Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	GEOTECHNICS
COURSE CODE	:	BFC 31703
PROGRAMME	:	3 BFF
EXAMINATION DATE	:	JUNE 2014
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	ANSWER QUESTION **Q1** AND ANY **THREE (3)** QUESTIONS IN SECTION B

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

SECTION A

Q1 (a) List the consolidation parameters that can be determined from one-dimensional consolidation test. Explain briefly the significance of consolidation parameters in the construction of an expressway on the soft soil.

(5 marks)

(b) There are two methods in determining the coefficient of consolidation, c_v namely Taylor's and Casagrande's method. Using your own word, briefly explain the difference between them.

(5 marks)

(c) Results of one increment of loading (from 200 to 400 kPa) in an oedometer test on Batu Pahat clay are given in Table **1**. At the start of the increment the height of the sample was 15.56 mm. The sample was able to drain from the top and bottom. Estimate:

(i) The coefficient of consolidation, c_v (m^2/year) using Casagrande's method.

(10 marks)

(ii) The time taken for 90% consolidation of a layer of clay 5 m thick, drained top and bottom.

(5 marks)

SECTION B

Q2 (a) United Soil Classification System (USCS) and American Association of State Highway and Transportation Officials (AASHTO) classification system are two soil classification systems that commonly used for soil classification.

Briefly explain any **ONE (1)** of the similarity and **TWO (2)** differences in between these two classification systems.

(6 marks)

(b) By plotting the particle size distribution curve, one can identify whether the soil is well graded, gap-graded or uniformly graded.

Please explain with the aid of sketches the differences in between the typical particle size distribution of soil that is well-graded and uniformly graded.

(4 marks)

(c) Clayey sand sample was sampled from the nearby construction site. It is found that the moisture content of the soil is 21%. The specific gravity of the soil is 2.7.

(i) Plot the variation of void ratio, e versus the degree of saturation, S_r for the degree of saturation, S_r of 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0 in the provided graph paper.

(5 marks)

(ii) Determine the bulk density and dry density of the soil at 50% saturation.

(4 marks)

(iii) The soil is isotropically compressed to a void ratio of 0.55. It is reported that the initial degree of saturation of the soil is 0.5. By assuming that the initial volume is 1 m^3, calculate the volume change in terms of percentage of the initial volume.

(6 marks)

Q3 (a) Explain briefly with suitable diagram the term of hydraulic gradient in the determination of the hydraulic conductivity in the soil.

(5 marks)

(b) An engineer is searching for a suitable soil to cap a sanitary landfill. This soil must have a hydraulic conductivity no greater than 1 x 10^{-8} cm/s. A soil specimen from the potential borrow site has been tested in a falling head permeameter. This specimen was 120 mm in diameter and 32 mm tall. The standpipe had an inside diameter of 8.0 mm. Initially, the water in the standpipe was 503 mm. Then, 8 hours and 12 minutes later the water was 322 mm. Compute the coefficient of permeability, k and determine if this soil meets the specification.

(8 marks)

(c) For the well shown in Figure **Q3**, assume the original from the ground surface to the phreatic surface is 16.9 m and coefficient of permeability of the soil in the aquifer is 10^{-2} cm/s.
What is the maximum pumping rate, Q such that the distance from the ground surface to the phreatic surface at observation well B is no greater than 18 m?

(12 marks)

Q4 (a) Briefly explains the Consolidated Undrained test (CU), and Unconsolidated Undrained test (UU) test with the aid of diagrams. Your answer should be based on its testing sequence.

(6 marks)

(b) Please explain and sketch the Effective stress path (ESP) and Total stress path (TSP) of Consolidated Drained (CD) compression test. The answer should include the consolidation stage and shearing stage.

(4 marks)

(c) Soil type A was tested for its strength using a Consolidated Undrained triaxial test with pore water measurement. The data of the tests are shown in Table **2**.

(i) Draw the Mohr circles for total and effective stress.

(4 marks)

(ii) Determine the apparent cohesion and angle of shearing resistance of total stress.

(4 marks)

(iii) Determine the apparent cohesion and angle of shearing resistance for effective stress.

(4 marks)

(iv) Please evaluate whether any differences in determining the shearing parameters using Mohr circle construction and plot of stress point at failure.

(3 marks)

Q5 (a) With the aid of diagrams, explain briefly the soil parameters and information needed for calculation of the effective stresses in the soil.

(5 marks)

(b) At a coastal site the ground conditions consist of 8 m of silty sand, overlying 2 m of gravel and then rock. The density of the silty sand is 1.7 Mg/m^3 above the water table and 1.9 Mg/m^3 below the water table. The density of the gravel is 2.1 Mg/m^3. The water table varies regularly between 1 m and 4 m below the ground surface. What are the maximum and minimum vertical effective stresses at a depth of 4 m.

(6 marks)

(c) A 5 m tall concrete wall with a vertical back is to be backfilled with a silty sand that has a unit weight of 18 kN/m^3, and effective cohesion of 0, and effective friction angle of 32°. The ground behind the wall will be leveled. Using Rankine's method:

(i) Draw a lateral pressure diagram.

(5 marks)

(ii) Determine the normal force per meter acting on the back of the wall.

(5 marks)

(iii) Determine the lateral earth pressure acting at the bottom of the wall.

(4 marks)

Q6 (a) Slopes can be classified as natural slopes or artificial slopes. List any **FOUR (4)** examples of slope.

(4 marks)

(b) Explain in your own words what are the main **THREE (3)** corrective or preventive measures that necessary to improve the stability of slopes.

(6 marks)

(c) As an designer, you are required to determine the factor of safety for a 45° plain strain slope with 30 m high as shown in Figure **Q6**. It is reported that the slope is a homogeneous slope with the soil properties: c_u= 100 kN/m^2, ϕ_u=0°, and γ_{bulk} = 18 kN/m^3

(i) Determine the factor of safety using total stress analysis if there is no surcharge load on the upper ground surface.

(8 marks)

(ii) Calculate the maximum surcharge load, q allowed with the length from the crest of the slope, L of 20 m before the slope will fail on the same slip circle.

(7 marks)

-END OF QUESTION-

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TABLE 1: Data from oedometer test

Time (minutes)	Settlement (mm)	Time (minutes)	Settlement (mm)
0	0	25	0.6934
0.25	0.0635	30.25	0.7468
1	0.1372	36	0.7899
2.25	0.2032	42.25	0.8306
4	0.2718	49	0.8634
6.25	0.3480	56.25	0.8909
9	0.4242	64	0.9130
12.25	0.4978	72.25	0.9273
16	0.5664	81	0.9389
20.25	0.6325	90.25	0.9504

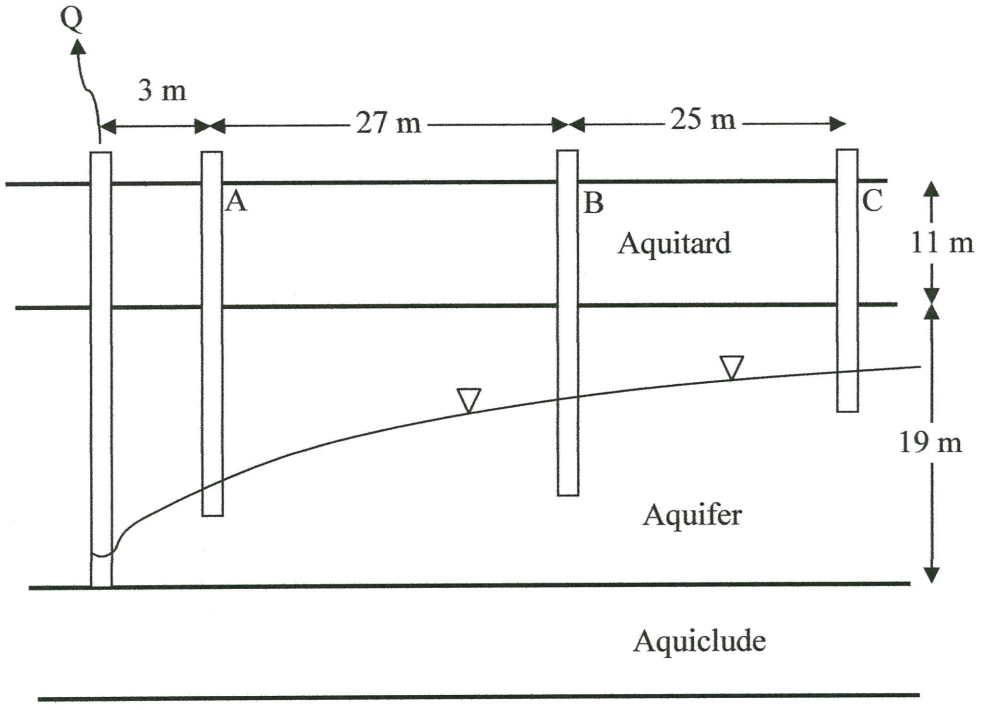

FIGURE Q3: Cross section of the well

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TABLE 2: Data of CU tests

Specimen	Confining pressure, σ_3 (kN/m^2)	Major principal stress, σ_1 (kN/m^2)	Pore water pressure at failure, u (kN/m^2)
1	200	320	102
2	400	630	200
3	600	956	299

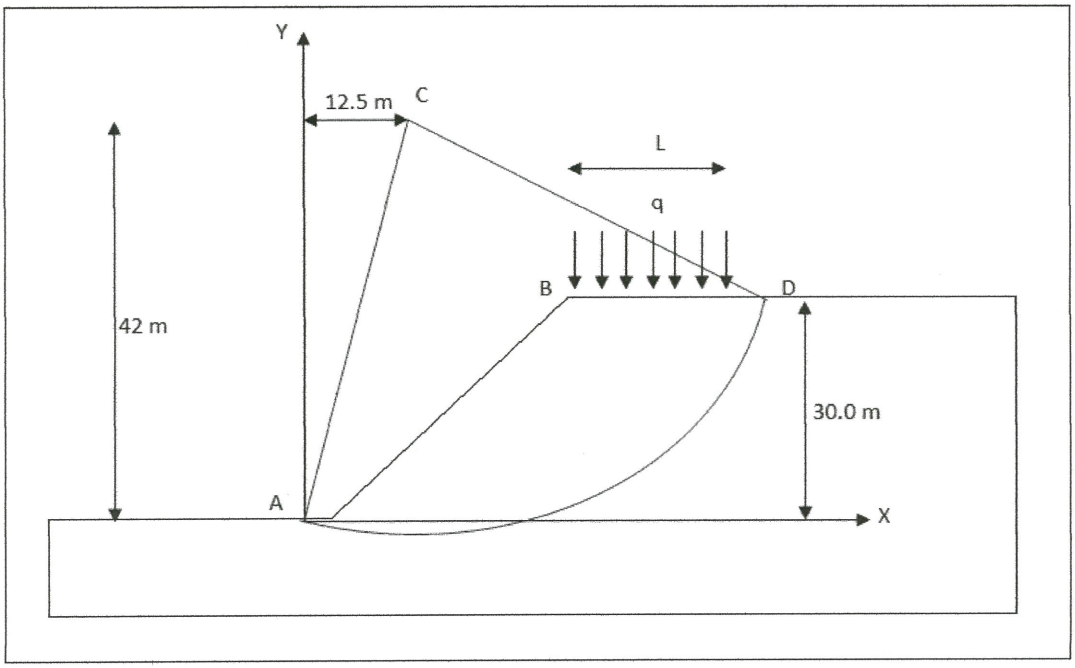

FIGURE Q6: Slope stability analysis

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FORMULAE

$$k = \frac{2.303q \log_{10}\left(\frac{r_1}{r_2}\right)}{\pi\left(h_1^2 - h_2^2\right)}$$

$$k = \frac{q \log_{10}\left(\frac{r_1}{r_2}\right)}{2.727H\left(h_1 - h_2\right)}$$

$$k = \frac{QL}{Aht}$$

$$k = 2.303\frac{aL}{At}\log\frac{h_1}{h_2}$$

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

$$q = kH\left(\frac{N_f}{N_d}\right)n$$

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

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

$$\Delta L_n = \frac{b_n}{\cos\alpha_n}$$

$$FS_s = \frac{\sum_{n=1}^{n=p}\left(c'\Delta L_n + W_n\cos\alpha_n\tan\phi'\right)}{\sum_{n=1}^{n=p} W_n\sin\alpha_n}$$

$$FS_s = \frac{\sum_{n=1}^{n=p}\left(c'\Delta L_n + \left(W_n\cos\alpha_n - u_n\Delta L_n\right)\tan\phi'\right)}{\sum_{n=1}^{n=p} W_n\sin\alpha_n}$$