EXPERIMENT 12

UNCONFINED COMPRESSION (UC) TEST

Purpose:

The primary purpose of this test is to determine the unconfined compressive strength, which is then used to calculate the unconsolidated undrained shear strength of the clay under unconfined conditions. According to the ASTM standard, the unconfined compressive strength (q_u) is defined as the compressive stress at which an unconfined cylindrical specimen of soil will fail in a simple compression test. In addition, in this test method, the unconfined compressive strength is taken as the maximum load attained per unit area, or the load per unit area at 15% axial strain, whichever occurs first during the performance of a test.

Standard Reference:

ASTM D 2166 - Standard Test Method for Unconfined Compressive Strength of Cohesive Soil

Significance:

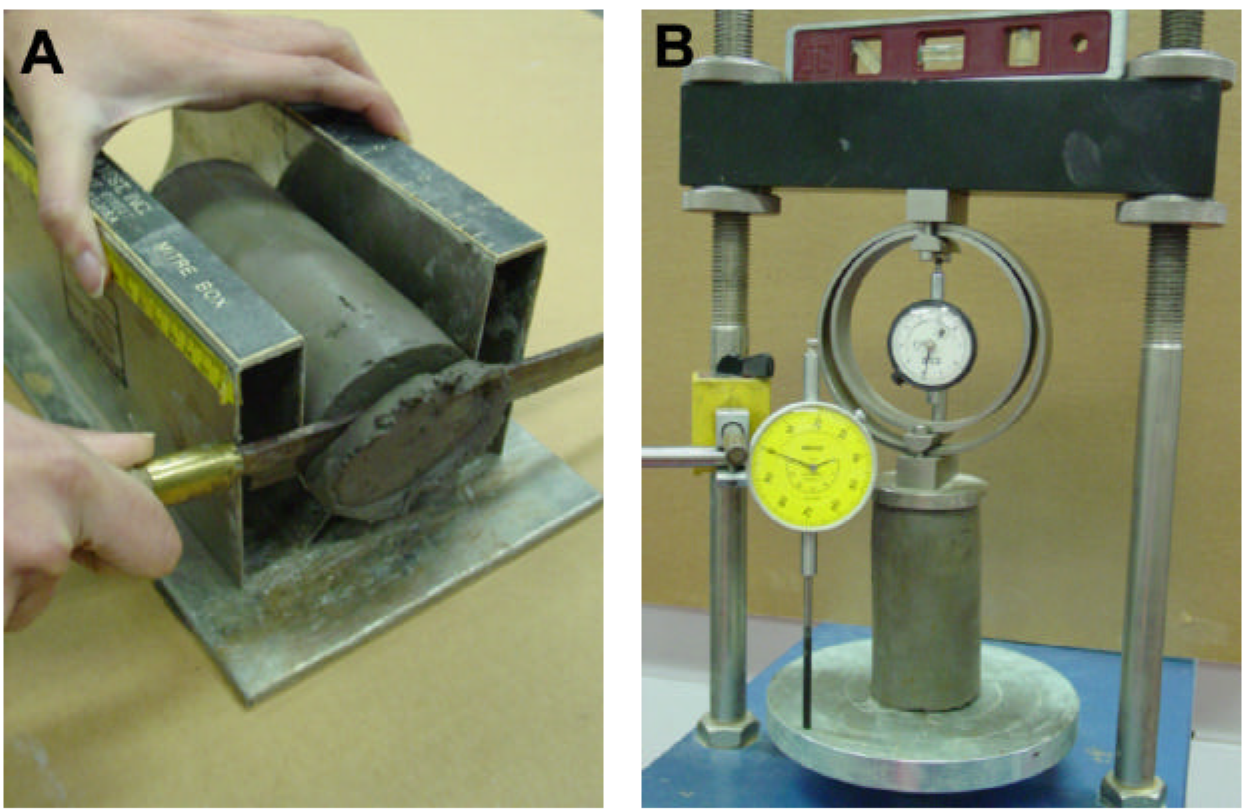
For soils, the undrained shear strength (s_u) is necessary for the determination of the bearing capacity of foundations, dams, etc. The undrained shear strength (s_u) of clays is commonly determined from an unconfined compression test. The undrained shear strength (s_u) of a cohesive soil is equal to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

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

Then, as time passes, the pore water in the soil slowly dissipates, and the intergranular stress increases, so that the drained shear strength (s), given by s = c + s‘tan f , must be used. Where s‘ = intergranular pressure acting perpendicular to the shear plane; and s‘ = (s - u), s = total pressure, and u = pore water pressure; c’ and φ’ are drained shear strength parameters. The determination of drained shear strength parameters is given in Experiment 14

Equipment:

Compression device, Load and deformation dial gauges, Sample trimming equipment, Balance, Moisture can.



Test Procedure:

(1) Extrude the soil sample from Shelby tube sampler. Cut a soil specimen so that the ratio (L/d) is approximately between 2 and 2.5.
Where L and d are the length and diameter of soil specimen, respectively.

(2) Measure the exact diameter of the top of the specimen at three locations 120° apart, and then make the same measurements on the bottom of the specimen. Average the measurements and record the average as the diameter on the data sheet.

(3) Measure the exact length of the specimen at three locations 120° apart, and then average the measurements and record the average as the length on the data sheet.

(4) Weigh the sample and record the mass on the data sheet.

(5) Calculate the deformation (ΔL) corresponding to 15% strain (ε).

$$\text{Strain (e)} = \frac{\Delta L}{L_o}$$

Where L_0 = Original specimen length (as measured in step 3).

(6) Carefully place the specimen in the compression device and center it on the bottom plate. Adjust the device so that the upper plate just makes contact with the specimen and set the load and deformation dials to zero.

(7) Apply the load so that the device produces an axial strain at a rate of 0.5% to 2.0% per minute, and then record the load and deformation dial readings on the data sheet at every 20 to 50 divisions on deformation the dial.

(8) Keep applying the load until (1) the load (load dial) decreases on the specimen 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 5.

(9) Draw a sketch to depict the sample failure.

(10) Remove the sample from the compression device and obtain a sample for water content determination. Determine the water content as in Experiment 1.

Analysis:

(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. (Confirm that the conversion is done correctly, particularly proving dial gage readings conversion into load)

(2) Compute the sample cross-sectional area $A_0 = \frac{\pi}{4} \times (d)^2$

(3) Compute the strain, $e = \frac{?L}{L_0}$

(4) Computed the corrected area, $A' = \frac{A_0}{1-e}$

(5) Using A', compute the specimen stress, $s_c = \frac{P}{A'}$

(Be careful with unit conversions and use constant units).

(6) Compute the water content, w%.

(7) Plot the stress versus strain. Show q_u as the peak stress (or at 15% strain) of the test. Be sure that the strain is plotted on the abscissa. See example data.

(8) Draw Mohr's circle using q_u from the last step and show the undrained shear strength, s_u = c (or cohesion) = $q_u/2$. See the example data.

EXAMPLE DATA

UNCONFINED COMPRESSION TEST
DATA SHEET

Date Tested: **August 30, 2002**

Tested By: **CEMM315 Class, Group A**

Project Name: **CEMM315 Lab**

Sample Number: **ST-1, 8'-10'**

Visual Classification: **Brown silty clay, medium plasticity, moist CL.**

Sample data:

Diameter (d) = **7.29 cm**
Length (L_0) = **14.78 cm**
Mass = **1221.4 g**

Table 1: Moisture Content determination

Sample no.	ST-1, 8-10
Moisture can number - Lid number	A
M_C = Mass of empty, clean can + lid (grams)	15.6
M_{CMS} = Mass of can, lid, and moist soil (grams)	45.7
M_{CDS} = Mass of can, lid, and dry soil (grams)	39.5
M_S = Mass of soil solids (grams)	23.9
M_W = Mass of pore water (grams)	6.2
W = Water content, w%	25.94

Area (A_0) = $\frac{p}{4} \times (7.29)$ = **41..74 cm²**

Volume = $\frac{p}{4} \times (7.29)^2 \times 14.78$ = **616.9 cm³**

Wet density = $\frac{1221.4}{616.9}$ = **1.98 g/cm³**

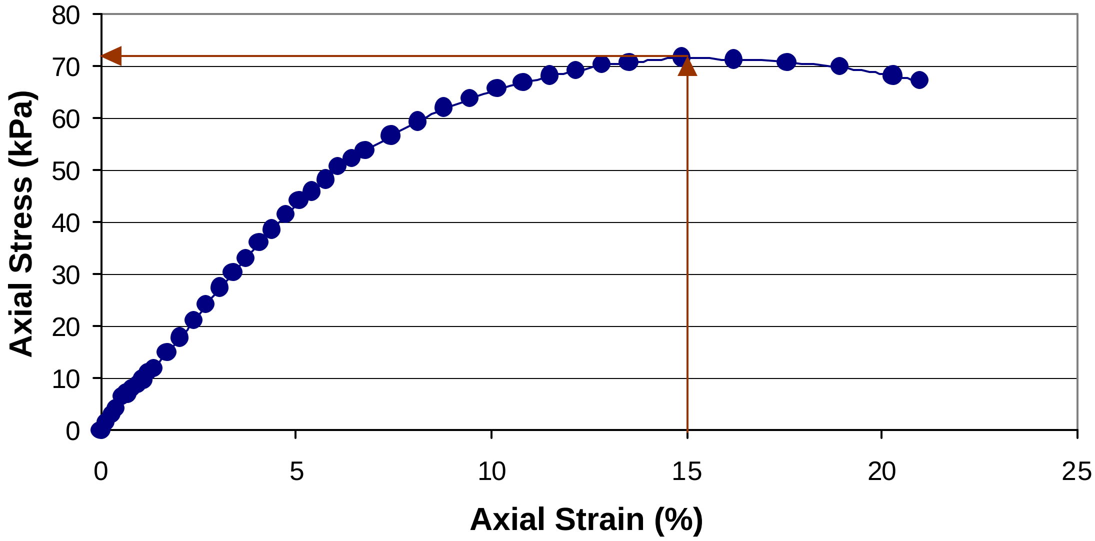
Water content (w%) = **25.9 %**

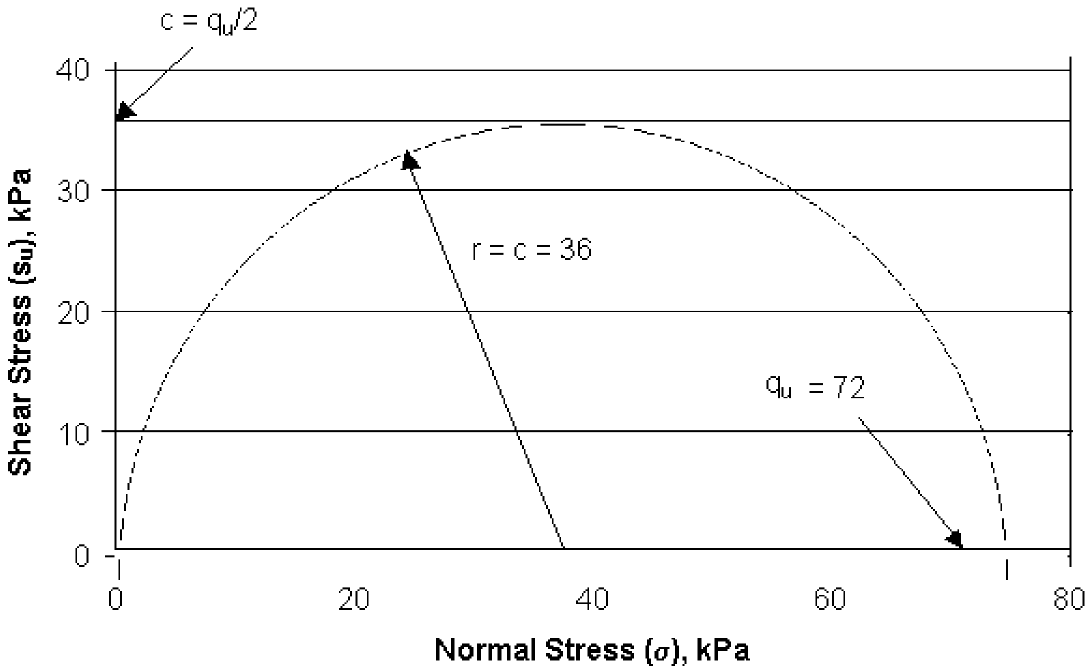
Dry density (?$_d$) = $\frac{1.98}{\left(1 + \frac{25.9}{100}\right)}$ = **1.57 g/cm³**

Table 2: Unconfined Compression Test Data (Deformation Dial: 1 unit = 0.10mm; Proving Ring No: 24691; Load Dial: 1 unit = 0.3154 lb)

Deformation Dial Reading	Load Dial Reading	Sample Deformation DL (mm)	Strain (e)	% Strain	Corrected Area A'	Load (lb)	Load (KN)	Stress (kPa)
0	0	0	0.000	0.000	41.739	0.000	0.000	0.000
20	4	0.2	0.001	0.135	41.796	1.262	56.131	1.343
40	9	0.4	0.003	0.271	41.853	2.839	126.295	3.018
60	12	0.6	0.004	0.406	41.909	3.785	168.393	4.018
80	19	0.8	0.005	0.541	41.966	5.994	266.622	6.353
100	21	1	0.007	0.677	42.024	6.625	294.687	7.012
120	24	1.2	0.008	0.812	42.081	7.571	336.786	8.003
140	26	1.4	0.009	0.947	42.138	8.202	364.851	8.658
160	29	1.6	0.011	1.083	42.196	9.148	406.949	9.644
180	33	1.8	0.012	1.218	42.254	10.410	463.080	10.959
200	36	2	0.014	1.353	42.312	11.356	505.178	11.939
250	45	2.5	0.017	1.691	42.457	14.196	631.473	14.873
300	54	3	0.020	2.030	42.604	17.035	757.768	17.786
350	64	3.5	0.024	2.368	42.752	20.189	898.095	21.007
400	74	4	0.027	2.706	42.900	23.344	1038.422	24.205
450	84	4.5	0.030	3.045	43.050	26.498	1178.750	27.381
500	93	5	0.034	3.383	43.201	29.338	1305.044	30.209
550	102	5.5	0.037	3.721	43.353	32.177	1431.339	33.016
600	112	6	0.041	4.060	43.505	35.331	1571.666	36.126
650	120	6.5	0.044	4.398	43.659	37.855	1683.928	38.570
700	129	7	0.047	4.736	43.814	40.694	1810.223	41.316
750	138	7.5	0.051	5.074	43.971	43.533	1936.517	44.041
800	144	8	0.054	5.413	44.128	45.426	2020.714	45.792
850	152	8.5	0.058	5.751	44.286	47.950	2132.976	48.163
900	160	9	0.061	6.089	44.446	50.473	2245.237	50.516
950	166	9.5	0.064	6.428	44.606	52.366	2329.434	52.222
1000	171	10	0.068	6.766	44.768	53.943	2399.598	53.600
1100	182	11	0.074	7.442	45.096	57.413	2553.958	56.634
1200	192	12	0.081	8.119	45.428	60.568	2694.285	59.309
1300	202	13	0.088	8.796	45.765	63.722	2834.612	61.939
1400	209	14	0.095	9.472	46.107	65.931	2932.841	63.610
1500	217	15	0.101	10.149	46.454	68.454	3045.103	65.551
1600	223	16	0.108	10.825	46.806	70.347	3129.300	66.856
1700	229	17	0.115	11.502	47.164	72.240	3213.496	68.134
1800	234	18	0.122	12.179	47.527	73.817	3283.660	69.090
1900	240	19	0.129	12.855	47.896	75.710	3367.856	70.315
2000	243	20	0.135	13.532	48.271	76.656	3409.954	70.642
2200	250	22	0.149	14.885	49.039	78.864	3508.184	71.539
2400	253	24	0.162	16.238	49.831	79.811	3550.282	71.247
2600	255	26	0.176	17.591	50.649	80.442	3578.347	70.650
2800	256	28	0.189	18.945	51.495	80.757	3592.380	69.762
3000	254	30	0.203	20.298	52.369	80.126	3564.314	68.062

SAMPLE: ST-1, 8'-10'





From the stress-strain curve and Mohr's circle:

Unconfined compressive strength (q_u) = **72.0 KPa**

Cohesion (c) = **36.0 KPa**

BLANK DATA SHEETS

UNCONFINED COMPRESSION TEST
DATA SHEET

Date Tested:
Tested By:
Project Name:
Sample Number:
Visual Classification:

Sample data:

Diameter (d) =
Length (L_0) =
Mass =

Table 1: Moisture Content determination

Sample no.	
Moisture can number - Lid number	
M_C = Mass of empty, clean can + lid (grams)	
M_{CMS} = Mass of can, lid, and moist soil (grams)	
M_{CDS} = Mass of can, lid, and dry soil (grams)	
M_S = Mass of soil solids (grams)	
M_W = Mass of pore water (grams)	
W = Water content, w%	

Area (A_0) =
Volume =
Wet density =
Water content (w%) =
Dry density ($?_d$) =

Table 2: Unconfined Compression Test Data (Deformation Dial: 1 unit = 0.10mm; Proving Ring No: 24691; Load Dial: 1 unit = 0.3154 lb)

Deformation Dial Reading	Load Dial Reading	Sample Deformation ΔL (mm)	Strain (ε)	% Strain	Corrected Area A'	Load (lb)	Load (KN)	Stress (kPa)
0								
20								
40								
60								
80								
100								
120								
140								
160								
180								
200								
250								
300								
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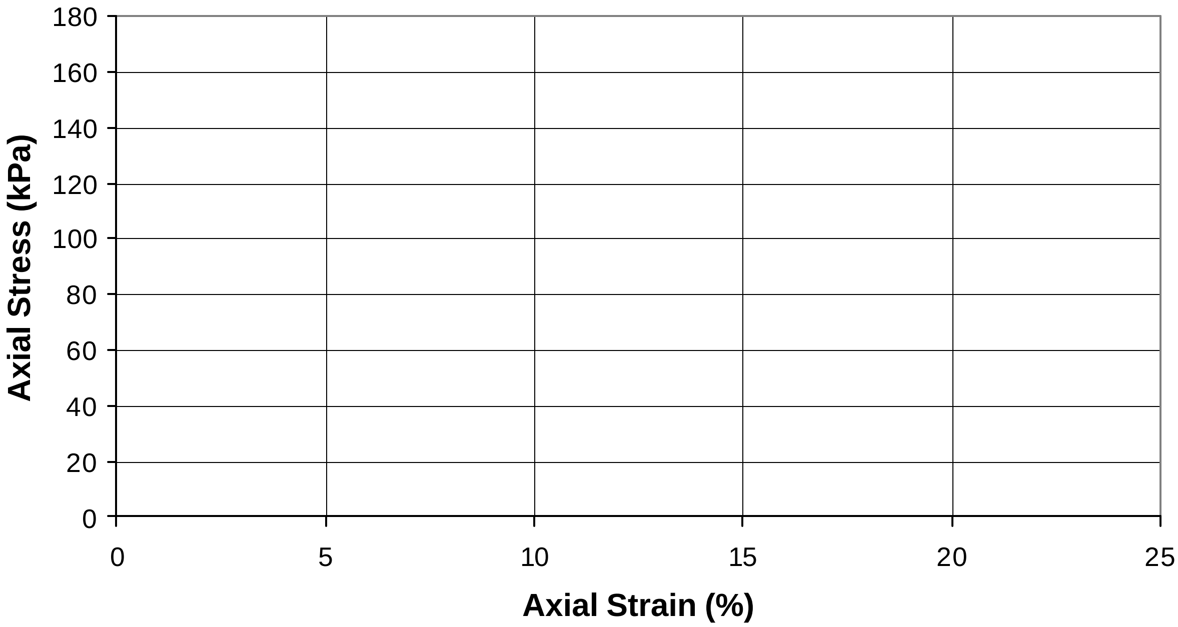

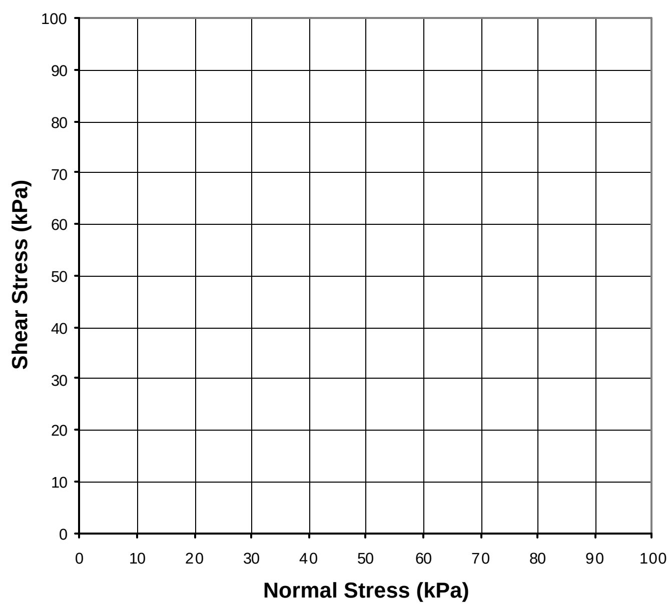

From the stress-strain curve and Mohr's circle:

Unconfined compressive strength (q_u) =

Cohesion (c) =