Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	GEOTECHNICS II
COURSE CODE	:	BFC 34402
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE/ JULY 2018
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS IN **PART A** 2. ANSWER **TWO (2)** QUESTIONS IN **PART B**

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THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

PART A

Q1 (a) Briefly explain the effect of rainfall on the stability of slope and also the reason behind it.

(4 marks)

(b) (i) Define the term safety factor that is normally used in slope stability analysis.

(2 marks)

(ii) Briefly explain with a sketch how the safety factor of cut slope and fill embankment change with time.

(6 marks)

(c) A potential slip circle of slope is shown in **Figure Q1 (c)**. The slope is partially saturated. By using the Ordinary Method of Slices, determine the factor of safety for the slope undergoing seepage and for the failure surface shown. The soil properties are as follows:

Bulk density = 1800 kg/m^3
Effective cohesion, c' = 28 kN/m^2
Effective friction angle, ϕ' = 30°

The weights of the slices have been determined and the average pore pressures acting on the bases of the slices have been determined from the flownet which are listed in **Table Q1 (c)**.

(28 marks)

PART B

Q2 (a) The continuous void spaces in soils and the interaction of soil with water can cause the phenomena of capillary rise, shrinkage and expansion (swell) in soils. Briefly explain all these phenomena.

(6 marks)

(b) A dam shown in **Figure Q2 (b)** retains 6 m of water. A sheet pile wall on the upstream side (which is to reduce seepage under the dam) penetrates 4 m into 10 m thick silty sand stratum. Below the silty sand is a thick deposit of clay. Assume that the silty sand is homogeneous and isotropic.

(i) Calculate the flow rate under the dam.

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(2 marks)

(ii) Calculate the pore water pressure distribution on the front of the sheet pile (at every 2 m of sheet pile @ at point A, F and G). Given the N_d of point A, F and G are 0.5, 1.5 and 3.0 respectively.

(6 marks)

(iii) Calculate the pore water pressure distribution at the base of the dam. (at every 5 m of dam base @ at point A, B, C, D and E). Given the N_d of point A, B, C, D and E are 5.6, 6.7, 8.0, 10.0, 13.0 respectively.

(10 marks)

(iv) Determine the uplift force.

(3 marks)

(v) Determine maximum hydraulic gradient. Given that L_{min} is 0.85 m.

(1 mark)

(vi) Determine the safety of factor against piping failure.

(2 marks)

Q3 (a) Define the terms of coefficient of lateral earth pressure at rest and coefficient of active lateral earth pressure.

(4 marks)

(b) Briefly explain any **TWO (2)** differences in assumptions between Rankine earth pressure theory and Coulomb earth pressure theory.

(6 marks)

(c) An 11 m high retaining wall is shown in **Figure Q3 (c)**. Determine;

(i) active earth pressure acting on the wall by using Rankine earth pressure theory and sketch the earth pressure distribution diagram.

(12 marks)

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

(8 marks)

Q4 (a) Briefly describe wherever necessary with the aid of diagrams/sketches the following terms:

(i) Preconsolidation stress (σ'_c)
(ii) Overconsolidation ratio (OCR)
(iii) Swelling/Expansion index (C_s)
(iv) Coefficient of compressibility (a_v)
(v) Coefficient of volume compressibility (m_v)

(10 marks)

(b) A soil profile is shown in **Figure Q4 (b)**. It was found that the initial void ratio of clay is 0.95 with the liquid limit equal to 40. If uniform distributed load $\Delta\sigma = 85$ kN/m^2 is applied at the ground surface;

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

(5 marks)

(ii) Determine the settlement of the clay layer caused by primary consolidation if the preconsolidation pressure, $\sigma'_c = 200$ kN/m^2? (Use Cs = 1/6 Cc).

(4 marks)

(iii) Calculate the hydraulic conductivity (in m/min) of the clay. (Given ef = 0.75 and time for 50% consolidation = 50 days on double drainage).

(8 marks)

(iv) How long (days) will it take to reach 70% consolidation if it is drained on one side.

(3 marks)

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

- END OF QUESTIONS-

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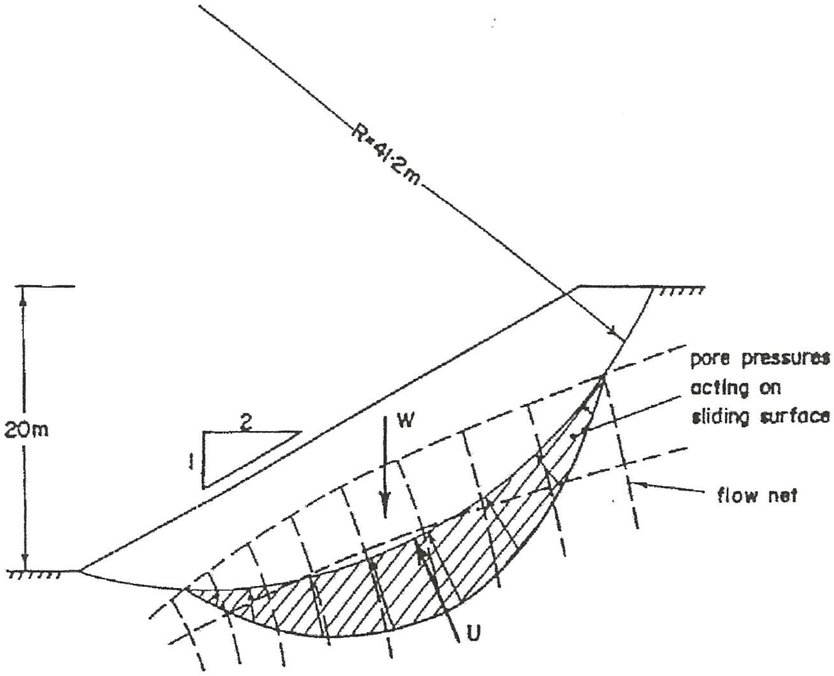
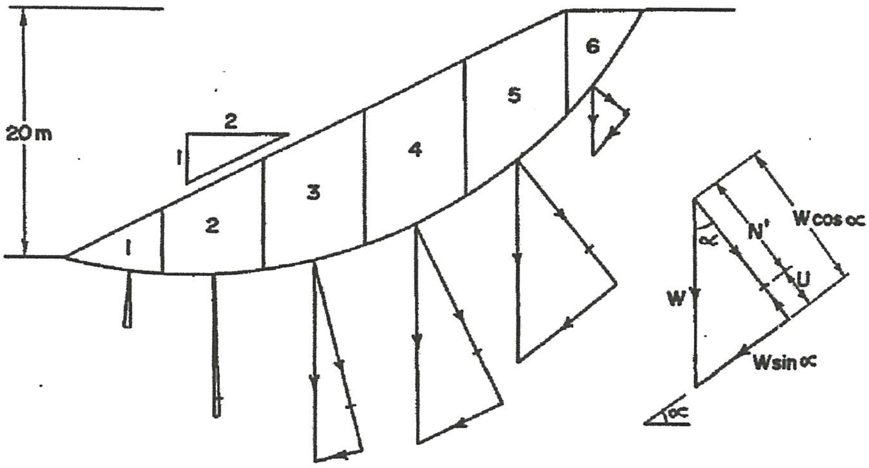


(a): Potential failure surface



(b) Slices of slope

FIGURE Q1 (c)

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TABLE Q1 (c): Details of slices of slope

Slice	Slice width (m)	Weight of slice, W (kN)	Pore pressure force, U (kN)	α (°)
1	8	450	0	-6.37
2	8	1118	150	2.81
3	8	1590	370	14
4	8	1742	450	25.85
5	8	1590	340	39.05
6	6	570	20	50.8

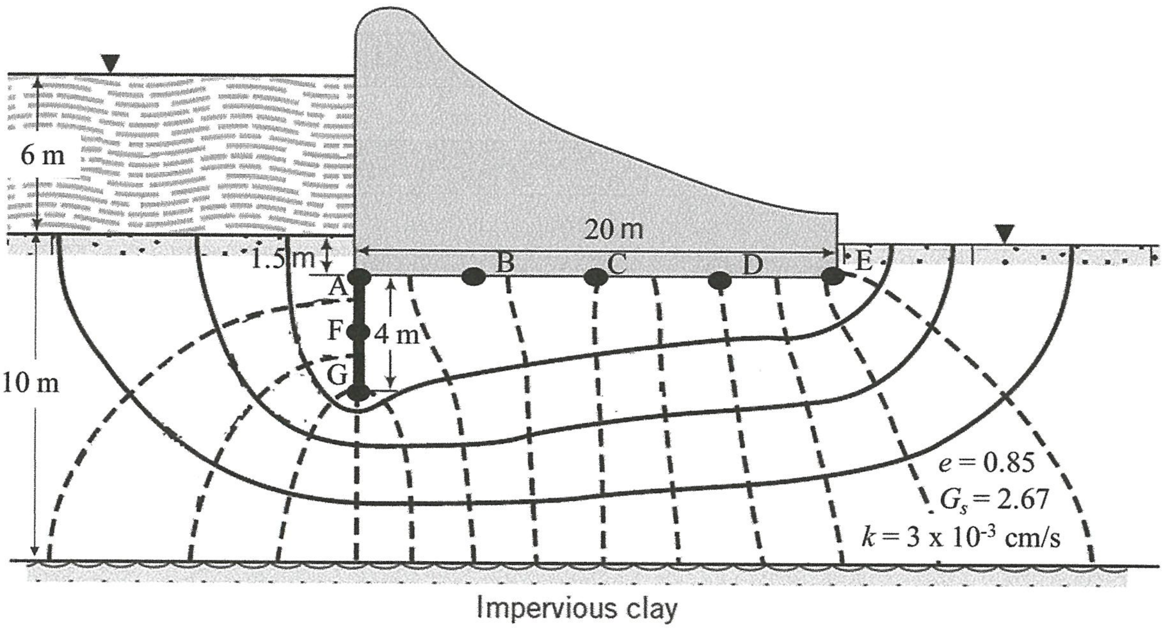

FIGURE Q2 (b): Earth dam with flownet

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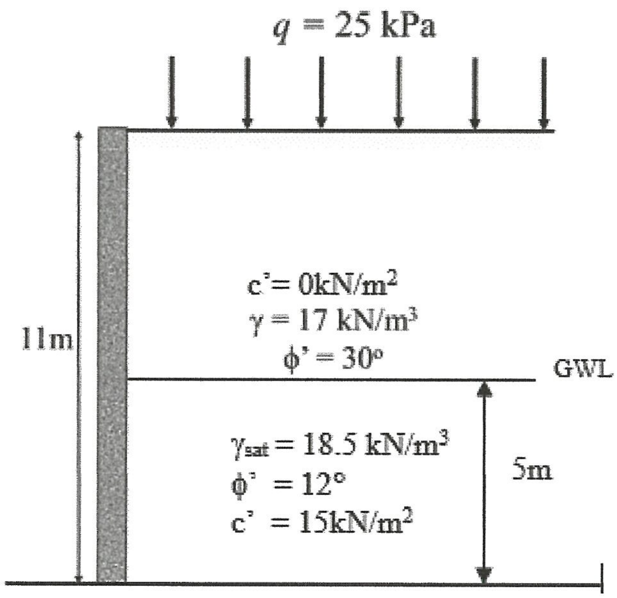

FIGURE Q3 (c): Earth retaining structure

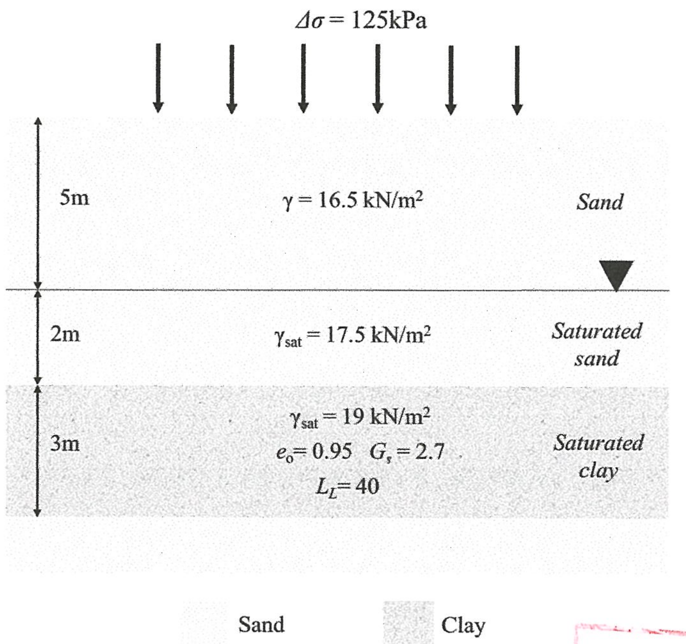

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FIGURE Q4 (b): Earth retaining structure

DR. MOHD KHAIDIR BIN ABU TALIB
Pensyarah
Jabatan Kejuruteraan Infrastruktur dan Geomatik
Fakulti Kejuruteraan Awam dan Alam Sekitar
Universiti Tun Hussein Onn Malaysia

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Flow in Soil

$$q = k\Delta H \frac{N_f}{N_d} \quad \textit{isotropic soil}$$

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

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

Head loss of each potential drop, $\Delta h = \dfrac{\Delta H}{N_d}$

$$p_w = \frac{\Delta x}{3}\left[u_1 + u_n + 2u_{i(odd)} + 4u_{i(even)}\right]$$

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

Stress in Soil

Conventional retaining walls

Rankine active and passive pressure

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

$$P_v = P_a \sin\alpha^\circ \qquad P_h = P_a \cos\alpha^\circ$$

$$\sigma'_a = k_a\gamma z \qquad \sigma'_p = k_p\gamma z$$

$$\sigma'_a = k_a(q + \gamma z) - 2c'\sqrt{k_a} \qquad \sigma'_p = k_p(q + \gamma z) + 2c'\sqrt{k_p}$$

$$K_a = \tan^2(45^\circ - \tfrac{1}{2}\phi'_1) \qquad K_p = \tan^2(45^\circ + \tfrac{1}{2}\phi'_2)$$

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

$$FS = \frac{\Sigma V \tan(\tfrac{2}{3}\phi'_2) + \tfrac{2}{3}Bc'_2 + P_p}{P_a \cos\alpha} \qquad z_o = \frac{2c_u}{\gamma}$$

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Consolidation and Settlement

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

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

$$S_p = \frac{C_c H}{1+e_o}\log\left(\frac{\sigma'_o + \Delta\sigma'}{\sigma'_o}\right) \qquad C_c = 0.009(L_L - 10)$$

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

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

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

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

$$T_v = \frac{\pi}{4}U^2_{avg} \qquad T_v = \frac{c_v t}{d^2} \qquad T_v = -0.933\log(1 - U_{avg}) - 0.085$$

$$U_z = 1 - \frac{u_e}{u_i} \qquad U_z = \frac{\Delta\sigma - u_e}{\Delta\sigma}$$

Slope Stability

$$FS = \frac{\sum_{n=1}^{n=p}(C_n \Delta L_n) + \sum_{n=1}^{n=p}(W_n \cos\alpha_n - u_n \Delta L_n)\tan\phi_n'}{\sum_{n=1}^{n=p} W_n \sin\alpha_n}$$

$$FS = \frac{\sum_{n=1}^{n=p}(C_n \Delta x_n \sec\alpha_n) + \sum_{n=1}^{n=p}(W_n \cos\alpha_n - U)\tan\phi_n'}{\sum_{n=1}^{n=p} W_n \sin\alpha_n}$$

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

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

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