# Abstract

This lab report covers the experiment that is done to determine the shear strength of a soil material in direct shear. It involves the determination of the peak and residual friction angle for a dry sand. The test is performed by deforming a specimen at a controlled strain rate. The stress-strain behavior of a loose and dense sand will be observed, as well as the effect of void ratio and stress level on the internal angle of friction of the soil. The expected results on the stress-displacement curve is having an increasing curve for both loose and dense sands but with only the dense one reaching a peak until they both meet at the ultimate shear stress.

# Introduction

A geotechnical structure depends on the strength of the soil which is the greatest stress it can support to maintain safety. Safety is a very important factor in engineering and construction to ensure the stability of a structure founded on a soil, because if the soil fails the structure will collapse and vice versa. The measure of a soil resistance to deformation by continuous displacement of its individual soil particles is called shear strength. So, we apply the direct shear test on sand in the lab in order to measure it and find its own properties. This test is very important and has a major purpose; it consists of a vertical stress applied on the specimen which is in the shear box. We should determine the stress-strain curve for each stress by recording the load applied and the stress developed for different intervals of time. In addition, according to the density and stress applied we determine the characteristics of the curve and the peak resistance of the sand. This test has many advantages such that it is simple, not expensive, affordable and gives useful results that an engineer will use them to know the behavior of a cohesionless soil.

# Apparatus

1. Direct Shear Test Apparatus
2. Balance
3. Loads
4. Loading head
5. Evaporating dish
6. Ottawa sand
7. Shear box
8. Funnel
9. Caliper

# Procedure

1. The shear box is assembled. The top and bottom of the shear box are aligned horizontally.
2. In the two alignment pins (tall screws) are inserted and screwed in the upper-right and lower-left holes until snug.
3. In the two spacing screws (short screws) are inserted and screwed in the upper-left and lower-right holes until just barely snug. Make sure that no space is created between the upper and the lower parts of the shear box.
4. The height inside of the empty shear box is measured using a caliper and recorded as (h1) in mm. Repeat this step three times at different locations and then take an average of these three measurements.
5. The thickness of the loading head is measured using a caliper and recorded as (h2) in mm. Repeat this step three times at different locations and take average of these three measurements.
6. Using the caliper, obtain three measurements of the diameter of the box, select the highest and calculate the area A. h1, h2 and A do not change. Note that they may be different from box to box.
7. Some dry sand is weighed in a dish (M1). The shear box is filled with sand in one (for loose) or 3(for dense) layers making sure that all sand goes into the shear box as the mass of the lost sand will be counted as part of the tested specimen. The funnel method is used to prepare a loose specimen. Note that loose specimens are very delicate and slight vibrations will cause the sand to densify. For the dense specimen, a tamper should be used to compact the soil – it is not recommended to compact the soil with the loading head as soil may get out of the shear box through the lower drainage holes. the top of compacted specimen should be about 0.5 in (12.7mm) below the top of the shear box. The mass of the sand placed in the shear box is determined by subtracting the new mass of the sand in the dish (M2) from (M1).
8. The loading head is weighed and recorded in kg.
9. The loading head is placed onto the specimen.
10. The level of the sand specimen is leveled off with the loading head.
11. With the loading head placed on top of the soil using the caliper, the distance between the top of the loading head and the top of the box (h3) is measured. An average of three readings made at different locations around the box is taken.
12. Given known volume and mass of specimen we can quickly calculate the void ratio and therefore the relative density of the specimen. Check that loose or dense specimen.
13. (1) the vertical displacement transducer is aligned vertically, (2) the loading pin and (3) the center of the loading head, making sure that no force is exerted on the specimen by the loading pin.
14. The center counterbalance is adjusted on the loading arm and the vertical location of the loading pin (by screwing) so that the loading pin just balance on the loading head, exerting no force on the specimen.
15. The desired weight is added to the hanger and recorded in Kg (L2).
16. Alignment pins are removed (upper-right and lower-left pins).
17. Spacing pins are screwed to create a gap between the top and bottom of the shear box. The space created should be at least 1.5 times the diameter of the largest particle size.
18. The spacing pins are unscrewed and removed.
19. The normal stress on the specimen is calculated.
20. Verify the loading rate of 1mm/min in the screen of the direct shear machine.

# Conclusion

The direct shear test is commonly used to measure the frictional characteristics of soils and many other granular materials. It is a simple, inexpensive and provide useful results for engineering practice. It illustrates how the characteristics of stress strain curve and the peak resistance of sands depend on the density and the applied normal stress. The expected results were, in the shear stress- shear displacement curve, the dense sample showing a peak while the loose did not, and both of them meet at the end (ultimate shear strength).