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Q:1 Define the following terms.

a) Hydraulic Gradient
b) Coefficient of permeability
c) Liquidity index
d) Porosity
e) Degree of saturation.

HYDRAULIC GRADIENT:

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

h = Head loss
L = Length

Headloss divided the length in which headloss take place is called hydraulic gradient

$$V \propto i$$

$$A \times V = Ki \times A$$

$$Q = KiA$$

$$K_r = Q/iA.$$

DEGREE OF SATURATION:

For the fully saturated soil sample the degree of saturation will be 1 or 100% & for dry soil sample. It will be zero

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

S_r = degree of saturation

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POROSITY:

Porosity of soil

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

η = porocity V_v = volume of voids.

V = volume of soil sample

LIQUIDITY INDEX:

The Liquidity index of soil shows that how much the soil sample is near to its Liquid limit

⇒ If the Liquidity index is 100% its means that the soil has in Liquid state

⇒ If the soil is in plastic state then its Liquidity index will be zero.

⇒ If the Liquidity index is in minus/negative then the soil is in hard dry form.

CO-EFFICIENT OF PERMEABILITY:

The co-efficient 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 & its density.

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Q NO: 2

A sample of wet soil has a volume of $0.192 m^3$ & a mass of 32kg. After drying the sample in an oven its mass reduce to 28.5 kg. Determine.

Bulk Density
Water content
Dry Density
Saturated Density
Void Ratio.

Given data:

Weight $w = 32kg$
Volume $V = 0.0192 m^3$
$w_2 = 28.5 kg$

Taking Specific Gravity of soil solid as.
$G_s = 2.65$

find:

$\gamma_b = ?$, $w = ?$, $\gamma_d = ?$
$V_{sat} = ?$, $e = ?$,

SOLUTION:

$$w_w = w - w_s$$
$$32 - 28.5 = 3.5 kg$$

$$w = \frac{w_w}{w_s} \times 100$$

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

$$\gamma_B = \frac{w}{V} = \frac{32}{0.0192} = 1666.67 \text{ kg/m}^3$$

$$\gamma_d = \frac{W_s}{V} = \frac{28.5}{0.0192} = 1484.37 \text{ kg/m}^3$$

$$\gamma_d = \frac{G_s \times \gamma_w}{1+e}$$ for finding e

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

$$e = \frac{2.65 \times 1000}{1484.37} - 1 \qquad e = 0.785.$$

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

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

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Q.2 Prove the given relation

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

Sol:

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

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

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

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

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

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

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

$$\gamma_s = G_s \gamma_w$$

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

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

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

Q No: Explain grain size classification of soil in detail.

A: GRAIN SIZE CLASSIFICATION:

*** Us - BURCAU of SOIL CLASSIFICATION:**

Clay	Silt	Sand				Gravel	
		very fine sand	find Sand	Medium sand	Coarse sand	fine Gravel	Coare Gravel.
Partical size	0.002 mm	0.05 mm	0.1 mm	0.25 mm	0.5 mm	1.00 mm	2.00 mm

*** ASTM SOIL CLASSIFICATION SYSTEM:**

Clay	Colloids. "or" colloidal clay	Silt	Sand		Gravel.
			fine Sand	Course Sand	
0.001 mm	0.005 mm	0.074 mm	0.25 mm	200 mm	

*** M. I. T SOIL CLASSIFICATION SYSTEM:**

Clay			Silt			Sand			Gravel
fine clay	Medium clay	Coarse clay	fine silt	Medimum silt	Coarse silt	fine sand	Medimum sand	Coarse Sand	
0.0002 mm	0.0006 mm	0.002 mm	0.006 mm	0.02 mm	0.06 mm	0.2 mm	.06 mm	200 mm	

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Q3. "a"

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

QUICK SAND:

When the seepage pressure due to upword flow of water in sand/Sandy soil balance the downword 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 force in a permeable medium.

CRITICAL HYDRAULIC GRADIENT:

At the bottom Surface

i-e at x-x

upword force $= (h+L)\gamma_w \cdot A$

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

Since : $\gamma_B = \frac{w}{V} \Rightarrow w = \frac{\gamma_w \times (G_s + e)}{(1+e)} \times V$

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

Balance = upword force = Downword force

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

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

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

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Q3. A sample of soil has a valume of 65 ml & weight of 0.96N. After complete drying its weight reduce to 0.785N. if the specific gravity of soil solid particales is 2.65 Determine the degree of saturation

GIVEN:

$V = 65\ ml = 0.000065\ m^3$ As $1ml = 10^{-6}\ m^3$

$W = 0.96N$.

$W_d = 0.785N$

$G_s = 2.65$

$S = ?$

Find:

Degree of Saturation = $S = ?$

Solution:

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

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

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

$e = \frac{V_v}{V_s}$, As, $V_s = \frac{W_s}{V_s}$.

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

$V_s = 0.000030\ m^3$

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

$$e = 1.167.$$

Also,

$$V = V_v + V_s.$$

$$V_v = V - V_s.$$

$$V_v = 0.000065 - 0.000030.$$

$$V_v = 0.0000\,35 m^3$$

But,

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

$$V_s = G_s \times V_w$$

$$V_s = 2.65 \times 9800$$

$$V_s = 25970\ N/m^3$$

Putting all the values in eq solve it for 's'

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