Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	ADVANCED GEOTECHNIC
COURSE CODE	:	BFG40203
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	DISEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 (a) Discuss the relationship between peak, critical state and residual strength for normally and heavily consolidated clay with appropriate illustration.

(5 marks)

(b) Based on your understanding, describe isotropic compression and swelling for critical state condition.

(5 marks)

(c) The water content of a sample of saturated soil at the mean effective stress of 20 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 $\phi'_{cs} = 25^{\circ}$

(6 marks)

Q2 (a) Discuss in detail the difficulties of adopting physical models in geotechnical engineering. Your answer must take into consideration of the dimensional analysis and scaling law.

(10 marks)

(b) Consider a soft, 20 m thick clay layer. This clay takes 12 years to reach 98% consolidation. Design how long (days) it will take to consolidate a centrifuge model of this clay layer in

(i) a 50 g centrifuge test

(4 marks)

(ii) a 100 g centrifuge test

(4 marks)

(iii) a thin sand seam of negligible thickness is introduced at the mid depth of the clay layer. Analyse how this changes the consolidation times in each of the above centrifuges.

(17 marks)

Q3 (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 **FIVE (5)** commercial software programs dedicated to the solution of geotechnical engineering problems.

(5 marks)

(b) The hydraulic conductivity function and also volumetric water function are important parameter in SEEP/W and SLOPE/W modeling in unsaturated analysis. Compile method and equation used to determine these parameters.

(8 marks)

(c) Investigate the importance of these term in numerical modeling using Geostudio,

(i) Boundary condition
(ii) Mesh properties
(iii) Material properties
(iv) Geometry
(v) Analysis type

(10 marks)

(d) Rainfall-induced slope failures are common problems in many tropical areas covered by residual soil. The infiltration of rainfall causes the reduction of the matrix suction and causes the slope to fail. As a geotechnical engineer, develop numerical modeling to monitor slope stability especially when it rains. The modeling should include selection of material properties, boundary condition, slope geometry, initial condition and also expected result.

(12 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

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

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

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

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

$$q_f = Mp'_f$$

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

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

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