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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	GEOTECHNICS 1
COURSE CODE	:	BFC21702
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2021
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	1. ANSWER **ALL** QUESTIONS IN **PART A** 2. ANSWER **ANY TWO (2)** QUESTIONS IN **PART B**

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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PART A

Q1 A clay layer of 4 m in thickness lies between two layers of sand as shown in **Figure Q1**. The upper sand layer is 4 m in thickness and the lower sand layer is 3 m. The ground level is at top of upper sand layer. Although the ground water level is at 3 m below the ground level, the piezometric pressure of the lower sand layer is 4 m above the ground level. The saturated unit weight of the clay is 20 kN/m^3. The saturated unit weight and the unit weight above the ground water level are-19 kN/m^3 and 16 kN/m^3 for both sand layers. Over a short period of time the ground water level rises by 2 m and is expected to remain permanently at this new level. Determine the total and effective stresses, and pore pressure distribution along the soil profile:

(a) Before the rise of water table.

(8marks)

(b) Immediately after the rise of the water table.

(8 marks)

(c) In long term (Assume piezometric level is constant).

(9 marks)

Q2 (a) In an unconfined compression test on a saturated clay, the maximum proving ring dial reading recorded was 240x10^{-3} mm, when the axial shortening of the specimen having an initial height of 70 mm and an initial diameter of 36 mm, is 12 mm. If the calibration factor of the proving ring is 3.2 N/10^{-3} mm, calculate the unconfined compressive strength and the undrained shear strength of the clay.

(8 marks)

(b) **Table Q2(b)** shows the results obtained from a series of CU triaxial tests on saturated samples of clay. Based on the data;

(i) Calculate the effective shear strength parameters (c' and φ') and plot the Mohr-Coulomb failure envelope.

(9 marks)

(ii) Vane shear test is used to determine the undrained shear strength of the same clay in Q2(b) (i). The shear vane used in the test has a diameter of 60 mm and length of 140 mm. The average torque recorded in the undisturbed state is found to be 65 kN.m. Calculate the undrained shear strength of the clay.

Hint: $T = \pi \times c_u \times (\frac{D^2 \times L}{2} + \frac{D^3}{6})$

(8 marks)

PART B

Q3 (a) Derive the γ_{sat} in terms of e, γ_w, and G_s

(4 marks)

(b) By using appropriate sketch, briefly explain the void ratio (e), porosity (n) and degree of saturation (S) of soil.

(9 marks)

(c) In laboratory, there is a 0.23 m^3 of moist clay soil with a mass of 300 kg. The soil was oven dried for 24 hours and the mass was reduced to 265 kg. If Gs = 2.65, with suitable sketch, determine the following weight volume relationship parameter.

(i) Moisture content (%)

(2 marks)

(ii) Moist unit weight (kN/m^3),

(2 marks)

(iii) Dry unit weight (kN/m^3)

(2 marks)

(iv) Void ratio (e)

(3 marks)

(v) Porosity (n)

(3 marks)

Q4 (a) Compaction will increase the strength characteristics of soils. Generally, when soil is compacted, it become denser and having greater strength compare to the looser compacted soil. From this situation, it shows that some factors were related to the effectiveness of the compaction work of the soil. Point out the factor which affect the compaction of the soil with their elaboration.

(6 marks)

(b) The terms compaction, consolidation and compressibility of soil are look similar since all of it are relates to soil settlement. In fact, there are different. Therefore, based on your understanding, differentiate between compaction with consolidation and compressibility.

(6 marks)

(c) **Table Q4(c)** shows laboratory test results of standard proctor test. Based on the result, determine maximum dry unit weight of compaction (kN/m^3) and optimum moisture content (%).

(13 marks)

Q5 (a) Briefly explain hydraulic conductivity measurement in the field. Use appropriate diagram to support your answer.

(8 marks)

(b) A permeameter has a diameter of 75 mm and length of the soil sample is 150 mm. Diameter of standpipe is 15 mm. During the test the head decreased from 1300 mm to 80 mm in 135 s. Calculate hydraulic conductivity of the soil by assuming Darcy's law

(6 marks)

(c) A permeability test was conducted on a clay soil sample by using permeameter at Geotechnical laboratory, UTHM and the results are given in **Table Q5(c)**. If the test was conducted at 20°C at which $\gamma_w = 9.789$ kN/m^3 and $n = 1.005 \times 10^{-3}$ N.s/m^2,

(i) Determine the absolute permeability of the soil (cm/sec).

(6 marks)

(ii) Compute the head difference at t = 6 min.

(5 marks)

– END OF QUESTIONS –

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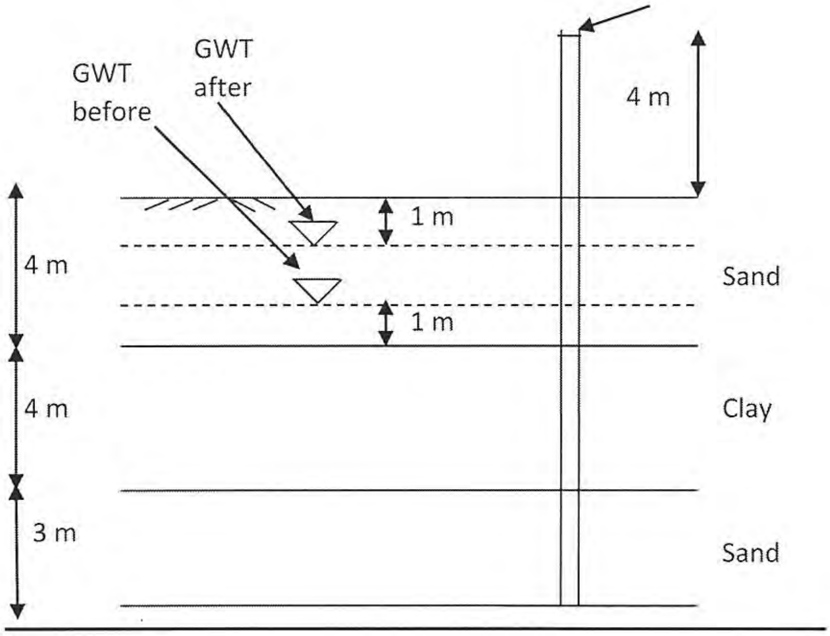

Figure Q1: Upward flow of water through a layer of sand in a tank

Table Q2 (b): CU Triaxial results

Test number	1	2	3
Confining Pressure (kPa)	40	80	120
Deviatoric stress (kPa)	110	190	240
Pore water pressure at failure (kPa)	20	15	35

Table Q4(c): Standard proctor test results

Volume of mold (cm^3)	Weight of moist soil in mold (N)	Moisture content, w (%)
944	15.81	8
944	16.84	10
944	17.41	12
944	17.33	14
944	16.84	16
944	16.35	18

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TableQ5(c): Permeability test results

Length of the soil sample	500 mm
Diameter of the soil sample	45 mm
Diameter of the standpipe	11 mm
Head difference at time, $t = 0$	140 mm
Head difference at time, $t = 10$ min	190 mm

LIST OF EQUATIONS

The following information may be useful. The symbols have their usual meaning.

$$\gamma = \frac{W}{V_m}$$

$$\rho_d = \frac{G_s \rho_w}{1 + \frac{w G_s}{S_r}}$$

$$\gamma_d = \frac{\gamma}{1 + \frac{w(\%)}{100}}$$

$$\gamma_d = \frac{G_s \gamma_w}{1 + \frac{G_s w}{S}}$$

$$\tau' = c + \sigma_n' \tan \phi'$$

$$Energy = \frac{\text{Number of Blow/Layer} \times \text{number of Layer} \times \text{Weight of Hammer} \times \text{Height of Drop}}{\text{Mold Volume}}$$

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

$$\sigma_3 = \sigma_1 \tan^2\left(45^\circ - \frac{\phi}{2}\right) - 2c \tan\left(45^\circ - \frac{\phi}{2}\right)$$

$$\sigma_n = \frac{\sigma_1 + \sigma_3}{2} + \frac{\sigma_1 - \sigma_3}{2} \cos 2\theta$$

$$q_i = A k_{eq} i$$

$$\tau_f = \frac{\sigma_1 - \sigma_3}{2} \sin 2\theta$$

$$k = \frac{q}{Ai} \quad k_{eq} = \sqrt{k_z k_x}$$

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

$$k = \frac{QL}{Aht}$$

$$i = \frac{\Delta h}{r}$$

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