Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2021/2022

COURSE NAME	:	SOFT SOIL ENGINEERING
COURSE CODE	:	BFG 40603
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JANUARY / FEBRUARY 2022
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS. 2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **CLOSE BOOK**.

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

Q1 (a) The large building consists of five basements with an excavation depth of 15.8 m, which will be constructed on marine clay. The basement construction is only five (5) meters away from two historical buildings. Proposed the monitoring instrumentation and its location to monitor the behaviour of the diaphragm wall and surrounding historical buildings.

(11 marks)

(b) An embankment will be constructed on very soft soil as shown in **Figure Q1(b)**. The details pertaining to a project is shown in **Table 1**. The selected PVDs have the cross sectional dimensions of 100 mm and 4 mm. The smear zone is assume to be 1.5 times the equivalent diameter of PVD. Assume that the PVD will be installed in square pattern.

(i) Determine the average consolidation ratio, U_{vr} after 6 months of preloading by considering the smear effect and ignoring the well resistance effect.

(10 marks)

(ii) Predict the settlement after 6 months of preloading.

(4 marks)

Q2 (a) The 15 m wide road will be constructed on soft marine clay deposits in Selangor. Prior to construction, the filling for the embankment will commence. Deposition of fill into very soft soil deposits often results in excessive lateral movement, mixing of fill with the very soft soil material, and the trapping of soft soil pockets within the fill, and resulting in significant differential settlement. As a geotechnical engineer, you are required to:

(i) Proposed the best improvement method to reduce or to overcome the stated problem.

(3 marks)

(ii) Justify the selection of the improvement method.

(8 marks)

(iii) Discuss with the aid of sketches the procedure of your proposed method.

(8 marks)

(iv) Compare the advantages of your proposed method with other improvement methods.

(6 marks)

Q3 (a) Obtaining the undisturbed samples for soft soil is very challenging, especially due to the high water content and very soft condition. With the aids of sketches, propose the best sampling techniques that can be used to collect this type of soil sample.

(5 marks)

(b) Determination of subsurface soil condition is very important in geotechnical design. There are many methods that can be used for this purpose. As an experience and practice engineer, propose and discuss in detail the best method to obtain reliable results of subsurface soil condition for soft soil area.

(8 marks)

(c) Construction of the embankment on peat area is the most challenging to engineer due to very high compressibility and low shear strength. As an engineer, you are responsible to write a proposal that related to the best soil improvement method, the construction method procedure and monitoring instrumentation for the construction of the embankment to avoid any structural failure. Write in details your proposal with the aid of diagrams.

(12 marks)

Q4 (a) The embankment on soft soil can be constructed using single stage loading and multi stage loading. Compare the advantages and disadvantages between these methods.

(4 marks)

(b) There are many factors causing the embankment failure of soft soil during construction. In your own words, discuss in detail the factors that contribute to this failure.

(4 marks)

(c) An embankment will be constructed on soft soil as shown in **Figure Q4(c)**. The Groundwater table (GWT) is located 1 m below the ground surface.

(i) Estimate the stress increase at point A, B and C by using Osterberg influence value as shown in **Figure Q4(c)(i)**.

(6 marks)

(ii) Discuss the results obtained in **Q4(c)(i)** in term of stresss increment.

(3 marks)

(iii) Predict the initial settlement (S_i) and primary settlement (S_p) due to embankment load.

(8 marks)

– END OF QUESTIONS –

FINAL EXAMINATION

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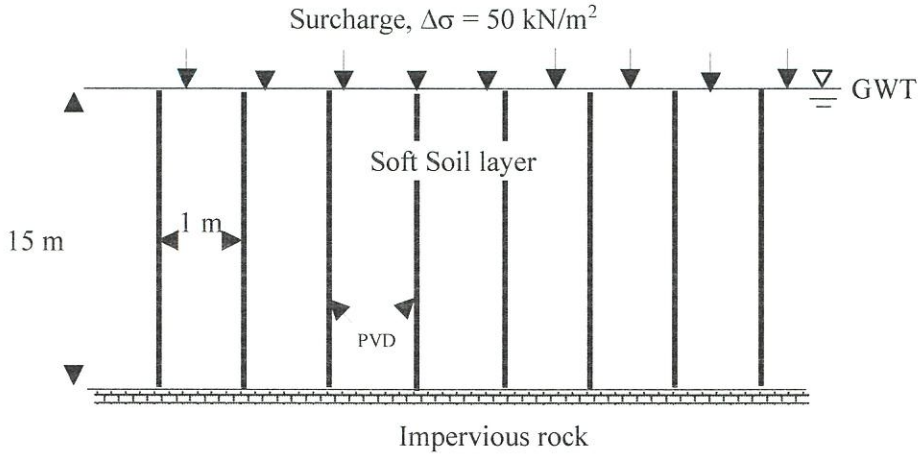

FIGURE Q1(b): Soil profile of soft soil improved PVD

TABLE 1: Data for PVD project

Item	*Parameters*	*Value*
Surcharge	$\Delta\sigma$	50 kN/m^2
Soft soil layer	Saturated unit weight, γ_{sat}	16 kN/m^3
	Compression index, C_c	0.7
	Coefficient of vertical consolidation, C_v	0.6 m^2/year
	Coefficient of horizontal consolidation, C_r	1.2 m^2/year
	Initial void ratio, e_o	1.4
	Vertical Permeability in undisturbed zone, k_v	5 x 10^{-9} m^2/s
	Horizontal Permeability in undisturbed zone, k_h	1 x 10^{-8} m^2/s
	Horizontal Permeability in smear zone, k_s	3.3x 10^{-9} m^2/s
PVD properties	Discharge capacity, Q_c	2.5 x 10^{-4} m^3/s

FINAL EXAMINATION

SEMESTER/SESSION : SEM I 2021/2022
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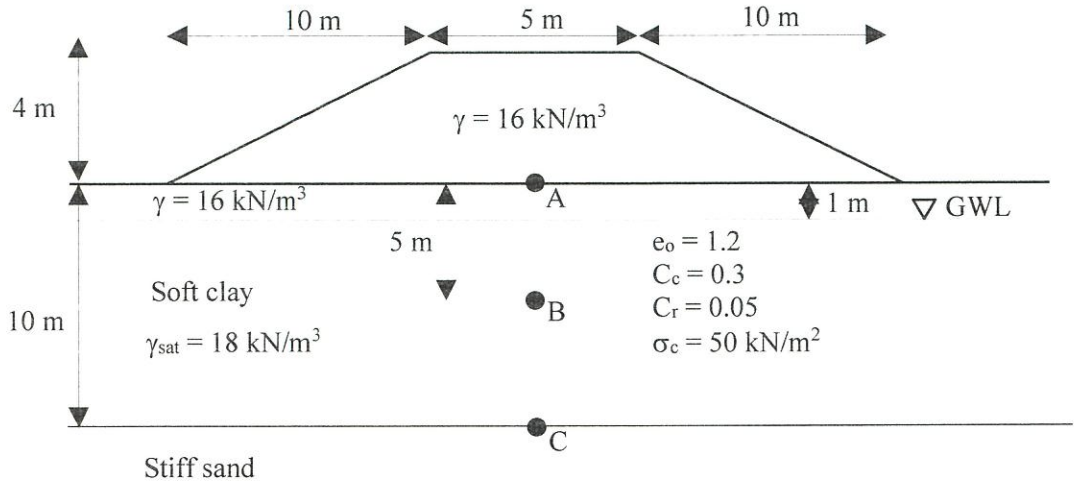

FIGURE Q4(c) : Geometry of embankment on soft soil

FINAL EXAMINATION

SEMESTER/SESSION : SEM I 2021/2022
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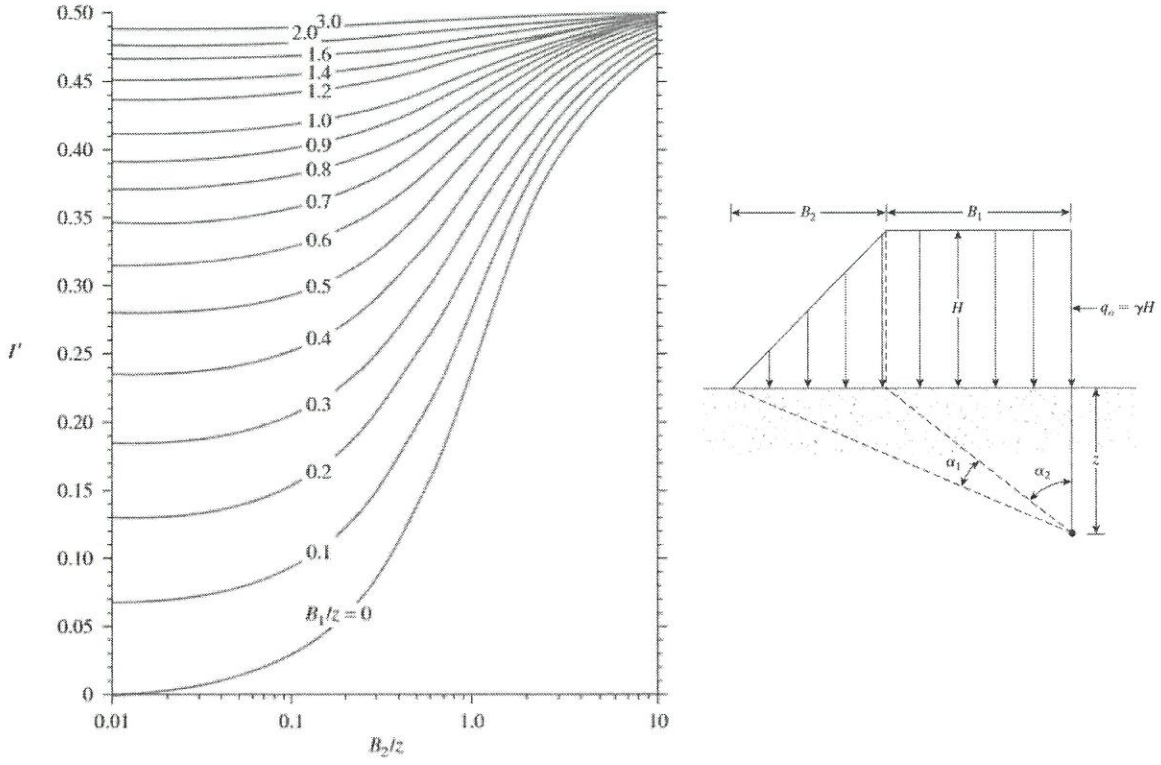

FIGURE Q4(c)(i): Influence value, I for embankment loading

FINAL EXAMINATION

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

Consolidation

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

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

$$S_p = \frac{C_c H}{1+e_o}\log\left(\frac{\sigma'_o+\Delta\sigma'}{\sigma'_o}\right)$$

$$S_p = \frac{C_r H}{1+e_o}\log\left(\frac{\sigma'_o+\Delta\sigma'}{\sigma'_o}\right)$$

$$S_p = \frac{C_r H}{1+e_o}\log\left(\frac{\sigma'_c}{\sigma'_o}\right)+\frac{C_c H}{1+e_o}\log\left(\frac{\sigma'_o+\Delta\sigma'}{\sigma'_c}\right)$$

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

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

PVD design

$$F_s = \frac{N_c c_u}{\Delta\sigma}, \text{ where } N_c = 5.14$$

$$T_v = \frac{C_v t}{h_{dr}^2}$$

$$U_v = \sqrt{\frac{4T_v}{\pi}}$$

$$U_{vr} = 1-(1-U_v)(1-U_r)$$

$$U_r = 1-\frac{(1-U_v)}{(1-U_{vr})}$$

$$d_c = \frac{b+t_g}{2}$$

$$d_e = 1.13S, \text{ for square pattern}$$

$$d_e = 1.05S, \text{ for triangular pattern}$$

$$N_D = \frac{d_e}{d_c}$$

$$T_r = \frac{C_r t}{d_e^2}$$

$$F_m(N_D) = \ln\frac{N_D}{N_s}+\frac{k_r}{k_s}\ln(N_s)-\frac{3}{4}+\pi z(2h_{dr}-z)\frac{k_r}{Q_c}$$

$$U_r = 1-\exp\left(\frac{-8T_r}{F_m(N_D)}\right)$$