UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	GEOTECHNICS II
COURSE CODE	:	BFC 35403
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

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

Q1 A sheet pile is primary used to provide lateral support for water retention in the clay soil as shown in **Figure Q1.1**.

(a) The pore water pressure distribution can be determined to identify the maximum shear force on the sheet pile. This provides an idea on the strength capacity of the sheet pile to maintain a safe and working environment.

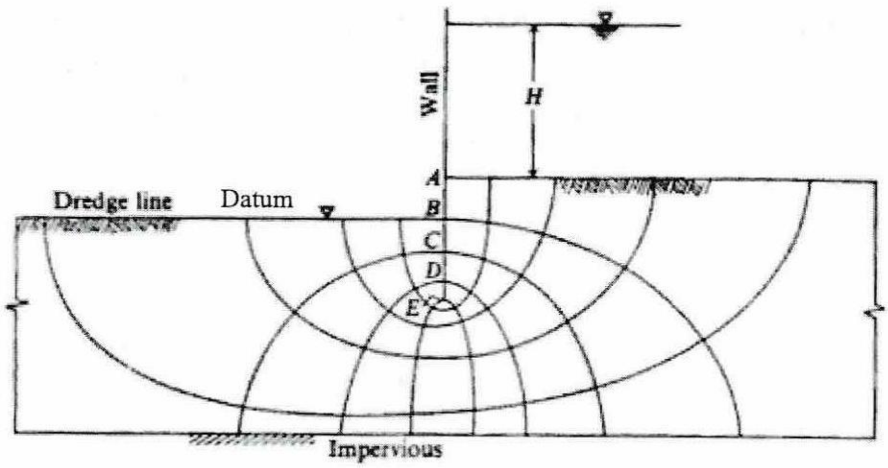

Figure Q1.1: The schematic diagram of the sheet pile wall

(i) The pore water pressure distribution values that appear on the upstream face of the sheet pile depends on certain factors. Describe **TWO (2)** factors that affects the pore pressure distribution.

(4 marks)

(ii) If the depth of the clay soil is increase under the structure, provide explanation on what will happen to the values of the pore pressure distribution on the upstream face of the sheet pile wall.

(4 marks)

(b) In addition to the construction of the sheet pile as shown in **Figure Q1.1**, the soil at the downstream of the sheet pile wall was slightly dredged below the original level. The height of the water behind the sheet pile wall, H is 8 meters in height. The coefficient of permeability of the soil sandy clay beneath is $k = 4 \times 10^{-5}$ m/s and has a saturated unit weight, γ_{sat} of 18.50 kN/m^3. The dimensions of the structure with reference to the diagram are AB = 2 m, BC = 2 m, CD = 1.5 m and DE = 1 m.

(i) Based on the information given, determine the flow of water, q (quantity per day) per meter of wall.

(4 marks)

(ii) Calculate the pore water force on the upstream face of the embedded sheet pile wall. You may use points A, B, C, D and E for reference as your pore water pressure points.

(13 marks)

Q2 Retaining walls, cantilever sheet-pile walls, sheet-pile bulkheads, braced cuts, and other, similar structures are utilized to support vertical or nearly vertical soil slopes.

(a) Explain **FOUR (4)** factors that are required to design the structures in the estimation of lateral earth pressure.

(8 marks)

(b) By referring to **Figure Q2.1**, determine the Rankine active force per unit length of the wall and the location of the resultant line of action.

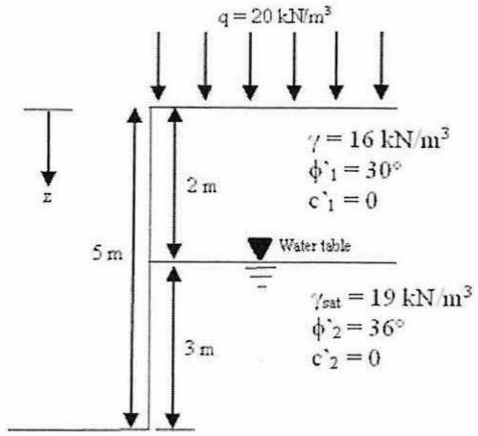

Figure Q2.1: An Embankment

(17 marks)

Q3 The oedometer test is a geotechnical engineering test that measures a soil sample's consolidation properties.

(a) **Table Q3.1** shows a set of experimental data for oedometer test. The original thickness of the soil specimen used in this test was 25 mm.

Table Q3.1: The soil settlement over elapsed time for a range of imposed load

Elapsed (min)	$\sigma 1$ 25Kpa	$\sigma 2$ 50Kpa	$\sigma 3$ 100Kpa	$\sigma 4$ 200Kpa	$\sigma 5$ 400Kpa	$\sigma 6$ 800Kpa	$\sigma 7$ 1600Kpa	$\sigma 9$ 25Kpa
0	0.00	0.085	0.265	0.53	0.942	1.63	2.518	3.50
0.5	-	-	0.270	-	-	-	2.59	-
1.0	-	-	0.280	-	-	-	2.67	-
2.0	-	-	0.30	-	-	-	2.70	-
4.0	-	-	0.335	-	-	-	2.75	-
10	-	-	0.40	-	-	-	2.87	-
15	-	-	0.425	-	-	-	3.00	-
25	-	-	0.455	-	-	-	3.10	-
40	-	-	0.475	-	-	-	3.18	-
50	-	-	0.480	-	-	-	3.21	-
60	-	-	0.487	-	-	-	3.24	-
80	-	-	0.495	-	-	-	3.27	-
100	-	-	0.50	-	-	-	3.30	-
150	-	-	0.505	-	-	-	3.35	-
200	-	-	0.510	-	-	-	3.37	-
400	-	-	0.520	-	-	-	3.40	-
1000	-	-.	0.525	-	-	-	3.470	-
1440 (24hr)	0.085	0.265	0.530	0.942	1.63	2.518	3.50	2.45

(i) Based on the information given in **Table Q3.1**, plot the experimental curve for settlement over elapsed time for imposed load of 100 kPa using square root fitting method.

(5 marks)

(ii) Determine the coefficient of consolidation, cv (m^2/yr) based on the plot obtained in question **Q3(a)(i)**.

(4 marks)

(iii) Explain whether the coefficient of consolidation for imposed load, σ_3 as determined from question **Q3(a)(ii)** will be constant for different imposed load or different with amount of imposed load. The explanations must be supported by relevant sketch (es).

(6 marks)

(b) A series of imposed load for consolidation test (as shown in **Table Q3.1** as σ_1, σ_2, σ_3, σ_4, σ_5, σ_6, σ_7, ……… σ_9) will be in some logical pattern. Explain its pattern and the practical application of the parameters obtained from this series of test.

(10 marks)

Q4 Slope stability is the ability of a soil slope to withstand its own weight and external forces without sliding or collapsing.

(a) Briefly explain the effect of rainfall on the stability of slope.

(2 marks)

(b) Briefly explain with a sketch how the safety factor of cut slope and fill embankment change with time.

(8 marks)

(c) A potential slip circle of slope is shown in **Figure Q4.1**. The slope is partially saturated. By using the Ordinary Method of Slices as shown in **Figure Q4.2**, determine the factor of safety for the slope undergoing seepage and for the failure surface shown. The soil properties are as follows:

Bulk density = 1780 kg/m^3
Effective cohesion, c' = 20 kN/m^2
Effective friction angle, ϕ' = 31°

The weights of the slices have been determined and the average pore pressures acting on the bases of the slices have been determined from the flownet which are listed in **Table Q4.1**.

(15 marks)

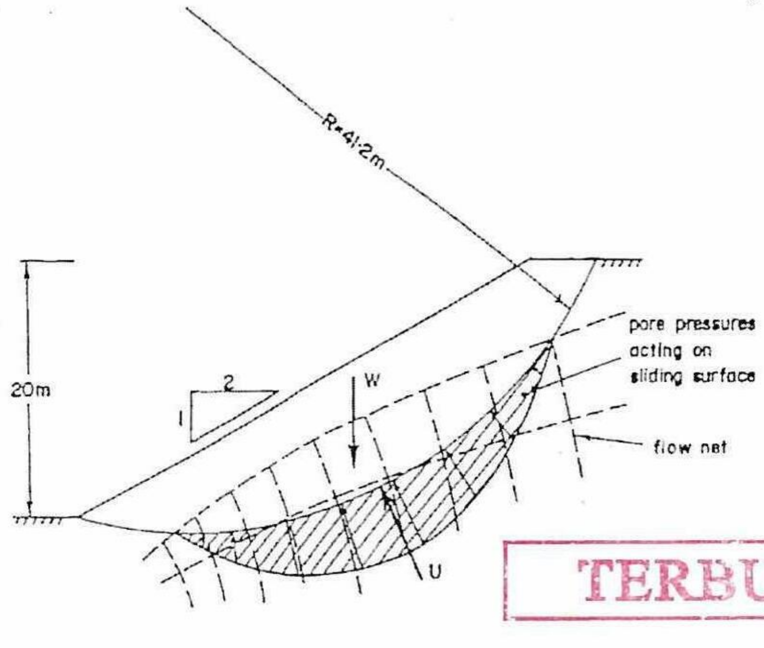

Figure Q4.1: Potential failure surface

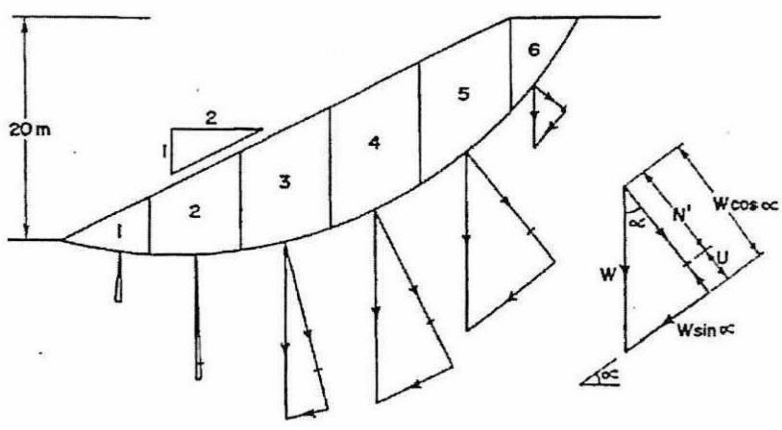

Figure Q4.2: Slices of slope

Table Q4.1: Details of slices of slope

Slice	Slice width (m)	Weight of slice, W (kN)	Pore pressure force, U (kN)	α (°)
1	5	375	0	-5.5
2	7	1043	135	1.85
3	7	1515	355	13.2
4	7	1667	435	24.1
5	7	1515	325	38.6
6	5	495	5	48.9

- END OF QUESTIONS -

APPENDIX A:

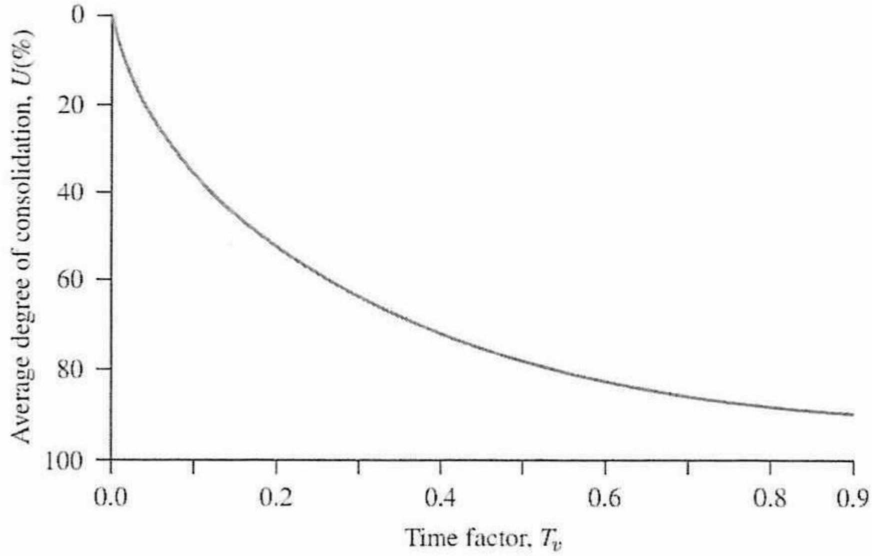

Figure Q3.2: Variation of average degree of consolidation with time factor, T_v

APPENDIX B: Formula

These formulas may be useful to you. The symbols have their usual meaning.

Seepage

$$q = k\Delta H \, {}^{N_f}\!/_{N_d}$$

Hydraulic gradient

$$i_{max} = \frac{\Delta h}{L_{min}}$$

Pore water pressure head

$$\mathrm{h_p = \Delta H - N_d \Delta h - h_z}$$

Coeficient of Consolidation

$$c_v = \frac{T_v H_{dr}^2}{t_{90}}$$

Factor of safety for slope

$$FS = \frac{\sum_{n=1}^{n=p}(C_n \Delta x_n sec\alpha_n) + \sum_{n=1}^{n=p}(W_n cos\alpha_n - U)\tan\phi_n}{\sum_{n=1}^{n=p}(W_n sin\alpha_n)}$$