EXPERIMENT NO. 4

To determine the shear strength of a cohesive soil with the help of unconfined compression test.

4.1 Reference

D2166/D2166M

4.2 Apparatus

- Unconfined compression device (electrically driven strain-controlled device)
- Remolding device
- Deformation dial gage
- Balance, capable of weighing to the nearest 0.01 gm
- Miscellaneous tools and equipment; spatula, moisture tins etc.

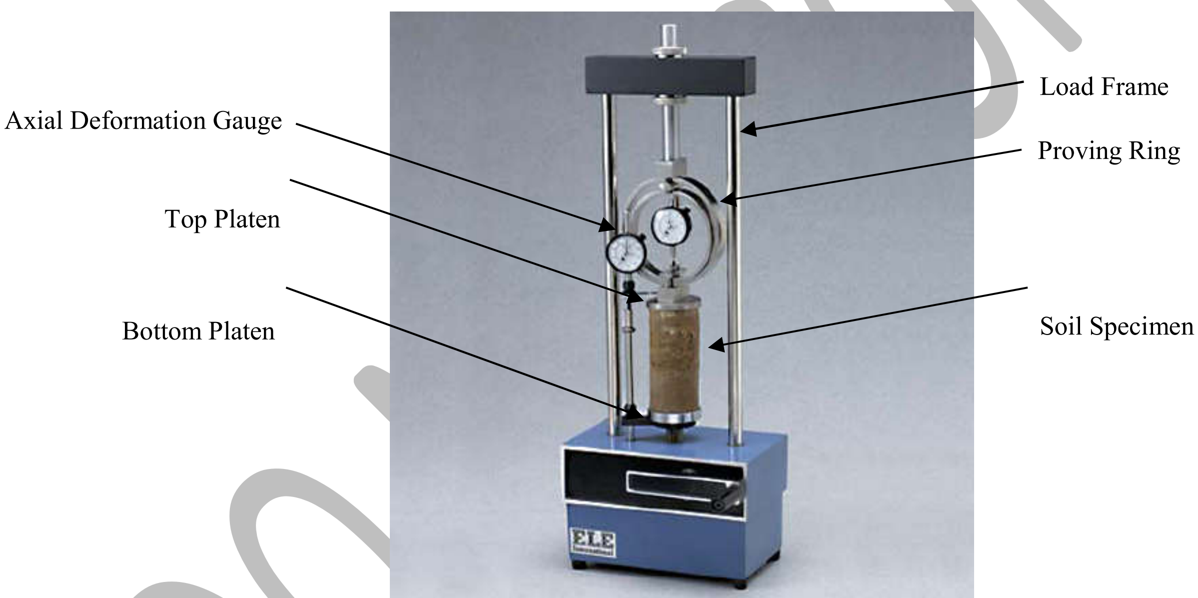


Fig 4.2 Unconfined Compression Machine

4.3 Related Theory

4.3.1 Unconfined Compressive Strength

Unconfined compressive strength of cohesive soil "qu" is defined as the load per unit area at which an unconfined prismatic or cylindrical specimen of soil will fail in a simple compressive test.

It is taken as the maximum load attained per unit area or the load per unit area at 20% axial strain, whichever is secured first during the performance of a test.

4.3.2 Limitation

This test procedure is usually limited to cohesive soils, since there is no lateral support and the soil sample must be able to stand alone. A non-cohesive soil (such as sand) cannot generally stand alone in this manner without lateral support. The cohesion "c" is taken to be one half the unconfined compressive strength ($c = qu/2$).

A cohesive soil gets most of its shear strength from its cohesion. Hence, for most cohesive soils, the cohesion (and therefore the shear strength) may be estimated from the results of unconfined compression test. However, for soft or sensitive clay, the cohesion is commonly obtained instead from the results of field or laboratory vane tests.

This computation is based on the fact that the minor principal stress σ_3 is zero (atmospheric), and the angle of internal friction ϕ of the soil is assumed zero. To give the unconfined compression test more dignity, it is often called an ***"undrained" or U test***.

4.3.3 Advantages of Unconfined Compression Test

4.3.4 Disadvantages of Unconfined Compression Test

4.3.5 Length to Diameter Ratio of Test Specimen

The length to diameter ratio of the test specimens should be large enough to avoid interference of potential 45° failure planes and short enough that we do not obtain a "Column" failure. The length/diameter ratio to satisfy this criterion is. $2 < L/d < 3$

4.3.6 Correction of Cross Sectional Area

It is conventional practice in soil mechanics to correct the area on which load P is acting. The original area Ao is corrected by considering that total volume of soil is unchanged.

The initial total soil sample volume is

$$Vt = Ao\ Lo \quad \ldots\ldots(1)$$

But after change in specimen length ΔL

$$Vt = A\ (Lo - \Delta L) \quad \ldots\ldots(2)$$

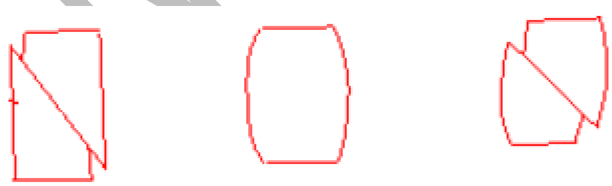
Equating equations (1) and (2), cancelling terms and then solving for corrected area A we get

$$A = Ao / (1 - \varepsilon)$$

5.3.8 Modes of Failure of Test Specimen

There are following types of failure modes of test specimen in triaxial compression test

a) Clear Shear Failure
b) Barrelled or Plastic Failure
c) Barrelled and Shear Failure



(a)Clear Shear Failure (b)Barrelled Failure (c)Barrelled and Shear Failure

4.4 Procedure

- If density and moisture content of the soil is known calculate the weight of the soil needed for preparation of three soil samples of 1.5 inch diameter and 3 inch height.
- Add specified moisture to the dry soil and mix thoroughly. Put some of the soil for moisture content determination.
- Prepare three soil samples of required density by packing the soil in the specimen mold
- If the sample specimen crumbles easily or a good bearing surface for the platen cannot be obtained it is permissible to cap the end using Plaster of Paris

- If evaporation from the soil is expected, the samples should he sealed by encapsulating the specimens in a thin latex membrane or sprayed on plastic immediately following specimens preparation.
- Carefully align the specimen in the compression machine.
- Set the load dial gauges to zero. At this time a very small load should be on the sample (order of ideal 1 unit of a load gage).
- Turn on machine and take load and deformation dial readings until of the following

a) Load decreases on sample significantly
b) Load holds constant for 4 readings
c) Deformation is significantly past 20 percent strain.

- Remove the specimen from compression machine and sketch the failed specimen. If an obvious failure plane is observed. Measure the angle of the failure plane with respect to the horizontal and record this angle as ϕ.
- Determine the water content of the sample
- Test at least two more samples. Compute the unit strain ε, the corrected area and the unit stress for enough of the readings to define the stress strain curve adequately.
- Plot the results on the graph paper from the test results, show qu the Peak stress of each test and show the average value of qu for three tests. Be sure to plot strain ε the abscissa.
- Draw a Mohr's circle using average qu and show the soil cohesion.

4.5 Observations & Calculation

Dia. Of Sample, D	=	1.5	in
Length of Sample, Lo	=	3	in
Orignal x-area of Sample, Ao	=	1.7671	in2
Volume of the Smaple, V	=	5.3014	in3
Wt. of the Specimen, M	=	0.375	lb
Bulk Density, γb	=	0.0707	lb/in3
Moisture Content, w	=	9	%
Proving Ring Constant	=	0.82	lb/div
DDG L.C.	=	0.0005	in

Sample #	DDG Reading	Proving Ring DG Reading	Sample Deformation ΔL=Col-2xLC	Axial Strain ε=ΔL/Lo	Corrected Area Ac=Ao/(1-ε)	Axial Load Col4xPRC	Axial Stress Col-7 / Col-6	
	(div.)	(div.)	(in)		(in2)	(lb)	(psi)	(kPa)
Col-1	Col-2	Col-3	Col-4	Col-5	Col-6	Col-7	Col-8	
1	0	0	0	0	1.7671	0	0	0
	20	10	0.01	0.0033	1.7731	8.2	4.6248	31.8868
	40	16	0.02	0.0067	1.7790	13.12	7.3749	50.8482
	60	23	0.03	0.0100	1.7850	18.86	10.5659	72.8490
	80	29	0.04	0.0133	1.7910	23.78	13.2773	91.5438
	100	32	0.05	0.0167	1.7971	26.24	14.6013	100.6726
	120	30	0.06	0.0200	1.8032	24.6	13.6423	94.0606

4.5.1 Graph b/w Axial Stress & Axial Strain

A graph is plotted between axial stress and axial strain to determine the maximum value of stress which is the major principal stress σ_1 or unconfined compressive strength q_u

4.5.2 Mode of Failure

The mode of failure of test specimen as shown in fig is ***partially shear failure*** or shear and barreling failure

Fig 4.5.2

4.5.3 Mohr's Circle

We know in case of unconfined compression test σ_3 is zero. Also, we have determined the value of σ_1. Using both values we can easily draw Mohr's circle

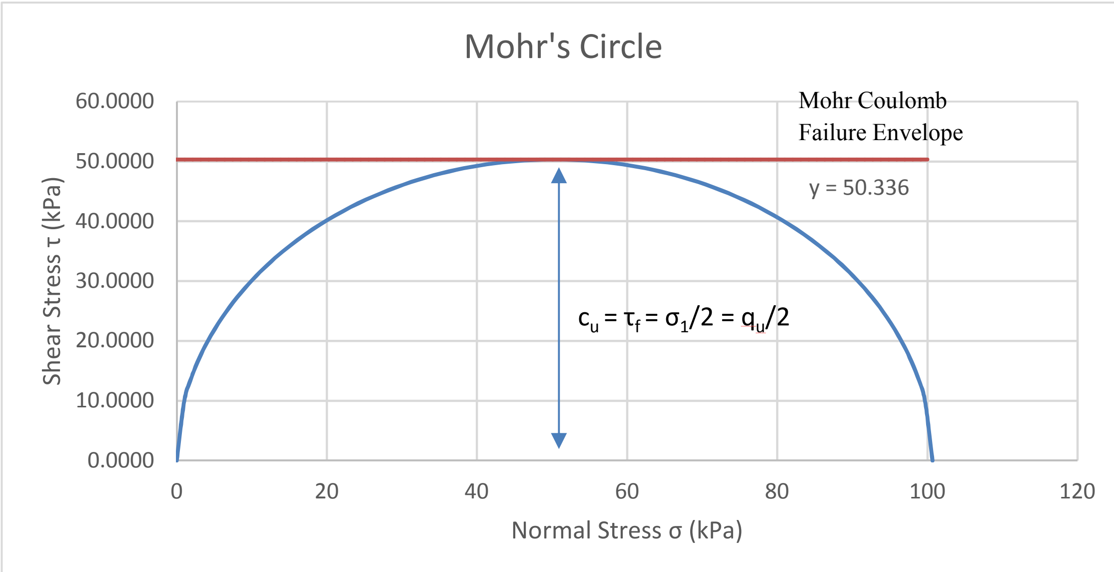


Fig 4.5.3

From the above chart value of ***Undrained Cohesion (C_u) or Undrained Strength (S_u) or τ_f*** can be determined which is

$$c_u = \tau_f = \sigma_1/2 = q_u/2$$

$$c_u = \tau_f = \quad \text{kPa}$$

4.6 Results

The shear strength parameters of the given clayey soil are

c_u = Soil cohesion (undrained cohesion) = kPa

ϕ = Angle of internal fiction = °

So the Mohr-Coulomb Failure Envelope is

$$\tau = c + \sigma \tan(\phi)$$

$$\tau = \quad + \sigma \tan(\quad ^\circ)$$

Undrained Cohesion (C_u) or Undrained Strength (S_u) or τ_f =

4.7 Comments