FIELD OR IN-SITU DENSITY TEST BY SAND REPLACEMENT METHOD

Aim: To determine the in-situ density of soil by Sand Replacement Method.

Reference IS Code: IS 2720- Part XXVIII

Materials and Equipment:

1. Standard sand
2. Sand pouring cylinder
3. Calibrating container
4. Metal tray
5. Balance accurate to 1 gm
6. IS sieves of sizes 600 micron and 300 micron
7. Tools for excavating hole
8. Containers for water content determination

Procedure:

Measurement of bulk density of standard sand

1. Close the shutter of the cylinder and fill it with standard sand.
2. Take the weight of the cylinder with sand = \( W_1 \)
3. Place the cylinder on a plane surface and open the shutter of the cylinder.
4. Allow the sand to run out from the cylinder until further movement stops and close the shutter.
5. Take the weight of the collected sand = \( W_2 \)
6. Refill the cylinder up to the same height as in step no. 1.
7. Put the cylinder centrally above the calibrating container and allow the sand to run out until further movement stops.
8. Close the shutter and take the weight of cylinder with remaining sand = \( W_3 \)
9. From the weight of sand \( W_a \) and volume of the calibrating container \( V_a \) the density of sand is determined.

Measurement of field density

1. Level an area of soil in the open field and place the tray on the levelled surface.
2. Excavate a circular hole of approximately 10cm diameter (size of the tray hole) and 15cm deep (depth of calibrating container) and collect all the excavated soil on the tray.
3. Take the weight of the excavated soil = \( W \)
4. Refill the sand pouring cylinder such that its weight is again \( W_1 \), remove the tray and place the sand pouring cylinder over the hole.
5. Open the shutter and allow the sand to run out into the hole.
6. Close the shutter of the cylinder when no further movement is seen.
7. Remove the cylinder and determine the mass $W_4$ of sand pouring cylinder with remaining sand.
8. Keep a representative sample of the excavated soil for water content determination.

**Observations:**

$W_1 = \text{weight of the sand pouring cylinder + sand, gm}$

$W_2 = \text{weight of the sand in cone, gm}$

$W_3 = \text{weight of cylinder and sand after pouring into the calibrating container and cone, gm}$

$W_4 = \text{weight of cylinder and sand after pouring into the excavated hole and cone, gm}$

$V_a = \text{volume of calibrating container, cc}$

$W = \text{weight of the soil from the excavated hole, gm}$

$W_d = \text{oven dried weight of the soil excavated from the hole, gm}$

$w = \text{water content (\%)}$

**Calculations and results:**

The weight of sand filling the calibrating container only ($W_a$) = $(W_1 - W_3) - W_2$, gm

i. Bulk density of sand, $\gamma_{\text{sand}} = \frac{W_a}{V_a}$, gm/cc

weight of sand filled in the excavated hole alone ($W_b$) = $(W_1 - W_4) - W_2$, gm

volume of sand filling the excavated hole alone $V = \frac{W_b}{\gamma_{\text{sand}}}$, cc

ii. Field or in-situ bulk density of the excavated soil, $\gamma_b = \frac{W}{V}$, gm/cc

iii. Water content of soil, $w\% = \frac{100(W - W_d)}{W_d}$, %

iv. In-situ dry bulk density of the excavated soil, $\gamma_d = \frac{W_d}{V}$, gm/cc