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Internal Assessment Test 1 – March 2019

Sub:	Basic Geotechnical Engineering				Sub Code:	15CV45	Branch:	CIVIL
Date:	7/3/2019	Duration:	90 mins	Max Marks: 50	Sem / Sec:	4A & 4B		OBE

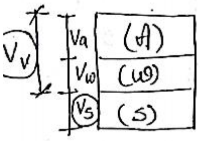
Answer ALL Questions

		MARKS	CO	RBT
1 (a)	Differentiate between:	[4]	CO1	L2

1) Void ratio and porosity

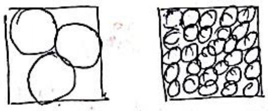
$M_w, M_s \rightarrow$ mass of water, solids

Void Ratio (e): It is defined as the ratio of volume of voids to volume of solids.



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

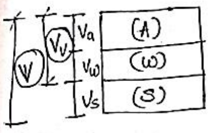
{expressed as decimals}
→ NO UNIT



Individual voids are larger in coarse grained soils but total void ratio is more for fine grained soils.

$e_{coarse} < e_{fine}$

Porosity (n) – It is the ratio of volume of voids to the total volume of soil. It is another way of representing the relative voids to solids proportion.



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

expressed as a %
→ NO UNIT

$0 \le n \le 100$ Max limit is 100%

2) Specific gravity of solids and mass specific gravity

① Specific gravity of solids (G_s)

'G_s' is the ratio of weight of soil solids to the weight of equal volume of water at 4°C.

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

$$= \frac{\left(\frac{W_s}{V_s}\right)}{\gamma_w}$$

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

	G_s
Sands & gravels	2.65–2.68
Silt	2.66–2.70
Inorganic clay	2.70–2.80
Soils with iron/mica	2.75–2.85
Organic soils	< 2

... wt. of solids to unit

(2) Mass specific gravity or apparent ...

$$G_m = \frac{W}{V \cdot \gamma_w} = \frac{\left(\frac{W}{V}\right)}{\gamma_w} = \frac{\gamma}{\gamma_w}$$

G_m is the ratio of bulk unit weight to unit weight of water. or G_m is the ratio of weight of total soil mass to

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1 (b) Prove from phase diagram that $\gamma_t = \left(\frac{G_s + se}{1+e}\right)\gamma_w$ — [6] CO1 L3

$$\gamma_t = \frac{W}{V} = \frac{W_s + W_w}{V_s + V_v} = \frac{\gamma_s V_s + \gamma_w V_w}{V_s + V_v}$$

we know $V_s = 1$ $V_v = e$ $\gamma_s = G_s \gamma_w$ $V_w = Se$

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

$$\boxed{\gamma_t = \frac{\gamma_w (G_s + Se)}{1+e}}$$

To write in terms of water content (w)

$w G_s = S e$

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

$$\boxed{\gamma_t = \frac{\gamma_w G_s (1 + w)}{1+e}}$$

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2 (a) A fully saturated soil sample has a water content of 35 % and specific gravity of solids of 2.65. Determine its porosity, saturated unit weight and dry unit weight. — [4] CO1 L3

2 (b) A 5000 m^3 embankment is to be constructed with a void ratio of 0.85. The details of the borrow pits are given below. Find the most economical pit. — [6] CO1 L3

Pit	Void ratio	Cost per m^3
X	0.95	30
Y	1.65	25

	③ Embankment — Pit A — Pit B — Pit C Given: Embankment $e = 0.85$, $V = 5000\ m^3$; Pit A $e = 0.95$, Rs $30/m^3$; Pit B $e = 0.90$, Rs $16/m^3$; Pit C $e = 1.65$, Rs $25/m^3$ To find → Which fill is economical?? $n = \frac{e}{1+e} = \frac{0.85}{1.85} = 0.46$ $\frac{V_v}{V} = 0.46$ $V_v = 0.46(5000) = 2300\ m^3$ $V_s = V - V_v = 5000 - 2300 = 2700\ m^3$ Pit A: $V_s = 2700\ m^3$; $e = \frac{V_v}{V_s} = 0.95$; $V_v = 0.95(2700) = 2565\ m^3$; $V = V_s + V_v = 5265\ m^3$; Cost $= 30 \times V = 30 \times 5265$ = Rs 1,57,950 Pit B: $V_s = 2700\ m^3$; $e = \frac{V_v}{V_s} = 0.90$; $V_v = 0.90(2700) = 2430\ m^3$; $V = V_s + V_v = 5130\ m^3$; Cost $= 16 \times 5130$ = Rs 82,080 Pit C: $V_s = 2700\ m^3$; $e = \frac{V_v}{V_s} = 1.65$; $V_v = 1.65(2700) = 4455\ m^3$; $V = V_s + V_v = 7155\ m^3$; Cost $= 25 \times 7155$ = Rs 1,78,875 pit C cost the highest & pit B cost the least hence pit B is the most economical.			
3(a)	Explain the determination of water content by oven drying method. ① Oven Drying Method The soil is taken in an air-tight container. The weight of soil + container is W_1. Set the temperature to 110°C and keep the container in oven for 24 hours. After drying the soil + container is weighed as W_2. The weight of dry empty container W_3. water content $= \frac{\text{Weight of water}}{\text{Weight of soil}} = \frac{W_1 - W_2}{W_2 - W_3}$ The minimum quantity of sample to be kept in oven depends on the size of particles. If size of particles is more than the sample required is more. Temperature A temperature of 110°C is not good for soils having gypsum or more organic content. gypsum loses its water of crystallization @ high temp. organic soils starts decomposing @ high temperature. Hence for soils having gypsum or organic matter a temp of 60°C – 80°C is sufficient	[4]	CO1	L1
3(b)	In a specific gravity test the following observations were recorded : Mass of dry soil = 103 g Mass of density bottle + soil + water = 538 g Mass of density bottle + water = 474.6 g What is the specific gravity of solids? What is the percentage error in calculating specific gravity if 2.5 ml of air got entrapped in mass of density bottle + soil + water?	[6]	CO1	L3

Part 1

Given

$W_2 - W_1 = 103\,g$

$W_3 = 538\,g$

$W_4 = 474.6\,g$

To find

G_s

Solution (Part) 1

$$G_s = \frac{W_2 - W_1}{(W_4 - W_1) - (W_3 - W_2)}$$

$$= \frac{W_2 - W_1}{W_4 - W_1 - W_3 + W_2}$$

$$= \frac{W_2 - W_1}{W_4 - W_3 + (W_2 - W_1)}$$

$$= \frac{103}{474.6 - 538 + 103}$$

$$G_s = 2.601$$

W_1 = weight of density bottle which is not given

Part 2

Given

2.5ml of air was entrapped in weight of density bottle + soil + water

To find

% error in calculating G_s.

Solution

W_3 = weight of density bottle + soil + water

2.5ml of air in W_3 will cause change in weight of water

2.5 ml of air is in $W_3 = 538\,g$

To remove it 2.5ml of water should be added

i.e. $2.5\,ml \times 1\,g/ml = 2.5\,g$ of water

Corrected $W_3 = W_3' = 538 + 2.5$

$= 540.5\,g$

Corrected $G_s = G_s' = \frac{103}{474.6 - 540.5 + 103}$

$= 2.77$

$$\%\ error = \frac{\text{Exact value} - \text{Erroneous value}}{\text{Exact value}}$$

$$= \frac{2.77 - 2.601}{2.77}$$

$= +6.1\%$

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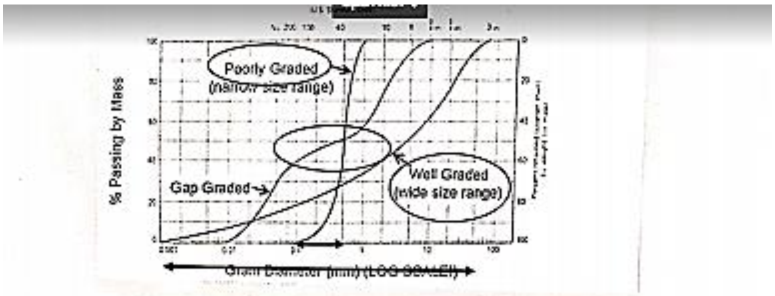
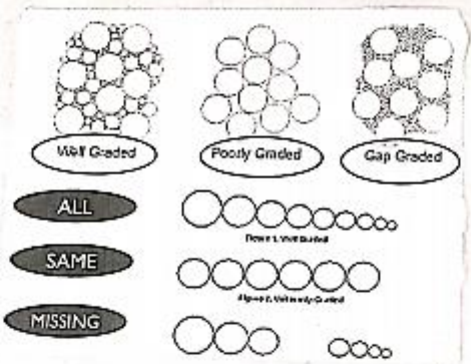
4 (a)	Explain with a particle size analysis curve : 1) Well graded soil 2) Gap graded soil 3) Poorly graded soil 4) Fine grained soil	[4]	CO1	L2





Well graded – All particle sizes are present. They have very less voids, good strength and less settlement.

Poorly graded – (Uniformly graded) They have same sizes of particles, More voids, more settlement.

Gap graded – Some grain sizes are missing. On loading this soil will segregate causing settlement.

4 (b)	A soil sample consisting of particles ranging from 0.5 mm to 0.01 mm is put on the surface of still water of 5 m deep tank. Calculate the time of settlement of the coarsest and finest particles of the sample to the bottom of the tank. $G_S = 2.66$ and $\eta = 0.01$ poise.	[6]	CO1	L3

Given

Coarse $D = 0.5$ mm

fine $D = 0.01$ mm

$H_e = 5$ m

$G_s = 2.66$

$\eta = 0.01$ poise $= 0.01 \times 0.1 \frac{N.s}{m^2} = 0.001 \frac{Ns}{m^2}$

To find 't'

$1 \text{ poise} = 0.1 \frac{Ns}{m^2}$

Coarse

$$\frac{H_e}{t} = \frac{(\gamma_s - \gamma_w) \cdot D^2}{18\eta} = \frac{\gamma_w (G_s - 1) D^2}{18\eta}$$

$$\frac{5}{t} = \frac{10 \times 1000 (2.66 - 1) \times (0.5 \times 10^{-3})^2}{18 \times 0.001}$$

$$\Rightarrow t = \underline{21.68 \text{ s}}$$

Fine

$$\frac{H_e}{t} = \frac{\gamma_w (G_s - 1) D^2}{18 \cdot \eta}$$

$$\frac{5}{t} = \frac{10 \times 1000 (2.66 - 1) \times (0.01 \times 10^{-3})^2}{18 \times 0.001}$$

$$\Rightarrow t = \underline{15.06} \text{ hours}$$

5 (a)	Explain the determination of in-situ density by core cutter method.	[5]	CO1	L1

① CORE CUTTER METHOD.

Core cutter is an open cylindrical barrel with one cutting edge. Measure the dimensions of the core-cutter - height (H), Diameter (D). Find the volume of core-cutter as $V = \frac{\pi}{4} D^2 H$. Find empty weight of core cutter (W_1)

Place the dolly over the core-cutter and ram into the earth with the dolly till few cm of dolly protrudes out of the earth. The soil surrounding the corecutter is removed. The corecutter along with the dolly is removed. The dolly is removed and soil extruding out of corecutter is removed.

Weight of core cutter + soil is W_2.

$$\text{Unit Weight (Bulk unit weight)} = \frac{W_2 - W_1}{V}$$

$$\text{Insitu - bulk density} = \frac{M_2 - M_1}{V}$$

The method is suitable for soft fine grained soil. It is ~~uni~~ unsuitable for hard soils and coarse grained soils.

5 (b)	A sample of sand was found to have a water content of 20 % and bulk unit weight of 1.93 g/cc. Laboratory tests on the soil sample indicated the void ratios in the loosest and densest possible states are 0.90 and 0.50 respectively. Calculate the relative density. Take Gs = 2.65.	[5]	CO1	L2

Given

$w = 0.20$

$\gamma_t = 1.93\ g/cc$

$e_{max} = 0.90$

$e_{min} = 0.50$

$G_s = 2.65$

To find

ρ_d, S

Solution

$$\rho_d = \frac{\gamma_t}{1+w} = \frac{1.93}{1+0.20} = 1.608\ g/cc$$

$$\rho_d = \frac{G_s \gamma_w}{1+e} \qquad \rho_w = 1 g/cc$$

$$1.608 = \frac{2.65 \times 1}{1+e} \Rightarrow e = 0.648$$

$$I_D = \frac{e_{max} - e}{e_{max} - e_{min}} \times 100 = \frac{0.90 - 0.648}{0.90 - 0.50} \times 100 = 63\%$$

$$w G_s = S e$$

$$0.20 \times 2.65 = S \times 0.648$$

$$\Rightarrow S = 0.818$$

Signature of CI Signature of CCI Signature of HOD