EXPERIMENT NO.

DETERMINATION OF DRY DENSITY AND DRY UNIT WEIGHT BY SAND REPLACEMENT METHOD

(IS: 2720 (Part 28) – 1974/88, Method for test of soils, Part 28 – Determination of dry density of soil in-place by sand replacement method)

Objective: The objective of the experiment is to determine the dry density and dry unit weight of natural or compacted fine or medium grained soil in-place by the sand replacement method.

This is a field test which helps in determining the dry density and dry unit weight of soil sample in the field itself. It may cause error by over estimating the dry density and dry unit weight for granular soils at wet condition.

Apparatus: **Small sand-pouring cylinder:** 3 litre capacity for fine and medium grained soils and 16.5 litre for fine, medium and coarse grained soils. It is mounted above a pouring cone and separated by a shutter cover plate and a shutter.

Tools for excavating holes: suitable tool such as a scraper tool to make a level surface, bent spoon, dibber.

Calibrating cylinder: cylindrical calibrating container 100 mm internal diameter and 150 mm internal depth fitted with 50 mm wide flange having 5mm thickness**.**

Balance: Balance accurate up to 1 g.

Glass or perplex plate or other plane surface: glass plate of 450 mm square and 9 mm thick or longer.

Metal tray: Metal tray with a central circular hole of diameter equal to the diameter of the pouring cone is used to collect the excavated soil.

Material: Clean, uniformly graded sand passing through 1.00 mm IS-sieve and retained on 600 micron IS-sieve. The material should be free from organic matter. It should be oven dried and should be stored for a suitable period of time to allow its water content to reach equilibrium to the atmospheric humidity.

Procedure: **Part A: Determination of Pass of sand filling the cone:**

1. Fill the clean, closely graded sand in the sand pouring cylinder up to a height of 1 cm below the top. Find out the total initial mass of the cylinder plus sand (say, M_1 g.) This total initial mass (M_1 g.) should be maintained constant throughout the tests for which the calibration is used.

2. Allow the sand of volume equivalent to that of the excavated hole in the

field (or equivalent to that of the calibrating container), to run out of cylinder by opening the shutter of pouring cylinder. Close the shutter and place the cylinder on the glass surface.

3. Open the shutter and allow the sand to run out. Close the valve when no further movement of the sand is observed. Remove the cylinder carefully. Weigh the sand collected on the glass surface. Its mass will give the mass of sand filling the pouring cone. Repeat the test three times at least and take the average mass (say M_2 g.). Put the sand back again into the cylinder in order to maintain its constant mass (M_1 g.)

Part B: Determination of bulk density of sand:

4. Determine the volume (V) of the calibrating container by filling it with water full to the brim and find out the mass of water as well. This volume can be checked by calculation using the measured internal dimensions of the container.

5. Place the sand pouring cylinder with constant mass M_1 g. concentrically on the top of the calibrating container. Open the shutter and allow the sand to run down into the calibrating container. Close the shutter when there is no further movement of the sand. Remove the pouring cylinder and find its mass.

6. Repeat step 5 at least three times and find out its mean mass (say M_3 g.).

7. Put all the sand back into the sand pouring cylinder so that its mass remain constant (M_1 g.)

Part C: Determination of dry density of *in-situ* soil:

8. Clean and clear a space of about 45 cm square area of a soil to be tested. Trim the area down to level surface. Keep the tray on the levelled surface and excavate a circular hole of approximately 10 cm diameter and 15 cm depth. Collect all the excavated soil in the tray and find out the mass of the collected soil (say M_{soil} g.).

9. Remove the tray and place the pouring cylindrical such that the base of the cylinder concentrically covers the hole excavated on the ground. Before placing the sand pouring cylinder it should be assured that the mass of the pouring cylinder remains constant (M_1 g.). Open the shutter and allow the sand to run into the excavated hole. Close the shutter when no further movement of sand is noticed. Remove the cylinder and determine its mass (M_4 g.).

10. Collect the representative excavated soil sample to determine its water content.

Observations:

Table A: Determination of mass of sand in core

Serial No.	Parameters	Quantity		
		Test 1	**Test 2**	**Test 3**
1	Mass of sand +mass of cylinder (M_1 g.)			
2	Mass of sand in the cone (g.)			
3	Mean mass of sand in cone (M_2 g.)			

Table B: Determination of bulk density of sand

Serial No.	Parameters	Quantity		
		Test 1	**Test 2**	**Test 3**
1.	Volume of calibrating container, V (cc)			
2	Mass of sand + cylinder after sand pouring (g.)			
3.	Mean mass of sand + cylinder after sand pouring, M_3 (g.)			
4.	Mass of sand filling the calibrating cylinder, $M = M_1 - M_2 - M_3$ (g.)			
5.	Bulk density, $\rho_{sand} = \frac{M}{V}$ (g./cc)			

Table C: Determination of bulk density of sand

Serial No.	Parameters	Quantity		
		Test 1	**Test 2**	**Test 3**
1.	Mass of wet soil collected from the excavated hole, M_{soil} (g.)			
2.	Mass of sand + cylinder after pouring into the hole, M_4 (g.)			
3.	Mass of sand in the hole, $M_h = M_1 - M_2 - M_4$ (g.)			
4.	Bulk density of soil, $\rho_{soil} = \frac{M_{soil}}{M_{sand}} \rho_{sand}$ (g./cc)			
5.	Bulk unit weight of soil, γ_{soil} (kN/m^3)			

Table D: Determination of water content

Serial No.	Parameters	Quantity		
		Test 1	**Test 2**	**Test 3**
1.	Container number			
2.	Mass of container with lid, m_1 (g.)			
3.	Mass of container + wet soil + lid, m_2 (g.)			
4.	Mass of container + dry soil + lid, m_3 (g.)			
5.	Mass of dry soil, $m_3 - m_1$ (g.)			
6.	Mass of water, $m_2 - m_3$ (g.)			
7.	Water content, $w = \frac{m_2 - m_3}{m_3 - 1} \times 100\%$			
8.	Average water content (%)			

Table E: Determination of dry density and dry unit weight

Serial No.	Parameters	Quantity		
1.	Dry density of soil, ρ_{dry} (g./cc) = $\frac{\rho_{soil}}{\left(1+\frac{w}{100}\right)}$			
2.	Dry unit weight, γ_{dry} (kN/m^3) = $\frac{\gamma_{soil}}{\left(1+\frac{w}{100}\right)}$			

***** In laboratory you may do only one test so accordingly you will prepare the table.

Results: For the given soil the *in-situ* results are listed below:

Bulk density:

Bulk unit weight:

Water content:

Dry density:

Dry unit weight:

Sample calculations:

Fig 1. Experimental setup for sand replacement test

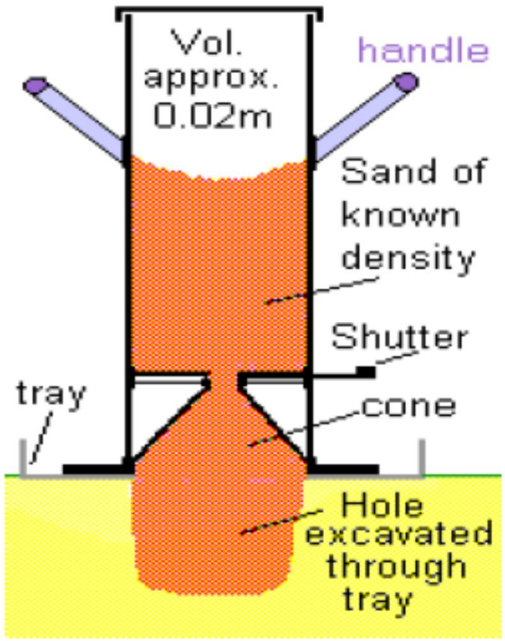

Fig 2. Sand pouring cylinder

Discussions: