UNCONSOLIDATED UNDRAINED TRIAXIAL TEST (QUICK TEST)

SOIL MECHANICS

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Test for determination of shear strength of Silts and Clays

1. General

When conducting site investigations for buildings, in most circumstances short term stability will be the most critical. Therefore this document will deal only with the determination of total shear strength parameters of cohesive soils using, Unconsolidated Undrained Tests.

There may be instances where effective shear strength parameters are required, and they would require other forms of tests such as Consolidated Undrained or Drained. Determination of those parameters will be dealt with in the proposed Sri Lankan standard on laboratory testing of soils.

Specimens used for the test are of cylindrical shape and should be undisturbed. Specimen is subjected to a confining fluid pressure in a triaxial chamber and axial load (deviator load) is applied in a strain controlled or stress controlled manner. In all stages of the test undrained conditions are maintained without allowing for any pore water pressure dissipation. Method does not generally measure pore water pressures and parameters determined are therefore in terms of total stresses.

2. Apparatus

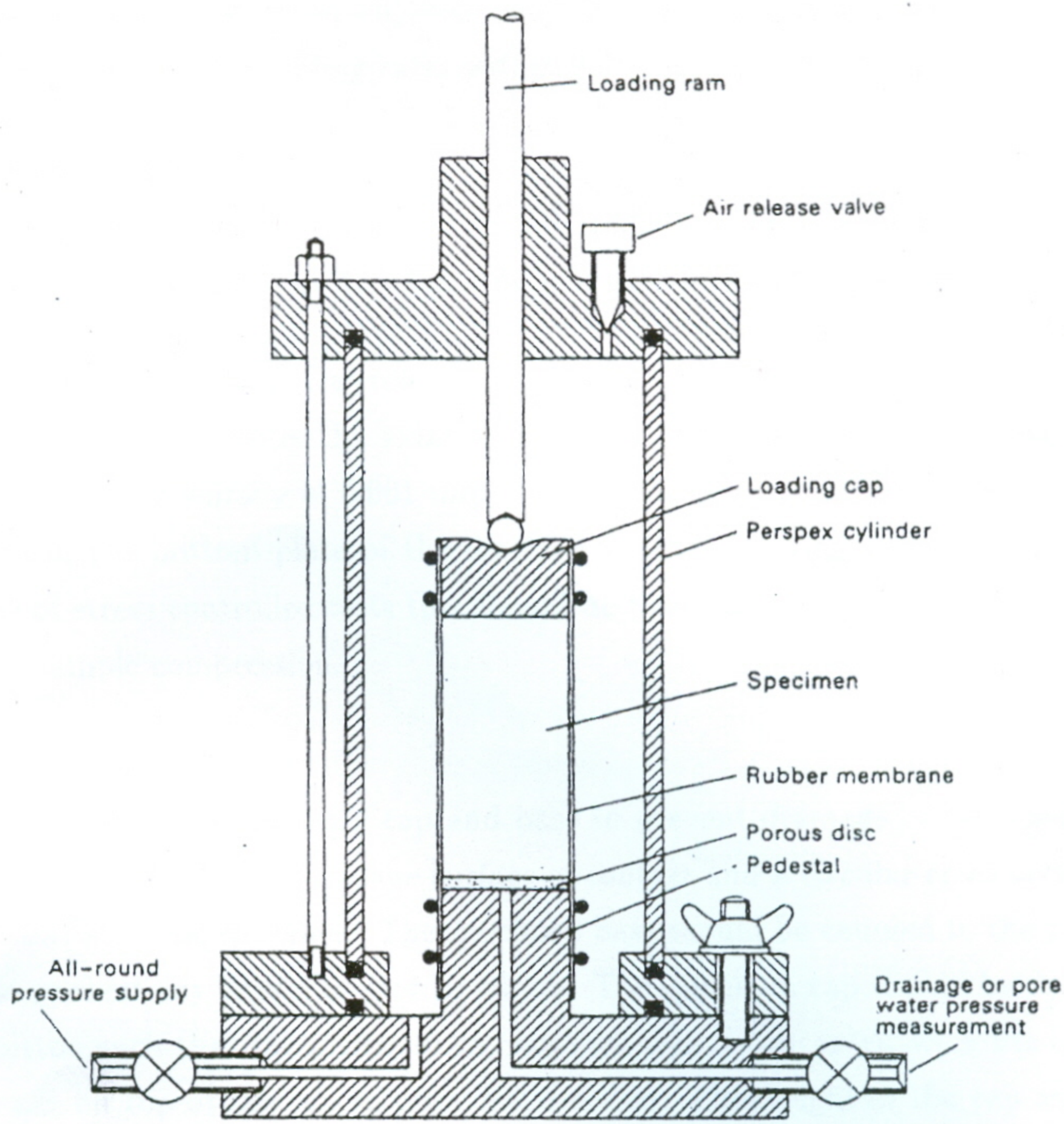
Figure 1 depicts the assembled apparatus with a specimen in position. Different parts of the apparatus are listed below and standards they should comply with are outlined.

Triaxial Compression Chamber

An apparatus shall be provided to keep the cylindrical soil specimen, enclosed by a rubber membrane sealed to the specimen cap and base, under the applied chamber pressure. The apparatus shall include a bushing and piston aligned with the axis of the specimen. Axial load is applied to the specimen through this system and friction in the system should be minimized.

Chamber Pressure Application device

There shall be a system capable of applying and maintaining the chamber pressure constant at the desired value (within 10 kPa) throughout the test. This device is connected to the triaxial chamber through pressure control devices. Pressure may be applied through hydraulic pressure system or by compressed air.



Loading ram
Air release valve
Loading cap
Perspex cylinder
Specimen
Rubber membrane
Porous disc
Pedestal
All-round
pressure supply
Drainage or pore
water pressure
measurement

Figure 1

Axial Loading Device

There shall be a device to provide the axial load in a specified controlled manner at the desired rate. It should have a sufficient loading capacity and should be free from vibrations. It may be a by a screw jack driven by an electric motor through geared transmission, a hydraulic pneumatic loading device or any other suitable device. If it is a strain controlled device it should be capable of providing rates within 0.05 mm/min to 10 mm/min.

Axial Load Measuring Device

There shall be a device to measure the deviator load applied to the specimen. This may be a Proving ring, hydraulic load cell or an electronic load cell with sufficient accuracy.

Axial Deformation Measuring Device

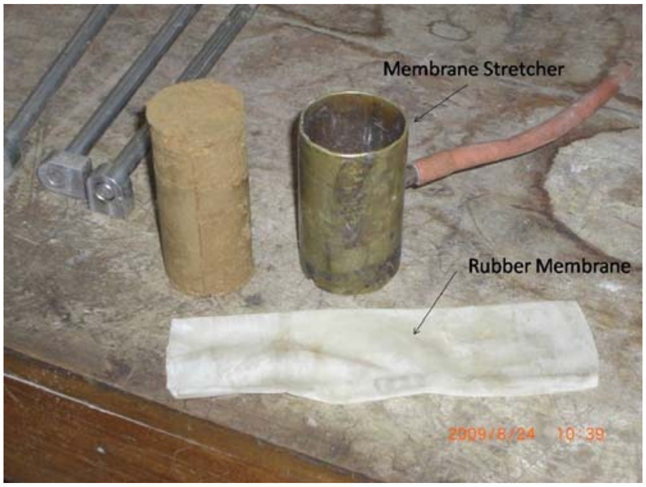
There shall be a device to measure the axial deformation of the specimen. This may be a dial gauge reading to an accuracy of 0.001 mm. In the case of a strain controlled test this may be attached to the bottom plate of the machine which is moving up at the constant rate. In the case of stress controlled tests this should be fixed to an appropriate position to directly read the sample compression.

Specimen cap and base

There should be an impermeable, rigid cap and base to prevent drainage of the specimen. Both the cap and base should have a plane surface of contact and a circular cross section of diameter equal to that of the specimen. The specimen base should be coupled to the triaxial chamber base to prevent any lateral motion or tilting. The specimen cap should be designed to receive the piston such that the piston to cap contact area is concentric with the cap. A hole shall be made on top of the cap to receive the piston. The weight of the cap shall be less than 0.5% of the anticipated applied axial load at failure.

Rubber Membranes, Membrane stretcher and 0 - rings

Rubber membranes should be used to encase the specimen to provide reliable protection against leakage. Membranes should be carefully inspected prior to use, and those with any flaws or pin-holes should be discarded. The membrane thickness shall not exceed 1 % of the diameter of the specimen. The unstretched membrane diameter shall be between 75% and 90% of the specimen diameter. The membrane shall be sealed to the specimen base and cap with rubber 0 - rings with diameter less than 75% of the specimen diameter. There shall be a membrane stretcher to suit the size of the specimen.



Sample Extruder

There should be a sample extruder capable of extruding the sample core from the tube. Movement of the sample should be of the same direction of its entrance to tube. If the sample is not extruded vertical, care should be taken to avoid bending stresses in the core due to gravity.

Devices for Specimen Weighing and Measuring

There should be a device to measure the height and diameter of the specimen to the nearest 0.3 mm and a weighing device to weigh the soil to the nearest 0.01 g.

3. Procedure

3.1 Preparation of the Sample

Specimens used for the test shall be undisturbed. They should be of a minimum diameter 33 mm and a have a length/diameter ratio between 2 and 3. Specimen should be weighed to the nearest 0.01 g prior to the testing.

Specimens should be handled very carefully to minimize disturbance, change cross section or loss of moisture. Specimens shall be uniform circular cross section with ends perpendicular to the axis of the specimen. If excessive irregularities are present at the ends due to crumbling, crushing or pebbles, ends may be packed with soil from the trimmings to produce the desired surface.

Weight of the specimen should be determined and encased by the membrane and sealed to the specimen base and cap immediately after the preparation, with the help of O rings.

3.2.1 Procedure of Testing

Triaxial chamber shall be assembled with the specimen encased in rubber membrane, and sealed to the specimen cap and base and kept in position. Axial load piston should be brought to contact with the specimen cap and proper seating should be provided.

When dealing with soft soils special care must be taken not to overload the specimen with the weight of the piston. Chamber shall be filled with the confining fluid (usually water) and placed in position in the axial loading device. Special care should be taken in aligning the axial load device, the axial load measuring device and the triaxial chamber to prevent application of lateral force to the piston during testing. Thereafter the chamber pressure maintaining and measuring device shall be attached and adjusted to provide the desired chamber pressure.

Axial load measuring device is usually located outside the triaxial chamber and chamber pressure will produce an upward force on the piston that will react against the axial loading device. In this case axial load measuring device should be adjusted to read zero prior to the application of the deviator load.

3.2.2 Application of the Axial Load (Using Controlled Strain)

The axial load may be applied at the desired strain rate, approximately 10 min after the application of chamber pressure. Proving ring readings should be recorded for intervals of axial deformation. Sufficient readings should be taken to capture the stress-strain curve. Thus more frequent reading are required, at the initial stages to capture the initial stiff part of the curve and also as the failure approaches to capture the failure point.

If the sample has not failed showing a reduction in the deviator load, loading shall be continued to 15% strain. If the residual strengths are required test may be continued further.

❖ **Note**

At the end of the test specimen shall be taken out, failure patterns may be noted and moisture content of the sample should be determined. Test should be performed on at least two other identical samples at different chamber pressures to construct the failure envelope and to determine the shear strength parameters.

4. Presentation of Results

Report should include

1. The state of the sample; i. e. undisturbed / remoulded
2. Whether the test is strain controlled or stress controlled, and rate of strain/ stress used in the test,
3. Visual description of specimen, perhaps with the soil group symbol,

4. Initial dry unit weight and moisture content for all the specimen tested at different cell pressures,
5. Deviator stress at failure at different cell pressures, and therefore the minor and major principal stresses,
6. Axial strain at maximum deviator stress for all cell pressures,
7. Remarks about any unusual conditions observed or failure patterns observed,
8. Mohr circles of stress at failure for all the cell pressures
9. Soil shear strength parameters C_u and $Ø_u$
10. Deviator stress vs. Axial strain information for all the cell pressers together with the stress strain curves

Name of the Organization			
Unconsolidated Undrained Triaxial Test Load – deformation Readings			
Project			
B.H. No:		Depth	
Load Gauge Constant (N/Div) = Initial Length of the Specimen (mm) = Initial Diameter of the Specimen (mm) =			
Mass of the Specimen (g) Mass of Wet sample + can (g) Mass of Dry sample + can (g) Mass of can (g)			
Moisture Content (%)			
Dry Density kg/m^3			
Displacement in mm	Load Gauge Readings for Cell pressure		

Dia (mm) = 38			height (mm) = 85			Area (m^2) = 0.0011335		
Client:			Project:					
Proving constant = 1.828			BH Num = BH 10			Depth = 1.0 – 2.0 m		
Deflection	P-ring 1	P-ring 2	P-ring 3	Strain	Area	Dev st.1	Dev st.2	Dev st.3
0	0	0	0	0	0.001134	0	0	0
10	11	9	25	0.00298824	0.00113694	17.69	14.47	40.20
25	21	35	27	0.00747059	0.00114207	33.61	56.02	43.22
50	48	50	52	0.01494118	0.00115073	76.25	79.43	82.60
75	63	58	63	0.02241176	0.00115953	99.32	91.44	99.32
100	70	64	69	0.02988235	0.00116846	109.51	100.13	107.95
150	84	73	84	0.04482353	0.00118673	129.39	112.45	129.39
200	93	82	93	0.05976471	0.00120559	141.01	124.33	141.01
250	99	83	98	0.07470588	0.00122506	147.73	123.85	146.23
300	103	84	102	0.08964706	0.00124517	151.21	123.32	149.74
350	108	85	104	0.10458824	0.00126594	155.95	122.74	150.17
400	109	87	109	0.11952941	0.00128743	154.77	123.53	154.77
450	110	90	113	0.13447059	0.00130965	153.54	125.62	157.72
500	112	95	113	0.14941176	0.00133265	153.63	130.31	155.00
550	112	95	112	0.16435294	0.00135648	150.93	128.02	150.93
						155.95	130.31	157.72

Wet weight	Dry weight	Can weight	Mass	Bulk Density	Dry Density
130.36	99.32	10.32	0.348764	173.16	1797.18
153.22	119.34	9.99	0.309831	178.96	1857.38
154.54	120.32	10	0.310189	180.56	1873.98

Specimen calculation

Applied cell pressure = 100 KN/m^2

Axial deformation dial reading = 75

Axial deformation = 75 x 0.001 x 25.4

= 1.905 mm

Axial strain = 0.022411

There is no drainage.

Thus the test is done under constant volume conditions.

$$AL = A_0 L_0$$

$$A = \frac{A_o L_o}{L} \quad \text{and} \quad L = L_o - L_o\,\varepsilon = L_o(1-\varepsilon)$$

$$A = \frac{A_o L_o}{L_o(1-\varepsilon)}$$

$$A = \frac{A_o}{(1-\varepsilon)}$$

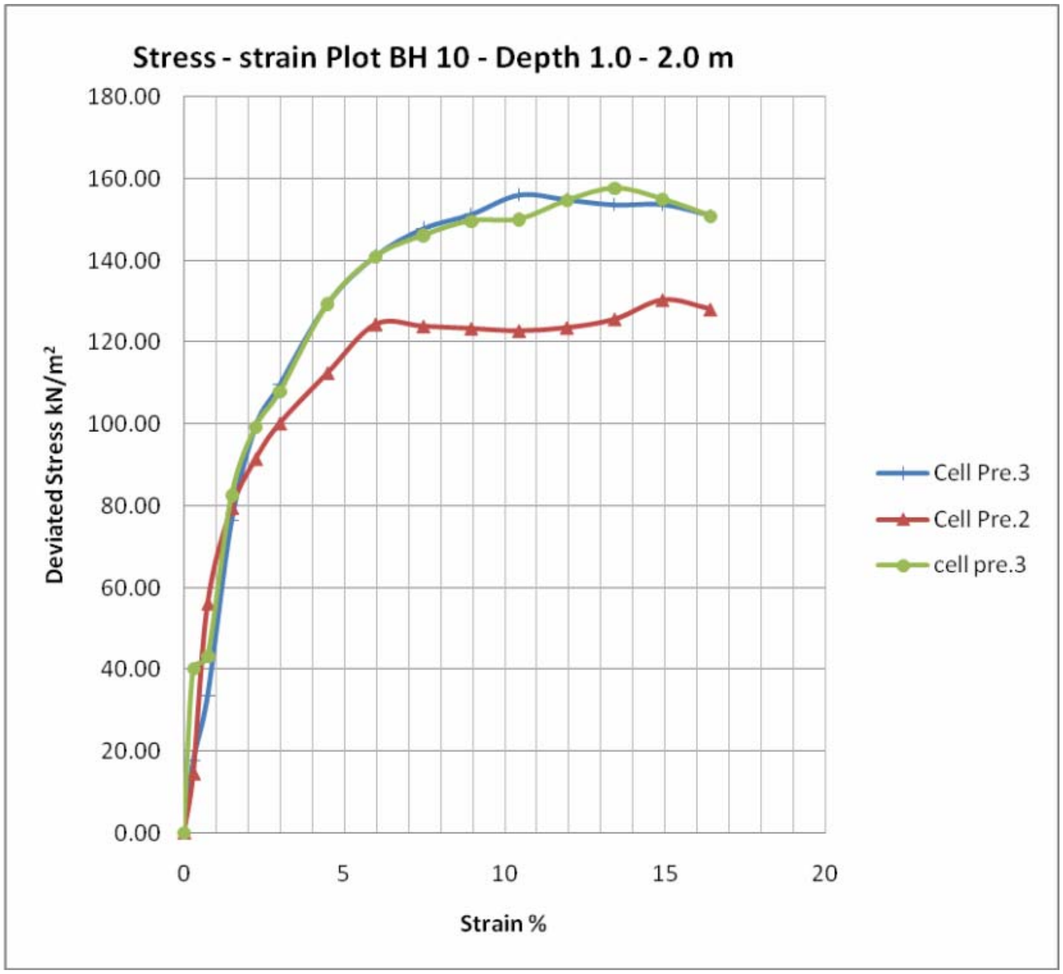
Deviator Load = 58 x 1.828

= 106.024 N

Deviator Stress = 106.024 / (1000 x 0.00115953)

= 91.44 kN / m^2

UU Test – Data for the Stress – Strain Plot			
Strain %	Cell Pressure 1	Cell Pressure 2	Cell Pressure 3
0	0.00	0.00	0.00
0.002988	17.69	14.47	40.20
0.007471	33.61	56.02	43.22
0.014941	76.25	79.43	82.60
0.022412	99.32	91.44	99.32
0.029882	109.51	100.13	107.95
0.044824	129.39	112.45	129.39
0.059765	141.01	124.33	141.01
0.074706	147.73	123.85	146.23
0.089647	151.21	123.32	149.74
0.104588	155.95	122.74	150.17
0.119529	154.77	123.53	154.77
0.134471	153.54	125.62	157.72
0.149412	153.63	130.31	155.00
0.164353	150.93	128.02	150.93



Stress - strain Plot BH 10 - Depth 1.0 - 2.0 m
Deviated Stress kN/m²
Strain %
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0
5
10
15
20
Cell Pre.3
Cell Pre.2
cell pre.3

Department of Civil Engineering University of Moratuwa Unconsolidated Undrained Triaxial Test Results			
Client : Soil and Foundation (pvt) Ltd. Project : Proposed Courts Complex at Getambe Peradeniya			
BH Number : BH 10	Depth (m) : 1.0 – 2.0 m		
Description of Sample : Brown Silty Clay			
Specimen Size: Diameter(mm) : 38	Height (mm) : 85		
Initial Conditions	Sample 01	Sample 02	Sample 03
Dry Unit Weight kg/m^3	1332.47	1418.03	1430.32
Moisture Content %	34.88	30.98	31.02
Failure Conditions :			
Cell Presure kN/m^2	50	100	150
Deviator Stress kN/m^2	155.95	130.31	157.72
Axial Stress	205.95	230.31	307.72
Axial Strain	14.90	14.90	14.90
Shear Strength parameters C_u = 65 kN/mm^2	$\varnothing_u = 0$		
Method of Loading : Constant strain at 0.05 in/min			
Remarks: