NATIONAL EXAMINATIONS – DECEMBER 2017
16-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:
Shallow foundations such as individual column footings or deep foundation such as pile foundations may be used for a 5 storey five star hotel. Explain in detail when you would recommend shallow or deep foundations providing valid reasons. The key words that should be used for answering this question include, strength and deformation behavior of soils.

(Value: 7 marks)

Question 2:
What are the parameters required for determining the short term stability of a natural slope in soft clay. Provide a summary of how you would proceed with the site investigation and laboratory studies to determine the said stability.

(Value: 7 marks)

Question 3:
What are the limitations of the Terzaghi Bearing Capacity equation compared to the General Bearing Capacity equation?

(Value: 7 marks)

Question 4:
The ultimate bearing capacity obtained from a plate load test is the same as that of a proposed foundation in a saturated clay regardless of size of plate (B_P) and foundation (B_F) [i.e. $(q_{ult})_P = (q_{ult})_F$]. Prove this statement using the Terzaghi bearing capacity equation given below using appropriate bearing capacity factors. State the assumptions that you made to answer this question.

$$qult = CN_c + qN_q + 0.5\gamma BN_\gamma$$

(Value: 7 marks)

Question 5:
When do you prefer to use CPT results in comparison to SPT results in conventional geotechnical engineering practice?

(Value: 7 marks)

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

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

Check the stability of the cantilever wall shown in **Figure 1** against (a) sliding and (b) overturning. Use Rankine's theory.

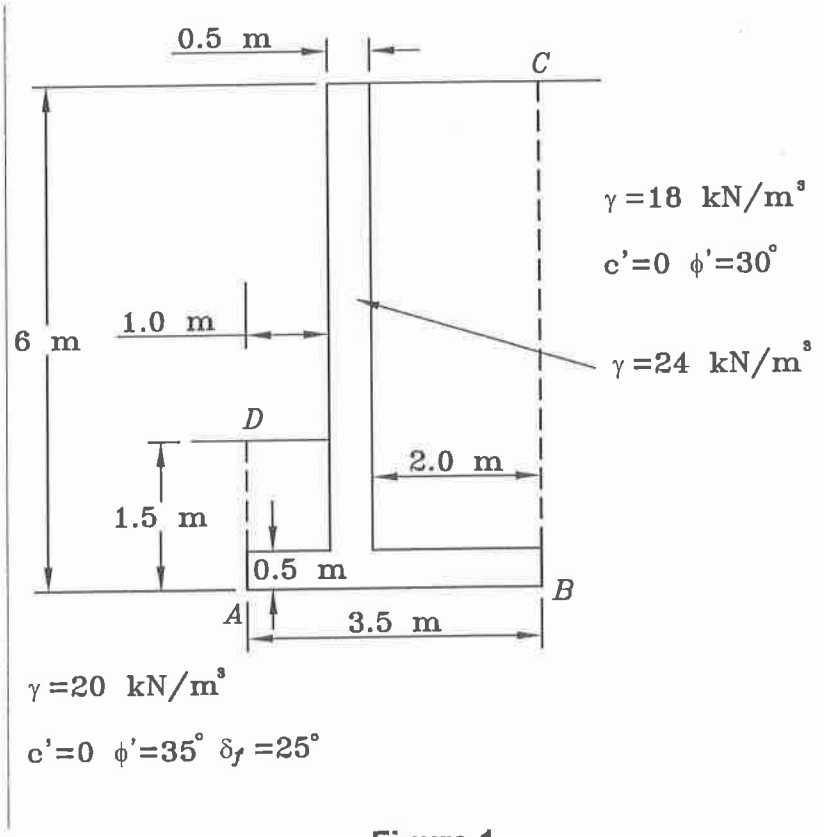

Figure 1

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

Bored cast-in-place concrete piles of 500 mm diameter are proposed to be designed as a pile group to carry a load of 2000 kN in a 12m deep 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	34
2	18.5	44
4	19	55
6	19.5	66
8	20	80
10	20	90
12	20	100

If the piles are 10 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 40%, what will be the approximate settlement in the clay layer due to this loading. **Note: Make any suitable assumptions in solving this problem.**

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

A continuous foundation on a deposit of sand layer is shown in Figure 2 along with the variation of the modulus of elasticity of the soils, E_s with respect to depth. Determine the maximum stress that can be applied at the level of the foundation (i.e. $\bar{q}$) in order for the settlement to be less than 25 mm. Given that time = 10 years for C_2 and the **maximum strain influence factor = 0.5**.

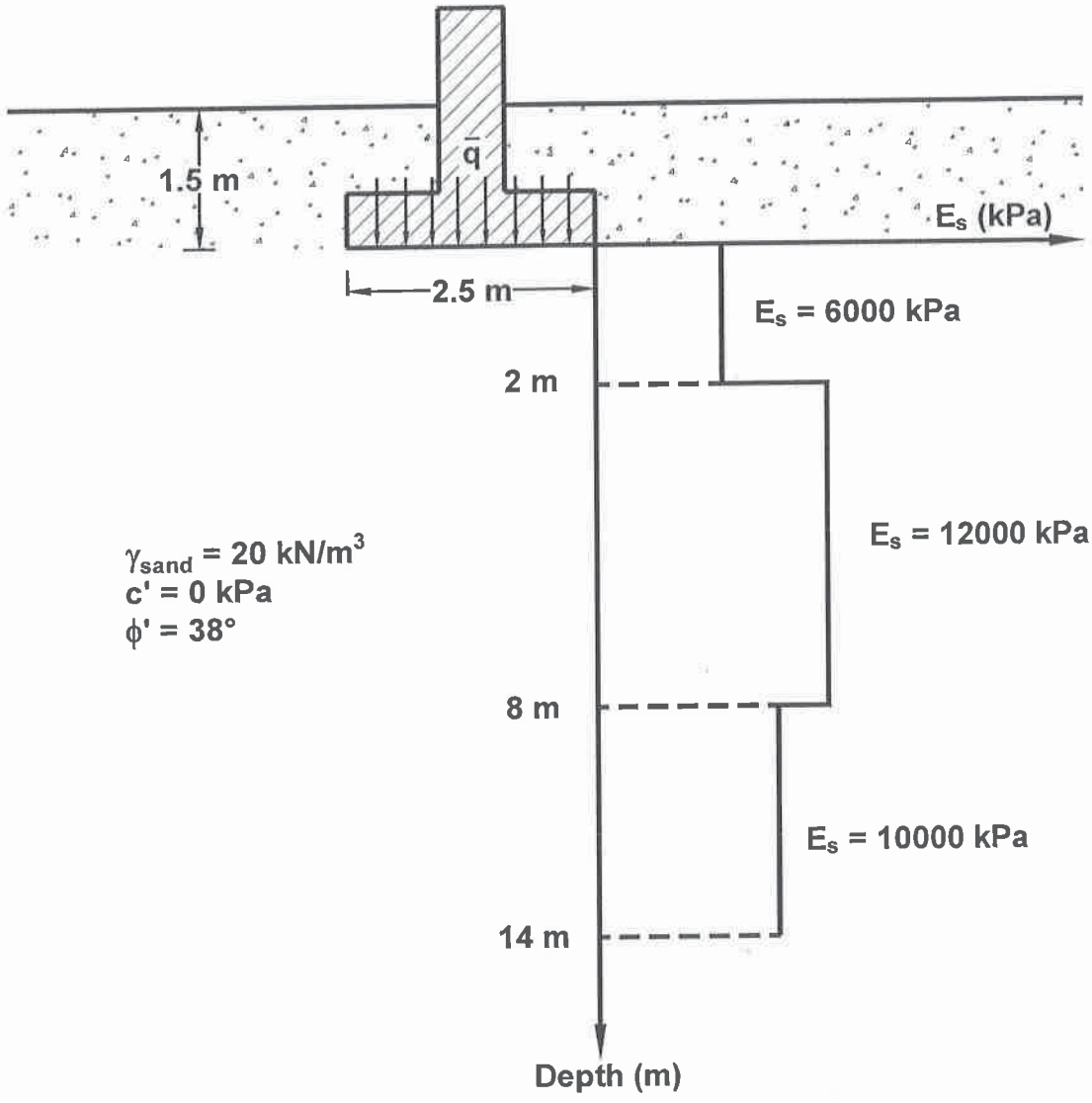

Figure 2

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

In Table 1 given below, the standard penetration test (SPT) results determined in the field for a sandy soil deposit are summarized. The ground water table was found to be located at a depth of 18m. Estimate the angle of internal friction, ϕ' from the provided data using an appropriate technique **(give the source where this information is obtained)** and design a shallow foundation measuring 3.0 x 3.0 m in plan and seated at a depth of 2.5 m. **Note: The design calculations should be based on the ϕ' value obtained, not on methods based on direct correlations of Bearing Capacity to Penetration Index**

Table 1

Depth [m]	Soil Unit Weight [kN/m^3]	N_{60}
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