SEISMIC GROUP UET LHR

PROBLEM SHEET NO. 2
(Physical Properties of Soil)

1. A moist soil sample weighs 346 g. After drying at 105° C its weight is 284 g. The specific gravity of the mass and of the solids is 1.86 and 2.70 respectively.
DETERMINE: a) water content b) void ratio
c) degree of saturation d) porosity.

2. A soil deposit is being considered as a fill for a building site. In its original state in the borrow pit the void ratio is 0.95. Based on laboratory tests, the desired void ratio in its compacted state at the building site should not be greater than 0.65.
FIND: The percentage decrease (or loss) of volume of the deposit from its original state.

3. A Shelby-tube sampler is cut such that the volume of the soil in the cut piece is equal to 413 cm^3. (From the constant cross sectional area and the average length of the specimen, one can estimate the specimen's volume expediently and reasonably accurately). The weight of the mass was 727 g. After drying, the sample's weight is 607 g. Assume $G_s = 2.65$, $\gamma_w = 1$ $gm/cm^3 = 9.807$ kN/m^3.
FIND: a) water content b) void ratio
c) porosity d) degree of saturation
e) specific gravity of mass.

4. A soil sample has a water content of 8 %, specific gravity Gs = 2.66 and bulk density = 1.9 gm/cc.
FIND: a) void ratio of the sample
b) degree of saturation
c) porosity
d) How much water (in kgs) should be added to $1m^3$ of this soil in order to bring the water content to 13%, assuming that the void ratio remains constant?

5. Why is the dry weight (weight of solids) rather than the total wt. Used in defining the water content? Can the water content exceed 100%? Explain.

6. A soil sample was determined to possess the following characteristics: $G_s = 2.74$, $e = 0.69$, and $w = 14$ percent. Determine
a) degree of saturation b) porosity
c) unit dry weight of the sample.

7. A moist soil sample was found to have a volume of 22.3 cm^3 & weight of 29.7 g. The dry weight of the sample was determined to be 23g. Assume Gs = 2.7.
DETERMINE: a) void ratio b) water content
c) porosity d) degree of saturation of the sample.

8. Laboratory tests on a soil sample yielded the following information:
Gs = 2.71, W = 13% , dry density = 1.8 gm/cc
CALCULATE a) void ratio b) degree of saturation
c) porosity.

9. A soil sample has a water content of 8 percent and a degree of saturation 42 percent after adding some water, the degree of saturation altered to 53 percent. Assuming no change in the volume of the voids, assuming Gs = 2.7 determine.
a) void ratio b) water content
c) specific gravity of the mass of the sample is the altered state.

Problem sheet = 2

Prob 1

Data

$W = 346g$

$W_s = 284g$

Mass $\longrightarrow G_m = 1.86$

Solids $\longrightarrow G_s = 2.70$

Sol:

a) Water content:

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

$$= \frac{62}{284}$$

$$\boxed{w = 21.88\%}$$

$W = W_w + W_s$

$346 - 284 = W_w$

$W_w = 62g$

b) ⑤ $V_v = V - V_s$

$V_v = 186.02 - 105.18$

$= 80.84$

Step 1 → $G_M = \frac{\gamma_b}{\gamma_w}$

② $\gamma_b = 1.86\ g/cc$

② $\gamma_b = \frac{W}{V}$

$V = \frac{346}{1.86}$

$V = 186.02\ cc$

④ $G_s = \frac{\gamma_s}{\gamma_w}$

$\gamma_s = 2.70\ g/cc$

③ $V_s = \frac{W_s}{G_s \gamma_w}$

$V_s = \frac{284}{2.70 \times 1}$

$V_s = 105.18\ cc$

⑥ Void ratio $\Rightarrow e = \frac{V_v}{V_s} = \frac{80.84}{105.18} = 0.768$

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c) $e = \frac{G_s \times w}{S}$

$S = \frac{(2.70)(0.218)}{0.768} = 0.766$

d) $n = \frac{e}{1+e} \times 100$

$= \frac{0.768}{1 + 0.768}$

$n = 43.4\%$

Prob 2.

Data:

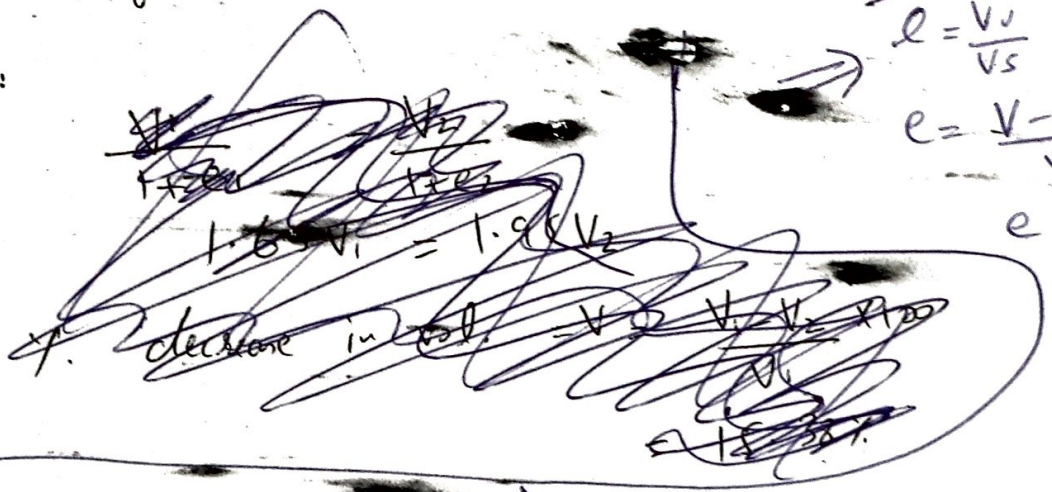
$e_1 = 0.95$

$e_2 = 0.65$

Initial volume $= V_1$

final volume $= V_2$

Sol:



Sol:

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

$e = \frac{V - V_s}{V_s}$

$e = \frac{V}{V_s} - 1$

$e_1 + 1 = \frac{V_1}{V_s}$

$V_1 = (e_1 + 1) V_s$

Or

$e_1 + 1 = \frac{V_1}{V_s}$

$e_2 + 1 = \frac{V_2}{V_s} \rightarrow V_2 = (e_2 + 1) V_s$

$\%$ loss of volume $= \frac{V_2 - V_1}{V_2} \times 100 \Rightarrow \frac{(e_2 + 1) V_s - (e_1 + 1) V_s}{(e_1 + 1) V_s} \times 100$

$= \frac{V_s [e_2 + 1 - e_1 - 1]}{(e_1 + 1) V_s} \times 100$

$= \frac{e_2 - e_1}{e_1 + 1} \times 100$

$= \frac{(0.65 - 0.95)}{0.95 + 1} \times 100$

$= -15.38\%$

Prob 3

Data:

$V = 413\ cm^3$

$W = 727g$

$W_s = 607g$

$G_s = 2.65$

$\gamma_w = 1\ g/cc = 9.807\ KN/m^3$

Sol:

a) Water content:

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

$$= \frac{120g}{607} \times 100 = 0.1976$$

$$\boxed{W = 19.76\%}$$

$\therefore W = W_w + W_s$

$W_w = 727 - 607$

$W_w = 120g$

b) Void ratio:

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

$$1.46 = \frac{(2.65)(1)}{1+e}$$

$$1.46 + 1.46e = 2.65$$

$$\boxed{e = 0.815}$$

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

$$= \frac{607}{413}$$

$\gamma_d = 1.46\ g/cc$

c) Porosity:

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

$$= \frac{0.815}{1+0.815}$$

$n = 0.449$ $\boxed{n = 44.9\%}$

d) deg. of saturation:

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

$$S = \frac{(0.1976)(2.65)}{0.815}$$

$$S = 0.642$$

$$\boxed{S = 64.2\%}$$

e) Specific gravity of mass:

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

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

$$G_m = \frac{(2.65)(1+0.1976)}{1+0.815}$$

$$\boxed{G_m = 1.748}$$

Prob-4

Data

$$w = 8\% = 0.08$$

$$G_s = 2.66$$

$$\gamma_b = 1.9 \text{ g/cc}$$

Sol:

a) void ratio

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

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

$$= \frac{(2.66)(1)}{1.759} - 1$$

$$\boxed{e = 0.512}$$

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

$$= \frac{1.9}{1+0.08}$$

$$\gamma_d = 1.759 \text{ g/cc}$$

c) Porosity:

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

$$= \frac{0.512}{1+0.512}$$

$$n = 0.338$$

$$\boxed{n = 33.8\%}$$

b) degree of saturation:

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

$$S = \frac{(0.08)(2.66)}{0.512}$$

$$S = 0.415$$

$$\boxed{S = 41.56\%}$$

d) $W_w = ?$ $V = 1 m^3$ $w = 13\%$

$1 m^3 = 10^6 cm^3$

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

$$0.13 = \frac{W_w}{}$$

Prob. 6.
Data:

$G_s = 2.74$

$e = 0.69$

$w = 14\% = 0.14$

Sol:

a) Degree of saturation:

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

$$\frac{(0.14)(2.74)}{0.69}$$

$$S = 0.555$$

$$\boxed{S = 55.5\%}$$

b) Porosity:

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

$$= \frac{0.69}{1+0.69}$$

$$n = 0.408$$

$$\boxed{n = 40.8\%}$$

c) Unit dry weight of sample:

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

$$\gamma_d = \frac{(2.74)(1)}{1+0.69}$$

$$\boxed{\gamma_d = 1.62 \text{ g/cc}}$$

Prob?

Data:

$V = 22.3 cm^3$

$W = 29.7 g$

$W_s = 23 g$

$G_s = 2.7$

Sol:

a) Void ratio

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

$$= \frac{(22.3)(2.7)(1)}{23} \quad -1$$

$$\boxed{e = 1.61}$$

b) water content:

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

$$= \frac{6.7}{23} \times 100$$

$$\boxed{w = 29.13\%}$$

$W = W_w + W_s$

$W_w = 29.7 - 23$

$W_w = 6.7$

c) Porosity:

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

$$n = \frac{1.61}{1+1.61} = 0.616$$

$$\boxed{n = 61.6\%}$$

d) deg. of sat:

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

$$= \frac{(29.13)(2.7)}{1.61}$$

$$\boxed{S = 48.8\%}$$

Prob 8

Data:

$G_s = 2.71$

$w = 13\% = 0.13$

$\gamma_d = 1.8 g/cc$

Sol:

a) Void ratio

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

$$1.8 = \frac{(2.71)(1)}{1+e}$$

$$\boxed{e = 0.50}$$

b) dg. of sat:

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

$$S = \frac{(0.13)(2.71)}{0.5}$$

$$S = 0.7046$$

$$\boxed{S = 70.46\%}$$

c) Porosity:

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

$$= \frac{0.5}{1+0.5}$$

$$n = 0.333$$

$$\boxed{n = 33.3\%}$$

Prob 9

Data:

$w = 8\% = 0.08$

$S_1 = 42\% = 0.42$

$S_2 = 53\% = 0.53$

$G_s = 2.7$ $\quad G_s = \frac{\gamma_s}{\gamma_w}$

Sol: $\gamma_s = 2.7 g/cc$ $\quad W_s = 2.7 g$

a) Void ratio:

$$e = \frac{w G_s}{S} = \frac{0.08 \times 2.7}{0.42} = 0.51$$

c) Porosity

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

$$n = \frac{0.51}{1+0.51} = 0.33$$

b) water content:

$$e = \frac{w_2 G_s}{S_2} \times 100$$

$w_2 = 10.01\%$

) Specific gravity of ~~water~~ mass of sample after alteration

$$\gamma_b = \frac{\gamma_w (1 + w_2) G_s}{1+e}$$

$$\gamma_b = \frac{1 (1 + 0.1001) 2.7}{1 + 0.51}$$

$\gamma_b = 1.96 g/cc$

$\boxed{G_b = 1.96}$

$1 g = 1 cc$

$1000 g = 1000 cc$

$1000 kg = 1 m^3.$