Soil

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Day 04

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GATE & Eng.

Important Relationship

$$\gamma_{bulk} = \frac{w}{v} = \frac{w_s + w_w}{v_s + v_v}$$

$$= \frac{w_s\left(1 + \frac{w_w}{w_s}\right)}{v_s\left(1 + \frac{v_v}{v_s}\right)}$$

$$= \frac{w_s}{v_s}\frac{(1+w)}{(1+e)}$$

$$= \gamma_s \frac{(1+w)}{(1+e)}$$

$\frac{w_w}{w_s} = w$

$\frac{v_v}{v_s} = e$

$$\gamma_t = \frac{\gamma_s (1+\omega)}{(1+e)}$$

$$= \frac{G_s \gamma_\omega (1+\omega)}{(1+e)}$$

$$= \frac{(G_s + G_s \omega)\gamma_\omega}{(1+e)}$$

$$\boxed{\gamma_t = \frac{(G_s + se)\gamma_\omega}{(1+e)}}$$

imp

$$G_s = \frac{\gamma_s}{\gamma_\omega}$$

$$\boxed{\gamma_s = G_s \gamma_\omega}$$

$$\boxed{se = \omega G_s}$$

Dry soil

$$\gamma_{dry} = \frac{G_s \gamma_w}{(1+e)}$$ ✓

$S = 0$

Saturated soil

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

$S = 1$

$$\gamma_{sub} = \gamma_{sat} - \gamma_w$$

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

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

$$\boxed{\gamma_{sub} = \frac{(G-1)}{(1+e)}\gamma_w}$$

$$\eta = \frac{e}{1+e}$$

$$e = \frac{\eta}{1-\eta}$$

$$\frac{1}{1+e} = (1-\eta)$$

Important Terms

Relative Density / Density Index

Degree of Denseness

↳ Cohesionless soil

I_D %

e_{max} → loose

e_{min} → Densest

$$I_D\% = \left[\frac{e_{max} - e}{e_{max} - e_{min}}\right] \times 100$$

$$0 \le I_D\% \le 100\%$$

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

$$\gamma_d \propto \frac{1}{e}$$

$$\gamma_{d\,max} \propto \frac{1}{e_{min}}$$

$$\gamma_{d\,min} \propto \frac{1}{e_{max}}$$

$$I_D\% = \left[\frac{\frac{1}{\gamma_{dmin}} - \frac{1}{\gamma_d}}{\frac{1}{\gamma_{dmin}} - \frac{1}{\gamma_{dmax}}}\right] \times 100$$

Relative Compaction → R_c

Cohessive & Cohesionless

$$R_c = \frac{\gamma_{dry}}{\gamma_{d\,max}} = \frac{\frac{G\gamma_w}{1+e}}{\frac{G\gamma_w}{1+e_{min}}}$$

$$R_c = \left[\frac{1+e_{min}}{1+e}\right]$$

Relationship between Relative Density & Relative Compaction

$$R_c\% = 80 + 0.2 I_D\%$$

valid for cohesionless soil.

R_c (80% - 100%)

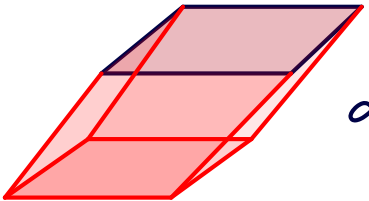
I_D [0 - 100%]

Maximum & Minimum Theoretical Void Ratio

$e_{max} = 0.91$ → loosest state → Rectangular or Cubical.

$n_{max} = 47\%$

$e_{min} = 0.35$ → Densest state → prizmoidal or Rhombohedral



$\alpha = 60°$

$n_{min} = 26\%$