UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	GEOTECHNICS II
COURSE CODE	:	BFC 34402
PROGRAMME	:	BACHELOR OF CIVIL ENGINEERING WITH HONOURS
EXAMINATION DATE	:	DECEMBER 2015/JANUARY 2016
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIFTEEN (15)** PAGES

Q1 (a) Flow of water through isotropic soil can be described by a Laplace equation and solved by drawing a flow net. Define the flow net and the general requirements needed in drawing the flow net in order to satisfy the Laplace equation.

(5 marks)

(b) A flow net can also be drawn for flow of water in an anisotropic soil with some adjustments. State and briefly described the adjustments needed in drawing the flow net in an anisotropic soil.

(5 marks)

(c) A single row of sheet piles wall was driven into an anisotropic soil. The drawing of the flow net of water around and underneath the wall is shown in **FIGURE Q1**.

If the coefficient of permeability of the soil in the vertical and horizontal directions are 2×10^{-2} mm/sec and 4×10^{-2} mm/sec, respectively, determine:

(i) The seepage loss of the dam in m^3/day/m.

(3 marks)

(ii) The maximum exit gradient.

(2 marks)

(iii) The velocity and the pore pressure of flow at point mark X in **FIGURE Q1**.

(3 marks)

(iv) Estimate the force acting on the downstream face of the sheet piles wall.

(4 marks)

(v) Discuss on the effect of driving the sheet piles wall to a depth deeper than the existing depth.

(3 marks)

Q2 (a) **FIGURE Q2(a)** summarises the important element in stresses.

(i) Figure out the other remaining element of x_1, x_2, x_3, and x_4, under concepts and application in soil stresses.

(3 marks)

(ii) Identify **ONE (1)** assumption or key ideas for each methods by Coulomb's theory, Rankine's theory, Boussinesq's theory, Fadum's theory, and Newmark's theory.

(5 marks)

(b) The plan of a foundation for a building is shown in **FIGURE Q2(b)**. Determine the vertical stress increase at a depth of 10 m below point A. The foundation applies a uniform vertical stress of 350 kPa on the soil surface.

Apply **TWO (2)** methods for this part, the Fadum's theory with the influence factors of *m* and *n* by referring to **Table 1**, and Newmark's theory with the number of elements covered by the loaded area in **FIGURE Q2(c)**.

(8 marks)

(c) A cantilever wall with 8 m height with two layer of soils at the back of the wall is required to maintain the grade for a freeway, as shown in **FIGURE Q2(d)**. Determine the active force and passive force and their line of action. Use Rankine's method to calculate the lateral forces. Neglect the crack tension at the back of the wall.

(9 marks)

Q3 (a) An increase in stress caused by construction of foundations or other loads compresses soil layers and cause settlement. However, there are different categories of settlement. Explain in detail, the difference between compaction and consolidation.

(4 marks)

(b) Compare the differences between Normally Consolidated soil and Overconsolidated soil in detail.

(4 marks)

(c) A road needs to be built on top of various layers of soil. A 5.0 m thick fill is to be made with a soil of a dry unit weight of 18.4 kN/m^3. The soil profile is shown in **FIGURE Q3**. To determine the consolidation settlement of the soil, a one dimensional consolidation test was done at the laboratory for samples taken from Points **A** and **B**.

(i) Determine the present effective vertical pressure, σ_o', at Point **A** and **B**.

(4 marks)

(ii) How would you apply what you learned to categorize if the layers between soft clay and medium clay soil, either the layer is normally consolidated or overconsolidated. Refer to **Table 2**.

(3 marks)

(iii) Determine the ultimate consolidation settlement of the soil caused by the weight of the fill.

(8 marks)

(iv) Solve for the consolidation settlement of the soil when the clay layer is 50% consolidated.

(2 marks)

Q4 (a) For a natural slope, there is a possibility that it may occur slope failure. Explain in detail with the aid of sketches FOUR (4) types of slope failure.

(4 marks)

(b) As an engineer, you have been appointed to inspect a natural slope that has been stabled for many years at a developed area near to Batu Pahat. In order to avoid potential dangers, you have to classify the possible causes that may SUDDENLY result to failure on the natural slope.

(6 marks)

(c) A slope has been recently constructed as shown in **FIGURE Q4**. The slope consist of four layers of soil.

(i) Using the ordinary method of slice, determine the factor of safety (FS) of the slope. The widths of each slices are not the same and its details are given in **Table 3**.

(12 marks)

(ii) If a surcharge is placed just above the top of the slope, determine whether there is an increase or decrease in the factor of safety of the slope. Explain why on your choice of answer.

(3 marks)

- END OF QUESTIONS –

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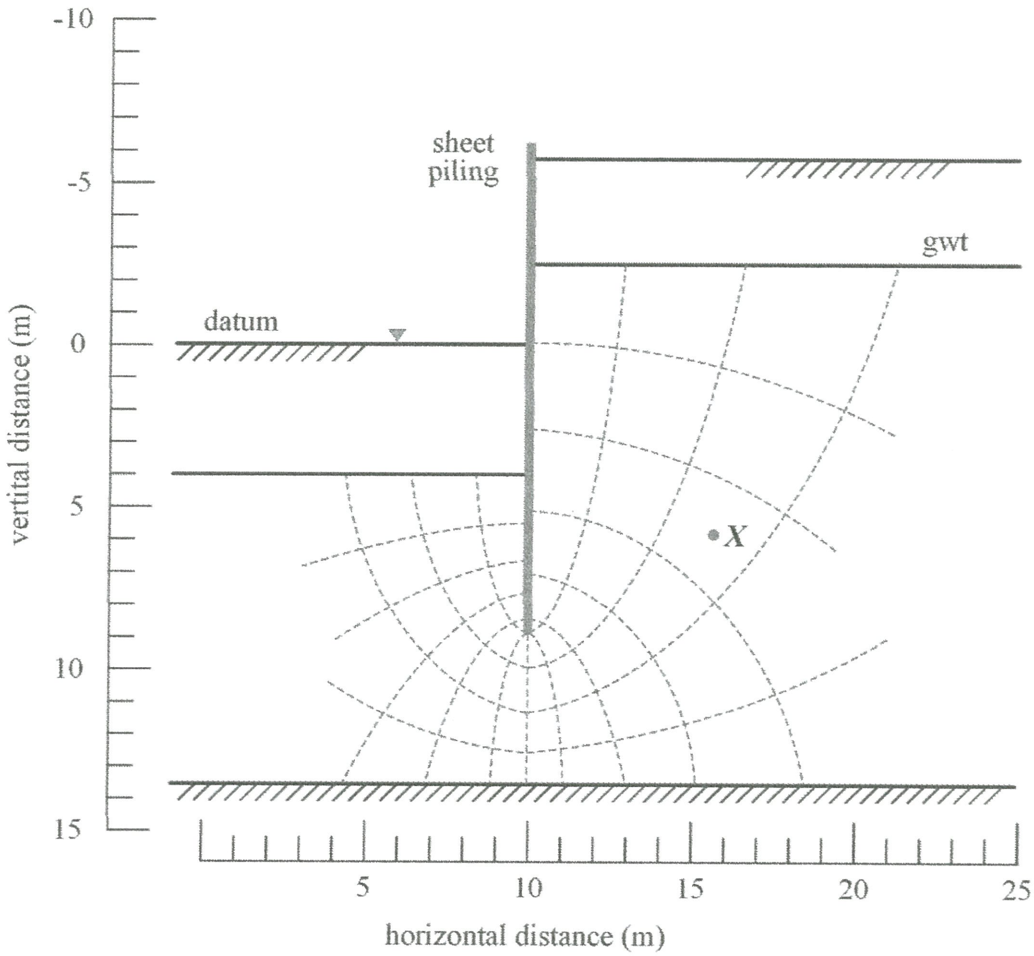

FIGURE Q1

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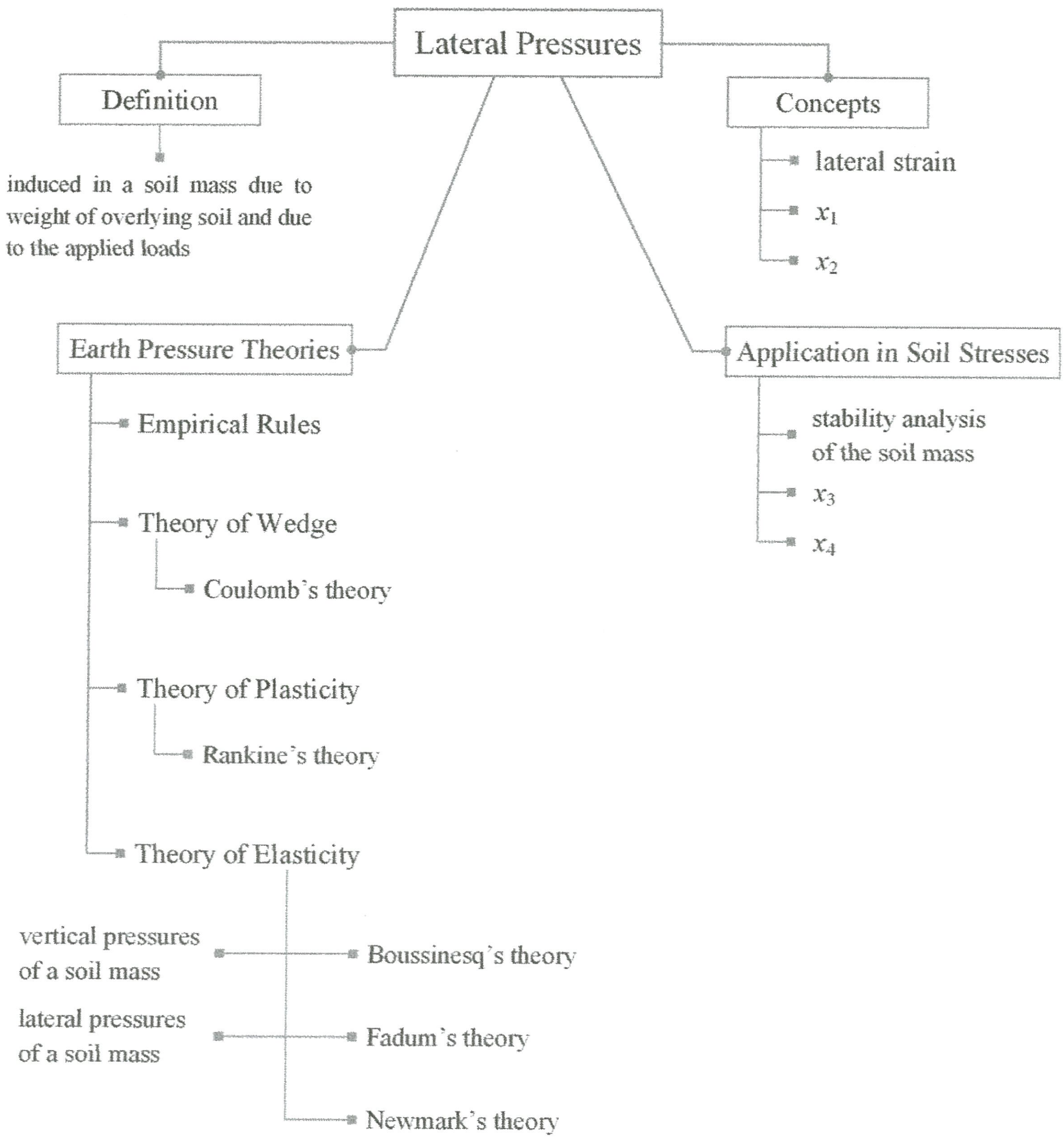

FIGURE Q2(a)

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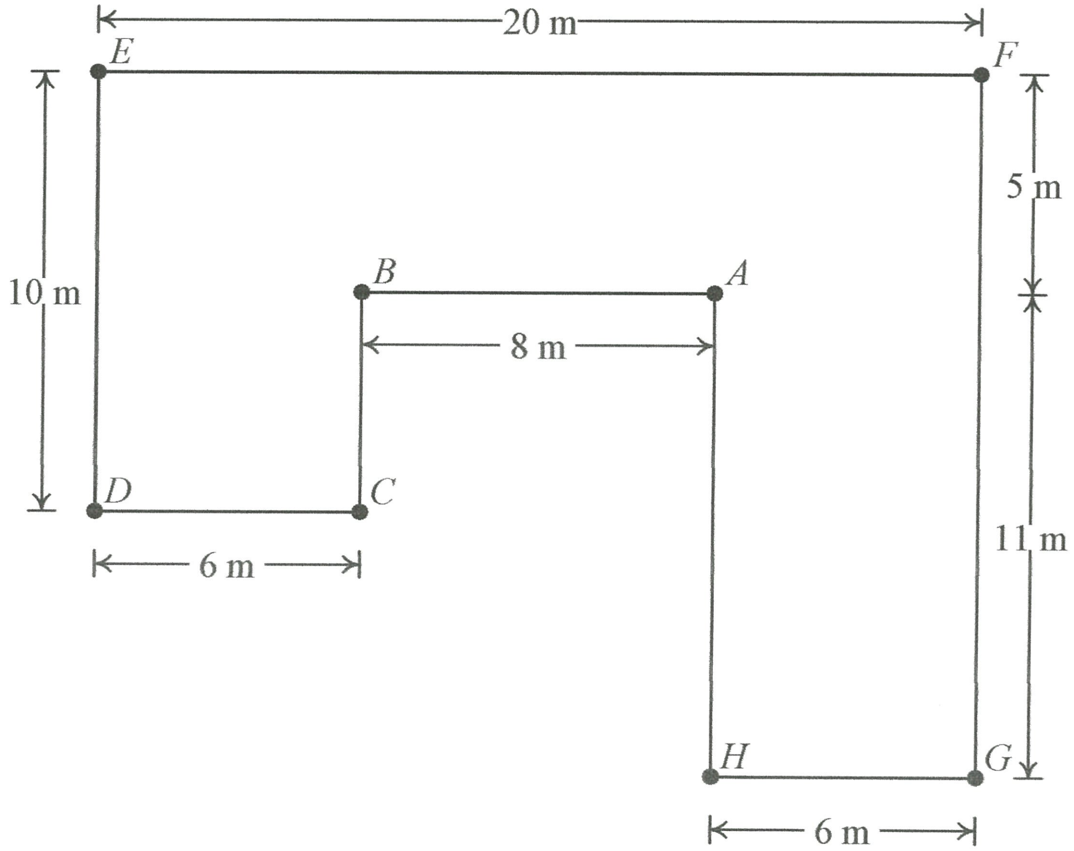

FIGURE Q2(b)

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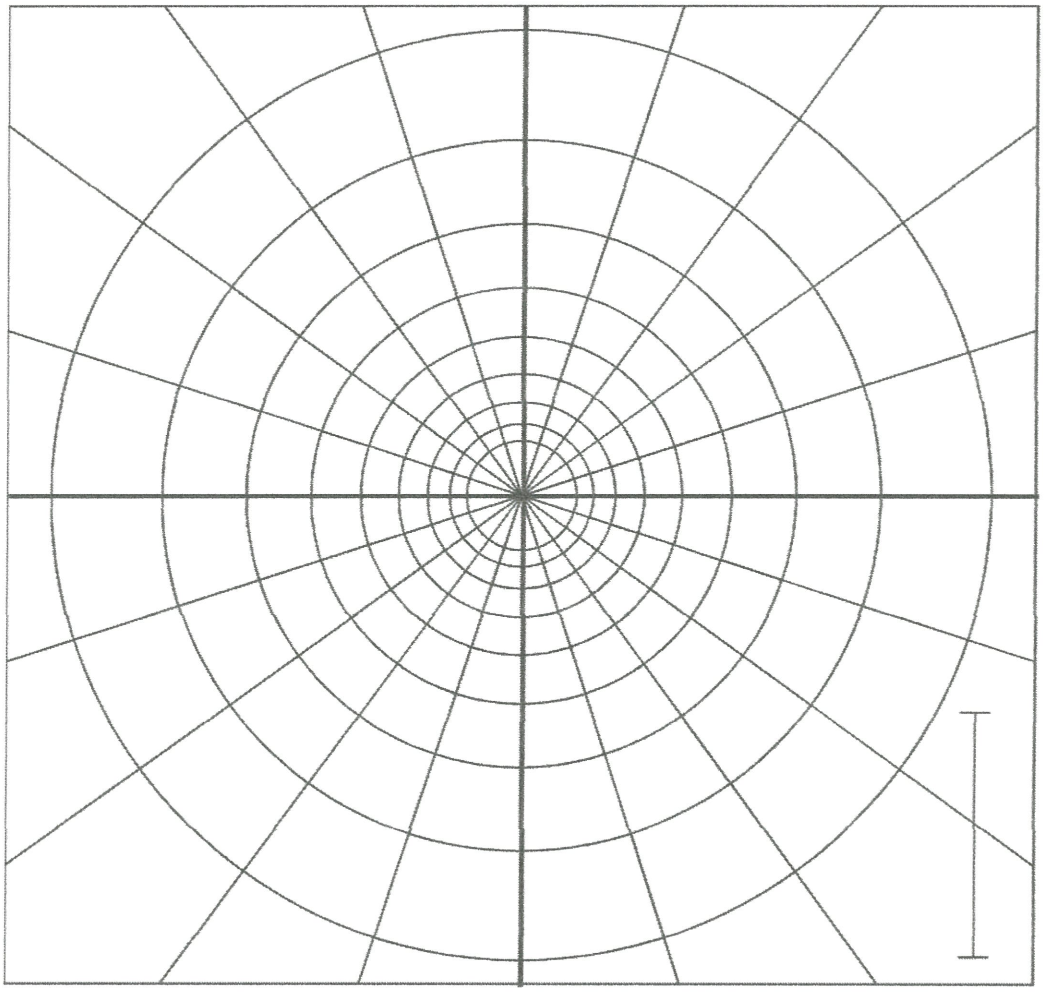

FIGURE Q2(c): Newmark's Method

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Table 1: Variation of I_3 with m and n by Fadum's Method

n	m									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	0.0047	0.0092	0.0132	0.0168	0.0198	0.0222	0.0242	0.0258	0.0270	0.0279
0.2	0.0092	0.0179	0.0259	0.0328	0.0387	0.0435	0.0474	0.0504	0.0528	0.0547
0.3	0.0132	0.0259	0.0374	0.0474	0.0559	0.0629	0.0686	0.0731	0.0766	0.0794
0.4	0.0168	0.0328	0.0474	0.0602	0.0711	0.0801	0.0873	0.0931	0.0977	0.1013
0.5	0.0198	0.0387	0.0559	0.0711	0.0840	0.0947	0.1034	0.1104	0.1158	0.1202
0.6	0.0222	0.0435	0.0629	0.0801	0.0947	0.1069	0.1168	0.1247	0.1311	0.1361
0.7	0.0242	0.0474	0.0686	0.0873	0.1034	0.1169	0.1277	0.1365	0.1436	0.1491
0.8	0.0258	0.0504	0.0731	0.0931	0.1104	0.1247	0.1365	0.1461	0.1537	0.1598
0.9	0.0270	0.0528	0.0766	0.0977	0.1158	0.1311	0.1436	0.1537	0.1619	0.1684
1.0	0.0279	0.0547	0.0794	0.1013	0.1202	0.1361	0.1491	0.1598	0.1684	0.1752
1.2	0.0293	0.0573	0.0832	0.1063	0.1263	0.1431	0.1570	0.1684	0.1777	0.1851
1.4	0.0301	0.0589	0.0856	0.1094	0.1300	0.1475	0.1620	0.1739	0.1836	0.1914
1.6	0.0306	0.0599	0.0871	0.1114	0.1324	0.1503	0.1652	0.1774	0.1874	0.1955
1.8	0.0309	0.0606	0.0880	0.1126	0.1340	0.1521	0.1672	0.1797	0.1899	0.1981
2.0	0.0311	0.0610	0.0887	0.1134	0.1350	0.1533	0.1686	0.1812	0.1915	0.1999
2.5	0.0314	0.0616	0.0895	0.1145	0.1363	0.1548	0.1704	0.1832	0.1938	0.2024
3.0	0.0315	0.0618	0.0898	0.1150	0.1368	0.1555	0.1711	0.1841	0.1947	0.2034
4.0	0.0316	0.0619	0.0901	0.1153	0.1372	0.1560	0.1717	0.1847	0.1954	0.2042
5.0	0.0316	0.0620	0.0901	0.1154	0.1374	0.1561	0.1719	0.1849	0.1956	0.2044
6.0	0.0316	0.0620	0.0902	0.1154	0.1374	0.1562	0.1719	0.1850	0.1957	0.2045

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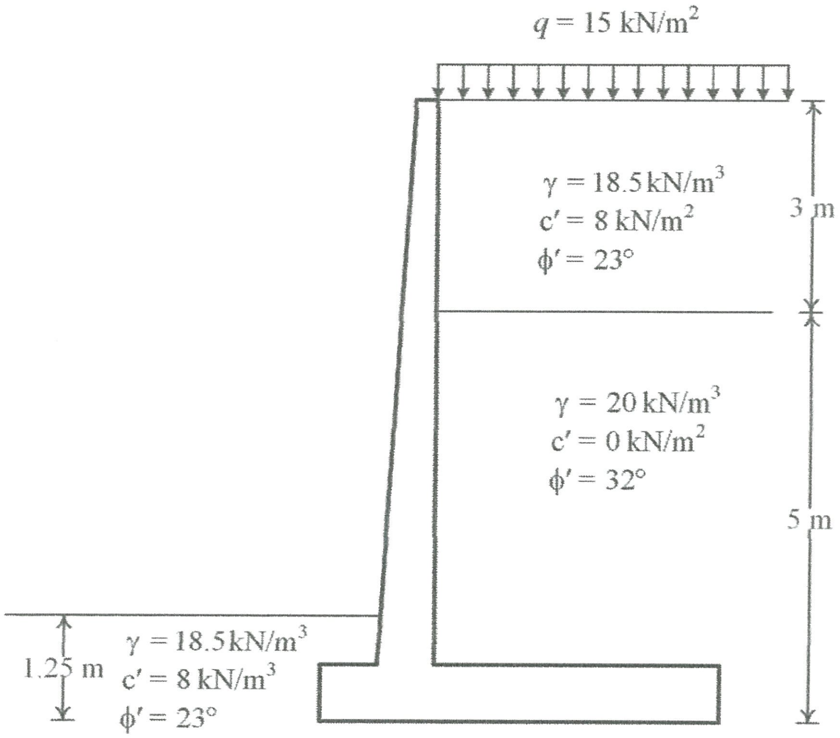

FIGURE Q2(d)

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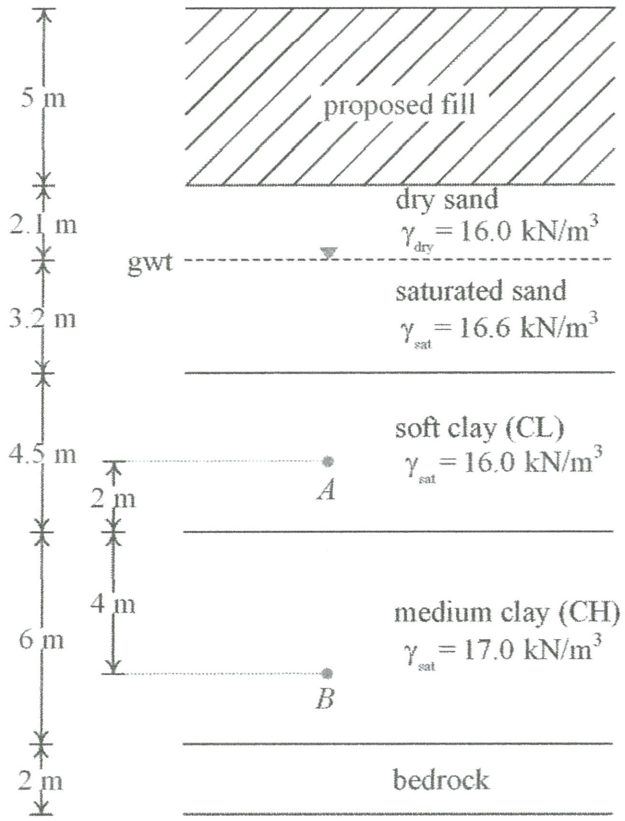

FIGURE Q3

Table 2

Sample	C_c	C_r	e_o	σ_c' (kN/m^2)
A	0.59	0.19	1.90	76
B	0.37	0.14	1.21	120

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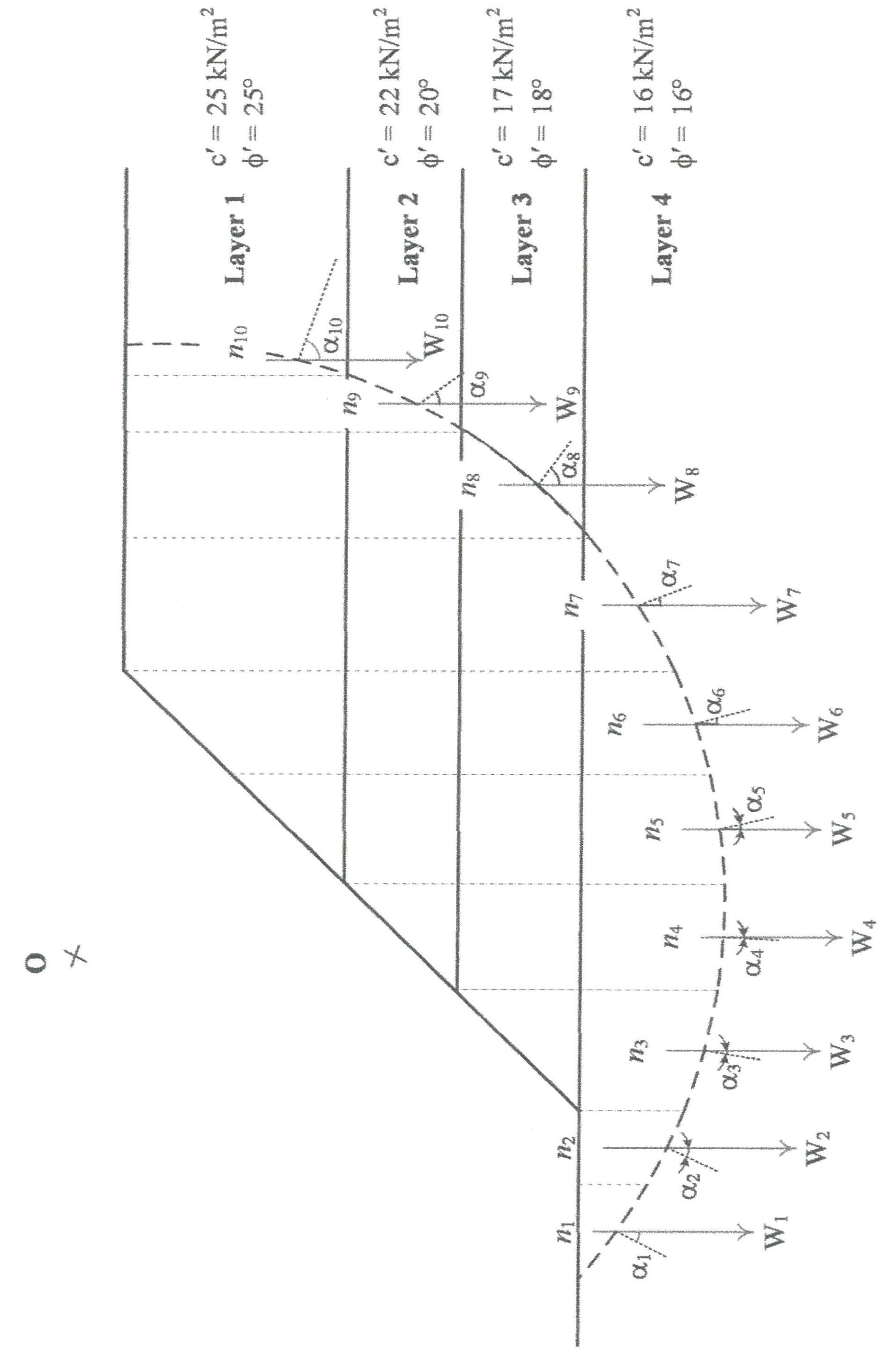

FIGURE Q4

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Table 3

Slice no., n	W_n (kN/m)	α_n (°)	L_n (m)				
①	②	③	④	⑤	⑥	⑦	⑧
1	18	17°	2.5				
2	28	15°	2.5				
3	144	9°	5.0				
4	240	3°	4.5				
5	320	13°	4.5				
6	370	15°	4.5				
7	440	21°	5				
8	345	36°	4				
9	135	54°	2				
10	45	70°	1				

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Flow and Seepage

$$q = kH\frac{N_f}{N_d}$$

$$i_{max} = \frac{\Delta h}{L}$$

$$q = \sqrt{k_x k_y} \cdot H\frac{N_f}{N_d}$$

$$\Delta h = \frac{\Delta H}{N_d}$$

In Situ Stresses and Lateral Earth Pressure

$$K_o = \frac{\sigma'_h}{\sigma'_o}$$

$$K_o = 1 - \sin\phi'$$

$$K_a = \frac{\sigma'_h}{\sigma'_o} = \frac{\sigma'_a}{\sigma'_o}$$

$$K_a = \tan^2(45° - 0.5\phi') = \frac{1-\sin\phi'}{1+\sin\phi'}$$

$$K_p = \frac{\sigma'_h}{\sigma'_o} = \frac{\sigma'_p}{\sigma'_o}$$

$$K_p = \tan^2(45° + 0.5\phi') = \frac{1+\sin\phi'}{1-\sin\phi'}$$

$$\sigma' = \sigma - u$$

$$P_a = 0.5\gamma H^2 K_a$$

$$\sigma'_o = \gamma z$$

$$P_p = 0.5\gamma H^2 K_p$$

$$\sigma'_v = \sigma_v - u_v = \gamma H - \gamma_w H_w$$

$$P_a = qHK_a$$

$$\sigma'_h = \sigma_v K - u_h = \gamma HK - \gamma_w H_w$$

$$P_p = qHK_p$$

$$\gamma' = \gamma_{sat} - \gamma_w$$

$$P_w = 0.5\gamma_w H_w^2$$

Incremental in Stresses

$\Delta\sigma = I_3 q$ with the function of $m = \frac{B}{z}$ and $n = \frac{L}{z}$

$\Delta\sigma = 0.005qM$ with the the number of elements, M

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Consolidation and Settlement

$$OCR = \frac{\sigma'_c}{\sigma'_o}$$

$$S_p = H\frac{\Delta e}{1+e_o}$$

$$S_p = \frac{C_s H_c}{1+e_o}\log\frac{\sigma'_c}{\sigma'_o} + \frac{C_c H_c}{1+e_o}\log\frac{\sigma'_o + \Delta\sigma'_{av}}{\sigma'_o}$$

$$S_p = \frac{C_s H_c}{1+e_o}\log\frac{\sigma'_o + \Delta\sigma'_{av}}{\sigma'_o}$$

$$S_{c(p)} = \frac{C_c H_c}{1+e_o}\log\frac{\sigma'_o + \Delta\sigma'_{av}}{\sigma'_o}$$

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

$$m_v = \frac{a_v}{1+e_{ave}} = \frac{\Delta e / \Delta\sigma'}{1+e_{ave}}$$

Slope Stability

$$FS = \frac{\Sigma\left(c'_n L_n + W_n \cos\alpha_n \tan\phi'_n\right)}{\Sigma W_n \sin\alpha_n}$$

$$FS = \frac{\Sigma\left(c_u R^2 \theta_{radian}\right)}{\Sigma(Wx)}$$

$$H = \frac{c'}{\gamma m}$$