(Reaffirmed 1995)

Indian Standard

METHODS OF TEST FOR SOILS

PART 14 DETERMINATION OF DENSITY INDEX (RELATIVE DENSITY) OF COHESIONLESS SOILS

(First Revision)

First Reprint MARCH 1994

UDC 624.131.21:624.131.431.5

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 4

April 1984

Indian Standard

METHODS OF TEST FOR SOILS

PART 14 DETERMINATION OF DENSITY INDEX (RELATIVE DENSITY) OF COHESIONLESS SOILS

(First Revision)

Soil Engineering and Rock Mechanics Sectional Committee, BDC 23

Chairman	*Representing*
Dr Jagdish Narain	Association of Indian Universities, New Delhi
Members	
Shri P. D. Agarwal	Public Works Department, Government of Uttar Pradesh, Lucknow
Shri B. L. Dhawan (*Alternate*)	
Prof Alam Singh	University of Jodhpur, Jodhpur
Shri B. Anjiah	Engineering Research Laboratories, Government of Andhra Pradesh, Hyderabad
Shri E. M. Benjamin	Concrete Association of India, Bombay
Shri N. C. Duggal (*Alternate*)	
Chief Engineer (IPRI)	Irrigation Department, Government of Punjab, Chandigarh
Director (Dam) (*Alternate*)	
Shri A. G. Dastidar	In personal capacity (*5 Hungerford Court, 12/1, Hungerford Street, Calcutta*)
Dr G. S. Dhillon	Indian Geotechnical Society, New Delhi
Director	Central Soil & Materials Research Station, New Delhi
Deputy Director (*Alternate*)	
Director, IRI	Irrigation Department, Government of Uttar Pradesh, Roorkee
Shri A. H. Divanji	Asia Foundations and Construction (P) Ltd, Bombay
Shri A. N. Jangle (*Alternate*)	
Dr Gopal Ranjan	University of Roorkee, Roorkee; *and* Institute of Engineers (India), Calcutta
Shri S. Gupta	Cemindia Company Limited, Bombay
Shri N. V. De-Sousa (*Alternate*)	

(*Continued on page* 2)

(*Continued from page* 1)

Members	*Representing*
Shri M. Iyengar	Engineers India Limited, New Delhi
Shri Ashok K. Jain	G. S. Jain and Associates, Roorkee
Shri Vijay K. Jain (*Alternate*)	
Joint Director Research (GE)-I, RDSO	Ministry of Railways
Joint Director Research (GE)-II RDSO (*Alternate*)	
Lt-Col V. K. Kanitkar	Engineer-in-Chief's Branch, Army Headquarters
Shri O. P. Malhotra	Public Works Department, Chandigarh Administration, Chandigarh
Shri D. R. Narahari	Central Building Research Institute (CSIR), Roorkee
Shri V. S. Agarwal (*Alternate*)	
Shri T. K. Natrajan	Central Road Research Institute (CSIR), New Delhi
Shri Ranjit Singh	Ministry of Defence (R & D)
Shri P. D. Deshpande (*Alternate*)	
Dr G. B. Rao	Indian Institute of Technology, New Delhi
Dr K. K. Gupta (*Alternate*)	
Research Officer (B & RRL)	Public Works Department, Government of Punjab, Chandigarh
Secretary	Central Board of Irrigation and Power, New Delhi
Deputy Secretary (*Alternate*)	
Shri N. Sivaguru	Roads Wing (Ministry of Shipping and Transport)
Shri P. R. Kalra (*Alternate*)	
Shri K. S. Srinivasan	National Buildings Organization, New Delhi
Shri Sunil Berry (*Alternate*)	
Dr N. Som	Jadavpur University, Calcutta
Shri N. Subramanyam	Karnataka Engineering Research Station, Krishnarajasagar
Superintending Engineer (P & D C)	Public Works Department, Government of Tamil Nadu, Madras
Executive Engineer (SMRD) (*Alternate*)	
Shri H. C. Verma	All India Instrument Manufacturers and Dealers Association, Bombay
Shri H. K. Guha (*Alternate*)	
Shri G. Raman, Director (Civ Engg)	Director General, ISI (*Ex-officio Member*)

Secretary

Shri K. M. Mathur
Senior Deputy Director (Civ Engg), ISI

Soil Testing Procedures Subcommittee, BDC 23 : 3

Convener	
Dr Alam Singh	University of Jodhpur, Jodhpur
Members	
Shri Amar Singh	Central Building Research Institute (CSIR), Roorkee
Shri M. R. Soneja (*Alternate*)	

(*Continued on page* 14)

Indian Standard

METHODS OF TEST FOR SOILS

PART 14 DETERMINATION OF DENSITY INDEX (RELATIVE DENSITY) OF COHESIONLESS SOILS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 28 November 1983, after the draft finalized by the Soil Engineering and Rock Mechanics Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 This part deals with the method for the determination of density index (relative density) of cohesionless soils. For cohesionless soils in the natural or artificially compacted state neither the actual density (or void ratio) nor the actual density express as a percentage of the maximum density give an exact idea of the compactness of the soil. The concept of density index (relative density) gives a practically useful measure of compactness of such soils. The compactive characteristics of cohesionless soils and the related properties of such soils are dependent on factors like grain size distribution and shape of individual particles. Density index (relative density) is also affected by these factors and serves as a parameter to correlate properties of soils. Various soil properties, such as penetration resistance, compressibility, compaction friction angle, permeability and California bearing ratio are found to have simple relationships with density index (relative density).

0.3 This standard was first published in year 1968. This revision has been prepared so as to give more details of vibratory table, deletions of specifications of moulds and its assembly, which are being published separately in detail, and adding an alternative method using vibratory hammer.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, final value, observed or calculated, expressing result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This part (Part 14) covers the principal and alternative laboratory methods for the determination of the density index (relative density) of cohesionless free draining soils.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definition shall apply.

2.1 Density Index, I_d (or Relative Density D_r)/ — The ratio of the difference between the void ratio of a cohesionless soil in the loosest state and any given void ratio to the difference between its void ratios in the loosest and in the densest states.

3. PRINCIPAL METHOD USING VIBRATORY TABLE

3.1 Apparatus

3.1.1 *Vibratory Table* — a steel table with a cushioned steel vibrating deck about 75 × 75 cm. The vibrator should have a net mass of over 45 kg. The vibrator shall have a frequency of 3 600 vibrations per minute, a vibrator amplitude variable between 0·05 and 0·65 mm in steps of 0·05 to 0·25 mm, 0·25 to 0·45 mm and 0·45 to 0·65 mm under a 11-kg load and shall be suitable for use with a 415-V three phase supply.

3.1.2 *Moulds — With Guide Sleeves* — cylindrical metal unit mass moulds of 3 000 cm^3 and 15 000 cm^3 capacity conforming to the requirements as given in IS : 10837-1984*.

3.1.3 *Surcharge Base Plates with Handle* — one surcharge base plate 10 mm in thickness for each size mould conforming to requirements given in IS : 10837-1984*.

3.1.4 *Surcharge Masses* — one surcharge mass for each size mould conforming to requirements given in IS : 10837-1984*.

3.1.5 *Dial Gauge Holder* — conforming to requirements given in IS : 10837-1984*.

3.1.6 *Dial Gauge* — 50 mm travel with 0·025 mm graduations (*see* IS : 2092-1962†).

3.1.7 *Calibration Bar* — of metal and 75 × 300 × 3 mm in size.

*Specification for moulds and accessories for determination of density index (relative density) of cohesionless soils.

†Specification for dial gauges.

3.1.8 *Pouring Devices* — consisting of funnels 12 mm and 25 mm in diameter and 15 cm long, with cylindrical spouts and lipped brims for attaching to 15 cm diameter and 30 cm high metal cans.

3.1.9 *Mixing Pans* — suitable size are 60 × 90 cm and 10 cm deep and 40 × 40 cm and 5 cm deep.

3.1.10 *Weighing Scale* — portable platform scale, 100 kg capacity with sensitivity of 20 g in accordance with IS : 1435-1960*.

3.1.11 *Hoist* — suitable hoist of at least 135 kg capacity.

3.1.12 *Metal Hand Scoop*

3.1.13 *Bristle Brush*

3.1.14 *Timing Device* — indicating in minutes and seconds.

3.1.15 *Metal Straight Edge* — about 40 cm long.

3.1.16 *Micrometer* — 0 to 25 mm, accurate to 0·025 mm.

3.2 Calibration — The volume of the mould should be determined by direct measurement (**3.2.1**) and checked by filling with water (**3.2.2**). The initial dial reading for computing the volume of the specimen should be determined as provided in **3.2.3**.

3.2.1 *Determination of Volume by Direct Measurement* — The average inside diameter and height of the mould should be measured to 0·025 mm. Volume of the 3 000 cm^3 mould should be calculated to the nearest 3 cm^3 and that of 15 000 cm^3 mould to the nearest 30 cm^3. The average inside cross-sectional area of the mould should also be calculated in square cetimetres.

3.2.2 *Determination of Volume by Filling with Water* — The mould should be filled with water and a glass plate should be slid carefully over the top surface of the mould in such a manner as to ensure that the mould is completely filled with water. The temperature of the water should be measured and the mass in grams of the water filling the mould should be determined. The volume of the mould should be calculated in cubic centimetres by multiplying the mass of water by the volume of water per gram at the measured temperature.

3.2.3 *Determination of Initial Dial Reading for Computing the Volumes of the Specimen* — The thickness of the surcharge base plate and the calibration bar should be measured to 0·025 mm using a micrometer. The

---

*Specification for platform weighing machines.

calibration bar should then be placed across a diameter of the mould along the axis of the guide brackets. The dial gauge holder should be inserted in each of the guide brackets on the mould with the dial gauge stem on top of the calibration bar and on the axis of the guide brackets. The dial gauge holder should be placed in the same position in the guide brackets each time by means of matchmarks on the guide brackets and the holder. Six dial gauge readings should be obtained, three on the left side and three on the right side, and these six readings averaged. The initial dial reading should be computed by adding together the surcharge base plate thickness and the average of the six dial gauge readings and subtracting the thickness of the calibration bar. The initial dial reading is constant for a particular mould and surcharge base plate combination.

3.3 Soil Sample

3.3.1 A representative sample of soil should be selected. The mass of soil sample to be taken depends upon the maximum size of particle in the soil as given in Table 1.

TABLE 1 MASS OF SOIL SAMPLE TO BE TAKEN FOR THE TEST

Maximum Size of Soil Particle	Mass of Soil Sample Required	Pouring Device to be Used in Test for the Determination of Minimum Density	Size of Mould to be Used
(1)	(2)	(3)	(4)
mm	kg		cm^3
75	45	Shovel or extra large Scoop	15 000
37·5	12	Scoop	3 000
19	12	Scoop	3 000
9·50	12	Pouring device (25 mm dia spout)	3 000
4·75	12	Pouring device (12 mm dia spout)	3 000

3.3.2 The soil sample should be dried in an oven at a temperature of 105 to 110°C. The soil sample should be pulverized without breaking the individual soil particles and sieved through the required sieve.

3.4 Procedure for the Determination of Minimum Density

3.4.1 The pouring device and mould should be selected according to the maximum size of particle as indicated in Table 1. The mould should be weighed and the mass recorded. Oven-dry soils should be used.

3.4.2 Soil containing particles smaller than 9·50 mm should be placed as loosely as possible in the mould by pouring the soil through the spout in a steady stream. The spout should be adjusted so that the height of free fall of the soil is always 25 mm. While pouring the soil the pouring device should be moved in a spiral motion from the outside towards the centre to form a soil layer of uniform thickness without segregation. The mould should be filled approximately 25 mm above the top and levelled with top by making one continuous pass with the steel straightedge. If all excess matter is not removed, an additional continuous pass should be made. Great care shall be exercised to avoid jarring the mould during the entire pouring and trimming operation. The mould and the soil should be weighed and the mass recorded.

3.4.3 Soil containing particles larger than 9·50 mm should be placed by means of a large scoop (or shovel) held as close as possible to and just above the soil surface to cause the material to slide rather than fall into the previously placed soil. If necessary, large particles may be held by hand to prevent them from rolling off the scoop. The mould should be filled to overflowing but not more than 25 mm above the top. The surface of the soil should be levelled with the top of the mould using the steel straightedge (and the fingers, if necessary) in such a way that any slight projections of the larger particles above the top of the mould shall approximately balance the larger voids in the surface below the top of the mould. The mould and the soil should be weighed and the mass recorded.

3.5 Procedure for the Determination of Maximum Density

3.5.1 The maximum density may be determined by either the dry or wet method.

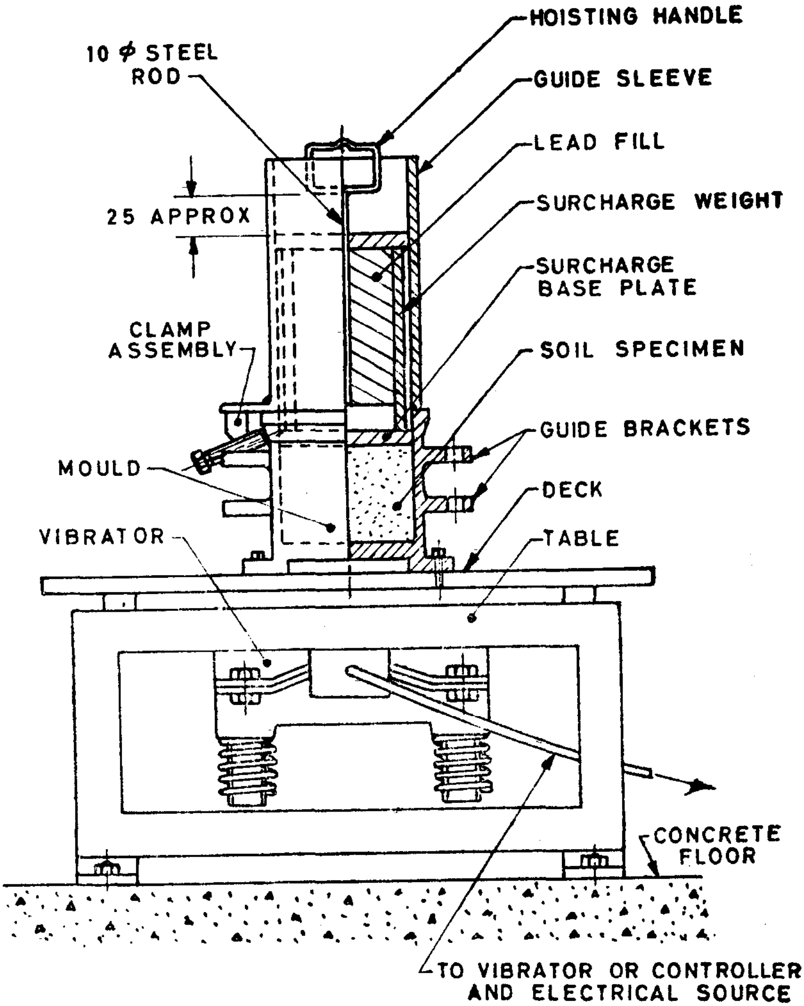
3.5.2 *Dry Method*

3.5.2.1 The guide sleeve should be assembled on top of the mould and the clamp assemblies tightened so that the inner surfaces of the walls of the mould and the sleeve are in line. The lock nuts on the two set screws equipped with them should be tightened. The third clamp should be loosened, the guide sleeve removed, the empty mould weighed and its mass recorded.

3.5.2.2 The mould should then be filled with the thoroughly mixed ovendry soil by the procedure explained in **3.4.2** or **3.4.3**. The mould filled for the determination of minimum density may also be used for this test.

3.5.2.3 The guide sleeves should be attached to the mould and the surcharge base plate should be placed on the soil surface. The surcharge weight should then be lowered on the base plate using the hoist in the case of the 15 000 cm^3 mould.

3.5.2.4 The mould should be fixed to the vibrator deck (*see* Fig. 1) for assembly. The vibrator control should be set at maximum amplitude and the loaded soil specimen should be vibrated for 8 minutes.



All dimensions in millimetres.

FIG. 1 ASSEMBLLY OF THE APPARATUS

The surcharge weight and guide sleeves should be removed from the mould. The dial gauge readings on two opposite sides of the surcharge base plate should be obtained and the average recorded. The mould with the soil should be weighed and its mass recorded.

3.5.3 *Wet Method*

3.5.3.1 The wet method (*see* Note) may be conducted on dry soil or wet soil from the field.

NOTE — While the dry method is preferred from the standpoint of securing results in a shorter period of time, the highest maximum density is obtained from some soils in a saturated state. At the beginning of a laboratory testing programme, or when a radical change of materials occurs, the maximum density test should be performed on both wet and dry soils to determine which method results in higher maximum density. If the wet method produces higher maximum densities (in excess of one percent) it shall be followed in succeeding tests.

3.5.3.2 The mould should be filled with wet soil. Sufficient water should be added to the soil to allow a small quantity of free water to accumulate on the surface of the soil during filling. During and just after filling the mould, it should be vibrated for a total of 6 minutes. During this period the amplitude of the vibrator should be reduced as much as necessary to avoid excessive boiling and fluffing of the soil, which may occur in some soils. During the final minutes of vibration, any water appearing above the surface of the soil should be removed.

3.5.3.3 The guide sleeve, surcharge base plate and surcharge weight should be assembled as described in **3.5.2.3.**

3.5.3.4 The specimen with the surcharge weight should be vibrated for 8 minutes. After the vibration, the surcharge weight and the guide should be removed from the mould. Dial gauge readings should be obtained on two opposite sides of the surcharge base plate and recorded. The entire wet specimen should be carefully removed from the mould, dried to constant mass, weighed and the mass recorded.

3.6 Calculations

3.6.1 *Minimum Density* — The minimum density, γ_{min}, in g/cm^3 should be calculated as follows :

$$\gamma_{min} = \frac{W_{sm}}{V_c}$$

where

W_{sm} = mass of dry soil in the minimum density test in g; and

V_c = calibrated volume of the mould in cm^3.

3.6.2 *Maximum Density* — The maximum density, γ_{max}, in g/cm^3 should be calculated as follows :

$$\gamma_{max} = \frac{W_s}{V_s}$$

where

W_s = mass of dry soil in the maximum density test in g;

V_s = volume of soil in maximum density test in cm^3;

= $V_c - (D_i - D_f) A$;

D_i = initial dial gauge reading in cm;

D_f = final dial gauge reading on the surcharge base plate after completion of the vibration period in cm; and

A = cross-sectional area of mould in cm^2.

3.6.3 *Density of Soil In-Place* — The dry density of soil in-place, γ_d should be determine in accordance with IS : 2720 (Part 28)-1966*.

3.6.4 *Density Index* (*Relative Density*) — The density index, I_d (relative density, D_r) expressed as a percentage should be calculated as follows:

$$I_d \text{ (or } D_r \text{)} = \frac{\gamma_{max} (\gamma_d - \gamma_{min})}{\gamma_d (\gamma_{max} - \gamma_{min})} \times 100$$

or in terms of void ratio

$$I_d \text{ (or } D_r \text{)} = \frac{e_{max} - e}{e_{max} - e_{min}} \times 100$$

where

e_{max} = void ratio of the soil in loosest state,

e = void ratio of the soil in the field, and

e_{min} = void ratio of the soil in its densest state obtainable in the laboratory.

4. ALTERNATE METHOD USING VIBRATORY HAMMER

4.1 Apparatus

4.1.1 *Moulds* — A cylindrical metal mould with an internal diameter of 152 mm and an internal effective height of 127 mm, with a detachable baseplate and a collar 50 mm deep, conforming to IS : 9669-1980†.

*Methods of test for soils : Part 28 Determination of dry density of soils in-place by the sand replacement method (*first revision*).

†Specification for CBR moulds and accessories.

4.1.2 *Vibratory Hammer* — An electric vibrating hammer having a power consumption between 600 W and 750 W and operating at a frequency between 25 Hz and 45 Hz.

4.1.3 *Tamper* — A steel tamper attached to the vibrating hammer; the tamper shall have a circular foot of 145 mm diameter and shall not exceed 3 kg in mass.

4.1.4 *Balance* — readable and accurate to 5 g.

4.1.5 *A 37·5-mm Sieve and Receiver*

4.1.6 *Straightedge* — a steel strip 300 mm long, 25 mm wide and 3 mm thick.

4.1.7 *Depth Gauge or Steel Rule.*

4.1.8 *Metal Tray* — 600 mm × 500 mm and with sides 80 mm deep.

4.1.9 *Stop-Watch or Stop Clock*

4.2 Procedure

4.2.1 *Soil not Susceptible to Crushing During Compaction*

4.2.1.1 The sample shall be mixed thoroughly with a suitable amount of water depending on the soil type.

4.2.1.2 The mould, together with its 50 mm collar and baseplate fixed firmly, shall be weighed (m_1), and then stood on a solid base, of a concrete floor. A quantity of the moist soil, sufficient to give a specimen 127 mm to 133 mm deep after compaction in the mould, shall be compacted in the mould in three layers of approximately equal mass, using the vibrating hammer fitted with the circular steel tamper. Each layer shall be compacted for a period of 60 seconds and throughout this period a firm downward pressure shall be applied to the vibrating hammer so that the total downward force, including that resulting from the mass of the hammer and tamper, shall be 300 to 400 N.

4.2.1.3 When the final layer has been compacted, any loose material around the sides of the mould shall be removed from the surface of the specimen. The straightedge shall be laid across the top of the collar of the mould and the depth of the specimen below the top of the collar measured to an accuracy of 0·5 mm. Readings shall be taken at four points spread evenly over the surface of the specimen, all at least 15 mm from the side of the mould, and the mean height, *h*, of the specimen calculated. If the specimen is more than 133 mm or less than 127 mm in height, it shall be rejected and a further test carried out.

4.2.1.4 The mould, together with the collar, baseplate and soil shall be weighed to the nearest 5 g (m_2).

4.2.1.5 The compacted soil specimen shall be removed from the mould and placed on the large metal tray. A representative sample of the specimen shall be taken and its moisture content w, shall be determined as in IS : 2720 (Part 8)-1983*.

4.2.1.6 The remainder of the soil specimen shall be broken up and then mixed with remainder of the original sample. Suitable increments of water shall be added successively and mixed into the sample, and the above procedure from operations shall be repeated for each increment of water added. The total number of determinations made shall be at least five, and the range of moisture contents should be such that the optimum moisture content, at which the maximum dry density occurs, is within that range.

4.2.2 *Soil Susceptible to Crushing During Compaction*

4.2.2.1 The sample shall be mixed thoroughly with different amounts of water to give a suitable range of moisture contents. The range of moisture contents should be such that the optimum moisture content, at which the maximum dry density occurs, is within that range.

4.2.2.2 Each sample shall be treated as in **4.2.1.2** to **4.2.1.5** and the remainder of each specimen shall be discarded.

4.3 Calculations

4.3.1 The bulk density, γ_b in t/m³, of each compacted specimen shall be calculated from the equation :

$$\gamma_b = \frac{m_2 - m_1}{18{\cdot}15h}$$

where

m_1 = mass of the mould + base + collar (g);

m_2 = mass of the mould + base + collar + compacted specimen (g); and

h = height of specimen (mm).

4.3.2 The dry density, γ_d in t/m³, shall be calculated from the equation :

$$\gamma_d = \frac{100\,\gamma_d}{100 + w}$$

*Methods of test for soils : Part 8 Determination of water content dry density relation using heavy compaction (*second revision*).

where

w = the moisture content of the soil (percent).

4.3.3 The dry densities, γ_d, obtained in a series of determinations, shall be plotted against the corresponding moisture contents, w. A smooth curve shall be drawn through the resulting points and the position of the maximum on this curve determined, and the zero, 5 percent and 10 percent air voids lines plotted for comparison.

5. REPORT

5.1 The experimental points and the smooth curve drawn through them showing the relationship between moisture content and dry density shall be reported.

5.2 The dry density corresponding to the maximum point on the moisture content/dry density curve shall be reported as the maximum dry density to the nearest 0·01.

5.3 The percentage moisture content corresponding to the maximum dry density on the moisture content/dry density curve shall be reported as the optimum moisture content and quoted to the nearest 0·2 for values below 5 percent to the nearest 0·5 for values from 5 to 10 percent and to the nearest whole number for values exceeding 10 percent.

5.4 The amount of soil retained on the 37·5 mm IS seive shall be reported to the nearest 1 percent.

5.5 The method of obtaining the result shall be stated. The procedure used shall also be stated, that is single sample or separate samples.

(*Continued from page* 2)

Members	*Representing*
ASSISTANT RESEARCH OFFICER (IPRI)	Public Works Department, Chandigarh
ASSISTANT RESEARCH OFFICER (SRD)	Irrigation Department, Government of Uttar Pradesh, Lucknow
DEPUTY DIRECTOR RESEARCH (GE-III), RDSO	Ministry of Railways
JOINT DIRECTOR RESEARCH (GE-I), RDSO (*Alternate*)	
DIRECTOR	Central Soil and Materials Research Station, New Delhi
DEPUTY DIRECTOR (*Alternate*)	
SHRI H. K. GUHA	Geologist Syndicate Private Limited, Calcutta
SHRI N. N. BHATTACHARAYA (*Alternate*)	
DR GOPAL RANJAN	University of Roorkee, Roorkee
DR S. C. HANDA (*Alternate*)	
DR SHASHI K. GULHATI	Indian Institute of Technology, New Delhi
SHRI P. JAGANATHA RAO	Central Road Research Institute (CSIR), New Delhi
LT-COL V. K. KANITKAR	Engineer-in-Chief's Branch, Army Headquarters
SHRI M. D. NAIR	Associated Instruments Manufacturers (I) Private Limited, New Delhi
PROF T. S. NAGARAJ (*Alternate*)	

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002

Telephones: 331 01 31, 331 13 75 Telegrams: Manaksanstha (Common to all Offices)

Regional Offices:	*Telephone*
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	331 01 31 331 13 75
*Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola, CALCUTTA 700054	36 24 99
Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036	2 18 43 3 16 41
Southern : C. I. T. Campus, MADRAS 600113	41 24 42 41 25 19 41 29 16
†Western : Manakalaya, E9 MIDC, Marol, Andheri (East), BOMBAY 400093	6 32 92 95
Branch Offices:	
'Pushpak', Nurmohamed Shaikh Marg, Khanpur, AHMADABAD 380001	2 63 48 2 63 49
‡Peenya Industrial Area 1st Stage, Bangalore Tumkur Road BANGALORE 560058	38 49 55 38 49 56
Gangotri Complex, 5th Floor, Bhadbhada Road, T. T. Nagar, BHOPAL 462003	6 67 16
Plot No. 82/83, Lewis Road, BHUBANESHWAR 751002	5 36 27
53/5, Ward No. 29, R.G. Barua Road, 5th Byelane, GUWAHATI 781003	3 31 77
5-8-56C L. N. Gupta Marg (Nampally Station Road), HYDERABAD 500001	23 10 83
R14 Yudhister Marg, C Scheme, JAIPUR 302005	6 34 71 6 98 32
117/418 B Sarvodaya Nagar, KANPUR 208005	21 68 76 21 82 92
Patliputra Industrial Estate, PATNA 800013	6 23 05
T.C. No. 14/1421, University P.O., Palayam TRIVANDRUM 695035	6 21 04 6 21 17
Inspection Offices (With Sale Point):	
Pushpanjali, First Floor, 205-A West High Court Road, Shankar Nagar Square, NAGPUR 440010	2 51 71
Institution of Engineers (India) Building, 1332 Shivaji Nagar, PUNE 411005	5 24 35

*Sales Office in Calcutta is at 5 Chowringhee Approach, P. O. Princep Street, Calcutta 700072 27 68 00

†Sales Office in Bombay is at Novelty Chambers, Grant Road, Bombay 400007 89 65 28

‡Sales Office in Bangalore is at Unity Building, Narasimharaja Square, Bangalore 560002 22 36 71

Reprography Unit, BIS, New Delhi, India