Middle East Technical University
Department of Civil Engineering
CE 363 - Soil Mechanics
PROBLEMS

NOTE. Unless otherwise stated, take $\gamma_w = 10$ kN/m^3

(a) BASIC PROPERTIES

A1. A cubic meter of soil in its natural state weighs 17.75 kN; after being dried it weighs 15.08 kN. The specific gravity of the solids is 2.70.

(a) Determine the water content, void ratio, porosity and degree of saturation for the soil as it existed in its natural state.

(b) What would be the bulk unit weight and water content if the soil were fully saturated at the same void ratio as in its natural state ?

A2. A sand with a minimum void ratio of 0.45 and a maximum void ratio of 0.97 has a relative density of 40 %.

How much will a 3 m thick stratum of this sand settle if the sand is densified to a relative density of 65 %? Assume that the sand layer is compressed in the vertical direction only, with no lateral strain.

A3. The results of sieve analysis on a soil sample are given below:

Sieve size	Percentage finer
19.1 mm	100
6.3 mm	94
2 mm	69
590 μm	32
210 μm	13
74 μm	2

(a) Plot the grain size distribution curve.

(b) Determine the percentages of gravel, sand and the fines in the sample.

(c) Determine D_{10}, D_{30}, D_{60}, C_u, C_c and comment on the gradation.

A.4. The consistency limits for a given clay were determined to be

LL = 55%, PL = 27%, SL = 20%

(a) If the specific gravity of solid particles is 2.70, and a 100 cm^3 saturated sample of this soil at its natural water content of 30% is allowed to dry, what will be its volume at a water content of 15%?

(b) What is the consistency of the soil in its natural state ?

(c) Calculate the plasticity index of the soil.

(d) Determine the liquidity index of the soil.

(a)Basic Properties

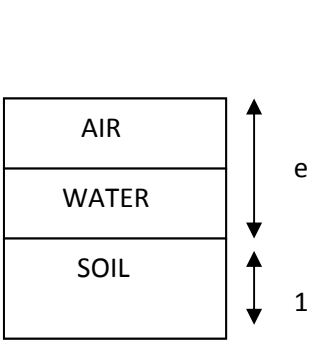
A1.

Given

W= 17.75 kN→W=15.08 kN (when dried)

$G_s = 2.70,\ \ V = 1m^3$

Determine w, e, n and S_r.



a)

$$w = \frac{M_w}{M_s} = \frac{17.75 - 15.08}{15.08} = 0.168 \rightarrow w = 16.8\%$$

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

$$\frac{17.75}{1} = 17.75\ kN/m^3$$

$$17.75 = \frac{2.70(1+0.168)(9.8)}{(1+e)}$$

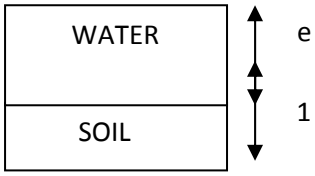
$$void\ ratioo = e = 0.741$$

$$porosity = n = \frac{V_v}{V} = \frac{e}{1+e} = 0.426$$

$$S_r = \frac{wG_s}{e} = \frac{0.168 * 2.70}{0.741} = 0.612$$

MASS

b)



asked; γ_{bulk} =? w =?

$$w = \frac{M_w}{M_s} = \frac{e\rho_w}{G_s\rho_w} = \frac{e}{G_s} = \frac{0.741}{2.70} = 0.274$$

$$\gamma_{bulk} = \frac{e\gamma_w + G_s\gamma_w}{1+e} = \frac{0.741 * 9.81 + 2.70 * 9.81}{1 + 0.741} = 19.36kN/m^3$$

A2)

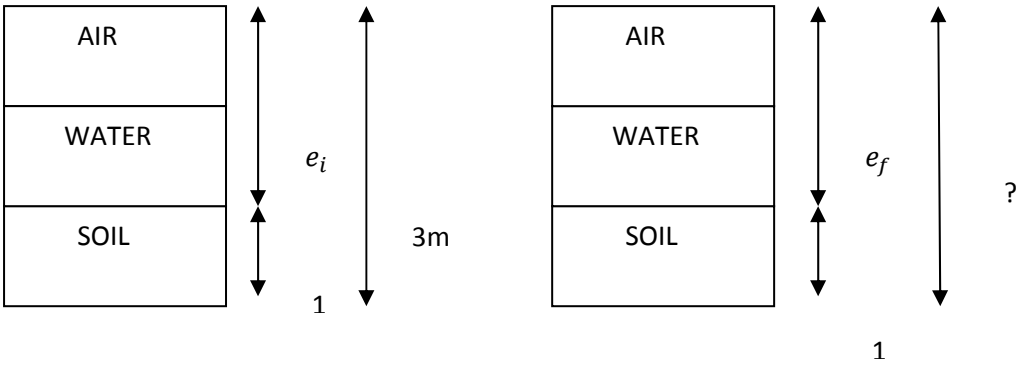
$$e_{min} = 0.45$$

$$e_{max} = 0.97$$

$$RD = \frac{e_{max} - e}{e_{max} - e_{min}} \rightarrow 65\%$$

$$0.40 = \frac{0.97 - e_i}{0.97 - 0.45} \rightarrow e_i = 0.762$$

$$0.65 = \frac{0.97 - e_f}{0.97 - 0.45} \rightarrow e_f = 0.632$$



$$(1 + 0.762) \rightarrow 3m$$

$$(1 + 0.631) \rightarrow ?$$

The assignment solutions are prepared by: Gizem CAN, Ezgi EROĞLU, Makbule ILGAÇ within the scope of undergraduate student assistantship programme

$\therefore$ X=2.780m , 3-2.780=0.220m settles.

A3)

b)

$$100 - 69 = 31\%\ gravel(..> 2mm)$$

$$69\%\ sand(0.06mm < \cdots < 2mm)$$

$$0\%\ fines(..< 0.06mm)$$

b) According to your grain size distribution curve determine; D_{10}, D_{30}, D_{60}.

Since

$$C_u = \frac{D_{60}}{D_{10}}$$

$$C_C = \frac{(D_{30})^2}{D_{60} * D_{10}}$$

Then check unified soil classification system. According to your C_u & C_C , find your soil.

A4)

Given,

LL=55%

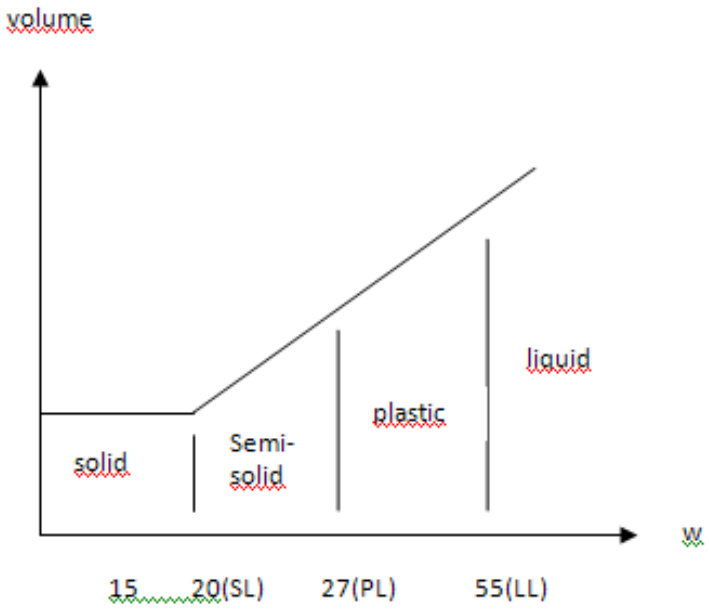
PL=27%

SL=20%

$G_s = 2.70$

V=100m^3

$w = 30 \rightarrow 15$



	Mass	Volume
AIR	0	0
WATER	$wG_s\rho_w$	wG_s
SOIL	$G_s\rho_w$	G_s

If we find the volume when the water content is 20%, we fill find directly the volume when the water content is 15% because of the constant volume of solid particles.

$$S_r = 1 \; since \; the \; soil \; is \; saturated$$

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

$$0.30 = \frac{e}{2.70} \rightarrow e = 0.81$$

$$volume \; of \; soil = 1 + e = 1.81 \; when \; volume = 100 \; cm^3$$

$$0.20 = \frac{e}{2.70} \rightarrow e = 0.540$$

$$volume \; of \; soil = 1 + e = 1.540 \; we \; are \; asked \; to \; find \; the \; volume$$

$$make \; interpolation$$
$$100 \; cm^3 \quad \rightarrow \quad 1.81$$
$$x \; cm^3 \quad \rightarrow \quad 1.540$$

Therefore X=85.083 cm^3