University of Technology
Building and Construction Eng. Dept.
Final Exam – 19/5/2016

Subject : Soil Mechanics Class: 3rd Year
Branch : All Branches Time : 3 hrs.

Note: Answer Four Questions only

Q1-A) - Answer three of the following. Enhance your answer with suitable sketches:

1- Compare between kaolinite and montmorillonite.
2- Compare between the unconsolidated undrained test (UU) and consolidated drained test (CD)
3- Compare between pore water pressure and excess pore water pressure.
4- Compare between standard Proctor compaction test and modified Proctor compaction test.

(9 marks)

Q1-B)-A soil sample has a bulk unit weight of 19.62 kN/m^3 and a dry unit weight of 17.66 kN/m^3. Given that the specific gravity of the soil is 2.70. Find: 1)void ratio (e) 2) porosity (n) 3) Degree of saturation (s) 4) Relative density , if the maximum and the minimum void ratios of the soil are 0.85 and 0.45 respectively . (16 marks)

Q2-A)-Answer with true (T) or false (F), and correct the false one.

1- All soils have approximately the same shear strength at their liquid limit.
2- A fine grained soil with S.L.=15% and ω_n =20%, then its S= 110%.
3- The void ratio decreases with decreasing in the water content below L.L.
4- The coefficient of permeability of coarse grained soils is always greater than that of fine grained soils.
5- The total settlement of a clay layer is dependent on its coefficient of permeability.

(10 marks)

Q2-B) A covered steel (unit weight = 80 kN/m^3) tank, 15 m in diameter and 10 m high and with 20 mm wall thickness, is filled with liquid (unit weight = 9 kN/m^3) up to a height of 9.9 m. The tank sits on a concrete (unit weight = 24 kN/m^3) foundation, 15 m diameter *0.6 m thick. The foundation rests on the surface of 5-m thick soft, normally consolidated clay above thick layer of gravel. Given $C_c = 0.6$, $C_r = 0.08$, $C_v = 1.0 \frac{m^2}{year}$, $\omega_c = 48\%$, *and* $G_s =$ 2.7. Ground water level is at the surface, calculate:

1) The final consolidation settlement at the center of the tank

2) Differential settlement between the center and edge of the tank.
3) Calculate the time for 50% consolidation to occur.
4) The settlement, if the tank is loaded to half its capacity and kept for 2 years.
5) If the tank is drained (height of liquid =0) , what is the heave due to emptying the tank. Given

X/R	0	0	1	1	2
Z/R	0.6	0.333	0.333	0.6	1.2
Factor	0.85	0.95	0.45	0.4	0.05

(15 marks)

Q3-A)- The following results were obtained from a shear box test for a soil sample and the dimensions of the shear box are (60 *60) mm. Calculate the shear strength parameters (c and ∅). (10 marks)

Normal Load (kN)	0.275	0.550	1.10
Shear Load (kN)	0.179	0.269	0.447

Q3-B)-For the soil profile shown, calculate at the middle of clay layer the:

1- Total stress, effective stress and pore water pressure for the following conditions:

a-before the application of the load.

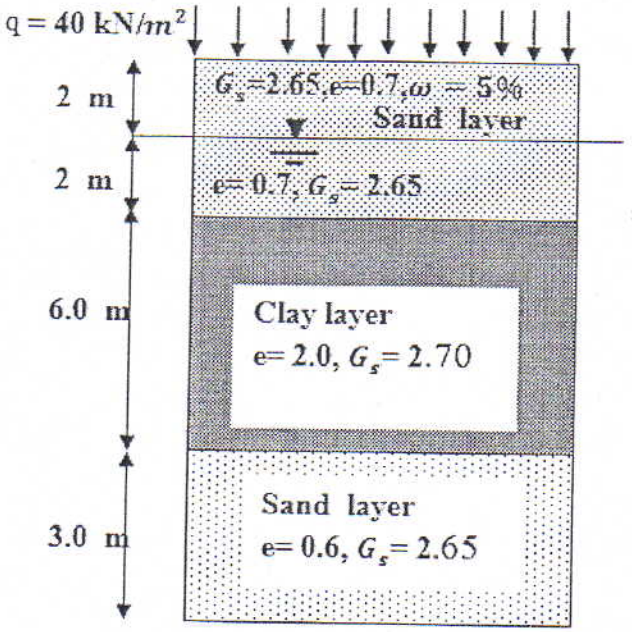
b-immediately after application of the load.

c- after very long time.

2- The final consolidation settlement at the middle of clay layer given the void ratio e=2.0 and the compression index $C_c = 2.0$.

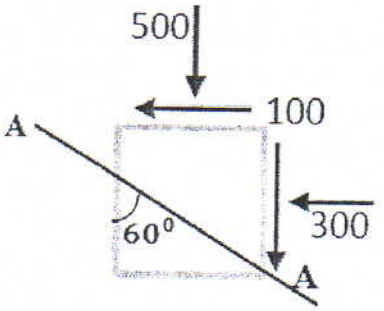
3- The days needed for consolidation to reach 80%. Given $C_v = 1.5 * 10^{-3}\ cm^2/sec.$ (15 marks)

U%	10	20	30	40	50	60	70	80	90
Tv	0.008	0.031	0.071	0.126	0.197	0.287	0.403	0.567	0.848



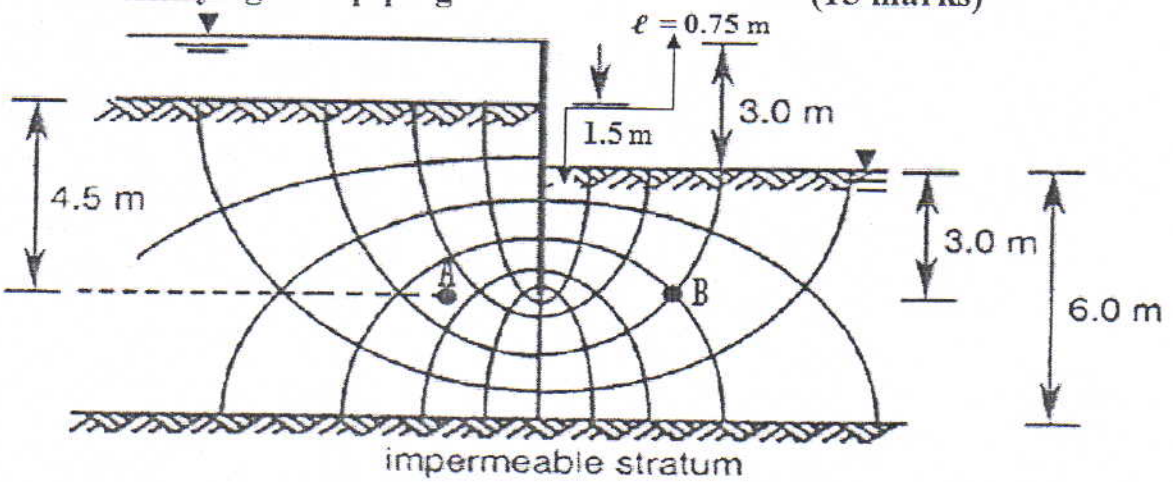
Q4-A)- Given : The stresses (in kPa) on an elements shown below: Find

1- The magnitude and direction of the major and minor principal stresses.
2- The maximum shear stress and the orientation of plane at which it acts.
3- The stresses on plan A-A shown in figure. (10 marks)



Q4-B) - For the sheet pile wall shown in figure below, find

1- Quantity of seepage (k= $0.5 * 10^{-3}$ m/sec)
2- Pore water pressure at points A and B
3- Factor of safety against piping (15 marks)



Q5-A)-Results of CU tests conducted on three saturated clay samples are given below. Determine:

1- The shear strength parameters c,∅, $\acute{c}$ *and* $\acute{\emptyset}$.

2- Plot the stress path (P-q) for the test. (10 marks)

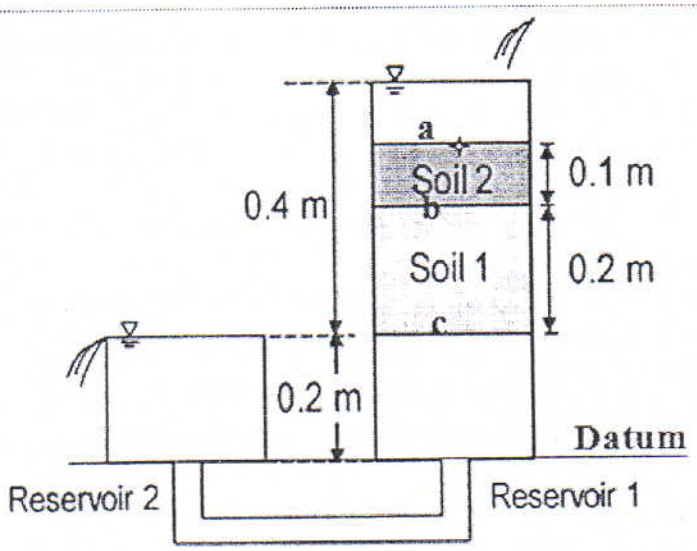
Test No.	1	2	3
Confining Pressure σ_3(kPa)	40	80	120
Deviator stress (kPa)	110	190	240
Pore water pressure at failure (kPa)	15	20	35

Q5-B) - For the setup shown. Given the hydraulic conductivity (k_1) of $2.4*10^{-5}$ m/min. and k_2 of $1.0*10^{-5}$m/min, cross–sectional area of ($area\ 1 = area\ 2$) = $1.0 * 10^{-2}\ m^2$. Calculate:

1- The flow rate ($\frac{m^3}{min}$).

2- ht, he and hp at points a, b and c (put your results in table).

3- The σ_{total}, $\sigma_{effective}$ and u at points a, b and c.
Given ($\gamma_1 = 17\ kPa$ *and* , $\gamma_2 = 20\ kPa$).



(15-marks)

Good Luck

Some useful information's:

$$Tv = \frac{Cv\,t}{d^2}$$

For N.C.C. $\quad S_{cf} = \frac{Cc}{1+e} H log \frac{\acute{P}_\circ + \Delta P}{\acute{P}_\circ}$

For O.C.C.

$$if\ \acute{P}_\circ + \Delta P \le \acute{P}_c\ \ then\ \ S_{cf} = \frac{Cr}{1+e} H log \frac{\acute{P}_\circ + \Delta P}{\acute{P}_\circ}$$

$$if\ \acute{P}_\circ + \Delta P > \acute{P}_c\ \ then\ \ \text{use :}$$

$$S_{cf} = \frac{Cr}{1+e} H log \frac{\acute{P}_c}{\acute{P}_\circ} + \frac{Cc}{1+e} H log \frac{\acute{P}_\circ + \Delta P}{\acute{P}_c}$$

$$O.C.R = \frac{\acute{P}_c}{\acute{P}_\circ}$$

$$T_v = \frac{\pi}{4} U_{av}^2 \qquad For \qquad U_{av} \le 60\%$$

$$T_v = 1.781 - 0.933 \log (100 - U_{av}) \qquad \textbf{For} \qquad U_{av} > 60\%$$

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Q.1 B)

$$\gamma_d = \frac{G_s}{1+e}\gamma_w \Rightarrow 17.66 = \frac{2.7}{1+e} * 10 \Rightarrow e = 0.53$$

$$n = \frac{0.53}{1+0.53} = 0.3464$$

$$\gamma_d = \frac{\gamma_t}{1+w} \Rightarrow 17.66 = \frac{19.62}{1+w} \Rightarrow w = 0.11$$

$$Se = G_s w \Rightarrow S * 0.53 = 2.7 * 0.11 \Rightarrow S = 56\%$$

$$R.D = \frac{0.85 - 0.53}{0.85 - 0.45} = 80\%$$

Q.2 B) weight of empty tank

الجدران $3.14 * 15 * 10 * 0.02 * 80 = 753.6$ kN

Base and roof $\left(\left(\frac{15}{2}\right)^2 \pi * 80 * 0.02\right) * 2 = 565.4$ kN

1319 kN

weight of foundation $= \left(\frac{15}{2}\right)^2 \pi * 0.6 * 24 = 2543$

weight of liquid $= \left(\frac{15}{2}\right)^2 \pi * 9.9 * 9 = 15737$

$$q_{\text{for full tank}} = \frac{1319 + 2543 + 15737}{\left(\frac{15}{2}\right)^2 \pi} = 111 \text{ kN/m}^2$$

$$q_{\text{for half full}} = \frac{1319 + 2543 + \frac{15737}{2}}{\left(\frac{15}{2}\right)^2 \pi} = 66.41 \text{ kN/m}^2$$

at center

$\frac{x}{r} = 0$, $\frac{z}{r} = \frac{2.5}{7.5} = 0.333$

factor $= 0.95$

at corner (edge)

$\frac{x}{r} = 1$, $\frac{z}{r} = 0.333$

factor $= 0.45$

$Se = G_s w$

$e = 2.7 * 0.48 = 1.296$

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

$$\gamma_{sat} = \frac{2.7 + 1.296}{1 + 1.296} * 10 = 17.4 \text{ kN/m}^3$$

$\sigma' = 2.5(17.4 - 10) = 18.5$

$$Sc \text{ at center} = \frac{0.6}{1+1.296} * 5 \log \frac{18.5 + (111 * 0.95)}{18.5} = 1.079$$

$$Sc \text{ at edge} = \frac{0.6}{1+1.296} * 5 \log \frac{18.5 + (111 * 0.45)}{18.5} = 0.742$$

Differential Sett $= 1.079 - 0.742 = 0.337$