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7386

Soil Mechanics

Summer Mid-term

Q1 a Hydralic Gradient= Q1 Part-A

It's symbol is i

It's formula is i = h/L

The definition of hydralic gradient is that It is equals to head loss divided by distance or length in which head loss takes place.

In order to find, total head at any point; the formula which is used is:-

Total head at any point = he + hp + hv.

Basically head loss is a measure of the reduction in the total head of fluid as it moves through a fluid system.

he = elevation head.

hp = pressure head.

hv = velocity head.

2. Coefficient of permeability:- It telles about the flow of a liquid through a soil, it basically focuses on how easily the fluid will pass. It is also known as hydraulic conductivity of a soil. There can be certain factors of the fluid which can affect it. It includes:-

1. viscosity
2. density
3. thickness/fluidity.

Coefficient of permeability or hydraulic conductivity is also affected by soil like it's particle shape or roughness of surface etc.

It awares about the rate at which the fluid will pass through a certain kind of soil.

It's easy to determine the rate by coefficient of permeability.

3. Liquidity Index:-

The symbol of liquid Index is LI.

The Mathematical Formula for it's Calculation is $LI = (W - PL)/(LL - PL)$

The definition of liquidity index is that It is the sum of difference between (W) natural water content and (P) plastic limit.

Through IL we can get to know about soil consistency

4. Porosity:- It is one of the properties of soil As it's name indicates, it awares about hole or pores in the soil. It focuses on the amount of pores or holes found in soil. It tells about the percentage of total volume of soil.

Mathematical formulas for its calculations are:

$$\text{Porosity} = (\text{Volume of Voids} / \text{Total Volume}) \times 100\%$$

$$\text{Porosity} = (\text{Total Volume} - \text{Volume of solid} / \text{Total Volume}) \times 100\%$$

Degree of Saturation:-

It is the ratio of a Volume of fluid to the total volume of voids in a porous material.

The symbol which is used for it is S.

It gives percentage. It's value changes depending upon the saturation of soil. When the soil is fully saturated it's value is 100%. and when the soil is dry it's percentage is 0%.

It tell about the relationship of weight of spaces between a moisture one & the saturated one.

$$\text{Degree of saturation \%} = \frac{\text{SH actual}}{\text{SH Saturated}} \times 10.$$

Q No 1 (Part B)

Given Data:-

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

$G_s = 2.65$

Required:-

$\gamma_B = ?$, $w = ?$, $\gamma_d = ?$, $\gamma_{sat} = ?$

$e = ?$, ~~n=?~~ , ~~S=?~~

Solution:-

$W_w = W - W_s$

$= 32 - 28.5$

$= 3.5\,kg$

$w = \dfrac{W_w}{W_s} \times 100$

$= \dfrac{3.5}{28.5} \times 100 = 12.3\,\%$

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

$= \dfrac{32}{0.0192}$

$= 1666.67\,kg/m^3$

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

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

$$= 1484.37 \, kg/m^3$$

$$\gamma d = \frac{G_s \times \gamma_w}{1+e}$$

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

$$= \frac{2.6 \times 1000}{1484.31} - 1$$

$$e = 0.785$$

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

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

Q#2 (Part A)

Proof the given Relation

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

Solution:-

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

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

$$\gamma_s = \frac{W_s}{V_s} \qquad = w_c = \frac{W_w}{W_s}, \quad e = \frac{V_v}{V_s}$$

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

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

$$\gamma_s = G_s \gamma_w$$

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

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

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

Q2#B

1. Grain Size Classification / Particle 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, 1.00 mm, 2.00 mm

ii ASTM Soil Classification System :-

Clay	Colloids or Colloidal Clay	Silt	Sand		Gravel
			Fine Sand	Coarse Sand	

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

iii M.I.T 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, 2.00 mm

Q # 3 (a)

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

When water Pressure with in the Soil get high enough to eliminate it's Shear Strength all together its Called water Supply. In other words it's also known as Quick Condition.

CRITICAL HYDRAULIC GRADIENT

At the bottom Surface

i.e, at $x-x$

upward force . $(h+L)\gamma_w.A$

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

when $U = A \times L$

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

At balance:-

upward force = Downward force

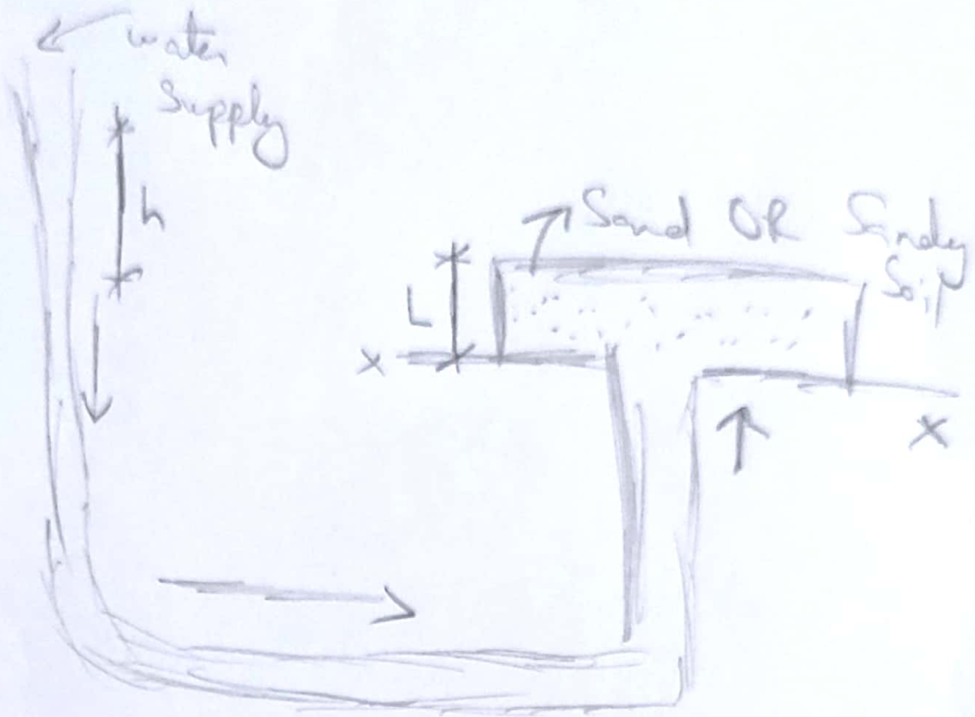
$$\frac{h+L}{L} = \frac{G_s + e}{1+e} \times \frac{L}{L}$$

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

$$i_c = \frac{G_s + \not{e} - 1 - \not{e}}{1+e}$$

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

DIAGRAM



P3

Q# 3 (Part-B)

Given Data:-

$V = 65 ml$

$= 0.000065 m^3$

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

$w = 0.96 N$

$w_d = 0.785 N$

$G_s = 2.65$

Required:-

$S = ?$

Solution:-

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

$$\gamma_B = \frac{W}{V} = \frac{0.96}{0.000065}$$

$= 14769 N/m^3$

$\gamma_w = 9800 N/m^3$

$$e = \frac{V_v}{V_s} \qquad e = \frac{0.000035}{0.000030} \qquad e = 1.167$$

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

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

$= \frac{0.785}{25970}$

$V_s = 0.000030\,m^3$

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

~~$e = 1.167$~~

Also

$V = V_v + V_s$

$V_v = V - V_s$

$V_v = 0.00006 - 0.000030$

$V_v = 0.000035\,m^3$

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

$\gamma_s = G_s \times \gamma_w$

$\gamma_s = 2.65 \times 9800$

$\gamma_s = 25970\,N/m^3$

Put it all values in (1) and Solve it for "S"

$S = 0.527$ or 52.7%