Expt. No: 03

Date :

3. Direct Shear Test

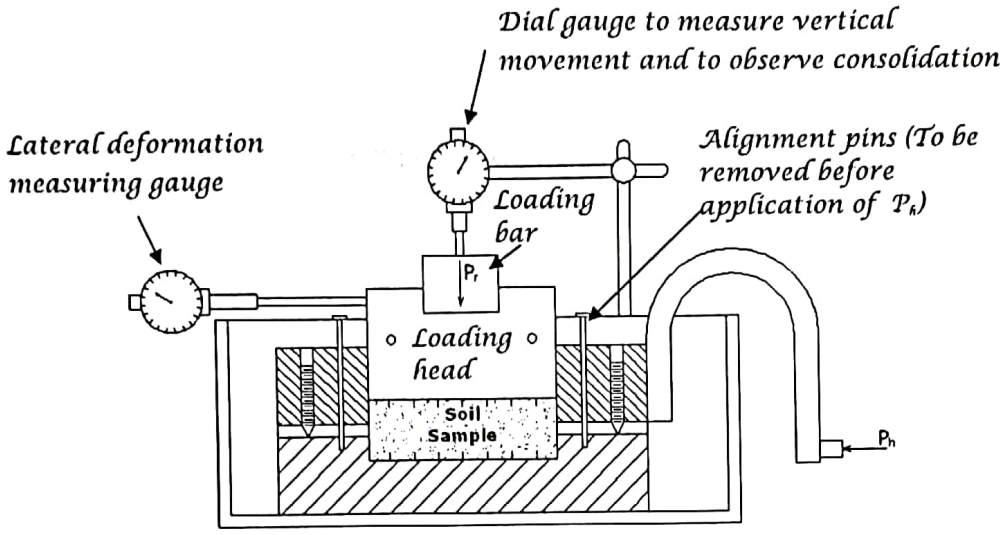
Aim: This test is performed to determine the shear strength parameters of the soil by conducting a direct shear test.

Standard Reference: ASTM D 3080-04: Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions

Introduction: The shear strength is one of the most important engineering properties of a soil, because it is required whenever a structure is dependent on the soil's shearing resistance. The shear strength is needed for engineering situations such as determining the stability of slopes or cuts, finding the bearing capacity for foundations, and calculating the pressure exerted by a soil on a retaining wall.

Significance: The direct shear test is one of the oldest strength tests for soils. In this laboratory, a direct shear device will be used to determine the shear strength of a cohesion less soil (i.e. angle of internal friction (ϕ)). From the plot of the shear stress versus the horizontal displacement, the maximum shear stress is obtained for a specific vertical confining stress. After the experiment is run several times for various vertical-confining stresses, a plot of the maximum shear stresses versus the vertical (normal) confining stresses for each of the tests is produced. From the plot, a straight-line approximation of the Mohr-Coulomb failure envelope curve can be drawn, ϕ may be determined, and, for cohesion less soils ($c = 0$), the shear strength can be computed from the equation: $\tau = \sigma \tan \phi$

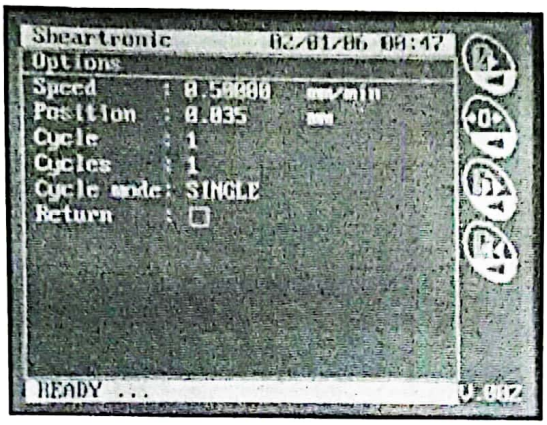
Equipment: Direct shear device, Balance, Vernier caliper



Test Procedure:

1. Weigh the initial mass of soil in the pan.
2. Measure the length, breadth and height of the shear box.
3. The two halves of the shear box are held together by locking pins. Insert the bottom plate and on top of this plate, place the plane grid with serrations at right angles to the direction of shear. On top of this place the porous stone.
4. Place the sand into the shear box and level off the top. Place a filter paper, a porous stone a plane grid, and a top loading plate on top of the sand.
5. Weigh the pan of the soil again and compute the mass of soil used.
6. Place the shear box in the tray of the direct shear testing machine. If required, the spacer bars can be used to fit the shear box perfectly in the tray.
7. Remove the large alignment screws from the shear box. Open the gap between the shear box halves to approximately 0.025 in. using the gap screws, and then back out the gap screws.
8. Complete the assembly of the direct shear device and arrange all the three gauges to be in its position.

9. Set the vertical load (or pressure) to a predetermined value.
10. Switch on the machine, and wait for a few seconds until the main program screen appears.



11. If  is pressed, the control panel will reset the test machine to zero. The gauge readings can also be initialized to zero.

12. Start the test by pressing  when the test machine setting phase has finished, and the control panel gives READY message,
13. Continue taking readings until the horizontal shear load peaks and then falls, or the horizontal displacement reaches 15% of the lateral dimension. Record the horizontal load for each 0.25 mm increment in the displacement.

14. The test in motion can be interrupted at any time by pressing. 

15. Press  to restart the interrupted test or  to return to the main screen.
16. Unload the machine, remove the shear box. Re assemble the box and test it for different vertical load.

Data Analysis:

1. Calculate the density of the soil sample from the mass of soil and volume of the shear box.
2. Compute the sample area A, and the vertical (Normal) stress $\sigma = \frac{P_n}{A}$
3. Calculate shear stress (τ) using $\tau = \frac{P_h}{A}$
4. Plot the horizontal shear stress (τ) versus horizontal (lateral) displacement ΔH.
5. Calculate the maximum shear stress for each test.
6. Plot the value of the maximum shear stress versus the corresponding vertical stress for each test, and determine the angle of internal friction (ϕ) from the slope of the approximated Mohr-Coulomb failure envelope.

Observations:

Shear box inside dimensions	:
Area of cross section (A)	:
Shear box height	:
Soil volume	:
Initial mass of soil and the pan	:
Final mass of soil and the pan	:
Mass of soil in the shear box	:
Density of soil in the box	:

Shear Box Test Data

Displacement rate :

Normal stress :

Sl. No	Horizontal displacement (mm)	Vertical displacement (mm)	Horizontal shear force (kN)	Shear stress (kN/m^2)
	0			
	0.25			
	0.50			
	0.75			
	1.0			
	1.5			
	2.0			
	2.5			
	3.0			
	3.5			
	4.0			
	4.5			
	5.0			
	5.5			
	6.0			
	6.5			
	7.0			
	7.5			

Shear Box Test Data

Displacement rate :

Normal stress :

Sl. No	Horizontal displacement (mm)	Vertical displacement (mm)	Horizontal shear force (kN)	Shear stress (kN/m^2)
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	0.50			
	0.75			
	1.0			
	1.5			
	2.0			
	2.5			
	3.0			
	3.5			
	4.0			
	4.5			
	5.0			
	5.5			
	6.0			
	6.5			
	7.0			
	7.5			

Shear Box Test Data

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	0.75			
	1.0			
	1.5			
	2.0			
	2.5			
	3.0			
	3.5			
	4.0			
	4.5			
	5.0			
	5.5			
	6.0			
	6.5			
	7.0			
	7.5			

Results:

1. The results of direct shear test are presented by a shear stress and shear displacement curve.
2. It usually consists of a plot of τ versus the shear displacement and normal displacement versus shear displacement
3. The two plots should be one below the other using the same scale for shear displacement. The angle of internal friction is found in the plot from τ_{max} versus σ for the three test conducted after making a straight line fit. Report the peak angle of internal friction of sand.

Sample Calculations:

DISCUSSIONS

1. Draw a typical stress strain diagram and indicate what are meant by peak strength and residual strength.
2. What are the limitations of direct shear stress?
3. If the test is under a normal stress of 2.5 kg/cm^2, find the shear load to which the soil will fail. (Use φ found from the test).
4. State the Mohr – Cuolomb criteria for shear strength in terms of the effective stresses
5. What are the advantages of the direct shear test over the triaxial test?