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PAPER :- Soil Mechanics

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Q.01 (a) Define the following Terms =

Ans => Hydralic Gradient:-

Definition:-

A line ~~joing~~ joining the points of heighest elevation of water in a series of vertical open pipes rising from a pipeline in which water flows under pressure.

=> Coefficient of permeability:-

The coefficient of permeability of a soil decribes how easily a liquid will move through a soil. it is also commonly reffered to as the hydraulic conductivity of a soil. This factor can be effected by viscosity and its density.

=> Liquidity index:-

The liquidity index is used for scaling the natural water content of a soil sample to the limits. it can be calculated as a ratio of difference between natural water content plastic limit & liquid limit

⇒ Porosity:-

Porosity is a measure of the void space in a material and is a fraction of the volume of voids over the total volume b/w 0 and 1 as a percentage b/w 0 and 100%. Strictly speaking

⇒ Formula:-

$$n = \frac{\text{Vol of void}}{\text{Total vol of soil mass}}$$

$$\Rightarrow V_v / V.$$

⇒ Degree of Saturation:-

$$S = \frac{\text{Vol of water}}{\text{Vol of voids}}$$

$$= V_w / V_v$$

Q.1
(B)

GIVEN DATA:-

$W = 32 kg$, $V = 0.0192 m^3$, $W_s = 28.5 kg$

$G_s = 2.65$

Required:-

$\gamma_B = ?$ $w = ?$ $\gamma_d = ?$ γ_{sat}

$n = ?$

Sol:-

(i) Bulk Density

$\gamma_B = W/V$

$= \frac{32}{0.0192}$

$= 1666.67 kg/m^3$

(ii) water Content:-

$W_w = W - W_s = 32 - 28.5 = 3.5 kg$

$w = \frac{W_w}{W_s} \times 100 = \frac{3.5}{28.5} \times 100 = 12.3\%$

iii) dry density

$\gamma_d = \frac{W_s}{V}$

$= \frac{28.5}{0.0192} = 1484.37 Kg/m^3$

$\gamma_d = \frac{G_s + \gamma_w}{1+e} \Rightarrow e = \frac{G_s \times \gamma_w}{\gamma_d} - 1 = \frac{2.65 \times 1000}{1484.3} - 1$

$e = 0.785$

(iv) Saturated density

γ_{sat} :-

$$\gamma_{sat} = \frac{(G_s + e)\gamma_w}{1+e} = \frac{(2.65 + 0.785)\times 1000}{1+0.785}$$

$$= 1924.37 \ kg/m^3$$

(v) Void Ratio :-

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

$$n = \frac{0.785}{1+0.785} = 0.44 \text{ or } 44\%$$

$$w = \frac{S \times e}{G_s}$$

$$S = \frac{w \times G_s}{e}$$

$$= \frac{0.123 \times 2.65}{0.785}$$

$$= 0.415 \text{ or } 41.5\%$$

---x---x---

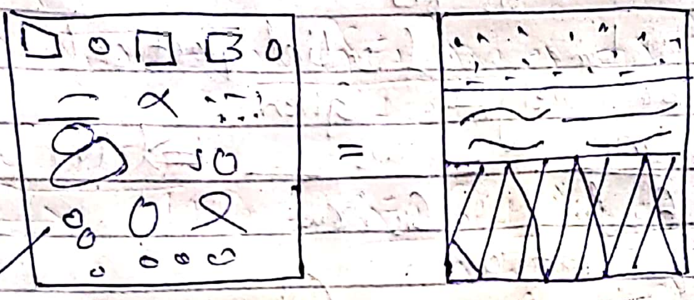
Q No (02)

(A) prove that

$$e = \frac{G_s \gamma_w (1 + w_c)}{\gamma_b} - 1$$

Proof

Consider the following soil mass



Soil

Phases	volumes	mass	weight
Air	V_A	0	0
water	V_w	M_w	w_w
Solid	V_s	M_s	w_s

As $w = mg \longrightarrow$ (i)

unit : $\gamma = \frac{w}{V} \longrightarrow$ (ii)

As $w = mg$

$$\gamma = \frac{mg}{V}$$

$$\Rightarrow \gamma = \rho g$$

$$w = \gamma V \longrightarrow (B)$$

specific gravity $G = \frac{\text{Density of material}}{\text{Density of water}}$

$$G = \frac{\gamma}{\gamma_w} \Rightarrow \text{(iii)}$$

for water $G_s \approx 2.65$

So $\rho_s = G_s \rho_w$

$\gamma_s = G_s \gamma_w$

hence volume of solid partical if mass or weight Given

$$V_s = \frac{M_s}{G_s \rho_w} = \frac{W_s}{G_s \cdot \gamma_w} \Rightarrow \text{(iv)}$$

As & ratio

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

Porosity, $n = \frac{V_v}{V} \Rightarrow \text{(vi)}$

(v) & (vi) $\Rightarrow$ $V_s = V - V_v = (1-n)V$

$$\Rightarrow e = \frac{V_v}{(1-n)V} \Rightarrow \text{(vii)}$$

So degree of saturation is

$$S = \frac{V_w}{V_v + V_w} \Rightarrow \text{(viii)}$$

$$\Rightarrow S = \frac{V_w}{eV_s}$$

$V_w = eS\,V_s \Rightarrow S = \frac{V_w}{eV_s}$

as $V_a = V_v - V_w = eV_s(1-S)$

Now

for figure (I)

Phase	Volum	mass	weight
Air	$e(1-s)$	0	0
water	es	$es\rho_w$	$es\gamma_w$
Solid	1	$G_s\rho_w$	$G_s\gamma_w$

$$\gamma_{bulk} = \frac{W}{V}$$

$$\Rightarrow \gamma_{bulk} = \frac{\gamma_w G_s + \gamma_w es}{1+e} \Rightarrow (A)$$

$$(A) \Rightarrow 1+e = \frac{\gamma_w G_s + \gamma_w es}{\gamma_b}$$

$$(II) \ \& \ (V) \Rightarrow 1+e = \frac{\gamma_w G_s + G_s \gamma_w w_w}{\gamma_b} \Rightarrow (B)$$

$$\boxed{e = \frac{G_s \gamma_w (1 - w_w)}{\gamma_b} - 1}$$

Hence Proved.

---x---x---

Q.: 2
(b)

Ans Classification of Soil:-

=) Grain Size classification:-

① US- Bureau of Soil Classification:-

Clay	Silt	Sand				Gravel	
		very Fine Sand	Fine Sand	medium Sand	course Sand	Fine Graval	coarse Gravel

Practical Size: 0.002 mm, 0.05 mm, 0.1 mm, 0.25 mm, 0.5 mm, 1.00 mm, 2.00 mm

② ASTM Soil Classification System

Clay	colloids clay	Silt	Sand		Gravel
			Fine Sand	coarse Sand	

0.001 mm, 0.005 mm, 0.074 mm, 0.25 mm, 2.00 mm.

③ M.I.T Soil Classification System:-

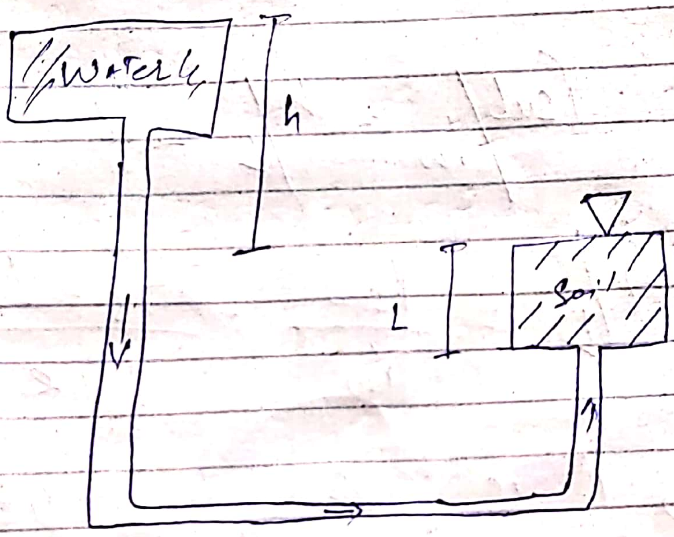
Clay			Silt			Sand			Gravel
Fine clay	Med clay	coarse clay	Fine silt	Med silt	coarse silt	Fine Sand	Med Sand	coarse Sand	

0.0002 mm, 0.006 mm, 0.002 mm, 0.006 mm, 0.02 mm, 0.06 mm, 0.2 mm, 0.6 mm, 2.00 mm

Q3
(A)

ANS: Physical Model:-

The Total Stress at the bottom of Soil Sample is:



$\sigma = \gamma_{SAT} \times L$

The upward pressure at the bottom of soil sample = water pressure from the left tank

$u = \gamma_w \times (h \times L)$.

Effective Stress, $\sigma' = \sigma - u$.

$\sigma' = \gamma_{SAT} \times L - \gamma_w \times (h + L)$

$\sigma' = \gamma_{SAT} \times L - \gamma_w \times h - \gamma_w \times L$

$$\sigma' = \gamma_{sub} \times L - \gamma_w \times h.$$

For Quick Condition

$$\sigma' = 0$$

or

$$\gamma_{sub} \times L - \gamma_w \times h = 0$$

or

$$\gamma_{sub} / \gamma_w = h/L = i$$

$$h/L = \frac{\gamma_{sub}}{\gamma_w} = \frac{G_s - 1}{1 + e}.$$

Where, i is called hydralic gradient

Taking The Specific gravity of Soil as 2.65 and void ratio as 0.65 The value of i become Unity.

if become Unity Then

$$i = i_c$$

i-e $h/L = 1$

or $\therefore$ $h = L$

This indicate that when quick sand condition is achieved the head causing flow equal to the thickness of length of the speeim.

$$\tau = \sigma' \times \tan\phi.$$

Where

τ = Shear Strength

σ' = Effective Stress

ϕ = Angle of internal fraction

When the effective normal stress

$\sigma' = 0$, $\tau = 0$.

if shear strength of soil is zero, it behave as liquid

When a natural soil become quick it cannot support the weight of man or animal.

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Q No (03) (B)

GIVEN DATA:

$V = 65 ml = 0.000065 m^3$

As $1 ml = 10^{-6} m^3$

$W = 0.96N$, $Wd = 0.785N$,

$Gs = 2.6N$.

Required:

$S = ?$

Solution:

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

$$\gamma_B = \frac{W}{V} = \frac{0.96}{0.000065} = 14769 N/m^3$$

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

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

As $= \gamma_s = W_s / V_s$

$V_s = 0.000030 m^3$

~~As =~~ $\gamma_s = \frac{W_s}{V_s}$

$$V_s = \frac{W_s}{\gamma_s} = \frac{0.785}{25970}$$

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

$e = 1.167$

But $G_s = \frac{\gamma_s}{\gamma_w}$

$\gamma_s = G_s \times \gamma_w$

$\gamma_s = 2.65 \times 9800$

$\gamma_s = 25970 N/m^3$

Also

$V = V_v + V_s$

$V_v = 0.000065 - 0.000030$

$V_v = 0.000035 m^3$

Putting all the values in (1) & solve it for "S".

$S = 0.527$ or, 52.7%

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