Q. A 588 cm^3 vol of moist sand weighs 1010 gm, its dry unit weight is 918 gm. and specific gravity of solid G is 2.67. assuming the density of water as 1 gm/cc the void ratio is ?

given, Volume $V = 588\ cm^3$ (cgs system)

total weight $W = 1010$ gm

dry weight $W_d = 918$ gm

$G_s = 2.67$

$\gamma_w = 1$ gm/cc

$e = ?$

$$\gamma_d \text{ or } \gamma_s = \frac{W_d}{V}$$

$$= \frac{918\ gm}{588\ cm^3}$$

$$= 1.56\ gm/cm^3$$

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

$$1.56\ gm/cc = \frac{2.67 \times 1\ gm/cc}{1+e}$$

$$\Rightarrow 1+e = \frac{2.67}{1.56}$$

$$\Rightarrow e = \frac{2.67}{1.56} - 1 = 0.71$$

$e = 0.71$ ans.

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Density Index (I_D)

- also known as relative density or degree of density.
- used to express relative compactness of a natural soil deposit.

$$I_D = \frac{e_{max} - e_{natural}}{e_{max} - e_{min}}$$

e_{max} = void ratio in the loosest state

e_{min} = void ratio in the densest state

$e_{natural}$ = natural void ratio of the deposit.

- used for cohesionless soil only.
- @ loosest form $e_{natural} = e_{max}$, $I_D = 0$

@ Densest form $e_{natural} = e_{min}$, $I_D = 1$

So $0 < I_D < 1$ for intermediate state

or $0 < I_D < 100\%$ if expressed in percentage.

Q A given cohesionless soil mass has $e_{max} = 0.85$ and $e_{min} = 0.5$. In the field the soil is compacted to a mass density of 1800 kg/m³ at a water content 8%. Take the mass density of water as 1000 kN/m³ and $G = 2.7$. The relative density of soil is ?

given; $e_{max} = 0.85$ (loosest state)

$e_{min} = 0.5$ (densest state)

$w = 8\%$

$G = 2.7$

$\gamma = 1800\ kg/m^3$, $\gamma_w = 1000\ kg/m^3$

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$$I_D = \frac{e_{max} - e_{natural}}{e_{max} - e_{min}} \times 100$$

$$\gamma = \frac{(G + Se)\gamma_w}{1+e}$$

$$Se = Gw = 2.7 \times 8\%$$

$$= 2.7 \times \frac{8}{100}$$

$$= 2.7 \times 0.08$$

$$= 0.216$$

$$1800\ kg/m^3 = \frac{(2.7 + 0.216)}{1+e} \times 1000\ kg/m^3$$

$$1+e = \frac{(2.7 + 0.216) \times 1000}{1800}$$

$$e = 1.62 - 1$$

$$e = 0.62 \quad e_{natural}.$$

$$I_D = \frac{e_{max} - e_{natural}}{e_{max} - e_{min}} \times 100$$

$$= \frac{0.85 - 0.62}{0.85 - 0.5} \times 100$$

$$= 65.7\%$$

ans.

Q A partially saturated sample from a borrow pit has a natural moisture content of 15% and bulk unit of 1.9 g/cc. The specific gravity of solids is 2.70. Determine the degree of saturation void ratio and saturated unit weight.

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given data -

$w = 15\% = 0.15$

γ_b or γ_t or γ = 1.9 gm/cc

$G_s = 2.70$

$S, e, \gamma_{sat} = ?$

$$\gamma = \frac{(G + se)\gamma_w}{1+e}$$

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

$$\gamma_d = \frac{1.9 \text{ gm/cc}}{1+0.15} = \frac{1.9}{1.15} = 1.65 \text{ gm/cc}$$

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

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

$$e = \frac{G_s \gamma_w}{\gamma_d} - 1$$

cgs system
$\gamma_w = 1$ gm/cc

$$= \frac{2.7 \times 1}{1.65} - 1$$

$= 1.63 - 1$

$e = 0.63$ ans

$se = Gw$

$$S = \frac{Gw}{e} = \frac{2.7 \times 0.15}{0.63} = 0.64 \text{ or } 64\%$$

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$$\gamma_{sat} = \frac{(G + se)\gamma_w}{1+e} \quad ; \; s = 1$$

$$= \frac{(G+e)\gamma_w}{1+e}$$

$$= \frac{(2.7 + 0.63) \times 1}{1 + 0.63}$$

$$= 2.04 \text{ gm/cc}$$

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