SEISMIC GROUP UET LHR

[redacted]

PROBLEM SHEET NO 1
(Physical Properties of Soils)

1) The wet density of a glacial outwash soil is 1.92 gm/cc the specific gravity of the solid particles of the soil is $G_s = 2.67$, and the moisture content of the soil is w = 12% by dry weight.
CALCULATE: a) dry density b) porosity
c) void ratio d) degree of saturation
e) percent of air voids.

2) From a borrow pit in which the void ratio is e = 1.20, 200,000 cu. meter of soil have to be excavated for building a fill with a void ratio of e = 0.70. How many cubic meter of fill can be constructed?

3) The moisture content of a saturated clay sample is 345%. The unit weight of the solids is 2.38gm/cc. Determine the unit weight of the saturated clay (gm/cc.).

4) The unit weight of the solids of given sand is 2.60 gm/cc. Its void ratio is 0.573.
CALCULATE: a) The unit weight of the dry sand
b) The unit weight of the sand when saturated
c) The submerged unit weight of the sand.

5) One cubic cm of wet soil weight 2.0 gm. Its dry weight is 1.8 gm. The specific gravity of the solid particles of soil is $G_s = 2.67$. Determine the moisture content, porosity, void ratio, and degree of saturation.

6) A clay sample at its natural moisture content, weighs 34.62 gms. The specific gravity of the solids of this soil is 2.70. After oven drying, the soil sample weighs 20.36 gms. To determine the volume of the moist clay, the sample is immersed in mercury prior to over drying. The displaced volume of the clay sample is found to be 24.26 cm^3.
CALCULATE: a) Moisture content b) Void ratio,
c) Degree of saturation of the soil

7) A cubic cm of soil at its natural moisture weighs 1.81 gm after being dried it weighs 1.54 gm. The specific gravity of the soil is 2.70. Determine the degree of saturation, void ratio, porosity, and water content for the soil as it existed in its natural state.

8) A container of saturated soil weighed 113.27gms before it was placed in an oven and 100.06 g after it remained in the oven overnight. The container alone weighs 49.31 gms, the specific gravity of the soil is 2.80. Determine the void ratio, porosity, and water content of the original soil sample. 0.73 0.42 26.02%

9) A saturated soil has a unit weight of 1.92gm/cc and water content of 32.5%. Determine the void ratio and specific gravity of the soil.
0.89

10) A sample of dry sand having a unit weight of 1.68 gm/cc and a specific gravity of 2.70 is placed in the rain. During the rain the volume of the sample remains constant but the degree of saturation increases to 40%. Determine the unit weight and water content of the soil after being in the rain. $\gamma_b = 1.83$ 9.04%

11) A soil sample taken from a borrow pit has an in-situ void ratio of 1.15. The soil is to be used for a compaction project where a total of 100,000 m^3 is needed in a compacted state with the void ratio predetermined to be 0.73. Determine how much volume is to be excavated from the borrow pit.

12) Laboratory tests determined the water content in a certain soil to be 14% at a degree of saturation of 62 percent, the unit weight of soil solids is 1.7 gm cc. Determine.
a) The specific gravity b) The porosity c) The void ratio of the mass.

13) A soil in its natural state was found to have a void ratio of 0.88 at a degree of saturation of 72 percent, the unit weight of soil solids is 1.7 gm cc. Determine:
a) The specific gravity
b) The water content
c) The porosity of the soil mass.

PROBLEM SHEET # 1

Problem 1

Data:

- $\gamma_b = 1.92 g/cm^3$
- $G_s = 2.67$
- $w = 12\% \Rightarrow \frac{12}{100} = 0.12$

Sol:

a) Dry density:

$$\gamma_d = \frac{\gamma_b}{1+w} = \frac{1.92}{1+0.12} = 1.71 g/cc$$

b) Porosity:

$$n = \frac{V_v}{V} \times 100 \qquad V = V_v + V_s \qquad V_s = \frac{W_s}{\gamma_w G_s} \qquad \frac{W_s}{V} = \gamma_d$$

$$1 - 0.64 = V_v \qquad = \frac{1.71}{(1)(2.76)} \qquad W_s = 1.71 g$$

$$= \frac{0.36}{1} \times 100 \qquad V_v = 0.36 cc \qquad V_s = 0.64 cc$$

$$\boxed{n = 36\%}$$

c) Void ratio

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

$$e = \frac{0.36}{0.64} = 0.5625$$

d) deg of saturation

$$S = \frac{V_w}{V_v} \times 100 \qquad \gamma_w = \frac{W_w}{V_w} \qquad w = \frac{W_w}{W_s}$$

$$= \frac{0.2052}{0.36} \times 100 \qquad V_w = \frac{0.2052 cc}{1} \qquad W_w = 0.12 \times 1.71$$

$$W_w = 0.2052 g$$

$$S = 57\%$$

e) % of air voids:

$$n_a = \frac{V_a}{V_v} \times 100$$

$$= \frac{0.1548}{0.36} \times 100$$

n_a = 43%.

$$V_v = V_a + V_w$$

$$V_a = 0.36 - 0.2052$$

$$V_a = 0.1548 \text{ cc}$$

Prob=2

Data:

$e_1 = 1.20$

$V_1 = 200{,}000 \text{ m}^3$

$e_2 = 0.70$

$V_2 = ?$

Sol:

$$e_1 = \frac{V_v}{V_s}$$

$$e_1 = \frac{V_1 - V_s}{V_s}$$

$$1.20 = \frac{200{,}000 - V_s}{V_s}$$

$$V_s = 90909.09 \text{ m}^3$$

$$V = V_v + V_s$$

$$V - V_s = V_v$$

$$e_2 = \frac{V_v}{V_s}$$

$$e_2 = \frac{V_2 - V_s}{V_s}$$

$$0.70 = \frac{V_2 - 90909.09}{90909.09}$$

$$V_2 = 154545.45 \text{ m}^3$$

Prob 3

Data:

$w = 345\% \Rightarrow 3.45$

$\gamma_s = 2.38 g/cc$

$\gamma_{sat} = ?$

Sol:

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

$$e = \frac{wG_s}{S}$$

$$e = \frac{(3.45)(2.38)}{1}$$

$$e = 8.211$$

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

$$G_s = 2.38$$

$$\gamma = \frac{(2.38 + 8.211)(1)}{1 + 8.211}$$

$\gamma_{sat} = 1.1498 g/cc$

$\gamma_{sat} = 1.1498 \times 62.4$

$\gamma_{sat} = 71.74$ pounds per ft^3 (pcf)

Prob 4

Data:

$\gamma_s = 2.60 g/cc$

$e = 0.573$

Sol:

a) Unit wt. of dry sand:

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

$$= \frac{(2.60)(1)}{1 + 0.573}$$

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

$G_s = 2.60$

$\boxed{\gamma_d = 1.653 g/cc}$

b) Unit wt. of saturated sand:

$$\gamma_{sat} = \frac{(G_s + e)\gamma_w}{1+e} = \frac{(2.6 + 0.573)}{1 + 0.573} = 2.02 \text{ g/cc}$$

c) Submerged unit wt. of sand:

$$\gamma_{sub} = \frac{\gamma_w (G_s - 1)}{1+e} = \frac{(1)(2.6 - 1)}{1 + 0.573} = 1.02 \text{ g/cc}$$

Probs

Data:

$\gamma_b = 2g$

$\gamma_d = 1.8g$

$G_s = 2.67$

Sol:

a) Moisture content:

$$\gamma_d = \frac{\gamma_b}{1+w}$$

$$1.8 = \frac{2}{1+w}$$

$$w = 0.111$$

$$\boxed{w = 11.1\%}$$

b) Porosity:

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

$$= \frac{V - V_s}{V} \times 100$$

$$= \frac{(1 - 0.674)}{1} \times 100$$

$$\boxed{n = 32.6}$$

$\because V = V_v + V_s$

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

$V_s = \frac{1.8}{(2.67)(1)}$

$V_s = 0.674 \text{ cc}$

$= W_s \in \gamma_s V_s$

$W_s \geq$

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

$W_s = 1.8g$

c) Void Ratio:

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

$$V = V_v + V_s$$

$$V_v = 1 - V_s$$

$$V_v = 1 - 0.674$$

$$V_v = 0.326$$

$$e = \frac{0.326}{0.674}$$

$$\boxed{e = 0.48}$$

d) deg. of saturation:

$$e = \frac{w G_s}{S}$$

$$S = \frac{w G_s}{e} = \frac{(0.11)(2.67)}{0.48}$$

$$\boxed{S = 0.61\ \%}$$

Prob 6

Data:

- $W = 34.62\ g$
- $G_s = 2.70$
- $W_s = 20.36 g$
- $V = 24.26 cm^3$

Sol:

a) Moisture content:

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

$$\therefore W = W_w + W_s$$

$$W_w = W - W_s$$

$$= 34.62 - 20.36$$

$$W_w = 14.26 g$$

$$w = \frac{14.26}{20.36} \times 100$$

$$\boxed{w = 70.03\%}$$

b) Void ratio:

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

$$\therefore V = V_s + V_v$$

$$V_v = 24.26 - 7.54$$

$$V_v = 16.71 cc$$

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

$$V_s = \frac{20.36}{2.70}$$

$$V_s = 7.54 cc$$

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

$$\gamma_s = 2.70 g/cc$$

$$e = \frac{16.71}{7.54}$$

$$\boxed{e = 2.216}$$

c) deg of saturation of soil:

$$S = \frac{V_w}{V_v} \times 100$$

$$= \frac{14.26}{16.71} \times 100$$

$$\boxed{S = 85.33\%}$$

$$V_w = \frac{W_w}{\gamma_w}$$

$$V_w = 14.26 cc$$

Prob 7

Given:

$W = 1.81g$

$W_s = 1.54g$

$G_s = 2.70$

Sol:

a) deg. of sat:

$S = \frac{V_w}{V_v} \times 100$

$\therefore V_w = \frac{W_w}{\gamma_w}$

$= \frac{0.27}{1}$

$V_w = 0.27 g/cc$

$\therefore W = W_w + W_s$

$W_w = W - W_s$

$= 1.81 - 1.54$

$W_w = 0.27g$

$S = \frac{0.27}{0.43} \times 100$

$S = 62.79\%$

$\therefore V = V_s + V_v$

$V_v = V - V_s$

$= 1 - 0.570$

$V_v = 0.43 cc$

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

$= \frac{1.54}{(1)(2.70)}$

$V_s = 0.570$

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

$\neq$

b) Void ratio:

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

$= \frac{0.43}{0.57}$

$e = 0.754\%$

c) Porosity:

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

$= \frac{0.43}{1} \times 100$

$n = 43\%$

d) Water content

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

$= \frac{0.27}{1.54} \times 100$

$w = 17.53\%$

Prob 2

Data:

$W = W_s + W_{cont} + W_w = 113.27\,g$

$W_s + W_{cont} = 100.06\,g$

$W_{cont} = 49.31\,g$

$G_s = 2.80$

$\Rightarrow W_s = 100.06 - 49.31$

$W_s = 50.75\,g$

Sol: a) Water content:

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

$$= \frac{13.21}{50.75} \times 100$$

$$\boxed{w = 26.02\%}$$

$W_w = 113.27 - 49.31 - 50.75$

$W_w = 13.21\,g$

b) Void ratio:

$$e = \frac{G_s w}{S}$$

$$e = 2.80 \times 0.2602$$

$$\boxed{e = 0.73}$$

c) Porosity:

$$n = \frac{e}{1+e}$$

$$= \frac{0.73}{1+0.73}$$

$$n = 0.42$$

$$\boxed{n = 42.19\%}$$

Prob. 9

Data:

$\gamma_{sat} = 1.92 \text{ g/cc}$

$w = 32.5\% = 0.325$

Sol:

a) Void Ratio:

$$e = \frac{w G_s}{S}$$

$e = 0.325 G_s$

$G_s = e(3.076)$

$G_s = (0.89)(3.076)$

$\boxed{G_s = 2.7376}$

b) Specific gravity

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

$$1.92 = \frac{(e(3.076) + e)}{1+e}$$

$1.92 + 1.92e = 4.076e$

$\boxed{e = 0.89}$

Prob 10

Data:

$\gamma_d = 1.68 \text{ g/cc}$

$G_s = 2.70$

$S = 40\% = 0.4$

Unit wt = ?

water content = ?

Sol:

water content:

$$e = \frac{w G_s}{S}$$

$$w = \frac{eS}{G_s}$$

$$= \frac{(0.607)(0.4)}{2.70}$$

$w = 0.0899$

$\boxed{w = 8.99\%}$

$$e = \frac{V G_s \gamma_w}{W_s} - 1$$

$$e = \frac{V(2.70)(1)}{1.68V} - 1$$

$e = 0.607$

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

$W_s = \gamma_d V$

$W_s = 1.68V$

Unit weight

$$\gamma_d = \frac{\gamma_b}{1+w}$$

$$1.68 = \frac{\gamma_b}{1+0.0899}$$

$$\boxed{\gamma_b = 1.83 \text{ g/cc}}$$

Prob 11

Data:

$e_1 = 1.15$

$V_2 = 100{,}000 m^3$

$e_2 = 0.73$

$V_1 = ?$

Sol:

$$V = V_v + V_s$$

$$e_1 = \frac{V_v}{V_s}$$

$$e_1 = \frac{V_1 - V_s}{V_s}$$

$$1.15 = \frac{V_1 - 57803.46}{57803.46}$$

$$\boxed{V_1 = 124277.44 \text{ cc}}$$

$$e_2 = \frac{V_2 - V_s}{V_s}$$

$$0.73 = \frac{100{,}000 - V_s}{V_s}$$

$$0.73V_s + V_s = 100{,}000$$

$$V_s = 57803.46 \text{ cc}$$

Q=12

Data:

$w = 14\% = 0.14$

$S = 62\% = 0.62$

$\gamma_s = 1.7 g/cc$

Sol:

a) Specific gravity

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

$$\boxed{G_s = 1.7}$$

b) Porosity:

$$n = \frac{e}{1+e}$$

$$= \frac{0.3838}{1+0.3838}$$

$$n = 0.277$$

$$\boxed{n = 27.73\%}$$

c) Void ratio

$$e = \frac{G_s w}{S}$$

$$= \frac{(1.7)(0.14)}{0.62}$$

$$e = 0.3838$$

$$\boxed{e = 38.38\%}$$

Q=13

Data

$e = 0.88$

$S = 72\% = 0.72$

$\gamma_s = 1.7 gm/cc$

Sol:

a) Specific gravity

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

$$\boxed{G_s = 1.7}$$

(2)

b) Water content:

$$e = \frac{w G_s}{S}$$

$$w = \frac{eS}{G_s}$$

$$= \frac{(0.88)(0.72)}{1.7}$$

$$w = 0.3727$$

$$\boxed{w = 37.27\ \%}$$

c) Porosity:

$$n = \frac{e}{1+e}$$

$$= \frac{0.88}{1+0.88}$$

$$n = 0.468$$

$$\boxed{n = 46.8\ \%}$$