

NATIONAL EXAMS – MAY 2003
98-GEOL-A6 SOIL MECHANICS

3 HOURS DURATION

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- 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. Any non-communicating calculator is permitted. This is an OPEN-BOOK exam. The candidate 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 workbook).
 3. Questions have the values shown.
 4. Candidates must identify clearly the source of charts used and where applicable the source of assumed values used in the calculations.
 5. In the absence of specific parameters required in the formulation and solution of problems, the candidates are expected to exercise sound engineering judgment and to clearly state their assumptions.
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1. With reference to Figure Q.1, two standpipe piezometers are installed in a system with two sandy aquifers, confined by clay layers. The position of the water in the piezometers is shown on the figure. The intake of piezometer #1 is located exactly in the middle of the sand layer #1. Flow through the system is vertical (only) and driven by the permeable rock and free water boundaries (both constant head boundaries) below and above respectively.

a. Determine the elevation “Z” of the water level in piezometer #1, above (or below) the surface of the free water.
 (value 15)

b. Calculate the rate of seepage and the seepage velocity through the aquitards.
 (value 5)

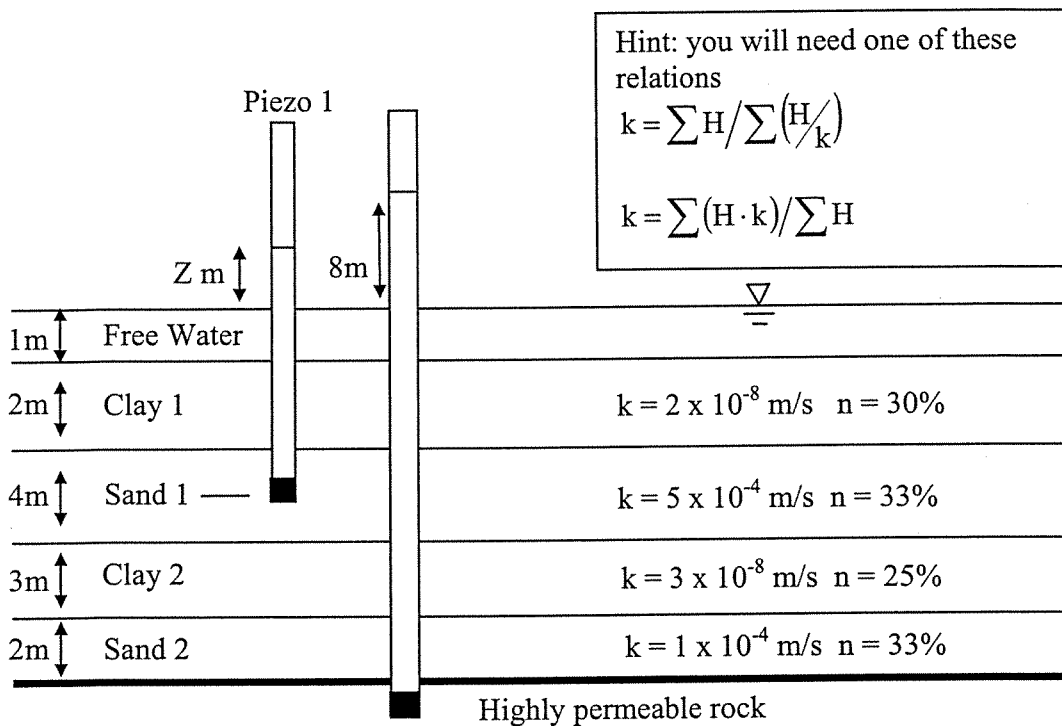


Figure Q.1

2. Soil having a void ratio of 0.68 as it exists in a gravel pit is to be excavated and transported to a fill site where it will be compacted to a void ratio of 0.45. The volume of fill required at the construction site (at a void ratio of 0.45) is 2,500 m³. Find the volume of soil that must be excavated from the gravel pit to provide the required volume of fill.

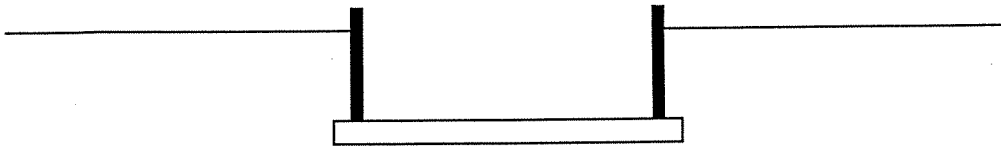
(value 10)

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3. Describe the physical and chemical processes that can be involved in the creation of tropical residual soils.

(value 10)

4. It is proposed to place a square rigid basement/raft foundation (see figure below) measuring 18m x 18m in an excavation taken to a depth of 5m. The total structure load, including the foundation, is 90MN. The soil at the site is a 15m thick clay layer over impervious bedrock. The water table is 5m below the surface. The bulk unit weight of the clay (γ) above and below the water table is 18kN/m³.



Laboratory tests on samples collected at two different depths, give the following information about the clay:

Depth: 7.5 m	$\sigma'_p = 200$ kPa	(preconsolidation pressure)
	$C_r = 0.070$	(recompression index)
	$C_c = 0.60$	(compression index)
	$e_o = 1.10$	(initial void ratio)
	$E_u = 90$ MPa	(undrained elastic modulus)
Depth: 12.5 m	$\sigma'_p = 300$ kPa	(preconsolidation pressure)
	$C_r = 0.040$	(recompression index)
	$C_c = 0.520$	(compression index)
	$e_o = 0.80$	(initial void ratio)
	$E_u = 90$ MPa	(undrained elastic modulus)

The coefficient of consolidation (c_v) of the entire clay deposit for the stress range being considered is 1×10^{-4} cm²/sec.

- a. Calculate the consolidation settlement of the footing.
- (value 15)
- b. Calculate the amount of consolidation settlement that will occur after 10 years.
- (value 5)
5. What are the soil strength parameters c' and ϕ' , what affects them and how can they be determined in the lab?
- (value 10)
6. List all of the factors that affect the hydraulic conductivity of a soil and describe two laboratory tests that can be performed to measure it, indicating to what type of conditions each test is best suited.
- (value 10)

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7. Using sketches of stress paths, describe the evolution of total and effective stresses in a clay layer subjected to the addition of a vertical load, in the short term and in the long term. (value 5)
8. Using sketches of stress paths, describe the evolution of total and effective stresses at the bottom of an excavation in clay, in the short term and in the long term. (value 5)
9. Explain why the horizontal force required to induce passive failure in a soil mass, is much greater than the force applied to a wall retaining the same soil mass in active failure (a sketch with Mohr circles and a Mohr-Coulomb failure criteria, is highly recommended). (value 10)