IS 2720 (Part 10) : 1991
(Reaffirmed 1995)

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मृदा परीक्षण पद्धतियाँ

भाग 10 अपरिबद्ध सम्पीडन सामर्थ्य ज्ञात करना

(दूसरा पुनरीक्षण)

Indian Standard

METHODS OF TEST FOR SOILS

PART 10 DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH

(Second Revision)

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BUREAU OF INDIAN STANDARDS
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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by Soils and Soil Engineering Sectional Committee had been approved by the Civil Engineering Division Council.

With a view to establish uniform procedure for determination of different characteristics of soils, Indian Standard methods of test for soils (IS 2720) covering each property in separate parts have been brought out. This Part deals with method for determination of unconfined compressive strength of soils. For the determination of shearing strength a specimen may or may not be subjected to a lateral pressure during the test. When it is not, the test is known as unconfined compression test. The purpose of this test is to obtain a quantitative value of compressive and shearing strength of soils in an undrained state.

This standard was first published in 1964 and revised in 1973. In this second revision, the major modifications made are:

a) More details for the apparatus used for the test incorporated,

b) The method of preparation of specimen elaborated,

c) Procedure based on the experience gained in the use of this test in the past 15 years elaborated, and

d) Various formulae and values expressed in SI units.

Indian Standard

METHODS OF TEST FOR SOILS

PART 10 DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH

(Second Revision)

1 SCOPE

1.1 This Standard (Part 10) describes the method for determining the unconfined compressive strength of clayey soil, undisturbed, remoulded or compacted, using controlled rate of strain.

2 REFERENCES

2.1 The following Indian Standards are the necessary adjuncts to this standard.

IS No.	*Title*
2132 : 1986	Code of practice for thin-walled tube sampling of soils (*second revision*)
2720 (Part 2) : 1973	Methods of test for soils: Part 2 Determination of water content (*second revision*)

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply.

3.1 Unconfined Compressive Strength, q_u

It is the load per unit area at which an unconfined cylindrical specimen of soil will fail in the axial compression test.

NOTE — If the axial compression force per unit area has not reached a maximum value even at 20 percent axial strain, q_u shall be taken as the value obtained at 20 percent axial strain.

4 APPARATUS

4.1 Compression Device

The compression device may be any of the following types:

a) Platfom weighing scale equipped with a screw-jack activated yoke;

b) Hydraulic loading device;

c) Screw jack with a proving ring; and

d) Any other loading device.

All these loading devices shall have sufficient capacity and strain control.

4.2 Proving Ring

The selection of the proving ring shall depend on the following:

For relatively weak soil with q_u less than 100 KPa (1 kgf/cm^2) load shall be measurable to 1 KPa (·01 kg/cm^2). For soils with q_u equal to or greater than 100 KPa (1 kgf/cm^2) load shall be measurable to the nearest 5 KPa (0·05 kgf/cm^2). The calibration of the proving ring shall be checked frequently, at least once a year.

4.3 Deformation Dial Gauge

Axial deformation of the sample shall be measured with a dial gauge having a least count of 0·01 mm and travel to permit not less than 20 percent axial strain.

4.4 Vernier Callipers

Suitable to measure physical dimensions of the test specimen to the nearest 0·1 mm.

4.5 Timer

Timing device to indicate the elapsed testing time to the nearest second may be used for establishing the rate of strain.

4.6 Oven

Thermostatically controlled, with interior of non-corroding material capable of maintaining the temperature at 110°C ± 5°C.

4.7 Weighing Balances

Suitable for weighing soil specimens specially. Specimens of less than 100 g shall be weighed to the nearest 0·01 g whereas specimens of 100 g or larger shall be weighed to the nearest 0·1 g.

4.8 Miscellaneous Equipment

Specimen trimming and carving tools, remoulding apparatus, water content cans, data sheets, etc, as required.

5 PREPARATION OF TEST SPECIMEN

5.1 The type of soil specimen to be used for test shall depend on the purpose for which it is tested and may be compacted, remoulded or undisturbed.

NOTE — However this test specimen is not suitable for sample containing appreciable quantity of silt and sand.

5.2 Specimen Size

The specimen for the test shall have a minimum diameter of 38 mm and the largest particle contained within the test specimen shall be smaller than 1/8 of the specimen diameter. If after completion of test on undisturbed sample, it is found that larger particles than permitted for the particular specimen size tested are present, it shall be noted in the report of test data under remarks. The height to diameter ratio shall be within 2 to 2·5. Measurements of height and diameter shall be made with vernier callipers or any other suitable measuring device to the nearest 0·1 mm.

5.3 Undisturbed Specimens

Undisturbed specimens shall be prepared from large undisturbed samples or samples secured in accordance with IS 2132 : 1986.

5.3.1 When samples are pushed from the drive sampling tube the ejecting device shall be capable of ejecting the soil core from the sampling tube in the same direction of travel in which the sample entered the tube and with negligible disturbance of the sample. Conditions at the time of removal of the sample may dictate the direction of removal, but the principal concern should be to keep the degree of disturbance negligible.

NOTES

1 Three specimens obtained by trimming and carving from undisturbed soil samples shall be tested.

2 When the sample is ejected horizontally, a curved plate may be provided to butt against the sampling tube such that the ejected specimen slips over it freely. This will avoid bending of the specimen and facilitate bringing specimen to vertical position in many cases.

5.3.2 The specimen shall be handled carefully to prevent disturbance, change in cross section, or loss of water. If any type of disturbance is likely to be caused by the ejection device, the sample tube shall be split lengthwise or be cut off in small sections to facilitate removal of the specimen without disturbance. If possible carved specimen should be prepared in a humid room to prevent, as far as possible, change in water content of the soil.

5.3.3 The specimen shall be of uniform circular cross-section with ends perpendicular to the axis of the specimen.

5.3.4 Specimen of required size may be carved from large undisturbed specimens. When sample condition permits use of a vertical lathe, which will accommodate the total sample, the same may be used as an aid in carving the specimen to the required diameter. Tube specimens may be tested without trimming except for squaring of ends.

5.3.5 Where the prevention of the possible development of appreciable capillary forces is required, the specimens shall be sealed with rubber membranes, thin plastic coatings, or with a coating of grease or sprayed plastic immediately after preparation and during the entire testing cycle.

5.3.6 Representative sample cuttings taken from the tested specimen shall be used for the determination of water content.

5.4 Remoulded Specimen

The specimen may be prepared either from a failed undisturbed specimen or from a disturbed soil sample. In the case of failed undisturbed specimen, the material shall be wrapped in a thin rubber membrane and thoroughly worked with the fingers to assure complete remoulding. Care shall be taken to avoid entrapped air, to obtain a uniform density, to remould to the same void ratio as that of the undisturbed specimen, and to preserve the natural water content of the soil.

5.5 Compacted Specimen

When compacting disturbed material, it shall be done using a mould of circular cross-section with dimensions corresponding to those given in **5.3**. Compacted specimen may be prepared at any predetermined water content and density.

5.5.1 After the specimen is formed, the ends shall be trimmed perpendicular to the long axis and removed from the mould. Representative sample cuttings shall be obtained or the entire specimen shall be used for the determination of water content after the test.

6 PROCEDURE

6.1 The initial length, diameter and weight of the specimen shall be measured and the specimen placed on the bottom plate of the loading device. The upper plate shall be adjusted to make contact with the specimen.

6.2 The deformation dial gauge shall be adjusted to a suitable reading, preferably in multiples of 100. Force shall be applied so as to produce axial strain at a rate of 0·5 to 2 percent per minute causing failure with 5 to 10. The force reading shall be taken at suitable intervals of the deformation dial reading.

NOTE — Up to 6% axial strain force, readings may be taken at an interval of 0·5 mm of the deformation dial reading. After 6% axial strain, the interval may be increased to 1·0 mm and, beyond 12% axial strain it may be increased even further.

6.3 The specimen shall be compressed until failure surfaces have definitely developed, or the stress-strain curve is well past its peak, or until an axial strain of 20 percent is reached.

6.4 The failure pattern shall be sketched carefully and shown on the data sheet or on the sheet

presenting the stress-strain plot. The angle between the failure surface and the horizontal may be measured, if possible, and reported.

6.5 The water content of the specimen shall be determined in accordance with IS 2720 (Part 2) : 1973 using samples taken from the failure zone of the specimen.

7 CALCULATIONS AND PLOTTING

7.1 Stress-strain values shall be calculated as follows:

a) The axial strain, e, shall be determined from the following relationship:

$$e = \frac{\triangle L}{L_0}$$

where

$\triangle L$ = the change in the specimen length as read from the strain dial indicator, and

L_0 = the initial length of the specimen.

b) The average cross-sectional area, A, at a particular strain shall be determined from the following relationship:

$$A = \frac{A_0}{1 - e}$$

where

A_0 = the initial average cross-sectional area of the specimen.

c) Compressive stress, σ_0, shall be determined from the relationship:

$$\sigma_0 = \frac{P}{A}$$

where

P = the compressive force, and

A = average cross-sectional aera.

7.2 Values of stress σ_0 and strain e obtained from **7.1** shall be plotted. The maximum stress from this plot gives the value of the unconfined compressive strength q_u. In case no maximum occurs within 20 percent axial strain, the unconfined compressive strength shall be taken as the stress at 20 percent axial strain.

7.3 In the case of soils which behave as if the angle of shearing resistance $\phi = 0$ (as in the case of saturated clays under undrained conditions) the undrained shear strength or cohesion of the soil may be taken to be equal to half the unconfined compressive strength obtained from **7.2**.

8 REPORT

8.1 The observations of the test shall be suitably recorded giving details indicated in Annex A. A recommended *pro forma* for the record of observations is given in Annex A.

ANNEX A

(*Clause* 8.1)

PRO FORMA FOR RECORD OF OBSERVATIONS OF UNCONFINED COMPRESSION TEST

Project

Date:

Tested by:

A-1 Details of Soil Somples

i) Location
ii) Boring No.
iii) Depth
iv) Visual description of soil
v) Date of sampling

A-2 Details of apparatus used

A-3 Details of load measuring device

A-3.1 Calibration factor

A-4 Details of the soil specimens:

i) Undisturbed remoulded or compacted
ii) Specific gravity of the soil

iii) Initial diameter, D_0 _____ mm

iv) Initial length, L_0 _____ mm

v) Initial area, A_0 _____ cm^2

vi) Initial volume, V_0 _____ cm^3

vii) Initial mass of the specimen _____ g

viii) Initial density _____ g/cm^3

ix) Initial water content _____ percent

x) Initial degree of saturation _____ percent

xi) Where test has been performed at *in situ* density and water content/maximum dry density _____ optimum water content

A-5 Observations of compression test

Rate of Strain:

Deformation dial reading	Axial deformation (mm)	Axial strain e	Area (cm^2) $A = \frac{A_0}{1-e}$	Proving ring dial reading	Axial force N (kgf)	Compressive stress KPa (kg/cm^2)	Remark

A-6 Sketch of failed specimen and description of failure:

A-7 Water content of the specimen after test (determined from water content samples taken from the failure zone of the specimen)

A-8 Unconfined compressive strength (q_u) _____ KPa

A-9 Undrained shear strength (if applicable) _____ KPa

A-10 Remarks

NOTE — Remarks should include observations with reference to **5.2** regarding the maximum particle size in the specimen.

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