Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2021/2022

COURSE NAME	:	GEOTECHNICS 1
COURSE CODE	:	BFC 21702
PROGRAMME	:	BFF
EXAMINATION DATE	:	JANUARY / FEBRUARY 2022
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	1. ANSWER **ALL** QUESTIONS IN **PART A**. 2. ANSWER **ANY TWO (2)** QUESTIONS IN **PART B.** 3. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **CLOSE BOOK**.

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

PART A (ANSWER ALL QUESTIONS)

Q1 (a) The viscous of water which flow through the interconnected pore spaces in soil can be effectively used to obtain the safety against heave on the downstream side of a hydraulic structure. Based on the statement, use the sketch to explain the force due no seepage, upward seepage and downward seepage on a volume of soil.

(4 marks)

(b) **Figure Q1(b)** shows the soil profile of dry sand and clay. Given $H_1 = 4$ m and $H_2 = 3$ m. If the groundwater table rises to 2 m below the ground surface, determine the net change in effective stress at the bottom of the clay layer.

(6 marks)

(c) **Figure Q1(c)** shows the soil profile with groundwater table is 6 m from the surface impermeable layer. Calculate the total stress, pore water pressure and effectives tress at points *D*.

(7 marks)

(d) **Figure Q1(d)** shows a layer of soil in a tank with upward seepage. Given the $H_1 = 1.5$ m, $H_2 = 2.5$ m, h = 1.5 m, $\gamma sat = 18.6$ kN/m^3. If the hydraulic conductivity of soil, $k = 0.13$ cm/s;

(i) Compute the upward seepage force per unit volume of soil.

(4 marks)

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

(4 marks)

Q2 (a) (i) The Mohr-Coulomb failure criterion is popularly adopted in soil mechanics analysis. Give an illustrated (with a suitable sketch) description of this failure criterion, which 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;

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

(4 marks)

(ii) A consolidated-drained triaxial test was conducted on a normally consolidated clay. Compute the angle, θ that the failure plane makes

with the major principal stress, if the laboratory test results is given as follows;

- σ_3 = 276 kN/m^2
- $(\Delta\sigma_d)_f$ = 276 kN/m^2

(4 marks)

(b) Three samples of soil are tested under consolidated undrained conditions with measurement of the pore water pressure as shown in **Figure Q2(b).** If the deviator stress is applied on sample 1 = 48 kN/m^2, sample 2 = 105 kN/m^2 and sample 3 = 198 kN/m^2;

(i) Compute Mohr-circle in term of total stress and effective stress on the same graph.

(9 marks)

(ii) Compute the cohesion and friction angle for total stress and effective stress.

(4 marks)

(iii) Based on the answer in **Q2(b)(ii)**, briefly discuss on the result obtained.

(4 marks)

PART B (ANSWER ANY TWO QUESTIONS)

Q3 (a) Discuss the differences between the Unified Soil Classification System (USCS) and the American Association of State Highway and Transportation Officials (AASHTO) soil classification system.

(4 marks)

(b) (i) With the aid of diagram, briefly explain the saturated, unsaturated and dry soil condition of the three phases.

(6 marks)

(ii) Based on your understanding, briefly discuss the relationship of mass, weight and volume in soil.

(6 marks)

(c) The moist clay soil with mass of 230 cm^3 and 400 g is tested in the geotechnic laboratory. The soil was then oven dried about 24 hours and the mass was determined as 350 g. If specific gravity, *Gs* of the soil is 2.65, compute the moisture content (%), moist unit weight and dry unit weight.

(9 marks)

Q4 (a) The in situ moist of soil with weight of 16.6 kN/m^3 containing 19% of moisture content. The soil will be excavated and transported to the construction site for a soil compacted fill works. It is estimated that the soil can be compacted with a minimum dry unit weight of 19.5 kN/m^3 at the same moisture content as 19%. If the one of US ton is considered as 8.896 kN;

(i) Compute how many cubic meters of soil from the excavation site are needed to produce 2,500 m^3 of compacted fill works.

(6 marks)

(ii) Compute how many truckloads with 20-ton (US ton) capacity are needed to transport the excavated soil.

(4 marks)

(b) **Table Q4(b)** shows the compaction test results for clay soil with different water content percentage conducted using a 1,000 cm^3 of compaction mould, *V*. If the specific gravity, G_s of the soil is 2.7 with using all unit's calculation in kN/m^3;

(i) Plot the graph to determine a Maximum Dry Density (MDD) and Optimum Moisture Content (OMC).

(10 marks)

(ii) Based on answer at **Q(b)(i),** plot 100% and 80% of saturation lines.

(1 marks)

(iii) Compute the range of water content needed to achieve a relative compaction of 95% at the field.

(2 marks)

(iv) Give your explanation on the differences between of 20% of air voids curve and 80% of saturation curve.

(2 marks)

Q5 (a) A sample in variable head permeameter with 80 mm in diameter and 180 mm height can estimate the permeable of water in 10×10^{-3} mm/sec. If the design of head in stand pipe falls from 1,000 mm to 500 mm in 3 minutes, compute the size of stand pipe needed for this test based on the assumptions of Bernoulli's Equation and Darcy Law.

(6 marks)

(b) Hydraulic gradient is representing the energy or driving force for liquid flow (water) through the void spaces of soil and can be considered as laminar. Based on the statements, with the sketch of diagrams, briefly describe the relationship between hydraulic gradient and velocity.

(9 marks)

(c) The constant head permeability test is conducted on soil sample with area of permeameter is 50×10^2 mm^2 and height is 60 mm. If a quantity of 430 cm^3 of water is passed down in 10 minutes under an effective constant head of 400 mm, compute a typical arrangement of the range coefficient of permeability and seepage velocity during the test period if the soil is compressed and consider with a constant void ratio. It takes the specific gravity, G_s of soil is 2.65 and the drying specimen weight is 4.98 N.

(10 marks)

- END OF QUESTIONS -

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Table Q4(b): Compaction test results

Testing Properties	Number of samples					
	1	2	3	4	5	6
Water content (%)	8.5	12.2	13.75	15.5	18.2	20.2
Weight of wet soil (kg)	1.8	1.94	2.00	2.05	2.03	1.98

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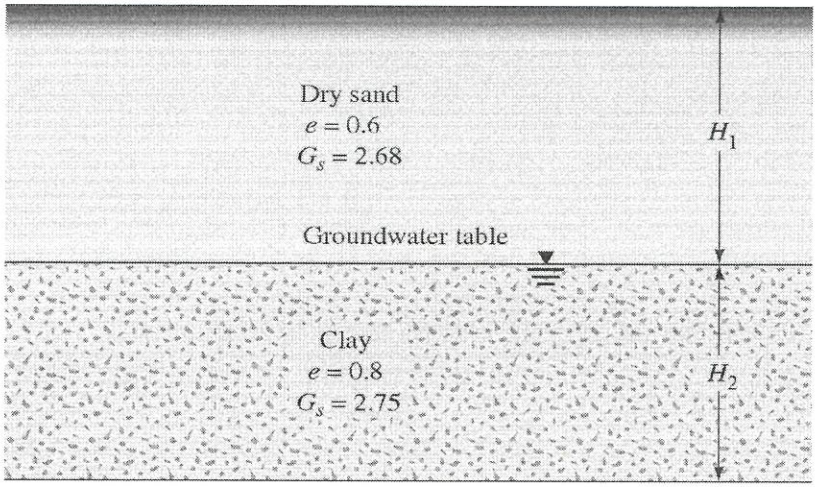

Figure Q1(b): The soil profile

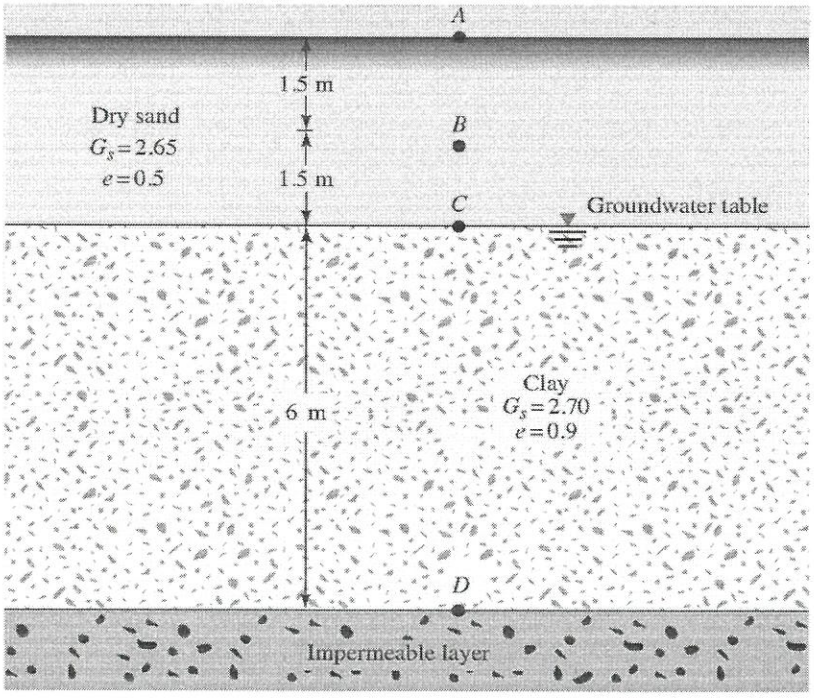

Figure Q1(c): The soil profile

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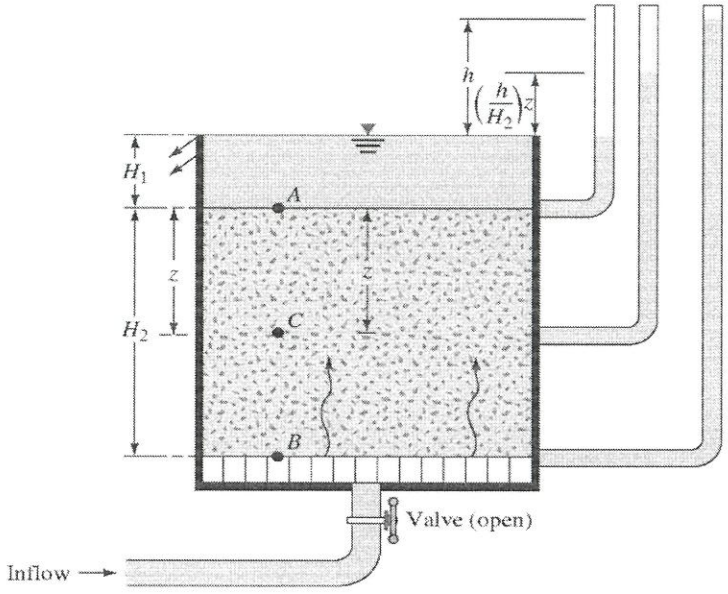

Figure Q1(d): Layer of soil in tank with upward seepage

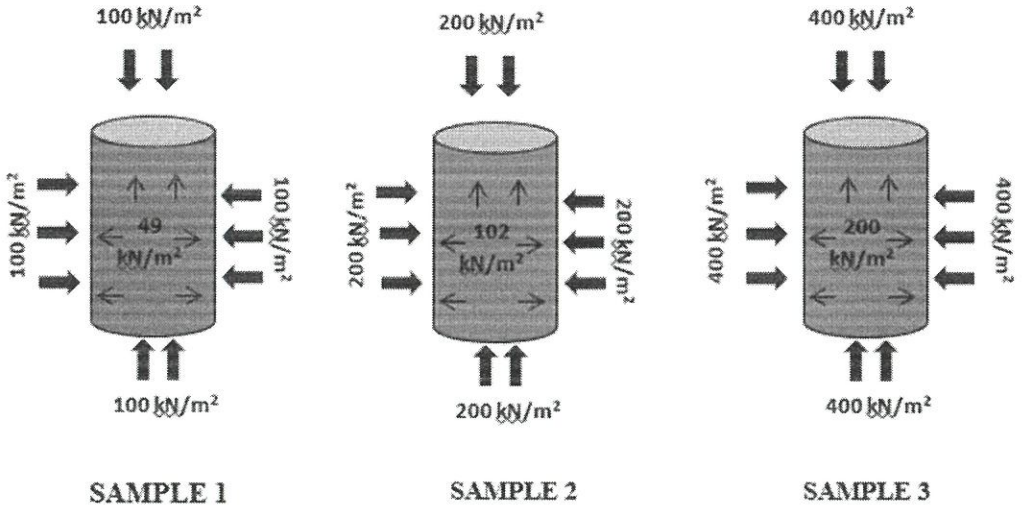

Figure Q2(b): Sample for Consolidate Undrained test