UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2013/14

COURSE NAME	:	GEOTECHNIC 1
COURSE CODE	:	BFC 21702
PROGRAMME	:	2 BFF
EXAMINATION DATE	:	DECEMBER 2013/JANUARY 2014
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

QUESTION CONSISTS OF **TEN (10)** PAGES

Q1 (a) In nature, soils are three-phase systems consisting of solid soil particles, and void containing water and air. Water has mass and weight while air is mass-less but it occupies part of the soil volume. Based on that statement,

(i) What is a full saturated of soil?

(2 marks)

(ii) Define the porosity of soil.

(2 marks)

(b) The representative soil specimen has been collected from the embankment field. The porosity, specific gravity of the solid soil as determined in the laboratory is 0.45 and 2.68, and moisture content = 10 %.
Calculate;

(i) The moist density of soil.

(3 marks)

(ii) The saturated density of soil.

(3 marks)

(iii) The mass of water to be added to 10 m^3 of soil for full saturation in kg.

(3 marks)

(c) The moist weight of 5.66 x 10^{-3} m^3 of a soil is 102.3 x 10^{-3} kN. The moisture content and the specific gravity of the solid soil are determined in laboratory to be 11% and 2.7, respectively. Calculate the following:

(i) Moisture unit weight (kN/m^3)
(ii) Dry unit weight (kN/m^3)
(iii) Void ratio
(iv) Porosity
(v) Degree of saturation (%)
(vi) Volume occupied by water (m^3)

(12 marks)

Q2 (a) Compaction increases the strength characteristics of soil, thereby increasing the bearing capacity of foundation. Vibratory rollers are mostly used for the densification of granular soils.

(i) What is the compaction?

(2 marks)

(ii) Name **FOUR (4)** common types of vibratory rollers in the field.

(4 marks)

(b) A dam project will be constructed in the Batu Pahat Town. Laboratory test on the soil being used indicated that it has a maximum dry density of a soil is 1900 kg/m^3. Specifications require 95 % compaction. In the field, dry density of the soil is found to be 1810 kg/m^3. A visual check of the soil in the field indicates that it contains about 20 % gravel sizes. Lab test for relative density of gravel is 2.65.

(i) Calculate the percentage of compaction.

(5 marks)

(ii) Based on your calculation, comment on the adequacy of the compaction percentage.

(3 marks)

(c) The in-situ moisture content of a soil is 18 % and the moist unit weight is 16.5 kN/m^3. The specific gravity of soil is 2.75. The soil is to be excavated and transported to a construction site for use in a compacted fill. If the specifications call for the soil to be compacted to minimum dry unit weight of 16.27 kN/m^3 at the same moisture content 18%. Determine;

(i) How many cube meters of soil from the excavation site are needed to produce 7651 m^3 of compacted fill?

(6 marks)

(ii) How many 178 kN truckloads are needed to transport the excavated soil.

(5 marks)

Q3 (a) The function of hydraulic conductivity and hydraulic gradient is to quantity the discharge velocity of water flowing in unit time through a unit gross cross-sectional area of the soil at right angles to the direction of flow. Based on the statement;

(i) What is the hydraulic gradient

(2 marks)

(ii) What is the hydraulic conductivity of soils.

(2 marks)

(b) In a constant head permeability test in the laboratory as shown in Figure 3(a), the following values are given as L = 305 mm and cross section area (A) = 96.8 cm^2. If the value of permeability (*k*) = 0.015 cm/sec and a flow rate of 7374 cm^3/hr must maintained through the soil.

Calculate;

(i) What is the head difference, *h*, across the specimens?

(4 marks)

(ii) The velocity under the test condition.

(5 marks)

(c) A permeable soil layer in underlain by an impervious layer, as ahown in Figure 3(b). With permeability (k) = 5.2 x 10^{-4} cm/sec for the permeable layer, calculate the rate of seepage through it in m^3/hr/m length. Given H = 3.8 m and $\alpha = 8°$.

(12 marks)

Q4 (a) (i) Figure 4(a) shows the soil profile. Given H_1=4m and H_2= 3m. If the groundwater table rises to 2m below the ground surface, determine the net change in effective stress at the bottom of the clay layer.

(5 marks)

(ii) Seepage force can be effectively used to obtain the safety against heave on the downstream side of a hydraulic structure.

With aid of the diagram, explain the force due to no seepage, upward seepage and downward seepage on a volume of soil.

(4 marks)

(b) Figure 4(b) shows a layer of soil in a tank with upward seepage.

Given:

hydraulic conductivity of soil, k = 0.13 c m/s, H_1 = 1.5 m,
H_2 =2.5 m, h = 1.5 m, γ_{sat} = 18.6 kN/m^3

(i) Explain the critical hydraulic gradient in soil for the upward water seepage through a soil mass.

(3 marks)

(ii) Calculate the upward seepage force per unit volume of soil.

(4 marks)

(iii) Determine the rate of upward seepage of water if the area of tank is 0.52 m^2. Give your answer in m^3 /min.

(3 marks)

(c) Figure 4(c) the soil profile. Calculate the total stress, pore water pressure and effectives tress at points A, B, C and D.

(6 marks)

Q5 (a) Suggest (write down) the name of the type of laboratory triaxial test that you would carry out in relation to the following field problems;

(i) The initial stability of a footing on saturated clay.

(2 marks)

(ii) Pavement structure Investigating the stability of a soft clay foundation on which a highway embankment is being constructed. The embankment construction will cause some consolidation of the foundation clay to take place.

(2 marks)

(iii) The long term stability of a slope cut in stiff fissured clay.

(2 marks)

(b) The Mohr-Coulomb failure criterion is popularly adopted in Soil Mechanics analysis. Give an Illustrated (with a suitable sketch) description of this failure criterion. Use the sketch to show that the inclination of the plane of failure (θ) to the horizontal, caused by shear in a soil sample tested in a standard triaxial test is given by;

$$\theta = \left(45 + \frac{\emptyset'}{2}\right) \text{ where } \emptyset' \text{ is the angle of effective friction}$$

(4 marks)

(c) For failure principal stresses (as represented by usual notations) σ_1 and σ_3, show that the Mohr-Coulomb failure criterion is given by the following relationship;

$$\sigma_1' = \sigma_3' \tan^2\left(45 + \frac{\emptyset'}{2}\right) + 2c' \tan\left(45 + \frac{\emptyset'}{2}\right)$$

(8 marks)

(d) When a saturated clayey soil was tested in an unconsolidated undrained triaxial test, the minor and major principal stresses at failure were 102 kN/m^2 and 193 kN/m^2.

(i) What will be the unconfined compressive strength and undrained shear strength of a similar specimen of the clay soil?

(4 marks)

(ii) Give reasons to justify your answers and illustrate your solution with a suitable sketch.

(3 marks)

- END OF QUESTION -

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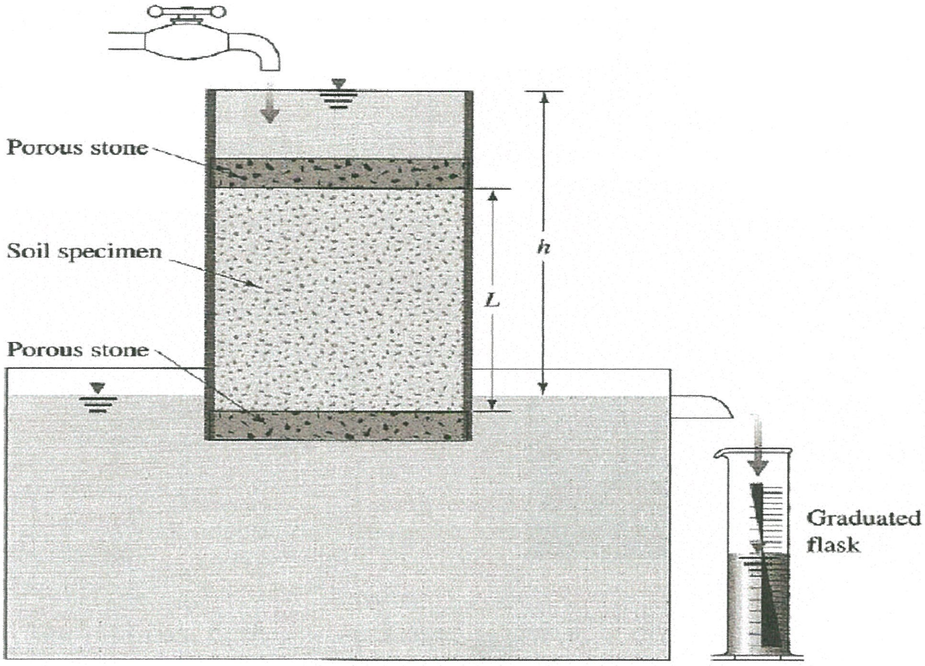

Figure 3(a): A constant head permeability test

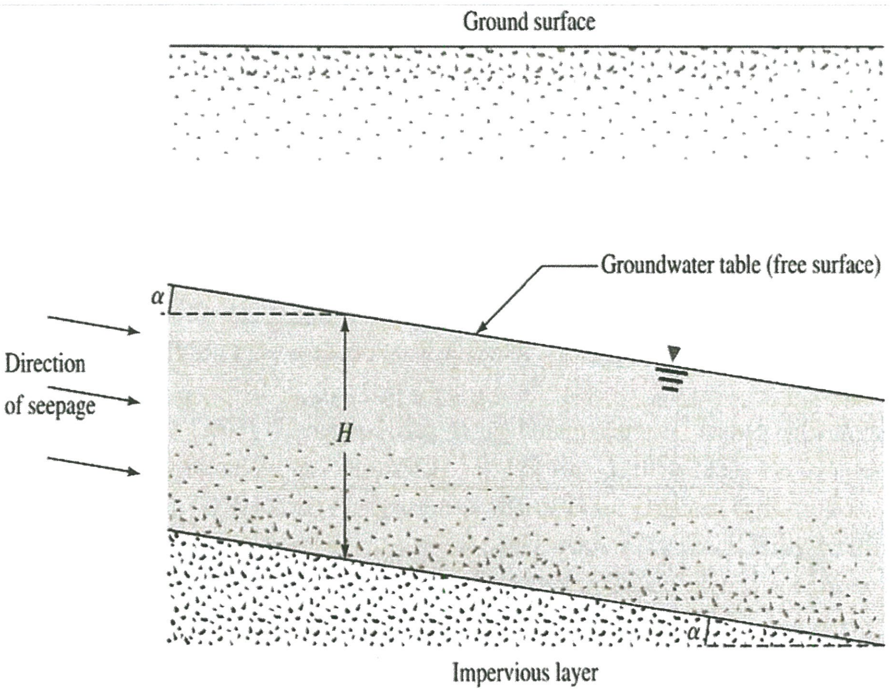

Figure 3(b): A permeable soil layer

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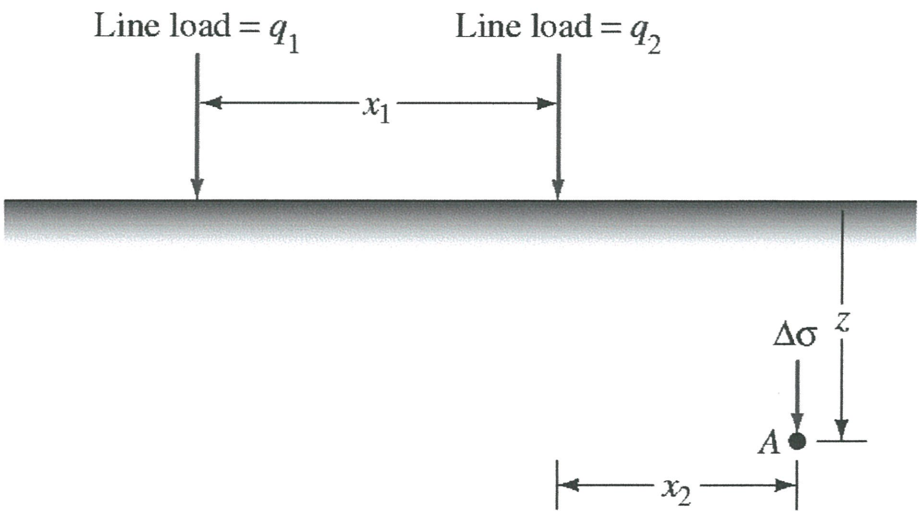

Figure 4(a): Stress at a point due to two line loads

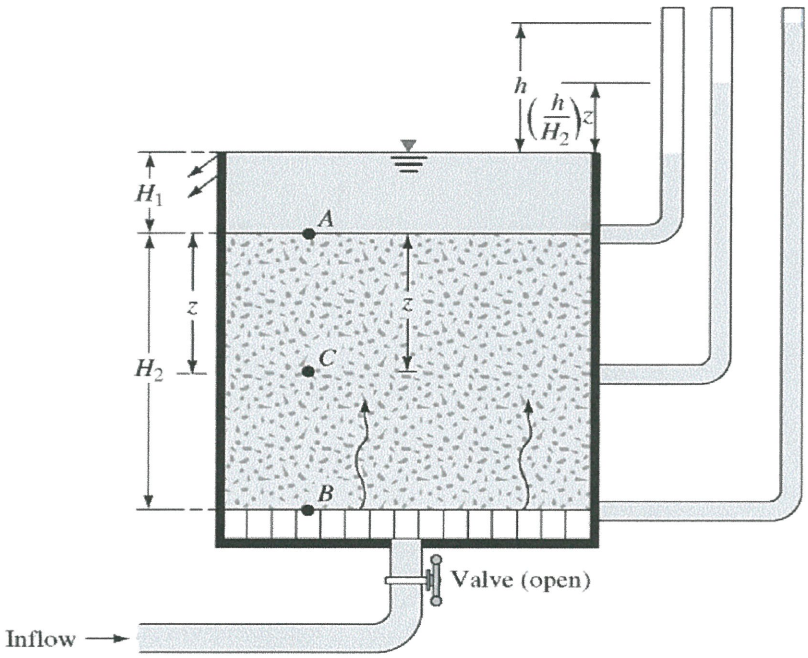

Figure 4(b): Layer of soil in tank with upward seepage

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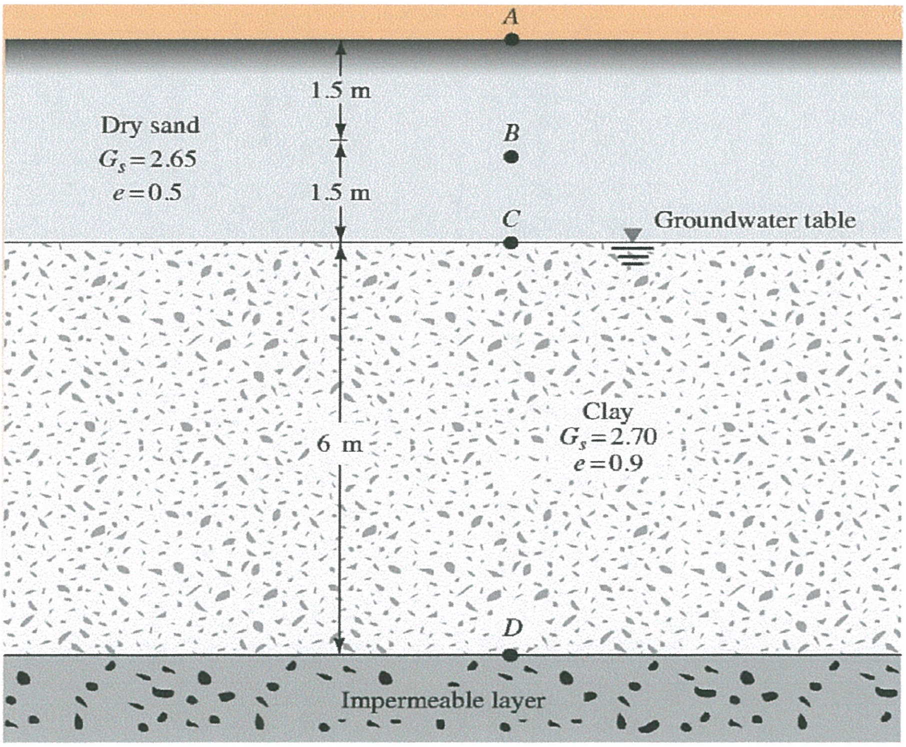

Figure 4(c): The soil profile

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List of Formula:

$$Q = A\left(k\frac{h}{L}\right)t$$

$$k = 2.303\frac{aL}{At}\log_{10}\frac{h_1}{h_2}$$

$$i = \frac{L''\tan\alpha}{\left(\dfrac{L'}{\cos\alpha}\right)}$$

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

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

$$\Delta\sigma = \frac{2qz^3}{\pi(x^2+z^2)^2}$$