UNCONFINED COMPRESSION TEST

(IS-2720-PART-10-1991) Reaffirmed-2006

THEORY:

Unconfined compression (UC) test also known as uniaxial compression tests, is a special case of a triaxial test, where confining pressure is zero. It is very quick and simple test as compared to triaxial test and does not require the sophisticated triaxial setup. In this test, a cylindrical specimen of soil without lateral support is tested to failure in simple compression, at a constant deformation rate. Compressive load per unit area required to fail the specimen without any confinement is called **unconfined compressive** strength of the soil. This test is mainly performed for the cohesive soil, whose specimens can stand without any support.

NEED AND SCOPE:

Unconfined compression test gives undrained shear strength (S_u) of cohesive soils. S_u is useful in determination of bearing capacity of soil, stability of earthen dam embankments (cohesive soil is used in the core of earthen dam) etc. One of the critical conditions for stability of earthen embankments occurs, immediately after construction, which represents the undrained condition. In such conditions, undrained shear strength obtained from UC test can be helpful for stability analysis.

APPARATUS REQUIRED:

Undisturbed Specimen Preparation

1) Hydraulic sample extractor
2) Sampling tubes/ Extraction tubes of required diameter
3) Metal cap for sampling tubes
4) Wire saw/ Soil Trimmer
5) Split sampler
6) Weighing balance of sensitivity 0.01 gm
7) Silicon spray

Remolded Specimen Preparation Using Moist Tamping Method

1) Split mold of same diameter as of specimen with bottom plate and collar arrangement
2)Mixing bowls
3) Cylindrical block with markings
4) Rammer to apply blows
5) Knife
6) Weighing balance of sensitivity 0.01 gm
7) Silicon spray

UC Test

1) Loading frame capable of generating constant rate of deformation.
2) Proving ring (Capacity ranging from 1 kN to 50 kN)
3) Bottom platen of required diameter made with perspex glass (diameter of the platen is selected according to the diameter of the sample).
4) Top cap of required diameter made with perspex glass, having a circular impression to accommodate steel ball arrangement (diameter of the plate is selected according to the diameter of the sample).
5) Dial gauge (0.01 mm accuracy)

PREPARATION OF SPECIMEN:

In this test, a cylindrical specimen of soil with aspect ratio 2 without lateral support is tested to failure in simple compression, at a constant deformation rate (1.25 mm/min, 2.25 mm/min, 2.5 mm/min). The compressive load per unit area required to fail the specimen is called unconfined compressive strength of the soil.

A. Undisturbed specimen

1. Note down the sample number, bore-hole number and the depth at which the sample was taken.
2. Remove the protective cover (paraffin wax) from the shallby tubes.
3. Place the sampling tube extractor and push the plunger till a small length of sample moves out.
4. Trim the projected sample using a wire saw, and push the plunger until a sample larger than required length comes out.
5. Cutout this sample carefully and hold it on the split sampler so that it does not fall and trim the specimens to required height.
6. Take about 10 to 15 g of soil from the tube for water content determination.
7. Measure the diameter at top, middle, and bottom of the sample. Find the average and record the same.
8. Measure the weight of the sample and record.

If the extracted sample has cracks, it can not be used for testing. Remolded specimens at in-situ density and water content needs to be prepared to conduct UC test.

B. Remolded sample

1. For the desired water content and the dry density, calculate the weight of the dry soil, W_S, required for preparing a specimen of required dimensions (diameter and height)
2. Add required quantity of water, w_w, to this soil.

$$W_W = W_S \times W/100 \text{ gm}$$

3. Mix the soil thoroughly with water.
4. Divide the wet soil into equal parts same as the number of the layers in which the soil is to be compacted.
5. Apply silicon spray coating on the inner side of split mold and bottom plate of mold.
6. Place the soil required for one layer in the split mold arrangement with bottom cap and collar.
7. Compact the soil using the cylindrical block and rammer until the required height of layer is achieved.

8. Check the height of the layer using the markings on the cylindrical block.
9. Scratch the layer before placing the soil for next layer to assure the proper bonding between two layers.
10. Repeat steps 7-9 for each layer until required height of specimen is achieved.
11. Extract the specimen from the split mold.
12. Record the height, weight and diameter of the specimen.

PROCEDURE:

1. Place the bottom platen on the loading frame and then place the specimen on bottom platen.
2. Place the top cap on the specimen and a steel ball on the circular impression of top cap.
4. Adjust the center line of the specimen such that the proving ring and the steel ball are in the same line.
5. Fix a dial gauge to measure the vertical compression of the specimen.
6. Adjust the gear position on the load frame to give suitable deformation rate. The deformation rate of 1.25 mm/min is commonly used to conduct the UC test on soil specimens of 38 mm diameter
7. Start applying the load and record the readings of the proving ring and compression dial for every 25 dial gauge reading.
8. Continue loading till failure or 20% axial strain (whichever is reached earlier) (IS-2720-PART-10-1991), and then take the picture of the failure pattern of the specimen
9. Repeat the procedure for atleast three specimens

OBSERVATION AND READING:

Data Sheet for Unconfined Compression Test

Project: Tested by:
Location: Boring No. :
Depth:

Sample details:

Type Undisturbed/Remoulded:

Dry density = _____ g/cc

Water content (%) = _____

Degree of saturation = _____ %

Diameter (D_o) of the sample _____ cm

Area of cross-section = _____ cm^2

Initial height (L_o) of the sample =_____ cm

Proving ring constant = _____

Dial gauge constant = _____mm

Deformation rate= _____ mm/min

Elapsed time (minutes)	Compression dial reading (divisions)	Axial deformation, ΔL (mm)	Axial Strain (ΔL / L_o) *100 (ε %)	Corrected Area A= A_o / (1-(ε/100)) $(cm)^2$	Proving ring reading (Divns)	Axial load (kN)	Compressive stress (kPa)

CALCULATIONS:

1. Axial stress = (Proving ring reading x Proving ring constant) / A_{corr}

2. $A_{corr} = A_0 / (1-\varepsilon)$; A_0 is initial cross-sectional area of the soil specimen, ε is the axial strain at that point of loading.

3. Repeat the test 3 times.

4. Plot the axial stress- axial strain curve for all three specimens on a single plot

5. Maximum axial stress is obtained, which is also considered to be the failure point of the specimen. Find the average value of maximum axial stress obtained in all three UC tests.

6. Unconfined compression strength of the soil, q_u = average value of maximum axial stress of three tests (If the plots are not overlapping and the variation in the maximum values are quite high, then the tests should be repeated until three similar plots are obtained)

7. Shear strength of the soil (cohesion, c) = $q_u/2$

8. Sensitivity = (q_u for undisturbed sample)/ (q_u for remoulded sample).