PROFESSIONAL ENGINEERS ONTARIO
NATIONAL EXAMINATIONS – December 2012
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:
A raft foundation is proposed to be constructed on soft clay which has a shallow ground water table. Explain the approach that you would adopt to design such a foundation.

(Value: 7 marks)

Question 2:
When do you prefer to use CPT results in comparison to SPT results in conventional geotechnical engineering practice?

(Value: 7 marks)

Question 3:
In many scenarios, it is the settlement and not the bearing capacity that is the governing parameter in the design of foundations in coarse-grained soils. Elaborate this statement with suitable practical examples.

(Value: 7 marks)

Question 4:
What are the appropriate shear strength parameters and the other properties that are required in determining the long-term stability of a slope for an earthen dam constructed with a clayey type of soil? Which method do you suggest for determining the factor of safety of such a slope? Give your reasons why these shear strength parameters are recommended. Also, what tests do you recommend to conduct to determine these parameters?

(Value: 7 marks)

Question 5:
Plate load tests (PLT) are considered to be reliable field tests to determine the bearing capacity of soils; however, these tests also have some limitations. Discuss both the advantages and limitations of the PLTs.

(Value: 7 marks)

SECTION B
ANSWER ANY THREE OF THE FOLLOWING FOUR QUESTIONS

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

A 0.3 m steel H-pile is driven 15 m into a clay soil where the following conditions exist: From the ground surface to a depth of 10 m, the clay is normally consolidated, with a unit weight equal to 17 kN/m^3 and undrained cohesion equal to 60 kPa; below 10 m, the clay is slightly overconsolidated, with a unit weight equal to 18 kN/m^3 and undrained cohesion equal to 100 kPa. Determine the design axial capacity of this pile, using a factor of safety of 2. Compute the shaft capacity by assuming that the skin friction is developed on the surface of the rectangular outer perimeter (0.3 m by 0.3 m) of the pile cross-section.

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

In Table I given below, the standard penetration test (SPT) results determined for a sandy soil deposit in the field are summarized. The ground water table was found to be located at a depth of 25m. Estimate the angle of internal friction, ϕ' from the provided data using an appropriate technique **(give the source where this information is obtained)** and determine the allowable load of a shallow foundation measuring 2.0 x 3.0 m in plan and seated at a depth of 1.5 m. **Note: The calculations should be based on the ϕ' value obtained, not on methods based on direct correlations of Bearing Capacity to Penetration Index**

Table I

Depth [m]	Soil Unit Weight [kN/m^3]	N_c
2	19.0	6
4	19.0	10
6	19.0	14
8	21.5	18
10	21.4	20
12	21.4	24
14	21.4	25
16	21.4	26

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

Figure 1 shows the details of likely slope failure surface in homogeneous saturated clay soil. Calculate the factor of safety of the slope given the undrained cohesive strength, $c_u = 30$ kN/m^2, and $\gamma = 17$ kN/m^3.
(Value: 24 marks)

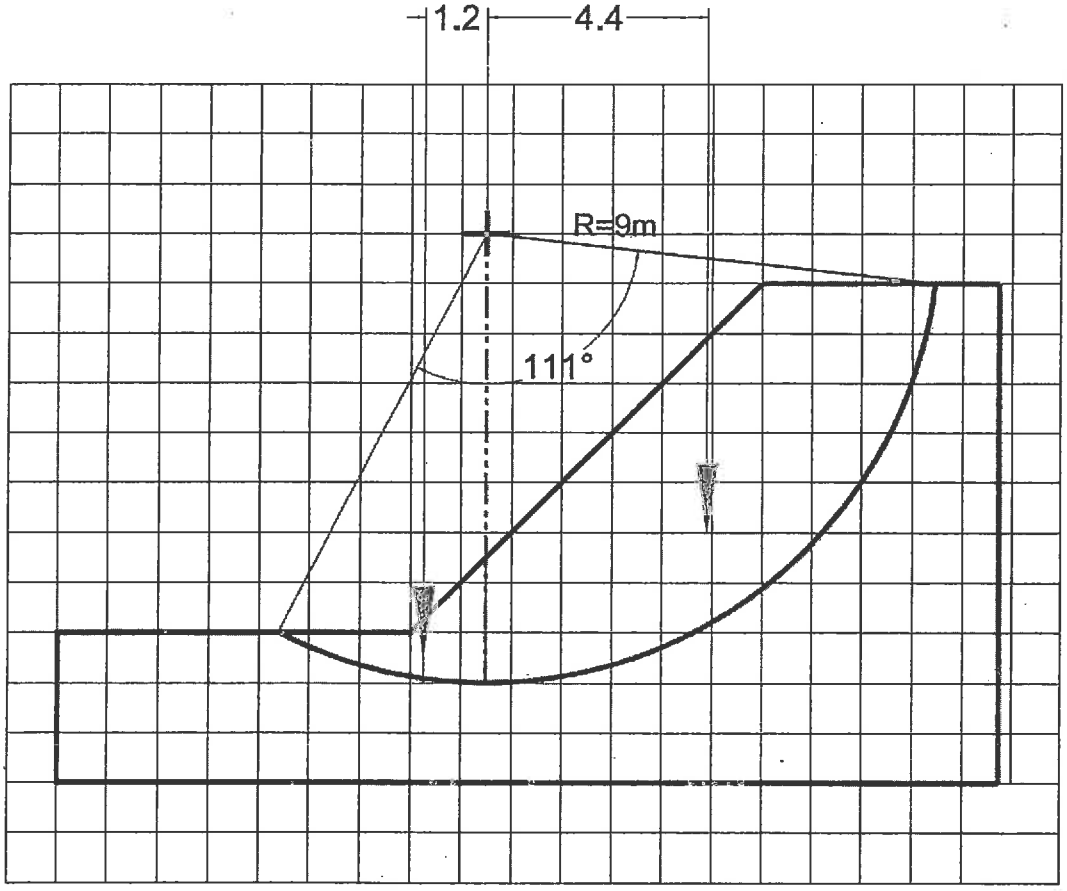

Figure 1

Question 9:
A strip foundation on a layer of sand is shown in **Figure 2** below, along with the variation of the modulus of elasticity of the soil, E_s. Assuming that $\gamma = 21$ kN/m^3 and assuming a creep time of 12 years for the correction factor C_2, calculate the elastic settlement of the foundation, using Schmertmann's strain Influence Factor.

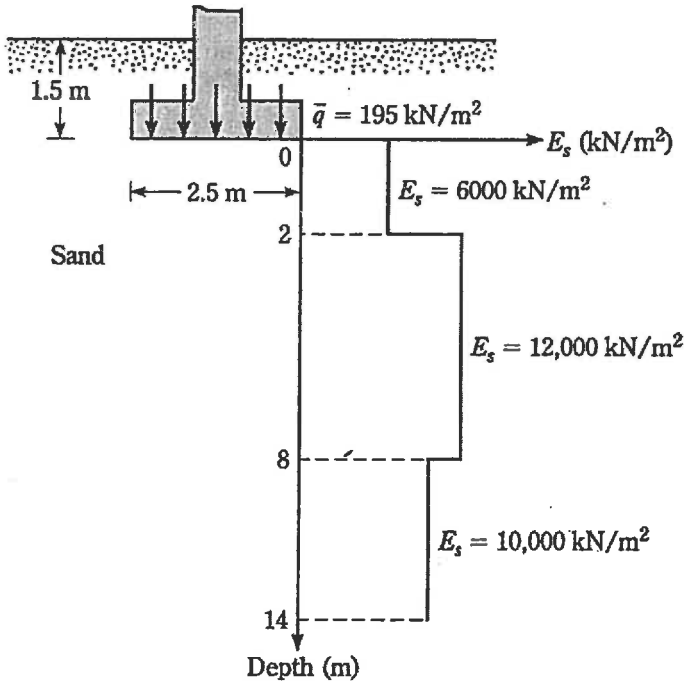
1.5 m
$\bar{q}$ = 195 kN/m²
E_s (kN/m²)
0
2.5 m
E_s = 6000 kN/m²
2
Sand
E_s = 12,000 kN/m²
8
E_s = 10,000 kN/m²
14
Depth (m)

Figure 2