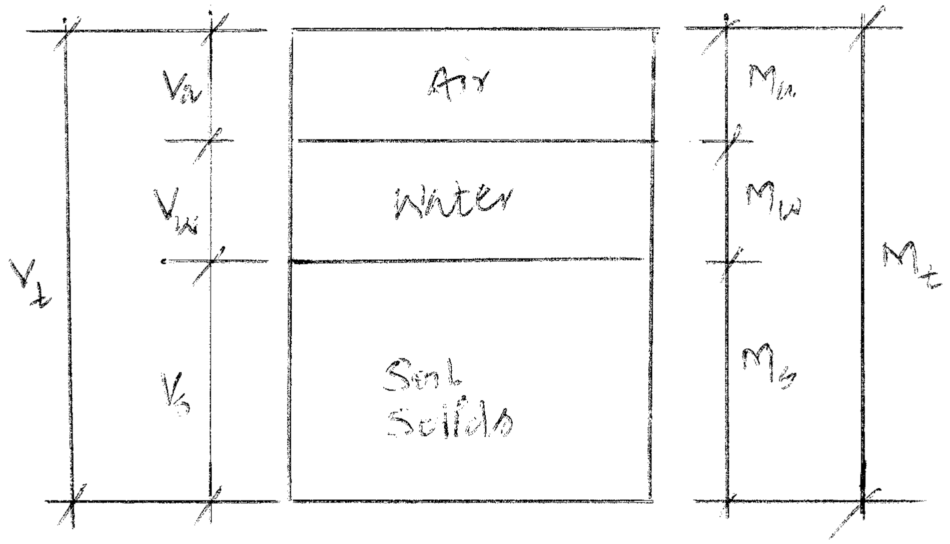
ASSIGNMENT 3a Solutions

Q. 1.



$V_t = 93.45\ cm^3$

$M_t = 181.5$ gms , $M_s = 157.0$ gms , $G_s = 2.67$

(1) $w = ?$

$$w = \frac{M_w}{M_s} = \frac{M_t - M_s}{M_s} = \frac{181.5 - 157}{157}$$

$$\boxed{w = 15.61\%}$$

(2) $\rho = ?\ (kg/m^3)$

$$\rho = \frac{M_t}{V_t} = \frac{181\ gms}{93.45\ cm^3} \times \frac{(100)^3}{1000} = 1936.9\ kg/m^3$$

$$\boxed{\rho = 1936.9\ kg/m^3}$$

(3) $\gamma_d = ?$ (kN/m^3)

$$\boxed{\frac{kg\text{-}m}{sec^2} = N}$$

$$\gamma = \rho * g = 1936.9\ \frac{kg}{m^3} * 9.806\ \frac{m}{sec^2}$$

$$= 18993.24\ N/m^3 = 18.99\ kN/m^3$$

$$\gamma_d = \frac{\gamma}{1+w} = \frac{18.99}{1+0.156} = 16.43\ kN/m^3$$

(4) $e = ?$

$$e = \frac{V_v}{V_s}$$

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

$$e = \frac{2.67 \times 9.806}{16.43} - 1 = 0.594$$

$$\boxed{e = 0.594}$$

(5) $n = ?$

$$n = \frac{e}{1+e} = \frac{0.594}{1+0.594}$$

$$\boxed{n = 37.26\%}$$

(6) $S = ?$

$$S = \frac{V_w}{V_v} = \frac{wG_s}{e} = \frac{0.156 \times 2.67}{0.594}$$

$$\boxed{S = 70.12\%}$$

(7) Air Content, $A = ?$

$$A = \frac{V_a}{V_t} = \frac{V_t - V_w - V_s}{V_s + V_v}$$

Let $V_s = 1$, then $V_v = e$ as $e = \frac{V_v}{V_s}$

and $V_t = 1 + e$

$$A = \frac{1+e - V_w - 1}{1+e} = \frac{e - V_w}{1+e}$$

$$\boxed{w = \frac{M_w}{M_s}}$$

$$V_w = \frac{M_w}{\rho_w} = \frac{w M_s}{\rho_w}$$

$$G_s = \frac{\rho_s}{\rho_w} = \frac{M_s}{\underbrace{V_s}_{=1} \cdot \rho_w} = \frac{M_s}{\rho_w} \Rightarrow M_s = G_s \rho_w$$

$$\therefore \quad V_w = \frac{w \cdot G_s \rho_w}{\rho_w} = w \cdot G_s$$

$$\Rightarrow \quad A = \frac{e - wG_s}{1+e} = \frac{e}{1+e}\left[1 - \frac{wG_s}{e}\right]$$

$$\Rightarrow \quad A = n[1 - S] = 0.373(1 - 0.701)$$

$$\boxed{A = 11.2\,\%}$$

Q. 2

$\gamma = 20.5\ kN/m^3$, $w = 10\ \%$

$M_s = 140.2\ gms$, $G_s = 2.71$

$\gamma_d = ?$, $e = ?$, $S = ?$, $A = ?$

(i) $\gamma_d = \dfrac{\gamma}{1+w} = \dfrac{20.5}{1+0.1} = 18.64\ kN/m^3$

(ii) $e = \dfrac{G_s \gamma_w}{\gamma_d} - 1 = \dfrac{2.71 \times 9.806}{18.64} - 1$

$\boxed{e = 0.426}$

(iii) $S = \dfrac{w G_s}{e} = \dfrac{0.10 \times 2.71}{0.426} = 63.6\ \%$

(iv) $A = n(1-S)$

$\Rightarrow A = \dfrac{e}{1+e}(1-S) = \dfrac{0.426}{1+0.426}(1-0.636)$

$\boxed{A = 10.87\ \%}$

Q. 3

$$(V_w)_{displaced} = \frac{(M_w)_{displaced}}{\gamma_w = 1} = M_{(t+wax)} - M_{(t+wax),\ in\ water}$$

$$(V_w)_{displaced} = 215.9 - 58.9 = 157\ cm^3$$

$$V_{soil} = (V_w)_{displaced} - V_{wax} = V_t$$

$$V_{wax} = \frac{M_{wax}}{\rho_{wax}} = \frac{M_{t+wax} - M_t}{\rho_{wax}} = \frac{215.9 - 181.8}{0.94}$$

$$V_{wax} = 36.28\ cm^3$$

$$V_{soil} = 157 - 36.28 = \boxed{120.7\ cm^3 = V_t}$$

$$\rho = \frac{M_t}{V_t} = \frac{181.8}{120.7} = 1.506\ gms/cm^3$$

$$\rho_d = \frac{\rho}{1+w} = \frac{1.51}{1+0.025} = 1.47\ gms/cm^3$$

$$e = \frac{V_v}{V_s} = \frac{V_t - V_s}{V_s}$$

more than one approaches can be used. e.g.,

(i) $V_s = ?$ $\quad \rho = \frac{M_t}{V_t} = \frac{M_s + M_w}{V_t} = \frac{M_s + wM_s}{V_t}$

$$\rho = \frac{M_s(1+w)}{V_t} \Rightarrow \frac{\rho}{1+w} = \frac{\rho_s V_s}{V_t}$$

$$V_s = \frac{\rho_d}{\rho_s} \cdot V_t = \frac{1.47}{2.7} \times 120.7 = 65.71\ cm^3$$

$$e = \frac{120.7 - 65.71}{65.71} = 0.837$$

2nd approach (direct formula)

$$e = \frac{G_s \cdot \rho_w}{\rho_d} - 1$$

$$G_s = \frac{\rho_s}{\rho_w} \quad , \quad \rho_w = 1$$

$$\Rightarrow G_s = \rho_s$$

$$\Rightarrow e = \frac{\rho_s}{\rho_d} - 1 = \frac{2.7}{1.47} - 1$$

$$\boxed{e = 0.837}$$

$$S = \frac{V_w}{V_v}$$

1st approach:

$$V_w = ? \quad , \quad w = \frac{M_w}{M_s} \Rightarrow M_w = w M_s$$

$$\Rightarrow \overset{1}{\rho_w} V_w = w \cdot \rho_s V_s$$

$$V_w = 0.25 \times 2.70 \times 65.71 = 44.35 \text{ cm}^3$$

$$V_v = V_t - V_s = 120.7 - 65.71 = 54.99 \text{ cm}^3$$

$$S = \frac{V_w}{V_v} = \frac{44.35}{54.99} =$$

$$\boxed{S = 80.6\,\%}$$

2nd approach: (we can use direct formula)

$$S = \frac{wG_s}{e} = \frac{0.25 \times 2.7}{0.837} = 80.6\%$$

Q. 4

$M_{init} = 5.912$ kg

$M_{final} = 2.378$ kg

$V_{sand} = (M_{init} - M_{final}) / \rho_{sand}$

$= (5.912 - 2.378)/1300 = 0.00272\ m^3$

$V_{hole} = V_{sand} - V_{sandcone}$

$= 0.00272 - 0.00114$

$V_{hole} = 0.00158\ m^3$

$$\rho = \frac{M_{(soil\ recovered)}}{V_{hole}} = \frac{2.883}{0.00158} = 1824.68\ kg/m^3$$

$\gamma = \rho \times g = 1824.68 \times 9.806 = 17892.55\ N/m^3$

$= 17.89\ kN/m^3$

$$\gamma_d = \frac{\gamma}{1+w} = \frac{17.89}{1+0.07} = 16.72\ kN/m^3$$

$$\%\ \text{compaction} = \frac{\gamma_d}{(\gamma_d)_{max}} \times 100. \quad \frac{16.72}{19} \times 100$$

$= 88\% < 95\%$ ∴ project specs. are not met.