University of Texas at Arlington
Geotechnical Engineering Laboratory

Unconfined Compressive Strength Test

Lecture Notes # **9**

Definitions, Objectives and Applications

Objective

To determine the unconfined compressive strength (q_u) of the soil

Significance

- A quick test to obtain the shear strength parameters of *cohesive (fine grained) soils* either in undisturbed or remolded state
- The test is not applicable to cohesionless or coarse grained soils
- The test is strain controlled and when the soil sample is loaded rapidly, the pore pressures (water within the soil) undergo changes that do not have enough time to dissipate
- Hence the test is representative of soils in construction sites where the rate of *construction is very fast* and the pore waters do not have enough time to dissipate

Applications

- The test results provide an estimate of the relative consistency of the soil as can be seen in Table 1.
- Almost used in all geotechnical engineering designs (eg. design and stability analysis of foundations, retaining walls, slopes and embankments) to obtain a rough estimate of the soil strength and viable construction techniques
- To determine Undrained Shear Strength or Undrained Cohesion (S_u or C_u) = $q_u/2$

Equipment

- Unconfined compression testing machine (Triaxial Machine)
- Specimen preparation equipment
- Sample extruder
- Balance

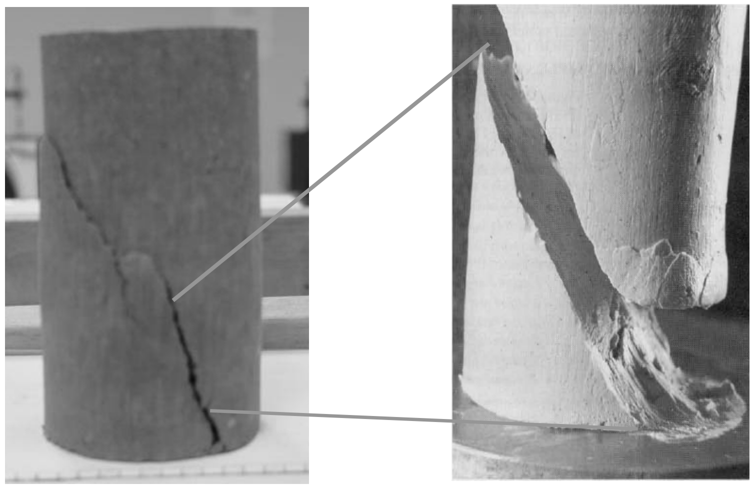


Figure 1. Failure pattern typical of brittle specimens

Table 1. Relative consistency as a function of unconfined compressive strength (Das, 2002)

Consistency	q_u (lb/ft^2
Very soft	0–500
Soft	500–1000
Medium	1000–2000
Stiff	2000–4000
Very stiff	4000–8000

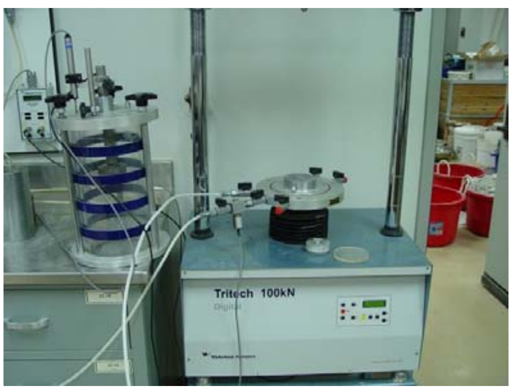
$$S_t = \frac{q_{u(\text{undisturbed})}}{q_{u(\text{remolded})}}$$

Sensitivity, S_t	Description
1–2	Slightly sensitive
2–4	Medium sensitivity
4–8	Very sensitive
8–16	Slightly quick
16–32	Medium quick
32–64	Very quick
> 64	Extra quick

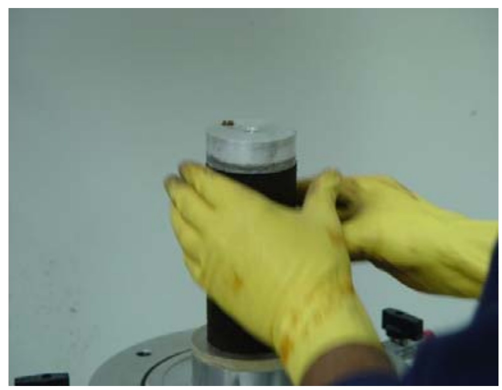
Test Procedure

- Remolded specimens are prepared in the laboratory depending on the proctors data at the required molding water content
  http://geotech.uta.edu/lab/Main/index.htm (look for UCS test in the menu)

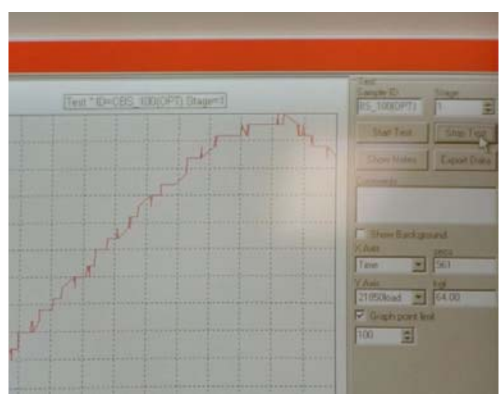
- If testing undisturbed specimens retrieved from the ground by various sampling techniques, trim the samples into regular triaxial specimen dimensions (2.8” x 5.6”)
- There will be a significant variation in strength of undisturbed and remolded samples
- Measure the diameter and length of the specimen to be tested
- If curing the sample (treated soils), wrap the samples in a geotextile and then a zip bag. Place the sample in a humidity room maintained at a relative humidity of 90%
- Prior to testing, avoid any moisture loss in the sample, place on a triaxial base (acrylic). The ends of the sample are assumed to be frictionless
- The triaxial cell is placed above the sample and no confinement is applied
- The rate of strain is maintained at 1.2700 mm/min as per ASTM specifications
- The data acquisition system collects real time data and the test is stopped when there is a drop observed in the strain versus load plot



Triaxial Setup


Placing the specimen


Placing the triaxial cell


Real time data

Interpretation of data for UCS test

The test results are saved as an EXCEL sheet and contain the load (in kg-force) and strain in (mm). This section explains how to apply the area correction and interpret the test results

Axial strain, $\varepsilon_a = \left(\frac{\Delta H}{H_o}\right) \times 100$

Stress, $\sigma = \frac{F}{A_c}$ where, $A_c = \frac{A_i}{1 - \varepsilon}$

A_i is the initial area of the specimen (πr_i^2)

Sample Data sheet from the test

1 Load, F (kg-f)	2 Deformation (mm)	3 Load Tarred	4 ΔH (mm)	5 ΔH (inches)	6 Load, F (lb)	7 vertical strain= ΔH /H_o	8 Corrected area, A_c	9 Stress (psi)
6	6.28	0	0.0000	0.0000	0.0000	0.0000	3.1400	0.0000
6	6.28	0	0.0000	0.0000	0.0000	0.0000	3.1400	0.0000
6	6.28	0	0.0000	0.0000	0.0000	0.0000	3.1400	0.0000
8	6.28	2	0.0000	0.0000	4.4092	0.0000	3.1400	1.4042
10	6.28	4	0.0000	0.0000	8.8183	0.0000	3.1400	2.8084
10	6.28	4	0.0000	0.0000	8.8183	0.0000	3.1400	2.8084
12	6.3	6	0.0200	0.0008	13.2275	0.0002	3.1405	4.2119
14	6.31	8	0.0300	0.0012	17.6367	0.0002	3.1407	5.6155
17	6.33	11	0.0500	0.0020	24.2504	0.0004	3.1412	7.7200
19	6.36	13	0.0800	0.0031	28.6596	0.0006	3.1420	9.1215
19	6.37	13	0.0900	0.0035	28.6596	0.0007	3.1422	9.1208
21	6.4	15	0.1200	0.0047	33.0688	0.0009	3.1430	10.5215
23	6.41	17	0.1300	0.0051	37.4780	0.0010	3.1432	11.9234

Area correction is applied in the interpretation of the results as the cross section of the sample doesn't remain constant as the load is increased. There will be an observed bulge at the middle of the specimen due to which it is almost presumptive to consider uniform stress through out the specimen length. However, the volume of the specimen is assumed constant.

Columns 1 and 2 are obtained from the test results
Column 3 = {Column 1 – 6 kg-f}. (Tarring the load and making it start from zero)
Column 4 = {Column 2 – 6.28 m} (Tarring the deformation and starting it from zero)
Column 5 = ΔH in inches
Column 6 = Load in lb
Column 7 = Strain calculated from H_o
Column 8 = Area correction from the above equation
Column 9 = F/A_c

Plot column 7 (on x-axis) against column 9 (y axis)

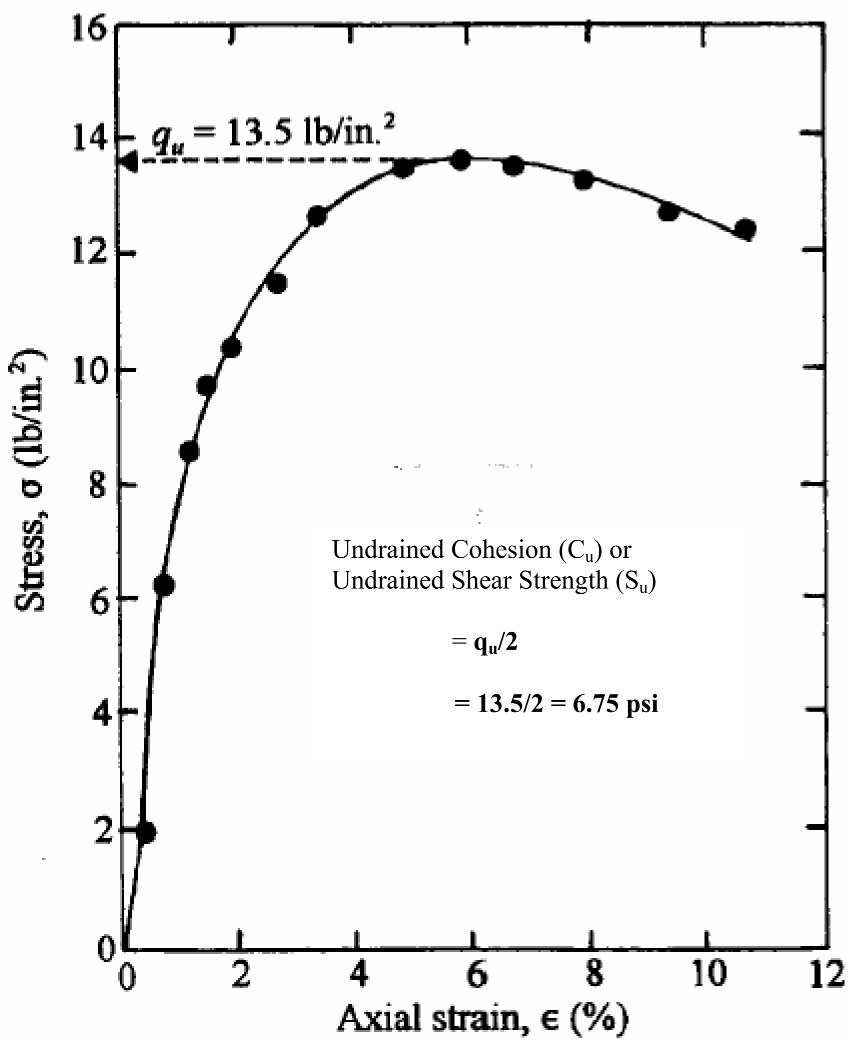


Figure 2. Typical stress vs strain plot from a triaxial test (Das, 2002)

References: Braja M. Das (2002) 'Soil Mechanics Laboratory Manual', Sixth Edition, Oxford University Press