LECTURE 4

Inter-Relations:

It is important to quantify the state of a soil immediately after receiving in the laboratory and prior to commencing other tests. The water content and unit weight are particularly important, since they may change during transportation and storage.

Some physical state properties are calculated following the practical measurement of others. For example, dry unit weight can be determined from bulk unit weight and water content. The following are some inter-relations**:**

$$w = \frac{W_W}{W_s} = \frac{\gamma_W . V_W}{G_s . \gamma_W . V_s} = \frac{V_W}{G_s . V_s} = \frac{S . V_v}{G_s . V_s} = \frac{S . e}{G_s}$$

$$\gamma = \frac{(G_s + S.e).\gamma_w}{1+e}$$

$$\gamma = \frac{(1+w).G_s.\gamma_w}{1+e}$$

$$\gamma_d = \frac{G_s.\gamma_w}{1+e}$$

$$\gamma_d = \frac{\gamma}{1+w}$$

$$\gamma' = \frac{[(G_s - 1) + (S-1)e] \ x \ \gamma_w}{1+e}$$

$$\gamma' = \frac{(G_s - 1).\gamma_w}{1+e}$$

Example 1: A soil has void ratio = 0.72, moisture content = 12% and G_s= 2.72. Determine its

(a) Dry unit weight

(b) Moist unit weight, and the

(c) Amount of water to be added per m^3 to make it saturated.

Use $\gamma_w = 9.81 \, kN/m^3$

Solution:

(a) $\gamma_d = \frac{G_s.\gamma_w}{1+e} = \frac{2.72 \ x \ 9.81}{1+0.72}$ = 15.51 kN/m^3

(b) $\gamma = \gamma_d(1+w)$

$= \dfrac{1+0.12}{1+0.72} \, x \, 2.12 \, x \, 9.81$ = 17.38 kN/m^3

(c) $\gamma_{sat} = \dfrac{G_s + e}{1+e} \cdot \gamma_w$

$= \dfrac{2.72+0.72}{1+0.72} \, x \, 9.81$ = 19.62 kN/m^3

Water to be added per m^3 to make the soil saturated

= $\gamma_{sat} - \gamma$ = 19.62 – 17.38 = 2.24 kN

Example 2: The dry density of a sand with porosity of 0.387 is 1600 kg/m^3. Find the void ratio of the soil and the specific gravity of the soil solids. [Take $\gamma_w = 1000 \, kg/m^3$]

n = 0.387

γ_d = 1600 kg/m^3

Solution:

(a) e = $\dfrac{n}{1-n} = \dfrac{0.387}{1-0.387}$ = 0.631

(b) $\gamma_d = \dfrac{G_s \cdot \gamma_w}{1+e}$

$\therefore$ G$_s$ = $\dfrac{(1+e)}{\gamma_w} \cdot \gamma_d = \dfrac{1+0.631}{1000} \, x \, 1600 = 2.61$