2.8 Direct Shear Test

- A test to determine the shearing characteristics of soils. (Based on stress states on failure plane)
- The shear strength parameters, c' and ϕ' (based on Mohr-Coulomb failure criteria ($s = c' + (\sigma - \Delta u)\tan\phi'$)) can be easily determined.

1) Test conditions and procedures

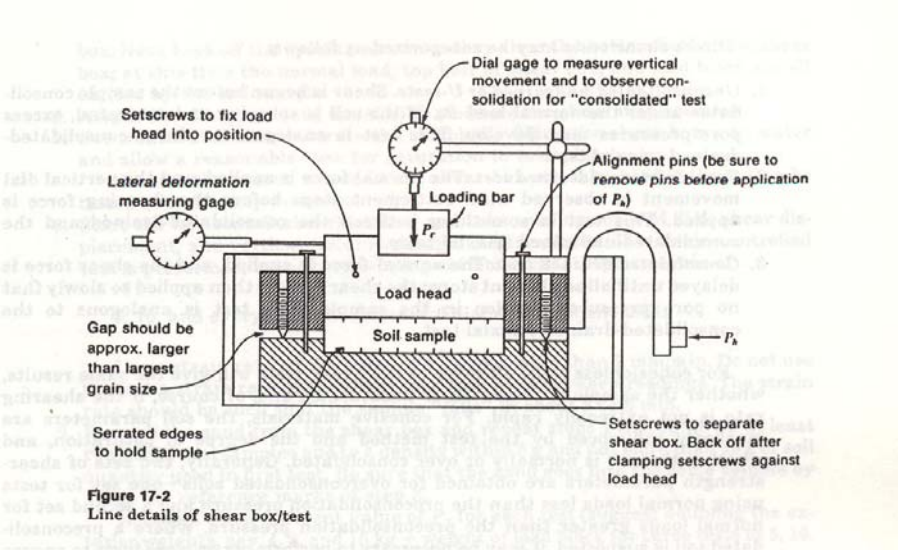

Fig. 17-2

i) Apply the desired vertical load (normal force) P_v and measure the vertical displacements (with time).

ii) Start horizontal loading at a constant displacement rate and measure horizontal load (shearing force) P_h, horizontal displacement (shear displacement), and vertical (volume change) displacement.

iii) Repeat i) – ii) for additional samples at different values of P_v. (At least, 3 tests are required to compute c' and ϕ')

- For cohesionless soils, it is reasonable to assume “drained” condition, due to short drainage path and very permeable property of sample at normal displacement rate (thickness of sample = 20 to 25 mm).

- For cohesive soils, drained condition can be simulated with low strain rate while undrained condition can be simulated with high strain rate.

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3) Typical test results

$$\sigma_n = P_v/A \text{ and } s = P_h/A$$

where A is the nominal area of the sample (or of the shear box).

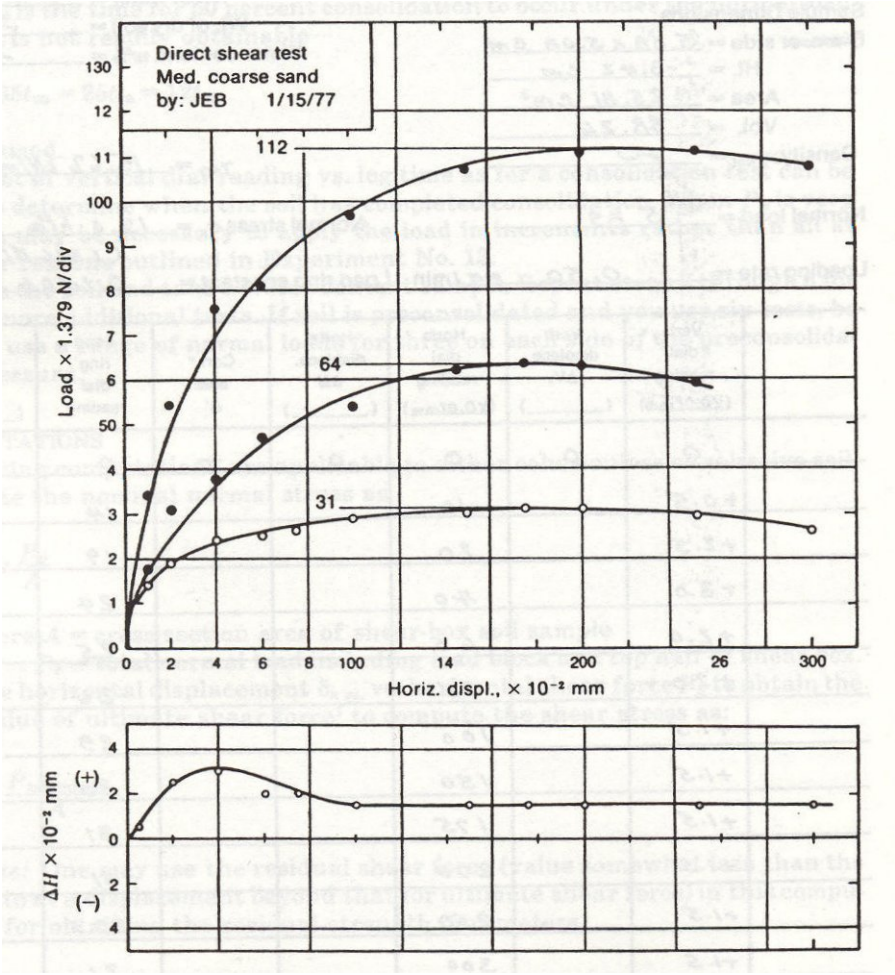


Figure 17-4

- Graphical determination of shear strength parameters

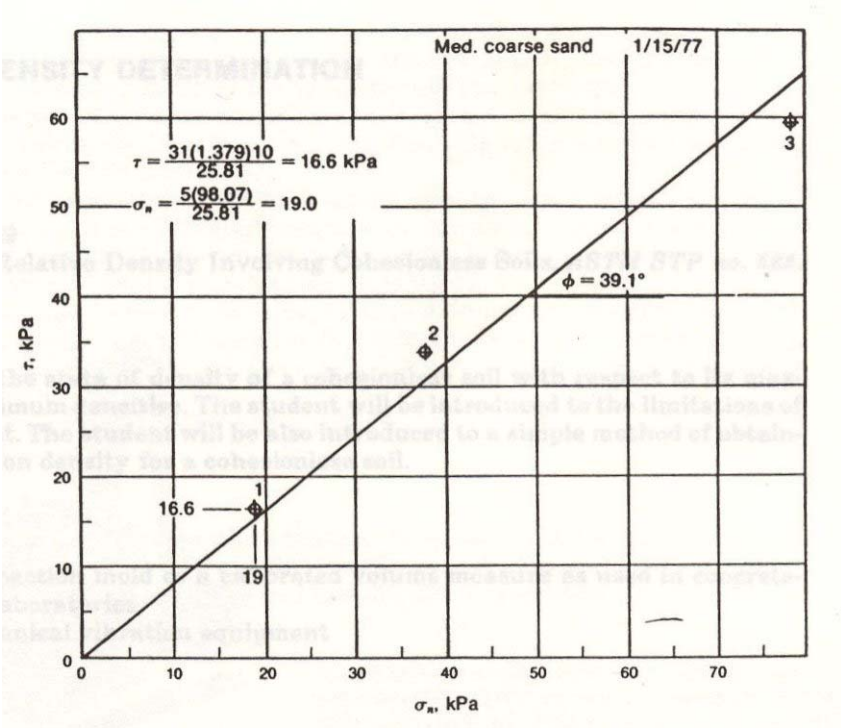


Figure 17-5

- A small “apparent cohesion” (less than 10 – 15 kPa) should be neglected.

4) Advantages

i) It is easy and simple to perform the tests and interpret test results.

ii) Drainage path is short. The time for consolidation is relatively short.

iii) The direct-shear machine is quite adaptable to electronic readout equipment.

5) Disadvantages and limitations

i) Cannot control drainage and thus cannot measure volume change or pore pressure.

ii) The area of sample changes as the test progresses.

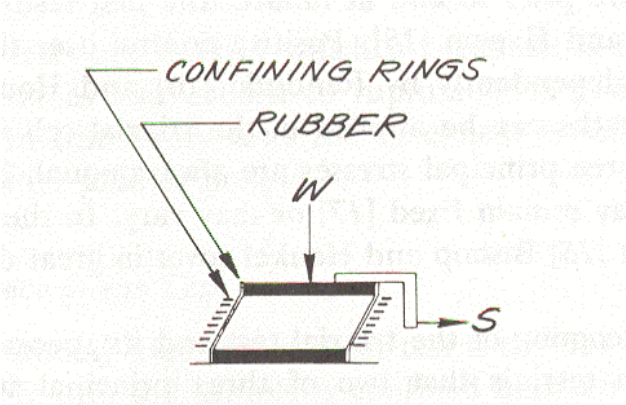
iii) The failure surface is predetermined as a plane.

iv) The shearing stress is not uniformly distributed over the failure plane.

v) The test uses a small sample so that preparation errors can become relatively important.

vi) Values of deformation modulus (E_s or G_s) cannot be determined.

6) Direct Simple Shear Test



i) The Direct simple shear uses a closed shear box fixed at the base with the top free to translate under a horizontal force. The shear box may

a) Use hinged sides.

b) Use a wire-reinforced rubber membrane for the sides.

ii) Direct simple shear test simulates the pure shear condition.

iii) Drainage condition can be controlled (partly).

iv) Cyclic stresses can be applied. ⇒ Particular application in liquefaction studies.