Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	ADVANCED GEOTECHNIC
COURSE CODE	:	BFG 4023/ BFG 40203
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	JUNE 2014
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) List the differences between stiffness and strength of the soil.

(5 marks)

(b) A cylindrical soil, 38 mm in diameter and 76 mm long, is laterally compressed. The length increase to 80 mm and the radius decrease by 2 mm. Calculate:

(i) The axial and radial strains

(2 marks)

(ii) The volumetric strains

(2 marks)

(iii) Poisson's ratio

(1 mark)

(c) A UU triaxial test with cell pressure, σ_3 = 200 kN/m^2 on an unsaturated residual soil sample with the initial height h_o, = 150 mm and h_o/d = 2. Giving the following data;

Axial Strain, ε_1 (%)	ΔV (cm^3)	Axial load, (N)	Pore pressure, u (kN/m^2)
0	0	0	32
0.34	-103	29	34
0.69	-2.33	223	34
1.37	-4.50	497	37
2.06	-6.56	618	39
3.43	-9.76	695	43
5.15	-12.74	703	45

(i) Plot the deviator stress versus axial strain.

(5 marks)

(ii) Determine the Young's modulus, tangent and secant stiffness at failure.

(5 marks)

(iii) Determine the shear stress, τ_f and effectives stress, σ_f at failure.

(5 marks)

Q2 (a) Briefly explain the phenomenon of capillary as shown in Figure **Q2** using your own word.

(5 marks)

(b) Determination of shear strength parameters of unsaturated soil can be performed using existing saturated equipment with some modification. Explain briefly with the aid of diagram, the procedure in conducting CU triaxial testing for unsaturated soil.

(5 marks)

(c) The following data were obtained from triaxial test for unsaturated residual soil specimen size of 38 mm in diameter and 76 mm height.

(u_a-u_w) (kN/m^2)	$(\sigma - u_a)$ (kN/m^2)	Shear stress, τ (kN/m^2)
0	0	10
93	50	44
159	100	68
225	150	92
288	200	115
354	250	139
420	300	163

(i) Plot the graph shear stress versus matric suction and shear stress versus net stress.

(6 marks)

(ii) Determine the shear strength of the soil if the applied matric suction and the net stress are 300 kN/m^2 and 550 kN/m^2 respectively.

(4 marks)

(iii) If the soil becomes saturated, what is the strength of the soil when the effective normal stress is 500 kN/m^2. Comment your answer.

(5 marks)

Q3 (a) Explain briefly the differences between OCR and R_o in critical state model.

(5 marks)

(b) The following data were obtained from a one dimensional consolidation test using oedometer equipment on a clay soil.

σ'	25	50	200	400	800	1600	800	400	200
e	1.65	1.64	1.62	1.57	1.51	1.44	1.45	1.46	1.47

Determine:

(i) The compression index, c_c and swelling index, c_r.

(6 marks)

(ii) The λ and κ.

(4 marks)

(c) A saturated sample of soil 38 mm in diameter and 76 mm high was isotropically consolidated to 400 kN/m^2 in a triaxial cell. It was decided to stop the consolidation when the excess porewater pressure (Δu) was 10 kN/m^2. The sample was subjected to a standard undrained test (σ_3 = 400 kN/m^2 is kept constant). Failure (critical state) was recorded when q_f = 94 kN/m^2. The water content was 40%, λ = 0.16, and κ = 0.03. If the specific gravity of a soil is 2.7, determine:

(i) e_Γ
(ii) M
(iii) Δu_f

(10 marks)

Q4 (a) Explain briefly the advantage of centrifuge modeling in geotechnical field compared to small-scale modeling.

(5 marks)

(b) With the aid of sketches, critically discuss the basic principle of centrifuge modeling in simulating geotechnical engineering problems.

(10 marks)

(c) The prototypes of embankment with the slope as shown in Figure **Q4** will be model using 100g centrifuge test. By using the scaling law as shown in Table **1**:

(i) Calculate and sketch the dimension of the slope model in centrifuge test.

(5 marks)

(ii) If the embankment will be constructed on the soft soil area, calculate the time to simulate a prototype soil settlement problem consolidated for 10 years.

(5 marks)

Q5 (a) List **TWO (2)** types of elements for 1D, 2D and 3D elements in finite element modeling.

(6 marks)

(b) With the aid of sketches, discuss the typical step in finite element analysis of the geotechnical problems in the finite element software.

(9 marks)

(c) The finite element modeling is dependent on the input file by the users and the results might be errors due to the mistakes during the input file step. Describe briefly, how to make sure that the results from the Finite element analysis is correct.

(10 marks)

-END OF QUESTION-

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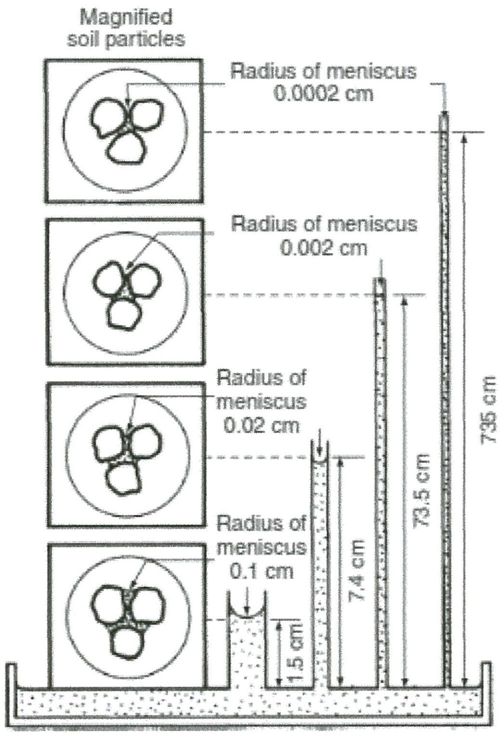

FIGURE Q2

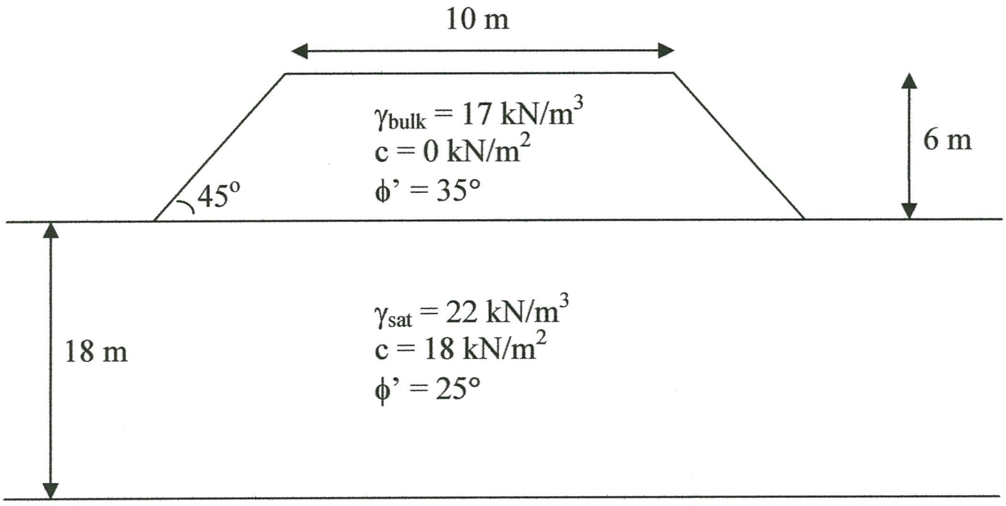

FIGURE Q4

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TABLE 1

Parameter	Scale (model/prototype)
Acceleration	n
Linear dimension	1/n
Area dimension	$1/n^2$
Volume dimension	$1/n^3$
Stress	1
Strain	1
Mass	$1/n^3$
Density	1
Unit weight	n
Force	$1/n^2$
Bending Moment	$1/n^3$
Bending Moment / unit width	$1/n^2$
Flexural stiffness / unit width	$1/n^3$
Time (dynamic)	1/n
Time (consolidation/ diffusion)	$1/n^2$
Time (creep)	1
Pore fluid velocity	n
Concentration	1
Velocity (dynamic)	1
Frequency	n

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FORMULAE

STRESS STRAIN PARAMETERS

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

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

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

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

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

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

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

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

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

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

UNSATURATED SOIL

$$(u_a - u_w) = \frac{4T}{(\nu - 1)d_s}$$

$$d_v = (\upsilon - 1)d_s$$

$$T\pi d_v = (u_a - u_w)\frac{\pi d_v^{\ 2}}{4}$$

$$\tau' = c' + (\sigma_n - u_a)\tan\phi' + (u_a - u_w)\tan\phi'^b$$

CRITICAL STATE

$$e_f = e_\Gamma - \lambda \ln p'_f$$

$$\lambda = \frac{C_c}{2.3}$$

$$\kappa = \frac{C_r}{2.3}$$

$$q = \pm Mp'\sqrt{\left(\frac{p'_c}{p'} - 1\right)}$$

$$q_f = Mp'_f$$

$$M_c = \frac{6\sin\phi'_{cs}}{3 - \sin\phi'_{cs}}$$

$$M_e = \frac{6\sin\phi'_{cs}}{3 + \sin\phi'_{cs}}$$

$$q_f = M\exp\left(\frac{e_\Gamma - e_o}{\lambda}\right)$$