National Exams May 2012

04-Env-A3, Geotechnical and Hydrogeological Engineering

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.

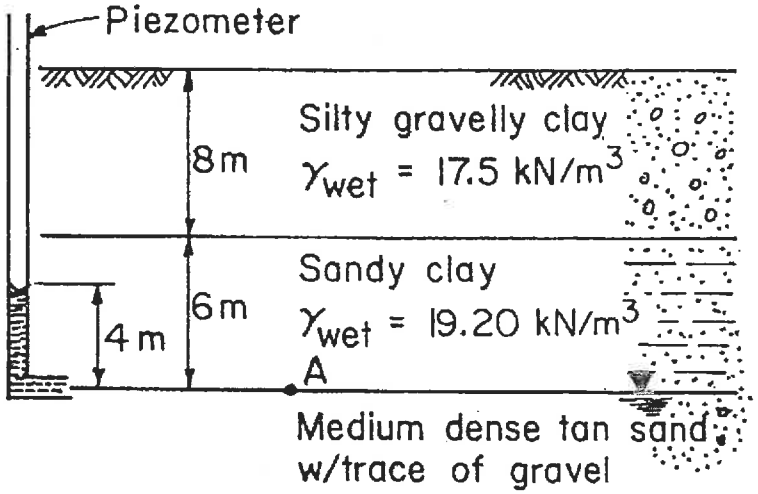
3. Five (5) questions constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.

4. Each question is of equal value.

5. Some questions require an answer in written format. Clarity and organization of the answer are important.

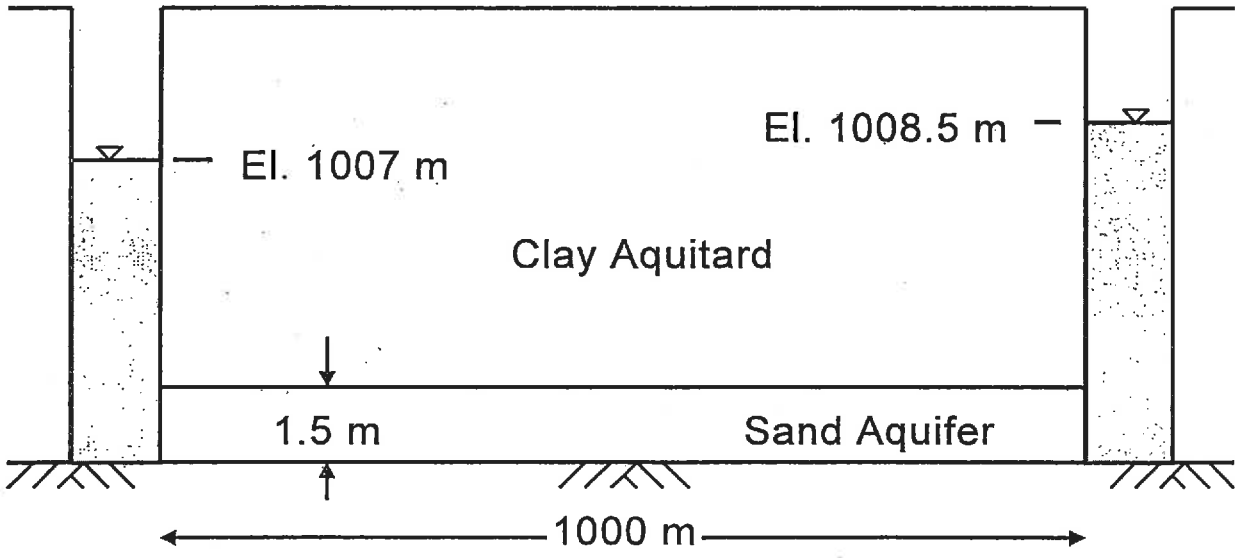
1.(20 Marks)
The figure below shows a soil profile for a three-layer system.

a. Determine the total stress, effective stress and pore pressure at point "A" in the figure for the conditions shown.
b. If the piezometric head drops 1.0 m due to a change in water table, what is the effective stress at "A"?
c. What piezometric head due to a change in water table location is required to make the effective stress at "A" = 0 kN/m^2?



2.(20 Marks) The figure below shows a thin aquifer connecting two irrigation canals 1000 m apart and running parallel to each other. The canal to the left has a water surface elevation of 1007 m while that to the right has a water surface elevation of 1008.5 m. The sand aquifer connecting the two has a constant thickness of 1.5 m, bottom elevation of 1000 m, porosity of 0.35 and a saturated hydraulic conductivity of 250 m/d. The sand layer is confined from above by a clay layer.

a. Sketch the steady state piezometric height in the aquifer for the situation above.
b. What will be the discharge (in m^2/day) in the aquifer from one canal to the other?
c. If a contaminant was accidently introduced into the canal on the right, how long would it take to reach the canal on the left?
d. If instead of a clay aquitard above, the sand continued to the surface, what would the discharge be?
e. If, in addition to the sand continuing to the ground surface as in part d, there was a recharge of 1.5 mm/day to the whole system:
    a. What would the piezometric surface look like (sketch this), and
    b. What would the discharge into the canal on the left be?



3.(20 Marks) The data in the table below are data collected from a falling head permeameter test conducted on a sample taken from the field. The sample has a diameter of 100 mm and a length of 150 mm. The standpipe used to measure the falling head is 10 mm in diameter. Determine:

a. The saturated hydraulic conductivity for the soil, and
b. Suggest what types of soil this might correspond to.

Time from start of test (s)	Height of water in standpipe above overflow (m)
0	1.60
60	1.51
120	1.42
240	1.26
480	0.99

4.(20 Marks)The figure on the last page of the examination shows a sheet pile wall used to keep an excavation dry. The material below the water above the impervious layer is homogeneous and isotropic with a saturated hydraulic conductivity of 6×10^{-4} m/s.

a. Using a flow net analysis, determine the seepage under the sheet pile wall per linear meter of the wall. Submit this page with your answer booklet.
b. What is the pore pressure on the sheet pile wall 1 m above the lowest point on either side of the wall?

5.(20 Marks) The table below gives the results from a standard compaction test on a soil using a mold with a 1000 cm^3 volume. Using a value for the soil grain specific gravity of 2.67:

a. Plot the dry density-water content curve (a chart is provided at the end of the test for this),
b. Determine the optimum water content,
c. Determine the maximum dry density
d. Value of the air content at the maximum dry density.
e. The porosity and void ratio at the maximum dry density.

Mass (g)	Water Content (%)
2010	12.8
2092	14.5
2114	15.6
2100	16.8
2055	19.2

6.(20 Marks) The results shown below were obtained at failure in a series of undrained triaxial tests on specimens of a saturated clay initially 38 mm in diameter and 76 mm long. Determine the shear strength parameters with respect to total stress.

Test	All-round pressure (kPa)	Axial Load (N)	Axial Deformation (mm)
1	200	222	9.83
2	400	215	10.06
3	600	226	10.28

Figure for use with Queston 4

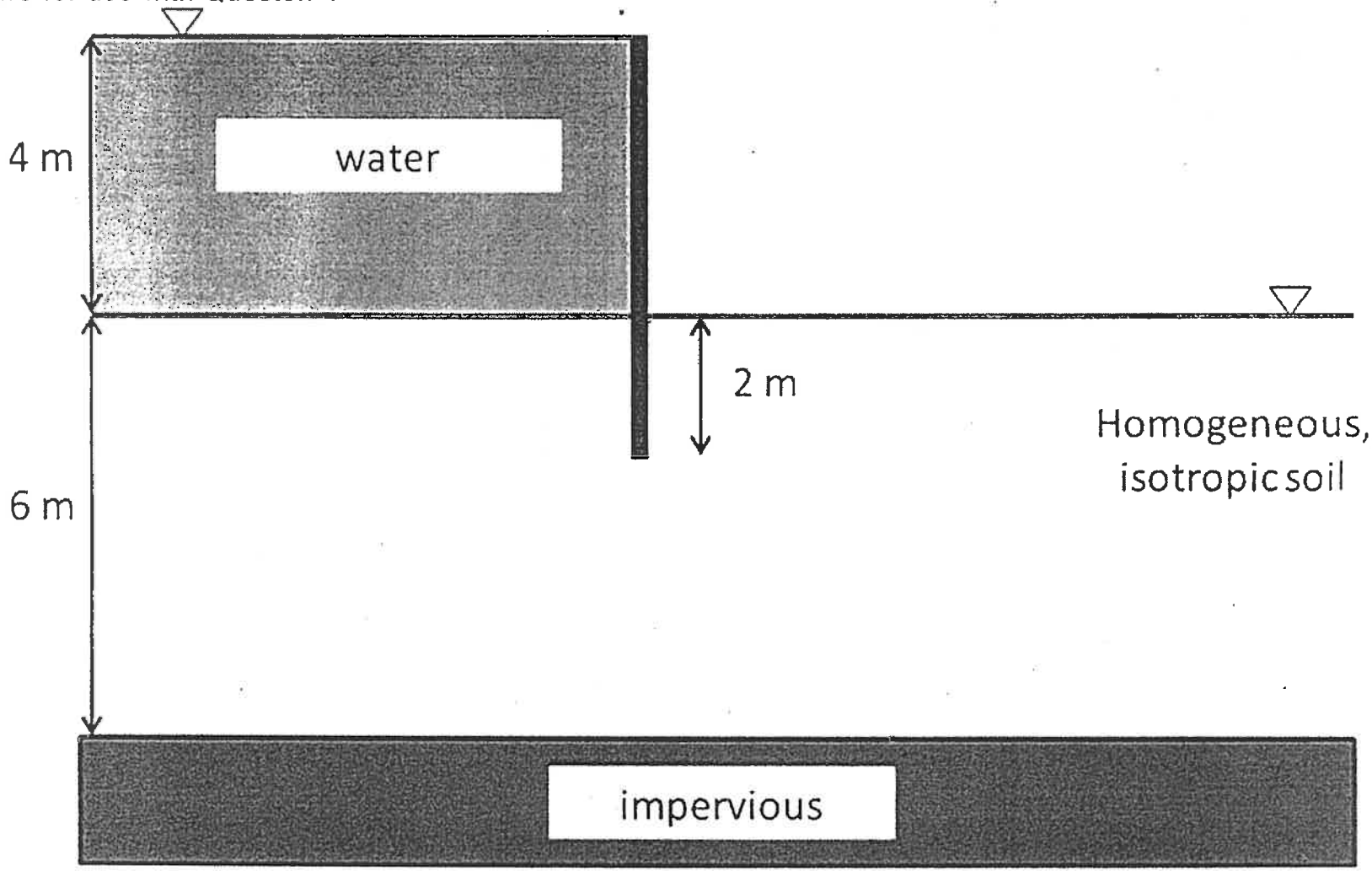


Figure for use with Question 5

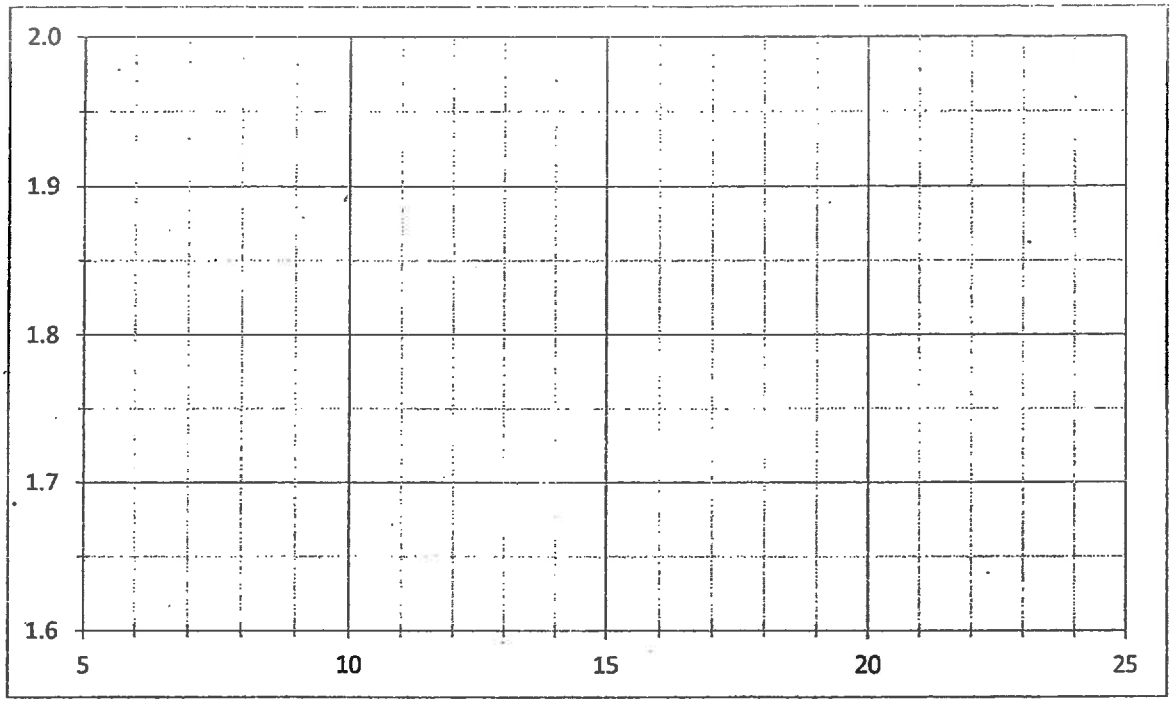


Figure for use with Question 6