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Subject Soil Mechanics

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Q18- (i) Define the following terms.

(a) Hydraulic gradient :-

Headloss divided by length in which headloss take place.

$$i = h/L$$

i = Hydraulic gradient
h = head loss
L = length.

(b) porosity :-

The ratio of volume of voids to the total volume of soil

$$\eta = \frac{V_v}{V} \times 100$$

η = porosity.

V_v = volume of voids
V = Total volume

(c) Degree of saturation :-

The ratio of volume of water to the volume of voids

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

S = degree of saturation
V_w = Volume of water
V_v = volume of voids

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(d) Liquidity index:-

$$L.I = \frac{w - P.L}{P.I}$$

L.I = Liquidity index
w = water content
P.L = plastic limit
P.I = plastic index.

(e) coefficient of Permeability:

$$i = \frac{\Delta h}{L}$$

Q1:- (ii)

Given data:

$w = 32\,kg$, $V = 0.0192\,m^3$
$w_s = 28.5\,kg$ $G_s = 2.65$

Required data:

$\gamma_B = ?$
$w = ?$
$\gamma_d = ?$
$\gamma_{sat} = ?$
$e = ?$
$n = ?$
$S = ?$

Sol:-

$$w_w = w - w_s = 32 - 28.5$$

$$\boxed{w_w = 3.5\,kg}$$

$$w = w_w / w_s \times 100 = 3.5/28.5 \times 100$$

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$V = 12.2\%$

$\gamma_B = W/V = 32/0.0192$

$\gamma_B = 1666.67 \text{ kg/m}^3$

$\gamma_d = W_s/V = 28.5/0.0192$

$\gamma_d = 1484.37 \text{ kg/m}^3$

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

$e = \frac{2.65 \times 1000}{1484.37} - 1$

$e = 0.785$

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

$\gamma_{sat} = \left(\frac{2.65 + 0.785}{1 + 0.785}\right) \times 1000$

$\gamma_{sat} = 1924.37 \text{ kg/m}^3$

Q2: (a) Prove the given relation:

$$e = \frac{G_s \times \gamma_w (1 + wc) - 1}{\gamma_B}$$

$$\gamma_B = \frac{(G_s \times \gamma_w (1 + w_c)}{1 + e}$$

$$\gamma_B = \frac{W}{V} = \frac{W_s + W_v}{V_s + V_v}$$

$$\gamma_B = \frac{\frac{W_s}{W_s}(W_s + W_v)}{\frac{V_s}{V_s}\left(V_s + \frac{V_v}{V_s}\right)}$$

$$\gamma_B = \frac{W_s\left(\frac{W_s}{W_s} + \frac{W_v}{W_s}\right)}{V_s\left(\frac{V_s}{V_s} + \frac{V_v}{V_s}\right)}$$

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$$\gamma_B = \frac{W_s\left(1+\frac{W_v}{W_s}\right)}{V_s\left(1+V_v/V_s\right)}$$

$\because W_v = W_a + W_w$

$$\gamma_B = \frac{W_s\left(1+\frac{W_w}{W_s}\right)}{V_s\left(1+V_v/V_s\right)}$$

$\because W_c = W_w/W_s$, $e = \frac{V_v}{V_s}$

$\therefore \gamma_s = W_s/V_s$

$$\gamma_B = \frac{\gamma_s\left(1+W_c\right)}{1+e}$$

$\because G_s = \gamma_s/\gamma_w \Rightarrow \gamma_s = G_s \cdot \gamma_w$

$$\gamma_B = \frac{G_s \cdot \gamma_w\left(1+w_c\right)}{1+e}$$

$$\boxed{e = \frac{G_s \gamma_w\left(1+w_c\right)}{\gamma_B} - 1}$$

Hence prove

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Q2:- (B) :- Explain Grain Size classification of Soil in detail.

Ans:- Classification of Soil :-

(1) Grain Size classification

(i) US - Bureau of Soil classification :-

	clay	Silt	Sand				Gravel	
			Very fine Sand	Fine Sand	Medium Sand	Coarse Sand	Fine gravel	Coarse gravel
particle size	< 0.002 mm		0.05 mm	0.1 mm	0.25 mm	0.5 mm	1 mm	2 mm

(ii) ASTM Soil classification System :-

clay	colloidal clay	silt	Sand		Gravel
			Fine	Coarse	
0.001 mm	0.005 mm	0.074 mm	0.25 mm		2 mm

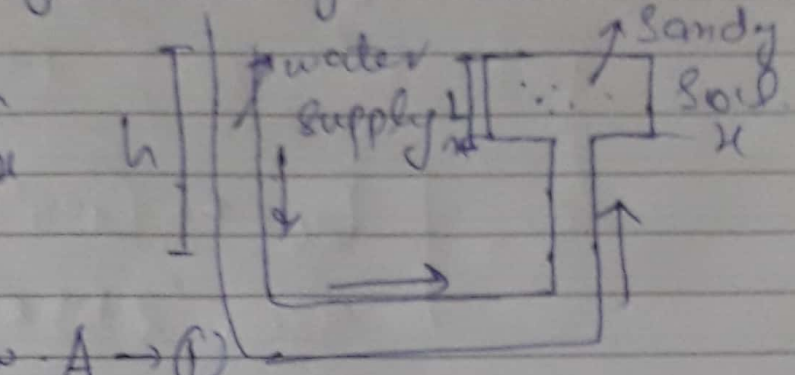
(iii) MIT Soil classification system :-

clay			silt			Sand			Gravel
Fine clay	Medium clay	Coarse clay	Fine silt	Medium silt	coarse silt	Fine Sand	Medium Sand	coarse Sand	
0.0002 mm	0.0006 mm	0.002 mm	0.006 mm	0.02 mm	0.06 mm	0.2 mm	0.6 mm	2 mm	

Q3:- (a) Derive the relation of critical hydraulic gradient for quick sand condition.

Ans:-

Critical hydraulic gradient.



At the bottom surface i.e x-x

upward force =

$= (h+L)\gamma_w \cdot A \rightarrow (1)$

Downward force $= \gamma_w \frac{(G_s+e)}{1+e} \times V$

Since $\gamma_B = W/V$

$W = \frac{\gamma_w (G_s+e)}{1+e} \times V$

Where $V = AL$

$W = \gamma_w \cdot \frac{(G_s+e)}{1+e} AL \rightarrow (2)$

upward force = down force

$(h+L)\gamma_w \cdot A = \gamma_w \frac{(G_s+e)}{1+e} AL$

$\frac{h+L}{L} = \frac{G_s+e}{1+e} \times \frac{L}{L}$

$\frac{h}{L} + 1 = \frac{G_s+e}{1+e}$

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$$\because \frac{h}{l} = \frac{G_s + e}{1+e} - 1$$

$$i_c = \frac{G_s + e - 1 - e}{1+e}$$

$$\boxed{i_c = \frac{G_s - 1}{1+e}}$$

Q38- (b) :-

Given data:- $\because 1ml = 10^{-6} m^3$

$V = 65ml = 0.000065 m^3$

$W = 0.96N$

$W_d = 0.785 N$

$G_s = 2.65$

Required :-

$S = ?$

Sol:- $\gamma_B = \frac{\gamma_w (G_s + e) S}{1+e} \rightarrow (1)$

$\gamma_B = W/V = 0.96/0.000065$

$\boxed{\gamma_B = 14769 N/m^3}$

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~~$\gamma_w = 9800\ N/m^3$~~

$\gamma_w = N\gamma \quad \gamma_w = 9800\ N/m^3$

$e = \frac{V_v}{V_s} \rightarrow (2)$

$\gamma_s = W_s/V_s \Rightarrow V_s = W_s/\gamma_s \rightarrow (3)$

$\Rightarrow \gamma_s = G_s \gamma_w$

$\gamma_s = 2.65 \times 9800$

$\boxed{\gamma_s = 25970\ N/m^3}$

Put the value in eq (3)

$V_s = 0.785/25970$

$\boxed{V_s = 0.000030\ m^3}$

$V = V_s + V_v \Rightarrow V_v = V - V_s$

$V_v = 0.000065 - 0.000030$

$\boxed{V_v = 0.000035\ m^3}$

Put the vakle in eq (2)

$e = \frac{0.000035}{0.000030}$

$\boxed{e = 1.167}$

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Put the values in eq (1)

$$14769 = \frac{9800\,(2.65 + 1.167)\,S}{1 + 1.167}$$

$$1 + 1.167(14769) = 9800\,(2.65 + 1.167)\,S$$

$$S = \frac{1 + 1.167(14769)}{9800\,(2.65 + 1.167)}$$

$$S = \frac{32069.42}{37406.6}$$

$$S = 0.527 \text{ or } 52.7\%$$

End