ORDRE DES INGÉNIEURS DU QUÉBEC

May 2016 SESSION

Open-book exam Calculators: only authorized models Duration: 3 hours

14-BA-A6 GEOTECHNICAL

Question 1. (15 %)
Based on grain size and test data given in Table 1, classify the soil samples A and B according to the USCS and AASHTO classification systems.

USCS: Unified Soil Classification System
AASHTO: American Association of State Highway and Transportation Officials

Table 1

Sieve	Soil A (% Finer)	Soil B (%Finer)
Sieve no. 4 (4.75mm)	*93*	*100*
Sieve no.10 (2mm)	*84*	*98*
Sieve no. 40 (0.42mm)	*73*	*87*
Sieve no. 100 (0.149)	*65*	*50*
Sieve no. 200 (0.075mm)	*60*	*9*
Atterberg limits Liquid limit (LL) Plastic limit (PL)	 *31* *20*	 *NL* *NP*

Question 2. (10 %)

A canal is dug parallel to a river, as shown in figure 1. A sandy-silt seam of average thickness 0.5m cuts across the otherwise impermeable clay. The average vertical and horizontal hydraulic conductivities are $2.5*10^{-5}$ cm/s and $25*10^{-5}$ cm/s, respectively. Determine the flow rate of water from the canal to the river for a 1m length of canal.

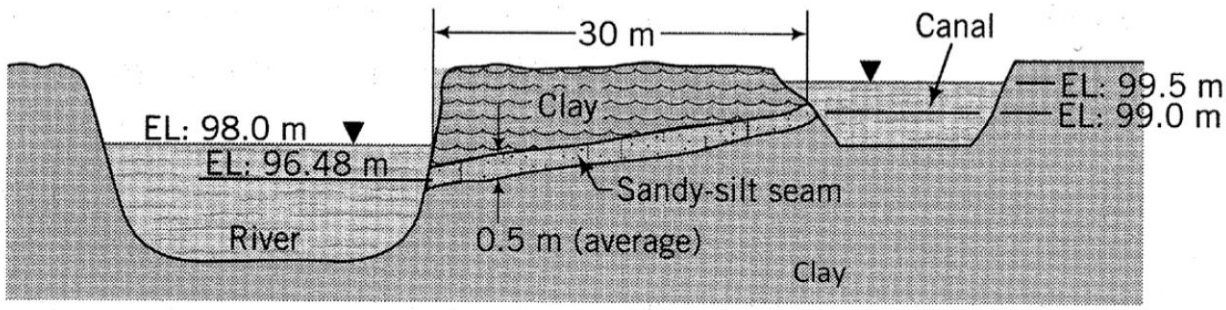


Figure 1.

Question 3. (15 %)

You are checking a field compacted layer of soil. The laboratory control curve has the following values:

ρ_d (Mg/m^3)	*W (%)*
1.667	14
1.691	16
1.699	18
1.683	20
1.659	22
1.619	24

The specification for compaction states that the compacted field soil must be at least 95% of the maximum control density and within ± 2% of the optimum moisture for the control curve. You dig a hole of 944000mm^3 in the compacted layer and extract a sample that weight 1814 g wet and 1542 dry.

a) What is the compacted ρd ? The compaction w ? The percent compaction? Does the sample meet the specification? ***(7.5%)***

b) If the density of the solids is 2.7 Mg/m3, what is the compacted degree of saturation? If the sample were saturated at constant density, what would be the water content? ***(7.5%)***

Question 4. (20 %)

Figure 2 shows a section of an impermeable sheet pile wall, retaining a mass of water on its left side.

a) Draw the flownet using five flow channels. ***(8 %)***
b) Determine the flow rate per metre length of sheet pile if the permeability coefficient is k= $3*10^{-4}$ cm/s.***(5 %)***
c) Determine the maximum hydraulic gradient and calculate the factor of safety against boiling if e=0.68 and G_s=2.6. ***(7 %)***

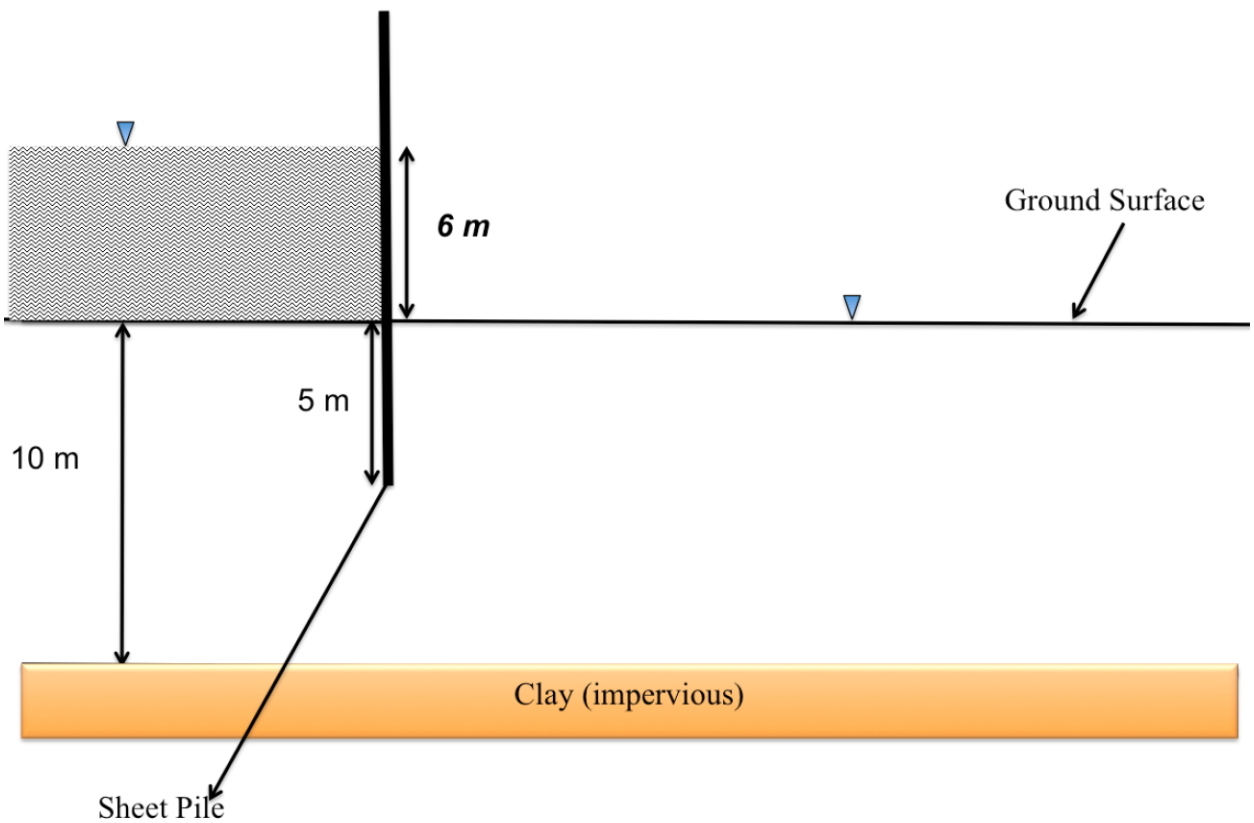


Figure 2

Question 4. (20 %)

We must assess the consolidation settlement at the center of a slab-type foundation with a thickness of 1 m and a dimension of 20m * 20m. The slab is constructed of a reinforced concrete. The load on the concrete slab is 110kPa. Figure 3 shows the soil stratigraphy. Consolidation test results gave these values for the clay soil.

$s_p = 132kPa \quad C_c = 0,43 \quad C_r = 0,03$

Determine the settlement at the center of the slab.

(Settlement in the sand layers is neglected)

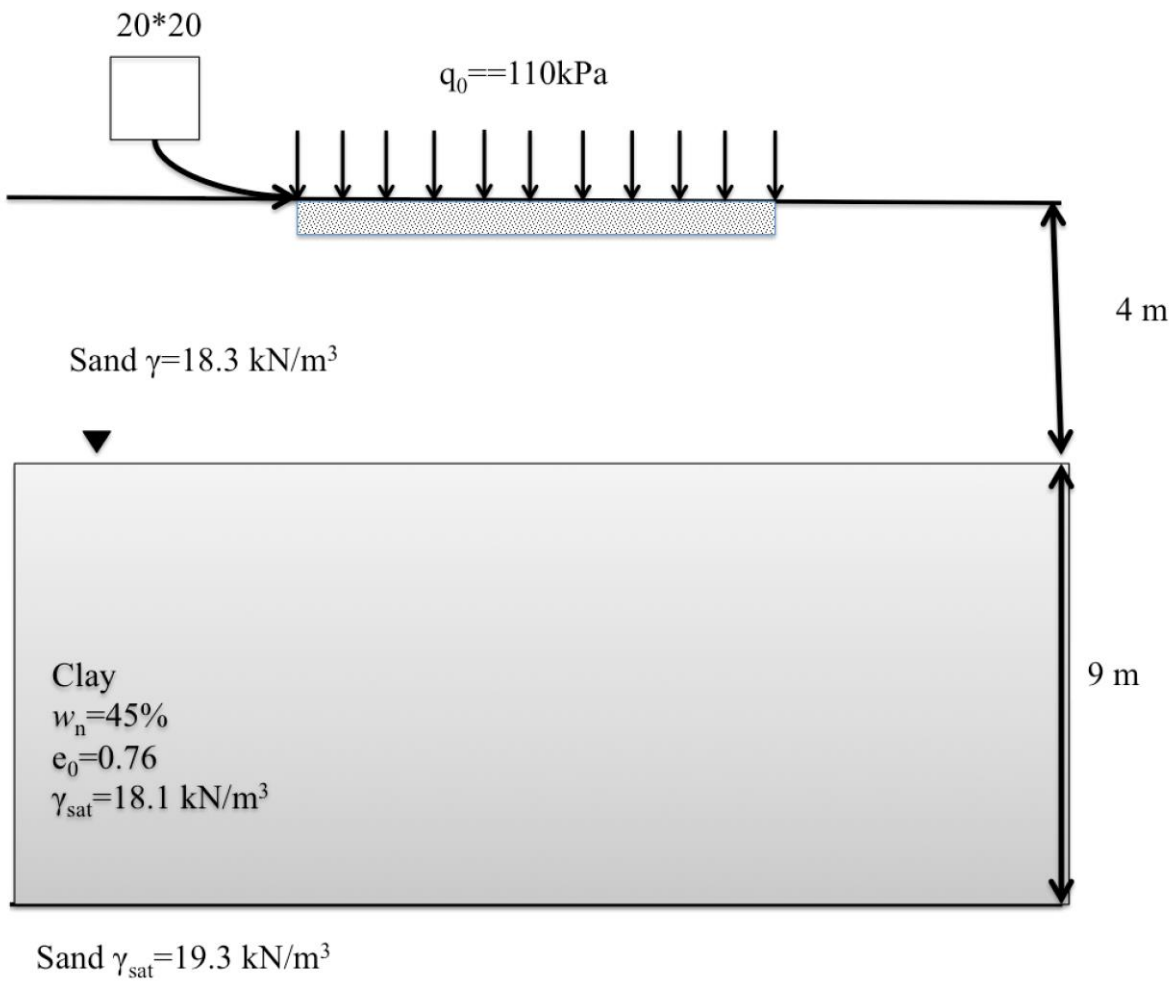


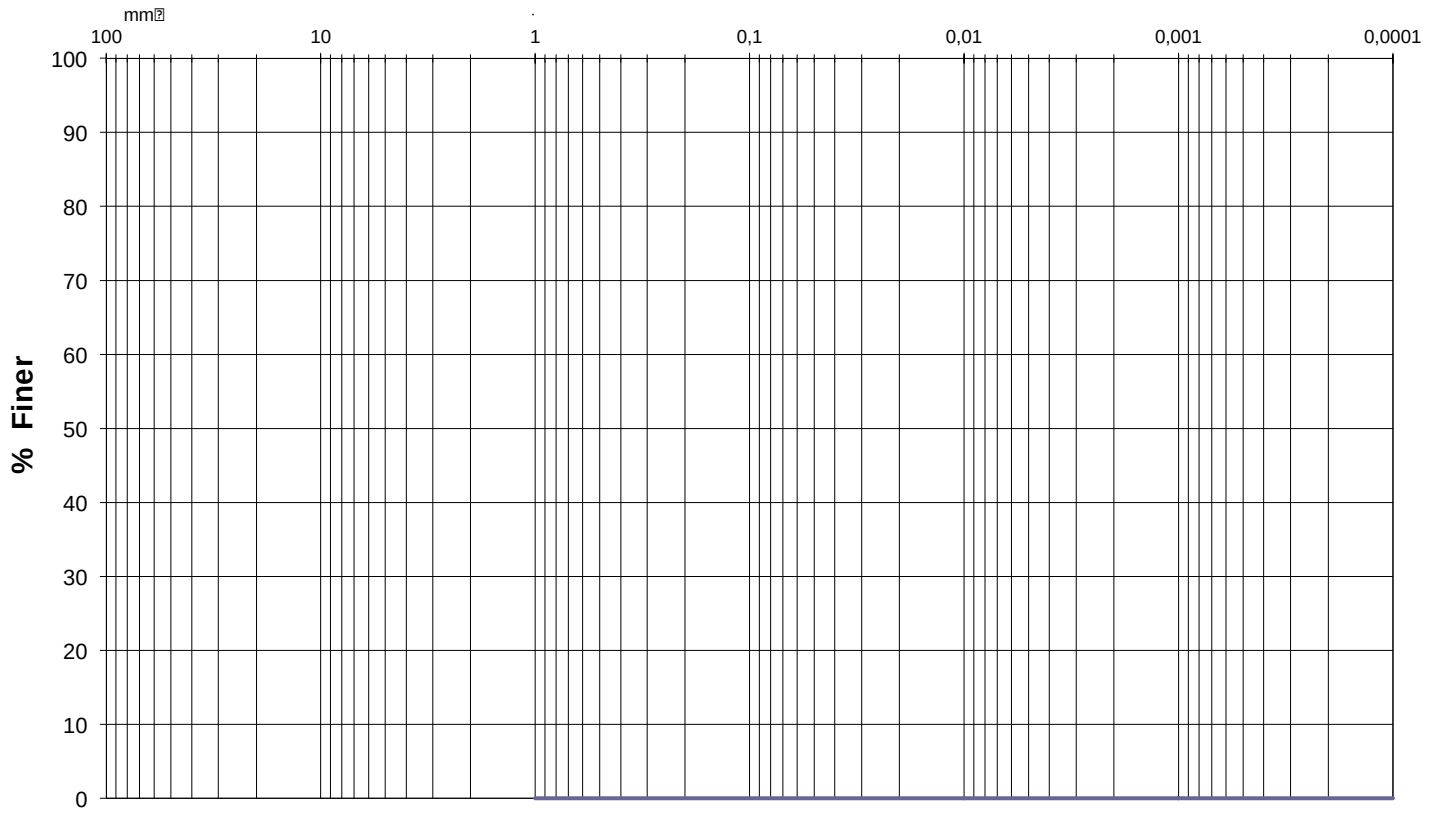
Figure 3

Question 5. (20 %)

Two conventional CD triaxial compression tests were conducted on a dense angular dry sand at the same void ratio. Test *A* had a confining pressure of 100kPa, while in test *B* the confining pressure was 400 kPa; these stresses were held constant throughout the test. At failure, tests *A* and *B* had maximum principal stress differences of 400 and 1700 kPa, respectively.

a) Plot the Mohr circles for both tests at failure. ***(5%)***
b) Assuming C=0 determine ϕ. ***(5%)***
c) What is the shear stress on the failure plane at failure for both tests? ***(5%)***
d) If a state of stress is σ'_1 =510kPa and σ'_3 =120kPa, what are the safety factors (SF)? What is the failure angle with respect to the horizontal plane? ***(5%)***

C: cohesion
ϕ: Friction angle


mm
100
10
1
0,1
0,01
0,001
0,0001
% Finer
100
90
80
70
60
50
40
30
20
10
0