UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	GEOTECHNICS II
COURSE CODE	:	BFC 34402
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE/ JULY 2019
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS IN **PART A** 2. ANSWER ANY **TWO (2)** QUESTIONS IN **PART B**

THIS QUESTION PAPER CONSISTS OF NINE (9) PAGES

PART A

Q1 (a) Define the terms safety factor of slope stability and briefly explain the effect of rainfall on the stability of slope.

(7 marks)

(b) With the aid of relevant example, explain the condition that infinite slope stability analysis is required.

(3 marks)

(c) Natural slopes which are in stable condition for many years may suddenly fail due to some causes. List and explain any **FIVE (5)** causes that may trigger the slope failure.

(10 marks)

(d) A typical infinite slope is shown in **Figure Q1 (c).** Given that:

$H = 3m$, $\beta = 25°$, $\gamma = 17.8\ kN/m^3$, $\phi' = 28°$, and $c' = 31\ kN/m^2$

(i) Determine the factor of safety against sliding along soil-rock interface.

(6 marks)

(ii) The thickness of soil, H was reduced to 2.5 m after excavation. Determine the effect of thickness reduction on slope stability.

(4 marks)

(e) Gue & Partners Sdn Bhd has been appointed as goetechnical consultant to determine the stability of the slope along Lata Iskandar to Cameron Highland roads. As an engineer, you are required to propose relevant soil tests and calculation needed to determine the factor of safety of the slope.

(10 marks)

PART B

Q2 (a) (i) Differentiate the differences in assumptions of one-dimensional flow and two- dimensional flow analysis.

(3 marks)

(ii) Give example of the application of one-dimensional flow and two dimensional flow analysis.

(2 marks)

(b) **Figure Q2(b)** shows a dam that was built together with a sheet pile wall on the upstream side in order to reduce seepage under the dam. A sheetpile penetrated into thick silty sand stratum which assumed as homogeneous and isotropic. By using the scale given;

(i) Determine the flow rate under the dam in m^3/s.

(2 marks)

(ii) Determine the pore water pressure distribution at the base of the dam. Use an interval, $x = 1.5$ m.

(10 marks)

(iii) Determine the uplift force.

(3 marks)

(iv) Determine the pore water pressure distribution on the front of the sheet pile. Use an interval, $x = 0.8$ m.

(6 marks)

(v) Determine the maximum hydraulic gradient.

(1 mark)

(vi) Determine the safety of factor against piping failure. Given the specific gravity and void ratio for the soil layer are 2.65 and 0.91 respectively.

(3 marks)

Q3 (a) Describe the differences between 'active Rankine state' and 'passive Rankine state'.

(4 marks)

(b) The 8 m high retaining wall is shown in **Figure Q3(b)**. Determine;

(i) Rankine active and passive force per unit length of the wall together with the location of the resultant.

(8 marks)

(ii) Rankine active force per unit length of the wall and the location of the resultant if the groundwater level was found at 3 m from the ground surface. Given saturated unit weight is 18.5 kN/m^3 with the friction angle 30°.

(18 marks)

Q4 (a) (i) Define the terms of consolidation and compaction.

(4 marks)

(ii) Briefly explain the differences between primary consolidation settlement and secondary compression settlement by relating it to the changes in soil structure.

(6 marks)

(b) **Figure Q4 (b)** shows the soil profile at a site for a proposed office building which consists of a layer of fine sand 6.5 m thick above a layer of soft clay 2 m thick. The groundwater table was observed at 1.5 m below ground level. The void ratio of the sand is 0.6 and the water content of the clay is 33%. The building will impose a vertical stress increase of 100 kPa at the middle of the clay layer.

(i) Determine the settlement of the clay layer caused by primary consolidation if the clay is normally consolidated.

(6 marks)

(ii) Determine the settlement of the clay layer caused by primary consolidation if the preconsolidation pressure, $\sigma'_c = 150$ kN/m^2 (Use $C_s = 1/5\ C_c$).

(4 marks)

(iii) Calculate the hydraulic conductivity (in m/min) of the clay. (Given $e_f = 0.81$ and time for 60% consolidation = 67 days on double drainage).

(7 marks)

(iv) How long (days) will it take to reach 90% consolidation if it is drained on one side.

(3 marks)

(**Notes:** You can use $T_v = \pi/4\ (U\% / 100)^2$ for $U < 60\%$ and $T_v = 1.781 - 0.933 \log (100 - U\%)$ for $U \geq 60\%$

- END OF QUESTIONS-

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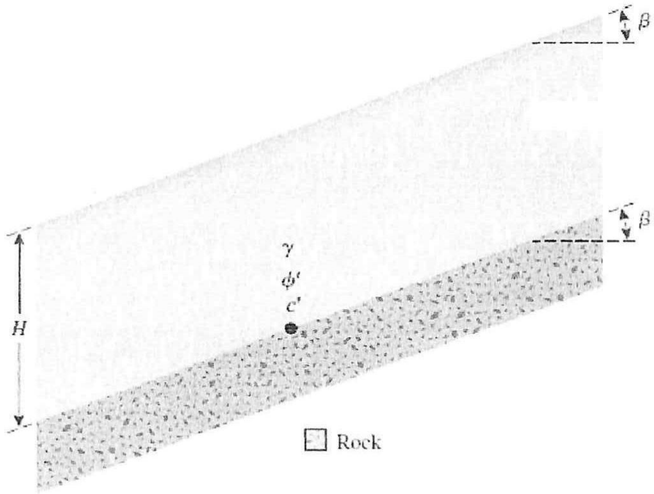

FIGURE Q1(c): Infinite slope

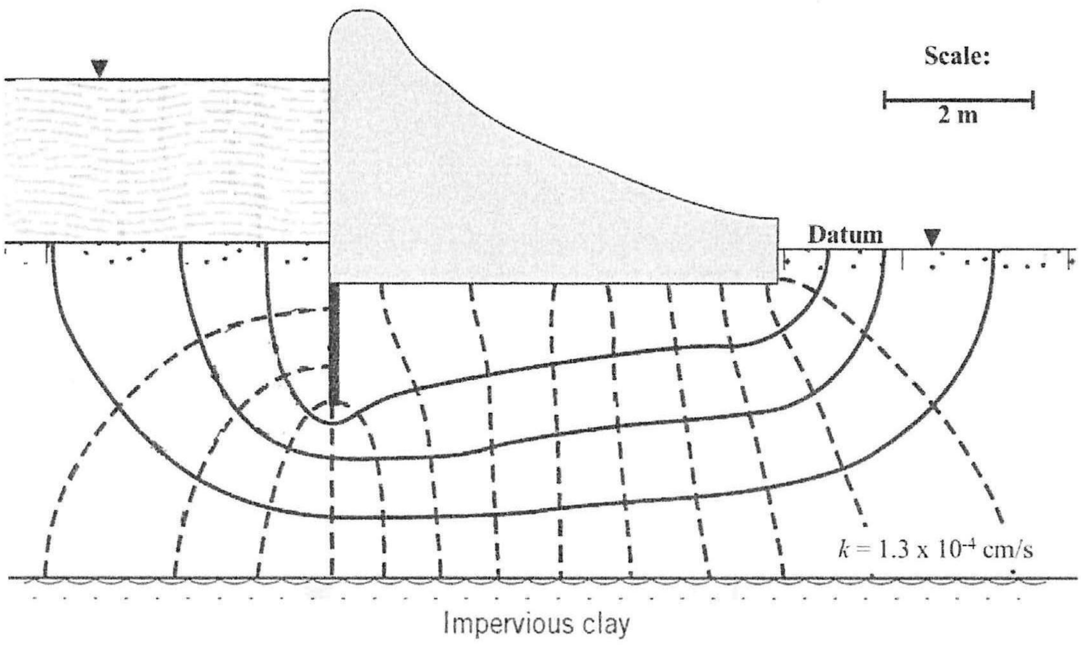

FIGURE Q2 (b): Flow net underneath earth retaining wall

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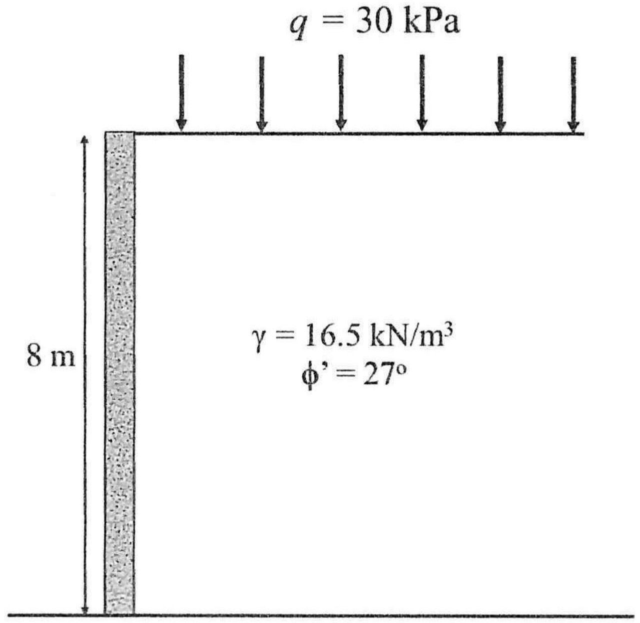

FIGURE Q3 (b): Retaining wall

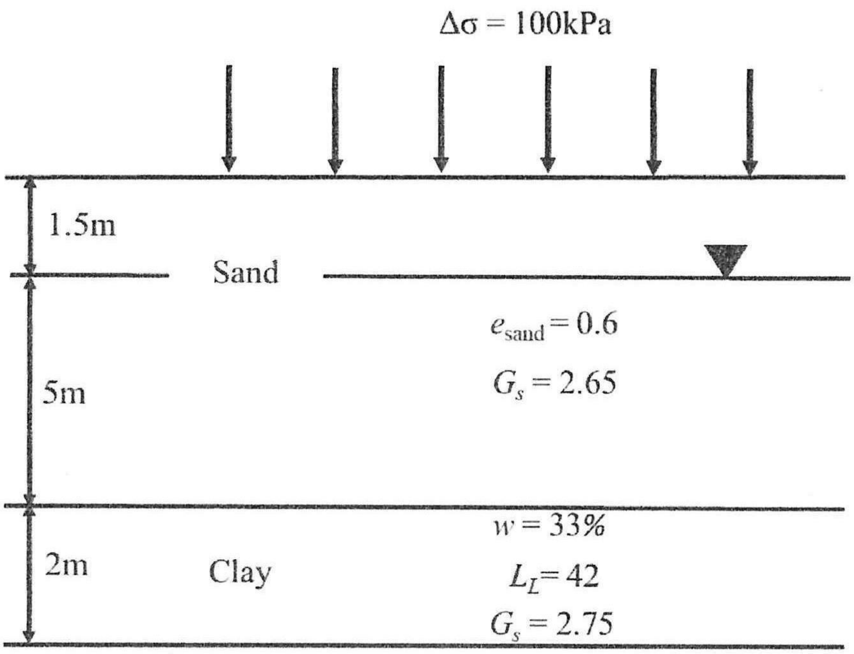

FIGURE Q4 (b): Soil profile for a proposed office building

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Flow in Soil

$$q = k\frac{HN_f}{N_d} \text{ isotropic soil}$$

$$q = \sqrt{k_x k_z}\frac{H\,N_f}{N_d} \text{ Anisotropic soil}$$

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

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

$$i_{cr} = \frac{G_s - 1}{1 + e_o}$$

Stress in Soil

Conventional retaining walls

Rankine active and passive pressure

$$P_a = \tfrac{1}{2}K_a\gamma_1 H^2 \qquad P_a = \tfrac{1}{2}K_a\gamma_1 H^2 + qK_a H$$

$$P_v = P_a \sin\alpha° \qquad P_h = P_a \cos\alpha°$$

$$P_p = \tfrac{1}{2}K_p\gamma_2 D^2 + 2c_2'\sqrt{K_p}D$$

$$K_a = \tan^2\left(45° - \tfrac{1}{2}\phi_1'\right) \qquad K_p = \tan^2\left(45° + \tfrac{1}{2}\phi_2'\right)$$

Factor of safety against overturning

$$FS = \frac{\Sigma W_i X_i}{\Sigma P_{a_i} z_{a_i}} = \frac{\Sigma(A_i \times \gamma_i)X_i}{\Sigma P_{a_i} z_{a_i}}$$

$$FS = \frac{\gamma_{n+i}A_{n+i}x_{n+i} + \ldots + \gamma_n A_n x_n}{P_a \cos\alpha(H'/3)}$$

Factor of safety against sliding

$$FS = \frac{\Sigma V \tan\left(\tfrac{2}{3}\phi_2'\right) + \tfrac{2}{3}Bc_2' + P_p}{P_a \cos\alpha}$$

$$z_o = \frac{2cu}{\gamma}$$

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Consolidation and Settlement

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

$$e_o = wG_s$$

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

$$\gamma_d = \frac{G_s\gamma_w}{1+e_o}$$

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

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

$$\gamma' = \left(\frac{G_s-1}{1+e_o}\right)\gamma_w$$

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

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

$$\gamma_{sat} = \left(\frac{G_s+e}{1+e_o}\right)\gamma_w$$

$$c_v = \frac{0.848H^2{}_{dr}}{t_{90}}$$

$$C_c = 0.009(L_L - 10)$$

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

$$T_v = \frac{\pi}{4}U^2{}_{avg}$$

$$T_v = 1.781 - 0.933\log(100 - U)$$

$$U_z = 1 - \frac{u_e}{u_i}$$

$$U_z = \frac{\Delta\sigma - u_e}{\Delta\sigma}$$

Slope Stability

$$FS = \frac{c_n l_n + \sum_{n=1}^{n=p}(W_n cos\alpha_n - r_u sec\alpha_n)tan\phi_n'}{\sum_{n=1}^{n=p} W_n sin\alpha_n}$$

$$FS = \frac{c'}{\gamma H\cos^2\beta\tan\beta} + \frac{\tan\phi'}{\tan\beta'}$$

$$FS = \frac{\sum_{n=1}^{n=p}(c'R\theta + W_n cos\alpha_n tan\phi')}{\sum_{n=1}^{n=p} W_n sin\alpha_n}$$

$$FS = \frac{\sum C_u R^2\theta}{\sum W_d}, \theta \text{ in radian}$$