PROFESSIONAL ENGINEERS ONTARIO
NATIONAL EXAMINATIONS – December 2010
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:

1	Consolidation settlement of a saturated clayey soil can be approximately estimated from the standard penetration tests (SPT) by estimating the swelling index, C_s.	T	F
2	The bearing capacity of a surface plate load test is higher for square footing on a sandy soil in comparison to circular footing of the same area?	T	F
3	The end bearing capacity of a 0.3 m diameter and 10 m length single pile in a uniform clayey deposit with an unconfined compressive strength of 30 kPa is negligible? in comparison to skin or frictional resistance.	T	F
4	Non-uniform settlement behavior poses more problems in comparison to uniform settlement.	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 four times the width of the foundation with uniform weight given to values over the entire depth of the foundation.	T	F
7	In many cases, it is settlement which is the governing parameter in the design of foundation rather than the bearing capacity.	T	F

(Value: 7 marks)

Question 2:
The following is a quote from a Foundation Manual: "In determining the load distribution in a pile extending through layers of weaker soils to a very competent stratum, such as a dense gravel, resistance should be assumed mobilized in this stratum, only". Explain the reasoning behind or the justification for this statement.

(Value: 7 marks)

Question 3:
Discuss the reasons for excavations losing strength with time and embankments gaining strength with time.

(Value: 7 marks)

Question 4:
Geosynthetics are widely used in ground improvement techniques. Suggest how geosynthetics can be used in improving the performance of pavements.

(Value: 7 marks)

Question 5:
What is the rationale for using Standard Penetration Test (SPT) results in the design of foundations in coarse-grained soils? What are the most common recommendations with respect to the use of SPT results in the design of foundations?

(Value: 7 marks)

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

Question 6: **(Value: 24 marks)**
A gravity retaining wall is shown in **Figure 1.** Calculate the factor of safety with respect to overturning. Use Coulomb's active pressure for the calculation and a soil-wall friction angle $\delta = 2/3\phi$.

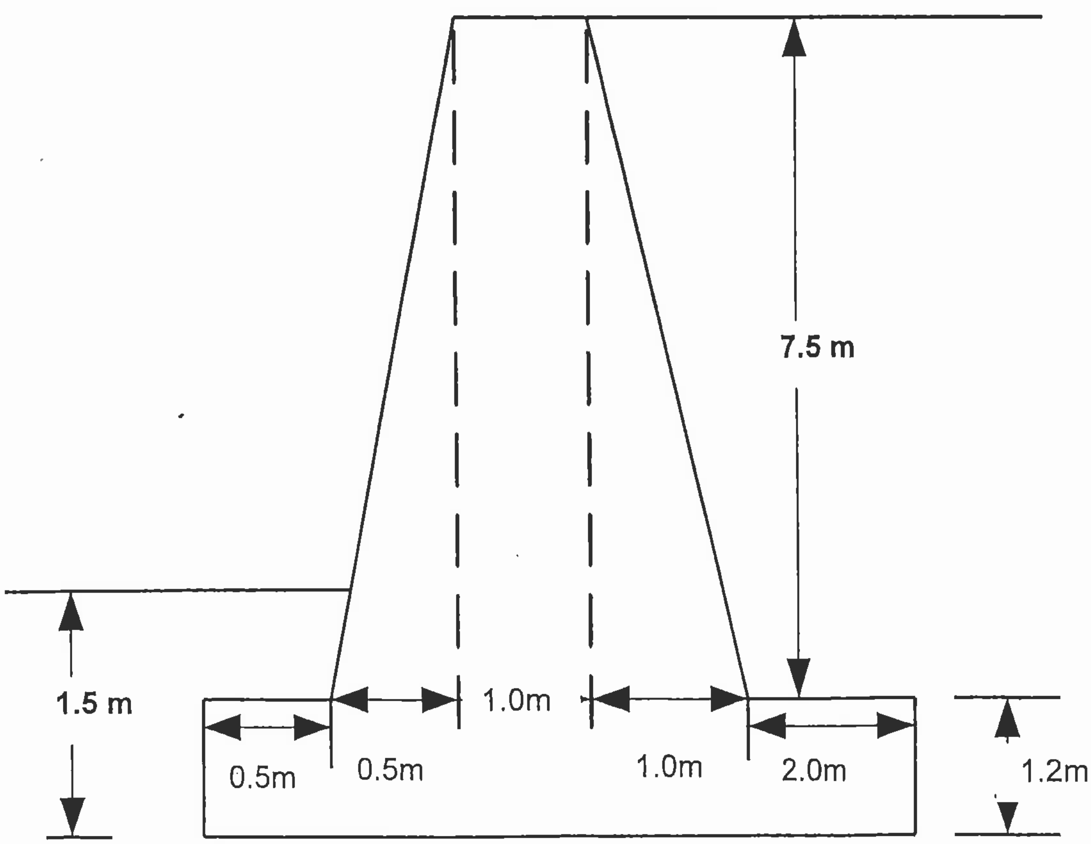

Figure 1

γ = 20 kN/m^3
c' = 0 kPa
ϕ' = 36°

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

Figure 2 below shows an embankment load on a silty clay layer of soil. Determine the stress increase at points A, B, and C, located at depth of 4 m below the ground surface.

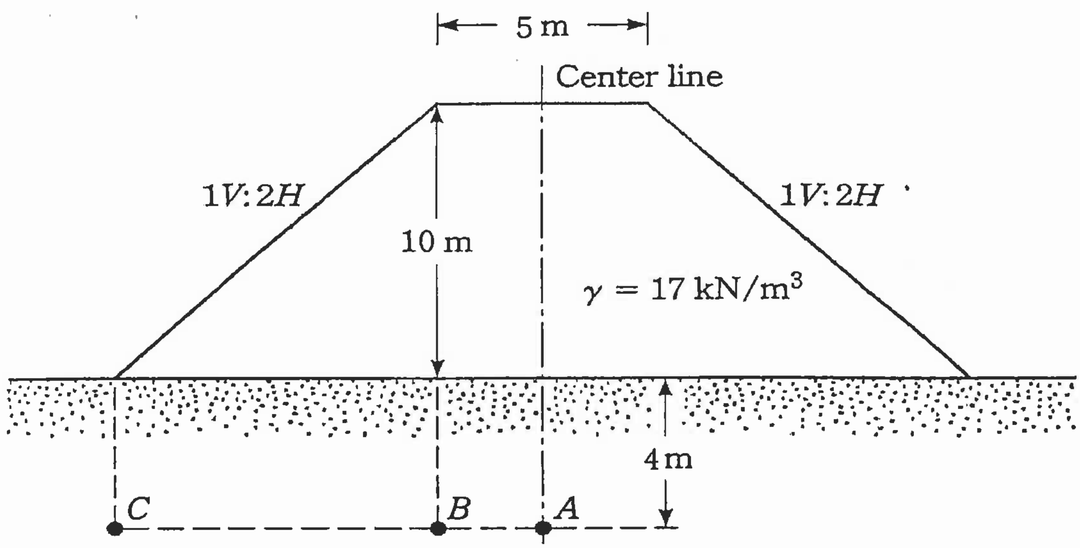

Figure 2

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

A column carries a vertical downward load of 600 kN. This load is proposed to be supported on a 1.5 m deep square footing. The soil which is normally consolidated beneath the footing has the following soil properties: $\gamma = 20$ kN/m^3, c' = 0.5 kPa, $\phi' = 36°$, $c_u = 150$ kPa, $\phi_u = 0$. Sub-surface investigations show that the groundwater table is reasonably stable throughout the year at a depth of 7.0 to 8.0 m below the natural ground surface. Determine the width of the footing for the above specifications such that the short-term factor of safety is equal to 2. **Use Meyerhof's general bearing capacity analysis.**

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

Calculate the ultimate bearing capacity of a square footing of 1.5 m size resting on the surface of a sand stratum, which lies 1.5 m below natural ground level. The footing details along with groundwater table conditions are shown in the Figure below. The 1.5 m depth of soil above the foundation is clay with the following properties: $\gamma_{total} = 17$ kN/m^3, $\gamma_{sat} = 19$ kN/m^3, undrained cohesion, $c_u = 60$ kPa and $\phi_u = 0$. The properties of the sand stratum are $\gamma_{sat} = 20$ kN/m^3, $c' = 2$ kPa and $\phi' = 40$ degrees. Use the general bearing capacity equation. State clearly your assumptions for solving this problem.

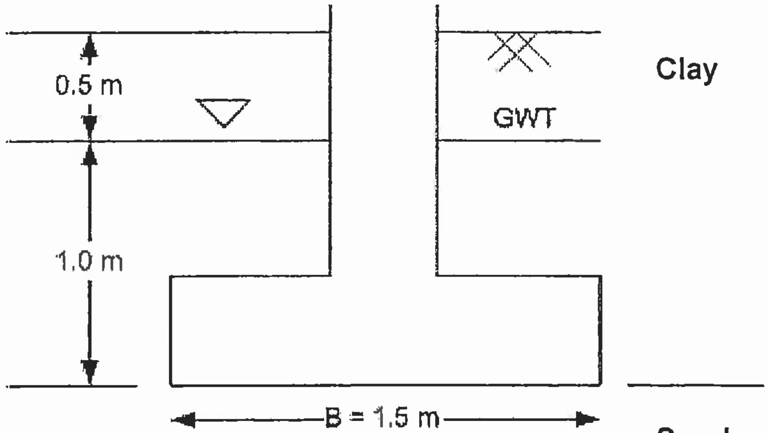

Figure 3