

Soil Physics and Mechanics

National Exams May 2002

98-Agric-A2, Soil Physics and Mechanics

3 hours duration

NOTES:

If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumptions made.

2. Any non-communicating calculator is permitted. This is an Open Book exam. Note to candidates you must indicate the type of calculator being used, i.e. write the name and model designation of the calculator, on the first inside left-hand sheet, of the exam work book.
3. Any **four** questions constitute a complete paper. Only the first four questions as they appear in your answer book will be marked.
4. All questions are of equal value.

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1. (25 Marks) The soil profile shown in the figure consists of 4.5 m of sand over 4.5 m of clay. The sand has a grain specific gravity of 2.68 and porosity of 0.5 while the clay has a saturated specific weight of 19.8 kN/m³.

- a. What is the total pressure at point "X"?
- b. What is the effective pressure at point "X"?
- c. Under different conditions, water in the piezometer rises 2.0 m while the water table remains constant. You may assume the excess pressure in the clay layer varies from zero at the top to $2\gamma_w$ at the bottom according to:

$$\Delta u = 2\gamma_w \sin\left(\frac{\pi y}{2 \times 4.5}\right)$$

in which y is the distance below the top of the clay layer in meters.

What is the total pressure at point "X"?

- d. For the conditions described in c, what is the effective pressure at point "X"?
- e. Can the conditions described in c be sustained over a long time? Why or why not?

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2. (25 Marks) A soil specimen with a volume of 60.0 cm^3 has a mass of 105.0 g . Its dry mass is 80.2 g and G_s is 2.65 . Determine the following soil characteristics:
- Water content in %.
 - Void ratio and porosity.
 - Bulk density
 - Degree of saturation.

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3. (25 Marks) The table below summarizes the grain-size analysis for two soils, A and B. For both soils determine:
- C_c and C_u as appropriate,
 - D_{10} and D_{85} ,
 - The clay fraction for soil B.

Sieve No.	% Passing, Soil A	% Passing, Soil B	
4	98.0		100.0
10	88.2		100.0
20	72.3		84.5
40	54.1		61.3
60	32.7		53.5
100	17.1		39.2
200	7.7		35.1
Hydrometer Analysis	N/A	0.05 mm	23.2
Hydrometer Analysis	N/A	0.01 mm	15.8
Hydrometer Analysis	N/A	0.005 mm	9.7
Hydrometer Analysis	N/A	0.001 mm	3.4

Note: A sheet of log-linear graph paper is provided to help answer this question.

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4. (25 Marks) A sample of soil for a constant-head permeability test provides the following data: diameter = 7.6 cm; $L = 20.0$ cm, $h = 15.0$ cm; $e = 0.55$; $\gamma_{\text{sat}} = 19.6$ kN/m³, time of test duration = 6.0 min; volume discharged = 1200 cm³.
- a. What is the seepage velocity?
 - b. What is the saturated hydraulic conductivity?
 - c. What are three soil characteristics that most affect the saturated hydraulic conductivity? Give examples of soil characteristics that would give high and low saturated hydraulic conductivities.

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5. (25 Marks) Given are the following void ratio versus pressure data from a laboratory test. The initial sample height is 200.00 mm and the diameter = 62.3 mm. Plot e vs. p and e vs. $\log(p)$ and determine:
- The coefficient of compressibility, a_v ,
 - The coefficient of volume compressibility, m_v ,
 - The compression index, C_c
 - What soil factors most affect the field compaction obtained for a soil? Explain why they do.

Pressure, p (kPa)	Void Ratio, e
0	1.02
25	0.98
50	0.975
100	0.954
200	0.880
400	0.781
800	0.688
1600	0.575

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6. (25 Marks) The table below summarizes the results from two consolidated-undrained triaxial tests on an unsaturated cohesive soil.
- What is meant by an “undrained” test?
 - What are the apparent shear strength parameters, c and ϕ ?
 - What are the effective shear strength parameters, c' and ϕ' ?
 - What other means are available for determining the shear strength characteristics of a soil besides a triaxial test?

Test	σ_1 (kPa)	σ_3 (kPa)	u (kPa)
1	190	65	35
2	340	130	60

Note: a sheet of graph paper is provided to help answer this question.