1.8 Unconfined Compression Test

- It gives a quick and simple measurement of the undrained strength of cohesive, undisturbed soil specimens.

1) Testing method

i) Trimming a sample.

Length-diameter ratio (L/D) = 2 – 2.5, in order to

a) minimize the effect of the end friction. (increasing L/D ratio)

b) avoid overlapping of potential failure zones. (increasing L/D ratio)

c) prevent a column failure due to its slenderness. (limiting L/D ratio)

ii) Placing it in a compression device

iii) Applying vertical load in a constant rate of strain (generally .5 – 2.0 %/min) with no confinement and measuring load and displacement (in the vertical direction).

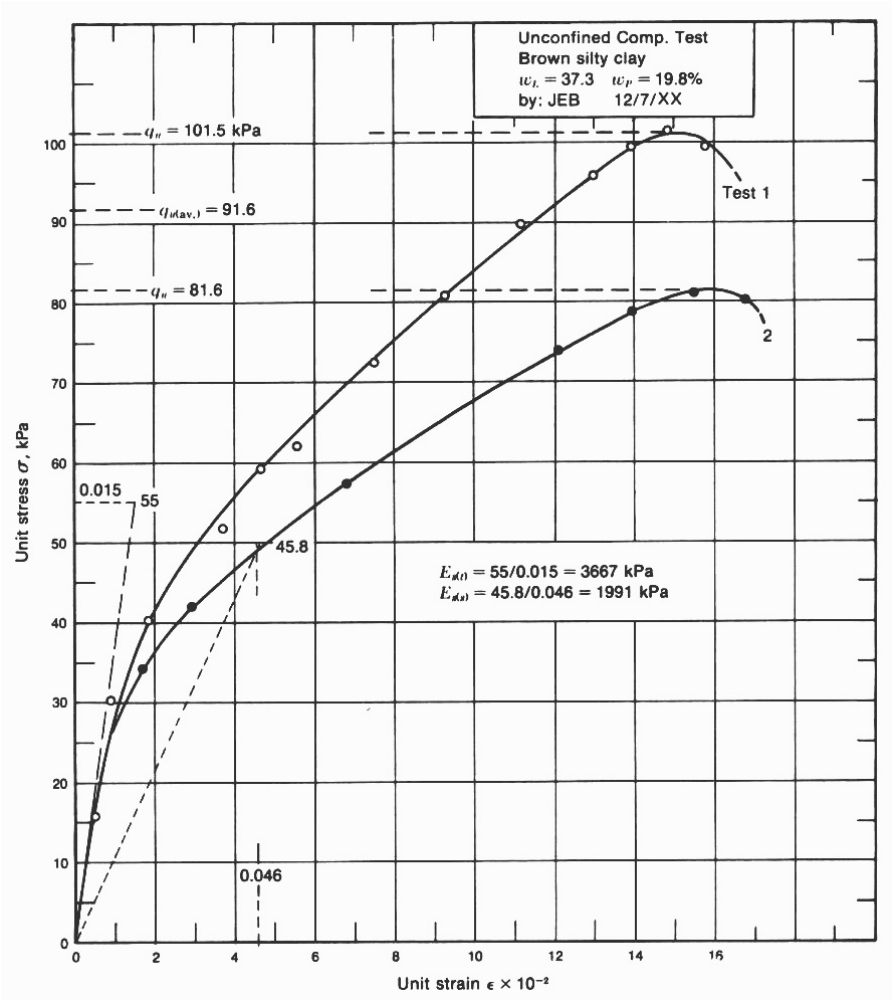
2) Test results

i) Stress – Strain curve

Vertical strain, $\varepsilon = \Delta L/L_0$

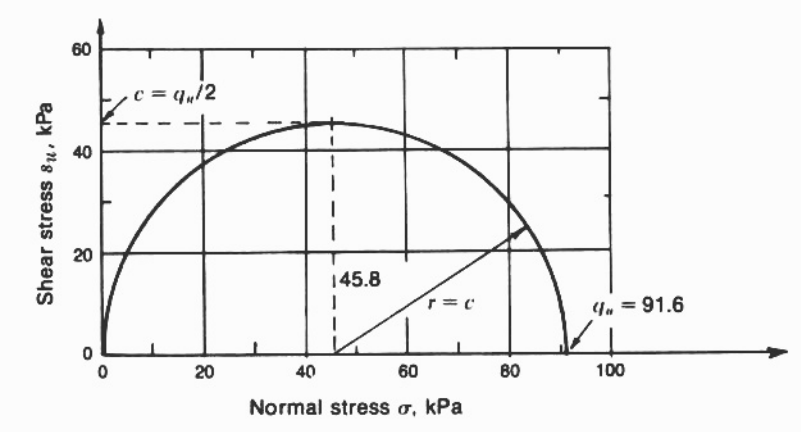
The vertical stress on the sample, $\sigma = P/A'$

where $A' = A_o/(1-\varepsilon)$.



* The initial slope of stress strain curve gives a modulus of elasticity, E_s. However, it is too low to apply to most geotechnical works, because no confining pressure is applied and it is obtained at higher strain level (> .1%) than the practical situations (<.1-1.0%).

ii) Mohr-Circle Construction



- We can obtain the undrained shear strength, s_u from measured vertical stress, q_u at failure (i.e. the unconfined compressive strength) as below

$$s_u = c = q_u/2$$

- s_u is determined with its state of initial effective stress and total stress measurement.

3) Limitations of the unconfined compressive test

i) Sample disturbance (in case of samples obtained from thin wall tube)

ii) Total and/or effective stress conditions in the field are not properly simulated.

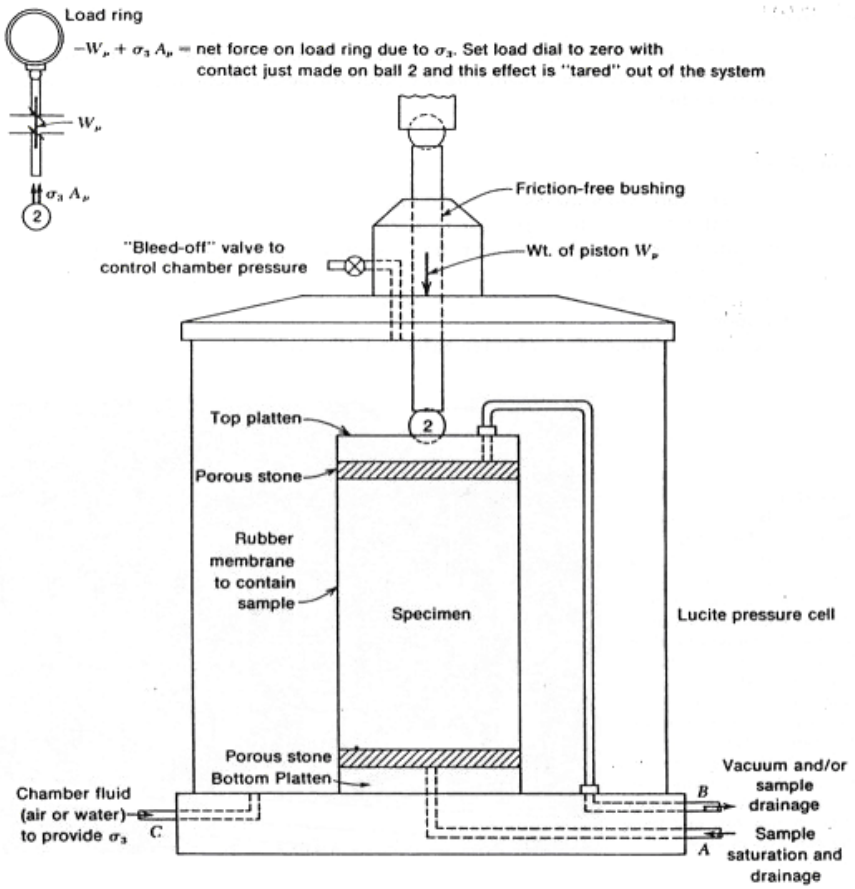
iii) The soil conditions at initial state and during the test (the degree of saturation, and the pore pressure development under stress deformation…) cannot be controlled and measured.

iv) Limitations of sample size to represent the in situ conditions of soil with sand seams gravel and crack or fissures.

1.9 Triaxial Test

- The test to estimate the stress-strain-strength characteristics of soils.
- It can determine the drained strength parameters (c' and ϕ') for sands and clays with CD test or CU test with pore pressure measurement and undrained strength parameters (s_u) for clays with CU and UU tests.

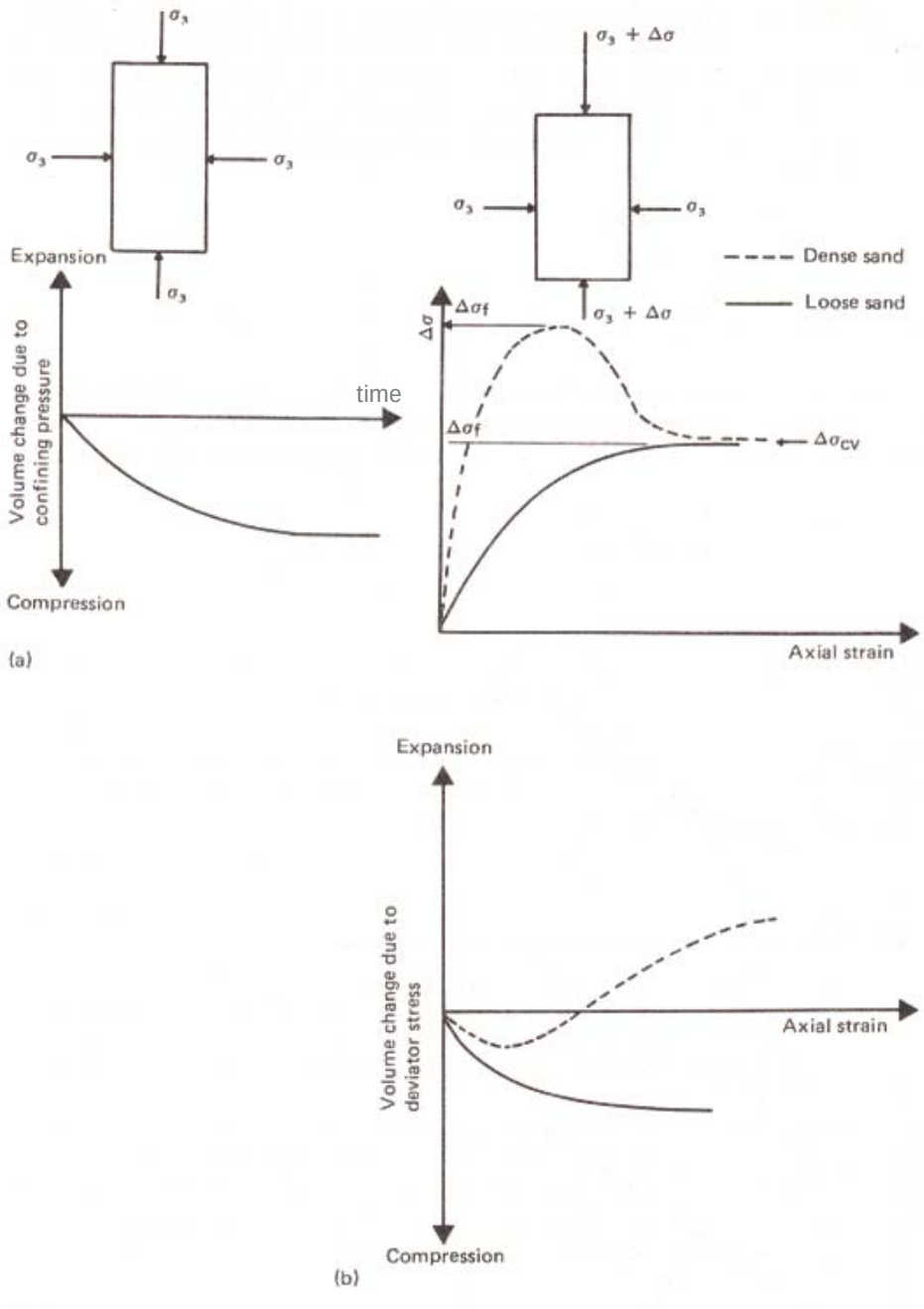
1) Test apparatus and testing method



i) After placing the sample inside the cell and assembling the cell, apply the confining pressure ($\sigma_c = \sigma_3$) with/without opening drainage valve. (To saturate the sample, back pressure is applied to the sample through drainage lines before consolidating the sample.) Measure the volume change with time, to determine consolidation characteristics and to monitor the end of consolidation.

ii) Shear the sample by increasing the vertical stress (= deviator stress = $\sigma_1 - \sigma_3$) at a constant rate of strain or stress with/without opening drainage valve. Measure the applied vertical force, P with axial deformation ΔL ($\sigma_1 - \sigma_3 = P/A'$ *and* $\varepsilon = \Delta L/L$). And volume change for CD test or pore pressure for CU test is also measured with vertical deformation.

2) Typical Test Results (CD test).



< Drained triaxial test in granular soils >

3) CU test (Consolidated Undrained test) for saturated cohesive soils

i) Strength in cohesive soils

- Drained strength based on effective stress : c' and ϕ' ($s = c' + (\sigma_n - \Delta u)\tan\phi'$)
- Undrained strength : $s_u = q_u/2 = (\sigma_1 - \sigma_3)/2 = (\sigma_1' - \sigma_3')/2$

ii) Advantages

- Effective stress states can be evaluated from the total stresses and pore pressures measured during the shearing stage of triaxial test. $\Rightarrow$ Both drained and undrained strength can be determined.
- CU tests with pore pressure measurement provide the rapid means to obtain the "effective" stress parameters for saturated cohesive soils. For CD test, time duration may be in the range of a week or more, because loading rate (strain rate) for shearing should be low enough to allow the excess pore pressure not to be developed.

iii) Key points in CU test

a) Saturation :

- If not saturated, pore pressure during shearing is distributed unevenly in the sample. (i.e. the excess pore pressure on the shear plane may not be the same as on the ends of the sample, at which a pore pressure measuring device is attached.)
- Method for saturation

  ① Apply vacuum.

  ② Apply back pressure.

- Saturation check

  B value ($B = \Delta u/\Delta\sigma_3$) $\Rightarrow$ B = 1 for perfectly saturated sample (degree of saturation S = 100 %) and $B \geq 0.95$ can be assumed to be saturated.

b) Pore pressure measurements

① A pore pressure transducer

② Null-pressure indicator device