RELATIVE DENSITY OF COHESIONLESS SOIL (IS 2720-PART 14-1983) Reaffirmed-2006

THEORY:

Relative density or density index is the ratio of the difference between the void ratios of a cohesionless soil in its loosest state and existing natural state to the difference between its void ratio in the loosest and densest states. Porosity of soil depends on the shape of grain, uniformity of grain size, and condition of sedimentation. Hence, porosity itself does not indicate whether the soil is in a loose or dense state. This information can only be obtained by comparing the porosity or void ratio of the given soil with that of the same soil in its loosest and densest possible state. hence the term, relative density is introduced.

$$\textbf{Relative Density} = \frac{\mathbf{e_{max} - e}}{\mathbf{e_{max} - e_{min}}}$$

Where, e_{max} = void ratio of cohesionless soil in its loosest state

e_{min} = void ratio of cohesionless soil in its densest state

e = void ratio of cohesionless soil in its natural existing state in the field.

We have

$\gamma_d = G_s\gamma_w/ (1+e)$;

$e = (G_s\gamma_w/\gamma_d) - 1$.

So, void-ratio *e* is inversely proportional to the dry density of the material (soil) under consideration.

NEED &SCOPE:

To determine the relative density of given cohesionless material. Relative density is an arbitrary character of sandy deposits. In the real sense, relative density expresses the ratio of actual decrease in volume of voids in a sandy soil to the maximum possible decrease in the volume of voids i.e. how far the sand under investigation can be capable of further densification beyond its natural state. Determination of relative density is helpful in compaction of cohesionless soils and in evaluating safe bearing capacity in the case of sandy soils. For very dense gravelly sand, it is possible to obtain relative density greater than one.

APPARATUS REQUIRED:

1. Cushioned steel vibrating deck 75x75 cm size, R.P.M: 3600; under a 115 kg load, electrical, 3 phase supply
2. Cylindrical metallic mould with a capacity of 3000 cc
3. 10 mm thick surcharge base plate with handle separately for each mould
4. Surcharge weights, one for each size having a weight equal to 140 gm/cm^2
5. Guide sleeves with clamps for each mould separately
6. Funnel
7. Vernier calliper
8. Stopwatch

SAMPLE PREPARATION:

1. Dry the soil sample in a thermostatically controlled electric oven.
2. Cool the sample at room temperature.
3. Segregate soil lumps without breaking individual particles and sieve through the required sieve size.

PROCEDURE:

1. Measure inside diameter of mould at different positions using a vernier calliper and take the average.
2. Keep the mould on a flat surface or flat plate. Measure the height at different positions and take the average (accuracy = 0.025 mm).
3. Calculate the volume (V).

Minimum Density:

4. Take the weight of mould accurately (W).
5. Pour the dry pulverized soil into the mould through a funnel in a steady stream. The funnel's spout is adjusted in such a way that the free fall height of soil particles is always 25 mm. While pouring soil, the spout must have a spiral motion from the rim to the center.
6. Continue the procedure to fill up the mould with soil up to about 25 mm above the top.
7. Level the surface of the soil with top of the mould using straightedge.
8. Take the weight of mould filled with the soil (W_1).

CALCULATIONS:

Volume of mould, V = cc

Mass of dry soil, M_s = (W_1-W) gm

=

$(\gamma_d)_{min}$ = M_s / V gm/cc

=

e_{max} = $G_s\gamma_w/(\gamma_d)_{min}$ -1

=

Maximum Density:

9. Put the collar on top of the mould and clamp it.
10. Place the mould on the vibrating deck and fix it with nuts and bolts.
11. Fill the mould with the oven-dried soil sample till 1/2 or 2/3 of the collar is filled.
12. Place the surcharge base plate on the top of the filled soil surface.
13. Place the surcharge weight on it.
14. Allow the vibrator to run for 8 minutes at 3600 rpm.
15. Take the weight of mould filled with the soil (W_2).

CALCULATIONS:

Volume of mould, V = cc

Mass of dry soil, M_s = (W_2-W) gm

=

$(\gamma_d)_{max}$ = M_s / V gm/cc

=

e_{min} = $G_s\gamma_w/(\gamma_d)_{max}$ -1

=

=

$$\text{Relative Density} = \frac{e_{max} - e}{e_{max} - e_{min}}$$

=

Where,

e = Natural void ratio of soil