

Soil Physical Relations

Moisture content	$w = \frac{W_w}{W_s} = \frac{M_w}{M_s}$
Void ratio	$e = \frac{V_v}{V_s}$
	$e = wG_s \text{ (saturated)}$
	$e = \frac{wG_s}{S_r} \text{ (partially saturated)}$
Porosity	$n = \frac{V_v}{V} = \frac{e}{1+e}$
Degree of saturation	$S_r = \frac{V_w}{V_v}$
Particle specific gravity	$G_s = \frac{W_s}{V_s \gamma_w} = \frac{M_s}{V_s \rho_w}$
Bulk density	$\rho_b = \rho_w \frac{(G_s + eS_r)}{1+e}$
Dry density	$\rho_d = \frac{\rho_w G_s}{1+e} = \frac{\rho_b}{1+w}$
Saturated density	$\rho_{sat} = \rho_w \frac{(G_s + e)}{1+e}$
Submerged density	$\rho' = \rho_w \frac{(G_s - 1)}{1+e}$
Bulk unit weight	$\gamma_b = \gamma_w \frac{(G_s + eS_r)}{1+e}$
Dry unit weight	$\gamma_d = \frac{\gamma_w G_s}{1+e} = \frac{\gamma_b}{1+w}$
Saturated unit weight	$\gamma_{sat} = \gamma_w \frac{(G_s + e)}{1+e}$
Submerged unit weight	$\gamma' = \gamma_w \frac{(G_s - 1)}{1+e}$
Relative density	$R.D. = \frac{e_{max} - e}{e_{max} - e_{min}}$