National Exams December 2015

04-Agric-A2, Soil Physics and Mechanics

3 hours 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 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.

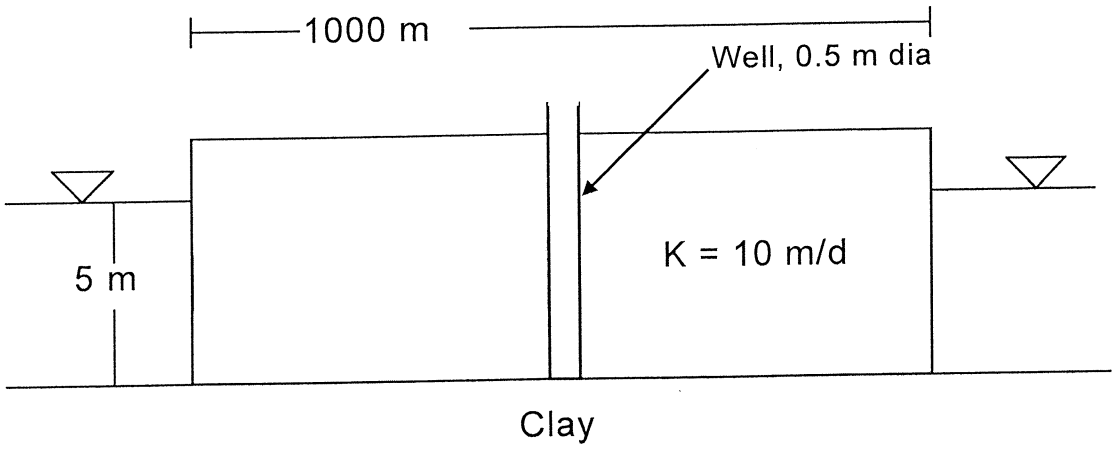
1.(20 Marks)

Short answers are required for each of the following:

a. What is the difference in effective stress and total stress in a soil? Why is this difference important when considering the shear strength of soils?
b. You have been asked to classify a material from a gravel pit according to the Unified Soil Classification System (USCS). The material is being considered for use as a road bed. What laboratory tests would you perform on the soil to allow this classification to be carried out and why?
c. A dewatering scheme is being designed for a deep excavation for a building foundation. For the design both the saturated hydraulic conductivity of the insitu material and the static water levels are needed. Describe how would you recommend these be determined to facilitate the design?
d. An area previously covered by a forest is to be cleared, tile drained and then used for agricultural production. You are expected to estimate the annual erosion losses from the soil during use for agriculture. Describe how you could estimate this and the information you would require to develop this estimate.

2. (20 Marks)
A circular (1 km diameter) island in a lake is shown below. For the purposes of this question you may assume the sides of the island are vertical, the island consists of a permeable sand material that is uniform and isotropic with a hydraulic conductivity of 10 m/day and sits on top of a layer of impermeable clay. The depth of the permeable material below the lake level and above the clay is 5 m. A well penetrates the entire depth of the permeable material down to the clay.

a. Sketch (without calculations) the profile of the water table of the unconfined aquifer through the island on the attached diagram for the following conditions:
   i. no withdrawal from the well and no infiltration
   ii. a constant withdrawal from the well and no infiltration
   iii. constant uniform infiltration at the surface and no withdrawal from the well
   iv. constant uniform infiltration and constant withdrawal from the well
b. If the well has a diameter of 0.5 m, what will the drawdown at the well be for a withdrawal rate of 50,000 L/day, assuming no infiltration?
c. If the infiltration rate is a constant 0.001m/d and a well withdrawal rate of 50,000 L/d, at what distance from the well will the water table elevation be at a maximum?
d. Under the conditions in the previous question, what will the drawdown at the well be?

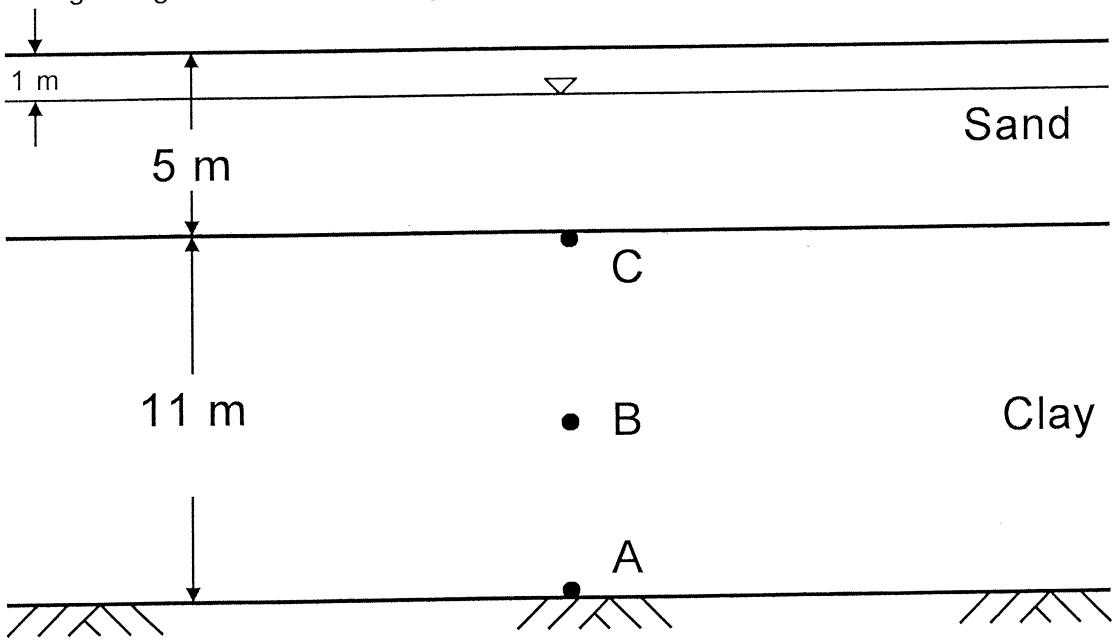


3. (20 Marks)
You are involved with a field investigation and need to determine the density characteristics of a fine grained soil. Without any of the standard investigative tools, you take a 10 cm long, 2 cm inside diameter copper pipe and push it into the undisturbed soil to collect soil for later analysis in the lab. Once in the lab you remove the soil and determine its mass is 49.2 g and after drying is only 45.8 g. You may assume that the density of the soil particles are typical of mineral soils. Determine:

a. Void Ratio and porosity of the insitu soil
b. Bulk and dry densities of the insitu soil
c. Degree of saturation
d. Comment on whether these seem appropriate for this type of soil
e. Comment on how you might improve your approach to sampling, testing and analysis

4.(20 Marks)
The figure below shows two soil strata for a proposed construction project. The lower layer consists of 10 m of clay and the upper layer is 5 m of coarse sand. The water table is 1 m below the ground surface as shown. Specific weights of the sand and clay in a dry condition are: 19 and 18 kN/m^3, respectively and saturated are 22 and 21 kN/m^3, respectively.

a. What are the pore, total and effective stresses in the soils at locations A, B and C? Note that B is ½ way between A and C.
b. If the water table is quickly drawn down for dewatering to location C (the sand/clay interface), what are the pore, total and effective stresses at these same locations immediately after draw down and some long time after?
c. Sketch the change in effective stress at location B as a function of time beginning before the lowering of the water table unit a long time after.



5.(20 Marks)
The infiltration characteristics of an agricultural field are being studied. On the basis of double-ring infiltrometer tests, the maximum initial infiltration for the soil is 90 mm/hr and after a long time of continuous testing yields a constant infiltration rate of 10 mm/hr. During testing it was noted that from 30 to 35 min after testing, 1.3 mm of water infiltrated.

a. If the Horton infiltration equation was used to model the infiltration characteristics of the soil, draw the infiltration rate as a function of time from a time of initially dry to say 4 hours.
b. During this same 4 hours, what would be total amount of water infiltrated in mm?

6.(20 Marks)
Soil from a borrow pit is to be used for a constructed fill in the construction of a storage lagoon. The construction details call for the fill to be placed and compacted to 95% Proctor density. This is known to correspond to a void ratio of 0.35. The material to be used for the fill comes from a borrow pit with a void ratio of 0.60.

a) Describe what "95% Proctor Density" means.
b) Is it possible to achieve a Proctor density of more than 100%? If yes, how would this be achieved? If no, why not?
c) What volume of material from the borrow pit will need to be removed to make up the required 500 m^3 of in-place material?
d) Plot the relationship between water content and bulk density for a soil undergoing a standard compaction effort.
e) Show on the same graph as used for item d, the effects of increasing or decreasing the compaction effort.
f) Suggest ways that the required compaction might be achieved in the construction.

7.(20 Marks)

The table below summarizes the results from two consolidated-undrained triaxial tests on a cohesive soil.

a) What is meant by an "undrained" test?
b) What are the apparent shear strength parameters, c and φ?
c) What are the effective shear strength parameters, c' and φ '?
d) 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 at the end to help answer this question.

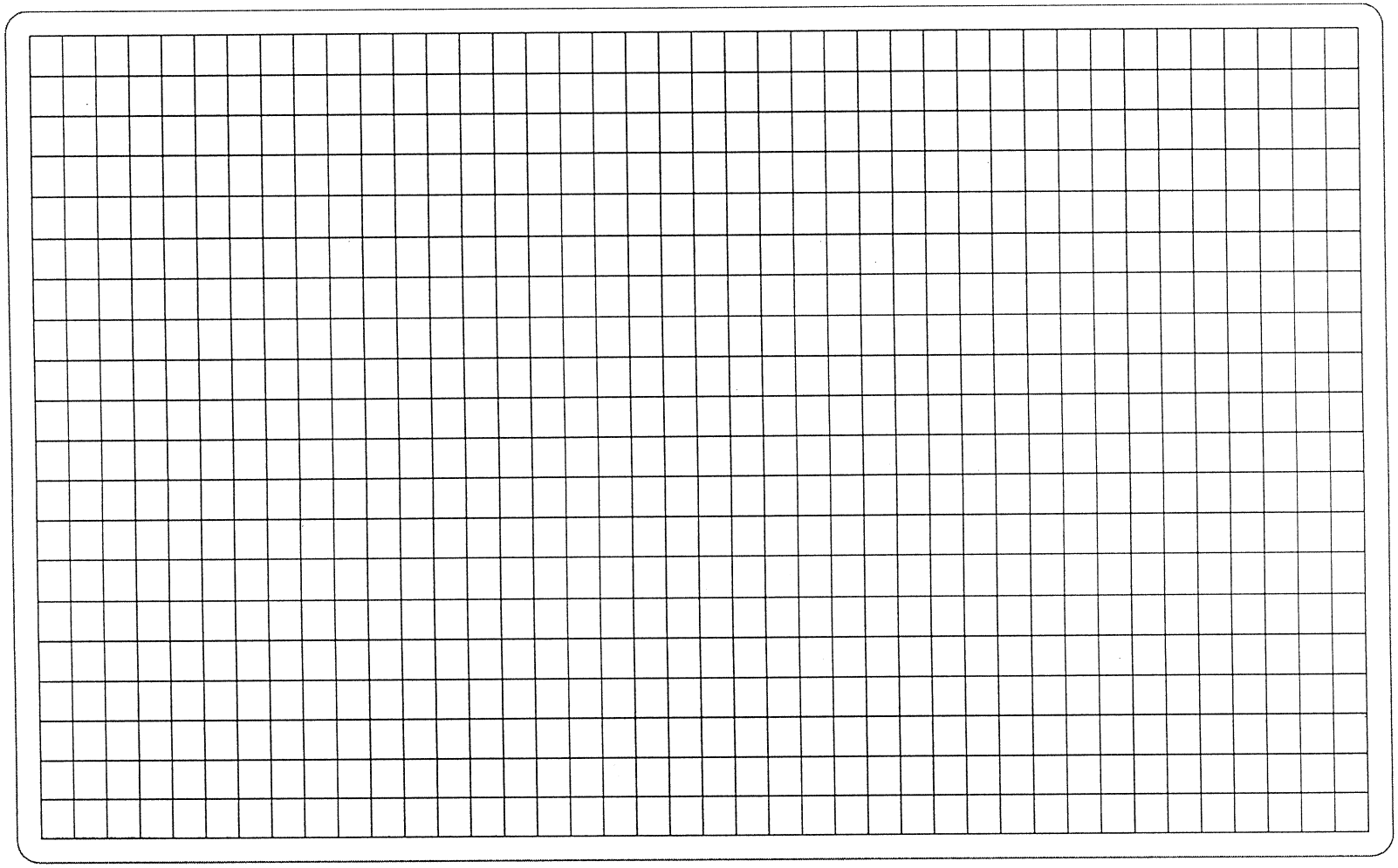


Figure to be used with question 7, include this page with your answer book.