Department of Civil Engineering
Katihar Engineering College, Katihar

Subject: Soil & Rock Mechanics
Topic: Shear Strength of Soil
Lecture: 02
Course Instructor: Prof. Rashid Mustafa

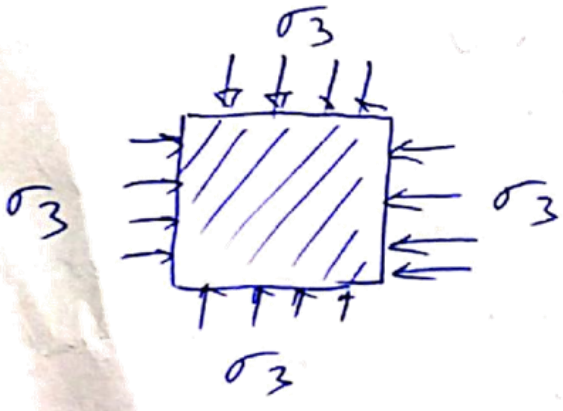
⇒ Type of shear test on the basis of drainage condition

→ The selection of test will depend on type of soil, Properties of test condition.

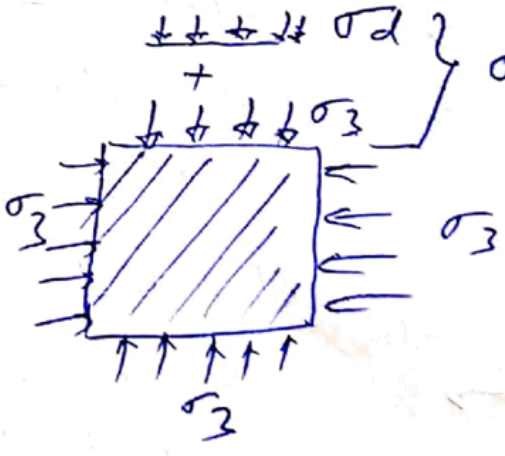
→ In shear test loading in two stages

(1) Cell Pressure stage / Confining stage

(2) Deviator stage / Shear stage



Ist stage
or Cell Pressure stage
or Confining stage



2nd stage
or Deviator stage
or Shear stage

(1) Unconsolidated - Undrained test
(UU test)

→ Quick test
→ Takes 5-7 minute.
→ In this test expulsion of pore water is not permitted in both the stages.
→ Suitable for saturated clay for short term analysis under undrained condition

(2) Consolidated Drained test (CD test)

→ Maximum time taking
→ May take few weeks for fine clay
→ Expulsion of pore water is permitted in both stages
→ Suitable for saturated sand
→ Suitable for long term stability analysis for clay.

(3) Consolidated Undrained test (CU test)

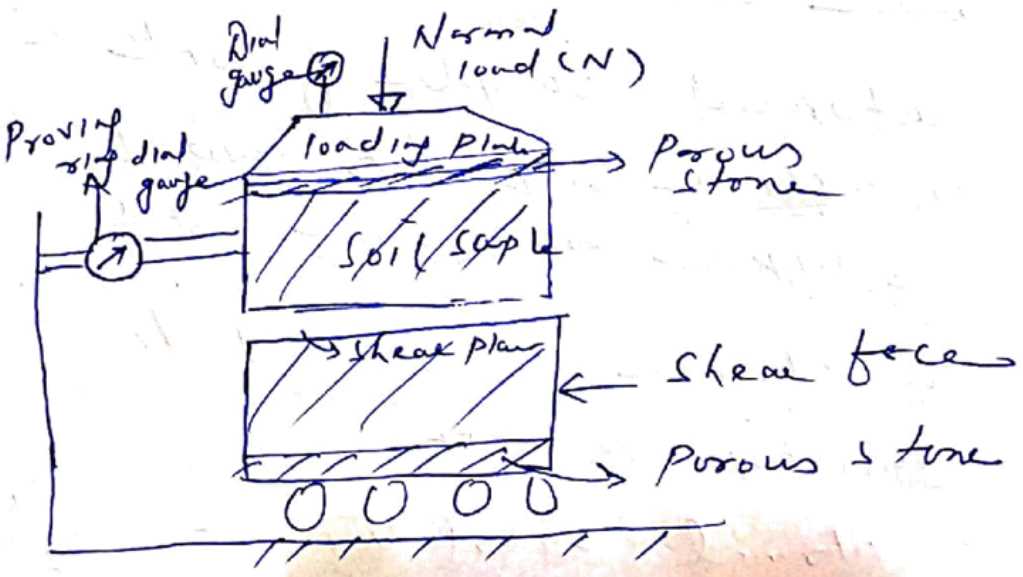
→ Expulsion of pore water is permitted in first stage but not in 2nd stage
→ Suitable for investigation of safety against failure of earthen dam which may occur due to sudden drawdown of water table

⇒ Type of shear test

- Lab test
  - Direct shear test or Box shear test
  - Triaxial test
  - Unconfined Compression test (UCS)
  - Vane shear test
  - Torsion balance shear test
  - Ring shear test
- Field test
  - Vane shear test
  - Standard Penetration test (SPT test)
  - Cone Penetration test (CPT test)

⇒ Laboratory test

(1) Direct shear test



→ suitable for sand.

→ Vertical load is applied through loading plate.

→ Apparatus used:

(i) Direct shear box (square or Circular)
(ii) loading frame
(iii) Dial gauge
(iv) Proving ring
(v) Balance to weigh upto 200 mg
(vi) spatula
(vii) Container
(viii) Tample

→ shear box is either square or Circular shape having size 60 x 60 mm or 90 x 90 mm

→ There is no provision to measure pore pressure, this test is performed under undrained Cond^n.

→ Saturated sample of soil is placed in shear box. has two part lower & upper which are separated.

→ A Normal force say N_1 is applied from top

→ Normal stress (σ_{n_1}) = $\frac{N_1}{A}$

→ Shear displacement is given & shear resistance is recorded on proving ring dial gauge. Let P_1 be proving ring reading at shear failure.

→ Let k & is the Proving ring castt (N/Mm) then shear force at failure on the failure plane is calculated

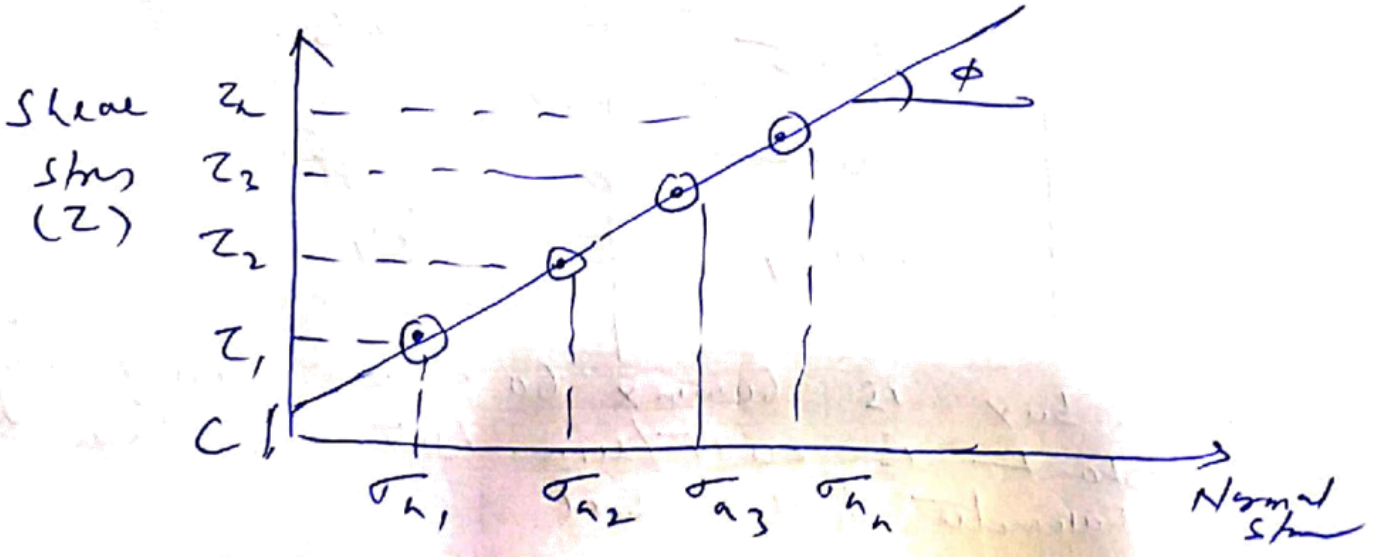
$$F = K \cdot P_1$$

$$\text{Shear stress } (\tau_1) = \frac{F_1}{A} = \frac{K \cdot P_1}{A}$$

Where A is area of x-section of soil

Similarly σ_2, τ_2, σ_3, τ_3 at failure can be computed.

→ With the help of σ_n (x-axis) & Shear stress (τ) (Y-axis) is plotted on the normal graph.



$C = \checkmark$ $\phi = \checkmark$

⇒ Limitations :

(i) Failure plane is predetermined which may not be the weakest plane.

(ii) There is no mechanism to measure pore pressure.

(iii) There is no controll of drainage.

⇒ Advantage :

(i) This test is simple

(ii) Easy to perform.

P-1. A shear box test carried on a sandy clay gave the following results.

Vertical load (kg)	Divisions of Proving ring dial gauge (1 div = 1 mm)
36.8	17
73.5	26
110.2	35
146.4	44

Shear box is 60mm x 60 mm & Proving ring Constant is 20 N/mm. Determine shear strength parameter of this soil

$A = 60 \times 60 = 3600 \text{ mm}^2$

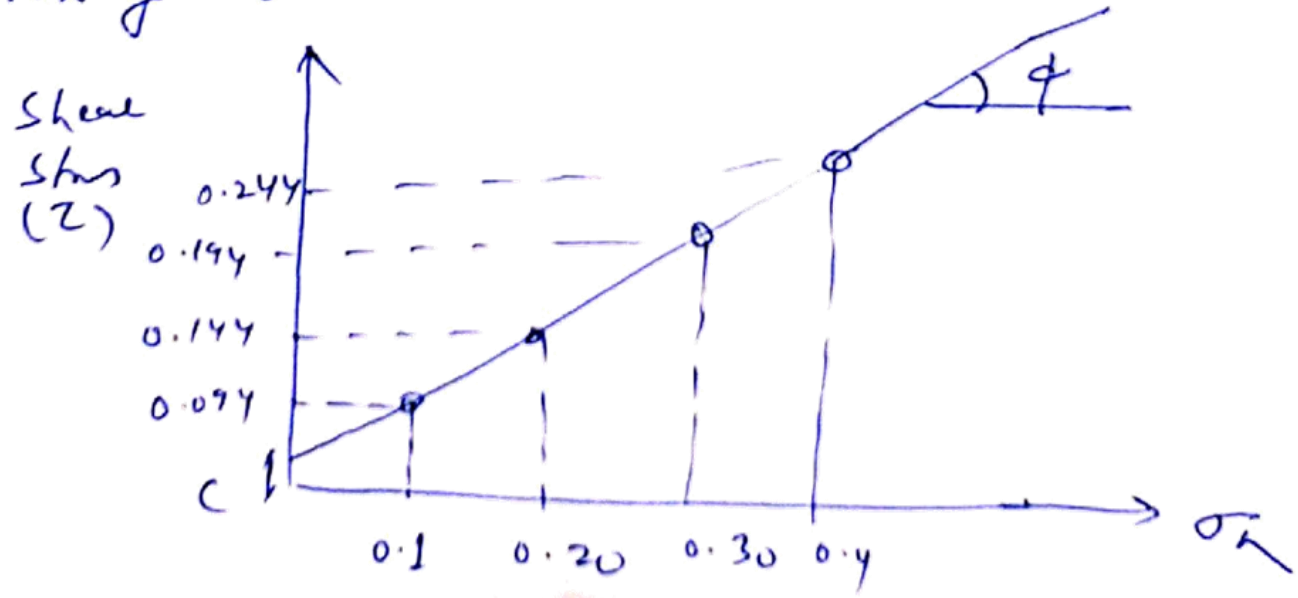
$k = 20 \text{ N/mm}$

$$\text{Normal stress } (\sigma_n) = \frac{\text{Load}}{\text{Area}} = \frac{\text{load (kg)} \times 9.81}{3600} \text{ N/mm}^2$$

$$\text{Shear stress } (\tau) = \frac{k \cdot P}{A} = \frac{20 \times P}{3600} \text{ N/mm}^2$$

Load (kg)	Dial gauge reading (P)	Normal stress (σ_n) (N/mm^2)	Shear stress (N/mm^2)
36.8	17	$\frac{36.8 \times 9.81}{3600} = 0.10$	$\frac{20 \times 17}{3600} = 0.09$
73.5	26	0.20	0.14
110.2	35	0.30	0.19
146.9	44	0.40	0.24

Drawing graph b/w σ_n & τ



Slope of the graph $= \tan\phi = \frac{0.244 - 0.094}{0.4 - 0.10}$

$= 1/2$

$\boxed{\phi = 26.56^\circ}$

$\tan\phi = \frac{1}{2} = \frac{0.244 - c}{0.40}$

$\boxed{c = 0.044\ N/mm^2}$

Shear strength Parameter $c = 0.044\ N/mm^2$

$\phi = 26.56^\circ$