National Exams May 2014

04-Agric-A2, Soil Physics & 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 a written answer. Clarity and organization of the answer are important.

1.(20 Marks)

Provide Definitions for the following terms:

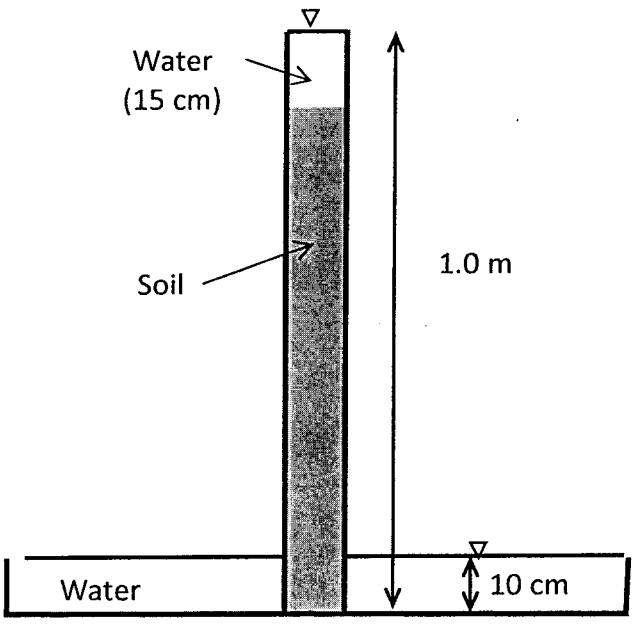
a. Saturated Hydraulic Conductivity
b. Effective stress
c. Soil texture
d. Loam
e. Porosity
f. Moisture content
g. Mohr's circle
h. Proctor Density
i. Phreatic Surface
j. Cohesive Soil

2. (20 Marks)

The following figure shows a device used for measuring the hydraulic conductivity of an undisturbed soil column. With this device the 10 cm inside diameter cylinder is pushed into the soil until the soil is 15 cm from the top of the cylinder and then removed. The cylinder with soil is then placed in another, larger, pan with 10 cm of water in it. Water is added to the top of the cylinder over time, keeping the water level in the cylinder constant and level with the top of the 10 cm diameter cylinder. The volumes of water added to keep the water level constant at the top is measured every hour and noted in the table below. The amounts added are larger than at the end.

a. From this data, estimate the saturated hydraulic conductivity of the soil
b. Provide an explanation, from a soil/water behaviour point of view, for the changes in the volumes necessary to keep the water level constant.

Time Interval (hours)	Volume Added (Litres)
0-0.5	1.20
0.5-1.0	0.750
1.0-1.5	0.604
1.5-2.0	0.520
2.0-2.5	0.515
2.5-3.0	0.520
3.0-3.5	0.525
3.5-4.0	0.515



3.(20 Marks)
A sandy loam soil sample is obtained from a construction site and subsequently dried. The characteristics are given in the table. Determine the following soils characteristics:

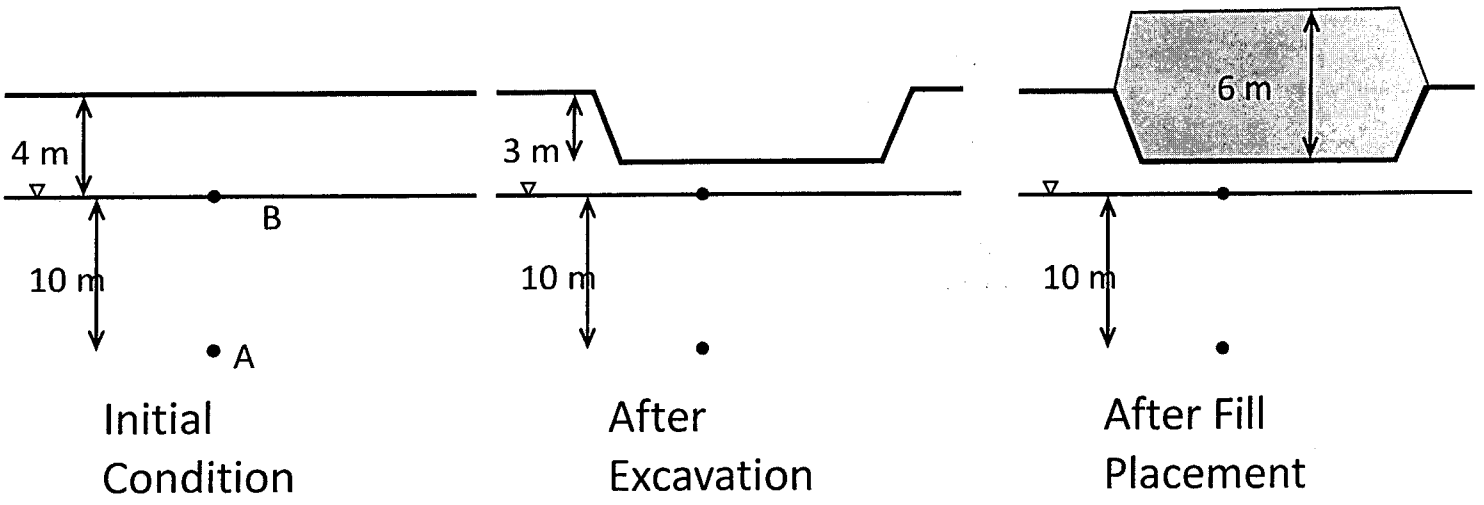
a. Void Ratio and porosity
b. Wet and dry densities
c. Degree of saturation
d. Comment on whether these seem appropriate for this type of soil

Characteristic	Value
Sample volume (cm^3)	1200
Original Mass (kg)	2.005
Mass after drying (kg)	2.915
Particle density (g/cm^3)	2.63

4.(20 Marks)
The figure below shows a subsurface profile in which the native soil is poorly drained and has a water table condition 4 m below the surface. Above the water table the soil specific weight is 16.7 kN/m^3, below the water table 19.9 kN/m^3 and the fill brought in has a density of 16.0 kN/m^3. To prepare for construction on the site the following sequence of construction is anticipated:

1. The top 3 m of existing soil will be removed over a large area
2. Shortly after that 6 m of fill will be brought in to consolidate the underlying soil strata and left for a considerable amount of time.

For this situation, determine the total, pore and effective stresses at the two points A and B in the figure at three points in time: prior to any work being completed, after the excavation, and immediately after the placement of the fill.



5.(20 Marks)
A new 1 m diameter irrigation supply well has been installedand fully penetrates a horizontal, unconfined aquifer. The initial saturated thickness of the aquifer is 5.0 m and the hydraulic conductivity is unknown. A steady state test is conducted at a flow rate of 50,000 L/day. Two nearby observation wells fully penetrate the aquifer and show steady state drawdowns of 0.001 and 0.021 m at distances of 20 and 5 m away from the pumping well, respectively.

a. What is your estimate of the hydraulic conductivity of the aquifer for these conditions?
b. What assumptions did you need to make to carry out the above estimate?
c. What amount of drawdown would you expect in the 1m diameter pumping well?

6.(20 Marks)
The data below has been collected for two soils to be used as fill material for the leaching bed of an on-site sewage system.

Sieve		% Finer	
Number	**Opening (mm)**	**Sample 1**	**Sample 2**
4	4.76	92	100
8	2.38	66	92
10	2.00	56	79
20	0.85	36	61
40	0.425	24	53
60	0.25	19	44
100	0.15	11	37
200	0.075	9	35
Characteristics of the -40 Fraction			
	LL	N/A	46%
	PL	N/A	29%

a. On the attached graph paper, draw the grain size curves for the two soil samples.
b. What are the coefficients of uniformity and concavity of the two soils?
c. Which of the soils is more poorly graded?
d. If the soil with the higher permeability is preferred for the leaching bed, which soil would you recommend?
e. Classify the soil you recommended according to the Unified Soil Classification System.

7.(20 Marks)
Several specimens of a particular soil are tested and found to have shear strength parameters of:

$\varphi' = 30^\circ$ and $c' = 10\ kN/m^2$.

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?

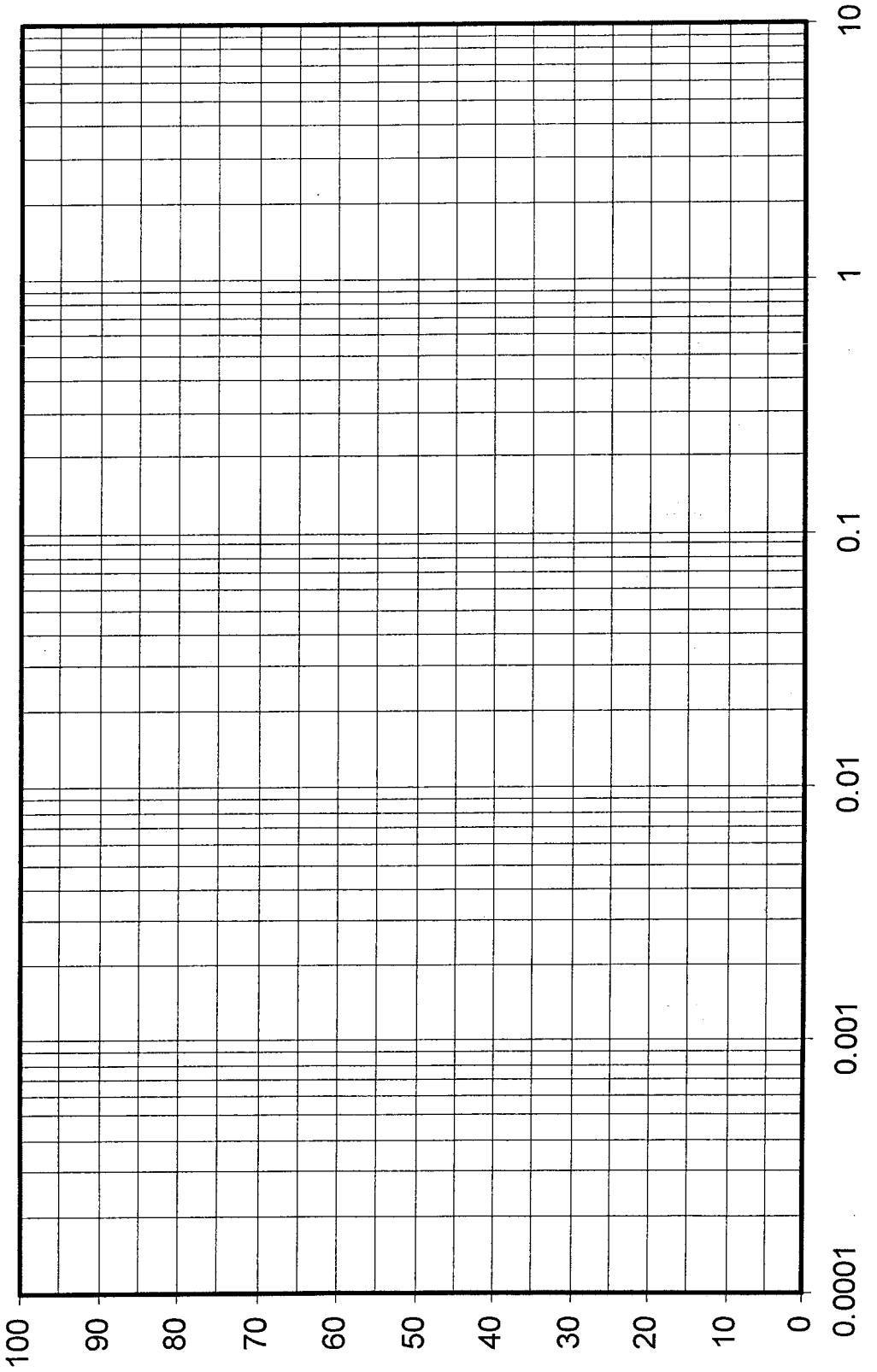


Figure to be used with question 6 – submit this with your answer booklet.