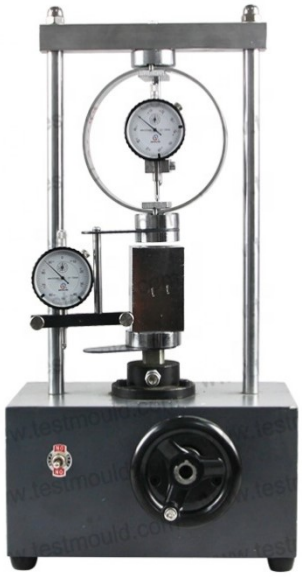
DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH OF SOIL

1. Objective: Unconfined Compressive Strength (UCS) stands for the **maximum axial compressive stress** that a cohesive soil specimen can bear under zero confining stress. Unconfined compression test is one of the fastest and cheapest methods of measuring shear strength of clayey soil.

Unconfined Compressive Strength (UCS) is the load per unit area at which an unconfined cylindrical specimen of soil will fail in the axial compression test. If the axial compression force per unit area has not reached a maximum value even at 20 percent axial strain, the UCS shall be taken as the value obtained at 20 percent axial strain.

2. Apparatus Required:

2.1 Compression Device

	The loading device shall have sufficient capacity and strain controlled. It may be any of the following type: (a) Platform 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.

2.2 Proving Ring

	For soils with UCS less than 100 KPa, load shall be measurable to 1 KPa. For soils with UCS greater than or equal to 100 KPa, load shall be measurable to nearest 5 KPa.

2.3 Deformation Dial Gauge, having a least count of 0.01mm and travel to permit not less than 20 percent axial strain.

2.4 Vernier Callipers, having least count of0.1mm.

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

2.6 Oven, thermostatically controlled with interior of non-corroding material and capable of measuring$110^{o} \pm 5^{o}$ C.

2.7 Weighing Balances, with least count of 0.01g if the specimen weight is less than 100g or least count of 0.1g if the specimen weight is equal to more than 100g.

2.8 Miscellaneous Equipment: Specimen trimming and carving tools, remoulding apparatus, water content cans etc.

3. Reference- IS 2720 (Part 10): 1991 (Reaffirmed 2020)"Determination of Unconfined Compressive Strength".

4. Preparation of Test Specimen:

4.1 Specimen Size: The specimen shall have a minimum diameter of 38mm and the largest particle in the specimen shall be smaller than 1/8 of the specimen diameter. After completion of test on the undisturbed sample, if it is found that the larger particles than permitted 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

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

4.2.1 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 in 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.

Note:

1. Three specimen 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 slipsover it freely. This will avoid bending of the specimen and facilitate bringing specimen to vertical position in many cases.

4.2.2 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 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.

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

4.2.4 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.

4.2.5 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 or grease or sprayed plastic immediately after preparation and during the entire testing cycle.

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

4.3 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.

4.4 Compacted Specimen: When compacting disturbed material, it shall be done using a mould of circular cross-section with dimensions corresponding to those given in Para 4.2 above. Compacted specimen may be prepared at any predetermined water content and density.

4.4.1 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.

5. Procedure:

5.1 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.

5.2 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 % 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.

5.3 The specimen shall be compressed until failure surfaces have definitely developed, or until an axial strain of 20% is reached.

5.4 The failure pattern shall be sketched carefully and shown on the data sheet or on the sheet presenting the stress- strain plot.

5.5 The water content of the specimen shall be determined from the failure zone of the specimen.

6. Calculations and Plotting:

6.1 Stress-strain values shall be calculated as follows:

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

$$e = \Delta_L / L_0$$

Where:

Δ_L = the change in the specimen length as read from the strain dial indicator, and

L_o= the initial length of the specimen.

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

$$A = A_0 / (1-e)$$

Where:

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

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

$$\sigma_0 = P/A$$

Where:

P= the compressive force, and

A= average cross-sectional area.

6.2 Values of stress σ_0 and strain e obtained shall be plotted. The maximum stress from plot gives the value of the unconfined compressive strength (q_u). In case no maximum occurs within 20% axial strain, the unconfined compressive strength shall be taken as the stress at 20% axial strain.

6.3 In the case of soils which behave as if the angle of shearing resistance Ø=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 in Para 6.2 above.

7. Report:

The observations of the test shall be suitably recorded giving details indicated in the recommended pro forma given below:

Date:

Project: Tested by:

1. Details of Soil Samples
   - i) Location
   - ii) Boring No.
   - iii) Depth
   - iv) Visual description of soil
   - v) Date of sampling

2. Details of apparatus used:

3. Details of load and measuring device
   - 3.1 Calibration factor

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 — mm
   - 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) Whether test has been performed at in-situ density and water content/ maximum dry density — optimum water content

5. Observations of compression test

   Rate of Strain

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

6. Sketch of failed specimen and description of failure:

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

8. Unconfined compressive strength (q_u) KPa

9. Undrained shear strength (if applicable) KPa

10. Remarks

8. Video

9. Download