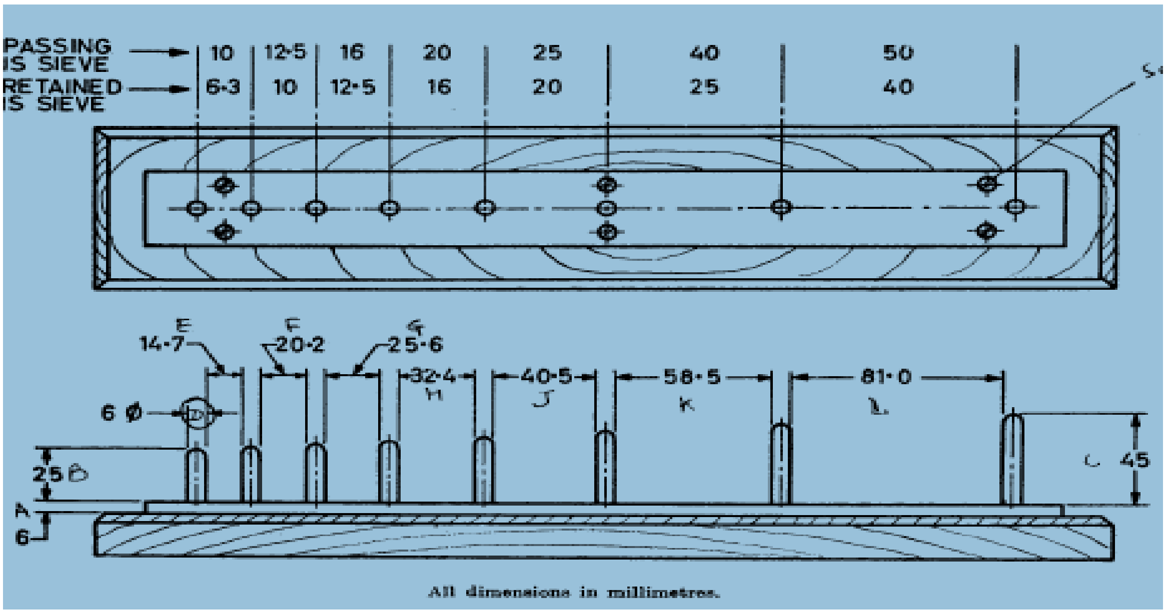
This method of test lays down the procedure for determining the elongation index of coarse aggregate.

NOTE — The elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than one and four fifth times their mean dimension. The test is not applicable to sizes smaller than 6.3 mm.

**9.2.2** *Apparatus*

The apparatus shall consist of the following:

a) *Balance* — The balance shall be of sufficient capacity and shall have an accuracy of 0.1 percent of the weight of the test sample.
b) *Metal Gauge* — The metal length gauge shall be of the pattern shown in Fig.5 with elongated slots of dimensions indicated in Fig.5. The tolerance on dimensions shall be ± 0.20 mm for dimensions equal to or more than 50 mm and ± 0.10 mm for dimensions less than 50 mm.
c) *Sieves* — IS Sieves of sizes shown in Table 8**.**



All dimensions in millimetres.

FIG. 5 LENGTH GAUGE

(‘64.4’ has been substituted for ’58.5’ based on amendment).

**9.2.3** *Sample*

A quantity of aggregate shall be taken sufficient to provide the minimum number of 200 pieces of any fraction to be tested.

**9.2.4** *Procedure*

**9.2.4.1** *Sieving* — The sample shall be sieved in accordance with the sieves specified in Table 8.

**9.2.4.2** *Separation of elongated material* — Each fraction shall be gauged in length gauge of the pattern shown in Fig. 5 or in bulk on sieves having elongated slots. The length of the slot used in the gauge or sieve shall be of the dimensions specified in col 4 of Table 8 for the appropriate size of material.

**9.2.4.3** The number of pieces passing the appropriate gauge in each size fraction shall be counted separately. The total mass of each size fraction of the sample also shall be determined**.**

**9.2.5** *Calculation and Reporting of Results*

**9.2.5.1** The mass of pieces retained on the appropriate gauge in each sieve fraction shall be calculated as a percentage of mass of the total number of pieces selected in each / fraction (x). The mass of total number of pieces in each sieve shall then be calculated as a percentage of the total mass of the whole sample that is the sample which is retained on 6.3 mm sieve (y). The weighted percentage of the mass of the pieces passing the appropriate gauge in each sieve fraction shall then be calculated by multiplying ‘x’ by ‘y’.

**9.2.5.2** The elongation index shall be expressed as the sum of weighted percentages of the material passing the appropriate gauge in each sieve fraction.

### 9.3 Determination of Combined Flakiness and Elongation Index

After carrying out the flakiness index test, the flaky material shall be removed from sample and the remaining portion shall be used for carrying out elongation index. Indices so worked out shall be added numerically to give combined flakiness and elongation index.

NOTE — For individual testing, the sample sizes shall be as per **9.1.3** and **9.2.3** shall be chosen, but for determination of combined flakiness and elongation index, sample size shall be such that a minimum of 300 for each test shall be available.

## 10 DETERMINATION OF SHELL CONTENT

### 10.1 Objective

This method of test describes the procedure for the determination of the shell content of coarse aggregate.

### 10.2 Apparatus

a) A sample divider, of size appropriate to the maximum particle size to be handled or alternatively a flat shovel and a clean, flat, hard horizontal surface, for example a metal tray for use in quartering.
b) A ventilated oven, thermostatically controlled to maintain a temperature of 105 ºC ± 5 ºC.
c) A balance, of suitable capacity accurate to 0.1 percent of the mass of the test portion.
d) IS sieves, with aperture sizes of 10.0 mm and 4.75 mm.

### 10.3 Preparation of Test Portion

Reduce the sample to produce a test portion that complies with Table 9. Dry the test portion by heating at a temperature of 105ºC ± 5ºC to achieve a dry mass with two successive weight of mass (in hot condition) after 2 hours of further drying do not differ by more than 0.1 percent of the previous mass. Which is constant to within 0.1 percent. Allow to cool and weigh.

**Table 9 Minimum Mass of Test Portion**
(*Clause* 10.3)

| **Sl. No.** | **Nominal Size of Material,** (mm) | **Minimum Mass of Test Portion,** (kg) |
|---|---|---|
| (1) | (2) | (3) |
| i) | 63 | 50 |
| ii) | 50 | 35 |
| iii) | 40 | 15 |
| iv) | 25 | 5 |
| v) | 20 | 2 |
| vi) | 12.5 | 1 |
| vii) | 10 | 0.5 |

### 10.4 Procedure

**10.4.1** Separate the test sample into test fractions by sieving through 10.0 mm and 4.75 mm test sieves, ensuring that the sieves are not overloaded. Weigh the fraction retained on the 10.0 mm test sieve to the nearest gram and record as mass M1. Similarly weigh the fraction retained on the 4.75 mm test sieve and record as mass M2. Discard any aggregate passing the 4.75 mm test sieve.

**10.4.2** Spread each fraction, separately, on a clean, dark surface and separate out any shells or shell fragments by hand picking under a good light. Weigh the total shell content in each fraction to the nearest gram and record as m1 and m2.

### 10.5 Calculation and expression of results

Calculate the value of the shell content, expressed as a percentage, from the formula:

Shell content coarser than 10 mm = (m1/M1) *100
and
shell content finer than 10 mm = (m2/M2) *100

Express the value of each shell content to the nearest whole number.

## 11 DETERMINATION OF SHALE CONTENT

Shales are typically grey in colour and are composed of clay minerals and quartz grains. The presence and extent of shales in the aggregates shall be determined by petrography as per IS 2386 (Part 5) at the time of selection and at the time of change of source.

## 12 DETERMINATION OF CLAY LUMPS

### 12.1 Objective

This method of test covers the procedure for the approximate determination of clay lumps in the routine examination of aggregates.

### 12.2 Apparatus

The apparatus shall consist of the following:

a) *Balance* — A balance or scale sensitive to within 0.1 percent of the weight of the sample to be weighed.
b) *Containers* — Containers of a size and shape that will permit the spreading of the sample on the bottom in a thin layer.
c) *Sieves* — Sieves conforming to IS 460**.**

### 12.3 Sampling

**12.3.1** Samples shall be obtained by quartering or by the use of a sampler, from a representative sample selected from the material to be tested. They shall be handled in such a manner as to avoid breaking up clay lumps which may be present.

**12.3.2** Samples shall be dried to constant weight at a temperature not exceeding 110°C such that two successive weights after 2 hours of further drying do not differ by more than 0.1 percent with the previous weight. Record the weight W.

**12.3.3** Samples of fine aggregate shall consist of particles coarser than 1.18 mm IS Sieve and shall weigh not less than 100 g.

**12.3.4** Samples of coarse aggregate shall be separated into different sizes using 4.75 mm, 10 mm, 20 mm and 40 mm IS Sieves. The weight of the sample for different sizes shall not be less than those indicated below:

| *Size of Particles Making Up the samples* (mm) (1) | *Weight of Sample, Min* (gm) (2) |
|---|---|
| Over 4.75 to 10 | 1 000 |
| Over 10 to 20 | 2 000 |
| Over 20 to 40 | 3 000 |
| Over 40 | 5 000 |

**12.3.5** In the case of mixtures of fine and coarse aggregates, the material shall be separated into two sizes on 4.75 mm IS Sieve, and the samples of fine and coarse aggregates shall be prepared as described under **12.3.3** and **12.3.4.**

### 12.4 Procedure

The sample shall be spread in a thin layer on the bottom of the container and examined for clay lumps. Any particles which can be broken into finely divided particles with the fingers, shall be classified as clay lumps. After all discernible clay lumps have been broken, the residue from the clay lumps shall be removed by the use of sieves indicated below:

| *Size of Particle Making Up the Sample* (1) | *Size of Sieve for Sieving Residue of Clay lumps* (2) |
|---|---|
| Fine aggregate (retained on 1.18 mm IS sieve) | 850 micron |
| Over 4.75 mm to 10 mm | 2.36 mm |
| Over 10 mm to 20 mm | 4.75 mm |
| Over 20 mm to 40 mm | 4.75 mm |
| Over 40 mm | 4.75 mm |

### 12.5 Calculation

The percentage of clay lumps shall be calculated to the nearest 0.1 percent in accordance with the following formula:

$$l = \frac{W - R}{W} \times 100$$

where,
$l$ = percentage of clay lumps,
$W$ = weight of sample, and
$R$ = weight of sample after removal of clay lump

### 12.6 Reporting of Results

The percentage of clay lumps in the aggregate shall be reported to an accuracy of 0·1 percent.

## 13 DETERMINATIONS OF CLAY, FINE SLIT AND FINE DUST (SEDIMENTATION METHOD)

### 13.1 Objective

This is a gravimetric method for determining the clay, fine silt and fine dust, which includes particles up to 20 micron. Differences in the nature and density of materials or in the temperature at time of testing may vary the separation point.

### 13.2 Apparatus

The apparatus shall consist of the following:

a) A watertight screw-topped glass jar of dimensions similar to a 1 kg fruit-preserving jar.
b) A device for rotating the jar about its long axis, with this axis horizontal, at a speed of 80 rev/min ± 20 rev/min.
c) A sedimentation pipette of the Andreason type of approximately 25 ml capacity and of the general form indicated in Fig. 6. This consists mainly of a pipette fitted at the top with a two-way tap and held rigidly in a clamp which can be raised or lowered as required, and which is fitted with a scale from which the changes in height of the pipette can be read.
The volume of the pipette A, including the connecting bore of the tap B, is determined by filling with distilled water; by reversing the tap, the water is run out into a bottle, weighed and the volume calculated.
d) A 1 000 ml measuring cylinder.
e) A scale or balance of capacity not less than 10 kg, readable and accurate to one gram.
f) A scale or balance of capacity not less than 250 g, readable and accurate to 0.001 g.
g) A well-ventilated oven, thermostatically controlled, to maintain a temperature of 100°C to 110°C.

**13.3 Chemicals** — A solution containing 8 g of sodium oxalate per litre of distilled water shall be taken. For use, this stock solution is diluted with distilled water to one tenth (that is 100 ml diluted with distilled water to one litre).

**13.4 Test Sample** — The sample for test shall be prepared from the main sample taking particular care that the test sample contains a correct proportion of the finer material. The amount of sample taken for test shall be in accordance with Table 10.

**Table 10 Weight of Sample for Determination of Clay, Fine Silt and Fine Dust**

(*Clause* 13.4)

| Maximum Size Present in Substantial Proportions | Approximate Weight of Sample for Test |
|---|---|
| mm | kg |
| (1) | (2) |
| 63 to 25 | 6 |

| | |
|---|---|
| 20 to 12.5 | 1 |
| 10 to 6.3 | 0.5 |
| 4.75 or smaller | 0.3 |

**13.4.1** All-in aggregates shall be separated into fine and coarse fractions by sieving on a 4.75 mm IS Sieve and the two samples so obtained shall be tested separately.

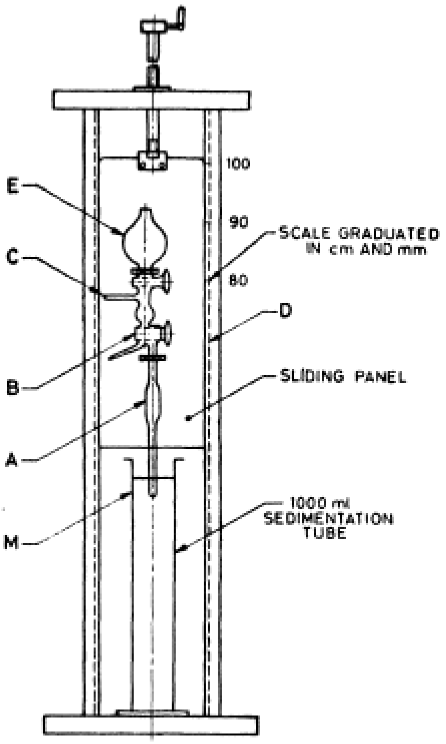


FIG. 6 SEDIMENTATION PIPETTE FOR DETERMINATION OF CLAY AND SILT CONTENT

**13.5 Test Procedure**

**13.5.1** *Method for Fine Aggregate* — Approximately 300 g of the sample in the air-dry condition, passing the 4.75 mm IS Sieve, shall be weighed and placed in the screw-topped glass jar, together with 300 ml of the diluted sodium oxalate solution. The rubber washer and cap shall be fixed, care being taken to ensure watertightness. The jar shall then be rotated about its long axis, with this axis horizontal, at a speed of 80 ± 20 rev/min for a period of 15 minutes.

**13.5.1.1** At the end of 15 minutes, the suspension shall be poured into the 1 000 ml measuring cylinder and the residue washed by gentle swirling and decantation of successive 150 ml ‘portions of sodium oxalate solution, the washings being added to the cylinder until the volume is made up to 1000 ml. The determination shall be completed as described in **13.5.3.**

**13.5.2** *Method for Coarse Aggregate* — The weighed sample shall be placed in a suitable container, covered with a measured volume of sodium oxalate solution (0.8 g per litre), agitated vigorously to remove all adherent fine material and the liquid suspension transferred to the 1 000 ml measuring cylinder. This process shall be repeated as necessary until all clayey material has been transferred to the cylinder.

The volume shall be made up to 1 000 ml with sodium oxalate solution and the determination completed as described in **13.5.3**.

**13.5.2.1** The suspension in the measuring cylinder shall be thoroughly mixed by inversion and the tube and contents immediately placed in position under the pipette. The pipette A shall then be gently lowered until the tip touches the surface of the liquid, and then lowered a further 10 cm into the liquid. Three minutes after placing the tube in position, the pipette A and the bore of tap B shall be filled by ‘opening B and applying gentle suction at C. A small surplus may be drawn up into the bulb between tap B and tube C, but this shall be allowed to run away and any solid matter shall be washed out with distilled water from E. The pipette shall then be removed from the measuring cylinder and its contents run into a weighed container, any adherent solids being washed into the container by distilled water from E through the tap B.

The contents of the container shall be dried at 100°C to 110°C to constant weight, cooled and weighed.

### 13.6 Calculations

The proportions of fine silt and clay or fine dust shall then be calculated from the following formula:

Percentage of clay and fine silt or fine dust $= \frac{100}{W_1}\left(\frac{1\,000\,W_2}{V} - 0.8\right)$

where,

$W_1$ = weight in g of the original sample,
$W_2$ = weight in g of the dried residue,
$V$ = volume in ml of the pipette, and
0.8 = weighed in g of sodium oxalate in one litre of the diluted solution.

NOTE — No correction is made for water soluble salts which may be present in the sand, since the amount of such salts shall be small.

### 13.7 Reporting of Results

The clay, fine silts and fine dust content shall be reported to the nearest 0.1 percent.

## 14 DETERMINATION OF LIGHT-WEIGHT PIECES (COAL AND LIGNITE)

### 14.1 Objective

This method of test covers the procedure (or determination of approximate percentage of light-weight pieces in aggregate by means of sink-float separation in a heavy liquid of suitable specific gravity.

### 14.2 Apparatus

The apparatus shall consist of the following:

a) *Balances* — For weighing fine aggregates, a balance having a capacity of not less than 500 g, sensitive to at least 0.1 g; for weighing coarse aggregates, a balance having a capacity of not less than 5 000 g, sensitive to at least 1 g.

b) *Containers* — Containers suitable for drying the aggregate sample, and containers suitable for holding the heavy liquid during the sink-float separation.

c) *Skimmer* — A piece of 300 micron sieve cloth of suitable size and shape for separating the floating pieces from the heavy liquid.

d) Hot-Plate or Oven.

**14.3 Heavy Liquid**

**14.3.1** The heavy liquid shall consist of a mixture of carbon tetrachloride, and 1, 1, 2, 2-tetrabromoethane, bromoform, and mono bromo benzene, or bromoform and benzene (*see* Note 1), in such proportions that the desired specific gravity will be obtained (*see* Note 2). Bromo trichloro methane may be used as a heavy liquid having a specific gravity of 2.00. The specific gravity shall be maintained within ± 0.01 of the specified value at all times during the test.

NOTES

**1** Recovery of the bromoform in the bromoform-benzene mixture can be affected by running a stream of water through the mixture until all benzene has been dissolved and removed.

**2** The chemicals listed in **14.3.1** are highly toxic, both by absorption through the skin and by inhalation. They shall be used only in a hood, and care shall be taken to avoid contact with the skin or inhalation of the fumes.

**14.3.2** The approximate volumes of materials to be combined to produce a mixture of the desired specific gravity may be computed from the following specific gravities of the different liquids:

| *Liquid* (1) | *Specific Gravity* (2) |
|---|---|
| 1,1,2,2-tetrabromethane | 2.97 |
| Benzene | 0.88 |
| Bromoform | 2.88 |
| Carbon Tetrachloride | 1.58 |
| Mono bromo benzene | 1.49 |

**14.3.2.1** For determining coal and lignite, the heavy liquid used shall have a specific gravity of 2.00 ± 0.01.

**14.4 Sample** — The minimum size of test sample shall be as follows:

| *Maximum Size of Aggregate* (mm) (1) | *Minimum Weight of Sample* (g) (2) |
|---|---|

| | |
|---|---|
| 6.3 (fine aggregate) | 200 |
| 20 | 3 000 |
| 40 | 5 000 |
| 80 | 10 000 |

**14.5 Procedure**

**14.5.1** *Fine Aggregate* — Allow the dried sample of fine aggregate to cool to room temperature and then sieve over a 300 micron IS Sieve until less than one percent of the retained material passes the sieve in one minute of continuous sieving. Weigh the material coarser than the 300 micron IS Sieve to the nearest 0.1 g, then introduce it into the heavy liquid in a suitable container, the volume of liquid shall be at least three times the absolute volume of the aggregate. Pour the liquid off into a second container, passing it through the skimmer and taking care that only the floating pieces are poured off with the liquid and that none of the sand is decanted onto the skimmer. Return to the first container the liquid that has been collected in the second container and, after further agitation of the sample by stirring, repeat the decanting process just described until the sample is free of floating pieces. Wash the decanted pieces contained on the skimmer in carbon tetrachloride, until the heavy liquid is removed, and then dry, the pieces will dry very quickly but may be placed in an oven at 105°C for a few minute if desired. Brush the dry decanted pieces from the skimmer onto the balance pan and determine the weight to the nearest 0.1 g.

**14.5.2** *Coarse Aggregate* — Allow the dried sample of coarse aggregate to cool to room temperature and sieve over a 4.75 mm IS Sieve. Weigh the material coarser than the 4.75 mm IS Sieve to the nearest 1 g, then introduce it into the heavy liquid in a suitable container, the volume of liquid being at least three times the absolute volume of the aggregate. Using the skimmer, remove the pieces that rise to the surface, and lave them. Repeatedly agitate the remaining pieces and remove the floating pieces until no additional pieces rise to the surface. Wash the decanted pieces in carbon tetrachloride until all of the heavy liquid is removed and allow to dry. Determine the weight of the decanted pieces to the nearest one gram.

NOTE — Materials, brownish black or black shall be considered as coal and lignite and shall be collected and weighed.

**14.6 Calculation** — Calculate the percentage of light-weight pieces (pieces floating on the heavy liquid) as follows:

For fine aggregate:

$$L = \frac{W_1}{W_2} \times 100$$

For coarse aggregate:

$$L = \frac{W_1}{W_3} \times 100$$

where,

$L$ = percentage of light weight pieces;
$W_1$ = dry weight in g, of portion of sample coarser than 300 micron IS Sieve; and
$W_2$ = dry weight in g, of portion of sample coarser than 300 micron IS Sieve; and.
$W_3$ = dry weight in g, of portion of sample coarser than 4.75 mm IS Sieve.

### 14.7 Reporting of Results

The percentage of light-weight pieces (coal and lignite) in the aggregate shall be reported with an accuracy of 0.1 percent.

## 15 DETERMINATION OF SOFT PARTICLES

### 15.1 Objective

This method of test deals with the procedure of determining the quantity of soft particles in coarse aggregates on the basis of scratch-hardness.

NOTE — This method is intended to be used to identify materials that are soft including those which are so poorly bonded that the separate particles in the piece are easily detached from the mass. The test is not intended to identify other types of deleterious materials in aggregates.

**15.2 Apparatus** — The apparatus shall consist of a brass rod, having a Rockwell hardness of 65 RHB to 75 RHB.

**15.2.1** A brass rod of about 1.6 mm diameter and of proper hardness inserted into the wood shaft of an ordinary lead pencil is a convenient tool for field or laboratory use.

### 15.3 Sample

**15.3.1** Aggregates for the test shall consist of material from which the sizes finer than the 10 mm IS Sieve have been removed. The sample tested shall be of such size that it will yield not less than the below mentioned amounts of the different sizes, which shall be available in amounts of 10 percent or more:

| *Sieve Size (Square Opening Sieves)* (mm) (1) | *Sample Weight* (g) (2) |
|---|---|
| Over 10 to 12.5 | 200 |
| Over 12.5 to 20 | 600 |
| Over 20 to 25 | 1 500 |
| Over 25 to 40 | 4 500 |
| Over 40 to 50 | 12 000 |

**15.3.2** If the sample contains less than 10 percent of any of the sizes specified under **15.3.1**, the size shall not be tested but, for the purpose of calculating the test results, it shall be considered to contain the same percentage of the soft particles as the average of the next smaller and the next larger size, or, if one of these sizes is absent.

It shall be considered to have the same percentage of soft particles as the next larger or next smaller size, whichever is present.

### 15.4 Procedure

Each particle of aggregate under test shall be scratched with the brass rod described in **15.2** using only a small amount (about 1 kg) of pressure. Particles are considered to be soft if during the scratching process, a groove is made in them without deposition of metal from the brass rod or if separate particles are detached from the rock mass.

> NOTE — In the case of some sandstones, brass fragments may be deposited on hard individual grains while at the same time separate particles are detached from the mess due to a weak binding medium. Such particles are to be considered as soft.

### 15.5 Calculation and Report

The report shall include the following information:

a) Weight and number of particles of each size of each sample tested with the brass rod;
b) Weight and number of particles of each size of each sample classified as soft in the test;
c) Percentage of test sample classified as soft by weight and by number of particles; and
d) Weighed average percentage of soft particles calculated from percentage in item (c) and based on the grading of sample of aggregate received for examination of, preferably, on the average grading of the material from that portion of the supply of which the sample is representative. In these calculations, sizes finer than the 10 mm Sieve shall not be included.

## 16 ESTIMATION OF ORGANIC IMPURITIES

### 16.1 Objective

This method of test covers an approximate method or estimating whether organic compounds are present in natural sand in sufficient quantities to be and hence is intended to show whether further tests are necessary or desirable.

### 16.2 Procedure

**16.2.1** The sand shall be tested as delivered and without drying. A 350 ml graduated clear glass medicine bottle shall be filled to the 75 ml mark with 3 percent solution of sodium hydroxide in water. The sand shall be added gradually until the volume measured by the sand layer is 125 ml. The volume shall then be made up to 200 ml by adding more solution. The bottle shall be stoppered and shaken vigorously and then allowed to stand for 24 hours.

**16.2.2** Other test shall be made if the colour of the liquid above the sand is darker than a standard solution freshly prepared as follows:

Add 2.5 ml of 2 percent solution of tannic acid in 10 percent alcohol, to 97.5 ml of a 3 percent sodium hydroxide solution. Place in a 350 ml bottle, stopper, shake vigorously and allow to stand for 24 hours before comparison with the solution above the sand. Alternatively, an instrument or coloured acetate sheets for making the comparison can be obtained, but it is desirable that these should be verified on receipt by comparison with the standard solution.

## 17 DETERMINATION OF ANGULARITY NUMBER

### 17.1 Objective

This method of test lays down the procedure for determining the angularity number of coarse aggregate.

NOTES

**1** Angularity or absence of rounding of the particles of an aggregate is a property which is of importance because it effects the ease of handling of a mixture of aggregate and binder, for example the workability of concrete, or the stability of mixtures that rely on the interlocking of. The particles. It is emphasised that this is a laboratory method intended for comparing the properties of different aggregates for mix design purposes.

**2** Since considerably more effort is used than in the test for bulk density and voids as given in **4**, the results of the two tests are different. Also weaker agrees may be crushed during compaction, and the angularity number test does not apply to any aggregate which breaks down during the test.

### 17.2 Apparatus

The apparatus shall consist of the following:

a) *Metal Cylinder* — A metal cylinder closed at one end and of about 3 litres capacity, the diameter and height of which shall be approximately equal, for example 15 cm and 15 cm. The cylinder shall be made from metal of thickness not less than 3 mm and shall be of sufficient rigidity to retain its shape under rough usage.
b) *Tamping Rod* — A straight metal tamping rod of circular cross- section of 16 mm diameter and 60 cm long, rounded at one end.
c) *Balance* — Balance or scale of capacity 10 kg readable to one gram.
d) *Scoop* — A metal scoop approximately 20 cm × 12 cm × 5 cm, that is, about 1 litre heaped capacity.

### 17.3 Calibration of the Cylinder

The cylinder shall be calibrated by determining to the nearest gram the weight of water at 27°C required to fill it, so that no meniscus is present above the rim of the container.

### 17.4 Preparation of the Test Sample

The amount of aggregate available shall be sufficient to provide, after separation on the appropriate pair of sieves, at least 10 kg of the predominant size, as determined by the sieve analysis on the 20 mm, 16 mm, 12.5 mm; 10 mm, 6.3 mm and 4.75 mm IS Sieves.

**17.4.1** The test sample shall consist of aggregate retained between the appropriate pair of IS Sieves (square mesh) from the following sets:

a) 20 mm and 16 mm
b) 16 mm and 12.5 mm
c) 12.5 mm and 10 mm
d) 10 mm and 6.3 mm
e) 6.3 mm and 4.75 mm

NOTE — In testing aggregates larger than 20 mm, the volume of the cylinder shall be greater than 3 litres, but for aggregate smaller than 4.75 mm a, smaller cylinder may be used. The procedure shall be the same as with 3 litre cylinder. Except that the amount of compactive effect (weight of tamping rod × height of fall × number of blows) shall be proportioned to the volume of the cylinder.

**17.4.2** The aggregate to be tested shall be dried for at least 24 hours in shallow trays in a well ventilated oven at a temperature of 100°C to 110°C, cooled in an air-tight container and tested.

**17.5 Test Procedure** – The scoop shall be filled and heaped to over-flowing with the aggregate, which shall be placed in the cylinder by allowing it to slide gently off the scoop from the least height possible.

**17.5.1** The aggregate in the cylinder shall be subjected to 100 blows of the tamping rod at a rate of about 2 blows per second. Each blow shall be applied by holding the rod vertical with its rounded end 5 cm above the surface of the aggregate and releasing it so that it falls freely. No force shall be applied to the rod. The 100 blows shall he evenly distributed over the surface of the aggregate.

**17.5.2** The process of filling and tamping shall be repeated exactly as described above with a second and third layer of aggregates; the third layer shall contain just sufficient aggregate to fill the cylinder level with the top edge before tamping.

**17.5.3** After the third layer has been tamped, the cylinder shall be filled to overflowing, and the aggregate struck off level with the top using the tamping rod as a straight edge.

**17.5.4** Individual pieces shall then be added and ‘rolled-in’ to the surface by rolling the tamping rod across the upper edge of the cylinder, and this finishing process shall be continued as long as the aggregate does not lift the rod off the edge of the cylinder on either side. The aggregate shall not be pushed in or otherwise forced down, and no downward pressure shall be applied to the tamping rod, which shall roll in contact with the metal on both sides of the cylinder.

**17.5.5** The aggregate in the cylinder shall then be weighed to the nearest 5 grams.

**17.5.6** Three separate determinations shall be made and the mean weight of aggregate in the cylinder calculated. If the result of any one determination differs from the mean by more than 25 grams, three additional determinations shall immediately be made on the same material and the mean of all the six determinations calculated.

### 17.6 Calculation

The angularity number shall be calculated from the formula:
Angularity number = $67 - \frac{100\,W}{C G_{\mathrm{A}}}$

where,
$W$ = Mean weight in g of the aggregate in the cylinder
$C$ = Weight of water in g required to fill the cylinder, and
$G_{\mathrm{A}}$ = Specific gravity of aggregate.

### 17.7 Reporting of Results

The angularity number shall be expressed to the nearest whole number.

## 18 DETERMINATION OF NECESSARY ADJUSTMENT FOR BULKING OF FINE AGGREGATE (FIELD METHOD)

### 18.1 Objective

This method of test covers the field method for determining the necessary adjustment for the bulking of fine aggregate.

### 18.2 General

Sand brought on to a building site or other works may contain an amount of moisture which will cause it, when loosely filled into a container, to occupy a larger volume than it would occupy if dry. If the sand is measured by loose volume, it is necessary in such a case to increase the measured volume of the sand, in order that the amount of sand. Put into the concrete may be the amount intended for the nominal mix used (based on dry sand). It will be necessary to increase the volume of sand by the 'percentage' bulking. The correction to be made is only a rough approximation, because the system of measurement by loose volume is a rough method at the best, but a correction of the right order can easily be determined and should be applied in order to keep the concrete uniform.

### 18.3 Procedure

**18.3.1** The procedure to be adopted may be varied, but two methods are suggested in **18.3.2** and **18.3.3**. Both depend on the fact that the volume of inundated sand is the same as if the sand were dry.

**18.3.2** Put sufficient quantity of the sand loosely into a container. Until it is about two-thirds full. Level off the top of the sand and pushing a steel rule vertically down through the sand at the middle to the bottom, measure the height. Suppose this is *h* cm.

**18.3.2.1** Empty the sand out of the container into another container where none of it will be lost. Half fill the first container with water. Put back about half the sand and rod it with a steel rod, about 6 mm in diameter, so that its volume is reduced to a minimum. Then add the remainder of the sand and rod it in the same way. Smooth and level the top surface of the inundated sand and measure its depth at the middle with the steel rule. Suppose this is h' cm.

**18.3.2.2** The percentage of bulking of the sand due to moisture shall be calculated from the formula:

Percentage bulking = $(\frac{h}{h'} - 1) \times 100$

**18.3.3** In a 250 ml measuring cylinder, pour the damp sand (consolidated by shaking) until it reaches the 200 ml mark with water and stir the sand well. Then fill the cylinder (The water shall be sufficient to submerge the sand completely.) It will be seen that the sand surface' is now below its original level. Suppose the surface is at the mark y ml. The percentage of bulking of the sand due to moisture shall be calculated from the formula:

Percentage bulking = $(\frac{200}{\gamma} - 1) \times 100$

## 18.4 Reporting of Results

Report the percentage bulking of the sand to the nearest whole number.

## 19 DETERMINATION OF SURFACE MOISTURE IN FINE AGGREGATE (FIELD METHOD)

## 19.1 Objective

This method of test covers the procedure for determining in the field, the amount of surface moisture in fine aggregates by displacement in water. The accuracy of the method depends upon accurate information on the specific gravity of the material in a saturated surface dry condition. The same procedure, with appropriate changes in the size of sample and dimensions of the container. May be applied to coarse aggregates.

## 19.2 Apparatus

The apparatus shall consist of the following:

a) *Balance* — A balance having a capacity of 2 kg or more and sensitive to 0.5 g or less.

b) *Flask* — A suitable container or flask preferably of glass or noncorrosive metal. The container may be a pycnometer, a volumetric flask, a graduated volumetric flask or other suitable measuring device. The volume of the container shall be from 2 to 3 times the loose volume of the sample. The container shall be so designed that it can be filled up to the mark, or the volume of its contents read, within 0.5 ml or less.

### 19.3 Sample

A representative sample of the fine aggregate to be tested for surface moisture content shall be selected. It shall weigh not less than 200 g. Larger samples will yield more accurate results.

### 19.4 Procedure

**19.4.1** The surface water content may be determined either by weight or by volume. In each case the test shall be made at a temperature range of 22°C to 32°C.

**19.4.2** *Determination by Weight* — The container shall be filled up to the mark with water and the weight in grams determined. The container shall be emptied. Enough water shall be placed in the container to cover the sample, after which the sample of fine aggregate shall be introduced into the container and the entrained air removed. The container shall then be filled to the original mark and the weight in grams determined. The amount of water displaced by the sample shall be calculated as follows:

$$V_s = M_c + M_s - M$$

where,

$V_s$ = weight in g of water displaced by the sample,
$M_c$= weight in g of container filled up to the mark with water,
$M_s$= weight in g of the sample, and
$M$= weight in g of the sample and container filled to the mark with water.

**19.4.3** *Determination by Volume* — A volume of water sufficient to cover the sample shall be measured in millilitres and placed in the container. The weighed sample of fine aggregate shall then be admitted into the container and the entrained air removed. The combined volume of the sample and the water shall be determined by direct reading when a graduated flask is used. Where a pycnometer or volumetric flask of known volume is used, the combined volume of the sample and the water shall be determined by filling up to the mark with a measured volume of water and subtracting this volume from the volume of the container.

The amount of water displaced by the sample shall be calculated as follows:

$$V_3 = V_2 - V_1$$

where,
$V_3$ = volume in ml of water displaced by the sample,
$V_2$ = combined volume in ml of the sample and water, and
$V_1$ = volume in ml of water required to cover the sample

## 19.5 Calculation

**19.5.1** The percentage of surface moisture in terms of the saturated surface-dry fine aggregate and in terms of the weight of wet fine aggregate shall be calculated as follows:

$$P_1 = \frac{V_3 - V_d}{M_3 - V_d} \times 100$$

$$P_2 = \frac{V_3 - V_d}{M_3 - V_d} \times 100$$

where,

$P_1$ = percentage surface moisture in terms of saturated surface-dry fine aggregate:

$V_3$ = weight in g of water displaced;

$V_d$ = the weight of the sample ($M_s$ in **19.4.2**) divided by the specific gravity on saturated and surface-dry basis, determined as prescribed;

$P_2$ = percentage surface moisture in terms of the weight of wet fine aggregate.

NOTE — These formulae are readily derived from basic relationships. For convenience, express $P_1$ in terms of the ratio r, that is the ratio of the weight of surface moisture to the weight of the saturated surface-dry sample. It follows that:

$$r = \frac{M_s - \frac{M_s}{1+r}}{\frac{M_s}{1+r}} \qquad \text{………... (1)}$$

If G id the specific gravity of the saturated surface-dry fine aggregate, then

$$V_s = \frac{M_s}{G(1+\gamma)} + (M_s - \frac{M_s}{1+\gamma}) \qquad \text{………...(2)}$$

Where the first term gives the water displaced by the saturated surface aggregate, and the second that displaced by the surface moisture.

From equation 2,

$$\frac{M_s}{1+r} = \frac{V_s - M_s}{\frac{1}{G} - 1}$$

By definition

$$M_s = V_d \times G$$

Substituting for $\frac{M_3}{1+\gamma}$ and $M_3$ in equation 1, and simplifying

$$\gamma = \frac{V_3 - V_d}{M_3 - V_3}$$

The formula for $P_2$ may be derived by similar reasoning, or directly from that for $P_2$ since

$$P_2 = \frac{\frac{V_3 - V_d}{M_3 - V_3}}{1 + \frac{V_3 - V_d}{M_3 - V_3}} \times 100$$

## 19.6 Reporting of Results

The surface moisture in the fine aggregate shall be reported to the nearest one percent and also the method of determination, that is, either by weight or by volume.

## 20 MEASURING MORTAR MAKING PROPERTIES OF FINE AGGREGATE

**20.1** This standard covers the test procedure for measuring the mortar-making properties of fine aggregate for concrete by means of a compression test on specimens made from a mortar of a plastic consistency and gauged to a definite water-cement ratio.

### 20.2 Basis for Comparison

**20.2.1** The fine aggregate shall be compared in mortar, as described in this method, with a sample or the same aggregate that has been washed in a 3 percent solution of sodium hydroxide followed by thorough rinsing in water. The treatment shall be repeated till the washed material produces a colour lighter than that of the standard solution described in test for Organic Impurities, However, it shall be ensured that no fines are lost while washing with sodium hydroxide. The washed and rinsed aggregate shall be checked with a suitable indicator such as phenolphthalein or litmus to assure that all traces of sodium hydroxide are removed from the aggregate before being used for making control mortar.

### 20.3 Apparatus

**20.3.1** *Flow Table and Flow Mould* — These shall conform to the requirements specified in **12** of IS 1727.

**20.3.2** *Tamping Bar* — The tamping bar shall be made of non-absorbent, abrasion resistant, non-brittle material such as a rubber compound having a Shore A durometer hardness of 80 ± 10 or seasoned teak wood rendered non-absorbent by immersion for 15 minutes in paraffin at approximately 200 ºC and shall have a cross-section of 12.5 mm x 25 mm and a convenient length of 125 mm to 150 mm. The tamping face shall be flat and at right angles to the length of the bar**.**

**20.3.3** *Trowel* — It shall have a steel blade 100 mm to 150 mm in length, with straight edges.

**20.3.4** *Moulds* — These shall be 50 mm cube moulds and shall conform to the requirements laid down in IS 10086.

**20.3.5** *Tamping Rod* — It shall be approximately 10 mm in diameter and 100 mm long, with one end rounded to a hemispherical tip 10 mm dia x 47 approx. 300 mm long.

**20.3.6** *Testing Machine* — A compression testing machine of suitable capacity and conforming to IS 14858, shall be used.

### 20.4 Mortar

**20.4.1** Place cement and water in quantities that will give a water-cement ratio of 0.6 by weight in an appropriate vessel and permit the cement to absorb water for one minute. Mix the materials into a smooth paste with a spoon. Beat into the mixture a known weight of the sample of sand under test that has been brought to a saturated surface-dry condition. Mix until the material appears to be of the desired consistency (flow 100 ± 5). Continue the mixing for 30 seconds and make a determination of the flow in accordance with **20.5**.

### 20.5 Procedure

**20.5.1** Carefully wipe the flow-table top clean and dry and place the flow mould at the centre. Immediately after completing the mixing operation, place a layer of mortar about 25 mm in thickness in the mould and tamp 20 times with the tamper. The tamping pressure shall be just sufficient to insure uniform filling of the mould. Fill the mould with mortar and tamp as specified for the first layer. Cut off the mortar to a plane surface, flush with the top of the mould, by drawing the straight edge of a trowel (held nearly perpendicular to the mould) with a sawing motion across the top of the mould. Wipe the table top clean and dry, being especially careful to remove any water from around the edge of the flow mould. Lift the mould away from the mortar one minute after completing the mixing operation. Immediately, drop the table through a height of 12.5 mm ten times in 6 seconds. The flow is the resulting increase in average diameter of the mortar mass, measured on at least four diameters at approximately equal angles, expressed as a percentage of the original diameter. Should the flow be too great, return the mortar to the mixing vessel, add additional sand, and make another determination of the flow. If more than two trials need be made to obtain a flow of 100 ± 5, consider the mortar as a trial mortar, and prepare test specimens from a new batch. If the mortar is too dry, discard the batch. Determine the quantity of sand used by subtracting the weight of the portion remaining after mixing from the weight of the initial sample.

### 20.6 Moulding Test Specimens

**20.6.1** Immediately following completion of the flow test, place the mortar in 50 mm cube moulds in two layers. Rod each layer in place with 25 strokes of the tamping rod. After the rodding has been completed, fill the moulds to overflowing. Place the specimens in a moist closet for curing. Three to four hours after moulding, strike off the specimens to a smooth surface. Remove the specimens from the moulds 20 h to 24 h after moulding and store in water until tested.

**20.6.2** The temperature of the mixing water, moist closet, and storage tank shall be maintained at 27°C ± 2°C.

### 20.7 Testing of Specimens

**20.7.1** Test the specimens for compressive strength as given in **20.7.1.1** to **20.7.1.3**.

**20.7.1.1** Test the specimens immediately after their removal from the moist closet in the case of 24 hours specimens, and from storage water in the case of all other specimens. If more than one specimen at a time is removed from the moist closet for the 24 hours tests, keep these specimens covered with a damp cloth until time of testing. If more than one specimen at a time is removed from the storage water for testing, keep these specimens in water at a temperature of 27 °C ± 2 °C and of sufficient depth to immerse completely each specimen until time of testing.

**20.7.1.2** Surface-dry each specimen and remove any loose sand grains or incrustations from the faces that will be in contact with the bearing blocks of the testing machine. Check these faces by applying a straight edge (*see* Note). If there is appreciable curvature, grind the face or faces to plane surfaces or discard the specimen.

> NOTE — Results much lower than the true strength will be obtained by loading faces of the specimen that are not truly plane surfaces. Therefore, it is essential that specimen moulds be kept scrupulously clean, us otherwise large irregularities in the surfaces will occur. Instruments for cleaning of moulds should always be softer than the metal in the moulds to prevent wear. In case grinding of specimen faces is necessary, it can be accomplished best by rubbing the specimen on a sheet of fine emery paper or cloth glued to a plane surface, using only a moderate pressure. Such grinding is tedious for more than a few hundredths of a millimetre; where more than this is found necessary, it is recommended that the specimen be discarded.

**20.7.1.3** Apply the load to specimen faces that were in contact with the true plane surfaces of the mould. Carefully place the specimen in the testing machine below the centre of the upper bearing block. Use no cushioning or bedding materials. An initial loading up to one-half of the expected maximum load for specimens having expected maximum loads of more than 2 500 kg may be applied at any convenient rate. Adjust the rate of load application so that the remainder of the load (or the entire load in the case of expected maximum loads of less than 2 500 kg) is applied, without interruption, to failure at such a rate that the maximum load will be reached in not less than 20 sec nor more than 80 sec. Make no adjustment in the controls of the testing machine while a specimen is yielding rapidly immediately before failure.

### 20.8 Reporting of Results

**20.8.1** Calculate the average crushing strength of not less than three specimens containing untreated sand. Similarly calculate the average crushing strength of the corresponding number of specimens containing treated sand. Report the average crushing strength of specimens containing untreated sand as a percentage of the average crushing strength or the specimens containing treated sand.

## ANNEX A

(*Clause* 2)

## LIST OF CROSS REFERRED STANDARDS

| *IS No.* | *Title* |
|---|---|
| IS 460 | Test sieves — Specification |
| (Part 1): 2020 | Wire cloth test sieves (*fourth revision*) |
| (Part 2): 2020 | Perforated plate test sieves (*fourth revision*) |
| CED 02 (27866) | Draft Indian Standard Aggregates — Specification: Part 1 Coarse and fine aggregates for concrete (*fourth revision of IS 383*) |
| CED 02 (27867) | Draft Indian Standard Aggregates — Specification: Part 2 Fine aggregate for masonry and plaster (*fourth revision of IS 383*) |
| IS 2386 (Part 5) | Methods of test for aggregates for concrete: Part 5 Petrographic examination of aggregates (*under development*) |
| IS 1314: 2024 | Calcium chloride — Specification (*third revision*) |
| IS 1727: 1967 | Methods of test for pozzolanic materials (*first revision*) |
| IS 1796: 2023 | Glycerine — Specification |
| IS 3321: 1973 | Specification for formaldehyde solution (*first revision*) |
| IS 10086: 2021 | Moulds for use in tests of cement, concrete and pozzolana (*first revision*) |
| IS 10262: 2019 | Concrete mix proportioning — Guidelines (*second revision*) |
| IS 14858: 2000 | Compression testing machine used for testing of concrete and mortar — Requirements |

# ANNEX B

(Foreword)

## COMMITTEE COMPOSITION

Cement and Concrete Sectional Committee, CED 02

(*The Committee composition will be added after finalization*)

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