

National Exams May 2010

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. Four (4) questions constitute a complete exam paper.
The first four 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. (25 Marks)

Provide Definitions for the following terms:

- a. Consolidation
- b. Void ratio
- c. Degree of saturation
- d. Montmorillonite
- e. Mohr's circle
- f. Proctor Density
- g. Phreatic Surface
- h. Soil Structure
- i. Cohesionless Soil
- j. Atterburg Limits
- k. Capilarity
- l. Saturated Hydraulic Conductivity

2. (25 Marks)

The infiltration characteristics of a soil are to be represented by the Horton Equation to describe the infiltration as a function of time.

Parameter estimates have already made and these include:

Initial infiltration capacity = 12 mm/hr

Equilibrium capacity = 1.0 mm/hr

Infiltration rate after 2.0 hours = 2.5 mm/hr

- a. What is the decay constant for the Horton Model of Infiltration?
- b. What is the infiltration rate after 4 hours of excess precipitation?
- c. What is the total depth of infiltration for a storm of approximately constant 15 mm/hr intensity for 4 hours?
- d. If the storm has a rainfall intensity 10 mm/hr, what is the total amount infiltrated in the first hour?

3. (25 Marks)

The table below shows the results of the grain size analysis of two soils.

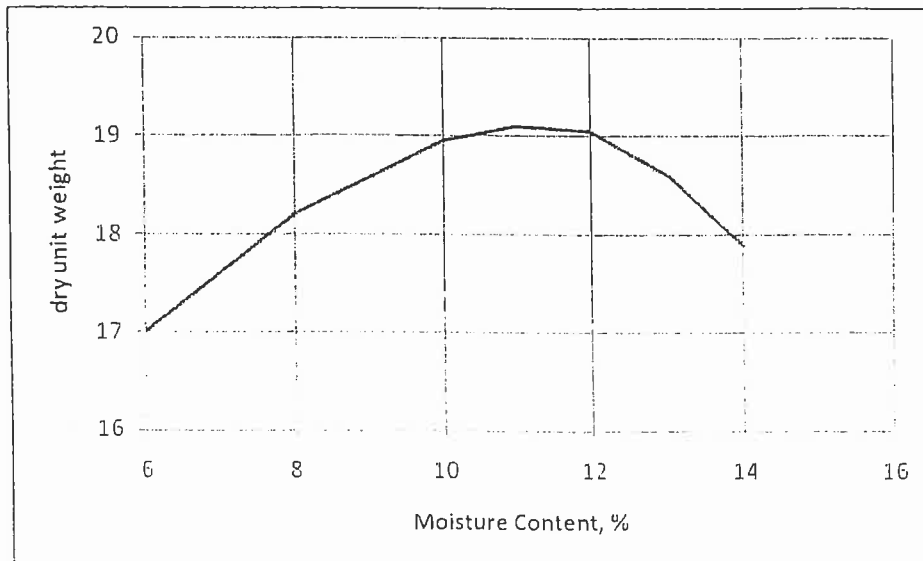
- Using the attached graph paper, graph the grain size distribution for each soil.
- Classify the two soils according the classification system of your choice.
- Which of the two soils is more poorly graded?
- For a fill application in which you are trying to encourage drainage, which of the two soils would you select? Justify your choice.

Particle Size	Soil F	Soil G
20 mm	100	
6.3 mm	94	
2.0	69	
0.60 mm	32	100
0.212 mm	13	95
0.063 mm	2	73
0.020 mm		46
0.006		25
0.002		13
Liquid Limit		32
Plastic Limit		24

4. (25 Marks)

The figure below shows the results of a standard proctor compaction test for soil to be used in construction. The soil is a gravelly, silty sand with particle grain specific gravity of 2.65

- Sketch on the figure where the line of zero air voids would plot.
- For the test completed at a water content of 10%, what is the % of the void volume filled with air?
- What is the effect on the soil after it is compacted in terms of its hydraulic, structural and erosive behavior?



5. (25 Marks)

The table below shows the results of a direct shear test on a soil specimen.

- For this soil determine the friction angle and the apparent cohesion.
- For what soils is a direct shear test most appropriate for?
- What alternative laboratory tests are there in addition to the direct shear test and why might they be used?
- What options are there for determining shear strengths of soil in the field? Why might they be preferred?

Test No.	Normal Force (kg)	Shear Force (kg)	Area (cm)
1	4.4	5.1	5.0x5.0
2	8.8	6.8	5.0x5.0
3	13.2	8.1	5.0x5.0
4	17.6	9.7	5.0x5.0

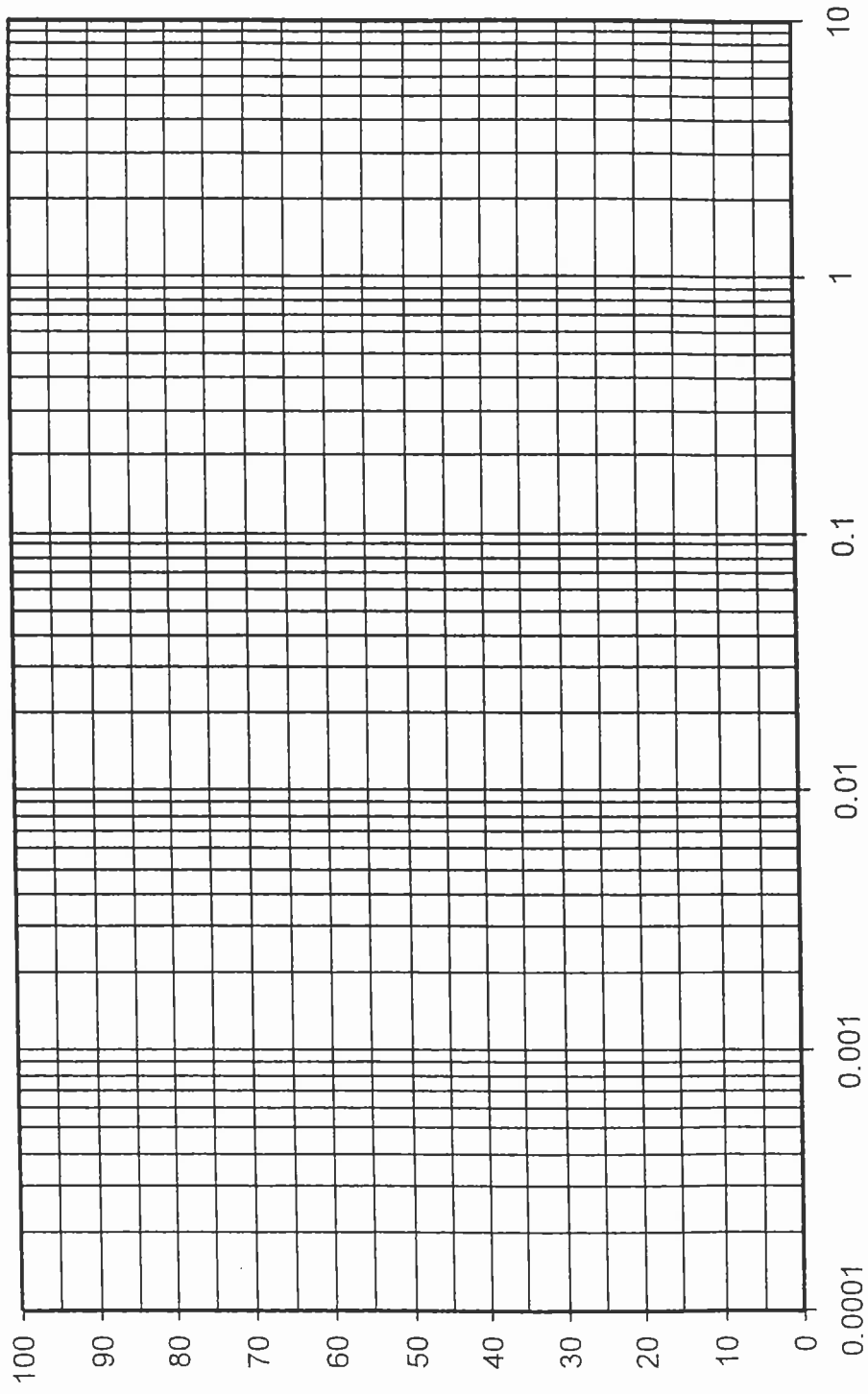
6.(25 Marks)

An excavation in a soil is made to determine some of the in-situ properties. The excavation is 1 m deep, with vertical walls. On one of the walls of the excavation a steel ring with an inside diameter of 3.3 cm and length of 2.8 cm is driven into the soil and removed with the soil flush at both ends. It is immediately placed in an air tight bag for later analysis. At the lab the soil is removed from the ring, weighed, then dried in an oven at 100°C for 24 hours and then weighed again. The data below was obtained:

Mass of the soil before drying: 41.023 g
 Mass of soil after drying: 37.122 g
 Density of soil particles: 2.65 g/cm³

- What is the in-situ bulk density of the soil?
- What is the dry density of the soil?
- What is the moisture content of the soil as collected in the field?
- What problems can you identify with this approach to determining the in situ properties above?

Figure to be used with question 3, include this page with your answer



book.