IS : 2720 (Part XXIX) - 1975
(Reaffirmed 1995)

Indian Standard

METHODS OF TEST FOR SOILS

PART XXIX DETERMINATION OF DRY DENSITY OF SOILS IN-PLACE BY THE CORE-CUTTER METHOD

(First Revision)

Third Reprint MARCH 1996

UDC 624·131·431·5

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

Gr 3 *March* 1976

Indian Standard

METHODS OF TEST FOR SOILS

PART XXIX DETERMINATION OF DRY DENSITY OF SOILS IN-PLACE BY THE CORE-CUTTER METHOD

(First Revision)

Soil Engineering Sectional Committee, BDC 23

Chairman	*Representing*
PROF DINESH MOHAN	Central Building Research Institute (CSIR), Roorkee
Members	
SHRI G. R. S. JAIN (*Alternate* to Prof Dinesh Mohan)	
PROF ALAM SINGH	University of Jodhpur, Jodhpur
DR A. BANERJEE	Cementation Co Ltd, Bombay
SHRI S. GUPTA (*Alternate*)	
SHRI K. N. DADINA	In personal capacity (*P-820 New Alipore, Calcutta 700053*)
SHRI A. G. DASTIDAR	In personal capacity [*Inter-State Equipment (P) Ltd, 3/1 Loudon Street, Calcutta 700017*]
SHRI R. L. DEWAN	Irrigation Research Institute, Khagaul, Patna
DR G. S. DHILLON	Indian Geotechnical Society, New Delhi
DIRECTOR	Land Reclamation, Irrigation & Power Research Institute, Amritsar
RESEARCH OFFICER (GEOTECHNICAL SECTION) (*Alternate*)	
DIRECTOR	Indian Institute of Technology, New Delhi
DR SHASHI K. GULHATI (*Alternate*)	
DIRECTOR (CSMRS)	Central Water Commission, New Delhi
DEPUTY DIRECTOR (CSMRS) (*Alternate*)	
SHRI A. H. DIVANJI	Rodio Foundation Engineering Limited; *and* Hazarat & Co, Bombay
SHRI A. N. JANGLE (*Alternate*)	
SHRI V. G. HEGDE	National Buildings Organisation, New Delhi
SHRI S. H. BALCHANDANI (*Alternate*)	

(*Continued on page* 2)

(*Continued from page* 1)

Members	*Representing*
JOINT DIRECTOR RESEARCH (FE), RDSO	Railway Board (Ministry of Railways)
DEPUTY DIRECTOR RESEARCH (SOIL MECHANICS), RDSO (*Alternate*)	
SHRI O. P. MALHOTRA	Public Works Department, Government of Punjab
SHRI J. S. MARYA	Roads Wing, Ministry of Transport & Shipping
SHRI N. SEN (*Alternate*)	
SHRI G. D. MATHUR	Public Works Department, Government of Uttar Pradesh
SHRI D. C. CHATURVEDI (*Alternate*)	
SHRI M. A. MEHTA	Concrete Association of India, Bombay
SHRI T. M. MENON (*Alternate*)	
SHRI T. K. NATARAJAN	Central Road Research Institute (CSIR), New Delhi
REPRESENTATIVE	Hindustan Construction Co Ltd, Bombay
MAJ K. M. S. SAHASI	Engineer-in-Chief's Branch, Army Headquarters
SHRI P. PUTHISIGAMANI (*Alternate*)	
SHRI K. R. SAXENA	Engineering Research Laboratory, Hyderabad
SECRETARY	Central Board of Irrigation & Power, New Delhi
DEPUTY SECRETARY (*Alternate*)	
DR SHAMSHER PRAKASH	University of Roorkee, Roorkee
SHRI H. D. SHARMA	Irrigation Research Institute, Roorkee
SUPERINTENDING ENGINEER (PLANNING AND DESIGN CIRCLE)	Concrete and Soil Research Laboratory, Public Works Department, Government of Tamil Nadu
EXECUTIVE ENGINEER INCHARGE (*Alternate*)	
SHRI C. G. SWAMINATHAN	Institution of Engineers (India), Calcutta
DR I. S. UPPAL	Building and Roads Research Laboratory, Chandigarh
SHRI H. C. VERMA	All India Instruments Manufacturers and Dealers Association, Bombay
SHRI V. K. VASUDEVAN (*Alternate*)	
SHRI D. AJITHA SIMHA, Director (Civ Engg)	Director General, ISI (*Ex-officio Member*)

Secretary

SHRI G. RAMAN
Deputy Director (Civ Engg), ISI

Soil Testing Procedures and Equipment Subcommittee, BDC 23 : 3

Convener	
PROF ALAM SINGH	University of Jodhpur, Jodhpur
Members	
SHRI N. K. BERRY	Beas Dam Project, Talwara Township
SHRI K. S. PREM (*Alternate*)	

(*Continued on page* 9)

Indian Standard

METHODS OF TEST FOR SOILS

PART XXIX DETERMINATION OF DRY DENSITY OF SOILS IN-PLACE BY THE CORE-CUTTER METHOD

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Part XXIX) (First Revision) was adopted by the Indian Standards Institution on 22 September 1975, after the draft finalized by the Soil Engineering Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 With a view to establishing uniform procedure for the determination of different characteristics of soils and also for facilitating comparative studies of the results, the Indian Standards Institution has brought out this Indian Standard methods of test for soils (IS:2720) which is published in parts. This part [IS:2720 (Part XXIX)-1975] deals with the determination of dry density of soil in-place by using a core-cutter. The in-place density of soil is needed for stability analysis, for the determination of the degree of compaction of compacted soil, etc. The core-cutter method covered by this part is suitable for fine-grained soils free from aggregations. It is less accurate than the sand-replacement method and is not recommended, unless speed is essential or unless the soil is well compacted. Other parts relating to in-place determination of density of soils are:

Part XXVIII Determination of dry density of soils in-place by the sand replacement method

Part XXXIII Determination of the density in-place by the ring and water replacement method

Part XXXIV Determination of density of soil in-place by the rubber-baloon method

0.2.1 This standard was first published in 1966. In this revision, the test has been made applicable to soil 90 percent of which passes the 4·75-mm IS Sieve. The dimensions and requirements of the core-cutter have been modified. Detailed requirements for the steel rammer required for the test have been spelt out.

0.3 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by basing the standard on the following publications:

BS 1377:1974 Methods of testing soils for civil engineering purposes. British Standards Institution.

INDIA. MINISTRY OF IRRIGATION AND POWER. CBIP Publication No. 42. Standards for testing soils, 1963. Central Board of Irrigation and Power, Delhi.

0.4 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 : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part XXIX) covers the method for the determination of the in-place density of fine-grained natural or compacted soils free from aggregates using a core-cutter.

1.1.1 For the purpose of the tests described in this standard, a soil shall be termed as fine-grained soil if not less than 90 percent of it passes a 4·75-mm IS Sieve.

2. APPARATUS

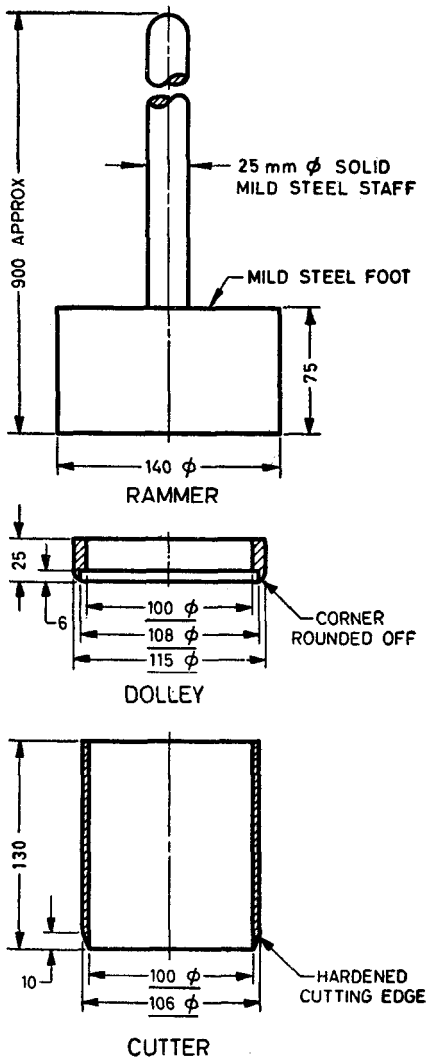
2.1 Cylindrical Core-Cutter — of seamless steel tube, 130 mm long (*see* Note 1) and 10 cm internal diameter, with a wall thickness of 3 mm, bevelled at one end, of the type illustrated in Fig. 1. The cutter shall be kept properly greased or oiled.

NOTE 1 — *Length of Cutter* — If the average density over a smaller depth is required then the appropriate length of cutter should be used.

NOTE 2 — Where situations permit, for quality control purposes smaller size cutters have also been used.

2.2 Steel Dolley — 2·5 cm high and 10 cm internal diameter with a wall thickness of 7·5 mm with a lip to enable it to be fitted on top of the core-cutter (*see* Fig. 1).

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



NOTE 1 — These designs have been found satisfactory, but alternative designs may be employed provided that the essential requirements are fulfilled.

NOTE 2 — Essential dimensions are underlined. (Tolerance on all essential dimensions shall be $\pm 0{\cdot}25$ mm).

All dimensions in millimetres.

FIG. 1 CORE-CUTTER APPARATUS FOR SOIL DENSITY DETERMINATION

2.3 Steel Rammer — With solid mild steel foot 140 mm diameter and 75 mm height with a concentrically screwed 25 mm diameter solid mild steel staff. The overall length of the rammer including the foot as well as the staff should be approximately 900 mm. The rammer (foot and staff together) should weigh approximately 9 kg (*see* Fig. 1).

2.4 Balance — Accurate to 1 g.

2.5 Palette Knife — A convenient size is one having a blade approximately 20 cm long and 3 cm wide.

2.6 Steel Rule

2.7 Grafting Tool or Spade or Pick Axe

2.8 Straight Edge — A steel strip about 30 cm long, 2·5 cm wide and 3 to 5 mm thick, with one bevelled edge will be suitable.

2.9 Apparatus for Extracting Samples from the Cutter — Optional.

2.10 Apparatus for Determination of Water Content — In accordance with IS : 2720 (Part II)-1973*.

3. PROCEDURE

3.1 The internal volume (V_c) of the core-cutter in cubic centimetres shall be calculated from its dimensions which shall be measured to the nearest 0·25 mm.

3.2 The cutter shall be weighed to the nearest gram (W_c).

3.3 A small area, approximately 30 cm square of the soil layer to be tested shall be exposed and levelled. The steel dolly shall be placed on top of the cutter and the latter shall be rammed down vertically into the soil layer until only about 15 mm of the dolly protrudes above the surface, care being taken not to rock the cutter (*see* Note). The cutter shall then be dug out of the surrounding soil, care being taken to allow some soil to project from the lower end of the cutter. The ends of the soil core shall then be trimmed flat to the ends of the cutter by means of the straight edge.

NOTE — The cutting edge should be kept sharp. The cutter should not be used in stony soils.

3.4 The cutter containing the soil core shall be weighed to the nearest gram (W_s).

3.5 The soil core shall be removed from the cutter and a representative sample shall be placed in an air-tight container and its water content (w) determined as in IS:2720 (Part II)-1973*.

*Methods of test for soils: Part II Determination of water content (*second revision*).

NOTE — It is necessary to make a number of repeat determinations (at least three) and to average results, since the dry density of the soil varies appreciably from point to point. The number of determinations should be such that an additional one would not alter the average significantly.

4. CALCULATIONS

4.1 The bulk density γ_b, that is, the weight of the wet soil per cubic centimetre shall be calculated from the following formula:

$$\gamma_b = \frac{W_s - W_c}{V_c}, \text{ g/cm}^3$$

where

W_s = weight of soil and core-cutter in g,

W_c = weight of core-cutter in g, and

V_c = volume of core-cutter in cm^3.

4.2 The dry density γ_d, that is, the weight of the dry soil per cubic centimetre shall be calculated from the following formula:

$$\gamma_d = \frac{100\ \gamma_b}{100 + w}, \text{ g/cm}^3$$

where

γ_b = bulk density (*see* **4.1**), and

w = water content of the soil (percent) to two significant figures.

5. REPORTING OF RESULTS

5.1 The results of the test shall be recorded in a suitable form. A recommended *proforma* for the record of the results of this test is given in Appendix A.

5.2 The following values shall also be reported:

a) Dry density of the soil to second place of decimal in g/cm^3, and

b) Water content of the soil (percent) to two significant figures.

APPENDIX A

(*Clause* 5.1)

DETERMINATION OF DRY DENSITY OF SOIL IN-PLACE (CORE-CUTTER METHOD)

A-1. The test results shall be tabulated as follows:

PROJECT: TESTED BY:

LOCATION: DATE:

1. Determination No.	1	2	3
2. Weight of core-cutter + wet soil (W_s), in g			
3. Weight of core-cutter (W_c), in g			
4. Weight of wet soil ($W_s - W_c$), in g			
5. Volume of core-cutter (V_c), in cm^3			
6. Bulk density $\left(\gamma_b = \frac{W_s - W_c}{V_c}\right)$, in g/cm^3			
7. Water content container No.			
8. Weight of container with lid (W_1), in g			
9. Weight of container with lid and wet soil (W_2), in g			
10. Weight of container with lid and dry soil (W_3), in g			
11. Water content (w), in percent $w = \frac{W_2 - W_3}{W_3 - W_1} \times 100$			
12. Dry density $\left(\gamma_d = \frac{100\ \gamma_b}{100 + w}\right)$, in g/cm^3			

(*Continued from page* 2)

Members	*Representing*
DR R. K. BHANDARI	Central Road Research Institute (CSIR), New Delhi
SHRI T. N. BHARGAWA	Roads Wing, Ministry of Transport & Shipping
SHRI A. S. BISHNOI (*Alternate*)	
DR A. K. CHATTERJEE	Public Works Department, Government of Uttar Pradesh
DR B. L. DHAWAN (*Alternate*)	
SHRI R. L. DEWAN	Irrigation Research Institute, Khagaul, Patna
DEPUTY DIRECTOR RESEARCH (SOIL MECHANICS)-I, RDSO	Railway Board (Ministry of Railways)
ASSISTANT DIRECTOR RESEARCH (SOIL MECHANICS)-I, RDSO (*Alternate*)	
DIRECTOR (CSMRS)	Central Water Commission, New Delhi
DEPUTY DIRECTOR (CSMRS) (*Alternate*)	
SHRI H. K. GUHA	Geologists' Syndicate Private Ltd, Calcutta
SHRI N. N. BHATTACHARAYA (*Alternate*)	
DR SHASHI K. GULHATI	Indian Institute of Technology, New Delhi
SHRI G. R. S. JAIN	Central Building Research Institute (CSIR), Roorkee
SHRI AMAR SINGH (*Alternate*)	
SHRI R. K. JAIN	United Technical Consultants Private Ltd, New Delhi
DR P. K. DE (*Alternate*)	
SHRI O. P. MALHOTRA	Building & Roads Research Laboratory, Punjab
DR I. S. UPPAL (*Alternate*)	
DR V. V. S. RAO	In personal capacity (*F-24 Green Park, New Delhi 110016*)
MAJ K. M. S. SAHASI	Engineer-in-Chief's Branch, Army Headquarters
SHRI P. PUTHISIGAMANI (*Alternate*)	
SHRI H. C. VERMA	Associated Instrument Manufacturers (India) Private Ltd, 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
Nortnern : 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
R1 4 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