PROFESSIONAL ENGINEERS ONTARIO
NATIONAL EXAMINATIONS – May 2016
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 first four answers submitted in Section A and the first three answers 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:
What the governing criterion in the design of a shallow foundation in a dense sand; stability or settlement? Give reasons.

(Value: 7 marks)

Question 2:
Explain why excavations in clays can stand without any lateral supports for short periods of time. Also, explain how embankments constructed with homogeneous clayey soils gain strength with time.

(Value: 7 marks)

Question 3:
A ten story building is to be constructed on a very compressible soft clay deposit of more than 100 m in depth. What is the key information that you require from site investigation? What is type of foundation that you would suggest that assures safety both with respect to stability and settlements behavior?

(Value: 7 marks)

Question 4:
List the various methods available to determine the field strength of soils. Suggest a suitable method that can be used in engineering practice for rapidly determining the shear strength of dense sands and soft clays? Discuss the limitations each of the methods that you have suggested.

(Value: 7 marks)

Question 5:
Discuss the influence of ground water table (GWT) on the ultimate bearing capacity of shallow foundations on sands for the following cases: (a) GWT at a depth of 5 times the width of foundation (b) GWT at the natural ground level. Do not provide any mathematical equations; explain in your own words.

(Value: 7 marks)

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

Question 6: **(Value: 24 marks)**
Figure 1 shows CPT results of a site from Robertson and Campanella (1988). The groundwater table at this site is at a depth of 3 m below the ground surface. A line load of 400 kN/m is to be supported by a 2.5 m x 30 m footing to be founded at a depth of 3.0 m below the ground surface. Use Schmertmann's method to compute the settlement of this footing soon after the construction and the settlement after 50 years after construction. Use $\gamma = 17$ kN/m^3 above groundwater table and $\gamma = 20$ kN/m^3 below.

Layer #	Depth (m)	q_c (kPa) (Average value)	Elasticity Modulus E_s (kPa)
1	2-3	200	4902
2	3-5	300	7353
3	5-6	410	10049
4	6-7	680	16667
5	7-8	900	22059
6	8-9	580	14216
7	9-12	1080	26471

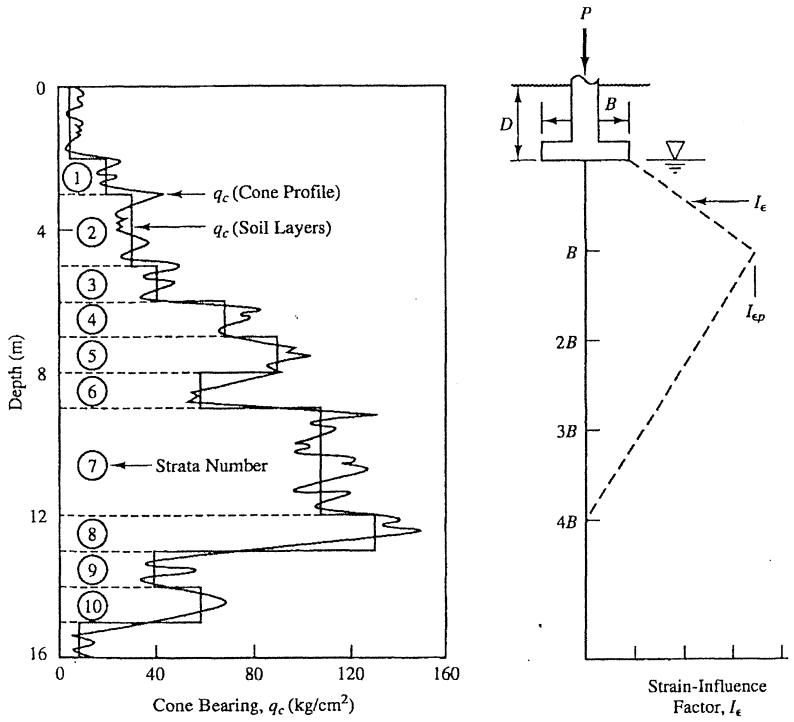

Figure 1

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

The cross section of a cantilever retaining wall is shown in **Figure 2** below. Determine the factors of safety with respect to overturning and bearing capacity. (Density of concrete: 2358 kg/m^3)

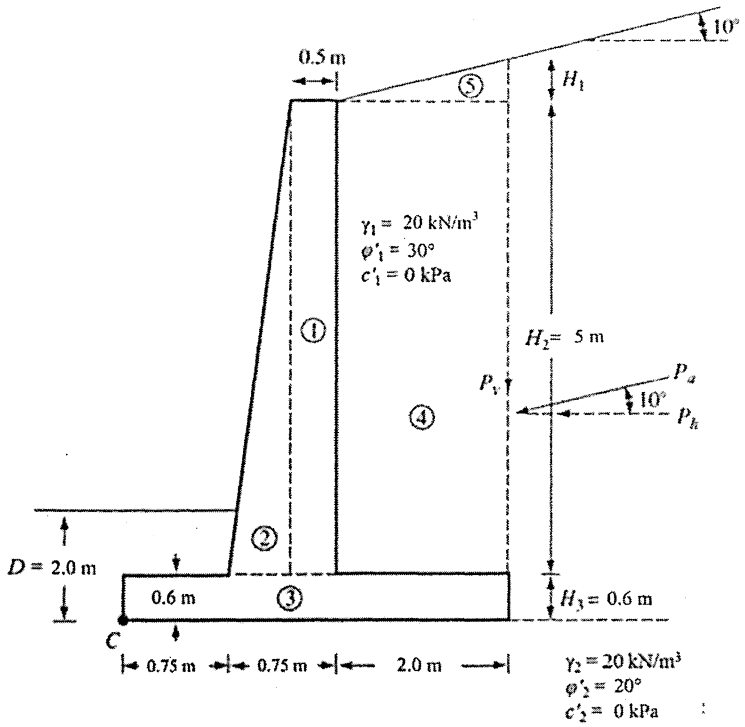

Figure 2

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

A prefabricated concrete pile is driven into a dense sand deposit as shown in **Figure 3**. Determine the ultimate bearing capacity of the pile.

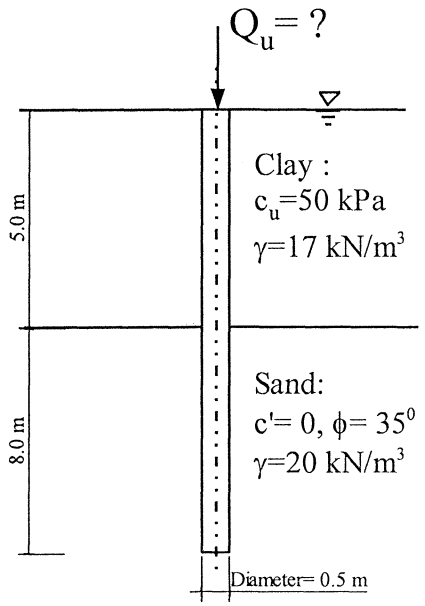

Figure 3.

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

An excavation was carried out in a stiff clay. A thin clayey seam was found when excavation reached a depth of $H = 5$ m, detailed investigation showed that this thin layer with an inclination angle of $\alpha = 30^{\circ}$ has a relative low shear strength compared with the stiff clay, as shown in **Figure 4** below. The thin layer is very likely to be the potential failure surface.

(a) If excavation angle $\beta = 85^{\circ}$ (near vertical) determine the factor of safety against sliding along the thin clayey seam.

(b) Determine the values of β, for which the factor of safety against sliding along the soil–rock interface is equal to 1.3 and 1.5, respectively.

Note: If the thickness of thin seam is neglected, the unit weight of stiff clay is 19.00 kN/m^3, the ground water table is deeper than H.

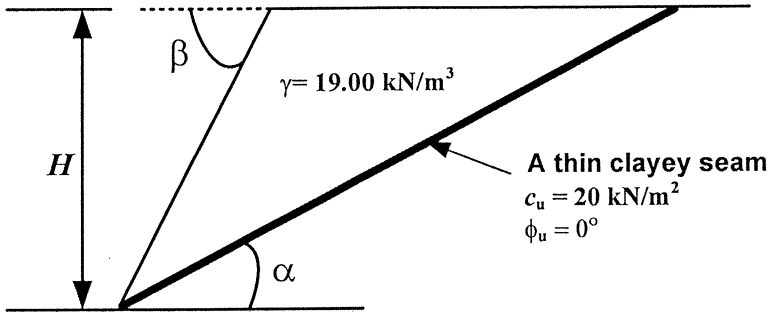

Figure 4.