NATIONAL EXAMINATIONS – May 2010
98-CIV-B3 GEOTECHNICAL DESIGN

PROFESSIONAL ENGINEERS ONTARIO
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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 for Section A and the first three answers submitted for 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:

1	Consolidation settlement of a normally consolidated saturated clayey soil can be approximately estimated from the information of Atterberg limits (i.e., liquid limit and plastic limit) without determining the compression index (C_c).	T	F
2	A fine-grained soil such as clay behaves like a liquid when the water content is greater than its liquid limit value.	T	F
3	The bearing capacity of a 2 m square footing will be greater than that of a 2 m diameter circular footing on the same soil.	T	F
4	It is the settlement which is the governing criterion in the design of foundations rather than the bearing capacity of soils.	T	F
5	Schertmann's method is conventionally used in the determination of the elastic settlement behavior of saturated clays.	T	F
6	For the design of shallow foundations on sand, a weighted averaging has to be made, after correction, of the measured SPT N-values from the zone between the base of the foundation and a depth of twice the width of the foundation with greater weight given to values closer to the base of the foundation.	T	F
7	The most reliable method of determination of the in-situ bearing capacity of sandy type soils is from plate load tests using the same plate dimensions as the actual footing dimensions.	T	F

(Value: 7 marks)

Question 2:

As a consulting engineer you were asked to estimate the settlement of an embankment to be constructed to facilitate transportation of heavy vehicles. The embankment will be on a clay soil deposit that extends to a depth of more than 10 m followed with a sand deposit of high bearing capacity. The length of the embankment is approximately 100 m, the average width is 7 m and the height is 5 m. What is the information required to be collected in the site investigation study. Also, suggest the procedure that you would follow to estimate the settlement of the clay deposit due to the construction of the embankment. **(Value: 7 marks)**

Question 3:

Clearly explain how seepage affects the stability of a homogeneous earth dam constructed with a clayey soil on a sandy deposit of large depth. Detail any two measures you recommend to improve the stability characteristics. Supplement your answer with a neat sketch. **(Value: 7 marks)**

Question 4:
Geosynthetics are being conventionally used in ground improvement techniques. Suggest how geosynthetics can be used in improving the performance of a retaining wall constructed with an impervious backfill material. **(Value: 7 marks)**

Question 5:
A homogeneous clay embankment was constructed with a native clay (i.e., using the same clay available at the site). What are the various tests that you require to determine the long term stability of the embankment? Give reasons why you are recommending these tests to be performed. **(Value: 7 marks)**

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

Question 6: **(Value: 24 marks)**
Determine the consolidation settlement of the footing shown in **Figure 1.** Given that B = 1.5 m, L = 2.5 m, and Q = 120 kN. Provide details of any two other methods that can be used for determining the consolidation settlement for the same problem. What additional data is necessary for the two methods you suggest?

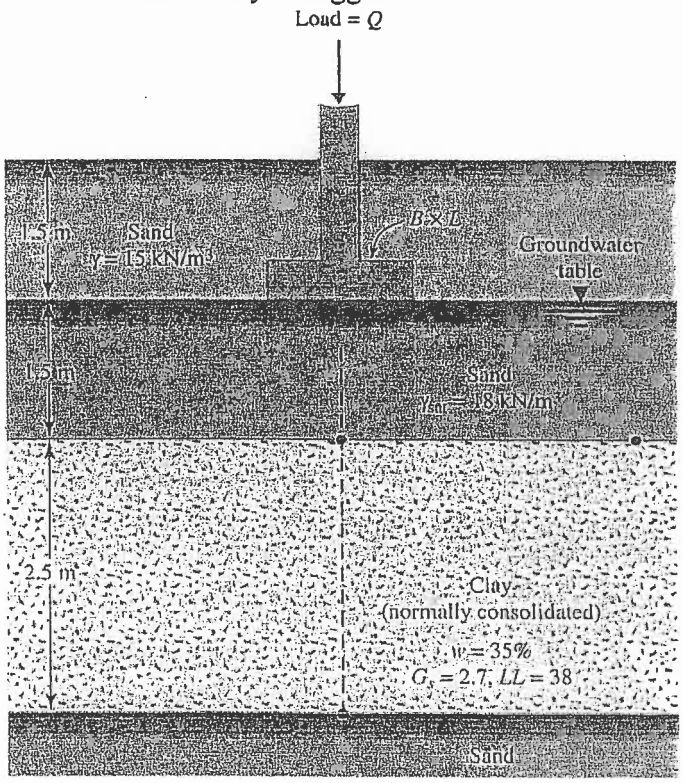

Figure 1

Note: Use $\Delta\sigma'_{av} = \dfrac{\Delta\sigma'_t + 4\sigma'_m + \Delta\sigma'_b}{6}$ for determining the average increase in the clay layer

where: $\Delta\sigma'_t$ = effective stress increase at the top of clay layer

$\Delta\sigma'_m$ = effective stress increase at the middle of clay layer

$\Delta\sigma'_b$ = effective stress increase at bottom of clay layer

Use any suitable method for finding increase in stress $\Delta\sigma'$.

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

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 γ = 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.

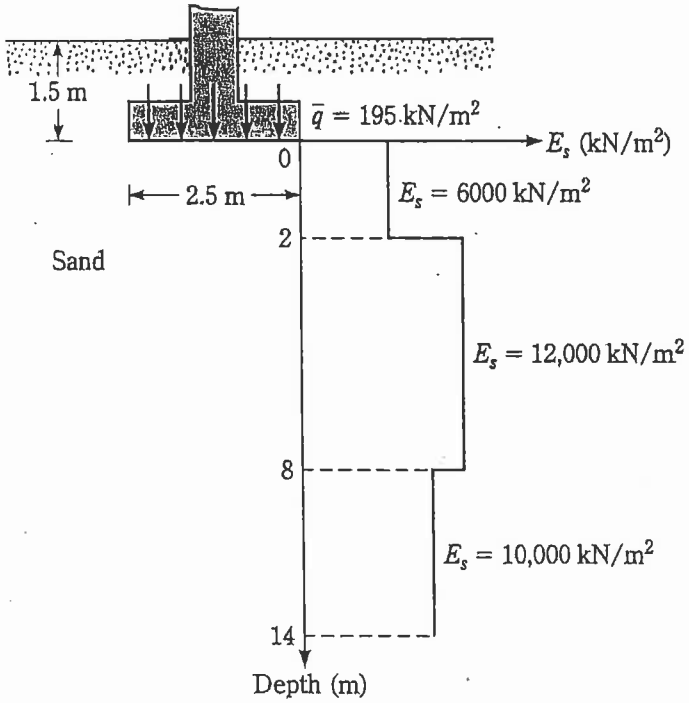

Figure 2

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

Figure 3 illustrates the cross-section of a slope and a potential circular failure surface. The undrained shear strength of the soil is assumed uniform. Calculate the short-term factor of safety corresponding to the failure surface illustrated on the figure.

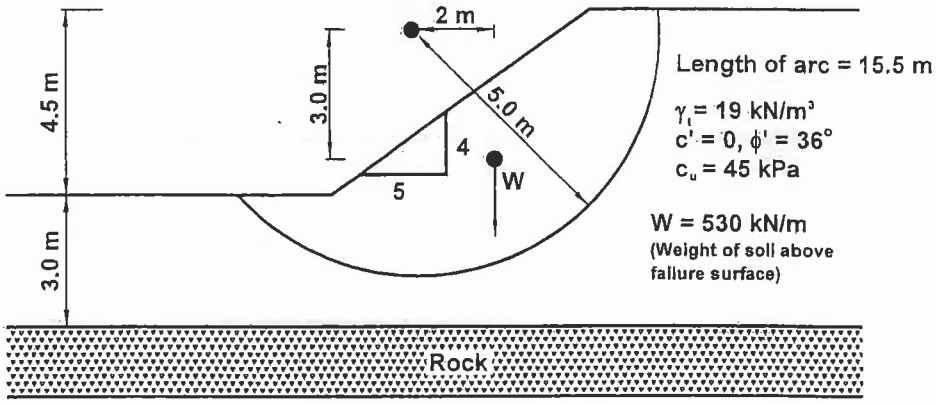

Figure 3

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

Calculate the allowable load that can be applied to a 4 by 5 group of cylindrical wooden piles driven into a loose fine sand with the following properties.

γ_d (dry unit weight) = 20 kN/m^3
G_s (Specific gravity) = 2.7
$\phi' = 30°$

The water table is at the ground surface. The piles are 6m long and have a diameter of 300mm. The spacing (center to center) between the piles is 1.2 m. The contract requires a factor of safety of 2.5 against failure of individual piles based on shaft resistance only.