Name Ikramullah

ID 7868

Sub to Engr Liaqat Ali

Mid term Examination Summer

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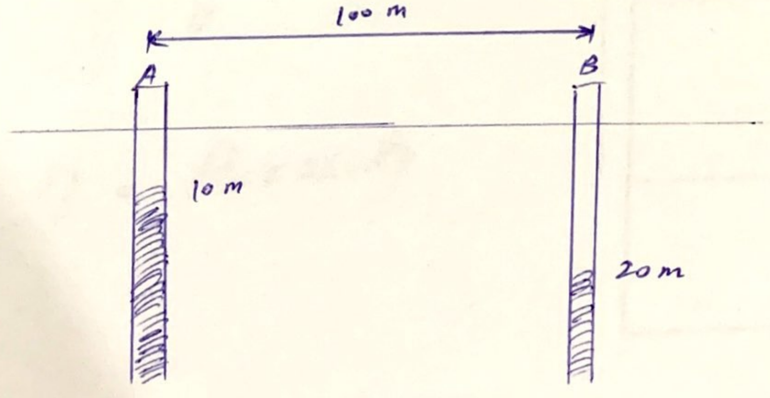
Question No 1 (A)

(a) Hydraulic Gradient :-

The hydraulic gradient is a vector gradient between two or more hydraulic head measurement over the length of the flow path.

The hydraulic gradient between any two points is the slope of the hydraulic head between those points. From the below diagram, the difference in head between the two wells is 10m, and the horizontal distance is 100m, So the hydraulic gradient 10/100 =0.1 Hydraulic gradient is always expressed as a fraction (e.g 0.1) not as a per cent, or as an angle.



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(b) Coefficient of Permeability :-

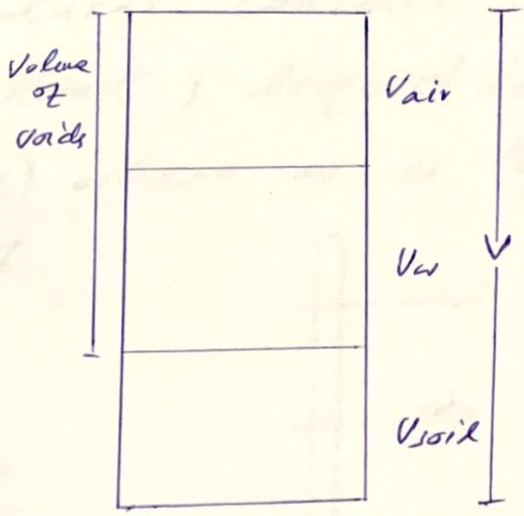
The coefficient of permeability of a soil describes how easily a liquid will move through a soil. It is also commonly reffered to as the hydraulic conductivity of a soil. This factor can be affected by the viscosity, or thickness (fluidity) of a liquid and its density.

(c) Porosity of soil :-

It is also called volume ratio of soil.

$$n = \frac{\text{volume of voids}}{\text{Total volume}}$$

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



n = Porosity

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(d) Degree of SATURATION :-

(Volume ratio)

$$S_r = \frac{\text{Volume of water}}{\text{Volume of voids}} \times 100$$

S_r = Degree of saturation

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

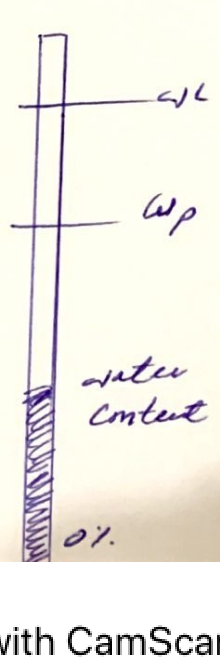
∵ Full saturated soil degree of saturation is 1 or 100 %.

∵ Dry soil degree of saturation is zero.

(e) Liquidity Index :-

The liquidity index (LI) 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 content of water and plastic limit, liquid limit

$LI = (W - PL)/(LL - PL)$ where W is the natural water content.



Liquidity Index :-

$$I_L = \frac{W_N - W_P}{I_P}$$

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Ques 2 (B)

A sample of wet soil ....

Given Data :-

Total weight of soil = 32 kg

Volume, $V = 0.0192\ m^3$

weight of dry sample = 28.5

Required data :-

Bulk density = ?

W_c = ?

γ_b = ?

Saturated density = ?

Void ratio = ?

Solution :-

Bulk Density = W/V

$$\gamma_B = \frac{32}{0.0192}$$

$$= 1562.5\ kg/m^3$$

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⇒ Water Content :-

$$w_c = \frac{\text{weight of water}}{\text{weight of soil}}$$

$$= \frac{32 - 28.5}{}$$

$$= 0.12 = 12\%$$

⇒ Dry Density :-

$$= \frac{W_{\text{soil solid}}}{\text{Total volume}}$$

$$= \frac{28.5}{0.0192}$$

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

⇒ Saturated Density :-

$$= W/V$$

$$= \frac{32}{0.0192}$$

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

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Void ratio:

$\gamma_B = ?$

$w = ?$

$\gamma_d = ?$

$\gamma_{sat} = ?$

$e = ?$

$W_w = W - W_s$

$W_w = 32 - 28.5$

$W_w = 3.5$ kg

$w = W_w / W_s \times 100$

$w = \frac{3.5}{28.5} \times 100$

$w = 12.3\ \%$

$\gamma_B = W/V = \frac{32}{0.0192}$

$\gamma_B = 1666.67$ kg/m³

$\gamma_d = W_s / V$

$\gamma_d = \frac{28.5}{0.0192} =$ $\gamma_d = 1484.37$ kg/m³

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

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

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

$$\boxed{e = 0.785}$$

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

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

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

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Question no 2 (A)

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

As

$$\gamma_B = W/V$$

$$\gamma_B = \frac{W_s + W_w}{V_s + V_v}$$

$$= \frac{W_s/W_s\,(W_s + W_w)}{V_s/V_s\,(V_s + V_v)}$$

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

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

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

$$= \frac{W_s\,(1 + w_c)}{V_s\,(1 + e)}$$

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

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

$$G_s \gamma_w = \gamma_s$$

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

Re-arranging the terms

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

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

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Question No 2 (B)

Explain grain size classification of soil in detail.

Classification of Soil :-

① Grain Size Classification

(A) U.S Bureau of Soil Classification

CLAY : < 0.002 mm

SILT : 0.002mm > 0.05 mm

SAND :

very fine sand 0.05 mm – 0.1 mm

fined sand 0.1 mm – 0.25 mm

Medium sand 0.25 mm – 0.5 mm

Coarse sand 0.5 mm – 1mm

Gravel :

Fine Gravel 1mm – 2mm

Coarse Gravel 2mm >

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(B) ASTM SOIL CLASSIFICATION

American society for testing & materials.

→ CLAY : < 0.001 mm

→ Collidal Clay : 0.001 mm — 0.005 mm

→ Silt : 0.005 mm — 0.074 mm

→ Sand

Fine sand 0.074 — 0.25 mm

Coarse Sand 0.25 mm — 2 mm

(C) MIT SOIL CLASSIFICATION :

→ Clay :

Fine Clay : < 0.0002 mm

Medium Clay : 0.0002 mm — 0.0006 mm

Coarse Clay : 0.0006 mm — 0.002 mm

→ SILT :

Fine Silt : 0.002 mm — 0.006 mm

Medium Silt : 0.006 mm — 0.02 mm

Coarse Silt : 0.02 mm — 0.06 mm

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→ Sand:

Fine sand:
0.06mm — 0.2mm

Medium sand:
0.2mm — 0.6mm

Coarse sand:
0.6mm — 2mm

→ Gravel:

2mm >

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Q3 Part (A)

Quick sand Condition :-

when the seepage pressure due to upward flow of water in sand / sandy soil balances the downward force of gravity (weight of material) a condition of instability arises in sand. Sand in this state is called Quick sand.

⇒ seepage :-
flow of water under gravitational forces in a Permeable medium.

⇒ Relation of Critical hydraulic gradient for quick sand Condition.

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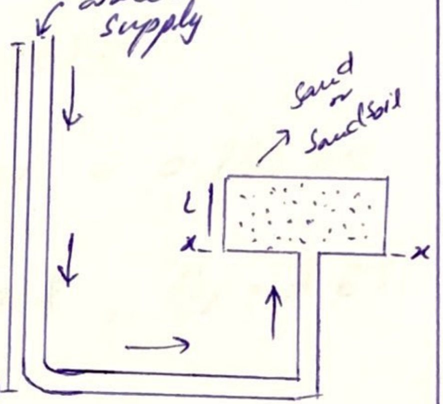
Question No 3 (A)

Derive the relation of critical hydraulic gradient for quick sand condition.

Critical Hydraulic Gradient :-

At the bottom surface

i.e: at $x-x$



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

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

Since $\gamma_B = \dfrac{W}{V} \Rightarrow W = \dfrac{\gamma_w \times (G_s+e)}{(1+e)} \times V$

$V = A \cdot L$

$$W = \gamma_w \times \frac{(G_s+e)}{(1+e)} \times A \times L \rightarrow ②$$

At balance Upward force = Downward force

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

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

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Question No 3 (b) A sample of soil has a volume of 65 ml and 0.96 N. After complete drying specific weight reduce to 0.785 N - If the specific gravity of solid particles is 2.65. Determine degree of Saturation.

Given data :-

Total weight of soil sample $= W = 0.96$ kN

Volume $= 65\,ml = 0.000065\,m^3$

weight of dry soil, $W_s = 0.785$ kN

Specific gravity of soil, $G_s = 2.65$

Required Data :-

$S_r = ?$

$\because 1\,ml = 10^{-6}\,m^3$

$65\,ml = 65 \times 10^{-6}$

$= 0.000065\,m^3$

Solution :-

$$\gamma_B = \frac{\gamma_w (G_s + e \cdot S_r)}{1+e}$$

$$\gamma_B = \frac{W}{V}$$

$$= \frac{0.96\,kN}{0.000065} = 14769\ kN/m^3$$

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⇒ Now for void ratio

$$e = \frac{V_v}{V_{solid}}$$

$$V = V_s + V_v$$

$$V_v = V - V_s$$

$$= 0.000065 - 0.00030$$

∴

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

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

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

$$\gamma_s = G_s \times \gamma_w$$

$$V_s = \frac{W_s}{G_s \times \gamma_w}$$

$$V_s = \frac{0.785}{2.65 \times 9.8} = 0.000030\ ft^3$$

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

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

$$= 1.167$$

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Now putting values of γ_B and e in equation (a)

$$14769 = 9.8\left(\frac{2.65 + 1.167 \cdot S_r}{1 + 1.167}\right)$$

$$S_r = 52.7\%$$

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