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Section: A

Paper : Soil Mechanics

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Question No 1 Part (A)

Ans:-

@ Hydraulic Gradient:

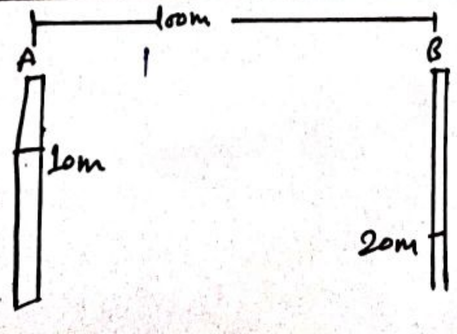
Is a vector gradient between two or more hydraulic head measurements over the length of the flow path.

For Groundwater (It is also called the ('Darcy slope'):

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 is 10/100 = 0.1 Hydraulic gradient is always expressed as a fraction, not as a percent, or as an angle.



(b) Co-efficient Of Permeability:-
The Co-efficient of permeability of a Soil describes how easily a liquid will move through a soil. It is also commonly referred 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) Liquidity Index: (LI)

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

where, W = water Content.
P.L = Plastic Limit.
P.I = Plasticity Index.

It can be calculated as a ratio of difference between natural water content, plastic limit, and liquid limit where w is the natural water content

d) Porosity:

$$n = \frac{\text{Vol. of Voids}}{\text{Total vol of Soil Mass}} = \frac{V_v}{V}$$

The Porosity of a Soil is expressed as a percentage of the total volume of the soil material. Porosity is an important measurement in areas where drinkage water is provided by ground water reserves.

e) Degree of Saturation:

$$S = \frac{\text{Volume of water}}{\text{Volume of voids}} = \frac{V_w}{V_v}$$

The degree of Saturation is the ratio of the volume of water to the volume of voids.

Question No. 01. Part (B)

Ans:-

Given data:-

$W = 32\,Kg$

$V = 0.0192\,m^3$

$Ws = 28.5\,Kg$

$Gs = 2.65$

Required data:-

i) $\gamma_B = ?$

ii) $w = ?$

iii) $\gamma d = ?$

iv) $\gamma sat = ?$

v) $e = ?$

Sol:-

$Ww = W - Ws$

$= 32 - 28.5$

$Ww = 3.5\,Kg$

$w = \frac{Ww}{Ws} \times 100 \Rightarrow \frac{3.5}{28.5} \times 100 = 12.3\%$

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

$\gamma_B = \frac{32}{0.0192} = 1666.67 \, kg/m^3.$

$\boxed{\gamma_B = 166667 \, kg/m^3}$

ii) $\gamma d = \frac{W_s}{V}$

$= \frac{28.5}{0.0192} = 1484.37 \, kg/m^3.$

$\boxed{\gamma d = 1484.37 \, kg/m^3}$

iii) Water Content:-

$W_c = \frac{\text{Weight of water}}{\text{weight of Soil}}$

$= 32 - 28.5$

$= 0.1$ or $12 \cdot /.$

iv) Saturated density :- (γ_{sat}):

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

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

(v) Void Ratio: "e"

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

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

$$\boxed{e = 0.785}$$

—— x —— x —— x

Question No 02 (B)
Explain grain size classification of soil in detail.

Ans:-

CLASSIFICATION OF Soil:-

Grain Size Classification.

A)

U.S Bureau of Soil Classification.

ClAY:

<0.002mm

SILT:

0.002mm >0.05mm

SAND:

Very fine Sand	0.05mm – 0.1mm
fined Sand	0.1mm – 0.25mm
Medium Sand	0.25mm – 0.5mm
Coarse Sand	0.5mm – 1mm

Gravel:

Fine Gravel	1mm – 2mm
Coarse Gravel	2mm >

(B) ASTM Soil Classification:

: American Society for testing and materials.

→ CLAY:-

< 0.001mm

→ Collidal Clay:

0.001mm — 0.005mm

→ Silt:

0.005mm — 0.074mm

→ Sand:

Fine Sand 0.074 — 0.25mm

Coarse Sand 0.25mm — 2mm

(C) MIT Soil Classification:

ClAY:-

Fine Clay: < 0.0002mm

Medium Clay: 0.0002mm — 0.0006mm

Coarse Clay: 0.0006mm — 0.002mm

→ Silt:

Fine Silt:

0.002mm — 0.006mm

Medium Silt:

0.006mm — 0.02mm

Coarse Silt:

0.02mm — 0.06mm

→ Sand:

Fine Sand:

0.06mm — 0.2mm

Medium Sand:

0.2mm — 0.6mm

Coarse Sand:

0.6mm — 2mm

→ Gravel:

2mm >

—— x —— x ——

Question No. 3 Part(A)

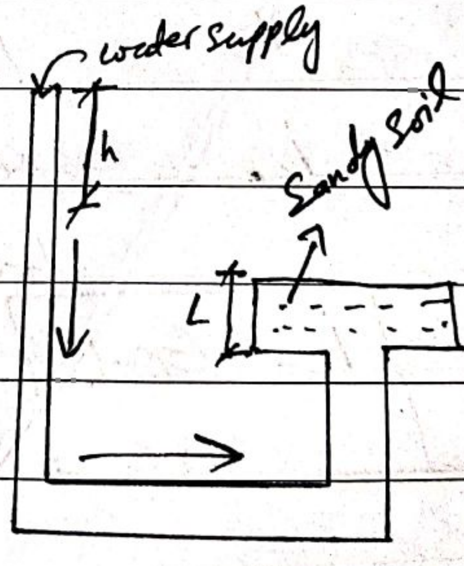
Answers:- Quick Sand:

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.

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; $\gamma_B = \dfrac{W}{V} \Rightarrow W = \dfrac{\gamma_w \times (G_s+e) \times V}{(1+e)}$ where; $V = A \times L$

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

The Soil is literally behaving as a Liquid rather than a solid.

At balance:-

Upward force = Downward force

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

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

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

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

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

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

Q#3 Part(B)

Ans #3 (Part(B))

Req:

$S_r = ?$

Given data:-

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

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

Weight of dry soil, $W_D = 0.785\,kN$

Specific gravity of soil, $G_s = 2.65$

Sol:-

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

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

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

$= 0.000065\,m^3$

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

Now putting the values.

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

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

Now for Void ratio.

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

$V = V_s + V_v$

$V_v = V - V_s$

$V_v = 0.000065 - 0.000030$

$V_v = 0.000035$

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

$V_s = \frac{W_s}{\gamma_s}$ $\quad G_s = \frac{\gamma_s}{\gamma_w}$

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

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

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

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

$\boxed{e = 1.166}$

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

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

$S_r = 52.7\%$

x x x