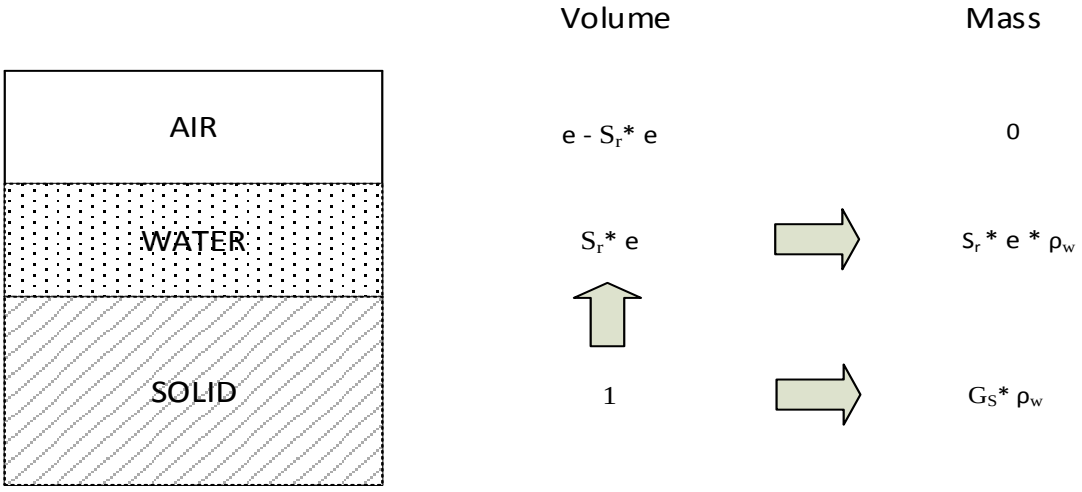
CE 363-364 Homework-1-Solution

Question 1

$V_{Total} = 860\ cm^3$, $M_{Total} = 1500\ g$, $M_{dry} = M_{solid} = 1200\ g$, $G.S = 2.65$

a) For unit V_S ;



- Note that all soil parameters in this topic are ratios. Therefore they can be calculated using either the actual volumes and masses, or those in the phase diagram given in terms of V_S. However the numerator and the denominator of these ratios must both come from the same place (both real quantities or both for unit V_S).

b) i) $M_{water} = M_{Total} - M_{dry} = 300\ g$, $w = \frac{M_{water}}{M_{solid}} = \frac{300\ g}{1200\ g} = 0.25$

ii) $\rho_{dry} = \frac{M_{dry}}{V_{Total}} = \frac{1200\ g}{860\ cm^3} = 1.395\ g/cm^3$, $\rho_{dry} = \frac{G_S}{1+e} * \rho_w = \frac{2.65}{1+e} * 1g/cm^3$

$\Rightarrow e = 0.9$

iii) $\rho = \frac{M_{Total}}{V_{Total}} = \frac{G_S*(1+w)}{1+e} * \rho_w = \frac{2.65*(1+0.25)}{1+0.9} = 1.74\ g/cm^3$

iv) $S_r = \frac{V_{water}}{V_{voids}}$, $V_{water} = \frac{M_{water}}{\rho_{water}} = \frac{300\ g}{1\ g/cm^3} = 300\ cm^3$,

$V_{solids} = \frac{M_{solid}}{G_s * \rho_w} = \frac{1200\ g}{2.65 * 1 g/cm\text{^}3} = 453\ cm^3$, $V_{voids} = 860 - 453 = 407\ cm^3$

$S_r = \frac{300\ cm^3}{407\ cm^3} = 73.7\ \%$

OR

$w * G_s = S_r * e$, $S_r = \frac{0.25 * 2.65}{0.9} = 73.7\ \%$

v) $n = \frac{e}{1+e} = \frac{0.9}{1+0.9} = 0.47$ OR $n = \frac{V_{voids}}{V_{Total}} = \frac{407\ cm^3}{860\ cm^3} = 0.47$

c) All voids are filled with water $\Rightarrow V_{water} = V_{voids} = e$, $M_{water} = e * \rho_w$, $W_{water} = e * \gamma_w$

$$\gamma_{sat} = \frac{G_s * \gamma_w + e * \gamma_w}{1 + e} = \frac{2.65 * 10 + 0.9 * 10}{1 + 0.9} = 18.7\ kN/m^3$$

$$G_s * w = S_r * e \quad \Rightarrow \quad w = \frac{0.9 * 1}{2.65} = 0.34$$

OR

$M_{water} = V_{voids} * \rho_w = 407\ cm^3 * 1\ g/cm^3 = 407\ g$

$$w = \frac{M_{water}}{M_{solid}} = \frac{407\ g}{1200\ g} = 0.34$$

Question 2

a) $98\ \%\ of\ \rho_{dry,max} = 1.7\ g/cm^3 * 0.98 = 1.666\ g/cm^3$

$$\rho_{dry} = \frac{G_s}{1+e} * \rho_w \qquad \Rightarrow \qquad e = \frac{G_s * \rho_w}{\rho_{dry}} - 1 = \frac{2.65 * 1 g/cm^3}{1.666\ g/cm^3} = 0.59$$

$$D_R = \frac{e_{max} - e}{e_{max} - e_{min}} = \frac{0.86 - 0.59}{0.86 - 0.52} = 79\ \%$$

b) $Maximum\ Cost \Rightarrow Maximum\ Volume \Rightarrow e_{max}$

$$V_{Total} = V_{embankment} = 1.5\ m * 20\ m * 20\ m = 600\ m^3$$

$$M_{solid} = \rho_{dry} * V_{embankment} = 1.666 \frac{10^{-6} t}{10^{-6} m^3} * 600\ m^3 = 100\ tons$$

$$V_{solid} = \frac{M_{solid}}{\rho_{solid}} = \frac{1000\ tons}{2.65 * 1\ g/cm^3} = 377\ m^3$$

$$V_{void} = V_{solid} * e = 378\ m^3 * 0.86 = 325\ m^3$$

$$V_{Total} = 377\ m^3 + 325\ m^3 = 702\ m^3$$

$$Cost = 702\ m^3 * 15 \frac{lira}{m^3} = 10530\ TL$$

OR

$After\ compaction\ ; e = 0.59\ and\ V_{solid} = 1\ (\ unity\ ), \qquad V_{Total} = 1 + 0.59 = 1.59\ units$

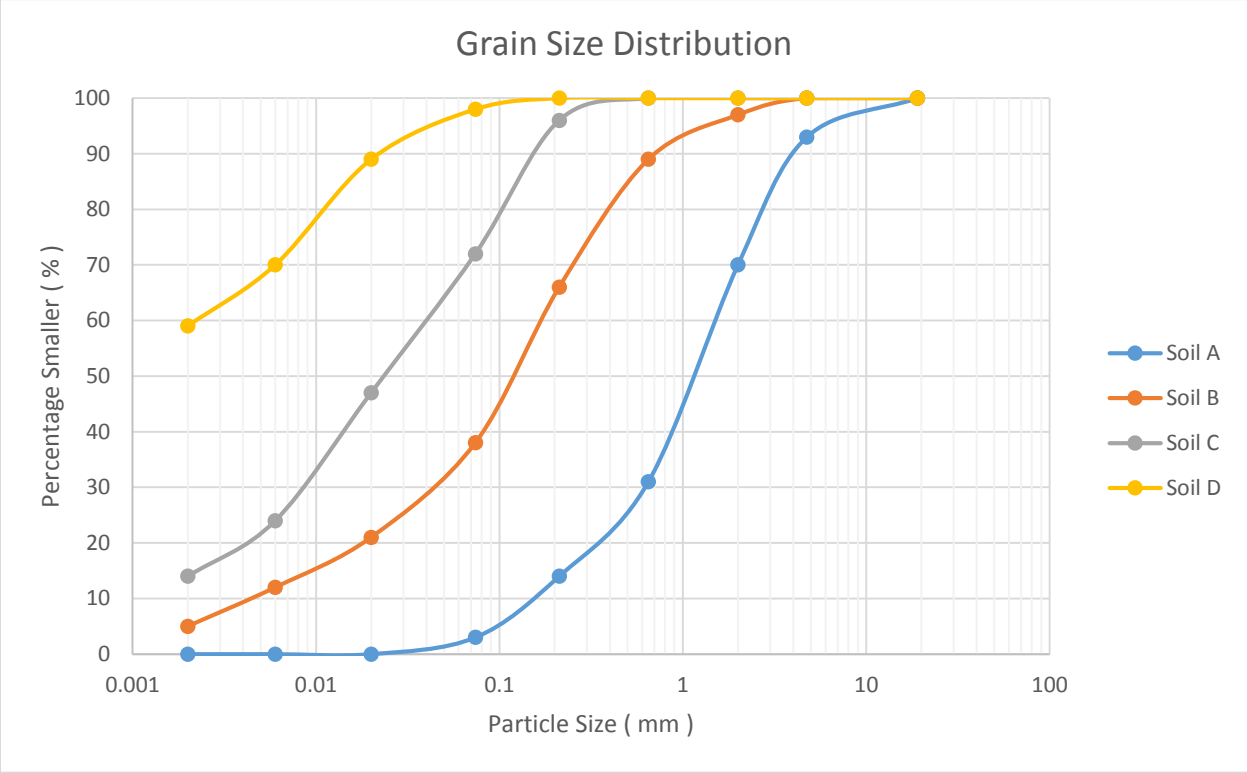
$Before\ comp.,\ in\ loosest\ state\ ; e_{max} = 0.86\ and\ V_{solid} = 1\ (\ unity), V_{Total} = 1.86\ units$

$1.59\ units\ volume \Rightarrow 600\ m^3 \quad , 1.86\ units \Rightarrow 600 * \frac{1.86}{1.59} = 702\ m^3$

$$Cost = 702\ m^3 * 15 \frac{lira}{m^3} = 10530\ TL$$

Question 3

Plotting the given data:



b) Soil A

Gravel percentage (> 4.75 mm) = 100 – 93 = 7 %

Sand percentage (<4.75 mm , >0.074 mm) = 93 – 3 = 90 %

Fines (<0.074 mm) = 3 %

Soil B

Gravel percentage (> 4.75 mm) = 0 %

Sand percentage (<4.75 mm , >0.074 mm) = 100 – 38 = 62 %

Fines (<0.074 mm) = 38 %

c) Soil A

$D_{10} = 0.16\ mm$

$D_{30} = 0.63\ mm$

$D_{60} = 1.5\ mm$

$$C_U = \frac{D_{60}}{D_{10}} = \frac{1.5\ mm}{0.16\ mm} = 9.4 > 6$$

$$C_z = \frac{(D_{30})^2}{D_{60} * D_{10}} = \frac{(0.63\ mm)^2}{1.5\ mm * 0.16\ mm} = 1.7$$

$C_u > 6\ \ and\ 1 < C_z < 3 \quad \Rightarrow Well\ Graded$

Soil B

$D_{10} = 0.0045\ mm$

$D_{30} = 0.045\ mm$

$D_{60} = 0.17\ mm$

$$C_U = \frac{D_{60}}{D_{10}} = \frac{0.17\ mm}{0.0045\ mm} = 37.8 > 6$$

$$C_z = \frac{(D_{30})^2}{D_{60} * D_{10}} = \frac{(0.045\ mm)^2}{0.17\ mm * 0.0045\ mm} = 2.6$$

$C_u > 6\ \ and\ 1 < C_z < 3 \quad \Rightarrow Well\ Graded$

d) Soil A

- More than 50 % is coarse (97 %)
- More than 50 % of coarse fraction is sand
- Small amount of fines
- Well Graded ⇒ SW , well graded sand

Soil B

- More than 50 % is coarse (62 %)
- More than 50 % of coarse fraction is sand
- Fines > 12 (38 %)
- Non Plastic ⇒ SM , silty sand , sand with non plastic fines

Soil C

- More than 50 % is fine (72 %).
- LL = 27 % , PI = 27-19 = 8 %
- Above A-line ⇒ CL (clay with low plasticity)

Soil D

- More than 50 % is fine (98 %)
- LL = 75% , PI = 75 – 38 = 37 %
- Below A-line ⇒ MH (silt with high plasticity)

e) $w_n = 55$ % is between PL (38 %) and LL (75 %) , so soil D is in plastic consistency.

$$PI = LL - PL = 75 - 38 = 37\ \%\ \ , \qquad I_L = \frac{55 - 38}{37} = 0.46 = 46\ \%$$