Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	ADVANCED GEOTECHNICAL ENGINEERING
COURSE CODE	:	MFG 10403
PROGRAMME	:	MFA
EXAMINATION DATE	:	JANUARY / FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY **OPEN BOOK EXAMINATION**

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

Q1 (a) Total settlement in soil can be divided into **THREE (3)** broad categories and they are the immediate settlement, the primary consolidation settlement and the secondary consolidation settlement. Sketch a typical settlement – time curve and indicate on the curve the **THREE (3)** broad categories. Briefly describe each of the settlement categories.

(6 marks)

(b) Terzaghi consolidation theory in one dimensional consolidation for saturated clay was derived based on some very important assumptions. List **FOUR (4)** of the assumptions.

(4 marks)

(c) A saturated clay sample was obtained from the middle of a clay layer of 6 m thickness. The results of an oedometer test on the sample were as shown in **Table Q1(c)**. The specific gravity of the soil particles was 2.68 and the moisture content at the end of the test was 23.1%.

(i) Calculate the void ratio at the end of each pressure.

(3 marks)

(ii) Plot void ratio versus logarizam of pressure (e vs log p) curve and determine the preconsolidation stress (p_c), compression index (C_c), and swelling index (C_s).

(3 marks)

(iii) If the clay is slightly overconsolidated with an overconsolidation ratio of 1.2, calculate the consolidation settlement of the layer if the average stress increase due to external load at the middle of the clay layer is 50 kN/m^2.

(4 marks)

(d) In the construction of UTHM's main campus in Parit Raja, Batu Pahat, Johor, prefabricated vertical drains (PVD) and surcharge techniques were used. Discuss the purpose of using these techniques in construction on soft clay deposits such as UTHM's main campus site.

(5 marks)

Q2 (a) Define in terms of principal stresses the parameters *q, p and p'*. Indicate how they relate to the quantities measured during a conventional undrained triaxial compression test.

(6 marks)

(b) The first three columns of **Table Q2(b)**_give data from a drained triaxial compression test in which the cell pressure was held constant at σ_c = 300 kPa and the pore pressure was held constant at u = 100 kPa. At start of the test the sample was 38 mm in diameter and 76 mm long and its specific volume was v = 2.19. Determine the ε_s , ε_v , v , q' and p'. Plot the graph q' vs p'.

(10 marks)

(c) A sample of clay has been isotropically normally consolidated to a stress p'_o = 200 kN/m^2 and a final void ratio of 0.92 and is sheared in a drained triaxial compression tests. For the soil constants given below calculate q' and p' at failure and the final specific volume and volumetric strain at failure. Given ; λ = 0.16 , Γ = 2.76 M = 0.89

(9 marks

Q3 (a) Describe briefly the purpose of geotechnical instrumentation and the factors affecting the choice of instruments.

(6 marks)

(b) In monitoring performance of the following geotechnical construction, discuss briefly the geotechnical problems associated with the construction and the instrumentation required to monitor the performance of the construction.

(i) Strutted excavations

(3 marks)

(ii) Excavated slopes

(3 marks)

(iii) Driven piles.

(3 marks)

(c) A group of researchers from UTHM planned to study the performance of a trial embankment on peat soil deposits in Sibu, Sarawak. As a member of the research team you are to suggest the instrumentation required to monitor the performance of the embankment. Discuss the geotechnical problems associated with this construction and suggest the instrumentation required to monitor the trial embankment performance.

(10 marks)

Q4 A 3.0 m height of fill is to be constructed with side side slopes of 1 in 2. The compated fill will have an undrained shear strength, c_u = 40 kPa, and undrained internal friction angle of 0°, and a unit weight γ = 20 kN/m^3. It is also to be placed in a pure soft clay layer generally having c_u = 20 kPa and γ = 20 kN/m^3. However, between 2.0 m and 3.0m depth, the clay layer has been found to be very soft with c_u = 5 kPa. Bedrock is present at 5.0 m depth.

(a) The stability of the fill has been considered by analyzing three circular failure surfaces as shown in the diagram in **Figure Q4(a)** below. These are centred on the point O and have radii of 9.0 m, 10.0 m and 12.0 m, respectively. Identify which of the **THREE (3)** failure surfaces you consider to be more critical, giving reasons for your selection and no calculation is required.

(5 marks)

(b) Calculate the factor of safety against shear failure for the highest and the lowest in factor of safety between these three failure surfaces. Do you consider the factor of safety to be adequate?Used Fellenius's method and used **Figures Q4(b)(i),** and/or **Q4(b)(ii)** and/or **Q4b(iii)**. Summaries your findings.

$$FS = \frac{\sum[c'_n L_n + (W_n \cos\alpha_n - u_n L_n) \tan\phi'_n}{\sum W_n \sin\alpha_n}$$

(16 marks)

(c) Do you consider that the Fellenius's approached is the suitable for analyzing this particular problem? If not, write the other approachable and effective method to solves this problem? What is the different between those method and Fellenius's method?

(4 marks)

Q5 (a) In many areas of the world, there are soils that make construction of foundations extremely difficult. Foundation engineers must be able to identify difficult soils when they are encountered in the field. Although it is not possible to solve all the problems caused by all soils, preventive measures can be taken to reduce the possibility of damage to structures built on them. Explain clearly the difference between the collapsible soil and expansive soil and also the problem of construction that related to these types of soil.

(10 marks)

(b) Soil improvement is one of the techniques that have been used widely to improve the soil properties on site. One of the main goals of most soil improvement techniques used for reducing liquefaction hazards is to avoid large increases in pore water pressure during earthquake shaking. This can be achieved by densification of the soil and/or improvement of its drainage capacity. Explain with the sketches between Vibroflotation and Dynamic Compaction techniques to improve the soil.

(8 marks)

(c) The challenges faced by engineers on road construction over peats and organic soils include limited accessibility, difficult traffic ability, expectations of very large settlements over an extended time period, and possibility of stability problems. The high compressibility, low shear strength and high ground water level causes specific problems for designing and constructing structures on such types of soil. You as geotechnical engineer responsible to construct road construction on the peat soil area. Explain **TWO (2)** different techniques that will you choose to overcome these problems. List also the advantages and disadvantages for both techniques.

(7 marks)

- END OF QUESTIONS -

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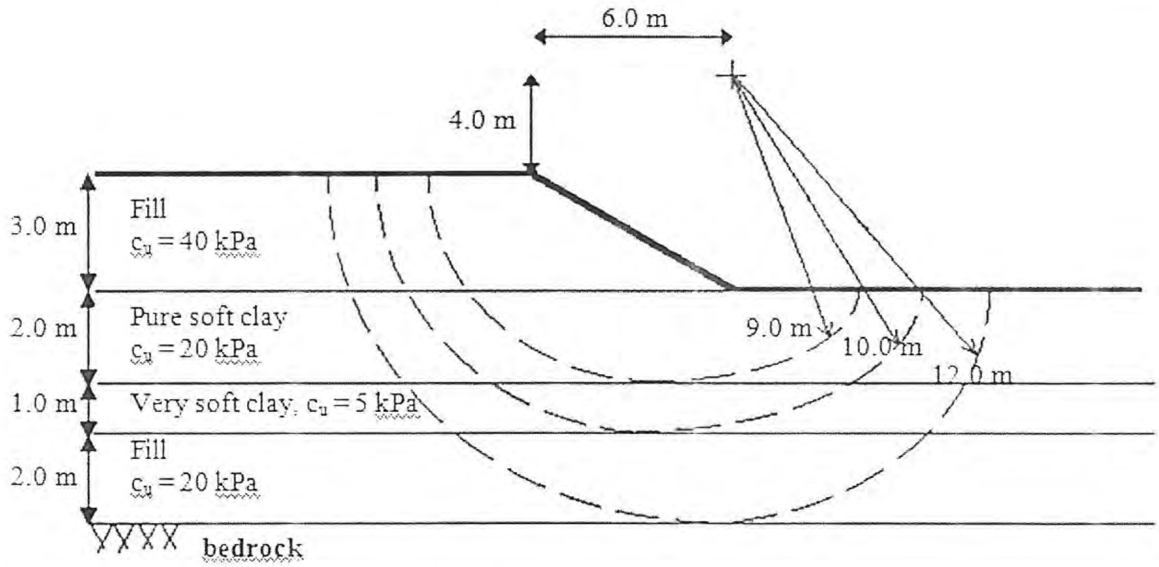

Not to scale

Figure Q4(a) : Three circular failure surface

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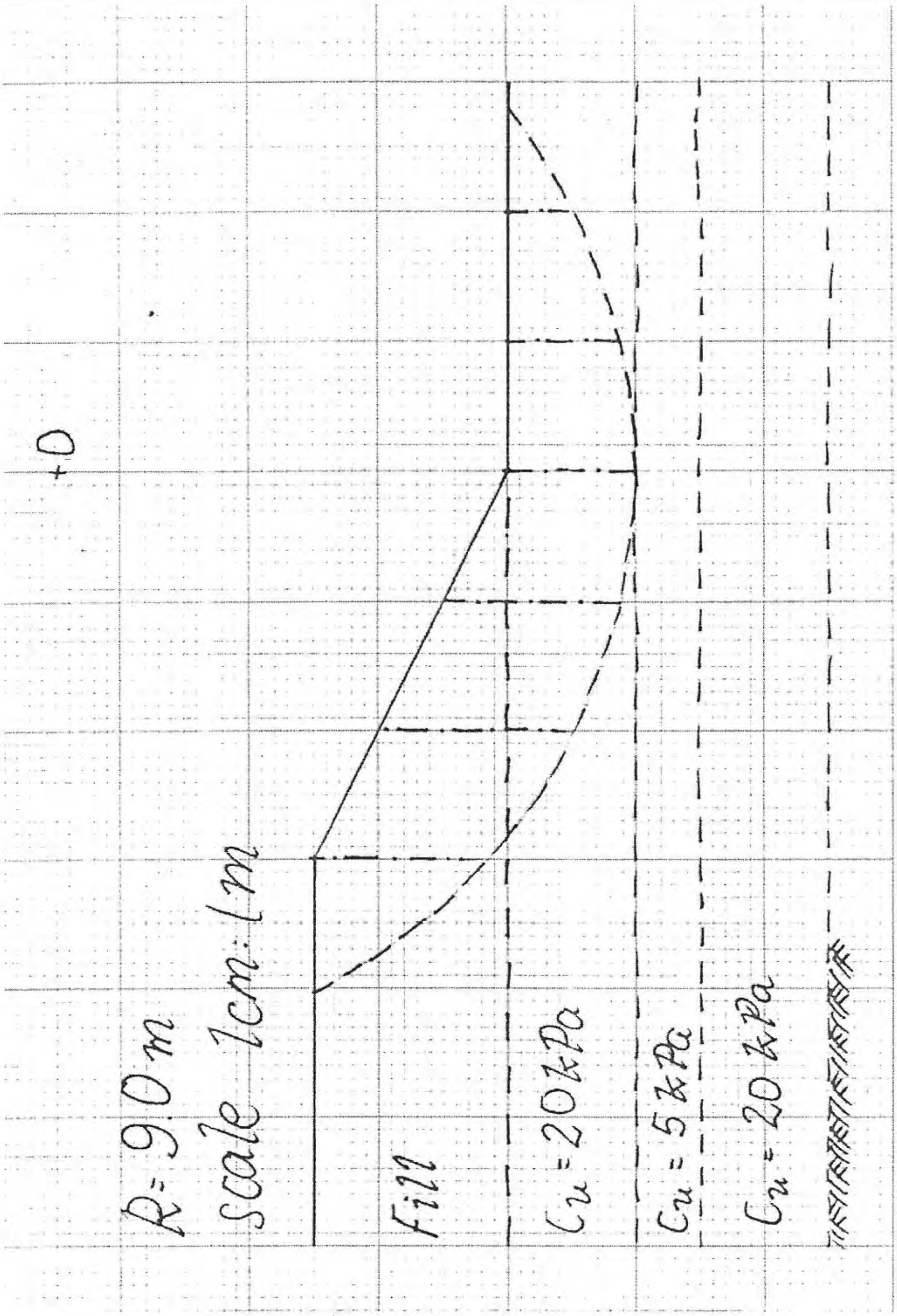

Figure Q4(b)(i) : Fellenius's method

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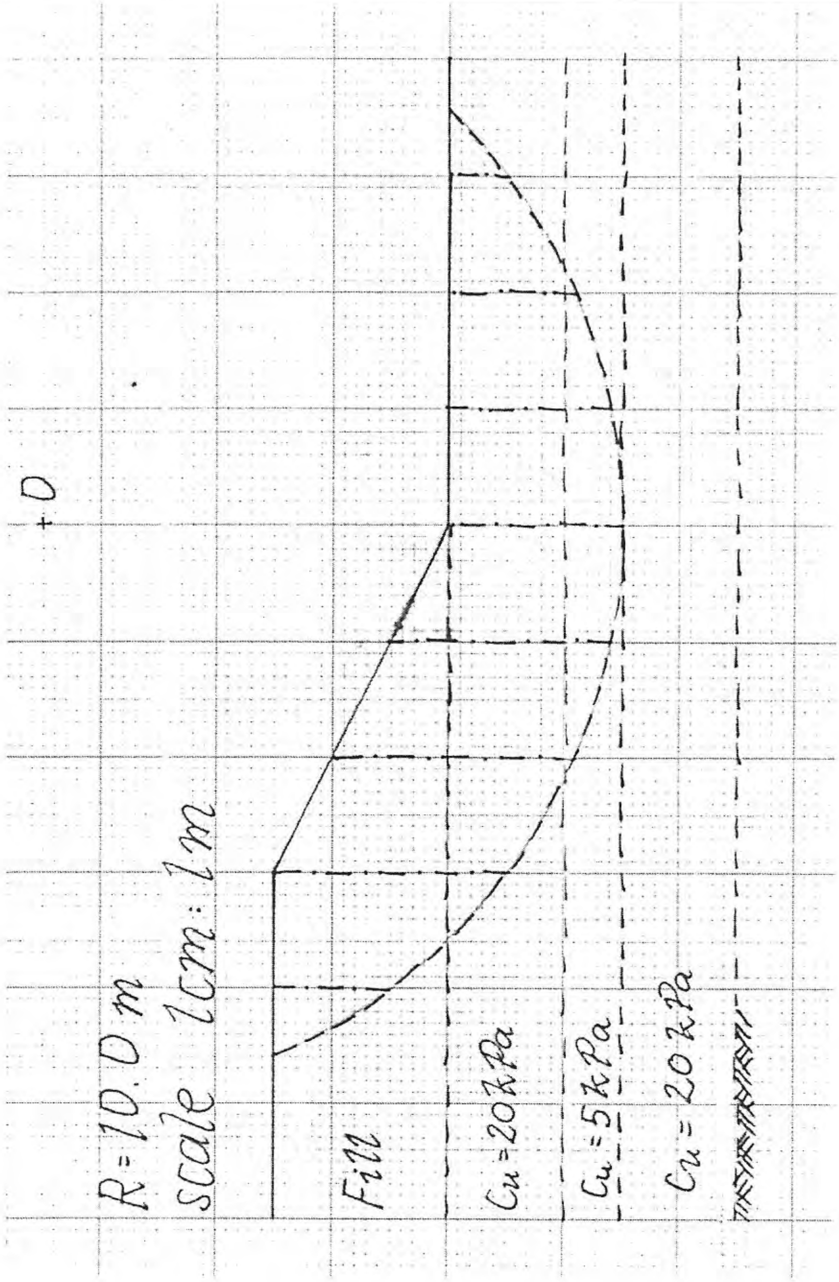

Figure Q4(b)(ii) : Fellenius's method

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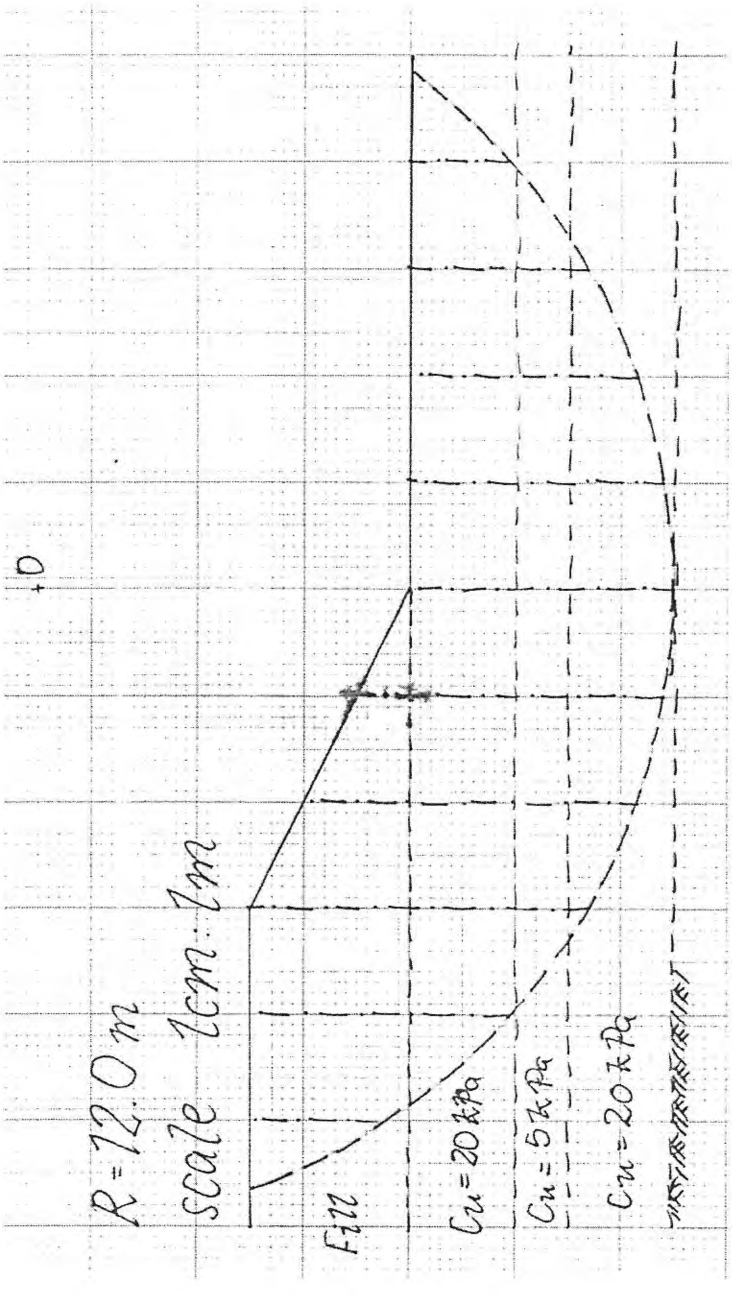

Figure Q4(b)(iii) : Fellenius's method

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Table Q1(c): Pressure, p (kN/m^2) versus thickness (mm)

Pressure, p (kN/m^2)	Thickness of the sample after 24h (mm)
0	25.0
50	24.6
100	24.4
200	24.2
400	23.9
800	23.7
0	24.2

Table Q2(b): Data for the triaxial drained test

Axial force, F_a (N)	Change of length ΔL (mm)	Change of volume ΔV (cm^3)
0	0	0
115	-1.95	-0.88
235	-5.85	-3.72
325	-11.70	-7.07
394	-19.11	-8.40
458	-27.30	-8.40