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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019

COURSE NAME	:	ADVANCED GEOTECHNIC
COURSE CODE	:	BFG40203
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE / JULY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

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Q1 (a) Explain the work hardening and work softening concept in Geotechnical engineering by using appropriate sketch.

(6 marks)

(b) The fill of the embankment will be placed on soft soil. The contractor is very concern about the stability of embankment immediately after construction. As an engineer, you are required to propose the most practical method, whether CU, UU or CD in obtaining the parameters of shear strength of soft soil in triaxial test. State your selection and justify your answer.

(5 marks)

(c) Briefly discuss the advantage and disadvantage of the unconsolidated undrained test and consolidated drain test in soil testing.

(4 marks)

(d) The Young Modulus (E) of soil samples from the Unconsolidated Undrained test is 25 Mpa. The soil sample has a diameter of 100 mm and 200 mm long. The axial stress has increased from 50 kN/m^2 to 350 kN/m^2 during shearing.

(i) Determine the changes of vertical displacement at the end of the shearing stage.

(3 marks)

(ii) If the radial expansion is 5 mm, determine the Poisson's Ratio, ν.

(3 marks)

(iii) Determine the shear modulus and bulk modulus of the soil. You can use these formula in your calculation.

$$G' = \frac{E'}{2(1+\nu')} \qquad K' = \frac{E'}{3(1-2\nu')}$$

(4 marks)

Q2 (a) (i) Briefly explain the difference between saturated and unsaturated soil.

(4 marks)

(ii) The unsaturated soil can be applied in some cases. Discuss only **ONE (1)** application of unsaturated soil in Geotechnical engineering.

(3 marks)

(b) The matric suction is the difference between the pore air and pore water pressures ($u_a - u_w$) and can be measured either in a direct or indirect manner.

(i) Outline the procedure in measuring the matric suction of unsaturated residual soil using filter paper method in the laboratory.

(6 marks)

(ii) The matric suction can also be measured in the field. Specify **ONE (1)** of the equipment involved and describe the test procedure.

(4 marks)

(c) The soil water characteristic curve (SWCC) is a conceptual understanding between the mass or volume of water in soil and the energy state of the water phase. The SWCC can be obtained using pressure plate extractor and Tempe cell.

(i) Discuss the advantages and disadvantages of the pressure plate extractor and Tempe cell in the determination of SWCC.

(4 marks)

(ii) The SWCC can be assumed as the heart of unsaturated soil. Discuss the importance of SWCC in unsaturated soil.

(4 marks)

Q3 (a) Using an appropriate figure, illustrate the critical state model in geotechnical engineering field.

(5 marks)

(b) The water content of a sample of saturated soil at the mean effective stress of 10 kN/m^2 is 85%. The sample was isotropically consolidated with a mean effective stress of 150 kN/m^2. At the end of the consolidation, the water content was 50%. The sample was then isotropically unloaded to a mean effective stress of 100 kN/m^2, and the water content increased by 1%. Assume $G_s = 2.7$.

(i) Construct the normal consolidation line (NCL) and the unloading/reloading lines (URL) in (p`, e) and (ln $p$`, e) spaces.

(8 marks)

(ii) Calculate the compression index (λ) and recompression index (κ).

(6 marks)

(iii) Develop the initial yield surface and the critical state line in (p`, $q$), ($p$`, e) and (ln p`, e) spaces if $\phi'_{cs} = 25°$

(6 marks)

Q4 (a) In a physical modeling, the centrifuge modeling can be adopted to simulate the soil behavior during loading. There are two phenomena that can cause the behaviour of the model to be appreciably different from that of the prototype of an identical soil. Describe what these two phenomena are.

(4 marks)

(b) Based on the theory of the scaling law, list down **FOUR (4)** parameters that are used in geotechnical engineering that is subjected to the scaling law.

(4 marks)

(c) Critically discuss the difficulties of adopting physical models in geotechnical engineering. Your answer must take into consideration of the dimensional analysis and scaling law.

(9 marks)

(d) In a centrifuge test, a model with a height of $h_m = R/n$ is placed at a distance R which is the effective radius of a centrifuge is equal to 9m. If the stresses of the model (σ_{vm}) at a depth of $2/3h_m$ in the centrifuge test is similar to that of the stresses of the prototype (σ_{vp}) at a depth of $2/3h_p$. Calculate the model depth (h_m) at maximum stress difference. Assume n = 3.

(8 marks)

Q5 (a) Modern advances in information technology and computers facilitate the solution of engineering problems using sophisticated software that simplify the defferential equations with appropriate numerical techniques. List the names of at least **FOUR (4)** commercial software programs dedicated to the solution of geotechnical engineering problems.

(4 marks)

(b) List **FIVE (5)** important parameters of the Mohr-Coulomb model and the advantage and disadvantage of this model in geotechnical engineering problems simulation.

(5 marks)

(c) Construction of road embankments is important for roadway usage in many developing countries. Construction on soft soil will be a difficult task for engineers to build road embankments. This can be solved by firstly simulating the conditions in software analysis. Based on your knowledge, construct the procedure in modeling the embankment construction in the Plaxis finite element software aided with appropriate figures. Your answer should consist of the selection of suitable soil parameters, structures, boundary condition, initial condition, mesh and stage construction and expected results of the embankment.

(16 marks)

-END OF QUESTIONS-

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LIST OF FORMULA

STRESS STRAIN PARAMETERS

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

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

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

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

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

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

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

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

$$\upsilon' = \frac{3K' - 2G}{2G + 6K'}$$

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

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

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

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

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

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

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

$$q_f = Mp'_f$$

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

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

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