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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION (ONLINE) SEMESTER II SESSION 2019/2020

COURSE NAME	:	SOFT SOIL ENGINEERING
COURSE CODE	:	BFG 40603
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2020
DURATION	:	6 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

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Q1 (a) There are various method of soil improvement for soft soil. Summarize the following method in term of general description, benefit and application.

(i) Stone columns
(ii) Fill preloading
(iii) Vacuum preloading

(6 marks)

(b) When the construction of infrastructure will be construct on highly compressible normally consolidated clayey soil, precompression method may be used to minimize post construction settlement. **Figure Q1(b)** shows the principles of compression method used in soft soil. Explain **Figure Q1(b)** to support the principles.

(5 marks)

(c) An embankment will be constructed on very soft soil as shown in **Figure Q1(c)**. 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) (i) Explain the definition of "Soft Soil" in term of Geotechnical Engineering Perspective.

(ii) Differentiate between soft soil, peat soil and expansive soil?

(5 marks)

(b) Describe with the aids of sketches the concept of "Floating Foundation Design" for road construction on very soft soil area.

(8 marks)

(c) Geotechnical engineers will face many challenges when dealing with the construction on soft soil.

(i) Discuss in details **FOUR (4)** of the challenges.

(8 marks)

(ii) Discuss **ONE (1)** example of selected case study that related to the type of construction in this area.

(4 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 –

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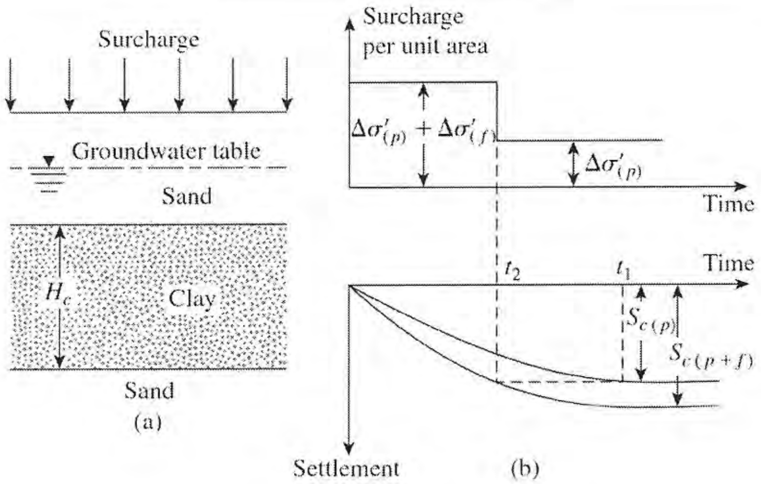

FIGURE Q1(b): Principles of compression

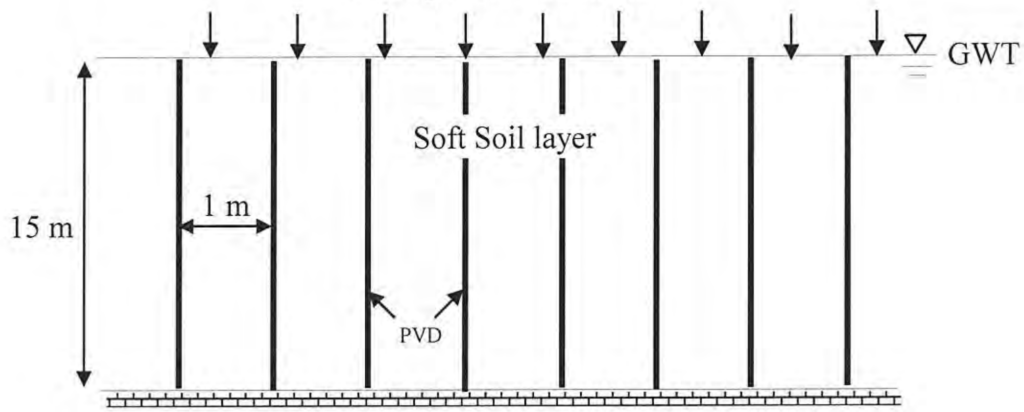

FIGURE Q1(c): Soil profile of soft soil improved PVD

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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	5×10^{-9} m^2/s
	Horizontal Permeability in undisturbed zone, k_h	1×10^{-8} m^2/s
	Horizontal Permeability in smear zone, k_s	3.3×10^{-9} m^2/s
PVD properties	Discharge capacity, Q_c	2.5×10^{-4} m^3/s

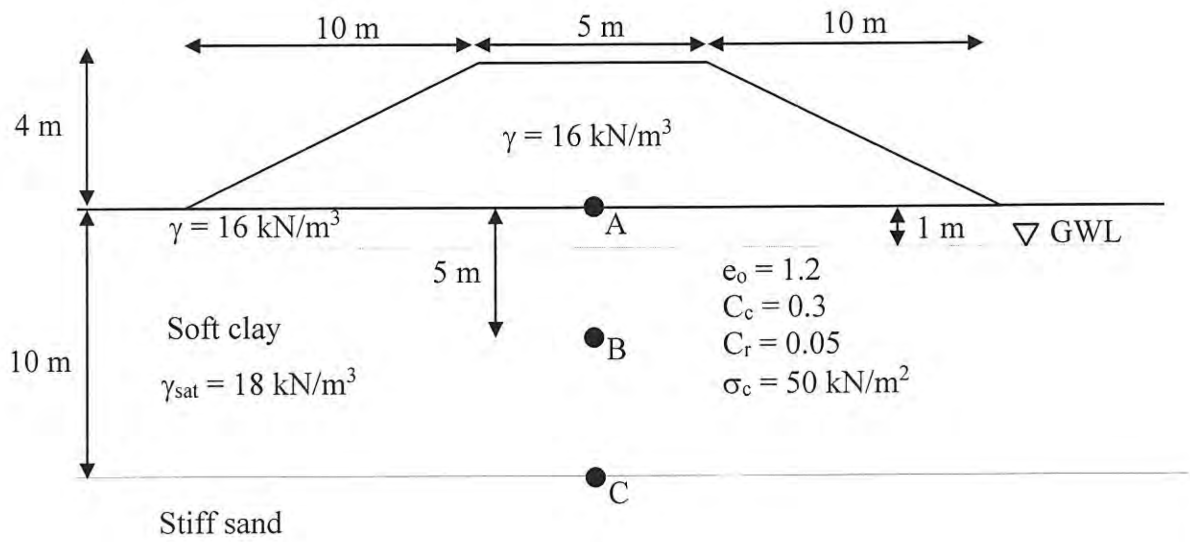

FIGURE Q4(c) : Geometry of embankment on soft soil

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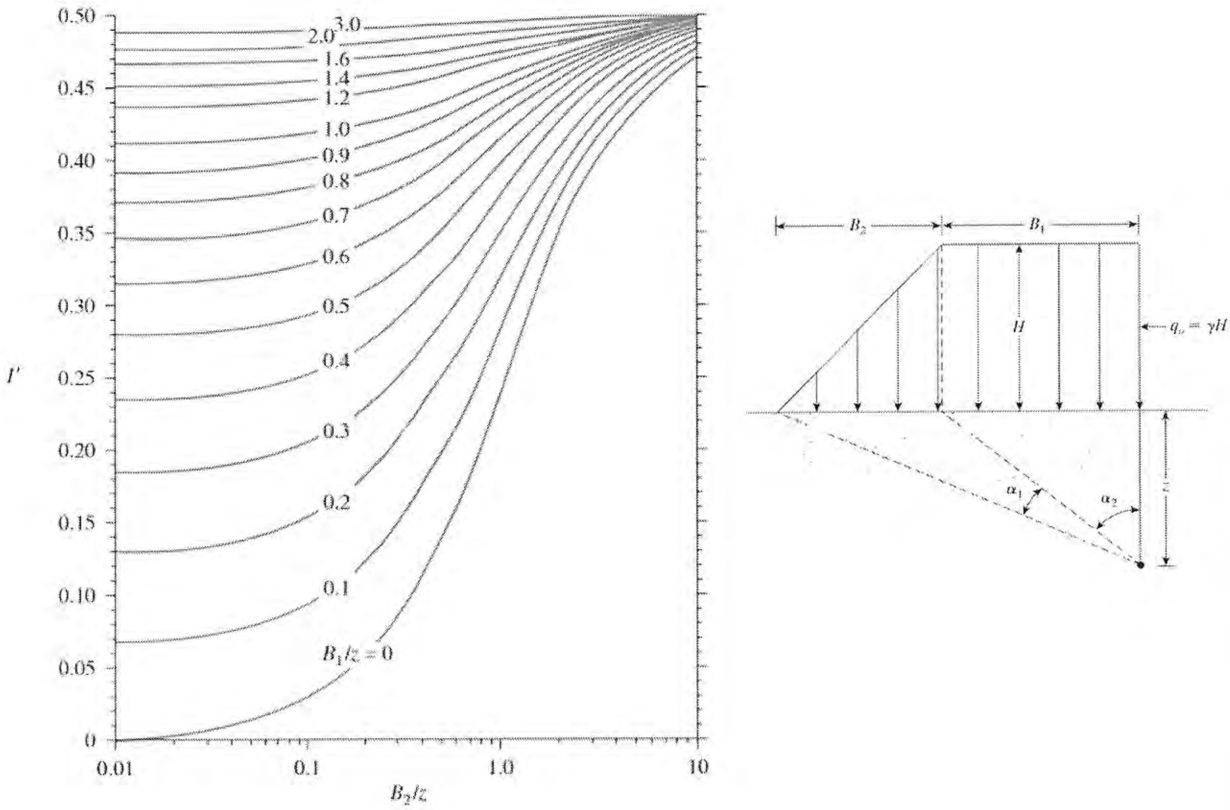

FIGURE Q4(c)(i): Influence value, I for embankment loading

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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

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

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

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

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

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

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

$d_e = 1.13S$, for square pattern

$d_e - 1.05S$, for triangular pattern

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

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

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

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