

National Exams May 2008

04 Agric A2 Soil Physics & Mechanics

3 hour duration

NOTES

- 1 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 This is an OPEN BOOK EXAM
Any non communicating calculator is permitted
- 3 Five (5) questions constitute a complete exam paper
The first five (5) questions as they appear in the answer book will be marked
- 4 Each question is of equal value
- 5 Some questions require an answer in written format Clarity and organization of the answer are important

Marking Scheme

1 4 4 3 3 3 3
2 7 7 6
3 4 4 4 4 4
4 4 4 4 4 4
5 4 4 4 4 4
6 7 7 6
7 12 8

- 1 A saturated sample of inorganic clay has a volume of 22.4 cm^3 and a mass of 36.7 g in its natural state. After drying at 105°C to a constant weight, the volume is found to be 14.0 cm^3 . The dry mass of soil is 23.2 g . For the soil in its natural state at the time of sampling, find
- The water content in %
 - Bulk specific gravity
 - Void ratio
 - Saturated unit weight in kN/m^3
 - Dry unit weight in kN/m^3 and
 - The shrinkage limit

- 2 Several specimens of a particular soil are tested and found to have shear strength parameters of

$$\phi = 30^\circ \text{ and } c = 10 \text{ kN/m}^2$$

In one of the tests it was found that $\sigma_3 = \sigma_1 / 10$ when the pore pressure was 175.3 kN/m^2

- a What were the effective principal stresses at failure?
- b What were the total principal stresses at failure?
- c What was the angle of shear failure?

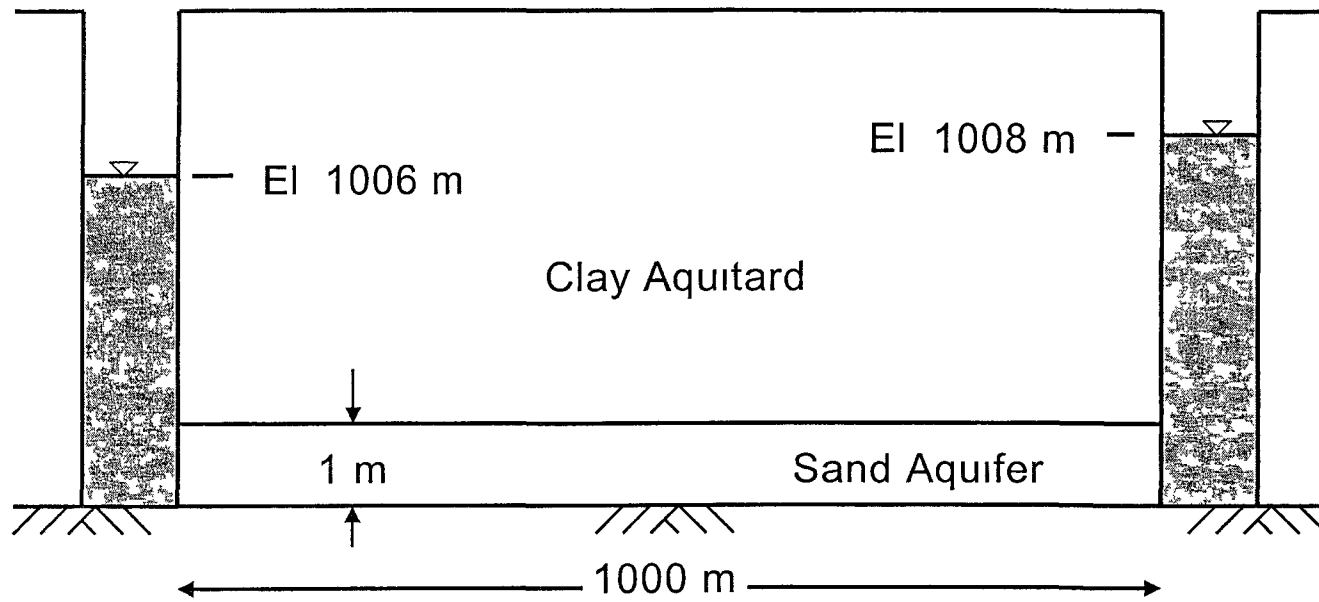
- 3 The table below summarizes the grain size measurements for two soils W and X. For both soils determine
- C_c and C_u as appropriate
 - D_{10} and D_{85}
 - The clay fraction for both soils
 - Classify at least one of the soils according to either the USCS classification system or the soil textural triangle and
 - Identify which soil is more likely to be able to infiltrate water at a greater rate and explain why

Note: A sheet of log linear graph paper is provided at the end of the exam paper to help answer this question. If you use this sheet, submit it with your answer book.

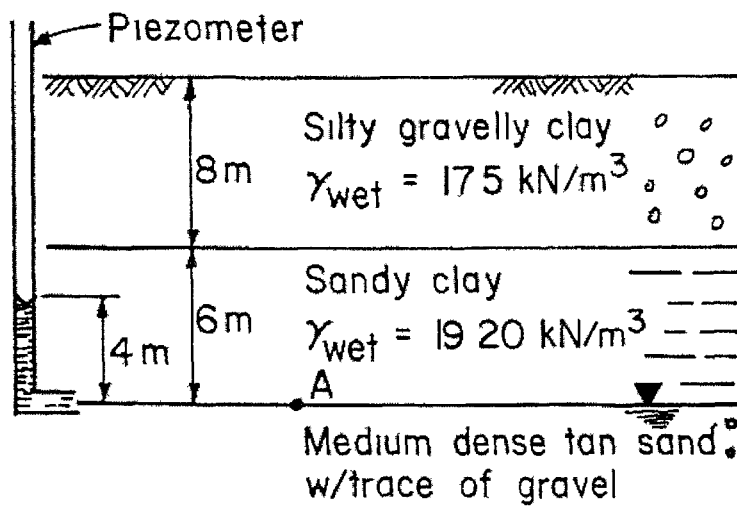
Sieve #	% Passing Soil W	% Passing Soil X	
4	98.0		100
10	88.2		100
20	72.3		84.5
40	54.1		61.3
60	32.7		53.5
100	17.1		39.2
200	7.7		35.1
Hydrometer Analysis	N/A	0.05 mm	23.2
Hydrometer Analysis	N/A	0.01 mm	15.8
Hydrometer Analysis	N/A	0.005 mm	9.7
Hydrometer Analysis	N/A	0.001 mm	3.4

- 4 Give short answers to the questions below
- a When compacting a soil what are two key factors affecting the final compaction density?
 - b What is the matric potential of a soil?
 - c Suggest two methods for determining the shear strength of the soil and their advantages and disadvantages
 - d Describe what the liquid plastic and shrinkage limits of a soil are
 - e When would a falling head permeameter test be preferred over a constant head permeameter test?

- 5 The figure on the next page shows a thin aquifer connecting two rivers 1000 m apart and running parallel to each other. The river to the left has a water surface elevation of 1006 m while that to the right has a water surface elevation of 1008 m. The sand aquifer connecting the two has a constant thickness of 1 m, porosity of 0.45, and a saturated hydraulic conductivity of 1000 m/d. The sand layer is confined from above by a clay aquitard layer.
- Sketch the steady state piezometric height in the aquifer for the situation above. Include this page with your answer book.
 - What will be the discharge (in m^2/day) in the aquifer from one river to another?
 - If a contaminant is introduced into the river on the right, approximately how long after it is introduced will it appear in the river on the left?
 - If the clay aquitard leaks into the aquifer at a steady rate of 0.03 m/day over the whole area, sketch the steady state piezometric height in the aquifer under this situation. What is the maximum value of the piezometric head in the aquifer and where does it occur?
 - What is the discharge into the river on the left under the conditions in part d?



- 6 The figure below shows a soil profile for a three layer soil system
- Determine the total stress effective stress and pore pressure at point A in the figure
 - If the piezometric head drops 0.5 m due to a change in water table what is the effective stress at A ?
 - What piezometric head due to a change in water table location is required to make the effective stress at A = 0 kN/m²?



- 7 The figure on the next page shows a 16 m long dam holding back a reservoir with a 6 m depth of water. The material immediately below the dam has a hydraulic conductivity of 5 cm/hr and is isotropic. The water depth downstream is at the ground surface approximately 0.5 m above the base of the dam.
- a Sketch the flow net for the water flow under the dam (include this figure with your answer book)
 - b Use the results of your flow net to determine the flow per unit width under the dam.

