PROFESSIONAL ENGINEERS ONTARIO
NATIONAL EXAMINATIONS – December 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.

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SECTION A
ANSWER ANY **FOUR** QUESTIONS

Question 1:
The soil profile at a site consists of 5 m of peat overlaying a very deep deposit of glacial till. A multi-story shopping complex is to be constructed on this site. What type of foundation do you recommend under such circumstances? Give reasons.

(Value: 7 marks)

Question 2:
What are the appropriate shear strength parameters to be used in short-term stability analyses of slope in a clayey soil? Give your reasons why these shear strength parameters are recommended. The short-term factor of safety value is typically suggested to be a higher value in comparison to long-term stability; is this statement true or false. Justify your statement providing explanation.

(Value: 7 marks)

Question 3:
"The magnitude of earth pressure depends upon the relative movement of an earth retaining structure". Explain this statement and illustrate with a practical example how active earth pressure is generated.

(Value: 7 marks)

Question 4:
You have been assigned a job as a geotechnical engineer to design shallow foundations for constructing a five star hotel in a clayey soil deposit where punching shear failure is likely expected. How do you proceed with a site investigation plan for this project? What are the key properties that you would like to determine from these investigations?

(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)**

Determine the design axial capacity of the pile shown in **Figure 1**, using a factor of safety of 2. Make reasonable assumptions providing justifications.

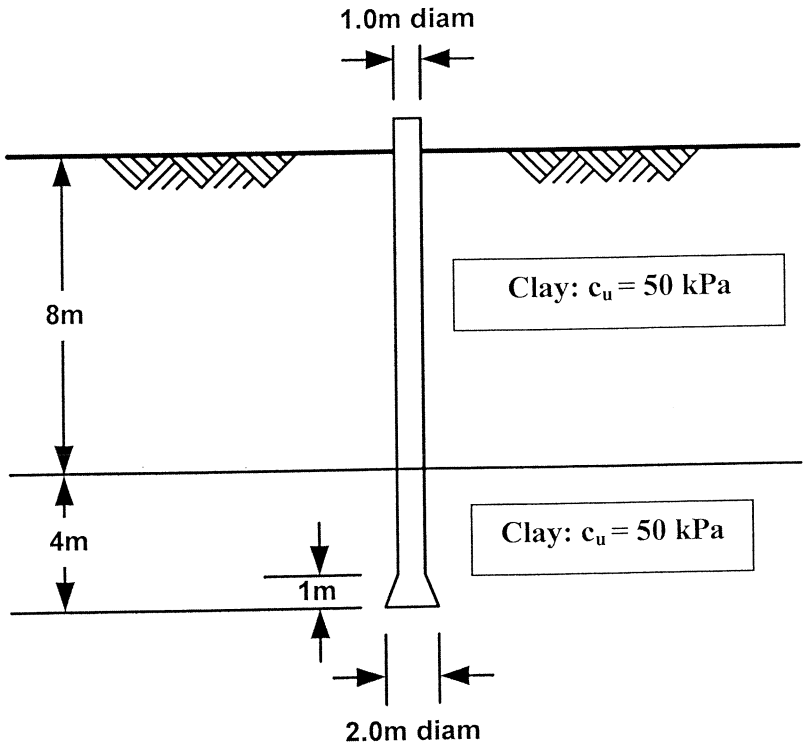

Figure 1

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

In the Table 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 2.0 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 I

Depth [m]	Soil Unit Weight [kN/m^3]	N_f
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)**

An empty bank of a canal has the profile shown below. The canal has been cut into homogeneous saturated clay with a unit weight of 20 kN/m^3. The undrained shear strength of the clay is 40 kN/m^2. For the trial slip circle shown the area of ABCDE is 155 m^2 and G is its centroid. Find the short-term factor of safety for this slip surface if the canal is empty. How would the short-term factor of safety be affected if the water in the canal is level with the top of the bank? **(Note: CD =tension zone depth, shown in Figure 2 below).**

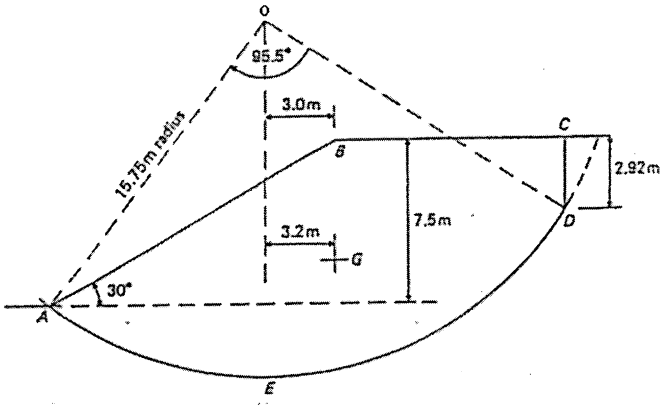

Figure 2

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

The cross section of a cantilever retaining wall is shown in **Figure 3**. Calculate the factors of safety with respect to overturning and sliding. The backfill material used is sand.

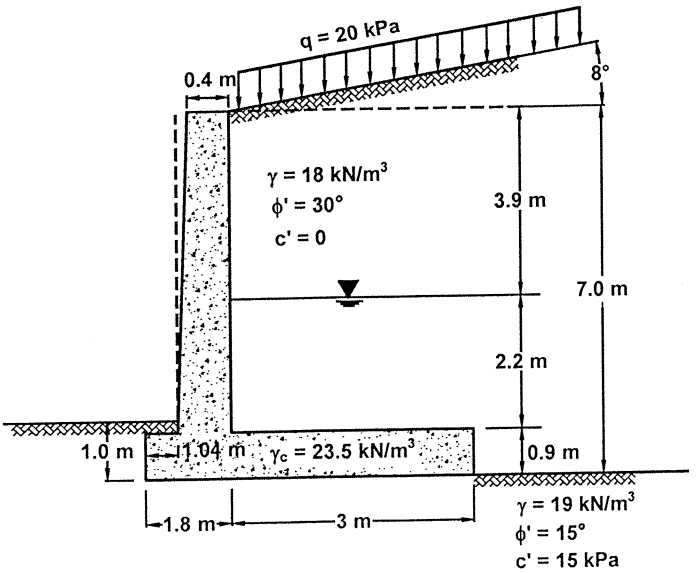

Figure 3