Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	SOFT SOIL ENGINEERING
COURSE CODE	:	BFG 40603
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE/JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 (a) As geotechnical engineer, you are responsible to propose the typical instrumentation during preloading on soft soil. Illustrate the arrangement of the instrument for field monitoring on the performance of fill preloading method.

(5 marks)

(b) The stability of the embankment on soft soil is influenced by the loading rate of the fill. Discuss in details the best procedure to control the loading rate.

(5 marks)

(c) A highway embankment is to be constructed on normally consolidated soft soil as shown in **Figure Q1(c).** The PVDs with the spacing of 1.2 m will be placed in a triangular pattern to the top of the dense sand to accelerate the consolidation. The selected PVDs have the cross sectional dimensions of 100 mm and 4 mm. The allowable discharge capacity of the PVD is $3\text{x}10^{-4}$ m^3/s. The smear zone is assume 2.5 times the equivalent diameter of PVD. The permeability of the smear zone is 40% of the vertical permeability of the natural soil.

(i) Determine the maximum height of embankment to fulfil the factor of safety against bearing failure of 1.3 during the construction.

(5 marks)

(ii) Predict the overall degree of consolidation by the end of the 9 months preloading.

(10 marks)

Q2 (a) Propose the suitable field test and laboratory test for road construction on soft soil.

(5 marks)

(b) Recommend the best procedure to minimize the disturbance of the undisturbed soil sample in term of drilling, tube sampling, tube extraction, transportation and storage, sample extrusion and specimen preparation.

(8 marks)

(c) A dilatometer test was conducted in a clay deposit. The groundwater table was located at a depth of 3 m below the ground surface. The unit weight of soil above and below the groundwater are 17 kN/m^3 and 19 kN/m^3 respectively. At a depth of 9 m below the surface, the contact pressure (p_o) was 280 kN/m^2 and the expansion stress (p_1) was 350 kN/m^2. Determine the following:

(i) the lateral stress at depth of 9 m from the surface

(6 marks)

(ii) identify whether the clay layer is overconsolidated or normally consolidated clay.

(3 marks)

(iii) the undrained shear strength, c_u

(3 marks)

Q3 (a) A cylindrical sample of soil 50 mm in diameter and 100 mm long is subjected to an axial effective stress of 400 kN/m^2 and radial effective stress of 100 kN/m^2. The axial and radial displacements are 0.5 mm and – 0.04 mm respectively. Assuming the soil is anisotropic and elastic material, determine the following:

(i) The mean stress (p') and deviatoric stress (q)

(3 marks)

(ii) The volumetric strain (ε_v) and shear strain (ε_s)

(3 marks)

(iii) The shear modulus (K') and bulk modulus (G)

(3 marks)

(iv) The Poisson's ratio and Young's modulus (E)

(3 marks)

(b) A 5.5 m deep compacted fill is to be placed over the soil profile shown in **Figure Q3(b)**. A consolidation test on a sample from points A and B produce the results as depicted in **Table 1**. These points represent the entire soft clay stratum of each layer. Estimate the ultimate consolidation settlement due to the weight of this fill.

(13 marks)

Q4 (a) The selection of the foundation is depending on many factors. Describe in detail the procedure in selecting the best foundation in soft soil.

(6 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.

(6 marks)

(c) A 0.36 m square prestressed concrete pile is to be driven in a clayey soil as shown in **Figure Q4(c)**. The design capacity of the pile is 500 kN. Design the necessary length of the pile if the factor of safety is 2.5 using α method.

(13 marks)

– END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2018/2019 PROGRAMME CODE : 4 BFF
COURSE NAME : SOFT SOIL ENGINEERING COURSE CODE : BFG 40603

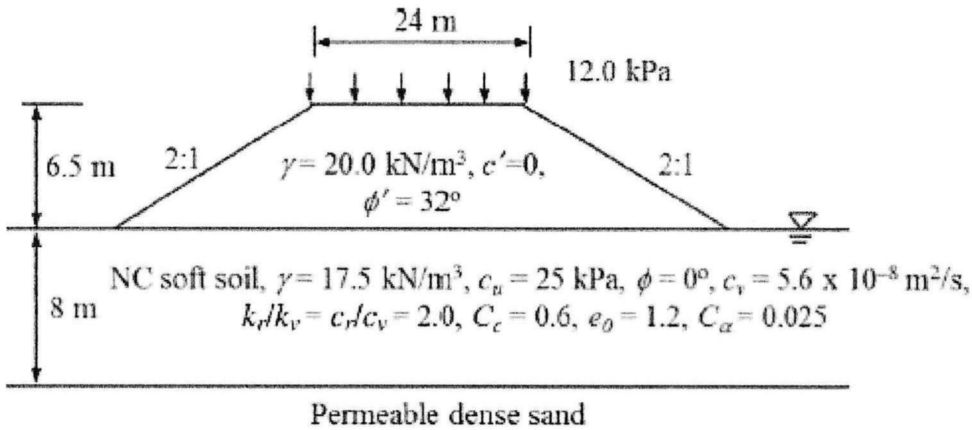

FIGURE Q1(c): Soil profile of soft soil improved PVD

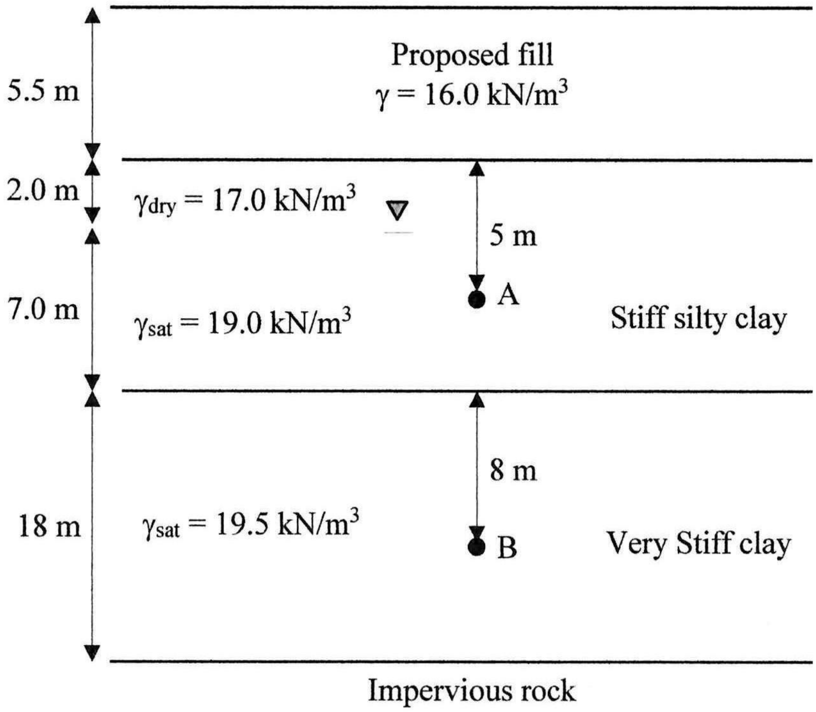

FIGURE Q3(b): Soil profile

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2018/2019 PROGRAMME CODE : 4 BFF
COURSE NAME : SOFT SOIL ENGINEERING COURSE CODE : BFG 40603

TABLE 1: Consolidation test results

Parameters	Point A	Point B
C_c	0.25	0.20
C_r	0.08	0.06
e_o	0.85	0.65
σ'_c	101 kN/m^2	510 kN/m^2

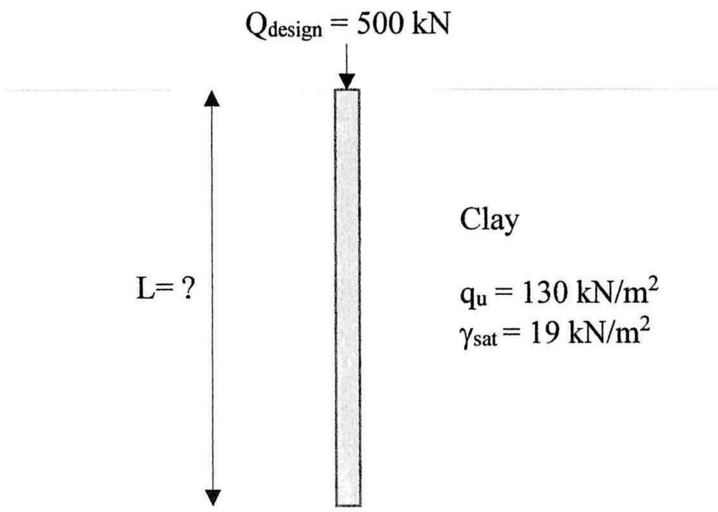

FIGURE Q4(c): Pile foundation in soft soil

FINAL EXAMINATION

SEMESTER/SESSION	: SEM II / 2018/2019	PROGRAMME CODE	: 4 BFF
COURSE NAME	: SOFT SOIL ENGINEERING	COURSE CODE	: BFG 40603

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

Consolidation

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

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

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

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

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

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

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

Flat Dilatometer test

$$K_D = \frac{p_o - u_o}{\sigma'_{vo}}$$

$$OCR = (0.5K_D)^{1.56}$$

$$K_o = (K_D / 1.5)^{0.47} - 0.6$$

$$c_u = 0.22\sigma'_{vo}(0.5K_D)1.25$$

PVD design

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

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

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

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

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

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

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

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

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

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

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

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

Stress strain behaviour

$$q' = \sigma'_1 - \sigma'_3$$

$$p' = \frac{1}{3}(\sigma'_1 - \sigma'_3)$$

$$\varepsilon_s = \frac{2}{3}(\varepsilon_1 - \varepsilon_3)$$

$$\varepsilon_v = \varepsilon_1 + 2\varepsilon_3$$

$$K' = \frac{\delta p'}{\delta \varepsilon_v}$$

$$3G' = \frac{\delta q'}{\delta \varepsilon_s}$$

$$E' = \frac{\delta' \sigma'_1}{\delta \varepsilon_1}$$

$$\upsilon' = -\frac{\delta' \varepsilon_3}{\delta \varepsilon_1}$$

$$\upsilon' = \frac{3K' - 2G}{2G + 6K'}$$

$$G' = \frac{E'}{2(1+\upsilon')}$$

$$K' = \frac{E'}{3(1-2\upsilon')}$$

Pile design

$$Q_s = \sum \alpha c_u p \Delta L$$

$\frac{c_u}{p_a}$	α
≤ 0.1	1.00
0.2	0.92
0.3	0.82
0.4	0.74
0.6	0.62
0.8	0.54
1.0	0.48
1.2	0.42
1.4	0.40
1.6	0.38
1.8	0.36
2.0	0.35
2.4	0.34
2.8	0.34

Note: p_a = atmospheric pressure
$\approx$ 100 kN/m^2 or 2000 lb/ft^2