Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	GEOTECHNICS 2
COURSE CODE	:	BFC34402
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	ANSWER **ALL** QUESTIONS IN **PART A**. ANSWER ANY **TWO (2)** QUESTIONS IN **PART B.**

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

PART A: ANSWER ALL QUESTIONS

Q1 (a) (i) Natural slopes which were stable for many years may suddenly fail due to some causes. The Varnes system divides slope failures into five types. Briefly explain all **FIVE (5)** types of slope failures with relevant sketch.

(10 marks)

(ii) Based on the answer in **Q1(a)(i)**, discuss **TWO (2)** similarities among these modes of slope failure.

(4 marks)

(iii) Define the term safety factor of slope stability and briefly explain the effect of rainfall on the stability of slope.

(5 marks)

(b) Briefly explain the importance of distiguishing flow failures and slip failures.

(6 marks)

(c) An embankment 15 m high is subjected periodically to full submergence and drawdown conditions. Given that the slope angle, specific gravity, void ratio and friction angle are 45°, 2.75, 0.9 and 20°, respectively.

(i) Determine the cohesion of soil, c_u required to give a factor of safety 1.5 in the submerged condition. Use Taylor's stability number curves in **Figure Q1(c)** in this case.

(5 marks)

(ii) Determine the cohesion of soil, c' required to give a factor of safety 1.3 in the drawdown condition. Use Taylor's stability number curves in **Figure Q1(c)** in this case.

(5 marks)

(iii) Discuss the effects of sudden drawdown on the stability of slope.

(5 marks)

PART B: ANSWER TWO (2) QUESTIONS ONLY

Q2 (a) Briefly explain **FIVE (5)** constraints for sketching flow net.

(5 marks)

(b) Sultan Mahmud Dam, located in Tasik Kenyir, Terengganu, contained with levees. Levee #111 runs North-South about 2 kilometres west of Kuala Berang and its cross section is shown in **Figure Q2(b)**. Laboratory tests indicate that the permeability of the 80-year old levee is 0.30 m/day. Calculate the volume of water lost through the levee along each kilometer in m^3/day.

(5 marks)

(c) A dam shown in **Figure Q2 (c)** retains 6m of water. A sheet pile wall on the upstream side (which is to reduce seepage under the dam) penetrates 4m into 10m 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 q in cm/s.

(2 marks)

(ii) Calculate the pore water pressure distribution on the front of the sheet pile (at every 2m @ 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.

(5 marks)

(iii) Calculate the pore water pressure distribution at the base of the dam. (at every 5m @ 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.

(8 marks)

(iv) Determine the uplift force.

(2 marks)

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

(1 mark)

(vi) Determine Factor of Safety. Identify either piping will occur or not.

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

(6 marks)

(c) For the frictionless wall shown in **Figure Q3(c)**, determine the following;

(i) The active lateral earth pressure coefficients.

(2 marks)

(ii) The active lateral earth pressure distributions.

(8 marks)

(iii) The active resultant lateral forces.

(6 marks)

(iv) The location of active resultant lateral forces.

(4 marks)

Q4 (a) In general, the soil settlement caused by loads may be divided into **THREE (3)** broad stages. Explain each stage with the aid of sketches/ diagrams.

(8 marks)

(b) A 2m clay layer underlies a layer of sand layer of 4m depth as shown in **Figure Q4(b).** The groundwater level was observed to be very deep. The unit weight of the sand layer is 17kN/m^3 while the clay layer is 19kN/m^3. The structure load will develop stress at 100kPa. It was observed that in place void ratio is 0.73. The collected data from the laboratory consolidation test are shown in **Table Q4(b).**

(i) Make necessary calculations and draw an e versus $\log \sigma'$ curve based on given data in **Table Q4(b).** Given dry mass of specimen = 100g, height of specimen at the beginning of the test = 20mm, specific gravity = 2.7 and specimen surface area =32 cm^2.

(10 marks)

(ii) Determine compression index and swell index.

(4 marks)

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

(4 marks)

(iv) Calculate the settlement of the clay layer caused by primary consolidation if the clay is normally consolidated and the groundwater level was located at the middle of the sand layer. Given the saturated unit weight of the sand layer is18 kN/m^3 while the clay layer is 19.5kN/m^3.

(4 marks)

– END OF QUESTIONS–

FINAL EXAMINATION

SEMESTER/SESSION	: SEM I / 2019/2020	PROGRAMME CODE	: 3 BFF
COURSE NAME	: GEOTECHNICS II	COURSE CODE	: BFC34402

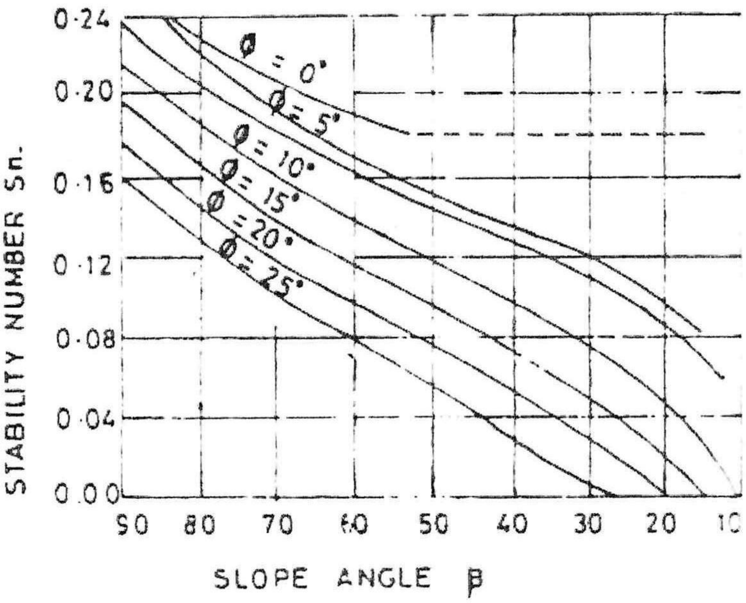

FIGURE Q1(a): Taylor's stability number

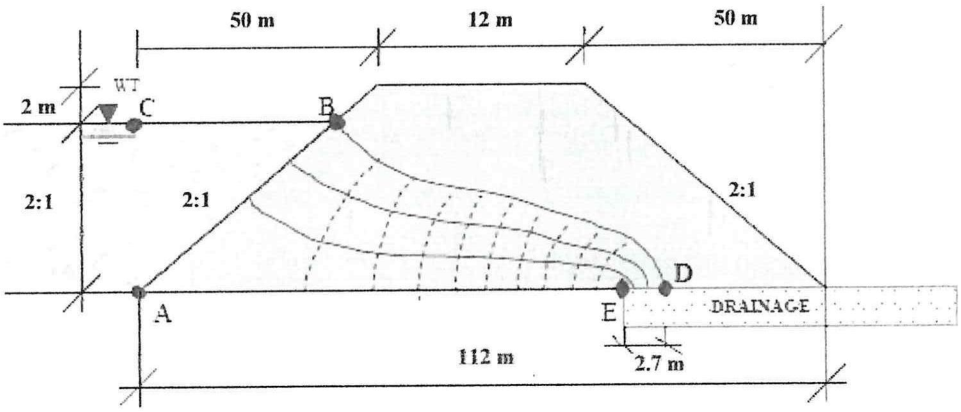

FIGURE Q2(b): Cross-section of levee looking north

FINAL EXAMINATION

SEMESTER/SESSION : SEM I / 2019/2020
COURSE NAME : GEOTECHNICS II
PROGRAMME CODE : 3 BFF
COURSE CODE : BFC34402

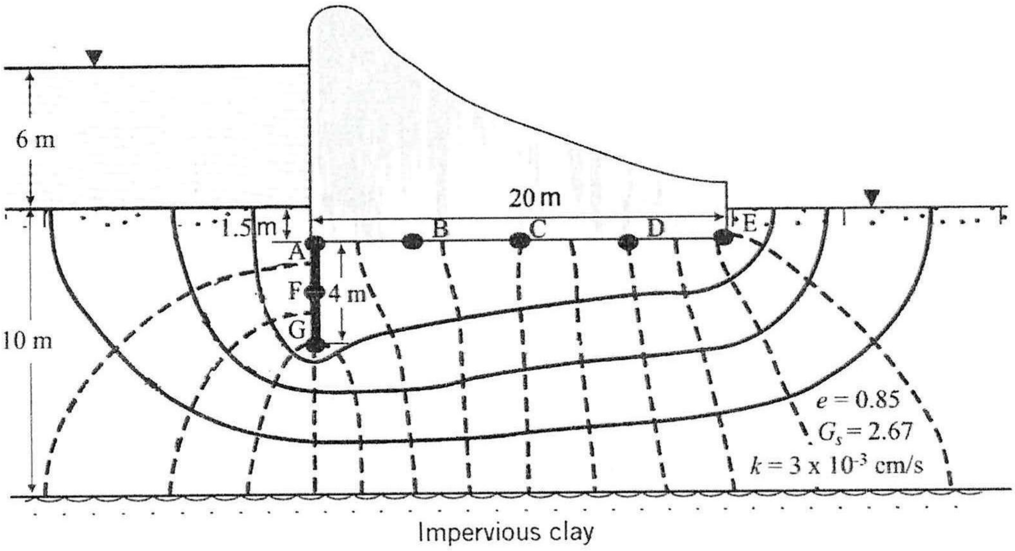

FIGURE Q2(c): Retaining wall

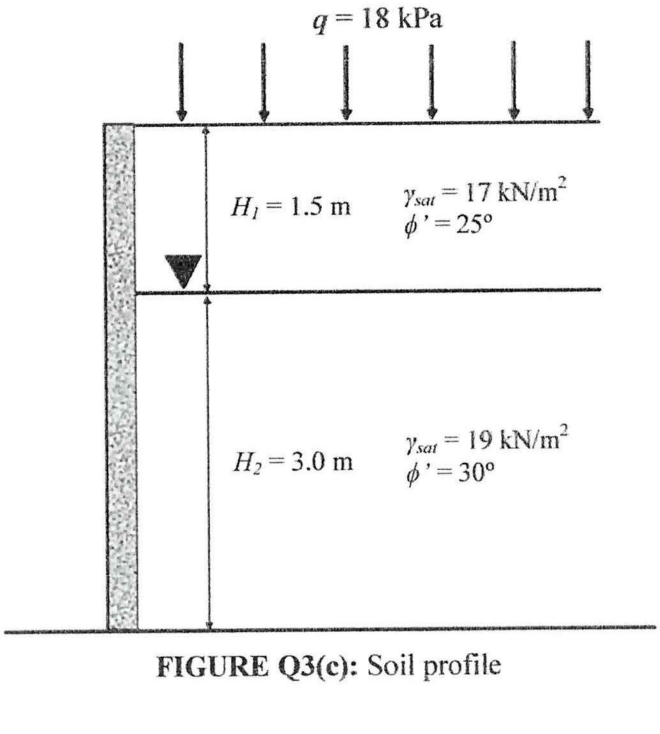

FIGURE Q3(c): Soil profile

FINAL EXAMINATION

SEMESTER/SESSION : SEM I / 2019/2020
COURSE NAME : GEOTECHNICS II
PROGRAMME CODE : 3 BFF
COURSE CODE : BFC34402

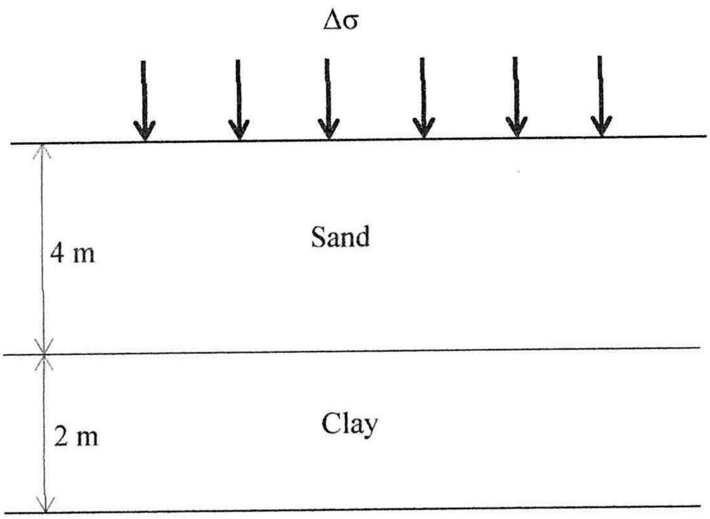

FIGURE Q4(b): Interbeded clay and sand layer with difference thickness

TABLE Q4(b): Laboratory consolidation test data

Remarks	Pressure, σ' (kN/m^2)	Height, H (mm)
Loading	0	20.00
	25	19.92
	50	19.79
	100	19.50
	200	18.80
	400	18.00
	800	17.20
	1600	16.35
Unloading	800	16.55
	400	16.90
	200	17.20

FINAL EXAMINATION

SEMESTER/SESSION : SEM I / 2019/2020
COURSE NAME : GEOTECHNICS II
PROGRAMME CODE : 3 BFF
COURSE CODE : BFC34402

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

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

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

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

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

$$P_w = \frac{\Delta x}{3}\left(u_1 + u_n + 2\sum_{\substack{i=3 \\ odd}}^{n} u_i + \sum_{\substack{i=2 \\ even}}^{n} u_i\right)$$

Stress in Soil

Conventional retaining walls

Rankine active and passive pressure

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

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

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

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

Factor of safety against overturning

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

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

Factor of safety against sliding

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

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

FINAL EXAMINATION

SEMESTER/SESSION : SEM I / 2019/2020 PROGRAMME CODE : 3 BFF
COURSE NAME : GEOTECHNICS II COURSE CODE : BFC34402

Consolidation and Settlement

$$OCR = \frac{\sigma'_c}{\sigma'_o} \qquad e_o = wG_s$$

$$S_p = H\frac{\Delta e}{1+e_o} \qquad \gamma_d = \frac{G_s\gamma_w}{1-e_o}$$

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

$$S_p = \frac{C_s H}{1+e_o}\log\left(\frac{\sigma'_o+\Delta\sigma'}{\sigma'_o}\right) \qquad \gamma' = \left(\frac{G_s-1}{1-e_o}\right)\gamma_w$$

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

$$T_v = \frac{c_v t}{H_{dr}^2} \qquad \gamma_{sat} = \left(\frac{G_s-e}{1-e_o}\right)\gamma_w$$

$$c_v = \frac{0.848H^2_{dr}}{t_{90}} \qquad C_c = 0.009(L_L-10)$$

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

$$T_v = \frac{\pi}{4}U^2_{avg} \qquad T_v = 1.781 - 0.933\log(100 - U)$$

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

$$FS = \frac{c_n l_n + \sum_{n=1}^{n=p}(W_n\cos\alpha_n - r_u\sec\alpha_n)\tan\phi_n'}{\sum_{n=1}^{n=p}W_n\sin\alpha_n} \qquad FS = \frac{c'}{\gamma H\cos^2\beta\tan\beta} + \frac{\tan\varphi'}{\tan\beta}$$

$$FS = \frac{\sum_{n=1}^{n=p}(c'R\theta + W_n\cos\alpha_n\tan\phi')}{\sum_{n=1}^{n=p}W_n\sin\alpha_n} \qquad FS = \frac{\sum C_u R^2\theta}{\sum W_d},\ \theta \text{ in radian}$$