PROFESSIONAL ENGINEERS ONTARIO
NATIONAL EXAMINATIONS – December 2011
98-CIV-B3 GEOTECHNICAL DESIGN

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. 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. Answer **any FOUR questions in Section A** and any **THREE questions in Section B.**

4. **Only the answers submitted to the first four questions of Section A and the first three questions of Section B will be marked. Extra questions answered will not be marked.**

5. Questions will have the values shown.

6. Candidates must identify **clearly the source of design charts used** and where applicable the **source of assumed values used** in the calculations.

7. In the absence of specific information required in the formulation of problems, the candidate is expected to exercise sound engineering judgment.

8. Figures follow the text of the exam.

SECTION A
ANSWER ANY **FOUR** QUESTIONS

Question 1:
Standard penetration tests (SPT) and cone penetration tests (CPT) are both used in geotechnical engineering practice. Which one of these methods is commonly used for testing sandy soils? Provide reasons.

(Value: 7 marks)

Question 2:
Plate load tests are supposed to provide reliable bearing capacity values for sandy soils. However, there are some limitations using the plate load results in engineering practice. What are they? How can you alleviate these limitations to reliably determine the bearing capacity?

(Value: 7 marks)

Question 3:
Slopes that are in imminent danger of failing may be stabilized by two basic approaches. What are these two approaches/methods?

(Value: 7 marks)

Question 4:
When do you prefer to use the λ method in comparison to the α or β method for estimation of the load carrying capacity of single piles?

(Value: 7 marks)

Question 5:
Briefly explain the engineering significance of the following terms a) Active Zone in Expansive soils; and b) Negative skin friction in pile foundations

(Value: 7 marks)

SECTION B
ANSWER **ANY THREE** OF THE FOLLOWING FOUR QUESTIONS

Question 6: **(Value: 24 marks)**

A reinforced concrete retaining wall with soil properties are shown in **Figure 1** below. The stability of this structure which was constructed several decades ago was questioned. Determine the Factor of Safety (FS) of this structure against overturning and sliding, neglecting the passive resistance.

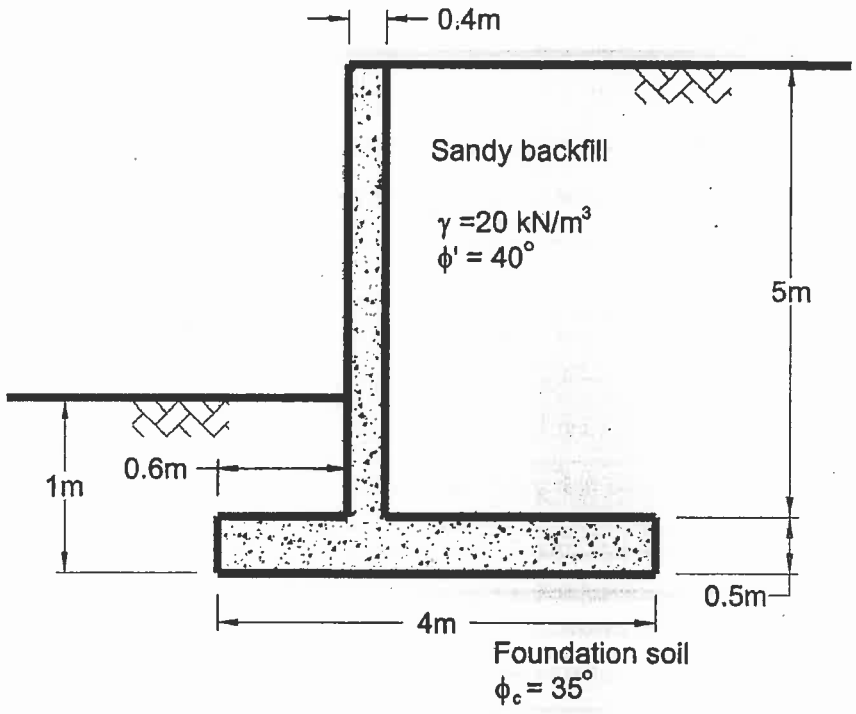

Figure 1

Question 7: **(Value: 24 marks)**

Figure 2 shows a 45° cut in a homogeneous clay with an undrained shear strength, s_u = 50 kPa. The height of the cut is 10 m. The clay is considerably stiff below the base of the cut implying that failure is likely to occur along a slip surface through the toe of the excavation. Calculate the Factor of Safety (FS) for the slip surface shown.

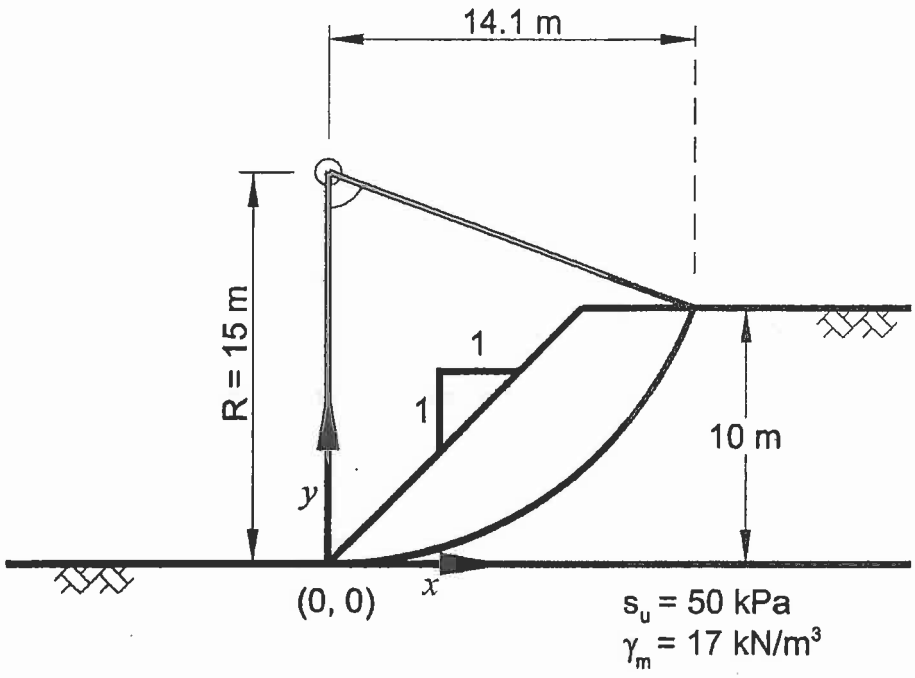

Figure 2

Question 8: **(Value: 24 marks)**

Bored piles of 250 mm diameter are proposed to be designed as a pile group to carry a load of 1500 kN on a soil deposit of clay having the following properties:

Depth (m)	Unit weight of soil (kN/m^3)	Undrained shear strength (kN/m^2)
0	18	60
2	18.5	70
4	19	80
6	19.5	90
8	20	100
10	20	100
12	20	100

If the piles are 9 m long, estimate the number of piles required in the pile group and suggest how they should be arranged. Also, determine the pile group efficiency. If the liquid limit of the clay is 45%, what will be the approximate settlement in the clay layer due to this loading. **Note: Make any suitable assumptions in solving this problem.**

Question 9: **(Value: 24 marks)**

Figure 3 below shows an embankment load on a silty clay layer. Determine the stress increase at points A, B, and C, located at a depth of 4 m below the ground surface.