SMG-10: UNCONFINED COMPRESSION TEST (UCT)

Reference Standard: BS 1377: 1975, Test 20, ASTM D 2166, ISO 17892-7:2017

INTRODUCTION

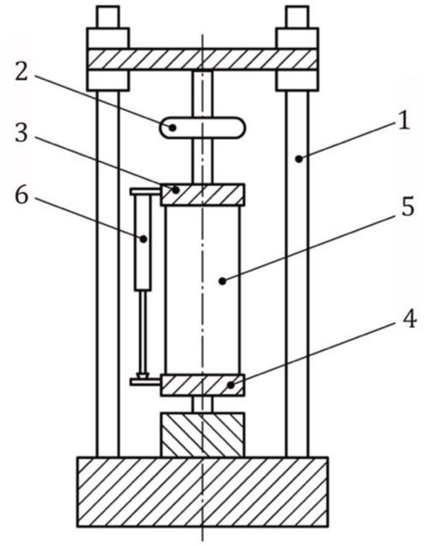
This procedure is applicable to the determination of the unconfined compressive strength for a homogeneous specimen in undisturbed, re-compacted, remoulded or reconstituted soil under compression loading within the scope of geotechnical investigations.

The unconfined compression test is the most popular method of soil shear testing because it is one of the fastest and least expansive methods of measuring shear strength. It is primarily used for saturated, cohesive soils recovered from thin-walled sampling tubes. The test is not applicable for dry sands or crumbly clays.

The unconfined compression test is strain-controlled, and when the soil sample is loaded rapidly, no pore water is lost from the sample during set-up or during the shearing process. A saturated sample will thus remain saturated during the test with no change in the sample volume, water content, or void ratio. Since, the pore pressures are not measured in an unconfined compression test; consequently, the effective stress is unknown. Hence, the undrained shear strength measured in an unconfined test is expressed in terms of the total stress. This condition is representative of soils in construction sites where the rate of construction is very fast, and the pore waters do not have time to dissipate.

For soils, the undrained shear strength (c_u) is necessary for the determination of the bearing capacity of foundations, dams, etc. The undrained shear strength (c_u) of clays is commonly determined from an unconfined compression test. The undrained shear strength (c_u) of cohesive soil is equal to one-half of the unconfined compressive strength (q_u) when the soil is under Ø = 0 condition (Ø is the angle of internal friction). The most critical condition for the soil usually occurs immediately after construction, which represents undrained conditions. The condition when the undrained shear strength is basically equal to the cohesion (C). This is expressed as:

$$c_u = c = \frac{q_u}{2}$$



Key
1 load frame
2 load measuring device
3 top platen
4 bottom platen
5 soil specimen
6 displacement measuring device

Figure 1 Schematic diagram of a typical unconfined compression apparatus (Source: ISO 17892-7:2017)

DATA PROCESSING

1) Convert the dial readings to the appropriate load and length units, and enter these values on the data sheet in the deformation and total load columns.
2) Compute the sample cross-sectional area $A_0 = \frac{\pi}{4} \times d^2$
3) Compute the strain,_$\varepsilon = \frac{\Delta L}{L_0}$
4) Compute the corrected area, $A' = \frac{A_0}{1-\varepsilon}$
5) Using A', compute the specimen stress, $\sigma = \frac{P}{A'}$
6) Compute the water content , w%.
7) Complete the table provided and show one sample calculation.
8) Plot the stress versus strain. Show maximum value of stress, $\boldsymbol{q_u}$ or at 15% strain, whichever occurs first.
9) Draw Mohr's circle using q_u and show the undrained shear strength, $S_u = c$ (or cohesion) = q_u /2 .

OBJECTIVES

1) To determine the unconfined compressive strength (q_u) of the soil
2) To observe the mode of failure of the soil specimen.

APPARATUS

List out equipment and apparatus use in the experiment complete with figures.

PROCEDURE

SAMPLE PREPARATION

1) The cross-sectional area of the specimen may either be circular or square and shall be at least 34 mm in diameter or 1000 mm^2 in area.
2) For cylindrical specimens, the ratio between height and diameter shall be between 1.8 and 2.5. For square specimens, the ratio between the height and length of the side shall be between 2.0 and 2.8.
3) Examine the sample prior to testing. If significant disturbance is apparent in the specimen, this should be recorded in the test report. Highly disturbed samples will not provide meaningful results and should not be tested.
4) The soil specimen end surfaces shall be plane and perpendicular to the longitudinal axis. Remove grooves and holes in the ends and sides of the specimen by further trimming or select new specimen, if available. Otherwise, fill grooves or holes not exceeding 1/6 of the specimen diameter with remoulded sample material.
5) Handle specimens carefully to prevent disturbance, changes in cross section or loss of water content.
6) Measure the specimen height, diameter and mass immediately before the test and record the values on the data sheet.
7) Calculate the deformation (ΔL) corresponding to 15% strain (ε).

$$Strain\ (\varepsilon) = \frac{\Delta L}{L_0}$$

8) Where L_0= Original specimen length (as measured in step 6).Place the specimen in the loading device so that it is centred with the top and bottom platens.

INITIAL READINGS

9) Carefully adjust the loading device so that the upper platen is about to contact with the specimen.

10) Zero the deformation indicator and the providing ring dial gauge.
11) Compress the specimen at a strain rate between 1% and 2% of the specimen height per minute. Report the strain rate in the data sheet.
12) Record load, deformation and time values at 20 seconds intervals to define the shape of the stress-strain curve. Successive loads are determined by multiplying proving ring dial readings by the providing calibration factor.
13) Continue loading until (1) the three or more consecutive readings of the load dial show a decreasing significantly, (2) the load holds constant for at least four deformation dial readings, or (3) the deformation is significantly past the 15% strain that was determined in step 7.

DISMOUNTING

14) Unload the specimen and remove it from the apparatus.
15) Sketch or photograph the specimen illustrating the mode of failure . Measure its inclination to the horizontal to the nearest 1° by using a protractor. Record any other features which are visible. Note: Make the sketch before removing it from the platen if the specimen is likely to fall apart.
16) Determine the bulk density and dry density of the specimen.

Calibration Chart for Load Measuring Ring:

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ELE International

COMPRESSION

Calibration Chart for Load Measuring Ring

Ring Serial Number:	1155-16-11903C	Temperature at calibration:	22.0 °C
Gauge Serial Number:	H8098.	Deflection must not exceed:	1230 divisions
Nominal capacity:	2.0kN	**Important:** Before loading, ensure that the dial gauge stem is in contact with the adjustable anvil and that the gauge is set to **zero** divisions.	
Calibration valid from:	Date of sale		

Load kN	Gauge Reading	Load kgf	Gauge Reading	Load lbf	Gauge Reading
0.0	0.0	0	0.0	0.0	0.0
0.2	118.3	20	116.0	45.0	118.4
0.4	238.8	40	234.2	90.0	239.0
0.6	360.2	60	353.2	135.0	360.5
0.8	479.8	80	470.5	180.0	480.2
1.0	601.4	100	589.7	225.0	601.9
1.2	721.5	120	707.5	270.0	722.1
1.4	844.2	140	827.8	315.0	844.9
1.6	969.0	160	950.3	360.0	969.8
1.8	1091.2	180	1070.1	405.0	1092.1
2.0	1215.0	200	1191.5	450.0	1216.1

The ring was calibrated in compression against proving device no. M2, NPL certificate reference 08F01/99336/LL233/14

Signed: [signature]

DATASHEET

Initial sample diameter, D = ________________ mm

Initial sample length, L_o = _________________ mm

Initial sample weight = ___________________ g

Sample area, A_o = _____________________ mm^2

Date tested: __________________

Deformation dial: 1 unit = 0.01 mm

Proving ring no.: _____________

Proving ring calibration: _________________ kN/div

Time, t (sec.)	**Load Dial Reading (div.)**	**Deformation, ΔL (mm) X 0.01**	**Strain, ε**	**% Strain**	**Corrected Area, A' (m^2)**	**Load, P (kN)** = Load Dial Reading X Proving Ring Calibration	**Stress, σ (kPa)**