MID TERM EXAM

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Subject: Soil Mechanics.

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Date: 24/08/2020

Semester: SENIOR

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Q2) A):. Define the following Terms:.

a):. **Hydraulic Gradient:.**

As per Bernoulli's equation, the total head at point in water under steady flow condition may be expressed as,

Total Head = Pressure Head + Velocity head + Elevation Head.

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 referred to as the hydraulic conductivity of a soil. This factor can be affected by the viscosity, or thickness (fluidity) of a liquid and it's density.

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c):: Liquidity Index :- (LI).

The liquidity Index (LI) is used for scaling the natural water content of a soil sample to itss limits. It can be calulated as a ratio of difference between natural water content. plastic limit, liquid limit.

$$LI = \frac{(w - PL)}{(LL - PL)}$$

Where w is the Natural water Content.

d): Porosity :. (e).

It is defined as the ratio of the volume of voids to the volume of solids.

$$\because \text{Void Ratio} = \frac{\text{Volume of Voids}}{\text{Volume of Solids}} = e = \frac{V_v}{V_s}$$

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e):. Degree of Saturation.

It is defined as the ratio of the volume of water to the volume of voids.

$\therefore$ Degree of Saturation = $\dfrac{\text{Volume of water}}{\text{Volume of Voids.}}$

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

→ In case of full saturated soil, voids are completely filled with water. There is no air.

$\because$ $V_w = V_v$.

$S = 1$

$\therefore$→ In case of fully dry soil, voids are completely filled with air. There is no water.

$\because$ $V_w = 0$

$\therefore$ $S = 0$

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Q2) B). Given Data:.

$W = 32\,kg$

Volume $(V) = 0.0192\,m^3$.

$W_s = 28.5\,kg$

Required:.

$\gamma_B = ?$

$w = ?$

$\gamma_d = ?$

γ_{sat} ?

$e = ?$

Solution:

$W_w = W - W_s$

$W_w = 32 - 28.5$

$W_w = 3.5\,kg$

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

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

$w = 12.3\%$.

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

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

$$\boxed{\gamma_B = 1666.67 \, kg/m^3}$$

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

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

$$\boxed{\gamma_d = 1487.37 \, kg/m^3}$$

We know that,

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

or

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

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

$$\boxed{e = 0.785}$$

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Now,

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

Putting values in eq(i).

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

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

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Q2):A). Prove the Given Relation:.

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

We know that,

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

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

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

As,

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

or

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

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

So,

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

Proved !

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QNo:. 2)B):. Explain grain size classification of soil in detail.

i):. 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. < 0.002mm, 0.05mm, 0.1mm, 0.25mm, 0.5mm, 1.00mm, 2.00mm

ii):. ASTM Soil classification System:.

			Sand		
Clay	Colloids OR Colloidal Clay	Silt	Fine Sand	Coarse Sand.	Gravel.

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

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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 0.0006mm 0.002 mm 0.006 mm 0.02 mm 0.06 mm 0.2mm 0.6mm 2.00mm

Partick Size

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Q3) A) :: Derive the relation of Critical hydraulic Gradient for quick sand condition.

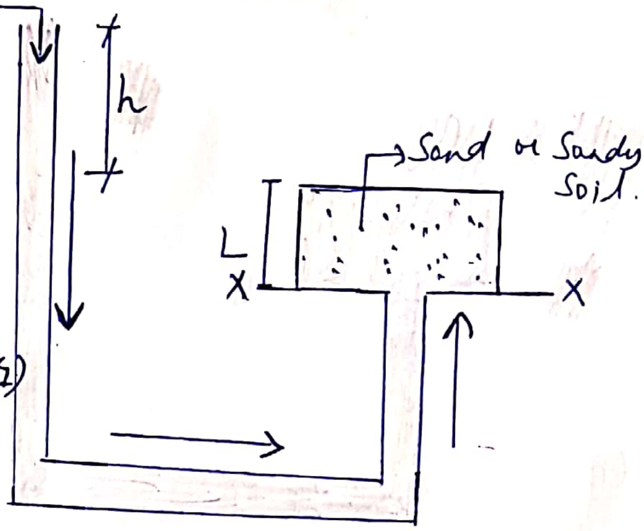
Quick Sand ::

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 unstability arises in sand. Sand in this state is called Quick sand.

* Seepage :: flow of water under gravitational forces in a permeable medium.

When the water pressure within the soil get high enough to dominate it shear strength all together it is called liquifaction. otherwise known as the Quick sand condition.

Critical Hydraulic Gradient:



At the bottom surface i-e. at $x-x$.

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

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

As,

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

or

$$W = \frac{\gamma_w \times (G_s + e) \times V}{(1+e)}$$

So,

As,

$$V = A \times L$$

$$W = \frac{\gamma_w \times (G_s + e)}{} \times A \cdot \times L \rightarrow \text{eqn (2)}.$$

At Balance,

Upward Force = Downward force.

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

So,

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

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So,

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

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

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

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

Q No:. 3) B. Given Data:

Volume (V) = 65 ml or 0.000065 m^3.

W = 0.96 N.

W_d = 0.785 N.

G_s = 2.65

As,

1 ml = 10^{-6} m^3.

Required:

S (Degree of Saturation) = ?

Solution:

We know that,

$$\gamma_B = \frac{\gamma_w \times (G_s + e \times S)}{(1+e)} \longrightarrow \text{equ (A)}.$$

As,

$$\gamma_B = \frac{W}{V} \rightarrow \text{equ (i)}.$$

Putting values in equ (i).

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

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

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As,

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

As,

$\gamma_s = \frac{W_s}{V_s}$ → equ (1). or $V_s = \frac{W_s}{\gamma_s}$ → equ(2)

Putting values in equ (2).
we get,

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

$$\boxed{V_s = 0.000030 m^3}$$

As,

$e = \frac{V_v}{V_s}$ → equ (3).

Putting values in equ(3)

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

$$\boxed{e = 1.167}$$

As,

$V = V_v + V_s$.

or

$V_v = V - V_s$.

$V_v = 0.000065 - 0.000030$

$$\boxed{V_v = 0.000035 m^3}$$

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As,

$$G_s = \frac{\gamma_s}{\gamma_w} \quad \text{or} \quad \gamma_s = G_s \times \gamma_w.$$

$$\gamma_s = 2.65 \times 9800$$

$$\boxed{\gamma_s = 25970 N/m^3}$$

Putting all the values in eqn (A).
And solve it for S =.

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

$$14769 = \frac{9800 \times (2.65 + 1.167 \times S)}{(1 + 1.167)}$$

After Rearranging & And calculating we gets,

$$S = 0.527$$

or

$$\boxed{S = 52.7\%}$$

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