PROFESSIONAL ENGINEERS ONTARIO
NATIONAL EXAMINATIONS – December 2003
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:
What is the rationale of using Standard Penetration Test (SPT) results in the design of foundations in coarse-grained soils? What are the recommendations of the Canadian Foundation Engineering Manual with respect to the use of SPT results in the design of foundations?

(Value: 7 marks)

Question 2:
What is the purpose of the factor α in the calculation of the carrying capacity of an augered cast in place pile? When do you prefer to use the α method in comparison to the β and λ methods?

(Value: 7 marks)

Question 3:
What is the rationale behind the use of undrained shear strength in geotechnical engineering analyses? Give two practical examples where geotechnical designs are based on undrained shear strength values.

(Value: 7 marks)

Question 4:
What are the appropriate shear strength parameters to be used in long-term stability analyses of slopes? What are the commonly recommended values of factor of safety for these analyses? Give your reasons why such factor of safety values are recommended.

(Value: 7 marks)

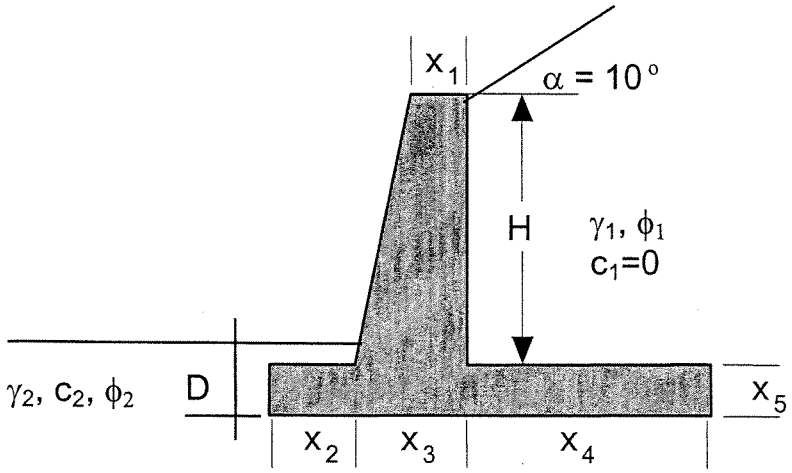
Question 5:
Several methods of ground improvement. Select any two methods and describe the process employed and detail the benefits for geotechnical engineering applications in practice.

(Value: 7 marks)

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

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

For the cantilever retaining wall shown in the Figure below, the wall dimensions are H=10m, x_1=0.5m, x_2=0.75m, x_3=1.5m, x_4=4 m, x_5= 1.2 m , D= 2.0 m, and α=10°; and the soil properties are γ_1=16.8 kN/m^3, ϕ_1=34°, γ_2=17.6 kN/m^3, ϕ_2=30 °, and c_2=10 kN/m^2. Calculate the factors of safety with respect to overturning and sliding.



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

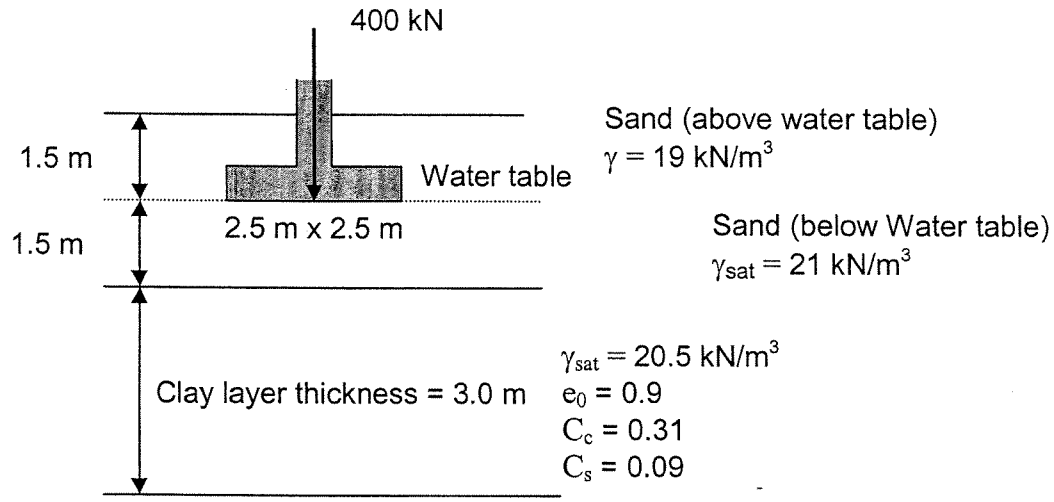
In the Table given below, the standard penetration test (SPT) results determined for a sandy soil deposit in the field are summarized. The ground water table was found to be located at a depth of 18m. Estimate the angle of internal friction, ϕ' from the provided data using an appropriate technique (give the source where this information is obtained) and design a shallow foundation measuring 2.5 x 2.5 m in plan. **Note: The design should be based on angle of internal friction, ϕ' value.**

Table I

Depth [m]	Soil Unit Weight [kN/m^3]	N_f
3	18.5	6
5	18.5	10
6	18.5	12
8	20.4	15
10	20.4	20
12	20.4	24
13.5	20.4	25
15	20.4	26

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

A square column foundation is shown in the Figure below. Determine the average increase of stress in the clay layer below the center of the foundation using the 2:1 method and estimate the average consolidation settlement of the clay layer.



Question 9: **Value: 24 marks**

An empty bank of a canal has the soil profile as 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 30 kN/m^2. For the trial slip circle shown the area of ABCDE is 155 m^2 and G is its centeroid. Determine the factor of safety for this slip surface if the canal is empty. Also, determine the factor of safety if the water in the canal is level with the top of the bank? *(Note: CD =tension zone depth, shown in Figure below).* Suggest two basic approaches that are commonly recommended for stabilization assuming that the slope is in imminent danger of failing.